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35 45 02.00 10	05/21, CHG 1: 08/23	SUBMERSIBLE PUMP, AXIAL-FLOW AND MIXED-FLOW TYPE
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41 22 13.15	11/22, CHG 1: 02/23	BRIDGE CRANES, OVERHEAD ELECTRIC, UNDER RUNNING TROLLEY
41 22 13.16	04/08, CHG 1: 02/20	GANTRY CRANES
41 22 13.33	05/10	PORTAL CRANE TRACK INSTALLATION
41 22 13.55	02/22, CHG 3: 02/23	BRIDGE CRANES, UNDER RUNNING, AIRCRAFT HANGAR
41 22 23.19	05/20	MONORAIL HOISTS
41 36 30.00 10	01/08	ULTRASONIC INSPECTION OF PLATES
41 65 10.00 10	05/09	[DIESEL][NATURAL GAS] FUELED ENGINE PUMP DRIVES

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43 15 00.00 20	04/06	LOW PRESSURE COMPRESSED AIR PIPING (NON-BREATHING AIR TYPE)
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USACE / NAVFAC / AFCEC **00 01 15 (February 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-00 01 15 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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USACE / NAVFAC / AFCEC **00 01 15 (February 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-00 01 15 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

****

DOCUMENT 00 01 15

LIST OF DRAWINGS
02/24

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NOTE: This guide specification covers the requirements for list of drawings for the project.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 SUMMARY

This section lists the drawings for the project pursuant to contract clause "DFARS 252.236-7001, Contract Drawings and Specifications."

1.2 CONTRACT DRAWINGS

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NOTE: Use revision column only if drawings show a revision date. NAVFAC projects must list the 7-digit NAVFAC drawing number in the third column.

****

Contract drawings are as follows:

DRAWING NO.	[REVISION NO.]	NAVFAC DWG NO.	TITLE
[_____]	[_____]	[_____]	[_____]

[1.3 SUPPLEMENTARY DRAWINGS

These supplementary drawings may not be a part of the contract but are included with the drawings for information.

[1.3.1 Reference Drawing[s]

****

NOTE: Use only when reference drawings must be included in the project.

****

The following reference drawing[s] [is][are] intended only to show the original construction. Drawing[s] [is][are] the property of the Government and shall not be used for any purpose other than that intended by the contract.[The drawing[s] [is][are] [half-][full-]size. Full-size drawings are available at the bidder's or Contractor's expense.[Information on procuring these full-size drawings may be obtained from the Contracting Officer.][Full size drawings may be inspected during regular working hours at[the office of the Contracting Officer.][the station.]]

NAVFAC DWG NO.	TITLE
[_____]	[_____]

]][1.3.2 Boring Logs

****

NOTE: Select this paragraph BORING LOGS or paragraph SUBSURFACE DATA if the boring logs and subsurface information are not already incorporated in the drawings. Use the first paragraph if boring logs are available and the second if they are incorporated into a soils report or if only a soils report is available.

****

The Government does not guarantee that borings indicate actual conditions, except for the exact locations and the time that they were made.[Subsurface data, not specified or indicated, have been obtained by the Government at this station. The data are available for examination by prospective bidders[in the office of the Contracting Officer][at the station].]

][1.3.3 Subsurface Data

Subsurface data, not specified or indicated, have been obtained by the Government at the station. The data are available for examination by prospective bidders[in the office of the Contracting Officer][at the station].[The soils report is included as part of the solicitation.]

]] -- End of Document --

****

USACE / NAVFAC / AFCEC **UFGS-01 11 00 (February 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 11 00 (August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 11 00

SUMMARY OF WORK

02/24

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-01 11 00 (February 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 11 00 (August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 11 00

SUMMARY OF WORK

02/24

****

NOTE: This guide specification covers the requirements for a description of work covered in this contract and is required for use in all projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: This section contains tailoring options for NAVFAC PAC and NAVY.

****

PART 1 GENERAL

1.1 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: For projects in the NAVFAC PAC Area of Operation, in SD-01 Preconstruction Submittals, remove the "G" designation for Salvage Plan.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Salvage Plan; G, [_____]

1.2 WORK COVERED BY CONTRACT DOCUMENTS

1.2.1 Project Description

****

NOTE: Describe the project (such as facility to be constructed and square footage, building shell construction, foundation) and the types of work involved in sufficient detail so as to present a general picture which is self contained but does not refer to the drawings or to other parts of the specification. Mention peculiar or hazardous work, and monitoring of archaeological resources.

****

The work includes [_____] and incidental related work.

1.2.2 Location

****

NOTE: Provide the station name and geographic location in the blank provided.

****

The work is located at the [_____], approximately as indicated. The exact location will be shown by the Contracting Officer.

1.3 OCCUPANCY OF PREMISES

****

NOTE: Use this paragraph if building is occupied during construction.

****

Building(s) will be occupied during performance of work under this Contract.[Occupancy notifications will be posted in a prominent location in the work area.]

Before work is started, arrange with the Contracting Officer a sequence of procedure, means of access, space for storage of materials and equipment, and use of approaches, corridors, and stairways.

[1.4 EXISTING WORK

Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.

Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Contracting Officer. At the completion of operations, existing work must be in a condition equal to or better than that which existed before new work started.

]1.5 LOCATION OF UNDERGROUND UTILITIES

****

NOTE: Check with Installation on if the Contractor or the Base marks the utilities. Use and edit the bracketed item in first paragraph if Contractor is responsible for location and marking of utilities.

****

Obtain digging permits prior to start of excavation, and comply with Installation requirements for locating and marking underground utilities.[Contact local utility locating service a minimum of [48 hours][_____] prior to excavating, to mark utilities, and within sufficient time required if work occurs on a Monday or after a Holiday.] Verify existing utility locations indicated on contract drawings, within area of work.

[Identify and mark all other utilities not managed and located by the local utility companies. Scan the construction site with Ground Penetrating Radar (GPR), electromagnetic, or sonic equipment, and mark the surface of the ground[, pier deck] or paved surface where existing underground utilities [or utilities encased in pier structures]are discovered. Verify the elevations of existing piping, utilities,and any type of underground [or encased]obstruction not indicated, or specified to be removed, that is indicated or discovered during scanning, in locations to be traversed by piping, ducts, and other work to be conducted or installed. Verify elevations before installing new work closer than nearest manhole or other structure at which an adjustment in grade can be made.

]1.5.1 Notification Prior to Excavation

****

NOTE: Check with the Installation to choose the bracketed item for number of days notification required.

****

Notify the Contracting Officer at least [48 hours][15 days][_____] prior to starting excavation work.

[1.6 GOVERNMENT-FURNISHED MATERIAL AND EQUIPMENT

****

NOTE: Include this paragraph only when the Contractor will be required to install Government-Furnished Materials and Equipment or provide utilities for same. Obtain information to identify the items from the Government.

****

****

NOTE: There are situations in which equipment installation data or templates would allow the Contractor to prepare rough-in and proceed with construction prior to taking delivery of Government-furnished equipment. This paragraph may be expanded to include scheduling delivery of installation data or templates as well as the equipment itself, if the data can be made available more quickly than the Government-furnished equipment and if advanced delivery would be helpful to the Government. Obtain listing of material from the activity providing it.

****

The Government will furnish the following materials and equipment for installation by the Contractor:

****

NOTE: Provide complete description and quantities for Government-furnished and Contractor-installed material and equipment. Identify manufacturer, make, model and operating characteristics. Avoid generic descriptions especially for equipment requiring utilities such as water service, drains, natural gas, steam, or electricity. This information should be made available by the activity furnishing the material or equipment to be installed through the Government. When a utility is required to serve the Government-furnished item, ensure that the appropriate Section for the utility needed is included in the project specification.

****

****

NOTE: Do not list salvage property to be removed and reused in the general work area; indicate such material on the drawings..

****

DESIGNATION NO.	DESCRIPTION	QUANTITY
[_____]	[_____]	[_____]

****

NOTE: Use this paragraph as applicable for quantities.

****

Quantities indicated for the above-listed items marked with an asterisk are estimates. It is the intention of the Government to furnish all quantities of the asterisk items required to complete the work as specified, and the various quantities will be adjusted when necessary. Quantities stated for the above items not marked with an asterisk are all that will be furnished by the Government. Provide any additional quantities that are required.

1.6.1 Delivery Schedule

****

NOTE: Choose the version of this paragraph which best satisfies the project conditions. The first alternative is best suited for projects requiring careful scheduling of Government-furnished equipment. Establish the number of calendar days required for notification or that have elapsed before availability after considering (1) a reasonable time between the Contract Award and the first need for Government-furnished equipment and (2) the lead time required for Government procurement. Set the storage rate at the commercial rate in the area of storage.

****

[Notify the Contracting Officer in writing at least [_____] calendar days in advance of the date on which the materials and equipment are required. Pick up materials and equipment no later than 30 calendar days after such date. When materials and equipment are not picked up by the 30th day, the Contractor will be charged for storage at the rate of [_____] per [45 kg][3 cubic meters] 100 [pounds][cubic feet] per month or fraction thereof.

][Materials and equipment will be available on or after [_____] calendar days after the award of contract.

]1.6.2 Delivery Location

The materials and equipment[are located at [_____]] [are located within [_____] miles of the jobsite] [will be delivered to [_____]][the salvage receiving point [_____]].

][1.7 GOVERNMENT-INSTALLED WORK

****

NOTE: Include this paragraph if the Government is to install equipment or perform other work at the job site, excluding inspection and testing. Define the extent and type of Government work that may impact the operations of the Contractor.

****

[_____].

]1.8 NAVY AND MARINE CORPS INTRANET (NMCI) COORDINATION REQUIREMENTS

****

NOTE: Use this paragraph for Navy projects only. In addition to the EIA/TIA standards for telecommunications, the architectural, structural, mechanical, plumbing, electrical and fire protection designs must comply with the requirements in the latest version of UFC 3-580-01, Telecommunications Interior Infrastructure Planning and Design.

****

1.8.1 NMCI Contractor Access

Allow the NMCI Contractor access to the facility towards the end of construction (finishes 90 percent complete, rough-in 100 percent complete, Inside Plant (ISP)/Outside Plant (OSP) infrastructure in place) to provide equipment in the telecommunications rooms and make final connections. Coordinate efforts with the NMCI Contractor to facilitate joint use of building spaces during the final phases of construction. After the Contracting Officer has facilitated coordination meetings between the two contractors, within one week, incorporate the effort of additional coordination with the NMCI Contractor into the construction schedule to demonstrate a plan for maintaining the contract duration.

1.9 SALVAGE MATERIAL AND EQUIPMENT

Items designated by the Contracting Officer to be salvaged remain the property of the Government. Segregate, itemize, deliver and off-load the salvaged property at the [Government designated] storage area located within [_____] kilometers miles of the construction site.

Provide a salvage plan, listing material and equipment to be salvaged, and their storage location. Maintain property control records for material or equipment designated as salvage. Provide a system for property control in the salvage plan. Store and protect salvaged materials and equipment until disposition by the Contracting Officer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 14 00 (November 2022)**
Change 4 - 02/25

Preparing Activity: NAVFAC **Superseding**
UFGS-01 14 00 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 14 00

WORK RESTRICTIONS

11/22, CHG 4: 02/25

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-01 14 00 (November 2022)**
Change 4 - 02/25

Preparing Activity: NAVFAC **Superseding**
UFGS-01 14 00 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 14 00

WORK RESTRICTIONS

11/22, CHG 4: 02/25

****

NOTE: This guide specification covers the requirements for work and site restrictions.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

This guide specification includes a variety of tailoring options for ease of initially editing the section. Selection or deselection of a tailoring option will include or exclude that option in the section but editing the resulting section to fit the project is still required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in

this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

FLORIDA ADMINISTRATIVE CODE (FAC)

FAC Chapter 15C-1	Department of Highway Safety and Motor Vehicles

INSTRUCTIONS AND STANDARDS FOR NAVBASE GUANTANAMO BAY CUBA (COMNAVBASEGTMOINST)

11300.3	Base Energy Conservation Regulations

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 101	(2024) Life Safety Code

NAVAL FACILITIES ENGINEERING AND EXPEDITIONARY WARFARE CENTER (NAVFAC EXWC)

NFESC UG-2029-ENV	(1998) Cross-Connection Control and Backflow Prevention Program Implementation at Shore Facilities, User's Guide

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. Code (USC)

8 USC 1101	Definitions
10 USC 6011	Navy Regulations

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

24 CFR 3280	(2019) Manufactured Home Construction and Safety Standards

[1.2 DEFINITIONS

****

NOTE: This paragraph is tailored for NAVFAC MARIANAS.

****

1.2.1 State

"State" when used in reference to states of the United States also includes the Territory of Guam.

][1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: The items in this Submittals Article contain tailoring for NAVFAC FE, NAVFAC MARIANAS, NAVFAC, SW, and NAVFAC SE. If the project is not at any of these locations, and no additional submittals are added, delete this Submittals Article altogether.

****

****

NOTE: For Navy Design-Build projects, delete 01 33 00 SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Meal Signature Record Book (MSRB)

Dining And Lodging Requirements

Housing Plan

Medical Plan

Contractor Regulations

Transportation of Personnel, Materials, and Equipment

Purchase Orders

List of Contact Personnel

Personnel List

Entry Approval for Employees; G, [_____]

SD-07 Certificates

****

NOTE: For Army and Army National Guard projects, require 3Rs Explosive Safety Education Training Certificate to be submitted annually.

****

3Rs Explosive Safety Education Training Certificate (annual submission required)

[Proof of IMD Ordnance Work Authorization; G, [_____]

]][1.4 SPECIAL SCHEDULING REQUIREMENTS

****

NOTE: If there are special requirements, use those portions of the following paragraph which apply to the project.

****

a. [_____] must be ready for operation as approved by Contracting Officer before work is started on [_____] which would interfere with normal operation.

b. Have materials, equipment, and personnel required to perform the work at the site prior to the commencement of the work. Specific items of work to which this requirement applies include:

(1) [_____]

(2) [_____]

c. The [_____] will remain in operation during the entire construction period. Conduct operations so as to cause the least possible interference with normal operations of the activity.

****

NOTE: Use 30 calendar days in bracket below for NBK Bangor, WA.

****

d. Permission to interrupt any Activity roads, railroads, or utility service must be requested in writing a minimum of [15] [_____] calendar days prior to the desired date of interruption.

[e. The work under this contract requires special attention to the scheduling and conduct of the work in connection with existing operations. Identify on the construction schedule each factor which constitutes a potential interruption to operations.

(1) The following conditions apply:

(2) [_____]

(3) [_____]

] **

NOTE: Use this paragraph on all projects involving potential conflicts with operating conditions other than utilities or where the work must be pursued in a particular sequence. Clearly detail the permissible extent of sequencing or duration of interruptions to station operation. Obtain information from the Government.

****

[f. Restricted Access Areas. The Government will monitor work in areas[listed below][indicated]. Notify Contracting Officer at least 14 calendar days prior to starting work in these areas.

(1) [_____]

]]1.5 CONTRACTOR ACCESS AND USE OF PREMISES

1.5.1 Activity Regulations

****

NOTE: Include the first bracketed sentence for projects at MCBH Kaneohe Bay. The two bracketed sentences are tailored for use at NAVFAC Hawaii.

****

Ensure that Contractor personnel employed on the Activity become familiar with and obey Activity regulations including safety, fire, traffic and security regulations. Keep within the limits of the work and avenues of ingress and egress.[Ingress and egress of Contractor vehicles at the Activity is limited to the H-3 gate.][To minimize traffic congestion, delivery of materials must be outside of peak traffic hours (6:30 to 8:00 a.m. and 3:30 to 5:00 p.m.) unless otherwise approved by the Contracting Officer.] Wear appropriate personal protective equipment (PPE) in designated areas. Do not enter any restricted areas unless required to do so and until cleared for such entry. Ensure all Contractor equipment, include delivery vehicles, are clearly identified with their company name.

1.5.1.1 Subcontractors and Personnel Contacts

Provide a list of contact personnel of the Contractor and subcontractors including addresses and telephone numbers for use in the event of an emergency. As changes occur and additional information becomes available, correct and change the information contained in previous lists.

[1.5.1.2 Additional Personnel Requirements

****

NOTE: Include the following for projects that have a Sensitive Compartmented Information Facilities (SCIF) or Special Access Program Facilities (SAPF). For SCIF and SAPF, coordinate personnel requirements with the Site Security Manager and the Construction Security Plan. These requirements apply to the SCIF or SAPF and not the entire facility unless the entire facility is the SCIF or SAPF.

****

****

NOTE: This paragraph is tailored for Navy use only.
****

****
NOTE: Include this paragraph for projects within the U.S. and its territories. Include Sitework, utilities, foundations, structure when the entire facility is a SCIF or SAPF.
****

[1.5.1.2.1 General Construction and Finish Work

****
NOTE: U.S. citizens or U.S. persons should be the default for projects within the U.S. and its territories.
****

General construction and finish work of the [secure area][controlled area][_____] must be performed by U.S. firms using U.S. citizens[or U.S. persons]. General construction includes construction activities such as [building sitework, utilities, foundations, structure, and]enclosure or shell, including doors, windows and façade work. Finish Work includes construction activities such as insulation, floor, partition, and ceiling systems; cabinet work; conveyor systems; specialties; building furnishings, fixtures, and equipment; and mechanical and electrical services and equipment including those specialized for fire protection, security, communication, control, energy conservation, safety, comfort, convenience, and similar purposes.

] **
NOTE: Include the following paragraphs for projects outside the U.S. and its territories. Include Sitework, utilities, foundations, structure when the entire facility is a SCIF or SAPF. Refer to the Construction Security Plan to determine whether U.S. SECRET or TOP SECRET-cleared workers are required for finish work.
****

[1.5.1.2.2 General Construction

General construction of the [secure area][controlled area][_____] must be performed by U.S. firms using U.S. citizens. General construction includes construction activities such as [building sitework, utilities, foundations, structure, and]enclosure or shell, including doors, windows and façade work. Utility work that penetrates the [secure area][controlled area][_____] and installation of doors in these areas are not general construction.

][1.5.1.2.3 Finish Work

Finish Work within the [secure area][controlled area][_____] must be accomplished by [U.S. SECRET-cleared][U.S. TOP SECRET-cleared] personnel. Finish Work includes construction activities such as insulation, floor, partition, and ceiling systems; cabinet work; conveyor systems; specialties; building furnishings, fixtures, equipment; and mechanical and electrical services and equipment including those specialized for fire protection, security, communication, control, energy conservation, safety, comfort, convenience, and similar purposes.

][1.5.1.2.4 Electronic Security Systems Equipment

****

NOTE: For projects that include Electronic Security Systems for the protection of areas such as Secure Rooms (Secret or Top Secret Open Storage), Sensitive Compartmented Information Facilities (SCIF) or Special Access Program Facilities (SAPF) include the following personnel requirements.

1. For Secure Rooms (Secret or Top Secret Open Storage) select the first bracketed option.

2. For SCIF and SAPF within the U.S., its possessions or territories, select the second bracketed option.

3. For SCIF and SAPF outside the U.S., its possessions or territories, choose the third or fourth bracketed option.

****

Electronic Security Systems equipment such as processing control units, workstations, field panels, sensors, high security locks, card readers, cable installation, and system programming, testing and training must be performed by [U.S. citizens who have been subjected to a trustworthiness determination] [U.S. companies using U.S. citizens who have been subjected to a trustworthiness determination] [[U.S. companies using U.S. TOP SECRET-cleared personnel] [U.S. companies using U.S. SECRET-cleared personnel]].

]]1.5.1.3 Installation Access

****

NOTE: Use this paragraph for Navy and Marine Corps installations, with the exception of overseas locations that do not employ the Defense Biometric Identification System (DBIDS). Confirm with installation security office and tailor DBIDS project requirements to local policy. This paragraph is tailored for Navy.

****

Obtain access to Navy installations through participation in the Defense Biometrics Identification System (DBIDS). Requirements for Contractor employee registration, and transition for employees currently under Navy Commercial Access Control System (NCACS), are available at https://www.cnic.navy.mil/Operations-and-Management/Base-Support/DBIDS/. No fees are associated with obtaining a DBIDS credential.

Participation in the DBIDS is not mandatory, and Contractor personnel may apply for One-Day Passes at the Base Visitor Control Office to access an installation.

1.5.1.3.1 Registration for DBIDS

Registration for DBIDS is available at

https://www.cnic.navy.mil/Operations-and-Management/Base-Support/DBIDS/. Procedure includes:

a. Present a letter or official award document (i.e. DD Form 1155 or SF 1442) from the Contracting Officer, that provides the purpose for access, to the base Visitor Control Center representative.

b. Present valid identification, such as a passport or Real ID Act-compliant state driver's license.

c. Provide completed SECNAV FORM 5512/1 to the base Visitor Control Center representative to obtain a background check. This form is available for download at https://www.cnic.navy.mil/Operations-and-Management/Base-Support/DBIDS/.

d. Upon successful completion of the background check, the Government will complete the DBIDS enrollment process, which includes Contractor employee photo, fingerprints, base restriction and several other assessments.

e. Upon successful completion of the enrollment process, the Contractor employee will be issued a DBIDS credential, and will be allowed to proceed to worksite.

1.5.1.3.2 DBIDS Eligibility Requirements

Throughout the length of the contract, the Contractor employee must continue to meet background screen standards. Periodic background screenings are conducted to verify continued DBIDS participation and installation access privileges. DBIDS access privileges will be immediately suspended or revoked if at any time a Contractor employee becomes ineligible.

An adjudication process may be initiated when a background screen failure results in disqualification from participation in the DBIDS, and Contractor employee does not agree with the reason for disqualification. The Government is the final authority.

1.5.1.3.3 DBIDS Notification Requirements

a. Immediately report instances of lost or stolen badges to the Contracting Officer.

b. Immediately collect DBIDS credentials and notify the Contracting Officer in writing under the following circumstances:

    (1) An employee has departed the company without having properly returned or surrendered their DBIDS credentials.

    (2) There is a reasonable basis to conclude that an employee, or former employee, might pose a risk, compromise, or threat to the safety or security of the Installation or anyone therein.

1.5.1.3.4 One-Day Passes

****

NOTE: This subpart is not applicable at NS Guantanamo Bay and should be deleted.

****

Personnel applying for One-Day passes at the Base Visitor Control Office are subject to daily mandatory vehicle inspection, and will have limited access to the installation. The Government is not responsible for any cost or lost time associated with obtaining daily passes or added vehicle inspections incurred by non-participants in the DBIDS.

[1.5.1.4 Additional Badge Requirements - NAS Patuxent River

****

NOTE: Use the following paragraph for projects at the Naval Air Station, Patuxent River, MD. This paragraph is tailored for NAVFAC WASH.

****

Identification badges will be issued to the Contractor and his employees in accordance with the Naval Air Station Security Regulations. A copy of the security regulations may be obtained from the security office. All badges must be returned or accounted for to the department of Public Safety's Pass and Identification Office upon expiration of the badge or contract, or termination of the employee.

][1.5.1.5 Employee List

****

NOTE: Include this paragraph for projects at Naval Air Station, Patuxent River , Maryland. This paragraph is tailored for NAVFAC WASH.

****

****

NOTE:

****

Provide to the Contracting officer, in writing, the names of two designated representatives authorized to request personnel and vehicle passes for employees and subcontractor's employees prior to commencement of work under this contract. Adhere to the requirements of "Important Clarifications - Contractors - How to Gain Access," dated 31 October 1995, in obtaining access to the Naval Air Station complex for the life of the contract. A copy of these requirements will be provided at the preconstruction meeting.

][1.5.1.6 Personnel Entry Approval

****

NOTE: Include this paragraph for projects at Naval Air Station, Patuxent River, MD. This paragraph is tailored for NAVFAC WASH.

****

Failure to obtain entry approval will not affect the contract price or time of completion.

]1.5.1.7 No Smoking Policy

Smoking is prohibited within and outside of all buildings on installation, except in designated smoking areas. This applies to existing buildings, buildings under construction and buildings under renovation. Discarding tobacco materials other than into designated tobacco receptacles is considered littering and is subject to fines. The Contracting Officer will identify designated smoking areas.

[1.5.2 Emergency Response Requirement

****

NOTE: Add the following paragraphs for projects at Norfolk Naval Shipyard (NNSY)

****

The Norfolk Naval Shipyard has instituted a requirement for all personnel to take shelter for personal safety in the event of certain emergencies. This policy includes Contractors, Subcontractors, and any person who is employed by the Contractor.

The most appropriate protective action for certain emergencies is to take shelter. Personnel must immediately seek shelter while an assessment is made of the threat and determinations are being made regarding subsequent actions such as "all clear" or selected building evacuations. The following procedures have been put in place in the event of an emergent condition.

(1) NOTIFICATION: The primary means of alerting personnel will be emergency alert signals. The alerting signal to seek shelter will be three steady tones that last for thirty seconds separated by ten seconds of silence. The notification for "all clear" will be three short tones repeated three times.

(2) SHELTERING: When personnel hear the alert signal, the area of work must be secured in a manner that will leave the site in safe condition. Personnel must seek shelter in the nearest occupied building in calm and orderly manner. If possible, secure all windows and doors and shut off ventilation. If working aboard ship, proceed into the interior of the ship and wait for further directions from official personnel. If in a vehicle, park the vehicle so that it does not block the normally traveled portion of the road and proceed into the nearest occupied building.

(3) EVACUATION: In the event of an evacuation, personnel will receive directions from team members of the Crowd Control Center (CCC) or the building custodian acting on the directions from the CCC. Contract personnel must comply with instructions given at all times.

][1.5.3 Shipyard Regulations

****

NOTE: Add the following paragraphs for projects at Norfolk Naval Shipyard (NNSY).

****

Ensure that Contractor personnel employed on the Shipyard become familiar with and obey Shipyard regulations. Wear appropriate personal protective equipment (PPE) in designated areas. Do not enter any restricted areas unless required to do so and until cleared for such entry. The Contractor's equipment must be conspicuously marked for identification. Comply with the following conditions:

a. Restrict employees/representatives to the work site and control travel directly to and from the work site.

b. Restore all traffic/parking/security signs and markings, including space numbers, designations, and lines, to their original form if such signs/markings are defaced or deleted during construction/repair.

c. Be responsible for control and security of Contractor-owned equipment and materials at the work site. Report immediately missing/lost/stolen property to the Shipyard Police Department (phone 396-7266) as each case occurs.

d. Ensure that no material is stacked within 3 meters 10 feet of the Controlled Industrial Area (CIA) perimeter. Remove from the work site, or secure ladders or other such equipment which could be used to climb the CIA perimeter fence. Ensure that no vehicles are parked within 3 meters 10 feet of the CIA perimeter.

e. Ensure that no openings in the roof/walls/windows/fence of the building exist at the end of the workday and do not exist where penetration is possible during non-working hours. If the building cannot be secured at the end of the workday, coordinate action with the Contracting Office to notify the cognizant code to arrange for a security watch by their personnel.

f. Seventy-two hours prior to making any penetrations (such as tunneling under, cutting through a fence or building) in a restricted area, contact the Shipyard Security Office to make arrangements for a security guard or other measures required to meet all security requirements. Cost of security guard will be charged to the Contractor.

]1.5.4 Entry to Radiologically Controlled Areas

****

NOTE: Add the following paragraphs for projects at Norfolk Naval Shipyard (NNSY).

****

Contractor personnel must not, under any circumstances, enter a radiologically controlled area or cross any posted radiological boundary. This paragraph applies to all phases of contract work. Radiation areas are posted with signs consistent with OSHA requirements. Ensure that employees are familiar with the radiation signs and symbols. All personnel entering the shipyard for the first time are required to receive radiological indoctrination training.

Should contract workers encounter radiological postings or boundaries which appear to limit their ability to access or carry out their intended work, they must notify their contract administrator for resolution of the problem.

1.5.4.1 Radioactive Materials and Equipment

All testing equipment, containing a radioactive source, must be operated in accordance with an approved radioactive equipment plan. This plan must be submitted to the Contracting Officer and approved by the Radiation Officer (Code 105.5), prior to bringing the equipment into the shipyard. This plan must include:

a. The name and type of equipment.

b. The type and size of radiation source.

c. The dates and locations of the equipment's usage.

d. The radiological controls that the Contractor will use while operating the equipment.

A different radioactive equipment plan will be required for each different type of equipment, type of radioactive source, or size of radioactive source. A data sheet of for each piece of new radioactive equipment must be submitted to the Contracting Officer to forward to the shipyard's Radiation Safety Officer. The data sheet must contain the following information:

a. Name of equipment.

b. Name and address of equipment manufacturer.

c. Type and size of radiation source.

d. The location of the installed radioactive equipment (i.e. building no., floor, code/shop area).

1.5.5 Working Hours

****

NOTE: When there is a need for special work periods, such as occupied family housing or when working in locations with non-traditional workdays such as Bahrain or Djibouti, modify this paragraph accordingly. Consult with the supported command or FEAD/ROICC office.

****

Regular working hours will consist of an [8 1/2 hour] [[_____] hour] period [established by the Contracting Officer], between [7 a.m. and 3:30 p.m.,] [[_____] a.m. and [_____] p.m.,] [Monday through Friday] [[_____] through [_____]], [and 7 a.m. to 3:30 p.m. on Saturday] [[_____] a.m. and [_____] p.m. on Saturday], excluding Government holidays.

1.5.6 Work Outside Regular Hours

****

NOTE: Discuss with the Contracting Officer when work outside regular hours is anticipated since it generally requires overtime pay for Government employees. When there is a need for special work periods, such in occupied family housing, modify this paragraph accordingly.

For MCBH Kaneohe Bay, use 30 calendar days in bracketed option.

For NAVFAC PAC and NAVFAC Hawaii, include the last bracketed item.

****

Work outside regular working hours requires Contracting Officer approval. Make application [15] [_____] calendar days prior to such work to allow arrangements to be made by the Government for inspecting the work in progress, giving the specific dates, hours, location, type of work to be performed, contract number and project title. Based on the justification provided, the Contracting Officer may approve work outside regular hours. During periods of darkness, the different parts of the work must be lighted in accordance with requirements of EM 385-1-1.[Make utility cutovers after normal working hours or on Saturdays, Sundays, and Government holidays unless directed otherwise.]

[1.5.7 Exclusionary Period

****

NOTE: Only use this paragraph and edit accordingly, only if project must shut down during certain, known dates or times.

****

No work may be performed during the period [_____] to [_____], inclusive, without prior written approval of the Contracting Officer. This period has not been considered in computing the time allowed for the performance of this contract.

][1.5.8 Occupied and Existing Building[s]

****

NOTE: Edit for all projects as appropriate. Delete this paragraph and its subparagraphs unless the work is in or around existing occupied buildings or unless Activity operations will materially affect the Contractor's operations. In most projects, the Government will remove furniture and equipment before the Contractor begins work. In this case the last subparagraph should be used. Examples of Activity operations materially affecting Contractor's operations include:

1. Restrictions regarding the time of day (or other period) or the duration of work in an area

2. Interruptions of work in an area for operations, one time or periodic

3. Interruption of work for a specific time for operations

4. Location or restrictions on location of construction equipment

5. Maintaining access.

Contact the Government to determine the complete details of scheduling restraints which may impact on the successful bidder's time or cost of performance of the work, and incorporate such details in this paragraph. Note that this paragraph defines the impact of Activity operations upon the Contractor. If the Contractor affects Activity operations, include that information in paragraph SPECIAL SCHEDULING REQUIREMENTS and not in this paragraph.

****

Work will be [in an existing building] [around existing buildings] which [is][are] occupied.[Do not enter the building[s] without prior approval of the Contracting Officer.]

[The existing buildings and their contents must be kept secure at all times. Provide temporary closures as required to maintain security as directed by the Contracting Officer.

][Provide dust covers or protective enclosures to protect existing work that remains, and Government material located in the [_____] during the construction period.

] [Relocate movable furniture [approximately [1.8 m] [6 feet] [_____] away from the Contractor's working area] [as required to perform the work], protect the furniture, and replace the furniture in [its] [their] original location[s] upon completion of the work.][Leave attached equipment in place, and protect [it] [them] against damage, or temporarily disconnect, relocate, protect, and reinstall [it] [them] at the completion of the work.]

[The Government will remove [and relocate] other Government property in the areas of the building[s] scheduled to receive work.

]]1.5.9 Utility Cutovers and Interruptions

a. Make utility cutovers and interruptions after normal working hours or on Saturdays, Sundays, and Government holidays. Conform to procedures required in paragraph WORK OUTSIDE REGULAR HOURS.

****

NOTE: Use the next two paragraphs on all projects involving potential conflicts with existing utility systems. Clearly detail the permissible extent, the sequencing, or the duration of outages. Contact the Government to determine the complete details of outage or scheduling restraints which may impact on the successful bidder's time or cost of performance of the work, and incorporate such details in this paragraph.

****

b. Ensure that new utility lines are complete, except for the connection, before interrupting existing service.

c. Interruption to water, sanitary sewer, storm sewer, telephone service, electric service, air conditioning, heating, fire alarm, compressed air, and [_____] are considered utility cutovers pursuant to the paragraph WORK OUTSIDE REGULAR HOURS.[Such interruptions are further limited to [_____] hours. This time limit includes time for deactivation and reactivation.]

[d. Operation of Station Utilities: Do not operate nor disturb the setting of control devices in the station utilities system, including water, sewer, electrical, and steam services. The Government will operate the control devices as required for normal conduct of the work. Notify the Contracting Officer giving reasonable advance notice when such operation is required.

] **

NOTE: The following paragraph is tailored for Navy use only. Coordinate with Installation to determine if permit is required and if so, time period required prior to connection. Edit Section 33 30 00 SANITARY SEWERAGE to specify permits and requirements for connections to existing sanitary sewer lines.

****

e. Connection to Existing Sanitary Sewer Line: Provide positive verification that the existing line conveys sanitary sewer; verify line is not incorrectly connected to a storm drain.[Obtain Installation's Sanitary Sewer Connection Permit[2 weeks][_____] prior to connection and in accordance with Section 33 30 00 SANITARY SEWERAGE.]

[1.5.10 Shipyard Area Work Clearance Request

****

NOTE: Include for Pearl Harbor Shipyard projects. This paragraph is tailored for NAVFAC HI.

****

Coordinate excavation and electrical work, including testing and troubleshooting of circuits, within the NAVFAC Hawaii Utilities Management (UM) and PHNSY&IMF via the Contracting Officer. Furnish the:

a. Contract title and number

b. Specific location of work

c. Reason for work

d. Duration of work

[1.5.10.1 Shipyard Hazardous Areas

Do not enter into work areas where Shipyard personnel are using protective equipment such as respirator and masks or marked boundary areas without prior approval.

]][1.5.11 Restrictions on Use of Yellow[, Orange-Yellow, Red, and Magenta] Materials

****

NOTE: Add the following for projects at Norfolk Naval Shipyard (NNSY). This paragraph is tailored for NNSY.

****

[Refrain from use of yellow or orange-yellow materials for the following purposes: sheeting, tarpaulins, polyethylene bottles or other containers, tapes, bags, banding of identification marks on tools, boundary markers such as ribbons. Contractor generated yellow waste materials such as torn foul weather gear must be disposed of by the Contractor off-yard. Shipyard dumpsters and trash cans must not be used for disposal of Contractor generated yellow waste materials. Yellow colored items such as described above are of specific significance within the shipyard and are subject to strict controls.

] **

NOTE: Add the following for shipyard projects at NAVFAC PAC. This paragraph is tailored for NAVFAC PAC.

****

[The use of yellow, yellow-orange, red and magenta materials for the following purposes is prohibited: sheeting, tarpaulins, polyethylene bottles or other containers, tapes, bags, banding of identification marks on tools, and boundary markers such as ribbons. Obtain Contracting Officer's prior approval for use of such colored materials for other purposes, such as buried vapor barrier membranes.

]][1.6 SECURITY REQUIREMENTS

****

NOTE: Add special or extraordinary security requirements which are unique to the station at which the work is to be performed because of the location of the project site on the station. This information will be made available by the station through the Government. For NAVFAC ML, include if the project involves Contractor access to "Classified" information or "Classified" areas.

This paragraph is tailored for several NAVFAC FECs.

****

[Contract Clause FAR 52.204-2 Security Requirements and Alternate II and the following apply:

Dual citizenship is not permitted. [_____].

][1.6.1 Naval Air Station (NAS), Patuxent River, MD

Foreign Nationals: The Contractor is responsible for notifying the Contracting Officer, at least five days in advance, of any foreign nationals coming into a restricted area so that proper clearance and escort procedures may be initiated.

][1.6.2 Naval Observatory(NOBSY), Washington, DC, Quarters "A"

Provide full name, date of birth, and Social Security number of all employees and representatives of the Contractor who need access to the Quarters "A" compound to the Contracting Officer at least 7 days in advance of the date on which access is desired. The Contractor will be advised should any of the proposed employees not meet security requirements for access to the Quarters "A" compound. For individual cases, access to the Quarters "A" compound can occasionally be obtained with a 4-hour advance notice; however, the Contracting Officer reserves the right to utilize the full 7 days should he determine it necessary.

[a. Personal identification: Before entering the Quarters "A" compound, all persons must furnish personal identification and receive a badge furnished by the Government. Badges must be worn so they are clearly visible at all times. Return badges to the issuing office when leaving the Quarters "A" compound.

][b. Security processing: Allow for a processing period of [15] [_____] minutes as employees enter the Quarters "A" compound at the beginning of each workday. All materials entering or in the Quarters "A" compound will be subject to search.

]][1.6.3 Naval Surface Warfare Center (NSWC), Dahlgren, VA

A copy of the security regulations may be obtained from the security office of the station.

]][1.6.4 Naval Surface Warfare Center (NSWC), Indian Head, MD

No employee or representative of the Contractor will be admitted to the work site unless he furnishes satisfactory proof that he is a citizen of the United States or is specifically authorized admittance by the OICC.

a. Identification Badges - A list of all employees to be engaged in the performance of work must be furnished to the Security Department. In the event employees are hired or discharged, a corrected list of employees must be furnished reflecting the change in personnel. Identification badges for the Contractor and his employees will be furnished by the Security Department, Indian Head Division, Naval Surface Warfare Center, Indian Head, MD. Immediately report instances of lost or stolen badges to the Contracting Officer. Upon completion of the contract or termination of the service of any employee, return the badges to the Security Pass Office. Compliance with this requirement is mandatory and certification thereof to the Contracting Officer is required prior to submitting final invoices. Failure to return badges will hold up Contractor's final payment.

b. Vehicles and Equipment - In addition to other conditions and requirements set forth hereinbefore, attention is invited to the fact that vehicles and equipment admitted to the Indian Head Division, Naval Surface Warfare Center, Indian Head, MD will be required to meet standards established be the Station Safety Department. The vehicular and equipment conditions must satisfactorily meet the following provisions:

    (1) Steering mechanism must be satisfactory and safe condition.

    (2) Horns and warning devices must be operable.

    (3) Windshield wipers must be satisfactory in place, clean and unbroken.

    (4) Rearview mirrors must be satisfactory in place, clean and unbroken.

    (5) General body conditions: Body must be satisfactory tight including fenders, bumpers, doors and latches thereto, and other parts which might become dislocated during travel.

    (6) Lights: All lights required by the type of vehicle/equipment in use must be functional with satisfactory bulbs and lenses.

    (7) Exhaust Systems: Exhaust systems must be completely functional with no leaks.

    (8) Fuel system must be free of leaks and show no evidence of loss of fuel or fumes.

(9) Brakes: All brakes must be functional and give evidence of the ability to halt the loaded vehicles within safe distances.

(10) Tires need not be new but must contain sufficient tread to indicate safety at operating speed with vehicle loaded.

(11) Electric Wiring: All wiring must be completely insulated as required, and in cases considered appropriate, waterproofing of wiring is required.

(12) Motors must be reasonably clean from excess grease, dust, and dirt, and if required must be steam cleaned to the satisfaction of the inspection personnel.

(13) Where applicable, inspection will include other such items as gauges, thermometers, controls, relief valves, piping, mechanical locks, limit switches, connectors, and other safety related devices associated with vehicles and equipment admitted to the Station.

][1.6.5 NSS, Washington, DC

The station is a secured facility:

a. Application: Furnish to the Contracting Officer a list showing, for employees and representatives to be engaged at the site, the name, address, date and place of birth, Social Security number, and, for anyone who is not a United States citizen, an alien registration number. Update the list with each addition and deletion to such engagement.

b. Passes and badges: Each individual engaged at the site must obtain a temporary pass each day. Car passes will be issued for parking on the station. Allow 15 minutes for this procedure at the beginning of each day. Additionally, expect to lose 25 crew hours over the duration of the contract due to delays in obtaining an escort while working in the inner compound. For the purpose of definition, a crew is defined as the size of the Contractor's workforce during any given workday. (If the Contractor has a crew of 10 men delayed 30 minutes on a given day, the delay period is one-half crew hour). Such delays will be at no additional cost to the Government.

[c. Escort: Work in or around Building[s] No. [_____] is in the inner compound and includes areas where an escort furnished by the Government must accompany the Contractor and his representatives and employees at all times.

]][1.6.6 Naval Research Laboratory (NRL), Washington, DC

The Contractor is working in highly secured areas. These areas include [_____]. Furnish notice to the Contracting Officer 30 days prior to working in these areas.

][1.6.7 Marine Corps Base Quantico (MCBQ), Quantico, VA

All Contractor and its employees performing services on Marine Corps Base, Quantico (MCBQ) requiring physical access to the installation must be properly screened. Screening consists of identity proofing and vetting in accordance with the standards set forth in Marine Corps Base Order 4200.3 (28 JUL 10). Request a copy of this policy from the Contracting Officer.

Hangars 2102 and 2103 are secured areas. Comply with the following security requirements:

[_____].

][1.6.8 Naval Support Facility, Thurmont, MD

****

NOTE: Obtain information needed from NAVFAC WASH, Code 09F.

****

The station is a secured facility. Comply with the following security requirements.

[_____].

][1.6.9 Joint Base Anacostia-Bolling (JBAB), Washington, DC

No employee or representative of the Contractor will be admitted to the work site unless he furnishes satisfactory proof that he is a citizen of the United States or is specifically authorized admittance by the OICC.

a. Personnel Information - All duty authorized non-military personnel utilizing the base are required to have in their possession at all times a Base Entry Pass. This pass is issued by the Visitors Control Center at the South Gate. Visitors Control is open Monday through Friday, 6:00 a.m. to 3:00 p.m. A minimum of 5 working days prior to start of work, furnish to the Joint Base Anacostia-Bolling (JBAB), Washington, DC, Security Department, via the Contracting Officer, the following information for Contractor and subcontractor personnel required to enter the Station:

    (1) Name of the company

    (2) Name of the employee

    (3) Social Security number

    (4) Proof of U.S. citizenship

    (5) A completed Contractor/Vendor Criminal History Record Request

    (6) A completed application for Base Entry Pass

b. Proof of Citizenship - Proof of citizenship will consist of copies of birth certificates, military dependent ID card, or naturalization papers, which will be returned once entered into the security computer system. The Security Department will run a criminal history check on Contractor employees and, as a condition of employment, each employee must willingly sign an authorization form allowing the Security Department to conduct the criminal history check. Subject authorization form will be maintained on file by the Security Officer. Based on proof of U.S. citizenship and the results of the criminal history check, the Security Officer will or will not grant entry to the Station. If entry is denied, the Contractor will be immediately notified.

c. Contractor Responsibility for Employees - The Contractor is responsible for employees under his employment. Ensure that employees are familiar with and obey station traffic, safety, and security regulations.

d. Motor Vehicle Operation - Ingress and egress of personnel will be subject to the security regulations of the Station.

(1) All personnel must be made aware of the base speed limits:

(2)	Housing areas	5 mph
(3)	Parking areas	10 mph
(4)	All other areas	25 mph (unless otherwise posted)

(5) Parking is in designed areas only, between two white lines. No parking is permitted in fire lanes, on seeded areas, in parking slots reserved for general officers and handicapped personnel.

(6) Traffic accidents should be reported immediately to the Security Police Law Enforcement Desk by calling 767-5000, 5001.

(7) All personnel entering the installation are subject to random vehicle inspections. The purpose of these inspections is to detect the theft of Government and private property, and to detect contraband or illegal drugs.

(8) Required Information on Privately Owned Vehicles - Advise company employees who desire to use their privately owned vehicles to personally bring the vehicle, vehicle registration, copy of vehicle insurance policy, valid state inspection documentation, and driver's license to the Visitor Control Center at the South Gate.

(9) Access to Restricted Areas - Base entry passes allow access to designated areas on the installation only. Entry into off limits areas is prohibited unless the contract requires it.

(10) Current Information - Contractors will be responsible for keeping the vehicle and employee lists current, and for securing and returning identification cards belonging to terminated employees to the Command Manager's Officer.

(11) Base Entry Passes - Contractor base entry passes will be valid for each entry aboard Joint Base Anacostia-Bolling (JBAB) from 6:00 a.m. to 6:00 p.m., Monday through Friday only, unless prior arrangements have been made with the Resident Officer in Charge of Construction, NDW, and the Base Security Officer, Joint Base Anacostia-Bolling (JBAB), has been notified. The passes are the property of the base and are to be returned to Visitors Control at the South Gate upon completion of the contract or termination of employment. Replacement passes must be requested in writing and be accomplished by written authorization from the Contracting Officer.

(12) Providing Information to Subcontractors - Prime Contractors are responsible for ensuring that subcontractors receive security information. Failure to comply with the specified requirements will result in prime contractors and subcontractors being denied

access to the construction site.

][1.6.10 Naval Weapons Station, Yorktown, VA

a. Personnel information. A minimum of 5 working days prior to start of work, the Contractor will furnish to the Naval Weapons Station (NWS), Yorktown, Security Department, via the Contracting Officer, the following information for Contractor and subcontractor personnel required to enter the station:

(1) Name of company

(2) Name of the employee

(3) Social Security number

(4) Proof of U.S. citizenship

(5) Completed Contractor/Vendor Criminal History Record Request

(6) Completed application for gate badge

b. Proof of citizenship. Proof of citizenship may consist of copies of birth certificate, military dependent identification card (ID), or naturalization papers, which will be returned once entered into the security computer system. The Security Department will run a criminal history check on Contractor employees and, as a condition of employment, each employee must willingly sign an authorization form allowing the Security Department to conduct the criminal history check. Subject authorization form will be maintained on file by the Security Officer. Based on proof of U.S. citizenship and results of the criminal history check, the Security Officer will or will not grant entry to the station. If entry is denied, the Contractor will be immediately notified.

c. Contractor responsibility for employees. The Contractor is responsible for employees under his employment. Ensure that employees are familiar with and obey station traffic, safety, and security regulations.

d. Motor vehicle operation. Ingress and egress of personnel are subject to the security regulations of the station. Motor vehicles operated within the NWS, Yorktown, must comply with the vehicle codes of Virginia which are incorporated into NWS Instruction 5510.5G, "Security and Traffic Regulations." Copies may be obtained from the Resident Officer in Charge of Construction, NWS, Yorktown, VA.

][1.6.11 Armed Forces Experimental Training Activity, Williamsburg, VA

This activity operates under strict security regulations and persons admitted to this activity will be accompanied by a military police escort or an official escort designated by the Security Officer, at all times. The activity Security Officer will authorize issuance of badges to selected responsible employees of the Contractor which permits the person issued the badge to act as an escort for other Contractor personnel on the activity.

][1.6.12 Norfolk Naval Shipyard, Portsmouth, VA

Contractor employees and representatives performing work under this contract are required to be United States citizens. If naturalized, the individual must present his naturalization papers to the Security Officer for inspection. Foreign born personnel must present evidence of citizenship regardless of citizenship of parents, as required by immigration laws. Contractors and Contractor personnel are the subject of a local police records check. Contractor personnel who possess a security clearance issued by the Defense Industrial Security Clearance Office (DISCO) will be issued a shipyard badge in the appropriate category. Each Contractor employee is required at the time of issuance of a personnel badge to submit a signed Privacy Act Release Form, in duplicate, to complete the local police check. Requested information must be furnished. Individuals who have felony convictions (e.g., murder, rape, drug offences, of theft) or who are deemed untrustworthy by the Security Department, Norfolk Shipyard will be denied access to the shipyard and their personnel badge will be recalled.

1.6.12.1 Shipyard CIA and Sensitive Areas

All Contractor or visitor personnel requesting access to the Controlled Industrial Area (CIA0) will be required to view an orientation videotape prior to receiving a badge. The videotape is 20 minutes in length and includes radiological indoctrination training as well as security, environmental, safety and health issues.

Entry into the CIA for those listed with the Contracting Officer may be authorized under one of the following conditions.

a. Contractors having a DOD Facility Security clearance and whose employees have a DOD security clearance may be badged for immediate unescorted access into the CIA.

b. Employees and representatives having current Shipyard ID badges authorizing CIA access will be permitted entry into the CIA.

c. Employees not holding a current DOD security clearance or current CIA access badge must establish suitability and eligibility prior to being badged for unescorted CIA access. Provide a Completed Special Access Determination (NAVSEA 5510/15) (Apr 90) for each employee.

d. For situations other than the above, US citizens who are employees or representatives requiring a CIA access may be issued an "Escort Required" ("ER") pass for CIA access under the escort of a cleared individual employed by the activity. Processing of "ER" passes may take up to 5 days.

    (1) The initial submittal of Visit Request forms need not be all inclusive. It may be expanded to meet essential requirements of the Contractor. Each individual added to the list, however, are subject to the same pre-entry screening requirements as outlined above.

    (2) Shipyard ID badge will be issued by the Shipyard pass and Identification Office (Pass and ID Office).

1.6.12.2 Vehicle Regulations in the Shipyard CIA

No vehicle will be permitted access to a work site in the CIA without a DOD vehicle sticker and a valid Shipyard vehicle pass. The Shipyard vehicle passes are issued by the Shipyard Pass and ID Office. Shipyard vehicle passes will not be issued unless a DOD vehicle sticker has been obtained and proof of vehicle registration to the Contractor's company has been presented to Shipyard Pass and ID. Vehicles are required to conform to Shipyard traffic regulations. The speed limit is 15 mph in the CIA. Outside the CIA, the speed limit is as posted or marked. No privately owned vehicles are allowed inside the CIA with the exceptions of handicap, CO/XO/CMC of ships.

Only those Contractor vehicles meeting the following criteria will be allowed to enter the CIA with the Shipyard vehicle pass:

a. Vehicles must clearly display an authorized company sign or logo.

b. Vehicles must be company or commercial vehicles used to transport heavy equipment or material to the job site or to conduct bona fide and required inspections and surveillance at the job site. Privately owned vehicles will not be used to transport employees to the job site and will not be allowed in the CIA.

1.6.12.3 Commercial Vehicles

Vehicle passes will be issued to each commercial vehicle that is required for the job, authorizing entry and parking within the CIA. Every vehicle entering the CIA will display the pass on the dashboard or visor (facing outward). The pass will be visible at all times while in the CIA. Parking is limited to those areas that are specifically identified on the pass. If additional passes are required, present adequate justification to the Pass and ID Office via the Contracting officer.

1.6.12.4 Parking

Prohibited on any piers and dry dock/waterfront areas. Do not park on or block the marked fire lanes or crane rail traveling zones (marked in yellow) at any time. Vehicles may stop on the piers or dry dock/waterfront areas for 15 minutes for loading and unloading. An exception may be made for vehicles which are part of the equipment needed to do the required work and are attached or connected to the pier of ship; for example, a truck which uses a mounted generator or a vehicle with built-in equipment.

1.6.12.5 Vehicle Searches

Vehicles are subject to search while entering, remaining in, or leaving the Shipyard. Government material being transported out of the CIA must be covered by a Property Pass (OP-7), issued and signed by the Security Officer. Material found without a Property Pass will be confiscated and a police officer offense report issued.

1.6.12.6 Escort

For entrance to and work inside any building inside the CIA, the cognizant Shipyard code will provide escort services in the affected area.

1.6.12.7 Areas Not Covered by Contract

Contractor personnel will not be permitted to enter Shipyard buildings, spaces, and areas not covered by this contract except on prior approval of the Shipyard department/office/shop having jurisdiction of the areas. Coordinate action with the Contracting officer to obtain such entry approval.

1.6.12.8 Access to Unclassified Information

Access to unclassified U.S. Navy shipbuilding, conversion, or repair technology and related technical information manuals, documents, drawings, plans, specifications, and other unclassified information is restricted to official need-to-know basis, designated by physical markings to show the appropriate control designations. Handle, control, and safeguard to prevent oral, visual, and documentary disclosure to the public, to foreign sources, and to personnel not having an official need-to-know. Return this information to the naval Shipyard upon completion of contracted work, except when specific retention authorization is granted by the Contracting Officer's Security Representative.

1.6.12.9 Photographs

Unofficial photograph is prohibited in the Naval Shipyard. When operationally required, submit a written request containing specific justification and details to the Security Officer prior to release.

1.6.12.10 Identification Badges

In addition to the requirements specified in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, comply with the following:

a. Submit a Visit Request (VR) and Special Access Determination (SAD) for each person listed to the Security Officer (Code 1125.2) via the Contracting Officer at least 6 weeks prior to the start date.

b. Employees and representatives requiring access are U.S. citizens or U.S. Nationals.

c. Under no circumstances may personnel hand carry their own visit request.

d. Employees must provide documented proof of U.S. citizenship to the Pass and ID Office prior to being issued a Shipyard badge.

e. Employees must be available for interviews upon request by the Shipyard Personnel Security Specialist.

f. Employees must wear and display the Shipyard badge in the chest area at all times while entering, remaining in, and exiting Shipyard spaces and each badge may be used only by the specific individual named on the badge.

g. Maintain strict accountability over identification badges and passes issued by the Pass and ID Office. Return badges/passes to the Pass Office immediately upon termination of any employee, expiration, completion of contract, or when no longer required.

][1.6.13 Naval Air Station, Oceana, Virginia Beach, VA

Contractor personnel are required to obtain personnel identification badges. In accordance with Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, paragraph SUBCONTRACTORS AND PERSONNEL, submit, in triplicate, a list of his subcontractors and the work each is to perform. On this listing must appear the names of the key personnel of the Contractor and subcontractors. A copy of the list of key personnel will be forwarded to the Naval Air Station, Oceana, Security Department by the Contracting Officer. The key personnel are responsible for identifying other

Contractor and subcontractor personnel for the purpose of obtaining identification badges. Contractors working in restricted work areas are also required to obtain special identification badges for personnel requiring access to the restricted work areas. Immediately after award, submit a letter to the Contracting Officer with the following information for each employee: Company name, employee's name, Social Security number, height, and weight. Also, indicate the names of persons authorized to vouch for additional employees requiring badges.

][1.6.14 Fleet Trng Cntr Atlantic (FTCLANT), Dam Neck, Virginia Beach, VA

a. Required Company Information. Furnish the FTCLANT Base Security Officer (Code 14) with the following information on company letterhead:

(1) Contract number and duration of contract.

(2) List of make, model, and license number of company vehicles requiring decals.

(3) Copy of insurance policy covering company vehicles, indicating the Virginia State minimum insurance requirements have been met.

(4) List of employees who will require ID cards with normal work hours.

(5) Name and sample signature of the representative responsible for obtaining and returning ID cards.

The preceding information must be received by the Commanding Officer, Fleet Training Center Atlantic, Dam Neck, Virginia Beach, VA 23461-5000, Attn: Base Security Officer (Code N31, Bldg. 543); or brought to the Base Security Office located in Building 448, prior to the first day of work.

b. Required Information on Privately Owned Vehicles. Advise company employees who desire to use their privately owned vehicles to personally bring the vehicle, vehicle registration, copy of vehicle insurance policy, valid State inspection documentation, and driver's license to the pass and decal office located at the main gate.

c. Current Information. Contractors are responsible for keeping the vehicle and employee lists current, and for securing and returning identification cards belonging to terminated employees to the command security manager's office.

d. Valid ID Cards. Contractor ID cards must be valid for each entry aboard FTCLANT from 6 a.m. to 6 p.m., Monday through Friday only, unless prior arrangements have been made with the Resident Officer in Charge of Construction, Naval Air Station Oceana, and the Base Police Officer, FTCLANT, has been notified.

e. Providing Information to Subcontractors. Prime Contractors are responsible for ensuring that subcontractors receive security information. Failure to comply with specified requirements will result in prime Contractors and subcontractors being denied access to construction sites.

][1.6.15 Naval Station Norfolk, Norfolk, VA

a. Contractor registration. Register with the Base Police Truck

Investigation Team, located behind pass and ID Office (Bldg CD-9) on Hampton Boulevard, Naval Station Norfolk, Norfolk, VA 23511-5000, telephone number 757-322-2979.

b. Storage and office trailer registration. Register storage and office trailers to be used on base with the truck investigation team. Trailers must meet State law requirements and must be in good condition.

(1) Trailers must be lockable and must be locked when not in use.

(2) Trailers must have a sign in the lower left hand corner of left door of trailer with the following information: Company name, address, registration number of trailer or vehicle identification number, location on base, duration of contract or stay on base, contract number, local on-base phone number, off-base phone number of main office, and emergency recall person and phone number.

c. Equipment markings. Equipment owned or rented by the company must have the company name painted or stenciled on the equipment in a conspicuous location. Rented equipment is to be conspicuously marked with a tag showing who rented the equipment. Register the equipment with the truck investigation team.

d. Procedure information. For additional information regarding registration procedures, contact the Officer in Charge of Construction at 757-445-1463 or Base Police at 757-444-8856.

][1.6.16 Naval Security Group Activity (NSGA), Northwest, Chesapeake, VA

a. All Contractor personnel and vehicles must report to Truck Control upon initial visit. All Contractors working at NSGA Northwest must have activity badges. Inform the Truck Control of the expected duration of the contract and its location. Truck Control hours are 6:00 a.m. to 5:00 p.m., Monday through Friday. Contractors required to work past 5:00 p.m. must notify Truck Control in person or by telephone at 421-8383, no later than 2:00 p.m. of that day. Contractors required to work weekends, or on Government holidays, must notify Truck Control no later than 11:30 a.m. the preceding normal workday.

b. The pass/ID clerk will issue an identification badge upon completion of part A of the activity pass application form. This outlines proper procedures and instructions to be followed when issuing activity badges and vehicle passes to Contractors. The following procedures apply:

(1) Contractors must submit to the Security Office via the Contracting Officer, an access list of all personnel who will be working on the contract job. Present a valid picture ID that the pass clerk can compare against the access list.

(2) A blue activity pass with photo will be issued for no longer than one year and no less than thirty days, corresponding with the length of time listed on the access list. Activity passes without photo will be issued to Contractors who will be at the job site for less than twenty-nine days. Contractors who will be at the job site for less than five days are required to check in and out through Truck Control daily, between the hours of 6:00 a.m. and 5:00 p.m. A Department of Defense decal with a black NSGA decal will be issued to the Contractor vehicles that will be utilized on-site for over ninety days. This will be verified by the

company or the designated on-site supervisor. All privately owned vehicles and company vehicles used on-site less than ninety days will be issued temporary passes, renewable as required,

(3) Renewal of activity/vehicle passes, or decals will be done after verifying applicant against a valid access list.

(4) Replacement of a lost or stolen pass will be granted after the applicant completes a signed statement outlining the circumstances. The applicant will be verified against a valid access list.

c. All vehicle operators must have a valid state driver's license. All Contractor vehicles must meet the state law requirements of the state in which it is registered.

d. All Contractors will be issued a badge/pass and it must be returned to Truck Control upon completion of the contract.

e. Any construction materials being removed from the NSGA Northwest base must be accompanied by a property pass signed with an original authorized signature.

][1.6.17 AEGIS Systems Combat Center, Wallops Island, VA

a. The Contractor will be working in the AEGIS Combat Systems Center (ACSC), a Navy facility. As soon as possible, and before work begins, submit to the Contracting Officer a list of all employees who will work on the project, including names, Social Security numbers, and dates and places of birth. Verify that all employees are not known felons nor have felony charges pending. Only United States citizens will be admitted to the work site.

b. At all times, while on Government property, the Contractor, subcontractors, and their employees must wear badges, and vehicle passes are required to access the jobsite. These badges and passes will be issued for the Navy by the Wallops Flight Facility Security Office at the direction of the Contracting Office. Make application for badges to the Navy Contracts Office. Badges previously issued by NASA for NASA projects may not be used to access Navy jobsites. Upon entering the AEGIS Combat Systems Center facility, employees and their gear are subject to inspection.

c. The Contractor is held accountable for identification badges and vehicle passes for the life of the contract. The Contractor is required to report badge loss or theft immediately to the Contracting Officer. Failure to surrender all badges and passes at the contract's end may result in the retainment of funds or the withholding of final payment by the Contracting Officer.

][1.6.18 Employment Restrictions For NAVFAC SW

Do not employ any person, for any work required by this contract, who: (1)is a non-immigrant as described in section 101(a)(15)(H)(ii) of the Immigration and Nationality Act 8 USC 1101(a)(15)(H)(ii), (2)is an alien having a residence in a foreign country which he has no intention of abandoning and who is coming to the United States to perform temporary services or labor.

1.6.18.1 Personnel List

Submit for approval, at least 15 days prior to the desired date of entry, an original alphabetical list of personnel who require entry into Government property to perform work on the project. Furnish for each person:

a. Name

b. Date and place of birth

c. Citizenship

d. Home address

[e. Social Security number

][f. Current pass expiration date

][g. Naturalization or Alien Registration number

][h. Passport number, place of issue, and expiration date

][The request for personnel passes must be accompanied with the following certification:

"I hereby certify that all personnel on this list are either born U.S. citizens, naturalized U.S. citizens with the naturalization number shown[, or legal aliens with the alien registration number indicated]."

Signature/Firm Name

]]1.6.19 Employment Restrictions For Guam

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NOTE: Use this paragraph and its subparagraphs ONLY for contracts for base operations support (BOS) on Guam that: (1) Are awarded as a result of a competition conducted under OMB Circular A-76; and (2) Are entered into or modified on or after November 18, 1997.

****

Do not employ any person, for any work required by this contract, who: (1)is a non-immigrant as described in section 101(a)(15)(H)(ii) of the Immigration and Nationality Act (8 U.S.C. 1101(a)(15)(H)(ii), (2) is an alien having a residence in a foreign country which he has no intention of abandoning and who is coming to the United States to perform temporary services or labor.

1.6.20 Personnel List

Submit for approval, at least 15 days prior to the desired date of entry, an original alphabetical list of personnel who require entry into Government property to perform work on the project. Furnish for each person:

a. Name

b. Date and place of birth

c. Citizenship

d. Home address

[e. Social Security number

][f. Current pass expiration date

][g. Naturalization or Alien Registration number

][h. Passport number, place of issue, and expiration date

][i. Guam Police clearance report for last six months

][The request for personnel passes must be accompanied with the following certification:

"I hereby certify that all personnel on this list are either born U.S. citizens, naturalized U.S. citizens with the naturalization number shown[, or legal aliens with the alien registration number indicated]."

Signature/Firm Name

]1.6.20.1 Citizenship Requirements

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NOTE: Verify with the Activity on the security requirements for Contractor's personnel.

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[Aliens will not be admitted to the work site without approval.][Aliens are not allowed on the project site.][Clearance for aliens may require approximately 20 workdays for approval.][Work under this contract is restricted to U.S. citizens.]

1.6.21 Guantanamo Bay, Cuba

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NOTE: This Article is tailored for NAVFAC SE. Use and edit for projects at Guantanamo Bay, Cuba.

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1.6.21.1 Work Force

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NOTE: Fill in the brackets when more specific direction is required.

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Due to the sensitive locale of the U.S. Naval Base, Guantanamo Bay, Cuba, foreign nationals from dissident political areas may be excluded and denied entry approval. In general, foreign nationals may be used [_____]. The Contractor agrees to dismiss from the site, when directed by the Contracting Officer, any individual whose continued employment is deemed to be contrary to the public interest or inconsistent with the best interest of the national security.

1.6.21.1.1 Entry Approval for Employees

No employee or representative of the Contractor will be admitted to the U.S. Naval Base, Guantanamo Bay, Cuba without prior entry approval. The background of Contractor personnel will be screened prior to entry to the U.S. Naval Base, Guantanamo Bay, Cuba. Submit to the Contracting Officer the full name, date and place of birth, Social Security number, and addresses of such persons. This information must be received by the Contracting Officer 45 calendar days prior to the scheduled or desired arrival at the Naval Base.

1.6.21.1.2 Identification of Employees

The Contractor is responsible for furnishing to each employee and for requiring each employee to display such identification as may be approved and directed by the Contracting Officer. Employees may be fingerprinted prior to employment as a condition of entry onto the Naval Base. Prescribed Government identification cards must immediately be delivered to the Contracting Officer for cancellation upon release of any employee.

1.6.21.1.3 Local Labor

Proselytizing of labor, that is the hiring of Government or Contractor on-base employees by offering higher wages or other amenities, is not permitted unless a release from the employer is executed or the employee resigns and leaves the base for a minimum of 90 days. Accordingly, labor which the Contractor proposes to use must be approved by the Contracting Officer.

1.6.21.1.4 Management Personnel

The Contractor is responsible for furnishing the personnel required, with the necessary skills and qualifications, to perform the work as described. Additionally, provide an individual on-site, who is authorized to negotiate and financially commit change orders for the Principal.

1.6.21.2 Access Roads

Refrain from the use of roads, grounds, or other facilities which have not been specifically authorized for their use.

]1.7 NAVFAC EURAFCENT REQUIREMENTS AND RESTRICTIONS

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NOTE: This paragraph is tailored for NAVFAC EURAFCENT.

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1.7.1 Building Entrance Restrictions

Contractor personnel are restricted from entering operational buildings or areas without the specific authorization of the Contracting Officer. To perform work, where "security escorts" are required for access to a facility, coordinate with the Contracting Officer for access to such facilities.

1.7.2 Public Release of Information

There must be no public release of information or photographs concerning any aspect of the materials or services relating to this contract or other documents resulting therefrom without the prior written approval of the Contracting Officer.

The Contractor agrees to insert the substance of above paragraph in each subcontract and purchase order generated for this contract.

1.7.3 Responsibility for Physical Security

The Contractor is responsible for physical security of construction materials, supplies, and equipment of every description (including property which may be Government furnished or owned) provided or utilized in the execution of this contract.

1.7.4 Employment

Should the continued employment of any person in connection with this contract, or any subcontract thereunder, be deemed by the Contracting Officer to be prejudicial to the interests of the Government, that person must immediately be removed from the work. In this connection the Contractor agrees that:

a. Cases which may involve disciplinary action against such persons, or the necessity of reassignment or termination of their services, will be investigated, processed, reported and disposed of, as directed by the Contracting Officer.

b. Employment contracts of all persons employed in connection with this contract, or any subcontract thereunder, will include clauses containing the substance of this clause.

1.7.5 Compliance

Compliance with the foregoing provisions of this clause by subcontractors is the responsibility of the Contractor.

1.7.6 Cultural Resources

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NOTE: This paragraph and following paragraph covers special requirements for projects located in Italy.

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Cultural resources such as archaeological remains or villa remains may be uncovered during construction excavation operations on and off the Installation. If during excavations, suspected cultural remains are found, excavation operations must immediately cease and notify the Contracting Officer who will contact the Installation Environmental office.

1.7.7 Unexploded Ordnance

The Contractor is advised that unexploded ordnance may exist in areas where excavation work is required. During the entire life of this Contract, perform both visual and electronic inspection of the work areas to prevent danger to personnel and loss of equipment from inadvertently exploding old ordnance.

During excavation work, use caution when unknown objects are encountered and thoroughly identify the object prior to removal. Upon discovery of suspected unexploded ordnance in the course of contract work, immediately clear the area and contact the Contracting Officer. Resultant exploratory and removal work may be subject to negotiations for a contract change in accordance with the Contract Clauses.

[1.7.7.1 Ordnance Removal Requirements

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NOTE: Use this paragraph if Installation requires Contractor to have ordnance removal team on-call and perform ordnance removal.

****

Upon issuance of contract change and notice to proceed by the Contracting Officer, provide exploratory excavation and removal of suspected unexploded ordnance. This work must be conducted only by a firm authorized by the Italian Ministry of Defense (IMD) to perform such work, and approved by the Contracting Officer. Submit proof of IMD ordnance work authorization to the Contracting Officer for review and approval prior to conducting ordnance work.

Have the approved ordnance removal firm committed to an on-call basis in the event that suspected unexploded ordnance is encountered during contract work.

][1.8 CONTRACTOR REGULATIONS FOR DIEGO GARCIA

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NOTE: Use this paragraph for Diego Garcia projects.

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Develop, promulgate and enforce operating regulations for campsite and other facilities and equipment under his control. The regulations must include the maintenance of good discipline, security, sanitation, and a fire plan. Prepare and submit for approval after consultation with Navy authorities.

][1.9 BRITISH INDIAN OCEAN TERRITORY (BIOT) LAWS FOR DIEGO GARCIA

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NOTE: Use the following paragraphs for projects at Diego Garcia.

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Applicable on Diego Garcia (DG) and enforced by the representative of the BIOT Commissioner on DG.

[1.9.1 BIOT Immigration Requirements

Third country Contractors and personnel must have valid passports. Requirements for Contractor employees who are residents of the BIOT must be as specified by the Commissioner of the BIOT.

][1.9.2 Contractor I.D.

Prepare and issue I.D. cards for each person with their equivalent General Schedule rating as prescribed in the JTR Manual Vol 11.

][1.9.3 Contractor-Owned Vehicles

Approved Contractor-owned vehicles will be permitted on the site. Motor scooters, mopeds, motorcycles, and privately owned vehicles are prohibited on DG. Drivers must have a valid international driver's license.

][1.9.4 Inspection

Personnel, equipment and plant are subject to customs inspection. Personnel are also subject to physical searches at random intervals.

][1.9.5 Business or Occupation on DG

Engaging in commercial enterprise or other than work covered by this contract is prohibited. This prohibition includes, but is not limited to, commercial fishing, oil or mineral exploration, and production in or under those areas of the waters, Continental shelf, and seabed around DG over which the United Kingdom has sovereignty or exercises sovereign rights.

][1.9.6 BIOT Taxes and Customs Duties

Base bids on the assumption that the Contractor's firm and employees are exempt from BIOT taxes and customs duties. There are import and export controls applicable to the BIOT. Personal household effects, privately-owned vehicles, drugs, firearms, and other controlled materials are not authorized. Authorized goods and materials for a non-U.S. Contractor must be consigned in care of the Contracting Officer.

]][1.10 BASE OPERATING SUPPORT (BOS) FOR WAKE ISLAND AND DIEGO GARCIA

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NOTE: Use for Wake, Johnston Island, and Diego Garcia projects.

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The BOS Contractor as mentioned herein is a private contractor retained by the Government for base operations support services. Coordinate with the Contracting Officer for services available from the BOS Contractor.

][1.11 FACILITIES AND SERVICES FOR WAKE ISLAND AND DIEGO GARCIA

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NOTE: Use for Wake, Johnston Island, and Diego Garcia projects.

****

Verify rates and available with the Activity.

[1.11.1 Meal Services for Diego Garcia

Available on a cost reimbursable basis. U.S. expatriate (EXPAT) and Third Country Nationals (TCN) personnel may obtain meals from the Navy Support Facility Consolidated Dining Facility, and the BOS Contractor TCN Dining Facility, respectively. Each employee must sign the Meal Signature Record Book (MSRB) before each meal. Submit to the Contracting Officer the Meal Signature Record Book (MSRB) on a daily basis. The Contractor will be charged by the number of personnel on island and not by the number of meals consumed. Cost for three meals per day is $3.85 per person for TCNs and $5.65 per person for EXPATs.

][1.11.2 Dining and Lodging Facilities for Wake Island

Meals and lodging facilities are available on a cost reimbursable basis. This includes furniture, bed, linen, a towel, janitorial services and shower/toilet facilities. Submit dining and lodging requirements at least 60 days prior to actual requirements for approval. Rates and schedule:

MEAL	RATES	SCHEDULE (DAILY)
Breakfast	$4.85	6:30 a.m. - 8:00 a.m.
Lunch	$6.00	11:00 a.m. - 1:00 p.m.
Dinner	$6.00	5:00 p.m. - 7:00 p.m.
Box Lunch	$2.50	
Lodging: $4.00/Person/Day		

][1.11.3 Housing for Diego Garcia

Provide suitable housing for employees using the Splendidville/PWC Camp facilities or other locations as directed. Approval required to upgrade these seahuts through alteration or construction. Develop and maintain a housing plan which reflects the actual use of housing assets under Contractor control. The housing plan and any revisions thereto will be subject to approval. Maintenance and repair of facilities are available on a cost reimbursable basis. TCN housing must not be air-conditioned unless approved.

][1.11.4 Medical Facilities for Wake and Diego Garcia

Limited medical facilities and services are available on a cost reimbursable basis. Submit a medical plan and medical records of employees prior to transporting them to the Island. The following conditions apply.

a. Medical plan: Include narrative description that delineates the procedures for maintaining medical records; screening physical exams and immunization requirements; testing for contagious disease, such as dengue, malaria, tuberculosis; and other diseases that may be associated with the employee's country of origin.

b. Personnel must receive a thorough dental and physical examination and should bring unique medication/drugs and two pairs of prescription eyeglasses.

c. Rates:

Out-patient Care	$30.00 per visit
In-patient Care	$100.00 per day
Pharmacy	Prevailing cost

****

NOTE: Also include this paragraph for Diego Garcia projects.
****

d. Government medical services are available in emergencies where life may be in danger and for infectious diseases. Treatment for long-term medical problems or those requiring hospitalization not available. When determined by the attending medical authorities, transfer patients to a non-Governmental medical facility as soon as possible. [X-ray services are available for emergencies.]

e. The MEDEVAC point is Kadena, Okinawa. The Contractor is responsible for transferring the patient from the air terminal to a private doctor or hospital. In case of extreme emergency, patients may be transferred to a private hospital in Okinawa at the Contractor's expense.

][1.11.5 Dental Treatment for Diego Garcia

Limited to out-patient dispensary service, at $30.00 per visit, during regular working hours for relief of pain, contagious oral diseases or humanitarian reasons.

][1.11.6 Retail Store

Limited items and quantities such as canned goods, bread, milk, produce, candy, toilet articles, magazines, and other such items, are available at the prevailing rates. Luxury items are not available for purchase.

][1.11.7 Alcohol and Gambling

[The Contractor may operate a combined mess and club where beer may be dispensed at authorized times.]Consumption of alcoholic beverages is only authorized in clubs, designated areas or quarters. Gambling is prohibited.

][1.11.8 Postal Services

Postal services via the U.S. Postal system are available to U.S. personnel. Foreign national employees may send letter mail to non-APO addressees and may receive letter mail. Foreign nationals may neither send nor receive packages or purchase money orders through the U.S. Postal system. Money orders are available.

][1.11.9 Custodial Service for Diego Garcia

Custodial services for personnel housing and other facilities under the Contractor's control are available on a cost reimbursable basis.

][1.11.10 Janitorial Services for Wake Island

Janitorial services, other than those included as part of the dining and lodging facilities, are available on a cost reimbursable basis.

][1.11.11 Recreation Facilities

Existing recreation facilities and special services activities are available. The Government retains the right to limit Contractor use or schedule such use so as not to interfere with Government employees.

][1.11.12 Club Privileges

Club privileges may be granted by invitation from the various clubs on the basis of classification or grade of the employee.

][1.11.13 Swimming and Fishing

Permitted.[However, exercise caution in eating fish caught within the [Midway][Wake] reef area as certain species are poisonous. Inform personnel of known species of poisonous fish.]

][1.11.14 Fuel for Wake Island

[JP-5 and MoGas are available at [$_____] and [$_____], respectively, plus a [_____] and [_____] percent surcharge, respectively. Diesel fuel is not available. The Government will not provide fuel storage facilities and will not be liable for damages and losses due to the use of JP-5 and MoGas purchased from the Government.

]][1.11.15 Fuel for Diego Garcia

[JP-5, MoGas, and diesel are available at $0.71, $0.82, and $0.69 per gallon, respectively. The Government will not provide fuel storage facilities and will not be liable for damages and losses due to the use of JP-5, MoGas, and diesel purchased from the Government.

]]][1.12 TRANSPORTATION OF PERSONNEL, MATERIALS, AND EQUIPMENT FOR WAKE AND DIEGO GARCIA

****

NOTE: Use the following paragraphs as applicable for Wake and Diego Garcia projects.

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Coordinate arrangements for transporting materials, equipment, and personnel with the Contracting Officer.[Rates shown were the latest available when this specification was prepared, and is furnished for informational purposes only.][The Contractor will be charged rates in effect at the time the services are actually provided.] The Contractor has the option to use commercial or privately-owned transportation.

[1.12.1 Surface Transportation

****

NOTE: Verify the availability and rates with the proper Government office.

****

Use of Government facilities are on a priority basis as determined by the Government. Repair damaged Government property such as docks, buoys, lightering watercraft and equipment due to the Contractor's negligence at the Contractor's own expense.

a. Military Sealift Command (MSC): [The current shipping cycle to Midway is approximately 90 days but is subject to change without notice]. [There is no regularly scheduled MSC service to [DG] [Wake]]. If the Contractor elects to use MSC services, the Contractor is responsible for costs incurred or delays encountered because of late or nondelivery of materials or equipment. MSC services are subject to the following conditions:

(1) Provided on a space available basis or if no commercial service is available.

(2) The Government has the right to reject cargo offered and to limit the quantities of materials accepted.

(3) The Government incurs no responsibility, expressed or implied, for return transportation, continued frequency, timeliness or reliability of the MSC service.

(4) Pay in advance by means of a special deposit account to the Fleet and Industrial Supply Center (FISC), administering the services for transportation, stevedoring, handling, securing and local accessorial services. For FISC [Pearl Harbor] rates are:

Transportation, Tonne Ton		
1.1 Cubic Meters Per Measurement 40 cubic feet Per Measurement		
		Stevedoring
General Cargo	$[_____]	$[_____]
Special Cargo	$[_____]	$[_____]
Cargo Trailer	$[_____]	$[_____]

(5) The BOS Contractor's stevedoring/lighterage rates are:

Laborers: [$_____] per hour

Operation Supervisor: [$_____] per hour

Safety Supervisor: [$_____] per hour

LCM-8 Boat Crew (5 Men per LCM-8): [$_____] per hr/man

Crane Operator: [$_____] per hour

Forklift Operator: [$_____] per hour

Administrative Charges: [$_____] per day

(6) Damages or loss due to handling, loading, securing, transporting, failure of, or delay in delivery will be borne by the Contractor. Obtain adequate insurance against damage, loss or failure of, or delay in delivery, as appropriate, and include the Government as a named insurer.

b. Commercial vessel:

(1) Lighterage operations are [normally 24 hours to avoid turnaround delay at Midway] [restricted to daylight hours unless approved otherwise at [Wake] [DG].]

(2) The Contractor is liable for accidental injury or death of Contractor's personnel and damages to material and equipment during stevedoring operations performed by the Contractor.

(3) Pay demurrage charges for barges and vessels not under Navy sponsorship, or vessels where delay results from the failure of the Contractor to perform specified stevedoring services. When demurrage is assessed to cargo belonging to several agencies, arrange with the agencies concerned in sharing such expenses. No priority will be afforded the Contractor's cargo over others, and cargo will be handled as the ship's cargo master elects to unload, except that food or medical supplies will be given first priority.

****

NOTE: Use the text below for Wake projects.

****

(4) Unload cargo from ships anchored offshore into BOS Contractor controlled watercraft and repair damages to Government lightering watercraft due to Contractor negligence. The movement of the cargo from the dock to the jobsite is the Contractor's responsibility.

(5) The Contractor will not be charged for the use of the watercraft dockside crane and two forklifts for lighterage operations but will be charged for the labor involved at the prevailing labor rates. Utilize the BOS Contractor's operators.

(6) Government lightering watercraft consists of two LCM-8's. The LCM-8's are 22.5 m long; 6.4 m wide; 2.8 m side board; 73 feet 8 inches long; 21 feet wide; 9 feet 4 inches side board; one meter 3 feet 3 inches draft light; 1.2 m 4 feet draft loaded; have 53 tonnes 53 1/2 tons load capacity, and 76.8 cubic meters 2742 cubic feet cargo space. The dockside crane capacity is 20,400 kg 45,000 pounds. Cargo that is not adequately crated/packed or cannot be safely handled by the LCMs or crane will not be unloaded by the Government. Materials in bulk, such as aggregate, will not be transported or handled by the BOS Contractor unless bagged or otherwise contained for convenient handling.

][1.12.2 Purchase Orders for Diego Garcia

Submit three copies of purchase orders for materials and equipment purchased from the U.S. prior to actual procurement for approval. Also submit monthly three copies of subsequent revisions or amendments to the purchase orders with the MSR. Purchase orders must refer to and contain the same nomenclature and item number as the corresponding item listed in the BM.

][1.12.3 Air Transportation

****

NOTE: Use the text in "a." below for Wake and Diego Garcia projects. Verify the availability and rates with the proper Government office.

****

a. Air Mobility Command (AMC) [is not scheduled on a regular basis to [Wake] [DG].][Service is subject to the following conditions:]

b. Commercial and private aircraft: If approved, special commercial chartered flights and private aircraft will be permitted to land on [DG] [Wake]. Submit for approval at least 30 days prior to the flight date.

][1.12.4 Agreement

****

NOTE: Use this paragraph AGREEMENT for Wake and Diego Garcia projects.

****

Submit prior to shipment of materials and equipment by Government air and surface transportation, an agreement in the following form:

"In consideration of the carriage of the property described as follows: ____

____

(Description and maximum quantity to be shipped--the latter to be stated in both weight and measurement tons.) I, ____________________________________ (Acting both individually and as the duly authorized agent of ______________________________________, the owner of said property) hereby agrees that neither the carrying vessels, nor the United States, nor an agent or agency incorporated or unincorporated thereof, will be liable for loss of, or damage of any nature whatsoever to, said property or for any failure to deliver above said property in the same quantity and in the same order and condition as when received by the initial carrying vessel, or for any delay in such delivery, whether said loss, damage or failure of or delay in delivery is occasioned by the negligence of the carrying vessel, the United States, or any employee or agency thereof, or by any cause whatsoever. The owner of said property and [_____] hereby further agree to hold harmless and indemnify the United States for any loss or damage arising out of the carriage of the aforesaid property and also agree to pay for freight and terminal service charges as may be determined by the Government loading and discharging terminals."

][1.12.5 Packaging

Package in accordance with "Department of Defense Military, Standard Transportation and Movement Procedures" and the requirements of the Government shipping service.

]]1.13 TRANSPORTATION OF PERSONNEL, MATERIALS, AND EQUIPMENT FOR GUANTANAMO BAY

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NOTE: Use this Article for projects at Guantanamo Bay, Cuba. This Article is tailored for NAVFAC SE.

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1.13.1 Ocean Freight

Provide loading of freight and ocean freight, off-loading, and handling as required, based on the following:

a. Marine Insurance: Marine insurance, to the extent required, must be provided by the Contractor.

b. Ship Arrival

(1) No ships or vessels may enter the Guantanamo Bay Defense Sea Area except as approved by Commander, U.S. Naval Base, Guantanamo Bay, Cuba. Not less than 48 hours prior to departure of vessel from the port of embarkation, provide to the Contracting Officer the following information:

(a) Name of vessel.

(b) Place of registry and registry number.

(c) Name, nationality, and address of owner.

(d) Name, nationality, and address of operator.

(e) Gross tonnage, length, beam, and draft of vessel.

(f) Nationality and numbers of officers and crew (include crew list).

(g) Number of passengers (include passenger list).

(h) Last port of call prior to entry into Guantanamo Bay Naval Defense Sea Area.

(i) Purpose of visit.

(j) Proposed date of entry and estimated duration of stay.

(2) Passengers and crew are subject to Base regulations.

(3) Commercial vessels will be permitted to discharge cargo at cargo docks to the extent that space is available.

(4) Coordinate off-loading of barge materials with the Naval Station Guantanamo Bay port operations contractor.

c. Vessels on Contract to Government

(1) Contract for shipping service, scheduled every other week to and from Guantanamo Bay, Cuba and Jacksonville, Florida, is provided by Schuler Line Navigation Co. LLC., as the Government Carrier. Sailing schedule set at 14 days between Jacksonville, Florida and Guantanamo Bay.

Schuler Line Navigation Co. (SLNC) LLC
130 Severn Ave, Ste 200
Annapolis MD 21403, United States
Office: (410) 216-9281
Fax: (410) 216-6021
Web: http://schulerline.com/cuba-liner-service

SLNC Broker: Dome Chartering & Trading Corp.
Office: (410) 216-6020
Fax: (410) 216-6021
Web: www.domechartering.com
Email: ops@domechartering.com

SLNC Jacksonville Port Agent: CB Agencies
Mr. Chuck Bridges
3565 Cardinal Point Drive
Jacksonville, FL 32257
Office: (904) 449-4714 (24 hrs)
Email: cbagency@aol.com

(2) Since these vessels are under Government contract, priority materials for Government agencies may delay receipt of Contractor's equipment and materials. The cost of containerization, shipping, on-loading, and off-loading is at the Contractor's expense; and arrangements must be made directly with the shipping company.

(3) The Government Carrier is subject to change. If a change in Government Carrier should occur, the Government is not liable for any additional costs which may be incurred by the Contractor for the construction contract.

(4) The Contractor is under no obligation to use the Government Carrier and may use others subject to the terms and conditions of this contract and U.S. Maritime law.

(5) The Contractor may ship materials and equipment by air or sea provided all clearances are met and approved in advance. The Contractor may make use of the Government Carrier's barge service, if space is available, at the established commercial rates provided by the Government Carrier. The Government's material has priority over Contractor material on the Government Carrier's barge.

1.13.2 On-Base Transportation

Provide necessary personnel, vehicles, and equipment required for on-base vehicular transportation, and bear the cost of required fuel, oil, lubricants, and maintenance there-for. The vehicles must be operated only by Contractor's employees who possess a valid motor vehicle operator's identification card; and vehicular registration will be provided without cost by the Government. Comply with the latest traffic safety program set forth in OPNAV Instruction 5100.12.

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NOTE: Use the bracketed paragraph below for projects within the JTF Area.

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[Expect varying delays, up to 20 minutes, at security checkpoints when entering the JTF Area.

]1.13.3 Transportation of Personnel

a. Air travel to and from the base is limited, with demand often far in excess of supply. Specifically:

(1) Travel to and from Jacksonville, Florida; Norfolk, Virginia; and Kingston, Jamaica is provided by the Air Mobility Command (AMC) at the Contractor's expense, and passage will be in reserved seats.

(2) Plane Fares to Guantanamo Bay, Cuba as of FY2024. Rates are

Subject to change.

From Norfolk, Virginia	$1128.00 Round Trip
From Jacksonville, Florida	$744.00 Round Trip
From Kingston, Jamaica	$204.00 Round Trip

(3) Emergency leave travel for verified personal emergencies such as death or serious illness of a family member will be authorized to any destination on the next available flight, also chargeable to the Contractor at the international tariff rate.

[1.14 EXTRAORDINARY SECURITY REQUIREMENTS FOR PEARL HARBOR

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NOTE: Do not add information related to Activity regulations which are of a routine nature. Unusual access provisions dictated by the needs of a particular project may be included, as directed.

For Pearl Harbor Naval Shipyard, coordinate with the Activity for security access requirements and add them to the project.

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[1.14.1 Other Sensitive Areas

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NOTE: For areas other than Pearl Harbor Naval Shipyard or Naval Base, verify with the Activity if required for communication buildings or other sensitive areas.

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1.14.1.1 Extraordinary Security Requirements

The Contract Clause entitled "Identification of Employees" and the following apply:

a. Vehicle searches. All construction vehicles will be searched by the Marine sentry.

b. Photographs. Photographs are prohibited in and around the building unless a written request containing specific justification and details is approved by the security officer via the Contracting Officer. Four days' advance notice is required. Photographs, when approved, may only be taken in the presence of an activity escort.

c. Personnel restrictions. Due to sensitivity of building operations, the following apply:

(1) Restrict personnel to the designated work site.

[(2) Contractor's movements within the building will be restricted. Contractor personnel will be escorted to and from designated work areas. Contractor personnel are not permitted outside of designated work areas without being escorted by authorized personnel.[Submit requests for entry into the building 4 days in advance with information required by paragraph PERSONNEL LIST for submission to the "Division Project Officer" through the Contracting Officer.]

]]]1.15 EXTRAORDINARY SECURITY REQUIREMENTS FOR PUGET SOUND NAVAL SHIPYARD & INTERMEDIATE MAINTENANCE FACILITY (PSNS & IMF), NAVAL BASE KITSAP BREMERTON, WASHINGTON

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NOTE: Use the following paragraphs for Puget Sound Naval Shipyard and Intermediate Maintenance Facility located at NBK Bremerton, WA.

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Do not enter into work areas where Shipyard personnel are using protective equipment such as respirator and masks or marked boundary areas without prior approval from the Contracting Officer.

****

NOTE: Do not add information related to Activity regulations which are of a routine nature. Unusual access provisions dictated by the needs of a particular project may be included, as directed.

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1.15.1 Vehicle Regulations in the Controlled Industrial Area (CIA) of Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS & IMF) Naval Base Kitsap, Bremerton, Washington and Sensitive Areas.

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NOTE: The provisions of these security requirements are applicable to the following area: Controlled Industrial Area (CIA) within the boundaries of Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS & IMF) at NBK Bremerton, WA.

****

Contractor vehicles requiring admittance into the CIA must be submitted to the Puget Sound Naval Shipyard Security Office via a CIA Vehicle Pass Request (PSNS & IMF 5530/25). Allow five full working days for processing of the request. CIA vehicle passes will not be issued unless a DOD vehicle sticker has been obtained and proof of vehicle registration to the Contractor's company has been submitted to the Pass and ID Office. Only those Contractor vehicles meeting the following criteria will be allowed to enter the CIA with the Shipyard vehicle pass:

a. Vehicles must clearly display an authorized company sign or logo.

b. Vehicles must be a company or commercial vehicles used to transport heavy equipment or material to the job site or to conduct required inspections and surveillance at the job site.

c. Privately owned vehicles will not be used to transport employees to the job site and will not be allowed in the CIA area.

d. Upon approval of the CIA Vehicle Pass Request, the Contractor will bring the vehicle's registration and insurance document, or a photocopy, to the Pass and ID Office where one of two CIA Vehicle

Permits will be issued.

(1) A Laydown permit that authorizes the vehicle to be brought into the CIA and parked in the negotiated site/laydown area. Each permit will include the company name, license plate number and expiration date.

(2) A Load/Unload permit that authorizes the vehicle to be brought into the CIA and parked in the negotiated site/lay down area. Each Permit will include the company name, license plate number and expiration date. Every vehicle entering the CIA will display the pass, visible at all times while in the CIA. Parking is limited to those areas that are specifically identified on the pass. If additional passes are required, present adequate justification to PSNS Security via the Contracting Officer.

e. Vehicles are required to conform to Shipyard traffic regulations. The speed limit is 20 mph in the CIA. Outside the CIA, the speed limit is as posted or marked. No privately owned vehicles are allowed inside the CIA with the exceptions of handicap, CO/XO/CMC of ships. Parking is prohibited on any piers and dry dock/waterfront areas. Do not park on or block the marked fire lanes or crane rail traveling zones (marked in yellow) at any time. Vehicles may stop on the piers or dry dock/waterfront areas for 15 minutes for loading and unloading. An exception may be made for vehicles which are part of the equipment needed to do the required work and are attached or connected to the pier of ship; for example, a truck which uses a mounted generator or a vehicle with built-in equipment. Vehicles are subject to search while entering, remaining in, or leaving the Shipyard. Government material being transported out of the CIA must be covered by a Property Pass (OP-7), issued and signed by the Security Officer. Material found without a Property Pass will be confiscated and a police officer offense report issued.

1.15.2 Restrictions On Use Of Yellow, Orange-Yellow, Red, And Magenta Materials

Refrain from use of yellow or orange-yellow materials for the following purposes: sheeting, tarpaulins, polyethylene bottles or other containers, tapes, bags, banding of identification marks on tools, boundary markers such as ribbons. Contractor generated yellow waste materials such as torn foul weather gear must be disposed of by the Contractor off-yard. Shipyard dumpsters and trash cans must not be used for disposal of Contractor generated yellow waste materials. Yellow colored items such as described above are of specific significance within PSNS & IMF and are subject to strict controls.

1.15.3 Tape Recorders

Tape Recorders are not allowed in Naval Base Kitsap (PSNS & IMF), Bremerton unless prior written approval has been obtained from the Contracting Officer.

1.15.4 Laptop Computers

Contractor may bring laptop computers into the CIA provided they are processed through the Visitor Center (Pass & ID) and receive a valid badge for personal entry. They must also complete an AIS SURVEY FORM. The completed form will be processed by the Contracting Officer, and a copy supplied to the Contractor upon approval.

The laptops:

WILL NOT contain a network card and will not be connected to the Shipyard Local Area Network.

WILL NOT process or store Navy Nuclear Propulsion Information – NOFORN data nor will they be used in Controlled Nuclear Information Areas or Nuclear Work Areas.

WILL NOT use a MODEM inside the shipyard. Systems operating in the Shipyard that are not in compliance with this policy will be confiscated.

WILL NOT contain a webcam or other means of image capturing capability.

1.15.5 Prohibited Items

Pursuant to the authority contained in 10 USC 6011 and U.S Navy Regulations, Chapter 8, Article 0826, the following items are prohibited:

a. Personal photographic equipment of any kind, including but not limited to cameras (still and video), film and cellular telephones with cameras.

b. Weapons or other dangerous materials of any kind, including but not limited to firearms, ammunition, knives (with blades longer than 2 inches), explosives, incendiaries, personnel defense aerosols/sprays.

c. Personal reproduction equipment of any kind, including but not limited to photocopying, copying, and recording devices.

d. Alcoholic beverages of any kind.

e. Personally owned portable electronic devices (PEDs) used for storing data, including, but not limited to removable storage devices (e.g., memory sticks, rewriteable CDs and DVDs, Zip and floppy disks).

1.15.6 Personally Owned Portable Electronic Device (PED) Functionality Matrix

PED Functionality/Device	**Example Device**	**PSNS & IMF Work Areas**
Any photographic or image capturing capability	Camera, Video Recorder Camera Cell Phone, Scanner	Prohibited
Single-function cell phone		Allowed
Multi-function cell phone		Allowed
Wireless transmitting capabilities	WIFI, 802.xx, Bluetooth	Allowed if turned off
RF receivers	Pager, AM/FM Radio, Satellite Radio	Allowed
RF transmitter	RF Radio	Written
Walkie-talkie		Approval Required

PED Functionality/Device	**Example Device**	**PSNS & IMF Work Areas**
Primary function audio recording devices	Digital voice recorders	Prohibited
Play-Only Devices without removable memory	MP3 players, CD Players, Digital Picture Frames, Digital Books	Allowed
Removable storage media	Memory Sticks, Thumb Drives, Flash Memory, SD Card	Prohibited
PEDs capable of connecting to government-owned systems without interface cables or cradles	Built-in USB Adapter	Prohibited
Cables and cradles for privately owned PEDs connecting to a computer system	MP3 Player to USB Cable	Prohibited

No PED device is allowed within 10 ft of Classified Information/Work

The use of personally owned PEDs to process or store government data/information is prohibited.

Additional Definitions on PED Functionality/Device Types

Single-function cell phones are defined as cellular devices with no additional photographic or network capabilities (can only be used for voice or text message communications over a cellular network, storage of speed dial caller ID information, and limited voice recording). SIM cards/embedded memory for cell phones are permitted.

Multi-function cell phone and PEDs with more than one functionality are controlled based on the most restrictive capability identified in this matrix.

An RF transmitter is defined as any radio frequency transmitter with the exception of single-function cell phones, which are addressed separately.

Amateur Radio Emergency Service (ARES)/Radio Amateur Civil Emergency Service (RACES) members must be approved in writing IAW ref (e) to carry hand-held transceivers.

CD Players capable of playing CD, CD-R, CD-RW, and MP3 formats are permitted. Only commercially produced media is allowed. No personally produced audio CDs are allowed within any PSNS and IMF facility.

1.15.7 Employment Restrictions For PSNS/IMF NBK Bremerton, WA.

Do not employ any person, for any work required by this contract, who is an alien having a residence in a foreign country.

1.16 CONTRACTED SERVICES FOR NBK BANGOR, SILVERDALE, WA.

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NOTE: Use the following paragraph for escort services into the specific activity location of projects located at NBK, Bangor, WA.

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1.16.1 Unarmed Escort Services

Unless noted otherwise in the contract, the contractor, vendors and deliveries will be required to have an unarmed escort provided by the Base Operations Support Contract (BOSC) for access to the SWFPAC Waterfront Restriction Area (WRA) and Main Limited Area (MLA). The contractor will be required to contract and coordinate directly with the Base Operations Service Contractor (BOSC) for this service. Contact the EJB Contracts Manager at (360) 396-6352 for escort requirements and to receive detailed information to cost a proposal.

1.17 NAVAL BASE KITSAP BANGOR, WA OPERATIONS AREA/SWFPAC PRODUCTION AREA SECURITY/WATERFRONT RESTRICTED AREA/MAIN LIMITED

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NOTE: Use the following paragraphs for projects located in the SWFPAC Operations Area at NBK Bangor, Silverdale, WA.

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Contractor personnel will require a B9 Code on their security badge to gain access to the SWFPAC Operation Area.

1.17.1 SWFPAC Safety and Security Brief

A SWFPAC Safety and Security Brief is required for the contractor's complete crew before any work can begin. The brief is approximately 30 minutes and is provided in Building 1040 prior to picking up badges.

1.17.1.1 Vehicle Access

Only authorized company vehicles will be allowed access to the SWFPAC Production Area. Prior to initial access, the individual driving the vehicle must stop by the SWFPAC Pass and ID Office and present the vehicle registration to obtain a vehicle pass for this area. The location of the SWFPAC Pass and ID Office is next to the NBK Pass & ID office in B1040, Naval Submarine Base Bangor (360-396-2440). Vehicle must be owned and titled to the company and have a company decal displayed.

1.17.1.2 Delays

Contractor operations are subject to reasonable delays, suspensions, and restrictions because of emergencies, alerts, drills, equipment movements and other such activities. Contractor must expect 8 hours per month due to these delays. Incorporate anticipated delay into construction schedule.

1.17.1.3 Searches and Inspections

Persons entering onto Government Property are, as a condition of access, subject to searches of all vehicles and personal belongings. This includes briefcases, handbags, tool chests, boxes, sealed packages, and personal articles. Random Administrative Vehicle Inspections are conducted by Security Police each day at various hours and locations on base. If selected for a vehicle inspection, be prepared to open your glove box, hood, trunk, and other personal items requested by Security. For the purpose of identification of unattended property, all hand carried bags and packages need to have identification tags attached. Tags may be any type or color as long as they contain the individual's name, activity, and contact number. Compliance with the security directions of SWFPAC Security Force Personnel is mandatory.

Loads or containers whose contents cannot be inspected visually are subject to inspection by Military Working Dog (MWD) teams. MWD inspections must be coordinated in advance with the SWFPAC POC and Contracting Officer at least five working days in advance. Loads that must be inspected by MWD's include, but are not limited to, concrete deliveries, asphalt deliveries, dirt loads, gravel loads, fuel trucks, and other enclosed work trucks.

1.17.1.4 Wireless Devices

Any commercial mobile wireless device or personal wearable device such as: cell phones, laptops, media devices, and smart watches, are prohibited in SWFPAC Areas. If equipment that contains wireless capabilities are required for completion of contracted work, prior approval is required by SWFPAC. Cell phones with cameras are not allowed.

1.17.1.5 HERO

Hazards of Electromagnetic Radiation to Ordnance (HERO) occurs when transmitting from any piece of equipment that emits a radio frequency (cell phone or radio (handheld or mobile)). You are allowed to use your equipment while at your work location only, in accordance with HERO Restrictions. Do not talk on your cell phone or radio while in transit within the Waterfront Restricted Area (WRA). A copy of the HERO form must be carried by anyone with a radio or phone and must be presented upon request, provided by SWFPAC Project Manager.

1.17.1.6 Photography

Photography by the contractor is prohibited.

1.17.1.7 Smoking

Smoking is only permitted in designated smoking areas. The SWFPAC Project Manager can provide the nearest designated smoking area upon request. Escort may be required.

1.17.1.8 Flame Producing Devices

Matches, lighters, and other spark producing devices are not allowed without a Hot Work Permit

1.17.1.9 Crane Operations

Coordinate with SWFPAC Project Manager regarding all work occurring inside contractor cranes operating envelope on appropriate safety precautions such as tagging, warning signage, and obstructions. SWFPAC Safety and Cranes may direct tagging out the crane at any time. The crane envelope is defined as the space the crane hook can travel and extending 152 mm 6 inches above and beside the side of the crane.

1.17.1.10 Contracted Services

Coordinate with SWFPAC Project Manager and Contracting Officer regarding the current list of approved firms that are qualified to provide unarmed escorts. This list is readily available upon request from the Contracting Officer. Additions/Omissions of firms to this list after award will not be cause for a claim or change order.

1.17.2 Main Limited Area (MLA) Security

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NOTE: Use the following paragraphs for projects located in the Main Limited Area of NBK Bangor, Silverdale, WA.

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The following requirements are in addition to those identified in the paragraph SWFPAC PRODUCTION AREA SECURITY

1.17.2.1 Exchange Badges

All personnel entering into the Main Limited Area are required to have an exchange badge. Request Exchange Badges through the BAVR system. Authorized Contractor personnel will be issued temporary uncleared visitor badges. Badges for the SWFPAC Main Limited Area will be issued by the SWFPAC Pass and ID Office. Hours of Operation are 7:00 am to 2:00 pm, Monday thru Friday, excluding Holidays. Pick up badges within 15 calendar days of the date of issue, except for emergencies. Badges not picked up within this timeframe will no longer be valid, and the Contractor will resubmit the badge request. The Contractor will ensure that each badge is returned to the SWFPAC Pass and ID Office, upon expiration of the badge or at the completion of the project, whichever occurs first. Failure to do so may affect issuance of future badges.

For work inside the Main Limited Area, only Prime Contractor personnel will be issued Limited Area badges for the contract duration. All other personnel will be issued Main Limited Area badges only for the period of time that their work is scheduled. Due to the highly restrictive nature of the Main Limited Area, keep LA badge requests to the minimum personnel required to accomplish the work.

1.17.2.2 Flammable Materials

Flammable materials can be brought into the Main Limited Area with a signed Burn Permit. Provide a written request, identifying the individuals who will be performing this work, a minimum of seven calendar days prior to required access, to the Contracting Officer for approval.

1.17.2.3 Vehicle Access

Only government and authorized company vehicles will be allowed access to the SWFPAC Production Area and Main Limited Area. Prior to initial access into these areas, the individual driving the vehicle into the Areas must stop by the SWFPAC Pass and ID Office and present the vehicle registration in order to receive an additional MLA specific vehicle pass. The location of the SWFPAC Pass and ID Office is the first floor of Building 6401, Naval Submarine Base Bangor (360-396-8426).

Every vehicle will be subject to an inspection and search by NBK Security each time access is requested and at any time after access to NBK Bangor is permitted. Navy security personnel will search all vehicles entering and exiting the Main Limited Area. Avoid transporting sealed containers (of a specific size, the real requirement is if the container is large enough to hide a person) into the Main Limited Area. If such containers must be introduced into the area, prior coordination with the SWFPAC POC and Contracting Officer, is required. Vehicle must be owned and titled to the company and have a company decal displayed.

1.17.2.4 Vehicle Disabling

At the completion of each workday, all vehicles must be left unlocked in a location designated by the SWFPAC POC. Construction equipment must be disabled (e.g., batteries disconnected). Ignition keys for all vehicles left on the work site must be removed from the work site at the end of each workday. Vehicles cannot be left on-site without prior permission from the Contracting Officer. The request to leave vehicles overnight must be requested at least 10 days in advance.

1.17.2.5 Escorts

All personnel entering into the Main Limited Area (MLA) are required to have an exchange badge. All uncleared visitors/contractors (denoted by a yellow or orange exchange badge) are required to be escorted at all times within the MLA. Each escort may escort up to five uncleared personnel. Each group of uncleared personnel must stay within visual range 22.8 m 25 yards of their assigned escort at all times. Each group must remain contiguous throughout each working day.

Uncleared personnel are allowed vehicles inside the MLA; however, there must be one escort per vehicle. The escort must ride inside the vehicle of the personnel they are escorting. The ratio of uncleared personnel to escort must not exceed five and is further limited to the number of personnel that can be safely seated inside the same vehicle. The only exemption to this rule is in the case of heavy construction equipment where only one operator my safely sit in the vehicle. Escorts are allowed to walk along side of, or follow in a separate vehicle, earth moving equipment such as excavators, rollers, loaders. Uncleared personnel must be attentive to and follow the direction of assigned escorts at all times.

Unarmed escort services must be obtained in accordance with the paragraph CONTRACTED SERVICES at the Contractor's expense. Prior coordination with the SWFPAC POC and Contracting Officer is required. A minimum of 5 working days notice is required for Military Escort coordination.

1.17.2.6 Smoking Area

There is no smoking in the Main Limited Area. The closest designated smoking area is outside of Alpha Gate (Building 6024).

1.17.2.7 Restrooms

Use Building 6594 for restrooms while working in the Main Limited Area.

1.17.2.8 Delays at India Gate

Due to extraordinary security requirements for Main Limited Area access, all vehicles and their contents will be searched by Marine Guard Force personnel on both ingress and egress at India Gate. This often results in vehicle delays of 30 minutes per gate transit, for each vehicle. Expect delays during morning rush hour (0700-0800) up to 60 minutes per gate transit, for each vehicle. Expect personnel delays during morning rush hour up to 30 minutes per gate transit, for each person. The Contractor may leave a cleared company passenger vehicle within the Limited Area to serve as a shuttle to the job site(s). These delays will not be the cause for a claim or change order.

1.17.2.9 Delays Inside Main Limited Area

Due to extraordinary security requirements for the Main Limited Area and the Waterfront Restricted Area, delays due to security drills, alerts, or missile movements can be expected to be more frequent and longer duration than would be expected elsewhere on the base. There is no predictable pattern, but delays averaging up to 8 hours per month are to be expected and will be considered an existing site condition.

Due to extraordinary security requirements for the Main Limited Area and the Waterfront Restricted Area access, all vehicles and their contents will be searched by Guard Force personnel. This often results in vehicle delays of 30 minutes per gate transit, for each vehicle. Expect delays at any time with emphasis during morning rush hour (0630-0830) up to 60 minutes per gate transit, for each vehicle. Expect personnel delays at any time with emphasis during morning rush hour up to 30 minutes per gate transit, for each person. Consider these delays an existing site condition.

1.17.2.10 Stockpiled Soil

Soil must not be stockpiled greater than 457 mm 18 inches in height in the Main Limited Area. All trenches in the Limited Area must be covered with traffic rated plates at the end of the work day

1.17.2.11 Clear Zone Requirements

The Limited Area Clear Zone is defined by a vertical plane, measured 9.1 m 30 ft from the Limited Area fence, around the entire perimeter of the Limited Area. There are Clear Zones on the interior and exterior of the Limited Area Fence perimeter. Contractors must not enter this area without permission of the Contracting Officer and SWFPAC POC. A minimum of three days noticed is required for this access to be coordinated. Construction equipment (e.g., tower cranes) must not enter into this clear zone. Soil must not be stockpiled greater than 203 mm 8 inches in height in the clear zone of the Limited Area.

1.17.2.12 Containers/Lockboxes

Contractor containers, lock boxes and equipment left overnight in the Production Area or Limited Area will be subject to search by SWFPAC Security Force Personnel. Construction locks may be utilized but during security events Security Forces reserve the right to cut locks for the purposes of inspection without recourse.

1.17.2.13 Locking of Handholes /Manholes

All new handholes or manholes over 619 mm2 96 in2 will be locked and keyed alike with SWFPAC existing locks. The key code used will be provided via the SWFPAC Project Manager.

Existing hand hole and manholes are locked. The key will be provided to the contractor, with prior coordination of at least 3 days, via the SWFPAC Project Manager. Existing hand hole or manholes fitted with single use cable locks will have their locks replaced to match existing. The specific make/model of cable lock currently being used can be provided via the SWFPAC Project Manager. All hand hole and manholes will be relocked with the approved locking devices at the end of each working day.

1.17.3 Waterfront Restricted Area (WRA) Security

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NOTE: Use the following paragraphs for projects located in the Waterfront Restricted Are (WRA) located at NBK Bangor, Silverdale, WA.

****

The following requirements are in addition to those identified in the paragraph SWFPAC PRODUCTION AREA SECURITY.

1.17.3.1 Vehicle Access

Only authorized company vehicles will be allowed access to the SWFPAC WRA. Prior to initial access into these areas, the individual driving the vehicle into the WRA must stop by the SWFPAC Pass and ID Office and present the vehicle registration in order to receive an additional WRA specific vehicle access pass. The location of the SWFPAC Pass and ID Office is the first floor of Building 6401, Naval Base Kitsap-Bangor (360-396-8426). They will need to obtain a WRA Vehicle pass for this area. The vehicle must be owned and titled to the company and have a company decal displayed.

1.17.3.2 Escorts

All personnel entering into the Waterfront Restricted Area (WRA) are required to have FAD Clearance and a visitor badge with a W code. All uncleared visitors/contractors are required to be escorted at all times within the WRA. Each escort may escort up to five uncleared personnel. Each group of uncleared personnel must stay within visual range 222.9 m 25 yards of their assigned escort at all times. Each group must remain contiguous throughout each working day.

Uncleared personnel are allowed vehicles inside the WRA; however, there must be one escort per vehicle. The escort must ride inside the vehicle of the personnel they are escorting. The ratio of uncleared personnel to escort must not exceed five and is further limited to the number of personnel that can be safely seated inside the same vehicle. The only exemption to this rule is in the case of heavy construction equipment where only one operator my safely sit in the vehicle. Escorts are allowed to walk along side of, or follow in a separate vehicle, earth moving equipment such as excavators, rollers, and loaders.

Unarmed escort services must be obtained in accordance with the paragraph CONTRACTED SERVICES at the Contractor's expense. A minimum of 5 working days notice is required for Military Escort coordination.

1.17.3.3 Delays

Due to extraordinary security requirements for the Main Limited Area and the Waterfront Restricted Area, delays due to security drills, alerts, or missile movements can be expected to be more frequent and longer duration than would be expected elsewhere on the base. There is no predictable pattern, but delays averaging up to eight hours per month are to be expected and will be considered an existing site condition.

Due to extraordinary security requirements for the Main Limited Area and the Waterfront Restricted Area access, all vehicles and their contents will be searched by Guard Force personnel. This often results in vehicle delays of 30 minutes per gate transit, for each vehicle. Expect delays at any time with emphasis during morning rush hour (0630-0830) up to 60 minutes per gate transit, for each vehicle. Expect personnel delays at any time with emphasis during morning rush hour up to 30 minutes per gate transit, for each person. Consider these delays an existing site condition.

1.17.3.4 Clear Zone Requirements

The Waterfront Restricted Area Clear Zone is defined by a vertical plane, measured 9.1 meters 30 feet from the Limited Area fence, around the entire perimeter of the Limited Area. There are Clear Zones on the interior and exterior of the Waterfront Restricted Area Fence perimeter. Contractors must not enter this area without permission of the Contracting Officer and SWFPAC POC. A minimum of three days noticed is required for this access to be coordinated.

Construction equipment (e.g., tower cranes) must not enter into this clear zone. Soil must not be stockpiled greater than 203 mm 8 inches in height in the clear zone of the Limited Area.

1.17.3.5 Containers/Lockboxes

Contractor containers, lock boxes, and equipment left overnight in the Production Area or Limited Area will be subject to search by SWFPAC Security Force Personnel. Construction locks may be utilized, but during security events, Security Forces reserve the right to cut locks for the purposes of inspection without recourse.

1.17.3.6 Locking of Handholes /Manholes

All new handholes or manholes over 619 mm2 96 in2 will be locked and keyed alike with SWFPAC existing locks. The key code used will be provided via the SWFPAC Project Manager.

Existing hand hole and manholes are locked. The key will be provided to the contractor, with prior coordination of at least 3 days, via the SWFPAC Project Manager. Existing hand hole or manholes fitted with single use cable locks will have their locks replaced to match existing. The specific make/model of cable lock currently being used can be provided via the SWFPAC Project Manager. All hand hole and manholes will be relocked with the approved locking devices at the end of each working day.

1.18 MATERIALS, FACILITIES, AND SERVICES FOR GUANTANAMO BAY

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NOTE: This Article is tailored for NAVFAC SE. Use

for projects at Guantanamo Bay, Cuba.
****

****
NOTE: Coordinate with Guantanamo Bay FEAD to update the prices for services and items, prior to PreFinal submittal.
****

The availability of Government materials, equipment, and services addressed in the following paragraphs may vary subject to local supply priority requirements for operations and maintenance of the base. Non-availability will not be considered as an excusable delay under the General Conditions Clause entitled "Changes." The cost of Government materials, equipment, and services reflected in this specification are subject to fluctuation, revision, and adjustment. Changes in rates or prices for goods and services in this and following paragraphs will not be used as a basis for a change to the contract. Some materials and equipment may be furnished to the Contractor by the Government at current rates subject to 3 days' advance notice in writing. Make all requests to the Contracting Officer. Equipment will not be available for long-term rental. Short-term equipment rental (1 to 2 days), one-time hauling service, and one-time crane service may be available if there is no conflict with Government workload. Government equipment will not be provided without Government operators.

1.18.1 Medical and Dental Services

Medical and dental services available to the Contractor's employees are limited in Guantanamo Bay. The Naval Hospital and Dental Clinic are staffed to treat primarily DOD personnel. Screen prospective employees with the objective to exclude those with admitted chronic disorders from traveling to Guantanamo Bay. Advise prospective employees of the limited medical and dental services available in Guantanamo Bay; and explain the Contractor's policy concerning the extent of liability and coverage for required treatment. Make every reasonable attempt to prevent personnel with chronic disorders, which may require treatment, such as cardiovascular defects, tuberculosis, mental health problems, and alcoholism, from being sent to Guantanamo Bay. Provide and have available, both at the job site and in the berthing areas, first aid for minor and emergency treatment. Government ambulance and medical care, when required, will be billed at the then current rates. The Naval Hospital and Dental Clinic use CHAMPUS Maximum Allowable Charge (CMAC) rates. These rates are reviewable at Health.mil.

1.18.2 Post Exchange and Commissary Privilege and Recreation Facilities

Post Exchange and commissary privileges and recreation facilities are available to authorized Contractor personnel and dependents of Contractor personnel in accordance with current base regulations.

1.18.3 Laundry and Dry Cleaning

The Government will make available laundry and dry cleaning facilities for Contractor personnel and dependents of Contractor personnel at current rates as set forth by the Navy Exchange, Guantanamo Bay, Cuba.

1.18.4 Food Facilities

Contractor personnel may eat at the Navy Exchange food outlets, or at other open food service facilities on a cash basis at current prices.

1.18.5 Contractor Debts

The Contractor is liable for debts to the Government incurred by their employees for personal services at Guantanamo Bay, Cuba, including but not limited to private telephone service, medical and dental services, and W.T. Sampson School expenses. If an employee departs the Guantanamo Bay Naval Base without liquidating debts, sufficient funds to cover this type of obligation will be withheld from Contractor payments until the debts are paid. Certify with every progress payment that all debts with the Naval Station are paid, including but not limited to, utility bills, HAZWASTE disposal charges, and Naval Hospital bills.

1.18.6 Energy Conservation

Observe and comply with the Base Energy Conservation Regulation, COMNAVBASEGTMO Instruction 11300.3 series. It is mandatory that the Contractor obtain a copy of this instruction and post it in a conspicuous location for the Contractor's employees to read. Copies of the instructions are available from the ROICC office. Ensure that employees comply with these regulations at all times. It is suggested that an employee be appointed as energy monitor by the Contractor for buildings under the jurisdiction of the Contractor.

1.18.7 Drug Abuse by Contract Employees

The Secretary of the Navy has determined that the illegal possession and use of drugs and paraphernalia by civilian and contract employees in the military setting contributes directly to military drug abuse and undermines command efforts to eliminate drug abuse among military personnel. The policy of the Department of the Navy, including the Marine Corps, is to deter and detect drug offenses by civilian and contract employees on military installations. Measures to be taken to identify drug offenses on military installations, and to prevent introduction of illegal drugs and paraphernalia include routine, random inspections of vehicles and personnel possessions on entry or exit, with drug detection dog teams, when available. Where there is probable cause to believe that a civilian or contract employee on board a Naval or Marine Corps installation has been engaged in use, possession, or trafficking of drugs, that employee may be restricted or detained for the period necessary until that employee can be removed from the installation or can be turned over to local law enforcement authorities having jurisdiction, as appropriate. When illegal drugs are discovered during an inspection or search of a vehicle operated by a civilian or contract employee, the employee and vehicle may be detained for a reasonable period of time necessary to turn the employee and the vehicle over to appropriate civil law enforcement officials; action may be taken to suspend, revoke, or deny installation driving privileges. Implicit with the acceptance of this contract is the Contractor's agreement to comply with Federal statutes, laws, and regulations, including those regulations issued by the commander of the military installation.

1.18.8 Government Utilities

****

NOTE: Coordinate with and add a reference to this paragraph in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS for utility services.

****

1.18.8.1 Rates

The contract Clause "Availability and Use of Utility Services" applies. Water and electricity will be available at designated outlets at the prevailing Government rates. Current rates (01 July 2023) are as follows:

Electricity	-	$ 412.37 per thousand kWh
Water	-	$ 18.37 per thousand gallons
Sewage	-	$ 2.74 per thousand gallons

1.18.8.2 Metering

Provide meters for power and water usage in office and shop areas. The meters provided must be sealed and tagged to indicate last calibration date and name of the person performing the calibration. The Government reserves the right to require the recalibration of the meters if erroneous readings are suspected.

1.18.8.3 Backflow Protection

Provide Backflow Protection at the source for temporary water connections used in accomplishment of this contract. Backflow device must be tested and pass certification prior to opening connection. Person installing and certifying device must be trained in accordance with NFESC UG-2029-ENV. Cross-Connection Control and Backflow Prevention Program Certification must be current prior to installation.

1.18.9 Port-a-let, Refuse Collection and Sanitary Sewage Trucking Service

These services are provided by the Base Maintenance Services Contractor, V2X. For the current rates, call 830-273-0685.

Refuse containers will be furnished and serviced by the Government at living quarters. Refuse collection service is mandatory. Contractors are required to meet base regulations concerning collection and disposal of refuse. Pickup is scheduled and charged based on volume of the dumpster, not necessarily the volume of refuse. Only refuse deposited in the Government-furnished containers will be collected. This service does not include articles left outside of the containers. This service is not available for construction or demolition sites.

1.18.10 Petroleum Products

Sales of petroleum products are made from Naval Station Supply Department Stocks under special deposit procedures based on prevailing stock ledger prices. Prices are adjusted on average two times per year. Fuel may be purchased in accordance with a Fuel Purchase Agreement between DLA Fuels and the Contractor.

Regular filling station pumps at the Navy Exchange (NEX) service station may be utilized by paying the current price at time of purchase.

1.18.11 Purchases From the Government

1.18.11.1 Sale of Government Supplies

Provisions and camp supplies other than petroleum products will be sold to the Contractor from Naval Station Supply Department Stocks under NAVSUP

Fleet Logistics Center Jacksonville (NAVSUP FLC) regulations. Miscellaneous construction materials may be sold to the Contractor under the same procedure if such sales are not detrimental to the Naval Station Supply Department stock position as determined by the Naval Station Supply Officer. Materials other than petroleum products may be issued as required, during normal working hours.

1.18.11.2 Payment for Purchases From the Government

Invoices covering sales of equipment and materials specified must be charged to a special deposit account, to be established by the Contractor in advance. Provide a cash deposit (only) to the Naval Station Comptroller prior to incurring charges. Maintain a minimum balance in this account equal to two times the anticipated monthly expenditures or $200, whichever is greater. Comply with directives governing special deposit accounts as established by the Comptroller, U.S. Naval Base, Guantanamo Bay, Cuba. Failure to settle accounts due promptly will jeopardize the availability of goods and services. The Government is entitled to withhold special deposit account arrearages from progress payments.

1.18.12 Electronic Invoices

Submit invoices electronically via e-mail or computer disc.

1.18.13 E-mail and Internet

The Contractor must have e-mail and Internet service for their office on the base.

1.18.14 Available Living Quarters

1.18.14.1 Crew Berthing

****

NOTE: Check with the Public Works Office at U.S. Naval Base Guantanamo Bay, Cuba to determine where Contractor employees will be berthed and if berthing is available. Use this paragraph for Crew Berthing requirements.

****

Provide temporary housing facilities (man camp) for prime and subcontractor workers. Contractor is responsible to provide all required facilities for Contractor personnel at a site designated by the Contracting Officer's designated representative. Tie into existing utilities at designated locations and maintain these utilities until completion of the project. The Government will bill Contractor for utilities at prevailing rates. Upon completion of the project, restore site to the original condition.

1.18.14.1.1 Codes

Temporary berthing units must be weather tight house trailers. Design, construct, and erect the trailers in accordance with ICC IBC, the latest edition of the 24 CFR 3280, ASCE 7-16 and as modified herein. Provide air conditioning units conforming to NFPA 90A and ANSI/AHRI 210/240. Electrical work must conform to NFPA 70. Design wind velocity must be in accordance with UFC 3-301-01 for location of NS Guantanamo Bay. Seismic loading criteria must be in accordance with NS Guantanamo Bay, of the referenced UFC.

Minimum furnishings must include a bed (single or bunked) and a wardrobe or dresser for each person. Minimum house furnishings must also include a television, cable box, telephone, and refrigerator that are shared with other assigned housemates. Two house mates may be assigned to one trailer. Provide a house trailer with a minimum of 9.3 square meters 100 square feet of useful floor area up and above the floor area required for the private furnishings and joint furnishings specified and the bathroom.

1.18.14.1.2 Description

The work includes delivery, erection, and removal of temporary berthing including all necessary furnishings adequate to house the Contractor's workforce for the duration of the project, complete and ready for use. The work includes providing a group site with stairs, platforms, railings, walks, parking, lighting and utility connections to existing water supply, sanitary, and electrical systems. Site must be properly drained. Provide refuse collection. Provide temporary berthing and utility connections prior to workforce arriving. Provide furnishings and equipment as required and specified.

****

NOTE: Confirm that the referenced documents are included in the project.

****

a. Layout and Location: Locate the trailers at a group site indicated on the drawings.

b. Shipping and Delivery: Provide transportation for temporary house trailers and associated accessories to and from the Naval Station and to and from the temporary site location as determined by the Contracting Officer, bearing all costs incurred. Delays in shipping must not cause an extension in the contract completion date, unless Contracting Officer determines otherwise.

c. Anchors, Piers and Tie-Down Components: Provide anchors, piers and tie-down components, used in the installation of temporary housing units, tested, listed and approved by FAC Chapter 15C-1.

d. Stairs and Ramps: Provide stairs, ramps, platforms and railings as required to facilitate access from finished grade to the temporary housing units. Construct stairs, ramps, and railings in accordance with NFPA 101.

e. Utility Connections: The facility must be connected to existing sanitary collection, water distribution, and electrical systems. Provide backflow protection in accordance with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROL. Meter power and water usage for temporary berthing with meters furnished and installed by, and at the expense of, the Contractor. Costs associated with establishing utility connection are the responsibility of the Contractor. Notify Contracting Officer 15 days prior to utility connections.

f. Refuse Collection: Provide refuse collection through the Base Maintenance Service Contractor.

1.18.14.1.3 Installation

a. Erection: Assemble, connect, and finish the facility in accordance with the 24 CFR 3280, the manufacturer's written instructions, and in accordance with applicable codes and ordinances. Provide temporary housing units with anchors, piers, and tie-down components in accordance with the minimum requirements of FAC Chapter 15C-1.

b. Maintenance: Maintain the site and temporary house trailers. Suitably paint and maintain the temporary facilities. Failure to do so is sufficient reason to require their removal. Keep the site free of refuse and unused debris. Provide a custodial service to clean each temporary berthing unit.

c. Removal: Remove temporary housing units and associated sited improvements within 45 days after the contract is completed. Notify Contracting Officer 15 days prior to disconnecting utilities.

d. Acceptance Testing: Upon completion and before final acceptance of work, test each system to demonstrate compliance with the contract requirements, including testing of air conditioning, ventilation, lighting, and plumbing systems. Adjust controls and balance systems prior to final acceptance of completed systems. Test controls through every cycle of operation. Test safety controls to demonstrate performance of required function. Correct defects in work and repeat tests. Furnish instruments, connecting devices, and personnel for tests. Flush and clean piping before placing in operation. Clean equipment, piping, strainers, ducts, and provide new filters.

1.18.14.2 Contractor Management/Supervisory Housing

****

NOTE: Check with the Public Works Office at U.S. Naval Base Guantanamo Bay, Cuba to determine where contractor employees will be berthed and if berthing is available. Use this paragraph if Contractor Management/Supervisory Housing is available.

****

For this contract, the Government will provide up to two housing units (based on availability) for the Contractor's use. These units are reserved for use by accompanied or unaccompanied management/supervisory personnel only.

Housing is assigned as follows: accompanied personnel by family composition with maximum family size of three dependents; unaccompanied personnel assignment will be made based on a minimum of one person per bedroom. If house sharing, accompaniment by dependents will not be allowed. The Government will provide family housing units with the following appliances: refrigerator, stove, dishwasher, microwave, washer, and dryer. All furnishings other than the listed appliances must be provided by the Contractor. Issuance of these housing units and rental rates are controlled by the Housing Department, Building 2295, phone 757-458-4172. Should the Contractor's assigned units not be fully occupied, the Housing Department will cancel the assignment and return the unit to inventory for other use. Personnel must abide by Family Housing instructions, which are not part of the contract but available on request. Contractors will pay rent under the Fair Market Rental (FMR) Program. Rental rates include trash and maintenance costs. Rental rates are normally adjusted annually based on market appraisal, utilities cost adjustment or the annual Consumer Price Index. Family housing units are equipped with electric and water meters. Utilities cost is billed along with monthly rent and is based on established rates and actual consumption. Rent is due in advance. No personal checks accepted. Remit payments via the Department of Treasury's web portal www.pay.gov. The Contractor is responsible for the applicable monthly rent above plus actual utilities. Rates may be adjusted annually. Current Fair Market Rental Rates as of March 2023:

Rental	Rate
2 Bedroom - 1 Bath	$1,043 Month
2 Bedroom - 1.5 Bath	$1,380 Month
3 Bedroom - 1 Bath	$1,249 Month
3 Bedroom - 2 Bath	$1,380 Month
4 Bedroom - 2.5 Bath	$1,649 Month

1.18.14.3 Contractor Berthing Facilities (CBF)

****

NOTE: Check with the Public Works Office at U.S. Naval Base Guantanamo Bay, Cuba to determine where Contractor employees will be berthed and if berthing is available. Use this paragraph for Contractor Berthing Facilities (CBF) requirements.

****

For this task order, the Government will supply the number of ESBF beds for the period of time as supported by the Contractor's personnel-loaded CPM schedule provided in Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULE (NAS). Except for allowed fair market rental units (Family/Management Quarters) Contractor employees (unaccompanied status) will be berthing with the Navy Exchange, Navy Gateway Inns and Suites Division (NGIS) in ESBF located on both sides of the bay; Windward (WW) and Leeward (LW). ESBF primarily consists of multi-occupancy rooms with wither shared or gang head bathrooms. Due to the configuration of most facilities, they are not suitable for mixing genders; therefore, female residents are not accepted by NGIS for occupancy in ESBF. Provide alternate berthing for all female employees.

1.18.14.3.1 Pricing

Costs are based on occupied beds. The current rate is $15.00 per person per bed, regardless of room configurations with the exception of suites located at Building AV640 which are $30.00. Rates are reviewed each March for implementation each October. Should prices increase, the Contractor will receive, at a minimum, 30 days notification. Bed night costs are not negotiable.

a. Utility Rates: In addition to the rates for berthing, the utility rate of $8.52 per day per person will apply, regardless of room configuration. Rates may be adjusted each Fiscal Year. This rate will be billed separately. Any price increases [and][or] decreases to CBF and utility rates/costs will not be subject to economic price adjustment(s) and any increases [and][or] decreases to these areas of Contractor overhead will not be considered and reimbursed pursuant to the changes and disputes clauses to this contract.

b. At no additional cost to the Government, the Contractor must provide temporary housing for their unaccompanied employees who do not qualify for CBF or if CBF is full. For transient lodging information or to make reservations contact the NGIS by e-mail at ngis.gtmo.reservation@navweb.org, by phone at 757-458-2044 or by visiting their main office located at Building 1670. Current transient rates as of June 2023 range from $60.00 to $90.00 depending on room configuration and location.

1.18.14.3.2 Billing

Contractors will be billed monthly for the number of beds assigned to their company. Contractors are charged for beds assigned to employees on leave unless the employee removed all personal property and checks out of the facility. Remit payment on or before due dates. Administrative and late fees apply. Failure to promptly pay can result in eviction from the premises regardless of impact to Contractor ability perform the contract specifications. NGIS makes no guarantee of bed availability or berthing locations.

1.18.14.3.3 Contractor Berthing Agreement

Prior to berthing any employees, complete a Contractor Berthing Agreement with the NGIS. A copy of this agreement is available at the NGIS management offices located at Building 1670. To determine availability, advance registration and notification of berthing requirements is highly recommended; send information via e-mail to NGIS mail box at ngis.gtmo.reservation@navweb.org. Allow 5-10 days for responses.

1.19 ARMY AND ARMY NATIONAL GUARD REQUIREMENTS AND RESTRICTIONS

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NOTE: This paragraph is tailored for ARMY. Use for projects on Army and Army National Guard installations.

****

1.19.1 3Rs Explosive Safety Education Training Certificate

All Contractor and subcontractor employees requiring access to Army or Army National Guard installations, facilities, and areas for the performance of a contract or subcontract must complete the 3Rs (Recognize, Retreat, Report) Explosives Safety Education Program training. Complete the training within 30 calendar days after the date of receipt of a written notice of award. The Contractor is responsible for ensuring that all subcontractor employees complete the training before access to the installation is required for performance of the subcontract. The Contractor is also responsible for ensuring that all contractor and subcontractor employees renew the training annually for the duration of the performance period of the contract or subcontract. Submit certificates of completion for each Contractor and subcontractor employee subject to this requirement to the Contracting Officer’s Representative (COR) or to the Contracting Officer, if a COR is not assigned, within 5 calendar days after completion of training. 3Rs Explosives Safety Education Program training is available at the following website: https://www.denix.osd.mil/uxo/3rs-training/.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 20 00 (November 2020)**
Change 5 - 02/25

Preparing Activity: NAVFAC **Superseding**
UFGS-01 20 00.00 20 (November 2011)
UFGS-01 20 00.05 20 (January 2012)
UFGS-01 22 00.00 10 (August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 01 20 00

PRICE AND PAYMENT PROCEDURES

11/20, CHG 5: 02/25

****

NOTE: For Navy projects, this guide specification covers the requirements for payment instruction paragraphs required for use in all projects.

NOTE: For Army projects, this guide specification provides an example of the appropriate form to be used in developing a project specification covering Job schedule payment items and unit price schedule payment items. This section was originally developed for and is recommended to be included in all Civil Works projects. Parts of this section are shown for illustration purposes only and the section must be extensively edited to fit the job.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This guide specification includes tailoring for DESIGN-BID-BUILD, DESIGN-BUILD, NAVY DESIGN-BUILD, ARMY and NAVY projects. Where an Editor's Note states a paragraph is tailored for a

Service or project type, the content of the paragraph, or a portion of the paragraph, is suited specifically to be included only for that Service or project type.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

U.S. ARMY CORPS OF ENGINEERS (USACE)

EP 1110-1-8	(2021) Engineering and Design -- Construction Equipment Ownership and Operating Expense Schedule

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

****
NOTE: For Navy Design-Build projects, delete 01 33 00 SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****
NOTE: The following submittal item is tailored for inclusion in Navy projects only. When a cost-loaded Network Analysis Schedule (NAS) is included in the project, the information required by this Section for the Schedule of Prices will be an integral part of the cost-loaded NAS. When a cost-loaded NAS is required retain [Earned Value Report]; otherwise retain [Schedule of Prices]. Edit the remainder of the bracketed options throughout the section consistent with the selected option.
****

****
NOTE: For projects in the NAVFAC PAC Area of Operation, and for the submittals identified as SD-01 Preconstruction Submittals, select the "G" designation.

****

[Schedule of Prices][Earned Value Report]; G

SD-03 Product Data

****
NOTE: The following submittal item is tailored for inclusion in Army projects only.
****

Weight Certificates

1.3 [SCHEDULE OF PRICES][EARNED VALUE REPORT]

****
NOTE: This Article is tailored for inclusion in Navy projects only.
****

1.3.1 Data Required

****
NOTE: For projects in the NAVFAC PAC Area of Operation, in the fourth sentence use "30" calendar days of "Contract Award".
****

[This Contract requires the use of a cost-loaded Network Analysis Schedule (NAS). Schedule of Prices must not be used with cost-loaded Network Analysis Schedule (NAS). Use Earned Value Report derived from cost-loaded NAS.][Within[15] [_____] calendar days of[notice of award][Contract Award], prepare and deliver to the Contracting Officer a[Schedule of Prices][Earned Value Report] (construction Contract) as directed by the Contracting Officer.][Schedule of Prices must have cost summarized and totals provided for each construction category.]Provide a detailed breakdown of the Contract price, giving quantities for each of the various kinds of work, unit prices, and extended prices. Indirect activities (e.g., meetings, presentations, submittals, surveys, haul road or storage yard maintenance, dust control, security) will not be cost loaded. Evenly distribute the costs across the associated construction activities. Contractor overhead and profit including salaries for field office personnel, if applicable, must be proportionately spread over all pay items and not included as individual pay items.

1.3.2 Payment Schedule Instructions

****
NOTE: This paragraph includes tailoring for NAVY DESIGN-BUILD projects. Include from the second sentence, describing design phase progress payments, through the lead-in sentence to sub-items (a. and b.) for Navy Design-Build projects.
****

Payments will not be made until the [Schedule of Prices][Earned Value Report from the cost-loaded NAS] has been submitted to and accepted by the Contracting Officer. For design phase progress payment(s), the Schedule of Prices or Earned Value Report from the Cost Loaded CPM must include detailed design activities and general (summarized) approach for the construction phase(s) of the project. The Schedule of Prices or Earned Value Report must be fully developed with detailed construction line items as design progresses. The complete design and construction Schedule of Prices or Earned Value Report must be submitted and accepted prior to starting construction work.

For Fast-Tracked or Critical Path Submittals of construction projects, the [Schedule of Prices][Earned Value Report] must include detailed design and construction line items for each fast-tracked/ critical path phase(s), submitted to and accepted by the Contracting Officer during the Post Award Kickoff Meetings and confirmed prior to starting construction work in that phase. Additionally, the [Schedule of Prices][Earned Value Report] must be separated as follows:

a. Primary Facilities Cost Breakdown:

Defined as work on the primary facilities out to the 1.5 m 5 foot line. Work out to the 1.5 m 5 foot line includes construction encompassed within a theoretical line 1.5 m 5 foot from the face of exterior walls and includes attendant construction, such as pad mounted HVAC cooling equipment, cooling towers, and transformers placed beyond the 1.5 m 5 foot line.

b. Supporting Facilities Cost Breakdown:

Defined as site work, including incidental work, outside the 1.5 m 5 foot line.

[1.3.3 Schedule Requirements for HVAC TAB

****

NOTE: This paragraph is tailored for NAVY projects. Include this paragraph when the Navy project includes testing and balancing of HVAC systems.

****

The field work requirements in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC must be broken down in the [Schedule of Prices and in the Construction Progress Documentation][Earned Value Report from the cost-loaded NAS] by separate line items which reflect measurable deliverables. The value for each pay item listed below will be established on a case by case basis for each Contract. The line items are as follows:

a. Approval of Design Review Report: The TABS Agency is required to conduct a review of the project plans and specifications to identify any feature, or the lack thereof, that would preclude successful testing and balancing of the project HVAC systems. Submit the resulting findings to the Government to allow correction of the design. The progress payment will not be issued until the report is reviewed and approved.

b. Approval of the pre-field engineering report: The TABS Agency submits a report which outlines the scope of field work. The report must contain details of what systems will be tested, procedures to be used, sample report forms for reporting test results and a quality control checklist of work items that must be completed before TABS field work commences.

c. Season I field work: Incremental payments are issued as the TABS field work progresses. The TABS Agency mobilizes to the project site and executes the field work as outlined in the pre-field engineering report. The HVAC water and air systems are balanced and operational data must be collected for one seasonal condition (either summer or winter depending on project timing).

d. Approval of Season I report: On completion of the Season I field work, the data is compiled into a report and submitted to the Government. The report is reviewed, and approved, after ensuring compliance with the pre-field engineering report scope of work.

e. Completion of Season I field QA check: Contract QC and Government representatives meet the TABS Agency at the jobsite to retest portions of the systems reported in the Season I report. The purpose of these tests are to validate the accuracy and completeness of the previously submitted Season I report.

f. Approval of Season II report: The TABS Agency completes all Season II field work, which is normally comprised mainly of taking heat transfer temperature readings, in the season opposite of that under which Season I performance data was compiled. Compile this data into a report and submit to the Government. On completion of submittal review to ensure compliance with the pre-field engineering report scope, progress payment is issued. Progress payment is less than that issued for the Season I report since most of the water and air balancing work effort is completed under Season I.

]1.4 CONTRACT COST BREAKDOWN

****

NOTE: This Article is tailored for inclusion in Army projects only.

****

The Contractor must furnish within 30 days after the date of Notice to Proceed, and prior to the submission of its first partial payment estimate, a breakdown of its single job pay item or items which will be reviewed by the Contracting Officer as to propriety of distribution of the total cost to the various accounts. Any unbalanced items as between early and late payment items or other discrepancies will be revised by the Contracting Officer to agree with a reasonable cost of the work included in the various items. This Contract cost breakdown will then be utilized as the basis for progress payments to the Contractor.

1.5 CONTRACT MODIFICATIONS

****

NOTE: This Article is tailored for inclusion in Navy projects only.

****

In conjunction with the Contract Clause DFARS 252.236-7000 Modification Proposals-Price Breakdown, and where actual ownership and operating costs of construction equipment cannot be determined from Contractor accounting records, base equipment use rates upon the applicable provisions of the EP 1110-1-8.

1.6 CONTRACTOR'S INVOICE AND CONTRACT PERFORMANCE STATEMENT

1.6.1 Content of Invoice

****

NOTE: This Article is tailored for inclusion in Navy projects only.

****

Requests for payment will be processed in accordance with the Contract Clause FAR 52.232-27 Prompt Payment for Construction Contracts and FAR 52.232-5 Payments Under Fixed-Price Construction Contracts. Invoices not completed in accordance with contract requirements will be returned to the Contractor for correction of the deficiencies. Include the documents listed below in the requests for payment.

a. The Contractor's invoice, on NAVFAC Form 7300/30 furnished by the Government, showing in summary form, the basis for arriving at the amount of the invoice. Form 7300/30 must include certification by Quality Control (QC) Manager as required by the Contract.

b. The [Estimate for Voucher/ Contract Performance Statement on NAVFAC Form 4330/54 furnished by the Government. Use NAVFAC Form 4330, unless otherwise directed by the Contracting Officer, on NAVFAC Contracts when a Monthly Estimate for Voucher is required.][Earned Value Report from the cost-loaded NAS.]

c. Contractor's Monthly Estimate for Voucher and Contractors Certification (NAVFAC Form 4330) with Subcontractor and supplier payment certification. Other documents, including but not limited to, that need to be received prior to processing payment include the following submittals as required. These items are still required monthly even when a pay voucher is not submitted.

d. Monthly Work-hour report.

e. Updated Construction Progress Schedule and tabular reports required by the contract.

f. Contractor Safety Self Evaluation Checklist.

g. Updated submittal register.

h. Solid Waste Disposal Report.

i. Certified payrolls.

j. Updated testing logs.

k. Other supporting documents as requested.

1.6.2 Submission of Invoices

****

NOTE: The following paragraphs are tailored for DESIGN-BID-BUILD (all Services) and NAVY projects. Include the first paragraph on all DESIGN-BID-BUILD projects. Include the second paragraph on NAVY DESIGN-BID-BUILD projects only.

****

If DFARS Clause 252.232-7006 Wide Area WorkFlow Payment Instructions is included in the Contract, provide the documents listed in above paragraph CONTENT OF INVOICE in their entirety as attachments in Wide Area Work Flow (WAWF) for each invoice submitted. The maximum size of each WAWF attachment is two megabytes, but there are no limits on the number of attachments. If a document cannot be attached in WAWF due to system or size restriction, provide it as instructed by the Contracting Officer.

Monthly invoices and supporting forms for work performed through the anniversary award date of the Contract must be submitted to the Contracting Officer within 5 calendar days of the date of invoice. For example, if Contract award date is the 7th of the month, the date of each monthly invoice must be the 7th and the invoice must be submitted by the 12th of the month.

1.6.3 Final Invoice

****

NOTE: The following subparagraphs are tailored for inclusion in DESIGN-BID-BUILD (all Services) projects only.

****

a. A final invoice must be accompanied by the certification required by DFARS 252.247.7023 Transportation of Supplies by Sea, and the Contractor's Final Release. If the Contractor is incorporated, the Final Release must contain the corporate seal. An officer of the corporation must sign and the corporate secretary must certify the Final Release.

b. For final invoices being submitted via WAWF, the original Contractor's Final Release Form and required certification of Transportation of Supplies by Sea must be provided directly to the respective Contracting Officer prior to submission of the final invoice. Once receipt of the original Final Release Form and required certification of Transportation of Supplies by Sea has been confirmed by the Contracting Officer, the Contractor must then submit final invoice and attach a copy of the Final Release Form and required certification of Transportation of Supplies by Sea in WAWF.

c. Final invoices not accompanied by the Contractor's Final Release and required certification of Transportation of Supplies by Sea will be considered incomplete and will be returned to the Contractor.

1.7 PAYMENTS TO THE CONTRACTOR

****

NOTE: This Article is tailored for inclusion in Navy projects only.

****

Payments will be made on submission of itemized requests by the Contractor which comply with the requirements of this section, and will be subject to reduction for overpayments or increase for underpayments made on previous payments to the Contractor.

1.7.1 Obligation of Government Payments

The obligation of the Government to make payments required under the provisions of this Contract will, at the discretion of the Contracting Officer, be subject to reductions and suspensions permitted under the FAR and agency regulations including the following in accordance with FAR 32.103 Progress Payments Under Construction Contracts:

a. Reasonable deductions due to defects in material or workmanship;

b. Claims which the Government may have against the Contractor under or in connection with this Contract;

c. Unless otherwise adjusted, repayment to the Government upon demand for overpayments made to the Contractor; and

d. Failure to maintain accurate "as-built" or record drawings in accordance with FAR 52.236.21 and the contract.

e. Failure to submit accurate monthly schedule updates in accordance with the contract.

1.7.2 Payment for Onsite and Offsite Materials

Progress payments may be made to the Contractor for materials delivered on the site, for materials stored off construction sites, or materials that are in transit to the construction sites under the following conditions:

a. FAR 52.232-5(b) Payments Under Fixed Price Construction Contracts.

b. Materials delivered on the site, but not installed, and off-site materials to be considered for progress payment must be major high cost, long lead, special order, or specialty items, not susceptible to deterioration or physical damage in storage or in transit to the construction site. Examples of materials acceptable for payment consideration include, but are not limited to, structural steel, non-magnetic steel, non-magnetic aggregate, equipment, machinery, large pipe and fittings, precast/prestressed concrete products, plastic lumber (e.g., fender piles/curbs), and high-voltage electrical cable. Materials not acceptable for payment include consumable materials such as nails, fasteners, conduits, gypsum board, glass, insulation, and wall coverings.

c. Provide the Contracting Officer with documentation (e.g., Purchase Orders or Material Contracts) to justify payment for materials in advance of installation. When appropriate, include the Defense Priorities and Allocations System (DFAS) ratings (e.g., DX or DO) on purchase orders or material contracts to ensure timely delivery.

d. Materials to be considered for progress payment prior to installation must be specifically and separately identified in the Contractor's estimates of work submitted for the Contracting Officer's approval in accordance with [Schedule of Prices][Earned Value Report] requirement of this Contract. Requests for progress payment consideration for such items must be supported by documents establishing their value (e.g., paid invoices) and that the title requirements of the clause at FAR 52.232-5 Payments Under Fixed-Price Construction Contracts have been met.

e. Ensure materials are adequately insured and protected from theft and exposure. Provide insurance documentation (e.g., Builder's Risk Insurance) which covers the overall value of the materials to be paid in advance of installation.

f. Provide a written consent from the surety company with each payment request for offsite materials.

g. Materials to be considered for progress payments prior to installation must be stored either in Hawaii, Guam, Puerto Rico, or the Continental United States. Other locations are subject to written approval by the Contracting Officer.

h. Materials in transit to the job site or storage site are not acceptable for payment.

[1.8 SINGLE JOB PAYMENT ITEMS

****

NOTE: This Article is tailored for Army projects. Include this Section for Army projects requiring single job payment items.

****

****

NOTE: A letter from the OFFICE OF THE UNDER SECRETARY OF DEFENSE dated October 3, 2011, SUBJECT: Contract Line Item Pricing Integrity, states, "No Contract action should be issued using 'lump sum' or 'dollars' as a unit of measure." Replace LUMP SUM with JOB in all UFGS sections for DoD Contracts.

****

****

NOTE: The number and identification of single job payment item(s) is primarily a Construction Division concern. Generally, it is better to keep the number of single job payment items to a minimum. The description of the work included in a payment item is unique for each job and must be developed for each construction Contract. For bracketed items, choose applicable item(s) or insert appropriate information.

****

Payment items for the work of this Contract for which Contract job payments will be made are listed in the [BIDDING][PRICING] PROPOSAL SCHEDULE and described below. All costs for items of work, which are not specifically mentioned to be included in a particular job or unit price payment item, are included in the listed job item most closely associated with the work involved. The job price and payment made for each item listed constitutes full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, environmental protection, meeting safety requirements, tests and reports, and for performing all work required for which separate payment is not otherwise provided.

1.8.1 Mobilization and Demobilization

****

NOTE: If mobilization and demobilization costs are expected to be a minor cost under the Contract, this clause and payment item should be deleted.

****

1.8.1.1 Payment

Payment will be made for costs associated with mobilization and demobilization, as defined in Special Contract [Clause][Requirement] PAYMENT FOR MOBILIZATION AND DEMOBILIZATION.

1.8.1.2 Unit of Measure

Unit of measure: job.

1.8.2 Structure No. 1

1.8.2.1 Payment

Payment will be made for costs associated with operations necessary for construction of the structure at Station XX+XX.

1.8.2.2 Unit of Measure

Unit of measure: job.

1.8.3 Structure No. 2

1.8.3.1 Payment

Payment will be made for costs associated with operations necessary for construction of the structure at Station XX+XX.

1.8.3.2 Unit of Measure

Unit of measure: job.

][1.9 UNIT PRICE PAYMENT ITEMS

****

NOTE: This Article is tailored for Army projects. Include this Section for Army projects requiring unit price payment items.

****

****

NOTE: Unit price payment items should be used only where appropriate under the guidance of Federal Acquisition Regulation (FAR) Part 36 - Construction and Architect-Engineer Contracts paragraph 36.207 Pricing Fixed-Price Construction Contracts.

The Unit Price payment items shown below are for illustration purposes only. Unit price payment item language must be written specifically for each job. Unit price payment item language appropriate for

inclusion below is contained in guide specification sections and must be moved to this section to develop the pay items for the project.
****

Payment items for the work of this Contract on which the Contract unit price payments will be made are listed in the [BIDDING][PRICING] PROPOSAL SCHEDULE and described below. The unit price and payment made for each item listed constitutes full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, environmental protection, meeting safety requirements, tests and reports, and for performing all work required for each of the unit price items.

1.9.1 Excavation

****
NOTE: Modify this paragragh if Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL is used. For bracketed items, choose applicable item(s) or insert appropriate information.
****

1.9.1.1 Payment

Payment will be made for costs associated with excavation [for the channel][and][for the structure], which includes performing required excavation and other operations incidental thereto, Contractor-furnished disposal area(s) and disposition of excess excavated material and unsuitable and frozen materials.

1.9.1.2 Measurement

The total quantity of excavated material for which payment will be made will be the theoretical quantity between the ground surface as determined by a survey and the grade and slope of the theoretical cross sections indicated. No allowance will be made for overdepth excavation or for the removal of any material outside the required slope lines unless authorized.

1.9.1.3 Unit of Measure

Unit of measure: cubic meter yard.

1.9.2 M 90 Riprap

****
NOTE: This example was taken from Section 35 31 19.40 STONE REVETMENTS.
****

1.9.2.1 Payment

Payment will be made for costs associated with furnishing, transporting, stockpiling (if applicable), placing, and constructing the stone protection as specified.

1.9.2.2 Measurement

Measure riprap for payment by the ton metric 2,000 pounds by weighing each truckload to the nearest 0.1 ton 200 pounds, and the final quantity of [each truckload][the whole sum] is rounded to the nearest whole ton. Weigh the riprap for payment on approved scales before being placed in the work. Quarry weights will not be accepted. Use scales of sufficient length to permit simultaneous weighing all axle loads. Scales must be inspected, tested and sealed as directed to assure accuracy with 0.5 percent throughout the range of the scales. Certify scales located at the site of the work as to accuracy by an acceptable scales company representative prior to weighing any riprap. Scales will be checked and certified before riprap hauling and rechecked and recertified whenever a variance is suspected. Furnish the scales. If commercial scales are readily available in close proximity, 15 kilometers 10 miles of site of work, the Contracting Officer may approve the use of the scales. Weigh riprap in the presence of the Government representative. The Contracting Officer may elect to accept certified weight certificates furnished by a public weighmaster in lieu of scale weights at the jobsite.

1.9.2.3 Unit of Measure

Unit of measure: ton metric 2,000 pounds.

1.9.3 Deformed Steel Bars for Concrete Reinforcement

****

NOTE: This example was taken from Section 03 30 00 CAST-IN-PLACE CONCRETE.

****

1.9.3.1 Payment

Payment will be made for costs associated with furnishing, transporting, delivering, and placing deformed steel bars for concrete reinforcement, which includes steel in laps as indicated or as required. No payment will be made for the additional steel in laps which are authorized for the convenience of the Contractor. No separate payment will be made for accessories; include payment in the Contract unit price for the items of work to which the accessories are incidental.

1.9.3.2 Measurement

The measured lengths of deformed steel bars for concrete reinforcement will be converted to weights for the size of bars listed by the use of the nominal weights per lineal meter foot specified in ASTM A615/A615M.

1.9.3.3 Unit of Measure

Unit of measure: per kilogram pound in place.

][1.10 CONTAMINATED SOIL REMOVAL

****

NOTE: Include this Article for Army projects requiring contaminated soil removal and edit accordingly.

****

Payment items for the work of this Contract on which the Contract unit price payments will be made are listed in the [PRICING][BIDDING] PROPOSAL SCHEDULE and described below. The unit price and payment made for each item listed must constitute full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, environmental protection, meeting safety requirements,[tests and reports,] and for performing all work required for each of the unit price items.

1.10.1 Unit of Measure

Unit of measure: cubic meter yard.

][1.11 DREDGING

****

NOTE: Include this Article for Army projects that include dredging. Modify this paragraph if SECTION 35 20 23 DREDGING is used.

****

Payment will be made at the Contract job price and must constitute full compensation for performing all dredging, disposal,[and ice and snow removal,] stockpiling, and replacement. Payment will be in accordance with above paragraph, SINGLE JOB PAYMENT ITEMS. In no case will payment be made for material removed from below the maximum pay-line or outside the dredging prism as indicated.

]PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 30 00 (November 2020)**
Change 5 - 02/25

Preparing Activity: NAVFAC **Superseding**
UFGS-01 30 00 (August 2015)
UFGS-01 30 00.05 20 (March 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 01 30 00

ADMINISTRATIVE REQUIREMENTS

11/20, CHG 5: 02/25

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

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****

SECTION 01 30 00

ADMINISTRATIVE REQUIREMENTS

11/20, CHG 5: 02/25

****

NOTE: This guide specification covers general administrative and procedural requirements for Contractor management and coordination.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

The initial Performance Assessment Plan (PAP) is available for download on the Whole Building Design Guide at: https://www.wbdg.org/dod/ufgs/ufgs-01-30-00

****

****

NOTE: This section contains tailoring for NAVY, NAVFAC EURAFCENT, NAVFAC FE, NAVFAC MAR, NAVFAC SE, ARMY, AIR FORCE, DESIGN-BUILD, DESIGN-BID-BUILD and NAVY DESIGN-BUILD. Where an Editor's Note states a paragraph is tailored for a Service or project type, the content of the paragraph, or a portion of the paragraph, is suited specifically to be included only for that Service or project type.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

15 CFR 772	Definition of Terms
15 CFR 773	Special Licensing Procedures

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

****
NOTE: For Navy DB projects, delete 01 33 00, SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****
NOTE: For projects in the NAVFAC PAC Area of Operation, and for the submittals identified as SD-01 Preconstruction Submittals, remove the "G" designation.
****

View Location Map

Progress and Completion Pictures

Design Submittal Packaging

Performance Assessment Plan (PAP)

SD-04 Samples

****
NOTE: The following submittal item is tailored for use on AIR FORCE projects and optional for ARMY projects. Do not use this submittal item in Design-Build projects.
****

Color Boards; G, [_____]

1.3 COLOR BOARDS

****

NOTE: This Article is tailored for AIR FORCE. Per AFI 32-1023, 2.16.2, this paragraph is for use only on Air Force projects. Do not use this paragraph in Design-Build projects.

This Article is tailored as optional for ARMY use on all projects. Check with the local field office to determine if it should be included.

****

Submit five sets of color boards within 90 calendar days after Contract Award. Each set of boards must include samples of colors and finishes of interior surfaces, such as walls, floors, and ceilings. Present the samples on 200 by 270 mm 8 by 10-1/2 inches boards (modules) with a maximum spread of 600 by 810 mm 24 by 31-1/2 inches for foldouts. Design modules to fit in a standard loose-leaf, three-ring binder. Where special finishes such as architectural concrete, carpet, or prefinished textured metal panels are required, submit samples not less than 300 mm 12 inches square with the board. If more space is needed, more than one board per set may be submitted. Certify that the color samples have been reviewed in detail, and that the color samples are in strict accordance with contract drawings and specifications, except as may be otherwise explicitly stated. Submittal of color samples does not relieve the Contractor of the responsibility to submit samples required elsewhere herein.

1.4 VIEW LOCATION MAP

Submit, prior to or with the first digital photograph submittals, a sketch or drawing indicating the required photographic locations. Update as required if the locations are moved.

1.5 PROGRESS AND COMPLETION PICTURES

Photographically document site conditions prior to start of construction operations.[Include aerial photographs.] Provide monthly, and within one month of the completion of work, digital photographs, 1600x1200x24 bit true color minimum resolution in[JPEG] [_____] file format showing the sequence and progress of work. Take a minimum of 20 digital photographs each week throughout the entire project from a minimum of ten different viewpoints selected by the Contractor unless otherwise directed by the Contracting Officer. Submit with the monthly invoice[two sets of digital photographs, each set on a separate compact disc (CD) or data versatile disc (DVD)][one set of digital photographs in the agency construction management system of record], cumulative of all photos to date. Indicate photographs demonstrating environmental procedures. Provide photographs for each month in a separate monthly directory and name each file to indicate its location on the view location sketch. Also provide the view location sketch[on the CD or DVD][with the submission in the agency construction management system of record] as a digital file. Include a date designator in file names. Photographs provided are for unrestricted use by the Government.

1.6 MINIMUM INSURANCE REQUIREMENTS

****

NOTE: Do not use this paragraph for projects at Guantanamo Bay.

****

Provide the minimum insurance coverage required by FAR 28.307-2 Liability, during the entire period of performance under this contract. Provide other insurance coverage as required by [State]Portugal Guam Diego Garcia BIOT law.

1.7 SUPERVISION

1.7.1 Superintendent Qualifications

****

NOTE: For first and second bracketed items, choose 10 years and 5 years respectively, for most projects. Fill in brackets and coordinate with Construction Manager/Resident Engineer for Army projects or ROICC/FEAD for Navy projects to determine if more experience is needed for larger, complex projects, or less, for simple, less costly projects.

****

****

NOTE: Include the second bracketed paragraph when Superintendent is permitted to also serve as Quality Control Manager.

****

Provide project superintendent with a minimum of [10][_____] years experience in construction with at least [5][_____] of those years as a superintendent on projects similar in size and complexity. The individual must be familiar with the requirements of EM 385-1-1 and have experience in the areas of hazard identification and safety compliance. The individual must be capable of interpreting a critical path schedule and construction drawings. The qualification requirements for the alternate superintendent are the same as for the project superintendent. The Contracting Officer may request proof of the superintendent's qualifications at any point in the project if the performance of the superintendent is in question.

[For projects where the superintendent is permitted to also serve as the Quality Control (QC) Manager as established in Section01 45 00 QUALITY CONTROL, the superintendent must have qualifications in accordance with that section.

]1.7.2 Minimum Communication Requirements

Have at least one qualified superintendent, or competent alternate, capable of reading, writing, and conversing fluently in the English language, on the job-site at all times during the performance of Contract work. In addition, if a Quality Control (QC) representative is required on the Contract, then that individual must also have fluent English communication skills.

1.7.3 Duties

The project superintendent is primarily responsible for managing subcontractors and coordinating day-to-day production and schedule adherence on the project. The superintendent is required to attend Red Zone meetings, partnering meetings, and quality control meetings. The superintendent or qualified alternative must be on-site at all times during the performance of this contract until the work is completed and accepted.

1.7.4 Non-Compliance Actions

The Project Superintendent is subject to removal by the Contracting Officer for non-compliance with requirements specified in the contract and for failure to manage the project to ensure timely completion. Furthermore, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders is acceptable as the subject of claim for extension of time or excess costs or damages by the Contractor.

1.8 PRECONSTRUCTION MEETING CONFERENCE

****

NOTE: The title of this paragraph, and the paragraph below is tailored for NAVY to use "Meeting" and tailored for ARMY to use "Conference."

****

****

NOTE: This paragraph includes tailored phrases for both Design-Bid-Build and Design-Build projects.

****

Immediately after award, Upon completion of design and design acceptance by the government, prior to commencing any work at the site, coordinate with the Contracting Officer a time and place to meet for the Preconstruction Meeting Conference. The meeting conference must take place within [35] [_____] calendar days after award of the contract, but prior to commencement of any work at the site. The purpose of this meeting conference is to discuss and develop a mutual understanding of the administrative requirements of the Contract including but not limited to: daily reporting, invoicing, value engineering, safety, base-access, outage requests, hot work permits, schedule requirements, quality control, schedule of prices or earned value report, shop drawings, submittals, cybersecurity, prosecution of the work, government acceptance, final inspections and contract close-out. Contractor must present and discuss their basic approach to scheduling the construction work and any required phasing.

1.8.1 Attendees

Contractor attendees must include the Project Manager, Superintendent, Site Safety and Health Officer (SSHO), Quality Control Manager and major subcontractors.

1.9 POST AWARD KICKOFF (PAK) MEETING

****

NOTE: This Article is tailored for NAVY DESIGN-BUILD projects. Include this Article and paragraphs for Navy Design-Build projects only.

****

Immediately after award, coordinate with the Contracting Officer a time and place for the PAK Meeting. The PAK meeting must be held within [35][_____] calendar days after contract award and prior to commencing work. If mutually agreed upon by the Contractor and the Government, the PAK Meeting may be held concurrently with the Design Presentation/Design Development Meeting or Concept Design Workshop (CDW) whichever is required.

1.9.1 PAK Meeting Outcomes

a. Integrate the Contractor and all client representatives into the project team.

b. Achieve consensus from the project team on any issues and concerns with the Contractor's technical proposal and the User's functional requirements.[Confirm the design is within the project budget.]

c. Review the administrative requirements of the contract that are critical during the design phase.

d. Establish clear lines of communication and points of contact for Government and Contractor team members.

e. Obtain an acceptable conceptual design including floor and site plans, signed by the client, Contractor and other key team members.

****

NOTE: Select 01 32 17.00 20 if a cost-loaded Primavera P6 schedule is required for the project - this specification Section applies primarily to MILCON projects and any other similar projects with multiple disciplines working simultaneously. Select 01 32 16.00 20 if a non-cost-loaded P6 schedule or a Microsoft Project schedule (cost-loaded or non-cost-loaded) is required - this specification applies to small projects, either simple or complex, that would not benefit from the use of a cost-loaded Network Analysis Schedule (NAS).

****

f. Review the project design schedule and design package requirement, design submittal packaging, and preliminary construction schedule in accordance with Section [01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULE (NAS)][01 32 16.00 20 SMALL PROJECT CONSTRUCTION PROGRESS SCHEDULES]. Discuss design milestones and events that will be included in the Quality Control Communication Plan.

g. Establish clear expectations and schedules for facility turnover, providing DD Form 1354 asset management records, eOMSI submittals, Guiding Principle Validation, Third Party Certification (if applicable), and training of Government maintenance personnel.

h. Establish procedure for design packages reviews, Contractor's resolution to comments, and Government's role in review of packages.

****

NOTE: Insert the bracketed paragraphs below ONLY if Concept Design Workshop (CDW) is required.

****

[i. Establish clear expectations for the Concept Design Workshop as established in UFGS 01 31 19.05 20 CONCEPT DESIGN WORKSHOP (CDW).

][j. Establish clear expectations for Design Model presentations for projects implementing Building Information Management/Modeling (BIM).

]1.9.2 PAK Meeting Contractor Attendees

****

NOTE: If a Commissioning Authority is used, delete the first bracketed option. If a Commissioning Authority is not used, delete the second bracketed option.

****

The following Contractor personnel must attend the PAK meeting; Project Manager, Project Scheduler, Lead Designer-of-Record (DOR), Design Staff responsible for each architectural/engineering discipline when facility design is discussed, Superintendent, QC Manager,[and the] DQC Manager[and the Commissioning Authority (CA)]. Optional attendees include: Principal, Assistant Project Manager, major subcontractors and specialized supplemental QC personnel.

[1.10 DESIGN PRESENTATION/DEVELOPMENT (DP/D)

****

NOTE: Insert the paragraph below for Design Presentation/Development ONLY if a Concept Design Workshop (CDW) is NOT required. If a CDW is required, do not insert this paragraph and use UFGS 01 31 19.05 20 CONCEPT DESIGN WORKSHOP (CDW).

****

The Contractor must lead discussions to develop an understanding of the facility design that the accepted technical proposal represents with the Government users and maintainers of the facility. Develop site plans, floor plans, exterior finish materials, and building elevations to conduct working sessions with the Government meeting attendees. The purpose of the DP/D Meeting is to confirm the appropriateness of the facility design and develop acceptable alternatives if changes are needed. The Contractor must anticipate that Government Facility Users represented at the DP/D Meeting will provide additional functional information. Incorporate functional design changes into the facility design as required to meet the needs of the Users. At the end of the DP/D Meeting the Contractor must provide either assurance that the updated design can be built within the budget or identify potential cost modification items and establish a follow-on DP/D Meeting to finalize a design that will include trade-offs to bring the project within the budget. The following Contractor key personnel must attend the Design Presentation: Project Manager, Project Scheduler, Cost Estimator, Lead Designer of Record, Design Staff responsible for each architectural/engineering discipline when facility design is discussed, Major Subcontractors, and DQC.

Demonstrate ability to achieve identified Guiding Principle sustainability goals and also Third-Party Certification sustainability goals, if applicable. Provide Preliminary Sustainability Notebook, refer to Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for requirements.

]1.11 FACILITY TURNOVER PLANNING MEETINGS (Red Zone Meetings)

Meet with the Government to identify strategies to ensure the project is carried to expeditious closure and turnover to the Client. Start planning the turnover process at the Pre-Construction Conference meeting with a discussion of the Red Zone process and convene at regularly scheduled Red Zone Meetings beginning at approximately 75 percent of project completion. Include the following in the facility Turnover effort:

1.11.1 Red Zone Checklist

a. Contracting Officer's Technical Representative (COTR) will provide the Contractor a copy of the Red Zone Checklist template.

b. Prior to 75 percent completion, modify the Red Zone Checklist template by adding or deleting critical activities applicable to the project and assign planned completion dates for each activity. Submit the modified Red Zone Checklist to the Contracting Officer. The Contracting Officer may request additional activities be added to the Red Zone Checklist at any time as necessary.

1.11.2 Meetings

a. Conduct regular Red Zone Meetings beginning at approximately 75 percent project completion, or three to six months prior to Beneficial Occupancy Date (BOD), whichever comes first.

b. The Contracting Officer will establish the frequency of the meetings, which is expected to increase as the project completion draws nearer. At the beginning, Red Zone meetings may be every two weeks then increase to weekly towards the final month of the project.

c. Using the Red Zone Checklist as a Plan of Action and Milestones (POAM) and basis for discussion, review upcoming critical activities and strategies to ensure work is completed on time.

d. During the Red Zone Meetings discuss with the COTR any upcoming activities that require Government involvement.

e. Maintain the Red Zone Checklist by documenting the actual completion dates as work is completed and update the Red Zone Checklist with revised planned completion dates as necessary to match progress. Distribute copies of the current Red Zone Checklist to attendees at each Red Zone Meeting.

[1.12 EXPORT LICENSES FOR OVERSEAS PROJECTS

****

NOTE: Include the following paragraph in projects at overseas locations.

****

Obtain individual export licenses and project export licenses required by the Department of Commerce regulations (15 CFR 772 and 15 CFR 773) so that no delays are experienced in shipping from the United States of America to a foreign country. For additional information, the Contractor may contact one of the U.S. and Foreign Commercial Service District Offices of the Department of Commerce which are located in almost every State.

][1.13 WAIVER FOR WORKER'S COMPENSATION

****

NOTE: Include the following paragraph in projects for overseas locations, except Guantanamo Bay.

****

In addition to FAR 52.228-4 Workers' Compensation and War-Hazard Insurance Overseas, the Secretary of Labor has granted a waiver. The waiver does not apply to employees who are hired in the United States, or who are residents, or citizens of the United States.

]1.14 PARTNERING

****

NOTE: Select one of two possible choices for the Level of Partnering. Coordinate with the Project Manager/ Design Manager and Construction Manager to determine whether Formal or Informal Partnering should be used.

The two Partnering Level options are:

1. Facilitated (Formal): Recommended for use on high risk, high visibility, compressed duration, technical complexity, or standalone contracts over approximately $15M for Army and Air Force, and approximately $1M for the NAVY. Facilitated by a third-party independent Formal Partnering Facilitator consultant paid for by Contractor. Contractor includes costs for facilitator, room rental and incidental items in bid. Participants pay own costs for meals, lodging and transportation. Partnering "re-groups" held as agreed in charter. Exceptions: When DB Contractor, Government and Supported Commands are already familiar with each other from recent contracts, consider using Informal Partnering.

2. Team Led (Informal): Recommended for use on Army and Air Force contracts less than $15M and NAVY projects less than $1M, without high risk, high visibility, compressed performance period, or technically complex characteristics. Exceptions: When new Supported Commands, new Contractor, first time use of new contract vehicle or other unique contract requirements consider upgrade to Formal Partnering to lessen risk.

****

****

NOTE: Partnering is required for all projects.

NOTE: For projects in the NAVFAC PAC Area of Operation, edit the paragraph by adding the first bracketed item to the paragraph.

****

[Host the partnering session within 45 calendar days of contract award.

]To most effectively accomplish this Contract, the Contractor and Government must form a cohesive partnership with the common goal of drawing on the strength of each organization in an effort to achieve a successful project without safety mishaps, conforming to the Contract, within budget and on schedule. The partnering team must consist of personnel from both the Government and Contractor including project level and corporate level leadership positions. Key Personnel from the supported command, end user, [NAVFAC, PWD, FEAD/ROICC][_____], Contractor, key subcontractors and the Designer of Record (DOR) (regardless of whether the contract is a design-build or a design-bid-build) are required to participate in the Partnering process.

[1.14.1 Facilitated (Formal) Partnering

****

NOTE: The subparagraphs below are tailored to include "Pre-construction" meeting for DESIGN-BID-BUILD projects and "PAK" meeting for NAVY DESIGN-BUILD projects.

****

****

NOTE: For NAVFAC PAC Area of Operation, remove the first bracketed sentence in list item a. below.

****

a. [Within [35][_____] calendar days after award and prior to the start of work,]host a Formal Partnering session with key personnel from the project team including both Contractor and Government personnel. All costs associated with the Partnering session including the third-party independent Facilitator Consultant, meeting room and other incidental items are the responsibility of the Contractor.

b. Before the Facilitated (Formal) Partnering session, coordinate with the Facilitator all requirements for incidental items (such as audio-visual equipment, easels, flipchart paper, colored markers, note pads, pens/pencils, colored flash cards) and have these items available at the Partnering session. Provide copies of any documents required for distribution to all attendees. Participants will bear their own costs for meals, lodging and transportation associated with Partnering.

c. The Initial Partnering Session must be a duration of [one][_____] day and be held at a location off base as agreed to by the Contracting Officer. Partnering session may take place concurrently with the Pre-Construction Post-Award Kickoff Meeting.

d. Facilitator must be experienced in conducting corporate Partnering sessions and must be a third-party independent facilitating consultant - not an employee of the Contractor. The Facilitator is responsible for leading all aspects of the Partnering session necessary to achieve the Partnering goal.

e. An outcome of the Partnering session must be an escalation matrix agreed upon by both the Government and Contractor, which identifies key Government and Contractor decision makers by name and anticipated decision durations.

f. Host follow-on Partnering Sessions at three- to six-month intervals or more frequently if needed and lasting generally a half day or less.

Attendees need only be those required to resolve current issues. The same Facilitator used in the Initial Partnering session must lead the follow-on sessions unless an alternative is permitted by the Contractor Officer. All costs associated with follow-on Partnering sessions are the responsibility of the Contractor.

][1.14.2 Team-Led (Informal) Partnering

a. The Contracting Officer will coordinate the initial Team-Led (Informal) Partnering Session with key personnel of the project team, including Contractor and Government personnel. The Partnering Session will be co-led by the Government Construction Manager and Contractor's Project Manager.

b. The Initial Team-led Partnering session may be held concurrently with the Pre-Construction Post-Award Kickoff meeting. Partnering sessions will be held at a location mutually agreed to by the Contracting Officer and the Contractor, typically at a conference room on-base or at the Contractor's temporary trailer.

c. The Initial Team-Led Partnering Session will be conducted and facilitated using electronic media (a video and accompanying forms) provided by Contracting Officer.

d. The Partners will determine the frequency of the follow-on sessions.

e. Participants will bear their own costs for meals, lodging and transportation associated with Partnering.

]1.15 PERFORMANCE ASSESSMENT PLAN (PAP)

****

NOTE: This Article is tailored for use on NAVY DESIGN-BUILD projects only.

****

The Performance Assessment Plan (PAP) will be used to document design innovation and budget management, provide performance feedback to the Contractor, and as a basis for interim and final evaluations in the Contractor Performance Appraisal Reporting System (CPARS) on-line database.

It is the intent of the Government to establish the PAP based on tangible, measurable indicators of outstanding contractor performance, and on commitments made in the Contractor's proposal. The initial PAP may be found on the NAVFAC Design-Build Request for Proposal website in RFP PART 6 Attachments or on the Whole Building Design Guide at: https://www.wbdg.org/dod/ufgs/ufgs-01-30-00.. Review and finalize the initial PAP during the Partnering Session. During the initial Partnering Session, the Government, the Contractor, the Designer-of-Record, and the Client will establish the PAP. Following the establishment of the PAP, the Contractor will present it, with his input, for update and discussion at projects meetings which discuss project performance. Submit an updated PAP on a monthly basis with the invoice for that period as a minimum.

[1.16 MOBILIZATION

****

NOTE: For projects in the NAVFAC PAC Area of Operation, add the following paragraph. Select the

first bracket for DBB and second bracket for DB.
****

Mobilize to the jobsite within [60 calendar days after contract award] [30 calendar days of final site or building design approval]. Mobilize is defined as having equipment AND having a physical presence of at least one person from the contractor's team on the jobsite.

]PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

****
USACE / NAVFAC / AFCEC　　　　**UFGS-01 31 20 (May 2022)**

Preparing Activity: USACE　　　　**New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-01 31 20 (May 2022)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 31 20

PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION

05/22

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NOTE: This guide specification covers the requirements for project technical data management and visualization.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This specification has been developed from lessons learned over a decade of DoD mega contracts, and input from the data management industry. What this has taught us is where the Contractor fully understands the activities and efforts associated with the collection and display of data during the bidding process, the more successful they are in providing what the Government requires from its system. It has also taught us that the enforceability of a specification depends on specific measures such as turnover times, government approval submittals, work product expectations, and

dedicated measurement and payment for features.

The data management system's primary function is to ensure quality construction that meets the organization's regulatory requirements, meets time and budget constraints. None of these components have been added frivolously but were thoughtfully developed with the hindsight of lessons learned on other mega contracts which resulted in significant additional cost, or a failure of some or all aspects of the system to meet the Government's needs.

Good data management system design relies heavily on communication and a common understanding of technical designer and construction office during the design process considering the project staff's technologic capabilities and the scope of the project. This communication is required to adequately customize this specification. It is strongly recommended to be as specific as possible about government goals and expectations and design the system and products with the same amount of detail as any other feature of work.

The Government has specific cybersecurity, project documentation, as built drawing specifications and software constraints defined by our security protocols and engineering regulations. Therefore, writing a vague, performance style specification without a thorough description of these needs and constraints - placing the onus entirely on the contractor to premeditate government needs - is not appropriate. A specification that is adequately descriptive but with room for contractor innovation will lead to better biddability, and a better understanding of the Government's goals and desired end products. This will lead to a better overall outcomes and avoid lengthy submittal processes and disagreements with the Contractor to arrive at acceptable workflows and deliverables.

Tailoring options have been added for:

SQL RDBMS EDB (for use of SQL RDBMS - generic database language which must be customized will remain even if this option is removed. Choose this option OR ACCESS ENTERPRISE DATABASE, not both)

ACCESS ENTERPRISE DATABASE (for small projects where Access is more appropriate choose this option - if removed generic database language will remain. Choose this option OR SQL RDBMS EDB, not both)

WEB INTERFACE Utilize this option for all types of web interfaces - spatial and non-spatial. This option contains the general requirements for security, accessibility and QA tools.

WEB-BASED GIS INTERFACE Utilize this option for

web-hosted GIS models such as ESRI ArcGIS on a federated ArcServer platform.

DYNAMIC DATA WEB INTERFACE Utilize this option for web-hosted data visualizations such a Microsoft PowerBI, QLIK, Tableau. to show data plots and analytics on testing or installation QC data.

DESKTOP GIS FILES Utilize this option for the receipt of files for GIS desktop products in the full-scale version of the software. This is different from the GIS web viewer in that you have the source files that can edited and republished to the Agency web service. The GIS web viewer is limited to viewing only and will no longer be available after the contract ends.

OPENGROUND USACE users should use this option for all boring data. If no rock or soil boring data will be collected, or if a different software format will be used, do not use this option.

SAMPLE DATA DELIVERABLES Intended to give a sample of the types of requirements that need to be detailed for different types of work. In a perfect world, these requirements would be placed in the feature of work section which details the work requirements.

ADDITIONAL DATA COLLECTION PLAN SUBMITTALS Contains sample data collection plans for the collection of automated grouting data and remote sensing data such as LiDAR, imagery, and photogrammetry. This option may become redundant if a grouting and remote sensing guide specification is published.

CAD 3D MODEL Utilize this option if Section 01 78 00 CLOSEOUT SUBMITTALS is not properly descriptive of standards and requirements for a spatially referenced CAD model.

CAD QUALIFICATIONS AND ROLES Utilize this option is Section 01 78 00 CLOSEOUT SUBMITTALS is not properly descriptive of qualifications for CAD personnel.

DATA VISUALIZATION SPECIALIST Utilize this option if this role is desired in addition to a data manager. See PART 1, PERSONNEL for a description of the position and notes about when it should be considered for use.

SDSFIE Utilize this option only if there is SDSFIE schema available for data to be collected on the project.

NETWORK INFRASTRUCTURE Utilize this option only if the project requires the Contractor to provide internet connectivity to the site for themselves or the Government.

If the content in any of these options is not needed, the options can be removed and will remove all language associated with the option. Language in the table in Part 1, DATA TURNOVER TIMEFRAMES must be manually corrected.

ALL TECHNICAL DATA GENERATED AS PART OF THE CONTRACT IS SUBJECT TO FEDERAL ACQUISITION REGULATION (FAR) CLAUSE 52.227-14 AND DEFENSE FEDERAL ACQUISITION REGULATION (DFAR) 227-71. THEY ARE NOT REFERENCED IN THE TECHNICAL SPECIFICATION SECTIONS BUT THIS LANGUAGE IS PART OF THE NON-TECHNICAL SECTIONS OF THE CONTRACT. FOR INFORMATION ON THESE CLAUSES TO ASSIST WITH ENFORCEMENT, GO TO:
https://www.acq.osd.mil/dpap/dars/dfars/pdf/current/20220101/227_71.pdf
https://www.ecfr.gov/current/title-48/chapter-1/subchapter-H/part-52

****

1.1 MEASUREMENT AND PAYMENT

****

NOTE: Measurement and payment have been handled a variety of ways on data management projects. It has been included as incidental to the Construction as well through separate CLINs. Strongly recommend a separate Data Management CLIN or price breakout item rather than treating this as incidental to construction. It can be done in one lump sum CLIN for the whole job, breakdown CLINs per PRODUCTS below, or a monthly payment. A lump sum payment is strongly recommended for the initial system development as a large effort will be required to design and stand up the system.

Monthly payment in a separate monthly CLIN is strongly recommended to give the Government leverage for timely corrections for elements which aren't being completed within required turnover times. Without the ability to withhold payments, the correction of deficiencies for data that is needed in a timely manner cannot be readily enforced. Alternatively, you must ensure that the Contractor develops the system in a timely manner.

NOTE FAR Subpart 227-71 - Rights in Technical Data (Section 227.7103-14 Conformity, acceptance, and warranty of technical data) details that Government can withhold payment "up to 10 percent of the contract price pending correction or replacement of the nonconforming technical data or negotiation of an equitable reduction in contract price."

****

1.1.1 Develop The Data Management System

1.1.1.1 Payment

****

NOTE: Edit bracketed items to ensure the payment is associated with the specific project deliverables. Tailoring options "WEB-BASED GIS INTERFACE" and "DYNAMIC DATA INTERFACE" are present. If the option is removed, all associated language will be removed.
****

Payment will be made for development and delivery of products to provide a complete and fully functioning data management system, as specified herein and in the Contract documents including [required preconstruction submittals, complete construction and testing of the enterprise database (EDB), all components of the web-based GIS/dynamic data interface, a functional SFTP site, data management planning meeting completion, delivery of the initial training session, and approval of the quick reference guide. Related costs include, but are not limited to, uploading of all existing data as provided by the Government into the data management system, initial design, build, scripting, and populating layers the web interface and desktop GIS products, and including incidental items per the Contract documents.] All incidental costs associated with the performance of work in this section are included in the Contract price. The Government will make no additional separate payment for items included herein or by reference.

1.1.1.2 Measurement

****
NOTE: Tailoring options are present for "WEB-BASED GIS INTERFACE" and "DESKTOP GIS FILES"
****

Measurement for payment of DEVELOP THE DATA MANAGEMENT SYSTEM will be paid in one lump sum. Payment for the data management system will be made after completion of the following work:

[a. The data management staff have been submitted and approved,

b. All preconstruction submittals have been submitted and approved,

c. The data management planning meeting with the Government has been conducted,

d. The 100 Percent Data Management Plan (and all related addenda) submitted and approved,

e. The initial training session has been conducted, and the quick reference guide submitted and approved, and

f. The database, web interface and GIS being fully developed to 95 percent including all available design features and historical project data loaded to the system, as submitted/demonstrated by the Contractor and approved by the Government. The five percent will account for any changes needed just prior to the start of work for which various components of the system has been built, or testing required to be conducted once initial data has been received.]

1.1.1.3 Unit of Measurement

Unit of Measurement: Lumps Sum (Ea).

1.1.2 Maintain The Data Management System And Turnover Of Final Products

1.1.2.1 Payment

****

NOTE: Tailoring options are present for "WEB-BASED GIS INTERFACE", "DESKTOP GIS FILES", "CAD 3D MODEL".

****

Payment will be made on a monthly basis for the maintenance of the data management system in a fully functional state with 24/7 accessibility by the Government, and up to date as specified in PART 1, "Data Turnover Timeframes". This includes the enterprise database, SFTP site, Web Interface, and desktop GIS components to be up to date (as defined by the turnover time requirements) at all times, and timely resolution of any issues with data correctness, completeness or other quality control measures identified by the Government as defined in this contract.

These payments include the timely submittal of all required data, digital CAD and GIS products, progress drawings, periodic as-built updates, and reports - as required by this and other sections of the Contract - throughout the Contract duration. This item includes all required support staff. This item also includes all final turnover items detailed in Part Three, FINAL EDB TURNOVER, PART 1, SUBMITTALS, SD-11 CLOSEOUT SUBMITTALS, and throughout this section. An amount not to exceed 10 percent of the total payments may be withheld if the Contractor fails to perform the required work. All incidental costs associated with the performance of work in this section are included in the Contract price. The Government will make no additional separate payment for items included herein or by reference.

1.1.2.2 Measurement

Measurement of payment for MAINTAIN THE DATA MANAGEMENT SYSTEM AND TURNOVER OF FINAL PRODUCTS will be made monthly for work completed and submitted as described above for the duration of the Contract activities for which the data management system applies.

1.1.2.3 Unit of Measure

Monthly (Mo) for the number of months which data management work is ongoing.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 19110	(2016) Geographic Information Methodology for Feature Cataloguing
ISO 19115-1	(2014) Geographic Information -- Metadata -- Part 1: Fundamentals
ISO 19115-2	(2019; AMD 1 2022) Geographic Information — Metadata — Part 2: Extensions for Acquisition and Processing
ISO 19119	(2016) Geographic Information - Services
ISO TS 19139-1	(2019) Geographic Information — XML Schema Implementation — Part 1: Encoding Rules

U.S. ARMY CORPS OF ENGINEERS (USACE)

ERDC/ITL TR-19-7	(2019) A/E/C CAD Standard - Release 6.1

U.S. DEPARTMENT OF DEFENSE (DOD)

SDSFIE Standards	Spatial Data Standards for Facilities, Infrastructure, and Environment

1.3 DEFINITIONS

****
NOTE: NOTE: Customize the definitions for the database type, and file transfer products that are actually required. Make sure to add any definitions for other products or processes that are required.
****

1.3.1 Data

****
NOTE: Tailoring option for "SQL RDBMS EDB" is present. The definition for a Relational Database Management System will be removed if the tailoring option is removed.
****

A representation of facts, concepts or instructions in a structured, semi-structured or unstructured format, suitable for processing and interpretation by humans or machines. Records generated by any activities related to features of construction detailed in this Contract or by any instrumentation or monitoring equipment or processes in use on the project. Includes raw data generated by automated collection systems, recorded manually on paper or tablets, and data tables and databases and their constituent records which can be used with custom or off-the-shelf software.

1.3.2 Data Cleaning

The process of preparing data for analysis by correcting or qualifying data that is incorrect, incomplete, irrelevant, duplicated, or improperly formatted.

1.3.3 Data Management

The identification, definition, collection, organization, verification, correction, storage, protection, processing, communication, and transfer of data in order to maintain project records in an organized, complete, and rapidly accessible archive for immediate and future use.

1.3.4 Data Management System (DMS)

The hardware, software and network components, architecture, policies, technical processes, and workflows that efficiently manage data and information for the duration of the contract-required activities.

1.3.5 Data Validation/Verification

The process of checking the accuracy and quality of source data before using, importing or otherwise processing data. The same process as data QA or QC. One form of data cleaning.

1.3.6 Documented Enterprise Database (EDB)

A relational database hosted on a server that is utilized to contain, organize, and relate large collections of data stored in individual tables. Capable of handling a range of 100 or more users at a time, and running queries of multiple users simultaneously. A database that is "documented" has detailed written documentation of the schema, in which all items from DEFINITIONS "Schema" are provided in table format, as well as an accompanying entity relationship diagram supplemented with explanatory text.

1.3.7 Metadata

A set of data that gives information about data. For geospatial data this includes information about the feature or dataset location in space (i.e. datums, projections, resolution, collection resolution and accuracy, and other common requirements), entered into the appropriate form in the GIS software platform; as well as information about the data attributes (units, assumptions, sources, and other common information). File metadata are stored in a text file with the same name as the target file. Database metadata are stored in table descriptions or in appropriately labeled metadata fields.

1.3.8 Relational Database Management System (RDBMS)

Relational Database Management System. A type of database management system (DBMS) that stores data in a row-based table structure which connects related data elements. An RDBMS includes functions that maintain the security, accuracy, integrity, and consistency of the data.

1.3.9 Report

Any data or information in a format designed for human communication, where file format is not tabular but comprised of conceptual narrative, formatted tables, or static visualizations, and the contained data is either static or requires conversion to other file formats or manual cleaning or entry for aggregation, processing and analysis by machines.

1.3.10 Schema

Also referred to as "database schema", it is the logical structure of the of the database. Schema consists of the following database elements:

(1) Table definitions and names;
(2) Field names;
(3) Field definitions;
(4) Field types (constraints), including precision and units for numeric fields;
(5) Primary and Foreign Keys (to determine table relationships);
(6) Field default values;
(7) Domains;
(8) Calculated fields and the calculations and equations to produce values that populate them;
(9) Selected database views required to produce values displayed in the web interface, used to derive reports, for ongoing CAD/GIS feature generation, or as requested by the COR.

1.3.11 Secure File Transfer Protocol (SFTP)

Also SSH File Transfer Protocol, a networked protocol to handle file transfers between computers over the internet. It provides file transfer, access and management over a secure connection communicating on server data port 22. This should not be confused with similarly-named "Simple File Transfer Protocol" which operates on server data port 115, and does not meet the requirements of an SFTP site for the purpose of this contract.

1.3.12 Tabular Data

Any structured or semi-structured numerical or qualitative facts in a character-limited field and record format. Suitable for processing by machines with minimal human interpretation, cleaning or processing, and in a file format suitable for importing into a database software program without any structural changes to the file.

1.3.13 Tag

A keyword or term applied to a computer file that is stored in the file metadata that can aid in searching for that file or document. Most commonly used with files such as imagery to aid in computer-based searching.

1.4 ADMINISTRATIVE REQUIREMENTS

1.4.1 Data Management Planning Meeting

****

NOTE: This meeting was added as a forum for getting the initial setup of the Contractor's data management system to meet the Government's expectations and goals and give the Government

insight into the limiting factors for turnover times and other requirements. The meeting circumvents using the submittal process to accomplish that. It allows the Government to have an immediate feedback about what kind of time requirements for turnover are realistic, and to set expectations, determine workflows, discuss schema changes to the database, and build rapport. Adjust the length of this meeting commensurate with the complexity and intensity of data production of the project.

Covid-19 has changed many elements of how we do business. If both parties are comfortable with in-person meetings based on current transmission and new case trends, it is recommended to have the meetings in person to help build rapport. If in-person meetings do not make sense given infection rates on site or in the area where personnel will be traveling from, this requirement can be relaxed by the government. If the project thinks it might want in-person attendance, leave the more stringent requirement in the specification so that it can be enforced as needed, however it can always be relaxed later.

Tailoring option is available for "DATA VISUALIZATION SPECIALIST" and "WEB-BASED GIS INTERFACE".

****

Hold a collaborative meeting with the [Contracting Officer (COR)] [Administrative Contracting Officer (ACO)] within 15 days of the approval of all applicable SD-01 submittals. This collaborative effort will consist of a meeting over [_____][4 full consecutive business] days, where primary Contractor and data management Contractor (if subcontracted) each provide in-person attendance. The data manager, data visualization specialist, and data management QC must physically attend this meeting with [COR][ACO] in order to facilitate the building of rapport and efficient communication. Additionally, personnel from each subcontractor having technical knowledge of data collection and processing for that subcontractor's features of work must also attend this meeting in person during designated days to be decided in the agenda. The meeting must not take place until submittals from paragraph SUBMITTALS - SD-01 are received and approved including:

(1) 50 Percent Data Management Plan
(2) Automated and Manual Data Collection Output Examples
(3) Data Cleaning and Verification Plan
(4) QC Data Collection Plan
(5) Backups, Archiving And Disaster Recovery Plan
(6) Data Transfer Workflow
(7) Data Management System Demobilization Plan

The goals of this meeting are:

a. To provide a venue for problem-solving on data requirements and workflows;

b. Discuss and decide on needed changes to the database schema;

c. To view, discuss and provide feedback on the web interface displays and functionality as specified;

d. Discuss and provide feedback on the SFTP file organization structure;

e. Discuss and resolve any Government questions about Contractor workflows as detailed in submittals;

f. Presentation and discussion of any Contractor-proposed changes to methods of execution;

g. Development of field data collection app form formats and associated products (if applicable);

h. Collaborate to support the Contractor in submittal of a 100 Percent Data Management Plan that meets the Government's expectations - including documentation of all requested or agreed changes to facilitate completion of the 100 Percent Data Management Plan submittal;

i. To establish a working rapport between all data management personnel;

j. To communicate and clarify the specific goals and expectations of the Government with respect to any part of the data management system.

****

NOTE: The following paragraphs are needed on large contracts with multiple features of work where the subcontractor for certain features will not be on site at the time of the initial data management planning meeting. In these cases, the methods and equipment which determine database schema, report formats, turnover times, and others may not be known until years after the NTP. It then becomes necessary to have a special planning meeting for each of these features due to timing.

****

1.4.2 Additional Planning Meetings

An additional data management planning meeting specifically for the [_____][Cutoff Wall][Concrete Placement][Excavation][Grouting] is required no later than 30 days prior to the start of work on that feature. For any feature of work where the data-generating Contractor will not be on site, and specific data-generating equipment will not be detailed until the start of that work which would affect the data management system, hold a specific data management planning meeting no later than 30 days prior to the start of work on that feature. These delayed coordination meetings must be of at least [_____][4 hours] duration (or as directed by COR) and must not be combined with other kickoff or coordination meetings. All the same personnel are required to be in attendance as the initial data management planning meeting.

1.4.3 Coordination and Technical Meetings

The Contractor's Data Manager, or another employee that can act competently on their behalf, must participate in recurring data management technical meetings as needed, scheduled at [COR][ACO] request. These meetings will be critical prior to, and at the start of work for which intensive or voluminous data collection will take place, but are not intended to be ongoing weekly throughout the entire project. For bidding purposes assume monthly meetings for the duration of work. Conduct these meetings in order to ensure the timely and adequate collection, formatting, quality, and flow of data from site to the EDB, SFTP site, and web interface, and to troubleshoot any recurring problems. These meetings are also a venue for collaboration to solve technical problems, make data management progress updates, give feedback, and make technical decisions about data.

Include high level data management updates in the overall weekly coordination meeting for the project.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Tailoring options are available for "ADDITIONAL DATA COLLECTION PLAN SUBMITTALS", "DATA VISUALIZATION SPECIALIST", "WEB-BASED GIS INTERFACE", "DESKTOP GIS FILES", "CAD 3D MODEL", "CAD QUALIFICATIONS AND ROLES", and "OPENGROUND".

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

50 Percent Data Management Plan; G, [_____]

****
NOTE: The intent of a Data Management Plan is to ensure that all data processes and policies are fully documented, and that the Contractor fully understands the expectations of the Government. The 50% Data Management Plan is the Contractor's first attempt to document their data management system. The finalization of the plan will be a collaborative effort, with the Government and the Contractor collaborating on the final 100 Percent Data Management Plan, which will be submitted by the Contractor after Government input during the data management planning meeting. For some data, supplied to the Contractor by the Government, these sections may need to be written by the Government and supplied to the Contractor.
****

Automated and Manual Data Collection Output Examples; G, [_____]

****
NOTE: csv, ASCII - which are common standard open data formats - are readable by MS Excel. Other programs than Excel can be used if the other program is nearly universally available at the home district. This is for ease of data sharing as needed among the construction and design teams. PDF captures the static view of the data but prevents data from easily being added to a database. It is used primarily for data verification purposes, with a static view that is more difficult to change for the purposes of QA/QC. Excel readable files (or database tables) allow the data to be better searched and analyzed and more easily ported into a database without the need for re-typing data that was already generated by a computer.
****

Data Cleaning and Verification Plan; G, [_____]

QC Data Collection Plan; G, [_____]

QC Daily Information Collection Plan; G, [_____]

Backups, Archiving And Disaster Recovery Plan; G, [_____]

Data Transfer Workflow; G, [_____]

Data Management System Demobilization Plan; G, [_____]

100 Percent Data Management Plan; G, [_____]

Proposed Changes To The Enterprise Database Schema; G, [_____]

Web Interface; G, [_____]

Quick Reference Guide; G, [_____]

****

NOTE: The following preconstruction submittals are ONLY to be included when the specification section covering the work does not already require one. They become especially important to understand what data will be collected in a performance specification where a methodology is not specified and so the Government will not know the details of the data collection until a proposed method is approved. These plans are samples based on common features of work. Customize the requirements, and add any additional plans as needed.

****

Automated Grouting And Water Pressure Testing Data Collection Plan; G, [_____]

Remote Sensing Data Collection Plan; G, [_____]

System Testing; G, [_____]

SD-05 Design Data

GIS Files; G, [_____]

SD-06 Test Reports

Photograph PDF'S; G, [_____]

Digital Photographs; G, [_____]

Database Files; G, [_____]

Digital 3D CAD Model Files; G, [_____]

SD-07 Certificates

Data Manager; G, [_____]

Data Visualization Specialist; G, [_____]

CAD Technician(s); G, [_____]

CAD Supervisor; G, [_____]

SD-10 Operation and Maintenance Data

Data Management Plan Updates; G, [_____]

Data Transfer and QC Reports; G, [_____]

Ongoing Schema Updates; G, [_____]

Web Interface Updates; G, [_____]

SD-11 Closeout Submittals

****

NOTE: Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

****

Data Management System Demobilization Plan Updates; G, [_____]

Finalized Enterprise Database; G, [_____]

Finalized OpenGround Cloud Borehole Database; G, [_____]

Final File Indexes; G, [_____]

Data Management Manual; G, [_____]

Final GIS Files; G, [_____]

1.6 PERSONNEL

1.6.1 Qualifications

****

NOTE: Extensive thought went into determining these roles, their technical qualifications, and responsibilities. The data manager is an essential role. The number of personnel needed to manage the project data should be scaled based on the breadth of the contract. The full-time Data Manager for the Contractor is needed for mega projects with data-intensive features of work that must meet specific regulations for quality, or have a significant life-safety component. Smaller projects may utilize a part time Contractor Data Manager with scheduled hours commensurate with the data production intensity of the work. The qualifications have been changed from previous versions of this specification to primarily include database skills. The QC data management role outlined in the note preceding section 1.6 under Section 01 45 00 is intended to assist with interpretation of the work-specific data as needed by the data manager to make any necessary schema changes needed to capture it.

The data visualization specialist is an important role for mega projects that will have a web interface designed by the Contractor that includes any business analytics functions in a dashboard style display. The purpose of this role is to ensure that the necessary data to monitor structural safety and quality management (when required) is displayed in the viewer in such a way that project and engineering staff can rapidly ascertain the "big picture" of the data. If no visualization, web-viewer, or geospatial component will be required, this role is unnecessary. If the project will use only a GIS web map it may make more sense

to combine the data management roles into one position.

If the data manager role is combined with the Data Visualization Specialist, it is very important to ensure that the relevant qualifications and responsibilities are captured in the Data Manager requirements below. Do this prior to removing the tailoring option DATA VISUALIZATION SPECIALIST. Tailoring options are available for "DATA VISUALIZATION SPECIALIST", and "CAD QUALIFICATIONS AND ROLES".

****

1.6.1.1 Data Manager

****

NOTE: Tailoring options are available for "SQL RDBMS EDB" and "ACCESS ENTERPRISE DATABASE".

****

The data manager must have the following verifiable credentials:

a. Have a minimum of [_____][5] years of advanced experience occurring in the past [_____][8] years overseeing the import, cleaning, verification, processing, storage, backup and scripted transfer of construction data, similar to the type that will be generated by work in the contract.

b. Have a minimum of [_____][5] years' experience occurring in the past [_____][5] years designing and editing [SQL][MS Access] enterprise databases utilizing an RDBMS such as MS SQL Server.

c. Have served as the data manager on at least two construction projects of similar complexity, with similar data production volume and data management requirements. Each project should be described in the resume detailing the data management tasks performed.

d. Be approved by the [COR][ACO] before any data is transferred into the EDB.

Submit the resume for approval within 15 calendar days after notice to proceed.

1.6.1.2 Data Visualization Specialist

The Data Visualization Specialist is responsible for the design, deployment, and maintenance of the spatial (GIS) and dynamic data web interface, and must have the following verifiable credentials:

a. Have a minimum of [_____][3] years of experience in use of [_____][ESRI ArcGIS Pro and ArcGIS Online];

b. A current working knowledge of cartographic design and geoprocessing methods to produce the required visualizations in planimetric, profile and 3D views;

c. Have a minimum of [_____][3] years of experience utilizing data visualization software such as Power BI, Qlik, PowerPivot, Tableau, Python/R data visualization/data science libraries, or equivalent web tools that will be used by the Contractor to meet the specification requirements.

d. Have performed similar work for one other construction project of similar size and complexity to this contract, and containing similar [geotechnical, civil and structural] engineering work.

Submit the resume for approval within 30 calendar days after the notice to proceed. Provide in the resume samples of the individual's work, including maps, visual analytics and other graphics that demonstrate the individual's analytical and problem-solving skills, and maximization of the tools to meaningfully visualize technical datasets.

1.6.1.3 CAD Supervisor

All CAD work must be completed under the supervision of a CAD supervisor with at least 10 years of CAD experience, [_____][5] years of which is in [_____][AutoDesk AutoCAD][Bentley MicroStation][Open Roads Designer SS4], and who has produced as-built drawings for a Contract of similar scale and complexity.

Submit resume for approval within 30 days of the notice to proceed including relevant education and experience, and details of previous work on the qualifying Contract as-builts. All CAD personnel must be approved by the [COR][ACO] prior to performing work as part of this contract.

1.6.1.4 CAD Technician(s)

The CAD technician(s) are responsible for the completion of all required prefinal and final as-built drawings and all digital 3D CAD model files in accordance with the requirements specified in Section 01 78 00 CLOSEOUT SUBMITTALS.

All CAD Technicians employed on the project must have at least [_____][3] years of experience utilizing [_____][AutoDesk AutoCAD][Bentley MicroStation][Open Roads Designer SS4]. In addition, at least one CAD technician must have at least [_____][3] years of experience utilizing [_____] [Autodesk Revit and Inventor]. Submit resume for approval within 30 days of the notice to proceed including relevant education and experience, and details of previous work on the qualifying Contract as-builts. All CAD personnel must be approved by the [COR][ACO] prior to performing work as part of this contract.

1.6.2 Roles and Responsibilities

1.6.2.1 Data Manager

The Data Manager is responsible for:

a. Population, maintenance, quality control, and oversight of the Contractor's Data Management System and components;

b. Coordination with data collection professionals from the primary Contractor and sub-contractors, QC personnel, and other parties performing work on and offsite as necessary to obtain data;

c. Automated and manual input of data into the enterprise database (EDB);

d. Ensuring all data generated physically or digitally during construction is captured, converted, cleaned, validated, QC-checked, and organized in the appropriate tabular and non-tabular formats as described in this specification;

e. Coordination with all other data management personnel to ensure data flows efficiently from site to database to visualizations or other end use;

f. Scripting of autogenerated reports required in this specification;

g. Automated and manual transfer of database .csv and backup files, non-tabular files, raw data, and all other documents to the SFTP site within the specified turnover timeframes;

h. Develop and oversee the processes for QC review of data entered into the EDB as required by this specification;

i. Develop and oversee the processes for backups of data as required by this specification;

j. Participate in all data-related technical meetings and report and speak on technical data matters when requests are made by the Government.

k. Author and compile the data management plans and other data-related submittals.

l. Provide username and password access to platforms required by this specification including the web interface and SFTP site, and any web applications utilized;

m. Work with the Data Management QC to develop and incorporate the workflows for integrating QC data into the data management system (via digital collection methods and automated transfer processes as applicable);

n. Design forms for QA digital data collection and processes to facilitate direct input of data by the Government to the web interface/database (as applicable).

o. All other data management tasks not specifically assigned.

If the Data Manager does not know how to execute any part of the technical processes needed to accomplish any work specified, provide them with the appropriate training. Provide training within 30 days of the data management kickoff meeting.

1.6.2.2 Data Visualization Specialist

The Data Visualization Specialist is responsible for:

a. Development, deployment, maintenance and updates of the web-based GIS and dynamic data display interfaces. Including all specified visualizations and graphical representations of data to communicate project progress, construction quality, and as applicable dam/life safety monitoring;

b. Coordination with the Government's data manager to design and edit data displays for maximum comprehension by Government personnel;

c. Development and maintenance of the desktop ArcGIS Pro projects and source files (.aprx, .gdb, feature classes, rasters, and other GIS products);

d. Assisting the Contractor's Data Manager in authoring and compiling the Data Management Plan for all visualization duties, GIS metadata and other documentation;

e. Working with the Contractor's data manager to provide scripted and digital updates to the visualizations whenever possible. Utilizing spatial data collected from the field that is outside of the database;

1.6.2.3 CAD Supervisor

The CAD supervisor is responsible for:

a. Quality Control of the CAD Technician work.

b. Ensuring proper use of advanced CAD tools and functions including the use of the [_____][eTransmit][Packager] tool and the proper export and transmittal of digital model files so that the full functionality of layers, data files, annotation, and other functions, are retained upon transmittal.

c. Ensuring the correct use of A/E/C CAD standard [_____][R6.1], contained in reference ERDC/ITL TR-19-7, in the creation of the digital CAD model and as-built drawings.

d. Ensuring the features in the 3D digital CAD model are geospatially referenced to the project survey control and incorporated using the correct horizontal and vertical datums.

e. Ensuring the inclusion of all required drawing elements and formatting as specified in Section 01 78 00 CLOSEOUT SUBMITTALS, and other feature of work sections of the contract.

f. Acting as a point of contact (POC) for any needed corrections or changes to either the preliminary as-built submissions or the 3D CAD model, or directly assigning a POC to interface with the Government as needed to address corrections and changes.

1.7 EXISTING DATA

The Government will provide existing data for use by the Government in the data management system including but not limited to [_____][boring logs, CAD drawings, and GIS feature classes and rasters]. The Government will provide all files via the SFTP site once it has been established.

1.8 DATA REQUIREMENTS

****

NOTE: This section is comprised of industry and Government standard practices that will remain mostly the same from project to project regardless of the type, size and scope. Only slight customization is intended.

****

1.8.1 Data Integrity

Maintain integrity of data such that records are accurate and internally consistent, that all data and records reflect the quality of the data gathered on the site, and that all data is preserved and archived for future use.

1.8.2 Data Ownership

****

NOTE: As stated in the initial note for this section, the entire contract is subject to Federal Acquisition Regulation (FAR) Clause 52.227-14 and Defense Federal Acquisition Regulation (DFAR) 227-71. They are not referenced in the technical specification sections, however this language IS included in the non-technical part of the contract. For complete language of these clauses visit:
https://www.acq.osd.mil/dpap/dars/dfars/pdf/current/20220101/227_71.pdf
https://www.ecfr.gov/current/title-48/chapter-1/subchapter-H/part-52

****

All data generated on-site by [_____][instrumentation, monitoring, anchorage, excavation, construction equipment, sampling, concrete and soil testing, grouting, blasting, surveying, concrete production, conveyance and placement, tunneling, mapping, cutoff wall construction, equipment calibration, maintenance], and all other data associated with the work performed is the property of the Government. All calculations and formulae and any constants or variables used to produce data, reports, or analytical products are the property of the Government and must be included in any required database fields, and turned over in an editable or otherwise specified format upon request.

****

NOTE: It is very common for Contractors to claim that data is proprietary. The following paragraph specifically sets up the legal expectation that no data may be withheld without exception - consistent with the FAR and DFAR clauses regarding data.

****

For any data to be excluded from the system, submit a written request for a Government determination of whether data can be classified as proprietary, along with a detailed justification. No data source is exempt from these data requirements unless a specific exemption is requested of and granted in writing by the [COR][ACO]. Under no circumstances will "proprietary data" impede the Government's ability to monitor construction, perform analyses, or evaluate the effectiveness of construction.

1.8.2.1 Custom Algorithms

****

NOTE: The below paragraph is meant to establish the ownership of the data, not the "means and methods" of custom software designed by or for the Contractor where ownership of the software remains with the Contractor. However, there is a need for the Government in many cases to review the process and algorithms of this software to ensure it is

providing accurate data.

For example, where a Contractor has set up a custom excel spreadsheet using formulas and/or Visual Basic for Applications code to calculate the cross-sectional area and 3D location of a barrier wall element during a barrier wall construction project and the Government did not specify software development on the part of the Contractor. In this case the Excel spreadsheet and Visual Basic for Applications code belong the Contractor, but the algorithm in the code and the results of that code need to be verified by the Government to ensure that the code is accurately processing the data and providing the correct output. For this example, the cross-sectional area and its location in 3D space will be directly relevant to showing that the barrier wall was placed per the contract requirements.

****

If software developed by or for the Contractor will be used for processing of data provided to the Government, detail to the Government the algorithms and procedures used to process the data. The Contractor maintains ownership of its computer code, unless otherwise specified, but must allow the Government access to the algorithms (with all values/variables defined) and procedures to verify how the data is processed so that the quality of the final data can be assessed.

1.8.3 Disclosure of Data or Advertisement of Project

Do not disclose any project data to third parties, and do not publish any data without prior written approval of the [COR][ACO]. Request and receive permission in writing prior to publishing or presenting any data from the project to any third parties not associated with this contract, this includes data with project references removed. If the data management system is the subject of any Contractor-produced papers, proper design credit must be explicitly attributed to the Government's data management designers, as well as appropriate Contractor/subcontractor personnel.

****

NOTE: If there are Governmental or other third-party owners/stakeholders of the project, make sure to provide permission to release the data to them in this section.

****

1.8.4 Backups, Archiving and Disaster Recovery

Avoid data loss by backup and archival of all digital and paper data records from the time of data generation until final data turnover. This includes having specific policies, workflows, and infrastructure in place to archive and have redundant backups on servers in either a commercial cloud computing platform or multiple locations according to industry standard practice. Address backups, archiving and disaster recovery plans in the appropriate submittal, as specified in paragraph SUBMITTALS, SD-01 Preconstruction Submittals.

If a data loss occurs, the Contractor is responsible for regeneration of the data. Any data which are re-generated from a non-primary source must be clearly noted in the record as shown in the EDB. Backup data within 24 hours of generation. Should a data loss occur, even if is within this 24-hour window, the Contractor is responsible for all steps necessary to recover from this data loss and will receive no additional payment for these data recovery efforts. Notify the [COR][ACO] of any data loss in writing within 12-hours of discovery that it has occurred.

****

NOTE: This section is needed to establish the expectation of industry-standard data backup routines on projects and assign ownership of all data loss risk to the Contractor. 24 hours is industry standard for backup times and should not be increased.

****

1.8.5 Contractor Quality Control of Technical Data Including Metadata

Verify and perform cleaning (see definitions provided in paragraph DEFINITIONS) of all tabular data entered into the databases including at a minimum:

(1) Verification of completeness of records such that all records are completed with all data within required turnover times;
(2) Correction of entry errors;
(3) Verification of source field data;
(4) Data review for verification of entry correctness;
(5) Consistency and accuracy of naming convention;
(6) Consistency and accuracy of field formats;
(7) Standardized character entry of fields and records, for example consistent use of spelling, capitalization, spaces and special characters (where allowed);
(8) Entry of required QC or correction metadata associated with the records (per paragraph RECORD TRACKING REQUIREMENTS).

Conduct this process in accordance with all procedures and policies outlined in the submitted and approved "Data Cleaning and Verification Plan" in paragraph SUBMITTALS, SD-01 Preconstruction Submittals. See paragraph DATA TURNOVER TIMEFRAMES for turnover time requirements.

1.8.6 Raw Data Requirements

1.8.6.1 Digital Raw Data

Submit raw digital data files for any data gathering system used on the project in accordance with the following:

****

NOTE: The types of data that will be expected by the design team should be listed above. The list in the example is not all-inclusive for every type of project.

In reference to number 2) - csv, ASCII, which are common standard open data formats, are readable by MS Microsoft Excel. Other programs can be used if it is nearly universally available at the home district. This is for ease of data sharing as

needed among the construction and design teams.
****

a. Provide these files in a format readable by the current version (at the time of the contract) of Microsoft Excel, such as a tab-delimited ASCII file, a CSV file, or other format readable by MS Excel.

b. To the extent possible, use data gathering systems that will generate "non-proprietary" or industry standard format data files readable in ASCII, CSV or with Microsoft Excel. Any necessary export or conversion, or software required to perform conversions, will be completed at the Contractor's expense.

c. Label all data columns so that it is apparent what data they contain, and provide metadata to [COR][ACO] including units, any formulae used to calculate the data, and any criteria used to generate the data. Detail metadata for these files in the Data Management Plan or in addenda to that plan as appropriate.

d. Where these files as generated are not directly readable by Microsoft Excel, submit raw data to the [COR][ACO] in their raw format and in a second file created in Microsoft Excel with column headings that include units.

****
NOTE: 1-4 are important to specify so that raw data can be accessed in the case where any disallowed changes such as averaging or fabrication of data may be occurring in the database.
****

e. Detect and correct any inconsistencies, mistakes, missing records or fields, or other anomalies in the data that may be generated through use of automated data collection systems - including but not limited to the automated grout monitoring and data collection system, and the instrumentation data collections system. Provide a written explanation of the nature and cause of any anomalies, and any corrected records within 48 hours of the resolution of the anomaly. Paragraph RECORD TRACKING REQUIREMENTS, Items 7-9 apply to corrections made as required in this section.

f. All data columns must be labeled so that it is apparent what data they contain, and metadata provided to [COR][ACO] including units, any formulae used to calculate the data, and any criteria used to generate the data. Metadata for these files must be detailed in the Data Management Plan or in addenda to that plan as appropriate. For all files with the same structure, metadata may be provided for the set of data documents and is not required for every single file. Data included in the EDB data tables from these raw data sources may be uploaded from the data source to minimize any duplicate data entry of tracking data.

1.8.6.2 Analog Raw Data

Submit clear, complete, readable, center-justified digital scans or photographs of all analog raw data collected for the project in accordance with the following requirements:

a. All analog reports of raw data must be scanned and transferred to the

Government via the Secure File Transfer Protocol (SFTP) site within 24 hours of generation in the field.

b. Any data collected via manual methods must be entered into the database by the Contractor within 48 hours of field generation. Analog data entered in the database must include a field in the appropriate table of the database with a hyperlink to the scan of the analog file for URL referencing. Ensure coordinate X, Y, and Z of features are included for any data collected by analog methods and entered into the database table for the associated record.

c. Handwriting and scan quality must be clear and legible, and contain any related information needed to place the data in context, to which the raw data pertains.

d. Scanned digital files must be named according to the approved naming convention, and stored in the appropriate location of the SFTP according to the file structure organization provided in the attachments.

e. Adjust data collection forms utilized at any time at [COR][ACO] request.

1.8.7 Data Turnover Timeframes

****

NOTE: Tailoring options are available for "DYNAMIC DATA INTERFACE" and "DESKTOP GIS FILES"

****

Provide all data from any automated data gathering system or manual collection system which is not otherwise described specifically in the feature of work sections, or this section, according to the following requirements:

Data Format	**Turnover Time**	**Turnover Location**	**Section**
Raw Data Files	24 hours	SFTP	a
Converted Raw Data Files	24 hours	SFTP	b
Reports	24 hours	SFTP	c
Generated Data as required by data dictionary	24 hours	EDB/Dynamic Data Interface	c
Appended QC Data	48 hours	EDB/Dynamic Data Interface	d
QC Data collected synchronously to work	24 hours	EDB/Dynamic Data Interface	d
[Instrumentation Readings - Automated]	10 mins	Field Interface/Dynamic Data Interface	e

Data Format	**Turnover Time**	**Turnover Location**	**Section**
[Instrumentation Readings - Manual]	1 hour - or as directed by [COR][ACO]	USGS/MIDAS database as directed by [COR][ACO]/Dynami Data Interface	e
[Cofferdam Piezometer Readings]	collect hourly 24 h	EDB	f
[Seismograph]	10 mins	Seismic Website	f
[Concrete Thermal]	10 mins	Concrete Thermal Data Website	f
QC Verification of Data	72 hours	EDB	g
Metadata	72 hours	EDB	g
[GIS Project Package (.aprx)]	24 hours when updated	SFTP	h
[ESRI Geodatabase (.gdb)]	24 hours when updated	SFTP	h
Enterprise Database Tables (.csv)	[_____][24 hours]	SFTP	
Enterprise Database backup files	[_____][Quarte	SFTP	

****

NOTE: All time frames listed in the table above and the text below have been reviewed for feasibility by industry practitioners and are considered appropriate. For small projects without significant concern for life safety or risk, or time-sensitive construction components, it may be appropriate to use longer time windows based on the amount of project staff, automation, and how often the Government needs to review the data being generated.

Customize the elements in accordance with the scope of this specification. For example if no GIS files are required, delete the associated text.

****

a. Submit all raw data within 24 hours of data collection to the [COR][ACO] via the SFTP site.

b. If conversion of this raw data is necessary in order for it to be readable by Microsoft Excel, submit this converted raw data file within 24 hours of data collection.

c. Transfer all non-tabular files (as defined in Part One, DEFINITIONS

"REPORT") to the SFTP site within 24 hours of submittal to RMS unless otherwise stated elsewhere in the Contract.

d. Import data records into the Enterprise Database (EDB) within 24 hours of generation.

e. Enter or append, as applicable, QC data collected after the initial generation of data for a given feature of work to the appropriate records in the EDB within 48 hours of the QC data collection, except where specifically stated otherwise. Enter QC data for features of work being collected synchronously to the work within 24 hours of generation.

f. Provide near real time access to continuously-recorded automated data. Maintain accessibility to [COR][ACO] using hyperlinks in the secure web interface as described in Part 2 PRODUCTS or other sections of this contract. Make any manually collected data that is part of this system available in the reporting system no later than 24 hours after it has been gathered. Enter all required data into the SQL EDB within 24 hours if applicable.

g. C verify the data and provide data verification metadata within the appropriate table of the EDB, with appropriate relationships in the database created within 72 hours of initial data appearing in the EDB. For detailed QC requirements see PART 1, "Contractor Quality Control of Data".

h. 8) Provide the most recent version of the ArcGIS Pro .aprx, .gdb and raster datasets within 24 hours of an update (or nightly when updates are occurring daily), to the SFTP site. See PART 3, DESKTOP GIS FILES for details.

i. Make data available in the dynamic data interface within 10 minutes for continuously recorded automated data (e.g., all automated instrumentation). Make any manually collected data that is part of this system (e.g., instrumentation data) available in the reporting system no later than 1 hour after it has been entered into the EDB per the timeframes above, unless internet connectivity at the site causes the inability of rapid transmission from the collection device. In this case update the data within 8 hours or as directed by the [COR][ACO].

1.8.8 Record Tracking Requirements

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NOTE: The following record tracking practices are industry standard. The intent is to be able to understand the provenance and quality of data. They track when and how records were created, entered, and altered.

****

Each record entered into the Enterprise Database (EDB) must document the following if not already specifically defined in the database schema, or allowed by the Government to be non-applicable in the Data Management Plan:

a. Source of the record (e.g. laboratory information, sample ID, instrument name, name and affiliation of observer/tester/data gatherer);

b. Organization generating the data (e.g. [COR][ACO], Contractor,

Contractor Laboratory);

c. Date and Time where data was created (e.g. when sample was taken, start and stop time of drilling or grouting, when observation was made);

d. Name of the data collector (when manually collected);

e. Date and Time data was entered into the system;

f. Name of the individual entering the data.

Where a complete record was modified after submission, document the following:

g. Date/time any data in the system was modified;

h. Name of personnel who made the edit;

i. Reasons for the edit (e.g. where laboratory testing data is appended to a sample record, correction was requested by the Government, correction for entry error of analog data, or other edits).

1.8.9 Naming Conventions

****

NOTE: Naming conventions are important for several reasons.

For certain programs such as MS SQL, Oracle PL/SQL or ArcGIS there are characters that should never be used in certain places because they interfere with the internal programming and cause features not to work. Assuring compatibility with the programs is very important to avoiding future labor to eliminate these errors.

All files must be named according to the same convention in order to automate the use, movement or querying of files.

Manually searching through hundreds or thousands of raw data records is much easier if the naming convention is meaningful. If the agency has already established a file naming convention that meets these criteria, utilize that one.

For photographs, contractors often have decent naming conventions, and renaming files according to a Government requirement is a large cost-driver. To avoid these costs, allow the Contractor to propose a convention instead of imposing one.

The following standards help to ensure all the above are covered.

Tailoring option in the following entries is available for "DESKTOP GIS FILES".

****

1.8.9.1 Fields of Database, ArcGIS Feature Classes, or Tables

Naming conventions for all elements must be developed according to the following requirements. Where a precedent exists in the project design or other parts of this contract, use the established precedent, however, change names prior to use in GIS/database to be consistent with the following:

a. No spaces. If a space is needed an underscore must be used;

b. 256-character limit;

c. No special characters;

d. No characters that are considered reserved in ArcGIS or MS SQL;

e. Do not start a name with an underscore or a number;

f. Each record must be named utilizing the same format and character length. For record names containing a numeric ID that could utilize a different number of characters between records, zeroes must be utilized as placeholders at the start of the ID number to ensure consistent character lengths for scripted searches;

g. Employ a standardized scheme for names that include element-specific information as required in the Contract section where required and eliminates random alphanumeric characters that do not relate to the element.

1.8.9.2 Folder and File Names

All files and report (non-tabular) and raw data files loaded to the SFTP site must be consistently named according to the following conventions (except photographs). Work with the Government to resolve any naming convention issues in the initial data management kickoff meeting, however the [COR][ACO] may direct a change to the naming convention of any files at any time throughout the duration of the Contract if the convention is not conducive to automation.:

a. No spaces. If a space is needed an underscore must be used;

b. 256-character limit;

c. No special characters;

d. No characters that are considered reserved in ArcGIS, or common database programs such as MS SQL, Oracle PL/SQL, Postgres, MySQL or other full scale RDBMS's;

e. Do not start a name with an underscore or a number;

f. Each group of file types must be named utilizing the same format and character length (where possible).

Propose in the Data Management Plan a file nomenclature for each file classification that should include the project/Contract code, work feature, applicable unit ID, and date data was generated (or began being generated if it spans across multiple dates). See the following examples:

Feature of Work File Type	Unit ID	Date	Sample File Name
Concrete Batch Ticket	Monolith R12 Lift 2	06/02/21	BatchTickets_R12-2_20210622
Grouting CSV - raw data file	Hole R1440P Stage 15-25	08/20/21	R1440P_15-25_20210802
Drilling Log PDF	Hole R32	07/26/21	BoringLog_R32_20220731
Load Cell Installation Log	Load cell 15	09/05/21	LoadCellInstall_15_20210905

1.8.9.3   Site Feature ID's

Propose a consistent naming convention for all features and tests on site in the Data Management Plan and utilize it unless otherwise specified in other locations of the plans and specifications. For features or tests that have failed or been abandoned where another feature or test for the same purpose is conducted, utilize the original ID for that feature or test, but designate a letter R (for "retest" or "redrill") or other letter convention as appropriate to the test.

For all naming conventions, document the convention and define all numbers and letters utilized for each in the associated work plan submittal and the Data Management Plan. Provide a table in the EDB which defines the naming convention components.

Feature	**Specification**	**Sample Name**
Grout Hole station 1(plus sign)00, Upstream, Primary hole	Yes, meets spec	0100UXP
Grout Hole station 1(plus sign)00, Upstream, Primary hole	No, does not meet spec	_P100USejlzhfo56

1.8.9.4   Photograph Naming Convention

Propose a naming convention for raw digital photograph files in the 50 Percent Data Management Plan which provides meaningful information about the subject of the photo. Utilize the approved convention for all photographs.

1.8.10   Spatial Data Projections

****

NOTE: Within the US, CAD and surveys will be done most commonly in State Plane. Using the same projection in GIS as well as in CAD will prevent confusion and errors. Alternative projections can be used (i.e., UTM), however, all metadata required to accurately reproduce data in 3D space must be provided, and for some systems this may require epoch as well as horizontal and vertical datums. All data provided to the Government should be on one consistent spatial system, rather than mixing and matching spatial systems which can lead to significant errors.

Tailoring is available for "DESKTOP GIS FILES"
****

All spatial data must be projected in modeling products using [_____] coordinates. The Horizontal Datum must be [_____], [_____], U.S. Survey Feet. The Vertical Datum is [_____], U.S. Survey Feet. Clearly describe projections and datums of data collection and display in the Data Management Plan and in all associated metadata forms and tables.

1.8.11 Geospatial Metadata

****
NOTE: This section should be included if geospatial data will be generated as a part of the contract. Geospatial data generation may also be required by other feature of work sections such as Surface Blasting or Instrumentation. The purpose of this section is to define how we want the contractor to apply the ISO and SDSFIE-M standards including basic general requirements and engineering-specific requirements as listed. The SDSFIE-M standard defines the feature-level metadata that is accessible to the user in ArcCatalog. This section defines the feature metadata that will be included in a metadata table of the database also.
****

For all geospatial metadata, utilize the ISO TS 19139-1 standard template XML for creation of fields in the GIS dataset level metadata. Follow the SDSFIE-M SDSFIE Standards, ISO 19115-1, and ISO 19115-2 for the completion of the ISO metadata form. The following list should also be included in the information completed in the ISO metadata form, as applicable. Utilize the following additional standards where applicable ISO 19110, ISO 19119, and ISO TS 19139-1.

Include all metadata as records in a metadata table of the EDB:

1.8.11.1 Vector Datasets

a. Date dataset was created;

b. Equipment used to collect the data;

c. Agency, personnel, and contact information for original dataset;

d. Name, description, and location of survey control the original dataset is referenced to;

e. Is the geometry and location as designed or as built;

f. If the data was derived, converted, or imported from another dataset, the source dataset file name, format, date, datum, projection, resolution, and description (as applicable);

g. Narrative information about the data and what it depicts (from "Summary/Description");

h. For layer files where the symbology is interpretive of engineering data (for example grout stage permeability, grout stage volumes, barrier wall element overlap/thickness) - describe in the notes section of the application any description needed to understand the symbology and binning applied. If symbology is calculated based on a field value, describe the field values and how they are derived in the field-level metadata;

i. If it is a derivative product made by geoprocessing from other datasets - document the datasets used to produce it including file name, format, date, and a description of the datasets. Include any information about interpolation methods, geoprocessing tools, and relevant variables (and their definitions) or settings used to create it.

1.8.11.2 Raster Datasets

a. Date data was collected;

b. Dataset resolution (raster): (1) Equipment resolution, (2) Accuracy of equipment resolution, (3) Dataset resolution;

c. Equipment used to collect the data;

d. Corrections or processing steps applied to the raster;

e. If the data was derived, converted, or imported from another dataset, the source dataset file name, format, date, datum, projection, resolution, and description (as applicable);

f. Narrative information about the data and what it depicts (from "Summary/Description");

g. For layer files where the symbology is interpretive (for example subsidence data from InSAR) - describe in the notes section of the application any description needed to understand the symbology and binning applied. If symbology is calculated based on a field value, describe the field values and how they are derived in the field-level metadata;

h. If it is a derivative product made by geoprocessing from other datasets - document the datasets used to produce it including file name, format, date, and a description of the datasets. Include any information about interpolation methods, geoprocessing tools, and relevant variables (and their definitions) or settings used to create it.

1.8.12 Photographs

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NOTE: The intent of this section is to ensure that all progress and other photos provided to the Government are transmitted in high resolution, and that they are able to be indexed and queried by their subject matter. Having several thousand photos with no data on where photos were taken, without dates and other critical data makes the photographs much less useful.

****

Submit Digital Photographs taken at the project site as specified throughout the contract, including progress photos required in Section

[_____], with a minimum of 181.11 pixels per cm 300 pixels per in resolution for all photo files. Provide photos in a lossless compression file format that does not lose any pixels in the compression process (e.g. .TIFF, .PNG, and .GIF). Ensure no loss of original resolution from the raw photo if converted to a lossless format. Create digital images and metadata that meet or exceed the specifications of the Exchangeable Image File Format (EXIF) version [_____][2.3] or higher.

The enterprise database must contain a populated table which identifies all images taken at the project, and includes fields for the listed captioning items, and fields for the basic metadata encoded in each digital image including resolution, latitude, longitude. Include a field for hyperlinking to the digital images.

1.8.13 SDSFIE

****

NOTE: Delete this section if SDSFIE schema does not exist for the dataset being collected. Determining a standard SDSFIE schema for construction data is not recommended due to the highly customized nature of the work. The SDSFIE requirement applies to all DoD projects, however each branch has their own version. Information is available at SDSFIE.org.

Tailoring is available for "SDSFIE"

****

Work with the Government's Data Manager to ensure all applicable spatial data and spatial metadata are SDSFIE compliant. This is not required for datasets where there is no established SDSFIE standard.

1.8.14 Network Infrastructure

****

NOTE: This may be covered in other areas of the contract. The purpose of this section is to ensure that if the contractor is maintaining the web interface from the site remotely that they have the required connectivity to push updates to the web interface and other components. Some remote sites also rely on the contractor to provide internet infrastructure for the government. This should be customized based on the project.

Tailoring is available for "NETWORK INFRASTRUCTURE"

****

Provide the Government with, and utilize network infrastructure that can achieve speeds of at least [_____][250] Kbps or the maximum commercially available in the area if [_____][250] Kbps cannot be achieved.

1.8.15 COR Access to Data

Provide any data or assistance in accessing the data, as specified in PART 2, SFTP SITE, and at any time as requested by the [COR][ACO]. Provide current database table [_____][.csv, backup] files or any other data/report files upon request.

Provide username and password access to any interfaces required by this Contract to any member of the Government or applicable third party at [COR][ACO] request. Provide access within 48 hours of the request.

****

NOTE: If any components referenced in this section are not required in the contract, remove the associated language (i.e. "SFTP", "interface", "database").

****

1.8.16 Conflicts of Data Requirements

In the case of a conflict between any data requirements in the Contract, the data requirement must be whichever is more detailed, rigorous, specific, precise, and complete as determined by the [COR][ACO].

1.8.17 Data Collection Prior to Full Approval of the Data Management System Components

If the Contractor is able to mobilize for the start of work prior to all components of the data management system being fully approved, collect all data and input/convert as necessary to integrate it into the final database, SFTP site, and web interface.

****

NOTE: The process for approving the data management system as laid out in this specification is complex and lengthy on large-scale projects. It is intended to premeditate and work out all potential issues at the start of construction when it is easy to fix them rather than wait until they occur. However, the cost associated with this strategy is extended time prior to system approval. This language is intended to make sure the contractor is aware that they need to apply the same standards and be able to integrate early data with the main dataset.

****

1.9 RELATED WORK SPECIFIED ELSEWHERE

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NOTE: It is the role of the 01 31 20 section to ensure the timely receipt of the data in a format appropriate for real time verification, and long-term retention and display. To do this, an understanding of what work verifications will be performed, and the data products needed to facilitate this is needed.

Data management design requires rigorous cross-checking of other specification sections for data generation requirements, and conflicts with the 01 31 20 data requirements. In this section of the 01 31 20 specification, list any technical sections where there is a data requirement or a reference back to 01 31 20. It is important to make sure they are cross-referenced, but NOT to restate the requirements in 01 31 20.

For any technical specification that has a data generation requirement, add the following to that section in the part one Requirements. Adapt the sections in 01 31 20, or in the technical specification section for the work if the requirements are different from the general requirements in the 01 31 20 language. This includes items such as file formats and nomenclature, turnover times, special reporting in the form of drawings.

The narrative below each section identifies common data and verification needs of each section. This is not an exhaustive list but a guide for how to think about designing the data specification based on the features of work of the contract.

For more data intensive features of work, the digital data generation should be addressed in that technical section or in the data management specification, and how the Government wants to receive it needs to be specified. See Part 3 "DATA REPORTS AND DISPLAYS" for examples.

General Data Management Requirements Sample Language for other specification sections in the Part 1 requirements:

1.X DATA MANAGEMENT REQUIREMENTS

The Contractor and any Subcontractors performing work specified in this section must provide all generated data. All data generated as part of this specification is subject to the requirements in Section 01 31 20 DATA MANAGEMENT. Conduct a thorough review of the data specifications in this section and in 01 31 20 DATA MANAGEMENT, and ensure proper review and compliance.

Provide data for all of the fields in the EDB for the project pertaining to the work described herein via the appropriate tables as specified by the Section 01 31 20 DATA MANAGEMENT, and the data dictionary.

Provide all analog data related to the specified work via the SFTP in accordance with the requirements specified in Section 01 31 20 DATA MANAGEMENT.

DIVISION 01
SURVEY CONTROL AND REMOTE SENSING

This is not a guide specification yet, however every construction project should include a section which identifies survey control requirements including accuracy and precision. Requirements typically stated in this section include personnel

requirements, datums, project survey control points to be used for development of survey baseline and construction of structures, survey accuracy and precision, and types of surveys to be conducted.

For remote sensing (such as LiDAR, orthoimagery, photogrammetry, bathymetry), the requirements include a data collection plan, the specific accuracy and precision of the equipment and the dataset, equipment and dataset resolution, any QC tests on the equipment or data, calibration requirements, and other standards related to geospatial accuracy of the dataset collected, data processing methods and steps, raw data and final data products and reports, and any procedural or security requirements related to the equipment utilized (i.e. UAS). These requirements will be developed in tandem with the technical designer for the data management specification and system, and the technical designer for the feature of work they are required on. For example, if LiDAR is required to be collected for quantities, the land surveyor and the RE may be involved in developing the requirements. If photogrammetry, LiDAR and or Orthoimagery are being collected to document geologic foundations, the lead geologist may also be involved in developing them to ensure the proper resolution is required. The 01 31 20 specification details for instance, what data is to be collected, the turnover times, the specific dataset requirements as needed for short term verifications or long-term project documentation.

For contractor-proposed methods, it is important to require detailed submittals on the specific accuracy and precision of the equipment and the dataset, equipment and dataset resolution, any QC tests on the equipment or data, calibration requirements, and other standards related to geospatial accuracy of the dataset collected, data processing methods and steps, raw data and final data products and reports. It is also essential to have all of this information reviewed and approved by qualified personnel (such as a licensed land surveyor) prior to approving it's use. It is also important to understand any procedural or security requirements related to the equipment utilized to ensure cybersecurity standards or other applicable federal regulations are followed (for example in UAS use).

Minimum references to be included in this section as applicable to specified work:

EM 1110-1-1005 (2007) Control and Topographic Surveying

EM 1110-1-1000 (2015) Photogrammetric and LiDAR Mapping

EM-1-1002 (2012) Survey Markers and Monumentations

EM 1110-1-1003 (2011) NAVSTAR Global Positioning System Surveying

Section 01 45 00 QUALITY CONTROL

It was determined as a major lesson learned that a QC person as part of the QC organization who is not the Contractor's Data Manager or other personnel in the data management spec should be assigned to coordinate the flow of the data from the field to the data management staff (typically remote employees). This role can also help the data management staff understand how the database schema will be set up for the specific data when the Contractor proposes means, methods and equipment. They also have a role in verifying data.

This person's role and responsibilities will be detailed in the quality control program specification section. This person should be an engineer and capable of understanding the work represented by the data. Sample language to be entered into the Experience Matrix table of Part 3 is as follows. Change the work experience requirement to match the project needs. This person is referenced in 01 31 20 under the QC data collection plan and the Data Management Planning Meeting - both of which they are required to participate in.

Data Management

Graduate Civil Engineer with 5 years' experience in the QC verification of features of work being performed as part of this contract. This requirement is a full time Quality Control staff position performing duties at the job site to support Data Management, facilitating the flow of data and documentation generated during work by all Contractors into the data management system in accordance with the specifications. This position also assists in verifying the validity of provided data as necessary. This position is in addition to the offsite Data Manager requirement in specification Section 01 31 20 and must not be combined with that position. This individual reports directly to the Quality Control Manager and must be not be assigned duties outside of Quality Control or as outlined in the specifications, however the position is expected to work in close collaboration with the Contractor's Data Manager in these and any specified duties. The Contractor must fill this position within 60 days of NTP.

The need for comprehensive digital collection of QC data also needs to be addressed in Section 01 45 00 so that the Contractor understands what we want and

bids it properly. The guide specification emphasis for this section is on QC daily reports submitted via RMS. It is strongly advised to add language in PART 1 that refers to this specification, and at least mentions the types of requirements that will apply to QC data. It is also strongly advised to add a requirement that the Contractor streamline the collection of QC data via digital means in coordination with their Data Manager. If the Contractor is struggling with manual entry of QC data, this will impact their turnover times, and our ability to use that information effectively. It is important to include the language in the QC section, so it is understood that this effort is part of the prime contractor's responsibility. If written in the Data Management section it will be assumed to be the responsibility of the data management subcontractor rather than a dedicated effort of the QC team. Sample language to be entered in PART 1 is as follows:

"1.X QUALITY CONTROL DATA
Section 01 31 20 DATA MANAGEMENT outlines specific requirements for the reporting of QC data and information as fields in the database related to the feature data (for example, concrete fresh properties tests, or the taped depths of blast holes prior to loading is a field in the drilling report tables). Collect discrete field QC data in such a way that it reduces the effort and time required to incorporate into the database and data management system. This may include utilizing digital data collection devices in the field, utilizing apps with customized forms that directly populate the database, or other methods developed by the Contractor in consultation with their Data Manager. The data management QC personnel in the QC matrix must assist in supporting and streamlining this effort.

Refer to Section 01 31 20 DATA MANAGEMENT for other details about time requirements for this data to be entered into the database, the preconstruction submittal "QC data collection plan", and data management coordination planning meeting. The data management QC personnel must coordinate with the Contractor's Data Manager as needed to create an efficient flow of field and QC data into the data management system. The Contractor must design this effort so that no repetition of effort between the data management system and RMS is required."

In addition to this, it is strongly recommended to add an item to the QC Plan submittal where the Contractor will outline how they plan to integrate data to the data management system. See the following sample language:

"Procedures, workflows and equipment used to collect QC data from the field and facilitate rapid

integration into the project database and data management system. Describe how the QC data collection plan from 01 31 20 DATA MANAGEMENT will be integrated into this plan."

Section 01 78 00 CLOSEOUT SUBMITTALS

The CAD standards, as-built drawing, and 3D CAD model requirements are contained in the 01 31 20 section. However, they are specified as a closeout submittal in 01 78 00, meaning the Government doesn't receive them until the end of the contract. This is a problem for more than one reason. The as-built library on a major project is enormous, and the contractor often doesn't apply resources to creating it until the end of a contract. If the Contractor is losing money, they may forego completing the as builts at all. This has happened. This also pushes reviews into a very short time period at the end of the contract when the project is likely to be losing staff. Review of the 3D CAD model by skilled CAD technicians should be taking place at milestones throughout the contract to make this more manageable and ensure a thorough review. For data management systems where the Government produces their own GIS or CAD model, the submission of the updated 3D CAD model weekly or however often is needed to utilize features for the construction of GIS features.

A MAJOR OVERSIGHT OF THE GUIDE SPECIFICATION IS THE LACK OF A REQUIREMENT THAT ALL FEATURES BE GEOSPATIALLY REFERENCED TO REQUIRED PROJECT SURVEY CONTROL POINT(S).

Other issues that should be addressed:
1) The requirement of document submission via "optical disk". Change this requirement to submission via the SFTP site, directly to the Government's data exchange platform if other than the SFTP site (i.e. Microsoft Azure, common cloud, ProjectWise - as the Government's methods and data transfer capabilities evolve), or external hard drive.
2) The requirement that "The CAD files must be complete in all details and identical in form and function to the CAD drawing files supplied by the Government." Is problematic when the Government's CAD model features are geometrically incorrect, not geospatially referenced, or otherwise incomplete. The Contractor should not be allowed to allow sloppy mistakes to matriculate into the final 3D CAD model.
3) The specification does not specifically require the use of the current A/E/C CAD model standard version [R.XX)], it only references where to find the government's CAD/BIM standards. The use of correct annotation references and other components of the standard should be a requirement to ensure you can fully understand the model.

DIVISION 02

Section 02 32 13 SUBSURFACE DRILLING AND SAMPLING

Ensure the format for data collection and final data products are consistent between 01 31 20 and any section that covers drilling or subsurface exploration. It is common for the software and format of drill logs to be specified in this section. For example, the USACE has moved to an enterprise subsurface data program called OpenGround. The requirements are stated within Section 01 31 20 and referenced in Section 02 32 13.

DIVISION 03 CONCRETE MATERIALS

There are several separate subsections for concrete, shotcrete, aggregate, and other materials, many of which have a specific and unique requirement for data. Include all subsections which require the generation of data that will be input into the data management system. The main datasets generated by concrete specifications are concrete and aggregate, grout and shotcrete QC testing. This includes tests covered by ASTM standards such as fresh properties (bleed, slump, mix temperature, air content, unit weight), strength development (with data collected at different time intervals), and thermal monitoring - among others. These tests are critical to ensuring concrete quality and structural integrity over time, and the data should be collected in the project database so that the project can accurately assess the concrete quality and any future variance requests, as well as identify potential areas of future O&M or remediation.

DIVISION 31

Section (TBD) INSTRUMENTATION

Because of the data-intensive nature of automated data acquisition systems, and the need for real time review, this specification is likely to be very data-heavy, and potentially include the use of a web-based user interface, a joint instrumentation monitoring plan (JIMP), data management duties, and a file sharing site. Make sure the two are cross-checked for consistency and ensure all applicable data requirements listed in 01 31 20 are understood to apply to instrumentation data as well.

Section 31 00 00 EARTHWORK

Excavation data is of interest to the government in order to verify quantities submitted for payment, to track the progress of work, to verify the excavation was achieved, and to assess spoils and disposal quantities and waste when the excavated materials

must be reused in specific designations. Often the contractor is allowed to survey at stations and produce cross sections for quantity determinations utilizing the "end area method". However, the use of the "composite method" is increasing, where subtraction is calculated between two LiDAR - derived DEM's with a much higher degree of accuracy. Quantities of material excavated and disposed of can also be tracked utilizing truck tickets. If the data management system will be used to track these quantities, it is important to ensure the correct data fields and data products are required within the specification.

Section 31 23 06.00 BLASTING - SURFACE

Blasting is a data-intensive feature of work. The blast design and quality, and whether the contractor followed specified tolerances are evaluated through specific data. Datasets to be collected as a baseline for any blasting program should include:
1) All blast design parameters used to include bench, burden, blast hole depth and diameter, stemming, decking, explosive agent and primers types, sizes and weights, holes per delay, pounds per delay, fragmentation index, and other pertinent design parameters.
2) Post blast evaluation and misfire information
3) Loading logs
4) Vibration and airblast predictions and reports (generally delivered realtime via website)
5) Drill hole plans and reports including penetration rates
6) Blast photos and videos

The blasting specification needs to support the receipt of the data types, and the 01 31 20 specification details what to do with them, entry into the database, if and how they are to be displayed in the web interface, relevant turnover times, file formats and other requirements. This data is valuable for protecting the government against differing site conditions claims or claims that the geology caused blast damage rather than the blast design.

Division 31 [31 32 23] Foundation Drilling and Grouting (no UFGS as of 2022)

Grouting is concrete injected into the subsurface via drill holes to fill in voids in the geology that might allow too much water to move through an area where that is not desirable for structural stability or operational efficiency. On civil works projects subject to engineering regulation ER 1110-2-1156 Safety of Dams, the grouting data requirements are intensive and specific. As of the writing of this specification the guide specification does not exist, however that technical section is where they

should be housed. This includes the requirements for the automated grouting control data collection system, grouting data collection plan, and other data and reporting verification requirements of the program needed to assess closure and final permeability. Ensure the receipt of data and the display formats properly capture needed verifications in this section.

Section [31 56 10] CUTOFF WALL (no UFGS as of 2022)

A cutoff wall, or barrier wall, is a specific structure installed into the subsurface of a dam where the geologic foundation is highly karstic and introduces significant risk of seepage and piping or internal erosion to the structure. This structure consists of concrete panels or secants placed along the upstream dam axis directly through the dam and into the rock foundation. This process involves the excavation of embankment material and rock, and replacement with concrete in panels or secants.

USACE has an informal guide specification for cutoff walls that has not yet been published through UFC as of the writing of this specification. Pertinent data for this feature of work will be detailed in the specification section, and generally includes the following:

1) Excavation verticality and orientation measurements - including raw data from a sonic measurement tool (i.e. Koden) or other equipment that does the measuring, and then analytical reports that show the verticality for approval prior to concrete placement. Because a section of the dam is sitting open with slurry stabilizing the embankment during this verification, it is very time sensitive;
2) Concrete placement including quantities, and all normal QC tests including fresh properties, strength, and other requirements.
3) Concrete verification cores including classification of concrete anomalies as specifically defined in the technical section;
4) Permeability testing, conducted using some method of falling head testing and converted to permeability values;
5) Analysis of panel or secant overlap and thickness in relationship to specification tolerance and geologic conditions (if sub-specification).
This work feature has very specific engineering verification needs in the field, and as a part of the post implementation evaluation conducted after the work has been completed. These needs are filled by a combination of static reports (1), numerical analysis (4) and visualizations (1-5).

Section 31 66 10 ROCK FOUNDATION PREPARATION

Foundation preparation is an important part of any

project where concrete will contact rock or other concrete. For projects subject to engineering regulation ER 1110-2-1156 Safety of Dams, ER 1110-1-1901 or EM 1110-1-2908 Rock Foundations the Government is required to document the rock foundations of its projects, and any dental treatments completed. As technology advances, USACE is employing remote sensing methods such as photogrammetry, LiDAR, and Orthoimagery to compliment hand-collected data on maps. The requirements in the foundation preparation section will coordinate with the requirements in any remote sensing and survey specification as well as this specification for data. There are no dedicated remote sensing guide specifications yet published, however the data product requirements are presented here for reference.

Section 31 63 26 DRILLED CAISSONS
Section 31 63 29 DRILLED CONCRETE PIERS AND SHAFTS

Drilled shafts and caissons are installed when the geologic foundation of a structure does not have rock of sufficient bearing strength for the weight of the structure that will be built on top of it.

The data generated by the installation of these features is important to verify the design assumptions have been met for the integrity of the structure. For drilled shafts, some of the data generated will be the pilot hole geologic log, penetration test, proof test, load tests, orientation and dimensions of the final shaft (ex. cross hole sonic logs), plumbness the installed reinforcement structure, groundwater data, concrete fresh properties, and strength data.

Section 31 68 13 SOIL AND ROCK ANCHORS

Where anchors are a technical component of structural stability, the documentation of anchor installation data is very important. Data such as the geologic log of the pilot hole, bond zone, alignment, water tightness test results, installation QC and QA, stressing and lock off, and any installed instrumentation such as load cells will be detailed in this technical section. Often concrete will be placed over anchors, and so anchor approval becomes part of the time sequencing for the construction schedule - the concrete should not be placed prior to the approval of the anchors, though the contractors will often try to negotiate this. In this case, the turnover time for this data in order to effectively assess and approve the anchor installation is very important, and should be considered in the time requirements for the submittal of the data.

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Section Number	Section Title
[_____]	WEATHER AND WATER STAGE DATA RESTRICTIONS
[_____]	SURVEY CONTROL
[_____]	REMOTE SENSING
01 33 00	SUBMITTAL PROCEDURES
01 33 16.00 10	DESIGN DATA (DESIGN AFTER AWARD)
01 45 00	QUALITY CONTROL
[_____]	LABORATORY TESTING FACILITIES
01 78 23	OPERATION AND MAINTENANCE DATA
02 32 13	SUBSURFACE DRILLING AND SAMPLING
03 23 00	STRESSED TENDON REINFORCING
03 30 00	CAST-IN-PLACE CONCRETE
03 30 53	MISCELLANEOUS CAST-IN-PLACE CONCRETE
03 33 00	CAST-IN-PLACE ARCHITECTURAL CONCRETE
03 37 00	PREPLACED-AGGREGATE CONCRETE
03 37 13	SHOTCRETE
03 37 23	ROLLER-COMPACTED CONCRETE FOR MASS CONCRETE CONSTRUCTION
03 37 29	CONCRETE FOR CONCRETE CUTOFF WALLS
03 70 00	MASS CONCRETE
31 00 00	EARTHWORK
[_____]	INSTRUMENTATION AND MONITORING
[_____]	CONTROL OF WATER AND DEWATERING
31 23 00.00	TUNNEL EXCAVATION - BLASTING
31 00 00	EARTHWORK
31 23 01	UNDERWATER BLASTING
31 23 06.00	BLASTING - SURFACE
31 36 00	GABIONS

Section Number	Section Title
31 41 16	METAL SHEET PILING
31 43 13.13	CONCRETE PRESSURE GROUTING
31 56 13.13	SOIL-BENTONITE SLURRY WALLS
31 62 13.13	CAST-IN-PLACE CONCRETE PILES
31 62 23	PILING: COMPOSITE, WOOD AND CAST IN-PLACE CONCRETE
31 62 23.13	CONCRETE-FILLED STEEL PILES
31 63 16	AUGERED CAST-IN-PLACE PILES
31 63 26	DRILLED CAISSONS
31 63 29	DRILLED CONCRETE PIERS AND SHAFTS
31 66 10	ROCK FOUNDATION PREPARATION
[_____]	GROUTING
[_____]	CUTOFF WALL CONSTRUCTION
31 68 13	SOIL AND ROCK ANCHORS
[_____]	ROCK TUNNELING
31 73 19	TUNNEL AND SHAFT GROUTING
35 20 14	STOPLOGS
35 31 19.40	STONE REVETMENTS
35 41 00	LEVEE CONSTRUCTION
35 73 13	EMBANKMENT FOR EARTH AND ROCKFILL DAMS

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Tailoring options are available for "SQL RDBMS EDB" and "ACCESS ENTERPRISE DATABASE".

****

The work covered by this section consists of a data management system for engineering and construction technical data. The system encompasses every aspect of how this technical data is handled from generation to turnover, and its constituent components - including specified metadata (e.g.

time/date of generation, equipment name for tracking, name of person generating the data). Elements of the data management system include hardware, software, network infrastructure, database architecture, a Data Management Plan, raw and processed tabular data, a web-based interface, and reports and documents incidental to all construction or verification activities, coordination, training, quality checking, and any other associated information deliverables required during the construction contract.

However, this specification does not replace nor supersede the USACE Resident Management System - Section 01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM) used for Contract monitoring, submittals and administration of the contract. It also does not replace nor supersede the Quality Control Specification 01 45 00 QUALITY CONTROL except where the specific data requirements are called out in this specification. The requirements in this specification are in addition to, but do not replace Section 01 78 00 CLOSEOUT SUBMITTALS which details closeout submittals and requirements for CAD as built drawings.

2.1.1 Overview of Goals and Components

The goals of the Government are to:

a. Minimize the cost to the Government required to transform, translate, research, aggregate, query and analyze data.

b. Consume project data in graphical and spatial displays that allow a rapid assessment of progress, and easy comprehension of dam safety and quality management verification.

c. Aggregate the project's data record in an organized manner for easy access during construction.

d. Receive data products in a timely manner that have been subject to thorough QC checking.

To accomplish these goals, an effective data management system ensures the following for data: complete collection, appropriate record formatting, cleaning, verification, timely transmission, complete documentation, and secure and organized storage. An [SQL][MS Access] enterprise database (EDB) using a relational database management system (RDBMS) is required to house all project data. The complete initial data dictionary to be used for the tables transferred to the Government and an entity relationship diagram will be provided by the Government.

The data collected must follow the guidelines as specified in this section. All coordinates for spatially located data must be provided in three dimensions such that the data can be used in 2D or in 3D GIS and other visualization, CAD and mapping software. In any instance where the Contract does not specify, the receipt of clean tabular data in a digital format is the default standard for project data.

****

NOTE: Depending on the requirements of the contract, the system should utilize some type of tabular database. For very large datasets such as are collected on dam safety modifications and navigation projects, an enterprise SQL language

database, maintained using a relational database management system (RDBMS) should be required. This is the only type of database with the functionality and storage capacity to handle very large datasets, power web-based visualization applications, and limit user entry error through the use of database rules and domain tables. For small contracts where data is to be collected and querying capabilities are desirable, use of an MS Access or similar database is acceptable.

The smallest datasets can utilize Microsoft Excel workbooks; however, we would caution against doing so. Excel has the most limited functionality, and there is no way to limit user entry to comply with field types or entry choices, so the dataset will require more manual cleaning, QA/QC, and data validation which would be avoided in true databases. This work will fall to the Government and is VERY labor-intensive.

If the database is the primary deliverable and the Government will utilize it to power their own web-based visualization applications, consider requesting the specific type of SQL database - e.g., Oracle PL/SQL, MSSQL, or PostgreSQL.

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2.2 DOCUMENTED ENTERPRISE [SQL][MS ACCESS] DATABASE

****

NOTE: The purpose of utilizing an SQL language enterprise database is the greater functionality it has and number of simultaneous users it can accommodate. For any megaproject, an SQL language EDB and RDBMS is the standard.

For projects of smaller scope and complexity, an access database may suffice for the effort. Excel is not a functional database structure and should not be utilized for several reasons unless the Government already has an established database to import excel files into, and provides the contractor with the specific data tables, fields and field types - all formatted for easy import into the Government's database. This is essentially the product the specification is designed to deliver in .csv updates, but for a different reason as explained below. Only a database has the power to query and aggregate data, and to accommodate massive datasets without becoming corrupted.

The nightly updates of .csv files are intended to be used by projects that already have a database and can perform automated updates for rapid reconciliation of new data. This would be the case for projects who are building and hosting their own visualizations (i.e. web model, dashboard). These same .csv files could be used to view the data in Microsoft Excel (by just opening the file with

Excel), but would need to be loaded into a database in order for the data to be readily queried. If the Contractor will host the visualizations, nightly .csv updates are not necessary, however the work to produce nightly versus weekly, monthly, or other is the same because the Contractor will be scripting these updates to run automatically - meaning the system updates itself - a person isn't performing this task.

The requirement for closeout backup files to be submitted should apply to all projects, regardless of whether the project or the Contractor is hosting the visualizations. The backup files allow the Government to inspect the Contractor's full work and obtain any required views or scripts in the database. Backup files can also be used by the Government to create the database if the project dos not have staff skilled in SQL database construction. In this case, the Contractor will usually be required to administer the web-based visualizations and database for the duration of the contract. The submitted SQL database backup files can be used by the agency's IT department/contractor to create the database on the Government's servers. For example USACE personnel can submit a service request ticket with G6 to "restore" - or set up a local instance of - the database and grant local user read/write/edit access. This is not an efficient workflow for transferring the database though, and should not be used as a substitute for the nightly .csv update due to the large amount of labor involved in setting up the database from backup files.

The requirement of a database mirror in Part Three DOCUMENTED ENTERPRISE [SQL][MS ACCESS] DATABASE of this specification is designed to provide a way for personnel to interact with the Contractor's SQL database data during a contract if the project does not have qualified personnel to set up an interface. The database mirror will provide the project with a Microsoft Access database updated daily. The benefit of the mirror is being able to directly access and manipulate the tabular data if there isn't a database on the Government's servers.

An ESRI EGDB is not a substitute for an enterprise database. Data is not designed to be easily queried and aggregated outside of the desktop GIS environment, and most project personnel are not usually GIS users. The database requirement and the ESRI products requirements are not redundant and should not be combined.

There are different ways to accomplish data transfer, this is the easiest currently, however that may change in the near future, and when it does this document will be updated accordingly. Having a non-DoD entity connecting to the DoD network through

the firewall to transfer data is currently only allowable with specific G6-authorized exceptions. If the project wants to have a shared data space that both the Contractor and the Government can access, Microsoft Azure is currently (2022) an approved cloud platform. Amazon cloud is also approved for DoD data. The transfer system would require different specifications with this method; however, data system developers savvy enough to use Azure or Amazon should have no problem tailoring this specification accordingly.

The use of the SFTP to receive .csv and backup files of the database is the least expensive, and most tried and true method for transfer of data (in files). If the Contractor will build a web interface, daily updates of the database tables are less important, however, it is still strongly recommended that these updates are required throughout the contract and not just as a closeout submittal so that USACE can examine the data for data QA.

Applicable to USACE projects only: The Contractor may utilize separate subs for instrumentation where applicable, however when the Contractor manages the instrumentation data outside of MIDAS, it absolutely should utilize an SQL EDB due to the massive amount of data it will store. Make sure to have a requirement that covers this need in the instrumentation monitoring specification. If the project will utilize the Contractor for instrumentation, but will also utilize MIDAS, set up a requirement for the Contractor to provide this data directly through API or some other means into MIDAS.

Tailoring options are available for "SQL RDBMS EDB" and "ACCESS ENTERPRISE DATABASE".
****

Set-up, maintain and update a documented [SQL][MS Access] enterprise database (EDB) in a full-scale RDBMS that is compatible with the Government's [SQL][MS Access] database, as proposed in the 50 Percent Data Management Plan and approved by the COR, for the duration of the contract. Store the EDB on the Contractor's servers or the Contractor's cloud storage account for the duration of the contract. Update Database Files including .csv files of the most current version of the database tables to the SFTP site by midnight daily. Update the [SQL RDBMS][MS Access] database backup file of the complete and most current version of the Government's portion of the database to the SFTP on a quarterly basis, and no later than 60 days after the loading of the last record, and at anytime requested by the [COR][ACO]. Utilize industry best practices in the formatting of .csv files so that text fields containing commas do not interfere with the structure of the .csv (i.e. enclose in double quotes or other industry standard).

Provide the Government with an exported data dictionary of the Contractor's EDB optimized for QA of the database tables and fields (to ensure all field types, names, units, precision, and other field parameters are correct) in the 100 Percent Data Management Plan submittal. Upon completion of the Contract and before final demobilization, deliver to the [COR][ACO] the Finalized Enterprise Database according to PART 1, SUBMITTALS prior to final payment.

2.3 CLOUD-BASED DATABASE SERVICES

If a cloud-based database solution is utilized for the database and file management which offers secure file transfer equivalent to or higher than the SFTP requirement, and third-party database access, this may be utilized in lieu of an additional SFTP or database mirror. Provide the Government username and password access to the project via that cloud environment, and include any instructions for access and use of all database and file transfer tools in the "Quick Reference Guide".

2.4 SFTP SITE

****

NOTE: Currently (2022) there are not many low cost, IT-security approved methods of transferring database files in real time across the firewall because of security constraints.

There will always be a lag time between data generation, Contractor entry and QC of the data, Contractor entry of related QC data, and incorporation into the database updates - even when the Contractor hosts the web interface. The method in this document outlines the most practiced and inexpensive method to date. Because data is coming in as files on the SFTP site, which is a secure, third-party hosted site, the Government can utilize scripts to download these files without having to perform manual updates. RMS or other systems utilized remain the venue for satisfying legal requirements of submission for payment. If the Contractor becomes able to load data directly into ProjectWise, or the structure of RMS permits it to function in this capacity, this could replace the SFTP use for non-tabular file document storage and transfer. Currently the database structure of RMS does not accommodate structured data from the Contractor.

If the Government needs to have the Contractor database hosted in a common environment that the Government can interact with in real time, and provides real time access to data, the Microsoft Azure specialty software is currently FedRAMP approved. However Azure required for use by the Contractor will add expense as it is not considered a common software for the Contractor to use, and it may also incur a licensing-usage fee for the district. Any cloud-based solution must be FedRAMP approved prior to implementation. The other methods for direct connection between the Contractor database and Government data management system would be through the approval of a firewall exception, a Government DMZ, or a Contractor-hosted DMZ. All of

these are governed by G6 policy and permissions which have no standard criteria for application. If you are interested in one of these methods, discuss with your local G6 or IT security professional.

The organizational structure of an SFTP site that is used by the Government to populate their own web-viewer and dashboards should be especially well-thought out because of the automated data transfer that will be designed to pull data from that location. Also consider the ease of access and intuitiveness of navigation for users. Alternatively, the Contractor may be required to propose a structure to be used, but this often only delays the Government having to think about it until the submittal process when it may be less convenient and there may be less time to design it properly. The Contractor prefers to know what the Government wants in most cases.

Tailoring options are available for "SQL RDBMS EDB" and "ACCESS ENTERPRISE DATABASE".
****

Host a SFTP site which serves as a system for file transfer for the duration of the contract. [COR][ACO] personnel must be granted unlimited 24/7 access to the SFTP site. Provide username and password access to this site to COR. Establish the SFTP site and provide [COR][ACO] access to the site no later than 7 days after notice to proceed has been issued. Provide [COR][ACO] personnel access from the list provided by the Government within 48 hours of the SFTP site being created, and for 6 months following the uploading of the last project record. Add new users as requested by the Government within 24 hours of the request. The SFTP site must allow traffic over Port 22 for compliance with US Government security protocols. Other web-based document sharing tools (e.g., OneDrive, Google Drive, DropBox or others) that do not comply with the SFTP requirements may not be used as a substitute for an SFTP site.

Host all reports and non-tabular files, raw data, [SQL][MS Access] database .csv and backup files, and other files as directed by the [COR][ACO], on the SFTP site in the same organizational structure as the template provided by the Government in the Volume [_____] attachments. The SFTP folder structure must be fully functional, accessible, current, easy to navigate, and complete with all specified data available for retrieval by both automated and manual methods. If this criteria is not met, pertinent payments will be withheld until the issue is resolved and acceptable to the [COR][ACO].

2.4.1 SFTP File Indexes

No later than 30 days after the last file transfer has been completed, and prior to demobilization, provide Final File Indexes of the SFTP site and all data files transferred in accordance with PART 1, SUBMITTALS, SD-11. Include an index of all files according to the specified organizational scheme, utilizing a standard naming convention, detailing all other files transferred to the Government. Account for all listed files on the SFTP site and verify they are within the same organizational structure as the index. Provide a signed accountability checklist showing the verification was conducted.

2.5 DATA TRANSFER AND QC REPORTS

****

NOTE: Typically, QA of the SFTP, database and GIS model have been problematic on large projects, especially when the Government's Data Manager is not on site and integrated in the construction office. The intent of the reports and automated emails is to ensure the Contractor is keeping the DMS components up to date based on the actual site project as work progresses.

Tailoring options are available for "DESKTOP GIS FILES".

****

Produce scripted reports of the following Data Transfer and QC Reports:

a. Data Transfer Reports:

(1) Automate the delivery of a weekly report (Excel-readable attachment) on Mondays before 7 am [_____][Eastern] time zone to COR-requested email recipients that summarizes all of the changes to the SFTP within the previous week, ending at 2359 hours local project time the previous day. Include the date, filepath, document name, associated submittal section and submittal item number, and other data for each record as requested by the COR. Format the attachment so that it is easy to understand what changes were made.

(2) Automate the delivery of a daily report (Excel-readable attachment) to COR-requested email recipients that lists all of the changes to the SFTP within the previous 24 hours from 0000 to 2359 local project time. Include the date, filepath, document name, associated submittal section and submittal item number, and other data as requested by the COR. Format the report so that it is easy to understand what changes were made.

(3) If a list of digital deliverables is provided by the Government, prepare the above reports in one and two to show what items on the list were submitted with a date, and what items are still outstanding.

(4) Automate the delivery of a daily report (Excel-readable attachment) to COR-requested email recipients that lists all of the changes within the previous 24 hours from 0000 to 2359 local project time to the EDB parent tables for which a feature ID number is associated (for example a Hole ID, Blast ID, Anchor ID, Stage ID, or other ID type). Include in the report the name of the parent table, the feature ID of each record added, and date the work was completed/record generated. If data records were updated - as opposed to newly generated - indicate this for each record. Filter out records in this report that would be generated by routine database maintenance and update processes. The goal of the Government is to track the addition of new records to the database to ensure the Contractor is updating the EDB within the specified turnover times.

(5) Automate the delivery of a weekly report (Excel-readable

attachment) to COR-requested email recipients that lists all of the changes within the previous 24 hours from 0000 to 2359 local project time to the GIS EGDB. Include in the report the GIS model alignment (i.e. 3D, 2D Plan, 2D Profile Cutoff Wall, and any others used) feature class name, the feature ID's added or updated, and date of update. The goal of the Government is to track the addition of new geospatial features and records to the web interface to ensure the Contractor is updating the GIS models within the specified turnover times so the Government can effectively track progress using the viewer.

b. QC Reports: Provide the contract-required individual QC inspector daily reports and combined QC daily report from RMS - including any attached reports or documentation - to the appropriate location of the SFTP site within 24 hours of upload to RMS.

Store copies of all above reports in the appropriate folder of the SFTP site. Add new reports to the SFTP synchronously to turnover time requirements for each item. Propose report formats for all elements described in this section as part of the 50 Percent Data Management Plan submittal. The Government will use these reports to QA the SFTP site, the database, and the web viewer to ensure the required data work is up to date. Process any requested changes to the report format or content within 48 hours of the request.

2.6 WEB-BASED SERVICE DELIVERY EXPECTATION

For all web-based services required within this Contract, ensure that service availability is maintained from 6:00 am to 10:00 pm local project time.

2.7 ESRI GIS REST SERVICES

****

NOTE: This product gives the Government pre-processed and pre-published access to the GIS products that are directly connected to the Contractor's project database and hosted within ESRI's online products on the web. Feature services are generally point, line and polygons, or tabular data you want in a dashboard that contains dummy coordinates (such as concrete QC test results). Imagery Layers or Tile Services are published for raster datasets such as aerial images and other DEM files. The benefit of this requirement is the ability to have full creative control over your visualizations if ESRI Enterprise Portal is used for CAC users on the Government's Portal, while avoiding the scripting and publishing from the database directly, which has not been effectively implemented in DoD to date. This requirement is used in conjunction with database requirements, but replaces the "WEBSITE INTERFACE OF DATA" and "WEB-BASED GIS INTERFACE". Using this method requires that the Government build and maintain their own web maps and dashboards, and to successfully accomplish this it will require providing the Contractor with a starting list of web services desired, including the schema of the attributes and any additional fields

needed to filter or classify the data. For example if the dashboard will show passing or failing, that is easiest as a field in the feature service. Additionally, if QC narrative is desired for the feature service, ensure that is included in a comments field of the attribute table schema.
****

Provide ESRI REST feature services, scene layers, image layers, and tile services hosted on ArcGIS Online (AGOL) or ArcGIS Enterprise Portal with export capability enabled. Deliver links to feature services which are shared with the Government's user group utilizing an ESRI collaboration, or provide username and password access to the Contractor's AGOL or Enterprise Portal account to access the links. Update REST feature services and scene layers within 15 minutes of an update to the database, and update other services within 24 hours of generation of the new dataset.

Specific feature service attribute schema is provided in the attachments to the solicitation. Ensure the attribute data in the feature services follows the schema requirements specified for the documented SQL database. The data within the attribute tables of all feature services must be free from errors, appropriately attributed, and utilize the field type of the corresponding database field. Make any changes to the feature services including the addition of attribute fields, corrections to data errors, numerical field precision, and field type as requested. Make the requested change within 48 hours of the request.

Provide the following web services in 2D and 3D:

a. [_____][Lifts of embankment material by zone];
b. [_____][Most current top of rock surface and contours];
c. [_____][Excavated quantities per billing cycle];
d. [_____][Placed quantities per contract billing cycle];
e. [_____][Spoils quantities per contract billing cycle];
f. [_____][Concrete structures including attributes for concrete materials testing. For concrete testing data without spatial coordinates create dummy coordinates. Include pass/fail for each test performed, retest and retest ID if applicable to the sample, and QC narrative about the test included in a comments field for all tests if failing or resampled];
g. [_____][Soils material testing locations including attributes for soil testing with pass/fail for each test performed, retest and retest ID if applicable, and QC narrative about the test included for all failing or retested samples];
h. [_____][Blast Plans and Reports including blast holes, polygons, overbreak in final surfaces, final grade survey, and any overexcavation];
i. [_____][All processed orthophotographs or aerial photos produced, and DEMs from LiDAR data gathered on site];
j. [_____][All grout stages and holes in 2d profile with grout stage summary data including grout volume, mix design, effective pressure]
k. [_____][Verification holes including all attribute data of water pressure testing, falling head testing, concrete anomalies]
l. [_____][Anchors including all attribute data for testing, and pass/fail for each test performed];
m. [_____][Cutoff wall panels and secant piles orientation and location in space, including all attribute data associated with alignment acceptance and materials testing].
n. Provide [_____][15] additional feature services not requested in this list or the schema provided as requested throughout the course of

construction.

2.8 WEB INTERFACE AND GEOGRAPHIC INFORMATION SYSTEMS (GIS)

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NOTE: Tailoring options are available in this section for "WEB-BASED GIS INTERFACE", "DYNAMIC DATA INTERFACE", and "DESKTOP GIS FILES".

****

Develop a web-based visual user interface to spatial and tabular project data that incorporates the following elements. Host this interface for the entire Contract duration, and for [_____][6] months following demobilization, or the Contract closeout, whichever comes first.

Within 30 days of the end of the data management planning meeting, provide a presentation of the initial Web Interface build for preliminary approval by the [COR][ACO]. Within 30 days after any subsequent Data Management Planning Meetings held for major features of work that weren't covered by the initial planning meeting, or where a change to the web interface is made due to the subject feature of work starting much later in the Contract (for example the [_____][cutoff wall]), provide a presentation of the components of the web interface to be added/updated including GIS and dynamic data components for approval by the COR to satisfy the Web Interface Updates submittal requirement.

****

NOTE: It is important not to require the web interface to be hosted past the contract end date. Six months has been a typical required time period on a large project.

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2.8.1 Web-based GIS Interface

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NOTE: ESRI ArcGIS is already a FEDRAMP approved software platform, and as such many agencies are already using it for web-hosted display and desktop products of geospatial data. If the designer wishes to specify a different service/program, remove and replace all bracketed language. If the designer will specify ESRI products, remove all brackets around ESRI language and empty brackets.

****

Develop [_____][ESRI] GIS web viewers in plan, profile and 3D views using web services published with [_____][ArcGIS Server or Enterprise]. Grant read-only access to the Government to all GIS services used in the web viewers such that the Government can securely add services to Government web viewers and [_____][ArcGIS Enterprise or Portal maps] applications. For details of execution see Part Three, EXECUTION.

2.8.2 Dynamic Data Web Interface

Develop the web interface to have a display component featuring tables, charts, graphs, plots, widgets, and other visualizations in an integrated dashboard style user interface with the GIS views as exampled in the mockups provided in the Volume [_____] attachments. Display data in near real-time from the appropriate enterprise database, even when the data displayed is not real-time from generation (i.e. analog data collection). As the needs of the project evolve, the [COR][ACO] will direct changes or additions to these displays. Make additions and changes to display components as requested by COR.

2.8.3 Desktop GIS Files

****

NOTE: Verify versions and update the software utilized based on what the project uses prior to finalization of spec. The intent of the last sentence in brackets is to clarify for the Contractor that there is not an existing 3D model of the planned or existing features and that the Contractor is to build it. Delete this language if this is not required.

****

Develop, update, and maintain the required 2D and 3D models, complete with all existing feature classes and rasters provided by the Government, and all available planned and completed elements of work as directed by this specification and the [COR][ACO] for the project duration. Develop desktop GIS files in ESRI ArcGIS Pro version [_____][2.X] or current as directed by the [COR][ACO]. The desktop map packages and associated spatial data (e.g. .aprx, .gdb's and other appropriate file types) must contain all formatting, symbology, labeling, binning, and other information requested by the Government. The formatting must be such that the user can easily produce a printed map(s) after performing only the most minor formatting or rescaling. Print templates will be provided by the Government. Provide these documents and all source files as specified in PART 3 EXECUTION.

The Government will provide all historical GIS layers, as detailed in the Volume [_____] attachments, that are required for display in the 2D web interface.[The Government will not provide a base 3D model or any 3D feature classes, however the Government will provide any data required to be displayed in the 3D GIS by the Contractor (as detailed in the Volume [_____] attachments).]

2.9 QUICK REFERENCE GUIDE

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NOTE: Tailoring options are available for "WEB-BASED GIS INTERFACE" and "WEB INTERFACE"

****

Develop a Quick Reference Guide that meets the following criteria at a minimum:

a. Describes how to access and view information management system tools and components;

b. Describes how to download data, reports, drawings and maps;

c. Describes how to make or change graphical outputs for the project;

d. Is designed in an indexed, and well-organized manner and written in plain English rather than technical jargon;

e. Includes web addresses of web-hosted sites in use, and POC information for administrators who can provide user-access to the Government;

f. Documents and indexes all the views and group layers and available graphical datasets in an intuitive user guide to the web viewer so that the user has an understanding of the full capabilities of each view;

g. Clearly describes how to view and filter data in the web viewer, as well as the use of all other functionality of the web interface of spatial and graphical data;

h. Clearly describes how to utilize field forms on digital devices to input data into the web viewer;

i. Clearly describes how to download and utilize any phone app required to utilize field forms for direct entry of field data;

j. Documentation of all URL's used and credentials.

k. Clearly describes the use of the custom web-based QA tool for the database;

l. Clearly describes how to use the database mirror functions.

Text, recorded videos (not to exceed 3 minutes each) with separate videos for each topic, and other COR-approved format may be provided as the quick reference guide, however it must meet the requirements for organization and indexing by subject. General software manufacturer product literature in whole or in part will not satisfy this requirement. Host the guide to an additional page of the web interface and provide meaningful user search, reference and selection options to find related videos/topical text/pictures. Prepare and submit the guide within 30 days of the approval of the initial web interface. If the guide is part of the web interface, schedule a 1-hour meeting to walk through the tool and functionalities. Record the meeting and submit the recording to RMS and the SFTP site, and make it accessible on the website itself.

2.10 DIGITAL CAD MODEL

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NOTE: If these requirements and submittals are already stated in Section 01 78 00 CLOSEOUT SUBMITTALS, remove the "CAD 3D MODEL" tailoring option from this specification.

If the project intends to maintain and update its own web interface in ESRI products, the turnover times and formats of the CAD model are more important to consider so that the 3D CAD model can be used to update the GIS model. Also consider the Interoperability between CAD and GIS programs used when requiring a specific CAD format.

****

Provide the Digital 3D CAD Model Files files comprising the 3-dimensional CAD model and associated data files in [_____][Autodesk AutoCAD][Bentley MicroStation][OpenRoads Designer 3D] format, compatible for use with [_____][AutoCAD 2018][Bentley CONNECT V.8]. The CAD files must be complete in all as-constructed details, and identical in form and function to the

Contract drawing files supplied by the Government, except to replace design with as-built data, and to correct mistakes in original design files.

Provide the most up to date version of all [.dwg][.dgn] files and associated data files comprising the 3D CAD model in a weekly update to the SFTP site by [_____][0600 hours] local time zone every [_____][Monday]. All items (polylines, points or others) in [.dwg][.dgn] files must be on correct A/E/C Layers, in accordance with A/E/C CAD standard ERDC/ITL TR-19-7. Utilize the same required templates as are required and used for redline and final as-built drawings as applicable. Utilize [_____][e-Transmit][Packager] to export all features and submit all associated files in one zip file when submitting the CAD files. The Government reserves the right to reject any files it deems incompatible with the Government CAD system, files not compliant with the [_____][R6.1] A/E/C standard, and files containing features without accurate geospatial referencing or with geometric inaccuracies.

2.10.1 Spatial Referencing

Spatially reference the features of the 3D CAD model to the verified primary project survey control, utilizing the established project horizontal and vertical datums and projections. Create all applicable features as geometrically correct closed 3D features which can be imported as closed multipatch features in ArcGIS. Ensure all features are true to as-constructed dimensions and locations.

2.11 DATA MANAGEMENT PLANS AND ADDENDA TO 100 PERCENT DATA MANAGEMENT PLAN

2.11.1 50 Percent Data Management Plan

****

NOTE: Tailoring options are available for WEB-BASED GIS INTERFACE", "SQL RDBMS EDB" and "ACCESS ENTERPRISE DATABASE".

****

Within 60 days after Notice to Proceed, prior to conducting the data management planning meeting, submit a 50 percent plan for management of all the various data collected throughout this contract. The Plan must be well-organized, and in a digital format where both text and tables can be easily edited during the data management planning meeting. The Plan must include all sections and information detailed in PART 3, DATA MANAGEMENT PLAN to the best of the Contractor's knowledge at the time. Proposed substitutions for any requirements will be approved in the 100 Percent Data Management Plan submittal. Include the following proposals to Contract requirements:

a. Any proposed substitutions to required visualizations in this document;

b. Proposed naming conventions per paragraph in PART 1 Naming Conventions;

c. Proposed Contractor database platform per paragraph in PART 2, DOCUMENTED ENTERPRISE [SQL][MS ACCESS] DATABASE;

d. Proposed format for required Data Transfer and QC Reports per paragraph Data Transfer and QC Reports in PART 2;

e. Proposed photograph PDF organization format per paragraph PHOTOGRAPH PDF'S AND RAW DIGITAL PHOTOS in PART 2.

This document serves as the seed document for use in the data management kickoff meeting containing all necessary information about the Contractor's side of the data management system with respect to the Contract requirements and in light of changes that may occur due to the design-build nature of the Contract. The 50 percent plan will be used to record all decisions and information about the joint data management system that are agreed upon in the meeting, and will become the basis for the 100 Percent Data Management Plan. Government approval of this plan indicates it is complete enough for use in the data management planning meeting. Approval does not indicate an approval of any proposed deviations or substitutions.

2.11.2 100 Percent Data Management Plan

Within 30 days after the end of the data management planning meeting, submit the initial comprehensive Data Management Plan for the project. The 100 Percent Data Management Plan must include all sections and information detailed in PART 3, DATA MANAGEMENT PLAN, and must reflect all [COR][ACO] input, and collaborative decisions, products and workflows from the data management planning meeting. It must be updated with the results of any subsequent kickoff meetings for features of work where the data-generating Contractor will not be on site, and specific data-generating equipment will not be detailed until the start of that work.

This document serves as the authoritative data management guide which documents the collection, processing, storage, flow, and visualization of information and data throughout the contract. At the end of construction, the final version will become the Data Management Manual outlined in SD-11 Closeout Submittals. Resubmit this document every 6 months with any updates per PART 1, SUBMITTALS SD-10. A sample Data Management Plan will be provided upon request after award.

2.11.3 Addenda to the 100 Percent Data Management Plan

****

NOTE: The following plans are intended to make the Contractor detail the workflows utilized to meet the specification requirements, and submit them for review by the Government. The plans are submitted prior to the data management planning meeting to give the Government a chance to review and discuss them with the Contractor during the meeting to help resolve any issues prior to the start of intensive data collection.

****

The addenda to the data management plans are submitted and approved prior to the data management planning meeting with the exception of the Proposed Changes to the Enterprise Database Schema, which is submitted synchronously to the 100 Percent Data Management Plan. These individual plans may be changed during the data management planning meeting based on the collaboration that occurs and are subject to a second approval as part of the 100 Percent Data Management Plan submittal, of which they are a component.

The addenda to the 100 Percent Data Management Plan must include the following:

2.11.3.1 Automated and Manual Data Collection Output Examples

Within 45 days after Notice to Proceed, before conducting the data management planning meeting, submit digital samples of all raw outputs from automated data collection systems and all manual processes. Submit automated systems outputs in two formats: 1) Excel-readable digital format with field types defined on separate pages or in a separate document as needed. 2) PDF of digital printouts. Submit forms or logs to be completed manually digitally in PDF format. The purpose of this submittal is to have all necessary data output formats available for use in the data management planning meeting and for the Government understanding of proposed changes to the EDB schema.

2.11.3.2 Data Cleaning and Verification Plan

Within 30 days after Notice to Proceed, before conducting the data management planning meeting, submit and have approved a detailed plan for cleaning and verification (see definitions provided in PART 1) of data generated either by an automated or manual process on site. This includes the identification of all procedures and policies related to consistency and accuracy of naming convention, field formats, standardized character entry of fields and records, correcting entry errors, verification of source field data and data review for verification of entry correctness. This plan must include all technical specifications for all hardware and software utilized in this process. This plan must be developed by the data manager and the data management quality control representative identified in Section 01 45 00 QUALITY CONTROL as applicable. Reference PART 1 for record tracking requirements of EDB contents.

2.11.3.3 QC Daily Information Collection Plan

Within 60 days after Notice to Proceed, before conducting the data management planning meeting, submit and have approved a detailed QC daily information collection plan that includes:

a. How the narrative information about installation procedures and performance of the work that goes into the QC daily reports will be added to the EDB and related to records for the features of work the QC was performed on.

b. How activity codes will be collected in conjunction with "a" and incorporated into the database and related to relevant fields.

c. How personnel hours and equipment and hours will be incorporated into the EDB.

d. Any proposed changes to the EDB that will be required to incorporate items a-c, and how the information will be related to the features of work.

2.11.3.4 Backups, Archiving and Disaster Recovery Plan

Within 30 days after Notice to Proceed, before conducting the data management planning meeting, submit and have approved a detailed plan for the backup, archiving and disaster recovery for data and data systems, sufficient to describe the steps the Contractor will take to protect and store project data of all types from the time of automated or manual generation, through project record turnover to [COR][ACO] and discontinuation of the SFTP site.

2.11.3.5 Data Transfer Workflow

Within 45 days after the Notice to Proceed, before conducting the data management planning meeting, submit and have approved a detailed plan describing the Contractor's data transfer technical workflow in detail. The plan must show in depth how the data transfer system on the Contractor's side will integrate all features specified by the Government in PART 1, Data Turnover Timeframes, how turnover times will be met, and how it will dovetail with the Government's system architecture (if applicable).

2.11.3.6 Proposed Changes to the Enterprise Database Schema

****

NOTE: Tailoring options are available for "SQL RDBMS EDB" and "ACCESS ENTERPRISE DATABASE".

****

Within 30 days after conducting the Data Management Planning Meeting, submit proposed changes to the EDB for approval. The Government acknowledges schema changes to the enterprise database will be required as a result of Contractor-specific systems and methods. Provide a detailed description of any proposed changes to the schema of the enterprise database required to make actual data collection for the project consistent with the Government's goals. As one example - adding fields to the table "Concrete_MixDesign" for the specific cementitious materials that will be used in the concrete mixes. As another example, adding fields specific to the type of hardware used to verify cutoff wall panel or secant alignment. This addendum must include written justification for each proposed change, and a draft version with all of the following with proposed changes highlighted:

(a) Data Dictionary
(b) Entity Relationship Diagram

Additionally, for each schema change, submit the SQL statement for the change. All changes must be in accordance with paragraphs DOCUMENTED ENTERPRISE [SQL][MS ACCESS] DATABASE in PART 1 and PART 2, and will require [COR][ACO] approval prior to implementation.

2.11.3.7 Data Management System Demobilization Plan

Within 45 days after Notice to Proceed, before conducting the data management planning meeting, submit a step-by-step plan documenting how the data management system will be demobilized including:

a. Schedule correlated to project schedule milestones and overall project completion for final deliverable completion and transfers and decommissioning of data system components.

b. Proposed method for transfer of all final datasets, (viewer components, GIS files, algorithms, scripts, and other products) to the Government.

c. Schedule of preliminary test of final data transfer from item b that includes adequate time to address these issues prior to data system closeout.

d. The steps of equipment/component demobilization and details of all impacts of these steps on the data management system functionality.

2.11.3.8 Data Management System Demobilization Plan Updates

Within [_____][12] months of scheduled project completion, begin submitting updates to the data management system demobilization plan. Provide any updates to the plan required for changes in technology (i.e., hardware, software, applications) and methodology that may have taken place throughout the execution of the contract. Resubmit the entire demobilization plan but clearly denote in the body of the plan what has been removed and what it was replaced by, or what has changed.

Full details of execution of the Data Management Plan are in PART 3, DATA MANAGEMENT PLAN.

2.12 TRAINING

****

NOTE: The purpose of training is user integration to the web-based tools and the DMS. If the Contractor is not hosting a web interface it may still provide value for familiarization with any other product they are producing such as the database, database mirror. This must be determined by each individual project.

Covid-19 has changed many elements of how we do business. If both parties are comfortable with in-person meetings based on current transmission and new case trends, it is recommended to have the meetings in person to help build rapport. If in-person meetings do not make sense given infection rates on site or in the area where personnel will be traveling from, this requirement can be relaxed by the government. If the project thinks it might want in-person attendance, leave the more stringent requirement in the specification so that it can be enforced as needed, however it can always be relaxed later.

Tailoring options are available for "WEB-BASED GIS INTERFACE"

****

Provide training sessions, on site or at the Government office - as coordinated with the Government, to familiarize and train Government users on the GIS and dynamic data web interfaces and use of the database mirror. Provide [_____][3] sessions, [_____][4] hours in length each.

2.12.1 Initial Training Session

Coordinate the initial session to take place no later than 15 days after the approval of the initial web interface. Contractor's Data Manager, and Data Visualization Specialist must be physically present at the meeting, and any other data management staff who made integral contributions must participate either in person or via webinar hosted by the Contractor.

Record the training session, bookmark the recordings according to topic, and host to the help section of the web interface (specified in PART 2, QUICK REFERENCE GUIDE) within 5 business days of the completion of the session.

2.12.2 Intermediate and Final Sessions

Coordinate the intermediate session to take place during execution of the Contract with date/time to be arranged between the Government and the Contractor. Demonstrate at this meeting that Government feedback from initial meeting has been implemented, and that adequate coordination between the Government and the Data Manager is taking place prior to the start of features of work for which intensive data collection will occur.

Coordinate the final session to take place near Contract completion to aid in transfer of information management system to the Government systems, including but not limited to transfer of databases, web services, and other data system components.

2.13 PHOTOGRAPH PDF'S AND RAW DIGITAL PHOTOS

In addition to the raw digital photo submissions described in Part One, submit PDF documents displaying all Contract required progress or other photos organized into separate documents. Propose document organization in the 50 Percent Data Management Plan for approval by the [COR][ACO] (for example by feature of work, work phase, work location, or other parameters which make navigation intuitive). Render the photos in the PDF with a resolution that represents the original photo resolution to the human eye. Place photos according to their proper orientation (portrait or landscape). Create an index with bookmarks for each PDF organized by submittal section and suborganized by work area (if applicable) and then by date in the sequence which they were taken.

Process all raw photos for inclusion in the PDF submission with a border including a 13 mm 0.5 in caption at the base of each photo for descriptive information. Include the following information for each photographic image in the caption:

Project Name
Contract Number
Contractor Name
Date
Station and Offset
Photo Number
Orientation View
Work Element Depicted
General Project Area

2.13.1 Turnover Times

Submit all raw photographs to the SFTP site within 48 hours of collection and organize in folders on the SFTP site in accordance with the provided file structure in the Volume [_____] attachments. Photos must be updated to the PDF documents within 7 days of collection. PDF documents must be updated and uploaded to the SFTP site weekly.

2.14 OPENGROUND CLOUD DATABASE AND RECORDS

****

NOTE: This section applies to USACE projects only - USACE uses OpenGround Cloud for drilling data. Delete the tailoring option for OPENGROUND if used

by other agencies or OpenGround will not be needed/used.

The Drilling Data Standards Committee in the Geotech, Geology & Materials Community of Practice in USACE developed the fields for boring log entry to streamline the usage of geologic terms and descriptors. These terms have been researched from USACE ER, EM, ATSM, and other standards. References to the standards can be found in the OpenGround Cloud program. This schema is available for use by any organization, and the software is DoD-approved. For more information, contact the Data Standards Committee Chair via the Geotech, Geology and Materials Community of Practice lead at USACE Headquarters.

In the most recent update to EM 1110-1-1804 Geotechnical Investigations, a National Drilling Manual was compiled from the drilling manuals of several districts. This manual was edited to include the use of the terms utilized in the drilling database fields. The manual is meant to be used in conjunction with the database and is intended to be provided to the Contractor and required for use in hole logging in the applicable subsurface investigations specification. The use of the manual in producing field logs will limit potential translation errors upon data entry. Ensure that sections of the Contract requiring drilling also require the use of the National Drilling Manual for consistency.

****

Provide all drilling and soil testing data utilizing USACE Bentley OpenGround Cloud configured for the [_____] project. USACE will provide necessary permissions to Contractors entering data. Provide a list of users with name and emails for the Government to grant access. If the Contractor does not already have a license for OpenGround cloud, user-specific "named user" or concurrent licenses must be obtained.

Enter the data for all drill holes on the project, including but not limited to [exploratory drilling, grout holes, pilot holes, verification holes, instrumentation holes, blast holes]. See PART 3, OpenGround Cloud Database and Records for details of execution.

PART 3 EXECUTION

****

NOTE: The purpose of requiring specific schema elements are to ensure that the Government is provided with values used for critical evaluation of engineering and construction work, and in a format where they can be rapidly queried and visualized without additional cleaning and formatting. Without providing the Contractor with a baseline of data expectations, they are expected to try to figure out what the Government wants. Lessons learned on mega projects from the past decade have shown that it is

far more efficient to detail the Government's expectations at the outset of the Contract, and in writing to ensure they are delivered.

****

3.1 DOCUMENTED ENTERPRISE [SQL][MS ACCESS] DATABASE

****

NOTE: Tailoring options are available for "SQL RDBMS EDB" and "ACCESS ENTERPRISE DATABASE".

****

Transfer the digital datasets identified in the data dictionary, and any additional datasets requested by the COR, to the Government via the project enterprise database (EDB). Provide data for all fields of each table, according to the field definitions provided in the data dictionary.

3.1.1 EDB Structure

The documented [SQL][MS Access] enterprise database must utilize the tables, fields and relationships detailed in the data dictionary. **The Contractor must supply all data for all tables and fields of the database for work being conducted within applicable turnover times.** If data is not provided within specified turnover times, funds for both the features of work being completed and for data management may be withheld until the data is provided.

A preliminary data dictionary will be provided with the Volume [_____] attachments. The database is required to convey the data in a way that can be easily researched, understood and ingested by the Government. The Contractor may utilize their own schema structure as needed within the above constraints for the values used by the Government. Populate all fields within each table for every record as applicable. Utilize the same table names, fields, field names, field types, domains, units, precision, and relationships as defined in the data dictionary agreed upon in the 100 Percent Data Management Plan. Tables added to the database exclusively for use by the Contractor for their own internal business processes not related to the verification of work are not required to be transferred to the Government. This exemption does not include QC data.

3.1.2 Schema Changes

Incorporate any additional requested database fields, tables, relationships and database views, either as requested by the [COR][ACO], or as necessary to capture new features of work, throughout the Contract. The Government's data manager will work with the Contractor's data manager to ensure requested new structural changes do not add significant burden.

Propose modifications to the database schema that will impact the Government's ability to ingest the data as needed. Any changes to the schema impacting the tables, fields and relationships ingested by the Government must be approved by [COR][ACO] prior to any change to the EDB and documented in the subsequent update to the Data Management Plan. This requirement does not apply to triggers, tables, and fields, and other elements that are built for the Contractor's use only. Clearly identify the table(s), field(s), and or relationship(s) to be changed, and the specific changes to be made. Repair or populate any records that were collected prior to the schema change that may be affected.

3.1.3 Database Mirror

Allow the Government to view all tables in the EDB using Microsoft Access software. This can be accomplished through upload of a mirror database to the SFTP (database(s) files updated daily which contain copies of the EDB tables but are not directly updated with new project data from sources other than the EDB), or by providing a Microsoft Access file with security-compliant live-linked data tables, and/or through other means proposed by the Contractor in the 50 Percent Data Management Plan, and accepted by the [COR][ACO].

3.1.4 Ongoing Schema Updates

For updates to schema of the Government's tables throughout construction after the initial "Proposed Changes To The Enterprise Database Schema" submittal in PART 1, SUBMITTALS SD-01, update the following documents hosted to the appropriate location of the SFTP site that detail the changes:

a. An excel document detailing the new field name, field type, associated units, field definition, relationships if any, and any associated calculation used to produce the value.

b. ER diagram of the database structure that reflects the change.

c. Any impacts to the existing dataset arising from the change.

d. Reason for the change.

Submit this spreadsheet weekly with all changes from the week for [COR][ACO] approval. If there are no schema updates, formal submittal is not necessary

3.1.5 Database Views

The construction of database views is required by the Contractor in order to facilitate providing data specified in some of the visualizations. The Government will provide the required calculations, constants and definitions needed to facilitate the construction of these database views.

3.2 DATA DELIVERABLES FOR SPECIFIC FEATURES OF WORK

****

NOTE: The state of data requirements across UFGS specifications are highly variable from document to document. This section is intended to specifically detail the data deliverables for work already specified in the feature of work sections as the examples in section 1.3 outline. This section is intended to provide a venue for detailing data and report deliverables that are NOT properly detailed in other sections of the contract. For example if there is no remote sensing section, the LiDAR, or photogrammetry deliverables may be stated here. Or if not covered in the grouting section, OPTV deliverables may be stated here. Keep in mind, this opens a can of worms. These types of work have precision, accuracy, equipment, calibration, QC, processing, and other requirements that should be stated somewhere to ensure a quality data product is

received. In a perfect world there would be no sections of requirements like this in this specification. Alternatively, this template can also be used for consistency in the appropriate feature of work specification sections if needed.

****

3.2.1 Data and Reports

****

NOTE: Insert a description of the data type.

****

[_____]

3.2.1.1 Raw Data

****

NOTE: Insert a list of the raw data file types, contents and turnover times and methods if different from what is specified in Part One "Geospatial Metadata". Some datasets may be appropriate for scanned copy of a paper record generated by the equipment, such as Koden raw data, however the majority of data will be received digitally.

****

[_____]

3.2.1.2 Processed Data

****

NOTE: Include any final deliverables required to be produced from the raw data including file type, resolution, hosting size.

****

[_____]

3.2.1.3 Reports

****

NOTE: Include the contents and requirements for reports associated with data submissions. Some verifications will be satisfied through the submission of a report containing the data rather than the data itself. One example of this is verticality verification for cutoff wall panel excavations - a report submitted showing verticality, alignment, and rotation of each element with plots generated from the Koden data is far more useful for rapid approvals than the raw data where the government would have to generate these products. Remember, these requirements belong in the appropriate work section. Only list them here if they have not been required there.

****

[_____]

3.2.1.4 Visualizations

****

NOTE: Include any specific visualizations needed in GIS including symbology and binning, plots, charts, graphs, and tables of data. in this section.

****

[_____]

3.2.1.5 Drawings

****

NOTE: If progress drawings are required as part of the delivery, detail here.

****

[_____]

[3.2.2 Grouting and Water Pressure Testing

****

NOTE: Below are examples of data sets for specific features of work, including how they will be displayed in GIS and the associated data plots needed. If the contract specifies that the Contractor builds and maintains a dashboard, the visualization information may be better placed within the section pertaining to the dashboard view of the data. It has been presented here for ease of reference. Format the specification according to the organizational structure that makes it the simplest to reference for both the Contractor and the Government.

Adjust this section as necessary to capture specific project needs. Other typical required reports could include anchor installation, drilled shafts/piles, excavation, blasting, earthwork, or other features of work.
These requirements must be developed with heavy input from the technical designer for that feature of work specific to the project. Tailoring options are available here for "WEB-BASED GIS INTERFACE".

ENSURE THESE ARE NOT DUPLICATE REQUIREMENTS IN OTHER SPECIFICATIONS.

****

3.2.2.1 Raw Data

Provide digital raw and appended raw data files of the automated grouting control and data collection system in .csv format and load to the appropriate location of the SFTP site within 12 hours for raw data and 24 hours for appended raw data. Format raw data files, or appended data files if not an option for raw data, such that the field headers have names that allow the user to understand what date they contain.

3.2.2.2 Processed Data

Provide grouting and water pressure testing data to all required fields of the EDB as detailed in the data dictionary, provided in the Volume [_____] attachments. Differentiate water pressure testing records in the naming convention and in the EDB records in accordance with the provided data dictionary.

3.2.2.3 Reports

Furnish records of pay quantities to the [COR][ACO] within 24 hours for the previous day's activities. Submit daily records in the form of drilling and grouting reports with the daily log of construction.

Include in the drilling report:

(1) The location and station/offset of each hole drilled;
(2) The date;
(3) Drill rig identification;
(4) Inclination and azimuth;
(5) Time drilling was started and stopped;
(6) Rock type and condition if core is logged;
(7) Any unusual drilling conditions encountered;
(8) Depth and quantity of drilling fluid loss and gain;
(9) Total footage drilled.

Include in the water pressure testing report:

(1) Equipment calibration logs;
(2) Date;
(3) Hole ID tested;
(4) Depth of test;
(5) Pressures applied;
(6) Time interval;
(7) Volume of flow.

Include in the grouting report:

(1) Hole ID;
(2) Date;
(3) Grout mixes used for each zone;
(4) Time of each grouting effort and pressures attained;
(5) Maximum, minimum and end injection pressure;
(6) Maximum injection rate;
(7) Volume of grout mixture placed;
(8) Volume of cement solids injected in the hole;
(9) Itemized total quantities of grout materials placed;
(10) Quantity of grout wasted;
(11) Temperature of the grout;
(12) A plot of the evolving permeability and pressure with time.

3.2.2.4 Visualizations

a. Graphs - Included in PDF documents, may also be included in Raw Data.

  (a) 1) Gauge Pressure, Effective Pressure (and Down hole Pressure if used) vs. Test Duration in minutes
  (b) 2) Flow Rate (gal/min) vs. Test Duration in Minutes

(c) 3) Apparent Lugeon value vs. Test Duration in Minutes
(d) 4) Volume of grout, water, or dye vs. Test Duration in Minutes

b. Grouting, Water Pressure Testing or Grout Trend Plots in PDF format for each borehole and for each test type with all stages and graphs shown (e.g., each borehole will have one PDF record of Grout Trends plots for all stages and one PDF record for water pressure test plots for all stages). Hyperlink grout stages in GIS profile view alignment to trend plots.

c. Grout summary symbology in the GIS environment: Symbolize grout stages as a layer(s) in a section view within the simplified and desktop GIS environment. Color stages along a borehole to highlight areas of high grout take. Initial symbology must be gray for 0-5 gallons, yellow for 5-15 gallons, brown for 15-30 gallons and red for over 30 gallons.

d. Water Pressure summary plots in the GIS Environment: Water (and dye testing) stages must be colored along a borehole to highlight areas of high lugeon values. Initial symbology must be green for 0-3 lugeons, yellow for 3-10 lugeons, brown for 10-50 lugeons and red for greater than 50 lugeons. Final "As-built" grout summary plot(s) must be provided in an Adobe PDF and as per Section 01 78 00 CLOSEOUT SUBMITTALS (as-built drawings).

e. Create and maintain a georeferenced, three-dimensional CAD file with plan and section views for the development of the as-built drawings outlined in this specification. Represent each hole drilled and grouted in both plan and section views of the model. Display the following information in section view, and submit accompanying plan view drawings for orientation of the profile. This may require more than one view of the same section:

(a) 1) Hole location by station with applicable orientation or orientation indication and inclination;
(b) 2) Grout volumes and mixes placed per stage in gallons;
(c) 3) Symbolized by grout volume;
(d) 4) Lugeon values from water pressure testing by stage;
(e) 5) Drilling information (e.g., cavities, rod drops, water losses,and other data as applicable);
(f) 6) Geologic formations along the profile as a backdrop;
(g) 7) Location and type of lost tooling;
(h) 8) Irregular events;
(i) 9) Hole depths and top and bottom elevations;
(j) 10) Stationing at regular intervals;
(k) 11) Grout hole IDs;
(l) 12) Elevations.

Display the following information in plan view:

(m) 1) Grout holes with labeled hole ID;
(n) 2) Instrumentation, exploratory drill holes, or other related structures in the immediate vicinity;
(o) 3) Final bottom elevation of the holes;
(p) 4) Northing and easting grid;
(q) 5) Compass rose and scale;
(r) 6) Total grout takes for finished holes in liters gallons;
(s) 7) Hole symbolized by status (such as planned, drilled, in-progress, completed, and other symbologies commonly used).

Provide all updated CAD source files for the drawings and all other necessary data to view and edit the drawings in the full CAD program via the SFTP site weekly. Use all applicable projections and datums specified and ensure all features are georeferenced to project survey control. Update records and drawings within [_____][48] hours of data collection, or [24] hours of progress status changes, and submit updated digital PDF copies on a weekly basis for the duration of the grouting via the SFTP site. Provide one full-size, color printed copy submitted to the Contracting Officer weekly. The [COR][ACO] may request changes in format or symbology at any time and should take effect within [_____][5] calendar days.

][3.2.3 Cutoff Wall Verticality and Orientation

****

NOTE: Tailoring options are available here for "WEB-BASED GIS INTERFACE".

****

3.2.3.1 Raw Data

Provide the digital raw data files of the verticality and orientation measuring device. If the native file format requires proprietary software to read, convert the files into an Excel-readable format. Provide printed hard copy data produced by the [_____][Koden] via a clean, legible scan in PDF format.

Load raw data files and scans to the SFTP within 12 hours of the measurement of the excavated element.

3.2.3.2 Processed Data

Provide active data and associated plots of verticality and rotation in Microsoft 365 Excel or another approved software application which clearly demonstrate actual position in space along every axis. Plot this against theoretical location in space and specification tolerances. Label all data, constants, and values with units, and orientation in relation to the project baseline. Provide plots within 24 hours of the excavation via RMS and the appropriate location on the SFTP.

3.2.3.3 Reports

Submit detailed reports of the verticality, alignment, and rotation of each element excavation within 24 hours of measurement of each excavation. Submit reports of verticality, alignment, and rotation for each element and its neighboring elements for signed off by the [COR][ACO] prior to backfilling the element with concrete, as detailed in Section [_____][Section 31 56 10 CUTOFF WALL]. Both reports must depict actual versus theoretical alignment as specified in this section. Refer to both the raw and corrected verticality and rotation measurement data with a full list and explanation of all values, constants, formulas, and information used to process this data. Submit to-scale graphical plots for each test per the requirements herein. Submit any diagrams/schematics necessary for interpretation of the data. Use the same reference orientation in all instrument reports.

3.2.3.4 Visualizations

Drawings showing an analysis of barrier wall elements must be completed for each element and each set of adjoining elements showing the verticality, orientation, overlap and continuity of the barrier wall. These drawings must be completed weekly.

Display actual location of these elements in space in the GIS environment, in plan and section views. Display overlap between elements in the GIS environment as a separate layer.

a. Sections of barrier wall elements taken at [_____] meters (m) [_____] foot (ft) depth intervals of the actual location of all barrier wall elements must be shown in plan view such that they are located correctly in space and the verticality and alignment of each element at each [_____] m [_____] ft depth intervals can be seen.

b. These plan view section cuts of the elements must also include a section at the top of the wall, at the soil-rock interface and at the bottom of the wall. The element section cuts at depths must be placed in layers by depth that can be turned on and off by the user separately such that user can look at section cuts of all completed barrier wall at some specified depth individually (e.g., 30 feet below work platform, or at bottom of barrier wall elements).

c. Overlap between adjoining elements must be shown as red when criteria specified in [31 56 10] is not met, yellow when criteria are within 0-5 percent over requirement and green where criteria is more than five percent over requirement. Final overlap analysis and drawings must be completed in CAD format as per Section 01 78 00 CLOSEOUT SUBMITTALS (as-built drawings).

d. Include all relevant base layers such as stratigraphic units, embankments extent, abutment contacts, instruments, station/elevation grid, location of features that cross-cut the embankment, existing grout curtain, existing post-grouting water permeability data, top-of-rock, and other datasets as requested. Also include the [Koden-]calculated excavation and placement geometry of panels/secants, and [hydromill-]detected top-of-rock if data is collected.

e. Visualize verification holes in the cutoff wall as line/polyline features, and concrete anomalies as point features with unique symbology for each type of concrete anomaly. See the Volume [_____] attachments for details.

f. Hyperlink verification hole elements in GIS to Hvorslev plots, CCTV footage files, and OPTV/ATV logs.

][3.2.4 LiDAR Surveys

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NOTE: Tailoring options are available here for "DESKTOP GIS FILES".

****

3.2.4.1 Raw Data

Provide raw LiDAR data in .LAS format, including acquired LiDAR line strips and the SBET files with all EO information included. Calibrate raw files. [The .LAS files must include all returns, intensity data and RGB values.] Submit all raw data to the SFTP within [_____][48] hours of generation.

Deliver mass point data utilizing .LAS [_____][V1.4], containing all .LAS items of point data record format 1. The header file must contain all system-generated .LAS items as defined in the Public Header Block, and at a minimum must contain the "File Creation Year Day" and "File Creation Year" which will represent the final deliverable-generated .LAS date. Specify the projection information for the point data in the Variable Length Record using the appropriate GeoTIFF tags.

3.2.4.2 Processed Data

a. Noise-removed LiDAR point cloud (classified points) with return number in .LAS format. Break files up into approved tile scheme. [The .LAS files must include all returns, intensity data and RGB values.]

b. Create Digital Elevation Model (DEM) using an appropriate interpolation method to produce [_____][0.01] m[_____][.3937008] in posting DEM for geologic foundations and slope monitoring surveys, and [_____][1.0] m [_____][3.28084] in -posting DTM for quantity surveys, however this resolution may be adjusted at the direction of the [COR][ACO]. Reference DEMs to the same horizontal and vertical datums as the .LAS files. Produce DEMs in GeoTIFF file format. Tiles must be edge joined and seamless within the project. Document interpolation and other data processing methods and provide in the metadata.

c. Process geologic foundation datasets to produce vector features in GIS of all discontinuity and other structural rock features and of dental concrete.

d. A sample symbology and visualization for monitoring survey deliverables showing cumulative displacement is provided in the Volume [_____] attachments. Utilize this sample as the basis for showing changes to monitored areas over time.

e. Provide project-based metadata for all final data products.

f. Submit processed datasets within [_____][7] days of conducting the field survey.

3.2.4.3 Reports

Produce a report for each foundation (horizontal and inclined surfaces or tunnel section), that includes all requisite metadata, quality control, field forms, the field checklist for foundation cleaning signoff showing data collection was not started until the [COR][ACO] confirmed appropriate cleaning had taken place, data collection technician and Government representative sign off that compliance with Section SURVEY CONTROL paragraphs LAWS AND REGULATIONS GOVERNING AERIAL DATA COLLECTION and SECURITY REQUIREMENTS were followed, and any other information as directed by the [COR][ACO].

For monitoring surveys produce a report including survey drawings showing cumulative displacement calculated between initial and most recent DEM datasets, and field notes, within [_____] [48] hours of data collection. For displacement drawings, utilize a binning for features that captures [_____][0.01] m [_____][.3937008] in changes, and a symbology that makes these changes easily identifiable utilizing both raster symbology and contouring lines as necessary to achieve a high-quality visualization. Submit a final report of monitoring surveys at the completion of the project and prior to demobilization. Submit all quantity surveys conducted utilizing LiDAR in accordance with [_____] SURVEY CONTROL.

][3.2.5 Orthoimagery

3.2.5.1 Raw Data

Provide the raw imagery exposures acquired (Stereo Pairs), the final aero-triangulation solution (Exterior Orientation EO files) in the format required, or as directed by the [COR][ACO]. Submit raw data to the appropriate folder of the SFTP within [_____] [48] hours of generation.

3.2.5.2 Digital Data

Orthorectify the imagery to create a digital mosaic for the entire project area. Employ software techniques to radiometrically process the orthophotos to ensure maximum tone and contrast balance between adjacent tiles. Document the techniques applied in the Data Management Plan.

Use the same tiling scheme from the LiDAR deliverables for each ortho deliverable, and provide the final 4-band digital orthophotos in uncompressed GeoTIFF format (.TIFF) with world files (.TFW) for each tile. Produce vector polygons in GIS of the dental concrete placed if collected with imagery. Submit all processed data to the appropriate folder of the SFTP site within [_____] [7] calendar days of generation for geologic foundations. Submit monthly site overview imagery within [_____] [48] hours of data collection.

3.2.5.3 Metadata

Project-level Metadata must comply with the current ISO Content Standards for Digital Geospatial Metadata including ISO 19115-2. ESRI ArcCatalog, ArcGIS Pro, or script-based geoprocessing tools may be used to create the metadata records. Construct metadata records with sufficient quality to pass through the USGS Metadata Compiler with less than three errors. All products generated must be identified in the metadata.

3.2.5.4 Reports

Include in the report for each foundation part all applicable information for orthoimagery collection. Submit to the appropriate folder of the SFTP site within [_____] [7] calendar days from data collection.

][3.2.6 Bathymetric Surveys

3.2.6.1 Raw Data

Provide all field verified survey control monuments as digital data in US Survey Feet reduced to the nearest [_____][0.3048] cm [_____][.01] foot. Survey control must be provided in PNEZD format and submitted in comma-separated values (.csv) file extensions.

Provide all hydrographic elevation soundings and topographic shots (if applicable) as digital data in US Survey Feet reduced to the nearest [_____][3.048] cm [_____][.1] foot referenced to mean lower low water (MLLW). Provide point files in ENZ format and submit with ".xyz" file extensions for all multi-beam hydrographic soundings sorted into [_____][30.48] cm [_____][1] foot cell size, mean biased (on cell-center), with z values in elevation mode.

3.2.6.2 Processed Data

Provide [.dgn] graphics files and DEM files with [Bentley OpenRoads Designer; MicroStation SS10; Autodesk]. Create files utilizing a data-reduction and averaging technique submitted and approved in the Bathymetric Survey Plan. Additionally, provide all vector feature classes (in a file geodatabase) for topographic contours or other applicable features loaded to the GIS model and created to produce progress or as-built drawings.

3.2.6.3 Progress Drawings

Provide progress drawings for each survey made, showing the excavated surfaces, and as applicable benches, fractures, any blast damage and whether slopes are in or out of specification tolerance.

Include [_____][15.24] cm [_____][0.5] foot contours and use a continuous color symbology for the raster surface which clearly shows how the excavated surface is changing over time. Reference surfaces to the digital plan files provided at award. Include all pertinent Contract information in the title block. Include below the notes section all tables for survey limits, survey project control, and excavation limits. Submit one digital PDF of the drawing for each slope verification survey, and the final survey with the digital stamped/signature of the Certified Hydrographer. Submit all required drawings and data files with the submittal for payment.

]3.3 WEBSITE INTERFACE OF DATA

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NOTE: The complexity of the web interface should be dependent upon the scale and complexity of the work performed. The requirements in this section should be added to the contract if there is any type of web interface utilized - they include general security, operability and system QA tools. The tailoring option for "WEB INTERFACE" is utilized for this section.

****

3.3.1 General

Visualize every element for which there are spatial coordinates, and provide construction verification and monitoring data and visualizations in a format constructed to maximize user comprehension of the data. [A mockup and tables of dashboard views, GIS alignments, specified plots, tables and GIS layers and group layers] are available in the Volume [_____] attachments. The verification and monitoring goals are specified in this section throughout PART 3 EXECUTION [and in the Volume [_____] attachments]. Show planned element layouts and positions for all designed elements within the Contract (such as [_____][barrier wall elements, rock reinforcements, or drilling and grouting locations]), in their geospatial location, at their proposed location before construction begins. Show these same elements in their correct geospatial location after construction of each element is complete in separate layers. Symbolize planned, in progress, and as-constructed elements using the COR-provided symbology, or as directed by the COR. Include as many data fields in the feature attributes appearing in the viewer as practical. Append related data to geospatial features at [COR][ACO] request.

Propose any visualization substitutions in the 50 Percent Data Management Plan in accordance with PART 2, DATA MANAGEMENT PLANS AND ADDENDA. Where an alternative will be utilized, incorporate in the 100 Percent Data Management Plan submittal for approval by the [COR][ACO]. Provide a preliminary presentation of the Web Interface components in accordance with PART 1, SUBMITTALS, SD-01. Provide Web Interface Updates for any features where the interface needs to be updated, changed, or further developed due to major features of work starting later in the contract, in accordance with PART 1, SUBMITTALS, SD-10. Examine these goals and requirements, and where the specified item would increase the cost of the system substantially due to additional software licensing, or where there is a superior or more innovative solution, propose an alternative visualization or process that accomplishes the same goal.

3.3.2   Security Credentials

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NOTE: Bracketed language is applicable to USACE personnel only. Verify this for any organizations outside of USACE prior to including in contract language.

****

Grant 24/7 read access to the Government, the Contractor, and any related subcontractors for this contract. Grant representatives of the Government any necessary username and password or other security credential for access no later than 30 days from the Notice to Proceed. The Government will provide a list of names and email addresses of users. [All Government employees can be assumed to have a ESRI Viewer license suitable for read-only access to ArcGIS Online map tools]. For new personnel requested by the Government throughout the contract, grant access and provide security credentials within 24 hours of the request.

3.3.3   Site Operability and Usability

Ensure the website is fully functional, current, easy to navigate, and complete with all data available for retrieval by both automated and manual methods. If the website does not meet this criteria, pertinent payments will be withheld until the issue is resolved and acceptable to the Contracting Officer.

3.3.4   User QA Feedback and Tracking

Provide graphic user interface forms on a web interface (can be a separate tool from the GIS viewer, but must still be linked/embedded via a tab or other integrated means into the main viewer) for any authorized user to provide direct feedback on the Contractor's database records, web interface, and SFTP site work including the ability to:

a. Verify, flag for correction or masking, and accept data from the database tables;

b. Submit corrections or updates needed to the GIS;

c. Submit corrections or updates needed to the dashboard;

d. Submit corrections or file updates needed to the SFTP site;

e. Track the status of submitted requests including relevant related information in a table which shows the following information:

(1) Data management system (DMS) component the correction was requested for;

(2) Date/time the request was submitted by the user;

(3) The dashboard page, GIS model alignment and feature class, SFTP folder or other element the comment/request pertains to;

(4) The narrative request entered by the user;

(5) Requesting user's name or initials;

(6) The status of the Contractor's response - i.e. "requested", "in progress", "resolved", and "expired resolution window". Script an automatic update of any "in progress" issues to "expired resolution window" when the 48-hour resolution window from the date and time of submission is exceed prior to the issue status being changed to "resolved".

(7) Date of resolution;

(8) Any resolution notes;

(9) Initials of Contractor personnel making the correction.

f. Provide the ability to filter the information shown in the table based on items a, c, and e above. Make any requested corrections or updates to data records or displays within 48 hours of the request. The Government will provide a list of authorized users for accepting and flagging database records, however submission of comments on the rest of the DMS components must be available to all Government project personnel.

3.4 WEB-BASED GIS INTERFACE

****

NOTE: Tailoring option "WEB-BASED GIS INTERFACE" is employed for this entire section".

****

Provide a secure GIS interface per PART 2, "Web-based GIS Interface" which meets the following minimum criteria:

a. Produce dynamic views of data in 2D plan view, profile view, section view and 3D, and integrate CAD and BIM elements to these views as appropriate to depict constructed components in correct geometry and geospatial location. Incorporate alternative alignments and static section views as specified in the Volume [_____] attachments or as requested by the COR;

b. Symbology of represented data in the GIS must be changeable upon request by the Government, but does not need to be editable inside the web environment. Complete requested symbology, filters, or other display changes within 24 hours of the request. Provide symbology for progress to represent "planned", "in progress" and "as-built" such that specific subcomponents of the structures (i.e. [cutoff wall bites and panels, control tower lifts, outlet works lifts]) can be tracked for progress with this layer. Additionally for all testing data displayed in the GIS, provide a symbology for passing, failing, and passing re-test (or as directed by COR);

c. Include a well-organized table of contents for the GIS viewer windows with the capability of turning layers and groups of layers on and off;

d. Group relevant layers in the GIS table of contents together by features of work as specified in the Volume [_____] attachments (e.g. [instrumentation, geotechnics, designed structures, blasting (plan and report), cutoff wall, tunnel, control tower, excavation, monitoring]);

e. Apply scaling labels to features so that at an appropriate scale the labels appear, but never overwhelm the view. Include the ability to turn labels off. Apply one feature class in each view with labels that always appear as a reference for the user for orientation such as a station line or other primary project location reference;

f. Include a self-serve function for downloading the most data associated with a selected feature in the web browser;

g. Provide a standard, off-the-shelf option to generate a PDF map from the current view in any GIS viewer alignment. The PDF must be of a formatting quality suitable for including in reports, for example the frame must be centered and in an appropriate size on the page, and contain a legend for all elements included. The Government may request any structural changes to the graphical displays of data at any time. Complete any requested changes within 48 hours of the request.

h. Include links to static documents and plots where documents are associated with a single location or location range - for example: photographs, PDF QA/QC reports, scanned handwritten documents and logs in PDF, PDF checklists, PDF or JPEG sample tickets, PDF test reports, grout plots, water pressure test results, and other important documents as directed), final submittal packets, interactive reports such as concrete breaks or other reports listed in this specification, and As-built or Progress Drawings for construction elements within this system. Set up the links using hyperlinks as specified or other techniques proposed by the Contractor in the 50 Percent Data Management Plan, and approved by [COR][ACO] in the 100 Percent Data Management Plan.

For reports (e.g. pdf's, photos, field form scans, and others) that are approved by the Government's data manager, provide a location on an anonymized external web folder such that the user does not have to provide user credentials to access each hyperlink. Examples of this type of data include [boring logs, verticality reports, or items for pay]. Hyperlink all documents which contain any structural schematics or information about distress in the embankment or structures directly to the SFTP site so that secured access is maintained. The [COR][ACO] will direct which additional datasets may be sensitive. Any document determined by the [COR][ACO] to contain sensitive information must be password protected.

[i. Provide the option of a storymap/operations dashboard style format with embedded GIS and summary statistics for QC testing data;

] j. Make new spatial features available in the ArcPortal environment within 24 hours of generation;

k. Make other data available within 24 hours of generation, or as specified in other sections of the contract.

3.5 SYSTEM TESTING

Provide a test of the data management system within 30 days prior to the start of production data generation. This includes loading dummy records to all fields of the database and feature services, and verifying that the data is correctly appearing in the digital delivery products required by the Contract.

Clearly mark all dummy records as such within a record tracking field of the database. Once the test has been successfully completed, remove the dummy records from the database. Provide documentation of the test conducted including the following:

a. Date the test was conducted;
b. Name(s) of person(s) conducting the test;
c. Specific steps conducted in order to test the system including a brief narrative explanation of the purpose of each step;
d. The results of each test step;
e. Any actions that were taken to achieve an acceptable test result which include a final operational system;
f. Documented support including any screenshots necessary to demonstrate that the system is operational according to the requirements of this specification.
g. Date and verification all/only dummy records were removed from the database.

3.6 DYNAMIC DATA WEB INTERFACE

****

NOTE: As with other elements of the data system design, the graphical data visualizations the Government wants need to be communicated clearly to the Contractor. Each specialty subcontractor may know what is expected from their specific work, but only the project personnel know what Government requirements need to be evaluated during construction and for post construction risk assessments (if applicable). If specific web interface visual formatting (e.g. item "i" above- or other specific views of certain data streams, ESRI storymap formats, or integrated data visuals and ESRI maps, the specification will need to be very detailed and prescriptive about what is wanted, and it is good to provide any additional attachments needed to clarify the Government's intent.

The tailoring option for "DYNAMIC DATA INTERFACE" has been employed for this entire section.

****

Provide functionality within the web interface platform to provide dynamic views of data plots, charts, graphs, tables, widgets, and other formats as directed by the COR. Visualization must meet or exceed requirements, deviations in style and navigation controls are acceptable however must be approved by the Government in the web viewer approval. The initial plots and other formats will be provided in the Volume attachments. The spatial web interface must meet the following criteria at a minimum, and must add other criteria as directed by the COR:

a. Build the plots and other data-displays for each feature of work as specified in the Volume attachments. As work progresses the may request additional plots or data displays based on specific issues encountered. Add new data displays within 48 hours of the request;

b. Provide the ability to adjust scales on the data displays, or update scales as requested by the COR, and complete requested changes within 24 hours;

c. Provide the ability to select data to be displayed (e.g. by groups of features, location, feature of work, and others as pertinent to the work) and to filter the data by crucial elements such as date range, feature subpart or other elements as directed by the COR.

d. Symbolic and color components of display, and scales or binning of values (where applicable) must be changed at [COR][ACO] request. Complete any requested changes within 24 hours;

e. Include an intuitive, well-organized, graphic user interface for navigation between and within the spatial and dynamic data portions of the website, and for hosting the user guide, recorded trainings, and user input forms for system QA;

f. Provide the ability to view relevant data displays together for ease of access and comparison. Specific requests are listed in the Volume [_____] attachments;

g. Provide legible symbology and legends for all plots, and label axes, axis points, and data points on displays as appropriate to balance the need for information with the need for comprehendible display. Apply scaling labels to features so that at an appropriate scale the labels appear, but never overwhelm the view - or so that labels appear when the mouse hovers above a plotted point/bar, or other feature. If the option for the user to turn labels on or off is available in the application, employ it. Make changes to symbology, scaling, labeling, and/or erroneous data masking when requested by the [COR][ACO] within 24 hours;

h. Script the connection of data displays to the Contractor's EDB, so that data is updated to the visualizations within 10 minutes of an update to the EDB;

i. Provide a method to create printed products with legends.

3.7 DESKTOP GIS FILES

****

NOTE: For software products such as ESRI ArcGIS, make sure to look up the version that is most currently available to the organization and fill it in. It is advised to have the contractor utilize software that is already FedRAMP approved and widely available to all Government technology users via an enterprise license. Allowing the contractor the

flexibility to use their own choice of software may result in a product that cannot be used by the project.

The tailoring option for "DESKTOP GIS FILES" had been employed for this entire section.

****

Build the ArcPro GIS project to contain geospatial data such as feature classes in geodatabases, rasters (e.g. DEM, DTM, .GeoTiff, .Tiff), point clouds, and other applicable geospatial file formats. Display all elements associated with the 3-dimensional location in this environment and include all associated attribute data. Build plan and profile views, any special section or other views, and 3D view as detailed in the Volume [_____] attachments. Add all data from EDB tables with associated spatial components, feature classes, rasters, imagery or CAD layers visualized in the simplified GIS as layers within this project package.

Publish updates of element progress or geometry/location changes, to the web-viewer within 48 hours of field generation of the data. Update the .aprx, .gdb(s), and raster datasets to the SFTP within 24 hours of an update (i.e. nightly when daily changes are occurring). Complete metadata fields for each feature class within the feature class and in a separate document according to the metadata standards specified in PART 1, Geospatial Metadata. Upon completion of the contract, complete metadata documentation and deliver to the Government finalized .aprx, .gdb, raster and other applicable files in the closeout submittal Final GIS Files.

3.8 FIELD DATA COLLECTION

****

NOTE: This requirement should be utilized when digital data collection in the field is needed by the Government and the Contractor is administering the database and all visualizations in a web viewer throughout the contract. The Government can develop and use the app forms themselves, however the Contractor needs to provide a method for ingestion and display of this data into the viewer.

The tailoring option for "WEB-BASED GIS INTERFACE" has been employed for this entire section as this work will only be utilized in association with a GIS viewer.

****

Provide a method for Government input of data into the project database and GIS web interface through the use of custom forms in an off-the-shelf app designed for use Survey123 or Collector, or a similar app accessible by the Government. Work with the Government's data manager to develop any additions to the database schema, spatial and dynamic data layers on the web interface, EGDB, and workflows for the input and visualization of this data not already detailed in this specification and attachments. If the Contractor will build the app forms and provide the ESRI account, the [COR][ACO] will provide the necessary information required for the Contractor to create the app fields and GIS features no later than 30 days prior to the start of data collection.

3.9 DATA MANAGEMENT PLAN

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NOTE: Tailoring options are available for "SQL RDBMS EDB" and "ACCESS ENTERPRISE DATABASE".

****

Submit the 100 Percent Data Management Plan within 30 days of the data management planning meeting, and update at least every six months for the duration of the Contract to include any changes or updates to any part of the data management system. Attach all data submittals or plans required as submittals in PART 1, SUBMITTALS SD-01 as addenda to the 100 Percent Data Management Plan. The Data Management Plan must include:

a. A data flow diagram describing Contractor's Data Management System including each data source type (e.g. raw data, raw appended data, analog field data, digital field data), and processes for structured and unstructured data collection and aggregation.

b. A table of all datasets generated during the project that includes: raw data format, data generation method, identifying the data generation system if digital or automated, necessary data transformations, data appending, estimated start date of data collection, and description of the data transfer process to the EDB and/or SFTP site. If data management is subcontracted, the primary Contractor must coordinate with all applicable subcontractors to provide all necessary information for the completion of this table.

c. Descriptions of components of the data management system including software used to create, store, transfer, process, analyze or visualize data.

d. Naming conventions utilized as detailed in PART 1, Naming Conventions.

e. Identify and describe data recording and gathering software and hardware (e.g. make, model, version and manufacturer) and the raw data file formats it produces.

f. Documentation of any formulae, queries, scripts, and macros used to calculate fields. Present the information in an organized and methodical format.

g. A realistic estimated (50 percent)/agreed (100 percent) schedule for data collection and upload frequency for each data source if different from what is required in Part 1, Data Turnover Timeframes.

h. A list with screenshots or written details of the visualizations and verification reports to be utilized as agreed in the data management planning meeting. The Contractor may propose better or more cost-efficient ways to show what is needed than what the Government required in the 50 Percent Data Management Plan submittal. These changes must be reviewed in the data management planning meeting and approved in the final 100 Percent Data Management Plan submittal.

i. Explain how automated data that is obtained directly from field sensors by various subcontractors will be integrated into the web-viewer. Examples of this data would be automated instrumentation data, seismic data, and concrete thermal data;

j. Enterprise database documentation including relationship diagrams, data source tables, and database schema including fields, field types, units, precision, views, and other pertinent data as directed. If new tables, fields, relationships or views are added to the EDB (as described in PART 3, Documented Enterprise [SQL][MS Access] Database, the changes must be reflected in the schema, and added to the Data Management Plan in an addendum table titled "Schema Changes". This table must show all information about each change and the date the change was effective in the EDB.

k. A table of names, roles and contact information for the data management personnel. Include one person for each feature of work identified from each subcontractor that will serve as the POC for technical data questions and problem-solving. Update when personnel changes.

l. Approved data transfer and data QC report format.

m. Approved Photograph PDF format.

n. All proposed and approved changes to any component of the data management system.

o. At no more than 6-month intervals, incorporate all changes into the main document and resubmit to COR. Resubmission is also required when a revision to the Data Management Plan is issued due to design after award components, or other such significant changes or additions to the EDB schema and visualizations. Resubmittal may occur after all additions for each such approved feature of design/work have been completed.

Ensure all final documentation of the EDB and other components of the data management system have been documented prior to a final closeout submission of the Data Management Plan.

p. Maintain all data plans listed in PART 2, Addenda to the 100 Percent Data Management Plan and submitted per PART 1, SUBMITTALS SD-01 Preconstruction submittals as addenda to the Data Management Plan. Updates to these plans must be reflected in Data Management Plan Updates.

3.10 FEATURE OF WORK DATA COLLECTION PLANS

****

NOTE: The following plans are provided in case the specification section associated with the feature of work does not contain the plans. It is more appropriate for these data collection plans to be located within the corresponding feature of work section.

This entire section is part of the tailoring option "ADDITIONAL DATA COLLECTION PLAN SUBMITTALS".

****

3.10.1 Automated Grouting And Water Pressure Testing Data Collection Plan

No later than [_____][90] days prior to the commencement of the work, submit a detailed description, name, manufacturers name, specifications, sample outputs, and sample MS Excel-compatible data files generated by the

Automated Grouting and Data Collection Systems to be used during grouting and water pressure testing. Name and provide product specifications for all software products used to control or process data from the automated grouting system(s). Additionally, name and provide specifications for any proprietary software required for gathering, processing, or viewing the automated data. Specifications for commonly used software such as Microsoft Office, Adobe Acrobat, or other similar programs are not required. Include descriptions of all mathematical operations and formulae contained within the software that are related to output files, such as the method for calculating the effective pressure. Provide calibration certificates for all instruments measuring pressure and flow.

3.10.2 Remote Sensing Data Collection Plan

No later than [_____][90] days prior to the start of data collection, propose a methodology and plan for the collection of [_____][LiDAR][orthoimagery][photogrammetry] in accordance with the data requirements specified for [_____][geologic foundations, routine monitoring, site progress, quantities], or for any other purpose that would impact the resolution and accuracy of the data collection. Organize the plan into separate sections for each method, and only combine sections applicable to both such as ground control and datums. Include the following at a minimum:

a. Data acquisition methods, workflow onsite, and how the data collection will be coordinated with construction activities and the brief window of time in which data may be collected;

b. Identify a designated lead in charge of mobilization, planning, and the coordination of activities with other elements of construction (e.g., foundation preparation and concrete placement) and define responsibilities in detail;

c. Identify roles and responsibilities of all personnel involved in the data collection and processing effort;

d. Data collection, classification, and other parameters to be employed as applicable (e.g., pulse rate, scanner frequency, point density or other parameters) in order to produce data to specified requirements;

e. Product delivery formats - list each product;

f. Metadata fields to be collected and provided and metadata format;

g. Ground control and accuracy standards;

h. Calibration testing methodology(s), equipment calibration schedule, and certificates/proof of calibration;

i. Proposed equipment for the collection of datasets including manufacturers specifications, catalog cuts and any applicable regulatory or calibration certificates/records for the specific equipment used;

j. Description of internal verification quality control processes;

k. Data processing workflow and methodologies for converting raw data into post-processed data products;

l. Data validation processes;

m. Pre-processing and accuracy check;

n. Processing quality control;

o. Product delivery workflow and quality control;

p. Propose a tile scheme and size for deliverables.

q. Propose a sample monitoring survey symbology for visualizing cumulative change detected if applicable.

3.11 OPENGROUND CLOUD DATABASE AND RECORDS

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NOTE: This section applies to USACE projects only - USACE uses OpenGround Cloud for drilling data. Delete the tailoring option for OPENGROUND if used by other agencies.

This requirement should be used for USACE projects where the technical specification requires drilling and core logging as part of the performance of work, and the submittal of associated boring logs. Some features of work which may require it are geotechnical investigations, blasting, grouting, drilled shafts (pilot holes).

This entire section is part of the tailoring option "OPENGROUND".

****

3.11.1 Digital Logging

The Contractor is encouraged but not required to utilize tablets in the field for borehole logging, with the software Dataforensics pLog, which is seamlessly integrated with Bentley OpenGround to import data from the field into the database. If a digital data-gathering device is utilized, apply the same record tracking requirements and data loss prevention standards as described in PART 1, Backups, Archiving and Disaster Recovery and Record Tracking Requirements. Load raw data files from the device to the SFTP site in .csv format in accordance with the turnover times stated in PART 1, Data Turnover Timeframes. The Contractor must be able to produce a written or printed backup of field data in case an equipment malfunction causes a data loss. In the event of a data loss, the Contractor is responsible to re-log the hole from the core, and must take all necessary steps to ensure the data has been captured prior to core disposal or storage as applicable. Store legible scans of these logs on the appropriate location of the SFTP site in PDF format within 48 hours of completion of the hole.

For digitally collected logs, the geologist who completed the logs must perform the required verification QC of the data in the database, and the Government-approved digital log format must be used to produce PDF's of the logs for submittal according to the same requirements as manually completed logs.

3.11.2 Manual Logging

If logs are completed manually, manually, enter the data into the OpenGround cloud database within 48 hours of the hole being drilled. The geologist who logged the hole must perform the data entry for continuity, and a separate geologist must perform the QC verification of the data in OpenGround within 96 hours of the hole being drilled.

3.11.3 Data Entry and PDF Drill Logs

For data entry into OpenGround, utilize fields with dropdown lists where applicable. Only use additional descriptions for text entry of data when a dropdown list for that feature does not exist. Verify there is no applicable field for a feature before using the Comments/Remarks fields in any table to enter data.

Produce PDF logs of each hole from the Cloud, and place on the SFTP site within 24 hours of hole entry into OpenGround, and submit in accordance with requirements in [_____][Section 02 32 13 SUBSURFACE DRILLING AND SAMPLING]. Submit a notification to the Government that the Finalized OpenGround Cloud Borehole Database is ready for review in the cloud environment within 96 hours of the final hole for the project being drilled.

3.12 DATA MANAGEMENT MANUAL

****

NOTE: Tailoring options are available in this section for "DESKTOP GIS FILES", and "WEB-BASED GIS INTERFACE".

****

Within 90 days of the last record update to the EDB and prior to demobilization, submit a final Data Management Manual. Incorporate as part of this manual the following:

a. All sections and contents of the final Data Management Plan, with the information updated to the end of the contract;

b. Final documentation of the EDB including all metadata, data dictionary and entity relationship diagrams (including table names, field names, table fields, and relationships between these tables, added field definitions), views/queries, macros, scripts (except those used as interim tools and not applicable for archiving), summary tables, formulae used to calculate values or automatically assign categories (e.g. Pass or Fail based on a number or criteria from another field), data source documentation, units, and file structure for all hyperlinked or referenced documents such that these links and references can be used once the EDB is installed on the [COR][ACO] network;

c. An index and description of all components of the Desktop GIS model, including all elements contained in the .aprx and .gdb(s), and any separate metadata documentation;

d. A detailed index of the published feature classes organized in the table of contents of the web-hosted GIS model;

e. The submitted and approved final index of the SFTP site contents by file structure - described in Part 2, SFTP SITE.

3.13 FINAL EDB TURNOVER

****

NOTE: Tailoring options are available in this section for "SQL RDBMS EDB" and "ACCESS ENTERPRISE DATABASE".

****

Notify [COR][ACO] when the EDB is considered final with all data being uploaded and finalized. Submittal of the Finalized Enterprise Database includes complete backup files from the [SQL RDBMS][MS Access] database and separate .csv files of the final, fully documented [SQL][MS Access] EDB tables containing all project data. Transfer must take place via the SFTP site prior to demobilization and within 60 days after the final record has been added to the database. The final database structure and contents are subject to the same QC requirements for final data verification and integrity, and must be approved by the [COR][ACO] prior to the final payment for data management. Host the final EDB for 6 months after transmitting EDB documentation, or until Contract closeout, whichever comes first.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-01 31 23.13 20 (August 2023)**

Change 1 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-01 31 23.13 20 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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ELECTRONIC CONSTRUCTION AND FACILITY SUPPORT CONTRACT MANAGEMENT SYSTEM (eCMS)

08/23, CHG 1: 02/24

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USACE / NAVFAC / AFCEC **UFGS-01 31 23.13 20 (August 2023)**

Change 1 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-01 31 23.13 20 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 01 31 23.13 20

ELECTRONIC CONSTRUCTION AND FACILITY SUPPORT CONTRACT MANAGEMENT SYSTEM (eCMS)

08/23, CHG 1: 02/24

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NOTE: This guide specification covers the requirements for the Navy use of NAVFAC's web-based Electronic Construction and Facility Support Contract Management System (eCMS).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This guide specification includes tailoring options for Design-Build (DB) projects. Selection or de-selection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

****

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NOTE: (1) For all military construction (MILCON) projects and other construction projects above $1M utilize eCMS for requests for information (RFIs), submittals, issues, non-compliance notices, punch lists, checklists, and daily reports to allow for

the collection of necessary construction data, KPIs, and metrics. An example list is below:
(a) Navy centrally managed facilities sustainment;
(b) Restoration and maintenance (FSRM) projects;
(c) U.S. Marine Corps – M2R2 projects;
(d) Defense Logistics Agency bulk fuel tank repair; or
(e) Air Force FSRM.
(2) For all projects above the Simplified Acquisition Threshold (SAT) (as of publication is $250K) and less than $1M, project teams will continue to utilize eCMS, at a minimum, as an electronic file repository to ensure maintenance of project related technical information. Use of the various communication and site management modules is highly recommended.
(3) For all projects below the SAT, project teams are encouraged to utilize eCMS, but its use remains optional.

Waivers. NAVFAC's business requirement is to utilize eCMS to store crucial DoD project documents, such as RFIs, submittals, QASP/CPARS checklists, etc. and to manage associated KPIs (e.g., processing times). Waivers that deviate from this policy pose unwarranted risks and additional costs to the eCMS, the business system integration, and the Authority-to-Operate. As such, waivers are disadvantageous to the government, are highly discouraged, and will only be considered in rare, extenuating circumstances where eCMS is non-functional and the contractor's solution does not pose unacceptable risks or additional costs to NAVFAC. Requests for waivers may be submitted via OPS for adjudication by HQ DCBL.

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PART 1 GENERAL

1.1 CONTRACT ADMINISTRATION

Utilize the Naval Facilities Engineering Systems Command's (NAVFAC's) Electronic Construction and Facility Support Contract Management System (eCMS) for the transfer, sharing, and management of electronic technical submittals and documents. The web-based eCMS is the designated means of transferring technical documents between the Contractor and the Government. Paper media or email submission, including originals or copies, of the documents are not permitted unless identified within the contract.

All government contracting specialist/officer, legal, and command communications will remain the same.

1.2 USER PRIVILEGES

The Contractor's key staff may be provided access to eCMS. Contact the COR for eCMS account access. Project roles and system roles will be established to control each user's menu, application, and software privileges, including the ability to create, edit, or delete objects.

Additional project roles may be assigned for workflow. The COR makes the final decision on roles for the project. User's ability to view, edit documents may be lowered at the discretion of the COR.

Only one eCMS user account is required regardless of the number of user's projects. Notify the COR within seven calendar days if a contractor user is no longer associated with company or project so they can remove them from any open record and inactivate them from the project.

1.2.1 eCMS Subcontractor Users

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NOTE: The second paragraph is tailored for DESIGN-BUILD.

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If the contractor's user is a subcontractor, the subcontractor must be registered under the name of their company and email. For example it is common for contractors to contract Quality Control Managers. The QC Manager's account should be under their company's name and email reducing the number of eCMS accounts required.

For Design Build, the contractor's Designer of Record Architectural Engineer will be given a single account. Only one account per AE is required. The role of the AE is determined by the project role assigned by the COR. The contractor is to request their AE staff be placed into the AE-KTR-DOR project role.

1.2.2 Users with Multiple Roles

Users may have multiple roles associated with their account within eCMS. Roles are used in workflow. When a user is added to the project, they will be assigned the default role when the user was created. Contact the COR to change or add roles to the user for the project.

1.2.3 Loss of Privilege

Users may lose privilege to access eCMS at the discretion of the Contracting Officer. The eCMS is a collaborative system that allows flexibility of use and does not restrict all inappropriate user actions. User activities are logged into eCMS in visible and background data collection. Users found to use eCMS in an inappropriate action may have their eCMS access revoked. Examples include, but not limited to, fraudulent representations, sharing user accounts with others, and changing approved records without the consent of the COR. Depending on the severity of the infraction, the users can lose eCMS access for a period of time, permanently for the project, or lose eCMS access for any project. The contractor may appeal the suspension in writing to the contracting officer within 14 calendar days of notice. The appeal must identify the infraction, supporting information, and steps to ensure the infraction will not happen in the future.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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NOTE: For Navy Design-Build projects, delete 01 33 00 SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****

NOTE: For projects in the NAVFAC PAC Area of Operation, and for the submittals identified as SD-01 Preconstruction Submittals, remove the "G" designation.

****

List of Contractor's Personnel; G, [_____]

For Division 1 government approved Pre-Construction submittals, combine into a single Pre-Construction Submittal Package. Annotated with SD Type of SD-01. Pre-Construction submittal package approval date will be used as a KPI.

1.4 SYSTEM REQUIREMENTS AND CONNECTIVITY

1.4.1 General

NAVFAC eCMS requires a web-browser (platform-neutral) and Internet connection. For best results, recommend using browser in InPrivate/Incognito mode; Internet speeds greater than 40mbps when uploading files, computers with high RAM and Solid State Drives, "White List" eCMS website, Zip or Split files for better uploading. Non-NAVFAC Users are not to use VPN when using eCMS per NAVFAC IT.

The use of eCMS is required by the Contractor and all associated costs and time necessary to utilize eCMS will be borne by the Contractor with no allowance for time extensions and at no additional cost to the government.

1.4.2 Contractor Personnel List

****

NOTE: This paragraph contains tailoring for Design-Build.

****

Within 20 calendar days of contract award, provide to the Contracting Officer a list of Contractor's personnel who will have the responsibility for the transfer, sharing and management of electronic design, submittals, RFIs, daily reports, and other files and will require access to the eCMS. Project personnel roles which must be filled as applicable in the eCMS, include, at a minimum, the Contractor's Project Manager (KTR-PM), Designer of Record (AE-KTR-DOR), Superintendent (KTSUPT), Quality Control (QC) Manager (KTR-QC), Principal (KTR-PRIN), and Site Safety and Health Officer (KTR-SSHO). Notify the COR immediately of any personnel changes to the project. The Contracting Officer reserves the right to perform a security check on all potential users.

[Internal design deliberations under a D-B contract are managed outside of eCMS. Besides the D-B DOR Representative, D-B design team members are neither required nor encouraged to create user accounts in eCMS. Users are highly recommended to take eCMS live or online training prior to use. See https://www.navfac.navy.mil/Business-Lines/Design-and-Construction/About-Us/Design-and-Construction-Documents/Electronic-Construction-Management-System-eCMS/ for eCMS useful information

] Provide the following information:

Company Name

Name (First, Last)

Email Address

Project Role (CQM, SSHO, Superintendent, CM, PM, Principal)

Existing or New eCMS User

1.5 SECURITY CLASSIFICATION

In accordance with Department of Navy guidance, all military construction contract data are unclassified, unless specified otherwise by a properly designated Original Classification Authority (OCA) and in accordance with an established Security Classification Guide (SCG). Refer to the project's OCA when questions arise about the proper classification of information.

In conformance with the Freedom of Information Act (FOIA), DoD INSTRUCTION 5200.48 CONTROLLED UNCLASSIFIED INFORMATION (CUI), and DoD requirements, any unclassified project documentation uploaded into the eCMS must be designated either "U - UNCLASSIFIED" (U) or "CUI - CONTROLLED UNCLASSIFIED INFORMATION" (CUI).NAVFAC eCMS must only be used for the transaction of unclassified information associated with construction projects. Controlled Unclassified Identification (CUI) documents may be loaded into eCMS with the appropriate markings.

1.5.1 Markings on CUI Documents

Contractor's proprietary information, or documents determined by the originator in accordance with CUI guidance, should be marked CUI. Proprietary information not marked CUI can be released under the Freedom of Information Act (FOIA). Apply the appropriate markings before any document is uploaded into eCMS. Markings are not required on Unclassified U documents.

1.6 eCMS UTILIZATION

****

NOTE: This paragraph is written for "Full Use" on projects greater than $1M. The project team is encouraged to choose Full Use regardless of dollar amount. The project team can optionally select "eCMS as an Electronic File Repository" if the project is less than $1M.

****

Establish, maintain, and update data and documentation in the eCMS throughout the duration of the contract. Utilize eCMS to transfer all submittals, RFIs, daily reports, and other files required by contract to be forwarded to the government.

[Full eCMS use is required. All Submittals/Information to use eCMS Modules including, but not limited to, RFIs, Daily Reports, Meeting Minutes, Communications, Issues, Punch Lists, Checklists, and Flysheets, unless otherwise directed by the COR or Contracting Officer.

][The eCMS as an Electronic File Repository is authorized for projects under $1M. Upload all files using the appropriate eCMS module or as directed by the COR. Bulk uploads of RFIs, Submittals, Daily Reports, Issues, Meeting Minutes or Communications records into eCMS modules are allowed. For RFIs, group files by specification number, RFP Part number, or sheet number. For Submittals, group files by specification number. For Daily Reports, group by date range(s), Issues by date range(s), Meeting Minutes by date range(s), and Communications by Type.

]1.6.1 Restricted Information

Personally Identifiable Information (PII) transmittal such as credit card, driver's license, passport, social security, and payroll number are not permitted in eCMS. Name, address, and email are permitted.
Pre-negotiation information such as cost estimates that require formal negotiations are not allowed. For example, proposed changes over the SAP level of $250k require formal negotiations. Cost estimates for LEAN, ULTRA

LEAN, and Design Changes under the SAP level are at the discretion of the COR's or Contract Specialist/Officer's direction. The eCMS must only be used for the transaction of unclassified information associated with construction projects. Controlled Unclassified Identification (CUI) documents may be loaded into eCMS with the appropriate markings. Uploading of files directly into the Documents folder is not allowed. All documents must be uploaded using an eCMS module.

1.6.2 Naming Convention for Files

Titles of files uploaded are to be descriptive of the purpose and content of the file. For example RFI_ROOF_Leak.doc or for submittals, SUB_LIGHT_FIXTURE.pdf. Titles of file to be uploaded must only contain uppercase letters, lowercase letters, numbers, hyphens (-), underscores (_) and periods (.). Use of any other characters is not allowed and may create an error. When practicable, adding the record number to the title is desired. For example RFI_XYZ12345_ROOF_Leak.doc. Uploading files with the same title will create a new revision in eCMS. Original revision is Rev 0, the first revision is Rev 1. Uploaded files are to use the default file location regardless of the module used unless directed by the COR.

Table 1 also identifies which eCMS application is to be used in the transmittal of data (these are subject to change based on the latest software configuration).

Table 1 - Project Documentation Types

SUBJECT/NAME	**REMARKS**	**eCMS APPLICATION**
As-Built Drawings	Locations of sensitive areas must be labeled as either "Controlled Area" or "Restricted Area" and may be shown on unclassified documents with the approval from Site Security Manager	Submittals
Building Information Modeling (BIM)	Locations of sensitive areas must be labeled as either "Controlled Area" or "Restricted Area" and may be shown on unclassified documents with the approval from Site Security Manager	Submittals
Construction Permits	Refer to rules of the issuing activity, state or jurisdiction	Submittals
Construction Schedules (Activities and Milestones)		Submittals
Construction Schedules		Submittals

SUBJECT/NAME	**REMARKS**	**eCMS APPLICATION**
Construction Schedules (3-Week Look ahead)	Import the schedule file into the scheduling application, and select "Approve" to establish a new schedule baseline	Meeting Minutes
DD 1354 Transfer of Real Property	When applicable, required for final billing.	Submittals
Daily Production Reports	Provide weather conditions, crew size, man-hours, equipment, and materials information	Daily Report
Daily Quality Control (QC) Reports	Provide QC Phase, Definable Features of Work Identify visitors	Daily Report
Designs and Specifications	Locations of sensitive areas must be labeled as either "Controlled Area" or "Restricted Area" and may be shown on unclassified documents with the approval from Site Security Manager	Submittals
Environmental Notice of Violation (NOV), Corrective Action Plan	Refer to rules of the issuing activity, state or jurisdiction	Submittals
Environmental Protection Plan (EPP)		Submittals
Invoice (Supporting Documentation)	Applies to supporting documentation only. Invoices are submitted in Wide-Area Workflow (WAWF)	Submittals
Jobsite Documentation, Bulletin Board, Labor Laws, SDS	Redact any PII information when loaded into eCMS	Submittals
Meeting Minutes		Meeting Minutes
Modification Documents	Provide final modification documents for the project. Upload into Modifications RFPs folder	Communications

SUBJECT/NAME	**REMARKS**	**eCMS APPLICATION**
Operations & Maintenance Support Information (OMSI/eOMSI), Facility Data Worksheet	1. Locations of sensitive areas must be labeled as either "Controlled Area" or "Restricted Area" and may be shown on unclassified documents with the approval from Site Security Manager 2. Design reviews will be performed in existing "Dr Checks"	Submittals
Photographs	Subject to base/installation restrictions	Submittals
QCM Initial Phase Checklists		Meeting Minutes or Checklists
QCM Preparatory Phase Checklists		Meeting Minutes or Checklists
Quality Control Plans		Submittals
QC Certifications		Submittals
QC Punch List		Punch Lists
Red-Zone Checklist		Punch List or Checklists
Rework Items List		Punch Lists
Request for Information (RFI) Post-Award		RFIs
Safety Plan		Submittals
Safety - Activity Hazard Analyses (AHA)		Submittals
Safety - Mishap Reports		Daily Report
Shop Drawings	Locations of sensitive areas must be labeled as either "Controlled Area" or "Restricted Area" and may be shown on unclassified documents with the approval from Site Security Manager	Submittals

SUBJECT/NAME	**REMARKS**	**eCMS APPLICATION**
Storm Water Pollution Prevention (Notice of Intent - Notice of Termination)	Refer to rules of the issuing activity, state or jurisdiction	Submittals
Submittals and Submittal Register		Submittals
Testing Plans, Logs, and Reports		Submittals
Training/Reference Materials		Submittals
Training Records (Personnel)	Redact any PII information if storing in eCMS	Submittals
Utility Outage/Tie-In Request/Approval		Submittals
Warranties/BOD Letter		Submittals
Quality Assurance Reports		Checklists (Government initiated)
Non-Compliance Notices		Non-Compliance Notices (Government initiated)
Other Government-prepared documents		GOV ONLY
Letters to government contracting, claims, REAs, and other contracting officer communications	eCMS is not the primary tool to use in contracting officer communications. eCMS can only store documents or letters after the submission to the contracting officer is made.	Communications
All Othere Documents	Refer to FOIA guidelines and contact the FOIA official to determine whether exemptions exist	As applicable

1.6.3 RFIs Module

Create contractor RFIs using eCMS RFIs module. The contractor must confirm the numbering convention with the COR if different than eCMS default.

If the government (GOV) Response has "No" Cost or Schedule Impact, this reply is given with the expressed understanding that it does not constitute a basis for any change in the amount or time of subject contract. Information provided in this response does not authorize work not currently included in the contract. If GOV Response is "Yes" or "Potentially" then this response may require a change to the contract. If the contractor disagrees with either the government's No Cost determination or No Schedule impact determination, or both, the contractor has 14 calendar days to notify the COR and Contracting Officer in writing.

1.6.4 Submittals Module

Create contractor submittals using eCMS Submittals module. The contractor must confirm the numbering convention with the COR if different than eCMS default.

1.6.5 Submittal Packages Module

Create submittal packages using the eCMS Submittal Packages module in lieu of or in addition to Related Objects. Submittal Packages track completion of the packaged submittals and is used in NAVFAC HQ's KPIs.

1.6.6 Communications Module

Create communications using the eCMS Communications module. The Communications module is used to create or document communications that are not a part of other eCMS modules. Use of Communications module will memorialize information into an eCMS record file. The following are Types of Communications:

Email

Memo to File

Face to Face

Telephone

Web Collaboration

Photos

Other Documents

Other

Unless directed by the COR, upload documents or files that do not have a corresponding eCMS module. Choose "Photos" Type for Photos and "Other Documents" for all other documents.

1.6.7 Issues Module

Create or respond to issues using the eCMS Issues module. Respond to CPARS issues using the Issues module.

1.6.8 Meeting Minutes Module

Create or respond to Meeting Minutes using the eCMS Meetings module.

Document required contractual meetings. Dates of meetings are used in NAVFAC KPIs. Minimum meetings in eCMS include the following:

Post Award Kickoff (PAK)

Pre-construction (Pre Con)

Initial and Preparatory Three Phases of Control

Quality Control (QC)

1.6.9 Potential Change Items Module

Not used.

1.6.10 Daily Report Module

Create Daily Reports using the eCMS Daily Report Module. The contractor must confirm the numbering convention with the COR if different than eCMS default.

1.6.11 Punchlists Testing Logs (Legacy)

Punchlist Testing Logs is a legacy program that is being replaced by the Punch Lists Module. This module is to be used for reference of past projects. Use the Punch Lists Module for all future work.

1.6.12 Punch Lists Module

The eCMS Punch Lists module is useful more than just for Punchlists. The module includes the capability of batch editing, create items from Optical Character Recognition (OCR) plans, assign tasks and track completion of individual items.

Create the following using the Punch Lists module:

Rework Items List

DFOW List

Punch-Out Inspection

Pre-Final Punchlist Inspection

Final Punchlist Inspection

Testing Logs

1.6.13 FWD UltraLean COAR RFP Module

Not used.

1.6.14 Non-Compliance Notices (NCN) Module

Respond to Non-Compliance Notices listed in the Non-Compliance Notices module.

1.6.15 Checklists

Use Checklist listed in the contractor's eCMS menu and as directed by the COR. Checklists capture data and is used in dashboards and KPIs.

1.6.15.1 Partnering Team Health Survey Checklist

Contractor must use the eCMS checklist to document the partnering team health survey. Partnering Team Health Survey is in accordance with the Partnering Specification of this contract.

1.6.16 Flysheets

Use Flysheets listed in the contractor's eCMS menu, if available, and as directed by the COR. Flysheets allow the contractor to print out information from other systems and upload into eCMS. The eCMS will use OCR to capture the information as data. Flysheets capture data and used in dashboards and KPIs.

1.6.17 eCMS Outage

In the case where eCMS is unavailable for 8 hours or more, paper or email may be used in the interim to maintain project schedule.

Once the system is operational, all final records are required to be recreated using the appropriate module. Subject/title of the record to include the type of record i.e., RFI/Submittal/Daily Report/Communication/Other, the identification number(s), and the statement "Processed Outside of eCMS". Example, "RFI 001 Processed Outside of eCMS".

1.6.18 User Account Activity

NAVFAC eCMS captures user data and activities that are directly related to the user's account. The user agrees through the use of eCMS, their account activities will be captured and can be displayed on eCMS printed reports.

1.7 QUALITY ASSURANCE

Requested Government response dates on Submittals must be in accordance with the terms and conditions of the Contract unless previously agreed by the COR. Requesting response dates earlier than the required review and response time, without concurrence by the Government COR, may be cause for rejection.

Incomplete submittals will be rejected without further review and must be resubmitted. Required Government response dates for resubmittals must reflect the date of resubmittal, not the original submittal date.

All submittals and associated attachments must be transmitted to the Government via the COR. Transmittals are no longer required when using eCMS since approval status is tracked on the submittal. Transmittal forms can be attached to submittals if approved by the COR. Submittals requiring government approval are "Transmitted For" "Approval". Submittals requiring contractor approved submittals, including those designated for Contractor Quality Control approval or Information Only, are "*Transmitted For" "Information Only" in the Submittal Module. Provide and sign the QC certification or approving statement on the attachment per submittal specification section. When Submittal Packages are required, use eCMS Submittal Packages after creating individual submittals. Importing

Submittals from the Submittal Register is optional. Contact the COR for the data conversion requirements.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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PROJECT SCHEDULE

08/23, CHG 1: 08/24

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References are in agreement with UMRL dated January 2025
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SECTION 01 32 01.00 10

PROJECT SCHEDULE
08/23, CHG 1: 08/24

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NOTE: This guide specification covers the requirements for the preparation and maintenance of the project schedule for construction projects or design-build construction projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

TO DOWNLOAD UFGS GRAPHICS for attachment to this section
Go to
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms
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PART 1 GENERAL

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NOTE: Coordinate selection of the optional requirements in this guide specification with Construction Division to ensure that the schedule requirements are appropriate for the complexity of the constructability portion of the BCOE review. See ER 415-1-11. Do not remove paragraphs from this specification except as noted.

If it is desired to monitor a Contractor's schedule by use of an in-house program, this will require use of the Standard Data Exchange Format (SDEF). Use of proprietary systems will not be specified. See ER 1-1-11, Appendix A.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AACE INTERNATIONAL (AACE)

AACE 29R-03	(2011) Forensic Schedule Analysis
AACE 52R-06	(2006) Time Impact Analysis - As Applied in Construction
AACE 84R-13	(2015) Planning and Accounting for Adverse Weather

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 67-17	(2017) Schedule Delay Analysis

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 1-1-11	(2017) Administration -- Project Schedules

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal

items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Project Scheduler Qualifications; G, [_____]

Preliminary Project Schedule; G, [_____]

Initial Project Schedule; G, [_____]

Periodic Schedule Update; G, [_____]

1.3 PROJECT SCHEDULER QUALIFICATIONS

Designate an authorized representative to be responsible for the preparation of the schedule and all required updating and production of reports. The Designated Project Scheduler must have prepared and maintained at least three previous construction schedules for projects of similar size and complexity to this contract, using Primavera P6.. Representative must have a comprehensive knowledge of CPM scheduling principles and application.

PART 2 PRODUCTS

2.1 SOFTWARE

The scheduling software utilized to produce and update the schedules required herein must be capable of meeting all requirements of this specification.

2.1.1 Government Default Software

The Government uses Primavera P6. Ensure exported schedule files are compatible with the version of P6 used by the Government.

2.1.2 Contractor Software

Scheduling software used by the contractor must be commercially available from the software vendor for purchase with vendor software support agreements available. The software routine used to create the required sdef file must be created and supported by the software manufacturer.

2.1.2.1 Primavera

If Primavera P6 is selected for use, provide the "xer" export file in a version of P6 importable by the Government system. Verify at the SEKO meeting which version of P6 is in use by the Government. Export the schedule in a version of P6 no newer than that used by the Government.

2.1.2.2 Other Than Primavera

If the Contractor chooses software other than Primavera P6, that is compliant with this specification, provide for the Government's use two licenses, two computers, and training for two Government employees in the use of the software. These computers will be stand-alone and not connected to Government network. Computers and licenses will be returned at project completion.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

****

NOTE: If tailoring options are not deselected, selection of design-bid-build or design-build text required.

****

Prepare for approval a Project Schedule, as specified herein, pursuant to FAR Clause 52.236-15 Schedules for Construction Contracts. Show in the schedule the proposed sequence to perform the work and dates contemplated for starting and completing all schedule activities. The scheduling of the entire project is required. The scheduling of design and construction is the responsibility of the Contractor. Contractor management personnel must actively participate in its development. Designers, Subcontractors, and suppliers working on the project must also contribute in developing and maintaining an accurate Project Schedule. Provide a schedule that is a forward planning as well as a project monitoring tool. Use the Critical Path Method (CPM) of network calculation to generate all Project Schedules. Prepare each Project Schedule using the Precedence Diagram Method (PDM).

3.1.1 Scheduling Expectations Kickoff Meeting(SEKO)

In conjunction with the post award conference or pre construction conference the Government and the Contractor will hold a separate and distinct Scheduling Expectations Kickoff Meeting(SEKO). The intent of this meeting is for the Government to review with the contractor the requirements of the scheduling specification, communicate the Government’s expectations regarding schedule development and management, and answer any questions the Contractor may have regarding the schedule requirements.

3.2 BASIS FOR PAYMENT AND COST LOADING

The schedule is the basis for determining contract earnings during each update period and therefore the amount of each progress payment. The aggregate value of all activities coded to a contract CLIN must equal the value of the CLIN. Match the progress payment "Pay Period Thru" date in RMS to the schedule data date.

3.2.1 Activity Cost Loading

Activity cost loading must be reasonable and without front-end loading. Activities with a negative cost loading is not allowed. Provide additional documentation to demonstrate reasonableness if requested by the Contracting Officer.

3.2.2 Cost Loading of Submittals

****

NOTE: Select tailored design-build construction text for Design-Build projects.

****

No costs are to be assigned to activities for the preparation, review, or approval of submittals, except as described under paragraph COST LOADING OF CLOSEOUT ACTIVITIES, paragraph AS-BUILT DRAWINGS, design submittals, and paragraph O&M MANUALS.

3.2.3 Withholdings / Payment Rejection

Failure to meet the requirements of this specification may result in the disapproval of the preliminary, initial, or periodic schedule updates and subsequent rejection of payment requests until compliance is met.

In the event that the Contracting Officer directs schedule revisions and those revisions have not been included in subsequent Project Schedule revisions or updates, the Contracting Officer may withhold 10 percent of pay request amount from each payment period until such revisions to the project schedule have been made.

3.3 PROJECT SCHEDULE DETAILED REQUIREMENTS

3.3.1 Level of Detail Required

Develop the Project Schedule to the appropriate level of detail to address major milestones and to allow for satisfactory project planning and execution. Failure to develop the Project Schedule to an appropriate level of detail will result in its disapproval. The Contracting Officer will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail:

3.3.2 Activity Durations

Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods. Non-procurement activities Original Durations (OD) are not to exceed 20 workdays or 30 calendar days.

3.3.3 Design and Permit Activities

****

NOTE: Include this paragraph in Design-Build projects..

****

Include design and permit activities with the necessary conferences and follow-up actions and design package submission dates. Include the design schedule in the project schedule, showing the sequence of events involved in carrying out the project design tasks within the specific contract period. Provide a detailed level of scheduling sufficient to identify all major design tasks, including those that control the flow of work. Also include review and correction periods associated with each item.

3.3.4 Procurement Activities

Include in the schedule activities associated with the critical submittals and their approvals, procurement, fabrication, and delivery of long lead materials, equipment, fabricated assemblies, and supplies. Long lead procurement activities are those with an anticipated procurement sequence of over 90 calendar days.

3.3.5 Mandatory Activities

****

NOTE: Selection of construction or design-build construction text required.

****

Include the following activities in the initial project schedule and all updates.

a. Submission, review and acceptance of SD-01 Preconstruction Submittals (individual activity for each).

b. Submission, review and acceptance of features requiring design completion Submission, review and acceptance of design packages.

c. Submission of mechanical/electrical/information systems layout drawings.

d. Submission and approval of O & M manuals.

e. Submission and approval of as-built drawings.

f. Submission and approval of DD1354 data and installed equipment lists.

g. Submission and approval of testing and air balance (TAB).

h. Submission of TAB specialist design review report.

i. Submission and approval of fire protection specialist.

j. Submission and approval of Building Commissioning Plan, Controls testing plan, test data, and reports: Develop the schedule logic associated with testing and commissioning of mechanical systems to a level of detail consistent with the contract commissioning requirements. All tasks associated with building testing and commissioning will be completed prior to submission of building commissioning report and subsequent contract completion.

   These activities may include but are not limited to: air and water balancing, building commissioning -functional performance testing, controls testing, and performance verification testing. Include other systems testing, if required. Include additional commissioning requirements noted elsewhere in the Contract as required in the schedule and discuss during the SEKO meeting, noted in paragraph SCHEDULING EXPECTATIONS KICKOFF MEETING (SEKO).

k. Contractor's pre-final inspection.

l. Correction of punch list from Contractor's pre-final inspection.

m. Government's pre-final inspection.

n. Correction of punch list from Government's pre-final inspection.

o. Final inspection.

3.3.6 Government Activities

****

NOTE: Selection of construction or design-build construction text required.

****

Show in schedule, Government and other agency activities that could impact progress. These activities include, but are not limited to approvals, acceptance, design reviews, environmental permit approvals by State regulators, inspections, utility tie-in, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements.

3.3.7 Standard Activity Coding Dictionary

Use the activity coding structure defined in the Standard Data Exchange Format (SDEF) in ER 1-1-11. This exact structure is mandatory. Develop and assign all Activity Codes to activities as detailed herein.

The SDEF format is as follows:

Field	Activity Code	Length	Description
1	WRKP	3	Workers per day
2	RESP	4	Responsible party
3	AREA	4	Area of work
4	MODF	6	Modification Number
5	BIDI	6	Bid Item (CLIN)
6	PHAS	2	Phase of work
7	CATW	1	Category of work
8	FOW	20	Feature of work*
*Some systems require that FEATURE OF WORK values be placed in several activity code fields. The notation shown is for Primavera P6. Refer to the specific software guidelines with respect to the FEATURE OF WORK field requirements.			

3.3.7.1 Workers Per Day (WRKP)

Assign Workers per Day for all field construction or direct work activities, if directed by the Contracting Officer. Workers per day is based on the average number of workers expected each day to perform a task for the duration of that activity.

3.3.7.2 Responsible Party Coding (RESP)

Assign responsibility code for all activities to the Prime Contractor, Subcontractor(s) or Government agency(ies) responsible for performing the activity.

a. Activities coded with a Government Responsibility code include, but are not limited to: Government approvals, Government design reviews, environmental permit approvals by State regulators, Government Furnished Property/Equipment (GFP) and Notice to Proceed (NTP) for phasing requirements.

b. Activities cannot have more than one Responsibility Code. Examples of acceptable activity code values are: DOR (for the designer of record); ELEC (for the electrical subcontractor); MECH (for the mechanical subcontractor); and GOVT (for USACE).

3.3.7.3 Area of Work Coding (AREA)

Assign Work Area code to activities based upon the work area in which the activity occurs. Define work areas based on resource constraints or space constraints that would preclude a resource, such as a particular trade or craft work crew from working in more than one work area at a time due to restraints on resources or space. Examples of Work Area Coding include different areas within a floor of a building, different floors within a building, and different buildings within a complex of buildings. Activities cannot have more than one Work Area Code.

3.3.7.4 Modification Number (MODF)

Assign a Modification Number Code to any activity or sequence of activities added to the schedule as a result of a Contract Modification, when approved by Contracting Officer. Key all Code values to the Government's modification numbering system. An activity can have only one Modification Number Code.

3.3.7.5 Bid Item Coding (BIDI)

Assign a Bid Item Code to all activities using the Contract Line Item Number (CLIN) to which the activity belongs, even when an activity is not cost loaded. An activity can have only one BIDI Code.

3.3.7.6 Phase of Work Coding (PHAS)

****

NOTE: Select tailored design-build construction text for Design-Build projects.

****

Assign Phase of Work Code to all activities. Examples of phase of work are design phase, procurement phase and construction phase. Each activity can have only one Phase of Work code.

a. Code proposed fast track design and construction phases proposed to allow filtering and organizing the schedule by fast track design and construction packages.

b. If the contract specifies phasing with separately defined performance periods, identify a Phase Code to allow filtering and organizing the schedule accordingly.

3.3.7.7 Category of Work Coding (CATW)

****

NOTE: Include tailored design-build construction text in Design-Build projects.

****

Assign a Category of Work Code to all activities. Category of Work Codes include, but are not limited to design, design submittal, design reviews, review conferences, permits, construction submittal, procurement, fabrication, weather sensitive installation, non-weather sensitive installation, start-up, and testing activities. Each activity can have no more than one Category of Work Code.

3.3.7.8 Feature of Work Coding (FOW)

Assign a Feature of Work Code to appropriate activities based on the Definable Feature of Work to which the activity belongs based on the approved QC plan.

Definable Feature of Work is defined in Section 01 45 00 QUALITY CONTROL. An activity can have only one Feature of Work Code.

3.3.8 Contract Milestones and Constraints

Milestone activities are to be used for significant project events including, but not limited to, project phasing, project start and end activities, or interim completion dates. The use of artificial float constraints such as "zero free float" or "zero total float" are prohibited.

Mandatory constraints that ignore or affect network logic are prohibited. No constrained dates are allowed in the schedule other than those specified herein. Submit additional constraints to the Contracting Officer for approval on a case by case basis.

3.3.8.1 Project Start Date Milestone and Constraint

The first activity in the project schedule must be a start milestone titled "NTP Acknowledged," which must have a "Start On" constraint date equal to the date that the NTP is acknowledged.

3.3.8.2 End Project Finish Milestone and Constraint

The last activity in the schedule must be a finish milestone titled "End Project."

Constrain the project schedule to the Contract Completion Date in such a way that if the schedule calculates an early finish, then the float calculation for "End Project" milestone reflects positive float on the longest path. If the project schedule calculates a late finish, then the "End Project" milestone float calculation reflects negative float on the longest path.

3.3.8.3 Interim Completion Dates and Constraints

Constrain contractually specified interim completion dates to show negative float when the calculated late finish date of the last activity in that phase is later than the specified interim completion date.

3.3.8.3.1 Start Phase

Use a start milestone as the first activity for a project phase. Call the start milestone "Start Phase X" where "X" refers to the phase of work.

3.3.8.3.2 End Phase

Use a finish milestone as the last activity for a project phase. Call the finish milestone "End Phase X" where "X" refers to the phase of work.

3.3.9 Adverse Weather

Ensure anticipated adverse weather is accounted for in the Project Schedule. AACE 84R-13 provides methodologies for techniques in planning for adverse weather. The preferred methodology is the use of a weather calendar. If a method other than a weather calendar is proposed, discuss the reason during the SEKO meeting.

3.3.10 Calendars

Schedule activities on a Calendar to which the activity logically belongs. Develop calendars to accommodate any contract defined work period such as a 7-day calendar for Government Acceptance activities, concrete cure times, etc. Develop the default Calendar to match the physical work plan with non-work periods identified including weekends and holidays. Develop Seasonal Calendar(s) and assign to seasonally affected activities as applicable.

****

NOTE: Refer to ER 415-1-15 CONSTRUCTION TIME EXTENSIONS FOR WEATHER for suggested working of the contract clause that must accompany this paragraph and for guidance on its application. Coordinate with the responsible party for the Special Contract Clauses or Special Contract Requirements to confirm that TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER is included in the solicitation.

****

If a weather calendar is used its implementation and execution is to be in accordance with AACE 84R-13

3.3.11 Open Ended Logic

Only two open ended activities are allowed: the first activity "NTP Acknowledged" is to have no predecessor logic, and the last activity -"End Project" is to have no successor logic. Except as noted above, each activity must have at least a start-to-start or finish-to-start relationship with its predecessor and a finish-to-finish or finish-to-start relationship with its successor.

Predecessor open ended logic may be allowed in a time impact analyses upon the Contracting Officer's approval.

3.3.12 Default Progress Data Disallowed

Actual Start and Finish dates must not automatically update with default mechanisms included in the scheduling software. Updating of the percent complete and the remaining duration of any activity must be independent functions. Disable program features that calculate one of these parameters from the other. Activity Actual Start (AS) and Actual Finish (AF) dates assigned during the updating process must match those dates provided in the Contractor Quality Control Reports. Failure to document the AS and AF dates in the Daily Quality Control report will result in disapproval of the Contractor's schedule.

3.3.13 Out-of-Sequence Progress

Activities that have progressed before all preceding logic has been satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case basis subject to approval by the Contracting Officer. Propose logic corrections to eliminate out of sequence progress or justify not changing the sequencing for approval prior to submitting an updated project schedule. Address out of sequence progress or logic changes in the Narrative Report and in the periodic schedule update meetings.

3.3.14 Added and Deleted Activities

Do not delete activities from the project schedule or add new activities to the schedule without approval from the Contracting Officer. Activity ID and description changes are considered new activities and cannot be changed without Contracting Officer approval.

3.3.15 Original Durations

Activity Original Durations (OD) must be reasonable to perform the work item. OD changes are prohibited unless justification is provided and approved by the Contracting Officer.

3.3.16 Leads, Lags, and Start to Finish Relationships

Lags must be reasonable as determined by the Government and not used in place of realistic original durations, must not be in place to artificially absorb or create float, or to replace proper schedule logic.

a. Leads (negative lags) are prohibited.

b. Start to Finish (SF) relationships are prohibited.

3.3.17 Retained Logic

Schedule calculations must retain the logic between predecessors and successors ("retained logic" mode) even when the successor activity(s) starts and the predecessor activity(s) has not finished (out-of-sequence progress). Software features that in effect sever the tie between predecessor and successor activities when the successor has started and the predecessor logic is not satisfied ("progress override") are not be allowed.

3.3.18 Percent Complete

Update the percent complete for each activity started, based on the realistic assessment of earned value. Activities which are complete but for remaining minor punch list work and which do not restrain the initiation of successor activities may be declared 100 percent complete to allow for proper schedule management. Budgeted cost of activity is to be reduced by the amount needed to correct deficiency. The activity referenced in paragraph COST LOADING of CLOSEOUT ACTIVITIES must have its budgeted cost increased by this amount.

3.3.19 Remaining Duration

Update the remaining duration for each activity based on the number of estimated workdays it will take to complete the activity. Remaining duration may not mathematically correlate with percentage found under paragraph entitled Percent Complete. The remaining duration for unstarted activities are not to be less than its orginal duration.

3.3.20 Cost Loading of Closeout Activities

Cost load the "Correction of punch list from Government pre-final inspection" activity(ies) not less than 1 percent of the present contract value. Activity(ies) may be declared 100 percent complete upon the Government's verification of completion and correction of all punch list work identified during Government pre-final inspection(s).

3.3.20.1 As-Built Drawings

If there is no separate contract line item (CLIN) for as-built drawings, cost load the "Submission and approval of as-built drawings" activity not less than $35,000 or 1 percent of the present contract value, which ever is greater, up to $200,000. Activity will be declared 100 percent complete upon the Government's approval.

3.3.20.2 O & M Manuals

Cost load the "Submission and approval of O & M manuals" activity not less than $20,000. Activity will be declared 100 percent complete upon the Government's approval of all O & M manuals.

3.3.21 Early Completion Schedule and the Right to Finish Early

An Early Completion Schedule is an Initial Project Schedule (IPS) that indicates all scope of the required contract work will be completed before the contractually required completion date.

a. No IPS indicating an Early Completion will be accepted without being fully resource-loaded (including crew sizes and hours) and the Government agreeing that the schedule is reasonable and achievable.

b. The Government is under no obligation to accelerate work items it is responsible for to ensure that the early completion is met nor is it responsible to modify incremental funding (if applicable) for the project to meet the contractor's accelerated work.

3.4 PROJECT SCHEDULE SUBMISSIONS

Provide the submissions as described below. The data reports and network diagrams required for each submission are contained in paragraph SUBMISSION REQUIREMENTS. If the Contractor fails or refuses to furnish the information and schedule updates as set forth herein, the Contractor will be deemed not to have provided an estimate upon which a progress payment can be made.

Review comments made by the Government on the schedule(s) do not relieve the Contractor from compliance with requirements of the Contract Documents.

3.4.1 Preliminary Project Schedule Submission

Within 15 calendar days after the NTP is acknowledged, submit the Preliminary Project Schedule defining the planned operations detailed for the first 90 calendar days for approval. The approved Preliminary Project Schedule will be used for payment purposes not to exceed 90 calendar days after NTP. Completely cost load the Preliminary Project Schedule to balance the contract award CLINS shown on the Price Schedule. The Preliminary Project Schedule may be summary in nature for the remaining performance period. It must be early start and late finish constrained and logically tied as specified. The Preliminary Project Schedule forms the basis for the Initial Project Schedule specified herein and must include all of the required plan and program preparations, submissions and approvals identified in the contract (for example, Quality Control Plan, Safety Plan, and Environmental Protection Plan) as well as design activities, planned submissions of all early design packages, permitting activities, design review conference activities, and other non-construction activities intended to occur within the first 90 calendar days. Government acceptance of the associated design package(s) and all other specified Program and Plan approvals must occur prior to any planned construction activities. Code activities that are summary in nature, after the first 90 calendar days, with the following activity codes: Bid Item (CLIN) code (BIDI), Responsibility Code (RESP), and Feature of Work code (FOW)..

3.4.2   Initial Project Schedule Submission

****

NOTE: Include tailored design-build construction text in Design-Build projects.

****

Submit the Initial Project Schedule for approval within 42 calendar days after notice to proceed is issued. The schedule must demonstrate a reasonable and realistic sequence of activities which represent all work through the entire contract performance period. Include in the design-build schedule detailed design and permitting activities, including but not limited to identification of individual design packages, design submission, reviews and conferences; permit submissions and any required Government actions; and long lead item acquisition prior to design completion. Also cover in the initial design-build schedule the entire construction effort with as much detail as is known at the time but, as a minimum, include all construction start and completion milestones, and detailed construction activities through the dry-in, including all activity coding and cost loading. Include the remaining construction, including cost loading, but it may be scheduled summary in nature. As the design proceeds and design packages are developed, fully detail the remaining construction activities concurrent with the monthly schedule updating process. Constrain construction activities by Government acceptance of associated designs. When the design is complete, incorporate into the then approved schedule update all remaining detailed construction activities that are planned to occur after the dry-in milestone. No payment will be made for work items not fully detailed in the Project Schedule.

3.4.2.1   Design Package Schedule Submission

****

NOTE: This paragraph applies only to design-build procurements.

****

With each design package submitted to the Government, submit a fragnet schedule extracted from the then current Preliminary, Initial or Updated schedule which covers the activities associated with that Design Package including construction, procurement and permitting activities.

3.4.3   Periodic Schedule Updates

****

NOTE: Include tailored design-build construction text in Design-Build procurements.

****

Update the Project Schedule on a regular basis, monthly at a minimum. Provide a draft Periodic Schedule Update for review at the schedule update meetings as prescribed in the paragraph PERIODIC SCHEDULE UPDATE MEETINGS. These updates will enable the Government to assess Contractor's progress. Update the schedule to include detailed construction activities as the design progresses, but not later than the submission of the final un-reviewed design submission for each separate design package. The Contracting Officer may require submission of detailed schedule activities for any distinct construction that is started prior to submission of a final design submission if such activity is authorized.

a. Update information including Actual Start Dates (AS), Actual Finish Dates (AF), Remaining Durations (RD), and Percent Complete. Updated information is subject to the approval of the Government at the meeting.

b. AS and AF dates must match the date(s) reported on the Contractor's Quality Control Report for an activity start or finish.

3.5 SUBMISSION REQUIREMENTS

Submit the following items for the Preliminary Schedule, Initial Schedule, and every Periodic Schedule Update throughout the life of the project:

3.5.1 Electronic Scheduling Data

Provide electronic scheduling data containing the current project schedule and all previously submitted schedules in the format of the scheduling software (e.g. .xer). Also include the Narrative Report and all required Schedule Reports. The electronic file is to identify the type of schedule (Preliminary, Initial, Update), full contract number, Data Date and schedule file name. Each schedule must have a unique file name and use project specific settings. The file naming convention is to be determined at SEKO meeting.

3.5.2 Narrative Report

Provide a Narrative Report with each schedule submission. The Schedule Narrative Report is a "stand alone" report in PDF or Word format. Title the report "Schedule Narrative Report". Show the Report date, schedule name, and contract number on the first page. Indicate who is responsible for the schedule update and narrative report. Provide a brief description of the Project Scope. The Narrative Report is expected to communicate to the Government the thorough analysis of the schedule output and the plans to compensate for problems, either current or potential, which are revealed through that analysis. Include the following information at a minimum in the Narrative Report:

a. Identify and discuss the work scheduled to start in the next update period.

b. Describe activities along the critical path in addition to activities on the next float path after the critical path.

c. Describe current and anticipated problem areas, delaying factors and their impact, and an explanation of corrective actions taken or required to be taken. Identify the party responsible for delay, if applicable.

d. Identify and explain why activities, based on their calculated late dates, should have either started or finished during the update period but did not.

e. Identify and discuss all schedule changes by activity ID and activity name including what specifically was changed and why the change was needed. Include at a minimum new and deleted activities, logic changes, duration changes, calendar changes, lag changes, resource changes, and actual start and finish date changes.

f. Identify and discuss out-of-sequence work.

g. If the longest path changes from a monthly update to the next, provide an explanation of the factors driving the change.

h. Respond to USACE Schedule Review Comments from the previous update(s).

3.5.3 Schedule Reports

The format, filtering, organizing, and sorting for each schedule report will be as directed by the Contracting Officer. Typically, reports contain Activity Numbers, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float, Actual Start Date, Actual Finish Date, and Percent Complete. Provide the reports electronically in .pdf format. Provide [_____] set(s) of hardcopy reports. The following lists typical reports that will be requested:

3.5.3.1 Activity Report

List of all activities sorted according to activity number.

3.5.3.2 Logic Report

List of detailed predecessor and successor activities for every activity in ascending order by activity number.

3.5.3.3 Total Float Report

A list of all incomplete activities sorted in ascending order of total float. List activities which have the same amount of total float in ascending order of Early Start Dates. Do not show completed activities on this report.

3.5.3.4 Earnings Report by CLIN

A compilation of the Total Earnings on the project from the NTP to the data date, which reflects the earnings of activities based on the agreements made in the schedule update meeting defined herein. Provided a complete schedule update has been furnished, this report serves as the basis of determining progress payments. Group activities by CLIN number and sort by activity number. Provide a total CLIN percent earned value, CLIN percent complete, and project percent complete. The printed report must contain the following for each activity: the Activity Number, Activity Description, Original Budgeted Amount, Earnings to Date, Earnings this period, Total Quantity, Quantity to Date, and Percent Complete (based on cost).

3.5.3.5 Scheduling and Leveling Report

Provide a Scheduling/Leveling Report generated from the current project schedule being submitted.

3.5.4 Network Diagram

The Network Diagram is required for the Preliminary, Initial and Periodic Updates. Depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:

3.5.4.1 Continuous Flow

Show a continuous flow from left to right with no arrows from right to left. Show the activity number, description, duration, and estimated earned value on the diagram.

3.5.4.2 Project Milestone Dates

Show dates on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

3.5.4.3 Critical Path

Show all activities on the critical path. The critical path is defined as the longest path.

3.5.4.4 Grouping and Sorting

Group and sort activities as directed to assist in the understanding of the activity sequence. Typically, this flow will group activities by major elements of work, category of work, work area and/or responsibility.

3.5.4.5 Cash Flow / Schedule Variance Control (SVC) Diagram

With each schedule submission, provide a SVC diagram showing 1) Cash Flow S-Curves indicating planned project cost based on projected early and late activity finish dates, and 2) Earned Value to-date.

3.6 PERIODIC SCHEDULE UPDATE

3.6.1 Periodic Schedule Update Meetings

Conduct periodic schedule update meetings for the purpose of reviewing the proposed Periodic Schedule Update, Narrative Report, Schedule Reports, and progress payment. Conduct meetings at least monthly within five days of the proposed schedule data date. Provide a computer with the scheduling software loaded and a projector which allows all meeting participants to view the proposed schedule during the meeting. The Contractor's authorized scheduler must organize, group, sort, filter, perform schedule revisions as needed and review functions as requested by the Contractor and/or Government. The Contractor scheduler must attend in person unless virtual attendance is approved by Contracting Officer. The meeting is a working interactive exchange which allows the Government and Contractor the opportunity to review the updated schedule on a real time and interactive basis. The meeting will last no longer than 8 hours. Submit schedule file and narrative to the Government a minimum of two workdays in advance of the meeting. The Contractor's Project Manager must attend the meeting with the authorized representative of the Contracting Officer. Superintendents, foremen and major subcontractors must attend the meeting as required to discuss the project schedule and work. Following the schedule update meeting, make corrections to the schedule and resubmit, following the required schedule naming convention. Include only those changes approved by the Government in the schedule review meeting. Only approved schedules may be used to generate invoices for payment.

3.6.2 Update Submission Following Progress Meeting

Submit the complete Periodic Schedule Update of the Project Schedule containing all approved progress, revisions, and adjustments, pursuant to paragraph SUBMISSION REQUIREMENTS not later than 4 workdays after the periodic schedule update meeting.

3.7 WEEKLY PROGRESS MEETINGS

Conduct a weekly meeting with the Government (or as otherwise mutually agreed to) between the meetings described in paragraph entitled PERIODIC SCHEDULE UPDATE MEETINGS for the purpose of jointly reviewing the actual progress of the project as compared to the as planned progress and to review planned activities for the upcoming two weeks. Use the current approved schedule update for the purposes of this meeting and for the production and review of reports. At the weekly progress meeting, address the status of RFIs, RFPs and Submittals.

3.8 REQUESTS FOR TIME EXTENSIONS

ASCE 67-17 provides delay analysis guidelines. If there is a conflict between the contract and guidance provided in ASCE 67-17, the contract will govern. Provide justification of delay to the Contracting Officer in accordance with the contract provisions and clauses for approval, within 10 days of a delay occuring. Also prepare a time impact analysis for each Government request for proposal (RFP).

3.8.1 Justification of Delay

Provide a description of the event(s) that caused the delay and/or impact to the work. As part of the description, identify all schedule activities impacted. Show that the event that caused the delay/impact was the responsibility of the Government. Provide a time impact analysis that demonstrates the effects of the delay or impact on the project completion date, or interim completion date(s). Evaluate multiple impacts chronologically; each with its own justification of delay. With multiple impacts consider any concurrency of delay. A time extension and the schedule fragnet becomes part of the project schedule and all future schedule updates upon approval by the Contracting Officer.

3.8.2 Changes That Do Not Cause Delay

If it is determined that a change does not constitute a schedule time extension, a fragnet as described in paragraph FRAGMENTARY NETWORK, is to be created and inserted into the Project schedule.

3.8.3 Time Impact Analysis (Prospective Analysis)

Submit requests for time extensions based on a prospective analysis if the work involved or the impact identified has not already occurred. Where the impact is ongoing a prospective analysis may be considered. However, the Government reserves the right to require a retrospective analysis be prepared after the impact has ended.

Prepare a time impact analysis for approval by the Contracting Officer based on industry recommended practice AACE 52R-06. Utilize a copy of the last approved schedule prior to the first day of the impact or delay for the time impact analysis. If Contracting Officer determines the time frame between the last approved schedule and the first day of impact is too great, prepare an interim updated schedule to perform the time impact analysis. Unless approved by the Contracting Officer, no other changes may be incorporated into the schedule being used to justify the time impact.

3.8.4 Forensic Schedule Analysis (Retrospective Analysis)

Submit requests for time extensions based on a retrospective analysis if the work involved or the impact identified has already occurred. The analysis must account for the actual performance of both the impacted work and all other contract work in the schedule.

If a methodology is chosen from AACE 29R-03, the method must adhere to the principles identified in ASCE 67-17. If there is a conflict with the methodology chosen from AACE 29R-03 and ASCE 67-17, ASCE 67-17 will govern. Choice of methodology should be discussed prior to submission to Government.

3.8.5 Fragmentary Network (Fragnet)

Prepare a proposed fragnet for time impact analysis consisting of a sequence of new activities that are proposed to be added to the project schedule to demonstrate the influence of the delay or impact to the project's contractual dates. Clearly show how the proposed fragnet is to be tied into the project schedule including all predecessors and successors to the fragnet activities. The proposed fragnet must be approved by the Contracting Officer prior to incorporation into the project schedule.

3.8.6 Time Extension

The Contracting Officer must approve the Justification of Delay including the time impact analysis before a time extension will be granted. No time extension will be granted unless the delay consumes all available Project Float and extends the projected finish date ("End Project" milestone) beyond the Contract Completion Date. The time extension will be in calendar days.

Actual delays that are found to be caused by the Contractor's own actions, which result in a calculated schedule delay, are not a cause for an extension to the performance period, completion date, or any interim milestone date.

3.8.7 Impact to Early Completion Schedule

No extended overhead will be paid for delay prior to the original Contract Completion Date for an Early Completion IPS unless the Contractor actually performed work in accordance with that Early Completion Schedule. The Contractor must show that an early completion was achievable had it not been for the impact.

3.9 FAILURE TO ACHIEVE PROGRESS

Should the progress fall behind the approved project schedule for reasons other than those that are excusable within the terms of the contract, the Contracting Officer may require provision of a written recovery plan for approval. The plan must detail how progress will be made-up to include which activities will be accelerated by adding additional crews, longer work hours, extra workdays, etc.

3.9.1 Artificially Improving Progress

Artificially improving progress by means such as, but not limited to, revising the schedule logic, modifying, or adding constraints, shortening activity durations, or changing calendars in the project schedule is prohibited. Indicate assumptions made and the basis for any logic, constraint, duration, and calendar changes used in the creation of the recovery plan. Any additional resources, manpower, or daily and weekly work hour changes proposed in the recovery plan must be evident at the work site and documented in the daily report along with the Schedule Narrative Report.

3.9.2 Failure to Perform

Failure to perform work and maintain progress in accordance with the supplemental recovery plan may result in an interim and final unsatisfactory performance rating and may result in corrective action directed by the Contracting Officer pursuant to FAR 52.236-15 Schedules for Construction Contracts, FAR 52.249-10 Default (Fixed-Price Construction), and other contract provisions.

3.9.3 Recovery Schedule

Should the Contracting Officer find it necessary, submit a recovery schedule pursuant to FAR 52.236-15 Schedules for Construction Contracts.

3.10 OWNERSHIP OF FLOAT

Except for the provision given in the paragraph IMPACT TO EARLY COMPLETION SCHEDULE, float available in the schedule, at any time, belongs to the Project and is available for Contractor and Government use. This includes activity and project float. Activity float is the number of workdays that an activity can be delayed without causing a delay to the "End Project" finish milestone. Project float (if applicable) is the number of work days between the projected early finish and the "End Project" finish.

3.11 TRANSFER OF SCHEDULE DATA INTO RESIDENT MANAGEMENT SYSTEM

Ensure schedule data is uploaded to RMS. This data is additional supporting data in a form and detail required by the Contracting Officer pursuant to FAR 52.232-5 Payments under Fixed-Price Construction Contracts. The receipt of a proper payment request pursuant to FAR 52.232-27 Prompt Payment for Construction Contracts is contingent upon the Government receiving both acceptable and approvable hard copies and matching electronic versions of the application for progress payment.

3.12 PRIMAVERA P6 MANDATORY REQUIREMENTS

Ensure Primavera P6 settings provide a schedule capable of fulfilling the requirements of the contract. The following settings are mandatory and required in all schedule submissions to the Government:

a. Activity Codes must be Project Level, not Global or EPS level.

b. Calendars must be Project Level, not Global or Resource level.

c. Activity Duration Types must be set to "Fixed Duration & Units".

d. Percent Complete Types must be set to "Physical".

e. Time Period Admin Preferences must remain the default "8.0 hr/day, 40 hr/week, 172 hr/month, 2000 hr/year". Set Calendar Work Hours/Day to 8.0 Hour days.

f. Set Schedule Option for defining Critical Activities to "Longest Path".

g. Set Schedule Option for defining progressed activities to "Retained Logic".

h. Set up cost loading using a single lump sum non-labor resource. The Price/Unit must be $1/hr, Default Units/Time must be "8h/d", and settings "Auto Compute Actuals" and "Calculate costs from units" un-selected.

i. Activity ID's must not exceed 10 characters.

j. Activity Names must have a verb-noun structure and contain the most defining and detailed description within the first 30 characters.

k. The daily ending hour for all work calendars must be the same.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-01 32 16.00 20 (August 2018)**
Change 1 - 08/20

Preparing Activity: NAVFAC **Superseding**
UFGS-01 32 16.00 20 (February 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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USACE / NAVFAC / AFCEC **UFGS-01 32 16.00 20 (August 2018)**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 01 32 16.00 20

SMALL PROJECT CONSTRUCTION PROGRESS SCHEDULES

08/18, CHG 1: 08/20

****

NOTE: This guide specification applies to Design-Build and Design-Bid-Build projects and covers the requirements for the preparation and use of construction schedules for small projects. The small projects covered by this specification may be simple or complex, but would not benefit from the use of a cost-loaded Network Analysis Schedule (NAS) as required by Section 01 32 17.00 20 COST LOADED NETWORK ANALYSIS SCHEDULES (NAS). This specification includes two schedule options to choose from based on the complexity of the project. Edit this specification by choosing the desired scheduling option described below.

Confirm with the Administering FEAD/ROICC that the project schedule should be prepared under the requirements of this section. Further, this section should be reviewed and approved by the Administering FEAD/ROICC prior to completion of the Request for Proposal.

Option 1: "Non-Cost Loaded Network Analysis Schedule (NAS)" – This is the NAVFAC preferred schedule for use on most small projects and requires either Primavera P6 or Microsoft Project 2010 scheduling software to be used. Option is provided for cost-loading Microsoft Project 2010 schedules at NAVFAC OCONUS locations where Primavera P6 support is not currently available.

Option 2: "Bar Chart Schedule" – In lieu of Option 1 for non-complex projects or projects with minimal disciplines, a simple bar chart (Non-NAS) may be specified. Project examples include: paving, painting, roof replacement, and lighting.

Coordination is required with Section 01 20 00 PRICE AND PAYMENT PROCEDURES, with selection of "Schedule of Prices" for bar charts and non-cost-loaded NAS, or "Earned Value Report" for cost-loaded Microsoft Project 2010 schedules.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Choose a tailoring option for either Network Analysis Schedule (NAS) or Bar Chart. Within NAS, Primavera P6 and Microsoft Project tailored options are available for the flexibility of allowing both, or choosing one, depending on the FEAD/ROICC requirement.

This section also contains tailored options for Design-Build (DB), Army, and NAVFAC FE.

****

PART 1 GENERAL

1.1 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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NOTE: For Navy Design-Build projects, delete 01 33 00, SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20, CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20, DESIGN SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****
NOTE: For projects in the NAVFAC PAC Area of Operation, and for the submittal(s) identified as SD-01 Preconstruction Submittals, select the "G" designation requiring Government approval.
****

Baseline Construction Schedule; G, [_____]

Baseline Design Schedule; G, [_____]

SD-07 Certificates

Monthly Updates

1.2 PRE-CONSTRUCTION SCHEDULE REQUIREMENT

****
NOTE: This paragraph contains tailoring for NAS and BAR CHART and for Design-Build (DB).

NOTE: For projects in the NAVFAC PAC Area of Operation, in the first sentence, select the default of "30" calendar days as the standard. If warranted, the amount of calendar days for projects requiring more time may be tailored based on project size and technical complexity.
****

[Within [30] [_____] calendar days after contract award and]Prior to the start of work, prepare and submit to the Contracting Officer a Baseline Design Schedule and Baseline Construction Schedule in the form of a Network Analysis Schedule (NAS) Bar Chart Schedule in accordance with the terms in Contract Clause FAR 52.236-15 Schedules for Construction Contracts, except as modified in this contract. The approval of a Baseline Construction Schedule is a condition precedent to:

a. The Contractor starting demolition work or construction stage(s) of the contract.

b. Processing Contractor's invoice(s) for construction activities/items of work.

c. Review of any schedule updates.

Submittal of the Baseline Design and Construction Schedule, and subsequent schedule updates, is understood to be the Contractor's certification that the submitted schedule meets the requirements of the Contract Documents, represents the Contractor's plan on how the work will be accomplished, and accurately reflects the work that has been accomplished and how it was sequenced (as-built logic).

1.3 SCHEDULE FORMAT

1.3.1 Network Analysis Schedule (NAS)

****

NOTE: This paragraph is tailored for NAS. Use this paragraph if Option 1 (described in the Initial Editing Notes) is applicable and a NAS is required for the project; otherwise delete. This paragraph contains tailoring within for Primavera P6 and Microsoft Project. Use the bracketed item "or" if both programs are allowed; otherwise delete, and choose the tailoring for Primavera P6 or Microsoft Project.

****

****

NOTE: Use the bracketed option if Microsoft Project is the only software allowed.

****

Use the critical path method (CPM) to schedule and control project activities. Prepare and maintain project schedules using Primavera P6[or] Microsoft Project 2010.[The scheduling software that will be utilized by the Government on this project is Microsoft Project 2010 by Microsoft, Inc. Notwithstanding any other provision in the contract, schedules submitted for this project must be prepared using Microsoft Project. Submission of data from another software system where data conversion techniques or software is used to import into Microsoft Projects scheduling software is not acceptable and will be cause for rejection of the submitted schedule.]Importing data into the scheduling program using data conversion techniques or third party software is cause for rejection of the submitted schedule.

Within 15 calendar days after approval of the Initial Schedule or approval of the final design for a design build project, submit to the Contracting Officer a final NAS schedule.

1.3.1.1 Activity Requirements

a. At a minimum, identify the following in the schedule:

    (1) Design and Construction time for major systems and components

(2) Each activity assigned with its appropriate Responsibility Code

(3) Each activity assigned with its appropriate Phase and Area Codes

(4) Major submittals and submittal processing time

(5) Major equipment lead time

b. Build the Schedule as follows:

****

NOTE: The following item contains a tailored option for NAVFAC FE to choose a bracketed option if 6-day or 7-day work weeks are required.

****

(1) Show design periods, submittals, Government review periods, material/equipment delivery, utility outages, on-site construction, inspection, testing, and closeout activities. Government and Contractor on-site work activities must be driven by calendars that reflect Saturdays, Sundays and all Federal Holidays as non-work days for 5-day work week calendars.[6-day work week calendars must reflect Sundays and all Federal Holidays as non-work days. 7-day work week calendars must reflect all Federal Holidays as non-work days unless otherwise agreed to by the Contracting Officer. Total work hours/day for all defined calendars is set to 8 unless otherwise agreed upon.]

(2) With the exception of the Contract Award and End Contract milestone activities, use of open-ended activities is not allowed; each activity must have predecessor and successor ties. No activity must have open start or open finish (dangling) logic. Minimize redundant logic ties. Once an activity exists on the schedule it must not be deleted or renamed to change the scope of the activity and must not be removed from the schedule logic without approval from the Contracting Officer. While an activity cannot be deleted, where said activity is no longer applicable to the schedule but must remain within the logic stream for historical record, it can be changed to a milestone. Document any such change in the milestone's "Notebook," including a date and explanation for the change. The ID number for a deleted activity must not be re-used for another activity.

(3) Assign each activity its appropriate Responsibility Code and Area Code, indicating location and responsibility to accomplish the work indicated by the activity, Phase Code, and Work Location Code. Include anticipated tasks to be assigned Government responsibility.

(4) Date/time constraints or lags, other than those required by the contract, are not allowed unless approved by the Contracting Officer. Include as the last activity in the contract schedule, a milestone activity named "Contract Completion Date".

(5) Include the following Contract Milestones:

(a) Include as the first activity on the schedule a start milestone titled "Contract Award", which must have a

Mandatory Start constraint equal to the Contract Award Date;

(b) Include Interim or Phased Completion Milestones required by the Contract or as approved by the Contracting Officer;

(c) Include Facility Turnover Planning Meeting Milestones;

(d) Include an unconstrained finish milestone on the schedule titled "Substantial Completion". Substantial Completion is defined as the point in time the Government would consider the project ready for beneficial occupancy wherein by mutual agreement of the Government and Contractor. Government use of the facility is allowed while construction access continues in order to complete remaining items (e.g. punch list and other close out submittals).

(e) Include an unconstrained finish milestone on the schedule titled "Projected Completion". Projected Completion is defined as the point in time the Government would consider the project complete. This milestone must have the Contract Completion Date (CCD) milestone as its only successor.

(f) Include as the last activity on the schedule a finish milestone titled "Contract Completion (CCD)" with constraint type "Must Finish No Later Than". Calculation of schedule updates must be such that if the finish of the "Projected Completion" milestone falls after the contract completion date, then negative float will be calculated on the longest path and if the finish of the "Projected Completion" milestone falls before the contract completion date, the float calculation must reflect positive float on the longest path. This milestone must be set to 5:00 pm.

(6) Provide lead time for major equipment.

1.3.1.2 Anticipated Weather Lost Work Days

****

NOTE: Check with the FEC's Scheduling Subject Matter Expert or with the FEAD/ROICC for known site-specific Adverse Weather Delays to determine how to edit this paragraph. If historical data is not available, choose the first paragraph using NOAA historical monthly averages as the basis for establishing non-workdays. Note that NOAA historical data may not be available for all OCONUS locations.

If the historical adverse weather data is available, use the bracketed paragraph and table and populate the table with the known data. Insert the data for each month in the blank, bracketed item provided. A bracketed choice of 2 days per month is provided only as an option to remind the Designer to insert the actual data.

****

****

NOTE: A tailored bracketed option is provided for

NAVFAC FE to use in lieu of NOAA if actual data is not available.
****

[Use the National Oceanic and Atmospheric Administration's (NOAA) Summary of Monthly Normals report to obtain the historical average number of days each month with precipitation, using a nominal 30-year, greater than 2.5 mm 0.10 inch precipitation amount parameter, as indicated on the Station Report for the NOAA location closest to the project site as the basis for establishing a "Weather Calendar" showing the number of anticipated non-workdays for each month due to adverse weather, in addition to Saturdays, Sundays and all Federal Holidays as non-work days.

][Use Japan Meteorological Agency's (JMA) 30 years historical monthly averages for days with precipitation, equal or greater than 10 mm 0.39 inch amount parameter, as indicated on the Station Report for the JMA location closest to the project site.

][Use the following schedule of anticipated monthly non-work days due to adverse weather as the basis for establishing a "Weather Calendar" showing the number of anticipated non-workdays for each month due to adverse weather, in addition to Saturdays, Sundays and all Federal Holidays as non-work days.

MONTHLY ANTICIPATED ADVERSE WEATHER DELAYS											
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]

] Assign the Weather Calendar to any activity that could be impacted by adverse weather. The Contracting Officer will issue a modification in accordance with the contract clauses, giving the Contractor a time extension for the difference of days between the anticipated and actual adverse weather delay if the number of actual adverse weather delay days exceeds the number of days anticipated for the month in which the delay occurs and the adverse weather delayed activities are on the longest path to contract completion in the period when delay occurred. A lost workday due to weather conditions is defined as a day in which the Contractor cannot work at least 50 percent of the day on the impacted activity. Impacts resulting from adverse weather must be documented in Narrative Report for the month that it occurred.

Make changes to P6 project calendars to reflect as-built conditions where work occurred where originally anticipated as non-work days, and where work did not occur (lost work day).

1.3.1.3 Activity Identification

a. Identify Government, Construction Quality Management (CQM), Construction activities planned for the project and other activities that could impact project completion if delayed.

b. Identify administrative type activity/milestones including pre-construction submittal and permit requirements prior to demolition or construction stage.

c. Create separate activities for each Phase, Area, Floor Level, and

Location the activity is occurring.

d. Do not use construction category activity to represent non-work type reference (Such as, Serial Letter or Request for Information) in NAS.

e. Place non-work reference within P6 activity details notebook. Activity categories included in the schedule are specified below.

1.3.1.4 Responsibility Code

Assign each activity its appropriate Responsibility Code indicating responsibility to accomplish the work indicated by the activity, Phase Code and Work Location Code.

1.3.1.5 Primavera P6 Settings and Parameters

****

NOTE: Use this tailored paragraph for NAS Schedules using Primavera P6. Delete this paragraph if only Microsoft Project 2010 is allowed. This paragraph is tailored for Primavera P6.

****

Use the following Primavera P6 settings and parameters in preparing the Baseline Schedule. Deviation from these settings and parameters, without prior consent of the Contracting Officer, is cause for rejection of schedule submission.

a. General: Define or establish Calendars and Activity Codes at the "Project" level, not the "Global" level.

b. Admin Drop-Down Menu, Admin Preferences, Time Periods Tab:

  (1) Set time periods for P6 to 8.0 Hours/Day, 40.0 Hours/Week, 172.0 Hours/Month and 2000.0 Hours/Year.

  (2) Use assigned calendar to specify the number of work hours for each time period: Must be checked.

c. Admin Drop-Down Menu, Admin Preferences, Earned Value Tab: Earned Value Calculation: Use "Budgeted values with current dates".

d. Project Level, Dates Tab: Set "Must Finish By" date to "Contract Completion Date", and set "Must Finish By" time to 05:00pm.

e. Project Level, Defaults Tab:

  (1) Duration Type: Set to "Fixed Duration & Units".

  (2) Percent Complete Type: Set to "Physical".

  (3) Activity Type: Set to "Task Dependent".

  (4) Calendar: Set to "Standard 5 Day Workweek". Calendar must reflect Saturday, Sunday and all Federal holidays as non-work days. Alternative calendars may be used with Contracting Officer approval.

f. Project Level, Calculations Tab:

(1) Activity percent complete based on activity steps: Must be Checked.

(2) Reset Remaining Duration and Units to Original: Must be Checked.

(3) Subtract Actual from At Completion: Must be Checked.

(4) Recalculate Actual units and Cost when duration percent complete changes: Must be Checked.

(5) Link Actual to Date and Actual This Period Units and Cost: Must be Checked.

(6) Price/Unit: Set to "$1/h".

(7) Update units when costs change on resource assignments: Must be Unchecked.

g. Project Level, Settings Tab:

(1) Define Critical Activities: Check "Longest Path".

h. The NAS must have a minimum of 30 construction activities. No on-site construction activity may have durations in excess of 20 working days.

1.3.1.6 Microsoft Project 2010 Settings and Parameters

****

NOTE: Use this tailored paragraph for NAS schedules using Microsoft Project 2010. Delete this paragraph if only NAS schedules using Primavera P6 are allowed. This paragraph is tailored for Microsoft Project.

****

Use the following MS Project 2010 settings and parameters in preparing the Baseline Schedule:

a. The Network must have a minimum of 30 construction activities.

b. No on-site construction activity may have durations in excess of 20 working days.

c. Critical is defined as having zero days of Total Slack. Within the Baseline Schedule no more than 20 percent of the activities shall be critical.

d. Logic: include the following setting: File, Options, Schedule tab - Split in-progress tasks - must be selected.

e. Status Date gridline is displayed in the Gantt Chart view.

f. Task Type is set to Fixed Work for "boots-on-the-ground" construction activities.

g. Task Type is set to Fixed Duration for design activities, submittals, Government reviews, procurement, material/equipment delivery, and utility outages.

h. "Effort Driven" is turned ON for Fixed Duration tasks.

i. Time Periods established for the project are set to 8 Hrs/Day, 40 Hrs/Week and 20 days/month.

j. Week starts on Monday must be selected.

k. Default start time is set to 8am (0800).

l. Default end time is set to 5pm (1700).

[1.3.1.7 Cost Loading Microsoft Project 2010 Schedules

****

NOTE: Use this paragraph for a Cost-Loading Microsoft Project Schedule on projects at or above $750,000 and when required; otherwise, delete. This paragraph is tailored for Microsoft Project.

****

Assign material, labor and equipment costs to their respective Construction Activities. Assign material and equipment costs, for which payment will be requested in advance of installation, to their respective procurement activity (i.e. the material/equipment on-site activity). Evenly disperse overhead and profit to each activity over the duration of the project. Cost loading must total to 100 percent of the value of the contract.

1.3.1.7.1 Software Settings

a. Resource Sheet

(1) Resource Name: Enter each code and resource for the project
(2) Type: Set to "Material"
(3) Material Label: Enter units of measurement for each resource
(4) Std. Rate: Enter unit cost for each resource
(5) Accrue at: Set to "Prorated"

b. Assigning Resources to Each Activity

(1) Select each activity in Gantt Chart
(2) Assign resources, Resource Tab
(3) Select each resource and enter the quantity of the units; then, assign the resource(s) to the activity

c. Baseline for Earned Value Calculation, File Tab, Options, Advanced, Default task Earned Value method: Set to "Physical Percent Complete" or as directed by the Contracting Officer

1.3.1.7.2 Tabular Reports

1.3.1.7.2.1 Tracking Gantt Schedule with Cost Table

Submit a Tracking Gantt Schedule with each schedule update showing activity baseline cost, cost percent complete, and Budgeted Cost of Work Performed (BCWP), as directed by the Contracting Officer.

1.3.1.7.2.2 Earned Value Over Time Report

a. With each schedule submission, submit Earned Value Over Time Report

S-Curves indicating Planned Value to the contract completion date based on projected early and late activity finish dates and Earned Value.

b. Revise Earned Value Over Time Report S-Curves when the contract is modified, or as directed by the Contracting Officer.

]1.3.2 Bar Chart Schedule

****
NOTE: Use this paragraph if Option 2 (described in the Initial Editing Notes) is applicable and a Bar Chart is required for the project. This paragraph is tailored for Bar Chart.
****

The Bar Chart must, as a minimum, show work activities, submittals, Government review periods, material/equipment delivery, utility outages, on-site construction, inspection, testing, and closeout activities. The Bar Chart must be time scaled and generated using an electronic spreadsheet program.

1.3.3 Schedule Submittals and Procedures

Submit Schedules and updates in hard copy and on electronic media that is acceptable to the Contracting Officer. Submit an electronic back-up of the project schedule in an import format compatible with the Government's scheduling program.

1.4 SCHEDULE MONTHLY UPDATES

****
NOTE: This paragraph contains tailoring for DB.
****

Update the Design and Construction Schedule at monthly intervals or when the schedule has been revised. Keep the updated schedule current, reflecting actual activity progress and plan for completing the remaining work. Submit copies of purchase orders and confirmation of delivery dates as directed by the Contracting Officer.

a. Narrative Report: Identify and justify the following:

   (1) Progress made in each area of the project;

   (2) Longest Path: Include printed copy on 279 by 432 mm 11 by 17 inch paper, landscape setting;

   (3) Date/time constraint(s), other than those required by the contract;

   (4) Listing of changes made between the previous schedule and current updated schedule including: added or removed activities, original and remaining durations for activities that have not started, logic (sequence, constraint, lag/lead), milestones, planned sequence of operations, longest path, calendars or calendar assignments, and cost loading.

   (5) Any decrease in previously reported activity Earned Amount;

   (6) Pending items and status thereof, including permits, changes

orders, and time extensions;

(7) Status of Contract Completion Date and interim milestones;

(8) Current and anticipated delays (describe cause of delay and corrective actions(s) and mitigation measures to minimize);

(9) Description of current and future schedule problem areas.

For each entry in the narrative report, cite the respective Activity ID and Activity Name, the date and reason for the change, and description of the change.

1.5 CONTRACT MODIFICATION

****

NOTE: Use this paragraph for projects with NAS schedules; otherwise, delete. Paragraph is tailored for NAS.

****

Submit a Time Impact Analysis (TIA) with each cost and time proposal for a proposed change. TIA must illustrate the influence of each change or delay on the Contract Completion Date or milestones. No time extensions will be granted nor delay damages paid unless a delay occurs which consumes all available Project Float, and extends the Projected Finish beyond the Contract Completion Date.

a. Each TIA must be in both narrative and schedule form. The narrative must define the scope and conditions of the change; provide start and finish dates of impact, successor and predecessor activity to impact period, responsible party, describe how it originated, and how it impacts the schedule. The schedule submission must consist of three native files:

(1) Fragnet used to define the scope of the changed condition

(2) Most recent accepted schedule update as of the time of the proposal or claim submission that has been updated to show all activity progress as of the time of the impact start date.

(3) The impacted schedule that has the fragnet inserted in the updated schedule and the schedule "run" so that the new completion date is determined.

b. For claimed as-built project delay, the inserted fragnet TIA method must be modified to account for as-built events known to occur after the data date of schedule update used.

c. TIAs must include any mitigation, and must determine the apportionment of the overall delay assignable to each individual delay. Apportionment must provide identification of delay type and classification of delay by compensable and non-compensable events. The associated narrative must clearly describe analysis methodology used, and the findings in a chronological listing beginning with the earliest delay event.

(1) Identify and classify types of delays as follows:

(a) Force majeure delay (e.g. weather delay): Any delay event caused by something or someone other than the Government (including its agents) or the Contractor, or the risk of which has not been assigned solely to the Government or the Contractor. If the force majeure delay is on the critical path, in absence of other types of concurrent delays, the Contractor is granted an extension of contract time, classified as a non-compensable event.

(b) A Contractor-delay: Any delay event caused by the Contractor, or the risk of which has been assigned solely to the Contractor. If the contractor-delay is on the critical path, in absence of other types of concurrent delays, Contractor is not granted extension of contract time, and classified as a non-compensable event. Where absent other types of delays, and having impact to project completion, provide a Corrective Action Plan, identifying plan to mitigate delay, to the Contracting Officer.

(c) A Government-delay: Any delay event caused by the Government, or the risk of which has been assigned solely to the Government. If the Government-delay is on the longest path, in absence of other types of concurrent delays, the Contractor is granted an extension of contract time, and classified as a compensable event.

(2) Use functional theory to analyze concurrent delays, where: Separate delay issues delay project completion, do not necessarily occur at same time, rather occur within same monthly schedule update period at minimum, or within same as-built period under review. If a combination of functionally concurrent delay types occurs, it is considered Concurrent Delay, which is defined in the following combinations:

(a) Government-delay concurrent with Contractor-delay: Excusable time extension, classified non-compensable event.

(b) Government-delay concurrent with force majeure delay: Excusable time extension, classified non-compensable event.

(c) Contractor-delay concurrent with force majeure delay: Excusable time extension, classified non-compensable event.

(3) A pacing delay, reacting to another delay (parent delay) equally or more critical than paced activity, must be identified prior to pacing. Contracting Officer will notify Contractor prior to pacing. Contractor must notify Contracting Officer prior to pacing. Notification must include identification of parent delay issue, estimated parent delay time period, paced activity(s) identity, and pacing reason(s). Pacing Concurrency is defined as follows:

(a) Government-delay concurrent with Contractor-pacing: Excusable time extension, classified compensable event.

(b) Contractor-delay concurrent with Government-pacing: Inexcusable time extension, classified non-compensable event.

1.6 3-WEEK LOOK AHEAD SCHEDULE

Prepare and issue a 3-Week Look Ahead schedule to provide a more detailed day-to-day plan of upcoming work identified on the Construction Schedule. Key the work plans to activity numbers when a NAS is required and update each week to show the planned work for the current and following two-week period. Additionally, include upcoming outages, closures, preparatory meetings, and initial meetings. Identify critical path activities on the Three-Week Look Ahead Schedule. The detail work plans are to be bar chart type schedules, maintained separately from the Construction Schedule on an electronic spreadsheet program and printed on 216 by 279 mm 8-1/2 by 11 inch sheets as directed by the Contracting Officer. Activities must not exceed 5 working days in duration and have sufficient level of detail to assign crews, tools and equipment required to complete the work. Deliver three hard copies and one electronic file of the 3-Week Look Ahead Schedule to the Contracting Officer no later than 8 a.m. each Monday, and review during the weekly CQC Coordination or Production Meeting.

1.7 CORRESPONDENCE AND TEST REPORTS:

Correspondence (e.g., letters, Requests for Information (RFIs), e-mails, meeting minute items, Production and QC Daily Reports, material delivery tickets, photographs) must reference Schedule Activities that are being addressed. Test reports (e.g., concrete, soil compaction, weld, pressure) must reference Schedule Activities that are being addressed.

1.8 ADDITIONAL SCHEDULING REQUIREMENTS

Any references to additional scheduling requirements, including systems to be inspected, tested and commissioned, that are located throughout the remainder of the Contract Documents, are subject to all requirements of this section.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 32 17.00 20 (November 2023)**
Change 1 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-01 32 17.00 20 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

****

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USACE / NAVFAC / AFCEC **UFGS-01 32 17.00 20 (November 2023)**
Change 1 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-01 32 17.00 20 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

****

SECTION 01 32 17.00 20

COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS)

11/23, CHG 1: 08/24

****

NOTE: This guide specification applies to Design-Bid-Build and Design-Build projects and covers the preparation and use of Cost-Loaded Network Analysis Schedules (NAS) for construction using Primavera P6.

This specification Section applies primarily to MILCON projects and any other similar projects with multiple disciplines working simultaneously. These projects may have known critical completion dates and may involve multiple phases.

Confirm with the Administering FEAD/ROICC that the project schedule should be prepared under the requirements of this section. Further, this section must be reviewed and approved by the administering FEAD/ROICC prior to completion of the Request for Proposal (RFP).

Coordination is required with Section 01 20 00 PRICE AND PAYMENT PROCEDURES with selection of "Earned Value Report" rather than "Schedule of Prices" in that section.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: This section contains tailoring for Design-Build (DB), Design-Bid-Build (DBB), TABS, and

Commissioning (CX). Use TABS tailoring when Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC are included in the contract specifications.
****

PART 1 GENERAL

1.1 DEFINITIONS

The cost-loaded Network Analysis Schedule (NAS) is a tool to manage the project, both for Contractor and Government activities. The NAS is also used to report progress, evaluate time extensions, and provide the basis for progress payments.

For consistency, when scheduling software terminology is used in this section, the terms in Primavera's scheduling programs are used.

1.2 SCHEDULE REQUIREMENTS PRIOR TO THE START OF WORK

1.2.1 Preliminary Scheduling Meeting

Before preparation of the Project Baseline Schedule, and prior to the start of work, meet with the Contracting Officer to discuss the proposed schedule and the requirements of this section. Propose projected data dates for monthly update schedules for the project and incorporate each monthly update submittal into submittal register. Discuss required forms, terminology, and submittal requirements of this section and other requirements related to schedule management for this contract. Use the NAVFAC-provided Preliminary Scheduling Meeting Guideline in the completion of the intended mutual understanding.

1.2.2 Project Baseline Schedule

****
NOTE: This paragraph is tailored for DESIGN-BID-BUILD.

For projects in the NAVFAC PAC Area of Operation, in the first sentence, select the default of "30" calendar days as the standard. If warranted, the amount of calendar days for projects requiring more time may be tailored based on project size and technical complexity.
****

Submit the Baseline NAS within [45] [30] [_____] calendar days after contract award. Data date must be set to contract award date and no progress recorded for any activity. Only bonds and the required Preliminary Scheduling Meeting may be recorded as complete prior to acceptance of the Baseline NAS. The acceptance of a Baseline NAS is a condition precedent to:

a. The Contractor starting demolition work or construction stage(s) of the contract.

b. Processing Contractor's invoices(s) for any items other than bonds.

c. Review of any schedule updates. The contractor is still required to submit monthly network analysis updates. Without an accepted baseline the Government may return schedule update as received for record.

Submittal of the Baseline NAS is the Contractor's certification that the submitted schedule meets the requirements of the Contract Documents and represents the Contractor's plan on how the work will be accomplished. Provide all items listed in paragraph REQUIRED TABULAR REPORTS AND NATIVE P6 XER FILES with baseline NAS submittal.

1.2.3 Project Baseline Schedule

****

NOTE: This paragraph is tailored for DESIGN-BUILD.

****

1.2.3.1 Baseline NAS

Submit the Baseline NAS at the Post-Award Kickoff (PAK) Meeting or within [30] [_____] calendar days after contract award whichever occurs first. The Baseline schedule must include detailed design activities and a general approach to construction, including summary activities for required phasing and definable areas. Summary Construction activities must not exceed duration of 60 calendar days, unless approved otherwise by Contracting Officer. Data date must be set to contract award date and no progress recorded for any activity.

Only bonds and the required Preliminary Scheduling Meeting may be recorded as complete prior to acceptance of the Baseline NAS. The acceptance of a Baseline NAS is a condition precedent to:

a. The Contractor submitting the first design submittal.

b. Processing Contractor's invoices(s)other than that for the bonds.

1.2.3.2 Post-Award Kickoff (PAK) Meeting and Baseline NAS

Present the Draft Baseline NAS at the PAK Meeting. Be prepared to discuss the schedule logic emphasizing how the schedule satisfies the design package requirements and incorporates the required government review periods for each design submittal.

1.2.3.3 Construction Baseline

Submit the detailed Construction Baseline NAS prior to the pre-final design submittal. The pre-final design submittal will not be reviewed until a Construction Baseline NAS is submitted.

The acceptance of the Construction Baseline NAS is a condition precedent to:

a. The contractor starting demolition work or construction stage(s) of the contract.

b. Processing Contractor's invoices for demolition or construction activities.

c. Review of any construction phase schedule updates.

Submittal of the Construction Baseline NAS must be the Contractor's certification that the submitted schedule meets the requirements of the

Contract Documents, and represents the Contractor's plan on how the work will be accomplished. Provide all items listed in paragraph REQUIRED TABULAR REPORTS AND NATIVE P6 XER FILES with baseline NAS submittal.

1.3 WEEKLY LOOK AHEAD SCHEDULE

1.3.1 Weekly CQC Coordination and Production Meeting

Submit the first look ahead schedule 30 days after contract award and continue to submit weekly until contract completion.

Transmit the Weekly Look Ahead Schedule Submittal to the Contracting Officer on the first day of the current week that the look ahead schedule covers and at least one working day prior to Quality Control meetings or as agreed to by Contracting Officer. Contractor is required to provide all attendees at meetings that require discussion of the schedule.

1.3.2 Weekly Look Ahead Schedule Requirements

****

NOTE: Select the default of "Three-Week" for the number of future weeks to be displayed in the Weekly Look Ahead Schedules for most projects. If the Administering FEAD/ROICC agree, the option "Four-Week" can be selected.

****

Prepare and issue a [Four-Week][Three-Week] Look Ahead schedule to provide a more detailed day-to-day plan of upcoming work identified on the Project Network Analysis Schedule. Requirements include:

a. For each Look Ahead schedule activity, identify parent NAS activity number(s). The parent NAS activity is the activity in the NAS that would incorporate the Look Ahead schedule activity requirement [and][or] scope of work.

b. Update schedule each week to show the planned work for the current and following [two-week][three-week] period. Also include previous week, as-built work, showing actual start and finish dates.

c. Include upcoming outages, closures, preparatory meetings, and initial meetings, testing and inspections.

d. Clearly identify longest path activities on the Weekly Look Ahead Schedule. Include a key or legend that distinguishes longest path activities. Include all Longest Path activity NAS start/finish dates exceeded [and][or] occurring during this period.

e. Identify responsibility for each activity.

f. The detail work plans are to be bar chart type schedules, derived from but maintained separately from the Project NAS on an electronic spreadsheet program and printed on 299 by 432 mm 11 by 17 inch sheets as directed by the Contracting Officer.

g. Activities must not exceed 5 working days in duration and have sufficient level of detail to assign crews, tools and equipment required to complete the work.

h. Lookahead activities are not limited to only onsite work. Include but not limited to submittal, offsite fabrication, and procurement activities if needed to ensure longest path is maintained. Include design activities and coordination when part of scope.

i. Upload Lookahead to eCMS as a submittal by the date and time required by contracting officer.

1.4 MONTHLY NETWORK ANALYSIS

Submittal of Monthly NAS is the Contractor's certification that the submitted schedule meets the requirements of the Contract Documents and represents the Contractor's plan on how the work will be accomplished. Provide all items listed in paragraph REQUIRED TABULAR REPORTS AND NATIVE P6 XER FILES with the monthly NAS submittal.

1.4.1 Monthly Network Analysis Updates

a. Regardless of whether an invoice is being submitted monthly, or no progress in the schedule occurred, an updated schedule (or with new data date) must be submitted monthly to the Government. The Monthly NAS update must be submitted within 10 [_____] calendar days of the data date.

b. Regardless of whether a baseline or other schedule is submitted [and][or] accepted, an updated schedule must be submitted monthly to the Government. Monthly updates submitted before the baseline being accepted will be considered as (interim and for information only) submittal.

c. Provide all items listed in paragraph REQUIRED TABULAR REPORTS AND NATIVE P6 XER FILES, with each monthly NAS update submittal.

d. Meet with Government representative(s) at monthly intervals to review and agree on the information presented in the updated project schedule. The submission of an accepted, updated schedule to the Government is a condition precedent to the processing of the Contractor's invoice.

e. Activity progress must incorporate as-built events as they occurred and correspond to records including but not limited to submittals and daily production and quality control reports.

f. Software Settings: Handle schedule calculations and Out-of-Sequence progress (if applicable) through Retained Logic, not Progress Override. Show all activity durations and float values in days. Show activity progress using Remaining Duration. Set default activity type to "Task Dependent".

g. Update schedule must reflect current Contract Completion Date and contract value in accordance with all conformed contract modifications issued prior to data date of NAS update.

1.4.2 As-Built Schedule

As a condition precedent to the release of retention and making final payment, submit an "As-Built Schedule," as the last schedule update showing all activities at 100 percent completion. This schedule must reflect the exact manner in which the project was actually constructed.

1.5 CORRESPONDENCE AND TEST REPORTS

Reference Schedule activity IDs that are being addressed in each correspondence (e.g., letters, Requests for Information (RFIs), e-mails, meeting minute items, Production and QC Daily Reports, material delivery tickets, photographs) and test report (e.g., concrete, soil compaction, weld, pressure).

1.6 ADDITIONAL SCHEDULING REQUIREMENTS

Other specification sections may include additional scheduling requirements, including systems to be inspected, tested and commissioned, and submittal procedures. Those schedule requirements must be incorporated into the NAS schedule.

1.7 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: For Design-Build projects, delete Section 01 33 00 SUBMITTAL PROCEDURES and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

****

Government approval/acceptance is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****

NOTE: For projects in the NAVFAC PAC Area of Operation, and for the submittals identified as SD-01 Preconstruction Submittals, select the "G" designation requiring Government approval for Baseline NAS and Construction Baseline NAS. Remove the "G" designation for Designated Project Scheduler.

****

Baseline NAS; G, [_____]

Construction Baseline NAS; G, [_____]

Designated Project Scheduler; G, [_____]

SD-07 Certificates

Weekly Look Ahead Schedule

Monthly Network Analysis Updates; G, [_____]

SD-11 Closeout Submittals

As-Built Schedule; G, [_____]

1.8 SOFTWARE

Prepare and maintain project schedules using Primavera P6 software in a version compatible with Government's current version. Importing data into P6 using data conversion techniques or third party software is cause for rejection of the submitted schedule. Schedules with Performing Organizational Breakdown Structure (POBS) data is cause for rejection.

1.9 DESIGNATED PROJECT SCHEDULER

****

NOTE: For projects in the NAVFAC PAC Area of Operation, remove the bracketed portion.

****

Within 30 calendar days of contract award, submit [to the Contracting Officer for approval an individual]who will serve as the Designated Project Scheduler. Include a copy of the candidate's resume with qualifications. The Contracting Officer may remove the Designated Project Scheduler, and require replacement, if the scheduler does not effectively fulfill their duties in accordance with the contract requirements. Payment request will not be processed without an approved Designated Project Scheduler.

1.9.1 Qualifications

The Designated Project Scheduler must have prepared and maintained at least three previous construction schedules, of similar size and complexity to this contract, using Primavera P6.

1.9.2 Duties

****

NOTE: If option item f. is incorporated into the Contract specifications, select one of two options concerning the meeting between the Designated Scheduler, Prime Contractor, and Government Representative. Select the first option for most projects. Only select the second option if specifically requested by the FEAD/ROICC office because requiring job site visits by the scheduler will likely add significant cost to the project.

****

Duties of the Designated Project Scheduler include to be actively involved and be responsible for the following::

a. Prepare Baseline NAS.

b. Prepare monthly schedule updates.

c. Prepare tabular reports.

d. Prepare Time Impact Analysis (TIA) as necessary.

e. Provide certification that NAS and TIA submittals conform to the contract requirements.

[f. Participate with the Prime Contractor and Government Representative in a monthly [teleconference call,][meeting at the job site in-person,] and scheduled with sufficient time to support the Monthly Network Analysis Updates process, to discuss project status, schedule updates, critical activities, potential delays, and contract modifications impacting the schedule. Have a computer with P6 software available during the meeting.

] **

NOTE: Retain the following list item where justified by project size [and][or] complexity.

****

[g. Be present on the project site full-time during working hours.

]1.10 NETWORK SYSTEM FORMAT

Prepare the schedule in accordance with the following Primavera P6 settings and parameters. Deviation from these settings and parameters, without prior consent of the Contracting Officer, is cause for rejection of schedule submission.

1.10.1 Schedule Activity Properties and Level of Detail

1.10.1.1 Activity Identification and Organization

****

NOTE: Item a. contains tailoring for DESIGN-BUILD projects, and item e. contains tailoring for sections used in DESIGN-BID-BUILD and DESIGN-BUILD.

****

a. Identify design and construction activities planned for the project and other activities that could impact project completion if delayed in the NAS.

b. Each activity must have a unique name.

c. Identify administrative type activity/milestones, including all pre-construction submittal and permit requirements prior to demolition or construction stage.

d. Include times for procurement, Contractor quality control and construction, acceptance testing and training in the schedule.

e. Include the Government approval time required for the submittals that require Government Approval prior to construction, as indicated in Section 01 33 00 SUBMITTAL PROCEDURES Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES.

f. Create separate activities for each Phase, Area, Floor Level and Location the activity is occurring.

g. Do not use construction category activity to represent non-work type reference (e.g., Serial Letter, Request for Information) in NAS. Place Non-work reference within the P6 activity details notebook.

Activity categories included in the schedule are specified below.

1.10.1.2 Activity Logic

a. With the exception of the Contract Award and Contract Completion Date (CCD) milestone activities, activity must not be open-ended; each activity must have at least one predecessor and at least one successor.

b. Activities must not have open start or open finish (dangling) logic.

c. Do not use lead or lag logic without Contracting Officer prior approval.

d. Minimize redundant logic ties.

e. Once an activity exists on the schedule it must not be deleted or renamed to change the scope of the activity and must not be removed from the schedule logic without approval from the Contracting Officer.

    (1) While an activity cannot be deleted, where said activity is no longer applicable to the schedule, but must remain within the logic stream for historical record, change the activity original and remaining duration to zero and clearly label "(NO LONGER REQUIRED)" after the activity name. Actual finish date for activity that falls behind the data date. Redistribute

accordingly any remaining budget associated with that activity, to other remaining appropriate activity.

(2) Document any such change in the activities' "Notebook," including a date and explanation for the change.

(3) The ID number for a "NO LONGER REQUIRED" activity must not be re-used for another activity.

1.10.1.3 Longest Path Activity Baseline Limitation

****

NOTE: Retain 30 percent threshold baseline in the bracketed item for most projects. However, for horizontal construction, and the more linear a project, (for example, sidewalk, roadway, fence) this threshold may be increased accordingly to as much as 80 percent, depending on the type of project. Consult with FEC scheduler if additional guidance is needed.

****

For P6 settings, critical activities are defined as being on the Longest Path. Longest Path (Critical) Activities must not make up more than [30 percent] [_____] of all activity within the Construction Baseline Schedule.

1.10.1.4 Assigned Calendars

All NAS activity must be assigned calendars that reflect required and anticipated non-work days.

1.10.1.5 Activity Categories

1.10.1.5.1 Design Activities

****

NOTE: This paragraph is tailored for DESIGN-BUILD projects.

****

Design activities must include design decision points and design submittal packages, including critical path submittals for Fast Tracked Phases. Review times for design development packages must be included in the schedule. Refer to Section 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES, for specific requirements.

1.10.1.5.2 Pre-construction Activities

Examples of pre-construction activities include, but are not limited to, bond approval, permits, pre-construction submittals and approvals. Include pre-construction activities that are required to be completed prior to the Contractor starting the demolition or construction stage of work.

1.10.1.5.3 Procurement Activities

Examples of procurement activities include, but are not limited to: Material/equipment submittal preparation, submittal and approval of material/equipment; material/equipment fabrication and delivery, and material/equipment on-site. As a minimum, separate procurement activities must be provided for critical items, long lead items, items requiring Government approval and material/equipment procurement for which payment will be requested in advance of installation. Show each delivery with relationship tie to the Construction Activity specifically for the delivery.

1.10.1.5.4 Government Activities

****

NOTE: The paragraph below includes DESIGN-BUILD tailoring for Design and Construction Start activities.

****

Government and other agency activities that could impact progress must be clearly identified. Government activities include, but are not limited to; Government approved submittal reviews, Government conducted inspections/tests, environmental permit approvals by State regulators, utility outages, Design Start, Construction Start (including Design/Construction Start for each Fast-Track Phase, and delivery of Government Furnished Material/Equipment.

1.10.1.5.5 Construction Quality Management (CQM) Activities

The Preparatory and Initial Phase meetings for each Definable Feature of Work identified in the Contractor's Quality Control Plan must be included in the Three-Week Look Ahead Schedule. Preparatory and Initial phase meetings are not required in the NAS, but can be represented by a start milestone linked to successor parent Construction Activity. The Follow-up Phase must be represented by the Construction Activities themselves in the NAS.

1.10.1.5.6 Construction Activities

On-site construction activities that are the responsibility of the Contractor or Contractor's subcontractors must not have a duration in excess of 20 working days without prior approval by the Contracting Officer. Contractor activities must be driven by calendars that reflect Saturdays, Sundays and all Federal Holidays as non-work days, unless otherwise defined in this contract. Federal Holidays are as defined in 5 USC 6103.

1.10.1.5.7 Turnover and Closeout Activities

Include activities or milestones for items on the NAVFAC Red Zone Checklist/POAM that are applicable to this project. As a minimum, include required Contractor testing, required Government acceptance inspections on equipment, Pre-Final Inspection, Punch List Completion, Final Inspection and Acceptance. Add an unconstrained start milestone for the initial NAVFAC Red Zone - Facility Turnover Planning Meeting at approximately 75 percent construction contract completion or six months prior to Contract Completion Date (CCD), whichever is sooner. Include a separate NAVFAC Red Zone - Facility Turnover Planning Meeting Milestone for each phase if the contract requires construction to be completed in phases.

1.10.1.5.8 Testing of HVAC - DALT, TAB, and PVT Activities

****

NOTE: Use this paragraph when Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC and

Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC are included in the contract specifications; otherwise, delete. This paragraph is tailored for TABS.

****

Include in the baseline schedule, activities and milestones associated with Government acceptance of Duct Air Leakage Test (DALT), Testing, Adjusting, and Balancing (TAB) and Performance Verification Test (PVT) as required and in accordance with Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC and Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

a. Identify the general area or location(s) for Government Acceptance Testing of DALT, TAB and PVT.

b. Incorporate into the baseline schedule, time periods required for advance notification of work, and Government submittal review in accordance with Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC, paragraph DALT AND TAB SUBMITTAL AND WORK SCHEDULE.

c. Include the following as schedule activities or milestones:

    (1) Pre-DALT/TAB/PVT Meeting

    (2) TAB Design Review Report, Government review

    (3) TAB Pre-Field Engineering Report, Government review

    (4) DALT Field Work

    (5) DALT Field Acceptance Testing

    (6) Certified Final DALT Report, Government review

    (7) Control Contractors PVT Plan, Government review

    (8) Equipment Suppliers PVT Plan, Government review

    (9) Season I TAB Field Work

    (10) Season I Certified Final TAB Report, Government review

    (11) Endurance Testing, Government review

    (12) PVT Field Work

    (13) PVT Report, Government review

    (14) Season I TAB Field Acceptance Testing

    (15) Season II TAB Field Work

    (16) Season II Certified Final TAB Report, Government review

    (17) Season II TAB Field Acceptance Testing

****

NOTE: Insert the following when required by, and coordinate the post-occupancy endurance testing and

post occupancy PVT Field Work with, Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.
****

[(18) Post-Occupancy Endurance Testing Government review

(19) Post-Occupancy PVT Field Work

]1.10.1.5.9 Commissioning Activities

****
NOTE: This paragraph is tailored for Commissioning (CX). Use this paragraph if Section 01 91 00.15 BUILDING COMMISSIONING is included in the contract specifications.
****

Include in the baseline schedule activities and milestones associated with Commissioning.

a. Identify the general area or location(s) of systems for Commissioning Inspection and Testing

b. Incorporate into the baseline schedule time periods for Government submittal review

1.10.1.6 Contract Milestones and Constraints

1.10.1.6.1 Project Start Date Milestones

Include as the first activity on the schedule a start milestone titled, "Contract Award", which must have a Mandatory Start constraint equal to the Contract Award Date.

1.10.1.6.1.1 Design Phase Completion Milestone

****
NOTE: This paragraph is tailored for DESIGN-BUILD projects.
****

Include an unconstrained finish milestone on the schedule titled, "Design Phase Completion". Design Phase Completion is defined as the point in time when all design requirements are complete and approved. Duration for Government review and approval must be included as predecessor activities to Design Phase Completion.

1.10.1.6.1.2 Post-Award Kickoff (PAK) meeting Milestone

Include an unconstrained finish milestone on the schedule titled, "Post-Award Kickoff Meeting". The Post Award Kickoff Meeting may be a single day, or it may range over several days. The intent is to cover all PAK topics, including Partnering and Concept Design Workshop (if required) in one continuous session.

1.10.1.6.2 Pre-Construction Meeting Milestone

****
NOTE: This paragraph is tailored for

DESIGN-BID-BUILD projects.
****

Include an unconstrained finish milestone on the schedule titled, "Pre-Construction Meeting". The Pre-Construction meeting may be a single day, or it may range over several days. The intent to cover all the Pre-Con topics, including Partnering and DD1354.

1.10.1.6.3 Preconstruction Submittals Finish Milestone

Include an unconstrained finish milestone on the schedule titled, "Preconstruction Submittals". This milestone is complete when all required preconstruction submittals have been reviewed and approved by the Government.

1.10.1.6.4 Contractor Mobilization Finish Milestone

Include an unconstrained finish milestone on the schedule titled, "Contractor Mobilization".

1.10.1.6.5 NAVFAC Red Zone - Facility Turnover Planning Meeting Milestones

See paragraph TURNOVER AND CLOSEOUT ACTIVITIES above.

1.10.1.6.6 Substantial Completion Milestone

Include an unconstrained finish milestone on the schedule titled "Substantial Completion." Substantial Completion is defined as the point in time the Government would consider the project ready for beneficial occupancy wherein by mutual agreement of the Government and Contractor, Government use of the facility is allowed while construction access continues in order to complete remaining items (e.g., punch list and other close out submittals). Include a separate Substantial Completion Milestone for each phase if the contract requires construction to be completed in phases.

1.10.1.6.7 DD-1354 Finish Milestone

Add unconstrained finish milestone, titled "DD-1354" and scheduled 30 calendar days prior to Substantial Completion, whenever a Form DD-1354 is required in accordance with Section 01 20 00 PRICE AND PAYMENT PROCEDURES. Include a separate DD-1354 Finish Milestone for each phase if the contract requires construction to be completed in phases.

1.10.1.6.8 Projected Completion Milestone

Include an unconstrained finish milestone on the schedule titled "Projected Completion." Projected Completion is defined as the point in time all contract requirements are complete and verified by the Government with a successful Final Inspection in accordance with Section 01 45 00 QUALITY CONTROL. This milestone must have the Contract Completion Date (CCD) milestone as its only successor.

1.10.1.6.9 Contract Completion Date (CCD) Milestone

Last schedule entry must be an unconstrained finish milestone titled "Contract Completion (CCD: DD-MM-YY)." DD-MM-YYYY is the current contract completion date at data date, day-month-year corresponding to P6 Must Finish By Date. NAS milestone updates of Project Completion finish date for longest path must reflect calculated float as positive or negative based on CCD. Calculation of schedule updates must be such that if the finish of the "Projected Completion" milestone falls after the contract completion date, then negative float is calculated on the longest path. If the finish of the "Projected Completion" milestone falls before the contract completion date, the float calculation must reflect positive float on the longest path.

1.10.1.6.10 Additional Milestones

Provide up to 5 additional milestones as required by Contracting Officer.

1.10.1.7 Work Breakdown Structure & Activity Code

At a minimum, establish a Work Breakdown Structure (WBS) and provide activity codes identified as follows:

1.10.1.7.1 Work Breakdown Structure (WBS)

Group all activities and milestones within appropriate WBS elements/levels including, at a minimum, the following:

****

NOTE: The following items a.(4) and a.(5) are tailored for DESIGN-BUILD Contracts.

****

a. Project Milestones:

    (1) Management Milestones

    (2) Project Administrative Meetings

    (3) Permits

    (4) Design Phase

    (5) Submittals and Reviews

b. Pre-Construction Phase:

    (1) Submittals and Reviews

    (2) Procurement

    (3) Mobilization

c. Construction Phase: Create multiple elements/levels in accordance with project specific definable features of work including in WBS descending order as follows:

    (1) General Area

        (a) Type of Work Item

            1. Location

d. Project Closeout: Include activity items such as, but not limited to, Punchlist, Demobilization, O&M, As-built Drawings, Training, and

As-built NAS.

e. Modifications: Create Conformed and Non-Conformed elements/levels under Modification WBS. Create multiple elements/levels as the project progresses identified by issue and Fragnet placed in Conformed for modifications issued prior data date, or Non-Conformed for issues not modified to contract prior data date.

f. Removed Activity: Activity is "removed" by remaining within logic sequence, eliminating duration and adding "(NO LONGER REQUIRED)" after Activity Name in Activity Table.

****

NOTE: The following item g. is tailored for Commissioning (CX). Use if Section 01 91 00.15 BUILDING COMMISSIONING is included in the contract specifications.

****

g. Commissioning & Testing:

    (1) Specific area/locations of commissioning

    (2) Final Testing

    (3) Training

1.10.1.7.2 Responsibility Code

Use "RESP" for Activity Code Name. All activities in the project schedule must be identified with the resource for completing the task. Activities must not belong to more than one responsible party.

1.10.1.7.3 Activity Category Code

Use "CAT" for Activity Code Name for the following Project Level activity codes:

****

NOTE: The following item h. is tailored for DESIGN-BUILD Contracts.

****

a. Assign "PROC" value to Procurement type activity

b. Assign "PRE-CON" value to Pre-construction activity

c. Assign "CONS" value to Construction type activity

d. Assign "TEST" value to dedicated testing type activities

e. Assign "CX" value to dedicated Commissioning type activities

f. Assign "CLOS" value to dedicated Close Out type activity

g. Assign "OTHR" to other activity not otherwise designated

h. Assign "DSGN" value to Design type activity

[1.10.1.7.4 Drawing Code

****

NOTE: Retain either or both of the following two paragraphs where justified by project complexity.

****

Identify all activities in the project schedule with its respective Drawing Code. The Drawing Code is the Sheet Number on the primary project drawing which indicates work to be performed. If an activity does not have an applicable Drawing Code (e.g., Mobilize), the code must be "0000".

][1.10.1.7.5 Additional Activity Codes

Provide up to an additional five activity codes as required by the Contracting Officer

]1.10.1.8 Adverse Weather Lost Work Days

****

NOTE: Check with the FEC's Scheduling Subject Matter Expert or with the FEAD/ROICC for known site-specific Adverse Weather Delays to determine how to edit this paragraph. If historical data is not available, choose the first paragraph using NOAA historical monthly averages as the basis for establishing non-workdays. Note that NOAA historical data may not be available for all OCONUS locations.

If the historical adverse weather data is available, use the second paragraph and table and populate the table with the known data. Insert the data for each month in the blank, bracketed item provided. A bracketed choice of 2 days per month is provided only as an option to remind the Designer to insert the actual data.

****

[Use the National Oceanic and Atmospheric Administration's (NOAA) Summary of Monthly Normals report to obtain the historical average number of days each month with precipitation, using a nominal 30-year, greater than 2.5 mm 0.10 inch precipitation amount parameter, as indicated on the Station Report for the NOAA location closest to the project site as the basis for establishing a "Weather Calendar" showing the number of anticipated non-workdays for each month due to adverse weather, in addition to Saturdays, Sundays and all Federal Holidays as non-work days.

][Use the following schedule of anticipated monthly non-work days due to adverse weather as the basis for establishing a "Weather Calendar" showing the number of anticipated non-workdays for each month due to adverse weather, in addition to Saturdays, Sundays and all Federal Holidays as non-work days.

MONTHLY ANTICIPATED ADVERSE WEATHER LOST WORK DAY											
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]	[2][_]

] Assign the Weather Calendar to any activity that could be impacted by adverse weather. The Contracting Officer will issue a modification in accordance with the contract clauses, giving the Contractor a time only extension for the difference of days between the anticipated and actual adverse weather delay if the number of actual adverse weather delay days exceeds the number of days anticipated for the month in which the delay occurs and the adverse weather delayed activities are on the longest path to contract completion in the period when delay occurred. A lost workday due to weather conditions is defined as a day in which the Contractor cannot work at least 50 percent of the day on the impacted activity. Impacts resulting from adverse weather must be documented in Narrative Report for the month that it occurred.

Make changes to P6 project calendars to reflect as-built conditions where work occurred where originally anticipated as non-work days, and where work did not occur (lost work day).

[1.10.1.9 Anticipated Restricted Delays

****

NOTE: Use this paragraph if base access restrictions are anticipated during the project timeframe; otherwise, delete. Revise number of days and period of time as appropriate for project specific requirements.

****

Unless otherwise noted or defined in Section 01 14 00 WORK RESTRICTIONS, allow in the schedule one [_____] lost workday for every two months [_____] of project duration for instances where base access is not permitted or where work areas are temporarily not accessible for security reasons which causes a delay in the work. Use Anticipated Restricted Delays as basis for establishing a "Security Calendar" showing the number of anticipated non-workdays for each month due to anticipated restrictions, in addition to anticipated adverse weather, Saturdays, Sundays and all Federal Holidays as non-work days. Assign the Security Calendar to any activity that could be impacted by restriction delays. The Contracting Officer will issue a modification in accordance with the contract clauses, giving the Contractor a time extension for the difference of days between the anticipated and actual lost work days if the number of actual restriction delay days exceeds the number of anticipated for the month in which the delay occurs and the restriction delayed activities are critical to contract completion. A lost workday due to restriction delay is defined as a day in which the Contractor cannot work at least 50 percent of the day on the impacted activity.

Impacts resulting from restriction delays must be documented in Narrative Report for the month that it occurred.

Make changes to P6 project calendars to reflect as-built conditions where work occurred where originally anticipated as non-work days, and where work did not occur (lost work day).

]1.10.1.10 Cost Loading

The Project Network Analysis Schedule (NAS) must be cost-loaded and will provide the basis for progress payments. Earned Value Reports must be derived from and correspond to cost loaded NAS. Use the Critical Path Method (CPM) and the Precedence Diagram Method (PDM) to satisfy time and cost applications.

Sum of all costs assigned to activities must equal the current contract value as of the data date of the baseline or update schedule. Activity cost loading must be without front-end loading. Provide additional documentation if requested by the Contracting Officer.

1.10.1.10.1 Cost Loading Activities

****

**NOTE: Choose 10 percent in the brackets below,
unless FEC or FEAD/ROICC scheduler directs otherwise.**

****

a. Cost load construction activities. Define construction activities as on-site work activities that can be traced directly to the construction, alteration, demolition, repair of a project facility, infrastructure, or sitework.

b. Assign costs for materials which payment will be requested in advance of installation, including their quantities, to their respective procurement activities that were approved by the Contracting Officer. Assign labor costs, including their quantities, for material and equipment paid for after installation to their respective construction activities.

c. Costs for mobilization will not be paid as individual pay items with the exception of batch plant set-up, mobilization of dredging equipment or other similar labor-intensive situations. If payment for mobilization costs are approved, assign costs for demobilization activities. The value of demobilization activities must not be less than 40 percent of the total costs for mobilization/demobilization activities. If not approved as a separate line item, evenly disperse over construction activities the costs for mobilization [and][or] demobilization.

d. The value of commissioning, testing, and closeout WBS section may not be less than[10] [_____] percent of the total costs for procurement and construction activities.

e. ALL activities assigned Government responsibility will have Zero Cost. No contractor cost should be assigned to an activity designated as a Government responsibility.

f. Do not include field overhead positions as individual cost loaded activities. Evenly disperse indirect costs (e.g., meetings, presentations, submittals, surveys, haul road or storage yard maintenance, dust control, security) and profit to construction activities assigned to the Construction Phase WBS level.

1.10.1.10.2 Partial Payment

Breakdown unit of measure and cost must be defined within P6 Activity Detail Expenses for partial payment of any cost loaded activity. Lump sum cost loaded activity will not be partially paid.

1.10.2 Schedule Software Settings and Restrictions

a. Activity Constraints: Date/time constraint(s), other than those required by the contract, are not allowed unless accepted by the Contracting Officer. Identify any constraints proposed and provide an explanation for the purpose of the constraint in the Narrative Report as described in paragraph REQUIRED TABULAR REPORTS.

b. Default Progress Data Disallowed: Actual Start is date work begins on activity with intent to pursue work to substantial completion. Actual Finish is date work is substantially complete to point where successor activity can begin. Actual dates on the CPM schedule must correspond with activity dates reported on the Contractor Quality Control and Production Reports.

c. At a minimum, include the following settings and parameters in P6 Schedule preparation:

  (1) General: Define or establish Calendars and Activity Codes at the "Project" level, not the "Global" level.

  (2) Admin Drop-Down Menu, Admin Preferences, Time Periods Tab:

    (a) Set time periods for P6 to 8.0 Hours/Day, 40.0 Hours/Week, 172.0 Hours/Month and 2000.0 Hours/Year.

    (b) Use assigned calendar to specify the number of work hours for each time period: Must be checked.

  (3) Admin Drop-Down Menu, Admin Preferences, Earned Value Tab:

    (a) Technique for computing performance percent complete: Use "Activity percent Complete"

    (b) Technique for computing Estimate to Complete: Use "PF = 1".

    (c) Earned Value Calculation: Use "Budgeted values with current dates".

  (4) Project Level, Dates Tab:

    (a) Set "Must Finish By" date to "Contract Completion Date", and set "Must Finish By" time to 05:00pm.

  (5) Project Level, Defaults Tab:

    (a) Duration Type: Set to "Fixed Duration & Units".

    (b) Percent Complete Type: Set to "Physical".

    (c) Activity Type: Set to "Task Dependent".

    (d) Calendar: Set to "Standard 5 Day Workweek". Calendar must reflect Saturday, Sunday and all Federal holidays as non-work days. Alternative calendars may be used with Contracting Officer approval.

(6) Project Level, Calculations Tab:

(a) Default Price/Unit for activities without resource or role Price/Units: Set to "$1/h".

(b) Activity percent complete based on activity steps: Must be Checked.

(c) Link Budget and At Completion for not started activities: Must be Checked.

(d) Reset Remaining Duration and Units to Original: Must be Selected.

(e) Subtract Actual from At Completion: Must be Selected.

(f) Recalculate Actual units and Cost when duration percent complete changes: Must be Checked.

(g) Update units when costs change on resource assignments: Must be Unchecked.

(h) Link Actual to Date and Actual This Period Units and Cost: Must be Checked.

(7) Project Level, Settings Tab:

(a) Define Critical Activities: Check "Longest Path".

(8) Work Breakdown Structure Level, Earned Value Tab:

(a) Technique for Computing Performance Percent Complete: "Activity percent complete" is selected.

(b) Technique for Computing Estimate to Complete (ETC): "PF = 1" is selected.

1.10.3 Required Tabular Reports and Native P6 XER Files

Include the following reports with the Baseline, Monthly Update and any other required schedule submittals:

a. Time Scaled Logic Schedule

b. Provide formatted 11 by 17-inch Time-scaled Logic Schedule in color and landscape-oriented with each schedule submittal. Clearly show activities on the longest path setting Gantt chart longest path activity bars to red. Group activities by WBS and sort by finish date in ascending order. Include the following information in column form for each activity and include accompanying Gantt chart:

(1) Activity ID

(2) Activity Name

(3) Original Duration

(4) Remaining duration

(5) Physical Percent Complete

(6) Start Date

(7) Finish Date

(8) Total Float

(9) Project-level Calendar

c. Previous Monthly Update Comparison Time Scaled Logic Schedule (Submit with all Monthly Update Schedule Submittals.)

d. Provide formatted 11 by 17-inch Time-scaled Logic Schedule in color and landscape-oriented with each monthly update schedule submittal. Clearly show activities on the current month longest path setting Gantt chart longest path activities bars to red. Show previous month activities as yellow bars and previous month milestones in yellow within Gantt chart. Sort by finish date in ascending order. Filter activities for longest path. Maintain and assign the accepted previous month update or the accepted baseline schedule for the first update submittal as the baseline and primary baseline in P6 before printing the schedule. Include the following information in column form for each activity and include accompanying Gantt chart:

(1) Activity ID

(2) Activity Name

(3) Original Duration

(4) Current Month Remaining Duration

(5) Current Month Start Date

(6) Previous Month Update Start Date (BL Project Start)

(7) Start Date Delta between Current Month and Previous Month (Variance - BL Project Start Date)

(8) Current Month Finish Date

(9) Previous Month Finish Date (BL Project Finish)

(10) Finish Date Delta between Current Month and Previous Month (Variance - BL Project Start Date)

(11) Current Month Total Float

e. P6 native XER file: Include the back-up native .xer program file compatible with the current Government version of Primavera P6. Each native schedule file must have a unique file name to include project name and data date using (yyyy-mm-dd) convention. Each native schedule must have a unique Project ID and Project Name.

f. Log Report: P6 Scheduling/Leveling Report.

g. Narrative Report: Identify and justify:

(1) Provide Project Summary Data in format below:

(a) Data Date ______

(b) Award Date: _______

(c) Original Project Duration: _____ days post Award Date

(d) Current Project Duration: ______ days post Award Date

(e) Time percent elapsed: ______ percent at data date

(f) Original CCD: _______

(g) Current CCD: _______ (thru MOD _______)

(h) Anticipated CCD: _____ (___ calendar days early/late)

(i) Original Contract Value: $____________

(j) Current Contract Value: $_________

(k) Invoiced Amount: $_________ (____ percent)

(l) Cost Growth: ____ percent

(m) Schedule Growth: ____ percent

(n) There are a total of ______ activities, ______ activities complete (____ percent), ____ activities in progress (____ percent), _____ activities not started (____ percent). Of the in progress and not started activities; ____ (____ percent) are on the longest path. The longest path has duration of _____ calendar days from data-date to anticipated project completion.

(2) Progress made in each area of the project;

(3) Longest Path;

(4) Date/time constraint(s), other than those required by the contract

(5) Listing of all changes made between the previous schedule and current updated schedule include: added or deleted activities, original and remaining durations for activities that have not started, logic (sequence constraint lag/lead), milestones, planned sequence of operations, longest path, calendars or calendar assignments, and cost loading;

(6) Any decrease in previously reported activity Earned Amount;

(7) Pending items and status thereof, including permits, changes orders, and time extensions;

(8) Status of Contract Completion Date and interim milestones;

(9) Status of Projected Completion Milestone and account of difference in calendar days between previous update Projected Completion Milestone

(10) Current and anticipated delays listing Activity Names and IDs for impacted activities(describe cause of delay and corrective actions(s) and mitigation measures to minimize);

(11) Description of current and potential future schedule problem areas.

(12) Identification of any weather and restricted lost time as compared to anticipated weather for the month and anticipated restricted days for which the update is submitted. Impacts resulting from adverse weather must be documented in tabular form showing the calendar month (or billing period) with the days on which construction activity incurred Lost Work Days due to adverse weather. In narrative form, describe the adverse weather cause such as precipitation measurement, temperature, wind or other influencing factors, and why work was impacted. Describe the construction activity(s) that was (were) scheduled, impacted.

h. Each entry in the narrative report must cite the respective Activity ID and Activity Name, the date and reason for the change, and description of the change.

i. Earned Value Report: Derive from and correspond to P6 cost loaded schedule. List all activities having a budget amount cost loaded. Compile total earnings on the project from notice to proceed to current progress payment request. Show current budget, previous physical percent complete, to-date physical percent complete, previous earned value, to-date earned value, cost this period and cost to complete on the report for each activity.

j. Schedule Variance Control (SVC) Diagram: With each schedule submission, provide a SVC diagram showing 1) A Cash Flow Curve indicating planned project cost based on each of projected early and projected late activity finish dates and 2) one curve for Earned Value to-date. Revise Cash Flow Curves when the contract is modified, or as directed by the Contracting Officer Include a legend on report clearly indication 3 curves: early finish, late finish, and earned-value to date.

k. Use the following settings in Activity Usage Profile Options:

(1) In the Data section, under Display, the radio box for Cost must be selected.

(2) In the Data section, under Filter for Bars/Graphs, the checkbox for Total must be checked.

(3) In the Show Bars/Curves section:

(a) Under the By Date column, the checkboxes for Baseline, Actual and Remaining Late must be checked. The checkboxes for Budgeted and Remaining Early must be unchecked.

(b) Under the Cumulative column, the checkboxes for Baseline, Actual and Remaining Late must be checked. The checkboxes for Budgeted and Remaining Early must be unchecked.

(c) Set the color for Baseline to green.

(d) Set the color for Actual to blue.

(e) Set the color for Remaining Late to red.

(4) In the Show Earned Value Curves section, the checkboxes for Planned Value Cost, Earned Value Cost and Estimate at Completion must be unchecked.

l. Logic Diagram showing timescale from data date to 60 days after data date with filter for longest path. Leave Group By selection blank and sort by finish date in ascending order.

m. Baseline or Monthly Update Checklist as applicable completed and certified by Qualified Scheduler. Baseline Project Schedule and Monthly Update Schedule Checklists can be found on the Whole Building Design Guide website at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-32-17-00-20

n. Screen shot PDF of Primavera P6 Time Periods Settings referenced in paragraph SCHEDULE SOFTWARE SETTINGS AND RESTRICTIONS, list item c.(2): ADMIN DROP-DOWN MENU, ADMIN PREFERENCES, TIME PERIODS TAB

o. Screen shot PDF of Primavera P6 Earned Value Settings referenced in paragraph SCHEDULE SOFTWARE SETTINGS AND RESTRICTIONS, list item c.(3): ADMIN DROP-DOWN MENU, ADMIN PREFERENCES, EARNED VALUE TAB

****

NOTE: Retain the following paragraph where justified by project complexity.

****

[p. Daily Reported Production Activity: Submit on a monthly basis, in electronic spreadsheet (format provided by the Government), summary of daily reported production activity for the reporting month in the update schedule. Use the following columns for reporting:

(1) Date

(2) Activity ID

(3) Work Description

(4) Contractor

(5) Billable Hours

]**

NOTE: Include the following when required for project. See Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

****

[q. HVAC/COMMISSIONING KTR Checklist. See Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC for checklist requirements. Complete checklist listing all items with baseline submittal. Complete checklist as required to complete project, submitting complete checklist in intermediately following monthly update submittal.

]1.11 CONTRACT MODIFICATION

1.11.1 Time Impact Analysis (TIA)

Submit a Time Impact Analysis with each cost and time proposal for a proposed change. TIA must illustrate the influence of each change or delay on the Contract Completion Date or milestones. No time extensions will be granted nor delay damages paid unless a delay occurs which consumes all available Project Float, impacts the longest path, and extends the Projected Completion beyond the Contract Completion Date.

a. Each TIA must be in both narrative and schedule form. The narrative must:

   (1) . Define the scope and conditions of the change;

   (2) . Provide start and finish dates of impact;

   (3) . Successor(s) and predecessor(s) activities to impact period;

   (4) . Responsible party;

   (5) . Describe how the impact originated;

   (6) . How it impacts the schedule's longest path.

b. The schedule submission must consist of three native XER files:

   (1) Fragnet used to define the scope of the changed condition

   (2) Most recent accepted schedule update as of the time of the impact start date. Update this schedule to show all activity progress as of the time of the impact start date. The impact start date is identified as the time when an existing activity is impeded for either starting or finishing.

   (3) The impacted schedule that has the Fragnet inserted in the updated schedule and the schedule "run" so that the new completion date is determined.

c. For claimed as-built project delay, the inserted Fragnet TIA method must be modified to account for as-built events known to occur after the data date of schedule update used. Updated schedules for periods following the impact start date will be used to evaluate how the project progressed (as-built) through the finish of impact. Impact to longest path must be determined for each following update period.

d. All TIAs must include any mitigation, and must determine the apportionment of the overall delay assignable to each individual delay. Apportionment must provide identification of delay type and classification of delay by compensable and non-compensable events. The associated narrative must clearly describe analysis methodology used, and the findings in a chronological listing beginning with the earliest delay event.

(1) Identify and classify types of delay defined as follows:

  (a) Force majeure delay (e.g., weather delay): Any delay event caused by something or someone other than the Government or the Contractor, or the risk of which has not been assigned solely to the Government or the Contractor. If the force majeure delay is on the longest path, in absence of other types of concurrent delays, the Contractor is granted an extension of contract time, classified as a non-compensable event.

  (b) A Contractor-delay: Any delay event caused by the Contractor, or the risk of which has been assigned solely to the Contractor. If the contractor-delay is on the longest path, in absence of other types of concurrent delays, Contractor is not granted extension of contract time, and classified as a non-compensable event. Where absent other types of delays, and having impact to project completion, Contractor must provide to Contracting Officer a Corrective Action Plan identifying plan to mitigate delay.

  (c) A Government-delay: Any delay event caused by the Government, or the risk of which has been assigned solely to the Government. If the Government-delay is on the longest path, in absence of other types of concurrent delays, the Contractor is granted an extension of contract time, and classified as a compensable event.

(2) Functional concurrency must be used to analyze concurrent delays, where: separate delay issues delay project completion, do not necessarily occur at same time, rather occur within same monthly schedule update period at minimum, or within same as-built period under review. If a combination of functionally concurrent delay types occurs, it is considered Concurrent Delay, which is defined in the following combinations:

  (a) Government-delay concurrent with contractor-delay: excusable time extension, classified non-compensable event.

  (b) Government-delay concurrent with force majeure delay: excusable time extension, classified non-compensable event.

  (c) Contractor-delay concurrent with force majeure delay: excusable time extension, classified non-compensable event.

(3) Pacing delay reacting to another delay (parent delay) equally or more critical than paced activity must be identified prior to pacing. Contracting Officer will notify Contractor prior to pacing. Contractor must notify Contracting Officer prior to pacing. Notification must include identification of parent delay issue, estimated parent delay time period, paced activity(s) identity, and pacing reason(s). Pacing Concurrency is defined as follows:

  (a) Government-delay concurrent with contractor-pacing: excusable time extension, classified compensable event.

  (b) Contractor-delay concurrent with Government-pacing: inexcusable time extension, classified non-compensable event

e. Submit electronic file containing the narrative and the source schedule files used in the time impact analysis.

1.12 PROJECT FLOAT

Project Float is the length of time between the Contractor's Projected Completion Milestone and the Contract Completion Date. Project Float available in the schedule will not be for the exclusive use of either the Government or the Contractor.

The use of Resource Leveling is prohibited. Techniques used for the purpose of artificially adjusting activity durations to consume float and influence longest path are prohibited.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-01 33 00 (August 2018)**
Change 4 - 02/21

Preparing Activity: USACE **Superseding**
UFGS-01 33 00 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS
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Preparing Activity: USACE **Superseding**
UFGS-01 33 00 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

****

SECTION 01 33 00

SUBMITTAL PROCEDURES

08/18, CHG 4: 02/21

****

NOTE: This guide specification covers the requirements for general procedures regarding submittals, data normally submitted for review to establish conformance with the design concept and contract documents, called for in other sections of the specifications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

This guide specification includes tailoring options for Army, Navy, and NAVFAC component requirements. Army tailoring options also include DESIGN-BUILD (DB) and DESIGN-BID-BUILD, and at least one of these options must be deselected. Do not use this section for Navy DESIGN-BUILD (DB)D projects. Use the DB specs in the NAVFAC DB Master posted within the Whole Building Design Guide**. Selection or deselection of a tailoring option will include or exclude that option in the section, but the resulting section must still be edited to fit the project required.**

****

PART 1 GENERAL

1.1 SUMMARY

****

NOTE: This paragraph contains tailoring for Army, Design-Bid-Build, and Design-Build. Use for Army projects only.

****

1.1.1 Submittal Information

The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

Units of weights and measures used on all submittals are to be the same as those used in the contract drawings.

1.1.2 Project Type

The Contractor's Quality Control (CQC) System Manager are to check and approve all items before submittal and stamp, sign, and date indicating action taken. Proposed deviations from the contract requirements are to be clearly identified. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals.

The Contractor and the Designer of Record (DOR), if applicable, are to check and approve all items before submittal and stamp, sign, and date indicating action taken. Proposed deviations from the contract requirements are to be clearly identified. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals.

1.1.3 Submission of Submittals

Schedule and provide submittals requiring Government approval before acquiring the material or equipment covered thereby. Pick up and dispose of samples not incorporated into the work in accordance with manufacturer's Safety Data Sheets (SDS) and in compliance with existing laws and regulations.

1.2 DEFINITIONS

1.2.1 Submittal Descriptions (SD)

****

NOTE: The SD numbers and titles, assigned by the SPECSINTACT Configuration, Control, and Coordinating Board, relate to the terminology of the technical

sections and should not be changed. Refer to UFC 1-300-02 UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS) FORMAT STANDARD **for additional information.**

****

****

NOTE: This paragraph contains tailoring tags for Army, Navy, Design-Bid-Build and Design-Build.

****

Submittal requirements are specified in the technical sections. Examples and descriptions of submittals identified by the Submittal Description (SD) numbers and titles follow:

SD-01 Preconstruction Submittals

****

NOTE: For projects in the NAVFAC PAC Area of Operation, the submittal(s) identified as SD-01 Preconstruction Submittal for this spec section, select the "G" designation requiring Government approval.

****

Submittals that are required prior to or commencing with the start of work on site. Submittals that are required prior to or at the start of construction (work) or the next major phase of the construction on a multiphase contract.

****

NOTE: For projects in the NAVFAC PAC Area of Operation, add the bracket paragraph below.

****

[Government approved Division 01 preconstruction submittals that are required prior to or commencing with the start of work must be submitted within 30 calendar days of contract award unless specified elsewhere in the specifications. Contractor approved Division 01 submittals that are required prior to or commencing with the start of work must be submitted within 45 calendar days of contract award unless specified elsewhere in the specifications.]

Preconstruction Submittals include schedules and a tabular list of locations, features, and other pertinent information regarding products, materials, equipment, or components to be used in the work.

****

NOTE: For projects in the NAVFAC PAC Area of Operation, remove the "List of Proposed Subcontractors", "List of Proposed Products", "Submittal Register" and "Work Plan". For Guam projects add the bracketed Explosive Safety Submission ESS Work Plan.

****

Certificates Of Insurance

Surety Bonds

List Of Proposed Subcontractors

List Of Proposed Products

Baseline Network Analysis Schedule (NAS)

Submittal Register

Schedule Of Prices Or Earned Value Report

Accident Prevention Plan

Work Plan

Quality Control (QC) plan

Environmental Protection Plan [Explosive Safety Submission ESS Work Plan]

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards ensuring work can be judged. Includes assemblies or portions of assemblies that are to be incorporated into the project and those that will be removed at conclusion of the work.

****

NOTE: This paragraph contains tailoring tags for

Army, and Design-Build.
****

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

Design submittals, design substantiation submittals and extensions of design submittals.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. Unless specified in another section, testing must have been within three years of date of contract award for the project.

Report that includes findings of a test required to be performed on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report that includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports

Daily logs and checklists

Final acceptance test and operational test procedure

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that the product, system, or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a manufacturer, supplier, installer or Subcontractor through Contractor. The document purpose is to further promote the orderly progression of a portion of the work by documenting procedures, acceptability of methods, or personnel qualifications.

Confined space entry permits

Text of posted operating instructions

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and Safety Data Sheets(SDS)concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must be signed by an authorized official of a testing laboratory or agency and state the test results; and indicate whether the material, product, or system has passed or failed the test.

Factory test reports.

SD-10 Operation and Maintenance Data

Data provided by the manufacturer, or the system provider, including manufacturer's help and product line documentation, necessary to maintain and install equipment, for operating and maintenance use by facility personnel.

Data required by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

Data incorporated in an operations and maintenance manual or control system.

SD-11 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

Submittals required for Guiding Principle Validation (GPV) or Third Party Certification (TPC).

Special requirements necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.2.2 Approving Authority

Office or designated person authorized to approve the submittal.

1.2.3 Work

As used in this section, on-site and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction. In exception, excludes work to produce SD-01 submittals.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

Submittal documents must not contain any Employee Personnel Information (EPI) or Protected Personal Information (PPI), including but not limited to Social Security Number, date of birth, home address, and home telephone number. If EPI/PPI is understood to be required as part of a submittal, contact the Contractor Officer for guidance on how to properly furnish the information in accordance with 32 CFR 701.115.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submittal Register; G

1.4 SUBMITTAL CLASSIFICATION

1.4.1 Government Approved (G)

****

NOTE: This paragraph contains tailoring tags for Army, Design-Bid-Build and Design-Build.

****

Government approval is required for extensions of design, critical materials, variations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Government.

Government approval is required for any variations from the Solicitation or the Accepted Proposal and for other items as designated by the Government.

Within the terms of the Contract Clause SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION, submittals are considered to be "shop drawings."

1.4.2 Design-Build Submittal Classifications

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NOTE: Use tis Subpart for Army Design-Build projects only.

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1.4.2.1 Designer of Record Approved (DA)

Designer of Record (DOR) approval is required for extensions of design; critical materials; any variations from the Solicitation, the Accepted Proposal, or the completed design; equipment whose compatibility with the entire system must be checked; and other items as designated by the Contracting Officer. Provide the Government with the number of copies designated hereinafter of all DOR approved submittals. The Government may review any or all Designer of Record approved submittals for conformance with the Solicitation, the Accepted Proposal, and the completed design. The Government will review all submittals designated as varying from the Solicitation or Accepted Proposal, as described below. Provide design submittals in accordance with Section 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD). Generally, list design submittals under SD-05 Design Data.

1.4.2.2 Government Conformance Review of Design (CR)

The Government will review all intermediate and final design submittals for conformance with the technical requirements of the Solicitation. Section 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD) covers the design submittal and review process in detail. Review will be only for conformance with the applicable codes, standards, and contract requirements. Design data includes the design documents described in Section 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD).

1.4.2.3 Designer of Record Approved/Government Conformance Review (DA/CR)

1.4.2.3.1 Variations from the Accepted Design

DOR approval and the Government's concurrence are required for any proposed variation from the accepted design that still complies with the contract before the Contractor is authorized to proceed with material acquisition or installation. If necessary to facilitate the project schedule, before official submission to the Government, the Contractor and the DOR may discuss with the Contracting Officer's Representative a submittal proposing a variation. However, the Government reserves the right to review the submittal before providing an opinion. In any case, the Government will not formally agree to or provide a preliminary opinion on any variation without the DOR's approval or recommended approval. The Government reserves the right to reject any design, variation that may affect furniture, furnishings, equipment selections, or operational decisions that were made, based on the reviewed and concurred design.

1.4.2.3.2 Substitutions

Unless prohibited or otherwise provided for elsewhere in the contract, where the Accepted Proposal named products, systems, materials or equipment by manufacturer, brand name, model number, or other specific identification, and the Contractor desires to substitute a manufacturer or model after award, submit a requested substitution for Government concurrence. Include substantiation, through identifying information and the DOR's approval, that the substitute meets the contract requirements and that it is equal in function, performance, quality, and salient features to that in the accepted contract proposal. If the contract otherwise prohibits substitutions of equal named products, systems, materials or equipment by manufacturer, brand name, model number or other specific identification, the request is considered a "variation" to the contract. Variations are discussed below in paragraphs: "DESIGNER OF RECORD APPROVED/GOVERNMENT APPROVED" and VARIATIONS.

1.4.2.4 Designer of Record Approved/Government Approved (DA/GA)

In addition to the above-stated requirements for proposed variations to the accepted design, both DOR and Government Approval and, where applicable, a contract modification are required before the Contractor is authorized to proceed with material acquisition or installation for any proposed variation to the contract (the Solicitation or the Accepted Proposal), that constitutes a change to the contract terms. The Government reserves the right to accept or reject any such proposed variation.

1.4.3 For Information Only

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NOTE: This paragraph contains tailoring for Army.

****

Submittals not requiring Government approval will be for information only. For Design-build construction all submittals not requiring DOR or Government approval will be for information only. Within the terms of the Contract Clause SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION, they are not considered to be "shop drawings."

1.4.4 Sustainability Reporting Submittals (S)

Submittals for Guiding Principle Validation (GPV) or Third Party Certification (TPC) are indicated with an "S" designation. These submittals are for information only and for use as specified in Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

Schedule submittals for these items throughout the course of construction as provided; do not wait until closeout.

1.5 FORWARDING SUBMITTALS REQUIRING GOVERNMENT APPROVAL

****

NOTE: Use for Navy projects only.

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NOTE: For bracketed items, choose NAVFAC for projects designed In-House, or choose AE for projects designed by AE, unless the AE is not contracted for post-award support.

****

As soon as practicable after award of contract, and before procurement or fabrication, forward to the [Commander, NAVFAC [_____], Code CI4[_____], [_____]] [Architect-Engineer: [_____],] submittals required in the technical sections of this specification, including shop drawings, product data and samples. In addition, forward a copy of the submittals to the Contracting Officer.

1.5.1 O&M Data

Submit data specified for a given item within 30 calendar days after the item is delivered to the contract site.

In the event the Contractor fails to deliver O&M data within the time limits specified, the Contracting Officer may withhold from progress payments 50 percent of the price of the items to which such O&M data apply.

[1.5.2 Submittals Reserved for NAVFAC [_____] Approval

****

NOTE: Use this bracketed para for projects designed by AE firms only; do not use for projects designed in-house. Coordinate with the Government project manager to validate who will review these submittals. Fill in the Command name and address in the bracketed items

****

As an exception to the standard submittal procedure for Government Approval, submit the following to the Commander, NAVFAC [_____], Code CI4[_____], [_____]:

****

NOTE: Add Section Reference tags where appropriate below when blanks are filled.

****

[a. Section [_____] [_____]: Pile driving records

][b. Section [_____] [_____]: All fire protection system submittals

][c. Section [_____] [_____]: All fire alarm system submittals

][d. Section [_____] [_____]: All elevator submittals

][e. Section 01 91 00.15 BUILDING COMMISSIONING: SD-06 Commissioning Plan, Certificate of Readiness, and Commissioning Report submittals

][f. Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC: SD-06 field test report submittals

][g. Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS: SD-06 field test report submittals

][h. Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC: All submittals

][i. Section 23 08 01.00 20 TESTING INDUSTRIAL VENTILATION SYSTEMS: All submittals

][j. Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS: All submittals

][k. Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS: All submittals

][l. Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION: Transformer submittals

][m. Section 26 11 16 SECONDARY UNIT SUBSTATIONS: Transformer submittals

][n. Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION: Transformer submittals

]][1.5.3 Overseas Shop Drawing Submittals

****

NOTE: Use this paragraph on overseas projects only.

****

Send submittals via overnight express mail service. All costs associated with the overnight express mail service are borne by the Contractor. Costs associated with the overnight express mail of submittals related to proposed submittal variances of resubmittals necessary as a result of noncompliant or incomplete Contractor submittals are the responsibility of the Contractor.

]1.6 PREPARATION

1.6.1 Transmittal Form

****

NOTE: This paragraph includes tailoring for Navy.

****

Transmit each submittal, except sample installations and sample panels to the office of the approving authority using the transmittal form prescribed by the Contracting Officer. Include all information prescribed by the transmittal form and required in paragraph IDENTIFYING SUBMITTALS. Use the submittal transmittal forms to record actions regarding samples.

****

NOTE: This paragraph includes tailoring for Army. ENG Form 4025 is not a part of this guide specification; a sample ENG Form 4025 may be added to this section locally. If a sample is inserted, fill in blocks as appropriate for the project. If the Contractor is required to use the RMS CM software for the contract, that system includes an electronic version of ENG Form 4025.

****

Use the ENG Form 4025-R transmittal form for submitting both Government-approved and information-only submittals. Submit in accordance with the instructions on the reverse side of the form. These forms or similar forms [will be furnished to the Contractor][are included in the RMS CM software that the Contractor is required to use for this contract][are included in the eCMS software that the Contractor is required to use for this contract]. Properly complete this form by filling out all the heading blank spaces and identifying each item submitted. Exercise special care to ensure proper listing of the specification paragraph and sheet number of the contract drawings pertinent to the data submitted for each item.

1.6.2 Identifying Submittals

****

NOTE: This paragraph includes tailoring for Navy. Select Quality Control Manager for Navy projects.

****

The Contractor's [Quality Control Manager] must prepare, review and stamp submittals, including those provided by a subcontractor, before submittal to the Government.

Identify submittals, except sample installations and sample panels, with the following information permanently adhered to or noted on each separate component of each submittal and noted on transmittal form. Mark each copy of each submittal identically, with the following:

a. Project title and location

b. Construction contract number

c. Dates of the drawings and revisions

d. Name, address, and telephone number of Subcontractor, supplier, manufacturer, and any other Subcontractor associated with the submittal.

e. Section number of the specification by which submittal is required

f. Submittal description (SD) number of each component of submittal

g. For a resubmission, add alphabetic suffix on submittal description, for example, submittal 18 would become 18A, to indicate resubmission

h. Product identification and location in project.

1.6.3 Submittal Format

1.6.3.1 Format of SD-01 Preconstruction Submittals

When the submittal includes a document that is to be used in the project, or is to become part of the project record, other than as a submittal, do not apply the Contractor's approval stamp to the document itself, but to a separate sheet accompanying the document.

Provide data in the unit of measure used in the contract documents.

1.6.3.2 Format for SD-02 Shop Drawings

Provide shop drawings not less than 210 by 297 mm 8 1/2 by 11 inches nor more than 1189 by 841 mm 30 by 42 inches, except for full-size patterns or templates. Prepare drawings to accurate size, with scale indicated, unless another form is required. Ensure drawings are suitable for reproduction and of a quality to produce clear, distinct lines and letters, with dark lines on a white background.

a. Include the nameplate data, size, and capacity on drawings. Also include applicable federal, military, industry, and technical society publication references.

b. Dimension drawings, except diagrams and schematic drawings. Prepare drawings demonstrating interface with other trades to scale. Use the same unit of measure for shop drawings as indicated on the contract drawings. Identify materials and products for work shown.

****

NOTE: Select either the hard copy submittal or electronic submittal paragraph for the project.

****

Present 210 by 297 mm shop drawings sized 8 1/2 by 11 inches as part of the bound volume for submittals. Present larger drawings in sets. Submit an electronic copy of drawings in PDF format and native electronic format.

1.6.3.2.1 Drawing Identification

Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph IDENTIFYING SUBMITTALS.

Number drawings in a logical sequence. Each drawing is to bear the number of the submittal in a uniform location next to the title block. Place the Government contract number in the margin, immediately below the title block, for each drawing.

****

NOTE: Do not use the following paragraph for NAVFAC PAC AOR.

****

Reserve a blank space, no smaller than [_____] millimeter inches on the right-hand side of each sheet for the Government disposition stamp.

1.6.3.3 Format of SD-03 Product Data

Present product data submittals for each section as a complete, bound volume. Include a table of contents, listing the page and catalog item numbers for product data.

Indicate, by prominent notation, each product that is being submitted; indicate the specification section number and paragraph number to which it pertains.

1.6.3.3.1 Product Information

Supplement product data with material prepared for the project to satisfy the submittal requirements where product data does not exist. Identify this material as developed specifically for the project, with information and format as required for submission of SD-07 Certificates.

Provide product data in metric dimensions. Where product data are included in preprinted catalogs with English units only, submit metric dimensions on separate sheet.

Provide product data in units used in the Contract documents. Where product data are included in preprinted catalogs with another unit, submit the dimensions in contract document units, on a separate sheet.

1.6.3.3.2 Standards

Where equipment or materials are specified to conform to industry or technical-society reference standards of such organizations as the American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), or Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.6.3.3.3 Data Submission

Collect required data submittals for each specific material, product, unit of work, or system into a single submittal that is marked for choices, options, and portions applicable to the submittal. Mark each copy of the product data identically. Partial submittals will [not] be accepted for expedition of the construction effort.

Submit the manufacturer's instructions before installation.

1.6.3.4 Format of SD-04 Samples

1.6.3.4.1 Sample Characteristics

Furnish samples in the following sizes, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately the same size as specified:

a. Sample of Equipment or Device: Full size.

b. Sample of Materials Less Than 50 by 75 mm 2 by 3 inches: Built up to 210 by 297 mm 8 1/2 by 11 inches.

c. Sample of Materials Exceeding 210 by 297 mm 8 1/2 by 11 inches: Cut down to 210 by 297 mm 8 1/2 by 11 inches and adequate to indicate color, texture, and material variations.

d. Sample of Linear Devices or Materials: 250 mm 10 inch length or length to be supplied, if less than 250 mm 10 inches. Examples of linear devices or materials are conduit and handrails.

e. Sample Volume of Nonsolid Materials: 750 ml Pint. Examples of nonsolid materials are sand and paint.

f. Color Selection Samples: 50 by 100 mm 2 by 4 inches. Where samples are specified for selection of color, finish, pattern, or texture, submit the full set of available choices for the material or product specified. Sizes and quantities of samples are to represent their respective standard unit.

g. Sample Panel: 1200 by 1200 mm 4 by 4 feet.

h. Sample Installation: 10 square meters 100 square feet.

1.6.3.4.2 Sample Incorporation

Reusable Samples: Incorporate returned samples into work only if so specified or indicated. Incorporated samples are to be in undamaged condition at the time of use.

Recording of Sample Installation: Note and preserve the notation of any area constituting a sample installation, but remove the notation at the final clean-up of the project.

1.6.3.4.3 Comparison Sample

Samples Showing Range of Variation: Where variations in color, finish, pattern, or texture are unavoidable due to nature of the materials, submit sets of samples of not less than three units showing extremes and middle of range. Mark each unit to describe its relation to the range of the variation.

****

NOTE: To avoid unnecessary effort by the Contractor, use the following paragraph only when no color board is prepared during design.

****

When color, texture, or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

1.6.3.5 Format of SD-05 Design Data

Provide design data and certificates on 210 by 297 mm 8 1/2 by 11 inch paper. Provide a bound volume for submittals containing numerous pages.

1.6.3.6 Format of SD-06 Test Reports

Provide reports on 210 by 297 mm 8 1/2 by 11 inch paper in a complete bound volume.

By prominent notation, indicate each report in the submittal. Indicate the specification number and paragraph number to which each report pertains.

1.6.3.7 Format of SD-07 Certificates

Provide design data and certificates on 210 by 297 mm 8 1/2 by 11 inch paper. Provide a bound volume for submittals containing numerous pages.

1.6.3.8 Format of SD-08 Manufacturer's Instructions

Present manufacturer's instructions submittals for each section as a complete, bound volume. Include the manufacturer's name, trade name, place of manufacture, and catalog model or number on product data. Also include applicable federal, military, industry, and technical-society publication references. If supplemental information is needed to clarify the manufacturer's data, submit it as specified for SD-07 Certificates.

Submit the manufacturer's instructions before installation.

1.6.3.8.1 Standards

Where equipment or materials are specified to conform to industry or technical-society reference standards of such organizations as the American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), or Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.6.3.9 Format of SD-09 Manufacturer's Field Reports

Provide reports on 210 by 297 mm 8 1/2 by 11 inch paper in a complete bound volume.

By prominent notation, indicate each report in the submittal. Indicate the specification number and paragraph number to which each report pertains.

1.6.3.10 Format of SD-10 Operation and Maintenance Data (O&M)

Comply with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA for O&M Data format.

1.6.3.11 Format of SD-11 Closeout Submittals

When the submittal includes a document that is to be used in the project or is to become part of the project record, other than as a submittal, do not apply the Contractor's approval stamp to the document itself, but to a separate sheet accompanying the document.

Provide data in the unit of measure used in the contract documents.

Provide all dimensions in administrative submittals in metric. Where data are included in preprinted material with English units only, submit metric dimensions on separate sheet.

1.6.4 Source Drawings for Shop Drawings

1.6.4.1 Source Drawings

The entire set of source drawing files (DWG) will not be provided to the Contractor. Request the specific Drawing Number for the preparation of shop drawings. Only those drawings requested to prepare shop drawings will be provided. These drawings are provided only after award.

1.6.4.2 Terms and Conditions

Data contained on these electronic files must not be used for any purpose other than as a convenience in the preparation of construction data for the referenced project. Any other use or reuse is at the sole risk of the Contractor and without liability or legal exposure to the Government. The Contractor must make no claim, and waives to the fullest extent permitted by law any claim or cause of action of any nature against the Government, its agents, or its subconsultants that may arise out of or in connection with the use of these electronic files. The Contractor must, to the fullest extent permitted by law, indemnify and hold the Government harmless against all damages, liabilities, or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.

These electronic source drawing files are not construction documents. Differences may exist between the source drawing files and the corresponding construction documents. The Government makes no representation regarding the accuracy or completeness of the electronic source drawing files, nor does it make representation to the compatibility of these files with the Contractor hardware or software. The Contractor is responsible for determining if any conflict exists. In the event that a conflict arises between the signed and sealed construction documents prepared by the Government and the furnished source drawing files, the signed and sealed construction documents govern. Use of these source drawing files does not relieve the Contractor of the duty to fully comply with the contract documents, including and without limitation the need to check, confirm and coordinate the work of all contractors for the project. If the Contractor uses, duplicates or modifies these electronic source drawing files for use in producing construction data related to this contract, remove all previous indication of ownership (seals, logos, signatures, initials and dates).

1.6.5 Electronic File Format

****

NOTE: Use the following two paragraphs when electronic files are submitted.

****

Provide submittals in electronic format, with the exception of material samples required for SD-04 Samples items. [In addition to the electronic submittal, provide [three] [_____] hard copies of the submittals.] Compile the submittal file as a single, complete document, to include the Transmittal Form described within, and also separately attach the native files which were used to create PDF. The attached files should include the original digital files used to create the submittal. Name the electronic submittal file specifically according to its contents, and coordinate the file naming convention with the Contracting Officer. Electronic files must be of sufficient quality that all information is legible. Use PDF as the electronic format, unless otherwise specified or directed by the Contracting Officer. Generate PDF files from original documents with bookmarks so that the text included in the PDF file is searchable and can be copied. If documents are scanned, optical character resolution (OCR) routines are required. Index and bookmark files exceeding 30 pages to allow efficient navigation of the file. When required, the electronic file must include a valid electronic signature or a scan of a signature.

****

NOTE: The DOD SAFE Web Application described in the following paragraph may be used for Army and Navy projects.

****

E-mail electronic submittal documents smaller than 10MB to an e-mail address as directed by the Contracting Officer. Provide electronic documents over 10 MB on an optical disc or through an electronic file sharing system such as the DOD SAFE Web Application located at the following website: https://safe.apps.mil/.

1.7 QUANTITY OF SUBMITTALS

****

NOTE: The quantities suggested below are consistent with the quantities to be retained by the Government, in paragraph QC ORGANIZATION RESPONSIBILITIES. Maintain the coordination.

****

1.7.1 Number of SD-01 Preconstruction Submittal Copies

Unless otherwise specified, submit [two][three] sets of administrative submittals.

1.7.2 Number of SD-02 Shop Drawing Copies

****

NOTE: Use when asking for hard copies of Shop Drawings and Product Data.

****

Submit [six][_____] copies of submittals of shop drawings requiring review and approval by a QC organization. Submit [seven][_____] copies of shop drawings requiring review and approval by the Contracting Officer.

1.7.3 Number of SD-03 Product Data Copies

Submit in compliance with quantity requirements specified for shop drawings.

1.7.4 Number of SD-04 Samples

****

NOTE: For NAVFAC, require one sample in paragraph "a," and delete the second sentence of paragraph "a."

****

a. Submit [two] [_____] samples, or [two] [_____] sets of samples showing the range of variation, of each required item. One approved sample or set of samples will be retained by the approving authority and one will be returned to the Contractor.

b. Submit one sample panel or provide one sample installation where directed. Include components listed in the technical section or as directed.

c. Submit one sample installation, where directed.

d. Submit one sample of nonsolid materials.

1.7.5 Number of SD-05 Design Data Copies

Submit in compliance with quantity requirements specified for shop drawings.

1.7.6 Number of SD-06 Test Report Copies

Submit in compliance with quantity and quality requirements specified for shop drawings, other than field test results that will be submitted with QC reports.

1.7.7 Number of SD-07 Certificate Copies

Submit in compliance with quantity requirements specified for shop drawings.

1.7.8 Number of SD-08 Manufacturer's Instructions Copies

Submit in compliance with quantity requirements specified for shop drawings.

1.7.9 Number of SD-09 Manufacturer's Field Report Copies

Submit in compliance with quantity and quality requirements specified for shop drawings other than field test results that will be submitted with QC reports.

1.7.10 Number of SD-10 Operation and Maintenance Data Copies

****

NOTE: In bracketed item, choose "three" copies for NAVFAC.

****

Submit [five][three][_____] copies of O&M data to the Contracting Officer for review and approval.

1.7.11 Number of SD-11 Closeout Submittals Copies

Unless otherwise specified, submit [two][three] sets of administrative submittals.

1.8 INFORMATION ONLY SUBMITTALS

****

NOTE: This paragraph contains tailoring tags for Army and Design-Build.

****

Submittals without a "G" designation must be certified by the QC manager and submitted to the Contracting Officer for information-only. Provide information-only submittals to the Contracting Officer a minimum of 14 calendar days prior to the Preparatory Meeting for the associated Definable Feature of Work (DFOW). Approval of the Contracting Officer is not required on information only submittals. The Contracting Officer will mark "receipt acknowledged" on submittals for information and will return only the transmittal cover sheet to the Contractor. Normally, submittals for information only will not be returned. However, the Government reserves the right to return unsatisfactory submittals and require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe. For Design-Build construction, the Government will retain [_____] copies of information-only submittals.

1.9 PROJECT SUBMITTAL REGISTER

****

NOTE: Create the submittal register from the project specification files, at the conclusion of the design. In SPECSINTACT, choose "Export Submittal Register" from the "Process" pull-down menu. Local procedures should be responsive to the requirement that the submittal register, required with the QC plan, is usually due from the Contractor within 20 days after the Notice of Award.

****

****

NOTE: Use bracketed items for Army projects only.

****

A sample Project Submittal Register showing items of equipment and materials for when submittals are required by the specifications is provided as "Attachment A - Submittal Register."

****

NOTE: This paragraph contains ARMY, and DESIGN-BUILD tailoring

NOTE: Use the first bracketed sentence of the paragraph if the Contractor is required by the contract to use the RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM). Use the second bracketed sentence of the paragraph if RMS CM is not required. It may not be necessary or beneficial to use the RMS CM in small, simple, short-duration contracts/delivery orders for construction, or for other contracts where its use would not be in the best interest of the Government.

****

1.9.1 Submittal Management

Prepare and maintain a submittal register, as the work progresses. Do not change data that is output in columns (c), (d), (e), and (f) as delivered by Government; retain data that is output in columns (a), (g), (h), and (i) as approved. As an attachment, provide a submittal register showing items of equipment and materials for which submittals are required by the specifications. This list may not be all-inclusive and additional submittals may be required. Maintain a submittal register for the project in accordance with Section 01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE(RMS CM).[The Government will provide the initial submittal register][in electronic format][with the following fields completed, to the extent that will be required by the Government during subsequent usage.]

Column (c): Lists specification section in which submittal is required.

Column (d): Lists each submittal description (SD Number. and type, e.g., SD-02 Shop Drawings) required in each specification section.

Column (e): Lists one principal paragraph in each specification section where a material or product is specified. This listing is only to facilitate locating submitted requirements. Do not consider entries in column (e) as limiting the project requirements.

Column (f): Lists the approving authority for each submittal.

****

NOTE: Use the following paragraph for Army projects only.

****

Thereafter, the Contractor is to track all submittals by maintaining a complete list, including completion of all data columns and all dates on which submittals are received by and returned by the Government.

1.9.2 Design-Build Submittal Register

****

NOTE: Use the following paragraph for Army Design-Build projects only.

****

The Designer of Record develops a complete list of submittals during design and identify required submittals in the specifications, and use the list to prepare the Submittal Register. The list may not be all inclusive and additional submittals may be required by other parts of the contract. Complete the submittal register and submit it to the Contracting Officer for approval within 30 calendar days after Notice to Proceed. The approved submittal register will serve as a scheduling document for submittals and will be used to control submittal actions throughout the contract period. Coordinate the submit dates and need dates with dates in the Contractor prepared progress schedule. Submit monthly or until all submittals have been satisfactorily completed, updates to the submittal register showing the Contractor action codes and actual dates with Government action codes. Revise the submittal register when the progress schedule is revised and submit both for approval.

1.9.3 Preconstruction Use of Submittal Register

Submit the submittal register. Include the QC plan and the project schedule. Verify that all submittals required for the project are listed and add missing submittals. Coordinate and complete the following fields on the register submitted with the QC plan and the project schedule:

Column (a) Activity Number: Activity number from the project schedule.

Column (g) Contractor Submit Date: Scheduled date for the approving authority to receive submittals.

Column (h) Contractor Approval Date: Date that Contractor needs approval of submittal.

Column (i) Contractor Material: Date that Contractor needs material delivered to Contractor control.

1.9.4 Contractor Use of Submittal Register

Update the following fields in the Government-furnished submittal register program or equivalent fields in the program used by the Contractor with each submittal throughout the contract.

Column (b) Transmittal Number: List of consecutive, Contractor-assigned numbers.

Column (j) Action Code (k): Date of action used to record Contractor's review when forwarding submittals to QC.

Column (l) Date submittal transmitted.

Column (q) Date approval was received.

1.9.5 Approving Authority Use of Submittal Register

Update the following fields:

Column (b) Transmittal Number: List of consecutive, Contractor-assigned numbers.

Column (l) Date submittal was received.

Column (m) through (p) Dates of review actions.

Column (q) Date of return to Contractor.

1.9.6 Action Codes

****

NOTE: Select the tailoring option for either Army, Design-Build; Army, Design-Bid-Build; or Navy.

****

1.9.6.1 Government Review Action Codes

"A" - "Approved as submitted"

"AN" - "Approved as noted"

"RR" - "Disapproved as submitted"; "Completed"

"NR" - "Not Reviewed"

"RA" - "Receipt Acknowledged"

1.9.6.2 Contractor Action Codes

****

NOTE: Use the following codes for Army, Design-Bid-Build projects only.

****

DESIGN BID BUILD SUBMITTALS			
Submittal Classifications shown in UFGS Sections	Submittal Classification	Corresponding SpecsIntact Submittal Register Code which is populated in the SI Submittal Register. Software Limitations: (The software shows one character delineation in the SpecsIntact Submittal Register)	RMS – The following Submittal Classifications are populated in RMS when the SpecsIntact Submittal Data File is pulled into RMS)
G	Submittal requires Government	G	GA
BLANK	Submittal is For Information Only (FIO)	BLANK	FIO
S	Submittal is for documentation of Sustainable requirements	S	S/FIO

1.9.6.3 Contractor Action Codes

****

NOTE: Use the following codes for Army, Design-Build projects only.

****

DESIGN BUILD SUBMITTALS			
Submittal Classifications shown in UFGS Sections	Submittal Classification	Corresponding SpecsIntact Submittal Register Code which is populated in the SI Submittal Register. Software Limitations: (The software shows one character delineation in the SpecsIntact Submittal Register)	RMS – The following Submittal Classifications are populated in RMS when the SpecsIntact Submittal Data File is pulled into RMS)
G	Submittal requires Government	G	GA

DESIGN BUILD SUBMITTALS			
BLANK	Submittal is For Information Only(FIO)	BLANK	FIO
DA	Submittal requires Designer of Record Approval	D	DA
CR	Submittal requires Government Conformance Review	C	CR
DA/CR	Submittal requires Designer of Record Approval and Government Conformance	R	DA/CR
DA/GA	Submittal requires Designer of Record Approval and Government Approval	A	DA/GA

1.9.7 Delivery of Copies

Submit an updated electronic copy of the submittal register to the Contracting Officer with each invoice request. Provide an updated Submittal Register monthly regardless of whether an invoice is submitted.

1.10 VARIATIONS

Variations from contract requirements require Contracting Officer approval pursuant to contract Clause FAR 52.236-21 Specifications and Drawings for Construction, and will be considered where advantageous to the Government.

1.10.1 Considering Variations

****

NOTE: For projects in the NAVFAC PAC Area of Operation, include bracketed item.

****

Discussion of variations with the Contracting Officer before submission [of a variation submittal] will help ensure that functional and quality requirements are met and minimize rejections and resubmittals. For variations that include design changes or some material or product substitutions, the Government may require an evaluation and analysis by a licensed professional engineer hired by the contractor.

****

NOTE: For projects in the NAVFAC PAC Area of Operation, include the second bracket option.

****

Specifically point out variations from contract requirements in a [transmittal letter][variation submittal]. Failure to point out variations may cause the Government to require rejection and removal of such work at no additional cost to the Government.

1.10.2 Proposing Variations

****

NOTE: Use the following paragraphs For projects in the NAVFAC PAC Area of Operation only.

****

[When proposing variation, deliver a submittal, clearly marked as a "VARIATION" to the Contracting Officer, with documentation illustrating the nature and features of the variation including any necessary technical submittals and why the variation is desirable and beneficial to Government. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.]

[The Contracting Officer will indicate an approval or disapproval of the variation request; and if not approved as submitted, will indicate the Government's reasons therefore. Any work done before such approval is received is performed at the Contractor's risk.]"

Specifically point out variations from contract requirements in a [transmittal letter][variation submittal]. Failure to point out variations may cause the Government to require rejection and removal of such work at no additional cost to the Government.

****

NOTE: Use the following paragraph for Army projects only.

****

Check the column "variation" of ENG Form 4025 for submittals that include variations proposed by the Contractor. Set forth in writing the reason for any variations and note such variations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted variations.

1.10.3 Warranting that Variations are Compatible

When delivering a variation for approval, the Contractor warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

1.10.4 Review Schedule Extension

****

NOTE: Allow a longer additional review period if the construction phase will have geographically scattered reviewers.

****

In addition to the normal submittal review period, a period of [14] [_____] calendar working days will be allowed for the Government to consider submittals with variations.

1.11 SCHEDULING

Schedule and submit concurrently product data and shop drawings covering component items forming a system or items that are interrelated. Submit pertinent certifications at the same time. No delay damages or time extensions will be allowed for time lost in late submittals. [Allow an additional [_____] calendar working days for review and approval of submittals for [food service equipment] [and] [refrigeration and HVAC control systems]].

a. Coordinate scheduling, sequencing, preparing, and processing of submittals with performance of work so that work will not be delayed by submittal processing. The Contractor is responsible for additional time required for Government reviews resulting from required resubmittals. The review period for each resubmittal is the same as for the initial submittal.

b. Submittals required by the contract documents are listed on the submittal register. If a submittal is listed in the submittal register but does not pertain to the contract work, the Contractor is to include the submittal in the register and annotate it "N/A" with a brief explanation. Approval by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but that have been omitted from the register or marked "N/A."

c. Resubmit the submittal register and annotate it monthly with actual submission and approval dates. When all items on the register have been fully approved, no further resubmittal is required.

****

NOTE: Use the first sentence with the number of days for review.

****

Contracting Officer review will be completed within [_____] calendar working days after the date of submission.

****

NOTE: Use the following items d and e for Navy projects only. The items are tailored for Navy.

****

d. Except as specified otherwise, allow a review period, beginning with receipt by the approving authority, that includes at least [15] [_____] working days for submittals for QC manager approval and [20] [_____] working days for submittals where the Contracting Officer is the approving authority. The period of review for submittals with Contracting Officer approval begins when the Government receives the submittal from the QC organization.

****

NOTE: At bracket, use 30 working days for projects estimated to require 180 or more calendar days to construct. For projects requiring less than 180 calendar days to complete, use at least 20 working days.

****

e. For submittals requiring review by a Government fire protection engineer, allow a review period, beginning when the Government receives the submittal from the QC organization, of [30][_____] working days for return of the submittal to the Contractor.

1.11.1 Reviewing, Certifying, and Approving Authority

****
NOTE: Use this subpart for NAVFAC projects only.
****

The QC Manager is responsible for reviewing all submittals and certifying that they are in compliance with contract requirements. The approving authority on submittals is the QC Manager unless otherwise specified. At each "Submittal" paragraph in individual specification sections, a notation "G" following a submittal item indicates that the Contracting Officer is the approving authority for that submittal item. Provide an additional copy of the submittal to the Government Approving authority

1.11.2 Constraints

****
NOTE: Use this subpart for NAVFAC projects only.
****

Conform to provisions of this section, unless explicitly stated otherwise for submittals listed or specified in this contract.

Submit complete submittals for each definable feature of the work. At the same time, submit components of definable features that are interrelated as a system.

When acceptability of a submittal is dependent on conditions, items, or materials included in separate subsequent submittals, the submittal will be returned without review.

Approval of a separate material, product, or component does not imply approval of the assembly in which the item functions.

1.11.3 QC Organization Responsibilities

****
NOTE: Use this subpart for NAVFAC projects only.
****

a. Review submittals for conformance with project design concepts and compliance with contract documents.

b. Process submittals based on the approving authority indicated in the submittal register.

    (1) When the QC manager is the approving authority, take appropriate action on the submittal from the possible actions defined in paragraph APPROVED SUBMITTALS.

    (2) When the Contracting Officer is the approving authority or when variation has been proposed, forward the submittal to the Government, along with a certifying statement, or return the submittal marked "not reviewed" or "revise and resubmit" as appropriate. The QC organization's review of the submittal

determines the appropriate action.

c. Ensure that material is clearly legible.

d. Stamp each sheet of each submittal with a QC certifying statement or an approving statement, except that data submitted in a bound volume or on one sheet printed on two sides may be stamped on the front of the first sheet only.

(1) When the approving authority is the Contracting Officer, the QC organization will certify submittals forwarded to the Contracting Officer with the following certifying statement:

"I hereby certify that the (equipment) (material) (article) shown and marked in this submittal is that proposed to be incorporated with Contract Number [_____] is in compliance with the contract drawings and specification, can be installed in the allocated spaces, and is submitted for Government approval.

Certified by Submittal Reviewer _____________________, Date _______
(Signature when applicable)

Certified by QC Manager _____________________________, Date ______"
(Signature)

(2) When approving authority is the QC manager, the QC manager will use the following approval statement when returning submittals to the Contractor as "Approved" or "Approved as Noted."

"I hereby certify that the (material) (equipment) (article) shown and marked in this submittal and proposed to be incorporated with Contract Number [_____] is in compliance with the contract drawings and specification, can be installed in the allocated spaces, and is approved for use.

Certified by Submittal Reviewer ______________________, Date ______
(Signature when applicable)

Approved by QC Manager _______________________________, Date _____"
(Signature)

e. Sign the certifying statement or approval statement. The QC organization member designated in the approved QC plan is the person signing certifying statements. The use of original ink for signatures is required. Stamped signatures are not acceptable.

f. Update the submittal register as submittal actions occur, and maintain the submittal register at the project site until final acceptance of all work by the Contracting Officer.

g. Retain a copy of approved submittals and approved samples at the project site.

h. For "S" submittals, provide a copy of the approved submittal to the Government Approving authority.

1.11.4 Government Reviewed Design

****

NOTE: Use this subpart for Army Design-Build projects only.
****

The Government will review design submittals for conformance with the technical requirements of the Solicitation. Section 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD) covers the design submittal and review process in detail. Government review is required for variations from the completed design. Review will be only for conformance with the contract requirements. Included are only those construction submittals for which the DOR's design documents do not include enough detail to ascertain contract compliance. The Government may, but is not required to, review extensions of design such as structural steel or reinforcement shop drawings.

1.12 GOVERNMENT APPROVING AUTHORITY

When the approving authority is the Contracting Officer, the Government will:

a. Note the date on which the submittal was received from the QC manager.

b. Review submittals for approval within the scheduling period specified and only for conformance with project design concepts and compliance with contract documents.

c. Identify returned submittals with one of the actions defined in paragraph REVIEW NOTATIONS and with comments and markings appropriate for the action indicated.

Upon completion of review of submittals requiring Government approval, stamp and date submittals. [_____] copies of the submittal will be retained by the Contracting Officer and [_____] copies of the submittal will be returned to the Contractor.If the Government performs a conformance review of other Designer of Record approved submittals, the submittals will be identified and returned, as described above.

1.12.1 Review Notations

Submittals will be returned to the Contractor with the following notations:

a. Submittals marked "approved" or "accepted" authorize proceeding with the work covered.

b. Submittals marked "approved as noted" or "approved, except as noted, resubmittal not required," authorize proceeding with the work covered provided that the Contractor takes no exception to the corrections.

c. Submittals marked "not approved," "disapproved," or "revise and resubmit" indicate incomplete submittal or noncompliance with the contract requirements or design concept. Resubmit with appropriate changes. Do not proceed with work for this item until the resubmittal is approved.

d. Submittals marked "not reviewed" indicate that the submittal has been previously reviewed and approved, is not required, does not have evidence of being reviewed and approved by Contractor, or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals returned for lack of review by Contractor or for being incomplete, with appropriate action, coordination, or change.

e. Submittals marked "receipt acknowledged" indicate that submittals have been received by the Government. This applies only to "information-only submittals" as previously defined.

1.13 DISAPPROVED SUBMITTALS

Make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications, give notice to the Contracting Officer as required under the FAR clause titled CHANGES. The Contractor is responsible for the dimensions and design of connection details and the construction of work. Failure to point out variations may cause the Government to require rejection and removal of such work at the Contractor's expense.

If changes are necessary to submittals, make such revisions and resubmit in accordance with the procedures above. No item of work requiring a submittal change is to be accomplished until the changed submittals are approved.

1.14 APPROVED SUBMITTALS

****

NOTE: For Navy projects, choose Design-Bid-Build text. For Army projects, choose either Design-Bid-Build or Design-Build text.

****

The Contracting Officer's approval of submittals is not to be construed as a complete check, and indicates only thatthe general method of construction, materials, detailing, and other information are satisfactory. the design, general method of construction, materials, detailing, and other information appear to meet the Solicitation and Accepted Proposal.

Approval or acceptance by the Government for a submittal does not relieve the Contractor of the responsibility for meeting the contract requirements or for any error that may exist, because under the Quality Control (QC) requirements of this contract, the Contractor is responsible for ensuring information contained with in each submittal accurately conforms with the requirements of the contract documents.

After submittals have been approved or accepted by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.15 APPROVED SAMPLES

Approval of a sample is only for the characteristics or use named in such approval and is not be construed to change or modify any contract requirements. Before submitting samples, provide assurance that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Match the approved samples for materials and equipment incorporated in the work. If requested, approved samples, including those that may be damaged in testing, will be returned to the Contractor, at its expense, upon completion of the contract. Unapproved samples will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make as that material. The Government reserves the right to disapprove any material or equipment that has previously proved unsatisfactory in service.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. Replace such materials or equipment to meet contract requirements.

1.16 WITHHOLDING OF PAYMENT

****

NOTE: Choose either Design-Bid Build construction or Design-Build construction text.

****

Payment for materials incorporated in the work will not be made if required approvals have not been obtained. No payment for materials incorporated in the work will be made unless all required DOR approvals or required Government approvals have been obtained. No payment will be made for any materials incorporated into the work for any conformance review submittals or information-only submittals found to contain errors or deviations from the Solicitation or Accepted Proposal.

1.17 CERTIFICATION OF SUBMITTAL DATA

Certify the submittal data as follows on Form ENG 4025: "I certify that the above submitted items had been reviewed in detail and are correct and in strict conformance with the contract drawings and specifications except as otherwise stated.

______NAME OF CONTRACTOR ______ SIGNATURE OF CONTRACTOR

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 33 16.00 10 (May 2016)**

Preparing Activity: USACE

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

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DESIGN DATA (DESIGN AFTER AWARD)

05/16

PART 1 GENERAL

ATTACHMENTS:

distribution list

Furniture Item Description (FID), Section 2.0 Product Descriptions and Quality Requirements

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-01 33 16.00 10 (May 2016)**

Preparing Activity: USACE

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 33 16.00 10

DESIGN DATA (DESIGN AFTER AWARD)

05/16

****

NOTE: This guide specification covers the requirements for a design/build project, including design development and design submittals. Use this section in a design/build project executed by the Army only.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification supplements UFGS 01 33 00 SUBMITTAL PROCEDURES, tailored for Design/Build projects. Section 01 33 00 covers general procedures primarily with respect to construction submittals. This section provides requirements for design submittals and design quality procedures.

In addition, the guide specification serves as a stand-alone reference point for all BIM, CIM, GIS, and/or CAD-related requirements for a project. Consult all appropriate agency guidance and policies

as well as stakeholder requirements to determine the components of this specification to retain for a particular project.

Thoroughly edit this section throughout and coordinate with any other related or referencing specifications. Commonly related specifications that may contain BIM, CIM, GIS, and/or CAD-related requirements include but are not limited to 01 33 00 SUBMITTAL PROCEDURES AND 01 78 00 CLOSEOUT SUBMITTALS.

Consult the USACE CAD/BIM Technology Center for additional information regarding all types of Advanced Modeling requirements. .
****

1.1 SUMMARY

After award, develop the accepted proposal into the completed design, as described herein. Use a collaborative, integrated design process for all stages of project delivery with comprehensive performance goals for site development, energy, water, material selection, indoor environmental quality, and waste diversion. Ensure incorporation of these goals in project delivery. Consider all stages of the building lifecycle, including deconstruction, rehabilitation, re-purposing, or demolition.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 19005-3	(2012) Document Management -- Electronic Document File Format for Long-Term Preservation -- Part 3: Use of ISO 32000-1

	with Support for Embedded Files (PDF/A-3)
ISO 19115-1	(2014) Geographic Information -- Metadata -- Part 1: Fundamentals
ISO 32000-1	(2008) Document Management -- Portable Document Format -- Part 1: PDF 1.7

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2024) Standard for the Installation of Sprinkler Systems

NATIONAL INSTITUTE OF BUILDING SCIENCES (NIBS)

NBIMS-US	(V3) National BIM Standard - United States
NCS	(V6) United States National CAD Standard

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-1-2909	(2012) Engineering and Design -- Geospatial Data and Systems
ERDC/ITL TR-19-6	(2019) A/E/C Graphics Standard, Release 2.1
ERDC/ITL TR-19-7	(2019) A/E/C CAD Standard - Release 6.1

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-200-02	(2020; Change 2, 2022) High Performance and Sustainable Building Requirements
UFC 1-300-02	(2014; with Change 3, 2021) Unified Facilities Guide Specifications (UFGS) Format Standard
UFC 3-101-01	(2020; with Change 4, 2024) Architecture
UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings
UFC 4-023-03	(2009; with Change 4, 2024) Design of Buildings to Resist Progressive Collapse

1.3 DEFINITIONS

1.3.1 Designer of Record (DOR)

Professional Registered members of the Contractor’s Design-Build team that check, approve, sign, date, and certify, prior to submitting the deliverables to the Government, that the D-B design submittals comply with the contract requirements.

The DOR's stamp, sign, and date each design drawing and other design deliverables under their responsible discipline at each design submittal stage. The DOR(s) are responsible for maintaining the integrity of the design and for compliance with the contract requirements through construction and documentation of the as-built condition by coordination, review and approval of extensions of design, material, equipment and other construction submittals, review and approval or disapproval of requested deviations to the accepted design or to the contract, coordination with the Government of the above activities, and by performing other typical professional design responsibilities.

1.3.2 Government Furnished Material (GFM)

Government material that may be incorporated into, or attached to, an end item to be delivered under a contract or which may be consumed in the performance of a contract. It includes, but is not limited to, raw and processed material, parts, components, assemblies, and small tools and supplies.

1.3.3 Advanced Modeling

A subset of geospatial technologies as defined in EM 1110-1-2909 to include BIM, CIM, GIS, and CAD. Advanced Modeling is comprised of models and drawings that form a digital representation of the project, or part thereof, that are comprised of model elements with facility data.

1.3.4 Model Element

A self-contained graphical element with a unique identification that is used to populate a model, and whose behavior and properties are defined by facility/site data and software processes. Model elements can represent a physical entity, such as a pump, a concrete wall, or a utility vault and range from the simple to the complex and can be custom modified.

1.3.5 USACE Minimum Modeling Matrix (M3)

The USACE Minimum Modeling Matrix (M3) describes the minimum modeling and data requirements by defining the level of development (LOD) and element grade.

1.3.6 Facility Data

Non-graphical data attached to surface and subsurface components for both building and site model elements that describe various facility characteristics such as parametric values that drive physical sizes, material definitions (e.g. wood, metal), manufacturer data, industry standards (e.g. AISC steel properties), location, and project identification numbers. Facility data can also define supplementary physical entities that are not shown graphically in the model, such as the system of a duct, hardware on a door, content of conduit, site surface, alignment, levee, channel or transformer properties.

[1.3.7 Industry Foundation Class (IFC)

****

NOTE: If there are no BIM or CIM deliverables for this project then delete this definition.

****

IFC are a standard and file format used for the exchange of model elements and data; see http://www.iai-tech.org. In the context of this section, IFC does not mean "Issued For Construction."

][1.3.8   Model Uses

****
NOTE: If there are no BIM or CIM deliverables for this project then delete this definition.
****

A Model Use is a method or strategy of applying modeling during a facility's life cycle to achieve one or more specific objectives. Reference NBIMS-US for the definitive list of Model Uses and definitions.

][1.3.9   USACE BIM/CIM Platform Configuration Standards - Templates, Workspaces, Catalogs, and Environments

****
NOTE: If there are no BIM or CIM deliverables for this project then delete this definition.
****

[1.3.9.1   Bentley AECOsim and InRoads Workspace

****
NOTE: If there are no Bentley AECOsim or InRoads deliverables for this project then delete this definition.
****

The Workspace is contained within the A/E/C Work Structure. It is comprised of a collection of content libraries and supporting files that define and embody a BIM standard. Libraries include content such as wall types, standard steel shapes, furniture, HVAC fittings, and sprinkler heads. The Workspace also contains sheet libraries such as print/plot configurations, font and text style libraries, and sheet borders and title blocks. The Workspace includes pre-defined datagroup parameters.

][1.3.9.2   USACE Revit Templates

****
NOTE: If there are no Revit deliverables for this project then delete this definition.
****

The USACE Revit templates are discipline specific and include family content pertinent to that discipline. The templates share standard symbology such as annotation families, line styles, and text styles. The templates include pre-defined shared parameters.

]]1.3.10   USACE CAD/BIM Technology Center

The USACE CAD/BIM Technology Center hosts all standard content for USACE. This content can be accessed through the CAD/BIM Technology Center website, .

[1.4   ORDER OF PRECEDENCE

****
NOTE: The information in this paragraph is covered by UAI Clause 52.236-5000. Confirm that the clause will be included in the contract to remove this paragraph.

****

In the event of a conflict or inconsistency between any of the requirements within the Contract, precedence is applied:

a. Any portions of the accepted proposal which both conform to and exceed the requirements of the solicitation.

b. The provisions of the solicitation.

c. All other provisions of the accepted proposal.

d. Any design products including, but not limited to, plans, specifications, engineering studies and analyses, shop drawings, and equipment installation drawings. These are "deliverables" under the contract are not part of the contract itself. Design products must conform to all provisions of the contract, in the order of precedence.

]1.5 PRECONSTRUCTION ACTIVITIES

1.5.1 Design Quality Control Plan

Submit a Design Quality Control Plan in accordance with Section 01 45 00 QUALITY CONTROL before design may proceed.

1.5.2 Meetings and Conferences

1.5.2.1 Post Award Conference

The Government will conduct a post award conference [at the project site] [_____], as soon as possible after Contract award, coordinated with issuance of the notice to proceed (NTP). Participation by the Contractor and major subcontractor representatives is mandatory. All designers need not attend this first meeting. The government will provide an agenda, meeting goals, meeting place, and meeting time to participants prior to the meeting.

As a minimum the following will be addressed during the conference: determination and introduction of contact person and their authorities; contract administration requirements; discussion of expected project progress processes; and coordination of subsequent meeting.

a. The government will introduce the Government project delivery team members, facility users, facility command representatives, and installation representatives.

b. Introduce key personal, major subcontractors and other needed staff.

c. Define expectations and duties of each participant.

d. Develop a meeting roster with complete contact information including name, office, project role, phone, mailing and physical address, and e-mail address for distribution to all participants. Also, provide minutes of the meeting to all participants.

1.5.2.2 Initial Design Conference

After Contract award, conduct the initial design conference, and provide a record of the meeting. All Designers of Record must participate in the conference. The primary purpose of the meeting is to make sure any needs are assigned and due dates established, as well as points of contact identified. The initial design conference may be scheduled and conducted at the project installation after the Post Award Conference and prior to initiation of significant preliminary design development, although it is recommended that the partnering process be initiated at the time of or before the initial design conference. Limit any design work conducted after award and prior to this conference to site work.

1.5.2.3 Advanced Modeling Kick-Off Meeting

Conduct an Advanced Modeling Kick-Off Meeting prior to submission of the Advanced Modeling PxP, within 45 days after Notice to Proceed. Required meeting attendance includes, at a minimum, the DOR, the design drawing and modeling specialist and the Geographic District BIM Manager or delegate.

The intent of this meeting is to coordinate the expectations for the Advanced Modeling PxP.

1.5.2.4 Advanced Modeling PxP Demonstration Meeting

Within 30 days after the acceptance of the Advanced Modeling PxP and M3, conduct a demonstration to review the Plan for clarification, and to verify the functionality of planned Model technology workflow and processes. If modifications are required, complete the modifications and resubmit the Advanced Modeling PxP performing a subsequent demonstration for Government acceptance.

1.5.2.5 Pre-Construction Conference

Before starting any construction activities, jointly conduct an administrative conference with the Government to discuss any outstanding requirements and to review local installation requirements. It is possible there will be multiple Pre-Construction Conferences based on the configuration of the design packages. Provide minutes of the meeting(s) to all participants.

1.6 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

When a "D" follows a submittal item, it indicates Designer of Record Approval (DA) is required for that item. When a "C" follows a submittal item, it indicates Government Conformance Review of Design (CR) is required for that item. When an "R" follows a submittal item, it indicates both a Designer of

Record Approval and Government Conformance Review (DA/CR) is required for that item. When an "A" follows a submittal item, it indicates both a Designer of Record Approval and Government Approval (DA/GA) is required for that item.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Each submittal includes an associated approval level designation as defined in the following table:

Approval Level Designation	Definition
G	Government approval
no designation	for information only
D	Designer of Record approval
C	Government Conformance Review of Design
R	Designer of Record Approval and Government Conformance Review
A	Designer of Record Approval and Government Approval
S	inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING

When used, a designation following the approval level designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Advanced Modeling Project Execution Plan (PxP); C, [_____]

Design Quality Control Plan; G, [_____]

Initial Design Conference

Preconstruction Conference

DCM Procedures; G, [_____]

Submittal Register; G, [_____]

SD-05 Design Data

Design and Code Checklists; C, [_____]

Sustainable Design; C, [_____]

Interim Design Submittals; R, [_____]

Building Rendering

Interior And Exterior Building Finishes Scheme; G, [_____]

Furniture, Fixtures & Equipment; G, [_____]

Conference Documentation

Final Design Submittals; R, [_____]

Design Complete Documents; C, [_____]

SD-11 Closeout Submittals

DD Form 1354; A, [_____]

1.7 DESIGN QUALITY CONTROL

1.7.1 Design And Code Checklists

Develop and utilize appropriate discipline-specific checklists during the design and quality control of each submittal. Submit these completed checklists with each design submittal, as applicable, as part of the project documentation. See Section 01 45 00 Contractor Quality Control and paragraph FIRE PROTECTION AND LIFE SAFETY CODE REVIEW for a sample Fire Protection and Life Safety Code Review checklist.

1.7.2 Advanced Modeling Project Execution Plan (PxP)

****

NOTE: The Project Execution Plan (PxP) submittal is mandatory for every project regardless of BIM/CIM/GIS/CAD deliverable type. DO NOT remove the requirement for a PxP submittal.

****

Develop an Advanced Modeling Project Execution Plan ("Plan" or "PxP") documenting mandatory and Contractor-elected BIM Uses, analysis technologies and workflows. Submit the PxP within 45 days after issuance of Notice to Proceed.

Use the USACE ADVANCED MODELING PROJECT EXECUTION PLAN (PxP) Template located at the USACE CAD/BIM Technology Center website to develop an acceptable Plan and update to include platforms and processes to meet the requirements of the project.

1.7.2.1 M3 Template

Use the M3 Template located at the USACE CAD/BIM Technology Center website and submit as part of the Advanced Modeling PxP.

1.7.2.2 Model Uses

Mandatory Model Uses are predefined in the Project Execution Plan (PxP) and cannot be modified. Identify additional elected Model Uses in the PxP.

1.8 DELIVERY, STORAGE, AND HANDLING

1.8.1 Electronic Design Submittal

Provide identical copies of discs for approval, for each submittal required.[Provide quantities and sizes indicated in [Section 01 33 00 SUBMITTAL PROCEDURES] [the distribution list at the end of this specification section][_____].][Provide on approved electronic media (one copy per disc or set of discs) as defined below.] [Provide submittal files on electronic storage media in compliance with the quality requirements identified in this specification.]

1.8.1.1 Malicious Content

Scan all electronic files for malicious viruses using commercially available scanning program that is routinely updated to identify and remove current virus threats.

1.8.1.2 Storage Media

Provide project data on disc-based (DVD±R/RW) media. Provide the full submittal on one single disc whenever possible. When separation of the submittal is required separate deliverables onto separate media. Document any media divisions in the PxP for approval by the Contracting Officer.

a. Directly print identification of contents onto storage media. Do not provide adhesived labels. Include the name of the submittal, project, project location, Contract number, Designer of Record firm/Prime Contractor company's name, title of submission, and security classification (in accordance with the applicable security classification labeling regulations) on the label. If multiple discs are provided, clearly document the contents of each disc on the label.

b. Include the name and contact information of the individual who produced the final data disc to ensure that any problems with the data or media can be easily resolved.

c. When browsed on any computer, the disc displays the following folders and their associated content:

    (1) Submittal files (containing all submittal data)

    (2) All supporting documents associated with the submittal

    (3) Readme containing one TXT, PDF, or HTML file with general use information, organizational instructions, and basic preparer contact information.

1.8.2   Advanced Model File Packaging

Execute the following actions for all design drawing and modeling files:

1.8.2.1   Bentley [AECOsim][,][InRoads][,][MicroStation]

Compress files with all options.

1.8.2.2   Autodesk [Revit][,][Civil3D][,][AutoCAD]

a. Purge unused

b. Audit

c. Compress

1.8.3   PDF File Packaging

Utilize PDF file format in accordance with ISO 32000-1 and ISO 19005-3. Provide files from original sources, text-searchable, and saved in "Standard" (uncompressed) resolution whenever possible.

1.8.3.1   Bookmarking

a. Bookmark drawing submittal PDF sets to include one Parent Bookmark per Discipline and one Child Bookmark per sheet within each Discipline. Format Parent Bookmarks as "Discipline" (e.g. Architectural). Format Child Bookmarks as "Sheet ID Sheet Title" (e.g. A-101 First Floor Plan).

b. Bookmark specification submittal PDF sets using the SpecsIntact Print Processing PDF Print/Publish feature, combining processed sections into one PDF document. Insert the Submittal Register into the file where specified by Section 01 33 00 SUBMITTAL PROCEDURES and bookmark.

c. Bookmark design analysis and calculation submittal PDF sets to include one Parent Bookmark per design analysis section and one Child Bookmark per major paragraph per section. Format Parent Bookmarks as "Section" (e.g. Architectural). Format Child Bookmarks as "major paragraph designation Sheet Title" (e.g. 2.1 Primary Facility Functions).

[1.8.3.2   Hyperlinking

****

NOTE: Hyperlinking is not required, but may be valuable depending upon the needs of the project. Include this paragraph if hyperlinking is desired.

****

Hyperlink all reference annotation symbology (e.g. section cut symbology, detail callout symbology, elevation callout symbology) to the sheet referenced by the annotation.

][1.8.4   Encryption

****

NOTE: Encryption is not required for all projects, but may be required for specific projects. Include this paragraph if encryption is required.

****

Encrypt deliverable data as directed by [Area][Resident][Project] Office Engineer. Document the encryption in the PxP.

][1.8.5 Hardcopy Design Submittal

****

NOTE: One of the bracketed options in this paragraph requires the Government to develop a distribution list of submittals. The option also requires that the distribution list be attached at the end of this section.

****

Print hard copy submittals directly from the electronically packaged PDF files.[Provide quantities and sizes as indicated in [Section 01 33 00 SUBMITTAL REQUIREMENTS] [the distribution list at the end of this specification section] [____].]

The Designer(s) of Record stamps and signs the original full size hard copy sheets as Released For Construction. Provide distribution from this set.

]PART 2 PRODUCTS

[2.1 GOVERNMENT FURNISHED MATERIALS

****

NOTE: Edit this paragraph to reflect the systems, platforms, and timing under which the Government intends to provide data. Remove the paragraph if none will be provided.

****

[The Government will provide Advanced Modeling files as GFM for use in design development. Develop and maintain the information and level of detail contained in the GFM in the Project design, as required by this Contract.][

The Contractor has the option of preparing their own Advanced Modeling files in the formats prescribed as a basis for design, design drawings, and interim design submittals. If so, maintain the same level of detail, properties, and functionality in the models that is prescribed in this specification.]

2.1.1 GFM Handover

[The Government will provide the GFM at [Contract Award][the Design Kick-Off Meeting] [_____].][The GFM has been provided as part of the Solicitation package.]

2.1.2 GFM File Formats

GFM are provided in the following file formats:

[2.1.2.1 Government Furnished BIM

The GFM includes [Autodesk Revit, Version [_____]][Bentley Systems AECOsim, Version [_____]][_____].

][2.1.2.2 Government Furnished CIM

The GFM includes [Autodesk Civil3D, Version [_____]] [Bentley Systems MicroStation InRoads, Version [_____]] [_____].

][2.1.2.3 Government Furnished GIS

The [Installation's] most current Standard GIS Database SDSFIE Adaptation will be furnished, including features and attributes relating to current project. Documentation of the required attributes and schema definitions will be provided with the GIS Template.

GIS source data and product data remain the property of the US Government. Be prepared to explain and demonstrate the company's process for protecting all geospatial data, including but not limited to geometry, attributes, metadata, topologies, and relational database schemas and operations used in association with this contract. Signing a non-disclosure agreement attesting to the same before source data are released may be required. Obtain further information about security and nondisclosure requirements from the Contracting Officer.

a. Some installation map data, source and/or product, may be considered by the Government to be "Controlled Unclassified Information" (CUI) also known as "Sensitive but Unclassified" (SBU). Release of this information to any third party without the explicit consent of the Contracting Officer is not authorized.

b. Return all source information to the Government or destroy upon completion of this contract.

][2.1.2.4 Government Furnished CAD

The GFM includes [Autodesk AutoCAD, Version [_____]][and][Bentley Systems MicroStation, Version [_____]][_____].

]2.1.3 Advanced Modeling Completion and Quality

The Government makes no guarantee that the BIM/CIM models, GIS data, CAD files and Facility Data provide the level of completeness or quality required for a submittal. Develop or update files and data to completely and correctly represent the as-built conditions of the facility and the site.

However, use of any Government Furnished [BIM][,CIM][and GIS] for creation of contract submittals is at the Contractor's own risk. Any quality control issues discovered in the GFM do not absolve the Contractor from submitting contract compliant deliverables as described in this and other specifications.

2.1.4 Data Loss, Corruption, and Error

Use of GFM files is at the Contractor's risk. Verify data integrity upon receipt and request a replacement if necessary.

Any adjustment of file structure, format, or software version required to make GFM compatible with computer systems and/or software is the responsibility of the Contractor.

]2.2 ADVANCED MODELING DOCUMENTS

Provide all of the following documents with each design submittal.

2.2.1 Submitted Files List

Provide list of all submitted electronic files including a description, directory, and file name for each file submitted. Identify which files have been produced from the Model and Facility Data. For all Sheet files, include a list of the sheet titles and sheet numbers.

2.2.2 Advanced Modeling Submittal Checklist

Complete the USACE BIM/CIM Advanced Modeling Submittal Checklist and include with each submittal. Download the Checklist from the USACE CAD/BIM Technology Center website (https://cadbimcenter.erdc.dren.mil/).

2.2.3 Advanced Modeling Electronic Files

Include all Advanced Modeling files associated with the contract scope of work.

2.2.3.1 3D Interactive Review Model

Provide a copy of each [BIM][and][CIM] Model in an approved interactive review format. Use [Autodesk Navisworks version [_____]][Autodesk Design Review Form (DWFX)][Bentley Navigator version [_____]][Adobe 3D PDF version [_____]][Google Earth (KMZ)][or other Government Approved format documented in the PxP] for the 3D Interactive Review Model format.

2.2.3.2 Industry Foundation Class (IFC) Coordination View

****

NOTE: Use the 2x3 Coordination View V2.0 schema unless the customer specifically requests a different schema.

****

Provide an IFC Coordination View for all deliverables. Provide exported property set data for all IFC supported named building elements. Submit all IFC models in the [IFC2x3 Coordination View V2.0][_____] schema.

2.2.3.3 Quality Control (QC) Reports

As a minimum, include the following reports:

2.2.3.3.1 Model Standards Checks and Reports

Provide QC checks demonstrating adherence to the NCS v6.0 BIM Implementation section. Identify and report non-compliant elements and submit a corrective action plan. Provide the Government with detailed justification and request Government acceptance for any non-compliant elements that the Contractor proposes to be allowed to remain in the Model. Verify the following for the Model(s) and Facility Data set:

a. No undefined, incorrectly defined, or duplicated elements.

a. No errors when opening.

b. No broken Links, References, or X-References.

c. Minimized extraneous information.

d. Content uses the coordinate system defined in the approved PxP.

e. Models share a common alignment point.

f. For a Design Complete or Record Submittal; no unloaded Links, References, or X-References exist.

2.2.3.3.2 Graphics Standards Checks and Report

Provide QC checks on all graphic deliverables demonstrating that the fonts, dimensions, symbology and other construction document formatting are compliant with the requirements of this specification. Identify and report non-compliant content.

2.2.3.3.3 CAD Standards Checks and Report

Provide QC checks on CAD Output demonstrating that filenames, sheet borders, layer/level names, and symbology are compliant with the requirements of this specification. Identify and report non-compliant content.

2.2.3.3.4 Interference Management (3D Coordination) Checks and Report

Execute Interference Management checks and provide a summary of the results noting total hard interferences (e.g., mechanical vs. structural, or mechanical vs. mechanical, overlaps in the same location) and soft interferences (e.g., conflicts regarding equipment clearance, service access, fireproofing, insulation, code space requirements).

2.2.3.3.5 Additional Parameters

Additional QC parameters as deemed appropriate for the Project may be developed and documented in the Advanced Modeling PxP.

2.2.4 Advanced Modeling Re-Submittals

If components of an Advanced Modeling submittal are rejected, provide the following for each Advanced Modeling Re-Submittal, in addition to re-submittal information required by Section 01 33 00 SUBMITTAL PROCEDURES:

a. Re-submit all components required under paragraph ADVANCED MODELING PACKAGE, including a new Advanced Modeling Checklist and updated content in response to Government comments.

b. Provide a copy of all Government review comments.

c. Provide a response to each Government review comment for back check.

2.3 DESIGN DRAWINGS

From advanced model files, produce design drawings that describe the scope of the Contract for all required submittals including all interim and final deliverables.

2.3.1 Electronic Drawing Files

Provide electronic drawing files in PDF format for each project drawing in the design set.

2.3.2 Drawing Index

Provide an index of drawings sheet as part of the drawing set, and an electronic table of all drawings submitted. Include the electronic file name, the sheet reference number, the sheet number, and the sheet title containing the data for each drawing.

2.3.3 Shop Drawings Used as Design Drawings

Design drawings may be prepared similar to shop drawings to minimize construction submittals after the Design Complete Submittals. Prepare and submit with the design drawings, appropriate connection, fabrication, layout, and product specific drawings.

2.3.3.1 Drawing Format For Shop Drawings Used as Design Drawings

Use the Contractor-originated drawings as the basis for the record drawings. Conform shop drawings included as design documents with the same drawing requirements such as drawing format, sheet size, layering, lettering, and title block used in design drawings.

2.3.3.2 Identification of Shop Drawings Used as Design Drawings

Indicate which shop drawings are being submitted as design drawings in the transmittal letter.

2.3.4 Seal on Documents

Sign, date and seal all Contractor-originated design drawings by the registered architect or the registered engineer of the respective discipline. This is the seal of the Designer of Record for that drawing. Application of the electronic seal and signature accepts responsibility for the work shown thereon.

2.4 SPECIFICATIONS

****

NOTE: If the contracting agency has a design guidance document that the design/build contractor is required to follow rather than the requirements detailed in this section, select the first set of brackets.

****

[Provide design specifications in accordance with [_____] Design Manual.][Provide a Contractor-originated design specification that, in conjunction with the drawings, demonstrates compliance with materials, equipment, execution, and field quality control requirements of the RFP and accepted proposal.

2.4.1 Specifications Format

Utilize the Unified Facility Guide Specifications (UFGS) current at the time of Contract award. Process the specifications with the SpecsIntact software package.

****

NOTE: Select the first bracketed option and delete the second bracketed option if the design prepared under this project will be used again as a site adapt project in the future.

****

a. Edit and expand the appropriate specifications to ensure that all project design requirements, current code requirements, and regulatory requirements are met. [Provide non-proprietary, descriptive project specifications in compliance with the requirements in UFC 1-300-02. Do not provide proprietary information in the project specifications unless approved by the Contracting Officer.][Design specifications may be prepared that include manufacturer specific data and catalog cuts in lieu of non-proprietary, descriptive specifications. Clearly identify, where appropriate, specific products chosen to meet the contract requirements (i.e., manufacturers' brand names and model numbers or similar product information).]

b. Note that the UFGS are based on design-bid-build contracting and will require editing to apply to a design-build project. For instance, they assume that the Government will approve most submittals, whereas in design-build, the DOR has that action, unless this solicitation requires Government approval for specific submittals.

c. Organize project sections not based on UFGS in accordance with CSI MasterFormat and UFC 1-300-02.

2.4.2 Identification of Manufacturer's Product Data Used as Specifications.

Provide complete and legible catalog cut sheets, product data, installation instructions, operation and maintenance instructions, warranty, and certifications for products and equipment for which final material and equipment choices have been made. Indicate, by prominent notation, each product that is being submitted including optional manufacturer's features, and indicate where the product data shows compliance with the Contract requirements.

2.4.3 Specifications Packaging

Provide specifications to include the following:

a. Cover sheet and project table of contents.

b. Specification sections, each section with a table of contents.

c. Manufacturer's Product Data. If providing as attachments to the applicable specification section, incorporate as attachment reference within the section and section table of contents.

]2.4.4 Specification Deliverable

Submit a bundled specification package in PDF format for each design package. As a minimum, bookmark each specification section in the bundled package. Also, submit the source files, in the processing system format, used to create the PDF.

2.5 DESIGN ANALYSIS

****

NOTE: If the contracting agency has a design guidance document that the design/build contractor is required to follow rather than the requirements detailed in this section, select the first set of brackets.

****

Prepare, organize, and present a design analysis [in accordance with [_____] Design Manual.] [that will document the general parameters, functional and technical requirements, design objectives, design assumptions, and provides design calculations applicable to a project's design. Organize the design analysis into three parts; Part 1 - General Description; Part 2 - Design Requirements and Provisions; and Part 3 - O&M Provisions.

The design analysis states the purpose, authorization, applicable criteria and the project description for the project, and provides a summary of the factors influencing the choice of the civil, environmental, architectural, structural, mechanical, electrical, communications, fire protection, physical security systems, HTRW, and sustainable design features used in the project along with an indication of how the initial costs and life cycle costs were factored into final selections. In the final design analysis clearly and succinctly include:

a. An introductory description of the project concepts that addresses the salient points of the design

b. An orderly and comprehensive documentation of criteria and rationale for system selection, supported by life cycle cost analysis.

c. The identification of any necessary licenses and permits that are anticipated to be required as a part of the design and/or construction process.

d. Identify all applicable codes and criteria and highlight specific requirements within these codes and criteria for critical issues in the facility design.

e. Required calculations as specified and as needed to support the design.

f. Clearly identify "Sustainable Design" features that address high performance and sustainable building (HPSB) concepts as required by UFC 1-200-02 [and current Army SDD Policy Update]. Sustainable design documentation must support Guiding Principles Validation and Third Party Certification (TPC) requirements in Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING to include HPSB and TPC checklists.

g. Clearly identify "Antiterrorism" requirement and document the antiterrorism and force protection features as required by UFC 4-010-01.

]

2.5.1 Design Requirements and Provisions

Include subparts for each major design discipline and basic project design requirements for each discipline that justify and validate design decisions to include, but not limited to: life cycle cost effectiveness, [_____]

2.5.1.1 Civil

Include soil analysis and survey data, site design, site improvements, planting and landscaping, paving, grading and drainage, water, waste-water and soil treatment, contaminant containment, utilities systems analysis and design, and provisions for airfields, ports and railroads, if required.

2.5.1.2 Environmental

Include an impact assessment checklist covering air, water and noise effects from the project and construction; worker health and safety; HTRW remediation cleanup and action levels; transportation and disposal regulation requirements; quality control for chemical sampling/analysis; wetlands determination (tidal and nontidal); special wildlife, plant, and endangered species considerations; ground water, waterway and floodplain protection assessment; pollution prevention control requirements; and design measures to be implemented (i.e., construction site sediment and erosion control requirements by Federal, state and local governments); and hazardous material management, natural and cultural resources, and environmental permits.

2.5.1.3 Architectural

Include space allowance, functional layout, unique features, interior design ,furniture planning, signage, accessibility, security, air barriers, energy conservation and sustainable design to include site analysis focusing on orientation, space-mass composition, materials used and details with respect to image, safety, maintenance and cost effectiveness and historical context.

2.5.1.4 Structural

Include foundation, structural, seismic, hardened structure,nuclear radiation and blast protection systems analysis and design.

2.5.1.5 Mechanical

Include heating, ventilation and air conditioning systems, refrigeration, plumbing, elevators and cranes, energy conservation, pollution control, noise and vibration control, heating and chilled water distribution, gas distribution, fuel storage and dispensing, and process systems design.

2.5.1.6 Electrical

Include power generation, transmission and distribution systems, lighting (interior and exterior), voice and video communications, intrusion detection, utilities monitoring control systems (UMCS), cathodic protection, lightning and static electricity protection systems analysis and design, aviation lighting, and electromagnetic protection

2.5.1.7 Fire Protection and Life Safety

Include building construction, exit requirements, fire extinguishing systems, fire protection water supplies, surge analysis, and alarm and detection systems analysis and design.

2.5.1.8 Physical Security

Include fencing, vaults, protective lighting, security systems, locks, arms rooms, controlled substances, entrances, guard facilities, classified material, patrol roads, clear zones, restricted areas, surveillance and penetration resistance.

2.5.1.9 Cybersecurity

[_____]

2.5.2 Operations and Maintenance (O&M) Provisions

Identify design provisions made to enhance and to reduce the cost of operating and maintaining the facility when completed. Identify any special safety considerations or occupational health related considerations that may affect operation and maintenance activities as a result of the final design.

2.5.3 Design Analysis Packaging

2.5.3.1 Assembly and Identification

Assemble design analysis in a single volume with a table of contents if possible. Include a cover page in the basis of design for each discipline indicating the project title and locations, contract number, table of contents, and tabbed separations or bookmarks for quick reference. At a minimum tab or bookmark for each discipline.

2.5.4 Calculations

Place the signature and seal of the designer of record responsible for the work on the cover page of the calculations for the respective design discipline.

PART 3 EXECUTION

3.1 DESIGN SUBMITTALS

Include all deliverable products and associated support documents described in Part 2 of this specification with each design submittal.

3.2 DESIGN SUBMITTALS PHASES

The stages of design submittals described below define requirements with respect to process and content. Determine how to best plan and execute the design and review process for the project, within the parameters listed below. As a minimum, provide at least one interim design submittal, at least one final design submittal before construction of a design package may proceed, and at least one Design Complete submittal that documents the accepted design.

3.2.1 Interim Design Submittals

****

NOTE: If the option to fast-track is selected, include and edit paragraph FAST-TRACKING below.

****

Submit [either] a single interim design for review, representing a complete package with all design disciplines[, or split the interim design into smaller, individual design packages as deemed necessary for fast-track construction purposes]. This is not necessarily a hold point for the design process; the Contractor may designate the interim design submittal(s) as a snapshot and proceed with design development at its own risk.

3.2.1.1 Interim Design Development Management

Maintain a fully functional configuration management system as described herein to track design revisions, regardless of whether or not there is a need for a formal interim design development review.

[3.2.1.2 Fast-Tracking

****

NOTE: Define project elements that the Government will allow to be fast-tracked.

****

[_____]

Identify the project elements that will be fast-tracked in the Design Quality Control Plan.

]3.2.1.3 Over-the-Shoulder Progress Review

To facilitate a streamlined design-build process, the Government and the Contractor may agree to one-on-one review or small group reviews, on-line, or at the Contractor's design offices or other agreed location, when practicable to the parties. Coordinate such reviews to minimize or eliminate disruptions to the design process. Due to limits on project funding, utilize the maximum virtual teaming methods. Facilitate these reviews with electronic format data transfer and collaboration. Through the partnering process, find ways to facilitate the quality assurance process and to facilitate meeting or bettering the design-build schedule.

3.2.1.4 Interim Design Development Review Waiver

The Government may agree to shorten or waive the formal interim design development review period for design package(s) if an effective, mutually agreeable partnering procedure is established and implemented for regular (e.g., weekly) over-the shoulder review. During the course of the procedure, keep the Government reviewers fully informed of the progress, contents, design intent, design documentation, and other pertinent factors of the design package.

3.2.2 Final Design Submissions

After acceptance of the interim design package, revise the design package to incorporate the comments generated and resolved, perform and document a back-check review and submit the final design package.

3.2.3 Design Complete Submittals

After the final design submission and review conference for a design package, revise the design package to incorporate the comments generated and resolved in the final review conferences, perform and document a back-check review and submit the final, design complete documents, which represents released for construction documents.

3.3 DESIGN PLATFORM AND FILE FORMATS

****

NOTE: Edit this paragraph to include only the required platforms and formats required for this project.

****

Design the project using the systems and platforms defined below:

[3.3.1 BIM

The BIM submittal format is [Bentley Systems AECOsim Version [_____]] [Autodesk Revit Version [_____]]. Provide the BIM submittals as fully operable, compatible, and editable within the native BIM/CIM tools.

][3.3.2 CIM

The CIM submittal format is [Bentley Systems InRoads Version [_____]] [Autodesk Civil 3D version [_____]]. Provide the CIM submittals as fully operable, compatible, and editable within the native BIM/CIM tools.

][3.3.3 GIS

Submit all GIS data in [Environment Systems Research Institute's (ESRI) ArcGIS] [Personal Geodatabase] [File Geodatabase], Version [_____] [Autodesk AutoCAD Map3D, Version [_____]] [Bentley Systems Map, Version [_____]] in compliance with SDSFIE, Version [_____] and appropriate ISO 19115-1 metadata.

][3.3.4 CAD

3.3.4.1 Native CAD Authoring Content

All content produced through CAD authoring software outside of any object/element based BIM or CIM platform must be compliant with ERDC/ITL TR-19-6 and ERDC/ITL TR-19-7. [Bentley MicroStation Seed Files [Most recent version at the time of Contract award].] [Autodesk AutoCAD Template Files [Most recent version at the time of Contract award].] Download form the CAD/BIM Technology Center website as part of the A/E/C Work Structure.

[3.3.4.2 CAD Extracted From BIM/CIM Authoring Platforms

****

NOTE: If the customer does not require standalone CAD drawings exported from BIM/CIM, remove entire bracketed subpart. Choose either NCS or ERDC/ITL bracketed option. The NCS bracketed option is recommended unless strict layering standards are required.

****

Provide editable CAD sheet files extracted from the BIM or CIM files. CAD content exported from a BIM or CIM modeling platform must comply with ERDC/ITL TR-19-6 and [NCS BIM Implementation section, part "2.0

Clarifications."][ERDC/ITL TR-19-7.]

]]3.4 ADVANCED MODELING REQUIREMENTS

****
NOTE: Edit this paragraph to include only the required platforms and formats required for this project.
****

[3.4.1 BIM and CIM Modeling Requirements

3.4.1.1 Minimum Modeling Requirements

Model to the requirements of the USACE M3 as identified in the approved Advanced Modeling PxP.

3.4.1.2 Graphics and Layer Standards

a. All content produced with object/element based BIM and CIM authoring software platforms must be compliant with ERDC/ITL TR-19-6.

b. All content produced with layer-centric BIM or CIM authoring software must be compliant with ERDC/ITL TR-19-7 and ERDC/ITL TR-19-6.

3.4.1.3 USACE Platform Configuration Standards

[USACE Bentley Workspace, [Version [_____]][most recent version at the time of Contract award]. Download from the USACE CAD/BIM Technology Center website [as part of the A/E/C Work Structure].][USACE Revit Templates, [Version [_____]][most recent version at the time of Contract award]. Download from the USACE CAD/BIM Technology Center website and, if required, upgrade to the Contract approved software version.]

3.4.1.4 Classification

Include Facility Data referencing one or more classification system(s) identified in the M3 for all modeled elements.

3.4.1.5 Space/Room Data

In the model, include spatial data defining actual net square footage and data to develop the room finish schedule, including room names and numbers. Include program information to verify design space against programmed space, using this information to validate area quantities.

3.4.1.6 BIM Coordinate System

****
NOTE: The Horizontal datum and Vertical datum are those currently defined in the National Spatial Reference System (NSRS) (currently NAD 83/2011 for Horizontal and NAVD 88 for Vertical). Delete this paragraph if this project does not have BIM requirements.
****

a. Coordinate System: [Geographic] [State Plane] [UTM] [_____]

b. Zone (for State Plane or UTM): [_____]

c. Horizontal Units of Measure: Meters [US Survey Feet] [International Feet]

d. Vertical Units of Measure: Meters Feet

e. Horizontal Datum: [NAD 83/2011] [_____]

****

NOTE: Other NSRS Vertical Datums for OCONUS: ASVD02, GUVD04, NMVD03, PRVD02, VIVD09

****

f. Vertical Datum: [NAVD 88] [_____]

3.4.1.7 CIM Coordinate System

****

NOTE: The Horizontal datum and Vertical datum are those currently defined in the National Spatial Reference System (NSRS) (currently NAD 83/2011 for Horizontal and NAVD 88 for Vertical). Delete this paragraph if this project does not have CIM requirements.

****

a. Coordinate System: [Geographic] [State Plane] [UTM] [_____]

b. Zone (for State Plane or UTM): [_____]

c. Horizontal Units of Measure: Meters [US Survey Feet] [International Feet]

d. Vertical Units of Measure: Meters Feet

e. Horizontal Datum: [NAD 83/2011] [_____]

****

NOTE: Other NSRS Vertical Datums for OCONUS: ASVD02, GUVD04, NMVD03, PRVD02, VIVD09

****

f. Vertical Datum: [NAVD 88] [_____]

3.4.1.8 Modeling Schedules

Comply with the NCS BIM Implementation section, part "2.4 Schedules." Produce schedules from, and link to, the Facility/Site Data within the Model. Document any exceptions in the PxP and submit for review.

3.4.1.9 Details and Enlarged Sections

Comply with the NCS BIM Implementation section, part "3.2 Model Coordination and Delivery." Derive all details and enlarged sections necessary for construction from the Model when possible. For those details and enlarged sections not derived directly from the Model, verify that geometry and data depicting the details and enlarged sections are consistent with Model elements. Details with significant drafted content such as 'standard' and 'typical' details cannot contradict the model and must utilize the model as an underlay when possible for the purposes of verification and coordination. Three dimensional, isometric, and section isometric details derived from the model are preferred. [Create details and enlarged sections that are not derived from the Model using native authoring tools within the Model or be embedded within the Model.]

3.4.1.10 Drawing Indices

Comply with the NCS BIM Implementation section, part "2.3 Sheet Organization." Where BIM authoring platform supports it, derive drawing indices from a model-driven schedule.

][3.4.2 GIS

3.4.2.1 Minimum Modeling Requirements

Provide final geo-referenced GIS database of the new building footprint, and site surface and subsurface features that exist outside the building footprint(s) out to the project extents compliant with current SDSFIE Adaptation.

Collect GIS georeferenced data pertaining to location and attribute data of subsurface utilities obtained at the time of project site excavation. Include the collection of elevation (Z) values in all data collection for underground utilities.

3.4.2.2 GIS Coordinate System

****

NOTE: The Horizontal datum and Vertical datum are those currently defined in National Spatial Reference System (NSRS) (currently NAD 83/2011 for Horizontal and NAVD 88 for Vertical).

****

a. Coordinate System: [Geographic] [State Plane] [UTM] [_____]

b. Zone (for State Plane or UTM): [_____]

c. Horizontal Datum: [NAD 83/2011] [_____]

****

NOTE: Other NSRS Vertical Datums for OCONUS: ASVD02, GUVD04, NMVD03, PRVD02, VIVD09

****

d. Vertical Datum: [NAVD 88] [_____]

e. Horizontal Units of Measure: Meters [US Survey Feet] [International Feet]

f. Vertical Units of Measure: Meters Feet

3.4.2.3 Standard GIS Database SDSFIE Adaptation

Use the Standard GIS Database SDSFIE Adaptation provided by the [Installation] Geospatial Support Office to produce the GIS deliverables required under this contract.

][3.4.3 CAD

All content produced through layer-centric CAD authoring software outside of any object/element based BIM or CIM platform must be compliant with ERDC/ITL TR-19-7 and ERDC/ITL TR-19-6.

[Bentley MicroStation Seed Files [Most recent version at the time of Contract award].] [Autodesk AutoCAD Template Files [Most recent version at the time of Contract award].] Download form the CAD/BIM Technology Center website as part of the A/E/C Work Structure.

]3.5 DESIGN CONFIGURATION MANAGEMENT (DCM)

3.5.1 Procedures

Develop and maintain effective, DCM procedures to control and track all revisions to the design documents subsequent to the Interim Design Submission and continuing through submission of the As-Built documents. After the final design is accepted, this process provides control of and documents revisions to the accepted design (See Special Contract Requirement: Deviating From the Accepted Design). Submit the DCM procedures within the Design Quality Control Plan.

a. Include authorities and concurrences in the DCM system to authorize revisions, including documentation as to why the revision is required.

b. An internal system may be used with interactive Government concurrences or the Government's "Dr Checks Design Review and Checking System" may be used.

c. Make the DCM data available to the Government reviewers at all times.

3.5.2 Tracking Design Review Comments

Although an internal system for overall design configuration management is allowed, use the DrChecks Design Review and Checking System to initiate, respond to, resolve and track Government design review comments.

The Government will set up the project in DrChecks. Throughout the design process parties enter, track, and back-check comments using the DrChecks system. Designers of Record annotate comments timely and specifically to indicate exactly the action to be taken or why the action is not required. After the design review conference and prior to the next design submittal for the package, the DORs annotate those comments that require DOR action or design revision to show how and where it has been addressed in the design documents. These procedures are part of the required design configuration management plan. Flag comments considered critical by the conference participants.

3.5.2.1 DrChecks Initial Account Set-Up

Identify a contact person within the office to act as the administrator for all Contractor personnel, including subcontractors, that will be accessing the PROJNET Dr Checks system. Through the Contracting Officer, coordinate with the Project Manager and the District PROJNET administrator for system access, system instruction and comment process instructions.

PROJNET contains an introductory file and other tutorial material that can be accessed once user accounts have been established. Upon log in, select Portals/User Documentation.

3.5.2.2 DrChecks Review Comments

Annotate and resolve all comments prior to the next submittal. Include the DrChecks comments and responses in the design analysis for record in the next design submittal for the package.

a. Upon review of comments prior to the design review conference, the DOR(s) evaluate the comments. Include exactly what action will be taken or why action is not required.

b. After the review conference, the DOR(s) formally respond to each applicable comment in DrChecks a second time, prior to the next submittal, clearly indicating what action was taken and what drawing/spec/analysis changed. Designers of Record are encouraged to directly contact reviewers to discuss and agree to the formal comment responses rather than relying only on DrChecks and review meetings to discuss comments. With the next design submittal, reviewers will back-check answers to the comments against the new submittal, in addition to reviewing additional design work.

c. Clearly annotate in DrChecks those comments that require effort outside the requirements of the contract. Do not proceed with work outside the contract until a modification to the contract is properly executed.

3.6 DISCIPLINE DESIGN REQUIREMENTS

****

NOTE: This article specifies data to be included in Design Packages. If an agency or local design manual is available, the requirements of that criteria may be specified by selecting the first bracketed option and deleting the second bracketed item, the remainder of this paragraph, and all of subparagraphs of DISCIPLINE DESIGN REQUIREMENTS already addressed in the design manual.

****

Provide interim design deliverables that [comply with requirements of the [_____] Design Manual] [include drawings, specifications, and design analysis for the part of design that the Contractor considers ready for review.

a. Drawings: Include comments from any previous design conferences incorporated into the documents to provide an interim design for the feature of work submitted.

b. Specifications: Provide specifications to ensure that all project design features are addressed, meeting current code requirements, and regulatory requirements. Use the track changes feature (redlines) to facilitate review of additions and deletions.

c. Design Analysis: Prepare and present design analysis under the authority of the DOR, with calculations necessary to substantiate and support all design documents submitted. Address design substantiation required by the applicable codes and references.

[d. Building Rendering: Provide a draft color computer, artist, or hand drawn rendering with the conceptual design submittal of the building exterior. Include a slightly overhead view of the entire building in perspective renderings, to encompass elevations and the roof configuration of the building. After Government review and acceptance, provide a final rendering, including the following:

(1) [Two][Three] A2 size (420 x 594) C size (17 x 22) color prints, framed and matted behind glass with project title underneath the print.

(2) One image file in JPG format [on optical disk] for those in the submittal distribution list.

]3.6.1 Geotechnical Investigations and Reports

****

NOTE: Include the first text paragraph if geotechnical investigations are not required elsewhere in the solicitation.

****

[Perform additional geotechnical investigations, as necessary, to determine the conditions for the actual locations of footings, other foundations and site paving features and other site features.

] Submit a final geotechnical evaluation report, prepared by the licensed geotechnical engineer, along with the first foundation design submittal. Make this information available as early as possible during the over-the-shoulder progress review process.

a. Summarize the subsurface conditions and provide recommendations for the design of appropriate utilities, foundations, floor slabs, retaining walls, embankments, and pavements.

b. Include compaction requirements for fill and backfill under buildings, sidewalks, other structures and open areas.

c. Recommend foundation systems to be used, allowable bearing pressures for footings, lateral load resistance capacities for foundation systems, elevations for footings, grade beams, slabs, etc.

d. Provide an assessment of post-construction settlement potential including total and differential.

e. Provide recommendations regarding lateral earth pressures (active, at-rest, passive) to be used in the design of retaining walls. Include the recommended spectral accelerations and Site Class for seismic design along with an evaluation of any seismic hazards and recommendations for mitigation, if required.

f. Include calculations to support the recommendations for bearing capacity, settlement, and pavement sections.

g. Include supporting documentation for all recommended design parameters such as Site Class, shear strength, earth pressure coefficients, friction factors, subgrade modulus, California Bearing Ratio (CBR).

h. Provide earthwork recommendations, expected frost penetration, expected groundwater levels, recommendations for dewatering and groundwater control and the possible presence of any surface or subsurface features that may affect the construction of the project such as sinkholes, boulders, shallow rock, old fill, old structures, soft areas, or unusual soil conditions.

i. Include pH tests, salinity tests, resistivity measurements, etc., required to design corrosion control and grounding systems.

j. Include the raw field data.

3.6.1.1 Inconsistency with the Preliminary Soils Information

Arrange a meeting with the Government subsequent to completion and evaluation of the site specific geotechnical exploration to outline any differences encountered that are inconsistent with the Government provided preliminary soils information. Clearly outline differences which require changes in the foundation type, or pavement and earthwork requirements from that possible and contemplated using the Government furnished preliminary soils investigation, which result in a change to the design or construction.

3.6.1.2 Vehicle Pavements

Provide flexible and rigid pavement designs, as applicable for the project, including design CBR and modulus of subgrade reaction and the required compaction effort for subgrades and pavement layers. Also, provide information on the types of base course materials available in the area and design strengths.

3.6.1.3 Certification

With the professional geotechnical engineer consultant, certify in writing that the design of the project has been developed consistent with the Contractor's final geotechnical report. Submit the certification, stamped by the consulting professional geotechnical engineer, with the first design submission. If revisions are made to the initial design submission, provide a new certification with the final design submission.

3.6.2 Civil Site and Utilities Design Contents

Include the following in the interim design for the site and utilities. This list is not intended to limit the contractor from providing different or additional information as needed to support the design presented.

a. Storm drainage design

b. Pavement design in coordination with the geotechnical investigation report.

c. Location and vicinity maps

d. Removal and/or relocation plan

e. Layout plan

f. Grading and drainage plan

g. Utility Plan: Identify and locate water lines, sanitary sewer lines, force mains, industrial waste lines, and other subsurface utility features

h. Road and parking area profiles

i. Utility Profiles: Indicate invert elevations of all drainage structures, manholes, storm drainpipe with size and invert elevations, ground profile, and new or existing structures or utilities crossing the new utilities.

j. Civil details sheet

[k. Concrete Joint Plan: Provide a joint layout plan for each concrete apron, hardstands, road, pavement, etc]

l. Erosion and Sediment Control Plan

m. Lawn and landscaping irrigation system

n. Landscape, planting and turfing

o. Site specific civil calculations

3.6.3 Structural Systems

3.6.3.1 General

a. Identify all loads to be used for design.

b. Describe the method of providing lateral stability for the structural system to meet seismic and wind load requirements. Include sufficient calculations to verify the adequacy of the method.

c. Calculations for all principal roof, floor, and foundation members and bracing and secondary members.

d. Drawings showing principal members for roof and floor framing plans as applicable.

e. Foundation plan showing main foundation elements where applicable.

f. Typical sections for roof, floor, and foundation conditions.

g. Complete seismic analyses for all structural, mechanical, electrical, architectural, and building features as dictated by the seismic zone in which the facility is being constructed.

h. Identify the program name, source, and version used for computer generated calculations. Provide input data, including loads, loading diagrams, node diagrams, and documentation to illustrate the design. On the schematic models used for input,t show, as a minimum, nodes/joints, element/members, materials/properties, and all loadings; induced settlements/deflections; and a list of load combinations. Include an output listing for maximum and minimum stresses, forces, and deflections for each element, and the reactions for each loading case and combination.

[i. Fully coordinate and integrate the overall structural design between two different or interfacing construction types, such as modular and stick-built or multistory, stacked modular construction. Provide substantiation of structural, consolidation/settlement analysis, etc., as applicable, through the interfaces.]

3.6.3.2 Anti-Terrorism/Force Protection (ATFP)

Provide a design narrative and calculations where applicable, demonstrating compliance with each of the 22 standards in UFC 4-010-01, which includes Design of Buildings to Resist Progressive Collapse (use the most recent version of UFC 4-023-03, regardless of references to any specific version in UFC 4-010-01).

a. Where sufficient standoff distance is not being provided, show calculations for blast resistance of the structural system and building envelope. b. Show complete calculations for members subjected to ATFP loads, e.g., support members of glazed items (jambs, headers, sills) connections of windows to support members and connections of support members to the rest of the structure.

c. For three story and higher buildings, provide calculations to demonstrate compliance with progressive collapse requirements.

3.6.4 Architectural

Provide a project design that meets the criteria and requirements identified in UFC 3-101-01. Consider architectural compatibility with the local environment, functional requirements, economy of construction, energy conservation, interior and exterior details, and life cycle costs. Optimize special functionality, aesthetics, material quality, and maintainability of operations to meet intended functional requirements in the final design.

Include the following in the basis of design as needed to sufficiently describe the project design

a. Composite Floor Plans, floor plans, roof plans showing slope, exterior elevations, reflected ceiling plans, building sections and cross sections indicating floor to floor heights and wall sections which clearly delineate materials systems.

b. Interior building elevations, enlarged details, door details, window details, enlarged toilet plans and details, enlarged stairway plans and details.

c. Door and window schedules, finish schedules, hardware schedules, special signage and graphic requirements and all required built-in casework and equipment.

d. Life safety analysis and life safety plans showing the location of all fire rated partitions, fire rated doors, egress pathways and exits.

e. Air Barrier System: air barrier system plans and details (i.e. window flashing details, penetration in air barrier details, door flashing details, roofing /ceiling barrier interface details).

f. Composite floor plan showing all pre-wired workstations

g. Comprehensive Interior Design Package, which includes Structural Interior Design (SID) and Furniture, Fixtures, and Equipment (FF&E)

Design packages.

3.6.5 Interior Design

3.6.5.1 Structural Interior Design (SID) Requirements

Structural Interior Design includes all interior and exterior building related elements and components generally part of the building itself, such as wall finishes, ceilings finishes, floor coverings, marker/bulletin boards, blinds, signage, built in casework and all exterior building finishes. Develop the SID in conjunction with the furniture footprint.

3.6.5.1.1 Format and Schedule

a. Prepare and submit for approval an interior and exterior building finishes scheme for an interim design submittal. Conduct a meeting between the DOR and the appropriate Government officials to discuss the finish schemes prior to preparation of the schemes to be presented. Present original sets of the schemes to reviewers at an interim design conference.

b. At the conclusion of the interim phase, after resolutions to the comments have been agreed upon between DOR and Government reviewers, the Contractor may proceed to final design with the interior finishes scheme presented.

c. Submit the SID information and samples in letter size format using three ring binders with pockets on the inside of the cover. When there are numerous pages with thick samples, use more than one binder. Large D ring binders are preferred to O-ring binders. Use page protectors that are strong enough to keep pages from tearing out. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Maximum spread for fold out items is 650 mm 25-1/2 inches. Provide cover and spine inserts sheets identifying the document as "Structural Interior Design" package. Include the project title and location, project number, Contractor/A/E name and phone number(s), submittal stage and date.

d. Design submittal requirements include, but are not limited to:

    (1) Narrative of the Structural Interior Design Objectives: Include a narrative in the SID that discusses the building related finishes. Include topics that relate to base standards, life safety, sustainable design issues, aesthetics, durability and maintainability, discuss the development and features as they relate to the occupants requirements and the building design.

    (2) Interior Color Boards

        (a) Identify and key each item item on the color boards to the contract documents to provide a clear indication of how and where each item will be used. Arrange finish samples to the maximum extent possible by room type in order to illustrate room color coordination. Label all samples on the color boards with the manufacturer's name, patterns and colors name and number. Key or code samples to match key code system used on contract drawings.

        (b) Material and finish samples indicating true pattern, color and texture. Provide photographs or colored photocopies of materials or fabrics to show large overall patterns in conjunction with actual samples to show the actual colors. Provide finish samples large enough to show a complete pattern or design where practical.

(c) Color boards include, but are not limited to, original color samples of

1. All walls finishes and ceiling finishes, including corner guards, acrylic wainscoting and wall guards/chair rail finishes.
2. All tile information, including tile grout color and tile patterns.
3. All flooring finishes, including patterns.
4. All door, door frame finishes and door hardware.
5. All signage, wall base, toilet partitions, locker finishes and operable/folding partitions and trim.
6. All millwork materials and finishes (cabinets, counter tops)
7. All window frame finishes and window treatments (sills, blinds)

(d) Color board samples reflect all actual finish textures, patterns and colors required as specified. Patterned samples sized to adequately show pattern and its repeat if a repeat occurs.

(3) Exterior Color Boards

(a) Prepare exterior finishes color boards in similar format as the interior finishes color boards, for presentation to the reviewers during an interim design conference. Provide original color samples of all exterior finishes including but not limited to the following:

All Roof Finishes
All Brick and Cast Stone Samples
All Exterior Insulation and Finish Samples
All Glass Color Samples
All Exterior Metals Finishes
All Window & Door Frame Finishes
All Specialty Item Finishes, including trim

(b) Identify each item on the exterior finishes color boards and key to the building elevations to provide a clear indication of how and where each item will be used.

3.6.5.1.2 Structural Interior Design Documents

Indicate the placement of extents of SID material, finishes and colors on related drawings and detail to define all interior work. The following is a list of minimum requirements:

3.6.5.1.2.1 Finish Color Schedule

Provide finish color schedule(s) in the contract documents. Provide a finish code, material type, manufacturer, series, and color designations. Key the finish code to the color board samples and drawings.

3.6.5.1.2.2 Interior Finish Plans

Indicate wall and floor patterns and color placement, material transitions and extents of interior finishes. Include a finish material/color board, presenting a physical representation of material selections

3.6.5.1.2.3 Furniture Footprint Plans

Provide furniture footprint plans showing the outline of all freestanding and systems furniture for coordination of all other disciplines.

3.6.5.1.2.4 Interior Signage

Include interior signage plans or schedules showing location and quantities of all interior signage. Key each interior sign to a quantitative list indicating size, quantity of each type and signage text.

3.6.5.1.2.5 Interior Elevations, Sections and Details

Indicate material, color and finish placement.

3.6.5.2 Furniture, Fixtures and Equipment (FF&E) Requirements

This paragraph provides instructions, requirements, and responsibilities for the design of the Furniture, Fixtures, and Equipment (FF&E) package.

3.6.5.2.1 Scope and Design Requirements

FF&E design is the selection, layout, specification and documentation of furniture. This furniture includes but is not limited to:

Freestanding	seating, tables, file cabinets, desks and workstations, wood casegoods, storage cabinets, bookcases
Furniture Systems	
Non-Mission Unique Equipment	residential refrigerators, industrial shelving, workbenches
Accessories	lamps, artificial plants, trash receptacles, re-cycle containers, artwork

3.6.5.2.1.1 Project Requirements

Interview appropriate Government personnel to discuss and coordinate furniture and equipment requirements prior to development of the FF&E.

This information includes the number of personnel to occupy the building, job functions and related furniture/office equipment to support the job function, room functions, rank and grade, and any applicable Army facility standards.

3.6.5.2.1.2 Design Direction

Design the FF&E package concurrently with the facility design. Limit the use of manufacturer representatives or dealers to providing specification and cost information only. Coordinate the FF&E package with the following:

a. Interior finish selections and generic furniture footprint plans developed as part of the Structural Interior Design (SID).

b. Building electrical outlets, switches, J-boxes, communication outlets and connections, and lighting as appropriate.

c. Other building features such as architectural elements, thermostats, location of TV's, and mission unique equipment (MUE)

d. Locate furniture in front of windows only if the top of the item falls below the window and unless otherwise noted, do not attach furniture including furniture systems to the building.

e. If a project has SIPRNET and/or NIPRNET, coordinate furniture layout with SIPRNET and NIPRNET separation requirements. Take special note of any Network Enterprise Center (NEC) requirements regarding the location of secure (SIPRNET) surface mounted conduit or raceways with associated clearances, wall drops, and wall lock boxes in order to coordinate with the location of desks and workstations that are to have SIPRNET accessibility. Verify that access required by NEC for SIPRNET box and conduit is provided. Coordinate with the User if there are any other types of secure cabling (classified networks) requirements for the project such as J-WIC's, and coordinate furniture and building location, separation and accessibility requirements with NEC.

f. Base executive wood casegoods on the facility type and rank of end user. Typically this is limited to command suites or to those areas specified by the Installation POC and, when applicable, Installation Design Guide for FF&E's.

3.6.5.2.2 Acquisition and Procurement

[3.6.5.2.2.1 Quality Standards

****

NOTE: This paragraph requires attaching a document to this section. Delete the paragraph if the requirement does not apply to the project.

****

Huntsville Center (HNC) has developed the minimum acceptable quality standards with regard to construction materials, fabrication methods, and ergonomic features and ranges, for many of the typical FF&E items specified for an administrative facility or area within a building. These standards are listed as part of the HNC Request for Quote (RFQ) scope of work. The document is titled: Furniture Item Description (FID), Section 2.0 Product Descriptions and Quality Requirements. A copy of this document will be provided to the DOR as part of this Scope of Work as an attachment to this section. Utilize the FID in developing the FF&E design package. It is the DOR's responsibility to insure that all items submitted in the FF&E design package meet any and all requirements listed in the Section 2.0 of the FID document for the type of item being specified to include all ANSI/BIFMA testing.

]3.6.5.2.2.2 Mission Unique Equipment

Identify locations on the FF&E drawings of known MUE items for space planning purposes. Clearly identify any FF&E items required by the User that cannot be procured by HNC and are; therefore MUE, on FF&E drawings as Not in Contract (NIC), unless otherwise directed. MUE includes, but is not limited to, items such as:

Most commercial appliances
Fitness equipment
IT equipment (photocopiers, printers, etc.)
AV equipment (projectors, smart boards, flat screen display monitors, AV racks, AV carts)
Floor safes
Shredders
Clocks

3.6.5.2.2.3 Sources

a. Utilize GSA Schedule manufacturers and products in selection of FF&E for this project. Open market sources can be specified when an item is not available on GSA Schedule, minimize use ($3,000 per line item/$25,000 per contract) and do not specify without written justification. Make a concerted effort to exclude items with proprietary features which would prevent competition.

b. Specify furnishings from within a manufacturer's family wherever possible while ensuring aesthetic, quality and functionality are not compromised. For example: Steelcase, Turnstone, Brayton International, Metro, and Vecta are all Steelcase companies. Each alternate should also be specified from a manufacturer's family of furniture, example: first set of alternates would be specified from Knoll's family of furniture and the second from Herman Miller family of furniture. Select office furniture, including case goods, tables, storage, and seating, that is compatible in style, finish and color.

c. It is acceptable to make selections from other than a manufacturer's family of furniture where costs are not reasonable for particular items, some items are not available or appropriate for the facility, or the items are not on GSA Schedule. If this occurs, specify product from an open line that is accessible by numerous dealerships.

d. See paragraph SUBMITTAL COMPONENTS for Product Data Sheet alternate manufacturer requirements.

3.6.5.2.3 Format and Submittal Requirements

Provide the design package in letter size format using three-ring binders with pockets on the inside of the cover. Provide project binder cover and spine inserts sheets identifying the document as "Furniture, Fixtures & Equipment" package and include the project name and location, Contractor/AE name and phone number(s), submittal phase and date. Include a footer on all text documents that lists the project name, location, date and submittal phase. See paragraph SUBMITTAL COMPONENTS on Color Boards for additional requirements. Use more than one binder when there are numerous pages with thick samples. Large D-ring binders are preferred to O-ring binders. Use color board material that is strong enough to keep pages from tearing out. Anchor large or heavy samples with mechanical fasteners, Velcro, or double-faced foam tape rather than rubber cement or glue. Fold out items may have a maximum spread of 650 mm 25-1/2 inches. Produce drawings in an A3 11 x 17 inch format size. See paragraph DESIGN SUBMITTAL PROCEDURE for the number of copies required. [Provide copies of each design submittal as outlined in the attached SUBMITTAL DISTRIBUTION QUANTITIES schedule.]

3.6.5.2.3.1 Interim Submittal

Include the following:

a. Design Narrative

b. Product Data Sheet

c. Drawings - Composite Furniture, Area Plans and Workstation Typicals

d. Color Boards

e. Cost Estimate

3.6.5.2.3.2 Final Submittal

Provide a final FF&E that includes any changes made as a result of interim review comments. Include the following:

a. Design Narrative

b. Product Data Sheet

c. Drawings - Composite Furniture, Area Plans and Workstation Typicals and Electrical and Communication Plans

d. Color Boards

e. Cost Estimate

3.6.5.2.3.3 Design Complete Submittal

Provide a design complete submittal that includes any changes made as a result of final review comments. Provide documents upon completion of the final architectural submittal or ten months prior to the contract completion date (whichever comes first), to ensure adequate time for furniture acquisition.

a. Design Narrative

b. Product Data Sheet

c. Drawings - Composite Furniture, Area Plans and Workstation Typicals and Electrical and Communication Plans

d. Color Boards

e. Cost Estimate

f. Include the following for HNC furniture purchase in one of the Installation's copies:

  (1) Disc 1: CAD drawings in the same format as the facility design. Provide all files, including any reference files, needed to view complete drawings.

  (2) Disc 2

    (a) All documents in PDF format including A3 11 x 17 inch drawings. Color boards are not required.

    (b) Excel file of the cost estimate.

  (3) Binder with paper copies of all FF&E components. Include binder cover and spine inserts with project information. Color boards are not required.

3.6.5.2.4 Submittal Components

Individually code all FF&E items. Use this code and cross-reference to all components of the FF&E.

3.6.5.2.4.1 Narrative of Interior Design Objectives

Provide a narrative description of the furniture, to include functional, safety and ergonomic considerations, durability, sustainability, aesthetics, and compatibility with the building design. Include the name and contact information for the DOR.

3.6.5.2.4.2 Product Data Sheet

Prepare one Product Data Sheet for each item specified in the design including typical workstations. This form identifies all information required to order each individual item. Include the following on the order form:

a. Item Code (example: C1, T1)

b. Item Name (example: Desk Chair, Training Table)

c. Manufacturer

d. Design Series

e. Model Number

f. GSA Information (FSC Group, contract number, expiration date)

g. Overall Dimensions

h. Finishes:

    (1) Paint color, wood species and finish, and plastic laminate. In addition to the manufacturer's furniture wood finish information that is provided, provide the manufacturer name, pattern name and manufacturer's identification number of a wood-patterned plastic laminate which can be used as a reference control sample for bidding purposes on all items that require wood components or veneer.

    (2) Fabric name and number, minimum Wyzenbeek Abrasion Test double rubs. Code to fabric samples on color boards. Use upholstery that is not proprietary to one furniture manufacturer, but accessible by multiple furniture manufacturers. Non-proprietary fabric includes, but is not limited to, textile manufacturer's fabrics that have been graded into furniture manufacturers fabric grades and are available through a manufacturer's GSA Schedule.

i. Quantity:

    (1) Item location by room number and room name

    (2) Quantity per room

    (3) Total Quantity

j. Alternate Manufacturers: Provide 2 alternates for the major items that include, but are not limited to, desks and workstations, wood casegoods, furniture systems, seating, and tables. Supply alternates that are available on GSA Schedule and meet the requirements of the product data sheet. Provide manufacturer name, product series and model number for each alternate manufacturer.

k. Furniture Item Illustration: Provide a high quality illustration for each furnishing item specified in the package. The illustration can be a photograph or a line drawing.

l. Product Description: Provide non-proprietary, project specific salient characteristics for the item specified. In general this includes, but is not limited to:

    (1) Functional features

    (2) Style (aesthetics): narrative description of the item's appearance

    (3) Sustainable design attributes

    (4) Construction: construction materials and methods that relate to minimum quality standards required

    (5) Testing requirements: BIFMA, etc.

    (6) Ergonomic features and ranges

    (7) Minimum warranty

    (8) List any critical dimensions to include any maximum/minimum

dimensions

m. For projects with furniture systems also provide the following minimum requirements information in the Product Description:

  (1) Type of furniture systems (panel, stacking panels, spine wall, desk based system, or a combination)

  (2) Minimum panel noise reduction coefficient (NRC)

  (3) Minimum panel sound transfer coefficient (STC)

  (4) Minimum flame spread and smoke development

  (5) UL testing for task lighting and electrical system

  (6) Panel widths and heights and their locations (this may be done on the drawings)

  (7) Worksurface types and sizes (this may be done on the drawings)

  (8) Type of storage components (lateral files, pedestals, overhead storage, shelving, tower storage)

  (9) Worksurface edge type

  (10) Varying panel/cover finish materials and locations (locations may be shown on the drawings)

  (11) Keyboard requirements

  (12) Lock and keying requirements

  (13) Accessory components (examples: tack boards, marker boards, monitor arms, paper management, task lighting)

  (14) Electrical and communication raceway requirement; type, capacity and location (base, beltline, below and/or above beltline)

  (15) Locations of communication cables (base, beltline, below and/or above beltline, top channel)

  (16) Types of electrical outlets required; including dedicated circuits

  (17) Types of communication jacks (provided and installed by others)

  (18) Locations of electrical outlets and communication jacks (this may be done on the drawings)

  (19) Type of cable (examples: Cat. 6 (UTP and STP), fiber optic) system needs to support (provided and installed by others)

n. Special instructions for procurement ordering and/or installation (if applicable)

3.6.5.2.4.3 Drawings

a. Coordinate all drawings developed as part of the FF&E interior design with the generic furniture floor plans provided and approved as part of the project construction drawings. Reflect any changes in size, quantity, or location of FF&E items during the FF&E design, from that shown on the construction drawing generic furniture plans, in the construction drawings.

b. Do not provide manufacturer specific information such as product names and numbers on drawings. Provide non-proprietary drawings.

c. Accurately reflect the proposed space planning and location of all FF&E items. Incorporate all applicable life safety codes and ABA/ADA requirements in space planning based on building type and utilization.

d. Although not included or specified as part of the FF&E design package, show and identify the location and approximate sizes for all Mission Unique (MUE) furnished equipment that will occupy floor space. This includes but is not limited to such items as photocopiers, printers, vending machines, kitchen equipment, etc. Clearly label MUE on the drawings.

e. Include, the following as a minimum:

    (1) Composite Furniture Plans: Scaled drawings indicating location of all furniture and equipment to clearly illustrate overall space planning concept and intent.

    (2) Area Furniture Plans: Scaled drawings showing detailed placement for each furniture, equipment, or accessory item. Provide a key plan identifying location in the building the area is located.

        (a) Identify all FF&E items by code on the area plan. Include a legend on each sheet listing all item codes and names.

        (b) Provide critical dimensions to include open office area aisle widths, and workstation spline wall centerline dimension to building walls.

        (c) Identify all mission unique equipment by item code and/or name and as not in contract (NIC). In addition, identify construction contractor provided equipment that has a significant footprint that will influence the location and arrangement of the FF&E furnishings items specified for this project.

    (3) Workstation Typical Plans: Large scaled plans and elevations/isometrics showing workstation typical configurations which clearly identify major workstation components to include but not be limited to panels, storage, worksurfaces, accessories (monitor arms, keyboard trays, etc), and task lighting. Include location of all electrical and communication outlets, indicate height on panel by note or symbol.

    (4) Electrical and Communication Plans: In order to facilitate and coordinate connectivity to the FF&E, also include copies of the building electrical and communications plans from the construction drawing set.

3.6.5.2.4.4 Color Boards

Accurately reflect the furniture fabric and finish patterns, textures and colors selected for the project. Provide samples of all finishes and fabrics indicated on the Product Data Sheet for each FF&E item.

Provide samples of sufficient size to adequately portray the pattern, color, and texture of the material. Photographic reproductions are prohibited. Label and cross-reference all samples to the furniture plans and Product Data Sheet. Arrange and group furniture finishes on the color boards corresponding to rooms or areas. Color boards include, but are not limited to, paint, plastic laminate, fabric, and wood finish (include plastic laminate reference control sample).

3.6.5.2.4.5 Cost Estimate

Base the cost estimate on GSA Schedules and organize by item code and name. Include separate line items for general contingency, installation, freight charges and any other related costs. Use installation and freight quotes from vendors in lieu of a percentage allowance when available. An estimate developed by a furniture dealership may be provided as support information for the estimate, but has to be separate from the DOR developed spreadsheet estimate.

a. Verification of Quantity: Ensure that quantity counts for each item matches between the product data sheet, plans and cost estimate.

b. Signature Block: Include a written statement at the bottom of the cost estimate that states all pricing is based on GSA Schedules. Provide a line for a government POC signature.

3.6.5.2.5 Furniture Specifications

Individually code all FF&E items. Use and cross-reference this code to all components of the FF&E.

3.6.5.2.5.1 Construction

a. Specify modesty or back panels on freestanding desks and workstations located against walls as a fixed 1/2 or 1/3 partial height panel, or a hinged panel. Coordinate fixed panel heights with the electrical and data outlet mounting heights shown on the construction drawings to provide direct access to these outlets.

b. Unless otherwise noted, provide lockable desks and workstations, filing cabinets and storage. Key all locks within a one person office the same; key all one person offices within a building differently. If an office or open office area has more than one workstation, key all the workstations differently, but key all locks within an individual workstation the same.

c. Use light-emitting diode (LED)/solid state lighting where task lighting is required in furniture.

3.6.5.2.5.2 Finishes and Upholstery

Keep placement of furniture systems panel fabric accent colors to a minimum.

Specify seating upholstery that meets Wyzenbeek Abrasion Test, 55,000 minimum rubs. Specify upholstery and finish colors and patterns that help hide soiling.

3.6.5.2.5.3 Sustainability

For all designs provided regardless of facility type, make every effort to implement all aspects of sustainability, including sustainable materials and products acquisition, to the greatest extent possible, where life cycle cost effective, for all the selections made in the FF&E package in accordance with UFC 1-200-02 requirements.

3.6.5.2.5.4 Furniture Systems

Minimize the number of workstation typicals including parts and pieces required to assist in future reconfiguration and inventorying.

3.6.5.2.5.5 Seating

a. Specify appropriate chair casters and glides for the floor finish where the seating is located.

b. Provide task seating that supports a minimum of 140 kg 300 pounds.

c. Select ergonomic desk chairs with casters, waterfall front, swivel, tilt, variable back lock, adjustable back height or adjustable lumbar support, pneumatic seat height adjustment, seat depth adjustment, 175 - 280 mm 7-11 inch arm height adjustment above the seat, and padded, contoured upholstered seat and back. Provide desk chairs with an adjustable seat height range of 115 mm 4 1/2 inches, range to include 420 - 510 mm 16-1/2 - 20 inches.

d. In heavy use lounge, waiting and reception areas provide seating with arms that are non-upholstered or upholstered with wood arm caps.

3.6.5.2.5.6 Training Tables

Provide reconfigurable, moveable and storable training tables. Specify power and data requirements, dollies, flip-top and modesty panels as required.

3.6.5.2.6 Warranties

Specify manufacturer's performance guarantees or warranties that include parts, labor and transportation as follows:

Furniture System, unless otherwise noted	10 year minimum
Furniture System Task Lights	2 year minimum, excluding bulbs
Furniture System Fabric	3 year minimum
Metal Desks and Workstations	12 year minimum
Seating, unless otherwise noted	10 year minimum
Ergonomic Task Seating 24/7	10 year minimum
Seating Mechanisms and Pneumatic Cylinders	10 years

Ergonomic Task Seating Fabric (includes 24/7 seating)	5 years minimum
Tables, unless otherwise noted	10 year minimum
Table Mechanisms	5 year minimum
Table Ganging Device	1 year minimum
Wood Casegoods, Files and Storage	10 year minimum
Wood Framed Seating	10 year minimum
Wood Seating Fabric	3 years minimum
Items not listed above	1 year minimum

3.6.6 Plumbing Systems

a. List all references used in the design including Government design documents and industry standards.

b. Provide justification and brief description of the types of plumbing fixtures, piping materials and equipment proposed for use.

c. Detail calculations for systems such as sizing of domestic hot water heater and piping; natural gas piping; LP gas piping and tanks; fuel oil piping and tanks.

d. Show locations and general arrangement of plumbing fixtures and major equipment.

e. Plan and isometric riser diagrams of all areas including hot water, cold water, waste and vent piping. Include natural gas (and meter as required), LP gas, fuel oil and other specialty systems as applicable.

f. Include equipment and fixture connection schedules with descriptions, capacities, locations, connection sizes and other information as required.

[g. When the geotechnical report indicates expansive soils are present, indicate in the first piping design submittal how piping systems will be protected against damage or backfall/backflow due to soil heave (from penetration of slab to the 5 foot building line).]

3.6.7 HVAC Systems

3.6.7.1 Design Analysis

Provide complete design calculations for mechanical systems. Include computations for sizing equipment, compressed air systems, air duct design, and U-factors for ceilings, roofs and exterior walls and floors.

Employ commercially available energy analysis techniques to determine the energy performance of all passive systems and features. Use of hourly energy load computer simulation is required. Based on the results of calculations, provide a complete list of the materials and equipment proposed with the manufacturer's published cataloged product installation specifications and roughing-in data.

3.6.7.2 Mechanical Floor Plans

On the floor plans, show all principle architectural features of the building which affect the mechanical design. Also show the following:

Room designations
Mechanical legend and applicable notes
Location and size of all ductwork and piping
Location and capacity of all terminal units (i.e., registers, diffusers, grilles, hydronic baseboards)
Pre-Fabricated Paint Spray Booth
Paint Preparation Area
Exhaust fans and specialized exhaust systems
Thermostat location
Location of all air handling equipment
Air balancing information
Flue size and location
Piping diagram for forced hot water system (if used)

3.6.7.3 Equipment Schedule

Providee complete equipment schedules. Include the following in the Schedule:

Capacity
Electrical characteristics
Efficiency (if applicable)
Manufacturer's name
Optional features to be provided
Physical sizes
Minimum maintenance clearances

3.6.7.4 Details

Provide construction details, sections, elevations, etc., only where required for clarification of methods and materials of design.

3.6.7.5 Controls

Submit complete HVAC controls equipment schedules, sequences of operation, wiring and logic diagrams, Input/Output Tables, equipment schedules, and all associated information. See the Statement of Work for additional specific requirements.

3.6.8 Fire Protection and Life Safety

Provide plan for each floor of each building that presents a compendium of the total fire protection features being incorporated into the design. Working plans and all other materials submittal must meet NFPA 13 requirements, with respect to required minimum level of detail. Include the following types of information:

a. The location and rating of any fire-resistive construction such as occupancy separations, area separations, exterior walls, shaft enclosures, corridors, stair enclosures, exit passageways.

b. The location and coverage of any fire detection systems.

c. The location and coverage of any fire suppression systems (sprinkler risers, standpipes, etc.).

d. The location of any other major fire protection equipment.

e. Indicate any hazardous areas and their classification.

f. Schedule describing the internal systems with the following information:

    (1) Fire hazard and occupancy classifications
    (2) Building construction type
    (3) L/sec per square meter GPM/square foot sprinkler density
    (4) Area of operation

3.6.8.1 Fire Protection/Suppression Analysis

a. Include building code analysis and basis of design for sprinkler and other suppression systems.

b. An FPE must perform all fire protection analyses. Provide the fire protection engineer's qualifications.

c. List all references used in the design including Government design documents and industry standards used to generate the fire protection analysis

d. Classification of each building in accordance with fire zone, building floor areas and height and number of stories

e. Discussion and description of required fire protection requirements including extinguishing equipment, detection equipment, alarm equipment and water supply. Interface alarm and detection equipment to requirements of Electronic Systems.

f. Plan for each floor of each building that presents a compendium of the total fire protection features being incorporated into the design. Include the following types of information:

   (1) The location and rating of any fire-resistive construction such as occupancy separations, area separations, exterior walls, shaft enclosures, corridors, stair enclosures, and exit passageways.

   (2) The location and coverage of any fire detection systems

   (3) The location and coverage of any fire suppression systems (e.g. sprinkler risers, standpipes)

   (4) The location of any other major fire protection equipment

   (5) Indicate any hazardous areas and their classification

g. Schedule describing the internal systems with the following information: fire hazard and occupancy classifications; building construction type; L/second/square meter GPM/square foot sprinkler density; area of operation and other as required.

h. Provide hydraulic calculations based on water flow test for each sprinkler system to insure that flow and pressure requirements can be met with current water supply. Include copies of water flow testing done to certify the available water source.

i. Meet NFPA 13 requirements with respect to required minimum level of detail on working plans and all other submitted materials.

3.6.8.2 Fire Protection and Life Safety Code Review

Use the information outlined in the document associated with this section at http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics- to provide the minimum requirement for development of Fire Protection and Life Safety Code submittals for all building projects. Additional and supplemental information may be used to further develop the code review. Insert N/A after criteria, which may be "not applicable".

3.6.9 Electrical Systems

3.6.9.1 Design Analysis

Include lighting calculations to determine maintained foot-candle levels, electrical load analysis and calculations, electrical short circuit and protective device coordination analysis and calculations and arc fault calculations.

3.6.9.2 Floor Plan

On the floor plans show all principle architectural features of the building which will affect the electrical design. Also show the following on the floor plan:

(1) Room designations
(2) Electrical legend and applicable notes
(3) Lighting fixtures, properly identified

(4) Switches for control of lighting
(5) Receptacles
(6) Location and designation of panelboards. Plans should clearly indicate type of mounting required (flush or surface) and be reflected accordingly in specifications.
(7) Service entrance (conduit and main disconnect)
(8) Location, designation and rating of motors and/or equipment which requires electrical service. Show method of termination and/or connection to motors and/or equipment. Show necessary junction boxes, disconnects, controllers (approximate only), conduit stubs, and receptacles required to serve the motor and/or equipment.

3.6.9.3 Building Riser Diagram

From pad-mounted transformer to unit load center panelboard indicate the types and sizes of electrical equipment and wiring. Include grounding and metering requirements.

3.6.9.4 Load Center Panelboard Schedule(s)

Indicate the following information in the schedule(s):

(1) Panelboard Characteristics (Panel Designation, Voltage, Phase, Wires, Main Breaker Rating and Mounting
(2) Branch Circuit Designations
(3) Load Designations
(4) Circuit Breaker Characteristics (Number of Poles, Trip Rating, AIC Rating)
(5) Branch Circuit Connected Loads (AMPS)
(6) Special Features

3.6.9.5 Lighting Fixture Schedule

Indicate the following information in the schedule:

(1) Fixture Designation
(2) General Fixture Description
(3) Number and Type of Lamp(s)
(4) Type of Mounting
(5) Special Features

3.6.9.6 Details

Provide construction details, sections, elevations only where required for clarification of methods and materials of design.

3.6.10 Telecommunications and Security

[_____]

3.6.10.1 ATFP

[_____]

3.6.10.2 Cybersecurity

[_____]

3.6.11 Specialty Equipment

[3.6.11.1 Elevators

a. List of criteria codes, documents and design conditions used.

b. List of any required permits and registrations for construction of items of special mechanical systems and equipment.

c. Description of the proposed control system.

d. Description, approximate capacity and location of any special mechanical equipment for elevators.

][3.6.11.2 Corrosion Control and Prevention Systems

Provide a report clearly describing structures, systems or components in soil or water to be protected. Describe methods proposed for protection of each. The report must be stamped by the licensed corrosion engineer or NACE specialist with the first design submission.

The designer must be qualified to engage in the practice of corrosion control of buried or submerged metallic surfaces. Either accreditation or certification by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection Specialist, or a registered professional engineer with a minimum of five years experience in corrosion control and cathodic protection is required.

]]3.7 INTERIM DESIGN REQUIREMENTS

At least one interim design submittal, review and review conference is required for each design package (except that the Contractor may, upon Government approval, skip the interim design submission and proceed directly to final design of the sitework and utilities package). Additional interim design conferences or over-the-shoulder reviews may be scheduled, as needed, to assure continued Government concurrence with the design work. Include the interim submittal review periods and conferences in the Section 01 32 01.00 10 PROJECT SCHEDULE and indicate in periodic schedule updates what part of the design work is at what percentage of completion. See also paragraph INTERIM DESIGN DEVELOPMENT REVIEW WAIVER for a waiver to the formal interim design review.

3.7.1 Submission Review

After receipt of an Interim Design submission, the Government requires [14] [_____] calendar days after receipt of the submission to review and comment on the interim design submittal. For smaller design packages, especially those that involve only one or a few separate design disciplines, the parties may agree on a shorter review period or alternative review methods (e.g., over-the -shoulder or electronic file sharing), through the partnering process.

a. For each interim design review submittal, the Contracting Officer will furnish a single consolidated, validated set of comments from the various design sections and from other concerned agencies involved in the review process using the DrChecks Design Review and Checking System. The review will be for conformance with the technical requirements of the Contract.

b. The Government reserves the right to reject design document submittals if comments are deemed significant.

c. Furnish disposition of all comments, in writing, through DrChecks. If there are technical disagreements with any comments, clearly outline, with justification, the reasons for disagreement and noncompliance within five calendar days after receipt of these comments.

d. The Contractor is cautioned that if it believes the action required by any comment exceeds the requirements of this contract, that it should take no action and notify the Contracting Officer in writing immediately.

3.7.2 Interim Review Conference

Hold an Interim Review conference for each design submittal at either the installation or as agreed upon as part of the partnering process. Attendees include, at a minimum, the DOR(s) involved in development of the design submittal. Schedule the conference to take place the week after the receipt of the comments. Notify the Contracting Officer of any comments that with concurrence would require further design development.

For smaller fast-track packages that involve only a few reviewers, the parties may agree to alternative conferencing methods, such as teleconferencing, or televideo, where available, as determined through Partnering.

3.7.3 Conference Documentation

3.7.3.1 Minutes and Comment Process

Provide meeting minutes within [two] [_____] work days after the conference adjourns, and enter final resolution of all comments into DrChecks. Include copies of comments, annotated with comment action agreed on, with the minutes.

a. Resolve issues remaining open after the conference adjourns by immediate follow-on action to close the issue within 30 calendar days.

b. Incorporate comments as agreed upon during the conference.

3.7.3.2 Availability

In order to facilitate the Government code and contract conformance reviews, identify, track resolution of, and maintain all comments and action items generated during the design review process. Make this available to the designers and reviewers prior to the subsequent design reviews.

3.8 FINAL DESIGN REQUIREMENTS

****

NOTE: This article specifies data to be included in Final Design Packages. If that level of specification is required, select the second bracketed option. However, if an agency or local design manual is available, the requirements of that criteria may be specified by selecting the first

bracketed option and deleting the remaining subparagraphs of FINAL DESIGN REQUIRMENTS already addressed in the design manual.

****

Provide final design submittals that [comply with requirements of the [_____] Design Manual][consist of 100 percent complete drawings, specifications, submittal register, design analyses] for Government review and acceptance.

a. Include any permits required by the contract for each package submitted.

b. In order to expedite the final design review, prior to the conference, ensure that the design configuration management data and all review comment resolutions are up-to-date.

c. Perform independent technical reviews and back-checks of previous comment resolutions, as required by Section 01 45 00 QUALITY CONTROL.

3.8.1 Design Drawings

Submit drawings complete with all contract requirements incorporated into the documents to provide a 100 percent design for each package submitted. In addition to all native Advanced Modeling files, provide separate electronic files in a PDF format.

3.8.1.1 Geo-Referenced Data

Capture geo-referenced coordinates of all changes that will be made to the existing site (facility footprint, utility line installations and alterations, roads, parking areas, etc) as a result of this contract.

Close-out requirements at the as-built stage, require final geo-referenced GIS Database of the new facility along with all exterior modifications. The Government will incorporate this data set into the Installation's GIS Masterplan or Enterprise GIS System. See also, Section 01 78 00 CLOSEOUT SUBMITTALS.

3.8.2 Design Analysis

Provide a design analysis with calculations necessary to validate and support all design work submitted. Expand and advance calculations and information presented in the interim design stage to the current level of design. The responsible DOR(s) stamp, sign and date the design analysis.

3.8.3 Specifications

Provide specifications 100 percent complete and in final form.

3.8.4 Submittal Register

Provide an updated, cumulative submittal register with each design package that identifies the design and construction submittals required by that design package.

[3.8.5 Final Framed Rendering and Copies

Provide the final original color rendering, one full size photographic reproduction(s) of the original rendering, and the photographic negative.

Mount original and reproductions on acid free board, matted with metal frames, and utilizing non-glare glass. Print the project name, location, and Architect/Engineer/Contractor firm's name on the matting.

Ship the rendering, the photographic copies, and the negative in resilient packaging to ensure damage-free delivery. Deliver to the party identified by the Contracting Officer.

][3.8.6 Preparation of DD Form 1354 (Transfer of Real Property)

This form itemizes the types, quantities and costs of various equipment and systems that comprise the project, for the purpose of transferring the new construction project from the Corps Construction Division to the Installation's inventory of real property. The Government will furnish the Contractor's design manager a DD Form 1354 checklist to use to produce a draft Form 1354. Submit the completed checklist and prepared draft Form DD 1354 with the 100 percent design. The Government will use these documents to complete interim and final DD 1354s for turnover of a portion or all of the construction project.

]3.9 DESIGN COMPLETE CONSTRUCTION DOCUMENT REQUIREMENTS

After the Final Design Submission and Review Conference, revise the design documents for the design package to incorporate the comments generated and resolved in the final review conference. Perform and document a back-check review and submit the final, design complete documents. The deliverable includes all documentation and supporting design analysis in final form, as well as the final review comments, disposition and the back-check. As part of the quality assurance process, the Government may perform a review of the released for construction documentation. Promptly correct any errors or omissions found during the Government review.

3.10 ACCEPTANCE AND RELEASE FOR CONSTRUCTION

After acceptance of the Design Complete Construction Document(s) the Contracting Officer will allow construction to start for that design package.

Government review and acceptance of design submittals is for contract conformance only and does not relieve the Contractor from responsibility to fully adhere to the requirements of the contract, including the Contractor's accepted proposal, or limit the Contractor's responsibility of design as prescribed under Special Contract Requirement: "Responsibility of the Contractor for Design" or limit the Government's rights under the terms of the contract. The Government reserves the right to rescind inadvertent acceptance of design submittals containing contract deviations not separately and expressly identified in the submittal for Government consideration and approval.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-01 33 23.33 (August 2018)**
Change 1 - 02/21

Preparing Activity: USACE **Superseding**
UFGS-01 33 23.33 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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AVIATION FUEL SYSTEM SPECIFIC SUBMITTAL REQUIREMENTS

08/18, CHG 1: 02/21

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-01 33 23.33 (August 2018)**
Change 1 - 02/21

Preparing Activity: USACE **Superseding**
UFGS-01 33 23.33 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 01 33 23.33

AVIATION FUEL SYSTEM SPECIFIC SUBMITTAL REQUIREMENTS

08/18, CHG 1: 02/21

****

NOTE: This guide specification covers the requirements for specific contract requirements for aircraft refueling systems constructed to the requirements of the DoD Type III/IV/V, and Cut'n Cover Hydrant Refueling System Standards

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Use this Section in conjunction with UFGS 01 33 00 SUBMITTAL PROCEDURES. DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following

location https://www.wbdg.org/ffc/dod/non-cos-standards.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

****

1.1 SUBMITTALS

Provide submittals as specified in each individual section and obtain approval as specified before procurement, fabrication, or delivery to the job site. Partial submittals are not acceptable and will be returned without review. Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts. SME for this project is [Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS)[[Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC)] [Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11)]]]. In addition to the definitions in Section 01 33 00 SUBMITTAL PROCEDURES, the following provisions apply:

1.1.1 SD-02 Shop Drawings

Drawings must be a minimum of A3 sheetANSI B in size, with a minimum scale of 1:1001/8 inch per foot, except as specified otherwise. Include floor plans, sectional views, wiring diagrams, and installation details of equipment; and equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams must identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings must indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, drawings must be revised to show acceptable equipment and be resubmitted. (Prior to the completion of the contract, on A1 sheet sizeANSI D Adobe.pdf reproducible drawings, for each system, wiring/control diagram and approved system layout drawing must be provided to the Contracting Officer with the operation and maintenance manuals specified herein).

1.1.2 SD-03 Product Data

Submittals for each manufactured item must be manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts. The submittals must also include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable Government, industry, and technical society publication references, years of satisfactory service, and other information necessary to establish contract compliance of each item the Contractor proposes to provide. Photographs of existing installations and data submitted in lieu of catalog data are not acceptable and will be returned without approval.

1.1.2.1 Standards Compliance

When materials or equipment are required to conform to the standards of organizations such as the American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturers Association (NEMA), ASME International (ASME), American Gas Association (AGA), American Petroleum Institute (API), Air-Conditioning and Refrigeration Institute (ARI), and Underwriters Laboratories (UL) or equivalent, submit proof of such conformance to the Contracting Officer. Factory Mutual (FM) listing or CSA International (CSA) listing will be acceptable in lieu of any UL listing requirements. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptable test and is approved by the Contracting Officer. The certificate must state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard. For materials and equipment whose compliance with organizational - standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, submit a certificate of compliance from the manufacturer. The certificate must identify the manufacturer, the product, and the referenced standard and must simply state that the manufacturer certifies that the product conforms to all requirements of the project specification and of the referenced standards listed.

1.1.2.2 Manufacturer's Installation Instructions

Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, furnish printed copies of these recommendations prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS/SERVICE AVAILABILITY

2.1.1 Materials and Equipment

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturer of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for two years prior to start of construction. The two-year use must include applications of equipment and materials under similar circumstances and of similar size. Contracting Officer approval of materials with less than two years experience is allowed if acceptable by the design agency and SME.

2.1.1.1 Experience Required

The two-year experience requirement must be satisfactorily completed for a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures.

2.1.1.2 Alternative Service Record

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory test, can be shown. Contracting Officer approval of materials with less than two years experience is allowed if acceptable by the design agency and SME.

2.1.2 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.1.3 Manufacturer's Nameplate

Provide a nameplate, on each item of equipment, bearing the manufacturer's name, address, model number, and serial number securely permanently affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

PART 3 EXECUTION

Not Used

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-01 33 29 (February 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 33 29 (February 2017)
UFGS-01 33 29.05 20 (March 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SUSTAINABILITY REQUIREMENTS AND REPORTING

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USACE / NAVFAC / AFCEC **UFGS-01 33 29 (February 2021)**

Preparing Activity: NAVFAC
Superseding
UFGS-01 33 29 (February 2017)
UFGS-01 33 29.05 20 (March 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 01 33 29

SUSTAINABILITY REQUIREMENTS AND REPORTING

02/21

****

NOTE: This guide specification covers the requirements for providing sustainability documentation for Guiding Principles Validation (GPV) and Third Party Certification (TPC). GPV is equivalent to meeting the requirements of UFC 1-200-02 "HIGH PERFORMANCE AND SUSTAINABLE BUILDING REQUIREMENTS." All projects must meet the requirements of UFC 1-200-02.

This guide specification includes tailoring for both DESIGN-BUILD and DESIGN-BID-BUILD.

This guide specification includes tailoring for ARMY. Deselect the ARMY tailoring option for Navy-executed projects.

Use a properly edited version of this guide specification for projects that contain one or more buildings that meet one of the following:

a) For Army and Navy, new buildings or stand-alone additions greater than or equal to 10,000 SF; for Air Force, all new buildings or stand-alone additions.

b) Comprehensive replacement in an existing building that is greater than or equal to 10,000 SF, with total cost (includes new work, renovation, operations and maintenance, sustainment, restoration, and modernization associated with and existing building renovation) greater than $3M and 50-percent or more Estimated Replacement Cost (ERC).

Use the HPSB Checklist for the Service who will maintain the building asset in their Real Property Record. Complete an HPSB Checklist for each applicable building in the project, before attaching to this specification. Checklist(s) must be

completely filled out before being used in a solicitation. Check with the user Command for additional requirements. Each Component’s HPSB Checklist may be found at: https://www.wbdg.org/ffc/dod/tri-services-sustainability-program/tracking-reporting

(Where Internet address appears on multiple lines, copy full address into Internet browser.)

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

COUNCIL ON ENVIRONMENTAL QUALITY (CEQ) (WHITE HOUSE)

HPSB Guiding Principles	(2016) Guiding Principles for Sustainable Federal Buildings and Determining Compliance with the Guiding Principles for Sustainable Federal Buildings

GREEN BUILDING INITIATIVE (GBI)

GBI DOD GP Compliance	(2017) GBI Department of Defense Guiding Principles Compliance Program for New Construction
GBI Green Globes for NC	(2017) Green Globes(tm) for New Construction Technical Reference Manual

GREEN BUSINESS CERTIFICATION INC. (GBCI)

GP Assessment (DOD)	Guiding Principles Assessment for Department of Defense

INTERNATIONAL CODE COUNCIL (ICC)

ICC IgCC	(2018) International Green Construction Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

ANSI/SMACNA 008	(2007) IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition

U.S. DEPARTMENT OF AGRICULTURE (USDA)

FSRIA 9002	Farm Security and Rural Investment Act Section 9002 (USDA BioPreferred Program)

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-200-02	(2020; Change 2, 2022) High Performance and Sustainable Building Requirements
UFC 3-210-10	(2023) Low Impact Development
UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED v4 BD+C	LEED v4 Building Design and Construction

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 433.300	Subpart C - Green Building Certification

	for Federal Buildings
40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials

1.2 SUMMARY

This section includes requirements for Sustainability documentation and reporting submittals per the federally mandated High Performance and Sustainable Building (HPSB) or HPSB "Guiding Principles" (GP),[and Third Party Certification (TPC) requirements,] in accordance with UFC 1-200-02 High Performance and Sustainable Building Requirements, and other identified requirements.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: Sustainability requirements have been identified in many of the technical performance sections. Include additional sustainability requirements throughout the technical specification sections according to goals of this project. Identify products and other submittals required for Guiding Principle Validation (GPV) and Third Party Certification (TPC) where applicable, with an "S" next to the submittal item. Use the following

format to add submittal items in the technical sections to comply with the requirements of this section:

<ITM>_{Insert Submittal Item}; _S</ITM>

Make corresponding edits in technical sections' Part 1, Part 2 Products or in Part 3 Execution to differentiate those pieces of equipment, products, or activities related to GPV and TPC.

****

****

NOTE: Choose the following bracketed paragraph for all projects except Navy-executed DESIGN-BUILD.

****

[Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

]

****

NOTE: For Air Force only: For every Air Force DESIGN-BUILD project, keep all bracketed SD-01, SD-05, and SD-11 submittals. For every Air Force DESIGN-BID-BUILD project, keep all SD-01 and SD-11 submittals

Add other Checklist and Sustainability eNotebook submittals to match the number of design submissions, based on the project scope, and add requirements paragraphs in Part 1.

****

SD-01 Preconstruction Submittals

****

NOTE: For Navy projects in the NAVFAC PAC Area of Operation only: remove the "G" designation from all SD-01 Preconstruction Submittals.

****

[Preliminary High Performance and Sustainable Building Checklist; G, [_____]

] Sustainability Action Plan; G, [_____]

[Preliminary Sustainability eNotebook; G, [_____]

] SD-05 Design Data

****

NOTE: The following four Submittals are tailored for DESIGN-BUILD.

****

[Interim Design High Performance and Sustainable Building Checklist; G, [_____]

][Interim Design Sustainability eNotebook; G, [_____]

][Final Design High Performance and Sustainable Building Checklist; G, [_____]

][Final Design Sustainability eNotebook; G, [_____]

] SD-06 Test Reports

****

NOTE: For DESIGN-BID-BUILD projects, delete the following submittal if it is not part of the contractor's scope.

****

[Third Party Certification Design Compliance Report; G, [_____]

] SD-11 Closeout Submittals

Final High Performance and Sustainable Building Checklist; G, [_____]

Final Sustainability eNotebook; G, [_____]

[Amended Final Sustainability eNotebook; G, [_____]

][Amended Final High Performance and Sustainable Building Checklist; G, [_____]

]

****

NOTE: Choose bracketed option for "Third Party Certification Certificate, Assessment, or Validation and Compliance Report" for TPC projects that require the Contractor to obtain the TPC certification.

****

[Third Party Certification Certificate, Assessment, or Validation and Compliance Report; G, [_____]

]1.4 GUIDING PRINCIPLES VALIDATION (GPV)

****

NOTE: GUIDING PRINCIPLES VALIDATION (GPV) is required in accordance with UFC 1-200-02 HIGH PERFORMANCE SUSTAINABLE BUILDING REQUIREMENTS and the notes under this specification's title above.

Complete Preliminary HPSB Checklist and include at the end of this specification. For projects with multiple buildings, attach HPSB Checklist for each building. See the notes under this specification's title above.

****

Provide the following sustainability activities and documentation to verify achievement of HPSB Guiding Principles Validation (GPV):

a. Analysis of each Guiding Principle Requirement and how project complies. Include final government approved narrative(s) in the HPSB Checklist submittal. Multiple checklists indicate multiple buildings that require individual HPSB Checklist tracking.

****

NOTE: Choose first bracket for all projects except Navy-executed DESIGN-BUILD. Choose second bracket for Navy-executed DESIGN-BUILD only.

****

b. No changes to the HPSB Checklist are allowed without approval from the Contracting Officer, in accordance with Section[01 33 00 SUBMITTAL REQUIREMENTS][01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and Section 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES, paragraph DESIGN CHANGE AND VARIATION]. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved HPSB Guiding Principles Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.

c. Documentation of all work required to incorporate the applicable HPSB Guiding Principles requirements indicated on the HPSB Checklist and in this contract, including all "S" submittals.

d. Sustainability Action Plan.

****

NOTE: The following paragraph is tailored for DESIGN-BUILD.

****

e. Design and construction related documentation for the project Sustainability eNotebook and keep updated with regularly-scheduled Construction Quality Control Meetings. Include design and construction related documentation containing the following components:

****

NOTE: The following paragraph is tailored for DESIGN-BID-BUILD.

****

f. Construction related documentation for the project Sustainability eNotebook and keep updated with regularly-scheduled Construction Quality Control Meetings. Include construction related documentation containing the following components:

(1) HPSB Checklist(s)

(2) Sustainability Action Plan

(3) Documentation illustrating HPSB Guiding Principles Requirements compliance, including "S" submittals

1.4.1 Sustainability Action Plan

Include the following information in the Sustainability Action Plan:

a. Analysis of each HPSB Guiding Principles Requirement and how project will comply. Final government approved narrative(s) must be included in the HPSB Checklist submittal.

b. Name and contact information for: Contractor's Point of Contact (POC) ensuring sustainability goals are accomplished and documentation is assembled. For TPC that include on-site visit by third party representative, provide list of required attendees.

c. Indoor Air Quality plan.

1.4.2 Calculations

****

NOTE: The following paragraph is tailored for DESIGN-BUILD.

****

Provide all design data, calculations, product data, labels and product certifications required in this specification to demonstrate compliance with the HPSB Guiding Principles Requirements.

****

NOTE: The following paragraph is tailored for DESIGN-BID-BUILD.

****

Provide all calculations, product data, labels and product certifications required in this specification to demonstrate compliance with the HPSB Guiding Principles Requirements.

1.5 SUSTAINABILITY SUBMITTALS

Provide HPSB Checklist and other documentation in the Sustainability eNotebook to indicate compliance with the sustainability requirements of the project.

1.5.1 High Performance Sustainable Building (HPSB) Checklist

Provide construction documentation that provides proof of, and supports compliance with, the completed HPSB Checklist.

1.5.1.1 HPSB Checklist Submittals

Submit updated HPSB Checklist with each Sustainability eNotebook submittal. Include the final HPSB Checklist(s) with the interim DD1354 Real Property Record Submittal.

1.5.2 "S" Submittals for Sustainability Documentation

****

NOTE: Include the bracketed phrases below for projects required to obtain TPC.

****

"S" submittals are the sustainability documentation requirements cited in the various sections of this contract. Submit the GPV[and TPC] sustainability documentation required in this section as "S" submittals in all affected UFGS Sections.

a. Highlight GPV[and TPC] compliance data in "S" submittal.

b. Add "S" submittals to the Sustainability eNotebook only after submittal approval, and bookmark them as required in paragraph SUSTAINABILITY ENOTEBOOK below.

c. Ensure all approved "S" submittals are included in each Sustainability eNotebook submittal.

1.5.3 Sustainability eNotebook

****

NOTE: Include the bracketed TPC phrases for projects required to obtain TPC.

****

The Sustainability eNotebook is an electronic organizational file that serves as a repository for all required sustainability submittals. To support documentation of compliance with an approved HPSB[and TPC] checklist, provide and maintain a comprehensive and current Sustainability eNotebook. Include all required data in Sustainability eNotebook, to support full compliance with the HPSB Guiding Principles Requirements, including:

a. HPSB checklist

b. Sustainability Action Plan

c. Calculations

d. Labels

e. "S" submittals

[f. Certifications, assessments, or validations and compliance report

][g. TPC documentation required in paragraph THIRD PARTY CERTIFICATION (TPC).

]1.5.3.1 Sustainability eNotebook Format

Provide Sustainability eNotebook in the form of an Adobe PDF file; bookmark each HPSB Guiding Principles Requirement[, TPC requirement,] and sub-bookmark at each document. Match format to HPSB Guiding Principles numbering system indicated herein. Maintain up-to-date information, such as spreadsheets, templates, with each current submittals.[For TPC projects, provide a second Table of Contents using TPC numbering system, for maintaining documentation unique to TPC.]

Contracting Officer may deduct from the monthly progress payment accordingly if Sustainability eNotebook information is not current and on track per project goals.

1.5.3.2 Sustainability eNotebook Submittal Schedule

Provide Sustainability eNotebook Submittals at the following milestones of the project:

****

NOTE: Choose submittal paragraphs, based on scope of project. In each of the following paragraphs, include the first bracketed phrase for projects required to obtain TPC.

****

[a. Preliminary Sustainability eNotebook

b. Submit preliminary Sustainability eNotebook with updated Preliminary High Performance and Sustainable Building Checklist[and TPC checklist] at the first post award meeting in accordance with Section 01 30 00 ADMINISTRATIVE REQUIREMENTS.

]

****

NOTE: The following two paragraphs are tailored for DESIGN-BUILD.

Choose submittal paragraphs, based on scope of project. In each of the following paragraphs, include the first bracketed phrase for projects required to obtain TPC. Include the second bracketed phrase for Navy-executed DESIGN-BUILD only.

****

[c. Interim Design Sustainability eNotebook

d. Submit updated Sustainability eNotebook with updated Interim Design High Performance and Sustainable Building Checklist[with TPC Checklist] with the final design[, in accordance with Section 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES]. If issues relating to achieving the sustainability goals of the project are subsequently identified, identify reasons and mitigation from DOR, and resubmit to the Contracting Officer for approval.

][e. Final Design Sustainability eNotebook

f. Submit updated Sustainability eNotebook with updated Final Design High Performance and Sustainable Building Checklist[with TPC Checklist] with the final design[, in accordance with Section 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES]. If issues relating to achieving the sustainability goals of the project are subsequently identified, identify reasons and mitigation from DOR, and resubmit to the Contracting Officer for approval.

]

****

NOTE: For projects required to obtain TPC, include the bracketed paragraph when seeking approval of TPC design requirements. This is the preferred method to obtain TPC, and it is preferred this report is obtained prior to construction award. For DESIGN-BID-BUILD projects, delete this report if it is not part of the contractor's scope.

****

[g. Third Party Certification Design Compliance Report

h. Obtain Third Party Certification Design Compliance Report after final design submittal is approved. Submittal must indicate 100 percent compliance with applicable design requirements. File approved submittal in the Sustainability eNotebook.

]

****

NOTE: Include the bracketed phrases for projects required to obtain TPC.

****

i. Construction Quality Control Meetings.

j. Provide up-to-date GP[and TPC] documentation in the Sustainability eNotebook[and TPC Online tool] for each meeting.

****

NOTE: Include the first bracketed phrase for projects required to obtain TPC.

Include the second bracketed phrase for Navy-executed DESIGN-BUILD only.

****

k. Final Sustainability eNotebook

l. Submit updated Sustainability eNotebook with updated Final High Performance and Sustainable Building Checklist[with TPC Checklist][, in accordance with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES] at Beneficial Occupancy Date (BOD). Final progress payment retainage may be held by Contracting Officer until Final Sustainability construction phase documentation is complete.

****

NOTE: Include the following paragraph when an amended Sustainability eNotebook is required (due to post-construction activities such as commissioning). Include the first bracketed phrase for projects required to obtain TPC.

****

[m. Amended Final Sustainability eNotebook

n. Amend and resubmit the Amended Final Sustainability eNotebook with Amended Final High Performance and Sustainable Building Checklist[and amended TPC Checklist], to include post-occupancy corrections, updates, and requirements. Final progress payment retainage may be held by Contracting Officer until amended final sustainability documentation is complete. Submit the Amended Final Sustainability eNotebook Submittal on DVDs to the Contracting Officer no later than 30 days after final GP[, TPC] determination.

]1.6 DOCUMENTATION REQUIREMENTS

a. Incorporate each of the following HPSB Guiding Principles requirements into project and provide documentation that proves compliance with each listed requirement. Items below are organized by

HPSB Guiding Principles. For life-cycle cost analysis requirements, one document with all analyses is acceptable, with Contracting Officer approval.

b. For each of the following paragraphs that require the use of products listed on Government-required websites, provide documentation of the process used to select products, or process used to determine why listed products do not meet project performance requirements.

****

NOTE: The following subparagraphs provide Guiding Principle Requirements.

Choose requirements that can be fully achieved, or partially achieved to the greatest degree possible. For partially achievable requirements, track them as "yes" only with one of the following justifications:

1. Life-cycle cost-effectiveness and energy model;
2. Mission restriction (ex: 24/7 operation);
3. Location/regional restriction (ex: availability of high-efficiency equipment service);
4. Locale restriction (ex: proximity of existing buildings restricts daylighting).

Delete requirements that are not applicable to the project. Non-applicability requires one of the following justifications:

1. Life-cycle cost-effectiveness and energy model;
2. Mission exclusion (ex: no daylighting in a theater or a SCIF);
3. Location/regional exclusion (ex: no local recycling facility); or
4. Locale exclusion (ex: there is no steam to meter).

****

1.6.1 Integrated Design Process

****

NOTE: This paragraph is tailored for DESIGN-BUILD.

****

For the submittal documentation below, demonstrate compliance with UFC 1-200-02.

1.6.1.1 Design Submittal Documentation

a. List the sustainability integrated design team, and a description of their roles in all stages of a project's planning and delivery:

   (1) Include Contractor's Sustainability Coordinators; Architecture and Engineering disciplines involved on the project, and the DOR in charge of the overall project and each discipline; Construction Subcontractors and the company representatives that align with each architectural and engineering discipline, Planning, Public Works, Environmental Specialist and other appropriate installation personnel.

(2) Describe their roles and responsibilities and plan-of-action for how each team member will be involved to achieve the project sustainability requirements, and how the Contractor will coordinate with Government personnel.

(3) Maintain an up-to-date list with descriptions throughout the project.

b. Provide narratives that:

(1) Indicate performance goals for siting, energy, water, materials, and indoor environmental quality along with other comprehensive design goals and ensures incorporation of these goals throughout the design and life cycle of the building.

(2) Demonstrate integration of the goals into design and construction.

(3) Demonstrate collaboration with other providers, such as Commissioning Authority[and Third Party Certification].

1.6.2 Commissioning (Cx)

Develop and incorporate Commissioning requirements into the documents, in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

1.6.3 Optimize Energy Performance

****

NOTE: This paragraph is tailored for DESIGN-BUILD.

****

For the submittal documentation below, demonstrate compliance with UFC 1-200-02.

1.6.3.1 Design Submittal Documentation

****

NOTE: For determining energy consumption reduction levels, comply with UFC 1-200-02 HIGH PERFORMANCE AND SUSTAINABLE BUILDING REQUIREMENTS, paragraphs titled "Life-Cycle Cost Analysis," "Energy Efficiency," and "Energy Compliance Analysis."

****

a. Narrative that provides a summary of:

(1) The decision-making process leading to the selection of at least three energy-efficient solutions (for each system contributing to the energy footprint of the building) to be analyzed; and the selected design solution(s)

(2) The specific energy standard and version utilized; and the software used in the analysis

(3) The calculated energy consumption and energy use intensity (EUI in kBTU/sf/yr) of the baseline building and the proposed design alternatives

b. A minimum of the following energy modeling files and summaries for the baseline and proposed alternatives:

  (1) Input, schedules and libraries; and output

  (2) Calculated energy use by energy type

  (3) Calculated energy use by building system

c. The life-cycle cost analysis input and output files for the baseline and the proposed alternatives

1.6.3.2 Construction Submittal Documentation

Provide revised energy modeling for actual system constructed.

1.6.4 Energy Efficient Products

Provide only energy-using products that are Energy Star rated or have Federal Energy Management Program (FEMP) recommended efficiency. Where Energy Star or FEMP recommendations have not been established, provide most efficient products that are life-cycle cost-effective. Provide only energy using products that meet FEMP requirements for low standby power consumption. Energy efficient products can be found at: https://www.energy.gov/eere/femp/federal-energy-management-program and http://www.energystar.gov/.

For construction submittal documentation, provide proof that product is labeled energy efficient and complies with the cited requirements.

1.6.5 On-site Renewable Energy Generation

****

NOTE: This paragraph is tailored for DESIGN-BUILD.

****

For the submittal documentation below, demonstrate compliance with UFC 1-200-02.

1.6.5.1 Design Submittal Documentation

Provide life-cycle cost analysis (LCCA). When found to be LCCE, do one of the following options:

a. Provide design drawings and calculations that demonstrate total on-site renewable energy as an annual percentage of proposed building energy consumption in kBTU/year; and provide equipment ratings, and calculations that demonstrate the generation capacity of the system in kBTU/year for thermal and kwh for electricity.

b. Provide documentation that renewable energy development at the Installation level is planned.

1.6.6 Solar Domestic Hot Water (SDHW)

****

NOTE: This paragraph is tailored for DESIGN-BUILD.

****

For the submittal documentation below, demonstrate compliance with UFC 1-200-02.

1.6.6.1 Design Submittal Documentation

Provide life-cycle cost analysis (LCCA). When found to be LCCE, provide design drawings and calculations that demonstrate total on-site renewable energy as an annual percentage of proposed building energy consumption in kBTU/year; and provide equipment ratings, and calculations that demonstrate the generation capacity of the system in kBTU/year for thermal.

1.6.7 Building-level Power Metering

Provide building-level meters for electricity, natural gas, and steam where applicable.

1.6.7.1 Design Submittal Documentation

****

NOTE: The following paragraph is tailored for DESIGN-BUILD.

****

Provide design drawings that highlight meter locations on the site.

1.6.7.2 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.8 Indoor Water Use

Provide Construction Documentation proof that fixtures are labeled EPA WaterSense, for products available with EPA WaterSense labeling; for all other fixtures, proof they comply with EPA WaterSense efficiency requirements.

1.6.9 Indoor Water Metering

Provide building-level meters for potable water use. Provide the requirements cited in the following paragraphs:

1.6.9.1 Design Submittal Documentation

****

NOTE: This paragraph is tailored for DESIGN-BUILD.

****

Provide design drawings that highlight meter locations on the site.

1.6.9.2 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.10 Outdoor Water Use

Where new irrigation is required, provide only non-potable sources. Provide the requirements cited in the following paragraphs:

1.6.10.1 Design Submittal Documentation

****
NOTE: This paragraph is tailored for DESIGN-BUILD.
****

a. Provide design drawings and analysis that identify the non-potable water source used and demonstrate the non-potable water source is appropriate for landscape irrigation.

b. Provide life-cycle cost analysis (LCCA).

1.6.10.2 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.11 Outdoor Water Meters

Provide meters for outdoor systems that use potable water. Provide the requirements cited in the following paragraphs:

1.6.11.1 Design Submittal Documentation

****
NOTE: This paragraph is tailored for DESIGN-BUILD.
****

a. Provide design drawings that highlight meter locations on the site.

b. Provide life-cycle cost analysis (LCCA).

1.6.11.2 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.12 Alternative Water

****
NOTE: This paragraph is tailored for DESIGN-BUILD.
****

Use alternative sources of water to replace potable water usage, when life-cycle cost-effective and to the extent permitted by local laws and regulations.

1.6.12.1 Design Submittal Documentation

a. Provide design drawings and calculations that demonstrate the alternative water sources used, potable water savings as compared to non-alternative water sourcing, and projected annual potable water savings.

b. Provide life-cycle cost analysis (LCCA).

1.6.13 Stormwater Management

****
NOTE: This paragraph is tailored for DESIGN-BUILD.
****

Develop and incorporate stormwater requirements into the documents. Submit design and construction documentation required by UFC 3-210-10 and Service processes, as proof of this tracking requirement.

1.6.14 Ventilation and Thermal Comfort

****
NOTE: This paragraph is tailored for DESIGN-BUILD.
****

For the submittal documentation below, demonstrate compliance with UFC 1-200-02.

1.6.14.1 Design Submittal Documentation

Provide design drawings and calculations that demonstrate HVAC systems and the building envelope have been designed to meet the requirements.

1.6.15 Daylighting

****
NOTE: This paragraph is tailored for DESIGN-BUILD.
****

For the submittal documentation below, demonstrate compliance with UFC 1-200-02.

1.6.15.1 Design Submittal Documentation

a. Provide floor plans and elevations.

b. Provide design analysis delineating requirements, to include compliant reflective surface locations and shading devices (where applicable).

1.6.16 Moisture Control

Provide the following:

1.6.16.1 Design Submittal Documentation

****
NOTE: This paragraph is tailored for DESIGN-BUILD.
****

Provide drawings of building envelope details and HVAC humidity controls.

1.6.16.2 Construction Submittal Documentation

Ensure construction materials are separated and protected in accordance with other sections in this contract document, with adequate humidity controls during construction. In accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, includes plan for ongoing building moisture control.

Coordinate with the moisture control requirements of Section 01 45 00 QUALITY CONTROL.

1.6.17 Reduce Volatile Organic Compounds (VOC) (Low-Emitting Materials)

Meet the requirements of Table 3-1 at the end of this specification.

For Construction submittal documentation, provide certifications or labels that demonstrate compliance with cited requirements, based on the attached TABLE 3-1.

1.6.18 Indoor Air Quality During Construction

Prior to construction, create indoor air quality plan. Develop and implement an IAQ construction management plan during construction and flush building air before occupancy.

****

NOTE: Choose the first bracketed sentence for new construction or renovation projects in buildings that are not occupied during construction.

Choose the second bracketed sentence for Navy-executed only.

Choose the third bracketed sentence for renovation projects in buildings that remain occupied during construction.

****

[For new construction and for renovation of unoccupied existing buildings, meet the requirements of ICC IgCC 1001.3.1.5 (10.3.1.4) Indoor Air Quality (IAQ) Construction Management.] [Coordinate with moisture control requirements in Section 01 45 00 QUALITY CONTROL.] [For renovation of occupied existing buildings, meet the requirements of ANSI/SMACNA 008 IAQ Guidelines for Occupied Buildings Under Construction.]

****

NOTE: Choose "building" for all new construction projects, and for renovation projects that substantially replace the building from the foundation up. Choose "area" for all other renovation projects.

****

Provide documentation showing that after construction ends and prior to occupancy, HVAC filters were replaced and [building][area] air was flushed out in accordance with the cited standard.

1.6.19 Recycled Content

Comply with 40 CFR 247. Refer to: https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program for assistance identifying products cited in 40 CFR 247. Selected products must comply with non-proprietary requirements of the Federal Acquisition Regulation and must meet performance requirements.

1.6.19.1 Construction Submittal Documentation

a. Provide manufacturers' documents stating the recycled content by material, or written justification for claiming one of the exceptions allowed on the cited website.

b. Substitutions: Submit for Government approval for proposed alternative products or systems that provide equivalent performance and appearance and have greater contribution to project recycled content requirements. For all such proposed substitutions, submit with the Sustainability Action Plan accompanied by product data demonstrating equivalence.

c. In order to complete compliance with FAR 52.223-9 Estimate of Percentage of Recovered Material Content for EPA Designated Items, refer to submittal requirement for recycled/recovered material content in Section 01 78 00 CLOSEOUT SUBMITTALS.

1.6.20 Bio-Based Products

Provide products and materials composed of the highest percentage of bio-based materials (including rapidly renewable resources and certified sustainably harvested products), consistent with FSRIA 9002 USDA BioPreferred Program, to the maximum extent possible without jeopardizing the intended end use or detracting from the overall quality delivered to the end user and when available at a reasonable cost. Use only supplies and materials of a type and quality that conform to applicable specifications and standards.

Comply with FSRIA 9002 USDA BioPreferred Program. Refer to www.biopreferred.gov for the product categories and BioPreferred Catalog. Selected products must comply with non-proprietary requirements of the Federal Acquisition Regulation and must meet performance requirements. Provide the following documentation:

a. USDA BioPreferred label for each product; for bio-based products used on project but not listed with BioPreferred program, provide bio-based content and percentage.

b. In order to complete compliance with FAR 52.223-1 Biobased Product Certification, refer to submittal requirement for biobased products in Section 01 78 00 CLOSEOUT SUBMITTALS, paragraphs CERTIFICATION OF EPA DESIGNATED ITEMS and CERTIFICATION OF USDA DESIGNATED ITEMS.

1.6.21 Waste Material Management (Recycling – Design)

****

NOTE: This paragraph is tailored for DESIGN-BUILD.

****

For the submittal documentation below, demonstrate compliance with UFC 1-200-02.

For design submittal documentation, provide drawing showing an appropriately sized and placed dedicated storage area for recyclables.

1.6.22 Waste Material Management (Recycling – Construction)

****

NOTE: Verify division percentage in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.
****

Divert demolition and construction debris in accordance with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

[1.6.23 Address Climate Change Risk

****
NOTE: This paragraph is tailored for DESIGN-BUILD.

Address only government-provided, specific scope direction related to the following paragraph. If none has been provided in the DD1391 or scope, delete this paragraph, and document on HPSB Checklist and other required tracking locations as "N/A due to location/regional exclusion".
****

For design submittal documentation, provide narrative of decisions for design associated with scoped requirements.

][1.6.24 Additional Sustainability Requirements

Provide the additional sustainability requirements cited in this paragraph.

****
NOTE: In addition to GPV and Sustainability eNotebook, Third Party Certification (TPC) is required for projects that meet the thresholds cited in Table 1-1 of UFC 1-200-02.

1. New building or stand-alone addition greater than or equal to 10,000 SF, with construction cost greater than $3M.

2. Comprehensive replacement in an existing building that is greater than or equal to 10,000 SF, with total cost greater than $3M and 50-percent or more ERC.

TPC is the generic term for a third party product that provides either certification of the third party vendor's proprietary product requirements (examples LEED, Green Globes), or a validation program by the third party vendor that UFC 1-200-02 requirements have been met (examples: Guiding Principles Assessment, Guiding Principles Compliance).

For each building that meets item 1 or item 2 above, choose one of the following paragraphs titled "Third Party Certification (TPC) Documentation" below, based on how TPC is executed, and delete the others.
****

[1.6.24.1 Third Party Certification (TPC) Documentation

****

NOTE: This paragraph is tailored for DESIGN-BUILD.

****

Third Party Certification certificate, assessment, or validation, and compliance report requirements are in addition to all requirements under header above GUIDING PRINCIPLES VALIDATION (GPV).

1.6.24.1.1 TPC Registration Required

****

NOTE: Choose the rating system below that best assists with Guiding Principles Validation and delete the others. Verify rating systems approved for use by Service.

Obtain, fill out, and include TPC checklist with this section. For projects with multiple buildings, attach completed TPC Checklist for each building that requires TPC.

For certifications, assessments, or validations that include a plaque, include the bracketed phrase in the first paragraph.

For Air Force ONLY: Choose one of the following methods for executing TPC:

a. For Guiding Principles Assessment for Department of Defense (by GBCI), choose "GP Assessment (DOD)", use only DOD version, and ask for it when registering.

b. For Green Building Initiative (GBI) Department of Defense Guiding Principles Compliance, or "GBI DOD GP Compliance", use only DOD version, and ask for it when registering.

For Army projects ONLY: Choose only the following method for executing TPC:

a. For USGBC LEED v4, choose "LEED v4 BD+C", and enter "Silver" in the bracket. For use of alternate certification systems, a waiver must be submitted per the current Army Sustainable Design and Development Policy.

For Navy ONLY: Choose one of the following methods for executing TPC:

a. For USGBC LEED v4, choose "LEED v4 BD+C", and enter the target level in the bracket.

b. For Guiding Principles Assessment for Department of Defense (by GBCI), choose "GP Assessment (DOD)", use only DOD version, and ask for it when registering.

c. For Green Building Initiative (GBI) Department of Defense Guiding Principles Compliance, or "GBI DOD GP Compliance", use only DOD version, and ask for it when registering.

d. For "GBI Green Globes for NC", enter the target level in the bracket.

e. For an alternate certification system, use only those that comply with the minimum requirements of 10 CFR 433.300 Subpart C – Green Building Certification for Federal Buildings, and insert the name of the compliant system in the empty bracket. Facilities Engineering Command (FEC) Capital Improvements (CI) Core must authorize the use of alternative system.

****

Register and achieve Third Party Certification (TPC), by meeting all TPC and project requirements to achieve [LEED v4 BD+C [_____]] [GP Assessment (DOD)] [GBI DOD GP Compliance] [GBI Green Globes for NC [_____]] [[_____][_____]], or Government-approved equivalent TPC sustainability certification, assessment, or validation. An equivalent TPC organization must demonstrate equivalency for Government consideration and meet the requirements of 10 CFR 433.300, prior to use on the project. Third Party Certification is met when Government receives TPC organization certificate, assessment, or validation and compliance report[and plaque].

Register project with TPC organization using the following format and content:

a. Project Title First Line: Building Owner (US Army, US Air Force, US Navy or US Marine Corps), Building Name (if known)

b. Project Title Second Line: MILCON P#, DD1391 Project Name

c. Project Address: UIC (Installation code), Category code, RPUID (Real Property Unique Identifier) Number

d. Project Owner Organization: US Army, US Air Force, US Navy or US Marine Corps

e. Primary Contact, Project Owner: Executing DOD Service's Project Manager or Design Manager

f. Building Owner Organization: US Army, US Air Force, US Navy or US Marine Corps

g. Building Owner Organization Project Number

****

NOTE: Choose first bracket for Air Force projects and delete the others. Choose second bracket for Army projects and delete the others. Choose third bracket for Navy projects and delete the others.

****

h. Additional Contact, Building Owner: [Base Civil Engineer][Department of Public Works][Public Works Officer] or Designee.

1.6.24.1.2 TPC Management and Certification

Execute the following TPC Certification, assessment, or validation requirements:

a. Refer to TPC Checklist at the end of this specification section. (Multiple checklists indicate multiple buildings that require TPC.)

b. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved TPC Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.

c. Complete all design and construction work to incorporate the applicable TPC Requirements.

d. Maintain the design and construction related information in the Sustainability eNotebook pertaining to additions and changes to the approved sustainability requirements. Maintain the Sustainability eNotebook in electronic format. Refer to explanation in the paragraph SUSTAINABILITY eNOTEBOOK. Provide the following components in the Sustainability eNotebook, in addition to the GPV components listed above:

    (1) TPC Checklist

    (2) Completed TPC forms. Transmit by the method required by TPC organization.

    (3) Copy of all correspondence with the TPC organization. Provide proof of TPC registration.

    (4) Documentation illustrating compliance with TPC requirements and additional documentation as requested by the Third Party certifier.

    (5) TPC Award Certificate, assessment or validation and compliance report.

e. Provide the following information in the Sustainability Action Plan. Provide this TPC information in addition to the Sustainability Action Plan items above:

    (1) Planned method to achieve each TPC requirement.

    (2) Provide analysis of each TPC credit and how project will comply.

    (3) Provide names and contact information for: Contractor sustainability point of contact (POC) and other names of sustainability professionals on the Contractor's Staff responsible for ensuring TPC sustainability goals are accomplished and documentation is assembled.

****

NOTE: For certifications, assessments, or validations that include a plaque, included the bracketed phrase.

****

f. Bear all costs associated with designing, constructing, demonstrating, and documenting that project complies with approved TPC requirements, including but not limited to:

  (1) Registration, review, certification, assessment, or validation[and plaque] fees.

  (2) Online (or offline with secure facilities) TPC management and documentation.

  (3) Obtaining TPC certification, assessment, or validation based on Government-approved sustainability goals.

  (4) Design and construction work required to incorporate TPC requirements.

  (5) Submittals required to demonstrate compliance with Government approved TPC checklists.

g. Provide all design data, calculations, product data, and certifications, assessments, or validations required in this specification to demonstrate compliance with the TPC Requirements.

h. Provide all online (or offline, with secure facilities) TPC management and documentation.

i. Provide all required responses to third party organization.

****

NOTE: Include the bracketed paragraph below for TPC that includes required site visit by a TPC representative. Coordinate with the TPC representative, Project Manager, Design Manager, and Construction Manager to determine participating team members. Include commissioning provider on applicable projects.

For projects that require the Construction Contractor to obtain TPC, the Construction Contractor’s designated Sustainability POC is responsible to coordinate the TPC site visit.

****

[j. Facilitate and participate in required TPC site visit. Coordinate with the Executing DOD Service's Project Manager and Design Manager, to determine participating team members. Include Commissioning provider on applicable projects.
]

****

NOTE: Include the bracketed paragraph below for TPC that include a certification, assessment, or validation. For TPC that include a plaque, include the bracketed phrases.

****

[k. Provide TPC [Plaque and]Certificate, assessment, or validation. Provide TPC compliance report that includes level achieved and reasons for non-compliance or not applicable elements. Use the following format to create the Plaque, Certificate, assessment, or validation, compliance report, and Letter of Congratulations. Forward to parties designated by Contracting Officer:

[(1) Plaque:

(2) Name: Final Building Name. If unknown, use the Form DD1391 Project Name.

] (3) Certificate, Assessment, or Validation:

(4) Project title, first line: P-(X); (1391 Project Name). Project title, second line: UIC (installation code)

(5) Letter of Congratulation (when provided):

(6) Address letter to the Facility's Installation Commander Name. Address the letter to an individual person.

(7) Compliance Report:

(8) Title page must cite Project title: P-(X); (1391 Project Name); Final Building Name if known; UIC (installation code); Owner Service; User organization if known; date of compliance.

(9) Include TPC scoresheet if applicable.

]

****

NOTE: Choose first bracket for Air Force projects. Choose second bracket for Army projects. Choose third bracket for Navy projects.

****

l. Once Final Certification is achieved, turn over Administrative rights to online TPC to the [Base Civil Engineer][Department of Public Works][Public Works Office] or designee, contact information provided by the Contracting Officer.

][1.6.24.2 Third Party Certification (TPC) Documentation

****

NOTE: Choose this DESIGN-BID-BUILD "Third Party Certification (TPC) Documentation" paragraph for Third Party Certification, assessment, or validation when the Designer of Record is responsible for the entire TPC process, with the Construction Contractor providing the construction documentation. This is the preferred method of TPC execution for DESIGN-BID-BUILD (DBB) Delete the other DESIGN-BID-BUILD "Third Party Certification (TPC) Documentation" paragraph option.

****

Third Party Certification certificate, assessment, or validation, and compliance report requirements are in addition to all requirements under header above GUIDING PRINCIPLES VALIDATION (GPV).

1.6.24.2.1 TPC Registration

****

NOTE: Choose the rating system below that best assists with Guiding Principles Validation, complies with Component policy, and delete the others.

Obtain, fill out, and include TPC checklist with this section. For projects with multiple buildings, attach TPC Checklist for each building that requires TPC.

For certifications, assessments or validations that include a plaque, include the bracketed phrase in the first paragraph.

For Air Force ONLY: Choose one of the following methods for executing TPC:

a. For Guiding Principles Assessment for Department of Defense (by GBCI), choose "GP Assessment (DOD)", use only DOD version, and ask for it when registering.

b. For Green Building Initiative (GBI) "Department of Defense Guiding Principles Compliance", or "GBI DOD GP Compliance", use only DOD version, and ask for it when registering.

For Army projects ONLY: Choose only the following method for executing TPC:

a. For USGBC LEED v4, choose "LEED v4 BD+C", and enter "Silver" in the bracket. For use of alternate certification systems, a waiver must be submitted per the current Army Sustainable Design and Development Policy.

For Navy ONLY: Choose one of the following methods for executing TPC:

a. For USGBC LEED v4, choose "LEED v4 BD+C", and enter the target level in the bracket.

b. For Guiding Principles Assessment for Department of Defense (by GBCI), choose "GP Assessment (DOD)", use only DOD version, and ask for it when registering.

c. For Green Building Initiative (GBI) "Department of Defense Guiding Principles Compliance", or "GBI GP DOD Compliance", use only DOD version, and ask for it when registering.

d. For Green Building Initiative (GBI) Green Globes, choose "GBI Green Globes for NC", and enter the target level in the bracket.

e. For an alternate certification system, use only

those that comply with the minimum requirements of 10 CFR 433.300 Subpart C — Green Building Certification for Federal Buildings, and insert the name of the compliant system in the empty bracket. Facilities Engineering Command (FEC) Capital Improvements (CI) Core must authorize the use of alternative system.

****

This project has been designed for, and must be constructed to achieve [LEED v4 BD+C [_____]] [GP Assessment (DOD)] [GBI DOD GP Compliance] [GBI Green Globes for NC [_____]] [_____]. Project is already registered with the TPC Organization. Provide construction related sustainability documentation, in the format required by the TPC Organization, to the Contracting Officer for approval, and for final approval by the TPC organization. Third Party Certification is met when Government receives TPC organization certificate, assessment, or validation and compliance report[and plaque]. Execute the following:

a. Refer to TPC Checklist at the end of this specification section. (Multiple checklists indicate multiple buildings that require TPC.)

b. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved TPC Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.

c. Complete all work required to incorporate the applicable TPC Requirements.

d. Maintain the construction related information in the Sustainability eNotebook pertaining to additions and changes to the approved sustainability requirements. Maintain the Sustainability eNotebook in electronic format. For more explanation, refer to paragraph SUSTAINABILITY eNOTEBOOK. Provide the following components in the Sustainability eNotebook, in addition to the GPV components above:

    (1) TPC Checklist

    (2) Provide construction documentation required to achieve third party certification

e. Provide the following information in the Sustainability Action Plan. Provide this TPC information in addition to the GPV Action Plan items above:

    (1) Planned method to achieve each TPC requirement.

    (2) For each TPC requirement that is attempted but not achieved, provide narrative explaining how mission or activity precludes achieving specific sustainability requirement or goal. Provide analysis of particular requirement and level to which project is able to comply.

    (3) Provide name and contact information for: Sustainability Point of Contact (POC) and other names of sustainability professionals responsible for ensuring TPC sustainability goals are accomplished and documentation is assembled. Sustainability POCs are also responsible for ensuring GPV required in paragraph GUIDING

PRINCIPLES VALIDATION (GPV) above.

f. Bear all costs associated with construction changes that affect sustainability design requirements, constructing, demonstrating, and documenting that project complies with approved TPC requirements, including but not limited to:

(1) TPC coordination with Government's AE and other consultants, TPC website requirements, and management for construction related documentation.

(2) Construction work required to incorporate TPC requirements.

(3) Submittals required to demonstrate compliance with Government approved TPC checklists.

(4) Documentation illustrating compliance with TPC requirements and additional documentation required by the TPC.

g. Provide all calculations, product data, and certifications, assessments, or validations required in this contract to demonstrate compliance with the TPC Requirements of this section.

][1.6.24.3 Third Party Certification (TPC) Documentation

****

NOTE: Choose this DESIGN-BID-BUILD "Third Party Certification (TPC) Documentation" paragraph, if the Construction Contractor is responsible for achieving the final TPC. Use of this method is discouraged. Delete the previous DESIGN-BID-BUILD "Third Party Certification (TPC) Documentation" paragraph option.

****

Third Party Certification certificate, assessment, or validation, and compliance report requirements are in addition to all requirements under header above GUIDING PRINCIPLES VALIDATION (GPV).

[1.6.24.3.1 TPC Registration Required

****

NOTE: Choose this bracketed paragraph if the Designer of Record (DOR) has not registered the project with a TPC organization, and the Construction Contractor must do so. Delete the second bracketed paragraph.

****

****

NOTE: Choose the rating system below that best assists with Guiding Principles Validation complies with Component policy and delete the others.

Obtain, fill out, and include TPC checklist with this section. For projects with multiple buildings, attach TPC Checklist for each building that requires TPC.

For certifications, assessments, or validations that

include a plaque, include the bracketed phrases below.

For Air Force ONLY: Choose one of the following methods for executing TPC:

a. For Guiding Principles Assessment by USGBC/GBCI (DOD Version), choose "GBCI GP Assessment", use only DOD version, and ask for it when registering.

b. For Green Building Initiative (GBI) "Department of Defense Guiding Principles Compliance", or "GBI GP DOD Compliance", use only DOD version, and ask for it when registering.

For Army projects ONLY: Choose only the following method for executing TPC:

a. For USGBC LEED v4, choose "LEED v4 BD+C", and enter "Silver" in the bracket. For use of alternate certification systems, a waiver must be submitted per the current Army Sustainable Design and Development Policy.

For Navy ONLY: Choose one of the following methods for executing TPC:

a. For USGBC LEED v4, choose "LEED v4 BD+C", and enter the target level in the bracket.

b. For Guiding Principles Assessment for Department of Defense (by GBCI), choose "GP Assessment (DOD)", use only DOD version, and ask for it when registering.

c. For Green Building Initiative (GBI) "Department of Defense Guiding Principles Compliance", or "GBI GP DOD Compliance", use only DOD version, and ask for it when registering.

d. For Green Building Initiative (GBI) Green Globes, choose "GBI Green Globes for NC", and enter the target level in the bracket.

e. For an alternate certification system, use only those that comply with the minimum requirements of 10 CFR 433.300 Subpart C – Green Building Certification for Federal Buildings, and insert the name of the compliant system in the empty bracket. Facilities Engineering Command (FEC) Capital Improvements (CI) Core must authorize the use of alternative system.

****

Pay all fees associated with registration and achievement of Third Party Certification (TPC), by meeting all TPC and project requirements to achieve [LEED v4 BD+C [_____]] [GP Assessment (DOD)] [GBI DOD GP Compliance] [GBI Green Globes for NC [_____]], or Government-approved equivalent TPC sustainability certification, assessment, or validation. An equivalent TPC organization must demonstrate equivalency for Government consideration and meet the requirements of 10 CFR 433.300, prior to use on the project. Third Party Certification is met when Government receives TPC organization certificate, assessment, or validation and compliance report[and plaque.]

Register project with TPC organization using the following format and content:

a. Project Title First Line: Building Owner (US Army, US Air Force, US Navy or US Marine Corps), Building Name (if known)

b. Project Title Second Line: MILCON P#, DD1391 Project Name

c. Project Address: UIC (Installation code), Category code, RPUID (Real Property Unique Identifier) Number

d. Project Owner Organization: US Army, US Air Force, US Navy or US Marine Corps

e. Primary Contact, Project Owner: Component Project Manager

f. Building Owner Organization: US Army, US Air Force, US Navy or US Marine Corps

g. Building Owner Organization Project Number

h. Additional Contact, Building Owner: Department of Public Works, Public Works Officer, Base Civil Engineer, or Designee

][1.6.24.3.2 TPC Already Registered

****

NOTE: Choose this bracketed paragraph if the DOR has registered the project with a TPC organization and will pass the responsibility for final TPC documentation and certification, assessment, or validation to the Construction Contractor. Delete the previous bracketed paragraph.

****

****

NOTE: Obtain, fill out, and include TPC checklist with this section. For projects with multiple buildings, attach TPC Checklist for each building that requires TPC.

For certifications, assessments, or validations that include a plaque, include the bracketed phrases below.

****

Project is already registered with TPC organization to achieve [LEED v4 BD+C [_____]] [GP Assessment (DOD)] [GBI DOD GP Compliance] [GBI Green Globes for NC [_____]] [_____]. When applicable, request TPC online access turnover from Government. Manage and provide all documentation for requirements of TPC and obtain Final Certification or validation. Third Party Certification is met when Government receives TPC organization certificate, assessment, or validation and compliance report[and plaque].

]1.6.24.3.3 TPC Management and Certification

Execute the following TPC Certification, assessment, or validation requirements:

a. Refer to TPC Checklist at the end of this specification section. (Multiple checklists indicate multiple buildings that require TPC.)

b. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved TPC Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.

c. Complete all work required to incorporate the applicable TPC Requirements.

d. Maintain the construction related information in the Sustainability eNotebook pertaining to additions and changes to the approved sustainability requirements. When construction changes are made that affect design sustainability requirements, provide all required updates to affected design requirements and update in the Sustainability eNotebook. Maintain the Sustainability eNotebook in electronic format. For more explanation, refer to paragraph SUSTAINABILITY eNOTEBOOK. Provide the following components in the Sustainability eNotebook, in addition to the GPV components above:

    (1) TPC Checklist

    (2) Completed TPC forms. Transmit by the method required by the TPC organization.

    (3) Copy of all correspondence with the TPC organization including proof of TPC registration

    (4) Documentation illustrating compliance with TPC requirements and additional documentation as requested by the TPC

    (5) TPC Award Certificate, assessment, or validation and compliance report.

e. Provide the following information in the Sustainability Action Plan. Provide this TPC information in addition to the Sustainability Action Plan items above:

    (1) Planned method to achieve each TPC requirement.

    (2) For each TPC requirement that is attempted but not achieved, provide narrative explaining how mission or activity precludes achieving specific sustainability requirement or goal. Provide analysis of particular requirement and level to which project is able to comply.

    (3) Provide name and contact information for: Sustainability point of contact (POC) and other names of sustainability professionals responsible for ensuring TPC sustainability goals are accomplished and documentation is assembled. Sustainability POCs are also responsible for ensuring GPV required in paragraph GUIDING PRINCIPLES VALIDATION (GPV) above.

****

NOTE: For certifications, assessments, or validations that include a plaque, included the bracketed phrase.

****

f. Bear all costs associated with construction changes that affect sustainability design requirements, constructing, demonstrating, and documenting that project complies with approved TPC requirements, including but not limited to:

   (1) Final TPC review, certification, assessment, or validation[and plaque] fees.

   (2) Online (or offline with secure facilities) TPC management and documentation.

   (3) Obtaining TPC certification or validation based on Government-approved sustainability goals.

   (4) Construction work required to incorporate TPC requirements.

   (5) Submittals required to demonstrate compliance with Government approved TPC checklists.

g. Provide all calculations, product data, and certifications, assessments, or validations required in this specification to demonstrate compliance with the TPC Requirements.

h. Provide all TPC management and documentation. Transmit TPC requirements by the method required by TPC organization.

i. Provide all required responses to third party organization.

****

NOTE: Include the bracketed paragraph below for TPC that includes required site visit by a TPC representative (this is typically required for GBI provided TPC). The Government Executing Agent's Project Manager is responsible to coordinate the TPC site visit. Project Manager must coordinate with the TPC representative, Design Manager, and Construction Manager to determine participating team members. Include commissioning provider on applicable projects.

****

[j. Facilitate and participate in required TPC site visit. Coordinate with the Contract Officer to determine participating team members. Include Commissioning provider on applicable projects.

]

****

NOTE: Choose the following paragraph for TPC that includes a certificate, assessment, or validation. For TPC that include a plaque, include the bracketed phrases.

****

[k. Provide TPC [Plaque and]Certificate, assessment, or validation.

Provide TPC compliance report that includes level achieved and reasons for non-compliance or not applicable elements. Use format below to create the Plaque, Certificate, assessment or validation, compliance report, and Letter of Congratulations (when provided). Forward to parties designated by Contracting Officer:

[(1) Plaque:

(2) Name: Final Building Name. If unknown, provide Form DD1391 Project Name.

] (3) Certificate, Assessment or Validation:

(4) Project Title, first line: P-(X); Form DD1391 Project Name).

(5) Project Title, second line: UIC (Installation code)

(6) Letter Congratulations (when provided):

(7) Address letter to Facility's Installation Commander Name. Address the letter to an individual person.

(8) Compliance Report:

(9) Title page must cite Project title: P-(X); (1391 Project Name); Final Building Name if known; UIC (installation code); Owner Service; User organization if known; date of compliance.

(10) Include TPC scoresheet if applicable.

]

****

NOTE: Choose first bracket for Air Force projects and delete the others. Choose second bracket for Army projects and delete the others. Choose third bracket for Navy projects and delete the others.

****

l. Once Final Certification is achieved, turn over Administrative rights to online TPC to the [Base Civil Engineer] [Department of Public Works] [Public Works Office] or designee, contact information provided by the Contracting Officer.

]][1.6.25 Additional Sustainability Requirements

****

NOTE: Include this bracketed paragraph when there are additional sustainability requirements, including additional TPC requirements. TPC optional requirements that align with HPSB requirements are mandatory. Add them as requirements in the following paragraph. Coordinate language throughout affected UFGS Sections in this project.

****

The following requirements are included, as required by the project scope or the applied sustainability Third Party Certification program:

[_____]

]PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 SUSTAINABILITY COORDINATION

****

NOTE: Choose all the bracketed options below for projects required to obtain TPC certification, assessment, or validation.

****

Provide sustainability focus and coordination at all meetings to achieve sustainability goals. Coordinate meeting requirements with other UFGS Sections meeting requirements in this project. Ensure the designated [TPC accredited]sustainability professional responsible for GP [and TPC]documentation participates in these meetings to coordinate documentation completion. Review GP[and TPC] sustainability requirements, HPSB Checklist[and TPC] documentation, Sustainability Action Plan, and completeness status of Sustainability eNotebook[, and TPC status] at the following meetings:

a. Pre-Construction Conference

b. Construction Quality Control Meetings

****

NOTE: The following three items are tailored for DESIGN-BUILD.

****

c. Refer to Section 01 30 00 ADMINISTRATIVE PROCEDURES for Post Award Meetings.

d. Post Award Meeting

e. Design Quality Assurance Meetings

f. Design Complete Review Meetings

g. Conduct review no later than 60 days after final design complete submission and identify any outstanding issues that affect correct completion of all documentation requirements, and actions that will achieve requirements. Conduct corrective actions.

****

NOTE: Choose the following bracketed sentences for TPC that require on-site visit.

****

[h. TPC On-site Visit

i. Execute, coordinate, and facilitate on-site visit by third party representative no later than 60 days before final turnover, or as required by TPC organization, whichever is greater.

] j. Facility Turnover Meetings

k. Conduct review no later than 60 days before final turnover and identify any outstanding issues that affect correct completion of all documentation[and final TPC certification, assessment or validation], and actions that will achieve requirements. Conduct corrective actions prior to turnover, to ensure all requirements are achieved.

[3.2 THIRD PARTY CERTIFICATION CERTIFICATE, ASSESSMENT, OR VALIDATION AND COMPLIANCE REPORT

****

NOTE: Choose this bracketed paragraph for projects that require the Contractor to obtain the TPC certification.

For certifications, assessments, or validations that include a plaque, include the bracketed phrase for the plaques.

****

Finalize the process requirements and obtain the TPC [Plaque and]Certificate, assessment, or validation, and compliance report, indicating completion of the project's sustainability goals. Include TPC compliance report with final TPC scoresheet as applicable.

****

NOTE: Choose the first bracketed sentence when the contract documents give specific instruction for placement of the plaque.

Choose the second bracketed sentence if the Contracting Officer has verified the building occupant wants a framed certificate, assessment, or validation, and what kind of framing.

For certification that include a plaque, include the last bracketed phrase.

****

[Provide and hang Plaque in accordance with contract documents.] [Provide one original framed copy of the certificate, assessment, or validation, mounted in 25 mm 1 inch deep metal frames, with double matt, and wire hangers, in location approved by Contracting Officer.]Deliver [one][_____] original certificate, assessment, or validation, and compliance report to Contractor Officer, unless otherwise instructed.[Provide and hang Plaque in a prominent interior location approved by the Contracting Officer.]

]3.3 TABLE 3-1 VOLATILE ORGANIC COMPOUNDS (VOC) (LOW EMITTING MATERIALS) REQUIREMENTS

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	**EMISSIONS REQUIREMENT**		**MATERIALS WITH ADDED VOC REQUIREMENT**	**EMISSIONS REQUIREMENTS**
Adhesives and Sealants	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Adhesives (carpet, resilient, wood flooring; base cove; ceramic tile; drywall and panel; primers) Sealants (acoustical; firestop; HVAC Air duct; primers) Caulks	**SCAQMD Rule 1168** (Use "other" category for HVAC duct sealant) (for firestop adhesive, UFC 3-600-01 overrides conflicting requirements)
			Aerosol adhesives	**Section 3 of Green Seal Standard GS-36** (except: cleaners, solvent cements, and primers used with plastic piping and conduit in plumbing, fire suppression, and electrical systems; HVAC air duct sealants when the application space air temp is less than 40 F (4.5 C).

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	**EMISSIONS REQUIREMENT**		**MATERIALS WITH ADDED VOC REQUIREMENT**	**EMISSIONS REQUIREMENTS**
Paints and Coatings	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Flat and nonflat, nonflat high-gloss, specialty, basement specialty, fire-resistive, floor, low-solids, rust preventative, wood, reflective wall coatings; concrete/masonry sealers; primers; sealers; undercoaters; shellacs (clear and opaque); stains; varnishes; conjugated oil varnish; lacquer; clear brushing lacquer	**Green Seal Standard GS-11**

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	**EMISSIONS REQUIREMENT**		**MATERIALS WITH ADDED VOC REQUIREMENT**	**EMISSIONS REQUIREMENTS**
Paints and Coatings	**CDPH/EHLB/Standar method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Concrete curing compounds; dry fog, faux finishing, graphic arts (sign paints), industrial maintenance, mastic texture, metallic pigmented, multicolor, recycled coatings; pretreatment wash primers, reactive penetrating sealers; specialty primers, wood preservatives, and zinc primers	**California Air Resources Board (CARB) Suggested Control Measure for Architectural Coatings** or **SCAQMD Rule 1113r**
Paints and Coatings	**CDPH/EHLB/Standar method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	High-temperature coatings; stone consolidants; swimming-pool coatings; tub- and tile-refining coatings; and waterproofing membranes	**California Air Resources Board (CARB) Suggested Control Measure for Architectural Coatings**

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	**EMISSIONS REQUIREMENT**		**MATERIALS WITH ADDED VOC REQUIREMENT**	**EMISSIONS REQUIREMENTS**
Floor Covering Materials	For carpet, all locations: **CDPH/EHLB/Standar Method V1.1 (California Section 01350)** or label for **Section 9** of **CDPH/EHLB/Standar Method V1.1 (California Section 01350)**		none	none
Insulation	**CDPH/EHLB/Standar method V1.1** (California Section 01350) (Use "office" or "classroom" space limits for all applications)		none	none

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	**EMISSIONS REQUIREMENT**		**MATERIALS WITH ADDED VOC REQUIREMENT**	**EMISSIONS REQUIREMENTS**
Composite Wood, Wood Structural Panel, and Agrifiber Products, no added urea-formaldehyde resins including laminating adhesives for composite wood and agrifiber assemblies - particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, door cores	Third-party certification (approved by CARB) of **California Air Resource Board's (CARB) regulation** Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products	or	none	**CDPH/EHLB/Standa method V1.1** (California Section 01350) (Use "office" or "classroom" space limits for all applications) (except: Structural panel components such as plywood, particle board, wafer board, and oriented strand board identified as "EXPOSURE 1," "EXTERIOR," or "HUD-APPROVED" are considered acceptable for
Office Furniture Systems and Seating installed prior to occupancy	**ANSI/BIFMA X7.1** **ANSI/BIFMA X7.1:** (95-percent of installed office furniture system workstations and seating units) **Section 7.6.2 of ANSI/BIFMA e3** (50-percent of office furniture system workstations and seating units)		none	none

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	**EMISSIONS REQUIREMENT**		**MATERIALS WITH ADDED VOC REQUIREMENT**	**EMISSIONS REQUIREMENTS**
Ceiling and Wall assemblies and systems including: acoustical treatments; ceiling panels and tiles; tackable wall panels and coverings; wall coverings; wall and ceiling paneling and planking	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)		none	none

****

Attach completed draft "High Performance and Sustainable Building (HPSB) Checklist". For Army and Navy, this is required when project exceeds threshold defined in notes under this section’s title. For Air Force, this is required for every project. For projects with multiple buildings, attach completed draft HPSB Checklist for each building.

Attach completed draft TPC checklist. This is required when project exceeds threshold defined in note above the paragraph THIRD PARTY CERTIFICATION (TPC) DOCUMENTATION. For projects with multiple buildings, attach completed draft TPC Checklist for each building that requires TPC.

****

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 35 13 (November 2020)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-01 35 13 (November 2011)
UFGS-01 35 13.05 20 (November 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

USACE / NAVFAC / AFCEC **UFGS-01 35 13 (November 2020)**
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Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 35 13

SPECIAL PROJECT PROCEDURES
11/20, CHG 1: 02/22

****

NOTE: This guide specification covers the requirements for special procedures for airfields, heliports, harbors and repetitive military housing facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification includes tailoring for AIR FORCE, NAVY, NAVY DESIGN-BUILD and NAVFAC HI projects. Where an Editor's Note states a paragraph is tailored for a Service or project type, the content of the paragraph, or a portion of the paragraph, is suited specifically to be included only for that Service or project type

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. Code (USC)

49 USC 44718	Structures Interfering with Air Commerce or National Security
49 USC 46301	Civil Penalties

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(2016; Rev L; Change 2) Obstruction Marking and Lighting
FAA AC 150/5300-13	(2022; Rev B) Airport Design

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

14 CFR 77	Safe, Efficient Use, and Preservation of the Navigable Airspace

1.2 DEFINITIONS

****

NOTE: Retain this Article only when Part 3 Article HAZARDS TO [AIRFIELD][HELIPORT] OPERATIONS is retained.

****

1.2.1 Landing Areas

"Landing Areas" means:

a. The primary surfaces, comprising the surface of the runway, runway shoulders, and lateral safety zones. The length of each primary surface is the same as the runway length. The width of each primary surface is 609.6 meters 2000 feet (304.8 meters 1000 feet on each side of the runway centerline).[Exceptions: Some airfields are based on a primary width of 457.2 meters 1500 feet (228.6 meters 750 feet on each side of the runway centerline). In such instances, substitute the proper width in the applicable statements.]

b. The "clear zone" beyond the ends of each runway is the extension of the primary surface for a distance of 914.4 meters 3000 feet in length for fixed wing aircraft and 121.92 meters 400 feet in length for helicopter only runways beyond each end of each runway.

c. All taxiways, plus the lateral clearance zones along each side for the length of the taxiways (the outer edge of each lateral clearance zone is laterally 76.2 meters 250 feet from the far or opposite edge of the taxiway (example: a 22.86 meter 75 foot wide taxiway must have a combined width and lateral clearance zone of 129.54 meters 425 feet.)

d. All aircraft parking aprons, plus the area 38.1 meters 125 feet in width extending beyond each edge around the aprons.

1.2.2 Safety Precaution Areas

"Safety Precaution Areas" means those portions of approach-departure clearance zones and transitional zones where placement of objects incident to Contract performance might result in vertical projections at or above the approach-departure clearance, or the transitional surface.

a. The "approach-departure clearance surface" is an extension of the primary surface and the clear zone at each end of each runway, for a distance of 15240 meters 50,000 feet, first along an inclined (glide angle) and then along a horizontal plane, both flaring symmetrically about the runway centerline extended.

  (1) The inclined plane (glide angle) begins in the clear zone 61 meters 200 feet past the end of the runway (and primary surface) at the same elevation as the end of the runway. It continues upward at a slope of 50:1 (0.305 meters one foot vertically for each 15.24 meters 50 feet horizontally) to an elevation of 152.4 meters 500 feet above the established airfield elevation. At that point the plane becomes horizontal, continuing at that same uniform elevation to a point 15240 meters 50,000 feet longitudinally from the beginning of the inclined plane (glide angle) and ending there.

  (2) The width of the surface at the beginning of the inclined plane (glide angle) is the same as the width of the clear zone. It then flares uniformly, reaching the maximum width of 4876.8 meters 16,000 feet at the end.

b. The "approach-departure clearance zone" is the ground area under the approach-departure clearance surface.

c. The "transitional surface" is a sideways extension of all primary surfaces, clear zones, and approach-departure clearance surfaces along inclined planes.

  (1) The inclined plane in each case begins at the edge of the surface.

  (2) The slope of the incline plane is 7:1 (.305 meters one foot vertically for each 2.13 meters 7 feet horizontally). It continues to the point of intersection with the:

(a) Inner horizontal surface (which is the horizontal plane 45.72 meters 150 feet above the established airfield elevation); or

(b) Outer horizontal surface (which is the horizontal plane 152.4 meters 500 feet above the established airfield elevation), whichever is applicable.

d. The "transitional zone" is the ground area under the transitional surface. (It adjoins the primary surface, clear zone, and approach-departure clearance zone.)

1.2.3 Federal Aviation Administration (FAA) Notice of Proposed Construction or Alteration

a. FAA Notice of Proposed Construction or Alteration may be required in accordance with 49 USC 44718 and 14 CFR 77, depending on height of construction equipment on site, height of temporary structures, proximity to an airport or heliport, and specific location of equipment or temporary structure. For the purpose of notifying the FAA, proximity is defined as within 5 nautical miles of a Government or civilian airfield, including landing areas, taxiways, runways and helicopter pads.

b. In order to determine if a FAA Notice of Proposed Construction or Alteration is required, refer to 14 CFR 77 Subpart B. Alternately, utilize the FAA's Notice Criteria Tool located at: https://oeaaa.faa.gov/oeaaa/external/portal.jsp. The FAA will determine if the equipment or temporary structure exceeds obstruction standards and may pose a hazard to air navigation.

c. Failure to comply with the provisions of 14 CFR 77 are subject to Civil Penalty under Section 902 of the Federal Aviation Act of 1958, as amended and pursuant to 49 USC 46301 Subpart (a).

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: For Navy Design-Build projects, delete 01 33 00 SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

[Heavy Equipment and Vehicle List

][Existing Conditions Survey

] FAA Form 7460-1

FAA Form 7460-2

Construction Operations Plan

[Watercraft List

][SD-04 Samples

Model Unit

]PART 2 PRODUCTS

2.1 AIRFIELD OBSTRUCTION LIGHTS

****

NOTE: Retain this Article when Part 3 Article HAZARDS TO [AIRFIELD][HELIPORT] OPERATIONS is retained; otherwise delete this Article and add "Not used.".

****

Airfield obstruction lights must be in accordance with FAA AC 70/7460-1 and have red or white lenses.

PART 3 EXECUTION

[3.1 HAZARDS TO [AIRFIELD][HELIPORT] OPERATION

****
NOTE: Include this Article and the applicable paragraphs in projects where work will occur on or near aircraft runways, taxiways, or similar aircraft operational facilities. Use the term ["landing strip"] ["landing pad"] when dealing with heliports. Use the term "landing area(s)" when dealing with airplanes. Use the term "Operations Officer," except as directed otherwise.
****

In addition to DFARS 252.236-7005 Airfield Safety Precautions, the following paragraphs apply.

3.1.1 Work in Proximity to [Landing Areas] [Landing Strips] [Landing Pad(s)]

Place nothing upon the landing area or applicable portions of safety precaution areas without authority of the Contracting Officer.

Use of [landing areas] [landing strips] [landing pads] for purposes other than aircraft operation, is prohibited without permission of the Contracting Officer, and the [landing area] [landing strip] [landing pad] is closed by order of the Contracting Officer and marked as indicated herein.

Accomplish all construction work on [the runways, taxiways, and parking aprons and in the end zones of the runways and 23 m 75 feet to each side of the runways and taxiways][the landing strip, 23 m 75 feet to each side thereof, and on the taxiways and parking aprons][the landing pad(s)]with extreme care regarding the operation of aircraft. Cooperate closely, and coordinate with [the Operations Officer and]the Contracting Officer. Park equipment in an area designated by the Contracting Officer. Parking of equipment, vehicles, or any storage features overnight or for any extended period of time in the proximity of the [landing areas or taxiways][landing strip][landing pad]is strictly prohibited. Leave no material in areas where extreme care is to be taken regarding the operation of aircraft.

During periods of active performance of work on the airfield by the Contractor, govern all operations of mobile equipment in accordance with the safety provisions.

3.1.2 Contractor FAA Notification

When required in accordance with 49 USC 44718 and 14 CFR 77, submit FAA Form 7460-1 and attachments directly to the FAA a minimum of 60 calendar days prior to the start date of the operations that may affect air traffic. Submit supplemental notification FAA Form 7460-2 to the FAA within 48 hours prior to start of the construction. Simultaneous with submission to the FAA, submit both forms to the Contracting Officer for information. It is the Contractor's responsibility to notify the FAA when required.

3.1.3 Schedule of Work/Aircraft Operating Schedules

Schedule work to conform to aircraft operating schedules. The Government will exert every effort to schedule aircraft operations so as to permit the maximum amount of time for the Contractor's activities; however, in the event of emergency, intense operational demands, adverse wind conditions, and other such unforeseen difficulties, the Contractor must cease operations at the specified locations in the aircraft operational area for the safety of the Contractor and military personnel and Government property. Submit a schedule of the work to the Contracting Officer [for transmittal to the Operations Officer]describing the work to be accomplished; the location of the work, noting distances from the ends of [landing areas, taxiways][landing strips][landing pads]and buildings and other structures as necessary; and dates and hours during which the work is to be accomplished. Keep the approved schedule of work current, and notify the Contracting Officer of changes prior to beginning each day's work.

Where flying is controlled, obtain permission from the control tower operator to enter a landing area unless such area is marked as hazardous to aircraft.

3.1.3.1 Construction Operations Plan

Submit a Construction Operations Plan prior to the start of work that includes a description of the airfield work to be accomplished; the exact location of the work, noting distances from the ends of [landing areas, taxiways][landing strips][landing pads]and buildings and other structures as necessary; and dates and hours during which the work is to be accomplished. Keep the approved schedule of work current and notify the Contracting Officer of changes prior to beginning each day's work.

[3.1.3.2 Existing Conditions Survey

Perform an Existing Conditions Survey and submit results to the Government prior to the start of work. As part of this survey, inspect the work site to identify existing conditions located within the vicinity of the contract work. Utilize original as-builts if available showing possible utilities, type of pavement, thickness, airfield lighting, equipment, vehicles, structures, and parked aircraft. Unless already specified in the Contract documents, utilize the RFI process to clarify responsibility for relocating appurtenances that will interfere with work. If the site is opened up (in/under construction), update the existing survey condition to include the actual condition of the underlying conditions such as sub base, base, and pavement thickness.

]3.1.4 Daytime Markings

During daylight, mark stationary and mobile equipment with international orange and white checkered flags, mark the material, and work with yellow flags.

Submit a Heavy Equipment and Vehicle List identifying all stationary and mobile equipment and vehicles that will be operating on the airfield. All equipment and vehicles must be identified by means of a flag on a staff attached to and flying above the vehicle. Flag size must be not less than one meter 3 feet square and consist of a checkered pattern of international orange and white squares not less than 300 millimeter one foot on each side. Flags varying in any dimension by not more than 10 percent of the specified dimensions are considered to comply with the stated requirements.

3.1.5 Nighttime Markings

During nighttime, which begins 2-hours before sundown and ends 2-hours after sunrise, mark stationary and mobile equipment and material, and work with [red lanterns][battery-operated, low-intensity, red flasher lights]. Where the [Operations Officer][Contracting Officer]determines that the [red lanterns][red flasher lights]may confuse pilots approaching for landings, the [Operations Officer][Contracting Officer]may direct that the [red lanterns][red flasher lights]be left off or that the color of the [globes][lights]be changed.

Provide lighting in accordance with FAA AC 70/7460-1. Provide a minimum of two aviation red or high intensity white obstruction lights on temporary structures (including cranes) over 30 meter 100 feet above ground level. Lights must be operational during periods of reduced visibility, darkness, and as directed by the Contracting Officer.

No separate payments will be made for lighting and protection necessitated by the safety provisions.

[3.1.6 Excavation

Open only those trenches for which material is on hand and ready for placing therein. As soon as possible after the material has been placed and work approved, backfill and compact the trenches as specified.

Maintain [landing areas][landings strips][landing pads]at all times free from hazards, holes, material piles, or projecting shoulders that might damage tires or landing gear. Keep paved surfaces clean at all times and free from small stones or other objects which could cause damage to propellers, craft, and personnel.

][3.1.7 Contractor Safety Precautions

The Contractor is advised that aircraft operations will produce extremely high noise levels and will induce vibrations in pavements, structures, and equipment in the vicinity, and may result in high velocity flying debris in the area. These anticipated hazards must be appropriately addressed in the Activity Hazard Analysis (AHA) associated with airfield work - the Activity Hazard Analysis must be in accordance with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. The Contractor is responsible for providing personal protective equipment (PPE) and other safety devices required to ensure protection of contractor personnel and equipment. Schedule the work to eliminate hazards to personnel and equipment and to prevent damage to work performed.

Boundary areas for hazardous work locations and restrictions are defined in FAA AC 150/5300-13. Construction activity within the limits of the boundary areas without approval of the Contracting Officer is prohibited.

]3.1.8 Base Civil Engineering (BCE) Work Clearance Request

****

NOTE: The following paragraph is tailored for Air Force projects. Include only for Air Force projects.

****

Obtain an approved BCE Work Clearance Request, AF Form 103, prior to the start of excavation, digging work, or work that disrupts aircraft or vehicular traffic flow, base utility services, fire and intrusion alarm system, or routine activities of the Activity.

3.1.9 Radio Contact

Provide necessary battery powered portable radios, including one radio for the tower. During work within the landing area, have an operator (who speaks fluent English) available for radio contact with the tower at all times. Obtain approval of radio frequency from the tower.

][3.2 HARBOR WATERWAYS

****

NOTE: Include this Article and the applicable paragraphs when the project involves work in navigable waterways. In the following paragraph, include the bracketed statements for projects at Pearl Harbor, or insert the name of the applicable waterway(s).

****

In addition to DFARS 252.236-7002 Obstruction of Navigable Waterways, obtain from the [Operations Officer at the Naval Base, Pearl Harbor via the] [_____] Contracting Officer, permission to use [Pearl Harbor] [_____] waterways and the regulations and directives governing such usage. Submit a watercraft list with a description of crafts, including sizes, types, numbers and boat crew for approval.

[3.2.1 Hazards to Navigation

Maintain complete control of the movement of floating equipment and material. Loose floating equipment and material are not permitted. Keep in readiness at all times a powered craft capable of moving, securing and disposing of floating equipment which may get loose and become a hazard to navigation.

][3.2.2 Submarine Cables or Underwater Utilities

****

NOTE: Include this paragraph whenever dredging and submarine cables or underwater utilities involved.

****

Physically locate submarine cables or underwater utilities as indicated prior to performance of work.

][3.2.3 RIMPAC Operational Exercises

****

NOTE: The following three paragraphs are tailored for NAVFAC Hawaii projects. Include these paragraphs when Pearl Harbor waterways are involved.

****

Due to the RIMPAC exercises conducted every even numbered years, the Contractor must anticipate delays and disruption in construction activities for a period of 60 consecutive calendar days during the Contract. Disruption may range from complete shutdown of construction activity for a prolonged period of time or periodic short term shutdown of less than a full day, but in no event will such shutdowns in the aggregate exceed 60 calendar days per calendar year. This affected period is anticipated between 1 April and 31 July of every even numbered year. Bidders must take into consideration such delays when preparing their bids.

][3.2.4 December 7, 1941 Commemorative Ceremonies

To minimize disturbances during Pearl Harbor's December 7, 1941 Commemorative Ceremonies, no construction activities will be permitted on the day that ceremonies are held.

][3.2.5 Annual Pearl Harbor "Hydrofest"

The annual Pearl Harbor "Hydrofest" activities will prevent access to the waterways for a 2-week period during October or November. Bidders must take into consideration such delays when preparing their bid.

]][3.3 MODEL UNIT

****

NOTE: Include the following Article and the applicable paragraphs on projects with repetitive unit construction. Require the Contractor to complete a model unit to various levels, and have the materials and workmanship approved prior to proceeding with the remainder of the project. Examples of such projects are BEQ's, BOQ's, and family housing units, both renovations and new construction.

****

Prior to placement of material orders for components of the [BEQ living suites] [BOQ living suites] [family housing units] [_____] and the installation of those components throughout the project, the Contractor must complete the construction of the components of the model unit, and gain the approval of the Contracting Officer for the materials and workmanship therein.

****

NOTE: Edit the following paragraph to describe the extents of the model unit(s), and delineate whether each is a housing unit building, or a multiple resident living unit within a multi-unit building.

****

****

NOTE: Choose housing unit and the last bracketed option in the paragraph for family housing projects.

****

3.3.1 Model Unit Description

Provide a model unit made up of enough [living suites consisting of two bedrooms and an interconnecting bathroom] [single family housing units] [_____] to show all of the different levels of completion required below.[The model unit must have enough [suites] [housing units] to show all level of completion simultaneously[, except for foundation and floor slab levels which are approved by the Contracting Officer and covered by following levels].] The model unit must be [living suites] [family housing units]

[_____] constructed at the location agreed upon with the Contracting Officer and [a part of the permanent structure as indicated] [a temporary structure constructed to full scale at the location indicated, and demolished at the completion of the Contract].

3.3.2 Model Unit Requirements

Adhere to the following requirements for model construction:

a. Provide materials in model unit identical to those actually approved in submittals. The QC Manager and Organization must approve and process submittals in accordance with Section 01 33 00 SUBMITTAL PROCEDURES. Do not procure, fabricate, or install materials prior to approval by the Contracting Officer.

b. The Contracting Officer retains the right to disapprove and reject materials or items which are not in compliance with the project drawings and specifications.

c. After approval of initial product submittals, provide full size samples of these components in the required color, and in sufficient quantity to completely outfit the model unit. Provide full size samples as dictated by the construction schedule for installation of those components in the model unit. Do not order or approve production of materials beyond those required for the model unit, until the full size samples have been installed in the model unit and approved by the Contracting Officer.

d. Proceed immediately with construction of the model unit after the Contracting Officer acknowledges the required product submittals are approved.

e. Provide temporary utilities and climate control necessary to construct, inspect, approve, and maintain the model unit.

f. Provide and maintain the following throughout the construction period of the entire project: Temporary parking at the model unit; signage from the temporary parking to the model unit; the visual approach to the unit including trash removal, lawn [and landscaping]maintenance.

g. Locate the model unit in an easily accessible location for public tours. The Government retains the right to use the model unit for supervised tours and public relations activities following each level of completion. Tours will take place during normal working hours.

[h. Prior to completion and approval of the model unit, and with written permission to start from the Contracting Officer, the Contractor may perform general sitework and run major utility lines for the rest of the project.
]

****

NOTE: Include the following subparagraph when construction time is limited. Confirm with Contracting Officer and Activity User that they can consistently inspect and approve the model unit's different levels of completion before adding this option.

****

[i. As each model unit's level of completion is approved by the Contracting Officer, construction of that level's components throughout the remainder of the project may proceed.

]3.3.3 Model Unit Levels of Completion

****

NOTE: Choose one of the three model unit completion paragraphs below and confirm the selection with the Using Activity and Contracting Officer. The first bracketed option requiring the model unit to be complete before starting the construction of the facilities should only be used when delivery time of the facility is not critical. This option will delay the construction of the facility(s) until the model unit is constructed and approved. The second bracketed option using two levels of completion is most effective on BEQ construction but can be used on housing. The third bracketed option using multiple levels of completion should be used when time is a critical issue, especially on housing. This option sets incremental approval of multiple levels allowing Contractor to proceed quickly into the construction of the facility(s). In the third option verify with the Contracting Officer the number of approval stages needed. In this option, levels may be combined if confirmed with Contracting Officer.

****

[The completed model unit must be exhibited for approval. Upon completion, the model unit must be available to the Government for a period of 15 working days for inspection after notification is received by Contracting Officer.

][Exhibit and secure approval of model unit at the following levels of completion:

a. Level 1 (Pre-Finished Level) - Model unit construction within a completed building exterior must exhibit plumbing, ductwork, electrical locations, exposed framing, and windows. Leave walls and floors unfinished but ready for application of final finish. Upon completion of this level, model unit must be available to the Government for a period of five working days for inspection.

b. Level 2 (Finished Level) - Model unit construction must exhibit all materials, completely finished as specified, including fixtures, wall and floor finishes, cabinets, and shelving. Upon completion, the model unit must be available to the Government for a period of 15 working days for inspection.

][Model unit must be exhibited and approved at the following [7] [_____] levels of completion:

c. Level 1, model must be available for Government inspection for 28 calendar days.

d. Levels 2 through 7, model unit must be available for Government inspection for 10 calendar days per level.

a. Level 1 (Foundation & Floor Slab Level) - Clearly demonstrate treatment of earth excavation, testing of underslab mechanical piping, earth compaction, assembly and support of concrete reinforcing, technique of concrete movement and placement, framing of foundation steps, placement of insulation, final exposed concrete finished surface treatment, location outlines of all walls, all slab penetrations, and structural support points.

b. Level 2 (Framing Level) - Clearly exhibit all load bearing and non-load bearing framing, sheathing, anchorage for exterior shell materials, and pre-trim frame-out.

c. Level 3 (Exterior Shell Level) - Exhibit all exterior finishes, windows and doors with temporary hardware, caulking, sealant, sheathing paper, wall ties, locations of mechanical equipment, roofing, louvers, vents and trim.

d. Level 4 (Plumbing, Mechanical and Electrical rough-in Level) - Exhibit electrical conduit and box location for switches, outlets fixtures, cable and data collection, ductwork, built-in plumbing fixtures, plumbing piping, and water pressure test of all plumbing pipe.

e. Level 5 (Interior Finishes-rough Level) - Exhibit non-veneer plaster, unspackled and uncaulked wall and ceiling finishes, insulation, interior doors, final locations of all outlets and fixtures.

f. Level 6 (Interior Finishes & Fixtures-final Level) - Exhibit final interior finishes, veneer plaster, painting, caulking, built-in shelving, cabinetwork, cabinet supported sinks, final door hardware, mechanical louvers, final electrical equipment connections, electrical fixtures, freestanding bathroom fixtures, properly functioning appliances, and operation of mechanical and electrical systems.

[g. Level 7 (Site Finishes Level) - Exhibit final driveway, walks, exterior stairs, final concrete and asphalt finished surface treatment, topsoil quality and application, sodding/seeding of lawn, tree and shrub planting, landscaping beds, playground fall areas and playground equipment. Contracting Officer retains the right to inspect all preparation and installation of pavings. Provide adequate notice to the Contracting Officer prior to commencing paving work.

]]] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 35 13.43 10 (August 2015)**

Preparing Activity: USACE

Superseding
UFGS-01240A (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 35 13.43 10

SPECIAL PROJECT PROCEDURES FOR CONTAMINATED SITES

08/15

ATTACHMENTS:

-- End of Section Table of Contents --

****

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****

SECTION 01 35 13.43 10

SPECIAL PROJECT PROCEDURES FOR CONTAMINATED SITES
08/15

****

NOTE: This guide specification covers the requirements for preparing a cost and performance documentation report on environmental remediation projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The work covered by this section will be restricted to report preparation. No design, construction, operation or maintenance requirements are included herein. The specifier or designer will include available information and data or provide appropriate references to prevent remedial action Contractor from duplicating previous efforts.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE (FRTR)

USAEC SFIM-AEC-ET-CR-97053	(2007) Federal Remediation Technologies Screening Matrix and Reference Guide, Fourth Edition

U.S. ARMY CORPS OF ENGINEERS (USACE)

EP 1110-1-19	(2001) A Guide to Preparing and Reviewing Remedial Action Reports of Cost and Performance
ER 1110-3-1301	(2016) Engineering and Design -- Environmental Remediation and Removal Programs Cost Engineering

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 542-B-98-007	(1998) Guide to Documenting and Managing Cost and Performance Information for Remediation Projects

1.2 DESCRIPTION OF WORK

Work consists of the preparation of a report containing cost and performance data from the [_____] environmental remediation project. Use the [partial] [draft] [_____] [Cost and Performance Report attached to this specification] [Cost and Performance Report included in EP 1110-1-19, Appendix A] [_____] to comply with this specification.

1.2.1 Report Format

Prepare the report in accordance with EPA 542-B-98-007. Present the report as follows: 1) Word processing format: MS Word, [12] [_____] point font size, typeface. 2) Page layout: 215 x 280 mm 8-1/2 x 11 inch size paper; [25] [_____] mm [1] [_____] inch margins; portrait or landscape orientation; bold headings, footnotes, page numbering. 3) Tables and charts software: spreadsheets, groundwater modeling. 4) Computer file: also present the document in Hypertext Mark-up Language (HTML 2.0) saved as an ASCII file; link postscript drawings to document text.

1.2.2 Drawing Format

Use the same format for drawings, including software, as that used in the investigative and design phases of the project. [Provide drawingfiles in post script [[_____].ps] [[_____].eps] [or] [[_____].gif] format.]

1.2.3 Quality Control

Develop a project-specific quality control program to detail the procedures for preparation of the report and for correction of deficiencies. Arrange for conferences to coordinate the work or to sequence related work for sensitive and complex items as needed and as requested by the Contracting Officer.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Report; G, [_____]

[Three] [_____] copies of the report upon completion of each of the following stages: Outline, Draft Report, and Final Report. Provide the report to the [Contracting Officer] [_____]. Provide and ASCII file of the report to the [Contracting Officer] [HTRW CX] [_____].

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 REPORT

Prepare the report in accordance with EP 1110-1-19.

3.1.1 Executive Summary

The Executive Summary is a brief overview of the Cost and Performance Report. It includes [a brief description of the historical activities that generated the need for environmental restoration,] [a brief summary of the appropriate regulatory framework under which the cleanup is to occur,] [the remedial technology specified,] [the date, number and title of decision document,] [any special sequencing and scheduling milestones,] [definitions for standard terminology used in the preparation of the report,] [average characteristics of the contaminated media pre- and post-treatment,] [and] [the cost breakdown for the complete remediation].

3.1.2 Site Information

****

NOTE: Site information data will be provided by USACE and/or design Contractor.

****

Information developed prior to remediation is [included] [_____].

3.1.2.1 Type of Action

State whether the cleanup to be performed is an entire site remediation or intermediate remedial project.

3.1.2.2 Period of Operation

Indicate the dates of start-up, shut-down, periods of retreatment, partial operation, inactivity and operation of the treatment system in the report.

3.1.2.3 Quantity of Material Treated During Application

Indicate the estimated quantity of material treated during the remedial or removal action. For ex-situ or in-situ treatment, determine the estimated volume of material treated as specified in the respective technical specification section and note in the report.

3.1.2.4 Performance Objectives

Bulletize the clean-up goals associated with this project.

3.1.2.5 Site Logistics/Contacts

List the addresses and telephone numbers for the [Project Manager,] [Regulatory Agency Contacts,] [and] [Vendors] involved in the cleanup activities.

3.1.3 Matrix and Contaminant Description

3.1.3.1 Matrix Identification

Report the type of matrix treated using the standard terminology contained in EP 1110-1-19.

3.1.3.2 Site Geology/Stratigraphy

Describe the site soils and geology in the site geology/stratigraphy narrative. Include the areal and vertical (stratigraphy) variability in the soils, soil classifications and particle-size distributions. Include depth to groundwater, depth to bedrock, and thickness of overburden soil.

3.1.3.3 Contaminant Characterization

Identify the primary contaminant and the extent of vertical and areal contamination in this section. Note other contaminants which may affect treatment.

3.1.3.4 Contaminant Properties

Report the properties of contaminants present at the remediation site as a summary of the results from the Sampling and Analysis Plan.

3.1.3.5 Nature and Extent of the Contaminants

Describe the of location, nature, and extent of contamination by text and/or appropriate contract drawings.

3.1.3.6 Matrix Characteristics Affecting Treatment Cost or Performance

Identify the measurement procedure used for each parameter. Provide the measurement, the procedure to obtain the measurement, and the effect on cost and performance for each parameter as shown in Tables 1 and 3 of EP 1110-1-19.

3.1.4 Treatment System Description

Describe treatment technologies using terminology from USAEC SFIM-AEC-ET-CR-97053 and EPA 542-B-98-007 or other approved similar terminology in areas where those documents are incomplete.

3.1.4.1 Primary Treatment Technology Types

List primary treatment technology types for each contaminant matrix using standard terminology and the listing of primary treatment technologies in

EP 1110-1-19.

3.1.4.2 Supplemental Treatment Technology Types

List Pre-treatment and Post-treatment technology types for each matrix using standard terminology and the listing of supplemental treatment technologies in EP 1110-1-19.

3.1.4.3 Time Line

Provide a tabular or Gannt chart form specifying the major tasks associated with the remediation. Include key milestones such as treatability testing; design completion; site preparation; site mobilization; excavation; treatment start date; adjustment dates; submittal dates, and demobilization. Initiate the time line at the onset of remedial investigations and terminate at completion of demobilization from the site. Designate the projects critical path on the time line.

3.1.4.4 Treatment System Operation

Provide a completion Process Flow Diagram in the report and include an overall schematic of the treatment system and each treatment unit process. Also include personnel requirements for operating the system, the approach used to operate the system over the course of the remediation, and the health and safety requirements including level of personal protective equipment required in the description of system operations.

3.1.4.5 Operating Parameters Affecting Treatment Cost or Performance

Provide a table presenting the major operating parameters affecting cost and performance for the primary treatment technologies and the values measured for each parameter. Include site-specific items such as number of samples, number of wells, and other specific parameters that may affect the cost of operation in the report in accordance with Table 4 of EP 1110-1-19.

3.1.5 Treatment System Performance

3.1.5.1 Treatment Performance Data

Report the pre-treatment and post-treatment contaminant concentrations in the soil or groundwater. Present the number and type of samples collected, management or reduction of sampling results, and the method number of the laboratory analysis in a table. For in-situ technologies, provide information for separate locations using cross-referenced site plans and tables. Present analytical results in tabular format using the following conventions for reporting data: mass/volume for contaminant levels in off-gas; mass/mass for solids; mass/volume for contaminant levels in water, and ND (DL) with footnote saying: not detected at levels above the detection limit (reported laboratory detection limit shown in parentheses).

3.1.5.2 Data Assessment and Deviations from Standard Performance

Describe the available performance data and discuss in terms of whether cleanup goals were met and whether treatment performance varied during the course of the remediation. Include an evaluation of the performance of the treatment system in the report. Include the information contained in the following paragraphs.

3.1.5.3 Material Balances

Perform material balances around the treatment unit; link the data to specific operating conditions. State whether balances are required for a specific process unit, the complete train of processes or both.

3.1.5.4 Target Contaminant and Operating Conditions

Match target contamination concentrations prior to treatment with concentrations in treated material. Link these data to specific operating conditions.

3.1.5.5 Target Contaminant and Removal Efficiencies

compare target contaminant concentrations prior to treatment with concentrations in treated material, to determine removal efficiencies and average concentrations.

3.1.5.6 Characteristics of Treated Material

Assess the physical and chemical state of the treated material using methods appropriate for the material.

3.1.6 Performance Data Quality

Provide an overall assessment of the quality control of the available performance data in the narrative. A brief description of the Quality Assurance Project Plan (QAPP) for the remediation effort must include how checks were made on the sample analysis and interpretation, and a discussion of the use of statistics in sampling program design and data interpretation.

3.1.7 Treatment System Cost

Use the work breakdown structure specified in ER 1110-3-1301 to the third (subsystem) level, in conjunction with the standard descriptions, to document costs for activities directly attributed to the treatment system; however, utilizing lower levels for each work breakdown structure is optional. Use the third (subsystem) level of detail for capturing the primary treatment technology costs. Identify documentation of costs for before treatment activities separately in the appropriate third-level remedial action work breakdown structure categories, i.e. Monitoring, Sampling, Testing, and Analysis. Separately identify post construction operation and maintenance using the O&M work breakdown structure. Identify unit costs and number of units for each cost element in the documentation, as specified in ER 1110-3-1301. Show cost for activities directly attributed to the treatment as a total cost and as a calculated cost on a per unit of media treated basis, and on a per unit of contaminant removed basis, as indicated. The second (system) and the third (subsystem) level cost elements for activities directly associated with the project are shown in the same referenced documents.

3.1.7.1 HTRW - Remedial Action Work Breakdown Structure

Appropriately allocate invoices for materials, labor, supplies, services, and other costs. Allocate these costs to pretreatment, treatment, and post-treatment activities. These cost allocations must include the sub-breakdown of cost elements. Further allocate costs between capital and operating costs.

3.1.7.2 Pre-Treatment Costs

Include preparation costs in the reported pre-treatment costs (i.e. Sampling Plans, Treatability Plans, [_____]) management and other distributive costs, mobilization, sampling and analysis, site work, excavation, [_____].

3.1.7.3 Costs Directly Associated with Treatment

Include solids, liquid, vapor preparation and handling; mobilization, spill control, testing, permits, training, and O&M costs in the costs directly associated with the treatment.

3.1.7.4 Post-Treatment Costs

The post-treatment costs include decontamination and decommissioning, disposal, site restoration, and demobilization.

3.1.8 Regulatory/Institutional Issues

List approvals, licenses and permits required for remediation along with the direct cost and time lines associated with obtaining them.

3.1.9 Observations and Lessons Learned

****

NOTE: Delete any of the following paragraphs when not applicable.

****

3.1.9.1 Cost Observations and Lessons Learned

Summarize observations or lessons learned concerning cost for each treatment system. Consider key factors that affected project costs, and major items that caused final costs to differ from initial bid. Issues to be discussed include change orders, reclarifications, liquidated damages, variations in quantities, and unforeseen conditions. Include recommendations for cost savings in future procurements of each treatment technology in the narrative.

3.1.9.2 Performance Observations and Lessons Learned

Summarize observations or lessons learned concerning performance of each treatment system for this contract. Consider key factors that caused performance variations from contract requirements/cleanup standards. Describe lessons learned from scaling-up treatability studies to full-scale activities. Discuss the accuracy of such treatability studies in predicting the full-scale application cost and performance. Also discuss recommendations for improved performance in future applications, including information from each treatment vendor.

3.1.9.3 Other Observations and Lessons Learned

Summarize observations or lessons learned from each treatment unit not directly related to cost or performance.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 35 26 (May 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 35 26 (November 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-01 35 26 (May 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 35 26 (November 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 01 35 26

GOVERNMENTAL SAFETY REQUIREMENTS

05/24

****

NOTE: This guide specification covers the requirements for safety and occupational health requirements for the protection of Contractor and Government personnel, property, and resources.

This guide specification is intended for use in Contracts that specify FAR 52.236-13 Accident Prevention, or its Alternate I, to include Contracts for construction, dismantling, renovation and demolition; dredging; environmental restoration (investigation, design, remediation); asbestos abatement or lead hazard control; projects in the continental U.S. and overseas.

The requirements of this guide specification are a supplement to the U.S. Army Corps of Engineers (USACE) Safety and Occupational Health Requirements, EM 385-1-1 and clarify safety concerns for high-risk construction activities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

All additions to the specification by the designers, must be written in accordance with the Plain Writing Act of 2010.

Remove information and requirements not required in respective project, whether or not brackets are present.

The Contractor Safety Self-Evaluation Checklist is

available for download on the Whole Building Design Guide at:
https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-35-26

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: This guide specification includes tailoring for DESIGN-BUILD, DESIGN-BID-BUILD, ARMY, NAVY, NAVFAC MAR, NAVFAC HI, NAVFAC PAC, INDOOR AIR QUALITY, and DREDGING projects. Where an Editor's Note states a paragraph is tailored for a Service or project type, the content of the paragraph, or a portion of the paragraph, is suited specifically to be included only for that Service or project type.

****

****

NOTE: Include other referenced sections in the Contract where work, such as environmental restoration, asbestos abatement, or lead hazard control, requires additional safety and health plans to be made part of and appended to the APP. These sections include Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES for environmental restoration project; Section 02 82 00 ASBESTOS REMEDIATION, for asbestos abatement; Section 02 83 00 LEAD REMEDIATION for lead hazard control activities; and Section 02 85 00 MOLD REMEDIATION. For NAVY environmental restoration Contracts, an APP is required with the overall Contract and a site specific Health and Safety Plan is required for each task order (contact the FEAD Safety Manager for applicability).

Many states and municipalities have more stringent or additional requirements; modify this section as required to meet local requirements and regulations.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ANSI/ASSP A10.34	(2021) Protection of the Public on or Adjacent to Construction Sites
ANSI/ASSP A10.44	(2020) Control of Energy Sources (Lockout/Tagout) for Construction and Demolition Operations
ANSI/ASSP Z490.1	(2016) Criteria for Accepted Practices in Safety, Health, and Environmental Training

ASTM INTERNATIONAL (ASTM)

ASTM D6245	(2012) Using Indoor Carbon Dioxide Concentrations to Evaluate Indoor Air Quality and Ventilation
ASTM D6345	(2010) Standard Guide for Selection of Methods for Active, Integrative Sampling of Volatile Organic Compounds in Air
ASTM F855	(2020) Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1048	(2016) Guide for Protective Grounding of Power Lines
IEEE C2	(2023) National Electrical Safety Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z89.1	(2014; R 2019) American National Standard for Industrial Head Protection

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA Z535.2	(2011; R 2017) Environmental and Facility Safety Signs

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 51B	(2024) Standard for Fire Prevention During Welding, Cutting, and Other Hot Work
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 241	(2022) Standard for Safeguarding Construction, Alteration, and Demolition Operations
NFPA 306	(2024) Standard for the Control of Gas Hazards on Vessels

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

ANSI/SMACNA 008	(2007) IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 20	Standards for Protection Against Radiation
29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1915	Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment
29 CFR 1919	Gear Certification
29 CFR 1926	Safety and Health Regulations for Construction
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
CPL 2.100	(1995) Application of the Permit-Required Confined Spaces (PRCS) Standards, 29 CFR 1910.146

1.2 DEFINITIONS

The following definitions are for the convenience of the reader. If there is a referenced document in the text of this specification section, that is the document that should define terms for that paragraph. If further clarification is needed, contact the Contracting Officer.

1.2.1 Site Safety and Health Officer (SSHO)

A Contractor Employee that is responsible for overseeing and ensuring implementation of the prime Contractor's Safety and Occupational Health (SOH) program according to the Contract, EM 385-1-1, applicable federal, state, and local requirements.

1.2.1.1 Level One SSHO

A designated employee with full-time SOH responsibility that meets and follows the requirements of EM 385-1-1.

1.2.1.2 Level Two SSHO

A designated employee with Level Two SSHO responsibility that meets and follows the requirements of EM 385-1-1. Level Two SSHOs cannot be assigned to projects that have a residual Risk Assessment Code (RAC) of high or extremely high.

1.2.1.3 Level Three SSHO

A designated Qualified Person or Competent Person with SOH responsibility that meets and follows the requirements of EM 385-1-1. Level 3 SSHOs cannot be assigned to projects that have a residual RAC of high or extremely high.

1.2.1.4 Alternate SSHO

An employee that meets the definition of the contract-required level SSHO, but is not the primary SSHO.

1.2.2 Competent Person (CP)

The CP is a person designated in writing, who, through training, knowledge and experience, is capable of identifying, evaluating, and addressing existing and predictable hazards in the working environment or working conditions that are unsanitary, hazardous, or dangerous to personnel, and who has authorization to take prompt corrective measures to eliminate them.

1.2.3 Qualified Person (QP)

The QP is a person designated in writing, who, by possession of a recognized degree, certificate, or professional standing, or extensive knowledge, training, and experience, has successfully demonstrated their ability to solve or resolve problems related to the subject matter, the work, or the project.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit

the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government Acceptance or Approval does not remove responsibility from the Contractors for their actions or liability.

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: For NAVFAC PAC Area of Responsibility, select the "G" designation for Accident Prevention Plan (APP) and remove the "G" designation for Indoor Air Quality (IAQ) Management Plan, under the SD-01 Preconstruction Submittals.

****

SD-01 Preconstruction Submittals

Accident Prevention Plan (APP); G, [_____]

Dive Operations Plan; G, [_____]

****

NOTE: The following two submittal items are tailored for INDOOR AIR QUALITY. Include the following submittal when required by Section 01 33 29

SUSTAINABILITY REQUIREMENTS AND REPORTING, IAQ requirements.
****

[Final IAQ Management Plan; S

] Indoor Air Quality (IAQ) Management Plan; G, [_____]

SD-06 Test Reports

Accident Reports; G, [_____]

LHE Inspection Reports

Monthly Exposure Reports; G, [_____]

SD-07 Certificates

Crane Operators/Riggers

Activity Hazard Analysis (AHA); G, [_____]

Certificate of Compliance

Contractor Safety Self-Evaluation Checklist

Hot Work Permit

License Certificates

Portable Gauge Operations Planning Worksheet; G, [_____]

Radiography Operation Planning Work Sheet; G, [_____]

Standard Lift Plan; G, [_____]

Third Party Certification of Floating Cranes and Barge-Mounted Mobile Cranes

1.4 PUBLIC HEALTH EMERGENCIES

In the event of a declared public health emergency, follow safety precautions as required by the Occupational Safety and Health Administration (OSHA) www.osha.gov, the Centers for Disease Control and Prevention (CDC) www.cdc.gov, and as required by federal, state and local requirements.

1.5 MONTHLY EXPOSURE REPORTS

Provide a Monthly Exposure Report by the fifth of each month. This report is a compilation of employee-hours worked each month for all site workers, both Prime and subcontractor. Failure to submit the report may result in retention of up to 10 percent of the progress payment.

1.6 CONTRACTOR SAFETY SELF-EVALUATION CHECKLIST

****
NOTE: Include this paragraph in NAVY projects only. Do not use on ARMY projects.

****

Contracting Officer will provide a "Contractor Safety Self-Evaluation checklist" to the Contractor at the preconstruction conference. Complete the checklist monthly and submit with each request for payment voucher. This submission is required monthly even when a payment voucher is not requested. An acceptable score of 90 or greater is required. Failure to submit the completed safety self-evaluation checklist or achieve a score of at least 90 may result in retention of up to 10 percent of the voucher. The Contractor Safety Self-Evaluation checklist can be found on the Whole Building Design Guide website at www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-35-26

1.7 REGULATORY REQUIREMENTS

****

NOTE: Edit to include any additional requirements which apply to the work to be performed including Federal, state and local laws, regulations and statutes; Host Nation requirements; and NAVY, AIR FORCE and ARMY installation or US Army Corps of Engineers District requirements by authority and document number. Consult with the supporting local Safety and Occupational Health Office (SOHO) for assistance in identifying local requirements.

****

In addition to the detailed requirements included in the provisions of this Contract, comply with the most recent edition of USACE EM 385-1-1, and the following[federal, state, and local][host nation] laws, ordinances, criteria, rules and regulations at the date of the Solicitation for this Contract. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements govern.

1.7.1 Subcontractor Safety Requirements

****

NOTE: Use this paragraph and subsequent subparagraphs for NAVY projects in CONUS and Hawaii only.

****

For this Contract, neither Contractor nor any subcontractor may enter into Contract with any subcontractor that fails to meet the following requirements. The term subcontractor in this and the following paragraphs means any entity holding a Contract with the Contractor or with a subcontractor at any tier.

1.7.1.1 Experience Modification Rate (EMR)

Subcontractors on this Contract must have an effective EMR less than or equal to 1.10, as computed by the National Council on Compensation Insurance (NCCI) or if not available, as computed by the state agency's rating bureau in the state where the subcontractor is registered, when entering into a subcontract agreement with the Prime Contractor or a subcontractor at any tier. The Prime Contractor may submit a written request for additional consideration to the Contracting Officer where the specified acceptable EMR range cannot be achieved. Relaxation of the EMR range will only be considered for approval on a case-by-case basis for special conditions and must not be anticipated as tacit approval. Contractor's Site Safety and Health Officer (SSHO) must collect and maintain the certified EMR ratings for all subcontractors on the project and make them available to the Government at the Government's request.

1.7.1.2 OSHA Days Away from Work, Restricted Duty, or Job Transfer (DART) Rate

Subcontractors on this Contract must have a DART rate, calculated from the most recent, complete calendar year, less than or equal to 3.4 when entering into a subcontract agreement with the Prime Contractor or a subcontractor at any tier. The OSHA Dart Rate is calculated using the following formula:

$$(N/EH) \times 200{,}000$$

Where:

N = number of injuries and illnesses with days away, restricted work, or job transfer

EH = total hours worked by all employees during most recent, complete calendar year

200,000 = base for 100 full-time equivalent workers (working 40-hours per week, 50 weeks per year)

The Prime Contractor may submit a written request for additional consideration to the Contracting Officer where the specified acceptable OSHA Dart rate range cannot be achieved for a particular subcontractor. Relaxation of the OSHA DART rate range will only be considered for approval on a case-by-case basis for special conditions and must not be anticipated as tacit approval. Contractor's Site Safety and Health Officer (SSHO) must collect and maintain self-certified OSHA DART rates for all subcontractors on the project and make them available to the Government at the Government's request.

1.8 SITE QUALIFICATIONS, DUTIES, AND MEETINGS

1.8.1 Site Safety and Health Officer (SSHO)

1.8.1.1 Qualifications of SSHO

All SSHOs will have met the training, experience requirements identified in the EM 385-1-1 and this Contract.

1.8.1.2 Duties of SSHO

All SSHOs will carry out the roles and responsibilities as identified in this Contract and the EM 385-1-1. All SSHOs will be designated on an ENG Form 6282, provided by the Contracting Officer. Superintendent, QC Manager, and SSHO are subject to dismissal if their required duties are not being effectively carried out. If either the Superintendent, QC Manager, or SSHO are dismissed, project work will be stopped and will not be allowed to resume until a suitable replacement is approved and the above duties are again being effectively carried out.

1.8.1.3 Safety Meetings

Conduct safety meetings to review past activities, plan for new or changed operations, review pertinent aspects of appropriate AHA (by trade), establish safe working procedures for anticipated hazards, and provide pertinent Safety and Occupational Health (SOH) training and motivation. Conduct meetings at least once a month for all supervisors at the project location. The SSHO, supervisors, or foremen must conduct meetings at least once a week for the trade workers. Document meeting minutes to include the date, persons in attendance, subjects discussed, and names of individual(s) who conducted the meeting. Maintain documentation on-site and furnish copies to the Contracting Officer on request. Notify the Contracting Officer of all scheduled meetings 7 calendar days in advance.

1.8.2 Roles and Responsibilities of Prime Contractor and SSHO

The Prime Contractor and SSHO must ensure that the requirements of all applicable OSHA and EM 385-1-1 are met for the project. The Prime Contractor must ensure an SSHO or an equally qualified Alternate SSHO(s) is at the worksite at all times to implement and administer the Contractor's safety program and Government accepted Accident Prevention Plan. If the required SSHO has to temporarily (that is, up to 24 hours / 1 day) leave the site of work due to unforeseen or emergency situations, a Level One, Two, or Three SSHO may be used in the interim and must be on the site of work at all times when work is being performed.

If the SSHO must be off-site for a period longer than 24 hours / 1 day, a qualified alternate that meets the contract requirements must be onsite.

a. Prime contractor must ensure all SSHOs will:

   (1) Are designated on an ENG Form 6282.

   (2) Meet minimum training and experience requirements identified in EM 385-1-1.

   (3) Execute roles and responsibilities identified in EM 385-1-1.

1.8.3 Additional Requirements

****

NOTE: This paragraph is tailored for NAVY. Choose the bracketed items below when the project allows the SSHO to serve as the QC Manager or Superintendent or both. Consult with the local NAVFAC, FEAD, or ROICC construction office to determine the potential for the SSHO to wear multiple hats on the specific project based on the hazards of the project, job complexity, size, and any other pertinent factors. Coordinate with Section 01 45 00 QUALITY CONTROL. A Level One must not serve any other roles. A level Two or Three may serve in additional roles.

****

The Level[One][Two][Three] SSHO[may also][must not] serve as the Quality Control Manager. The[One][Two][Three] SSHO[may also][must not] serve as the Superintendent.

****
NOTE: Use this subparagraph for NAVFAC Pacific (excluding Contingency Engineering), Hawaii, and Marianas projects only.
****

The SSHO must have completed a 40-hour contract safety awareness course based on the content and principles of EM 385-1-1, and instructed in accordance with the guidelines of ANSI/ASSP Z490.1, by a trainer meeting the qualifications of paragraph QUALIFIED TRAINER REQUIREMENTS. If the SSHO does not have a current certification, certification must be obtained within 60 days, maximum, of Contract award.

[1.8.4 Contract Site Safety And Health Officer(s)(SSHOs) Minimum Requirements

Provide a minimum of one Level One SSHO that meets the requirements of EM 385-1-1 for this project.

][1.8.5 Contract Site Safety and Health Officer(s)(SSHOs) Minimum Requirements for Projects with[Multiple Work Sites,][Multiple Shifts,][Limited Scope,][or Maintenance, or Service Contracts].

****
NOTE: Insert this paragraph when a contract has:

1) More than one worksite or multiple shifts that require a separate full-time SSHO.

2) A limited Scope.

3) Maintenance and Service Contracts.

Fill in the worksite locations below and the required level of SSHO when a project has more than one worksite that requires a dedicated full-time SSHO. Just because a project has more than one worksite does not automatically mean additional full-time SSHOs are required. Only consider specifying additional full-time SSHOs when the contract includes separate projects and each project is uniquely different from one another usually having separate plans and specifications or large geographical distances. This is very rare and should only be specified after careful consideration and consultation with the KO, SOHO, and administering construction office. This is very rare and should only be specified after careful consideration and consultation with the FEAD/OICC/ROICC. Add or delete locations as needed.
****

Provide a separate full-time Level [One][Two][Three] SSHO at each of the following worksites:

a. [INDICATE WORKSITE LOCATION] Level [One][Two][Three] SSHO

b. [INDICATE WORKSITE LOCATION] Level [One][Two][Three] SSHO

c. [INDICATE WORKSITE LOCATION] Level [One][Two][Three] SSHO

The SSHOs for the worksites listed above must each have the required training, experience, and qualifications in accordance with EM 385-1-1.

Each SSHO is responsible for implementing and managing the Safety and Occupational Health (SOH) program at the worksite indicated, while ensuring that the 29 CFR 1926, EM 385-1-1, Contracts, and all applicable federal, state, and Local requirements are met.

]1.8.6 Dredging Contract Site Safety and Health Officer(s)(SSHOs) Requirements

****

Note: This paragraph and subsequent paragraphs are tailored for DREDGING. Dredging Contracts may include several project sites. Specification writers must coordinate with the local USACE District (KO and SOHO), NAVFAC, FEAD (Facilities, Engineering and Acquisition Division), or ROICC (Resident Officer in Charge of Construction) office to determine the project site and SSHO staffing requirements, considering size of Contract, organization of dredging operation requirements, dispersion of operations, and travel time to associated sites by SSHO.

****

1.8.6.1 Dredging SSHO Personnel Requirements

a. Provide a minimum of one primary Level One SSHO assigned for the primary shift.

Note: Hopper Dredges with U.S. Coast Guard, credentialed crews the prime contractor may designate a Level Two SSHO in lieu of having a Level one SSHO onboard.

b. For a project involving multiple work shifts, provide a minimum of a Level[One][Two] SSHO for each additional shift.

c. For individual dredging projects the prime contractor will designate additional Level Three SSHOs at locations where the primary Level One SSHO is not located (example: on dredge, tug, material placement site).

Examples of one dredging project site is reflected in each of the following:

(1) a mechanical dredge, tug(s) and scow(s), scow route, and material placement site; or

(2) a hydraulic pipeline dredge, attendant plant, and material placement site; or,

(3) a hopper dredge (include land-based material placement site - if applicable.)

d. Designated SSHOs must be present at the project site, located so that they have full mobility and reasonable access to all major work operations and must be available during their shift for immediate verbal consultation and notification.

e. Designated Level One and Two SSHOs must have direct report authority to a senior project (or corporate) management official.

f. Designated Level Three SSHOs must report potential safety and occupational health hazards, incidents, and concerns to the Level One or Two SSHO on shift.

g. Level One and Level Two SSHOs for dredging must have a minimum of 3 years experience in one of the following areas:

  (1) Supervising/managing dredging activities.

  (2) Supervising/managing marine construction activities.

  (3) Supervising/managing land-based construction activities.

  (4) Work managing safety programs or processes.

  (5) Conducting hazard analyses and developing controls in activities or environments with similar hazards.

1.8.7 Competent Person for Confined Space Entry

Provide a CP for Confined Space Entry who meets the requirements of EM 385-1-1 and herein. The CP for Confined Space Entry must supervise the entry into each confined space in accordance with EM 385-1-1.

****

NOTE: Use this paragraph for operations involving combustible or hazardous materials.

****

[Since this work involves operations that handle combustible or hazardous materials, this person must have the ability to understand and follow through on the air sampling, Personal Protective Equipment (PPE), and instructions of a Marine Chemist, Coast Guard authorized persons, or Certified Industrial Hygienist. Confined space and enclosed space work must comply with NFPA 306, 29 CFR 1915, "Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment," or as applicable in 29 CFR 1910 for general industry, 29 CFR 1926 for construction.

]1.8.8 Qualified Trainer Requirements

****

NOTE: Subparagraph Item "a" below with reference to NAVFAC is tailored for NAVFAC Marianas projects only.

****

Individuals qualified to instruct the 40-hour contract safety awareness course, or portions thereof, must meet the definition of a Competent Person Trainer as defined in the EM 385-1-1, and, at a minimum, possess a working knowledge of the following subject areas: EM 385-1-1, Electrical Standards, Lockout/Tagout, Fall Protection, Confined Space Entry for Construction; Excavation, Trenching and Soil Mechanics, and Scaffolds in accordance with 29 CFR 1926.

Instructors are required to:

a. Prepare class presentations that cover construction-related safety requirements and includes topics covered in the NAVFAC Construction Safety Hazard Awareness Course for Contractors.

b. Ensure that all attendees attend all sessions by using a class roster signed daily by each attendee. Maintain copies of the roster for at least 5 years. This is a certification class and must be attended 100 percent. In cases of emergency where an attendee cannot make it to a session, the attendee can make it up in another class session for the same subject.

c. Update training course materials whenever an update of the EM 385-1-1 becomes available.

d. Provide a written exam of at least 50 questions. Students are required to answer 80 percent correctly to pass.

e. Request, review and incorporate student feedback into a continuous course improvement program.

1.8.9 Requirements for All Contractor Jobsite Personnel Holding H-1B or H-2B Visas

****

NOTE: This paragraph is tailored for inclusion in NAVFAC MARIANAS projects only.

****

All Contractor jobsite workers holding an H-1B or H-2B visa must complete a minimum 16-hours of classroom training on the requirements of the latest version of EM 385-1-1 prior to their first day on the jobsite to include but not limited to the following topics: Sanitation; Medical and First Aid Requirements; Temporary Facilities; Personal Protective Equipment; Electrical; Hand and Power Tools; Material Handling and Storage; Motor Vehicles; Fall Protection; Work Platforms and Scaffoldings; Demolition; Safe Access, Ladders, Floor & Wall Openings, Stairs and Railing Systems; Excavations and Trenching; and Confined Spaces, prior to reporting to the jobsite.

Submit a list of workers who have completed the training to the Contracting Officer prior to them reporting to the jobsite. Update the list as additional workers are added. Maintain the updated list at the jobsite for review by the Government's designated authority. Include the name and qualifications of qualified trainer(s) that provided the training. Personnel who have taken the 40-hour Construction Safety Hazard Awareness Training Course for Contractors or similar course that includes emphasis on EM 385-1-1 compliance, are not required to take the 16-hours of classroom training on the requirements of the latest version of the EM 385-1-1. The 16-hours classroom training may be provided by the Guam Contractors Association (GCA), Trades Academy, or other qualified trainers as outlined in paragraph QUALIFIED TRAINER REQUIREMENTS.

1.8.10 Crane Operators/Riggers

****

NOTE: Add the following paragraph for projects in the State of Hawaii only. Paragraph is tailored for

NAVFAC HI.
****

Crane Operators must also meet the crane operator requirements of the State of Hawaii for Crane certification.

1.8.11 Preconstruction Conference

a. Contractor representatives who have a responsibility or significant role in accident prevention on the project must attend the preconstruction conference. This includes the project superintendent, Site Safety and Occupational Health Officer, quality control manager, or any other assigned safety and health professionals who participated in the development of the APP (including the Activity Hazard Analyses (AHAs) and special plans, program and procedures associated with it).

b. Discuss the details of the submitted APP to include incorporated plans, programs, procedures and a listing of anticipated AHAs that will be developed and implemented during the performance of the Contract. This list of proposed AHAs will be reviewed and an agreement will be reached between the Contractor and the Contracting Officer as to which phases will require an analysis. In addition, establish a schedule for the preparation, submittal, and Government review of AHAs to preclude project delays. The creation of the APP and Schedule will be created after being given Notice to Proceed.

c. Deficiencies in the submitted APP, identified during the Contracting Officer's review, must be corrected, and the APP re-submitted for review prior to the start of construction. Work is not permitted to begin until an APP is established that is acceptable to the Contracting Officer.

1.9 ACCIDENT PREVENTION PLAN (APP)

****
NOTE: Contracts that include FAR 52.236-13 Accident Prevention require the Contractor to prepare and execute a written Accident Prevention Plan (APP) in accordance with EM 385-1-1 to include Activity Hazard Analyses (AHA). For Design-Build projects a Design Submittal of an APP is also required.
****

1.9.1 Accident Prevention Plan (APP)

****
NOTE: This paragraph is tailored for DESIGN-BUILD, use for DESIGN-BUILD projects only.
****

Provide a site-specific Accident Prevention Plan (APP), including Activity Hazard Analyses (AHA), in accordance with EM 385-1-1, ENG Form 6293, for the design team to follow during site visits and investigations. For subsequent visits, update the plan if there are changes in the personnel who will be attending, or the tasks to be performed. Submit the APP for review and acceptance by the Government at least 15 calendar days prior to the start of the design field work after being given Notice to Proceed. Field work must not begin until the design APP is accepted by the Contracting Officer. Prior to the start of construction incorporate the

Design APP into the Construction APP so that one site specific APP exists for the project and submit to the Contracting Officer for acceptance.

If the design scope includes borings or other subsurface investigations, include in the APP the type of field investigation and verification techniques, such as visual, local utility locating service scanning and third party subcontractor scanning, potholing, or hand digging within two feet of a known utility that will be required. Mark underground utilities before starting any ground-disturbing actions. Notify the Contracting Officer 15 days prior to the start of soil borings or sub-surface investigations.

1.9.2 Accident Prevention Plan (APP)

****

NOTE: Second paragraph includes tailoring for ARMY projects. In second paragraph, choice of bracketed options are for ARMY projects only.

****

Submit the Accident Prevention Plan (APP) for review and acceptance by the Government at least 15 calendar days prior to the start, after being given Notice to Proceed. A competent person must prepare the written site-specific APP. Prepare the APP in accordance with the format and requirements of EM 385-1-1, ENG Form 6293, and herein. The APP must be job-specific and address any unusual or unique aspects of the project or activity for which it is written. The APP must interface with the Contractor's overall safety and occupational health program referenced in the APP in the applicable APP element, and made site-specific. Describe the methods to evaluate past safety performance of potential subcontractors in the selection process. Also, describe innovative methods used to ensure and monitor safe work practices of subcontractors. The Government considers the Prime Contractor to be the "controlling employer" for all worksite safety and health of the subcontractors. Contractors are responsible for informing their subcontractors of the safety provisions under the terms of the Contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out. The APP must be signed in accordance with the APP and ENG Form 6293 Accident Prevention Plan Worksheet. The SSHO must provide and maintain the APP and a log of signatures by each subcontractor foreman, attesting that they have read and understand the APP, and make the APP and log available on-site to the Contracting Officer. If English is not the foreman's primary language, the Prime Contractor must provide an interpreter.

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NOTE: For projects in the NAVFAC PAC Area of Responsibility, DESIGN-BUILD projects select the first set of brackets and edit the sentence by selecting "15" calendar days. For DESIGN-BID-BUILD projects, select the second set of brackets.

****

[Submit the APP to the Contracting Officer [15] [_____] calendar days prior to the date of the preconstruction conference for acceptance.][Submit the APP to the Contracting Officer within 30 calendar days of Contract award and not less than 10 calendar days prior to the date of the preconstruction conference for acceptance.]Work cannot proceed without an accepted APP. Once reviewed and accepted by the Contracting Officer, the APP and attachments will be enforced as part of the Contract. Disregarding the provisions of this Contract or the accepted APP is cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified. Continuously review and amend the APP, as necessary, throughout the life of the Contract. Changes to the accepted APP must be made with the knowledge and concurrence of the Contracting Officer, project superintendent, SSHO and Quality Control Manager. Incorporate unusual or high-hazard activities not identified in the original APP as they are discovered. Should any severe hazard exposure (i.e., imminent danger) become evident, stop work in the area, secure the area, and develop a plan to remove the exposure and control the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate and remove the hazard. In the interim, take all necessary action to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public (as defined by ANSI/ASSP A10.34), and the environment.

1.9.3 Names and Qualifications

Provide plans in accordance with the requirements outlined in EM 385-1-1, including the following:

a. Names and qualifications (resumes including education, training, experience and certifications) of site safety and health personnel designated to perform work on this project to include the designated Site Safety and Health Officer and other competent and qualified personnel to be used. Specify the duties of each position.

b. As a minimum, designate and submit qualifications of Competent Persons (CP) for each of the following major areas: excavation; scaffolding; fall protection; hazardous energy; confined space; health hazard recognition, evaluation and control of chemical, physical and biological agents; and personal protective equipment and clothing to include selection, use and maintenance. Designate and submit qualifications for additional CPs as applicable to the work performed under this Contract.

1.9.4 Plans

Provide plans in the APP in accordance with the requirements outlined in EM 385-1-1, including the following:

[1.9.4.1 Lead, Cadmium, and Chromium Compliance Plan

****

NOTE: Include this bracketed subparagraph and the following subparagraphs when project is expected to involve these hazardous materials or contaminated sites.

****

Identify the safety and health aspects of work involving lead, cadmium and chromium, and prepare in accordance with Section 02 83 00 LEAD REMEDIATION.

][1.9.4.2 Asbestos Hazard Abatement Plan

Identify the safety and health aspects of asbestos work, and prepare in accordance with Section 02 82 00 ASBESTOS REMEDIATION.

][1.9.4.3 Site Safety and Health Plan

Identify the safety and health aspects, and prepare in accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.

][1.9.4.4 Polychlorinated Biphenyls (PCB) Plan

Identify the safety and health aspects of Polychlorinated Biphenyls work, and prepare in accordance with Sections 02 84 33 REMOVAL AND DISPOSAL OF POLYCHLORINATED BIPHENYLS (PCBs) and 02 61 23 REMOVAL AND DISPOSAL OF PCB CONTAMINATED SOILS.

][1.9.4.5 Site Demolition Plan

****

NOTE: Include this subparagraph when the project includes demolition or deconstruction activities. This paragraph includes NAVY tailoring - include the last tailored sentence on NAVY projects only. Refer to the other sections of the Contract for the types of surveys needed.

****

Identify the safety and health aspects, and prepare in accordance with Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION] and referenced sources. Include engineering survey as applicable.

]1.10 ACTIVITY HAZARD ANALYSIS (AHA)

Before beginning each activity, task or Definable Feature of Work (DFOW) involving a type of work presenting hazards not experienced in previous project operations, or where a new work crew or subcontractor is to perform the work, the Contractor(s) performing that work activity must prepare an AHA. AHAs must be developed by the Prime Contractor, subcontractor, or supplier performing the work, and provided for Prime Contractor review and approval before submitting to the Contracting Officer. AHAs must be signed by the SSHO, Superintendent, QC Manager and the subcontractor Foreman performing the work. Format the AHA in accordance with EM 385-1-1 or as directed by the Contracting Officer. Submit the AHA for review at least [15][_____] working days prior to the start of each activity task, or DFOW. The Government reserves the right to require the Contractor to revise and resubmit the AHA if it fails to effectively identify the work sequences, specific anticipated hazards, site conditions, equipment, materials, personnel and the control measures to be implemented.

AHAs must identify competent persons required for phases involving high risk activities, including confined entry, crane and rigging, excavations, trenching, electrical work, fall protection, and scaffolding.

1.10.1 AHA Management

Review the AHA list periodically (at least monthly) at the Contractor supervisory safety meeting, and update as necessary when procedures, scheduling, or hazards change. Use the AHA during daily inspections by the SSHO to ensure the implementation and effectiveness of the required safety and health controls for that work activity.

1.10.2 AHA Signature Log

Each employee performing work as part of an activity, task or DFOW must review the AHA for that work and sign a signature log specifically maintained for that AHA prior to starting work on that activity. The SSHO must maintain a signature log on site for every AHA. Provide employees whose primary language is other than English, with an interpreter to ensure a clear understanding of the AHA and its contents.

1.11 SITE SAFETY REFERENCE MATERIALS

Maintain safety-related references applicable to the project, including those listed in paragraph REFERENCES. Maintain applicable equipment manufacturer's manuals.

1.12 EMERGENCY MEDICAL TREATMENT

Contractors must arrange for their own emergency medical treatment in accordance with EM 385-1-1. The Government has no responsibility to provide emergency medical treatment.

1.13 NOTIFICATIONS AND REPORTS

1.13.1 Accident Notification

Notify the Contracting Officer in accordance with the EM 385-1-1 Accident Reporting Timeline.

Table
Accident Reporting Required Timeline

Accident Type	Notify KO or COR	Complete Final Accident Report on ENG 3394 and provide to KO or COR
Fatality, in-patient hospitalization, amputation, eye loss, or property damage over $600,000.	Immediately, no later than (NLT) 8 Hours	Within 7 Days
All other accidents and near misses	Immediately, no later than (NLT) 24 Hours	Within 7 Days

Within notification include Contractor name; Contract title; type of Contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (for example, type of construction equipment used and PPE used). Preserve the conditions and evidence on the accident site until the Government investigation team arrives on-site and Government investigation is conducted. Assist and cooperate fully with the Government's investigation(s) of any accident or near miss.

1.13.2 Accident Reports

****

NOTE: The following subparagraphs include tailoring for NAVY and ARMY projects. The sentences referring to ESAMS are tailored for use on NAVY projects. The sentences referring to ENG Form 3394 are tailored for use on ARMY projects.

****

a. Conduct an accident investigation for recordable injuries and illnesses, property damage, and near misses as defined in EM 385-1-1, to establish the root cause(s) of the accident. Complete the applicable NAVFAC Contractor Incident Reporting System (CIRS), and electronically submit via the NAVFAC Enterprise Safety Applications Management System (ESAMS). Complete and submit an accident investigation report in ESAMS within 7 days for accidents as defined by EM 385-1-1. Complete the investigation report within 30 days. Accidents must include a written report submitted as an attachment in ESAMS using the following outline:

(1) Summary description to include:

(a) process

(b) findings

(c) outcomes

(2) Root Cause

(3) Direct Factors

(4) Indirect and Contributing Factors

(5) Corrective Actions

(6) Recommendations

All accidents are reportable, regardless of whether or not it is recordable.

a. Conduct an accident investigation for recordable injuries and illnesses, property damage, and near misses as defined in EM 385-1-1, to establish the root cause(s) of the accident. All accidents are reportable, regardless of whether or not it is recordable. Complete the applicable USACE Accident Report, ENG Form 3394, and provide the report to the Contracting Officer within 7 calendar days of the accident. The Contracting Officer will provide copies of any required or special forms. All accidents are reportable, regardless of whether or not it is recordable.

****

NOTE: The following subparagraph includes tailoring for ARMY and NAVY projects. The first set of sentences is tailored for use on NAVY projects only, and the second set is tailored for use on ARMY projects only.

****

b. Near Misses: For Navy Projects, complete the applicable documentation in NAVFAC Contractor Incident Reporting System (CIRS), and electronically submit via the NAVFAC Enterprise Safety Applications Management System (ESAMS). For Army projects, report all "Near Misses" to the[Contracting Officer][COR][_____], using local accident reporting procedures, within 24 hours. The[Contracting Officer][COR][_____] will provide the Contractor the required forms. Near miss reports are considered positive and proactive Contractor safety management actions.

****

NOTE: Include the following subparagraph for all NAVY projects.

****

c. Conduct an accident investigation for any load handling equipment accident (including rigging accidents) to establish the root cause(s) of the accident. Complete the Load Handling Equipment (LHE) Accident Report (Crane and Rigging Accident Report) form and provide the report to the Contracting Officer within 30 calendar days of the accident. Do not proceed with crane operations until cause is determined and corrective actions have been implemented to the satisfaction of the Contracting Officer. The Contracting Officer will provide a blank copy of the accident report form.

1.13.3 LHE Inspection Reports

Submit LHE inspection reports required in accordance with EM 385-1-1 and as specified herein with Daily Reports of Inspections.

[1.13.4 Certificate of Compliance and Pre-lift Plan/Checklist for LHE and Rigging

****

NOTE: Include the following paragraph for all NAVY projects; paragraph is optional for ARMY projects.

****

Provide a Certificate of Compliance for LHE entering an activity under this Contract and in accordance with EM 385-1-1. Post certifications on the crane.

Develop a Standard Lift Plan (SLP) in accordance with EM 385-1-1 and using Standard Pre-Lift Crane Plan/Checklist for each lift planned. Submit SLP to the Contracting Officer for approval within 15 calendar days in advance of planned lift.

][1.13.5 Third Party Certification of Floating Cranes and Barge-Mounted Mobile Cranes

****

NOTE: The following paragraph is tailored for NAVY projects. Include this tailored paragraph for CONUS NAVY projects only. Paragraph can be deleted on projects where no floating or barge-mounted mobile cranes would be used.

****

Floating cranes and barge-mounted mobile cranes used to perform work under the terms of this Contract must be certified in accordance with 29 CFR 1919 by an OSHA accredited person prior to submitting the required Lift Plan.

Include proof of certification with the initial Lift Plan submission.

]1.14 HOT WORK PERMIT

1.14.1 Permit and Personnel Requirements

Submit and obtain a written permit prior to performing "Hot Work" (i.e., welding or cutting) or operating other flame-producing/spark producing devices, from the [Fire Division][_____]. A permit is required from the Explosives Safety Office for work in and around where explosives are processed, stored, or handled. Contractors are required to meet all criteria before a permit is issued. Provide at least two 9 kg 20 pound 4A:20 BC rated extinguishers for normal "Hot Work". The extinguishers must be current inspection tagged, and contain an approved safety pin and tamper resistant seal. It is also mandatory to have a designated FIRE WATCH for any "Hot Work" done at this activity. The Fire Watch must be trained in accordance with NFPA 51B and remain on-site for a minimum of 1 hour after completion of the task or as specified on the hot work permit.

When starting work in the facility, require personnel to familiarize themselves with the location of the nearest fire alarm boxes and place in memory the emergency [Fire Division][_____] phone number. Report any fire, no matter how small, to the responsible [Fire Division][_____] immediately.

1.14.2 Work Around Flammable Materials

Obtain permit approval from a NFPA Certified Marine Chemist, or Certified Industrial Hygienist for "Hot Work" within or around flammable materials (such as fuel systems or welding/cutting on fuel pipes) or confined spaces (such as sewer wet wells, manholes, or vaults) that have the potential for flammable or explosive atmospheres.

Whenever these materials, except beryllium and chromium (VI), are encountered in indoor operations, local mechanical exhaust ventilation systems that are sufficient to reduce and maintain personal exposures to within acceptable limits must be used and maintained in accordance with manufacturer's instruction and supplemented by exceptions noted in EM 385-1-1.

1.15 RADIATION SAFETY REQUIREMENTS

****

NOTE: The following paragraph includes tailoring for NAVY projects. Include the tailored item for NAVY projects only.

****

Submit License Certificates, employee training records, and Leak Test Reports for radiation materials and equipment to the Contracting Officer and Radiation Safety Office (RSO), and Contracting Oversight Technician (COT) for all specialized and licensed material and equipment proposed for use on the construction project (excludes portable machine sources of ionizing radiation including moisture density and X-Ray Fluorescence (XRF)). Maintain on-site records whenever licensed radiological materials or ionizing equipment are on Government property.

Protect workers from radiation exposure in accordance with 10 CFR 20, ensuring any personnel exposures are maintained As Low As Reasonably Achievable.

1.15.1   Radiography Operation Planning Work Sheet

****

NOTE: The following paragraph includes tailoring for NAVY projects. Include the tailored item for NAVY projects only.

****

Submit a Gamma and X-Ray Radiography Operation Planning Work Sheet to Contracting Officer 14 days prior to commencement of operations involving radioactive materials or radiation generating devices. For portable machine sources of ionizing radiation, including moisture density and XRF, use and submit the Portable Gauge Operations Planning Worksheet instead. The Contracting Officer and COT will review the submitted worksheet and provide questions and comments.

Contractors must use primary dosimeters process by a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory.

1.15.2   Site Access and Security

****

NOTE: The following paragraph includes tailoring for NAVY projects. Include the tailored items for NAVY projects only.

****

Coordinate site access and security requirements with the Contracting Officer and COT for all radiological materials and equipment containing ionizing radiation that are proposed for use on a government facility. For gamma radiography materials and equipment, a Government escort is required for any travels on the Installation. The Navy COT or Government authorized representative will meet the Contractor at a designated location outside the Installation, ensure safety of the materials being transported, and will escort the Contractor for gamma sources onto the Installation, to the job site, and off the Installation. For portable machine sources of ionizing radiation, including moisture density and XRF, the Navy COT or Government authorized representative will meet the Contractor at the job site.

Provide a copy of all calibration records, and utilization records to the COT for radiological operations performed on the site.

1.15.3   Loss or Release and Unplanned Personnel Exposure

Loss or release of radioactive materials, and unplanned personnel exposures must be reported immediately to the Contracting Officer, RSO, and Base Security Department Emergency Number.

1.15.4   Site Demarcation and Barricade

****

NOTE: Add any applicable Instructions or local requirements to first sentence.

****

Properly demark and barricade an area surrounding radiological operations to preclude personnel entrance, in accordance with EM 385-1-1, Nuclear

Regulatory Commission, and Applicable State regulations and license requirements, and in accordance with requirements established in the accepted Radiography Operation Planning Work Sheet.

Do not close or obstruct streets, walks, and other facilities occupied and used by the Government without written permission from the Contracting Officer.

1.15.5 Security of Material and Equipment

Properly secure the radiological material and ionizing radiation equipment at all times, including keeping the devices in a properly marked and locked container, and secondarily locking the container to a secure point in the Contractor's vehicle or other approved storage location during transportation and while not in use. While in use, maintain a continuous visual observation on the radiological material and ionizing radiation equipment. In instances where radiography is scheduled near or adjacent to buildings or areas having limited access or one-way doors, make no assumptions as to building occupancy. Where necessary, the Contracting Officer will direct the Contractor to conduct an actual building entry, search, and alert. Where removal of personnel from such a building cannot be accomplished and it is otherwise safe to proceed with the radiography, position a fully instructed employee inside the building or area to prevent exiting while external radiographic operations are in process.

1.15.6 Transportation of Material

Comply with 49 CFR 173 for Transportation of Regulated Amounts of Radioactive Material. Notify Local Fire authorities and the site Radiation Safety Officer (RSO) of any Radioactive Material use.

1.15.7 Schedule for Exposure or Unshielding

Actual exposure of the radiographic film or unshielding the source must not be initiated until after 5 p.m. on weekdays.

1.15.8 Transmitter Requirements

Adhere to the base policy concerning the use of transmitters, such as radios and cell phones. Obey Emissions control (EMCON) restrictions.

1.16 CONFINED SPACE ENTRY REQUIREMENTS

****

NOTE: The following paragraph includes tailoring for NAVY projects. Include the last bracketed sentence for NAVY projects only as applicable.

****

Confined space entry must comply with EM 385-1-1, 29 CFR 1926, 29 CFR 1910, and Directive CPL 2.100. Any potential for a hazard in the confined space requires a permit system to be used.[Contractors entering and working in confined spaces while performing shipyard industry work are required to follow the requirements of 29 CFR 1915.]

1.16.1 Rescue Procedures and Coordination with Local Emergency Responders

Develop and implement an on-site rescue and recovery plan and procedures. The rescue plan must not rely on local emergency responders for rescue from a confined space.

1.17 CONSTRUCTION INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN

****

NOTE: This paragraph and subsequent subparagraphs are tailored for INDOOR AIR QUALITY.

****

****

NOTE: Preventing indoor air quality problems resulting from the construction process sustains the comfort and health of construction workers and building occupants. Include last bracketed sentence when required by Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING, IAQ requirements.

For projects in the NAVFAC PAC Area of Responsibility, select the second set of brackets, "not less than 10 calendar days before the preconstruction conference."

The following paragraph contains tailoring for DESIGN-BUILD and DESIGN-BID-BUILD.

****

Submit an IAQ Management Plan [within [15][_____] calendar days after design [Contract award][notice to proceed] and not less than 10 calendar days before the preconstruction conference.][not less than 10 calendar days before the preconstruction conference.] Revise and resubmit Plan as required by the Contracting Officer. Make copies of the final plan available to all workers on site. Include provisions in the Plan to meet the requirements specified below and to ensure safe, healthy air for construction workers and building occupants.[Submit Final IAQ Management Plan for inclusion in the Sustainability eNotebook, in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.]

1.17.1 Requirements During Construction

Provide for evaluation of indoor Carbon Dioxide concentrations in accordance with ASTM D6245. Provide for evaluation of volatile organic compounds (VOCs) in indoor air in accordance with ASTM D6345. Use filters with a Minimum Efficiency Reporting Value (MERV) of 8 in permanently installed air handlers during construction.

1.17.1.1 Control Measures

Meet or exceed the requirements of ANSI/SMACNA 008 to help minimize contamination of the building from construction activities. The five requirements of this manual which must be adhered to are described below:

a. HVAC protection: Isolate return side of HVAC system from surrounding environment to prevent construction dust and debris from entering the duct work and spaces.

b. Source control: Use low emitting paints and other finishes, sealants, adhesives, and other materials as specified. When available, cleaning products must have a low VOC content and be non-toxic to minimize building contamination. Utilize cleaning techniques that minimize dust generation. Cycle equipment off when not needed. Prohibit idling motor vehicles where emissions could be drawn into building. Designate receiving/storage areas for incoming material that minimize IAQ impacts.

c. Pathway interruption: When pollutants are generated use strategies such as 100 percent outside air ventilation or erection of physical barriers between work and non-work areas to prevent contamination.

d. Housekeeping: Clean frequently to remove construction dust and debris. Promptly clean up spills. Remove accumulated water and keep work areas dry to discourage the growth of mold and bacteria. Take extra measures when hazardous materials are involved.

e. Scheduling: Control the sequence of construction to minimize the absorption of VOCs by other building materials.

1.17.1.2 Moisture Contamination

a. Remove accumulated water and keep work dry.

b. Use dehumidification to remove moist, humid air from a work area.

c. Do not use combustion heaters or generators inside the building.

d. Protect porous materials from exposure to moisture.

e. Remove and replace items which remain damp for more than a few hours.

1.17.2 Requirements After Construction

After construction ends and prior to occupancy, conduct a building flush-out or test the indoor air contaminant levels. Flush-out must be a minimum 2 weeks with MERV-13 filtration media as determined by ASHRAE 52.2 at 100 percent outside air. Air contamination testing must be consistent with EPA's current Compendium of Methods for the Determination of Air Pollutants in Indoor Air. After building flush-out or testing and prior to occupancy, replace filtration media. Filtration media must have a MERV of 13 as determined by ASHRAE 52.2.

1.18 DIVE SAFETY REQUIREMENTS

****

NOTE: NAVFAC SE projects require 25 working days in the bracketed option.

****

Develop a Dive Operations Plan, AHA, emergency management plan, and personnel list that includes qualifications, for each separate diving operation. Submit these documents to the District Dive Coordinator (DDC) via the Contracting Officer, for review and approval at least [15][_____] working days prior to commencement of diving operations. These documents must be at the diving location at all times. Provide each of these documents as a part of the project file.

1.19 [SEVERE STORM PLAN][SEVERE WEATHER PLAN FOR MARINE ACTIVITIES (SWPMA)]

In the event of a severe storm warning, the Contractor must comply with the applicable Storm Plan and:

a. Secure outside equipment and materials and place materials that could be damaged in protected areas.

b. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.

c. Ensure that temporary erosion controls are adequate.

PART 2 PRODUCTS

****
NOTE: Use this tailored paragraph for ARMY projects only.
****

Not used.

2.1 CONFINED SPACE SIGNAGE

****
NOTE: Include this tailored paragraph for NAVY projects only.
****

Provide permanent signs integral to or securely attached to access covers for new permit-required confined spaces. Signs for confined spaces must comply with NEMA Z535.2. Provide signs with wording: "DANGER--PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" in bold letters a minimum of 25 mm one inch in height and constructed to be clearly legible with all paint removed. The signal word "DANGER" must be red and readable from 1520 mm 5 feet.

PART 3 EXECUTION

3.1 CONSTRUCTION AND OTHER WORK

Comply with EM 385-1-1, NFPA 70, NFPA 70E, NFPA 241, the APP, the AHA, Federal and State OSHA regulations, and other related submittals and activity fire and safety regulations. The most stringent standard prevails.

PPE is governed in all areas by the nature of the work the employee is performing. Use personal hearing protection at all times in designated noise hazardous areas or when performing noise hazardous tasks. Safety glasses must be worn or carried/available on each person. Mandatory PPE includes:

a. Head Protection that meets ANSI/ISEA Z89.1

b. Long Pants

c. Appropriate Safety Footwear

d. Appropriate Class Reflective Vests

3.1.1 Worksite Communication

Employees working alone in a remote location or away from other workers must be provided an effective means of emergency communications (i.e., cellular phone, two-way radios, land-line telephones or other acceptable means). The selected communication must be readily available (easily within the immediate reach) of the employee and must be tested prior to the start of work to verify that it effectively operates in the area/environment. Develop an employee check-in/check-out communication procedure to ensure employee safety.

3.1.2 Hazardous Material Use

****

NOTE: This paragraph is tailored for NAVY. Include this paragraph for NAVY projects only.

****

Each hazardous material must receive approval from the Contracting Office or their designated representative prior to being brought onto the job site or prior to any other use in connection with this Contract. Allow a minimum of 10 working days for processing of the request for use of a hazardous material.

3.1.3 Hazardous Material Exclusions

Notwithstanding any other hazardous material used in this Contract, radioactive materials or instruments capable of producing ionizing/non-ionizing radiation (with the exception of radioactive material and devices used in accordance with EM 385-1-1 such as nuclear density meters for compaction testing and laboratory equipment with radioactive sources) as well as materials which contain asbestos, mercury or polychlorinated biphenyls, di-isocyanates, lead-based paint, and hexavalent chromium, are prohibited. The Contracting Officer, upon written request by the Contractor, may consider exceptions to the use of any of the above excluded materials. Low mercury lamps used within fluorescent lighting fixtures are allowed as an exception without further Contracting Officer approval. Notify the Radiation Safety Officer (RSO) prior to excepted items of radioactive material and devices being brought on base.

3.1.4 Unforeseen Hazardous Material

Contract documents identify materials such as PCB, lead paint, and friable and non-friable asbestos and other OSHA regulated chemicals (i.e., 29 CFR Part 1910.1000). If material(s) that may be hazardous to human health upon disturbance are encountered during demolition, repair, renovation, or construction operations. Stop that portion of work and notify the Contracting Officer immediately. Within [14][_____] calendar days the Government will determine if the material is hazardous. If material is not hazardous or poses no danger, the Government will direct the Contractor to proceed without change. If material is hazardous and handling of the material is necessary to accomplish the work, the Government will issue a modification.

3.2 UTILITY OUTAGE REQUIREMENTS

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NOTE: Consult with local Installation on notice required for utility outage.

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Apply for utility outages[at least [_____] days in advance][in sufficient time as to not result in impacts or delays to the project schedule]. At a minimum, the written request must include the location of the outage, utilities being affected, duration of outage, any necessary sketches, and a description of the means to fulfill energy isolation requirements in accordance with EM 385-1-1. In accordance with EM 385-1-1, where outages involve Government or Utility personnel, coordinate with the Government on all activities involving the control of hazardous energy.

These activities include, but are not limited to, a review of Hazardous Energy Control Program (HECP) and HEC procedures, as well as applicable Activity Hazard Analyses (AHAs). In accordance with EM 385-1-1 and NFPA 70E, work on energized electrical circuits must not be performed without prior Government authorization. Government permission is considered through the permit process and submission of a detailed AHA. Energized work permits are considered only when de-energizing introduces additional or increased hazard or when de-energizing is infeasible.

3.3 OUTAGE COORDINATION MEETING

****

NOTE: For bracketed items, choose representative required for the Installation.

****

After the utility outage request is approved and prior to beginning work on the utility system requiring shut-down, conduct a pre-outage coordination meeting in accordance with EM 385-1-1. This meeting must include the Prime Contractor, the Prime and subcontractors performing the work, the Contracting Officer, and the[Installation representative][Public Utilities representative]. All parties must fully coordinate HEC activities with one another. During the coordination meeting, all parties must discuss and coordinate on the scope of work, HEC procedures (specifically, the lock-out/tag-out procedures for worker and utility protection), the AHA, assurance of trade personnel qualifications, identification of competent persons, and compliance with HECP training in accordance with EM 385-1-1. Clarify when personal protective equipment is required during switching operations, inspection, and verification.

3.4 CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)

Provide and operate a Hazardous Energy Control Program (HECP) in accordance with EM 385-1-1, 29 CFR 1910, 29 CFR 1915, ANSI/ASSP A10.44, NFPA 70E.

3.4.1 Safety Preparatory Inspection Coordination Meeting with the Government or Utility

For electrical distribution equipment that is to be operated by Government or Utility personnel, the Prime Contractor and the subcontractor performing the work must attend the safety preparatory inspection coordination meeting, which will also be attended by the Contracting Officer's Representative, and required by EM 385-1-1. The meeting will occur immediately preceding the start of work and following the completion of the outage coordination meeting. Both the safety preparatory inspection coordination meeting and the outage coordination meeting must occur prior to conducting the outage and commencing with lockout/tagout procedures.

3.4.2 Lockout/Tagout Isolation

Where the Government or Utility performs equipment isolation and lockout/tagout, the Contractor must place their own locks and tags on each energy-isolating device and proceed in accordance with the HECP. Before any work begins, both the Contractor and the Government or Utility must perform energy isolation verification testing while wearing required PPE detailed in the Contractor's AHA and required by EM 385-1-1. Install personal protective grounds, with tags, to eliminate the potential for induced voltage in accordance with EM 385-1-1.

3.4.3 Lockout/Tagout Removal

Upon completion of work, conduct lockout/tagout removal procedure in accordance with the HECP. In accordance with EM 385-1-1, each lock and tag must be removed from each energy isolating device by the authorized individual or systems operator who applied the device. Provide formal notification to the Government (by completing the Government form if provided by Contracting Officer's Representative), confirming that steps of de-energization and lockout/tagout removal procedure have been conducted and certified through inspection and verification. Government or Utility locks and tags used to support the Contractor's work will not be removed until the authorized Government employee receives the formal notification.

3.5 FALL PROTECTION PROGRAM

Establish a fall protection program, for the protection of all employees exposed to fall hazards. Within the program include company policy, identify roles and responsibilities, education and training requirements, fall hazard identification, prevention and control measures, inspection, storage, care and maintenance of fall protection equipment and rescue and evacuation procedures in accordance with EM 385-1-1.

3.5.1 Fall Protection Equipment and Systems

Enforce use of personal fall protection equipment and systems designated (to include fall arrest, restraint, and positioning) for each specific work activity in the Site Specific Fall Protection and Prevention Plan and AHA at all times when an employee is exposed to a fall hazard. Protect employees from fall hazards as specified in EM 385-1-1.

Provide personal fall protection equipment, systems, subsystems, and components that comply with EM 385-1-1 and 29 CFR 1926.

3.5.1.1 Additional Personal Fall Protection Measures

In addition to the required fall protection systems, other protective measures such as safety skiffs, personal floatation devices, and life rings, are required when working above or next to water in accordance with EM 385-1-1. Personal fall protection systems and equipment are required when working from an articulating or extendible boom, swing stages, or suspended platform. In addition, personal fall protection systems are required when operating other equipment such as scissor lifts. The need for tying-off in such equipment is to prevent ejection of the employee from the equipment during raising, lowering, travel, or while performing work.

3.5.1.2 Personal Fall Protection Equipment

Only a full-body harness with a shock-absorbing lanyard or self-retracting lanyard is an acceptable personal fall arrest body support device. The use of body belts is not acceptable. Harnesses must have a fall arrest attachment affixed to the body support (usually a Dorsal D-ring) and specifically designated for attachment to the rest of the system. Snap hooks and carabineers must be self-closing and self-locking, capable of being opened only by at least two consecutive deliberate actions and have a minimum gate strength of 1633 kg 3,600 lbs in all directions. Use webbing, straps, and ropes made of synthetic fiber. The maximum free fall distance when using fall arrest equipment must not exceed 1.8 m 6 feet, unless the proper energy absorbing lanyard is used. Always take into consideration the total fall distance and any swinging of the worker (pendulum-like motion), that can occur during a fall, when attaching a person to a fall arrest system. Equip all full body harnesses with Suspension Trauma Preventers such as stirrups, relief steps, or similar in order to provide short-term relief from the effects of orthostatic intolerance in accordance with EM 385-1-1.

[3.6 SHIPYARD REQUIREMENTS

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NOTE: This paragraph is tailored for NAVY. Include this paragraph for Navy projects located within a shipyard only.

****

All personnel who enter the Controlled Industrial Area (CIA) must wear mandatory personal protective equipment (PPE) at all times and comply with PPE postings of shops both inside and outside the CIA.

]3.7 EQUIPMENT

3.7.1 Use of Explosives

Explosives must not be used or brought to the project site without prior written approval from the Contracting Officer. Such approval does not relieve the Contractor of responsibility for injury to persons or for damage to property due to blasting operations.

Storage of explosives, when permitted on Government property, must be only where directed and in approved storage facilities. These facilities must be kept locked at all times except for inspection, delivery, and withdrawal of explosives.

3.8 ELECTRICAL

Perform electrical work in accordance with EM 385-1-1.

3.8.1 Electrical Work

As described in EM 385-1-1, electrical work is to be conducted in a de-energized state unless there is no alternative method for accomplishing the work. In those cases obtain an energized work permit from the[Contracting Officer][Commanding Officer]. The energized work permit application must be accompanied by the AHA and a summary of why the equipment/circuit needs to be worked energized. Underground electrical spaces must be certified safe for entry before entering to conduct work. Cables that will be cut must be positively identified and de-energized prior to performing each cut. Attach temporary grounds in accordance with ASTM F855 and IEEE 1048. Perform all high voltage cable cutting remotely using hydraulic cutting tool. When racking in or live switching of circuit breakers, no additional person other than the switch operator is allowed in the space during the actual operation. Plan so that work near energized parts is minimized to the fullest extent possible. Use of electrical outages clear of any energized electrical sources is the preferred method.

When working in energized substations, only qualified electrical workers are permitted to enter. When work requires work near energized circuits as defined by NFPA 70, high voltage personnel must use personal protective equipment that includes, as a minimum, electrical hard hat, safety footwear, insulating gloves and electrical arc flash protection for personnel as required by NFPA 70E. Insulating blankets, hearing protection, and switching suits may also be required, depending on the specific job and as delineated in the Contractor's AHA. Ensure that each employee is familiar with and complies with these procedures and 29 CFR 1910.

3.8.2 Qualifications

Electrical work must be performed by QP with verifiable credentials who are familiar with applicable code requirements. Verifiable credentials consist of State, National and Local Certifications or Licenses that a Master or Journeyman Electrician may hold, depending on work being performed, and must be identified in the appropriate AHA. Journeyman/Apprentice ratio must be in accordance with State, Local[and Host Nation] requirements applicable to where work is being performed.

3.8.3 Arc Flash

Conduct a hazard analysis/arc flash hazard analysis whenever work on or near energized parts greater than 50 volts is necessary, in accordance with NFPA 70E.

All personnel entering the identified arc flash protection boundary must be QPs and properly trained in NFPA 70E requirements and procedures. Unless permitted by NFPA 70E, no Unqualified Person is permitted to approach nearer than the Limited Approach Boundary of energized conductors and circuit parts. Training must be administered by an electrically qualified source and documented.

3.8.4 Grounding

Ground electrical circuits, equipment and enclosures in accordance with [NFPA 70][and][IEEE C2] to provide a permanent, continuous and effective path to ground unless otherwise noted by EM 385-1-1.

3.8.5 Testing

Temporary electrical distribution systems and devices must be inspected, tested and found acceptable for Ground-Fault Circuit Interrupter (GFCI) protection, polarity, ground continuity, and ground resistance before initial use, before use after modification and at least monthly. Monthly inspections and tests must be maintained for each temporary electrical distribution system, and signed by the electrical CP or QP.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-01 35 29.13 (November 2015)**
Change 1 - 08/22

Preparing Activity: USACE **Superseding**
UFGS-01 35 29.13 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES

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USACE / NAVFAC / AFCEC **UFGS-01 35 29.13 (November 2015)**
Change 1 - 08/22

Preparing Activity: USACE **Superseding**
UFGS-01 35 29.13 (January 2008)

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****

SECTION 01 35 29.13

HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES

11/15, CHG 1: 08/22

****
NOTE: This guide specification covers requirements for safety and health documents and procedures for hazardous toxic radioactive waste (HTRW) site cleanup projects. Use this section as a supplement to Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. Include this section when section 02 65 00 UNDERGROUND STORAGE TANK REMOVAL is used.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: This guide specification addresses requirements specified in 29 CFR 1910.120/29 CFR 1926.65 for safety and occupational health (SOH) at HTRW site cleanup projects.

Use this section to assure employee protection (and regulatory compliance) from all hazards, traditional hazards associated with all construction as well as the special chemical, physical, radiation and biological hazards that are associated with work on

(HTRW) site cleanup projects.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 2219	(2016) Safe Operation of Vacuum Trucks Handling Flammable and Combustible Liquids in Petroleum Service

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z358.1	(2014; R 2020) American National Standard for Emergency Eyewash and Shower Equipment

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 85-115	(1985) Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements
EM 385-1-97	(2013) Explosives -- Safety and Health Requirements Manual
ER 385-1-92	(2018) Safety -- Safety and Occupational Health Requirements for Environmental Cleanup Projects

ER 385-1-95	(2014) Safety -- Safety and Health Requirements for Operations and Activities Involving Munitions and Explosives of Concern

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 20	Standards for Protection Against Radiation
29 CFR 1904	Recording and Reporting Occupational Injuries and Illnesses
29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.65	Hazardous Waste Operations and Emergency Response
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements

1.2 PRECONSTRUCTION SAFETY CONFERENCE

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NOTE: Specify safety and occupational health issues to be addressed in the preconstruction safety conference. Confer with the construction District's Installation's Safety and Occupational Health Office representatives to make this determination. If this conference is addressed in another specification section, reference the appropriate section.

****

Conduct a preconstruction safety conference prior to the start of site activities and after submission of the Accident Prevention Plan/Site Safety And Health Plan (APP/SSHP). The objective of the meeting is to discuss health and safety concerns related to the impending work, discuss project health and safety organization and expectations, review and answer comments and concerns regarding the APP/SSHP or other health and safety concerns . Ensure that those individuals responsible for health and safety at the project level are available and attend this meeting.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Work Zones; G, [_____]

Decontamination Facilities; G, [_____]

SD-03 Product Data

Amendments to the APP/SSHP; G, [_____]

Exposure Monitoring/Air Sampling Program

Site Control Log

SSHO's Daily Inspection Logs

SD-07 Certificates

Certificate Of Worker/Visitor Acknowledgement

SD-11 Closeout Submittals

Safety And Health Phase-Out Report; G, [_____]

1.4 ACCIDENT PREVENTION PLAN/SITE SAFETY AND HEALTH PLAN (APP/SSHP)

Develop and implement a Site Safety and Health Plan in accordance with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS, and attach to the Accident Prevention Plan (APP) as an appendix (APP/SSHP). Address all occupational safety and health hazards (traditional construction as well as contaminant-related hazards) associated with cleanup operations within the APP/SSHP. Cover each SSHP element in sections 28.A.01 and 33.B of EM 385-1-1 and each APP element in Appendix A of EM 385-1-1. There are overlapping elements in Section 28.A.01 and Appendix A of EM 385-1-1. SSHP appendix elements that overlap with APP elements need not be duplicated in the APP/SSHP provided each safety and occupational health (SOH) issue receives adequate attention and is documented in the APP/SSHP. The APP/SSHP is a dynamic document, subject to change as project operations/execution change. Modify the APP/SSHP to address changing and previously unidentified health and safety conditions. Ensure that the APP/SSHP is updated accordingly. Submit amendments to the APP/SSHP to the Contracting Officer as the APP/SSHP is updated. For long duration projects resubmit the APP/SSHP to the Contracting Officer annually for review. The APP/SSHP must contain all updates.

1.4.1 Acceptance and Modifications

Prior to submittal, the APP/SSHP must be signed and dated by the Safety and Health Manager and the Site Superintendent. Submit for review [_____] days prior to the Preconstruction Safety Conference. Deficiencies in the APP/SSHP will be discussed at the preconstruction safety conference, and must be revised to correct the deficiencies and resubmitted for acceptance. Onsite work must not begin until the plan has been accepted. Maintain a copy of the written APP/SSHP onsite. Changes and modifications to the APP/SSHP must be made with the knowledge and concurrence of the Safety and Health Manager, the Site Superintendent, and the Contracting Officer. Bring to the attention of the Safety and Health Manager, the Site Superintendent, and the Contracting Officer any unforeseen hazard that becomes evident during the performance of the work, through the Site Safety and Health Officer (SSHO) for resolution as soon as possible. In the interim, take necessary action to re-establish and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Disregard for the provisions of this specification or the accepted APP/SSHP is cause for stopping work until the matter has been rectified.

1.4.2 Availability

Make available the APP/SSHP in accordance with 29 CFR 1910.120, (b)(1)(v) and 29 CFR 1926.65, (b)(1)(v).

1.5 STAFF ORGANIZATION, QUALIFICATION AND RESPONSIBILITIES

****

NOTE: Select the options below so that the Contractor's safety and health manager meets the following professional certification requirements.

Certified Industrial Hygienist - for cleanup of uncontrolled HTRW sites where cleanup is for the control of chemicals released into the environment and the chemical contamination presents occupational

health hazards.

Certified Safety Professional - for cleanup of uncontrolled HTRW sites where cleanup is for the control of chemicals released into the environment and the chemical contamination presents occupational safety hazards.

Certified Health Physicist - for cleanup of uncontrolled HTRW sites where cleanup is for the control of radioactive isotope contamination.

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Provide hazardous waste operations and emergency response organization in accordance with EM 385-1-1, Section 33.

1.5.1 Safety and Health Manager

Safety and Health Manager must be [an Industrial Hygienist certified by the American Board of Industrial Hygiene] [a safety professional certified by the Board of Certified Safety Professionals] [a health physicist certified by the American Board of Health Physicists].

Apply the following in conjunction with the required qualifications and responsibilities stated in EM 385-1-1, Section 33.C.01.

1.5.1.1 Additional Qualifications

The Safety and Health Manager must have the following qualifications:

a. A minimum of [3] [_____] years experience in developing and implementing safety and occupational health programs [at HTRW sites] [in the HTRW disposal industry] [in the chemical industry] [in the petroleum processing industry] [at underground storage tank removal projects].

b. Documented experience in supervising professional and technician level personnel.

c. Documented experience in developing worker exposure assessment programs and air monitoring programs and techniques.

d. Documented experience in managing personal protective equipment (PPE) programs and conducting PPE hazard evaluations for the types of activities and hazards likely to be encountered on the project.

e. Working knowledge of state and Federal occupational safety and health regulations.

1.5.1.2 Responsibilities and Duties

a. Development, implementation, oversight, and enforcement of the APP/SSHP.

b. Provide onsite consultation as needed to ensure the APP/SSHP is fully implemented.

c. Conduct initial site-specific training.

d. Be [present onsite] [available for consultation] during the [first 3 days] [_____] of remedial activities and at the startup of each new major phase of work.

e. Visit the site as needed and at least [once per week] [once per month] [_____] for the duration of activities, to audit the effectiveness of the APP/SSHP.

f. Be available for emergencies.

g. Coordinate any modifications to the APP/SSHP with the Site Superintendent, the SSHO, and the Contracting Officer.

h. Be responsible for evaluating air monitoring data and recommending changes to engineering controls, work practices, and PPE.

i. Provide continued support for upgrading/downgrading of the level of personal protection.

j. Serve as a member of the quality control staff.

k. Review accident reports and results of daily inspections.

l. Sign and date the APP/SSHP prior to submittal.

1.5.2 Site Safety and Health Officer

Designate an individual and [one alternate][[_____] alternates] as the Site Safety and Health Officer (SSHO). Include the name, qualifications (education and training summary and documentation), and work experience of the Site Safety and Health Officer and [alternate][alternates] in the APP/SSHP.

The Apply the following in conjunction with the required qualifications and responsibilities stated in EM 385-1-1, Section 33.C.02.

1.5.2.1 Qualifications

The following requirements are in addition to those in Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS.

a. A minimum of 1 year experience in implementing SOH programs [at HTRW sites][in the HTRW disposal industry][at underground storage tank removal projects][in the chemical or petroleum processing industry][radioactive waste cleanup projects] where [Level B][Level C] personal protective equipment was required.

b. Meet 29 CFR 1910.120/29 CFR 1926.65 requirements for 40-hour initial and 8-hour supervisor training and, maintain 8-hour refresher training requirements.

c. Specific training in personal and respiratory protective equipment, confined space entry and in the proper use of air monitoring instruments and air sampling methods including monitoring for ionizing radiation.

d. Documented experience in construction techniques and construction safety procedures.

e. Working knowledge of Federal and state occupational SOH regulations.

1.5.2.2 Responsibilities and Duties

The following requirements are in addition to those in Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS.

a. Assist and represent the Safety and Health Manager in onsite training and the day to day onsite implementation and enforcement of the accepted APP/SSHP.

b. Be assigned to the site on a full time basis for the duration of field activities. The SSHO [will have no duties other than] [can have collateral duties in addition to] SOH related duties. If operations are performed during more than 1 work shift per day, a site Safety and Health Officer must be present for each shift and when applicable, act as the radiation safety officer (RSO) as defined in paragraph 06.F.02 of EM 385-1-1 on radioactive waste cleanup projects.

c. Have authority to stop work if unacceptable health or safety conditions exist, and take necessary action to re-establish and maintain safe working conditions.

d. Have authority to ensure site compliance with specified SOH requirements, Federal, state and OSHA regulations and all aspects of the APP/SSHP including, but not limited to, activity hazard analyses, air monitoring, monitoring for ionizing radiation, use of PPE, decontamination, site control, standard operating procedures used to minimize hazards, safe use of engineering controls, the emergency response plan, confined space entry procedures, spill containment program, and preparation of records by performing a daily SOH inspection and documenting results on the Daily Safety Inspection Log in accordance with 29 CFR 1904.

e. In coordination with site management and the Safety and Health Manager, recommend corrective actions for identified deficiencies and oversee the corrective actions.

f. Consult with and coordinate any modifications to the APP/SSHP with the Safety and Health Manager, the Site Superintendent, and the Contracting Officer.

g. Conduct daily safety inspection and document SOH findings into the Daily Safety Inspection Log. Track noted SOH deficiencies to ensure that they are corrected.

h. Conduct accident investigations and prepare accident reports.

i. Serve as a member of the quality control staff on matters relating to SOH.

1.5.3 Additional Certified Health and Safety Support Personnel

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NOTE: Review project hazards and the safety and health manager's certification requirements and select the paragraphs below requiring the Contractor to retain services from a Certified Industrial Hygienist (CIH), Certified Safety Professional (CSP)

or Certified Health Professional (CHP) if project hazards warrant and if the safety and health manager will not possess the certification, knowledge and experience to address all occupational safety and occupational health problems expected to be encountered. Delete the paragraphs below if they do not apply to the project and the use of additional safety and health professionals (beyond the safety and health manager) is not necessary.

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Retain [health physics support from a health physicist certified by the American Board of Health Physics to develop radiation protection requirements of the APP/SSHP and, when necessary, visit the site to help implement ionizing radiation protection requirements of the APP/SSHP.][safety support from a safety professional certified by the Board of Certified Safety professionals to develop written occupational safety procedures for the APP/SSHP and, when necessary, visit the site to help implement APP/SSHP requirements.][industrial hygiene support from an industrial hygienist certified by the American Board of Industrial Hygiene to develop occupational health practices for the APP/SSHP and, if necessary, visit the site to help implement APP/SSHP requirements.]

1.5.4 Occupational Physician

Utilize the services of a licensed physician, who is certified in occupational medicine by the American Board of Preventative Medicine, or who, by necessary training and experience is Board eligible. The physician must be familiar with the site's hazards and the scope of this project. Include the medical consultant's name, qualifications, and knowledge of the site's conditions and proposed activities in the APP/SSHP. The physician is responsible for the determination of medical surveillance protocols and for review of examination/test results performed in compliance with 29 CFR 1910.120, (f) and 29 CFR 1926.65, (f) and paragraph MEDICAL SURVEILLANCE PROGRAM.

1.5.5 Persons Certified in First Aid and CPR

At least two persons who are currently certified in first aid and CPR by the American Red Cross or other approved agency must be onsite at all times during site operations. They must be trained in universal precautions and the use of PPE as described in the Bloodborne Pathogens Standard of 29 CFR 1910, Section .1030. These persons may perform other duties but must be immediately available to render first aid when needed.

1.5.6 Safety and Health Technicians

For each work crew in the exclusion zone, one person, designated as a Safety and Health technician, must perform activities such as air monitoring, decontamination, and safety oversight on behalf of the SSHO. They must have appropriate training equivalent to the SSHO in each specific area for which they have responsibility and report to and be under the supervision of the SSHO.

1.6 EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

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NOTE: It is the designers responsibility to contact and meet with local emergency response planning

agencies to assure that emergency response services will be available to the Contractor during remedial action construction. Inform the Government Project Manager if special procedures/arrangements or equipment have to be included in the design to accommodate local emergency responder needs.

****

Develop and implement an Emergency Response Plan, that meets the requirements of EM 385-1-1 Section 33.G, 29 CFR 1910.120 (l) and 29 CFR 1926.65 (l), as a section of the APP/SSHP. In the event of any emergency associated with remedial action, without delay, alert all onsite employees and as necessary offsite emergency responders that there is an emergency situation; take action to remove or otherwise minimize the cause of the emergency; alert the Contracting Officer; and institute measures necessary to prevent repetition of the conditions or actions leading to, or resulting in, the emergency. Train employees that are required to respond to hazardous emergency situations to their level of responsibility according to 29 CFR 1910.120 (q) and 29 CFR 1926.65 (q) requirements. Rehearse the plan regularly as part of the overall training program for site operations. Review the plan periodically and revised as necessary to reflect new or changing site conditions or information. Provide copies of the Emergency Response Portion of the accepted APP/SSHP to the affected local emergency response agencies. Address, as a minimum, the following elements in the plan:

a. Pre-emergency planning. Coordinate with local emergency response providers during preparation of the Emergency Response Plan. At a minimum, coordinate with local fire, rescue, hazardous materials response teams, police and emergency medical providers to assure all organizations are capable and willing to respond to and provide services for on-site emergencies. Ensure the Emergency Response Plan for the site is compatible and integrated with the local fire, rescue, medical and police security services available from local emergency response planning agencies.

b. Personnel roles, lines of authority, communications for emergencies.

c. Emergency recognition and prevention.

d. Site topography, layout, and prevailing weather conditions.

e. Criteria and procedures for site evacuation (emergency alerting procedures, employee alarm system, emergency PPE and equipment, safe distances, places of refuge, evacuation routes, site security and control).

f. Route maps to nearest prenotified medical facility. Site-support vehicles must be equipped with maps. At the beginning of project operations, drivers of the support vehicles must become familiar with the emergency route and the travel time required.

g. Specific procedures for decontamination and medical treatment of injured personnel.

h. Emergency alerting and response procedures including posted instructions and a list of names and telephone numbers of emergency contacts (physician, nearby medical facility, fire and police departments, ambulance service, Federal, state, and local environmental agencies; as well as Safety and Health Manager, the Site Superintendent, the Contracting Officer and their alternates).

i. Criteria for initiating community alert program, contacts, and responsibilities.

j. Procedures for reporting incidents to appropriate government agencies. In the event that an incident such as an explosion or fire, or a spill or release of toxic materials occurs during the course of the project, the appropriate government agencies must be immediately notified. In addition, verbally notify the Contracting Officer and the local district safety office immediately and submit a written notification within 24 hours. Include within the report the following items:

   (1) Name, organization, telephone number, and location of the Contractor.

   (2) Name and title of the person(s) reporting.

   (3) Date and time of the incident.

   (4) Location of the incident, i.e., site location, facility name.

   (5) Brief summary of the incident giving pertinent details including type of operation ongoing at the time of the incident.

   (6) Cause of the incident, if known.

   (7) Casualties (fatalities, disabling injuries).

   (8) Details of any existing chemical hazard or contamination.

   (9) Estimated property damage, if applicable.

   (10) Nature of damage, effect on contract schedule.

   (11) Action taken to ensure safety and security.

   (12) Other damage or injuries sustained, public or private.

k. Procedures for critique of emergency responses and follow-up.

1.7 CERTIFICATE OF WORKER/VISITOR ACKNOWLEDGEMENT

A copy of a certificate of worker/visitor acknowledgement must be completed and submitted for each visitor allowed to enter contamination reduction or exclusion zones, and for each employee, following the Example Certificate Of Worker/Visitor Acknowledgement at the end of this section.

1.8 INSPECTIONS

Attach to and submit with the Daily Quality Control reports the SSHO's Daily Inspection Logs. Include with each entry the following: date, work area checked, employees present in work area, PPE and work equipment being used in each area, special SOH issues and notes, and signature of preparer.

1.9 SAFETY AND HEALTH PHASE-OUT REPORT

Submit a Safety and Health Phase-Out Report in conjunction with the project close out report, prior to final acceptance of the work. Include the following minimum information :

a. Summary of the overall performance of SOH (e.g., accidents or incidents including near misses, unusual events, lessons learned).

b. Final decontamination documentation including procedures and techniques used to decontaminate equipment, vehicles, and on site facilities.

c. Summary of exposure monitoring and air sampling accomplished during the project.

d. Signatures of Safety and Health Manager and SSHO.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

Comply with EM 385-1-1, 29 CFR 1926.65, 29 CFR 1910.120, OSHA requirements in 29 CFR 1910 and 29 CFR 1926 with work performed under this contract, and state specific OSHA requirements where applicable. Submit to the Contracting Officer for resolution matters of interpretation of standards before starting work. The most stringent requirements apply where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary.

2.2 PERSONAL PROTECTIVE EQUIPMENT

2.2.1 Site Specific PPE Program

****

NOTE: The last sentence of the first text paragraph is tailored for use in Army projects only.

****

Provide onsite personnel exposed to contaminants with appropriate personal protective equipment. Components of levels of protection (B, C, D and modifications) must be relevant to site-specific conditions, including heat and cold stress potential and safety hazards. Use only respirators approved by NIOSH. Commercially available PPE, used to protect against chemical agent, must be approved by [the director of Army Safety through the Chemical Agent Safety and Health Policy Action Committee (CASHPAC)][_____].

Keep protective equipment and clothing clean and well maintained. Include site-specific procedures to determine PPE program effectiveness and for onsite fit-testing of respirators, cleaning, maintenance, inspection, cartridge change out, and storage of PPE within the PPE section of the APP/SSHP.

2.2.2 Levels of Protection

The Safety and Health Manager must establish and evaluate as the work progresses the levels of protection for each work activity. Also establish action levels for upgrade or downgrade in levels of PPE. Describe in the SSHP the protocols and the communication network for changing the level of protection. Address air monitoring results, potential for exposure, changes in site conditions, work phases, job tasks, weather, temperature extremes, and individual medical considerations within the PPE evaluation protocol.

2.2.2.1 Initial PPE Components

****

NOTE: Specify all components of each minimum initial level of protection that will be required for this site. Consult industrial hygiene staff and the following references to determine appropriate components for levels of protection:

NIOSH, OSHA, USCG, EPA, Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, October 1985, NIOSH 85-115; EM 385-1-1, Section 5 and Appendix L; 29 CFR 1910.120, Appendix B; and 29 CFR 1926.65, Appendix B.

Components must be included that provide protection for the respiratory system, skin, eyes, face, hands, feet, head, body, and hearing. Specify the types of materials (e.g., neoprene, nitrile) for gloves and boots and types of cartridges for air purifying respirators based on site-specific contaminants. Include types and thicknesses of radiation shielding, if applicable.

Cotton and cotton/polyester blend coveralls rented from local textile rental and laundering services provide dermal protection equivalent to uncoated disposable coveralls for a significantly reduced cost and offer superior personnel heat stress control performance. Require the Contractor to consider substituting cotton or cotton/polyester blend coveralls for disposables for Level D or Level C if site conditions warrant use of minimal dermal protection (tasks do not require manual handling of wet sloppy contaminated material and there are no chemical splash hazards). Check with the Textile Rental Services Association (tsra.org) or the Uniform Textile Services Organization (utsa.com) to determine likelihood of the Contractor finding local textile rental and laundering services.

****

The following items constitute initial minimum protective clothing and equipment ensembles.

Level D	[_____]
Modified Level D	[_____]
Level C	[_____]
Level B	[_____]

2.2.3 PPE for Government Personnel

****

NOTE: Confer with the Government construction oversight agent, Construction Division or Resident or Area Engineer in the Construction oversight Distric for USACE,, FEAD or ROICC for NAVFAC, to determine the appropriate number of sets of PPE and personal dosimeters required.

****

[Three] [_____] clean sets of personal protective equipment and personal dosimeters for work on radioactive waste cleanup sites and clothing (excluding air-purifying negative-pressure respirators and safety shoes, which will be provided by individual visitors), as required for entry into the Exclusion Zone and Contamination Reduction Zone, must be available for use by the Contracting Officer or official visitors. The items must be cleaned, maintained and stored [in the clean room of the decontamination facility] [_____] and clearly marked: "FOR USE BY GOVERNMENT ONLY." Provide basic training in the use and limitations of the PPE provided.

2.3 EMERGENCY EQUIPMENT AND FIRST AID REQUIREMENTS

Maintain, as a minimum, the following items onsite and available for immediate use:

a. First aid equipment and supplies approved by the consulting physician.

b. Emergency eyewashes and showers that comply with ANSI/ISEA Z358.1.

c. Emergency-use respirators. For escape purposes, supply [_____] 5- to 15-minute emergency escape masks. For rescue purposes, Supply [2] [_____] positive pressure self-contained breathing apparatus (SCBA). Dedicate these for emergency use only and maintained onsite in the Contamination Reduction Zone.

d. Provide fire extinguishers of sufficient size and type at site facilities and in all vehicles and at any other site locations where flammable or combustible materials present a fire risk.

[
e. [_____].]

PART 3 EXECUTION

3.1 SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

3.1.1 Project/Site Conditions

****

NOTE: Review all available site records and reports and direct the Contractor to the reports with the information which can be used to guide development of the APP/SSHP. These reports are likely to be: the Remedial Investigation/Feasibility Study (RI/FS); Record of Decision (ROD); Engineering Evaluation/Cost Analysis (EE/CA) and Action Memorandums for CERCLA projects; the RCRA Facility Investigation (RFI); Corrective Measures Study (CMS) and Statement of Basis for RCRA facility sites; and

Site specific investigative documents for UST removals. There may also have been predesign studies performed which can be valuable sources of occupational safety and health information. Direct the Contractor where to find the documents if they are not incorporated into the design.
****

Refer to the following reports and information for the site description and contamination characterization. They are located at [_____].

3.1.1.1 CERCLA Documents

[_____].

3.1.1.2 RCRA Documents

[_____].

3.1.1.3 UST Documents

[_____].

3.1.2 Ordnance and Explosives (OE)

****
NOTE: Retain this paragraph if there is a possibility that Ordnance and Explosives (OE), explosive media or Chemical Agent Contaminated Media (CACM) may be discovered while performing HTRW site cleanup activities. The definitions for OE, explosive media and CACM are in ER 385-1-95.
****

****
NOTE: The first text paragraph and the last sentence of this second text paragraph are tailored for use in Army projects only.
****

Establish the site Munitions and Explosives of Concern (MEC) probability assessment prior to starting work in accordance with EM 385-1-97 and ER 385-1-92. Produce a probability assessment to establish the MEC support requirements. Brief personnel on Recognize, Retreat and Report (3R's) and the POC list. EM 385-1-97, Chapter 1 provides follow-on actions necessary before going back to work status.

Stop work and contact the Contracting Officer if ordnance and explosives (OE), explosive media or chemical agent contaminated media (CACM) are discovered during HTRW site cleanup activities. Proceed with work after the Contracting Officer gives permission and, according to ER 385-1-95 requirements.

3.2 TASK SPECIFIC HAZARDS, INITIAL PPE, HAZWOPER MEDICAL SURVEILLANCE AND TRAINING APPLICABILITY

****
NOTE: Evaluate and specify all the major tasks to be performed by the Contractor on the Task Hazard

and Control Sheets at the end of this section.
Specify the following for each task:
1. 29 CFR 1910.120/29 CFR 1926.65 (HAZWOPER) Medical Surveillance and Training applicability.
2. Safety, chemical, physical and radiological hazards associated for each task.
3. Initial PPE and operational requirements to mitigate the hazards for each activity.
****

Task specific occupational hazards, task specific HAZWOPER medical surveillance and training applicability and task specific initial PPE requirements for the project are listed on the Task Hazard and Control Sheets at the end of this section. Reevaluate occupational safety and health hazards as the work progresses and to adjust the PPE and onsite operations, if necessary, so that the work is performed safely and in compliance with occupational safety and health regulations.

3.3 TRAINING

In conjunction with EM 385-1-1, Section 33D, meet the training program requirements for workers performing cleanup operations and who will be exposed to contaminants.

3.3.1 General HTRW Operations Training

All Personnel performing duties with potential for exposure to onsite contaminants must meet and maintain the following 29 CFR 1910.120/ 29 CFR 1926.65 (e) training requirements:

a. 40 hours of off site HTRW instruction.

b. 3 days actual on-the-job field experience under the direct supervision of a trained, experienced supervisor.

c. 8 hours refresher training annually.

Onsite supervisors must have an additional 8 hours management and supervisor training specified in 29 CFR 1910.120/29 CFR 1926.65 (e) (4).

3.3.2 Pre-Entry Briefing

Prior to commencement of onsite field activities, all site employees, including those assigned only to the Support Zone, must attend a site-specific SOH training session. This session will be conducted by the Safety and Health Manager and the Site Safety and Health Officer to ensure that all personnel are familiar with requirements and responsibilities for maintaining a safe and healthful work environment. Thoroughly discuss procedures and contents of the accepted APP/SSHP and Sections 01.B.02 and 28.D.03 of EM 385-1-1 . Each employee must sign a training log to acknowledge attendance and understanding of the training. Notify the Contracting Officer at least [5] [_____] days prior to the initial site-specific training session so government personnel involved in the project may attend.

3.3.3 Periodic Sessions

Conduct periodic onsite training by the SSHO at least [weekly] [daily] for personnel assigned to work at the site during the following [week] [day].

Address SOH procedures, work practices, any changes in the APP/SSHP, activity hazard analyses, work tasks, or schedule; results of previous week's air monitoring, review of safety discrepancies and accidents. Convene a meeting prior to implementation of the change should an operational change affecting onsite field work be made, to explain SOH procedures. Conduct a site-specific training sessions for new personnel, visitors, and suppliers by the SSHO using the training curriculum outlines developed by the Safety and Health Manager. Each employee must sign a training log to acknowledge attendance and understanding of the training.

3.3.4 Other Training

****

NOTE: If site conditions warrant additional special training, specify requirements below.

For sites where employees will be required to work with radiation, determine and specify applicable training requirements (Federal and state).

****

[Special site specific training requirements: [_____]] [Site specific training for sites where radioactive wastes are to be cleaned up include:

a. Site specific procedures for handling and storing radioactive materials;

b. Health and safety hazards associated with exposure to the radioactive material that will be cleaned up or otherwise handled and the purpose and function of protective devices and precautions used to minimize exposures;

c. Elements of the APP/SSHP and company specific procedures intended to provide protection from radiation exposure;

d. Worker responsibility to report any unsafe acts which might result in exposure to ionizing radiation;

e. Appropriate worker response procedures to events that may result in worker exposure to ionizing radiation;

f. Worker rights and responsibilities with respect to ionizing radiation exposure.] [Provide training as specified by 29 CFR 1910 Section .146, by the Safety and Health Manager for employees who are required to supervise, standby, or enter permit-required confined spaces.] [Train in accordance with 49 CFR 172, persons involved in any aspect of the transportation of hazardous materials.]

3.4 MEDICAL SURVEILLANCE PROGRAM

Meet all requirements of 29 CFR 1910.120/29 CFR 1926.65 medical surveillance program and EM 385-1-1, Section 33.G for workers performing cleanup operations and who will be exposed to contaminants. Ensure the Occupational Physician or the physician's designee performs the physical examinations and reviews examination results. Participation in the medical surveillance program is without cost to the employee, without loss of pay and at a reasonable time and place.

3.5 EXPOSURE MONITORING/AIR SAMPLING PROGRAM

****

NOTE: Exposure monitoring for the protection of workers must be representative of the chemical and physical hazards presented by the onsite activities. Evaluate physical properties of hazardous materials and how they will be managed/handled and specify initial occupational exposure monitoring requirements which will assess initial personal protective equipment adequacy. Consult local industrial hygiene staff to select appropriate initial monitoring instruments and exposure monitoring methods.

****

Prepare and implement by the Safety and Health Manager an exposure monitoring/air sampling program to identify and quantify SOH hazards and airborne levels of hazardous substances in order to assure proper selection of engineering controls, work practices and personal protective equipment for affected site personnel. Include action levels for upgrading/downgrading PPE in the program. Submit personnel exposure monitoring/sampling results. Monitor for the following gasses and vapors [_____]. Monitor for the following aerosolized contaminants[_____].

[3.5.1 Ionizing Radiation Sampling and Dosimetry

****

NOTE: Check with local health physics staff or members of the radiation safety support team to determine the appropriate air sampling, dosimeters and instruments to determine occupational exposure/dose to radioactive isotopes and ionizing radiation fields. If radioactive isotopes and ionizing radiation fields are not a part of the project this paragraph and its subparagraphs can be eliminated from the specification.

****

3.5.1.1 Air Sampling and Dosimetry

3.5.1.1.1 Instruments

Use the following instrument[s] to evaluate occupational exposure to radioactive isotopes and ionizing radiation fields: [_____]

3.5.1.1.2 Sampling Methods

Use the following sampling method[s] to evaluate occupational exposure to radioactive isotopes and ionizing radiation fields: [_____]

3.5.1.1.3 Dosimeters

Use the following dosimeter[s] to evaluate occupational exposure to radioactive isotopes and ionizing radiation fields: [_____]

3.5.1.2 Evaluation

Radiation dosimetry must be evaluated by an individual or company holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP). Electronic dosimetry may be used to assign external dose if approved by the Contracting Officer. Internal intake assessment and applicable monitoring must be evaluated by the Certified Health Professional (CHP).

3.5.1.3 Documentation

Document employee exposure to external radiation. Include reviewing each employee's radiation exposure history in accordance with 10 CFR 20 Section .2104, for compliance with exposure standards prior to allowing the employee access to a restricted area. If the employee has no exposure history, the employee must provide a signed written statement to that effect.

3.5.1.4 Reporting

Furnish reports of exposure to ionizing radiation to the Contracting Officer as soon as available and to each employee annually, upon termination, and within 30 days of any personal request.

]3.6 HEAT STRESS MONITORING AND MANAGEMENT

Document in the APP/SSHP and implement the procedures and practices in section 06.J. in EM 385-1-1 to monitor and manage heat stress.

3.7 SPILL AND DISCHARGE CONTROL

****

NOTE: If requirements for spill and discharge control are described in a separate section, reference the appropriate section. Determine local notification requirements and include them in the following paragraph.

****

Develop and implement written spill and discharge containment/control procedures. Address radioactive wastes, shock sensitive wastes, laboratory waste packs, material handling equipment, as well as drum and container handling, opening, sampling, shipping and transport. Describe prevention measures, such as building berms or dikes; spill control measures and material to be used (e.g. booms, vermiculite); location of the spill control material; personal protective equipment required to cleanup spills; disposal of contaminated material; and who is responsible to report the spill. Storage of contaminated material or hazardous materials must be appropriately bermed, diked and contained to prevent any spillage of material on uncontaminated soil. If the spill or discharge is reportable, or human health or the environment are threatened, notify the National Response Center, the state, and the Contracting Officer as soon as possible. Provide control as required by Section 01 57 19 TEMPORARY ENVIRONMENT CONTROLS. Reporting requirements must be in accordance with [Section 02 65 00 UNDERGROUND STORAGE TANK REMOVAL][_____].

3.8 MATERIALS TRANSFER SAFETY

Remove liquids and residues from the tanks using explosion-proof or air-driven pumps. In accordance with EM 385-1-1, Section 9, electrically bond the tank and ground pump motors and suction hoses to prevent electrostatic ignition hazards. Use of a hand pump will be permitted to remove the last of the liquid from the bottom of the tanks. If a vacuum truck is used for removal of liquids or residues, the area of operation for the vacuum truck must be vapor free. Locate the truck upwind from the tank and outside the path of probable vapor travel. Discharge the vacuum pump exhaust gases through a hose of adequate size and length downwind of the truck and tank area. Vacuum truck operating and safety practices must conform to API RP 2219. Collect tank residues in drums, tanks, or tank trucks labeled according to 49 CFR 171 and 49 CFR 172 and disposed of as specified. Disconnect and drain fittings and lines of their contents after the materials have been transferred and the tanks have been exposed. Do not spill contents into the environment during cutting or disconnecting of tank fittings. Transfer materials drained into DOT-approved drums for storage and transportation. Use only non-sparking or non-heat producing tools to disconnect and drain or to cut through tank fittings. Electrical equipment (e.g., pumps, portable hand tools) used for tank preparation must be explosion-proof. Following cutting or disconnecting of the fittings, plug openings leading to the tanks.

3.9 SITE CONTROL MEASURES

Coordinate site control measures with Section 01 57 19 TEMPORARY ENVIRONMENT CONTROLS.

3.9.1 Work Zones

****

NOTE: Utilize the contamination characterization information and the preliminary hazard/risk analysis to delineate work zone boundaries on the drawings. Include a note on the drawings that these are only initial anticipated work zone boundaries and they must be modified by the Contractor to show the actual zones.

On sites where ionizing radiation or radioactive material may be encountered, specify that the Contractor designates restricted areas (Radiation Areas, High Radiation Areas and Airborne Radioactive Contamination Areas as defined in 10 CFR 20).

****

Initial anticipated work zone boundaries (exclusion zone, contamination reduction zone, support zone, all access points and decontamination areas) are to be clearly delineated on the site drawings. Base delineation of work zone boundaries on the contamination characterization data and the hazard/risk analysis to be performed as described in EM 385-1-1 06.A.02. As work progresses and field conditions are monitored, work zone boundaries may be modified (and site drawings modified) with approval of the Contracting Officer. Clearly identify work zones and mark in the field (using fences, tape, or signs). Submit and post a site map, showing work zone boundaries and locations of decontamination facilities in the onsite office. Work zones must consist of the following:

3.9.1.1 Exclusion Zone (EZ)

The exclusion zone is the area where hazardous contamination is either known or expected to occur and the greatest potential for exposure exists. Control entry into this area and exit may only be made through the Contamination Reduction Zone (CRZ).

3.9.1.2 Contamination Reduction Zone (CRZ)

The CRZ is the transition area between the Exclusion Zone and the Support Zone. The personnel and equipment decontamination areas must be separate and unique areas located in the CRZ.

3.9.1.3 Support Zone (SZ)

The Support Zone is defined as areas of the site, other than exclusion zones and contamination reduction zones, where workers do not have the potential to be exposed to hazardous substances or dangerous conditions resulting from HTRW operations. Secure the Support Zone against active or passive contamination. Site offices, parking areas, and other support facilities must be located in the Support Zone.

3.9.2 Site Control Log

A log of personnel visiting, entering, or working on the site must be maintained. Include the following: date, name, agency or company, time entering and exiting site, time entering and exiting the exclusion zone (if applicable). Before visitors are allowed to enter the Contamination Reduction Zone or Exclusion Zone, they must show proof of current training, medical surveillance and respirator fit testing (if respirators are required for the tasks to be performed) and fill out a Certificate of Worker or Visitor Acknowledgment. Record this visitor information, including date, in the log.

3.9.3 Communication

****

NOTE: Specify the appropriate communication systems (i.e., air horns, walkie talkies, radios, telephones) based on site-specific conditions.

****

Provide and install an employee alarm system that has adequate means of on and off site communication in accordance with 29 CFR 1910 Section .165. The means of communication must be able to be perceived above ambient noise or light levels by employees in the affected portions of the workplace. The signals must be distinctive and recognizable as messages to evacuate or to perform critical operations. This includes: [_____].

3.9.4 Site Security

****

NOTE: Specify the appropriate type of site security (i.e., warning signs, fences, 24-hour security guard, site access procedures) based on site-specific conditions.

On sites where ionizing radiation or radioactive material may be encountered, specify and post signs that meet the requirements of 10 CFR 20 for restricted areas.

****

Provide the following site security: [_____]. Print signs in bold large letters on contrasting backgrounds. Signs must be visible from all points where entry might occur and at such distances from the restricted area that employees may read the signs and take necessary protective steps before entering.

3.10 PERSONAL HYGIENE AND DECONTAMINATION

Personnel entering the Exclusion or Contamination Reduction Zones or otherwise exposed to hazardous chemical vapors, gases, liquids, or contaminated solids must decontaminate themselves and their equipment prior to exiting the contamination reduction zone (CRZ) and entering the support zone. Consult Chapter 10.0 of NIOSH 85-115 when preparing decontamination procedures. Submit a detailed discussion of personal hygiene and decontamination facilities and procedures to be followed by site workers as part of the APP/SSHP. Train employees in the procedures and enforce the procedures throughout site operations.

3.10.1 Decontamination Facilities

Submit drawings showing the layout of the personnel and equipment decontamination [areas] [facilities].

3.10.2 Personnel Decontamination

****

NOTE: Evaluate project specific tasks and contaminants to be handled and select appropriate initial personnel decontamination techniques and procedures below. Add appropriate decontamination techniques if not included. Select the showering option below when specific OSHA standards (29 CFR 1910.1003, 13 Carcinogens for example) require shower use or if industrial hygiene staff recommend showering for personnel decontamination. Specify the equipment necessary to perform personnel decontamination on this project.

****

Initially set up a decontamination line in the CRZ. Employees must exit the exclusion zone through the CRZ and implement the following decontamination procedures and techniques: [Scrub and rinse water proof outer garments] [remove all outer garments] [hand and face wash] [shower]. Showers, if needed, must comply with 29 CFR 1910, Section.141 and EM 385-1-1, 02 F, Washing Facilities. Following are additional decontamination procedures personnel are to follow: [_____]. It is the Site Safety and Health Officer's responsibility to recommend techniques to improve personnel decontamination procedures, if necessary. Initial personnel decontamination equipment includes the following: [_____].

3.10.3 Equipment Decontamination

Decontaminate the vehicles and equipment used in the EZ in the CRZ prior to leaving the EZ.

3.10.3.1 Facilities for Equipment and Personnel

****

NOTE: Other sections of the specifications and drawings should contain detailed requirements for the vehicle or equipment decontamination pad. As an alternative, the design of the decontamination pad

may be a Contractor submittal. The language in this paragraph provides general requirements for the Contractor's submittal. Edit as necessary for project.
****

Provide a [vehicle][/][equipment] decontamination station within the CRZ for decontaminating vehicles and equipment leaving the EZ. [Construct a decontamination station pad, which meets the site decontamination needs for all vehicles and larger equipment decontamination. Construct the pad to capture decontamination water, including overspray, and allow for collection and removal of the decontamination water using sumps, dikes and ditches as required.] [Provide a high pressure, low volume, water wash area for equipment and vehicles.] [Provide a steam cleaning system for use after the mud or site material has been cleaned from the equipment.] [Perform dry decontamination using a broom to remove dry/loose spilled materials on accessible surfaces.] [Provide a designated "clean area" in the CRZ for performing equipment maintenance. Use this area when personnel are required by normal practices to come in contact with the ground, i.e., crawling under a vehicle to change engine oil. Equipment within the EZ or CRZ must be decontaminated before maintenance is performed.]

3.10.3.2 Procedures

****
NOTE: Specify necessary procedures. Include any special procedures and methods to determine adequacy of decontamination.
****

Procedures for equipment decontamination must be developed and utilized to prevent the spread of contamination into the SZ and offsite areas. These procedures must address disposal of contaminated products and spent materials used on the site, including, as a minimum, containers, fluids, and oils. Assume any item taken into the EZ to be contaminated and perform an inspection and decontaminate. Vehicles, equipment, and materials must be cleaned and decontaminated prior to leaving the site. Handle construction material in such a way as to minimize the potential for contaminants being spread or carried offsite. Prior to exiting the site, vehicles and equipment must be monitored to ensure the adequacy of decontamination.

Task Hazard and Control Requirements Sheet	
Task	
Initial Anticipated Hazards	
Initial PPE	
Initial Controls	
Initial Exposure Monitoring	
[Yes][No]	HAZWOPER Medical Surveillance Required
[Yes][No]	HAZWOPER Training Required

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-01 42 00 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-01 42 00 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS
****

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS

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USACE / NAVFAC / AFCEC **UFGS-01 42 00 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-01 42 00 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS

05/24

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NOTE: This guide specification provides a listing of organizations whose publications are referenced in other sections of the specifications.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

In accordance with FAR 11.201 Identification and Availability of Specifications, identification of sources for obtaining documents referenced in the specifications must be provided in contract documents.

****

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization (e.g., ASTM B564 Standard Specification for Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

****

NOTE: This paragraph is automatically edited when processed using SpecsIntact. The processor removes those organizations not included in other sections of the project specifications when SpecsIntact (Reconcile Addresses item from the Print menu) is used for job processing. However, if publications of organizations in addition to those listed below are used in the project, add such organizations to this paragraph.

****

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided.

AACE INTERNATIONAL (AACE)
726 East Park Avenue #180
Fairmont, WV 26554 USA
Ph: 304-296-8444
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U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)
1322 Patterson Ave. SE, Suite 1000
Washington Navy Yard, DC 20374-5065
Ph: 202-685-9387
Internet: http://www.navfac.navy.mil

U.S. NAVAL SEA SYSTEMS COMMAND (NAVSEA)
Commander Naval Sea Systems Command
1333 Isaac Hull Ave., SE
Washington Navy Yard, DC 20376
Ph: 202-781-0000
Internet: https://www.navsea.navy.mil/

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Fax: 416.757.8727
E-mail: cec@ul.com
Internet: https://canada.ul.com/

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)
Corporate Headquarters
2711 LBJ Freeway, Suite 1000
Dallas, TX 75234
Ph: 972-243-3902
Fax: 972-243-3907
E-mail: info@uni-bell.org
Internet: https://www.uni-bell.org/

VIBRATION ISOLATION AND SEISMIC CONTROL MANUFACTURERS ASSOCIATION (VISCMA)
994 Old Eagle School Road
Suite 1019
Wayne, PA 19087-1866
Ph: 610-971-4850
E-mail: info@viscma.com
Internet: http://www.viscma.com

WALLCOVERINGS ASSOCIATION (WA)
35 E wacker Dr Suite 850

Chicago, IL 60611
Ph: 312-224-2574
E-mail: info@wallcoverings.org
Internet: https://www.wallcoverings.org

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Cheri Randich, Manager
110 Legislative Building
Olympia, WA 98504-0600
Ph: 360-786-7573
E-mail: support@leg.wa.gov
Internet: https://app.leg.wa.gov/wac/

WASHINGTON STATE DEPARTMENT OF ECOLOGY (WSDE)
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Lacey, WA 98503
Ph: 360-407-6000
Fax: 360-407-6989
Internet:
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WATER ENVIRONMENT FEDERATION (WEF)
601 Wythe Street
Alexandria, VA 22314
Ph: 800-666-0206
Fax: 703-684-2400
E-mail: csc@wef.org
Internet: https://www.wef.org/

WATER QUALITY ASSOCIATION (WQA)
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Lisle, IL 60532-3696
Ph: 630-505-0160
Fax: 630-505-9637
Internet: https://www.wqa.org/

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)
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Federal Way, WA 98003
Ph: 253-835-3344

Internet: https://www.plib.org/

WESTERN WOOD PRESERVERS INSTITUTE (WWPI)
12503 SE Mill Plain Blvd, Ste 205
Vancouver, WA 98684
Ph: 360-693-9958
Internet: https://wwpinstitute.org/

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)
2 Centerpointe Drive STE 360
Lake Oswego, OR 97035
Ph: 503-224-3930
E-mail: info@wwpa.org
Internet: http://www.wwpa.org

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)
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3rd Floor North
Washington, DC 20006
Ph: 202-367-1157
or
330 N Wabash Avenue, Suite 2000
Chicago, IL 60611
Ph: 312-321-6802
E-mail: membersupport@wdma.com
Internet: https://www.wdma.com/

WIRE ROPE TECHNICAL BOARD (WRTB)
108 Loyd Drive
Fredericksburg, VA 22315-8550
Ph: 703-299-8550
Fax: 703-299-9253
E-mail: wrtb@usa.net
Internet: http://www.wireropetechnicalboard.org

WISCONSIN DEPARTMENT OF NATURAL RESOURCES (WDNR)
101 S. Webster Street
PO Box 7921
Madison, WI 53707-7921
Ph: 1-888-936-7463
Internet: https://dnr.wisconsin.gov/

MOULDING AND MILLWORK PRODUCERS ASSOCIATION (MMPA)
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Yuba City, CA 95993-2625
Ph: 530-661-9591

Fax: 530-661-9586
E-mail: info@wmmpa.com
Internet: https://www.wmmpa.com/

WOODWORK INSTITUTE (WI)
1455 Response Road, Suite 110
Sacremento, CA 95815
Ph: 916-372-9943
Fax: 916-372-9950
E-mail: info@woodinst.com
Internet: https://woodworkinstitute.com

WOOLMARK COMPANY (WBI)
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New York, NY 10010
or
WeWork One Culver
10000 Washington Blvd
Culver City, CA 90232
Ph: 347-767-3160
E-mail: woolmark.americas@wool.com
internet: https://www.woolmark.com/

PART 2   PRODUCTS

Not used

PART 3   EXECUTION

Not used

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 42 15 (February 2024)**

Preparing Activity: USACE **Superseding**
UFGS-01 42 15 (February 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 01 42 15

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02/24

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****
USACE / NAVFAC / AFCEC **UFGS-01 42 15 (February 2024)**

Preparing Activity: USACE **Superseding**
UFGS-01 42 15 (February 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 01 42 15

METRIC MEASUREMENTS
02/24

****
NOTE: This guide specification covers the requirements for metric measurements in project specifications. Only use this section in metric system (SI) projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether brackets are present or not.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM SI10	(2016) American National Standard for Use of the International System of Units (SI): The Modern Metric System

1.2 GENERAL

****

NOTE: The Metric Conversion Act of 1975 (P.L. 94-168) designated the metric (SI) system as the preferred system of measurements in the United States. The Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418) amended the 1975 Act (P.L. 94-168) to include a requirement for each Federal agency "to the extent economically feasible ..., use the metric system of measurement..., except to the extent that such use is impractical or is likely to cause significant inefficiencies...".

Executive Order 12770 of July 25, 1991, Metric Usage in Federal Government Programs, assigned certain responsibilities to the Department of Commerce and to the Executive Branch departments and agencies toward implementation of P.L. 94-168 and P.L. 100-418. The Executive Order requires use of the metric system of measurement in Federal Government procurements, grants, and other business-related activities "to the extent economically feasible" and further states that "Metric usage is not required to the extent that such use is impractical or is likely to cause significant inefficiencies or loss of markets to United States firms".

Public Law 104-289 of October 11, 1996, Savings in Construction Act of 1996 (110 Stat. 3411) states that "a Federal agency may require that specifications for the acquisition of structures or systems of concrete masonry be expressed under the metric system of measurement, but may not incorporate specifications, that can only be satisfied by hard-metric versions of concrete masonry units, unless: 1) hard-metric specifications are necessary in a contract for the repair or replacement of parts Federal Facilities in existence or under construction upon the effective date of the

Savings in Construction Act of 1996; or 2) the following 2 criteria are met: (A) the application requires hard-metric concrete masonry units to coordinate dimensionally into 100 millimeter building modules; and (B) the total installed price of hard-metric concrete masonry units is estimated to be equal to or less than the total installed price of using non-hard-metric concrete masonry units." The Savings in Construction Act of 1996 also contains similar requirements for recessed lighting fixtures.

This guide specification establishes the basis for Contractor compliance with the specified metric requirements and provides information necessary for the Contractor and Government administrative personnel to better understand the metric requirements. This guide specification is to be used in projects designated to use metric measurements.

ASTM SI10 have been used to the extent practicable in establishing the metric measurements in guide specifications.

The following is an illustration of designer choices for SI or I-P measurements:

SI MEASUREMENT	**I-P MEASUREMENT**
50 mm	**2 inches**
50.8 mm	**2 inches**

For the choices shown above, the metric measurement of 50 mm is a soft metric value, and 50.8 mm is a hard metric value.

The UFGS are prepared with both the SI and I-P measurements, including appropriate automation tagging. During the SPECSINTACT Editor viewing and SPECSINTACT printing process two automated options are available:

1) For individual sections in the project either all SI or all I-P units can be selected.

2) For all sections in the project either all SI or all I-P units can be used.

A third option for a mix of SI and I-P units in a section is not automatic and requires the removal of the measurement tags and the unwanted requirements on a case-by-case basis during the editing process.
****

This project includes metric units of measurements. The metric units used are the International System of Units (SI) developed and maintained by the General Conference on Weights and Measures (CGPM); the name International System of Units and the international abbreviation SI were adopted by the 11th CGPM in 1960. When both metric and English inch-pound (I-P) measurements are included, the Specifications may contain measurements for products that are manufactured to industry recognized hard metric dimensions but are allowed to be substituted by I-P products, to indicate industry and/or Government standards, test values or other controlling factors, such as the code requirements where I-P values are needed for clarity, or to trace back to the referenced standards, test values, or codes.

1.3 USE OF MEASUREMENTS IN SPECIFICATIONS

Measurements are in either SI or I-P units as indicated. When only SI or I-P measurements are specified for a product, procure the product in the specified units (SI or I-P) unless otherwise authorized by the Contracting Officer. The Contractor is responsible for the associated labor and materials when authorized to substitute one system of units for another and for the final assembly and performance of the specified work and products.

1.3.1 Hard Metric

Hard metric measurements are often used for field data such as distance from one point to another or distance above the floor. Products are considered to be hard metric when they are manufactured to metric dimensions or have an industry recognized metric designation.

1.3.2 Soft Metric

a. A soft metric measurement is a non-mathematical, industry related conversion. Soft metric measurements are used for measurements pertaining to products, test values, and other situations where the I-P units are the standard for manufacture, verification, or other controlling factor.

b. A soft metric measurement is also indicated for products that are manufactured in industry designated metric dimensions but are required by law to allow substitute I-P products.

1.3.3 Neutral

A neutral measurement is indicated by an identifier which has no expressed relation to either an SI or an I-P value (e.g., American Wire Gage (AWG) which indicates thickness but is neither SI nor I-P).

1.4 COORDINATION

Bring discrepancies, such as mismatches, product unavailability, arising from use of both metric and non-metric measurements, and discrepancies between the measurements in the Specifications and the measurements in the Drawings to the attention of the Contracting Officer for resolution.

1.5 RELATIONSHIP TO SUBMITTALS

Submittals must cover only the SI or I-P products furnished. Submit the required shop drawings and calculations in the same units used in the Contract documents describing the product or requirement, unless otherwise instructed or approved. Use ASTM SI10 as the basis for establishing metric measurements used in submittals.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 45 00 (August 2023)**

Change 1 - 05/24

Preparing Activity: NAVFAC

Superseding
UFGS-01 45 00.00 10 (November 2016)
UFGS-01 45 00.00 20 (November 2011)
UFGS-01 45 00.05 20 (June 2015)
UFGS-01 45 00.10 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 01 45 00

QUALITY CONTROL

08/23, CHG 1: 05/24

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USACE / NAVFAC / AFCEC **UFGS-01 45 00 (August 2023)**

Change 1 - 05/24

Preparing Activity: NAVFAC **Superseding**
UFGS-01 45 00.00 10 (November 2016)
UFGS-01 45 00.00 20 (November 2011)
UFGS-01 45 00.05 20 (June 2015)
UFGS-01 45 00.10 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 45 00

QUALITY CONTROL
08/23, CHG 1: 05/24

****

NOTE: This guide specification covers the preparation and use of Design-Bid-Build (DBB) and Design-Build (DB) Quality Control. This section, as edited, must be reviewed and approved by the Administering Construction Office prior to the 100 percent design submission.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: For Navy - When this specification is used, it will be in conjunction with Section 01 32 16.00 20 SMALL PROJECT CONSTRUCTION PROGRESS SCHEDULES, or 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS).

****

****

NOTE: Options to allow for the QC Manager to serve as the Site Safety and Health Officer or the Project

Superintendent or both have been incorporated into this guide specification. These options can include the use of QC Specialists responsible for performing QC for specific areas of work and for a specified frequency. Specify QC Specialists for those areas of work that are of sufficient complexity or size to justify the expense.

Consider:

a. Design and complexity of project.

b. Location of project.

c. Cost and type of Contract.

d. Characteristics of area construction labor market.

e. Amount and type of off-site fabrication.

f. Duration of project.

When requiring the use of a Registered Professional Engineer/Architect or a graduate Engineer/Architect for the QC Manager or QC Specialist(s), keep in mind the additional cost. The over-specifying of expertise for QC personnel should be avoided.

****

PART 1 GENERAL

****

NOTE: This section contains tailoring options for ARMY, NAVY, COMMISSIONING, INDOOR AIR QUALITY, DESIGN-BUILD, SPECIAL INSPECTIONS, DESIGN-BID-BUILD, and SECURE SPACE.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile

references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D3740	(2019) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E543	(2021) Standard Specification for Agencies Performing Non-Destructive Testing

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements
ER 1110-3-12	(2021) Military Engineering and Design Quality Management

1.2 PAYMENT

****
NOTE: The following paragraph has tailoring for DESIGN-BID-BUILD and DESIGN-BUILD.
****

Separate payment will not be made for providing and maintaining an effective Quality Control program. Include all associated costs in the applicable Bid Pricing Schedule item.

1.3 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal

items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-01 Preconstruction Submittals

****
NOTE: For projects in the NAVFAC PAC Area of Operation, and for the submittal(s) identified as SD-01 Preconstruction Submittals, select the "G" designation requiring Government approval for Contractor Quality Control (QC) Plan.
****

Contractor Quality Control (CQC) Plan; G, [_____]

Additional Requirements For Design Quality Control (DQC) Plan; G, [_____]

SD-05 Design Data

Design Quality Control

Discipline-Specific Checklists

Design Quality Control Documentation (DQCD)

SD-06 Test Reports

Verification Statement

SD-07 Certificates

Certificate Of Readiness; G, [_____]

1.4 GENERAL REQUIREMENTS

****

NOTE: The following paragraph includes tailoring for DESIGN-BUILD.

****

Establish and maintain an effective quality control (QC) system that complies with FAR 52.246-12 Inspection of Construction. QC is comprised of plans, procedures, and organization necessary to produce an end product that complies with the Contract requirements. The QC system covers all design and construction operations, both onsite and offsite, and must be keyed to the proposed design and construction sequence. The Quality Control Manager, Superintendent, Site Safety and Health Officer (SSHO), and all on-site supervisors are responsible for the quality of work and are subject to removal by the Contracting Officer for non-compliance with the quality requirements specified in the Contract. The Quality Control Manager must maintain a physical presence at the work site at all times and is the primary individual responsible for all quality control.

1.5 QUALITY CONTROL (QC) PROGRAM REQUIREMENTS

****

NOTE: The following paragraph has tailoring for COMMISSIONING and SPECIAL INSPECTIONS.

****

Establish and maintain a QC program as described in this section. This QC program is a key element in meeting the objectives of the Commissioning Process (Cx). The QC program consists of a QC Organization, QC Plan, QC Plan Meeting(s), a Coordination and Mutual Understanding Meeting, QC meetings, three phases of control, submittal review and approval, testing, completion inspections, QC certifications, independent Special Inspections in accordance with Section 01 45 35 SPECIAL INSPECTIONS, and documentation necessary to provide materials, equipment, workmanship, fabrication, construction and operations that comply with the requirements of this Contract. The QC program must cover on-site and off-site work and be keyed to the work sequence. No construction work or testing may be performed unless the QC Manager is on the work site. The QC Manager must report to an officer of the firm and not be subordinate to the Project Superintendent or the Project Manager. The QC Manager, Project Superintendent and Project Manager must work together effectively. Although the QC Manager is the primary individual responsible for quality control, all individuals will be held responsible for the quality of work on the job.

1.5.1 Meetings

1.5.1.1 Quality Control Plan Meeting

Prior to submission of the QC Plan, the Contractor may request a meeting with the Contracting Officer to discuss the QC Plan requirements of this Contract.

The purpose of this meeting is to develop a mutual understanding of the QC Plan requirements prior to plan development and submission and to agree on the Contractor's list of Definable Feature of Work (DFOW).

1.5.1.2 Coordination and Mutual Understanding Meeting

****

NOTE: Tailored text in the following paragraph provides language for DESIGN-BID-BUILD and DESIGN-BUILD construction procurements.

****

After the Preconstruction Conference,Post Award Conference, before start of design or construction, and prior to acceptance by the Government of the CQC Plan, meet with the Contracting Officer and discuss the Contractor's quality control system. During the meeting, a mutual understanding of the system details must be developed, including the forms for recording the CQC operations, design activities, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting will be prepared by the QC Manager and signed by the Contractor, the Architect/Engineer (A/E), and the Government. Provide a copy of the signed minutes to all attendees[and include in the QC Plan]. At a minimum the Coordination and Mutual Understanding Meeting must be repeated when a new QC Manager is appointed. There can be other occasions when subsequent conferences will be called by either party to reconfirm mutual understandings or address deficiencies in the CQC system or procedures which can require corrective action by the Contractor.

1.5.1.2.1 Purpose

****

NOTE: The following paragraph contains tailoring for COMMISSIONING and SPECIAL INSPECTIONS.

****

The purpose of this meeting is to develop a mutual understanding of the QC details, including documentation, administration for on-site and off-site work, design intent, Cx in accordance with Section 01 91 00.15 BUILDING COMMISSIONING, environmental requirements and procedures, coordination of activities to be performed, Special Inspections, and the coordination of the Contractor's management, production, and QC personnel. At the meeting, the Contractor must explain in detail how three phases of control will be implemented for each DFOW, as well as how each DFOW will be affected by each management plan or requirement as listed below:

a. Waste Management Plan.

b. Procedures for noise and acoustics management.

c. Environmental Protection Plan.

d. Environmental regulatory requirements.

****

NOTE: The following item is tailored for COMMISSIONING.
****

e. Cx Plan requirements in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

****
NOTE: The following item is tailored for SPECIAL INSPECTIONS.
****

f. Special Inspections.

****
NOTE: The following item is tailored for INDOOR AIR QUALITY.
****

g. Indoor Air Quality (IAQ) Management Plan.

1.5.1.2.2 Coordination of Activities

****
NOTE: The following paragraph contains tailoring for INDOOR AIR QUALITY and SPECIAL INSPECTIONS.
****

Coordinate activities included in various sections to assure efficient and orderly installation of each component. Coordinate operations included under different sections that are dependent on each other for proper installation and operation. Schedule construction operations with consideration for indoor air quality as specified in the IAQ Management Plan.Coordinate Special Inspections.

1.5.1.2.3 Attendees

****
NOTE: The following paragraph contains tailoring for SPECIAL INSPECTIONS and COMMISSIONING.
****

As a minimum, the Contractor's personnel required to attend include an officer of the firm, the Project Manager, Project Superintendent, QC Manager, Alternate QC Manager,[Assistant QC Manager,][QC Specialists,] Special Inspector,[Special Inspector of Record,] Commissioning Provider (CxC), Environmental Manager, and subcontractor representatives. Each subcontractor who will be assigned QC responsibilities must have a principal of the firm at the meeting.

1.5.1.3 Quality Control (QC) Meetings

****
NOTE: The following paragraph contains tailoring for SPECIAL INSPECTIONS and COMMISSIONING.
****

After the start of construction, conduct weekly QC meetings led by the QC Manager at the work site with the Project Superintendent,[the QC

Specialists,] the Special Inspector,[the Special Inspector of Record,] CxC, and the other personnel as necessary. The QC Manager is to prepare the minutes of the meeting and provide a copy to the Contracting Officer within 2 working days after the meeting. The Contracting Officer may attend these meetings. As a minimum, accomplish the following at each meeting:

a. Review the minutes of the previous meeting.

b. Review the schedule and the status of work and deficiencies/rework. Review the most current approved schedule (in accordance with schedule specification) and the status of work and deficiencies/rework.

c. Review the status of submittals and Request For Information (RFIs).

****

NOTE: The following item contains tailoring for NAVY and ARMY.

****

d. Review the work to be accomplished in the next 3 weeks as defined by the schedule section paragraph WEEKLY LOOK AHEAD in Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS) WEEKLY PROGRESS MEETINGS in Section 01 32 01.00 10 PROJECT SCHEDULE and all documentation required for that work.

e. Review Testing Plan and Log including status of tests performed since last QC Meeting.

f. Resolve QC and production problems. Discuss status of pending change orders.

g. Address items that may require revising the QC Plan.

h. Review Accident Prevention Plan (APP) and effectiveness of the safety program.

i. Review environmental requirements and procedures.

j. Review Environmental Management Plan.

k. Review Waste Management Plan.

l. Review the status of training completion.

****

NOTE: The following item is tailored for COMMISSIONING.

****

m. Review Cx Plan and progress. Review Issues Log and resolution.

****

NOTE: The following item is tailored for INDOOR AIR QUALITY.

****

n. Review IAQ Management Plan.

1.5.2 Contractor Quality Control (CQC) Plan

****

NOTE: The following paragraph contains tailoring for NAVY, ARMY, and DESIGN-BUILD.

****

Submit no later than [30][_____] days after Contract Award after receipt of notice to proceed, the CQC Plan proposed to implement the requirements FAR 52.246-12 Inspection of Construction. The Government will consider an interim plan for the first [_____] days of operation. Design and Construction will be permitted to begin only after acceptance of the CQC Plan and other Contract requirements or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional work. Design work is not permitted to start prior to approval of a Design Quality Control Plan.

1.5.2.1 Content of Contractor Quality Control (CQC) Plan

Provide a CQC Plan, prior to start of construction that includes a table of contents, with major sections identified, pages numbered sequentially, and that documents the proposed methods and responsibilities for accomplishing quality control during the construction of the project. The CQC Plan must at a minimum include the following sections:

a. A description of the quality control organization and acknowledgment that the CQC staff will implement the three phase control system for all aspects of the work specified.

b. An organizational chart showing the quality control organization with individual names and job titles and lines of authority up to an executive of the company at the home office.

c. NAMES AND QUALIFICATIONS: Names and qualifications, in resume format, (including position titles and durations for qualifying experiences) for each person in the QC organization. Include the Construction Quality Management (CQM) for Contractors course certifications for the QC personnel as required by the paragraph CONSTRUCTION QUALITY MANAGEMENT TRAINING.

d. DUTIES, RESPONSIBILITY AND AUTHORITY OF QC PERSONNEL: Duties, responsibilities, and authorities of each person in the QC organization.

e. OUTSIDE ORGANIZATIONS: A listing of outside organizations, such as architectural and consulting engineering firms, that will be employed by the Contractor and a description of the services these firms will provide.

****

NOTE: The following item contains tailoring for DESIGN-BUILD and COMMISSIONING.

****

f. APPOINTMENT LETTERS: Letters signed by an officer of the firm appointing the QC Manager and Alternate QC Manager, Design Quality Control Manager, CxC, and stating that they are responsible for implementing and managing the QC program as described in this

Contract. Include in this letter the responsibility of the QC Manager and Alternate QC Manager to implement and manage the three phases of control, and their authority to stop work that is not in compliance with the Contract. Letters of direction are to be issued by the QC Manager to[the Assistant QC Manager and] all other QC Specialists or quality control representatives outlining their duties, authorities, and responsibilities. Include copies of the letters in the QC Plan.

****

NOTE: The following item contains tailoring for DESIGN-BUILD.

****

g. SUBMITTAL PROCEDURES AND INITIAL SUBMITTAL REGISTER: Procedures for reviewing, approving, scheduling, and managing submittals, including those of subcontractors, designers of record, consultants, architect-engineers (AE), offsite fabricators, suppliers, and purchasing agents. Provide the name(s) of the person(s) in the QC organization authorized to review and certify submittals prior to approval. Provide the initial submittal of the Submittal Register as specified in Section 01 33 00 SUBMITTAL PROCEDURES.

h. TESTING LABORATORY INFORMATION: Testing laboratory information required by the paragraph ACCREDITATION REQUIREMENTS, as applicable.

i. TESTING PLAN AND LOG: A Testing Plan and Log that includes the tests required, associated feature of work required, referenced by the specification paragraph number requiring the test, the frequency, and the person responsible for each test.

****

NOTE: The following item contains tailoring for DESIGN-BUILD.

****

j. Procedures to complete design and construction deficiencies from identification through acceptable corrective action. Establish verification procedures that identified deficiencies have been corrected. This phase is performed prior to beginning work on each definable feature of work, after all required plans, documents, materials are approved, and after copies are at the work site.

k. Reporting procedures, including proposed reporting formats.

l. Procedures for submitting and reviewing design changes/variations prior to submission to the Contracting Officer.

****

NOTE: The following item contains tailoring for DESIGN-BUILD.

****

m. LIST OF DEFINABLE FEATURES: A Definable Feature of Work (DFOW) is a task that is separate and distinct from other tasks and has control requirements and work crews unique to that task. A DFOW is identified by different trades or disciplines, or it is work by the same trade in a different environment. A DFOW is by definition any item or activity on the construction schedule, and the schedule specification provides direction regarding how the DFOWs are to be structured. Include in the list of DFOWs for all activities on the Construction Schedule. Provide separate DFOWs in the Network Analysis Schedule for each design development stage and submittal package. Although each section of the specifications can generally be considered as a definable feature of work, there are frequently more than one definable features under a particular section. Identify the specification section number and schedule activity ID for each DFOW listed. The DFOW list will be reviewed in coordination with the construction schedule and agreed upon during the Coordination of Mutual Understanding Meeting.

n. PROCEDURES FOR PERFORMING AND TRACKING THE THREE PHASES OF CONTROL: Identify procedures used to ensure the three phases of control to manage the quality on this project. For each Definable Feature of Work (DFOW), a Preparatory and Initial phase checklist will be filled out during the Preparatory and Initial phase meetings. Conduct the Preparatory and Initial Phases and meetings with a view towards obtaining quality construction by planning ahead and identifying potential problems for each DFOW.

****

NOTE: The following is tailored for SPECIAL INSPECTIONS.

****

o. Coordinate scheduled work with Special Inspections required by Section 01 45 35 SPECIAL INSPECTIONS, the Statement of Special Inspections and the Special Inspections Project Manual. Where the applicable code issued by the International Code Council (ICC) calls for inspections by the Building Official, the Contractor must include the inspections in the Quality Control Plan and must perform the inspections required by the applicable ICC. The Contractor must perform these inspections using independent qualified inspectors. Include the Special Inspections Project Manual requirements in the QC Plan.

****

NOTE: Contact the Administering Construction Office to determine if the following three paragraphs are applicable to the project and edit.

****

[p. [o][p]. PROCEDURES FOR COMPLETION INSPECTION: Procedures for identifying and documenting the completion inspection process. Include in these procedures the responsible party for punch out inspection, pre-final inspection, and final acceptance inspection.

][q. [p][q]. TRAINING PROCEDURES AND TRAINING LOG: Procedures for coordinating and documenting the training of personnel required by the Contract.

][r. [q][r]. ORGANIZATION AND PERSONNEL CERTIFICATIONS LOG: Procedures for coordinating, tracking and documenting all certifications required for entities such as subcontractors, testing laboratories, suppliers, and personnel. The QC Manager will ensure that certifications are current, appropriate for the work being performed, and will not lapse during any period of the Contract that the work is being performed.

]1.5.2.2 Additional Requirements for Design Quality Control (DQC) Plan

****

NOTE: This paragraph is tailored for DESIGN-BUILD and contains additional tailoring for ARMY and NAVY. Use this paragraph for Design-Build projects only.

For Army projects, use term Agency Technical Review (ATR) for technical reviews on Civil Works projects as defined by ER 1165-2-217. Use term Independent Technical Review (ITR) for technical reviews on Military Engineering Design projects as defined by ER 1110-3-0201.

For Navy projects, Design Quality Control Reviews are defined by FC 1-300-09N.

****

The following additional requirements apply to the DQC Plan:

a. Submit and maintain a DQC Plan as an effective quality control program which assures that all services required by this Contract are performed and provided in a manner that meets professional architectural and engineering quality standards. As a minimum, all documents must be technically reviewed by competent, independent reviewers identified in the DQC Plan. The same element that produced the product may not perform the[Independent Technical Review (ITR)][Agency Technical Review (ATR)] Design Quality Control Review. Correct errors and deficiencies in the design documents prior to submitting them to the Government.

b. Include the design schedule in the master project schedule, showing the sequence of events involved in carrying out the project design tasks within the specific Contract period. Schedule must include sufficient detail to identify all major design tasks, including those that control the flow of work. Include review and correction periods associated with each item. Schedule must be a forward planning as well as a project monitoring tool. The schedule reflects calendar days and not dates for each activity. If the schedule is changed, submit a revised schedule reflecting the change within 7 calendar days.

c. Include in the DQC Plan the discipline-specific checklists to be used during the design and quality control of each submittal. Submit at each design phase as part of the project documentation these completed discipline-specific checklists. ER 1110-3-12 provides some useful information in developing checklists.

d. Implement the DQC Plan by a Design Quality Control Manager who has the responsibility of being cognizant of and assuring that all documents on the project have been coordinated and who coordinates work with and reports to the Contracting Officer via the QC Manager. Notify the Contracting Officer, in writing, of the name of the individual and the name of an alternate person assigned to the position.

e. Provide Quality Control Documentation procedures such as QC review sets and QC comments to demonstrate that cross checking of all engineering disciple's design drawings and specifications has taken place. The QC review documentation must exhibit a checking process of the design documents for completeness, accuracy, and constructability.

****

NOTE: The following items are tailored for NAVY.
****

f. Names of the individuals, including their respective firm names, who will be serving as the Designer of Record (DOR) in their respective design discipline.

g. Submit a formal Communication Plan that indicates the frequency of design meetings and what information is covered in those meetings, key design decision points tied to the Network Analysis Schedule and how the DOR plans to include the Government in those decisions, peer review procedures, interdisciplinary coordination, design review procedures, and comment resolution.

The Communication Plan must emphasize key decisions and possible problems the Contractor and Government may encounter during the design phase of the project. Provide a plan to discuss design alternatives and design coordination with the stakeholders at the key decision points as they arise on the project. Identify individual stakeholders and suggested communication methods that will be employed to expedite and facilitate each anticipated critical decision. Communication methods may include: Concept Design Workshop, over-the-shoulder review meetings, presentation at client's office, lifecycle cost analysis presentation, technical phone conversation, and formal review meeting. The design portion of the Communication Plan must be written by the DQC Manager and confirmed during the Post Award Kick-off Partnering. Update the Communication Plan at every Partnering meeting.

h. A statement of Life Safety and Fire Protection Features Inspections and Testing must be prepared by the Fire Protection DOR. Examples of life safety and fire protection features include, but are not limited to, water distribution systems including fire pumps and fire hydrants, fire resistive assemblies such as fire rated walls/partitions, through penetration firestop systems, spray-applied fireproofing of structural components, fire alarm and detection systems, fire suppression and standpipe systems, means of egress components, emergency and exit lighting fixtures. The plan must include a listing of the individuals, approved agencies or firms that will be retained for conducting the required inspections and tests accompanied by a description of individual inspector's experience, and a copy of all required certifications. Additional copies of this plan must be submitted to the NAVFAC Fire Protection Engineer and the Installation Fire Chief. This plan must include the following:

(1) Comprehensive list of systems, components or features to be inspected and tested.

(2) Description of performance verification testing activities for each system or component.

(3) Procedures and schedules for functional performance tests of all systems requiring functional testing.

i. Procedures for ensuring the design documents are submitted in accordance with FC 1-300-09N, Navy and Marine Corps Design Procedures and other procedures to ensure disciplines have been properly coordinated to eliminate conflicts.

1.5.3 Acceptance of the Quality Control (QC) and Design Quality Control (DQC) Plan

****

NOTE: The following paragraph contains tailoring for ARMY and DESIGN-BUILD.

****

The Contracting Officer's acceptance of the Contractor QC Plan, or interim plan applicable to the particular feature of work to be started, and Design Quality Control Plan is required prior to the start of design and construction. The Government will consider an interim plan for the first [_____] days of operation. Work outside of the accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional work. The Contracting Officer reserves the right to require changes in the QC and DQC Plan and operations as necessary, including removal or addition of personnel, to ensure the specified quality of work. The Contracting Officer reserves the right to interview any member of the QC and DQC organization at any time to verify the submitted qualifications. All QC and DQC organization personnel are subject to acceptance by the Contracting Officer. The Contracting Officer may require the removal of any individual for non-compliance with quality requirements specified in the Contract.

1.5.4 Preliminary Construction Work Authorized Prior to Acceptance

****

NOTE: This paragraph is tailored for NAVY.

****

The only construction work that is authorized to proceed prior to the acceptance of the QC Plan is mobilization of storage and office trailers, temporary utilities, and surveying with specific prior approval of the Contracting Officer.

1.5.5 Notification of Changes

Notify the Contracting Officer, in writing, of any proposed changes in the QC Plan or changes to the QC organization personnel. Proposed changes are subject to acceptance by the Contracting Officer.

1.5.6 Special Inspections

****

NOTE: This paragraph is tailored for SPECIAL INSPECTIONS.

Special Inspections are required for all projects except the following per IBC:

1. Construction of a minor nature as determined by the designer of record. Where renovation construction does not alter existing gravity or lateral load resisting system, would constitute construction that is minor in nature.

2. Utility and miscellaneous Group U occupancies that are accessories to a residential occupancy.

3. Portions of structures designed and constructed in accordance with the cold-formed steel light-frame construction provisions of Section 2211 of IBC or the conventional light-frame construction provisions of Section 2308 of IBC.

****

Perform all required Special Inspections per Section 01 45 35 SPECIAL INSPECTIONS, the statement of Special Inspections and the Schedule of Special Inspections.

1.6 QUALITY CONTROL (QC) ORGANIZATION

****

NOTE: Consult with Administering Construction Office for qualifications of the QC organization members.

****

1.6.1 Personnel Requirements

****

NOTE: This paragraph is tailored for ARMY.

****

****

NOTE: Selection of Design-Build construction text required.

****

The requirements for the CQC organization are a Site Safety and Health Officer (SSHO), QC Manager, a Design Quality Manager, and enough qualified personnel to ensure safety and Contract compliance. The SSHO reports directly to a senior project (or corporate) official independent from the QC Manager. The SSHO will also serve as a member of the CQC Staff Personnel identified in the technical provisions as requiring specialized skills to assure the required work is being performed properly. The CQC staff always maintains a presence at the site during progress of the work and have complete authority and responsibility to take any action necessary to ensure Contract compliance. The CQC staff will be subject to acceptance by the Contracting Officer. Provide adequate office space, filing systems and other resources as necessary to maintain an effective and fully functional CQC organization. Promptly complete and furnish all letters, material submittals, shop drawing submittals, schedules, and all other project documentation to the CQC organization. The CQC organization is responsible for always maintaining these documents and records at the site, except as otherwise acceptable to the Contracting Officer.

1.6.2 Quality Control (QC) Manager

1.6.2.1 Duties

****

NOTE: Consult with Administering Construction Office to determine if QC Manager may serve as SSHO or Project Superintendent or both based on complexity of project. A Level one SSHO may not serve in any other roles. A Level two or three SSHO may serve in additional roles. Select the second

bracketed item allowing Project Superintendent duties for routine projects. Select the third bracketed item allowing no other duties for large or complex projects.

Remove the bracketed phrases referring to QC Specialists when none are specified.

Use the tailoring for the QC manager to be responsible for coordinating the Special Inspection Activities when a Special Inspector of Record is not required for the project.

Coordinate the last bracketed sentence with paragraph QUALITY CONTROL (QC) FOR[SECURE SPACE][CONTROLLED AREA][SOUND RATED] PERIMETER CONSTRUCTION of this specification.
****

****
NOTE: The following paragraph contains tailoring for ARMY, NAVY, SPECIAL INSPECTIONS, and SECURE SPACE.
****

Provide a QC Manager at the work site to implement and manage the QC program, and to serve as the [Level two][Level three] Site Safety and Health Officer (SSHO) as detailed in Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. The QC Manager must be employed by the Prime Contractor.[In addition to implementing and managing the QC program, the QC Manager may perform the duties of Project Superintendent.][The only duties and responsibilities of the QC Manager are to manage and implement the QC program on this Contract.] The QC Manager must attend the partnering meetings, QC Plan Meetings, Coordination and Mutual Understanding Meeting, conduct the QC meetings, perform the three phases of control[except for those phases of control designated to be performed by QC Specialists], perform submittal review and approval, ensure testing is performed and provide QC certifications and documentation required in this Contract. The QC Manager is responsible for managing and coordinating the three phases of control and documentation performed by[the QC Specialists,] testing laboratory personnel and any other inspection and testing personnel required by this Contract. The QC Manager is the manager of all QC activities. The QC manager is responsible for notifying the Special Inspector[and Special Inspector of Record] of activities which require their review. The QC manager is responsible for coordinating the Special Inspection activities, see paragraph CONTRACTOR'S QUALITY CONTROL (QC) MANAGER, in Section 01 45 35 SPECIAL INSPECTIONS. The QC manager is responsible for the quality control for[Secure Space][Controlled Area][Sound Rated] perimeter construction.

1.6.2.2   Qualifications

****
NOTE: Designer of Record, Specification Writer, or Project Manager or both must consult with the executing Construction Office to ensure proper qualifications for the QC Manager are defined. Do not specify qualifications here without first consulting with the Administering Construction

Office.

Select and edit first bracketed paragraph for projects NOT requiring the QC Manager to have a degree in engineering or architecture.

Select and edit second bracketed paragraph for projects requiring the QC Manager to have a 4-year degree in engineering or architecture. Select the bracketed option within the second paragraph for a professionally licensed engineer or registered architect.

For Navy projects, requiring the QC Manager to have a degree in engineering or architecture with or without professional licensing or registration should be the exception and only reserved for the most complex projects where the contractor will likely employ a QC staff with QC Assistants as opposed to a lone QC Manager.

Selection choices for technical/professional qualifications and experience levels should be commensurate with the project complexity, location, and execution considerations to assure the execution of the QC process is reasonably within the capacities of an individual meeting the selected qualifications. If specific State or Territory registration is not specifically required for contract execution edit using the "in a US State or Territory" bracketed selection.

****

[The QC Manager must be an individual with a minimum of [5][10][_____] years combined experience in the following positions: Project Superintendent, QC Manager, Project Manager, Project Engineer or Construction Manager on similar size and type construction Contracts which included the major trades that are part of this Contract. The individual must have at least [2][4][_____] years experience as a QC Manager. The individual must be familiar with the requirements of EM 385-1-1 and have experience in the areas of hazard identification, safety compliance, and sustainability.

****

NOTE: The following paragraph contains tailoring options for ARMY.

****

][The QC Manager must possess at least a Bachelor's degree in engineering, architecture, or construction management, with[a current professional engineer registration [in the state of [_____]] [in a US State or Territory] or a current licensed architect [in the state of [_____]] [in a US State or Territory] and] a minimum of [10][_____] years construction experience as a Project Superintendent, QC Manager, Project Manager, Project Engineer or Construction Manager on similar size and type construction Contracts which included the major trades that are part of this Contract. The individual must have at least [2][4][_____] years experience as a QC Manager. The individual must be familiar with the requirements of EM 385-1-1 and have experience in the areas of hazard identification, safety compliance, and sustainability.

] The QC Manager and all members of the QC organization must be capable of reading, writing, and conversing fluently in the English language.

1.6.2.3 Construction Quality Management Training

In addition to the above experience and education requirements, the QC Manager and all members of the QC team must have completed the CQM for Contractors course. If the QC Manager does not have a current certification, obtain the CQM for Contractors course certification within 90 days of award. This course is periodically offered by the Naval Facilities Engineering Systems Command and the Army Corps of Engineers. Contact the Contracting Officer for information on the next scheduled class.

The Construction Quality Management Training certificate expires after 5 years. If the QC Manager's certificate has expired, retake the course to remain current.

[1.6.2.4 Quality Control Requirements for Multiple Work Sites

****

NOTE: Insert this paragraph when a contract has more than one work site that requires a separate full-time QC Manager. Fill in the work site locations below that require a full-time QC Manager when a project has more than one work site that requires a dedicated full-time QC Manager.

Just because a project has more than one work site doesn't automatically mean additional full-time QC Manager(s) are required. Only consider specifying additional full-time QC Managers when the contract includes separate projects and each project is uniquely different from one another usually having separate plans and specifications. This is very rare and should only be specified after careful consideration and consultation with the administering construction office.

****

Provide separate full-time QC Managers at the work sites listed below. Provide a separate full-time QC Manager at the following work sites:

a. [INDICATE WORK SITE LOCATION]

b. [INDICATE WORK SITE LOCATION]

[c. [INDICATE WORK SITE LOCATION]

] The QC Managers for the work sites listed above are each responsible for implementing and managing the QC Program at the designated work site. They must perform the three phases of control, perform submittal review, ensure testing is performed, and prepare QC certifications and documentation required by this Contract. The qualification requirements for the QC Managers at each site are listed in the paragraph QUALIFICATIONS.

]1.6.3 Organizational Changes

Maintain the QC staff with personnel as required by the specification section at all times. When it is necessary to make changes to the QC staff, revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer for acceptance.

1.6.4 Design Quality Control (DQC) Manager

****

NOTE: This paragraph and subparagraphs are tailored for DESIGN-BUILD.

Selection of design-build construction text required.

The following paragraph contains tailoring option for COMMISSIONING.

For Navy projects, the designer should review specification 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES to ensure proper coordination with SI submittals.

****

The DQC Manager must be a member of the QC organization, must coordinate actions with the QC Manager, and must not be subordinate to the Project Superintendent or the Project Manager. The DQC Manager may also act as the CxC if all CxC qualifications are met.

1.6.4.1 Qualifications

****

NOTE: The following items are tailored for NAVY.

****

a. A minimum of [5][_____] years experience as a design Architect or Engineer on similar size and type designs / or design-build Contracts. Provide education, experience, and management capabilities on similar size and type Contracts.

b. Be a registered professional engineer or architect with an active registration. Provide proof of registration as part of the resume submittal package.

c. Complete the US Army Corps of Engineers (USACE) course entitled "Construction Quality Management (CQM) for Contractors."

****

NOTE: The following item is tailored for ARMY.

****

a. Must be a person who has verifiable engineering or architectural design experience and is a registered professional engineer or architect.

1.6.4.2 Responsibilities

a. Be responsible for the design integrity, professional design standards, and all design services required.

****
NOTE: The following items are tailored for NAVY.
****

b. Be a member of the DOR firm but may not be the DOR or the person stamping and approving final construction drawings or approving submittals.

c. Be responsible for development of the design portion of the QC Plan, incorporation and maintenance of the approved Design Schedule, and the preparation of DQC Reports and minutes of all design meetings.

d. Participate in the Post Award Kick-Off, all design planning meetings, design presentations, partnering, and QC meetings.

e. Implement the DQC Plan and must remain on staff involved with the project until completion of the project.

f. Be cognizant of and assure that all design documents on the project have been developed in accordance with the Contract.

g. Provide Design Quality Control Documentation (DQCD) which indicates design coordination of the engineering disciplines. Submit DQCD with the pre-final and final design submittals as required in Section 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

h. Develop the submittal register. Coordinate with each DOR to determine what items need to be submitted, and who needs to approve.

i. Provide QC certification for design compliance.

j. Certify and sign statement on each invoice that all work to be paid to the DOR under the invoice has been completed in accordance with the Contract requirements.

k. Prepare weekly DQC Reports that document the work the design team accomplished that week.

l. Coordinate all training requirements with the QC and in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.5 Alternate Quality Control (QC) Manager Duties and Qualifications

****
NOTE: The following paragraph contains tailoring for NAVY.
****

Designate an alternate for the QC Manager at the work site to serve in the event of the designated QC Manager's absence. The period of absence may not exceed 2 weeks at one time, and not more than 30 workdays during a calendar year. The qualification requirements for the Alternate QC Manager must be the same as for the QC Manager.

[1.6.6 Assistant Quality Control (QC) Manager Duties and Qualifications

****
NOTE: This option will rarely be used. Select either the first or second bracketed paragraph.

Consider specifying an Assistant QC Manager only if this is a labor intensive project, a very complex project, a project with multiple work sites, or a project where shifts are worked. Select the first bracketed paragraph in most cases. Select and edit the second paragraph when the project involves shift work. Select the qualifications from the QC Manager paragraphs.

Delete the words "Assistant QC Manager" throughout this section when this paragraph is not used.

Fill in the qualification requirements based on the nature and complexity of job. Consult with the Administering Construction Office to determine if an Assistant QC Manager is required and what the qualifications should be.

****

[Provide a full-time assistant to the QC Manager at the work site to perform the three phases of control, perform submittal review, ensure testing is performed, and prepare QC certifications and documentation required by this Contract. The qualification requirements for the Assistant QC Manager must be [_____]. The individual must be familiar with the requirements of EM 385-1-1 and have experience in the areas of hazard identification and safety compliance.

][Provide a full-time assistant to the QC Manager at the work site to perform the three phases of control, perform submittal review, ensure testing is performed, and prepare QC certifications and documentation required by this Contract. The Assistant QC Manager must be on the work site during supplemental work shifts[beyond the regular shift] and perform the duties of the QC Manager during such supplemental shift work. The qualification requirements for the Assistant QC Manager must be [FILL IN BASED ON NATURE AND COMPLEXITY OF JOB]. The individual must be familiar with the requirements of EM 385-1-1 and have experience in the areas of hazard identification and safety compliance.

] The Assistant QC Manager must be capable of reading, writing, and conversing fluently in the English language.

]

1.6.7 Designer of Record (DOR) Qualifications

****

NOTE: This paragraph is tailored for NAVY and DESIGN-BUILD.

****

The DOR must be a registered design professional, retained by the Prime Contractor, responsible for the overall design and review of submittal documents prepared by others. The DOR is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws in the state in which the design professional works. The DOR cannot serve as the DQC Manager.

1.6.8 Commissioning

****

NOTE: This paragraph is tailored for COMMISSIONING.

Coordinate with Section 01 91 00.15 BUILDING COMMISSIONING.
****

Commissioning (Cx) is a systematic, quality-focused process for delivery of a project focusing on verifying and documenting all commissioned systems and assemblies are installed, tested, and operating as they were planned and designed to meet the project requirements. The Quality Control requirements outlined in this specification section are key in supporting the objectives of the Cx process, specifically coordinating testing, documenting, and verifying proper system operation. Properly executed the Quality Control support of Cx ensures timely execution of necessary tasks to deliver the fully commissioned and operating systems in coordination with the overall construction and project schedule.

Provide Cx in addition to the quality control requirements of this section and not as a substitute for quality control requirements. The QC Manager is responsible for carrying out the three phases of control while ensuring the functional performance and integrated systems tests are coordinated with the Cx provider as required for each system to be commissioned.

1.6.8.1 Certificate of Readiness

The QC Manager must issue a Certificate of Readiness for Government approval for each system to be commissioned. Schedule Functional Performance Tests for each system only after the Certificate of Readiness has been approved by the Government for the system. The Certificate of Readiness certifies that all required inspections have been completed and deficiencies that were identified through any prior review, inspection, or test activity have been corrected before the start of Functional Performance Tests. Refer to Cx requirements in Section 01 91 00.15 BUILDING COMMISSIONING for a list of systems to be commissioned and detailed requirements for the Cx provider.

1.6.9 Quality Control (QC) Specialists

****
NOTE: Only specify QC Specialists for those areas of work of sufficient complexity or size where a specialist is required to supplement the QC Manager. In the Experience Matrix insert the number of years based on project scope and complexity of the project. The requirement for a QC Specialist must be included in Part 3 of the technical section of the specification where a QC Specialist is needed. For Navy projects, the use of Registered Professional Engineers or Architects for QC Specialists may be allowed in special cases, but only after consultation with and approval by the Administering Construction Office. Indicate the specific time and frequency when the QC Specialist must be on the site.

TAB personnel must be specified when the Contract specifications contain Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Select options accordingly.

Delete the words "QC Specialists" throughout this section when this paragraph is not used.

This paragraph has tailoring for DESIGN-BUILD and ARMY.

****

Provide a separate QC Specialist at the work site for each of the areas as listed in the Matrix listed below, who must assist and report to the QC Manager and who[may perform production related duties but must be allowed sufficient time to perform][must have no duties other than] their assigned quality control duties. These individuals or specialized technical companies[are directly employed by the Prime Contractor and cannot be employed by a supplier or subcontractor on this project][are employees of the Prime or subcontractor including Designer of Record (DOR)]. A single person can cover more than one area provided that the single person is qualified to perform quality control activities in each designated and that workload allows. QC Specialists must be physically present at the work site with frequency as indicated in the Experience Matrix below, to participate in the QC Meetings, perform the three phases of control, including participation in Preparatory and Initial Phase meetings, and to perform and document Follow-up inspections as an extension of the QC Manager for each definable feature of work in their area of responsibility. QC Specialist must assist and be present for training events, and Critical System Acceptance inspections by the Government. Qualification, experience, Area of Responsibility, and frequency of QC surveillance are provided in Matrix listed herein.

Experience Matrix

1. Area	**2-1. Qualification** **2-2. Experience**	**3-1. Area of Responsibility**
[Civil]	[2-1. Graduate Civil Engineer or Construction Manager with [a professional engineer registration [in the state of [_____]], and] 2-2. 2 years experience in the type of work being performed on this project or technician with 5 years related experience]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final inspection.]
[Mechanical]	[2-1. Graduate Mechanical Engineer with [a professional engineer registration [in the state of [_____]], and] 2-2. 2 years experience or person with 5 years of experience supervising mechanical features of work in the field with a construction company]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final inspection.]

[Electrical]	[2-1. Graduate Electrical Engineer with [a professional engineer registration [in the state of [_____]], and] 2-2. 2 years related experience or person 5 years of experience supervising electrical features of work in the field with a construction company]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final inspection.]
[Structural]	[2-1. Graduate Civil Engineer (with Structural Track or Focus) or Construction Manager with [a professional engineer registration [in the state of [_____]], and] 2-2. 2 years experience or person 5 years of experience supervising structural features of work in the field with a construction company]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final inspection.]
[Architectural]	[2-1. Graduate Architect with [a registered architect [in the state of [_____]], and] 2-2. 2 years experience or person with 5 years related experience]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final
[Environmental]	[2-1. Graduate Environmental Engineer with [a professional engineer registration [in the state of [_____]], and] 2-2. 3 years experience]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final
[Submittals]	[2-1. Submittal Clerk 2-2. 1 year experience]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final

[Occupied Family Housing]	[2-1. Person, customer relations type, 2-2. Coordinator experience]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final
[Concrete, Pavements and Soils]	[2-1. Materials Technician 2-2. 2 years experience for the appropriate area]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final
[Testing, Adjusting and Balancing (TAB) Personnel]	[2.1. TAB Team Field Leader must be a member of AABC or an experienced technician of the firm certified by the NEBB 2-2. 3 years experience immediately preceding this Contract]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final inspection.]
[Roofing Manufacturer's Technical Representative]	[2-1. Installation and testing of roofing systems, Section 07 53 23 ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING 2-2. 5 years experience minimum]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [Full-time] during installation and including final
[Mechanical Inspector, International Code Council (ICC) Certified]	[2-1. Installation and testing of boilers, Section 23 52 49.00 20 STEAM BOILERS AND EQUIPMENT (500,000 - 18,000,000 BTU/HR) 2-2. 5 years experience minimum]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [Minimum three times a week during installation and full-time during testing] during installation and
[Geotechnical]	[2-1. [_____] 2-2. [_____] years of experience]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final

[Telecommunication	[2-1. [_____] 2-2. [_____] years of experience]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final
[Low-Voltage Specialties/ESS]	[2-1. [_____] 2-2. [_____] years of experience]	[3-1. Area of Responsibility: [_____] 3-2. Frequency of QC surveillance and inspection will be [_____] during installation and including final
[Underwater QC Team]	[Note: See paragraph UNDERWATER QC TEAM]	[Note: See paragraph UNDERWATER QC TEAM]
[Fire Protection QC Specialist (FPQC)]	[Note: See paragraph FIRE PROTECTION QC SPECIALIST (FPQC)]	[Note: See paragraph FIRE PROTECTION QC SPECIALIST (FPQC)]
[Building Envelope QC Specialist]	[2-1. Roofing Manufacturer's Technical Representative 2-2. 5 years minimum with roofing system used]	[3-1. Area of Responsibility: Installation and testing of roofing. 3-2. Frequency of QC surveillance and inspection will be once a week during installation, once a week during flashing installation and full-time during roof
[_____]	[_____]	[_____]

[1.6.9.1 Underwater QC Team

****

NOTE: This paragraph to be used only when the inspection of underwater work is required.

****

Provide Underwater QC (UWQC) Team at the work site to perform underwater surveillance and inspection for the Contractor. The UWQC Team divers must have current commercial diver's license, with a minimum of 5 years experience with underwater inspection. The personnel make-up of the UWQC team must comply with EM 385-1-1, OSHA, and local requirements for Contract diving operations. Comply with all the applicable safety requirements of EM 385-1-1, OSHA, and local requirements for Contract diving operations. The UWQC lead diver must be thoroughly familiar with the design plans and specifications to sufficiently understand the engineering aspects of the underwater construction and to be able to recognize and document potential problem areas, such as improperly constructed or defective areas. Provide all necessary equipment to conduct surveillance and inspection services, including diver's equipment, dive boat, communication equipment, and photographic or video equipment or both. Diver(s) must be equipped to maintain two-way communication with QC personnel during diving operations. Prepare and submit a report including photographs or videos or both with the QC report after each dive. Frequency of underwater surveillance and inspection will be [_____] during installation and including final inspection. The UWQC Team must be an independent third party hired directly by the Prime Contractor, and must not be involved with the design, preparation of Contract, or installation of work.

][1.6.9.2 Fire Protection QC Specialist (FPQC)

****

NOTE: Insert the requirement for an FPQC when the project involves the installation or modification of fire protection or life safety systems.

A Schedule of Fire Protection System Inspections prepared by the DOR FPE must be included at the end of this specification section whenever a FPQC is specified. A template for the Schedule of Fire Protection System Inspections can be found on the Whole Building Design Guide (WBDG) website at www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-45-00**. The DOR FPE must edit the template to indicate the inspections and observations required by the FPQC that pertain to the scope of this project.**

****

Provide a Fire Protection Quality Control Specialist (FPQC) within the QC organization to perform quality control related activities as specified herein on fire protection and life safety systems installed under this Contract.

1.6.9.2.1 Qualifications

The FPQC must have the following qualifications:

a. Be a registered Professional Engineer (P.E.) licensed by a Licensing Board in the United States, the District of Columbia, Guam or Puerto Rico, having passed the National Council of Examiners for Engineering and Surveying (NCEES) examination specifically in the discipline of Fire Protection Engineering.

b. Have a minimum of 5 years of Fire Protection Engineering experience on projects of similar relevance and complexity to the fire protection work specified under this Contract.

c. Other than the contractual obligations with the Prime Contractor, the FPQC must have no other business relationship (i.e., employee, owner, partner, operating officer, distributor, salesman, technical representative, family relationship, or financial investment) with the Prime Contractor or subcontractors.

****
NOTE: The following item includes tailoring for DESIGN-BUILD projects.
****

d. Be employed by an independent engineering firm or company or be the Fire Protection Engineer on the Prime Contractor's Design-Build team. The firm may identify multiple, to a maximum of five, licensed Fire Protection Engineers for the performance of the duties under this Contract but must submit the names and qualifications for Government approval for all individuals identified prior to them performing any work under this Contract. These individuals may not be substituted without prior approval from the Contracting Officer.

1.6.9.2.2 Responsibilities

FPQC duties and responsibilities:

a. Assist in the development of the QC Plan including the Testing Plan and Log and executing the three phases of control for work involving the installation and testing of fire protection and life safety systems as an extension of the QC Manager.

b. Participate in project QC Meetings. Participate in Preparatory and Initial Phase meetings and perform and Follow-up inspections for work involving the installation and testing of fire protection and life safety systems.

****
NOTE: The following item includes tailoring for DESIGN-BUILD and DESIGN-BID-BUILD projects.
****

c. Review and certify that all submittals pertaining to fire protection and life safety systems are complete and accurate prior to submission to the Government for surveillance approval. Forward each submittal reviewed by the FPQC to the Government for surveillance within 10 working days of FPQC certification. The FPQC Specialist is responsible for ensuring submittals are complete and accurate and all corrections have been made prior to submission to the Government. The Government reserves the right to reject any submittal that has not first been reviewed and certified by the FPQC and so marked, in writing, attesting to such review and completeness of the submittal.

d. The Government reserves the right to reject any submittal or construction that is not in compliance to Contract. Government reviews do not relieve the Contractor responsibility for providing adequate quality control measures and do not constitute or imply acceptance of Contract variation.

e. Perform construction surveillance in accordance with the Schedule of Fire Protection System Inspections. Construction surveillance includes but is not limited to performing periodic on-site inspections during construction at specified milestones, performing a pre-final inspection of installed systems and witnessing functional testing; and participating and documenting in an on-site final acceptance inspection of fire protection and life safety systems with the Government FPE.

****

NOTE: Select remote inspections only if prior approval is received by the DFPE. Select video/ photographic documentation of inspections when directed to include by the DFPE.
****

f. Document inspection results on a FPQC report prepared each day inspections are performed. The report must include a description of the visual inspection or observation performed, a written summary of findings, a conclusion on compliance with the Contract documents, and signature of the FPQC Specialist.[[In person inspection][and][Remote inspections] must be documented via [video (.mp4)][or][photo (.jpeg)][or both]. Video/photographic documentation must include before and after conditions and physical measurements.] Forward the FPQC daily report to the QC Manager who must include the report with the submission of their daily QC Report to the Government each day. Every site visit by the FPQC must be documented on a FPQC daily report.

1.6.9.2.3 Schedule of Fire Protection System Inspections

A schedule, prepared by the Fire Protection DOR, which lists each of the required visual inspections and observations required by the FPQC. The schedule is included at the end of this UFGS section.

]1.6.9.3 Quality Control (QC) for[Secure Space][Controlled Area][Sound Rated] Perimeter Construction

****
NOTE: This paragraph and subparagraphs are tailored for SECURE SPACE.

Use this paragraph for wall, ceiling, floor, door, window and other utility penetrations required to comply with acoustic separation requirements. Coordinate specifications to provide an acoustically isolated enclosed assembly around the perimeter of the space indicated. Refer to DoD Unified Facilities Criteria (UFC), and "IC Tech Spec - for ICD/ICS 705".

Choose the name of the space in the brackets and coordinate with the drawings; typically use either "Secure Space" or "Controlled Area." Use "sound rated" for spaces that do not have to meet "IC Tech Spec – for ICD/ICS 705". Do not identify spaces as a SCIF or SAPF on Contract documents.

Choose the bracketed option to coordinate inspections with appointed Site Security Manager (SSM) when assemblies are required to meet "IC Tech Spec – for ICD/ICS 705".

Coordinate all specification sections providing a consistent acoustically isolated enclosed assembly meeting the Sound Transmission Class (STC) factory testing requirements specified. Consider coordination with the following sections: Sections 08 31 00 ACCESS DOORS AND PANELS, 08 34 73 SOUND CONTROL DOOR ASSEMBLIES, 08 81 00 GLAZING, 09 29 00

GYPSUM BOARD, as well as any fenestration systems not covered under the preceding sections.

Include options for electronic security systems, man-bar installation, inspection ports, and TEMPEST countermeasures when these elements are included in the project.

****

1.6.9.3.1   Periodic (Follow-Up Phase) Inspections

Once construction begins, perform periodic inspections of[Secure Space][Controlled Area][Sound Rated Area] identified in the Contract drawings at least once every 2 weeks. Increase frequency to weekly inspections within 30 days of planned acceptance testing.[Coordinate periodic inspections with the appointed Government Site Security Manager (SSM) responsible for ensuring the assembly meets the requirements for accreditation.] Inspections must verify that construction and materials comply with the Contract documents, the description of the assembly in the ASTM E90 Factory Report for acoustical testing, and the approved submittals. Focus inspections on the construction of the sound rated assemblies, perimeter penetrations, perimeter doors,[electronic security system,][man-bar installation,][inspection ports,][and TEMPEST countermeasures]. Document periodic inspections in Daily QC Reports.

1.6.9.3.2   Preliminary Inspection

The Government and QC Manager will perform a joint preliminary inspection of the[Secure Space][Controlled Area][Sound Rated Area] after construction of the assembly is complete to verify compliance with the design requirements and other Contract documents. The Contracting Officer[and the appointed Government SSM] will participate in the preliminary inspection. Provide the Contracting Officer a minimum [14][_____] calendar days notification in advance of the preliminary inspection.

As a result of the preliminary inspection, prepare a[Secure Space][Controlled Area][Sound Rated Area] punch list with deficiencies identified. Include with the punch list the estimated date by which the deficiencies will be corrected. Document the preliminary inspection in the Daily QC Report and attach the punch list. Notify the Contacting Officer when deficiencies are corrected. Deficiencies from the Preliminary Inspection must be corrected prior to scheduling the Final Acceptance Inspection.

1.6.9.3.3   Acceptance Testing for Sound Attenuation

****

NOTE: Coordinate requirements in this paragraph with Section 09 29 00 GYPSUM BOARD and Section 08 34 73 SOUND CONTROL DOOR ASSEMBLIES.

****

Perform acceptance testing for sound transmission loss of sound rated door assemblies as required in Section 08 34 73 SOUND CONTROL DOOR ASSEMBLIES and Section 09 29 00 GYPSUM BOARD for sound rated assemblies. Acceptance testing must be performed during the preliminary inspection. The Contracting Officer[and the appointed Government SSM] must witness acceptance testing. Deficiencies identified during acceptance testing must be included in the[Secure Space][Controlled Area][Sound Rated Area] punch list and corrected prior to the final acceptance inspection.

1.6.9.3.4 Acceptance Testing for Electronic Security Systems

****

NOTE: Coordinate requirements in this paragraph with Section 09 29 00 GYPSUM BOARD, Section 08 34 73 SOUND CONTROL DOOR ASSEMBLIES, Section 28 08 10 ELECTRONIC SECURITY SYSTEM ACCEPTANCE TESTING, and Section 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS).

****

Perform acceptance testing for Electronic Security Systems in accordance with Section 28 08 10 ELECTRONIC SECURITY SYSTEM ACCEPTANCE TESTING. Acceptance testing must be performed during the preliminary inspection. The Contracting Officer[and the appointed Government SSM] must witness acceptance testing. Deficiencies identified during acceptance testing must be included in the[Secure Space][Controlled Area][Sound Rated Area] punch list and corrected prior to the Final Inspection.

1.6.9.3.5 Final Inspection

Perform a final inspection of the[Secure Space][Controlled Area][Sound Rated Area] after required testing has been successfully completed as part of the preliminary inspection and all punch list items corrected. Testing is not permitted during the final inspection. QC Manager and Superintendent must attend the final inspection and Government attendees will include the Contracting Officer[and appointed Government SSM]. Request a final inspection by the Contracting Officer a minimum of 14 calendar days in advance.

1.6.10 Special Inspector [and Special Inspector of Record]

****

NOTE: This paragraph is tailored for SPECIAL INSPECTIONS.

This paragraph is required if project involves structural or fire protection.

The Special Inspector of Record is required for the following project conditions:

1) Seismic Design Category D, E or F; and assigned to Risk Cat III, IV or V.

2) Seismic Design Category D, E or F; and with a height greater than 22860 mm 75 feet.

3) Seismic Design Category E, assigned to Risk Category I or II and the building is greater than two stories above grade plane.

4) Nominal design wind speed in excess of 49 m/sec 110 mph; and assigned to Risk Cat III, IV or V.

5) Nominal design wind speed in excess of 49 m/sec 110 mph; and with a height greater than 22860 mm 75 ft.

****

The Special Inspector (SI)[and Special Inspector of Record (SIOR)] must be an independent third party hired directly by the Prime Contractor. The SI[and SIOR] must not be a company employee of the Contractor or any subcontractor performing the work to be inspected. The qualifications of the SI[and SIOR] are defined in Section 01 45 35 SPECIAL INSPECTION.

[1.6.11 Submittal Reviewer[s] Duties and Qualifications

****

NOTE: Edit as appropriate. Select this paragraph along with one of the three options available when submittal reviewers are desired to assist the QC Manager. Consult with the Administering Construction Office on which option to use.

The following paragraph contains tailoring for COMMISSIONING.

****

Provide[a] Submittal Reviewer[s], other than the QC Manager or CxC, qualified in the discipline[s] being reviewed, to review and certify that the submittals meet the requirements of this Contract prior to certification or approval by the QC Manager.

****

NOTE: Select this bracketed phrase for routine projects.

****

[Each submittal must be reviewed by an individual with 10 years of construction experience.
]

****

NOTE: Select this bracketed phrase for large or complex projects.

****

[Each submittal must be reviewed by a registered architect or professional engineer.
]

****

NOTE: Select and edit this bracketed group of phrases and table for projects where[a] submittal reviewer[s] of specific discipline for certain specification sections or submittals are needed.

****

****

NOTE: The following are examples of Submittal Reviewer qualification, duties and experience.

Qualification / Experience in Submittal Discipline	**Submittals to be reviewed:**	
	Spec Section No	**Submittal**
Registered Mechanical Engineer	**Division 22 & 23**	**All**
Registered Structural Fabrication Engineer, (P.E.)	**Section 05 12 00 STRUCTURAL STEEL**	**Drawings Erection Plan**
Certified Industrial Hygienist (CIH)/ Comprehensive practice with 5 years experience in asbestos	**Section 02 82 00 ASBESTOS REMEDIATION**	**Asbestos Hazard Abatement Plan**

****

[Each of the following submittals must be reviewed by[an] individual[s] meeting the qualifications/experience specified below:

Qualification / Experience in Submittal Discipline	Submittals to be reviewed:	
	Section No	Submittal
[_____]	[_____]	[_____]

]]1.7 SUBMITTAL AND DELIVERABLES REVIEW AND APPROVAL

****

NOTE: The following paragraph contains tailoring for COMMISSIONING.

****

Procedures for submission, review and approval of submittals are described in Section 01 33 00 SUBMITTAL PROCEDURES. Procedures must include field verification of relevant dimensions and component characteristics by the QC organization prior to submittal being sent to the Contracting Officer. The CQC organization is responsible for certifying that all submittals and deliverables are in compliance with the Contract. When Section 01 91 00.15 BUILDING COMMISSIONING are included in the Contract, the submittals required by those sections have to be coordinated with Section 01 33 00 SUBMITTAL PROCEDURES to ensure adequate time is allowed for each type of submittal required.

1.8 THREE PHASES OF CONTROL

CQC enables the Contractor to ensure that the construction, including that of subcontractors and suppliers, complies with the requirements of the Contract. At least three phases of control must be conducted by the QC

Manager to adequately cover both on-site and off-site work for each definable feature of the construction work as follows:

1.8.1 Preparatory Phase

****
NOTE: The second paragraph below has tailoring options for COMMISSIONING and SPECIAL INSPECTIONS.
****

Document the results of the preparatory phase actions by separate minutes prepared by the QC Manager and attach to the daily CQC report. Instruct applicable workers as to the acceptable level of workmanship required to meet Contract specifications.

Notify the Contracting Officer at least 2 business days in advance of each preparatory phase meeting. The meeting will be conducted by the QC Manager and attended by[the QC Specialists,] the Project Superintendent, the CxC, the Special Inspector,[the Special Inspector of Record,] and the foreman responsible for the DFOW. When the DFOW will be accomplished by a subcontractor, that subcontractor's foreman must attend the preparatory phase meeting. This phase is performed prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. Perform the following prior to beginning work on each DFOW:

a. Review each paragraph of the applicable specification sections, reference codes, and standards. Make available during the prepatory inspection a copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field. Maintain and make available in the field for use by Government personnel until final acceptance of the work.

b. Review the Contract drawings.

c. Verify that field measurements are as indicated on construction or shop drawings or both before confirming product orders, to minimize waste due to excessive materials.

d. Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required.

e. Review the testing plan and ensure that provisions have been made to provide the required QC testing.

f. Examine the work area to ensure that the required preliminary work has been completed and complies with the Contract and ensure any deficiencies/rework items in the preliminary work have been corrected and confirmed by the Contracting Officer.

g. Review coordination of product/material delivery to designated prepared areas to execute the work.

h. Examine the required materials, equipment and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data and are properly stored.

i. Check to assure that all materials and equipment have been tested, submitted, and approved.

j. Discuss specific controls to be used, construction methods, construction tolerances, workmanship standards, and the approach that will be used to provide quality construction by planning ahead and identifying potential problems for each DFOW. Ensure any portion of the plan requiring separate Contracting Officer acceptance has been approved.

k. Review the APP and appropriate Activity Hazard Analysis (AHA) to ensure that applicable safety requirements are met, and that required Safety Data Sheets (SDS) are submitted.

****

NOTE: The following item is tailored for COMMISSIONING.

****

l. Review the Cx requirements in accordance with Section 01 91 00.15 BUILDING COMMISSIONING and ensure all preliminary work items have been completed and documented.

****

NOTE: The following items are tailored for ARMY.

****

m. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.

n. Discuss schedule and execution of the initial control phase and confirmation or construction quality compliance.

****

NOTE: The following item is tailored for SPECIAL INSPECTIONS.

****

o. Review Special Inspections required by Section 01 45 35 SPECIAL INSPECTION, the Statement of Special Inspections and the Schedule of Special Inspections.

1.8.2 Initial Phase

****

NOTE: The following paragraph contains tailoring options for SPECIAL INSPECTIONS.

****

Notify the Contracting Officer at least 2 business days in advance of each initial phase. When construction crews are ready to start work on a DFOW, conduct the initial phase with[the QC Specialists,] the Project Superintendent, the Special Inspector,[the Special Inspector of Record,] and the foreman responsible for that DFOW. Observe the initial segment of the DFOW to ensure that the work complies with Contract requirements. Document the results of the initial phase in the[daily CQC Report and in the] Initial Phase Checklist. Repeat the initial phase for each new crew to work on-site when acceptable levels of specified quality are not being met. Indicate the exact location of initial phase for definable feature of work for future reference and comparison with follow-up phases. Perform the following for each DFOW:

a. Check work to ensure that it is in full compliance with Contract requirements. Review minutes of the preparatory meeting.

b. Verify adequacy of controls to ensure full Contract compliance. Verify required control inspection and testing comply with the Contract.

c. Establish level of workmanship and verify that it meets the minimum acceptable workmanship standards. Compare with required sample panels as appropriate.

d. Resolve any workmanship issues.

e. Ensure that testing is performed by the approved laboratory.

f. Check work procedures for compliance with the APP and the appropriate AHA to ensure that applicable safety requirements are met.

****

NOTE: The following item contains tailoring for COMMISSIONING.

****

g. Review project specific work plans (i.e., Cx, HAZMAT Abatement, Stormwater Management) to ensure all preparatory work items have been completed and documented.

****

NOTE: The following item is tailored for SPECIAL INSPECTIONS.

****

h. Coordinate scheduled work with Special Inspections required by Section 01 45 35 SPECIAL INSPECTIONS, the Statement of Special Inspections and the Schedule of Special Inspections.

1.8.3 Follow-Up Phase

****

NOTE: Include tailored Cx line item when Commissioning Provider is a subcontractor to the Construction Contractor.

****

Perform the following for on-going DFOW daily, or more frequently as necessary, until the completion of each DFOW. The Final Follow-Up for any DFOW will clearly note in the daily report the DFOW is completed, and all deficiencies/rework items have been completed in accordance with the paragraph DEFICIENCY/REWORK ITEMS LIST. Each DFOW that has completed the Initial Phase and has not completed the Final Follow-up must be included on each daily report. If no work was performed on that DFOW for the period of that daily report, it must be so noted. Document all Follow-Up activities for DFOWs in the daily CQC Report:

a. Ensure the work including control testing complies with Contract requirements until completion of that particular work feature. Record checks in the CQC documentation.

b. Maintain the quality of workmanship required.

c. Ensure that testing is performed by the approved laboratory.

d. Ensure that deficiencies/rework items are being corrected. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of work which may be affected by the deficient work.

e. Do not build upon nor conceal non-conforming work.

f. Assure manufacturers' representatives have performed necessary inspections if required and perform safety inspections.

****

NOTE: The following item is tailored for COMMISSIONING.

****

g. Review the Cx requirements in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

****

NOTE: The following item is tailored for SPECIAL INSPECTIONS.

****

h. Coordinate scheduled work with Special Inspections required by Section 01 45 35 SPECIAL INSPECTIONS, the Statement of Special Inspections and the Schedule of Special Inspections.

1.8.4 Additional Preparatory and Initial Phases

Conduct additional preparatory and initial phases on the same DFOW if the quality of on-going work is unacceptable, if there are changes in the applicable QC organization, if there are changes in the on-site production supervision or work crew, if work on a DFOW has not started within 45 days of the initial preparatory meeting or has resumed after 45 days of inactivity, or if other problems develop.

1.8.5 Notification of Three Phases of Control for Off-Site Work

Notify the Contracting Officer at least 2 weeks prior to the start of the preparatory and initial phases.

1.8.6 Deficiency/Rework Items List

The QC Manager must maintain a list of work that does not comply with the Contract, identifying what items need to be corrected, the activity ID number associated with the item, the date the item was originally discovered, the date the item will be corrected by, and the date the item was corrected.

The QC Manager reviews the list at each weekly QC Meeting:

a. There is no requirement to report a deficiency/rework item that is corrected the same day it is discovered.

b. No successor task may be advanced beyond the preparatory phase meeting until all deficiencies/rework items have been cleared by the QC Manager and concurred with by the Contracting Officer. This must be confirmed as part of the Preparatory Phase activities.

c. Attach a copy of the "Deficiency/Rework Items List" to the last daily CQC Report of each month.

d. The Contractor is responsible for including those items identified by the Contracting Officer.

e. All deficiencies/rework items must be confirmed as corrected by the QC Manager, and concurred by the Contracting Officer, prior to commencement of any completion inspections per paragraph COMPLETION INSPECTIONS unless specifically exempted by the Contracting Officer.

****

NOTE: The following item has tailoring for DESIGN-BUILD.

****

f. Non-Compliance with these requirements is grounds for removal in accordance with paragraph ACCEPTANCE OF THE QUALITY CONTROL (QC) and DESIGN QUALITY CONTROL (DQC) PLAN.

g. All delays, concurrent or related to failure to manage, monitor, control, and correct deficiencies/rework items are entirely the responsibility of the Contractor and can not be made the subject, or any component of any request for additional time or compensation.

1.9 TESTING

****

NOTE: For Navy projects, a check must be made to ensure that all required field and factory tests are listed in each technical section. Use of accredited laboratories overseas, when available, will be implemented at the discretion of the Contracting Officer. Edit the following paragraphs accordingly.

****

Perform specified or required tests to verify that control measures are adequate to provide a product which conforms to Contract requirements. Upon request, furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and acceptance tests when specified. Procure the services of an U.S. Army Corps of Engineers approved testing laboratory or establish an approved testing laboratory at the project site or within [_____] miles. Perform the following activities and record and provide the following data:

a. Verify that testing procedures comply with Contract requirements.

b. Verify that facilities and testing equipment are available and comply with testing standards.

c. Check test instrument calibration data against certified standards.

d. Verify that recording forms and test identification control number system, including all test documentation requirements, have been prepared.

e. Record results of all tests taken, both passing and failing on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test. If approved by the Contracting Officer, actual test reports are submitted later with a reference to the test number and date taken. Provide an information copy of tests performed by an offsite or commercial test facility directly to the Contracting Officer. Failure to submit timely test reports as stated results in nonpayment for related work performed and disapproval of the test facility for this Contract.

1.9.1 Accreditation Requirements

****

NOTE: This paragraph is tailored for NAVY.

****

Construction materials testing laboratories must be accredited by a laboratory accreditation authority and must submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards (ASTM E329, ASTM C1077, ASTM D3666, ASTM D3740, ASTM E543) listed in the technical sections of the specifications. Laboratories engaged in Hazardous Materials Testing must meet the requirements of OSHA and EPA. The policy applies to the specific laboratory performing the actual testing, not just the Corporate Office.

1.9.2 Laboratory Accreditation Authorities

****

NOTE: The following paragraph is tailored for ARMY.

****

All testing laboratories must be validated by the USACE Material Testing Center (MTC) for the tests to be performed. Information on the USACE MTC with web-links to both a list of validated testing laboratories and for the laboratory inspection request for can be found at: https://mtc.erdc.dren.mil

****

NOTE: Request for listing additional laboratory accreditation programs must be submitted to NAVFACENGCOM EOC/OCR through the Design Manager (DM) of the project.

The following paragraph is tailored for NAVY.

****

Laboratory Accreditation Authorities include the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National Institute of Standards and Technology at https://www.nist.gov/nvlap, the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program at http://www.aashtoresource.org/aap/overview, International Accreditation Services, Inc. (IAS) at https://www.iasonline.org/, U.S. Army Corps of Engineers Materials Testing Center (MTC) at https://www.erdc.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/476661/materials-testing-center/, the American Association for Laboratory Accreditation (A2LA) program at https://a2la.org/, the Washington Association of Building Officials (WABO) at https://www.wabo.org/ (Approval authority for WABO is limited to projects within Washington State), and the Washington Area Council of Engineering Laboratories (WACEL) at https://www.wacel.org/lab-accreditation-and-inspection-agency-audit-programs/laboratory-accreditation-program/(Approval authority by WACEL is limited to projects within Facilities Engineering Command (FEC) Washington geographical area).

1.9.3 Capability Check

The Contracting Officer retains the right to check laboratory equipment in the proposed laboratory and the laboratory technician's testing procedures, techniques, and other items pertinent to testing, for compliance with the standards set forth in this Contract. Laboratories utilized for testing soils, concrete, asphalt, and steel must meet criteria detailed in ASTM D3740 and ASTM E329.

1.9.3.1 Capability Recheck

****

NOTE: The following paragraph is tailored for ARMY.

****

If the selected laboratory fails the capability check, the Contractor will be assessed a charge of [_____] to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the Contract amount due the Contractor.

1.9.3.2 Onsite Laboratory

****

NOTE: The following paragraph is tailored for ARMY.

****

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

1.9.4 Test Results

****

NOTE: The following paragraph has tailoring for NAVY.

****

Cite applicable Contract requirements, tests or analytical procedures used. Provide actual results and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, notify the Contracting Officer immediately. Conspicuously stamp the cover sheet for each report in large red letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements, whichever is applicable. Test results must be signed by a testing laboratory representative authorized to sign certified test reports. Furnish the signed reports, certifications, and other documentation to the Contracting Officer via the QC Manager. Furnish a summary report of field tests at the end of each month, in accordance with paragraph DOCUMENTATION

AND INFORMATION FOR THE CONTRACTING OFFICER.

1.9.5 Test Reports and Monthly Summary Report of Tests

****

NOTE: The following paragraph is tailored for NAVY.

****

Furnish the signed reports, certifications, and a summary report of field tests at the end of each month to the Contracting Officer. Attach a copy of the summary report to the last daily CQC Report of each month.[Provide a copy of the signed test reports and certifications to the Operation and Maintenance Support Information (OMSI) preparer for inclusion into the OMSI documentation, in accordance with Sections 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW).]

1.10 COMPLETION INSPECTIONS

1.10.1 Punch-Out Inspection

Near the completion of all work or any increment thereof, established by a completion time stated in the Contract Clause entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the QC Manager must conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved drawings, specifications, and Contract. Include in the punch list any remaining items on the "Deficiency/Rework Items List", that were not corrected prior to the Punch-Out Inspection as approved by the Contracting Officer in accordance with the paragraph DEFICIENCY/REWORK ITEMS LIST. Include within the punch list the estimated date by which the deficiencies will be corrected. Provide a copy of the punch list to the Contracting Officer.

The QC Manager, or staff, must make follow-on inspections to ascertain that all deficiencies have been corrected. All punch list items must be confirmed as corrected by the QC Manager and concurred by the Contracting Officer. Once this is accomplished, notify the Government that the facility is ready for the Government "Pre-Final Inspection".

1.10.2 Pre-Final Inspection

The Government and QC Manager will perform this inspection to verify that the facility is complete and ready to be occupied. A Government "Pre-Final Punch List" will be documented by the QC Manager as a result of this inspection. The QC Manager will ensure that all items on this list are corrected and concurred by the Contracting Officer prior to notifying the Government that a "Final" inspection with the Client can be scheduled. All items noted on the "Pre-Final" inspection must be corrected and concurred by the Contracting Officer in a timely manner and be accomplished before the Contract completion date for the work, or any increment thereof, if the project is divided into increments by separate completion dates unless exceptions are directed by the Contracting Officer.

1.10.3 Final Acceptance Inspection

Notify the Contracting Officer at least 14 calendar days prior to the date a final acceptance inspection can be held. State within the notice that all items previously identified on the pre-final punch list will be corrected and acceptable, along with any other unfinished Contract work, by the date of the final acceptance inspection. The Contractor must be represented by the QC Manager, the Project Superintendent, and others deemed necessary. Attendees for the Government will include the Contracting Officer, other Government QA personnel, and personnel representing the Client. Failure of the Contractor to have all Contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the Contract Clause entitled "Inspection of Construction."

1.11 QUALITY CONTROL (QC) CERTIFICATIONS

1.11.1 Contractor Quality Control (CQC) Report Certification

Contain the following statement within the CQC Report: "On behalf of the Contractor, I certify that this report is complete and correct and equipment and material used, and work performed during this reporting period is in compliance with the Contract drawings and specifications to the best of my knowledge, except as noted in this report."

1.11.2 Completion Certification

Upon completion of work under this Contract, the QC Manager must furnish a certificate to the Contracting Officer attesting that "the work has been completed, inspected, tested and is in compliance with the Contract." Provide a copy of this final QC Certification for completion to the preparer of the Operation & Maintenance (O&M) documentation.

1.11.3 Invoice Certification

****

NOTE: The following paragraph is tailored for NAVY.

****

Furnish a certificate to the Contracting Officer with each payment request, signed by the QC Manager, attesting that as-built drawings are current, coordinated and attesting that the work for which payment is requested, including stored material, complies with Contract requirements.

1.12 DOCUMENTATION AND INFORMATION FOR THE CONTRACTING OFFICER

****

NOTE: The following paragraphs are tailored for ARMY.

****

Maintain current and complete records of on-site and off-site QC program operations and activities.

****

NOTE: List enclosed forms. Sample forms are not a part of this guide specification and should be provided by the specifier.

****

Contact the Contracting Officer for sample forms or print from RMS-QCS as needed. Prior to commencing work on construction, the Contractor must obtain a copy set of the current report forms. The report forms will consist of the Contractor Quality Control (CQC) Report, CQC Report (Continuation Sheet), Contractor Production Report, Contractor Production

Report (Continuation Sheet), Preparatory Phase Checklist, Initial Phase Checklist, Testing Plan and Log, and Rework Items List. Unless otherwise provided by the Contracting Officer, Contractor may use the forms provided as related material located at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-45-00.

1.12.1 Construction Documentation

Reports are required for each day that work is performed and must be attached to the Contractor Quality Control Report prepared for the same day. Maintain current and complete records of on-site and off-site QC program operations and activities. Reports are required for each day work is performed. Account for each calendar day throughout the life of the Contract.

The Project Superintendent and the QC Manager must prepare and sign the Contractor Production and CQC Reports, respectively. Every space on the forms must be filled in. Use N/A if nothing can be reported in one of the spaces. The reporting of work must be identified by terminology consistent with the construction schedule. In the "Remarks" sections of the reports, enter pertinent information including directions received, problems encountered during construction, work progress and delays, conflicts or errors in the drawings or specifications, field changes, safety hazards encountered, instructions given and corrective actions taken, delays encountered, a record of visitors to the work site, quality control problem areas, deviations from the QC Plan, construction deficiencies encountered, and meetings held. For each entry in the report(s), identify the Schedule Activity No. that is associated with the entered remark.

1.12.2 Quality Control Activities

CQC and Contractor Production reports will be prepared daily to maintain current records providing factual evidence that required quality control activities and tests have been performed. Include in these records the work of subcontractors and suppliers on an acceptable form that includes, as a minimum, the following information:

a. The name and area of responsibility of the Contractors and any subcontractors.

b. Operating plant/equipment with hours worked, idle, or down for repair.

c. Work performed each day, giving location, description, and by whom. When a Network Analysis Schedule (NAS) is used, identify each item of work performed each day by NAS activity number.

d. Control phase activities performed. Preparatory, and Initial phase Checklists associated with the DFOW referenced to the construction schedule. Follow-up phase activities identified to the DFOW. If testing or specific QC Specialist activities are associated with the Follow-up phase activities for a specific DFOW note this and include those reports.

e. Test and control activities performed with results and references to specifications and drawings requirements. Identify the control phase (Preparatory, Initial, Follow-up). List of deficiencies noted, along with corrective action in accordance with the paragraph DEFICIENCY/REWORK ITEMS LIST.

f. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications and drawings requirements.

g. Submittals and deliverables reviewed, with Contract reference, by whom, and action taken.

h. Offsite surveillance activities, including actions taken.

i. Job safety evaluations stating what was checked, results, and instructions or corrective actions.

j. Instructions given/received and conflicts in plans and specifications.

****

NOTE: The following item is tailored for DESIGN-BUILD and has tailoring options for ARMY and NAVY.

****

k. Provide documentation of design quality control activities. For independent design reviews, provide, as a minimum, identification of the [Independent Technical Review (ITR)][Agency Technical Review (ATR)] Design Quality Control Review team and their review comments, responses and the record of resolution of the comments.

1.12.3 Verification Statement

Indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. Cover both conforming and deficient features and include a statement that equipment and materials incorporated in the work and workmanship comply with the Contract.

Furnish the original and one copy of these records in report form to the Government by 10:00 AM the next working day after the date covered by the report. As a minimum, prepare and submit one report for every 7 days of no work and on the last day of a no work period. All calendar days need to be accounted for throughout the life of the Contract. The first report following a day of no work will be for that day only. Reports need to be signed and dated by the QC Manager. Include copies of test reports and copies of reports prepared by all subordinate quality control personnel within the QC Manager Report.

[1.12.4 Reports from the Quality Control (QC) Specialist(s)

****

NOTE: Delete the requirement for the QC Specialist when QC Specialists are not specified.

****

Document inspection results on a QC specialist report prepared each day work is performed in their area of responsibility. The report must include a description of the visual inspection or observation performed, a written summary of findings, a conclusion on compliance with the Contract documents, and signature of the QC Specialist. In person inspections must be documented with Video/photographs. Video/photographic documentation of deficiencies must include before and after conditions and physical measurements, as necessary. Forward the QC daily report to the QC Manager who must include the report with the submission of their daily QC Report to the Government each day. Every site visit by the QC Specialist must be documented on a QC Specialist daily report.

]1.12.5 Quality Control Validation

Establish and maintain the following in an electronic folder. Divide folder into a series of tabbed sections as shown below. Ensure folder is updated at each required progress meeting.

a. CQC Meeting minutes in accordance with paragraph QUALITY CONTROL (QC) MEETINGS.

b. All completed Preparatory and Initial Phase Checklists, arranged by specification section, further sorted by DFOW referenced to the construction schedule. Submit each individual Phase Checklist the day the phase event occurs as part of the CQC daily report.

c. All milestone inspections, arranged by Activity Number referenced to the construction schedule.

****

NOTE: The following item has tailoring options for NAVY.

****

d. An up-to-date copy of the Testing Plan and Log with supporting field test reports, arranged by specification section referenced to the DFOW to which individual reports results are associated. Individual field test reports will be submitted within 2 working days after the test is performed in accordance with the paragraph QUALITY CONTROL ACTIVITIES. Monthly Summary Report of Tests:[Submit the report as an electronic attachment to the CQC Report at the end of each month.][Mail or hand-carry the original attached to the last QC Report of the month.]

e. Copies of all Contract modifications, arranged in numerical order. Also include documentation that modified work was accomplished.

f. An up-to-date copy of the paragraph DEFICIENCY/REWORK ITEMS LIST.

****

NOTE: The following item is tailored for COMMISSIONING.

****

g. Cx documentation in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

****

NOTE: The following item is tailored for SPECIAL INSPECTIONS.

****

h. [g][h]. Special Inspection reports.

i. [g][h][i]. Upon commencement of Completion Inspections of the entire project or any defined portion, maintain up-to-date copies of all punch lists issued by the QC staff to the Contractor and subcontractors and all punch lists issued by the Government in accordance with the paragraph COMPLETION INSPECTIONS.

1.12.6 Testing Plan and Log

****

NOTE: The following paragraph has tailoring for COMMISSIONING.

****

As tests are performed, the CxC and the QC Manager will record on the "Testing Plan and Log" the date the test was performed and the date the test results were forwarded to the Contracting Officer. Attach a copy of the updated "Testing Plan and Log" to the last daily CQC Report of each month. Provide a copy of the final "Testing Plan and Log" to the preparer of the Operation & Maintenance (O&M) documentation.

1.12.7 As-Built Drawings

The QC Manager must ensure the as-built drawings, required by Section 01 78 00 CLOSEOUT SUBMITTALS are kept current on a daily basis and marked to show deviations which have been made from the Contract drawings. The as-built drawings document commences with the QC Manager ensuring all amendments, or changes to the Contract prior to Contract award are accurately noted in the initial document set creating the accurate baseline of the Contract prior to any work starting. Ensure each deviation has been identified with the appropriate modifying documentation (e.g., PC No., Modification No., Request for Information No.). The QC Manager[or QC Specialist assigned to an area of responsibility] must initial each revision. Upon completion of work, the QC Manager will furnish a certificate attesting to the accuracy of the as-built drawings prior to submission to the Contracting Officer.

1.13 NOTIFICATION ON NON-COMPLIANCE

The Contracting Officer will notify the Contractor of any detected non-compliance with the Contract. Take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, is deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders will be made the subject of a claim for extension of time for excess costs or damages by the Contractor.

1.14 DELIVERY, STORAGE, AND HANDLING

Designate receiving/storage areas for incoming material to be delivered according to installation schedule and to be placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. Store and handle materials in a manner as to prevent loss from weather and other damage. Keep materials, products, and accessories covered and off the ground, and store in a dry, secure area. Prevent contact with material that may cause corrosion, discoloration, or staining. Protect all materials and installations from damage by the activities of other trades.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 45 00.15 10 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-01 45 00.10 10 (November 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 45 00.15 10

RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM)

11/23

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-01 45 00.15 10 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-01 45 00.10 10 (November 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 45 00.15 10

RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM)

11/23

****

NOTE: This guide specification covers the requirements for use of the Resident Management System (RMS) for contract monitoring and administration.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This section contains tailoring options for DESIGN-BUILD.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 MEASUREMENT AND PAYMENT

The work of this section is not measured for payment. The Contractor is responsible for the work of this section, without any direct compensation other than the payment received for contract items.

1.3 CONTRACT ADMINISTRATION

****

NOTE: The clauses and sections listed below are closely related to this section and must be coordinated with this section. These clauses and sections should reference this Section whenever appropriate and necessary to require use of QCS by the Contractor.

- **Contract Clause, Schedules for Construction - Contracts**
- **Contract Clause, Payments**
- **Section 01 32 01.00 10 PROJECT SCHEDULE**
- **Section 01 33 00 SUBMITTAL PROCEDURES**
- **Section 01 45 00 QUALITY CONTROL**

****

The Government will use the Resident Management System (RMS) to assist in its monitoring and administration of this contract. The Government accesses the system using the Government Mode of RMS (RMS GM) and the Contractor accesses the system using the Contractor Mode (RMS CM). The term RMS will be used in the remainder of this section for both RMS GM and RMS CM. The joint Government-Contractor use of RMS facilitates electronic exchange of information and overall management of the contract. The Contractor accesses RMS to record, maintain, input, track, and electronically share information with the Government throughout the contract period in the following areas:

Administration
Finances
Quality Control
Submittal Monitoring
Scheduling
Closeout
Import/Export of Data

1.3.1 Correspondence and Electronic Communications

For ease and speed of communications, exchange correspondence and other documents in electronic format to the maximum extent feasible.[Some documents[such as correspondence, including pay requests and payrolls,] may be required in paper format with original signatures. Paper documents will govern in the event of discrepancy with the electronic version. Contracting Officer will determine which documents require submission of paper copies.]

1.3.2 Other Factors

Other portions of this document have a direct relationship to the reporting accomplished through RMS. Particular attention is directed to FAR 52.236-15 Schedules for Construction Contracts; FAR 52.232-27 Prompt Payment for Construction Contracts; FAR 52.232-5 Payments Under Fixed-Priced Construction Contracts; Section 01 32 01.00 10 PROJECT SCHEDULE; Section 01 33 00 SUBMITTAL PROCEDURES; Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS; and Section 01 45 00 QUALITY CONTROL.

1.4 RMS SOFTWARE

RMS is a web based application. Download, install and be able to utilize the latest version of RMS within 7 calendar days of receipt of the Notice to Proceed. RMS software, user manuals, access and installation instructions, program updates and training information are available from the RMS website (https://rms.usace.army.mil). The Government and the Contractor will have different access authorities to the same contract database through RMS. The common database will be updated automatically each time a user finalizes an entry or change.

1.5 CONTRACT DATABASE - GOVERNMENT

The Government will enter the basic contract award data in RMS prior to granting the Contractor access. The Government entries into RMS will generally be related to submittal reviews, correspondence status, and Quality Assurance(QA)comments, as well as other miscellaneous administrative information.

1.6 CONTRACT DATABASE - CONTRACTOR

Contractor entries into RMS establish, maintain, and update data throughout the duration of the contract. Contractor entries generally include prime and subcontractor information, daily reports, submittals, RFI's, schedule updates and payment requests. RMS includes the ability to import attachments and export reports in many of the modules, including submittals. The Contractor responsibilities for entries in RMS typically include the following items:

1.6.1 Administration

1.6.1.1 Contractor Information

Enter all current Contractor administrative data and information into RMS within 7 calendar days of receiving access to the contract in RMS. This includes, but is not limited to, Contractor's name, address, telephone numbers, management staff, and other required items.

1.6.1.2 Subcontractor Information

Enter all missing subcontractor administrative data and information into RMS CM within seven calendar days of receiving access to the Contract in RMS or within seven calendar days of the signing of the subcontractor agreement for agreements signed at a later date. This includes name, trade, address, phone numbers, and other required information for all subcontractors. A subcontractor is listed separately for each trade to be performed.

1.6.1.3 Correspondence

Identify all Contractor correspondence to the Government with a serial number. Prefix correspondence initiated by the Contractor's site office with "S". Prefix letters initiated by the Contractor's home (main) office with "H". Letters are numbered starting from 0001. (e.g., H-0001 or S-0001). The Government's letters to the Contractor will be prefixed with "C" or "RFP".

1.6.1.4 Equipment

Enter and maintain a current list of equipment planned for use or being used on the jobsite, including the most recent and planned equipment inspection dates in accordance with Section 01 45 00 QUALITY CONTROL.

1.6.1.5 Reports

Track the status of the project using the reports available in RMS. The value of these reports reflects the quality of the data input. These reports include but are not limited to the Progress Payment Request worksheet, Quality Control (QC) comments, Deficiency Tracking Log, Submittal Register Status, and Three-Phase Control worksheets in accordance with Sections 01 20 00 PRICE AND PAYMENT PROCEDURES, Section 01 32 01.00 10 PROJECT SCHEDULE, 01 33 00 SUBMITTAL PROCEDURES, and 01 45 00 QUALITY CONTROL.

1.6.1.6 Request For Information (RFI)

Create and track all Requests For Information (RFI) in the RMS Administration Module for Government review and response. Provide status at weekly progress meeting in accordance with Section 01 32 01.00 10 PROJECT SCHEDULE.

1.6.2 Finances

1.6.2.1 Pay Activity Data

Develop and enter a list of pay activities in conjunction with the project schedule in accordance with Section 01 32 01.00 10 PROJECT SCHEDULE. The sum of pay activities equals the total Contract amount, including modifications. Each pay activity must be assigned to a Contract Line Item Number (CLIN). The sum of the activities assigned to a CLIN equals the amount of each CLIN.

1.6.2.2 Payment Requests

Prepare all progress payment requests using RMS. Update the work completed under the Contract at least monthly, measured as percent or as specific quantities. After the update, generate a payment request and prompt payment certification using RMS. Submit the signed prompt payment certification and payment request as well as supporting data, either electronically or by hard copy.

1.6.3 Quality Control (QC)

Enter and track implementation of the 3-phase QC Control System, QC testing, transferred and installed property and warranties in RMS. Link each deficiency and QC test to a pay activity. Prepare daily reports, identify and track deficiencies, document progress of work, and support other Contractor QC requirements in RMS. Maintain all data on a daily basis. Ensure that RMS reflects all quality control methods, tests and actions contained within the Contractor Quality Control (CQC) Plan and Government review comments. Provide within seven calendar days of Government acceptance of the CQC Plan.

1.6.3.1 Quality Control (QC) Reports

The Contractor's Quality Control (QC) Daily Report in RMS is the official report. The Contractor can use other supplemental formats to record QC data, but information from any supplemental formats are to be consolidated and entered into the RMS QC Daily Report. Any supplemental information may be entered into RMS as an attachment to the report. QC Daily Reports must be finalized and signed in RMS within 24 hours after the date covered by the report.[Provide the Government a printed signed copy of the QC Daily Report, unless waived by the Contracting Officer.]

1.6.3.2 Deficiency Tracking

Use the QC Daily Report Module to enter and track deficiencies. Deficiencies identified and entered into RMS by the Contractor or the Government will be sequentially numbered with a QC or QA prefix for tracking purposes. Enter each deficiency into RMS the same day that the deficiency is identified. Monitor, track and resolve all QC and QA entered deficiencies. A deficiency is not considered to be corrected until the Government indicates concurrence in RMS.

1.6.3.3 Three-Phase Control Meetings

Maintain scheduled and actual dates and times of preparatory and initial control meetings in RMS, and upload meeting minutes of the meetings. Worksheets for the three-phase control meetings are generated within RMS.

1.6.3.4 Labor and Equipment Hours

Enter labor and equipment exposure hours on a daily basis. Roll up the labor and equipment exposure data into a monthly exposure report.

1.6.3.5 Accident/Safety Reporting

Both the Contractor and the Government enter safety related comments in RMS as a deficiency. The Contractor must monitor, track and show resolution for safety issues in the QC Daily Report area of the RMS QC Module. In addition, follow all reporting requirements for accidents and incidents as required in EM 385-1-1, Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and as required by any other applicable Federal, State or local agencies.

1.6.3.6 Definable Features of Work

Enter each feature of work, as defined in the approved CQC Plan, into the RMS QC Module. A feature of work may be associated with a single or multiple pay activities, however a pay activity is only to be linked to a single feature of work.

1.6.3.7 Activity Hazard Analysis

Import activity hazard analysis electronic document files into the RMS QC Module utilizing the document package manager. Prepare activity hazard analysis in accordance with Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS.

1.6.4 Submittal Management

Enter all current submittal register data and information into [RMS within seven calendar days of receiving access to the Contract in RMS][within the time frame directed by the Contracting Officer].[Contractor is responsible for entering Activity Numbers for each submittal item corresponding to their Schedule.][The Contractor will import the information shown in the submittal register following the specification Section 01 33 00 SUBMITTAL PROCEDURES unless otherwise directed by the Contracting Officer.] Group electronic submittal documents into transmittal packages to send to the Government, except very large electronic files, samples, spare parts, mock ups, color boards, or where hard copies are specifically required. Track transmittals and update the submittal register in RMS on a daily basis throughout the duration of the Contract.[Submit hard copies of all submittals unless waived by the Contracting Officer.]

****

NOTE: The following paragraph is tailored for DESIGN-BUILD.

****

Enter all submittals as listed in the approved design's submittal register within [14][30] calendar days of design approval for construction.

Contractor may request submittals to be added to RMS throughout the lifecycle of the project. Approval/disapproval of Contractor requests is at the discretion of the Contracting Officer. Submittals entry into RMS must be updated daily or as practical for performance of the Contract, as approved by the Contracting Officer.

1.6.5 Schedule

****

NOTE: If the contract requires a schedule, use Section 01 32 01.00 10 PROJECT SCHEDULE; if not, use

the Contract clause.
****

Enter and update the contract project schedule in RMS by either manually entering all schedule data or by importing the Standard Data Exchange Format (SDEF) file, based on the requirements in Section 01 32 01.00 10 PROJECT SCHEDULE.

1.6.6 Closeout

Closeout documents, processes and forms are managed and tracked in RMS by both the Contractor and the Government. Ensure that all closeout documents are entered, completed and documented within RMS.

1.7 IMPLEMENTATION

Use of RMS as described in the preceding paragraphs is mandatory. Ensure that sufficient resources are available to maintain contract data within the RMS system. RMS is an integral part of the Contractor's required management of quality control.

1.8 NOTIFICATION OF NONCOMPLIANCE

Take corrective action within seven calendar days after receipt of notice of RMS non-compliance by the Contracting Officer.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-01 45 35 (May 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 45 35 (November 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 45 35

SPECIAL INSPECTIONS

05/24

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-01 45 35 (May 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 45 35 (November 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 01 45 35

SPECIAL INSPECTIONS
05/24

****

NOTE: This guide specification covers the requirements for special inspections where required by UFC 3-301-01.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification includes tailoring for DESIGN-BID-BUILD, DESIGN-BUILD, ARMY and NAVY projects. Where an Editor's Note states a paragraph is tailored for a Service or project type, the content of the paragraph, or a portion of the paragraph, is suited specifically to be included only for that Service or project type.

****

PART 1 GENERAL

****

NOTE: This guide specification is applicable to both new structures and rehabilitation of existing structures designed according to UFC 3-301-01

STRUCTURAL ENGINEERING.

In addition to the required Special Inspections, a registered design professional must perform "structural observations" during construction where required by UFC 3-301-01 or UFC 3-301-02. All observed deficiencies will be immediately reported to the Contracting Officer. The registered design professional performing these observations must be a representative of the Structural Engineer of Record (SER) for the structure being constructed.

Structural observations are required for the following project conditions according to the relevant UFCs and ICC IBC Chapter 17:

1) The structure is classified as Risk Category III, IV, or V in accordance with Table 2-2 of UFC 3-301-01.

2) The structure is a high-rise building, which is defined in the 2024 IBC as a building with an occupied floor or occupied roof located more than 22860 mm 75 feet above the lowest level of fire department vehicle access.

3) The structure is assigned to Seismic Design Category E, and is greater than two stories above the grade plane.

4) Where specifically required by the Engineer of Record responsible for the structural design. This is recommended for large-magnitude or critical projects where additional quality control is warranted.

5) Where specifically required by the Authority Having Jurisdiction.

For Design-Build projects, the Structural Engineer on the Prime Contractor's Design Team will serve as the Structural Engineer of Record (SER) and provide Structural Observations. For Design-Bid-Build projects, the Structural Engineer of Record (SER) of the project or a representative of the SER will perform the Structural Observations.

Special Inspections are minimum Quality Assurance requirements that are in addition to Structural Observations and Contractor Quality Control requirements defined in Section 01 45 00 QUALITY CONTROL.

The requirements for Special Inspections, the special inspector, and related testing will be used where required by UFC 3-301-01 and UFC 4-023-03.
****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military Assets

1.2 GENERAL REQUIREMENTS

Perform Special Inspections in accordance with the Statement of Special Inspections, Schedule of Special Inspections, Chapter 17 of ICC IBC, and UFC 3-301-01. The Statement of Special Inspections and Schedule of Special Inspections are included as an attachment to this specification. Special Inspections are to be performed by an independent third party and are intended to ensure that the work of the Prime Contractor is in accordance with the Contract Documents and applicable building codes. Special inspections do not take the place of the three phases of control inspections performed by the Contractor's QC Manager or any testing and inspections required by other sections of the specifications.

[Structural observations will be performed by the Structural Engineer of Record (SER). The Contractor must provide notification to the Contracting Officer and Structural Engineer of Record (SER) 14 days prior to the following points of construction to allow for structural observation:

****

NOTE: Define the points in construction that structural observations need to occur.

****

a. [_____]

b. [_____]

c. [_____]

]1.3 DEFINITIONS

1.3.1 Continuous Special Inspections

Continuous Special Inspections is the constant monitoring of specific tasks by a special inspector. These inspections must be carried out continuously over the duration of the particular tasks.

1.3.2 Perform

Perform these tasks for each weld, fastener or bolted connection, and noted required verification.

1.3.3 Observe

Observe these items randomly during the course of each work day to insure that applicable requirements are being met. Observe these Special Inspections items on a periodic daily basis. Operations need not be delayed pending these inspections.

1.3.4 Special Inspector (SI)

A qualified person retained by the Contractor and approved by the Contracting Officer as having the competence necessary to inspect a particular type of construction requiring Special Inspections. The SI must be an independent third party hired directly by the Prime Contractor.

1.3.5 Associate Special Inspector (ASI)

A qualified person who assists the SI in performing Special Inspections but who must perform inspection under the direct supervision of the SI and who cannot perform inspections without the SI on site.

1.3.6 Third Party

A Special inspector must not be an employee of the Contractor or of any Sub-Contractor performing the work to be inspected.

[1.3.7 Special Inspector of Record (SIOR)

****

NOTE: The Special Inspector of Record is required for the following project conditions in accordance

with UFC 3-301-01:

1) The structure is classified as a Risk Category III, IV, or V.

2) The structure is a high-rise building, which is defined in the 2024 IBC as a building with an occupied floor or occupied roof located more than 22860 mm 75 ft above the lowest level of fire department vehicle access.

3) The structure is assigned to Seismic Design Category E, and is greater than two stories above the grade plane.

4) Where specifically required by the Engineer of Record responsible for the structural design. This is recommended for large-magnitude or critical projects where additional quality control is warranted.

5) Where specifically required by the Authority Having Jurisdiction.

****

A licensed professional engineer in responsible charge of supervision of all special inspectors for the project and approved by the Contracting Officer. The SIOR must be an independent third-party entity hired directly by the Prime Contractor.

]1.3.8 Contracting Officer

The Government official having overall authority for administrative contracting actions. Certain contracting actions may be delegated to the Contracting Officer's Representative (COR).

1.3.9 Quality Control (QC) Manager

****

NOTE: For Design-Bid-Build projects, include Section 01 45 00 QUALITY CONTROL for Army and Navy projects.

****

An individual retained by the Prime Contractor and qualified in accordance with the Section 01 45 00 QUALITY CONTROL having the overall responsibility for the Contractor's QC organization.

1.3.10 Structural Engineer of Record (SER)

****

NOTE: The following paragraph includes tailoring for DESIGN-BID-BUILD and DESIGN-BUILD projects. For Design-Bid-Build projects, select either "employed by the Government" or "contracted by the Government as an A/E" based on how these services are being contracted for the project. For Design-Build projects, select "retained by the Prime Contractor".

****

A registered design professional[employed by the Government][contracted by the Government as an A/E] retained by the Prime Contractor responsible for the overall design and review of submittal documents prepared by others. The SER is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws in the state in which the design professional works. The SER is also referred to as the Engineer of Record (EOR) in design documents.

1.3.11 Statement of Special Inspections (SSI)

****

NOTE: The Statement of Special Inspections will be developed by the SER and must cover the following items:

1) List of the Architectural Components that are part of the Designated Seismic System.
   - **a. These components are in or attached to a Risk Category IV or V structure and are needed for continued operation of the facility or their failure could impair the continued operation of the facility.**

2) List of the Mechanical Components that are part of the Designated Seismic System.
   - **a. For Seismic Design Category C or Risk Category V, list the following:**
     - **i. Heating, ventilation and air-conditioning (HVAC) ductwork containing hazardous materials and anchorage of such ductwork.**
     - **ii. Piping systems and mechanical units containing flammable, combustible or highly toxic materials.**
   - **b. For Seismic Design Category D, E, or F or Risk Category V list mechanical components that meet one of the following:**
     - **i. Life safety components required to function after an earthquake**
     - **ii. Components that contain hazardous content**
     - **iii. All components in an essential facility needed for continued operation after an earthquake**

3) List of the Electrical Components that are part of the Designated Seismic System.
   - **a. For Seismic Design Category C or Risk Category V list the following:**
     - **i. Anchorage of electrical equipment used for emergency or standby power systems.**
   - **b. For Seismic Design Category D, E, or F list electrical components that meet one of the following:**
     - **i. Life safety components required to function after an earthquake**
     - **ii. Components that contain hazardous content**
     - **iii. All components in an essential facility needed for continued operation after an earthquake**

4) Define the periodic walk-down inspections required by UFC 3-301-01 or UFC 3-301-02.

The Statement of Special Inspections and the Schedule of Special Inspections must be included as an attachment to this specification.

****

****

NOTE: A template for the Statement of Special Inspections can be found on the Whole Building Design Guide website at www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-45-35

****

A document developed by the SER identifying the materials, systems, components and work required to have Special Inspections. This statement is included at the end of this specification.

1.3.12 Schedule of Special Inspections (SSI)

****

NOTE: A template for the Schedule of Special Inspections can be found on the Whole Building Design Guide website at www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-45-35

****

A schedule which lists each of the required Special Inspections, the extent to which each Special Inspection is to be performed, and the required frequency for each in accordance with ICC IBC Chapter 17. This schedule is included at the end of this specification.

[1.3.13 Designated Seismic Systems (DSS)

****

NOTE: Include this paragraph where Designated Seismic Systems are required in accordance with UFCs 3-301-01 and 3-301-02 (as applicable) and are identified in the Statement of Special Inspections.

****

Those nonstructural components that require design in accordance with ASCE 7-22 Chapter 13 and for which the component importance factor, Ip, is greater than 1.0. This designation applies to systems that are required to be operational following the Design Earthquake for RC I - IV structures and following the MCER for RC V structures. All systems in RC V facilities designated as MC-1 in accordance with UFC 3-301-02 are considered part of the Designated Seismic Systems.

]1.3.14 Definable Feature of Work (DFOW)

An inspection group that is separate and distinct from other inspection groups, having inspection requirements or inspectors that are unique.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

`**************************************************************************`

`**************************************************************************`

NOTE: For Navy Design-Build projects, delete Section 01 33 00 SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

`**************************************************************************`

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

`**************************************************************************`

NOTE: For projects in the NAVFAC PAC Area of Operation, the submittal(s) identified as SD-01 Preconstruction Submittal for this specification section, select the "G" designation requiring Government approval.

`**************************************************************************`

SIOR Letter of Acceptance; G, [_____]

Special Inspections Project Manual; G, [_____]

Special Inspections Agency's Written NDT Practices with method and evidence of regular equipment calibration where applicable

SD-06 Test Reports

Special Inspection Daily Reports

Special Inspection Biweekly Reports

SD-07 Certificates

****

NOTE: The following certifications are required.

****

AISC Certified Steel Fabricator

Steel Truss Plant Quality Assurance Program

Wood Truss Plant Quality Assurance Program

AC472 Accreditation

Precast Concrete Institute (PCI) Certified Plant

Certificate of Compliance

Special Inspector of Record Qualifications; G, [_____]

Special Inspector Qualifications; G, [_____]

Qualification Records for Nondestructive Testing Technicians

SD-11 Closeout Submittals

****

NOTE: Include this submittal for large complex projects.

****

Interim Report of Special Inspections from each DFOW; G, [_____]

Comprehensive Final Report of Special Inspections; G, [_____]

Final Report of Structural Observations where required; G, [_____]

1.5 SPECIAL INSPECTOR QUALIFICATIONS

****

NOTE: The following paragraphs and subparagraphs include special inspector qualification requirements for a variety of building or site components. Not all components are included on every project. Delete building or site component paragraphs and corresponding submittal requirements where they are not applicable on a particular project. In order to

qualify as a Special Inspector or Special Inspector of Record, one can either submit the certifications listed below or equivalent alternate certification as approved by the Contracting Officer.

****

Submit qualifications for each special inspector[and the special inspector of record] according to the following certification requirements. The Government will consider alternate equivalent certification upon request. Without written acceptance deviations to the following qualifications are not approved.

1.5.1 Steel Construction and High Strength Bolting

1.5.1.1 Special Inspector

a. ICC Structural Steel and Bolting Special Inspector certificate with one year of related experience, or

b. Registered Professional Engineer with 3 years of related experience

1.5.1.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.2 Welding Structural Steel

1.5.2.1 Special Inspector

****

NOTE: For highly complex steel projects use only AWS Certified Welding Inspectors.

****

a. ICC Structural Welding Special Inspector certificate with one year of related experience, or

b. AWS Certified Welding Inspector

1.5.2.2 Associate Special Inspector

AWS Certified Associate Welding Inspector

1.5.3 Nondestructive Testing of Welds

1.5.3.1 Special Inspector

NDT Level III Certificate

1.5.3.2 Associate Special Inspector

NDT Level II Certificate plus one year of related experience

1.5.4 Cold Formed Steel Framing

1.5.4.1 Special Inspector

a. ICC Structural Steel and Bolting Special Inspector certificate with one year of related experience, or

b. ICC Commercial Building Inspector with one year of experience, or

c. Registered Professional Engineer with 3 years related experience

1.5.4.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.5 Concrete Construction

1.5.5.1 Special Inspector

a. ICC Reinforced Concrete Special Inspector Certificate with one year of related experience, or

b. ACI Concrete Construction Special Inspector, or

c. Registered Professional Engineer with 3 years of related experience

1.5.5.2 Associate Special Inspector

a. ACI Concrete Construction Special Inspector-in-Training, or

b. Engineer-In-Training with one year of related experience

1.5.6 Prestressed Concrete Construction

1.5.6.1 Special Inspector

a. ICC Prestressed Concrete Special Inspector Certificate with one year of related experience, or

b. PCI Quality Control Technician/Inspector Level II Certificate with one year of related experience, or

c. Registered Professional Engineer with 3 years of related experience

1.5.6.2 Associate Special Inspector

a. PCI Quality Control Technician/Inspector Level I Certificate with one year of related experience, or

b. Engineer-In-Training with one year of related experience

1.5.7 Post-tensioned Concrete Construction

1.5.7.1 Special Inspector

a. PTI Level 2 Unbonded PT Inspector Certificate, or

b. Registered Professional Engineer with 3 years of related experience

1.5.7.2 Associate Special Inspector

a. PTI Level 1 Unbonded PT Inspector Certificate with one year of related experience, or

b. Engineer-In-Training with one year of related experience

1.5.8 Masonry Construction

1.5.8.1 Special Inspector

a. ICC Structural Masonry Special Inspector Certificate with one year of related experience, or

b. Registered Professional Engineer with 3 years of related experience

1.5.8.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.9 Wood

1.5.9.1 Special Inspector

a. ICC Commercial Building Inspector Certificate with one year of related experience, or

b. ICC Residential Building Inspector with one year of experience, or

c. Registered Professional Engineer with 3 years of related experience

1.5.9.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.10 Verification of Site Soil Condition, Fill Placement and Load-Bearing Requirements

1.5.10.1 Special Inspector

a. ICC Soils Special Inspector Certificate with one year of related experience, or

b. National Institute for Certification in Engineering Technologies (NICET) Soils Technician Level II Certificate in Construction Material Testing, or

c. Geologist-In-Training with 3 years of related experience, or

d. Registered Professional Engineer with 3 years of related experience

1.5.10.2 Associate Special Inspector

a. NICET Soils Technician Level I Certificate in Construction Material Testing with one year of related experience, or

b. Engineer-In-Training with one year of related experience

1.5.11 Deep Foundations

1.5.11.1 Special Inspector

a. NICET Soils Technician Level II Certificate in Construction Material Testing, or

b. Geologist-In-Training with 3 years of related experience, or

c. Registered Professional Engineer with 3 years of related experience

1.5.11.2 Associate Special Inspector

a. NICET Soils Technician Level I Certificate in Construction Material Testing with one year of related experience, or

b. NICET Geotechnical Engineering Technician Level I Construction or Generalist Certificate with one year of related experience, or

c. Engineer-In-Training with one year of related experience

1.5.12 Sprayed Fire-Resistive Material

1.5.12.1 Special Inspector

a. ICC Spray-applied Fireproofing Special Inspector Certificate, or

b. ICC Fire Inspector I Certificate with one year of related experience, or

c. Registered Professional Engineer or Architect with related experience

1.5.12.2 Associate Special Inspector

Engineer-In-Training with one year of related experience

1.5.13 Intumescent Fire-Resistive Coatings

1.5.13.1 Special Inspector

a. ICC Spray-applied Fireproofing Special Inspector Certificate, or

b. ICC Fire Inspector I Certificate with one year of related experience, or

c. Registered Professional Engineer or Architect with related experience

1.5.13.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.14 Exterior Insulation and Finish System (EIFS)

1.5.14.1 Special Inspector

a. Association of the Wall and Ceiling Industry (AWCI) EIFS Inspector Certificate, or

b. Exterior Design Institute Certificate, or

c. Registered Professional Engineer or Architect with related experience

1.5.14.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.15 Fire-Resistant Penetrations and Joints

1.5.15.1 Special Inspector

a. Passed the UL Firestop Exam with one year of related experience, or

b. Passed the FM Firestop Exam with one year of related experience, or

c. Passed the International Firestop Council Exam with one year of related experience, or

d. Registered Professional Engineer with related experience

1.5.15.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.16 Smoke Control

1.5.16.1 Special Inspector

a. Associated Air Balance Council (AABC) Technician Certification with one year of related experience, or

b. Registered Professional Engineer with related experience

1.5.16.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

[1.5.17 Special Inspector of Record (SIOR)

Registered Professional Engineer with 5 years of related experience.

]PART 2 PRODUCTS

2.1 SPECIAL INSPECTION OF FABRICATED ITEMS

Special Inspection of fabricator's work performed in the fabricator's shop is required to be inspected in accordance with the Statement of Special Inspections and the Schedule of Special Inspections unless the fabricator is certified by the approved agency to perform such work without Special Inspections. Submit the following[certification][certifications] to the Contracting Officer for information to allow work performed in the fabricator's shop to not be subjected to Special Inspections.

****

NOTE: The following certifications meet the requirements for fabricator approval in accordance with paragraph 1704.2.5.1 of IBC.

****

[AISC Certified Steel Fabricator.

][Truss Plate Institute (TPI) steel truss plant quality assurance program certification.

][Truss Plate Institute (TPI) wood truss plant quality assurance program certification.

] **

NOTE: AC472 Accreditation is the accreditation criteria for inspection programs for manufacturers of metal building systems.

****

[International Accreditation Service, AC472 Accreditation

][Precast Concrete Institute (PCI) Certified Plant, Group C - Commercial (Structural) Products

] At the completion of fabrication, submit a certificate of compliance, to be included with the comprehensive final report of Special Inspections, stating that the materials supplied and work performed by the fabricator are in accordance with the construction documents.

PART 3 EXECUTION

3.1 RESPONSIBILITIES

[3.1.1 Special Inspector of Record

****

NOTE: Include this paragraph where the SIOR is required.

****

a. Supervise all Special Inspectors required by the Contract Documents and the IBC.

b. Submit an SIOR Letter of Acceptance to the Contracting Officer attesting to acceptance of the duties of SIOR, signed and sealed by the SIOR.

c. Verify the qualifications of all of the Special Inspectors.

d. Verify the qualifications of fabricators.

****

NOTE: Include the following bracketed requirements when the structural design is required to follow AISC 341 for seismic design of steel structures.

****

[e. Submit Special Inspection agency's written NDT practices for the monitoring and control of the agency's operations to include the following:

(1) The agency's procedures for the selection and administration of inspection personnel, describing the training, experience and examination requirements for qualification and certification of inspection personnel.

(2) The agency's inspection procedures, including general inspection, material controls, and visual welding inspection.

f. Submit Qualification Records for Nondestructive Testing Technicians for nondestructive testing (NDT) technicians designated for the project.

g. Submit NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.

] h. Prepare a Special Inspections Project Manual, which must cover the following:

(1) Roles and responsibilities of the following individuals during Special Inspections: SIOR, SI, ASI, General Contractor's QC Manager and SER.

(2) Organizational chart or communication plan, indicating lines of communication.

(3) Contractor's internal plan for scheduling inspections. Address items such as timeliness of inspection requests, whom to contact for inspection requests, and availability of alternate inspectors.

(4) Indicate the Government reporting requirements.

(5) Propose forms or templates to be used by SI and SIOR to document inspections.

(6) Indicate procedures for tracking nonconforming work and verification that corrective work is complete.

(7) Indicate how the SIOR and SI will participate in weekly QC meetings.

(8) Indicate how Special Inspections of shop fabricated items will be handled when the fabricator's shop is not certified in accordance with paragraph SPECIAL INSPECTION OF FABRICATED ITEMS.

(9) Include a section in the manual that covers each specific item requiring Special Inspections that is indicated on the Schedule of Special Inspections. Provide names and qualifications of each special inspector who will be performing the Special Inspections for each specific item. Provide details on how the Special Inspections are to be carried out for each item so that the expectations are clear for the General Contractor and the Subcontractor performing the work.

Make a copy of the Special Inspections Project Manual available on the job site during construction. Submit a copy of the Special Inspections Project Manual for approval.

i. Attend coordination and mutual understanding meeting where the information in the Special Inspections Project Manual will be reviewed to verify that all parties have a clear understanding of the Special Inspection provisions and the individual duties and responsibilities of each party.

j. Maintain a 3-ring binder for the Special Inspector's daily and special inspection biweekly reports and the Special Inspections Project Manual. This binder must be located in a conspicuous place in the project trailer/office to allow review by the Contracting Officer and the SER.

k. Submit a copy of the Special Inspector's special inspection daily reports to the QC Manager.

l. Discrepancies that are observed during Special Inspections must be reported to the QC Manager for correction. If discrepancies are not corrected before the Special Inspector leaves the site, the observed discrepancies must be documented in the daily report.

m. Submit a biweekly Special Inspections report until all work requiring Special Inspections is complete. A report is required for each biweekly period in which Special Inspection activity occurs; the report must include the following:

  (1) A brief summary of the work performed during the reporting time frame.

****

NOTE: Include the bracketed portion of the following line when there are mechanical and electrical components that are part of the designated seismic system.

****

  (2) Changes from and discrepancies with the drawings, specifications[and mechanical or electrical component certification] that were observed during the reporting period.

  (3) Discrepancies which were resolved or corrected.

  (4) A list of nonconforming items requiring resolution.

  (5) All applicable test results including nondestructive testing reports.

****

NOTE: Include the following subparagraph on large complex projects.

****

[n. At the completion of each Definable Feature of Work (DFOW) requiring Special Inspections, submit an interim report that documents the Special Inspections completed for that DFOW, including corrections of all discrepancies noted in the daily reports. Interim reports of Special Inspections must be signed and dated by the SIOR.

] o. At the completion of the project submit a comprehensive final report of Special Inspections that documents the Special Inspections completed for the project including corrections of all discrepancies noted in the daily reports. The comprehensive final report of Special Inspections must be signed, dated and sealed by the SIOR.

]3.1.2 Quality Control Manager

****

NOTE: Include the bracketed items where there is no SIOR.

****

[a. Supervise all Special Inspectors required by the Contract Documents and the IBC.

b. Verify the qualifications of all the Special Inspectors.

c. Verify the qualifications of all fabricators.

d. Maintain a 3-ring binder for the Special Inspector's special inspection daily reports and special inspection biweekly reports. This binder must be located in a conspicuous place in the project trailer/office to allow review by the Contracting Officer and the SER.

] e. [a.][e.] Maintain a rework items list that includes discrepancies noted on the Special Inspector's daily report.

3.1.3 Special Inspectors

a. Inspect all elements of the project which the special inspector is qualified to inspect and which are identified in the Schedule of Special Inspections.

b. Attend preparatory phase meetings related to the Definable Feature of Work (DFOW) which the Special Inspector is qualified to inspect.

****

NOTE: Include subparagraphs "c" through "j" when the SIOR is NOT required.

****

****

NOTE: Include subparagraphs "c" through "e" requirements when the structural design is required to follow AISC 341 for seismic design of steel structures.

****

[c. Submit Special Inspection agency's written NDT practices for the monitoring and control of the agency's operations, to include the following:

(1) The agency's procedures for the selection and administration of inspection personnel, describing the training, experience and examination requirements for qualification and certification of inspection personnel.

(2) The agency's inspection procedures, including general inspection, material controls, and visual welding inspection.

d. Submit Qualification Records for Nondestructive Testing Technicians for nondestructive testing (NDT) technicians designated for the project.

e. Submit NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.

] f. Submit a copy of the special inspection daily reports to the QC Manager.

g. Report discrepancies that are observed during Special Inspections to the QC Manager for correction. If discrepancies are not corrected before the special inspector leaves the site the observed discrepancies must be documented in the daily report.

h. Submit a biweekly Special Inspection Report until all inspections are complete. A report is required for each biweekly period in which Special Inspections activity occurs, and must include the following:

(1) A brief summary of the work performed during the reporting time frame.

****

NOTE: Include the bracketed portion when there are mechanical and electrical components that are part of the designated seismic system.

****

(2) Changes from and discrepancies with the drawings, specifications[and mechanical or electrical component certification] that were observed during the reporting period.

(3) Discrepancies which were resolved or corrected.

(4) A list of nonconforming items requiring resolution.

(5) All applicable test result, including nondestructive testing reports.

****

NOTE: Include the following subparagraph for large complex projects.

****

[i. At the completion of each DFOW requiring Special Inspections, submit an interim report of Special Inspections that documents the Special Inspections completed for that DFOW. Identify the inspector responsible for each item inspected and corrections of all discrepancies noted in the daily reports. The interim report of Special Inspections must be signed and dated and it must indicate the certification of the Special Inspector qualifying them to conduct the inspection.

] j. At the completion of the project, submit a comprehensive final report of Special Inspections that documents the Special Inspections completed for the project and corrections of all discrepancies noted in the daily reports. The comprehensive final report of Special Inspections must be signed and dated and it must indicate the certification of the Special Inspector qualifying them to conduct the inspection.

****

NOTE: Include the following requirement when the SIOR is required.

****

[k. Submit special inspection daily reports to the SIOR.

][3.1.4 Structural Engineer of Record (SER)

****

NOTE: This paragraph is tailored for DESIGN-BUILD projects. Include this paragraph on Design-Build projects when the SER is retained by the Prime Contractor.

****

a. Develop the Statement of Special Inspections and the Schedule of Special Inspections as defined in Chapter 17 of ICC IBC. Submit the Statement of Special Inspections and the Schedule of Special Inspections for approval by the Contracting Officer.

The Statement of Special Inspections must include the following information:

(1) List of Architectural Components that are part of the Designated Seismic System.

(2) List of Mechanical Components that are part of the Designated Seismic System.

(3) List of the Electrical Components that are part of the Designated Seismic System.

(4) List of periodic walk-down inspections required by UFC 3-301-01.

(5) List of elements that are part of the progressive collapse resisting system.

Develop Schedule of Special Inspections using the template located on the Whole Building Design Guide website at: www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-45-35

****

NOTE: Include the following subparagraphs when the project conditions according to the UFC's and ICC IBC Chapter 17 are met and structural observations are required.

****

[b. Prior to the start of structural observations submit a written statement identifying the frequency and extent of structural observations.

c. At the conclusion of the structural observations submit a final report of structural observations indicating that the structural observation site visits have been made and identify any reported deficiencies which, to the best of the structural observer's knowledge, have not been resolved.

] **

NOTE: Include the following subparagraphs when the project includes mechanical and electrical components that are part of the designated seismic system for mechanical and electrical components in accordance with UFC 3-301-01.

Include the Nonstructural Component Design Review Panel for Risk Category V structures in accordance with UFC 3-301-02.

****

[d. Perform a final walk-down inspection of the mechanical and electrical components that are part of the designated seismic system[with the Nonstructural Component Design Review Panel] to ensure that the nonstructural components satisfy life safety mounting requirements as defined in the Statement of Special Inspections.

e. Submit a report of the final walk-down inspection that includes the following:

  (1) Record of/observations from final site visit.

  (2) Documentation that all required inspections were performed in accordance with the Statement of Special Inspections.

  (3) Documentation that the Designated Seismic Systems were installed in accordance with the construction documents and the requirements of ICC IBC Chapter 17, as modified by UFC 3-301-01 or UFC 3-301-02.

]]3.2 DEFECTIVE WORK

Check work as it progresses, but failure to detect any defective work or materials must in no way prevent later rejection if defective work or materials are discovered, nor obligate the Contracting Officer to accept the defective work or materials.

-- End of Section --

****

USACE / NAVFAC / AFCEC	**UFGS-01 50 00 (November 2020)** **Change 3 - 08/24** **-----------------------------------**
Preparing Activity: USACE	**Superseding** **UFGS-01 50 00 (May 2018)** **UFGS-01 50 00.05 20 (November 2007)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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PART 3 EXECUTION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-01 50 00 (November 2020)**
Change 3 - 08/24

Preparing Activity: USACE **Superseding**
UFGS-01 50 00 (May 2018)
UFGS-01 50 00.05 20 (November 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 50 00

TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS

11/20, CHG 3: 08/24

****

NOTE: This specification covers the requirements for temporary construction facilities, safety systems, construction traffic provisions, construction signage, jobsite Wi-Fi, and controls over Contractor operations required for use in all projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

This guide specification includes tailoring for ARMY, NAVY, AIR FORCE, NAVFAC ML, NAVFAC FE, NAVFAC LANT, NAVFAC PAC, NAVFAC HAWAII, NAVFAC SE and NAVY DESIGN-BUILD projects. Where an Editor's Note states a paragraph is tailored for a Service or project type, the content of the paragraph, or a portion of the paragraph, is suited specifically to be included only for that Service or project type.

****

PART 1 GENERAL

****

NOTE: To download UFGS Forms, Graphics, and Tables,

go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables
On the drawings, show:

1. Location of temporary buildings and storage areas, if specified;

2. Location of temporary utility connections, if specified.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C511	(2017; R 2021) Reduced-Pressure Principle Backflow Prevention Assembly

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 241	(2022) Standard for Safeguarding Construction, Alteration, and Demolition Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: For Navy Design-Build projects, delete 01 33 00 SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****

NOTE: For projects in the NAVFAC PAC Area of

Operation, and for the submittals identified as SD-01 Preconstruction Submittals, remove the "G" designation.
****

Construction Site Plan; G, [_____]

Traffic Control Plan; G, [_____]

Haul Road Plan; G, [_____]

Contractor Computer Cybersecurity Compliance Statements; G, [_____]

Contractor Temporary Network Cybersecurity Compliance Statements; G, [_____]

SD-03 Product Data

Backflow Preventers; G, [_____]

SD-06 Test Reports

Backflow Preventer Tests

SD-07 Certificates

Backflow Tester Certification

Backflow Preventers Certificate of Full Approval

1.3 CONSTRUCTION SITE PLAN

Prior to the start of work, submit for Government approval a site plan showing the locations and dimensions of temporary facilities (including layouts and details, equipment and material storage area (onsite and offsite), and access and haul routes, avenues of ingress/egress to the fenced area and details of the fence installation. Identify any areas which may have to be graveled to prevent the tracking of mud. Indicate if the use of a supplemental or other staging area is desired. Show locations of safety and construction fences, site trailers, construction entrances, trash dumpsters, temporary sanitary facilities, and worker parking areas.

1.4 BACKFLOW PREVENTERS CERTIFICATE

1.4.1 Backflow Tester Certificate

Prior to testing, submit to the Contracting Officer certification issued by the State or local regulatory agency attesting that the backflow tester has successfully completed a certification course sponsored by the regulatory agency. Tester must not be affiliated with a company participating in other phases of this Contract.

1.4.2 Backflow Prevention Training Certificate

Submit a certificate recognized by the State or local authority that states the Contractor has completed at least 10 hours of training in backflow preventer installations. The certificate must be current.

1.5 DOD CONDITION OF READINESS (COR)

DOD will set the Condition of Readiness (COR) based on the weather forecast for sustained winds 50 knots (93 km/hr58 mph) or greater. Contact the Contracting Officer for the current COR setting.

Monitor weather conditions a minimum of twice a day and take appropriate actions according to the approved Emergency Plan in the accepted Accident Prevention Plan, EM 385-1-1 Emergency Plan requirements and the instructions below.

Unless otherwise directed by the Contracting Officer, comply with:

a. Condition FOUR (Sustained winds of 93 km/hr 58 mph or greater expected within 72 hours): Normal daily jobsite cleanup and good housekeeping practices. Collect and store in piles or containers scrap lumber, waste material, and rubbish for removal and disposal at the close of each work day. Maintain the construction site including storage areas, free of accumulation of debris. Stack form lumber in neat piles less than one m 3.3 feet high. Remove all debris, trash, or objects that could become missile hazards. Review requirements pertaining to "Condition THREE" and continue action as necessary to attain "Condition FOUR" readiness. Contact Contracting Officer for weather and COR updates and completion of required actions.

b. Condition THREE (Sustained winds of 93 km/hr 58 mph or greater expected within 48 hours): Maintain "Condition FOUR" requirements and commence securing operations necessary for "Condition ONE" which cannot be completed within 18 hours. Cease all routine activities which might interfere with securing operations. Commence securing and stow all gear and portable equipment. Make preparations for securing buildings. Reinforce or remove formwork and scaffolding. Secure machinery, tools, equipment, materials, or remove from the jobsite. Expend every effort to clear all missile hazards and loose equipment from general base areas. Contact Contracting Officer for weather and COR updates and completion of required actions. Review requirements pertaining to "Condition TWO" and continue action as necessary to attain "Condition THREE" readiness.

c. Condition TWO (Sustained winds of 93 km/hr 58 mph or greater expected within 24 hours): Secure the jobsite, and leave Government premises.

d. Condition ONE. (Sustained winds of 93 km/hr 58 mph or greater expected within 12 hours): Contractor access to the jobsite and Government premises is prohibited.

1.6 CYBERSECURITY DURING CONSTRUCTION

****

NOTE: The requirements in this subpart are included to provide a basic level of "cyber hygiene" during the construction process, and the controls that they are related to are still noted for reference. Paragraphs in this Article contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only, and enables coordination of the

requirements of this Article with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

****

{For Reference Only: This subpart (and its subparts) relates to AC-18, SA-3, CCI-00258.} Meet the following requirements throughout the construction process.

1.6.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. When used, contractor computers must meet the following requirements:

1.6.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.6.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. All computers used on this project must be scanned using the installed software at least once per day.

1.6.1.3 Passwords and Passphrases

The passwords and passphrases for all computers must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.6.1.4 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-50-00. Each Statement must be signed by a cybersecurity representative for the relevant company.

1.6.2 Temporary IP Networks

****

NOTE: The allowance of connection to "Government furnished IP networks provided for this purpose" covers the case of there being a "guest" network the contractor can use. This is likely not available in many cases, but is covered here for the instances in which it is offered by the project site.

Use the first bracketed option if Contractor furnished Wi-Fi network is optional. Use the second bracketed option if the Contractor must provide a

Wi-Fi network for Government use.
****

[Temporary Contractor-installed IP networks may be used during construction.][Provide Government access to Contractor furnished temporary IP networks during construction.] When used, temporary contractor-installed IP networks must meet the following requirements:

1.6.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than IP networks provided under this project or Government furnished IP networks provided for this purpose. Any and all network access from outside the project site is prohibited.

1.6.3 Government Access to Network

Government personnel, as defined, prescribed, and identified by the Contracting Officer, must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification. If there is a Government agency responsible for network access, identify that agency.

1.6.4 Temporary Wireless IP Networks

****
NOTE: Contractor provided Wi-Fi network option provides capability for the Government to have access to Wi-Fi for use with mobile devices in the field. Edit the option in paragraph TEMPORARY IP NETWORKS to select the second bracketed option and include the bracketed option in paragraph CONTRACTOR PROVIDED WI-FI NETWORK below.
****

1.6.4.1 Contractor Provided Wi-Fi Network

Provide standalone Wi-Fi network for authorized Government personnel. Network access must be available throughout the jobsite and for the entire Contract period. The Government will use the Wi-Fi service for coordination in the field and related activities. Do not attach or connect the temporary Wi-Fi network to Government networks or systems unrelated to construction activities.

Password information must adhere to requirements outlined in Paragraph PASSWORDS AND PASSPHRASES. Provide password and Wi-Fi network name (SSID) to the Contracting Officer for Government personnel access. Wi-Fi performance must be capable of handling bandwidth to support Government and Contractor activities, including drawing and model access onsite. Provide a point of contact for reporting Wi-Fi outages.

1.6.4.2 Temporary Wireless IP Networks Security

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks must not interfere with existing wireless network and must use WPA2 security. Network names (SSID) for wireless networks must be changed from their default values.

1.6.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.6.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-50-00. Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

PART 2 PRODUCTS

2.1 TEMPORARY SIGNAGE

2.1.1 Bulletin Board

Prior to the commencement of work activities, provide a clear weatherproof covered bulletin board not less than 915 by 1220 mm 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the Contract, Wage Rate Information poster, Safety and Health Information as required by EM 385-1-1 and other information approved by the Contracting Officer. Coordinate requirements herein with 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. Locate the bulletin board at the project site in a conspicuous place easily accessible to all employees, and in location as approved by the Contracting Officer.

2.1.2 Project Identification Signs

The requirements for the signs, their content, and location are [as indicated][and][as specified in Section 01 58 00 PROJECT IDENTIFICATION]. Erect signs within 15 days after receipt of the notice to proceed. Correct the data required by the safety sign daily, with light colored metallic or non-metallic numerals.

2.1.3 Warning Signs

Post temporary signs, tags, and labels to give workers and the public adequate warning and caution of construction hazards according to the EM 385-1-1. Attach signs to the perimeter fencing every 150 feet warning the public of the presence of construction hazards. Signs must require unauthorized persons to keep out of the construction site. Correct the data required by safety signs daily. Post signs at all points of entry designating the construction site as a hard hat area.

2.2 TEMPORARY TRAFFIC CONTROL

2.2.1 Haul Roads

****

NOTE: For projects in the NAVFAC PAC Area of Operation, remove the bracketed portion "by the

Contracting Officer" in the 6th sentence.
****

Construct access and haul roads necessary for proper prosecution of the work under this Contract in accordance with EM 385-1-1. Construct with suitable grades and widths; avoid sharp curves, blind corners, and dangerous cross traffic. Submit haul road plan for approval. Provide necessary lighting, signs, barricades, and distinctive markings for the safe movement of traffic. The method of dust control, although optional, must be adequate to ensure safe operation at all times. Location, grade, width, and alignment of construction and haul roads are subject to approval[by the Contracting Officer]. Lighting must be adequate to assure full and clear visibility for full width of haul road and work areas during any night work operations.

2.2.2 Barricades

Erect and maintain temporary barricades to limit public access to hazardous areas. Barricades are required whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Securely place barricades clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

2.3 FENCING

****
NOTE: Evaluate fencing requirements based on the exposure potential of the construction site to the public. The public is considered as any non-construction personnel. Minimum fencing may range from nylon fabric (reinforced by a top supporting cable to provide adequate strength to provide needed physical protection) to 2400 mm 8 foot chain link fencing.
****

****
NOTE: Use the second (optional) paragraph if projects require special privacy fencing based on project size, scope, complexity, and visibility. Coordinate with the supporting local USACE District for Army projects and NAVFAC FEAD or ROICC office for Navy projects to determine if a privacy fence is required.
****

Provide fencing along the construction site and at all open excavations and tunnels to control access by unauthorized personnel. Safety fencing must be highly visible to be seen by pedestrians and vehicular traffic. All fencing must meet the requirements of EM 385-1-1. Remove the fence upon completion and acceptance of the work.

[To block public view of the construction, enclose the project work area and Contractor lay-down area with a 2400 mm 8 ft high [shadow-box type, wooden fence and gates][chain link fence and gates with brown, UV light resistant, plastic fabric mesh netting (similar to tennis court or other screening).]

]2.3.1 Polyethylene Mesh Safety Fencing

Temporary safety fencing must be a high visibility orange colored, high density polyethylene grid, a minimum of 1.2 m 48 inches high and maximum mesh size of 50 mm 2 inches. Fencing must extend from the grade to a minimum of 1.2 m 48 inches above the grade and be tightly secured to T-posts spaced as necessary to maintain a rigid and taut fence. Fencing must remain rigid and taut with a minimum of 90.7 kilograms (kg) 200 pounds of force exerted on it from any direction with less than 100 mm 4 inches of deflection.

2.3.2 Chain Link Panel Fencing

****

NOTE: Select 6 feet high chain link fencing unless 8 feet is needed for additional security.

****

Temporary panel fencing must be galvanized steel chain link panels [1.8 m6 feet] [2.4 m8 feet] high. Multiple fencing panels may be linked together at the bases to form long spans as needed. Each panel base must be weighted down using sand bags or other suitable materials in order for the fencing to withstand anticipated winds while remaining upright. Fencing must remain rigid and taut with a minimum of 90.7 kg 200 pounds of force exerted on it from any direction with less than 100 mm 4 inches of deflection.

2.3.3 Post-Driven Chain Link Fencing

Temporary post-driven fencing must be galvanized chain link fencing [1.8 m6 feet] [2.4 m8 feet] high supported by an tightly secured to galvanized steel posts driven below grade. Fence posts must be located on minimum 3 meter 10 foot centers. Posts may be set in various surfaces such as sand, soil, asphalt or concrete as necessary. Chain link fencing must remain rigid and taut with a minimum of 90.7 kg 200 pounds of force exerted on it from any direction with less than 100 mm 4 inches of deflection. Completely remove fencing and posts at the completion of construction and restore surfaces disturbed or damaged to its original condition. Locate and identify underground utilities prior to setting fence posts. Equip fence with a lockable gate. Gate must remain locked when construction personnel are not present.

2.4 TEMPORARY WIRING

Provide temporary wiring in accordance with EM 385-1-1, NFPA 241 and NFPA 70. Include monthly inspection and testing of all equipment and apparatus.

2.5 BACKFLOW PREVENTERS

****

NOTE: Include the following for all projects connecting to a potable water supply.

Consider using a lead free, brass body backflow preventer assembly on water lines 50 mm 2 inches or smaller. For water lines greater than 50 mm 2 inches, consider using a cast-iron body backflow preventer assembly.

Coordinate with Base Utilities/PWD for any approved

list of backflow preventers and edit accordingly. Add any specific testing or certification requirements to Part 3 Article for Backflow Preventers.

****

Certificate of Full Approval from FCCCHR List, University of Southern California, attesting that the design, size and make of each backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. Certificate of Provisional Approval is not acceptable.

Reduced pressure principle type conforming to the applicable requirements AWWA C511. Provide backflow preventers complete with [68 kg][150 pound][_____] flanged [cast iron],[ductile iron,] [bronze,][brass] mounted gate valve [and strainer], [304][_____] stainless steel or bronze, internal parts.

PART 3 EXECUTION

****

NOTE: Delete inapplicable paragraphs, selecting desired options for electricity, water, gas, heating and ventilating, sanitary, and fire protection facilities.

****

3.1 EMPLOYEE PARKING

Construction Contract employees must park privately owned vehicles in an area designated by the Contracting Officer. Employee parking must not interfere with existing and established parking requirements of the Government installation.

3.2 AVAILABILITY AND USE OF UTILITY SERVICES

3.2.1 Temporary Utilities

Provide temporary utilities required for construction. Materials may be new or used, must be adequate for the required usage, not create unsafe conditions, and not violate applicable codes and standards.

3.2.2 Payment for Utility Services

****

NOTE: Use the following paragraphs related to payment of utilities for Army and Navy projects only.

Coordinate this paragraph with the Contracting Officer. Coordinate with FAR 52.236-14 Availability and Use of Utility Services. Choose one of the following options. For NAVFAC, delete this set or paragraphs if utility service is covered in a paragraph "Utilities at (_____)"; used for some stations on a regional basis.

Government utilities listed in this paragraph may be

furnished, if available without interfering with Government needs. These services will not be made free of charge except: (1) on Air Force projects; (2) on other projects when administrative costs exceed the value of the services; or (3) when otherwise advantageous to the Government. Indicate the point at which the Government will deliver each utility specified and show pertinent data such as voltage, L/min gal/min, and pipe sizes on the general layout plan or other appropriate drawing. Information regarding the types of utilities available, the rates, the points of connection' and the quantities available should be obtained from the Government.

****

a. The Government will make all reasonably required utilities available from existing outlets and supplies, as specified in the Contract. Unless otherwise provided in the Contract, the amount of each utility service consumed will be charged to or paid at prevailing rates charged to the Government or, where the utility is produced by the Government, at reasonable rates determined by the Contracting Officer. Carefully conserve utilities furnished without charge.

b. Reasonable amounts of the following utilities will be made available [without charge.] [at the prevailing rates.] [at the following rates:]

c.

Utility Services		
	Cost ($) per	Unit
Electricity		
Potable Water		
Salt Water		
Compressed Air		
Steam		
Natural Gas		
Sanitary Sewer		

d. The point at which the Government will deliver such utilities or services and the quantity available is [as indicated][must be coordinated with the Contracting Officer]. Pay all costs incurred in connecting, converting, and transferring the utilities to the work. Make connections, including [providing backflow-preventing devices on connections to domestic water lines;] [providing meters;] and providing transformers; and make disconnections. Under no circumstances will taps to base fire hydrants be allowed for obtaining domestic water.

****

NOTE: If constraints prevent the Government from providing utilities, include the following paragraph and delete prior paragraphs applicable to provision of utilities by the Government.

****

e. The Contractor must provide their own utilities.

3.2.3 Meters and Temporary Connections

Provide and maintain necessary temporary connections, distribution lines, and meter bases (Government will provide meters) required to measure the amount of each utility used for the purpose of determining charges. Notify the Contracting Officer, in writing, 5 working days before final electrical connection is desired so that a utilities contract can be established. The Government will provide a meter and make the final hot connection after inspection and approval of the Contractor's temporary wiring installation. Do not make the final electrical connection.

3.2.4 Advance Deposit

An advance deposit for utilities consisting of an estimated month's usage or a minimum of $50.00 will be required. The last monthly bills for the fiscal year will normally be offset by the deposit and adjustments will be billed or returned as appropriate. Services to be rendered for the next fiscal year, beginning 1 October, will require a new deposit. Notification of the due date for this deposit will be mailed prior to the end of the current fiscal year.

3.2.5 Final Meter Reading

Before completion of the work and final acceptance of the work by the Government, notify the Contracting Officer, in writing, 5 working days before termination is desired. The Government will take a final meter reading, disconnect service, and remove the meters. Then remove all the temporary distribution lines, meter bases, and associated appurtenances. Pay all outstanding utility bills before final acceptance of the work by the Government.

3.2.6 Utilities at Special Locations

****

NOTE: The following set of paragraphs are tailored for use on NAVY projects only.

****

****

NOTE: For NAVFAC projects choose one of the following options. The first subparagraph is tailored for use on NAVFAC LANT projects only. For the first option, in the first set of brackets, insert the name of the activity to which application should be made. Include the second bracketed expression for projects located at MCAS Cherry Point.

****

[a. Reasonable amounts of utilities will be made available at the prevailing Government rates. These rates may be obtained upon application to the Commanding Officer, [_____], by way of the Contracting Officer. Make connections, provide transformers and meters, and make disconnections; and provide backflow preventer devices on connections to domestic water lines. [Neither potable water nor sanitary facilities will be available at the main Contractor laydown area at Marine Corps Air Station (MCAS), Cherry Point, NC.]]

****
NOTE: Use the following option for projects located in Argentina and the Azores and for Air Force projects in the NAVFAC Atlantic Area of Responsibility. Use this paragraph for other activities only when approved by the activity.
****

[b. Reasonable amounts of utilities will be made available without charge. Make connections, provide transformers and meters, and make disconnections; and provide backflow preventer devices on connections to domestic water lines. Under no circumstances will taps to base fire hydrants be allowed for obtaining domestic water.]

****
NOTE: Use the following option only for MCON funded and non-appropriated funds projects at Marine Corps Base, Camp Lejeune and Marine Corps Air Station (Helicopter (H)), New River.
****

[c. Reasonable amounts of utilities will be made available at the prevailing Government rates and may be obtained upon application to the Base Maintenance Officer, Bldg. 1202, Marine Corps Base, Camp Lejeune. A refundable security deposit to the Resident Officer in Charge of Construction must be made prior to application for services. Provide transformers, meter bases, electrical service poles and drops for electrical services, and backflow preventer devices on connections to domestic water lines. Final taps and tie-ins to the Government utility grid will be made by Base Maintenance who will also provide and seal a 120 or 208 volt, three-wire kWh meter. Tap-in cost, if any, is the responsibility of the Contractor. Tampering or movement of a sealed meter without notification to base maintenance is grounds for discontinuance of electrical service. Provide larger meters required if they are not available from the Government. The Contractor is responsible for the cost of utility services required until the date of Government acceptance. Under no circumstances will taps to base fire hydrants be allowed for obtaining domestic water.]

****
NOTE: The following set of subparagraphs are tailored for use on NAVFAC PAC projects only. Include the bracketed options as applicable.
****

[3.2.6.1 Utilities at Guam by Contractor for Special Projects

****
NOTE: Use this subparagraph for projects in Guam.
****

Contact the Government of Guam for water and electricity.

][3.2.6.2 Utility Services at Midway

****
NOTE: Use the following subparagraphs for projects

at Midway.
****

a. Potable water is rationed during dry periods and not available for construction purposes during the months of June and July.

b. Electrical power available, primary voltage is 2400 volt 3 phase, 3 wire, 60 cycle AC. Secondary voltages may be 120/208 or 120/240 volts.

c. Provide new meters for potable water, brackish water and electricity. The cost of utility services furnished may be reduced by the cost the Government would normally pay for comparable meters if, at the end of the job, the meters are delivered to the Government in good condition.

]

****
NOTE: The following set of paragraphs are tailored for use on NAVFAC FE projects only. Include the bracketed options as applicable.
****

[3.2.7 Utility Services for Diego Garcia Projects

****
NOTE: Use the following paragraphs for Diego Garcia projects. Contact the local Public Works office and insert the prevailing utility rates at the time of the project.
****

a. Potable water will be made available to Contractor's office and housing. The prevailing rate for potable water is [$_____] per 3800 L thousand gallons.

b. No charge for brackish water.

c. Electrical power available is primary, 2400 volt 3 phase, 3 wire, 60 cycle AC, secondary voltages may be 120/208 or 120/240 volts. The prevailing rate for electricity is [$_____] per kilowatt hour (KWH).

d. Sewage costs at [$_____] per 3800 L KGAL.

e. Provide new meters for potable water and electricity. The cost of utility services furnished may be reduced by the cost the Government would normally pay for comparable meters if, at the end of the job, the meters are delivered to the Government in good condition.

[3.2.7.1 Contractor-Owned and Operated Radio Telecommunications

A transmitter/receiver and antenna may be erected upon approval by the Contracting Officer. Submit for approval, 30 calendar days prior to the use of the equipment, the type of radio equipment power and band width of the equipment.

][3.2.7.2 Off-Island

The Government will provide military message communication from Diego

Garcia at no cost. The Contractor is responsible for the cost of retransmitting messages through commercial sources. Process messages through the Contracting Officer. Messages will be screened and limited use of communication facilities will be permitted. Private messages will be permitted only for emergencies. The Navy voice communication system is no longer available for use. A local vendor provides commercial voice and teletype services for [$_____] per minute.

]]3.2.8 Utility Services for Wake Island

****

NOTE: Use the following paragraphs for Wake Island projects. Contact the local Public Works office and insert the prevailing utility rates at the time of the project.

****

[a. Potable water may not be available for construction during dry periods. Desalinized water available during dry periods at [$_____] per day for 114-150 kL 30,000-40,000 gallons per day.

b. Available primary voltage is 4160 volts, 3 phase, 3 wire, 60 cycle. Secondary voltage is 120/208 volts, 3 phase, 60 cycle.]

[3.2.9 Telephones at Midway, Wake, and Diego Garcia

****

NOTE: Use the following paragraph for Midway, Wake Island, and Diego Garcia projects only. Contact the local Public Works office and insert the prevailing utility rates at the time of the project.

****

On-Island service may be obtained if lines are available. Make arrangements through the Contracting Officer. The prevailing rate for cable or wireless is [$_____] per phone. There is no charge for on-island telephone service. [Current rates are [$_____] per month for each private telephone line plus an installation charge of [$_____] for each instrument and [$_____] per month for two-party lines plus [$_____] per month for each extension. Pay for the cost of the wiring on runs in excess of two spans]. Long distance services are usually available at commercial rates. The Navy Radio Communication System or Defense Switch Network will not be available for use. [Limited teletypewriter circuit service is available.]

]3.2.10 Sanitation

Provide and maintain within the construction area minimum field-type sanitary facilities in accordance with EM 385-1-1. Locate the facilities behind the construction fence or out of the public view. Clean units and empty wastes at least once a week or more frequently into a municipal, district, or station sanitary sewage system, or remove waste to a commercial facility. Obtain approval from the system owner prior to discharge into a municipal, district, or commercial sanitary sewer system. Penalties or fines associated with improper discharge will be the responsibility of the Contractor. Coordinate with the Contracting Officer and follow station regulations and procedures when discharging into the station sanitary sewer system. Maintain these conveniences at all times.

Include provisions for pest control and elimination of odors. Government toilet facilities will not be available to Contractor's personnel.

3.2.11 Telephone

Make arrangements and pay all costs for telephone facilities desired.

3.2.12 Fire Protection

Provide temporary fire protection equipment for the protection of personnel and property during construction. Remove debris and flammable materials [daily][weekly][monthly] to minimize potential hazards.

3.3 STATION OPERATION AFFECT ON CONTRACTOR OPERATIONS

****

NOTE: Use this paragraph on all projects involving potential conflicts with operating conditions other than utilities or where the work must be pursued in a particular sequence. Clearly detail the permissible extent of sequencing or duration of interruptions to station operation. Obtain information from the Government.

****

[ ].

3.4 TRAFFIC PROVISIONS

3.4.1 Maintenance of Traffic

a. Conduct operations in a manner that will not close a thoroughfare or interfere with traffic on railways or highways except with written permission of the Contracting Officer at least 15 calendar days prior to the proposed modification date, and provide a Traffic Control Plan for Government approval detailing the proposed controls to traffic movement for approval. The plan must be in accordance with State and local regulations and the MUTCD, Part VI. [Make all notifications and obtain all permits required for modification to traffic movements outside Station's jurisdiction.]. Contractor may move oversized and slow-moving vehicles to the worksite provided requirements of the highway authority have been met.

b. Conduct work so as to minimize obstruction of traffic, and maintain traffic on at least half of the roadway width at all times. Obtain approval from the Contracting Officer prior to starting any activity that will obstruct traffic.

c. Provide, erect, and maintain, at Contractor's expense, lights, barriers, signals, passageways, detours, Life Safety Signage, overhead protection, and other items that may be required by the authority having jurisdiction.

d. Provide cones, signs, barricades, lights, or other traffic control devices and personnel required to control traffic. Do not use foil-backed material for temporary pavement marking because of its potential to conduct electricity during accidents involving downed power lines.

3.4.2 Protection of Traffic

Maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Contracting Officer. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment the work, and the erection and maintenance of adequate warning, danger, and direction signs, will be as required by the State and local authorities having jurisdiction. Provide self-illuminated (lighted) barricades during hours of darkness. All personnel working in roadways will wear brightly-colored vests or other high visibility apparel in accordance with EM 385-1-1. Protect the traveling public from damage to person and property. Minimize the interference with public traffic on roads selected for hauling material to and from the site. Investigate the adequacy of existing roads and their allowable load limit. Contractor is responsible for the repair of damage to roads caused by construction operations.

3.4.3 Rush Hour Restrictions

Do not interfere with the peak traffic flows preceding and during normal operations[for [_____]] without notification to and approval by the Contracting Officer.

3.4.4 Dust Control

Dust control methods and procedures must be approved by the Contracting Officer. Coordinate dust control methods with 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

3.5 REDUCED PRESSURE BACKFLOW PREVENTERS

****

NOTE: Include the following for all projects connecting to a potable water supply.

Coordinate with Base Utilities/PWD for any specific testing or certification requirements and edit accordingly.

****

Provide an approved reduced pressure backflow prevention assembly at each location where the Contractor taps into the Government potable water supply.

Perform backflow preventer tests using test equipment, procedures, and certification forms conforming to those outlined in the latest edition of the Manual of Cross-Connection Control published by the FCCCHR Manual. Test and tag each reduced pressure backflow preventer upon initial installation (prior to continued water use) and[quarterly][monthly][ ] thereafter. Tag must contain the following information: make, model, serial number, dates of tests, results, maintenance performed, and signature of tester. Record test results on certification forms conforming to requirements cited earlier in this paragraph.

3.6 CONTRACTOR'S TEMPORARY FACILITIES

Contractor is responsible for security of their property. Provide adequate outside security lighting at the temporary facilities. Trailers must be anchored to resist high winds and meet applicable state or local standards for anchoring mobile trailers. Coordinate anchoring with EM 385-1-1. The Contract Clause entitled "FAR 52.236-10, Operations and Storage Areas" and the following apply:

3.6.1 Administrative Field Offices

Provide and maintain administrative field office facilities within the construction area at the designated site. Government office and warehouse facilities will [not] be available to the Contractor's personnel.

In the event a new building is constructed for the temporary project field office, it must be a minimum 3.6 m 12 feet in width, 5 m 16 feet in length and have a minimum of 2.1 m 7 feet headroom. Equip the building with approved electrical wiring, at least one double convenience outlet and the required switches and fuses to provide 110-120 volt power. Provide a work table with stool, desk with chair, two additional chairs, and one legal size file cabinet that can be locked. The building must be waterproof, supplied with a heater, have a minimum of two doors, electric lights, a telephone, a battery-operated smoke detector alarm, a sufficient number of adjustable windows for adequate light and ventilation, and a supply of approved drinking water. Provide approved sanitary facilities. Screen the windows and doors and provide the doors with deadbolt type locking devices or a padlock and heavy-duty hasp bolted to the door. Door hinge pins must be non-removable. Arrange the windows to open and to be securely fastened from the inside. Protect glass panels in windows by bars or heavy mesh screens to prevent easy access. In warm weather, provide air conditioning capable of maintaining the office at 50 percent relative humidity and a room temperature 11 degrees C 20 degrees F below the outside temperature when the outside temperature is 35 degrees C 95 degrees F. Unless otherwise directed by the Contracting Officer, remove the building from the site upon completion and acceptance of the work.

[3.6.2 Quality Control Manager Records and Field Office

****

NOTE: Include this paragraph when project has separate QC Manager and project Superintendent. Edit to suit the size and location of the project.

****

Provide on the jobsite an office with approximately [9][18][_____] square meter [100][200][_____] square feet of useful floor area for the exclusive use of the QC Manager. Provide a weathertight structure with adequate [heating and cooling,] toilet facilities, lighting, ventilation, a 1200 by 2400 mm 4 by 8 foot plan table, a standard size office desk and chair, computer station, and working communications facilities. [Provide either a 1,500 watt radiant heater and a window-mounted air conditioner rated at 2.6 kW 9,000 Btus minimum or a window-mounted heat pump of the same minimum heating and cooling ratings.] Provide a door with a cylinder lock and windows with locking hardware. Make utility connections. Locate [as directed][where indicated]. File quality control records in the office and make available at all times to the Government. After completion of the work, remove the entire structure from the site.

]3.6.3 Storage Area

Construct a temporary 1.8 m 6 foot high chain link fence around trailers and materials. Include plastic strip inserts, colored [green][brown], so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit. Do not place or store trailers, materials, or equipment outside the fenced area unless such trailers, materials, or equipment are assigned a separate and distinct storage area by the Contracting Officer away from the vicinity of the construction site but within the installation boundaries. Trailers, equipment, or materials must not be open to public view with the exception of those items which are in support of ongoing work on the current day. Do not stockpile materials outside the fence in preparation for the next day's work. Park mobile equipment, such as tractors, wheeled lifting equipment, cranes, trucks, and like equipment within the fenced area at the end of each work day.

Keep fencing in a state of good repair and proper alignment. If the Contractor elects to traverse grassed or unpaved areas which are not established roadways with construction equipment or other vehicles, cover the grassed or unpaved areas with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways; gravel gradation must be at the Contractor's discretion. Mow and maintain grass located within the boundaries of the construction site for the duration of the project. Grass and vegetation along fences, structures, under trailers, and in areas not accessible to mowers must be edged or trimmed neatly.

3.6.4 Supplemental Storage Area

Upon request, and pending availability, the Contracting Officer will designate another or supplemental area for the use and storage of trailers, equipment, and materials. This area may not be in close proximity of the construction site but will be within the installation boundaries. Maintain the area in a clean and orderly fashion and secured if needed to protect supplies and equipment. Utilities will not be provided to this area by the Government.

3.6.5 Appearance of Trailers

a. Trailers must be roadworthy and comply with all appropriate state and local vehicle requirements. Trailers which are rusted, have peeling paint or are otherwise in need of repair will not be allowed on Installation property. Trailers must present a clean and neat exterior appearance and be in a state of good repair.

b. Maintain the temporary facilities. Failure to do so will be sufficient reason to require their removal at the Contractor's expense.

3.6.6 Trailers or Storage Buildings

****

NOTE: This paragraph is tailored for use on NAVY projects only.

****

a. Trailers or storage buildings will be permitted, where space is available, subject to the approval of the Contracting Officer.

b. Mount a sign not smaller than 350 by 350 mm 13.78 by 13.78 inches on the trailer or building that shows the company name, business phone number, emergency phone number and conforms to the following requirements and sketch:

Graphic panel	Aluminum, painted blue
Copy	Screen painted or vinyl die-cut, white
Typeface	Univers 65 u/lc
See Sketch No. 01500 (graphic).	

3.6.7 Safety Systems

Protect the integrity of all installed safety systems or personnel safety devices. Obtain prior approval from the Contracting Officer if entrance into systems serving safety devices is required. If it is temporarily necessary to remove or disable personnel safety devices in order to accomplish Contract requirements, provide alternative means of protection prior to removing or disabling any permanently installed safety devices or equipment and obtain approval from the Contracting Officer.

[3.6.8 Special Storage Requirements

****

NOTE: The following subparagraphs are tailored for use on Navy projects only to designate any special storage requirements. Coordinate with the supporting local NAVFAC FEAD or ROICC office to determine these special requirements and select the appropriate bracketed options, or insert other requirements, as applicable. If no special storage requirements apply to the project delete this bracketed set of subparagraphs in its entirety.

****

The following special storage requirements apply:

[3.6.8.1 Storage Size and Location

The [roofed][enclosed][open] site available for storage must be [confined to the indicated operations area][within 300 m 1,000 feet of the operations area][as indicated]. The storage area will be approximately [____] square meter square feet.

][3.6.8.2 Storage in Existing Buildings

The Contractor will be working [in][around] existing building[s]; the storage of material [will be allowed in a [____] square meter square foot area][where indicated][will not be allowed in the building[s]]. [Provide 2.4 m 8 foot high-security fence with a lockable gate around the storage area. Remove at the completion of work.]

]]3.6.9 Weather Protection of Temporary Facilities and Stored Materials

Take necessary precautions to ensure that roof openings and other critical openings in the building are monitored carefully. Take immediate actions required to seal off such openings when rain or other detrimental weather is imminent, and at the end of each workday. Ensure that the openings are completely sealed off to protect materials and equipment in the building from damage.

3.6.9.1 Building and Site Storm Protection

When a warning of gale force winds is issued, take precautions to minimize danger to persons, and protect the work and nearby Government property. Precautions must include, but are not limited to, closing openings; removing loose materials, tools and equipment from exposed locations; and removing or securing scaffolding and other temporary work. Close openings in the work when storms of lesser intensity pose a threat to the work or any nearby Government property.

[3.7 GOVERNMENT FIELD OFFICE

****

NOTE: Use this paragraph for ARMY and AIR FORCE. Do not use for NAVY projects. This paragraph is tailored for ARMY and AIR FORCE.

****

3.7.1 Resident Engineer's Office

Provide the [Government Resident Engineer] [Government Engineer] with an office, approximately 19 square meters 200 square feet in floor area, located where directed and providing space heat, [air conditioning unit,] electric light and power, and toilet facilities consisting of one lavatory and one water closet complete with connections to water and sewer mains. Provide a mail slot in the door or a lockable mail box mounted on the surface of the door. Include a 1200 by 2400 mm 4 by 8 foot plan table,[computer work space] a standard size office desk and chair, and telephone. At completion of the project, the office will remain the property of the Contractor and be removed from the site. Utilities must be connected and disconnected in accordance with local codes and to the satisfaction of the Contracting Officer. Compliance with safety and appearance requirements for temporary facilities stated in previous paragraphs is required.

3.7.2 Trailer-Type Mobile Office

The option is available to, furnish and maintain a trailer-type mobile office acceptable to the Contracting Officer to meet the requirements of the minimum facilities specified above. Securely anchor the trailer to the ground at all four corners to guard against movement during high winds. Coordinate requirements for proper anchoring with EM 385-1-1.

]3.8 PLANT COMMUNICATIONS

Whenever the individual elements of the plant are located so that operation by normal voice between these elements is not satisfactory, install a satisfactory means of communication, such as telephone or other suitable devices and make available for use by Government personnel.

3.9 TEMPORARY PROJECT SAFETY FENCING

As soon as practicable, but not later than 15 days after the date established for commencement of work, furnish and erect temporary project safety fencing at the work site. Maintain the safety fencing during the life of the Contract and, upon completion and acceptance of the work, remove from the work site.

3.10 DUMPSTERS

****

NOTE: This Aryicle is tailored for use on NAVFAC SE projects only. Use the bracketed item where visibility to the public is an issue.

****

Equip dumpsters with a secure cover and paint the standard installation color. Keep dumpster closed, except when being loaded with trash and debris.[Locate dumpsters behind the construction fence or out of the public view.] Empty site dumpsters at least once a week, or as needed to keep the site free of debris and trash. If necessary, provide 200 liter 55 gallon trash containers painted the darker installation color to collect debris in the construction site area. For large demolitions, large dumpsters without lids are acceptable, but must not have debris higher than the sides before emptying.

3.11 CLEANUP

Remove construction debris, waste materials, packaging material and the like from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways must be cleaned away. Store all salvageable materials resulting from demolition activities within the fenced area described above or at the supplemental storage area. Neatly stack stored materials not in trailers, whether new or salvaged.

3.12 RESTORATION OF STORAGE AREA

Upon completion of the project remove the bulletin board, signs, barricades, haul roads, and all other temporary products from the site. After removal of trailers, materials, and equipment from within the fenced area, remove the fence. Restore areas used during the performance of the Contract to the original or better condition. Remove gravel used to traverse grassed areas and restore the area to its original condition, including top soil and seeding as necessary.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-01 57 19 (August 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 57 19 (November 2015)
UFGS-01 57 19.01 20 (November 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 01 57 19

TEMPORARY ENVIRONMENTAL CONTROLS

08/22

ATTACHMENTS:

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-01 57 19 (August 2022)**

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UFGS-01 57 19 (November 2015)
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 57 19

TEMPORARY ENVIRONMENTAL CONTROLS

08/22

****

NOTE: This guide specification covers the requirements for environmental protection and other environmental temporary controls.

Use this specification for design and construction projects located CONUS and OCONUS. Edit this specification to the extent that is allowed and does not conflict with the applicable Status of Forces Agreements (SOFA), Host Nation-Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA), and country-specific Final Governing Standards (FGS) or the DoD Overseas Environmental Baseline Guidance Document (OEBGD), DoD 4715.05. The OEBGD applies when there are no FGS in place.

Only edit the parts of this specification section that have bracketed choices.

Many States and Municipalities have more stringent or additional requirements:

For Navy projects, use this section and those portions of this section which contain State and Local requirements. Add any further local requirements into this section. Use these sections for both Design-Bid-Build and Design-Build projects.

For Army projects. Edit this section to include weblinks to the State or Local requirement. Add the State and Local source to the Reference list and cite within the body of this section. Clearly state in this section deviations from the State and Local requirements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide**

specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

NOTE: To download UFGS Forms, Graphics, and Tables, go to: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATION OF ILLINOIS SOIL AND WATER CONSERVATION DISTRICTS (AISWCD)

IUM	(2020) Illinois Urban Manual

ASTM INTERNATIONAL (ASTM)

ASTM E2356	(2018) Standard Practice for Comprehensive Building Asbestos Surveys

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY (IEPA)

35 IAC 900-901	Title 35 of Illinois Administrative Code, Subtitle H: Noise, Chapter I: Pollution Control Board

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT (IDEM)

327 IAC 2-6.1	Indiana Administrative Code, Volume 6, Title 327, Article 2, Rule 6.1. Spills; Reporting, Containment, and Response
327 IAC 15-5	Indiana Administrative Code, Volume 6, Title 327, Article 15, Section 5. Storm Water Run-off Associated with Construction Activity
327 IAC 15-5-6	Indiana Administrative Code, Volume 6, Title 327, Article 15, Section 5-6. Submittal of an NOI Letter and Construction Plans
327 IAC 15-5-6.5	Indiana Administrative Code, Volume 6, Title 327, Article 15, Section 5-6.5. Requirements for Construction Plans
327 IAC 15-5-7	Indiana Administrative Code, Volume 6, Title 327, Article 15, Section 5-7. General Requirements for Storm Water Quality Control

INSTRUCTIONS AND STANDARDS FOR NAVBASE GUANTANAMO BAY CUBA (COMNAVBASEGTMOINST)

1710.10	Outdoor Recreational and Wildlife Instruction
4400.2A	Consolidated Hazardous Material Reutilization and Inventory Management Program
5090.1	Hazardous Waste Management Plan
5090.4	Standard Operating Procedures for Landfill
5090.7	Pollution Control Procedures for Oil and Hazardous Substances
5090.8	Asbestos Program Management
5100.13	Hazardous Material/Excess Hazardous Material Control and Safety Program
FGS	(1994) Final Governing Standards for Environmental Protection by U.S. Forces in Cuba

PUGET SOUND CLEAN AIR AGENCY (PSCAA)

PSCAA Regulation	Regulation I, II, and III

STATE OF VIRGINIA ADMINISTRATIVE CODE (VAC)

9 VAC 25-840	Title 9, Agency 25, Chapter 840: Erosion And Sediment Control Regulations
9 VAC 25-850	Title 9, Agency 25, Chapter 850: Erosion And Sediment Control And Stormwater Management Certification Regulations
9 VAC 25-870	Title 9, Agency 25, Chapter 870: Virginia Stormwater Management Program (VSMP) Regulation

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4715.05	(2020) Overseas Environmental Baseline Guidance Document: Conservation

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1053	Respirable Crystalline Silica
29 CFR 1910.1200	Hazard Communication
29 CFR 1926.1153	Respirable Crystalline Silica
40 CFR 50	National Primary and Secondary Ambient Air Quality Standards
40 CFR 60	Standards of Performance for New Stationary Sources
40 CFR 61.145	Standard for Demolition and Renovation
40 CFR 63	National Emission Standards for Hazardous Air Pollutants for Source Categories
40 CFR 64	Compliance Assurance Monitoring
40 CFR 68	Chemical Accident Prevention Provisions
40 CFR 82	Protection of Stratospheric Ozone
40 CFR 112	Oil Pollution Prevention

40 CFR 122.26	Storm Water Discharges (Applicable to State NPDES Programs, see section 123.25)
40 CFR 152	Pesticide Registration and Classification Procedures
40 CFR 152 - 186	Pesticide Programs
40 CFR 241	Guidelines for Disposal of Solid Waste
40 CFR 243	Guidelines for the Storage and Collection of Residential, Commercial, and Institutional Solid Waste
40 CFR 258	Subtitle D Landfill Requirements
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 261.7	Residues of Hazardous Waste in Empty Containers
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 262.11	Hazardous Waste Determination and Recordkeeping
40 CFR 262.34	Standards Applicable to Generators of Hazardous Waste-Accumulation Time
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 273	Standards for Universal Waste Management
40 CFR 273.2	Standards for Universal Waste Management - Batteries
40 CFR 273.3	Standards for Universal Waste Management - Pesticides

40 CFR 273.4	Standards for Universal Waste Management - Mercury Containing Equipment
40 CFR 273.5	Standards for Universal Waste Management - Lamps
40 CFR 273.6	Applicability - Aerosol Cans
40 CFR 279	Standards for the Management of Used Oil
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 300.125	National Oil and Hazardous Substances Pollution Contingency Plan - Notification and Communications
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
40 CFR 403	General Pretreatment Regulations for Existing and New Sources of Pollution
40 CFR 745	Lead-Based Paint Poisoning Prevention in Certain Residential Structures
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 172.101	Hazardous Material Regulation-Purpose and Use of Hazardous Material Table
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 178	Specifications for Packagings
77 FR 12286	Final National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Construction Activities

WASHINGTON STATE ADMINISTRATIVE CODE (WAC)

WAC-173-60	Maximum Environmental Noise Levels
WAC-173-160	Minimum Standards for Construction and Maintenance of Wells

WAC-173-303	Washington Dangerous Waste Regulations
WAC-173-303-330	Personnel Training
WAC-173-303-573	Standards for Universal Waste Management
WAC-173-303-573(2)	Standards for Universal Waste Management - Batteries
WAC-173-303-573(3)	Standards for Universal Waste Management - Mercury-containing Equipment
WAC-173-303-573(5)	Standards for Universal Waste Management - Lamps
WAC-173-350	Solid Waste Handling Standards
WAC-222-30	Timber Harvesting
WAC-246-290	Department of Health Drinking Water Regulation

WASHINGTON STATE DEPARTMENT OF ECOLOGY (WSDE)

WSDE SMM	(2014) Washington State Stormwater Management Manual for Western Washington

WISCONSIN DEPARTMENT OF NATURAL RESOURCES (WDNR)

s. NR 415, Wis. Adm. Code	Control of Particulate Emissions

1.2 DEFINITIONS

****

NOTE: Delete definitions not used within the section edited for a project.

****

1.2.1 Class I and II Ozone Depleting Substance (ODS)

Class I ODS is defined in Section 602(a) of The Clean Air Act. A list of Class I ODS can be found on the EPA website at the following weblink. https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances.

Class II ODS is defined in Section 602(s) of The Clean Air Act. A list of Class II ODS can be found on the EPA website at the following weblink. https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances.

1.2.2 Contractor Generated Hazardous Waste

Contractor generated hazardous waste is materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of material brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e., methyl ethyl ketone, toluene), waste thinners, excess paints, excess solvents, waste solvents, excess pesticides, and contaminated pesticide equipment rinse water.

1.2.3 Electronics Waste

Electronics waste is discarded electronic devices intended for salvage, recycling, or disposal.

1.2.4 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally or historically.

1.2.5 Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2.6 Hazardous Debris

As defined in paragraph SOLID WASTE, debris that contains listed hazardous waste (either on the debris surface, or in its interstices, such as pore structure) in accordance with 40 CFR 261. Hazardous debris also includes debris that exhibits a characteristic of hazardous waste in accordance with 40 CFR 261.

1.2.7 Hazardous Materials

Hazardous material is any material that: Is defined in 49 CFR 171, listed in 49 CFR 172, regulated as a hazardous material in accordance with 49 CFR 173; or requires a Safety Data Sheet (SDS) in accordance with 29 CFR 1910.1200; or during end use, treatment, handling, packaging, storage, transportation, or disposal meets or has components that meet or have potential to meet the definition of a hazardous waste as defined by 40 CFR 261 Subparts A, B, C, or D. Designation of a material by this definition, when separately regulated or controlled by other sections or directives, does not eliminate the need for adherence to that hazard-specific guidance which takes precedence over this section for "control" purposes. Such material includes ammunition, weapons, explosive actuated devices, propellants, pyrotechnics, chemical and biological warfare materials, medical and pharmaceutical supplies, medical waste and infectious materials, bulk fuels, radioactive materials, and other materials such as asbestos, mercury, and polychlorinated biphenyls (PCBs).

1.2.8 Hazardous Waste

Hazardous Waste is any material that meets the definition of a solid waste and exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity) as specified in 40 CFR 261, Subpart C, or contains a listed hazardous waste as identified in 40 CFR 261, Subpart D, or meets a state, local, or host nation definition of a hazardous waste.

1.2.9 Installation Pest Management Coordinator

****

NOTE: The following paragraph is tailored for ARMY. Use this paragraph for Army projects only. Do not use for Navy or Air Force projects. Delete as appropriate if project is not on an installation.

****

Installation Pest Management Coordinator (IPMC) is the individual officially designated by the Installation Commander to oversee the Installation Pest Management Program and the Installation Pest Management Plan.

1.2.10 Land Application

Land Application means spreading or spraying discharge water at a rate that allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, discharge into defined drainage areas, or discharge into the "waters of the United States" must occur. Comply with federal, state, and local laws and regulations.

1.2.11 Municipal Separate Storm Sewer System (MS4) Permit

MS4 permits are those held by municipalities or installations to obtain NPDES permit coverage for their stormwater discharges.

1.2.12 National Pollutant Discharge Elimination System (NPDES)

The NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

1.2.13 Oily Waste

Oily waste are those materials that are, or were, mixed with Petroleum, Oils, and Lubricants (POLs) and have become separated from that POLs. Oily wastes also means materials, including wastewaters, centrifuge solids, filter residues or sludges, bottom sediments, tank bottoms, and sorbents which have come into contact with and have been contaminated by, POLs and may be appropriately tested and discarded in a manner which is in compliance with other state and local requirements.

This definition includes materials such as oily rags, "kitty litter" sorbent clay and organic sorbent material. These materials may be land filled provided that: It is not prohibited in other state regulations or local ordinances; the amount generated is "de minimus" (a small amount); it is the result of minor leaks or spills resulting from normal process operations; and free-flowing oil has been removed to the practicable extent possible. Large quantities of this material, generated as a result of a major spill or in lieu of proper maintenance of the processing equipment, are a solid waste. As a solid waste, perform a hazardous waste determination prior to disposal. As this can be an expensive process, it is recommended that this type of waste be minimized through good housekeeping practices and employee education.

1.2.14 Pesticide

****

NOTE: The following paragraph is tailored for ARMY

use only.
****

Pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, or intended for use as a plant regulator, defoliant or desiccant.

1.2.15 Pesticide Treatment Plan

****
NOTE: The following paragraph is tailored for ARMY use only.
****

A plan for the prevention, monitoring, and control to eliminate pest infestation.

1.2.16 Pests

****
NOTE: The following paragraph is tailored for ARMY use only.
****

Pests are arthropods, birds, rodents, nematodes, fungi, bacteria, viruses, algae, snails, marine borers, snakes, weeds and other organisms (except for human or animal disease-causing organisms) that adversely affect readiness, military operations, or the well-being of personnel and animals; attack or damage real property, supplies, equipment, or vegetation; or are otherwise undesirable.

1.2.17 Project Pesticide Coordinator

****
NOTE: The following paragraph is tailored for ARMY use only.
****

The Project Pesticide Coordinator (PPC) is an individual who resides at a Civil Works Project office and who is responsible overseeing of pesticide application on project grounds.

1.2.18 Regulated Waste

Regulated waste are solid wastes that have specific additional federal, state, or local controls for handling, storage, or disposal.

1.2.19 Sediment

Sediment is soil and other debris that have eroded and have been transported by runoff water or wind.

1.2.20 Solid Waste

Solid waste is a solid, liquid, semi-solid or contained gaseous waste. A solid waste can be a hazardous waste, non-hazardous waste, or non-Resource Conservation and Recovery Act (RCRA) regulated waste. Types of solid waste typically generated at construction sites may include:

1.2.20.1 Debris

****
NOTE: State and local requirements regarding the acceptability of reinforcement in inert debris vary. Check with the Solid Waste Authority at the state or local level and edit the second sentence accordingly.
****

Debris is non-hazardous solid material generated during the construction, demolition, or renovation of a structure that exceeds 60 mm 2.5-inch particle size that is: a manufactured object; plant or animal matter; or natural geologic material (for example, cobbles and boulders), broken or removed concrete, masonry, and rock asphalt paving; ceramics; roofing paper and shingles. Inert materials [may][may not] be reinforced with or contain ferrous wire, rods, accessories and weldments. A mixture of debris and other material such as soil or sludge is also subject to regulation as debris if the mixture is comprised primarily of debris by volume, based on visual inspection.

1.2.20.2 Clean Construction and Demolition Debris (CCDD)

****
NOTE: The following paragraph is tailored for ILLINOIS and is for State of Illinois use only.
****

As defined by the Illinois Environmental Protection Agency, CCDD is uncontaminated broken concrete without protruding metal bars, bricks, rock, stone, or reclaimed asphalt pavement generated from construction or demolition activities. When uncontaminated soil is mixed with any of these materials, the uncontaminated soil is considered CCDD.

1.2.20.3 Green Waste

Green waste is the vegetative matter from landscaping, land clearing and grubbing, including, but not limited to, grass, bushes, scrubs, small trees and saplings, tree stumps and plant roots. Marketable trees, grasses and plants that are indicated to remain, be re-located, or be re-used are not included.

1.2.20.4 Material Not Regulated As Solid Waste

Material not regulated as solid waste is nuclear source or byproduct materials regulated under the Federal Atomic Energy Act of 1954 as amended; suspended or dissolved materials in domestic sewage effluent or irrigation return flows, or other regulated point source discharges; regulated air emissions; and fluids or wastes associated with natural gas or crude oil exploration or production.

1.2.20.5 Non-Hazardous Waste

Non-hazardous waste is waste that is excluded from, or does not meet, hazardous waste criteria in accordance with 40 CFR 261.

1.2.20.6 Recyclables

****

NOTE: State and local requirements regarding the inclusion within recyclables of paint cans and lead contaminated or lead based paint contaminated metal or wiring sold to scrap metal companies vary. Check with the Solid Waste Authority at the state or local level and edit accordingly.

****

Recyclables are materials, equipment and assemblies such as doors, windows, door and window frames, plumbing fixtures, glazing and mirrors that are recovered and sold as recyclable,[wiring,][insulated/non-insulated copper wire cable,][wire rope,] and structural components. It also includes commercial-grade refrigeration equipment with Freon removed, household appliances where the basic material content is metal, clean polyethylene terephthalate bottles, cooking oil, used fuel oil, textiles, high-grade paper products and corrugated cardboard, stackable pallets in good condition, clean crating material, and clean rubber/vehicle tires. Metal meeting the definition of lead contaminated or lead based paint contaminated [may][may not] be included as recyclable if sold to a scrap metal company. Paint cans that meet the definition of empty containers in accordance with 40 CFR 261.7 may be included as recyclable if sold to a scrap metal company.

1.2.20.7 Surplus Soil

Surplus soil is existing soil that is in excess of what is required for this work, including aggregates intended, but not used, for on-site mixing of concrete, mortars, and paving. Contaminated soil meeting the definition of hazardous material or hazardous waste is not included and must be managed in accordance with paragraph HAZARDOUS MATERIAL MANAGEMENT.

1.2.20.8 Scrap Metal

This includes scrap and excess ferrous and non-ferrous metals such as reinforcing steel, structural shapes, pipe, and wire that are recovered or collected and disposed of as scrap. Scrap metal meeting the definition of hazardous material or hazardous waste is not included.

1.2.20.9 Wood

Wood is dimension and non-dimension lumber, plywood, chipboard, hardboard. Treated or painted wood that meets the definition of lead contaminated or lead based contaminated paint is not included. Treated wood includes, but is not limited to, lumber, utility poles, crossties, and other wood products with chemical treatment.

1.2.21 Surface Discharge

Surface discharge means discharge of water into drainage ditches, storm sewers, or creeks meeting the definition of "waters of the United States". Surface discharges from construction sites are discrete, identifiable sources and require a permit from the governing agency. Comply with federal, state, and local laws and regulations.

****

NOTE: The following paragraph is tailored for ILLINOIS and is for State of Illinois use only.

****

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, or "waters of the United States" and would require a permit to discharge water from the governing agency. All projects with land disturbances greater than or equal to one acre in total area must have a National Pollution Discharge Elimination System (NPDES) Construction Site Activity Storm Water Permit to discharge surface water from a construction site, issued by the Illinois Environmental Protection Agency. All projects with discharge of dredged or fill material to waters of the United States must have a Section 401 Water Quality Permit issued by the Illinois Environmental Protection Agency.

****

NOTE: The following paragraph is tailored for INDIANA and is for State of Indiana use only.

****

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, or "waters of the United States". All projects with land disturbances greater than or equal to one acre in total area must have a National Pollution Discharge Elimination System (NPDES) Construction Site Activity Storm Water Permit, issued by the Indiana Department of Environmental Management. All projects with discharge of dredged or fill material to waters of the United States must have a Section 401 Water Quality Permit issued by the Indiana Department of Environmental Management.

****

NOTE: The following paragraph is tailored for WISCONSIN and is for State of Wisconsin use only.

****

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, or "waters of the United States". All projects with land disturbances greater than or equal to one acre in total area must have a National Pollution Discharge Elimination System (NPDES) Construction Site Activity Storm Water Permit, issued by the Wisconsin Department of Natural Resources (WDNR). All projects with discharge of dredged or fill material to waters of the United States must comply with Sections 404 and 401 of the Clean Water Act, including obtaining all required permits and approvals.

1.2.22 Wastewater

Wastewater is the used water and solids that flow through a sanitary sewer to a treatment plant.

1.2.22.1 Stormwater

Stormwater is any precipitation in an urban or suburban area that does not evaporate or soak into the ground, but instead collects and flows into storm drains, rivers, and streams.

1.2.23 Waters of the United States

Waters of the United States means Federally jurisdictional waters, including wetlands, that are subject to regulation under Section 404 of the Clean Water Act or navigable waters, as defined under the Rivers and Harbors Act.

1.2.24 Wetlands

Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

1.2.25 Universal Waste

****

Note: States' universal waste regulations may differ from the federal requirements below. Verify all constituents listed below are categorized as universal waste by the State where the project is located and edit accordingly. Some states may include additional materials. Include those here.

****

The universal waste regulations streamline collection requirements for certain hazardous wastes in the following categories: batteries, pesticides, mercury-containing equipment (for example, thermostats), and lamps (for example, fluorescent bulbs). The rule is designed to reduce hazardous waste in the municipal solid waste (MSW) stream by making it easier for universal waste handlers to collect these items and send them for recycling or proper disposal. These regulations can be found at 40 CFR 273.

1.2.26 Location Specific Universal Waste

Any of the following dangerous waste that are subject to the universal waste requirements of WAC-173-303-573: Batteries as described in WAC-173-303-573(2)); Lamps as described in WAC-173-303-573(5); Mercury-containing equipment as described in WAC-173-303-573(3).

1.2.27 Dangerous Waste

****

NOTE: This paragraph is tailored for NAVFAC NW use only.

****

Waste defined as dangerous waste in accordance with WAC-173-303. This includes, but is not limited to, hazardous waste, extremely hazardous waste and state-only dangerous waste.

1.2.28 Encountered Waste

****

NOTE: This paragraph is tailored for NAVFAC NW use only.

****

Material that is of Government origin that becomes a waste during construction at or on Government property. This term includes both foreseen and unforeseen Government waste discovered at the worksite.

1.2.29 Firewood

****
NOTE: This paragraph is tailored for NAVFAC NW use only.
****

Raw, woody material cut into short lengths and burned to produce energy.

1.2.30 Fugitive Dust

****
NOTE: This paragraph is tailored for NAVFAC NW use only.
****

Particulate matter or any visible air contaminant (smoke, dust, or fume) other than uncombined water that is not collected by a capture system and emitted from a stack, but is released to the atmosphere at the point of generation.

1.2.31 Ozone Depleting Substance (ODS) Substitute

****
NOTE: This paragraph is tailored for NAVFAC NW use only.
****

Any chemical or product, whether existing or new, that is used by any person as an EPA-approved replacement for a Class I or Class II ODS in a given refrigeration or air-conditioning end-use.

1.2.32 Refrigerant

****
NOTE: This paragraph is tailored for NAVFAC NW use only.
****

Any substance consisting in part or whole of a Class I or Class II ODS, or an ODS substitute that is used for heat transfer purposes and provides a cooling effect.

1.2.33 Refuse

****
NOTE: This paragraph is tailored for NAVFAC NW use only.
****

Includes, but is not limited to garbage, rubbish, trash, some soils, and non-painted demolition and construction debris. The Government will designate refuse. When designated as "refuse," the Government has determined the waste is not "Dangerous Waste."

1.2.34 Sewage

****

NOTE: This paragraph is tailored for NAVFAC NW use only.
****

Liquid waste designated by the Government as "domestic sanitary sewage" and normally discharged through domestic sanitary sewage systems. Liquids designated as "sewage" include human body waste, and wastewater from sinks, showers, laundries, dishwashers, and garbage disposals when these liquids use only chemicals approved by the Government for discharge into the sanitary sewer.

1.2.35 Spill Event

****
NOTE: The following paragraph and subparagraphs are tailored for NAVFAC NW use only.
****

A spill is any release of oil or hazardous substances to the water or ground that is not controlled or permitted. This includes any spilling, leaking, pumping, emitting, discharging, injecting, escaping, leaching, disposing, or dumping of liquid or solid material that is not authorized in writing by the Contracting Officer.

1.2.35.1 Reportable Release

A reportable release means any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of a known or unknown material or hazardous substance that poses an immediate threat to human health or the environment to the air, soil, or water. Reportable releases are: a sheen of oil on the water; a violation of the Installation's or project's water permit (NPDES permit); a sewage spill that threatens human health or the environment; a Comprehensive Environmental Response, Compensation, and Liability Act reportable quantity for hazardous/toxic substances (40 CFR 302); an air or hazardous substance release that is a threat to human health or the environment, or released outside the facility boundaries; any discharge from an underground storage tank regulated under WAC 173-360; or oil spilled to the ground or to permeable secondary containment of 160 liters 42 gallons and greater.

1.2.35.2 Non-emergency Spill Event

A non-emergency spill event is a discharge of a known material or any hazardous substance that does not pose an immediate threat to human health or the environment, can be cleaned up as part of normal housekeeping by the personnel who discovered the spill, and is not released on the soil or into any waterway inlet (for example, storm drain) or outside Navy property boundaries.

1.2.36 Timber, Merchantable

****
NOTE: This paragraph is tailored for NAVFAC NW use only.
****

Any raw material yielded by a forest that is of a size, quality and condition suitable for marketing under given economic conditions, even if it is situated such that it is not immediately accessible for logging.

1.2.37 Nonroad Engine

****

NOTE: This paragraph is tailored for NAVFAC NW use only.

****

Any internal combustion engine, except motor vehicle (highway engines, stationary engines, or engines that remain at one location for more than 12 months), engines used solely for competition, or engines used in aircraft. This definition is based on the principle of mobility and portability, and includes engines installed on (1) self-propelled equipment, (2) equipment that is propelled while performing its function, or (3) equipment that is portable or transportable, as indicated by the presence of wheels, skids, carrying handles, dolly, trailer, or platform. Examples of regulated applications include farm tractors, excavators, bulldozers, wheel loaders, backhoe loaders, road graders, diesel lawn tractors, logging equipment, portable generators, skid steer loaders, or forklifts.

[1.2.38 Landfill-Controlled Waste

****

NOTE: This paragraph is tailored for NAVFAC NW use only.

****

Waste containing harmful substances but not designated as dangerous in accordance with WAC-173-303 that are screened by a receiving facility to ensure that it meets the requirements of their operating permit. Examples include petroleum-contaminated soil, abrasive blast grit, street or dry-dock sweepings, treated wood, oily debris, and waste containing free liquids as determined by the Paint Filter Liquids Test method 9095.

]1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: For Navy Design-Build projects, delete 01 33 00 SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****

NOTE: For projects in the NAVFAC PAC Area of Operation, and for the submittals identified as SD-01 Preconstruction Submittals, select the "G" designation requiring Government approval for Environmental Protection Plan, and Stormwater Pollution Protection Plan. Remove the "G" designation for Stormwater Notice of Intent, Solid Waste Management Permit, Regulatory Notifications, Dirt and Dust Control Plan, Employee Training Records, and Environmental Manager Qualifications.

****

****

NOTE: Include the following submittal for NBK Bangor and NBK Keyport.

****

Waste Originator Training Certification; G, [_____]

****

NOTE: Include the following submittal for NBK Bangor, NBK Keyport, NBK Bremerton, NAVSTA Everett.

****

[PSCAA Nonroad Engine Notification Form; G, [_____]

] **

NOTE: Include the following submittal for construction of a new air pollution source. At NBK Bangor, NBK Keyport, NBK Bremerton, and Everett

choose PSCAA. At Indian Island, choose ORCAA. At Whidbey, choose NWCAA.

****

Notice of Construction, [PSCAA][ORCAA][NWCAA]; G, [_____]

****

NOTE: Include the following three submittals for NAVFAC SE projects.

****

[Dewatering Permit

][Florida Environmental Resource Permit

] Excavation Permits; G, [_____]

****

NOTE: Include the following submittal item for NAVFAC PAC projects.

****

Storage Material Inventory; G, [_____]

Preconstruction Survey

Regulatory Notifications; G, [_____]

Environmental Manager Qualifications; G, [_____]

Employee Training Records; G, [_____]

Environmental Protection Plan; G, [_____]

Dirt and Dust Control Plan; G, [_____]

Solid Waste Management Permit; G, [_____]

[Stormwater Pollution Prevention Plan (SWPPP); G, [_____]

][Stormwater Notice of Intent (for NPDES coverage under the general permit for construction activities); G, [_____]

] Spill Prevention Control And Countermeasure (SPCC) Plan; G, [_____]

****

NOTE: The following two submittal items are tailored for NAVFAC NW.

****

[Project Report

][Contractor's Operation and Maintenance (O & M) Plan

] SD-06 Test Reports

Monthly Solid Waste Disposal Report; G, [_____]

[Inspection Reports

][Laboratory Analysis

] SD-07 Certificates

****

NOTE: The following submittal item is tailored for NAVY.

****

ECATTS Certificate Of Completion; G, [_____]

Employee Training Records; G, [_____]

[Erosion and Sediment Control Inspector Qualifications

] **

NOTE: The following submittal item is tailored for ARMY.

****

Certificate of Competency

****

NOTE: Include the following for NBK Bremerton and NAVSTA Everett.

****

Storm Drain and Sanitary Sewer Discharge Approval; G, [_____]

[Monthly Project Waste Summary Report

][Landfill Disposal Form; G, [_____]

][Dangerous Waste Profile; G, [_____]

][Dangerous Waste Manifests; G, [_____]

][Contractor Request for 45/90-Day Hazardous Waste Accumulation Certification/Recertification; G, [_____]

][Contractor Request for Hazardous Waste Satellite Accumulation Area (SAA) Registration; G, [_____]

] Accumulation Area Inspection Record

[Hazardous Waste Accumulation Area Registration Form

] **

NOTE: Include the following submittal for Whidbey and NAVSTA Everett.

****

Certificate Of Final Disposal; G, [_____]

SD-11 Closeout Submittals

****

NOTE: Use the following submittal for NBK Keyport,

NBK Bangor, NAVSTA Everett, and Indian Island.
****

Refrigerant Work Checklist; G, [_____]

[Refuse and Recycle Quantity Form; G, [_____]

][Project Completion Report; G, [_____]

][Operation and Maintenance Records (Air Pollution Sources)

] **
NOTE: Select ORCAA for Indian Island, NWCAA for Whidbey, or PSCAA for Everett, NBK Bangor, NBK Bremerton, and NBK Keyport.
****

Notice of Completion, [PSCAA][NWCAA][ORCAA]

****
NOTE: Use the following submittal item for NBK Bremerton and Whidbey.
****

Solid Waste Tracking Sheet

Regulatory Notifications; G, [_____]

Assembled Employee Training Records; G, [_____]

Solid Waste Management Permit; G, [_____]

[Stormwater Pollution Prevention Plan Compliance Notebook; G, [_____]

][Stormwater Notice of Termination (for NPDES coverage under the general permit for construction activities); G, [_____]

][As-Built Topographic Survey

] Waste Determination Documentation; G, [_____]

Project Solid Waste Disposal Documentation Report; G, [_____]

Sales Documentation; G, [_____]

[Contractor Certification

] Hazardous Waste/Debris Management; G, [_____]

Disposal Documentation for Hazardous and Regulated Waste; G, [_____]

Contractor Hazardous Material Inventory Log; G, [_____]

****
NOTE: Include the following submittal for NAVFAC SE projects.
****

[Hazardous Waste Inspection Logs; G, [_____]

]1.4 ENVIRONMENTAL PROTECTION REQUIREMENTS

Provide and maintain, during the life of the contract, environmental protection as defined. Plan for and provide environmental protective measures to control pollution that develops during construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the project. Protect the environmental resources within the project boundaries and those affected outside the limits of permanent work during the entire duration of this Contract. Comply with federal, state, and local regulations pertaining to the environment, including water, air, solid waste, hazardous waste and substances, oily substances, and noise pollution.

Tests and procedures assessing whether construction operations comply with Applicable Environmental Laws may be required. Analytical work must be performed by qualified laboratories; and where required by law, the laboratories must be certified.

1.4.1 Training in Environmental Compliance Assessment Training and Tracking System (ECATTS)

****

NOTE: The following is tailored for NAVY. Use this paragraph and subparagraphs for Navy projects only. Delete for other projects.

Coordinate with the Installation Environmental Office to add additional staff that require training. Coordinate with paragraph ENVIRONMENTAL MANAGER.

****

1.4.1.1 Personnel Requirements

The Environmental Manager is responsible for environmental compliance on projects. The Environmental Manager[and other staff], must complete applicable ECATTS training modules (installation specific or general) prior to starting respective portions of on-site work under this Contract. If personnel changes occur for any of these positions after starting work, replacement personnel must complete applicable ECATTS training within 14 days of assignment to the project.

1.4.1.2 Certification

Submit an ECATTS certificate of completion for personnel who have completed the required ECATTS training. This training is web-based and can be accessed from any computer with Internet access using the following instructions.

Register for NAVFAC Environmental Compliance Assessment, Training, and Tracking System, by logging on to https://environmentaltraining.ecatts.com/. Obtain the password for registration from the Contracting Officer.

1.4.1.3 Refresher Training

This training has been structured to allow contractor personnel to receive credit under this contract and to carry forward credit to future contracts. Ensure the Environmental Manager review their training plans for new modules or updated training requirements prior to beginning work. Some training modules are tailored for specific state regulatory requirements; therefore, Contractors working in multiple states will be required to retake modules tailored to the state where the contract work is being performed.

1.4.2 Conformance with the Environmental Management System

Perform work under this contract consistent with the policy and objectives identified in the installation's Environmental Management System (EMS). Perform work in a manner that conforms to objectives and targets of the environmental programs and operational controls identified by the EMS. Support Government personnel when environmental compliance and EMS audits are conducted by escorting auditors at the Project site, answering questions, and providing proof of records being maintained. Provide monitoring and measurement information as necessary to address environmental performance relative to environmental, energy, and transportation management goals. In the event an EMS nonconformance or environmental noncompliance associated with the contracted services, tasks, or actions occurs, take corrective and preventative actions. In addition, employees must be aware of their roles and responsibilities under the installation EMS and of how these EMS roles and responsibilities affect work performed under the contract.

Coordinate with the installation's EMS coordinator to identify training needs associated with environmental aspects and the EMS, and arrange training or take other action to meet these needs. Provide training documentation to the Contracting Officer. The Installation Environmental Office will retain associated environmental compliance records. Make EMS Awareness training completion certificates available to Government auditors during EMS audits and include the certificates in the Employee Training Records. See paragraph EMPLOYEE TRAINING RECORDS.

1.5 SPECIAL ENVIRONMENTAL REQUIREMENTS

****

NOTE: The special environmental requirements with which the Contractor must comply must be developed during the design process, included in the bidding documents, and made a part of the contract. The special environmental requirements must be developed by the Designer from such documents as the National Environmental Policy Act (NEPA) compliance measures specified in the Categorical Exclusion documentation, Environmental Assessment (EA), or the Environmental Impact Statement (EIS), the Installation Master Plan, or the Installation Storm Water Management Plan. For Civil Works projects, the Environmental commitments made during planning are usually tracked by Project Management. Coordination with the Project Manager is essential in developing the special requirements.

List attachments referenced below in paragraph

LICENSES AND PERMITS, which require Contractor's actions, in the blank provided and attach to the end of this Section. Remove this paragraph if not required in the project after coordination with paragraph LICENSES AND PERMITS.
****

Comply with the special environmental requirements listed here [_____] and attached at the end of this section.

1.5.1 Mid-Atlantic

****
NOTE: The following paragraph and subparagraphs are tailored for NAVFAC ML use only.
****

****
NOTE: Applicable environmental requirements such as; erosion/sediment control, storm water, hazardous waste, and solid waste may have unique state regulations. Edit this section to include these unique state requirements for each state listed below.
****

****
NOTE: For each project, provide the following:
1. Unique local requirements and state regulations.
2. Environmental Point of Contact information for design review and base specific requirements.
3. For every installation in area of responsibility, the FEC must identify the facility Hazardous Waste Generator status as specified in paragraph FACILITY HAZARDOUS WASTE GENERATOR STATUS.
4. For each installation listed below, provide specific requirements of the installation's Environmental Management System (EMS) that relate to construction operations. Identify those site specific EMS actions that the Contractor must perform under this contract.
****

Comply with the following state, regional, and local requirements.

1.5.1.1 Virginia

****
NOTE: The following paragraphs apply to Hampton Roads Installations (Norfolk Naval Station, NAS Oceana, Dam Neck Annex, JEB Little Creek/Fort Story, Norfolk Naval Shipyard, NWS Yorktown, NSA Hampton Roads) Modify and add requirements if used for other Installations in Virginia according to their practices.
****

1.5.1.1.1 Definition and Disposal Requirements of Empty Paint Cans

Paint Cans: Paint cans that are empty (free of liquids and as defined in 40 CFR 261.7) of paints, solvents, thinners and adhesives may be disposed of in dumpsters.

Metal paint cans that meet the empty standard can be placed in dumpsters marked "metal only"; plastic cans may be placed in solid waste dumpsters. Manage paint cans with liquid or more than 2.54 cm one inch of solidified oil-based paint as a hazardous waste and label properly. Manage paint cans with excess water-based paint as non-hazardous waste provided that they do not contain free liquids or contain any substance with a hazardous characteristic as defined in 40 CFR 261. Contact NAVFAC MIDLANT Environmental Services for management requirements.

1.5.1.1.2 Erosion and Sediment Control Measures and Stormwater Management

1.5.1.1.2.1 Erosion and Sediment Control

****

NOTE: Use this paragraph where land disturbance is 929 square meters 10,000 square feet or greater.

****

Submit an erosion and sediment control plan, and comply with the requirements specified in the Virginia Erosion and Sediment Control Law and Regulations. (Virginia Code: 9 VAC 25-840). Obtain a Certificate of Competency in accordance with 9 VAC 25-850.

1.5.1.1.2.2 Construction Dewatering

Construction site stormwater runoff must be treated using proper erosion control measures or stormwater management practices prior to release from the construction site. Pollutants, including but not limited to chemicals, fuels, lubricants, sewage, paints, sedimentation, and other harmful materials must not be discharged into or alongside any river, stream, or impoundment, or into any channels leading to them. Implement appropriate erosion and sediment control measures to all disturbed areas or bare soils to prevent unauthorized offsite sedimentation. Apply stabilization measures to denuded portions of a project that are at final grade or where work has temporarily ceased within 7 days.

1.5.1.1.3 Virginia Stormwater Management

****

NOTE: Use this paragraph where land disturbance is 4047 square meters one acre or greater.

****

Where land disturbance is equal to or exceeds 4046 square meters one acre, prepare and submit a Stormwater Pollution Prevention Plan (SWPPP) and comply with the requirements specified in the Virginia Stormwater Management Law and Regulations (Virginia Code: 9 VAC 25-870). Obtain Certificate of Competency in accordance with 9 VAC 25-850.

1.5.1.1.3.1 Stormwater General Permit for Construction Activities Registration Statement

In accordance with 9 VAC 25-870, submit a Registration Statement to the

State to obtain Virginia Stormwater Management Program General Permit coverage, and as required under the General Permit, develop a SWPPP for the project. The SWPPP must meet the requirements of the State General Permit for storm water discharges from construction activities. Submit the Registration Statement and appropriate permit fees to the appropriate state agency for approval a minimum of 15 calendar days prior to the start of any land disturbing activities. Maintain an approved copy of the SWPPP at the onsite construction office, and continually update as regulations require, reflecting current site conditions.

Coverage under this permit requires the Contractor to prepare a SWPPP, prepare and submit a Registration Statement and provide the permit fee to the responsible state agency before any land disturbing activities begin. File for permit coverage on behalf of both the Contractor and the Construction Officer, and file a Notice of Termination once construction is complete and the site is stabilized with a final sustainable cover. Install, inspect, maintain best management practices (BMPs), and submit stormwater BMP inspection reports and SWPPP inspection reports as required under the terms and conditions of the permit. Ensure construction operations and management comply with the terms and conditions of the general permit for stormwater discharges from construction activities.

1.5.1.1.3.2 Stormwater General Permit Inspection Reports

Complete and document, in the SWPPP Notebook, the Stormwater Inspection Reports as required by the State VSMP General Permit. The Stormwater inspections reports must include items required by the General Permit and must be completed at the inspection frequency detailed in 9 VAC 25-870. Obtain certificate of competency in accordance with 9 VAC 25-850.

1.5.1.1.4 Asbestos Abatement and Notification Procedures

Structures must be surveyed for the presence of asbestos prior to demolition or renovation in accordance with 40 CFR 61.145. A structure is defined as including any load-bearing portion of a structure. The survey must be performed by a licensed, certified, accredited asbestos inspector in accordance with ASTM E2356.

Notify EPA and Virginia Department of Labor and Industry (VADOLI) at least 20 calendar days before start of asbestos abatement if asbestos is expected to total at least 79 linear meters 260 linear feet, 14.9 square meters 160 square feet, or one cubic meter 35 cubic feet. Provide copies of notifications to the environmental office (Air Manager) through the Contracting Officer prior to beginning work. Make notifications for any project that includes asbestos abatement (and for all demolition projects, regardless of whether asbestos containing materials are present in the structure or facility) in accordance with paragraph DEMOLITION. Notification is not required if asbestos is nonfriable asbestos containing roofing, flooring, or siding materials that when installed, encapsulated, or removed do not become friable. If the material is damaged, the matrix binding the asbestos fibers has deteriorated, or mechanical removal results in more-than-incidental breakage, then notification is required. Activities such as grinding, mechanical chipping, sawing or drilling can make the asbestos containing material friable and would require notification.

1.5.1.1.4.1 Best Management Practices

Use BMPs to ensure EPA and VADOLI requirements are met, including:

preventing airborne emissions via wetting asbestos prior to removal; using glove bags or containment; using HEPA-filtered vacuum or ventilation systems; restricting access to asbestos-control areas until thoroughly cleaned and inspected, and acceptable air-samples have been received. Consideration should be given to other environmental program requirements such as Clean Water Act (CWA) requirements when making decisions regarding BMPs.

1.5.1.1.4.2 Asbestos Waste Disposal

For asbestos waste disposal, phone the NAVFAC MIDLANT Environmental (EV) Service Desk to arrange pick up in your area. A manifest must be signed by this office prior to waste being removed from the installation. Provide copies of manifests and notifications to NAVFAC Mid-Atlantic EV Hazardous Waste (HW) Program Manager.

1.5.1.1.5 Hazardous Waste Requirements for Virginia Installations

1.5.1.1.5.1 Demolition

Remove the following items from the site prior to demolition: polychlorinated biphenyls (PCBs), fluorescent bulbs, mercury and metal components (such as furnaces, ducts, and piping), and any hazardous materials. Manage lead, fluorescent bulbs, mercury-containing equipment, and any other waste as "hazardous or universal waste" as appropriate (see paragraph HAZARDOUS AND UNIVERSAL WASTE GENERATION). If the demolition activity encompasses the whole building (the building must be demolished to the ground), the resulting construction debris (including lead paint) requires Toxicity Characteristic Leaching Procedure (TCLP) analysis to make a waste determination and ensure proper management and disposal before it can be disposed as solid waste.

1.5.1.1.5.2 Hazardous and Universal Waste Generation

****

NOTE: Activity Hazardous Material Reutilization, Hazardous Waste Minimization and Disposal Guide is available for download at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

Hazardous and Universal Waste includes fluorescent bulbs, PCB ballast, lead paint, and mercury-containing equipment. Contact the EV HW Program Manager to set up an appropriate accumulation area. Manage waste in a satellite accumulation area (SAA), hazardous waste accumulation area (HWAA), or universal waste accumulation area (UWAA) as directed by the EV HW Program Manager through the Contracting Officer. Keep containers securely closed unless adding or removing material and waste. Ensure custodians managing the accumulation area(s) have appropriate training that has been taken within the year prior to the area being established. Training is an annual requirement that can be taken on the https://environmentaltraining.ecatts.com/ site. Keep copies of training records and certificates on site.

Hazardous Waste Accumulation Areas (less than 90-day sites) require Virginia Department of Environmental Quality (VDEQ) notification. Notify the HA Media Manager (HW MM) 14 days prior to the start of waste accumulation. The EV HW Program Manager is authorized to notify VDEQ when

Hazardous Waste Accumulation Areas are established. A copy of the Activity Hazardous Material Reutilization, Hazardous Waste Minimization and Disposal Guide will be provided by the Contracting Officer. For waste disposal, phone the NAVFAC MIDLANT EV Service Desk to arrange pick up in your area. Fax a completed DD 1348-1A to the Service Desk for all waste turn-ins. Notify the Service Desk if any containers are leaking or are in poor condition. A representative from NAVFAC MIDLANT EV Services is the authorized entity approved to sign manifests for off-site waste disposal.

[1.5.1.1.5.3 Waste Management - Disposal by the Contractor

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NOTE: Coordinate with the installation EV to determine whether paragraph WASTE MANAGEMENT - DISPOSAL BY THE CONTRACTOR or paragraph WASTE MANAGEMENT - DISPOSAL BY THE NAVY is applicable for the project's location.

****

Manage and dispose of all Hazardous Waste generated or discovered during the project. Dispose of all waste in accordance with all federal and state environmental regulations. Sign and submit all paperwork (lab analyses, profiles, manifests) and records to the Navy. Allow inspection by the Regional Environmental Core for compliance with federal, state and Navy requirements.

1.5.1.1.5.3.1 Contractor Site Custodian

a. Designate a Site Custodian and an Alternate for waste management. Provide 24-hour phone numbers where Site Custodian and alternate can be contacted in the event of an emergency.

b. Personnel must be trained in hazardous waste management procedures to comply with the requirements of 40 CFR 262.34 and 40 CFR 265.16.

1.5.1.1.5.3.2 Waste Accumulation

a. Establish a SAA, UWAA or a temporary 90-Day HWAA for waste accumulation. Obtain the HW Media Manager approval. Do not use accumulation areas as lay-down areas.

b. EV Core HW MM will notify VDEQ. Notify the HW MM 14 days prior to the start of waste accumulation. All agency notifications will originate from the Regional Environmental Core.

c. The Site Custodian and Alternate must attend the HW MM training session for the management of the SAA, UWAA or HWAA.

1.5.1.1.5.3.3 Waste Disposal

a. The Navy will be considered the "generator" for all wastes that are generated on Navy property, regardless if the waste was generated as result of Contractor activity.

b. Pack, mark, label and transport all waste in accordance with Department of Transportation 49 CFR Regulations.

c. Obtain the EPA Hazardous Waste Identification Number (EPA ID#) for the installation or off-site Contractor location, from the EV Core HW MM.

Use the generator's EPA ID# on the Hazardous Waste Manifest.

(1) Provide the name and EPA ID Number for the Hazardous Waste Transporter and the disposal facility to the HW MM.

(2) Submit all waste profiles and documentation supporting the waste disposal to the HW MM for review.

d. Obtain the Hazardous Waste Manifest signature from designated representative of the Regional Environmental Services Group (EV Services). Contact the Environmental Services Department Dispatcher to schedule this service. Obtain signature on the day the waste is scheduled to be picked up.

e. The Contractor is to ensure that the Certificates of Disposal and Manifests are mailed to EV Services, in accordance with the all Federal and State regulations.

][1.5.1.1.5.4 Waste Management - Disposal by the Navy

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NOTE: Coordinate with the installation EV to determine whether paragraph WASTE MANAGEMENT - DISPOSAL BY THE CONTRACTOR or paragraph WASTE MANAGEMENT - DISPOSAL BY THE NAVY is applicable for the project's location.

****

Coordinate waste management actions with the HW MM responsible for the installation. Manage all hazardous waste in accordance with federal, state and Navy Environmental Regulations. Sign and submit all paperwork (lab analyses, profiles, manifests) and records to the Navy. Allow inspection by the Regional Environmental Core for compliance with federal, state and Navy requirements.

1.5.1.1.5.4.1 Contractor Site Custodian

a. Designate a Site Custodian and an alternate for waste management. Provide 24-hour phone numbers where Site Custodian or Site Manager and alternate can be contacted in the event of an emergency.

b. Personnel must be trained in hazardous waste management procedures to comply with the requirements of 40 CFR 262.34 and 40 CFR 265.16.

1.5.1.1.5.4.2 Waste Accumulation

a. Establish a Satellite Accumulation Area (SAA), Universal Waste Accumulation Area (UWAA) or a temporary 90-Day Hazardous Waste Accumulation Area (HWAA) for waste accumulation. Do not use accumulation areas as Contractor lay-down areas.

b. EV Core HW MM will notify VDEQ. Notify the HW MM 14 days prior to the start of waste accumulation. All agency notifications will originate from the Regional Environmental Core.

c. The Site Custodian and alternate must attend the HW MM training session for the management of the SAA, UWAA or HWAA.

d. Manage waste containers in accordance with all applicable Federal, State, and Navy regulations.

1.5.1.1.5.4.3 Waste Disposal

a. The Navy will be considered the "generator" (EPA definition) for all wastes that are generated on Navy property, regardless if the waste was generated as result of Contractor activity.

b. Obtain a Job Order Number from the NAVFAC MIDLANT Financial Management Business Line, Accounts Receivable Department.

c. Submit all waste profiles and documentation supporting the waste disposal to the HW MM for review.

d. Coordinate with the HW MM for waste pickup by EV Services. EV Services will pick up the waste and coordinate transport to an off-site permitted Treatment Storage or Disposal facility.

e. Obtain the Hazardous Waste Manifest signature from designated representative of the Regional EV Services. Contact the Environmental Services Department Dispatcher to schedule this service. Obtain signature on the day the waste is scheduled to be picked up.

]1.5.1.1.5.5 Excavation

If soil is to be reused onsite, sampling is not required unless otherwise directed. Excavated soil may be reused within the construction site with no testing necessary. Soil may be stockpiled until the end of the project, then reused as much as possible prior to sampling and analysis for residual soil to be disposed. Store in a manner that prevents rain from infiltrating the soil matrix and preventing runoff into the surrounding soil or pavement (for example, store the soil on top of plastic sheets and covered with plastic sheets or store in lined, covered dumpsters). If the soil is going to be relocated or disposed outside the construction site, sampling and analysis is required. Contact the installation HW Program Manager prior to disposal to determine the appropriate sampling and test parameter. Soil disposal requirements will depend on test results. If soil is to be shipped to a destination outside the fire ant quarantine area (outside of James City County, York County, Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, or Williamsburg) it MUST have a valid inspection certificate issued by an Officer of the Plant Protection and Quarantine Program (PPQ) of the U.S. Department of Agriculture. Contact the EV Pest Management Coordinator for additional information.

1.5.1.1.5.6 Painting and Paint Removal

Air-drying cans for disposal are allowed only if liquid residue is less than 2.54 cm one inch; keep all paint or solvent containers closed and secured when not adding or removing material or waste. Waste paint chips and debris must be collected and sampled to determine the proper disposal method. Contact the NAVFAC MIDLANT EV HW Program Manager for sampling requirements. If waste paint is determined to be hazardous, waste must be managed as hazardous and an appropriate accumulation area must be established. Contact the NAVFAC MIDLANT EV HW Program Manager for site setup.

1.5.1.1.5.7 Dumpsters

Label trash containers to appropriately describe the contents.

1.5.1.1.6 Air Requirements

1.5.1.1.6.1 Concrete Crushing

Secure an air permit for the crusher from the regulatory agency where the equipment is home-based (in Virginia contact VADEQ). Provide a copy of the permit to the EV Office (Air Program Manager) through the Contracting Officer at least 30 days prior to bringing crusher onsite.

1.5.1.1.7 Spill Response and Reporting

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NOTE: Attach Table 1 - Spill Reporting Contact Numbers, which is available for download at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

Report spills at Hampton Roads Navy installations to the appropriate installation Emergency Call Center (ECC) immediately upon discovery.

After notifying the installation ECC, notify the Navy point of contact. Refer to the Installation Hazardous Material Reutilization, Hazardous Waste Minimization and Disposal Guide Appendix 3 for spill contact procedures. Refer to Table 1 - Spill Reporting Contact Number for the appropriate point of contact.

1.5.1.2 Maryland

a. Patuxent River

1.5.1.3 West Virginia

a. Sugar Grove

1.5.1.4 Pennsylvania

1.5.1.5 New Jersey

1.5.1.6 North Carolina

1.5.1.6.1 Camp Lejeune

1.5.1.6.1.1 Removal of Waste from Camp Lejeune

Remove and dispose of rubbish and debris from Government property. Provide 24-hour advance written notice to the Contracting Office of Contractor's intention to dispose rubbish and debris off base. Disposal at sites or landfills not holding a valid state of North Carolina permit is specifically prohibited. The prohibition also applies to sites where a permit my have been applied for but not yet obtained. If construction debris has been disposed off-base outside the parameter of this paragraph at a site without state permits or not in accordance with regulatory requirements, remove, transport, and relocate the debris to a state-approved site at Contractor expense. Pay any required fines, penalties, or fees related to the illegal disposal of construction debris. Metal will not be accepted at the Base Sanitary Landfill.

1.5.1.6.1.2 Surplus Soils Disposal for Camp Lejeune & MCAS New River

Transport all surplus soil to one of the designated locations on government property. No surplus material will leave government property without approval of installation Environmental Program Manager and the Contracting Officer. Deliver and properly manage surplus soil that cannot be reused on its originating site to one of the following locations:

a. Area managed by G-3/5 for reuse on training areas for various maintenance activities:

b. 3.5 acre storage, within TLZ Condor off Verona Loop Road, approximate coordinates 34d 38'07.3"N 77d 26' 41.7"W.

c. Coordinate with G-3/5 Project Development Specialist, MCIEAST-MCB CAMLEJ at (910) 451-5772 to determine capacity available at the storage location, prior to delivery.

d. This site operates Monday through Thursday between 0730 and 1500.

e. Area managed by PWD for use as daily cover:

f. Base landfill, located on Piney Green Road, approximate coordinates 34d 41' 26.9"N 77d 19' 27.4"W.

g. Contractor must provide temporary silt fencing around designated stockpile areas as needed.

h. Coordinate with Landfill Manager at (910) 451-8666. Landfill use letters will be provided so that deliveries can be tracked.

i. This site operates Monday through Thursday between 0730 and 1500 and on Friday between 0700 and 1400.

Contact POCs listed above 7 to 10 days in advance to coordinate delivery of material at the storage locations.

Prior to transportation to one of the designated locations, screen all surplus soil to remove all objects greater than 75 mm 3 inches and deleterious material. Deleterious material consists of organic debris such as roots, stumps, timber, and construction debris. Construction debris may include, but is not limited to wood, plastic, glass, concrete, brick, and metal. Dispose of deleterious material and objects larger than 75 mm 3 inches as specified.

Provide all plant, material, and labor for placement and management of the surplus material at the designated locations. Grade surplus material to a flat condition and slope to provide positive drainage daily. Submit the following verification documents to the Contracting Officer for review and approval:

(1) Photographic documentation that surplus soil has been properly placed. Photograph will include time and date of image.

(2) Certification statement indicating volume, in cubic yards (CY), of material delivered and confirming material is free of contaminants.

NOTE: Soil contaminated with debris or chemicals cannot be disposed at the stockpile locations. If contaminated soils are suspected or confirmed through presence of UXO, odors, or visual staining, affected soils must be properly tested, manifested, and disposed of in accordance with RCRA regulations. Contact Base EMD, ER Program Manager, for more information.

1.5.1.6.2 MCAS Cherry Point

1.5.1.7 New York

1.5.1.8 Maine

1.5.1.9 District of Columbia

1.5.2 Northwest (Washington and Oregon)

****

NOTE: The following paragraph and subparagraphs are tailored for NAVFAC NW use only.

Forms referenced for attachment are available for download at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

Comply with the following state, regional, and local requirements.

1.5.2.1 Contractor Employee Training Records

Train employees in accordance with WAC-173-303-330. Training must be completed and documented prior to the generation of waste.

1.5.2.1.1 Waste Originator Training for NBK Bangor

NBK Environmental Division Waste Originator Training Certification is obtained by attending the Bangor Waste Originator Class and passing the Originator Test given at the end of the class. Contact the Contracting Officer for dates and times of the Originator Class.

1.5.2.1.2 Waste Originator Training for NBK Keyport

NBK Keyport Waste Originator Training Certification is obtained by taking the electronic "Hazardous Waste Site Manager/Alternate (Waste Generator)" training module (contact the Contracting Officer for an electronic copy) and passing the test at the end of the training module. Training must be completed and documented prior to the generation of waste.

1.5.2.1.3 Waste Originator Training for NBK Bremerton

Employees must be familiar (read and understand) the approved Environmental Protection Plan and the "Contractor's Guide to Environmental Compliance." Complete the ECATTS course titled "Site Specific Hazardous Waste Management Training for the Bremerton Naval Complex" in order to satisfy the Contractor Employee Training Records submittal requirement. Taken annually, this course will satisfy the refresher-training requirement of WAC-173-303 for work at NBK Bremerton and is not required on a per project basis.

1.5.2.1.4 Waste Originator Training for NBK Everett

Contractor personnel generating hazardous waste must obtain Site-Specific Hazardous Waste Training. Allow one hour for training. Coordinate with the NAVFAC NW PWC Environmental Division, 425-304-3470.

1.5.2.2 Refrigerant Work Checklist

Submit a completed Refrigerant Work Checklist form to document that work was performed in compliance with 40 CFR 82 requirements. Complete one form for each piece of equipment containing refrigerant that must be installed, removed, or serviced as part of this Contract.

1.5.2.3 Environmental Protection Plan (EPP)

The following clarifications and requirements supplement paragraph ENVIRONMENTAL PROTECTION PLAN.

1.5.2.3.1 Solid Waste Management

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NOTE: For NBK Bangor, choose the second bracketed sentence and delete the first. For other locations, choose the first bracketed sentence and delete the second.

****

[Include the Solid Waste Management Plan as part of the EPP. Identify each solid-waste disposal facility, including: the type of facility, name, physical address, phone numbers, issuing authority and approval signature, permitted entity and period of issuance for waste. Submit a copy of the county hauling permit (for nonexempt franchised haulers).] [Include the Solid Waste Management Plan from as part of the EPP. Specify name and address of permitted refuse disposal facilities (clearly state how asbestos waste will be handled). Specify procedures for providing the Contracting Officer with dump tickets that include waste quantities and dates of disposal. Specify procedures for providing refuse waste quantities, dates and certifications of disposal on the Refuse and Recycle Quantity Form.]

****

NOTE: Choose PSNS&IMFINST 5090.30 and 5090.5 for projects at NBK Bremerton, choose BKCHD 2010-1 for projects in Kitsap County, or choose JCC Chapter 8.10 projects at Indian Island.

****

Perform waste management practices in accordance with[PSNS&IMFINST 5090.30, Water Pollution Prevention and Control Plan; PSNS&IMFINST 5090.5, Waste Management Plan][Bremerton-Kitsap County Health District Ordinance 2010-1, Solid Waste Regulations;][Jefferson County Code, Chapter 8.10, Solid Waste Regulations;] WAC-173-303, WAC-173-350, 40 CFR 262, 40 CFR 263, 40 CFR 264, 49 CFR 172, and 49 CFR 178.

1.5.2.3.2 Control and Management of Hazardous Waste

[1.5.2.3.2.1 Dangerous Waste Turn-in

****

NOTE: Select "turn-in" for NBK Bangor, NBK Keyport,

Indian Island, and most projects at NBK Bremerton.

Delete paragraphs for Installations other than where the work is to be performed.

****

Specify procedures to handle, process and dispose of dangerous waste. Project-generated dangerous waste must be turned into the Government for disposal. Collect dangerous waste in Department of Transportation (DOT)-approved containers in accordance with 49 CFR 171, 49 CFR 172, and 49 CFR 178 properly labeled to identify the type of waste, hazard to personnel, and the start date. Containers and labels will be supplied by the Government.

Notify the Contracting Officer 14 calendar days in advance for request of bulk containers. Request is accomplished by submission of a Waste Information Specification including an estimated quantity of dangerous waste and the number of containers. Identify dangerous waste generated within the confines of the station by the use of the station's EPA generator identification (ID) number. Accumulate in an approved satellite or 90-day accumulation area that meets the requirements set forth in WAC-173-303. Contact the Contracting Officer no more than 45 calendar days from the start date for 90-day accumulation areas to arrange for transport. Accumulate bulk dangerous waste in a 90-day area. Turn in non-bulk dangerous waste from a 90-day area within 45 days of the start date. Turn in dangerous waste from satellite accumulation areas to the Government prior to exceeding time and quantity limits. Onsite treatment of waste is prohibited.

1.5.2.3.2.1.1 Naval Base Kitsap (NBK) Bangor

Complete Waste Information Specification in accordance with paragraph WASTE DETERMINATION DOCUMENTATION, for each waste stream. Contractor personnel submitting Waste Information Specification forms must have already received Bangor Waste Originator Training and Certification.

1.5.2.3.2.1.2 Naval Base Kitsap (NBK) Keyport

NBK Keyport will not provide a copy of the Hazardous Waste Management Plan. Information required for the control and disposal of Hazardous Waste at NBK Keyport is included in the "Hazardous Waste Site Manager/Alternate (Waste Generator)" training module and the NAVSEA Keyport Contractor's Guide to Environmental Compliance.

Explain how waste designated by the Government will be disposed of in accordance with Waste Generation Record (WGR) instructions. Complete WGR in accordance with paragraph WASTE DETERMINATION DOCUMENTATION, for each waste stream. Contractor personnel submitting WGR forms must have already received Keyport Waste Originator Training and Certification.

1.5.2.3.2.1.3 Indian Island

Complete Waste Generation Record in accordance with paragraph WASTE DETERMINATION DOCUMENTATION for each waste stream. Contractor personnel submitting WGR forms must have already received Bangor Waste Originator Training and Certification.

][1.5.2.3.2.2 Dangerous Waste Disposal

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NOTE: Select "disposal" for projects at Whidbey Island, Everett, and Reserve Centers.
****

Specify procedures to handle, process, and dispose of dangerous waste. For disposal at a TSDF, provide the following if the TSDF is not on the approved list of the Defense Reutilization and Marketing Service (DRMS) https://www.dla.mil/DispositionServices/Offers/Disposal/HazardousWaste/QualifiedFacilitiesList/: facility name, physical address, telephone number, description of the facility, EPA waste numbers that the facility accepts, and date of most recent Resource Conservation and Recovery Act(RCRA) inspection. If the TDSF is on the DRMS list, then provide the name and physical address.

For transporters to be used to transport dangerous waste, furnish the following: name, address, EPA ID number, and phone numbers of the transport firm and the principal Contractor. Onsite treatment of waste is prohibited.

]1.5.2.3.3 Stormwater Management and Control

****
NOTE: Choose first bracketed option for Construction projects that disturb one acre or more. Choose second bracketed option for all other projects.
****

[This project disturbs more than one acre. A SWPPP[including mandatory Bremerton Naval Complex BMPs and WSDE SMM BMPs] is required.

][A narrative of the storm water management and control is required. Include the following:

a. A brief project description

b. Total disturbed acreage in accordance with EPA's Construction General Permit definitions.

c. United States Waters that the project will drain onto

d. The sequence of construction events

e. Stormwater BMPs that will be applied to the site[including mandatory Bremerton Naval Complex BMPs].

f. Site map showing location of BMP measures

g. Description of periodic and routine inspections

h. How and where hazardous materials will be handled and stored on site

i. Exposed soil coverage practices

j. Final site stabilization method(s)

][1.5.2.3.4 Clean Air Act Compliance for [NBK Bangor][NBK Keyport][NBK Bremerton][Everett]

Identify any air pollution generating equipment or processes that may require a Notice of Construction pursuant to[PSCAA] Regulation.

Identify portable and stationary internal combustion engines (ICEs) that will must be supplied, used, or serviced. Address compliance with 40 CFR 60 Subpart IIII, 40 CFR 63 Subpart ZZZZ, and[PSCAA] Regulations as applicable. Include PSCAA Nonroad Engine Notification Form.

]1.5.2.3.5 Clean Air Act Compliance for Whidbey Island and Indian Island

****

NOTE: Use ORCAA for Indian Island. Use NWCAA for Whidbey Island.

****

Identify any air pollution generating equipment or processes that may require a Notice of Construction pursuant to [ORCAA][NWCAA] Regulation.

Identify portable and stationary internal combustion engines (ICEs) that must be supplied, used, or serviced. Address compliance with 40 CFR 60 Subpart IIII, 40 CFR 63 Subpart ZZZZ, and [ORCAA][NWCAA] Regulations as applicable.

As a minimum, include the following:

a. Identify engine certification status.

b. Identify non-resettable hour meter status.

c. For portable (skid- or trailer-mounted) ICEs, identify the make, model, manufacture date, size, and brake horsepower.

d. Identify methods of recording run time and reason for operation.

e. Do NOT include motor vehicles.

1.5.2.3.6 Notice of Construction (NOC) and Notice of Completion Licenses and Permits

****

NOTE: Identify all local permit requirements, as found in the Permits Record of Decision (PROD).

Identify, and include copies of, all project permits obtained by the Government (prior to award).

****

****

NOTE: Include if NOC is required. Delete this subparagraph if NOC is not required. Permit requirements are found in the Permits Record of Decision (PROD). NOC permits may require up to 120 days to receive approval from outside regulatory agencies. Examples of taskings that may require an NOC include, but are not limited to, the following:

- Installation of certain Boilers or other

stationary combustion sources such as electrical generators
- Certain portable combustion sources (not including motor vehicles)
- Blasting or paint spray booths
- Fuel storage tanks, dispensers, and loading racks
- Modification of existing equipment that has a NOC
- Industrial ventilation and dust control systems to control dust and fumes from activities such as grinding, sanding, or solvent cleaning.

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NOTE: For projects in the NAVFAC PAC Area of Operation, edit this paragraph by removing "approval" and selecting "review" to this paragraph.

****

Allow up to 120 days to receive approval from outside regulatory agencies for NOC permits. Prepare and forward the permit application package to the Contracting Officer for [approval] [review] and submittal to the applicable regulatory agency. Pay for associated fees. Permit approval must be obtained prior to the start of work covered by the permit. Upon completion of work, notify the Contracting Officer, who will submit the Notification of Completion to the applicable regulatory agency.

Equipment and work provided as part of this Contract must comply with the terms and conditions of the permit, and other applicable federal, state, and local air pollution-control regulations.

1.5.3 Southeast

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NOTE: The following paragraph and subparagraphs are tailored for NAVFAC SE use only.

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NOTE: Applicable environmental requirements such as; erosion/sediment control, storm water, hazardous waste, and solid waste may have unique state regulations. Edit this section to include these unique state requirements for each state listed below.

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NOTE: For each project, provide the following:
1. Unique local requirements.
2. Environmental Point of Contact information for design review and location specific requirements.
3. For every installation in area of responsibility, the FEC must identify the facility Hazardous Waste Generator status as specified in paragraph FACILITY HAZARDOUS WASTE GENERATOR STATUS.
4. For each installation listed below, provide specific requirements of the installation's Environmental Management System (EMS) that relate to construction operations. Identify those site

specific EMS actions that the Contractor must perform under this contract.

****

Comply with the following state, regional, and local requirements.

1.5.3.1 Florida

[Dewatering Permit

][Florida Environmental Resource Permit

]1.5.3.1.1 Naval Air Station (NAS) Jacksonville

1.5.3.1.1.1 Definition: Petroleum-Contaminated Waste

Surface water, groundwater, soil, or sediment that has the presence of petroleum or petroleum products or their chemical constituents (except hazardous waste as defined in the paragraph HAZARDOUS WASTE in quantities that exceed the applicable cleanup target levels as stated in FL 62-780.

1.5.3.1.1.2 Environmental Protection Requirements

NAS Jacksonville is governed by the Federal Facilities Agreement (FFA) signed by the Government, the EPA, and the Florida Department of Environmental Protection. The FFA is incorporated by reference into this Contract and subcontracts. Specific restoration sites have been identified in the FFA, and other Contractors or Government personnel may undertake sampling, investigative work, or remediation actions related to other projects simultaneously with the efforts related to this project. Information concerning this agreement or specific site information may be obtained from the Facilities Department at NAS Jacksonville.

1.5.3.1.1.3 Employee Training Records

Maintain a copy of the training certificate at the job site showing that the required module(s) were completed in accordance with requirements in paragraph TRAINING IN ENVIRONMENTAL COMPLIANCE ASSESSMENT TRAINING AND TRACKING SYSTEM (ECATTS). Complete this training prior to starting work on this project, but not later than 30 days after award of the Contract. Contractor employees must carry a wallet-size card demonstrating that the required module(s) have been completed. The card must be presented to the Contracting Officer or the Contracting Officer's Representative upon request.

1.5.3.1.1.4 Control and Management of Hazardous Waste

Dispose of hazardous waste generated during construction through PWC Jacksonville; do not take hazardous waste off station. Pay disposal costs in accordance with PWC Jacksonville's published rates. Air-drying any containers to render them empty is prohibited.

1.5.3.1.1.5 Battery Disposal

Comply with hazardous waste requirements when disposing of waste lead-acid batteries and electrolyte.

1.5.3.1.1.6 Mercury Containing Devices Management and Disposal

Manage mercury-containing devices in compliance with hazardous waste or universal waste management and disposal, as applicable.

1.5.3.1.2 Naval Air Station (NAS) Pensacola

1.5.3.1.2.1 Excavation Permits

Before any excavation is started, obtain an approved NAS Pensacola Permit through the Contracting Officer (excavation is defined as digging or opening of an existing surface to a depth exceeding 20 cm 8 inches below the existing grade, as well as driving of piles or auger borings). The permit form is self-explanatory. Fill in the applicable items on the permit and give it to the Contracting Officer in sufficient time for Station personnel to process the permit, but not less than 5 working days prior to the planned excavation.

Ensure each employee and subcontractor employee performing construction or service work on this project completes a course entitled "NAS Pensacola Environmental Compliance Training" using the website developed by the Government and Florida Department of Environmental Protection http://www.navfac.navy.mil. Log on: contract (lower case), Password: navfac (lower case).

After gaining entry to the website, establish a unique password. Each Contractor and subcontractor employee doing (or managing) construction or service work on this project must complete the course and have a certificate on file at the job site. Employees (except those involved in any painting, caulking, asbestos work, or well pointing) will complete training within 30 days of mobilization on this project. Employees performing painting, caulking, asbestos work, or well pointing must complete training before starting work on this project. Within 30 days of mobilization, submit a letter to the Contracting Officer certifying that employees have obtained training and provide copies of certificates. The letter must certify that future employees will obtain training in accordance with this specification requirement.

1.5.3.2 Georgia

a. Naval Submarine Base (NSB) Kings Bay

1.5.3.3 Mississippi

1.5.3.3.1 Naval Construction Battalion Command (NCBC) Gulfport

1.5.3.3.1.1 Excavation Permits

Before any excavation is started, obtain an approved NCBC Gulfport permit through the Public Works Management Engineering Division via the Contracting Officer (excavation is defined as digging or opening of an existing surface to a depth exceeding 20 cm 8 inches below the existing grade, as well as driving of piles or auger borings). The permit form is self-explanatory. Fill in the applicable items on the permit and give it to the Contracting Officer in sufficient time for Station personnel to process the permit, but not less than 5 working days prior to planned excavation.

1.5.3.3.2 Naval Air Station (NAS) Meridian

1.5.3.3.2.1 Contractor Hazardous Material Inventory Log

Submit a "Contractor Hazardous Material Inventory Log" to the Contracting Officer on the 10th day of each month. Copies of the Station-specific forms can be obtained from the Contracting Officer.

1.5.3.4 South Carolina

a. Naval Weapons Station (NWS) Charleston

1.5.3.5 Texas

a. Naval Air Station (NAS) Corpus Christi

b. Naval Air Station (NAS) Dallas

1.5.3.6 Cuba

1.5.3.6.1 Naval Station, Guantanamo Bay (GTMO)

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NOTE: This guide specification is for use in construction projects at U.S. Naval Station Guantanamo Bay, Cuba where environmental protection and other environmental temporary controls are required. All paragraph have been revised in accordance with U.S. Naval Station Guantanamo Bay, Cuba rules and regulations.

Remove information and requirements not required in respective project, whether or not brackets are present.

****

1.5.3.6.1.1 Contractor Liabilities for Environmental Protection

Obtain copies of the following GTMO instructions prior to the start of work: 4400.2A, 5090.1, 5090.4, 5090.7, 5090.8, 5100.13 and 1710.10. The station is subject to Commander Fleet Forces Command or Naval Facilities Engineering Systems Command - Southeast inspections to review compliance with environmental protection laws. A Multi-media inspection by CFFC or NAVFAC SE may include questioning of Contractor personnel who are working with or have contact with Hazardous Materials and waste.

Complete and provide documentation for environmental training required by the FGS/OEGBD and station instructions. Ensure employees, even during employee off-duty hours, are aware and comply with Station regulations.

1.5.3.6.1.2 Licenses and Permits

A permit is required for welding. Allow 14 calendar days for processing of the application. Obtain a Landfill Pass for asbestos-containing materials and solid waste being disposed at the landfill, in accordance with 5090.4. The initial stop for the Landfill Pass is the Recycling Center at Building 1751, off Rogers Road North of Sherman Avenue, for non-asbestos items, and Building 850 (Hazardous Waste Facility) for asbestos loads.

1.5.3.6.1.3 Environmental Protection Plan (EPP)

Meet with the Contracting Officer to discuss the proposed EPP 10 days after the award of Contract. Submit the EPP for further discussion, review, and approval 14 days after the meeting. The EPP should include the following, in addition to what is listed in paragraph ENVIRONMENTAL PROTECTION PLAN:

a. A listing of any hazardous materials planned for use on the station, in accordance with 4400.2A. The total amount of hazardous material stored onsite is to be less than 110 gallons unless preapproved by the Government. This information is included in the Station's Hazardous Material Tracking Program. To assist this effort, submit a list (including quantities) of hazardous materials to be brought to the safety station and copies of the corresponding Safety Data Sheets (SDSs). Submit this list to the Contracting Officer. Sign a Memorandum of Understanding (MOU) and comply with Station Instruction. Develop an Authorized User List (AUL) request form for each hazardous material item and update this list as additional materials are required. Barcode hazardous material items as specified in the MOU and Station Instruction. Include a plan addressing excess hazardous materials will be managed at the conclusion of each task order or at the end of the project.

b. In accordance with Station regulations, substitute materials as necessary to reduce the generation of hazardous material and include a statement to that effect in the EPP.

c. For major activities covering large acreage or steep slopes, submit a separate Land-Disturbing Activity Plan, as required, addressing erosion and sedimentation control in major land- clearing and grading operations.

d. Provide a point-of-contact to address Cuban rock iguanas, Cuban boas, and other protected species that may be onsite during each phases of work associated with this Contract.

1.5.4 Southwest

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NOTE: The following paragraph and subparagraphs are tailored for NAVFAC SW use only.

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NOTE: Applicable environmental requirements such as; erosion/sediment control, storm water, hazardous waste, and solid waste may have unique state regulations. Edit this section to include these unique state requirements for each state listed below.

****

****

NOTE: For each project, provide the following:
1. Unique local requirements and state regulations.
2. Environmental Point of Contact information for design review and base specific requirements.
3. For every installation in area of responsibility, the FEC must identify the facility Hazardous Waste

Generator status as specified in paragraph FACILITY HAZARDOUS WASTE GENERATOR STATUS.
4. For each installation listed below, provide specific requirements of the installation's Environmental Management System (EMS) that relate to construction operations. Identify those site specific EMS actions that the Contractor must perform under this contract.
****

Comply with the following state, regional, and local requirements.

1.5.4.1 Arizona

1.5.4.1.1 Regulatory Requirements for the Notice of Intent (NOI)

Submit a vicinity map and a NOI to the Arizona Department of Environmental Quality (ADEQ). ADEQ does not require a filing fee). If the construction project is scheduled to exceed one year, submit NAVFAC SW Legal Fee Letter to ADEQ - attach it to the NOI. Resident Officer in Charge of Construction (ROICC) or Facilities Engineering and Acquisition Division (FEAD) Contracting Officer reviews and signs NOI and NOT. If discharges to a unique or impaired water body are proposed, submit the SWPPP along with the NOI. See the General Permit for instructions. Submit NOT to ADEQ within 30 days after permit conditions have been met.

Arizona Pollutant Discharge Elimination System General Permit for Dischargers from Construction Activities to Water of the United States 2008, Permit No. AZG2013-001 expires June 3, 2025.

https://static.azdeq.gov/permits/azpdes/cgp_permit.pdf

1.5.4.2 California

1.5.4.2.1 Regulatory Requirements for the Notice of Intent

Submit a site map of the vicinity, NOI, and applicable filing fee (not to exceed $700.00) to the State Water Resources Control Board (SERCB). If the construction project is scheduled to exceed one year, submit NAVFAC SW Legal Fee Letter to SWRCB as an attachment the NOI. State of California requires the NOI to be submitted 30 days prior to start of construction. The ROICC or FEAD Contracting Officer reviews and signs NOI.

Complete and submit the NOT to the local Regional Water Quality Control Board (RWQCB).

https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html

1.5.4.2.2 Stormwater Notice of Termination

Submittal of the NOT constitutes notice that the Government (and their Contractor) of the site identified on this form is no longer authorized to discharge storm water associated with construction activity by NPDES General Permit No. CAS000002. Submit the NOT to the appropriate Executive Officer of the RWQCB responsible for the area in which the facility is located. The ROICC or FEAD Contracting Officer reviews and signs the NOT.

1.5.4.2.3 Sampling and Analysis of Hazardous Waste

The analysis must be performed by a California certified laboratory.

1.5.4.3 Nevada

1.5.4.3.1 Regulatory Requirements for the Notice of Intent

Submit a vicinity map and NOI to the Nevada Division of Environmental Protection (NDEP). If the construction project is scheduled to exceed one year, submit NAVFAC SW Legal Fee Letter to NDEP - attach it to the NOI. ROICC or FEAD Contracting Officer reviews and signs the NOI.

Prepare and submit a complete NOT to the NDEP within 30 days after permit conditions have been met.

2002 Stormwater Nevada General Permit No. NRV10000-General Permit.

https://ndep.nv.gov/water/water-pollution-control/permitting/stormwater-discharge-permits

NDEP Best Management Practices Handbook: https://ndep.nv.gov/uploads/water-nonpoint-docs/NVBMPHandbook1994.pdf

1.5.5 Pacific

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NOTE: The following paragraph and subparagraphs are tailored for NAVFAC PAC use only.

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NOTE: Applicable environmental requirements such as; erosion/sediment control, storm water, hazardous waste, and solid waste may have unique state regulations. Edit this section to include these unique state requirements for each state listed below.

****

****

NOTE: For each project provide the following:
1. Unique local requirements and state regulations.
2. Environmental Point of Contact information for design review and base specific requirements.
3. For every installation in area of responsibility, the FEC must identify the facility Hazardous Waste Generator status as specified in paragraph FACILITY HAZARDOUS WASTE GENERATOR STATUS.
4. For each installation listed below, provide specific requirements of the installation's Environmental Management System (EMS) that relate to construction operations. Identify those site specific EMS actions that the Contractor must perform under this contract.

****

Comply with the following state, regional and local requirements.

1.5.5.1 Control and Disposal of [Ionization Smoke Detectors][Tritium Exit Signs]

****

NOTE: For NAVFAC PAC projects requiring control and disposal of ionization smoke detectors (which contain low-level radioactive material) and tritium exit signs by Radiological Affairs Support Office (RASO).

****

1.5.5.1.1 Material Bagging

Remove existing [ionization smoke detectors][and tritium exit signs,] and place like types, together (that is same manufacturer and model number) in a plastic bag. Label the bag with the following data:

Manufacturer:	Activity:
MODEL No.:	Contract No.:
Isotope and Quantity (if known):	

1.5.5.1.2 Material Storage

****

NOTE: Insert applicable activity in the blank space.

****

Store plastic bags in 208 liter 55 gallon covered drum(s). Do not seal the drum(s). Provide a label with a description of the contents and note on the label "TO BE DISPOSED OF BY RASO". Apply the label to the exterior surface of the cover and site of the drum(s). Provide a record copy of the label for each drum storage material inventory to the Contracting Officer, [the RASO at COMNAVREG Pearl Harbor,] and [_____].

1.5.5.1.3 Storage Site and Disposal

****

NOTE: For NAVFAC PAC projects where government is responsible for storage and disposal. Insert location of storage site in the blank space.

****

Deliver drums to [_____] [MCBH Bunker 709, Sumner Road] [PWC Pearl Harbor Bldg. [_____]] for storage and disposal of [ionization smoke detectors][and][tritium exit signs][as directed by the Contracting Officer].

1.5.5.1.4 Storage and Disposal by Contractor

****

NOTE: For NAVFAC PAC projects where the Contractor is responsible for storage and disposal.

****

Store of[ionization smoke detectors][and tritium exit signs] in accordance with federal, state, and local laws and regulations.

1.5.5.2 Hawaii

1.5.5.3 Guam

1.5.5.4 Japan

1.5.6 Europe

****

NOTE: The following paragraph and subparagraphs are tailored for NAVFAC EURAFCENT use only.

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****

NOTE: Applicable environmental requirements such as; erosion/sediment control, storm water, hazardous waste, and solid waste may have unique local regulations. Edit this section to include these unique state requirements for each location listed below.

****

****

NOTE: For each project, provide the following:
1. Unique local requirements and state regulations.
2. Environmental Point of Contact information for design review and base specific requirements.
3. For every installation in area of responsibility, the FEC must identify the facility Hazardous Waste Generator status as specified in paragraph FACILITY HAZARDOUS WASTE GENERATOR STATUS.
4. For each installation listed below, provide specific requirements of the installation's Environmental Management System (EMS) that relate to construction operations. Identify those site specific EMS actions that the Contractor must perform under this contract.

****

Comply with the following regional and local requirements.

1.5.6.1 Italy

a. Naval Air Station (NAS) Naples

b. Naval Air Station (NAS) Sigonella

c. Aviano (NAVFAC EURAFCENT)

1.5.6.2 Spain

a. Naval Station (NS) Rota

1.5.6.3 Greece

a. Naval Support Activity (NSA) Souda Bay

1.6 QUALITY ASSURANCE

1.6.1 Preconstruction Survey and Protection of Features

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NOTE: Use this paragraph as applicable. For example, it may not be necessary for an interior renovation project.

****

This paragraph supplements the Contract Clause PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS. Prior to start of any onsite construction activities, perform a Preconstruction Survey of the project site with the Contracting Officer, and take photographs showing existing environmental conditions in and adjacent to the site. Submit a report for the record. Include in the report a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the Contractor's assigned storage area and access route(s), as applicable. The Contractor and the Contracting Officer will sign this survey report upon mutual agreement regarding its accuracy and completeness. Protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference that their preservation may cause to the work under the Contract.

1.6.2 Regulatory Notifications

****

NOTE: Coordinate with the Installation Environmental Office as applicable to fill in the number of days that notification is required prior to work starting.

****

Provide regulatory notification requirements in accordance with federal, state and local regulations. In cases where the Government will also provide public notification (such as stormwater permitting), coordinate with the Contracting Officer. Submit copies of regulatory notifications to the Contracting Officer at least [_____] days prior to commencement of work activities. Typically, regulatory notifications must be provided for the following (this listing is not all-inclusive): demolition, renovation, NPDES defined site work, construction, removal or use of a permitted air emissions source, and remediation of controlled substances (asbestos, hazardous waste, lead paint).

1.6.3 Environmental Brief

****

NOTE: Coordinate incorporation of this requirement with the Installation Environmental Office as applicable.

****

Attend an environmental brief to be included in the preconstruction meeting. Provide the following information: types, quantities, and use of hazardous materials that will be brought onto the installation; and types and quantities of wastes/wastewater that may be generated during the

Contract. Discuss the results of the Preconstruction Survey at this time.

Prior to initiating any work on site, meet with the Contracting Officer and installation Environmental Office to discuss the proposed Environmental Protection Plan (EPP) or equipment local requirement. Develop a mutual understanding relative to the details of environmental protection, including measures for protecting natural and cultural resources, required reports, required permits, permit requirements (such as mitigation measures), and other measures to be taken.

[1.6.4 Environmental Manager

****

NOTE: Coordinate incorporation of this requirement with the Installation Environmental Office as applicable. Consider project environmental risks versus project size or dollar value. A small project, such as demolishing a plating shop could be low cost, but high risk and a large project, such as replacing a roof on a hangar, could be high cost, but low risk.

****

Appoint in writing an Environmental Manager for the project site. The Environmental Manager is directly responsible for coordinating contractor compliance with federal, state, local, and installation requirements. The Environmental Manager must ensure compliance with Hazardous Waste Program requirements (including hazardous waste handling, storage, manifesting, and disposal); implement the EPP; ensure environmental permits are obtained, maintained, and closed out; ensure compliance with Stormwater Program requirements; ensure compliance with Hazardous Materials (storage, handling, and reporting) requirements; and coordinate any remediation of regulated substances (lead, asbestos, PCB transformers). This can be a collateral position; however, the person in this position must be trained to adequately accomplish the following duties: ensure waste segregation and storage compatibility requirements are met; inspect and manage Satellite Accumulation areas; ensure only authorized personnel add wastes to containers; ensure Contractor personnel are trained in 40 CFR requirements in accordance with their position requirements; coordinate removal of waste containers; and maintain the Environmental Records binder and required documentation, including environmental permits compliance and close-out. Submit Environmental Manager Qualifications to the Contracting Officer.

]1.6.5 Employee Training Records

****

NOTE: Insert the bracketed text for projects on a Large Quantity Generator Facility. See paragraph FACILITY HAZARDOUS WASTE GENERATOR STATUS for determination of generator status.

Erosion and Sediment Control Inspector Qualifications are determined by the state; not all states require the inspector be certified by the state.

****

Prepare and maintain Employee Training Records throughout the term of the contract meeting applicable 40 CFR requirements. Provide Employee Training

Records in the Environmental Records Binder.[Ensure every employee completes a program of classroom instruction or on-the-job training that teaches them to perform their duties in a way that ensures compliance with federal, state and local regulatory requirements for RCRA Large Quantity Generator. Provide a Position Description for each employee, by subcontractor, based on the Davis-Bacon Wage Rate designation or other equivalent method, evaluating the employee's association with hazardous and regulated wastes. This Position Description will include training requirements as defined in 40 CFR 265 for a Large Quantity Generator facility.] Submit these Assembled Employee Training Records to the Contracting Officer at the conclusion of the project, unless otherwise directed.

Train personnel to meet [EPA][state] requirements. Conduct environmental protection/pollution control meetings for personnel prior to commencing construction activities. Conduct additional meetings for new personnel and when site conditions change. Include in the training and meeting agenda: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection/pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, waters of the United States, and endangered species and their habitat that are known to be in the area.[Provide copy of the Erosion and Sediment Control Inspector[Qualifications as defined by EPA][Certification as required by[state]].]

1.6.5.1 Pest Control Training

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NOTE: The following paragraph is tailored for ARMY. Use this paragraph for Army projects only. Delete for other projects.

****

Trained personnel in pest control. Conduct a pest control meeting for personnel prior to commencing construction activities. Conduct additional meetings for new personnel and when site conditions change. Include in the training and meeting agenda: methods of detecting and pest infestation; familiarization with statutory and contractual pest control standards; installation and care of devices, and instruments, if required, for monitoring purposes to ensure adequate and continuous pest control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of waters of the United States, and endangered species and their habitat that are known to be in the area. Provide a Certificate of Competency for the personnel who will be conducting the pesticide application and management of pest control.

1.6.6 Non-Compliance Notifications

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with federal, state or local environmental laws or regulations, permits, and other elements of the Contractor's EPP. After receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. FAR 52.242-14 Suspension of Work provides that a suspension, delay, or interruption of work due to the fault or negligence of the Contractor allows for no adjustments to the contract for time extensions or equitable adjustments. In addition to a suspension of work, the Contracting Officer may use additional authorities under the contract or law.

1.7 ENVIRONMENTAL PROTECTION PLAN

****

NOTE: Edit this paragraph to include any environmental concerns or plans that may be required for the construction Contractor to protect the environment during construction of the project. Coordinate the requirements with the Installation Environmental Office as applicable in addition to the Federal, State, Regional, and Local agencies.

Some permits required under the Environmental Protection Plan require up to 90 days advance regulator notice before site work may begin.

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NOTE: For DBB projects in the NAVFAC PAC Area of Operation, remove the second bracketed sentence and select the first bracketed sentence and edit this paragraph sentence to include "EPP within 30 calendar days after Contract award..." and "...not less than 10 calendar days before the preconstruction meeting." For DB projects remove the first bracketed sentence and select the second bracketed sentence.

****

The purpose of the EPP is to present an overview of known or potential environmental issues that must be considered and addressed during construction. Incorporate construction related objectives and targets from the installation's EMS into the EPP. Include in the EPP measures for protecting natural and cultural resources, required reports, and other measures to be taken. Meet with the Contracting Officer or Contracting Officer Representative to discuss the EPP and develop a mutual understanding relative to the details for environmental protection including measures for protecting natural resources, required reports, and other measures to be taken.[Submit the EPP within [15][_____] days after [Contractor award][notice to proceed] and not less than [_____][10] days before the[preconstruction] meeting.][Submit the EPP not less than 60 calendar days before scheduled final site or building design approval.] Revise the EPP throughout the project to include any reporting requirements, changes in site conditions, or contract modifications that change the project scope of work in a way that could have an environmental impact. No requirement in this section will relieve the Contractor of any applicable federal, state, and local environmental protection laws and regulations. During Construction, identify, implement, and submit for approval any additional requirements to be included in the EPP. Maintain the current version onsite.

The EPP includes, but is not limited to, the following elements:

1.7.1 General Overview and Purpose

1.7.1.1 Descriptions

****

NOTE: Edit paragraph below to include those plans required for the project. The bracketed list of plans is for example only and not meant to be all inclusive.

Use bracketed option for Pesticide Treatment Plan for Army projects only; this option is tailored for ARMY use.

****

A brief description of each specific plan required by environmental permit or elsewhere in this Contract such as[stormwater pollution prevention plan,][spill control plan,][solid waste management plan,][wastewater management plan,][air pollution control plan,][contaminant prevention plan,][pesticide treatment plan,][a historical, archaeological, cultural resources, biological resources and wetlands plan,][traffic control plan][Hazardous, Toxic and Radioactive Waste (HTRW) Plan][Non-Hazardous Solid Waste Disposal Plan][borrowing material plan][_____].

1.7.1.2 Duties

The duties and level of authority assigned to the person(s) on the job site who oversee environmental compliance, such as who is responsible for adherence to the EPP, who is responsible for spill cleanup and training personnel on spill response procedures, who is responsible for manifesting hazardous waste to be removed from the site (if applicable), and who is responsible for training the Contractor's environmental protection personnel.

1.7.1.3 Procedures

A copy of any standard or project-specific operating procedures that will be used to effectively manage and protect the environment on the project site.

1.7.1.4 Communications

Communication and training procedures that will be used to convey environmental management requirements to Contractor employees and subcontractors.

1.7.1.5 Contact Information

Emergency contact information contact information (office phone number, cell phone number, and e-mail address).

1.7.2 General Site Information

1.7.2.1 Drawings

Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, jurisdictional wetlands, material storage areas, structures, sanitary facilities, storm drains and conveyances, and stockpiles of excess soil.

1.7.2.2 Work Area

Work area plan showing the proposed activity in each portion of the area and identify the areas of limited use or nonuse. Include measures for marking the limits of use areas, including methods for protection of features to be preserved within authorized work areas and methods to control runoff and to contain materials on site, and a traffic control plan.

Show where any fuels, hazardous substances, solvents, or lubricants will be stored. Provide a spill plan to address any releases of those materials.

1.7.2.3 Documentation

A letter signed by an officer of the firm appointing the Environmental Manager and stating that person is responsible for managing and implementing the Environmental Program as described in this contract. Include in this letter the Environmental Manager's authority to direct the removal and replacement of non-conforming work.

1.7.3 Management of Natural Resources

a. Land resources

b. Tree protection

c. Replacement of damaged landscape features

d. Temporary construction

e. Stream crossings

f. Fish and wildlife resources

g. Wetland areas

1.7.4 Protection of Historical and Archaeological Resources

a. Objectives

b. Methods

1.7.5 Stormwater Management and Control

a. Ground cover

b. Erodible soils

c. Temporary measures

    (1) Structural Practices

    (2) Temporary and permanent stabilization

d. Effective selection, implementation and maintenance of Best Management Practices (BMPs).

e. Stormwater Pollution Prevention Plan (SWPPP).

****

NOTE: The following listed items are tailored for INDIANA and are for State of Indiana use only.

****

f. f. Construction Plan and Storm Water Pollution Prevention Plan.

(1) All projects must comply with the State of Indiana's NPDES General Permit for storm water run-off associated with construction activity, as described in 327 IAC 15-5. The Construction Plan must meet all requirements listed in 327 IAC 15-5-6.5, including, but not limited to: project narrative and supporting documents; vicinity map depicting the project site location; existing project site layout map that indicates structures, waterways, soil maps, vegetation, adjacent land-use, and topography; final project site layout map; a grading plan indicating locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil material; a drainage plan; and a Storm Water Pollution Prevention Plan. The Storm Water Pollution Prevention Plan must include all items listed in 327 IAC 15-5-7 including, but not limited to, the following: description of temporary and permanent storm water quality measures; temporary stabilization plans; permanent stabilization plans; construction sequencing describing the relationship between implementation of storm water quality measures and stages of construction, including a schedule of these activities; self-monitoring program; description of potential pollutant sources associated with construction activities; and material handling and storage.

(2) If land disturbing activities are greater than or equal to one acre, it is the responsibility of the Contractor to have the Construction Plan, which includes the Storm Water Pollution Prevention Plan, reviewed and approved by the applicable reviewing agency. The State of Indiana designates different reviewing agencies for different counties in the state. Commonly, the reviewing agency is the local Soil and Water Conservation District (SWCD) or Department of Natural Resources Division of Soil Conservation. Information on approving agencies can be obtained from the Indiana Department of Environmental Management. The reviewing agency has up to 28 calendar days from the date of submittal to review the Construction Plan. The Environmental Protection Plan must include documentation of the reviewing agency's approval of the Construction Plan, or the Contractor may submit, in the instance that the reviewing agency has exceeded the 28 calendar day review period, documentation that the reviewing agency has exceeded the review period. If notice of a deficient plan is received, the plans must be revised to satisfy the deficiencies in accordance with 327 IAC 15-5-6 and resubmitted to the reviewing agency, at which time the 28 calendar-day review period starts over.

(3) The Government will review the Environmental Protection Plan, including the Construction and Storm Water Pollution Prevention Plans and then will submit the Notice of Intent (NOI), along with the proof of public notice and permit fee, to the Indiana Department of Environmental Management and the appropriate reviewing agency after the plan has been approved. The Contractor

will be notified of the submission date for the NOI. No land disturbing activity may take place until 48 hours after submission of the NOI. Approval of the Contractor's plan will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and other environmental protection measures.

(4) The Government will provide copies of the NOI, and all other Government correspondence with IDEM, to the Contractor. The Contractor must post the information required in 327 IAC 15-5-7 (b)(6) in a publicly accessible location near the main entrance of the project site. The location will be jointly agreed to by the Contractor and the Government during the Pre-Construction Conference. The Contractor must take all actions necessary to keep the NOI and correspondence protected from the weather so that it remains legible. If, in the judgment of the Contracting Officer's Representative, the documents degrade to the point of being illegible, the Contractor must replace the documents with fresh copies and remedy the problems that caused the degradation.

g. Spill Control Plan must include the procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance regulated by 40 CFR 68, 40 CFR 302, 40 CFR 355, or regulated under State or Local laws and regulations. The Spill Control Plan supplements the requirements of EM 385-1-1. The plan must meet the requirements of 327 IAC 2-6.1. This plan must include as a minimum:

(1) The name of the individual who will report any spills or hazardous substance releases and who will follow up with complete documentation. This individual must immediately notify the Contracting Officer and the local fire department or emergency response agency in addition to the legally required Federal, State, and local reporting channels (including the National Response Center 1-800-424-8802) if a reportable quantity is released to the environment. The plan must contain a list of the required reporting channels and telephone numbers.

(2) The name and qualifications of the individual who will be responsible for implementing and supervising the containment and cleanup.

(3) Training requirements for Contractor's personnel and any subcontractors, and methods of accomplishing the training.

(4) A list of materials and equipment to be immediately available at the job site, tailored to cleanup work of the potential hazard(s) identified.

(5) The names and locations of suppliers of containment materials and locations of additional fuel oil recovery, cleanup, restoration, and material-placement equipment available in case of an unforeseen spill emergency.

(6) The methods and procedures to be used for expeditious contaminant cleanup.

****

NOTE: The following paragraph and list are tailored for ILLINOIS and are for State of Illinois use only.

****

The EPP must include a Stormwater Pollution Prevention Plan (SWPPP). The Government will review the EPP, including the Stormwater Pollution Prevention Plan, and then will submit the Notice of Intent (NOI) to the Illinois Environmental Protection Agency after the plan has been approved. No construction will take place before the submission of the NOI; approval of the NPDES permit requires 30 calendar days after the submission of the NOI. The Contractor may NOT begin earthmoving activities until 30 calendar days after the submission of the NOI. Approval of the Contractor's plan by the Government will not relieve the Contractor of his responsibility for control of pollutants and other environmental protection measures. Address all comments to the SWPPP generated by the Illinois Environmental Protection Agency within seven calendar days of receipt of comments. Certify, in writing, that all recommended changes have been made to the SWPPP, and must submit certification to the Contracting Officer's Representative (COR). Post, in a visible location accessible for public viewing, the IEPA response letter, to be provided by the Government, and ILR10 at the project site.

a. A Stormwater Pollution Prevention Plan which identifies the type and location of the erosion and sediment controls to be provided. The plan must meet the requirements of the Illinois NPDES Permit No. ILR10 (included at the end of this section). The management practices, controls, and other provisions contained in the plan must be as protective as the requirements in the Illinois Urban Manual, IUM. The contents of the plan must address all items listed in Part IV of the permit, including but not limited to:

   (1) Site description, controls, maintenance, inspections, and non-stormwater discharges.

   (2) A map of the final site conditions.

   (3) A site construction plan that includes the locations and dimensions of land disturbing activities, locations of soil stockpiles, locations and dimensions of erosion control measures, and a schedule with the start and finish dates of each land disturbing activity, including the installation of erosion control measures. Provisions and a schedule for maintenance of the erosion control measures during construction must also be included in the plan.

   (4) Name and qualifications of the person(s) responsible for inspecting the site in accordance with the requirements given in ILR10.

   (5) A copy of the blank inspection checklist that will be used during ILR10 site inspections.

   (6) The plan must contain the certification statement contained in Part IV(F) of the NPDES Permit No. ILR10.

1.7.6 Protection of the Environment from Waste Derived from Contractor Operations

Control and disposal of solid and sanitary waste.

Control and disposal of hazardous waste.

This item consist of the management procedures for hazardous waste to be generated. The elements of those procedures will coincide with the Installation Hazardous Waste Management Plan when within an installation. The Contracting Officer will provide a copy of the Installation Hazardous Waste Management Plan as applicable.

As a minimum, include the following:

a. List of the types of hazardous wastes expected to be generated

b. Procedures to ensure a written waste determination is made for appropriate wastes that are to be generated

c. Sampling/analysis plan, including laboratory method(s) that will be used for waste determinations and copies of relevant laboratory certifications

d. Methods and proposed locations for hazardous waste accumulation/storage (that is, in tanks or containers)

e. Management procedures for storage, labeling, transportation, and disposal of waste (treatment of waste is not allowed unless specifically noted)

f. Management procedures and regulatory documentation ensuring disposal of hazardous waste complies with Land Disposal Restrictions (40 CFR 268)

g. Management procedures for recyclable hazardous materials such as lead-acid batteries, used oil, and similar

h. Used oil management procedures in accordance with 40 CFR 279; Hazardous waste minimization procedures

i. Plans for the disposal of hazardous waste by permitted facilities; and Procedures to be employed to ensure required employee training records are maintained.

1.7.7 Prevention of Releases to the Environment

Procedures to prevent releases to the environment

Notifications in the event of a release to the environment

1.7.8 Regulatory Notification and Permits

List what notifications and permit applications must be made. Some permits require up to 180 days to obtain. Demonstrate that those permits have been obtained or applied for by including copies of applicable environmental permits. The EPP will not be approved until the permits have been obtained.

1.7.9 Clean Air Act Compliance

1.7.9.1 Environmental Protection Plan

****

NOTE: This paragraph is tailored for WISCONSIN and is for State of Wisconsin use only.

****

An Air Pollution Control Plan detailing provisions to assure that dust, debris, materials, trash, do not become airborne and travel off the project site. The air pollution control plan must include a dust control plan. Air pollution control must comply with s. NR 415, Wis. Adm. Code.

1.7.9.2 Haul Route

Submit truck and material haul routes along with a Dirt and Dust Control Plan for controlling dirt, debris, and dust on Installation roadways. As a minimum, identify in the plan the subcontractor and equipment for cleaning along the haul route and measures to reduce dirt, dust, and debris from roadways.

1.7.9.3 Pollution Generating Equipment

Identify air pollution generating equipment or processes that may require federal, state, or local permits under the Clean Air Act. Determine requirements based on any current installation permits and the impacts of the project. Provide a list of all fixed or mobile equipment, machinery or operations that could generate air emissions during the project to the Installation Environmental Office (Air Program Manager). Ensure required permits are obtained prior to installing and operating applicable equipment/processes.

1.7.9.4 Stationary Internal Combustion Engines

Identify portable and stationary internal combustion engines that will be supplied, used or serviced. Comply with 40 CFR 60 Subpart IIII, 40 CFR 60 Subpart JJJJ, 40 CFR 63 Subpart ZZZZ, and local regulations as applicable. At minimum, include the make, model, serial number, manufacture date, size (engine brake horsepower), and EPA emission certification status of each engine. Maintain applicable records and log hours of operation and fuel use. Logs must include reasons for operation and delineate between maintenance/testing, emergency, and non-emergency operation.

1.7.9.5 Refrigerants

Identify management practices to ensure that heating, ventilation, and air conditioning (HVAC) work involving refrigerants complies with 40 CFR 82 requirements. Technicians must be certified, maintain copies of certification on site, use certified equipment and log work that requires the addition or removal of refrigerant. Any refrigerant reclaimed is the property of the Government, coordinate with the Installation Environmental Office to determine the appropriate turn in location.

1.7.9.6 Air Pollution-engineering Processes

Identify planned air pollution-generating processes and management control measures (including, but not limited to, spray painting, abrasive blasting, demolition, material handling, fugitive dust, and fugitive emissions). Log hours of operations and track quantities of materials used.

1.7.9.7 Monitoring

****

NOTE: The following paragraph is tailored for ARMY projects only. This paragraph pertains to Hazardous, Toxic and Radioactive Waste (HTRW) construction when the Designer has determined that

the need to protect Air Quality during HTRW remedial action is necessary and appropriate. The paragraph applies to contaminant emissions to the air from HTRW remedial action construction area sources.

An air pathway analysis needs to be conducted prior to specifying the items below. The Designer is referred to EP 1110-1-21 Air Pathway Analysis (APA) for the Design of HTRW Remedial Action Project. Design perimeter air monitoring requirements (action levels for the contaminants of concern, monitoring/sampling frequency) based on APA results. Specify airborne contaminants of concern, action levels, monitoring/sampling locations below. See 40 CFR 300.430(e)(9) of the National Contingency Plan.

****

For the protection of public health, monitor and control contaminant emissions to the air from Hazardous, Toxic, and Radioactive Waste remedial action area sources to minimize short-term risks that might be posed to the community during implementation of the remedial alternative in accordance with the following.

a. Perimeter Air Contaminant of Concern [_____].

b. Time Averaged Perimeter Action Levels [_____].

Concentration	[_____]
Time	[_____]

c. Perimeter Sampling/Monitoring Location[s] [_____].

d. Monitoring Instruments/Sampling and Analysis Methods [_____].

e. Staffing [_____].

1.7.9.8 Compliant Materials

Provide the Government a list of SDSs for all hazardous materials proposed for use on site. Materials must be compliant with all Clean Air Act regulations for emissions including solvent and volatile organic compound contents, and applicable National Emission Standards for Hazardous Air Pollutants requirements. The Government may alter or limit use of specific materials as needed to meet installation permit requirements for emissions.

1.8 LICENSES AND PERMITS

****

NOTE: The terms and conditions contained in any permits obtained by the Government must be made a part of the contract. The design must be in accordance with these permits. The title and requirements of this paragraph may be changed to include environmental reviews and approvals, if pertinent. Coordinate this paragraph with paragraph

SPECIAL ENVIRONMENTAL REQUIREMENTS.

For Design-Bid-Build (DBB) projects, establish a list of permits, prepare the permits for review and signature and obtain approval of all permits prior to bid. In rare occasions it may be permissible to note the anticipated permit approval date in the contract. If this is the case, the contract documents need to clearly define which portion of the work is not to be disturbed by the Contractor and for what time period.

For Design-Build (DB) projects (Request for Proposals) edit the paragraphs below for permits to be obtained.
****

****
NOTE: For Navy DB and DBB projects: Complete the Permit Record of Decision (PROD) in consultation with the cognizant Navy civil and environmental engineers and in accordance with FC 1-300-09N, NAVY AND MARINE CORPS DESIGN PROCEDURES. Edit the paragraph below to coordinate with the identified requirements. Refer to the applicable section for guidance on locally required permits and licenses.
****

Obtain licenses and permits required for the construction of the project and in accordance with FAR 52.236-7 Permits and Responsibilities. Notify the Government of all equipment that may require permits or special approvals that the Contractor plans to use on site. This paragraph supplements the Contractor's responsibility under FAR 52.236-7 Permits and Responsibilities.

****
NOTE: Edit the applicable bracketed paragraphs below as required for the particular project.

Use this paragraph for permits obtained by the Government. Identify which permits have been obtained by the Government.
****

[a. The following permits have been obtained by the Government:

[(1) [_____]

][(2) [_____]

][(3) [_____]
]]
****
NOTE: Identify which permits will be obtained by the Government.
****

[b. The following permits will be obtained by the Government:

[(1) [_____]

][(2) [_____]

][(3) [_____]

]]1.9 ENVIRONMENTAL RECORDS BINDER

Maintain on-site a separate three-ring Environmental Records Binder and submit at the completion of the project. Make separate parts within the binder that correspond to each submittal listed under paragraph CLOSEOUT SUBMITTALS in this section.

1.10 PESTICIDE DELIVERY, STORAGE, AND HANDLING

****

NOTE: This Article is tailored for ARMY. Use this paragraph and subsequent subparagraphs for Army projects only. Do not use for Navy or Air Force projects.

****

1.10.1 Delivery and Storage

Deliver pesticides to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses. Store pesticides according to manufacturer's instructions and under lock and key when unattended.

1.10.2 Handling Requirements

Formulate, treat with, and dispose of pesticides and associated containers in accordance with label directions and use the clothing and personal protective equipment specified on the labeling for use during each phases of the application. Furnish SDSs for pesticide products.

1.11 SOLID WASTE MANAGEMENT PERMIT

Provide the Contracting Officer with written notification of the quantity of anticipated solid waste or debris that is anticipated or estimated to be generated by construction. Include in the report the locations where various types of waste will be disposed or recycled. Include letters of acceptance from the receiving location or as applicable; submit one copy of the receiving location state and local Solid Waste Management Permit or license showing such agency's approval of the disposal plan before transporting wastes off Government property.

1.11.1 Monthly Solid Waste Disposal Report

Monthly, submit a solid waste disposal report to the Contracting Officer. For each waste, the report will state the classification (using the definitions provided in this section), amount, location, and name of the business receiving the solid waste.

1.12 FACILITY HAZARDOUS WASTE GENERATOR STATUS

****

NOTE: Insert the name of the installation as applicable in the blank space. Contact the

installation Environmental Office prior to start of design to determine the generator status of the activity, and edit to select the appropriate status.
****

[_____] is designated as a[Large Quantity Generator][Small Quantity Generator][Conditionally Exempt-Small Quantity Generator]. Meet the regulatory requirements of this generator designation for any work conducted within the boundaries of this Installation. Comply with provisions of federal, state, and local regulatory requirements applicable to this generator status regarding training and storage, handling, and disposal of construction derived wastes.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PROTECTION OF NATURAL RESOURCES

****
NOTE: Specify any special protection requirements and specifically describe how the Contractor is to protect the resources. This paragraph should be used when the Government knows of resources which should be protected and there are no requirements under Federal, State or local laws or regulations which would ensure that the Contractor would provide protection. If there are known Endangered or Threatened Species onsite or in the area including their habitat, this paragraph must identify the species and their habitat and must include any requirements or methods for protection.
****

Minimize interference with, disturbance to, and damage to fish, wildlife, and plants, including their habitats. Prior to the commencement of activities, consult with the Installation Environmental Office as applicable, regarding rare species or sensitive habitats that need to be protected. The protection of rare, threatened, and endangered animal and plant species identified, including their habitats, is the Contractor's responsibility.[The following species are known and could be affected within the construction area: [_____].]

Preserve the natural resources within the project boundaries and outside the limits of permanent work. Restore to an equivalent or improved condition upon completion of work that is consistent with the requirements of the Installation Environmental Office or as otherwise specified. Confine construction activities to within the limits of the work indicated or specified.

3.1.1 Flow Ways

Do not alter water flows or otherwise significantly disturb the native habitat adjacent to the project and critical to the survival of fish and wildlife, except as specified and permitted.

3.1.2 Vegetation

Except in areas to be cleared, do not remove, cut, deface, injure, or destroy trees or shrubs without the Contracting Officer's permission. Do not fasten or attach ropes, cables, or guys to existing nearby trees for anchorages unless authorized by the Contracting Officer. Where such use of attached ropes, cables, or guys is authorized, the Contractor is responsible for any resultant damage.

Protect existing trees that are to remain to ensure they are not injured, bruised, defaced, or otherwise damaged by construction operations. Remove displaced rocks from uncleared areas. Coordinate with the Contracting Officer and Installation Environmental Office to determine appropriate action for trees and other landscape features scarred or damaged by equipment operations.

3.1.3 Streams

****

NOTE: Review federal, state, and local requirements and obtain all necessary permits that are required for stream crossings.

****

Stream crossings must allow movement of materials or equipment without violating water pollution control standards of the federal, state, and local governments. Construction of stream crossing structures must be in compliance with all required permits including, but not limited to, Clean Water Act Section 404, and Section 401 Water Quality.

The Contracting Officer's approval and appropriate permits are required before any equipment will be permitted to ford live streams. In areas where frequent crossings are required, install temporary culverts or bridges. Obtain Contracting Officer's approval prior to installation. Remove temporary culverts or bridges upon completion of work, and repair the area to its original condition unless otherwise required by the Contracting Officer.

3.2 STORMWATER

****

NOTE: Check with Installation Environmental Office as applicable to make sure that you are including all relevant state and local agency requirements.

****

Do not discharge stormwater from construction sites to the sanitary sewer. If the water is noted or suspected of being contaminated, it may only be released to the storm drain system if the discharge is specifically permitted. Obtain authorization in advance from the Installation Environmental Office for any release of contaminated water.

[3.2.1 Construction General Permit

****

NOTE: Include this paragraph and subparagraphs when one or more acres (0.4 or more hectares) of total land area are to be disturbed or disturbs less than one acre but is part of a larger common plan of

development or sale that will disturb one or more acres. Coordinate with Installation Environmental Office as applicable to determine if project is part of larger common plan of development. Most states are approved to implement the General Permits Program. EPA remains the permitting authority in a few states, territories, and on most land in Indian Country. Refer to https://www.epa.gov/npdes/authorization-status-epas-construction-and-industrial-stormwater-programs **for the approved list. Edit the bracketed item accordingly.**

****

Provide a Construction General Permit as required by 40 CFR 122.26 or [EPA][the State of [_____]] General Permit. Under the terms and conditions of the permit, install, inspect, maintain BMPs, prepare stormwater erosion and sediment control inspection reports, and submit SWPPP inspection reports. Maintain construction operations and management in compliance with the terms and conditions of the general permit for stormwater discharges from construction activities.

3.2.1.1 Stormwater Pollution Prevention Plan

****

NOTE: For projects in the NAVFAC PAC Area of Operation, edit this paragraph to include bracketed portion "within 30 calendar days of Contract award and..."

****

Submit a project-specific Stormwater Pollution Prevention Plan (SWPPP) to the Contracting Officer for approval, [within 30 days of Contract Award and]prior to the commencement of work. The SWPPP must meet the requirements of 40 CFR 122.26 and [the EPA General Permit][the [_____] State General Permit] for stormwater discharges from construction sites.

****

NOTE: Coordinate with the Installation Environmental Management Office to edit the bracketed items. Use the last bracketed item "d" for NAVY only projects when local environmental controls are provided.

****

Include the following:

a. Comply with terms of the [EPA][state] general permit for stormwater discharges from construction activities. Prepare SWPPP in accordance with [state][EPA] requirements. Use [state][EPA guide Developing your Stormwater Pollution Prevention Plan located at https://www.epa.gov/npdes/developing-stormwater-pollution-prevention-plan-swppp to prepare the SWPPP.]

b. Select applicable BMPs from EPA Fact Sheets located at https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater#constr or in accordance with applicable state or local requirements.

c. Include a completed copy of the Notice of Intent, BMP Inspection Report Template, and Stormwater Notice of Termination, except for the effective date.

****

NOTE: The following item is tailored for NAVY use only.

****

[d. Comply with local additional requirements.

]3.2.1.2 Stormwater Notice of Intent for Construction Activities

****

NOTE: Refer to the Construction General Permit for Construction Activities permit application form to determine if co-permittee status, with the Contractor and Installation covered under one permit, is required by the permitting authority. Choose first bracketed sentence when co-permittee status is not required. Choose second bracketed sentence when co-permittee status is required.

Use the last, NAVY tailored paragraph for Navy projects only.

****

****

NOTE: For projects in the NAVFAC PAC Area of Operation, add the first and last bracketed paragraphs to this paragraph.

****

[Prepare and submit the Notice of Intent for NPDES coverage under the general permit for construction activities to the Contracting Officer for review.

][Prepare and submit the Notice of Intent for NPDES coverage under the general permit for construction activities to the Contracting Officer for review and approval.

][Prepare and submit a Notice of Intent as a co-permittee to the Contracting Officer, for review and approval.

] Submit the approved NOI and appropriate permit fees onto the appropriate federal or state agency for approval. No land disturbing activities may commence without permit coverage. Maintain an approved copy of the SWPPP at the onsite construction office, and continually update as regulations require, reflecting current site conditions.

Comply with additional state and local requirements.

3.2.1.3 Inspection Reports

****

NOTE: Use the last NAVY tailored, bracketed sentence for Navy projects only.

****

Submit "Inspection Reports" to the Contracting Officer in accordance with

[EPA][the State of [_____]]Construction General Permit.[Provide Inspection Reports in accordance withlocal requirements.]

3.2.1.4 Stormwater Pollution Prevention Plan Compliance Notebook

****

NOTE: Use the bracketed option to identify the permit issuing agency.

****

Create and maintain a three ring binder of documents that demonstrate compliance with the Construction General Permit. Include a copy of the permit Notice of Intent, proof of permit fee payment, SWPPP and SWPPP update amendments, inspection reports and related corrective action records, copies of correspondence with the [EPA][the [_____]State Permitting Agency], and a copy of the permit Notice of Termination in the binder. At project completion, the notebook becomes property of the Government. Provide the compliance notebook to the Contracting Officer.

3.2.1.5 Stormwater Notice of Termination for Construction Activities

****

NOTE: Use bracketed item if as-built topographic survey information is required by the permitting agency for certification of the stormwater management system.

****

Submit a Notice of Termination to the Contracting Officer for approval once construction is complete and final stabilization has been achieved on all portions of the site for which the permittee is responsible. Once approved, submit the Notice of Termination to the appropriate state or federal agency.[Prepare as-built topographic survey information required by the permitting agency for certification of the stormwater management system, and provide to the Contracting Officer.]

]3.2.2 Erosion and Sediment Control Measures

****

NOTE: For projects that have a State permit, delete subparagraphs EROSION CONTROL and SEDIMENT CONTROL PRACTICES.

****

Provide erosion and sediment control measures in accordance with state and local laws and regulations. Preserve vegetation to the maximum extent practicable.

****

NOTE: The following paragraph is tailored for ILLINOIS and is for State of Illinois use only.

****

The Contractor's best management practices must also be in accordance with the State of Illinois National Pollutant Discharge Elimination System (NPDES) Storm Water Pollution Prevention requirements. Any temporary measures must be removed after the area has been stabilized.

****

NOTE: The following paragraph is tailored for INDIANA and is for State of Indiana use only.

****

The Contractor will be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations. The erosion and sediment controls selected and maintained by the Contractor must be such that water quality standards are not violated as a result of the Contractor's construction activities. The area of bare soil exposed at any one time by construction operations should be kept to a minimum. The Contractor must construct or install temporary and permanent erosion and sediment control best management practices (BMPs). BMPs may include, but not be limited to, vegetation cover, stream bank stabilization, slope stabilization, silt fences, construction of terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels, and sedimentation basins. The Contractor's best management practices must also be in accordance with the State of Indiana National Pollutant Discharge Elimination System (NPDES) Storm Water Pollution Prevention requirements. Any temporary measures must be removed after the area has been stabilized.

****

NOTE: The following paragraph is tailored for WISCONSIN and is for State of Wisconsin use only.

****

The Contractor will be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations. The erosion and sediment controls selected and maintained by the Contractor must be such that water quality standards are not violated as a result of the Contractor's construction activities. The area of bare soil exposed at any one time by construction operations should be kept to a minimum. The Contractor must construct or install temporary and permanent erosion and sediment control best management practices (BMPs). BMPs may include, but not be limited to, vegetation cover, stream bank stabilization, slope stabilization, silt fences, construction of terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels, and sedimentation basins. The Contractor's best management practices must also be in accordance with the State of Wisconsin National Pollutant Discharge Elimination System (NPDES) Storm Water Pollution Prevention requirements. Any temporary measures must be removed after the area has been stabilized.

Erosion control inspection reports may be compiled as part of a stormwater pollution prevention plan inspection reports.

[3.2.2.1 Erosion Control

****

NOTE: Use last bracketed sentence if Section 32 92 19 SEEDING is included in the project.

****

Prevent erosion by[mulching,][Compost Blankets,][Geotextiles,][temporary slope drains,][_____]. Stabilize slopes by[chemical stabilization,][sodding,][seeding,][_____] or such combination of these methods necessary for effective erosion control. Use of hay bales is prohibited.

[Provide seeding in accordance with Section 32 92 19 SEEDING.

]][3.2.2.2 Sediment Control Practices

****

NOTE: Select the sediment control practices appropriate for the project. See https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater#constr**. Use last bracketed sentence when sediment control practices are indicated on the drawings. Include details.**

****

Implement sediment control practices to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Implement sediment control practices prior to soil disturbance and prior to creating areas with concentrated flow, during the construction process to minimize erosion and sediment laden runoff. Include the following devices:[silt fence,][temporary diversion dikes,][storm drain inlet protection,][_____,][Location and details of installation and construction are indicated on the drawings].

]3.2.3 Work Area Limits

Mark the areas that need not be disturbed under this Contract prior to commencing construction activities. Mark or fence isolated areas within the general work area that are not to be disturbed. Protect monuments and markers before construction operations commence. Where construction operations are to be conducted during darkness, all markers must be visible in the dark. Personnel must be knowledgeable of the purpose for marking and protecting particular objects.

3.2.4 Contractor Facilities and Work Areas

Place field offices, staging areas, stockpile storage, and temporary buildings in areas designated on the drawings or as directed by the Contracting Officer. Move or relocate the Contractor facilities only when approved by the Government. Provide erosion and sediment controls for onsite borrow and spoil areas to prevent sediment from entering nearby waters. Control temporary excavation and embankments for plant or work areas to protect adjacent areas.

3.2.5 Municipal Separate Storm Sewer System (MS4) Management

****

NOTE: Use this paragraph if the Installation holds a MS4 permit. Coordinate with the Installation Environmental Office. Use tailored, bracketed sentence for Navy only projects.

****

Comply with the Installation's MS4 permit requirements.[Comply with local requirements.]

3.3 SURFACE AND GROUNDWATER

3.3.1 Cofferdams, Diversions, and Dewatering

****

NOTE: Edit the first sentence by removing items not included in the project.

****

Construction operations for dewatering, removal of cofferdams, tailrace excavation, and tunnel closure must be constantly controlled to maintain compliance with existing state water quality standards and designated uses of the surface water body. Comply with[the State of [_____] water quality standards and anti-degradation provisions] [and][the Clean Water Act Section 404, Nation Wide Permit No. [_____]]. Do not discharge excavation ground water to the sanitary sewer, storm drains, or to surface waters without prior specific authorization in writing from the Installation Environmental Office or Contracting Officer. Discharge of hazardous substances will not be permitted under any circumstances. Use sediment control BMPs to prevent construction site runoff from directly entering any storm drain or surface waters.

****

NOTE: The following paragraph is tailored for ILLINOIS and is for State of Illinois use only.

****

The Contractors diversions and dewatering operations must comply with the state of Illinois water quality standards and anti-degradation provisions, Section 404 of the Clean Water Act, and the Section 401 Water Quality Certification for this project.

If the construction dewatering is noted or suspected of being contaminated, it may only be released to the storm drain system if the discharge is specifically permitted. Obtain authorization for any contaminated groundwater release in advance from the Installation Environmental Officer and the federal or state authority, as applicable. Discharge of hazardous substances will not be permitted under any circumstances.

3.3.2 Waters of the United States

****

NOTE: All wetlands on the site or adjacent to the site must be identified on the drawings and this paragraph edited accordingly. If the wetlands on site must be disturbed, coordination with the regulatory agencies during design for identification of Section 401 and 404 of the Clean Water Act permits whether the permit is an Individual, Nationwide, Regional, State, or Local 404 or similar permit. Include permit requirements in the LICENSES AND PERMITS paragraph and attach to this specification. In addition, coordinate any mitigation requirements for the project.

Government Natural Resources staff will approve all Section 404 permit mitigations; the Contractor is not authorized to agree to mitigations on behalf of the Government.

If no wetlands are onsite or adjacent to the site, delete this paragraph in its entirety. The first sentence should normally remain intact with the first bracketed item. This will require the Contractor to be cognizant of the responsibility to protect wetlands regardless of whether they are identified on drawings or in the event site conditions have changed since design.

****

Do not enter, disturb, destroy, or allow discharge of contaminants into waters of the United States[.][except as authorized herein. The protection of waters of the United States shown on the drawings in accordance with paragraph LICENSES AND PERMITS is the Contractor's responsibility. Authorization to enter specific waters of the United States identified does not relieve the Contractor from any obligation to protect other waters of the United States within, adjacent to, or in the vicinity of the construction site and associated boundaries.]

3.3.3 Stream Crossings

****

NOTE: The following paragraph is tailored for ILLINOIS and is for State of Illinois use only.

****

Comply with the State of Illinois water quality standards and anti-degradation provisions, Section 404 of the Clean Water Act, and the Section 401 Water Quality Certification for construction of stream crossing for this project.

3.4 PROTECTION OF CULTURAL RESOURCES

****

NOTE: Obtain the National Historic Preservation Act Section 106 documentation from the Government and include requirements agreed to during the consultation process with the State Historic Preservation Officer. If Section 106 has not been completed delete the following paragraphs.

****

3.4.1 Archaeological Resources

****

NOTE: If there are known archaeological resources on the project site, include the bracketed sentence and show the required protection area and other protection measures on the drawings. The exact location of known archaeological resources is sensitive information that will not be distributed unless necessary for protection. The Contracting Officer will review and approve what is shown on the drawings.

****

[Existing archaeological resources within the work area are shown on the drawings. Protect these resources and be responsible for their preservation during the life of the Contract.]If, during excavation or other construction activities, any previously unidentified or unanticipated historical, archaeological, and cultural resources are discovered or found, activities that may damage or alter such resources will be suspended. Resources covered by this paragraph include, but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rock or coral alignments, pavings, wall, or other constructed features; and any indication of agricultural or other human activities. Upon such discovery or find, immediately notify the Contracting Officer so that the appropriate authorities may be notified and a determination made as to their significance and what, if any, special disposition of the finds should be made. Cease all activities that may result in impact to or the destruction of these resources. Secure the area and prevent employees or other persons from trespassing on, removing, or otherwise disturbing such resources. The Government retains ownership and control over archaeological resources.

[3.4.2 Historical Resources

****

NOTE: If there are known historical or other cultural resources on the project site, include this paragraph and show the required protection area and other protection measures on the drawings. Show the exact location of known historical resources on the drawings.

****

Existing historical resources within the work area are shown on the drawings. Protect these resources and be responsible for their preservation during the life of the Contract.

]3.5 AIR RESOURCES

Equipment operation, activities, or processes will be in accordance with 40 CFR 64 and state air emission and performance laws and standards.

3.5.1 Preconstruction Air Permits

****

NOTE: Coordinate with local Installation Environmental Office as applicable to determine if Government will obtain these permits, or if Contractor will be required to obtain them.

Include permit application fees; coordinate with the Installation Environmental Office for the estimated fee based on project specifics. Fee amount will depend on location of work and type of work. Typical fees range from $250 to $3500.

****

Notify the Air Program Manager, through the Contracting Officer, at least 6 months prior to bringing equipment, assembled or unassembled, onto the Installation, so that air permits can be secured. Necessary permitting time must be considered in regard to construction activities. Clean Air Act (CAA) permits must be obtained prior to bringing equipment, assembled or unassembled, onto the Installation.

[Permits will be provided by the Government.] [Confirm that these permits have been obtained.]

3.5.2 Oil or Dual-fuel Boilers and Furnaces

Provide product data and details for new, replacement, or relocated fuel fired boilers, heaters, or furnaces to the Installation Environmental Office (Air Program Manager) through the Contracting Officer. Data to be reported include: equipment purpose (water heater, building heat, process), manufacturer, model number, serial number, fuel type (oil type, gas type) size (MMBTU heat input). Provide in accordance with paragraph PRECONSTRUCTION AIR PERMITS.

3.5.3 Burning

****

NOTE: Edit the paragraph after coordinating with the governing agencies.

****

[Burning is prohibited on the Government premises.] [Burning is allowed on Government premises[; confine fires to a closed vessel that is guarded and under constant surveillance until contents have burned out or have been extinguished].[Burning must completely reduce the materials to ashes.]]

3.5.4 Class I [and II]ODS Prohibition

Class I [and II]ODS are Government property and must be returned to the Government for appropriate management. Coordinate with the Installation Environmental Office to determine the appropriate location for turn in of all reclaimed refrigerant.

3.5.5 Venting of Refrigerant

Accidental venting of a refrigerant is a release and must be reported immediately to the Contracting Officer. Intentional venting of refrigerants (including most Non-ODS substitute refrigerants) is prohibited per 40 CFR 82.

3.5.6 EPA Certification Requirements

Heating and air conditioning technicians must be certified through an EPA-approved program. Maintain copies of certifications at the employees' places of business; technicians must carry certification wallet cards, as provided by environmental law.

3.5.7 Dust Control

****

NOTE: Only use the bracketed sentence if dust suppressants are allowed at the Installation and with permission of the Installation's Environmental office.

****

Keep dust down at all times, including during nonworking periods.[Sprinkle or treat, with dust suppressants, the soil at the site, haul roads, and other areas disturbed by operations.] Dry power brooming will not be permitted. Instead, use vacuuming, wet mopping, wet sweeping, or wet power brooming. Air blowing will be permitted only for cleaning nonparticulate debris such as steel reinforcing bars. Only wet cutting will be permitted for cutting concrete blocks, concrete, and bituminous concrete. Do not unnecessarily shake bags of cement, concrete mortar, or plaster. Since these products contain Crystalline Silica, comply with the applicable OSHA standard, 29 CFR 1910.1053 or 29 CFR 1926.1153 for controlling exposure to Crystalline Silica Dust.

3.5.7.1 Particulates

****

NOTE: This is a general performance type requirement for particulate control. For projects where special construction activities, such as concrete batch plants, or extensive earthwork are involved, the Designer should consider the need for a more descriptive specification giving methods, frequency of application, and monitoring methods for controlling particulates.

****

Dust particles, aerosols and gaseous by-products from construction activities, and processing and preparation of materials (such as from asphaltic batch plants) must be controlled at all times, including weekends, holidays, and hours when work is not in progress. Maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates that would exceed 40 CFR 50, state, and local air pollution standards or that would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, baghouse, scrubbers, electrostatic precipitators, or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp. Provide sufficient, competent equipment available to accomplish these tasks. Perform particulate control as the work proceeds and whenever a particulate nuisance or hazard occurs. Comply with state and local visibility regulations.

3.5.7.2 Abrasive Blasting

****

NOTE: Determine whether the paint to be removed contains any hazardous components. Test a representative sample of the paint in accordance with 40 CFR 261. Include the bracketed sentence on hazardous material if it is determined the paint is toxic.

****

Blasting operations cannot be performed without prior approval of the Installation Air Program Manager. The use of silica sand is prohibited in sandblasting.

Provide tarpaulin drop cloths and windscreens to enclose abrasive blasting operations to confine and collect dust, abrasive agent, paint chips, and other debris.[Perform work involving removal of hazardous material in accordance with 29 CFR 1910.]

3.5.8 Odors

Control odors from construction activities. The odors must be in compliance with state regulations and local ordinances and may not constitute a health hazard.

****

NOTE: The following paragraph is tailored for INDIANA and is for State of Indiana use only.

****

Odors must be controlled at all times. The odors must not cause a health hazard and must be in compliance with State of Indiana regulations and ordinances.

****

NOTE: The following paragraph is tailored for WISCONSIN and is for State of Wisconsin use only.

****

Odors must be controlled at all times. The odors must not cause a health hazard and must be in compliance with State of Wisconsin regulations and local ordinances.

3.6 WASTE MINIMIZATION

Minimize the use of hazardous materials and the generation of waste. Include procedures for pollution prevention/ hazardous waste minimization in the Hazardous Waste Management Section of the EPP. Obtain a copy of the installation's Pollution Prevention/Hazardous Waste Minimization Plan for reference material when preparing this part of the EPP. If no written plan exists, obtain information by contacting the Contracting Officer. Describe the anticipated types of the hazardous materials to be used in the construction when requesting information.

3.6.1 Salvage, Reuse and Recycle

Identify anticipated materials and waste for salvage, reuse, and recycling. Describe actions to promote material reuse, resale or recycling. To the extent practicable, all scrap metal must be sent for reuse or recycling and will not be disposed of in a landfill.

Include the name, physical address, and telephone number of the hauler, if transported by a franchised solid waste hauler. Include the destination and, unless exempted, provide a copy of the state or local permit (cover) or license for recycling.

3.6.2 Nonhazardous Solid Waste Diversion Report

****

NOTE: Edit the Nonhazardous Solid Waste Diversion Report to reflect the Using Service's requirements.

Coordinate the requirements in this paragraph with Section 02 41 00 [DEMOLITION][AND][DECONSTRUCTION].

****

Maintain an inventory of nonhazardous solid waste diversion and disposal of construction and demolition debris. Submit a report to [_____ through] the

Contracting Officer on the first working day after each fiscal year quarter, starting the first quarter that nonhazardous solid waste has been generated. Include the following in the report:

Construction and Demolition (C&D) Debris Disposed	[_____] [cubic yards][tons],[cubic meters] as appropriate
C&D Debris Recycled	[_____] [cubic yards][tons],[cubic meters] as appropriate
C&D Debris Composted	[_____] [cubic yards][tons],[cubic meters] as appropriate
Total C&D Debris Generated	[_____] [cubic yards][tons],[cubic meters] as appropriate
Waste Sent to Waste-To-Energy Incineration Plant (This amount should not be included in the recycled amount)	[_____] [cubic yards][tons],[cubic meters] as appropriate

3.7   WASTE MANAGEMENT AND DISPOSAL

3.7.1   Waste Determination Documentation

Complete a Waste Determination form (provided at the pre-construction conference) for Contractor-derived wastes to be generated. All potentially hazardous solid waste streams that are not subject to a specific exclusion or exemption from the hazardous waste regulations (e.g., scrap metal, domestic sewage) or subject to special rules, (lead-acid batteries and precious metals) must be characterized in accordance with the requirements of 40 CFR 262.11 or corresponding applicable state or local regulations. Base waste determination on user knowledge of the processes and materials used, and analytical data when necessary. Consult with the Installation environmental staff for guidance on specific requirements. Attach support documentation to the Waste Determination form. As a minimum, provide a Waste Determination form for the following waste (this listing is not exhaustive): oil- and latex -based painting and caulking products, solvents, adhesives, aerosols, petroleum products, and containers of the original materials.

[3.7.1.1   Sampling and Analysis of Waste

****

NOTE: Use this paragraph when the project generates HW that are not identified in 40 CFR 261, Hazardous Waste Listing.

Coordinate with the Installation Environmental Office as applicable to determine if the installation provides sampling and analysis for Contractor Waste.

****

3.7.1.1.1   Waste Sampling

Sample waste in accordance with EPA SW-846. Clearly mark each sampled drum or container with the Contractor's identification number, and cross reference to the chemical analysis performed.

3.7.1.1.2 Laboratory Analysis

Follow the analytical procedure and methods in accordance with the 40 CFR 261. Provide analytical results and reports performed to the Contracting Officer. Coordinate all activities with Installation Hazardous Waste Manager.

3.7.1.1.3 Analysis Type

Identify hazardous waste by analyzing for the following characteristics:[ignitability,][corrosivity,][reactivity,][toxicity based on TCLP results,] [_____].

]3.7.2 Solid Waste Management

3.7.2.1 Project Solid Waste Disposal Documentation Report

****

NOTE: Select bracketed item when sales documentation is not available. Revise close out submittal to include Contractor Certification instead of the sales documentation.

****

Provide copies of the waste handling facilities' weight tickets, receipts, bills of sale, and other sales documentation. In lieu of sales documentation, a statement indicating the disposal location for the solid waste that is signed by an employee authorized to legally obligate or bind the firm may be submitted. The sales documentation[Contractor certification] must include the receiver's tax identification number and business, EPA or state registration number, along with the receiver's delivery and business addresses and telephone numbers. For each solid waste retained for the Contractor's own use, submit the information previously described in this paragraph on the solid waste disposal report. Prices paid or received do not have to be reported to the Contracting Officer unless required by other provisions or specifications of this Contract or public law.

3.7.2.2 Control and Management of Solid Wastes

****

NOTE: Select appropriate disposal alternative. In some states certain quantities of clearing debris may be classified as solid waste. Include appropriate language to comply with State requirements. Remove non-applicable bracketed options.

****

Pick up solid wastes, and place in covered containers that are regularly emptied. Do not prepare or cook food on the project site. Prevent contamination of the site or other areas when handling and disposing of wastes. At project completion, leave the areas clean. Employ segregation measures so that no hazardous or toxic waste will become co-mingled with non-hazardous solid waste.[Transport solid waste off Government property and dispose of it in compliance with 40 CFR 260, state, and local requirements for solid waste disposal. A Subtitle D RCRA permitted landfill is the minimum acceptable offsite solid waste disposal option.

Verify that the selected transporters and disposal facilities have the necessary permits and licenses to operate.][Haul waste materials to the Government landfill site[shown on the drawings][designated by the Contracting Officer].][Comply with site procedures.][Segregate and separate treated wood components disposed at a lined landfill approved to accept this waste in accordance with local and state regulations] Solid waste disposal offsite must comply with most stringent local, state, and federal requirements, including 40 CFR 241, 40 CFR 243, and 40 CFR 258.

Manage hazardous material used in construction, including but not limited to, aerosol cans, waste paint, cleaning solvents, contaminated brushes, and used rags, in accordance with 49 CFR 173.

3.7.3 Control and Management of Hazardous Waste

Do not dispose of hazardous waste on Government property. Do not discharge any waste to a sanitary sewer, storm drain, or to surface waters or conduct waste treatment or disposal on Government property without written approval of the Contracting Officer and Installation Hazardous Waste Manager.

3.7.3.1 Hazardous Waste/Debris Management

Identify construction activities that will generate hazardous waste or debris. Provide a documented waste determination for resultant waste streams. Identify, label, handle, store, and dispose of hazardous waste or debris in accordance with federal, state, and local regulations, including 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, and 40 CFR 268.

Manage hazardous waste in accordance with the approved Hazardous Waste Management Section of the EPP. Store hazardous wastes in approved containers in accordance with 49 CFR 173 and 49 CFR 178. Hazardous waste generated within the confines of Government facilities is identified as being generated by the Government. Prior to removal of any hazardous waste from Government property, hazardous waste manifests must be signed by personnel from the Installation Environmental Office. Do not bring hazardous waste onto Government property. Provide the Contracting Officer with a copy of waste determination documentation for any solid waste streams that have any potential to be hazardous waste or contain any chemical constituents listed in 40 CFR 372-SUBPART D.

3.7.3.2 Waste Storage/Satellite Accumulation/90 Day Storage Areas

Accumulate hazardous waste at satellite accumulation points and in compliance with 40 CFR 262 and applicable state or local regulations. Individual waste streams will be limited to 208 liter 55 gallons of accumulation (or 0.95 liter one quart for acutely hazardous wastes). If the Contractor expects to generate hazardous waste at a rate and quantity that makes satellite accumulation impractical, the Contractor may request a temporary 90-day or 180-day, as appropriate, accumulation point be established. Submit a request in writing to the Contracting Officer and provide the following information (Attach Site Plan to the Request):

Contract Number	[_____]
Contractor	[_____]
Haz/Waste or Regulated Waste POC	[_____]

Contract Number	[_____]
Phone Number	[_____]
Type of Waste	[_____]
Source of Waste	[_____]
Emergency POC	[_____]
Phone Number	[_____]
Location of the Site	[_____]

Attach a Waste Determination form for the expected waste streams. Allow 10 working days for processing this request. Additional compliance requirements (e.g., training and contingency planning) that may be required are the responsibility of the Contractor. Barricade the designated area where waste is being stored and post a sign identifying as follows:

"DANGER - UNAUTHORIZED PERSONNEL KEEP OUT"

3.7.3.3 Hazardous Waste Disposal

[3.7.3.3.1 Responsibilities for Contractor's Disposal

****

NOTE: Choose this paragraph for Contractor Disposal of the Hazardous Waste.

****

Provide hazardous waste manifest to the Installations Environmental Office for review, approval, and signature prior to shipping waste off Government property.

3.7.3.3.1.1 Services

Provide service necessary for the final treatment or disposal of the hazardous material or waste in accordance with 40 CFR 260 - 40 CFR 279, local, and state, laws and regulations, and the terms and conditions of the Contract within 60 days after the materials have been generated. These services include necessary personnel, labor, transportation, packaging, detailed analysis (if required for disposal or transportation, include manifesting or complete waste profile sheets, equipment, and compile documentation).

3.7.3.3.1.2 Samples

Obtain a representative sample of the material generated for each job done to provide waste stream determination.

3.7.3.3.1.3 Analysis

****

NOTE: Use this paragraph when the project generates HW that are not identified in 40 CFR 261, Hazardous Waste Listing.

Coordinate with the Installation Environmental Office as applicable to determine if the

installation provides sampling and analysis for Contractor Waste.

****

Analyze each sample taken and provide analytical results to the Contracting Officer. See paragraph WASTE DETERMINATION DOCUMENTATION.

3.7.3.3.1.4 Labeling

During waste accumulation label all containers in accordance with 40 CFR 262. Prior to offering a waste for off-site transport, determine the Department of Transportation's (DOT's) proper shipping names for waste in accordance with 49 CFR 172 (each container requiring disposal) and demonstrate to the Contracting Officer how this determination is developed and supported by the sampling and analysis requirements contained herein. Label all containers of hazardous waste with the words "Hazardous Waste" or other words to describe the contents of the container in accordance with 40 CFR 262 and applicable state or local regulations.

][3.7.3.3.2 Contractor Disposal Turn-In Requirements

****

NOTE: Choose this paragraph if Contractor will turn-in waste into an Installation's waste accumulation facilities. Coordinate with the Installations Environmental Office to further edit this paragraph to meet Installation requirements. Contractor will not prepare manifest documentation when this option of disposal is selected. Coordinate language in other paragraphs to clarify manifesting requirements.

****

Hazardous waste generated must be disposed of in accordance with the following conditions to meet installation requirements:

a. Drums must be compatible with waste contents and drums must meet DOT requirements for 49 CFR 173 for transportation of materials.

b. Band drums to wooden pallets.

c. No more than three 208 liter 55 gallon drums or two 321 liter 85 gallon over packs are to be banded to a pallet.

d. Band using 32 millimeters 1-1/4 inch minimum band on upper third of drum.

e. Provide label in accordance with 49 CFR 172.101.

f. Leave 7 to 12 centimeters 3 to 5 inches of empty space above volume of material.

]3.7.3.4 Universal Waste Management

****

NOTE: The following list contains tailoring for ARMY and NAVY

State requirements may differ from federal

regulation. Use last ARMY tailored item for Army projects only. For Navy projects, use NAVY tailored item for additional requirements.

****

Manage the following categories of universal waste in accordance with federal, state, and local requirements and installation instructions:

a. Batteries as described in 40 CFR 273.2

b. Lamps as described in 40 CFR 273.5

c. Mercury-containing equipment as described in 40 CFR 273.4

d. Aerosol cans as described in 40 CFR 273.6

e. Pesticides as described in 40 CFR 273.3

e. Installation specific

Mercury is prohibited in the construction of this facility, unless specified otherwise, and with the exception of mercury vapor lamps and fluorescent lamps. Dumping of mercury-containing materials and devices such as mercury vapor lamps, fluorescent lamps, and mercury switches, in rubbish containers is prohibited. Remove without breaking, pack to prevent breakage, and transport out of the activity in an unbroken condition for disposal as directed.

3.7.3.5 Electronics End-of-Life Management

Recycle or dispose of electronics waste, including, but not limited to, used electronic devices such computers, monitors, hard-copy devices, televisions, mobile devices, in accordance with 40 CFR 260-262, state, and local requirements, and installation instructions.

3.7.3.6 Disposal Documentation for Hazardous and Regulated Waste

Contact the Contracting Officer [or designated representative]for the facility RCRA identification number that is to be used on each manifest.

****

NOTE: Use the following bracketed item for Navy projects only. Coordinate with installation special requirements. A Base Environmental point of contact will be identified for Base specific requirements.

****

[Submit a copy of the applicable EPA and or state permit(s), manifest(s), or license(s) for transportation, treatment, storage, and disposal of hazardous and regulated waste by permitted facilities. Hazardous or toxic waste manifests must be reviewed, signed, and approved by the Contracting Officer before the Contractor may ship waste. To obtain specific disposal instructions, coordinate with the Installation Environmental Office. Refer to location special requirements for the Installation Point of Contact information.

]3.7.4 Releases/Spills of Oil and Hazardous Substances

3.7.4.1 Response and Notifications

Exercise due diligence to prevent, contain, and respond to spills of hazardous material, hazardous substances, hazardous waste, sewage, regulated gas, petroleum, lubrication oil, and other substances regulated in accordance with 40 CFR 300. Maintain spill cleanup equipment and materials at the work site. In the event of a spill, take prompt, effective action to stop, contain, curtail, or otherwise limit the amount, duration, and severity of the spill/release. In the event of any releases of oil and hazardous substances, chemicals, or gases; immediately (within 15 minutes) notify the Installation Fire Department, the Installation Command Duty Officer, the Installation Environmental Office, the Contracting Officer[and the state or local authority].

Submit verbal and written notifications as required by the federal (40 CFR 300.125 and 40 CFR 355), state, local regulations and instructions. Provide copies of the written notification and documentation that a verbal notification was made within 20 days. Spill response must be in accordance with 40 CFR 300 and applicable state and local regulations. Contain and clean up these spills without cost to the Government.

3.7.4.2 Clean Up

Clean up hazardous and non-hazardous waste spills. Reimburse the Government for costs incurred including sample analysis materials, clothing, equipment, and labor if the Government will initiate its own spill cleanup procedures, for Contractor- responsible spills, when: Spill cleanup procedures have not begun within one hour of spill discovery/occurrence; or, in the event of the Government's judgment, spill cleanup is inadequate and the spill remains a threat to human health or the environment.

3.7.5 Mercury Materials

Immediately report to the Environmental Office and the Contracting Officer instances of breakage or mercury spillage. Clean mercury spill area to the satisfaction of the Contracting Officer.

Do not recycle a mercury spill cleanup; manage it as a hazardous waste for disposal.

3.7.6 Wastewater

****

NOTE: Coordinate with the Installation Environmental Office as applicable. Identify and obtain permits required by governing agencies. Insert or delete the brackets with the name of process producing the wastewater. If there is an area on the project site for a retention pond, a choice may be given for disposal in a retention pond. If there is a possibility that the water is contaminated, then identify and specify the appropriate analytical testing be performed.

****

3.7.6.1 Disposal of Wastewater

Disposal of wastewater must be as specified below.

3.7.6.1.1 Treatment

Do not allow wastewater from construction activities, such as onsite material processing, concrete curing, foundation and concrete clean-up, water used in concrete trucks, and forms to enter water ways or to be discharged prior to being treated to remove pollutants. Dispose of the construction- related waste water[off-Government property in accordance with 40 CFR 403, state, regional, and local laws and regulations.][by collecting and placing it in a retention pond where suspended material can be settled out or the water can evaporate to separate pollutants from the water. The site for the retention pond must be coordinated and approved with the Contracting Officer. The residue left in the pond prior to completion of the project must be removed, tested, and disposed of off-Government property in accordance with federal, state, and local laws and regulations. Backfill the area to the original grade, top-soiled, and seeded or sodded.[Test the water in the retention pond for [_____] and have the results reviewed and approved by the Contracting Officer prior to being discharged or disposed of off- Government property].]

3.7.6.1.2 Surface Discharge

For discharge of ground water,[obtain a state or federal permit specific for pumping and discharging ground water prior to surface discharging.][Surface discharge in accordance with federal, state, and local laws and regulations.][Surface discharge in accordance with the requirements of the NPDES or state STORMWATER DISCHARGES FROM CONSTRUCTION SITES permit.]

3.7.6.1.3 Land Application

Water generated from the flushing of lines after[disinfection or disinfection in conjunction with hydrostatic testing][hydrostatic testing] must be[land- applied in accordance with federal, state, and local laws and regulations for land application][discharged into the sanitary sewer with prior approval and notification to the Wastewater Treatment Plant's Operator].

3.8 HAZARDOUS MATERIAL MANAGEMENT

Include hazardous material control procedures in the Safety Plan, in accordance with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. Address procedures and proper handling of hazardous materials, including the appropriate transportation requirements. Do not bring hazardous material onto Government property that does not directly relate to requirements for the performance of this contract. Submit an SDS and estimated quantities to be used for each hazardous material to the Contracting Officer prior to bringing the material on the installation. Typical materials requiring SDS and quantity reporting include, but are not limited to, oil and latex based painting and caulking products, solvents, adhesives, aerosol, and petroleum products. Use hazardous materials in a manner that minimizes the amount of hazardous waste generated. Containers of hazardous materials must have National Fire Protection Association labels or their equivalent. Certify that hazardous materials removed from the site are hazardous materials and do not meet the definition of hazardous waste, in accordance with 40 CFR 261 and state[and installation] requirements.

3.8.1 Contractor Hazardous Material Inventory Log

****
NOTE: The following paragraph is tailored for NAVY. Use this paragraph for Navy projects only. Delete for other projects.
****

Submit the "Contractor Hazardous Material Inventory Log"(found at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables), which provides information required by (EPCRA Sections 312 and 313) along with corresponding SDS, to the Contracting Officer at the start and at the end of construction (30 days from final acceptance), and update no later than January 31 of each calendar year during the life of the contract. Keep copies of the SDSs for hazardous materials onsite. At the end of the project, provide the Contracting Officer with copies of the SDSs, and the maximum quantity of each material that was present at the site at any one time, the dates the material was present, the amount of each material that was used during the project, and how the material was used.

The Contracting Officer may request documentation for any spills or releases, environmental reports, or off-site transfers.

3.9 PREVIOUSLY USED EQUIPMENT

Clean previously used construction equipment prior to bringing it onto the project site. Equipment must be free from soil residuals, egg deposits from plant pests, noxious weeds, and plant seeds. Consult with the U.S. Department of Agriculture jurisdictional office for additional cleaning requirements.

[3.10 CONTROL AND MANAGEMENT OF ASBESTOS-CONTAINING MATERIAL (ACM)

Manage and dispose of asbestos- containing waste in accordance with all applicable federal, state, and local (or Host Nation) requirements. Refer to Section 02 82 00 ASBESTOS REMEDIATION. Manifest asbestos-containing waste and provide the manifest to the Contracting Officer. Notifications to the regulatory authorities and Installation Air Program Manager are required before starting any asbestos work.

][3.11 CONTROL AND MANAGEMENT OF LEAD-BASED PAINT (LBP)

Manage and dispose of lead-contaminated waste in accordance with 40 CFR 745 and Section 02 83 00 LEAD REMEDIATION. Manifest any lead-contaminated waste and provide the manifest to the Contracting Officer.

][3.12 CONTROL AND MANAGEMENT OF POLYCHLORINATED BIPHENYLS (PCBs)

Manage and dispose of PCB-contaminated waste in accordance with 40 CFR 761 and Section 02 84 33 REMOVAL AND DISPOSAL OF POLYCHLORINATED BIPHENYLS (PCBs).

][3.13 CONTROL AND MANAGEMENT OF LIGHTING BALLAST AND LAMPS CONTAINING PCBs

Manage and dispose of contaminated waste in accordance with 40 CFR 761.[Refer to Section 02 84 16 HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY.]

][3.14 MILITARY MUNITIONS

****

NOTE: Delete this paragraph if not needed in the project

****

In the event military munitions, as defined in 40 CFR 260, are discovered or uncovered, immediately stop work in that area and immediately inform the Contracting Officer.

]3.15 PETROLEUM, OIL, LUBRICANT (POL) STORAGE AND FUELING

****

NOTE: Choose one of the last bracketed sentences after coordination with the Installation Environmental Office.

****

POL products include flammable or combustible liquids, such as gasoline, diesel, lubricating oil, used engine oil, hydraulic oil, mineral oil, and cooking oil. Store POL products and fuel equipment and motor vehicles in a manner that affords the maximum protection against spills into the environment. Manage and store POL products in accordance with EPA 40 CFR 112, and other federal, state, regional, and local laws and regulations. Use secondary containments, dikes, curbs, and other barriers, to prevent POL products from spilling and entering the ground, storm or sewer drains, stormwater ditches or canals, or navigable waters of the United States. Describe in the EPP (see paragraph ENVIRONMENTAL PROTECTION PLAN) how POL tanks and containers must be stored, managed, and inspected and what protections must be provided.[Storage of oil, including fuel, on the project site is not allowed. Fuel must be brought to the project site each day that work is performed.][Storage of fuel on the project site must be in accordance with EPA, state, and local laws and regulations and paragraph OIL STORAGE INCLUDING FUEL TANKS.]

3.15.1 Used Oil Management

Manage used oil generated on site in accordance with 40 CFR 279. Determine if any used oil generated while onsite exhibits a characteristic of hazardous waste. Used oil containing 1,000 parts per million of solvents is considered a hazardous waste and disposed of at the Contractor's expense. Used oil mixed with a hazardous waste is also considered a hazardous waste. Dispose in accordance with paragraph HAZARDOUS WASTE DISPOSAL.

3.15.2 Oil Storage Including Fuel Tanks

Provide secondary containment and overfill protection for oil storage tanks. A berm used to provide secondary containment must be of sufficient size and strength to contain the contents of the tanks plus 12 centimeters 5 inches freeboard for precipitation. Construct the berm to be impervious to oil for 72 hours that no discharge will permeate, drain, infiltrate, or otherwise escape before cleanup occurs. Use drip pans during oil transfer operations; adequate absorbent material must be onsite to clean up any spills and prevent releases to the environment. Cover tanks and drip pans during inclement weather. Provide procedures and equipment to prevent overfilling of tanks. If tanks and containers with an aggregate aboveground capacity greater than 5000 liter 1320 gallons will be used onsite (only containers with a capacity of 208 liter 55 gallons or greater are counted), provide and implement a Spill Prevention Control and Countermeasure (SPCC) plan meeting the requirements of 40 CFR 112. Do not bring underground storage tanks to the installation for Contractor use during a project. Submit the SPCC plan to the Contracting Officer for approval.

Monitor and remove any rainwater that accumulates in open containment dikes or berms. Inspect the accumulated rainwater prior to draining from a containment dike to the environment, to determine there is no oil sheen present.

3.16 INADVERTENT DISCOVERY OF PETROLEUM-CONTAMINATED SOIL OR HAZARDOUS WASTES

If petroleum-contaminated soil, or suspected hazardous waste is found during construction that was not identified in the Contract documents, immediately notify the Contracting Officer. Do not disturb this material until authorized by the Contracting Officer.

3.17 PEST MANAGEMENT

****

NOTE: The following Article is tailored for ARMY. Use the following paragraphs for Army projects only. Do not use for Navy or Air Force projects.

****

****

NOTE: DoD Installations are required under DoDI 4150.7 to develop an integrated pest management plan (IPMP). This does not apply to USACE Civil Works Projects. The Facility IPMP has been developed by the installation to identify potential pest-related risks of damage to installation properties as well as approaches to be used to limit these risks. The Designer should coordinate with the Installation Pest Management Coordinator early in the design process to address structural, landscaping and other pest damage reduction alternatives to pesticide applications when cost effective. This effort may be multidisciplinary in scope (e.g., planner/landscape architect and natural resource manager). The pest management plans and strategies developed during design and construction should be reviewed and approved by DoD pest management professionals and coordinated with IPMC as required by DA AR 200-1 and DoDI 4150.7.

****

****

NOTE: The following paragraph is to be used when the application of pest management chemicals is OR is NOT anticipated. These requirements must be included as a plan within the Environmental Protection Plan. When a pest is known to be in the soil, identify the pest and the area to be treated. This paragraph should be left intact to cover pesticides applications not anticipated by the

Designer. When termiticide is required, include the bracketed sentence and Section 33 40 00 STORMWATER UTILITIES in the contract specifications. Delete last sentence when not applicable. The "installation pest management coordinator" is a term used in DA AR 200-1. DA AR 200-1 is not applicable to USACE Civil Works activities. Appropriate USACE personnel should be referenced when this specification is used for civil works. See CECW-ON EP 1130-2-540 ENVIRONMENTAL STEWARDSHIP OPERATIONS AND MAINTENANCE GUIDANCE AND PROCEDURES, Chapter 3 - Pest Control Program for Civil Works Projects.

****

In order to minimize impacts to existing fauna and flora, coordinate with the Installation Pest Management Coordinator (IPMC) or Project Pesticide Coordinator (PPC), through the Contracting Officer, at the earliest possible time prior to pesticide application. Discuss integrated pest management strategies including prevention of invasive species as applicable with the [IPMC][PPC] and receive concurrence from the [IPMC][PPC] through the Contracting Officer prior to the application of any pesticide associated with these specifications. Provide Installation Project Office Pest Management personnel the opportunity to be present at meetings concerning treatment measures for pest or disease control and during application of the pesticide.[For termiticide requirements, see[Section 31 31 16.13 CHEMICAL TERMITE CONTROL][Section 31 31 16.19 TERMITE CONTROL BARRIERS]] The use and management of pesticides are regulated under 40 CFR 152 - 186.

3.17.1 Application

Apply pesticides using a state-certified pesticide applicator in accordance with EPA label restrictions and recommendation. The certified applicator must wear clothing and personal protective equipment as specified on the pesticide label. The Contracting Officer will designate locations for water used in formulating. Do not allow the equipment to overflow. Inspect equipment for leaks, clogging, wear, or damage and repair prior to application of pesticide.

3.17.2 Pesticide Treatment Plan

****

NOTE: The pesticide treatment plan serves two purposes: It provides a mechanism for early coordination with the appropriate installation personnel through the Contracting Officer and provides a mechanism for reporting pesticide use information to the Installation as required by the Federal Insecticide Fungicide and Rodenticide Act (FIFRA). For military construction, this information must be provided to the Installation under DoDI 4150.7 DoD Pest Management Instruction, under DA AR 200-1, Chapter 5--Pest Management.

****

Include and update a pesticide treatment plan, as information becomes available. Include in the plan the sequence of treatment, dates, times, locations, pesticide trade name, EPA registration numbers, authorized uses, chemical composition, formulation, original and applied concentration, application rates of active ingredient (that is, pounds of active ingredient applied), equipment used for application and calibration of equipment. Comply with 40 CFR 152-189, state, regional, and local pest management record-keeping and reporting requirements as well as any additional Installation Project Office specific requirements in conformance with [DA AR 200-1 Chapter 5, Pest Management, Section 5-4 "Program requirements"] for data required to be reported to the Installation.

3.18 CHLORDANE

Evaluate excess soils and concrete foundation debris generated during the demolition of housing units or other wooden structures for the presence of chlordane or other pesticides prior to reuse or final disposal.

3.19 SOUND INTRUSION

****

NOTE: Insert State's name or remove last sentence when State rules are not applicable. Include any facility specific requirements such as operational hours around base housing.

****

Make the maximum use of low-noise emission products, as certified by the EPA. Blasting or use of explosives are not permitted without written permission from the Contracting Officer, and then only during the designated times. Confine pile-driving operations to the period between [_____] [8 a.m.] and [_____] [4 p.m.], [_____] [Monday through Friday], exclusive of holidays, unless otherwise specified.

Keep construction activities under surveillance and control to minimize environment damage by noise. Comply with the provisions of the State of [_____] rules.

****

NOTE: Use the following tailored paragraph for the State of Illinois.

****

Keep construction activities under surveillance and control to minimize environment damage by noise. Comply with the provisions of the State of Illinois rules given in 35 IAC 900-901.

3.20 POST CONSTRUCTION CLEANUP

Clean up areas used for construction in accordance with Contract Clause: "Cleaning Up". Unless otherwise instructed in writing by the Contracting Officer, remove traces of temporary construction facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. Grade parking area and similar temporarily used areas to conform with surrounding contours.

3.21 NORTHWEST (Washington and Oregon)

****

NOTE: This Article is tailored for NAVFAC NW. Use this paragraphs and subparagraphs for NAVFAC NW projects only. Delete for other projects.

****

3.21.1   Protection of Natural Resources

****

NOTE: Include the following paragraphs as applicable for the work.

****

[Only native species for the local area are permitted for use.

] [Implement landscaping and construction operations in a manner that prevents the spread of invasive species (for example, scotch broom, knotweed, butterfly bush).] [Damaged trees must be appraised. Reimburse the Government for the lost tree value based on current rates at the time the damages occurred.]

3.21.1.1   Erosion and Sediment Control Measures

Polyacrylamide (PAM) must NOT be used as a BMP for erosion control.

Erosion control BMPs must be selected for the site to meet the requirements of the WSDE SMM.

****

NOTE: Include the following text for work at NBK Bremerton and NAVSTA Everett.

****

[Use of straw or hay bales is prohibited.

] **

NOTE: Include the following text for work at NBK Bangor.

****

[If straw is used as an erosion control BMP, it must be certified weed free.

][3.21.1.2   Erosion and Sediment Control Inspection Reports

****

NOTE: For sites disturbing less than one acre, delete this paragraph and subparagraphs.

For sites disturbing one acre or more, include the following paragraphs as clarifying direction.

When computing disturbed area, it is generally the sum total of all areas disturbed by the project, including areas for stockpiling and batch plants, and may not necessarily be contiguous.

****

The following clarifications and requirements supplement paragraph EROSION AND SEDIMENT CONTROL INSPECTION REPORTS.

3.21.1.2.1 Stormwater Notice of Intent for Construction Activities and Storm Water Pollution Prevention Plan

Prepare a SWPPP in accordance with the requirements outlined in 77 FR 12286, the Construction General Permit and the latest version of the Stormwater Management Manual for Western Washington. The SWPPP must be completed and approved prior to submitting the NOI.

3.21.1.2.2 Stormwater NOI

Upon Government approval of the SWPPP, submit a draft NOI for the Construction General Permit to the Government for approval prior to EPA submittal. The NOI must be approved by EPA prior to commencing construction activities. Note that EPA imposes a mandatory wait of 14 days after receiving the NOI. Only electronic submittals to EPA are acceptable. The EPA website for completing an electronic NOI is: https://www.epa.gov/npdes/submitting-notice-intent-noi-notice-termination-not-or-low-erosivity-waiver-lew-under.

3.21.1.2.3 Public Notice

Post a notice near the main entrance of the construction site with a copy of the NOI, Contractor name, name and phone number of a local contact person (Construction Manager's office), brief description of the project, and the location of the SWPPP.

3.21.1.2.4 Stormwater NOT

Upon completion of construction, submit the NOT to the Government for approval prior to submitting to the NOT to the EPA of coverage under the Construction General Permit. Refer to electronic NOI webpage for electronic submission of the NOT.

3.21.1.2.5 Stormwater Inspection Reports for General Permit

Submit Erosion and Sediment Control Inspection Reports for the project site either weekly or every 14 calendar days and within 24 hours of a storm event that produces 6 mm 0.25 inch of rain or greater. Meet all reporting and certification requirements described in Section 4.1.7 of the Construction General Permit.

]3.21.1.3 Water Resources

[For Project work near streams, lakes, wetlands, or other waterways, maintain buffers as follows according to the Washington State Wetland Rating System established in WAC-222-30-021:

Wetland Buffer Width

Category of Wetland	Buffer Width
Category I	60 meter 200 feet
Category II	30 meter 100 feet
Category III	15 meter 50 feet
Category IV	9 meter 30 feet

Riparian Zone Buffer Widths

Category of Water Body	Buffer Width
Contains habitat for salmonids, game fish, and other anadromous fish	45 meter 150 feet
Does not contain fish habitat	15 meter 50 feet

] **

NOTE: Include the following for work at NBK Bremerton.

****

[Employ mandatory Bremerton Naval Complex BMPs under the facility's NPDES permit. If the applicable BMPs are not effective in preventing the discharge of pollutants, then select and employ additional BMPs.

][3.21.1.4 Stormwater Drainage and Construction Dewatering

****

NOTE: Include the following subparagraph for work at NBK Bremerton.

****

Perform dewatering of excavation sites as specified in the Groundwater/Stormwater Flow Chart. Coordinate requirements with Section 31 00 00 EARTHWORK.

Submit a Storm Drain and Sanitary Sewer Discharge Approval form to obtain approval before discharging uncontaminated water into storm drain.

]3.21.1.5 Groundwater

Construct, maintain, and decommission any wells and wellheads associated with, or impacted by, the project in accordance with Washington State Standards for Construction and Maintenance of Wells (WAC-173-160).

[3.21.1.6 Merchantable Timber

****

NOTE: Include this paragraph if trees or other forest products are present in areas to be cleared or disturbed, either temporarily or permanently (e.g,. geotechnical analysis, construction trailer placement, lay-down areas, stormwater ponds, road construction/reconstruction, utility placement, project implementation.)

****

Contact the Contracting Officer prior to site disturbance to request a timber appraisal by a Navy Forester. Delineate the limits of clearing on the ground in a manner that the boundary can be easily identified during timber appraisal. Once delineation is complete, notify the Contracting Officer and allow [30][_____] days for timber appraisal.

Merchantable forest products such as timber and firewood must be appraised and payment received by the Government prior to disturbance or removal, in accordance with COMNAVREGNWINST 11015.1, Forest Product Sales and Permit Program. Purchase, through the Navy Forestry program, merchantable forest products at a neutrally determined rate. Timber value and related expenses are not reimbursable under any circumstance. Federal timber may not be exported and timber excise tax is the responsibility of the purchaser.

][3.21.2 Historical and Archaeological Resources

****

NOTE: For NBK Bremerton and PSNS & IMF, use archaeological probability map. Include this paragraph as necessary for the project.

****

Excavation is in an area of [high][moderate] archaeological potential.

][3.21.3 Concrete Operations

****

NOTE: Include this subparagraph as applicable.

****

****

NOTE: Include the following bracketed text for work at NBK Bremerton.

****

[Sawcutting and rinse water must be collected and managed as waste unless the following conditions exist: Water can seep into permeable ground if the quantity is less than 378 liter 100 gallons per day, is more than 9 m 50 feet away from a storm drain, open ditch, or receiving water, and the ground is a future pour site and is not subject to surface water runoff. For collected waste, allow sawcutting water to let solids settle. Check the pH by the end of the shift in which the water was collected. For water with a pH less than 11, immediately decant the water and discharge to the sanitary sewer as specified on the [Waste Information Specification] [Waste Information Sheet]. For water with a pH of greater than 11, manage as a dangerous waste.

][3.21.3.1 Washing of Concrete Truck at [NBK Bremerton][Everett][Whidbey Island]

****

NOTE: Include this paragraph for work at NBK Bremerton, Everett, or Whidbey Island.

****

Concrete trucks are prohibited from being washed on Base unless there is an area at the project site that is going to be a future pour site (for example, a foundation) and the location is not subject to surface water runoff and is more than 9 meter 50 feet away from a storm drain, open ditch, or receiving water.

][3.21.3.2 Washing of Concrete Truck at [Indian Island][NBK Bangor][NBK Keyport]

****

NOTE: Include this paragraph for work at Indian Island, NBK Bangor, or NBK Keyport.

****

Concrete trucks are prohibited from being washed on station. without approval from Base Environmental Office. Submit proposed Wash Procedure within the HMW and Stormwater Plan for Government review and approval. In no case must a wash area be subject to surface water runoff and be less than 9 meter 50 feet away from a storm drain, open ditch, or receiving water.

Washout stations that are not future pour sites must have an impermeable barrier to prevent infiltration of the concrete wash water. Activities must follow requirements of the NPDES General Permit for Stormwater Discharges from Construction Activities.

]][3.21.4 Control and Management of Solid Waste at Whidbey Island

****

NOTE: Include this paragraph for work at Whidbey Island. Attach Solid Waste tracking sheet located at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

Do not dispose of solid waste on Island County nor use the solid waste transfer facilities on Island County. Do not contact County officials. Complete the Solid Waste Tracking Sheet (SWTS). Complete the SWTS in accordance with the instructions on the back of the form. Submit a SWTS for each load of solid waste. The SWTS requires the weight of solid waste. If scales are not available, calculate the weight based on the formula provided in Monthly Project Waste Summary Report (for example, for refuse, 3 cubic yards multiplied by 250 = 750 pounds).

][3.21.5 Control and Management of Solid Waste at NBK Bremerton

****

NOTE: Include this paragraph for work at NBK Bremerton.

****

Complete a serialized Solid Waste Tracking Sheet (SWTS) for each off site shipment of solid waste (except sanitary sewage), recyclable materials, and non-dangerous recyclable waste. Do not use SWTS for asbestos, PCBs, or dangerous waste. Ensure the transporter has the SWTS before leaving the base. Hand-off exchange is preferred. When a face-to-face hand-off is not possible, the following procedure is required:

a. Firmly affix a clear (no color), waterproof envelope to the front left corner of the accumulation container (a zipper sealed baggie duct-taped to the box is acceptable). At the end of the shift prior to pick-up time, inspect the box, complete the applicable portion of the SWTS, and place it in a waterproof envelope.

b. The transporter removes the SWTS from the envelope, signs on the appropriate line, and provides it to the receiver for signature at the disposal site. The receiver completes their portion of the SWTS and returns it to the Contractor.

c. When no SWTS is in the envelope, the waste must not be transported for disposal.

][3.21.6 Wastewater Discharge [NBK Bremerton][Everett][Whidbey Island]

****
NOTE: Include this subparagraph for work at NBK Bremerton, Everett, or Whidbey Island.
****

Submit Waste Determination Documentation for each unique type of wastewater.

[3.21.6.1 Discharge at NBK Bremerton

Notify the Contracting Officer for wastewater discharges to the sanitary sewer in quantities greater than 3785 liter 1,000 gallons per day or 3,785 liter 1,000 gallons for the entire project, and allow 10 working days to obtain discharge approval from the City of Bremerton via the Contracting Officer. If discharge is less than 3785 liter 1,000 gallons per day or per project, then complete the Waste Determination Documentation specifying disposition to sanitary sewer completes the approval process.

][3.21.6.2 Discharge at Everett

Conduct work in compliance with processed waste water permit, City of Everett Permit No. 7722-14. Provide sampling and analysis of waste water effluent prior to discharge to sanitary system. Effluents must meet and not exceed permit limits for metals, fats, oils, and grease, as well as pH, biological oxygen demand and total suspended solids. Contact the Waste Water Operations Project Manager, via the Contracting Officer, for specific analytical requirements prior to discharge.

][3.21.6.3 Hydrotest Water Discharge at NBK Bremerton

****
NOTE: Reconcile NBK Bremerton requirements with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.
****

Waste Determination Documentation is not required to discharge water from new, clean piping system to the sanitary system at a flow rate less than [385] [_____] liter [100] [_____] gallons per minute and [11356] [_____] liter [3000] [_____] gallons per day. Notify the Contracting Officer 10 working days prior to discharge to the sanitary system to obtain approval for greater flowrates. Clean, uncontaminated, hydrotest water may also be discharged to the storm drain. Submit a Storm Drain/Sanitary Sewer Discharge Approval form to obtain approval before discharging.

]]3.21.7 Control and Disposal of Landfill-Controlled Waste

****
NOTE: Include these subparagraphs for work at Everett, Indian Island, Whidbey Island, or NBK Bremerton.
****

Store landfill controlled waste under cover in a manner that minimizes contact with process water or storm water. Keep covered and secured except when adding waste or taking samples. Store in containers or in the following manner:

a. Underlay the waste with a continuous impervious sheet of plastic with a thickness sufficient to contain the waste with a minimum thickness of 10 mils. Thicker or reinforced plastic, or other measures, to protect the integrity of the plastic underlayment may be required if there is danger that the plastic will be punctured or torn during accumulation. Weld, heat seal, or continuously tape (on both sides) seams. Protect the plastic from perforation during loading and handling operations.

b. Install a berm around the pile so that the landfill-controlled waste remains in the designated area. Straw or hay bales are prohibited. The edges of the underlayment must be laid over the top of the berm and secured to prevent water from running under the pile.

c. Install an impervious continuous sheet of plastic, 10 mils minimum thickness, over the pile and over the outside of the berm so that rainwater is directed away from the landfill controlled waste inside the berm. Weld, heat seal, or continuously tape (on both sides) seams.

d. Secure the top cover to ensure that wind will not balloon the cover or blow it aside leaving the pile exposed to weather.

****

NOTE: Include the following bracketed text for work at NBK Bremerton.

****

[e. Place a label on stockpiled soil containers or top cover that identifies the waste or soil as "Soil, Non-hazardous Pending Sampling."

][f. Disposal of Landfill Controlled Waste:

g. Submit a Landfill Disposal Form as required by the receiving landfill prior to removal of solid waste off Government property. The Landfill Disposal Form may have different titles, depending upon the landfill (for example, Waste Disposal Application, Contaminated Soil Waste Information Sheet, and Industrial Waste Information Sheet). The Government will co-sign forms.

]3.21.8 Waste Determination Documentation Northwest

****

NOTE: Identify waste to be generated by the work and complete the Encountered Waste Summary (a.k.a Estimated Waste Table). At NBK Bremerton and PSNS & IMF, submit a Sampling and Analysis Plan for approval prior to TCLP sample collection and analysis. At NBK Bangor, perform site visit with Base Environmental Office prior to survey.

The Designer must provide survey data only for NBK Bremerton and PSNS & IMF projects. The Encountered Waste Summary will be prepared by the Government. Elsewhere, provide survey data and provide, with draft specifications, a waste designation table for review and approval by base environmental office.

Local Waste Tables are available for download at:
https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

****

NOTE: Choose the following bracketed item for Design-Build Projects only and delete the next bracketed item. This paragraph is tailored for DESIGN-BUILD.

****

[Comply with the requirements of FC 3-810-10N, including building survey and analytical services required to identify existing materials that may represent health risks, and to properly demolish, designate, and dispose of materials during site improvements.
]

****

NOTE: Choose the following bracketed sentences and attach the completed/approved table in the RFP for Design-Bid-Build Projects.

For bracketed items, choose "Estimated Waste Table" for work at NBK Bangor, NBK Keyport, or Indian Island; choose "Encountered Waste Summary" for all other locations.

****

[The [Estimated Waste Table] [Encountered Waste Summary], attached, provides a summary table of anticipated encountered waste along with the corresponding probable waste designation. This table may not be inclusive of waste that could be encountered. This table does not require such waste to be disposed rather than recycled or reused. This table is intended to provide a bid basis. These estimated designations are subject to change upon receipt of the completed Waste Determination Documentation. Any segregation, addition, or mixing of identified waste invalidates these estimated designations. Where such action increases the quantity of dangerous waste, such waste must be disposed at the Contractor's expense.

] Waste Determination Documentation must consist of the base-specific waste form and related documentation prepared by the Contractor and submitted to the Government for the purpose of Government designation of waste. Examples of related documentation include SDS, sampling and analysis plans, analytical information, and description of waste or process that generate waste. No waste must be transported off site without completed Waste Determination Documentation. Follow instructions provided on completed Waste Determination Documentation forms.

[3.21.8.1 Waste Information Specification Form for NBK Bangor

****

NOTE: Include this paragraph for work at NBK Bangor.

****

For waste produced during the project, provide a completed "Side One" of Naval Base Kitsap at Bangor form, via the Contracting Officer. Return the Waste Information Specification form to the Naval Base Kitsap Environmental Division, via the Contracting Officer. Follow the Originator Disposal instructions provided on "Side Two" of the Waste Information Specification form.

][3.21.8.2 Waste Information Sheet Form for Everett

****
NOTE: Include the following paragraph for work at Everett.
****

Not less than 15 working days before removal of waste to locations off Government property, submit a Waste Information Sheet for each unique process that potentially generates recyclable material, solid waste (except garbage), dangerous waste, sewage, sediment, asbestos, PCB, stormwater, and wastewater generated onsite.

][3.21.8.3 Waste Information Sheet Form for NBK Bremerton

****
NOTE: Include this paragraph for work at NBK Bremerton.
****

Within one working day after waste stream has been produced, submit a Waste Information Sheet for each waste (except sanitary waste) generated on site for designation by the Government. Submit a[Waste Information Specification][Waste Information Sheet] for each waste stream anticipated to be produced to the maximum extent possible for pre-designation of waste. The Government will complete Section II and Section III of the Waste Information Sheet.

][3.21.8.4 Waste Generation Record for[Indian Island][NBK Keyport][Whidbey Island]

****
NOTE: Include this paragraph for work at Indian Island, NBK Keyport, or Whidbey Island.

For NBK Keyport, choose "20" in brackets.
****

Not less than [15][20][_____] working days before removal of waste to locations off Government property, submit a Waste Generation Record (WGR) for each unique process that potentially generates recyclable material, solid waste (except garbage), dangerous waste, sewage, sediment, asbestos, PCB, stormwater, and wastewater generated on site.

****
NOTE: Include this paragraph for work at Indian Island or NBK Keyport.
****

[The Government will complete the portion entitled "ENVIRONMENTAL USE ONLY BELOW THIS LINE."

]][3.21.8.5 Control of Waste Without Documented Waste Determination

Collect waste for which the Waste Determination Documentation has not been completed; label "waste awaiting designation" or "WAD" to indicate that analysis is pending. Accumulate and manage in an area that meets the minimum criteria for satellite accumulation in accordance with WAC-173-303 and the Contract specifications[, except for the time and quantity limitations].

Submit Waste Determination Documentation for each undesignated waste type within one day of generation. Do not transport waste offsite prior to designation by the Government.

]3.21.8.6 Laboratory Analysis

****

NOTE: Select the waste analysis responsibilities.

For work at NBK Bremerton: Select the first paragraph by default and delete the second. For NBK Bremerton projects generating large quantities of waste, such as whole building demolition, delete the first paragraph.

For work at all other locations, select the second paragraph and delete the first.

****

[When analytical information is necessary to designate waste, the Government will sample and test waste in accordance with WAC-173-303 and EPA SW-846.] [When, at the sole discretion of the Government, laboratory analytical information is necessary to designate waste, provide sampling and analysis services in accordance with WAC-173-303 and EPA SW-846.]

Submit analytical results and reports to the Contracting Officer as part of the Waste Determination Documentation.

3.21.9 Contractor Hazardous Material Inventory Log

In addition to the materials (for example, paints, lacquers, thinners, adhesives, sealants, cleaners) required in the Contractor Hazardous Material Inventory Log, include the following materials:

a. If performing abrasive blasting operations, denote blast grit usage, blast nozzle throughput in tons, and blasting unit efficiency.

b. If performing welding, denote welding rod usage and welding rod type (for example, aluminum, carbon steel).

****

NOTE: Include this sentence for work at NBK Bremerton.

****

[Use local form, PSNS 5090/132 CHMI for this purpose.

][3.21.10 Hazardous Materials Prohibition

****

NOTE: Include this paragraph for work at Indian Island, NBK Bangor, or NBK Keyport.

****

Products prohibited by the Government, which will not be approved for use, include but are not limited to: leads, chromiums, mercury, phenols, trichloroethylene, chlorofluorocarbons, halons, PCBs, asbestos, silica sand (for use as blasting agent), Class I ODS as defined and identified herein, radioactive materials or instruments capable of producing ionizing radiation, and chemicals listed in 40 CFR 355.50, Appendix A. This prohibition prevails over any other provision, specification, drawings, or referenced documents. The Contracting Officer may consider exceptions to the use of any of the above excluded materials upon written request by the Contractor, and with Base Environmental Office approval.

][3.21.11 Solid Waste Management Report

****

NOTE: For bracketed items, choose "not required" for work at Everett. Choose "Monthly Project Waste Summary Report" for work at NBK Bremerton or Whidbey Island or "Refuse and Recycle Quantity Form" for work at Indian Island, NBK Bangor, or NBK Keyport.

Attach report or form as appropriate, located at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables **and choose "and attached" in brackets.**

****

The Solid Waste Management Report is[not required][known locally as the Contractor's Monthly Project Waste Summary Report][known locally as the Refuse and Recycle Quantity Form][and attached].

]3.21.12 Fuel Tanks

Provide and implement a SPCC plan if tanks and containers of oil will have an aggregate aboveground capacity greater than 5,000 liters 1,320 gallons (only containers with a capacity of 208 liters 55 gallons or greater are counted). Do not bring underground storage tanks to this installation for Contractor use during a project.

3.21.13 Releases and Spills of Oil and Hazardous Substances

****

NOTE: Choose applicable location.

****

In the event of an reportable release immediately notify the [PSNS & IMF and NBK Bremerton Regional Dispatch Center, station phone 911, or (360) 476-3333 on outside lines or cellular phones] [NAS Whidbey Fire Department at (360) 257-3333] [NBK Regional Dispatch Center, station phone 911, or (360) 396-4444] [Regional Dispatch Center, station phone 911, or (360) 396-4444] [Everett Central Monitoring Dispatch Center at (425) 304-3333, NAVSTA Everett phone 911] [Hospital Communication Center at phone 4444 within the Hospital or (360) 475-4444] [FISC Puget Sound, Fuel Department Operator In Charge (OIC) at (360) 476-2135, ext. 232 for oil spills] [Port Hadlock Detachment Central Monitoring Dispatch Center at (360) 396-5333], then notify the Contracting Officer.

****

NOTE: Include this item for work at Indian Island, NBK Bangor, or NBK Keyport. Include phone numbers for Indian Island.

****

[Notify the Base Environmental Office[at: (360) 396-5353, (360) 396-5394, or (360)396-5221].
]
****

NOTE: Include this item for work at NBK Bangor.

****

[The Government will respond to emergency spills. Follow incident commander verbal instructions. Notify the Base Environmental Office of spills, and reportable and non-reportable releases.

]3.21.14 Control and Management of Hazardous Waste

The following clarifications and requirements supplement paragraph CONTROL AND MANAGEMENT OF HAZARDOUS WASTE.

3.21.14.1 Facility Hazardous Waste Generator Status

****

NOTE: Choose appropriate location. Coordinate with paragraph FACILITY HAZARDOUS WASTE GENERATOR STATUS. Include this paragraph in this section with name and status.

****

[[Naval Base Kitsap, Bremerton] [PSNS & IMF] [Naval Base Kitsap, Bangor] [Naval Station (NAVSTA), Everett] [Naval Magazine, Indian Island, WA (NAVMAGII)] [Naval Undersea Warfare Center (NUWC), Keyport] [Naval Hospital (NAVHOSP), Bremerton] [Naval Air Station, Whidbey Island (NASWI)] is a fully regulated Large Quantity Generator.

][FISC Puget Sound, Manchester Fuel Department is a fully regulated medium quantity generator.

]3.21.14.2 Hazardous Waste Management

****

NOTE: Choose one of the paragraphs below and delete the other. Choose the first paragraph for NBK Keyport. Also choose for NBK Bremerton projects, that do not generate large quantities of dangerous waste. Coordinate the requirement with NBK Bremerton.

Choose the second paragraph for projects at Everett and Whidbey Island, and large projects generating large quantities of dangerous waste at NBK Bremerton.

****

[Containers and labels will be supplied by the Government. Notify the Contracting Officer 14 calendar days in advance for request of bulk containers. Submit Waste Determination Documentation including an estimated quantity of dangerous waste and the number of containers. Accumulate in an approved satellite or 90-day accumulation area meeting the requirements set forth in WAC-173-303[and the Keyport "Hazardous Waste Site Manager/Alternate (Waste Generator)" training module]. Contact the Contracting Officer no more than 45 calendar days from the start date for 90-day accumulation areas to arrange for transport. Accumulate bulk dangerous waste in a 90-day area. Turn in non-bulk dangerous waste from a

90-day area within 45 days of the start date.

][Collect and dispose of dangerous waste in accordance with WAC-173-303. Identify dangerous waste generated within the confines of the station by the use of the station's EPA generator ID number. Submit a Dangerous Waste Profile for each unique type of dangerous waste[not less than [45] [20] days from scheduled removal from Government property]. Profiles are to be completed and signed by an EPA-permitted TSDF. The Government will approve and co-sign profiles. Approval of each dangerous waste profile must be complete before manifesting. Accumulate in an approved satellite or 90-day accumulation area meeting the requirements set forth in WAC-173-303. Waste Determination Documentation must be submitted and dangerous waste must be designated before removal from Government property. Submit a copy of the applicable EPA and state permit(s), manifest(s), Land Disposal Restriction (LDR) forms, and license(s) for transportation, treatment, storage, and disposal of hazardous and regulated waste by permitted facilities. Dangerous waste manifests must be reviewed, signed, and approved by the Government before the Contractor may ship waste. To obtain specific disposal instructions, coordinate with the Activity environmental office. Labels will be supplied by the Government.

][3.21.14.3 Contractor-Generated Hazardous Waste

****

NOTE: Include this subparagraph for projects at NBK Bangor or Indian Island.

****

Identify and turn in dangerous Contractor-Generated Hazardous Waste to the Government as encountered waste. Follow all encountered waste procedures in paragraph ENCOUNTERED WASTE below.

][3.21.14.4 Encountered Waste

****

NOTE: Include this subparagraph for projects at NBK Bangor or Indian Island.

****

Identify, minimize, segregate, contain, package, label and turn in dangerous and industrial encountered waste to the Government in accordance with the approved Environmental Protection Plan. Contractor-generated dangerous or industrial waste must be disposed of by the Government at Contractor's expense. On base disposal of Contractor generated waste is prohibited.

Follow originator disposal instructions provided in NAVBASEKITSAPINST 5090.3(Series) and on side 2 of the [Waste Information Specification] [Waste Information Sheet]. Package according to 49 CFR specifications and attach a completed SUBASE Bangor Originator Label when instructed. Properly stage and transfer encountered waste to a Government-approved accumulation area within 7 miles of the project site. Transportation to the Government site must be within 72 hours of generation. Provide the Project Number on Crew/Code line of the Originator Label. Turning in encountered waste to the Government, in accordance with [Waste Information Specification] [Waste Information Sheet] instructions, is not considered disposal.

][3.21.14.5 Certificate of Final Disposal (CFD)

****

NOTE: Include this subparagraph for projects at Whidbey Island.

****

Within 10 working days after final disposal of dangerous waste, submit the CFD to the Contracting Officer. Final disposal means disposal of dangerous waste and any residues from the treatment of the waste prior to disposal. The CFD includes, at a minimum the following:

a. Waste Profile Sheet Number, Government Manifest Number, and Shipment Date

b. Unit of Measure

c. Quantity of Disposal

d. Waste that required land disposal, including effluents from treatment systems.

e. Disposal facility's (Facilities') EPA ID number, name, location, and phone. In addition, include the name, address, phone number, and EPA ID number of each TSDF the waste was taken to for any intermediate steps for final disposal.

f. Disposal Method

g. Date of Final Disposal

h. Signature of the person responsible for adequate and appropriate disposition of the waste

][3.21.14.6 Regulated Waste Storage, Satellite Accumulation, and 90-Day Storage Areas

****

NOTE: Include this subparagraph for work at Naval Hospital, Bremerton.

****

[Accumulate waste in the Contractor's satellite accumulation area or the Government's 90-Day accumulation area. Contractor-operated 90-Day accumulation areas are prohibited at Naval Hospital, Bremerton.
]

****

NOTE: Include these subparagraphs for work at NBK Bremerton.

****

[Prior to generating waste, submit an accumulation area registration form, known locally as Contractor Request for 45/90-Day Hazardous Waste Accumulation Certification/Recertification or Contractor Request for Hazardous Waste Satellite Accumulation Area (SAA) Registration.

90-Day areas are known locally as 45/90 day areas and such waste must be manifested prior to 45 days. Satellite accumulation over-water, such as on piers and dry docks, is not authorized unless waste is accumulated with secondary containment and is attended by a trained person. 90-Day areas will not be authorized in dry docks, on piers, or on an over-water site. Submit to the Contracting Officer once every 7 calendar days an Accumulation Area Inspection Record meeting the requirements set forth in WAC-173-303. Closure of 90-day areas require inspection and approval by the Government.

]

****

NOTE: Include this subparagraph for work at NBK Keyport.

****

[Submit the Hazardous Waste Accumulation Area Registration Form as instructed in the "Hazardous Waste Site Manager/Alternate (Waste Generator)" training module. Attach Site Plan to the Request. Attach Waste Determination Documentation.

]][3.21.14.7 Vacuum Cleaners

****

NOTE: Include this subparagraph for work at NBK Bremerton.

****

Container ID labeling requirements apply to vacuums used onsite. Vacuum cleaners must be empty when they arrive at the BNC, and emptied into approved containers in accordance this section. If a vacuum cleaner cannot be emptied at the end of the shift, it must be managed as a hazardous waste container and stored in a registered satellite accumulation area. Hazardous waste container labeling and storage requirements of this section apply to vacuum cleaners used for pickup and storage of hazardous waste.

]3.21.14.8 Class I and Class II ODS Prohibition

Turn over to the Government Class I ODS reclaimed as part of this Contract, upon the completion of the work covered by this Contract.

3.21.15 Noise

Conduct work in full compliance with WAC-173-60.

[3.21.16 Drinking Water

****

NOTE: Many Navy activities in Washington State, including, but not limited to, Whidbey Island, NBK Bangor, NBK Keyport, MWR Pacific Beach, Naval Radio Station (t) Jim Creek, NAVORDCEN Det Port Hadlock, and NBK Bremerton are regulated as public water system purveyors. Delete this paragraph if there is no potable water system change, or the change is listed as one of the exceptions in accordance with WAC-246-290. For projects which involve applicable construction, repair, or alteration of a drinking water system, ensure the work is covered in the activity's Water System Plan (WSP).

For Design-Build projects, choose the first sentence in first paragraph; this sentence is tailored for

DESIGN-BUILD. Include the Project Report in the Design Build Requirements to accommodate this evaluation.
****

[3.21.16.1 Project Report

[Submit a Project Report, in accordance with WAC-246-290-110(2).][This project includes work on a potable water[treatment,][storage,][and][distribution] system that is regulated by WAC-246-290.][The design specifications have been reviewed and approved by the Washington State Department of Health.][The design specifications conform to the activity's approved Water System Plan.][Do not use any materials of construction or construction practices that deviate from the approved water system design.]

][3.21.16.2 Public Works Department Permit

Obtain permit from the Public Works Department prior to any connections or changes to the potable drinking water system, or access to fire hydrants. Do not access any part of the potable water system (including fire hydrants) without obtaining a connection permit from the Government. Connections or work pertaining to the potable water system as part of the Contract must be in accordance with the instructions specified in the connection permit and in compliance with state and federal regulations. Submit an Inspection Report to the Government for acceptance. Include the most recent annual calibration inspection report for the test assembly to be used.

][3.21.16.3 Project Completion Report

****
NOTE: If the project is not identified in the Water System Plan and is not exempted according to WAC-246-290-125, the construction manager must submit a Project Completion Report to the Washington Department of Health within 60 days after completion of the project.
****

Within 15 days after completion of an approved water system project, submit a Project Completion Report in accordance with WAC-246-290-120(5). The report must be signed by a Washington State-registered professional engineer. This report is required for new construction on exterior building potable water system components. Any significant changes from the approved water system design must receive prior approval of the Contracting Officer and written approval from the Department of Health in accordance with WAC-246-290-120 prior to use.

][3.21.16.4 Disinfection of Water System Components

****
NOTE: Include this paragraph for work at NBK Bremerton when Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING is used.
****

Disinfect water system in accordance with paragraph DISINFECTION in Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

]][3.21.17 Contractor's Operation and Maintenance (O&M) Plan

****

NOTE: For Indian Island, choose ORCAA. For Whidbey Island, choose NWCAA. For Everett and all Kitsap locations, choose PSCAA. For additional information, see https://ecology.wa.gov/Air-Climate

****

Prior to using the types of air contaminant-generating equipment defined in [PSCAA Regulation][ORCAA Regulation][NWCAA Regulation], develop and submit a Contractor's Operation and Maintenance (O & M) Plan. Maintain the O & M Plan and any associated records on site for the duration of the project. Be prepared to provide these records for review, within 30 minutes, when requested by regulatory agencies or the Contracting Officer. The O&M Plan must contain at a minimum the following elements:

a. Maintain equipment in good working order. Follow manufacturer's O & M recommendations, at a minimum.

b. Maintain records of any repairs made, including records of preventive maintenance and chemicals used, including SDSs.

c. Inspect periodically, including, but not limited to, evidence of fugitive emissions. If fugitive emissions are found, determine whether reasonable precautions are being taken to minimize such emissions. List requirements to repair the equipment or shut down operations, when reasonable precautions are not being taken to minimize fugitive emissions or unreasonable odors.

d. Ensure deficiencies are promptly repaired. Secure operation of such equipment if immediate repairs are not feasible.

e. List any requirements noted under "Conditions" on the Order of Approval for the equipment.

f. Generate records that list any actions (for example, inspections, maintenance, shut down) that have been taken or completed, including the location, date, time, and name of person(s) completing the actions. Records may be maintained in the form of a logbook. Submit Operation and Maintenance Records at Contract completion.

g. Maintain records of operating permit(s) and related permit compliance records.

]3.21.18 Emission Standards

Opacity from Contractor equipment and operations must be in compliance with [PSCAA Regulation I, Section 9.03] [_____] including but not limited to Visual Emissions (Opacity), Odor, Fugitive Dust, Spray Coating, Crushing, and Maintenance of Equipment.

3.21.18.1 Volatile Organic Compound Emission Control

Do not leave containers of paint, epoxy, or solvent open to the atmosphere unless they are being used. Secure containers at the end of each shift. Do not use evaporation as a means of minimizing or disposing of hazardous waste.

3.22 SOUTHEAST

****

NOTE: This Article is tailored for NAVFAC SE. Use this paragraphs and subparagraphs for NAVFAC SE projects only. Delete for other projects.

****

3.22.1 Florida

[3.22.1.1 Laboratory Analysis

Test soil and groundwater that will be disposed under this Contract in accordance with the paragraph LABORATORY ANALYSIS.

]3.22.1.2 Waste Storage/Satellite Accumulation

For Hazardous Waste accumulation areas, submit weekly hazardous waste inspection logs to the Station Hazardous Waste Manager via the Contracting Officer and maintain compliance with 40 CFR 265.16 personnel training requirements. Ensure containers are kept closed (except when adding or removing waste) and that containers remain in good condition and are properly labeled by PWC Jacksonville or the Station. Store Regulated waste for up to 190 day.

3.22.1.3 Control and Management of Hazardous Waste

3.22.1.3.1 Universal Waste

Dispose of lead-acid batteries that are not damaged or leaking at the NAS Jacksonville MWR Recycling Center or at a state-approved battery-recycling facility. For lead-acid batteries that are leaking or have cracked casings, dispose of the battery by calling PWC Jacksonville for disposal. Collect and segregate alkaline batteries, non-alkaline batteries, lithium batteries, metal hydride batteries, and nickel-cadmium batteries by type for turn-in to the activity for disposal or recycling.

3.22.1.3.2 Mercury Containing Materials

Prior to starting work, remove bulbs, thermostats, switches, and other components that contain mercury. Upon removal, place items containing mercury in DOT approved containers, label, and turn over to the activity for disposal or recycling. For projects at NAS Jacksonville, fluorescent bulbs are to be turned in to Self-Help for recycling. For projects at Naval Aviation Depot and Naval Hospital Jacksonville, turn in fluorescent bulbs in to the appropriate environmental office as directed by the Contracting Officer. Bulbs must be boxed, stenciled with the words "spent mercury-containing devices for recycling", and marked with the date of accumulation.

3.22.1.3.3 Aerosol Cans Management and Disposal

Do not dispose of aerosol cans as solid waste or construction and demolition debris. Collect aerosol cans and segregate from other waste in a suitable container on site. Label the container "aerosol cans for recycling" and turn it in to the General HM Locker at Building 102.

3.22.1.3.4 Disposal of Regulated Waste

In accordance with Station requirements, accumulate regulated waste in DOT-approved containers. Ensure containers remain closed except when adding or removing waste and they are marked with the appropriate Non-hazardous Waste Label, which will be provided by PWC Jacksonville or the Station. Air-drying any containers to render them empty is prohibited. Dispose of regulated waste, except for asbestos and petroleum-contaminated waste, through PWC Jacksonville and do not take them off Station. Pay disposal costs in accordance with PWC Jacksonville's published rates.

3.22.1.3.5 Disposal of Petroleum Contaminated Waste

Provide the completed Non-hazardous Waste Manifest for offsite disposal of petroleum-contaminated waste to the Contracting Officer within 7 days of disposal.

3.22.1.4 Dumpsters

Equip dumpsters with a secure cover and paint the standard installation color. Keep dumpster covers closed, except when being loaded with trash and debris. Locate dumpsters behind the construction fence or out of the public view. Empty site dumpsters at least once a week, or as needed to keep the site free of debris and trash. If necessary, provide 208 liter 55 gallon trash containers painted the darker installation color to collect debris in the construction site area. Locate the trash containers behind the construction fence or out of the public view. Empty trash containers at least once a day. For large demolitions, large dumpsters without lids are acceptable, but should not have debris higher than the sides before emptying.

3.22.2 Cuba

3.22.2.1 Fish and Wildlife Resources

Ensure compliance, including off-duty hours with 1710.10. Ensure employees comply with prohibitions on feeding and raising indigenous wildlife and feral animals during working and non-working hours. Specifically, direct or indirect feeding of iguanas resulting in the domestication or semi-domestication of these animals is strictly prohibited. Further, direct or indirect feeding of feral chickens, cats, dogs, goats, or other feral domestic animals is strictly prohibited. Prohibitions of this section apply to living and working areas. Recognizing that many foreign national personnel use chickens as livestock, request provisions from the Contracting Officer to allow employees to raise chickens as livestock, if necessary. Accompany any such request with a Livestock Management Plan addressing construction and maintenance of pens to confine the animals, provisions for feeding and watering the animals, pen and surrounding area sanitation, limits on numbers of animals to be raised, and a point-of-contact for livestock management responsibility. Under no circumstances will livestock be permitted to roam or be otherwise free range.

3.22.2.2 Protection of Erodible Soils

Use endemic or regionally native and drought and heat-tolerant grass species as specified by the Contracting Officer.

3.22.2.3 Control and Management of Solid Waste

Dispose of solid waste generated at locations as directed by the Contracting Officer. Solid waste disposal service is available from other on-Station Contractors on a cost-reimbursable basis. Refer to Section 01 14 00 WORK RESTRICTIONS, for more information.

3.22.2.3.1 Disposal of Solid Waste and Debris

Dispose of solid waste, debris, and metal containers in accordance with the requirements specified herein.

3.22.2.3.1.1 Base Sanitary Landfill and Concrete Areas

Only authorized solid waste approved for deposit by the landfill attendant or equipment operator may be dumped at a designated area in the Windward Landfill. Prepare a Landfill Access Pass in accordance with 5090.4. Deposit demolition material such as grading or excavated materials at the designated area, provided such material does not contain segregated metals, as directed by Landfill Attendant. Landfill hours of operation are Monday through Saturday, 7:30 A.M. to 11:00 A.M., and 12:30 P.M. to 4:00 P.M.

3.22.2.3.2 Disposal of Rubbish and Debris

Haul rubbish and debris to the Government landfill (Windward Landfill) in accordance with 5090.4, an approved Landfill Access Pass must be presented prior to entry into the landfill.

3.22.2.3.2.1 Permitted Material in Landfill

A Landfill Access Pass must be obtained prior to transporting asbestos-containing materials to the Asbestos Landfill in accordance with 5090.4. The Landfill Access Pass must be approved by Hazardous Waste Facility personnel (Bldg. 850). Materials that may be deposited in the landfill include the following:

CATEGORY	CONSTRUCTION DEBRIS DISPOSAL - BASE SANITARY LANDFILL EXAMPLE/GENERAL INFORMATION FOR DEPOSIT IN THE LANDFILL
Mixed Debris	The following materials may be placed in the landfill in a location designated by the landfill operator. These items may be mixed together.
	Gypsum board panels, plaster, glass (broken).
	Non-asbestos insulation-(bag fiberglass and mineral wool).
	Packing paper, Styrofoam, and pasteboard boxes.

CATEGORY	CONSTRUCTION DEBRIS DISPOSAL - BASE SANITARY LANDFILL EXAMPLE/GENERAL INFORMATION FOR DEPOSIT IN THE LANDFILL
	Painted wood such as doors, windows, siding, and trim.
	Plastic and fiberglass such as pipe, electrical boxes, cover plates, and similar.
	Ceramic and vinyl flooring or tile, ceiling tile.
Shingles	Non-asbestos roofing materials such as shingles built-up and single roofing.
Masonry and Concrete	Deliver concrete, block, brick, mortar to the landfill separate from any other items, and place in a location designated by the landfill operator.
Non-recyclable Wall Pallets	Deliver concrete, block, brick, mortar to the landfill separate from any other items, and place in a location designated by the landfill operator.
Treated Lumber	Deliver treated wood, and such as piling and power poles, to the landfill separated from any other items and place in locations as designated by the Landfill Operator.
Fiberglass Tanks	Clean tanks before delivery to landfill. 208 liter55 Gallons or less are turned in at recycling.
Asphalt Pavement	Deliver to Windward Landfill.
Construction Debris	Separate each category of construction debris at the construction site and deliver separately to the landfill. Place each category of construction debris in the landfill at a location designated by the Landfill Operator.

CATEGORY	CONSTRUCTION DEBRIS DISPOSAL - BASE SANITARY LANDFILL EXAMPLE/GENERAL INFORMATION FOR DEPOSIT IN THE LANDFILL
Asbestos	Place in designated area of the landfill. Transport asbestos-containing materials in covered vehicles, wetted, double bagged, and properly marked and documented. Obtain a Landfill Access Pass at the Hazardous Waste Facility after the load has been inspected
Lead Based Paint and Materials	Dispose of building components and materials removed that have lead-based paint (LBP) at the construction waste cell at the Landfill. Prior to disposal, test a sample of these components for lead. Dispose of abatement waste, such as blast material, paint chips, paint stripper scrapings, and similar, where the LBP has been removed from a substrate in approved drums and deliver material to the Hazardous Waste Facility, Building 850, properly marked and documented for proper analysis and potential disposal in the United States at Contractor expense.

3.22.2.3.2.2 Metals Disposal

Metals will not be accepted at the landfill site. Dispose of metal construction debris by obtaining a landfill pass at the Recycling Center, Bldg. 1751. Recycling Center personnel will inspect metals and instruct the driver to go to the landfill where the load will be weighed. If material is not recyclable, a Landfill Access Pass will be issued in accordance with 5090.4. Remove metals from each category before delivery to the landfill, including tanks (for example: remove hardware from doors and windows). Aluminum, brass, copper, lead, other metal, electrical wiring, cable (cut in one meter 3 foot or less sections) must be taken to the Recycling Center.

3.22.2.4 Sewage

Dispose of sewage through connection to a station sanitary sewage system or the Lizard Island treatment pump station as directed by the Contracting Officer. Where such a system is not available, use chemical toilets or comparable effective units and periodically empty waste into a pump station designated by the Contracting Officer.

3.22.2.5 Control and Disposal of Hazardous Waste

Disposal of hazardous waste at the Windward Landfill and Concrete Fill Area is prohibited.

3.22.2.5.1   Hazardous Waste Generation

Handle generated hazardous waste in accordance with the DOD 4715.05 and 5090.1.

3.22.2.5.2   Hazardous Waste Disposal

Dispose of hazardous waste in accordance with federal and station regulations, especially 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, the DOD 4715.05 and 5090.1. Do not bring hazardous waste onto the Station. In accordance with 5090.1 turn in hazardous waste for disposal to the Hazardous Waste Facility (Bldg. 850). Obtain containers for hazardous waste or oily waste from Hazardous Waste Facility. Containerize the waste. Waste in containers must meet DOT shipping container requirements in accordance with 49 CFR 178. Package the containers in accordance with 49 CFR 171 for waste. Knowingly mismanaging or disposing of hazardous waste are grounds for immediate debarment and administrative action.

3.22.2.5.3   Hazardous Waste Accumulation

Accumulate and manage hazardous waste in accordance with federal and station regulations, 40 CFR 261, 40 CFR 262, DOD 4715.05, 5090.1, and revisions. Properly identify, package, and label hazardous waste in accordance with 49 CFR 172 and 5090.1 and turn it in for disposal to the Hazardous Waste Facility (Bldg. 850). Obtain containers for hazardous waste and used oil from the Hazardous Waste Facility. Containerize and transport the waste to the Hazardous Waste Facility. If hazardous materials are mismanaged so they become hazardous waste, or if a hazardous waste is not managed properly and costs more for disposal because of contamination, the Contractors' Special Deposit Account will be charged for sampling, analysis, and disposal rates as specified or identified. Itemized statements will be provided to the Contractor via the Contracting Officer.

3.22.2.5.3.1   Site Storage

In accordance with 5090.1, store hazardous waste near the point of generation up to a total quantity of one quart of acutely hazardous waste or 208 liter 55 gallons of hazardous waste. Move any volume exceeding these quantities to an approved Hazardous Waste Storage area (from the approved EPP) within 3 days. Prior to generating hazardous waste, contact the Hazardous Waste Facility for labeling requirements for the accumulation of hazardous waste. Accumulate hazardous waste (no longer than 90 days) in containers in accordance with 49 CFR 178 and Station instructions. Identify hazardous waste in accordance with 40 CFR 261, 40 CFR 262, and Station instructions. Ensure hazardous waste is properly labeled and segregated. Every effort must be made to ensure used oil is not contaminated. Used oil generated must be containerized and delivered to the Hazardous Waste Facility (Bldg. 850) for disposal.

3.22.2.5.3.2   Turn-In

Hazardous waste must be turned into the Hazardous Waste Facility for shipment or disposal off Station. At the conclusion of the project, turn in all unused hazardous materials to the Consolidated Hazardous Material Reutilization and Inventory Management Program for reuse. Exceptions to this will be hold back of minor amounts for possible warranty work. Properly dispose of waste generated from a project at the conclusion of each task order or project.

3.22.2.5.4 Spills of Oil and Hazardous Materials

Package, transport, and dispose of contaminated material, equipment, and clothing generated during the spill cleanup procedures, which must be at no additional cost to the Government in accordance with 5090.1 and 5090.7. Provide SDSs to the Contracting Officer to ensure material is properly identified for disposal, or reimburse the Government for analytical data (to include labor and costs of analysis) should data be required to properly identify the waste. Transport packaged waste to the Hazardous Waste Facility (Bldg. 850).

Complete the spill report provided in 5090.7 and submit it to the Contracting Officer within 24 hours of spill occurrence. Contractor's special deposit account will be charged for disposal of spilled material and associated waste.

3.22.2.5.5 Oily and Hazardous Substances

Limit the storage of fuels, lubricants, solvents, paints, and hazardous substances to a total of less than 1040 liter 275 gallons onsite unless preapproved by the Government.

3.22.2.5.6 Lead-Acid Batteries

Dispose of lead-acid batteries that are not damaged or leaking at the Base Recycling Center. For lead-acid batteries that are leaking or have cracked casings, dispose of battery at the Hazardous Waste Facility (Bldg. 850).

3.22.2.5.7 Mercury Controls

Prior to starting work, remove thermostats, switches, and other components that contain mercury. Prior to removal, obtain proper containers from the Hazardous Waste Facility (Bldg. 850).

3.22.2.5.8 Petroleum Products

Dispose of petroleum products and oily water at the Hazardous Waste Facility (Bldg. 850).

3.22.2.5.9 Class I and Class II Ozone Depleting Substances (ODS)

Transfer ODS and other refrigerants to DOT-approved recovery cylinders. Properly label and deliver to the Hazardous Waste Facility (Bldg. 850) at the conclusion of the Task Order or project. Do not mix different refrigerants in the same cylinder.

Certified technicians must perform refrigerant work using EPA-approved recovery equipment. Releases of ODS or refrigerants to the atmosphere is strictly prohibited.

3.22.2.5.10 Vegetation

Remove trees and other landscape features scarred or damaged by equipment operations, and replace with equivalent, undamaged trees and landscape features. Obtain Contracting Officer's approval before replacement. Replace trees on a one-to-one basis. Use Regionally native plants as specified by the station Integrated Natural Resources Management Plan

(INRMP) as replacement landscape features.

3.22.2.5.11 Contract Completion and Close-Out

At project completion, remove any hazardous material brought onto the Station. Account for the quantity of hazardous material brought to the station, the quantity used or expended during job, and the leftover quantity that (1) may have additional useful life as a hazardous material and must be removed by the Contractor, or (2) may be a hazardous waste, which must then be removed as specified herein. The sale of any hazardous material to other Contractors (or Base entity) must be specifically approved in writing by the Contracting Officer prior to the sale.

Laydown areas, vehicle storage and repair facilities, and similar that were Contractor operated and controlled must be returned to a condition similar to the time of the contract award. This includes the removal of break shacks, kitchens, gardens, and similar.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 58 00 (August 2019)**
Change 5 - 08/22

Preparing Activity: NAVFAC **Superseding**
UFGS-01 58 00 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 58 00

PROJECT IDENTIFICATION

08/19, CHG 5: 08/22

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-01 58 00 (August 2019)**
Change 5 - 08/22

Preparing Activity: NAVFAC **Superseding**
UFGS-01 58 00 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 58 00

PROJECT IDENTIFICATION

08/19, CHG 5: 08/22

****

NOTE: This guide specification covers the requirements for temporary signs for project identification.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: Include the following on project drawings:

1. Location of project sign.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA U1	(2024) Use Category System: User Specification for Treated Wood

U.S. ARMY CORPS OF ENGINEERS (USACE)

EP 310-1-6a	(2006; 2019 Change 2) Project Operation -- Sign Standards Manual, VOL 1
EP 310-1-6b	(2006) Sign Standards Manual, VOL 2, Appendices

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NOTE: Include the following Submittal and Quality Assurance paragraphs in all design-build projects and on other applicable projects where the Contractor must provide the rendering.

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1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Preliminary One Line Drawings Of Project Rendering; G, [_____]

Preliminary Drawing Indicating Layout And Text Content; G, [_____]

Sign Legend Orders; G, [_____]

SD-04 Samples

[Final Rendering Sample; G, [_____]

][Final Framed Rendering and Copies; G, [_____]

] Facility Recognition Plaque; G, [_____]

1.3 QUALITY CONTROL

****

NOTE: Use following subpart "Rendering" and associated subparts only if submittal of project rendering is the responsibility of the Contractor. If project rendering is not required, or is to be provided by the Designer of Record (DOR), delete subpart and associated subparts.

****

[1.3.1 Rendering

Provide the project rendering in accordance with the following drawing stages as required in the SUBMITTALS paragraph. The following submittal data is required to properly identify the appropriate view and approve the final rendering of the facility. The final painted rendering will be used to produce the image for the signboard and framed photographic copies provided to the Contracting Officer.

1.3.1.1 Preliminary One Line Drawings

Provide three different views of the facility in a preliminary single line drawing (black and white) format. These three views will represent the best angles at which to view the proposed facility showing the [_____] [best design features] and the three dimensional character of the facility.

1.3.1.2 Final Rendering Sample

Provide a photographic copy (200 by 250 millimeters8 by 10 inches minimum size) of final rendering for approval of color, landscaping, and foreground/background development prior to final submittal.

1.3.1.3 Final Framed Rendering and Copies

Provide final full color rendering of the proposed facility as specified.

][1.3.2 Facility Recognition Plaque

****

NOTE: The following paragraph is tailored for NAVY. Include this paragraph for new people oriented/ people occupied MCON/MILCOM facilities such as: BEQ, Administration, Child Care Centers, Fitness Centers, and other appropriate landmark or unique facilities. Confirm the decision to use this plaque with the Project Manager. Provide design, details and specifications on the contract documents for this plaque. Coordinate the names and organizations that will be identified on the plaque with the Project Manager. Refer to UFC 1-300-09N, "Design Procedures" for further plaque requirements.

****

Submit full size drawing of Facility Recognition Plaque for approval. Confirm the content (message), location and mounting with Contracting Officer prior to fabrication. The final names on the plaque will be determined at the end of the project duration to assure that current participants can be identified and recognized on the plaque.

]1.4 PROJECT IDENTIFICATION SIGN

****

NOTE: This paragraph is tailored for NAVY and AIR FORCE.

****

****

NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

****

NOTE: Refer to Project Sign Details Related Materials

Provide project Signboard on all MILCON and other significant facility projects for NAVY and NAVFAC in

accordance with Plates 1USN, 3, and 4, with Rendering Details in accordance with Plates 2USN, 3, 4 and 5. Unless waived by Government project management, provide project signboard with rendering for all MILCON and other significant projects.

For USMC and NAVFAC projects: Signboard - Plates 1MC, 3 and 4; Rendering Details - Plates 2MC, 3, 4 and 5.

For Air Force and NAVFAC projects (Air Force projects on Navy installations with NAVFAC execution): Signboard - Plates 1USAF, 3 and 4; Rendering Details - Plates 2USAF, 3, 4 and 5.

For Army and NAVFAC projects: Signboard - Plates 1USARMY, 3 and 4; Rendering Details - Plates 2USARMY, 3, 4 and 5.

For DLA and NAVFAC projects: Signboard - Plates 1DLA, 3 and 4; Rendering Details -Plates 2DLA, 3, 4 and 5.

If the sponsoring agency is not noted above utilize the logo file within the Project Sign Details reference material zip file to create an appropriate signboard based on the DLA template.

Significant projects are those projects, greater than $1,000,000, that are located in an area visible to large numbers of people; will provide visual construction activities; will be of sufficient size and scope; or of high interest to the using activity.

Signs are generally not required for projects located in remote areas; projects involving all interior work; parking lot and utilities projects whether overhead or underground; etc. Discuss the necessity of a sign with the using Activity.

****

****

NOTE: The 1220 mm by 2440 mm 4 ft by 8 ft size of the signboard depicted in Plates 1 and 2 is a minimum size requirement. Adjust size to suit, massing, distance from most traveled roads, traffic and speed. When a size larger than the minimum is warranted, provide adequate support and bracing based on soil and wind conditions and increase lettering size in proportion to the dimensions of the sign.

****

****

NOTE: For design-build projects eliminate the bracketed option stating that the Government will provide a temporary rendering and include the last bracketed option for Contractor to provide a color

rendering.

****

Prior to initiating any work on site, provide [one] [_____] project identification sign at the location [indicated] [designated]. Construct the sign in accordance with project sign detail, which can be downloaded at: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables. Maintain sign throughout the life of the project. Upon completion of the project, remove the sign from the site.[The Government will temporarily supply a copy of the rendering to use in the production of the final signboard artwork.][Provide color rendering of the project. Reproduce the rendering on the signboard or enclose a copy of the rendering under a water-proof, transparent cover, and caulk for weather protection.]

****

NOTE: This paragraph is tailored for NAVFAC LANT and NAVFAC EURAFCENT and is for use on NAVFAC Atlantic projects and for NAVFAC Europe projects in Italy. Obtain the current name of the Design Safety Coordinator from NAVFAC Atlantic or NAVFAC Europe project manager and insert below. Obtain the current name of the Resident Officer in Charge of Construction from NAVFAC Atlantic or NAVFAC Europe project manager and insert as the Construction Safety Officer.

****

[On the project sign, provide points of contact for the Design Safety Coordinator and the Construction Safety Officer in accordance with Italian Law as follows: "Design Safety Coordinator-[_____], CEC, U.S. Navy, Commanding Officer, Engineering Field Activity Mediterranean" "Construction Safety Officer - [_____], CEC, U.S. Navy, Resident Officer in Charge of Construction".

]1.4.1 Project Identification Signboard

****

NOTE: The following paragraphs are tailored for NAVY and AIR FORCE. Use the NAVY-tailored paragraphs for all NAVY projects and include the appropriate project identification signboard plates at the end of this section. Signboard Plates are grouped for CNIC and NAVFAC without rendering, USMC and NAVFAC without rendering, CNIC and NAVFAC with rendering, and USMC and NAVFAC with rendering. Use the AIR FORCE-tailored paragraphs for Air Force projects on Air Force Installations.

****

Provide a project identification signboard in accordance with attached Plates [1, 3, and 4][1MC, 3, and 4][2, 3, 4, and 5][2MC, 3, 4, and 5]. Provide a preliminary drawing indicating layout and text content. Erect a signboard at a conspicuous location on the job site where directed by the Contracting Officer.

a. The field of the sign consists of a 1200 by 2400 mm 4 by 8 foot sheet of grade B-B medium density overlaid exterior plywood.

b. Lumber is B or better Southern pine, pressure-preservative treated in accordance with AWPA U1. Nails are aluminum or galvanized steel.

c. Give one coat of exterior alkyd primer and two coats of exterior alkyd enamel paint to the entire signboard and supports. Perform the lettering and sign work by a skilled sign painter using paint known in the trade as bulletin colors. The colors, lettering sizes, and lettering styles are as indicated. Where preservative-treated lumber is required, utilize only cured pressure-treated wood which has had the chemicals leached from the surface of the wood prior to painting.

d. Use spray applied automotive quality high gloss acrylic white enamel paint as background for the NAVFAC logo. NAVFAC logo is an applied 0.0508 mm 2 mil film sticker/decal with either transparent or white background or paint the logo by stencil onto the sign. The weather resistant sticker/decal film is rated for a minimum of 2-year exterior vertical exposure. Mount the self-adhering sticker to the sign with pressure sensitive, permanent acrylic adhesive. Shop cut sticker/decal to rectangular shape and provide pull-off backing sheet on adhesive side of design sticker for shipping.

e. Sign paint colors (manufacturer's numbers/types listed below for color identification only)

(1) Blue = To match dark blue color in the NAVFAC logo.

(2) White = To match Brilliant White color in the NAVFAC logo.

f. NAVFAC logo must retain proportions and design integrity. NAVFAC logos in electronic format may be obtained from the WBDG at the following link:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables.
Use the following to choose color values for the paint to be used:

(1) Dark Blue = equivalent to CMYK values 100, 72, 0, 8.

(2) Light Blue = equivalent to CMYK values 69, 34, 0, 0.

(3) Cyan = equivalent to CMYK values 100, 9, 0, 6.

(4) Yellow = equivalent to CMYK values 0.9,94, 0.

****

NOTE: Use the following paragraph when a rendering is required on the signboard.

****

[g. Final signboard artwork (rendering) may be either mounted under plexiglass as indicated in attached Plates 2 and 5, or may be electrostatically printed on 0.1016 mm 4 mil self-adhering, weather resistant, glossy vinyl film and mounted to signboard. Provide film that is capable of full color reproduction of the building rendering and cover it with an ultra-violet protection film. Laminate the 0.0508 mm 2 mil satin gloss clear protection film to the white 0.1016 mm 4 mil vinyl image film. Utilize pressure sensitive "controltac" adhesive to attach rendering to signboard and smooth out surface with hand pressure tools in accordance with manufacturer's recommendations. Shop cut sticker to size required and provide pull-off backing sheet on adhesive side of film for shipping. Provide the rendering on film that is rated for a minimum of 2-years exterior vertical exposure.

] **

NOTE: The following paragraphs are tailored for AIR FORCE.

****

****

NOTE: For Air Force Projects on Guam, add the paragraph below.

****

[On the project sign, list two points of contact by name and telephone number for a Navy representative and an Air Force representative. Points of contact will be provided by the Contracting Officer.

]

****

NOTE: Confirm with Contracting Officer for each project as to whether the Contractor or Government will provide the applied Air Force logo. The NAVFAC logos are not provided by the Government. If the Government will provide Air Force stickers delete the following requirement.

****

[Created in the design indicated, the 450 mm 18 inch maximum width and height for Air Force and rectangular height for NAVFAC applied stickers, and printed on a 2 mil transparent film. The weather resistant, self adhering film is rated for a minimum of 2-year exterior vertical exposure and be mounted to sign with pressure sensitive, permanent acrylic adhesive. Shop cut sticker to square shape and provide pull-off backing sheet on adhesive side of sticker for shipping.

][1.4.1.1 Project Rendering

****

NOTE: The following paragraphs are tailored for NAVY and AIR FORCE.

****

****

NOTE: Use the following paragraph for projects that require the Contractor to provide the rendering.

****

Provide a full color rendering of the proposed facility as follows:

a. Provide rendering by a company that regularly does this work as a major component of their normal business.

b. Colors used on the rendering to match the exterior color scheme indicated in the contract document.

c. The rendering is a full vignette/fully developed, on heavy illustration board. Approximate finished size is 610 by 760 mm 24 by 30 inches with minimum inside mat dimension of 406 by 508 mm 16 by 20 inches. Draw the rendering at [human eye] [roof] [bird's eye] [_____] level view, painted with Case-in Tempera.

****
NOTE: Use contract award date for fully designed projects and preliminary design approval for Design Build projects.
****

d. Provide three preliminary single line black and white perspectives prior to proceeding with the color rendering. Provide these preliminary perspectives within 30 days after [preliminary design approval] [contract award] for evaluation by the Contracting Officer. Develop the view selected by the Contracting Officer into the final rendering.

e. Provide the final rendering sample photograph within 30 days after approval of preliminary single line drawings. Provide this sample photograph for evaluation by the Contracting Officer.

f. Provide final original color rendering, two full size photographic reproductions of the original rendering, and the photographic negative. Mount the original and reproductions on acid free board, double-matted (acid free matting) with appropriate colored board and framed in contemporary metal frames, using non-glare glass. Print on the matting the project name, location, and the Architect/Engineer firm's name. On the back of the renderings and reproductions, indicated the project name, the location, the contract number, and the date of reproduction.

****
NOTE: Insert into the blank the address of the EFD/EFA Project Manager of the project design.
****

g. Ship the rendering, the photographic copies, and the negative in resilient packaging to ensure damage-free delivery.

(1) Deliver to: [_____]

h. Provide copy of rendering to be used for the signboard that has been protected from UV damage as per specifications.

]1.4.2 Project Signboard

****
NOTE: The following paragraphs are tailored for AIR FORCE.
****

****
NOTE: Use the following paragraph for Air Force projects on Air Force Installations. The host Activity provides sign colors and details to the Government in the project book submittal.

For Air Force projects on a Navy Installation with NAVFAC execution refer to paragraph PROJECT IDENTIFICATION SIGNBOARD above. For Air Force projects on an Army Installation with USACE execution refer to paragraph CONSTRUCTION PROJECT

SIGN below.

****

Furnish the sign, maintain the sign during construction, and remove the sign from the job site upon completion of the project. Details of sign graphics and construction are indicated in Plates 6 and 7 of sketches attached to this section.

****

NOTE: Use this paragraph for projects at Aviano Air Base, Aviano, Italy (NAVFAC EURAFCENT) only.

****

[Move the "PLANNED COMPLETION DATE" to the sign left edge and add to the sign right side "EMERGENCY RESPONSE (ERP) COORDINATES: [_____]". These coordinates, that are used to locate base emergencies, will be provided by the ROICC.

]1.4.3 Construction Project Signs

****

NOTE: The following paragraphs are tailored for ARMY and AIR FORCE.

****

****

NOTE: Use the following paragraph for all Army projects.

****

Furnish the construction project sign package, maintain the signs during construction, and remove the signs from the job site upon completion of the project. The construction project sign package consists of two signs: one for project identification and the other to show the on-the-job safety performance of the contractor. Ensure that the package conforms to the requirements of EP 310-1-6a and EP 310-1-6b, specifically Section 16. Submit the sign legend orders as described in Section 16 of EP 310-1-6a before erecting the signs.

****

NOTE: The following paragraphs are tailored for AIR FORCE.

****

****

NOTE: For Air Force projects on an Army Installation with USACE execution use the paragraph below.

****

[Furnish project sign in accordance with ECB 2020-1 Attachment A Example

Graphic of Signage with Dimensions for MILCON Project.

] **

NOTE: For Army projects on Air Force installations with USACE execution use the paragraph below.

****

Utilize the Example Graphic of Signage with Dimensions for MILCON Project and follow USACE policy provided in Engineering Pamphlet (EP) 310-1-6a, Sign Standards Manual, VOL 1 for guidelines on fabricating, locating, and mounting construction project signs (https://www.publications.usace.army.mil/Portals/76/Users/182/86/2486/EP_310-1-6a%20change%202.pdf).

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-01 74 19 (February 2019)**
Change 3 - 11/21

Preparing Activity: USACE **Superseding**
UFGS-01 74 19 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

02/19, CHG 3: 11/21

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-01 74 19 (February 2019)**
Change 3 - 11/21

Preparing Activity: USACE **Superseding**
UFGS-01 74 19 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

02/19, CHG 3: 11/21

****

NOTE: This guide specification covers the requirements for the management of non-hazardous construction waste and demolition debris/waste materials.

Every project must use a properly edited version of this guide specification.

This guide specification contains tailoring for AIR FORCE, ARMY, NAVY, NAVFAC PAC, and NAVFAC SE. Select/deselect tailoring prior to editing.

This specification section must be coordinated with Section 02 41 00 [DEMOLITION][AND][DECONSTRUCTION] and Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, and when included, Section 01 33 29, SUSTAINABILITY REQUIREMENTS AND REPORTING.

Requirements in this guide specification apply to all DoD installations (including government owned / contractor operated installations and tenant activities) regardless of the funding source.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The DOD Integrated (Non-Hazardous) Solid Waste Management Policy, requires all facilities to meet a non-hazardous solid waste diversion goal of 60% Construction and Demolition Diversion. This guide specification should be used to identify requirements necessary to meet construction waste management requirements under government construction or demolition contract.

Coordinate the requirements of this specification with the installation's waste management programs where the project is located. Where available, include information about access to recycling centers and storage areas in the technical content for better coordination with the contract requirements.

Disposal of hazardous waste or toxic waste materials is specified in Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS and Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 273	Standards for Universal Waste Management
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 178	Specifications for Packagings

1.2 DEFINITIONS

1.2.1 Co-mingle

The practice of placing unrelated materials together in a single container, usually for benefits of convenience and speed.

1.2.2 Construction Waste

Waste generated by construction activities, such as scrap materials, damaged or spoiled materials, temporary and expendable construction materials, and other waste generated by the workforce during construction activities.

1.2.3 Demolition Debris/Waste

Waste generated from demolition activities, including minor incidental demolition waste materials generated as a result of Intentional dismantling of all or portions of a building, to include clearing of building contents that have been destroyed or damaged.

1.2.4 Disposal

Depositing waste in a solid waste disposal facility, usually a managed landfill or incinerator, regulated in the US under the Resource Conservation and Recovery Act (RCRA).

1.2.5 Diversion

The practice of diverting waste from disposal in a landfill or incinerator, by means of eliminating or minimizing waste, or reuse of materials.

1.2.6 Final Construction Waste Diversion Report

A written assertion by a material recovery facility operator identifying constituent materials diverted from disposal, usually including summary tabulations of materials, weight in short-ton.

1.2.7 Recycling

The series of activities, including collection, separation, and processing, by which products or other materials are diverted from the solid waste stream for use in the form of raw materials in the manufacture of new products sold or distributed in commerce, or the reuse of such materials as substitutes for goods made of virgin materials, other than fuel.

1.2.8 Reuse

The use of a product or materials again for the same purpose, in its original form or with little enhancement or change.

1.2.9 Salvage

Usable, salable items derived from buildings undergoing demolition or deconstruction, parts from vehicles, machinery, other equipment, or other components.

1.2.10 Source Separation

The practice of administering and implementing a management strategy to identify and segregate unrelated waste at the first opportunity.

1.3 CONSTRUCTION WASTE (INCLUDES DEMOLITION DEBRIS/WASTE)

****

NOTE: All projects are required to divert at least 60 percent of their non-hazardous solid wastes from the waste stream (including waste from construction, demolition, or deconstruction operations).

****

Divert a minimum of [60][_____] percent by weight of the project construction waste and demolition debris/waste from the landfill or incinerator. Follow applicable industry standards in the management of waste. Apply sound environmental principles in the management of waste. (1) Practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction waste and demolition debris/waste from landfills and incinerators and to facilitate the recycling or reuse of excess construction materials.

1.4 CONSTRUCTION WASTE MANAGEMENT

Implement a Construction Waste Management Program for the project. Take a pro-active, responsible role in the management of construction construction waste, recycling process, disposal of demolition debris/waste, and require all subcontractors, vendors, and suppliers to participate in the Construction Waste Management Program. Establish a process for clear tracking, and documentation of construction waste and demolition debris/waste.

1.4.1 Implementation of Construction Waste Management Program

Develop and document how the Construction Waste Management Program will be implemented in a Construction Waste Management Plan. Submit a Construction Waste Management Plan to the Contracting Officer for approval. Construction waste and demolition debris/waste materials include un-used construction materials not incorporated in the final work, as well as demolition debris/waste materials from demolition activities or deconstruction activities. In the management of waste, consider the availability of viable markets, the condition of materials, the ability to provide material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates.

1.4.2 Oversight

****

NOTE: For Army Project select the first bracketed

option.

For Air Force Project being designed and administered by Army, select the first bracketed option.

For Navy Projects, select the second bracketed option.

For Air Force Project being designed and administered by Navy, select the second bracketed option.

****

[The Quality Control Manager, as specified in Section 01 45 00 QUALITY CONTROL, is responsible for overseeing and documenting results from executing the Construction Waste Management Plan for the project.][The Environmental Manager, as specified in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, is responsible for overseeing and documenting results from executing the Construction Waste Management Plan for the project.]

1.4.3 Special Programs

Implement special programs involving rebates or similar incentives related to recycling of construction waste and demolition debris/waste materials. Retain revenue or savings from salvaged or recycling, unless otherwise directed. Ensure firms and facilities used for recycling, reuse, and disposal are permitted for the intended use to the extent required by federal, state, and local regulations.

1.4.4 Special Instructions

Provide on-site instruction of appropriate separation, handling, recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the projects. Designation of single source separating or commingling will be clearly marked on the containers.

1.4.5 Waste Streams

Delineate waste streams and characterization, including estimated material types and quantities of waste, in the Construction Waste Management Plan. Manage all waste streams associated with the project. Typical waste streams are listed below. Include additional waste steams not listed:

a. Land Clearing Debris

b. Asphalt

c. Masonry and CMU

d. Concrete

e. Metals (Includes, but is not limited to, banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized, stainless steel, aluminum, copper, zinc, bronze.)

f. Wood (nails and staples allowed)

g. Glass

h. Paper

i. Plastics (PET, HDPE,PVC,LDPE,PP,PS, Other)

j. Gypsum

k. Non-hazardous paint and paint cans

l. Carpet

m. Ceiling Tiles

n. Insulation

o. Beverage Containers

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: For Navy Design-Build projects, delete 01 33 00 SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****

NOTE: For projects in the NAVFAC PAC Area of Operation, the submittals identified as SD-01 Preconstruction Submittal for this spec section, remove the "G" designation. The preconstruction submittal(s) in this spec section must be approved by the Contractor's Quality Control System.

****

Construction Waste Management Plan; G, [_____]

****

NOTE: The following three submittals are tailored for AIR FORCE and ARMY.

****

SD-06 Test Reports

Quarterly Reports

Annual Report

SD-11 Closeout Submittals

Final Construction Waste Diversion Report; S

1.6 MEETINGS

Conduct Construction Waste Management meetings. After award of the Contract and prior to commencement of work, schedule and conduct a meeting with the Contracting Officer to discuss the proposed Construction Waste Management Plan and to develop a mutual understanding relative to the management of the Construction Waste Management Program and how waste diversion requirements will be met.

The requirements of this meeting may be fulfilled during the coordination and mutual Understanding meeting outlined in Section 01 45 00 QUALITY CONTROL. At a minimum, discuss and document waste management goals at following meetings:

a. [Preconstruction][Pre-demolition] meeting.

b. Regular [site][Quality Control] meetings.

c. Work safety meeting (if applicable).

1.7 CONSTRUCTION WASTE MANAGEMENT PLAN

****

NOTE: For projects in the NAVFAC PAC Area of Operation, for DBB projects select the first bracketed sentences (1st and 2nd sentence), and edit this first sentence by selecting "45" and "calendar" and "contract award", and delete the second bracketed sentences. For DB project select the second bracketed (3rd and 4th sentence) sentences and remove the first bracketed sentences.

For projects in the NAVFAC Southeast Area of Operation, the requirements for the Contractor's Waste Management Plan must be coordinated with the waste management plan for the Installation. Revise the paragraph as necessary to meet the Installation's requirements. Verify that items are able to be desposed of as specified herein. The contractor may include specified items in item (i) below if explanation or justification exists, when approved by the Contracting Officer.

****

[Submit Construction Waste Management Plan within [15] [45] [calendar] days after [contract award][notice to proceed]. Revise and resubmit Construction Waste Management Plan as necessary, in order for construction to begin.]. [Submit Construction Waste Management Plan not less than 60 calendar days before scheduled final site or building design approval. Revise and resubmit Construction Waste Management Plan until it receives final approval from the Contracting Officer, in order for construction to begin.] Execute demolition or deconstruction activities in accordance with Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION]. Manage demolition debris/waste or deconstruction materials in accordance with the approved construction waste management plan.

An approved Construction Waste Management Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations or meeting project cumulative waste diversion requirement. Ensure all subcontractors receive a copy of the approved Construction Waste Management Plan. The plan demonstrates how to meet the project waste diversion requirement. Also, include the following in the plan:

a. Identify the names of individuals responsible for waste management and waste management tracking, along with roles and responsibilities on the project.

b. Actions that will be taken to reduce solid waste generation, including coordination with subcontractors to ensure awareness and participation.

c. Description of the regular meetings to be held to address waste management.

d. Description of the specific approaches to be used in recycling/reuse of the various materials generated, including the areas on site and equipment to be used for processing, sorting, and temporary storage of materials.

e. Name of landfill and incinerator to be used.

f. Identification of local and regional re-use programs, including non-profit organizations such as schools, local housing agencies, and organization that accept used materials such as material exchange networks and resale stores. Include the name, location, phone number for each re-use facility identified, and provide a copy of the permit or license for each facility.

g. List of specific materials, by type and quantity, that will be salvaged for resale, salvaged and reused on the current project, salvaged and stored for reuse on a future project, or recycled. Identify the recycling facilities by name, address, and phone number.

h. Identification of materials that cannot be recycled or reused with an explanation or justification, to be approved by the Contracting Officer.

i. Description of the means by which materials identified in item (g) above will be protected from contamination.

j. Description of the means of transportation of the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).

k. Copy of training plan for subcontractors and other services to prevent contamination by co-mingling materials identified for diversion and waste materials.

****

NOTE: Include list items below when required by Third Party Certification (TPC). Refer to section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for third party certification requirements.

****

[l. Identification of at least [5] [_____] construction or demolition material streams for diversion.
]

[m. Detailed plan and distribution of waste diversion between buildings, when project is a part of a campus.]

[n. Facilities or subcontractors offering construction waste transport on-site or off-site must ensure that proper shipping orders, bill of lading, manifests, or other shipping documents containing waste diversion information meet requirements of 40 CFR 273 Universal Waste Management, 49 CFR 173 Shippers - General Requirements for Shipments and Packagings, and 49 CFR 178 Specifications for Packaging. Individuals signing manifests or other shipping documents should meet the minimum training requirements.]

[o. List each supplier who deliver construction materials, in bulk, or package products in returnable containers or returnable packaging, or have take-back programs. List each program and the applicable material to actively monitor and track to assist in meeting waste diversion requirements on the project.]

****

NOTE: Include items below when a project is located outside the Continental United States (OCONUS) and

is subject to known host nation agreements. Delete the additional items below, if the project is inside the United States and not subject to Host Nation Agreements.

****

[p. Identify local jurisdiction requirements for waste management. Include local requirements and points of contact.]

Distribute copies of the waste management plan to each subcontractor, Quality Control Manager Environmental Manager, and the Contracting Officer.

1.8 RECORDS (DOCUMENTATION)

1.8.1 General

Maintain records to document the types and quantities of waste generated and diverted though re-use, recycling and sale to third parties; through disposal to a landfill or incinerator facility. Provide explanations for materials not recycled, reused or sold. Collect and retain manifests, weight tickets, sales receipts, and invoices specifically identifying diverted project waste materials or disposed materials.

1.8.2 Accumulated

Maintain a running record of materials generated and diverted from landfill disposal, including accumulated diversion rates for the project. Make records available to the Contracting Officer during construction or incidental demolition activities. Provide a copy of the diversion records to the Contracting Officer upon completion of the construction, incidental demolitions or minor deconstruction activities.

1.9 REPORTS

****

NOTE: This paragraph is tailored for Armyand Air Force.

For Army projects, waste reports go to the SWARS Coordinator or Department of Public Works (DPW) Solid Waste Manager.

For Air Force projects, coordinate with the Base and identify the appropriate person to receive this data.

Edit the bracket selection for Quarterly Reporting and insert the appropriate office/point of contact that will receive the waste reports.

****

1.9.1 General

Maintain current construction waste diversion information on site for periodic inspection by the Contracting Officer. Include in the quarterly reports, annual reports and final reports: the project name, contract information, information for waste generated, diverted and disposed of for the current reporting period and show cumulative totals for the project. Reports must identify quantifies of waste by type and disposal method.

Also include in each report, supporting documentation to include manifests, weigh tickets, receipts, and invoices specifically identifying the project and waste material type and weighted sum.

1.9.2 Quarterly Reporting

Provide cumulative reports at the end of each quarter (December, March, June, and September, corresponding with the federal fiscal year for reporting purposes). Submit quarterly reports not later than 15 calendar days after the preceding quarter has ended. [Submit Quarterly Reports to the appropriate office or identified point of contact.]

1.9.3 Annual Reporting

****

NOTE: Edit bracketed option to tell Contractor where additional copies of annual report is required to be submitted.

Identify who the appropriate installation POC is and insert in the bracketed option. Delete bracketed option if not applicable.

****

Provide a cumulative construction waste diversion report annually. Submit annual report not later than 30 calendar days after the preceding fourth quarter has ended.[Provide copy of annual construction waste diversion report to the installation POC.]

1.10 FINAL CONSTRUCTION WASTE DIVERSION REPORT

A Final Construction Waste Diversion Report is required at the end of the project. Provide Final Construction Waste Diversion Report [60] [_____] days prior to the Beneficial Occupancy Date (BOD). The final Construction Waste Diversion Report must be included in the Sustainability eNotebook in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

1.11 COLLECTION

Collect, store, protect, and handle reusable and recyclable materials at the site in a manner which prevents contamination, and provides protection from the elements to preserve their usefulness and monetary value. Provide receptacles and storage areas designated specifically for recyclable and reusable materials and label them clearly and appropriately to prevent contamination from other waste materials. Keep receptacles or storage areas neat and clean.

Train subcontractors and other service providers to either separate waste streams or use the co-mingling method as described in the Construction Waste Management Plan. Handle hazardous waste and hazardous materials in accordance with applicable regulations and coordinate with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS and Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Separate materials by one of the following methods described herein:

1.11.1 Source Separation Method

Separate waste products and materials that are recyclable from trash and sort as described below into appropriately marked separate containers and then transport to the respective recycling facility for further processing. Deliver materials in accordance with recycling or reuse facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process). Separate materials into the category types as defined in the Construction Waste Management Plan.

****

NOTE: Contact local recycling centers or Installation POC if the Installation has a recycling program to determine if Co-Mingled Method is allowed. Include the following section if applicable.

****

[1.11.2 Co-Mingled Method

Place waste products and recyclable materials into a single container and then transport to an authorized recycling facility, which meets all applicable requirements to accept and dispose of recyclable materials in accordance with all applicable local, state and federal regulations. The Co-mingled materials must be sorted and processed in accordance with the approved Construction Waste Management Plan.

]1.11.3 Other Methods

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

1.12 DISPOSAL

Control accumulation of waste materials and trash. Recycle or dispose of collected materials off-site at intervals approved by the Contracting Officer and in compliance with waste management procedures as described in the waste management plan. Except as otherwise specified in other sections of the specifications, dispose of in accordance with the following:

1.12.1 Reuse

****

NOTE: Determine if sale of recovered materials is allowed at the Installation, and choose the appropriate bracketed phrase.

****

Give first consideration to reusing construction and demolition materials as a disposition strategy. Recover for reuse materials, products, and components as described in the approved Construction Waste Management Plan. Coordinate with the Contracting Officer to identify onsite reuse opportunities or material sales or donation available through Government resale or donation programs. Sale of recovered materials [is] [is not] allowed on the Installation. Consider the use of surplus industrial supply broker services, who match entities with reusable or repurpose industrial materials with entities with need of such materials.

1.12.2 Recycle

****

NOTE: Crushing lamps on site creates a hazardous waste stream, which has additional handling and disposal requirements. If this process is required based on the facility type, make adjustments in the associated text.

****

Recycle non-hazardous construction and demolition/debris materials that are not suitable for reuse. Track rejection of contaminated recyclable materials by the recycling facility. Rejected recyclables materials will not be counted as a percentage of diversion calculation. Recycle all fluorescent lamps, HID lamps, mercury (Hg) -containing thermostats and ampoules, and PCBs-containing ballasts and electrical components as directed by the Contracting Officer. Do not crush lamps on site as this creates a hazardous waste stream with additional handling requirements.

****

NOTE: Include bracket paragraph if a composting pile can remain on site after construction is completed or if the Installation has a Composting Program or partners with a local composting venue. Verify if advertised composting opportunities are still available at the time of the contract and remove if no longer available. Construction Waste Management Plan should expressly address the strategy to utilize composting or not to utilize composting, if the opportunity exists.

****

[1.12.3 Compost

****

NOTE: If a compost pile can remain on site after construction is complete, and if there is a use for the finished compost, employ composting practices throughout the project.

****

Consider composting on site if a reasonable amount of compostable materials will be available and a utilization of compostable material can be determined and appropriately planned for. Compostable materials include plant materials, sawdust and certain food scraps. Composting as a strategy must be explicitly addressed in the Construction Waste Management Plan submitted for approval to ensure it is feasible.

]1.12.4 Waste

Dispose by landfill or incineration only those waste materials with no practical use, economic benefit, or recycling opportunity.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used. -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 78 00 (May 2019)**
Change 1 - 08/21

Preparing Activity: USACE **Superseding**
UFGS-01 78 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

USACE / NAVFAC / AFCEC **UFGS-01 78 00 (May 2019)**
Change 1 - 08/21

Preparing Activity: USACE **Superseding**
UFGS-01 78 00 (August 2011)

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****

SECTION 01 78 00

CLOSEOUT SUBMITTALS

05/19, CHG 1: 08/21

****

NOTE: This guide specification covers the requirements for closeout submittals including: revised project documents, warranty management, testing, adjusting and balancing, O & M manuals, and cleanup.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

This guide specification includes tailoring options for DESIGN-BID-BUILD (DBB), DESIGN-BUILD (DB), ARMY, NAVY, and AIR FORCE projects. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required. This guide specification also includes tailoring options for BIM and Advanced BIM Modeling and is tailored for ARMY and AIR FORCE.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Coordinate with the customer regarding

special warranty requirements and options.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E1971	(2024) Standard Guide for Stewardship for the Cleaning of Commercial and Institutional Buildings

GREEN SEAL (GS)

GS-37	(2017) Cleaning Products for Industrial and Institutional Use

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-1-2909	(2012) Engineering and Design -- Geospatial Data and Systems
ERDC/ITL TR-19-6	(2019) A/E/C Graphics Standard, Release 2.1
ERDC/ITL TR-19-7	(2019) A/E/C CAD Standard - Release 6.1

U.S. DEPARTMENT OF DEFENSE (DOD)

FC 1-300-09N	(2024) Navy and Marine Corps Design
UFC 1-300-08	(2023) Criteria for Transfer and Acceptance of DoD Real Property

1.2 DEFINITIONS

1.2.1 As-Built Drawings

****
NOTE: All Navy project use first set of brackets. The second set of brackets are tailored options for use on Army projects only.
****

As-built drawings are the marked-up drawings, maintained by the Contractor on-site, that depict actual conditions and deviations from the Contract Documents. These deviations and additions may result from coordination required by, but not limited to: contract modifications; official responses to submitted Requests for Information (RFI's); direction from the Contracting Officer; design that is the responsibility of the Contractor, and differing site conditions. Maintain the as-builts throughout construction as[red-lined hard copies on site][and][or][red-lined PDF files]. These files serve as the basis for the creation of the record drawings.

1.2.2 Record Drawings

****
NOTE: Use this paragraph for Design-Build projects. For Design-Bid-Build projects, only use this paragraph if the Contractor is preparing the Record Drawings.

Use the second bracketed paragraph, tailored for Army, if the record drawings are to be produced from the Record Model.
****

The record drawings are the final compilation of actual conditions reflected in the as-built drawings.

****
NOTE: Use the following tailored paragraphs for Army projects only. Select the preferred method of producing the Record Drawings for the project.

Insert information when BIM is required on a project.

If the preferred method is to produce Record Drawings from the Record Model, edit and keep the paragraphs below.
****

[Produce the record drawings from the Record Model(s) and do not include annotations indicating revisions.]

[1.2.3 Record Model

A model reflecting approved changes during construction including red-lines, requests for information (RFI's), and contract modifications. Include updated construction phase facility/site data for components.

][1.2.4 Advanced Modeling

A subset of geospatial technologies as defined in EM 1110-1-2909 to include Building Information Modeling (BIM), Civil Information Modeling (CIM), Geographic Information Systems (GIS), and Computer-Aided Design (CAD). Advanced modeling is comprised of models and drawings that form a digital representation of the project, or part thereof, that are comprised of model elements with facility data.

][1.2.5 USACE CAD/BIM Technology Center

The USACE CAD/BIM Technology Center hosts all standard content for USACE. This content can be accessed through the CAD/BIM Technology Center website, https://cadbimcenter.erdc.dren.mil/.

]1.3 SOURCE DRAWING FILES

****

NOTE: Use this paragraph if Contractor is providing the Record Drawings.

****

Request the full set of electronic drawings, in the source format, for Record Drawing preparation, after award and at least 30 days prior to required use.

1.3.1 Terms and Conditions

Data contained on these electronic files must not be used for any purpose other than as a convenience in the preparation of construction [drawings and]data for the referenced project. Any other use or reuse is at the sole risk of the Contractor and without liability or legal exposure to the Government. The Contractor must make no claim and waives to the fullest extent permitted by law, any claim or cause of action of any nature against the Government, its agents or sub consultants that may arise out of or in connection with the use of these electronic files. The Contractor must, to the fullest extent permitted by law, indemnify and hold the Government harmless against all damages, liabilities or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.

These electronic CAD drawing files are not construction documents. Differences may exist between the CAD files and the corresponding construction documents. The Government makes no representation regarding the accuracy or completeness of the electronic CAD files, nor does it make representation to the compatibility of these files with the Contractor hardware or software. In the event that a conflict arises between the signed and sealed construction documents prepared by the Government and the furnished Source drawing files, the signed and sealed construction documents govern. The Contractor is responsible for determining if any conflict exists. Use of these Source Drawing files does not relieve the Contractor of duty to fully comply with the contract documents, including and without limitation, the need to check, confirm and coordinate the work of all contractors for the project. If the Contractor uses, duplicates or modifies these electronic source drawing files for use in producing construction [drawings and]data related to this contract, remove all previous indicia of ownership (seals, logos, signatures, initials and dates).

1.4 RECORD DRAWINGS

****

NOTE: Use this paragraph for ARMY only. Do not use for NAVY projects. This paragraph is tailored for ARMY.

****

The Government will provide pdf and or program files at the preconstruction conference that contains one set of "as-designed" electronic CAD files in the specified software and format revised to reflect all amendments and the final contract PDF drawings. The CAD files are provided to enable preparation of as-built or as-constructed drawings. If discrepancies exist between the CAD files and the contract PDF drawings, correct the CAD files to show the contract PDF drawings.

1.4.1 Variation with Contract Drawings

The electronic files provided are not part of the contract documents. If there is any discrepancy between the electronic files and the contract drawings, the contract drawings govern. The Government has no responsibility to modify any GFM due to changes in the design that occur after award.

Evaluate the content and quality of the GFM upon receipt. If major discrepancies or omissions occur in the GFM, notify the Contracting Officer and indicate the nature of such variations.

1.4.2 Data Loss, Corruption, and Error

Transfer of GFM files may result in corrupted files resulting in data loss and errors. Use of GFM files at own risk. Verify data integrity upon receipt and request a replacement if necessary. Make any adjustment in file structure, format, or software version as needed to make GFM compatible with computer systems and/or software to meet the requirements of the contract.

****

NOTE: Edit the paragraph below if production of a final model is a requirement on this project. Delete the paragraph below if BIM is not a requirement on the project.

****

[1.4.3 Modeling Completeness and Quality

The Government makes no guarantee that the GFM provide the level of completeness or quality as required by the contract. Further, the Government makes no guarantee that identified variations will be corrected upon notification.

]1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

****
NOTE: For Navy Design-Build projects, delete 01 33 00 SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Warranty Management Plan

Warranty Tags

Final Cleaning

Spare Parts Data

SD-08 Manufacturer's Instructions

Posted Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings; G, [_____]

Record Drawings; G, [_____]

Record Model; G, [_____]

As-Built Record of Equipment and Materials

Warranted Equipment and Materials

Final Approved Shop Drawings; G, [_____]

Construction Contract Specifications; G, [_____]

Certification of EPA Designated Items; G, [_____]

Certification Of USDA Designated Items; G, [_____]

Interim DD FORM 1354; G, [_____]

High Performance and Sustainable Building (HPSB) Checklist; G

List Of Installed Building Equipment Items For DD Form 1354

1.6 SPARE PARTS DATA

****

NOTE: Following sentence contains tailoring for NAVFAC NW for four copies.

****

Submit [two][_____][four] copies of the Spare Parts Data list.

a. Indicate manufacturer's name, part number, and stock level required for test and balance, pre-commissioning, maintenance and repair activities. List those items that may be standard to the normal maintenance of the system.

****

NOTE: Use this tailored paragraph for ARMY projects only. Spare parts are not permitted to be provided for Navy projects.

****

b. At acceptance of commissioning, ensure the required stock level is supplied as indicated in subparagraph a for maintenance and repair activities through the facilities warranty period. Provision of spare parts does not relieve the Contractor of responsibilities listed under the contract guarantee provisions.

1.7 QUALITY CONTROL

****

NOTE: This subpart is tailored for ARMY use only. Do not use this paragraph for NAVY projects.

****

Additions and corrections to the contract drawings must be equal in quality and detail to that of the originals. Line colors, line weights, lettering, layering conventions, and symbols must [conform to ERDC/ITL TR-19-7][be the same as the original line colors, line weights, lettering, layering conventions, and symbols].

1.8 WARRANTY MANAGEMENT

****

NOTE: A warranty package based on a cost/benefit determination will be established with the customer at the beginning of a project. Coordinate with the customer regarding special warranty requirements and options.

****

****

NOTE: Use four sets for NAVFAC NW.

****

1.8.1 Warranty Management Plan

Develop a warranty management plan which contains information relevant to FAR 52.246-21 Warranty of Construction. At least 30 days before the planned pre-warranty conference, submit [one set] [[_____]][four sets] of the warranty management plan. Include within the warranty management plan all required actions and documents to assure that the Government receives all warranties to which it is entitled. The plan narrative must contain sufficient detail to render it suitable for use by future maintenance and repair personnel, whether tradesmen, or of engineering background, not necessarily familiar with this contract. The term "status" as indicated below must include due date and whether item has been submitted or was accomplished. Submit warranty information, made available during the construction phase, to the Contracting Officer for approval prior to each monthly pay estimate. Assemble approved information in a binder and turn over to the Government upon acceptance of the work. The construction warranty period must begin on the date of project acceptance and continue for the full product warranty period. Conduct a joint 4 month and 9 month warranty inspection, measured from time of acceptance; with the Contractor, Contracting Officer and the Customer Representative. The warranty management plan must include, but is not limited to, the following:

a. Roles and responsibilities of personnel associated with the warranty process, including points of contact and telephone numbers within the organizations of the Contractors, subcontractors, manufacturers or suppliers involved.

b. For each warranty, the name, address, telephone number, and e-mail of each of the guarantor's representatives nearest to the project location.

c. A list and status of delivery of Certificates of Warranty for extended warranty items, including roofs, HVAC balancing, pumps, motors, transformers, and for commissioned systems, such as fire protection and alarm systems, sprinkler systems, and lightning protection systems.

d. Warranted Equipment and Materials list for each warranted equipment, item, feature of construction or system indicating:

(1) Name of item.
(2) Model and serial numbers.
(3) Location where installed.
(4) Name and phone numbers of manufacturers or suppliers.
(5) Names, addresses and telephone numbers of sources of spare parts.
(6) Warranties and terms of warranty. Include one-year overall warranty of construction, including the starting date of warranty of construction. Items which have warranties longer than one year must be indicated with separate warranty expiration dates.
(7) Cross-reference to warranty certificates as applicable.
(8) Starting point and duration of warranty period.
(9) Summary of maintenance procedures required to continue the warranty in force.
(10) Cross-reference to specific pertinent Operation and Maintenance manuals.
(11) Organization, names and phone numbers of persons to call for warranty service.
(12) Typical response time and repair time expected for various warranted equipment.

e. The plans for attendance at the 4 and 9 month post-construction warranty inspections conducted by the Government.

f. Procedure and status of tagging of equipment covered by warranties longer than one year.

g. Copies of instructions to be posted near selected pieces of equipment where operation is critical for warranty or safety reasons.

1.8.2 Performance Bond

****

NOTE: Use the bracketed item if the bond must extend beyond the construction period; coordinate requirement with the Contracting Officer.

****

The Performance Bond [must remain effective throughout the construction and warranty period] [_____].

a. In the event the Contractor fails to commence and diligently pursue any construction warranty work required, the Contracting Officer will have the work performed by others, and after completion of the work, will charge the remaining construction warranty funds of expenses incurred by the Government while performing the work, including, but not limited to administrative expenses.

b. In the event sufficient funds are not available to cover the construction warranty work performed by the Government at the Contractor's expense, the Contracting Officer will have the right to recoup expenses from the bonding company.

c. Following oral or written notification of required construction warranty repair work, respond in a timely manner. Written verification will follow oral instructions. Failure to respond will be cause for the Contracting Officer to proceed against the Contractor.

1.8.3 Pre-Warranty Conference

Prior to contract completion, and at a time designated by the Contracting Officer, meet with the Contracting Officer to develop a mutual understanding with respect to the requirements of this section. At this meeting, establish and review communication procedures for Contractor notification of construction warranty defects, priorities with respect to the type of defect, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer for the execution of the construction warranty In connection with these requirements and at the time of the Contractor's quality control completion inspection, furnish the name, telephone number and address of a licensed and bonded company which is authorized to initiate and pursue construction warranty work action on behalf of the Contractor. This point of contact must be located within the local service area of the warranted construction, be continuously available, and be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of its responsibilities in connection with other portions of this provision.

1.8.4 Contractor's Response to Construction Warranty Service Requirements

****

NOTE: This subpart is tailored for ARMY only.
Delete this paragraph for NAVY projects.

****

Following oral or written notification by the Contracting Officer, respond to construction warranty service requirements in accordance with the "Construction Warranty Service Priority List" and the three categories of priorities listed below. Submit a report on any warranty item that has been repaired during the warranty period. Include within the report the cause of the problem, date reported, corrective action taken, and when the repair was completed. If the Contractor does not perform the construction warranty within the timeframe specified, the Government will perform the work and back charge the construction warranty payment item established.

a. First Priority Code 1. Perform onsite inspection to evaluate situation, and determine course of action within 4 hours, initiate work within 6 hours and work continuously to completion or relief.

b. Second Priority Code 2. Perform onsite inspection to evaluate situation, and determine course of action within 8 hours, initiate work within 24 hours and work continuously to completion or relief.

c. Third Priority Code 3. All other work to be initiated within 3 work days and work continuously to completion or relief.

d. The "Construction Warranty Service Priority List" is as follows:

Code 1-Life Safety Systems
(1) Fire suppression systems.
(2) Fire alarm system(s) in place in the building.

Code 1-Air Conditioning Systems
(3) Recreational support.
(4) Air conditioning leak in part of building, if causing damage.
(5) Air conditioning system not cooling properly.

Code 1-Doors
(6) Overhead doors not operational, causing a security, fire, or safety problem.
(7) Interior, exterior personnel doors or hardware, not functioning properly, causing a security, fire, or safety problem.

Code 3-Doors
(8) Overhead doors not operational.
(9) Interior/exterior personnel doors or hardware not functioning properly.

Code 1-Electrical
(10) Power failure (entire area or any building operational after 1600 hours).
(11) Security lights
(12) Smoke detectors

Code 2-Electrical
(13) Power failure (no power to a room or part of building).
(14) Receptacle and lights (in a room or part of building).

Code 3-Electrical
(15) Street lights.

Code 1-Gas
(16) Leaks and breaks.
(17) No gas to family housing unit or cantonment area.

Code 1-Heat
(18) Area power failure affecting heat.
(19) Heater in unit not working.

Code 2-Kitchen Equipment
(20) Dishwasher not operating properly.
(21) All other equipment hampering preparation of a meal.

Code 1-Plumbing
(22) Hot water heater failure.
(23) Leaking water supply pipes.

Code 2-Plumbing
(24) Flush valves not operating properly.
(25) Fixture drain, supply line to commode, or any water pipe leaking.
(26) Commode leaking at base.

Code 3 -Plumbing
(27) Leaky faucets.

Code 3-Interior
(28) Floors damaged.
(29) Paint chipping or peeling.
(30) Casework.

Code 1-Roof Leaks
(31) Temporary repairs will be made where major damage to property is occurring.

Code 2-Roof Leaks
(32) Where major damage to property is not occurring, check for

location of leak during rain and complete repairs on a Code 2 basis.

Code 2-Water (Exterior)
(33) No water to facility.

Code 2-Water (Hot)
(34) No hot water in portion of building listed.

Code 3-All other work not listed above.

1.8.5 Warranty Tags

****

NOTE: Paragraph below contains tailoring for NAVFAC NW for four copies.

****

At the time of installation, tag each warranted item with a durable, oil and water resistant tag approved by the Contracting Officer. Attach each tag with a copper wire and spray with a silicone waterproof coating. Also, submit [two][_____][four] record copies of the warranty tags showing the layout and design. The date of acceptance and the QC signature must remain blank until the project is accepted for beneficial occupancy. Show the following information on the tag.

Type of product/material	
Model number	
Serial number	
Contract number	
Warranty period from/to	
Inspector's signature	
Construction Contractor	
Address	
Telephone number	
Warranty contact	
Address	
Telephone number	
Warranty response time priority code	

WARNING - PROJECT PERSONNEL TO PERFORM ONLY OPERATIONAL MAINTENANCE DURING THE WARRANTY PERIOD.

PART 2 PRODUCTS

2.1 RECORD DRAWINGS

****

NOTE: This paragraph is tailored for ARMY only. Do not use for NAVY projects.

****

****

NOTE: Use and edit this paragraph to specify CAD files compatible with the customers CAD system.

****

Prepare the CAD drawing files in AutoCAD Release [2013][____]MicroStation [J][V8][_____] format compatible with a [Windows 7][_____] operating system.

2.1.1 Additional Drawings

If additional drawings are required, prepare them using the specified electronic file format applying [the same graphic standards specified for original drawings][ERDC/ITL TR-19-7 and ERDC/ITL TR-19-6]. The title block and drawing border to be used for any new final record drawings must be identical to that used on the contract drawings.

2.1.1.1 Sheet Numbers and File Names

If a sheet needs to be added between two sequential sheets, append a Supplemental Drawing Designator in accordance with ERDC/ITL TR-19-7 Adding a drawing sheet, and ERDC/ITL TR-19-6 Adding or deleting drawing sheets and index sheet procedures.

[2.2 ADVANCED MODELING PACKAGE

****

NOTE: This paragraph is tailored for Army.

Delete this section if Advanced BIM Modeling is not required on the project.

Delete item (f): If exports from the Model are not required to as a part of the contract requirements for the project.

****

For each Advanced Modeling Package submittal for both the Interim Record Model Package and the Final Record Model Package, submit in accordance with ERDC/ITL TR-19-7 [and in accordance with Section 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)] and also provide the following items:

a. Advanced Modeling PxP: Provide an electronic copy of the most current approved version of the project Advanced Modeling PxP.

b. Electronic Files: Provide an electronic list (.txt file or similar), of all submitted electronic files including a description, directory, and file name for each file submitted. Identify which files have been produced from the Model and Facility Data. For all sheet files, include a list of the sheet titles and sheet numbers.

c. Advanced Modeling Submittal Checklist: Complete the USACE BIM/CIM Advanced Modeling Submittal Checklist and include with each submittal. Download the Checklist from the USACE CAD/BIM Technology Center website.

d. Advanced Modeling Files: Provide all native Advanced Modeling files associated with the production of the contract drawings and associated as-modeled drawings. Update and maintain in compliance with the Advanced Modeling formatting, content requirement, and standards in [Section 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)] [_____], in order to yield a complete and coordinated document package.

e. Quality Control (QC) Reports: Provide electronic PDFs of all QC reports and checklist utilized to ensure full compliance with the contract requirements and standards.

[f. CAD Exports of BIM-Generated Sheets and Drawings: Provide supplemental 2D CAD exports from the project BIM model as needed to demonstrate compliance with contract requirements. Export all contract drawings sheets to the CAD format(s) defined in Section 01 33 16.00 10 DESIGN DATA(DESIGN AFTER AWARD).]

][2.3 CERTIFICATION OF EPA DESIGNATED ITEMS

****

NOTE: This paragraph addresses requirements for Certification of EPA Designated Items.

By signing this contract the Offeror is certifying that the percentage of recovered/recycled materials for EPA Designated items delivered or used in the performance of this contract will meet the minimum amount required in accordance with the FAR references in the contract documents.

****

Submit the Certification of EPA Designated Items as required by FAR 52.223-9 Estimate of Percentage of Recovered Material Content for EPA Designated Items and FAR 52-223-17 Affirmative Procurement of EPA designated items in Service and Construction Contracts. Include on the certification form the following information: project name, project number, Contractor name, license number, Contractor address, and certification. The certification will read as follows and be signed and dated by the Contractor. ["I hereby certify the information provided herein is accurate and that the requisition/procurement of all materials listed on this form comply with current EPA standards for recycled/recovered materials content. The following exemptions may apply to the non-procurement of recycled/recovered content materials:

a. The product does not meet appropriate performance standards;

b. The product is not available within a reasonable time frame;

c. The product is not available competitively (from two or more sources);

d. The product is only available at an unreasonable price (compared with a comparable non-recycled content product)."][_____]

Record each product used in the project that has a requirement or option of containing recycled content in accordance with SECTION 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING, noting total price, total value of post-industrial recycled content, total value of post-consumer recycled content, exemptions (a, b, c, or d, as indicated), and comments. Recycled content values may be determined by weight or volume percent, but must be consistent throughout.

]2.4 CERTIFICATION OF USDA DESIGNATED ITEMS

****

NOTE: This paragraph addresses requirements for Certification of USDA Designated Items.

By signing this contract the Offeror is certifying that the percentage of Biobased materials for USDA Designated items delivered or used in the performance of this contract will meet the minimum amount required in accordance with the FAR references in the contract documents.

****

Submit the Certification of USDA Designated Items as required by FAR 52-223-1 Bio-based Product Certifications and FAR 52.223-2 Affirmative Procurement of Biobased Products Under Service and Construction Contracts. Include on the certification form the following information: project name, project number, Contractor name, license number, Contractor address, and certification. The certification will read as follows and be signed and dated by the Contractor. ["I hereby certify the information provided herein is accurate and that the requisition/procurement of all materials listed on this form comply with current USDA standards for biobased materials content. The following exemptions may apply to the non-procurement of biobased content materials:

a. The product does not meet appropriate performance standards;

b. The product is not available within a reasonable time frame;

c. The product is not available competitively (from two or more sources);

d. The product is only available at an unreasonable price (compared with a comparable bio-based content product)."][_____]

Record each product used in the project that has a requirement or option of containing biobased content in accordance with SECTION 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING, noting total price, total value of post-industrial recycled content, total value of post-consumer recycled content,[total value of biobased content,] exemptions (a, b, c, or d, as indicated), and comments. Biobased content values may be determined by weight or volume percent, but must be consistent throughout.

2.5 PDF AS-BUILT FILES

****

NOTE: This paragraph is tailored for ARMY.

****

Provide electronic PDF "plots" of all contract drawings sheets associated with the as-built drawing submittal. Compile and organize the PDF set to match the contract drawings. Bookmark and label the pages of the PDF file in accordance with Section 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD).

2.6 REDLINES AND MARKUPS

****

NOTE: This paragraph is tailored for ARMY.

****

Provide PDFs of the current working redlines and/or markups complying with the as-builts drawing and markup requirements contained in this specification.

[2.7 GEO-DATA-BASE FILES

****

NOTE: This paragraph is tailored for ARMY.

Delete this requirement if Advanced Modeling is not a requirement in this project.

****

Provide a SDSFIE/FGDC GeoReferenced personal GeoDataBase. For all information outside of the building walls, provide a personal GeoDataBase in .mdb format using the latest version of Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE) as the database structure. Provide a shell database to define the projection and database structure.

For all drawings within and including the exterior walls, utilize the advanced modeling formats described and referenced herein. Provide a short GeoDataBase read-me file explaining the deliverable. The read-me file will include a description of the software used to create the data, projection, and include the attribute tables used.

]2.8 AS-BUILT OR ADVANCED MODELING RE-SUBMISSION REQUIREMENTS

****

NOTE: This paragraph is tailored for ARMY.

****

If elements of an as-built submittal or advanced modeling package are rejected, provide the following for each re-submission, in addition to any information required in Section 01 33 00 SUBMITTAL PROCEDURES:

a. Re-submit all components required under paragraph As-Builts or Advanced Modeling Package, including a new Advanced Modeling Submittal Checklist and updated content in response to Government comments.

b. Provide a copy of all Government review comments.

c. Provide a disposition/response to each Government review comment for a back-check of the re-submission deliverable.

PART 3 EXECUTION

3.1 AS-BUILT DRAWINGS

Provide and maintain two black line print copies of the PDF contract drawings for As-Built Drawings. Maintain the as-builts throughout construction as red-lined hard copies on site[and][or] red-lined PDF files. Submit As-Built Drawings 30 days prior to Beneficial Occupancy Date (BOD).

3.1.1 Markup Guidelines

****

NOTE: The following information is provided to improve the quality of the markup prints and facilitate preparation of final as-built drawings. The most important guideline is that the markup changes on the prints are complete and understandable. Complete and understandable markup prints will minimize effort to transfer information to CAD files.

****

Make comments and markup the drawings complete without reference to letters, memos, or materials that are not part of the As-Built drawing. Show what was changed, how it was changed, where item(s) were relocated and change related details. These working as-built markup prints must be neat, legible and accurate as follows:

a. Use base colors of red, green, and blue. Color code for changes as follows:

    (1) Special (Blue) - Items requiring special information, coordination, or special detailing or detailing notes.

    (2) Deletions (Red) - Over-strike deleted graphic items (lines), lettering in notes and leaders.

    (3) Additions (Green) - Added items, lettering in notes and leaders.

b. Provide a legend if colors other than the "base" colors of red, green, and blue are used.

c. Add and denote any additional equipment or material facilities, service lines, incorporated under As-Built Revisions if not already shown in legend.

d. Use frequent written explanations on markup drawings to describe changes. Do not totally rely on graphic means to convey the revision.

e. Use legible lettering and precise and clear digital values when marking prints. Clarify ambiguities concerning the nature and application of change involved.

f. Wherever a revision is made, also make changes to related section views, details, legend, profiles, plans and elevation views, schedules, notes and call out designations, and mark accordingly to avoid conflicting data on all other sheets.

g. For deletions, cross out all features, data and captions that relate to that revision.

h. For changes on small-scale drawings and in restricted areas, provide large-scale inserts, with leaders to the applicable location.

i. Indicate one of the following when attaching a print or sketch to a markup print:

   (1) Add an entire drawing to contract drawings

   (2) Change the contract drawing to show changes on the drawing.

   (3) Provided for reference only to further detail the initial design.

j. Incorporate all shop and fabrication drawings into the markup drawings.

3.1.2 As-Built Drawings Content

****

NOTE: The following subpart contains tailoring for ARMY. For Navy, only use the last sentence in paragraph below, and the items following, which are not tailored.

****

Revise [As-Built Drawings][and][or][red-lined PDF files] in accordance with ERDC/ITL TR-19-6[and][ERDC/ITL TR-19-7]. Keep these working as-built markup drawings current on a weekly basis and at least one set available on the jobsite at all times. Changes from the contract drawings which are made during construction or additional information which might be uncovered in the course of construction must be accurately and neatly recorded as they occur by means of details and notes. Submit the working as-built markup drawings for approval prior to submission of each monthly pay estimate. For failure to maintain the working and final record drawings as specified herein, the Contracting Officer will withhold [10][_____] percent of the monthly progress payment until approval of updated drawings. Show on the as-built drawings, but not limited to, the following information:

a. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, show by offset dimensions to two permanently fixed surface features the end of each run including each change in direction on the record drawings. Locate valves, splice boxes and similar appurtenances by dimensioning along the utility run from a reference point. Also record the average depth below the surface of each run.

b. The location and dimensions of any changes within the building structure.

c. Layout and schematic drawings of electrical circuits and piping.

d. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.

e. Changes in details of design or additional information obtained from working drawings specified to be prepared or furnished by the Contractor; including but not limited to shop drawings, fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment, and foundations.

f. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.

g. Changes or Revisions which result from the final inspection.

h. Where contract drawings or specifications present options, show only the option selected for construction on the working as-built markup drawings.

i. If borrow material for this project is from sources on Government property, or if Government property is used as a spoil area, furnish a contour map of the final borrow pit/spoil area elevations.

j. Systems designed or enhanced by the Contractor, such as HVAC controls, fire alarm, fire sprinkler, and irrigation systems.

k. Changes in location of equipment and architectural features.

l. Modifications and compliance with FC 1-300-09N procedures.

m. Actual location of anchors, construction and control joints, etc., in concrete.

n. Unusual or uncharted obstructions that are encountered in the contract work area during construction.

o. Location, extent, thickness, and size of stone protection particularly where it will be normally submerged by water.

3.2 RECORD DRAWING FILES

****

NOTE: Use this paragraph for ARMY only. Do not use for NAVY projects. Paragraph is tailored for ARMY.

****

****

NOTE: Edit this paragraph to specify CAD drawings compatible with the customer's CAD system, providing the version where applicable.

****

If additional drawings are required, prepare them using the specified electronic file format applying [the same graphic standards specified for original drawings][ERDC/ITL TR-19-7 and ERDC/ITL TR-19-6]. The title block and drawing border to be used for any new final record drawings must be identical to that used on the contract drawings. Accomplish additions and corrections to the contract drawings using CAD files. Provide all program files and hardware necessary to prepare final PDF record drawings. The Contracting Officer will review final PDF record drawings for accuracy and return them to the Contractor for required corrections, changes, additions, and deletions.

3.2.1 Rename the CAD Drawing files

Rename the CAD Drawing files using the contract number as the Project Code field,(e.g., W91238-15-C-10A-102.DWGDGN) as instructed in the Pre-Construction conference. Use only those renamed files for the Marked-up changes. Make all changes on the layer/level as the original item.

a. For AutoCAD files (DWG), enter all as-built delta changes and notations on the AS-BUILT layer.MicroStation files (DGN), enter all as-built delta changes and notations on:

(1) - Level #63
(2) - Level/Layer Name contains: ANNO-REVS
(3) - Level/Layer Description: Revisions

b. When final revisions have been completed, show the wording "RECORD DRAWING AS-BUILTS" followed by the name of the Contractor in letters at least 5 mm 3/16 inch high on the cover sheet drawing. Date RECORD DRAWING AS-BUILTS" drawing revisions in the revision block.

c. Within [1020][_____] days after Government approval of all of the working record drawings for a phase of work, prepare the final CAD record drawings for that phase of work and submit PDF drawing files and two sets of prints for review and approval. The Government will promptly return one set of prints annotated with any necessary corrections. Within [710][_____] days revise the CAD files accordingly at no additional cost and submit one set of final prints for the completed phase of work to the Government. Within [1020][_____] days of substantial completion of all phases of work, submit the final record drawing package for the entire project. Submit one set of electronic CAD files, and one set of the approved working record PDF and or programfiles with two sets of prints. The CAD files must be complete in all details and identical in form and function to the CAD drawing files supplied by the Government. Prepare AutoCAD files for transmittal using e-Transmit. Prepare MicroStation files for transmittal using the Packager (Archive). Make any transactions or adjustments necessary to accomplish this. The Government reserves the right to reject any drawing files it deems incompatible with the customer's CAD system. Paper prints, drawing files and storage media submitted will become the property of the Government upon final approval. Failure to submit final record PDF drawing files, CAD files and marked prints as specified will be cause for withholding any payment due under this contract. Approval and acceptance of final record drawings must be accomplished before final payment is made.

3.3 RECORD DRAWINGS

****

NOTE: Use the following paragraph for Navy Projects only. Only use this paragraph if Contractor is providing the Record Drawings. Paragraph is tailored for NAVY.

****

Prepare and provide Record Drawings and Source Documents in accordance with FC 1-300-09N. Provide four copies of Record Drawings and Documents on separate CDs or DVDs [30][_____] days after BOD.

****

NOTE: Use the following paragraphs for ARMY projects only. Do not use for NAVY projects. Paragraphs are tailored for ARMY.

****

****

NOTE: The USACE policy on Record (As-Built) drawings is as follows:

a. Method of Preparation for DoD Projects. The construction Contractor must prepare the final Record drawings in PDF from the CAD files.

b. Method of Preparation for Civil Works Projects. The preferred method of preparing the final Record drawings is by the construction Contractor. The management plan for the project must justify the preparation of the final Record drawings by any other method, such as by in-house personnel. Two such exceptions are "emergency construction" and operations work performed with hired labor. Revise the following specification paragraphs if as-builts are not to be done by the Contractor.

c. Customer Coordination. Discuss the method of producing the record drawings and format with the customer at the beginning of a project, and record it in the Memorandum of Understanding with the customer (if applicable) and the Project Management Plan.

****

Prepare final record drawings after the completion of each definable [feature][phase] of work as listed in the Contractor Quality Control Plan (such as Foundations, Utilities, or Structural Steel as appropriate for the project). Transfer the changes from the approved working as-built markup drawings to the original electronic CAD drawing files. Modify the as-built CAD drawing files to correctly show the features of the project as-built by bringing the working CAD drawing set into agreement with approved working as-built markup drawings, and adding such additional drawings as may be necessary. Refer to ERDC/ITL TR-19-6. Jointly review the working as-built markup drawings with printouts from working as-built CAD drawing PDF files for accuracy and completeness. Monthly review of working as-built CAD drawing PDF file printouts must cover all sheets revised since the previous review. These PDF drawing files are part of the permanent records of this project. Any drawings damaged or lost must be satisfactorily replaced at no expense to the Government.

Drawing revisions (include within change order price the cost to change working and final record drawings to reflect revisions) and compliance with the following procedures.

a. Follow directions in the revision for posting descriptive changes.

b. The revision delta size must be 8 mm 5/16 inch unless the area where the delta is to be placed is crowded. Use a smaller size delta for crowded areas.

c. Place a revision delta at the location of each deletion.

d. For new details or sections which are added to a drawing, place a revision delta by the detail or section title.

e. For minor changes, place a revision delta by the area changed on the drawing (each location).

f. For major changes to a drawing, place a revision delta by the title of the affected plan, section, or detail at each location.

g. For changes to schedules or drawings, place a revision delta either by the schedule heading or by the change in the schedule.

3.3.1 Final Record Drawing Package

****

NOTE: This subpart is tailored for ARMY only. Do not use on NAVY projects.

****

Submit the final record PDF and CAD drawings package for the entire project within 20 days of substantial completion of all phases of work. Submit one set of ANSI D size PDF and CAD files, two sets of ANSI D size prints and one set of the approved working record drawings. The package must be complete in all details and identical in form and function to the contract drawing files supplied by the Government.

3.4 FINAL APPROVED SHOP DRAWINGS

****

NOTE: This paragraph is tailored for ARMY only. Do not use for NAVY projects. Delete this subpart if Section 01 78 23 OPERATION AND MAINTENANCE DATA is in the job.

****

Submit final approved project shop drawings [30][_____] days after transfer of the completed facility.

3.5 CONSTRUCTION CONTRACT SPECIFICATIONS

****

NOTE: This paragraph is tailored for ARMY projects. Do not use for NAVY projects.

****

Submit final PDF file record construction contract specifications, including revisions thereto, [30][_____] days after transfer of the completed facility.

3.6 AS-BUILT RECORD OF EQUIPMENT AND MATERIALS

****

NOTE: This subpart is tailored for ARMY use only. Do not use for NAVY projects.

****

****
NOTE: This paragraph is intended to provide data on equipment and materials incorporated in the construction of the project that cannot readily be determined after completion of construction. The data is expected to be of value for future maintenance, alteration, and repair work. The designer should predetermine the items on which data is required and list them in the DESCRIPTION column of the following form. A typical list of items would include such things as: roofing, insulation, and special wall coverings.
****

Furnish [one copy][[_____]copies] of preliminary record of equipment and materials used on the project [15][_____] days prior to final inspection. This preliminary submittal will be reviewed and returned [2][_____] days after final inspection with Government comments. Submit [Two][_____] sets of final record of equipment and materials [10][_____] days after final inspection. Key the designations to the related area depicted on the contract drawings. List the following data:

RECORD OF DESIGNATED EQUIPMENT AND MATERIALS DATA				
Description	Specification Section	Manufacturer and Catalog, Model, and Serial Number	Composition and Size	Where Used

3.7 OPERATION AND MAINTENANCE MANUALS

****
NOTE: For NAVY projects, delete this paragraph if Section 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW) is used. Submittal requirements are in that section.

If Section 01 78 23 OPERATION AND MAINTENANCE DATA is in the project, use the first bracketed sentence. If Section 01 78 23 OPERATION AND MAINTENANCE DATA is not in the project, use the second set of bracketed sentences.
****

[Provide project operation and maintenance manuals as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.][Provide [four] [_____] electronic copies of the Operation and Maintenance Manual files[and [one][_____]] hard copy of the Operation and Maintenance Manuals]. Submit to the Contracting Officer for approval within [30][_____] calendar days of the Beneficial Occupancy Date (BOD). Update and resubmit files for final approval at BOD.

3.8 CLEANUP

****
NOTE: Parts of this paragraph are tailored for the NAVY only.
****

Provide final cleaning in accordance with ASTM E1971 and submit [two] [four] [_____] copies of the listing of completed final clean-up items. Leave premises "broom clean." Comply with GS-37 for general purpose cleaning and bathroom cleaning. Use only nonhazardous cleaning materials, including natural cleaning materials, in the final cleanup. Clean interior and exterior glass surfaces exposed to view; remove temporary labels, stains and foreign substances; polish transparent and glossy surfaces; vacuum carpeted and soft surfaces. Clean equipment and fixtures to a sanitary condition. [Clean][Replace] filters of operating equipment and comply with the Indoor Air Quality (IAQ) Management Plan. Clean debris from roofs, gutters, downspouts and drainage systems. Sweep paved areas and rake clean landscaped areas. Remove waste and surplus materials, rubbish and construction facilities from the site. Recycle, salvage, and return construction and demolition waste from project in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, and 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

[3.8.1 Extraordinary Cleanup Requirements

****
NOTE: Do not add information related to facility regulations which are of a routine nature. Include unusual cleanup requirements.
****

The following cleanup requirements apply: [_____].

]3.9 REAL PROPERTY RECORD

****
NOTE: All DoD projects require DD Form 1354 to be completed, made final, and submitted for entry into the applicable service database of real property. Complete procedural instructions for design and construction government forces are provided at the checklist URL below.
****

****
NOTE: Modify paragraph below if Command requires the activity contracting office to complete the form instead of the Contractor.
****

Refer to UFC 1-300-08 for instruction on completing the DD FORM 1354. Contact the Contracting Officer for any project specific information necessary to complete the DD FORM 1354.

3.9.1 Interim DD FORM 1354

Near the completion of Project, but a minimum of 60 days prior to final acceptance of the work, complete[, update draft DD FORM 1354,] and submit an accounting of all installed property with Interim DD FORM 1354. Include any additional assets, improvements, and alterations from the Draft DD FORM 1354.

3.9.2 Completed DD FORM 1354

****

NOTE: Separate lists of installed building equipment (IBE) (real property) and equipment in place (EIP) (personal property) may be attached to the DD Form 1354 in accordance with Service guidance.

****

[Attach the Real Property receiving Component's completed High Performance and Sustainable Building (HPSB) Checklist for each applicable building to the completed DD 1354, in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.]For convenience, a blank fillable PDF DD FORM 1354 may be obtained at the following link: www.esd.whs.mil/Portals/54/Documents/DD/forms/dd/dd1354.pdf

Submit the completed List of Installed Building Equipment items for DD FORM 1354. Attach this list to the updated DD FORM 1354.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-01 78 23 (May 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 78 23 (August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

05/23

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-01 78 23 (May 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-01 78 23 (August 2015)

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****

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA
05/23

****

NOTE: This guide specification covers the requirements for Operation and Maintenance (O&M) data packages, manuals and training.

In addition to this Section, use Section 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW) on projects at Marine Corps Installations and at Navy Installations, Joint Bases, Department of Defense (DoD) Agencies, or Field Activities where NAVFAC PW is the maintenance provider of the facility for:

1. New Construction Projects greater than or equal to $1 Million.

2. Major Renovation projects greater than or equal to 50 percent of the Plant Replacement Value (PRV).

For other projects below the threshold, consult the Administering Public Works Facilities Management Division (FMD) to determine if Section 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW) is required.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This specification contains tailoring for NAVY, ARMY, COMMISSIONING AUTHORITY, NAVY DESIGN-BUILD, NAVFAC EURAFCENT, AND NAVFAC FE.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE GUIDELINE 1.4	(2019) Preparing Systems Manuals for Facilities

ASTM INTERNATIONAL (ASTM)

ASTM E1971	(2024) Standard Guide for Stewardship for the Cleaning of Commercial and Institutional Buildings
ASTM E2166	(2016; R 2023) Standard Practice for Organizing and Managing Building Data

U.S. DEPARTMENT OF DEFENSE (DOD)

FC 1-300-09N	(2024) Navy and Marine Corps Design

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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NOTE: For Navy Design-Build projects, delete 01 33 00, SUBMITTAL PROCEDURES, and replace with SECTION 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and SECTION 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: In SD-10 Operation and Maintenance Data, use the bracketed item for Facility Data Workbook only if SECTION 01 78 24.00 10 FACILITY DATA REQUIREMENTS or SECTION 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW) are not used in the project. When one of these Sections is included, the Facility Data Workbook is included as a submittal in the Section used and will not be used in this Section.

****

SD-10 Operation and Maintenance Data

[Facility Data Workbook; G, [_____]

] Training Plan; G, [_____]

Training Outline; G, [_____]

Training Content; G, [_____]

Operation And Maintenance Manual, Progress Submittal; G, [_____]

Operation And Maintenance Manual, Prefinal Submittal; G, [_____]

Operation And Maintenance Manual, Final Submittal; G, [_____]

SD-11 Closeout Submittals

Training Video Recording; G, [_____]

Validation of Training Completion; G, [_____]

Training Plan; G, [_____]

Record Drawings And Utility Systems; G, [_____]

1.3 MEETINGS

To assure that Operation and Maintenance Manual and Facility Data Workbook requirements are being met through the duration of the project, organize the following meetings and discuss the subsequent topics:

1.3.1 [Post-Award Kickoff Meeting] [Pre-Construction Meeting]

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NOTE: Use Post-Award Kickoff Meeting for Design-Build Projects, or use Pre-Construction Meeting for Design-Bid-Build Projects.

****

At a minimum, discuss the following:

a. The requirement for Operation and Maintenance Manuals and Facility Data deliverables under this contract including coordination meetings

b. Processes and method of gathering Facility Data information during construction

c. Primary roles and responsibilities associated with the development and delivery of the Operation and Maintenance Manuals and Facility Data deliverables, and

d. Identify and agree upon a date and attendance list for the meetings described below:

1.3.2 Operation and Maintenance Manual and Facility Data Workbook Coordination Meeting

Facilitate a meeting after the [Pre-Construction Meeting] [Post-Award

Kickoff Meeting] prior to the submission of the Operation and Maintenance Manual Progress Submittal. Meeting attendance must include the Contractor's Operation and Maintenance Manual and Facility Data Workbook Preparer, [Designer of Record (DOR),]Quality Control Manager, [the Commissioning Authority (CxA),]the Government's Design Manager (DM), Contracting Officer's Representative, and Government's facility data reviewer. Include any Mechanical, Electrical, and Fire Protection Sub-Contractors.

The purpose of this meeting is to reach a mutual understanding of the scope of work concerning the contract requirements for Operation and Maintenance Manual and coordinate the efforts necessary by both the Government and Contractor to ensure an accurate collection, preparation and timely Government review of Operation and Maintenance Manual.

1.3.3 Submittal Coordination Meeting

Facilitate a meeting following submission and Government review of each design or progress submittal of the Operation and Maintenance Manual and Facility Data Workbook.

a. Include personnel from the Coordination meeting and any additional personnel identified.

b. The purpose of this meeting is to demonstrate ongoing compliance with the requirements identified in this specification. Discuss Government review comments and unresolved items preventing completion and Government approval of the Operation and Maintenance Manuals and Facility Data Workbook (FDW).

c. The applicable deliverables, along with Government remarks associated with review of these submittals serve as the primary guide and agenda for this meeting.

1.3.4 Facility Turnover Meeting

Include Operation and Maintenance Manual in NAVFAC Red Zone (NRZ) facility turnover meetings as specified in Section 01 30 00, ADMINISTRATIVE REQUIREMENTS.

1.4 FACILITY DATA WORKBOOK

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NOTE: In this paragraph, choose the first set of brackets if Section 01 78 24.00 10 FACILITY DATA REQUIREMENTS for Army projects or 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW) for Navy projects is in contract. Otherwise, choose the second bracketed sentence.

****

Develop an editable, electronic spreadsheet based on the equipment in the Operation and Maintenance Manuals that contains the information required to start a preventive maintenance program[as outlined in [01 78 24.00 10 FACILITY DATA REQUIREMENTS][01 78 24.00 20 FACILITY DATA WORKBOOK (FDW)]].[As a minimum, provide Facility Data Workbook as a list of system equipment, location installed, warranty expiration date, manufacturer, model, and serial number.]

1.5 OPERATION AND MAINTENANCE MANUAL MEDIA

Assemble Operation and Maintenance Manual into an electronically bookmarked file using the most current version of Adobe Acrobat or similar software capable of producing PDF file format. Provide compact disks (CD) or data digital versatile disk (DVD) as appropriate, so that each one contains operation, maintenance and record files, project record documents, and training videos. Include a complete bookmarked operation and maintenance directory.

1.5.1 CD or DVD Label and Disk Holder or Case

Provide the following information on the disk label and disk holder or case:

a. Building Number

b. Project Title

c. Activity and Location

d. Construction Contract Number

e. Prepared For: (Contracting Agency)

f. Prepared By: (Name, title, phone number and email address)

g. Include the disk content on the disk label

h. Date

i. Virus scanning program used

[1.5.2 O&M Manual Tabbed Hard Copy

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NOTE: Use this paragraph only if a hard copy is required.

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Provide a hard copy of the O&M manual upon completion of the project. Provide tabs for each section and subsection for ease of navigation by the user.

]1.6 O&M MANUAL CONTENT

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NOTE: See Operation and Maintenance Manual template located at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-78-23.

****

Organize the bookmarked Operation and Maintenance Manual into the following Parts in accordance with ASHRAE GUIDELINE 1.4, and as modified and detailed below. Word template for O&M Manual is available at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-78-23.

1.6.1 Part 1: Executive Summary

Provide a summary of the information found in the O&M manual including the purpose of the manual and a description of the manual's organization.

1.6.2 Part 2: Facility Design and Construction

1.6.2.1 General Facility and Systems Description

Provide an overview of the intent for design and use of the facility. Provide a PDF of the Record Drawings prepared in accordance with [FC 1-300-09N and] 01 78 00 CLOSEOUT SUBMITTALS and bookmarked using the sheet title and sheet number. Include uncluttered 28 by 43 mm 11 by 17 inches floor plans with room numbers, type or function of space, and overall facility dimensions on the floor plans. Do not include items such as construction instructions, references, or frame numbers.

Detail the overall dimensions of the facility, number of floors, foundation type, expected number of occupants, and facility Category Code list and generally describe all the facility systems and any special building features (for example, HVAC Controls, Sprinkler Systems, Cranes, Elevators, and Generators). Include photographs marked up and labeled to show key operating components and the overall facility appearance.

1.6.2.2 Basis of Design

Provide a copy of the contract Basis of Design.

1.6.2.3 Contract Documents, RFP, Amendments, and Modifications

Provide the contract construction documents complete, to include specifications, drawings, Request for Proposal, amendments, and modifications.

1.6.2.4 Room Inventory of Real Property and Finishes

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NOTE: This paragraph is intended to provide data on equipment and materials incorporated in the construction of the project that cannot readily be determined after completion of construction. The data is expected to be of value for future maintenance, alteration, and repair work.

****

Provide a list of installed equipment furnished under this contract. Include all information usually listed on manufacturer's name plate. Include, as applicable, the following information for each piece of equipment installed: description of item, all dimensions, location by room number, model number, serial number, capacity, name and address of manufacturer, name and address of equipment supplier, condition, spare parts list, manufacturer's catalog, and warranty. Real property includes, but is not limited to, floor coverings, wall surfaces, ceiling surfaces, windows, roofing, HVAC filters, plumbing fixtures, and lighting fixtures. Submit the final list [30] [_____] days after transfer of the completed facility.

Include spatial data defining actual net square meters square footage and data of each room. Also include the room finish schedule including room names and numbers. Include schedules in the construction drawings in the room inventory. Add a column to each schedule to record what was provided by the contractor during construction. Provide a PDF of room inventory. Key the designations to the related area depicted on the contract drawings. List the following data:

RECORD OF DESIGNATED EQUIPMENT AND MATERIALS DATA				
Description	Specification Section	Manufacturer and Catalog, Model, and Serial Number	Composition and Size	Where Used
[_____]				

1.6.3 Part 3: Facilities, Systems, and Assemblies Information

1.6.3.1 Organization

Bookmark information in this section using the current version of ASTM E2166 Uniformat II, UFGS numbers, and document type as outlined in the example below. Bookmark/tab each item to the third level for easy navigation of the manual.

Example as shown in Table below:

PARTS AND SUBPART NUMBERING
3.1 B20 EXTERIOR CLOSURE (System)
3.1.1 B2030 EXTERIOR DOORS (Subsystem)
3.1.1.1 B2030110 GLAZED DOORS (Component)
3.1.1.1.1 Applicable specifications List in UFGS Format
3.1.1.1.2 Manufacturer's Operations and Maintenance Data
3.1.1.1.3 Approved Submittal
3.1.1.1.4 Coordination/Shop Drawings
3.1.1.1.5 Sequence of Operation for Operating Equipment
3.1.1.1.6 Testing Equipment Information and Performance Data
3.1.1.1.7 Routine Maintenance Requirements
3.1.1.1.8 Repair Procedures
3.1.1.1.9 Emergency Procedures & Locations of Applicable Controls
3.1.1.1.10 Warranties
3.1.1.1.11 Record Drawings and Utility Systems

PARTS AND SUBPART NUMBERING
3.1.1.1.12 Contractor / Supplies Listing and Contact Information

1.6.3.2   Related Specifications

Reference each specification related to the subsystem in this section, and locate the actual specification section in Part 2 of the O&M Manual. List specifications in table format as shown in the below example.

UFGS Number	Specification Title	Page Spec Begins in Part 2

1.6.3.3   Manufacturer's Operations and Maintenance Data

Provide a copy of all manufacturer specifications and cutsheets. Provide text-searchable, high-quality document files from the manufacturer's online or electronic documentation. Color documents are preferred. Provide documents specific to the product(s) installed under this Contract. Provide identification and coverage for the parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Provide Uniformat II Level 3 identification for D20, D30, D40 installed equipment. When possible, do not submit document files containing multiple product catalogs from the same manufacturer, or product data from multiple manufacturers in the same files. Provide documents directly from the manufacturer whenever possible. Do not provide scanned copies of hardcopy documents. Provide identification and coverage for the parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing must show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Group the parts shown in the listings by components, assemblies, and subassemblies in accordance with the manufacturer's standard practice. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as typically shown in a master part catalog.

1.6.3.4   Approved Submittals and Certificates

Provide a copy of all submittals documented with the required approval as applicable for each UFGS specification listed in the table outlined in applicable specifications. Include copies of SD-07 Certificates submittals documented with the required approval, SD-08 Manufacturer's Instructions submittals documented with the required approval, and SD-10 Operation and Maintenance Data submittals documents with the required approval.

1.6.3.5 Approved Coordination/Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work. Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project. Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

1.6.4 Sequence of Operation for Operating Equipment

Provide record one-line diagrams for each floor, delineating mechanical equipment location within the building. Provide specific instructions, procedures, and illustrations for the following phases of operation for the installed model and features of each system:

1.6.4.1 Safety Precautions and Hazards

List personnel hazards and equipment or product safety precautions for operating conditions. List all residual hazards identified in the Activity Hazard Analysis provided under Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. Provide recommended safeguards for each identified hazard. Specify if any certifications or licenses are required to operate the equipment.

1.6.4.2 Operator Prestart

Provide procedures required to install, set up, and prepare each system for use.

1.6.4.3 Startup, Shutdown, and Post-Shutdown Procedures

Provide narrative description for Startup, Shutdown and Post-shutdown operating procedures including the control sequence for each procedure.

1.6.4.4 Normal Operations

Provide Control Diagrams with data to explain operation and control of systems and specific equipment. Provide narrative description of Normal Operating Procedures.

1.6.4.5 Emergency Operations

Provide Emergency Procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Provide Emergency Shutdown Instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance and procedures for emergency operation of utility systems including required valve positions, valve locations and zones or portions of systems controlled.

1.6.4.6 Operator Service Requirements

Provide instructions for services to be performed by the operator such as lubrication, adjustment, inspection, and recording gauge readings.

1.6.4.7 Environmental Conditions

Provide a list of Environmental Conditions (temperature, humidity, and other relevant data) that are best suited for the operation of each product, component or system. Describe conditions under which the item equipment should not be allowed to run.

1.6.4.8 Operating Log

Provide forms, sample logs, and instructions for maintaining necessary operating records.

1.6.4.9 Additional Requirements for Equipment Control Systems

Provide Data Package 5 and the following for all control systems:

a. Provide a narrative description on how to perform and apply functions, features, modes, and other operations, including unoccupied operation, seasonal changeover, manual operation, and alarms. Include detailed technical manual for programming and customizing control loops and algorithms.

b. Submit complete controls equipment schedules, full as-built sequence of operations, wiring and logic diagrams, Input/Output Tables, equipment schedules, copies of checkout tests and calibrations performed by the Contractor (not Cx tests), and all associates information.

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NOTE: Include the following items c through f below, depending on the project scope.

Make sure these are consistent with Operation and Maintenance Manual.

****

c. Full points list. Provide a listing of rooms with the following information for each room:

  (1) Floor

  (2) Room number

  (3) Room name

  (4) Air handler unit ID

  (5) Reference drawing number

  (6) Air terminal unit tag ID

  (7) Heating or cooling valve tag ID

  (8) Minimum cfm

  (9) Maximum cfm

d. Full print out of all schedules and set points after testing and acceptance of the system.

e. Full as-built print out of software program.

f. Marking of system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

1.6.4.10 Testing Equipment Information and Performance Data

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components. Provide final set points.

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms. Provide final set points.

1.6.5 Routine Maintenance Requirements

1.6.5.1 Preventive Maintenance Plan, Schedule, and Procedures

Provide manufacturer's schedule for routine preventive maintenance, inspections, condition monitoring (predictive tests) and adjustments required to ensure proper and economical operation and to minimize repairs. Provide instructions stating when the systems should be retested. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including requirements by type of activity. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

a. Define the anticipated time required to perform each test (work-hours), test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements within the schedule. Provide a remarks column for the testing validation procedure referencing operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Delineate procedures for preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize repairs.

b. Repair requirements must inform operators how to check out, troubleshoot, repair, and replace components of the system. Include electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting of the system after acceptance.

1.6.5.2 Lubrication Data

Include the following preventive maintenance lubrication data, in addition to instructions for lubrication required under paragraph OPERATOR SERVICE REQUIREMENTS:

a. A table showing recommended lubricants for specific temperature ranges and applications.

b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities. Provide procedural instructions for Oil Sampling for all equipment.

c. A Lubrication Schedule showing service interval frequency.

1.6.6 Repair Procedures

Provide instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards. Provide manufacturer's recommended procedures and instructions for correcting problems and making repairs for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials. Specify if any certifications or licenses are required to repair the equipment.

1.6.6.1 Troubleshooting Guides and Diagnostic Techniques

Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

1.6.6.2 Wiring Diagrams and Control Diagrams

Provide point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation configuration and numbering.

1.6.6.3 Removal and Replacement Instructions

Provide step-by-step procedures and a list of required specialty tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Use a combination of text and illustrations.

1.6.6.4 Repair Work-Hours

Provide manufacturer's projection of repair work-hours including requirements by type of craft. Identify, and tabulate separately, repair that requires the equipment manufacturer to complete or to participate.

1.6.6.5 Warranty Information

List and explain the various warranties and clearly identify the servicing and technical precautions prescribed by the manufacturers or contract documents in order to keep warranties in force. Identify if replacement of a subassembly, attachment or accessory requires the entire assembly to be replaced. Include warranty information for primary components of the system. Provide copies of warranties required by Section 01 78 00 CLOSEOUT SUBMITTALS.

1.6.6.6 Extended Warranty Information

List all warranties for products, equipment, components, and sub-components whose duration exceeds one year. For each warranty listed, indicate the applicable specification section, duration, start date, end date, and the point of contact for warranty fulfillment. Also, list or reference the specific operation and maintenance procedures that must be performed to keep the warranty valid. Provide copies of warranties required by Section 01 78 00 CLOSEOUT SUBMITTALS.

1.6.6.7 Record Drawings and Utility Systems

The record drawings are the final compilation of actual conditions reflected in the as-built drawings. Provide record drawings as outlined in 01 78 00 CLOSEOUT SUBMITTALS.

Using Record Source Drawings, show and document details of the actual installation of the utility systems, annotate and highlight the Operation and Maintenance information. Provide the following drawings at a large enough scale to differentiate designated isolation units from surrounding valves and switches.

1.6.6.8 Personnel Training Requirements

Provide information available from the manufacturers that is needed for use in training designated personnel to properly operate and maintain the equipment and systems.

1.6.6.9 Contractor / Supplier Listing and Contact Information

Provide a list that includes the name, address, telephone number, email and website of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name address and telephone number of the manufacturer's representative and service organization that can provide replacements most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

1.6.7 Part 4: Facility Operations

1.6.7.1 Completed Facility Operating Plan

Provide a plan that documents that procedures for the operation of systems and assemblies in the facility. The systems that should be included in the Operating Plan include, but are not limited to:

a. Electrical systems and equipment

b. Mechanical systems and equipment

c. Fire Protection systems and equipment

d. Control Systems and equipment

e. Architectural and Structural systems, fixtures, structures, and equipment

f. Vertical transportation such as elevators and escalators

1.6.7.2 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components. Provide final set points.

1.6.7.3 Testing and Performance Data

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms. Provide final set points.

1.6.7.4 Approved Field Test Reports and Manufacturer's Field Reports

Compile and provide approved Field Test Reports (SD-06) and Manufacturer's Field Reports (SD-09) submittals.

1.6.7.5 Maintenance Plans, Procedures, Checklists, Records, and Spare Parts Inventory

1.6.7.5.1 Maintenance Schedules

Include recommended maintenance schedules for systems and equipment.

1.6.7.5.2 Ongoing Commissioning Operational and Maintenance Record Keeping

Include ongoing commissioning and optimization procedures and documentation to monitor and improve the performance of facility systems.

1.6.7.5.3 Janitorial and Cleaning Plans and Procedures

Include a copy of facility cleaning and janitorial plan with procedures and intended chemicals and equipment.

Provide environmentally friendly cleaning recommendations in accordance with ASTM E1971.

1.6.7.6 Utility Record Drawings

1.6.7.6.1 Utility Schematic Diagrams

Provide a one-line schematic diagram for each utility system such as power, water, wastewater, and gas/fuel. Schematic diagram must show from the point where the utility line is connected to the mainline up to the 1.5 meter 5 foot connection point to the facility. Indicate location or area designation for route of transmission or distribution lines; locations of duct banks, manholes/handholes or poles; isolation units such as valves and switches; and utility facilities such as pump stations, lift stations, and substations.

1.6.7.6.2 Enlarged Connection and Cutoff Plans

Provide enlarged floor plans and provide information between the 1.5 meter 5 foot utilities connection point and where utilities connect to facility distribution. Enlarge floor plans/elevations of the rooms where the utility enters the building and indicate on these plans the locations of the main interiors and exterior connection and cutoff points for the utilities. Also enlarge floor plans/elevations of the rooms where equipment is located. Include enough information to enable someone unfamiliar with the facility to locate the connection and cutoff points. Indicate designations such as room number, panel number, circuit breaker, or valve number of each utility and equipment connection and cutoff point, and what that connection and cutoff point controls.

1.6.7.6.2.1 Description of Utility Metering and Monitoring Systems

Provide in narrative format a description of the utility metering and monitoring systems. Include locations, function, and related systems.

1.6.7.6.2.2 Procedures for Tracking Utility Use and Reporting

Procedures for usage reporting and tracking in support of establishing and monitoring utility budgets and costs, and in developing annual energy reports.

1.6.7.6.2.3 One-Line Diagrams and Meter Location of System

Provide one-line diagrams and design drawings that highlight meter locations on the site.

1.6.7.6.3 Spare Parts and Supply Lists

Provide lists of spare parts and supplies required for repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead-time to obtain.

1.6.8 Part 5: Training

Provide a copy of training plans used for each type of equipment along with training materials used, arranged in specification sequence. Provide a copy of training records, sign-in sheets, and agendas. Include training and documentation on the updating and continued use of the O&M Manual.

1.6.9 Part 6: Cx Project Report and TAB Report

Provide the final Cx Plan and complete Cx reports with evaluation and testing forms and records for each building system. Include relevant commissioned system assemblies test reports including installers checklists of assemblies. Provide all Cx Progress Reports, issues and resolutions logs with resolution or status of each item, and a list of any open items and seasonal or additional testing required.

1.6.10 Part 7: Regulatory Requirements

Provide information describing regulatory and policies compliance requirements or provide a reference to where it is stored.

1.6.11 Part 8: Permits

Provide information requiring frequently asked questions and associated answers or provide a reference to where it is stored.

1.6.12 Part 9: Operations and Maintenance Manual Approval

Provide a signed document stating that the project O&M Manual has been reviewed and confirming agreement with the approach it presents. Include contact information for the signer for coordination of any future changes.

1.7 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

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NOTE: The type of O&M data needed for any product,

system, or piece of equipment depends upon the complexity of that item. If not, specify the appropriate Data Package number in the technical section using the Data Package Number from the choices 1 through 5 below.

Data Package 1 is typically used for architectural items requiring simple but specific maintenance and replacement; for example, acoustical ceiling, floor tile or carpeting system.

Data Package 2 is used for an item that is less simple; for example, an item having a motor and some sequence of operation such as a refrigerated drinking fountain.

Data Package 3 is used for a complex piece of equipment, having a specific troubleshooting sequence, but one which does not require an operator on watch; for example, HVAC temperature controls.

Data Package 4 is used for an extremely complex piece of equipment, having an extensive sequence of operation, a complex troubleshooting sequence and one requiring frequent operator attention; at least for start-up and shut-down. Examples include small boilers and small diesel generator sets.

Data Package 5 is used for electrical equipment, components or systems on which, wiring and control diagrams are needed for operation, maintenance or repair. Examples are 400 Hz frequency converters, annunciator panels and cathodic protection systems.

****

Provide the O&M data packages specified in individual technical sections. O&M Data Packages are one of the components of the O&M Manual. The information required in each type of data package follows:

1.7.1 Package Quality

Documents must be fully legible. Operation and Maintenance data must be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions.

1.7.2 Data Package 1

a. Safety precautions and hazards

b. Cleaning recommendations

c. Maintenance and repair procedures

d. Warranty information

e. Extended warranty information

f. Contractor information

g. Spare parts and supply list

1.7.3 Data Package 2

a. Safety precautions and hazards

b. Normal operations

c. Environmental conditions

d. Lubrication data

e. Preventive maintenance plan, schedule, and procedures

f. Cleaning recommendations

g. Maintenance and repair procedures

h. Removal and replacement instructions

i. Spare parts and supply list

j. Parts identification

k. Warranty information

l. Extended warranty information

m. Contractor information

1.7.4 Data Package 3

a. Safety precautions and hazards

b. Operator prestart

c. Startup, shutdown, and post-shutdown procedures

d. Normal operations

e. Emergency operations

f. Environmental conditions

g. Operating log

h. Lubrication data

i. Preventive maintenance plan, schedule, and procedures

j. Cleaning recommendations

k. Troubleshooting guides and diagnostic techniques

l. Wiring diagrams and control diagrams

m. Maintenance and repair procedures

n. Removal and replacement instructions

o. Spare parts and supply list

p. Product submittal data

q. O&M submittal data

r. Parts identification

s. Warranty information

t. Extended warranty information

u. Testing equipment and special tool information

v. Testing and performance data

w. Contractor information

x. Field test reports

1.7.5 Data Package 4

a. Safety precautions and hazards

b. Operator prestart

c. Startup, shutdown, and post-shutdown procedures

d. Normal operations

e. Emergency operations

f. Operator service requirements

g. Environmental conditions

h. Operating log

i. Lubrication data

j. Preventive maintenance plan, schedule, and procedures

k. Cleaning recommendations

l. Troubleshooting guides and diagnostic techniques

m. Wiring diagrams and control diagrams

n. Repair procedures

o. Removal and replacement instructions

p. Spare parts and supply list

q. Repair work-hours

r. Product submittal data

s. O&M submittal data
t. Parts identification
u. Warranty information
v. Extended warranty information
w. Personnel training requirements
x. Testing equipment and special tool information
y. Testing and performance data
z. Contractor information
aa. Field test reports

1.7.6 Data Package 5

a. Safety precautions and hazards
b. Operator prestart
c. Start-up, shutdown, and post-shutdown procedures
d. Normal operations
e. Environmental conditions
f. Preventive maintenance plan, schedule, and procedures
g. Troubleshooting guides and diagnostic techniques
h. Wiring and control diagrams
i. Maintenance and repair procedures
j. Removal and replacement instructions
k. Spare parts and supply list
l. Product submittal data
m. Manufacturer's instructions
n. O&M submittal data
o. Parts identification
p. Testing equipment and special tool information
q. Warranty information
r. Extended warranty information
s. Testing and performance data
t. Contractor information

u. Field test reports

[v. Additional requirements for HVAC control systems

]1.7.7 Changes to Submittals

Provide manufacturer-originated changes or revisions to submitted data if a component of an item is so affected subsequent to acceptance of the O&M Data. Submit changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data within 30 calendar days of the notification of this change requirement.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 TRAINING

****

NOTE: Use tailored option for Facility Management Specialist for Navy projects only.

****

Prior to acceptance of the facility by the Contracting Officer for Beneficial Occupancy, provide comprehensive training for the systems and equipment specified in the technical specifications. The training must be targeted for the Facilities Management Specialist, building maintenance personnel, and applicable building occupants. Instructors must be well-versed in the particular systems that they are presenting. Address aspects of the Operation and Maintenance Manual submitted in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS. Training must include classroom or field lectures based on the system operating requirements. The location of classroom training requires approval by the Contracting Officer.

3.1.1 Training Plan

****

NOTE: This paragraph contains tailoring for COMMISSIONING AUTHORITY.

Choose the COMMISSIONING AUTHORITY tailoring option (CxA) to oversee and approve the training plan if the project requires a CxA. If a CxA is not required, choose the bracketed option for the QC to oversee and approve the training plan and schedule.

****

Submit a written training plan to the Contracting Officer for approval at least 60 calendar days prior to the scheduled training. Training plan must be approved by the [Quality Control Manager (QC)][Commissioning Authority (CxA)] prior to forwarding to the Contracting Officer. Also, coordinate the training schedule with the Contracting Officer and [QC][CxA]. Include within the plan the following elements:

a. Equipment included in training

b. Intended audience

c. Location of training

d. Dates of training

e. Objectives

f. Outline of the information to be presented and subjects covered including description

g. Start and finish times and duration of training on each subject

h. Methods (e.g. classroom lecture, video, site walk-through, actual operational demonstrations, written handouts)

i. Instructor names and instructor qualifications for each subject

j. List of texts and other materials to be furnished by the Contractor that are required to support training

k. Description of proposed software to be used for video recording of training sessions.

3.1.2 Training Content

****

NOTE: In the second sentence, choose the CxA (Commissioning Authority) bracketed option to oversee and approve the training content if the project requires a CxA. Otherwise, choose the QC bracketed option for the QC to oversee and approve the training content.

****

The core of this training must be based on manufacturer's recommendations and the operation and maintenance information. The [QC][CxA] is responsible for overseeing and approving the content and adequacy of the training. Spend 95 percent of the instruction time during the presentation on the OPERATION AND MAINTENANCE DATA. Include the following for each system training presentation:

a. Start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming, troubleshooting, and alarms.

b. Relevant health and safety issues.

c. Discussion of how the feature or system is environmentally responsive. Advise adjustments and optimizing methods for energy conservation.

d. Design intent.

e. Use of O&M Manual Files.

f. Review of control drawings and schematics.

g. Interactions with other systems.

h. Special maintenance and replacement sources.

i. Tenant interaction issues.

3.1.3 Training Outline

Provide the Operation and Maintenance Manual Files (Bookmarked PDF) and a written course outline listing the major and minor topics to be discussed by the instructor on each day of the course to each trainee in the course. Provide the course outline 14 calendar days prior to the training.

3.1.4 Training Video Recording

Record classroom training session(s) on video. Provide to the Contracting Officer two copies of the training session(s) in DVD video recording format. Capture within the recording, in video and audio, the instructors' training presentations including question and answer periods with the attendees. The recording camera(s) must be attended by a person during the recording sessions to assure proper size of exhibits and projections during the recording are visible and readable when viewed as training.

3.1.5 Unresolved Questions from Attendees

If, at the end of the training course, there are questions from attendees that remain unresolved, the instructor must send the answers, in writing, to the Contracting Officer for transmittal to the attendees, and the training video must be modified to include the appropriate clarifications.

3.1.6 Validation of Training Completion

Ensure that each attendee at each training session signs a class roster daily to confirm Government participation in the training. At the completion of training, submit a signed validation letter that includes a sample record of training for reporting what systems were included in the training, who provided the training, when and where the training was performed, and copies of the signed class rosters. Provide two copies of the validation to the Contracting Officer, and one copy to the Operation and Maintenance Manual Preparer for inclusion into the Manual's documentation.

3.1.7 Quality Control Coordination

****

NOTE: This paragraph contains tailoring for COMMISSIONING AUTHORITY.

Choose the COMMISSIONING AUTHORITY tailoring option (CxA) for QC coordination if the project requires a CxA. If a CxA is not required, choose the bracketed option for the QC to approve the training content.

****

Coordinate this training with the [QC][CxA] in accordance with Section 01 45 00 QUALITY CONTROL.

3.2 SUBMITTAL SCHEDULING

3.2.1 Operation and Maintenance Manual, Progress Submittal

Submit the Progress submittal when construction is approximately 50 percent complete, to the Contracting Officer for approval. Provide Operation and Maintenance Manual Files (Bookmarked PDF). Include the elements and portions of system construction completed up to this point. The purpose of this submittal is to verify progress is in accordance with contract requirements as discussed during the Operation and Maintenance Manual Coordination Meeting.

3.2.2 Operation and Maintenance Manual, Prefinal Submittal

****

NOTE: Choose the bracketed option of submission of the Prefinal submittal 90 calendar days prior to BOD for MILCON and Special Projects. Choose 60 calendar days prior to BOD for renovations or repairs, or provide a timeframe practical to the project duration for smaller projects.

****

Submit the 100 percent submittal of the Operation and Maintenance Prefinal Submittal to the Contracting Officer for approval within [90] [60] [_____] calendar days of the Beneficial Occupancy Date (BOD). This submittal must provide a complete, working document that can be used to operate and maintain the facility. Any portion of the submittal that is incomplete or inaccurate requires the entire submittal to be returned for correction. Any discrepancies discovered during the Government's review of Operation and Maintenance Progress submittal must be corrected prior to the Prefinal submission. The Prefinal Submittal must include Operation and Maintenance Manual Files (Bookmarked PDF).

3.2.3 Operation and Maintenance Manual, Final Submittal

****

NOTE: In the first sentence, option for hard copies is tailored for ARMY.

****

Submit completed Operation and Maintenance Manual Files (Bookmarked PDF)[and [one][_____] hard copy of the Operation and Maintenance Manuals]. The Final submittal is due at BOD. Any discrepancies discovered during the Government's review of the Prefinal submittal, including the Field Verification, must be corrected prior to the Final submission.

3.2.4 Final Operation and Maintenance Manual Submittal Translation

****

NOTE: This paragraph is tailored for NAVFAC FE and NAVFAC EURAFCENT. For OCONUS locations, choose the appropriate foreign language that will be used based on the location of the project. If a foreign translation is not required, delete this bracketed paragraph.

****

Provide a translation in [Italian] [Spanish] [Portuguese] [Greek]

[Japanese] [_____] of the Operation and Maintenance Manual in electronic format. Provide drawings, charts and tables in both English and the foreign language. If required by Contracting Officer, provide a split format showing the foreign language on the left and English translation on the right.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 78 23.33 (August 2018)**
Change 1 - 02/21

Preparing Activity: USACE **Superseding**
UFGS-01 78 23.33 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 78 23.33

OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS

08/18, CHG 1: 02/21

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-01 78 23.33 (August 2018)**
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References are in agreement with UMRL dated January 2025

****

SECTION 01 78 23.33

OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS

08/18, CHG 1: 02/21

****

NOTE: This guide specification covers the requirements for O&M Manuals for Aircraft Refueling systems constructed to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards**.**

The project containing this Section does not necessarily require the inclusion of UFGS 01 78 00 CLOSEOUT SUBMITTALS or UFGS 01 78 23 OPERATION AND MAINTENANCE DATA.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. DEFENSE LOGISTICS AGENCY (DLA)

DLA J4 Handbook	(Part IV) Federal Supply Class Assignments (Numeric and Alphabetic Listing) (http://www.dla.mil/)

1.2 CONTRACTOR RESPONSIBILITY

The Contractor is responsible for providing the technical publications specified herein for all of the components, assemblies, sub-assemblies, attachments, and accessories, required to be supplied in accordance with submittal requirements of each specification section, regardless of whether the item was manufactured and assembled in-house or obtained from other sources. The System Supplier is responsible to the Contractor for providing the technical publications specified herein for all of the components, assemblies, sub-assemblies, attachments, and accessories that the System Supplier provided.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-10 Operation and Maintenance Data

System Instructions; G, [_____]

PART 2 PRODUCTS

2.1 DEVELOPMENT OF SUBMITTALS

2.1.1 Operation and Maintenance System Instructions (OMSI) Submittal Requirements

OMSI submittals are required in order that complete documentation can be assembled to provide the Government "Activity" with the necessary information and orientation to adequately operate and maintain the new structures/facilities of this project. Submit the OMSI documents and information specified for the equipment listed under the OMSI submittal paragraphs in each technical section. Provide copies of each Electronic Operation and Maintenance Support Information (e-OMSI) submittal to the Contracting Officer no later than 120-days prior to contract completion. In addition to requirements of this section, see Section [01 78 24.00 10 FACILITY DATA REQUIREMENTS][01 78 23 OPERATION AND MAINTENANCE DATA] for additional requirements on assembly of operation and maintenance data. OMSI submittals are to be submitted separate from and in addition to Contractor's product approval submittals.

2.1.2 Assembly

Provide submittals in separate folders consistent with the Contractor's standard practice. For hard copy manufacturer's manuals or data for the components, assemblies, subassemblies, and other operating parts which are provided must be assembled into a loose-leaf notebook-type folder, indexed by major assembly and component in sequential order. Manuals must be complete in all respects for all equipment, controls, and accessories provided. In addition, provide an electronic copy of the manuals in Adobe Acrobat 11.0 or later (CD-ROM or DVD-ROM). Utilize Bookmarks to display indexing, and assembly and component requirements.

2.2 IDENTIFICATION

On each folder identify and mark as follows:

a. Inscribe on the cover, the words, "FUEL SYSTEM OPERATION AND MAINTENANCE MANUAL", the name and location of the building, and the contract number.

b. Equipment manufacturer and/or Contractor's address and telephone number; names, address and telephone numbers of each subcontractor installing equipment; and local representative for each item of equipment.

c. Volume number and title of the folder.

d. The manual must have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. Sub-divide manuals or provide separate manuals for each of the following categories.

    (1) Operating Instructions
    (2) Maintenance, Service, and Repair Instructions
    (3) Parts Manual

PART 3 EXECUTION

3.1 OPERATING INSTRUCTIONS

The operator's instructions must include specific instructions and illustrations of the equipment operation required or recommended by the manufacturer as follows:

3.1.1 Safety

Include manufacturer's safety precautions to be observed while operating under all conditions for which the equipment was designed. Clearly list all major hazards to personnel and equipment safety that are peculiar to systems and equipment described in the manual.

3.1.2 Operator Prestart

Include instructions for prestart checks, lubrication, and service requirements necessary for setting up or preparing each system for use, warm up procedures, and verification of normal operation. Include control diagrams with data to explain detailed operation and control of each item of the equipment.

3.1.3 Starting and Shutdown Procedures and Controls

Include a control sequence describing start up operation and provide shutdown procedures and post-shutdown requirements.

3.1.4 Normal Operating Instructions

Instructions must be sufficient to enable the mechanic to adjust, stop and start, and operate the equipment properly. Special startup precautions must be noted, as well as other items requiring action before the equipment may be put into service. Include detailed drawings indicating procedure and valve numbers and status as to normally open/closed.

3.1.5 Emergency Operating Procedures

Include action to be taken in the event of a malfunction of the unit, either to permit a short period of continued operation or to prevent further damage to the unit and to the system in which it is installed.

3.1.6 Operator Service Requirements

Include instructions for operator service requirements during operation of the equipment.

3.2 OPERATION INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors who will give full instruction to the designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment or system specified. Each instructor must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work. Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. A minimum of 1 man-day (8-hours) of instruction must be furnished for each system specified in other sections. When more than 4 man-days of instruction are specified, approximately half of the time must be used for classroom instruction. All other time must be used for instruction with the equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, additional instruction must be provided to acquaint the operating personnel with the changes or modifications. Government representatives must be allowed to video tape all classroom and field instructions.

3.3 MAINTENANCE, SERVICE AND REPAIR INSTRUCTIONS

The shop or maintenance manual must include manufacturer's instructions to maintain the equipment in a safe and serviceable condition. The maintenance or shop manual must contain all necessary instructions, illustrations, charges and diagrams covering, as a minimum, the items listed below.

3.3.1 Lubrication Instructions

a. Include a table showing recommended lubricants for specific temperature ranges and applications.

b. Include chart(s) with schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities. Provide a lubrication schedule showing service interval frequency.

3.3.2 Table of Preventative Maintenance Instructions

Include frequency in time, miles or hours covering routine servicing, lubrication, and adjustments.

3.3.3 Preventative Maintenance Inspection

Points and checklist should be clearly spelled out as part of operator-type inspection in this section. Include chart with schematic diagram and/or a separate inspection checklist indicating what should be examined for wear or possible malfunction and what should be reported for repair.

3.3.4 Troubleshooting Guides and Diagnostic Techniques

Provide step-by-step procedures to enable prompt isolation of the cause of a malfunction with corrective maintenance instructions. Instructions must clearly indicate why the check out is performed and what conditions are to be sought.

3.3.5 Removal and Replacement Instructions

Provide step-by-step procedures for removal, replacement, disassembly and assembly of all components, assemblies, sub-assemblies, accessories, and attachments normally subjected to wear, damage, malfunction, and frequent replacement. These instructions should provide for a judicious combination of text and illustrations.

3.3.6 Maintenance and Repair Procedure

****

NOTE: If the SME directs the designer to hydrostatically test the system to 1.5 times the design pressure, exceeding the flange rating, the designer is required to write the commissioning hydrostatic testing procedures; removing all ball valves, control valves, and instructing the testing people what valves to close, where to connect the hydrostatic test pump, blind flange placements, and other safety requirements. It should also be noted that this test is to be done every five years, as determined by the SME.

****

Provide instructions for tolerances, dimensions, settings, and adjustments normally required for performing routine maintenance servicing.

Instructions must provide the necessary information to bring equipment up to the required serviceable standard when it becomes unserviceable. Include instructions for examining equipment for needed repairs and adjustment, and any tests or inspections required to determine whether or not parts must be replaced.

3.4 PARTS MANUAL

3.4.1 Contents

The parts manual must provide positive identification and coverage for all of the parts of components, assemblies, sub-assemblies, and accessories of the end item normally subject to wear, malfunctioning, damage, or loss. Include any special hardware requirements (e.g., high-strength bolts and nuts). The parts manual may cover more than one model or series or equipments, components, assemblies, subassemblies, attachments, or accessories, such as a master parts catalog, in accordance with the manufacturer's standard commercial practice. Identification of the parts must be such that all parts may be ordered and centrally stocked by the government without further identification to the make, model, and serial number of the equipment being provided.

3.4.2 Illustrations, Drawings, and/or Exploded Views

Provide clear and legible illustrations, drawings, and/or views to enable easy identification of all individual parts, components, assemblies, sub-assemblies, and accessories of the end item. Show part numbers and description on illustrations or list separately. When the illustrations omit the part numbers and description, both the illustrations and separate listing must show the index, reference, or key number which will cross-reference the illustrated part to listed part. Parts shown in the listings must be grouped by components, assemblies, and sub-assemblies with individual parts identified to the assembly.

3.4.3 End Item Manufacturer's Part Numbers

Include parts for which the end item manufacturer has proprietary rights or has exercised design control, and for which the end item manufacturer is the logical supplier. The end item manufacturer must also assign numbers to purchased production parts, if such parts are altered to meet the prime manufacturer's design configuration. (Repainting, marking, or other insignificant operations are not adequate cause for use of exclusively assigned numbers).

3.4.4 Components Assemblies/Parts

Include those components assemblies/parts purchased by the end item manufacturer for which the end item manufacturer does not have control, and must be identified by the actual manufacturer's name and part numbers. Detail parts in the manufacturer's assembly, as well as attaching parts, for which the manufacturer does not have design control must also be identified by the applicable actual manufacturer's parts numbers. This paragraph does not restrict the end item manufacturer from assigning part numbers as long as the actual manufacturer's part number and the Federal Supply Code for Manufacturer (DLA J4 Handbook) or manufacturer is shown.

3.4.5 Appendices

End item manufacturer may add an appendix for cross-reference to implement components assemblies/parts requirements when implementation in manual form varies drastically with the style, format, and method of Contractor's standard commercial practice. Subject cross-referenced in an appendix will appear in the following format:

End Item Manufacturer's Alpha Numeric Seq.	Actual Manufacturer's Name and/or FCSM* from DLA J4 Handbook	Actual Manufacturer Part No.
100001	John Doe & Co. 000000	2000002
*Federal Supply Code for Manufacturers Cataloging Handbook, Name to Code		

3.5 VALIDATION

Each submittal must be validated by the Contractor or Manufacturer as being accurate and applicable to the systems and equipment provided.

3.6 SPECIFIC EQUIPMENT SUBMITTALS

The technical sections of this specification identify the specific equipment or systems for which OMSI submittals are required. This paragraph' and its subparagraph contain a general list of various types of equipment and systems together with the OMSI information required for each type. The applicable OMSI information contained in this paragraph must be submitted for each specific piece of equipment or system listed under the "OMSI Submittals" paragraph in the technical sections. Operating instructions; maintenance, service, and repair instructions; and parts manuals must conform to the requirements of their -respective paragraph herein. Provide validation in accordance with paragraph VALIDATION for all submittals.

3.6.1 Pressure Gages

a. Manufacturer's descriptive literature, general.

b. Parts manuals and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

3.6.2 Automatic Pump Controls

Includes Pressure Indicating Transmitters, Flow Switches, Venturi Tubes, Differential Pressure Transmitters.

a. Manufacturer's descriptive literature, general.

b. Parts manual.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Control wiring diagrams showing all terminations of conductors (and all control devices) labeled to permit identification in the field; part numbers of all control devices; normally open or normally closed; voltage of all control components.

h. Name, address and telephone number of the nearest manufacturer's representative.

3.6.3 Meters

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service, calibration instructions, and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Name, address and telephone number of the nearest manufacturer's representative.

3.6.4 Oil/Water separator and Accessories

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Name, address and telephone number of the nearest manufacturer's representative.

3.6.5 Product Recovery Tank and Accessories

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Name, address and telephone number of the nearest manufacturer's representative.

3.6.6 Truck Offload System

a. General description and specifications.

b. Comprehensive discussion of operating program.

c. Installation and initial checkout procedures.

d. Detailed electrical description.

e. Complete troubleshooting procedures, diagrams, and guidelines.

f. Complete alignment and calibration procedures for components.

g. Preventive maintenance requirements.

h. Detailed system schematics, system field assembly drawings, and system component specifications and dimensions.

i. Complete spare parts lists.

j. Complete as-built bill of materials, control drawings, schedules, and sequence of operations.

k. Safety precautions.

l. Control sequence describing start-up, operation, and shutdown. Control sequence must be integrated with startup and operation of the motor control center.

m. Provide part list that clearly indicates sources of supply, recommended spare parts, and name of servicing organization.

n. Manufacturer's name, address, and telephone number.

3.6.7 Hydrant Outlet Pits, Isolation Valve Pits, High Point Vent and Low Point Drain Pits

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

e. Name, address and telephone number of the nearest manufacturer's representative.

3.6.8 Operating Tank Level Indicator

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Control wiring diagrams showing all terminations of conductors (and all control devices) labeled to permit identification in the field; part numbers of all control devices; normalcy open or normally closed; voltage of all control components.

h. Name, address and telephone number of the nearest manufacturer's representative.

3.6.9 Pantographs

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Name, address and telephone number of the nearest manufacturer's representative.

h. SSEA approval letter.

3.6.10 Piping and Fittings

a. Certificates of Compliance.

b. Batch run numbers.

c. Manufacturer's descriptive literature, general.

d. Name address and telephone number of manufacturer.

3.6.11 Manual Valves

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Where specified to have limit switches, control wiring diagrams showing all terminations of conductors (and all control devices) labeled to permit identification in the field; part numbers of all control devices; normally open or normally closed; voltage of all control components.

h. Name, address and telephone number of the nearest manufacturer's representative.

3.6.12 Flexible Ball Joints

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

e. Name, address and telephone number of the nearest manufacturer's representative.

3.6.13 Gaskets and Isolating Gasket Kits

a. Manufacturer's descriptive literature, general.

b. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

c. Name, address and telephone number of the nearest manufacturer's representative.

3.6.14 Strainers

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

e. Name, address and telephone number of the nearest manufacturer's representative.

3.6.15 Protective Coatings

a. Manufacturer's descriptive literature, general.

b. Maintenance, service and repair instructions.

c. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

d. Name, address and telephone number of the nearest manufacturer's representative.

e. Product standards compliance and the materials system data sheet.

3.6.16 Sample Connections

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Name, address and telephone number of the nearest manufacturer's representative.

3.6.17 Filter Separators

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Name, address and telephone number of the nearest manufacturer's representative.

3.6.18 Water Draw-Off System

a. Manufacturer's descriptive literature, general.

b. Maintenance, service and repair instructions.

c. Operating Instructions.

d. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

e. Name, address and telephone number of the nearest manufacturer's representative.

3.6.19 Pumps - Fueling, Offload, Fuel Transfer, Bowser Pumpoff Pump, Product Return

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

e. Performance data at specified flow rates. Performance must include:

   (1) Head developed, horsepower required and efficiency.

   (2) Pump curves, flow and power requirements, efficiency, head and operating speed. Curves to show operating points at full range of operating conditions.

f. Control wiring diagrams showing all terminations of conductors (and all control devices) labeled to permit identification in the field; part numbers of all control devices; normally open or normally closed; voltage of all control components and operational description.

g. Plan and elevation views of equipment showing clearance required for maintenance and/or replacement.

h. Name, address and telephone number of the nearest manufacturer's representative.

i. Shipping and operating weights.

j. Operating instructions.

k. Factory run test curves indicating flow, head rpm, vibration amplitude and BHP.

3.6.20 Flexible Hoses

a. Manufacturer's descriptive literature, general.

b. Maintenance service and repair instructions.

c. Manufacturer's name, model number, serial number.

d. Name, address and telephone number of the nearest manufacturer's representative.

3.6.21 Control Valves

Submit for each type control valve specified

a. Manufacturer's descriptive literature, general.

b. Operational description of valve and control pilots.

c. Description of valve assembly complete with parts list.

d. Recommended spare parts list for main valve and pilot control systems.

e. Instructions for trouble shooting.

f. Maintenance, service and repair instructions.

g. Manufacturer's name, model number and stock number.

h. Operational Test Data.

3.6.22 Engine-Generator

a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the system or equipment.

b. A control sequence describing startup', operation, and shutdown.

c. Description of the function of each principal item of equipment.

d. Installation and maintenance instructions.

e. Safety precautions.

f. Diagrams and illustrations.

g. Testing methods.

h. Performance data.

i. Lubrication schedule including type, grade, temperature range, and frequency.

j. Parts list: Provide list that clearly indicates sources of supply, recommended spare parts, and name of servicing organization.

k. List qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

3.6.23 Fire Alarm and Fire Detecting System

a. Manufacturer's descriptive literature, general.

b. Parts manual.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Drawing of component arrangement, schedule of components with sizes, types, and ratings, and wiring diagrams.

f. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

g. Name, address and telephone number of the nearest manufacturer's representative.

3.6.24 Motor Control Center

a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the system or equipment.

b. A control sequence describing startup, operation, and shutdown.

c. Description of the function of each principal item of equipment.

d. Installation and maintenance instructions.

e. Safety precautions.

f. Diagrams and illustrations.

g. Parts list.

h. Drawing of component arrangement, schedule of components with sizes, types, and ratings.

i. Manufacturer's name, model number, serial number.

j. Name, address and telephone number of the nearest manufacturer's representative.

3.6.25 Non-Automatic Transfer Switch

a. Manufacturer's descriptive literature, general.

b. Parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Drawing of component arrangement, schedule of components with sizes, types, and ratings, and wiring diagrams.

f. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

g. Name, address and telephone number of the nearest manufacturer's representative.

3.6.26 Pump Control Panel (PCP)

a. General description and specifications.

b. Comprehensive discussion of both hardware and operating program.

c. Installation and initial checkout procedures.

d. Detailed electrical and logical description.

e. Complete troubleshooting procedures, diagrams, and guidelines.

f. Complete alignment and calibration procedures for components.

g. Preventive maintenance requirements.

h. Detailed system schematics, system field assembly drawings, and system component specifications and dimensions.

i. Complete spare parts lists.

j. Interface requirements and capabilities.

k. Signal identification and timing diagrams.

l. Complete as-built bill of materials, control drawings, schedules, and sequence of operations.

m. Safety precautions.

n. Control sequence describing start-up, operation, and shutdown. Control sequence must be integrated with startup and operation of the motor control center.

o. Provide part list that clearly indicates sources of supply, recommended spare parts, and name of servicing organization.

p. Manufacturer's name, address, and telephone number.

q. Supplier name, manufacturer and version of all software including: PLC, desktop computer, laptop computer, and "alternate" desktop computer.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-01 78 24.00 10 (May 2023)**

Preparing Activity: USACE

Superseding
UFGS-01 78 24.00 10 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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FACILITY DATA REQUIREMENTS

05/23

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-01 78 24.00 10 (May 2023)**

Preparing Activity: USACE **Superseding**
UFGS-01 78 24.00 10 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 01 78 24.00 10

FACILITY DATA REQUIREMENTS
05/23

****

NOTE: This guide specification covers the requirements for maintenance and turnover of electronic Facility Data for use by O&M personnel and systems of record.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Consult the appropriate Administering Public Works Office on all construction contracts under the stated threshold values to determine if insertion of this guide specification is required.

Always use and include UFGS 01 33 00 SUBMITTAL PROCEDURES, 01 78 00 CLOSEOUT SUBMITTALS, and UFGS 01 78 23, OPERATION AND MAINTENANCE DATA, with this section. Also include UFGS 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD) as applicable.

This specification may be included in A-E services (design-only), design-build or design-bid-build (construction-only) contracts. Remove all

specification requirements for construction deliverables in design-only contracts. Remove all specification requirements for design deliverables in construction-only Contracts.

****

****

NOTE: Facility Data Requirements are divided into two primary deliverables:

a. Facility Data Workbook (FDW): A pre-formatted spreadsheet template used by the designer or Contractor to compile data on facility Assets and Attributes that the Government wishes to manage via electronic means.

b. Facility Document Set (FDS): An electronically compiled document containing the following project information:

(1) For A-E services (design-only) contracts, the FDS contains the "Design Complete" or "Issued for Construction" (IFC) design drawings, specifications, and design analysis.

(2) For design-bid-build (construction-only) and design-build contracts, the FDS contains all Government-Approved Data Packages required by 01 78 23 OPERATION AND MAINTENANCE DATA and final, Government-Approved Record Drawings.

****

****

NOTE: The Facility Document Set (FDS) is archived with and serves as a supplement to the Facility Data Workbook (FDW). Together, these two documents comprise the Facility Data deliverables required by this specification.

See "DEFINITIONS" listed in this specification for more information regarding these deliverables.

****

****

NOTE: Thoroughly edit this section throughout and coordinate with other electronic data requirements stipulated by the project and Owner requirements.

****

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NOTE: Facility Data Exchange information is available at https://cadbim.usace.army.mil**.**

****

PART 1 GENERAL

****

NOTE: Proper procurement of deliverables described in this specification requires a high degree of

coordination between this specification, 01 33 00 SUBMITTAL PROCEDURES, 01 78 00 CLOSEOUT SUBMITTALS, and 01 78 23 OPERATION AND MAINTENANCE DATA. Ensure that submittal and deliverable content and formatting requirements are organized in a manner that do not present conflicting requirements. Edit these specifications as necessary to present requirements that build on one another. Do not include requirements that are redundant or are duplicated elsewhere in the project specifications.

****

****

NOTE: This guide specification contains bracketed options for an array of procurement methods. This specification may be used on design-only contracts, design-build contracts, and design-bid-build contracts. Edit the specification references below as applicable using the appropriate bracketed options.

****

This specification requires the collection, organization, and turnover of electronic Facility Data for specific assets designed and constructed as part of this contract. Provide a Facility Document Set (FDS) and Facility Data Workbook (FDW) as defined in this specification. See Sections 01 33 00 SUBMITTAL PROCEDURES, 01 78 00 CLOSEOUT SUBMITTALS,[and][01 78 23 OPERATION AND MAINTENANCE DATA,][and][01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)][_____] for additional Facility Data delivery requirements.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 19005-3	(2012) Document Management -- Electronic Document File Format for Long-Term Preservation -- Part 3: Use of ISO 32000-1 with Support for Embedded Files (PDF/A-3)
ISO 32000-1	(2008) Document Management -- Portable Document Format -- Part 1: PDF 1.7

1.2 DEFINITIONS AND ABBREVIATIONS

1.2.1 Assets

Assets are specific items of property or equipment.

1.2.2 Attributes

Attributes are individual pieces of Facility Data that describe facilities and their associated assets.

1.2.3 Facility Data

Information defined and collected in the Facility Data Workbook (FDW) and Facility Document Set (FDS).

1.2.4 Facility Document Set (FDS)

An electronically compiled and organized document containing the supporting documents and data used to populate the Facility Data Workbook during its respective phase of development.

[a. For design-based deliverables, the FDS contains the "Design Complete" or "Issued for Construction" (IFC) design drawings, specifications, and design analysis.]
[b. For construction-based deliverables, the FDS is comprised of the project Operation and Maintenance Data Packages and Government-Approved Record drawings.]

1.2.5 Facility Data Workbook (FDW)

A pre-formatted spreadsheet template used to compile Asset, Attribute, Facility, and Space Data that the Government wishes to manage via electronic means. The FDW also contains all requirements associated with proper collection, organization, and turnover of the Facility Data.

1.2.6 Facility Data Project Execution Plan (FDPxP)

A document that describes the clear and organized plan for the collection, organization, and turnover of the Facility Data deliverables required by this specification.

1.3 UNITS OF MEASURE

****

NOTE: For design-bid-build contracts, choose the first bracketed option (referring to contract documents). For design-only or design-build contracts, choose the second bracketed option for

Section 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD).
****

Provide Facility Data deliverables utilizing the units of measure[identified in the contract documents.][required by[01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)][_____].]

1.4 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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NOTE: If desired, it is possible (but not required) that FDW and FDS submittals be duplicated and individually named for ease of tracking by the Government. Each facility named in "Part 2" will require a separate FDW and FDS delivered to the Government. Tracking, review, and approval of those deliverables may be easier if they are tracked individually for each facility.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Facility Data Project Execution Plan(FDPxP)

[SD-05 Design Data

Facility Data Workbook, Design; G, [_____]

Facility Document Set, Design; G, [_____]]

[SD-10 Operation and Maintenance Data

Facility Data Workbook, Construction Progress; G, [_____]

Facility Document Set, Construction Progress; G, [_____]]

[SD-11 Closeout Submittals

Facility Data Workbook, Construction Final; G, [_____]

Facility Document Set, Construction Final; G, [_____]]

1.5 QUALITY CONTROL

****

NOTE: For Design-Build Contracts, there is no necessity for the Designer of Record to maintain Facility Data during project design.

A Design-Build Contractor may require that a Designer of Record assemble or maintain Facility Data in order to meet Contract Requirements, but that should be treated as an extension of construction services. A properly constructed FDPxP should address this working relationship and Government reviewers should consider this when reviewing that documentation.

This specification may be edited to require design-based deliverables in design-only contracts. Project teams should consider the necessity of this and employ those requirements as warranted. Edit this specification as applicable.

****

1.5.1 Facility Data Project Execution Plan (FDPxP)

Provide the Government with a plan for the collection, organization, and turnover of the Facility Data deliverables to the Government.[The Contractor may consolidate BIM PxP requirements defined in[01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)][and][_____] and FDPxP requirements defined herein and integrate them into a single, consolidated BIM/Facility Data PxP for Government approval.] At a minimum, include the following items in the FDPxP:

1.5.1.1 Front Matter

Provide a Cover Page, Table of Contents, and Executive Summary/Objectives.

1.5.1.2 Project Information

List the Project Owner, Project Name, Project Location and address, Contract Type, Project Description, Project/Contract Number, Project Milestones.

1.5.1.3 Submittal Schedule

Identify delivery schedule for all deliverables in compliance with the submission requirements identified in this specification.

1.5.1.4 Personnel

Identify key personnel involved in the development of the Facility Data deliverables including Contractor and Government personnel.

1.5.1.5 Facility Data Workbook(s)

Identify Facility and Space Data as applicable at time of FDPxP submission. Individually list every asset group from the FDW Requirements that will require Facility Data collection. No attribute data is required at this time. Identify asset groups from the FDW Requirements that are not required within the scope of this Contract. Document the version of FDW to be used through the duration of the project.

1.5.1.6 Facility Document Set(s)

Define structure and format of the submittal. Provide a comprehensive outline of the final FDS to be delivered. Organize the outline with headings, titles, and descriptions such that the Government may ascertain that working documents comply with the formatting requirements defined by this specification.

1.5.1.7 Protocols

Detailed procedures:

a. Facility Data documentation/collection process.

b. Facility Document Set production/development process.

c. Collaboration procedures including strategy, meetings, communication, and subcontractor/consultant involvement.

d. Quality Control, including site verification of FDW, as applicable.

e. File and folder naming structure.

f. Hardware and software being used for collection and organization of Facility Data. Identify type, format, and anticipated organization of digital storage media to be provided as part of required deliverables. Include means and methods for checking deliverables for malicious content.

1.5.2 Meetings

To assure that Facility Data requirements are being met through the duration of the project, organize the following meetings and discuss the subsequent topics:

1.5.2.1 [Post-Award Kickoff Meeting][Pre-Construction Meeting]

****

NOTE: For Design-Bid-Build, choose the Pre-Construction Meeting bracketed option and coordinate requirements with 01 30 00 ADMINISTRATIVE REQUIREMENTS.. For design-build or design-only contracts, choose the Post-Award Kickoff Meeting bracketed option and coordinate requirements with 01 33 16 DESIGN DATA (DESIGN AFTER AWARD).

****

At a minimum, discuss the following:

a. The requirement for Facility Data deliverables under this contract.

b. Primary roles and responsibilities associated with the development and delivery of the Facility Data deliverables, and.

c. Identify and agree upon a date and attendance list for the meetings described below:

1.5.2.2 FDPxP Coordination Meeting

****

NOTE: Choose the Commissioning Authority bracketed option below when Commissioning is required for this project.

Choose Designer of Record (DOR) for design-only and design-build contracts.

****

a. Facilitate a meeting following submission and Government review of the FDPxP. Include the Facility Data Preparer(s),[Designer of Record (DOR),], Quality Control (QC) Manager,[Commissioning Authority (CA),] Government's Facility Data Proponent, Contracting Officer's Representative, and[Directorate of Public Works (DPW)][Base Civil Engineer (BCE)] Facilities Management Specialist (FMS).[Also include Government personnel required for obtaining security clearances and waivers for proper Facility Data collection in this meeting.]

b. The purpose of this meeting is to coordinate the efforts necessary by contract parties to ensure an accurate collection, preparation, quality control, and submittal of these deliverables.

c. The FDPxP serves as the primary agenda for this meeting. At a minimum, discuss the following:

  (1) Processes and methods of gathering facility data during construction. Discuss and obtain special permissions and waivers as necessary (such as photo waivers and data encryption);

(2) Contractor Quality Control practices and procedures;

(3) Corrective actions necessary for Government approval of FDPxP;

(4) Necessity for additional or recurring Facility Data Coordination Meetings outside of those required by this specification, as requested by the Contractor. Intent of these meetings would be to maintain regular contact between responsible parties of the Contractor and Government with regard to development of the facility data deliverables. Conduct status meetings with a frequency agreed upon at this meeting.

****

NOTE: For design-bid-build contracts, design submittals are most often not necessary (require construction submittals only). For design-only contracts, design submittals are likely the only deliverable. For design-build contracts, both design and construction submittals may be requested, but construction submittals are the only required deliverable. Edit the specification as applicable using the appropriate bracketed options.

****

1.5.2.3 Submittal Coordination Meeting

a. Facilitate a meeting following submission and Government review of each design or progress submittal of the Facility Data. Include the Facility Data Preparer(s), Designer of Record (DOR), Quality Control (QC) Manager,[Commissioning Authority (CA),] Government's Facility Data Proponent, Contracting Officer's Representative, and[Directorate of Public Works (DPW)][Base Civil Engineer (BCE)] Facilities Management Specialist (FMS). Include Mechanical, Electrical, Plumbing, and Fire Protection subcontractors as applicable.

b. The purpose of this meeting is to demonstrate ongoing compliance with the requirements identified in this specification.

c. The applicable deliverables, along with Government remarks associated with review of these submittals serve as the primary guide and agenda for this meeting. At a minimum, discuss the following during this meeting:

(1) Review assets, applicable attributes, facility, and space data in FDW at time of submittal;

(2) Demonstrate Quality Control and site verification procedures, as applicable, by Contractor QC;

(3) Review contents and organization of FDS at time of submittal;

(4) Discuss Government review comments and unresolved items preventing completion and Government approval of the Facility Data Workbook and Facility Document Set.

1.5.3 Facility Turnover and Contract Closeout

Include the Facility Document Set, Construction Final as a deliverable in Facility Turnover and Contract Closeout procedures as defined in[

01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)][and][01 78 00 CLOSEOUT SUBMITTALS].

1.5.4 Facility Data Workbook Quality Requirements

For each submittal, ensure that the information contained in the FDW(s) reflects the minimum content requirements defined in the PART 3 EXECUTION portion of this section. Ensure that information provided as part of the FDW(s) conforms to the standards described below:

a. Compile FDW(s) using approved spreadsheet templates. Do not alter the formatting or organizational layout of the templates. For this Contract, templates are [available for download from the USACE CAD/BIM Technology Center website, site information provided in the PART 2 PRODUCTS portion of this section][attached to this specification. Editable copies of the templates will be provided upon Contract Award].

b. Instructions for the proper maintenance and completion of these FDWs are contained in the FDW Requirements contained within the FDW template.

1.5.5 Facility Document Set Quality Requirements

****

NOTE: The paragraph below contains bracketed options for submittal quality requirements. Unless 01 33 00 SUBMITTAL REQUIREMENTS and 01 78 23 OPERATION AND MAINTENANCE DATA clearly identify submittal quality requirements across all project submittals, select the "below:" bracket and include all quality requirements listed below. Quality metrics are default values and may be edited to suit project needs.

****

Ensure that information provided as part of each FDS conforms to the electronic and data formatting standards identified[in 01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)][in 01 33 00 SUBMITTAL REQUIREMENTS and 01 78 23 OPERATION AND MAINTENANCE DATA.][below:]

[1.5.5.1 Document Files

Utilize PDF file format in accordance with ISO 32000-1 and ISO 19005-3 for all document-based files. Provide files from original sources, text-searchable, and saved in "Standard" (uncompressed) resolution. Bookmark and label files as defined in the PART 2 PRODUCTS portion of this section.

][1.5.5.2 Photograph Files

If photographs are required, utilize JPEG file format for all photograph and image files. Provide full-color photos with photo resolution of not less than 4 megapixels and not more than 12 megapixels.

Provide a copy of installation-specific letters or waivers allowing permission to take installed equipment photographs on this Contract. Waivers need not be attached to every photo, only one copy of each permission letter need be included in the Government deliverables.

][1.5.5.3 Drawing Files

Provide all drawings required by this specification in full-size PDF format in accordance with ISO 32000-1 and ISO 19005-3. Produce PDF files from original sources, text-searchable, and saved in "Standard" (uncompressed) resolution whenever possible. Bookmark and label files as defined in the PART 2 PRODUCTS portion of this section.

Submission of scanned or photocopied drawing files is prohibited. Only vector-preserved PDF files are acceptable.

]1.5.6 Facility Document Set Integrity Requirements

Ensure that information provided as part of each FDS conforms to the integrity standards identified below:

1.5.6.1 File Protection

Do not restrict data files, document files or photographic files from being printed, exported, modified or copied. Do not deliver files with restrictions such as expiration date and locks for access, viewing, archiving, or editing.

1.5.6.2 Manufacturer-Specific Documents

Provide text-searchable, vector-based document files from the manufacturer's online or electronic documentation. Color documents are preferred. Provide documents specific to the product(s) installed under this Contract. When possible, do not submit document files containing multiple product catalogs from the same manufacturer, or product data from multiple manufacturers in the same file. Provide documents directly from the manufacturer whenever possible. Do not provide scanned copies of hardcopy documents.

1.6 DELIVERY, STORAGE, AND HANDLING

****

NOTE: The paragraph below contains bracketed options for submittal delivery requirements. Unless 01 33 00 SUBMITTAL REQUIREMENTS and 01 78 23 OPERATION AND MAINTENANCE DATA clearly identify submittal delivery requirements across all project submittals, include both bracketed options in this paragraph.

****

Deliver facility data submittals in an organized and legible manner. Provide submittals adhering to the requirements of [01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)][of 01 33 00 SUBMITTAL REQUIREMENTS and 01 78 23 OPERATION AND MAINTENANCE DATA][described below].

1.6.1 Number of Copies

Provide [three] [_____] identical copies of disks for approval; for each submittal and each facility required. Provide on approved electronic media (one copy per disk or set of disks) as defined below. Provide submittal files on electronic storage media in compliance with the quality requirements identified in this specification.

1.6.2 Malicious Content

Scan all files for malicious viruses using a commercially available scanning program that is routinely updated to identify and remove current virus threats.

1.6.3 Storage Media

Provide facility data on disk-based (DVD-R/RW) media. Deviations from the required storage media must be approved by the Government. Select and apply technology used for electronic data transmission to ensure that the full Facility Data submittal for each facility is provided on one single disk, whenever possible. When separation of the submittal is required, first separate the FDS and the FDW onto separate media. Second, separate FDS into logical segments or components. Further divisions must be documented in the FDPxP and approved by the Government.

Provide Facility Data on disk-based (DVD-R/RW) media. Deviations from the required storage media must be approved by the Government. Select and apply technology used for electronic data transmission to ensure that the full Facility Data submittal for each facility is provided on one single disk, whenever possible. When separation of the submittal is required, first separate the FDS and the FDW onto separate media. Second, separate FDS into logical segments or components. Further divisions must be documented in the FDPxP and approved by the Government.

a. Apply a label directly printed to storage media. Do not provide adhesive, paper-based labels. List the name of the facility, Project, Project location, Contract number, Designer of Record firm/Prime Contractor company's name, title of submission, and security classification (in accordance with the appropriate security classification labeling regulations) on the label. If multiple disks are provided, clearly document the contents of each disk on the label.

b. Include the name and contact information of the individual who produced the final data disk to ensure that problems with the data or media can be easily resolved.

c. When browsed on a computer, the disk must display the following folders and their associated content:

    (1) Facility Data Workbook (containing 1 FDW per facility);
    (2) Facility Document Set (containing 1 FDS per facility);
    (3) FDPxP (containing 1 PxP per contract);
    (4) Readme (Containing 1 TXT, PDF, or HTML file with general use information, organizational instructions, and basic preparer contact information. Include all information included on the storage media label).

[1.6.4 Encryption

****

NOTE: The paragraph contains bracketed options for data encryption. Data encryption is only required if expressly required by the project.

Add detailed encryption requirements if available.

****

Encrypt deliverable data as directed by [District][Area][Resident][Project] Office Engineer. Document the encryption to be used in the FDPxP.

]PART 2 PRODUCTS

2.1 FACILITIES

****

NOTE: The paragraph below requires the Designer of Record to identify the individual facilities for which Facility Data deliverables be separated under this Contract. For simple projects (such as single-building, site) there need be only one facility listed. For more complex projects (such as multiple-building, building complex, multiple sites) multiple facilities may be identified.

For each facility listed, one each FDS and FDW will be delivered to the Government under this specification. The specifier must consider this and coordinate with the appropriate Administering Public Works or Real Property Office(s) to determine the best way to identify facilities, and by extension, the number of deliverables required for this Contract.

Provide clear designations of facilities. Include facility name (as identified on form DD1391), PN, RPUID and other appropriate designations in the paragraph below.

****

Facilities that require individual (separate and complete) Facility Data deliverables as described in this specification are as follows:

a. [_____]
[b. [_____]]
[c. [_____]]
[d. [_____]]

2.2 FACILITY DATA WORKBOOK(S)

****

NOTE: The Facility Data Workbook(XLSM format) templates are located at the following location: https://cadbimcenter.erdc.dren.mil. Require the Contractor to use the most current FDW template unless specific Project constraints are identified. It is not necessary to utilize the bracketed option to attach a pre-populated FDW unless specific Project constraints dictate its necessity.

If an FDW is attached, provide the Contractor with an native .xlsm file whenever possible. A PDF may be attached for bidding purposes, but the preference should be to transfer an editable file upon Contract Award.

****

Provide one compiled FDW for each facility identified above. Complete all portions of each FDW including facility, space, asset, and attribute data in compliance with the FDW Requirements. [An FDW with pre-populated basis-of-design information is attached to this section. The Government will provide electronic copy of the attached FDW(s) to the Contractor upon award in [.xlsm][PDF][_____] format.][Download the current FDW template (.xlsm format) from the USACE CAD/BIM Technology Center website at https://cadbimcenter.erdc.dren.mil.]

2.2.1 Spaces

****

NOTE: This section includes minimum space definition requirements for the FDW. Provide additional requirements as appropriate for project and stakeholder.

****

Provide data for all applicable spaces in the facility. Minimum space definitions are as follows:

a. Provide all rooms as defined in the design documents.
b. If not otherwise defined, provide a minimum of one "roof" space in the FDW.
c. If not otherwise defined, provide a minimum of one "site" space in the FDW.
d. Provide all spaces not otherwise described, but necessary to accurately indicate the location of all FDW assets required by this specification.
[e. _____
]

2.2.2 Assets

a. Compile an FDW that contains the[_____,] maintainable and warrantable equipment (assets) associated with each facility. This includes assets in contract scope and within the project extents. See 01 78 00 CLOSEOUT SUBMITTALS [and 01 78 23 OPERATION AND MAINTENANCE DATA]for related requirements. Assets include, but are not limited to, those types described in the "Required Assets" portion of the FDW template[, those assets listed in the table below,] and additional assets defined in the FDPxP. Itemized FDW asset entries (instance-based). Entries indicative of multiple assets (type-based) are not allowed.

****

NOTE: The FDW Template contains a list of baseline required assets that should be adequate for most projects. The specifier should review the FDW required assets and engage the appropriate Administering Public Works Office to determine whether the project or stakeholders require additional asset facility data be collected beyond those defined in the FDW template. A few assets that could be considered are listed in the table as examples, but add, edit, or delete the table according to project requirements.

****

[

SUPPLEMENTAL ASSET LIST (INCLUDE IN ADDITION TO "REQUIRED ASSETS" LISTED IN FDW TEMPLATE)	
Asset	Description/Example
[Fixtures, Furnishings, and Equipment]	[Furniture, systems furniture, appliances, and other significant items of equipment]
[Kitchen Equipment and Fixtures]	[Kitchen and foodservice equipment including but not limited to stoves, steamers, accessory hoods, cooking devices, refrigeration devices]
[Valves]	[All operable valves in facility including but limited to those installed in plumbing, HVAC, and fire protection systems.]
[Tanks and Vaults]	[Items such as expansion tanks, septic tanks, oil-water separators, grease separators]
[Material Handling Equipment]	[Items such as cranes, coveyor belts, equipment lifts]
[DDC and EMCS Equipment]	[Panels and consoles associated with the facility automation and control systems integration.]
[All Inspectable Equipment]	[__________]
[_____]	[__________]

] Document assets applicable to the scope of this project in the FDPxP.

b. Sub-component assets that are an integral and functional part of another component (e.g. An electric motor that serves as part of an air-handling unit) need not be duplicated or listed separately as its own asset.

c. Definitions, descriptions, and formatting requirements for these assets can be found in the FDW Requirements contained within the FDW template.

d. If an asset type is not included in the scope of the Project, no Facility Data (assets or attributes) are to be included in the FDW (even as a placeholder) for that asset type.

2.2.3 Attributes

a. Populate each individual asset with all required attributes defined in the "Required Attributes" portion of the FDW template.

b. Definitions, descriptions, and formatting requirements for these attributes can be found in the FDW Requirements contained within the FDW template.

c. If an attribute is not applicable, populate that field with "[N/A][_____]." Do not leave it blank.

****

NOTE: For design-bid-build contracts, design submittals are typically not necessary; require construction submittals only. For design-only contracts, design submittals are the only required

deliverable. For design-build contracts, both design and construction submittals may be requested, but construction submittals are the only required deliverable. Edit the specification as applicable using the appropriate bracketed options.

****

2.3 FACILITY DOCUMENT SET

2.3.1 Organization

Organize the FDS in a hierarchical manner as follows. Use electronic bookmarks to create an easily navigable document. The first and primary hierarchical level must contain the following bookmarks:

[a. "Design Data" - See subordinate hierarchical requirements in the "DESIGN DATA HIERARCHY" paragraph.

][

b. "O&M Data" - See subordinate hierarchical requirements in the "O&M DATA HIERARCHY" paragraph.

][

c. "Record Drawings" - See subordinate hierarchical requirements in paragraph RECORD DRAWINGS HIERARCHY.]

[2.3.1.1 Design Data Hierarchy

Under "Design Data," provide all Government-Approved "Design Complete" or "Issued for Construction" design documents as defined in[01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)][____], including:

a. Design Drawings - Provide the Government-Approved, "Design Complete" or "Issued for Construction" design drawings.

b. Design Specifications - Provide the Government-Approved, "Design Complete" or "Issued for Construction" design specifications.

c. Design Analysis - Provide the "Design Complete" or "Issued for Construction" Government-Approved Design Analysis.

][2.3.1.2 O&M Data Hierarchy

Under "O&M Data" provide all Government-Approved O&M Data Packages as defined in 01 78 23 OPERATION AND MAINTENANCE DATA and as required by technical specifications contained within this contract. Further organize this information under the following hierarchical levels:

a. The contract specification and title under which the Data Package and the associated equipment or system references. (e.g. 26 23 00 - LOW-VOLTAGE SWITCHGEAR)

b. The Data Package Number as defined in 01 78 23 OPERATION AND MAINTENANCE DATA. (e.g. Data Package 2)

][2.3.1.3 Record Drawings Hierarchy

Under "Record Drawings" provide an electronic copy of the Government-Approved record drawings, as specified in 01 78 00 CLOSEOUT SUBMITTALS, for the project in PDF format. Further group discipline sheets under the following hierarchical levels:

a. The full discipline heading represented by the contents of the sheet and as shown in the Record Drawing Sheet Index. Organize these headings in the order that the drawings set is organized. (General, Civil, Structural, Architectural, Interiors, Plumbing, Mechanical, Electrical, Telecommunications)

b. The Sheet ID and Sheet Name as found in the Record Drawing Sheet Index and in accordance with the AEC CAD Standard referenced in 01 78 00 CLOSEOUT SUBMITTALS. (e.g. G-001 - LEGEND; CS101 - SITE PLAN AREA 101; A-101 - OVERALL FIRST FLOOR PLAN; P-601 - FIRST FLOOR DWS WATER RISER DIAGRAM)

]PART 3 EXECUTION

****

NOTE: For design-bid-build contracts, design submittals are typically not necessary (require construction submittals only). For design-only contracts, design submittals are the only required deliverable. For design-build contracts, both design and construction submittals may be requested, but construction submittals are the only required deliverable. Edit the specification as applicable using the appropriate bracketed options.

****

[3.1 DESIGN SUBMITTALS

Submit the Facility Data Workbook and Facility Document Set design submittals together. Meet the following completeness and formatting requirements listed below:

a. Provide Facility Data Workbook, Design submittals(s) when at "Design Complete" or "Issued for Construction" phase as defined by [01 33 16.00 10 DESIGN DATA (DESIGN AFTER AWARD)][_____]. Populate the FDW with all data required for the design submittal, detailed in the FDW Requirements. Clearly identify assets or asset groups missing in the "variations" section of the ENG Form 4025 Transmittal Form provided with the submittal. See the FDW Requirements contained within the FDW template for a list of attributes to be completed for this submittal. Intent of this submittal is to populate the FDW with all design-based asset information prior to Project advertisement or construction.

b. Submit individual FDW templates for each facility identified in the "FACILITIES" paragraph. While FDWs will not be complete at this phase, provide accurate and correctly formatted data according to the FDW Requirements.

c. Submit Facility Document Set, Design submittal as defined in Part 2 of this specification.

][3.2 CONSTRUCTION PROGRESS SUBMITTALS

****

NOTE: For Construction Progress FDW submittal, recommended delivery is 60 days prior to BOD for small projects and 90 days prior to BOD on large projects. Specifier may insert alternative delivery

date if project requirements dictate differently.
****

Submit the FDW and FDS construction progress submittals together. Meet the following completeness and formatting requirements listed below:

a. Provide Facility Data Workbook, Construction Progress submittal(s) when all assets are identified, but not later than [60][90][__] days prior to Beneficial Occupancy Date (BOD) as identified in the Government-Approved construction schedule. Clearly identify assets or asset groups missing in the "variations" section of the ENG Form 4025 Transmittal Form provided with the submittal. Populate assets with front-loaded attribute data that is available at the time of asset input. See the FDW Requirements contained within the FDW template for a list of attributes to be completed for this submittal.

b. Submit individual FDW templates for each facility identified in the "FACILITIES" paragraph. While FDWs are not required to be complete for this submittal, provide accurate and correctly formatted data according to the FDW Requirements.

c. Submit a sample or working Facility Document Set, Construction Progress submittal containing "draft" or "example" documents that are organized in the manner defined by this specification. Draft or example documents need not be technically accurate or complete in their content, but defined and separated in a manner such that all organizational and formatting requirements defined by this specification may be evaluated.

][3.3 CONSTRUCTION FINAL SUBMITTALS

****
NOTE: Unlike the Construction Progress Submittal, it is unlikely that the Contractor will be able to submit the full Construction Final Submittal at one time. The FDW(s) are most beneficially submitted during commissioning of building systems, prior to the Beneficial Occupancy Date (BOD). Components of the FDS can only be compiled and finalized after Government-Acceptance of its individual components (Record Drawings, O&M Data Packages). This will likely not occur until after BOD. Specifier should edit this specification with this understanding and tailor this paragraph as necessary to comply with individual project requirements.
****

****
NOTE: For Facility Data, Construction Final Submittal, recommended delivery is 60 days after BOD for small projects and 90 days after BOD on large projects. Specifier may insert alternative delivery dates if project requirements dictate differently.
****

Submit the FDW and FDS construction final submittals [as they are completed][__________]. Coordinate the Facility Data Workbook, Construction Final submittal with data verification procedures as defined in the accepted FDPxP. Provide the Facility Document Set, Construction

Final submittal only after Government acceptance of its individual components as defined by[01 78 00 CLOSEOUT SUBMITTALS][and][01 78 23 OPERATION AND MAINTENANCE DATA].

]3.4 FACILITY DATA WORKBOOK VERIFICATION

****

NOTE: Choose the Commissioning Authority bracketed option below when Commissioning is being required by this project. Insert the appropriate commissioning specification number and title used on this project.

****

****

NOTE: On-site verification of Facility Data contained in the FDW(s) is required for assurance of quality data. The best time to verify this data is during facility commissioning procedures. If commissioning of building systems is part of the scope of this project, require that the Contractor align verification of FDW with commissioning. If commissioning is not required for the project, Data Verification is most beneficial during Contract Closeout, prior to BOD.

****

Verify the FDW through the quality control personnel and procedures as defined in the FDPxP.[Coordinate and conduct verification with commissioning procedures defined in [_____].] One-hundred percent accuracy of FDW information is required for Government acceptance of the [Facility Data Workbook, Design submittal][and][Facility Data Workbook, Construction Final submittal].

****

NOTE: The following bracketed option for "Attachments" should only be included if the Project requires a pre-populated FDW be included in the contract. If a pre-populated FDW is necessary, edit the "FACILITY DATA WORKBOOK(S)" and "Facility Data Workbook Quality Requirements" paragraphs above to indicate as such and include the bracketed reference below. Print a PDF copy of the pre-populated FDW and attach to the end of this specification in the contract solicitation. Preserve a copy of the pre-populated FDW for turnover to the Contractor upon Contract Award.

If a pre-populated FDW is not necessary, remove this bracketed option.

****

--Attachments--
Project Facility Data Worksheets

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 78 24.00 20 (May 2023)**
Change 1 - 11/23
Preparing Activity: NAVFAC **Superseding**
UFGS-01 78 24.00 20 (February 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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05/23, CHG 1: 11/23

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USACE / NAVFAC / AFCEC **UFGS-01 78 24.00 20 (May 2023)**
Change 1 - 11/23

Preparing Activity: NAVFAC **Superseding**
UFGS-01 78 24.00 20 (February 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 01 78 24.00 20

FACILITY DATA WORKBOOK (FDW)

05/23, CHG 1: 11/23

****

NOTE: This guide specification covers the requirements for Facility Data Workbook (FDW).

This Section is required for use on New Construction projects greater than or equal to $1 Million, and Major Renovation projects greater than or equal to 50 percent of the Plant Replacement Value, at Marine Corps Installations and at Navy Installations, Joint Bases, Department of Defense (DoD) Agencies, or Field Activities, where NAVFAC PW is the maintenance provider of the facility. For other projects below the threshold, consult the NAVFAC Public Works Facilities Management Division (FMD) to determine if this guide specification is required. Use both this Section and Section 01 78 23, OPERATION AND MAINTENANCE DATA.

Collaborate with the FMD to edit this Section and to develop the preliminary eOMSI Facility Data Workbook to attach to this Section for Design-Bid-Build (DBB) or to develop for Design-Build (DB).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

This guide specification includes tailoring options for DESIGN-BID-BUILD, DESIGN-BUILD, COMMISSIONING AUTHORITY, and NAVY DESIGN-BUILD. Selection or de-selection of a tailoring option will include or exclude that option in the Section, but editing the resulting Section to fit the project is still required.

****

****

NOTE: For Medical Facilities, thoroughly edit this Section throughout, and coordinate with Defense Health Agency (DHA) for projects designed in accordance with UFC 4-510-01 DESIGN: MEDICAL MILITARY FACILITIES.

****

****

NOTE: The eOMSI Facility Data Workbook is available for download on the Whole Building Design Guide under UFGS Forms, Graphics, and Tables and UFGS-01 78 24.00 20.

To download from UFGS Forms, Graphics, and Tables:

Go to http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables, **locate "01 78 24.00 20" in the UFGS Title column and then select "eOMSI Facility Data Workbook (FDW)" to download the Excel spreadsheet to your hard drive.**

To download from UFGS-01 78 24.00 20:

Go to UFGS 01 78 24.00 20 **and select "eOMSI Facility Data Workbook (FDW)" under Related Materials.**

****

PART 1 GENERAL

1.1 DEFINITIONS AND ABBREVIATIONS

1.1.1 eOMSI

Electronic Operation and Maintenance Support Information

1.1.2 Facility Data Workbook (FDW)

A Microsoft Excel file containing required facility information populated by the Contractor.

1.1.3 Systems

The words "system", "systems", and "equipment", when used in this document refer to as-built systems and equipment.

1.1.4 KTR

An abbreviation for "Contractor."

1.2 OPERATION AND MAINTENANCE MANUAL AND FACILITY DATA WORKBOOK MEETINGS

1.2.1 Pre-Construction Meeting Post-Award Kickoff Meeting

****

NOTE: The paragraph title contains tailoring for DESIGN-BID-BUILD and DESIGN-BUILD.

****

Meeting requirements are identified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 SUBMITTAL SCHEDULING

1.3.1 Facility Data Workbook (FDW), Progress Submittal

****

NOTE: Paragraph contains tailoring for FACILITY DATA WORKBOOK.

****

Submit the Progress submittal when construction is approximately 50 percent complete, to the Contracting Officer for approval. Provide Facility Data Workbook (Excel). Include the elements and portions of system construction completed up to this point.

The purpose of this submittal is to verify progress is in accordance with contract requirements as discussed during the Operation and Maintenance Manual and Facility Data Workbook Meetings. Field verify a portion of the eOMSI information in accordance with paragraph FIELD VERIFICATION.

1.3.2 Facility Data Workbook (FDW), Prefinal Submittal

****

NOTE: Choose the bracketed option of submission of the Prefinal submittal 90 calendar days prior to BOD for MILCON and Special Projects. Choose 60 calendar days prior to BOD for renovations or repairs, or provide a timeframe practical to the project duration for smaller projects.

****

Submit the 100 percent submittal of the FDW Prefinal Submittal to the Contracting Officer for approval within [90] [60] [_____] calendar days of the Beneficial Occupancy Date (BOD). This submittal must provide a complete, working document that can be used to operate and maintain the facility. Any portion of the submittal that is incomplete or inaccurate requires the entire submittal to be returned for correction. Any discrepancies discovered during the Government's review of FDW Progress submittal must be corrected prior to the Prefinal submission.

1.3.3 Facility Data Workbook (FDW), Final Submittal

Submit completed Facility Data Workbook (Excel). The Final submittal is due at BOD. Any discrepancies discovered during the Government's review of the Prefinal eOMSI submittal, including the Field Verification, must be corrected prior to the Final eOMSI submission.

1.4   UNITS OF MEASURE

****

NOTE: This paragraph is tailored for DESIGN-BID-BUILD and DESIGN-BUILD to reference the corresponding Section.

****

Provide FDW utilizing the units of measure used in the Government generated contract documents. required by the RFP for the facility. Refer to Section 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES.[Metric eOMSI must be in SI (System International) metric units exclusively.]

1.5   SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: For Design-Build projects, delete 01 33 00, SUBMITTAL PROCEDURES, and replace with UFGS 01 33 00.05 20, CONSTRUCTION SUBMITTAL PROCEDURES and UFGS 01 33 10.05 20, DESIGN SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-11 Closeout Submittals

Facility Data Workbook (FDW), Progress Submittal; G, [_____]

Facility Data Workbook (FDW), Prefinal Submittal; G, [_____]

Facility Data Workbook (FDW), Final Submittal; G, [_____]

PART 2 PRODUCTS

2.1 eOMSI FACILITY DATA WORKBOOK

****

NOTE: Coordinate with NAVFAC FEC's PW FMD or Marine Corps Facilities maintenance lead to help identify the Mastersystems, Systems, and Subsystems based on project scope.

****

****

NOTE: The eOMSI Facility Data Workbook.xlsm can be downloaded from the following location: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

****

NOTE: For DBB, attach PDF of edited, Model & Facility Data Matrix tab, from the eOMSI Facility Data Workbook, to this Section. Edit Model & Facility Data Matrix tab by selecting MASTERSYSTEMS, SYSTEMS, and SUBSYSTEMS within the project scope.

For DB, the Contractor provides the Facility Data Workbook, complete.

****

****

NOTE: This paragraph contains tailoring for DESIGN-BID-BUILD and DESIGN-BUILD.

****

An initial, pre-edited draft of the Model & Facility Data Matrix tab within the Facility Data Workbook is attached to this Section. The Government will provide this Facility Data Workbook electronically to the Contractor upon award. Add, delete, and update Mastersystems, Systems, and Subsystems that may have changed during construction, or any items that may have been omitted or missed during design, at no additional cost to the Government. Complete the KTR Facility Data File tab based on the selection of Mastersystems, Systems, and Subsystems installed. Download the eOMSI Facility Data Workbook at the following location: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables.

Complete the KTR Facility Data File tab based on the selection of Mastersystems, Systems, and Subsystems installed. The following tabs are included in the eOMSI Facility Data File Workbook and serve the purpose stated:

a. Instructions Tab: Instructions for completing Model & Facility Data Matrix Tab and KTR Facility Data File Tab. If a discrepancy exists between what is required in this Section and the Workbook, the instructions within the workbook take precedence.

b. Model & Facility Data Matrix Tab: - The Matrix lists Required Facility Asset Fields for each SYSTEM and SUBSYSTEM. The Designer of Record selects SYSTEMS and SUBSYSTEMS that are within the project scope, which the Contractor needs to include and populate in KTR Facility Data File tab. The "Required Facility Asset Field Position Numbers," one through thirty-five, are pre-populated, and are not editable.

c. Required Facility Asset Fields Tab: Defines the 35 Required Facility Asset Field Position Numbers used in Model and Facility Data Matrix and KTR Facility Data File tabs.

d. KTR Sample Facility Data File Tab: Sample KTR eOMSI facility data file. This tab provides an example of the mandatory fields of equipment installed by the Contractor, and populated in the KTR eOMSI Facility Data File Tab, along with their descriptions.

e. KTR Facility Data File Tab: Required eOMSI facility data file deliverable provided to the Government. Provide a separate and unique new row for each facility component or piece of equipment installed. Coordinate with the Government's Contracting Officer's Representative and NAVFAC PW FMD for specific facility component naming convention.

PART 3 EXECUTION

3.1 FIELD VERIFICATION

****

NOTE: The following paragraph contains tailoring for COMMISSIONING AUTHORITY. Only use this paragraph if project requires Facility Data Workbook.

****

Field verify Facility Data Workbook information with Contractor and Government personnel. Include the following personnel in this meeting: Contractor's Facility Data Workbook Preparer and Quality Control Manager, Commissioning Authority, and the Government's Contracting Officer's Representative and NAVFAC PW FMD. Request, and provide, an eOMSI Field Verification Meeting no sooner than 14 calendar days after submission of the Progress FDW submittal, and another, no sooner than 14 calendar days after submission of the Prefinal FDW submittal. During this meeting, the Government and Contractor will verify that the Facility Data Workbook is complete and accurate.

Field verify that at least 5 Subsystems under each of the Mastersystems are accurate, for a total of 25 Subsystems. For each of these items, verify that the required facility asset field, as defined in the "Model & Facility Data Matrix" tab, contains the specified data and it is accurate (i.e., item description, manufacturer, model no., serial no.). 100 percent accuracy of eOMSI information is required for successful field verification. If data discrepancies are discovered amongst the 25 Subsystems verified, resubmit an updated eOMSI FDW, and request a make-up field verification meeting. At the make-up field verification meeting 25 new Subsystems and their associated required facility asset fields will be field verified; the 25 new Subsystems must be 100 percent accurate. Any discrepancies discovered must be corrected prior to next eOMSI Facility Data Workbook Submittal.

****

NOTE: Edit and modify the following Master Systems, to specify a total of 5 that correspond with the project scope.

****

(1) D10 - CONVEYING
(2) D20 - PLUMBING
(3) D30 - HVAC
(4) D40 - FIRE PROTECTION
(5) D50 - ELECTRICAL

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-01 91 00.15 (May 2023)**
Change 3 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-01 91 00.15 10 (May 2019)
UFGS-01 91 00.15 20 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-01 91 00.15 (May 2023)**
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UFGS-01 91 00.15 10 (May 2019)
UFGS-01 91 00.15 20 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 01 91 00.15

BUILDING COMMISSIONING
05/23, CHG 3: 08/24

****

NOTE: This guide specification covers Building Commissioning requirements for design and construction of Army managed, Navy managed, and Air Force Managed: new building; additions; existing building sustainment, restoration, and modernization.

For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

Coordinate all Sections that reference commissioning with this section, including Sections 01 45 00 QUALITY CONTROL, 01 91 19 BUILDING ENCLOSURE COMMISSIONING, 23 08 00 COMMISSIONING OF MECHANICAL[AND PLUMBING] SYSTEMS, 22 33 30.00 10 SOLAR WATER HEATING EQUIPMENT, 26 08 00 APPARATUS INSPECTION AND TESTING, 26 31 00 SOLAR PHOTOVOLTAIC (PV) COMPONENTS, 26 51 00 INTERIOR LIGHTING, and 26 56 00 EXTERIOR LIGHTING.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1   GENERAL

****

NOTE: This section contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, GOVT HIRED COMMISSIONING PROVIDER, ARMY, NAVY, DESIGN-BUILD, DESIGN-BID-BUILD, and INTEGRATED SYSTEMS TESTING. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

Select KTR HIRED COMMISSIONING PROVIDER tailoring for projects that require the Commissioning Provider to be provided by the Construction Contractor.

Select GOVT HIRED COMMISSIONING PROVIDER tailoring for Navy managed projects where the Commissioning Provider is retained under a separate contract with the Government.

ARMY tailoring applies to construction projects managed by the Army. Army managed projects will always have a KTR HIRED COMMISSIONING PROVIDER in accordance with Engineering Regulation 1110-345-723 TOTAL BUILDING COMMISSIONING PROCEDURES. Do NOT select GOVT HIRED COMMISSIONING PROVIDER tailoring for Army managed projects. Refer to Engineering Regulations for further information.

Army Engineering Regulation (ER) 1110-345-723 describes Army managed project commissioning leadership structure. In all cases, the construction contractor will be required to provide a Contractor's Commissioning Specialist (CxC), herein referred to as the Lead Commissioning Specialist, to perform the duties listed. For design-build projects, the CxC serves as the Commissioning Specialist for Design (CxD) as defined in ER 1110-345-723. The Army will utilize a Government Commissioning Specialist (CxG) as described in the ER. Regardless of whether the CxG is provided by Army personnel or third party contract, all communication and coordination with the CxG will be managed through the Contracting Officer via processes established in other specification sections such as Quality Control and Submittal Procedures.

NAVY tailoring applies to construction projects managed by the Navy.

For Air Force projects managed by the Army or the Navy, tailor this Section for the Service that is managing the construction project. If Air Force is managing the construction project, choose the Service tailoring option that best fits the project requirements.

Select DESIGN-BUILD tailoring for Design-Build project execution.

Select DESIGN-BID-BUILD tailoring for Design-Bid-Build project execution.

Select INTEGRATED SYSTEMS TESTING tailoring for buildings with central control systems and interactive operation among different systems. (Examples include mission critical facilities such as hospitals, laboratories, mission operations, or other essential (RCIV) and strategic asset (RCV) facilities.)

Coordinate this Section with the commissioning requirements of ASHRAE Standard 90.1 as required by UFC 1-200-02, "High Performance and Sustainable Building Requirements" paragraph "Commissioning".
****

Building Commissioning is a systematic, quality-focused process for enhancing the delivery of a project that focuses on verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the project requirements. The purpose is to reduce the cost and performance risks associated with delivering facilities projects, and to increase value to owners, occupants, and users.

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE 180	(2018) Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
ASHRAE 202	(2024) Commissioning Process for Buildings and Systems

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline	(2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB S1110	(2019) Whole Building Technical Commissioning of New Construction; 2nd Edition

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

ANSI/SMACNA 014	(2013) HVAC Systems Commissioning Manual, 2nd Edition

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 25-345-1	(2019) Commissioning -- Systems Manual

1.2 DEFINITIONS

Commissioning Process (Cx) - a quality-focused process for enhancing the delivery of a project. Refer to ASHRAE 202 for a comprehensive description of the commissioning process.

****

NOTE: The following paragraph contains tailoring for ARMY, NAVY, and GOVT-HIRED COMMISSIONING PROVIDER. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

****

Commissioning Provider Lead Commissioning Specialist (CxC) - The entity hired by the Government, who leads, plans, and coordinates the Commissioning Team. The terms Commissioning Provider, Commissioning Firm, Lead Commissioning Specialist, Commissioning Specialist, and Commissioning Authority (CA or CxA) when used by sustainable Third Party Certification (TPC) programs, are interchangeable.

Commissioning Authority – The Government retains the authority for oversight and assurance of the entire commissioning process, and final approval of all commissioning deliverables.

****

NOTE: The following paragraph is tailored for NAVY. For Navy managed projects, refer to NAVFAC Instruction 3960.1 "Technical Oversight and Acceptance Testing of Critical Systems" for information on Acceptance Testing Representatives' roles and responsibilities.

****

Government Acceptance Testing Representatives - Government Acceptance Testing Representatives perform the inherently Governmental function of technical oversight and quality assurance for critical systems, and is distinctly separate from the commissioning process. Government Acceptance Testing Representatives witness final testing of critical systems and report systems' acceptance to the COR. Submittals to be surveilled and approved by Government Acceptance Testing Representatives are identified in Section 01 33 00 SUBMITTAL PROCEDURES 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES. Testing required to be witnessed by Government Acceptance Testing Representatives are identified in system level sections.

****

NOTE: The Owner's Project Requirements (OPR) document may be included as deemed appropriate by the project team or as required by some Third Party Certification (TPC) systems (such as LEED and Green Globes). The preliminary design deliverables and preliminary design authority (PDA) documentation (1391, Basis of Design, UFCs, etc.) constitute the Owner's Project Requirements (OPR) and may be used in lieu of a stand-alone OPR. If used, the OPR is referenced by the CxC during design review when the specification is tailored for KTR HIRED COMMISSIONING PROVIDER.

NOTE: The Owner's Project Requirements (OPR) document may be included as deemed appropriate by the project team or as required by some Third Party Certification (TPC) systems (such as LEED and Green Globes). When not otherwise required for TPC, inclusion of the OPR for CxC review may be beneficial for ensuring large or complex projects conform to the Owner's needs. This may be unnecessary for more typical construction projects. If used, the OPR is referenced by the CxC during design review and during submittal review, inspections, and testing.

NOTE: If used, insert the OPR as Appendix A to the specification section. Include a statement on the OPR cover stating that the document is provided for commissioning review purposes only and is not a contract requirement. Retain the bracketed references to Owner's Project Requirements (OPR) throughout the specification when one is included. Delete the bracketed OPR references when the OPR is not included.

****

[Owner's Project Requirements (OPR) - document that details the stakeholders' requirements for the project and the expectations for how it will be used and operated. The OPR is provided for commissioning review purposes only and is not a contract requirement.

]1.3 COMMUNICATION WITH THE GOVERNMENT COMMISSIONING PROVIDER

****

NOTE: The following paragraph contains tailoring for ARMY, NAVY, KTR HIRED COMMISSIONING PROVIDER,

and GOVT HIRED COMMISSIONING PROVIDER. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

****

The Lead Commissioning Specialist (CxC) must submit all plans, schedules, reports, and documentation directly to the Contracting Officer's Representative concurrent with submission to the Quality Control (QC) Manager.

The Lead Commissioning Specialist must have direct communication with the Contracting Officer's Representative regarding all elements of the commissioning process; however, the Government has no direct contract authority with the Lead Commissioning Specialist.

The QC Manager must communicate directly with the CxC and Contracting Officer's Representative regarding all elements of the commissioning process; however, the CxC has no direct contract authority. Coordinate with the Contracting Officer's Representative for all commissioning activities required by the Commissioning Provider. Inform the Contracting Officer's Representative when systems are ready for commissioning activities, and allow access to the construction site and system(s) to be tested.

1.4 COMMUNICATION WITH GOVERNMENT ACCEPTANCE TESTING REPRESENTATIVES

The QC Manager must communicate directly with the Government Acceptance Testing Representatives and Contracting Officer's Representative regarding Government acceptance testing activities. Inform the Contracting Officer's Representative when systems are ready for testing to be witnessed by Government Acceptance Testing Representatives, and allow access to the construction site and system(s) to be tested.

1.5 SYSTEMS TO BE COMMISSIONED

****

NOTE: The following systems are required to be commissioned per ASHRAE Standard 90.1 as required by UFC 1-200-02 paragraph "Commissioning." Select all systems that are part of the scope. Add other systems as required by the scope of the project or required by the applied sustainable third party certification program. Other systems may be appropriate for commissioning depending on scope and funding such as communications systems or specialty process systems. Per UFC 1-200-02, paragraph Outdoor Water, new, permanent, potable irrigations systems are not allowed. Only include the bracketed irrigation system line item for new, non-potable irrigation systems or existing irrigation systems that are part of the commissioning scope of work.

Include bracketed "Building envelope" for new buildings and renovation projects that include significant envelope scope. Coordinate with Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING.

****

Coordinate commissioning and quality control activities for the following systems, equipment, and associated controls. System-specific requirements are located in the associated specification sections. Commission the following systems, equipment, and associated controls in accordance with this section and the inspection, testing, and quality control requirements of their respective sections:

[Heating, ventilating, air-conditioning, and refrigeration systems (mechanical and passive) and associated controls (HVAC)

][Lighting systems: interior and exterior, automatic and manual daylighting controls, occupancy sensing devices, automatic shut-off controls, time switching, and other lighting control devices, and dimming systems

][Service hot-water systems and controls

][Water pressure-booster systems

][Building Control Systems

][Utility Monitoring and Control Systems

][Metering and sub-metering

][Automatic Receptacle Control

][Building Envelope in accordance with Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING.

] [_____]

1.6 RELATED SECTIONS

Refer to the following technical sections for additional commissioning requirements for respective systems:

[Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING

][Section 23 08 00 COMMISSIONING OF MECHANICAL[AND PLUMBING] SYSTEMS

][Section 26 08 00 APPARATUS INSPECTION AND TESTING

]

1.7 COMMISSIONING TEAM

****

NOTE: The following paragraph contains ARMY, NAVY, and DESIGN-BUILD tailoring. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

Select the contractors and Government team members based on systems to be commissioned and the commissioning plan. Include Government Acceptance Testing Representatives for all Navy managed projects.

DOR involvement in commissioning is required for design-build projects. DOR involvement is highly encouraged for design-bid-build projects when

available during the construction phase of the project (such as with in-house design personnel or when construction phase services are contracted for the DOR). When DESIGN-BUILD tailoring is selected, the DOR in included in the list. When DESIGN-BID-BUILD is selected, the DOR is in brackets, and the project team will include the DOR as appropriate.

****

The Commissioning team will include, but is not limited to the following team members.

Ensure all Design and Construction Activities for systems to be commissioned are coordinated with the appropriate commissioning team members.

a. Commissioning Provider Lead Commissioning Specialist (CxC)

b. QC Manager

c. Sub-Contractor Representatives for each trade responsible for construction/installation of systems to be commissioned

d. Construction Manager (CM) Contractor's Project Manager

e. Technical Commissioning Specialists for each system to be commissioned

f. TAB Representative

g. Equipment manufacturer representatives

h. Government Contracting Officer

i. Government Representatives

j. Installation Maintenance Representative

k. Facility End User

[l. Designer of Record (DOR)

] m. Designer of Record (DOR)

n. Government Acceptance Testing Representatives

o. [_____]

1.8 PROJECT SCHEDULE

****

NOTE: This paragraph contains tailoring options for ARMY and NAVY. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

Edit milestones based on systems to be commissioned and the requirements of the contract documents.

Select bracketed items as applicable. Include

additional schedule tasks as necessary. Final editing will require renumbering remaining items.
****

Include the following tasks in the project schedule required by Section 01 32 01.00 10 PROJECT SCHEDULE 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS) and in the construction phase commissioning plan. Ensure sufficient time is scheduled to complete each item. The order of items listed below is not intended to imply a specified sequence:

****
NOTE: The following two items are tailored for KTR HIRED COMMISSIONING PROVIDER and DESIGN-BUILD.
****

a. Submission and approval of the Commissioning Firm Qualifications

b. Submission and approval of the Design Phase Commissioning Plan

****
NOTE: The following items are tailored for KTR HIRED COMMISSIONING PROVIDER. Select the Design Review Report submittal if a design review will be conducted post-contract award. Commissioning design review report may be required by applicable Sustainability Third Party Certification guidelines.
****

[c. Submission and approval of the Design Review Report

] d. Submission and approval of the Interim and Final Construction Phase Commissioning Plans

e. Commissioning Kickoff Meeting

f. Regular Commissioning Coordination Meetings

g. Installation of permanent utilities (gas, water, electric, steam)

h. Building Enclosure Construction

i. Submission and approval of the Completed Building Enclosure Inspection Checklists

j. Manufacturer's Equipment Start-Up for each of the systems to be commissioned

k. Submission and approval of the Completed Commissioning Observation Checklists

l. Submission and approval of Certificate of Readiness for each system to be commissioned

m. Commissioning Testing, including Functional Performance Testing, for each system to be commissioned

****
NOTE: The following item is tailored for INTEGRATED SYSTEMS TEST.

****

n. Integrated Systems Tests

o. Post-test deficiency correction for each system to be commissioned

p. Re-Testing

****
NOTE: The following two items are tailored for ARMY.
****

q. Submission and approval of the Maintenance and Service Life Plans

r. Submission and approval of the Systems Manual

s. Training for each of the systems to be commissioned

****
NOTE: The following item is tailored for KTR HIRED COMMISSIONING PROVIDER.
****

t. Submission and approval of the Initial and Final Commissioning Reports

****
NOTE: The following item is tailored for NAVY.
****

u. Final testing required to be witnessed by Government Acceptance Testing Representatives, as identified in system level sections.

[v. [_____]

][1.9 PHASING

****
NOTE: Include this bracketed paragraph and provide instruction to contractor for projects with phases or multiple buildings to convey particular commissioning scheduling requirements beyond the Contractor's means and methods. Determine whether systems are to be commissioned as each phase or building is completed, or deferred until all phases or buildings are complete. Coordinate scheduling requirements with project manager.
****

[This project includes multiple [phases][and][buildings]. Commissioning activities for each project phase[and][building] must be scheduled separately and must correspond to each completion milestone in the master schedule.] [_____]

]1.10 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal

items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army managed projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

For Navy design-build projects, delete Section 01 33 00 SUBMITTAL PROCEDURES, and replace with Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES and Section 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES. For Army managed projects, use Section 01 33 00 SUBMITTAL PROCEDURES for both design-build and design-bid-build projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

SD-05 Design Data

****
NOTE: The following submittal is tailored for KTR HIRED COMMISSIONING PROVIDER and DESIGN-BUILD.
****

Design Phase Commissioning Plan; G, [_____]

SD-06 Test Reports

Completed Construction Observation Checklists; G, [_____]

****

NOTE: The following submittals are tailored for KTR HIRED COMMISSIONING PROVIDER. Select the Design Review Report submittal if a design review will be conducted post-contract award. Commissioning design review report may be required by applicable Sustainability Third Party Certification guidelines.

****

[Design Review Report; G, [_____]

] Interim Construction Phase Commissioning Plan; G, [_____]

Final Construction Phase Commissioning Plan; G, [_____]; S

Initial Commissioning Report; G, [_____]

Issues Log; G, [_____]

SD-07 Certificates

****

NOTE: The following submittal is tailored for KTR HIRED COMMISSIONING PROVIDER.

****

Commissioning Firm; G, [_____]

Certificate of Readiness; G, [_____]

SD-10 Operation and Maintenance Data

****

NOTE: The following submittal is tailored for ARMY and KTR HIRED COMMISSIONING PROVIDER.

****

Maintenance and Service Life Plan; G, [_____]

Systems Manual; G, [_____]

SD-11 Closeout Submittals

****

NOTE: The following submittals are tailored for KTR HIRED COMMISSIONING PROVIDER. Retain the Updated Final Commissioning Report submittal for projects that require a Warranty Phase Site Visit.

****

Final Commissioning Report; G, [_____]

Updated Final Commissioning Report; G, [_____]

****

NOTE: Retain the following submittal for projects that are required to track "S" submittals in the Sustainability eNotebook, in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

[Final Commissioning Report (eNotebook); S

][Updated Final Commissioning Report (eNotebook); S

]1.11 COMMISSIONING FIRM

****
NOTE: The following paragraphs are tailored for KTR HIRED COMMISSIONING PROVIDER. Verify the certifications below cover the requirements of the systems to be commissioned in the project. Add or delete certificates as appropriate.
****

Employ the services of a Commissioning Firm and all Commissioning Specialists required to perform work for this project. The Commissioning Firm must be a first-tier subcontractor that is financially and corporately independent from prime contractor and all other subcontractors and the Designer of Record and that is not participating in any other work on this Contract, including design, furnishing equipment, construction, or testing, adjusting, and balancing.

****
NOTE: Choose the bracketed option 60 days for large or complex projects or projects with long duration. Choose the bracketed option 30 days for small or non-complex projects, or projects with shorter duration.
****

a. Submit the Commissioning Firm's and Commissioning Specialists' qualifications, including the name of the firm and each CxC and each certification, no later than [60][30] calendar days after contract award notice to proceed notice to proceed.

b. If, for any reason, a specialist loses a certification during this period, immediately notify the Contracting Officer and submit another Commissioning Specialist for approval. An approved successor must validate all work performed for this project by the CxC who lost a certification.

1.11.1 Commissioning Specialists (CxC)

Assign Lead Commissioning Specialist and other appropriate Commissioning Specialists for the systems to be commissioned.

1.11.1.1 Lead Commissioning Specialist (CxC)

****
NOTE: Retain the bracketed certifications for CONUS and other locations where commissioning firms are likely to achieve this level of qualification. Delete the bracketed certification requirements in locations, such as other countries, where these certificates are not normally acquired.
****

Lead Commissioning Specialist (CxC) coordinates all aspects of the commissioning process. Duties include leading and overseeing the commissioning work and acting as the primary point of contact for the commissioning work. CxC may serve as a systems Specialist if all requirements for both designations are met. CxC must have a minimum of five years of commissioning experience, including two projects of similar size and complexity to this project.

[CxC must be certified in one of the following:

NEBB Building System Commissioning Professional (CxCP)

ACG Certified Commissioning Authority (CxA)

ICB/TABB Certified Commissioning Supervisor

BCA Certified Commissioning Professional (CCP)

AEE Certified Building Commissioning Professional (CBCP)

University of Wisconsin-Madison Qualified Commissioning Process Provider (QCxP)

ASHRAE Building Commissioning Professional (BCxP).

]1.11.1.2 Commissioning Specialists

****

NOTE: Retain Commissioning Specialists based on the systems to be commissioned. Coordinate requirements with referenced UFGS Sections.

Choose bracketed phrases that are part of the project scope of work. Add any specialists necessary to execute the commissioning scope of this project.

****

Refer to the related technical commissioning specification section for additional qualifications for each Commissioning Specialist associated with each system. Include all Commissioning Specialist qualifications with the Commissioning Firm submittal:

[a. Mechanical Commissioning Specialist: The technical work associated with mechanical systems to be commissioned must be performed by a Commissioning Specialist certified by NEBB, ACG, ICB/TABB, AEE, University of Wisconsin-Madison, ASHRAE, or BCA in the commissioning of HVAC systems with five years of experience in the commissioning of HVAC systems.
]

****

NOTE: Low complexity electrical systems, such as lighting control systems, may not necessitate the use of an electrical specialist. In such cases, the project team may allow the mechanical specialist to perform the electrical specialist role. Select the appropriate bracketed language. The contractor may then determine which type of specialist to use.

NOTE: More complex electrical systems may

necessitate an electrical commissioning specialist. When the project includes specification Section 26 08 00 APPARATUS INSPECTION AND TESTING, the engineering technician performing the inspection and testing work described in that section may serve as the electrical commissioning specialist for commissioning. Select the appropriate bracketed language. Include bracketed option for utilizing Mechanical Commissioning Specialist to commission low complexity systems.

****

[b. Electrical Commissioning Specialist: The technical work associated with electrical systems to be commissioned must be performed by an engineering technician with five years of experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.[The lead engineering technician specified in specification Section 26 08 00 APPARATUS INSPECTION AND TESTING may serve as the Electrical Commissioning Specialist.][The Mechanical Commissioning Specialist may be utilized to perform the technical work associated with electrical systems to be commissioned.]

] c. Building Enclosure Commissioning Specialist: The technical work associated with the Building Envelope system must be performed by a Building Enclosure Commissioning Specialist that is a[registered architect or engineer, or building scientist, with five years of building enclosure design or construction experience][or a professional with training and Certification in Building Enclosure Commissioning from a third-party certification organization plus five years of commissioning experience]. The commissioning provider must have the necessary training, experience, and FPT equipment.

1.12 GOVERNMENT HIRED COMMISSIONING PROVIDER

****

NOTE: This paragraph is tailored for NAVY and GOVT HIRED COMMISSIONING PROVIDER when the Commissioning Provider is retained under a separate contract by the Government.

****

The Commissioning Provider (CxC) is employed by Government under separate contract. Incorporate key milestones of the Commissioning process into the Project Schedule identified in this Section.

1.13 COMMISSIONING STANDARD

****

NOTE: This paragraph is tailored for ARMY or KTR HIRED COMMISSIONING PROVIDER.

****

Comply with ASHRAE 202 and the commissioning standards under which the Commissioning Firm and Specialists qualifications are approved, which may include ACG Commissioning Guideline, NEBB S1110, or ANSI/SMACNA 014. Comply with the requirements of the commissioning standard under which the Commissioning Firm and Specialists qualifications are approved. When the firm and specialists are certified by BCA, AEE, ASHRAE, or the University of Wisconsin-Madison, comply with the requirements of one of these acceptable standards: ACG Commissioning Guideline, NEBB S1110, ANSI/SMACNA 014, or ASHRAE 202. In a conflict, the most stringent requirements apply. In addition, comply with ASHRAE 90.1 - IP commissioning requirements for all systems. Refer to related technical commissioning specification sections for additional standards requirements.[Comply with applicable International Electrical Testing Association (NETA) testing standards for electrical systems.] The following requirements apply to all project commissioning and test standards:

a. Implement all recommendations and suggested practices contained in the Commissioning Standard and test standards.

b. Use the Commissioning Standard for all aspects of Commissioning, including calibration of instruments.

c. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, adhere to the manufacturer calibration recommendations.

d. All quality assurance provisions of the Commissioning Standard such as performance guarantees are part of this contract.

e. The Commissioning Specialists must develop commissioning procedures for any systems or system components not covered in the Commissioning Standard.

f. Use any new requirements, recommendations, and procedures published or adopted by the body responsible for the applicable Commissioning Standards at the time of project award.

g. If there is a conflict between the requirements of the contract documents and the commissioning standard used, the contract documents take precedent.

1.14 SUSTAINABILITY THIRD PARTY CERTIFICATION (TPC)

****

NOTE: Select this paragraph for projects applying sustainability Third Party Certification (TPC) requirements. Refer to UFC 1-200-02 to determine when SUSTAINABLE THIRD PARTY CERTIFICATION (TPC) is required. Coordinate with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. This paragraph is tailored for KTR HIRED COMMISSIONING PROVIDER.

****

The Commissioning Specialist must perform all commissioning activities, coordination, and submittals required by the sustainability Third Party Certification (TPC) program applied to this project, in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

NOTE: Choose this paragraph for projects applying sustainability third party certification LEED. Edit the bracketed phrases based on the credits (options and paths) in the project scope. For design-bid-build projects, ensure a Government team

member or a third party contractor is qualified to act as the LEED Commissioning Authority, based on LEED requirements.

Include bracketed option "and Option 2: Envelope Commissioning" on LEED projects for new buildings or renovation projects with significant envelope scope.

****

[CxC must provide documentation or perform commissioning activities, coordination and submittals as required by Leadership in Energy and Environmental Design (LEED) Fundamental Commissioning and Verification[and Enhanced Commissioning [Option 1: Path 1 Enhanced Commissioning] [Option 1: Path 2 Enhanced and Monitoring-Based Commissioning] [and Option 2: Envelope Commissioning]].

]1.15 ISSUES LOG

The Commissioning Specialist develops and maintains an Issues Log for the systems to be commissioned. The issues log documents and tracks resolution of deficiencies identified during submittal reviews, inspection, and testing. At any point during construction, any commissioning team member finding deficiencies may communicate those deficiencies in writing to the Commissioning Specialist for inclusion into the Issues Log. For each issue, the Issues Log includes, but is not limited to, a unique reference number, description of the issue with contract requirement referenced, location of or equipment name/tags exhibiting the issue, the initials of the individual's name whom reported the issue, the date of first observation, the proposed resolution of the issue and date proposed, the date of any subsequent observations with applicable additional information, and the date of implementation of the final resolution of the issue as confirmed by the Commissioning Specialist and Contracting Officer. Issues must not be deleted from the issues log.

****

NOTE: This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, ARMY, and NAVY. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

****

CxC must submit the Issues Log monthly and within three working days from changes to the Issue Log. The CxC is responsible for distributing the Issues Log to the Commissioning Team. QC Manager must track construction deficiencies identified in the Issues Log using a quality management system in accordance with Section[01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE(RMS CM)][01 45 00 QUALITY CONTROL]. The QC Manager is responsible for notifying the CxC and Contracting Officer of outstanding deficiencies and tracking them to resolution in accordance with Section 01 45 00 QUALITY CONTROL, "Quality Control Plan".

1.16 CERTIFICATE OF READINESS

****

NOTE: This paragraph contains tailoring options for ARMY and NAVY. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

Choose the bracketed phrases required in the project

scope.
****

Prior to scheduling Commissioning Tests for each system, the Quality Control Manager must issue a Certificate of Readiness for each system, certifying that inspections have been completed, open issues have been resolved, and the system is ready for Commissioning Tests. Refer to each related technical commissioning specification section for additional requirements.

Submit the Certificate of Readiness for each system [30] [_____] calendar days [20] [_____] working days prior to Commissioning Tests of that system. Do not schedule Commissioning Tests for a system until the Certificate of Readiness is approved by the Government.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 DESIGN COMMISSIONING COORDINATION MEETING

****
NOTE: This paragraph is tailored for DESIGN-BUILD, and contains tailoring options for KTR HIRED COMMISSIONING PROVIDER and GOVT HIRED COMMISSIONING PROVIDER.

The design phase commissioning coordination meeting should occur prior to 50 percent design completion.
****

Conduct a design commissioning coordination meeting led by the CxC prior to the [35] [50] percent design submittal for systems to be commissioned. Discuss Participate in a design commissioning coordination meeting led by the CxC prior to the [35] [50] percent design submittal for system to be commissioned. The purpose of the meeting is to discuss the commissioning process, including project contract requirements, lines of communication, roles and responsibilities, schedules, and documentation requirements.

****
NOTE: This paragraph contains tailoring options for ARMY and NAVY. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied. Choose bracketed option for command and maintenance activity representatives as applicable.
****

The Construction Manager, Contractor's Project Manager, Quality Control team, Designer of Record, and the Government Acceptance Testing Representatives and other Government team members must attend this meeting. Invite the User and[a Directorate of Public Works Representative][a Reserve Support Command Representative] [_____][a Public Works Division Representative] [Base Civil Engineering Representative] [_____] to attend this meeting. The meeting may be conducted by teleconferencing.

3.2 DESIGN PHASE COMMISSIONING PLAN

****

NOTE: This paragraph is tailored for DESIGN-BUILD and contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, GOVT HIRED COMMISSIONING PROVIDER, and NAVY.

****

Submit the Design Phase Commissioning Plan no later than 14 calendar days after the Design Commissioning Coordination Meeting. Outline the commissioning process, commissioning team members and responsibilities, lines of communication, and documentation requirements for the design phase of the project in the Design Phase Commissioning Plan. Identify the Commissioning Standards chosen for the project.

Provide a list of team members for systems to be commissioned with contact information, a list of tests as required by Section 01 33 00 SUBMITTAL PROCEDURES01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES, and project schedule as required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULE for inclusion in the Design Phase Commissioning Plan no later than 14 calendar days after the Design Commissioning Coordination Meeting.

[3.3 DESIGN REVIEW

****

NOTE: For Navy managed projects, the DESIGN REVIEW paragraph is a bracketed selection; select the DESIGN REVIEW paragraph if a design review is required after contract award. For Army managed projects, the DESIGN REVIEW paragraph is not bracketed. Commissioning design review report is required for Army managed projects and may be required by applicable Sustainability Third Party Certification guidelines.

This paragraph contains tailoring options for ARMY, NAVY, KTR HIRED COMMISSIONING PROVIDER and GOVT HIRED COMMISSIONING PROVIDER. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

Choose bracketed language regarding the Owner's Project Requirements Document for projects that require one (refer to specifier note regarding OPR in paragraph DEFINITIONS for further information).

NOTE: When a KTR hired commissioning provider is used for a DESIGN-BID-BUILD project, the first opportunity for the CxC to review the project is early in construction. Leveraging the CxC's experience in review of the design to identify any remaining problems allows early correction, where correction is necessary. This can allow major problems to be addressed with minimal time and cost growth during construction. The Government, in coordination with designers, must review the Design Review Report to determine if any design changes are necessary. Changes to the construction contract are

still at the sole discretion of the Contracting Officer.

****

The CxC and other Commissioning Specialists must review design documents. The design review must occur prior to [60] [_____] percent design completion. The design review must include verifying that the design for the systems to be commissioned are prepared in accordance with the contract documents.

Provide a Design Review Report identifying discrepancies or deficiencies that would prevent the systems to be commissioned from operating or performing effectively in accordance with the design requirements or being adequately safely maintained. Report must include individual list of each deficiency and corresponding corrective action necessary for proper system performance.[Identify any discrepancies between the design and the Owner's Project Requirements Document. The Owner's Project Requirements Document is provided for commissioning review purposes only and does not form a part of the contract documents for this project.] **Submit the Design Review Report no later than [14] [_____] calendar days after approval of the Commissioning Firm and Commissioning Specialists after completing the review of the design.** The Contracting Officer, Construction Manager, the Contractor's Project Manager, the CxC, and the Designers of Record for the associated systems must meet, discuss, and resolve any outstanding items contained in the report no later than 14 calendar days after submission of the report. The CxC must verify that their review comments have been adequately addressed in subsequent design submittals.

The CxC is responsible for reviewing the design and preparing a Design Review Report identifying discrepancies or deficiencies that would prevent the systems to be commissioned from operating or performing in accordance with the design requirements or being safely maintained.

The Contracting Officer, the CxC, and the Designers of Record for the associated systems must meet, discuss, and resolve any outstanding items contained in the report no later than 14 calendar days after submission of the report. The CxC will verify that their review comments have been adequately addressed in subsequent design submittals.

]3.4 CONSTRUCTION SUBMITTAL REVIEWS

****

NOTE: This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, GOVT HIRED COMMISSIONING PROVIDER, and DESIGN-BUILD.

This paragraph contains tailoring for ARMY. Choose bracketed "and the Owner's Project Requirements" for projects that require one. Refer to specifier note regarding OPR in paragraph DEFINITIONS for further information.

****

Coordinate construction submittal document reviews for commissioned systems and assemblies with the CxC. The commissioning submittal review does not replace the designer of record (DOR) or Government submittal review, in accordance with Section 01 33 00 SUBMITTAL PROCEDURES 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES.

The CxC must identify construction submittals to be provided by the contractor for the commissioned systems. The CxC must evaluate construction submittals for compliance with the contract documents[and Owner's Project Requirements Document] prior to submission to the Government concurrent with DOR review. Include a copy of CxC comments with the construction submittals. The CxC is responsible for identifying construction submittals to be provided by the contractor for the commissioned systems. The CxC is responsible for evaluating construction submittals for compliance with the contract documents. The DOR must consider the CxC's comments, and the DOR provides direction to the contractor as necessary. Provide a copy of final DOR submittal reviews with comment responses to the CxC. Include a copy of the submittal document review transmittal and response in the Commissioning Report.

3.5 COMMISSIONING KICKOFF MEETING

****

NOTE: This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER and GOVT HIRED COMMISSIONING PROVIDER.

****

Conduct a Commissioning Kickoff Meeting, led by the CxC, after approval of the Commissioning Firm and Commissioning Specialists, and no later than [30] [_____] days following approval of the Commissioning Firm and Specialists. Discuss The CxC is responsible for conducting a Commissioning Kickoff Meeting no later than 60 days following construction notice to proceed to discuss the commissioning process including contract requirements, lines of communication, roles and responsibilities, schedules, documentation requirements, inspection and test procedures, and logistics as specified in this section.

****

NOTE: This paragraph contains tailoring options for ARMY and NAVY. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied. Choose bracketed option for command and maintenance activity representatives as applicable.

****

The Construction Manager, Contractor's Project Manager, Quality Control team, Designer of Record, and the Government Acceptance Testing Representatives and other Government team members must attend this meeting. Invite the User and[a Directorate of Public Works Representative][a Reserve Readiness Division Representative] [_____][a Public Works Division Representative] [Base Civil Engineering Representative] [_____] to attend this meeting.

3.6 REGULAR COMMISSIONING COORDINATION MEETINGS

****

NOTE: This paragraph contains tailoring options for ARMY, NAVY, KTR HIRED COMMISSIONING PROVIDER, and GOVT HIRED COMMISSIONING PROVIDER. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied. Choose bracketed option for command and maintenance activity representatives as applicable.

****

The Quality Control team, Designer of Record, and the Government Acceptance Testing Representatives and other Government team members must attend this meeting. Sub-Contractor Representatives for each trade responsible for construction/installation of systems to be commissioned must attend this meeting as requested by the CxC. Invite the User and[a Directorate of Public Works Representative][a Reserve Readiness Division Representative][a Public Works Division Representative] [_____] [a Base Civil Engineering Representative] [_____] to attend this meeting.

CxC must conduct monthly commissioning coordination meetings when installation of commissioned systems begins. Provide status of commissioned systems, open issues log items, outstanding submittals, and upcoming commissioning activities. Conduct bi-weekly commissioning coordination meetings within 30 days of the scheduled date for commissioning testing.

Participate in monthly commissioning coordination meetings led by the CxC when installation of commissioned systems begins. Provide status of commissioned systems, open issues log items, outstanding submittals, and upcoming commissioning activities. Participate in bi-weekly commissioning coordination meetings within 30 days of the scheduled date for commissioning testing.

3.7 CONSTRUCTION PHASE COMMISSIONING PLANS

****

NOTE: Portions of the following paragraphs contain tailoring options for KTR HIRED COMMISSIONING PROVIDER, GOVT HIRED COMMISSIONING PROVIDER, INTEGRATED SYSTEMS TEST, ARMY, and NAVY.

Include bracketed "and Template Building Enclosure Inspection Checklists" for new buildings or renovation projects with significant envelope scope.

Choose Sustainability eNotebook bracketed option as applicable. Refer to Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

The Interim Construction Phase Commissioning Plan identifies the commissioning and testing standards and outline the overall commissioning process, the commissioning schedule, the commissioning team members and responsibilities, lines of communication, documentation requirements for the construction phase of the project[, and Template Building Enclosure Inspection Checklists]. Submit the Interim Construction Phase Commissioning Plan, prepared by the CxC, 14 calendar days after the Construction Commissioning Coordination Meeting and 14 days prior to the start of construction of the building enclosure. Include the following items in the commissioning schedule in addition to the items in paragraph PROJECT SCHEDULE: [Commissioning Site Visits,]Seasonal Testing, Warranty Phase Site Visit, Post-Construction Endurance Testing, and Updated Commissioning Report. Provide a list of team members for systems to be commissioned with contact information, a list of tests as required by Section 01 33 00 SUBMITTAL PROCEDURES 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES, and project schedule as required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULE for inclusion in the Interim Construction Phase Commissioning Plan no later than 14 calendar days after the Commissioning Coordination Meeting.

The Final Construction Phase Commissioning Plan includes the information provided in the Interim Construction Phase Commissioning Plan as well as commissioning construction observation checklists and test procedures such as Pre-Functional Checklists, Integrated Systems Test Checklists, and Functional Performance Test Checklists and other Commissioning Test Checklists for each building, for each system required to be commissioned, and for each component for inclusion in the Final Construction Phase Commissioning Plan. Refer to the related technical commissioning specification section for additional requirements for checklists. Submit the Final Construction Phase Commissioning Plan, prepared by the CxC, no later than [90] [_____] calendar days prior to the start of Commissioning Inspections.[Once approved, file the approved plan in the Sustainability eNotebook.] Provide updates to the list of team members for systems to be commissioned with contact information, a list of tests as required by Section 01 33 00 SUBMITTAL PROCEDURES, and project schedule as required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULE for inclusion in the Final Construction Phase Commissioning Plan within 14 calendar days of a written request from the CxC.

3.7.1 Construction Observation Checklists

****

NOTE: This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER and GOVT HIRED COMMISSIONING PROVIDER.

****

Construction Observation Checklists must include items for physical inspection or testing that demonstrate that installation and start-up of equipment and systems is complete. Refer to paragraph COMMISSIONING INSPECTIONS. Construction observation checklists must be tailored to verify the specific installation requirements and details of the construction documents and manufacturer's instructions.
Use the Construction Observation Checklists prepared by the CxC for physical inspection or testing to demonstrate that installation and start-up of equipment and systems is complete. Refer to paragraph COMMISSIONING INSPECTIONS.

3.7.2 Test Procedures and Checklists

****

NOTE: This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER and GOVT HIRED COMMISSIONING PROVIDER.

****

Test procedures and checklists must include procedures that explain, step-by-step, the actions and expected results that will demonstrate that the systems perform in accordance with the contract. Refer to paragraph COMMISSIONING TESTS. Include the following sections and details appropriate to the systems being tested in the test procedures and checklists:

a. Notable system features including information about controls to facilitate understanding of system operation

b. Conclusions and recommendations. Conclusions must clearly indicate if system does or does not perform in accordance with contract requirements. Recommendation must clearly indicate that the system should or should not be approved by the Government.

c. Test conditions including date, beginning and ending time, and beginning and ending outdoor air conditions

d. Attendees

e. Identification of the equipment involved in the test

f. Control system feature identification

g. As-found condition of the system operation

h. List of test items with step numbers along with the corresponding feature or operation, intended test procedure, expected system response, and pass/fail indication.

i. Space for comments for each test item.

Use the test procedures and checklists prepared by the CxC that list, step-by-step, the actions and expected results that will demonstrate that the systems perform in accordance with the contract. Refer to paragraph COMMISSIONING TESTS.

[3.8 COMMISSIONING SITE VISITS

****

NOTE: This paragraph contains tailoring for KTR HIRED COMMISSIONING PROVIDER and ARMY. Choose the bracketed "and the Owner's Project Requirements Document" for projects that will include an OPR.

Commissioning Inspections will require the CxC to visit the site to the extent necessary to validate completion of Construction Observation Checklists. This paragraph requires additional site visits throughout the construction of the commissioned systems to provides an opportunity to identify issues earlier when impacts to schedule and costs are lower. This may be beneficial for large, complex projects or when additional support is needed to supplement construction quality assurance personnel. The paragraph should be included at the project team's discretion. Project teams should specify the frequency of commissioning site visits based on project complexity, number of facilities or phases, and anticipated construction schedule.

An alternative strategy to setting a frequency of visit is to tie visits to specific events during construction. The project team may replace the paragraph with a schedule of visits, if appropriate.

****

The CxC must visit the construction site no less than once every[90] [_____] days during construction of the commissioned systems to verify that construction is achieving the requirements of the contract documents[and the Owner's Project Requirements Document].[The frequency of the site visits must increase to[bi-weekly] [_____] within[90] [_____] days of the scheduled commissioning tests.] The CxC must vist the construction site more frequently, as needed, to complete commissioning inspections. Document deficiencies or issues in the Issues Log.

]3.9 COMMISSIONING INSPECTIONS

****

NOTE: Choose bracketed "and the Owner's Project Requirements (OPR)" for projects that will include an Owner's Project Requirements (OPR) document. Refer to specifier note regarding OPR in paragraph DEFINITIONS for further information.

****

Complete inspections using Construction Observation Checklists for each individual item of equipment or system for each system required to be commissioned in accordance with the commissioning plan. Indicate commissioning team member inspection and validation of each checklist item by initials. Validation of each checklist item by each team member indicates that item conforms to the contract documents and design in their area of responsibility. Commissioning Specialist validation of each checklist item indicates that each item has been installed correctly and in accordance with contract documents[and the Owner's Project Requirements (OPR)]. Submit the initialed and Completed Construction Observation Checklists no later than 7 calendar days after completion of inspection of all checklists items for each system.

3.10 COMMISSIONING TESTS

****

NOTE: This paragraph contains tailoring for ARMY and NAVY. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied. Choose bracketed "and the Owner's Project Requirements Document" for projects that will include an Owner's Project Requirements (OPR) document. Refer to specifier note regarding OPR in paragraph DEFINITIONS for further information.

****

Demonstrate that all systems, equipment, and components have been installed correctly and that the systems operate and perform, including interactive operation between systems, in accordance with contract documents[and the Owner's Project Requirements Document]. Perform tests as specified in related technical commissioning specifications. Provide all materials, services, and labor required to perform all commissioning tests.

Commissioning Specialist's duties include leading and documenting all tests for the systems to be commissioned with appropriate sub-contractors performing the Tests. The representatives listed in the paragraph COMMISSIONING TEAM must attend the tests with the exception of the Construction Manager Contractor's Project Manager.

3.10.1 Test Scheduling and Coordination

****

NOTE: The following paragraph contains tailoring for INTEGRATED SYSTEMS TEST.

****

Schedule Commissioning Tests for each system only after the Certificate of Readiness has been approved by the Government for the system. Correct all deficiencies identified through any prior review, inspection, or test activity before the start of Commissioning tests.

Commissioning Tests and Integrated Systems Tests must be performed with the CxC present. Government reserves the right to witness all tests. Coordinate test schedule with Government representatives.

3.10.2 Testing Procedures

****

NOTE: Select bracketed language for electrical system testing. Mechanical and building enclosure testing requirements are included in related sections. Until an electrical commissioning specification section is available, detailed requirements for electrical system testing are not available. Testing will be as required in referenced standards, including ASHRAE Standard 90.1.

****

Commissioning tests include tests such as functional performance and integrated systems tests.[For electrical systems testing, include testing of sensor calibrations, control responses, safeties, interlocks, operating modes, capacity, lighting levels, and verification of all other electrical system contract performance requirements.] Perform test procedures in accordance with the commissioning standards specified. In addition, comply with the testing procedures specified in the sections listed in paragraph RELATED SECTIONS.

3.10.3 Sample Strategy

****

NOTE: This paragraph contains tailoring for DESIGN-BUILD AND DESIGN-BID-BUILD. For design-bid-build projects, sample strategy will be addressed by the related technical commissioning specification sections (such as Section 23 08 00 COMMISSIONING OF MECHANICAL[AND PLUMBING] SYSTEMS). Because of the need for Section 01 91 00.15 to stand-alone for some design-build solicitations, sample strategy will be specified in this paragraph for design-build projects.

For design-build projects, select the percentage sample size for large groups of identical equipment as determined by the project delivery team. Higher percentages may be appropriate for critical systems or projects or for small numbers of equipment.

Electrical systems sampling must be addressed in this specification. Add equipment/system types and sample size for each electrical item as appropriate.

****

Refer to the sections identified in paragraph RELATED SECTIONS for sample strategy. Perform commissioning tests for all systems and equipment to be commissioned using the sample strategy identified herein. Complete a Test Checklist for each item of equipment or system to be tested. For sample sizes less than 100 percent for similar equipment, the Contracting Officer's Representative reserves the right to select the specific equipment or system to be tested.

[For electrical systems, test 100 percent of all equipment and systems except for the following. Test at the sample rate shown:

a. Lighting Controls [_____]

b. [_____]

c. [_____]

] Test all central plant equipment, primary air handling units, and process cooling or heating equipment. Test all system-level equipment serving multiple zones. [Twenty-five][Fifty][_____] percent sample testing is allowed for large groups of identical equipment with identical controllers serving single zones such as air terminal units, fan coil units, unitary equipment, and plumbing fixtures. Sample size may be no less than three units.

For electrical systems, test 100 percent of all equipment and systems except for the following[. Test at the sample rate shown]:

a. [_____]

b. [_____]

c. [_____]

3.10.3.1 100 Percent Sample Procedures

Systems or equipment for which 100 percent sample size are tested fail if one or more of the test procedures results in discovery of a deficiency and the deficiency cannot be resolved within 5 minutes during the test.

Re-test to the extent necessary to confirm that the deficiencies have been corrected without negatively impacting the performance of the rest of the system.

3.10.3.2 Less than 100 Percent Sample Procedures

Randomly test each sample group of identical equipment. Sample size must be at least three units. If 10 percent of the units in the first sample fail the commissioning tests, test a second sample group, the same size as the first sample group. The second sample must not include any units from the first sample group.

If 10 percent of the units in the second sample fail, test all remaining units. If at any point frequent failures occur, the CxC may stop the testing and require the contractor to perform and document a checkout of the remaining equipment prior to continuing commissioning testing.

3.10.4 Aborted Tests and Re-Testing

Abort any test if any deficiency prevents successful completion of the test or if any required commissioning team member is not present for the test. Re-test after all deficiencies identified during the original test have been corrected. Contracting Officer may withhold payment equivalent to lost time, re-testing, and aborted tests. These costs may include salary, travel costs, and per diem for Government team members.

3.11 TRAINING PLAN

****

NOTE: Coordinate requirements with Sections 01 91 19 BUILDING ENCLOSURE COMMISSIONING, 01 78 23 OPERATION AND MAINTENANCE DATA, and 01 45 00 QUALITY CONTROL, all of which address training plans.

This paragraph contains tailoring options for NAVY.

****

CxC must review the training plan for training associated with the equipment and systems to be commissioned, checking that each plan has the trainer name, trainer contract information, training schedule and location. Submit review at least 30 days prior to the first training event. Incorporate CxC review comments prior to submitting training plan in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW). Update and resubmit the training plan based on any corrective action taken.

[3.12 SYSTEMS MANUAL

****

NOTE: This paragraph is tailored for ARMY, NAVY, DESIGN-BUILD, KTR HIRED COMMISSIONING PROVIDER, GOVT HIRED COMMISSIONING PROVIDER, and INTEGRATED SYSTEMS TEST. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

NOTE: A Systems Manual is required for Army managed projects in accordance with Engineering Regulations. A Systems Manual is required for projects applying LEED or Green Globes sustainability third party certification. Refer to Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Coordinate requirements with Section 01 78 23 OPERATION AND MAINTENANCE DATA and 01 45 00 QUALITY CONTROL, both of which address manuals.

****

The Systems Manual includes the Basis of Design, system single line diagrams, as-built sequences of operation and controls drawings, as-built control setpoints, recommended schedule for sensor and actuator calibration, recommended schedule of maintenance when not in the O&M manuals, recommended re-testing schedule with proposed testing forms, and full equipment warranty information for all commissioned systems. Incorporate CxC review comments prior to submitting Systems Manual in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW). [Obtain the Basis of Design for incorporation into the Systems Manaul from the Contracting Officer.]

Submit Systems Manual no later than 30 calendar days following completion of Functional Performance Tests and Integrated Systems Tests. Update and resubmit the system manual information based on any corrective action taken during the warranty period.

****

NOTE: This paragraph is tailored for ARMY and KTR HIRED COMMISSIONING PROVIDER and includes tailoring for DESIGN-BID-BUILD. For Army design-bid-build projects, the contractor must obtain the Basis of Design from the Government for inclusion in the Systems Manual.

****

Prepare and submit a Systems Manual, including a signed certification or letter from the Commissioning Specialists and the CxC stating that the Systems Manual is complete, clear, and accurate. The Systems Manual, for all commissioned systems, must conform to Appendix A SYSTEMS MANUAL ORGANIZATION AND CONTENT per ER 25-345-1, available at the USACE Publications website at the following location: https://www.publications.usace.army.mil/USACE-Publications/Engineer-Regulations/. Obtain the Basis of Design for incorporation into the Systems Manual from the Contracting Officer. Submit Systems Manual no later than 30 calendar days following completion of Functional Performance Tests and Integrated Systems Tests. Update and resubmit the Systems Manual based on any corrective action taken during the warranty period.

Ensure Systems Manual is coordinated with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA and Quality Control requirements.

]3.13 MAINTENANCE AND SERVICE LIFE PLAN

****

NOTE: This paragraph is tailored for ARMY. This paragraph contains tailoring for INTEGRATED SYSTEMS TEST. The Maintenance and Service Life Plans are required for Army and Army Reserve projects. Coordinate requirements with Sections 01 78 23 OPERATION AND MAINTENANCE DATA and 01 45 00 QUALITY CONTROL, both of which address maintenance requirements.

****

3.13.1 Maintenance Plan

Prepare and submit a Maintenance Plan for the project mechanical, electrical, plumbing, and fire protection systems. Prepare the HVAC and refrigeration sections of the Maintenance Plan in accordance with ASHRAE 180. Develop required inspection and maintenance tasks similar to Section 5 of ASHRAE 180 for the other commissioned systems and fire protection systems. Ensure Maintenance Plan is coordinated with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Submit the Maintenance Plan no later than 30 calendar days following the completion of Functional Performance Tests and Integrated Systems Tests.

3.13.2 Service Life Plan

Prepare and submit a Service Life Plan for the building enclosure, structural systems, and site hardscape that includes the following for each assembly or component:

a. A description of each including the materials or products.

b. The estimated service life, in years.

c. The estimated maintenance frequency and description of maintenance tasks.

d. The point of maintenance access for the components with estimated service life less than service life of the building.

Ensure Service Life Plan is coordinated with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit the Service Life Plan no later than 30 calendar days following the completion of Functional Performance Tests and Integrated Systems Tests.

3.14 COMMISSIONING REPORT

****

NOTE: This paragraph contains tailoring options for ARMY, NAVY, KTR HIRED COMMISSIONING PROVIDER, GOVT HIRED COMMISSIONING PROVIDER, and INTEGRATED SYSTEMS TESTS. For Air Force managed projects, either ARMY or NAVY tailoring options may be applied.

Choose Sustainability eNotebook bracketed option as applicable. Refer to Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Choose bracketed "and the Owner's Project Requirements Document" for projects that require one. Refer to specifier note regarding OPR in paragraph DEFINITIONS for further information.

Include two bracketed "Building Enclosure Inspection Checklists" for new buildings or renovation projects with significant envelope scope.

NOTE: Include the bracketed option Air Leakage Test Reports and Diagnostic Test Reports for Army managed projects that include this report in Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING.

****

Submit an Initial Commissioning Report Final Commissioning Report no later than 14 calendar days following commissioning team validation of all Commissioning Tests, including Functional Performance Tests, and Integrated Systems Tests, with the exception of Seasonal Tests. Submit a Final Commissioning Report upon completion of training and trend log reviews. [File the approved Final Commissioning Report (eNotebook) in the Sustainability eNotebook.]Include the following information in the Final Commissioning Report:

a. An executive summary describing the overall commissioning process, the results of the commissioning process, outstanding deficiencies and recommended resolutions, and seasonal testing that must be scheduled for a later date. Indicate, in the executive summary, whether the systems meet the requirements of the contract documents[and the

Owner's Project Requirements Document].

b. A list of deficiencies discovered during the commissioning process and the corrective actions taken in the report.

c. Completed [Building Enclosure Inspection Checklists,]Pre-Functional Checklists and other Commissioning Observation Checklists, Commissioning Test Checklists such as Functional Performance Test Checklists and Integrated Systems Test Checklists,[, the Air Leakage Test Reports and Diagnostic Test Reports,] the Final Construction Phase Commissioning Plan, the Issues Log, Training Attendance Rosters, the Design Review Reports, Submittal Review Report, and any other documents as specified by related technical commissioning specification sections.

The Commissioning Specialist is responsible for preparing a Commissioning Report following commissioning team validation of all Commissioning Tests, including Functional Performance Tests, and Integrated Systems Tests, with the exception of Seasonal Tests. [File the Commissioning Report in the Sustainability eNotebook.]Provide information including, but not limited to, outstanding deficiencies and recommended resolutions, seasonal testing that must be scheduled for a later date, Completed [Building Enclosure Inspection Checklists,] Pre-Functional Checklists and other Commissioning Observation Checklists, Training Attendance Rosters, PVT Report, and the approved TAB Report within 14 days of request.

[3.15 WARRANTY PHASE SITE VISIT

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NOTE: Warranty phase site visit is recommended to document any deficiencies and verify systems function according to project requirements post-occupancy. Warranty phase site visit may be required by applicable Sustainability Third Party Certification guidelines.

Choose Sustainability eNotebook bracketed option as applicable. Refer to Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Choose bracketed "and the OPR" for projects that will include an Owner's Project Requirements (OPR) document. Refer to specifier note regarding OPR in paragraph DEFINITIONS for further information.

This paragraph contains tailoring options for ARMY, KTR HIRED COMMISSIONING PROVIDER and GOVT HIRED COMMISSIONING PROVIDER.

Choose bracketed "and the Owner's Project Requirements" for projects that require one. Refer to specifier note regarding OPR in paragraph DEFINITIONS for further information. Choose bracketed Post-Construction Endurance Test and Trend Log Report if included in the project from Section 23 08 00 COMMISSIONING OF MECHANICAL[AND PLUMBING] SYSTEMS.

****

The Lead Commissioning Specialist must visit the building site concurrent with the 9 month warranty inspection to inspect building system equipment and review building operation with the building operating/maintenance staff, and identify any deficiency of the building systems to operate in accordance with the contract documents[and the Owner's Project Requirements Document]. The Commissioning Specialist must notify the Contracting Officer of any identified deficiencies and the proposed corrective action. Submit Updated Final Commissioning Report and Systems Manuals, documenting the results of the warranty phase inspection. Include other warranty or post-construction phase activities as specified in related technical commissioning specification sections, such as Seasonal testing results[and Post-Construction Endurance Test and Trend Log Report].[File the approved Updated Final Commissioning Report (eNotebook) in the Sustainability eNotebook.]

Notify the Lead Commissioning Specialist at least 28 calendar days prior to visiting building site for the 9 month warranty inspection. Provide updates to any documentation included in the Commissioning Report based on the results of the warranty phase inspection. Provide all warranty phase documentation, such as Seasonal testing results to the Commissioning Specialist.[File the Updated Final Commissioning Report (eNotebook) in the Sustainability eNotebook.]

]

[APPENDIX A - OWNER'S PROJECT REQUIREMENTS DOCUMENT

****

NOTE: If an Owner's Project Requirements document (OPR) is to be included with the specification, attach it as Appendix A. Include a statement on the OPR cover stating that the document is provided for commissioning review purposes only and is not a contract requirement. Refer to paragraph DEFINITIONS for information regarding the OPR.

****

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-01 91 19 (May 2023)**

Preparing Activity: USACE **Superseding**
UFGS-07 05 23 (August 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 91 19

BUILDING ENCLOSURE COMMISSIONING

05/2023

PART 1 GENERAL

ATTACHMENTS:

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-01 91 19 (May 2023)**

Preparing Activity: USACE **Superseding**
UFGS-07 05 23 (August 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 01 91 19

BUILDING ENCLOSURE COMMISSIONING
05/2023

****
NOTE: This guide specification covers building enclosure/envelope commissioning, including requirements for pressure testing a building's air barrier for air leaks. Minimizing air leakage through an air barrier helps reduce energy costs. This specification is applicable to new building construction and major renovations involving upgrades to the building envelope.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

NOTE: TO DOWNLOAD UFGS GRAPHICS AND APPENDICES
Go to
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms
****

PART 1 GENERAL

****
NOTE: This UFGS Section contains tailoring options for Contractor (KTR) HIRED COMMISSIONING PROVIDER, GOVT HIRED COMMISSIONING PROVIDER, DESIGN-BUILD, ARMY, and NAVY.

Select KTR HIRED COMMISSIONING PROVIDER tailoring for projects that require the Commissioning Provider to be provided by the Construction Contractor.

Select GOVT HIRED COMMISSIONING PROVIDER tailoring for projects where the Commissioning Provider is retained under a separate Contract with the Government.

Select DESIGN-BUILD tailoring for Design-Build project execution.

Select ARMY tailoring for projects that will report the real property asset for Air Force or Army.

Select NAVY tailoring for projects that will report the real property asset for Navy or Marine Corps.

Verification of the energy performance of the building envelope is required for all projects that require commissioning and verification in accordance with UFC 1-200-02; facilities that require air barrier inspection and testing are defined within UFC 3-101-01. As directed in UFC 1-200-02, the Commissioning requirements in this Section are based on ASHRAE 90.1 as required for commercial and multi-family high-rise buildings; for projects involving low-rise residential buildings this Section will need to be edited to meet the Commissioning requirements of IECC. For commissioning requirements of Medical Treatment Facilities, refer to UFC 4-510-01 and edit this Section accordingly. When a project requires this Section, edit and include UFGS Section 07 27 10 BUILDING AIR BARRIER SYSTEM for additional performance testing and verification requirements. For projects where more oversight is needed beyond the minimum building envelope requirements of ASHRAE 90.1 and the requirements of Section 07 27 10 BUILDING AIR BARRIER SYSTEM, revise this specification accordingly. (Examples include facilities with pressurization or humidity control requirements such as armories, electronic equipment facilities, hospitals, and laboratories.)

Coordinate this Section with the commissioning requirements of ASHRAE 90.1, as required by UFC 1-200-02, "High Performance and Sustainable Building Requirements" paragraph "Commissioning."

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NOTE: The basis for the air leakage testing within this specification is UFC 3-101-01 and the U.S. Army Corps of Engineers Air Leakage Test Protocol for Measuring Air Leakage in Buildings. This protocol can be found at the following web site: https://www.wbdg.org/FFC/ARMYCOE/usace_airleakagetestprotocol.pdf.

This specification includes additional recommendations not found in the aforementioned protocol. These recommendations are based on personal pressure test experience and discussions with industry experts.

An Excel spreadsheet titled Pressure Test Data Analysis, available for download at http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms **is an integral part of the building's air barrier pressure test. Data obtained during the test may be input into the spreadsheet to determine the air barrier's leakage rate.**

This specification describes the responsibilities of the Contractor and the Contractor's pressure test agency. The building designer is responsible for creating, defining and detailing the air barrier envelope. The Contractor's pressure test agency is responsible for preparing the building envelope for the pressure test, performing the test, recording test results, and returning the building to pre-test conditions. The test agency is also responsible for performing the calculations to determine if the envelope passed the pressure test. Diagnostic testing is also the responsibility of the test agency.

This specification does not cover duct and HVAC system pressure testing and is limited to the envelope penetrating dampers as deemed applicable for leakage testing. Duct and HVAC system pressure testing references can be obtained from ASHRAE Handbook of Fundamentals, HVAC Design Section and Chapters and ASHRAE Standard 215, Method of Test to Determine Leakage of Operation HVAC Air Distribution Systems, should duct and HVAC system pressure testing be required by other specifications. See Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC for duct testing requirements.

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1.1 SUMMARY

Use this Section in conjunction with UFGS 01 91 00.15 BUILDING COMMISSIONING. Building Enclosure Commissioning (BECx) is an essential part of overall Building Commissioning. The final BECx report is part of the Final Commissioning Report as defined in 01 91 00.15 BUILDING COMMISSIONING. This Section covers Building Enclosure Commissioning for all six surfaces (4 walls, roof, and floor, for a rectangular shaped zone) of a building. Additional Quality Control and testing requirements for specific components of the building enclosure are described in the Division 03 thru 08 UFGS Sections of the project specifications.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referenced within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501.2	(2015) Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-105	(2020) ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel
ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel
ASNT SNT-TC-1A	(2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 202	(2024) Commissioning Process for Buildings and Systems
ASHRAE RP-935	(1998) Protocol for Field Testing of Tall Buildings to Determine Envelope Air Leakage Rate

ASTM INTERNATIONAL (ASTM)

ASTM C1193	(2016) Standard Guide for Use of Joint

	Sealants
ASTM D3464	(1996; R 2014) Standard Test Method for Average Velocity in a Duct Using a Thermal Anemometer
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E779	(2019) Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
ASTM E783	(2002; R 2018) Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
ASTM E1105	(2015; R 2023) Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference
ASTM E1186	(2022) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
ASTM E1258	(1988; R 2018) Standard Test Method for Airflow Calibration of Fan Pressurization Devices
ASTM E1827	(2022) Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
ASTM E2029	(2011) Standard Test Method for Volumetric and Mass Flow Rate Measurement in a Duct Using Tracer Gas Dilution
ASTM E2813	(2018) Standard Practice for Building Enclosure Commissioning
ASTM E2947	(2021) Standard Guide for Building Enclosure Commissioning

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 6781	(1983) Thermal Insulation - Qualitative Detection of Thermal Irregularities in Building Envelopes - Infrared Method
ISO 6781-2	(2010) Performance of Buildings - Detection of Heat, Air, and Moisture Irregularities in Buildings by Infrared Methods - Part2: Equipment Requirements
ISO 6781-3	(2015) Performance of Buildings - Detection of Heat, Air, and Moisture

Irregularities in Buildings by Infrared
Methods - Part 3: Qualifications of
Equipment Operators, Data Analysts, and
Report Writers

1.3 DEFINITIONS

The definitions included here are specific to this Section. Refer to UFGS 01 91 00.15 for definitions that apply to both Sections. The following terms as they apply to this section:

1.3.1 Air Barrier Envelope

The surface that separates the inside air from the outside air. The combination of air barrier assemblies and air barrier components, connected by air barrier accessories are designed to provide a continuous barrier to the movement of air through an environmental separator. A single building may have more than one air barrier envelope. The air barrier surface includes the top, bottom, and sides of the envelope. The term "air barrier envelope" is also known as "air barrier system" or simply "air barrier".

1.3.2 Air Leakage Rate

A measurement of air infiltration or exfiltration through the building envelope over time. The air leakage rate is the rate of air flow across the air barrier per unit surface area of the envelope at a defined differential pressure.

1.3.3 Basis of Design (BoD)

A document developed by the design team which includes technical concepts, assumptions, calculations, decisions, and product selections to support the Owner's Project Requirements (OPR).

1.3.4 Bias Pressure

Also known as zero flow pressure, baseline pressure, offset pressure or background pressure. With the envelope not artificially pressurized, bias is the differential pressure that always exists between the envelope that has been prepared (sealed) for the pressure test and the outdoors. Bias pressure is made up of two components, fixed static offset (usually due to stack effect or the HVAC system) and fluctuating pressure (usually due to wind or a moving elevator). Because of pressure fluctuations many bias pressure readings are recorded and averaged for use in the calculations.

1.3.5 Blower Door

Commonly used term for an apparatus used to pressurize and depressurize the space within the building envelope and quantify air leakage through the envelope. The blower door typically includes a door fan and an air resistant fabric or a series of hard panels that extends to cover and seal the door opening between the fan shroud and door frame. The door fan is a calibrated fan capable of measuring air flow and is usually placed in the opening of an exterior door. With the air barrier otherwise sealed, air produced by the door fan pressurizes or de-pressurizes the envelope, depending on the fan's orientation.

1.3.6 Building Enclosure (or envelope)

The materials, components, systems, and assemblies intended to provide an environmental separator between the interior and exterior or between interior spaces with different environment requirements. "Enclosure" is used interchangeably with "envelope".

1.3.7 Building Enclosure Commissioning (BECx)

Technical service provided on behalf of the Government to provide a quality-focused process for enhancing the performance of the building enclosure by validating the design phase and verifying during the construction phase that the performance of the building enclosure materials components, assemblies, and systems are designed and installed to meet the Owner's Project Requirements (OPR).

1.3.8 Building Enclosure Commissioning Provider (BECxP)

An entity that functions as part of the overall Commissioning Team and is responsible for validating the design phase and verifying during the construction phase that the performance of the building enclosure materials, components, assemblies, and systems are designed and installed to meet the Owner's Project Requirements (OPR).

1.3.9 Construction Phase

The period of a project following the award of construction Contract to project completion.

1.3.10 Design Phase

The period of the project delivery process when a design supporting the Owner's Project Requirements is developed and translated into Contract Documents.

1.3.11 Environmental Separator

The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments. The term "environmental separator" is also known as the "control layer".

1.3.12 Functional Performance Test (FPT)

A systematic process to verify that controls and other elements of the building project are capable of and configured to operate or perform as required.

[1.3.13 Owner's Project Requirements (OPR)

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NOTE: The Owner's Project Requirements (OPR) document may be included as deemed appropriate by the project team or as required by some Third Party Certification (TPC) systems (such as LEED and Green Globes). The preliminary design deliverables and preliminary design authority (PDA) documentation (such as 1391, Basis of Design, and UFCs) constitute the Owner's Project Requirements (OPR) and may be

used in lieu of a stand-alone OPR. If used, the OPR is referenced by the CxC during design review when the specification is tailored for KTR HIRED COMMISSIONING PROVIDER.

NOTE: The Owner's Project Requirements (OPR) document may be included as deemed appropriate by the project team or as required by some Third Party Certification (TPC) systems (such as LEED and Green Globes). When not otherwise required for TPC, inclusion of the OPR for CxC review may be beneficial for ensuring large or complex projects conform to the Owner's needs. This may be unnecessary for more typical construction projects. If used, the OPR is referenced by the CxC during design review and during submittal review, inspections, and testing.

NOTE: If used, insert the OPR as Appendix A to Section 01 91 00.15 BUILDING COMMISSIONING. Include a statement on the OPR cover stating that the document is provided for commissioning review purposes only and is not a Contract requirement. Retain the bracketed references to Owner's Project Requirements (OPR) throughout the specification when one is included. Delete the bracketed OPR references when the OPR is not included.

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A document that details the stakeholders' requirements for the project and the expectations for how it will be used and operated. The OPR is provided for commissioning review purposes only and is not a Contract requirement.

]1.3.14 Pressure Test

A generic term for a test in which the envelope is either pressurized or de-pressurized with respect to the outdoors.

1.3.15 Negative Pressure Test (Depressurization Test)

A test wherein air inside the envelope is drawn to the outdoors. This places the envelope at a lower (negative) pressure with respect to the outdoors.

1.3.16 Positive Pressure Test (Pressurization Test)

A test wherein outdoor air is pushed into the envelope. This air movement places the envelope at a higher (positive) pressure with respect to the outdoors.

1.3.17 Verification & Testing (V&T) Provider

An entity who completes the activities needed to implement the building functional performance testing (FPT) activities or verify that elements of the building project meet stated requirements.

1.4 COMMUNICATION WITH THE GOVERNMENT COMMISSIONING PROVIDER

For communication responsibilities, see Section 01 91 00.15 BUILDING

COMMISSIONING.

1.5 COMMUNICATION WITH GOVERNMENT ACCCEPTANCE TESTING REPRESENTATIVES

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NOTE: The following paragraph is tailored for use on NAVY projects only.

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The QC Manager must communicate directly with the Government Acceptance Testing Representatives and Contracting Officer's Representative regarding Government acceptance testing activities. Inform the Contracting Officer's Representative when systems are ready for testing to be witnessed by Government Acceptance Testing Representatives, and allow access to the construction site and system(s) to be tested

1.6 ENCLOSURE COMPONENTS TO BE COMMISSIONED

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NOTE: The following components are required to be commissioned per ASHRAE 90.1. Select all systems that are part of the scope. Add other systems as required by the scope of the project or required by the applied sustainable third-party certification program.

Whole building air tightness testing is required for all projects as outlined in the Editor's Note for the Part 3 section BUILDING ENVELOPE AIR TIGHTNESS REQUIREMENT; however, this test is performed near the end of the project. Once the building enclosure is fully constructed, installation corrections needed to comply with the test requirements may require substantial disassembly and re-work. Smaller scale tests performed on mock-ups or at the initial installation of building components are recommended to validate the design and installation of building enclosure elements and systems. These tests may include:

Adhesion tests on liquid-applied or adhered waterproofing and air/weather barrier such as ASTM D4541, Test Method for Pull-off Strength Coatings Using Portable Adhesion Testers.

Air leakage testing of fenestration or opaque walls using a site-built test chamber to provide different pressures such as ASTM E783, Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Doors.

Small scale tests of waterproofing or air weather barriers such as the bubble test described in ASTM E1186, Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.

Water penetration tests of fenestration with a site-built test chamber (same chamber as ASTM E783) per ASTM E1105, Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference.

Water penetration testing using a hose with a calibrated nozzle such as AAMA 501.2, Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtainwall, and Sloped Glazing Systems.

Adhesion and cohesion testing of sealants according to ASTM C1193, Guide for Use of Joint Sealants: Field-Applied Sealant Joint Hand Pull Tab.

Depending on the project complexity, budget, and interior environmental requirements, consider including the small-scale testing listed above on mock-ups or early in the installation of that construction component. Additional tests not listed may be selected in consultation with the BECxP and Design Team. See ASTM E2813 for additional test options. Select and include additional building enclosure tests required to verify envelope performance as appropriate to the project complexity, OPR, environmental requirements and geographic location.

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1.6.1 Verification of the Design and Installation of the Continuous Air Barrier

a. Conduct periodic field inspection of the continuous air barrier materials and assemblies, including all penetrations through the six sides of the air barrier, during construction while the continuous air barrier is still accessible for inspection and repair (after installation of all penetrations and wall cladding anchoring devices and before the installation of interior finishes) to verify and document compliance with the requirements. Conduct inspections at initial installation of each building envelope component and at in-progress construction intervals as stated in Part 3 section titled BUILDING ENVELOPE INSPECTION AND TESTING.

[b. Conduct Performance Verification Testing of the entire building envelope (systems, components, and assemblies) for air tightness in accordance with Part 3 section titled BUILDING ENVELOPE AIR TIGHTNESS REQUIREMENT.]

1.6.2 Inspection of Fenestration and Doors

a. Fenestration and Doors must be labeled and inspected to verify compliance with Building Envelope energy requirements, including applicable U-factors, Solar Heat Gain Coefficient (SHGC), Visible Transmittance (VT), and air leakage rates.

b. Inspect doors and windows for coordination with the insulating plane of the wall, continuity with the air/weather barrier, and flashing.

c. Inspect operation of doors, closers, and operating mechanisms for conformance with manufacturer's instructions.

d. Inspect seals and gaskets for fenestration and doors (including loading dock, sectional, and coiling doors) for proper installation and to verify that seals are in good condition.

1.6.3 Inspection of Opaque Roof, Walls, and Floors

Opaque roof, above-grade and below-grade walls, and floors, must be subject to the following inspections during construction:

a. Use of ASHRAE 90.1 - IP-compliant materials and assemblies.

b. Insulation material meets design specifications and is continuous.

1.6.4 Fenestration Inspections

Conduct inspections of the following fenestration-related items during construction:

a. Skylights size and location in relation to the designed primary sidelighted area and secondary sidelighted area below.

b. Roof monitor size and location in relation to the designed primary sidelighted area and secondary sidelighted area below.

c. Dynamic glazing compliance with SHGC and U-factors, and testing of the operation for conformance with the manufacturer's instructions.

d. Permanent fenestration projections installation and performance in accordance with ASHRAE 90.1 - IP requirements and the Contract documents.

[1.6.5 Loading Dock Weatherseal Inspections

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NOTE: Include this paragraph where loading dock weatherseals are a part of the project.

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Inspect loading dock weatherseals for proper installation and to verify the seals are in good condition.

][1.6.6 Additional Building Enclosure Tests

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NOTE: Include any additional testing needed to verify performance of the building enclosure elements in this paragraph, with examples in the prior Editor's Note.

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Conduct the following building enclosure tests on mock-ups or early in the installation of the related building components:

[ ]

]1.7 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third-Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Building Enclosure Commissioning Specialist Qualifications; G , [_____]

Building Enclosure Testing Work Plan; G , [_____]

SD-03 Product Data

Thermal Imaging Camera; G, [_____]

Test Equipment; G, [_____]

SD-05 Design Data

Envelope Surface Area Calculations; G, [_____]

SD-06 Test Reports

Completed Building Envelope Inspection Checklists; G, [_____]

Pressure Test Procedures; G, [_____]

Air Leakage Test Report; G, [_____]

Diagnostic Test Report; G, [_____]

SD-07 Certificates

Pressure Test Agency

Thermographer Qualifications

Certificate of Readiness

SD-10 Operation and Maintenance Data

Training; G, [_____]

1.8 BUILDING ENCLOSURE TESTING WORK PLAN

For each building enclosure test to be performed, submit the following not later than [120] [_____] calendar days [after Contract award, but] before start of testing work, steps to be taken by the lead test technician to accomplish the required testing.

a. Memorandum of test procedure.

   (1) Proposed dates for conducting the tests.

   (2) Submit detailed test procedures prior to the test. Provide a plan view showing proposed locations (personnel doors or other similar openings) to install equipment (such as blower doors or flexible ducts for trailer-mounted fans, if used).

b. Test equipment to be used.

c. Scaffolding, scissor lifts, power, electrical extension cords, duct tape, plastic sheeting and other Contractor's support equipment required to perform all tests.

d. Other Contractor's support personnel who will be on site for testing.

1.9 ACCESSIBILITY REQUIREMENTS

Air barrier components, insulation, fenestration, and doors for commissioned systems must be made accessible for inspections. Contractor must make necessary modifications at Contractor's own expense if systems and enclosures are not accessible for inspections and testing. Assist commissioning team in testing and inspections by removing equipment covers, opening access panels, and other required activities that assist with visual oversight. Furnish ladders, flashlights, meters, gauges, or other inspection equipment as necessary.

1.10 SCHEDULING

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NOTE: The following paragraph is tailored for NAVY. For Navy projects, roof systems are considered critical systems per NAVFACINST 3960.1. Quality Assurance functions by NAVFAC is done on the roofing systems to ensure Contractor's construction

quality control (CQC) program and commissioning deliver a high quality and properly functioning critical system.
****

Notify the Contracting Officer a minimum [14][_____] calendar days in advance of site visits and inspections by the roof system manufacturer technical representative for coordination with the Government Acceptance Testing Representative.

1.11   COORDINATION

Refer to Section 01 91 00.15 BUILDING COMMISSIONING for requirements pertaining to coordination during the commissioning process. Coordinate with the Commissioning Provider in accordance with Section 01 91 00.15 and in accordance with the Commissioning Plan to schedule inspections as required to support the commissioning process. Furnish additional information requested by the Commissioning Provider.

Coordinate scheduling of air barrier inspections and air barrier pressure testing with the commissioning team. Upload plans, reports, notes, and other documentation to the Commissioning Provider's web-based commissioning software, or as specified in the commissioning plan, as it is completed.

1.12   QUALITY CONTROL

1.12.1   Modification of References

Perform all pressure and diagnostic tests according to the referenced publications listed in paragraph REFERENCES and as modified by this section. Consider the advisory or recommended provisions, of the referred references, as mandatory.

1.12.2   Qualifications

1.12.2.1   Building Enclosure Commissioning Specialist Qualifications

See UFGS 01 91 00.15 BUILDING COMMISSIONING for the qualification requirements of the Building Enclosure Commissioning Specialist.

1.12.2.2   Pressure Test Agency

Submit, no later than [15] [_____] calendar days after Contract award, information certifying that the pressure test agency is not affiliated with any other company participating in work on this Contract. The work of the test agency is limited to pressure testing the building envelope, performing a thermography test and fog test, and investigating, through various methods, the location of air leaks through the air barrier. See Part 3 paragraph PRESSURE TEST AGENCY for additional requirements. For thermographer qualifications, see paragraph THERMOGRAPHER QUALIFICATIONS.

Use the sample TEST AGENCY QUALIFICATIONS SHEET form (Appendix C), to submit the following information.

a. Verification of [2][_____] years of experience as an agency in pressure testing commercial or industrial buildings.

b. List of at least ten commercial/industrial facilities with building envelopes that the agency has tested within the past 2 years. Include building name, address, and name of prime construction Contractor and Contractor's point-of-contact information.

c. Confirmation of 2 years of commercial and or industrial building pressure test experience for the lead pressure test technician and the thermographer in using the specified ASTM E779 or ASTM E1827 testing standard. References from five Contracting Officers for facilities where the lead test technician has supervised commercial and or industrial building pressure tests in the last 2 years.

d. Verification that the lead pressure test technician has been employed by a building pressure testing agency in the capacity of a lead pressure test technician for not less than 1 year.

1.12.2.3 Thermographer Qualifications

To perform an infrared diagnostic evaluation, use a lead thermographer who has at least an active Level II Certification that is based on the requirements in ANSI/ASNT CP-105 or ANSI/ASNT CP-189 and is in accordance with ASNT SNT-TC-1A. The course of study is to be specifically focused on infrared thermography for building science. The thermographer must have at least two years of building science thermography experience in IR testing commercial or industrial buildings. The thermographer must also have experience in building envelopes and building science in order to make effective recommendations to the Contractor should the envelope require additional sealing. Thermographic equipment operators, data analysts and report writers must comply with the requirements of ISO 6781-3. Submit the thermographer's certificate for approval. Submit a list of at least ten commercial/industrial buildings on which the thermographer has performed IR thermography in the past two years. The thermographer is to have a current active certification. Submit certification at least 60 days prior to thermography testing.

1.12.3 Test Reports

No later than 14 days after completion of the pressure test, submit electronic copies of an organized report[and [_____] bound paper copies in a durable 3-ring binder]. The report is to contain a table of contents, an executive summary, an introduction, a results section and a discussion of the results. Submit the air leakage test report as described in paragraph AIR LEAKAGE TEST REPORT. Submit a diagnostic test report as described in paragraph LOCATING LEAKS BY DIAGNOSTIC TESTING. The diagnostic test report is to include the Thermographic Investigation Report and the Fog Test Report (if performed).

Submit field data and completed report forms found in the appendices. Use the sample forms, Test Agency Qualification Sheet, Air Leakage Test Form and Air Leakage Test Results Form to summarize the tests for the appropriate building envelope. Submit both electronically populated and field hand filled-in forms.

Report Data. Include in the report the following information for all tests:

a. Date of issue

b. Project title and number

c. Name, address, and telephone number of testing agency

d. Dates and locations of samples and tests or inspections

e. Names of individuals making the inspection or test

f. Designation of the work and test method

g. Identification of product and specification section

h. Complete inspection or test data

i. Test results and an interpretation of test results

j. Comments or professional opinion on whether inspected or tested work complies with Contract document requirements

k. Recommendations on retesting

1.13 CLIMATE CONDITIONS SUITABLE FOR A PRESSURE TEST

As the test date approaches, monitor the weather forecast for the test site. Avoid testing on days forecast to experience high winds, rain, or snow. Monitor weather forecasts prior to shipping pressure test equipment to the site. Based on current and forecast weather conditions, the Contracting Officer's representative is to grant final approval for testing to occur.

1.13.1 Rain

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NOTE: Leakage through some floor, roof, and wall assemblies can be affected by heavy rain when minute cracks and holes become temporarily sealed. Rain may close potential leaks, making the envelope appear tighter than it would be in drier conditions. Rainwater can also block pneumatic tubes used in pressure testing thereby altering differential pressure readings.

****

For safety reasons, avoid testing during rain or if rain is anticipated during testing. If pneumatic hoses are installed and exposed to rain inspect the hose to ensure rainwater has not migrated into the hose ends. Orient all exposed hose ends to keep them out of water puddles. Success in temporarily sealing outdoor ventilation components such as louvers and exhaust fans may also be compromised by rain. Don't seal roof-mounted ventilation components during times of potential lightning.

1.13.2 Wind

Because wind can skew pressure test results, test only on days and at times when winds are anticipated to be the calmest. Avoid pressure testing during gusty or high wind conditions. Avoid installing test fans on the windward side of the building if wind gusts during the test are anticipated to be greater than 16.1 kilometers/hour 10 miles per hour.

1.14 CERTIFICATE OF READINESS

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NOTE: This paragraph contains tailoring options for ARMY and NAVY. Select or insert the number of calendar days for desired notification prior to system commissioning tests. Include the last bracketed sentence when the project requires air tightness testing; whole building envelope air tightness testing is required for projects as outlined in the Editor's Note for the Part 3 section BUILDING ENVELOPE AIR TIGHTNESS REQUIREMENT.

****

Prior to scheduling the Commissioning Tests as required by this Section, submit Certificate of Readiness documentation in accordance with Section 01 91 00.15 BUILDING COMMISSIONING for each enclosure-related system, certifying that inspections have been completed, open issues have been resolved, and the system is ready for the Commissioning Tests. Documentation would include Building Envelope Inspection Checklists as required within this Section, as well as any inspections or test reports required within each enclosure-related technical specification section. Additional Quality Control and testing requirements for specific components of the building enclosure are described in the Division 03 thru 08 UFGS Sections of the project specifications.

Submit the Certificate of Readiness for each system [30][____] calendar days [20][____] working days prior to Commissioning Tests of that system. Do not schedule Commissioning Tests for a system until the Certificate of Readiness is approved by the Government. [Do not schedule air tightness testing of the building envelope system until Certificates of Readiness and supporting documentation for enclosure-related systems have been submitted, reviewed and approved by the Government.]

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

Provide all equipment required to perform testing for the systems and components to be commissioned. Provide all testing equipment of sufficient quality and accuracy to test and measure system performance with the tolerances specified. Provide a sufficient quantity of two-way radios for each subcontractor.

Submit a signed and dated list of instruments to be used for testing, their application, manufacture, model, serial number, range of operation accuracy, and date of most recent calibration. Calibration data applicable to fan systems must be in accordance with ASTM E1258. Also list special equipment and proprietary tools specific to a piece of equipment required for testing.

2.2 PRESSURE TEST EQUIPMENT

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NOTE: The size of the envelope and the abundance of leaks through the envelope determines the type and quantity of pressure testing equipment needed. A single blower door system usually provides sufficient airflow (2360 to 3775 L/s5000 to 8000 CFM) to test an average single family residence. A building the size of a basketball gymnasium may require two or more blower door systems.

Logistically there may be an upper limit to the number of blower door systems that can be installed and operated together. The author of this specification has anecdotal knowledge of up to 24 blowers being used in one test to deliver about 90,615 L/s 192,000 CFM at 75 Pa. This means that a building envelope of up to about 71,350 sq. m 768,000 sq. ft can be pressure tested to meet a leakage rate of 1.27 L per sec/sq. m. 0.25 cfm/sq. ft. at 75 Pa using blower door equipment. Trailer mounted fans that can typically deliver up to 28,317 L/s 60,000 CFM may be used for both pressurization and de-pressurization. Blower door systems and trailer mounted fans may also be used together in a test. If blower door systems and trailer mounted fans provide insufficient air for pressure testing, the building's own air handling system can be used in lieu of blower door fans and trailer mounted fans. Obtaining accurate flow reading when using a building's own air handling system may be especially challenging. Delete unnecessary pressure test methods as necessary.

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Depending on site conditions and size of the envelope, the test may be conducted using [blower door equipment] [and] [trailer-mounted fans] [or the building's own supply air system]. The testing agency is to supply sufficient quantity of blower equipment that will produce a minimum of 75 Pa differential pressure between the envelope and outdoors using the test methods described herein. Supplying additional blower test equipment to provide additional airflow capacity or to act as a backup is highly recommended.

2.2.1 Blower Door Fans and Trailer Mounted Fans

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NOTE: For General Information Only.
There currently are only 3 manufacturers of blower door equipment in the United States. Infiltec, Minneapolis Blower Door and Retrotec. The author has anecdotal knowledge of blower door and trailer-mounted fan testing being used in Canada, Great Britain, Ireland, Australia and some Scandinavian countries.

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Each air flow measuring system including blower door fans and trailer mounted fans are to be calibrated within the last 5 years. Calibrated blower door fans and trailer mounted fans must measure accurately to within plus or minus 5 percent of the flow reading. Blower door equipment and trailer mounted fans are to be specifically designed to pressurize building envelopes. Each set of blower door equipment is to include fan(s), digital gage(s), door frame, door fabric or hard panels.

2.2.2 Digital Gages as Test Instruments

Use only digital gages as measuring instruments in the pressure test; analog gages are not acceptable. The gauges must be accurate to within 1.0 percent of the pressure reading or 0.15 Pa, whichever is greater. Each gage is to have been calibrated within two years of the test. The calibration is to be checked against a National Institute of Standards and Technology (NIST, formerly National Bureau of Standards) traceable standard.

2.3 THERMAL IMAGING CAMERA REQUIREMENTS

The thermal imaging camera used in the thermography test must have a thermal sensitivity (Noise Equivalent Temperature Difference.) of +/- 0.1 degree C at 30 degrees C 0.18 degrees F at 86 degrees F or less. Ensure the camera's operating spectral range falls between 2 and 15 micrometers. Ensure the camera's IR image viewing screen resolution measures at least 320x240 pixels. Ensure the camera has a means of recording thermal images seen on the camera viewing screen. The camera is to display output as individual still frame images that also can be downloaded and inserted into an electronic Thermographic Investigation Report. All thermographic equipment must comply with the requirements of ISO 6781-2. Submit camera make and model, and catalog information that defines the camera thermal sensitivity for approval.

PART 3 EXECUTION

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NOTE: Select and include in Part 1 of this Section and later in Part 3 those building enclosure tests required to verify envelope performance as appropriate to the project complexity, OPR, environmental requirements and geographic location. Tests should be selected through consultation between the BECxP and Design Team. ASTM E2813 provides a list of options for building enclosure tests that might be included. Note that all testing listed in ASTM E2813 is not required; thus, the text below states to follow ASTM E2947 except where it references ASTM E2813.

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Conduct building enclosure commissioning in accordance with ASHRAE 202 and ASTM E2947 in addition to the requirements herein. Follow ASTM E2947 except where it references ASTM E2813. Commissioning must document in sufficient detail compliance of the building envelope with the design intent as defined in the Contract documents.

3.1 MEETINGS

Attend all meetings in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

Provide timely updates on construction schedule changes so Commissioning Provider has scheduling information needed to execute commissioning process efficiently. Notify Contracting Officer of anticipated construction delays to commissioning activities not yet performed or not yet scheduled.

3.2 DESIGN PHASE COORDINATION MEETING

****

NOTE: This Article is tailored for inclusion in DESIGN-BUILD projects only. This Article also includes tailoring for ARMY and NAVY. Select which

design submittal will include the design phase commissioning coordination meeting. Also, select or insert which Government representatives need to be invited to the meeting.
****

Participate in a design phase commissioning coordination meeting led by the CxC prior to the [35] [50] percent design submittal for systems to be commissioned. The purpose of the meeting is to discuss the commissioning process, including project Contract requirements, lines of communication, roles and responsibilities, schedules, documentation requirements, and to develop a Preliminary BECx Plan.

The Quality Control team, Designer of Record, and the Government Acceptance Testing Representatives and other Government team members must attend this meeting. Invite the User and[a Directorate of Public Works Representative][a Reserve Support Command Representative][ ][a Public Works Division Representative][ ] to attend this meeting. Meeting may be conducted by teleconferencing.

3.3 PRELIMINARY BECx PLAN

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NOTE: The Article contains tailoring options for DESIGN-BUILD and DESIGN-BID-BUILD projects.
****

Submit the Preliminary BECx Plan no later than 14 calendar days after the Design Commissioning Coordination Commissioning Kickoff Meeting. Submit the Preliminary BECx Plan for inclusion in the Design Phase Interim Construction Phase Commissioning Plan as identified in Section 01 91 00.15 BUILDING COMMISSIONING. Coordinate the development of this plan with the commissioning plans required in Section 01 91 00.15 BUILDING COMMISSIONING. Outline the commissioning process, commissioning team members and responsibilities, lines of communication, inspections, and documentation requirements for BECx. Identify the Commissioning Standards chosen for the project. Establish appropriate and quantifiable enclosure related performance metrics, test standards, and test methodology in accordance with referenced standards for inclusion in the Contract documents. Provide a list of team members for systems to be commissioned with contact information, a list of tests as required to complete the scope of all commissioning and a copy of the project schedule as required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULE 01 32 01.00 10 PROJECT SCHEDULE for inclusion in the Preliminary BECx Plan.

The Preliminary BECx Plan must include, at a minimum, the following:

1. Required performance of commissioned equipment, systems, and assemblies, and results of FPT and verification.

2. Summary of compliance of the building and its components, assemblies, controls, and systems with requirements.

3. Issues and resolution logs, including itemization of deficiencies found during verification, testing, and commissioning that have not been corrected at the time of report preparation.

4. Deferred tests that cannot be performed at the time of report preparation.

5. Documentation of the training of operation personnel and building occupants on commissioned systems, and a plan for the completion of any deferred trainings not completed at the time of report preparation.

6. A plan for the completion of commissioning and training, including climatic and other conditions required for performance of the deferred tests.

[3.4 DESIGN REVIEW

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NOTE: For Navy, the Design Review is a bracketed selection; select the Design Review paragraph if a design review is required after contract award. For Army tailoring, the paragraph is not bracketed. The commissioning design review report is required for Army managed projects and may be required by applicable Sustainability third Party Certification guidelines. This Article contains tailoring options for ARMY, NAVY, KTR HIRED COMMISSIONING PROVIDER and GOVERNMENT HIRED COMMISSIONING PROVIDER. Choose bracketed language regarding the Owner's Project Requirements Document for projects that require one (refer to specifier note regarding OPR in paragraph DEFINITIONS for further information). Select the design submittal on which the design review will occur; depending on the size and complexity of the project, review of multiple design submittals can be included.

NOTE: When a KTR hired commissioning provider is used for a DESIGN-BID-BUILD project, the first opportunity for the BECxP to review the project is early in construction. Leveraging the BECxP's experience in review of the design to identify any remaining problems allows early correction, where correction is necessary. This can allow major problems to be addressed with minimal time and cost growth during construction. The Government, in coordination with designers, must review the Design Review Report to determine if any design changes are necessary. Changes to the construction contract are still at the sole discretion of the Contracting Officer.

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The BECxP must review enclosure-related design documents. The review must occur prior to the [50 percent][PRE-FINAL][FINAL] design submittal. The design review must include verifying that the design for the systems to be commissioned are prepared in accordance with the Contract documents

Provide a Design Review Report identifying discrepancies or deficiencies that would prevent the systems to be commissioned from operating or performing in accordance with the design requirements or being safely maintained. Submit the building enclosure-related Design Review Report for inclusion in the overall project Design Review Report as identified in Section 01 91 00.15 BUILDING COMMISSIONING. Report must include individual list of each deficiency and corresponding corrective action necessary for proper system performance. [Identify any discrepancies between the design and the Owner's Project Requirements Document. The Owner's Project Requirements Document is provided for commissioning review purposes only and does not form a part of the contract documents for this project.] Submit the Design Review Report no later than [14][__] calendar days after approval of the Commissioning Firm and Commissioning Specialists after completing the review of the design. The Contracting Officer, Construction Manager, the Contractor's Project Manager, the BECxP, and the Designers of Record for the associated systems must meet, discuss, and resolve any outstanding items contained in the report no later than 14 calendar days after submission of the report. The BECxP must verify that their review comments have been adequately addressed in subsequent design submittals.

The BECxP is responsible for reviewing the design and preparing a Design Review Report identifying discrepancies or deficiencies that would prevent the systems to be commissioned from operating or performing in accordance with the design requirements or being safely maintained. The Contracting Officer, the CxC, the BECxP, and the Designers of Record for the associated systems must meet, discuss, and resolve any outstanding items contained in the report no later than 14 calendar days after submission of the report. The BECxP must verify that the review comments have been adequately addressed in subsequent design submittals.

Give particular attention to the continuity of the air barrier, vapor and moisture control within enclosure assembly, acoustic control of the enclosure assemblies to meet required Outdoor Indoor Transmission Class (OITC) values, flashing, thermal bridges, and resistance to water penetration or ponding.

]3.5 FINAL BECx PLAN

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NOTE: This Article includes tailoring for ARMY and NAVY projects.

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Submit the Final BECx Plan for inclusion in the Interim Construction Phase Commissioning Plan as identified in Section 01 91 00.15 BUILDING COMMISSIONING. Outline the commissioning process, commissioning team members and responsibilities, lines of communication, and documentation requirements for BECx. Identify the Commissioning Standards chosen for the project. Identify enclosure related inspections, performance metrics, test standards, and test methodologies in accordance with referenced standards for inclusion in the commissioning process.

Provide a list of team members for systems to be commissioned with contact information, a list of tests as required by this Section as well as 07 27 10 BUILDING AIR BARRIER SYSTEM, and a copy of the project schedule as required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULE 01 32 01.00 10 PROJECT SCHEDULE for inclusion in the Final BECx Plan. Final BECx plan must be submitted with the Interim Construction Phase Commissioning Plan, and must be updated and included with the Final Construction Phase Commissioning Plan as identified in Section 01 91 00.15 BUILDING COMMISSIONING.

3.6 CONSTRUCTION SUBMITTAL REVIEWS

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NOTE: This Article contains tailoring options for

KTR HIRED COMMISSIONING PROVIDER, GOVT HIRED COMMISSIONING PROVIDER, and DESIGN BUILD.
****

Coordinate construction submittal document reviews for commissioned systems and assemblies with the CxC and BECxP. The commissioning submittal review does not replace the designer of record (DoR) or Government submittal review, in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

The BECxP must identify construction submittals to be provided by the Contractor for the commissioned systems, and coordinate with the CxC. The BECxP must evaluate construction submittals related to BECx for compliance with the Contract documents. The BECxP is responsible for identifying construction submittals to be provided by the Contractor for the commissioned systems and coordinating with the CxC. The BECxP is responsible for evaluating construction submittals related to BECx for compliance with the Contract documents. The DoR must consider the BECxP's comments and provide direction to the Contractor as necessary. Provide a copy of final DoR submittal reviews with comment responses to the BECxP. Include a copy of the submittal document review transmittal and response in the Commissioning Report.

3.7 TEMPLATE BUILDING ENVELOPE INSPECTION CHECKLISTS

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NOTE: This Article contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, and GOVT HIRED COMMISSIONING PROVIDER.
****

The Building Enclosure Commissioning Specialist must develop the Template Building Envelope Inspection Checklists to verify the building materials and construction maintain the required air tightness of the building envelope system.

Use the Template Building Envelope Inspection Checklists prepared by the CxC to verify the building materials and construction maintain the required air tightness of the building envelope system.

The Building Envelope Compliance Documentation Form from ASHRAE 90.1 - IP User's Manual may be used as an example. The submitted checklist is not required to match the format of the form; however, the checklist must contain the same level of detail as shown on the mandatory provisions of the sample form.

3.8 BUILDING ENVELOPE INSPECTION AND TESTING

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NOTE: This Article contains tailoring options for KTR HIRED COMMISSIONING PROVIDER and GOVT HIRED COMMISSIONING PROVIDER.

Edit the frequency of site visits based on the size and complexity of the project. Monthly inspections at a minimum are recommended as air barrier construction progresses; also take into account the complexity of the project (such as lab or medical facility vs. a storage building). Keep in mind it is best to inspect during initial construction

installation of key envelope elements; subpar conditions are difficult to correct in later stages of construction.

Whole building envelope air tightness testing is required for projects as outlined in the Editor's Note for the Part 3 section BUILDING ENVELOPE AIR TIGHTNESS REQUIREMENT; include the last bracketed sentence when the project requires air tightness testing.
****

Demonstrate that all system components have been installed, that each building enclosure component operates, and that the systems operate and perform in accordance with Contract documents and the Owner's Project Requirements. Provide all materials, services, and labor required to perform the Building Envelope Inspections.

Document building envelope inspections by the commissioning team using the approved Template Building Envelope Inspection Checklists. Indicate commissioning team member inspection and validation of each Building Envelope Inspection Checklist item by initials at the time they are inspected and found to be in conformance with Contract requirements. Inspect checklist items before they become hidden as construction progresses. Submit the initialed and completed Building Envelope Inspection Checklists no later than 14 calendar days after completion of inspection of all checklist items. The BECxP must conduct inspections at initial installation of each building envelope component and a minimum of [monthly][_____] site visits to the site to observe construction of the building envelope in-progress, each time reviewing the in-progress checklists to ensure that the commissioning team is inspecting the building envelope as required. Coordinate inspection requirements with Section 07 27 10 BUILDING AIR BARRIER SYSTEM and other Division 7 Specifications. [The BECxP must witness the building envelope pressure tests and diagnostic tests specified in this Section; review the resulting reports; and provide recommendations for correction of any deficiencies or further testing.]

Participate in periodic building envelope inspections with the commissioning specialists using the approved Template Building Envelope Inspection Checklists to observe and document construction of the building envelope in-progress. Coordinate inspection requirements with Section 07 27 10 BUILDING AIR BARRIER SYSTEM and other Division 7 Specifications. Complete the checklists and indicate inspection and validation of each Building Envelope Inspection Checklist item by initials at the time they are inspected. Notify the Commissioning Specialist and Contracting Officer at least 21 calendar days before checklist items are concealed to ensure inspection items can be observed before construction progresses. Submit the initialed and Completed Building Envelope Inspection Checklists no later than 14 calendar days after completion of inspection of all checklist items. [Notify the BECx at least 21 calendar days prior to the building envelope pressure tests and diagnostic tests specified in this Section.]

[3.8.1 Additional Building Enclosure Testing

****
NOTE: Select and include those building enclosure tests required to verify envelope performance as appropriate to the project complexity, OPR, environmental requirements and geographic location.

Tests should be selected through consultation between the BECxP and Design Team. ASTM E2813 provides a list of options for building enclosure tests that might be included. Some options include:

Adhesion tests on liquid-applied or adhered waterproofing and air/weather barrier such as ASTM D4541, Test Method for Pull-off Strength Coatings Using Portable Adhesion Testers.

Air leakage testing of fenestration or opaque walls using a site-built test chamber to provide different pressures such as ASTM E783, Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Doors.

Small scale tests of waterproofing or air weather barriers such as the bubble test described in ASTM E1186, Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.

Water penetration tests of fenestration with a site-built test chamber (same chamber as ASTM E783) per ASTM E1105, Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference.

Water penetration testing using a hose with a calibrated nozzle such as AAMA 501.2, Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtainwall, and Sloped Glazing Systems.

Adhesion and cohesion testing of sealants according to ASTM C1193, Guide for Use of Joint Sealants: Field-Applied Sealant Joint Hand Pull Tab.

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[a. Conduct adhesion tests on liquid-applied and adhered waterproofing and air/weather barrier in accordance with ASTM D4541.

][b. Conduct air leakage testing of fenestration in accordance with ASTM E783.

][c. Conduct small scale bubble tests of waterproofing and air/weather barriers in accordance with ASTM E1186.

][d. Conduct water penetration tests of fenestration in accordance with ASTM E1105.

][e. Conduct water penetration tests of installed storefronts, curtainwall, and sloped glazing systems in accordance with AAMA 501.2.

][f. Conduct adhesion and cohesion tests of sealants in accordance with ASTM C1193.

][g. [_____]

]]3.9 BUILDING ENCLOSURE AIR BARRIER PRESSURE TESTING

3.9.1 Pressure Test Agency

Employ an independent agency to conduct the pressure test on the building envelope in accordance with ASTM E779 and this specification section. The test agency is to be an independent third-party subcontractor, not an affiliated or subsidiary of the prime Contractor, subcontractors, or A/E firm. The agency is to be regularly engaged in pressure testing of commercial/industrial building envelopes. If using blower door or trailer-mounted fans, the lead test technician must have at least two years of experience in using such equipment in building envelope pressurization tests. Formal training using pressure test equipment is highly recommended. Technicians using the building's air handling system for pressure testing are to have tested at least five commercial/industrial buildings within the past two years with each building having over 4645 square meters 50,000 square feet of floor area. Submit the name, address, and floor areas of each of these five buildings for approval.

3.9.1.1 Field Work

The lead pressure test technician and thermographer are to be present at the project site while testing is performed and is to be responsible for conducting, supervising, and managing of their respective test work. Management includes health and safety of test agency employees.

3.9.1.2 Reporting Work

The lead pressure test technician is to prepare, sign, and date the test agenda, equipment list, and submit a certified Air Leakage Test Report. The thermographer is to prepare, sign, and date the test agenda, equipment list, and submit a certified Thermographic Investigation Report. The Contractor is to prepare a final report that identifies improvements that were made to the envelope to reduce air leaks [, mitigate thermal bridging][, eliminate moisture migration,][, repair insulation voids] discovered during diagnostic tests. The Verification & Testing (V&T) providers must certify completion of required verification and FPT and include a plan for the completion of any deferred FPT, including climatic and other conditions required for performance of the deferred tests; include the results of the FPT and verification activities in the completed verification and FPT (functional performance testing) documentation. Jointly submit all reports.

3.9.2 Envelope Surface Area Calculation

****

NOTE: The design architect is responsible for defining the air barrier boundary (all 6 sides), showing the boundaries on the drawings, calculating the air barrier envelope surface area, and showing the calculation result on the drawings.

****

The architectural air barrier boundary includes the floor, walls, and ceiling. After construction of the air barrier envelope is complete, field measure the envelope to ensure the physical measurements match the design drawings and the air barrier envelope surface area calculations are generated. If the calculation result is not within 10 percent of the defined air barrier boundary calculation result as indicated, submit the envelope surface area calculation and results for review. [If the air barrier was defined during design but the air barrier envelope surface area was not calculated, calculate it during construction and submit the envelope surface area calculations and result for review.]

3.9.3 Preparing The Building Envelope For The Pressure Test

3.9.3.1 Testing During Construction

The pressure test cannot be conducted until all components of the air barrier system have been installed. After all sealing as described herein has been completed, inspect the envelope to ensure it has been adequately prepared. During the pressure test, stop all ongoing construction within and neighboring the envelope which may impact the test or the air barrier integrity. The pressure test may be conducted before finishes that are not part of the air barrier envelope have been installed. For example, if suspended ceiling tile, interior gypsum board or cladding systems are not part of the air barrier the test can be conducted before they are installed. Recommend testing prior to installing the finished ceilings and interior wall finishes within the envelope and immediately surrounding it. The absence of finishes allows for inspection and diagnostic testing of the roof/wall interface and for implementation of repairs to the air barrier, if necessary to comply with the maximum allowed leakage.

3.9.3.2 Sealing the Air Barrier Envelope

****

NOTE: The design drawings are to detail architectural treatments necessary to provide a complete air barrier including sealing all interfaces in the air barrier envelope.

****

The Contractor is to seal all penetrations through the air barrier. Unavoidable penetrations due to electrical boxes or conduit, plumbing, and other assemblies that are not air-tight are to be made so by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly. Support the air barrier to withstand the maximum positive and negative air pressure to be placed on the building without displacement or damage, and transfer the load to the structure. Durably construct the air barrier to last the anticipated service life of the assembly and to withstand the maximum positive and negative pressures placed on it during pressure testing. Do not install lighting fixtures that are equipped with ventilation holes through the air barrier.

3.9.3.3 Sealing Plumbing

Prime all plumbing traps located within the envelope full of water.

3.9.3.4 Close and Lock Doors

Close and lock all doors and windows in the envelope perimeter. For doors not equipped with latching hardware, temporarily secure them in the closed position. Secure the doors in such a way that they remain fully closed even when the maximum anticipated differential air pressure produced during the test acts on them. Provide signage stating not to open the door and the time and duration of the test.

3.9.3.5 Hold Excluded Building Areas at the Outdoor Pressure Level

Keep building areas immediately surrounding but excluded from the test envelope at the outdoor pressure level during the pressure test. Maintain these areas at the outdoor pressure level by propping exterior doors open, opening windows and de-energizing all air moving devices in or serving these areas.

3.9.3.6 Maintain an Even Pressure within the Envelope

Ensure the pressure differences within the envelope are minimized by opening all internal air pathways including propping open all interior doors. Distribute test fans throughout the envelope as necessary to ensure the internal pressures are uniform (within 10 percent of the average differential pressure). Ideally, do not install suspended ceilings until after all pressure tests have been completed. If, however the envelope includes finished suspended ceiling spaces, temporarily remove approximately 5 percent of all ceiling tiles or a minimum of 1 tile from each isolated suspended ceiling space, whichever comprises the greatest surface area. Temporarily remove additional ceiling tiles during testing to allow for inspection and diagnostic testing of the ceiling/wall interface. An alternative to removing ceiling tiles is to measure the differential pressure between each isolated suspended ceiling space and the outdoors when the area below the suspended ceiling is maintained at a differential pressure of 75 Pa with respect to the outdoors. If the suspended ceiling differential pressure measurement is within ten percent of the 75 Pa pressure below the suspended ceiling no ceiling tiles need to be removed.

3.9.3.7 Maintain Access to Mechanical and Electrical Rooms

Maintain access to mechanical rooms and electrical rooms associated with the envelope to allow for de-energizing ventilation equipment and resetting circuit breakers tripped by blower door equipment, if used.

3.9.3.8 Minimize Potential for Blowing Dust and Debris

Because high velocity air will be blown into and out of the envelope during the test, debris, including dust and litter, may become airborne. Airborne debris may become trapped or entangled in test equipment, thereby skewing test results. Ensure areas within and surrounding the envelope are free of dust, litter and construction materials that are easily airborne. If pressurizing existing, occupied areas, provide adequate notice to building occupants of blowing dust and debris, and general disruption of normal activities during the test.

3.9.3.9 De-energize Air Moving Devices

De-energize all air moving devices serving the envelope to keep air within the envelope as still as reasonably achievable. De-energize all fans that deliver air to, exhaust air from, or recirculate air within the envelope. Also, de-energize all fans serving areas adjacent to but excluded from the envelope.

[3.9.3.10 Installing Blower Door Equipment in a Door Opening

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NOTE: Delete this paragraph if blower door equipment will not be used for the pressure test.

****

Where blower door fans are used, before installing blower door equipment, select a door opening that does not restrict air flow into and out of the envelope and has at least 1.5 m 5 feet clear distance in front of and behind the door opening. Disconnect the door actuator and secure the door open to prevent it from being drawn into the fan-by-fan pressure. Avoid installing blower door equipment on the windward side of the building.

]3.9.4 Building Envelope Air Tightness Requirement

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NOTE: UFC 3-101-01 imposes air tightness requirements for all buildings but requires only inspection (and not air tightness leak testing) for the specific building types. See UFC 3-101-01 for building types which require only inspections.

Seal existing buildings undergoing major renovations, especially the ones located in cold or hot and humid climates, to the same standard as newly constructed ones. The air barrier boundaries of the conditioned portion may not necessarily follow the exterior boundary of the building; it may only be a part of the whole. For additional guidance, see Air Leakage Test Protocol for Building Envelope at the following site: (https://www.wbdg.org/FFC/ARMYCOE/usace_airleakagetestprotocol.pdf).

The Architectural Plus HVAC test should be applied in the specifications of a Contract when the building is designed such that the HVAC system may operate intermittently and when dampers will be utilized to prevent air leakage out of the conditioned space through the HVAC system. The Architectural Plus HVAC test may be applied to residential projects with intermittent HVAC system operation or a project in which there is a need to verify mechanical dampers in the HVAC system for leakage performance.

****

For each building envelope, perform the Architectural Only test and if noted below, the Architectural Plus HVAC System test. The purpose of the pressure (air leakage) test is to determine final compliance with the airtightness requirement by demonstrating the performance of the continuous air barrier. An effective air barrier envelope minimizes infiltration and exfiltration through unintended air paths (leaks). The tests may be performed in any desired order.

3.9.4.1 Architectural Only Test

The test envelope is the architectural air barrier boundary as defined on the Contract drawings. This boundary includes connecting walls, roof and floor which comprise a complete, whole, and continuous three-dimensional envelope. Perform both a positive pressure test and a negative pressure test on this envelope, unless otherwise directed.

3.9.4.1.1 Test Goal

****

NOTE: Edit and include Section 07 27 10, BUILDING AIR BARRIER SYSTEM. The paragraph of Section 07 27 10 titled "Air Barrier Envelope Surface Area

and Leakage Requirements" includes the allowable leakage rate. These rates are different depending on if the test is Architectural Only or Architectural Plus HVAC System.

****

Input data from the test into the Air Leakage Rate by Fan Pressurization spreadsheet as described in paragraph CALCULATION PROGRAM via the Air Leakage Test Form. Compare output from the spreadsheet against the maximum allowable leakage defined in Section 07 27 10 BUILDING AIR BARRIER SYSTEM. The envelope passes the test if the leakage rate, as calculated using the spreadsheet, is equal to or lower than the Architectural Only leakage rate goal.

3.9.4.1.2 Preparing the Envelope for the Pressure Test - Seal All Openings through the Air Barrier

Temporarily close all perimeter windows, roof hatches and doors in the envelope perimeter except for those doors that are to remain open to accommodate blower door or trailer mounted fan test equipment installation. Seal, or isolate all other intentional openings, pathways, and fenestrations through the architectural envelope prior to pressure testing. Follow the Recommended Test Envelope Conditions identified in ASTM E1827, Table 1, for the Closed Envelope condition. These openings may include boiler flues, fuel-burning water heater flues, fuel-burning kitchen equipment, clothes dryer vents, fireplaces, wall or ceiling grilles, diffusers, and other similar openings. Before sealing flues, close their associated fuel valves and verify the associated pilot lights are extinguished. Prime all plumbing traps located within the envelope full of water. In lieu of applying tape or plastic, typical temporary sealing materials include tape and sheet plastic or a self-adhesive grille wrap. Use and apply tape and plastic in a manner that does not deface or remove paint or mar the finish of permanent surfaces. Be especially aware of residue that remains from tape applied to stainless steel surfaces such as kitchen hoods or rollup doors. For painted surfaces, use tape types that do not remove finish paint when the tape is removed. If paint is removed from the finished surface, repaint to match existing surfaces. Secure dampers closed either manually or by using the building's HVAC system controls. Use the table below for further guidance in building preparation.

Building Component	Envelope Condition
Air handling units, duct fans	As found (open) or temporarily sealed as necessary
Clothes dryer	Off
Clothes dryer vents	Temporarily sealed
Dampers - intake, exhaust	Physically closed or closed using control power or temporarily sealed
Diffusers, registers, grilles within the envelope	Temporarily sealed
Doors, personnel type, at the envelope perimeter	Secured closed
Doors, personnel type, within the envelope	Secured (propped) open

Building Component	Envelope Condition
Doors, roll-up type, at the envelope perimeter	Closed (no additional sealing)
Exhaust hoods	Closed* and temporarily sealed
Fireplace hearth	Temporarily sealed *
Kitchen hoods	Temporarily sealed *
Pilot light and associated fuel valve	Extinguished and closed, respectively
Vented combustion appliance	Temporarily sealed *
Vented combustion appliance exhaust flue	Off
Windows	Secured closed
* If the building component has an associated manual or automatic damper, consider securing the damper closed in lieu of temporarily sealing.	

[3.9.4.2 Architectural Plus HVAC System Test

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NOTE: The Architectural Plus HVAC System test should be applied in the specifications of a Contract when the building is designed such that the HVAC system may operate intermittently and when dampers will be used to prevent air leakage out of the conditioned space through the HVAC system. The Architectural Plus HVAC System test may be applied to residential projects with intermittent HVAC system operation or a project in which there is a need to verify mechanical dampers in the HVAC system for leakage performance. Include or remove this paragraph as required.

****

This test envelope includes the architectural air barrier boundary as defined on the Contract drawings plus all HVAC supply, return and exhaust systems that penetrate and terminate within said architectural air barrier boundary and that extends outward from said boundary. All associated ductwork, intake and exhaust dampers, and air moving devices, including air handling units and fans, are included in this test envelope even if they are physically located outside of the architectural air barrier boundary. The boundary extends to and includes the low leakage intake and exhaust dampers. Perform both a positive pressure test and a negative pressure test on this envelope, unless otherwise indicated.

3.9.4.2.1 Test Goal

****

NOTE: Edit and include Section 07 27 10, BUILDING AIR BARRIER SYSTEM. The paragraph of Section 07 27 10 titled "Air Barrier Envelope Surface Area and Leakage Requirements" includes the allowable

leakage rate. These rates are different depending on if the test is Architectural Only or Architectural Plus HVAC System.
****

Data from the test is to be input into the Air Leakage Rate by Fan Pressurization spreadsheet as described in paragraph CALCULATION PROGRAM via the Air Leakage Test Form. If both positive and negative pressure tests were performed, both data sets are to be input in the spreadsheet. Compare output from the spreadsheet against the leakage rate goal. The envelope passes the test if the leakage rate, as calculated using the spreadsheet, is equal to or lower than the Architectural Plus HVAC System leakage rate goal.

3.9.4.2.2 Preparing the Building for the Pressure Test

In preparation for this test, de-energize all air moving devices within this envelope by putting their controls in the Unoccupied mode. This allows the building's HVAC controls to close all associated motorized intake, exhaust, and relief dampers. Make no other changes to the HVAC systems. Temporarily sealing diffusers, grilles, registers, kitchen hoods, exhaust hoods, fans, air handling units and all other HVAC system elements with tape or plastic sheeting or any other means is not allowed. If the envelope includes a fireplace hearth do not seal it with tape and plastic. Use the table below for further guidance in building preparation.

Building Component	Envelope Condition
Air handling units, duct fans	As found (open)
Clothes dryer	Off
Clothes dryer vents	As found (no preparation)
Dampers - intake, exhaust	As found (no preparation)
Diffusers, registers, grilles within the envelope	As found (open)
Doors, personnel type, at the envelope perimeter	Secured closed
Doors, personnel type, within the envelope	Secured (propped) open
Doors, roll-up type, at the envelope perimeter	Closed (no preparation)
Exhaust hoods	Closed
Fireplace hearth	As found (open)
Kitchen hoods	As found (open)
Pilot light and associated fuel valve	Extinguished and closed, respectively
Vented combustion appliance	Off
Vented combustion appliance exhaust flue	As found (open)

Building Component	Envelope Condition
Windows	Secured closed

]3.9.5 Conducting The Pressure Test

Notify the Contracting Officer at least ten(10) working days before conducting the pressure tests to provide the Government the opportunity to witness the tests and to monitor weather forecasts for conditions favorable for testing. Do not pressure test until verifying that the continuous air barrier is in place and installed without failures in accordance with installation instructions. During the pressure test periodically inspect temporarily sealed items to ensure they are still sealed. Seals on temporarily sealed items tend to release more readily at higher pressures. Test data obtained after temporarily sealed items become unsealed cannot be used as input into the calculation program. Follow the Envelope Pressure Test Procedures in the paragraphs below. Submit detailed pressure test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed for the building envelope pressure (air tightness) test. Submit these procedures not later than 60 days after Notice to Proceed.

3.9.5.1 Extend Pneumatic Tubes and Establish a Reference Differential Pressure

Confirm the various zones within the envelope have a relatively uniform interior pressure distribution by establishing a representative differential pressure between the envelope and the outdoors with blower door or trailer-mounted fans operating. The number of indoor pressure difference measurements (pneumatic hoses) required depends on the number of interior zones separated by bottle necks that could create significant pressure drops (e.g., doorways and stairwells). Extend at least four pneumatic hoses (differential pressure monitoring ports) to locations within the envelope that are physically opposite of each other. In multiple story buildings, especially those over three stories, extend hoses to multiple floors. Locate the hose ends away from the effects of air discharge from blower test equipment. Select one of the four (or more) interior hoses, one judged by the test agency to be the most unaffected by air velocity produced by blower test equipment, to serve as the interior reference pressure port. Extend at least one additional pneumatic hose to the outdoors (outdoor pressure port). To the end of this hose manifold at least four hoses together and terminate each hose on a different side of the building. With the envelope sealed and the blowers energized, measure the differential pressure using the interior reference pressure port and the four outdoor pressure ports. Then measure and record the differential pressure by individually using each of the remaining three interior hoses. Ensure each reading is within plus or minus 10 percent of the reference reading. Thus, at an average 75 Pa maximum pressure difference across the envelope, the difference between the highest and lowest interior pressure difference measurements should be 15 Pa or less. If this condition cannot be met, attempt to create additional air pathways within the envelope to minimize pressure differences within the envelope. If necessary, move the interior hose ends. See step 2.13 of the Air Leakage Test Form in Appendix A.

3.9.5.2 Bias Pressure Readings

With the fan pressurization equipment de-energized and the envelope sealed, obtain the differential pressure between the outdoors and the envelope. Record 12 bias pressure readings before the pressure test and 12 bias pressure readings after the pressure test. Each reading is the average of ten or more 1-second measurements. Include positive and negative signs for each reading. To help dampen bias pressures that significantly contribute to test pressure, reduce temperature differences between indoor and outdoor air. Temperature differences can be reduced by operating test fan equipment for a few minutes to replace most of the indoor air with outdoor air.

3.9.5.3 Testing in Both Positive and Negative Directions

****

NOTE: The preferred way to dampen bias pressure due to wind is to test the building envelope in both the pressurization and depressurization directions and average the results. Bias pressures are nonlinear and cannot be adequately allowed for by merely subtracting the bias from the pressure reading. Testing in both directions more effectively dampens bias pressures thus tolerating the occurrence of larger bias pressures during a test, up to 30 percent of the lowest test pressure. Allow single direction testing only if testing in both directions cannot logistically be performed.

****

The preferred method for testing a building envelope is to test in both the pressurized and depressurized directions. Testing in one direction is only allowed if opposite direction testing cannot logistically be performed due to test equipment limitations or restrictions. After obtaining the pre-test bias differential pressure readings, conduct the pressure test. Record the envelope pressures (in units of Pascals) from one interior pneumatic hose (monitoring port) and the outdoor pneumatic hose(s), averaged or manifolded, with corresponding flows (in units of L/s cfm) for each fan. Record the flow rates at least 10 to 12 positive and 10 to 12 negative building pressure readings. If conducting both positive and negative pressure tests the lowest allowable test pressure is 40 Pa and the highest test pressure is 85 Pa. Keep at least 25 Pa difference between the lowest and highest test pressure readings. Include the 75 Pa pressure value between the lowest and highest readings. The 10 to 12 readings in each direction are to be roughly evenly spaced along the range of pressures and flows. After testing is complete de-energize the equipment used to provide pressurization and obtain an additional 10 to 12 post-test bias pressure readings. None of the bias pressure readings are allowed to exceed 30 percent of the minimum test pressure. If these limits are exceeded the test fails and must be repeated.

[3.9.5.4 Single Direction Testing

****

NOTE: Allowing testing in only one direction, acknowledges that very large buildings may require truck or trailer mounted blower equipment that logistically will not easily allow testing in both

positive and negative directions. Because bias pressures will have a greater impact on single-direction tests, the maximum allowable bias pressure under these circumstances is 10 percent of the lowest test pressure. At these generally higher pressures, the effects due to bias pressure is somewhat masked by the higher test pressure range. Because building envelopes are often leakier when measured in one direction than the other, testing in only one direction is considered less accurate than testing in both directions. Assume for example, that the bias pressure in a 12 m40 foot high building envelope where the temperature is -18 degrees C 0 degrees F outside and 20 degrees C 68 degrees F inside and with negligible wind is 10.5 Pa. This bias pressure can typically be assumed to be 5.25 Pa at the top of the building envelope and -5.25 Pa at the bottom of the building envelope.

****

After obtaining the 12 aforementioned bias pressure readings, conduct the [positive][negative] pressure test. Obtain flow rates at 10 to 12 roughly evenly spaced pressure readings over a pressure range of 50 to 85 Pa. After the data is recorded, de-energize the blower equipment and obtain an additional 10 to 12 bias pressure readings. None of the bias pressure readings may exceed 10 percent of the minimum test pressure. If these limits are exceeded the test fails.

]3.9.5.5 Using a Building's Own Air Handling System to Pressure Test an Envelope

****

NOTE: Very few US standards exist that adequately address the special requirements for pressurizing an envelope using the building's own air handling system. However, ASTM E779 attempts to address this topic. Canadian General Standards Board reference CAN/CGSB-149.15, "Determination of the Overall Envelope Airtightness of Buildings by Fan Pressurization Method Using the Building's Air Handling Systems" may help the designer better understand this test method. Using the building's air handling system is a less preferred test method due to the difficulty obtaining accurate readings and should only be used if a door blower fan is not feasible.

****

3.9.5.5.1 Test Setup

Temporarily seal the envelope in a manner similar to that for testing with blower door or trailer-mounted fans. To positively pressurize the envelope, de-energize all ventilation equipment and close all associated dampers, except those outside air intake dampers associated with supply fans that will be used to pressurize the building envelope. Fully open these dampers. For the negative pressure test, de-energize all ventilation equipment except for those fans that will be used to de-pressurize the envelope. All dampers associated with de-energized fans are to be closed and all exhaust dampers associated with fans used to de-pressurize the envelope will be fully opened.

3.9.5.5.2 Measuring Airflows

When using the building's own air handling system to pressure test the envelope, air flows can generally be measured using one of the following methods:

a. [When testing using the building's own air handling system, ensure flow readings obtained by anemometer comply with ASTM D3464.]Pitot tube or hot wire anemometer traverse in accordance with ASTM D3464.

b. Pressure compensated shrouds (especially recommended for rooftop exhaust fans)

c. Tracer gas methods for measuring airflows in ducts in accordance with ASTM E2029. Do not use tracer gas decay, constant injection, and constant concentration methods for estimating the total ventilation rate of the envelope.

3.9.5.5.3 Outdoor Air Flow Measuring Stations

Air flow stations may be used to measure outdoor airflows if one of the above methods is used to check accuracy of at least one air flow reading for each station or if the design of the HVAC system specifically placed outdoor air flow stations in locations that will yield accurate results. Field verify the accuracy of readings at the air flow measuring stations before obtaining pressure test readings.

3.9.5.6 Pressure Testing - Special Cases

[3.9.5.6.1 Pressure Testing a Tall or Large Building Envelope

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NOTE: Use this method only if the entire envelope cannot be pressure tested using the methods previously described. Note that if this method of pressure testing is used, the Architectural Plus HVAC test cannot be performed.

****

Pressure testing the envelope of a tall or large building may be unworkable and unrealistic using blower door or trailer-mounted equipment. In this case, the test agency may define and pressure test separate zones or floors within the envelope and sum the leakage all of the zones to create an overall envelope leakage rate. Using this method, the test agency is to comply with the requirements of ASHRAE RP-935.

]3.9.5.6.2 Pressure Testing a Multiple Isolated Zoned Building

****

NOTE: Some buildings may consist of multiple zones that do not share a common air plenum and cannot easily be modified to do so. Typically, these buildings are dormitories, apartment buildings, hotels and offices wherein occupants enter and leave each zone via a separate, exclusive, exterior door. Walls and floors isolate each zone such that no discernable air pathway between zones exists. In

this case, testing cannot be performed on the entire building envelope; rather, several representative air barrier zones within the building are to be individually pressure tested.

****

Pressure test each exterior corner zone plus at least an additional 20 percent (as measured by floor area) of remaining zones. The Contracting Officer is responsible for selecting which of these additional zones to test. If all zones pass the pressure test it is assumed that all untested zones also pass and no further testing is required. If, however, any zone fails to pass the test's leakage requirements, re-seal, and re-test until it passes in accordance with paragraph FAILED PRESSURE TEST. Test an additional 20 percent of previously untested zones. If all tested zones pass, no further testing is needed. If any zone in this group fails the test re-seal and re-test the zone until it passes. Continue this process until all the tested zones pass. When testing a zone, the doors to all adjacent zones that share a common surface with the tested zone are to have their doors opened to the outdoors. The resulting leakage from the test zoned is that through all six surfaces (4 walls, roof, and floor, for a rectangular shaped zone).

3.9.5.6.3 Pressure Testing a Building Addition

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NOTE: UFC 3-101-01 indicates that pressure testing a new building addition is not required if the interface between new and existing surfaces cannot be (or are not) adequately sealed for testing. An accurate pressure test can still be performed on the building addition using the method described in this paragraph. If a pressure test is performed on the addition, the surface area calculation should only include those surfaces equipped with an air barrier and not the interface (common) surfaces.

****

If the existing building is occupied, coordinate the pressure test with building representatives. In preparation of the test, de-energize the air handling system serving that portion of the existing building that shares surfaces with the new building addition. Pressure testing a new building addition may also require pressurizing that part of the existing building that shares surfaces in common with the new building addition. If an air barrier is applied to the common surfaces separating the existing building from the new addition, prior to the test prop open a sufficient quantity of doors and windows to keep the existing building at the same pressure as the outdoors. If an air barrier is not applied to the common surfaces separating the existing building from the new addition, pressurize that part of the existing building that shares surfaces in common with the building addition to the same level as the as the addition using separate test pressurization equipment.

3.9.5.7 Failed Pressure Test

If the pressure test fails to meet the established criteria, use diagnostic test methods described in paragraph LOCATING LEAKS BY DIAGNOSTIC TESTING to discover the leak locations. Provide additional permanent sealing measures to reduce or eliminate leak sources discovered during diagnostic testing. Retest (perform another pressure test) after sealing has been completed.

Repeat this sequence of documenting test results in the test report, performing diagnostic tests, documenting recommendations for additional sealing measures in the test report, sealing leak locations per recommendations, and re-testing as necessary until the building envelope passes the pressure test and is in compliance with the performance requirements.

3.9.5.8 Air Leakage Test Report

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NOTE: Edit and include Section 07 27 10, BUILDING AIR BARRIER SYSTEM. The paragraph of Section 07 27 10 titled "Air Barrier Envelope Surface Area and Leakage Requirements" includes the allowable leakage rate. These rates are different depending on if the test is Architectural Only or Architectural Plus HVAC System.

****

Report volumetric flow rates and corresponding differential pressures in liters per second (L/s) cubic feet per minute (cfm) and Pascals (Pa), respectively, on the Air Leakage Test Form sample form found in Appendix A. Populate the accompanying spreadsheet file titled Pressure Test Data Analysis with information obtained during the test. The spreadsheet uses equations found in ASTM E779 as a basis for calculating the envelope leakage rate. Other similar leakage rate calculation programs cannot be used or submitted for review. Submit a printout of the data input and output in the report. Should any air tightness (pressure) test fail, the pressure test report is to include data and results from all previous failed tests along with the final successful test data and results. Indicate if the resulting leakage rate did or did not meet the goal leakage requirement. Identify and document deficiencies in the building construction upon failure of a test to meet the specified maximum leakage rate.

Test reports on leakage tests performed using fan pressurization must meet ASTM E779 requirements; reports on tests performed utilizing blower door testing must meet ASTM E1827 requirements. Include the Test Agency Qualification Sheet, Air Leakage Test Form and Air Leakage Test Results Form in the written report. Document every test set-up condition with diagrams and photos to ensure the tests can be made repeatable. Document all pneumatic hose termination locations. Record in detail how the building envelope was prepared for the tests. Also describe in detail which building items were temporarily sealed. Include photos of test equipment and sealing measures in the report. Include an electronic (pdf) version of all test reports on a CD. If the building envelope fails to meet the leakage rate goal, provide recommendations to further seal the envelope and document these recommendations in the test report.

3.9.6 Locating Leaks By Diagnostic Testing

Use diagnostic test methods described herein to discover obvious leaks through the envelope. Perform diagnostic tests on the building envelope regardless of the envelope meeting or failing to meet the designated leakage rate goal. Use diagnostic test methods in accordance with ASTM E1186 and in conjunction with pressurization equipment, as necessary. Use the thermography diagnostic test to establish a baseline for envelope leakage. Apply additional diagnostic tests (find, feel, fog or other tests) as necessary to further define leak locations and pathways discovered using thermography or to find additional leaks not readily detected by thermography. Using a variety of diagnostic tests may help locate leaks that would otherwise go undetected if only a single diagnostic test were used. Pay special attention to locating leaks at interfaces where there is a change in materials or a change in direction of like materials. These interfaces, at a minimum, include roof/wall, wall/wall, floor/wall, wall/window, wall/door, wall/louver, roof mounted equipment/roof curb interfaces and all utility penetrations (such as ducts, pipes, and conduit) through the envelope's architecture. Also use diagnostic tests to check for leakage between the air duct and duct damper, when the damper, under normal control power, is placed in the closed position.

3.9.6.1 Sealing and Re-Testing

Should leaks be discovered during diagnostic tests, thoroughly document the exact leak locations on a floor plan so that sealing can be later applied, if required or as directed. If the envelope passes the leakage test, use the diagnostic test procedure described above to identify obvious leakage locations. Seal the leaks at the discretion of the COR based on the magnitude, location, potential for liquid moisture penetration or retention, potential for condensation, presence of daylight through an architectural surface or if the leakage location could potentially cause rapid deterioration or mold growth of, or in the building envelope materials and assemblies. Apply sealing measures after diagnostic testing is complete and all pressurization blowers are off. To verify that the applied sealing measures are effective, re-test for leaks using the same diagnostic methods that discovered the leak. Reseal and retest until the envelope meets the leakage rate goal and all obvious leaks through the envelope are sealed.

3.9.6.2 Find Test

Use visual observation to locate daylight or artificial light streaming from the opposite side of the envelope. Observe all interfaces identified above.

3.9.6.3 Feel Test

Use the building's air handling system or blower door equipment to negatively pressurize the building envelope, to at least 25 Pa but no greater than 85 Pa, with respect to the outdoors. The larger the pressure difference, the easier discovering leaks by feeling them becomes. While inside the envelope, hand feel roof/wall, wall/wall, and floor/wall interfaces and utility penetrations (such as ducts, pipes and conduit) for leaks and note the leak locations on a floor plan. The "Feel" test may also be used to check for leaks between the ductwork and ductwork damper. To do this, positively pressurize the envelope and check for air movement from the envelope exterior.

3.9.6.4 Infrared Thermography Test

****

NOTE: Generally, thermography can only be performed if there is a sufficiently significant temperature difference, a minimum of 5 degrees C 9 degrees F per ASTM E1186 between the indoors and outdoors. Pressurizing and depressurizing the envelope while performing thermography can help exaggerate leaks, thereby making them more noticeable.

****

Coordinate thermography examination with the pressure test agency and the test agency's pressurization equipment. The pressure test agency is to allow adequate time for the thermographer to perform a complete thermographic examination, as described hereinafter, of the envelope interior and exterior, including readings of the roof.

3.9.6.4.1 Thermography Test Methods

Before thermographic testing, remove furniture, construction equipment, and all other obstructions both inside and outside the building as necessary to gain a clear field of view. In the Thermographic Investigation Report, document all areas where obstructions remain. For exterior thermal examination of the envelope, including readings of the roof, verify that no direct solar radiation has heated the envelope surfaces to be examined for a period of approximately 3 hours for frame construction and for approximately 8 hours for masonry veneer construction. Conduct exterior investigations after sunset, before sunrise, or on an overcast day when the influence of solar radiation can be determined to be minimal. Limit exterior examinations to times when the influence of solar radiation is minimal, such as after sunset or before sunrise or during an overcast day. Conduct thermal imaging tests only when wind speeds are less than 8 mph at the time of analysis and at the end of analysis. Document any variations in wind during the test. Document all variations of test conditions in the Thermographic Investigation Report. Test only when exterior surfaces are dry. Monitor and document ongoing test parameters, such as the temperatures inside and outside the air barrier envelope, wind speed, and differential pressure.

3.9.6.4.1.1 Thermography Testing of the Air Barrier

Test the building envelope in accordance with ISO 6781, and ASTM E1186. Perform a complete thermographic inspection consisting of the full inspection of the interior and exterior of the complete air barrier envelope, to include readings of the roof. Document envelope areas that are inaccessible for testing. Use infrared thermography technology in concert with standard pressurization methods (blower doors, trailer mounted fans or the building's own air handling systems) to locate leaks through the air barrier. Adjust the HVAC system, if possible, to create or enhance the temperature difference between the envelope interior and exterior. The minimum allowable temperature difference is 5 degree C 9 degrees F. Maintain this temperature difference for at least 3 hours prior to the test. Use pressurization methods to establish a minimum of +20 Pa pressure difference with respect to the outdoors while using an infrared camera to view the envelope from outdoors. When viewing with the camera from inside the envelope, keep the envelope at a pressure differential of -20 Pa with respect to the outdoors using pressure testing equipment or the building's own air handling system.

3.9.6.4.2 Thermography Test Results

Document the location of all leaks, anomalies, and unusual thermal features on a floor plan or elevation view and catalog them with a visible light picture for locating the defect for correction. The thermographer is to recommend corrective actions to eliminate the leaks, anomalies, and unusual thermal features. Where leaks are found perform corrective sealing as necessary to achieve the whole envelope air leakage rate specified. After sealing, again use thermography in concert with standard pressurization methods to verify that the air leakage has been reduced. After these leaks have been permanently sealed, note all actions taken on the drawings or in the Thermographic Investigation Report. Submit the drawings for approval as part of the Thermographic Investigation Report. Also include thermographic photos that show where leaks were discovered. Include thermograms using an imaging palette that clearly shows the observed thermal patterns indicating air leakage. The Contracting Officer's Representative is to witness all testing.

3.9.6.5 Fog Test

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NOTE: A fog generator is an electrical device that heats a water-based fluid and converts it into a safe, breathable and relatively buoyant fog. This fog can be issued towards a building interface from a distance of 6 m 20 feet or greater. Consumer grade fog generators are commonly used for parties or during the Halloween season.

****

Before using a theatrical fog generator, disable all building smoke detectors as they may alarm when fog is issued. Coordinate fog tests and the disabling of all smoke detectors with the Contracting Officer's representative and the local fire department as necessary. Use pressure test equipment or the buildings own air handling system to positively pressurize the building envelope to at least 25 Pa but not greater than 85 Pa over the outdoors. Using a theatrical fog generator within the envelope, direct fog at suspected leakage points such as at building interfaces. Test the following interfaces: roof/wall, wall/wall, floor/wall, wall/window, roof/mounted mechanical equipment. From the vantage point immediately outside the envelope and opposite that of the interface being tested, observe the effect as the fog is issued. Detection may also be further enhanced by using a scented fog liquid or a fog liquid that produces a colored fog. Look for fog and smell for associated odor percolating through the interface. Also use smoke puffers and smoke sticks as necessary to locate leaks at these and other interface locations. If the Architectural Plus HVAC System pressure test will be/was performed introduce fog into ductwork to check for leakage between ductwork and associated dampers. After fog testing has ended, reactivate the building smoke detectors, and notify the Contracting Officer and local fire department that the test has ended. After sealing has been completed retest these areas using fog. Seal additional leaks that are found. (Note that theatrical fog may release quantities of the water vapor, glycol, mineral oil, or other media that could damage electronics and interior finishes or cause allergic reactions. Small scale smoke trace could be used as an alternative. See "Effects of Theatrical Smokes and Fogs on Respiratory Health in the Entertainment Industry" at www.nih.gov.)

3.9.6.6 Diagnostic Test Report

Once the diagnostic tests have been completed and the leakage locations identified and sealed, document these procedures, locations, and recommendations in the diagnostic test report. Submit plan and profile drawings that thoroughly identify leak locations. Describe in detail all leak locations so that the seal-up crew knows where to apply sealing measures. After sealing measures have been applied, describe the methods used along with applicable photos of the final sealed condition.

3.9.6.6.1 Thermographic Investigation Report

Submit a report of each thermographic investigation identifying the thermal discontinuities in the thermal control layer. Indicate in the final report locations to which improvements for both the air control layer and the thermal control layer were made to reduce air leaks and correct discontinuities in the thermal control layer. Include in the report some selected radiometric images of suspected failure points in the air barrier envelope that indicate before and after conditions.[Devote a chapter(s) of the Thermographic Investigation Report to identifying suspected points of thermal bridging, moisture migration through roofs and walls, and insulation voids.] Indicate in the final report improvements that were made to the envelope to reduce air leaks. Include the following items in the report:

a. Brief description of the building construction

b. Types of interior and exterior surface materials used in the building.

c. Geographical orientation of the building with a description of the exterior surroundings including other buildings, vegetation, landscaping, and surface water drainage.

d. Camera brand, model and serial number, and most recent calibration date; optional lenses with serial numbers (if applicable)

e. Thermographer's and Government Inspector's names

f. Date and time of tests

g. Air temperature and humidity inside the air barrier envelope

h. Outdoor air temperature and humidity

i. General information for the last 12 hours on the solar radiation conditions in the geographic area where the test is being performed.

j. Ambient conditions such as precipitation and wind direction and speed occurring with the last 24 hours, as applicable. Refer to specific requirements in each section of each thermographic inspection type for requirements in each specific area.

k. Documentation of those portions of the building envelope which were not within test conditions when the scan was performed, and which portions were obstructed by adjacent structures, interior furnishings, intervening cavities, or reflective surfaces.

l. Other relevant information, which may have influenced test results.

m. Drawings, sketches, floor plans and photographs detailing the locations in the buildings where thermograms were taken detailing possible irregularities in the components being tested.

n. Thermal images taken during the inspection with their relative locations and written or voiced recorded explanations of the anomaly listed along with visual and reference images.

o. An identification of the aspects or components of the building being examined.

p. Explanations for the type and the extent of each construction defect observed during the inspection.

q. Any results from additional measurements and investigations. Identify additional equipment used and support with type, model number, serial number, and date of most recent calibrated.

3.9.6.6.2 Fog Test Report

Document all turbulent air flow and dead air spaces within the envelope. Report fog behavior as it exits from or is entrained within the building. Include a floor plan in the report that documents the locations where fog passed through the envelope.

3.9.7 Calculation Program

To calculate the envelope leakage rate and other required outputs, input the data obtained during the pressure tests as documented in the Air Leakage Test Form (Appendix A) into the Air Leakage Rate by Fan Pressurization Excel spreadsheet. This spreadsheet can be found at the following web site: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-

3.9.8 After Completion Of The Pressure And Diagnostic Test

After all pressure and diagnostic testing has been completed unseal all temporarily sealed items. Unless otherwise directed by the Contracting Officer, return all dampers, doors, and windows to their pre-test condition. Remove tape and plastic from all temporarily sealed openings, being careful not to deface painted surfaces. If paint is removed from finished surfaces, repaint to match existing surfaces. Unless otherwise directed by the Contracting Officer's representative, return fuel (gas) valves to their pre-test position and relight pilot lights. Return all fans and air handling units to pre-test conditions. Restore smoke/fire detectors to operating condition.

3.9.9 Repair And Protection

Repair and protection are the Contractor's responsibility, regardless of the assignment of responsibility for testing, inspection, and similar services. Upon completion of inspection, testing, or sample taking and similar services, repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

3.10 TRAINING

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NOTE: This Article contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, and GOVT HIRED COMMISSIONING PROVIDER.

****

The Building Enclosure Commissioning Specialist must review the training plan required by Section 01 78 00 OPERATION AND MAINTENANCE DATA and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.

The Commissioning Provider is responsible for overseeing and approving the training plan required by Section 01 78 00 OPERATION AND MAINTENANCE DATA and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.

Coordinate, schedule, and document training of all commissioned systems as required by Section 01 91 00.15 BUILDING COMMISSIONING paragraph titled "Training Plan".

3.11 FINAL BECx REPORT

The BECx must provide a final BECx report that includes information generated by the BECx process including: BECx meeting minutes, design reports, test reports, the final OPR, BoD, final BECx Plan, issue and resolution log, site observations, as-built drawings (provided by the Contractor), submittals, record of training, and recommended preventive maintenance actions and intervals.

The BECxP must ensure the Final BECx Report is submitted as a portion of the Final Commissioning Report for the project, as defined in Section 01 91 00.15 BUILDING COMMISSIONING. Submit report within 14 calendar days of completion of all commissioning efforts.

3.12 APPENDICES

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NOTE: Download appendices from http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms **and insert as specified. Attachments to this section will be listed in the section table of contents generated through the SpecsIntact print process.**

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The following forms are available for download as a MS Word file at http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-

Appendix A - Air Leakage Test Form
Appendix B - Air Leakage Test Results Form
Appendix C - Test Agency Qualifications Sheet

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 32 13 (February 2021)**

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Preparing Activity: USACE **Superseding without Revision**
UFGS-02 32 00 (May 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 32 13

SUBSURFACE DRILLING AND SAMPLING

02/21

PART 1 GENERAL

ATTACHMENTS:

approximate locations of [drill holes] [test pits] [_____]

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-02 32 13 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-02 32 00 (May 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 32 13

SUBSURFACE DRILLING AND SAMPLING
02/21

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NOTE: This guide specification covers the requirements for determining the type, nature, and characteristics of subsurface materials as they exist to the depths and at the locations specified. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

NOTE: TO DOWNLOAD UFGS GRAPHICS
Go to
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms

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PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 **PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below**

should be inserted into Section 01 20 00.
****

Make all measurements for payment by or in the presence of the Contracting Officer. Preserve all holes in good condition until final measurement and until the records and samples have been examined and accepted. Payment will be made only for drilling and pressure testing those holes or for excavating those test pits that are included in the SCHEDULE OF DRILLING, SAMPLING, AND TESTING, or are directed by the Contracting Officer to be so drilled or excavated. Payment will not be made for any hole or testing for which satisfactory records (and samples), as determined by the Contracting Officer, are not furnished.

1.1.1 Mobilization and Demobilization

1.1.1.1 Payment

Payment will be made for costs associated with mobilization and demobilization. Sixty percent of the Mobilization and Demobilization lump sum price will be paid following completion of moving onto the site, including complete assembly in working order, of all equipment necessary to perform the required drilling, sampling, pressure-testing and test pit excavation operations. The remaining 40 percent of the contract lump sum price will be paid after all site restoration is completed and all equipment has been removed from the site. No separate payment will be made for moves between holes or test pits.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Auger Boring and Sampling of Drill Holes

1.1.2.1 Payment

Payment will be made for costs associated with Auger Boring and Sampling, [_____] mm inch Diameter Drill Holes.

1.1.2.2 Measurement

Auger Boring and Sampling, [_____] mm inch Diameter Drill Holes will be measured for payment to the nearest 300 mm linear foot, based upon the linear meters feet of holes that were actually drilled through overburden with augers in accordance with the specifications. Measurements will be made from the original ground surface.

1.1.2.3 Unit of Measure

Unit of measure: linear meter foot.

1.1.3 Drive Sample Boring and Sampling

1.1.3.1 Payment

Payment will be made for costs associated with Drive Sample Boring and Sampling, - [_____] mm inch Diameter Samples.

1.1.3.2 Measurement

Drilling for drive sample boring and sampling will be measured for payment to the nearest 300 mm linear foot, based upon the linear meters feet of holes that were actually drilled by drive-sample-boring methods in accordance with the specifications. Measurements will be made from the original ground surface.

1.1.3.3 Unit of Measure

Unit of measure: linear m foot.

1.1.4 Undisturbed Sample Boring and Sampling

1.1.4.1 Payment

Payment will be made for costs associated with Undisturbed Sample Boring and Sampling, [_____] mm inch Diameter Samples.

1.1.4.2 Measurement

Drilling for undisturbed sample boring and sampling will be measured for payment to the nearest 300 mm foot, based upon the linear meters feet of holes that were actually drilled by undisturbed sampling methods in accordance with the specifications. Measurements will be made from the original ground surface.

1.1.4.3 Unit of Measurement

Unit of measure: linear m foot.

1.1.5 Core Hole Overburden Drilling, Without Sampling

1.1.5.1 Payment

Payment will be made for costs associated with Core Hole Overburden Drilling, Without Sampling, [_____] mm inch Diameter Drill Holes, [Vertical] [Inclined].

1.1.5.2 Measurement

Core hole drilling through overburden in order to permit core drilling of rock for [vertical] [inclined] holes where sampling of overburden is not required will be measured for payment to the nearest 300 mm foot, based upon the linear meters feet of hole actually drilled and cased in accordance with these specifications.

1.1.5.3 Unit of Measure

Unit of measure: linear m foot.

1.1.6 Core Drilling, [Vertical] [Inclined] Holes

1.1.6.1 Payment

Payment will be made for costs associated with Core Drilling [Vertical] [Inclined] Holes for [_____] mm inch Diameter Cores.

1.1.6.2 Measurement

Core Drilling [Vertical] [Inclined] Holes for [_____] mm inch Diameter Cores will be measured for payment to the nearest 300 mm foot, based upon the linear meters feet of hole actually drilled in rock in accordance with the specifications.

1.1.6.3 Unit of Measure

Unit of measure: linear m foot.

1.1.7 Pressure Testing (Hydraulic)

1.1.7.1 Payment

Payment will be made for costs associated with Pressure Testing (Hydraulic).

1.1.7.2 Measurement

Pressure Testing (Hydraulic) will be measured for payment based upon the number of hours that pressure testing (hydraulic) was actually performed at the direction of the Contracting Officer and in accordance with the specifications or as otherwise required. Pressure testing (hydraulic) will be measured from the time the pressure testing is begun at the direction of the Contracting Officer to the time of completion of the test as determined by the Contracting Officer. Time spent in placing packer elements in the holes, raising or lowering the packer elements from one lift to another, or removing the packer elements from the holes and time spent in preparation for testing will not be included.

1.1.7.3 Unit of Measure

Unit of measure: hour.

1.1.8 Test Pit Excavation

1.1.8.1 Payment

****

NOTE: Delete the first bracketed option below if the payment paragraphs are inserted in Section 01 20 00 PRICE AND PAYMENT PROCEDURES; otherwise delete the second bracketed option.

****

Payment will be made for costs associated with excavating test pits in accordance with [this section] [Section 01 20 00 PRICE AND PAYMENT PROCEDURES].

1.1.8.2 Measurement

Test Pit Excavation will be measured for payment based upon the contract unit price for each test pit excavated[, which includes the cost of all shoring materials].

1.1.8.3 Unit of Measure

Unit of measure: each.

1.1.9 Test Pit Undisturbed Sample

1.1.9.1 Payment

****

NOTE: Delete the first bracketed option below if the payment paragraphs are inserted in Section 01 20 00 PRICE AND PAYMENT PROCEDURES; otherwise delete the second bracketed option.

****

Payment will be made for costs associated with undisturbed sampling in a test pit in accordance with [this section] [Section 01 20 00 PRICE AND PAYMENT PROCEDURES].

1.1.9.2 Measurement

Test Pit Undisturbed Sample will be measured for payment based upon the contract unit price for each sample obtained.

1.1.9.3 Unit of Measure

Unit of measure: each.

1.1.10 Material for Shoring/Lining Pit Excavation

1.1.10.1 Payment

Payments will be made for costs associated with Shoring/Lining Test Pit Excavations at the contract unit price for each test pit excavation.

1.1.10.2 Measurement

Material used for shoring/lining test pit excavations will be measured for payment based upon the amount of material actually used as directed by the Contracting Officer for shoring/lining the excavations. Material salvaged and re-used at the direction of the Contracting Officer will be paid for at the rate of 30 percent of the contract unit price.

1.1.10.3 Unit of Measure

Unit of measure: each.

1.1.11 Casing Left in Drill Holes

1.1.11.1 Payment

Payment will be made for costs associated with Casing Left in Drill Holes, [_____] mm inch Diameter.

1.1.11.2 Measurement

Casing Left in Drill Holes will be measured for payment to the nearest 300 mm foot, based upon the linear meters feet of casing actually left in the drill holes at the direction of the Contracting Officer.

1.1.11.3 Unit of Measure

Unit of measure: linear m foot.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1452/D1452M	(2016) Standard Practice for Soil Exploration and Sampling by Auger Borings
ASTM D1586/D1586M	(2018) Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D1587/D1587M	(2015) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D2113	(2014) Rock Core Drilling and Sampling of Rock for Site Investigation
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-1-1906	(1996) Engineering and Design -- Soil Sampling

1.3 SYSTEM DESCRIPTION

Provide the data to determine the type, nature, and characteristics of subsurface materials and the extent and conditions of the various materials as they exist to the depths and at the locations specified. This is to be accomplished by means of [auger borings], [drive sample borings] [undisturbed sample borings] [core drilling] [pressure testing] [test pits] [_____].

1.3.1 Auger Borings and Sampling

An auger boring is any boring made in unconsolidated soils with a conventional manually or power-driven earth auger for the purpose of obtaining samples of subsurface materials. Perform auger boring and sampling in accordance with [Chapter [_____], EM 1110-1-1906] [ASTM D1452/D1452M], [as directed by the Contracting Officer].

1.3.2 Drive Sample Borings and Sampling

A drive sample boring is a boring made through unconsolidated or partly consolidated sediments or decomposed rock by means of a mechanically driven sampler. The purpose of these borings is to obtain knowledge of the composition, the thickness, the depth, the sequence, the structure, and the pertinent physical properties of foundation or borrow materials. Perform drive sample boring and sampling in accordance with [Chapter [_____] of EM 1110-1-1906] [ASTM D1587/D1587M] [as directed by the Contracting Officer]. Perform standard penetration tests (SPT) in accordance with [Appendix [_____] of EM 1110-1-1906] [ASTM D1586/D1586M].

1.3.3 Undisturbed Sample Borings and Sampling

An undisturbed sample boring is a boring made to obtain soil samples which, when tested, will show properties as close to the in situ (in place) properties as any sample which can be obtained. Accomplish all undisturbed sampling in accordance with [Chapter [_____] of EM 1110-1-1906] [ASTM D1587/D1587M] [as directed by the Contracting Officer].

1.3.4 Core Drilling

****

NOTE: See TABLE 1 COMMON CORE DIAMETERS.

****

Provide core drilling consisting with a [_____] mm inch Diameter. Core Drilling of cores must be [by any approved standard and accepted method of rotary rock core drilling that will provide continuous and complete rock cores of the required diameter from any subsurface interval of bedrock specified for investigation] [performed in accordance with ASTM D2113]. Provide equally good recovery of cores from both hard and soft rocks.

1.3.5 Pressure Testing (Hydraulic)

Hydraulic pressure testing is the process of forcing water under pressure into subsurface rock formations through pre-drilled holes for the purpose of determining the subsurface leakage conditions and possible grouting requirements.

1.3.6 Test Pit Excavation and Sampling

A test pit is any excavation in soil, hardpan, decomposed rock, or other unconsolidated or partially consolidated overburden materials which has an open cross-sectional area large enough to permit efficient excavation and shoring/lining, engineering and geological inspection and photographing of the subsurface soils and manual undisturbed sampling from within the test pit. Excavate, dewater (if necessary), shore/line and protect all test pits from surface water drainage in accordance with all applicable Federal, State, local, Corps of Engineers, and OSHA safety regulations.

1.3.7 Sequencing and Scheduling

1.3.7.1 Schedule of Drilling, Sampling, and Testing

Prior to starting work, submit a plan for drilling, sampling, testing, and safety which includes, but is not limited to, the proposed method of drilling and sampling including a description of the equipment and sampling tools that will be used, a listing of any subContractors to include a description of how the subContractors will be used and a description of all methods and procedures that will be utilized to insure a safe operation and to protect the environment. Do not perform any work until this plan has been approved and no deviation from the approved plan will be permitted without prior approval by the Contracting Officer. The schedule of Drilling, Sampling, and Testing is [indicated.] [listed in the following schedule:]

SCHEDULE OF DRILLING, SAMPLING AND TESTING				
[HOLE NO.][PIT NO.]	METHOD	DEPTH (METERS) (FEET)	VERTICAL OR INCLINED	SPECIAL INSTRUCTIONS

1.3.7.2 Order of Work

****
NOTE: Select appropriate alternative.
****

[The order in which the work is to be accomplished will be determined in the field by the Contracting Officer.] [Commence operations on [Hole No. [_____]] [Test Pit No. [_____]] [_____] and proceed so as to complete [Holes] [Test Pit] [Nos. [_____], [_____], and [_____]] before starting [Hole] [Test Pit] Nos. [_____] and [_____].]

[1.3.7.2.1 Numerical Sequence

It is intended that the [drilling] [test pit excavating] [_____] be accomplished in the numerical sequence indicated in the [SCHEDULE OF DRILLING, SAMPLING, AND TESTING shown on the drawings] [listed in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING]; however, the Contracting Officer may vary the order whenever and in whatever manner is deemed best for accomplishing the work.

1.3.7.2.2 Reporter

Provide a qualified, licensed Geologist experienced in subsurface exploration for each drill unit to oversee all drilling, sampling, and field testing operations. This individual is responsible for the preparation of a separate log and/or report for each boring, pressure test, or test pit. This individual is also responsible for the preparation of all soil and rock samples for delivery to the designated point.

1.3.7.2.3 Government Oversight

The presence of a Government representative or the keeping of separate drilling records by the Contracting Officer does not relieve the Contractor of the responsibility for the work specified in this specification.

]1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drilling Log; G, [_____]

SD-03 Product Data

Permits, Certifications, and Licenses
Schedule of Drilling, Sampling, and Testing; G, [_____]

1.5 QUALITY ASSURANCE

Comply with all Federal, State and local laws, regulations and ordinances relating to the performance of this work. Procure all required permits, certifications and licenses required by Federal, State, and local law for the execution of this work. Submit copies of all permits, certifications, and licenses prior to starting work. Include a statement of the prior experience, in the type of work described in these specifications, of the person or persons designated to perform the work specified herein.

1.6 DELIVERY, STORAGE, AND HANDLING

****

NOTE: Insert delivery address for samples.

****

1.6.1 General

The Contractor is solely responsible for preserving all samples in good condition. Keep samples from freezing and undue exposure to the weather. Keep all descriptive labels and designations on sample jars, tubes, and boxes clean and legible until final delivery of samples to, and acceptance by, the Contracting Officer. Except as otherwise specified, deliver samples to [_____]. Deliver samples within the time limits specified for each type of investigation or in accordance with schedules prepared by the Contracting Officer.

1.6.2 Undisturbed Samples

Take every precaution to avoid damage to samples as a result of careless handling and undue delay in shipping. Ship samples in containers approved by the Contracting Officer. Provide durable containers to protect the samples from any damage during shipment. Pack the sample tubes in vermiculite or other equal material approved by the Contracting Officer to protect the samples against vibration. Avoid exposing sealed and crated samples to precipitation, direct sunlight, freezing and temperatures in excess of 38 degrees C 100 degrees F. Replace frozen, as well as partially frozen, samples. In general, undisturbed samples are not allowed to remain on the site of sampling for more than one week before shipment. Store and ship samples with the tube in a [horizontal] [vertical] position in order to prevent consolidation and segregation or change of water content.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Environmental Requirements

****

NOTE: Select appropriate alternative.

****

[Comply with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.] [In order to prevent and to provide for abatement and control of any environmental pollution arising from Contractor activities in the performance of this contract, the Contractor and its subContractors must comply with all applicable Federal, State, and local laws, regulations, and ordinances concerning environmental pollution control and abatement.

a. The Contractor is responsible for keeping informed of all updates and changes in all applicable laws, regulations, and ordinances.

b. Do not pollute lakes, ditches, rivers, springs, canals, waterways, groundwaters, or reservoirs with drill fluids, fuels, oils, bitumens, calcium chloride, insecticides, herbicides, or other materials that may be harmful to the environment or a detriment to outdoor recreation.]

1.7.2 Field Measurements

The approximate locations of [drill holes] [test pits] [_____] are shown on the attached drawings. The actual locations will be established in the field by the Contracting Officer prior to the start of work. The elevations of the established locations will also be provided by the Contracting Officer prior to the start of work. Provide access to the locations as necessary for the prosecution of the work. Since no separate payment will be made for access construction, include all costs associated with this in the cost of [drilling] [excavating].

PART 2 PRODUCTS

2.1 CONTAINERS

Furnish jars, tubes, and boxes that meet the following requirements. All such containers will become the property of the Government and the cost thereof will be included in the contract price for the applicable item for which payment is provided.

2.1.1 Sample Jars

Provide sample jars that are [0.5 L 1 pint] [1.0 L 1 quart] capacity, wide-mouth [over 57 mm 2-1/4 inches in diameter] [glass] [plastic] jars with moisture-tight screw tops.

2.1.2 Shipping Boxes

Provide [corrugated cardboard] [wooden] boxes that have the capacity to hold no more than 12 sample jars and the strength to contain and protect the jars and their contents under ordinary handling and environmental conditions.

2.1.3 Tubes and Crates

Ship undisturbed samples in thin walled Shelby tubes packed in crates.

2.1.4 Core Boxes

Use longitudinally partitioned, hinged top, wooden core boxes constructed of plywood and dressed lumber or other approved materials in general accordance with the arrangement and dimensions shown in FIGURE 1 for all rock cores. Use as many core boxes as required to box all core. Furnish core boxes completely equipped with all necessary partitions, hinges, and a hasp for holding down the cover. Also provide wood spacers made of surfaced lumber (not plywood) and having dimensions that are 3 mm 1/8 inch less than the inside dimensions of the individual core box troughs and no less than 19 mm 3/4 inch thick for blocking the core in the boxes and for providing a marking space to identify core runs and pull depths/elevations. The quantities of these blocks that are required are: ten blocks per core box for 75 mm 3 inch or smaller core, five blocks per core box for 100 mm 4 inch and PQ core, and three blocks per core box for 150 mm 6 inch core. The box should have the following capacities:

Box Capacities	
150-mm6-inch core	single row of core
100-mm4-inch or PQ core	2 rows of core
75-mm3-inch or smaller core	3 or 4 rows of core

Provide core box with a maximum length of 1.2 m 4 feet for 75 mm 3 inch or smaller core and dimensioned so that a box will hold 3.6 to 4.9 m 12 to 16 feet of core. The maximum length of a core box for core that is larger than 75 mm 3 inches must be 1.5 m 5 feet.

2.2 LABELS

2.2.1 Sample Jar Labels

Affix a printed or type-written, fade resistant and waterproof label to the outside of each jar containing the following information:

PROJECT	(such as Table Rock Dam)	LOCATION	(such as Borrow Area B)
HOLE NO.		STATION	
JAR NO.		of	______ JARS
TOP ELEVATION OF		DEPTH OF SAMPLE	
DESCRIPTION OF MATERIAL	(such as moist, silty, medium sand)		

2.2.2 Shipping Box Labels

Identify each box of jar samples with weatherproof and wear-proof labels indicating the following:

PROJECT	[_____]
LOCATION	

JAR SAMPLES FROM HOLE OR HOLES	

2.2.3 Core Box Labels

Identify core boxes with stenciled labels containing the following information:

PROJECT	[_____]
HOLE NO.	
BOX NO.	
TOTAL NUMBER OF BOXES FOR THE HOLE	

2.3 EQUIPMENT AND SUPPLIES

2.3.1 Auger Boring and Sampling

Furnish the equipment for making auger borings including, but not limited to, standard continuous flight augers and/or standard cup-type earth augers, similar or equal to the Iwan Auger and not less than 100 mm 4 inches in diameter unless otherwise approved. Equip augers with all the accessories necessary for boring and sampling of overburden materials to the depths and diameters specified or shown on the drawings.

2.3.2 Drive Sample Boring and Sampling

Furnish equipment for making drive sample borings including, but not limited to, standard [50 mm 2-inch OD] [[_____] mm inch OD] [split barrel] [solid barrel] drive samplers and power-driven drilling machinery of a type or types approved by the Contracting Officer, complete with a [_____] kN drive-hammer drive-hammer of [_____]-pound weight and all other accessories for taking samples of all types of soils or decomposed rock at the locations and to the depths indicated [in the SCHEDULE OF DRILLING, SAMPLING, AND TESTING shown on the drawings] [in the schedule in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING]. Provide hardened steel drive shoe for the split barrel samplers and replace or repair when it becomes dented or distorted. Include all casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling.

2.3.3 Undisturbed Sample Boring and Sampling

Furnish equipment for making undisturbed sample borings including, but not limited to, power-driven drilling machinery of an approved type or types complete with the special devices and accessories enumerated and described hereinafter. Provide hydraulic feed type drilling machinery. Include all samplers, casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling. Provide drill casing, if used, of such minimum inside diameter as to allow use of the selected sampler.

2.3.3.1 Sands and Cohesive Soils

The sampling device used to sample fine to medium grain sands and cohesive soils must be a fixed or stationary piston type that uses a [75-mm 3-inch]

[125-mm 5-inch] diameter thin wall Shelby tube. [Subject to the approval of the Contracting Officer, floating or free piston and non-piston type samplers may be used provided adequate means, such as check valve or vacuum system, are provided to prevent loss of samples.]

2.3.3.2 Stiff and Dense Soils

Provide sampling device for obtaining samples of stiff and dense soils similar or equal to a Denison double tube, swivel head core barrel, or a Pitcher sampler and approved by the Contracting Officer prior to use.

2.3.4 Core Drilling

****

NOTE: See TABLE 1 COMMON CORE DIAMETERS.

****

Provide core drilling consisting of a [_____] mm inch Diameter Core. Furnish equipment for core drilling including core-drilling machinery of a type or types approved by the Contracting Officer, complete with all the accessories needed to take continuous rock cores of a diameter consistent with bit size to the depths specified. Use, as a minimum, a standard ball-bearing, swivel-head, double-tube core barrel, or equivalent. Capacity of the core barrel exceeding 3.2 m 10.5 feet of core is not acceptable. Include all casing, drill rods, core barrels, coring bits, piping, pumps, water, tools, and power required for drilling and all boxes and containers required for core samples. Selection of the type of bit is at the Contractor's discretion provided that the selected bit produces high quality rock core (see paragraph SUPPLEMENTAL [BORINGS] [PITS]).[Provide drilling equipment capable of drilling inclined as well as vertical core holes as specified.]

2.3.5 Pressure Testing (Hydraulic)

Furnish pressure testing equipment including, but not limited to, the following: water pump with a minimum capacity of 3.15 L/second 50 gpm that is capable of delivering a constant discharge pressure of [_____] kPa psi, double expander packers with rubber expansion elements set [1.5] [3] [_____] m [5] [10] [_____] feet apart with piping so arranged that water may be admitted either below the bottom packer element or between the two packer elements, a pressure relief valve, a pressure gage capable of measuring water pressures to the nearest [_____] kPa psi and water meter capable of measuring flows to the nearest [_____] 0.1 L/second gpm. Include all accessory valves, gages, surge tanks, stopcocks, plugs, expanders, potable water for testing, standby pumps, fuels, pipes, pressure hose, and tools necessary for maintaining uninterrupted tests for each boring to be tested. Configure the pressure test equipment such that the pressure gage is located at the top of the hole, a by-pass water line and valve are located between the pump and the gage, a flow meter is located between the by-pass and the pressure gage, and a valve is located in the line between the flow meter and the pressure gage. All equipment and supplies used for pressure testing must be approved by the Contracting Officer prior to use.

2.3.6 Test Pit Excavation and Sampling

Selection of the test pit excavation, shoring/lining and dewatering (if necessary) methods and equipment is at the Contractor's discretion but must be approved by the Contracting Officer. When the number of test pits to be excavated is large, and when adaptable mechanical trenching equipment is available, the Contracting Officer may require that such mechanical excavating equipment be used to expedite completion of the pits. Supplies for obtaining undisturbed samples include, but are not be limited to, split metal cylinders and/or metal or wooden boxes of acceptable sizes and types. Provide cylinders with minimum inside dimensions of [_____] mm inches in diameter by [_____] mm inches in length. Provide wooden boxes that are cubic in shape with a minimum inside dimension of [_____] mm inches. Accessories include, but are not be limited to, a small sample trimming shovel or spade, hatchet, trimming knife, [_____] wax and facilities for melting and brushing same, trowels, labels, and boxes for shipping samples. Also furnish all materials required for shoring/lining to comply with all applicable safety regulations. The Contracting Officer may require the Contractor to salvage and re-use this shoring/lining material in successive test pits.

PART 3 EXECUTION

3.1 MOBILIZATION AND DEMOBILIZATION

****

NOTE: Delete this paragraph if Mobilization and Demobilization is not a separate payment item.

****

3.1.1 Mobilization

Mobilization consists of the delivery to the site of all plant, equipment, materials and supplies to be furnished by the Contractor, the complete assembly in satisfactory working order of all such plant and equipment at the jobsite and the satisfactory storage at the site of all such materials and supplies.

3.1.2 Demobilization

Demobilization consists of the removal from the site of all plant, equipment, materials and supplies after completion of the work and also includes, at the direction of the Contracting Officer, the cleanup and removal of all scrap, waste backfill material, waste drilling fluid, soil contaminated with engine/hydraulic oil, backfilling all sumps or excavations resulting from the operations and, in general, returning the site as close to its original condition as possible.

3.2 IDENTIFYING SAMPLES

Provide sample jars, shipping boxes, and labels that comply with PART 2, paragraphs SAMPLE JARS, SHIPPING BOXES, and LABELS, respectively. [In addition, place a moisture proof label containing the project name, hole number and sample number inside the jar or write this information using a waterproof pen or scribe on the jar lid.] Take all precautions required to insure that the shipping boxes are not subjected to rough handling or damaging environmental conditions [, and complies with paragraph CARE AND DELIVERY OF SAMPLES]. [Enclose a copy of the boring log for the portion of the boring that the samples came from in the shipping box.]

3.3 AUGER BORING AND SAMPLING

Label samples in accordance with paragraph IDENTIFYING SAMPLES. Obtain samples for each change of overburden material and at maximum vertical intervals of [0.3] [1] [1.5] [_____] m [1] [3] [5] [_____] feet [as directed by the Contracting Officer]. In order to retain the natural moisture content of the material to the fullest extent possible, provide samples of sufficient volume to completely fill the sample jars and place the samples in the sample jars as soon as possible after they are taken from the hole. Label all sample jars. In general, no sample is allowed to remain on the site of boring for more than 1 week after being taken from the boring and placed in a jar.

3.4 DRIVE SAMPLE BORING AND SAMPLING

Label samples in accordance with paragraph IDENTIFYING SAMPLES. Case drive sample borings drilled through overburden materials to permit obtaining drive samples of the size or sizes specified or as directed. Take samples continuously or at maximum vertical intervals of [1] [1.5] [_____] m [3] [5] [_____] feet or at a change in materials [in accordance with instructions contained in the SCHEDULE OF DRILLING, SAMPLING, AND TESTING] [as shown on the drawings] or as otherwise directed by the Contracting Officer. Drive the sampler with the force of the [620 140] [_____] N pound drive hammer under a free fall of [_____] mm inches. To minimize the compacting effect of casing driving when casing is used to stabilize a boring, keep the bottom of the casing as high above the soil sampling zone as conditions permit. If hollow stem auger is used as a casing and/or to advance the boring, a plug assembly must be used to keep soil from entering the inside of the auger. Above the water table, obtain samples from a dry hole. Below the water table, maintain water within the hole at or above the groundwater level. Where information on the natural water content of soils above the water table is not needed and when approved by the Contacting Officer, boreholes may be drilled without casing by using a suitable drilling fluid to prevent collapse of sidewalls. When a drilling fluid is used, perform soil sampling by such means that will prevent inclusion of drilling fluid in the samples. Place the samples in sample jars as soon as possible after they are taken from the hole and, when possible, the volume of the sample must be large enough to completely fill the sample jar in order that the natural moisture content of the material may be retained to the fullest extent possible. Label all samples. No sample is permitted to remain at the site of boring for more than one week after being taken from the hole.

3.5 UNDISTURBED SAMPLE BORING AND SAMPLING

In general, label undisturbed samples in conformance to paragraph IDENTIFYING SAMPLES. Take particular care to indicate the top and bottom of each sample tube. Label tubes and crates for undisturbed samples "DO NOT JAR OR VIBRATE" and "HANDLE, HAUL, AND SHIP IN A [HORIZONTAL] [VERTICAL] POSITION".

3.5.1 Procedure

The procedure for Undisturbed Sample Boring and Sampling is outlined in paragraph DRIVE SAMPLE BORING AND SAMPLING, except that the sampling device must be advanced downward by one continuous, smooth drive using the drill rig's hydraulic feed system. Read and record the hydraulic down pressure at 150 mm 6 inch intervals during each sample drive. Advance the sampling device for stiff and dense soils by continuous rotation of the outer cutting barrel in conjunction with use of drill fluid circulation. Driving of any undisturbed sampling device by means such as a drop hammer will not be permitted.

3.5.2 Sealing

3.5.2.1 Alternate 1

Retain the soil sample obtained in a thin wall Shelby tube in the tube and sealed on both ends with a mechanically expandable O-ring sealing disk of the appropriate size.

3.5.2.2 Alternate 2

Extrude the soil sample obtained in a thin wall Shelby tube from the tube in the field as soon as the tube is removed from the boring by a method approved by the Contracting Officer. Immediately wrap the extruded soil sample in [aluminum foil] [thin plastic wrap] and placed in the center of a [metal bottomed, waxed cardboard] [plastic] tube that has a diameter of at least 25 mm 1 inch larger than the diameter of the soil sample, is at least 25 mm 1-inch longer than the length of the soil sample, and has at least 13 mm 1/2-inch of congealed [50/50 mixture of paraffin and microcrystalline wax] [microcrystalline wax] in the bottom. Fill the annular space between the soil sample and the tube with [a 50/50 mixture of paraffin and microcrystalline wax] [microcrystalline wax] to a distance of at least 13 mm 1/2-inch above the top of the soil sample.

3.5.2.3 Alternate 3

Clean both ends of the soil sample tube/liner obtained with a Denison barrel, or its equivalent, to remove all drill fluid contaminated and/or disturbed soil or to a minimum distance of 50 mm 2 inches from the ends of the tube/liner. Place any material removed that is not contaminated with drill fluid in a sample jar and label in accordance with paragraph IDENTIFYING SAMPLES. Seal the cleaned out ends of the sample liner tube with [a 50/50 mixture of paraffin and microcrystalline wax] [microcrystalline wax]. Insert a metal or wooden disk, having a diameter just slightly smaller than the inside diameter of the liner tube into the wax to a distance of 6 mm 1/4-inch from the end of the soil sample. Position the wax plugs flush with the ends of the tube and place a final seal consisting of a metal cap or tape over the ends of the tube.

3.6 CORE HOLE OVERBURDEN DRILLING

[Where samples of overburden materials are required in connection with core drilling, drill and sample the soil overburden in accordance with the applicable provisions for the type of samples required.] [Where sampling of the overburden materials is not required, the Contractor may utilize any method and equipment for drilling and, if required, casing through the overburden that will not affect the quality of the core drilling from the rock surface downward in accordance with these specifications. The method chosen must be approved by the Contracting Officer prior to starting any overburden drilling.]

3.7 CORE DRILLING

****

NOTE: See TABLE 1 COMMON CORE DIAMETERS.

****

Provide core drilling consisting of a [_____] mm inch Diameter Core

3.7.1 Procedure

Drill all holes [vertically] [at the inclined angles [indicated in the SCHEDULE OF DRILLING, SAMPLING, AND TESTING shown on the drawings] [listed in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING]] to the bottom elevations or depths specified unless indicated in the schedule of borings or directed to be drilled otherwise. Off-setting of borings from the locations specified in the Plan of Borings or as shown on the drawings, will not be permitted without prior approval. Casing through the overburden may be required. Seal this casing in the rock at the elevation where rock is encountered prior to commencement of rock coring. Operate the drills at required speeds and down pressures to control drill fluid pressures and quantities to insure maximum core quality and recovery in whatever kind of rock is encountered. Where soft or broken rock is encountered, reduce the length of runs to 1.5 m 5 feet or less in order to reduce and/or keep core loss and core disturbance to the minimum. Failure to comply with the foregoing procedures will constitute justification for the Contracting Officer to require redrilling, at the Contractor's expense, of any boring from which the core recovery is unsatisfactory. Exercise particular care in recording zones of water loss, cavities, rod jerks, rough drilling and other unusual and non-ordinary coring experiences that, supplementing the core record, will throw light on the nature and the extent of any fracturing or abnormalities.

3.7.2 Arrangement of Core

Provide core boxes in compliance with PART 2, paragraph CORE BOXES. Arrange all cores neatly in the partitioned boxes in the same sequence in which they occurred before removal from the hole. Facing the open box with the hinged cover above and the open box below, arrange cores in descending sequence beginning at the left end of the trough nearest the hinges and continuing in the other troughs from left to right. Place the highest part of the core in box 1, and place the lower portions of the core in the other boxes in consecutive order.

3.7.3 Preservation of Core

Wrap representative samples of core (not less than [_____] percent of the total core drilled) in [aluminum foil] [thin plastic wrap] [cheese cloth] and then seal by applying [paraffin wax] [microcrystalline wax] [50/50 mixture of paraffin and microcrystalline wax] to the outside of the wrapping material prior to placing the core in the core box. Accomplish this sealing process as soon as possible after the core is removed from the core barrel. A minimum length of core that is preserved from each boring less than 2.5 times the core diameter is not acceptable. Mark and place spacer blocks in the core box to show where samples have been removed.

3.7.4 Labeling, Marking and Packing Core

Place stenciled labels for core boxes complying with paragraph CORE BOX LABELS on the inside and outside of the top cover in addition to each end. In addition, mark the depths (or elevations) of each core run/pull with a black waterproof pen on the spacer blocks that are placed between core pulls. When a box is full, fill the space between the core and the trough sides with finely ground vermiculite or other packing material approved by the Contracting Officer.

3.7.5 Disposition of Core

While onsite, protect the filled core boxes from direct sunlight, precipitation, and freezing by some form of Contracting Officer approved shelter that allows ventilation to the boxes. Upon completion of core drilling and sampling operations, [store core boxes containing cores in an area provided by the Contracting Officer near the site of drilling] [ship or deliver core boxes containing cores to [provide address]].

3.8 PRESSURE TESTING (HYDRAULIC)

[Pressure-test each hole in [1.5] [3] [_____] m [5] [10] [_____] foot sections commencing at the top of bedrock and progressing downward to the bottom of the hole or to such depths as determined by the Contracting Officer below which testing of the hole is not necessary.] [Pressure test the bottom [1.5] [3] [_____] m [5] [10] [_____] foot section of hole immediately after it is cored. After a [_____] m foot section is cored, the coring equipment will be removed from the section and a single rubber expansion packer placed at the top of the section (bottom of the previously tested section) and the section pressure tested. After the pressure test is completed, remove the packer assembly and the next [_____] m foot section cored and then pressure tested. Continue this procedure to the bottom of the hole or to depths determined by the Contracting Officer.] Where core data from the test holes indicate only isolated zones that are open or fractured, pressure testing may be limited by the Contracting Officer to these zones only. Determine water pressure employed for each lift in the field and do not exceed 22.6 kPa per meter of depth one pound per square inch per foot of depth to the upper expander. Pressure greater than [_____] kPa psi is not acceptable. The pressure test will be divided into two phases; the first phase will be a flow test followed by the second phase, which is a duration test. In performing the first phase, water is pumped slowly at first, and the flow then gradually increased to the point where the predetermined maximum pressure is maintained, by adjusting the valve on the by-pass line. Hold the allowable pressure for 1 minute before any readings are taken. Measure the volume of flow into the test section for a period of 5 minutes without varying the pressure no more than 34.5 kPa 5 psi. After this 5-minute test, start the second phase by closing the valve located between the flow meter and the pressure gage. The drop in pressure is then read for a period of 5 minutes at [15] [30] [_____]-second intervals. In some situations, such as in a very tight formation, the Contracting Officer may eliminate phase one of the test. The Contractor may be required to make check tests at its own expense if the testing equipment or its assembly and arrangement are found to be faulty during or after the testing of any holes. Record all gage and meter readings made during a pressure test on a suitable form approved by the Contracting Officer. A sample form is shown in FIGURE 2 - PRESSURE TEST DATA FORM.

3.9 TEST PIT EXCAVATION AND SAMPLING

3.9.1 Excavation

Excavate the test pits in the order scheduled in [the SCHEDULE OF DRILLING, SAMPLING, AND TESTING shown on the drawings] [paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING], and excavate to depths and dimensions indicated [in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING] [on the drawings]. Become thoroughly familiar with work site and with all available subsurface data, particularly groundwater conditions, before excavating pits. Regardless of the method of excavation employed, excavate [, dewater] and shore/line the pits in conformance with all applicable safety regulations.

3.9.2 Sampling

Obtain soil samples from each pit [at the depths/elevations indicated in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING] [at depths of [_____] m feet, [_____] m feet, and [_____] m feet,] [at depths determined by the Contracting Officer]. Obtain a total of [_____] samples from each test pit. In obtaining samples from test pits, preserve the undisturbed in situ (in place) natural physical and structural characteristics of the sampled materials insofar as possible both while samples are being taken and during shipment to the point of testing. In cohesive and partially cohesive soils this may be accomplished by isolating the soil column or cube to be sampled by gently trenching around it and knife-trimming it to the required dimensions of the split cylinder or box. Apply a thin coating of melted [50/50 mixture of paraffin and microcrystalline][microcrystalline] wax quickly but gently to the sample with a paint brush to seal it against loss of moisture. Remove the top and bottom from the metal or wooden sample container and place over the wax coated sample such that the sample is centered within the container and the top of the container sides are at least 25 mm 1 inch above the top of the sample. Fill the spaces between the sample and the side walls of the container with melted [_____] wax. After this wax has congealed, fill the space between the top of the sample container sides and the top of the sample with [_____] wax. After this wax has congealed, trim so that when the top of the sample container is installed there is no void between the container top and the wax. After the container top is installed, cut off the soil column or cube few hundred mm inches below the container, invert and remove the sample and container from the pit and trim the sample at the base so that the bottom of the sample is at least 25 mm 1 inch below the bottom of the container. Fill this space with [_____] wax and, after the wax has congealed, trim it so that when the bottom of the container is installed, there is no void between the wax and the bottom of the container. Where overburden materials to be sampled are only partially cohesive, it is best not to expose the entire soil column before waxing. By exposing and waxing small sections at a time, the sample will be subjected to less disturbance. Where natural moisture content is an important factor, do not delay taking the sample in order to retain the natural moisture content of the material to the fullest extent.

3.9.3 Disposition of Samples

Pack samples in vermiculite or a packing material approved by the Contracting Officer and shipp in sturdy wooden boxes of strength and construction sufficient to guarantee against damage during shipment. Boxes should be no larger than is required for shipping two such samples. Mark all sample boxes FRAGILE-HANDLE WITH CARE and identify by labels, similar to those as specified in paragraph IDENTIFYING SAMPLES, attached to the outside of each box. Take extreme care to indicate the top and bottom of each sample. Avoid exposing sealed and crated samples to precipitation and extremes of temperature. Replace frozen, as well as partially frozen, undisturbed samples. Do not hold these samples at the site for a period in excess of one week. Prior to shipment, check each sealed and boxed sample for correct labeling.

3.10 SUPPLEMENTAL [BORINGS] [PITS]

[Borings] [Pits] that are abandoned or from which [unsatisfactory samples or cores are obtained] [less than [_____] percent total core recovery has been obtained, exclusive of open or filled cavities] will be supplemented by other [borings] [pits] adjacent to the original in order that satisfactory samples or the required information will be obtained. Actual locations of any supplemental [borings] [pits] will be established by the Contracting Officer. Penetration to the depth where the original was abandoned or to the depths where unsatisfactory samples were obtained may be made by any method selected by the Contractor that in the opinion of the Contracting Officer will permit satisfactory completion and sampling below the elevation where the last satisfactory sample was obtained in the abandoned or satisfactory sampling in the reaches where satisfactory samples were not obtained in the original [borings] [pits]. No payment will be made for supplemental [borings] [pits] that are required to be [drilled] [excavated] to replace [borings] [pits] that were abandoned or from which satisfactory samples were not obtained because of mechanical failure of drilling and sampling equipment, negligence on the part of the Contractor, or other preventable cause for which the Contractor is responsible except that payment will be made for acceptable portions of these supplementary [borings] [pits] below the depths or outside the reaches for which payment was made for the original [borings] [pits].

3.11 BACKFILLING

3.11.1 Drill Holes

Unless otherwise noted in these specifications or directed by the Contracting Officer, backfill and abandon all drill holes in accordance with all Federal, State, and local laws, regulations and ordinances. Preserve all holes in good condition until final measurement and until the records and samples have been accepted. As a minimum, grout all holes from the bottom of the hole to within 600 mm 2 feet of the ground surface using a grout mixture of 23 to 30 liters six to eight gallons of water per sack (42.6 kg) (94 pounds) of portland cement. Pump all grout through a [tremie] [_____] pipe that is inserted to the bottom of the boring to insure that the grout fills the full extent of the hole. Backfill the remaining ungrouted top 600 mm 2 feet of the hole with local soil and tamp. Perform all backfilling operations in the presence of the Contracting Officer and, if required by regulation, Federal, State, and local officials. No separate payment will be made for backfilling drill holes. Include the cost of this work in the drilling costs.

3.11.2 Test Pits

Backfill all test pits with local soil compacted to original densities as directed by the Contracting Officer. No separate payment will be made for backfilling test pits. Include the cost of this work in the test pit excavation costs.

3.12 RECORDS

Submit complete, legible copies of DRILLING LOG, ENG FORM 1836 and 1836A, and records to the Contracting Officer [upon completion of the work or at such other time or times as directed] [within [_____] days after a [hole] [test pit] is completed]. Keep accurate driller's logs (DRILLING LOG, ENG FORM 1836, and 1836-A will be provided by the Contacting Officer) and records of all work accomplished under this contract and deliver complete, legible copies of these logs and records to the Contracting Officer [upon completion of the work or at such other time or times as directed] [within [_____] days after a [hole] [test pit] is completed]. Record all such records during the actual performance of the work and preserve in good condition and order until they are delivered and accepted. The Contracting Officer has the right to examine and review all such records at any time prior to their delivery and has the right to request changes to the record keeping procedure. Include the following information on the logs or in the records for each [hole] [test pit]:

a. [Hole] [Test Pit] number or designation and elevation of top of [hole] [test pit].

b. Driller's name and Geologist's name.

c. Make, size, and manufacturer's model designation of [drilling,] [sampling,] [pressure testing,] [and] [test-pit excavating] equipment.

d. Type of [drilling,] [sampling,] [and] [pressure testing] operation by depth.

e. Hole diameter.

f. Dates and time by depths when [test-pit excavation,] [drilling,] [sampling,] [and] [pressure testing] operations were performed.

g. Time required for [drilling each run] [and] [pressure testing each interval tested].

h. Drill action, rotation speed, hydraulic pressure, water pressure, tool drops, and any other unusual and non-ordinary experience which could indicate the subsurface conditions encountered.

i. Depths [at which samples or cores were recovered or attempts made to sample or core including top and bottom depth of each run] [and] [of each interval pressure tested].

j. Classification or description by depths of the materials [sampled,] [cored,] [or] [penetrated] using the Unified Soil Classification System (ASTM D2487) and including a description of moisture conditions, consistency and other appropriate descriptive information described in paragraph SUPPLEMENTAL [BORINGS] [PITS] of ASTM D2488. Make this classification or description immediately after the samples or cores are retrieved.

k. Classification and description by depths of rock materials [sampled] [or] [cored] including rock type, composition, texture, presence and orientation of bedding, floiation, or fractures, presence of vugs or other interstices, and the RQD for each cored interval.

l. Indication of penetration resistance such as [drive-hammer blows given in blows per foot for driving sample spoons and casing] [and] [the pressure in kPa psi applied to push thin-wall or piston-type samplers].

m. Force Weight of drive hammer.

n. Percentage of sample or core recovered per run.

o. Depth at which groundwater is encountered initially and when stabilized.

p. Depths at which drill water is lost and regained and amounts.

q. Depths at which the color of the drill water return changes.

r. Type and weight of drill fluid.

s. Depth of bottom of hole.

t. Pressures employed in pressure testing.

u.

TABLE 1 - COMMON CORE DIAMETERS		
	CORE DIAMETER MM INCHES	HOLE DIAMETER MMINCHES
Conventional Core Barrels		
AWG	301.185	481.890
BWG	421.655	602.360
NWG	552.155	762.980
HWG	763.000	993.907
Wireline Core Barrels*		
A	271.064	481.890
B	36.51.432	602.360
N	47.61.875	762.980
H	622.450	943.716
	853.345	1234.827
Large Diameter Series		
2-3/4" X 3-7/8"	682.690	983.875
4" X 5-1/2"	1003.970	1405.495
6" X 7-3/4"	151.65.970	1977.750
* No Industry Standard for Wireline Sizes. Diameters shown for wireline core barrels are nominal and vary between manufacturers.		

FIGURE 2 - PRESSURE TEST DATA FORM

SHEET _____ 0F _____
DATE _____________

REPORT OF WATER PRESSURE TESTING IN CORE DRILL HOLES

DAM SITE _______________ RIVER ________________ HOLE NO. _____ RIG NO. _____
LOCATION OF HOLE ____
CONTRACTOR ____________________ DRILLER ___________ ELEV. TOP OF HOLE _____

DATA ON FLOW TEST											
SECTION OF HOLE TESTED						WATER METER READINGS					
TOP		BOTTOM		PRESSURE DURING TEST	START TIME	STOP TIME	TIME MINUTES	AT START OF	AT END OF	TOTAL WATER USED (L) (GAL)	(L)(GAL) PER SEC
DEPTH	ELEV	DEPTH	ELEV								

DATA ON PRESSURE DURATION TEST									
SECTION OF HOLE TESTED									
TOP		BOTTOM		GAGE PRESSURE AT TEST INTERVAL					REMARKS
DEPTH	ELEV	DEPTH	ELEV						

OBSERVED BY ________________________________

****

NOTES: Insert TYPICAL CORE BOX, FIGURE 1, after the previous table. FIGURE 1 - TYPICAL CORE BOX, exist as CADD files stored on
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms

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-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-02 41 00 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-02 41 00 (May 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 41 00

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USACE / NAVFAC / AFCEC **UFGS-02 41 00 (August 2022)**

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SECTION 02 41 00

[DEMOLITION][AND][DECONSTRUCTION]

08/22

****

NOTE: This guide specification covers the requirements for demolition, deconstructon, dismantling, reconditioning and disposal of existing building materials, equipment and utilities as a part of new construction or renovation work.

The requirements for demolition and deconstruction activities must be coordinated with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL. Disposal of demolition waste or recycling of deconstructed materials must be properly planned and managed in the Construction Waste Management Plan.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

TO DOWNLOAD UFGS GRAPHICS
Go to
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms

****

PART 1 GENERAL

****

NOTE: Where premises are occupied, certain spaces

may exist where activities cannot be interrupted or disturbed during normal working hours. To prevent disputes or possible contract claims resulting from restriction of demolition or removal work in such spaces, provisions for scheduling of the work must be specified in the contract documents. Restrictions for scheduling of demolition or removal work in areas adjacent to or in occupied spaces should reflect the requirements resulting from the consultation with occupants of the affected spaces. These provisions are necessary to alert prospective bidders about the spaces where business is not to be interrupted or disturbed during construction.

Delete requirements if inapplicable.

Where suspect deck conditions are encountered during design investigation, identify and include appropriate repair and safety provisions in the design documents to draw attention to the suspect areas and the need for additional safety precautions.

Include "Notification of Demolition and Renovation" form for Hawaii only.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI Guideline K	(2009) Guideline for Containers for Recovered Non-Flammable Fluorocarbon Refrigerants

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 145	(1991; R 2012) Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.6	(2006) Safety & Health Program Requirements for Demolition Operations - American National Standard for Construction and Demolition Operations

ASTM INTERNATIONAL (ASTM)

ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

CARPET AND RUG INSTITUTE (CRI)

CRI 104	(2015) Carpet Installation Standard for Commercial Carpet
CRI 105	(2015) Carpet Installation Standard for Residential Carpet

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEFENSE LOGISTICS AGENCY (DLA)

DLA 4145.25	(Jun 2000; Reaffirmed Oct 2010) Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders; https://www.dla.mil/Portals/104/Documents/DispositionSer /ddsr/docs/cylinderjointpub.pdf

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M	(2006) MILSTRIP - Military Standard Requisitioning and Issue Procedures
MIL-STD-129	(2014; Rev R; Change 1 2018; Change 2 2019; Change 3 2023) Military Marking for Shipment and Storage

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(2016; Rev L; Change 2) Obstruction Marking and Lighting

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 82	Protection of Stratospheric Ozone
49 CFR 173.301	Shipment of Compressed Gases in Cylinders and Spherical Pressure Vessels

1.2 PROJECT DESCRIPTION

****

NOTE: Make a determination as to whether any material of a hazardous nature, as classified in the National Emissions Standards, OSHA, or EPA regulations, will result from the work described. If such material is determined likely, specify precautions and standards to be complied with. Since the Contractor performs the work, the Contractor will be the one responsible for complying with all necessary regulations.

Protect personnel from possible airborne contaminants, such as asbestos fibers, dried fecal matter (bird droppings) and metal dusts.

For Navy projects: Contact an industrial hygienist at (1) A Navy Regional Medical Center, (2) A Navy Environmental and Preventive Medicine Unit, or (3) the Navy Environmental Health Center for assistance. Disposal of materials must not endanger or pollute the environment. Obtain assistance from the environmental branch of the Engineering Field Division of the Naval Facilities Engineering Systems Command or from the Naval Facilities Engineering Service Center, Norfolk, Virginia.

Non-friable materials containing asbestos, such as cement-asbestos siding and roofing and vinyl-asbestos flooring materials, normally do not require special handling and disposal procedures unless such materials are sawn, ground, sanded, drilled, pulverized, or handled in such a manner that will cause dust and airborne asbestos fiber to be released. Thus the removal of non-friable asbestos will not normally require the use of Section 02 82 00 ASBESTOS REMEDIATION. If the project contains non-friable asbestos that is considered to be hazardous due to material condition (broken down or excessively old and decayed) or demolition or deconstruction procedures to be used, then specify the non-friable asbestos to be removed in accordance with Section 02 82 00.

For "NAVFAC SE" projects use "project site" in Guantanamo Bay, Cuba; for all other projects use "station daily."

Deconstruction is the process of taking apart a facility with the primary goal of preserving the value of all useful building materials, so that they may be reused or recycled. It should be considered when adaptive reuse of a building is not an option, and may be used in conjunction with demolition. Deconstruction minimizes demolition landfill materials and reduces material costs for the converted facility. Diverting demolition waste from the landfill contributes to meeting Federal requirements for waste diversion. Coordinate with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

****

1.2.1 Definitions

1.2.1.1 Demolition

Demolition is the process of tearing apart and removing any feature of a facility together with any related handling and disposal operations.

1.2.1.2 Deconstruction

Deconstruction is the process of taking apart a facility with the primary goal of preserving the value of all useful building materials.

1.2.1.3 Demolition Plan

Demolition Plan is the planned steps and processes for managing demolition activities and identifying the required sequencing activities and disposal mechanisms.

1.2.1.4 Deconstruction Plan

Deconstruction Plan is the planned steps and processes for dismantling all or portions of a structure or assembly, to include managing sequencing activities, storage, re-installation activities, salvage and disposal mechanisms.

1.2.2 Demolition/Deconstruction Plan

****

NOTE: Either a Demolition Plan or a Deconstruction Plan is required. A project requiring both demolition and deconstruction work will name the plan according to the majority of the work being performed, and the plan will include requirements for both types of work.

****

Prepare a [Demolition Plan] [Deconstruction Plan] and submit proposed [salvage,] [demolition,] [deconstruction,] and removal procedures for approval before work is started. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress[, a disconnection schedule of [utility services,] [and] [airfield lighting,] a detailed description of methods and equipment to be used for each operation and of the sequence of operations]. Identify components and materials to be salvaged for reuse or recycling with reference to paragraph Existing Facilities to be Removed. Append tracking forms for all removed materials indicating type, quantities, condition, destination, and end use. Coordinate with Waste Management Plan in accordance with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.[Include statements affirming Contractor inspection of the existing roof deck and its suitability to perform as a safe working platform or if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the work.] Provide procedures for safe conduct of the work in accordance with EM 385-1-1. Plan must be approved by [Structural PE] [Contracting Officer] prior to work beginning.

1.2.3 General Requirements

Do not begin demolition or deconstruction until authorization is received from the Contracting Officer. The work of this section is to be performed in a manner that maximizes the value derived from the salvage and recycling of materials. [Remove rubbish and debris from the [station daily] [project site]; do not allow accumulations [inside or outside the building[s]] [on airfield pavements].] [The work includes [demolition,] [deconstruction], salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer.] In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Section 17, Demolition, and other applicable Sections.

1.3 ITEMS TO REMAIN IN PLACE

Comply with FAR 52.236-9 to protect existing vegetation, structures, equipment, utilities, and improvements. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract. Do not overload [structural elements] [pavements to remain]. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

1.3.1 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove [snow,]dust, dirt, and debris from work areas daily.

1.3.2 Weather Protection

For portions of the building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of existing roofing is necessary to accomplish work, have materials and workmen ready to provide adequate and temporary covering of exposed areas.

1.3.3 Trees

Protect trees within the project site which might be damaged during demolition or deconstruction, and which are indicated to be left in place, by a 1.8 m 6 foot high fence. Erect and secure fence a minimum of 1.5 m 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Contracting Officer.

1.3.4 Utility Service

****

NOTE: Delete the first bracketed sentence when the Government will disconnect and seal utilities. Delete the second bracketed sentence when the Contractor will disconnect and seal utilities.

****

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations. Prior to start of work, [utilities serving each area of alteration or removal will be shut off by the [Government] [utility provider] and disconnected and sealed by the Contractor] [the [Government] [utility provider] will disconnect and seal utilities serving each area of alteration or removal upon written request from the Contractor].

1.3.5 Facilities

Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Contracting Officer. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.4 BURNING

The use of burning at the project site for the disposal of refuse and debris [will not be permitted] [will be permitted in the area located [_____] and between the hours of [_____] and [_____]]. Where burning is permitted, adhere to federal, state, and local regulations.

1.5 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available [at contract award.] [in accordance with the following schedule:

Schedule	
Area	Date
[_____]	[_____]

]

1.6 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Demolition Plan; G, [_____]

Deconstruction Plan; G, [_____]

Existing Conditions

SD-07 Certificates

Notification; G, [_____]

Notification of Demolition and Renovation Form

SD-11 Closeout Submittals

Receipts

1.7 QUALITY ASSURANCE

Submit timely notification of [demolition] [deconstruction] [and] [renovation] projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the [Regional Office of the United States Environmental Protection Agency (USEPA)] [State's environmental protection agency] [local air pollution control district/agency] and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSP A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives [will] [will not] be permitted.

1.7.1 Hawaii Requirements

****

NOTE: Use the following for Hawaii projects only. "Notification of Demolition and Renovation" form is required for all demolition and deconstruction involving "load-supporting" structures and/or asbestos work. Use the first bracket for "demolition" and/or "deconstruction" work that does not involve asbestos, or "demolition" and/or "deconstruction" work where the combined amount of RACM to be stripped, removed, dislodged, cut, drilled, or similarly disturbed is less than 80 linear meters 260 linear feet on pipes or less than 15 square meters 160 square feet on other facility components. Use the second bracket for "demolition" and/or "deconstruction" and/or "renovation" work when the amount of RACM is greater than those stated above.

"Demolition" means the wrecking or taking out of any "load-supporting structural member" of a facility together with any related handling operations or the intentional burning of any facility. "Deconstruction" means the disassembly of buildings to recover materials. "Renovation" means altering a facility or one or more facility components in any way, including the stripping or removal of RACM from a facility component. "Regulated asbestos-containing material" (RACM) means:

1. Friable asbestos material;

2. Category I nonfriable ACM that has become friable;

3. Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading, or;

4. Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition, deconstruction, or renovation operations regulated by this subpart.

The designer will complete paragraphs III.A, V, VI, VII, and ensure the quantity of asbestos indicated reflects what is shown on the drawings.

****

Complete and submit Notification of Demolition and Renovation form to Federal and State authorities and Contracting Officer, postmarked or delivered at least ten working days prior to commencement of work, in accordance with 40 CFR 61, Subpart M. [Complete paragraphs I, II, III.B, III.C (if applicable), IX, and XVI of form.] [Complete paragraphs I, II, III.B, III.C (if applicable), VIII, and IX thru XIX of form.] Copy of form is attached at end of this section.

1.7.2 Dust[and Debris] Control

Prevent the spread of dust [and debris] [to occupied portions of the building] [on airfield pavements] and avoid the creation of a nuisance [or hazard] in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. [Vacuum and dust the work area [daily] [_____].] [Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to aircraft.]

1.8 PROTECTION

****

NOTE: Delete requirements if inapplicable. For aircraft safety, Air Force ETL 11-29: Use of Light Emitting Diode (LED) Fixtures on Air Force Installations and Enduring/Contingency Locations, dated 22 Dec 2011, does NOT allow use of LED fixtures for Obstruction Lighting. For work on airfield, coordinate with the Airfield manager the construction phasing plan and operational safety on the airfield during construction per UFC 3-260-01, Section 14.

****

1.8.1 Traffic Control Signs

a. Where [pedestrian and driver] [aircraft] safety is endangered in the area of removal work, use traffic barricades with flashing lights. [Anchor barricades in a manner to prevent displacement by wind, jet or prop blast.] Notify the Contracting Officer prior to beginning such work.

[Provide a minimum of 2 FAA type L-810 steady burning red obstruction lights on temporary structures (including cranes) over 30 m 100 feet, but less than 60 m 200 ft, above ground level. The use of LED based obstruction lights are not permitted. For temporary structures (including cranes) over 60 m 200 ft above ground level provide obstruction lighting in accordance with FAA AC 70/7460-1. Perform light construction and installation in compliance with FAA AC 70/7460-1. Lights must be operational during periods of reduced visibility, darkness, and as directed by the Contracting Officer. Maintain the temporary services during the period of construction and remove only after permanent services have been installed and tested and are in operation.]

1.8.2 Protection of Personnel

Before, during and after the [demolition][and][deconstruction] work continuously evaluate the condition of the [site specific features] [structure] [_____] being [demolished] [and] [deconstructed] and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.9 FOREIGN OBJECT DAMAGE (FOD)

****

NOTE: Delete requirements if inapplicable.

Some large scale apron, hangar, or other type projects to be constructed adjacent to areas with operational aircraft may require temporary barricades or debris fences installed in place prior to the start of work. The station's air operations and public works departments must be contacted by the designer to determine project requirements. If fences or other type barricades are required, they must be designed and located to suit the project

****

Aircraft and aircraft engines are subject to FOD from debris and waste material lying on airfield pavements. Remove all such materials that may appear on operational aircraft pavements due to the Contractor's operations. If necessary, the Contracting Officer may require the Contractor to install a temporary barricade at the Contractor's expense to control the spread of FOD potential debris. Provide a barricade consisting of a fence covered with a fabric designed to stop the spread of debris. Anchor the fence and fabric to prevent displacement by winds or jet/prop blasts. Remove barricade when no longer required.

1.10 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Repair or replace items to be relocated which are damaged by the Contractor with new undamaged items as approved by the Contracting Officer.

1.11 EXISTING CONDITIONS

Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer [or the Contracting Officer's Representative] [and a representative from the non-federal sponsor] showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs or electronic images with a minimum resolution of 3072 x 2304 pixels, capable of a print resolution of 300 dpi, will be acceptable as a record of existing conditions. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit survey results to the Contracting Officer [or the Contracting Officer's Representative].

PART 2 PRODUCTS

2.1 FILL MATERIAL

a. Comply with excavating, backfilling, and compacting procedures for soils used as backfill material to fill basements, voids, depressions or excavations resulting from demolition or deconstruction of structures. Provide fill material consisting of waste products from demolition or deconstruction until all waste appropriate for this purpose is consumed.

[b. Provide fill material conforming to the definition of satisfactory soil material as defined in [ASTM D2487] [AASHTO M 145, Soil Classification Groups A-1, A-2-4, A-2-5 and A-3]. In addition, fill material must be free from roots and other organic matter, trash, debris, frozen materials, and stones larger than 50 mm 2 inches in any dimension.

c. Proposed fill material must be sampled and tested by an approved soil testing laboratory, as follows:

Soil classification	AASHTO M 145
Moisture-density relations	AASHTO T 180, Method B or D

]

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

****

NOTE: Thoughtful and considered disassembly as opposed to standard demolition will produce more usable "reusables" and will help prevent damage to items scheduled to remain.

Suggested uses for salvaged materials are as follows.
1. Whole buildings can be sold, leased, or donated and either moved or dismantled.
2. Separate asphalt roofing materials for milling

and recycling.
3. Salvage whole bricks for reuse, keeping exterior bricks separate. Salvage remaining masonry to be crushed and used as landscape cover, sub-base material, or fill.
4. Salvage precast concrete panels as whole units for use as erosion control or landscape features. Salvage whole concrete blocks for reuse. Salvage concrete block pieces to be crushed and used as sub-base material or fill. Crush and grade remaining concrete for use as riprap, aggregate, sub-base material, or fill.
5. Chipped or shredded wood can be used onsite as ground cover, mulch, compost, pulp, or process fuel.
6. Crushed porcelain may be used for fill.
7. Wood cleared from the site can be chipped or shredded for use as ground cover, mulch, compost, pulp, or process fuel.
8. Salvage clean, unpainted, non-biocide-treated gypsum board to be ground up and used as soil amendment or recycled.

****

Inspect and evaluate existing structures onsite for reuse. Disassemble existing construction scheduled to be removed for reuse. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Designate materials for reuse onsite whenever possible.

3.1.1   Structures

****

NOTE: Where necessary, add additional requirements relating to specific types of existing construction such as masonry, concrete, and other special requirements for removal work. It is very difficult to specify particular removal criteria in a guide specification or even a project specification. It may be more advantageous to show the work on the drawings.

****

a. Remove existing structures indicated to be removed to [grade] [top of foundation walls] [[_____] meters feet below grade]. Remove interior walls, other than retaining walls and partitions, to [_____] m feet below grade or to top of concrete slab on ground. Break up basement slabs to permit drainage. Remove sidewalks, curbs, gutters and street light bases as indicated.

b. [Demolish] [Deconstruct] structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each tier or floor before the supporting members on the lower level are disturbed. [Demolish] [Deconstruct] concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods as approved by the Contracting Officer.

c. Locate demolition and deconstruction equipment throughout the structure and remove materials so as to not impose excessive loads to supporting walls, floors, or framing.

d. [Building, or the remaining portions thereof, not exceeding 25 m 80 feet in height may be demolished by the mechanical method of demolition.]

3.1.2 Utilities and Related Equipment

3.1.2.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.2.2 Disconnecting Existing Utilities

****

NOTE: Where the materials, meters, or related equipment to be affected in the area of demolition or deconstruction are the property of the local utility companies and not of the Government, the specifier must contact them, determine the disposition of the existing utilities, and modify the requirements herein as needed.

****

Remove existing utilities [, as indicated] [uncovered by work] and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer. When utility lines are encountered but are not indicated on the drawings, notify the Contracting Officer prior to further work in that area. Remove meters and related equipment and deliver to a location [on the station] in accordance with instructions of the Contracting Officer.

3.1.3 Chain Link Fencing

Remove chain link fencing, gates and other related salvaged items scheduled for removal and transport to designated areas. Remove gates as whole units. Cut chain link fabric to [_____] 7 m 25 foot lengths and store in rolls off the ground.

3.1.4 Paving and Slabs

****

NOTE: Delete requirements if inapplicable.

****

[Remove [ground] [scarified] [sawcut] concrete and asphaltic concrete paving and slabs [including aggregate base] [as indicated] to a depth of [_____] mm inches below [existing adjacent] [new finish] grade. [Demolition of concrete pavement on airfields and other heavy duty pavements will follow methods in Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS.][Provide neat sawcuts at limits of pavement removal as indicated.]] Move, grind and store pavement and slabs designated to be recycled and utilized in this project as directed by the Contracting Officer. Remove pavement and slabs not to be used in this project from the [installation] [project site] at Contractor's expense.

3.1.5 Roofing

****

NOTE: Delete requirements if inapplicable.

Where suspect deck conditions are encountered during design investigation, identify and include appropriate repair and safety provisions in the design documents to draw attention to the suspect areas and the need for additional safety precautions.

****

[Remove existing roof system and associated components in their entirety down to existing roof deck.] [Remove [built-up] [single-ply] roofing to effect the connections with new flashing or roofing.] [Remove gravel surfacing from existing roofing felts for a minimum distance of 450 mm 18 inches back from the cut. Remove gravel without damaging felts.] [Salvage asphalt roofing materials.] [Cut existing [felts] [membrane] [and insulation] along straight lines.] [Remove roofing system [and insulation] without damaging the roof deck.] Sequence work to minimize building exposure between demolition or deconstruction and new roof materials installation.

3.1.5.1 Temporary Roofing

Install temporary roofing and flashing as necessary to maintain a watertight condition throughout the course of the work. Remove temporary work prior to installation of permanent roof system materials unless approved otherwise by the Contracting Officer. [The existing [deck] [and support structure] is deteriorated where indicated, such that ability to support foot traffic and construction loads is unknown. Make provisions for worker safety during demolition, deconstruction, and installation of new materials as described in paragraphs entitled "Statements" and "Regulatory and Safety Requirements."]

3.1.5.2 Reroofing

When removing the existing roofing system from the roof deck, remove only as much roofing as can be recovered by the end of the work day, unless approved otherwise by the Contracting Officer. Do not attempt to open the roof covering system in threatening weather. Reseal all openings prior to suspension of work the same day.

3.1.6 Masonry

Sawcut and remove masonry so as to prevent damage to surfaces to remain[, to removed materials being salvaged] [and to facilitate the installation of new work]. Where new masonry adjoins existing, abut or tie the new work into the existing construction as [indicated] [specified for the new work]. Provide square, straight edges and corners where existing masonry adjoins new work and other locations.[Salvage masonry removed in whole blocks and store for reuse.] [Masonry removed in pieces must be crushed[for use as aggregate]].

3.1.7 Concrete

Saw concrete along straight lines to a depth of a minimum 50 mm 2 inch. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished work, and the remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. [Salvage removed concrete.] [Sawcuts in existing [concrete sidewalk] [roads] [concrete pads] [parking areas] must be at the nearest existing expansion joint or weakened plane joint and at full depth.]

3.1.8 Structural Steel

****

NOTE: Delete structural steel and miscellaneous metals only if it is determined that there are no existing metals or structural steel to be recycled or salvaged.

****

Dismantle structural steel at field connections and in a manner that will prevent bending or damage. Salvage for [reuse] [recycle] structural steel, steel joists, girders, angles, plates, columns and shapes. [Do not use flame-cutting torches] [Flame-cutting torches are permitted when other methods of dismantling are not practical]. Transport steel joists and girders as whole units and not dismantled. Transport structural steel shapes to a designated [storage area] [recycling facility] [area as directed by the Contracting Officer], stacked according to size, type of member and length, and stored off the ground, protected from the weather.

3.1.9 Miscellaneous Metal

Salvage shop-fabricated items such as access doors and frames, steel gratings, metal ladders, wire mesh partitions, metal railings, metal windows and similar items as whole units. Salvage light-gage and cold-formed metal framing, such as steel studs, steel trusses, metal gutters, roofing and siding, metal toilet partitions, toilet accessories and similar items. [Scrap metal is the Contractor's property.] Recycle scrap metal as part of demolition and deconstruction operations. Provide separate containers to collect scrap metal and transport to a scrap metal collection or recycling facility, in accordance with the Waste Management Plan.

3.1.10 Carpentry

Salvage for [reuse] [recycle] lumber, millwork items, and finished boards, and sort by type and size. [[Chip or shred and]recycle salvaged wood unfit for reuse, except stained, painted, or treated wood.] [Salvage] [Remove] windows, doors, frames, and cabinets, and similar items as whole units, complete with trim and accessories. [Do not remove hardware attached to units, except for door closers.] [Salvage hardware attached to units for reuse.] Brace the open end of door frames to prevent damage.

3.1.11 Carpet

Remove existing carpet for reclamation in accordance with manufacturer recommendations and as follows. Remove used carpet in large pieces, roll tightly, and pack neatly in a container. Remove adhesive according to recommendations of the Carpet and Rug Institute (CRI). Provide adhesive removal solvents in compliance with CRI 104/CRI 105. Recycle removed carpet cushion.

3.1.12 Acoustic Ceiling Tile

Remove, neatly stack, and recycle acoustic ceiling tiles. Recycling may be available with manufacturer. Otherwise, give priority to a local recycling organization. Recycling is not required if the tiles contain or may have been exposed to asbestos material.

3.1.13 Airfield Lighting

Remove existing airfield lighting as indicated and terminate in a manner satisfactory to the Contracting Officer. Remove [edge lights], [associated transformers] [and] [_____] as indicated and [deliver to a location on the station in accordance with instructions of the Contracting Officer] [dispose of off station] [_____].

3.1.14 Patching

Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces, using on-site materials when available. Where new work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new work. Make finished surfaces of patched area flush with the adjacent existing surface and match the existing adjacent surface as closely as possible to texture and finish. Provide patching as specified and indicated, and include the following:

a. Concrete and Masonry: Completely fill holes and depressions, [caused by previous physical damage or] left as a result of removals in existing masonry walls to remain, with an approved masonry patching material, applied in accordance with the manufacturer's printed instructions.

b. Where existing partitions have been removed leaving damaged or missing resilient tile flooring, patch to match the existing floor tile.

c. Patch acoustic lay-in ceiling where partitions have been removed. Make the transition between the different ceiling heights by continuing the higher ceiling level over to the first runner on the lower ceiling and closing the vertical opening with a painted sheet metal strip.

3.1.15 Air Conditioning Equipment

****

NOTE: Delete requirements if inapplicable.

Quantify by weight the amount and type of refrigerant to be recovered and indicate on plans.

Directives from the Secretary of the Navy prohibit sale or transfer of Class I ODS materials outside of the Navy without prior approval from the Chief of Naval Operations or the Commandant of the Marine Corps.

****

[Remove air conditioning, refrigeration, and other equipment containing refrigerants without releasing chlorofluorocarbon refrigerants to the atmosphere in accordance with the Clean Air Act Amendment of 1990.] [Recover all refrigerants prior to removing air conditioning, refrigeration, and other equipment containing refrigerants and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."] [Turn in salvaged Class I ODS refrigerants as specified in paragraph, "Salvaged Materials and Equipment."]

3.1.16 Cylinders and Canisters

Remove all fire suppression system cylinders and canisters and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."

3.1.17 Locksets on Swinging Doors

****

NOTE: Use this paragraph when project includes removal and disposal of hinged or pivoted swinging doors. (This is a security measure.)

****

Remove all locksets from all swinging doors indicated to be removed and disposed of. Deliver the locksets and related items to a designated location for receipt by the Contracting Officer after removal.

3.1.18 Mechanical Equipment and Fixtures

****

NOTE: Delete, revise, or add to the text to cover the project requirements. Materials and equipment scheduled for salvage should be noted on the drawings.

****

Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Disconnect mechanical equipment and fixtures at fittings. Remove service valves attached to the unit. Salvage each item of equipment and fixtures as a whole unit; listed, indexed, tagged, and stored. Salvage each unit with its normal operating auxiliary equipment. Transport salvaged equipment and fixtures, including motors and machines, to a designated [on station] storage area as directed by the Contracting Officer. Do not remove equipment until approved. Do not offer low-efficiency equipment for reuse[; provide to recycling service for disassembly and recycling of parts].

3.1.18.1 Preparation for Storage

Remove water, dirt, dust, and foreign matter from units; drain tanks, piping and fixtures; if previously used to store flammable, explosive, or other dangerous liquids, steam clean interiors. Seal openings with caps, plates, or plugs. Secure motors attached by flexible connections to the unit. Change lubricating systems with the proper oil or grease.

3.1.18.2 Piping

Disconnect piping at unions, flanges and valves, and fittings as required to reduce the pipe into straight lengths for practical storage. Store salvaged piping according to size and type. If the piping that remains can become pressurized due to upstream valve failure, attach end caps, blind flanges, or other types of plugs or fittings with a pressure gage and bleed valve to the open end of the pipe to ensure positive leak control. Carefully dismantle piping that previously contained gas, gasoline, oil, or other dangerous fluids, with precautions taken to prevent injury to persons and property. Store piping outdoors until all fumes and residues are removed. Box prefabricated supports, hangers, plates, valves, and specialty items according to size and type. Wrap sprinkler heads individually in plastic bags before boxing. Classify piping not designated for salvage, or not reusable, as scrap metal.

3.1.18.3 Ducts

Classify removed duct work as scrap metal.

3.1.18.4 Fixtures, Motors and Machines

Remove and salvage fixtures, motors and machines associated with plumbing, heating, air conditioning, refrigeration, and other mechanical system installations. Salvage, box and store auxiliary units and accessories with the main motor and machines. Tag salvaged items for identification, storage, and protection from damage. Classify [non-porcelain]broken, damaged, or otherwise unserviceable units and not caused to be broken, damaged, or otherwise unserviceable as debris to be disposed of by the Contractor. [Salvage and crush porcelain plumbing fixtures unsuitable for reuse.]

3.1.19 Electrical Equipment and Fixtures

Salvage motors, motor controllers, and operating and control equipment that are attached to the driven equipment. Salvage wiring systems and components. Box loose items and tag for identification. Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.

3.1.19.1 Fixtures

Remove and salvage electrical fixtures. Salvage unprotected glassware from the fixture and salvage separately. Salvage incandescent, mercury-vapor, and fluorescent lamps and fluorescent ballasts manufactured prior to 1978, boxed and tagged for identification, and protected from breakage.

3.1.19.2 Electrical Devices

Remove and salvage switches, switchgear, transformers, conductors including wire and nonmetallic sheathed and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. Box and tag these items for identification according to type and size.

3.1.19.3 Wiring Ducts or Troughs

Remove and salvage wiring ducts or troughs. Dismantle plug-in ducts and wiring troughs into unit lengths. Remove plug-in or disconnecting devices from the busway and store separately.

3.1.19.4 Conduit and Miscellaneous Items

Salvage conduit except where embedded in concrete or masonry. Consider corroded, bent, or damaged conduit as scrap metal. Sort straight and undamaged lengths of conduit according to size and type. Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed.

3.1.20 Elevators and Hoists

Remove elevators, hoists, and similar conveying equipment and salvage as whole units, to the most practical extent. Remove and prepare items for salvage without damage to any of the various parts. Salvage and store rails for structural steel with the equipment as an integral part of the unit.

3.1.21 Items With Unique/Regulated Disposal Requirements

****

NOTE: Batteries and materials with lead based finishes are examples of items with unique or regulated disposal requirements.

****

Remove and dispose of items with unique or regulated disposal requirements in the manner dictated by law or in the most environmentally responsible manner.

3.2 CONCURRENT EARTH-MOVING OPERATIONS

****

NOTE: Caution must be taken to prevent uncovered holes and other such hazards. If work is to be under a separate contract and subsequent filling is not required under the separate contract, arrangements must be made to have the filling done under this contract.

****

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition or deconstruction work in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings.

3.3 DISPOSITION OF MATERIAL

****

NOTE: This article entitled "Disposition of Material" and the paragraphs that follow are for all projects except as noted.

****

3.3.1 Title to Materials

****

NOTE: To minimize the possibility of contested ownership of materials or equipment in structures to be demolished or deconstructed, the following letter

should be sent to the station sufficiently in advance of the date on which action is required, and the response thereto incorporated in either the project specifications or bidding documents. The Government will prepare this letter. For project prepared by an A/E, the A/E must notify the Government the need for this correspondence.

From: (Appropriate EDF Activity)

To: Commanding Officer, (Station)

Subj: Contract (Number) - [_____]:
(Including [Demolition] [and] [Deconstruction] of [(_____)]

1. This activity is preparing the documents preliminary to advertising the subject contract for bids. A portion of this contract will be concerned with the ownership of the materials in the structure(s) and the contents of the building(s) to be [demolished] [and] [deconstructed]. It is normal practice to specify that the structures, and all equipment or other material inside the structures at the time the contract is advertised for bids, become the property of the Contractor.

2. Accordingly, it is requested that this activity be advised of the existence of any material or equipment within the limits of the contract which is to remain the property of the Government. A negative reply is requested. If there is any material or equipment in this category, it is requested that action be initiated to remove it from the limits of the contract. If prompt removal is impractical, it will be necessary for the station to make a complete inventory of, and tag or mark, each item which is to remain the property of the Government. A copy of the inventory, a description of the tag or mark used, and the desired disposition of the item must be forwarded to this activity for inclusion in the specification or bidding documents.

3. In the past, this activity has experienced considerable difficulty where a building evacuated prior to demolition or deconstruction is then used to store other material or equipment temporarily and the items were in storage during the bid advertising period. Upon award of the contract, the Contractor claimed the material and either removed it or claimed and was awarded compensation for it. Therefore, it is requested that the structure(s) to be demolished or deconstructed which are included in this contract not be used for temporary storage during the bid advertising period.

4. It is requested that the reply to this letter be sent to this activity not later than [60] [_____] days after the date of this letter. Failure to do

so may result in unnecessary cost to the Government in claims.

5. Insert name of contract and identify buildings(s) to be included under contract. Further revise as necessary to suit conditions.

****

Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, become the property of the Contractor and must be removed from Government property. Materials approved for storage by the Contracting Officer must be removed before completion of the contract. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

3.3.2 Reuse of Materials and Equipment

****

NOTE: Delete if inapplicable, or edit to suit individual requirements. Items to be salvaged must be described in adequate detail to establish the limits of the items involved. Requirements for preparation and disposition will be as required to meet job conditions.

****

Remove and store materials and equipment [listed [in the [Demolition] [Deconstruction] Plan] [_____]] [indicated [_____]] to be reused or relocated to prevent damage, and reinstall as the work progresses. Coordinate the re-use of materials and equipment with the re-use requirements in accordance with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL. Capture re-use of materials in the diversion calculations for the project.

3.3.3 Salvaged Materials and Equipment

****

NOTE: Delete if inapplicable, or edit to suit individual requirements. Describe items to be salvaged in adequate detail to establish the limits of the items involved. Requirements for preparation and disposition will be as required to meet job conditions.

****

Remove materials and equipment that are [listed [in the [Demolition] [Deconstruction] Plan][_____]] [indicated [_____]] [and] [specified [_____]] to be removed by the Contractor and that are to remain the property of the Government, and deliver to a storage site [, as directed within [_____] km miles of the work site].

a. Salvage items and material to the maximum extent possible.

b. Store all materials salvaged for the Contractor as approved by the

Contracting Officer and remove from Government property before completion of the contract. Coordinate the salvaged materials with tracking requirements in accordance with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL. Capture salvaged materials in the diversion calculations for the project.

c. Remove salvaged items to remain the property of the Government in a manner to prevent damage, and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage must be repaired or replaced to match existing items. Properly identify the contents of containers. Deliver the following items reserved as property of the Government to the areas designated: [_____].

d. Remove the following items reserved as property of the using service prior to commencement of work under this contract: [_____].

e. Remove historical items in a manner to prevent damage. Deliver the following historical items to the Government for disposition: Corner stones, contents of corner stones, and document boxes wherever located on the site.

****

NOTE: For Class I ODS materials, use the first bracketed statement if the Contractor is to remove the material. Use the second bracketed statement if a Public Works Center or other Navy activity is to remove the Class I ODS materials. Edit statements for the project as necessary.

****

f. [Remove and capture all Class I ODS refrigerants in accordance with the Clean Air Act Amendment of 1990, and turn in to the Navy [as directed by the Commanding Officer.] [by shipping the refrigerant container to the Defense Logistics Agency at the following address:

(1) Defense Depot Richmond VA (DDRV)
(2) SW0400
(3) Cylinder Operations
(4) 00 Jefferson Davis Highway
(5) Richmond, VA 23297-5900]]

g. [The Government will remove and capture Class I ODS refrigerants. To view the web site for ODS, link to: https://www.osd.mil/denix/Public/News/DLA/ODS/sect1.html]

3.3.4 Debris Disposal in the San Diego Area

****

NOTE: This paragraph is for appropriate NAVFAC SW projects only.

****

Landfill coupons, that permit waste disposal at the Miramar Landfill free of charge, are available from the Contracting Officer. The coupons will be issued only upon the submission of a written request, by the prime contractor to the ROICC, which must identify the nature of the waste and the number of coupons requested. The landfill coupons issued under this contract are to be used only for the disposal of waste generated by this contract. If the prime contractor, one of its subcontractors, or one of its waste haulers is found to be misusing the landfill coupons by disposing of waste not generated under this contract, all rights under the contract to use landfill coupons are forfeited, from the date of misuse forward. All unused coupons will be returned to the Contracting Officer and no additional coupons will be issued for the duration of the contract. The Contracting Officer's refusal to issue landfill coupons, because of prior misuse, is not a change to the contract and no adjustment of the contract price will be made.

3.3.5 Disposal of Ozone Depleting Substance (ODS)

Class I and Class II ODS are defined in Section, 602(a) and (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting AHRI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling. Recovered ODS must be [Put recovered ODS back into the existing equipment.] [Turn over recovered ODS to the Contracting Officer.] [Remove recovered ODS from Government property and dispose of in accordance with 40 CFR 82.] Dispose products, equipment and appliances containing ODS in a sealed, self-contained system (e.g. residential refrigerators and window air conditioners) in accordance with 40 CFR 82. Submit Receipts or bills of lading, as specified. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped to the Defense Depot, Richmond, Virginia.

3.3.5.1 Special Instructions

No more than one type of ODS is permitted in each container. Apply a warning/hazardous label to the containers in accordance with Department of Transportation regulations. Provide a tag with the following information on all cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS:

a. Activity name and unit identification code

b. Activity point of contact and phone number

c. Type of ODS and pounds of ODS contained

d. Date of shipment

e. National stock number (for information, call (804) 279-4525).

3.3.5.2 Fire Suppression Containers

Deactivate fire suppression system cylinders and canisters with electrical charges or initiators prior to shipment. Also, safety caps must be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.3.6 Transportation Guidance

Ship all ODS containers in accordance with MIL-STD-129, DLA 4145.25 (also referenced one of the following: Army Regulation 700-68, Naval Supply Instruction 4440.128C, Marine Corps Order 10330.2C, and Air Force Regulation 67-12), 49 CFR 173.301, and DOD 4000.25-1-M.

3.3.7 Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable noncombustible material in the disposal area located [_____]. Maintain the fill in the disposal area below elevation [_____] and after disposal is completed, uniformly grade the disposal area to drain. Dispose of unsalvageable and non-recyclable combustible material [in the sanitary fill area located [_____]] [off the site] [by burning].

3.4 CLEANUP

Remove debris and rubbish from [basement] [project site] and similar excavations. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations with all applicable federal, state and local regulations as contractually specified [off the [_____] center] [in the Waste Management Plan] [_____]. [Storage of removed materials on the project site is prohibited.]

3.5.2 Burning on Government Property

[Burning of materials removed from demolished and deconstructed structures will not be permitted on Government property] [Transport combustible materials removed from demolished and deconstructed structures to the areas designated for burning. Control fires for protection of persons and property. Monitor fires continuously until the fires have burned out or have been extinguished. Comply with Federal, State and local laws regulating the building and maintaining of brush and trash fires].

3.5.3 Removal to Spoil Areas on Government Property

Transport noncombustible materials removed from demolition and deconstruction structures to designated spoil areas on Government property.

3.5.4 Removal from Government Property

Transport waste materials removed from demolished and deconstructed structures, except waste soil, from Government property for legal disposal. Dispose of waste soil [as directed] [per Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS].

3.6 REUSE OF SALVAGED ITEMS

Recondition salvaged materials and equipment designated for reuse before installation. Replace items damaged during removal and salvage operations or restore them as necessary to usable condition.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 42 51 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-02 42 51 (February 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 02 42 51

CARPET REMOVAL AND RECLAMATION

11/19

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-02 42 51 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-02 42 51 (February 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 02 42 51

CARPET REMOVAL AND RECLAMATION
11/19

****

NOTE: This guide specification covers the requirements for removal and reclamation of used carpet, including EPA Affirmative Procurement requirements and Carpet America Recovery Efforts (CARE).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.6	(2006) Safety & Health Program Requirements for Demolition Operations - American National Standard for Construction and Demolition Operations

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 340/1-90/018	(1990) Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance
EPA AP-42	(1995) Compilation of Air Pollution Emission Factors

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61-SUBPART M	National Emission Standard for Asbestos
40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials

1.2 SUMMARY

****

NOTE: Recycled materials are listed in the EPA's Comprehensive Procurement Guidelines (CPG) http://www.epa.gov/cpg/. Guidelines are stated for the recommended recycling of Building Materials, Paint, and other miscellaneous materials.

If the Architect/Engineer/Contracting Officer determines that the salvage value of certain materials meeting the CPG guidelines is insufficient in quantity to merit recycling, or if due to geographical considerations impractical to implement, a waiver may be initiated for the project.[Written justification may be submitted on a Request for Waiver Form to the[_____] Environmental Program Manager for approval.]

****

Furnish a contract for used carpet reclamation, including planned procedures for removal and reclamation of used carpet.

Refer to related Section 09 68 00 CARPETING for floor preparation prior to installation of new carpet.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

Use the "S" Classification only in SD-11 Closeout Submittals. The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Dust-Control Measures; G, [_____]

Packing and Transportation Measures; G, [_____]

Schedule of Carpet Reclamation Activities; G, [_____]

Carpet Reclamation Agency Records; G, [_____]

1.4 QUALITY CONTROL

1.4.1 Carpet Reclamation Agency

Provide documentation of being a Carpet America Recovery Efforts (CARE) approved carpet removal contractor (or designated agent firm) providing used carpet recycling under the most current EPA recognized Carpet Reclamation Program, or equivalent from alternate recycling agent.

1.4.2 Carpet Remover Requirements

Submit details for the following:

dust-control measures

packing and transportation measures

1.4.3 Carpet Reclamation Agency Submittal

Submit a copy of carpet reclamation agency records verifying receipt and disposition of used carpet.

1.4.4 Regulatory Requirements

Comply with governing regulations; including, but not limited to:

a. EPA 340/1-90/018

b. EPA AP-42

c. 40 CFR 61-SUBPART M

d. ASSP A10.6

e. 40 CFR 247

Comply with hauling and disposal regulations of authorities having jurisdiction. Record and maintain records of all off-site removal of debris and materials.

Provide the following information regarding the removed materials within the schedule of carpet reclamation activities:

a. Time and Date of Removal.

b. Type of Material.

c. Weight and Quantity of Materials.

d. Final Destination of Materials.

1.4.4.1 Carpet Reclamation Agency and Carpet Remover Certification

Certify in writing that used carpet was removed and recycled in accordance with the current EPA recognized Carpet Reclamation Program. Do not place removed carpet and associated materials in a landfill.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

Obtain approval of Owner before performing operations which generate contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Carpet Reclamation Agency

The current approved reclamation agency is Carpet America Recovery Effort (CARE).

2.1.2 Carpet Removers

Submit documentation of being a CARE approved carpet removal contractor.

2.2 MATERIALS

2.2.1 Adhesive Removal Solvents

Comply with Carpet and Rug Institute Publication 104.

2.2.2 Used Carpet

Maintain possession of removed used carpet. Immediately remove from site and place in container or trailer.

Carefully remove, store, and protect designated materials and equipment for re-installation under other Sections or for retention by Owner.

2.2.3 Carpet Pad

Provide recycling of carpet padding where locally available or as designated by Carpet Reclamation Agency.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Verification of Conditions

Examine areas and conditions under which work is to be performed. Identify conditions detrimental to proper or timely completion. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

Provide, erect, and maintain barricades, lighting, and guardrails as required to protect general public, workers, and adjoining property.

Vacuum used carpet before removal.

3.3 APPLICATION

3.3.1 Carpet Removal

Remove used carpets in large pieces, roll tightly, and pack neatly in container. Include carpet scrap and waste from new installation.

Deposit only clean, dry carpet in containers. "Clean" is defined as free from demolition debris, asbestos contamination, garbage, and tack strips.

Remove adhesive according to recommendations of the Carpet and Rug Institute (CRI).

3.3.2 Container Disposal

Place used carpet in fully-enclosed, front [end] loading 30 cubic m 40-yard container supplied by Carpet Reclamation Agency. Place only used commercial carpeting in collection container. Keep container locked or supervised.

Use effective packing techniques to maximize the amount of material in the container. On average, a container holds 1700-2500 square m 2,000-3,000 square yards. Neatly stack carpet tiles or repack in cardboard boxes before placing in container.

When container is full, contact Carpet Reclamation Agency to coordinate pickup and drop-off of replacement container. If container is locked for security purposes, remove lock before pickup.

3.3.3 Truck Trailer Disposal

Place used carpet in a 16 m 53 foot trailer supplied by Carpet Reclamation Agency. Place only used commercial carpeting in trailer. Keep trailer locked or supervised.

Use effective packing techniques to maximize the amount of material in the trailer. Comply with Department of Transportation regulations for weight limits. Typical maximum weight of used carpet on trailers is 20,000 kg 45,000 pounds.

Neatly stack carpet tiles or repack in cardboard boxes before placing in trailer. Do not stack higher than 2 m 6 feet. When trailer is full, contact Carpet Reclamation Agency to coordinate pickup and drop-off of replacement trailer. If trailer is locked for security purposes, remove lock before pickup.

3.3.4 Interior Operations

Seal doors and other openings with duct tape at heads, jambs, and sills to contain contaminants from work which occurs within a single room.

Use window exhaust systems to establish negative pressure in contaminant-producing work areas, ensuring continuous flow of air into work area.

Do not open windows in work area except when an exhaust fan is used. Close windows at end of each work shift. Seal exhaust system ductwork which might leak into building or mechanical systems.

Damp mop hard surface floors in work area daily to minimize tracking of contaminants from work area. In carpeted areas, protect carpet with plastic and plywood. Provide hard-surfaced area at entrances for daily damp mopping.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 42 91 (November 2018)**

Preparing Activity: USACE **Superseding**
UFGS-02 42 91 (May 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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REMOVAL AND SALVAGE OF HISTORIC CONSTRUCTION MATERIALS

11/18

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USACE / NAVFAC / AFCEC **UFGS-02 42 91 (November 2018)**

Preparing Activity: USACE **Superseding**
UFGS-02 42 91 (May 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 02 42 91

REMOVAL AND SALVAGE OF HISTORIC CONSTRUCTION MATERIALS

11/18

****

NOTE: This guide specification covers the requirements for removal and salvage of historic building materials of historic buildings and structures.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification will be coordinated with the appropriate sections and the drawings, and the bracketed choices will be selected or omitted and the bracketed blank spaces filled in or omitted as required.

The work may involve a historic property. The designer must coordinate review of the proposed work with the appropriate cultural resources manager (CRM) and cultural resource laws and regulations, as part of the environmental review and permitting process. Consultation with stakeholders, including the state historic preservation office, may be

required, and work involving historic properties will likely be required to confirm to the Secretary of the Interior's Standards for the Treatment of Historic Properties (usually at the REHABILITATION level). See https://www.nps.gov/tps/standards/four-treatments/treatment-rehabilitation.htm
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts, and Mists
40 CFR 261	Identification and Listing of Hazardous Waste

1.2 PROJECT DESCRIPTION

The work includes removal and salvage of identified historic items and materials, and removal of resulting rubbish and debris. General demolition of non-historic materials and removal of resulting rubbish and debris must comply with the requirements of Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION]. Store salvaged or recycled materials daily in areas and in a manner specified by the Contracting Officer. In the interest of conservation, pursue salvage and recycling to the maximum extent possible. Submit a Work Plan that includes procedures proposed for the accomplishment of the work. The Work Planprocedures must provide for safe conduct of the work, careful removal and disposition of materials specified to be salvaged or recycled, dust control, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. Include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations in the Work Plan.

1.2.1 Dust Control

Control the amount of dust resulting from removal, salvage and demolition operations to prevent the spread of dust to occupied portions of the construction site, to avoid creation of a nuisance in the surrounding area and to minimize occupational exposures. Occupational exposures cannot exceed the requirements in 29 CFR 1910.1000 and 29 CFR 1926.55. Use of water to control dust will not be permitted when it will result in, or create, damage to existing building materials and hazardous or objectionable conditions such as ice, flooding and pollution.

1.2.2 Protection

1.2.2.1 Protection of Existing Historic Property

Survey the site and examine the drawings and specifications to determine the extent of work before beginning any removal, salvage or demolition work. Take necessary precautions to avoid damage to existing historic items that are to remain in place, to be reused, or to remain the property of the Government. Repair or restore items damaged by the Contractor to original condition, or replace, as approved by the Contracting Officer. Coordinate the work of this section with all other work and construct and maintain shoring, bracing and supports, as required. Ensure that structural elements are not overloaded and provide additional supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.2.2.2 Protection From the Weather

Protect the interior of buildings to remain and salvageable materials from the weather at all times. Store salvaged historic materials off the ground and under weathertight covering.

1.2.2.3 Environmental Protection

Comply with the requirements of [Section 02 82 00 ASBESTOS REMEDIATION][Section 02 83 00 LEAD REMEDIATION] [_____]. Ensure a thorough inspection has been performed for hazardous materials prior to beginning work.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

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SD-01 Preconstruction Submittals

Work Plan; G, [_____]

1.4 QUALIFICATIONS

Provide qualified workers trained and experienced in whole-building recycling, including removal and salvage of historic materials. Submit documentation of five consecutive years of work of this type with a list of similar projects identifying when, where, and for whom the work was done. Provide a current point-of-contact for identified references.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 HAZARDOUS MATERIALS

Unforeseen hazardous materials may exist in wall cavities, beneath floors, in chases, inside various components, as well as other building materials. Exercise extreme care when performing demolition and salvage operations to ensure unexpected hazardous materials area not inadvertently disturbed creating a potential exposure concern. If suspect hazardous materials are observed or encountered, stop work and notify the Contracting Officer immediately.

3.2 SALVAGED ITEMS

Salvage items to the maximum extent possible. Remove historic items to be salvaged from the structure prior to demolition work. Remove salvageable items by hand labor to the maximum extent possible. Do not damage historic portions of the structure to remain or items identified for salvage. Remove furnishings, equipment, and materials not scheduled for salvage or recycling prior to any salvaging procedures. Keep a complete recording of all salvaged materials including the condition of such materials before, and after, salvage operations.

3.2.1 Site Work

Remove intact and salvage the following site items: [fences and gates] [site furnishings] [fountains] [sculpture] [site ornaments] [site lighting fixtures] [_____].

3.2.2 Concrete

Remove intact and salvage the following concrete items: [precast architectural elements] [_____].

3.2.3 Masonry

Remove intact and salvage the following masonry items: [brick] [stone] [terra cotta] [cast stone] [clay tile trim elements] [cornerstones] [_____].

3.2.4 Metals

Remove intact and salvage the following metal items: [ladders] [stairs and handrails] [cast architectural ornament] [architectural metalwork] [ornamental ironwork] [gratings and metal walkways] [_____].

3.2.5 Wood

Remove intact and salvage the following materials: [wood decking] [millwork] [custom paneling] [wood stairs and handrails] [ladders] [architectural woodwork] [custom casework] [wood timbers (125 x 125 mm 5 x 5 inch or larger)] [_____].

3.2.6 Thermal and Moisture Protection

Remove intact and salvage the following materials: [slate tiles] [clay tiles] [gutters, leaders, and downspouts] [skylights] [roof accessories] [exterior siding] [_____].

3.2.7 Doors and Windows

Remove doors and windows with associated hardware and operating mechanisms intact (including glass) and salvagein accordance with the schedule.

3.2.8 Finishes

[Remove][protect] the following special or historic finishes : [stenciling] [decorative tile] [molded ornament] [decorative ceiling materials] [wood flooring] [textured wall coverings] [murals] [_____].

3.2.9 Equipment and Specialty Items

Remove intact and salvage the following equipment and specialty items: [chalkboards and tackboards] [toilet partitions] [louvers and vents] [stoves] [plaques] [lockers] [mirrors] [bath accessories] [partitions] [contents of cornerstones] [document boxes] [_____].

3.2.10 Mechanical Equipment

Remove intact and salvage the following mechanical equipment: [bathroom fixtures] [radiators] [registers and grilles] [fans] [_____].

3.2.11 Electrical Equipment

Remove intact and salvage the following electrical fixtures and equipment: [light fixtures] [switches] [switch plates] [outlet covers] [clocks] [telecommunications equipment] [_____].

3.3 RECYCLED MATERIALS

Recycle materials to the maximum extent possible. Use hand labor wherever possible to remove recyclable materials. Do not damagehistoric portions of the structure indicated to remain and items identified for salvage while removing materials for recycling. Recycle the following materials: [dimension lumber] [scrap wood] [paper and cardboard] [gypsum wallboard] [asphalt] [rubble] [glass] [metals] [_____].

3.4 DISPOSITION OF MATERIALS

The Contractor, upon receipt of notice to proceed, is vested with the title to materials and equipment to be demolished, except Government and using service salvage and historical items. The Government will not be responsible for the condition, loss or damage to such property after notice to proceed.

3.4.1 Material Salvaged for the Contractor

Temporarily store salvaged material as approved by the Contracting Officer and remove from Government property before completion of the contract. Sale of salvaged material on the site is prohibited.

3.4.2 Items Salvaged for the Government

Remove salvaged items to remain the property of the Government in a manner to prevent damage, packed or crated to protect the items from damage, or as directed by the Contracting Officer. Repair or replace items damaged during removal or storage to match existing items. Properly label and identify containers as to contents. Deliver the following items reserved as property of the Government to the areas designated: [_____].

3.4.3 Items Salvaged for the Using Service

Prior to commencement of work under this contract, remove the following items reserved as property of the using service: [_____].

3.5 CLEAN-UP

Upon completion of the work, clean portions of structure to remain and adjacent areas and structures of dust, dirt, and debris caused by salvage and demolition operations. Verify that debris and rubbish created by the work is non-hazardous. If any debris and rubbish is suspect hazardous waste characterize it in accordance with 40 CFR 261. If the debris and rubbish is determined to be hazardous materials notify the Contracting

Officer. Remove and transport non-hazardous debris and rubbish in a manner that prevents spillage on streets or adjacent areas. Transport and dispose of all material in accordance with all local, state and Federal regulations.   Provide copies of all disposal manifests to the the Contracting Officer.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-02 51 19 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 51 19 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-02 51 19 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 51 19 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 51 19

SOLIDIFICATION AND STABILIZATION DECONTAMINATION
02/25

****

NOTE: This guide specification covers the requirements for solidification/stabilization (S/S) of contaminated materials.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification provides the framework for developing a project-specific S/S specification. This guide specification is not intended for in situ applications of the S/S technology, specifically when contaminated materials are present at depth and specialized equipment is required for reagent delivery and mixing. This guide specification should be modified as necessary for a given site, to incorporate the conditions, mix design, mixing method, and regulatory requirements which are specific to the site. This guide specification specifically considers S/S

applications using ex-situ mixing of contaminated materials and reagents in a dedicated mixing system such as a pug mill. This guide specification can also be modified to accommodate other applications of the S/S technology such as mixing reagents into contaminated materials at the surface or at shallow in-situ depths (e.g. using an excavator bucket or soil tiller for mixing). For these relatively simple applications, many elements of this guide specification will be un-necessary and should be deleted.

The S/S treatment considered in this guide specification starts with the raw contaminated material; continues through preparation, feeding, and mixing reagents into the contaminated material. Other specification sections would provide requirements for handling, stockpiling, and final disposition of the treated material (either left in-place, moved to an on-site designated permanent storage unit, or transported off-site for final disposal). As applicable, refer to Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL for requirements related to excavation and stockpiling of the contaminated materials; Section 31 00 00 EARTHWORK for placement of treated materials in on-site permanent storage; and Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS for requirements relevant to offsite transportation and disposal.

****

1.1 MEASUREMENT AND PAYMENT

1.1.1 Unit Prices

****

NOTE: Edit this paragraph based on whether the Contract will use a single job price or unit prices. If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is in the project, move these paragraphs to that Section for editing.

If the project includes Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS, coordinate measurement and payment methods and contaminated material handling and stockpiling between this Section and Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS.

****

1.1.1.1 Contaminated Materials

****

Use the first bracketed paragraph for measurement by volume. Use the second bracketed paragraph for measurement by weight. Batch processing is likely to use weight as the method of measurement. In situ processes are more likely to use volume as the

method of measurement.
****

[Measure contaminated materials by the cubic meter cubic yard of contaminated material that is treated by solidification and stabilization (S/S). Compute volume by[the average end area method from cross sections taken before and after excavation of contaminated material][the surficial area and treatment depth when treating contaminated material in-situ].

][Measure contaminated materials by the metric ton ton of contaminated material treated by S/S. Use a properly calibrated weighing system to accurately measure the gross (bulk) weight of the contaminated material. Convert the measured gross (bulk) weight of the contaminated materials to be treated to dry weight based on the[percent moisture content of representative contaminated material samples. Determine the percent moisture content in accordance with[ASTM D2216][ASTM D4643][ASTM D4959][_____]. Determine moisture content[daily][for every[500][_____] metric tons tons of contaminated material that is treated]][_____].

] Unit price must include costs for materials, labor[, moisture reduction][, hauling][, stockpiling], processing and treatment, testing and analyzing,[and] operation and maintenance[, and wastes (solid, liquid and/or gaseous) treatment and disposal].

1.1.2   Single Job Prices

[1.1.2.1   Bench-Scale Treatability Studies

****
NOTE: Delete this paragraph if bench-scale treatability studies have already been performed.
****

If the Government requires the Contractor to perform bench-scale treatability studies, the studies will be[included as part of base bid items][measured at a single job price][_____]. The price must include costs for labor and materials for:

a. Preparing plans.

b. Collecting representative contaminated materials.

c. Conducting the studies (including sampling and analysis).

d. Evaluating results.

e. Report preparation.

f. Treating and disposing of study-derived wastes.

]1.1.2.2   Field Demonstration

Payment for field demonstrations will be[included as part of base bid items][based on a single job price for each field demonstration requested by the Contracting Officer and properly completed]. The price will include costs for labor and materials for:

[a. Moisture reduction.

][b. Hauling.

][c. Stockpiling.

] d. Processing and treating.

e. Testing and analyzing.

f. Preparing reports.

g. Treating and disposing of wastes (solid liquid and/or gaseous) generated during field demonstrations.

h. Other incidental work (such as manufacturers' field services, health and safety monitoring and controls, and utilities).

1.1.2.3 Other Work Items

****

NOTE: Coordinate this paragraph with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS. Temporary utility connections are covered in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.

****

Include work items related to the work of this Section, but not included in the above paragraphs, in the base bid for treatment of the contaminated materials. Such work items include:

a. Submittals related to operation of the S/S treatment system.

b. Mobilization and demobilization.

c. Site preparation in the treatment area.

d. Configuration and installation of the treatment system.

e. Manufacturers' field services.

f. Environmental compliance monitoring.

g. Health and safety monitoring and controls.

h. Utilities required for the S/S treatment, if approved by the Government as necessary for the project.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this aragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of

the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1632	(2007) Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D1633	(2000; R 2007) Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM D5084	(2016a) Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
EPA 600/2-85/028	(1985) Guide For Decontaminating Buildings, Structures, and Equipment At Superfund Sites

EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

1.3 PRE-INSTALLATION MEETINGS

****

NOTE: Delete this paragraph if the requirements are included in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, Section 01 32 01.00 10 PROJECT SCHEDULE, or other Specification Section.

Appropriate facility personnel should be present at the pre-installation meeting if siting of the treatment facility and other associated work areas will be discussed.

****

Conduct a pre-installation meeting at the jobsite at least[five business days prior to the start of operations on the project][_____]. Arrange the pre-installation meeting and follow the written pre-installation meeting agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this Section and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Site Foreman and [Contracting Officer][_____].

Record pre-installation meeting minutes and publish via email within 48 hours to all attendees. Re-publish the minutes within 48 hours via email pending any subsequent comments from the attendees.

1.4 SYSTEM DESCRIPTION

****

NOTE: Indicate if the Government knows/assumes that there are multiple dissimilar types of contaminated materials that will require different S/S treatment processes. This may be based on site investigations and/or previously completed treatability studies.

****

The work consists of S/S treatment of approximately [_____][cubic meters cubic yards][metric tonstons] of contaminated material.

1.4.1 Design Requirements

****

NOTE: The complexity of S/S treatment processes can vary. Examples of simplistic applications would be spreading reagents onto contaminated materials and mixing with an excavator bucket or tow-behind tractor tiller. Examples of more complex applications would be multi-step processes of separating oversize material, blending/homogenizing

contaminated materials, feeding contaminated materials and reagents into a mixing unit, and conveying treated materials to a stockpile location or load-out area. The design requirements below are written for a complex S/S application. Edit as necessary for a simplistic S/S application.

Omit the third- and fourth-to-last sentences of this paragraph ("The Contractor may propose … must be addressed in detail…") if a specific method of treatment (in situ or ex-situ) is desired.

****

Configure the treatment plant based on the contaminated material characteristics data, [the Contractor's own interpretation of the previously conducted treatability study results][_____], and [the bench-scale [and][or] pilot-scale treatability studies performed by the Contractor][_____] to ensure the treated material conforms to paragraph PERFORMANCE REQUIREMENTS.[The treatment plant must be transportable.] The materials, components, accessories, and equipment used to fabricate the treatment plant must meet their functional requirements and must be compatible with the contaminants of concern, the reagents used in the treatment processes, and the operating conditions of each unit operation.[The Contractor may propose a treatment plant different from the treatment plant specified. Government approval of a Contractor-proposed treatment plant does not relieve the Contractor of responsibility for meeting specified requirements for safety, reliability, and performance.] Provide a safe and reliable treatment plant in compliance with the applicable codes and regulations and specified requirements. The treatment plant must consist of the following:

1.4.1.1 Contaminated Material Preparation and Feed System

****

NOTE: Since heterogeneity and inconsistent feed conditions can impact S/S treatment efficiency, if appropriate, pre-processing steps to maintain homogenization for optimal treatment efficiency should be specified. Alternatively, contaminated materials may need to be segregated by order of magnitude concentrations and treated using different process conditions to optimize treatment throughput and minimize treatment costs, which should be determined during the treatability/design steps.

Oversize material will likely need to be removed when S/S is performed ex-situ. Edward Bates and Colin Hills' Stabilization and Solidification of Contaminated Soil and Waste: A Manual of Practice (2015) indicates that most ex-situ S/S mixers require feed material to be less than 2.5 cm 1 in.

Bates & Hills "Stabilization and Solidification of Contaminated Soil and Waste: A Manual of Practice" is available at: https://clu-in.org/download/techfocus/stabilization/S-S-Manual-of-Practice.pdf

****

Provide a contaminated material preparation and feed system which includes, but is not limited to:

a. Oversize material separation.

b. Blending or separation of different materials to provide a consistent feedstock(if needed).

c. Stockpiling of oversize and feed contaminated materials.

d. Conveying, feeding, treatment [and][or] disposal of oversize material.

e. [Dust][emission] controls.

f. Measurement of oversize and feed contaminated materials.

Base the capacity of this system on the downstream treatment system operations. Refer to Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL for requirements related to excavation and stockpiling of the contaminated materials.

1.4.1.2 Reagent Feed and Mixing System

****

NOTE: The suggested mixing equipment production rates provided below are average values from the Edward Bates' and Colin Hills' 2015 Stabilization and Solidification of Contaminated Soil and Waste: A Manual of Practice. When specifying minimum production rates, the designer should also be aware of potential production rate limitations associated with the available storage area for stockpiling treated materials and turnaround times for testing of treated materials for performance requirement verification.

****

Provide satisfactory means, incorporating weighing, metering, or volumetric measurement to deliver the required quantity of each reagent. Equip and operate silos and feeders to prevent caking of reagent and variation in feed. Ensure that each reagent can be easily sampled. Provide mixing equipment [with a minimum capacity adequate to meet performance and schedule requirements] [capable of treating[515][_____] cubic meters/day[675][_____] cubic yards/day] and with positive means for controlling the mix proportions, maintaining the time of mixing constant, and maintaining the appropriate rotation speed of the mixer.

1.4.1.3 Plant Supporting System

Include a supporting system in the treatment plant for water storage and distribution, reagents storage and distribution, power generation and distribution, and fire safety. Provide these supporting facilities with adequate capacities to deliver water, reagents, power,[_____], and fire protection necessary for operation of the S/S system. Refer to [Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____] for requirements related to spill containment structures and stormwater pollution prevention.

1.4.1.4 Utilities

****

NOTE: The locations and details (such as utility point of contact, sizes, capacities, and flows) of the utility hookups should be provided on the drawings for the Contractor's use. Verify the utilities are available on-site before including the second sentence.

****

In accordance with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS, provide the utilities associated with the installation and operation of the treatment plant including, but not limited to:[telecommunications,][electricity,][water,][gas,][_____,][sanitary,] and solid waste facilities.[The[telecommunications][electricity][water][gas][sanitary] and[solid waste facilities][_____] are available at the site.]

1.4.1.5 Material Measurement

****

NOTE: This paragraph is primarily intended to ensure that calibrated scales are being used to weigh materials when weight is being used as the basis for measurement and payment.

****

Provide scales, meters, and volumetric measuring devices for measuring oversize materials, feed contaminated materials, reagents, and water which conform to the applicable requirements of NIST HB 44, except that the accuracy must be plus or minus[0.1][_____] percent of the quantity being measured. For scales used to measure weight of material in vehicles, provide scales of sufficient length to permit simultaneous weighing of all axle loads. For scales used to make measurement for payment, ensure the scale is certified[by an acceptable scales company representative][by an inspector of the State Inspection Bureau charged with scales inspection] prior to weighing any materials. Perform a check of calibration of measuring equipment prior to initial use, and once every [seven][_____] calendar days. The requirements of this paragraph do not apply to measurement of chemical or physical data for purposes of demonstrating compliance with paragraph PERFORMANCE REQUIREMENTS.

[1.4.1.6 Bench-Scale Treatability Study Work Plan

****

NOTE: Typically, a bench-scale treatability study will have been performed prior to development of this specification; however, the Contractor is sometimes required to complete a bench-scale treatability study prior to performing full-scale work at the site. Bench-scale treatability study test results should include the proposed reagents and mix ratios to be used during full scale treatment. The test results submitted should verify that the mix design proposed meets the post-treatment criteria listed in paragraph PERFORMANCE REQUIREMENTS. Consideration should also be given to the need to monitor off-gas and dust emissions during the bench-scale treatability study.

Further guidance on conducting treatability studies

for S/S treatment can be found in the Interstate Technology and Regulatory Council's July 2011 Development of Performance Specifications for Solidification/Stabilization and Edward Bates' and Colin Hills' 2015 Stabilization and Solidification of Contaminated Soil and Waste: A Manual of Practice.

ITRC "Development of Performance Specifications for Solidification/Stabilization" (2011) is available at:
https://itrcweb.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileK
****

Submit a Bench-Scale Treatability Study Work Plan within[60][_____] calendar days after notice to proceed. Do not perform the treatability study until the work plan is approved. Prepare [draft for Government review] [draft-final for [regulatory][_____] review] and final versions of the Bench-Scale Treatability Study Work Plan. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. Address the technical requirements, listed below and in paragraph BENCH-SCALE TREATABILITY STUDY, in the work plan. The technical requirements include, but are not limited to:

1.4.1.6.1 Conceptual Implementation Plan

Describe the proposed means of meeting the S/S treatment requirements in paragraph PERFORMANCE REQUIREMENTS for the contaminated materials, including reagent delivery and mixing methods, anticipated cure times for treated materials, and methods for transporting contaminated and treated materials between various stages of the treatment process.

1.4.1.6.2 Proposed Mixes

Submit multiple proposed mixes of contaminated soil and reagents to be included in the bench-scale treatability study designed to optimize the treatment effectiveness. At a minimum, include the following reagents in the proposed mixes:[Portland cement,][fly ash,][activated carbon,][_____].

1.4.1.6.3 Laboratory Procedures

Describe how the parent contaminated material sample will be processed to remove oversize materials, homogenized, and subdivided into aliquots for testing of different proposed mixes. Describe how reagents will be mixed with contaminated materials. Identify and justify deviations between the Conceptual Implementation Plan and Laboratory Procedures (e.g., the Conceptual Implementation Plan is to mix dry reagents into contaminated materials, but the Laboratory Procedure proposes mixing reagents as slurries).

[1.4.1.6.4 Testing Approach

****
NOTE: If a UFP-QAPP is prepared and covers testing during the Bench-Scale Treatability Study, this paragraph should be deleted or replaced with a reference to the UFP-QAPP.
****

Describe the testing approach which will be used to assess performance of the different proposed mixes.

]]1.4.1.7 S/S Treatment Work Plan

****

NOTE: The Designer may wish to require the S/S Treatment Work Plan, UFP-QAPP, and other preconstruction submittals required under this section to be completed concurrently or with the other plans being appendices of one primary plan. This Section should be edited to reflect such a requirement if applicable.

****

Submit an S/S Treatment Work Plan[within[200][_____] calendar days after notice to proceed][not less than[60][_____] calendar days prior to the anticipated start of full-scale S/S operations]. Do not perform S/S of contaminated material until the work plan is approved. Prepare [draft for Government review] [draft-final for [regulatory][_____] review] and final versions of the S/S Treatment Work Plan. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. Address the technical requirements, below, in the work plan. The technical requirements include, but are not limited to:

a. Schedule. Specify dates for the start and completion of design documentation, mobilization, installation, field demonstrations, treatment of contaminated materials, disposal of treated materials and wastes, and demobilization. Include details such as intended hours of operation, scheduled downtime, and routine maintenance downtime.

b. Project Organization. Propose a project organization for carrying out the S/S treatment. Provide an organization chart including subcontractors. Clearly define the project responsibilities of each individual, including, but not limited to:

    (1) Project management and coordination.

    (2) Scheduling and schedule control.

    (3) Quality control.

    (4) Sampling, measurement, analysis, and data management.

    (5) Operation and maintenance of the treatment plant.

c. Mix Design: Propose the mix design and method of mixing to be used in treating the contaminated material. Indicate if different mix designs will be needed for dissimilar types of contaminated materials based on Contractor interpretation of existing conditions. Document that sufficient quantities of reagents are available to complete the project. Identify the proposed source of water for the S/S process.

d. Equipment: Propose the homogenization and mixing equipment, batching equipment, and process control instrumentation. Include process flow diagrams, mixing times, and processing rates. Identify anticipated pretreatment of the contaminated material and indicate if there is a maximum allowable particle size for the S/S mixing equipment. Identify equipment foundation requirements to ensure a stable and safe area for S/S treatment equipment.

e. Drawings: Provide drawings indicating dimensions and layout of the S/S system, material laydown areas, and haul routes on the site. Drawings must be to scale.

f. Quality Control: Provide a quality control plan as required in Section 01 45 00 QUALITY CONTROL which addresses control and documentation of batch proportions, mixing time, mixing speed, sample collection, sample curing, and post-treatment testing. This program must ensure that the Contractor's operations comply with the Contract requirements with respect to quality of materials, workmanship, construction, finish, functional performance, and accuracy of data.

g. Mobilization and Demobilization: Include a mobilization plan and a post-treatment demobilization plan detailing the cleanup and sampling plan for the treatment area. Address the requirements in paragraphs MOBILIZATION and DEMOBILIZATION.

h. Outline the planned Field Demonstration and evaluation activities. This plan must address, but not be limited to:

    (1) Contaminated materials characterization.

    (2) Proposed demonstration testing runs (including specification of mix design and testing/operating conditions of the unit processes/operations for each run).

[(3) Sampling locations.

][(4) Analyses and analytical methods.

] (5) Mass balance calculation and performance evaluation [for each major piece of equipment].

    (6) Treated materials and waste characterization.

    (7) Health and safety monitoring and control.

    (8) Waste treatment and disposal.

i. Oversize Material Surface Cleaning Decontamination (if needed): If the S/S project has the potential to generate oversize material that cannot be treated via S/S, develop a surface cleaning decontamination plan. Consult EPA 600/2-85/028 when preparing the surface cleaning decontamination plan.

j. Process Material Tracking Schedule. Provide a Process Material Tracking Schedule for recording and managing the quantities of the contaminated materials processed,[other waste streams requiring disposal such as [_____]][reprocessing of treated materials that fail to meet post treatment criteria][_____], and the treated materials to be re-deposited on-site (e.g., use as backfill) or materials requiring off-site disposal. Track each material from the original source, continue through various stages of handling and treatment, and end at the ultimate disposal.

k. Permits, permit equivalents, and certifications in accordance with paragraph REGULATORY REQUIREMENTS. For items requiring a longer time frame, submit copies of applications and scheduled dates for receiving final approval.

[

l. Bench-Scale Treatability Study Test Report: After completion of testing, compile the data from the bench-scale treatability study and prepare a Bench-Scale Treatability Study Test Report that includes but is not limited to, the materials, procedures, and methods used in the study; tests performed; sampling and analysis results; conclusions with supporting dialog; and proposed conditions to be tested in the Field Demonstration. Submit the Bench-Scale Treatability Study Test Report as an attachment to the S/S Treatment Work Plan.]

1.4.1.8 Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP)

****

NOTE: This section may reference a separate specification section requiring preparation of a quality assurance project plan or may be excluded entirely if the requirements are part of another specification section.

****

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with the requirements set forth in EPA 505-B-04-900A and using the UFP-QAPP WKSTS. Incorporate sampling and analysis requirements from this Section into the UFP-QAPP. Prepare [draft for Government review] [draft-final for [regulatory][_____] review] and final versions of the UFP-QAPP. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. Submit the UFP-QAPP [within [30][_____] calendar days after notice to proceed] [at the same time the S/S Treatment Work Plan is submitted][_____]. Do not perform work at the site, with the exception of site inspection and surveys, until the UFP-QAPP is approved. Tailor the content to the requirements of the project and the site conditions.

1.4.2 Performance Requirements

1.4.2.1 Treated Material

****

NOTE: The table in this paragraph should be developed on a site specific basis considering the purpose of S/S treatment in the overall strategy for managing the contaminated material. Ideally, post-treatment testing criteria will be defined in a site-specific decision document. Post-treatment testing depends on the purpose of the S/S treatment. In general, S/S treatment is either completed as on-site pre-treatment prior to disposing the treated material off-site, or S/S treatment is performed to reduce chemical leachability and improve strength properties for material that will remain on-site (either in-situ or in a designated permanent storage unit).

The Toxicity Characteristic Leaching Procedure (TCLP) by EPA Method 1311 is usually the definitive test for contaminated materials that are pre-treated via S/S prior to off-site disposal. TCLP test results are used to determine if a contaminated material must be managed as a hazardous waste. In some instances, such as when a contaminated material is considered a listed hazardous waste, "total" chemical testing data may be needed in addition to or instead of TCLP data.

TCLP testing should generally not be used to demonstrate performance when contaminated materials are left on-site after S/S treatment. The Synthetic Precipitation Leaching Procedure (SPLP) by EPA Method 1312 is an alternative testing method that can be used to determine the mobility of both organic and inorganic contaminants. Note that the SPLP method involves mechanically reducing the particle size of samples if greater than 9.5 mm 0.375 inch, so if the S/S treatment process creates a monolithic solid material, the SPLP method may overestimate the leachability of contaminants by artificially creating a greater surficial area for leaching than actually exists. For monolithic materials, EPA's Leaching Environmental Assessment Framework (LEAF) Methods 1313 - 1316 provide a testing method which may be more applicable.

Physical testing methods may also be appropriate when S/S-treated contaminated materials are left on-site. Physical tests such as unconfined compressive strength represent the treated materials capacity to support loads placed on the treated material and can also serve as a surrogate measure of durability and chemical reaction success between the treatment reagent and contaminated material. Permeability testing indicates the degree to which liquids can move through treated material and cause contaminants to leach.

The excessive addition of reagents during treatment can result in a greater than anticipated volume increase. Limiting volume increase is important if the treated material is to be placed in an onsite permanent storage unit with limited storage space. For this reason, monitoring of volume increase is often done during the treatability study, field demonstration, and/or full-scale treatment. A volume increase performance requirement may not be necessary if there is abundant space available for disposal of treated contaminated material. A volume increase performance requirement is also not appropriate if the plans and specifications require specific treatment mixtures and application methods, in which case the Contractor would have little control over volume increase.

Two approaches are provided for attaining

performance criteria: meeting performance criteria for every sample of treated material (conservative approach) or meeting performance criteria on the average for all samples of treated material. The averaging approach would not be appropriate if S/S treated materials are to be sent off-site for disposal, because averaging of sample results cannot be used for waste characterization to determine if a material is or is not a hazardous waste.

****

Conduct the work in a manner that will ensure that treated material is a homogenous mixture of contaminated materials and reagents[with no clumps of intact contaminated material larger than the size specified in Table 1 that have not been mixed].[Each sample of treated material must meet the criteria shown in Table 1.][An average of all samples of treated material must meet the performance criteria in Table 1; for chemical properties no individual sample can be greater than [_____][110 percent] of the criteria in Table 1 with no more than [_____][20 percent] of the samples exceeding; for physical properties other than maximum clump size no individual sample can be less than [_____][90 percent] of the criteria in Table 1 with no more than [_____][20 percent] of the samples falling short.]

Table 1 - POST-TREATMENT PERFORMANCE CRITERIA

PROPERTY	TEST VALUE	TEST METHOD
Chemical Properties		
pH	[_____]	[_____]
[_____]	[_____]	[_____]
Physical Properties		
Paint Filter Liquids Test	No Free Liquids	EPA SW-846 9095B
Min. Unconfined Compressive Strength	[_____] kPa [_____] psi	ASTM D1633
Hydraulic Conductivity	[_____] centimeters per second (cm/s) [_____] feet per second (f/s)	ASTM D5084
Maximum Volume Increase(1)	[_____] percent	
Maximum Clump Size	[10][_____] cm [4][_____] inches	Visual
[_____]	[_____]	[_____]

Note (1): Determine the volume increase by comparing the volume of in situ contaminated material to be treated to the volume of treated material using the following formula:

B= 100 x [(1+R) x (D in situ/D treated) - 1], where

B= Volume increase in percent.
R= Dry weight ratio of solidifying agent to contaminated material.
D in situ = Dry unit weight of in-situ contaminated material.
D treated = Dry unit weight of compacted treated material.

1.4.2.2 Emission and Dust Controls

****

NOTE: Specifications for emission and dust controls should be provided in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. The remaining text in this note discusses S/S technology-specific emission and dust control considerations to incorporate into Section 01 57 19. An air pathways analysis should be performed during design in accordance with EP 200-1-24 Air Pathway Analysis for the Design of Hazardous, Toxic and Radioactive Waste (HTRW) Remedial Action Projects. Depending upon the contaminants of concern in the contaminated materials, the unit processes/operations employed in the treatment plant, the amount of pollutants emitted, and the geographical location of the site, the emission standards and limitations for certain contaminants and dust control can be identified from the following regulations including, but not limited to, National Primary and Secondary Ambient Air Quality Standards, National Emission Standards for Hazardous Air Quality Pollutants, and state and local regulations.

Based on the regulatory requirements, the proper technologies or apparatus for the emissions control if required can be determined. Upon completion of the design of the treatment plant, these emission requirements and control technologies should be defined by the design engineer.

If a performance specification is prepared, the emissions, dust sources, and contaminants of concern should meet specified requirements based on applicable regulations. Section 01 57 19 should list the emissions criteria for the contaminants of concern for each emission and dust source, and if applicable, monitoring requirements should be specified. The applicable federal, state, and local regulations should also be identified. If the specification is prepared based on detailed design, the technologies or apparatus for controlling the emissions and dust sources should also be specified.

****

Provide an S/S treatment system which meets the emissions and dust control requirements in accordance with[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____].

1.4.2.3 Noise Control

****

NOTE: Specifications for noise controls should be covered in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. The remaining text in this note discusses S/S technology-specific emission and dust control considerations to incorporate into Section 01 57 19. Based on the geographical location of the site, and the land uses and environment surrounding the site, the site-specific noise level requirements for the day and night operations and monitoring requirements can be identified from state and local regulations and/or developed by interacting with the state and local agencies.

****

Provide an S/S treatment system which meets the noise control requirements in accordance with[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____].

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Installation Meeting Agenda

Pre-Installation Meeting Minutes; G, [_____]

S/S Treatment Work Plan; G, [_____]

Bench-Scale Treatability Study Work Plan; G, [_____]

Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP); G, [_____]

Pre-Installation Equipment Examination

Pre-Installation Examination Report

SD-05 Design Data

Adjusted Mix Design; G, [_____]

SD-06 Test Reports

Field Demonstration Report; G, [_____]

Operations Reports

Water Supply Analysis

SD-07 Certificates

Qualifications; G, [_____]

Reagent Certificates Of Analysis

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

****

NOTE: Include Federal, state, and local regulatory requirements; utility company regulations; and applicable codes and standards published by scientific and engineering institutions where appropriate in the body of this Section. Some of the potentially applicable Federal regulations are listed as follows:

Toxicity Characteristic Leaching Procedure (TCLP)

Recording and Reporting Occupational Injuries and Illnesses

Occupational Safety and Health Standards

Safety and Health Regulations for Construction

Permitting

National Primary and Secondary Ambient Air Quality Standards

National Emission Standards for Hazardous Air Quality Pollutants

State and Local Air Quality Standards

National Pollution Discharge Elimination System (NPDES) Discharge Limitations and Permit Procedures

Hazardous Waste Identification and Standards Applicable to Generators, Transporters, and Owners and Operators of Treatment, Storage and Disposal Facilities (TSDF)

Land Disposal Restrictions (LDRs)

Department of Transportation Hazardous Materials Program Procedures

Hazardous Materials Transportation Regulations

Standards for Protection Against Radiation

Land Disposal of Low-Level Radioactive Waste

Packaging and Transportation of Radioactive Materials

For sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, delete this section.

****

Obtain the permits, permit equivalents, and certifications; and meet the regulatory requirements necessary for the installation, operation, and closure of the project.[Correspondence from regulatory agencies, and other relevant information, is attached to the specifications to indicate the level of effort necessary to obtain finalized permits, permit equivalents, certifications and to meet substantive regulatory requirements.]

1.6.2 Qualifications

****

NOTE: Requirements for the Contractor's experience should be determined and specified based on the experience, availability, and state of the S/S

treatment technology industry and the site-specific requirements. If S/S treatment is being used for unique contaminants, consider specifically identifying contractor S/S experience requirement for those contaminants in the optional bracket at the end of paragraph CONTRACTOR EXPERIENCE.
****

1.6.2.1 Contractor Experience

Submit evidence of successful completion of[at least one S/S project][[_____] S/S projects of comparable size and scope][at least[three][_____] S/S pilot scale treatability studies, demonstration studies, or full scale remediation projects that required handling and transportation of materials contaminated with[RCRA hazardous wastes][CERCLA hazardous material][_____]] using the proposed system or a similar system.

1.6.2.2 Key Personnel

Provide key personnel who have a minimum of[three][_____] years of S/S field experience. Include system operators, quality control personnel, and supervisory engineering and technical staff involved with the S/S system operation in key personnel. Submit a list of these personnel with their qualifications.

1.6.2.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting the requirements of[Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.7 DELIVERY, STORAGE, AND HANDLING

Safely transport, store, and handle equipment and raw materials (including reagents). Package and ship these items in compliance with United States Department of Transportation requirements. Store and handle these items onsite in accordance with the manufacturer's recommendations and in compliance with applicable regulatory requirements.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

****
NOTE: Consider the site-specific conditions when determining allowable ambient temperatures at which S/S and curing may take place. Low temperatures near or below freezing can be very detrimental due to inability to adequately mix frozen material and limiting of chemical reactions which occur in the aqueous phase. Very high temperatures above 32 degrees C 90 degrees F can also have a negative effect on S/S performance when curing of cementitious materials is important; however high temperatures are overall less likely to be

detrimental compared to low temperatures. Treatability studies can be used to address the situation of high temperatures during curing.

****

Do not perform S/S in an ambient temperature below[4][_____] degrees C[40][_____] degrees F without approval from the Contracting Officer. Ensure the temperature of the treated material remains above freezing while curing. Do not treat contaminated material if it contains any frozen material. Do not perform S/S during periods of heavy rainfall as this will result in the addition of excess water to the mixture.

1.8.2 Existing Conditions

****

NOTE: Place the site characterization data in an appendix to the Specifications or on the Drawings. Include:

- **Available information about the extent and characterization of significant quantities of debris.**
- **The detail to which site characterization has been performed and indicate where obvious data gaps exist.**
- **Construction limits.**
- **Property utilities.**
- **Chemical data.**
- **Geotechnical data.**
- **Sampling locations.**
- **Boring logs.**
- **Locations and details (such as utility point of contact, sizes, capacities, and flows) of the utility hookups.**

Indicate if there are multiple dissimilar types of contaminated materials that will require different S/S treatment processes. Materials may be considered dissimilar due to different types or relative concentrations of contaminants. Determination of dissimilar materials may be based on site investigations and/or previously completed treatability studies.

****

The existing site conditions are presented[in Appendix [_____]][and][on the Drawings]. These include[physical configuration,][utilities,][topography,][land uses,][geotechnical characteristics of the contaminated materials (including[grain size analysis,][total organic content,][cation exchange capacity,][pH,][moisture content,][bulk density,][porosity,]),][hydrogeology,][treatability study results,] and[nature and extent of contamination]. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions could occur. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within[48 hours][_____] of discrepancies between the data provided and actual field conditions.

PART 2 PRODUCTS

2.1 WATER

****

NOTE: Two options are provided. The first option is to only allow the Contractor to use potable water. The second option allows the Contractor to use non-potable water, but includes a testing requirement to limit the chance that the Contractor supplies a water that could introduce contaminants into the treated materials. The first option is simpler, but could lead to higher project costs if the volume of water needed is significant and/or potable water sources are not readily available. When specifying the chemical contaminant criterion to be met for water, the Designer should consider if there are other standards which are more appropriate for the specific project (e.g. state groundwater cleanup criteria).

Maximum concentrations for potential chemical interferences from water used with cementitious binders are available in ASTM C1602/C1602M Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete. Requiring testing for these chemicals may not be considered necessary given that the specification requires using the water in a bench-scale treatability study, which would demonstrate performance.

****

Supply the water used to facilitate S/S treatment.[Use only potable water from a regulated public water system.][If non-potable water is to be used, provide water that does not contain oils, acids, salts, alkalis, organic matter, solids, or other substances at concentrations that could be detrimental to the successful treatment of the contaminated materials. If non-potable water is to be used, the proposed water must be used during a Bench-Scale Treatability Study conducted in accordance with the requirements of this Section to demonstrate that the water is acceptable for use. Also characterize non-potable water prior to its use by collecting a sample from the water source and analyzing according to Table 2. Submit a Water Supply Analysis demonstrating that water meets requirements.

TABLE 2 - TREATMENT WATER CRITERIA

ANALYTICAL METHOD NUMBER (From EPA SW-846)	ANALYSIS TYPE	CRITERION TO BE MET

TABLE 2 - TREATMENT WATER CRITERIA

6010[and 7470A]	Metals[and Mercury]	[Less than Maximum Contaminant Level (MCL)] [_____]
8260	Volatile Organics	
8270	Semi-volatile Organics	
8082	PCBs	
1633	PFAS	
8081	Pesticides	

Within each Analytical Method, only analyze for analytes which have a [MCL] [_____].]

2.2 REAGENTS

Provide reagents which are free of chemicals which could result in secondary contamination of the material being treated. Provide a Reagent Certificates of Analysis with each shipping unit of reagent. A confidentiality agreement may be requested if proprietary reagents are being used.

[2.3 SAMPLES OF CONTAMINATED MATERIAL FOR TREATABILITY STUDIES

****

NOTE: This paragraph should be included if bench-scale treatability studies are to be performed by the Contractor. Action level criteria should be specified for the purpose of collecting representative samples for bench-scale treatability studies. Table 3 should be edited based on site-specific contaminants of concern and their corresponding action levels. Additional testing may be needed to verify that physical properties (e.g. grain size, total organic content, density, porosity, moisture content) of the samples are also representative of site conditions.

To reduce the overall risk to the Government, it is strongly advised that the project team should require the Contractor to collect samples for the bench-scale treatability study unless the nature of the site prevents the Contractor from doing so. Depending on site conditions and project needs (e.g. site security, access issue, etc.), the government may provide samples to the Contractor to conduct bench-scale treatability studies.

****

[The Contracting Officer will provide the required samples to conduct the bench-scale treatability studies.][Select sampling locations and collect representative samples to conduct the bench-scale treatability studies. Consider the existing site conditions presented in paragraph EXISTING

CONDITIONS when selecting sampling locations. Coordinate the sampling protocol with the Contracting Officer before obtaining the samples.] The collected bench-scale treatability study samples must have contaminant concentration levels [representative of the average concentration of the contaminants identified][and][meeting than the action level criteria presented in Table 3]. Otherwise, repeat sampling until the contaminant concentration levels exceed the action level criteria. Test samples of contaminated materials intended to be used in the bench-scale treatability studies in accordance with procedures in the[Bench-scale Treatability Study Work Plan][and][UFP-QAPP]. Do not commence bench-scale treatability studies until contaminated material sample results meet the aforementioned concentration criteria.

TABLE 3 - ACTION LEVEL CRITERIA

PARAMETER	ACTION LEVEL CRITERIA
pH	[<][>] [_____]
[_____]	[_____]

]2.4 MIX DESIGN

****

NOTE: In most instances, the Government will have conducted treatability studies prior to advertisement for bids. Results of these treatability studies are generally provided to bidders and included in the contract documents. In some limited circumstances, the designer may elect to specify the exact reagent mix to be used by the Contractor; modify the paragraph below if using this approach. This is generally not recommended because it places project performance risk on the Government.

****

Select a mix design which is capable of producing treated materials meeting the performance criteria listed in paragraph PERFORMANCE REQUIREMENTS for use during full scale treatment.

PART 3 EXECUTION

3.1 EXAMINATION

[3.1.1 Bench-Scale Treatability Study

****

NOTE: If a Treatability Study has previously been performed or is otherwise not needed, delete this paragraph. To reduce the chances of using soil samples that are not representative of site conditions, a minimum volume of 4 liters 1 gallon is recommended for each condition to be tested at the bench scale.

****

Perform at least [three][_____] replicate tests simultaneously for each selected mix from the approved Bench-Scale Treatability Study Workplan. Homogenize and divide the contaminated soil into replicate volumes prior to initiating testing. Do not use less than less than [4][_____] liters [1][_____] gallon of contaminated soil in each mix. Test samples of curing treated materials in accordance with procedures in the [Bench-Scale Treatability Study Work Plan][and][UFP-QAPP] and at a frequency of no less than every [7][_____] days. Cure treated material for a period of not less than [28 days][_____] or until target levels identified in paragraph PERFORMANCE REQUIREMENTS are reached, whichever is shorter.

]3.1.2 Pre-Installation Equipment Examination

Conduct a pre-installation examination of the S/S treatment equipment for damage, defects, and dilapidation. Submit the results of the pre-installation examination to the Contracting Officer for review and information. The Contracting Officer may conduct an independent examination to ascertain the condition and functionality of the equipment. Based on this examination, the Contracting Officer has the right to reject the entire system or damaged, defective, or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection must be borne by the Contractor. Routinely and properly inspect and maintain the equipment to provide the operation of the treatment plant as required by the Contract schedule. Schedule delays and costs due to lack of inspections and maintenance are the responsibility of the Contractor. Provide alternate/auxiliary power source if sufficiently reliable sources are not available.

3.1.3 Infrastructure Conditions

Conduct a pre-installation examination of the on-site infrastructure, utility conduits, monitoring points, and site access constraints. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-operation conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would potentially have significant impacts on operations and public safety. Submit a Pre-Installation Examination Report documenting the examination activity. Obtain all necessary utility clearances before initiation of subsurface work.

3.2 PREPARATION

3.2.1 Mobilization

****

NOTE: Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES includes requirements for decontaminating equipment that has been used in contaminated zones. Modify that Section to extend decontamination/cleaning requirements to equipment being brought on-site to cover the requirements of this paragraph.

****

Follow the approved mobilization and demobilization plans submitted as part of the S/S Treatment Work Plan. Do not mobilize the treatment plant to the site until the [S/S Treatment Work Plan][UFP-QAPP] has been approved by the Contracting Officer and the Contractor has received written confirmation. Delays caused by the Contractor's failure to meet regulatory requirements must result in no additional cost to the Government. In accordance with[Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR

CONTAMINATED SITES][_____], the equipment which is rented and/or previously used for other site remediation must be decontaminated and tested for contaminants of concern before being brought to the site.

3.2.2 Stockpiles

****

NOTE: Sufficient area should be prepared for stockpiling untreated and treated contaminated materials based on consideration of equipment production rates, allowable stockpile sizes, and overall project schedule. Background sampling under the stockpiles of contaminated materials should be performed before their construction, unless previous information is adequate. Coordinate with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL. If Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL is not in the project, copy stockpiling information from paragraphs EXCAVATION WORK PLAN, GEOMEMBRANE, CONTAMINATED MATERIAL STORAGE, and SAMPLING BENEATH STORAGE UNITS into this section.

****

Prepare areas that will be used to stockpile untreated and treated contaminated materials in accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL. Provide sufficient area to stockpile [_____] [cubic meters][metric tons][cubic yards][tons] of untreated contaminated material and[six][_____] stockpiles of[500][_____][cubic meters][metric tons][cubic yards][tons] of treated contaminated material.

[3.2.3 Foundations

****

NOTE: Delete this paragraph if the S/S treatment does not involve erecting/installing a fixed S/S system (e.g. treating contaminated materials in-situ). Minimum requirements should be specified for the foundation/containment area of the treatment plant. An option is provided at the end of the paragraph to require installing a liner and berm in the location where the S/S treatment plant will be constructed; this option addresses cross-contamination risk if the treatment plant is located on non-contaminated ground.

****

Construct equipment foundations in accordance with the approved S/S Treatment Work Plan and this paragraph. Grade the area around the S/S treatment plant so that the water drains away from the work area adjacent to the treatment area.[Construct a liner and berm surrounding the S/S treatment plant. Construct the liner and berm[in accordance with the stockpile liner and berm requirements in Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL][_____]].

][3.3 ERECTION, INSTALLATION, AND DEMOBILIZATION

****

NOTE: Delete this paragraph if the S/S treatment

does not involve erecting/installing a fixed S/S system (e.g. treating contaminated materials in-place). Referenced UFGS should be edited to include only the minimum requirements applicable to a temporary installation.

****

Erect and install the treatment plant on a temporary basis so that it can be readily removed from the site after completion of the Contract work. Perform the erection and installation to incur minimal damage to the existing site environment.[Complete mechanical work in accordance with the requirements of Section 23 30 00 HVAC AIR DISTRIBUTION.][Complete electrical work in accordance with Sections[33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION,][33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION,][and][26 20 00 INTERIOR DISTRIBUTION SYSTEM][and [_____]].][Complete plumbing work in accordance with[Section 22 00 00 PLUMBING, GENERAL PURPOSE][Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING][_____]].

]3.4 FIELD DEMONSTRATION

****

NOTE: The need for a formal Field Demonstration should be discussed with the Contracting Officer and would be a function of the uncertainty of the materials to be treated. For well-defined contaminants and contaminated material compositions that are known to be amenable to S/S treatment, data obtained from the bench-scale treatability or full-scale system startup should be adequate to negate the need for a formal Field Demonstration. If the contaminants/contaminated material is not known to be amenable to S/S treatment, then a formal Field Demonstration in accordance with the following requirements will need to be performed. If a formal Field Demonstration is not required, sufficient startup testing should be done to validate performance prior to ramping up to full-scale operation.

If processing of contaminated material must stop pending field demonstration results, the Contract must provide for issuing a second notice (or third notice in a project where treatability studies are performed) to proceed by Contracting Officer upon approval of the field demonstration.

****

Prior to full-scale operations, perform a field demonstration. Process at least [500][_____][cubic meters][metric tons][cubic yards][tons] of contaminated material. Perform a field demonstration on each dissimilar type of contaminated material and reagent mix to be treated. During the field demonstration, handle dissimilar materials in accordance with paragraph DISSIMILAR MATERIALS, and follow paragraph CHANGE OF OPERATING CONDITIONS as needed.

3.4.1 Full-Scale Processing Equipment

Use the full-scale processing equipment, reagents, mix ratios, and mixing procedures proposed for full scale S/S treatment.

3.4.2 Contaminated Material Sourcing

****

NOTE: Prior to implementing the field demonstration, chemical testing should generally be performed to verify that the materials to be used for the test run contain the contaminants of concern at high enough concentrations to adequately test the system. Additional testing may be warranted to verify that the physical properties of the materials are also representative of site conditions.

****

Obtain contaminated material used for the field demonstration from [the location specified by the Contracting Officer][_____]. Prior to performing the field demonstration, test each dissimilar type of contaminated material to be used for the field demonstration. Consider the existing site conditions presented in paragraph EXISTING CONDITIONS when selecting sampling locations. The contaminated material samples must have contaminant concentration levels [representative of the average concentration of the contaminants identified][and][meeting the action level criteria presented in Table 4]. Otherwise, repeat sampling until the contaminant concentration levels exceed the action level criteria. Test samples of contaminated materials intended to be used in the field demonstration in accordance with procedures in the [Bench-Scale Treatability Study Work Plan][and][UFP-QAPP].

TABLE 4 - ACTION LEVEL CRITERIA

PARAMETER	ACTION LEVEL CRITERIA
pH	[<][>] [_____]
[_____]	[_____]

3.4.3 Field Demonstration Treated Material Testing

****

NOTE: Consideration should be given to the need for monitoring off-gas, dust, and noise generation during the field demonstration to ensure compliance with local, state, and federal regulations.

****

Once the field demonstration has generated the required quantity of treated material, perform the tests identified in paragraph POST TREATMENT TESTING on on[five][_____] representative samples of the treated material. If the treated materials produced during the field demonstration do not meet the criteria in the paragraph PERFORMANCE REQUIREMENTS, process an equal quantity of the same type of material using properly modified operating conditions and/or incorporation of reagents that have been proven effective as part of the treatability testing, until satisfactory results are obtained. Return the treated materials that failed the demonstration testing to the contaminated materials stockpile for re-processing during full-scale treatment.

3.4.4 Field Demonstration Test Results

****

NOTE: Two options are provided for the next step after the field demonstration. The first option (halting processing contaminated soils until results from the field demonstration testing indicate the Contractor's proposed operating conditions can successfully treat the contaminated soils) would generally only be appropriate if the S/S treatment process has yet to be demonstrated on a large scale for the specific contaminants and soil composition.

****

Submit a Field Demonstration Report including pre-treatment and post-treatment test results. Document other relevant field demonstration data including but not limited to: batch proportions, mixing time, and mixing speed. Include off-gas, dust, and noise test results. After completion of the field demonstration,[do not process additional contaminated material until test results from the field demonstration verify that the treated material meets the criteria listed in paragraph PERFORMANCE REQUIREMENTS. Allow[14][_____] calendar days in the schedule for Government review and approval of the field demonstration report.][contaminated material may continue to be processed. However, if test results from the field demonstration do not pass the criteria in paragraph PERFORMANCE REQUIREMENTS, reprocess the contaminated material treated with the failing mix design in accordance with paragraph RETESTING AND REPROCESSING].

3.5 OPERATION

3.5.1 Dissimilar Materials

****

NOTE: Delete the bracketed text item if dissimilar materials are not known to be present at time of preparing project specifications.

****

Do not mix together dissimilar materials that either prior testing or field quality control observations during S/S operations have indicated need different mix formulations.[Materials known to be dissimilar at the site are defined in[paragraph EXISTING CONDITIONS][_____].]

3.5.2 Oversize Material

****

NOTE: This paragraph can be deleted if S/S is performed in-situ unless there is large debris that needs to be removed to facilitate mixing and/or protect mixing equipment from damage. An optional requirement is included if oversize material must be decontaminated before it is transported off-site for disposal.

****

Reduce the size of oversize contaminated material to less than [2.5 cm one inch][the maximum allowable particle size of the S/S mixing unit as defined in the S/S Treatment Work Plan][_____]. Treat oversize contaminated material which can be reduced to an allowable size for the S/S process. Remove oversize material that cannot be reduced to an allowable size for the S/S unit process.[Decontaminate oversize materials in accordance with the procedure developed in the S/S Treatment Workplan]. Dispose oversize material off-site in accordance with [Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIAL][_____].

3.5.3 Treated Materials

3.5.3.1 Temporary Storage of Treated Materials

****

NOTE: The second option in the paragraph below applies only to S/S treatment when the treated material is placed into permanent on-site storage. To prevent double handling it is preferable to place treated material directly into the permanent storage area rather than stockpiling until post-treatment testing is completed.

****

[Separate treated material into units (stockpiles) for post-treatment testing. Keep dissimilar materials in separate stockpiles pending test results. Unit size greater than the quantity pertaining to the most frequent quality control test is prohibited. If the test results indicate the treated materials of a stockpile meet the post treatment criteria presented in paragraph PERFORMANCE REQUIREMENTS, this stockpile of treated materials[may][must][_____] be combined with other stockpiled material which has also met the post treatment criteria.]

[Place treated material directly into the permanent storage unit after treatment. Place treated material such that the material from specific batches/runs can be defined and removed if it fails post-treatment testing.]

3.5.3.2 Final Disposal of Treated Materials

Dispose treated materials which meet the treatment performance requirements in paragraph PERFORMANCE REQUIREMENTS[off-site in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS][in the designated permanent storage unit. Place treated materials in accordance with Section 31 00 00 EARTHWORK].

3.5.4 Change of Operating Conditions

****

NOTE: If adjustment to the mix design is required due to change in contaminated material characteristics, then the Contractor's adjusted mix design should be evaluated by the Contracting Officer for the extent of changes from the previous mix design. Further, price negotiation may be required based on the extent of changes from the previous mix design.

****

The following two requirements must be met in order to be considered for change of operating conditions:

a. The physical and chemical characteristics of the contaminated materials are significantly different from the originally defined characteristics.

b. The treatment requirements cannot be met under the current S/S treatment plant design and related mix design/operating conditions.

When change of operating condition is necessary, notify the Contracting Officer before changes are made to the mix design and related operating conditions. The Contracting Officer may require the Contractor to perform a field demonstration for significant changes made to the mix design and related operating conditions in accordance with paragraph FIELD DEMONSTRATION, for approval. If adjustment to the mix design is required due to change in contaminated material characteristics, submit an adjusted mix design for the extent of changes from the previous mix design for approval. Further, price negotiation may be required based on the extent of changes from the previous mix design.

3.6 FIELD QUALITY CONTROL

****

NOTE: Leaching and hydraulic conductivity tests are not amenable to real time quality control because of the time required to perform the tests; therefore, it is preferable to minimize the number of leaching and hydraulic conductivity tests performed and to maintain quality control of the S/S process by verifying that the mix design works during the field demonstration and maintaining quality control by monitoring batch proportions and mixing time. Real time indicator tests such as pH, specific conductance, mix temperature, and water content can also be used as quality control tools.

****

The post treatment testing specified in this paragraph is needed by the Government to generate documentation that the S/S treatment has been accomplished in accordance with performance requirements approved by applicable authorities. The results of these tests may be used as part of the Contractor's QC program; however it is the contractor's sole responsibility to meet the performance requirements specified in this section. Therefore, it is expected that the Contractor will perform additional testing and measurements to assure that treated materials meet requirements without rejection of batches, retesting, and/or reprocessing.

3.6.1 Tests

3.6.1.1 Post Treatment Testing

****

NOTE: If cementitious reagents are used in treatment, a requirement is included to collect samples for post-treatment testing immediately after treatment. This eliminates the need to remove samples from the treated mass after it has cured.

The values shown in Table 5 for frequency of testing are only examples and need to be determined on a site specific basis. Coordinate the properties in this table with the properties in paragraph PERFORMANCE REQUIREMENTS. Edward Bates' and Colin

Hills' 2015 Stabilization and Solidification of Contaminated Soil and Waste: A Manual of Practice includes discussion on sampling frequency (Section 6.2.1) and provides examples. It may be acceptable to change the number of samples during development of a UFP-QAPP, but attempt to establish a reasonable sampling frequency in the Specifications to provide a basis for the Contractor to bid the project.

****

Collect post treatment confirmation samples in accordance with the [UFP-QAPP][basewide QAPP][_____] and this paragraph. Collect confirmation samples at a minimum frequency [defined in Table 5][_____]. Collect samples as [discrete grabs][composites][incremental samples][_____]. Collect samples for quality control and quality assurance testing immediately after treatment and allow to cure as specified in ASTM D1632 or by another approved method. Analyze samples for the parameters identified in paragraph PERFORMANCE REQUIREMENTS. Complete all other sampling and analysis activities in accordance with the [UFP-QAPP][basewide QAPP][_____] (including but not limited to sample handling, preservation, transportation, collection/analysis of quality control samples, data validation, and data reporting). Any deviations to sampling frequency, number of samples, or sample collection methods must be [established in the approved [UFP-QAPP][basewide QAPP]][approved by the Contracting Officer].

Table 5 - POST-TREATMENT QUALITY CONTROL TESTING FREQUENCY

PROPERTY	FREQUENCY [Cubic Meters][Metric Tons]
Chemical Properties	
pH	1 per [500][_____]
[_____]	1 per [500][_____]
Physical Properties	
Paint Filter Liquids Test	1 per [500][_____]
Min. Unconfined Compressive Strength	1 per [500][_____]
Hydraulic Conductivity	1 per [500][_____]
Maximum Volume Increase(1)	1 per [500][_____]
Maximum Clump Size	1 per [500][_____]
[_____]	1 per [500][_____]

3.6.1.2 Retesting and Reprocessing

****

NOTE: An option is provided for retesting treated contaminated materials which fail to meet performance requirements. Retesting without first reprocessing treated contaminated materials should

generally be prohibited unless there is reason to believe the original test result was inaccurate due to mislabeling/mishandling of the sample or analytical error discovered during validation of laboratory results (simply believing that a sample did not reflect the treatment is not sufficient to consider a result inaccurate).

If S/S treated material is being sent off-site for disposal, do not permit retesting unless there is reason to believe the original test result was inaccurate as described in the paragraph above. This is because waste characterization and disposal is based on grab sampling results, and averaging of sampling results cannot be used to determine that a waste meets regulatory disposal requirements.

****

Reprocess and then retest units of treated contaminated materials that do not meet the post-treatment criteria in paragraph PERFORMANCE REQUIREMENTS[or quality assurance testing].[The Contractor may propose to retest failing units of treated contaminated soils prior to reprocessing. If the Contracting Officer approves retesting, collect and test two additional samples for the failed parameter(s). If both samples pass, re-processing the unit will not be required. If either sample fails, reprocess the unit.]

3.6.1.3 Government Quality Assurance Testing

****

NOTE: Consider the need for quality assurance testing on a project-by-project basis. If QA testing is unnecessary, delete this paragraph. Factors to consider include whether the Government has access to a laboratory that can analyze quality assurance samples in a timely manner to not delay the project execution. Use of quality assurance testing data use also needs to be considered. A relatively straightforward data use is to compare quality assurance sample results to the project Performance Requirements, and failing result would be treated the same way as a failing Contractor test result. A more complicated data use is to compare results from quality assurance samples and contractor quality control samples for the purpose of determining if there is meaningful disagreement between the results. In this case, procedures would need to be developed for determining when there is a meaningful disagreement between quality assurance and quality control sample results; corrective actions for when a meaningful disagreement was identified would also need to be developed. The process of defining procedures for identifying and correcting meaningful differences should be documented in a project-specific Quality Assurance Project Plan and referenced in this specification; the process is likely to complex to be adequately defined in this specification.

****

Provide duplicate samples to the Government's quality assurance laboratory for Government quality assurance. Submit samples at a frequency of one set of samples per [10][_____] sets of quality control tests performed. Quality assurance samples will be tested for the same parameters as the parent quality control sample. Provide additional quality assurance samples upon request.

3.6.2 Inspection

3.6.2.1 Batch Proportions

Visually inspect treated materials to confirm that a homogeneous mixture has been created and maximum clump size is being met as defined in paragraph PERFORMANCE REQUIREMENTS. Record the mixing time, mixing speed, and quantities of contaminated material, reagents, and water added to each batch. Maintain mixing time, mixing speed, and batch proportions within the limits specified in the approved Work Plan and as modified during the field demonstration.

3.6.2.2 Government Inspection

The Government may conduct inspection of the system installation and perform periodic inspections during the S/S treatment operation to verify that the project activities are performed in accordance with the approved plans, specifications, and the regulatory requirements. Inspection findings must be addressed immediately and resolved to the Government's satisfaction.

3.6.2.3 Operations Reports

Submit operations reports [daily][weekly] for the first [10][_____] weeks, and at a frequency of [_____] thereafter. The operations reports must consist of a log of operating conditions including, but not limited to: hours of operation; staffing; weather conditions; process materials tracking schedule; sample shipment (include chain of custody documents); receipt of analytical results; changes in operating parameters; results of the testing and calibration activities; and inspection and maintenance activities. In addition, attach the physical and chemical test results generated onsite or received from offsite laboratories to the report. Include the following information with test results: time of sampling, location of sampling, and Contractor Quality Control (such as duplicate sample analysis, field and trip blank analysis, laboratory QC analysis, etc.) results. Perform data validation of the test results [in accordance with the project UFP-QAPP][before submittal].

3.7 DEMOBILIZATION

****

NOTE: If there is a separate Specification Section which provides overall requirements for demobilization/site cleanup, such as 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS, move the requirements from this paragraph into that Section.

****

Follow the approved mobilization and demobilization plans submitted as part of the S/S Treatment Work Plan. Demobilize to restore the site to its initial state, prior to the construction and operation of the S/S treatment facilities. Do not commence demobilization until written approval is received from the Contracting Officer. Demobilization must include, but must not be limited to:[disconnecting of utility service lines,][decontamination and removal of equipment and materials,][disposal of decontamination wastes,][disposal of any residual wastewater,] [removal of unused amendments and other materials,][removal of material overlying liners,][removal of liners,][regrading and removal of berms,][demolition and disposal of the treatment pad, other foundation slabs, and paved surfaces,][_____].[Perform post-treatment testing of soils below stockpile storage units and work area surfaces in accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL.]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-02 53 16.13 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 53 16.13 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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02/25

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USACE / NAVFAC / AFCEC **UFGS-02 53 16.13 (February 2025)**

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****

SECTION 02 53 16.13

REMEDIATION OF CONTAMINATED SOILS BY THERMAL DESORPTION

02/25

****

NOTE: This guide specification covers the requirements for onsite thermal desorption of non-radioactive materials contaminated by hazardous or toxic organic wastes and by petroleum, oil, or lubricants (POL).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification provides the framework for developing a project-specific thermal desorption specification. This guide specification should be modified as necessary for a given site, to incorporate the conditions, contaminants, thermal desorption heating method, and regulatory requirements specific to the site.

A systematic project planning approach should be employed when developing sampling procedures to demonstrate the performance of the thermal desorption treatment process, ideally through implementation of the Uniform Federal Policy for

Quality Assurance Project Plans (UFP-QAPP) or some such similar process. The sampling procedures may affect the maximum allowable size of a stockpile, and subsequently, determine the number of days required to reach this quantity based on the daily generation of the treated materials.

The thermal desorption treatment considered in this guide specification starts with the raw contaminated material; continues through preparation, feeding, stockpiling of treated contaminated material (if necessary); and ends with final disposition of the treated material (either returned to its original location, moved to an on-site designated permanent storage unit, or transported off-site for final disposal). As applicable, refer to Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL for requirements related to excavation and stockpiling of the contaminated materials; Section 31 00 00 EARTHWORK for placement of treated materials in on-site permanent storage; and Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS for requirements relevant to offsite transportation and disposal.

****

1.1 MEASUREMENT AND PAYMENT

1.1.1 Unit Prices

****

NOTE: Edit this paragraph based on whether the Contract will use a single job price or unit prices. If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is in the project, move these paragraphs to that Section for editing.

If the project includes Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS, coordinate measurement and payment methods and contaminated material handling and stockpiling between this Section and Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS.

****

1.1.1.1 Contaminated Materials

****

NOTE: Use the first bracketed paragraph for measurement by volume. Use the second bracketed paragraph for measurement by weight. The unit price for thermal desorption of contaminated soils/solids should generally be based on in-situ volume. For liquids and sludges the unit of measure should be mass.

****

[Measure contaminated materials by the cubic meter cubic yard of contaminated material that is treated. Compute volume by the average end area method from cross sections taken before and after excavation of contaminated material.

][Measure contaminated materials by the metric ton ton of contaminated material treated by thermal desorption. Use a properly calibrated weighing system to accurately measure the gross (bulk) weight of the contaminated material. Convert the measured gross (bulk) weight of the contaminated materials to be treated to dry weight based on the[percent moisture content of representative contaminated material samples. Determine the percent moisture content in accordance with[ASTM D2216][ASTM D4643][ASTM D4959][_____]. Determine moisture content[daily][for every[500][_____] metric tons tons of contaminated material that is treated]][_____].

] Unit price must include costs for materials, labor[, moisture reduction][, hauling][, stockpiling], processing and treatment, testing and analyzing,[and] operation and maintenance[, and wastes (solid, liquid and/or gaseous) treatment and disposal].

1.1.2 Single Job Prices

[1.1.2.1 Bench-Scale Treatability Studies

****

NOTE: Delete this paragraph if treatability studies have already been performed.

****

If the Government requires the Contractor to perform bench-scale treatability studies, the studies will be[included as part of base bid items][measured at the single job price][_____]. The price must include costs for labor and materials for:

a. Preparing plans.

b. Collecting representative contaminated materials.

c. Conducting the studies (including sampling and analysis).

d. Evaluating results.

e. Report preparation.

f. Treating and disposing of study-derived wastes.

]1.1.2.2 Field Demonstration

Payment for field demonstrations will be[included as part of base bid items][based on single job price for each field demonstration requested by the Contracting Officer and properly completed]. The price will include costs for labor and materials for:

[a. Moisture reduction.

][b. Hauling.

][c. Stockpiling.

] d. Processing and treating.

e. Testing and analyzing.

f. Preparing reports.

g. Treating and disposing of wastes (solid liquid and/or gaseous) generated during field demonstrations.

h. Other incidental work (such as manufacturers' field services, health and safety monitoring and controls, and utilities).

1.1.2.3 Other Work Items

****

NOTE: Coordinate this paragraph with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS. Temporary utility connections are covered in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.

****

Include work items related to the work of this Section, but not included in the above paragraphs, in the base bid for treatment of the contaminated materials. Such work items include:

a. Submittals related to operation of the thermal desorption treatment system.

b. Mobilization and demobilization. Mobilization includes transportation of the equipment to the site, equipment erection and installation, but not start-up and operation.

c. Site preparation in the treatment area.

d. Configuration and installation of the treatment system.

e. Manufacturers' field services.

f. Environmental compliance monitoring.

g. Health and safety monitoring and controls.

h. Utilities required for the thermal desorption treatment, if approved by the Government as necessary for the project.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM E953/E953M	(2016) Standard Practice for Fusibility of Refuse-Derived Fuel (RDF) Ash

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas

	Code
NFPA 82	(2024) Standard on Incinerators and Waste and Linen Handling Systems and Equipment
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices
NIST SP 250	(1991) Calibration Services Users Guide

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 450/4-80/023R	(1985) Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations)
EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

[1.3 ADMINISTRATIVE REQUIREMENTS

****

NOTE: Delete this paragraph if the requirements are included in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, Section 01 32 01.00 10 PROJECT SCHEDULE, or other Specification Section.

Appropriate facility personnel should be present at the pre-installation meeting if siting of the treatment facility and other associated work areas will be discussed.

****

1.3.1   Pre-Installation Meetings

Conduct a pre-installation meeting[and site walk-through] at least[five business days prior to the start of operations on the project][_____]. Arrange the pre-installation meeting and follow the written pre-installation meeting agenda submitted prior to the meeting. The purpose of this meeting is to identify key logistical, safety, and community concerns. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Site Foreman and [Contracting Officer] [_____].

Record pre-installation meeting minutes and publish via email within 48 hours to all attendees. Re-publish the minutes within 48 hours via email pending any subsequent comments from the attendees.

1.3.2   Sequencing and Scheduling

The Government will not permit the Contractor to begin the next phase of operations until the Contractor has submitted documentation of successful accomplishment of the objectives of the previous phase of operation. Do not commence mobilization until approval of the mobilization plan as part of the Remedial Action Work Plan is received from the Contracting Officer.

]1.4   SYSTEM DESCRIPTION

****

NOTE: Indicate if the Government knows/assumes that there are multiple dissimilar types of contaminated materials that will require different thermal desorption treatment processes. This may be based on site investigations and/or previously completed treatability studies.

****

The work consists of thermal desorption treatment of approximately[[_____] cubic meters [_____] cubic yards][[_____] metric tons [_____] tons] of contaminated material. Provide and operate the thermal desorption system to transfer organic compounds from contaminated materials to a gaseous stream drawn through the system. The system must consist of a process or series of processes to remove organic contaminants from the contaminated materials by heating the soil or sludge matrix. Complete removal/treatment of organic vapors in one or more air pollution control systems.

1.4.1   Design Requirements

****

NOTE: The first option for thermal desorption system capacity is preferred. It is more difficult to enforce schedule constraints with the second option.

Omit the third- and fourth-to-last sentences of this paragraph ("The Contractor may propose … must be addressed in detail…") if a specific method of treatment is desired.

****

Provide a thermal desorption treatment system with a capacity that is[consistent with the remedial action schedule][a minimum of[_____] kg/hr

[_____] tons/hour]. Configure the treatment plant based on the contaminated material characteristics data[, the Contractor's own interpretation of the previously conducted treatability study results, [_____], and[the bench-scale or pilot-scale treatability studies performed by the Contractor] so that the treated material conforms to paragraph PERFORMANCE REQUIREMENTS.][The treatment plant must be transportable.] The materials, components, accessories, and equipment of the treatment plant must meet their functional requirements and be compatible with the contaminants of concern and the operating conditions of each unit operation.[The Contractor may propose a treatment plant different from the treatment plant specified. Government approval of a Contractor-proposed treatment plant does not relieve the Contractor of responsibility for meeting specified requirements for safety, reliability, and performance.] Provide a safe and reliable treatment plant in compliance with the applicable codes, regulations, and specified requirements. The treatment plant must consist of the following major systems:

1.4.1.1 Primary Desorption Chamber

****

NOTE: The nature of the heating process may invoke other requirements if it is considered "incineration." The designer should particularly verify the ramifications of the use of a direct-fired chamber on the regulatory status.

****

The primary desorption chamber volatilizes the compounds of concern. The primary chamber must be[directly fired with the primary chamber operated at a pressure lower than atmospheric.][indirectly fired.][An inert carrier gas must be recycled through the desorber and stack emissions treatment system.]

1.4.1.2 Air Pollution Control System Requirements

****

NOTE: If site materials contain polychlorinated biphenyls (PCBs), consider eliminating the use of an afterburner to alleviate permitting problems during construction. If per- and polyfluoroalkyl substances (PFAS) are present, the designer should determine if there are any prohibitions against incineration, such as a Department of Defense moratorium or state/local regulation. An afterburner could not be used if there is any prohibition on PFAS incineration.

****

Provide an air pollution control system containing[an afterburner. The temperature of the afterburner must be greater than the temperature of the primary desorption chamber][an afterburner operating at a minimum temperature of [_____] degrees C [_____] degrees F][a quench followed by an adsorption type treatment system][a condenser followed by an adsorption type treatment system][_____].

1.4.1.3 Auxiliary Fuel System

1.4.1.3.1 Feed Capability

Provide an auxiliary fuel system with direct feed capability to the thermal destruction system. Provide meters, pressure gages, and controls to maintain proper operating conditions. Design must be in conformance with NFPA 30 and NFPA 31, NFPA 54 or NFPA 58, as appropriate to the fuel type.

1.4.1.3.2 Secondary Containment

Provide auxiliary fuel storage tanks with secondary containment in accordance with[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][NFPA 30].

1.4.1.4 Contaminated Material Feed System

[1.4.1.4.1 Conveyors

****

NOTE: Use this paragraph only if there is a potential for unacceptable quantities of volatile organic chemicals (based on calculations from the Remedial Action Work Plan). This paragraph may not apply for batch-type desorption systems and may be deleted if batch treatment is anticipated.

****

Cover contaminated material feed conveyors and vent to the air pollution control system if calculations in the Remedial Action Work Plan indicate unacceptable quantities of volatile organic compounds (VOCs) would be released during contaminated material conveying.

]1.4.1.4.2 Support Equipment

****

NOTE: Address rocks, construction debris, trees, stumps, drums, barrels, etc. and oversize materials. Oversize materials are any materials too large to be compatible with the thermal desorber. Materials may be required to be shredded and treated or separated from the feed material, decontaminated and disposed on or offsite. Maximum allowable sizes to be treated in the thermal desorber should be specified.

****

Provide material handling and contaminated material feed systems capable of[shredding][, conveying][, pumping][, and][screw feeding] of contaminated materials, separately or in combination, to the primary chamber. Pre-treatment includes crushing or grinding and screening as required to produce material no larger than [_____] mm [_____] inch in diameter and which is otherwise compatible with the thermal desorber.

1.4.1.4.3 Capacity

Provide the contaminated material feed system such that its capacity is consistent with the capacity of the other components of the thermal desorption system.

1.4.1.4.4 Material Measurement

****

NOTE: This paragraph is primarily intended to ensure that calibrated scales are being used to weigh materials, when weight is being used as the basis for measurement and payment.

****

Provide scales; meters; and volumetric measuring devices for measuring the contaminated materials (liquid and solid) introduced into the thermal desorption system which conform to the applicable requirements of NIST HB 44, except that the accuracy must be plus or minus[0.1][_____] percent of the quantity being measured. For scales used to measure weight of material in vehicles, provide scales of sufficient length to permit simultaneous weighing of all axle loads. For scales used to make measurement for payment, ensure the scale is certified[by an acceptable scales company representative][by the State Inspection Bureau charged with scales inspection] prior to weighing any materials. Perform a check of calibration of measuring equipment prior to inital use and at least once every[week][[_____] working days]. The requirements of this paragraph do not apply to measurement of chemical or physical data for purposes of demonstrating compliance with paragraph PERFORMANCE REQUIREMENTS.

1.4.1.4.5 Rehydration

****

NOTE: Final moisture content may be specified here, if appropriate.

****

Include provisions for rehydration, prior to storage, of material leaving the thermal desorption system to reduce fugitive emissions and to confine the materials to the proper storage area. Rehydrate treated soils to achieve a minimum moisture content of [_____] percent.

1.4.1.5 Air Supply And Pollution Control Systems

1.4.1.5.1 Air Supply

Use a forced draft (FD) blower/fan or fans to provide combustion air for the burners.

1.4.1.5.2 Induced Draft (ID) Fan

Use ID blower/fan or fans to maintain negative pressure throughout the system.

1.4.1.5.3 Fugitive Emissions Control

****

NOTE: Select the second bracketed option for indirectly fired units.

****

[Control emissions from the desorption zone by keeping the desorption zone sealed and maintaining a desorption zone pressure lower than atmospheric pressure.][With the approval of the Contracting Officer, implement means that have been demonstrated to provide fugitive emissions control.]

1.4.1.5.4 Quench

Cool off-gases from the primary soil treatment zone to temperatures that protect downstream units and equipment.

1.4.1.5.5 Stack Emissions Control

****

NOTE: Indicate design wind force the stack will have to withstand. Structural design must also include seismic resistance in accordance with UFC 3-301-01, when appropriate.

****

The air pollution control system must be capable of controlling gaseous, solid, and aerosol type emissions to meet the performance requirements. Provide stack support in accordance with NFPA 82 and NFPA 211, as applicable. Provide vertical and lateral supports for exterior chimneys to withstand wind forces of [_____] kph [_____] mph. Provide stack sampling port and equipment for collecting discrete and composite samples with adequate access for personnel and equipment.

1.4.1.5.6 Water and Liquid Waste

Design the air pollution control system to minimize water consumption and liquid waste generation. Recirculate liquids in the air pollution control system to the maximum extent practicable prior to wasting to the liquid waste system.

1.4.1.6 Instrumentation And Controls

Provide continuous emission monitors in accordance with paragraph PERFORMANCE REQUIREMENTS and EPA 450/4-80/023R. Protect systems from damage from onsite activity.

1.4.1.6.1 Instrumentation, Sensors, Recorders, and Sampling

Provide instrumentation and equipment including sensors, local indicators, connecting devices, recorders, analyzers and components necessary to monitor and control the safe and efficient operation of the system. Provide thermometers conforming to ASME PTC 19.3 TW, with wells and temperature range suitable for the use encountered. Provide draft gauges conforming to ASME B40.100 with a diaphragm or bellows actuating system and a circular scale. The gauges must have a zero adjustment screw. Provide suitable shutoff cocks.

Provide pressure gauges conforming to ASME B40.100 that are the pressure detecting class, single Bourdon tube style, and suitable for detecting air pressure. Provide sensors in the desorption chamber or as otherwise directed. Provide thermocouples suitable for continuous operation and control at temperatures up to[1,540][_____] degrees C[2,800][_____] degrees F, accurate to 0.75 percent, and long enough to be inserted 150 mm 6 inches into the furnace. Provide thermocouples with an adjustable flange and a high-temperature metal alloy, closed-end, protecting tube suitable for insertion into the furnace without support of the projecting end. Supply compensating lead wire 1.52 mm 16 gauge in diameter and 30 meters 100 feet long with a weatherproof braid supplied for connecting the thermocouple to the instrument. The installed unit must indicate gas passage temperatures and must control burner operation.

1.4.1.6.2 Control Room

****

NOTE: Consult the military installation regarding the usage of radio communications. Closed circuit TV requirements should be deleted if specified in Section 28 10 05 ELETRONIC SECURITY SYSTEMS (ESS).

****

Maintain a fully enclosed control room provided with system controls, instrument readouts, and data recording devices. The control room must be heated and air conditioned, permitting year round occupancy, and must meet instrumentation and control equipment manufacturer's operating specifications. If the control room is located in the exclusion zone, provision must be made for personnel using protective clothing and equipment. If the control room is located in the support zone, provide a[hard-wired][or][radio] intercommunication system with two communication channels between the control room and thermal desorption system operating area to allow control room operators to communicate with system operators.[Provide closed circuit television monitoring of operations in the control room.]

1.4.1.6.3 Redundancies

Provide fully redundant backup capability within each subsystem to safely terminate system operations at the control room and at the thermal desorption system. Provide uninterrupted continuous monitoring of the emissions and demonstrate operation in accordance with the approved operating conditions using adequate duplexing or redundancies withing the instrumentation and control systems. Provide documentation of these redundancy measures.

1.4.1.6.4 Displays and Data

Locally display and record monitored parameters and excursion alarms in the control room. Maintain digital process and emissions data in the control room in the approved digital format. Maintain hard copies of recorded data and summaries of recorded data in the control room. Provide copies upon request.

1.4.1.7 Interlocks and Alarms

1.4.1.7.1 Visible Alarms

Visible alarms consist of lights on the main control panel, flashing symbols on the screen of the microprocessor controller in the control room and, for each interlock that stops the contaminated material feed system, lights at the equipment location.

1.4.1.7.2 Audible Alarms

Provide audible alarm activation for each interlock that stops the feed to the thermal processing unit.

[1.4.1.7.3 Remote Alarms

****

NOTE: Delete this paragraph if remote alarms are not required. Furnish the calling sequence, in priority order, at the pre-installation meeting. The Contracting Officer or a designated representative must be included in the calling sequence.

****

Provide auto dialing to the indicated remote locations for each interlock that stops the contaminated material feed to the thermal processing unit. The Government will provide the calling sequence and priority order.

]1.4.1.8 Utilities

****

NOTE: The system utilities requirements should be identified in the Contractor's design. Verify the utilities are available on-site before including the second sentence. The following information may be used as a check: the amount required for a 12,000 - 18,000 kg 15 - 20 ton per hour unit is 5 - 35 L per second 75 - 600 gpm of water, 1,200 - 2,500 kw of electricity and 30 - 60 cubic meters per minute 1,000 - 2,000 scfm of natural gas. The Contractor should verify the adequacy of the existing utilities and be responsible for the required agreements with the utility companies for usage and any required changes.

****

In accordance with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS, provide the utilities associated with the installation and operation of the treatment plant including, but not limited to: [telecommunications][, electricity][, water][, steam,][gas,][_____], sanitary, and solid waste facilities. The[telecommunications][, electricity][, steam][, water][, gas][, sanitary][, and][solid waste facilities][_____] are available at the site.

1.4.1.9 Remedial Action Work Plan

****

NOTE: The Designer may wish to require the Remedial Action Work Plan, UFP-QAPP, and other preconstruction submittals required under this section to be completed concurrently or with the other plans being appendices of one primary plan. This Section should be edited to reflect such a requirement if applicable.

****

Submit a Remedial Action Work Plan[within[200][_____] calendar days after notice to proceed][not less than[60][_____] calendar days prior to the anticipated start of full-scale thermal desorption treatment operations]. Do not perform thermal desorption of contaminated material until the work plan is approved. Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Remedial Action Work

Plan.[Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review].] Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. Submit the following in a Remedial Action Work Plan:

a. Flow diagram for process equipment associated with the thermal desorption system and data, including but not limited to: contaminated material stream flows; direction of material flow, including range of flow rate and range of composition, identified by lines and arrows denoting the direction and destination of the flow; material, mass and energy balances for the entire thermal desorption system.

b. Piping and instrumentation diagram indicating: process equipment; instrumentation; piping and valves; stacks, vents and dampers; control equipment (including sensors, process controllers, control operators, valves, interlocks, alarms, and contaminated material feed cut-off systems); labels and other necessary information to correlate to the process flow diagram.

c. Detail drawings showing dimensions of the equipment, layout of the thermal desorption system and subsystems, including location of components and onsite improvements. Drawings showing dimensions, layout, location of barriers, capacities, and placement of the stockpiles. Drawings must be to the approved scale.

d. System schedule including dates and durations for system mobilization, start-up, Field Demonstration, interim operation, production operations, and demobilization prior to beginning site activities.

e. Specific procedures and requirements for onsite placement of the thermal desorption system and its subsystems.

f. Plan identifying instruments requiring calibration and describing the required calibration procedure and tolerances.

g. List of the proposed operating conditions for process parameters to be continuously monitored and recorded. Include detailed descriptions of the Field Demonstration schedule, operating conditions and parameters, material sources, and required sampling and analyses.

h. Include specific detailed procedures for continued operation of the system, based on the Field Demonstration results; and adjustments for variation in the contaminated material feed. Include schedule of inspection and maintenance procedures and activities.

i. Mobilization and demobilization plan detailing specific procedures to be used for decontamination of system components, test methods for verification of decontamination, and the schedule for equipment decontamination and removal from the site. Address the requirements in paragraphs MOBILIZATION and DEMOBILIZATION.

j. Information on function, design capacity, and expected operational capacity for the following equipment in the thermal desorption system: feed preparation equipment, feed/treated materials conveying equipment, thermal treatment equipment (primary chamber, blowers, air pollution control equipment). Equipment specifications identifying manufacturer and model number, materials of construction, interior and exterior dimensions, design limitations, and normal operating conditions. Operating capacity and operating conditions for subsystem equipment;

pumps, valves and other in-line devices; sizes of conveying and/or feeding devices; size and number of parallel components or lines.

k. Detailed manufacturer's data on the overall controls, sequence of control, description of components, wiring diagrams, logic diagrams, control panel layouts, legends and standard symbols, sensors, process controllers, control operators, valves, alarms, interlocks and contaminated material feed cut-off systems. Data describing in detail the equipment used to monitor stack emissions, including the stack sampling probe, filters, gas transport tubing, sampling pump, moisture removal system, analyzer's calibration system, and data recorder. Instructions for use of software packages necessary to evaluate the operating data from the control system.

l. An analysis demonstrating that the noise generated at a distance of[30][_____] meters[100][_____] feet for the following octave band frequencies: 31.5, 63, 125, 250, 500, 1000, 2000, 4000, and 8000 hertz will not exceed the approved noise levels.

m. A determination of the maximum contaminated material feed rate which could be sustained without releasing volatile organic compounds to the air in violation of air quality regulations. This determination should be made using feed rates and contaminant concentrations typical of full scale production.

n. Backup and redundancy analysis containing a failure mode analysis and an emergency manual that indicates responses to be taken under the following circumstances:

(1) Sudden loss of integrity of refractory lining.

(2) Puffing or sudden occurrence of fugitive emissions.

(3) Failure of temperature monitoring control mechanism.

(4) Primary burner and/or air port clogging or failure.

(5) Electrical power failure (primary or secondary).

(6) Scrubber water flow or scrubber water makeup flow out of range.

(7) Excessive solids deposition in the air pollution control system.

(8) Loss of quench water.

(9) Increase in gas temperature after quench zone.

(10) Demister operation failure.

o. Permits, permit equivalents, and certifications in accordance with paragraph REGULATORY REQUIREMENTS. For above-listed items requiring a longer time frame, submit copies of applications and scheduled dates for receiving final approval.

[p. Bench-Scale Treatability Study Test Report: After completion of testing, compile the data from the bench-scale treatability study and prepare a Bench-Scale Treatability Study Test Report that includes but is not limited to, the materials, procedures, and methods used in the study; tests performed; sampling and analysis results; conclusions with supporting dialog; and proposed conditions to be tested in the Field Demonstration. Submit the Bench-Scale Treatability Study Test Report as an attachment to the Remedial Action Work Plan.]

q. Field Demonstration Plan: Outline the planned Field Demonstration and evaluation activities. This plan must address, but not be limited to, contaminated materials characterization, proposed demonstration testing runs (including testing/operating conditions of the unit processes/operations for each run),[sampling locations,][analyses and analytical methods,] mass balance calculation and performance evaluation[for each major piece of equipment], treated materials and waste characterization, health and safety monitoring and control, and waste treatment and/or disposal.

1.4.1.10 Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP)

****

NOTE: This Section may reference a separate Specification Section requiring preparation of a quality assurance project plan or may be excluded entirely if the requirements are part of another Specification Section.

Indicate in this paragraph if the UFP-QAPP should include any testing protocols specific to the contaminated soil matrix and thermal desorption technology (e.g., soil organic matter content, moisture content, etc.).

****

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with the requirements set forth in EPA 505-B-04-900A and using the UFP-QAPP WKSTS. Incorporate sampling and analysis requirements from this Section into the UFP-QAPP. Prepare [draft for Government review] [draft-final for [regulatory] [_____] review] and final versions of the UFP-QAPP. Allow [30] [_____] calendar days for [Government] review [and [30] [_____] calendar days for regulatory review]. Allow [45] [_____] days for comment resolution following each review and preparing the next version of the document. Submit the UFP-QAPP [within [30][_____] calendar days after notice to proceed] [at the same time the Remedial Action Work Plan is submitted] [_____]. Do not perform work at the site, with the exception of site inspection and surveys, until the UFP-QAPP is approved. Tailor the content to the requirements of the project and the site conditions.

[1.4.1.11 Bench-Scale Treatability Study Work Plan

****

NOTE: A bench-scale treatability study may have been performed prior to development of this Specification; however, the Contractor is sometimes required to complete a treatability study prior to performing full-scale work at the site. Treatability study test results should include the proposed operating conditions to be used during full scale treatment. The test results submitted should verify that the proposed operating conditions meet the post-treatment criteria listed in paragraph PERFORMANCE REQUIREMENTS. Consideration should also be given to the need to monitor off-gas and dust

emissions during the treatability study.

Further guidance on conducting treatability studies for thermal desorption treatment can be found in the U.S. EPA's Guide for Conducting Treatability Studies under CERCLA: Thermal Desorption Remedy Selection, EPA/540/R-92/074A, September 1992.

****

Submit a Bench-Scale Treatability Study Work Plan within[60][____] calendar days after notice to proceed. Do not perform the bench-scale treatability study until the work plan is approved. Prepare [draft for Government review] [draft-final for [regulatory][_____] review] and final versions of the Bench-Scale Treatability Study Work Plan. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. Address the technical requirements, listed below and in paragraph BENCH-SCALE TREATABILITY STUDY, in the work plan. The technical requirements include, but are not limited to:

1.4.1.11.1 Conceptual Implementation Plan

Describe the proposed means of meeting the treatment performance requirements in paragraph PERFORMANCE REQUIREMENTS for the contaminated materials, including methods for transporting contaminated and treated materials between various stages of the treatment process.

1.4.1.11.2 Laboratory Procedures

Describe how the parent contaminated material sample will be processed to remove oversize materials, homogenized, and subdivided into aliquots for testing. Identify and justify deviations between the Conceptual Implementation Plan and Laboratory Procedures.

[1.4.1.11.3 Testing Approach

****

NOTE: If a UFP-QAPP is prepared and covers testing during the Treatability Study, this paragraph should be deleted or replaced with a reference to the UFP-QAPP.

****

Describe the testing approach which will be used to assess performance.

]]1.4.2 Performance Requirements

1.4.2.1 Treatment Criteria

****

NOTE: The table in this paragraph should be developed on a site specific basis considering the purpose of thermal desorption in the overall strategy for managing the contaminated material. Ideally, post-treatment testing criteria will be defined in a site-specific decision document. Post-treatment testing depends on the purpose of the thermal desorption treatment. In general, thermal

desorption treatment is performed to reduce chemical concentrations for material that will remain on-site (either in-situ or in a designated permanent storage unit). In rare instances, the thermally treated material is removed for off-site disposal (e.g., where there is no room for on-site placement).

The Toxicity Characteristic Leaching Procedure (TCLP) by EPA Method 1311 is usually the primary test for contaminated materials that are pre-treated via thermal desorption prior to off-site disposal. TCLP test results are used to verify if a contaminated material need not be managed as a hazardous waste. In some instances, such as when a contaminated material is considered a listed hazardous waste, "total" chemical testing data may be needed in addition to or instead of TCLP data.

Two approaches are provided for attaining performance criteria: meeting performance criteria for every sample of treated material (conservative approach) or meeting performance criteria on the average for all samples of treated material. The averaging approach would not be appropriate if thermal desorption treated materials are to be sent off-site for disposal, because averaging of sample results cannot be used for waste characterization to determine if a material is or is not a hazardous waste.

The "chemical properties" in Table 1 would include specific chemicals or totals of a contaminant class (e.g., PCBs) of concern. These are site- and project-specific requirements for the designer to populate in the table.
****

Conduct the work to ensure that treated material is evenly heated[with no clumps of intact contaminated material larger than the size specified in Table 1].[Each sample of treated material must meet the criteria shown in Table 1.][An average of all samples of treated material must meet the performance criteria in Table 1; no individual sample shall can be greater than[_____][110 percent] of the criteria in Table 1 with no more than[_____][20 percent] of the samples exceeding.]

TABLE 1 - TREATMENT CRITERIA		
PROPERTY	TREATMENT CRITERIA	TEST METHOD
Chemical Properties		
[_____]	[_____]	[_____]
Physical Properties		
Maximum Clump Size	[_____] mm [_____] inch	

TABLE 1 - TREATMENT CRITERIA		
[_____]	[_____]	[_____]

1.4.2.2 Emission Criteria

****

NOTE: Current federal regulations are not directly applicable to thermal desorption. The designer should perform an air pathway analysis per EP 200-1-24 and obtain the State or air quality regional requirements. Note that obtaining an actual permit would not be required at a site managed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), but compliance with substantive requirements would be required. Include mass or concentration limits, as appropriate.

****

Do not exceed emissions criteria, as shown in TABLE 2.

TABLE 2 - EXHAUST GAS EMISSIONS CRITERIA

COMPONENT	CRITERIA 1	CRITERIA 2
Organic removal efficiency (minimum percent)	[_____]	[_____]
Total hydrocarbons	[_____]	[_____]
Principal Organics	[_____]	[_____]
Opacity	[_____]	[_____]
Oxygen (minimum)	[_____]	[_____]
Carbon Monoxide	[_____]	[_____]
Carbon Dioxide	[_____]	[_____]
Metals	[_____]	[_____]
Particulates	[_____]	[_____]
Hydrogen chloride	[_____]	[_____]
Hydrogen fluoride	[_____]	[_____]
[Products of Incomplete Combustion (PICs)]	[_____]	[_____]
[_____]	[_____]	[_____]

1.4.2.3 Slagging Control

****

NOTE: The bench-scale treatability study should determine the ash fusion temperature of the feed materials in accordance with ASTM E953/E953M.
****

Minimize slagging by operating at [_____] degrees C [_____] degrees F less than the ash fusion temperature of the feed materials, as determined by ASTM E953/E953M.

1.4.2.4 Noise Control

****
NOTE: Specifications for noise controls should be covered in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. The remaining text in this note discusses noise control considerations to incorporate into Section 01 57 19. Based on the geographical location of the site, and the land uses and environment surrounding the site, the site-specific noise level requirements for the day and night operations and monitoring requirements can be identified from the state and local regulations and/or developed by interacting with the state and local agencies.
****

Provide a thermal desorption treatment system which meets the noise control requirements in [Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS] [_____].

1.4.2.5 Material Handling Fugitive Emissions Dust Controls

****
NOTE: Specifications for fugitive dust controls associated with handling (stockpiling, conveying, etc.) of untreated and treated contaminated materials should be provided in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. The remaining text in this note discusses thermal desorption technology-specific emission and dust control considerations to incorporate into Section 01 57 19. An air pathways analysis should be performed during design in accordance with EP 200-1-24 Air Pathway Analysis for the Design of Hazardous, Toxic and Radioactive Waste (HTRW) Remedial Action Projects. Depending upon the contaminants of concern in the contaminated materials, the unit processes/operations employed in the treatment plant, the amount of pollutants emitted, and the geographical location of the site, the emission standards and limitations for certain contaminants and dust control can be identified from the following regulations including, but not limited to, National Primary and Secondary Ambient Air Quality Standards, National Emission Standards for Hazardous Air Quality Pollutants, and state and local regulations.

Based on the regulatory requirements, the proper technologies or apparatus for the emissions control

if required can be determined. Upon completion of the design of the treatment plant, these emission requirements and control technologies should be defined by the design engineer.

If a performance specification is prepared, the emissions, dust sources, and contaminants of concern should meet specified requirements based on applicable regulations. Section 01 57 19 should list the emissions criteria for the contaminants of concern for each emission and dust source, and if applicable, monitoring requirements should be specified. The applicable federal, state, and local regulations should also be identified. If the specification is prepared based on detailed design, the technologies or apparatus for controlling the emissions and dust sources should also be specified.

****

Provide a thermal desorption treatment system with material handling practices which meet the fugitive dust control requirements in[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____].

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Remedial Action Work Plan; G, [_____]

Pre-Installation Meeting Minutes; G, [_____]

Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP); G,[_____]

Bench-Scale Treatability Study Work Plan; G, [_____]

Pre-Installation Equipment Examination

Pre-Installation Examination Report

Pre-Installation Meeting Agenda

SD-03 Product Data

Startup Plan; G, [_____]

SD-05 Design Data

Adjusted Operating Conditions; G

SD-06 Test Reports

Operations Reports

Water Supply Analysis

Field Demonstration Report; G

Startup Report

SD-07 Certificates

Qualifications; G, [_____]

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

****

NOTE: Include Federal, state, and local regulatory requirements; utility company regulations; and applicable codes and standards published by scientific and engineering institutions where appropriate in the body of this Section. Some of the potentially applicable Federal regulations are listed as follows:

TCLP

Recording and Reporting Occupational Injuries and Illnesses

Occupational Safety and Health Standards

Safety and Health Regulations for Construction

Permitting

National Primary and Secondary Ambient Air Quality Standards

National Emission Standards for Hazardous Air Quality Pollutants

State and Local Air Quality Standards

National Pollution Discharge Elimination System (NPDES) Discharge Limitations and Permit Procedures

Hazardous Waste Identification and Standards Applicable to Generators, Transporters, and Owners and Operators of Treatment, Storage and Disposal Facilities (TSDF)

Land Disposal Restrictions (LDRs)

Department of Transportation Hazardous Materials Program Procedures

Hazardous Materials Transportation Regulations

Standards for Protection Against Radiation

Land Disposal of Low-Level Radioactive Waste

Packaging and Transportation of Radioactive Materials

For sites addressed under CERCLA, administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, delete this section.

****

Obtain the permits, permit equivalents, and certifications; and meet the regulatory requirements necessary for the installation, operation, and closure of the project.[Correspondence from regulatory agencies, and other relevant information, is attached to the specifications to indicate the level of effort necessary to obtain finalized permits, permit equivalents, certifications and to meet substantive regulatory requirements.]

1.6.2 Qualifications

****

NOTE: Requirements for the Contractor's experience should be determined and specified based on the experience, availability, and state of the thermal desorption treatment technology industry and the site-specific requirements. If thermal desorption treatment is being used for unique contaminants, consider specifically identifying contractor thermal desorption experience requirement for those contaminants in the optional bracket at the end of paragraph CONTRACTOR EXPERIENCE.

****

1.6.2.1 Contractor Experience

Submit evidence of successful completion of[at least one thermal desorption project][[_____] thermal desorption projects] of comparable size[and scope][at least[three][_____] thermal desorption pilot scale treatability studies, demonstration studies, or full scale remediation projects that required handling and transportation of materials contaminated with[RCRA hazardous wastes][CERCLA hazardous material][_____]] using the proposed system or a similar system.

1.6.2.2 Key Personnel

Provide key personnel with a minimum of [three][_____] years of thermal desorption field experience. Include system operators, quality control personnel, and supervisory engineering and technical staff involved with the thermal desorption system operation in key personnel. Perform welding in accordance with AWS D1.1/D1.1M by welders certified to have passed qualification tests using procedures covered in AWS B2.1/B2.1M or ASME BPVC SEC IX. Require welders to retake the test when, in the opinion of the Contracting Officer, the work creates reasonable doubt as to the welder's proficiency. Submit a list of these personnel with their qualifications.

1.6.2.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting the requirements of [Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.7 SITE CONDITIONS

****

NOTE: The pertinent site characterization data should be placed in the appendix of the specifications or on the drawings and referenced here. If the contaminated material to be treated contains a significant amount of debris, the available information about its extent and characterization should also be provided. Indicate the detail to which site characterization has been performed and indicate where obvious data gaps

exist. The information should also include construction limits, property utilities, chemical data, geotechnical data, sampling locations, and boring logs. The locations and details (such as utility point of contact, sizes, capacities, and flows) of the utility hookups should also be provided for the Contractor's use.

Indicate if there are multiple dissimilar types of contaminated materials that will require different thermal desorption operations. Materials may be considered dissimilar based on possessing different types or relative concentrations of contaminants. Determination of dissimilar materials may be based on site investigations and/or previously completed treatability studies.

****

1.7.1 Existing Conditions

The existing site conditions are presented [in Appendix [_____]][and][on the Drawings]. These include [physical configuration][topography][land uses][geotechnical characteristics of the contaminated materials (including [grain size analysis][total organic carbon content][pH][moisture content][bulk density][porosity]) [hydrogeology]] and [nature and extent of contamination][_____]. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions could occur. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within [48 hours][_____] if discrepancies between the data provided and actual field conditions are discovered.

[1.7.2 Results of Previously Conducted Treatability Studies

****

NOTE: Delete this paragraph if previous treatability studies have not been conducted.

The unit processes/operations employed in the previous treatability studies (bench and/or pilot scale) may not be the same as those proposed by the Contractor. Documentation of the previous treatability studies should provide prospective Contractors with sufficient information to prepare a detailed proposal and should include the testing materials, procedures and conditions, sampling and analytical methods, evaluation, and results.

****

The previously conducted treatability study documents in Appendix [_____] are for information purposes only. The results indicate that thermal desorption is capable of meeting the post treatment criteria identified in this Section. Nevertheless, perform an independent evaluation of these studies and results. If deemed necessary, perform additional studies [at the Contractor's own expense] to confirm the previously conducted treatability studies and results. Based on the Contractor's interpretation of the previous studies and results [and the Contractor's studies and results], provide a full-scale treatment plant which meets the requirements of this Section.

]PART 2   PRODUCTS

2.1   MATERIAL HANDLING EQUIPMENT

Provide equipment and storage facilities for removing, handling and storing residues resulting from thermal treatment, including treated material and solids captured by the pollution control system.

[2.2   SAMPLES OF CONTAMINATED MATERIAL FOR TREATABILITY STUDIES

****

NOTE: This paragraph should be included if bench-scale treatability studies are to be performed by the Contractor. Action level criteria should be specified for the purpose of collecting representative samples for bench-scale treatability studies. Table 3 should be edited based on site-specific contaminants of concern and their corresponding action levels. Additional testing may be needed to verify that physical properties (e.g. grain size, total organic content, density, porosity, moisture content) of the samples are also representative of site conditions.

To reduce the overall risk to the Government, it is strongly advised that the project team should require the Contractor to collect samples for the bench-scale treatability study unless the nature of the site prevents the Contractor from doing so. Depending on site conditions and project needs (e.g. site security, access issue, etc.), the government may provide samples to the Contractor to conduct bench-scale treatability studies..

****

[The Contracting Officer will provide the required samples to conduct the treatability studies.][Select sampling locations and collect representative samples to conduct the bench-scale treatability studies. Consider the existing site conditions presented in paragraph EXISTING CONDITIONS when selecting sampling locations. Coordinate the sampling protocol with the Contracting Officer before obtaining the samples.] The collected treatability study samples must have contaminant concentration levels [representative of the average concentration of the contaminants identified][and][greater than the action level criteria presented in Table 3]. Otherwise, repeat sampling until the contaminant concentration levels exceed the action level criteria. Test samples of contaminated materials intended to be used in the bench-scale treatability studies in accordance with procedures in the [Bench-Scale Treatability Study Work Plan][and][UFP-QAPP]. Do not commence treatability studies until contaminated material sample results meet the aforementioned concentration criteria.

TABLE 3 - ACTION LEVEL CRITERIA

PARAMETER	ACTION LEVEL CRITERIA
[_____]	[_____]

]2.3 WATER

****

NOTE: Two options are provided. The first option is to only allow the Contractor to use potable water. The second option allows the Contractor to use non-potable water, but includes a testing requirement to limit the chance that the Contractor supplies a water that could introduce contaminants into the treated materials. The first option is simpler, but could lead to higher project costs if the volume of water needed is significant and/or potable water sources are not readily available. When specifying the chemical contaminant criterion to be met for water, the Designer should consider if there are other standards which are more appropriate for the specific project (e.g. state groundwater cleanup criteria).

****

Supply water used to facilitate thermal desorption treatment.[Use only potable water from a regulated public water system.][If non-potable water is to be used, provide water that does not contain oils, acids, salts, alkalis, organic matter, solids or other substances at concentrations that could be detrimental to the successful treatment of the contaminated materials. Also characterize non-potable water prior to its use by collecting a sample from the water source and analyzing according to Table 4. Submit a Water Supply Analysis demonstrating that water meets requirements.

TABLE 4 - TREATMENT WATER CRITERIA

ANALYTICAL METHOD NUMBER (From EPA SW-846)	ANALYSIS TYPE	CRITERION TO BE MET
6010[and 7470A]	Metals[and Mercury]	[Less than Maximum Contaminant Level (MCL)] [_____]
8260	Volatile Organics	
8270	Semi-volatil Organics	
8082	PCBs	
1633	PFAS	
8081	Pesticides	

Within each Analytical Method, only analyze for analytes which have a [MCL] [_____].]

PART 3 EXECUTION

3.1 EXAMINATION

[3.1.1 Bench-Scale Treatability Study

****

NOTE: If a Treatability Study has previously been

performed or is otherwise not needed, delete this paragraph. To reduce the chances of using soil samples that are not representative of site conditions, a minimum volume of 4 liters 1 gallon is recommended for each condition to be tested at the bench scale.

****

Complete a bench-scale treatability study in accordance with the Bench-Scale Treatability Study Work Plan and this paragraph. Perform at least [three][_____] replicate tests simultaneously for each proposed operating condition from the approved Bench-Scale Treatability Study Work Plan. Homogenize and divide the contaminated soil into replicate volumes prior to initiating testing. Do not use less than less than [four][_____] liters [one] gallon of contaminated soil in each replicate. Test samples of treated materials in accordance with the procedures in the [Bench-Scale Treatability Study Work Plan][and][UFP-QAPP].

]3.1.2 Pre-Installation Equipment Examination

Conduct a pre-installation examination of the thermal desorption treatment equipment for damage, defects, and dilapidation. Submit the results of the pre-installation examination to the Contracting Officer for review and information. The Contracting Officer may conduct an independent examination to ascertain the condition and functionality of the equipment. Based on this examination, the Contracting Officer has the right to reject the entire system or damaged, defective, or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection must be borne by the Contractor. Routinely and properly inspect and maintain the equipment to provide the operation of the treatment plant as required by the Contract schedule. Schedule delays and costs due to lack of inspections and maintenance are the responsibility of the Contractor. Provide alternate/auxiliary power source if sufficiently reliable sources are not available.

3.1.3 Infrastructure Conditions

Conduct a pre-installation examination of the on-site infrastructure, utility conduits, monitoring points, and site access constraints. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-operation conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would potentially have significant impacts on operations and public safety. Submit a Pre-Installation Examination Report documenting the examination activity. Obtain all necessary utility clearances before initiation of subsurface work.

3.2 PREPARATION

****

NOTE: Coordinate the drawings to allow the best access possible to the work area. If thermal desorption treatment is part of a larger project which includes specification sections for activities such as Section 31 11 00 CLEARING AND GRUBBING and Section 31 00 00 EARTHWORK, reference to those specification sections instead. Otherwise edit this paragraph as needed.

****

Do not increase the size of the process area without approval of the Contracting Officer. Costs associated with area increases are borne by the Contractor, including costs of construction, demolition, and site restoration.

3.2.1 Mobilization

****

NOTE: Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES includes requirements for decontaminating equipment that has been used in contaminated zones. Modify that Section to extend decontamination/cleaning requirements to equipment being brought on-site to cover the requirements of this paragraph.

****

Follow the approved mobilization and demobilization plans submitted as part of the Remedial Action Work Plan. Do not mobilize the treatment plant to the site until the Remedial Action Work Plan has been approved by the Contracting Officer and the Contractor has received written confirmation. Delays caused by the Contractor's failure to meet regulatory requirements must result in no additional cost to the Government. In accordance with[Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____], the equipment which is rented and/or previously used for other site remediation must be decontaminated and tested for contaminants of concern before being brought to the site.

3.2.2 Clearing and Grubbing

****

NOTE: If Section 31 11 00 CLEARING AND GRUBBING is in the project, select the first bracketed option. If 31 11 00 CLEARING AND GRUBBING is not in the project, select the second bracketed option.

****

[Perform clearing and grubbing in accordance with Section 31 11 00 CLEARING AND GRUBBING.][Clear and grub the process area [as-indicated][as required and directed by the Contracting Officer] of all trees, stumps, downed timber, brush, rubbish, roots larger than 75 mm 3 inches in diameter, and matted roots prior to commencing operations. Saw cut concrete or asphalt pavement at the limits of removal and break, remove and dispose of the resulting debris [off Government Property][at the location indicated]. Remove fencing or other items in the process area and [salvage for reuse][dispose offsite].]

3.2.3 Foundations

****

NOTE: Minimum requirements should be specified in the Remedial Action Work Plan for the foundation/containment area of the treatment plant. An option is provided at the end of the paragraph to require installing a liner and berm in the location where the thermal desorption treatment plant will be constructed; this option addresses

cross-contamination risk if the treatment plant is located on non-contaminated ground.
****

Construct equipment foundations in accordance with the approved Remedial Action Work Plan. Grade the area around the thermal desorption treatment plant so that the water drains away from the work area adjacent to the treatment area.[Construct a liner and berm surrounding the thermal desorption treatment plant. Construct the liner and berm[in accordance with the stockpile liner and berm requirements in Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL.][_____]].

3.2.4 Equipment

Use the area indicated for equipment such as:

a. Auxiliary generator.

b. Dewatering equipment.

c. Pre-treatment equipment such as shredders and screens.

d. Air emission controls and monitoring equipment.

e. Contaminated material conveyance, preparation and loading equipment.

f. Fuel tanks.

3.2.5 Stockpiles

****
NOTE: Sufficient area should be prepared for stockpiling untreated and treated contaminated materials based on consideration of equipment production rates, allowable stockpile sizes, and overall project schedule. Background sampling under the stockpiles of contaminated materials should be performed before their construction, unless previous information is adequate. Coordinate with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL. If Section 02 61 13 is not in the project, copy stockpiling information from paragraphs EXCAVATION WORK PLAN, GEOMEMBRANE, CONTAMINATED MATERIAL STORAGE, and SAMPLING BENEATH STORAGE UNITS into this section.
****

Provide separate storage for treated material and solids captured by the pollution control system handling systems. Prepare areas for stockpiling untreated and treated contaminated materials in accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL. Provide sufficient area to stockpile [_____] [cubic meters][metric tons] [cubic yards][tons] of untreated contaminated material and [six][_____] stockpiles of [500][_____] [cubic meters][metric tons] [cubic yards][tons] of treated contaminated material.

3.2.6 Fuel System

Perform fuel system installation and testing in compliance with the applicable requirements of NFPA 30 and either NFPA 31, NFPA 54 or NFPA 58, as appropriate to the type of fuel.

3.3 INSTALLATION/ERECTION/REMOVAL

****

NOTE: Referenced UFGS should be edited to include only the minimum requirements applicable to a temporary installation.

****

Perform the installation/erection of the thermal desorption system to allow removal of the system from the site and site restoration. Erect and install the system to incur minimal damage to the existing site environment.[Complete mechanical work in accordance with the requirements of Section 23 30 00 HVAC AIR DISTRIBUTION.][Complete electrical work in accordance with[Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION,][Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION,][and][Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM][and [_____]].][Complete plumbing work in accordance with[Section 22 00 00 PLUMBING, GENERAL PURPOSE][, Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING][and [_____]].]

3.4 STARTUP

****

NOTE: To streamline the project schedule, startup requirements in this paragraph could be incorporated into the Field Demonstration activity instead of being a standalone activity. In that case, the subparagraphs for Instrumentation Calibration, Control Interlock Demonstration, and 24-Hour Operation would need to be moved under the Field Demonstration paragraph.

****

Startup includes material handling systems demonstration, instrumentation calibration, [and] control interlock demonstration[, and 24-hour operation]. Demonstrate that the system is capable of processing material at the proposed feed rate and that the air pollution control system is capable of attaining the required throughput rates during startup operations. Perform startup activities using uncontaminated material.

3.4.1 Startup Plan

Submit a startup plan. Describe control system functions and specific procedures proposed to demonstrate each function and for testing the system with uncontaminated materials; formats and procedures for reporting the material handling demonstration and hot check results; proposed operating procedures for the Field Demonstration with detailed descriptions of the sampling and analysis to be performed.

3.4.2 Systems Demonstration

Demonstrate the contaminated material preparation and feed systems and the treated material and solids captured by the pollution control system handling systems. Do not perform the systems demonstration until written approval is received from the Contracting Officer. The systems and the treated material and solids captured by the pollution control system handling systems must operate continuously at the proposed maximum feed rate for 4 hours without a malfunction or shutdown related to the systems. Conduct the systems demonstration using uncontaminated material. Fugitive emissions, or "dusting" is prohibited.

3.4.3 Instrumentation Calibration

Perform instrumentation calibration to ensure that compliance-related instrumentation functions will be performed reliably and accurately. Calibrate test instruments by a recognized standards laboratory 30 days prior to testing with standards traceable to NIST SP 250. Instrumentation and control system calibrations may be witnessed by the Contracting Officer.

3.4.4 Control Interlock Demonstration

Following instrumentation calibration, demonstrate that control system interlocks and alarms are programmed correctly and are fully functional. Test each alarm point for proper response. Demonstrate alarms, interlocks, and emergency responses (activation of combustion gas by-pass system or an emergency system shut down). Operating conditions which trigger system alarms may be artificially induced in the field, or the control set points may be altered to invoke the desired response alarm. Demonstrate appropriate control system responses (including interlocks, alarms, by-pass activation and/or emergency shutdowns) to each of the specified stimuli.

3.4.5 24-Hour Operation

Place the system in operation under conditions proposed in the Field Demonstration Plan for 24 hours or the treatment of one batch (if a batch system). The system must operate without a malfunction or shutdown related to the contaminated material feed or the treated material and solids captured by the pollution control system handling systems and with the continuous emissions monitoring systems functional throughout the 24-hour operation. Begin shakedown after the 24 hour prove-out period; shakedown may be performed on contaminated materials.

3.4.6 Reporting

An interim letter-report will be acceptable with the results formally reported in the startup report.

3.5 FIELD DEMONSTRATION

****

NOTE: The need for a formal Field Demonstration should be discussed with the Contracting Officer and would be a function of the uncertainty of the materials to be treated. For well-defined contaminants and contaminated material compositions that are known to be amenable to low-temperature thermal desorption treatment, data obtained from the bench-scale treatability or full-scale system startup should be adequate to negate the need for a formal Field Demonstration. If the contaminants/contaminated material is not known to be amenable to low-temperature thermal desorption treatment, then a formal Field Demonstration in accordance with the following requirements will need to be performed. If a formal Field Demonstration is not required, sufficient startup testing should be

done to validate performance prior to ramping up to full-scale operation.

The system should not be approved for operation until acceptable removal and other operating parameters are successfully achieved during the Field Demonstration. Production operating conditions should be established from the Field Demonstration results.

Approved production operating conditions should become contract requirements.

If acceptable removal and other operating parameters are not achieved, production operations should not be approved. Results of the Field Demonstration should be analyzed, and the causes of deficiencies evaluated. The Contractor should be required to make physical and operational changes to the thermal desorption system to bring it into compliance with the required operating parameters and removal efficiencies.

If the first attempt at performing a Field Demonstration fails, each subsequent attempt should include a separate Field Demonstration report. Second and third Field Demonstrations, if needed, should be performed at no extra cost to the Government.

Upon completion of a successful Field Demonstration, the thermal desorption system should be approved for production operations contingent on the specified operating conditions established from the successful Field Demonstration test results.

A complete Field Demonstration, regardless of similarities between treatment trains, should be conducted on each treatment train of multiple secondary treatment trains or air pollution control trains that are used with a single thermal desorption unit. Each train should be tested simultaneously to the maximum practical extent. For multiple treatment trains that will be operated under different operating conditions or different contaminated material feed rates, each proposed set of conditions should be demonstrated during the Field Demonstration.

An interim operating period should commence within 7 calendar days after receipt of the Field Demonstration test results and the issuance of interim operating conditions. The interim operating period should continue for the total number of calendar days remaining in the period of time allowed for preparation and submittal of the Field Demonstration report and the number of calendar days allowed for review and approval. Loss of potential interim operating time resulting from delays in

submittal of an acceptable Field Demonstration report should be the responsibility of the Contractor. The interim operating approval should expire at the end of the period described above and operation should cease until a final production operation approval is issued. Operating conditions during the interim operating period should be determined based upon performance data obtained during Field Demonstration operations. At a minimum, these conditions should include:

a. Total mass feed should be based on the feed rate demonstrated to meet treated material quality standards during preproduction operations.

b. Desorber operating conditions should demonstrate the ability to meet treatment standards during preproduction operations.

c. Air pollution control system operating conditions should be demonstrated during the Field Demonstration to ensure compliance with all emissions standards.

d. Sampling and analysis requirements of treated materials should be in accordance with the Sampling and Analysis Plan.
****

Conduct Field Demonstration in accordance with the Field Demonstration Plan that is included in the Remedial Action Work Plan.

3.5.1 Schedule

Provide written notification of the anticipated date of the full Field Demonstration at least seven calendar days prior to the projected start date. Field Demonstration operations may begin upon receipt of written approval of the Field Demonstration Plan and written notification that final shake down activities have been completed and that all systems are ready to conduct a full Field Demonstration.

3.5.2 Source of Material

****
NOTE: Prior to implementing the field demonstration, chemical testing should generally be performed to verify that the materials to be used for the test run contain the contaminants of concern at high enough concentrations to adequately test the system. Additional testing may be warranted to verify that the physical properties of the materials are also representative of site conditions.
****

Obtain contaminated material used for the field demonstration from [the location specified by the Contracting Officer][_____]. Prior to performing the field demonstration, test each dissimilar type of contaminated material to be used for the field demonstration. Consider the existing site conditions presented in paragraph EXISTING CONDITIONS when selecting sampling locations. The contaminated material samples must have contaminant concentration levels [representative of the average concentration of the contaminants identified][and][greater][than the action level criteria presented in Table 5]. Otherwise, repeat sampling until the contaminant concentration levels exceed the action level criteria. Test samples of contaminated materials intended to be used in the field demonstration in accordance with procedures in the [Field Demonstration Plan][and][UFP-QAPP].

TABLE 5 - ACTION LEVEL CRITERIA

PARAMETER	ACTION LEVEL CRITERIA
[_____]	[_____]

3.5.3 Operating Conditions

Operate all systems at the conditions specified in the Field Demonstration Plan for the duration of the Field Demonstration.

3.5.4 Field Demonstration Report

Include results of the Field Demonstration, including sample analysis data, calculations, and conclusions within [seven][14][_____] days of the completion of a Field Demonstration in the Field Demonstration report. After completion of the field demonstration, [do not process additional contaminated material until test results from the field demonstration verify that the treated material meets the criteria listed in paragraph PERFORMANCE REQUIREMENTS. Allow [14][_____] calendar days in the schedule for Government review and approval of the field demonstration report.][contaminated material may continue to be processed in an interim operations period.] At a minimum, collect sufficient data during each Field Demonstration to make the following determinations:

3.5.4.1 Quantitative Analysis of the Materials

A quantitative analysis of each contaminated feed, treated material, and pollution control system stream for each individual run for each parameter stated in the Field Demonstration Plan. Once the field demonstration has generated the required quantity of treated material, perform the tests identified in paragraph CONTAMINATED MATERIAL TREATMENT TESTING on representative samples of the treated material. If the treated materials produced during the field demonstration do not meet the criteria in the paragraph PERFORMANCE REQUIREMENTS, process an equal quantity of the same type of material using properly modified operating conditions until satisfactory results are obtained. Return the treated materials that failed the demonstration testing to the contaminated materials stockpile for re-processing during full-scale treatment.

3.5.4.2 Quantitative Analysis of the Stack Gases

A quantitative analysis of the stack exhaust gases for the concentration and mass emissions of constituents listed in paragraph EMISSION CRITERIA[and [_____]]. Continuously measure and record the stack gas velocity and the concentration of constituents listed in paragraph EMISSION CRITERIA[and [_____] in the stack exhaust gases].

3.5.4.3 Material and Energy Balances

****

NOTE: If the contaminated material characterization data showed negligible chloride content, delete the hydrochloric acid (HCl) requirement.

****

Compute the mass emission rate of particulates in accordance with 40 CFR 264, Subpart O. If the hydrochloric acid (HCl) emission rate exceeds 1.8 kg 4 pounds of HCl per hour, compute the HCl removal efficiency in accordance with 40 CFR 264, Subpart O.

3.5.4.4 Fugitive Emissions

Identification of sources of fugitive emissions and means of control of the emissions.

3.5.4.5 Continuous Measurement and Recording

Continuous measurement and recording of operating parameters as required in the approved Field Demonstration Plan.

3.5.4.6 Other Requirements

Other monitoring, sampling, and analyses required by the approved Field Demonstration Plan. Submit an Operating Plan based on the Field Demonstration results.

3.6 OPERATION

3.6.1 Dissimilar Materials and Pre-Treatment Material Handling

****

NOTE: Delete the bracketed text item if dissimilar materials are not known to be present at time of preparing project specifications.

****

Do not mix together dissimilar materials that either prior testing or field quality control observations during operations have indicated need different thermal desorption operational parameters.[Materials known to be dissimilar at the site are defined in [paragraph EXISTING CONDITIONS][_____]]. Ensure maximum moisture content of the materials to be treated does not exceed [20][_____] percent by weight.

3.6.2 Oversize Material

****

NOTE: An optional requirement is included if oversize material must be decontaminated before it is transported off-site for disposal.

****

Reduce the size of oversize contaminated material to less than [2.5 cm one inch][the maximum allowable particle size of the thermal desorption process as defined in the Remedial Action Work Plan][_____]. Treat oversize contaminated material which can be reduced to an allowable size for the thermal desorption process. Remove oversize material that cannot be reduced to an allowable size for the thermal desorption process.[Decontaminate oversize materials in accordance with the procedure developed in the Remedial Action Work Plan.] Dispose oversize material off-site in accordance with[Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIAL][_____].

3.6.3 Treated Materials

3.6.3.1 Temporary Storage of Treated Materials

****

NOTE: Thermal desorption is a separation process. Combining the air pollution control residuals with the treated materials may make the treated material fail performance requirements. Regulations generally allow combining prior to testing. The second option in the paragraph below applies only to thermal desorption treatment when the treated material is placed into permanent on-site storage. To prevent double handling it is preferable to place treated material directly into the permanent storage area rather than stockpiling until post-treatment testing is completed.

****

Do not mix dissimilar contaminated materials, treated materials and solids captured by the pollution control system.[Separate treated material into units (stockpiles) for post-treatment testing. Unit size greater than the quantity pertaining to the most frequent quality control test is prohibited. If the test results indicate the treated materials of a stockpile meet the post treatment criteria presented in paragraph PERFORMANCE REQUIREMENTS, this stockpile of treated materials [may][must][_____] be combined with other stockpiled material which has also met the post treatment criteria.][Place treated material directly into the permanent storage unit after treatment. Place treated material such that the material from specific batches/runs can be defined and removed if it fails post-treatment testing.]

3.6.3.2 Final Disposal of Treated Materials

****

NOTE: If treated materials are intended to be used as on-site surficial backfill, additional requirements for properly conditioning the soils should be developed in the appropriate specification section. Without additional post-treatment conditioning, soils that have been treated by thermal desorption will generally lack adequate organic carbon content to support vegetation growth.

****

Dispose treated materials which meet the treatment performance requirements in paragraph PERFORMANCE REQUIREMENTS[off-site in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS][in the designated permanent storage unit. Place treated materials in accordance with Section 31 00 00 EARTHWORK].

3.6.4 Change of Operating Conditions

****

NOTE: If adjustment to the thermal desorption operating parameters is required due to change in contaminated material characteristics, then the Contractor's proposed adjustments should be evaluated by the Contracting Officer for the extent of changes from the previous operating parameters. Further, price negotiation may be required based on the extent of changes from the previous operating parameters.

****

The following two requirements must be met in order to be considered for change of operating conditions:

a. The physical and chemical characteristics of the contaminated materials are significantly different from the originally defined characteristics.

b. The treatment requirements cannot be met under the current thermal desorption treatment plant design and related mix design/operating conditions.

When change of operating condition is necessary, notify the Contracting Officer before changes are made to the operating conditions. The Contracting Officer may require the Contractor to perform a field demonstration for significant changes made to the operating conditions in accordance with paragraph FIELD DEMONSTRATION, for approval. If adjustment to operating conditions is required due to change in contaminated material characteristics, submit an adjusted operating conditions for the extent of changes from the previous operating conditions for approval. Further, price negotiation may be required based on the extent of changes from the previous operating conditions.

3.7 FIELD QUALITY CONTROL

3.7.1 Tests

****

NOTE: Sampling requirements are project specific. Sampling frequency requirements and composite sampling techniques are negotiated with the regulatory agency.

Typically, treated materials from each day are stockpiled separately. Therefore, testing is normally done on a daily basis with varying composite sampling requirements.

****

Sample and analyze contaminated material feed, treated material, and solids captured by the air pollution control system as allowed by the permits and as specified. The post treatment testing specified in this paragraph is needed by the Government to generate documentation that the thermal desorption treatment has been accomplished in accordance with performance requirments approved by applicable authorities. The results of these tests may be used as part of the Contractor's QC program; however it is the Contractor responsibility to meet the performance requirements specified.

Therefore, it is expected that the Contractor will perform additional testing and measurements to ensure that treated materials meet requirements without rejection of batches, retesting, or reprocessing.

3.7.1.1 Stack Emissions Monitoring and Sampling

Provide continuous monitoring with calibration/verification sampling as shown in TABLE 6. Record process parameters at intervals not exceeding one minute. Calibrate sensors with standards traceable to NIST and in conformance with NIST SP 250.

TABLE 6 - STACK EMISSIONS MONITORING AND SAMPLING SCHEDULE

PARAMETER	OPERATING PERIOD	FREQUENCY
Oxygen	[Field Demonstration]	[continuous][_____]
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]
Carbon Monoxide	[Field Demonstration]	[continuous][_____]
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]
Carbon Dioxide	[Field Demonstration]	[continuous][_____]
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]
Total Hydrocarbon (HC)	[Field Demonstration]	[continuous][_____]
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]
Principal Organic	[Field Demonstration]	[in accordance with Field Demonstration
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]
[Products of Incomplete Combustion (PICs)]	[Field Demonstration]	[in accordance with Field Demonstration
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]
Opacity	[Field Demonstration]	[Weekly][Daily][_____]
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]

TABLE 6 - STACK EMISSIONS MONITORING AND SAMPLING SCHEDULE		
Particulates	[Field Demonstration]	[in accordance with Field Demonstration
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]
Hydrogen Chloride	[Field Demonstration]	[in accordance with Field Demonstration
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]
Hydrogen Fluoride	[Field Demonstration]	[in accordance with Field Demonstration
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]
Metals	[Field Demonstration]	[in accordance with Field Demonstration
	[Interim Operations]	[_____][not required]
	[Operations]	[_____][not required]

3.7.1.2 Contaminated Material Treatment Testing

****

NOTE: The values shown in Table 7 for frequency of testing are only examples and need to be determined on a site specific basis. Coordinate the properties in this table with the properties in paragraph PERFORMANCE REQUIREMENTS. It may be acceptable to change the number of samples during development of a UFP-QAPP, but the Designer should attempt to establish a reasonable sampling frequency in the specifications to provide a basis for the Contractor to bid the project.

****

Collect confirmation samples for post treatment testing in accordance with the [UFP-QAPP][basewide QAPP] and this paragraph. Analyze samples for the parameters listed in paragraph PERFORMANCE REQUIREMENTS. Collect samples for testing at a minimum frequency [provided in Table 7][_____]. Complete all other sampling and analysis activities in accordance with the [UFP-QAPP][basewide QAPP][_____] (including but not limited to sample handling, preservation, transportation, [collection][analysis] of quality control samples, data validation, and data reporting). Any deviations to sampling frequency, number of samples, or sample collection methods must be [established in the approved [UFP-QAPP][basewide QAPP]][approved by the Contracting Officer].

TABLE 7 - MATERIAL SAMPLING FREQUENCY REQUIREMENTS			
PROPERTY	MATERIAL SAMPLING FREQUENCY [cubic meter][(metric ton)][(cubic yard)][ton]		
	CONTAMINATED MATERIAL	TREATED MATERIAL	SOLIDS CAPTURED BY THE POLLUTION CONTROL SYSTEM
[_____]	One per [100][_____]	One per [100][_____]	One per [100][_____]

3.7.1.3 Retesting and Reprocessing

****

NOTE: An option is provided for retesting treated contaminated materials which fail to meet performance requirements. Retesting without first reprocessing treated contaminated materials should generally be prohibited unless there is reason to believe the original test result was inaccurate due to mislabeling/mishandling of the sample or analytical error discovered during validation of laboratory results (simply believing that a sample did not reflect the treatment is not sufficient to consider a result inaccurate).

If thermal desorption treated material is being sent off-site for disposal, do not permit retesting unless there is reason to believe the original test result was inaccurate as described in the paragraph above. This is because waste characterization and disposal is based on grab sampling results, and averaging of sampling results cannot be used to determine that a waste meets regulatory disposal requirements.

****

Reprocess and then retest units of treated contaminated materials that do not meet the post-treatment criteria in paragraph PERFORMANCE REQUIREMENTS[or quality assurance testing].[The Contractor may propose to retest failing units of treated contaminated soils prior to reprocessing. If the Contracting Officer approves retesting, collect and test two additional samples for the failed parameter(s). If both samples pass, re-processing the unit will not be required. If either sample fails, reprocess the unit.]

3.7.1.4 Government Quality Assurance Testing

****

NOTE: Consider the need for quality assurance testing on a project-by-project basis. If QA testing is unnecessary, delete this paragraph. Factors to consider include whether the Government has access to a laboratory that can analyze quality assurance samples in a timely manner to not delay the project execution. Use of quality assurance testing data use also needs to be considered. A relatively straightforward data use is to compare quality assurance sample results to the project Performance Requirements, and failing result would

be treated the same way as a failing Contractor test result. A more complicated data use is to compare results from quality assurance samples and contractor quality control samples for the purpose of determining if there is meaningful disagreement between the results. In this case, procedures would need to be developed for determining when there is a meaningful disagreement between quality assurance and quality control sample results; corrective actions for when a meaningful disagreement was identified would also need to be developed. The process of defining procedures for identifying and correcting meaningful differences should be documented in a project-specific Quality Assurance Project Plan and referenced in this specification; the process is likely to complex to be adequately defined in this specification.

****

Provide duplicate samples to the Government's quality assurance laboratory for Government quality assurance. Submit samples at a frequency of one set of samples per [10][_____] sets of quality control tests performed. Quality assurance samples will be tested for the same parameters as the parent quality control sample. Provide additional quality assurance samples upon request.

3.7.2 Inspections

3.7.2.1 Visual Inspections

Inspect the thermal desorber and associated equipment (pumps, valves, conveyors, pipes, etc.) for leaks, spills, fugitive emissions, and signs of tampering or mechanical failure as indicated in TABLE 8. Inspect feed materials for changes in composition and presence of particles larger than [gravel][____] size. Visually inspect treated materials to confirm that maximum clump size is being met as defined in paragraph PERFORMANCE REQUIREMENTS.

TABLE 8 - VISUAL INSPECTION SCHEDULE

PHASE OF OPERATION	MINIMUM INSPECTION FREQUENCY
Field Demonstration	[Once per 8-hour shift][Daily]
Interim operations	[Once per 8-hour shift][Daily]
Operations	[Daily][Weekly]

3.7.2.2 Interlocks, Automatic Cut-Offs and Alarms

Test interlocks, automatic contaminated material feed cut-off and associated alarms [weekly][_____].

3.8 OPERATIONS REPORTS

Submit operations reports [daily][weekly] for the first [10][_____] weeks, and at a frequency of [_____] thereafter. The operations reports must consist of a log of operating conditions including, but not limited to:

a. Hours of operation.

b. Staffing.

c. Weather conditions.

d. Process materials tracking schedule.

e. Sample shipment (including chain of custody documents).

f. Receipt of analytical results.

g. Changes in operating parameters.

h. Results of the testing and calibration activities.

i. Inspection and maintenance activities.

Attach the physical and chemical test results generated onsite or received from offsite laboratories to the report. Include the following information with test results: time of sampling, location of sampling, and Contractor Quality Control (such as duplicate sample analysis, field and trip blank analysis, laboratory QC analysis) results. Perform data validation of the test results [in accordance with the project UFP-QAPP][before submittal].

3.9 DEMOBILIZATION

****

NOTE: If there is a separate Specification Section which provides overall requirements for demobilization/site cleanup, such as 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS, move the requirements from this paragraph into that Section.

****

Follow the approved mobilization and demobilization plans submitted as part of the Remedial Action Work Plan. Demobilize to restore the site to its initial state, prior to the construction and operation of the thermal desorption treatment facilities. Do not commence demobilization until written approval is received from the Contracting Officer. Demobilization must include, but must not be limited to: [disconnecting of utility service lines,][decontamination and removal of equipment and materials,][disposal of decontamination wastes,][disposal of any residual wastewater,][removal of unused amendments and other materials,] [removal of material overlying liners,][removal of liners,][regrading and removal of berms,][demolition and disposal of the treatment pad, other foundation slabs, and paved surfaces,][_____].[Perform post-treatment testing of soils below stockpile storage units and work area surfaces in accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL.]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-02 53 16.16 (February 2025)**

Preparing Activity: USACE **New Section**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-02 53 16.16 (February 2025)**

Preparing Activity: USACE **New Section**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 53 16.16

IN-SITU THERMAL REMEDIATION

02/25

****

NOTE: This guide specification covers the requirements for in-situ thermal remediation (ISTR) of materials contaminated by hazardous or toxic organic wastes and/or by petroleum, oil, or lubricants (POL). The ISTR can be achieved by electrical resistance heating, thermal conduction heating, or steam enhanced extraction. Site-specific criteria for temperature, mass removal, target treatment zone (TTZ), and treatment of extracted fluids would be determined and presented in this specification.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: This paragraph should be deleted if the work is in one single job price or there is a separate Measurement and Payment Section.

Any requirements for bid items need to be consistent with any bid sheet or list of contract line items. Payment for operations can be done as a single job price, especially for performance-based contracts, but if specifications are used, the work is usually bid on a unit-cost basis.

****

1.1.1 Preparation of Planning Documents, Permits[, and Community Relations Support] (Single Job Price)

The preparation of all required planning documents and obtaining permits [and providing community relations support] will be a single job price.

1.1.2 Site Preparation (Single Job Price)

The necessary actions to prepare the site for installation of the heating and treatment infrastructure, for installation of fencing, and for utility coordination will be a single job price.

1.1.3 Monitoring Point Installation and Baseline Sampling (Single Job Price)

The installation of new monitoring points, abandonment of existing monitoring points, and sampling of soil, soil vapor, and groundwater prior to heating will be a single job price.[Include costs for any additional characterization in this bid item.]

1.1.4 Installation (Single Job Price, Plus Unit Cost per Area or Volume)

****

NOTE: The language of this section allows payment for installation of subsurface and above-ground treatment infrastructure based on the identified TTZ as a single job amount. If treatment of additional volumes is necessary based on assessment of observed baseline concentrations or observations during installation of monitoring points or heater wells, contract options can be included to provide flexibility in expanding the TTZ without need for contract modification.

****

Installation of all components will be a single job price.[Bid options for installation of components to remediate additional treatment [area][volume] units on a [per square meter] [per square foot] [per cubic meter] [per cubic yard][_____] basis according to the bid sheet.]

1.1.5 Operations (Heating and Utilities)

****

NOTE: The language of this section allows payment for operations based on the actual effort required to meet the overall objectives. The operations bid costs may ideally be broken out into unit costs for operations per time and energy and power costs. Alternatively, the operations can be bid for an assumed amount of time at full target temperature and for the identified TTZ as a single job price though this shifts risks to the contractor. If a

single job price-approach is taken, and if additional treatment time or treatment of additional volumes is necessary based on assessment of observed concentrations or mass removal rates, contract options can be included to provide flexibility to continue operations for additional periods without need for contract modification. If the Government procures power or natural gas via separate contract directly with the utility provider, it can avoid contractor markup on those costs.

****

Bid prices for operations will be provided separately for operations and utility costs. Operations, other than utility costs,[for heating to target temperature] will be bid on a single job price[with contract options for additional operations time as per the bid sheet].

1.1.5.1 Operations During Heating to Target Temperature

Bid prices for operations necessary to bring the target treatment zone (TTZ) to target temperature will be bid on a single job price.

1.1.5.2 Operations at Target Temperature

Bid prices for operations will be per [week][day] spent at full temperatures.

1.1.5.3 Utilities Costs

****

NOTE: The contractor normally coordinates with local utility purveyors and pays for utility costs. There is often an administrative cost or mark-up associated with the contractor managing payment for the utilities. Some cost savings may be possible if the Government directly pays for the utilities. On active Department of Defense (DoD) installations, the Government may be better positioned to directly provide the utilities.

****

Include all utility costs, including but not limited to usage, distribution, and other fees associated with power, water, sewer, fuel, and other consumable materials to operate all equipment related to the in-situ thermal remediation (ISTR) system in the bid[except for the cost of [_____] to be provided by the Government].[Energy costs will be bid on a megawatt-hours of power delivered to the subsurface.][British thermal units (BTUs) delivered to the subsurface.] Non-energy utility costs will be bid as a single job price.

1.1.6 Site Restoration (Single Job Price, Plus Unit Cost per Well, Electrode, and Area)

Site restoration will be bid as a single job price. Additional [area][volume] requiring restoration will be bid on a [per square meter][per square foot][per cubic meter][per cubic yard][_____] basis.

1.1.7 Treatability Study

****

NOTE: Treatability studies are generally not required for ISTR for typical contaminants, but may be necessary where complex mixes of contaminants or emerging contaminants with less history of treatment are present, or where design parameters would be refined by such a study.

****

Bid treatability study as a single job price. Include costs for collecting necessary samples of site media and any characterization necessary to identify the media for the treatability study.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D5092	(2016) Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 86	(2023) Standard for Ovens and Furnaces

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

1.3 DEFINITIONS

1.3.1 Target Treatment Zone (TTZ)

The TTZ encompasses the full three-dimensional limits of the subsurface requiring heating to meet the performance criteria. The heated volume will include subsurface media beyond the TTZ to allow for necessary contaminant mass removal and containment and to prevent redistribution of contamination due to condensation or migration.

1.3.2 Critical Infrastructure

Utilities, roadways, and structures whose function must be maintained during ISTR treatment are considered critical infrastructure.

1.3.3 Temperature Strings

Temperature strings are series of temperature sensors (e.g., thermocouples) arranged in a linear fashion in boreholes in and around the TTZ to assess the temperature response to energy input to the subsurface.

[1.4 ADMINISTRATIVE REQUIREMENTS

****

NOTE: These paragraphs should be omitted if the requirements are identified in other specifications, such as 01 30 00 Administrative Requirements.

****

1.4.1 Pre-Installation Meetings

A pre-installation meeting [and site walk-through] will be held to identify key logistical, safety, and community concerns. Prepare minutes of this meeting and submit these for review as part of the Pre-Installation Examination Report[and include them in the Remedial Action Work Plan].

1.4.2 Sequencing and Scheduling

If the treatment is to be conducted in discrete phases, the phasing of treatment, referred to herein as "stages" must occur in a manner that does not allow recontamination of a treated area or from upgradient. Similarly, the operation of each stage of treatment must not impact newly treated areas by maintaining hydraulic and pneumatic control.

]1.5   SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Remedial Action Work Plan; G, [_____]

Uniform Federal Policy Quality Assurance Project Plan; G, [_____]

Treatability Study Work Plan; G, [_____]

Permits

Pre-Installation Examination Report

Pre-Commissioning Checklist; G, [_____]

SD-02 Shop Drawings

****
NOTE: Drawings may be submitted as part of the RAWP.
****

SD-03 Product Data

****
NOTE: Product data may be required and submitted as part of the RAWP.
****

SD-05 Design Data

Treatability Study Testing Results And Recommendations; G, [_____]

SD-06 Test Reports

Piping Coupon Testing

Baseline Sampling And Monitoring Point Installation Report

Commissioning Report

Daily Contractor Quality Control Reports; G, [_____]

Weekly And Monthly Reports

SD-07 Certificates

Qualifications; G, [_____]

SD-11 Closeout Submittals

Remedial Action Report; G, [_____]

Post Heating Sampling Results

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

****
NOTE: Additional references from Federal, state, and local regulatory requirements; utility company regulations; and applicable codes and standards published by scientific and engineering institutions should be included where appropriate in the body of the specification. Some of the potentially applicable Federal regulations are listed as follows:

Recording and Reporting Occupational Injuries and Illnesses

Occupational Safety and Health Standards

Safety and Health Regulations for Construction

Permitting

National Primary and Secondary Ambient Air Quality Standards

National Emission Standards for Hazardous Air Quality Pollutants

State and Local Air Quality Standards

National Pollution Discharge Elimination System (NPDES) Discharge Limitations and Permit Procedures

Hazardous Waste Identification and Standards Applicable to Generators, Transporters, and Owners and Operators of Treatment, Storage and Disposal Facilities (TSDF)

Land Disposal Restrictions (LDRs)

Department of Transportation Hazardous Materials Program Procedures

Hazardous Materials Transportation Regulations

Standards for Protection Against Radiation

Land Disposal of Low-Level Radioactive Waste

Packaging and Transportation of Radioactive Materials

For sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. The permits or permit equivalents may include those addressing air discharges, treated water discharge, well installation and abandonment, underground injection, and possibly others. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, delete this section.

****

Coordinate and obtain all[permits][, permit equivalents][, and meet the substantive regulatory requirements] necessary for the installation, operation and closure of the project prior to the initiation of the relevant activities. Submit documentation of the completed permitting or permit equivalent to the Contracting Officer [as part of the Remedial Action Work Plan (RAWP)]. Comply with all Federal, state, and local regulations. For any of the above-listed items requiring a longer time frame, copies of applications, and scheduled dates for receiving final approval, must be included.

1.6.2 Qualifications

****

NOTE: Requirements for the Contractor's experience should be determined and specified based on the

experience, availability, and state of the ISTR industry and the site-specific requirements. If not provided in other portions of the contract documents, the requirements can be provided below.

****

1.6.2.1 Contractor Experience

Submit evidence of successful completion of[at least [1][_____] ISTR project of comparable size and scope][at least [3][_____] ISTR pilot scale treatability studies, demonstration studies, and/or full scale remediation projects that required treatment of materials contaminated with[RCRA hazardous wastes][CERCLA hazardous material][_____]] using the proposed system or a similar system.

1.6.2.2 Key Personnel

Provide key personnel with a minimum of [3][_____] years of ISTR field experience, including project engineer, lead operator, site safety and health officer, quality control officer, project chemist and other lead technical staff involved with the ISTR system operation. Submit a list of these personnel with their qualifications.

1.6.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting thein accordance with[Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.7 DELIVERY, STORAGE, AND HANDLING

Safely store, transport, and handle the equipment, materials, and any contaminated materials. Follow United States Department of Transportation (USDOT) requirements for packaging and shipping of these items. Store and handle these items onsite in accordance with the manufacturer's recommendations and in compliance with applicable regulatory requirements.

1.8 PROJECT/SITE CONDITIONS

****

NOTE: This section would provide necessary background information on conditions at the site that are relevant to the ISTR system construction and would affect the performance of the ISTR. Alternatively, reference can be made to other Government-furnished information. Important considerations would include site contaminants (location, depth, and concentrations); the TTZ; areas for material and equipment laydown and treatment and control system construction; soil types and groundwater flow conditions; surface topography; subsurface utilities, including potential for leaking water and sewer lines, potential subsurface obstructions or buried waste; and available utility connections.

****

The existing site conditions as currently understood are presented [in Appendix [_____]][and][on the drawings][and][in the specifications]. These include [physical configuration,][utilities,][topography,][land uses,][site access,][project limits,][geotechnical characteristics of the contaminated materials (including[grain size analysis,][total organic content,][moisture content,][density,] and[porosity])][hydrogeology,][treatability study results,][nature and extent of contamination,][mass estimate and approximate breakdown by constituent type within the TTZ,] and [_____]. The contaminants of concern are given in [Table 1][_____]. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions may be anticipated. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within[48 hours][_____] if discrepancies between the data provided and actual field conditions or apparent data gaps are discovered.

1.9 WARRANTY

****

NOTE: Vendors may offer warranties for attaining the cleanup goals. If the ISTR services are obtained under a performance-based contract, the full contract payment is based on the attainment of the goals, and therefore, a warranty does not provide additional value beyond the existing contract terms. A performance bond may be required.

****

Provide all warranties for the performance of the work[in the RAWP].

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Vendors normally provide their own equipment for the duration of the treatment and retain the equipment at the completion of the project. The requirements for the heating and treatment equipment can be specified here, but a performance-based approach will generally obviate the need for the specification of the products and materials.

To maximize the pool of potential bidders, recommend leaving the ISTR technology unspecified and focusing on the performance requirements. The bidders will identify what they believe to be the most cost-effective approach that may include one or more ISTR technologies. It is important to provide the necessary site information that will allow the bidders to assess the technology applicability, including contaminant type, concentration, and mass; groundwater depth and flow velocities; surface constraints, etc.

****

Provide and install an ISTR system that will introduce the energy into the subsurface necessary to attain all treatment requirements and to collect and appropriately manage all recovered vapors and liquids to meet all discharge and disposal requirements.

2.1.1 Design Requirements

Design the ISTR system in accordance with all applicable building codes and licensing requirements with the following design requirements.

2.1.1.1 Remedial Action Work Plan

Prepare a Remedial Action Work Plan (RAWP) and submit for approval within [60][_____] calendar days of receiving the notice to proceed. If the work is to be conducted in stages, each stage of ISTR will require a work plan addendum detailing any changes to the approach outlined in the RAWP and stage-specific treatment details omitted from the RAWP. Address all items in the RAWP and associated addenda as discussed in this specification and other relevant specifications.

Address the following topics in the RAWP:

a. Contractor’s basis of design for its selected equipment and approach including targeted design temperature, heating element layout/spacing, materials of construction, and design approach/basis for vapor/liquid treatment equipment.[If the treatment of the TTZ is to be conducted in discrete phases, referred to herein as "stages," describe how the stages will be treated in a manner that does not allow recontamination of a treated area. In addition, explain how lessons learned from initial stages will be incorporated into operations for later stages.]

b. Modeled estimates of energy needs for optimal temperature increase and duration necessary to reduce subsurface mass and concentration to performance requirements and/or provide results from other field efforts substantiating the operational assumptions.

c. Equipment sizing, staging locations, and installed layout.

d. Well-field layout (number, spacing, depths of heating wells and elements, monitoring wells, extraction wells, all other wells, and temperature sensor strings).

e. Process piping and instrumentation diagrams.

f. Electrical one-line diagrams.

g. Vapor/liquid collection and treatment system layout plans.

h. Component process flow diagrams.

i. Estimated amount of energy, water, fuel, and other consumable materials (e.g., granular activated carbon) to operate the ISTR system and vapor/liquid treatment system during the duration of the treatment period.

j. Connections for electrical, water, sewer, natural gas, communications, and the layout of these utility connections.

k. System Commissioning Plan, including a pre-commissioning checklist.

l. Other information as required to describe the design, construction, installation, and operations approach of the system to implement the remediation in accordance with the Contract Documents.

m. Contingency planning for operations in the event of various failure scenarios (i.e., develop a risk register with likely mitigation actions for the important risks).

n. Proposed decision logic for heating shutdown and logic/approach for confirmation sampling.

o. Security and fencing plans.

p. Traffic control plan.

q. Stormwater protection plan.

r. Waste management plan.

s. Contingent actions if downgradient groundwater concentration limits are exceeded.

t. Comprehensive schedule for mobilization, installation, operation, and close-out activities.

u. Surface cover materials, thickness, seaming details, and R-values (thermal resistance per unit area).

[Prepare [draft for Government review][, draft-final for [regulatory] [_____] review][, and] final versions of the RAWP. Allow [30][_____] calendar days for [Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.]
[
A review meeting to discuss and resolve Government comments and concerns on the draft RAWP will be held prior to the submittal of a final draft version of that plan.]

2.1.1.2 Uniform Federal Policy Quality Assurance Project Plan

****

NOTE: This section may reference a separate specification section requiring preparation of a quality assurance project plan or may be excluded entirely if the requirements are part of another specification section.

****

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with EPA 505-B-04-900A and UFP-QAPP WKSTS. Tailor the content to the requirements of the project and the site conditions and media of interest and address the collection of chemical and physical data necessary to make operational and shut-down decisions. Include the standard procedures for sampling hot media in the UFP-QAPP.[Prepare [draft for Government review] [draft-final for [regulatory] [_____] review] and final versions of the UFP-QAPP. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.]

2.1.2 Performance Requirements

****

NOTE: As ISTR projects are typically done under a performance-based contracting approach, the performance standards provided in this section are critical to the project success. Multiple performance standards are recommended to assure the desired outcome, but not all of the requirements listed below need to be included.

****

Meet the following performance requirements. These are either primary or secondary requirements, where primary requirements are to be met upon shutdown of the ISTR treatment and secondary requirements are those that to be met during operation of the ISTR system.

2.1.2.1 Target Treatment Zone

****

NOTE: The appropriate delineation of the TTZ is the most critical performance requirement. If ISTR projects fail to meet other performance requirements, it is often due to an incomplete understanding of the actual extent of this zone. The zone is three-dimensional, and lateral and vertical dimensions are given. There is an opportunity to revise the zone based on observations during installation of ISTR subsurface system components, and the specification allows for adjustment of the TTZ. Depending on the contract approach, this can be accomplished through performance-based contract requirements or through the exercise of options for additional treatment volumes. If the top of the contaminated zone is below the water table, the TTZ needs to extend some distance above the water table to assure capture of contaminant vapors before they condense.

****

The TTZ is shown[on the drawings][Figure [_____] of the [_____] report]. Meet performance requirements throughout the entire TTZ as specified below. The basis for the TTZ is the [_____][ug/kg][mg/kg][ug/L][mg/L][soil concentration][groundwater concentration][soil vapor] contour [based on the maximum concentration observed at any depth][and the contact with the [_____] geologic unit]. During construction of the subsurface components of the remedy, inform the Contracting Officer of any unexpected contamination above the concentrations used as a basis for the TTZ but that exists outside the defined TTZ.

2.1.2.2 Soil Concentration Goals

Attain the target soil concentrations described in Table 1 below[on average][at each sampling interval][at [_____] percent of sampling points] [_____][with no point exceeding [_____] times the performance goal] within the TTZ based on the approved post-treatment verification sampling program described in the appropriate UFP QAPP. If measured soil concentration[s] exceed[s] the values shown in the table below, resume treatment as described in paragraph BASIS FOR SYSTEM RESTART.

2.1.2.3 Groundwater Concentrations Goals

****

NOTE: The operation of the ISTR system may induce groundwater flow into the TTZ. If significantly contaminated groundwater exists outside the TTZ, this may affect the ability to attain a groundwater performance goal. Periodic sampling of groundwater during heating can be used to track progress toward goals.

****

Attain the target groundwater concentrations described in Table 1[on average][at each prescribed sampling point][at [_____] percent of the sampling points][with no sampling point exceeding [_____] times the groundwater performance requirements] [_____] based on the approved post-treatment verification sampling program described in the UFP QAPP. If measured groundwater concentration[s] exceed[s] the values shown in Table 1, resume treatment as described in paragraph BASIS FOR SYSTEM RESTART. Containment or treatment actions are required if exceedances of downgradient groundwater concentration limits are observed.

TABLE 1 - PERFORMANCE REQUIREMENTS

Contamina	Soil concentratio ^{1} [ug/kg] [mg/kg]	Groundwater concentratio ^{1} [ug/L] [mg/L]	Treated air discharge limit ^{2} [ug/L] [ug/m ^{3}] [ppmv] [ppbv] [lb/day] [kg/day]	Downgradie groundwate concen-tra limit ^{1,2} [ug/L] [mg/L]	Soil Vapor Concentra ^{1,2} [ug/L] [ug/m ^{3}]	Treated water discharge limit ^{2} [ug/L] [mg/L]
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

[1] Primary requirement; [2] Secondary requirement

2.1.2.4 Temperature

****

NOTE: Time of heating and minimum temperature requirements should only be specified as a minimum and the other criteria should be the primary lines of evidence for true attainment of treatment goals. Although azeotropic boiling may occur at temperatures below100 degrees C 212 degrees F, progress is fastest and remediation more likely to be complete if temperatures of 100 degrees C 212 degrees F (or higher temperatures at depth below the water table) are targeted.

****

Achieve a temperature of[[100][_____] degrees C [212][_____] degrees F][equal to boiling accounting for hydrostatic pressure] at [95][_____] percent of the temperature monitoring points with no point in the TTZ below

[90][_____] degrees C [194][_____] degrees F. Continue full heating for a minimum of [_____] weeks following the attainment of a minimum temperature of [_____] degrees C degrees F at all temperature monitoring points and an average temperature of [_____] degrees C degrees F across the TTZ prior to proposing cessation of heating.

2.1.2.5 Mass Removal

Continue treatment until mass removal rates have[reached asymptotic conditions as defined in the RAWP][fallen below levels observed at start-up][fallen below [_____] percent of the peak weekly average mass removal][fallen below [_____] kg/day lbs/day for [_____] days [_____] based on measurements of the recovery of [all contaminants][contaminants listed in Table 1] in vapors, non-aqueous phase liquid (NAPL), and dissolved form][and no extraction point is continuing to recover mass at a considerable rate]. Compute mass removal rates for this purpose when all the intended heating and recovery wells are operating.

2.1.2.6 Vapor Control

Capture and manage all contaminants volatilized and mobilized by the thermal treatment via a vapor recovery system and convey them to a treatment system.[Facilitate capture through the installation of a surface cover as specified in paragraph SURFACE COVER.] Do not allow surface breakthrough of steam and contaminant vapors to occur.[Maintain an inward pneumatic gradient to the TTZ.][Monitor vapor concentrations in sampling points outside and above the TTZ to demonstrate vapor control as required by the UFP-QAPP and RAWP.] Prevent lateral migration of contaminant vapors outside the TTZ described in paragraph VAPOR RECOVERY of this specification and contaminant vapor migration into occupied buildings [at concentrations above [EPA Regional Screening Levels][_____]].

2.1.2.7 Off-gas Treatment Concentration Limits

Treat recovered vapors[to the standards specified in Table 1][to the level specified in the applicable permit equivalent] prior to discharge.

2.1.2.8 Liquid Treatment Concentration Limits

****

NOTE: The goal for treatment of water will depend on the discharge location (e.g., publicly owned treatment works [POTW], surface water, reinjection). If the disposal of the treated water is left to the Contractor to propose in the RAWP, direct the Contractor to determine and achieve the applicable treatment requirements based on applicable statutes, regulations, and rules for the selected discharge location, in accordance with paragraph PERMITS. Modify Table 1 to reflect the need for the Contractor to determine the appropriate treatment goals. Discharge to a local POTW offers advantages, and information on the local POTW and any pre-treatment requirements should be made available to the bidders.

****

Treat condensed and recovered liquids[to standards specified in Table 1][to the level specified in the applicable permit equivalent for the selected discharge location] prior to discharge. Discharge treated water[to the sanitary sewer][to the storm sewer][to the surface water body][to injection wells][to [_____]][as indicated on the drawings].

2.1.2.9 Noise Limits and Operational Hours

****

NOTE: Noise limitations may also be addressed in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. If specified there, this paragraph can be omitted.

****

Provide noise mitigation measures to reduce sound levels at[the site boundary][nearby homes and businesses][_____] to [[_____] decibels (dB)][levels that comply with local noise ordinances]. Normal hours of operation during ISTR construction installation, and close-out activities must be between [7:00 am][_____] and [7:00 pm][_____] for all noise generating activities, [Monday through Friday][_____], excluding federal holidays. Do not conduct construction work outside these working hours without first obtaining written approval from the Government. These working hours may be further modified based on local ordinances, as applicable. ISTR operations will be on a 24-hour per day basis, from heating commencement through completion.

2.1.2.10 Permits

Obtain all necessary permits, including but not limited to air discharge permits, well drilling and abandonment permits, electrical permits, construction permits, water discharge permits, and underground injection permits, as required by Federal, state, and local agencies and in accordance with paragraph REGULATORY REQUIREMENTS.

2.1.3 Backup Power Supply

Provide a back-up power source capable of operating the ISTR vapor and liquid extraction and treatment equipment as well as monitoring and controls to maintain pneumatic and hydraulic control if the primary power source is lost. The backup power source will be capable of maintaining pneumatic and hydraulic control without refueling for at least [24][_____] hours[and will engage automatically upon loss of primary power (e.g., automatic transfer switch)]. Configure the back-up power supply to maintain continuity of control system function and to cause the operator to be notified of a loss of line power. Use EPA Tier 4 Final certified generators for on-site back-up and non-emergency purposes.

2.2 EQUIPMENT

2.2.1 Government-Furnished Equipment

****

NOTE: If there is no Government-furnished equipment, Table 2 should be omitted and other tables renumbered as necessary.

****

There [is][is not any] Government-furnished equipment available for this project.[The available equipment is described in Table 2.]

TABLE 2 - GOVERNMENT-FURNISHED EQUIPMENT		
Item	Location	Notes
Dedicated sampling pumps	Monitoring wells	[_____]
Transformer	[_____]	[_____]
[_____]	[_____]	[_____]

2.2.2 Contractor Equipment

Provide all equipment necessary to perform the work[except for the Government-furnished equipment noted in paragraph GOVERNMENT-FURNISHED EQUIPMENT]. Prepare the site for equipment installation prior to delivery and off-loading of equipment and system components. Decontaminate all equipment prior to entering or leaving the site. Include and describe in detail any additional equipment not specified below in the RAWP. Design, install, construct, operate, control, and monitor all equipment as one complete, compatible unit. Assure all components utilized at the site are constructed of materials that are thermally and chemically compatible with the contaminants and temperatures of the vapors and liquids recovered. Select all equipment to be properly rated for the environment and location where it will be operating, to include the potential for being in contact with hazardous, flammable, or explosive materials or explosive vapors, as well as extreme weather. Provide and install all equipment in conformance to pertinent local and national codes.

2.3 COMPONENTS

****

NOTE: As ISTR projects are typically done under a performance-based contracting approach, the individual above-ground equipment provided for extraction and treatment of site contaminants are not normally specified, but additional requirements for specific equipment can be added.
Delete requirements for secondary containment if these are addressed in Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS. If Section 33 56 19 FUEL IMPERMEABLE LINER SYSTEM is used, the Designer should review that section to remove specific requirements that may be excessive for a temporary secondary containment.

****

Provide and install an above-ground treatment system with appropriate heat exchangers and condensation capabilities; air-liquid separators, with adequate liquid storage and transfer capabilities to allow continuous operations; vacuum blowers suitable to capture all generated vapors; liquid treatment equipment appropriate for the liquid production rates and site contaminants and other extracted compounds that may be recovered in liquid form; and vapor treatment equipment appropriate for the non-condensable vapor extraction rates and vapor-phase contaminants. Provide secondary containment of all liquid storage and treatment equipment[in accordance with specification Section 33 56 19 FUEL IMPERMEABLE LINER SYSTEM.][with either double-walled containers or impermeable surfaces suitable to contain a spill or release of liquid.

Impermeable means having a maximum permeability for any hazardous substance that is being contained of 1x10-7 centimeters per second 3x10-9 feet per second at the maximum anticipated hydrostatic pressure.]

2.3.1 Instrumentation

Provide instrumentation and controls, including but not limited to indicators, sensors, transmitters, recorders, alarms, and auto-dialers, necessary to monitor and operate the equipment and heating infrastructure continuously,[remotely,] and safely. Provide such equipment that detect, monitor, record, and control key operating parameters such as liquid levels, equipment and air temperatures, gas and liquid flow rates, pressures, subsurface temperatures and pressures, etc. Select temperature, pressure, and flow sensors suitable for and tolerant of the expected range of conditions to be encountered.

Provide a system control panel that contains, at a minimum, all local control devices, circuit breakers, power control transformers, system disconnect switches, and alarm components, as necessary to operate the system effectively and safely. Provide the control system with all functions required for complete automatic and manual operation of the system, including but not limited to the following:

a. System shutdown and alarm on high-high liquid level conditions in moisture separator, other liquid handling equipment, and discharge locations,

b. Manual start and stop for blowers,

c. System shutdown if the secondary containment around critical process vessels indicates a spill,

d. System shutdown and alarm on low and no flow in system,

e. Automatic call-out and notification in the event of an alarm,

[

f. Automatic shutdown or opening of dilution valve if lower-explosive limit sensors indicate the influent concentrations to a thermal oxidizer will cause its operation outside of National Fire Protection Association guidelines, including those in NFPA 86.]

g. Automatic shutdown if an emergency stop is engaged.

The control system must also be furnished with a means to allow for remote, real-time access to monitoring data and data retrieval. Provide catalog information on the supervisory control and data acquisition (SCADA) system to be used during start-up and operations. Include this information in the RAWP.

2.3.2 Spare and Redundant Critical Components

Provide redundant or spare critical system components, including sensors [primary blowers,][transfer pumps,][and][_____]. Identify the redundant and spare components in the RAWP.

2.4 MATERIALS

2.4.1 Well and Piping Materials

Propose well and piping materials in the RAWP and select materials for well and piping construction that are compatible with site contaminants and other compounds that may be extracted in vapor or liquid form and can withstand the temperatures and pressures or vacuum levels encountered during operation without failure or excessive pressure drop. Provide insulation or other means of protection on piping that will conduct hot fluids that could be contacted by site personnel or trespassers.[Provide features, such as heat tracing, to winterize all parts of the system that will be exposed to cold weather.] Polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) piping is prohibited for vapor transport under pressurized, above-ground service.

2.4.2 Electrical Supply and Equipment

****

NOTE: The designer should modify this section to provide site-specific details about electrical connection and coordination requirements. The designer should determine the following details about the electrical supply: 1) nearest suitable power, 2) infrastructure for the purveyor to bring power to the site, 3) the available voltages at the primary electrical feed, 4) requirements for secondary metering, 5) seasonal or daily restrictions on power availability and pricing policies, 6) necessary lead time for power drop to the site, 7) approximate costs for bringing service to the site.

****

[Necessary electrical service at the site will be provided by the Government.][Provide electrical service to the site of adequate capacity to support all planned remediation operations.] Coordinate with the local power utility company as necessary[and provide all engineering support to evaluate the adequacy of existing service lines]. All material, equipment, and incidentals in hazardous locations must meet local and state codes, and NFPA 70 National Electrical Code (NEC). Bury all primary service lines connecting the power drop to any transformer. Provide proper electrical grounding for all equipment. All cables and conductors must be rated for electrical loading specified in the RAWP and constructed with materials compatible with its designated environment.

2.4.3 Natural Gas Supply

Provide natural gas service in accordance with Section 33 11 23 NATURAL AND LIQUID PETROLEUM PIPING.

2.4.4 Surface Cover

****

NOTE: A surface cover is usually necessary to prevent the release of steam and contaminant vapors at the surface, inhibit infiltration of cold moisture, and to allow higher temperatures at shallow depths to facilitate vapor recovery and

prevent condensation of vapor-phase contaminants near the surface. Higher R values may be necessary for treatment of high-boiling-point compounds close to the surface. If the target ISTR treatment zone does not extend vertically to near the surface (e.g., is more than 3 meters 10 feet below the surface), a surface cover may not be necessary.
****

Install an insulating and vapor-controlling surface cover capable of achieving a minimum R value of [20][_____]. If thick concrete surface slabs are in place, the R value may be proportionally adjusted. Integrate a [seamed geomembrane][or equivalent] vapor barrier into the cover.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

2.5.1 Piping Coupon Testing

****
NOTE: Coupon testing would be warranted if there are concerns about potentially corrosive treatment streams generated during treatment. The coupon testing can be conducted during a pilot test or initial stage of treatment where multiple stages of treatment are necessary due to TTZ size or power limitations. Conducting such testing during design and providing results as part of Government-furnished information would reduce risk to the bidder and result in bids with lower risk premiums.
****

Conduct coupon testing for corrosion for proposed piping, well construction, and treatment equipment to demonstrate compatibility with site conditions and contaminants. Propose coupon testing procedures in the RAWP. Submit results of the coupon testing.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Site Conditions

Conduct a pre-installation examination of the on-site infrastructure, utility conduits, monitoring points, site access constraints, and infrastructure. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-treatment conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would potentially have significant impacts on treatment and public safety. Examine location, condition, and construction of monitoring points in the treatment zone and surrounding area to assess the need to protect, abandon, or replace any monitoring point. Submit a Pre-Installation Examination Report documenting the examination activity. Obtain all necessary utility clearances before initiation of subsurface work.

3.1.2 Contractor-Supplied Equipment

The Government may examine equipment provided by the Contractor for the project to identify any that is dilapidated, damaged, unsafe, or defective. Based on this examination, the Contracting Officer has the right to reject the entire system or any damaged, defective, unsafe, or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection will be borne by the Contractor. Properly and routinely inspect and maintain equipment to provide the operation of the system as required by the contract schedule. Any schedule delay and cost associated with improper functioning of equipment and controls, unavailability of labor and materials, etc., is the responsibility of the Contractor.

3.1.3 Treatability Study and Pre-Design Characterization

****

NOTE: The need for a treatability study may depend on the site contaminants and ISTR method to be used. Treatability studies are not normally needed for common contaminants such as trichloroethylene or benzene and would be more appropriate for complex mixtures of unusual contaminants. Treatability study testing to assess steam volumes needed to achieve cleanup goals, changes in NAPL density and viscosity with temperature, or treatment options may be specified.

If there are data gaps, additional characterization may be required. Optional text in this paragraph addresses the requirements for the additional investigations to refine the TTZ or assess groundwater flux.

****

Conduct treatability testing to determine the[response of site NAPL viscosity and density to temperature increases][design and operational parameters for treatment of influent streams][necessary steam pore-volume flushes][_____]. Propose treatability testing procedures, including sampling of site media, test instrumentation, chemical analysis, and data analysis[in the RAWP][in a Treatability Study Work Plan]. Submit the Treatability Study Testing Results and Recommendations.

[

Perform initial field-scale pilot test to verify design assumptions and treatment performance. Propose objectives, location, duration, methodology, monitoring, and data analysis for the pilot test in the Treatability Study Work Plan.]

[

Conduct additional characterization activities as necessary to address data gaps regarding[the definition of the TTZ][and][groundwater flux through the TTZ]. Include [groundwater,][soil,][and][soil vapor] sampling[and permeability testing] in the characterization effort. Provide the rationale, number, location, and methodology for the proposed characterization in the RAWP. Present the results in the Baseline Sampling and Monitoring Point Installation Report.]

3.2 SITE PREPARATION

3.2.1 Protection

3.2.1.1 Stormwater Management

Provide stormwater collection and conveyance systems to prevent interference of stormwater with the ISTR system.[Stormwater collection piping exists on the property including within the ISTR treatment area[as shown on the drawings][as indicated in the design report].] Identify the locations of stormwater infrastructure and impact of existing infrastructure on ISTR operations. Design the ISTR system and surface cover to account for possible infiltration of site surface water. The impact that the footprint of the thermal cover has on stormwater runoff must be considered within the construction and stormwater permits detailed in[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____]. If required, describe upgrades to stormwater drainage features in the RAWP.

3.2.1.2 Environmental and Infrastructure Protection

Protect site vegetation, wetlands and critical habitat, site features, and infrastructure in accordance with the approved Environmental Protection Plan prepared in accordance with[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____]. Restore damaged areas and site infrastructure to at least its original condition upon completion of the project. Areas within the footprint of the TTZ, under conveyance systems and wiring, along site access roads, and within the area of the above-ground control and treatment systems are considered separate from these requirements and restoration of these areas is addressed in paragraph CLOSE-OUT ACTIVITIES.

3.2.2 Clearing and Grubbing

Conduct clearing, grubbing, and filling and grading necessary to prepare the site for placement of the surface cover, site access, and equipment in accordance with Section 31 11 00 CLEARING AND GRUBBING. Provide necessary filling, grading, compaction, and placement of aggregate necessary to provide stable conditions for site access and placement of equipment. Avoid disturbance to contaminated soils.

3.2.3 Infrastructure Removal, Rerouting, and Protection

****

NOTE: Critical infrastructure (e.g., communications lines, water supplies, sewer service) that cross or lie adjacent to the TTZ may need to be maintained and protected from the effects of heating or will need to be rerouted around the TTZ (e.g., non-watertight storm sewers). Other utilities may be heat-tolerant (e.g., ductile iron piping or pre-cast concrete sewer lines). If unneeded or if relocated, the abandoned utilities in the TTZ may need to be sealed to prevent undesirable contaminant migration or infiltration of cold water into the TTZ. Provide clear information and direction to the contractor on what utilities exist in the area of the TTZ in Government-furnished information or drawings.

****

Protect or relocate critical infrastructure indicated on the drawings.

Other utilities and infrastructure within the TTZ may be left in place, abandoned, or removed. Properly decommission monitoring wells that would be damaged during ISTR treatment in accordance with all applicable State and local requirements. Assure all materials used in the monitoring well decommissioning are compatible with temperatures and pressures to be generated during treatment so the locations will not allow releases of contaminants to the atmosphere or detrimentally affect treatment. Describe all procedures for protection, relocation, and decommissioning in the RAWP.

3.2.4 Monitoring Well Replacement

****

NOTE: The presence of monitoring or extraction wells within or near the TTZ that are not constructed with materials compatible with the elevated temperatures during treatment (e.g., PVC) or that may interfere with heating (e.g., metal wells near electrodes) need to be abandoned, and where necessary replaced with appropriately constructed wells. Section 33 51 39 MONITORING WELLS can be used to describe the installation requirements for the monitoring wells, but modifications to that specification would be necessary to address the conditions during ISTR. If Section 33 51 39 is used, delete all but the first sentence of this paragraph and replace with a reference to Section 33 51 39.

****

Replace or abandon monitoring wells identified on the drawings and in Table 3 with materials compatible with the conditions to be created during treatment. Follow State and local requirements, including regarding licensing of any driller, and ASTM D5092, with necessary and allowable modifications for the ISTR application. Develop the new wells until turbidity levels are less than [10][_____] nephelometric turbidity units (NTUs)[or as approved by the Government]. Install pressure- and temperature-rated wellhead fittings on monitoring wells within or near the TTZ. Include a sample port, and ball valve to allow pressure relief prior to opening. Describe well construction, installation methods, development, and abandonment techniques in the RAWP. Submit documentation of well construction and materials encountered in accordance with ASTM D5092 and ASTM D2488.

TABLE 3 - MONITORING WELLS

Well Name	Construction Details (Depth, diameter, screened interval, casing and screen material, grout type)	Abandon	Replace
[_____]	[_____]	[_____]	[_____]

3.2.5 Pre-Heating Sampling

****

NOTE: If groundwater remediation is required, sampling of new and existing groundwater monitoring wells in and near the TTZ prior to treatment should be conducted to establish a baseline condition. Pre-treatment soil or soil vapor sampling may be conducted if groundwater treatment is not required and remediation of the unsaturated soil is desired, or if unsaturated soil and groundwater are both to be remediated.

****

Sample the monitoring wells listed in Table 4 within [____] days prior to initiating heating.[Collect soil samples during the installation of new monitoring wells and temperature monitoring strings.] Collect, transport, and analyze samples in accordance with the requirements of the UFP-QAPP. Submit pre-heating sampling results in a Baseline Sampling and Monitoring Point Installation Report.

TABLE 4 - MONITORING WELL SAMPLING			
Well to be Sampled	New/Existing	Analyses to be Performed	Depth/Screened Interval
[_____]	[_____]	[_____]	[_____]

3.3 SYSTEM INSTALLATION

3.3.1 Equipment

Stage equipment in a location that minimizes impact to nearby residences and offset the staging area from the property boundary by at least [23][_____] meters [75][_____] feet. Assure all outdoor installations are weather-proof and all installations in hazardous locations meet NEC, NFPA, UL, National Electrical Manufacturers Associated (NEMA), and the US Occupational Safety and Health Administration (OSHA) requirements.[Winterize the ISTR system to allow operation during subfreezing conditions. Winterization may include, but is not limited to, insulation and heat tracing around piping and liquid vessels, insertion heaters, and recirculation within liquid storage vessels.]

3.3.2 Subsurface Instrumentation

Decontaminate drilling equipment prior to use at the site. Provide a copy of the drillers' licenses as part of the RAWP along with other personnel qualifications. Provide logs at representative locations as proposed in the RAWP with descriptions of materials encountered during drilling for information in accordance with ASTM D2488, including evidence of contamination potentially above treatment goals outside the TTZ.[Include details about the installation, location, and construction of temperature and pressure monitoring points in the Baseline Sampling and Monitoring Point Installation Report.]

3.3.2.1 Heating Infrastructure

Install [electrodes][heater wells][steam injection wells] at locations and to depths necessary to achieve treatment requirements and prevent contaminant migration from the TTZ in accordance with the RAWP.

3.3.2.2 Temperature Monitoring

Install temperature monitoring strings at locations indicated in the RAWP in boreholes dedicated for this purpose. Provide temperature sensors at a vertical interval of[1.5 meters 5 feet][3 meters 10 feet] [_____] meters [_____] feet within and including 3 meters 10 feet above and below the TTZ and with a density of one temperature string per[[380][_____] square meters [4,000][_____] square feet][[3,800][_____] cubic meters [5,000][_____] cubic yards]. Install a minimum of [75][_____] percent of temperature strings at the centroid between heating locations. Install additional temperature strings [3][_____]meters [10][_____] feet laterally outside the TTZ with a spacing of [15][_____] meters [50][_____] feet around the perimeter of the TTZ[and within [3][_____] meters [10][_____] feet of sensitive receptors].

3.3.2.3 Vapor and Pressure Monitoring

Install vapor monitoring points at locations indicated in the RAWP to allow vapor sampling and temperature and pressure monitoring. Provide vapor monitoring points within the vadose zone within and above the TTZ at a rate of at least one vapor monitoring point per [460][_____] square meters [5,000][_____] square feet and surrounding the TTZ at a rate of at least one every [60][_____] meters [200][_____] feet where no buildings are adjacent to the TTZ and every [30][_____] meters [100][_____] feet where buildings are adjacent to the TTZ. Install vapor monitoring ports every [3][_____] meters [10][_____] feet vertically above the TTZ and at likely steam migration depths outside the TTZ.

3.3.2.4 Subsidence Monitoring

****

NOTE: Where soils with high organic content (e.g., peat) exist within the TTZ, subsidence may occur during treatment. Monitoring of ground subsidence and settlement of engineered structures over or near the TTZ should be monitored.

****

Conduct a baseline elevation survey using a surveyor licensed in the state and monthly subsidence monitoring of surveyed elevation points over the TTZ and near footings or other load-bearing engineered structures. Survey in accordance with Section 33 51 39 MONITORING WELLS. Conduct a pre-heating structural survey of building over and near the TTZ. Report the results of the baseline surveys and the pre-heating structural survey in the RAWP and the results of monthly settlement measurements in the [weekly][monthly][_____] reports.

3.3.2.5 Vapor Recovery

Install vapor recovery wells [and surface plenum] as described in the RAWP. Vapor recovery wells may be integrated with heating wells. Install an adequate number and distribution of vapor recovery wells to recover volatilized contaminant mass and to prevent lateral contaminant vapor migration outside of the TTZ or uncontrolled contaminant vapor discharge to the atmosphere. Capture, manage, and transport volatilized and mobilized contaminants through a vapor recovery system to a treatment system.

3.3.3 Utilities

Arrange for the design, permitting, furnishing, and installation of all utilities required supporting the ISTR operations, including the electrical service drop and natural gas and process water supply. Provide a description of all utility work to be conducted and a drawing of the proposed utility layout as part of the RAWP. Install all wiring, conduits, and interconnections necessary for a fully operable system.

3.3.4 Surface Cover

****

NOTE: Unless the top of the TTZ is deep and there are no potential surface receptors, a surface cover is typically required to prevent vapor/steam emissions at the surface, prevent infiltration, and to insulate the ground surface to prevent condensation of contaminant vapors near the surface.

****

Install the surface cover over the [entire][portions of the] TTZ as described in the RAWP. Where the TTZ extends to within 3 meters 10 feet of the existing ground surface, extend the surface cover a minimum of [3][_____] meters [10][_____] feet beyond the lateral limits of the TTZ.

3.3.5 Piping and Cables

Construct all piping and other lines in such a manner (sloped) to prevent any media from condensing or collecting where it would not be recovered or otherwise interfere with effective operations. Install and maintain all piping/connections in a neat manner and properly support all piping in accordance with local and national codes. Lay out electrical supply lines and cables between power distribution equipment and the well field and treatment system using conduit, ramps, and cable bundling to minimize slip, trip, and fall hazards and exposure to vehicle traffic. All cables and conductor must be rated for electrical loading specified in the RAWP and constructed with materials compatible with its designated environment.

3.4 SITE SECURITY

Provide site security during ISTR installation and operation to protect site equipment and public safety[, including on-site security personnel,][security patrols,][and][cameras and motion detectors]. Provide[temporary]fencing with warning signs and gate access that is lockable. Provide adequate area lighting to support security monitoring and inspection of facilities[and assure that lighting is not directed at nearby residences]. During operation, integrate controls to shutdown the system if unauthorized site intrusion occurs. Provide security and fencing plans as part of the RAWP.

3.5 FIELD QUALITY CONTROL

3.5.1 Tests

Identify all field quality control tests in the [RAWP][Contractor Quality

Control Plan required in accordance with Section 01 45 00 QUALITY CONTROL]. Report the results of these tests in the Daily Contractor Quality Control Reports.

3.5.2 Inspection

Allow on-site audits and inspections by the Government during the remedial construction and operation.

3.6 COMMISSIONING AND STARTUP

Submit a Commissioning Plan as part of the RAWP. Notify the Contracting Officer at least 14 calendar days before starting commissioning. If multiple phases of thermal treatment are proposed, a separate commissioning plan is not required for each stage of treatment, but submit significant changes to the Commissioning Plan as an addendum.

3.6.1 Start-up Testing

Designate team members to participate in the pre-commissioning checks and the functional performance testing. Prepare pre-commissioning checklists that detail the critical system interlocks including type of alarm (shutdown or warning), instrument involved, and equipment affected by the alarms. The Government will be represented by the Contracting Officer[, the Design Agent's Representative, and a representative of the Using Agency]. Include the following team members:

Contractor's Chief Quality Control Representative
Contractor's Mechanical Representative
Contractor's Electrical Representative
Contractor's Testing, Adjusting, and Balancing Representative
Contractor's Controls Representative

Prepare commissioning checklists to be included with the Commissioning Plan. The commissioning team will complete each checklist. Indicate acceptance by each commissioning team member of each pre-commissioning checklist item by initials and date. Acceptance by each commissioning team member for each functional performance test checklist must be indicated by signature and date.

3.6.2 Commissioning Testing

Provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. Abort the pre-commissioning check or functional performance test if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test.

3.6.2.1 Pre-Commissioning Tests

Perform pre-commissioning checks for the items indicated on the checklists. Correct deficiencies discovered during these checks and re-test in accordance with the applicable contract requirements. Complete and submit the Pre-Commissioning Checklist for Government approval.

3.6.2.2 Functional Performance Tests

Conduct functional performance tests for the items indicated on the checklists. Begin functional performance tests only after all pre-commissioning checks have been successfully completed. Tests must prove all modes of the sequences of operation and must verify all other relevant contract requirements. Begin tests with equipment or components and progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, correct all deficiencies in accordance with the applicable contract requirements. The checklist must then be repeated until it has been completed with no errors. Submit a Commissioning Report.

3.7 APPLICATION

Commence operations following successful commissioning in accordance with the RAWP.

3.7.1 Safety and Environmental Controls

Take corrective measures to cease any unexpected release of steam and contaminant vapors at the surface or in nearby potentially occupied spaces.[Prevent stray voltages above 15 Volts within the TTZ and within [_____] meters [_____] feet of the TTZ.] Prevent contact with hot piping and equipment by workers, visitors, and trespassers.

3.7.2 Monitoring and Data Collection

****

NOTE: Most ISTR contractors have automated data collection systems that record temperature data from thermistors and flow rates on essentially a continuous basis. Concentration data for vapors are typically collected using photoionization detectors or similar equipment on a daily (or more frequent) basis, supplemented by confirmatory fixed-laboratory analyses. Treated vapor and liquid effluent concentrations are measured on a frequency that are sensitive to the rate of contaminant loading, regulatory expectations, and the robustness of the treatment system.

****

Monitor the following parameters in accordance with Table 5. Describe the sampling locations and frequencies for parameters not listed in Table 5 in the RAWP. Include summaries of recorded parameters and interpretations of these data in weekly reports. Submit monthly reports that roll up the interpretation of these data and propose any changes necessary to operations.

3.7.2.1 Temperature Monitoring

The Government may require replacement of a temperature sensor if it fails and is critical for evaluating the attainment of performance goals.

3.7.2.2 Mass Removal Monitoring

Monitor mass removal rates in all media including vapor and condensed liquids based on the inflow to the treatment systems. Monitor, as needed for optimization of subsurface treatment, mass removal from specific wells or system legs.

3.7.2.3 Air Monitoring

Prepare and implement under the supervision of the Safety and Health Manager an exposure monitoring and air sampling program to identify and quantify safety and occupational health hazards and airborne levels of hazardous substances to assure proper selection of engineering controls, work practices and personal protective equipment for affected site personnel[and nearby residences, business, and other occupied structures or activities]. Describe the program in the [Site Safety and Health Plan][RAWP] in accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.

3.7.2.4 Power Input

Monitor total power input to the TTZ and to all individual energy delivery points daily.

3.7.2.5 Piezometric Monitoring

Monitor piezometric levels to assess groundwater flow through or below the TTZ.

3.7.2.6 Groundwater Monitoring

Collect groundwater samples from locations and with a frequency as specified in Table 5. Propose well-head design and hot groundwater sampling methods in the UFP-QAPP and conduct the sampling in accordance with all safety requirements described in the Site Safety and Health Plan.

TABLE 5 - OPERATIONAL MONITORING

Parameter	Frequency	Locations	Required Analysis Turn-Around Time (days)	Notes
Subsurface Temperature	[continuous] [daily] [______]			
Subsurface vapor concentrations	[weekly] [______]			
Subsurface pressures or vacuum	[weekly] [______]			
Piezometric levels	[monthly] [______]			
Groundwater contaminant concentrations	[monthly] [______]			

TABLE 5 - OPERATIONAL MONITORING				
Parameter	Frequency	Locations	Required Analysis Turn-Around Time (days)	Notes
Air monitoring results	[per permit equivalent] [_____]			
Power input (total and by individual point)	[weekly] [_____]			
Extracted vapor contaminant concentrations	[daily] [_____]			
Condensate contaminant concentrations	[weekly] [monthly] [_____]			
NAPL recovery	[weekly] [_____]			
Total extracted vapor flow rate	[daily] [hourly] [_____]			
Recovered liquid flow rates	[daily] [_____]			
Liquid treatment effluent contaminant concentrations permit parameters	[per permit equivalent] [_____]			
Vapor treatment effluent contaminant concentrations permit parameters	[per permit equivalent] [_____]			

3.7.3 Availability of Monitoring Data

Make all parameter data available to the Government via a secure project web page or similar means. Include tabulated data identified in Table 5, and provide temperature[, subsurface vacuum/pressure data][, power input,][and][_____] available in graphical form in both map and cross-sectional view to facilitate Government assessment of project progress. Include the same data in weekly and monthly reports.

3.7.4 Adjustments to Operations

Make adjustments to vapor [and liquid] recovery system, energy input, or groundwater controls to address areas that are not making necessary progress toward meeting treatment goals as expected or where unacceptable contaminant migration may be occurring. Propose cessation of heating to limited portions of the site that are believed to have met treatment goals for Government approval in weekly and monthly report.

3.7.5 Notification of Critical Alarms and Shutdowns

Notify the government within [24][_____] hours of critical alarms and unplanned shutdowns that last longer than 2 hours. Outline these alarm conditions in the RAWP.

3.7.6 Weekly and Monthly Reports

Submit an electronic version of the process monitoring result reports to the Government on a weekly basis during the ISTR start-up, testing, operation and maintenance phases of the project to document monitoring of the treatment process. The electronic data must be submitted in a spreadsheet (e.g., Microsoft Excel). The process monitoring data to be included are specified in paragraph MONITORING AND DATA COLLECTION, and include the following parameters, tabulated, when possible, with a short associated text description:

a. Power and energy input during period.

b. Temperatures at each measurement point and depth as well as at heater wells.

c. Pressures at each measurement point and depth.

d. Vacuums and flow rates from each vapor recovery well and through the entire system.

e. Vapor volatile organic compound (VOC) measurements at each location monitored.

f. Mass (discrete and cumulative) of total VOCs removed.

g. Running mass (discrete points and cumulative total) of VOC emissions from the well-field.

h. Running indication of vapor treatment removal efficiency.

i. Amount of groundwater/process water generated during the reporting period.

j. Description of any wastes generated during reporting period and their disposition.

k. System runtime hours, and downtime log with description of reasons and corrective actions; and

l. Any other data (soil, groundwater, air, soil gas, etc.) obtained during the reporting period.

Monthly progress reports must be submitted within 14 days of the reporting period. Monthly reports must include all cumulative routine operational data, any available analytical data collected, and a summary of progress towards meeting the performance criteria.

3.8 SHUTDOWN AND CLOSEOUT

****

NOTE: The cessation of heating is based on the interpretation of the temperature, energy delivered, mass removal rates, and media concentrations, in that order, conducted jointly by the contractor and the Government. The contractor may propose the cessation of heating for Government approval. The Government may allow a temporary shutdown of power input to facilitate sampling of soil and groundwater with the understanding that the system may need to be restarted based on the sampling results. Until confirmation is received that all performance requirements have been attained, all contractor equipment should remain on-site.

****

3.8.1 Basis for Shutdown

Propose cessation of heating when it can be inferred based on parameter measurements, including temperatures, energy input, mass removal, and media concentrations, that the [soil][and][groundwater][has][have] achieved performance goals set forth in paragraph PERFORMANCE REQUIREMENTS. Cease heating only with the approval of the Government. Assume Government review and approval will be provided within [5][_____] business days. Continue vapor control measures following cessation of heating[for two weeks][for four weeks][for [_____] days][, and until vapor migration to the surface and contaminant condensation outside the TTZ is no longer a risk to workers or the community]. Maintain all equipment in stand-by condition pending confirmation of attainment of all performance goals. These requirements also apply for cessation of heating in a portion of the TTZ. If performance goals have not been attained, resume heating throughout the TTZ, or with Government approval, within a portion of the TTZ that has not attained performance goals. Submit all Post Heating Sampling Results to the Government in a timely manner to support shutdown decisions.

3.8.1.1 Confirmation Groundwater Sampling

****

NOTE: If groundwater concentration targets are part of the treatment goals, requiring the acquisition of groundwater samples at other locations may be prudent, especially those areas that did not sustain boiling temperatures or that were still yielding some contaminant mass. Specifying obtaining

groundwater grab sampling at a number of location as directed by the Government is optional, but recommended.

****

Consider groundwater sampling results in assessing attainment of performance goals, including the potential for rebound and inflow of contaminants from areas outside the TTZ. Conduct a minimum of [one][two][_____] round[s] of groundwater sampling after cessation of heating to verify attainment of the performance goals. Obtain samples from the monitoring wells identified in Table 4 and analyze the samples for the analytes in Table 4. Conduct all sampling in accordance with hot sampling methods outlined in the UFP-QAPP and the Site Safety and Health Plan.[Obtain additional groundwater grab samples during soil sampling at [_____] locations directed by the Government, and analyze these samples for the same list of contaminants as the samples from the monitoring wells.]

3.8.1.2   Soil Sampling

****

NOTE: Subsurface soil sampling is difficult during active heating given the typical presence of piping, cabling, and a surface cover that prevents access for even small drill rigs. Pre-planned drilling access or temporary removal of piping and other infrastructure can make sampling possible. Such sampling can be very useful in assessing progress. Soil sampling can be conducted after cessation of heating for confirmation sampling. Removal (or extraordinary protection) of surface infrastructure is required, so confirmation soil sampling is not typically conducted without a high level of confidence that performance goals have been achieved.

****

Conduct soil sampling to confirm attainment of performance goals only after other evidence, including mass removal rates and extracted concentrations, indicate a high likelihood of attainment of these goals. Remove surface cover, if this can be safely done without allowing discharge of contaminant vapors and steam, and relocate piping and cabling as necessary to provide access for drilling equipment.[Replace surface cover following the soil sampling.] Sample soil at[one location per [____] square meters [____] square feet of the TTZ] [[____] locations][as specified in the UFP-QAPP][as directed by the Government][at the centroid of areas between heater locations][and at locations that either did not attain target temperatures or attained them for the shortest time]. Obtain soil samples at up to [5][_____] locations above and below the TTZ and at locations [2][_____] meters [6][_____] feet outside the TTZ lateral boundary and spaced every [30][_____] meters [100][_____] feet around the perimeter of the TTZ to assess condensation or downward migration of contaminant. Conduct hot soil sampling in accordance with procedures described in the UFP-QAPP and in accordance with the Site Safety and Health Plan.

3.8.2   Retention of Equipment

Retain all contractor-furnished equipment upon the verification of the attainment of the treatment goals. Government-furnished equipment will remain the property of the Government.

3.8.3 Basis for System Restart

****

NOTE: It is common for the ISTR system to be restarted after confirmation soil sampling at least until the receipt of the analytical results.

****

Following the initial cessation of heating, restart the system upon the direction of the Government or if the [soil][and][groundwater] sampling results indicate the treatment goals have not been fully achieved. These criteria also apply for restart of heating in a portion of the TTZ.

3.8.4 Close-Out Activities

Begin close-out activities only after receiving authorization from the Government.

3.8.4.1 Equipment, Cover, and Piping Removal

Remove all the contractor-furnished equipment, material, temporary facilities, and supplies from the site and clean the area. If a surface cover is used, remove and dispose of it off site in accordance with applicable local, state, and federal requirements. Restore the site to the condition that existed before commencement of the ISTR. Restore any impacted stormwater drainage pipes to full working condition at the end of ISTR operations. If the Contractor protected existing infrastructure from elevated temperatures in the TTZ, conduct tests during restoration to document restored conditions match or exceed baseline conditions.

3.8.4.2 Recycling and Waste Disposal

Recycle or process for reuse any materials and equipment that would have suitable value. This may include plastic and/or concrete cover materials, piping, wiring, and spent non-hazardous granular activated carbon.[Manage spent carbon and other wastes in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.] Decontaminate materials for recycling or reuse to the extent necessary prior to removal from the site.

3.8.4.3 Well Decommissioning

****

NOTE: Suggest including an approximate estimate of the number of monitoring wells that will be retained. The number of monitoring wells to be retained will likely depend on the results of the ISTR and can't easily be predicted. It may be best to retain all monitoring wells and decommission them at a later date under separate contract.

Well abandonment procedures are usually governed by state or local requirements and often involve pressure grouting and removal of the upper 0.6 to 1.5 meters 2 to 5 feet of the well or other infrastructure with necessary backfilling.

****

Decommission subsurface infrastructure, including heater, extraction, and injection wells, temperature sensor strings, vapor/vacuum monitoring points in accordance with state and local requirements with modification as necessary for the construction of the features and the residual heat in the TTZ. The Government will identify monitoring wells to be retained for future monitoring. Provide documentation of the decommissioning activities in the remedial action report.

3.8.4.4 Site Restoration

Restore the site to the condition that existed before commencement of the ISTR (except for the items discussed above), grade to ensure proper drainage, and revegetate to prevent erosion until final site restoration. Provide photographic documentation of completed restoration activities in the remedial action report.

3.8.4.5 Remedial Action Report

Submit a Remedial Action Report. The remedial action report must include, but is not limited to the following:

a. Description of field operations including energy applied, duration of treatment, temperatures reached, mass removal rates and cumulative totals over time, monitoring point concentrations over time.

b. Evaluation of ISTR effectiveness relative to treatment requirements.

c. All sampling results, which are to include process monitoring and confirmation sampling results, perimeter and work zone air monitoring results, and monitoring results.

d. Any deviations from the approved RAWP, UFP-QAPP, and rationale/justification for each.

e. Any site restoration activities.

f. As-built drawings which are to detail well field infrastructure locations, all confirmation sampling locations, air monitoring locations, monitoring well locations, and depict post restoration site conditions.

g. As-built drawings for excavations detailing the horizontal and vertical extent of excavations and confirmation sampling locations.

h. Wastes generated and disposition (including characterization analysis of wastes).

i. Chemical data final report.

j. Lessons Learned as an appendix.

k. Photos of the installed wells, piping, surface cover, treatment equipment, sampling activities, effluent discharge locations, any recovered NAPL, and pre- and post-treatment site surface conditions, as appropriate.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-02 54 19.13 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 54 19.13 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-02 54 19.13 (February 2025)**

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****

SECTION 02 54 19.13

BIOREMEDIATION USING LANDFARMING
02/25

****
NOTE: This guide specification covers the requirements for reduction of the concentrations of organic contaminants in soils by bioremediation using landfarming systems..

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: An edited version of this Section may be used to solicit a request for proposal (RFP). Use of an RFP approach may prevent the contract from being awarded to a Contractor that is not technically qualified. This guide specification was developed based on the use of landfarming to treat contaminated soil. Other terms that have been used in place of "landfarming" include "land treatment" and "prepared bed bioreactors." The same process is believed to be applicable for treatment of some other types of organic contaminants in soil. Bioremediation processes, such as landfarming, are usually considered innovative

technologies, and may satisfy CERCLA/SARA considerations of innovation in remediation.

According to Landfarming guidance from the Federal Remediation Technologies Roundtable (FRTR), Landfarming typically applies to treat aerobically biodegradable compounds including nonhalogenated volatile organic compounds, nonhalogenated semivolatile organic compounds, oily sludge, wood-preserving wastes (e.g. pentachlorophenol [PCP] and creosote), and fuels. Landfarming does not effectively degrade chlorinated and nitrate-containing compounds due to the need for anaerobic conditions. Other conditions should be considered when selecting Landfarming. A large amount of space is required and debris greater than 8 3 inches in diameter typically should be removed prior to processing. Very high contaminant concentrations and heavy metals can be toxic to microorganisms. Local regulatory requirements should also be taken into consideration since some volatile contaminants may evaporate during aeration instead of being biodegraded. These constituents may be required to be trapped and treated to avoid release to the atmosphere. This specification section presumes that the project team has confirmed landfarming is generally a feasible remedy for the site before the specs and contract are prepared.

Please also note that "Contracting Officer" mentioned throughout this document is intended to be an umbrella term for anyone, including the Contracting Officer, designated by the Contracting Officer.

Recommended references for design and operation of landfarming facilities include:

1. Bioremediation of Contaminated Soils, Agronomy Monograph no. 37, American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, 1999. This includes the following chapter titles: "Prepared Bed Bioreactors", Sims, J. L., et al., and "Landfarming of Petroleum Contaminated Soils", Sims, R. C. and Sims, J. L.

2. Bioremediation Using the Land Treatment Concept, EPA/600/R-93/164, Pope, D. F., and Matthews, J. E.

3. Guidelines for Land Treating Petroleum Hydrocarbon-Contaminated Soils, Journal of Soil Contamination, 3(3):299-318, Huesemann, M. H., 1994.

4. How To Evaluate Alternative Cleanup Technologies For Underground Storage Tank Sites, U.S. Environmental Protection Agency, EPA 510-B-17-003, October 2017 (see Chapter V within, titled Landfarming, dated October 1994)

5. Aerobic Biodegradation of Oily Wastes, A Field Guidance Book For Federal On-scene Coordinators Version 1.0, October 2003, U.S. Environmental Protection Agency, Region 6 South Central Response and Prevention Branch

6. Website: Center for Public Environmental Oversight, Webpage: Land Farming, http://www.cpeo.org/techtree/ttdescript/lanfarm.htm>http://www.cpeo.org/techtr accessed December 2023 .

7. Website: Federal Remediation Technologies Roundtable, Webpage: Landfarming, https://www.frtr.gov/matrix/Landfarming/>https://www.frtr.gov/matrix/Landfarmi Accessed July 2024.

A systematic project planning approach should be employed when developing sampling procedures to demonstrate the performance of the landfarming treatment process, ideally through implementation of the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP). A specific landfarming work plan documented the sampling procedures is also acceptable and can be an appendix of a UFP-QAPP or a standalone document, depending on the project.

The landfarming treatment considered in this guide specification starts with the raw contaminated material; a treatment cell is constructed; contaminated soils are pre-processed, placed into the treatment cell, and amended with various treatment agents; contaminated soils are tilled, aerated, and moisture controlled as necessary; testing is conducted to confirm treatment performance; and ends with final disposition of the treated material (either left in-place, moved to an on-site designated permanent storage unit, or transported off-site for final disposal). As applicable, refer to Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL for requirements related to excavation and stockpiling of the contaminated materials; Section 31 00 00 EARTHWORK for placement of treated materials in on-site permanent storage; and Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS for requirements relevant to offsite transportation and disposal.

****

1.1 MEASUREMENT AND PAYMENT

****

NOTE: Edit this paragraph based on whether the Contract will use a single job price or unit prices. If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is in the project, move these paragraphs to that Section for editing. The project team should involve their Contracting Office to determine the best way to create a payment schedule/milestone

for their Contract or Task Order.

If the project includes Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS, coordinate measurement and payment methods and contaminated material handling and stockpiling between this Section and Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS.

If the quantities of contaminated soils are well defined, payment may be based upon a single job price structure. However, it is usually more cost-effective to use a unit price structure when there is a significant degree of uncertainty in the amount of contaminated material. When the amount of contaminated material is inadequately defined or uncertain, a data gap investigation is generally advised before any landfarming activity begins. When specifying a unit price structure for treatment, separate items should be provided in the Contract Price Schedule to cover any other work required. Other work items include, but are not limited to: preparation of submittals, mobilization and demobilization, site preparation, construction of the treatment cell and run on/runoff controls, water storage facilities, contact water treatment and disposal, sampling and testing, implementing health and safety requirements, and utilities. Inclusion of separate items in the Contract Price Schedule for the above work tasks should result in a lower unit price for treatment.

****

1.1.1 Unit Prices

1.1.1.1 Field Demonstration

****

NOTE: Prior to planning the field demonstration, bench-scale treatability study testing should be performed to determine if the contaminants of concern are amenable to landfarming in the site-specific soil matrix. The field demonstration may either be conducted prior to the construction of the full-scale facilities, or conducted using the full-scale facilities and equipment. Payment for the field demonstration should be covered by a separate single job price, or by a unit price that is separate from the unit price for full-scale treatment. Because more intensive monitoring is usually required during the field demonstration, the unit price for the field demonstration will usually be higher than the unit price for full-scale treatment. Testing for chemical data is not included as a component of the price in this paragraph. The contract price schedule should include separate, unit price items for testing for chemical data.

If the results of the field demonstration indicate that an extended treatment period (or other special measures) will be required to meet cleanup goals, it may become necessary to modify the bid item that covers treatment pricing for full-scale operations.

****

Payment for the field demonstration must be[by the Contract unit price schedule for each[cubic meter yard][_____] treated during the field demonstration][a lump sum price for completion of approved tests]. The price must include the cost of labor, materials, equipment usage, utilities, and fuel for: [pre-processing,][operation, maintenance and process monitoring (not including testing for chemical data),][ancillary waste treatment and disposal,][preparation of Field Demonstration Report,][and][_____]. Costs for procurement and handling of amendments must be included in the unit price for treatment.

1.1.1.2 Contaminated Soils Treatment Unit Price

****

NOTE: Testing for chemical data is not included in the unit price. The contract price schedule should include separate, unit price items for testing for chemical data.

Unit price payment may either be based on weight or volume (in-place or ex-situ). This paragraph uses ex-situ volume as the default unit.

If unit price payment will be based on weight, dry weight should be specified and requirements should be included for moisture content testing so that dry weight can be determined. However, surveys are usually required before and after excavation of contaminated material, so that excavation and backfilling can be paid for on the basis of in-place volume. Thus, in some cases, it may be advantageous to pay for processing and treatment of soils using in-place volume as the pricing unit.

If the size of the site is well-known, it may be reasonable to simplify contracting and subsequent billing, performance verification and payment by awarding the project as a fixed single job price. If flexibility is desired, additional volume or additional weight may be contracted at fixed unit rates, however additional surveying or other performance verification will be needed for the additional effort beyond the single job price effort.

This paragraph should be coordinated with the treatment criteria and sampling requirements paragraphs so that it will be possible to distinguish between soil that passes, and does not pass, treatment criteria.

****

[Payment for treatment of contaminated soil will be by the contract unit price schedule for each cubic meter yard of contaminated soil that is treated based on [ex-situ volume, after separation of oversize material][_____].

][Payment for treatment of contaminated soil will be by the contract unit price schedule for each metric ton ton of contaminated soil that is treated. Use a properly calibrated weighing system to accurately measure the gross (bulk) weight of the contaminated material. Convert the measured gross (bulk) weight of the contaminated materials to be treated to dry weight based on the[percent moisture content of representative contaminated material samples. Determine the percent moisture content in accordance with[ASTM D2216][ASTM D4643][ASTM D4959][_____]. Determine moisture content[daily][for every[500][_____] metric tons tons of contaminated material that is treated]][_____].

]This unit price must include the cost of labor, materials, equipment usage, utilities, and fuel for: [pre-processing,][operation, maintenance and process monitoring (not including testing for chemical data),][ancillary waste treatment and disposal,][preparation of operations reports,][and][_____]. Costs for procurement and handling of amendments must be included in the unit price for treatment. After each lift of soil has been treated, the quantity of soil that does not meet treatment criteria must be reported and subtracted from the quantity of soil comprising the lift, when determining payment for treatment. See paragraph TREATMENT CELL SIZING for a definition of "lift of soil". Payment will not be made for soil that does not meet treatment criteria. If additional tests, or additional processing and testing, are necessary to show that material meets treatment criteria, the additional costs must be borne by the Contractor.

1.1.1.3 Oversize Materials from Contaminated Areas

****

NOTE: This paragraph should be deleted if payment for treatment and disposal of oversize materials will be included as part of the unit price item for treatment of contaminated soil. Payment for disposal of oversize materials may be by weight or volume, depending on the nature of the materials. Oversize materials may include brush, trees, roots, rocks, rubble, and construction debris.

****

Payment for[treatment][and][disposal] of oversize material separated from contaminated soil will be by the Contract unit price schedule for each[kilogram pound][_____]. Separate soil, free water, and other extraneous materials from oversize materials prior to measuring quantities.

1.1.2 Single Job Prices

[1.1.2.1 Bench-Scale Treatability Study Testing

****

NOTE: Single job pricing is recommended for each bench-scale treatability study testing run. The single job price should include the cost for testing for chemical data. However, bidders should also be required to provide a unit cost amount for testing for chemical data. This will provide a basis for

payment for additional analytical costs, if it is determined that more testing will be required.
****

Payment for bench-scale treatability study testing will be a single job price for completion of specified tests. Include in the price the cost of labor, materials, equipment usage, utilities, and fuel for:

[a. Preparation of the bench-scale treatability study test plan.

][b. Collecting samples.

][c. Sample shipment.

][d. Pre-processing.

][e. Process monitoring (including testing for chemical data).

][f. Disposal of treated material and waste.

][g. Ancillary waste treatment and disposal.

][h. Preparation of the bench-scale test treatability study report.

][i. [_____]].

Costs for procurement and handling of amendments must be included in the unit price for treatment.

]1.1.2.2 Other Work Items

****
NOTE: Coordinate this paragraph with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS. Temporary utility connections are covered in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.
****

Payment for work items not included above must be included in the payment for the base bid for treatment of the contaminated materials. The other work items include submittals related to mobilization and demobilization, site preparation in the treatment cell, manufacturers' field services, environmental compliance monitoring, health and safety monitoring and controls, and utilities required for the landfarming treatment if approved by the Government as necessary for the project.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of

the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2974	(2020; E 2020) Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM D4972	(2018) Standard Test Methods for pH of Soils
ASTM D6836	(2016) Standard Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using a Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, and/or Centrifuge

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
EPA 600/R-96/084	(2000) Guidance for Data Quality Assessment: Practical Methods for Data Analysis EPA QA/G-9, QA00 version

EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1200	Hazard Communication

[1.3 PRECONSTRUCTION MEETING

****

NOTE: Delete this paragraph if the requirements are included in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, Section 01 32 01.00 10 PROJECT SCHEDULE, or other Specification Section.

Appropriate facility personnel should be present at the pre-installation meeting if siting of the treatment facility and other associated work areas will be discussed.

****

Arrange and conduct a preconstruction meeting at the jobsite[at least five business days prior to the start of operations on the project][_____]. The preconstruction meeting must follow the written preconstruction meeting agenda submitted [_____] days prior to the meeting. The purpose of this meeting is to review the requirements of this Section and the associated plans. The following individuals must attend this meeting: [Contractor's project manager,][site foreman,][and Contracting Officer].

Record preconstruction meeting minutes and publish via email within 48 hours to the attendees. Re-publish the meeting minutes within 48 hours via email pending subsequent comments from the attendees.

]1.4 SYSTEM DESCRIPTION

****

NOTE: Requirements for a specific method of treatment are provided below. If the use of a variation on landfarming process described will be allowed, this paragraph should be revised to indicate that a process, other than described in this Section, may be proposed by the Contractor; that the Contractor's approved submittals must demonstrate equivalent capabilities; and that such approval will not relieve the Contractor of responsibility for meeting specified requirements for safety, reliability, and performance.

****

Perform treatment using a safe, reliable method to treat contaminated material conforming to paragraph PERFORMANCE REQUIREMENTS. Requirements for a specific method of treatment are provided below.[The Contractor may propose an alternative treatment method. Government approval of a Contractor-proposed plans does not relieve the Contractor of responsibility for meeting specified requirements for safety, reliability, and performance.]

1.4.1 DESIGN REQUIREMENTS

1.4.1.1 Landfarming Treatment Cell

****

NOTE: Siting of the treatment facility should be in accordance with regulatory requirements. The prevailing wind direction and the potential for dust generation should also be taken into consideration. The design of the treatment cell should include provisions for control of storm water and contact water, and should take into account the expected wheel loads of material handling equipment.

In-situ applications of landfarming are usually not recommended due to the potential for spreading contamination into the vadose zone and groundwater. Typically, treatment of contaminated soil is performed in a lined treatment cell. Lined treatment cells usually include a composite clay or geomembrane liner with a leachate collection system.

Care should be used when applying standards established for landfill liner systems, to avoid requiring over-conservative and costly designs.

****

Locate the treatment cell in an area where seasonal, high water table level is at least [1.5][_____] meters [5.0][_____] feet below the lowest level of the liner. The treatment cell must be designed to support the load of material handling and tilling equipment. Provide the water collection system and sump in accordance with paragraph CONTACT WATER MANAGEMENT SYSTEM AND DESIGN STORM.

1.4.1.1.1 Treatment Cell Sizing

****

NOTE: The dimensions of the treatment cell should be based on the amount of time required to reach cleanup goals for each lift of soil (including laboratory turn-around time for compliance testing), the volume of soil and amendments that can be held in the treatment cell, the configuration of the irrigation system, and the type of material handling equipment that will be used. A pie-shaped, or semi-circular, treatment cell lends itself well to the use of a center-pivot irrigation system. Laboratory turn-around time is usually about 2 to 4 weeks. The depth to which soil can be treated (i.e., lift depth) is limited by the practical depth of tilling (usually about 300 mm 1 foot).

Traditionally, new lifts of contaminated soil were placed in the treatment cell after treatment of

preceding lifts were completed. However, material handling requirements may be decreased by placing the entire volume of contaminated soil onto the treatment cell at once. Under the latter scenario, treated lifts are successively removed after they have been shown to meet clean-up goals. One-time placement of all the contaminated soil onto the treatment cell may also eliminate the need to establish a contaminated soil stockpile area.
****

Locate the treatment cell [within the area indicated on the drawings][_____]. Size the treatment cell to hold at least [_____] cubic meters cubic yards of soil per lift, based on a lift depth of [0.3][_____] meters [1][_____] foot. A lift is a single layer of contaminated soil contained within the treatment cell which can be mixed to it full thickness by tilling. Active treatment occurs primarily in the uppermost lift of soil in the treatment cell. Traditionally, a new lift of contaminated soil is placed in the treatment cell after treatment of the preceding lift has been completed. Alternatively, the entire volume of contaminated soil may be placed onto the treatment cell at once; then treated lifts are successively removed after they have been shown to meet clean-up goals. Size the treatment cell based on completing treatment of the estimated, total volume of contaminated soil in [_____] months from initiating treatment of the first lift, assuming treatment is initiated on the following date: [_____].

1.4.1.1.2 Porous Drainage Layer

****
NOTE: Specification of the drainage layer is deferred to Section 33 46 16 SUBDRAINAGE PIPING. The remaining information is provided for consideration when preparing that specification section. The gradation limits of the porous drainage layer should be compatible with the grain-size distribution of the contaminated soil. Gradation limits should be determined as shown in EM 1110-2-1913, Engineering and Design - Design of Construction Levees (see Appendix D Filter Design). The slot width of the leachate drainage piping (or pore size of filter fabric around the drainage piping) must also be compatible with the gradation limits of the porous drainage layer.

Geotextiles may be incorporated into the porous drainage layer to help prevent fines from migrating into the leachate collection system. Due to the potential for clogging, use of geotextiles could pose a problem for a treatment cell that is designed for long-term operation. Geotextiles provide attachment sites for microorganisms. Growth of biomass may lead to reductions in the permeability of the geotextile material. However, experience at Region 8 EPA landfarming operations for treatment of creosote-contaminated soil indicates that clogging of geotextile has not been observed at projects that were completed within about 5 years.

To protect the drainage piping, a minimum distance should be maintained between the top of the drainage piping and the top of the porous drainage layer (e.g., 203 to 254 mm 8 to 10 inches). Use of low-profile piping, such as panel pipe for highway edge drains, laid flat against the geomembrane will allow the thickness of the porous drainage layer to be minimized.

****

Provide a porous drainage layer in accordance with Section 33 46 16 SUBDRAINAGE PIPING. Design the porous drainage layer to facilitate drainage of free water and to prevent entry of contaminated soils.

1.4.1.1.3 Leachate Controls and Collection

****

NOTE: Specification of the drainage layer leachate controls and collection is deferred to Section 33 46 16 Subdrainage Piping. The remaining information is provided for consideration when preparing that specification section. Lined landfarm units should have a granular drainage layer to allow free water to drain from the soil layer, and a leachate collection system to remove drainage. Some problems unique to landfarming applications are:

a. Exposure to equipment traffic (e.g., applying soil, tilling, and removing soil), can damage drainage layers and liners.

b. Removing lifts of treated soil requires scraping and shoveling the treated lift from the treatment cell, typically with a front-end loader. To protect the leachate collection and geomembrane layers, an armoring layer (gravel or crushed stone) is often used to indicate over-excavation to the equipment operator. The armoring layer is usually positioned immediately above the porous drainage layer.

Slotted piping generally has more area available for water to flow into the pipe than perforated piping, and is less susceptible to clogging and fouling than filter fabric covered piping. Thus slotted piping should be considered for treatment cells that are designed for long-term operation, or where clogging or fouling is a strong concern.

Perforated piping is generally less expensive than slotted. The combination of perforated piping within a geotextile (filter fabric) sleeve has been used with success in landfarm drainage layers. The pore size of the geotextile must be compatible with the grain-size distribution of the porous drainage layer. Installing a layer of geotextile across the entire area of a treatment cell is not recommended because it would require substantially more material than using only geotextile sleeves around the collection piping, and geotextile sheets would be

susceptible to damage during removal of lifts of treated soil.

Leachate drainage lines are routed to a sump, which is usually placed below the treatment cell. The sump usually consists of a lined depression in the impermeable layer packed with gravel. Water holding facilities outside of the treatment cell are commonly used for additional water storage capacity. When the gravel sump reaches a set level, water is pumped from the sump to the outer water holding facility. Options for water storage facilities outside of the treatment cell include: an above-ground storage tank, a reinforced concrete basin, vertical caisson piping, or a lined earthen pit.

See U.S. Army Corps of Engineers, CPD-74B, Hydrologic Modeling System HEC-HMS, Technical Reference Manual, March 2000 for additional information on runoff issues relevant to landfarming.

****

Provide leachate controls and collection in accordance with Section 33 46 16 SUBDRAINAGE PIPING.

1.4.1.1.4 Geomembrane and Clay Liners

****

NOTE: Liners usually consist of high density polyethylene (HDPE) geomembrane or recompacted clay. It is atypical to require a composite liner system for a temporary landfarming facility. Options have been provided for HDPE liners and recompacted clay liners.

If granular material in the drainage layer is greater than 13 mm 1/2 inch, a sand or geotextile protective layer should be required between the geomembrane liner and the granular material.

The drawings should provide requirements for sloping of the surface of the liner. Recommended, minimum sloping requirements are as follows: 2 percent from the sides of the treatment cell to the central drainage line, and 1 percent over the length of the central drainage line (from the upslope end to the entry into the gravel sump).

Sections 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT and 02 56 13.16 CLAY WASTE CONTAINMENT provide some testing requirements for the liner. Additional testing and leak monitoring may be necessary for some projects. Leak monitoring will be more important for projects where the treatment cell is located over an area with clean groundwater and a clean vadose zone.

Monitoring wells, downgradient of the treatment

cell, can be used to determine if leaks have occurred in the past. Lysimeters may be installed within and around the perimeter of the treatment cell. If used, lysimeters should be installed before the liner to avoid damage to the liner during placement of lysimeters. Penetrations through the liner must also be properly sealed. Generally there is greater potential for leaks to occur in the sump, than in other locations of the liner. Water may remain in the sump for extended periods if the sump is being used to store contact water.

Leak sensing technologies are described in the following reference, Leak Detection for Landfill Liners, Overview of Tools for Vadose Zone Monitoring, Karen Hix, Technology Status Report Prepared for USEPA Technology Innovation Office under a National Network of Environmental Management Studies Fellowship, Aug. 1998. The reference can be accessed at the following internet site: http://www.clu-in.org/download/char/leaklnfl.pdf

Most of the leak sensing technologies involve installation of leak sensing devices below the liner, prior to placement of the liner. Because of the relatively high capital and operation and maintenance (O&M) costs for leak detection systems, they are usually not installed.

As a relatively inexpensive construction QA measure, the Two Electrode method can be used for leak testing of the sump area. The test can be performed by filling the sump with water (before it has been filled with gravel) for a set period (e.g., 24 hours), and monitoring for passage of current from the inside the sump to the soil outside of the sump area. If current is detected in the electrode placed in the soil outside of the sump area, then the liner is checked for penetrations, repaired, and the test is repeated.

Leak testing, using one of the methods or devices described in the above reference, is highly recommended; especially in the area immediately below the sump.

****

Line the treatment cell with [a chemically resistant, high density polyethylene geomembrane liner with a minimum thickness of [0.1][_____] mm [40][_____] mils.][a recompacted clay liner with a minimum thickness of [0.6][_____] meters [2][_____] feet and a maximum permeability of [1 x 10^{-7}][_____] cm/s [3.28 x 10^{-9}][_____] feet/s.] Subgrade preparation and installation, testing, inspection, and protection of the liner, must be in accordance with Section [02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT][02 56 13.16 CLAY WASTE CONTAINMENT]. The surface of the liner must be sloped [as indicated][_____].

1.4.1.1.5 Other Work Area Surfaces

****

NOTE: This paragraph should be revised if paved surfaces will not be required. It may be necessary to require paving in areas designated for handling contaminated material and operation of heavy equipment (e.g., front-end loaders). Concrete pads are typically more expensive, though less permeable than asphalt pads. Asphalt pads have been used for hazardous waste composting projects.

****

Locate the soils pre-processing area[within the area indicated][_____], and construct and pave in accordance with Section [03 30 00 CAST-IN-PLACE CONCRETE][_____].

1.4.1.2 Contact Water Management System and Design Storm

****

NOTE: In accordance with regulatory requirements, excess contact water may be discharged to National Pollutant Discharge Elimination System (NPDES) storm water discharge outfalls, publicly owned treatment works (POTW) sewers, facility sewer to onsite treatment systems, or treated and disposed of offsite.

The source of data for the design storm should be referenced. Sources for hypothetical storm information in the United States are referenced in Appendix A of Hydrological Analysis of Ungaged Watersheds Using HEC-1, Training Document No. 15, USACE Hydrologic Engineering Center, April 1982; another source is NOAA Atlas 14. Previous through current versions of the HEC Hydrologic Modeling System (HMS), as well as training materials, are available at https://www.hec.usace.army.mil/software/hec-hms/documentation.aspx

The surface of the treatment cell must be sloped so that surface run-off from high intensity precipitation events and snow melt can be collected and transferred to contact water storage facilities. If too much surface water penetrates the contaminated soil layer, the soil may become waterlogged and contaminant degradation rates may decrease. The degree of slope must be tailored to account for the frequency of the high intensity precipitation events and the wind and humidity patterns at the project site. It is critical that the landfarming cell be able to drain rapidly after high intensity precipitation events.

****

Contact water is defined as water that has come into contact with contaminated materials, or other contaminated surfaces. Sources of contact water may include, but are not limited to: water from decontamination of equipment, personnel, and PPE; runoff water from storage and pre-processing areas; and water that leaches through the treatment cell. The design storm must be the [24][_____] hour duration storm with a return interval of [25][_____] years, based on data from [_____]. Water head in the gravel sump (under the treatment cell), in excess of [0.3][_____] meter [1][_____] foot, must be removed within [24][_____] hours of the design storm event. The water head in the gravel sump (under the treatment cell) must be maintained at no more than [0.3][_____] meter [1][_____] foot between storm events. The surface of the top layer of the treatment cell must be sloped, [as shown on the drawings,][_____] to allow surface run-off to be collected and transferred to contact water storage facilities.

1.4.1.2.1 Perimeter Berms

Berms must be constructed around the perimeter of the following areas: [treatment cell,][contact water storage,][laydown and storage areas,][and][_____]. Size the perimeter berms to prevent flood water run-on from the [25][_____] year flood while maintaining a minimum freeboard of [0.3][_____] meter [1][_____] foot. The perimeter berms must also be sized to contain water from the design storm that collects on the surface, inside of bermed areas, while maintaining a minimum freeboard of [0.3][_____] meter [1][_____] foot. Key berms constructed around the [treatment cell and contact water storage facility][_____] into the underlying liners of these areas, [as shown on drawings][_____]. Include ramps to permit vehicle access across berms constructed around the [treatment cell, and laydown and storage areas][_____].

1.4.1.2.2 Storage Volume

****

NOTE: Typically, storage and testing of contact water is required prior to discharge. Thus contact water storage facilities should be sized to contain the peak detention volume for the design storm. In order to minimize treatment and disposal costs, it is often desirable to reuse the contact water to irrigate the treatment cell. Using this approach, the storage volume must be sufficient to retain the volume of water in storage prior to the design storm, and the volume of water generated by the design storm.

Sources of contact water include: water from decontamination of equipment, personnel, and personal protective equipment; and water that drains from storage, pre-processing and treatment areas. If the storage, pre-processing, or treatment areas are covered, then the volume of contact water resulting from precipitation events should be reduced.

****

Size contact water storage facilities to contain [30][_____] percent above that required for the design storm, and [the maximum volume that will be held in storage for reuse][_____].

1.4.1.2.3 Reuse, Treatment, and Disposal

****

NOTE: It is possible for contact water to

accumulate compounds (e.g., acids, bases, or salts) at levels which may inhibit microbial activity. However, contact water can usually be applied to contaminated soil with little or no treatment. Water which has accumulated excessive levels of acids, bases or salts may require treatment, or offsite disposal.

****

Reuse contact water to the maximum extent, to minimize the need for new makeup water and to limit the treatment, discharge and offsite disposal of wastewater. Prior to reuse, test contact water in accordance with paragraph CONTACT WATER TESTING and confirm that contact water meets the requirements of paragraph WATER SUPPLY. Prior to disposal, collect and test contact water that cannot be applied to contaminated soil in accordance with paragraph TREATMENT CRITERIA FOR CONTACT WATER. Treat process sludge (resulting from the removal of suspended material in the contact water) to meet the requirements of[paragraph TREATMENT CRITERIA FOR SOIL][_____].

1.4.1.3 Irrigation Equipment

****

NOTE: Irrigation is critical to maintaining optimum moisture content, and maintaining high degradation rates. In arid climates, water usage rates will obviously be higher than in non-arid climates. Drip irrigation systems are generally not recommended for landfarming because they are not designed to distribute moisture uniformly. Center-pivot irrigation systems have been successfully used in conjunction with pie-shaped, or semi-circular, treatment cells.

****

Provide irrigation equipment capable of delivering at least 0.7 L/s/1000 m^2 40 gpm/acre distributed uniformly over the surface of the treatment cell. Design the irrigation system to minimize interference with tilling of the treatment cell. Do not use flood or overland flow irrigation methods.

1.4.1.4 Weather Cover

****

NOTE: This paragraph should be deleted if there will be no requirement for use of a weather cover. Weather covers allow an added measure of control over moisture delivery to the treatment cell, and may also be used to increase soil temperature. Use of a weather cover will also allow the scale of the contact water management facilities to be reduced. Clam-shell buildings, metal buildings, pole barns, large tents, or other prefabricated structures may serve as weather covers. The section containing requirements for the weather cover (e.g., Section 13 34 19 METAL BUILDING SYSTEMS), should include the design snow load, maximum wind speed, soil bearing capacity, seismic parameters in accordance with UFC 3-301-01, and maximum and minimum ambient air temperatures.

If landfarming will be performed inside of an enclosed structure, adequate ventilation must be provided. A rate of 3 to 6 air changes per hour has been recommended for composting facilities. Carbon dioxide is generated and oxygen may become depleted during landfarming. However, rates of oxygen consumption for most landfarming applications will be significantly lower than that of composting. During material handling operations (e.g., tilling) dust and engine exhaust fumes will accumulate. To ensure that proper and consistent ventilation requirements are specified, this section should be coordinated with Section 23 30 00 HVAC AIR DISTRIBUTION.

****

Use weather covers, or appropriate structures, to prevent precipitation from coming into contact with soil in the treatment cell, and design in accordance with Section[13 34 19 METAL BUILDING SYSTEMS][_____]. Provide covers which allow for free exchange of gases between the atmosphere and the soil. Size weather covers to allow unimpaired maneuvering of [front-end loaders,][soil mixing equipment,][and][_____]; size openings in weather covers to allow for entry and exit of [front-end loaders,][soil mixing equipment,][and][_____]. Provide ventilation of the covered facility in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

1.4.1.5 Stockpiles

****

NOTE: Typical stockpile design requirements are provided in Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL. In very arid climates, covers may not be necessary. If operations will continue during subfreezing conditions, it may be necessary to ensure that the Contractor has included provisions to prevent a portion of the contaminated soil stockpile from freezing. The stockpile requirements in that section should be edited based on site-specific factors and regulatory requirements.

****

In accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL, prepare areas that will be used to stockpile [contaminated material,][oversize material,][treated material][and][_____].

1.4.1.6 Material Measurement

****

NOTE: This paragraph is primarily intended to ensure that calibrated scales are being used to weigh treated soil, when weight is being used as the basis for measurement and payment.

****

Provide scales, meters, and volumetric measuring devices for measuring oversize materials, feed contaminated materials, reagents, and water which conform to the applicable requirements of NIST HB 44, except that the accuracy must be plus or minus [0.1][_____] percent of the quantity being measured. For scales used to measure weight of material in vehicles, provide scales of sufficient length to permit simultaneous weighing of all axle loads. For any scales used to make measurement for payment, ensure the scale is certified [by an acceptable scales company representative][by an inspector of the State Inspection Bureau charged with scales inspection within the state in which the project is located] prior to weighing any materials. Perform a check of calibration of measuring equipment prior to initial use, and once every [seven][_____] calendar days. The requirements of this paragraph do not apply to measurement of chemical or physical data for purposes of demonstrating compliance with paragraph PERFORMANCE REQUIREMENTS.

1.4.1.7 Utilities

****

NOTE: The locations and details (such as utility point of contact, sizes, capacities, and flows) of the utility hookups should be provided on the drawings for the Contractor's use. Verify the utilities are available on-site before including the second sentence.

****

In accordance with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS, provide the utilities associated with landfarming including, but not limited to:[telecommunications,][electricity,][water,][gas,][sanitary,][_____,] and solid waste facilities. The [telecommunications,][electricity,][water,][gas,][sanitary,][_____,] and [solid waste facilities] are available at the site.

1.4.2 PERFORMANCE REQUIREMENTS

1.4.2.1 Treatment Criteria and Criteria for Reuse of Treated Soil

****

NOTE: Landfarming is primarily applicable to nonvolatile and semi-volatile organic contaminants, including: low-volatility components of fuels, diesel fuel, kerosine-based fuels, fuel oils, PCP, some polycyclic aromatic hydrocarbons (PAHs, as found in creosote), some pesticides, and some herbicides. Biodegradation of PAHs becomes more difficult as the number of aromatic rings increases. Thus, landfarming is usually not considered to be an efficient process for treating PAHs that contain more than four aromatic rings. Contaminated soil will be aerated during tilling and material handling operations. Thus, the volatility of contaminants of concern should be taken into consideration to ensure that air emissions requirements are not exceeded. Non-weathered, light fuels such as gasoline are not suitable for landfarming since the most toxic components (i.e., BTEX) will readily volatilize.

Depending on regulatory requirements, both total concentration and leachability concentrations for some compounds may be required. Total

concentrations can be used to estimate worst case leachate concentrations. If the contaminated material is classified as characteristic waste, leachability testing will usually be required, and the appropriate leachability test (e.g., EPA Synthetic Precipitation Leaching Procedure (SPLP) or EPA Toxicity Characteristic Leaching Procedure (TCLP)) must be selected. If the treated material will not be disposed of in a landfill, SPLP testing may be appropriate.

Although there are EPA Land Application regulations for metals and pathogens (40 CFR 503 - Standards for Use or Disposal of Sewage Sludge), these regulations are not normally applicable to hazardous waste landfarming.

For compounds whose partial breakdown products (intermediates) have been defined, it may be necessary to include testing for key intermediates. However, it may not be practical to require testing for intermediates if chemical standards are not available. A compound should not be targeted for analysis unless there is a defensible basis for acquiring the data (e.g., if there is strong probability of generating an intermediate with higher toxicity than the parent compound).

Treatment criteria, and criteria for disposal (or reuse) should be in accordance with Federal, state and local regulations. Prior approval by regulatory representatives should be acquired for treatment criteria values.

****

1.4.2.1.1   Treatment Criteria for Soil

****

NOTE: Treatment criteria can be based on the total concentrations of a class of substances particularly if an analytical method exists that outputs only the total, such as for total petroleum hydrocarbons (TPH), however it is more typical that treatment criteria are based on individual substances.

It is possible for petroleum, oils and lubricants (POLs) and other fluids from material handling equipment to be spilled onto soil during process operations. Thus, testing for POLs should be considered.

In some cases attaining a target concentration for the site's contaminants of concern might not be sufficient; landfarming may not completely degrade, or mineralize, the contaminants but rather converts them to a series of complex degradation products which may not be analyzable with regular lab methods, and which will likely not have health based screening values. These products may bind

irreversibly to the soil, indicating that landfarming is a technology that has both degradation and stabilization aspects. In this case it may be necessary to augment the treatment criteria by adding a bacterial assay, such as the Ames Mutagenicity test, to verify the safety of the finished landfarming soils or the safety of the leachate from the finished landfarming. Another factor is that the mixing of the soils with carbon rich amendments, and their bacterial degradation, will change the redox balance of the soil and possibly convert native insoluble metals to mobile forms. This can be detected with TCLP testing of the finished soil. Lastly, there can be the concern that mixing large amounts of amendments with contaminated soil causes dilution of the contaminants, that is, it causes an immediate decrease in contaminant concentration without any landfarming having occurred. It is possible that stakeholders may insist on reducing the soil remedial criteria by this dilution factor, in order that no benefit is provided solely by the amendment mixing step toward attaining those criteria. This paragraph should be edited to include site-specific criteria.

If a statistically based criteria for determining attainment of treatment criteria will be used, the contract should be prepared to allow some flexibility as to the number of samples that will be required for confirmatory sampling.

****

Treat contaminated material to the criteria shown in Table 1A. The mean of the data for [the grids representing the top lift of soil in the treatment cell][_____] must be less than the level shown for each contaminant in Table 1A. Analyze data [using the One-Sample t-Test in accordance with EPA 600/R-96/084 (see p. 3-8 of the reference for an example of this procedure), and apply the following statistical conditions][_____]. The statistical conditions include: [true mean greater than or equal to action level (assume site is dirty) maximum false rejection rate (alpha) = 5 percent; maximum false acceptance rate (beta) = 20 percent; width of grey region (delta) = 15 percent of treatment criteria value][_____].

TABLE 1A - TREATMENT CRITERIA FOR ORGANICS

CONTAMINANT	MAXIMUM TOTAL CONCENTRATION IN SOIL
[_____]	[_____] mg/kg
[_____]	[_____] mg/kg

1.4.2.1.2 Criteria for Reuse of Treated Soil

****

NOTE: For some projects this paragraph could be combined with the above paragraph, Treatment Criteria for Soil. For the purposes of this guide specification, this paragraph has been separated to

emphasize that a separate set of regulatory criteria may have to be met before treated soil can be incorporated into topsoil.

The land application or beneficial use of treated soil will be largely controlled by existing land disposal restrictions (40 CFR 268), specifically toxicity characteristics for RCRA metals, volatiles, and semi-volatiles and any triggered universal treatment standards (40 CFR 268.48). While the metals loading rates found in 40 CFR 503 (i.e., 40 CFR 503.13 - Pollutant limits) may be useful in evaluating beneficial reuse alternatives, the designer is cautioned that the scope of that standard is for domestic sewage sludge. Soils treated via landfarming may not meet that definition, and therefore would not be excluded from hazardous waste management regulations. The application of ceiling values listed in 40 CFR 503.13 to treated soil not excluded from hazardous waste regulations is not allowed under regulation (40 CFR 503.6).

Although reductions in concentrations of heavy metals may occur due to mixing and dilution effects, landfarming is usually not considered a treatment process for inorganics. Depending on regulatory requirements and intended end use, it may be necessary to require testing for some inorganic parameters. This paragraph should be edited to include site-specific criteria.

****

Prior to final disposition, treat contaminated material to the criteria shown in Table 1B. The mean of the data for [the grids representing the top lift of soil in the treatment cell][_____] must be less than the level shown for each contaminant in Table 1B. Analyze data [using the One-Sample t-Test in accordance with EPA 600/R-96/084 (see p. 3-8 of the reference for an example of this procedure), and apply the following statistical conditions][_____]. The statistical conditions include: [true mean greater than or equal to action level (assume site is dirty) maximum false rejection rate (alpha) =5.0 percent; maximum false acceptance rate (beta) =20.0 percent; width of grey region (delta) =15.0 percent of treatment criteria value][_____].

TABLE 1B - REUSE CRITERIA FOR INORGANICS

INORGANIC CONTAMINANT	MAXIMUM TOTAL CONCENTRATION IN SOIL
[_____]	[_____] mg/kg
[_____]	[_____] mg/kg

1.4.2.1.3 Particle Size Criteria for Treated Soil

****

NOTE: Oversized materials are typically separated

from contaminated soil during soil pre-processing. Relatively impermeable oversize materials (e.g., rocks) are often treated by rinsing or pressure washing. However, clods of contaminated soil or other large particle-size materials that are not broken-up during tilling cannot be assumed to be adequately treated by landfarming. If attrition of this chunk-material does not occur with repeated tilling, it may be necessary to perform additional sampling and analysis specifically to determine if chunk-material is being treated.

Particle size criteria may be waived if sampling and analysis of the large particle-size materials demonstrates that treatment criteria is being achieved. A sufficient quantity of large particle-size material should be collected so that samples will be representative of the "chunk-fraction" throughout the treatment cell. The large particle-size material must then be ground-up so that subsamples can be submitted for testing.

If treatment of large particle-size materials cannot be adequately demonstrated, then an additional processing step may be necessary. Equipment such as soil shredders will increase the cost of treatment, but can be used to reduce the particle size and thereby improve the degree of treatment achieved. The goal should be to reduce the particle size of treated soil to approximately 13 to 40 cm 0.5 to 1.5 inches.

****

To achieve uniform treatment, reduce particle size of clumps of soil as necessary by tilling or other mechanical means. The maximum particle size in the treated soil matrix must be not greater than [40][_____] mm [1.5][_____] inches.

1.4.2.2 Treatment Criteria for Contact Water

****

NOTE: Treatment and disposal options for contact water include: onsite treatment and discharge; offsite treatment and disposal; and storage and reuse as irrigation water. It is possible for POLs and other fluids from material handling equipment to be spilled onto soil during process operations. Thus, testing for POLs should be considered. This paragraph should be edited to include site-specific criteria. A State permit under the Clean Water Act may be required for onsite discharge of water, and will include criteria that must be met and documented prior to discharge. The permit may limit discharge of the constituents that are being treated, as well as other constituents introduced in the amendments or conditions caused by the introduction of the amendments.

****

Contact water must meet the criteria shown in Table 2 at the time of [discharge][offsite disposal][_____]. If a State permit is required for onsite discharge, the water must be documented to have met the criteria in the permit prior to discharge.

TABLE 2 - WATER DISPOSAL/DISCHARGE CRITERIA	
PARAMETER	MAXIMUM CONCENTRATION
[_____]	[_____]
[_____]	[_____]

1.4.2.3 Treatment Criteria for Other Waste

****

NOTE: Other waste may include sludge or sediment resulting from treatment of contact water and oversize material. Treatment may not be required for some wastes. Treatment criteria should be provided if treatment will be conducted onsite. Treatment criteria and methods for porous oversize material such as wood chips may be difficult to develop. A separate table should be developed for the criteria. If treatment criteria already provided in the preceding paragraphs do not adequately cover "Other Wastes", it may be necessary to provide additional criteria, specific to "Other Wastes". Oversize material is often pressure-washed prior to disposal. Sludge or sediment may often be blended with contaminated soil for processing in the treatment cell.

****

Treat the following materials prior to disposal: [sludge or sediment resulting from treatment of contact water, and oversize material that has been separated from contaminated soil][_____]. Treat in accordance with regulatory requirements.

1.4.2.4 Emissions and Dust Controls

****

NOTE: Specifications for emission and dust controls should be provided in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. If Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS is not included in the project specifications, emissions, dust, and odor control sources and control activities should be specified here. The remaining text in this note discusses landfarming technology-specific emission and dust control considerations to incorporate into Section 01 57 19. An air pathways analysis should be performed during design in accordance with EP 200-1-24 Air Pathway Analysis for the Design of Hazardous, Toxic and Radioactive Waste (HTRW) Remedial Action Projects. Depending upon the contaminants of concern in the contaminated

materials, the unit processes/operations employed in landfarming, the amount of pollutants emitted, and the geographical location of the site, the emission standards and limitations for certain contaminants and dust control can be identified from the following regulations including, but not limited to, National Primary and Secondary Ambient Air Quality Standards, National Emission Standards for Hazardous Air Quality Pollutants, and state and local regulations.

When editing Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, consider the following: For each stage of operations, an air pollution control plan must include, but not be limited to: the sources of emissions, dust and odors during each stage of operations, and proposed control measures. The stages of operation must include, but are not limited to: construction of paved or lined surfaced, soil preprocessing; treatment, transport, and disposal of oversize material; blending of soil and amendments; during the landfarming process, including during mixing; transport, storage, and disposal of treated material. The plan must specifically address fugitive emissions and odor control during the following activities: amendment delivery and storage; blending of soil and amendments; during the landfarming process, including during mixing; transport of compost; storage of compost; and disposal of compost. If local air pollution regulations require capture and control of specific emissions, the type of collection and treatment equipment should be identified. If air monitoring will be required, the following must also be included: type and locations of monitoring devices, secure retention of the data; and for each stage of operations: frequency of sampling, number of samples from each location, the total number of samples, and the parameters to be monitored. If operations are to occur near occupied areas, consideration must be given to using perimeter air monitoring to generate a defensible record showing that unacceptable air concentrations have not extended past the boundaries of the site .

Based on the regulatory requirements, the proper technologies or apparatus for the emissions control if required can be determined. Upon completion of the design of the landfarming operation, these emission requirements and control technologies should be defined by the design engineer. It may be necessary to implement control measures during the following activities: the field demonstration, excavation, hauling, stockpiling, separation of oversize materials, spreading of amendments, tilling, and disposal of treated soil.

If a performance specification is prepared, the emissions, dust sources, and contaminants of concern

should meet specified requirements based on applicable regulations. Section 01 57 19 should list the emissions criteria for the contaminants of concern for each emission and dust source, and if applicable, monitoring requirements should be specified. The applicable federal, state, and local regulations should also be identified. If the specification is prepared based on detailed design, the technologies or apparatus for controlling the emissions and dust sources should also be specified.
****

Execute the landfarming process to meet the emissions and dust control requirements in [Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][___].

1.4.3 LANDFARMING WORK PLAN

****
NOTE: To avoid duplications in submittal requirements, submittals in this Section should be coordinated with other sections of the contract (e.g., 01 45 00 QUALITY CONTROL, and 01 32 01.00 10 PROJECT SCHEDULE).

If an RPF contract is being prepared, this paragraph and the Submittals paragraph should be edited and used to form the basis for Contractor proposals.
****

Submit a Landfarming Work Plan [as an appendix of the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP)][as a standalone document] not more than [480][_____] calendar days after notice to proceed. [Prepare [draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Landfarming Work Plan. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.] The plan must include, but not be limited to, the following.

1.4.3.1 Schedule

****
NOTE: Landfarming may rely substantially on the supply of seasonal farm-generated inputs like manure and straw. The seasonal availability of these items must be incorporated into the operating schedule. The seasonality may be lessened by stockpiling these materials; if so this feature must be described in the workplan.
****

Provide a schedule specifying dates and durations for: excavation, hauling, stockpiling, start and completion of mobilization, treatment cell construction, separation of oversize materials, delivery and stockpiling of amendments, field demonstration, full-scale treatment of contaminated materials, storage of treated material, disposal of treated material and other wastes, and demobilization. Provide the following details: intended days and hours of operation; plans for operating, or scaling back operations during winter conditions; routine maintenance down-time for tilling equipment; anticipated time to reach cleanup goals for each lift of soil; and laboratory turn-around time to receive data from compliance samples.

1.4.3.2 Project Organization and Personnel

Provide an organization chart, including subcontractors; include the names, responsibilities, education, and resume of the key project personnel. Key personnel must meet the requirements of this paragraph and paragraph KEY PERSONNEL. Key personnel must include, but must not be limited to: project managers, quality control personnel, supervisory operators and technicians, and engineering staff. Clearly define responsibilities of each individual in the organization in terms of project activities including, but not limited to: project management and coordination; scheduling; quality control and quality assurance; sampling; measurement; field and laboratory analysis; data management; operation and maintenance; and health and safety management.

1.4.3.3 Selection of Amendments

****

NOTE: Options are provided for the Designer to either specify that inoculants will not be allowed, or prompting the Contractor to indicate what inoculants they intend to use. The second option provides more flexibility if the Designer does not have a strong reason to disallow inoculants. With some manure amendments, sufficient bacteria are present to inoculate the landfarming cell without resorting to purchase and introduction of a laboratory or factory grown consortia. Some research indicates that bioaugmentation with inoculants can improve landfarming results.

****

Provide rationale for use of each proposed amendment. [Do not use any inoculants as part of the landfarming amendments.][Include rationale for use of any inoculants that will be used in combination with other landfarming amendments.] Provide a description of, and sources for, each amendment; including at least one alternative source for each category of amendment. Include locations of each source, and distances from the site. For amendments that are only available on a seasonal basis, provide a plan for substituting alternative types of amendments. For organic amendments, such as manure or wood products, state the intended freshness of the amendment; or the length of the planned period of aging, prior to incorporating the amendment into soil. Include the proposed quantity of each amendment that will be added to each cubic meter cubic yard of contaminated soil.

1.4.3.4 Operations and Process Monitoring

Provide a detailed description of the proposed operation in the [UFP-QAPP][the Landfarming Work Plan]. The description must include: plans for pre-processing of contaminated soils; plans for stockpiling materials; plans and schedule for pick-up, transport, delivery and storage of each amendment during operations; plans for mixing amendments into soil; methods for measuring quantities of soil and amendments; treatment cell area required for each lift; contact water management plans; parameters that will be monitored during landfarming; frequency of monitoring, tilling and irrigation during operations; locations of each sampling station shown from plan view; sampling locations shown on a diagram depicting a cross-section of the treatment cell; the number of sampling stations per each lift of soil; moisture and temperature monitoring locations must also be shown; and plans for storage and disposal of treated materials.

1.4.3.5 Non-Landfarming Treatment Processes

Provide a detailed description of the procedures for treatment of air, liquid, and solid wastes that will be treated by a process other than landfarming, including: treatment criteria for oversize material and other wastes.

1.4.3.6 Equipment and Servicing

Provide a detailed description of the proposed treatment equipment. For each proposed piece of equipment, describe: function, design capacity, equipment specifications identifying manufacturer and model number, material of construction, recommended operating conditions, and the number of units that will be present on-site during each stage of operations. Equipment described must include, but must not be limited to: tilling devices; pumps; irrigation equipment. Provide plans for servicing equipment, and explain how material handling and tilling will be accomplished during servicing of equipment, and during unanticipated breakdown of machinery. Decontamination of equipment is as required in the mobilization and demobilization plans included in the UFP-QAPP.

1.4.3.7 Process Material Tracking Schedule

Provide a Process Material Tracking Schedule for recording and managing the quantities of the contaminated materials processed. Provide the dates and duration of the following activities for each lift of contaminated material: initiation of landfarming; completion of landfarming; re-processing of any treated materials that failed to meet treatment criteria; storage of treated material; disposal of treated material.

1.4.3.8 Disposal and Reuse of Wastes

Provide a detailed description of the plans for disposal of solid and liquid wastes. For each type of waste that will be generated, specify: origin and description of waste; estimated total quantity of waste; method of transport to disposal location; disposal location; disposal documentation to be provided by the receiving facility; and schedule showing the anticipated quantities and dates for generation, transport, and disposal of the wastes. Waste types must include: treated soil, oversize materials, contact water, and other solid and liquid wastes generated during the project.

1.4.3.9 Uniform Federal Policy Quality Assurance Project Plan

a. Prepare a UFP-QAPP in accordance with EPA 505-B-04-900A and using the UFP-QAPP WKSTS.

b. Provide a detailed, chronological description of the sequence of procedures and tests that will be used to determine whether the soil has met [treatment][and][or][disposal] criteria, including:

   (1) The location of each sampling station shown from plan view.

(2) The number of sampling stations per each lift of soil.

(3) Sampling locations shown on a diagram depicting a cross-section of the treatment cell.

(4) The number of samples that will be tested for each type of test performed.

(5) The decision process to be made with the sample results, i.e., whether the results are to be used individually and applied to the individual areas of the lift, or averaged in order to make a volume-average decision for the entire lift.

(6) If decisions are made based on individual samples instead of lift-wide, the means for reproducibly defining the boundaries of the individual areas within the lift, and the means of segregating out-of-specification soils in one individual area from in-specification soils in another area, and re-treating the out-of-specification soils.

c. Describe any sampling and testing devices for process monitoring; and moisture and temperature monitoring devices that will be used at the landfarming site.

d. For air, liquid, and solid wastes that will be treated by processes other than landfarming, include: testing parameters; sampling locations; number of samples; monitoring frequency; and laboratory turn-around-time.

e. Provide a mobilization and demobilization plan as an attachment to the UFP-QAPP to include, but not be limited to: transport of personnel, material, and equipment; decontamination and disposal of materials and equipment brought to the site; decontamination and disposal of the treatment pad and other paved surfaces; and decontamination of equipment during demobilization. Include a Post-Treatment Cleanup and Sampling Plan in the mobilization and demobilization plan for areas where there was contact with contaminated materials and were disturbed by the Remedial Action/Site Work. Also, discuss the restoration of disturbed areas such as grading, seeding, etc.

f. Submit the UFP-QAPP not more than [480][_____] calendar days after notice to proceed. Prepare [draft for Government review][draft-final for [regulatory][_____] review] and final versions of the UFP-QAPP. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.

[1.4.3.10 Bench-Scale Treatability Study Test Report

Provide the bench-scale treatability study test report as part of the Landfarming Work Plan and after completion of the bench-scale treatability study test. Include: characterization test results for each amendment; the source of each amendment; for each condition tested, the quantity of each amendment that was added per unit volume of soil; the date that the bench scale treatability study test was initiated; chronological table showing all materials added, quantity added, date of addition, and each mixing, irrigation and sampling event. For organic amendments, such as manure or wood products, state the freshness of the amendment; and the length of the period of aging, prior to incorporating the amendment into soil. The report must also include: physical and chemical monitoring data from before, and during treatment; degradation rates; final disposition of wastes and treated material; and conclusions. Provide recommendations for the field demonstration in the report.

]1.4.3.11 Materials Data

Provide safety data sheets (SDSs), certificates of analysis, and product performance data. SDSs must be in accordance with 29 CFR 1910.1200(g).

1.4.3.12 Permits, Permit Equivalents, and Certifications

Provide copies of the permits, permit equivalents and certifications with the Landfarming Work Plan. For the above-listed items requiring a longer time frame, include copies of applications and scheduled dates for receiving final approval.

1.4.4 Other Submittal Requirements

****

NOTE: Submittal scheduling should allow for an adequate amount of time for:
1. Preparation and review of submittals.
2. The treatment period of the bench-scale treatability study test and the field demonstration.
3. Receipt of analytical results from the laboratory for samples collected on the last day of the treatment period.

The time periods shown for completing submittals have been sequenced to illustrate this point. Ideally, the Bench-scale Treatability Study Test Report should be completed before the Contractor is required to submit the Field Demonstration Plan, and the Field Demonstration Report should be completed before the Contractor is required to submit the Landfarming Work Plan.

****

Submit the following as specified:

[1.4.4.1 Bench-Scale Treatability Study Test Plan

Prepare [draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Bench-Scale Treatability Study Test Plan. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. Submit a Bench-Scale Treatability Study Test Plan not more than [30][_____] calendar days after notice to proceed. This plan must incorporate the requirements in paragraph BENCH-SCALE TREATABILITY STUDY TEST and must include:

a. Location of test facility.

b. Minimum and maximum initial levels of contaminants in the soil to be used for the study.

c. Locations that will serve as the source of soil for the study.

d. Test parameters and number of samples that will be used to confirm that the soil meets criteria for the study

e. Rationale for use of each proposed amendment.

f. The source of each amendment. For organic amendments, such as manure or wood products, state the intended freshness of the amendment and the length of the period of aging, prior to incorporating the amendment into soil.

g. For each test condition, provide:

    (1) Quantity of each amendment that will be added per unit volume of soil.

    (2) Temperatures under which testing will be performed.

    (3) The number of replicate tests for each test condition.

    (4) Description of containers that will be used.

    (5) Procedure for mixing soil.

    (6) Frequency of mixing.

    (7) Testing and monitoring parameters.

    (8) Number of samples.

    (9) Monitoring frequency.

    (10) Length of monitoring period.

    (11) Laboratory turn-around-time.

h. Test methods, and other sampling and analysis requirements for the bench-scale treatability study test must be [_____].

]1.4.4.2 Field Demonstration Plan

****

NOTE: It is important that the field demonstration match the intended implementation as closely as possible in terms of inputs and process. Landfarming is sensitive to a variety of factors like moisture, temperature, chemical conditions, and most critically, the survival and propagation of the bacteria. The difference in scale between the demonstration and the implementation will inevitably introduce changes in the conditions. The conditions in the demonstration need to be measured to a greater degree than might be initially supposed, such as greater resolution in the temperature and moisture over time and across the volume of soil being treated, so that the differences due to scale can be identified and minimized, and the implementation can reproduce as

closely as possible the successful conditions of the demonstration.

****

Submit a Field Demonstration Plan not more than [270][_____] calendar days after notice to proceed. Prepare [draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Field Demonstration Plan. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. This plan must include:

a. Location for performing the field demonstration.

b. Minimum, initial levels of contaminants in the soil to be used for the demonstration.

c. Locations that will serve as the source of soil for the demonstration. test parameters and number of samples that will be used to confirm that the soil meets criteria for the demonstration.

d. Rationale for use of each proposed amendment and the source of each amendment.

e. For organic amendments, such as manure or wood products, state the intended freshness of the amendment and the length of the period of aging, prior to incorporating the amendment into soil.

f. For each test condition, indicate:

    (1) Quantity of each amendment that will be added to each cubic meter yard of contaminated soil.

    (2) Anticipated temperatures under which the field demonstration will be performed.

    (3) Irrigation and tilling equipment specifications.

    (4) Irrigation water source.

    (5) Plan for operation, maintenance and process monitoring.

    (6) Laboratory turn-around-time.

g. Test methods, and other sampling and analysis requirements for the field demonstration test must be [_____].

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preconstruction Meeting Agenda

Preconstruction Meeting Minutes; G, [_____]

Bench-Scale Treatability Study Test Plan; G, [_____]

Field Demonstration Plan; G, [_____]

Landfarming Work Plan; G, [_____]

SD-05 Design Data

Adjusted Design; G, [_____]

SD-06 Test Reports

Amendment Test Report

Bench-Scale Treatability Study Test Report; G, [_____]

Pre-Operation Examination Report

Preconstruction Equipment Examination Report

Field Demonstration Operations Reports

Treatment Completion Records; G, [_____]

Water Supply Analysis

Operations Reports

Field Demonstration Report; G, [_____]

Bench-Scale Test Report; G, [_____]

SD-07 Certificates

Certificate Of Analysis For Synthetic Or Manufactured Additives

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

****

NOTE: Regulatory requirements will be location specific and may include local ordinances and State regulatory requirements. Correspondence from regulatory agencies, and other relevant information, should be attached to the specifications to indicate the level of effort necessary for the Contractor to obtain finalized permits, permit equivalents, certifications and to meet substantive regulatory requirements.

For sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. The permits or permit equivalents may include those addressing air discharges, treated water discharge, well installation and abandonment, underground injection, and possibly others. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, delete this section.

****

Obtain the permits, permit equivalents, and certifications; and meet the substantive regulatory requirements necessary for the installation, operation, and closure of the project.[Correspondence from regulatory agencies, and other relevant information, are attached to the specifications to indicate the level of effort necessary to obtain finalized permits, permit equivalents, certifications and to meet substantive regulatory requirements.]

1.6.2 Qualifications

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NOTE: For sites with unusual, or difficult to treat, contaminants of concern, the designer should consider including a requirement that the Contractor have completed a field demonstration or full-scale

project where the same type of contaminants were successfully treated. However, including such a requirement may limit the number of qualified bidders, and drive up the price of the contract. Delete the paragraph if the Contractor has been pre-selected.
****

1.6.2.1 Contractor Experience

Have successfully completed at least[one][_____] landfarming project that required processing of a volume of contaminated soil comparable to the estimated volume that will require treatment during this project. Also have successfully completed at least[one][_____] full-scale project, that required handling and transport of soil contaminated with[a RCRA hazardous constituent, or CERCLA hazardous substance, or petroleum waste][_____]. For each project, provide the following:

a. Site name.

b. Location.

c. Names of the Contractor's key personnel.

d. Key points of contact and phone numbers (including Government representatives, and other parties involved in the project).

e. Dates of mobilization/demobilization.

f. Contaminants of concern.

g. The volume of contaminated soil handled or treated.

Also provide the following, if available:

h. Dates for initiating and completing treatment.

i. Quantity of time required to treat each lift of contaminated soil.

j. Volume and weight of amendments added per unit volume and weight of contaminated soil.

k. Initial volume of soil, and final volume after treatment.

l. Concentrations of contaminants of concern in soil before treatment, during treatment period, and after treatment.

m. The treatment concentration goal.

1.6.2.2 Key Personnel

Provide key personnel with a minimum of[three][_____] years of landfarming field experience. Include system operators, quality control personnel, and supervisory engineering and technical staff involved with the landfarming operation in key personnel. Perform all survey work under the supervision of a registered land surveyor licensed in the [applicable jurisdiction] [State of [_____]].[Perform surveys in accordance with Section:[_____].]

1.6.2.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory[in accordance with [Section 01 45 00 QUALITY CONTROL][_____] and][approved by the Contracting Officer]. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.6.3 Drawings

Project drawings must include:

a. Limits of planned excavations.

b. Layout of the facility.

c. Dimensions of amendment storage areas, pre-processing areas, and treatment cell.

d. Details of treatment cell liner and sumps.

e. Dimensions and volumes of stockpiles for contaminated soils, oversize materials, and treated materials.

f. Locations, dimensions, and volume of collection sumps and any ancillary water storage facilities.

g. Plan view and cross sections of perimeter berms and collection sumps.

h. Ancillary water storage facilities.

i. Size of contact water conveyance devices and structures.

j. Piping and instrumentation diagrams.

k. Process flow diagrams.

1.7 DELIVERY, STORAGE, AND HANDLING

Safely transport, store, and handle equipment and raw materials (including reagents). Package and ship these items in compliance with United States Department of Transportation (USDOT) requirements. Store and handle these items onsite in accordance with the manufacturer's recommendations and applicable regulatory requirements.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

When soil temperatures fall below[5 degrees C 40 degrees F, remain below that temperature for[[_____] hours][[_____] days], and written approval has been received from the Contracting Officer,][_____], suspend operation of the landfarm for the season. Resume operation of the landfarm when soil temperatures remain above [5 degrees C 40 degrees F for[[_____] hours][[_____] days], and written approval has been received from the Contracting Officer][_____]. Do not conduct tilling within[24][_____] hours of a rainfall or irrigation event which saturates the soils.

1.8.2 Existing Conditions

****

NOTE: The pertinent site characterization data should be placed in the appendices of the technical specifications or on the drawings, and referenced here. If the site contains a significant amount of debris, the available information about its extent and characterization should also be provided. Indicate the detail to which site characterization has been performed. The information should also include: construction limits, property survey, access gates and haul roads available to the Contractor, locations of utilities, water sources, area available for the field demonstration and treatment cell, restricted areas adjacent to the project site, chemical data, geotechnical data, sampling locations, and boring logs. Reference the administrative record locations, whether they are physical or digital, of the site if they exist.

Indicate if there are multiple dissimilar types of contaminated materials that will require different operations. Materials may be considered dissimilar based on possessing different soil properties, types of contaminants, or relative concentrations of contaminants. Determination of dissimilar materials may be based on site investigations and/or previously completed treatability studies.

****

The existing site conditions are presented [in Appendix [_____]][and][on the drawings]. These include [physical configuration][utilities][topography][land uses][geotechnical characteristics of the contaminated materials (including [grain size analysis][total organic content][cation exchange capacity][pH][moisture content][density][porosity]) [hydrogeology]] and [nature and extent of contamination][_____]. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions could occur. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within [48 hours][_____] if discrepancies between the data provided and actual field conditions are discovered.

[1.8.3 Previously Conducted Bench-Scale Treatability Studies

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NOTE: This paragraph should be deleted if no previous treatability studies have been conducted.

The methods employed in previous bench-scale treatability studies may not be the same as those proposed by the Contractor. Documentation of the previous bench-scale treatability studies should include the same information shown in the following sub-paragraphs: BENCH-SCALE TREATABILITY STUDY TEST REPORT and FIELD DEMONSTRATION REPORT. Bench-Scale Treatability study reports should be prepared to provide prospective Contractors with sufficient

information to prepare a responsive bid, or proposal, for the contract.
****

Appendix [A][_____] "Bench-Scale Treatability Study Report" is for information purposes only.

]PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Materials and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of such products and must essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, capable of providing service, materials and equipment in an expedient manner.

2.2 WATER SUPPLY

****
NOTE: One important concern for irrigation water is to ensure that salts do not accumulate to levels that inhibit biological activity. Conductivity is an indicator of salt content. Conductivity may be reported in micro-siemen per cm, or micro-mho per cm. Total dissolved solids (TDS) testing may be substituted for conductivity.

Possible water sources include: a nearby pond, or other surface water body; a hydrant, or other connection to a water distribution line; runoff from precipitation; and contact water; see paragraph Storage Volume.
****

Water for irrigation must not contain oils, acids, salts, alkalis, organic matter, solids or other substances at concentrations that could be detrimental to the successful treatment of the contaminated materials. The acceptable ranges, or levels, of the following parameters in the irrigation water must not exceed the criteria established in Table 3.

TABLE 3 - IRRIGATION WATER LANDFARMING CRITERIA CRITERIA

PARAMETER	REUSE CRITERIA
maximum conductivity	[_____] micro-mho per cm
minimum pH	[_____] standard units
maximum pH	[_____] standard units
[_____]	[_____]

Provide water for irrigation that does not contain contaminants that would persist through the landfarming process and that would thereby cause the landfarmed soil to be considered contaminated and not suitable for reuse. Contaminants must also be avoided that may leach through the project site and contaminate groundwater.[If non-potable water is to be used, the irrigation water must be characterized prior to its use using Table 4. Sufficient numbers of samples must be collected to characterize the irrigation water source. Irrigation water that does not meet the criteria in this table may be treated to these criteria prior to landfarming use. Submit a Water Supply Analysis demonstrating that irrigation water meets requirements.

TABLE 4 - IRRIGATION WATER CONTAMINANT CRITERIA

Chemical Contaminants

ANALYTICAL METHOD NUMBER From EPA SW-846	ANALYSIS TYPE	CRITERION TO BE MET
6010 [and 7470A]	Metals [and Mercury]	[Less than Maximum Contaminant Level (MCL)] [_____]
8260	Volatile Organics	
8270	Semi-volatile Organics	
8082	PCBs	
1633	PFAS	
8081	Pesticides	
Within each Analytical Method, only analyze for analytes which have a [MCL] [_____].		

]2.3 AMENDMENTS

****

NOTE: Use of amendments may not be necessary for treatment of some types of soils. Adding amendments such as manure at too high of a rate can change porosity characteristics, and may prevent proper drainage and aeration. Organic contaminants will adsorb onto organic amendments (e.g., wood chips), and may become less available to degrading microorganisms. Adsorption of contaminants can make it appear like the contaminants have been biodegraded. An in-depth discussion of adsorption and bio-transformation reactions can be found in the chapter titled, "Microbe-Soil-Organic Contaminant Interactions", Haider, K., from the text, Bioremediation of Contaminated Soils, Agronomy Monograph no. 37, American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, 1999.

Factors driving selection of amendments include: seasonal availability, proximity of sources to the site, costs, storage and handling properties, moisture content, odor potential, texture and porosity, carbon-to-nitrogen (C:N) ratio, previous

experience with using an amendment, and consistency in the quality of an amendment.

Addition of manure is an inexpensive way to bolster microbial activity, provide nutrients (nitrogen, phosphorous and micro-nutrients), and increase the field capacity of sandy soils. Relative to most other types of manure, chicken manure has a high nitrogen content. Fresh manure will contain higher levels of nitrogen than dried. Nutrients will leach more readily from fresh than from dried manure. Swine manure is not recommended due to the potential for odor problems. Because of the diversity of the bacterial populations within their digestive systems, manure from ruminant animals (e.g., cows) is generally considered to be good source of microbial inoculum. Bedding materials will often be intermixed with manure. These bedding materials may help increase porosity, depending on the soil type. Pope and Matthews previously recommended that manure be applied to each lift at a rate of about 3-4 percent by weight of soil (Bioremediation Using the Land Treatment Concept, EPA/600/R-93/164). Pope currently recommends a 2-4 application rate.

Arsenic-containing compounds are often fed to chicken, turkey and swine as growth promoters. Thus, there is potential for residual levels of arsenic to be present in these types of manure (see "Sources and Practices Contributing to Soil Contamination", Knox, A. S., et al., from the text, Bioremediation of Contaminated Soils, Agronomy Monograph no. 37, American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, 1999.

The C and N contents of candidate amendments can be estimated using literature values, see Appendix A of the On-Farm Composting Handbook (Northeast Regional Agricultural Engineering Service, 1992). Laboratory testing, for moisture and ash content, may also be used to estimate carbon content. By subtracting the ash content from the dry weight, the organic matter content can be determined. The carbon content is usually estimated by dividing the organic matter content by 1.8.

Carbon in the form of aged wood, or other aged wood products is generally considered to be unavailable. Carbon in manure and other relatively soluble organic materials is generally considered to be available. Amendments with high C:N ratios, and high levels of available carbon, will tend to exert a nitrogen demand. Microorganisms will consume nitrogen as they degrade the organic carbon in the amendment. Use of amendments high in available carbon and with high C:N ratios should be limited; as their use will increase the amount of fertilizer needed to replenish nitrogen.

Wood chips, shredded wood or bark may be used to increase the porosity of soil; however, depending on plans for end-use, large-diameter materials may have to be separated from treated soil. It becomes more difficult to maintain aerobic conditions as the porosity decreases, and as the moisture content increases (see paragraph MOISTURE CONTROL). Organic contaminants will often adsorb and accumulate onto wood products present in the contaminated-soil matrix.

Wood products derived from treated wood should not be used, as this may result in secondary contamination of soil. Treated wood especially older treated wood, may contain CCA (chromated copper arsenate), PAHs (from creosote), PCP, or other contaminants. Even newer treated wood that uses wood preservatives approved by the USEPA in the 2010 or later timeframe should be avoided due to the risk of contamination and inhibition of microbial activity. Types of wood which contain naturally occurring compounds that inhibit microbial activity (e.g., cedar) should be avoided. Freshly processed wood products can also release other organic compounds (e.g., organic acids) that can be detrimental to the treatment process. Wood products should be aged under moist conditions for several months prior to use.

****

Provide amendments that are free of chemicals, such as wood preservatives, which could result in secondary contamination of soil. The concentration of glass, plastic, and other foreign materials in each shipment of amendment must not exceed [5][_____] percent, by dry weight. Do not use asbestos containing materials as amendments.

Analyze manure amendments to verify absence of constituents that would pass unaltered through the landfarming process and possibly accumulate in the product soil. The following table should be used:

TABLE 5 - MANURE AMENDMENT CONTAMINANT CRITERIA		
Chemical Contaminants		
ANALYTICAL METHOD NUMBER From EPA SW-846	ANALYSIS TYPE	CRITERION TO BE MET
6010 [and 7470A]	Metals [and Mercury]	[Less than USEPA Residentional Soil Regional Screening Level if one exists] [_____]
8082	PCBs	
1633	PFAS	

TABLE 5 - MANURE AMENDMENT CONTAMINANT CRITERIA
Chemical Contaminants
Within each Analytical Method, only analyze for analytes which have a [Residential Soil RegionalScreening Level] [_____].

2.4 SYNTHETIC OR MANUFACTURED ADDITIVES

Commercial fertilizers are an example of a synthetic or manufactured additive. A Certificate of Analysis for Synthetic or Manufactured Additives must accompany each shipping unit of synthetic or manufactured additive supplied by the vendor.

[2.5 Samples for Bench-Scale Tests

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NOTE: To reduce the overall risk to the government, it is strongly advised that the project team should require the Contractor to collect samples for the bench-scale treatability study test unless the nature of the site prevents the Contractor to do so. Depending on site conditions and project needs (e.g. site security, access issue, etc.), the Government may provide samples to the Contractor to conduct bench-scale treatability study tests.

****

[The Contracting Officer will provide the required samples to conduct the bench-scale treatability study test.][Select sampling locations and collect representative samples to conduct the bench-scale treatability study test. Consider the existing site conditions presented in paragraph EXISTING CONDITIONS when selecting sampling locations.[Conduct sample collection activity in the presence of Contracting Officer.]] The collected bench-scale treatability study test samples must have contaminant concentration levels [representative of the average concentration of the contaminants identified][and][greater than the action level criteria presented in Table 6]. Otherwise, repeat sampling until the contaminant concentration levels exceed the action level criteria. A minimum of [2 composite samples][_____] must be tested. Also provide a physical description of each soil sample, either prepared by or under the supervision of a licensed geologist, to demonstrate that soil-type is representative of the contaminated zone. Do not commence bench-scale treatability study testing until contaminated material sample results meet the aforementioned concentration criteria.

TABLE 6 - ACTION LEVEL CRITERIA	
PARAMETER	ACTION LEVEL CRITERIA
[_____]	[_____] mg/kg

]PART 3 EXECUTION

[3.1 SOIL AND AMENDMENT TESTING AND BENCH-SCALE TREATABILITY STUDY TESTING

****

NOTE: Bench-scale treatability study tests should be performed to confirm that the landfarming process is capable of meeting treatment criteria for the specific contaminants and soil matrix. For contaminants that are known to be amenable to landfarming in a soil matrix similar to that of the project site, bench scale testing may not be necessary. The following reference should be used to prepare the plan for Bench-Scale Treatability Study Testing: EPA 540/R-93-519a, Guidance for Conducting Treatability Studies Under CERCLA, Biodegradation Remedy Selection, 1993.

These paragraphs, and the corresponding submittal descriptions, should be deleted if amendment testing and bench-scale testing were performed prior to awarding this contract.

****

3.1.1 Amendment Test Report

****

NOTE: If a proven type of amendment will be used, testing may not be necessary. However, if a type of amendment has been proposed for which there is no previous experience, the following tests should be considered: bulk density, moisture content, field capacity (or water holding capacity), conductivity, pH, organic matter content (or volatile solids), ash content, and total Kjeldahl nitrogen (TKN). The field capacity of coarse, sandy soils may be improved by adding an amendment with a high field capacity. Conductivity is an indicator of salt content. High salt levels can be detrimental to microbial activity. Organic matter content, ash content, and TKN can be used to determine C:N ratios (see note under paragraph AMENDMENTS).

Contaminants may be present in an amendment that could affect plans for disposal of treated soil. Testing should be performed if it is suspected that use of an amendment could result in secondary contamination of soil.

****

Prior to the bench-scale test, collect and test samples of amendments for: [moisture content, pH, and conductivity][_____]. For each type of amendment, [2 composite samples][_____] must be tested. Submit the amendment test report along with the Bench-Scale Treatability Study Test Report in accordance with paragraph BENCH-SCALE TREATABILIITY STUDY TEST REPORT. Include the following in the report: characterization test results for each amendment; the source and approximate age of each amendment; the date that each amendment was shipped, received and tested by the laboratory; procedure used to ship each amendment (including type of containers and temperature); if amendments were stored for any period of time, the temperature of storage; testing methods used; certification or laboratory reports showing the amendment is contaminant-free; and proposed recipes of soil and amendments for bench-scale treatability study testing.

3.1.2 Bench-Scale Treatability Study Test

****

NOTE: To reduce the chances of using soil samples that are not representative of site conditions, a minimum volume of 4 liters 1 gallon is recommended for each condition to be tested at the bench scale. Use of large particle-size amendments (e.g., bark chips) makes it all-the-more important to require relatively large soil samples for bench-scale treatability study testing.

Prior to initiating the bench-scale treatability study, the soil to be used in the study should be tested to confirm that the levels of contaminants are within the desired range. If test results indicate that the soil is not representative, or contaminant levels are outside of the desired range, then more soil may need to be collected. The bench-scale treatability study should not be initiated until it can be ascertained that the soil that has been collected meets the desired criteria.

****

Submit the proposed test conditions to be included in the bench-scale treatability study testing. Perform at least [two, replicate][_____] tests simultaneously for each selected test condition. Prior to initiating testing, homogenize and divide the soil into replicate volumes. The volume of contaminated soil included in each soil pan must be not less than [[4][_____] liters [1][_____] gallons][_____]. Bench-scale treatability study testing must be performed for a period of not less than [60 days][_____] or until target levels are reached, whichever is shorter.

3.1.2.1 Bench-Scale Test Report

After completion of testing, compile the data, submit the Bench-Scale Test Report and propose the conditions to be tested in the field demonstration, and include the proposal for the in the Bench-Scale Test Report.

]3.2 PREPARATION

****

NOTE: Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES includes requirements for decontaminating equipment that has been used in contaminated zones. That section should be modified to extend decontamination/cleaning requirements to equipment being brought on-site to cover the requirements of this paragraph.

****

3.2.1 Mobilization

Do not mobilize to the site until [the Landfarming Work Plan][UFP-QAPP] has been approved by the Contracting Officer and the Contractor has received written confirmation. Delays caused by the Contractor's failure to meet regulatory requirements must result in no additional cost to the Government. In accordance with[Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____], do not bring rented equipment and equipment previously used for other site remediation to the site until such equipment has been decontaminated and tested.

3.2.2 Pre-Operation Examination

Conduct a pre-operation examination of the on-site infrastructure, utility conduits, monitoring points, and site access constraints. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-treatment conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would potentially have significant impacts on treatment and public safety. Submit a Pre-Operation Examination Report documenting the examination activity [before mobilization begins][_____]. Obtain the necessary utility clearances before initiation of subsurface work.

3.2.3 Preconstruction Equipment Examination

Conduct a preconstruction examination of the landfarming equipment for damages, defects, and dilapidation. Submit the Preconstruction Equipment Examination Report to the Contracting Officer [before construction begins][_____]. The Contracting Officer may conduct an independent examination to ascertain the condition and functionality of the equipment. Based on this examination, the Contracting Officer may reject the entire system or damaged, defective, or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection must be borne by the Contractor. Routinely and properly inspect and maintain the equipment to provide the operation as required by the Contract schedule. Schedule delays and the associated costs are the responsibility of the Contractor. Provide an alternate or auxiliary power source if sufficiently reliable sources are not available.

3.3 FIELD DEMONSTRATION

****

NOTE: Field demonstrations should be performed to confirm that the landfarming process is capable of meeting treatment criteria in a reasonable time frame.

The field demonstration requirements are a function of the uncertainty of the materials to be treated. For well defined wastes, known to be amenable to landfarming, optimization testing may be adequate. Optimization testing would typically be performed using full-scale equipment and facilities. If the amenability of the contaminated material to landfarming, has not been established, the field demonstration should be preceded by bench-scale testing. If the process has yet to be demonstrated on a large scale for the specific soil type and contaminants of concern, it may be advantageous to perform the field demonstration prior to construction of full-scale facilities.

The treatment conditions and amendments used in the

field demonstration should be based on the results of the bench-scale treatability study test. To prevent scale-up problems between the field demonstration and full-scale operations, the area of each treatment cell used for the field demonstration should be at least 5 percent of the area planned for each full-scale treatment cell.

****

Prior to full scale landfarming operations, a field demonstration must be performed. If the materials treated during the field demonstration do not meet the treatment criteria, an equal quantity of the same type of material that failed must be processed, using modified operating conditions, until satisfactory results are obtained. Any treated materials that failed the field demonstration must be kept segregated and returned to the contaminated materials stockpile area for processing during full-scale remediation. The area of each demonstration treatment cell must be a minimum of [9][_____] square meters [100][_____] square feet. Separate treatment cells spaced to prevent intermingling of contaminated material, must be provided for each condition being tested. Conditions to be tested must include: [_____]. The field demonstration must be conducted using the same lift-depth, and similar irrigation and tilling methods as proposed for the full scale operations. The field demonstration must not be initiated until written approval has been received from the Contracting Officer.

3.3.1 Sampling Locations

****

NOTE: Chemical testing should be performed to verify that the materials to be used for the field demonstration contain the contaminants of concern at high enough concentrations to adequately test the process. Additional testing may be warranted to verify that the physical properties of the materials are representative of site conditions.

****

Obtain contaminated material used for the field demonstration from [the location specified by the Contracting Officer][_____]. Prior to performing the field demonstration, test [three composite samples][_____] of the contaminated material to be used for the field demonstration. Consider the existing site conditions presented in paragraph EXISTING CONDITIONS when selecting sampling locations. The contaminated material samples must have contaminant concentration levels [representative of the average concentration of the contaminants identified][and][greater][than the action level criteria presented in Table 7]. Otherwise, repeat sampling until the contaminant concentration levels exceed the action level criteria. Test samples of contaminated materials intended to be used in the field demonstration in accordance with procedures in paragraph PRE-COMPLIANCE TESTING. Do not commence the field demonstration until soil samples meet the aforementioned concentration criteria. Also provide a physical description of each soil sample, either prepared by or under the supervision of a licensed geologist, to demonstrate that soil-type is representative of the contaminated zone.

TABLE 7 - ACTION LEVEL CRITERIA	
PARAMETER	ACTION LEVEL CRITERIA
[_____]	[_____] mg/kg
[_____]	[_____] mg/kg

3.3.2 Monitoring

****

NOTE: Because a more intensive level of monitoring is usually required during the field demonstration than during full-scale operations, a separate set of Operation, Maintenance and Process Monitoring requirements may need to be prepared. The following differences in monitoring requirements are typical for the field demonstration versus full-scale operations: sampling stations may be spaced more densely; temperature, moisture, and respiration testing may be performed more frequently; and sampling and analysis for contaminants of concern may be performed on a more frequent, and more regular basis. A sufficient number of samples should be tested to assess the heterogeneity of contaminant concentrations. The field demonstration may also provide an opportunity to develop a site-specific correlation between field, and laboratory analysis methods.

A sufficient amount of time,which should be based on the results from the bench-scale treatability study test, should be scheduled for the field demonstration to determine the amount of time it will take to reach cleanup goals during full-scale operations. Degradation rates typically decrease as contaminant levels decrease; e.g., it may take 3 times as long to go from 25 to 10 mg/kg as it takes to from 100 to 25 mg/kg. Thus, trends in contaminant levels should not be extrapolated in an attempt to predict how long it will take to reach cleanup goals.

****

During the field demonstration, sampling and analysis must be performed as indicated under paragraph OPERATION AND FIELD QUALITY CONTROL; in addition to these requirements, the following processing monitoring requirements must be implemented: [_____]. The treatment period of the field demonstration must not exceed [180][_____] days, without written approval from the Contracting Officer.

3.3.3 Field Demonstration Operations Reports

During the field demonstration furnish reports weekly for the first [10][_____] weeks, and every [two][_____] weeks thereafter. Maintain copies of the reports at the facility. Record and maintain the following information until closure of the facility: description (including sources) of contaminated soil and amendments on site; the locations of all amendments and contaminated soil on site, and the quantity at each location; receipt, storage, treatment, disposal date, offsite disposal location, volume, and weight of hazardous and non-hazardous wastes including contaminated and treated soil and amendments; and manifests/proof of receipt from the disposal facility for hazardous and non-hazardous wastes. Dispose of all hazardous materials and wastes in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Record the location and quantity of each type of material on a map or diagram of the site. Include cross-references to specific manifest document numbers, if the waste was accompanied by a manifest. Provide summary reports and details of all incidents that require implementing contingency plans, or corrective action measures. Also include:

a. Date and time of each monitoring or testing event.

b. Results from each monitoring or testing event.

c. Monitoring procedure, or test method used.

d. Individual performing the monitoring or testing, and other individuals present.

e. Remarks.

Cross-reference to submittals specified in other Sections to prevent duplicate information in separate submittals.

3.3.4 Field Demonstration Report

****

NOTE: If the results of the field demonstration will be used to inform the Landfarming Work Plan, it may be preferred to report the field demonstration results in the Landfarming Work Plan instead of having a separate Field Demonstration Report. Update the Landfarming Work Plan paragraph and delete this paragraph if using that approach.

****

Provide the field demonstration report[not more than [60][_____] calendar days after completion of the field demonstration. Prepare [draft for Government review] [draft-final for [regulatory][_____] review] and final versions of the Field Demonstration Report. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document]. Include: characterization test results for each amendment; the source of each amendment; for each condition tested, the amount of each amendment that was added per unit volume of soil; chronological table showing all materials added, amount added, date of addition, and each mixing, precipitation, irrigation and sampling event. For organic amendments, such as manure or wood products, state the freshness of the amendment; and the length of the period of aging, prior to incorporating the amendment into soil. The report must also include: physical and chemical monitoring data from before, and during treatment; degradation rates; final disposition of wastes and treated material; and conclusions. Provide recommendations for full-scale operations in the report. In addition, include the day-to-day log of operations and adjustments in an appendix.

3.4 SOIL PRE-PROCESSING

****

NOTE: Soil pre-processing may include stockpiling, screening, and blending of soil and amendments. The maximum recommended particle diameter for soil mixing / tilling equipment can range from 25 to 100 mm 1 to 4 inches. Although it is possible to include relatively large particles in the soil matrix during landfarming, an additional screening step may also be necessary to remove the large particles prior to disposal. The end use for the treated soil often governs the maximum allowable particle diameter. More stringent requirements will apply if treated soil will be allowed to be incorporated into top soil. For surficial landscaping purposes, the concentration of glass, plastic, and other foreign materials should not exceed 5 percent, by dry weight. This paragraph should be coordinated with paragraph AMENDMENTS.

Relatively impermeable oversize materials (e.g., rocks) are usually treated by rinsing or pressure washing. For further discussion see paragraph, Particle Size Criteria for Treated Soil.

****

Pre-process contaminated soils as necessary by [screening][blending][shredding][_____] to provide a maximum particle size in the contaminated soil matrix [compatible with approved material handling and tilling equipment][and no greater than 80 mm 3 inches][_____]. Oversize materials must be separated from contaminated soil prior to mixing soil with amendments.

3.5 OPERATION AND FIELD QUALITY CONTROL

****

NOTE: Operation and monitoring requirements should be based on: applicable literature references; knowledge gained from bench-scale treatability studies and the field demonstration; and historical data from projects with similar soils, and contaminants. Aeration of soil (via tilling) and maintaining proper moisture content are fundamental to successful landfarming. Because there will always be exceptions, where the default values provided in these paragraphs do not suit a specific project, the following paragraphs should be edited appropriately. These paragraphs should be coordinated with Division 1 Sections of the contract; operations, maintenance, and process monitoring requirements are covered in a Division 01 Section of some contracts.

Reference a UFP-QAPP that has been prepared in accordance with DoD and EPA guidance. UFP-QAPPs follow the Data Quality Objectives (DQO) process and are required for DoD environmental restoration work. If a UFP-QAPP has been prepared for the overall

project that landfarming is being used on, referencing to the UFP-QAPP for testing requirements avoids potential for conflicting requirements between the UFP-QAPP and the specifications.
****

Do not initiate full-scale operations until the Landfarming Work Plan[and the UFP-QAPP] has been approved, and written approval has been received from the Contracting Officer. Operation of the landfarming must proceed continuously, through the term of the contract, except as described in paragraph ENVIRONMENTAL REQUIREMENTS. The testing specified in the following sub-paragraphs is needed by the Government to generate documentation that the landfarming treatment has been accomplished in accordance with performance requirements listed in the decision document and approved by the government and regulators (e.g. EPA or other state agencies). The results of these tests may be used as part of the Contractor's QC program; however the Contractor must meet the performance requirements specified in this Section. Perform additional testing and measurements to ensure that treated materials meet requirements without rejecting batches, retesting, or reprocessing.

3.5.1 Dissimilar Soils

****
NOTE: Delete the bracketed text item if dissimilar materials are not known to be present at time of preparing project specifications.
****

Do not mix together dissimilar soils if the bench-scale treatability study and/or field demonstration testing results indicate that different operating conditions have to be implemented to achieve effective treatment of these soils.[Materials known to be dissimilar at the site are defined in [paragraph EXISTING CONDITIONS][_____].]

3.5.2 Containment Inspection

****
NOTE: Routine operation of heavy equipment within lined landfarm facilities can result in damage to the geomembrane liner. Periodically, the granular drainage layer and geomembrane liner should be inspected. Use of rubber-tracked equipment may minimize the risk of such damage.

Containment inspection may not be necessary where the mode of operation involves successively placing new lifts of contaminated soil on top of treated lifts of soil.

Electrical leak location may be an alternative to visually inspecting the geomembrane liner. If electrical leak location is specified, the designer should have a good understanding of electrical leak location methods, availability of testing firms to perform the work, and integration into the project schedule. Refer to ASTM D6747 Standard Guide for Selection of Techniques for Electrical Leak Location of Leaks in Geomembranes to determine the

appropriate location technique. If electrical leak location is retained, the specification and references must indicate how leaks will be identified and how repairs will be made.

****

Inspect the geomembrane liner when the liner may have been damaged during removal of soil from the treatment cell. This requirement does not apply when completing final disposition of the treatment cell. Reason to suspect damage to the geomembrane liner includes [inadvertent removal of more than [half][_____] the thickness of the drainage layer][observations of potential damage by Contractor or Government QC personnel][_____]. Define the limits of potential damage, remove the porous drainage layer material by hand, and conduct a visual inspection of the geomembrane liner [with the Contracting Officer present]. Repair damages to the geomembrane liner in accordance with Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT. Restore the porous drainage layer to the approved design requirements.

3.5.3 Tilling and Aeration

****

NOTE: Tilling too soon after heavy precipitation or irrigation may lead to the formation of hard clods; especially, for soils with high clay content. Light irrigation prior to tilling will help keep dust down.

The direction of tilling should be alternated to facilitate thorough mixing and uniform treatment of the contaminated material. Thorough tilling will result in more homogenous soil, and should reduce the variability of chemical data.

The goal of tilling is to mix and aerate the soil while minimizing compaction. Tilling too frequently can compromise soil structure (i.e., reduce pore volume, and lead to compaction). Although conventional agricultural plowing methods (e.g., using a disk harrow or chisel plows) can result in some degree of mixing and aeration, they are usually much less effective than rotary tilling equipment. Periodic deep tilling (to a depth of about 500 mm1.6 ft) using subsoil tillers can be used to provide a limited degree aeration at depth, and may hasten treatment of soil below the depth limit of a rotary tiller.

Although most categories of organic contaminants biodegrade most readily under aerobic conditions, there are some types of contaminants that are more amenable to biodegradation under anaerobic conditions. There are also some contaminants that are most readily biodegraded under alternating conditions (e.g., anaerobic followed by aerobic conditions). It may be necessary to modify tilling requirements to accommodate these types of alternative treatment strategies. Tilling and aeration procedures should be based on the results and recommendations from the Field Demonstration report approved by the government.

****

Till using a [rotary tiller, with tines attached to a rotating shaft][_____]. Alternate the direction of tilling between lengthwise, crosswise, and diagonal. A light irrigation event, prior to tilling, may be used as a dust control measure. Till the soil in the treatment cell at least once every [14][_____] days, unless monitoring indicates that soil gas oxygen levels are greater than [2 percent][_____], by volume, in which case it may be tilled less frequently. Additional tilling may be required in response to process monitoring; for example, to provide additional aeration.

3.5.4 Moisture Control

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NOTE: The water content at saturation will vary with soil type, and depending on whether amendments were added. Determination of water content as a percent of field capacity (or water holding capacity) provides a more universal indicator of the degree of saturation. Field capacity is determined by saturating a sample, allowing the free water to drain, and then determining the moisture content; field capacity is the mass of water in the sample divided by the dry weight. According to Bioremediation Using the Land Treatment Concept, EPA/600/R-93/164, field capacity can range from 5 percent (for a sandy soil) to 30 percent (for a clay soil). The recommended moisture content for landfarming is between 40 and 80 percent of the moisture content at field capacity. For example, if the field capacity of a soil is determined to be 20 percent, then optimum moisture content would be between 8 and 16 percent.

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3.5.4.1 Field Capacity

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NOTE: The following methods may be used as approximate measures of field capacity: ASTM D425 or ASTM D6836.

When using porous-plate or pressure-membrane apparatus, the pressure that should be applied depends on the soil-specific factors such as organic matter content, soil structure, compaction, and percent sand, silt, and clay. As a general guideline, Methods of Soil Analysis recommends the following pressures for the following soil types: 5-10 kPa 0.7-1.4 psi for coarse-textured, 33 kPa 4.8 psi for medium-textured, and 50 kPa 7.3 psi for fine-textured. If the centrifuge method is used, the centrifuge speed should be adjusted to accommodate differences in soil types (this is analogous to the above guideline for pressure versus soil type).

****

Prior to treating each lift of contaminated material, a minimum of [4][_____] representative composite samples must be tested to determine field capacity (or water holding capacity). Testing soil for field capacity must be performed in accordance with [ASTM D6836][_____].

3.5.4.2 Moisture Content

****

NOTE: Visual/manual methods for estimating moisture content should be used in conjunction with laboratory and field testing. Moisture content should be monitored more frequently than other process parameters. The frequency of monitoring usually depends on the climate and soil type; more frequent monitoring is required in arid climates and for high permeability soils.

ASTM D2974 and ASTM D2216 are equivalent, gravimetric laboratory methods for moisture content testing.

Many moisture monitoring devices used in agricultural applications are not suitable for landfarming because they must be positioned in one location and left undisturbed. Because landfarming involves frequent tilling, moisture monitoring devices that can be inserted into the soil to take immediate readings are preferred.

Several types of electronic moisture sensing devices that provide real-time readings are available. Electrical conductivity moisture sensors are inexpensive but not highly accurate, compared to some of the more sophisticated instruments available. Neutron probes and time domain reflectometry (TDR) moisture sensors offer a higher degree of accuracy, but at a substantially higher capital cost. However, neutron probes are not particularly well suited to landfarming because they are not accurate for measurements less than 180 mm 7 inches from the surface.

****

Quantitatively test the moisture content using a field method (for example, electronic field instrument) at least every [Monday, Wednesday, and Friday][_____] for the first [six][_____] weeks, and every [Monday and Thursday][_____] thereafter. The field method may involve the use of an instrument that correlates moisture content to electrical conductivity. Collect samples for laboratory analysis, and test in accordance with [ASTM D2216][ASTM D2974][_____] to determine moisture content, according to the following schedule: [a minimum of two samples per week, for the first four weeks; and a minimum of two samples, once every eight weeks thereafter][_____]. Collect these samples immediately after testing using the field method, and from the same location as the samples tested using the field method.

3.5.4.3 Irrigation

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NOTE: Factors influencing irrigation water requirements include the field capacity of the soil, water holding properties of amendments (if used), and the climate. A tank truck or a water storage tank may be necessary if a local water source is not available.

****

Irrigate the treatment cell when testing indicates that the soil moisture content is below [40][_____] percent of the field capacity. Do not irrigate at a rate greater than [13][_____] mm [1/2][_____] inch per hour. Irrigate sufficiently to bring the moisture content to within the acceptable limits within [24][_____] hours. Immediately cease irrigation if ponded water is observed in the treatment cell, or if irrigation water is observed running off the treatment cell. Measure the application rate with a water meter. Record the application rate, duration of the irrigation period, and volume of water applied. Measure and record the quantity of water from each precipitation event each weekday.

3.5.4.4 Contact Water Testing

Test contact water, to be reused as irrigation water, for pH and conductivity on the [first,][second,][_____][and][fourth][_____] week after initiating treatment of each lift of soil. If there is more than [13][_____] mm [1/2][_____] inch of precipitation in 24 hours, test the pH and conductivity of the contact water after water from the precipitation event has collected in the contact water storage facility. Each time testing is performed, either withdraw one representative sample from the contact water holding vessel, or directly test the water in the holding vessel by immersing the instrument probe in the water.

3.5.5 Nitrogen and Phosphorus Control

****

NOTE: Commercial fertilizers are often used as a source of nitrogen (N) for landfarming operations. In commercial fertilizer specifications, N is the first of the three components listed (i.e., 33:3:3 refers to N:P:K). The N and P (phosphorous) content is usually expressed as weight percent of N and phosphorus pentoxide equivalents (P2O5) in the fertilizer. To determine the percent of P, by weight, the number corresponding to P should be divided by 2.3. The potassium content, expressed as K2O, in commercial fertilizers is much more significant for plants than it is for microbial nutrition. Slow release fertilizers require less frequent application and supply nutrients at a more constant level. Examples of slow-release, nitrogen fertilizers include: sulfur-coated urea, urea formaldehyde, as well as some organic products (e.g., fish meal, blood meal, etc.). Agricultural spreaders are commonly used to distribute fertilizer across the treatment cell, or it may be dissolved into irrigation water and applied to the cell by the irrigation system.

When measuring nutrients in soils it is important to distinguish between available and total

concentrations of N and P. Readily available nutrients are in a form that can be rapidly assimilated by microorganisms. Total nitrogen is usually determined by adding the level of total Kjeldahl nitrogen (TKN) to that of nitrate nitrogen. TKN includes ammonia nitrogen and nitrogen bound to organics. Nitrate and ammonia (inorganic N) represent the most readily available forms of nitrogen.

There are several different methods for determining available phosphorous in soil. Agricultural labs often use the Bray P-1 method (also known as Phosphorous Soluble in Dilute Acid-Fluoride). For highly calcareous soils (greater than 4 percent calcium carbonate), the Olsen P method (also known as Phosphorous Soluble in Sodium Bicarbonate) is recommended. For additional information on test methods see, Methods of Soil Analysis, Part 2 Chemical and Microbiological Properties, American Society of Agronomy and Soil Science Society of America, 1982.

The following information are found in the literature and are for information only. The Contractor can propose different ratios based on the results from the bench-scale treatability study

testing and field demonstration.

A wide range of optimal carbon-to-nitrogen (C:N) and carbon to phosphorous (C:P) ratios for landfarming have been reported in the literature. A C:N:P ratio range of 100:10:1 to 300:10:1 was recommended (Pope & Matthews, EPA/600/R-93/164). C:N ratios between 25:1 and 38:1 have also been recommended (Huddleston, R.L., et al., Land treatment biological degradation processes. p. 41-61. In R.C. Lowhr and J.F. Malina, Jr. (editors) Land treatment: A hazardous waste management alternative. Water Resour. Symposium 13th. Center for Research in Water Resour., Univ. of Texas, Austin, 1986.)

Insufficient nitrogen levels may lead to sub-optimal degradation rates. However, excessive levels of nitrate and ammonia can also reduce hydrocarbon degradation rates (see Huesemann, "Guidelines for Land-Treating Petroleum Hydrocarbon-Contaminated Soils", Journal of Soil Contamination, 3(3):299-318, 1994). Also organic nitrogen is often present in soil before fertilizer has been added, and recycling of nitrogen will occur as microorganisms die-off. According to Huesmann, one-time additions of inorganic N should be limited, and inorganic N levels should be maintained above a threshold level of about 50 mg/kg. Treatment of soil with high levels of organic contaminants usually requires repeated applications of N.

If the Contractor can demonstrate that increasing one-time applications of N to a value higher than the recommendations from the bench-scale testing, field demonstration, or that prescribed below does not adversely affect contaminant degradation rates, then the Contractor should present such data to obtain approval to increase one-time N application rates. However the data should be from the same site, using the same soil type, the same type of N amendment, and treating the same contaminants.

****

Test the levels of nitrogen and phosphorous within the [first two weeks][_____] of initiating treatment of each new lift of contaminated soil in the treatment cell. Perform subsequent nitrogen and phosphorous testing once every [90 days][_____]. Nutrient testing and application of nutrients may be performed as a pre-treatment step, prior to placement of the soil in the treatment cell. Test a minimum of one representative, composite sample per each 1,000 cubic meters 1,300 cubic yards. Nitrogen analysis must include testing for the following parameters: [nitrate, ammonia, and total Kjeldahl nitrogen][_____]. Phosphorous analysis must be performed by testing for [phosphorous soluble in dilute acid - fluoride][_____]. When the sum of the nitrate and ammonia levels fall below [50][_____] mg/kg as N, apply fertilizer to restore nitrogen levels. Do not exceed 0.18 kg 0.31 pounds of N per cubic meter yard during one time applications of nitrate and ammonia. Apply phosphorous-containing fertilizer when the levels of phosphorous fall below [5][_____] mg/kg as P. Each time fertilizer is applied, record the product name, quantity, and N:P:K content. Take necessary precautions to prevent the release of chemicals, such as nitrate, to the vadose zone and groundwater.

3.5.6 Temperature Monitoring

****

NOTE: Control of temperature is usually not practical for large-scale treatment cells. The treatment cell can be covered by a layer of mulch to help insulate the soil. However the mulch layer may reduce the rate of oxygen diffusion from the atmosphere to the soil, and will have to be removed prior to tilling. In cold climates, activity at large-scale landfarming operations is usually seasonal. Follow the recommended effective temperature range in the Landfarming Work Plan and cease landfarming operation when it becomes impractical. The typical effective Soil temperature range is between 10 and 45 degrees C 50 and 113 degrees F for landfarming operation based on the guidance from Federal Remediation Technologies Roundtable (https://www.frtr.gov/matrix/Landfarming/).

For small-scale projects, it may be possible to perform landfarming inside of a heated building or other type of covered structure during the winter. Structures similar to temporary greenhouses have been used to extend the "landfarming season" during cold periods. More than 3 temperature monitoring locations should be required if a cover structure is being used to determine if adequate temperatures are being maintained throughout the treatment cell.

****

Use the recommended low/high temperature range in the approved Landfarming Work Plan for reference, which should also follow the temperature range requirements listed in paragraph ENVIRONMENTAL REQUIREMENTS. Measure the temperature of the soil in the treatment cell[once every four weeks at the following times: 0800 hours, 1200 hours, and 1600 hours][_____]. Monitor the temperature at a minimum of [three][_____] locations, in the treatment cell. Monitor at the same locations during each event, and at a depth of at least 76 mm 3 inches below the surface of the soil. Record the temperature, time, depth and location of each temperature reading during each monitoring event. Record ambient air temperatures at the time of monitoring.

3.5.7 Soil pH

****

NOTE: The optimum pH range for biodegradation of most types of contaminants is between 6.0 and 8.5 standard units. However, where acclimated populations of microbes are present, degradation may proceed at an adequate rate when the pH is as low as 5.0. The pH can influence the availability of N, P, micronutrients, metals and some types of organic contaminants (see Sims, et al., Prepared Bed Bioreactors, in Bioremediation of Contaminated

Soils, Agronomy Monograph no. 37, American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, 1999).

Biological degradation of organic constituents may result in a reduction of the pH of soils. Strong caustics should not be used to adjust the pH of the soil because they can cause large, rapid changes in soil pH, which may inhibit biological activity. Crushed limestone or lime are commonly used to increase the pH. Agricultural lime is available in several particle-size grades. Finely graded material acts faster than coarsely graded product.

Some soils are naturally alkaline and may require downward pH adjustment. Sulfur-based amendments (e.g., elemental sulfur) may be used to decrease the pH of the soil.

The goal of pH adjustment should be to adjust the pH in small increments. If it appears that pH adjustment may be necessary, samples should be sent to a local soils laboratory (after ascertaining that the laboratory can accept soil from a hazardous waste site). Agricultural extension services (e.g., USDA, Natural Resources Conservation Service) possess knowledge of local soil characteristics any may be able to identify site-specific factors that can influence pH, nutrient availability and other considerations.

Test results should be used to calculate how much pH adjustment agent should be added (e.g., lime requirement test, or excess lime test). Amendments used to adjust the pH should be added in conservative, calculated doses.

****

Unless otherwise described in the approved Landfarming Work Plan, at a minimum, test the pH of soil in the treatment cell[each Monday of the first, second, fourth, and eighth week after initiating treatment of each new lift of contaminated soil, and every six weeks thereafter][_____]. Test a minimum of one representative, composite sample per each 1,000 cubic meters 1,300 cubic yards. The first [three][_____] times pH testing is performed, test a minimum of [two][_____] samples in accordance with ASTM D4972 to determine the pH, and to verify the field method. After the field method has been verified, all subsequent testing may be performed in the field. If the soil pH is greater than 8.5, or less than 6.0, send soil samples to a local soil testing laboratory (such as an agricultural extension laboratory) to determine how much pH adjustment product should be added. Prior to sending any samples, notify the local soil testing laboratory regarding the contaminants that are present in the soil, to determine if they can accept such samples. Test samples for [Lime Requirement or Excess Lime][_____]. The first time the pH is adjusted, not more than [one fifth][_____] of the area of the treatment cell must be adjusted. Do not perform additional pH adjustment until after pH adjustment has been demonstrated to result in increased rates of contaminant degradation, and written approval has been received from the Contracting Officer. Laboratory or field demonstration data may be used to demonstrate that pH adjustment results in increased rates of contaminant degradation. After approval for pH adjustment has been obtained, the pH of stockpiled soil may be adjusted as a pre-treatment step, prior to placement of the soil in the treatment cell. Each time a pH adjustment product is applied, test the soil pH before and after adding the pH adjustment product. Also record the product name, quantity, and supplier of the pH adjustment product used after each application. Do not use aqueous caustics, such as sodium hydroxide, as pH adjusting agents.

3.5.8 Odor Control

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NOTE: If Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS is not included in the project specifications, emissions, dust, and odor sources and control activities should be specified here. To help control odor problems, storage of manure on-site should be avoided. If it is being used as an amendment, manure should be incorporated into soil as soon as possible after delivery to the site.

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Implement odor control requirements as specified in the approved Landfarming Work Plan [and in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____].

3.5.9 Microbial Activity

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NOTE: Several categories of tests are available for assessing microbial activity; however, these tests are almost never direct indicators of the rate of biodegradation of the contaminants of concern. If chemical data indicates that the levels of contaminants of concern are steadily decreasing, then there may not be any need to test for microbial activity. In addition to plate counts and respiration testing (as discussed in the following paragraphs), there are a host of other tests that can be used as indicators of microbial activity.

Nucleic acid probes can be used to determine whether a gene coding for an enzyme capable of degrading a specific contaminant of concern is present in soil, or to determine whether a specific strain of microorganisms are present. Use of nucleic acid probes requires that the gene that codes for the specific enzyme be known, or that the nucleic acid sequence of the specific microorganism be known. It is important to note that nucleic acid probes usually measure the potential for expression of a gene. Only messenger RNA (mRNA) probes measure the actual activity of a gene. For additional information on microbial activity assays see, Methods of Soil Analysis, Part 2 Microbiological and Biochemical Properties, Soil Science Society of America, 1994.

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3.5.9.1 Enumeration of Soil Bacteria

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NOTE: It is not uncommon for topsoil to contain greater than 1 X 10 6 colony forming units (CFU) of heterotrophic bacteria per gram of soil. However, enumeration methods that rely on non-selective media (e.g., counts of heterotrophic bacteria) do not target the specific microorganisms responsible for degrading contaminants of concern. Furthermore, enumeration data is generally not well correlated with microbial activity in soil.

Plate counts performed using selective media can be used to enumerate microorganisms capable of degrading specific contaminants of concern. Selective culturing procedures (i.e., enrichment culture methods) require use of defined growth media. For example, to select for PCP degrading microorganisms, a defined media which includes PCP as the sole carbon source would be used.

****

Enumeration of soil bacteria will not be required, but may be used as a diagnostic, or trouble-shooting, tool. Contaminant-specific selective culturing methods (e.g., pentachlorophenol-degrading bacteria), are recommended over non-specific test methods (e.g., total heterotrophic bacteria).

3.5.9.2 Field Respiration Testing

****

NOTE: Depleted oxygen and elevated carbon dioxide levels in soil gas are often used as indicators of microbial respiration. Soil gas testing may be performed in the field, and can provide a real-time indicator of microbial activity. However, respiration tests do not target the specific groups of microorganisms responsible for degrading contaminants of concern. Oxygen is usually considered to be a better indicator than carbon dioxide because carbon dioxide can be released (or consumed) via abiotic reactions. Levels of respiration are dependent on temperature and moisture. Thus, respiration measurements should be accompanied by temperature and moisture measurements.

Oxygen levels will usually decrease gradually after each tilling event as aerobic microorganisms consume oxygen. Oxygen concentrations greater than about 2 percent, by volume, are generally indicative of aerobic conditions. The concentration of oxygen in the atmosphere is approximately 21 percent, by volume. For most types of organic contaminants, rates of biodegradation will be highest under aerobic conditions.

The depth of insertion of the gas probe and the volume of sample withdrawn must be synchronized to

minimize the chances of drawing in air from the atmosphere. For example, assuming an air-filled pore volume of 25 percent, a 4 mL 0.25 cubic inch air sample drawn from a depth of 100 mm 4 inch would theoretically come from a spherical zone with a diameter of about 78 mm 3 inch (from a depth of 61 to 139 mm 2.4 to 5.5 inches)

****

Unless otherwise described in the approved Landfarming Work Plan, perform soil gas monitoring at least once every [seven][_____] days for the first [six][_____] weeks of treatment, and every [two][_____] weeks thereafter. Perform soil gas monitoring at not less than [five][_____] randomly selected locations in the treatment cell. Test soil gas for levels of [oxygen and carbon dioxide][_____]. The soil gas meter must be sensitive to [oxygen and carbon dioxide][_____] levels of at least [0.1][_____] percent, by volume. The depth of insertion for the soil gas probe must be no less than [200][_____] mm [7.9][_____] inches, and the volume of air withdrawn for the sample must not be greater than [10][_____] milliliters (mL) [0.61][_____] cubic inches. Perform field measurements of soil temperature and moisture at the same time and location of each soil gas measurement. When soil gas monitoring is performed record the following information: the monitoring location, soil temperature, soil moisture (by field method), the elapsed time since the last tilling event, and the time of day when monitoring was performed.

3.5.10 Sampling and Analysis for Contaminants of Concern

****

NOTE: Field analysis methods (e.g., immunoassay or colorimetric test kits) are usually much less expensive than laboratory analysis for contaminants of concern. However, a site-specific correlation between data from field and laboratory analysis should be developed. Pigmented materials present in extracts from soil samples may cause interferences in colorimetric, definitive field analysis. Laboratory analysis should be required on a minimum percentage of samples to verify data from definitive field analysis.

The goal of the sampling should be to collect samples that are chemically and physically representative of the soil in the treatment cell. The strategy for sampling and analysis should be consistent with the regulatory requirements for the data.

Sample designs that may be applied to treatment cells include: simple random, ranked set, and systematic grid. Systematic grid sampling is simple to apply, and provides for relatively uniform coverage of the area of interest (i.e., the treatment cell). See the following reference for more information on sampling designs: Guidance on Choosing a Sampling Design for Environmental Data Collection (G-5S), EPA/240/R-02/005, Dec. 2002. Visual Sampling Plan, a useful software program that can be used to develop sampling designs, can be

accessed at the following internet site: https://www.pnnl.gov/projects/visual-sample-plan

The following paragraphs provide an example of sampling and analysis requirements, using a systematic grid sampling approach, with randomly selected sample locations within each grid (also known as unaligned grid). This example also includes a field analysis component for pre-compliance testing. This is only an example of sampling and analysis requirements. Compliance testing requirements are project specific, and usually based on negotiations with regulatory officials.

****

Perform sampling and analysis in accordance with the approved UFP-QAPP. Furnish results from each sampling event to the Contracting Officer no more than [24][_____] hours after data is recorded by the Contractor, or released by the laboratory.

3.5.10.1 Pre-Compliance Sampling Design

****

NOTE: In the sample design described in these paragraphs, one of the purposes of pre-compliance testing is to determine the variability of the data (i.e., standard deviation). The variability of the data is then used to determine the minimum number of samples (i.e., maximum grid-size) that will be required for confirmatory sampling via the One-Sample t-Test. Typical, default assumptions include: that the data is normally distributed, and that the clean-up goals have not been met (assume site is dirty). An example of using the One-Sample t-Test to determine the minimum, required number of samples is shown on page 3-8 of the following reference: Guidance for Data Quality Assessment, EPA QA/G-9, EPA/600/R-96/084. The same calculation can be performed using the Visual Sampling Plan software program (see https://www.pnnl.gov/projects/visual-sample-plan).

The grid size shown in this example was arbitrarily set at a maximum of 1,000 square meters 10,800 square feet. Grid sizing is a function of the variability of the data, and the statistical criteria that will be used to demonstrate attainment of clean-up criteria. As the grid size increases, the required number of grids (and samples) decrease. Larger grid sizes may be allowable for data that exhibits low variability. An estimate of data variability should be used to arrive at the grid size (and number of samples) for pre-compliance sampling.

Based on landfarming project experience at "wood treater" sites in EPA Region 8, about 10-12 samples per treatment cell are usually needed to meet the

statistical requirements to show that clean-up goals were met. Thus, the default number in this paragraph was set at a minimum of 8 samples. It may be necessary to perform additional sampling and analysis, if the One-Sample t-Test indicates that too few samples were collected.

The default specified by this paragraph is for composite sampling within each grid. Relative to discrete sampling, compositing provides a better measure of the mean contaminant level at a given number of analyses. Discrete sampling is useful for assessing variability within the treatment cell. A round of discrete sampling is recommended during treatment of the first one or two lifts of soil to assess the effectiveness of the Contractor's mixing (i.e., tilling) practices. Discrete sampling would typically involve sampling from one randomly selected location per grid.

****

To determine pre-compliance sampling locations, divide the treatment cell into grids of equal area. Divide the treatment cell into a minimum of [eight][_____] grids. Each grid must be a maximum [1,000][_____] square meters [10,800][_____] square feet. Sample from [four, randomly selected locations][_____] within each grid. Samples from each grid must be [composited][_____] prior to testing. Each sample must include material from the entire depth interval of the top lift of soil in the treatment cell.

3.5.10.2 Sampling Frequency for Pre-Compliance Testing

****

NOTE: Another purpose of pre-compliance testing is to determine whether contaminant levels have decreased to the point where compliance testing should be performed. Performing pre-compliance testing using a field analysis method can result in considerable cost savings by avoiding the expense of unnecessary (i.e., premature) compliance testing.

****

Approved field analysis methods may be used for pre-compliance testing. Sampling must be performed at least twice during treatment of each lift of soil in the treatment cell: (1) immediately after initiating treatment of new lift of contaminated soil; and (2) at the estimated time at which the cleanup levels will have been met (based on the results of the field demonstration). Intermediate sampling may be performed to determine if contaminant degradation is occurring according to schedule expectations.

3.5.10.3 Pre-Compliance Testing

****

NOTE: Low-cost, definitive field analysis methods are recommended for pre-compliance testing (if they are available for the contaminants of concern).

****

Test for the following analytes during pre-compliance testing: [_____].

Test using the [field analysis][_____] method for pre-compliance testing.

3.5.10.4 Compliance Sampling Design

****

NOTE: Compositing samples from each grid is recommended in order to provide a reliable determination of the mean concentration of contaminant levels in the treatment cell while minimizing analytical costs. However, compositing will decrease the variability of the data.

Determination of the minimum number of samples will be dependent on the data variability. Data from discrete samples will usually exhibit a greater degree of variability than data from composite samples. A data set produced from discrete samples may result in more samples being required to demonstrate attainment of treatment criteria, relative to a data set produced from composite samples. Thus, the determination of the required, minimum number of confirmatory samples will be influenced by whether data from discrete (or composite) samples was used.

****

To determine compliance sampling locations [use the same grid divisions from pre-compliance testing][_____]. The required, minimum number of samples must be[based on a statistical analysis of the data from pre-compliance testing, using the One-Sample t-Test in accordance with EPA 600/R-96/084 (see p. 3-8 of the reference for an example of this procedure)][_____]. Sample from [four, randomly selected locations][_____] within each grid. Samples from each grid must be [composited][_____] prior to testing. Each sample must include material from the entire depth interval of the top lift of soil in the treatment cell.

3.5.10.5 Compliance Sampling Collection

****

NOTE: Oversight must be performed to ensure that representative samples are being collected by the Contractor, and to ensure that proper sampling procedures are being followed. The proportion of fines and coarse particles in samples should be nearly the same as that within the treatment cell. Clumps of soil should not be excluded from samples. Clumps of soil present in samples should be crushed before finishing homogenizing the sample. The procedure for excluding other types of particles (e.g., rocks that exceed a maximum diameter) should be established up front, and in accordance with the approved UFP-QAPP/Landfarming Work Plan.

****

Perform compliance testing after pre-compliance testing indicates that a lift of soil has met treatment criteria, and written approval has been received from the Contracting Officer. Perform compliance sampling in the presence of the Contracting Officer. Conduct testing using the method specified in [_____].

3.5.10.6 Government Quality Assurance Testing

****

NOTE: The need for quality assurance testing should be considered on a project-by-project basis, and if not considered necessary this paragraph should be deleted. Factors to consider include whether the Government has access to a laboratory that can analyze quality assurance samples in a timely manner to not delay the project execution. Use of quality assurance testing data also needs to be considered. A relatively straightforward data use is to compare quality assurance sample results to the project Performance Requirements, and a failing result would be treated the same way as a failing Contractor test result. A more complicated data use is to compare results from quality assurance samples and contractor quality control samples for the purpose of determining if there is meaningful disagreement between the results. In this case, procedures would need to be developed for determining when there is a meaningful disagreement between quality assurance and quality control sample results; corrective actions for when a meaningful disagreement was identified would also need to be developed. The process of defining procedures for identifying and correcting meaningful differences should be documented in a project-specific UFP-QAPP and referenced in this specification; the process is likely to complex to be adequately defined in this specification.

****

Provide duplicate samples to the Government's quality assurance laboratory for Government quality assurance. Submit samples at a frequency of one set of samples per [10][_____] sets of quality control tests performed. Quality assurance samples will be tested for the same parameters as the parent quality control sample. Provide additional quality assurance samples upon request.

3.5.11 Post-Treatment Procedure

****

NOTE: If treatment criteria for contaminants of concern have been met, but criteria for re-use (see paragraph CRITERIA FOR REUSE OF TREATED SOIL, in PART 1) have not been met, the soil should either remain in the treatment cell, or be moved to a storage area.

At one Superfund project, lifts of treated soil were overlain by a new lifts of contaminated material, gradually increasing the height of the treatment cell, as each lift was treated. This decreased material handling requirements, as the treatment cell location served as the final disposal site. However, such a plan may also require monitoring to determine if contaminants are migrating into and

re-contaminating the treated material.

There may be a benefit to purposely leaving a small volume of fully treated soil in the treatment cell to mix with the new lift of contaminated soil. Mixing about 50 mm 2 inches of the treated lift with untreated soil may decrease the treatment time for the untreated lift; i.e., material from the treated lift may act as a "starter culture" for the untreated lift.

****

After compliance test data indicates that treatment criteria have been met, and written approval from the Contracting Officer has been received, [remove the treated lift of soil from the treatment cell][_____]. Submit Treatment Completion Records which include, but are not limited to, a summary of the activities performed at the site as part of landfarming, materials and equipment used, and the testing and sampling results.

3.5.12 Procedure for Non-Attainment of Treatment Criteria

****

NOTE: The situation may arise where there are one or two grids that still exhibit substantially higher contaminant levels than other grids (i.e., outlier data points). If the statistical criteria for demonstrating attainment of clean-up criteria can be satisfied based on data from all but the one or two outlier grids, then it may be acceptable to move all of the treated soil (except for the outlier grids) to the disposal location. Soil from the one or two outlier grids should continue to undergo treatment (either by themselves, or via mixing the soil from the outlier grids with the next lift of soil across the entire treatment cell).

If additional sampling is performed to provide more data points for statistical analysis, the Contractor should not be allowed to exclude "selected" data from samples collected during the same time period. Following additional treatment, and more time for biodegradation to occur, data from new samples should be considered separate from pre-existing data sets.

****

If the treatment criteria is not achieved, implement corrective action at no additional cost. The corrective action may include: [supplemental sampling and analysis to increase the size of the data set, to allow the statistical analysis to be repeated; or continued treatment followed by additional sampling and analysis][_____]. If there are sections of the treatment cell for which substantial reduction of contaminants of concern was not observed after the end of the estimated treatment period, prepare a report detailing all activities associated with those sections of the treatment cell. The report must include: probable causes as to why significant reductions were not observed; measures that will be implemented to prevent the same problems from recurring; and a proposed plan for continued treatment of those sections of the treatment cell where treatment criteria were not met. Obtain written approval from the Contracting

Officer prior to implementing measures that deviate from the Landfarming Work Plan. Continue monitoring (at no additional cost, and in accordance with paragraph OPERATIONS AND FIELD QUALITY CONTROL), until the treatment criteria is attained. Submit Treatment Completion Records as specified.

3.5.13 Post-Treatment Screening

****

NOTE: If wood chips or other large diameter particles must be separated from the treated soil prior to disposal, it may be desirable to reuse this material in subsequent lifts of contaminated soil.

Additional sampling and analysis may be required prior to disposal of wood chips. Organic contaminants will often adsorb and accumulate on wood, or other organic materials present in the contaminated-soil matrix. Even though soil may meet clean-up goals, interspersed wood chips may contain relatively high levels of contaminants.

****

Wood chips or other materials whose diameter exceeds the maximum acceptable particle size for the intended end use must be separated from the treated soil prior to disposal.

3.5.14 Operations Reports

Submit operations reports weekly for the first [10][_____] weeks, and every [2][_____] weeks thereafter. Requirements of the Operations Reports must be in accordance with paragraph FIELD DEMONSTRATION OPERATIONS REPORT.

3.5.15 Change of Operating Conditions

****

NOTE: If adjustment to the landfarming operating conditions is required due to change in contaminated material characteristics, then the Contractor's adjusted operating conditions should be evaluated by the Contracting Officer for the extent of changes from the previous operating conditions. Further, price negotiation may be required based on the extent of changes from the previous operating conditions.

****

The following two requirements must be met in order to be considered for change of operating conditions:

a. The physical and chemical characteristics of the contaminated materials are significantly different from the originally defined characteristics.

b. The treatment requirements cannot be met under the current landfarming amendment design and related operating conditions.

When change of operating condition is necessary, notify the Contracting Officer before changes are made to the amendment design and related operating conditions. The Contracting Officer may require the Contractor to perform a field demonstration for significant changes made to the amendment design and related operating conditions in accordance with paragraph FIELD DEMONSTRATION, for approval. If adjustment to the amendment design and/or operating conditions is required due to change in contaminated material characteristics, submit an adjusted design for the extent of changes from the previous design for approval. Further, price negotiation may be required based on the extent of changes from the previous mix design.

3.6 DISPOSAL

****

NOTE: Depending upon the characteristics and quantities, the potential disposal scenarios for wastes may include: on-site treatment and backfilling; partial on-site treatment / backfill, and partial offsite disposal; and offsite disposal. Asphalt surfaces may be removed and sent offsite for recycling, or left in place if desired by stakeholders. One disposal scenario for each type of waste should be clearly defined.

If the treated soil will be incorporated into topsoil, the following indices should meet quality guideline standards: pH, conductivity, maximum particle size, foreign material content, and the levels of heavy metals. See the On-Farm Composting Handbook (Natural Resource, Agriculture, and Engineering Service, 1992) regarding quality guidelines for different end uses of compost; also, see paragraph Criteria for Reuse of Treated Soil.

****

Dispose treated soil that has met Treatment Criteria for Soil[and Criteria for Reuse of Treated Soil] in accordance with regulatory requirements and [UFP-QAPP][Landfarming Work Plan]. After it has been demonstrated that the treated soil meets disposal criteria, dispose the following materials on-site: [oversize materials][sludge resulting from treatment of contact water][excess amendments][and][_____]. Treat, if necessary, and dispose the following materials of off-site: [spent personal protective equipment][spent granular activated carbon][and][_____]. Perform offsite disposal of hazardous wastes in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS, which includes the preparation and submission of manifests and disposal certificates for materials disposed of offsite.

3.7 DEMOBILIZATION

****

NOTE: A separate table should be prepared if criteria for soils below the treatment pad, or other areas of the treatment facility, differ from criteria in paragraph TREATMENT CRITERIA FOR SOIL. This paragraph should be edited appropriately if it is desired to retain portions of the landfarming treatment facilities after project completion. This paragraph should also be coordinated with Division 1 Sections of the contract.

After treatment of the final lift of contaminated

soil, an economical approach for disposition of the treatment cell would involve: leaving the treated lift in-place, puncturing the liner, and re-seeding the treated soil.

The paragraph ENVIRONMENTAL REQUIREMENTS FOR OFF-SITE SOIL in Section 31 00 00 EARTHWORK should be edited to include an appropriate list of chemical testing parameters for off-site soil. Some backfill sources may have chemical testing data already available; the Government should require chemical testing if the backfill chemical testing data is inadequate or does not exist. Off-site backfill should not be tested for only the site contaminants of concern. At a minimum, samples should be analyzed for target contaminant list (TCL) VOCs, TCL SVOCs, target analyte list (TAL) Metals, and Pesticides/PCBs. Additional analyses such as Total Petroleum Hydrocarbons may be appropriate also. Individual States or military installations may require or recommend additional parameters. Typical frequency of sampling would be one sample per 1,900 to 2,300 cubic meters 2,500 to 3,000 cubic yards. However, individual States or military installations may require or recommend more frequent or less frequent sampling.

****

Do not commence demobilization until written approval is received from the Contracting Officer. Follow the approved mobilization and demobilization plan and requirements under paragraph MOBILIZATION AND DEMOBILIZATION. Demobilization must include restoration of the [following areas, as shown on drawings, to their original condition: [_____]]. Disposition of paved surfaces, and subsurface liners must include: [_____]. Disposition of the treatment cell must include: [leaving the last lift of treated soil in-place, puncturing the liner on 2-meter 6.6-foot centers across the length and width of the cell, re-seeding the treated soil[in accordance with Section 32 92 19 SEEDING]]. Demobilization must include, but must not be limited to: [removal of structures and materials used to house or cover the treatment cell,][disconnecting of utility service lines,][decontamination and removal of equipment and materials,][disposal of decontamination wastes,][disposal of residual wastewater,][removal of fertilizer, amendments and other unused materials,][and regrading of berms, as shown on drawings][_____].[Perform post-treatment testing of soils below work area surfaces to verify that the area is not contaminated. These soils must meet the following criteria: [treatment criteria in accordance with paragraph TREATMENT CRITERIA FOR SOIL.][_____]]. If soil excavation is also part of the field activity, excavated areas need to be backfilled and restored to the original condition in accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL and Section 31 00 00 EARTHWORK.[Perform confirmation sampling within the excavated areas in accordance with the UFP QAPP to ensure all contaminated soil above treatment criteria are removed.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 54 19.16 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 54 19.16 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-02 54 19.16 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 54 19.16 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 54 19.16

BIOREMEDIATION OF SOILS USING WINDROW COMPOSTING

02/25

****

NOTE: This guide specification covers the requirements for reduction of the concentrations of organic contaminants in soils by bioremediation using windrow composting.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification was developed based on the use of composting to treat explosives-contaminated soil. According to Composting guidance from Federal Remediation Technologies Roundtable (FRTR), composting also applies to treat soils and sediments contaminated with petroleum hydrocarbons and aerobically biodegradable organic compounds such as nonhalogenated volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). Composting effectiveness is varied for halogenated VOCs, SVOCs, and pesticides and is not effective for more highly

chlorinated compounds (such as polychlorinated biphenyls (PCBs)). This Specification presumes that the project team has confirmed composting is generally a feasible remedy for the site before the specs and contract are prepared.

Please also note that "Contracting Officer" mentioned throughout this document is intended to be an umbrella term for anyone, including the Contracting Officer, designated by the Contracting Officer.

An edited version of this Section may be used to solicit a request for proposal (RFP). Use of an RFP approach may prevent the contract from being awarded to a Contractor that is not technically qualified.
****

1.1 MEASUREMENT AND PAYMENT

****
NOTE: Edit this paragraph based on whether the Contract will use a single job price or unit prices. If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is in the project, move these paragraphs to that Section for editing. The project team should involve their Contracting Office to determine the best way to create a payment schedule/milestone for their Contract or Task Order.

If the project includes Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS, coordinate measurement and payment methods and contaminated material handling and stockpiling between this Section and Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS.

If the quantities of contaminated soils are well defined, payment may be based upon a single job price structure. When the amount of contaminated material is inadequately defined or uncertain, a data gap investigation is generally advised before any windrow composting activity begins. When specifying a unit price structure for treatment, separate items should be provided in the Contract Price Schedule to cover any other work required. Other work items include, but are not limited to: preparation of submittals, mobilization and demobilization, site preparation, construction of the treatment pad and run on/runoff controls, water storage facilities, contact water treatment and disposal, sampling and testing, implementing health and safety requirements, and utilities. Inclusion of separate items in the Contract Price Schedule for the above work tasks should result in a lower unit price for treatment.
****

1.1.1 Unit Prices

1.1.1.1 Field Demonstration

****

NOTE: Prior to planning the field demonstration, bench-scale treatability study testing should be performed to arrive at a suitable recipe of amendments, and to determine if the contaminants of concern are amenable to composting in the site-specific soil matrix. The field demonstration may either be conducted prior to the construction of the full-scale facilities or conducted using the full-scale facilities and equipment. Payment for the field demonstration should be covered by a separate single job price, or on a unit price that is separate from the unit price for full-scale treatment. Because more intensive monitoring is usually required during the field demonstration, and because a demonstration generally has a smaller weight of treated soil over which fixed costs can be distributed, the unit price for the field demonstration will usually be higher than the unit price for full-scale treatment. Analytical Testing for chemical data is not included as a component of the price in this paragraph. The contract price schedule should include separate, unit price items for analytical testing.

If the results of the field demonstration indicate that an extended treatment period (or other special measures) will be required to meet cleanup goals, it may become necessary to modify the bid item that covers treatment pricing for full-scale operations.

****

Payment for the field demonstration will be[by the contract unit price schedule for each[cubic meter yard][_____] treated during the field demonstration][a single job price for proper completion of approved tests]. The price must include the cost of labor, materials, equipment usage, utilities, and fuel for: [pre-processing,] [operation, maintenance and process monitoring (not including testing for chemical data),][ancillary waste treatment and disposal,][preparation of Field Demonstration Report,][and][_____]. Costs for procurement and handling of amendments used in the compost must be included in the unit price for treatment.

1.1.1.2 Contaminated Soils Treatment Unit Price

****

NOTE: Except for equipment usage costs (e.g., rental), other equipment costs are not included as a component of the unit price for treatment in this paragraph; testing for chemical data is also not included in the unit price. The contract price schedule should include separate, unit price items for testing for chemical data.

If unit price payment will be based on weight, dry

weight should be specified and requirements should be included for moisture content testing so that dry weight can be determined. However, surveys are usually required before and after excavation of contaminated material, so that excavation and backfilling can be paid for on the basis of in-place volume. Thus, it is advantageous to pay for processing and treatment of soils using in-place volume as the pricing unit.

****

[Payment for composting treatment of contaminated material will be by the contract unit price schedule for each cubic meter yard of contaminated soil that is treated based on[in-situ volume, or for each measured unit of weight, after separation of oversize material][_____].]

[Payment for composting treatment of contaminated material will be by the contract unit price schedule for each metric ton ton of contaminated soil that is treated. Use a properly calibrated weighing system to accurately measure the gross (bulk) weight of the contaminated material. Convert the measured gross (bulk) weight of the contaminated materials to be treated to dry weight based on the[percent moisture content of representative contaminated material samples. Determine the percent moisture content in accordance with[ASTM D2216][ASTM D4643][ASTM D4959][_____]]. Determine moisture content[daily][for every[500][_____] metric tons tons of contaminated material that is treated][_____].]

[This unit price must include the cost of labor, materials, equipment usage, utilities, and fuel for: [pre-processing,][operation, maintenance and process monitoring (not including testing for chemical data),][ancillary waste treatment and disposal,][preparation of operations reports,][and][_____]. Costs for procurement and handling of amendments used in the compost must be included in the unit price for treatment. After each batch has been treated, the quantity of material that does not meet treatment criteria must be reported and subtracted from the quantity of material comprising the batch, when determining payment for treatment. Payment will not be made for material that does not meet treatment criteria. If additional tests, or additional processing and testing, are necessary to show that material meets treatment criteria, the additional costs must be borne by the Contractor.]

1.1.1.3 Oversize Materials from Contaminated Areas

****

NOTE: This paragraph should be deleted if payment for treatment and disposal of oversize materials will be included as part of the price item for treatment of contaminated soil. Payment for disposal of oversize materials may be by weight or volume, depending on the nature of the materials. Oversize materials may include brush, trees, roots, rubble, construction debris, and materials that cannot be composted.

****

Payment for [disposal][and treatment] of oversize material separated from contaminated soil will be by the contract unit price schedule for each[kilogram pound][_____]. Soil, free water and other extraneous materials must be separated from oversize materials prior to measuring quantities.

1.1.2 Single Job Prices

[1.1.2.1 Bench-Scale Testing

****

NOTE: Single job pricing for each bench-scale treatability study testing run is recommended for this item. The single job price should include analytical costs to evaluate the treatment effectiveness. However, bidders should be required to provide a unit cost amount for testing for chemical data. This will provide a basis for payment for additional analytical costs, if it is determined that more testing will be required. The following reference should be used to prepare the Bench-Scale Treatabilit Study Test Plan: EPA 540/R-93-519a, Guidance for Conducting Treatability Studies Under CERCLA, Biodegradation Remedy Selection, 1993.

****

Payment for bench-scale treatability study testing will be a single jobprice for proper completion of specified tests. The price must include the cost of labor, materials, equipment usage, utilities, and fuel for:

[a. Preparation of the bench-scale treatability study test plan.

][b. Collecting samples.

][c. Sample shipment.

][d. Pre-processing.

][e. Process monitoring (including testing for chemical data).

][f. Disposal of treated material and waste.

][g. Ancillary waste treatment and disposal.

][h. Preparation of the bench-scale test treatability study report.

][i. [_____].]

]1.1.2.2 Other Work Items

****

NOTE: Coordinate this paragraph with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS. Temporary utility connections are covered in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.

****

Payment for other work items not included in the above paragraphs will be included in the payment for the base bid for treatment of the contaminated materials. The other work items include submittals related to mobilization and demobilization, site preparation in the treatment pad, manufacturers' field services, environmental compliance monitoring, health and safety monitoring and controls, and utilities required for the composting treatment if approved by the Government as necessary for the project.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating

BIOCYCLE, JOURNAL OF COMPOSTING AND RECYCLING (BIOCYCLE)

BIOCYCLE	(Nov 1995; 5th Ed 2009) A Standardized Test for Evaluation of Compost Self-Heating; Briton, W.F.Jr, et. al.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

PLANT AND LIFE SCIENCES PUBLISHING (PALS)

NRAES 54	(1992) On-Farm Composting Handbook

U.S. ARMY (DA)

DA PAM 385-64	(2023) Ammunition and Explosives Safety Standards

U.S. ARMY ENVIRONMENTAL COMMAND (USAEC)

USAEC CETHA-TS-CR-93043	(1993) Windrow Composting Demonstration for Explosives-Contaminated Soils at the Umatilla Depot Activity (NTIS PB95-200119)
USAEC SFIM-AEC-ET-CR-96184	(1996) Cost Report: Windrow Composting to Treat Explosives-Contaminated Soils at Umatilla Army Depot Activity (UMDA) (NTIS AD-A318001)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

[1.3 PRE-CONSTRUCTION MEETING

****

NOTE: Delete this paragraph if the requirements are included in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, Section 01 32 01.00 10 PROJECT SCHEDULE, or other Specification Section.

Appropriate facility personnel should be present at the pre-installation meeting if siting of the treatment facility and other associated work areas will be discussed.

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Arrange and conduct a preconstruction meeting at the jobsite[at least five business days prior to the start of operations on the project][_____]. The preconstruction meeting must follow the written pre-construction meeting agenda submitted [_____] days prior to the meeting. The purpose of this meeting is to review the requirements of this Section and the associated plans. The following individuals must attend this meeting: [Contractor's project manager,][site foreman,][and Contracting Officer].

Record pre-construction meeting minutes and publish via email within 48 hours to the attendees. Re-publish the meeting minutes within 48 hours via email pending subsequent comments from the attendees.

]1.4 SYSTEM DESCRIPTION

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NOTE: Requirements for a specific method of treatment are provided below. If the use of a process other than windrow composting will be allowed, this paragraph should be revised to indicate that a process, other than described in this section, may be proposed by the Contractor; other composting methods may include static piles, aerated static piles, or in-vessel. The Contractor's approved submittals must demonstrate equivalent capabilities; and that such approval will not relieve the Contractor of responsibility for meeting specified requirements for safety, reliability, and performance.

It is also recommended that copies of USAEC CETHA-TS-CR-93043, and USAEC SFIM-AEC-ET-CR-96184 be made available to prospective Contractors to provide descriptions of the intended treatment process.

****

Perform treatment using a safe, reliable method to treat contaminated material conforming to paragraph PERFORMANCE REQUIREMENTS, USAEC CETHA-TS-CR-93043, and USAEC SFIM-AEC-ET-CR-96184.[Requirements for a specific process are provided below. The Contractor may propose an alternative process. Government approval of a Contractor-proposed plan does not relieve the Contractor of responsibility for meeting specified requirements for safety, reliability, and performance.]

1.4.1 Design Requirements

1.4.1.1 Composting Treatment Pad

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NOTE: Siting of the treatment facility should be in accordance with regulatory requirements. The prevailing wind direction and the potential for odor and dust generation should also be taken into consideration. The design of the treatment pad and weather cover should include provisions for control of storm water and contact water, and should take into account the expected wheel loads of and contact with material handling equipment. Besides the windrow mixer, various bladed and/or bucketed equipment may have to be used to establish, dress or maintain, and remove the windrows. Concrete pads are typically more expensive, though less permeable than asphalt pads. Asphalt pads have been used for hazardous waste composting projects. It may also be necessary to construct asphalt pads for the following areas: soils pre-processing area; and the amendment and soil blending area.

As an alternative to paving, a polyvinyl chloride (PVC) liner may be used to cover the treatment pad area with laying 2 feet of impermeable soil on top. Place a layer of straw before windrows are formed. The straw layer is an indicator where the bottom of the windrow is. Soil pad should be sampled before disposing of offsite in accordance with federal, state, and local regulatory requirements, and 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Generally, PVC liner can be disposed at an off-site, non-hazardous waste landfill.

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[Pave the treatment pad and other work area surfaces in accordance with Section [32 12 16.16 ROAD-MIX ASPHALT PAVING.][03 30 00 CAST-IN-PLACE CONCRETE.]][_____]. Design the treatment pad to withstand operation of material handling equipment, and to prevent infiltration of contact water. The slope of the surface of the treatment pad must be not less than [2 percent][_____]. Water collection channels must be incorporated into the paved treatment pad, and the pad must drain, by gravity, to collection sumps. The water collection system and sump must be in accordance with paragraph CONTACT WATER MANAGEMENT SYSTEM AND DESIGN STORM. Sloping, placement of collection channels, and sump must be sufficient to prevent ponding in the treatment pad area.

1.4.1.1.1 Treatment Pad Sizing

****

NOTE: The dimensions of the treatment pad should be based on the amount of time required to reach cleanup goals for each batch of compost (including laboratory turn-around time for compliance testing), the amount of time allotted for treatment of the contaminated soil within the contract schedule (i.e., the project duration), the "per-batch amount" of material that will be composted, the bulk density of the compost and soil, windrow dimensions and spacing, and the type of material handling equipment that will be used. A batch is defined as that amount of material, including soil and amendments, for which treatment is initiated at the same time during full-scale operations. After cleanup goals have been met for contaminants of concern, it may be necessary to continue to cure the compost (see paragraph CURING AND STORAGE). The compost may be moved to a separate area for curing. On a previous composting project for explosives, each batch required about 4 weeks on the treatment pad (about 2 weeks treatment time, plus about 2 weeks to receive laboratory data from confirmation samples). Curing was not required on this project.

Formulas for the areas of typical windrow cross sections are provided in NRAES-54. The bulk density of compost will vary depending on what amendments are used and the proportions of soil and amendments (see paragraph AMENDMENTS). See paragraph WINDROW CONSTRUCTION 3 for information on windrow

dimensions. Use of long, narrow treatment pads may allow windrow mixing equipment to process a greater volume of material using a minimal number of turn-arounds. Thus long, narrow treatment pads may result in a more efficient operation than a wider treatment pad. It may be economically advantageous for the Contractor to divide the treatment pad into separate areas, so that mixing equipment does not sit idle: on a portion of the pad, daily mixing of windrows may continue until definitive field analysis indicates that the compost is ready for compliance testing; on the other portion of the pad, the windrows may be allowed to set static while waiting for laboratory data from compliance testing.

****

Locate the treatment pad within the area indicated.[Size the treatment pad to avoid constricting other parts of the composting operations that must be conducted within the designated area available for composting operations.][Size the treatment pad based on the information from, but not limited to, the Remedial Investigation Report, Decision Documents, Bench Scale Treatability Study Test Report, Field Demonstration Report, and Amendment Test Report.]

1.4.1.1.2 Other Work Area Surfaces

****

NOTE: The dimensions of the curing and storage area should be based on the amount of time required for curing, the amount of time that cured compost will remain in storage, and the dimensions of curing and storage piles. The volume of treated material will usually be less than the initial volume of the compost (see paragraph DISPOSAL). The compost is usually allowed to cure until after the following has been observed: the high temperature (43 to 65 degrees C 110 to 150 degrees F) stage of the process has been completed; the temperature has fallen back to about 38 degrees C 100 degrees F or less; and the windrows no longer heat-up after turning. The On-Farm Composting Handbook recommends curing for at least one month. Immature, or improperly cured compost may be detrimental to plants.

It may be necessary to require paving in areas designated for handling contaminated material, and operation of heavy equipment (e.g., front-end loaders).

Curing and storage may not be needed for some projects based on the results of bench-scale treatability study testing, field demonstration, or project team's site-specific knowledge. The main text below may need to be modified if curing and storage are not part of the project requirements.

****

The slope of the surface of the areas for curing and storage must be not less than [2 percent][_____]. The surfaces of areas for curing and storage must be well drained and kept free of standing water at all times. Locate the soils pre-processing area, curing and storage area, and the area designated for blending soil and amendments within the area indicated; and construct and pave in accordance with paragraph COMPOSTING TREATMENT PAD.

1.4.1.2 Contact Water Management System and Design Storm

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NOTE: Windrow composting areas may generate contact water from precipitation if they are uncovered, or from wetting or irrigation to achieve a certain moisture content whether they are covered or uncovered. If in accordance with regulatory requirements, excess contact water may be discharged to national pollutant discharge elimination system (NPDES) storm water discharge outfalls, publicly-owned treatment works (POTW) sewers, facility sewer to onsite treatment systems, or treated and disposed of offsite. If the treatment area is uncovered, the source of data for the design storm should be referenced. Sources for hypothetical storm information in the United States are referenced in Appendix A of Hydrological Analysis of Ungaged Watersheds Using HEC-1, Training Document No. 15, USACE Hydrologic Engineering Center, April 1982; another source is NOAA Atlas 14.

****

Contact water is defined as water that has come into contact with contaminated materials, or other contaminated surfaces. Sources of contact water may include, but are not limited to: water from decontamination of equipment, personnel, and personal protective equipment (PPE); and runoff water from storage, preprocessing and treatment areas. Use a design storm with [24][_____] hour duration and a return interval of [25][_____] years, based on data from [_____]. The collection, conveyance, storage, treatment and disposal system must remove all contact water from the design storm in not more than [24][_____] hours.

1.4.1.2.1 Perimeter Berms

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NOTE: Use of barriers constructed from interlocking concrete blocks may, for some applications, be an acceptable substitute for berms.

****

Construct berms around the perimeter of the following work areas: [treatment,] [storage areas,][and][_____]. Size the perimeter berms to prevent flood water run-on from the [25][_____] year flood, and to contain runoff from the design storm. Maintain a minimum of [0.3][_____] meter [1][_____] foot from the top of the berm to the surface inside of the work area, and from the top of the berm to the surface outside of the work area. Provide at least [3][_____] meters [10][_____] feet of lateral distance between berms and windrows in the treatment pad area to allow passage of equipment for mixing and dressing windrows. Include ramps to permit vehicle access across berms constructed around the [treatment cell and laydown and storage areas][_____].

1.4.1.2.2 Storage Volume

****

NOTE: Typically, storage and testing of contact water is required prior to discharge. Thus contact water storage facilities should be sized to contain the peak detention volume for the design storm. In order to minimize treatment and disposal costs, it is often desirable to reuse the contact water to irrigate windrows. If this approach is applied, the storage volume must be sufficient to retain the volume of water in storage prior to the design storm, and the volume of water generated by the design storm.

Sources of contact water include: water from decontamination of equipment, personnel, and PPE; and runoff water from storage, preprocessing and treatment areas. If the storage, preprocessing, and treatment areas are adequately covered, then the amount of contact water resulting from precipitation events should be limited.

****

Size contact water storage facilities to contain [30][_____] percent above that required for the design storm, and [the maximum volume that will be held in storage for reuse][_____]. The design storm is defined above.

1.4.1.2.3 Reuse, Treatment, and Disposal

****

NOTE: Although it is possible for contact water to accumulate compounds (e.g., acids, bases, or salts) at levels which may inhibit microbial activity, contact water may, typically, be applied to contaminated soil or compost with little or no treatment. Water which has accumulated excessive levels of acids, bases or salts may require treatment and/or offsite disposal.

****

Reuse contact water to the maximum extent in order to minimize the need for new makeup water and to limit the treatment, discharge and offsite disposal of wastewater. Prior to reuse, test contact water in accordance with paragraph CONTACT WATER TESTING and confirm that contact water meets the requirements of paragraph WATER SUPPLY. Prior to disposal, collect and test contact water that cannot be applied to contaminated soil or compost in accordance with paragraph TREATMENT CRITERIA FOR CONTACT WATER. Treat process sludge (resulting from the removal of suspended material in the contact water) to meet the requirements of paragraph [TREATMENT CRITERIA FOR OTHER WASTE][TREATMENT CRITERIA FOR COMPOSTED SOIL][_____].

1.4.1.3 Irrigation Equipment

****

NOTE: Water may be added at many different points in the process: to the raw materials prior to blending; during blending of amendments, before soil has been added; during the initial blending of

compost; and during turning of the compost windrows. Mixing equipment may be equipped with spray nozzles for applying water. Timely irrigation of compost is critical during thermophilic stages of composting, when the highest rates of evaporation occur. In arid climates, water usage rates will obviously be higher than in non-arid climates.

****

Provide irrigation equipment capable of delivering at least [2.9][_____] liters of water per cubic meter [1.0][_____] gallons of water per cubic yard of compost per day, and meeting the requirements of paragraph MOISTURE CONTROL.

1.4.1.4 Weather Cover

****

NOTE: Although "breathable", water resistant cover material is available, direct contact between the covering material and the compost should be avoided. Clam-shell buildings, metal buildings, pole barns, large tents, or other prefabricated structures may serve as weather covers. The section containing requirements for the weather cover (e.g., Section 13 34 19 METAL BUILDING SYSTEMS), should include the design snow load, maximum wind speed, soil bearing capacity, seismic parameters in accordance with UFC 3-301-01, maximum and minimum ambient air temperatures. The interior of the weather cover should be suitable for a high water-vapor environment. Metal surfaces may be subject to corrosive conditions. If the composting will be conducted inside of an enclosed structure, adequate ventilation must be provided. A rate of 3 to 6 air changes per hour has been recommended for composting facilities. Carbon dioxide is generated and oxygen may become depleted during composting. Ammonia gas is commonly generated as well. If volatile compounds are being remediated in the piles and the piles are in the thermophilic stage, such compounds can be volatilized. It is also possible for methane to be generated, if anaerobic conditions are allowed to develop. Finally, steaming can be extensive enough to block the vision of equipment operators. To ensure that proper and consistent ventilation requirements are specified, this section should be coordinated with other sections; e.g., Section 23 30 00 HVAC AIR DISTRIBUTION, edited accordingly.

****

Use weather covers, or appropriate structures, to prevent precipitation from coming into contact with windrows, and design in accordance with Section [13 34 19 METAL BUILDING SYSTEMS][_____]. Provide covers which allow for free exchange of gasses between the atmosphere and the compost. Size weather covers to allow unimpaired maneuvering of[front-end loaders,][windrow mixing equipment,][and][_____]; size openings in weather covers to allow for entry and exit of[front-end loaders,][windrow mixing equipment,][and][_____]. Provide ventilation of the composting facility in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

1.4.1.5 Stockpiles

****

NOTE: Typical stockpile design requirements are provided in Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL. However, in very arid climates, covers may not be necessary. If composting operations will continue during subfreezing conditions, it may be necessary to ensure that the Contractor has included provisions to prevent a portion of the contaminated soil stockpile from freezing. The stockpile requirements in that section should be edited based on site-specific factors and regulatory requirements.

****

In accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL, prepare areas that will be used to stockpile[contaminated material,][oversize material,][treated material that has not been fully cured,][treated material that has been fully cured,][and][_____].

1.4.1.6 Amendment Storage Facilities

****

NOTE: Some types of amendments should be kept covered to prevent contact with precipitation. However, in very arid climates covers may not be necessary. Usually, synthetic membranes are used as covers. To ensure that stored material can be removed from stockpiles and blended with other compost ingredients in subfreezing conditions, it may be necessary to store a portion of some materials at above 0 degrees C 32 degrees F.

To prevent undesired infiltration, some types of amendments (e.g., manure) should be stored in containers, or on a paved surface (e.g., asphalt pad) with containment walls. However, if the amendment is delivered directly to a blending vessel, use of storage facilities may not be necessary. See paragraph AMENDMENT STORAGE regarding controls for insects and rodents.

****

Cover the following amendments to prevent contact with precipitation: [_____]. Covers will not be required for [woodchips][_____]. Use frames, or other materials to prevent contact between covers, and the following amendments: [manure,][and][_____]. Design the storage area to withstand operation of material handling equipment, and to minimize infiltration of contact water. The slope of the surface of the storage area must be not less than [2][_____] percent. Water collection channels must be incorporated into the surface of the storage area, and the storage area must drain, by gravity, to collection sumps. The water collection system and sump must be in accordance with paragraph CONTACT WATER MANAGEMENT SYSTEM AND DESIGN STORM. Sloping, placement of collection channels, and sump must be sufficient to prevent ponding in the storage area.

1.4.1.6.1 Paved Storage Area

Store the following amendments on a paved surface with perimeter berms: [manure,][potato waste (or other vegetable wastes),][and][_____]. Pave the storage area in accordance with Section [32 12 16.16 ROAD-MIX ASPHALT PAVING.][03 30 00 CAST-IN-PLACE CONCRETE.] Provide berms surrounding the paved storage area in accordance with paragraph PERIMETER BERMS.

1.4.1.6.2 Unpaved Storage Area

Store the following amendments on an unpaved surface with containment walls, or stockpile in accordance with paragraph STOCKPILES: [manure,][potato waste (or other vegetable wastes),][and][_____]. Geomembrane liners will not be required for storage of the following amendments: [sawdust,][alfalfa,][wood chips,][and][_____].

1.4.1.7 Material Measurement

Provide scales, meters, and volumetric measuring devices for measuring oversize materials, feed contaminated materials, reagents, and water which conform to the applicable requirements of NIST HB 44, except that the accuracy must be plus or minus [0.1][_____] percent of the quantity being measured. For scales used to measure weight of material in vehicles, provide scales of sufficient length to permit simultaneous weighing of all axle loads. For any scales used to make measurement for payment, ensure the scale is certified [by an acceptable scales company representative][by an inspector of the State Inspection Bureau charged with scales inspection within the state in which the project is located] prior to weighing any materials. Perform a check of calibration of measuring equipment prior to initial use, and once every [seven][_____] calendar days. The requirements of this paragraph do not apply to measurement of chemical or physical data for purposes of demonstrating compliance with paragraph PERFORMANCE REQUIREMENTS.

1.4.1.8 Utilities

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NOTE: The locations and details (such as utility point of contact, sizes, capacities, and flows) of the utility hookups should be provided on the drawings for the Contractor's use. Verify the utilities are available on-site before including the second sentence.

****

In accordance with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS, provide the utilities associated with windrow composting including, but not limited to: [telecommunications,][electricity,][water,][gas,][_____], sanitary, and solid waste facilities. The [telecommunications][electricity][water][gas][sanitary][and][solid waste facilities][_____] are available at the site.

1.4.2 Performance Requirements

1.4.2.1 Treatment Criteria and Criteria for Reuse of Composted Soil

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NOTE: Some types of nonvolatile and semi-volatile organic contaminants are believed to be amenable to

composting, including some explosives, polynuclear aromatic hydrocarbons (PAHs, as found in creosote), and some pesticides and herbicides (see Engineering Bulletin, Composting, EPA 540/S-96-/502; also, see The Science of Composting, by Epstein, 1997). Since temperatures may exceed 65 degrees C 150 degrees F during composting, the volatility of contaminants of concern should be taken into consideration (see paragraph TEMPERATURE).

Depending on regulatory requirements, both total concentration and leachability concentrations for some compounds may be required. Total concentrations can be used to estimate worst case leachate concentrations. If the contaminated material is classified as characteristic waste, leachability testing will usually be required, and the appropriate leachability test (e.g., EPA Synthetic Precipitation Leachate Procedure (SPLP) or EPA Toxicity Characteristic Leachate Procedure (TCLP)) must be selected. If the treated material will not be disposed of in a landfill, SPLP testing may be appropriate.

Although there are EPA Land Application regulations for metals and pathogens (40 CFR 503 - Standards for Use or Disposal of Sewage Sludge), these regulations are not normally applicable to hazardous waste composting (see paragraph CRITERIA FOR REUSE OF COMPOSTED SOIL). Treatment criteria, and criteria for reuse should be in accordance with Federal, state and local regulations. Prior approval by regulatory representatives should be acquired for treatment criteria values.

For those parent compounds for which partial breakdown products (intermediates) have been defined and analytical standards are readily available, it may be necessary to include testing for key intermediates. A compound should not be targeted for analysis unless there is a defensible basis for including the compound.
****

1.4.2.1.1 Treatment Criteria for Composted Soil

****
NOTE: Paragraph CONFIRMATION OF ATTAINMENT OF TREATMENT CRITERIAshould be coordinated with this paragraph, and reviewed for guidance on adding a separate set of "ceiling values", 40 CFR 503.13 for each contaminant of concern to this paragraph. In some cases attaining a target concentration for the site's contaminants of concern might not be sufficient; composting typically does not completely degrade, or mineralize, the contaminants but rather converts them to a series of complex degradation products which may not be analyzable with regular lab methods, and which will likely not have health

based screening values. These products may bind irreversibly to the soil, indicating that composting is a technology that has both degradation and stabilization aspects. In this case it may be necessary to augment the treatment criteria by adding a bacterial assay, such as the Ames Mutagenicity test, to verify the safety of the finished compost, or the safety of the leachate from the finished compost. Another factor is that the mixing of the soils with carbon rich amendments, and their bacterial degradation, will change the redox balance of the soil and possibly convert native insoluble metals to mobile forms. This can be detected with TCLP testing of the finished soil. Lastly, there can be the concern that mixing large amounts of amendments with contaminated soil causes dilution of the contaminants, that is, it causes an immediate decrease in contaminant concentration without any composting having occurred. Soil remedial criteria could be reduced by a dilution factor to demonstrate that treatment is actually occurring and not just dilution. However, the amendments should be added to the windrows per the bench-scale treatability study test recommendations and be controlled to ensure the recommended amount of amendments was added. Periodic testing should be conducted to confirm the degradation rate and contaminant concentrations and determine if the performance requirements will be or have been met. This paragraph should be edited to include site-specific criteria. Table 1 would include contaminants specific to the project objectives.

****

The mean of the data for each batch of compost must be less than the criteria shown in Table 1. The definition of a batch of compost, over which a "pass/fail" decision will be made, must be determined during project planning, and may be defined as large as one or more windrows, or as small as individual sampling sections of a windrow. If the batch is as small as the 23 cubic meter 30 cubic yards sampling unit, the workplans must define how such a unit of compost can be removed from the windrow if the unit is the only one in the windrow to attain the Treatment Criteria.

TABLE 1 - TREATMENT CRITERIA FOR ORGANICS

ORGANIC CONTAMINANT	TOTAL CONCENTRATION IN COMPOST
[_____]	[_____] mg/kg

1.4.2.1.2 Criteria for Reuse of Composted Soil

****

NOTE: The land application or beneficial use of the compost will be largely controlled by existing land disposal restrictions (40 CFR 268), specifically toxicity characteristics for RCRA metals, volatiles, and semi-volatiles and any triggered universal treatment standards (40 CFR 268.48). While the

metals loading rates found in 40 CFR 503 - Standards for the Use or Disposal of Sewage Sludge (i.e. 40 CFR 503.13 - Pollutant limits) may be useful in evaluating beneficial use alternatives, the designer should be cautioned that the scope of that standard is for domestic sewage sludge. Composted materials may not meet that definition, and therefore the designer must confirm and check with hazardous waste management regulations prior to land application or beneficial use of the materials. The application of ceiling values listed in 40 CFR 503.13 to finished compost not excluded from hazardous waste regulations, is not allowed under regulation (40 CFR 503.6).

Although reductions in concentrations of heavy metals may occur due to dilution (through addition of amendments), composting is usually not considered a treatment process for inorganics. However, depending on regulatory requirements and intended end use, it may be necessary to require testing for some inorganic parameters (in both compost and compost TCLP leachate), for pathogens, and to include requirements to ensure that the compost has been properly cured (see paragraph CURING AND STORAGE). Toxicological testing of treated and untreated material was previously performed as part of a treatability study (see Characterization of Explosives Processing Waste Decomposition Due to Composting [DTIC ADA294505] , prepared for USATHAMA by Oak Ridge National Laboratory, Sep. 1994); however, toxicity testing is usually not required during full-scale operations. This paragraph should be edited to include site-specific criteria.

****

Prior to final disposition, the compost must meet the following criteria to determine if it has been properly cured:

a. Minimum and maximum pH [5.0][_____] and [7.6][_____], respectively.

b. The increase in temperature observed during the Dewar self-heating test must be not more than [15][_____] degrees C[60][_____] degrees F above the ambient temperature; and the ambient temperature must not be greater than 25 degrees C 77 degrees F.

c. The soluble salt concentration (conductivity) of the finished compost must be less than [20][_____] Millimhos per centimeter (mmhos/cm).

d. Dewar self-heating testing, and conductivity testing must be performed in accordance with paragraph NON-STANDARD SAMPLING AND ANALYSIS, in PART 3.

e. The treated material must meet the criteria shown in Table 2.

TABLE 2 - REUSE CRITERIA FOR INORGANICS	
MAXIMUM TOTAL INORGANIC CONTAMINANT	CONCENTRATION IN COMPOST
[_____]	[_____] mg/kg
[_____]	[_____] mg/kg

1.4.2.2   Treatment Criteria for Contact Water

****
NOTE: Treatment and disposal options for contact water include: onsite treatment and discharge; offsite treatment and disposal; and storage and reuse as irrigation water. It is possible for petroleum, oils and lubricants (POLs) and other fluids from material handling equipment to be spilled onto compost during process operations. Thus, testing for POLs should be considered. The treatment criteria shown below are only examples. This paragraph should be edited to include site-specific criteria. A State permit under the Clean Water Act may be required for onsite discharge of water, and will include criteria that must be met and documented prior to discharge. The permit may limit discharge of the constituents that are being treated, as well as other constituents introduced in the amendments or conditions caused by the introduction of the amendments. If treated contact water is to be disposed of at an offsite facility, the facility's specific standards and analysis criteria should be met.
****

Contact water must meet the criteria shown in Table 3 at the time of [discharge][offsite disposal][_____]. If a State permit is required for onsite discharge, the water must be documented to have met the criteria in the permit prior to discharge.

TABLE 3 - WATER DISPOSAL/DISCHARGE CRITERIA	
PARAMETER	MAXIMUM CONCENTRATION
[_____]	[_____]

1.4.2.3   Treatment Criteria for Other Waste

****
NOTE: Other waste may include: excess amendments, sludge resulting from treatment of contact water, oversize material, and manufactured material. Treatment may not be required for some wastes. Treatment criteria should be provided if treatment will be conducted onsite. Treatment criteria and methods for porous oversize material such as wood chips may be difficult to develop. A separate table should be developed for the criteria. One treatment

scenario for each type of waste should be clearly defined. If treatment criteria already provided in the preceding paragraphs do not adequately cover "Other Wastes", it may be necessary to provide additional criteria, specific to "Other Wastes". Oversize material is often pressure-washed prior to disposal. Sludge or sediment may often be blended with contaminated soil for processing in the composting operation.

****

The following materials must be treated prior to disposal: [excess manure and vegetable wastes, sludge resulting from treatment of contact water, and oversize material that has been separated from contaminated soil][_____]. Treatment must be in accordance with regulatory requirements.

1.4.2.4 Emissions and Dust Control

****

NOTE: Specifications for emission and dust controls should be provided in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. If Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS is not included in the project specifications, emissions, dust, and odor control sources and control activities should be specified here. The remaining text in this note discusses composting technology-specific emission and dust control considerations to incorporate into Section 01 57 19. An air pathways analysis should be performed during design in accordance with EP 200-1-24 Air Pathway Analysis for the Design of Hazardous, Toxic and Radioactive Waste (HTRW) Remedial Action Projects. Depending upon the contaminants of concern in the contaminated materials, the unit processes/operations employed in the treatment plant, the amount of pollutants emitted, and the geographical location of the site, the emission standards and limitations for certain contaminants and dust control can be identified from the following regulations including, but not limited to, National Primary and Secondary Ambient Air Quality Standards, National Emission Standards for Hazardous Air Quality Pollutants, and state and local regulations. For projects near sensitive populations, contaminant, dust, and wind speed monitoring may be considered at the property boundary to provide evidence of no adverse offsite effect. If perimeter air monitoring, and emission control requirements are not necessary, this paragraph should be deleted.

When editing Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, consider the following: For each stage of operations, an air pollution control plan must include, but not be limited to: the sources of emissions, dust and odors during each stage of operations, and proposed control measures. The stages of operation must include, but are not limited to: construction of paved or lined surfaced,

soil preprocessing; treatment, transport, and disposal of oversize material; blending of soil and amendments; during the composting process, including during mixing; transport of compost; storage of compost; disposal of compost. The plan must specifically address fugitive emissions and odor control during the following activities: amendment delivery and storage; blending of soil and amendments; during the composting process, including during mixing; transport of compost; storage of compost; and disposal of compost. If local air pollution regulations require capture and control of specific emissions, the type of collection and treatment equipment should be identified. If air monitoring will be required, the following must also be included: type and locations of monitoring devices, secure retention of the data ; and for each stage of operations: frequency of sampling, number of samples from each location, the total number of samples, and the parameters to be monitored. If operations are to occur near occupied areas, consideration must be given to using perimeter air monitoring to generate a defensible record showing that unacceptable air concentrations have not extended past the boundaries of the site .

Based on the regulatory requirements, the proper technologies or apparatus for the emissions control if required can be determined. Upon completion of the design of the treatment plant, these emission requirements and control technologies should be defined by the design engineer. It may be necessary to implement control measures during the following activities: the field demonstration, excavation, hauling, stockpiling, separation of oversize materials, blending amendments, blending amendments and soil, construction of windrows, mixing windrows, transport of compost, disposal of finished compost, and reuse of finished compost (e.g., land application). There may be an increased potential for human exposure to ammonia gas and mold spores (e.g., Aspergillus fumagatus) during composting.

If a performance specification is prepared, the emissions, dust sources, and contaminants of concern should meet specified requirements based on applicable regulations. Section 01 57 19 should list the emissions criteria for the contaminants of concern for each emission and dust source, and if applicable, monitoring requirements should be specified. The applicable federal, state, and local regulations should also be identified. If the specification is prepared based on detailed design, the technologies or apparatus for controlling the emissions and dust sources should also be specified.

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Execute the windrow composting process to meet the emissions and dust control requirements in [Section 01 57 19 TEMPORARY ENVIRONMENTAL

CONTROLS][_____].

1.4.3 Composting Work Plan

****

NOTE: To avoid duplications in submittal requirements, submittals in this Section should be coordinated with other sections of the contract (e.g., 01 45 00 QUALITY CONTROL, and 01 32 01.00 10 PROJECT SCHEDULE).

If a request-for-proposal contract is being prepared, this paragraph and the Submittals paragraph should be edited and used to form the basis for Contractor proposals.

****

Submit a Composting Work Plan [as an appendix of the Unified Federal Policy-Quality Assurance Project Plan (UFP-QAPP)][as a standalone document] no more than [200][_____] calendar days after notice to proceed.[Prepare [draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Landfarming Work Plan. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.] The composting work plan must include, but must not be limited to, the following:

1.4.3.1 Schedule

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NOTE: Composting may rely substantially on the supply of seasonal farm-generated amendments like manure and straw. The seasonal availability of these items must be incorporated into the operating schedule. The seasonality may be lessened by stockpiling these materials; if so this feature must be described in the workplan.

****

Provide a schedule specifying dates and durations for: excavation, hauling, stockpiling, start and completion of mobilization, treatment pad construction, separation of oversize materials, delivery and stockpiling of amendments, field demonstration, full-scale treatment of contaminated materials, storage of treated material, disposal of treated material and other wastes, and demobilization. Provide the following details: intended hours of operation, routine maintenance downtime, other scheduled downtime, anticipated time to reach cleanup goals for each batch of soil and amendments, anticipated laboratory turn-around time to receive data from compliance samples.

1.4.3.2 Project Organization and Personnel

Provide an organization chart, including sub-contractors; include the names, responsibilities, education, and resume of the key project personnel. Key personnel must meet the requirements of this paragraph and paragraph KEY PERSONNEL. Key personnel must include, but must not be limited to: project managers, quality control personnel, supervisory operators and technicians, and engineering staff. Clearly define responsibilities of each individual in the organization in terms of project activities including, but not limited to: project management and coordination; scheduling; quality control and quality assurance; sampling; measurement; field and laboratory analysis; data management; operation and maintenance; and health and safety management.

1.4.3.3 Selection of Amendments

The selection of amendments and the prescribed quantities needed should be based on the recommendations of the Bench-Scale Treatability Study Test Report. Provide a description of, and preferred sources for each proposed amendment; including at least one alternative source for each category of amendment. Include total quantity needed, timeframe (estimated year and month) when needed, locations of each source, and distances from the site. Amendment categories must include: carbon and microbial sources (e.g., manure, vegetable waste) and bulking (e.g., alfalfa hay, and wood materials). For amendments that are only available on a seasonal basis, provide a plan for substituting alternative types of amendments. Include the proposed quantity of each amendment that will be added to each cubic meter cubic yard of contaminated soil.

1.4.3.4 Operations and Process Monitoring

Provide a detailed description of the proposed operation in the [UFP-QAPP][the Composting Work Plan]. The description must include: plans for pre-processing of contaminated soils; plans for stockpiling materials; plans and schedule for pick-up, transport, delivery and storage of each amendment during operations; plans for mixing amendments, soil and constructing windrows; initial volumes of soil and amendments to be treated in each batch; methods for measuring quantities of soil, amendments, and compost; treatment pad area required for each batch; water management plans; parameters that will be monitored during composting, curing and storage; frequency of monitoring, windrows turnover, and irrigation/moisture addition during each stage of operations; locations of each windrow sampling station shown from plan view; sampling locations shown on a diagram depicting a cross-section of a windrow; the number of sampling stations per each batch of compost; windrow moisture and temperature monitoring locations must also be shown; and plans for storage of treated materials.

1.4.3.5 Non-Composting Treatment Processes

Provide a detailed description of the procedures for treatment of solid and liquid wastes that will be treated by a process other than composting; including: treatment criteria for oversize material and other wastes.

1.4.3.6 Equipment and Servicing

Provide a detailed description of the proposed treatment equipment. For each proposed piece of equipment, describe: function, design capacity, equipment specifications identifying manufacturer and model number, material of construction, recommended operating conditions, and the number of units that will be present onsite during each stage of operations. Equipment described must include, but must not be limited to: mixing devices; windrow turning equipment; pumps, valves and other in-line devices; irrigation/moisture equipment.[For equipment that will be in contact with explosives-contaminated material, a copy of the explosives hazard analysis report for each piece of equipment must be provided; this includes equipment used to homogenize and grind samples. Explosives hazard analysis reports must be in accordance with DA PAM 385-64.] Provide plans for servicing equipment and explain how material handling and windrow mixing will be accomplished during servicing of equipment, and during unanticipated breakdown of machinery. Decontamination of equipment is as required in the mobilization and demobilization plans included in the UFP-QAPP.

1.4.3.7   Process Material Tracking Schedule

Provide the Process Material Tracking Schedule for recording and managing the quantities of the contaminated materials treated. Provide the dates and duration of the following activities for each batch of contaminated material: initiation of composting; completion of composting; reprocessing of any treated materials that failed to meet treatment criteria; storage of treated material; disposal of treated material.

1.4.3.8   Disposal and Reuse of Wastes

Provide a detailed description of the plans for disposal or on-site treatment of solid and liquid wastes. For each type of waste that will be generated, specify: origin and description of waste; estimated total quantity of waste; method of transport to disposal location; disposal location; on-site water treatment equipment and planned discharge option if allowed; disposal documentation to be provided by the receiving facility; and schedule showing the anticipated quantities and dates for generation, transport, and disposal of the wastes. Waste types must include, but must not be limited to: finished compost, other treated material, oversize materials, contact water, and other solid and liquid wastes generated during the project.

1.4.3.9   Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP)

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP QAPP) in accordance with the requirements set forth in EPA 505-B-04-900A and using the UFP-QAPP WKSTS. Submit the UFP-QAPP no more than [200][_____] calendar days after notice to proceed. Prepare [draft for Government review][draft-final for [regulatory][_____] review] and final versions of the UFP-QAPP. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.

1.4.3.9.1   Procedures And Tests

Provide a detailed, chronological description of the sequence of procedures and tests that will be used to determine whether the compost has met criteria for[disposal][and][or][reuse]; including: the location of each sampling station shown from plan view; the number of sampling stations per each batch of compost; sampling locations shown on a diagram depicting a cross-section of a compost pile; the number of samples that will be collected and tested for each type of test performed; and the manner in which the data will be used, such as compositing the data over the entire windrow for a windrow-wide "pass/reject" decision, or dividing a windrow into multiple sectors for individual "pass/reject" decisions.

For the solid and liquid wastes that will be treated by a process other than composting, provide testing parameters; sampling locations; number of samples; monitoring frequency; and laboratory turn-around-time. Describe moisture and temperature control instrumentation and sampling and testing devices for process monitoring.

1.4.3.9.2 Mobilization and Demobilization

Provide a mobilization and demobilization plan as an attachment to the UFP-QAPP to include, but not be limited to: transport of personnel, material, and equipment; decontamination and disposal of materials and equipment that brought to the site; decontamination and disposal of the treatment pad and other paved surfaces; and decontamination of equipment during demobilization. Include a Post-Treatment Cleanup and Sampling Plan in the mobilization and demobilization plan for areas where there was contact with contaminated materials and were disturbed by the Remedial Action/Site Work. Also, discuss the restoration of disturbed areas such as, grading and seeding.

[1.4.3.10 Bench-Scale Treatability Study Test Report

Submit the bench-scale treatability study test report as part of the Composting Work Plan after completion of the bench-scale treatability study test. Include: characterization test results for each amendment; the source and approximate age of each amendment; the proportions of amendments and soil in each recipe tested; the date that each amendment was shipped and received by the laboratory; procedure used to ship each amendment (including type of containers and temperature); how long amendments were stored prior to use and the ambient temperature of the storage area; the date that the bench scale test was initiated; physical and chemical monitoring data; and proposed recipes of soil and amendments for the field demonstration. Graphs of temperature versus time must be provided for each self-heating test performed. Both ambient temperatures and compost temperatures must be provided. After completion of bench-scale testing, review the test results, and propose the recipes of soil and amendments to be included in the field demonstration. Include the proposal for the field demonstration in the Field Demonstration submittal.

]1.4.3.11 Materials Data

Provide safety data sheets (SDSs), certificates of analysis, and product performance data. SDSs must be in accordance with 29 CFR 1910, Section 1200(g).

1.4.3.12 Permits, Permit Equivalents, and Certifications

Provide copies of the permits, permit equivalents and certifications with the Composting Work Plan. For any of the above-listed items requiring a longer time frame, include copies of applications and scheduled dates for receiving final approval.

1.4.4 Other Submittals Requirements

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NOTE: Submittal scheduling should allow for an adequate amount of time for:
1. Preparation and review of submittals.
2. The treatment period of the bench-scale treatability study test and the field demonstration.
3. Receipt of analytical results from the laboratory for samples collected on the last day of the treatment period.

The time periods shown for completing submittals

have been sequenced to illustrate this point. Ideally, the Bench-Scale Treatability Study Test Report should be completed before the Contractor is required to submit the Field Demonstration Plan, and the Field Demonstration Report should be completed before the Contractor is required to submit the Composting Work Plan.
****

Submit the following as specified:

1.4.4.1 Amendment Test Plan

Submit the amendment test plan not more than [21][_____] calendar days after notice to proceed. Prepare[draft for Government review][draft-final for [regulatory] [_____] review] and final versions of the Amendment Test Plan. Allow [30][_____] calendar days for[Government]review[and [30] [_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. This plan must address, but must not be limited to: the source of each amendment; testing parameters; and the number of samples. Proposed procedures for shipping amendments to the laboratory must also be provided, including: type of containers; and the maximum time periods between shipping, laboratory receipt, and initiation of testing.

[1.4.4.2 Bench-Scale Treatability Study Test Plan

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NOTE: The following reference should be used to evaluate the Bench-Scale Treatability Study Test Plan: EPA 540/R-93-519a, Guidance for Conducting Treatability Studies Under CERCLA, Biodegradation Remedy Selection, 1993. Consider including these references as requirements in for the Bench-Scale Test Plan.
****

Submit the Bench-Scale Treatability Study Test Plan no more than [90][_____] calendar days after notice to proceed. Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Bench-Scale Treatability Study Test Plan. Allow [30][_____] calendar days for[Government]review[and [30] [_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. This plan must incorporate the requirements in paragraph BENCH-SCALE TREATABILITY STUDY TEST and must address, but must not be limited to: location of test facility; amendment selection rationale; the various amendment recipes to be testing with rationale; the source of each amendment; test parameters, number of samples, and sampling locations that will be used determine the source of soil; the proposed proportions of amendments and soil in each recipe; the number of replicate tests for each selected recipe; procedure for mixing soil and amendments; types of containers that will be used; frequency of mixing; testing and monitoring parameters; number of samples; monitoring frequency; length of monitoring period; and laboratory turn-around-time. Proposed procedures for shipping amendments to the laboratory must also be provided, including: type of containers; and the maximum time periods between shipping, test facility receipt, and initiation of testing. Test methods, and other sampling and analysis requirements for the bench-scale treatability study test must be [_____].

]1.4.4.3 Field Demonstration Plan

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NOTE: It is important that the field demonstration match the intended implementation as closely as possible in terms of inputs and process. Composting is sensitive to a variety of factors like moisture, temperature, chemical conditions, etc. The difference in scale between the demonstration and the implementation will inevitably introduce changes in the conditions. The conditions in the demonstration need to be measured to a greater degree than might be initially supposed, such as greater resolution in the temperature and moisture over time and across the volume of soil being treated, so that the differences due to scale can be identified and minimized, and the implementation can reproduce as closely as possible the successful conditions of the demonstration .

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Submit a field demonstration plan not more than [150][_____] calendar days after notice to proceed. Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Field Demonstration Plan. Allow [30][_____] calendar days for[Government]review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. This plan must address, but must not be limited to: target levels of contaminants in soil that will be treated; test parameters, number of samples, and sampling locations that will be used to determine the source of contaminated soil; sources of amendments; the proposed quantity of each amendment that will be added to each cubic meter cubic yard of contaminated soil; irrigation water source; plan for physical and chemical monitoring; laboratory turn-around-time; plan for maintaining proper temperatures, and moisture contents; irrigation and mixing equipment specifications; and waste disposal plan. Test methods, and other sampling and analysis requirements for the field demonstration test must be [_____]. For equipment that will be in contact with explosives-contaminated material, a copy of the explosives hazard analysis report for each piece of equipment must be provided. Explosives hazard analysis reports must be in accordance with DA PAM 385-64.

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Construction Meeting Agenda

Pre-Construction Meeting Minutes; G, [_____]

Bench-Scale Treatability Study Test Plan; G, [_____]

Field Demonstration Plan; G, [_____]

Amendment Test Plan; G, [_____]

Composting Work Plan; G, [_____]

Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP); G

SD-05 Design Data

Adjusted Design; G

SD-06 Test Reports

Field Demonstration Report; G, [_____]

Operations Reports

Treatment Completion Records

Pre-Operation Examination Report

Preconstruction Equipment Examination Report

Water Supply Analysis

Field Demonstration Operations Report

Bench-Scale Treatability Study Test Report

SD-07 Certificates

Certificate Of Analysis For Synthetic Or Manufactured Additives

Testing Laboratory Validation; G, [_____]

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

****

NOTE: Regulatory requirements will be location specific and may include local ordinances and State regulatory requirements. Correspondence from regulatory agencies, and other relevant information, should be attached to the specifications to indicate the level of effort necessary for the Contractor to obtain finalized permits, permit equivalents, certifications and to meet substantive regulatory requirements.

For sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. The permits or permit equivalents may include those addressing air discharges, treated water discharge, well installation and abandonment, underground injection, and possibly others. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, delete this section.

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Obtain the permits, permit equivalents and certifications; and meet the substantive regulatory requirements necessary for the installation, operation and closure of the project.[Correspondence from regulatory agencies, and other relevant information, is attached to the specifications to indicate the level of effort necessary to obtain finalized permits, permit equivalents, certifications and to meet substantive regulatory requirements.]

1.6.2 Qualifications

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NOTE: The majority of composting projects completed to date have involved treatment of soil contaminated primarily with explosive compound trinitrotoluene (TNT). Literature research should be conducted to review past projects or lesson learned to determine

if windrow composting is suitable and effective for the site before remedy selection. For sites with unusual, or difficult to treat, contaminants of concern (e.g., exceptionally high levels of HMX or RDX), the designer should consider including a requirement that the Contractor have completed a field demonstration or full-scale project where explosives-contaminated soil was successfully treated. Although including such a requirement may limit the number of qualified bidders and drive up the price of the contract, coordinate with Contracting Office to conduct market research to identify possible qualified vendor or contractor that could perform the contract requirements successfully.

****

1.6.2.1 Contractor Experience

Have successfully completed at least [one][_____] windrow composting project[s] that required processing of a volume of compost comparable to the estimated volume of compost that will be generated during this project. Also have successfully completed at least [one][_____] full-scale project[s], that required handling and transport of soil contaminated with a [RCRA hazardous constituent, or CERCLA hazardous substance][_____]. For each project, provide the following: site name, location, the names of the Contractor's key personnel; key points of contact and phone numbers (including government representatives, and other parties involved in the project); dates of mobilization/demobilization; contaminants of concern; and the volume of contaminated soil handled or treated. Provide the following also, if applicable: dates for initiating and completing treatment; quantity of time required to treat each batch of contaminated soil; volume of amendments added per unit volume of contaminated soil; final volume of finished compost; concentrations of contaminants of concern in soil (before treatment), day zero (in compost), during treatment, and after treatment.

1.6.2.2 Key Personnel

Provide key personnel with a minimum of[three][_____] years of composting field experience. Include system operators, quality control personnel, and supervisory engineering and technical staff involved with the landfarming windrow composting operation in key personnel. Perform all survey work under the supervision of a registered land surveyor licensed in the [applicable jurisdiction][State of [_____]].[Perform surveys in accordance with Section:[_____].]

1.6.2.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP)accredited commercial testing laboratory in accordance with[Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.6.3 Drawings

Project drawings must include, and not be limited to:

a. Layout of the facility.

b. Dimensions of amendment storage areas, preprocessing areas, treatment pad, noting areas under roof and within structures.

c. Dimensions and volumes of contaminated soils stockpiles, treated materials stockpiles, and waste stockpiles.

d. Locations, dimensions, and volume of collection sumps and any ancillary water storage facilities.

e. Dimensions, volumes, and cross-sections of windrows.

f. Plan view and cross-sections of perimeter berms and collection sumps.

g. Ancillary water storage facilities.

h. Size of contact water conveyance devices and structures.

i. Piping and instrumentation diagrams.

j. Process flow diagrams.

1.7 DELIVERY, STORAGE, AND HANDLING

Safely transport, store, and handle equipment and raw materials (including reagents). Package and ship these items in compliance with United States Department of Transportation (USDOT) requirements. Store and handle these items onsite in accordance with the manufacturer's recommendations and in compliance with applicable regulatory requirements.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Existing Conditions

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NOTE: The pertinent site characterization data should be placed in the appendices of the technical specifications or on the drawings, and referenced here. If the site contains a significant amount of debris, the available information about its extent and characterization should also be provided. Indicate the detail to which site characterization has been performed. The information should also include: construction limits, property survey, access gates and haul roads available to the Contractor, locations of utilities, water sources, area available for the field demonstration and treatment cell, restricted areas adjacent to the project site, chemical data, geotechnical data, sampling locations, and boring logs. Reference the administrative record locations, whether they are physical or digital, of the site if they exist.

Indicate if there are multiple dissimilar types of contaminated materials that will require different operations. Materials may be considered dissimilar based on possessing different soil properties, types

of contaminants, or relative concentrations of contaminants. Determination of dissimilar materials may be based on site investigations and/or previously completed treatability studies.

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The existing site conditions are presented[in Appendix [_____]][and][on the drawings]. These include [physical configuration][utilities][topography][land uses][geotechnical characteristics of the contaminated materials (including [grain size analysis][total organic content][cation exchange capacity][pH][moisture content][density][porosity])[hydrogeology]][and][nature and extent of contamination][_____]. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions could occur. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within [48 hours][_____] if discrepancies between the data provided and actual field conditions are discovered.

[1.8.2 Previously Conducted Treatability Studies

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NOTE: This paragraph should be deleted if no previous treatability studies have been conducted.

The methods employed in the previous treatability studies may not be the same as those proposed by the Contractor. Documentation of the previous treatability studies should include the same information shown in the following sub-paragraphs: Bench-Scale Treatability Study Test Report and Field Demonstration Report. Bench-Scale Treatability Study Reports should be prepared to provide prospective Contractors with sufficient information to prepare a responsive bid, or proposal, for the contract. Treatability studies are a necessary part of each composting project. Bench-scale treatability study tests and field demonstrations should be performed to determine which recipes of soil and amendments are most likely to fulfill the treatment criteria.

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Appendix [A][_____] "Bench-Scale Treatability Study Report" is for information purposes only.

]PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

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NOTE: It may be necessary to perform an explosive hazard analysis on equipment used to process explosives-contaminated material (see DA PAM 385-64). Equipment used on previous composting projects may already have been subject to an explosives hazard analysis (see Hazard Review of KW Windrow Composter, March 1992, in Appendix E of USAEC CETHA-TS-CR-93043).

****

Provide materials and equipment that are the standard products of a manufacturer regularly engaged in the manufacture of such products and essentially duplicate items that have been in satisfactory use for at least two years prior to bid opening. Provide support for equipment by a service organization that is, in the opinion of the Contracting Officer, capable of providing service, materials and equipment in an expedient manner.

2.2 WATER SUPPLY

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NOTE: One important concern for irrigation water is to ensure that salts do not accumulate to levels that inhibit biological activity. Conductivity is an indicator of salt content. Conductivity may be reported in micro-Siemen per cm, or micro-mho per cm. Total dissolved solids (TDS) testing may be substituted for conductivity.

Possible water sources include: a nearby pond, or other surface water body; a hydrant, or other connection to a water distribution line; used decontamination water; and runoff from precipitation; see paragraph STORAGE VOLUME. For most composting operations, spontaneous combustion is an unlikely occurrence. However, if large quantities of very dry materials (e.g., leaves) will be used as amendments, it may be necessary to include provisions for fire detection and/or fire protection (see paragraph MOISTURE CONTROL). If there are susceptible structures nearby, it may be necessary to ensure that the local water distribution system is adequate to prevent a fire from spreading. It may also be necessary to coordinate this Section with Sections 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE; 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE; 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE; or 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE . This Section does not include provisions for fire protection.

****

Provide water for irrigation that does not contain oils, acids, salts, alkalis, organic matter, solids or other substances at concentrations that could be detrimental to the successful treatment of the contaminated materials. The acceptable ranges, or levels, of the following parameters in the irrigation water must not exceed the criteria established in Table 4.

TABLE 4 - IRRIGATION WATER CRITERIA

PARAMETER	REUSE CRITERIA
maximum conductivity	[_____] micro-mho per cm

TABLE 4 - IRRIGATION WATER CRITERIA	
PARAMETER	REUSE CRITERIA
minimum pH	[_____] standard units
maximum pH	[_____] standard units
[_____]	[_____]

Provide water for irrigation that does not contain contaminants that would persist through the composting process and that would thereby cause the composted soil to be considered contaminated and not suitable for reuse. Contaminants must also be avoided that may leach through the project site and contaminate groundwater.[If non-potable water is to be used, the irrigation water must be characterized prior to its use using Table 5. Sufficient numbers of samples must be collected to characterize the irrigation water source. Irrigation water that does not meet the criteria in this table may be treated to these criteria prior to windrow composting use. Submit a Water Supply Analysis demonstrating that irrigation water meets requirements.

TABLE 5 - IRRIGATION WATER CONTAMINANT CRITERIA		
ANALYTICAL METHOD NUMBER from US EPA SW-846	ANALYSIS TYPE	CRITERIA TO BE MET
6010[and 7470A]	Metals[and Mercury]	[Less than Maximum Contaminant Level (MCL)] [_____]
8260	Volatile organics	
8270	Semi volatile organics	
8081	Pesticides	
8082	PCBs	
1633	PFAS	
Within each Analytical Method, only analyze for analytes which have a [MCL][_____].		

]

2.3 AMENDMENTS

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NOTE: Factors driving selection of amendments should include: seasonal availability, proximity of sources to the site, costs, amenability to storage and handling, moisture content, odor potential, texture and porosity, carbon-to-nitrogen (C:N)

ratio, previous experience with using an amendment, and variability in the quality of an amendment. Amendment mixtures that have been successfully used for previous projects, involving treatment of hazardous-waste-contaminated soil, should be given primary consideration.

Theoretically, the C:N ratio of the compost recipe should be between 20:1-40:1. The C and N contents of candidate amendments can be estimated using literature values (see Appendix A of the On-Farm Composting Handbook). Laboratory testing, for moisture and ash content, may also be used to determine carbon content. By subtracting the ash content from the dry weight, the organic matter content can be determined. The carbon content is usually determined by dividing the organic matter content by 1.8. Other amendment selection considerations are provided in paragraph AMENDMENT TESTING AND BENCH-SCALE TREATABILITY STUDY TESTING, .

If the bulk density of the amendment recipe (not including soil) is greater than 640 kg per cubic meter 40 lbs per cubic foot, the recipe may not be sufficiently porous. Wood chips may be used to increase the porosity of a compost recipe; however, depending on plans for end-use, large-diameter materials may have to be separated from the finished material (see paragraphs SOIL PRE-PROCESSING, CURING AND STORAGE, and DISPOSAL). It becomes more difficult to maintain aerobic conditions in the windrow as the porosity decreases, and as the moisture content increases (see paragraph MOISTURE CONTROL in PART 3). Use of amendments with an extremely high moisture content (e.g., liquid manure) should be avoided. The moisture content of the soil and amendments will control the initial moisture content of the compost. If the initial moisture content is too high, the windrow may not heat up properly, and the process may fail.

The following amendment mixture has been successfully used for full-scale treatment of explosives-contaminated soil: 30 percent soil, 17.5 percent sawdust, 17.5 percent hay, 21 percent cow manure, 10.5 percent chopped potato waste, 3.5 percent chicken manure (as reported in USAEC CETHA-TS-CR-93043). Based on previous, successful composting projects for explosives-contaminated soil, the following recipe of soil and amendments is recommended:

a. 30 percent Contaminated Soil. It may be necessary to reduce the soil percentage if clayey soils are being treated.

b. 15 - 20 percent Saw Dust/Wood Chips. It may be advantageous to substitute all or a portion of the sawdust with wood chips. Wood chips provide for

greater porosity in the compost. Use of cedar chips, or other aromatic wood chips, should be avoided.

c. 15 - 17 percent Alfalfa Hay. The quality of the hay may be marginal. Moldy alfalfa hay has been found to perform satisfactorily, and it is usually less expensive than feed quality hay.

d. 10 - 20 percent Potato Waste. Chopped potatoes are better than whole potatoes. It may be possible to use other starch sources in lieu of potatoes.

e. 15 - 25 percent Manure. Must be fresh (not dried). Although chicken manure has a higher nitrogen content, satisfactory results have been obtained using only cow or steer manure. Manure from ruminant animals (e.g., cows) is thought to be the best source of microbial inoculum.
****

Test representative samples from the first shipment of [manure, and potato waste (or other vegetable waste)][_____] for: conductivity, and moisture content. The concentration of glass, plastic, and other foreign materials in each shipment of amendment must not exceed [5][_____] percent, by dry weight. Do not use asbestos containing materials as amendments. The initial soluble salt content (conductivity) of the compost (including soil and amendments) must not exceed [20][_____] mmhos/cm. The initial moisture content of the compost (including soil and amendments) must not exceed [60][_____] percent of the moisture content at field capacity (or water holding capacity).

Analyze manure amendments to verify absence of constituents that would pass unaltered through the windrow composting process and possibly accumulate in the product soil. The following table should be used:

TABLE 6 - MANURE AMENDMENT CONTAMINANT CRITERIA		
ANALYTICAL METHOD NUMBER from USEPA SW-846	ANALYSIS TYPE	CRITERION TO BE MET
6010 [and 7470A]	Metals [and Mercury]	[Less than USEPA Residentional Soil Regional Screening Level if one exists] [_____]
8082	PCBs	
1633	PFAS	
Within each Analytical Method, only analyze for analytes which have a [Residential Soil RegionalScreening Level] [_____].		

2.4 SYNTHETIC OR MANUFACTURED ADDITIVES

****
NOTE: It is usually unnecessary to include synthetic or manufactured additives (e.g., surfactants or microbial inoculum) in compost recipes. This paragraph should be deleted if synthetic or

manufactured additives will not be used.
****

A Certificate of Analysis for Synthetic or Manufactured Additives must accompany each shipping unit of synthetic or manufactured additive supplied by the vendor.

[2.5 SAMPLES FOR BENCH-SCALE TREATABILITY STUDY TESTS

****
NOTE: To reduce the overall risk to the government, it is strongly advised that the project team should require the Contractor to collect samples for the bench-scale treatability study test unless the nature of the site prevents the Contractor to do so. Depending on site conditions and project needs (e.g. site security, access issue, etc.), the Government may provide samples to the Contractor to conduct bench-scale treatability study tests.
****

[The Contracting Officer will provide the required samples to conduct the bench-scale treatability study test.][Select sampling locations and collect representative samples to conduct the bench-scale treatability study test in accordance with the approved work plan. Consider the existing site conditions presented in paragraph EXISTING CONDITIONS when selecting sampling locations. [Conduct sample collection activity in the presence of Contracting Officer.]] The collected bench-scale treatability study test samples must have contaminant concentration levels [representative of the average concentration of the contaminants identified][and][greater than the action level criteria presented in Table 7]. Otherwise, repeat sampling until the contaminant concentration levels exceed the action level criteria. A minimum of [two composite samples][_____] must be tested. Also provide a physical description of each soil sample, either prepared by or under the supervision of a licensed geologist, to demonstrate that soil-type is representative of the contaminated zone. Do not commence bench-scale treatability study testing until contaminated material sample results meet the aforementioned concentration criteria.

TABLE 7 - ACTION LEVEL CRITERIA

PARAMETER	ACTION LEVEL CRITERIA
[_____]	[_____] mg/kg

]PART 3 EXECUTION

[3.1 AMENDMENT TESTING AND BENCH-SCALE TREATABILITY STUDY TESTING

****
NOTE: If a proven recipe will be used, testing of amendments may not be necessary (see paragraph AMENDMENTS). However, if a type of amendment has been proposed for which there is no previous experience, the following tests may be warranted: bulk density, moisture content, field capacity (or water holding capacity), free carbonate, organic matter content (or volatile solids), ash content,

pH, conductivity, and total Kjeldahl nitrogen. These paragraphs, and the corresponding submittal descriptions, should be deleted if amendment testing and bench-scale treatability study testing were performed prior to awarding this contract.
****

3.1.1 Amendment Test

Prior to the bench-scale treatability study test, collect and test samples of amendments for: [moisture content, pH, and conductivity][_____]. For each type of amendment,[two composite samples][_____] must be tested. The following amendments must be included in testing: [manure, potato waste (or other vegetable waste),][_____]. Submit the amendment test report along with the Bench-Scale Treatability Study Test Report in accordance with paragraph BENCH-SCALE TREATABILITY STUDY TEST REPORT. Include the following in the report: characterization test results for each amendment; the source and approximate age of each amendment; the date that each amendment was shipped, received and tested by the laboratory; procedure used to ship each amendment (including type of containers and temperature); if amendments were stored for any period of time, the temperature of storage; testing methods used; and proposed recipes of soil and amendments for bench-scale treatability study testing.

3.1.2 Bench-Scale Treatability Study Test

****
NOTE: The testing described below is closely related to the Dewar self-heating test that is used to determine the maturity of compost. However, the testing described below requires more intensive monitoring, a larger volume of material, and more time than a standard Dewar self-heating test.

Self-heating tests are typically performed using insulated containers (e.g., Dewar flasks), and may be used to assess whether recipes of soil and amendments are suitable for composting; a recipe may be suitable if it heats up, and remains at a sufficiently high temperature for an extended period of time. Self-heating tests may also be used to determine if an organic contaminant that has not previously been treated via composting, is amenable to composting.

It is possible to use vacuum-insulated containers with a volume of less than 4 L 1 gallon for self-heating tests; however, a minimum volume of 4 L 1 gallon is recommended for the following reasons: to more accurately simulate conditions of a compost windrow (height of about 1.5 m 5 feet); and to reduce the chances of using soil samples that are not representative of site conditions.
****

After completion of amendment testing, review the test results, and submit the proposed recipes of soil and amendments to be included in the bench-scale treatability study testing designed to optimize the treatment effectiveness. At a minimum, the proposed recipe should include the following: selected carbon/nutrient amendment (e.g., wastewater treatment sludge/biosolids, manure, potato waste, corn processing waste) and selected bulking agent[s] (e.g., mulch, wood bark, corn stalks, straw); ratio of soil to treatment and bulking amendments (e.g., 30 percent soil to 70 percent amendment); moisture level (e.g., 50 percent to 60 percent of field capacity); carbon to nitrogen ratio (e.g., 20-40:1); projected treatment timeframe (typically 15-45 days). Perform at least [three, replicate][_____] self-heating tests simultaneously for each selected recipe. Prior to testing, homogenize and divide each recipe into replicate volumes. The volume of material (including soil and amendments) included in each container for the self-heating tests must be not less than [[4][_____] L [1][_____] gal][_____]. Self-heating tests must be performed for a period of not less than [28 days][_____], during which temperature monitoring must be performed [daily][_____].

]3.2 PREPARATION

3.2.1 Mobilization

****

NOTE: Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES includes requirements for decontaminating equipment that has been used in contaminated zones. That section should be modified to extend decontamination/cleaning requirements to equipment being brought on-site to cover the requirements of this paragraph.

****

Do not mobilize to the site until [the Composting Work Plan][UFP-QAPP] has been approved by the Contracting Officer and the Contractor has received written confirmation. Delays caused by the Contractor's failure to meet regulatory requirements must result in no additional cost to the Government. In accordance with[Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____], the equipment which is rented and/or previously used for other site remediation must be decontaminated and tested for contaminants of concern before being brought to the site.

3.2.2 Pre-Operation Examination

Conduct a pre-operation examination of the on-site infrastructure, utility conduits, monitoring points, site access constraints, and infrastructure. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-treatment conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would potentially have significant impacts on treatment and public safety. Submit a Pre-Operation Examination Report documenting the examination activity [before mobilization begins][_____]. Obtain all necessary utility clearances before initiation of subsurface work.

3.2.3 Pre-Construction Equipment Examination

Conduct a preconstruction examination of the landfarming equipment for damages, defects, and dilapidation. Submit the Preconstruction Equipment Examination Report to the Contracting Officer[before construction begins][____]. The Contracting Officer may conduct an independent examination to ascertain the condition and functionality of the equipment. Based on this examination, the Contracting Officer may reject the entire system or damaged, defective, or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection must be borne by the Contractor. Routinely and properly inspect and maintain the equipment to provide the operation as required by the Contract schedule. Schedule delays and the associated costs are the responsibility of the Contractor. Provide an alternate/auxiliary power source if sufficiently reliable sources are not available.

3.3 FIELD DEMONSTRATION

****

NOTE: The field demonstration requirements are a function of the uncertainty of the materials to be treated. For well defined wastes that are known to be amenable to composting, optimization testing (performed using full-scale equipment and facilities) may be adequate. If the amenability of the contaminated material to composting has not been established, the field demonstration should be preceded by bench-scale treatability study testing. If the process has yet to be demonstrated on a large scale for the specific soil type and contaminants of concern, it may be advantageous to perform the field demonstration prior to construction of full-scale facilities.

The recipe of soil and amendments used in the field demonstration will be based on the results of the bench-scale treatability study test. To prevent scale-up problems between the field demonstration and full-scale operations, the batch size used for the field demonstration should be at least 23 cubic meters 30 cubic yards, and not less than 5 percent of the proposed batch size for full-scale operations. A batch is defined as that amount of material, including soil and amendments, for which treatment is initiated at the same time during full-scale operations.

****

Prior to full scale composting operations, perform a field demonstration. If the materials treated during the field demonstration do not meet the treatment criteria, process an equal quantity of the same type of material that failed, using properly modified operating conditions, until satisfactory results are obtained. Segregate any treated materials that failed the field demonstration and return this material to the contaminated materials stockpile area for processing during full-scale remediation. The volume of each windrow, including soil and amendments, included in the field demonstration must be no less than [23][_____] cubic meters [30][_____] cubic yards. Separate windrows, spaced to prevent intermingling of contaminated material, must be provided for each recipe and/or condition being tested. Recipes and/or conditions to be tested must include: [_____]. Conduct the field demonstration using the same windrow dimensions, and similar irrigation and mixing methods as proposed for the full scale operations. Do not initiate the field demonstration until written approval has been received from the Contracting Officer.

3.3.1 Samples for Field Demonstration Tests

****

NOTE: Chemical testing should be performed to verify that the materials to be used for the field demonstration contain the contaminants of concern at high enough concentrations to adequately test the process. Additional testing may be warranted to verify that the physical properties of the materials are representative of site conditions.

****

Obtain contaminated material used for the field demonstration from [the location specified by the Contracting Officer][_____]. Prior to performing the field demonstration, test [three composite samples][_____] of the contaminated material to be used for the field demonstration. Consider the existing site conditions presented in paragraph EXISTING CONDITIONS when selecting sampling locations. The contaminated material samples must have contaminant concentration levels [representative of the average concentration of the contaminants identified] [and] [greater] [than the action level criteria presented in Table 8]. Otherwise, repeat sampling until the contaminant concentration levels exceed the action level criteria. Test samples of contaminated materials intended to be used in the field demonstration in accordance with procedures in paragraph PRE-COMPLIANCE TESTING. Do not commence the field demonstration until soil samples meet the aforementioned concentration criteria. Also provide a physical description of each soil sample, either prepared by or under the supervision of a licensed geologist, to demonstrate that soil-type is representative of the contaminated zone.

TABLE 8 - ACTION LEVEL CRITERIA

PARAMETER	ACTION LEVEL CRITERIA
[_____]	[_____] mg/kg

3.3.2 Monitoring

****

NOTE: Because a more intensive level of monitoring is usually required during the field demonstration than during full-scale operations, a separate set of Operation, Maintenance and Process Monitoring requirements may need to be prepared. The following differences in monitoring requirements are typical for the field demonstration versus full-scale operations: sampling stations may be spaced more densely; temperature, moisture content, and field capacity testing may be performed more frequently; and sampling and analysis for contaminants of concern may be performed on a more frequent, and more regular basis. The field demonstration may also provide an opportunity to develop a site-specific correlation between field, and laboratory analysis methods. A sufficient amount of time, which should be based on the results from the bench-scale treatability study test, should be

scheduled for the field demonstration to allow each contaminant of concern to reach asymptotic levels. Also, the amount of sampling and analysis for contaminants of concern should be sufficient to assess the degree of variability in the final concentrations; so that it can be determined if cleanup goals will be reached.
****

During the field demonstration, perform sampling and analysis as indicated under paragraph OPERATION AND FIELD QUALITY CONTROL; in addition to these requirements, implement the following processing monitoring requirements: [_____]. The field demonstration must extend long enough for project treatment goals to be attained with reasonable confidence, or to reach an asymptotic limit to the concentrations, but not to exceed [60][_____] days from the initial blending of soil and amendments until completion of composting.

3.3.3 Field Demonstration Operations Report

During the field demonstration furnish reports weekly. Maintain copies of the reports at the facility. Record and maintain the following information until closure of the facility: description (including sources) of contaminated soil and amendments on site; the locations of all amendments and contaminated soil on site, and the quantity at each location; receipt, storage, treatment, disposal date, offsite disposal location, volume, and weight of hazardous and non-hazardous wastes including contaminated and treated soil and amendments; and manifests/proof of receipt from the disposal facility for hazardous and non-hazardous wastes. Dispose of all hazardous materials and wastes in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Record the location and quantity of each type of material on a map or diagram of the site. Include cross-references to specific manifest document numbers, if the waste was accompanied by a manifest. Provide summary reports and details of all incidents that require implementing contingency plans, or corrective action measures. Also include: date and time of each monitoring or testing event; results from each monitoring or testing event; monitoring procedure, or test method used; individual performing the monitoring or testing, and other individuals present; and remarks. Cross-reference to submittals specified in other Sections to prevent duplicate information in separate submittals.

3.3.4 Field Demonstration Report

****
NOTE: If the results of the field demonstration will be used to inform the Composting Work Plan, it may be preferred to report the field demonstration results in the Composting Work Plan instead of having a separate Field Demonstration Report. Update the Composting Work Plan paragraph and delete this paragraph if using that approach.
****

Submit the field demonstration report not more than [120][_____] calendar days after completion of the field demonstration. Prepare[draft for Government review][draft-final for [regulatory][_____] review]and final versions of the Field Demonstration Report. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. The report must document relevant data including, but not limited to: characterization test results for each amendment; the source and age of each amendment; the proportions of amendments and soil in each recipe tested; chronological table showing all materials added to each windrow, quantity added, date of addition, and each mixing, precipitation, irrigation and sampling event. The report must also include: physical and chemical monitoring data from before, during and after treatment; degradation rates; final disposition of wastes and treated material; conclusions; recommendations; and proposed recipe of soil and amendments for full-scale operations. In addition, the day-to-day log of operations and adjustments must be included in an appendix. After completion of field demonstration, review the data from the field demonstration. Proposed changes in Operations, Maintenance and Process Monitoring must be included in the Field Demonstration Report submitted to the Contracting Officer for review.

3.4 SOIL PRE-PROCESSING

****

NOTE: Soil pre-processing may include stockpiling, screening, and blending of contaminated materials. The maximum recommended particle diameter for compost mixing equipment can range from 25 to 100 mm 1 to 4 inches. However, the end use for the compost may dictate that the maximum particle diameter not exceed 13 mm 0.5 inch (see paragraph CURING, STORAGE AND DISPOSAL); and that the concentration of glass, plastic, and other foreign materials in soil not exceed 5 percent, by dry weight. Although it may be possible to include relatively large particles in compost, an additional screening step may also be necessary to remove the large particles prior to disposal. This paragraph should be coordinated with paragraph AMENDMENTS. In addition, composting is generally not effective for materials with high concentration of nitroaromatics. If encountered during pre-processing, materials with high level of nitroaromatics should be segregated and disposed of at an offsite facility. If explosives-contaminated soil will be treated, it may be necessary to require that an explosives hazard analysis be performed on the material handling equipment (see DA PAM 385-64; and Hazard Review of KW Windrow Composter, March 1992, in Appendix E of USAEC CETHA-TS-CR-93043r).

****

Pre-process contaminated soils as necessary by [screening][blending][shredding][_____] to provide a maximum particle size in soil [compatible with approved material handling equipment][_____]. Separate oversize materials[and materials with high concentration of nitroaromatics that cannot be composted successfully] from contaminated soil prior to mixing soil with amendments.

3.5 OPERATION AND FIELD QUALITY CONTROL

****

NOTE: Operation and monitoring requirements should be based on: applicable literature references;

knowledge gained from treatability studies and the field demonstration; and historical data from projects with similar soils, amendments, and contaminants. Diligent process monitoring (e.g., monitoring temperature and controlling moisture content) is fundamental to successful composting. Because there will always be exceptions, where the default values provided in these paragraphs do not suit a specific project, the following paragraphs should be edited appropriately. These paragraphs should be coordinated with Division 1 Sections of the contract; operations, maintenance, and process monitoring requirements are covered in a Division 01 Section of some contracts.

Reference a UFP-QAPP that has been prepared in accordance with DoD and EPA guidance. UFP-QAPPs follow the Data Quality Objectives (DQO) process and are required for DoD environmental restoration work. If a UFP-QAPP has been prepared for the overall project that composting is being used on, referencing to the UFP-QAPP for testing requirements avoids potential for conflicting requirements between the UFP-QAPP and the specifications.

****

Do not initiate full-scale composting operations until the Composting Work Plan [and the UFP-QAPP] has been approved, and written approval has been received from the Contracting Officer. The testing specified in the following sub-paragraphs is needed by the Government to generate documentation that the composting treatment has been accomplished in accordance with performance requirements in the decision document and approved by the government and regulators (e.g. EPA or other state agencies). The results of these tests may be used as part of the Contractor's QC program; however it is the contractor's sole responsibility to meet the performance requirements specified in this Section. Perform additional testing and measurements to assure that treated materials meet requirements without rejection of batches, retesting, and reprocessing.

3.5.1 Dissimilar Soils

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NOTE: Delete the bracketed text item if dissimilar materials are not known to be present at time of preparing project specifications.

****

Do not mix together dissimilar soils if the bench-scale treatability study and/or field demonstration testing results indicate that different operating conditions have to be implemented to achieve effective treatment of these soils.[Materials known to be dissimilar at the site are defined in [paragraph EXISTING CONDITIONS][_____].]

3.5.2 Amendment Storage

****

NOTE: Manure and vegetable wastes are the primary sources of objectionable odor during composting. After blending manure and vegetable wastes with the

woody bulking amendments, objectionable odors will usually dissipate after about 7 to 14 days. It may be allowable to relax the maximum holding time for manure and vegetable wastes, if the site is remotely located and odor control is not an issue.

Depending on amendment selection and other site-specific factors, controls may be necessary to prevent insects and rodents from infesting the amendment storage area. Consider including a requirement here to keep amendment piles covered (if such requirement is not included in other specifications dealing with air/emissions controls).

****

To minimize odor generation, deliver manure and vegetable wastes to the site not more than [72 hours][_____] prior to blending of soil and amendments. Any excess manure and vegetable wastes, not blended with soil, must either be removed from the site not more than [24 hours][_____] after blending was initiated; or must be blended with other excess amendments and composted onsite. Excess manure and vegetable wastes must be disposed of in accordance with regulatory requirements.

3.5.3 Windrow Construction

****

NOTE: Initial homogenization may be accomplished by layering the raw materials into the shape of a windrow, and then mixing with windrow turning equipment. However, it may be possible to achieve a more thorough mix of the soil and amendments if they are blended in a separate vessel prior to forming windrows. The percentage of soil in the compost mixture should be based on previous composting projects, or preferably bench-scale treatabiity study testing and a field demonstration.

Typical dimensions for compost piles created by self propelled windrow turners are: 1.2 to 2.7 m 4 to 9 feet high, and 3 to 6 m 10 to 20 feet wide. However, sufficient temperatures may not be reached unless the initial height of the windrows is at least 1.5 m 5 feet. The height of the windrows will decrease during treatment.

****

The following measures must be taken to prevent freezing of contaminated soil that is scheduled to be composted during sub-freezing conditions: [_____]. The initial height of compost windrows must be not less than [1.5][_____] m [5][_____] feet.

3.5.4 Mixing

****

NOTE: If irrigation and turning are performed separately, mixing should be performed soon after irrigation to provide for more uniform distribution of moisture.

The frequency of mixing should be related to temperature monitoring. When temperatures exceed 65 degrees C 150 degrees F, mixing may be implemented to cool the pile. If excessively high temperatures cannot be controlled through turning, then the size of the compost windrows may have to be reduced. Low temperatures may indicate that oxygen levels in pore spaces within the pile are insufficient, and that the pile should be mixed. However, excessive mixing may impede the pile from reaching optimal temperatures. Isolated hot or cool spots may indicate the location of incompletely mixed pockets. After optimal temperatures have been maintained for about 10 days, it may be possible to reduce the frequency of mixing without adversely affecting the process. However, frequent and thorough mixing should result in more homogenous compost, and should reduce the variability of chemical data. On a previous project, daily windrow mixing was discontinued after definitive field analysis indicated that cleanup goals had been met. Thus, after about 12 days of mixing, the windrows were allowed to remain undisturbed until after data from compliance samples was received. Even if mixing is discontinued, temperature and moisture content monitoring should continue.

****

Unless otherwise indicated, mix the compost pile each day. To ensure the entire cross-section of the windrow is mixed, the windrow turner must be adjusted to its lowest height without actually contacting the treatment pad, and the turner must extend beyond each side of the windrow. Perform mixing at least once per day, for at least [10][_____] days. Additional mixing may be required in response to process monitoring; for example, to control temperature, odor and to provide additional aeration.

3.5.5 Moisture Control

****

NOTE: The potential for spontaneous combustion will increase as the moisture content falls below optimum levels. The water content at saturation will vary depending on what raw materials were used in the compost. Determination of water content as a percent of field capacity (or water holding capacity) provides a more "universal" indicator of the degree of saturation. Field capacity is determined by saturating a sample, allowing the free water to drain, and then determining the moisture content; field capacity is the mass of water in the sample divided by the dry weight. According to Bioremediation Using the Land Treatment Concept, EPA 600/R-93/164, field capacity can range from 5 percent (for a sandy soil) to 30 percent (for a clay soil).

The recommended moisture content for windrow composting is between 40 and 80 percent of the moisture content at field capacity. For example, if

the field capacity of a soil is determined to be 20 percent, then optimum moisture content would be between 8 and 16 percent. The procedure shown in USAEC CETHA-TS-CR-93043 has been used to determine the field capacity of compost for previous projects. Because the field capacity will change as the compost matures, periodic testing for field capacity should be required. Finally, a crude indicator of proper moisture content has been described as follows: the compost should feel moist, but not so moist that free water is released when squeezed by the hand.

****

3.5.5.1 Moisture Content and Field Capacity Testing

Immediately after initiating treatment of each batch of compost, test a minimum of one representative, composite sample per each [69][_____] cubic meters [90][_____] cubic yards of compost to determine percent moisture (by weight) and the moisture content at field capacity. Perform field capacity testing every week for the first [four][_____] weeks and [every two weeks][_____], thereafter. Perform testing for moisture content three times each of the first [four][_____] weeks and twice per week thereafter.

3.5.5.2 Irrigation

****

NOTE: Factors influencing irrigation water requirements include the initial moisture content of the soil and amendments, and the climate. A tank truck or a water storage tank may be necessary if a local water source (e.g., surface water body) is not available; see paragraph STORAGE VOLUME.

****

Irrigate the moisture-deficient portions of each windrow when testing indicates that the moisture content is below [40][_____] percent of the design field capacity. Measure the water application rate. Record the application rate, duration of the irrigation period, and volume of water applied. Provide sufficient irrigation to bring the moisture content to within the acceptable limits in not more than [48][_____] hours. Irrigation and mixing must be synchronized so that water is distributed uniformly throughout the windrows. Immediately cease irrigation if ponded water is observed near any windrow; record the time, date, and location of the ponded water in the Operations Reports, and remove the ponded water.

3.5.5.3 Contact Water Testing

Test contact water, to be reused as irrigation water, for pH and conductivity on the [first,][second,][_____][and][fourth][_____] week after initiating treatment of each batch of compost. If there is more than [13][_____] mm [1/2][_____] inches of precipitation in a 24 hour period, test the pH and conductivity of the contact water after water from the precipitation event has collected in the contact water storage facility. Each time testing is performed, either withdraw one representative sample from the contact water holding vessel, or directly test the water in the holding vessel by immersing the instrument probe in the contact water.

3.5.6 Temperature

****

NOTE: Temperature is indicator of microbial activity, and one of the most important parameters for monitoring the composting process. The temperature of windrows should be monitored immediately before and after mixing. The temperature range for the thermophilic stage of composting is usually considered to be between 43 and 65 degrees C 110 and 150 degrees F, preferably between 54 and 60 degrees C 130 and 140 degrees F. When temperatures continue to increase past 71 degrees C 160 degrees F, microbes become dormant or die. See paragraph MIXING regarding control of excessively high temperatures. The temperature of a compost pile will gradually stratify after mixing. The highest temperatures may be observed in the outer layer of the pile while initially heating, but may become highest along the center core of the pile later, especially if not mixed frequently. Temperature is affected by the composting heat generation which is driven by amendment content, moisture, and oxygen availability, and by the heat loss to the environment, so temperature is highly location- and time-dependent in a windrow pile. It is important to have a method to easily measure temperature anywhere in the windrow pile. Reference: TEMPERATURE DISTRIBUTION AND VARIATION IN PASSIVELY AERATED STATIC COMPOST PILES, Bioresource Technology 48 (1994) 257-263.

****

3.5.6.1 Temperature Probe Calibration

Provide temperature probes with a measurement range from [0][_____] to at least [100][_____] degrees C [32][_____] to at least [212][_____] degrees F. Calibrate probes by taking readings in an ice bath, and in boiling water. Mark each temperature probe for identification and calibrate prior to use. Record readings from each probe with each calibration event, before and after calibration, and include the identifier on the temperature probe in the recording. Maintain an identified composting design temperature (e.g., approximately 52 to 68 degrees C 125 to 155 degrees F). Submit corrective measures to the Contracting Officer if an optimal design temperature is not maintained.

3.5.6.2 Temperature Monitoring

Measure the temperature of the windrows each day immediately before and after mixing. Monitor the temperature at a minimum of [two][_____] locations, per [23][_____] cubic meter [30][_____] cubic yard section of compost. Record the temperature, time, and monitoring location during each monitoring event. Record the depth and location of each temperature reading. Record ambient air temperatures in the treatment area, and the time of monitoring daily.

3.5.7 Compost pH

****

NOTE: The pH should usually be maintained between 5.5 and 9, preferably between 6 and 8 standard units. Excessive volatilization of ammonia may result if the pH exceeds 5.5. However, it is usually unnecessary to adjust the pH during composting; and use of pH adjusting agents (e.g., lime) may be detrimental to the process.
****

At a minimum, test the pH of the compost twice during the [first, second, and third][_____] week after initiating treatment of each batch of compost, and once per week thereafter until treatment criteria has been met for contaminants of concern. Perform testing of the pH of compost in accordance with paragraph NON-STANDARD SAMPLING AND ANALYSIS. Maintain pH above 5.5, and preferably below 8. Adjust pH below 5.5 by careful addition of typical soil pH adjusting materials like lime, or limestone. Each time a pH adjustment product is applied, test the soil pH before and after adding the pH adjustment product. Also record the product name, quantity, and supplier of the pH adjustment product used after each application. Do not use aqueous caustics, such as sodium hydroxide, as pH adjusting agents.

3.5.8 Odor Control

****
NOTE: If Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS is not included in the project specifications, odor control sources and control activities should be specified here. When editing Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, consider the following:

Odor is an important indicator of the condition of a compost pile. Strong putrid odors usually indicate that anaerobic conditions are present, and that mixing (aeration) may be necessary for the pile from which odors are arising. Strong odors may also indicate that the pile, or a portion of the pile is too wet. Excessive ammonia odors may indicate that the C:N ratio of the compost recipe is too low, and/or that the pH is too high. Odors will usually be generated during the following activities: amendment delivery and storage; blending of soil and amendments; and during the composting process, including during mixing. See paragraph AMENDMENT STORAGE for more information.

The following text can be considered when editing Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. Monitor and record the presence or absence of odors in the treatment facility [each day][_____], for not less than [five][_____] days of each week. If objectionable odors are detected, record the following in the Operations Reports: locations where the odors are the strongest; description of the odors; the times and dates when the odors were detected; and the name of individual who observed, described and recorded the odor. If, in the opinion of the Contracting Officer, there is a persistent problem with objectionable odors that has not been

properly addressed, the Contractor will be notified to implement measures to reduce odor levels. Odor control measures must be implemented not more than [24][_____] hours after notification from the Contracting Officer. The initial choice of remedy for odor in the windrow pile is additional mixing.
****

Implement odor control requirements as specified in [Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____].

3.5.9 Oxygen

****
NOTE: The concentration of oxygen in the air spaces within the compost pile should typically be greater than 5 percent by volume (the concentration of oxygen in air is approximately 21 percent by volume). Oxygen levels will continually decrease after each mixing event as aerobic microorganisms consume oxygen. If used, oxygen monitoring should be performed at regular intervals, after each mixing event. Usually, temperature monitoring is adequate to control the composting process, and oxygen monitoring is unnecessary.
****

Regularly scheduled monitoring of interstitial oxygen levels will not be required. However, oxygen monitoring may be used as a diagnostic, or trouble-shooting tool. If oxygen monitoring is performed, record the monitoring location, the time of the last mixing event, and the time of each oxygen monitoring event. Maintain a minimal oxygen level of greater than 2 percent. Increase the frequency of windrow turnovers if this minimum oxygen level is not maintained.

3.5.10 Non-Standard Sampling and Analysis

****
NOTE: This paragraph only contains methods for relatively uncommon tests, and tests that are unique to composting. Field capacity may also be determined via ASTM D6836 Standard Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using a Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, and/or Centrifuge.

As alternatives to the Dewar self-heating test, respiration tests may be used to determine the maturity of compost. The text, The Science of Composting, by Epstein, 1997, provides compost stability index values for respiration testing (both for oxygen uptake, and carbon dioxide evolution). ASTM D5975 also uses oxygen consumption to assess compost maturity. Depending on the planned end use for the compost, some tests shown in this paragraph may not be necessary and should be deleted.

The solicitation package should provide prospective

Contractors with a means to acquire any references that are not included with the contract documents, and are not publicly available. The BIOCYCLE reference shown below is only a few pages and should be included with the solicitation package to provide information on self-heating tests, and compost stability testing. It is also recommended that copies of USAEC CETHA-TS-CR-93043 be made available to prospective Contractors to provide descriptions of the intended treatment process.

****

Perform testing of compost for field capacity (or water holding capacity) in accordance with USAEC CETHA-TS-CR-93043, Section 3.8.1 (Moisture Monitoring). Perform testing of compost for pH and conductivity (soluble salts) in accordance with NRAES 54, Chapter 3 (Raw Materials), the Saturated Paste Method.[Perform the Dewar self-heating test for compost maturity in accordance with BIOCYCLE][_____].

3.5.11 Sampling and Analysis for Contaminants of Concern

****

NOTE: Under some conditions, it may be more cost-effective to use field analysis methods (e.g., immunoassay or colorimetric methods), than to require laboratory analysis for all contaminants of concern. However, it may also be necessary to develop a site-specific correlation between data from field, and laboratory analysis. Pigmented materials present in extracts from compost samples may cause interferences in colorimetric, definitive field analysis. For more information see EPA 540 R-97/501, Field Sampling and Selective On-Site Analytical Methods for Explosives in Soil. Laboratory analysis should be required on a minimum percentage of samples to verify data from definitive field analysis.

Collecting samples from the edges and outer surface of the pile should be avoided, since these locations may not be representative of the bulk of the pile. The strategy for sampling and analysis should be consistent with the regulatory requirements for the data. States may impose more restrictive sampling requirements than those under Federal regulations. Compliance testing requirements are usually project specific, and agreed upon by the regulatory officials.

****

Perform sampling and analysis in accordance with the approved UFP-QAPP. Furnish results from each sampling event to the Contracting Officer not more than [24][_____] hours after data are recorded by the Contractor or released by the laboratory.

3.5.11.1 Sampling Frequency and Locations for Pre-Compliance Testing

****

NOTE: This is an example of a pre-compliance testing

protocol used during a previous composting project, and should be applicable to projects where field analysis will be used.
****

At a minimum, conduct sampling two times during treatment of each batch: (1) immediately after initial blending of soil and amendments; and (2) at the estimated time at which the cleanup levels will have been met (based on the results of the field demonstration). To determine locations of sampling stations, divide the windrows into sections. Each section must be a maximum [23][_____] cubic meters [30][_____] cubic yards. Each section must include one sampling station. Sampling stations must be represented by vertical planes that traverse the width of the windrow. Collect samples from a minimum of [four][_____], separate locations within each sampling station. Samples from each sampling station must be [composited prior to testing][_____].

3.5.11.2 Pre-Compliance Testing

****
NOTE: Definitive field analysis methods have been used for pre-compliance testing during previous composting projects.
****

Test for the following analytes during pre-compliance testing: [_____]. Test using the [field analysis][_____] method for pre-compliance testing.

3.5.11.3 Compliance Sampling

****
NOTE: Various methods of statistical analysis may be used to determine if treatment criteria has been attained. For example, after treatment of each batch is completed, the Contractor may be required to show that the mean of the data for each batch is below a specified value, and/or that the upper 95th percentile of the data for each batch is below a specified value. Although the following EPA reference describes procedures for determining whether a specified percentile of material is less than a cleanup standard (EPA 230/02-89-042, Methods of Evaluation and Attainment of Cleanup Standards), it may not be practical to implement this type of requirement. One alternative is to establish "ceiling" values for each contaminant of concern. Thus, in addition to requiring that the mean of the data for each batch be below a specified value, there may be a requirement that "single-sample" values must not exceed a pre-determined ceiling value. Use of ceiling values may eliminate the need for statistical analysis of data by construction QA representatives. There should be a statistical basis for ceiling values, and the basis for establishing ceiling values should be proposed early-on in design (e.g., in the design analysis report). Establishing ceiling values for contaminants of concern should be project specific, and based on negotiations with regulatory

officials. The contract should require a UFP-QAPP which provides a clear and consistent basis for determining the amount of sampling and analysis that will be required.

Treatment criteria should be specified on a "per-batch basis" so that the Contractor will be free to proceed with treating subsequent batches after the data from each batch has been received. This paragraph should be coordinated with paragraph, TREATMENT CRITERIA FOR COMPOSTED SOIL. This is only an example of compliance testing requirements, based on a contract from a previous composting project.

****

After pre-compliance testing indicates that a batch of compost has met treatment criteria, and written approval has been received from the Contracting Officer, perform compliance sampling. To determine sampling locations, [use the same section divisions from pre-compliance testing][_____]. Test two discrete samples, collected from randomly selected locations within each section. If the samples collected for analysis contain rock or gravel, remove this material from the sample and return it to the windrow before submitting the sample for analysis . Conduct testing in accordance with [_____].

3.5.11.4 Government Quality Assurance Testing

****

NOTE: The need for quality assurance testing should be considered on a project-by-project basis, and if not considered necessary this paragraph should be deleted. Factors to consider include whether the Government has access to a laboratory that can analyze quality assurance samples in a timely manner to not delay the project execution. Use of quality assurance testing data also needs to be considered. A relatively straightforward data use is to compare quality assurance sample results to the project Performance Requirements, and a failing result would be treated the same way as a failing Contractor test result. A more complicated data use is to compare results from quality assurance samples and contractor quality control samples for the purpose of determining if there is meaningful disagreement between the results. In this case, procedures would need to be developed for determining when there is a meaningful disagreement between quality assurance and quality control sample results; corrective actions for when a meaningful disagreement was identified would also need to be developed. The process of defining procedures for identifying and correcting meaningful differences should be documented in a project-specific UFP-QAPP and referenced in this specification; the process is likely too complex to be adequately defined in this specification.

****

Provide duplicate samples to the Government's quality assurance laboratory for Government quality assurance. Submit samples at a frequency of one set of samples per [10][_____] sets of quality control tests performed. Quality assurance samples will be tested for the same parameters as the parent quality control sample. Provide additional quality assurance samples upon request.

3.5.12 Post-Treatment Procedure

****

NOTE: If treatment criteria for contaminants of concern have been met, but criteria for re-use (see paragraph TREATMENT CRITERIA AND CRITERIA FOR REUSE OF COMPOSTED SOIL) have not been met, the compost should either remain on the treatment pad, or be moved to a curing/storage area.

****

After compliance test data indicates that treatment criteria have been met, and written approval from the Contracting Officer has been received, the treated material may be removed from the treatment pad to a curing and storage location or kept on the treatment pad until final disposal, at the Contractor's option. Submit Treatment Completion Records which include, but are not limited to, a summary of all activities performed at the site as part of Windrow Composting, materials and equipment used, and all testing and sampling results.

3.5.13 Procedure for Non-Attainment of Treatment Criteria

If the Treatment Criteria and Criteria for Reuse of Composted Soil are not achieved, implement corrective action (continued windrow composting) at no additional cost to the Government until the criteria have been achieved. The corrective action may include: additional sampling to provide more data points for statistical analysis; or continued treatment. If there are portions of compost for which substantial reduction of contaminants of concern was not observed after the end of the estimated treatment period, prepare a report detailing all activities associated with those portions of the compost. The report must include: probable causes as to why significant reductions were not observed; measures that will be implemented to prevent the same problems from recurring; and a proposed plan for continued treatment of those portions of the compost where treatment criteria were not met. Obtain written approval from the Contracting Officer prior to implementing measures that deviate from the approved Composting Work Plan. Continue monitoring and windrow composting (at no additional cost to the Government, and in accordance with paragraph OPERATION AND FIELD QUALITY CONTROL), until the treatment criteria have been attained.

3.5.14 Curing and Storage

****

NOTE: Properly cured compost should have no objectionable odor. Although it is usually unnecessary to turn compost during curing, the compost should remain aerobic. Thus, the size of the piles should be limited. During curing and storage, the potential for spontaneous combustion and development of anaerobic conditions (or souring) increases as the dimensions of the compost piles increase. Monitoring for temperature, moisture and

oxygen will be needed for curing piles, though at a lesser frequency than is needed for treatment windrows. On a previous composting project, a cellulose tackifying agent was used to prevent the wind from dispersing treated compost. Only readily biodegradable tackifying agents should be used.
****

If anaerobic conditions develop during curing or storage, remix the compost, spread on a covered, dry surface, and allow to aerate for at least 24 hours before reforming the piles.

3.5.15 Post-Treatment Screening

****

NOTE: If wood chips or other large diameter particles must be separated from the finished compost prior to disposal, it may be desirable to reuse this material in subsequent batches of compost. If this material cannot be reused in other batches and must instead be repurposed or disposed, it may have to be ground to a powder and representative samples be submitted for chemical analysis to verify that Treatment Criteria have been met and no other contaminants are present above allowable limits.
****

Separate wood chips or other materials whose size exceeds the maximum acceptable size for the intended end use from the finished compost prior to disposal.

3.5.16 Operations Reports

Submit operations reports weekly for the first [10][_____] weeks, and every [two][_____] weeks, thereafter. The report must be kept at the facility during the [field demonstration][and][full-scale operation]. The following information must be recorded and maintained until closure of the facility: description (including sources) of contaminated soil and amendments on site; the dates of receipt, storage, treatment, and disposal of contaminated soil and amendments; the location of all amendments, contaminated soil, and compost on site; and the quantity at each location. The location and quantity of each type of material must be recorded on a map or diagram of the site. This information must include cross-references to specific manifest document numbers, if the waste was accompanied by a manifest. Summary reports and details of all incidents that require implementing contingency plans, or corrective action measures must also be provided. The reports must also include: date and time of each monitoring or testing event; results from each monitoring or testing event; monitoring procedure, or test method used; individual performing the monitoring or testing, and other individuals present; and remarks. Cross-references to submittals specified in other Sections may be provided to prevent duplicate information in separate submittals. Copies of records for treated or processed materials which have been disposed of not more than [45][_____] calendar days after disposal of each batch of materials. The following must be included for each batch of treated material: disposal location; date of transport to disposal location; volume or weight of material; and chemical data reports. Cross-references to the submittal specified in Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS, which includes the manifests and disposal certificates, must be provided for materials disposed of offsite. For non-manifested materials disposed of offsite, the following information must also be provided: address, phone number, proof of receipt from the disposal facility, and point of contact for each receiving offsite disposal facility.

3.5.17 Change of Operating Conditions

****

NOTE: If adjustment to the composting operating conditions is required due to change in contaminated material characteristics, then the Contractor's adjusted operating conditions should be evaluated by the Contracting Officer for the extent of changes from the previous operating conditions. Further, price negotiation may be required based on the extent of changes from the previous operating conditions.

****

The following two requirements must be met in order to be considered for change of operating conditions: (1) the physical and chemical characteristics of the contaminated materials are significantly different from the originally defined characteristics, and (2) the treatment requirements cannot be met under the current composting amendment design and related operating conditions. When change of operating condition is necessary, notify the Contracting Officer before changes are made to the amendment design and related operating conditions. The Contracting Officer may require the Contractor to perform a field demonstration for significant changes made to the amendment design and related operating conditions in accordance with paragraph FIELD DEMONSTRATION, for approval. If adjustment to the amendment design and/or operating conditions is required due to change in contaminated material characteristics, submit an adjusted design for the extent of changes from the previous design for approval. Further, price negotiation may be required based on the extent of changes from the previous mix design.

3.6 DISPOSAL

****

NOTE: Depending upon the characteristics and quantities, the potential disposal scenarios for wastes may include: onsite treatment and backfilling; partial onsite backfill and partial offsite disposal; and offsite disposal. Asphalt surfaces may be removed and sent offsite for recycling. One disposal scenario for each type of waste should be clearly defined.

After treatment, a volume decrease of approximately 50 percent may be observed for compost that originally contained 30 percent soil and 70 percent amendments. If the compost will be applied as a soil amendment, the following indices should meet quality guideline standards: pH, the Dewar self-heating test, conductivity, maximum particle size, foreign material content, and the levels of heavy metals. In addition, the plan for final disposition of the compost should take into account

the conductivity, maximum particle size, foreign material content, and the levels of heavy metals in the untreated soil to assess if the final product will be suited for the desired end use. See the On-Farm Composting Handbook for more on quality guidelines for different end uses of compost; also, see paragraph TREATMENT CRITERIA AND CRITERIA FOR REUSE OF COMPOSTED SOIL. According to the On-Farm Composting Handbook, if the end use for compost will be as a soil amendment, the compost application rate should not exceed 4 cubic meters per 110 square meters 4 cubic yards per 1,000 square feet.

****

Dispose or recycle/reuse compost that has met treatment criteria [and criteria for reuse] in accordance with regulatory requirements. If necessary, [treat and] dispose of the following materials on-site: [oversize materials][sludge resulting from treatment of contact water][excess amendments][and][_____]. If necessary, treat the following materials and dispose of off-site: [spent personal protective equipment][spent granular activated carbon][and][_____]. Perform offsite disposal of hazardous material and wastes in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS, which includes the preparation and submission of manifests and disposal certificates for materials disposed of offsite.

3.7 DEMOBILIZATION

****

NOTE: A separate table should be prepared if criteria for soils below the treatment pad, or other areas of the treatment facility, differs from criteria in paragraph TREATMENT CRITERIA AND CRITERIA FOR REUSE OF COMPOSTED SOIL. This paragraph should be edited appropriately if it is desired to retain portions of the composting treatment facilities after project completion. This paragraph should also be coordinated with Division 01 Sections of the contract.

The paragraph ENVIRONMENTAL REQUIREMENTS FOR OFF-SITE SOIL in Section 31 00 00 EARTHWORK should be edited to include an appropriate list of chemical testing parameters for off-site soil. Some backfill sources may have chemical testing data already available; the Government should require chemical testing if the backfill chemical testing data is inadequate or does not exist. Off-site backfill should not be tested for only the site contaminants of concern. At a minimum, samples should be analyzed for target contaminant list (TCL) VOCs, TCL SVOCs, target analyte list (TAL) Metals, and Pesticides/PCBs. Additional analyses such as Total Petroleum Hydrocarbons may be appropriate also. Individual States or military installations may require or recommend additional parameters. Typical frequency of sampling would be one sample per 1,900 to 2,300 cubic meters 2,500 to 3,000 cubic yards. However, individual States or military installations

may require or recommend more frequent or less frequent sampling.
****

Do not commence demobilization until written approval is received from the Contracting Officer. Follow the approved mobilization and demobilization plan and requirements under paragraph MOBILIZATION AND DEMOBILIZATION. Demobilization must restore the site to its initial state, prior to the construction and operation of the composting treatment facilities. Demobilization must include, but must not be limited to: [removal of structures and materials used to house or cover the compost piles,][disconnecting of utility service lines,][decontamination and removal of equipment and materials,][disposal of decontamination wastes,][disposal of any residual wastewater,][removal of unused amendments and other materials,][removal of material overlying liners,][removal of liners,][regrading and removal of berms,][demolition and disposal of the treatment pad, other foundation slabs, and paved surfaces,][seeding of disturbed, previously vegetated areas,][_____]. [Perform post-treatment testing of soils below work area surfaces (after the liners or pavement have been removed), to verify that the area is not contaminated. These soils must meet the following criteria: [treatment criteria in accordance with paragraph TREATMENT CRITERIA FOR COMPOSTED SOIL.][_____.]] If soil excavation is also part of the field activity, excavated areas need to be backfilled and restored to the original condition in accordance with Section 02 61 13 EXCAVATION OF AND HANDLING OF CONTAMINATED MATERIAL and Section 31 00 00 EARTHWORK.[Perform confirmation sampling within the excavated areas in accordance with the UFP QAPP to ensure all contaminated soil above treatment criteria are removed.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 54 23 (February 2025)**

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Preparing Activity: USACE **Superseding**
UFGS-02 54 23 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 54 23

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USACE / NAVFAC / AFCEC **UFGS-02 54 23 (February 2025)**

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****

SECTION 02 54 23

SOIL WASHING THROUGH SEPARATION/SOLUBILIZATION
02/25

****
NOTE: This guide specification covers the requirements for removal of contaminants by soil washing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This UFGS provides the framework for developing a project-specific soil washing specification. It should be modified as necessary for a given site, to incorporate the conditions, soil washing technology, and regulatory requirements which are specific to the site.

Soil washing can be applied to the removal of most contaminants, including heavy metals and other inorganics, organics (including per- and polyfluoroalkyl substances [PFAS]), and radioactive wastes. Water-based applications involve separation of fine from coarse-grained soil particles to reduce

the volume requiring on- or off-site disposal (i.e., adsorption to the soil matrix, which consists of organic carbon content and soil particles themselves). Larger soil fractions may need to undergo attrition scrubbing or other methods to remove attached contaminated finer soil fractions. Solvent-based applications involve the dissolution of contaminants into the aqueous phase for removal and subsequent treatment or disposal of the extraction solvent/reagent waste stream. Refer to paragraph BENCH-SCALE TREATABILITY STUDY WORK PLAN for more details regarding the applicability and physical limitations of soil washing.

A systematic project planning approach should be employed when developing sampling procedures to demonstrate the performance of the soil washing treatment process, ideally through implementation of the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) or some such similar process.

The soil washing operation considered in this section starts with the raw contaminated soil piles; continues through preparation, feeding, washing, separation, stockpiling, waste (solid, liquid and/or gaseous) treatment and disposal; and ends at the treated clean soil piles. As applicable, refer to Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL for requirements related to excavation, stockpiling, and handling of the contaminated soils; Section 31 00 00 EARTHWORK for placement of treated soils in on-site permanent storage; and Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS for requirements relevant to offsite transportation and disposal

****

1.1 MEASUREMENT AND PAYMENT

1.1.1 Unit Prices

****

NOTE: Edit this paragraph based on whether the Contract will use a single job price or unit prices. If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is in the project, move these paragraphs to that Section for editing.

If the project includes Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS, coordinate measurement and payment methods and contaminated material handling and stockpiling between this Section and Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS.

This paragraph should be modified based on the project specific conditions. Special Clauses should address modification of the full scale remediation

unit price due, if warranted, based on the results of bench-scale treatability studies or the field demonstration testing. For remediation using soil washing, a Request for Proposal rather than Invitation for Bid procurement process is generally used to select a Contractor.
****

1.1.1.1 Contaminated Materials

Payment for soil washing treatment of the feed soils will be based on the contract unit price schedule for each [metric ton ton][_____] on a dry weight basis of the previously untreated feed soils entering the treatment plant following removal of feed oversize soil. This unit price will include costs for materials, labor, processing and treatment, testing and analyzing, operation and maintenance.

Weigh the feed oversize and the feed soils separately during operation of the soil washing treatment plant (the treatment plant). The feed oversize (or debris) consists of the oversized soils separated from the raw contaminated soils by the soil preparation and feed system. The feed soils are the balance of the raw contaminated soils after the feed oversize has been removed. Convert the measured gross (bulk) weight of the feed soils to be treated by soil washing to dry weight based on the [percent moisture content][_____] of representative feed soil samples.[Determine the percent moisture content in accordance with [ASTM D2216][ASTM D4643][ASTM D4959][_____].][Determine moisture content[daily.][for every [500][_____] metric tons tons of feed soil.]]

1.1.2 Single Job Prices

[1.1.2.1 Bench-Scale Treatability Studies

****
NOTE: Delete this paragraph if bench-scale treatability studies have already been performed.
****

Payment for bench-scale treatability studies will be[included as part of base bid items][based on a single job price for each bench-scale treatability study test run requested by the Contracting Officer and properly completed][_____]. Include costs for labor and soils materials for: preparing plans; collecting representative contaminated soils; conducting the studies (including sampling and analysis); evaluating results; preparing the treatability study report; and treating [and][or] disposing of study-derived wastes.

]1.1.2.2 Field Demonstration

Payment for field demonstration test runs will be[included as part of base bid items][based on a single job price for each test run requested by the Contracting Officer and properly completed]. Include costs for labor and materials for: processing and treatment, testing and analyzing, report preparation, and other incidental work (such as, manufacturers' field services, health and safety monitoring and controls, and utilities).

1.1.2.3 Feed Oversize Materials Treatment [and][or] Disposal

Payment for treatment [and][or] disposal of feed oversize soils, washwater process sludge, spent washwater, and process treatment soils exceeding post-treatment criteria is provided in [Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS][_____].

1.1.2.4 Other Work Items

****

NOTE: Coordinate this paragraph with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS. Temporary utility connections are covered in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.

****

Payment for other work items not included in the above paragraphs will be included in the payment for the base bid for remediation of the contaminated soils. The other work items include submittals related to operation of the treatment plant, mobilization and demobilization, configuration and installation of the treatment plant, manufacturers' field services, environmental compliance monitoring, health and safety monitoring and controls, and utilities required for the soil washing treatment if approved by the Government as necessary for the project.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating

ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
EPA 540/2-91/020A	(1991) Guide for Conducting Treatability Studies under CERCLA: Soil Washing: Interim Guidance
EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

[1.3 PRE-INSTALLATION MEETINGS

****

NOTE: Delete this paragraph if the requirements are included in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, Section 01 32 01.00 10 PROJECT SCHEDULE, or other Specification Section.

Appropriate facility personnel should be present at the pre-installation meeting if siting of the treatment facility and other associated work areas will be discussed.

****

Conduct a pre-installation meeting at the jobsite at least [five business days prior to the start of operations on the project][_____]. Arrange the pre-installation meeting and follow the written pre-installation meeting agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Site Foreman and [Contracting Officer][_____].

Record pre-installation meeting minutes and publish by way of email within 48 hours to all attendees. Re-publish the meeting minutes within 48 hours pending any subsequent comments from the attendees.

]1.4   SYSTEM DESCRIPTION

****

NOTE: If pretreatment such as blending for a homogenous feed or separating contaminated soils with different characteristics for different treatment operating conditions is required, some of the pretreatment requirements should be specified in Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS so the pretreatment required can be properly specified in this specification without any duplication. In addition, representative samples of the contaminated soils excavated and stockpiled should be collected and analyzed regularly to check and document its physical and chemical characteristics for design consistency and suitability as a feed of the contaminated soils.

Indicate if the Government knows/assumes that there are multiple dissimilar types of contaminated materials that will require different soil washing treatment processes. This may be based on site investigations and/or previously completed treatability studies.

****

The work consists of soil washing treatment of approximately [_____] metric tons [_____] tons of contaminated material.

1.4.1   Design Requirements

1.4.1.1   Soil Washing Treatment Process

****

NOTE: Modify this paragraph if the Designer will require the use of specific washwater mixtures (e.g. methanol solvent for PFAS-contaminated materials) based on previously conducted treatability studies, etc.

****

Provide washwater consisting of[water only][water plus approved extraction [solvents][reagents] such as acids, bases, surface active agents (surfactants), solvents, and chelating or sequestering agents] to enhance the solubilization [and][or] separation of the contaminants from the coarser [and][or] finer grained soils as needed to increase the efficiency of the soil washing treatment. Identify specific extraction [solvents][reagents] during the bench-scale treatability [study][design] steps.

1.4.1.2   Soil Washing Treatment Plant

****

NOTE: Omit the third- and fourth-to-last sentences of this paragraph ("The Contractor may propose … must be addressed in detail…") if a specific method of treatment is desired.

****

Configure the treatment plant based on the contaminated soils characteristics data and the Contractor's own interpretation of the bench-scale or pilot-scale treatability study results performed by the Contractor. Provide a full-scale treatment plant that is transportable. The capacity of the soil washing system must be [_____][consistent with the remedial action schedule]. The materials, components, accessories, and equipment used to fabricate the treatment plant must meet their functional requirements, and must be compatible with the contaminants of concern, the extraction [solvents][reagents] used in the treatment processes, and the operating conditions of each unit operation.[The Contractor may propose a treatment plant different from the treatment plant specified, in which case the proposed treatment plant capable of providing equivalent performance must be addressed in detail [in the Contractor's proposal][and][in the Soil Washing Work Plan][_____].] Provide a safe and reliable soil washing treatment plant in compliance with the applicable codes, regulations, and specified requirements. The treatment plant must consist of the following major systems:

1.4.1.2.1   Soil Preparation and Feed System

Soil preparation and feed system must include, but not be limited to, feed oversize separation, blending [and][or] separation of different soil particle sizes [and][or] contaminant levels (if needed) to provide a consistent feed, stockpiling of feed oversize and feed soils, conveying, feeding, treatment [and][or] disposal of feed oversize, dust/emission controls, and measurement of feed oversize and feed soils. Base the capacity of this system on the downstream treatment system operations. Refer to Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL for requirements related to excavation, handling, and stockpiling of the contaminated soils. Since heterogeneity and inconsistent feed conditions can impact soil washing removal efficiency, if appropriate, pre-processing steps to maintain homogenization for optimal removal efficiency should be specified in the Soil Washing Work Plan. Soils may need to be segregated by order of magnitude contaminant concentrations and either blended for more homogeneity or treated using different process conditions to optimize treatment throughput and minimize treatment costs, which should be determined during the [treatability][design] steps.

1.4.1.2.2   Soil Washing and Separation System

Provide a soil washing and separation system which includes mixing, washing [(including the preparation and addition of any extraction [solvents][reagents])], [solids and liquid separation][soil particle size separation][_____], dewatering of treated soil, and measurement of process parameters and treated soils. For example, coarse grained soils can be separated using vibratory screens or trommels. Additional separation of the finer grained soils can be performed using hydrocyclones or spiral classifiers that leverage differences in settling velocities of the particles. Treated soils are the feed soils having been washed and separated by the soil washing and separation system. Treated clean soils are the treated soils which meet the post-treatment criteria. Provide a soil washing system that is equipped with direct means for controlling the washwater settings including[pH][temperature][pressure][composition][quantity][contact time][and][particle size separation][_____]. The mixing and washing equipment must have the capability to dissociate the contaminated fine soil particulate [types][sizes] from the coarse soil particulate [types][sizes] [and][or] to solubilize the contaminants into the washwater mixture so that the post-treatment criteria can be achieved at a minimum for the coarser grained soils.[Magnetic separation of ferrous soil must be done using electromagnets.] Provide dewatering equipment that is capable of lowering the moisture content of treated soils and corresponding washwater treatment sludges to less than [10][15][_____] percent as required for on-site backfilling [and][or] offsite disposal.

1.4.1.2.3 Spent Washwater Treatment System

Spent washwater is washwater that has been in contact with contaminated feed soils or other contaminated surfaces, consisting of a mixture of contaminated fine particles [and][or] dissolved contaminants, washwater, and run off water from soil storage and treatment areas. If required, provide a spent washwater treatment system to include physical, chemical, [and][or] biological treatment of spent washwater; dissolved [and][or] suspended solids removal; process sludge dewatering; recycle, reuse, [and][or] discharge of treated washwater; and measurement of treatment parameters and dewatered [and][or] treated process sludge. Process sludge is the sludge resulting from the removal of dissolved contaminants [and][or] the contaminated suspended [soils][solids] in the spent washwater. If a washwater treatment system is required, it must have the capacity and capability to treat the generated volume from the design capacity of the treatment plan (also including collected stormwater run-off and any leachate collected from the soil piles) for recycle, reuse, or treatment and discharge. The treated washwater must meet the quality limits for [recycle][reuse][discharge], [and][or] [disposal][_____]. The process sludge must be treated [and][or] disposed of according to its characteristics and regulatory requirements.

1.4.1.2.4 Plant Supporting System

Include a supporting system in the treatment plant for water storage and distribution, extraction [solvents][reagents] storage and distribution, [power and steam][power] generation and distribution, and fire safety. Provide these supporting facilities with adequate capacities to deliver water, extraction [solvents][reagents], power, [steam][_____], and fire protection necessary for operation of the soil preparation and feed system, soil washing and separation system, and[spent washwater treatment system][_____].[Provide [alternate][auxiliary] power source if sufficiently reliable source is not available. Provide emergency power for lighting, controls, and computer system operation[, _____].] Provide material feeding equipment for each extraction [solvent][reagent] consisting of a feed tank and mixer for preparing feed stock, and a metering pump for controlled feeding. Refer to [Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____] for requirements related to spill containment structures, stormwater pollution prevention, and air quality.

1.4.1.2.5 Sampling, Monitoring, and Control Requirements

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NOTE: The process and waste generation data storage requirements should be specified based on the quantity, frequency, and requirement of data reduction and analysis for a specific project.

****

Provide appropriate sampling and monitoring equipment for controlling the performance of the treatment processes and for complying with design and regulatory requirements. Provide monitoring and control equipment for the treatment processes with the necessary accuracy and sensitivity to measure and control the operating ranges for system parameters such as[material feed rate][washwater flow rate][pH][contact time][cut size][_____] so that the treatment plant can perform to its designed capacity, efficiency, and reliability. The unit operations of the treatment plant must be complete with required instruments, controls, and local control panels. Provide a main control center to facilitate the overall control of the treatment plant. The main control center must have the necessary provisions for heating, ventilation, and air conditioning for proper operation of the instruments, controls, and electronic data storage system. Refer to Section 23 30 00 HVAC AIR DISTRIBUTION for proper heating, ventilation, air conditioning. The signal transmission to and from the main control center must be [4-20 mA][_____].

1.4.1.3 Utilities

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NOTE: The locations and details (such as utility point of contact, sizes, capacities, and flows) of the utility hookups should be provided on the drawings for the Contractor's use. Verify the utilities are available on-site before including the second sentence.

****

In accordance with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS, provide the utilities associated with the installation and operation of the treatment plant including, but not limited to: [telecommunications][electricity][water][steam][gas][sanitary][and][solid waste facilities][_____]. The[telecommunications][electricity][steam][water][gas][sanitary][and][solid waste facilities][_____] are available at the site.[Refer to the drawings for hookup locations and other details.]

1.4.1.4 Material Measurement

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NOTE: This paragraph is primarily intended to ensure that calibrated scales are being used to weigh treated soil, when weight is being used as the basis for measurement and payment.

****

Provide scales, meters, and volumetric measuring devices for measuring oversize materials, feed contaminated materials, reagents, and water which conform to the applicable requirements of NIST HB 44, except that the accuracy must be plus or minus[0.1][_____] percent of the quantity being measured. For scales used to measure weight of material in vehicles, provide scales of sufficient length to permit simultaneous weighing of all axle loads. For scales used to make measurement for payment, ensure the scale is certified[by an acceptable scales company representative][by an inspector of the State Inspection Bureau charged with scales inspection] prior to weighing any materials. Perform a check of calibration of measuring equipment prior to initial use, and once every [seven][_____] calendar days. The requirements of this paragraph do not apply to measurement of chemical data.

[1.4.1.5 Bench-Scale Treatability Study Work Plan

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NOTE: Typically, a bench-scale treatability study will have been performed prior to development of this specification; however, the Contractor is sometimes required to complete a bench-scale treatability study prior to performing full-scale work at the site. Bench-scale treatability study test protocol and results should include any proposed extraction solvents/reagents (including water) and the respective mix ratios to be used during full-scale treatment. This paragraph should indicate if the Designer will require bench-scale treatability testing of any specific extraction solvents/reagents (e.g. methanol for PFAS-contaminated materials). The test results submitted should verify that the mix design proposed meets the post-treatment criteria listed in paragraph PERFORMANCE REQUIREMENTS.

Since soil particle size separation represents the primary method of contaminant removal/soil volume disposal reduction, the bench-scale treatability study work plan must include a detailed soil grain size analysis and laboratory testing for contaminant distribution within pre-determined ranges of separated soil types/grain sizes. Outcomes from the bench-scale treatability study should first establish and determine a go/no- go decision point for the viability and cost effectiveness for moving forward with soil washing for the identified soil particle size mix and contaminant distribution and the viability of meeting post-treatment criteria. In general based on soil washing's history, it is less cost effective as the percentage of finer grained soils increases. For example, a literature rule-of-thumb particle size distribution of 0.25 to 2 millimeters 0.001 to 0.08 inches is considered optimal for soil washing, while <0.063 millimeters 0.002 inches may not be viable - which correlates to <25% silts and clays considered optimal and >50% may not be viable. High clay content with corresponding high moisture levels poses a soil handling and feed challenge.

****

Submit a Bench-Scale Treatability Study Work Plan consistent to the extent practical with EPA 540/2-91/020A within [30][_____] calendar days after notice to proceed. Do not perform the bench-scale treatability study until the work plan is approved. Prepare [draft for Government review] [draft-final for [regulatory][_____] review] and final versions of the Bench-Scale Treatability Study Work Plan. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. The technical requirements to address include, but are not limited to, the following: procedures for obtaining contaminated soils to be used in the bench-scale treatability study; contaminant distribution as a function of distribution within defined soils lithology types/grain sizes); washwater requirements determination and optimization; residuals management; mass balance calculation; unit processes/operations evaluation; definition of particle size separation requirements based on fine versus coarse grain sizes or specific particle size distribution that meets the post-treatment criteria to allow for on-site re-deposition and minimizes the off-site disposal volume; soil [testing][sampling] protocols and analytes. If appropriate, the work plan should also include the testing of appropriate extraction [solvents][reagents] besides water for more difficult to extract contaminants or for higher percentages of finer grained soils to optimize removal efficiencies. In addition, the work plan must include a thorough discussion of how the study's operating conditions will compare with full-scale conditions, and how the variances will be addressed in scale-up. If proprietary extraction [solvents][reagents] are to be used in the processes, Safety Data Sheets and other non-proprietary type information must be provided to assess their potential for secondary contamination or other exposures during the installation and operation of the treatment plant.

]1.4.1.6 Soil Washing Work Plan

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NOTE: The Designer may wish to require the Soil Washing Work Plan, UFP-QAPP, and other preconstruction submittals required under this section to be completed concurrently, or with the other plans being appendices of one primary plan. This Section should be edited to reflect such a requirement if applicable.

****

Submit a Soil Washing Work Plan[within [60][_____] calendar days after completion of the Bench-Scale Treatability Study][no less than [120][_____] calendar days prior to the anticipated start of full-scale soil washing operations]. Do not perform soil washing until the Work Plan is approved. Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Soil Washing Work Plan. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. The Work Plan must address the technical requirements listed in this Section and must include, but is not limited to, the following:

a. Schedule. Specify dates for the start and completion of [treatability studies][_____], design documentation, mobilization, installation, field demonstrations, treatment of contaminated soils, disposal of wastes, and demobilization. Include details such as intended hours of operation, scheduled downtime, and routine maintenance downtime.

b. Project Organization. Propose a project organization for carrying out the remediation of contaminated soils by soil washing treatment. Provide an organization chart including subcontractors. Clearly define the responsibilities of each individual in the organization in terms of project activities including, but not limited to: project management and coordination; scheduling and schedule control; quality control; sampling, measurement, analysis, and data management; and operation and maintenance of the treatment plant.

c. Principles of Operation. Provide a detailed description of the proposed treatment plant. Include treatment systems and corresponding unit operations, treatment capacity, preparation of feed soils, soil handling and feed systems, treatment requirements for washwater, properties and handling of extraction [solvents][reagents] (including reuse, reclamation, or disposal of spent or recovered materials), mechanism of contaminant removal, characteristics and stockpiling of the treated soils, and wastes generation and disposal. Post treatment soil criteria for on-site re-deposition,[disposal criteria][washwater treatment discharge criteria][and][air emissions criteria][_____] must be presented based on regulator [feedback][permit] requirements and other site requirements.

d. Equipment. Describe treatment system equipment completely, including, but not be limited to, equipment identification, manufacture make and model, physical size, operating conditions, and materials of construction.

e. Drawings. Provide drawings showing at least: layout of the treatment plant, including feed soil stockpiles; storm water drainage and soil pile leachate collection plan for the soil stockpile storage areas; pre-treatment and post-treatment soil stockpile construction; washwater treatment system and discharge design/construction; and piping, instrumentation, and electrical process flow diagrams and details.

f. Quality Control. Provide a quality control plan as required in Section 01 45 00 QUALITY CONTROL, to detail the procedures for inspection, testing, and correction of deficiencies. This program must ensure that the Contractor's operations comply with the requirements of the contract plans and specifications with respect to quality of materials, workmanship, construction, finish, functional performance, and accuracy of data.

g. Process Soils Tracking Schedule. Provide a Process Soils Tracking Schedule for recording and managing the quantities of the contaminated soils processed,[feed oversize treated [and][or] requiring disposal],[process sludge treated [and][or] requiring disposal,][other waste streams requiring disposal such as [_____],][reprocessing of treated soils that fail to meet post treatment criteria][_____], and the treated clean soils to be re-deposited on-site (e.g., use as backfill) or soils exceeding post-treatment criteria requiring off-site disposal. Track each soil from the original source, continue through various stages of handling and treatment, and end at the ultimate disposal.

h. Mobilization and Demobilization. Include a mobilization and demobilization plan containing, but not be limited to: transport of personnel, material, and equipment; decontamination and disposal of materials and equipment brought to the site; decontamination and disposal of the treatment area and other paved surfaces; and decontamination of equipment during demobilization. Include a Post-Treatment Cleanup and Sampling Plan in the mobilization and demobilization plan for areas where there was contact with contaminated materials and were disturbed by the remedial action/site work. Also, discuss the restoration of disturbed areas such as grading, seeding, etc. Address the requirements in paragraphs MOBILIZATION and DEMOBILIZATION.

i. Soil Handling Plan. Elements of the plan must include excavation of contaminated soils (refer to Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS and Section 31 00 00 EARTHWORK); storage of the feed soils; conveyance of soils through the pretreatment and soil washing process; storage of treated soils until sampling is completed; segregation of soils that meet the post-treatment criteria for on-site [backfilling][re-deposition] versus soils requiring off-site disposal; and excavation backfilling (using treated soils or clean borrow soils). This plan needs to account for and balance the following: factors: minimizing the open excavation area for safety and minimization of rainfall contact with contaminated soils; optimizing and matching of the daily capacity of the soil washing treatment system with the daily soil excavation volumes and capacity for final deposition of the treated soils (including post-treatment sampling and analysis timeframe); minimizing of pre- and post-treatment soil storage volumes that must also fit available treatment system footprint area; and soil storage area [cover][liner][stormwater] diversion measures to prevent direct contact of precipitation with pre- and post-treatment soils. This plan must include appropriate drawings and specifications for the various soil handling operations and storage areas for review.

j. Permits, certifications, [and][or] substantive regulatory requirements necessary for the configuration, installation, operation, and closure of the soil washing treatment plant. For those permits, certifications, [and][or] substantive regulatory requirements which have not been obtained, provide a copy of these applications. Possible permits or substantive regulatory requirements that may be applicable include [air emissions from the soil washing operation (e.g., particulates, fugitive emissions from extraction [solvent][reagent]] [washwater treatment discharge (e.g., national pollutant elimination system discharge to surface water body or direct discharge to municipal publicly owned treatment works)].

[k. Bench-Scale Treatability Study Test Report: After completion of testing, compile the data from the treatability study and propose the conditions to be tested in the Field Demonstration. Submit the Bench-Scale Treatability Study Test Report, describing the protocol and results for the treatability study that addresses, but is not be limited to, the materials, procedures, and methods used in the study; tests performed; sampling and analysis; mass balance and performance evaluation; and results, conclusions with supporting dialog, and recommendations.]

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NOTE: It would be normal practice that a Field Demonstration Plan be included as part of the Soil Washing Work Plan unless a separate submission is required by the regulator or due to site circumstances and schedule. If a separate Field Demonstration Work Plan is required, the specification should be edited to include that requirement, including schedule and reviews.

****

l. Field Demonstration Plan. This plan must address, but not be limited to, the following: contaminated feed soil characterization (including the contaminant concentrations as a function of grain size to evaluate consistency with the bench-scale treatability study; proposed demonstration testing runs (including verification [and][or] optimization of the washwater mix design and [testing][operating] conditions and other key operating parameters for the unit [processes][operations] for each run); sampling protocol, locations, and analytical methods to verify that the design output criteria have been met, including required particle size separation, target contaminant concentration distribution; attainment of soil cleanup levels for any on-site re-deposition, and attainment of [permit][substantive] regulatory criteria; overall mass balance calculation and performance evaluation; and soil and waste characterization of any treatment residuals requiring disposal (e.g., washwater treatment sludges). In addition, the day-to-day log of operations and adjustments to optimize the treatment system must be included in the appendices.

1.4.1.7 Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP)

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NOTE: This section may reference a separate specification section requiring preparation of a quality assurance project plan or may be excluded entirely if the requirements are part of another specification section.

Indicate in this paragraph if the UFP-QAPP should include any testing protocols specific to the contaminated soil matrix and soil washing technology (e.g. filtering or homogenizing samples if larger contaminant debris may be present).

****

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with the requirements set forth in EPA 505-B-04-900A and using the UFP-QAPP WKSTS. Tailor the content to the requirements of the project and the site conditions and media of interest and address the collection of chemical and physical data necessary to make operational decisions. Prepare [draft for Government review] [draft-final for [regulatory][_____] review] and final versions of the UFP QAPP. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. Do not perform work at the site, with the exception of site inspection and surveys, until the UFP-QAPP is approved.

1.4.2 Performance Requirements

1.4.2.1 Contaminant Concentrations

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NOTE: The table in this paragraph should be developed based on site-specific contaminants of concern and regulatory requirements.

Planned post-treatment criteria, as well as sampling and analysis requirements, should be reviewed by regulatory agencies in the early stages of design. These criteria generally consist of cleanup levels and/or contaminant limits derived from risk-based requirements, Toxicity Characteristic Leaching Procedure (TCLP) limits, Synthetic Precipitation Leachate Procedure, Resource Conservation and Recovery Act (RCRA), Land Disposal Restrictions (LDRs), and RCRA delisting requirements. Coordinate backfilling with Section 31 00 00 EARTHWORK to

ensure geotechnical parameters are specified.

Two approaches are provided for attaining performance criteria: meeting performance criteria for every sample of treated soil (conservative approach) or meeting performance criteria on the average for multiple samples of treated soils from a defined soil volume or decision unit (e.g., soil stockpile). For purposes of waste characterization, collected soil sample(s) must be considered representative of the total waste stream.

****

The concentrations of the contaminants in the treated coarser or finer grained soils intended for on-site re-depostion must not exceed the post treatment criteria specified in Table 2. The determination for attaining the post-treatment criteria will be based on applicable sampling protocol described in the UFP QAPP. Examples of possible post-treatment criteria include the following: [Each sample of post-treatment soil must meet the criteria shown in Table 2.] [An average of all samples of treated soil must meet the performance criteria in Table 2 with no individual sample greater than [_____][110 percent] of the criteria in Table 2 and with no more than [_____][20 percent] of the samples exceeding.] Projected removal efficiencies for the finer grained soils should at least be consistent with the levels identified during the bench-scale treatability and design steps. Post-treatment soils that do not meet the post-treatment criteria must either be re-treated until the applicable criteria are met or staged for off-site disposal.

TABLE 2 - POST TREATMENT CRITERIA

	CLEANUP LEVEL IN TREATED MATERIAL	
PARAMETER	TOTAL CONCENTRATION IN TREATED MATERIAL	TCLP EXTRACT LIMIT
[_____]	[_____] mg/kg	[_____] mg/L

[1.4.2.2 Cut Size Requirement

****

NOTE: This paragraph should be deleted if removal of contaminants is not dependent upon separation of contaminated fine particles (i.e., entirely due to solubilization or other removal techniques). This paragraph provides options for either the design engineer to specify or the Contractor to choose the cut size requirements. The feed materials at a given site may have different physical and chemical characteristics. Therefore, during soil washing treatment, different cut sizes may be used so that the treated materials will meet the post-treatment criteria. If the design engineer chooses to specify the cut size, and if treatment involves a variety of cut sizes, then the different cut sizes should be specified for different feed materials.

****

Cut size is the targeted grain size used to define the demarcation of the coarse and fine grained soil fractions of the feed materials to be separated during the soil washing operation. Cut size specification for purposes of soil particle size separation design to attain the post-treatment criteria must be identified by the Contractor based on experience and bench-scale [treatability][pilot] study results. Each selected cut size with supporting documentation must be submitted for review prior to implementation. The supporting document must include information correlating contaminant concentrations for the various size fractions based on the grain size distribution.

]1.4.2.3 Spent Washwater Treatment and Disposal Requirements

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NOTE: These paragraphs provide the generic requirements for washwater treatment and disposal, solid waste treatment and disposal, and emission and dust control. These paragraphs should be modified based on the site specific design of the soil washing treatment plant and regulatory requirements. The spent washwater should be treated if necessary and reused, discharged in accordance with applicable regulations (federal, state, and local), or sent for offsite disposal.

Modify this paragraph to reflect the following site-specific requirements.

If a performance specification is prepared, the treatment and disposal requirements should be specified based on the conceptual/process design and applicable regulations. Table 3 should be presented to list the disposal/discharge criteria for the contaminants of concern in accordance with regulatory requirements. If the specification is prepared based on detailed design, the detailed design requirements describing the treatment and disposal scenario as well as the unit processes/operations employed should also be specified.

If sent for off-site disposal, spent washwater should be characterized to determine whether it constitutes a RCRA hazardous waste in accordance with RCRA Identification and Listing of Hazardous Wastes or applicable state regulations. The "derived-from" rule requires treatment residues from the treatment of RCRA listed waste to be managed as listed waste. If the spent washwater is classified as a hazardous waste, a determination should be made as to whether additional treatment is required to comply with RCRA land disposal restrictions. In addition, the requirements in RCRA Standards for Generators of Hazardous Waste and applicable state regulations should be identified and satisfied.
If other washwaters are treated along with the spent washwater, they should be mentioned in this paragraph. These washwaters may include, for example, the rainfall run offs from the stockpiles

of feed oversize, feed soils, treated soils, and process sludge; and the washwaters generated from onsite treatment of feed oversize, process sludge, and/or spent process treatment materials.

In the event the project is performance-based, Table 3 will be left blank, and the Contractor must define the spent washwater permit or substantive discharge criteria in the Soil Washing Work Plan.
****

The spent washwater must meet the criteria presented in Table 3 at the time of [disposal][discharge].

TABLE 3 - SPENT WASHWATER DISPOSAL/DISCHARGE CRITERIA	
PARAMETER	DISPOSAL/DISCHARGE CRITERIA
[_____]	[_____] mg/L

1.4.2.4 Solid Waste Treatment and Disposal Requirements

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NOTE: Solid wastes generated during the plant operation may include feed oversize, process sludge, and/or spent process treatment materials. One treatment and disposal scenario for each of these solid wastes should be clearly defined. If a performance specification is prepared, the treatment and disposal requirements should be specified based on the conceptual/process design. Table 4 should be presented to list the disposal criteria for the contaminants of concern for each of the solid wastes. The applicable federal, state, and local regulations specifically related to the site should be identified. If the specification is prepared based on detailed design, the description of the treatment and disposal scenario as well as the individual treatment components should also be specified.

If secondary solid, liquid, and gaseous wastes are generated by onsite treatment, their treatment and disposal requirements should be addressed in the same manner as the solid, liquid, and gaseous wastes generated by the treatment plant. If the liquid wastes are treated along with the spent washwater, their treatment and disposal requirements should be addressed in the paragraph entitled SPENT WASHWATER TREATMENT AND DISPOSAL REQUIREMENTS. Similarly, the gaseous wastes can also be addressed in the paragraph titled EMISSIONS AND DUST CONTROL.
****

The[oversize debris, rocks, minor quantities of clayey soil clumps too large to be processed, etc. screened out of the feed soils][washwater process sludge][fine grained soils not meeting treatment criteria][spent process treatment soil][_____] from installation, operation and closure of the treatment plant must be properly treated [and][or] disposed to the levels specified in Table 4. Spent process treatment material is the process treatment material for which the capacity to remove contaminants from the contaminated medium in a treatment process has been used or exhausted (e.g., spent adsorbent media from washwater treatment). The Contractor must present the waste characterization data and identify disposal options for all applicable media in the Soil Washing Work Plan.

TABLE 4 - SOLID WASTE DISPOSAL CRITERIA

	DISPOSAL CRITERIA	
PARAMETER	CONCENTRATION LEVEL IN TREATED SOLID WASTE	TCLP EXTRACT LIMIT
[_____]	[_____] mg/kg	[_____] mg/L

1.4.2.5 Emissions and Dust Control

****

NOTE: Specifications for emission and dust controls should be provided in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. The remaining text in this note discusses soil washing technology-specific emission and dust control considerations to incorporate into Section 01 57 19. An air pathways analysis should be performed during design in accordance with EP 200-1-24 Air Pathway Analysis for the Design of Hazardous, Toxic and Radioactive Waste (HTRW) Remedial Action Projects. Depending upon the contaminants of concern in the contaminated soils, the unit processes/operations employed in the treatment plant, the amount of pollutants emitted, and the geographical location of the site, the emission standards and limitations for certain contaminants and dust control can be identified from the following regulations including, but not limited to, National Primary and Secondary Ambient Air Quality Standards, National Emission Standards for Hazardous Air Quality Pollutants, and state and local regulations.

Based on the regulatory requirements, the proper technologies or apparatus for the emissions control if required can be determined. Upon completion of the design of the treatment plant, these emission requirements and control technologies should be defined by the design engineer.

If a performance specification is prepared, the emissions, dust sources, and contaminants of concern should meet specified requirements based on applicable regulations. Section 01 57 19 should list the emissions criteria for the contaminants of concern for each emission and dust source, and if applicable, monitoring requirements should be specified. The applicable federal, state, and local regulations should also be identified. If the specification is prepared based on detailed design,

the technologies or apparatus for controlling the emissions and dust sources should also be specified.

****

Provide and operate a soil washing treatment system which meets the emissions and dust control requirements in [Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____].

1.4.2.6 Noise Control

****

NOTE: Specifications for noise controls should be covered in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. The remaining text in this note discusses soil washing technology-specific emission and noise control considerations to incorporate into Section 01 57 19. Based on the geographical location of the site, and the land uses and environment surrounding the site, the site-specific noise level requirements for the day and night operations and monitoring requirements can be identified from the state and local regulations and/or developed by interacting with the state and local agencies. These requirements should be specified in this paragraph.

****

Provide and operate a soil washing treatment system which meets the noise control requirements in [Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS] [_____].

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Installation Meeting Agenda

Pre-Installation Meeting Minutes; G, [_____]

Bench-Scale Treatability Study Work Plan; G, [_____]

Soil Washing Work Plan; G, [_____]

Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP); G, [_____]

Pre-Installation Equipment Examination

Pre-Installation Examination Report

SD-05 Design Data

Adjusted Design; G

SD-06 Test Reports

Field Demonstration Report; G, [_____]

Water Supply Analysis

Operations Reports

SD-07 Certificates

Reagent Certificates of Analyses

Qualifications; G, [_____]

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

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NOTE: The appropriate regulatory agencies should be consulted to obtain their approval of work plans, specifications, drawings, and on the sampling methodology for a soil washing treatment project.

Additional references from federal, state, and local regulatory requirements; utility company regulations; and applicable codes and standards published by scientific and engineering institutions should be included where appropriate in the body of the specification. Some of the potentially applicable Federal regulations are listed as follows:

TCLP

Permitting

National Primary and Secondary Ambient Air Quality Standards

National Emission Standards for Hazardous Air Quality Pollutants

State and Local Air Quality Standards

National Pollution Discharge Elimination System (NPDES) Discharge Limitations and Permit Procedures

Hazardous Waste Identification and Standards Applicable to Generators, Transporters, and Owners and Operators of Treatment, Storage and Disposal Facilities (TSDF)

Land Disposal Restrictions (LDRs)

Department of Transportation Hazardous Materials Program Procedures

Hazardous Materials Transportation Regulations

Land Disposal of Low-Level Radioactive Waste

Packaging and Transportation of Radioactive Materials

For sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, delete this section.

****

Obtain the permits, permit equivalents and certifications; and meet the substantive regulatory requirements necessary for the installation, operation, and closure of the project.[Correspondence from regulatory agencies, and other relevant information, is attached to the specifications to indicate the level of effort necessary to obtain finalized permits, permit equivalents, certifications and to meet substantive regulatory requirements.]

1.6.2 Qualifications

****

NOTE: Requirements for the Contractor's experience should be determined and specified based on the experience, availability, and advancement of the soil washing technology industry and the site-specific requirements. If soil washing is being used for unique contaminants, consider specifically identifying contractor soil washing experience requirement for those contaminants in the optional bracket at the end of the paragraph CONTRACTOR EXPERIENCE.

****

1.6.2.1 Contractor Experience

Demonstrate a minimum of [three][_____] years of experience in the field of soil washing or the successful completion of [at least [one][_____] soil washing project of comparable size and scope][at least [three][_____] soil washing pilot scale treatability studies, demonstration studies, [and][or] full scale remediation projects that required handling and transportation of soils contaminated with [RCRA hazardous wastes][CERCLA hazardous substances][_____]].

1.6.2.2 Key Personnel

Provide key personnel with a minimum of [three][_____] years of soil washing field experience. Include soil washing unit operators, quality control personnel, supervisory engineering, and technical staff involved with the soil washing unit operation in key personnel. Submit a list of these personal with their qualifications.

1.6.2.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting the requirements of[Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.7 DELIVERY, STORAGE, AND HANDLING

Safely transport, store, and handle equipment and raw materials (including extraction [solvents][reagents]). Package and ship these items in compliance with United States Department of Transportation (USDOT) requirements. Ensure that extraction [solvents][reagents] are shipped in properly labeled containers with instructions for handling and storage. Store and handle these items onsite in accordance with the manufacturer's recommendations and in compliance with applicable regulatory requirements. Store sufficient quantities of the required extraction [reagents][additives] in the plant area to support the operation of the treatment plant. Do not exceed the extraction [solvent][reagent] holding times.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

****

NOTE: When temperature is below the freezing point, the treatment plant equipment may not function properly or efficiently. Frozen soils can make excavation, conveying, screening, and blending operations difficult and less cost-effective. The general practice is to avoid the operation of an outdoor treatment plant during extreme winter weather. In places where there is a long winter season or in projects where the plant operation is required throughout the year to meet the project schedule, it may be necessary to perform soil washing inside a temporary building with proper heating and ventilation.

Two options are provided. The first option is more restrictive and does not allow the Contractor to operate in adverse environmental conditions. The second option requires that the Contractor develops plans to mitigate adverse environmental conditions.

****

[Do not implement soil washing during winter [conditions][temperatures] (e.g., ambient temperature below [0][_____] degrees C [32][_____] degrees F.][It is not recommended to implement soil washing during winter [conditions][temperatures] (e.g., ambient temperature below [0][_____] degrees C [32][_____] degrees F due to the mechanical and logistical issues associated with the required equipment and soil handling requirements, which includes use and treatment of water. If there is a need to operate during winter conditions, include in the Soil Washing Work Plan an appropriate structure [and][or] heat tracing and other appropriate operating procedures to minimize downtime due to freezing.][It is also not recommended to perform soil washing during periods of heavy rainfall if this will interfere with the effective operation of the treatment plant, because of adverse impacts to soil handling or particle size separation operations.] Do not perform operations during inadequate daylight or at night unless sufficient lighting is available for treatment plant operation.[Section 26 56 00 EXTERIOR LIGHTING for illumination.]

1.8.2 Existing Conditions

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NOTE: The pertinent site characterization data should be placed in the appendix of the specifications or on the drawings and referenced here. If the contaminated soils to be treated contain a significant amount of feed oversize (aka debris), the available information about its extent and characterization should also be provided. Indicate the detail to which site characterization has been performed and indicate where obvious data gaps exist. The information should also include construction limits, property utilities, chemical data, geotechnical data, sampling locations, and boring logs. The locations and details (such as

utility point of contact, sizes, capacities, and flows) of the utility hookups should also be provided for the Contractor's use.

Indicate if there are multiple dissimilar types of contaminated materials that will require different soil washing operations. Materials may be considered dissimilar based on possessing different soil properties, types of contaminants, or relative concentrations of contaminants. Determination of dissimilar materials may be based on site investigations and/or previously completed treatability studies.

****

Available information that describe existing site conditions are presented [in Appendix [_____]][and][on the Drawings]. This includes[physical configuration][utilities][topography][land uses][geotechnical characteristics of the contaminated soils (including[grain size analysis][total organic content][cation exchange capacity][pH][moisture content][density][porosity])[hydrogeology][and][nature and extent of contamination][_____]]. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions could occur. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within [48 hours][_____] if discrepancies between the data provided and actual field conditions are discovered. The Contractor must communicate any additional data needs to complete the soil washing design to the Contracting Officer.

[1.8.3 Results of Previously Conducted Treatability Studies

****

NOTE: This paragraph should be deleted if no previous treatability studies have been conducted.

In some instances, the Government will have conducted treatability studies prior to advertisement for bids. Results of these treatability studies are generally provided to bidders and included in the contract documents. In most instances, the Contractor will perform the bench-scale treatability studies to support its full-scale design (i.e., soil washing contractors typically perform turnkey design/construction, and operation and maintenance services as the subject matter expert for this technology).

The unit processes/operations employed in the previous treatability studies (bench and/or pilot scale) may not be the same as those proposed by the Contractor. Documentation of the previous treatability studies should provide prospective Contractors with sufficient information to prepare a detailed proposal and should include the testing soils, procedures and conditions, sampling and analytical methods, evaluation, and results.

****

The previously conducted treatability study documents in Appendix [_____] are for information purposes only. The results indicate that soil washing is capable of meeting the post treatment criteria identified in this Section. Nevertheless, perform an independent evaluation of these studies and results. If deemed necessary, perform additional bench-scale treatability studies [at the Contractor's own expense] to confirm the previously conducted treatability studies and results. Based on the Contractor's own interpretation of the previous studies and results [and the Contractor's own studies and results], provide a full-scale treatment plant which meets the requirements identified in this Section.

]PART 2   PRODUCTS

2.1   MATERIALS AND EQUIPMENT

2.1.1   Water Supply

****

NOTE: Two options are provided. The first option is to only allow the Contractor to use potable water. The second option allows the Contractor to use non-potable water, but includes a testing requirement to limit the chance that the Contractor supplies a water that could introduce contaminants into the treated materials. The first option is simpler, but could lead to higher project costs if the volume of water needed is significant and/or potable water sources are not readily available. When specifying the chemical contaminant criterion to be met for water, the Designer should consider if there are other standards which are more appropriate for the specific project (e.g. state groundwater cleanup criteria).

****

Supply water used to facilitate soil washing.[Use only potable water from a regulated public water system.][If non-potable water is to be used, provide water that does not contain oils, acids, salts, alkalis, organic matter, solids or other substances at concentrations that could be detrimental to the successful treatment of the contaminated materials. Also characterize non-potable water prior to its use by collecting a sample from the water source and analyzing according to the following table. Submit a Water Supply Analysis demonstrating that water meets requirements.

TABLE 5 - TREATMENT WATER CRITERIA

Chemical Contaminants

ANALYTICAL METHOD NUMBER From EPA SW-846	ANALYSIS TYPE	CRITERION TO BE MET

TABLE 5 - TREATMENT WATER CRITERIA		
Chemical Contaminants		
6010 [and 7470A]	Metals [and Mercury]	[Less than Maximum Contaminant Level (MCL)] [_____]
8260	Volatile Organics	
8270	Semi-volatile Organics	
8082	PCBs	
1633	PFAS	
8081	Pesticides	
Within each Analytical Method, only analyze for analytes which have a [MCL] [_____].		

]

2.1.2 Extraction Solvent/Reagent Certificates of Analyses

The treatment plant may use [reagents][additives] for formulation of washwater, treatment of spent washwater, control of air emissions, and treatment of solid wastes. The residuals of these [reagents][additives] in the treated soils or the solid, liquid and gaseous wastes from the treatment plant must not cause secondary contamination to the environment. The parameters for each [reagent][additive] to be provided must include, but are not limited to, chemical formula, [grade][purity], form, strength, and typical supplier. Provide a Reagent Certificates of Analysis with each shipping unit of reagent. A confidentiality agreement may be requested if proprietary extraction [solvents][reagents] are being used.

[2.1.3 Samples For Bench-Scale Treatability Studies

****

NOTE: This paragraph should be included if treatability studies are to be performed by the Contractor. Action level criteria should be specified for the purpose of collecting representative samples for treatability studies. Table 6 should be developed based on site-specific contaminants of concern and their corresponding action levels. Since the action level criteria are also applicable to excavation, coordination between this section and the section dealing with excavation and stockpiling should be made with respect to these criteria.

To reduce the overall risk to the government, it is strongly advised that the project team should require the Contractor to collect samples for the bench-scale test unless the nature of the site is preventing the Contractor to do so. Depending on site conditions and project needs (e.g. site security, access issue, etc.), the government may provide samples to the Contractor to conduct bench-scale tests.

****

[The Contracting Officer will provide the required samples to conduct the bench-scale treatability study.][Select sampling locations and collect representative samples to conduct the bench-scale treatability study. The soil sampling protocol, locations, volume, and analytes will be included in the Bench-Scale Treatability Study Work Plan. Consider the existing site conditions presented in paragraph EXISTING CONDITIONS when selecting sampling locations. Multiple samples may need to be collected to obtain optimal information regarding the soil washing efficacy over a range of site lithology mix and contaminant concentrations that may be processed.[Conduct sample collection activity in the presence of Contracting Officer.]] The collected treatability study samples for bench-scale treatability study testing must have contaminant concentrations representative of[the average contaminant concentrations and site lithology mix,][greater than the action level criteria presented in Table 6,][projected worst-case contaminant concentrations that may be processed from different areas,][and][different mixes of fine- and coarse-grained lithology mixes that may be processed from different areas]. Otherwise, repeat sampling until the above criteria are successfully met. Test samples of contaminated soils intended to be used in the bench-scale treatability studies in accordance with procedures in paragraph CONTAMINATED SOILS TREATMENT TESTING. Do not commence treatability studies until contaminated soil sample results meet the aforementioned concentration and soil lithology mix criteria and approved by the Government.

TABLE 6 - ACTION LEVEL CRITERIA

PARAMETER	ACTION LEVEL CRITERIA
[_____]	[_____] mg/kg

]PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Pre-Installation Equipment Examination

Conduct a pre-installation examination of the treatment plant equipment versus specifications, as well as for any damage, defect, and dilapidation. Document the results of the pre-installation examination and submit to the Contracting Officer for review and documentation. Upon completion of the treatment plant installation, perform a pre-operational test of the equipment and controls under operating conditions using clean water to check for leaks, continuity, and functionality of operating controls and shutdown alarms. The Contracting Officer may conduct an independent examination to ascertain the condition and functionality of the equipment. Based on this examination, the Contracting Officer has the right to reject the entire system or any damaged, defective or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection must be borne by the Contractor. Routinely and properly inspect and maintain the equipment to provide the operation of the treatment plant as required by the Contract schedule. Schedule delays and costs due to lack of inspections and maintenance, power failure, line plugging, improper functioning of equipment and controls, unavailability of labor and materials, etc. are the responsibility of the Contractor. Provide [alternate][auxiliary] power source if sufficiently reliable sources are not available.

3.1.2 Infrastructure Conditions

Conduct a pre-installation examination of the on-site infrastructure, utility conduits, monitoring points, and site access constraints. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-operation conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would potentially have significant impacts on operations and public safety. Submit a Pre-Installation Examination Report documenting the examination activity. Obtain all necessary utility clearances before initiation of subsurface work.

[3.1.3 Bench-Scale Treatability Study

****

NOTE: If a Treatability Study has previously been performed or is otherwise not needed, delete this paragraph. To reduce the chances of using soil samples that are not representative of site conditions, a minimum volume of 4 liters 1 gallon is recommended for each condition to be tested in the treatability study.

****

Perform at least [three][_____] replicate tests simultaneously for each proposed operating condition. Homogenize and divide the contaminated soil into replicate volumes prior to initiating testing in accordance with the Bench-Scale Treatability Study Work Plan requirements. Do not use less than less than [four][_____] liters [one][_____] gallons of contaminated soil in each replicate. Test samples of treated soils in accordance with procedures in paragraph CONTAMINATED SOIL TREATMENT TESTING.

]3.2 PREPARATION

3.2.1 Mobilization

****

NOTE: Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES includes requirements for decontaminating equipment that has been used in contaminated zones. That section should be modified to extend decontamination/cleaning requirements to equipment being brought on-site to cover the requirements of this paragraph.

****

Follow the approved mobilization and demobilization plans submitted as part of the Soil Washing Work Plan. Do not mobilize the treatment plant to the site until the [Soil Washing Work Plan][UFP-QAPP] has been approved by the Contracting Officer and the Contractor has received written confirmation. Delays caused by the Contractor's failure to meet regulatory requirements must result in no additional cost to the Government. In accordance with [Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____], the equipment which is rented [and][or] previously used for other site remediation must be decontaminated and tested for contaminants of concern before being brought to the site.

3.2.2 Clearing and Grubbing

****

NOTE: If Section 31 11 00 CLEARING AND GRUBBING is not included in the projects specifications, include clearing and grubbing requirements here. Clearing and grubbing requirements should specify limits of work, methods of cutting pavement, how salvageable items such as fencing will be managed, and how waste materials generated from clearing and grubbing will be disposed, particularly if activities occur within areas of contamination.

****

Perform clearing and grubbing in accordance with Section 31 11 00 CLEARING AND GRUBBING.

3.2.3 Foundations

****

NOTE: Minimum requirements should be specified in the Soil Washing Work Plan for the foundation/containment area of the treatment plant. An option is provided at the end of the paragraph to require installing a liner and berm in the location where the soil washing treatment plant will be constructed; this option addresses cross-contamination risk if the treatment plant is located on non-contaminated ground.

****

Construct equipment foundations in accordance with the approved Soil Washing Work Plan. Grade the area around the soil washing treatment plant so that the water drains away from the work area adjacent to the treatment area.[Construct a liner and berm surrounding the soil washing treatment plant. Construct the liner and berm [in accordance with the stockpile liner and berm requirements in Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL.][_____]].

3.2.4 Stockpiles of Contaminated Soils

****

NOTE: Sufficient area should be prepared for stockpiling untreated and treated contaminated soil based on consideration of equipment production rates, allowable stockpile sizes, and overall project schedule. If Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS is not included in project specifications, copy stockpiling information from paragraphs EXCAVATION WORK PLAN, GEOMEMBRANE, CONTAMINATED MATERIAL STORAGE, and SAMPLING BENEATH STORAGE UNITS into this section.

Background sampling under the stockpiles of contaminated soils should be performed before their construction, unless previous information is adequate. Coordinate with Section 02 61 13

EXCAVATION AND HANDLING OF CONTAMINATED SOIL.
****

Prepare areas that will be used to stockpile untreated and treated contaminated materials in accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL. Provide sufficient area to stockpile [_____][metric tons][tons] of untreated contaminated material and [six][_____] stockpiles of [500][_____][metric tons][tons] of treated contaminated material.

3.3 ERECTION, INSTALLATION, AND DEMOBILIZATION

****
NOTE: Referenced UFGS should be edited to include only the minimum requirements applicable to a temporary installation.
****

Erect and install the treatment plant in accordance with applicable action-specific and location-specific federal, state, and local regulations. If the technical specifications overlook [and][or] conflict with the applicable codes, standards, [and][or] regulations, inform and consult with the Contracting Officer for interpretation. Erect and install the treatment plant on a temporary basis so that it can be readily removed from the site after completion of the contract work. Perform the erection and installation such that there is minimal damage to the existing site environment.

Complete the mechanical work in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION. Complete the electrical work in accordance with[Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION][Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION][_____],[and][Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM]. Complete the plumbing work in accordance with[Section 22 00 00 PLUMBING, GENERAL PURPOSE][Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING][_____].[Refer to Section 46 07 13.13 PRECIPITATION, COAGULATION, AND FLOCCULATION for respective treatment requirements related to the removal of suspended solids as part of the washwater treatment; as well as Section 46 61 00 FILTRATION for respective requirements for the removal of colloidal suspended particulates as part of the washwater treatment.]

3.4 FIELD DEMONSTRATION

****
NOTE: The need for a formal Field Demonstration should be discussed with the Contracting Officer and would be a function of the uncertainty of the materials to be treated. For well-defined contaminants and soil compositions that are known to be amenable to soil washing, data obtained from the bench-scale treatability study or full-scale system startup should be adequate to negate the need for a formal Field Demonstration, and a written waiver will then be issued by the Contracting Officer. If the amenability of the contaminants/soil composition is not known to be amenable to soil washing, then a formal Field Demonstration in accordance with the following requirements will need to be performed. If a formal "Field Demonstration" is not required,

sufficient startup testing should be done to validate performance prior to ramping up to full-scale operation.

If processing of contamianted material must stop pending field demonstration results, the contract should contain provisions for issuing a second notice (or third notice in project where treatability studies are performed) to proceed by Contracting Officer upon approval of the field demonstration.

This paragraph is prepared based on a continuous operation of the treatment plant. If the treatment plant is operated as a batch process, the requirements on the minimum operation time and the sample frequency should be modified accordingly.
****

Prior to full scale soil washing operations, perform a field demonstration at the full scale throughput capacity to verify the performance of the treatment plant. Perform preliminary tests and system checkout prior to the field demonstration in order to minimize problems during the field demonstration. Conduct each field demonstration run for a minimum period of [eight][_____] hours per day for at least [two][_____] days. Perform field demonstration run on each dissimilar type of soil or contaminant which requires a substantial change in treatment plant operating conditions.

3.4.1   Full Scale Processing Equipment

Use the full scale treatment plant and operating conditions proposed for use during full scale soil washing.

3.4.2   Contaminated Soil Sourcing

****
NOTE: Prior to implementing the field demonstration, chemical testing should generally be performed to verify that the soils to be used for the test run contain the contaminants of concern at high enough concentrations to adequately test the system. Additional testing may be warranted to verify that the physical properties of the soils are also representative of site conditions. If paragraph SAMPLES FOR BENCH-SCALE TREATABILITY STUDIES is deleted, copy the range of contaminant concentrations and soil lithology requirements into this paragraph.
****

Obtain contaminated soils used for the field demonstration from [the location specified by the Contracting Officer][_____]. Prior to performing the field demonstration, test, [one][_____] initial composite sample(s) of contaminated for chemical analysis per each demonstration run. The contaminated soil samples must be representative of the range of contaminant concentrations and soil lithology mixes as described in paragraph SAMPLES FOR BENCH-SCALE TREATABILITY STUDIES. Otherwise, repeat sampling until the contaminant concentration levels exceed the action level criteria or upon approval by the Contracting Officer. Test samples of contaminated soils intended to be used in the field demonstration in accordance with procedures in paragraph CONTAMINATED SOIL TREATMENT TESTING. Do not commence the field demonstration until soil samples meet the aforementioned concentration criteria.

3.4.3 Treated Soil Testing

During the demonstration run, collect confirmation samples of the treated soils in accordance with the UFP-QAPP. Examples of confirmation sampling of the treated soils include [composites samples][_____] every [two][_____] hours from the feed soils, [feed oversize][_____], spent washwater, effluent from treatment of spent washwater, treated soils, process sludge, and the other locations necessary to perform mass balance calculations and to verify that the treated soils from the soil washing operation meets the post-treatment criteria listed in paragraph PERFORMANCE REQUIREMENTS. Perform testing of the contaminated and the treated soils before and after demonstration test runs in accordance with the same testing protocol as proposed for the full-scale operation described in the UFP-QAPP and paragraph CONTAMINATED SOIL TREATMENT TESTING. If the treated soils produced during the field demonstration do not meet the post-treatment criteria, process an equal quantity of the same type of soils until satisfactory results are attained using properly modified operating conditions [and][or] incorporation of extraction [solvents][reagents] that have been proven effective as part of the treatability testing. Return the treated soils that failed the demonstration testing to the contaminated soils stockpile for re-processing during full-scale treatment.

3.4.4 Field Demonstration Test Results

****

NOTE: Two options are provided for the next step after the field demonstration. The first option (halting processing contaminated soils until results from the field demonstration testing indicate the Contractor's proposed operating conditions can successfully treat the contaminated soils) would generally only be appropriate if the soil washing treatment process has yet to be demonstrated on a large scale for the specific contaminants and soil composition.

****

After completion of the field demonstration, [do not process additional contaminated soil until written approval has been received from the Contracting Officer, and the following submittals have been approved: [Field Demonstration Report][_____]. Allow [10][_____] working days in the schedule for Government review and approval of the Field Demonstration Report.][contaminated soils may continue to be processed. However, if test results indicate that treated soils do not meet the post treatment criteria listed in paragraph PERFORMANCE REQUIREMENTS, the contaminated soils treated with the failed operating conditions must be reprocessed at no additional cost to the Government.]

3.5 OPERATION

3.5.1 Dissimilar Soils

****

NOTE: Delete the bracketed text item if dissimilar

materials are not known to be present at time of preparing project specifications.

****

Do not mix together dissimilar soils if the bench-scale treatability study [and][or] field demonstration testing results indicate that different operating conditions of the treatment plant have to be implemented to achieve effective treatment of these soils. Materials known to be dissimilar at the site are defined in [paragraph EXISTING CONDITIONS] [_____].

[3.5.2 Feed Soil Stockpiles

****

NOTE: Delete this paragraph if feed soils will already be placed in stockpiles prior to performing the soil washing operation.

****

Limit feed soil stockpiles to the number and sizes of soil stockpiles defined in the Soil Handling Plan prepared as part of the Soil Washing Work Plan.

]3.5.3 Feed Oversize

Pre-screening operations should include a combination of removing oversize materials, clayey soil clumps too large to be processed, and debris (e.g., rocks, man-made debris). At the discretion of the Contractor if it will not interfere with the soil washing operation (i.e., clay content too dominant), reduce the size of any clayey soil clumps to less than [2.5 cm 1 inch][the maximum allowable particle size of the soil washing process][_____]. Also reduce any oversize contaminated soils which can be reduced to an allowable size for the soil washing process. Remove oversize soil that cannot be reduced to an allowable size for the soil washing process.[Decontaminate oversize materials in accordance with the procedure developed in the Soil Washing Work Plan]. Dispose of oversize materials off-site in accordance with [Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS][_____].

3.5.4 Material Management

****

NOTE: During the design, the design engineer should interact with the regulatory agencies to determine the requirements pertaining to the type of storage facility, accumulation time, and permitting for feed oversize, feed soils, treated soils, and process sludge for incorporation into the related subparagraphs.

****

Handle soils, washwater, solid wastes, and dust generated during stockpile management as specified in paragraph SYSTEM DESCRIPTION. Manage the soil stockpiles so no contaminants or fine particles are released into the environment. Control stormwater run on and run off water from contacting the soil stockpile areas. Collect and treat the stormwater runoff and any collected leachate soil from the stockpile areas for discharge/disposal or use for make-up water in the treatment plant.

3.5.4.1 Treated Soils

Handle treated soils per protocol described in the Soil Handling Plan included as part of the Soil Washing Work Plan. Stage treated soils segregated by cut size (i.e., defined finer versus coarser grained soils separated during the soil washing process as discussed in paragraph CUT SIZE REQUIREMENT) into units (stockpiles) for post-treatment testing. Stockpile sizes greater than the soil confirmation sampling decision unit as defined in the UFP-QAPP are prohibited. Manage the treated soils such that specific [batches][runs] can be defined and stored following post-treatment testing either as; clean backfill for on-site redisposition that meets the post-treatment criteria; off-site disposal of finer grained soils that exceed the post-treatment criteria; or coarser grained soils for re-processing that exceeds the post-treatment criteria. The post-treatment criteria are defined in paragraph PERFORMANCE REQUIREMENTS. Conduct backfilling in accordance with Section 31 00 00 EARTHWORK.

3.5.4.2 Treated Soils Above Post-Treatment Criteria

Treated soils that do not meet the post-treatment criteria in paragraph PERFORMANCE REQUIREMENTS must be handled in accordance with direction from the Contract Officer, which could include the re-processing of coarser grained soils if the [treatability][field] demonstration studies determine that the post-treatment criteria should be met; or the segregation of finer grained soils for off-site disposal[or coarser grained soils if the Contract Officer determines that further re-processing will not be cost effective or would not likely meet the treatment criteria based on, e.g. contaminant concentrations and total fines content]. Dispose of treated soils above post-treatment criteria approved by the Contracting Officer in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.

3.5.4.3 Treatment Plant Washwater

Recycle [and][or] reuse the washwater generated by the unit operations of the soil washing treatment plant to the maximum extent for plant operations in order to minimize the need for new makeup water and limit the treatment, discharge, [and][or] offsite disposal of washwater. Treated washwater discharged to a regulatory approved receptor, or sent to an offsite treatment facility, must comply with the requirements identified in paragraph SPENT WASHWATER TREATMENT AND DISPOSAL REQUIREMENTS.

3.5.4.4 Stockpile Leachate

****

NOTE: Leachate may not need treatment. If treatment is needed, it can be treated and disposed of at an offsite facility or treated along with the spent washwater for reuse, discharge, and/or offsite disposal. If the leachate is classified as derived waste from a listed hazardous waste, it should be contained and then characterized.

Coordinate this paragraph with requirements in paragraph SPENT WASHWATER TREATMENT AND DISPOSAL REQUIREMENTS. Typically, water will be treated on a batch basis. If a continuous discharge is anticipated, modify the paragraph accordingly and include sample type and frequency.

****

Characterize the leachate collected from the stockpiles to determine the need for treatment prior to reuse in the soil washing process. Do not discharge the leachate to the environment, or transport it offsite for disposal prior to analyzing for and meeting the discharge requirements in paragraph SPENT WASHWATER TREATMENT AND DISPOSAL REQUIREMENTS. The vessel, impoundment, [_____], storing the leachate must be tested prior to emptying that storage facility. No leachate must be added to a storage facility after a sampling event until the unit is emptied.

3.5.5 Change of Operating Conditions

****

NOTE: If adjustment to the mix design is required due to change in feed material characteristics, then the Contractor's adjusted mix design should be evaluated by the Contracting Officer for the extent of changes from the previous mix design. Further, price negotiation may be required based on the extent of changes from the previous mix design.

****

The following two requirements must be met in order to be considered for change of operating conditions: (1) the physical and chemical characteristics of the contaminated soils are significantly different from the originally defined characteristics, and (2) the treatment requirements cannot be met under the current treatment plant design and related operating conditions. When change of operating condition is necessary, notify the Contracting Officer before changes are made to the design and related operating conditions. The Contracting Officer may require the Contractor to perform a field demonstration for significant changes made to the design and related operating conditions in accordance with paragraph FIELD DEMONSTRATION, for approval. If adjustment to the design is required due to change in feed soils characteristics, submit an adjusted design for the extent of changes from the previous design for approval. Further, price negotiation may be required based on the extent of changes from the previous mix design.

3.6 FIELD QUALITY CONTROL

3.6.1 Tests

****

NOTE: The amount of post treatment testing performed should be minimized. It is preferable to maintain quality control of the treatment plant by verifying the designed operating conditions during the field demonstration and by monitoring and controlling the operating parameters to achieve the designed performance.

****

The post treatment testing specified in this paragraph is needed by the Government to generate documentation that the soil washing treatment has been accomplished in accordance with performance requirements approved by applicable authorities. The results of these tests may be used as part of the Contractor's QC program; however it is the contractor's sole responsibility to meet the performance requirements specified in this

Section. Therefore, it is expected that the Contractor will perform additional testing and measurements to assure that treated soils meet requirements without rejection of batches, retesting, [and][or] reprocessing

3.6.1.1 Contaminated Soil Treatment Testing

****

NOTE: The values shown in Table 7 for frequency of testing are only examples and need to be determined on a site specific basis. It may be acceptable to change the number of samples during development of a UFP-QAPP, but the Designer should attempt to establish a reasonable sampling frequency in the specifications to provide a basis for the Contractor to bid the project.

Time limits for sample shipment, analysis, and reporting of results should be selected based on the analytical costs and the management of stockpiles. The shorter the turnaround time requested, the higher the analytical cost will be. In addition, there are time limits on how fast the requested analyses can be completed. Coordinate with the regulators regarding the maximum quantity of soil volume per composite sample. This will define the size of each stockpile, and the time required to reach this quantity.

The feed oversize is generally handled by either onsite decontamination for backfilling or offsite disposal. The disposal of spent process treatment materials such as activated carbon is generally negotiated as part of the suppliers contract and may not require post treatment testing. Therefore, only treated soils and the process sludge are addressed in this paragraph. Offsite transportation and disposal of feed oversize, spent process treatment materials, and process sludge require manifesting and record keeping for each shipment.

****

Collect samples for post-treatment testing in accordance with the [UFP-QAPP][basewide QAPP][_____] and this paragraph. Analyze the samples for the parameters specified in the [UFP-QAPP][basewide QAPP][waste disposal][applicable permit or substantive requirements]. Collect samples for testing at a minimum frequency [provided in Table 7][_____]. Complete all other sampling and analysis activities in accordance with the [UFP-QAPP][basewide QAPP][_____] (including but not limited to sample handling, preservation, transportation, [collection][analysis] of quality control samples, data validation, and data reporting). Any deviations to sampling frequency, number of samples, or sample collection methods must be established in the approved [UFP-QAPP][basewide QAPP][approved by the Contracting Officer].

TABLE 7 - SOIL WASHING OPERATION TESTING FREQUENCIES	
SOIL STREAM	TESTING FREQUENCY Metric Tons Tons
Contaminated Feed Soil	1 per [100][_____]
Treated Soil	1 per [100][_____]
Process Sludge	1 per [100][_____]
Feed Oversize Material	1 per [100][_____]
Treated Washwater	1 per [_____] liters gallons

3.6.1.2 Reprocessing and Retesting

****

NOTE: An option is provided for retesting soils which fail to meet performance requirements. Retesting without first reprocessing treated soils should generally not be allowed unless there is reason to believe the original test result was inaccurate due to mislabeling/mishandling of the sample or analytical error discovered during validation of laboratory results (simply believing that a grab sample did not reflect the treatment is not sufficient to consider a result inaccurate). Retesting should also generally not be allowed if samples are being used for waste characterization and disposal. This is because waste characterization and disposal is based on grab or composite sampling results, and averaging of sampling results cannot be used to determine that a waste meets regulatory disposal requirements.

****

Reprocess and then retest any unit of treated soils that does not meet the post-treatment criteria in paragraph PERFORMANCE REQUIREMENTS [or quality assurance] testing.[The Contractor my propose to retest any failing unit of treated soils prior to reprocessing. If the Contracting Officer approves retesting, collect and test two additional samples for the failed parameter(s). If both tests pass, re-processing of the soils will not be required. If either sample fails, a coarser-grained soils unit should re-processed while a finer-grained soil unit should be staged for off-site disposal. The Contracting Officer should be consulted regarding the final disposition of any soils unit that does not meet the post-treatment criteria.]

3.6.1.3 Government Quality Assurance Testing

****

NOTE: Consider the need for quality assurance testing on a project-by-project basis. If QA

testing is unnecessary, delete this Paragarph. Factors to consider include whether the Government has access to a laboratory that can analyze quality assurance samples in a timely manner to not delay the project execution. Use of quality assurance testing data use also needs to be considered. A relatively straightforward data use is to compare quality assurance sample results to the project Performance Requirements, and failing result would be treated the same way as a failing Contractor test result. A more complicated data use is to compare results from quality assurance samples and contractor quality control samples for the purpose of determining if there is meaningful disagreement between the results. In this case, procedures would need to be developed for determining when there is a meaningful disagreement between quality assurance and quality control sample results; corrective actions for when a meaningful disagreement was identified would also need to be developed. The process of defining procedures for identifying and correcting meaningful differences should be documented in a project-specific Quality Assurance Project Plan and referenced in this specification; the process is likely to complex to be adequately defined in this specification.

****

Provide duplicate samples to the Government's quality assurance laboratory for Government quality assurance. Submit samples at a frequency of one set of samples per [10][_____] sets of quality control tests performed. Quality assurance samples will be tested for the same parameters as the parent quality control sample. Provide additional quality assurance samples upon request.

3.6.2 Inspections

3.6.2.1 Operations Reports

Submit operations reports [daily][weekly] for the first [10][_____] weeks, and at a frequency of [_____] thereafter. The operations reports must consist of a log of operating conditions including, but not limited to: hours of operation; staffing; weather conditions; noise, dust, and emissions monitoring data; process soils tracking schedule; sample shipment; receipt of analytical results; changes in operating parameters; results of the testing and calibration activities; and inspection and maintenance activities. In addition, attach the physical and chemical test results generated on-site or received from offsite laboratories to the report.

3.6.2.2 Government Inspection

The Government may conduct inspection of the system installation and perform periodic inspections during the plant operation to verify that the project activities are performed in accordance with the approved plans, specifications, and the regulatory requirements. Address and resolve inspection findings immediately to the Government's satisfaction.

3.7 DEMOBILIZATION

****

NOTE: If there is a separate specification section which provides overall requirements for demobilization/site cleanup, such as 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS, move the requirements from this paragraph into that section.

****

Demobilize to restore the site to its initial state, prior to the construction and operation of the soil washing treatment facilities. Do not commence demobilization until written approval is received from the Contracting Officer. Demobilization must begin only after the contaminated soils, spent washwater, and solid wastes have been treated and disposed of in accordance with paragraph MATERIAL MANAGEMENT. Follow the approved mobilization and demobilization plan prepared as part of the Soil Washing Work Plan. Demobilization must include, but must not be limited to: [disconnecting of utility service lines,][decontamination and removal of equipment and materials,][disposal of decontamination wastes,][disposal of any residual washwater,][removal of unused amendments and other materials,][removal of soil overlying liners,][removal of liners,][regrading and removal of berms,][demolition and disposal of the treatment pad, other foundation slabs, and paved surfaces,][_____].[Perform post-treatment testing of soils below stockpile storage units and work area surfaces in accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS.]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-02 56 13.13 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 56 13.13 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

USACE / NAVFAC / AFCEC **UFGS-02 56 13.13 (February 2025)**

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****

SECTION 02 56 13.13

GEOMEMBRANE WASTE CONTAINMENT
02/25

****

NOTE: This guide specification covers the requirements for geomembrane barrier for waste containment applications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This section is intended for geomembrane applications in waste containment applications only. Other UFGS sections should be used for geomembrane applications in other situations. Refer to Section 33 56 19 FUEL IMPERMEABLE LINER SYSTEM (and Standard Design AW 78-24-27). Refer to Section 33 47 13 POND AND RESERVOIR LINERS.

This specification section is referenced in several other UFGS sections as a requirement for lining stockpiles of contaminated and treated materials. For those applications, Designers should consider reducing the overall scope of requirements in this specification section. Some of the requirements in

this specification section may be overly conservative for applications where a geomembrane is used for a short period of time (months to years) and then the contaminated materials and geomembrane are ultimately removed from the site. In those applications, the integrity of the geomembrane may not be as critical compared to using a geomembrane for indefinite storage of contaminated materials in a landfill, for example. Requirements which could be reduced in this specification section include qualifications of the manufacturer/installer and frequency of quality assurance/quality control testing.

This guide specification includes multiple different types of geomembrane materials that may be used depending on the specific application. The Designer must select the appropriate geomembrane material for the specific application; this guide specification is not intended as design recommendation or to endorse specific geomembrane materials. High density polyethylene (HDPE) is the geomembrane material that is almost always used in long-term waste containment applications (i.e. landfill liner and cover systems). Other geomembrane materials which have been used in certain waste containment applications include linear low density polyethylene (LLDPE), polyvinyl chloride (PVC), or polypropylene (PP). Some newer or less-commonly used materials include flexible polypropylene (fPP), ketone ethylene ester/ethylene interpolymer alloy (KEE/EIA), and urethane. These materials can be produced with both smooth and textured surfaces. The need for a textured versus a non-textured material will be based on containment system stability analyses (e.g. veneer stability). The drawings must clearly indicate the limits of placement for textured and non-textured geomembranes.

****

1.1 UNIT PRICES

****

NOTE: These paragraphs should be edited based on whether the contract will use a single job price or unit prices. If there is a separate Measurement and Payment section, edited versions of these paragraphs should be inserted in that section.

****

1.1.1 Measurement

Complete a survey to measure the total surface area in square meters square feet covered by geomembrane. Final quantities will be based on as-built conditions. Allowance will be made for geomembrane in anchor and drainage trenches; however, no allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor.

1.1.2 Payment

Geomembrane installed and accepted by the Contracting Officer will be paid for at the respective contract unit price in the bidding schedule. This unit price will include the costs of materials, equipment, installation, testing, and other costs associated with placement of the geomembrane.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D413	(1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D4873/D4873M	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D5321/D5321M	(2020) Standard Test Method for Determining the Shear Strength of

	Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
ASTM D5641/D5641M	(2016) Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D5820	(1995; R 2018) Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
ASTM D6392	(2012; R 2018) Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D7176	(2006; R 2011) Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications
ASTM D7408	(2012; R 2020) Non Reinforced PVC (Polyvinyl Chloride) Geomembrane Seams

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GM7	(1995) Accelerated Curing of Geomembrane Test Strip Seams Made by Chemical Fusion Methods
GSI GRI GM9	(1995; R 2013) Cold Weather Seaming of Geomembranes
GSI GRI GM13	(2016) Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GSI GRI GM17	(2015) Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
GSI GRI GM18	(2015) Test Methods, Test Properties and Testing Frequencies for Flexible Polypropylene (fPP and fPP-R) Nonreinforced and Reinforced Geomembranes
GSI GRI GM19a	(2002; R 2017) Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers
GSI GRI GM34	(2023) Test Methods, Test Properties and Testing Frequency for Ethylene Interpolymer Alloy (EIA=PVC+KEE) Geomembranes

1.3 DEFINITIONS

****

NOTE: These definitions are adapted from Waste Containment Facilities, Guidance for Construction Quality Assurance and Construction Quality Control of Liner and Cover Systems, Daniel and Koerner, 2nd Edition.
****

a. Construction Quality Assurance (CQA): CQA includes inspections, audits, and evaluations of materials and workmanship to determine and document the quality of the constructed facility. CQA is performed by a party independent from the Contractor.

b. Construction Quality Control (CQC): A planned system of inspections that is used to directly monitor and control the quality of the geomembrane installation project. CQC is normally performed by the geomembrane installation contractor/subcontractor, and is necessary to achieve quality in the geomembrane system. CQC refers to measures taken by the installer or contractor to determine compliance with the requirements for materials and workmanship as stated in the plans and specifications for the project

c. Manufacturing Quality Control (MQC): A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of the geomembrane material and is necessary to ensure minimum (or maximum) specified values in the geomembrane. MQC refers to the measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications

1.4 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout And Detail Drawings; G, [_____]

As-Built Drawings; G, [_____]

SD-03 Product Data

Manufacturer's Quality Control Manual

Fabricator's Quality Control Manual

Installer's Quality Control Manual

Materials; G, [_____]

Manufacturer's Warranty

Installer's Warranty

SD-04 Samples

Interface Shear Testing Soil Sample

CQA Product Acceptance Sample

Destructive Field Seam Test Sample

SD-06 Test Reports

Product Acceptance Tests

Trial Seam Logs

Non-Destructive Field Seam Testing

Destructive Field Seam Testing

Destructive Seam Test Repairs

Interface Friction Testing

Manufacturer's Certified Raw And Sheet Material Test Reports

SD-07 Certificates

Certificate Of Subgrade Acceptance

Qualifications; G, [_____]

SD-08 Manufacturer's Instructions

Geomembrane Manufacturer's Installation Instructions

1.5 QUALITY CONTROL

1.5.1 Manufacturer's [and Fabricator's] Quality Control Manual

Submit the Manufacturer's Quality Control Manual[and Fabricator's Quality Control Manual] which describes testing procedures, frequency of testing and [acceptance][rejection] criteria for MQC[and Fabricator Quality Control] testing at least [14][_____] calendar days prior to delivery of the geomembrane.

1.5.2 Installer's Quality Control Manual

Submit the installer's quality control manual a minimum of [seven][_____] calendar days prior to geomembrane placement.

1.5.3 Qualifications

Submit manufacturer[and fabricator] qualification statements a minimum of [seven][_____] calendar days prior to geomembrane shipment. Also submit installer, CQC inspector, [MQC][CQC] laboratory, and Licensed Surveyor qualification statements including resumes of key personnel involved in the project a minimum of [seven][_____] calendar days prior to geomembrane placement.

1.5.3.1 Manufacturer

Manufacturer will have produced the proposed geomembrane sheets for at least five completed projects having a total minimum area of [930,000][_____] square meters [10][_____] million square feet.

1.5.3.2 Fabricator

****

NOTE: Fabricators produce geomembrane products that are combinations of individual manufactured components (e.g. seaming together smaller off-the-shelf geomembrane panels into larger panels). Fabricators are not used on every geomembrane project, so this paragraph can be deleted if a fabricator is not anticipated/allowed on the specific project.

****

TThe fabricator is responsible for [seaming geomembrane sheets into panels][_____]. Fabricator will have fabricated the proposed geomembrane panels for at least [five][_____] completed projects having a total minimum area of [186,000][_____] square meters [2][_____] million square feet.

1.5.3.3 Installer

****

NOTE: The International Association of Geosynthetic Installers (IAGI) provides a certification program for installer personnel engaged in seaming (referred to as welding by IAGI). An optional requirement for installer personnel to have IAGI certification is included; the designer should confirm that this requirement does not violate any contracting requirements.

****

The Installer is responsible for field handling, deploying, seaming, and anchoring of the geomembrane. The Installer will have installed the proposed geomembrane material for at least [five][_____] completed projects having a total minimum area of [186,000][_____] square meters [2] [_____] million square feet. At least one seamer, designated the Master Seamer, will have experience seaming a minimum of [93,000][_____] square meters [1][_____] million square feet of the proposed geomembrane using the same type of seaming equipment specified for this project.[Installer personnel conducting seaming operations will be Certified Welding Technicians by the International Association of Geosynthetic Installers.]

1.5.3.4 Licensed Surveyor

Perform all survey work under the supervision of a Surveyor licensed in the [applicable jurisdiction][State of [_____]].[Perform surveys in accordance with Section [_____].]

1.5.3.5 CQC Inspector

****

NOTE: A separate third party CQA contract should be considered based on the qualifications of the Government CQA personnel, the size and importance of the project, and impacts of a geomembrane failure. CQC inspectors are still considered necessary even if the Government provides independent third-party CQA inspection.

****

The CQC inspector is the person or corporation hired by the Contractor, who is responsible for monitoring and documenting activities related to the CQC of the geomembrane from manufacturing through installation. The CQC inspector will have provided CQC and/or CQA inspection during installation of the proposed geomembrane material for at least [five][_____] completed projects having a total minimum area of [186,000][_____] square meters [2][_____] million square feet.

1.5.3.6 [MQC][CQC] Laboratory

The [MQC][CQC] laboratory will have provided [MQC][CQC] or CQA testing of the proposed geomembrane and geomembrane seams for at least [five][_____] completed projects having a total minimum area of [186,000][_____] square meters [2][_____] million square feet. The [MQC][CQC] laboratory must be accredited by the [Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP)][_____] for the tests the [MQC][CQC] laboratory will be required to perform.

1.5.4 Construction Quality Assurance

****

NOTE: Although independent CQA by the Government is strongly recommended, this paragraph should be deleted if CQA will not be performed and only CQC will be performed. If CQA is not performed, references to CQA throughout the specification should be deleted. Note that the specification section uses the term Contracting Officer as a blanket term that would include CQA personnel acting under the Contracting Officer. Activities specified for the CQA personnel acting under the Contracting Officer would also need to be removed.

Depending on the project, the Government may also elect to implement Manufacturing Quality Assurance (MQA) activities, which include manufacturing facility inspections, verifications, audits, and evaluation of the raw materials and finished products (Daniel and Koerner, 2007). MQA is done in addition to MQC. The Contractor does not have an active role in MQA, but must be aware if MQA will occur on a project.

****

All work must be constructed, monitored, and tested in accordance with the requirements of a CQA[and MQA] Plan. Be aware of all activities outlined in the CQA[and MQA] Plan and account for these activities in the construction schedule. If CQA inspections or testing indicate work which does not meet the requirements of the specifications, the Contracting Officer will establish the extent of the nonconforming area. Repair the nonconforming area in accordance with paragraph DEFECTS AND REPAIRS.[If MQA inspections indicate products do not meet the requirements of this specification, applicable portions of the product will be rejected.]

1.6 DELIVERY, STORAGE, AND HANDLING

****

NOTE: ASTM D4873/4873M provides guidance on delivery, storage, and handling of geomembrane materials. The designer should be familiar with the requirements of that ASTM standard; in some cases the ASTM standard provides options or suggestions as opposed to strict requirements. The designer can edit this paragraph to include stricter or more specific requirements than allowed in the ASTM.

****

Deliver only approved geomembrane materials to the project site. Deliver, store, and handle geomembrane materials in accordance with ASTM D4873/D4873M and this section.[Deliver the geomembrane materials to the project site at least [14][_____] calendar days prior to installation to allow sufficient time for testing in accordance with paragraph PRODUCT ACCEPTANCE.] Deliver and unload the geomembrane with the CQC inspector [and Contracting Officer] present. Confirm the presence of a label on each geomembrane [roll][panel] with the manufacturer's name, product identification number, [roll][panel] number, and roll dimensions. Reject geomembrane rolls which are not labeled upon delivery to the project site.

1.7 PROJECT/SITE CONDITIONS

****

NOTE: To minimize geomembrane contraction stresses, seaming should ideally be carried out in the morning and late evening when the geomembrane is relatively contracted, and during the middle of the day if overcast conditions prevail. If the geomembrane is to be seamed in the middle of a sunny day, the Contractor must ensure that there is sufficient slack in the geomembrane to prevent excessive stresses or trampolining when the geomembrane contracts as cooler temperatures prevail. The required amount of slack must be determined by the Contractor, and it should not be so much so as to cause excessive wrinkling of the geomembrane. Bridging/trampolining is a condition where the geomembrane lifts off the subgrade; this is often observed due to thermal contraction at breaks in grade. If excessive trampolining or wrinkling of the geomembrane is observed, the Contractor will be required to make repairs to eliminate the problem at no additional cost to the Government.

****

Do not deploy or field-seam geomembrane in the presence of excess moisture (i.e., rain, fog, dew), in areas of ponded water, or in the presence of excess wind. Unless authorized by the Contracting Officer, do not place or seam at ambient temperatures below 0 degrees C 32 degrees F or above 40 degrees C 104 degrees F. Measure ambient temperature at a height less than 150 mm 6 inches above the ground or geomembrane surface. If seaming is allowed below 0 degrees C 32 degrees F, follow the procedures outlined in GSI GRI GM9. In marginal conditions, cease seaming unless destructive field seam tests, conducted by the CQC laboratory, confirm that seam properties meet the requirements listed in paragraph PERFORMANCE REQUIREMENTS. Conduct tests in accordance with paragraph DESTRUCTIVE FIELD SEAM TESTING.

1.8 WARRANTY

****

NOTE: Several manufacturers should be contacted to determine what length of warranty is available for geomembrane materials and installation. Manufacturers provide prorated material warranties ranging from 1 to 30 years depending on the application. Installation warranties are generally specified as 1 to 2 years in length.

****

Provide manufacturer's warranty stating that the geomembrane materials meet all requirements of the Contract documents and that for the intended use, the geomembrane is warranted for [_____] years against deterioration. Provide installer's warranty stating that the geomembrane will not fail due to improper installation within [_____] years.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

2.1.1.1 Layout And Detail Drawings

****

NOTE: Minimize the number of penetrations and show their locations on the drawings. Referencing the manufacturer's typical penetration details is generally acceptable. When reviewing submitted penetration details, Designer's and others involved in a project such as CQA personnel may wish to consult ASTM D6497 Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.

****

Submit geomembrane panel layout and penetration detail drawings a minimum of [seven][_____] calendar days prior to geomembrane placement. Provide geomembrane penetration details [as indicated][as recommended by the geomembrane manufacturer].

2.1.2 Performance Requirements

2.1.2.1 Field Seams

****

NOTE: Field seam strength and related property requirements for HDPE, LLDPE, and fPP are defined in GRI-GM19a Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers". For PVC, Reference ASTM D7408 Standard Specification for Non-Reinforced PVC (Polyvinyl Chloride) Geomembrane Seams

****

Construct seams in the field conforming to the strength and related property requirements defined in [GSI GRI GM19a][ASTM D7408][_____].

2.2 FABRICATION

****

NOTE: Polyethylene geomembranes are not usually factory seamed. Delete this paragraph when factory seaming is not applicable.

****

Factory seam geomembrane sheets into maximum sized panels to minimize field seaming. Factory seaming must be by methods approved by the geomembrane manufacturer. Seams must meet the minimum shear and peel strength requirements in paragraph Performance Requirements. Factory seams must extend to the end of the sheet so that no unbonded edges greater than 3.2 mm 0.125 inch wide are present.

2.3 MATERIALS

****

NOTE: Non-Government standards are available for the various types of geomembranes considered in this specification section. This specification section is formatted to reference those standards without repeating the requirements from those standards. The designer should be familiar with those standards, and any deviations should be noted in this specification section. For other geomembrane material types not covered by one of the referenced standards, evaluate at least three current manufacturer's property sheets for each acceptable material type before specifying property test values.

****

2.3.1 Raw Material Properties

Use raw materials meeting the requirements of[ASTM D7176][GSI GRI GM13] [GSI GRI GM17][GSI GRI GM18][GSI GRI GM34][_____] and this paragraph. All regrind, reworked, or trim materials must be from the same manufacturer and exactly the same formulation as the geomembrane sheet being produced. Submit a copy of the test reports and MQC certificates for materials used in the manufacturing of the geomembrane shipped to the site.

2.3.2 Sheet Material Properties

****

NOTE: USACE practice on landfill cover systems has been to use a minimum nominal geomembrane thickness of 1 mm 40 mils. This criterion is based on survivability. USACE practice for landfill liner systems has been to use a minimum nominal geomembrane thickness of 1.5 mm 60 mils. Site-specific analyses should be conducted to determine the appropriate thickness for both landfill liners and covers. Reinforced geomembranes are generally not recommended where geomembrane elongation properties are critical (i.e., landfill covers) but may be suitable for other applications such as liquid surface impoundments.

****

Provide geomembrane sheets meeting the requirements in Table 1. Provide geomembrane sheets that are uniform in color, thickness, and surface texture. The textured surface features consist of raw materials identical to that of the parent sheet material and are uniform over the entire face of the geomembrane. Provide sheets that are free of and resistant to fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants and other imperfections.

TABLE 1 - GEOMEMBRANE PROPERTIES	
Nominal Thickness	[_____] mm [_____] mils

TABLE 1 - GEOMEMBRANE PROPERTIES	
Manufactured in Accordance with	[GSI GRI GM13 for HDPE] [GSI GRI GM17 for LLDPE] [ASTM D7176 for PVC] [GSI GRI GM18 for fPP and fPP-R] [GSI GRI GM34 for EIA] [_____]
Material Type	[HDPE] [LLDPE] [PVC] [fPP] [fPP-R] [EIA] [_____]
Category	[unreinforced] [reinforced]
Surface Finish [for geomembrane on slopes greater than or equal to 1V on [_____] H]	[smooth] [textured one side] [textured both sides]
Minimum Manufactured Sheet Width	[_____] meter[s] [_____] feet
Minimum Manufactured Sheet Length	[_____] meter[s] [_____] feet
[_____]	[_____]

2.3.3 Field Seaming Materials

****

NOTE: Requirements for the resin used in extrusion welding are provided below. If welding by other means is allowed/required and that welding involves use of materials such as adhesives or chemicals, provide requirements for those materials here.

****

[Manufacture seaming rods and pellets using materials which are essentially identical to that used in the geomembrane sheet. Test seaming rods and pellets for density, melt index and carbon black content in accordance with the approved Manufacturer's Quality Control manual. Do not use seaming rods and pellets which fail to meet the corresponding property values required for the sheet material for seaming.][_____.]

2.3.4 Interface Shear Testing Soil Sample

****

NOTE: This paragraph can be deleted if the geomembrane interface is not against a soil layer, but rather another geosynthetic. An optional requirement is included for the contractor to test the soil that will be used in the interface shear testing, to demonstrate that the soil meets project requirements. This demonstration testing would not be necessary if the borrow source has already been adequately investigated, or if the soil used for interface testing is collected at the same time that other borrow source sampling is conducted.

To reduce the overall risk to the Government, it is strongly advised that the Contractor is required to collect samples for interface shear testing unless the nature of the site prevents the Contractor to do so. Depending on site conditions and project needs

(e.g. site security, access issues, etc.), the Government may provide samples to the Contractor to conduct interface shear testing.

****

[The Contracting Officer will provide][Obtain] soil to be used for interface shear testing from [the proposed borrow source][_____].[Conduct one set of tests and submit testing results demonstrating that the soils to be used for interface shear testing meet the material requirements in accordance with [______].]

2.4 EQUIPMENT

****

NOTE: Optional requirements are included for the Contractor to provide a spare seaming apparatus and specifying the type of seaming apparatus. These requirements can be deleted if they are considered excessively strict for the particular project.

****

Use the geomembrane manufacturer's recommended equipment to perform the work and maintain equipment in satisfactory working condition.[Maintain at least one spare operable seaming apparatus on site.][Provide seaming apparatuses that are automated vehicular mounted devices equipped with gauges indicating the applicable temperatures and pressures.]

2.5 ACCESSORIES

2.5.1 Geomembrane Fittings

Provide geomembrane fittings (e.g., pipe vents, boots, sleeves, etc.) that are factory prefabricated components [produced by the same manufacturer as the geomembrane][confirmed to be compatible by the geomembrane manufacturer][_____] and having the same fabrication characteristics as the geomembrane.

2.5.2 Fasteners

Provide fasteners (e.g. clamps, slips, bolts, nuts, etc.) to secure the geomembrane to each fitting. Provide fasteners that are factory prefabricated components[produced by the same manufacturer as the geomembrane][confirmed to be compatible by the geomembrane manufacturer][_____].

2.5.3 Temporary Ballast

Provide temporary ballast used during geomembrane installation including sandbags, tires, or other material as recommended by the geomembrane manufacturer. Use non-abrasive material, free of sharp edges or other features that may damage the geomembrane liner.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

2.6.1 Interface Friction Testing

****

NOTE: Interface friction testing should be conducted on all potential slip interfaces. The

rate of displacement and normal stresses used for interface friction testing are dependent on the materials being tested and anticipated site conditions. Normal stresses specified should cover the range of anticipated field loads. Selection of peak versus residual values should be based on anticipated interface displacements taking into account seismic activities and long term conditions. Table 2 is from ASTM D5321/5321M; the Designer should verify that the table is current if ASTM D5321/53231M is updated.

The number of interface friction tests must be determined on a site specific basis considering regulator input and the potential for damage due to a shear failure. This testing should be completed during design or by the Contractor prior to the start of construction.

A method sometimes used to model saturated conditions at the shear interface is to wet these surfaces prior to shearing.

Note that if an interface surface for the geomembrane is a geosynthetic clay liner (GCL), interface friction/shear testing should be a requirement of the specification for that GCL and should follow ASTM D6243/D6243M Standard Test Method for Determining the Internal and Interface Shear Strength of Geosynthetic Clay Liner by the Direct Shear Method.

****

The frequency of testing for each interface is [1 per [_____] hectares [_____] acres of geomembrane placed][[_____] per project]. Conduct tests in accordance with ASTM D5321/D5321M using the conditions specified in Table 2. Use the same soil components that are used for full scale construction. Provide geosynthetics that are the same materials as those proposed for use during full scale construction. A minimum [peak][residual] interface friction angle of [_____] degrees is required for all interfaces. Submit certified laboratory interface friction test results including description of equipment and test method, a minimum of [seven][_____] calendar days prior to geomembrane shipment.[For interfaces between a geomembrane and geosynthetic clay liner, perform interface [friction][shear] testing in accordance with [Section 02 56 13.16 GEOSYNTHETIC CLAY LINER WASTE CONTAINMENT][_____].]

TABLE 2 - INTERFACE FRICTION TESTING PROPERTIES	
Type of test	[Procedure A - Geosynthetic on Geosynthetic Interface Friction] [Procedure B - Soil on Geosynthetic Interface Friction]
Material(s) for which shear will be tested	1 - [_____] 2 - [_____]

TABLE 2 - INTERFACE FRICTION TESTING PROPERTIES	
Side or characteristics for the side of material to be tested at the interface	1 - [_____] 2 - [_____]
Orientation of material	1 - [Machine Direction][Cross Direction][N/A] 2 - [Machine Direction][Cross Direction][N/A]
Soil Interface Compaction Density and Moisture Content (MC) (Note 1)	[Lightly Compacted] [Specified Density = [_____] kN/m3 [_____] lb/ft3] [As-received MC] [Specified MC = [_____] percent] [Based on ASTM D698 test results: Maximum Dry Density = [_____] kN/m3 [_____] lb/ft3, Optimum MC = [_____] percent] [Based on ASTM D1557 test results: Maximum Dry Density = [_____] kN/m3 [_____] lb/ft3, Optimum MC = [_____] percent] If compaction unit weight and moisture content for soil placement based on ASTM D698 or D1557 test results, compaction [_____] percent of maximum dry unit weight and Moisture Content [optimum water content] [plus [_____] percent relative to optimum] [minus [_____] percent relative to optimum]
Conditioning of Geosynthetic Materials	[Wetted by pouring water over entire specimen][Wetted by spraying water over entire specimen][As-received]
Shear Test Normal Loads (Note 2)	[_____], [______],[_____], [______], [_____] kPa[_____], [______],[_____], [______], [_____] psi
List if there is a specified Normal Load Application Sequency to be applied:	[_____]
Interface saturation condition	[Inundated with Water - Interface is submerged in water prior to consolidation and through duration of shear][Spray Wetted - The interface is wetted using a spray bottle during placement of specimens, but not submerged in water][Dry - No addition of water during placement of specimens or shear]
Settling/Consolidation time under test normal load prior to shearing	[_____] hours
Shear displacement rate	[1.0][5.0][_____] mm [0.04][0.2][_____] inches per minute

TABLE 2 - INTERFACE FRICTION TESTING PROPERTIES	
Other test instructions	[_____]
Note 1 - Over-sized corrected test values from ASTM D698 and ASTM D1557 are typically not applied in calculating compaction density and moisture content as gradations minus 19.5 mm 0.75 inch sieve of soil sample are used due to dimensions of most shear boxes. If requesting use of rock correction values to be applied, indicate so. Note 2 - The normal loads selected should bracket the design normal loads being evaluated.	

2.6.2 Manufacturing, Sampling, and Testing

****

NOTE: The testing required in this paragraph and subparagraphs occurs at the manufacturing facility. Additional testing is required once materials are delivered to the site, as defined in paragraph PRODUCT ACCEPTANCE.

****

Submit manufacturer's certified raw and sheet material test reports and a copy of the MQC certificates, a minimum of [seven][_____] calendar days prior to shipment of geomembrane to the site.

2.6.2.1 Raw Material Testing

Test raw materials in accordance with the approved Manufacturer's Quality Control Manual and[ASTM D7176][GSI GRI GM13][GSI GRI GM17][GSI GRI GM18][GSI GRI GM34][_____]; test according to the stricter standard if there are deviations. Do not use any raw material which fails to meet the requirements of paragraph RAW MATERIAL PROPERTIES.

2.6.2.2 Sheet Material Testing

Test geomembrane sheets in accordance with the approved Manufacturer's Quality Control Manual and[ASTM D7176][GSI GRI GM13][GSI GRI GM17][GSI GRI GM18][GSI GRI GM34][_____]; test according to the stricter standard if there are deviations. Do not send sheets not meeting the minimum requirements specified in paragraph SHEET MATERIAL PROPERTIES to the site.

2.6.3 Product Acceptance

****

NOTE: The testing required in this paragraph and subparagraphs occurs at project site.

****

2.6.3.1 Product Acceptance Samples

Obtain one CQC sample, 500 mm 18 inches in length, for the entire width of a roll, for every 9,000 square meters 100,000 square feet of material delivered to the site. Do not obtain samples from the first three feet of the roll. For accordion folded geomembranes, collect samples of equivalent size from approved locations. Identify the samples by manufacturer's name, product identification, lot and roll/panel number. Also, note the date, a unique sample number, and the machine direction. In addition, collect and label a [305 by 305 mm][_____] [12 inch by 12 inch][_____] CQA Product Acceptance Sample, and submit to the Contracting Officer each time CQC samples are collected.[Collect all CQC and CQA samples for product acceptance with the [Contracting Officer][_____] present.]

2.6.3.2 Product Acceptance Tests

****

NOTE: The testing methods listed below are those recommended by Daniel and Koerner 2007. Note that puncture is not a test specified by ASTM D7167 for PVC geomembranes, and ply adhesion only applies for reinforced geomembranes.

****

Provide all CQC samples to the CQC laboratory to determine[thickness,] [tensile strength at break,][elongation at break,][puncture,][tear,][and][ply adhesion]. Test the samples in accordance with the methods specified in [ASTM D7176][GSI GRI GM13][GSI GRI GM17][GSI GRI GM18][GSI GRI GM34][_____]. Samples not meeting the specified requirements will result in the rejection of applicable [rolls][panels]. As a minimum, test [rolls][panels] produced immediately prior to and immediately after the failed [roll][panel] for the same failed parameter. Continue testing until a minimum of three successive [rolls][panels] on both sides of the original failing [roll][panel] pass the failed parameter.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Certificate of Subgrade Acceptance

****

NOTE: An example Certificate of Subgrade Acceptance can be found in the USACE Engineering Manual EM 1110-1-4011. Depending on the specific design of the geomembrane and subgrade, the examination items specified below should be revised.

****

Each day during placement of geomembrane, the CQC Inspector [and Contracting Officer] and installer must inspect the surface on which geomembrane is to be placed and certify in writing on a Certificate of Subgrade Acceptance that the surface is acceptable. Examine the subgrade for compliance with the items in the list below. Perform repairs to the subgrade in accordance with paragraph PREPARATION, and at no additional cost to the Government.

a. A project-qualified land surveyor has verified the lines and grades of the subgrade meet project design;

b. All CQC and CQA of the underlying soils or geosynthetics has been completed and results have been accepted by the Contracting Officer;

c. The subgrade is free of irregularities, protrusions, loose soil, and abrupt changes in grade;

d. The subgrade is not excessively deformed or rutted by construction equipment used to deploy geomembrane rolls. Ruts of the underlying soil should not exceed [25][_____] mm [1][_____] inch in depth.

e. The underlying soil surface (if present) does not contain stones, litter, or organic matter which may be damaging to the geomembrane. Rocks larger than [13][_____] mm [0.5][_____] inch in diameter and any other material which could damage the geomembrane must be removed from the surface to be covered with the geomembrane;

f. If installed on soil, no area of the underlying soil surface is excessively softened by high water content; and

g. If installed on soil, no area of the underlying soil surface contains desiccation cracks which may damage the geomembrane.

3.2 PREPARATION

****

NOTE: Ensure other sections of the specification package adequately address compaction requirements for soil subgrade layers. If the geomembrane is placed directly on top of a compacted clay layer, reference Section 02 56 13.16 CLAY WASTE CONTAINMENT for repairs/preparation.

****

3.2.1 Subgrade Repair

For any subgrade found deficient in accordance with paragraph EXAMINATION, perform repairs in accordance with [Section 31 00 00 EARTHWORK][Section 02 56 13.16 CLAY WASTE CONTAINMENT][_____].

3.2.2 Anchor Trenches

****

NOTE: Anchor trench dimensions are often site-specific and are therefore defined in the project drawings. If that is the case, replace the dimensioning sentences with a reference to the project drawings/plans. Dimensions for a 90 degree anchor trench are included in the paragraph; if other standard anchor trench designs such as a "V" trench or horizontal runout are used instead, replace the dimensions as appropriate.

****

Where an anchor trench is required, place it [610][_____] mm [24][_____] inches back from the edge of the slope to be covered. Provide an anchor trench [610][_____] mm [24][_____] inches deep and [460][_____] mm [18][_____] inches wide. If the anchor trench is excavated in cohesive soil susceptible to desiccation, excavate only the quantity of anchor trench required for placement of geomembrane in a single day. Remove ponded water from the anchor trench while the trench is open. Slightly round trench corners to avoid sharp bends in the geomembrane. Remove loose soil, rocks larger than [13][_____] mm [0.5][_____] inch in diameter, and any other material which could damage the geomembrane from the surfaces of the trench. Extend the geomembrane down the front wall and across the bottom of the anchor trench. Perform backfilling and compaction of the anchor trench in accordance with [Section 31 00 00 EARTHWORK][_____].

3.3 GEOMEMBRANE INSTALLATION

3.3.1 Geomembrane Placement

****

NOTE: An optional requirement is provided for using a rub/slip sheet when placing the geomembrane. Rub sheets are thin sheets of plastic placed between the geomembrane and another surface. Rub sheets facilitate movement/placement of the geomembrane, particularly when the geomembrane is textured.

****

At least [seven][_____] calendar days prior to placement, submit geomembrane manufacturer's installation instructions. Complete geomembrane placement in accordance with the geomembrane manufacturer's installation instructions and this paragraph. Do not elongate, wrinkle, scratch, or otherwise damage the geomembrane, other geosynthetic layers, or the underlying subgrade. Replace or repair geomembrane damaged during installation at the [CQC inspector's][and][Contracting Officer's] discretion. Only deploy geomembrane panels that can be anchored and seamed together the same day.[Deploy a [rub][slip] sheet (e.g. 0.50 mm 20 mil smooth HDPE) when placing the geomembrane and carefully remove the rub sheet to avoid shifting the geomembrane once the geomembrane is in place.] Place adequate ballast on the geomembrane, without damaging the geomembrane, to prevent uplift by wind. On side slopes, anchor the geomembrane at the top and deploy down the slope to minimize wrinkles. Minimize dragging of geomembrane panels over the ground surface. Do not operate equipment on the top surface of the geomembrane without permission from the Contracting Officer. Orient seams parallel to the line of maximum slope. Where seams can only be oriented across the slope, lap the upper panel over the lower panel. Minimize wrinkles and tensile stresses in the geomembrane. Provide adequate slack to prevent the creation of tensile stress. Wrinkle height to width ratio for installed geomembrane exceeding 0.5 is unacceptable. In addition, geomembrane wrinkles exceeding 150 mm 6 inches in height is prohibited. Cut out and repair wrinkles that do not meet the above criteria in accordance with the installer's approved CQC manual.

3.3.2 Field Seaming

3.3.2.1 Trial Seams

Make trial seams under field conditions on strips of excess geomembrane. Make trial seams each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment and at least once every four hours, by each seamer and each piece of seaming equipment used that day. Collect and test trial seam samples in accordance with ASTM D6392. Obtain one sample from each trial seam. This sample must be at least 920 mm long by 305 mm wide 36 inches long by 12 inches wide with the seam centered lengthwise. Where necessary, conduct accelerated curing of trial seams made by chemical methods in accordance with GSI GRI GM7. To be acceptable, four out of five replicate test specimens must meet seam strength requirements specified in paragraph PERFORMANCE REQUIREMENTS. If the field tests fail to meet these requirements, repeat the entire operation. If the additional trial seam fails, do not use the seaming apparatus or seamer until the deficiencies are corrected by the installer and two consecutive successful trial seams are achieved. Submit trial seam logs following the completion of installation.

3.3.2.2 Field Seams

****

NOTE: Additional requirements for geomembrane seaming apparatuses may be considered on a project-specific basis. As discussed in GSI GRI GM 32 Geomembrane Seaming Data Using Data Acquisition Hot Wedge Welding Devices, welding/seaming devices which continuously record and display temperature, pressure, and speed data can be used. These devices provide information that can be used by both the geomembrane installer during installation and CQC/CQA personnel during inspection and testing. Furthermore, automatic feedback welders (aka "smart welding devices") exist which can be used to maintain operations within a seaming window for temperature, speed, and pressure.

****

Completely unroll and layout adjacent geomembrane panels/sheets before performing field seaming. Seam panels in accordance with the geomembrane manufacturer's recommendations and the requirements listed in this paragraph. Perform seaming with an automated seaming device [equipped with gauges for measuring [temperature][pressure][speed]][_____]. Where the geomembrane manufacturer's recommendations disagree with the requirements of this specification [follow the more stringent requirement][notify the Contracting Officer].

a. Complete seaming only when the Master Seamer is present.

b. In sumps, corners and odd-shaped geometric locations, minimize the number of field seams.

c. Overlap geomembrane panels a minimum of [75][_____] mm [3][_____] inches and a maximum of [150][_____] mm [6][_____] inches.

d. Only use temporary bonding procedures that [are approved by the geomembrane manufacturer][will not damage the geomembrane].

e. Extend seaming to the outside edge of panels.

f. Clean the seam area to provide an area that is free of moisture, dust, dirt, and foreign material at the time of seaming. Do not use solvent for cleaning.

g. If grinding is required, follow a grinding process approved by the geomembrane manufacturer. Complete grinding in a manner that does not damage the geomembrane.

h. Repair fish mouths (half-cylinder openings/voids caused by wrinkling/shifting) in seam.

i. Provide adequate illumination when seaming at night.

j. Protect exposed geomembrane edges at the end of each day or whenever an installation activity is temporarily suspended during the day.

3.3.2.3 Polyethylene Seams

Seam polyethylene geomembranes by thermal fusion methods. Only use extrusion welding for patching and seaming in locations where thermal fusion methods are not feasible. Ground seam overlaps that are to be attached using extrusion welds prior to welding. Orient grinding marks perpendicular to the seam direction and do not extend marks beyond the extrudate after placement. Begin extrusion welding within 10 minutes after grinding. Where extrusion welds are temporarily terminated long enough to cool, ground prior to applying new extrudate over the existing seam. The total depth of the grinding marks greater than 10 percent of the sheet thickness is unacceptable.

3.3.2.4 Non-Polyethylene Seams

Seam non-polyethylene geomembranes by methods as recommended by the geomembrane manufacturer. Store seaming adhesives, solvents, or chemical cleaning agents away from the geomembrane and only use spill-resistant containers while working on the geomembrane. If low temperatures slow the curing process of chemically fused seams and delay seam testing, use the procedures in GSI GRI GM7 to accelerate sample curing.

3.3.3 Penetrations

Install geomembrane fittings (e.g., pipe vents, boots, sleeves, etc.) as shown on the drawings and in accordance with any manufacturer's recommendations.

3.3.4 Defects and Repairs

3.3.4.1 Destructive Seam Test Repairs

Seams that fail destructive seam testing may be overlaid with a strip of new material and seamed (cap stripped). Alternatively, retrace the seaming path to an intermediate location a minimum of 3 meters 10 feet on each side of the failed seam location. At each location, take a 305 by 460 mm 12 by 18 inch minimum size seam sample for two additional shear strength and two additional peel adhesion tests using an approved quantitative field tensiometer. If these tests pass, send the remaining seam sample portion to the CQC laboratory for five shear strength and five peel adhesion tests in accordance with the CQC laboratory's approved procedures. To be acceptable, four out of five replicate test specimens must meet specified seam strength requirements. If these laboratory tests pass, cap strip or repair the seam using other approved methods between that location and the original failed location. If field or laboratory tests fail, repeat the process. After repairs are completed, non-destructively test the repaired seam in accordance with paragraph NON-DESTRUCTIVE FIELD SEAM TESTING. Submit CQC inspector certified test results on all repaired seams.

3.3.4.2 Patches

Repair tears, holes, blisters and other defects with patches. Provide patches that have rounded corners, are made of the same geomembrane, and extend a minimum of 150 mm 6 inches beyond the edge of defects. Repair minor localized flaws by spot welding or seaming as determined by the CQC inspector. Non-destructively test repairs. The Contracting Officer or the

CQC inspector may also elect to perform destructive seam tests on suspect areas.

3.4 FIELD QUALITY CONTROL

3.4.1 Visual Inspection of Field Seams

Visually inspect each field seam to confirm that the seams are tightly bonded. Perform the inspection of a seam within 30 hours after the manufacturer's suggested application, curing, and cooling time. Repair and re-inspect seams found to be defective in accordance with manufacturer's recommendations.

3.4.2 Non-Destructive Field Seam Testing

****

NOTE: Multiple non-destructive field seam testing methods are included below. Not all testing methods are applicable to all types of geomembranes. The pressurized air channel test is only applicable when a dual track hot wedge seaming method is employed. The pressurized air channel test method is considered a preferred method when applicable. Because the pressurized air channel method is not applicable for testing extrusion welds, at least one other non-destructive testing method should be required such as the vacuum box test.

****

Perform non-destructive testing on all field seams over the full seam length and on any other areas showing damage or other distresses. Allowable methods are stated below. Alternate methods approved by the geomembrane manufacturer may be submitted for approval by the Contracting Officer. Submit non-destructive field seam test reports following the completion of installation and prior to covering the geomembrane liner. Non-destructively test field seams for penetrations in accordance with the installer's approved CQC manual. Repair seams that fail non-destructive testing in accordance with the installer's approved CQC manual and non-destructively test prior to acceptance.

3.4.2.1 Liner Pressurized Air Channel Test

Perform air pressure testing in accordance with ASTM D5820. Upon completion of the test, relieve pressure from the opposite end of the seam being tested to verify continuity of the seam.

3.4.2.2 Liner Vacuum Box Test

Perform a vacuum box test in accordance with ASTM D5641/D5641M on each field seam, the area around the seams, and each liner surface showing injury due to scuffing, penetration by foreign objects, or distress from rough subgrade. If the vacuum box test indicates a continuous stream of bubbles on repeated testing at the same location, then the area being tested is considered damaged and must be repaired and retested. Perform repairs in accordance with manufacturer's recommendations.

3.4.3 Destructive Field Seam Testing

****

NOTE: Destructively testing field seams at a fixed frequency (the method described in this paragraph) is a fairly standard approach for testing geomembrane seams. However, it is also a somewhat dated approach that was established prior to development of additional concepts that improve quality of geomembrane installations (e.g. taped edges, automatic welders, advanced non-destructive testing methods, certification of geomembrane installers). Destructive seam testing creates holes in a geomembrane where the samples are collected. These holes are patched/repaired using an extrusion seaming method which may be challenging to execute correctly. See Geosynthetic Institute's GRI Test Method GM29, December 2013 for additional discussion. The designer may wish to specify a different frequency of destructive field seam testing based on their own experience, the concepts discussed in GM29, and the application of some of the improved quality concepts mentioned above. However if doing so, the designer should be aware of any specific regulatory requirements on destructive field seam testing (i.e. a destructive testing method that is not acceptable to regulators should not be specified).

****

Obtain a minimum of one test sample per [230][_____] meter[s] [750][_____] feet of field seam. Recommended locations include the ends of seams or anchor trenches, so as to minimize the impact of required repairs to the geomembrane; however, final sample locations will be determined by the [CQC inspector][Contracting Officer]. Do not identify sample locations prior to seaming. Provide samples that are a minimum of 305 mm 12 inches by 1.1 meter[s] 42 inches long with the seam centered lengthwise. Cut each sample into three equal pieces, with one piece retained by the installer, one piece given to the CQC laboratory, and the remaining destructive field seam test sample submitted to the Contracting Officer for CQA testing and/or permanent record. Number and cross reference each sample to a field log which identifies: (1) panel number; (2) seam number; (3) date and time cut; (4) ambient temperature within 150 mm 6 inches above the geomembrane; (5) seaming unit designation; (6) name of seamer; and (7) seaming apparatus temperature and pressures (where applicable). Cut ten 25 mm 1 inch wide replicate specimens from the installer's sample. Field test in accordance with [ASTM D6392 for non-reinforced liner][or][ASTM D751 and ASTM D413 for fabric-reinforced liner]. Jaw separation speed must be in accordance with the approved CQC manual. To be acceptable, four out of five replicate test specimens must meet the seam strength requirements specified in paragraph PERFORMANCE REQUIREMENTS. If the field tests pass, test five specimens at the CQC laboratory for shear strength and five for peel adhesion in accordance with the CQC laboratory's approved procedures. To be acceptable, four out of five replicate test specimens must meet the seam strength requirements specified in paragraph PERFORMANCE REQUIREMENTS. If the field or laboratory tests fail, repair the seam in accordance with paragraph DESTRUCTIVE SEAM TEST REPAIRS. Repair holes for destructive seam samples the same day they are cut. Submit Installer and certified CQC laboratory test results on all destructively tested field seams.

[3.4.4 Electrical Leak Location

****

NOTE: Electrical leak location is strongly encouraged by some organizations as a means of investigating and improving installed geomembranes. The designer should have a good understanding of electrical leak location methods, availability of testing firms to perform the work, and scheduling of electrical leak location testing to align with completion of placement of the geomembrane and covering/protection of the geomembrane. Refer to ASTM D6747 Standard Guide for Selection of Techniques for Electrical Leak Location of Leaks in Geomembranes to determine the appropriate location technique. If electrical leak location is used, the frequency of destructive testing of geomembrane seams can potentially be reduced (for more information see the note for paragraph DESTRUCTIVE FIELD SEAM TESTING). If electrical leak location is retained, the specification and references must indicate how leaks will be identified and how repairs will be made.

****

Perform electrical leak location in accordance with [_____].

]3.4.5 Visual Inspection And Evaluation

Immediately prior to covering, the CQC inspector [and Contracting Officer] will visually inspect the geomembrane, seams, and non-seam areas for defects, holes, or damage due to weather conditions or construction activities. At the Contracting Officer's or the CQC inspector's discretion, the surface of the geomembrane must be brushed, blown, or washed by the Installer if the quantity of dust, mud, or foreign material inhibits inspection or functioning of the overlying material. Non-destructively test each suspect location in accordance with paragraph NON-DESTRUCTIVE FIELD SEAM TESTING. Repair each location that fails non-destructive testing in accordance with paragraph PATCHES, and non-destructively retest.

[3.5 PROTECTION AND BACKFILLING

Do not leave any tools or equipment on the geomembrane after active work ceases in the area. Do not cover the geomembrane until the Contracting Officer approves the geomembrane liner installation. Cover the deployed and seamed geomembrane with the specified material within [five][14][_____] calendar days of acceptance. Prevent wrinkles in the geomembrane from folding over during placement of cover materials. Do not drop cover soil onto the geomembrane or overlying geosynthetics from a height greater than 1 meter 3 feet. Push the soil out over the geomembrane or overlying geosynthetics in an upward tumbling motion. Place soil from the bottom of the slope upward. Provide an initial loose soil lift thickness of [350][_____] mm [12][_____] inches. Do not operate equipment directly on the geomembrane. Use equipment with ground pressures less than 50 kPa 7 psi to place the first lift over the geomembrane. Maintain a minimum of [460][610][915][_____] mm [18][24][36][_____] inches of soil between construction equipment with ground pressures greater than 50 kPa 7 psi and the geomembrane. Cover soil compaction and testing requirements are described in [Section 31 00 00 EARTHWORK][_____]. While placing cover soil do not operate equipment by stopping abruptly, making sharp turns, spinning their wheels, or traveling at speeds exceeding [2.2][_____] m/s [5][_____] mph.

]3.6 As-Built drawings

Submit final as-built drawings of the geomembrane installation. Include panel numbers with a unique identifier that can be linked to the [resin][roll] [number][factory] panel number, seam numbers, location of repairs, destructive seam samples, and penetrations in these drawings.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 56 13.16 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 56 13.16 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 56 13.16

CLAY WASTE CONTAINMENT

02/25

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USACE / NAVFAC / AFCEC **UFGS-02 56 13.16 (February 2025)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 02 56 13.16

CLAY WASTE CONTAINMENT
02/25

****
NOTE: This guide specification covers the requirements for construction of a clay barrier layer (liner and cover) to isolate contaminated material from the environment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 UNIT PRICES

****
NOTE: These paragraphs should be edited based on whether the contract will use a single job price or unit prices. If there is a separate Measurement and Payment section, edited versions of these paragraphs should be inserted in that section.

Weight measurement may be used to supplement volume measurement surveys if significant subgrade settlement (landfill cover applications) is anticipated.
****

Base measurement and payment for the clay barrier layer on the unit price schedule for each cubic meter cubic yard of clay in place. Include the cost for development of the clay borrow source, cost of clay, excavation, hauling, equipment, placement, testing, and other incidental work required to construct the clay barrier layer in this unit cost.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75-μm (No. 200) Sieve in Soils by Washing
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1587/D1587M	(2015) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D2167	(2015) Density and Unit Weight of Soil in

	Place by the Rubber Balloon Method
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D4220/D4220M	(2014) Preserving and Transporting Soil Samples
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D5084	(2016a) Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D6913/D6913M	(2017) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO ISO/IEC 17025	(2017) General Requirements for the Competence of Testing and Calibration Laboratories

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

1.3 SYSTEM DESCRIPTION

****

NOTE: Describe other components of the liner or cover system and reference specification Sections that contain the requirements for these components. Other specification sections that may be included in a liner or cover project are: Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT, Section 02 56 13.19 GEOSYNTHETIC CLAY LINER WASTE CONTAINMENT, Section 02 66 13 SELECT FILL AND TOPSOIL FOR LANDFILL COVER, and Section 02 66 16 TEST FILL.

State regulations may provide for different hydraulic conductivity than the value recommended below.

If this guide specification is being prepared to include requirements for both a liner and cover system on the same project, the Designer should ensure that appropriate edits are made throughout the specification section to identify requirements that are specific to either the liner or cover component (e.g. a liner may have different thickness and hydraulic conductivity requirements that a cover).

****

Construct a clay waste containment[liner][cover] layer consisting of a minimum [_____] inch thick compacted clay with a hydraulic conductivity of less than [1 x 10^{-7}][_____] cm/s.

[1.4 PRE-INSTALLATION MEETING

****

NOTE: Delete this paragraph if a separate specification section is developed for the entire project to cover pre-installation meetings and other administrative requirements.

****

Conduct a pre-installation meeting at the jobsite [at least five business days prior to the start of earthwork operations on the project][_____]. The pre-installation meeting is to be arranged by the Contractor and is to follow the written pre-installation meeting agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this Specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Project Superintendent, earthwork subcontractor's Project Manager and Site Foreman, Contractor's Geotechnical Engineer and Testing Agency, Government Geotechnical Engineer and Civil Engineer, and Government Construction Manager and Engineering Technician.

Record pre-installation meeting minutes and publish by way of email within 48 hours to all attendees. The minutes must be re-published within 48 hours pending any subsequent comments from the attendees.

]1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Installation Meeting Agenda

Pre-Installation Meeting Minutes; G, [_____]

Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP); G, [_____]

Material Handling Plan; G, [_____]

Borrow Source Assessment Report; G, [_____]

SD-04 Samples

Clay

SD-06 Test Reports

Water Supply Analysis

Clay Material Laboratory And Field Test Results

Moisture Content and Density Tests of Clay

Hydraulic Conductivity Tests of Clay

Geotechnical Evaluation Report; G, [_____]

SD-07 Certificates

Qualifications; G, [_____]

Certificate Of Subgrade Acceptance; G, [_____]

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

****

NOTE: Regulatory requirements will be location specific and may include local ordinances and State regulatory requirements. At a minimum, an approved Soil Erosion and Sediment Control Plan will be required by the local Soil Conservation District.

For sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. The permits or permit equivalents may include those addressing air emissions, water discharge, stormwater pollution prevention, and possibly others. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, such as Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, delete this section.

****

Obtain all State and Local [permits][permit equivalents] required to perform the work.

1.6.2 Qualifications

Provide a Professional Geotechnical Engineer licensed in the [applicable jurisdiction][state that work is being performed] to provide inspection of the clay barrier layer throughout construction. The Geotechnical Engineer must have [five][_____] years of experience in design, construction, Quality [Assurance][Control], or certification of [landfill][dump] liners including low permeability clay barrier liners. The Geotechnical Engineer is responsible for performing pre-construction, periodic during construction, and final at completion of construction site visits to inspect and [approve][certify] that the clay barrier layer meets specifications. The Geotechnical Engineer is responsible for preparing and updating the Materials Handling Plan and Borrow Source Assessment Report as construction progresses to reflect changing conditions and submit updated plans if necessary. Submit a [monthly][_____] Geotechnical Evaluation

Report, informing the Contractor and Contracting Officer of the status of the plans and an accounting of the Contractor's adherence to the plans addressing any present or potential problems. The Contractor is responsible for arranging meetings with the Geotechnical Engineer and Contracting Officer throughout the contract duration.

1.6.3 Qualified Technician

Provide a Qualified Technician to inspect, monitor, sample, and perform field testing. The technician qualifications need to be one of the following: a current National Institute for Certification in Engineering Technologies (NICET) Level II minimum certification in Construction Materials Testing Soils; Professional Civil or Geotechnical Engineer with minimum [two][_____] years of experience in design, construction, Quality [Assurance][Control], or certification of [landfill][dump] liners including low permeability clay barrier liners.

1.6.4 Lab Validation

Perform testing by an accredited commercial testing laboratory meeting the requirements listed below. Items a-c apply to testing laboratories used for soil geotechnical testing (all tests other than chemical contamination tests). Item d applies to testing laboratory used for chemical contamination tests. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

a. Comply with applicable requirements of ASTM E329.

b. Testing laboratory must be licensed to operate in the State of [_____]. Third party laboratory testing must be conducted by a laboratory either validated by the USACE Materials Testing Center or have an AASHTO Materials Reference Laboratory (AMRL) certification for the required tests.

c. Testing equipment used by laboratory must be calibrated at maximum intervals of 12 months by devices of accuracy traceable to one of the following: NIST Standard Reference Materials, ISO ISO/IEC 17025, certified by state or local bureau.

d. Perform the testing in paragraph CHEMICAL CONTAMINATION TESTING by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting the requirements of [Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Delivery

Deliver clay to the site in trucks that meet all local, state, and federal transportation regulations[and have added containment of material in the form of a fabric cover to prevent spillage].

1.7.2 Storage

Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear and grub the ground surface at stockpile locations. Protect stockpiles from contamination from unsuitable materials, including but not limited to soils not meeting the definition of Clay defined in this Specification, volunteer vegetation growth, or windblow waste [material][debris], which may destroy the quality and fitness of the clay material. If the Contractor fails to protect the stockpiles, and any clay material becomes unsatisfactory, remove and replace such material with satisfactory clay material from approved sources. Unsatisfactory materials include materials which do not comply with the requirements for satisfactory materials in this Section, and also include man-made fills; trash; refuse; backfills from previous construction; roots and other organic matter or frozen material. Do not place stockpiles on prepared subgrade or any portion of the prepared subgrade or clay barrier layer. Place a [geotextile][geocomposite][____] beneath stockpiles and between stockpiles of dissimilar material to keep materials separated. Provide stormwater sediment and erosion controls in accordance with[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____]. Do not allow water to pond in the stockpile areas.

1.8 [PROJECT][SITE] CONDITIONS

1.8.1 Environmental Requirements

Do not install the clay barrier layer when temperatures are below freezing or during precipitation events. Do not install the clay barrier layer when the subgrade is frozen, excessively wet, or extremely dry such that the subgrade compaction requirements in paragraph SUBGRADE EXAMINATION AND PREPARATION cannot be met, or in a condition otherwise detrimental to proper grading. Any relaxation of this requirement must be approved by the Contracting Officer.

1.8.2 Existing Conditions

****

NOTE: Existing conditions are site specific and are generally shown on the plans and provided in design or investigation documents prepared for the site. If there are specific conditions the Contractor should be made aware of that are contained in plans or documents provided, describe here.

****

The existing site conditions are presented [in Appendix [_____]][on the Drawings]. Immediately notify the Contracting Officer if there are discrepancies between the existing site conditions as presented and field conditions discovered during execution.

PART 2 PRODUCTS

2.1 EQUIPMENT

****

NOTE: A soil stabilizer or road regrader is often specified for use on soils that have clods or particles which are difficult to reduce to an acceptable size.

****

Do not operate equipment to place the clay barrier layer by braking suddenly, turning sharply, or traveling at speeds exceeding 8 km 5.0 miles per hour.

2.1.1 Compaction Equipment

Use compaction equipment consisting of tamping foot compactors which have a minimum weight of [20,500][_____] kg [45,000][_____] pounds. Provide at least one tamping foot for each [81,000][_____] square mm [126][_____] square inches of drum surface. The length of each tamping foot, from the outside surface of the drum, must be [25][_____] mm [1][_____] inch greater than the loose lift thickness to assure proper permeability between lifts. During compaction operations, keep the spaces between the tamping feet clear of materials which would impair the effectiveness of the tamping foot compactors.

2.1.2 Scarification Equipment

****

NOTE: Tamping foot compactors create a roughened surface on each lift of clay. The designer must determine if scarification is required to further roughen the surface of the clay barrier layer prior to placement of additional lifts of clay. If additional scarification is not required, omit this paragraph and other references to scarification throughout this section.

****

Provide disks, rotor tillers, [stabilizers][reclaimers], or other approved means to scarify the surface of each lift of clay prior to placement of the next lift. Provide scarification equipment capable of controlling depth to uniformly disturb the upper 25 mm 1 inch of each lift of the clay barrier layer to provide bonding, elimination of failure planes, and to assure continuous homogenous hydraulic conductivity between lifts.

2.1.3 Steel Wheeled Rollers

****

NOTE: The upper surface of the clay barrier layer must be smooth rolled if a geosynthetic will be placed on top of the clay barrier layer. Smooth rolling is also required to control moisture (precipitation infiltration or drying out) of the clay barrier layer between placement of lifts.

****

Use a smooth, non-vibratory steel wheeled roller to produce a smooth compacted surface on the clay barrier layer and to prevent moisture intrusion or drying. Steel wheeled rollers less than [9,070][_____] kg [20,000][_____] pounds are not acceptable.

2.1.4 Hand Operated Tampers

Provide hand operated tampers consisting of rammers or other impact type equipment. Vibratory plate-type equipment will not be allowed.

2.2 MATERIALS

2.2.1 Clay

****

NOTE: The physical criteria listed in Table 1 are minimum requirements. More restrictive criteria may be appropriate depending on local soils. For composite geomembrane/clay covers and liners, the maximum particle size should be reduced to 13 mm 0.5 inches in the upper lift of clay barrier layer to prevent puncturing of the geomembrane.

Bentonite is often added to soils that do not contain enough clay to achieve the desired hydraulic conductivity. Refer to EPA/600/R-93/182 - Quality Assurance and Quality Control for Waste Containment Facilities if bentonite will be used as an additive to the available soils.

****

Provide clay that has a Unified Soil Classification System classification (USCS) of CH, CL, or SC and is free of roots, debris, organic or frozen material. Clay material must comply with the criteria listed in Table 1. Submit a minimum of 23 kg 50 pounds of clay from each proposed borrow source to the Government at least [15][_____] business days prior to placement; this material is for possible Government Quality Assurance testing and not the Quality Control testing required by the Contractor.

TABLE 1 - REQUIRED PHYSICAL PROPERTIES OF CLAY

PROPERTY	TEST VALUE	TEST METHOD
Max. particle size	[25][__] mm [1][__] inch	ASTM D6913/D6913M
In Contact With Geomembrane Max. particle size	[13][_____] mm [1/2][_____] inch	ASTM D6913/D6913M
Min. percent passing 4.75 mm No. 4 sieve	[80] [_____]	ASTM D6913/D6913M
Min. percent passing 0.075 mm No. 200 sieve	[50] [_____]	ASTM D1140
Min. liquid limit	[35] [_____]	ASTM D4318
Min. plasticity index	[10] [_____]	ASTM D4318
Max. plasticity index	[30] [_____]	ASTM D4318

2.2.2 Water

****

NOTE: Two options are provided. The first option is

to only allow the Contractor to use potable water. The second option allows the Contractor to use non-potable water, but includes a testing requirement to limit the chance that the Contractor supplies a water that could introduce contaminants into the clay barrier layer. The first option is simpler, but could lead to higher project costs if the volume of water needed is significant and/or potable water sources are not readily available. When specifying the criterion to be met for water, the Designer should consider if there are other standards which are more appropriate for the specific project (e.g. state groundwater cleanup criteria).

****

Supply water used to increase moisture content of the clay barrier layer for the sake of compaction during installation. Maintain an accurate record of water usage.[Use only potable water from a regulated public water system.][If non-potable water is to be used, provide water that does not contain oils, acids, salts, alkalis, organic matter, solids, or other substances at concentrations that could be detrimental. Also characterize non-potable water prior to its use by collecting a sample from the water source and analyzing according to Table 2. Submit a Water Supply Analysis demonstrating that water meets requirements.

TABLE 2 - MOISTURE CONDITIONING AND DUST CONTROL WATER CRITERIA

ANALYTICAL METHOD NUMBER (From EPA SW-846; use current version)	ANALYSIS TYPE	CRITERIA TO BE MET
6010 [and 7470A]	Metals [and Mercury]	[Less than Maximum Contaminant Level (MCL)][_____]
8260	Volatile Organics	
8270	Semi-volatile Organics	
8082	PCBs	
1633	PFAS	
8081	Pesticides	
Within each Analytical Method, only analyze for analytes which have an [MCL][_____].		

]

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

2.3.1 Borrow Source Assessment

****

NOTE: Shear strength testing is often required for landfill covers and liners which contain geosynthetics. Testing should be conducted on all potential slip interfaces. Criteria for shear

strength testing (also referred to as interface friction testing) are described in Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT or Section 02 56 13.19 GEOSYNTHETIC CLAY LINER WASTE CONTAINMENT.

The testing defined in paragraphs MOISTURE-DENSITY (COMPACTION) TESTING and HYDRAULIC CONDUCTIVITY TESTING is performed to determine the acceptable zone of moisture and compaction to assure that hydraulic conductivity of the clay barrier layer meets requirements; this testing is not to assure structural compaction of the soil. The compaction and moisture testing utilized in field quality control is used to indirectly determine hydraulic conductivity through plotting on the developed acceptable zone.

****

Perform borrow source assessment tests on each principal type and combination of materials proposed for use in the clay barrier layer to assure compliance with specified requirements and to develop compaction requirements for placement. Perform one set of borrow assessment tests for each [400][_____] cubic meters [500][_____] cubic yards for each borrow source proposed. Perform at least three borrow assessment tests for each soil type and borrow source. A set of borrow source assessment tests is comprised of classification testing, moisture-density (compaction) testing, and hydraulic conductivity testing.

2.3.1.1 Classification Testing

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NOTE: Test pits should be used, if possible, because they provide a better method of characterizing borrow sources than borings.

****

Use [test pits][borings] placed in a grid pattern to characterize each proposed borrow source. Extend the [test pits][borings] to the full depth of the proposed borrow source. Perform visual classification as described in ASTM D2488 over the full depth of each [test pit][boring] by the [Geotechnical Engineer described in paragraph GEOTECHNICAL ENGINEER][Qualified Technician described in paragraph QUALIFIED TECHNICIAN]. Group soils into "principal types" based on visual classification. Perform classification testing on representative samples of each principal type and combination of materials. Classification testing consists of the tests identified in the table in paragraph CLAY.

2.3.1.2 Moisture-Density (Compaction) Testing

****

NOTE: A minimum of two compaction efforts are recommended to adequately define the relationship between moisture-density and hydraulic conductivity.

****

Test representative samples from each principal type and combination of borrow materials to establish compaction curves using ASTM D698 and ASTM D1557. Use a minimum of [five][_____] points to develop each compaction curve. Plot the compaction curves for each principal type and combination of borrow materials on a single graph of dry density versus moisture content.

2.3.1.3 Hydraulic Conductivity Testing

****

NOTE: When performing hydraulic conductivity testing, the average effective confining pressure should be representative of post construction conditions. The minimum effective confining pressure should be equal to or greater than 21 kPa 3 psi to avoid side wall leakage.

If the clay barrier layer will be placed beneath hazardous waste, chemical compatibility testing may be appropriate. Chemical compatibility testing consists of performing hydraulic conductivity tests on the clay liner material using a representative leachate sample as the permeant.

****

Perform hydraulic conductivity tests on representative samples of each principal type and combination of borrow materials. A set of tests is comprised of one hydraulic conductivity test run on a representative sample corresponding to each point from each compaction curve (ASTM D698 and ASTM D1557) at or above ASTM D1557 optimum moisture content. Conduct hydraulic conductivity testing referenced in this Section in accordance with ASTM D5084. In addition, adhere to the following procedures when performing the hydraulic conductivity testing:

a. Verify saturation of test specimens by determining the B coefficient. The B coefficient must be at least 0.95. The B coefficient is defined as the change in pore water pressure divided by the change in confining pressure.

b. During consolidation of the test specimens, record outflow volumes versus time on a semi-log graph to confirm primary consolidation has been completed prior to permeation of the specimens.

c. Use a permeant of 0.01 molar calcium chloride solution created from deaired, deionized water as specified in ASTM D5084 for back pressure saturation and permeation.

d. Provide an average effective confining pressure of [_____] kPa [_____] psi.

2.3.1.4 Chemical Contamination Testing

****

NOTE: This section includes a requirement to prepare a UFP-QAPP to define chemical contamination testing. Alternatively, this section may reference a separate specification section in the project requiring preparation of a UFP-QAPP. If that is the case, ensure that UFP-QAPP requirements from this section are appropriately incorporated into the separate specification section.

Suggested chemical analyses, sampling frequency, sample collection methods, and chemical concentration screening level standards are included as optional requirements to be considered in the UFP-QAPP. The Designer can include more specific requirements in the list of UFP-QAPP elements to be addressed. Individual states where work is being completed may have requirements that should also be considered.

The Designer should take care that requirements are not too strict for what is considered "clean" soils. Natural and anthropogenic background concentrations of chemicals should be considered in addition to health-based screening levels defined by regulatory agencies. The Designer may wish to use alternative methods instead of conducting project-specific specific chemical contamination testing; alternative methods could include using previously approved borrow sources where chemical contamination testing has already been conducted or using borrow sources where chemical contamination is not suspected based on knowledge of land use, etc.

****

2.3.1.4.1 Uniform Federal Policy Quality Assurance Project Plan

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with the requirements set forth in EPA 505-B-04-900A and using the UFP-QAPP WKSTS. Submit the UFP-QAPP within [30][_____] calendar days after notice to proceed. Do not perform chemical contamination testing until the UFP-QAPP is approved. Prepare [draft for Government review][draft-final for [regulatory][_____] review] and final versions of the UFP-QAPP. Allow [30][_____] calendar days for [Government] review [and [30][_____] calendar days for regulatory review]. Allow [45][_____] calendar days for comment resolution following each review and preparing the next version of the document. Tailor the content to the requirements of the project and the site conditions. The UFP-QAPP must specifically address the following elements:

a. Chemical analyses: Specify the chemicals to be analyzed in each sample. [At minimum the following analyses must be included: [target compound list volatile organic compounds][target compound list semi-volatile organic compounds][target analyte list metals][pesticides/polychlorinated biphenyls][______].]

b. Acceptable chemical concentrations for the clay barrier layer soils. [At minimum the following standards must be considered: [U.S. Environmental Protection Agency Regional Screening Levels][state-specific screening levels defined at [______]][background chemical concentrations defined at [______]].]

c. Chemical contamination sampling frequency. Assume a minimum sampling frequency of one sample for every [2,000][_____] cubic meters [2,500][_____] cubic yards of clay brought on site. Consider other sampling frequency requirements such as state regulations or guidance.

d. Sample collection method (e.g. discrete grabs, composites, incremental samples).

e. Borrow source chemical contamination acceptance criteria, indicating how sample results will be compared to acceptable chemical concentrations to determine if the borrow source is acceptable (e.g. each sample must meet acceptable concentrations, average of samples must meet acceptable concentrations).

2.3.1.4.2 Chemical Contamination Sampling and Analysis

Sample and analyze each proposed borrow source for chemical contamination in accordance with [the UFP-QAPP][_____]. Any deviations to sampling frequency, number of samples, or sample collection methods must be [established in the approved [UFP-QAPP][_____]][approved by the Contracting Officer].

2.3.1.5 Borrow Source Assessment Report

****

NOTE: Additional testing may be required to determine the "Acceptable Zone" based on shear strength considerations. The Designer would need to modify the Acceptable Zone requirement listed below in that case. For more discussion on this approach, see Chapter 3.4 of Waste Containment Facilities, Guidance for Construction Quality Assurance and Construction Quality Control of Liner and Cover Systems, 2nd Edition, 2007 (ASCE Press).

Experience with some materials indicates that the Acceptable Zone can be expanded to include soils that are 1-2 percent less than optimum moisture content while still achieving the require hydraulic conductivity. This would represent a less conservative approach, but one that could be less costly and difficult to achieve.

****

Submit a Borrow Source Assessment Report at least [15][_____] business days prior to clay placement. Do not place clay until the Borrow Source Assessment Report is approved. Include the following in the report:

a. Location of each borrow source.

b. Plan view and estimated available quantity of clay.

c. Locations and logs of subsurface explorations.

d. Laboratory test results.

e. Acceptable Zone of moisture contents and densities, displayed with the compaction curve graphs for each principal type of borrow material and combination of borrow materials. The Acceptable Zone is comprised of moisture-density values that meet the following requirements: maximum hydraulic conductivity = [1×10^{-7} cm per second][_____]; the minimum allowable moisture content must be no less than [optimum moisture content][_____] and no greater than [four][_____] percent above optimum based on ASTM D1557; the minimum allowable density must be no less than [90][_____] percent of maximum dry density based on ASTM D698.

f. Chemical testing data demonstrating that clay material is acceptable.

PART 3 EXECUTION

3.1 SUBGRADE EXAMINATION AND PREPARATION

****

NOTE: An example Certificate of Subgrade Acceptance can be found in the USACE Engineering Manual (EM) 1110-1-4011.

****

3.1.1 Examination

Each day during placement of the clay barrier layer, the Qualified Technician[and Government QA representative] must inspect the subgrade to verify it is acceptable for placement of the clay barrier layer. Examine the subgrade for compliance with the items in the list below. If subgrade is not suitable to place the clay barrier layer, prepare the subgrade in accordance with paragraphs CLEARING AND GRUBBING, GRADING, SUBGRADE COMPACTION, and PROOF ROLLING. Inspect and submit a Certificate of Subgrade Acceptance each day that the clay barrier layer is placed.

a. A project-qualified land surveyor has verified the lines and grades of the subgrade meet project design.

b. All CQC and CQA of the underlying geosynthetics has been completed and results have been accepted by the Contracting Officer.

c. The subgrade is free of irregularities, protrusions, loose soil, and abrupt changes in grade. The subgrade is free of vegetation and ruts and is not wet or frozen.

d. All tools, equipment, and temporary covers have been removed from the geosynthetic.

3.1.2 Clearing and Grubbing

[Clear and grub in accordance with Section 31 11 00 CLEARING AND GRUBBING.] Remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations. Remove stumps entirely. Grub out matted roots and roots over 75 mm 3 inches in diameter to at least 500 mm 18 inches below existing surface. Remove all organics and rocks greater than 25 mm 1 inch from the top 150 mm 6 inches.

3.1.3 Grading

Grade subgrade to the lines and grades indicated on the plans. Provide finished surface that are uniformly graded and free from depressions, mounds, or windrows. The top surface of the subgrade must be between 0 and minus 76 mm 3 inches of the grades indicated on the plans. No plus tolerance will be permitted.

3.1.4 Subgrade Compaction

Subgrade materials that exhibit deflection greater than 25 mm 1 inch or rutting during proof rolling need to be scarified, aerated, and re-compacted to 90 percent of maximum dry density based on ASTM D1557 or 95 percent of maximum dry density based on ASTM D698 at [plus][0-4][_____]

percent of optimum moisture content prior to being considered for remedial action by the Contracting Officer.

3.1.5 Proof Rolling

Perform proof rolling on exposed subgrade that is unfrozen and free of surface water (wet conditions resulting from rainfall).[Notify the Contracting Officer a minimum of three business days prior to proof rolling.][Perform proof rolling in the presence of the Contracting Officer.][After final grading to the planned elevation,] proof roll the existing subgrade of all areas to receive compacted clay barrier layer with six passes of a[[45][_____] metric ton [50][_____] short ton loaded offroad dump truck] [[45][_____] metric ton[50][_____] short ton loaded scraper]. Operate the [scraper][truck] in a systematic manner to ensure the number of passes over all areas, and at speeds between 4 to 5.5 km 2.5 to 3.5 miles per hour. The subgrade is considered to extend 1.5 meters 5 feet beyond the limits of the clay barrier layer. Smooth drum roll the final subgrade surface with a smooth drum compactor.

3.2 INSTALLATION

3.2.1 Material Handling Plan

Submit a Material Handling Plan at least [15][_____] business days prior to clay placement. Do not place clay until the Material Handling Plan is approved. Include the following in the plan: processing and placement of the clay; type, model number, weight and critical dimensions of equipment to be used for soil processing, compaction, scarification, and smooth rolling; method of protecting clay from changes in moisture content and freezing after placement.

3.2.2 Pre-Processing

****

NOTE: Clods of soil can be broken down with tilling equipment. Stones can be sieved out of the soil with large vibratory sieves, mechanized "rock pickers" passed over a loose lift of soil, or by laborers who remove oversized material by hand. Pulverization machines can process soil in a loose lift, breaking down hard chunks and crushing stone or large clods.

****

Prior to placement of the clay barrier layer, process clay to break down clods of soil to less than 50 mm 2 inches, to remove rocks greater than the maximum particle size specified in paragraph CLAY, and condition the soil to the proper moisture content for compaction. Process clay at the location designated on the drawings or approved by the Contracting Officer. The Materials Handling Plan must identify equipment and methods to process the soil in preparation of placement.

3.2.3 Clay Placement

****

NOTE: Clay is placed parallel to the direction of maximum slope. Clay placement parallel to the slope becomes difficult on slopes steeper than 3 horizontal on 1 vertical. Horizontal lifts should

be considered for clay placement on slopes steeper than 3 horizontal on 1 vertical.

The U.S. Environmental Protection Agency document, EPA/600/R-93/182 Quality Assurance and Quality Control for Waste Containment Facilities discourages the use of grade stakes which penetrate the clay barrier layer to control lift thickness.

If a test pad is considered necessary, include Section 02 66 16 TEST FILL in the project specifications and provide a reference in this section. Section 02 66 16 TEST FILL should be modified to include hydraulic conductivity testing per ASTM D6391.

****

Place clay to the lines and grades shown on the drawings. The thickness of the clay liner at any location must be measured perpendicular to the slope at that location. Place the clay in loose lifts not to exceed 25 mm 1 inch less than the foot length of the compactor. Do not place subsequent lifts until the previous lift has passed all testing requirements described in paragraph FIELD QUALITY CONTROL. In areas where hand operated tampers must be used, the loose lift thickness exceeding [100][_____] mm [4][_____] inches is not acceptable.[Do not drive grade stakes into the clay barrier layer.][If grade stakes are driven into the clay barrier layer to control lift thickness, number and account for them at the end of each shift. When removing grade stakes, do not leave broken portions of the grade stakes in the clay barrier layer. Backfill and compact holes left by grade stakes by following the procedure in paragraph Repair of Voids.]

For clay barrier layers placed over geosynthetics, the first lift must be 305 mm 12 inches. This lift is not considered in determining the required thickness of the clay barrier layer. For clay barrier layers placed above geosynthetics, require the placement and compaction equipment work from the base of the slope up to prevent damage to underlying geosynthetics. Do not operate equipment directly on the top surface of geosynthetics.

3.2.4 Moisture Control

Place and compact clay within the "Acceptable Zone" moisture content range in the approved Borrow Source Assessment Report. Maintain uniform moisture content throughout each lift. Add and thoroughly incorporate water into the clay to ensure uniformity of moisture content prior to compaction. Seal roll the clay barrier layer with approved steel wheeled rollers and make smooth and free from ruts or indentations at the end of every working day, when precipitation is forecast, or at the completion of compaction operations in an area.

3.2.5 Compaction

****

NOTE: Special compaction procedures are required if geosynthetic layers are located immediately beneath the clay barrier layer. This lift of soil is typically placed with low ground pressure track mounted equipment with a track pressure of 21 to 41 kPa 3 to 6 psi.

****

Compact clay to meet the density requirements in the approved Borrow Source Assessment Report and by at least [six][_____] one-way passes of the approved compaction equipment over all areas of each lift. Compactor wheel passes must have 15 percent to 25 percent overlap to assure compaction over the entire area. For self-propelled compactors, one pass is defined as one pass of the entire vehicle. Use hand operated tampers in areas where standard compaction equipment cannot be operated.

The transition from an existing full-depth section of clay barrier layer to the beginning of an adjacent section that is to be constructed subsequently must be accomplished by cutting minimum 3 meter 10 foot wide stair steps for each lift of the clay barrier layer, scarifying the surface of each stair step, and then immediately placing the adjacent lifts of clay liner.

3.2.6 Scarification

****

NOTE: For geomembrane/clay composites, the final lift of clay is smooth rolled instead of being scarified to allow intimate contact between the clay surface and the overlying geomembrane. Smooth rolling also helps to prevent desiccation and precipitation infiltration increasing moisture outside of the workable range during delays in construction.

****

Prior to placement of the next lift, perform scarification on all areas of the upper surface of each clay lift that has been seal rolled. Accomplish scarification with approved equipment. If a geosynthetic is to be placed in contact with the clay surface, do not scarify the final lift of clay. Roll the final lift with the approved smooth steel wheeled roller to provide a smooth surface with no ridges or depressions.

3.2.7 Repair of Voids

Repair voids created in the clay barrier layer during construction (including, but not limited to, penetrations for test samples, grade stakes, and other penetrations necessary for construction) by removing sand or other non-clay material, placing clay backfill in lifts no thicker than 76 mm 3 inches and tamping each lift with a steel rod. Tamp each lift a minimum of 25 times altering the location of the rod within the void for each blow. Scarify, fill and compact to grade other ruts and depressions in the surface of the lift.

3.2.8 Construction Tolerances

Provide finished surfaces that are uniformly graded and free from depressions, mounds, or windrows. The top surface of the clay barrier layer greater than [76][_____] mm [3][_____] inches above the lines and grades shown on the drawings is prohibited. No minus tolerance will be permitted.

3.3 FIELD QUALITY CONTROL

3.3.1 Clay Material Laboratory and Field Test Results

During construction of the clay barrier layer, take representative samples for testing at the frequencies listed in Table 3 [from the borrow source][from onsite stockpiles][after a loose lift of clay has been placed][_____]. Test results must meet the requirements listed in Table 1.

TABLE 3 - CLAY MATERIAL PROPERTIES		
Property	Frequency	Test Method
Particle size analysis (Note 1)	[800][_____] cubic meters[1,000][_____] cubic yards	ASTM D6913/D6913M
Percent Passing 0.075 mm (No. 200 sieve)	[800][_____] cubic meters[1,000][_____] cubic yards	ASTM D1140
Liquid Limit (Note 1)	[800][_____] cubic meters[1,000][_____] cubic yards	ASTM D4318
Plastic Limit (Note 1)	[800][_____] cubic meters[1,000][_____] cubic yards	ASTM D4318
Plasticity Index (Note 1)	[800][_____] cubic meters[1,000][_____] cubic yards	ASTM D4318
Compaction (Note 2)	[5,000][_____] cubic meters[6,500][_____] cubic yards	ASTM D698 ASTM D1557
Note 1: Perform at least one test each day that soil is placed. Note 2: Compare compaction test results to previous results on the same material type to verify the compaction characteristics have remained the same.		

3.3.2 Moisture Content and Density Tests of Clay

****

NOTE: Test results using ASTM D6938 may show a significant amount of scatter in some situations. ASTM D4643 (microwave method) can be used as an alternative to ASTM D6938 for quick determinations of moisture content.

****

Perform moisture content and density tests, for clay in-place, in a grid pattern staggered for successive lifts, so that sampling points are not at the same location in each lift. These tests are needed to assure hydraulic conductivity is within acceptable zone and meets specifications. Perform moisture content and density tests in accordance with Table 4.

TABLE 4 MOISTURE CONTENT AND DENSITY TESTS OF IN-PLACE CLAY		
Property	Frequency Per Lift	Test Method
Nuclear Moisture Content	[450][_____] square meters [5000][_____] square feet - Minimum of 3 tests per day	ASTM D6938
Standard Moisture Content	1 for every 10 nuclear tests, minimum 1 test per day	ASTM D2216
Nuclear Density	[450][_____] square meters [5000][_____] square feet - Minimum of 3 tests per	ASTM D6938
Standard Density	1 for every 20 nuclear density tests, minimum 1 test per day	ASTM D1556/D1556M or ASTM D2167

3.3.2.1 Test Frequencies and Locations

Perform nuclear density and moisture content tests at locations that are representative of moisture and compaction based on visual observations during placement of the lift. Perform standard tests at locations which are underneath the nuclear gauge or as close as possible to the location of the nuclear tests being checked.

3.3.2.2 Nuclear Density and Moisture Content Tests

Take nuclear density readings in the direct transmission mode. When ASTM D6938 is used, check and adjust calibration curves using only the sand cone method as described in ASTM D1556/D1556M. ASTM D6938 results in a wet unit weight of soil and when using this method, use ASTM D6938 to determine the moisture content of the soil. Check calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938; make calibration checks of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer.

3.3.2.3 Test Results

Plot the field moisture content and density test results on the "Acceptable Zone" plot that corresponds to the appropriate material type being tested. If test results are not within the "Acceptable Zone" for moisture content or density, repair the lift of soil out to the limits defined by the Qualified Technician based on visual observation, process monitoring, and additional nuclear testing. Retest the area as directed. Document repairs to the clay barrier layer including location and volume of soil affected, corrective action taken, and results of retests.

3.3.3 Hydraulic Conductivity Tests of Clay

****

NOTE: Laboratory hydraulic conductivity tests during clay barrier layer installation constitute a major inconvenience because the tests usually take several days to perform. For this reason, the use of laboratory hydraulic conductivity tests should be minimized or eliminated if possible.

****

Take undisturbed samples from the in-place clay for hydraulic conductivity testing at a frequency of once per 3,720 square meter 40,000 square feet for each lift of clay placed. Cut samples from the lift in accordance with ASTM D1587/D1587M and transport in the vertical position in accordance with ASTM D4220/D4220M, Group C. Test each undisturbed sample for hydraulic conductivity in accordance with ASTM D5084[, moisture content in accordance with ASTM D2216,][particle size analysis in accordance with ASTM D6913/D6913M,][and][liquid and plastic limits in accordance with ASTM D4318]. Conduct hydraulic conductivity testing in accordance with paragraph HYDRAULIC CONDUCTIVITY TESTING. If any test result is greater than the "Maximum Allowable Hydraulic Conductivity", modifications must be proposed and approved for future placement of clay of that type. If the hydraulic conductivity of any test is more than one-half of one order of magnitude greater than the "Maximum Allowable Hydraulic Conductivity", perform [three][_____] additional tests near the location of the original failed test. If all retests pass, take no additional action. If any of the retests fail, repair the area out to the limits defined by passing hydraulic conductivity tests. Retest the area as directed. Document repairs to the clay barrier layer including location and volume of soil affected, corrective action taken, and results of retests.

3.3.4 Government Quality Assurance Testing

****

NOTE: Quality assurance (QA) testing and inspections should be performed on all landfill construction as the liability is long term and cost due to failure is significant. Factors to consider include whether the Government has access to a laboratory that can analyze quality assurance samples in a timely manner to not delay the project execution. If conducting quality assurance testing, a separate third-party quality assurance contract should be considered based on the qualifications of the Government QA personnel, the size and importance of the project, and the impacts of clay barrier layer failure.

Use of quality assurance testing data also needs to be considered. A relatively straightforward data use is to compare quality assurance sample results to the project performance requirements, and failing result would be treated the same way as a failing Contractor test result. A more complicated data use is to compare results from quality assurance samples and contractor quality control samples for the purpose of determining if there is meaningful disagreement between the results. In this case, procedures would need to be developed for determining when there is a meaningful disagreement between quality assurance and quality control sample results; corrective actions for when a meaningful disagreement was identified would also need to be developed. The process of defining procedures for identifying and correcting meaningful differences should be documented in a project specific CQA Plan or Quality Assurance Project Plan and referenced in

this specification; the process is likely too complex to be adequately defined in this specification.

Two options are provided for defining Government Quality Assurance. The first option is to defer details of the Government QA to a separate CQA Plan. The CQA Plan would need to be developed and provided to the Contractor with the project specifications. This option would be preferred for large, complex projects where the clay barrier layer is one component of a larger waste containment system. A second, simpler option is provided to define Government QA testing frequency.

The Government's QA personnel should visit off-site borrow sources to assure that soils identified in the Borrow Source Assessment Report are being utilized and no water is being added.

****

[Work will be monitored and tested in accordance with the CQA Plan. Be aware of all monitoring and testing activities defined in the CQA Plan and account for these activities in the construction schedule. Quality Assurance testing and monitoring does not relieve the Contractor of the responsibility to complete the quality control testing and monitoring defined in this specification Section.]

[

[Provide][The Contracting Officer will provide] duplicate quality assurance samples to the Government's quality assurance laboratory at a frequency of one set of samples per [10][_____] sets of quality control tests performed. Quality assurance samples will be tested for the same parameters as the parent quality control sample. A failed quality assurance test will require the same corrective actions defined in this Section as a failed Contractor quality control test. The Contracting Officer may require additional quality assurance tests as a result of failed quality assurance or quality control tests. Account for Government quality assurance testing in the construction schedule. Quality Assurance testing and monitoring does not relieve the Contractor of the responsibility to complete the quality control testing and monitoring defined in this specification Section.]

3.4 PROTECTION

3.4.1 Moisture Content

****

NOTE: Smooth rolling or other measures as defined in the Material Handling Plan are necessary to limit moisture loss and/or promote run-off of surface water.

****

After placement, maintain or adjust moisture content per the procedure defined in the Material Handling Plan to meet the acceptable zone criteria.

3.4.2 Erosion

Repair all visible erosion, including but not limited to erosion rills greater than 13 cm 0.5 inch depth that occurs in the clay barrier layer and re-establish grades.

3.4.3 Freezing and Desiccation

Prevent freezing and desiccation of the clay barrier layer. If freezing or desiccation (soils outside the acceptable moisture window, cracking, or platelet failure) occurs, remove or recondition the affected soil as directed.

3.4.4 Retests

Retest areas that have been repaired as directed. Document repairs to the clay barrier layer including location and volume of soil affected, corrective action taken, and results of retests.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-02 56 13.19 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 56 13.19 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 56 13.19

GEOSYNTHETIC CLAY LINER WASTE CONTAINMENT

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****

SECTION 02 56 13.19

GEOSYNTHETIC CLAY LINER WASTE CONTAINMENT
02/25

****
NOTE: This guide specification covers the requirements for geosynthetic clay liners.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 UNIT PRICES

****
NOTE: These paragraphs should be edited based on whether the contract will use a single job price or unit prices. If there is a separate Measurement and Payment section, edited versions of these paragraphs should be inserted in that section.
****

1.1.1 Measurement

Complete a survey to measure the total surface area covered by geosynthetic clay liner (GCL) in square meters square yards. Final quantities will be based on as-built conditions. Allowance will be made for GCL in anchor and drainage trenches; however, no allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor.

1.1.2 Payment

GCL installed and accepted by the Contracting Officer will be paid for at the respective Contract unit price in the bidding schedule. This unit price will include the costs of materials, equipment, installation, testing, and other costs associated with placement of the GCL.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D5887/D5887M	(2020) Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D5888	(2006; R 2016) Standard Guide for Storage and Handling of Geosynthetic Clay Liners
ASTM D5890	(2011) Swell Index of Clay Mineral Component of Geosynthetic Clay Liners

ASTM D5993	(2014) Measuring Mass Per Unit of Geosynthetic Clay Liners
ASTM D6072/D6072M	(2019) Standard Practice for Obtaining Samples of Geosynthetic Clay Liners
ASTM D6243/D6243M	(2020) Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
ASTM D6496/D6496M	(2020) Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
ASTM D6768/D6768M	(2020) Standard Test Method for Tensile Strength of Geosynthetic Clay Liners

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GCL3	(2005; R2019) Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)

1.3 DEFINITIONS

****

NOTE: NOTE: These definitions are adapted from Waste Containment Facilities, Guidance for Construction Quality Assurance and Construction Quality Control of Liner and Cover Systems, Daniel and Koerner, 2nd Edition.

****

a. Construction Quality Assurance (CQA): CQA includes inspections, audits, and evaluations of materials and workmanship to determine and document the quality of the constructed facility. CQA is performed by a party independent from the Contractor.

b. Construction Quality Control (CQC): A planned system of inspections that is used to directly monitor and control the quality of the geomembrane installation project. CQC is normally performed by the GCL installation [contractor][subcontractor], and is necessary to achieve quality in the geomembrane system. CQC refers to measures taken by the installer or contractor to determine compliance with the requirements for materials and workmanship as stated in the plans and specifications for the project.

c. Manufacturing Quality Control (MQC): A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of the geomembrane material and is necessary to ensure minimum (or maximum) specified values in the geomembrane. MQC refers to the measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and Contract specifications.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout and Detail Drawings; G, [_____]

As-Built Drawings; G, [_____]

SD-03 Product Data

Manufacturer's Quality Control Manual

Installer's Quality Control Manual

GCL

Accessory Bentonite

Adhesive

Installer's Warranty

Manufacturer's Warranty

SD-04 Samples

CQA Product Acceptance Sample

Interface Shear Testing Soil Sample

SD-06 Test Reports

Product Acceptance Tests

Visual Inspection and Evaluation

Manufacturer's Certified Raw And Roll Material Data Sheets

Mid-Plane And Interface Shear Strength Test Results

SD-07 Certificates

Certificates of Subgrade Acceptance

Qualifications; G, [_____]

SD-08 Manufacturer's Instructions

GCL Manufacturer's Installation Instructions

1.5 QUALITY CONTROL

1.5.1 Manufacturer's Quality Control Manual

Submit the manufacturer's quality control manual which describes testing procedures, frequency of testing and acceptance/rejection criteria for MQC testing at least [14][_____] days prior to delivery of the GCL.

1.5.2 Installer's Quality Control Manual

Submit the installer's quality control manual a minimum of [7][_____] calendar days prior to GCL placement.

1.5.3 Qualifications

Submit manufacturer qualification statements a minimum of [7][_____] calendar days prior to GCL shipment. Also submit installer, CQC inspector, [MQC][CQC] laboratory, and Licensed Surveyor qualification statements including resumes of key personnel involved in the project a minimum of [7][_____] calendar days prior to GCL placement.

1.5.3.1 Manufacturer

Provide GCL that is the product of a GCL Manufacturer who has produced the proposed GCL using the same bentonite,[geotextiles,][polyethylene geomembrane,][polymer,][sewing thread,][and][adhesive] for at least [5][_____] completed projects and has produced a minimum of

[186,000][_____] square meters [2][_____] million square feet of the proposed GCL.

1.5.3.2 Installer

****
NOTE: Small projects may not require the use of a specialized GCL installer. If a specialized GCL installer will not be required, this paragraph should be omitted and the submittal requirements above edited accordingly.
****

The installer is responsible for field handling, deploying, seaming, and anchoring the GCL. The installer will have installed GCL at a minimum of [5][_____] projects of comparable scope and complexity and will have installed a minimum of [186,000][_____] square meters[2][_____] million square feet of the proposed GCL.

1.5.3.3 CQC Inspector

****
NOTE: A separate third party CQA contract should be considered based on the qualifications of the Government CQA personnel, the size and importance of the project, and impacts of a GCL failure. CQC inspectors are still considered necessary even if the Government provides independent third-party CQA inspection.
****

The CQC inspector is the person or corporation hired by the Contractor, who is responsible for monitoring and documenting activities related to the CQC of the GCL from manufacturing through installation. The CQC inspector will have provided CQC [and][or] CQA inspection during installation of GCL material for at least [5][_____] projects and performed CQC [and][or] CQA inspection on a minimum of [186,000][_____] square meters [2][_____] million square feet of GCL.

1.5.3.4 [MQC][CQC] Laboratory

The [MQC][CQC] laboratory will have provided [MQC][CQC] [and][or] CQA testing of GCL for at least [5][_____] completed projects and performed [MQC][CQC] [and][or] CQA testing for a minimum of [186,000][_____] square meters [2][_____] million square feet of GCL. The [MQC][CQC] laboratory must be accredited via the [Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP)][_____] for the tests the [MQC][CQC] laboratory are required to perform.

1.5.3.5 Licensed Surveyor

Perform all survey work under the supervision of a Surveyor licensed in the [applicable jurisdiction][State of [_____]].[Perform surveys in accordance with Section [_____].]

1.5.4 Construction Quality Assurance

****
NOTE: Although independent CQA by the Government is

strongly recommended, this paragraph should be deleted if CQA will not be performed and only CQC will be performed. If CQA is not performed, references to CQA throughout the specification should be deleted. Note that the specification section uses the term Contracting Officer as a blanket term that would include CQA personnel acting under the Contracting Officer. Activities specified for the CQA personnel acting under the Contracting Officer would also need to be removed.

Depending on the project, the Government may also elect to implement Manufacturing Quality Assurance (MQA) activities, which include manufacturing facility inspections, verifications, audits, and evaluation of the raw materials and finished products (Daniel and Koerner, 2007). MQA is done in addition to MQC. The Contractor does not have an active role in MQA, but must be aware if MQA will occur on a project.

****

All work will be constructed, monitored, and tested in accordance with the requirements of a CQA [and MQA] Plan. Be aware of all activities outlined in the CQA [and MQA] Plan and account for these activities in the construction schedule. If CQA inspections or testing indicate work which does not meet the requirements of the specifications, the Contracting Officer will establish the extent of the nonconforming area. Repair the nonconforming area in accordance with paragraph DEFECTS AND REPAIRS.[If MQA inspections indicate products do not meet the requirements of this specification, applicable portions of the product will be rejected.]

1.6 DELIVERY, STORAGE, AND HANDLING

****

NOTE: ASTM D5888 provides guidance on delivery, storage, and handling of GCL materials. The designer should be familiar with the requirements of that ASTM standard; in some cases the ASTM standard provides options or suggestions as opposed to strict requirements. The designer can edit this paragraph to include stricter or more specific requirements than allowed in ASTM D5888.

****

Perform delivery, storage, and handling of GCL in accordance with ASTM D5888 and this Section. Deliver only approved GCL materials to the project site.[Deliver the GCL materials to the project site at least [14][_____] calendar days prior to installation to allow sufficient time for testing in accordance with paragraph PRODUCT ACCEPTANCE.] Deliver and unload the geomembrane with the CQC inspector [and Contracting Officer] present. Confirm the presence of a label on each GCL [roll][panel] with the manufacturer's name, product identification number, [roll][panel] number, and roll dimensions. Reject GCL rolls which are not labeled upon delivery to the project site.

1.7 PROJECT/SITE CONDITIONS

****

NOTE: The primary concern associated with weather conditions and GCL placement is exposure of the GCL to moisture that can result in premature hydration. GCL should be covered relatively quickly after it is placed, but a competing interest is the need to allow adequate time for CQC and CQA inspections of the GCL before covering it with the subsequent layer of the waste containment system. Temporary covering (aka tarping) can be considered, but temporary covers may not be effective on relatively flat areas where rain/snow can penetrate seams in temporary covers. The designer should consider the site specific design, speed at which CQC/CQA can be completed, and temporary/permanent covering methods when specifying buffer time between GCL placement and forecasted precipitation.

****

Consider present and forecasted weather conditions prior to GCL placement. Do not place GCL during periods of rain or snow or if rain or snow is forecasted within [4][_____] hours after placement will end.

1.8 WARRANTY

****

NOTE: Several manufacturers should be contacted to determine what length of warranty is available for GCL materials and installation. Manufacturers provide prorated material warranties ranging from 1 to 30 years depending on the application. Installation warranties are generally specified as 1 to 2 years in length.

****

Provide manufacturer's warranty stating that the GCL materials meet all requirements of the Contract and that for the intended use, the GCL is warranted for [_____] years against deterioration. Provide installer's warranty stating that the GCL will not fail due to improper installation within [_____] years.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

2.1.1.1 Layout and Detail Drawings

****

NOTE: The proposed GCL panel layout should be reviewed by the project engineer for compliance with the design conditions and best practices in laying-out panels. On slopes, panels should be installed with the long dimension of the panel parallel to the maximum slope. If end-of-panel seams (i.e. seams are perpendicular to the direction

of maximum slope) are proposed, the designer must confirm that the GCL is not expected to be in tension.

Minimize the number of penetrations and show their locations on the drawings. Referencing the manufacturer's typical penetration details is generally acceptable. When reviewing submitted penetration details, Designer's and others involved in a project such as CQA personnel may wish to consult the penetration examples in ASTM D6102 Standard Guide for Installation of Geosynthetic Clay Liners.
****

Submit GCL panel layout and detail drawings, for approval, a minimum of [seven][_____] calendar days prior to placement. Provide GCL penetration details [as indicated][as recommended by the GCL manufacturer]. At a minimum, pipe penetrations must incorporate a collar of GCL wrapped around the pipe and securely fastened.

2.2 MATERIALS

2.2.1 GCL

****
NOTE: GRI-GCL3 is used as the basis for specifying the properties of the GCL components (bentonite, geosynthetic bonding components) and the finished GCL. GRI-GCL3 provides material properties, minimum/maximum acceptable values, testing methods, and testing frequencies. Depending on the specific application of the GCL, the designer may wish to modify the specific requirements of GRI-GCL3. Any modifications to the material property requirements in GRI-GCL3 should be specified in this paragraph. ASTM D5889 is an alternative to GRI-GCL3. The primary difference is that GRI-GCL3 provides minimum/maximum property values for the GCL; ASTM D5889 only provides the testing methods and frequencies. Apart from this difference the two standards are overall very similar. If the Designer wishes to use the ASTM standard instead, replace the references to GRI-GCL3 in this paragraph and in paragraph MANUFACTURING SAMPLING AND TESTING. Provide minimum/maximum tested properties for the GCL.

Test method ASTM D5887 is an index test used to determine the flux rate of water through a GCL specimen. If a contaminated fluid will contact the GCL, compatibility testing should be considered during the design phase to ensure that the GCL can perform as desired. The following ASTM test methods should be referenced when performing compatibility testing:

ASTM D6141 - Standard Guide for Screening Clay Portion and Index Flux of Geosynthetic Clay Liner

(GCL) for Chemical Compatibility to Liquids, and

ASTM D6766 REV A - Standard Test Method for Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Aqueous Solutions.

A residual mid-plane shear strength should never be specified. The designer must ensure that the design is configured such that the allowable peak mid-plane shear stress is not exceeded.

Certain aggressive leachates may interfere with the performance of traditional sodium bentonite GCLs. GCLs made with polymer-modified bentonite or other bentonite additives may provide improved performance. If the designer determines that a polymer (or other additive) modified bentonite is needed, this paragraph and the paragraph MANUFACTURER QUALIFICATIONS should be modified to reflect that requirement.

GCL constructed with nonwoven geotextiles on both sides should be considered for situations where increased frictional resistance is required. Required values for internal friction and interface friction must be based on site-specific conditions including, but not limited to, normal stresses, saturation conditions, liquid type, consolidate time, shearing rate, shearing distance, etc.

****

Provide a GCL that is a manufactured product consisting of a [sodium montmorillonite clay (bentonite) layer][_____]. Provide a GCL that meets the requirements in Table 1 and is free of tears, holes, or other defects that may affect its serviceability. Provide a GCL with overlap lines printed onto the GCL [in accordance with GSI GRI GCL3][_____]. Mechanically bond encapsulating geotextiles together using a needle punch or stitch bonding process. If needle punching or stitch bonding is used for construction of the GCL, provide a GCL that has been continuously inspected for broken needles using an in-line metal detector, and all broken needles have been removed.

TABLE 1 - GCL PROPERTIES	
Tested Properties	As defined in [GSI GRI GCL3][_____]
GCL Category	[Reinforced][Nonreinforced]
GCL Joining	[geotextile][polymer-coated geotextile][smooth geomembrane/geofilm][textured geomembrane/geofilm]
Minimum Peak Internal Friction	[_____] degrees
Minimum [Peak][Residual] Interface Friction	[_____] degrees
Minimum Manufactured Sheet Width	[4.1][_____] meters [13.5][_____] feet

TABLE 1 - GCL PROPERTIES	
Minimum Manufactured Sheet Length	[30][_____] meters [98][_____] feet
Note 1: GCL which is [capped][carried] by geotextile is identified as "Geotextile Related" in GSI GRI GCL3; GCL which is [capped][carried] by polymer coated geotextile is identified as "Geotextile Polymer Coated" in GSI GRI GCL3; GCL which is attached to a geomembrane or geofilm is identified as "Geomembrane/Geofilm Related" in GSI GRI GCL3.	

2.2.2 Accessory Bentonite

Provide accessory bentonite used for sealing seams, penetrations, or repairs that is produced by the same manufacturer as the GCL and confirmed by the manufacturer to be compatible for use in sealing seams. Submit manufacturer documentation demonstrating compatibility.

[2.2.3 Interface Shear Testing Soil Sample

****

NOTE: This paragraph can be deleted if the GCL interface is not against a soil layer, but rather another geosynthetic. An optional requirement is included for the contractor to test the soil that will be used in the interface shear testing, to demonstrate that the soil meets project requirements. This demonstration testing would not be necessary if the borrow source has already been adequately investigated, or if the soil used for interface testing is collected at the same time that other borrow source sampling is conducted.

To reduce the overall risk to the Government, it is strongly advised that the Contractor is required to collect samples for interface shear testing unless the nature of the site prevents the Contractor to do so. Depending on site conditions and project needs (e.g. site security, access issues, etc.), the Government may provide samples to the Contractor to conduct interface shear testing.

****

[The Contracting Officer will provide][Obtain] soil to be used for interface shear testing from [the proposed borrow source][_____].[Conduct one set of tests and submit testing results demonstrating that the soils to be used for interface shear testing meet the material requirements in accordance with [______].]

]2.2.4 Adhesive

Provide adhesives used for securing repair patches that is approved for use by the GCL manufacturer. Submit manufacturer documentation demonstrating compatibility.

2.3 ACCESSORIES

2.3.1 Temporary Ballast

Provide temporary ballast used during GCL installation including sandbags, tires, or other material as recommended by the GCL manufacturer. Use non-abrasive material, free of sharp edges or other features that may damage the GCL.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

2.4.1 Manufacturing Sampling and Testing

****

NOTE: The testing required in this paragraph and subparagraphs occurs at the manufacturing facility. Additional testing is required once materials are delivered to the site, as defined in paragraph PRODUCT ACCEPTANCE. GRI-GCL3 provides testing frequencies, test methods, and minimum/maximum required properties. If paragraph GCL provides any required properties for the GCL that differ from GRI-GCL3, this paragraph must indicate the testing methods and frequencies associated with those properties.

****

Sample and test GCL and its components in accordance with the Manufacturer's Quality Control Manual and GSI GRI GCL3; sample and test according to the stricter requirement if there are deviations. Test results not meeting the requirements specified in paragraph GCL will result in the rejection of applicable rolls. Describe procedures used to determine rejection of applicable rolls in the Manufacturer's Quality Control Manual. As a minimum, test rolls produced immediately prior to and immediately after the failed roll tested for the same failed parameter. Continue testing until a minimum of three successive rolls on both sides of the original failing roll pass the failed parameter. Submit manufacturer's certified raw and roll material data sheets. The certified data sheets must be attested to by a person having legal authority to bind the GCL manufacturing company. If needle punching or stitch bonding is used in construction of GCL, indicate that the GCL has been continuously inspected for broken needles using an in-line metal detector and all broken needles have been removed in the certification.

2.4.2 Shear Strength Testing

****

NOTE: Frictional resistance of GCL is highly dependent on the hydrating fluid, hydration state, confining stresses during saturation, confining stresses during shear, and strain rate. These parameters should be specified on a site specific basis. For interface shear strength testing, a set of direct shear tests should consist of a minimum of three tests performed at normal stresses bracketing the anticipated average normal field stresses. For additional discussion on the significance of GCL shear strength and design, see GRI-GCL5 Design Considerations for Geosynthetic Clay Liners (GCLs)

in Various Applications.

Tables 2 and 3 are from ASTM D6243/6243M; the Designer should verify that the tables are current if ASTM D6243/6243M is updated.

The hydration state of the GCL can have a significant effect on its shear strength. The shear strength of bentonite decreases with increasing moisture content. In addition, hydration of bentonite may affect the properties of reinforced GCL by stretching the reinforcement as the bentonite swells. For geotextile backed GCLs, interface shear strength is reduced due to the bentonite extruding into the interface. As a preliminary guideline, minimum hydration time should be 24 hours for mid-plane and interface shear strength testing. However, it must be pointed out that research indicates these hydration times will probably not result in complete hydration of the GCL. Hydration times of up to 25 days are required to attain complete hydration.

ASTM D6243/6243M indicates that strain/shear rates of 1 mm/min 0.04 in/min for interface shear and 0.1 mm/min 0.004 in/min for internal shear provide appropriate shear strengths for design when hydrated under normal stress of at least 7 kPa 1 psi and consolidated under normal stress of 70 kPa 10 psi. However, other conditions can require different hydrating/consolidation/strain parameters. Additional guidance on determining the appropriate strain rate to prevent the build-up of pore pressure is provided in ASTM D6243/D6243M.

****

Perform mid-plane and interface shear strength testing in accordance with ASTM D6243/D6243M. Submit mid-plane and interface shear strength test results at least [14][_____] calendar days prior to GCL shipment. Include the final moisture content of the GCL at the center of each specimen with the test results. Submit modifications to the test procedures described in this Section for approval prior to use.

2.4.2.1 Internal Shear Strength Testing

Perform [one set][[_____] sets] of internal shear tests. Conduct tests using the conditions specified in Table 2.

TABLE 2 - Internal Shear Strength Testing	
Material(s) for which shear will be	1 - [_____] 2 - [_____]
Side or characteristics for the side of material to be tested at the	1 - [_____] 2 - [_____]

TABLE 2 - Internal Shear Strength Testing	
Orientation of material	1 - [Machine Direction][Cross Direction][N/A] 2 - [Machine Direction][Cross Direction][N/A]
Soil Interface Compaction Density and Moisture Content (MC) (Note 1)	[Lightly Compacted] [Specified Density = [_____] kN/m3 [_____] lb/ft3] [As-received MC][Specified MC = [_____] percent] [Based on ASTM D698 test results: Maximum Dry Density = [_____] kN/m3 [_____] lb/ft3, Optimum MC = [_____] percent] [Based on ASTM D1557 test results: Maximum Dry Density = [_____] kN/m3 [_____] lb/ft3, Optimum MC = [_____] percent] If compaction unit weight and moisture content for soil placement based on ASTM D698 or ASTM D1557 test results, compaction [_____] percent of maximum dry unit weight and Moisture Content [optimum water content][plus [_____] percent relative to optimum][minus [_____] percent relative to optimum]
Conditioning of GCL	[Hydrated] [Partially hydrated to [_____] percent Water Content] [Wetted by pouring water over entire specimen] [Wetted by spraying water over entire specimen]
If GCL hydrated under applied normal load other than test normal load prior to application of test normal load	Normal load = [_____] kPa [_____] psi Minimum duration = [_____] hours
Conditioning of Other Geosynthetic Materials	[Wetted by pouring water over entire specimen] [Wetted by spraying water over entire specimen] [As-received]
Shear Test Normal Loads (Note 2)	[_____], [______],[_____], [______], [_____] kPa [_____], [______],[_____], [______], [_____] psi
List if there is a specified Normal Load Application Sequencey to be applied	[_____] hours
Interface saturation condition	[Inundated with Water - Interface is submerged in water prior to consolidation and through duration of shear][Spray Wetted - The interface is wetted using a spray bottle during placement of specimens, but not submerged in water][Dry - No addition of water during placement of specimens or shear]
Settling/Consolidatio time under test normal load prior to shearing	[_____]

TABLE 2 - Internal Shear Strength Testing	
Shear displacement rate	[0.1][_____] mm per minute [0.004][_____] inches per minute
Other test instructions	Provide free drainage along both sides of the GCL to aid in hydration. Do not relieve the normal stresses prior to or during shearing of the specimens. Run tests until peak strength is determined. Use [tap water][_____] for testing. [_____]
Note 1: Over-sized corrected test values from ASTM D698 and ASTM D1557 are typically not applied in calculating compaction density and moisture content as gradations minus 19.5 mm 0.75 in sieve of soil sample are used due to dimensions of most shear boxes. If requesting use of rock correction values to be applied, indicate so. Note 2: The normal loads selected should bracket the design normal loads being evaluated.	

2.4.2.2 Interface Shear Strength Testing

Perform [one set][[_____] sets] of interface direct shear tests on both interfaces of the GCL. Conduct tests using the conditions specified in Table 3. Place the other side of the GCL against the interface material on which the test will be run. Keep the interface material in place during hydration, consolidation, and shearing.

TABLE 3 - Interface Shear Strength Testing Properties	
Material(s) for which shear will be	1 - [_____] 2 - [_____]
Side or characteristics for the side of material to be tested at the	1 - [_____] 2 - [_____]
Orientation of material	1 - [Machine Direction][Cross Direction][N/A] 2 - [Machine Direction][Cross Direction][N/A]

TABLE 3 - Interface Shear Strength Testing Properties

Soil Interface Compaction Density and Moisture Content (MC) (Note 1)	[Lightly Compacted] [Specified Density = [_____] kN/m3 [_____] lb/ft3] [As-received MC][Specified MC = [_____] percent] [Based on ASTM D698 test results: Maximum Dry Density = [_____] kN/m3 [_____] lb/ft3, Optimum MC = [_____]percent] [Based on ASTM D1557 test results: Maximum Dry Density = [_____] kN/m3 [_____] lb/ft3, Optimum MC = [_____]percent] If compaction unit weight and moisture content for soil placement based on ASTM D698 or ASTM D1557 test results, compaction [_____] percent of maximum dry unit weight and Moisture Content [optimum water content][plus [_____] percent relative to optimum][minus [_____] percent relative to optimum]
Conditioning of GCL	[Hydrated] [Partially hydrated to [_____] percent Water Content] [Wetted by pouring water over entire specimen] [Wetted by spraying water over entire specimen] [As-received]
If GCL hydrated under applied normal load other than test normal load prior to application of test normal load	Normal load = [_____] kPa [_____] psi Minimum duration = [_____] hours
Conditioning of Other Geosynthetic Materials	[Wetted by pouring water over entire specimen] [Wetted by spraying water over entire specimen] [As-received]
Shear Test Normal Loads (Note 2)	[_____], [______],[_____], [______], [_____] kPa [_____], [______],[_____], [______], [_____] psi
List if there is a specified Normal Load Application Sequence to be applied	[_____]
Interface saturation condition	[Inundated with Water - Interface is submerged in water prior to consolidation and through duration of shear][Spray Wetted - The interface is wetted using a spray bottle during placement of specimens, but not submerged in water][Dry - No addition of water during placement of specimens or shear]
Settling/Consolidatio time under test normal load prior to shearing	[_____] hours
Shear displacement rate	[1][_____] mm per minute [0.04][_____] inches per minute

TABLE 3 - Interface Shear Strength Testing Properties	
Other test instructions	Provide free drainage along both sides of the GCL to aid in hydration. Do not relieve the normal stresses prior to or during shearing of the specimens. Run tests until a minimum total displacement of [50][_____] mm [2][_____] inches is reached. Use [tap water][_____] for testing.
Note 1: Over-sized corrected test values from ASTM D698 and D1557 are typically not applied in calculating compaction density and moisture content as gradations minus 19.5 mm 0.75 in sieve of soil sample are used due to dimensions of most shear boxes. If requesting use of rock correction values to be applied, indicate so. Note 2: The normal loads selected should bracket the design normal loads being evaluated.	

2.4.3 Product Acceptance

****

NOTE: The testing required in this paragraph and subparagraphs occurs at the project site. Some technical documents refer to this type of testing as "conformance testing". The need for and amount of CQC testing performed by the CQC laboratory should be determined on a site specific basis. Permeability and tensile strength tests are often performed at a reduced frequency in comparison to the mass per unit area test referenced in this paragraph. Daniel and Koerner (2007) presents an alternative approach to specifying testing frequencies on the basis of amount of GCL received.

****

2.4.3.1 Product Acceptance Samples

Collect CQC Product Acceptance samples at approved locations upon delivery to the site. Collect, package, and transport samples in accordance with ASTM D6072/D6072M and this paragraph. Identify samples with a waterproof marker; include the date and other information as specified in ASTM D6072/D6072M. Collect samples by cutting the full-width of the GCL sheet a minimum of 1 meter 3 feet wide in the machine direction. Collect and label an additional [610 by 610][_____] mm [24 by 24][_____] inch CQA Product Acceptance Sample and submit to the Contracting Officer each time CQC Product Acceptance samples are collected.[Collect all CQC and CQA Product Acceptance samples with the [Contracting Officer][_____] present].

2.4.3.2 Product Acceptance Tests

Provide CQC Product Acceptance samples to the CQC laboratory for testing as required in Table 4. Based on testing results, reject rolls and complete supplemental testing as described in paragraph MANUFACTURING SAMPLING AND TESTING.

TABLE 4 - PRODUCT ACCEPTANCE TESTS		
Property	Test Method	Test Frequency
Bentonite Mass per Unit Area	ASTM D5993	[once per [10,000][_____] square meters [100,000][_____]
Swell Index	ASTM D5890	[once per [10,000][_____] square meters [100,000][_____]
Flux	ASTM D5887/D5887M	[once per [10,000][_____] square meters [100,000][_____]
Internal Shear Strength	ASTM D6243/D6243M	[once per [10,000][_____] square meters [100,000][_____]
Peel Strength (1)	ASTM D6496/D6496M	[once per [4,000][_____] square meters [45,000][_____] square feet] [_____]
Tensile Strength, MD	ASTM D6768/D6768M	[once per [10,000][_____] square meters [100,000][_____]
[_____]	[_____]	[_____]
(1) Peel Strength testing is not applicable for a non-reinforced GCL.		

PART 3 EXECUTION

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NOTE: Designers may wish to consult ASTM D6102 Standard Guide for Installation of Geosynthetic Clay Liners when using this UFGS section. ASTM D6102 is not written in a way that it can wholly replace a project specification, but it does provide useful information and refences as well as example GCL penetration details and CQA checklists. The execution concepts discussed in the 2023 version of that ASTM are substantially addressed in this UFGS section.

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3.1 CERTIFICATES OF SUBGRADE ACCEPTANCE

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NOTE: An example Certificate of Subgrade Acceptance can be found in the USACE Engineering Manual EM 1110-1-4011 Construction Quality Assurance (CQA) Plan - Requirements for Hazardous Waste Landfills. The list of subgrade conditions in this paragraph is written assuming that the GCL is underlain by soil;

if a different subgrade is used such as a geosynthetic, the examination items specified below should be revised (e.g. requirements related to rutting, soil surfaces, etc. will not be necessary).

Guidance from GCL manufacturers indicates that in applications where a GCL is the sole barrier providing containment, subgrade surfaces consisting of granular soils or gravel may not be appropriate due to large void content. Minimum recommended properties of subgrade in this application are greater than 80% of soil finer than 0.25 mm #60 sieve and no particles larger than 25 mm 1 inch. This requirement should be included in a specification section for subgrade preparation, but could also be included in this specification section at the discretion of the Designer.

****

Each day during placement of GCL, the CQC Inspector [and Contracting Officer] and installer must inspect the surface on which GCL is to be placed and certify in writing on a Certificate of Subgrade Acceptance that the surface is acceptable. Examine the subgrade for compliance with the items in the list below. Perform repairs to the subgrade in accordance with paragraph PREPARATION, and at no additional cost to the Government.

a. A project-qualified land surveyor has verified the lines and grades of the subgrade meet project design.

b. All CQC and CQA of the underlying soils or geosynthetics has been completed and results have been accepted by the Contracting Officer.

c. The subgrade is free of irregularities, protrusions, loose soil, ice, standing water, and abrupt changes in grade.

d. The subgrade is not excessively deformed or rutted by construction equipment used to deploy GCL rolls. Ruts should not exceed [25][_____] mm [1][_____] inch in depth.

e. The underlying soil surface (if present) does not contain stones, litter, or organic matter which may be damaging to the GCL. Rocks larger than [13][_____] mm [0.5][_____] inch in diameter and any other material which could damage the GCL must be removed from the surface to be covered with the GCL.

f. If installed on soil, no area of the underlying soil surface is excessively softened by high water content.

g. If installed on soil, no area of the underlying soil surface contains desiccation cracks which may damage the GCL.

3.2 PREPARATION

3.2.1 Subgrade Repair

****

NOTE: Ensure other sections of the specification package adequately address compaction requirements for soil subgrade layers. If the geomembrane is

placed directly on top of a compacted clay layer, reference Section 02 56 13.16 CLAY WASTE CONTAINMENT for repairs/preparation. If the GCL is placed onto a geomembrane, reference Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT.
****

For any subgrade found deficient in accordance with paragraph EXAMINATION, perform repairs in accordance with [Section 31 00 00 EARTHWORK][Section 02 56 13.16 CLAY WASTE CONTAINMENT][Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT][_____].

3.2.2 Anchor Trench

****
NOTE: Anchor trench dimensions are often site-specific and are therefore defined in the project drawings. If that is the case, replace the dimensioning sentences with a reference to the project drawings/plans. Dimensions for a 90 degree anchor trench are included in the paragraph; if other standard anchor trench designs such as a "V" trench or horizontal runout are used instead, replace the dimensions as appropriate.
****

Where anchor trenches are required, place them a minimum of [610][_____] mm [24][_____] inches back from the edge of slopes to be covered. Make anchor trenches a minimum of [610][_____] mm [24][_____] inches deep and [457][_____] mm [18][_____] inches wide. If the anchor trench is excavated in cohesive soil susceptible to desiccation, excavate only the quantity of anchor trench required for placement of GCL in a single day. Remove ponded water from the anchor trench while the trench is open. Round the front edge of the trench so as to eliminate sharp corners that could damage the GCL. Remove loose soil, rocks larger than [13][_____] mm [0.5][_____] inch in diameter, and any other material which could damage the GCL from the surfaces of the trench. Extend the GCL down the front wall and across the bottom of the anchor trench. Use soils for backfill with a maximum particle size of 25 mm 1.0 inch. Compaction and testing requirements are described in [Section 31 00 00 EARTHWORK][_____].

3.3 GCL INSTALLATION

3.3.1 CGL Placement

****
NOTE: An optional requirement is provided for using a rub/slip sheet when placing the GCL. Rub sheets are thin sheets of plastic placed between the GCL and another surface. Rub sheets facilitate movement/placement of the GCL, particularly when the GCL is in contact with a textured geomembrane or other geosynthetic.
****

At least [seven][_____] calendar days prior to placement, submit GCL manufacturer's installation instructions detailing the following:

a. Penetration completion methods.

b. Acceptable temporary ballasting methods.

c. Seam overlap dimensions.

d. Accessory bentonite placement rates.

e. Method(s) of securing repair patches to underlying GCL.

Complete GCL placement in accordance with the GCL manufacturer's installation instructions and this paragraph. Install GCL as soon as practical after completion and approval of the subgrade. Deliver rolls to the work area in their original packaging. Immediately prior to deployment, carefully remove the packaging without damaging the GCL. If the subgrade is soil, construction equipment may be used to deploy GCL. If the subgrade is a geosynthetic, deploy GCL by hand or by use of approved light weight equipment with pneumatic tires which will not damage the underlying geosynthetic. Do not operate equipment on the top surface of the GCL. On side slopes, anchor GCL at the top and deploy down the slope to minimize wrinkles. Minimize dragging of GCL panels over the ground surface.[Deploy a [rub][slip] sheet (e.g. 0.50 mm 20 -mil smooth HDPE) when placing the GCL and carefully remove the rub sheet to avoid shifting the geomembrane once the geomembrane is in place.] Lay deployed GCL panels flat on the subgrade surface, with no wrinkles or folds.

3.3.2 Seams

****

NOTE: The geomembrane portion of geomembrane-backed GCLs may be seamed/welded together. Refer to Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT for geomembrane seaming requirements. The Designer may wish to consult GSI GRI GCL6 Practice for Field Seaming of Overlapped Geosynthetic Clay Liners (GCLs).

****

Completely unroll and layout adjacent GCL [panels][sheets] before performing field seaming. On side slopes, place GCL with seams oriented parallel to the line of maximum slope and free of tension or stress upon completion of installation. Position panels with the overlap recommended by the manufacturer, but not less than 150 mm 6 inches for panel sides or 500 mm 20 inches for panel ends. Remove soil or other foreign matter from the overlap area immediately prior to seaming. If recommended by the manufacturer, place accessory bentonite along the entire overlap width at a minimum rate of 0.37 kg/linear meter 0.25 lbs./linear foot or as recommended by the manufacturer. Use construction adhesive or other approved seaming methods recommended by the manufacturer for horizontal seams on slopes. Construct overlaps which occur on slopes with the up slope GCL shingled over the down slope GCL. Alternate seaming methods approved by the manufacturer may be proposed.

3.3.3 Penetrations

Install penetrations (e.g., pipe vents, boots, sleeves) as shown on the drawings and in accordance with any manufacturer's recommendations. Place dry bentonite or bentonite paste around the penetration as recommended by the GCL manufacturer.

3.3.4 Defects and Repairs

Repair holes, tears, or other defects in GCL by placing a patch of the same GCL extending a minimum of 305 mm 12 inches beyond the edges of the hole or tear on all sides. If recommended by the manufacturer, apply accessory bentonite in the overlap area. Secure patches to the underlying GCL with a construction adhesive or other approved methods as recommended by the manufacturer. Remove and replace GCL which has been hydrated prior to being covered by an overlying geomembrane or a minimum of 305 mm 12 inches of cover soil.

3.4 FIELD QUALITY CONTROL

3.4.1 Visual Inspection and Evaluation

Immediately prior to covering or at the end of each day GCL is installed (whichever comes first), the CQC inspector[and Contracting Officer] must[will] visually inspect the GCL, seams, and non-seam areas for defects, holes, evidence of hydrated GCL, proper orientation of the GCL (top and bottom sides), seaming practices, or damage due to weather conditions or construction activities. Hydrated GCL is defined as having become soft as determined by squeezing the material with finger pressure or material which has exhibited swelling. At the Contracting Officer's or the CQC inspector's discretion, the surface of the GCL must be brushed or blown by the installer if the quantity of dust, mud, or foreign material inhibits inspection or functioning of the overlying material. Repair each location where defects are identified in accordance with paragraph DEFECTS AND REPAIRS. Submit a Visual Inspection and Evaluation report for each day that GCL is installed.

3.5 PROTECTION AND COVERING

3.5.1 Protection

Unpack and install only those GCL panels which can be anchored and covered in the same day. If exposed GCL cannot be permanently covered before the end of a working day, temporarily cover with plastic or other waterproof material to prevent hydration. Ballast the temporary cover and ensure that water cannot enter from the sides. Do not leave any tools or equipment on the GCL after active work ceases in the area.

3.5.2 Covering

****

NOTE: This paragraph should be modified or removed if the GCL will be covered by another geosynthetic layer.

Generally, cover soil should have a maximum particle size of 25 mm1 inch or less. The required maximum particle size should be based on design and compatible with the manufacturer's recommendations. Final thickness of cover soil is typically at least 305 mm1 foot thick to provide confining stress, eliminate the potential for seam separation, and prevent damage from equipment, soil erosion, etc.

In cases where a non-aqueous liquid (i.e. jet fuel, gasoline, etc.) is being contained by the GCL, it

may be necessary to hydrate the GCL with water prior to use. Hydration may be accomplished by introducing water into the containment area either by flooding or by the use of sprinklers. The GCL supplier should be contacted for specific procedures if manual hydration is necessary.

****

Do not cover GCL prior to inspection and approval by the CQC Inspector [and Contracting Officer]. Use cover soil that is free of angular stones or other foreign matter which could damage the GCL. A maximum particle size of the cover soil greater than [25][_____] mm [1][_____] inch is unacceptable. Do not drop cover soil directly onto the GCL from a height greater than 1 meter 3 feet. Push the soil out over the GCL in an upward tumbling motion. The direction of backfilling must proceed in the direction of down gradient shingling of GCL overlaps; except that on side slopes, place soil backfill from the bottom of the slope upward. Place cover soil such that soil does not enter the GCL overlap zone and tensile stress are not mobilized in the GCL. Do not operate equipment on the top surface of the GCL. The initial loose soil lift thickness must be [305][_____] mm [12][_____] inches. Use equipment with ground pressures less than 50 kPa 7.0 psi to place the first lift over the GCL. Maintain a minimum of [305][610][915][_____] mm [12][24][36][_____] inches of soil between construction equipment with ground pressures greater than 50 kPa 7 psi and the GCL during the covering process. While placing cover soil do not operate equipment by stopping abruptly, making sharp turns, spinning their wheels, or traveling at speeds exceeding [2.2][_____] m/s [5][_____] mph. Cover soil compaction and testing requirements are described in [Section 31 00 00 EARTHWORK][_____].

3.6 AS-BUILT DRAWINGS

Submit final as-built drawings of the GCL installation. Include panel numbers with a unique identifier that can be linked to the roll number/factory panel number, location of repairs, and penetrations in these drawings.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-02 61 13 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 61 13 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-02 61 13 (February 2025)**

Preparing Activity: USACE **Superseding**
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****

SECTION 02 61 13

EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL
02/25

****

NOTE: This guide specification covers the requirements for excavation, handling, and temporary storage of contaminated material.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: These paragraphs should be edited based on whether the contract will use a single job price, or unit prices. If there is a separate Measurement and Payment Section, edited versions of these paragraphs should be inserted in that section.

The amount of contaminated material to be excavated is often subject to uncertainty due to the difficulty in fully characterizing subsurface conditions prior to excavation. For this reason, single job pricing that is fair to both the

Government and Contractor can be a challenge. One option if using single job pricing is to set the base bid using the best estimate of the amount of contaminated material to be excavated and include options that can be exercised for additional volumes or weights. Coordinate requirements of these paragraphs with the bidding schedule.

****

1.1.1 Measurement

****

NOTE: Options are provided for payment by either volume or weight. If payment is on a weight basis, weights must either be measured on-site using a scale system (provided by the Government or the Contractor) or off-site at the point of disposal (e.g. a landfill).

****

Base measurement for excavation and onsite handling on the[actual number of cubic meters cubic yards of contaminated material in-place prior to excavation. Base determination of the volume of contaminated material excavated on cross-sectional volume determination reflecting the differential between the original elevations of the top of the contaminated material and the final elevations after removal of the contaminated material.][metric tons tons of contaminated material excavated. Use a properly calibrated weighing system to accurately measure the gross (bulk) weight of the contaminated material. Covert the measured gross (bulk) weight of the contaminated material to dry weight based on the[percent moisture content][_____] of representative contaminated material samples. Determine the percent moisture content in accordance with[ASTM D2216][ASTM D4643][ASTM D4959][_____]. Determine moisture content[daily.][for every [500][_____] metric tons tons of excavated contaminated material.]] Base measurement for construction, maintenance, and removal of stockpile areas on the number of square meters square yards of stockpile liner constructed.

1.1.2 Payment

1.1.2.1 Excavation and Handling

Compensation for excavation and onsite handling of contaminated material will be paid as a unit cost. Include any other items incidental to excavation and handling not defined as having a specific unit cost.

1.1.2.2 Stockpiling

Compensation for construction of stockpile areas will be paid for as a unit cost. Include all aspects of grading stockpile areas, preparation of stockpile areas, handling and placing contaminated materials in the stockpiles, maintenance of stockpile liners covers, leachate collection systems, removal of contaminated materials from stockpiles, disposal of stockpile cover materials and liner materials, and all other items incidental to construction of stockpiles in the unit cost.

1.1.2.3 Other Work Items

****

NOTE: If extensive dewatering to facilitate excavation of contaminated materials may be needed, or dewatering quantities are especially uncertain, consider including a separate unit price payment item for dewatering.

****

Payment for other work items not included in the above paragraphs will be included in the payment for the base bid for excavation, handling, and temporary storage of the contaminated materials. The other work items include preparation of submittals, mobilization and demobilization, site preparation, environmental compliance monitoring, health and safety monitoring and controls, and utilities required for the project if approved by the Government as necessary for the project.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM D5434	(2012) Field Logging of Subsurface Explorations of Soil and Rock

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

1.3 SYSTEM DESCRIPTION

****

NOTE: The Designer should include the bracketed text if the amount and type of debris anticipated to be present in the PCB-contaminated soil will not impact the work described in this section and referenced sections. If the amount or type of debris is significant (see Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, for definitions related to debris), this section and associated sections should be edited to indicate how debris will be managed.

****

The work consists of excavation and temporary storage of approximately[cubic meters cubic yards][metric tons tons][_____] of contaminated material[and any debris contained within the contaminated material].

1.3.1 Design Requirements

1.3.1.1 Excavation Work Plan

****

NOTE: The Designer may wish to require the Excavation Work Plan, UFP-QAPP, and any other preconstruction submittals required under this section to be completed concurrently or with all other plans being appendices of one primary plan. This section should be edited to reflect such a requirement if applicable.

****

Submit an Excavation Work Plan within [30][_____] calendar days after notice to proceed. Do not perform work at the site, with the exception of site inspections and surveys, until the work plan is approved. Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Excavation Work Plan. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. No adjustment for time or money will be made if resubmittals of the work plan are required due to deficiencies in the plan. At a minimum, include the following in the work plan:

a. Schedule of activities.

b. Method of excavation and equipment to be used.

c. Shoring or side-wall slopes proposed.

d. Dewatering and Leachate Management Plan which includes: anticipated sources and quantities of water that will enter the excavation, means of removing water from the excavation, means of storage and treatment, discharge requirements, and discharge methods.

e. Storage methods and locations for liquid and solid contaminated material. Provide design details for stockpiles including but not limited to: geomembrane liner and cover, berms, anchors/ballast for cover, vehicle access points, and leachate collection sumps.

f. Haul routes.

g. Decontamination procedures developed in accordance with[Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____].

h. Temporary use areas required for staging equipment and supplies, for temporary storage of excavated materials, or for stockpiles.

1.3.1.2 Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP)

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with the requirements set forth in EPA 505-B-04-900A and using the 2012 UFP-QAPP WKSTS. Submit the UFP-QAPP within [30][_____] calendar days after notice to proceed. Do not perform work at the site, with the exception of site inspection and surveys, until the UFP-QAPP is approved. Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the UFP-QAPP. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. Tailor the content to the requirements of the project and the site conditions. If field analyses methods are used as described in paragraph EXCAVATION, include those field analysis in the UFP-QAPP.

1.3.2 Performance Requirements

****

NOTE: This paragraph provides for two approaches to excavation of contaminated materials. The first approach is to excavate only a fixed volume of contaminated material. This approach could be used in a situation where excavation cannot proceed beyond certain limits, or excavation is being used to target hot-spots of contamination only. If this approach is used, the bracketed text and Table should be deleted. The second approach is to excavate to "clean" soil, using post-excavation

confirmation samples to demonstrate achievement of cleanup goals. Cleanup goals should be determined on a site-specific basis considering the purpose of the excavation, applicable regulations, and other criteria. Ideally, cleanup goals will be defined in a site-specific decision document. Guidance on defining cleanup goals is beyond the scope of this section.

****

Excavate to the limits as shown on the drawings.[When excavation samples collected in accordance with paragraph FIELD QUALITY CONTROL indicate that remaining contaminant concentrations exceed the cleanup goals specified in Table 1, conduct additional excavations to achieve the cleanup goals in the excavation.

TABLE 1 - CLEANUP GOALS FOR EXCAVATION BASE AND SIDEWALLS

CONTAMINANT	TOTAL CONCENTRATION IN EXCAVATION BASE/SIDEWALL
[_____]	[_____] mg/kg
[_____]	[_____] mg/kg
[_____]	[_____] mg/kg

][1.4 PRE-INSTALLATION MEETING

****

NOTE: Delete this paragraph if a separate specification section is developed for the entire project to cover pre-installation meetings and other administrative requirements.

****

Conduct a pre-installation meeting at the jobsite[at least five business days prior to the start of operations on the project][_____]. The pre-installation meeting is to be arranged by the Contractor and is to follow the written pre-installation meeting agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Site Foreman and [Contracting Officer][_____].

Record pre-installation meeting minutes and publish via email within 48 hours to all attendees. The minutes must be re-published within 48 hours via email pending any subsequent comments from the attendees.

]1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Installation Meeting Agenda

Pre-Installation Meeting Minutes; G, [_____]

Excavation Work Plan; G, [_____]

Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP); G, [_____]

Pre-Installation Examination Report

Pre-Construction Equipment Examination

SD-02 Shop Drawings

Surveys

SD-06 Test Reports

Dewatering Performance Records

SD-07 Certificates

Qualifications; G, [_____]

SD-11 Closeout Submittals

Closeout Report; G, [_____]

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

1.6.1.1 Permits and Licenses

****

NOTE: For sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. The permits or permit equivalents may include those addressing air emissions, water discharge, stormwater pollution prevention, and possibly others. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, such as 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, delete this section.

****

Coordinate and obtain all necessary [permits][permit equivalents] prior to the initiation of the relevant activities. Submit documentation of the completed permitting or permit equivalent to the Contracting Officer[as part of the Excavation Work Plan]. Comply with all Federal, state, and local regulations. Obtain the permits, permit equivalents and certifications, and meet the substantive regulatory requirements necessary for the execution of the project. For any of the above-listed items requiring a longer time frame, copies of applications, and scheduled dates for receiving final approval, must be included.

1.6.1.2 Environmental Protection

****

NOTE: This specification section does not attempt to provide comprehensive environmental protection requirements, but rather refers to a separate specification section that would be prepared using UFGS Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. Specific technical considerations for excavation projects are discussed below.

An air pathway analysis should be performed during design to determine what air monitoring and controls are required. Guidance on air pathway analyses is provided in EP 200-1-24 Air Pathway Analysis for the Design of Hazardous, Toxic, and Radioactive Waste (HTRW) Remedial Action Projects. Specify perimeter air monitoring requirements in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

UFGS Section 01 57 19 provides information related to regulations of spills including notification and

response requirements. Spills on excavation projects can occur due to releases from equipment, fuel storage tanks, etc. Excavated materials can also be inadvertently spilled during transport between the excavation and storage locations. Lastly, although not directly related to spills, excavation projects have the potential to encounter unanticipated materials such as buried tanks, containers, munitions and explosive constituents, etc. An environmental protection plan prepared under Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS should include provisions for managing both spills and encountering unanticipated materials.

****

Develop and implement environmental protection requirements in accordance with[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____].

1.6.2 Qualifications

****

NOTE: Requirements for the Contractor's experience should be determined and specified based on the experience and availability of Contractors in the area as well as the complexity of the project. An option is included to require the Contractor to demonstrate experience with excavation of regulated hazardous waste/material. The Designer could also edit the option text to list specific contaminants applicable to the project.

****

1.6.2.1 Contractor Experience

Submit evidence of successful completion of at least [1][_____] project of comparable size and scope[for materials contaminated with[RCRA hazardous wastes][CERCLA hazardous material][_____]].

1.6.2.2 Key Personnel

Provide key personnel with a minimum of [3][_____] years of excavation field experience. Include the Site Foreman, quality control personnel, and supervisory engineering and technical staff involved with operation in key personnel. Perform all survey work under the supervision of a registered land surveyor licensed in the[applicable jurisdiction][State of [_____]]. Submit a list of these personnel with their qualifications.

1.6.2.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting the requirements of[Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.7 [PROJECT][SITE] CONDITIONS

1.7.1 Environmental Requirements

****

NOTE: Revise this paragraph if requirements are provided in other specification sections, health and safety plans, environmental permits/permit equivalents, etc. The conditions described in the following paragraph represent challenges to environmental protection (winds causing dust, rain causing stormwater contamination), saturation of excavated materials (rain), or site damage (saturated soils).

****

Do not conduct excavation or handling of contaminated materials in the following conditions: [wind speeds in excess of [50][_____] kilometers [30][_____] miles per hour,][moderate rain greater than [5][_____] mm [0.2][_____] inches per hour,][saturated soils caused by recent [rains][snowmelt] such that equipment traffic would cause excessive rutting or damage].

1.7.2 Existing Conditions

****

NOTE: Include any pertinent information regarding project/site conditions in this paragraph, the appendices to the specifications, or on the drawings. If the contaminated material to be excavated contains a significant amount of debris, the available information about its extent and characterization should also be provided. Indicate the detail to which site characterization has been performed and indicate where obvious data gaps exist. The following information should be shown on the project drawings (unless the Contractor is required to develop any aspects of the project design under a performance-based project):

a. Overall site plan, borrow areas, stockpile areas, storage areas, security requirements, special shoring requirements, boring logs, and access routes.

b. Individual site plans of each area of contamination with site features such as buildings, roads, utilities, topography, trees, shrubs, surface conditions, etc.

c. Limits of pavement removal, fence removal, and the location of ancillary equipment to be removed.

****

The existing site conditions are presented[in Appendix [_____]][and][on the Drawings]. These include[physical configuration][utilities][topography][land uses][groundwater depth][geotechnical characteristics of the contaminated materials (including[grain size analysis][pH][moisture content][density][porosity])[hydrogeology][nature and extent of contamination][_____]]. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions could occur. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within [48 hours][_____] if discrepancies between the data provided and actual field conditions are discovered.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Backfill

****

NOTE: If Section 31 00 00 EARTHWORK is not in the project, backfill information can be copied from that section and edited as appropriate.

The paragraph ENVIRONMENTAL REQUIREMENTS FOR OFF-SITE SOIL in Section 31 00 00 EARTHWORK should be edited to include an appropriate list of chemical testing parameters for off-site soil. Some backfill sources may have chemical testing data already available; the Government should require chemical testing if the backfill chemical testing data is inadequate or does not exist. Off-site backfill should not be tested for only the site contaminants of concern. At a minimum, samples should be analyzed for target contaminant list (TCL) VOCs, TCL SVOCs, target analyte list (TAL) Metals, and Pesticides/PCBs. Additional analyses such as Total Petroleum Hydrocarbons may be appropriate also. Individual States or military installations may require or recommend additional parameters. Typical frequency of sampling would be one sample per 1,900 to 2,300 cubic meters 2,500 to 3,000 cubic yards. However, individual States or military installations may require or recommend more frequent or less frequent sampling.

In many cases, the degree of engineering control of the materials used as backfill may not need to be as stringent as described in Section 31 00 00 EARTHWORK. In other cases, such as under pavements, special compaction and material requirements may apply and the specifications will need to address these special requirements.

At some sites, previously contaminated material which has been removed from the excavation is reused as backfill following treatment to remove the contaminant of concern.

****

Provide backfill in accordance with[Section 31 00 00 EARTHWORK][_____].

2.1.2 Topsoil

****

NOTE: If Section 31 00 00 EARTHWORK is not in the

project, topsoil information can be copied from that section and edited as appropriate. Section 31 00 00 EARTHWORK includes a provision to strip existing on-site topsoil for re-use. The project specifications should only allow that practice if topsoil has been tested or will be tested to confirm that it is not considered contaminated.

****

Provide topsoil in accordance with the requirements in[Section 31 00 00 EARTHWORK][_____]. Stripping existing topsoil for re-use on-site[is][is not] allowed.

2.1.3 Geomembrane

****

NOTE: If Section 02 56 13.16 GEOMEMBRANE WASTE CONTAINMENT is not in the project, geomembrane material information can be copied from that section and edited as appropriate.

Scrim reinforced geomembranes are commonly specified for stockpile covers and liners. Due to their higher strength properties, scrim reinforced geomembranes can generally be thinner than non-reinforced geomembranes. For bottom liners, a commonly used minimum thickness is 0.5 mm (20 mils) for non-reinforced geomembrane and for scrim reinforced geomembranes a common minimum weight is 20 kg/100 square meter (40 lbs./1000 square feet). For stockpile cover geomembranes, a commonly used minimum thickness is 0.25 mm (10 mils) for non-reinforced geomembrane and for scrim reinforced geomembranes a common minimum weight is 13 kg/100 square meter 26 lbs./1000 square feet.

Section 02 56 13.16 GEOMEMBRANE WASTE CONTAINMENT includes substantial levels of effort for construction quality control and construction quality assurance (CQC/CQA) that are meant to ensure performance when geomembranes are used in long-term applications like a landfill. For use of geomembranes in temporary stockpiles of contaminated soils, the designer should consider reducing the level of CQC/CQA in Section 02 56 13.16 GEOMEMBRANE WASTE CONTAINMENT. Specific CQC/CQA requirements that could be reduced include Qualifications, requirements for Layout and Detail Drawings, Tests/Inspections/Verifications of materials conducted off-site, and on-site CQA/CQC of Field Seams. Reduced material requirements for temporary applications of geomembranes can also be considered; instead of using HDPE geomembranes that are 1 mm (40 mil) or greater (typical for landfills), other materials such as PVC may be appropriate.

****

Provide geomembranes for lining [and][or] covering contaminated material stockpiles. Provide geomembranes in accordance with[Section 02 56 13.16

GEOMEMBRANE WASTE CONTAINMENT][_____].

2.2 EQUIPMENT

2.2.1 Scales

****

NOTE: This paragraph is primarily intended to ensure that calibrated scales are being used to weigh excavated contaminated material, when weight is being used as the basis for measurement and payment. If off-site scales will be used (e.g. at a weighing station or disposal facility), this paragraph can be deleted.

****

Provide scales of sufficient length to permit simultaneous weighing of all axle loads and with an accuracy within 0.2 percent throughout the range of the scales. Ensure the scale's accuracy conforms to the applicable requirements of NIST HB 44 and is certified[by an acceptable scales company representative][by an inspector of the State Inspection Bureau charged with scales inspection within the state in which the project is located] prior to weighing any excavated contaminated material.[Locate the scales at the site of work.][Ensure the scales are capable of printing a weight ticket including time, date, truck number, and weight.] Perform a check of calibration of measuring equipment prior to initial use, and once every [7][_____] calendar days. The requirements of this paragraph do not apply to measurement of chemical data.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Surveys

****

NOTE: If payment for the project is based on a single job price or based on weight of material exported/imported from the site, then a highly accurate survey by a registered land surveyor may not be necessary. A lower level of effort in these cases could be to require the Contractor to survey only the excavation, using a handheld, sub-meter accurate GPS unit.

****

Perform surveys immediately prior to and after excavation of contaminated material to determine the volume of contaminated material removed. Provide cross-sections on [7.6][_____] meter [25][_____] foot intervals and at break points for all excavated areas. Survey and show locations of confirmation samples on the drawings. Perform surveys in accordance with Section: [_____].

3.1.2 Conditions

Conduct a pre-installation examination of the on-site infrastructure, utility conduits, monitoring points, site access constraints, and infrastructure. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-excavation conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would potentially have significant impacts on excavation and public safety. Submit a Pre-Installation Examination Report documenting the examination activity. Obtain all necessary utility clearances before initiation of subsurface work.

3.1.3 Pre-Construction Equipment Examination

Conduct a pre-construction examination of the excavation equipment for any damage, defect, and dilapidation. Submit the results of the pre-construction examination to the Contracting Officer for review and information. The Contracting Officer may conduct an independent examination to ascertain the condition and functionality of the equipment. Based on this examination, the Contracting Officer has the right to reject any damaged, defective or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection must be borne by the Contractor. Routinely and properly inspect and maintain the equipment to provide the project execution as required by the contract schedule. Any schedule delay and cost associated with power failure, improper functioning of equipment and controls, unavailability of labor and materials, etc., must be the responsibility of the Contractor.

3.2 PREPARATION

3.2.1 Mobilization

****

NOTE: Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES includes requirements for decontaminating equipment that has been used in contaminated zones. That section should be modified to extend decontamination/cleaning requirements to equipment being brought on-site to cover the requirements of this paragraph.

****

Do not mobilize to the site until the [Excavation Work Plan][_____] has been approved by the Contracting Officer and the Contractor has received written confirmation. Delays caused by the Contractor's failure to meet regulatory requirements must result in no additional cost to the Government. In accordance with[Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____], the equipment which is rented [and][or] previously used for other site remediation must be decontaminated and tested for contaminants of concern before being brought to the site.

3.2.2 Clearing

****

NOTE: Grubbing is typically not required at sites where contaminated soil is being excavated for treatment and/or disposal. Typically, vegetation that is cut off above a certain height is defined as clean and any stumps and brush below this height are defined as contaminated.

****

Perform clearing to the limits[shown on the drawings][defined in the Excavation Work Plan][_____] in accordance with[Section 31 11 00 CLEARING AND GRUBBING][_____].

3.3 CONTAMINATED MATERIAL REMOVAL

Notify the Contracting Officer [_____] calendar days prior to the start of excavation of contaminated material. The [Contracting Officer][Contractor] is responsible for contacting regulatory agencies in accordance with the applicable reporting requirements.

3.3.1 Excavation

****

NOTE: For large excavations, more than one excavation log may be required.

When the intent of excavation is to remove all contamination exceeding cleanup goals, the use of onsite field screening or field analysis (supported at a prescribed frequency by fixed laboratory analysis) should be encouraged to avoid prolonged delays or equipment downtime. Optional text is provided for using field screening/field analysis. Common field analytical tools include handheld X-ray fluorescence (XRF) analyzers for measuring metals concentrations, photoionization detector (PID) or flame ionization detectors (FID) for measuring volatile organics, and various field screening kits for measuring individual chemicals or groups of chemicals.

****

Excavate areas of contamination to meet the requirements in paragraph PERFORMANCE REQUIREMENTS.[After all material suspected of being contaminated has been removed, examine the excavation for evidence of contamination. If the excavation appears to be free of contamination, use field analysis to determine the presence of contamination using[a real time vapor monitoring instrument][X-ray fluorescence analyzer][immunoassay field kits][_____]. Calibrate and use field analysis equipment in accordance with manufacturer instructions[and the UFP QAPP]. Excavate additional material as directed by the Contracting Officer.] Maintain an excavation log describing visible signs of contamination encountered for each area of excavation. Prepare excavation logs in accordance with ASTM D5434.

Use methods and equipment that result in minimal disturbance to remaining soil beyond the excavation limits. Remove and dispose of any material that becomes contaminated as a result of the Contractor's operation at no additional cost to the Government. Stage operations to minimize the time the contaminated soil is exposed to the weather .

3.3.2 Shoring, Sloping, or Bracing

Implement shoring, sloping, bracing, or any other excavation health and safety requirements in accordance with[Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS][_____].

3.3.3 Dewatering

****

NOTE: Dewatering can significantly increase the cost of a project involving the excavation of contaminated material and should be carefully considered during design. UFC 3-220-05 Dewatering and Groundwater Control provides guidance on the design of dewatering systems.

If water from dewatering operations will be allowed to discharge onto the ground, a National Pollutant Discharge Elimination System (NPDES) permit for dewatering may be required (see Paragraph REGULATORY REQUIREMENTS Designer's Note for more details on permits). Reference the permits paragraph of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS for permit requirements.

Note that Section 31 00 00 EARTHWORK also includes dewatering requirements, but they are limited in scope and do not include any consideration of collection, treatment, sampling, or discharge of contaminated waters. If Section 31 00 00 EARTHWORK is included in the project, either delete dewatering requirements from that section or cut and paste the dewatering requirements from this section into Section 31 00 00.

****

Divert surface water to prevent entry into the excavation.[Limit dewatering to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met.][Do not perform dewatering without prior approval of the Contracting Officer.] Conduct dewatering in accordance with the Dewatering and Leachate Management Plan developed as part of the Excavation Work Plan.

[3.3.3.1 Collection and Disposal of Incidental Contaminated Water

****

NOTE: Determine appropriate disposal method. Choose this paragraph when significant quantities of groundwater will not be encountered and only small amounts of rinse and other contaminated waters are expected.

****

Collect rinsewater. Collect ground, surface, and rain water contaminated by operations including water collected in the open excavation pit or temporary containment. Soak up with absorbent material so that no free liquid is present. Containerize, sample, and analyze contaminant absorbed material and dispose of as specified for contaminated soils.

][3.3.3.2 Collection, Treatment, and Discharge of Contaminated Water

****

NOTE: Choose these paragraphs when groundwater will be encountered or when significant amount of rinse

water or other contaminated water is expected, and on-site treatment is allowed. Typical treatment system consists of particulate/suspended solids removal by various means such as settling or filtration and contaminant removal by carbon filtration. Location of discharge for water after it is treated must be coordinated and approved by appropriate (EPA, State, station, local, and regional) authority.

Another option to consider is to containerize liquid and haul to off-site publicly-owned treatment works (POTW) with pretreatment capability, however this can be extremely costly for large quantities of water. Use unit pricing, assumed quantities, or some other method to give Contractor something to base bids on when water is to be taken off site. Where off site facilities are involved, verify such facilities exist, that they are permitted to accept, and that they will accept the liquid waste stream. Specification will require modifying for site specific requirements.

****

Furnish labor, materials, and equipment necessary for collecting, treating, and discharging of contaminated surface and subsurface water in excavations at the site. Conduct excavation and backfilling operations at the site in a manner that minimizes the amount of surface and subsurface water which may collect in the open excavation. Collect standing surface water in contact with contaminated material.

3.3.3.2.1 Subsurface Drainage

Remove water by pumping or other methods to prevent softening of surfaces exposed by excavation. Provide water treatment necessary to treat water to levels specified in the Dewatering and Leachate Management Plan. Operate dewatering system continuously until construction work below static water levels is complete. Submit Dewatering Performance Records weekly. Measure and record performance of the dewatering system at the same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system.

3.3.3.2.2 Treatment System Requirements

The Contractor is responsible for all aspects of verifying design parameters designing, providing, installing, operating, maintaining, and removing collection, storage, and treatment facilities as required to discharge treated waters within the treatment limits required. The treatment system must:

a. Be capable of removing contaminants to below the limit defined in the Dewatering and Leachate Management Plan for contaminated water.

b. Include effluent holding tanks designed to allow on-site testing of water quality prior to discharge.

c. Include recycle capability for retreatment of effluent not meeting the discharge requirements of this specification, as determined by on-site testing.

3.3.3.2.3 Treatment System Operations

Monitor, test, and adjust the treatment system in accordance with the Dewatering and Leachate Management Plan[and [UFP-QAPP][and basewide QAPP][_____]], or as otherwise modified by special regulatory requirements. If there is a conflict between requirements, the more stringent requirement prevails.

3.3.3.2.4 Discharge of Treated Water

Do not discharge any water until tests results show water is below contaminated water limits as specified in the Dewatering and Leachate Management Plan. Provide erosion control at outlet of piping to minimize erosion. Discharge treated water to the [_____].

3.3.3.2.5 Cleanup and Removal of Treatment System

Upon completion of work, close and remove from the site the surface water and groundwater treatment system. Decontaminate equipment in accordance with the[Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____]. Containerize, sample, test, and dispose of carbon, residues, cleaning aids, decontamination liquids, and waste as specified for the contaminated soils.

]3.3.4 Contaminated Material Storage

****

NOTE: For CERCLA sites, permits are not required to store hazardous waste in a stockpile. However, storage structures and conditions must be in compliance with the Applicable, Relevant, and Appropriate Regulations (ARARs). For RCRA sites, permits are required to store hazardous waste in a stockpile. However, for RCRA sites, hazardous waste can be stored in a drum or roll-off unit for up to 90 days without a permit.

For temporary storage of more than 90 days, dual containment of hazardous liquid and some hazardous solids may be required. Containment system requirements are described in 40 CFR 264.175. For stockpiles that meet the definition of a waste pile, see 40 CFR 264.250.

To provide secondary containment, tanks and roll-off units are sometimes stored on lined areas similar in design to what is described in paragraph Contaminated Material Stockpiles.

****

Place material in temporary storage[immediately after excavation][after treatment while awaiting test results]. The following paragraphs describe acceptable methods of material storage. Provide storage units that are in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, clearly label each unit with an identification number and keep a written log to track the source of contaminated material in each temporary storage unit.

3.3.4.1 Contaminated Material Stockpiles

****

NOTE: Check state regulations to determine the minimum requirements for stockpiles and modify this paragraph accordingly. For contaminated material with high moisture content, the subgrade for the stockpile must be sloped and a sump should be provided.

For post treatment stockpiles, chemical testing is usually required to determine if material is contaminated or clean. Maximum stockpile size should be based on the required frequency of chemical testing. For example, if chemical tests are required at a frequency of one per 1,000 cubic meters cubic yards, then stockpiles should be no greater than 1,000 cubic meters cubic yards in size.

As noted in paragraph GEOMEMBRANE, the Designer may wish to reduce the level of CQC/CQA requirements if using Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT as the requirement for installation of the stockpile bottom liner.

****

Construct stockpiles to isolate stored contaminated material from the environment. Cover stockpiles at the end of each workday. Stockpile size greater than [_____] cubic meters cubic yards is prohibited. Construct stockpiles to include:

a. [Place a geomembrane liner on a ground surface that is free of rocks greater than 13 mm 0.5 inches in diameter and any other object which could damage the membrane. Where multiple geomembrane panels are necessary to construct the liner, seam the panels together and test the seams in accordance with[manufacturer requirements][Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT]][Use pavement as the liner system. Construct pavement in accordance with Section [_____]].

b. Place a geomembrane cover over the stockpiles. Extend the cover material over the berms and anchor or ballast to prevent it from being removed or damaged by wind. Where multiple geomembrane panels are necessary to construct the cover, shingle the upslope panel over the downslope panel and overlap the panels at least [150][_____] mm [6][_____] inches. Secure the panels together using[ballast such as sandbags or tires][adhesives][thermal fusion seams][_____].

c. Construct berms surrounding the stockpile, a minimum of 300 mm 12 inches in height. Berm vehicle access points.

d. Slope the liner system to allow collection of leachate. Construct sumps to facilitate removal of leachate from the stockpile. Store and remove liquid which collects in the stockpile, in accordance with paragraph[COLLECTION AND DISPOSAL OF INCIDENTAL CONTAMINATED WATER][COLLECTION, TREATMENT, AND DISCHARGE OF CONTAMINATED WATER].

3.3.4.2 Roll-Off Units

Use water-tight roll-off units to temporarily store contaminated material. Place a cover over the units to prevent precipitation from contacting the stored material. Remove liquid which collects inside the units and store in accordance with paragraph[COLLECTION AND DISPOSAL OF INCIDENTAL CONTAMINATED WATER][COLLECTION, TREATMENT, AND DISCHARGE OF CONTAMINATED WATER].

3.3.5 Backfilling and [Finishing][Finish] Operations

Backfill excavations immediately after all contaminated materials have been removed and confirmation test results have been approved. Conduct backfilling and [finishing][finish] operations in accordance with[Section 31 00 00 EARTHWORK][_____].

3.3.6 Treatment and Disposal of Excavated Contaminated Material

****

NOTE: If excavated contaminated materials will be taken off-site for treatment (if necessary) and disposal, select the first set of bracketed text. If on-site treatment will be used, select the second set of bracketed text and indicate the section(s) that define the onsite treatment.

****

[Perform offsite disposal of excavated contaminated material in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.][Perform treatment of excavated contaminated material onsite in accordance with Section [_____].]

[3.3.7 Closeout Report

****

NOTE: If there is a separate section in Division 01 that defines project close-out documentation, edited versions of this paragraph should be inserted in that section, and this paragraph deleted. In addition to progress photos, video has been used at some sites to record site activities.

****

Submit [_____] copies of a Closeout Report within [60][_____] calendar days of completing work at the site. Label the report with the contract number, project name, location, date, name of general Contractor, and the Government agency contracting for the work. As a minimum, include the following information:

a. A cover letter signed by a[responsible company official][Professional Engineer registered in the State of [_____] who is a responsible company official] certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.

b. A narrative report including, but not limited to, the following:

   (1) site conditions, ground water elevation, and cleanup goals;

(2) excavation logs;

(3) field screening readings;

(4) quantity of materials removed from each area of contamination;

(5) quantity of water/product removed during dewatering;

(6) sampling locations and sampling methods;

(7) sample collection data such as time of collection and method of preservation;

(8) sample chain-of-custody forms; and

(9) source of backfill.

c. Copies of all chemical and physical test results.

d. Copies of all manifests and land disposal restriction notifications.

e. Copies of all certifications of final disposal signed by the responsible disposal facility official.

f. Waste profile sheets.

g. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 15 m 50 feet of excavation, sample locations, and sample identification numbers. Show on-site stockpile, storage, treatment, loading, and disposal areas on the drawings. Provide separate cross-sections of each excavation area before and after excavation and after backfilling, based on survey data.

h. Progress Photographs. Use color photographs to document progress of the work. Take a minimum of four views of the site showing the location of the area of contamination, [entrance][exit] road, and any other notable site conditions before work begins. After work has been started, photographically record [daily][weekly] activities at each work location. Provide photographs including:

(1) Soil removal and sampling.

(2) Dewatering operations.

(3) Unanticipated events such as spills and the discovery of additional contaminated material.

(4) Contaminated material/water storage, handling, treatment, and transport.

(5) Site or task-specific employee respiratory and personal protection.

(6) Fill placement and grading.

(7) Post-construction photographs. After completion of work at each site, take a minimum of four views of each excavation site.

Include a digital version of all photos shown in the report with the Closure Report. Provide photographs with a minimum of 181.11 pixels per cm

300 pixels per inch resolution for all photo files. Provide photos in a lossless compression file format that does not lose any pixels in the compression process (e.g. .TIFF, .PNG, and .GIF). Ensure no loss of original resolution from the raw photo if converted to a lossless format. Create digital images and metadata that meet or exceed the specifications of the Exchangeable Image File Format (EXIF) version [_____][2.3] or higher. In addition to the raw digital photo submissions, submit a PDF document as part of the Closeout Report displaying all required progress or other photos organized into separate documents. Render the photos in the PDF with a resolution that represents the original photo resolution to the human eye. Place photos according to their proper orientation (portrait or landscape). Create an index with bookmarks for each PDF organized by submittal section and suborganized by work area (if applicable) and then by date in the sequence which they were taken.

Process all raw photos for inclusion in the PDF submission with a border including a 13 mm 0.5 inch caption at the base of each photo for descriptive information. Include the following information for each photographic image in the caption:

Project Name
Contract Number
Contractor Name
Date
Station and Offset
Photo Number
Orientation View
Work Element Depicted
General Project Area

]3.4 FIELD QUALITY CONTROL

3.4.1 Tests

3.4.1.1 Sampling Excavations

****

NOTE: The number of confirmation samples must be based on the size of the excavation and regulatory requirements. For small excavations, a minimum of one sample should be taken from near the center of the excavation (or where there is the highest potential for contamination). It may be acceptable to change the number of samples during development of a UFP-QAPP, but the Designer should attempt to establish a reasonable sampling frequency in the specifications to provide a basis for the Contractor to bid the project. Additional samples may be oriented symmetrically relative to the center sample and the limits of the excavation. Incremental sampling should be considered as discussed below.

Many military facilities have base-wide sampling and analysis plans which have been approved by the applicable regulatory agencies. These plans may specify the number of confirmation samples which must be taken.

For larger excavations, EPA 230/02-89-042 Methods of

Evaluation and Attainment of Cleanup Standards provides guidance on the design of statistically based sampling intervals.

With regulator approval, confirmation sampling and analysis may be accomplished using an averaging technique for comparison to cleanup criteria. This is based on the fact that most soil risk exposure scenarios do not model contamination as existing in discrete hot spots but as a more disperse phenomenon. Two ways to accomplish this averaging technique are to take discrete samples and average the data or by using an incremental sampling approach. Incremental sampling has an objective of obtaining a single sample per decision unit for laboratory analysis. Further information on incremental sampling can be found in the Interstate Technology Regulatory Council's Incremental Sampling Methodology (ISM-1), February 2012 and update (ISM-2), October 2020.

Confirmation sampling at a site with radioactive contamination in surface soils or on building surfaces will be performed in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575 Rev-1, EPA 402-R-97-016, Rev-1. This manual is a guide for confirmation survey design (planning) and for data evaluation. Its primary purpose is to acquire legally defensible data concerning the post excavation residual radioactivity at the site to demonstrate that the site meets release criteria.

The sentences regarding additional excavation would not be necessary if the project requirement is to only excavate a fixed volume of contaminated material as discussed in the Performance Requirements paragraph Designer's Note.
****

Collect excavation base and sidewall confirmation samples in accordance with the[UFP-QAPP][basewide QAPP][_____], and this paragraph. Collect confirmation samples at a minimum frequency of one per [_____] square meter square yard from the bottom [and each of the side walls]. Collect a minimum of one sample from the bottom [and each side wall] of the excavation. Collect samples as[discrete grabs][composites][incremental samples][_____]. Analyze samples for the contaminants identified in paragraph PERFORMANCE REQUIREMENTS. Complete all other sampling and analysis activities in accordance with the[UFP-QAPP][basewide QAPP][_____] (including but not limited to sample handling, preservation, transportation, [collection][analysis] of quality control samples, data validation, and data reporting). Any deviations to sampling frequency, number of samples, or sample collection methods must be[established in the approved[UFP-QAPP][basewide QAPP]][approved by the Contracting Officer].[Based on confirmation sample results, propose any additional excavation which may be required to remove material which is contaminated above the cleanup goals defined in paragraph PERFORMANCE REQUIREMENTS. Additional excavation is subject to approval by the Contracting Officer.] Mark locations of samples in the field and document on the as-built drawings.

3.4.1.2 Sampling of Stored Material

****

NOTE: Additional samples are sometimes collected from excavated material to determine the contaminants present prior to treatment or disposal.

Composite samples are often collected from stockpiled material. However, composite samples cannot be taken if the samples are being analyzed for volatile organic contaminants.

At sites with radioactive contamination, ex-situ sampling of excavated material is typically performed to ensure that the material meets disposal facility acceptance criteria and, in some cases, to assist with the preparation of shipping papers. The ex-situ sampling regime is site-specific. It is usually determined in consultation with the disposal facility and its regulatory agency.

****

Collect samples of stored material in accordance with the[UFP-QAPP][basewide QAPP][_____] and this paragraph. Collect samples of stored material at a minimum frequency of once per [_____] cubic meters cubic yards. Collect samples as[discrete grabs][composites][incremental samples][_____]. Complete all other sampling and analysis activities in accordance with the[UFP-QAPP][basewide QAPP][_____] (including but not limited to sample handling, preservation, transportation, [collection][analysis] of quality control samples, data validation, and data reporting). Any deviations to sampling frequency, number of samples, or sample collection methods must be[established in the approved[UFP-QAPP][basewide QAPP]][approved by the Contracting Officer]. Test samples for the following parameters: [_____].

3.4.1.3 Sampling Beneath Storage Units

****

NOTE: At some sites, samples are collected to verify the soil underlying a contaminated material storage unit has not become contaminated due to leachate migration or mixing of contaminated soils with underlying soils .

Sampling along any connecting pipelines that transport contaminated liquid may also be appropriate. A standard practice is to sample at 6 m (20 foot) intervals under piping and at connections such as bends, elbows, or tees.

****

Collect samples from beneath storage units in accordance with the[UFP-QAPP][basewide QAPP][_____] and this paragraph. Collect samples from beneath each storage unit[prior to construction of and] after removal of the storage unit. Collect samples at a minimum frequency of one per each [_____] square meter square yard from a depth interval of [0 to 0.15][_____] meters [0 to 0.5][_____] feet and analyze for the contaminants identified in paragraph PERFORMANCE REQUIREMENTS. Collect samples as[discrete grabs][composites][incremental samples][_____]. Complete all other sampling and analysis activities in accordance with the[UFP-QAPP][basewide QAPP][_____] (including but not limited to sample handling, preservation, transportation, [collection][analysis] of quality control samples, data validation, and data reporting). Any deviations to sampling frequency, number of samples, or sample collection methods must be[established in the approved[UFP-QAPP][basewide QAPP]][approved by the Contracting Officer].

If sample results from beneath storage units exceed the cleanup goals specified in paragraph PERFORMANCE REQUIREMENTS, remove soil which has become contaminated at no additional cost to the Government. Handle contaminated material which is removed from beneath the storage unit in accordance with paragraph TREATMENT AND DISPOSAL OF EXCAVATED CONTAMINATED MATERIAL. As directed by the Contracting Officer and at no additional cost to the Government, perform additional sampling and testing per the requirements of this paragraph to verify areas of contamination found beneath stockpiles have been excavated to below action levels.

3.4.1.4 Government Quality Assurance Testing

****

NOTE: The need for quality assurance testing should be considered on a project-by-project basis, and if not considered necessary this paragraph should be deleted. Factors to consider include whether the Government has access to a laboratory that can analyze quality assurance samples in a timely manner to not delay the project execution. If conducting quality assurance testing, a separate third-party quality assurance contract should be considered based on the qualifications of the Government QA personnel, and the size and importance of the project.

Use of quality assurance testing data also needs to be considered. A relatively straightforward data use is to compare quality assurance sample results to the project performance requirements, and failing result would be treated the same way as a failing Contractor test result. A more complicated data use is to compare results from quality assurance samples and contractor quality control samples for the purpose of determining if there is meaningful disagreement between the results. In this case, procedures would need to be developed for determining when there is a meaningful disagreement between quality assurance and quality control sample results; corrective actions for when a meaningful disagreement was identified would also need to be developed. The process of defining procedures for identifying and correcting meaningful differences should be documented in a project-specific CQA Plan or Quality Assurance Project Plan and referenced in this specification; the process is likely too complex to be adequately defined in this specification.

Two options are provided for defining Government Quality Assurance. The first option is to defer details of the Government QA to a separate CQA Plan. This option would be preferred for large, complex projects where the excavation is one component of a larger process. A second, simpler option is provided to define Government QA testing frequency.

****

[Work will be monitored and tested in accordance with the requirements of the Construction Quality Assurance (CQA) Plan. Be aware of all monitoring and testing activities defined in the CQA Plan and account for these activities in the construction schedule. Quality Assurance testing and monitoring does not relieve the contractor of the responsibility to complete the quality control testing and monitoring defined in this specification section.

][[Provide][The Contracting Officer may provide] duplicate quality assurance samples to the Government's quality assurance laboratory at a frequency of one set of samples per [10][_____] sets of quality control tests performed. Quality assurance samples will be tested for the same parameters as the parent quality control sample. The Contracting Officer may require additional quality assurance tests as a result of failed quality assurance or quality control tests. Account for Government quality assurance testing in the construction schedule. Quality Assurance testing and monitoring does not relieve the contractor of the responsibility to complete the quality control testing and monitoring defined in this specification section.]

3.5 PROTECTION

Do not store or stockpile contaminated materials on excavation areas that have been completed and tested in accordance with paragraph FIELD QUALITY CONTROL.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-02 61 23 (February 2025)**

Preparing Activity: NAVFAC **Superseding**
UFGS-02 61 23 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 02 - EXISTING CONDITIONS

SECTION 02 61 23

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02/25

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-02 61 23 (February 2025)**

Preparing Activity: NAVFAC **Superseding**
UFGS-02 61 23 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 61 23

REMOVAL AND DISPOSAL OF PCB CONTAMINATED SOILS
02/25

****

NOTE: This guide specification covers the requirements for the removal of polychlorinated biphenyls (PCBs) contaminated soils.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: This guide specification is intended for use where as-found concentrations of PCBs in soils exceed 50 parts per million (ppm). The as-found concentration is defined in the Environmental Protection Agency's (EPA's) PCB Question and Answer Manual (June 2014): "The concentration of the PCBs in the waste at the site at the time the waste is discovered, as opposed to the concentration of the PCBs in the material that was originally spilled, released, or otherwise disposed of at the site. For example, if dielectric fluid containing PCBs at greater than 500 ppm was spilled onto soil, and testing revealed the PCB concentration of the soil to be less than 50 ppm, the soil would be managed as

having a concentration of less than 50 ppm, not as having the concentration of the dielectric fluid that spilled. You may not dilute the as-found concentration of the contaminated soil by mixing it with clean soil during excavation or other management activities."

For disposal and removal of PCBs not in soils, use Section 02 84 33 REMOVAL AND DISPOSAL OF POLYCHLORINATED BIPHENYLS (PCBs).

This guide specification section is intended for use when PCBs are either the sole contaminant or the contaminant "driving" cleanup decisions. However, if PCBs are only a co-contaminant and not the sole/"driving" contaminants, Section 02 61 13 EXCAVATION AND HANDING OF CONTAMINATED MATERIAL should be used, and relevant requirements from this section should be copied into that section, including but not limited to paragraphs 1) REGULATORY REQUIREMENTS, 2) PERFORMANCE REQUIREMENTS, 3) FIELD SCREENING TEST KITS, 4) DECONTAMINATION MATERIALS, 5) DECONTAMINATION OF NON-POROUS SURFACES, 6) REMOVAL OF POROUS SURFACES, and 7) SAMPLING SOLID SURFACES.

****

1.1 UNIT PRICES

****

NOTE: These paragraphs should be edited based on whether the contract will use a single job price or unit prices. If there is a separate Measurement and Payment section, edited versions of these paragraphs should be inserted in that section.

The amount of contaminated material to be excavated is often subject to uncertainty due to the difficulty in fully characterizing subsurface conditions prior to excavation. For this reason, single job pricing that is fair to both the Government and Contractor can be a challenge. One option if using single job pricing is to set the base bid using the best estimate of the amount of contaminated material to be excavated and include options that can be exercised for additional volumes or weights. Coordinate requirements of these paragraphs with the bidding schedule.

****

1.1.1 Measurement

****

NOTE: Options are provided for payment by either volume or weight. If payment is on a weight basis, weights must either be measured on-site using a scale system (provided by the Government or the Contractor) or off-site at the point of disposal (e.g., a landfill).

****

Base measurement for removal and onsite transportation on the[actual number of cubic meters cubic yards of PCB-contaminated material in-place prior to excavation. Base determination of the volume of contaminated material excavated on cross-sectional volume determination reflecting the differential between the original elevations of the top of the PCB-contaminated material and the final elevations after removal of the contaminated material.][metric tons tons of PCB-contaminated material excavated. Use a properly calibrated weighing system to accurately measure the gross (bulk) weight of the PCB-contaminated material. Covert the measured gross (bulk) weight of the PCB-contaminated material to dry weight based on the[percent moisture content] [_____] of representative PCB-contaminated material samples. Determine the percent moisture content in accordance with[ASTM D2216][ASTM D4643][ASTM D4959] [_____]. Determine moisture content[daily.][for every [500][_____] metric tons tons of excavated PCB-contaminated material.]] Base measurement for construction, maintenance, and removal of stockpile areas on the number of square meters square yards of stockpile liner constructed.

1.1.2 Payment

1.1.2.1 Excavation and Handling

Compensation for excavation and onsite handling of PCB contaminated soil will be paid as a unit cost. Include any other items incidental to excavation and handling not defined as having a specific unit cost.

1.1.2.2 Stockpiling

Compensation for construction of stockpile areas will be paid for as a unit cost. Include all aspects of grading, preparation, handling, placement, maintenance, removal, treatment, and disposal of stockpile cover materials and liner materials and all other items incidental to construction of stockpiles in the unit cost.

1.1.2.3 Other Work Items

Payment for other work items not included in the above paragraphs will be included in the payment for the base bid for excavation, handling, and temporary storage of the PCB contaminated soils. The other work items include preparation of submittals; mobilization and demobilization; site preparation; environmental compliance monitoring; health and safety monitoring and controls; and utilities required for the project if approved by the Government as necessary for the project.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM D5434	(2012) Field Logging of Subsurface Explorations of Soil and Rock

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
EPA 560/5-86-017	(1986) Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup
EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions

1.3 SYSTEM DESCRIPTION

****

NOTE: The Designer should include the bracketed text if the amount and type of debris anticipated to be present in the PCB-contaminated soil will not impact the work described in this section and referenced sections. If the amount or type of debris is significant (see Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS for definitions related to debris), this section and associated sections should be edited to indicate how debris will be managed.

****

The work includes removal of approximately [_____] [metric tons][cubic meters] [tons][cubic yards] of PCB-contaminated soils[and any debris contained within the contaminated soils].

1.3.1 Design Requirements

1.3.1.1 PCB Contaminated Soil Removal Plan

****

NOTE: The Designer may wish to require the PCB Contaminated Soil Removal Plan, UFP-QAPP, and any other preconstruction submittals required under this section to be completed concurrently or with all other plans being appendices of one primary plan. This section should be edited to reflect such a requirement if applicable.

****

Submit a PCB Contaminated Soil Removal Plan within [30][_____] calendar days after notice to proceed. Do not perform work at the site, with the exception of site inspection and surveys, until the Removal Plan is approved. Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the PCB Contaminated Soil Removal Plan. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. No adjustment for time or money will be made if resubmittals of the Removal Plan are required due to deficiencies in the plan. Describe methods, techniques, and phases of dealing with the PCB contaminated soil, including: a schedule to be employed in the excavation, a sequence of operations, the method of excavation, hauling, and handling of the contaminated materials, and the proposed equipment. Provide design details for stockpiles including but not limited to: geomembrane liner and cover, berms, anchors/ballast for cover, vehicle access points, and leachate collection sumps. Identify temporary use areas required for staging equipment and supplies, for temporary storage of excavated materials, or for stockpiles.

1.3.1.2 Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP)

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with the requirements set forth in EPA 505-B-04-900A and using the UFP-QAPP WKSTS. Submit the UFP-QAPP within [30][_____] calendar days after notice to proceed. Do not perform work at the site, with the exception of site inspection and surveys, until the UFP-QAPP is approved. Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the UFP-QAPP. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document. Tailor the content to the requirements of the project and the site conditions. If field screening test kits are used as described in paragraphs EXCAVATION and FIELD SCREENING, include those field analysis in the UFP-QAPP.

1.3.1.3 PCB Contaminated Water Handling Plan

****

NOTE: Include the bracketed items when on site treatment of contaminated water is required.

****

Prepare and submit a plan detailing methods and techniques for collection[and treatment] of PCB contaminated water.[For treatment system, include size and location of equipment, catalog data on all components of system, size and arrangement of filters, type and quantity of filtering material, and method of containment.]

1.3.1.4 Hazardous Waste Management Plan

****

NOTE: If Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS is not in the project, details of a Hazardous Waste Management Plan can be copied from that section and edited as appropriate.

A Hazardous Waste Management Plan should include the following minimum elements: identification of PCB wastes associated with the work; estimated quantities of wastes to be generated and disposed of; names and qualifications of each Contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and a 24-hour point of contact. Include regulatory agency PCB waste permits and regulatory identification numbers; spill prevention, containment, and cleanup contingency measures to be implemented.

****

Prepare a Hazardous Waste Management Plan in accordance with [Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS][_____].

1.3.2 Performance Requirements

****

NOTE: This paragraph provides for two approaches to excavation of contaminated materials. The first approach is to excavate only a fixed volume of contaminated material. This approach could be used in a situation where excavation cannot proceed beyond certain limits, or excavation is being used to target hot-spots of contamination only. If this approach is used, the bracketed text and Table should be deleted. The second approach is to excavate to "clean" soil, using post-excavation confirmation samples to demonstrate achievement of cleanup goals.

Typical PCB cleanup goals for soils are 1 ppm, 10 ppm, or up to 25 ppm or more. Cleanup levels for non-porous surfaces are those defined in 40 CFR 761.61. Cleanup goals depend on many factors including the State that work is located in, land use (high occupancy, low occupancy, etc.), and proximity to surface and ground water. Cleanup goals should be determined on a site-specific basis considering the purpose of the excavation, applicable regulations, and other criteria. Ideally, cleanup goals will be defined in a site-specific decision document. Guidance on

defining cleanup goals is beyond the scope of this section.

This section includes provisions for managing PCB-contaminated non-porous and porous surfaces that are known to be present or may be encountered during excavation. If non-porous and porous surfaces are not present, the optional text in this paragraph, cleanup goals in Table 1, and work requirements related to non-porous and porous surfaces in Part 3 need to be deleted.
****

Excavate to the limits as shown on the drawings.[Excavation includes decontamination of non-porous surfaces and removal of porous surfaces[as shown on the Drawings][encountered within the excavation limits] [_____].][When excavation samples collected in accordance with paragraph FIELD QUALITY CONTROL indicate that remaining contaminant concentrations exceed the cleanup goals specified in Table 1, conduct additional excavations to achieve the cleanup goals in the excavation.]

TABLE 1 - CLEANUP GOALS	
SAMPLE TYPE	PCB CLEANUP GOAL
PCB Contaminated Soil and Porous Surfaces	
[_____]	[<=1][<=10][<=25][_____] mg/kg (parts per million)
[_____]	[<=1][<=10][<=25][_____] mg/kg (parts per million)
Non-Porous Surfaces	
[_____]	[<=10][<=100][_____]ug/100 cm^2
[_____]	[<=10][<=100][_____]ug/100 cm^2
Run-on Stormwater, Dewatered Groundwater, and Rinsewater Containing PCBs	
[_____]	[<=0.5][<3][_____]ug/L

[1.4 PRE-INSTALLATION MEETING

****
NOTE: Delete this paragraph if a separate specification section is developed for the entire project to cover pre-installation meetings and other administrative requirements.
****

Conduct a pre-installation meeting at the jobsite [at least 5 business days prior to the start of operations on the project][_____]. The pre-installation meeting is to be arranged by the Contractor and is to follow the written pre-installation meeting agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Site

Foreman and [Contracting Officer][_____].

Record pre-installation meeting minutes and publish via email within 48 hours to all attendees. The minutes must be re-published within 48 hours via email pending any subsequent comments from the attendees.

]1.5 DEFINITIONS

PCB and PCBs (Polychlorinated Biphenyls), 40 CFR 761. PCB and PCBs means any chemical substance that is limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances which contain such substance.

1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

[Pre-Installation Meeting Agenda

][Pre-Installation Meeting Minutes; G, [_____]

] PCB Contaminated Soil Removal Plan; G, [_____]

PCB Contaminated Water Handling Plan; G, [_____]

Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP); G, [_____]

[Confirmatory Grid Sampling Plan; G, [_____]

] Pre-Installation Examination Report

Pre-Construction Equipment Examination

Hazardous Waste Management Plan

SD-02 Shop Drawings

Surveys

SD-03 Product Data

Field Screening Test Kits

SD-06 Test Reports

Dewatering Performance Records

SD-07 Certificates

Qualifications; G, [_____]

SD-11 Closeout Submittals

Closeout Report; G, [_____]

1.7 QUALITY CONTROL

1.7.1 Regulatory Requirements

****

NOTE: Some States regulate PCBs as hazardous waste. The Designer should verify presence of State-level PCB regulations and their impact on this section and associated referenced sections.

****

Maintain at the job site one readily available copy each of 29 CFR 1910.1000, 40 CFR 761, and all contractor prepared plans required under paragraph SUBMITTALS. Ensure that work operations or processes involving PCB-contaminated materials are conducted in accordance with 40 CFR 761 and the applicable requirements of this section, including but not limited to:

a. Obtaining advance approval of PCB storage sites.

b. Notifying Contracting Officer prior to commencing the operation.

c. Reporting leaks and spills to the Contracting Officer.

d. Cleaning up spills.

e. Maintaining an access log of employees working in a PCB control area and providing a copy to the Contracting Officer upon completion of the operation.

f. Inspecting PCB and PCB-contaminated items and waste containers for leaks and forwarding copies of inspection reports to the Contracting Officer.

g. Maintaining a spill kit.

h. Maintaining inspection, inventory, and spill records.

1.7.1.1 Environmental Protection

****

NOTE: This specification section does not attempt to provide comprehensive environmental protection requirements, but rather refers to a separate specification section that would be prepared using UFGS Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. Specific technical considerations for excavation projects are discussed below.

An air pathway analysis should be performed during design to determine what air monitoring and controls are required. Guidance on air pathway analyses is provided in EP 200-1-24 Air Pathway Analysis for the Design of Hazardous, Toxic, and Radioactive Waste (HTRW) Remedial Action Projects. Specify perimeter air monitoring requirements in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS provides information related to regulations of spills including notification and response requirements. Spills on excavation projects can occur due to releases from equipment, fuel storage tanks, etc. Excavated materials can also be inadvertently spilled during transport between the excavation and storage locations. Lastly, although not directly related to spills, excavation projects have the potential to encounter unanticipated materials such as buried tanks, containers, munitions and explosive constituents, etc. An environmental protection plan prepared under Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS should include provisions for managing both spills and encountering unanticipated materials.

The environmental protection plan should also consider the following spill-prevention and control related requirements: use appropriate vehicles and operating practices to prevent spillage or leakage of contaminated materials from occurring during operations; inspect vehicles leaving the contaminated soil removal site to ensure that no

contaminated soil adheres to the wheels or undercarriage; immediately report any spills to the Contracting Officer and provide cleanup in accordance with 40 CFR 761, Subpart G.
****

Develop and implement environmental protection requirements per [Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____].

1.7.2 Qualifications

****
NOTE: Requirements for the Contractor's experience should be determined and specified based on the experience and availability of Contractors in the area as well as the complexity of the project.
****

1.7.2.1 Contractor Experience

Submit evidence of successful completion of at least [one][_____] project of comparable size and scope.

1.7.2.2 Key Personnel

Provide key personnel with a minimum of [3][_____] years of contaminated soil excavation field experience. Include the Site Foreman, quality control personnel, and supervisory engineering and technical staff involved with operation in key personnel. Perform all survey work under the supervision of a registered land surveyor licensed in the[applicable jurisdiction][State of [_____]]. Submit a list of these personal with their qualifications.

1.7.2.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting the requirements of [Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

****
NOTE: Revise this paragraph if requirements are provided in other specification sections, health and safety plans, environmental permits/permit equivalents, etc. The conditions described in the following paragraph represent challenges to environmental protection (winds causing dust, rain causing stormwater contamination), saturation of excavated materials (rain), or site damage (saturated soils).
****

Do not conduct excavation or handling of PCB-contaminated materials in the following conditions: [wind speeds in excess of [50][_____] kilometers [30][_____] miles per hour,][moderate rain greater than [5][_____] mm [0.2][_____] inches per hour,][saturated soils caused by recent rains/snowmelt such that equipment traffic would cause excessive rutting or damage].

1.8.2 Existing Conditions

****

NOTE: Include any pertinent information regarding project/site conditions in this paragraph, the appendices to the specifications, or on the drawings. If the PCB-contaminated soil to be excavated contains a significant amount of debris, the available information about its extent and characterization should also be provided. Indicate the detail to which site characterization has been performed and indicate where obvious data gaps exist. The following information should be shown on the project drawings (unless the Contractor is required to develop any aspects of the project design under a performance-based project):

a. Overall site plan, borrow areas, stockpile areas, storage areas, security requirements, special shoring requirements, boring logs, and access routes.

b. Individual site plans of each area of contamination with site features such as buildings, roads, utilities, topography, trees, shrubs, surface conditions, etc.

c. Limits of pavement removal, fence removal, and the location of ancillary equipment to be removed.

****

The existing site conditions are presented[in Appendix [_____]][and][on the Drawings]. These include[physical configuration,][utilities,][topography,][land uses,][groundwater depth,][geotechnical characteristics of the contaminated materials (including[grain size analysis,][pH,][moisture content,][density,][porosity]),][hydrogeology,][nature and extent of contamination,] [_____]. The existing conditions presented are the result of site investigations at specific locations; variations in the existing site conditions could occur. Perform an independent interpretation of the site characterization data. Notify the Contracting Officer within [48 hours][_____] if discrepancies between the data provided and actual field conditions are discovered.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Field Screening Test Kits

Provide PCB field screening test kits which analyze PCBs by EPA SW-846 Method 4020 or equivalent screening method having a false negative rate of less than 5 percent when PCBs are present at 1 ppm, and providing on-site results within 2 hours of sample collection.

2.1.2 Backfill

****

NOTE: If Section 31 00 00 EARTHWORK is not in the project, backfill information can be copied from that section and edited as appropriate.

The paragraph ENVIRONMENTAL REQUIREMENTS FOR OFF-SITE SOIL in Section 31 00 00 EARTHWORK should be edited to include an appropriate list of chemical testing parameters for off-site soil. Some backfill sources may have chemical testing data already available; the Government should require chemical testing if the backfill chemical testing data is inadequate or does not exist. Off-site backfill should not be tested for only the site contaminants of concern. At a minimum, samples should be analyzed for target contaminant list (TCL) VOCs, TCL SVOCs, target analyte list (TAL) Metals, and Pesticides/PCBs. Additional analyses such as Total Petroleum Hydrocarbons may be appropriate also. Individual States or military installations may require or recommend additional parameters. Typical frequency of sampling would be one sample per 1,900 to 2,300 cubic meters 2,500 to 3,000 cubic yards. However, individual States or military installations may require or recommend more frequent or less frequent sampling.

In many cases, the degree of engineering control of the materials used as backfill may not need to be as stringent as described in Section 31 00 00 EARTHWORK. In other cases, such as under pavements, special compaction and material requirements may apply and the specifications will need to address these special requirements.

At some sites, previously contaminated soil which has been removed from the excavation is reused as backfill following treatment to remove the contaminant of concern.

****

Provide backfill in accordance with the requirements in [Section 31 00 00 EARTHWORK][_____].

2.1.3 Topsoil

****

NOTE: If Section 31 00 00 EARTHWORK is not in the project, topsoil information can be copied from that section and edited as appropriate. Section 31 00 00 EARTHWORK includes a provision to strip existing on-site topsoil for re-use. The project specifications should only allow that practice if topsoil has been tested or will be tested to confirm that it is not considered contaminated.

****

Provide topsoil in accordance with the requirements in [Section 31 00 00 EARTHWORK][_____]. Stripping existing topsoil for re-use on-site[is][is not] allowed.

2.1.4 Decontamination Materials

Provide solvents for decontaminating non-porous surfaces. Suggested solvents are stoddard solvent or hexane.

2.1.5 Geomembrane

****

NOTE: If Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT is not in the project, geomembrane material information can be copied from that section and edited as appropriate.

Scrim reinforced geomembranes are commonly specified for stockpile covers and liners. Due to their higher strength properties, scrim reinforced geomembranes can generally be thinner than non-reinforced geomembranes. For bottom liners, a commonly used minimum thickness is 0.5 mm 20 mils for non-reinforced geomembrane and for scrim reinforced geomembranes a common minimum weight is 20 kg/100 square meter 40 lbs./1000 square feet. For stockpile cover geomembranes, a commonly used minimum thickness is 0.25 mm 10 mils for non-reinforced geomembrane and for scrim reinforced geomembranes a common minimum weight is 13 kg/100 square meter 26 lbs./1000 square feet.

Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT includes substantial levels of effort for quality control and quality assurance (QC/QA) that are meant to ensure performance when geomembranes are used in long-term applications like a landfill. For use of geomembranes in temporary stockpiles of contaminated soils, the designer should consider reducing the level of QC/QA in Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT. Specific QC/QA requirements that could be reduced include Qualifications, requirements for Layout and Detail Drawings, Tests/Inspections/Verifications of materials conducted off-site, and on-site QA/QC of Field Seams. Reduced material requirements for temporary applications of geomembranes can also be considered; instead of using HDPE geomembranes that are 1 mm 40 mil or greater (typical for landfills), other materials such as PVC may be appropriate.

****

Provide geomembranes for lining and/or covering PCB contaminated soil stockpiles. Provide geomembranes in accordance with [Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT][_____].

[2.2 SCALES

****

NOTE: This paragraph is primarily intended to ensure that calibrated scales are being used to weigh excavated contaminated soil, when weight is being used as the basis for measurement and payment. If off-site scales will be used (e.g., at a weighing station or disposal facility), this paragraph can be deleted.

****

Provide scales of sufficient length to permit simultaneous weighing of all axle loads and with an accuracy within 0.2 percent throughout the range of the scales. Ensure the scale's accuracy conforms to the applicable requirements of NIST HB 44 and is certified[by an acceptable scales company representative][by an inspector of the State Inspection Bureau charged with scales inspection within the state in which the project is located] prior to weighing any excavated contaminated soil.[Locate the scales at the site of work.][Ensure the scales are capable of printing a weight ticket including time, date, truck number, and weight.] Perform a check of calibration of measuring equipment prior to initial use, and once every [7][_____] calendar days. The requirements of this paragraph do not apply to measurement of chemical data.

]PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Surveys

****

NOTE: If payment for the project is based on a single job price or based on weight of material exported/imported from the site, then a highly accurate survey by a registered land surveyor may not be necessary. A lower level of effort in these cases could be to require the Contractor to survey only the excavation, using a handheld, sub-meter accurate GPS unit.

****

Perform surveys immediately prior to and after excavation of PCB contaminated soils to determine the volume of contaminated soil removed. Provide cross-sections on [7.6][_____] meter [25][_____] foot intervals and at break points for all excavated areas. Survey and show locations of confirmation samples on the drawings.[Perform surveys in accordance with Section: [_____].]

3.1.2 Site Conditions

Conduct a pre-installation examination of the on-site infrastructure, utility conduits, monitoring points, site access constraints, and infrastructure. Photographically document, with identifying labels, the existing condition of infrastructure and utilities, particularly for comparison to post-removal conditions. Verify locations of critical utilities that cannot be disrupted and those utilities that would potentially have significant impacts on removal and public safety. Submit a Pre-Installation Examination Report documenting the examination activity. Obtain all necessary utility clearances before initiation of subsurface work.

3.1.3 Pre-Construction Equipment Examination

Conduct a pre-construction examination of the excavation equipment for any damage, defect, and dilapidation. Submit the results of the pre-construction examination to the Contracting Officer for review and information. The Contracting Officer may conduct an independent examination to ascertain the condition and functionality of the equipment. Based on this examination, the Contracting Officer has the right to reject any damaged, defective or dilapidated equipment. The cost associated with equipment or control replacement or repair, and delays caused by the rejection must be borne by the Contractor. Routinely and properly inspect and maintain the equipment to provide the project execution as required by the contract schedule. Any schedule delay and cost associated with power failure, improper functioning of equipment and controls, unavailability of labor and materials, etc., must be the responsibility of the Contractor.

3.2 PREPARATION

3.2.1 Mobilization

****

NOTE: Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES includes requirements for decontaminating equipment that has been used in contaminated zones. That section should be modified to extend decontamination/cleaning requirements to equipment being brought on-site to cover the requirements of this paragraph.

****

Do not mobilize to the site until the [PCB Contaminated Soil Removal Plan][_____] has been approved by the Contracting Officer and the Contractor has received written confirmation. Delays caused by the Contractor's failure to meet regulatory requirements must result in no additional cost to the Government. In accordance with [Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____], the equipment which is rented [and][or] previously used for other site remediation must be decontaminated and tested for contaminants of concern before being brought to the site.

3.2.2 Clearing

****

NOTE: Grubbing is typically not required at sites where contaminated soil is being excavated for treatment and/or disposal. Typically, vegetation that is cut off above a certain height is defined as clean and any stumps and brush below this height are defined as contaminated.

****

Perform clearing to the limits[shown on the Ddrawings][defined in the PCB Contaminated Soil Removal Plan] [_____] in accordance with [Section 31 11 00 CLEARING AND GRUBBING][_____].

3.3 PCB CONTAMINATED SOIL REMOVAL

Notify the Contracting Officer [_____] calendar days prior to the start of excavation of PCB contaminated soil. The[Contracting Officer][Contractor] is responsible for contacting regulatory agencies in accordance with the applicable reporting requirements.

3.3.1 Excavation

****

NOTE: For large excavations, more than one excavation log may be required.

****

Excavate areas of contamination to meet the requirements in paragraph PERFORMANCE REQUIREMENTS. Perform excavation in a manner that will limit spills and the potential for contaminated soil to be mixed with uncontaminated soil. Maintain an excavation log describing visible signs of contamination encountered for each area of excavation. Prepare excavation logs, describing materials in accordance with ASTM D5434.

Use methods and equipment that result in minimal disturbance to remaining soil beyond the excavation limits. Remove and dispose of any material that becomes contaminated as a result of the Contractor's operation at no additional cost to the Government. Stage operations to minimize the time the contaminated soil is exposed to the weather.

3.3.2 Shoring, Sloping, or Bracing

Implement shoring, sloping, bracing, or any other excavation health and safety requirements in accordance with [Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS][_____].

3.3.3 Contaminated Soil Storage

Place material in temporary storage[immediately after excavation][after treatment while awaiting test results]. The following paragraphs describe acceptable methods of material storage. Provide storage units that are in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, clearly label each unit with an identification number and keep a written log to track the source of contaminated material in each temporary storage unit.

3.3.3.1 PCB Contaminated Soil Stockpiles

****

NOTE: Check state regulations to determine the minimum requirements for stockpiles and modify this paragraph accordingly. For contaminated soil with high moisture content, the subgrade for the stockpile must be sloped and a sump should be provided.

For post treatment stockpiles, chemical testing is usually required to determine if material is contaminated or clean. Maximum stockpile size should be based on the required frequency of chemical testing. For example, if chemical tests are required at a frequency of one per 1,000 cubic meters cubic yards, then stockpiles should be no greater than 1,000 cubic meters cubic yards in size.

If anticipated volumes of PCB contaminated soils are small, consider requiring work methods that do not use stockpiles, such as storing PCB contaminated soils in roll-offs (included below) or in trucks suitable for carrying PCB contaminated soils as specified herein. Avoiding use of stockpiles means that soils do not need to be double handled, liners and covers do not need to be constructed, and sampling under stockpiles is not necessary.

As noted in paragraph GEOMEMBRANE, the Designer may wish to reduce the level of QC/QA requirements if using Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT as the requirement for installation of the stockpile bottom liner.

****

Construct stockpiles to isolate stored contaminated soil from the environment. Cover stockpiles at the end of each workday. Stockpile size greater than [_____] cubic meters cubic yards is prohibited. Construct stockpiles to include:

a. [Place a geomembrane liner on a ground surface that is free of rocks greater than 13 mm 0.5 inches in diameter and any other object which could damage the membrane. Where multiple geomembrane panels are necessary to construct the liner, seam the panels together and test the seams in accordance with[manufacturer requirements][Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT].][Use pavement as the liner system. Construct pavement in accordance with Section [_____]].

b. Place a geomembrane cover over the stockpiles. Extend the cover material over the berms and anchor or ballast to prevent it from being removed or damaged by wind. Where multiple geomembrane panels are necessary to construct the cover, shingle the upslope panel over the downslope panel and overlap the panels at least [150][_____] mm [6][_____] inches. Secure the panels together using[ballast such as sandbags or tires][adhesives][thermal fusion seams] [_____].

c. Construct berms surrounding the stockpile, a minimum of 300 mm 12 inches in height. Berm vehicle access points.

d. Slope the liner system to allow collection of leachate. Construct sumps to facilitate removal of leachate from the stockpile. Store and remove liquid which collects in the stockpile, in accordance with paragraph[COLLECTION AND DISPOSAL OF INCIDENTAL CONTAMINATED WATER][COLLECTION, TREATMENT, AND DISCHARGE OF CONTAMINATED WATER].

3.3.3.2 Roll-Off Units

Use water-tight roll-off units to temporarily store contaminated soil. Place a cover over the units to prevent precipitation from contacting the stored material. Remove liquid which collects inside the units and manage in accordance with paragraph[COLLECTION AND DISPOSAL OF INCIDENTAL CONTAMINATED WATER][COLLECTION, TREATMENT, AND DISCHARGE OF CONTAMINATED WATER].

3.3.4 Decontamination of Non-Porous Surfaces

****

NOTE: Management of decontaminated non-porous surfaces should be specified here and should align with the cleanup goals provided in paragraph PERFORMANCE REQUIREMENTS.

****

Non-porous surfaces as defined in 40 CFR 761.3 encountered within the limits of excavation may be decontaminated in accordance with the requirements of 40 CFR 761, Subpart D, and this paragraph. Brush to remove soil materials and clean by double rinsing. Collect and manage washdown water in accordance with paragraph CONTAMINATED WATER. Repeat cleaning process and testing until PCBs are below the limits defined in paragraph PERFORMANCE REQUIREMENTS. Manage decontaminated non-porous surfaces by [_____].

3.3.5 Removal of Porous Surfaces

Remove porous surfaces as defined in 40 CFR 761.3 encountered within the limits of excavation. PCB-contaminated concrete may be scarified to remove the contaminated portion of the concrete; following scarification, collect samples in accordance with paragraph POROUS SURFACES. Manage the removed porous surface materials[in accordance with the same requirements for excavated contaminated soils in this section] [_____].

3.3.6 Contaminated Water

****

NOTE: Water treatment can significantly increase the cost of a project involving the excavation of contaminated soil and should be carefully considered during design. UFC 3-220-05 Dewatering and Groundwater Control provides guidance on the design of dewatering systems.

If water from dewatering operations will be allowed to discharge onto the ground, an NPDES permit for dewatering may be required (see Regulatory Requirements Designer's Note for more details on permits). Reference the permits paragraph of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS for permit requirements.

Note that Section 31 00 00 EARTHWORK also includes dewatering requirements, but they are limited in scope and do not include any consideration of collection, treatment, sampling, or discharge of contaminated waters. If Section 31 00 00 EARTHWORK is included in the project, either delete dewatering requirements from that section or cut and paste the dewatering requirements from this section into 31 00 00.

****

Divert surface water to prevent entry into the excavation.[Limit dewatering to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met.][Do not perform dewatering without prior approval of the Contracting Officer.]

[3.3.6.1 Collection and Disposal of Incidental PCB-Contaminated Water

****

NOTE: Determine appropriate disposal method. Choose this paragraph when significant quantities of groundwater will not be encountered and only small amounts of rinse and other contaminated waters are expected.

****

Collect rinsewater. Collect ground, surface, and rain water contaminated by operations including water collected in the open excavation pit or temporary containment. Soak up with absorbent material so that no free liquid is present. Containerize, sample, and analyze PCB absorbed material and dispose of as specified for contaminated soils.

][3.3.6.2 Collection, Treatment, And Discharge Of PCB-Contaminated Water

****

NOTE: Choose these paragraphs when groundwater will be encountered or when significant amount of rinse water or other contaminated water is expected, and on-site treatment is allowed. Paragraphs may need modifying to fit site specific requirements. Typical treatment system consists of particulate/suspended solids removal by various means such as settling or filtration and contaminant removal by carbon filtration. Location of discharge for water after it is treated must be coordinated and approved by appropriate (EPA, State, station, local, and regional) authority.

Another option to consider is to containerize liquid and haul to off-site publicly-owned treatment works (POTW) with pretreatment capability, however this can be extremely costly for large quantities of water. Use unit pricing, assumed quantities, or some other method to give Contractor something to base bids on when water is to be taken off site. Where off site facilities are involved, verify such facilities exist, that they are permitted to accept, and that they will accept the liquid waste stream. Specification will require modifying for site specific requirements.

****

Furnish labor, materials, and equipment necessary for collecting, treating, and discharging of PCB-contaminated surface and subsurface water in excavations at the site. Conduct excavation and backfilling operations at the site in a manner that minimizes the amount of surface and subsurface water which may collect in the open excavation. Collect standing surface water in contact with PCB contaminated soil.

3.3.6.2.1 Subsurface Drainage

Remove water by pumping or other methods to prevent softening of surfaces exposed by excavation. Provide water treatment necessary to treat water to levels specified in paragraph PERFORMANCE REQUIREMENTS. Operate dewatering system continuously until construction work below static water levels is complete. Submit Dewatering Performance Records weekly. Measure and record performance of the dewatering system at the same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system.

3.3.6.2.2 Treatment System Requirements

The Contractor is responsible for all aspects of verifying design parameters, designing, providing, installing, operating, maintaining, and removing the collection, storage, and treatment facilities as required to discharge treated waters within the treatment limits required. The treatment system must:

a. Be capable of removing PCB contaminants to below the limit defined in paragraph PERFORMANCE REQUIREMENTS for contaminated water.

b. Include effluent holding tanks designed to allow on-site testing of water quality prior to discharge.

c. Include recycle capability for retreatment of effluent not meeting the discharge requirements of this specification, as determined by on-site testing.

3.3.6.2.3 Treatment System Operations

Monitor, test, and adjust the treatment system in accordance with the PCB Contaminated Water Handling Plan[and UFP-QAPP][basewide QAPP], or as otherwise modified by special regulatory requirements. If there is a conflict between requirements, the more stringent requirement prevails.

3.3.6.2.4 Discharge of Treated Water

Do not discharge any water until tests results show water is below PCB contaminated water limits as specified in paragraph PERFORMANCE REQUIREMENTS. Provide erosion control at outlet of piping to minimize erosion. Discharge treated water to the [_____].

3.3.6.2.5 Cleanup and Removal of Treatment System

Upon completion of work, close and remove from the site the surface water and groundwater treatment system. Restore the site to its original condition. Decontaminate equipment in accordance with [Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____]. Containerize, sample, test, and dispose of carbon, residues, cleaning aids, decontamination liquids, and waste as specified for the contaminated soils.

]3.3.7 Backfilling and Finishing/Finish Operations

Backfill excavations immediately after all contaminated soils have been removed and confirmation test results have been approved. Conduct backfilling and finishing/finish operations in accordance with [Section 31 00 00 EARTHWORK][_____].

3.3.8 Disposal Requirements

****

NOTE: Federal Regulations (40 CFR 761) require (with some exceptions) that generators, transporters, commercial storers, and disposers of PCB waste possess U.S. EPA identification numbers. If required, verify that the activity has a U.S. EPA generator identification number for use on the Uniform Hazardous Waste Manifest. (There are exceptions to this requirement of obtaining an identification number. In the case of a Very Small Quantity Generator, for example, who is not required to use the hazardous waste manifest except when shipping PCBs, which are not hazardous waste in most states, but still require the use of a hazardous manifest.) If not, the activity must file and obtain an identification number with EPA prior to commencement of removal work. Where disposal will be through the Defense Logistics Agency (DLA), modify paragraphs to meet DLA requirements.

Specific information for PCB waste shipment documents is described in 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.

****

Provide transportation and disposal of PCB-contaminated soils and materials per [02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS][_____].

3.3.9 Closeout Activities

Maintain surfaces of the PCB control area free of accumulations of PCBs. Restrict the spread of dust and debris; keep waste from being distributed over work area. Do not remove any PCB control area and warning signs required per [Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____] prior to the Contracting Officer's approval. Reclean areas showing residual PCBs.

3.3.9.1 Cleanup Wastes

****

NOTE: If the reference to Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES is used, the Designer should ensure that the cleanup waste procedures in 40 CFR 761.61 (a)(5)(v) are referenced in that section.

****

Decontaminate or dispose of cleanup wastes, such as contaminated tools and containers, after use in accordance with [Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES][_____].

3.3.9.2 Closeout Report

****

NOTE: If there is a separate section in Division 01 that defines project close-out documentation, edited

versions of this paragraph should be inserted in that section, and this paragraph deleted. In addition to progress photos, video has been used at some sites to record site activities.
****

Submit [_____] copies of a Closeout Report within [60][_____] calendar days of completing work at the site. Label the report with the contract number, project name, location, date, name of general Contractor, and the Government Agency contracting for the work. As a minimum, include the following information:

a. A cover letter signed by a[responsible company official][Professional Engineer registered in the State of [_____] who is a responsible company official] certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.

b. A narrative report including, but not limited to, the following:

    (1) site conditions, ground water elevation, and cleanup criteria;

    (2) excavation logs;

    (3) field screening readings;

    (4) quantity of materials removed from each area of contamination;

    (5) quantity of water/product removed during dewatering;

    (6) sampling locations and sampling methods;

    (7) sample collection data such as time of collection and method of preservation;

    (8) sample chain-of-custody forms; and

    (9) source of backfill.

c. Copies of all chemical and physical test results.

d. Copies of all manifests and land disposal restriction notifications.

e. Copies of all certifications of final disposal signed by the responsible disposal facility official.

f. Waste profile sheets.

g. Documentation verifying that vehicles and containers were decontaminated prior to leaving the disposal site, were properly operating, and were covered.

h. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 15 m 50 feet of excavation, sample locations, and sample identification numbers. Show on-site stockpile, storage, treatment, loading, and disposal areas on the drawings.

i. Progress Photographs. Use color photographs to document progress of the work. Take a minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions before work begins. After work has been started, photographically record[daily][weekly] activities at each work location. Provide photographs including:

(1) Soil removal and sampling.

(2) Dewatering operations.

(3) Unanticipated events such as spills and the discovery of additional contaminated soil.

(4) Contaminated soil/water storage, handling, treatment, and transport.

(5) Site or task-specific employee respiratory and personal protection.

(6) Fill placement and grading.

(7) Post-construction photographs. After completion of work at each site, take a minimum of four views of each excavation site.

Include a digital version of all photos shown in the report with the Closure Report. Provide photographs with a minimum of 181.11 pixels per cm 300 pixels per inch resolution for all photo files. Provide photos in a lossless compression file format that does not lose any pixels in the compression process (e.g., .TIFF, .PNG, and .GIF). Ensure no loss of original resolution from the raw photo if converted to a lossless format. Create digital images and metadata that meet or exceed the specifications of the Exchangeable Image File Format (EXIF) version [_____][2.3] or higher. In addition to the raw digital photo submissions, submit a PDF document as part of the Closeout Report displaying all required progress or other photos organized into separate documents. Render the photos in the PDF with a resolution that represents the original photo resolution to the human eye. Place photos according to their proper orientation (portrait or landscape). Create an index with bookmarks for each PDF organized by submittal section and suborganized by work area (if applicable) and then by date in the sequence which they were taken.

Process all raw photos for inclusion in the PDF submission with a border including a 13 mm 0.5 inch caption at the base of each photo for descriptive information. Include the following information for each photographic image in the caption:

Project Name

Contract Number

Contractor Name

Date

Station and Offset

Photo Number

Orientation View

Work Element Depicted

General Project Area

3.4 FIELD QUALITY CONTROL

3.4.1 Tests

****

NOTE: If a UFP-QAPP will be prepared for the project, the detailed requirements included in this paragraph and it's sub-paragraphs can be replaced with simple statements indicating that sampling is to be performed in accordance with the UFP-QAPP. If that approach is used, the unique PCB sampling requirements in 40 CFR 761 (detailed below) would need to be incorporated into the UFP-QAPP to ensure compliance.

****

3.4.1.1 Sampling Solid Surfaces

3.4.1.1.1 Non-Porous Surfaces

Collect wipe samples from non-porous surfaces that are either removed from the excavation area or washed down in accordance with paragraph DECONTAMINATION OF NON-POROUS SURFACES.[Collect wipe samples in accordance with the[UFP-QAPP][basewide QAPP] [_____], which defines sampling frequency, location, and analysis.][40 CFR 761. A 10 cm by 10 cm template gauze pad or glass wool of known size which has been saturated in the laboratory with hexane and stored in sealed glass vials. Wipe immediately after exposing medium to air. Place sample in precleaned glass bottle, cap, label, and place in ice chest until analyzed.]

3.4.1.1.2 Porous Surfaces

Collect destructive samples from porous surfaces[in accordance with the[UFP-QAPP][basewide QAPP] [_____], which defines sampling frequency, location, and analysis.][in accordance with EPA 560/5-86-017 and this paragraph. Remove sufficient sample for analysis using chisel, hole saw, drills, etc. Take samples less than 1 cm 3/8 inch deep and place in glass precleaned sample bottle, cap, label, and place in ice chest.]

3.4.1.2 Sampling Excavations

****

NOTE: If excavations are limited to a fixed extent and do not proceed until clean soils are encountered, delete the field screening requirements included below.

****

3.4.1.2.1 Field Screening

Collect soil samples at the same interval as determined for the confirmatory grid sampling plan along the bottom and along the sidewalls of the excavation, and test using field screening test. Follow field screening test kit manufacturer directions[and the UFP-QAPP].

3.4.1.2.2 Confirmation Sampling and Testing

[Collect excavation base and sidewall confirmation samples in accordance with the[UFP-QAPP][basewide QAPP] [_____], which defines sampling frequency, location, and analysis.][When field screening results show PCB concentrations below the cleanup goals defined in paragraph PERFORMANCE REQUIREMENTS, test using confirmation sampling and testing. Sample along the bottom and sidewalls of excavation. Use sampling grid scheme and number of samples as defined in EPA 560/5-86-017. Do not composite samples for analysis. Submit and receive approval of Confirmatory Grid Sampling Plan scheme prior to starting work. Analyze samples in accordance with EPA SW-846, Method 8080 for PCBs. Determine moisture content of the sample in accordance with EPA Method 160.3. Provide quality control in accordance with EPA guidelines, and as a minimum as follows:

a. Duplicate samples - collect and analyze duplicate soil samples at the rate of 10 percent of the total number of samples (rounded to the next highest number).

b. Matrix spike and matrix spike duplicate - collect one matrix spike sample for every 20 samples collected (rounded to the next highest number). Split the matrix spike sample, and analyze both the matrix spike and the matrix spike duplicate.]

3.4.1.3 Sampling of Stored PCB-Contaminated Soil

[Collect samples of stored material in accordance with the[UFP-QAPP][basewide QAPP] [_____], which defines sampling frequency, location, and analysis.][Take composite samples from stored material prior to removing from site. Analyze a minimum of one composite sample for every [75][_____] cubic meters [100][_____] cubic yards or fraction thereof of soil to be disposed of from any one site. To develop a composite sample of the size necessary to run the required tests, take several samples from different areas along the surface and in the center of the stockpile. Combine these samples and thoroughly mix to develop the composite sample.]

3.4.1.4 Sampling Beneath Storage Units

****

NOTE: At some sites, samples are collected to verify the soil underlying a contaminated material storage unit has not become contaminated due to leachate migration or mixing of contaminated soils with underlying soils.

Sampling along any connecting pipelines that transport contaminated liquid may also be appropriate. A standard practice is to sample at 6 meter 20 foot intervals under piping and at connections such as bends, elbows, or tees.

Options are provided for defining sampling requirements by either reference to a UFP-QAPP/basewide QAPP (first option) or including the requirements in this section (second option). As noted previously, referencing a UFP-QAPP is the preferred approach.

****

Collect samples from beneath storage units in accordance with the[UFP-QAPP][basewide QAPP] [_____] and this paragraph. Collect samples from beneath each storage unit[prior to construction of and] after removal of the storage unit. Collect samples at a minimum frequency of one per each [_____] square meter [_____] square yard from a depth interval of [0 to 0.15][_____] meter [0 to 0.5][_____] feet and analyze for the contaminants identified in paragraph PERFORMANCE REQUIREMENTS. Collect samples as[discrete grabs][composites][incremental samples] [_____]. Complete all other sampling and analysis activities in accordance with the[UFP-QAPP][basewide QAPP] [_____] (including but not limited to sample handling, preservation, transportation, collection/analysis of quality control samples, data validation, and data reporting). Any deviations to sampling frequency, number of samples, or sample collection methods must be[established in the approved[UFP-QAPP][basewide QAPP]][approved by the Contracting Officer].

If sample results from beneath storage units exceed the cleanup goals specified in paragraph PERFORMANCE REQUIREMENTS, remove soil which has become contaminated at no additional cost to the Government. Handle contaminated soil which is removed from beneath the storage unit in accordance with the requirements for managing excavated PCB contaminated soils. As directed by the Contracting Officer and at no additional cost to the Government, perform additional sampling and testing per the requirements of this paragraph to verify areas of contamination found beneath stockpiles have been excavated to below the cleanup goals specified in paragraph PERFORMANCE REQUIREMENTS.

3.4.1.5 Government Quality Assurance Testing

****

NOTE: The need for quality assurance testing should be considered on a project-by-project basis, and if not considered necessary this paragraph should be deleted. Factors to consider include whether the Government has access to a laboratory that can analyze quality assurance samples in a timely manner to not delay the project execution. If conducting quality assurance testing, a separate third-party quality assurance contract should be considered based on the qualifications of the Government QA personnel, and the size and importance of the project.

Use of quality assurance testing data also needs to be considered. A relatively straightforward data use is to compare quality assurance sample results to the project performance requirements, and failing result would be treated the same way as a failing Contractor test result. A more complicated data use is to compare results from quality assurance samples and contractor quality control samples for the purpose of determining if there is meaningful disagreement between the results. In this case, procedures would need to be developed for determining when there is a meaningful disagreement between quality assurance and quality control sample results; corrective actions for when a meaningful disagreement was identified would also need to be developed. The process of defining procedures for

identifying and correcting meaningful differences should be documented in a project-specific CQA Plan or Quality Assurance Project Plan and referenced in this specification; the process is likely too complex to be adequately defined in this specification.

Two options are provided for defining Government Quality Assurance. The first option is to defer details of the Government QA to a separate CQA Plan. This option would be preferred for large, complex projects where the excavation is one component of a larger process. A second, simpler option is provided to define Government QA testing frequency.

****

[Work will be monitored and tested in accordance with the requirements of the Construction Quality Assurance (CQA) Plan. Be aware of all monitoring and testing activities defined in the CQA Plan and account for these activities in the construction schedule. Quality Assurance testing and monitoring does not relieve the contractor of the responsibility to complete the quality control testing and monitoring defined in this specification section.

][[Provide][The Contracting Officer may provide]duplicate quality assurance samples to the Government's quality assurance laboratory at a frequency of one set of samples per [10][_____] sets of quality control tests performed. Quality assurance samples will be tested for the same parameters as the parent quality control sample. The Contracting Officer may require additional quality assurance tests as a result of failed quality assurance or quality control tests. Account for Government quality assurance testing in the construction schedule. Quality Assurance testing and monitoring does not relieve the contractor of the responsibility to complete the quality control testing and monitoring defined in this specification section.

]3.5 PROTECTION

Do not store or stockpile contaminated soils on excavation areas that have been completed and tested in accordance with paragraph FIELD QUALITY CONTROL.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-02 62 13.00 10 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-11 24 27 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-02 62 13.00 10 (August 2018)**

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SECTION 02 62 13.00 10

AIR AND STEAM STRIPPING

08/18

****

NOTE: This guide specification covers the requirements for systems to transfer volatile compounds from a water stream to an air stream.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification covers air strippers for removal of volatile substances from water. Refer to Design Guide (DG) 1110-1-3 Air Stripping.

****

1.1 UNIT PRICES

****

NOTE: If the Contractor is required to treat water, as well as to furnish the equipment, measurement and payment and unit pricing may be necessary to cover treatment costs.

****

Determine measurement and payment and unit prices for quantities of water treated (if applicable) in accordance with the Bid Schedule.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C653	(2020) Disinfection of Water Treatment Plants
AWWA D100	(2021) Welded Steel Tanks for Water Storage
AWWA D102	(2024) Coating Steel Water-Storage Tanks
AWWA D103	(2019) Factory-Coated Bolted Steel Tanks for Water Storage
AWWA D120	(2019) Thermosetting Fiberglass-Reinforced Plastic Tanks

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National

Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01 (2023; with Change 2, 2024) Structural Engineering

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 [Pre-Installation Meetings] [Partnering Conference]

Participation by the Contractor in the [Pre-installation][Partnering] conference is [requested][required] by the Contracting Officer. Ensure that all of the involved subcontractors, suppliers, and manufacturers are represented. Furnish to the Contracting Officer the date and time of the conference for approval.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

- Process Flow Diagrams
- Process and Instrumentation Diagram (P&ID)
- Installation drawings

SD-03 Product Data

- Air Stripping System
- Qualifications
- Field Training
- Framed Instructions
- Spare Parts

SD-05 Design Data

- Calculations
- Foundations

SD-06 Test Reports

- Tests

SD-07 Certificates

- Manufacturer's Representative
- Materials and Equipment

SD-08 Manufacturer's Instructions

- Air Stripping System

SD-09 Manufacturer's Field Reports

- Air Stripping System

SD-10 Operation and Maintenance Data

- Air Stripping System
- Maintenance

1.5 QUALITY CONTROL

1.5.1 Qualifications

Submit qualifications of the installer, supplier's representative, and the people listed in the following subparagraphs.

1.5.1.1 Constructor

A minimum of [2][3][5][_____] years' experience in the construction of water treatment, wastewater treatment, and/or industrial wastewater treatment and/or industrial wastewater pretreatment plants is required for the Constructor to be considered qualified.

1.5.1.2 Manufacturer's Representative

Provide the services of a manufacturer's field representative who is experienced in the installation, adjustment, and operation of the equipment furnished and who has complete knowledge of the proper operation and maintenance of the system. Submit names and qualifications of each manufacturer's field representative and training engineer with written certification from the manufacturer that each representative and trainer is technically qualified.

1.5.1.3 Welding

****

NOTE: Use wording in second set of brackets when critical pipe welding is required.

****

[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders are to be qualified in accordance with [_____]. Welding procedures qualified by others, and welders and welding operators qualified by another employer are acceptable as permitted by [_____]. Notify the Contracting Officer 24 hours in advance of tests. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures for piping is specified in Section 40 05 13.96 WELDING PROCESS PIPING.] [Welding qualifications for welding procedures, welders, and welding operators are to in accordance with Sections 8.2 and 8.8 of AWWA D100 and Section 40 05 13.96 WELDING PROCESS PIPING.] [Procedures and welders are required to be qualified in accordance with the code under which the welding is specified to be accomplished.]

1.5.2 Single Source Supplier

Assign to a single supplier the full responsibility for the furnishing of the air stripping system. The designated single supplier need not manufacture the system but is responsible for coordinating the design, assembly, installation, and testing of the entire system as specified herein. Submit a complete list of material, including manufacturer's descriptive and technical literature, catalog cuts, drawings, and installation instructions, performance charts, technical literature, catalog cuts for [packing,] [mist eliminator,] [perforated trays and number,] [perforated bubbler tubes,] [venturi design] stripper, instrumentation and controls, including capacities, make and model, materials of construction, valving, and pressure gauges.

1.6 DELIVERY, STORAGE, AND HANDLING

Preassemble parts to the maximum extent practical, compatible with transportation limitations and equipment protection considerations. Field assembly, if any, consists merely of bolting together of match-marked components. Crate and protect equipment against damage during shipping and delivery. Protect flange faces from damage. Cover openings to prevent entrance of dirt, water and debris. Protect parts so that no damage or deterioration occurs during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation. Protect finished iron or steel surfaces to prevent rust and corrosion. Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, and other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

****

NOTE: The contaminant concentration and flow rate to be used in the design are critical to this specification. Install multiple strippers to accommodate extreme variations from the design flow rate and contaminant concentrations or to maintain the groundwater gradient.

Determine design wind speed from ASCE 7-16; use 161 km/h 100 mph minimum. Use 1.2 kPa 25 psf snow load for most heavy snow climates; delete snow load where maximum snow is insignificant. Local climates and topography may dictate that a value greater than 1.2 kPa 25 psf be used for snow loading. Consult ANSI A58 and local codes. Wind speed and snow load can be deleted if the air stripper is installed inside.

Seismic criteria are given in paragraph Seismic Protection. Consult NFPA 780 to determine if lightning protection is needed.

****

Provide a system complying with the following requirements:

	Maximum	Minimum
Water/wastewater flow rate	[_____] L/s gpm	[_____] L/s gpm
Water/wastewater temperature	[_____] degrees C F	[_____] degrees C F
Ambient air temperature	[_____] degrees C F	[_____] degrees C F
Air Stripper system dimensions Maximum vertical projection	[_____] mm ft	
Maximum ground surface coverage including blower, motor and other appurtenances	[_____] by [_____] mm [_____] by [_____] ft	
Soil bearing capacity	[_____] MPa psf	
Seismic parameters	[_____]	[_____]
Wind speed	[_____] km/h mph	

	Maximum	Minimum
Ground snow load	[_____] kPa psf	[_____] kPa psf
Design Life		[_____] years

2.1.2 Influent Inorganic Chemical Conditions

Measured influent inorganic chemical concentrations of [waste water][water from surface impoundment][ground water][total][filtered]have been:

	Average	Maximum
pH [_____] Minimum	[_____]	[_____]
Total Hardness as CaCO3	[_____] mg/L	[_____] mg/L
Total alkalinity as CaCO3	[_____] mg/L	[_____] mg/L
Hydroxide alkalinity as CaCO3	[_____] mg/L	[_____] mg/L
Carbonate	[_____] mg/L	[_____] mg/L
Bicarbonate	[_____] mg/L	[_____] mg/L
Total Dissolved Solids	[_____] mg/L	[_____] mg/L
Langelier Index	[_____]	[_____]
Total Suspended Solids	[_____] mg/L	[_____] mg/L
Total Iron	[_____] mg/L	[_____] mg/L
Dissolved Iron	[_____] mg/L	[_____] mg/L
Total Manganese	[_____] mg/L	[_____] mg/L
Dissolved Manganese	[_____] mg/L	[_____] mg/L
Calcium	[_____] mg/L	[_____] mg/L
Magnesium	[_____] mg/L	[_____] mg/L
Sodium	[_____] mg/L	[_____] mg/L
Potassium	[_____] mg/L	[_____] mg/L
Sulfate	[_____] mg/L	[_____] mg/L
Nitrate	[_____] mg/L	[_____] mg/L
Chloride	[_____] mg/L	[_____] mg/L
Fluoride	[_____] mg/L	[_____] mg/L

2.1.3 System Performance Requirements

2.1.3.1 Air to Water Ratio

Maximum at maximum flow	[_____] volume/volume
Minimum at minimum flow	[_____] volume/volume

2.1.3.2 Influent and Effluent Organic Contaminant Concentrations

****

NOTE: Either specify maximum effluent concentrations or percent removal requirements.

****

Maximum Influent	[_____] µg/L
Average Influent	[_____] µg/L
Minimum Influent	[_____] µg/L

[

Maximum Effluent	[_____] µg/L

][

Removal Required	[_____] percent
Determine removal percentage as follows: ((Maximum Influent concentration - Maximum Effluent concentration)/Maximum Influent concentration) times 100 percent	

]

2.1.3.3 Operating Schedule

****

NOTE: Air stripping systems can be designed to be operated either continuously or intermittently. Typically, groundwater treatment systems have a central influent holding tank. The air stripper may be designed to cycle on and off, depending on the water level in the influent holding tank. Use of an influent holding tank allows for greater flexibility in accommodating variable flow rates from extraction wells. However, the air stripping system must be designed to accommodate a maximum, projected flow rate.

****

Size the system for capacity and design the air stripper and accessories to operate continuously for [24 hours per day, 7 days per week][_____].

2.1.4 Seismic Protection

****

NOTE: Provide seismic details on the drawings or remove the second bracketed sentence.

****

Design the air stripper shell and components structurally for seismic forces [in accordance with UFC 3-301-01 and Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT][as indicated]. [The calculations and drawings are required to be stamped by a professional engineer qualified to practice at the site.]

2.1.5 Design Loads

Structurally design the air stripper and appurtenances for the wind loads listed in the system performance requirements, plus live and dead loads resulting from internally supported parts, weight of operating liquid when the shell is completely full of water, piping structural supports, and internal or external pressures with an appropriate safety factor. Design the concrete base in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.6 Foundations

****

NOTE: Coordinate with paragraph Design Requirements.

The footprint and the piping connections for the air stripper on the floor plan, and height required may vary considerably depending on the type of air stripper. The designer should allow enough space for the type of air stripper that will be selected (usually, either a low-profile air stripper, or a packed tower).

****

Design the reinforced concrete foundations to support the stripper full of water in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE and in accordance with Section 12 of AWWA D100 or Sections 11 and 8.5 of AWWA D103 for earth, with the bearing value stated in the design requirements. Provide an AWWA D100 Type 1 or an AWWA D103 Type 1 or Type 2 foundation for the stripper. Use a factor of safety on overturning under design wind load of 1.5 minimum. When a footing is required, using an inverted truncated pyramid of earth with 2 on 1 side slopes above top of footing in determining overturning stability is acceptable. Ensure the elevation at the top of the foundations is not less than 200 mm 8 inches above the finished grade. Submit calculations for the shell and concrete foundations, mounting and support details including the seismic analysis, where appropriate.

2.1.7 Anchors

2.1.7.1 Number of Anchors

Install an adequate number of anchors designed to prevent overturning of the [stripper][shell] when empty. If anchor bolts are used, provide with a nominal diameter not less than 25 mm 1 inch, plus a corrosion allowance of at least 6 mm 1/4 inch on the diameter. If anchor straps are used, pre-tension them before welding to the shell.

2.1.7.2 Anchor Bolts and Straps

Provide bolts with a right angle bend, hook, or plate washer. Provide anchor straps with only a plate welded to the bottom. Insert the anchors into the foundation to resist the computed uplift.

2.1.7.3 Attachment

Attach anchors to the shell in a manner that does not add localized stresses to the shell in excess of the material tolerance. When determining the method of attachment, consider the effects of deflection and rotation of the shell. Do not attach anchors to the shell bottom. Attach the anchor bolts to the shell through stiffened chair-type assemblies or anchor rings of adequate size and height.

2.1.7.4 Seismic Requirements

Provide anchors in accordance with UFC 3-301-01 and Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT.

2.2 EQUIPMENT

2.2.1 Standard Products

Provide materials and equipment, which are the standard products of a manufacturer regularly engaged in the manufacture of the products, and that essentially duplicate equipment that has been in satisfactory operation for at least [2] [_____] years prior to bid opening. Support equipment by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Submit verification from a Registered Professional Engineer, registered in the state where the system is located, that the stack, [the shell, ladder, platform and cage calculations for the air stripper,] the foundation and lifting lugs were designed for the listed conditions in accordance with the appropriate requirements, codes and standards.

2.2.2 Nameplates

Provide major equipment items with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Ensure each piece of equipment bears the approval designation and the markings required for that designation. Mark valves in accordance with MSS SP-25 to bear a securely attached tag with the manufacturer's name, catalog number and valve identification permanently displayed.

2.3 COMPONENTS

****

NOTE: Consider if the influent or the stripper must be acid cleaned or chlorine-treated in selection of materials. Stainless steel may not be appropriate if a chlorine solution will be used for extended periods of time. Galvanized steel or corrodible metal internals should not be used.

****

2.3.1 Pump

Provide pumps in accordance with Section 23 21 23 HYDRONIC PUMPS.

2.3.2 Blower

Provide fans, blowers and or vacuum pumps in accordance with Section 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS.

2.3.3 Pipe Connections

Provide influent pipe connections with full line diameter of the connecting pipe. Make effluent pipe connections with standard reducing fittings only if there is adequate vertical run to avoid back-up. Provide air and off-gas piping as specified in Section 31 21 00 OFF-GASSING MITIGATION. Provide liquid piping as specified in Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING.

2.3.4 Mist Eliminator

Provide a mist eliminator that has the minimum separation efficiency stated in the performance requirements. Ensure materials are provided as specified for the stripper internals.

2.3.5 Exhaust Stack

****

NOTE: Maintain velocities within limits to reduce condensation/freezing on the stack surface.

****

Size exhaust stack for gas velocity between 3 and 7.5 m/sec 10 and 25 feet/second. Ensure materials are provided as specified for the stripper.

2.3.6 Off-Gas Control

****

NOTE: An air pollution control device may not be required depending on state and local regulations. The air pollution control system is a separate unit process, with different design requirements.

****

Convey off gas from the air stripper column to an air pollution control unit for treatment as specified in Section [44 13 10.13 VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS] [44 13 51 THERMAL OXIDATION EQUIPMENT].

2.3.7 Instrumentation and Controls

****

NOTE: Specify the instrumentation and controls as either direct-reading instruments at the column or remote-reading at some other location.

****

Provide instrumentation and controls that conform to the requirements of Section 40 60 00 PROCESS CONTROL and the requirements specified for each piece of the equipment with the interlocks and control devices specified herein.

a. Provide gauges with 150 mm 6 inch dials, stem mounted, that conform to ASME B40.100. Ensure the accuracy of gauges is Grade A or better. Calibrate gauges in kPa and psi psi in not more than 10 kPa and 2 psi 2 psi increments from 0 to 350 kPa and 0 to 50 psi 0 to 50 psi in excess of the normal operating pressure at the tank.

b. Control to shut down the system and activate an alarm if the blower fails and if water level in the bottom of the stripper exceeds the high-level set point.

c. Interlock for concurrent operation of blowers and influent [pumps] [control valves].

d. Water flow indicators [_____] to [_____] L/second [_____] to [_____] gpm.

e. Effluent water temperature gauge [_____] to [_____] degrees C [_____] to [_____] degrees F.

f. Pressure drop instrument [_____] to [_____] mm [_____] to [_____] inch water.

g. Direct reading pressure gauges in the air inlet and outlet throats.

2.3.8 Chemical Feed Systems

****

NOTE: Determine if there is an environmentally preferred alternative and evaluate the options for cleaning compounds. The potential for reuse of cleaning chemicals will depend on the fouling material composition and if the suspended biomass or chemicals can be easily removed by settling and/or filtration. Consider conventional acids (HCl, H_2SO_4) with environmentally safer products such as acetic and citric acids for chemical fouling. NaOCl may be needed for biological fouling.

Perform a cost/benefit study to select between alternative cleaning solutions, reusing the cleaning solution and disposal options. This specification does not include the disposal of sludge generated during the cleaning.

Acid-feed or sequestrant-feed systems are often used immediately upstream of air strippers to control scaling. Acid-feed systems, when used, are integrated with a pH monitoring and control system. For example, a target pH range is set, and the acid feed rate automatically adjusts to maintain the pH within the set range before the water enters the air stripper.

****

Meet chemical feed requirements as specified in Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS and/or Section 46 31 11 CHLORINE GAS FEED EQUIPMENT (AUTOMATIC, SEMIAUTOMATIC AND MANUAL).

2.3.9 Cleaning Provisions

****

NOTE: The type of cleaning chemicals used to remove mineral deposits and/or biological growth which may foul the air stripper interior and adversely affect the unit's performance will be unique to each site and depends on whether the fouling is from biological growth or chemical deposition and on the materials of construction. Tests may be needed before or after the system is started to determine the best cleaning solution.

For some types of relatively small, low-profile air strippers, the trays can easily be removed and cleaned by submerging and soaking in an acidic solution. Relatively large, low-profile air strippers, may require the use of an overhead hoist system to remove individual trays; which would tend to make in-place cleaning be more practical than a procedure that involves removing the trays. For packed tower air strippers, unless the packed tower air stripper is relatively small, and the packing can be easily removed, cleaning is usually performed via an in-place procedure (e.g., circulation of a cleaning solution). Periodic, replacement of the packing may need to be considered for situations where the cleaning procedure has limited effectiveness.

****

[Furnish the air stripper with a cleaning package capable of being operated periodically. The system includes tanks, pipes and valves to allow flushing with chemical cleaners, biocides or disinfectants. The package includes a corrosion resistant pump, chemical addition port, [cleaning solution storage tank] and plumbing accessories to allow the re-circulation of cleaning solutions through the stripper.] [Design the air stripper for a cleaning procedure during which the air stripper is isolated and filled or flooded with a [[10][_____] percent maximum [sulfuric] [hydrochloric] [_____] acid solution] [_____] cleaning solution.]

2.3.10 Assembly

Factory pre-assemble the system into reasonably sized modules for easy field assembly and mounted on a skid. Supply the skid with a welded steel frame with [2.4][6.4] mm [3/32][1/4] inch thick steel plate or fiberglass reinforced plastic (FPU) grating with ultraviolet (UV) inhibitors decking.

2.3.11 Lifting Lugs

Provide [trays][columns][stacks] and other major components with lifting lugs, as necessary for easy handling with a crane or similar device during installation, maintenance and replacement of column internals.

2.3.12 Guy Wires

****

NOTE: Size of the columns should be taken into

account. In temporary installations, or in areas of high seismic activity, guy wires may be acceptable.

****

Supply air strippers and air stripper that are free standing and supported entirely by anchoring in a concrete base and are compatible with the dimensional constraints indicated. Each column air stripper [and stack] are to be self-supporting. A superstructure or frame not extending beyond the foundation is permitted. Guy wires are not be permitted unless directed by the Contracting Officer.

2.3.13 Freeze Protection

****

NOTE: When cold dry air is used for stripping, the evaporative cooling may chill the water more than the conduction of heat through the shell of the stripping column. If evaporative calculations show that this will significantly lower the rate at which the volatiles are removed from the water, the problem can be eliminated by stripping with re-circulated air.

In cold climates, ice may accumulate where the air exits the exhaust stack. The configuration of the exhaust stack should be designed to safely allow for the ice to periodically be removed.

****

[Provide insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Insulate and jacket the system to prevent freezing under the most severe conditions stated in the performance requirements with a water temperature drop of less than 3 degrees C 5 degrees F.] [Recirculating air from the stripper that had the volatilized contaminants removed by the subsequent air pollution control device into the bottom of the column is allowable].

2.3.14 Sump

Provide each air stripper with a sump to receive and store the treated effluent. Size sump to provide a minimum residence time of [2][5][10] minutes when the stripper is operating at the specified capacity. Provide [an inspection port][and][a 13 mm 1/2 inch diameter (minimum) drain/sample port with manually operated valve] at the bottom of the sump to completely drain the air stripper.

2.3.15 Electrical Equipment

****

NOTE: Show NFPA 70 hazardous area classification on the drawings. If the potential for an explosive atmosphere exists, the wiring, blower, motor and other electrical equipment must meet the applicable explosive prevention standards.

****

The electrical equipment is required conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide equipment and wiring in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification. Provide equipment located outdoors, not provided with climate controlled enclosure that is capable of operating in the ambient temperature range indicated in paragraph Design Requirements unless otherwise specified. Provide electrical motor-driven equipment specified herein complete with motor control centers, panels, motor starters, etc.

2.3.16 STRIPPER

****

NOTE: See DG 1110-1-3 Air Stripping for recommendations.

****

The stripper system consist of [1][2][_____] [packed column] [perforated plate (sieve tray)] or [enclosed low profile mass transfer mechanism] air stripper to transfer volatile organic compounds from the water phase to the air base. Use manufacturer's standard size units whenever possible.

2.3.16.1 Materials

****

NOTE: Limit the materials of construction to those that will not be corroded or dissolved by the contaminants in the water or cleaning solutions (acids).

****

2.3.16.1.1 Shell

****

NOTE: Use coated steel for short term applications only, since cracking of the coating could allow the column to corrode.

****

Construct the air stripper of [polyethylene (HDPE) seamless one piece molded modular sections,] [polyvinylchloride (PVC) with ultraviolet (UV) inhibitors,] [fiberglass reinforced plastic (FRP) with ultraviolet (UV) inhibitors,] [structural grade aluminum,] [304 stainless steel,] [316 stainless steel,] or [steel with internal and external coating as specified,] of suitable thickness to prevent deformation. Provide steel tank materials that conform to the applicable provisions of Section 2 of AWWA D100 or Section 2 of AWWA D103 or AWWA D120. Ensure design, fabrication, and erection comply the applicable requirements of AWWA D100 or AWWA D103 except as modified herein and in the design requirements of this specification. Ensure shop fabrication conforms [to Section 9 of AWWA D100 or Section 7 of AWWA D103 or AWWA D120][the manufacturer's recommended fabrication procedures].

2.3.16.1.2 Internals

Construct the air stripper internals of [polyethylene (HDPE)][polyvinylchloride (PVC)][fiberglass reinforced plastic (FRP)][aluminum] [304 stainless steel][316 stainless steel] or copper.

2.3.16.2 Low Profile (Sieve Tray) Stripper

****

NOTE: Low-profile air strippers may also be referred to as sieve-tray, tray-aeration, or perforated-plate air strippers.

Determining the number of trays needed in a perforated plate air stripper is more difficult than determining the height of packing in a packed column air stripper. The efficiency of each tray must be known or estimated to determine the number of trays required. The designer may have to rely on the manufacturer's test data or other estimation methods. These methods may be empirical, scale up from smaller units or more theoretical mass transfer calculation methods.

Volatile organic chemicals in the water phase transfer to the bubbles in the air phase. The air phase containing the volatile chemicals then leaves the top of the column.

****

2.3.16.2.1 Features

Provide the stripper with the following features: Vertically stacked trays with horizontal perforated plate (sieve trays) bottoms that are enclosed in a shell and are separated vertically. Contaminated water is introduced at the top, flows across a perforated plate, over a weir and down to the next lower plate. The process is repeated for each tray until the water reaches the bottom of the unit and enters the sump. Air is introduced at the bottom of the unit and is forced up through the perforations in the trays to form bubbles.

2.3.16.2.2 Calculations

Submit manufacturer calculations to clearly show the basis for the selected number of trays (each tray contains one perforated plate), size and number of the perforations on each plate, tray spacing, size of trays and tray efficiency. Submit actual performance data from the manufacturer or submit calculation methods. Submit design calculations indicating removals of each of the listed volatile compounds; air and water pressure drops through each component of the system, including line sizing, hydraulic loading (L/sq. m gal/sq. ft), air volume (cubic m/second CFM, air to water ratio (dimensionless and with appropriate units).

2.3.16.2.3 Perforated Plates (Sieve Trays)

****

NOTE: Stainless steel is recommended on large units. Plastic materials are acceptable for small low profile air strippers; plastic materials on large air strippers may warp and then leak between the trays.

If frequent fouling is anticipated, stainless steel should be used as it is easier to clean. Plastic can be damaged by scraping and steam or high pressure water cleaning.

****

Provide all materials for perforated plates, downcomers, downcomer seals, baffles and other components constructed of materials allowed by paragraph Internals, of suitable thickness to prevent deformation. Design tray to prevent short-circuiting of air or water. Provide the number and size of perforations to maximize mass transfer.

2.3.16.2.4 Gaskets

Provide the trays with gaskets that prevent air and water leakage in and out of the shell and between trays. Supply gaskets made of a material compatible with the influent and with the cleaning methods.

2.3.16.2.5 Disassembly

****

NOTE: Once disassembled, high pressure water, steam or physical scraping can be used to clean the trays.

****

Ensure the strippers are easily disassembled for cleaning or have hatches for access to the individual trays or other internal components for inspection and cleaning.

2.3.16.3 Diffused-Aeration Air Stripper

****

NOTE: Diffused-aeration air strippers employ a variety of methods to facilitate the mass transfer of volatile chemicals from the water phase to the air phase. Calculation methods for these air strippers are unique to each design and may not be readily available. Designers may have to rely heavily on manufacturer supplied performance data, or use mass transfer calculation methods developed for other processes, such as distillation or waste water aeration, to verify the performance. If manufacturer supplied performance data are relied on, the designer should determine whether the computer models use theoretical equations calibrated to actual test data, or whether they are based only on theoretical equations or empirical data.

****

Furnish a diffusion-aeration air stripper that is enclosed, uses mass transfer mechanisms which include, but are not limited to perforated bubble tubes or the venturi design to transfer (volatilize) contaminants from the water phase to the air phase.

2.3.16.4 Packed Column

****

NOTE: Calculations must be provided to clearly show the basis for the diameter and packing height. Base the diameter of the column on a maximum liquid loading rate of 60 to 80 per cent of the flooding loading rate. Data for the mass transfer coefficient (Kla) and pressure drop/flooding calculations must be obtained from a pilot plant run with this packing on the same or similar pollutants

or vendor supplied data run with this packing on the same or similar pollutants.

These data and the requirement that the Contractor must meet the removal efficiencies or effluent criteria specified in the system performance requirements should assure that the column is sized properly.
****

Furnish a packed column air stripper with the following features: A column filled with packing material that has a large surface area to volume ratio. The contaminated water is pumped to the top of the column above the packing and is distributed uniformly over the packing. Air is forced up through the bed of packing at the same time the water is "trickling" down through the packing (i.e. countercurrent flow).

2.3.16.4.1 Packing

Furnish the column filled with high efficiency open packing, either structured "arranged" or random "dumped" polypropylene, PVC, stainless steel, ceramic or other media that is durable under the service conditions. Packing diameter does not exceed 20 percent of the column diameter and is as near 9 percent of the column diameter as is feasible with the type of media supplied. Provide the packed section of the column between [_____] and [_____] mm [_____] and [_____] feet in diameter and the height of the packing between [_____] and [_____] mm [_____] and [_____] feet.

2.3.16.4.2 Water Distribution and Re-distribution System

****
NOTE: Columns that are wider relative to their depth need more distributor and re-distributors than are considered in the manufacturer literature
****

Furnish water distribution system made of [PVC] [[304][316] stainless steel] [aluminum] full solid cone spray nozzle or distributor tray that distributes the water over the fill area of the packing. Ensure water distribution system produces a minimum of [125][50][_____] streams/sq. m [12][4.8] [_____] streams/sq. ft at the normal pumping rate. Design the distribution system for easy removal and replacement. If a full solid cone spray nozzle is used, place it at the correct distance from the top of the packing to distribute the spray uniformly over the top of the packing. Provide water re-distribution systems as recommended by the manufacturer. Space the distance between re-distributors to not exceed [_____] mm ft and to be less if recommended by the packing manufacturer.

2.3.16.4.3 Packing Support

Furnish packing support make of [PVC][HDPE][fiberglass reinforced plastic] [aluminum] [[304][316] stainless steel]. If the bed depth exceeds the packing manufacturer's recommended maximum vertical depth of packing, install an intermediate support. Provide a support of suitable thickness to prevent deformation when the packing becomes plugged and the entire shell above the packing support fills with water.

2.3.16.4.4 Access

****

NOTE: View ports should be considered if the column is tall and the water can become poorly distributed or if biological, iron, manganese, or calcium fouling is likely to occur.

****

Bolt the top of each column to provide access to tower internals from above. Install view ports at the [top] [and bottom] of the column to check the water distribution and to check for fouling. Design the stripper for easy removal of the packing.

2.3.16.4.5 Manholes and Pipe Connections

****

NOTE: Additional ports should be provided if packing fouling is expected to be a problem.

****

Provide the number, type, location, and size of manholes and pipe connections as shown on the drawings and as specified herein. Section 7 of AWWA D100 and Section 5 of AWWA D103 contain the minimum requirements for manholes and pipe connections. Provide flanged access ports, [460][525][600] mm [18][21][24] inch in diameter, that are water and vapor tight, and able to withstand all loads and internal pressures during construction, operation, and cleaning. Provide one or two access ports at the top of the column for access to the mist eliminator and liquid distributor, and locate one near the bottom of the column to provide removal of the packing and packing support; and provide one with access to the sump.

2.3.16.4.6 View Ports

****

NOTE: View ports may not be necessary if the concentration of minerals in the water is low and iron, calcium or biological fouling is not expected to be a problem.

****

Provide view ports at the top and bottom of the packing to allow checks of the distribution and check for fouling.

2.3.16.4.7 Ladders, Platforms and Cages

****

NOTE: Ladder should start 2.5 m 8 feet above the ground, if the area is not secured. Ladders, platforms and cages may not be appropriate for small units.

****

Provide the air stripper with a platform at the top of the column, and an access ladder to provide access to each access port. Provide catwalks, ladders, cages, and guardrails where indicated or required for safe operation and maintenance of equipment and in accordance with Sections 7.4 and 7.5 of AWWA D100 or Sections 5.4 and 5.5 of AWWA D103. Make provision for the attachment of a scaffold cable support at the top of the roof on welded tanks. Provide ladders with side rails and non-slip rungs that are a minimum of 19 mm 3/4 inches in diameter and 406 mm 16 inches long. Start the access ladder at [ground level] [2.5 m 8 feet] above the ground. Ensure the distance between rungs does not exceed 305 mm 12 inches. Bolt the ladder and platform onto brackets that are welded to the columns, or welded directly to the column. Design platforms to support a uniform live load of 3.6 kPa 75 psf plus the dead load of the structure. Provide a platform that is a minimum of 915 mm 3 feet wide and fabricated from steel, aluminum, or fiberglass reinforced plastic. Grating openings are required to have no dimension greater than 25 mm 1 inch.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 PREPARATION

Requirements for excavating, filling, and grading in Section 31 00 00 EARTHWORK.

3.3 INSTALLATION

Install equipment as shown and in accordance with the written instructions of the manufacturer, under the direct supervision of the manufacturer's representative, and in accordance with the applicable provisions of Section 10 of AWWA D100 or Section 8 of AWWA D103 or Section 7 of AWWA D120. Submit installation drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and properly functions as a unit. Show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation in the provided drawings.

3.4 FIELD QUALITY CONTROL

3.4.1 Manufacturer's Field Service

Prior to startup, inspect the equipment for alignment and connections by a factory representative. The manufacturer's representative inspection of the final installation is required to include supervising the adjustment and testing of the equipment. The manufacturer's representative is required to demonstrate that the system meets the performance requirements.

3.4.2 Framed Instructions

Post framed instructions, under glass or in laminated plastic, for installation instruction procedures, sequences, and precautions, including tolerances for level, horizontal, and vertical alignment. Include grouting requirements, grout spaces and materials, process flow diagrams and wiring and control diagrams showing the complete layout of the entire system, where directed. Submit process flow diagrams showing all major pieces of process equipment with flow rates and material balances. Prepare in typed form, the condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system.

Framed as specified above for the wiring and control diagrams and post beside the diagrams. Submit posted diagrams, instructions, and other sheets prior to posting. Submit [one][_____] framed process and instrumentation diagram (P&ID) showing all instrumentation and control locations, functions and settings; major process equipment, pumps, pipes, valves, instruments direction of flow, flow rates pressures and temperatures.

3.4.3 Tests

****

NOTE: Avoid further mention of sampling or analytical methods in this section. Always refer to the chemistry section to avoid conflicts.

****

3.4.3.1 Hydrostatic Tests

Hydrostatically test each unit by completely filling the shell with water and inspecting for leaks. Repair leaks and retest the column. Check equipment for leaks after it has been filled for at least one hour. Conduct shell inspections and testing in accordance with Section 11 of AWWA D100 or Section 9 of AWWA D103. [Perform mill and shop inspections using an approved commercial inspection agency.] [Perform radiographic inspections of the welded shell.] Perform the hydrostatic test and the vacuum box leak test of the tank bottom. Perform final leak test and hydrostatic test before painting.

3.4.3.2 Performance Testing

Operate each unit at the maximum flow specified in the performance requirements for at least one hour prior to sampling. Submit performance reports in booklet form, upon completion of testing of the installed system. Include in the test reports all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Indicate within each test report the final position of all controls. Reflect all performance test data in the operating instructions.

3.4.3.3 Influent and Effluent Sampling

Collect samples in the presence of the Contracting Officer and transport the samples to the laboratory for analysis.

3.4.3.4 Influent and Effluent Analyses

Inspect and test all equipment under operating conditions after installation. Demonstrate the unit to run without operator intervention for 72 contiguous hours. If inspection or test shows defects, correct such defects, and the inspection and test will then be repeated. Performance test samples will be tested in accordance with [_____].

3.4.3.5 Discharge

****

NOTE: A holding/mixing tank requirement can be deleted if an NPDES or sewer discharge permit has been secured.

****

During the performance testing, contain the effluent from the air stripper system within the holding/mixing tank with no flow discharged to the [system] [stream] [sewer].

3.4.3.6 Noncompliance

Removals will meet or exceed the specified system performance requirements. If at any time the result of the organic analyses of the influent and effluent water indicate that the air stripping system is not in compliance with Contract Documents, stop flow through the air stripper and declare the system inoperable. If at any time the operation of the air stripping system does not meet the hydraulic, instrumentation, or control requirements set forth in this contract, stop flow through the air stripping system and declare the system inoperable. Upon notification of the air stripping system non-compliance, immediately proceed to repair or modify the system to meet compliance. Make repairs or modifications at no cost to the government. Notify the Contracting Officer one day before the restarting/retesting the air stripping system.

3.5 SYSTEM STARTUP

****

NOTE: Modify this paragraph for Contractor operation.

****

After completion of all testing, the plant operators are required to be assisted by the manufacturer's representative during plant startup.

3.6 ADJUSTING AND CLEANING

3.6.1 Adjustments

Make adjustments, within the control range, to obtain optimum performance under actual field conditions.

3.6.2 Cleaning

For potable water systems, cleaning [is] [and disinfection in accordance with AWWA C653 are] required prior to placing the unit in service.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Field Training

Conduct a training course of operating staff as designated by the Contracting Officer. Start the training period, for a total of [24][36][_____] hours of normal working time, immediately after the system is functionally complete but prior to final acceptance tests. Cover the topics included in the Operating and Maintenance Manuals in the field instructions. Submit training course curriculum and training instructions, [14][_____] days prior to the start of training.

3.8 PROTECTION

****

NOTE: Some state and local health agencies have listings of acceptable paint materials for the

interior of potable water tanks; they will also apply to the interior of the air stripper. The designer must contact the appropriate state and local authorities to determine if the proposed paint systems are acceptable. If these systems are not acceptable, the designer must determine the best acceptable system and revise this specification accordingly. Any deviation from this specification and AWWA Standards must be submitted with justification to CEMP-RT for approval.

****

3.8.1 Welded Tanks

3.8.1.1 Exterior Surfaces

Apply the paint system to the outside of the tank air stripper in accordance with Section 09 90 00 PAINTS AND COATINGS. Solvent-clean all factory primed surfaces before painting. Prepare and prime surfaces that have not been factory primed in accordance with the paint manufacturer's recommendations.

3.8.1.2 Interior Surfaces

Coat tank interior surfaces in accordance with Sections 3.2, 3.3, 3.4, 3.5, 3.6 or 3.7 of AWWA D102.

3.8.2 Touch-up Painting

Touch up factory painted items as needed. Clean items of all foreign material and prime and top coat with the manufacturer's standard factory finish.

3.8.3 Field Painting

Paint equipment which did not receive a factory finish as specified in Section 09 90 00 PAINTS AND COATINGS.

3.8.4 Corrosion Resistant Metals

Do not paint corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel unless otherwise specified.

3.9 MAINTENANCE

****

NOTE: Select the option that is compatible with the Bid Schedule.

****

a. Manage, operate, maintain, and monitor the off-gas control system [until contract close out] [for at least [one year][_____] after construction, startup and performance testing are complete]. At a minimum, provide an operator onsite [eight][_____] hours per week to operate, maintain, and calibrate the equipment and instruments, and to collect samples for analyses. Ensure a qualified person is on call to respond to emergencies and alarm conditions at the off-gas system within two hours of alarm conditions. Prepare and maintain compliance and monitoring records and reports for the Contracting Officer and regulatory agencies. The operator is required to maintain a log of the actions taken.

b. Provide spare parts for each different item of material and equipment specified, including all parts recommended by the manufacturer to be replaced after [1 year][and][3 years]service. Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals, and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply. List of all special tools, instruments, accessories, and special lifting and handling devices required for periodic maintenance, repair, adjustment, and calibration.

c. Include the following information in either the manual or manufacturer literature that contains the information and furnish it with the O&M Manuals. Include in each manual an index listing the contents. Bind all manuals in sturdy three-ring, loose-leaf binders. Provide copies of the O&M Manuals and the manufacturer's literature in electronic format.

  (1) Submit [six][_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, normal operation, short- and long-term deactivation, and shutdown. Include an introduction and overall equipment description, purpose, functions, and simplified theory of operation in the beginning of the instructions. Include within theinstructions the manufacturer's name, model number, service manual, parts list and brief description of each piece of equipment and its basic theory and operating features. Include within the instructions piping and component layouts and wiring and control diagrams for the systems as installed. Reflect all performance test data in the operating instructions.

  (2) Submit [six][_____] complete copies of maintenance instructions listing routine maintenance procedures, calibration procedures, possible breakdowns and repairs and troubleshooting guides. Include procedures for cleaning and removal of scale.

-- End of Section --

****
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Preparing Activity: USACE **Superseding**
UFGS-02 01 50 (May 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

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SECTION 02 62 16.13 10

OPERATION, MAINTENANCE, AND PROCESS MONITORING FOR SOIL VAPOR EXTRACTION (SVE) SYSTEMS

08/18

****
NOTE: This guide specification covers the requirements for operation, maintenance, and process monitoring for soil vapor extraction (SVE) systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This guide specification covers the initial period of operations (usually a 12 month period following completion of construction, commissioning and demonstration), or periods of operation beyond the initial period. Requirements for start-up and prove-out of SVE systems are covered by Section 02 62 16.16 10 COMMISSIONING AND DEMONSTRATION FOR SOIL VAPOR EXTRACTION (SVE) SYSTEMS.

Operations, Maintenance and Process Monitoring covers requirements to be followed by the operations staff to ensure proper operation of the SVE system equipment (e.g., monitoring vacuum levels and air

flow rates, vapor stream monitoring, and performing preventative maintenance). The operations and maintenance manual should be completed during the initial period of operation (see paragraph, Assistance in Preparation of O & M Manuals). Additional guidance on design and operation of SVE systems can be found in EM 1110-1-4001, Soil Vapor Extraction and Bioventing, June 2002.

The following information should be shown on the project drawings:

a. Individual site plans of each area of contamination with site features such as buildings, roads, utilities, trees, surface covers, locations of *vapor* extraction wells, vadose zone pressure monitoring points, and groundwater monitoring wells. Depths of screened intervals for wells should also be shown in cross-section.

b. Process flow diagram of above-ground process equipment and, piping diagrams showing the locations of devices for monitoring pressure, temperature, flow. Locations of sampling ports and valves should also be shown.

****

1.1 UNIT PRICES

****

NOTE: If there is a separate Price and Payment Procedures Section, edited versions of these paragraphs should be inserted in that section. Coordinate requirements of these paragraphs with the bidding schedule. The bid schedule should include separate unit price items for laboratory analysis of samples for chemical data. Under the pricing structure shown below, costs for laboratory analysis of samples for chemical data are not covered by this section. Unit pricing should also be considered for replacement of granular activated carbon (GAC), if GAC vapor stream treatment will be required.

These paragraphs should be coordinated with Sections 44 13 10.13 VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS and 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS.

The bid sheet should include separate, optional items for tasks such as: training, pneumatic flow meter testing, and completion testing.

****

Measurement is based on completion of contract requirements. Payment is based on the respective contract prices in the bidding schedule.

1.1.1 Unit Pricing

****

NOTE: Incentives for the Contractor to complete remedial action in a timely manner should be incorporated into the pricing structure, if possible. Unit pricing alternatives for payment include: hours of operation, volume of air extracted, and mass of contaminants removed.

Although pricing by mass of contaminants removed creates incentive, mass of contaminants removed is more difficult to accurately measure than time or air volumes. Also there is typically a high degree of uncertainty in predicting mass removal rates, which will make it difficult for bidders to assign reasonable prices when preparing bids.

Another performance based payment option is to make periodic payments to the Contractor based on the degree of reduction in contaminant levels. For example, partial payment to the Contractor is made based on the percentage reduction in contaminant levels. However this type of payment scheme should be used with caution, since removal rates typically decrease as contaminant levels decrease; e.g., it may take 3 times as long to go from 25 to 10 mg/kg as it takes to go from 100 to 25 mg/kg.

Lump sum pricing, with performance requirements (see paragraph Operation of the SVE System), is generally recommended for Operations, Maintenance and Process Monitoring. Under this pricing structure, the Contractor receives periodic payments (e.g., monthly) so long as performance requirements are being met. If performance requirements are not met, then the Contracting Officer may withhold payment until the Contractor demonstrates that performance requirements are being met.

If it is expected that large volumes of condensate will be generated, and that treatment or offsite disposal will be required; then a separate paragraph should be added to cover treatment and disposal of condensate. A unit pricing structure would be appropriate to pay for treatment or offsite disposal of condensate.

****

Compensation is based on a lump sum price for Operation of the SVE System, Maintenance, and Process Monitoring. [Include costs for Contaminated Material Storage and Disposal in this price.] [Costs for replacement adsorption media for the vapor stream treatment system is covered under a separate paragraph and not included in this price.] Include physical and chemical testing performed in the field, and sampling in this price. Costs for laboratory analysis of samples is not included in this price.

1.1.2 Training

****

NOTE: If it is expected that close out of the site will be completed within the period of the contract,

then Training should be listed as an optional item on the bid sheet.
****

Compensation is lump sum price for Training.

1.1.3 Disposal and Replacement of Vapor Phase Activated Carbon

****
NOTE: This paragraph should be deleted if any of the following conditions apply: vapor steam treatment will not be required; the vapor stream treatment system does not use activated carbon; or payment for activated carbon is covered under a separate Section.
****

Compensation for disposal of spent vapor phase activated carbon is based on and calculated by the contract unit price schedule for each [_____] [kgpound], based on [the dry weight of the spent activated carbon][_____]. Compensation for replacement of spent vapor phase activated carbon is calculated by the contract unit price schedule for each [_____][kg pound], based on [invoices from the supplier of the replacement activated carbon][_____].

1.1.4 Pneumatic Flow Meter Testing

****
NOTE: This paragraph should be deleted if pneumatic flow meter testing will not be required. If this paragraph is retained, the bid sheet should include a separate, optional item for pneumatic flow meter testing.
****

Compensation for pneumatic flow meter testing by the contract unit price schedule on a per well basis. Include physical and chemical testing performed in the field, and sampling will be included in this price. Costs for laboratory analysis of samples is not included in this price.

1.1.5 Completion Testing

****
NOTE: Completion testing is defined as testing that is performed determine if regulatory requirements have been met, so that the SVE system can be permanently shut down.

This paragraph should be deleted if completion testing will not be included in the contract. If this paragraph is retained, the bid sheet should include a separate, optional item for completion testing.
****

Base compensation for completion testing on a lump sum price. Include physical and chemical testing performed in the field, and sampling in this price. Costs for laboratory analysis of samples is not included in this price.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SESDPROC-105-R2	(2013) Groundwater Level and Well Depth Measurement

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 302	Designation, Reportable Quantities, and Notification

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Chemical Testing

Conduct chemical sampling and analysis.

1.3.2 Assistance in Preparing O & M Manuals

****

NOTE: Traditionally, O & M manuals are prepared by the designers of the treatment system, e.g. under Title II services. The draft O & M manual should be required after completing construction of the treatment system. Since unanticipated events often occur during the period of operation (e.g., changes in levels of contaminants), it is not uncommon for operating procedures to deviate from the procedures set out in the draft O & M manual. The authors should seek input from the operators of the treatment system during preparation of the final O & M Manual. The final O & M manual should be required

before the period of the operations contract expires.

On some projects, it may be more expedient to have the Contractor prepare the O & M Manuals. If the Contractor will be tasked to prepare the O & M Manuals, this paragraph should be rewritten, and submittal requirements for draft and final O & M Manuals should be added.
****

Provide assistance to the team tasked to prepare the Draft and Final O & M Manuals. Include the following assistance: [providing equipment manufacture's literature, as requested; 24 hours of demonstrating operation, maintenance, and monitoring protocols during facility tours; and 4 hours of answering follow-up questions][_____].

1.3.3 Sequencing and Scheduling

****
NOTE: The initial period of operation should not begin until the Contractor has fulfilled the requirements for commissioning and demonstration of the full-scale SVE system.
****

Do not initiate the first period of operation of the full-scale system until after test and inspection reports in Section 02 62 16.16 10 COMMISSIONING AND DEMONSTRATION FOR SOIL VAPOR EXTRACTION (SVE) SYSTEMS have been submitted and approved. Notify the Contracting Officer not less than [14][_____] calendar days prior to initiating the first period of operation.

1.4 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy

and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

SVE System Operation Plan; G, [_____]

Process Monitoring; G, [_____]

Contaminated Material Storage and Disposal; G, [_____]

Completion Testing; G, [_____]

SD-06 Test Reports

Laboratory Analysis Reports

Completion Testing Report

SD-07 Certificates

Operator Qualifications

Maintenance Schedule

SD-10 Operation and Maintenance Data

Operations Reports; G, [_____]

Operations Log; G, [_____]

Maintenance Log; G, [_____]

Contract Completion Report; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Permits and Licenses

****

NOTE: It is important for the designer to become familiar with the appropriate state and local

requirements to determine if there is a need to obtain an operating permit for the system and to include those requirements in these paragraphs. The designer should also bear in mind that any SVE system operated as part of site remediation under CERCLA authority does not require federal, state or local permits. This includes all NPL and non-NPL sites being remediated under CERCLA authority such as DERP, IRP, FUDS, or BRAC program projects. Permits that have already been acquired should be attached to the specifications and referenced.

These paragraphs should be coordinated with Sections 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS and 44 13 10.13 VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS (if used).

****

Obtain required federal, state, and local permits for operation of the SVE system.

1.5.2 Air Emissions

****

NOTE: An air pathway analysis should be performed during design to determine if air monitoring will be required. Guidance on air pathway analyses is provided in EP 200-1-24 - Air Pathway Analysis for the Design of Remedial Action Projects, 30 September 2015.

Appropriate federal, state, and local permits should be identified in this paragraph, and site specific permit requirements should also be provided. For projects where a permit is required, usually the State agency will issue an air pollution control permit (or permit equivalent) that will specify emissions control requirements. The following requirement is an example from a State air pollution control permit equivalent, "The maximum emission rate of total VOC not exceed 0.092 lbs/hr".

****

Monitor, control and report air emissions in accordance with the following regulatory requirements: [_____]. [The air pollution control permit equivalent has been acquired and is shown in Appendix [_____]].

1.5.3 Noise Control

****

NOTE: In the equipment specifications there should be a requirement for the blower not to exceed a specified noise level. This paragraph is intended to ensure that the Contractor maintains noise control throughout the period of operation, during all site activities. Ensuring that noise levels are adequately controlled is especially important for projects near residential areas.

****

Ensure the SVE system [meets state and local noise pollution control regulations.][does not exceed [_____] decibels at any site boundary.]

1.5.4 Operator Qualifications

****

NOTE: Some states may already have licensing or certification requirements for operators at sites where an air pollution control permit is required (e.g., on most RCRA projects). If the project does not require an air pollution control permit (e.g., on some CERCLA projects), then there are usually not any state licensing requirements for operators.

If remediation is not being performed under CERCLA authority (this includes both National Priority List (NPL) and non-NPL sites under Defense Environmental Restoration Program (DERP), Installation Restoration Program (IRP), Formerly Used Defense Sites (FUDS), or Base Realignment and Closure (BRAC) programs), the operator must comply with applicable state or local requirements for certification and training for operation of the SVE system. As some states have these requirements and others do not, the designer must research the state or local requirements and include them in this paragraph.

****

Provide a the chief operator with at least [2][_____] years of experience in operating air emissions control equipment, and at least [3][_____] years of experience working on projects involving clean-up of CERCLA hazardous substances, or RCRA hazardous wastes. Each member of the operations staff is required to possess a [high school diploma or equivalent] [_____]. Submit Operator Qualifications not more than [21][_____] calendar days prior to initiating the first period of operation. Allow a period of not less than [14][_____] calendar days in the schedule for Government review. Provide resume of each member of the operations including a chronology of education, state licenses, and relevant work experience.

1.6 PROJECT/SITE CONDITIONS

****

NOTE: Include any pertinent information regarding project/site conditions in this paragraph and on the drawings.

****

Approximate locations of contaminated zones are shown on the drawings. Chemical analysis of contaminated material and soil gas testing [has not been performed][has been performed and is shown in Appendix [_____]]. Boring logs are shown [on the drawings][in Appendix [_____]]. Ground water is approximately [_____] meters feet below ground surface. [A pilot-scale SVE demonstration has been performed and the report is shown in Appendix [_____]].

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Spill Response Materials

Keep the following spill response materials on site: [containers, adsorbents, shovels, and personal protective equipment][_____]. Keep spill response materials available at all times in which hazardous materials/wastes are being handled or transported. Ensure spill response materials are compatible with the type of materials being handled, and are located [as shown on drawings][_____].

PART 3 EXECUTION

3.1 APPLICATION

3.1.1 SVE System Operation

****

NOTE: The length of the initial period of operation should be defined in the bid schedule, typically the construction Contractor is required to operate the treatment system for a period of about 12 months, after completion of the prove-out period. Contracts may also be written to include options for additional periods of operation. The length of the periods of operation should be based on the expected time to complete the remedial action. Use of optional periods of operation makes for a more flexible contract. Once clean-up goals have been reached, any remaining options for additional periods of operation would not be exercised.

****

Submit an SVE System Operation Plan not more than [30][_____] calendar days after notice to proceed. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. In the plan, include an outline of the Operations Reports. The period of operation begins after approval of the following plans, and receipt of written approval from the Contracting Officer: (a) System Operation, (b) Maintenance Plan, (c) Process Monitoring Plan, and (d) Contaminated Material Storage and Disposal Plan.

3.1.1.1 Period of Operation

Operate the SVE system for a period of [365][_____] calendar days. Do not include time required to complete commissioning and demonstration in the period of operation.

3.1.1.2 Hours of Operation and Reliability

****

NOTE: The reliability requirement should allow enough downtime for the Contractor to perform scheduled maintenance.

****

Unless otherwise directed by the Contracting Officer, keep the SVE system in operation [24 hours per day, 7 days a week][_____]. Reliability is the percent of time that the system is on, and minimum airflow rates are being maintained. Ensure the reliability of the system is at least [95 percent][_____] of the total hours available in each 30 calendar day period. Record hours of operation and downtime in the Operations Log, at least once every [14][_____] calendar days. Keep the Operations Log at the facility, and available for inspection.

3.1.1.3 Operational Airflow Rates

For the SVE system to be considered in operation, turn the blower on and ensure air is flowing from the wells designated in Table 1 at the flow rates shown in Table 1, [except during off-cycle periods as designated in Table 2][_____].

TABLE 1 - AIRFLOW RATES

WELL IDENTIFICATION	MINIMUM AIRFLOW RATE
[_____]	[_____]

3.1.1.4 Intermittent Operation of Wells

****

NOTE: This paragraph should be deleted unless there are wells that will be operated intermittently.

Periodic shutdown of selected SVE wells can be used to allow time for subsurface VOC levels to rebound, and to thereby maintain higher recovery rates from active wells. The length of the shut down period is site specific, and should be based on soil gas monitoring at the site. At some sites soil gas VOC levels will increase very slowly after shutdown, and a longer shutdown period may be required. Periodic sampling of the soil gas concentrations during the shutdown can also assist in assessment of the remaining mass in the site. Refer to Appendix F of EM 1110-1-4001.

The frequency of vapor stream monitoring should be increased immediately after bringing SVE wells back on line, in order to measure the rebound spike. Periodic rebound testing is a useful tool for assessing the progress of SVE operations. See paragraph, Rebound Testing.

****

Cycle operation of designated wells in accordance with Table 2.

TABLE 2 - SCHEDULE FOR CYCLICAL OPERATION OF WELLS

WELL IDENTIFICATION	ON-CYCLE PERIOD	OFF-CYCLE PERIOD
[_____]	[_____]	[_____]

3.1.1.5 Adjustments to Mode of Operation

****

NOTE: After the system has been in continuous operation for a few months (and vapor stream data has been reviewed), strategies that may hasten completion of the project (and reduce operating costs) should be considered. Such strategies may include: installing impermeable surface covers; increasing, decreasing or stopping air flow from certain wells; and periodic cycling of designated wells. In extremely arid climates, controlled irrigation may improve contaminant removal rates. Also see paragraph, Pneumatic Flow Meter Testing. Any changes may require that the contract be modified

Value Engineering (VE) Clauses are usually included in contracts to provide incentive for the Contractor to identify areas where savings can be realized. If there are clearly areas that show a strong potential for substantial cost savings, then it may be worthwhile to request that the Contractor submit a VE proposal to change the mode of operation. The Design Team should verify that a VE Clause is included in the contract.

Remedial System Evaluations(RSE) offer another way to assess the performance of the system, and to determine if changes should be made to hasten completion of the project, and reduce operating costs. A description of RSEs and RSE checklists can be found at the following internet site: . RSEs are typically performed after a treatment system has been in operation for at least one year. If RSE recommendations will require costly modifications to the treatment system equipment, and the period of the Contract is nearly over, then it may be best to build these recommendations into a future contract. The Contractor tasked to make substantial changes to the treatment system should be responsible for a minimum period of operation after the changes have been implemented.

****

Obtain written approval from the Contracting officer before implementing any changes to the mode of operation.

3.1.1.6 Operations Reports

Submit Reports as specified and scheduled as follows: [weekly for the 1st two weeks; every 4 weeks for the 3rd through the 10th week; and every 3 months thereafter][_____]. Submit reports within 7 [_____] days of the end of the period covered by the report. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. For the period covered by each Operations Report, provide the following data: [hours of operation and hours of downtime; the amount of time that each SVE well was in use; and the cumulative total hours of operation][_____].

Organize results of Process Monitoring according to category, and shown chronologically within each category. Include Meteorological and Subsurface Monitoring data, and Process Air Stream and Equipment Monitoring data in each report. Provide the following graphs with each Operations Report. For each SVE well, plots of: volume of air extracted versus time, cumulative volume of air extracted versus time, field measurements of concentration of [contaminants of concern] [_____] versus time, vacuum responses in [all] vacuum monitoring points [_____], mass removal rate of [contaminants of concern] [_____] versus time, and cumulative mass of [contaminants of concern] [_____] removed versus time. For the SVE system as a whole, plots of: the concentration of [contaminants of concern] [_____] versus time, mass removal rate of [contaminants of concern] [_____] versus time, and cumulative mass of [contaminants of concern] [_____] removed versus time. Sign and date the reports by the Contractor's Quality Control representative. If warranted, provide in the reports any recommendations for changing airflow rates from individual wells, and other proposed adjustments to the mode of operation.

3.1.1.7 Operations Log

Submit copies of operations log sheets with each Operations Report for the period covered by the Operations Report. Keep the original log sheets in notebooks organized in chronological order, and submitted with the Contract Completion Report not more than [14][_____] calendar days after completing work at the site.

3.1.2 Process Monitoring

****

NOTE: Periodically the monitoring parameters, and the frequency of monitoring should be re-evaluated to determine if monitoring requirements should be changed. For most projects, the frequency of monitoring can be decreased as more operational data is generated.

Labor costs and the accessibility of the site should be factored into the monitoring schedule. For small-scale SVE systems that are designed to operate with minimal operator attention, the frequency of monitoring should be less than that of a large-scale, more complex SVE system.

****

Evaluate the monitoring schedule every [6 months][_____]. Propose recommended changes to the monitoring schedule, if warranted. Obtain written approval from the Contracting officer before implementing any changes to the monitoring schedule. Submit a plan for Process Monitoring not more than [30][_____] calendar days after notice to proceed. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Include physical and chemical monitoring requirements, including test parameters, frequency of sampling, number of samples, and sampling locations; and laboratory turn-around-time in the plan.

3.1.2.1 Meteorological and Subsurface Monitoring

Perform meteorological and subsurface monitoring to assess the response of the subsurface to the SVE system.

3.1.2.1.1 Meteorological Monitoring

****

NOTE: Automated monitoring equipment can be used to collect meteorological data. Meteorological data may also be available from a monitoring site in the immediate vicinity (e.g., an airport).

****

Record the following data at least once every [Monday, Tuesday, Wednesday, Thursday, and Friday][_____]: ambient temperature, and daily amount of precipitation. Record the barometric pressure each time that airflow rate monitoring is performed.

3.1.2.1.2 Vadose Zone Pressure Monitoring

****

NOTE: Vadose zone pressure should be monitored periodically, and each time that changes are made to the air extraction rates, or to the configuration of active extraction wells. Ideally, the site should be equipped with nested pressure monitoring points, placed at discrete depth intervals (corresponding to the depths of contaminated zones), and at several locations within the contaminated zones. It is also important to monitor from locations in the contaminated zone that are mid-way between SVE wells, and at relatively long distances from SVE wells, since "stagnant zones" (or reduced airflow rates) may occur at these locations.

Vadose zone pressure monitoring should be performed as part of the assessment of the zone of influence. Determination of air velocity (or travel time), rather than just vacuum levels, at vadose zone monitoring points should be used to assess the zone of influence. If vadose zone modeling will be performed, then data requirements for the model should be consistent with the monitoring procedures.

****

Perform vadose zone pressure monitoring at least once every [28][_____] calendar days, and each time that changes are made to the configuration of active SVE wells. Monitor at the following locations: [_____].

3.1.2.1.3 Groundwater Levels

****

NOTE: Groundwater level monitoring may be necessary to determine if operation of the SVE system results in upwelling of the water table, or if fluctuations in the water table (not related to SVE operations) are limiting the effective depth of SVE. If upwelling is occurring, then soils that were previously part of the lower vadose zone may become saturated and thus will not be treated via operation of the SVE system. Upwelling is usually localized around extraction wells (especially in porous soils), but some monitoring may be necessary to

determine the extent of upwelling. If the contaminated zones are well above the water table then groundwater level monitoring may not be necessary.

Site-specific considerations should be incorporated into the monitoring schedule. Water levels may be influenced by factors such as tidal cycles, and seasonal pumping from irrigation wells.
****

Measure groundwater levels at least once every [90][_____] calendar days at the following monitoring wells: [_____]. Perform water level measurement in accordance with EPA SESDPROC-105-R2. Record water level readings to the nearest 3.0 mm 0.01 foot. Decontaminate the part of the measuring device that was wetted after each measurement.

3.1.2.1.4 Pneumatic Flow Meter Testing

****
NOTE: This paragraph should be deleted if pneumatic flow meter testing will not be required. If it has not already been performed, pneumatic flow meter testing of the SVE wells should be considered. Ideally, pneumatic flow meter testing should be performed during design investigations. However, information gained from these tests can be used as part of a systematic plan to optimize operation of an SVE system.

Pneumatic logging of SVE wells is analogous to borehole flow meter testing of groundwater wells. A probe accurately measures the incremental increases in airflow as it moves up from the bottom of the well while air is extracted from the well. A sampling port on the probe allows the determination of the soil gas concentration in the well at the depth of the probe. The sampling data, coupled with the flow data, allows a determination of the contaminant mass input at different depths.

Pneumatic logging data is useful for producing vertical air permeability profiles, evaluating the distribution of contaminants, tailoring well construction, and changing operating strategy. Pneumatic logging data may also be used to define input values for vadose zone modeling.
****

Perform pneumatic flow meter testing at the following SVE wells [_____]. Monitor the following parameters continuously during testing: [airflow rate, vacuum, probe depth, and PID or FID response][_____].

3.1.2.2 Process Air Stream and Equipment Monitoring

Perform process air stream and equipment monitoring as part of the overall assessment of the SVE system, and to monitor operation of SVE system equipment.

3.1.2.2.1 Combustible Organic Vapor Monitoring

****

NOTE: Some SVE systems are designed to handle vapor stream contaminant levels that are above the lower explosive limit. However, even if an explosion-proof blower and motor are being used, ignition of an organic-laden vapor stream is still possible (e.g., static electricity may build up inside piping that is not grounded, and a spark may be released). Combustible organic vapor monitoring should be performed to reduce the risk of a fire or explosion during operation of SVE systems.

A flame ionization detector (FID) is usually recommended for this type of monitoring. Combustible gas indicators (CGI) can also be used, but only if oxygen levels are also being monitored. Combustible gas indicators can produce false readings if the level of oxygen in the sample is less than the minimum level of oxygen required for the instrument to function properly.

Site-specific action levels should be established prior to initiating the first period of operation. Action levels should be based on the types of volatile organic compounds present in the vadose zone, and the specific monitoring instrument and calibration gas being used. The action levels may require modification as more monitoring data is generated.

****

After opening the valves to begin extracting air from an extraction well that is being brought on-line for the first time, initiate monitoring during the following time intervals: [0-1 minute, 30-45 minutes, 60-75 minutes, and 120-135 minutes][_____]. In addition, monitor at least one time daily during the first [_____][200 hours] of operation of the SVE system, and at least one time daily until each extraction well has been in continuous operation for a minimum of [_____][72 hours]. During each monitoring event, record [at least 3 readings, separated by 1 minute increments,] [_____]. Monitor at the following location: [in the combined piping manifold (upstream from the inlet bleed line)] [_____]. If the [flame ionization detector][_____] indicates that the vapor stream has reached [5000 ppmV as isobutylene][_____], then immediately make adjustments to decrease the level of organic compounds in the vapor stream. Such adjustments may include adjusting airflow rates from selected wells. Repeat the monitoring and adjustment procedure until the organic vapor level of the vapor stream has been decreased to less than [5000 ppmV as isobutylene][_____].

3.1.2.2.2 Airflow Rate Monitoring

****

NOTE: To accurately determine volumetric airflow rates the density of the air stream should be calculated. Air density is dependent on relative humidity, temperature and barometric pressure. The Contractor's measurement of airflow rates should

periodically be independently verified by a NEEB or AABC certified Testing, Adjusting, and Balancing specialist.

****

Monitor pressures, temperatures, and airflow rates at the following locations at least once every [14][_____] calendar days: [in piping from each individual SVE well being used; in the combined piping manifold (upstream from the inlet bleed line); in the inlet bleed line; and at the discharge stack][_____]. Monitor airflow rate in accordance with manufacturer's instructions for the airflow monitoring devices. Record instrument readings, and provide, in each Operations Report, any assumed values that were used to calculate airflow rates. Verify measurement of airflow rates independently by a NEEB or AABC certified Testing, Adjusting, and Balancing specialist at least once every [90][_____] calendar days, and perform in accordance with Section 23 05 93 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS. Attach a copy of the airflow rates determined and signed by the NEEB or AABC certified Testing, Adjusting, and Balancing specialist to the Operations Report for the period when the airflow rate was verified.

3.1.2.2.3 Air/Water Separator and Condensate

****

NOTE: During cold weather, greater volumes of condensate may accumulate than during warm weather. More frequent monitoring may be necessary during periods of cold weather.

****

Record the volume of condensate in the air/water separator at least once every [14][_____] calendar days. Also record the volume of condensate generated since the previous monitoring event and cumulative total volume of condensate.

3.1.2.2.4 Blower and Particulate Filter

Record the following parameters at least once every [14][_____] calendar days: hour meter readings from the totalizing hour meter on the blower; pressures and temperatures immediately upstream from the blower and immediately downstream from the blower; and pressures immediately upstream and downstream from the inlet particulate air filter.

3.1.2.3 Vapor Stream Contaminant Level Monitoring

****

NOTE: Real-time vapor monitoring instruments are sensitive to the gasoline, or light fuel fraction contaminants such as benzene, toluene, ethyl benzene, and xylene (BTEX). A photo-ionization detector (PID) or flame-ionization detector (FID) may be used to detect constituents normally found in gasoline such as BTEX. For some types of contaminants (e.g., PCE and TCE), use of an FID is preferred over a PID. For SVE applications, an FID is usually recommended over a PID because the vapor stream is commonly moist, and an FID is less sensitive to moisture.

Vapor stream monitoring requirements are site specific, and must be in accordance with regulatory requirements. Regulatory representatives should be provided the opportunity to provide input on vapor stream monitoring requirements in the early stages of remedial design. The monitoring protocol shown below is provided as an example only, and has no regulatory basis.

****

Perform vapor stream monitoring within the first hour after startup, every six hours for the first two days, and once per day for the next five days. Monitor in accordance with regulatory requirements.

3.1.2.3.1 Field Analysis

Perform vapor stream monitoring at least once every [14][_____] calendar days. During each monitoring event, record [at least 3 readings, separated by 2 minute increments,] [_____]. Collect in each monitoring event the [flame ionization detector readings][_____] from the following locations: [each individual SVE well being used; in the combined piping manifold (upstream from the inlet bleed line); the inlet of the vapor stream treatment system; between the lead and lag vapor stream treatment units; and from the discharge stack][_____].

3.1.2.3.2 Laboratory Analysis

Perform laboratory analysis of vapor stream samples as follows: [weekly for the first 2 weeks, every 4 weeks for week 3 through 11, and at least once every 90 calendar days thereafter.][_____]. Collect one air stream sample for laboratory analysis from each of the following locations: [in the combined piping manifold (upstream from the inlet bleed line); the inlet of the vapor stream treatment system; and from the discharge stack] [_____]. Take the sample for laboratory analysis immediately after collecting the sample for field analysis at each sample port. Test samples for the following analytes: [_____].

3.1.2.4 Vapor Stream Treatment System

****

NOTE: These paragraphs should be deleted if vapor stream treatment will not be required. If the vapor stream treatment system involves a process other than granular activated carbon adsorption, then these paragraphs should be revised accordingly.

****

Whenever soil vapor is being extracted, route the vapor stream continuously through [2 adsorption vessels, configured in series,] [_____] before being released to the atmosphere.

3.1.2.4.1 Vapor Stream Heating

****

NOTE: If granular activated carbon is being used for vapor stream treatment, then the relative humidity of the vapor stream should be less than 50 percent before entering the carbon vessels. Adsorption efficiency will be reduced, and carbon

consumption will increase as the relative humidity increases. The heat generated by the blower can often be used to decrease the relative humidity of the vapor stream. A temperature rise of about 11 degrees F 20 degrees F is usually sufficient to reduce the relative humidity of the vapor stream to about 50 percent. If the temperature and pressure of the vapor stream are being monitored at locations upstream and downstream of the blower, then the change in relative humidity across the blower can be calculated.

****

Before entering the lead adsorption vessel, heat the vapor stream to at least [11 degrees C 20 degrees F] [_____] higher than the temperature coming out of the extraction wells.

3.1.2.4.2 Pressure and Temperature

Monitor pressures, and temperatures of the vapor stream at the following locations at least once every [14][_____] calendar days: [at the inlet to the lead adsorption vessel; between the lead and lag adsorption vessels; and at the outlet of the lag adsorption vessel][_____].

3.1.2.4.3 Change-Out of Adsorption Vessels

****

NOTE: Site-specific action levels should be established prior to initiating the first period of operation. Action levels should be based on the types of volatile organic compounds present in the vadose zone, and the specific monitoring instrument and calibration gas being used. The action levels may require modification as more monitoring data is generated.

****

Not more than [72][_____] hours after detection of breakthrough, replace the lead vessel by the lag vessel and place a fresh vessel in the lag position. Breakthrough is defined as follows: when field analysis indicates that contaminant concentrations at the outlet of the lead vessel [has reached the level that corresponds to the permitted maximum emission rate][exceed [_____]% of the influent concentrations]. Record the volume of air that was treated from the time that the vessel was placed in the upstream position until breakthrough was consistently determined as the breakthrough volume. Submit to the Contracting Officer a written record of the field analysis data, and the breakthrough volume, not more than [24][_____] hours after breakthrough was detected.

3.2 QUALITY CONTROL

3.2.1 Completion Testing

****

NOTE: This paragraph should be deleted if completion testing will not be included in the contract. There is often a great deal of uncertainty regarding how long the treatment system will be required to operate. At some sites,

completion testing may not be appropriate until after the contract for construction and the initial period of operation of the treatment system has been completed. However, it may be advantageous to include a separate, optional item in the contract for completion testing. If it is not possible to determine the completion testing requirements when this contract is being written, then a contract modification may be required as soon as the completion testing requirements have been determined.

Many military facilities have base-wide sampling and analysis plans that have been approved by the applicable regulatory agencies. However these plans may not specify the number of confirmation samples which must be taken. The number of confirmation samples should be based on the depth and area extent of the contaminated zone and regulatory requirements. The following reference provides guidance on the design of statistically based sampling intervals: EPA 230/02-89-042 - Methods of Evaluation and Attainment of Cleanup Standards.

Some of the samples used for completion testing should be collected from locations that are mid-way between SVE wells, and near the perimeter of the area of concern, to determine if SVE operations have adequately remediated the contaminated zone. One or more lines of evidence may be required as part of completion testing. The following reference includes guidance for obtaining closure of SVE operations: Evaluation of Mass Flux to and from Groundwater Using a Vertical Flux Model (VFLUX): Application to the Soil Vapor Extraction Closure Problem; DiGiulio, et al., Groundwater Monitoring and Remediation, Spring 1999, Vol. 19, No. 2; Soil Vapor Extraction System Optimization, Transition, and Closure Guidance, PNNL-21842, February 2013, available at https://bioprocess.pnnl.gov/SVEET_Request.htm.

Completion testing requirements are site specific, and must be in accordance with regulatory requirements. Regulatory representatives should be provided the opportunity to provide input on completion testing requirements during design. If attainment of the original completion requirements is later determined to be technically impractical, then regulatory input will be required to explore the possibility of revising the completion testing requirements. The requirements shown below are provided as examples only, and have no regulatory basis.

****

a. Completion testing is defined as testing to determine whether to continue, or shutdown, operation of the SVE system. Provide written notification to the Contracting Officer not less than [14] [_____] calendar days prior to performing completion testing. Include the following information in the notification: the type of testing to be performed, the date and time of testing, and the names of the Contractor's representatives who will be present. Submit a plan for Completion Testing not more than [14] [_____] calendar days after requested. Allow a period of not less than [30] [_____] calendar days in the schedule for Government review. Address testing requirements for determining if regulatory clean-up criteria have been met, and for determining if the SVE system can be permanently shut down in the plan.

b. Submit a Completion Testing Report not more than [45] [_____] calendar days after finishing Completion Testing. Allow a period of not less than [30] [_____] calendar days in the schedule for Government review. Include narrative descriptions of each type of testing that was performed, and scaled drawings showing: [type of sample; sampling locations (and depths, if applicable); and sample identification numbers] [_____]in the report. Organize results of testing according to category, and shown chronologically within each category. Ensure the report is signed and dated by the Contractor's Quality Control representative.

3.2.1.1 Soil Boring Sampling

****

NOTE: This paragraph should be deleted if soil boring sampling will not be a required component of completion testing. Immunoassay field kits are available that are sensitive to light fuel fractions. EM 200-1-2, Appendix G, provides additional guidance on field analysis methods. See ASTM D4700, Standard Guide for Soil Sampling from the Vadose Zone, for additional information on sampling methods.

****

Collect soil boring samples from the following locations and depth intervals: [_____]. Record locations of samples in the field, and documented on the as-built drawings. Perform soil boring sampling in accordance with Section 02 32 13 SUBSURFACE DRILLING AND SAMPLING. Samples are to be tested for the following analytes: [_____].

3.2.1.2 Groundwater Sampling

****

NOTE: This paragraph should be deleted if groundwater testing will not be a required component of completion testing. Groundwater monitoring may be necessary after the levels of volatile organics in the vapor stream have dropped to asymptotic levels. If high levels of volatile organics are present in groundwater, then VOCs from groundwater may be continually migrating into, and re-contaminating, the vadose zone. Volatile organic vapors can also transfer contamination to the ground water.

****

Perform groundwater sampling as part of an assessment of the mass transfer rate of volatile organic contaminants from groundwater to the vadose zone. Perform sampling at the following monitoring wells: [_____]. Test samples for the following analytes: [_____].

3.2.1.3 Rebound Testing

****

NOTE: This paragraph should be deleted if rebound (or equilibrium) testing will not be a required component of completion testing. If the level of contaminants represented by the "rebound spike" is less than about ten times the level of the initial contaminant level spike (from when the system was first started up), this may indicate that recovery of volatiles has become diffusion limited and that continued operation of the SVE system will be of limited value. However, it still may be possible to increase contaminant removal rates through other means, see Analysis of Selected Enhancements for Soil Vapor Extraction, EPA-542-R-97-007, Sept. 1997.

Periodic rebound testing is a useful tool for assessing the progress of SVE operations. On some projects rebound testing is performed on a regularly scheduled basis (e.g., every 4 months). Comparison of the initial contaminant level spike to subsequent rebound spikes should play into the decision on whether to continue SVE operations. Analysis of rebound behavior can provide information on the remaining mass and progress toward closure. References that can guide the analysis include Brusseau, Rohay, and Truex, 2010, Analysis of Soil Vapor Extraction Data to Evaluate Mass-Transfer Constraints and Estimate Source Zone Mass Flux, Groundwater Monitoring and Remediation, Vol. 30, No.3, pp. 57-64 and Appendix F of the US Army Corps of Engineers Soil Vapor Extraction and Bioventing Engineer Manual EM 1110-1-4001, 2002 (see www.publications.usace.army.mil/LinkClick.aspx?fileticket=2t7j4pDfSiA%3ddtabid **).**

The length of the shut down period is site specific, and should be based on soil gas monitoring at the site. At some sites soil gas VOC levels will increase very slowly after shutdown, and a longer shutdown period may be required.

****

a. After the level of contaminants in the vapor stream have reached asymptotic levels, and written approval has been received from the Contracting Officer, shut the SVE system down for a period of [28][_____] calendar days. After the SVE system has remained idle for the prescribed time period, turn the system back on. Commence vapor stream monitoring immediately after turning the SVE system back on. perform vapor stream monitoring [every 30 minutes for the first 4 hours, every hour for the 4th through the 24th hour, and every 4 hours for the 24th through the 60th hour] [_____]. During each monitoring event, record [at least 3 readings, separated by 2 minute increments,][_____]. Data collected each monitoring event will include [flame ionization detector readings][_____] from the following locations: [each individual SVE well being used; and in the combined piping manifold (upstream from the inlet bleed line)][_____].

b. Submit Laboratory Analysis Reports for the vapor stream contaminant as specified in the Submittals paragraph. Results from laboratory analysis not more than [40][_____] calendar days after collecting samples. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Provide a table comparing field data to the laboratory data, for samples collected at the same time and from the same sampling port, with each set of laboratory analysis results. Sign and date the reports along with the Contractors Quality Control representative.

3.2.1.4 Soil Gas Monitoring

****

NOTE: This paragraph should be deleted if soil gas monitoring will not be a required component of completion testing. Use of passive soil gas sampling devices is generally not recommended at SVE sites; i.e., air should be withdrawn from the vadose zone to collect soil gas samples. If levels of volatile organics in whole air samples are below detection limits, they can be concentrated by passing a known volume of extracted soil gas through an adsorption device. See ASTM D5314, Standard Guide for Soil Gas Monitoring in the Vadose Zone, for additional information.

****

Perform soil gas monitoring by extracting air from the following soil vapor extraction wells and vadose zone monitoring points: [_____]. [In addition, perform a soil gas survey to collect samples from the following locations and depth intervals: [_____].] Perform soil gas sampling by either collecting whole-air samples, or by passing a known volume of extracted soil gas through an adsorption device. Test samples for the following analytes: [_____].

3.3 CLOSEOUT ACTIVITIES

3.3.1 Training

****

NOTE: If continued operation of the treatment system will be required after the contract expires, then the outgoing Contractor should be required to train the incoming Contractor. This paragraph should be coordinated with training prescribed in Sections 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS; OFF-GAS and 44 13 10.13 VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS.

****

Provide a minimum of [32 hours][_____] of training to the incoming Contractor prior to completion of the contract. Scheduling of training will be subject to approval by the Contracting Officer. In the Training sessions, include: [familiarizing the incoming Contractor with the O & M Manual; touring the treatment facility; demonstrating the use of each piece of equipment; demonstrating the use all interlocks and system controls;

demonstrating start-up and shut-down of system; demonstrating maintenance procedures; demonstrating process monitoring requirements and sampling procedures during a scheduled monitoring event; providing written inventory and showing the locations of materials and spare parts that will be left on-site; and answering questions][_____].

3.3.2 Contract Completion Report

****

NOTE: In addition to progress photos, video tapes have been used at some sites to record site activities.

****

Submit [_____] copies of Contract Completion Report not more than [14][_____] calendar days after completing work at the site. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Label the report with the contract number, project name, location, date, name of general Contractor, and the Corps of Engineers District Contracting for the work. Include in the report the following information as a minimum:

a. A cover letter signed by a [responsible Contractor representative] [Professional Engineer registered in the State of [_____] who is a responsible Contractor representative] certifying that all services involved have been performed in accordance with the terms and conditions of the contract specifications.

b. A narrative report including but not limited to the following:

    (1) site conditions, ground water elevation, and clean-up criteria;

    (2) monitoring locations and methods;

    (3) dates of the last 3 monitoring events;

c. Copies of the most recent test results and the final Operations Report.

d. Copies of manifests.

e. For materials that required offsite disposal, copies of certifications of final disposal signed by the responsible disposal facility official, and waste profile sheets.

3.4 MAINTENANCE

3.4.1 Contaminated Material Storage and Disposal

****

NOTE: For SVE systems, the most common type of potentially-contaminated media that may require collection and disposal is condensate from the air/water separator. However, the level of volatile contaminants in the condensate will be limited by the continuous flow of air through the piping. If significant volumes of condensate accumulate in the air/water separator, periodic testing may be necessary to determine storage and disposal requirements.

If activated carbon is being used for vapor stream treatment, then spent activated carbon will have to be regenerated or sent to a disposal facility.

For RCRA sites, hazardous waste can be stored in a drum or roll-off unit for up to 90 days without a permit. For temporary storage of more than 90 days, dual containment of hazardous liquid and some hazardous solids is required. Containment system requirements are described in 40 CFR 264.175 - Containment.

Storage requirements will depend on factors such as whether the contaminated material is determined to be hazardous waste. If there are site-specific factors that dictate the need for dual containment, this paragraph should be revised accordingly. The Contractor may be required to identify all necessary permits or permit equivalents and actions necessary to comply with applicable regulations.
****

Ensure the methods of contaminated material storage are in accordance with regulatory requirements. If multiple storage units are required, label each unit clearly with an identification number and keep a written log to track the source of contaminated material in each temporary storage unit. Submit a plan for Contaminated Material Storage and Disposal not more than [30] [_____] calendar days after notice to proceed. Allow a period of not less than [30] [_____] calendar days in the schedule for Government review. Include testing requirements, including test parameters, frequency of sampling, number of samples, and sampling locations; laboratory turn-around-time in the plan.

3.4.1.1 Liquid Storage

Store liquid collected temporarily in [220 L 55 gallon barrels] [[2000] [_____] L [500] [_____] gallon tanks]. Ensure liquid storage containers have no leaks and are be located [as shown on the drawings] [_____].

3.4.1.2 Sampling Liquid

****
NOTE: The frequency of testing should be based on the rate of liquid generation, the size of the storage containers, and regulatory requirements. Offsite disposal may require additional testing and analysis prior to disposal. NPDES requirements must be considered for onsite disposal of liquids.
****

Sample liquid collected at a frequency of at least once every [2,000] [_____] L [500] [_____] gallons of liquid collected. Test samples for the following analytes: [_____].

a. Chemical Parameter: [_____].

b. Regulatory Limit: [_____].

Treat liquid with contaminant levels that exceed regulatory limits [offsite. Analyses for contaminated liquid to be taken to an offsite treatment facility conforming to local, state, and federal criteria as well as to the requirements of the treatment facility. Furnish documentation of all analyses performed to the Contracting Officer. Additional sampling and analysis required by the receiving off-site treatment, storage or disposal (TSD) facility is the responsibility of the Contractor] [onsite. Treat liquid in accordance with Section [_____]].

3.4.2 Spills

****

NOTE: Regarding pre-established spill reporting procedures, the designer should consult CEMP-RT memorandum of 20 July 1995, Subject: Spill Reporting Procedures for USACE Personnel Involved in HTRW Projects.

****

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), pollutant, contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), notify the Contracting Officer immediately. If the spill exceeds the reporting threshold, follow the pre-established procedures for immediate reporting to the Contracting Officer. Take immediate containment actions to minimize the effect of any spill or leak. Clean-up in accordance with applicable federal, state, and local regulations. Additional sampling and testing may be required to verify spills have been cleaned up. Perform spill clean-up and testing at no additional cost to the Government.

3.4.3 Disposal Requirements

Dispose of contaminated material offsite in accordance with SECTION 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.

3.4.4 Maintenance

****

NOTE: Proper servicing of equipment is especially important for equipment that will remain onsite after the contract expires. Maintenance oversight for equipment that will be retained by the Contractor may not be necessary.

****

3.4.4.1 Equipment Maintenance Schedules

Perform maintenance of equipment in accordance with manufacture's recommendations. Submit a preventative maintenance schedule for inspecting equipment, and a schedule for servicing of major equipment items. Submit a plan for Maintenance of the SVE System not more than [30][_____] calendar days after notice to proceed. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Perform maintenance according to schedule, and in response to monitoring data.

3.4.4.2 Maintenance Logs

Keep maintenance logs for each of the following units of equipment:

[air/water separator, particulate filters, blower, motor, instrumentation and control system, and vapor stream treatment system][_____]. Each time one of these units is serviced, make an entry in the maintenance log. Include the following entries in the maintenance log: date, reason for servicing, description of service performed, a list of the parts that were replaced, name of the service organization and technician performing the maintenance, and signature of the Contractor's Quality Control Representative. Keep the Maintenance Log at the facility, and available for inspection. Submit maintenance log sheets attached to each Operations Report for the period covered by the Operations Report. Keep the original log sheets in notebooks organized in chronological order, and submit with the Contract Completion Report not more than [14][_____] calendar days after completing work at the site.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 62 16.16 10 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS--02 62 16 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 62 16.16 10

COMMISSIONING AND DEMONSTRATION FOR SOIL VAPOR EXTRACTION (SVE) SYSTEMS

08/18

****

NOTE: This guide specification covers the requirements for commissioning and demonstration for soil vapor extraction (SVE) systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Commissioning is performed after construction has been completed, and is an ordered process for testing and start-up of SVE system equipment. During commissioning, pre-commissioning checklists are completed, and functional performance tests are performed to test individual components of the system and subsystems. Demonstration serves as a prove-out period. The purpose of the demonstration is to show that the SVE system, as a whole, is ready to be put into service.

This guide specification should be used in conjunction with Section 02 62 16.13 10 OPERATION, MAINTENANCE, AND PROCESS MONITORING FOR SOIL VAPOR

EXTRACTION SYSTEMS. For small-scale SVE projects, editing and combining this section with Section 02 62 16.13 10 should be considered. Additional guidance on start-up of SVE systems can be found in EM 1110-1-4001 SOIL VAPOR EXTRACTION AND BIOVENTING.

This guide specification should be coordinated with other sections that may also include commissioning requirements for SVE system components, to avoid unnecessary duplication of requirements.

****

1.1 UNIT PRICES

****

NOTE: If there is a separate Price and Payment Procedures Section, edited versions of these paragraphs should be inserted in that section. Coordinate these paragraphs with the bidding schedule.

Separate, lump sum prices are generally recommended for Baseline Monitoring, Commissioning, and Demonstration. However it is also recommended that bidders be required to provide unit cost amounts for laboratory testing for chemical data. Unit costs will provide a basis for negotiating for additional tests, if determined that more testing than was originally anticipated is required.

It is recommended that the bid sheet be structured so that a portion of the payment (i.e., at least 30 percent) for construction of the SVE system be withheld at least until the full-scale demonstration has been completed. If acceptance of the SVE system is granted before the bugs are worked out, there may not be sufficient incentive for the Contractor to finish fixing problems with the SVE system.

****

Base all measurements in accordance with completion of contract requirements. Payment is calculated at the respective contract prices in the bidding schedule.

1.1.1 Baseline Monitoring

Compensation is based on a lump sum price for Baseline Monitoring. Include physical and chemical testing performed in the field and sampling in this price. Cost for laboratory analysis of samples is not included in this price.

1.1.2 Commissioning

****

NOTE: Laboratory analysis of samples is usually not required during Commissioning. Vapor stream monitoring during commissioning typically involves using a field instrument, such as a flame ionization detector (FID).

****

Compensation is based on a lump sum price for completion of Commissioning. Include physical and chemical testing performed in the field and sampling in this price. Laboratory analysis of samples [is][is not] required during Commissioning.

1.1.3 Demonstration

****

NOTE: Vapor stream monitoring during the full-scale demonstration typically involves using a field instrument, such as an FID, in conjunction with laboratory analysis of a limited number of samples.

****

Compensation is based on a lump sum price for completion of Demonstration. Include physical and chemical testing performed in the field and sampling in this price. Costs for laboratory analysis of samples are not included in this price.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SESDPROC-105-R2	(2013) Groundwater Level and Well Depth Measurement

1.3 ADMINISTRATIVE REQUIREMENTS

****

NOTE: Commissioning and demonstration of the full-scale SVE system should be preceded by a pilot-scale demonstration. The pilot-scale

demonstration (or field demonstration) is usually the last step of the design investigation. Data gained during the pilot-scale demonstration are critical to proper sizing of the blower and other process equipment, and to proper lateral and vertical placement of SVE wells. This section only addresses commissioning and demonstration for full-scale SVE systems.

The specifications for the treatment system, or for components of the treatment system, should include requirements for testing, adjusting and balancing. Blowers, motors and air handling components of the SVE system should be tested in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS prior to commissioning. Although Section 23 05 93 is oriented primarily toward HVAC systems, the same testing, adjusting, and balancing requirements should be applied to components of the SVE system.

****

1.3.1 Chemical Testing

Conduct chemical sampling and analysis.

1.3.2 Submittal Requirements

Provide submittals in both hard copy, and electronic files on disc. Provide electronic files compatible with the following software: [_____]. If a part of a submittal is not available in electronic format, include a note describing which items were not provided in electronic format and explaining why the items could not be provided in electronic format.

1.3.3 Sequencing and Scheduling

Follow the sequence of work as outlined below: construction completion, commissioning, and full-scale field demonstration. [Complete baseline monitoring prior to initiating commissioning.] Do not initiate commissioning of the full-scale system until after work required in the following Sections has been completed, and test requirements in these Sections have been substantially completed: [Sections 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS, 31 21 00 OFF-GASSING MITIGATION, 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS, and 44 13 10.13 VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS][_____].

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item,

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Baseline Monitoring Plan; G, [_____]

Commissioning Team

Commissioning Plan; G, [_____]

Full-Scale Demonstration Plan; G, [_____]

Pre-Commissioning Tests; G, [_____]

Baseline Monitoring Schedule

Pre-commissioning checks

SD-06 Test Reports

Baseline Monitoring Report

Commissioning Report

Full-Scale Demonstration Report

Full-Scale Demonstration Log

Laboratory Analysis Report

1.5 QUALITY CONTROL

1.5.1 Regulatory Requirements

1.5.1.1 Permits and Licenses

****

NOTE: It is important for the designer to become familiar with the appropriate state and local requirements to determine if there is a need to obtain an operating permit for the system and to include those requirements in these paragraphs. The designer should also bear in mind that any SVE system operated as part of site remediation under CERCLA authority does not require federal, state or local permits. This includes all NPL and non-NPL sites being remediated under CERCLA authority such as DERP, IRP, FUDS, or BRAC program projects. Permits that have already been acquired should be attached to the specifications and referenced.

These paragraphs should be coordinated with Sections 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS and 02 62 16.13 10 OPERATION, MAINTENANCE, AND PROCESS MONITORING FOR SOIL VAPOR EXTRACTION (SVE)SYSTEMS.

****

As required by regulations, obtain federal, state, and local permits for commissioning and demonstration of the SVE system. [Permits that have already been acquired are attached to the specifications.]

1.5.1.2 Air Emissions

****

NOTE: Federal, state, and local air quality requirements (as necessary during commissioning and demonstration) should be identified in this paragraph.

This paragraph should be deleted if air emissions monitoring will not be required during commissioning and demonstration.

****

Monitor, control, and report air emissions in accordance with the following regulatory requirements: [_____].

1.5.1.3 Noise Control

****

NOTE: In the equipment specifications there should be a requirement for the blower not to exceed a specified noise level. This paragraph is intended to ensure that the Contractor maintains noise control during commissioning and demonstration. Ensuring that noise levels are adequately controlled is especially important for projects near residential areas.

****

Ensure the SVE system [meets state and local noise pollution control regulations.][does not exceed [_____] decibels at any site boundary.]

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 BASELINE MONITORING

Do not initiate baseline monitoring until after the Baseline Monitoring Plan has been approved, and written approval has been received from the Contracting Officer. Notify the Contracting Officer at least [14][_____] calendar days before starting baseline monitoring.

3.1.1 Baseline Monitoring Plan

Submit a plan for Baseline Monitoring at least [60][_____] calendar days before initiating Baseline Monitoring. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Include physical and chemical monitoring requirements, including test parameters, frequency of sampling, number of samples, and sampling locations; and laboratory turn-around-time in the plan. Include the field record data forms and an outline of the Baseline Monitoring Report in the plan. Submit Baseline Monitoring Schedule, at least [14][_____] calendar days prior to the start of baseline monitoring. Submit Baseline Monitoring Report not more than [35][_____] calendar days after completing baseline monitoring.

3.1.2 Team Members

Submit list of team members who represent the Contractor in the pre-commissioning checks and functional performance tests, at least [14][_____] calendar days prior to the start of pre-commissioning checks.

3.1.3 Sampling Results

Submit results from laboratory analysis not more than [40][_____] calendar days after collecting samples. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Provide table comparing field data to the laboratory data, for samples collected at the same time and from the same sampling port, with each set of laboratory analysis results. Submit the reports signed and dated by the Contractor's Quality Control representative.

3.1.4 Baseline Monitoring Requirements

3.1.4.1 Temperature and Precipitation

Record ambient temperature readings at least daily during baseline monitoring. Record temperature readings each time that barometric pressure readings are recorded. Record temperature readings to the nearest 0.5 degree C 1.0 degree F. Measure precipitation daily during baseline monitoring activities. Record precipitation readings to the nearest 2.0 mm 0.1 inch.

3.1.4.2 Barometric Pressure and Vadose Zone Pressure

****

NOTE: The subsurface response to changes in

barometric pressure should be established during baseline monitoring. At sites with low permeability layers there may be a pressure differential between the atmosphere and the subsurface, or there may be a lag period before the subsurface equilibrates with the atmosphere.

****

Record barometric pressure readings 3 times per day for 3 consecutive days at the following times: [0800, 1200, and 1700 hours][_____]. To establish subsurface response to changes in barometric pressure, record vadose zone pressures within 15 minutes of the barometric pressure readings at the following soil vapor extraction wells and vadose zone monitoring points: [_____]. Record pressure readings to the nearest 2.0 mm 0.1 inch of mercury.

3.1.4.3 Soil Gas Monitoring

****

NOTE: This paragraph should be deleted if baseline soil gas sampling has already been performed. In addition to contaminants of concern, testing for the following parameters should be considered: total volatile hydrocarbons, oxygen, carbon dioxide, and methane.

Use of passive soil gas sampling devices is generally not recommended at SVE sites; i.e., air should be withdrawn from the vadose zone to collect soil gas samples. If levels of volatile organics in whole air samples are below detection limits, they can be concentrated by passing a known volume of extracted soil gas through an adsorption device. See ASTM D5314, Standard Guide for Soil Gas Monitoring in the Vadose Zone, for additional information.

****

Prior to start-up of the system, perform soil gas monitoring by extracting air from the following soil vapor extraction wells and vadose zone monitoring points: [_____]. [In addition, perform a soil gas survey to collect samples from the following locations and depth intervals: [_____].] Perform soil gas sampling by either collecting whole-air samples, or by passing a known volume of extracted soil gas through an adsorption device. Test samples for the following analytes: [_____].

3.1.4.4 Groundwater Levels

Record water levels for each of the following wells: [_____]. Complete water level measurements for all designated wells in not more than [72][_____] hours, from start to finish. Perform water level measurement in accordance with EPA SESDPROC-105-R2. Record water level readings to the nearest 3.0 mm 0.01 foot. Decontaminate the part of the measuring device that was wetted after each measurement.

3.1.4.5 Soil Boring Sampling

****

NOTE: This paragraph should be deleted if the soil

boring sampling has already been performed. In addition to contaminants of concern, testing for the following parameters should be considered: percent moisture, and fraction organic carbon.

Immunoassay field kits are available that are sensitive to light fuel fractions. See ASTM D4700, Standard Guide for Soil Sampling from the Vadose Zone, for additional information on sampling methods.
****

Collect soil boring samples from the following locations and depth intervals: [_____]. Perform soil boring sampling in accordance with Section 02 32 13 SUBSURFACE DRILLING AND SAMPLING. Test samples for the following analytes: [_____].

3.1.5 Baseline Monitoring Report

Submit a baseline monitoring report. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Organize results of Baseline Monitoring according to category, and shown chronologically within each category. Include in the report monitoring locations (and depths, if applicable), and sample identification numbers. Prepare separate plan view maps showing monitoring locations and depths, and the results of [soil gas monitoring, groundwater levels, and soil boring sampling][_____]. Ensure that the report is signed and dated by the Contractor's Quality Control representative.

3.2 COMMISSIONING

Do not initiate commissioning until the Commissioning Plan has been approved, and written approval has been received by the Contracting Officer. Notify the Contracting Officer at least [14][_____] calendar days before starting commissioning. Perform combustible organic vapor monitoring during commissioning in accordance with paragraph 3.10.6.1, Combustible Organic Vapor Monitoring.

3.2.1 Commissioning Plan

Submit a plan for Commissioning at least [60][_____] calendar days before initiating Commissioning. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Include in the Commissioning Plan a list of Pre-Commissioning and Functional Performance Tests. Include the field record data forms. Include detailed procedures for pre-commissioning checks and functional performance tests, at least [35][_____] calendar days prior to the start of pre-commissioning checks. Allow a period of not less than [21][_____] calendar days in the schedule for Government review. A schedule for pre-commissioning checks and functional performance tests, at least [14][_____] calendar days prior to the start of pre-commissioning checks. Submit the Commissioning Report not more than [14][_____] calendar days after completing commissioning. Allow a period of not less than [14][_____] calendar days in the schedule for Government review. Submit completed pre-commissioning checklists and functional performance tests checklists (organized by system and by subsystems) as one package. Include the results of failed tests along with a description of the corrective action taken.

3.2.2 Team Members

Submit list of team members who represent the Contractor in the pre-commissioning checks and functional performance tests, at least [14][_____] calendar days prior to the start of pre-commissioning checks.

3.2.3 Sampling Results

Submit results from laboratory analysis not more than [40][_____] calendar days after collecting samples. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Provide table comparing field data to the laboratory data, for samples collected at the same time and from the same sampling port, with each set of laboratory analysis results. Submit the reports signed and dated by the Contractor's Quality Control representative.

3.2.4 Commissioning Requirements

3.2.4.1 Commissioning Team and Checklists

****

NOTE: The "design Agent's Representative" will be a member of the design team, i.e. from the AE or from Engineering Division. Where possible, the "Design Agent's Representative" should be included as a member of the commissioning team for the pre-commissioning checklists. The Design Agent's Representative will participate in functional performance tests. The planning, programming and funding for the Design Agent's Representative, whether in-house or A-E personnel will be used, must be addressed no later than the Predesign Conference.

The number of team members required to be present during commissioning should be based on the scale and complexity of the SVE system. The disciplines that need to be represented should be based on the types of equipment incorporated into the SVE system. Commissioning of a relatively simple system will require fewer individuals.

The checklists provided are to be used as guides for the preparation of project-specific checklists. An appropriate checklist should be included for each major component of the SVE system. The designer should insert additional checklists for equipment or systems not included in this guide specification, or modify the checklists where necessary for project-specific requirements.

****

Designate team members to participate in the pre-commissioning checks and the functional performance testing. In addition, the Government will be represented by a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency. The team members that are required are listed below:

Designation	Function
Q	Contractor's Chief Quality Control Representative
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing Representative
C	Contractor's Controls Representative
D	Design Agent's Representative
O	Contracting Officer's Representative
U	Using Agency's Representative

The commissioning team is required to complete each checklist shown in Appendices A and B. Indicate acceptance by each commissioning team member of each pre-commissioning checklist item by entering initials and date unless an "X" is shown indicating that participation by that individual is not required. Indicate acceptance by each commissioning team member of each functional performance test checklist by signature and date.

3.2.4.2 Tests

Perform the pre-commissioning checks and functional performance tests in a manner that essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, establish methods and document that provide the information required. Perform testing and verification required by this section during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and may not be used to satisfy any of the requirements specified in this Section. Provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. Abort pre-commissioning check or functional performance test if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. Reimburse the Government for all costs associated with effort lost due to tests that are aborted. Include costs for salary, travel costs and per diem (where applicable) for Government commissioning team members.

a. Pre-commissioning Tests: Perform pre-commissioning checks for the items indicated on the checklists in Appendix A. Correct and retest deficiencies discovered during these checks in accordance with the applicable contract requirements.

b. Functional Performance Tests: Conduct functional performance tests for the items indicated on the checklists in Appendix B. Begin functional performance tests only after all pre-commissioning checks have been successfully completed. Prove all modes of the sequences of operation work by the tests. Verify all other relevant contract requirements by the tests. Begin tests with equipment or components and then progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, correct all deficiencies in accordance with the applicable contract requirements. Repeat entire checklist until it has been completed with no errors. Submit a Commissioning Report as specified in the Submittals paragraph.

3.3 DEMONSTRATION OF FULL-SCALE SYSTEM

Do not demonstrate the full-scale system until after commissioning has been successfully completed, the Full-Scale Demonstration Plan has been approved, and written approval has been received from the Contracting Officer. Notify the Contracting Officer at least [14][_____] calendar days before starting the demonstration, and provide a schedule of demonstration activities at least [7][_____] calendar days before starting the demonstration.

3.3.1 Full-Scale Demonstration Plan

Submit plan for Full-Scale Demonstration at least [60][_____] calendar days before initiating the Full-Scale Demonstration. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Include Demonstration Plan Schedule, physical and chemical monitoring requirements, including test parameters, frequency of sampling, number of samples, and sampling locations; and laboratory turn-around-time in the plan.Include the field record data forms and an outline of the Full-Scale Demonstration Report. Submit Full-Scale Demonstration Report not more than [7][_____] calendar days after completion of the Demonstration. Operations log sheets attached to the Full-Scale Demonstration Report. Keep the log in notebooks organized in chronological order, and submit with the Full-Scale Demonstration Report not more than [14][_____] calendar days after completing the Full-Scale Demonstration.

3.3.2 Team Members

Submit list of team members who represent the Contractor in the Full-Scale Demonstration, at least [14][_____] calendar days prior to the start of pre-commissioning checks.

3.3.3 Sampling Results

Submit results from laboratory analysis not more than [40][_____] calendar days after collecting samples. Allow a period of not less than [30][_____] calendar days in the schedule for Government review. Provide a table comparing field data to the laboratory data, for samples collected at the same time and from the same sampling port, with each set of laboratory analysis results. Submit the reports signed and dated by the Contractor's Quality Control representative.

3.3.4 Demonstration Time Frame

3.3.4.1 Period of Demonstration

Operate the SVE system continuously for a period of at least [120][_____] hours. Do not include time required to complete commissioning in the period of demonstration.

3.3.4.2 Hours of Operation and Downtime

Unless otherwise directed by the Contracting Officer, operate the SVE system [24][_____] hours per day. Do not exceed [6 hours during the 120 hour demonstration period][_____] for SVE System Downtime. If downtime exceeds [6 hours during the 120 hour demonstration period][_____], re-start the demonstration, until the continuous operation requirement is satisfied. Record hours of operation and downtime in the Demonstration Log, at least once every [24][_____] hours. Maintain the Full-Scale Demonstration Log at the facility, and available for inspection.

3.3.4.3 Operational Airflow Rates

For the SVE system to be considered in operation, turn on the blower and ensure air is flowing from those wells designated in Table 1 at the flow rates shown in Table 1.

TABLE 1 - AIRFLOW RATES

WELL IDENTIFICATION	MINIMUM AIRFLOW RATE
[_____]	[_____]

3.3.4.4 Processing Monitoring

Obtain written approval from the Contracting officer before implementing any changes to the full scale demonstration schedule.

a. Meteorological Monitoring: Record the following data [daily][_____] during the full-scale demonstration: [ambient temperature, daily amount of precipitation, and barometric pressure][_____].

b. Vadose Zone Pressure Monitoring: Perform Vadose zone pressure monitoring at least [daily][_____] during the full-scale demonstration. Perform monitoring at the following vadose zone monitoring points: [_____].

3.3.4.5 Groundwater Levels

Measure groundwater levels on the [first and third][_____] day of the full-scale demonstration, while the system is in operation, at the following monitoring wells: [_____].

3.3.4.6 Process Air Stream and Equipment Monitoring

Monitor process air stream and equipment as part of the overall assessment of the SVE system, and to monitor operation of SVE system equipment.

a. Combustible Organic Vapor Monitoring: After opening the valves to begin extracting air from each extraction well for the first time, monitor during the following time intervals: [0-1 minute, 30-45 minutes, 60-75 minutes, 120-135 minutes][_____]. In addition, monitor at least once every [8][_____] hours during the full-scale demonstration. During each monitoring event, record [at least 3 readings, separated by 1 minute increments,][_____]. Monitor at the following location: [in the combined piping manifold (upstream from the inlet bleed line)][_____]. If the [flame ionization detector][_____] indicates that the vapor stream has reached [5000 ppmV as isobutylene][_____], then immediately make adjustments to decrease the organic vapor level. Such adjustments may include increasing and/or decreasing airflow rates from selected wells. Repeat the monitoring and adjustment procedure until the organic vapor level of the vapor stream has been decreased to less than [5000 ppmV as isobutylene][_____].

b. Airflow Rate Monitoring: Monitor pressures, temperatures, and air flow rates at the following locations at least [daily][_____] during the full-scale demonstration: [in piping from each individual SVE well being used; in the combined piping manifold (upstream from the inlet bleed line); in the inlet bleed line; and at the discharge stack][_____]. Maintain airflow rate monitoring in accordance with manufacturer's instructions for the air flow monitoring devices. Record instrument readings, and provide, in the Full-Scale Demonstration Report, any assumed values that were used to determine airflow rates. Independently verify measurement of airflow rates by a NEEB or AABC certified Testing, Adjusting, and Balancing specialist during the first day of the full-scale demonstration. Performed measurement in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Attach a copy of the airflow rates determined and signed by the NEEB or AABC certified Testing, Adjusting, and Balancing specialist to the Full-Scale Demonstration Report.

c. Air/Water Separator and Condensate: Record the volume of condensate in the air/water separator at least [daily][_____] during the full-scale demonstration. Also record the volume of condensate generated since the previous monitoring event and cumulative total volume of condensate.

d. Blower and Particulate Filter: Record the following parameters at least once every [24][_____] hours during the full-scale demonstration: hour meter readings from the totalizing hour meter on the blower; pressures and temperatures immediately upstream from the blower and immediately downstream from the blower; and pressures immediately upstream and downstream from the inlet air filter.

3.3.4.7 Vapor Stream Contaminant Level Monitoring

Perform vapor stream contaminant level monitoring within [2][_____] hours of airflow rate monitoring to allow mass removal rates to be determined. Monitor in accordance with regulatory requirements.

a. Field Analysis of Vapor Stream Samples: Perform vapor stream monitoring [every 30 minutes for the first 4 hours, every hour for the 4th through the 24th hour, every 4 hours for the 24th through the 48th hour, and at least once every 8 hours thereafter][_____]. During each monitoring event, record [at least 3 readings, separated by 2 minute increments,][_____]. Ensure data collected in each monitoring event includes [FID readings][_____] from the following locations: [each individual SVE well being used; in the combined piping manifold (upstream from the inlet bleed line); the inlet of the vapor stream treatment system; between the lead and lag vapor stream treatment units; and from the discharge stack][_____].

b. Laboratory Analysis of Vapor Stream Samples: Collect vapor on the [first and last day][_____] of the full-scale demonstration. Collect one air stream sample for laboratory analysis from each of the following locations: [in the combined piping manifold (upstream from the inlet bleed line); the inlet of the vapor stream treatment system; and from the discharge stack][_____]. Take the sample for laboratory analysis immediately after collecting the sample for field analysis at each sample port. Test samples for the following analytes: [_____]. Submit the Laboratory Analysis Report.

3.3.5 Full-Scale Demonstration Report

Submit a full-scale demonstration report. Allow a period of not less than [14][_____] calendar days in the schedule for Government review. Include the following data in the report: [hours of operation and hours of downtime; the amount of time that each SVE well was in use; and the cumulative total hours of operation][_____]. Organize results of Process Monitoring according to category, and show it chronologically within each category. Include Meteorological and Subsurface Monitoring data, and Process Air Stream and Equipment Monitoring data in each report. Provide the following graphs in the Report. For each SVE well, plots of: volume of air extracted versus time, cumulative volume of air extracted versus time, concentration of [contaminants of concern][_____] versus time, mass removal rate of [contaminants of concern][_____] versus time, and cumulative mass of [contaminants of concern][_____] removed versus time. For the SVE system as a whole, plots of: the concentration of [contaminants of concern][_____] versus time, mass removal rate of [contaminants of concern][_____] versus time, and cumulative mass of [contaminants of concern][_____] removed versus time. The reports are required to be signed and dated by the Contractor's Quality Control representative. If warranted, provide in the report recommendations for changing airflow rates from individual wells, and other proposed adjustments to the mode of operation.

APPENDIX A

PRE-COMMISSIONING CHECKLISTS

Pre-commissioning checklist - Piping								
For SVE System Piping								
Checklist Item	Q	M	E	T	C	D	O	U
Installation								
Piping complete.			X		X			
Piping flushed / cleaned.			X		X			
Leak testing complete (except for joints that have to be tested while the blower is operating).			X		X			
Valves installed as required.			X		X			
Heat tracing installed as required.			X		X			
Piping insulated as required.								
Thermometers, gauges, sampling ports, and monitoring ports installed as required.			X		X			
Verify operation of valves.			X					
Flexible connectors installed as required.			X		X			
Verify that piping has been labeled and valves identified as required.			X					
If potentially flammable organic vapors will be extracted, verify that piping is properly grounded.					X			
As-built shop drawings submitted.			X		X			
Testing, Adjusting, and Balancing (TAB)								
Monitoring ports and airflow monitoring devices installed and properly			X		X			

Pre-commissioning checklist - Air / Water Separator								
For Air / Water Separator Unit: [_____]								
Checklist Item	Q	M	E	T	C	D	O	U
Installation								
Leak testing complete.			X		X			
Valves installed as required.			X	X	X			

Pre-commissioning checklist - Air / Water Separator								
For Air / Water Separator Unit: [_____]								
Checklist Item	Q	M	E	T	C	D	O	U
Verify operation of valves.			X	X				
Verify that piping has been labeled and valves identified as required.			X	X	X			
Condensate drainage is unobstructed. (Verify by draining water from collection vessel of air / water separator).			X	X	X			

Pre-commissioning checklist - Blower								
For Blower Unit: [_____]								
Checklist Item	Q	M	E	T	C	D	O	U
Installation								
Vibration isolation devices installed [and freed to float with adequate movement and seismic restraint] as specified.			X	X	X			
Casing undamaged.			X	X	X			
Silencers undamaged			X	X	X			
Proper belt tension, if belt driven.			X	X	X			
Protective covers over rotating equipment.			X	X	X			
Manufacturer's required maintenance clearance provided.			X	X	X			
Spare inlet air filters present on-site.			X	X	X			
Pressure/temperature gauges installed.			X					
Verify proper installation of air cooling equipment, for cooling blower exhaust, if used.			X					
Verify that special tools and spare parts are present on site.			X	X	X			
Electrical								

Pre-commissioning checklist - Blower								
For Blower Unit: [_____]								
Checklist Item	Q	M	E	T	C	D	O	U
Power available to unit disconnect.				X				
Power available to unit control panel.				X				
Control system interlocks functional.				X				
Motor and blower rotation checked.				X	X			
Verify that power disconnect is located within sight of the unit it controls.				X				
Grounding properly installed.				X				
Controls								
Control valves/actuators properly installed.			X					
Control valves/actuators operable.			X					
Control interlocks properly installed.			X	X				
Control interlocks operable.			X	X				
Testing, Adjusting, and Balancing (TAB)								
Construction filters removed and replaced.			X		X			
Pressure/temperature gauges installed.			X		X			

Pre-commissioning checklist - SVE System Controls								
For SVE System: [_____]								
Checklist Item	Q	M	E	T	C	D	O	U
Installation								
As-built shop drawings submitted.			X	X				
Layout of control panel matches drawings.			X	X				
Components properly labeled (on inside and outside of panel).			X	X				
Control components piped and/or wired to each labeled terminal strip.				X				
Control wiring and tubing labeled at all terminations, splices, and junctions.				X				
Shielded wiring used on electronic sensors.				X				
Main Power								
Power available to panel.				X				

Pre-commissioning checklist - Vapor Stream Treatment System								
For Vapor Stream Treatment System: [_____]								
Checklist Item	Q	M	E	T	C	D	O	U
Installation								
Piping complete.			X		X			
As-built shop drawings submitted.			X		X			
Leak testing complete.			X		X			
Valves installed as required.			X		X			
Piping insulated as required.			X		X			
Thermometers, gauges, sampling ports, and monitoring ports installed as required.			X					
Verify operation of valves.			X					

Pre-commissioning checklist - Vapor Stream Treatment System

For Vapor Stream Treatment System: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Flexible connectors installed as required.			X	X	X			
Verify that piping has been labeled and valves identified as required.			X					
Verify use of flexible lines and connectors for changing positions of lead, lag, and spare vessels, as required.			X	X	X			
Spare vessel on-site, if required.			X	X	X			
Verify status of air pollution control permit, if required.		X	X	X	X			

Pre-commissioning checklist - Ancillary Equipment

For SVE System: [_____]

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
Field monitoring instruments calibrated.					X			
Lighting installed and functional.		X		X				

APPENDIX B

FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

Functional Performance Test Checklist - Piping

For SVE System Piping

1. Functional Performance Test: Verify operation of the SVE system piping in accordance with specification. The following items are required to be verified while the blower is operating:

a. Check vacuum response at each SVE wellhead before and after valving on each well.

b. With the valves to all SVE wells in the open positions, gradually modulate the inlet bleed valve from fully open position, adjusting toward the fully closed position.

c. As wells are valved on, leak-test joints not previously tested. Also leak-test accessible portions of SVE wells and pressure monitoring points. Note the locations of any leaks.

2. If piping system includes drainage points, check for water at drainage points at the end of each day during commissioning.

3. Conduct Independent measurement of air flow rates (from each extraction well, and total extraction airflow rate) alongside TAB specialist. Ensure results differ by no more than 10 percent.

4. Verify operation of heat tracing.

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	________________________
Contractor's Mechanical Representative	________________________
Contractor's Electrical Representative	________________________
Contractor's Testing, Adjusting and Balancing Representative	________________________
Contractor's Controls Representative	________________________
Contracting Officer's Representative	________________________
Using Agency's Representative	________________________

Functional Performance Test Checklist - Air / Water Separator

For Unit: [_____]

1. Start blower.

a. Check inlet and outlet connections for any signs of leaks. Note the

Functional Performance Test Checklist - Air / Water Separator

For Unit: [______]
locations of any leaks.

b. Check pressure drop across air / water separator:

Inlet pressure		kPa gauge psig
Outlet pressure		kPa gauge psig

c. If equipped with a sight glass, check for unobstructed view of water level.

d. Compare airflow rate and pressure drop to contract specifications, and manufacturer's performance specifications.

	CONTRACT	MANUFACTURER'S RANGE	ACTUAL
Airflow Rate (L/s) (CFM)			
Inlet pressure (kPa gauge) (PSIG)			
Outlet pressure (kPa gauge) (PSIG)			

2. Turn blower off.

a. Check operation of drain valve for condensate holding vessel.

b. Check setting of high level alarm in condensate holding vessel.

c. If the unit is designed to allow the drain valve to be used while the blower is operating, check operation of drain valve for condensate holding vessel while the blower is operating.

3. Unusual vibration, noise, etc.

____

4. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative ______________________________

Contractor's Mechanical Representative ______________________________

Contractor's Electrical Representative ______________________________

Contractor's Testing, Adjusting and Balancing Representative ______________________________

Contractor's Controls Representative ______________________________

Contracting Officer's Representative ______________________________

Using Agency's Representative ______________________________

Functional Performance Test Checklist - Blower

For Blower Unit: [_____]

1. Functional Performance Test: Verify operation of blower in accordance with specification. Verify the following items after the blower has been operating for a minimum period of [30][_____] minutes:

a. Record current draw from blower, and voltage.

Amperage _____
Voltage _____

b. Record blower air flow rate and air temperatures.

Air flow rate		L/s cfm
Inlet air temperature		degrees C F
Outlet air temperature		degrees C F

c. Record blower fan speed. _____ rpm

d. Check noise level. _____ [decibels at 1 meter][_____]

e. Verify operation of variable speed (if equipped). _____

f. Verify setting of vacuum relief valve. _____

g. Verify setting of pressure relief valve. _____

h. Verify setting of high-temperature shutdown. _____

2. Plot test readings of pressure and airflow rate on blower curve, compare results to manufacture's specifications, and submit testing, adjusting, balancing (TAB) report. TAB results within acceptable ranges.

____

3. Unusual vibration, noise, etc.

____

4. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative _____________________

Contractor's Mechanical Representative _____________________

Contractor's Electrical Representative _____________________

Contractor's Testing, Adjusting and Balancing Representative ________________________________

Contractor's Controls Representative ________________________________

Contracting Officer's Representative ________________________________

Using Agency's Representative ________________________________

Functional Performance Test Checklist - SVE System Controls

For Control Unit: [_____]

1. Functional Performance Test: Verify operation of SVE controls in accordance with specification. Perform the following tests:

a. Verify that controller is maintaining the set point by manually measuring the controlled variable with a thermometer, differential pressure gage, etc.

b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare readings taken manually. Record all readings.

Sensor	
Manual measurement	
Panel reading value	

c. Verify that interlocks function in accordance with specifications.

d. Verify interlock with other SVE controls.

2. Verify that operation of control system conforms to that specified in the sequence of operation.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative _________________________

Contractor's Mechanical Representative _________________________

Contractor's Electrical Representative _________________________

Contractor's Testing, Adjusting and Balancing Representative _________________________

Contractor's Controls Representative _________________________

Contractor's Officer's Representative _________________________

Using Agency's Representative _________________________

Functional Performance Test Checklist - Vapor Stream Treatment System

For Vapor Stream Treatment Unit: [_____]

1. Functional Performance Test: Verify operation of the Vapor Stream Treatment System in accordance with specification. Verify the following while the system is operating:

a. Check inlet and outlet connections for any signs of leaks. Note the locations of any leaks.

b. Check airflow rates at inlet and outlet of vapor stream treatment system:

Inlet Airflow Rate		L/s cfm
Outlet Airflow Rate		L/s cfm

c. Check temperature and pressure across [lead treatment vessel][_____]:

Inlet pressure		kPa gauge psig
Outlet pressure		kPa gauge psig
Inlet temperature		degrees C F
Outlet temperature		degrees C F

d. Check temperature and pressure across [lag treatment vessel][_____]:

Inlet pressure		kPa gauge psig
Outlet pressure		kPa gauge psig
Inlet temperature		degrees C F
Outlet temperature		degrees C F

e. Compare vapor stream temperatures, pressures and airflow rates, to contract specifications, and manufacturer's performance specifications.

	CONTRACT	MANUFACTURER'S RANGE	ACTUAL
Inlet airflow rate (L/s) (CFM)			
Inlet temperature (degrees C F)			
Inlet pressure (kPa gauge) (psig)			
Outlet airflow rate (L/s) (CFM)			

	CONTRACT	MANUFACTURER'S RANGE	ACTUAL
Outlet temperature			
Outlet pressure (kPa gauge) (psig)			
Pressure drop across lead vessel (kPa gauge) (psig)			
Pressure drop across lag vessel (kPa gauge) (psig)			

f. Using a [flame ionization detector][_____], check organic vapor level readings of the vapor stream at the following locations:

Inlet of Vapor Stream Treatment System		ppmV as [isobutylene][_____]
Between Lead and Lag Vessels		ppmV as [isobutylene] [_____]
Outlet of Vapor Stream Treatment System		ppmV as [isobutylene] [_____]

2. Unusual vibration, noise, etc.

____

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative ______________________

Contractor's Mechanical Representative ______________________

Contractor's Electrical Representative ______________________

Contractor's Testing, Adjusting and Balancing Representative ______________________

Contractor's Controls Representative ______________________

Contracting Officer's Representative ______________________

Using Agency's Representative ______________________

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-02 65 00 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-02 65 00 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 65 00

UNDERGROUND STORAGE TANK REMOVAL

11/22

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-02 65 00 (November 2022)**

Preparing Activity: USACE

Superseding
UFGS-02 65 00 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 02 65 00

UNDERGROUND STORAGE TANK REMOVAL
11/22

****

NOTE: This guide specification covers the requirements for removal and disposal of underground, nonhardened tanks and piping used to store petroleum products, waste oils or hazardous wastes in accordance with Federal, State, and local regulations.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Show the following information on the project drawings:

(1) Overall installation plan which identifies and locates tanks and equipment; borrow, disposal, and stockpile areas; temporary containment areas; special security areas; shoring and special support requirements; and access routes.

(2) Individual as-built site plans of tank locations which identify site features such as buildings, roads, utilities, topography, trees and shrubs, surface condition, etc. If as-built drawings are not available, a site investigation and site plans are required to show the general location of existing tanks and site features. Detail drawings to include dimensions, sections, elevations, slopes and size of excavations and temporary containment areas. Provide, as part of the Tank Closure Report, a detailed map showing exact location of the tank prior to removal.

(3) Limits of pavement removal, fence removal, and the location of ancillary equipment to be removed.

Hardened tanks are deep buried tanks as would be found with some missile facilities. Cut and Cover tanks are not considered hardened by this specification's defintion. Note this in the contract as they require deeper excavations and possibly substantial demolition of concrete.

Tanks will not be abandoned in place unless a waiver is granted in accordance with state or local requirements, Air Force Civil Engineer Center Environmental (AFCEC/CZ). Waivers will be obtained prior to advertising the closure project. Exceptions will be granted when requested in writing on a case by case basis. Absence of contamination must still be verified prior to closure and prior to obtaining a waiver.

Incorporate installation, state and local requirements into this specification, including the necessary approval processes, licensing, or having their representative on site during removal operations. In many cases, the state or local jurisdiction has final authority on approval of the Work Plan. While states often enforce petroleum tank removal regulations, counties and cities are sometimes delegated authority.

Petroleum sludge and contaminated media are often considered "special wastes" and are subject to regulations enforced by the State Fire Marshals Office, local agencies, etc. Some states have adopted federal rules for management of petroleum waste.

State requirements usually involve testing, analysis, and a report. The review by the state may require additional testing or other work, and may take several months; therefore, the designer is forewarned to investigate these requirements in advance. Areas most likely to be impacted are waste and tank disposal, tank cleaning, residue and soil sampling and analysis, contaminated soil disposal or remediation, reporting, and requirements for a clean

closure.

Petroleum sites which are known to have extensive soil contamination or where groundwater contamination is a possibility, should have a Corrective Action Plan under Subtitle I of RCRA and applicable state and local regulations; refer to EM 1110-1-4006, Removal of Underground Storage Tanks (USTs).

For sites where the tank contained a hazardous waste, remediation should occur under the RCRA Corrective Action requirements of 40 CFR 264, 40 CFR 265, and applicable state requirements.

Coordinate with the customer regarding possible designer's discussions with the regulators, and the existence of unique requirements. Some MACOMS require the Installation Project/Program Manager to either be responsible for all coordination or be included on all contacts with the regulators. For projects not on an active installation discuss requirements with the regulators and omit references to the installation and the Installation Environmental Coordinator.

For sites holding DLA-capitalized fuel, coordinate with DLA Energy on the requirements for removal, re-use, or disposal.

Include the applicable state and local regulatory references where appropriate in the body of the specification. It is recommended that the specifier refer to DoD "Policy and Guidelines for Acquisitions Involving Environmental Sampling or Testing (November 2007)

The following specifications must be used in conjunction with this section:

SECTION 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS

Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES

SECTION 01 32 01.00 10 PROJECT SCHEDULE

[SECTION 01 32 16.00 20 SMALL PROJECT CONSTRUCTION PROGRESS DOCUMENTATION] or

[SECTION 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS)]

SECTION 01 45 00 QUALITY CONTROL

Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS

****

[1.1 UNIT PRICES

****

NOTE: This paragraph will be deleted if the work is in one lump sum contract price. If it is retained and more detail is needed, items of consideration may include: excavation, contaminated soil, clean backfill required, non-hazardous sludge, pumpable liquids, analytical (PCB & asbestos), analytical (contaminated water), remove piping, and remainder of work. Coordinate this paragraph with the bidding schedule.

****

Compensation for removal of [contaminated soil] [and] [pumpable liquids] will be paid as a unit cost. This unit cost includes testing, excavation, stockpiling, transportation and disposal of the contaminated soil and backfilling with non-contaminated soil. Payment for all other work is under the base bid for the tank removal and constitutes full payment for all work defined in the contract documents including testing of the contents, excavation and disposal of the tank, and testing of the underlying soil.

****

NOTE: Include unit prices for removal and disposal of temporarily stockpiled contaminated soil which was excavated for tank and piping removal, provision of clean fill material to replace contaminated soils for use in backfilling tank and piping excavations, and removal and disposal of temporarily stored contaminated water in Contract's price schedule as follows:

ITEM	**UNIT**	**UNIT PRICE**	**NO. UNITS**	**EXTENSION**
Removal and disposal of stockpiled contaminated soils from excavations for removal of underground storage tanks and associated piping.	**CUBIC METERS** **CUBIC YARDS**	**[$_____]**	**[_____]**	**[$_____]**
Furnish clean fill material for use in backfilling excavations for removal of underground storage tanks and piping.	**CUBIC METERS** **CUBIC YARDS**	**[$_____]**	**[_____]**	**[$_____]**

ITEM	UNIT	UNIT PRICE	NO. UNITS	EXTENSION
Removal and disposal of stored contaminated water collected during dewatering to remove underground storage tanks and piping.	LITERSGALLONS	[$_____]	[_____]	[$_____]
Quantities of contaminated soils, fill material and contaminated water must be estimated taking into consideration site conditions, and age and history of tanks.				

****

NOTE: For some locations, such as a contaminated site scheduled for site remediation, it may be permissible to use contaminated soil materials for backfill in tank and piping excavations. Get approval from local regulating authority before using contaminated soil materials.

****

Assume, for bidding purposes, that soil [bituminous pavement, concrete slabs,concrete deadman] and water encountered during the removal of the underground tanks are contaminated with [jet fuel] [and] [diesel fuel] [and] [AVGAS] [and] [gasoline] to be handled as specified herein. [Payment for removal from temporary stockpile and disposal of contaminated soil and furnishing clean soil will be paid for at the contract unit price per CUBIC METERS CUBIC YARDS.] Wash bituminous pavement and concrete slabs or deadmans and dispose of as demolition debris. Collect and store wash water. [Disposal of contaminated water will be paid for at the contract unit price per LITERSGALLONS.]

]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature
to update the issue dates.

References not used in the text will automatically
be deleted from this section of the project
specification when you choose to reconcile
references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API PUBL 1628	(1996) A Guide to the Assessment and Remediation of Underground Petroleum Releases
API RP 1604	(1996; R 2010) Closure of Underground Petroleum Storage Tanks
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 2217A	(2017) Safe Work in Inert Confined Speaces in the Petroleum and Petrochemical Industries
API RP 2219	(2016) Safe Operation of Vacuum Trucks Handling Flammable and Combustible Liquids in Petroleum Service
API Std 2015	(2018) Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks

ASTM INTERNATIONAL (ASTM)

ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4397	(2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 200-1-1	(1994) Environmental Quality -- Validation of Analytical Chemistry Laboratories
EM 200-1-6	(1997) Environmental Quality -- Chemical Quality Assurance for Hazardous, Toxic and Radioactive Waste (HTRW) Projects
EM 200-1-7	(2001) Environmental Quality - Performance Evaluation (PE) Program
EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements
EM 1110-1-4006	(1998) Engineering and Design -- Removal of Underground Storage Tanks (USTs)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 530-R-97-007	(1997) Best Management Practices (BMPs) for Soils Treatment Technologies;, Suggested Operational Guidelines to Prevent Cross-Media Transfer of Contaminants During Cleanup Activities
EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes
EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of

	Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 279	Standards for the Management of Used Oil
40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)

1.3 SYSTEM DESCRIPTION

****

NOTE: 40 CFR 280, RCRA Subtitle I closures are primarily performed on petroleum or chemical product tanks and require a minimum of 30 days notice prior to a change in service or closure.

The RCRA Subtitle C tank closures fit into three categories:

a. Hazardous waste accumulation tanks as per 40 CFR 262.34(a)(1)(ii). These tanks store hazardous waste for less than 90 days.

b. Tanks storing hazardous waste over 90 days without a permit (illegal storage).

c. Part B permitted storage tanks.

The Installation Environmental Coordinator should decide who is responsible for contacting the Implementing Agency. Accomplish Subtitle C tank closures in accordance with the closure plans previously prepared and approved, and other applicable regulatory standards including the Land Ban 40 CFR 268 requirements.

****

The work consists of removal, decontamination and disposal of [one] [_____], [_____] L gallon underground storage tank[s] and associated piping and ancillary equipment, including but not limited to dewatering (if approved), [disposal of contaminated soil,] [laboratory testing,] providing reports which are required by regulatory agencies, and backfilling.. The [tank is] [tanks are] constructed of [steel] [fiberglass] [_____] and [is] [are] at [the location shown on the drawings] [the following location: [_____]]. The [_____] L gallon tank was used for storing [jet fuel] [leaded gasoline] [unleaded gasoline] [fuel oil] [diesel fuel] [waste oil] [diesel oil] [hazardous waste] [_____] and was taken out of service in [_____]. Residue remaining in the tank is considered a [special] [hazardous] waste. Subsurface conditions are represented [herein] [on drawings] [in Appendix [_____]] [_____]. Existing native soils are predominantly [_____]. Available backfill material is typically [_____]. Groundwater [has been encountered within [_____] m feet of the surface] [is not expected to be encountered]. Verify the actual conditions prior to submitting a bid.[Treat the site as a hazardous waste site.] [The site is not a hazardous waste site, but due due to the nature of the materials and hazards present, use specified procedures until closure activities are complete.]

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G, [_____].

Site Safety and Health Plan; G, [_____]

Excavation and Material Handling Plan; G, [_____]

Field Sampling and Laboratory Testing Plan; G, [_____]

Tank and Piping Removal And Disposal Plan; G, [_____]

Spill and Discharge Control Plan; G, [_____]

Qualifications; G, [_____]

Laboratory Services; G, [_____]

State Licensed [Hazardous]Waste Transporter

SD-06 Test Reports

Laboratory and Field Testing Reports

Backfill Material

Tank Contents Verification

Contaminated Water Disposal

Soil Examination, Testing, and Analysis

Backfilling; G, [_____].

SD-11 Closeout Submittals

Salvage Rights; G, [_____]

Tank Closure Report

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

****

NOTE: Require certification for tank removals whenever work will be performed under a jurisdiction requiring certification.

The laboratory validation process for underground storage tank projects is addressed in EM 1110-1-4006 Removal of Underground Storage Tanks, dated 30 September 1998; EM 200-1-1 Validation of Analytical Chemistry Laboratories, dated 1 July 1994; and EM 200-1-7, dated 01 February 2001.

****

Substantiate a minimum of [2][_____] years of tank removal experience, including subcontractors and personnel employed on the project, and certification by the [[State] [County] [City] of [_____]] [local authority having jurisdiction] for tank removal work. Include experience for removal, transportation, and disposal of underground tanks and associated piping, in conformance with the following:

a. API RP 1604

b. 40 CFR 280, State and local regulations and procedures.

c. Applicable safety rules and regulations.

d. Use of equipment and procedures for testing and vapor-freeing tanks.

e. Handling and disposal of types of wastes encountered in underground tank and pipe removal including disposal of underground tanks and associated piping.

f. Excavation, testing, and disposal of petroleum contaminated soils, liquids, and sludge.

g. Project titles, dates performed, owner's names, points of contact for each project with current contact phone numbers.

1.5.2 Laboratory Services

Submit documentation for laboratory services in accordance with [EM 1110-1-4006, EM 200-1-1, EM 200-1-6 and EM 200-1-7]

1.5.3 Support Staff

Identify all staff involved for the various components, including personnel collecting and shipping samples, and detail staff member's qualifications.

1.5.4 Preconstruction Conference and Work Plan

Prior to the commencement of work, a preconstruction conference will be scheduled by the Contracting Officer. Prepare and submit a comprehensive Work Plan within [30][_____] days of contract award. The work plan will conform to the requirements of this specification, API RP 1604, API Std 2015, API RP 2003, API RP 2217A and API RP 2219. Allow [30][_____] days in the schedule for the Government's review and approval. No adjustment for time or money will be made for re-submittals required as a result of noncompliance. No work at the site is allowed, with the exception of site inspections and mobilization, until the Work Plan is approved. As a minimum, include the following in the Work Plan:

1.5.4.1 Site Safety and Health Plan

Furnish detailed safety, health, and accident prevention provisions and develop a Site Safety and Health Plan (SSHP). Incorporate the requirements of 29 CFR 1910 and EM 385-1-1 into the SSHP. Include current training certification statement for personnel prior to entry into the work site. Do not commence work until the SSHP is approved by the Contracting Officer. As a minimum, include the following:

a. Health and safety organization, including discussion of distribution of functions and responsibilities.

b. Organization and components of the SSHP.

c. Physical and chemical site hazard identification.

d. Basic toxicology and toxicity information.

e. Discussion of the EZ and CRZ.

f. Protective clothing.

g. Respiratory protection.

h. Air quality monitoring.

i. Personnel exposure guidelines.

j. Decontamination procedures.

k. Basic first aid review.

l. Emergency response and contingency plan.

m. Site entry and exit procedures.

n. Sampling procedures.

1.5.4.2 Excavation and Material Handling Plan

Describe methods, means, equipment, sequence of operations and schedule to be employed in excavation, transport, handling, borrowing source and stockpiling of soil during underground tank removal. Include shoring requirements. [Fifteen][_____] days before beginning tank removal work, submit to the Contracting Officer, for approval, a material handling plan that describes phases of dealing with the contaminated soil and water as it relates to the proposed tank[s] and piping removal, including methods of excavating, a material handling plan for the contaminated material, soil testing requirements, and water pumping and collection requirements.

1.5.4.3 Field Sampling and Laboratory Testing Plan

Submit a detailed Sampling and Analysis Plan in accordance with [_____].

Describe field sampling methods and quality control procedures. Identify laboratory and laboratory methods to be used for contamination testing. Include sample reports showing sample identification for location, date, time, sample method, contamination level, name of individual sampler, identification of laboratory, and quality control procedures.

1.5.4.4 Tank and Piping Removal and Disposal Plan

Describe methods, means, sequence of operations, and schedule to be employed in the testing, pumping, cleaning, de-vaporizing, inspecting, [cutting and]removal, and disposal of underground storage tanks and piping. Include methods to be employed for product, sludge, vapor, and pumpable liquid removal; purging and inerting; and storage methods proposed for control of surface water. Also address the following:

a. Treatment Options
b. Identification of waste, tank and contaminated soil transporters and means of transport.
c. Disposal and alternate facilities, disposal or remediation.
d. Decontamination procedures and coordination with SSHP.

[Coordinate decontamination procedures, shoring, and safety measures in accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.]

1.5.4.5 Spill and Discharge Control Plan

Develop a comprehensive spill and discharge control plan. Consider and provide contingency measures for potential spills and discharges from handling and transportation of contaminated soils and water. A possible source of guidance for assessment and remediation is API PUBL 1628.

1.5.4.6 Site Safety And Health Officer

Identify an individual to serve as the Site Safety and Health Officer (SSHO) [Certified Industrial Hygienist (CIH)]to report problems and concerns regarding health and safety to the Contracting Officer. Provide documentation that the SSHO [CIH] possesses working knowledge of local and Federal occupational safety and health regulations, and provide training, in accordance with 29 CFR 1910 to Contractor employees in air monitoring practices and techniques. The SSHO [CIH or an Industrial Hygiene Technician (IHT) who is under the direction of the CIH] must remain onsite to provide day to day industrial hygiene support, including air monitoring, training, and daily site safety inspections. The SSHO [CIH] may be assigned other duties, such as project foreman or quality control manager.

1.5.5 Permits and Licenses

As required or as directed by the Contracting Officer, obtain local, state, or federal permits and licenses that directly impact the Contractor's ability to perform the work prior to commencing removal operations.

1.5.6 Statutes and Regulations

Perform tank closures, removal, and disposal in accordance with 40 CFR 280, 40 CFR 262, 40 CFR 264, and 40 CFR 265 as well as the applicable local, State of [_____], and Federal regulations. Transport hazardous [material] [waste] in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.

1.6 PROJECT/SITE CONDITIONS

****

NOTE: Include any pertinent information regarding the former uses of the area as a gas station or waste oil storage facility, any results of chemical analyses done on contents and/or soils, leak testing results, and any hazardous material that has been stored there, if it has been removed and any unusual site features that may be helpful to the bidders. Refer to EM 1110-1-4006 for more information.

If waste oil tanks were included in the Installation Part B Permit, include that information in this paragraph.

Coordinate with state/local regulators, and EM 1110-1-4006 for information regarding designation of non-contaminated waste oil or petroleum wastes as special wastes.

Edit the specification to reflect the implementing Agency (IA) requirements regarding Treatment, Storage, and Disposal (TSD) facilities.

****

Notify the Installation Environmental Coordinator (IEC) and the Contracting Officer [_____] days prior to tank removal. The [Contractor is] [Contracting Officer will be] [IEC will be] responsible for contacting the Implementation Agency (IA) [_____] in accordance with the applicable reporting requirements.

PART 2 PRODUCTS

2.1 BACKFILL MATERIAL

****
NOTE: Part or all of this paragraph may be deleted if the subject is addressed in other sections. Refer to EM 1110-1-4006 for special compaction requirements such as under pavements.
****

Obtain backfill material from [the location indicated] [offsite]. Classify backfill in accordance with ASTM D2487 as GW, GP, GM, GC, SW, SP, SM, SC, MH, CL, or CH and free from roots and other organic matter, trash, debris, snow, ice or frozen materials. Secure and submit soil classification test results, including the chain-of-custody records, prior to bringing offsite materials onsite. The testing frequency for backfill material is 1 per 1000 cubic meters yards or a minimum of 1 test. Use non-contaminated material removed from the excavation for backfill in accordance with Paragraph BACKFILLING.

2.2 PLASTIC SHEETING

Provide plastic sheeting conforming to ASTM D4397.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Furnish labor, materials, necessary permits, laboratory tests, and reports and equipment to [remove and dispose of products remaining in the underground tanks; clean and vapor free the underground tanks and connecting product and vapor recovery piping;] excavate, remove underground tanks and associated piping, and backfill to the level of the adjacent ground; sample soil and water to determine if contaminated; dispose of tanks and associated piping[, and] [petroleum contaminated soil] [and] [water].

3.1.1 Safety Guidelines

Comply with personnel safety guidelines specified in Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES, and conform to the guidelines as stipulated in the approved SSHP.

3.1.2 Exclusion Zone (EZ) And Contamination Reduction Zone (CRZ)

Do not permit personnel, not directly involved with the project, to enter work zones, called the EZ and CRZ. The EZ is an area around the tank a minimum of 3 m 10 feet from the limits of the tank excavation. At the perimeter of the EZ, establish a CRZ. Clean equipment and personnel within the CRZ, as stated in the paragraph titled "Personnel and Equipment Decontamination." Locate the Contractor's site office, parking area, and other support facilities outside the EZ and CRZ. Clearly mark and post boundaries of the EZ and CRZ. Include a site map, outlining the extent of work zones and location of support facilities, in the SSHP.

3.1.3 Onsite Training

Prior to starting onsite work, conduct a health and safety training class directed by the SSHO [CIH] to discuss the implementation of the SSHP. Notify the Contracting Officer 24 hours prior to beginning the training class.

3.1.4 Personnel Protection

Furnish appropriate personal safety equipment and protective clothing to personnel and ensure that safety equipment and protective clothing is kept clean and well maintained. Furnish three clean sets of personal protective equipment and clothing for use by the Contracting Officer or official visitors as required for entry into the EZ.

3.1.5 Respiratory Protection Program

Fully employ respiratory protection program, addressing respirator usage and training, in accordance with 29 CFR 1910 and EM 385-1-1.

3.1.6 Decontamination

Decontaminate or properly dispose of personal protective equipment and clothing worn in contaminated areas at the end of the work day. The SSHO [CIH] is responsible for ensuring that personal protective clothing and equipment are decontaminated before being reissued.

3.1.7 Emergency Response and First Aid Equipment

a. Prior to commencement of work, thoroughly review emergency response and contingency plan in accordance with 29 CFR 1910. In an emergency, take action to remove or minimize the cause of the emergency, alert the Contracting Officer, and institute necessary measures to prevent repetition of the emergency. Equip site-support vehicles with route maps providing directions to the medical treatment facility.

b. Provide appropriate emergency first aid equipment for treatment of exposure to site physical and chemical hazards. Provide and post a list of emergency phone numbers and points of contact for fire, hospital, police, ambulance, and other necessary contacts. Provide and post a route map detailing the directions to the nearest medical facility.

c. Notify the Contracting Officer of any unforeseen hazard or condition which becomes evident during work.

3.1.8 Burning and Explosives

Use of explosives or burning debris is not allowed. Do not permit ignition sources in the EZ and CRZ.

3.1.9 Protection of Existing Structures and Utilities

Take all necessary precautions to avoid damage to existing structures, their appurtenances, monitoring wells, or utilities that may be affected by work activities. Repair any damage to [utilities][pavements] [monitoring wells] resulting from the Contractor's operations at no expense to the Government. Coordinate with the installation to locate underground utilities prior to beginning construction. Do not disturb utilities encountered which were not previously shown or otherwise located without approval from the Contracting Officer.

3.1.10 Shoring

Provide shoring in accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.

3.2 TANK CONTENTS VERIFICATION

Conduct sampling and analysis in accordance with the approved Sampling and Analysis Plan. Submit reports, including the chain-of-custody records.

3.2.1 Sampling

****

NOTE: If the contents have been properly characterized or already removed and disposed, delete the non-applicable portions of the specification.

The designer will detail the sampling requirements (number of samples and analytical methodology) based on the state/local regulations and EM 1110-1-4006 (i.e. tank contents, contaminated water, pumpable liquids and sludge, stockpiled soils, and in situ soils).

If the Government is to perform sampling and analyses, specify what data will be available from the Government. This will enable the Contractor to ascertain if additional analysis will be required by the TSD facility and should be reflected in the bid.

****

Sample tank [product,] [pumpable liquids,] [tank coatings] [and] [sludge]. If the data is not adequate, additional sampling and analysis to the extent required by the approved [offsite] [permitted treatment, storage or disposal (TSD)] facility receiving the material is the responsibility of the [Contractor] [Government]. Meeting all regulatory requirements, including the preparation of hazardous materials and waste for transportation, is the responsibility of the Contractor.

3.2.2 Analysis

****

NOTE: The designer will consult the state/local regulations and EM 1110-1-4006 for assistance in determining the appropriate analytical parameters for tank contents samples. Analytical protocol will also be based on historical records of tank usage and/or tank contents testing. Ensure that the Contractor addresses the specific laboratory preparation and analytical methods to be employed, especially variations in fuel related analyses.

****

[Government will test] [Test] tank contents for the parameters listed herein. Include [total petroleum hydrocarbons (TPH)] [benzene, ethylbenzene, toluene and xylene (BETX)] [lead] [_____] in the analysis.

3.2.3 Characterization

****

NOTE: Regarding "in a special manner", some states require that petroleum contaminated soils (special wastes) be disposed of in specially designated landfills.

Refer to EM 1110-1-4006 for additional information.

****

[Prior to removing any of the tank contents, characterize the contents to determine the type of required disposal: [as a [hazardous] [special] waste] [in a special manner] based on local, state, and Federal disposal regulations. Characterize [tank product] [tank product, pumpable liquids, and sludge] in accordance with 40 CFR 261 and 40 CFR 279. Submit the waste contents determination and accompanying test results for each phase present in the tank to the Contracting Officer.] [The following analyses will be performed by the Government prior to removing the tank contents: [_____]. The Contractor is responsible for any additional requirements identified by the disposal facility. Do not remove the tank contents until approval is given by the Contracting Officer.]

3.3 CLEARING, GRUBBING AND REMOVALS

****

NOTE: If underground storage tank removal is part of a larger project which contains Section 31 11 00 CLEARING AND GRUBBING, use it instead of this paragraph. Otherwise edit this paragraph as needed.

****

[Perform clearing and grubbing in accordance with Section 31 11 00 CLEARING AND GRUBBING.] [Clear areas designated for clearing and grubbing [as indicated] [as required and directed by the Contracting Officer] of all trees, stumps, downed timber, brush, rubbish, roots larger than 75 mm 3 inches in diameter, and matted roots prior to commencing operations. Saw cut concrete or asphalt pavement at the limits of removal and break, remove and dispose of the the resulting debris [off Government Property] [at the location indicated]. Chain link fence must be [removed and salvaged for reuse] [disposed of offsite].]

3.4 TOPSOIL

****

NOTE: If underground storage tank removal is part of a larger project which contains Section 31 00 00 EARTHWORK, use it for topsoil requirements instead of this paragraph. Otherwise edit this paragraph as needed.

****

[Ensure topsoil meets the requirements in Section 31 00 00 EARTHWORK.] [Strip and stockpile uncontaminated topsoil separately for reuse [at the location shown] [at a location approved by the Contracting Officer] if it meets the requirements of clean fill given in Paragraph BACKFILLING.] [Obtain additional topsoil in excess of that produced by excavation [offsite] [from designated location onsite].] [Cover with topsoil all areas disturbed by tank removal operations, other than areas to receive pavement or similar surface under this contract.] [Use topsoil wherever shown or stated on the drawings.]

3.5 PREPARATIONS FOR EXCAVATION

Before excavating, [drain product piping back to the tank] [remove residual liquids trapped in the product lines] [and] remove all product from the tank. Purge and vent the tank in accordance with API RP 1604, and as specified herein.

3.5.1 Removal of Product, Pumpable Liquids, and Sludge

****

NOTE: See EM 1110-1-4006 for the analytical parameters required for recyclability, reusability and disposal consistent with characterization of tank contents.

If the DLA Disposition Services is unwilling to take the wastes, delete reference to delivery inside the installation. Early in the design stage coordinate with the DLA Disposition Services to ensure their capabilities are used to the maximum benefit of the Government and on approved containers that might be available or required by the DLA Disposition Services. The bid documents must have a letter of waste acceptance attached thereto to be considered a responsive bid. Coordinate with the state regulatory personnel. Other options are addressed in EM 1110-1-4006.

Petroleum contaminated water disposal is addressed in EM 1110-1-4006.

TSD facilities appropriate to accept the wastes generated by this project may be identified. If an analysis is available, bid acceptance may be subject to the bidders having a signed letter of acceptance from a permitted TSD attached to the bid; otherwise the bid should be declared nonresponsive.

****

[Contain and store tank product, pumpable liquids, and sludge onsite, prior to disposal. Treat contaminated water as specified. Analyze and segregate tank product, pumpable liquids, and sludge to recover reusable products prior to being transported to the [designated location] [treatment, storage and disposal (TSD) facility.]] [Remove and dispose of tank product, pumpable liquids, and sludge. Use of Government facilities for permanent storage or disposal of the wastes is prohibited. Temporary storage on Government facilities will be allowed only until testing is complete, manifests (if necessary) are complete, and transportation is arranged.] The Contractor is responsible for obtaining all required permits. Usable product will be the property of the [Government] [Contractor]. Provide approved containers, vehicles, equipment, labor, signs, labels, placards and manifests and associated land disposal restriction notices and notifications, necessary for accomplishment of the work, including materials necessary for cleaning up spills that could occur from tank removal operations.

3.5.2 Contaminated Water Disposal

3.5.2.1 Sampling, Analysis, and Containment

****

NOTE: The designer will detail the analytical parameters for contaminated water and treated effluent, treated onsite or offsite, according to the state regulations, the requirements of the recycler and/or TSD facility, and EM 1110-1-4006. Sampling and analysis are to be conducted for parameters consistent with characterization of tank contents.

****

Sample and analyze contaminated water both prior to and after treatment. [Analyze contaminated water produced from excavation operations and tank pumping treated onsite, for pH; benzene, ethylbenzene, toluene, and xylene (BETX); total lead; oil and grease; total petroleum hydrocarbons (TPH); and [_____]. Perform sampling and analysis prior to [discharge to the installation sanitary sewer] [disposal] for every [_____] [200,000] L [_____] [50,000] gallons of contaminated water treated.] [Conform analysis of contaminated water to be taken to an offsite treatment facility to the requirements of the treatment facility, with documentation of all analyses performed furnished to the Contracting Officer in accordance with paragraph RECORDS. Contain, store onsite, and analyze contaminated water [prior to transport to the approved treatment, storage and disposal facility] [and dispose of in accordance with applicable Federal and state disposal regulations].] Provide approved containers, vehicles, equipment, labor, signs, labels, placards and manifests and associated land disposal notices and notifications, necessary for accomplishment of the work. Conform to [_____] for sampling and analyses of contaminated water, treated water, the Contractor, and laboratory quality assurance program.

3.5.2.2 Treatment

Treat contaminated water [onsite] [offsite] by [oil water separation] [_____] [filtering] [air stripping] [and] [activated carbon], or other means as approved by the Contracting Officer. If contaminated water is to be treated onsite, specify the proposed treatment in the Work Plan and submit for approval, including the chain-of-custody records. Install temporary storage and treatment equipment [in the general vicinity of the tanks] at a location approved by the Contracting Officer. Sample and analyze treated effluent and secure approval of results by the Contracting Officer before discharge to [the sanitary sewer] [the surface] [_____]. Treat and discharge effluent in accordance with the discharge permit.

3.6 PURGING AND INERTING

****

NOTE: Coordinate explosive limits with health effects, especially for BTEX (benzene, toluene, ethylbenzene, xylene) containing mixtures. Coordinate with EM 1110-1-4006, health and safety specialists or industrial hygienists.

****

After the tank and piping contents have been removed, but prior to excavation beyond the top of the tank, disconnect all the piping (except the piping needed to purge or inert the tank). Purge flammable and toxic vapors from the tank or make the tank inert in accordance with API RP 1604, with the exception that filling with water is not permitted and, if dry ice is employed, use a minimum of 1.8 kg per 500 L 3 pounds per 100 gallons of tank volume. Continuously monitor the tank atmosphere for combustible vapors if the tank is purged, or continuously monitor for oxygen, if the tank is inerted.

3.7 EXCAVATION

****

NOTE: Some states may require the use of VOC emission suppression protocols during excavation, stockpiling, and transportation operations for VOC contaminated soil. The designer may need to include requirements for submittals of VOC suppression products (polyethylene sheeting, foam, or liquid VOC suppressants) and use field demonstrations to show there are no interferences from the suppression technology used with field screening devices. Approval from state/local regulators may be required prior to usage of these products and the designer should specify accordingly.

****

Mark all excavation areas, as well as work near roadways, in accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.

3.7.1 Exploratory Trenches

a. Excavate exploratory trenches as necessary to determine the tank location, limits and the location of ancillary equipment. Upon commencing exploratory excavation, utilize organic vapor analyzer/flame ionization device (OVA/FID) equipment to obtain readings for [total petroleum hydrocarbons (TPH),] [and] [benzene, toluene, ethylbenzene, and xylene (BTX), [and] [toxicity characteristic leaching procedure (TCLP)].][If BTEX indicates gasoline, then provide TCLP.]

b. [Contaminated soil materials may be used as backfill for tank and pipe excavations.] [To determine soil contamination levels, continuously monitor soil materials excavated to remove tanks with an OVA/FID capable of detecting volatile organic vapors to a minimum of one ppm. Further test contaminated soils with OVA/FID readings of [10] [_____] ppm or greater for TPH and BTEX as specified herein. Soils with OVA/FID readings less than [10] [_____] ppm may be used as clean backfill.] [Dispose of contaminated soils in accordance with Federal, State, and local regulations.]

3.7.2 Tank Excavation

****

NOTE: Acceptable levels of contaminations are dependent on regulations applicable to the location where tanks and piping are being removed; therefore, verify acceptable levels.

For some locations, such as a contaminated site scheduled for site remediation, it may be permissible to use contaminated soil materials for backfill in tank and piping excavations. Get approval from local regulating authority before using contaminated soil materials.

If contaminated soil materials are approved for backfill, retain first bracketed sentence and delete the second and third bracketed sentences.
****

a. [Provide Contracting Officer with written documentation, no later than 30 days before work begins, that proper State or local authorities have been notified.] Notify the Contracting Officer at least 48 hours prior to start of tank removal work. Stage operations to minimize the time that tank excavation is open and the time that contaminated soil is exposed to the weather. Provide protection measures around the excavation area to prevent water runoff and to contain the soil within the excavation area.

b. Perform excavation around the perimeter of the tank to limit the amount of potentially [petroleum][_____] contaminated soil that could be mixed with previously uncontaminated soil. Segregate [petroleum][_____] contaminated soil in separate stockpiles.

c. Maintain an excavation around the tank of sufficient size to allow workers ample room to complete the work, but also protect the workers from sliding or cave-ins. Install sheeting, bracing, or shoring in the absence of adequate side slopes if there is a need for workers to enter the excavated area. Divert surface water to prevent direct entry into the excavation.

d. Dewatering of the excavation may require a discharge permit by the State and will be limited to allow adequate access to the tank and piping, to assure a safe excavation, and to ensure that compaction and moisture requirements are met during backfilling. Dewatering may result in the production of petroleum contaminated water and/or free product. Recover free product from the groundwater only as part of necessary dewatering.

e. Collect and test water generated by dewatering during excavation required for removal of tanks or piping, surface water collected in open excavation, or water used for washing equipment or existing concrete or bituminous surfaces, in accordance with EPA 530-R-97-007, EPA 600/4-79/020, EPA SW-846 and state or locally required analyses.

3.7.3 Temporary Containment of Excavated Soil

Provide temporary containment area near the excavated area. Cover containment area with 0.75 mm 30 mil polyethylene sheeting. Place excavated soil on the impervious barrier and cover with 0.15 mm 6 mil polyethylene sheeting. Provide straw bale berm around the outer limits of the containment area and cover with polyethylene sheets. Secure edges of sheets to keep the polyethylene sheeting in place.

3.7.4 Piping Excavation

Perform excavation as necessary to remove tank piping and ancillary equipment in accordance with paragraphs: Shoring, Tank Excavation, and Open Excavations.

3.7.5 Open Excavations

****

NOTE: The time that tank excavations are left open depends on a variety of factors, a major one being the capability of the Contractor's lab to provide analyses within the specified turnaround time. Since short turnaround time adds cost, carefully evaluate the need for short turnarounds to avoid unnecessary costs.

If the excavation cannot be left open, it should be lined with a geomembrane and backfilled. This will aid excavation if test results reveal further contamination. However, placing a geomembrane in the excavation prior to backfilling may interfere with future in-situ remediation (e.g. soil vapor extraction, bioventing, etc.) and should only be allowed after careful consideration.

****

Secure open excavations and stockpile areas while awaiting confirmation test results from the soil beneath the tank. Backfill the excavation as soon as possible after tank and contaminated soil removals have been completed and confirmation samples have been taken. Divert surface water around excavations to prevent water from directly entering into the excavation.

3.7.6 Hidden Structures

During excavation activities, if asphalt pavement, concrete slabs, or other hidden structures are encountered, remove and wash with high pressure water cleaning equipment. Remove and dispose of the pavement, concrete, and other structures as specified in Section 02 41 00 DEMOLITION.

3.7.7 Stockpiles

****

NOTE: Soils characterized or contaminated by a listed hazardous waste and not excluded by 40 CFR 261.4(b)(10) cannot be stockpiled unless the area has been designated by the state RCRA office as a corrective action management unit (CAMU); stockpiling of hazardous waste soil constitutes storage in a waste pile and requires a RCRA permit; placing hazardous waste contaminated soil onto plastic still constitutes a waste pile; therefore, except as stated above, all hazardous waste soils must be placed into containers such as drums, roll-offs or dumpsters.

If analytical tests have not been taken before editing of this specification, historical data may be used to assume whether a tank contained petroleum waste only or hazardous waste, until analytical test results are in and contents are verified. If the

historical information indicates that a tank did not contain hazardous waste (as defined by the state), and there is no reason to believe the tank ever contained hazardous waste, the soil may be stockpiled until analytical test results required of the Contractor are received. If at that time the results indicate the presence of hazardous waste, the contaminated soil must be managed according to RCRA: no stockpiles unless they are designated CAMUs. If historical data indicates the presence of hazardous waste, or if there is no historical data, the specification should be edited to assume that the contaminated soil is hazardous and should be containerized.

****

Uncontaminated excavated soil and petroleum contaminated soil, that is not a state-regulated hazardous waste, will be [stockpiled and used for backfill in the tank excavation prior to using borrow material] [disposed of in the area designated on the drawings] [disposed of offsite] [_____]. Excavated material that is regulated by the state as a hazardous waste [which is visibly stained] [for which real time vapor monitoring instrument readings exceed [_____] for volatile and possibly semi-volatile hydrocarbons depending on the performance criteria for the field screening method] [and] [which has an obvious petroleum odor] [or as required by the State of [_____] or implementing agency] is considered contaminated. [Stockpile material if the site is a RCRA-designated CAMU] [Place in containers such as drums, roll-offs or dumpsters] for sampling in accordance with paragraph Stockpiled Material Sampling. Separately stockpile uncontaminated soil from the contaminated soil, a safe distance away from, but adjacent to, the excavation. [Place allowable stockpiles of contaminated soil on an impermeable geomembrane a minimum of 3 layers, each [0.152] [0.762] [_____] mm [6] [30] [_____] mils thick, covered with a [0.152] [0.254] [_____] mm [6] [10] [_____] mils sheet of geomembrane [as detailed on the drawings] [as specified]. Place the geomembrane to prevent the stockpiled soil from coming into contact with surface water run-off.] Locate the [geomembrane] [container] cover to prevent rain or surface water from coming into contact with the contaminated soil, as well as limit the escape of the volatile constituents in the [container] [stockpile].

3.7.8 Acceptable Levels of Contamination

****

NOTE: Acceptable levels of contamination are dependent on regulations applicable to the location where tanks and piping are being removed. Specifier must verify acceptable levels.

For some locations such as a contaminated site scheduled for site remediation, it may be permissible to use contaminated soil materials for backfill in tank and piping excavations. Specifier must get approval from local regulating authority before using contaminated soil materials.

If contaminated soil materials are approved for backfill, delete paragraph.

****

Take further samples and test soils with OVA/FID readings of [10] [_____] ppm or greater for TPH and for BTEX in accordance with EPA SW-846 and EPA 600/4-79/020, and for toxicity characteristic leaching procedure (TCLP) for lead if leaded gasoline was stored in or near the underground tank being removed. For stockpiled soils, provide a minimum of one test for every [77] [_____] cubic meters [100] [_____] cubic yards for TPH, and one test for every [77] [19] [_____] cubic meters [100] [25] [_____] cubic yards for BTEX and TCLP. Soils that contain [50] [_____] ppm or more TPH, [10] [_____] ppm or more BTEX or have TCLP reading of [10] [_____] ppm lead or virgin petroleum products are considered contaminated materials. Soils which are less than the above may be used as clean fill. Furnish results to the Contracting Officer within 24 hours after the results are obtained.

3.8 REMOVAL OF PIPING, ANCILLARY EQUIPMENT, AND TANK

****

NOTE: Consult the state regulators to determine how the state views tank and ancillary equipment transportation, disposal and salvage rights, and what state requirements for cleaning are applicable. Depending on tank material and contents, permits and manifests and other documentation may be required.

****

3.8.1 Piping and Ancillary Equipment

Disconnect all piping and ancillary equipment from the tank. Remove the piping [completely (interior and exterior of the tank)] [from the exterior surface of the tank, cap and abandon in place] [as shown on the drawings] [or] [as directed by the Contracting Officer]. Cap all tank ancillary equipment and piping connections, except those connections necessary to inert the tank within the excavation zone. Clean the piping exterior and ancillary equipment to remove all soil and inspect for signs of corrosion and leakage. Ensure no spillage of the piping contents occurs, as specified in the Work Plan, and as required in paragraph SPILLS. If the soil under and around the tank pad is [contaminated, remove the tank pad and dispose of offsite at an approved [non-hazardous] [hazardous] waste facility.] [not contaminated, leave the tank pad in place.]

3.8.2 Tank

Remove the tank from the excavation and clean the exterior to remove all soil and inspect for signs of corrosion, structural damage, or leakage. Use only non-sparking type materials or equipment which comes into contact with the tank, or in the vicinity of the excavation such as shovels, slings and tools. After removal from the excavation, place the tank on a level surface [adjacent to the tank excavation] [at an approved location] [at the location shown on the drawings] and secure it with wood blocks to prevent movement.

3.8.3 Contaminated Soil, Tank and Piping Excavation Examination

****

NOTE: Determine the appropriate field-screening instruments for health and safety monitoring; methods should be based on historical records of tank contents testing and age of release; refer to EM 1110-1-4006 for selection. Consider the use of

immunoassay field kits to save time and money. Separate immunoassay field kits sensitive to the light and heavy fuel fractions are available; these kits will not be used as real time health and safety monitoring devices.

Include the Coordinator's Name, Office, and Phone Number.

If contamination is expected, the state may request to be present onsite to oversee contaminated soil excavation and supervise sampling efforts. The designer's or Environmental Coordinator's experience at the site or similar sites may provide a basis for estimating the amount of contaminated soil.

If USACE labs are expected to perform analysis, coordinate with them early on to verify they have the adequate resources to accomplish the work.
****

a. After the tank has been removed from the ground, examine and test the adjacent and underlying soil for any evidence of leakage. Visually inspect the soil for staining after removal of all obviously contaminated soil, then screen for the presence of [volatile and/or semi-volatile] [_____] contamination using [a real time vapor monitoring instrument] [immunoassay field kits].

b. If tank is [6] [_____] m [20] [_____] feet or less in length, take [two] [_____] samples. Take each sample [0.60] [_____] m [2] [_____] feet from each end of the tank and [0.60] [_____] m [2] [_____] feet below the bottom of the excavation.

c. If the tank is greater than [6] [_____] m [20] [_____] feet, take [three] [_____] samples. Take two samples [0.60] [_____] m [2] [_____] feet from each end of the tank and [0.60] [_____] m [2] [_____] feet below the bottom of the excavation. Take a third sample from the middle of the tank area and [0.60] [_____] m [2] [_____] feet below the bottom of the excavation.

d. Analyze samples for TPH, BTEX, and TCLP. Perform sampling and analysis conforming to standards specified above for stockpiled soils. Soils that contain [50] [_____] ppm or more TPH, [10] [_____] ppm or more BTEX, or have TCLP reading of [10] [_____] ppm of lead or virgin petroleum products are considered contaminated materials. Soils which are less than the above may be used as clean fill. Furnish results to the Contracting Officer within 24 hours after the results are obtained. Along with the results furnish a sketch showing underground tank, sampling location, and extent of excavations.

e. [Stockpile onsite in accordance with paragraph Stockpiles] [Transport offsite for disposal] uncontaminated soil or petroleum contaminated soil not regulated by the state as hazardous waste. Stockpile contaminated soil or suspected contaminated soil, or, if the site is a RCRA-designated CAMU, containerized until further disposition.

f. The [Contracting Officer] [State of [_____] inspector] will determine the extent of the contaminated soil to be removed from each site, not to exceed [_____] [cubic meters cubic yards] [kg tons] per site.

Report any evidence indicating that the amount of contaminated soil may exceed the individual site limit specified, to the [Installation's Environmental Coordinator] [Contracting Officer] [_____] the same day it is discovered. If minimal additional excavation is required, the Contracting Officer may allow the Contractor to proceed. If extensive contamination is encountered, sample the excavation and backfill in accordance with paragraph BACKFILLING.

g. After the known contaminated soil is removed, sample and analyze the excavation in accordance with [_____].

3.8.4 Testing Along Piping

****

NOTE: Testing requirements are dependent on regulations applicable to the locations where tanks and piping are being removed. Verify number of tests required and required location for tests.

****

For every [7.5] [_____] m [25] [_____] linear feet of product delivery piping, [for every change in direction,] [and at every mechanical joint] take [one] [______] soil sample and analyze for TPH, BTEX, and TCLP. Conform sampling and analysis of soil materials to EPA standards specified above.

3.9 TANK CLEANING

****

NOTE: 1. For tanks larger than 15,120 L 4,000 gallons or for projects that have tanks, some of which are smaller or larger than 15,120 L 4,000 gallons, select the first optional paragraph and include Section 33 01 50.55 CLEANING OF PETROLEUM STORAGE TANKS.

2. For tanks 15,120 L 4,000 gallons and smaller, select the second optional paragraph.

****

[Provide additional requirements for cleaning and vapor freeing tank as specified in Section 33 01 50.55 CLEANING OF PETROLEUM STORAGE TANKS.] [Provide clean and vapor free tank in accordance with API RP 1604 and the following:

****

NOTE: Data for these paragraphs should be obtained from the Commanding Officer of the individual Naval facility having tanks for cleaning.

****

a. Table of Tank History

Tank No.	Tank Location	Tank Capacity	Date Constructed	Type of Lining (If Applicable	Type of Fuel	Remarks From the Last Inspection

a. Table of Tank History						
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

****

NOTE: Contact the fuel department of the nearest Naval Supply Center or Depot to determine if dirty residual fuel can be accepted by the Government for reclamation. If not reclaimed by the Government, consider the following: Depending on the amount of residual fuel remaining in the tank after pump down by the Government and the degree of fuel emulsification, the designer, in consultation with the activity, should decide on whether to require fuel/water separation under the scope of this contract, dispose of the mixture as hazardous waste if tests show presence of hazardous constituents, or use other options available to the Government.

****

b. Fuel Removal: All possible fuel will be pumped or otherwise removed from the tank by the Government. Consider remaining fuel contaminated or waste fuel; [pump into 208 liters 55 gallon drums or other suitable containers for disposal in accordance with approved procedures meeting local, State, and Federal regulations] [provide oil/water separators for further recovery of fuels and turn over to the Government for use]. Dispose of remaining fuel emulsions in accordance with applicable local, State, and Federal regulations. Drums or tanks used for containerizing waste fuel will be furnished by the [Contractor] [Government]. Oil/water separator for fuel will be furnished by the [Contractor] [Government].

****

NOTE: Information on the hazardous waste characteristics of sludge in tanks should be provided by the activity. If not, sampling and analysis must be conducted during the 0 to 35 percent design stage to properly define scope and costs.

****

c. Identification of Tanks With Hazardous Waste Sludge and Residue

The following [tank is] [tanks are] known or suspected to contain hazardous wastes:

Tank No.	Product	Hazardous Waste, Status, Type and Basis Known[or Suspect]
[1]	[MOGAS]	[Sludge and sandblast residue; ignitibility and lead.]

]

3.9.1 Exterior

****

NOTE: Acceptable levels of contaminations are dependent on regulations applicable to the location where tanks and piping are being removed; therefore, verify acceptable levels.

For some locations, such as a contaminated site scheduled for site remediation, it may be permissible to use contaminated soil materials for backfill in tank and piping excavations. Get approval from local regulating authority before using contaminated soil materials.

If contaminated soil materials are approved for backfill, retain first bracketed sentence and delete the second and third bracketed sentences.
****

Remove soil from the exterior of the tank, piping, and associated equipment to eliminate soil deposition on roadways during transportation to a temporary storage area, ensure markings will adhere to the surfaces, and simplify tank cutting. Use non-sparking tools to remove soil. Recover removed uncontaminated soil and soil not regulated by the state as a hazardous waste [and use them as backfill in the former tank excavation] [and] [or] [disposed of onsite]. Remove and containerize soil believed to be contaminated, or if the site is a RCRA designated CAMU, collect it on 3 layers of [0.152] [0.762] [_____] mm [6] [30] [_____] mil impermeable geomembrane and stockpile it with other contaminated soil removed from the excavation.

3.9.2 Temporary Storage

****
NOTE: Add any special state/local regulatory requirements.
****

If the tank is stored after the tank exterior is cleaned and ancillary equipment is removed, and prior to being cut into sections, label the tank as directed in API RP 1604, place it on blocks, and temporarily store it [on a flat area adjacent to the excavation] [at the location indicated on the drawings] [in the area of the existing tank site]. Prior to cleaning the tank interior, monitor the tank atmosphere for combustible vapors and purge or inert it if combustible vapors are detected. Provide warning labels as follows:

"TANK HAS CONTAINED LEADED GASOLINE

NOT VAPOR FREE

NOT SUITABLE FOR STORAGE OF FOOD OR LIQUIDS
INTENDED FOR HUMAN OR ANIMAL CONSUMPTION

DATE OF REMOVAL: MONTH/DAY/YEAR"

[Make tank unusable for future use, then transport and dispose of tank [at an EPA approved disposal site in accordance with applicable local, State, and Federal regulations] [in accordance with Federal, State, and local regulations].
]

3.9.3 Interior

****

NOTE: In lieu of eliminating any sheen, many states require a triple rinse. Coordinate with the appropriate regulators to ascertain what "clean" is, regarding tank interiors and to determine cleaning requirements for the piping and ancillary equipment; cleaning operations are highly dependent upon tank material and contents, and which state requirements are applicable. Often the state fire inspector's office has been tasked with Subtitle I program implementation; hence the following NFPA and API standards may be used to a greater degree than in situations in which another office of state government has been tasked with enforcing the UST regulations.

NFPA-30 Flammable and Combustible Liquids Codes

NFPA-327 Standard Procedure for Cleaning or Safeguarding Small Tanks and Containers

NFPA-329 Recommended Practice for Handling Underground Leakage of Flammable and Combustible Liquids

API Std 2015 Cleaning Petroleum Storage Tanks

If API Std 2015 is used, flooding the tank should not be used in any circumstances.

****

[Clean tank interior using a high pressure (greater than 3.45 MPa 500 psi), low volume (less than 0.13 L/s 2 gpm) water spray] [or] [Steam clean tank interior until all loose scale and sludge is removed, and contamination, in the form of a sheen, is no longer visible in the effluent stream]. Also clean the interior surfaces of piping, to the extent possible, using the same method used for cleaning the tank. Contaminated water generated from interior cleaning operations (of both piping and tank) must not exceed the following quantities for each UST cleaned:

UST VOLUME (LITERS) (GALLONS)	PERCENT OF UST VOLUME
3,785 or less1,000 or less	5
37,850 or less10,000 or less	5 or 378 L, whichever is less5 or 100 gal., whichever is less
75,700 or less20,000 or less	1 or 568 L, whichever is less1 or 150 gal., whichever is less
greater than 75,700greater than 20,000	1 or 946 L, whichever is less1 or 250 gal., whichever is less

[Collect and store onsite] [Discharge to the installation sanitary sewer after passing through an oil water separator] [Handle in accordance with paragraph Contaminated Water Disposal] all contaminated water resulting from cleaning operations. Clean so as to eliminate, to the greatest extent possible, the need for personnel to enter the tank. Use specially designed tank cleaning equipment which allows the tank to be cleaned prior to cutting into sections without requiring personnel to enter the tank or, if less specialized equipment is used, the tank is to be partially dissected to overcome confined space entry hazards. Accomplish this work in accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.

3.10 SOIL EXAMINATION, TESTING, AND ANALYSIS

3.10.1 Tank Excavation Sampling Procedures

****

NOTE: The designer will detail the confirmation soil sampling requirements and analytical parameters, including pipe trenches and near pump islands, based on the state/local regulations, EM 1110-1-4006.

In most cases, a 72-hour turnaround-time (TAT) is appropriate to avoid excessive downtime or remobilization of the Contractor; determine if a quicker TAT is warranted for the offsite analytical.

If the State will have an individual onsite to oversee sampling and/or excavation operations, the following may be substituted for the first sentence: "After soil known to be contaminated has been removed, collect and analyze soil samples as directed by the Contracting Officer in consultation with [_____]."

A backhoe should be used for soil sampling to eliminate the need to have personnel enter the excavation.

If the regulators do not specify the number of samples required, use a minimum of 2 samples at the bottom of the tank excavation zone, with one in the center of the tank excavation and one where the highest instrument reading was obtained or where contamination is most likely to occur.

If additional samples will likely be required, it may be best to include additional testing as a separate bid item so a credit can be easily obtained if the additional tests are not required.

If there is evidence of spillage around the tank or the possibility of horizontal movement of leaked material, the following requirement can be added: "A sample must be obtained from each of the 4 walls of the excavation at [[600] [_____] mm [2] [_____] foot vertical intervals] [approximately 2/3 of the total depth of the excavation] and [composited] [tested as individual samples].

****

After soil known to be contaminated has been removed or after soil excavation is complete, sample the excavation with procedures, number, location, and methodology [as specified] [in accordance with] [state regulations].[Obtain samples from the pits using a backhoe with a Shelby tube attached to the bucket.]

3.10.2 Stockpiled Material Sampling

****

NOTE: Detail the sampling requirements and include unique stockpile segregation procedures required by the implementing agency in the body of the specification. Analytical testing of stockpiled soils will be based on visual observation, knowledge of tank contents records and testing of tank contents.

Soil that is a hazardous waste will not be allowed to be stockpiled. Unless this is a designated corrective action management unit, stockpiling of hazardous waste will require a permit. Coordinate with the state on Subtitle C tanks.

****

[Stockpiled contaminated soil must be sampled and preserved in accordance with the approved Sampling and Analysis Plan.] [Sampling locations, number and specific procedures are as required by the [State of [_____]] [implementing agency] and the disposal facility.]

3.10.3 Analysis

****

NOTE: Hydrocarbon tests may vary vastly from state to state. Designer should consult the latest state requirements for the appropriate hydrocarbon test methods.

Take into consideration that testing of stockpiled soils and testing of the excavation pit to confirm "clean closure" may require different testing. Stockpiled materials testing is performed relative to disposal criteria, confirmation soil testing from the pit is tested to demonstrate clean closure.

****

Test soil samples from the excavation and stockpiled material in accordance with the approved Sampling and Analysis Plan for the following parameters: [total petroleum hydrocarbon (TPH)] [benzene, ethylbenzene, toluene, xylene (BETX)] [toxicity characteristic leaching procedure (TCLP)] [the following constituents: [_____]]. Submit copies of all test results, including the chain-of-custody records,.to the Contracting Officer.

3.11 BACKFILLING

****

NOTE: Coordinate with the IA regarding the maximum contaminant levels allowable for clean closure, and if waste from one stockpile can be used as backfill for another. Coordinate with the user concerning

preferences in regard to leaving excavations open pending lab results, state inspector's evaluations, road closures and other factors. Lab turnaround time plays a critical role in the duration of excavations left open and times must be coordinated. If field analysis is allowed by the state inspector, this would reduce or eliminate turnaround time concerns.

If the Government or state will analyze samples, revise this paragraph and give the length of time the Contractor should expect the excavation to be open.

If additional constituents require analyses to meet state/local closure requirements, include the appropriate limits in this paragraph and include the same limits in the definition for clean fill.

Add applicable requirements for backfilling the excavation in this section or revise the reference to the appropriate section of the specifications; see EM 1110-1-4006 for guidance.

****

a. Backfill the tank area and any other excavations [as soon as possible after tank and contaminated soil removals have been completed and confirmation samples have been taken] [only after the soil test results have been approved]. Complete contaminated soil removal after [the bottom of the tank excavation is determined to have soil contamination levels below the state standards of [100] [_____] ppm TPH] [approval by the [state inspector] [Contracting Officer]].

b. Dewater the excavation if necessary. Use stockpiled material, subjected to chemical confirmation testing as backfill, if it is found to [conform to the requirements of clean fill in accordance with appropriate [state] [local] regulations] [contain less than [100] [_____] ppm of total petroleum hydrocarbons (TPH)] [contain less than [10] [_____] ppm of BETX] [_____]. Place clean backfill in layers with a maximum loose thickness of [_____] [200] mm [_____] [8] inches, compacted to [90] [_____] percent maximum density for cohesive soils and [95] [_____] percent maximum density for cohesionless soils. Perform density tests using an approved commercial testing laboratory or by facilities furnished by the Contractor. Attach test results to Contractor's Quality Control Report; submit [_____] copies of the report for each UST site opened, prepared in a standard 3-ring binder, within 14 days of completing work at each site. Label each binder with contract number, project name, location and tank number; each binder must be indexed. Furnish a copy of the report to the Installation Environmental Coordinator. Perform a minimum of 1 density test on [each] [_____] lift. Determine laboratory tests for moisture density relations in accordance with ASTM D1557, Method B, C, or D, or ASTM D6938. A mechanical tamper may be used, provided that the results are correlated with those obtained by the hand tamper. Determine field in-place density is in accordance with ASTM D1556/D1556M, ASTM D6938, or ASTM D2167.

3.12 DISPOSAL REQUIREMENTS

3.12.1 Treatment, Disposal, and Recycling

****

NOTE: List approved facilities in the area of the project.

Many IA's allow contaminated soil treatment onsite and the specification revised accordingly with potential IA approval of a work plan. The approval process should be started by the designer, if possible, to ensure IA approval does not cause project delays.

Supply the EPA hazardous waste number in accordance with 40 CFR 261.

****

Perform disposal of [hazardous] [or] [special] wastes in accordance with all local, State, and Federal solid and hazardous waste laws and regulations; the RCRA; Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS; and conditions specified herein. This work includes all necessary personnel, labor, transportation, packaging, detailed analyses (if required for disposal, manifesting or completing waste profile sheets), equipment, and reports. Recycle product and pumpable liquids removed from the tank to the greatest extent practicable. Dispose of the tanks removed at one of the following state approved facilities: [_____]. Provide manifest for each tank disposed of in this manner as required by the State of [_____] to document delivery and acceptance at the disposal facility.

3.12.2 Tank and Ancillary Equipment Disposal

After the tank, piping, and ancillary equipment have been removed from the excavation and the tank cleaned, cut the tank into sections with no dimension greater than [1500][_____] mm [5][_____] feet. [Recycle] [Dispose of] tank and piping sections [in a State approved offsite disposal facility] [or] [in a salvage yard] [at the DLA Disposition Services] [at the location shown on the drawings]. Perform tank cutting prior to being taken [off Government property] [from the tank removal site]. Do not sell the tank intact. [Recycle] [Dispose of] ancillary equipment at [an approved offsite disposal facility] [a salvage yard] [the DLA Disposition Services] Piping must be disconnected from the tank and [removed] [grouted full of a portland cement and water slurry consisting of 22.7 L 6 gallons of clean water per 42.6 kg 94 pound sack of portland cement, thoroughly mixed and free of lumps] unless otherwise indicated.

3.12.3 Transportation of Wastes

Provide transportation in accordance with Department of Transportation (DOT) Hazardous Material Regulations and State and local requirements, including obtaining all necessary permits, licenses, and approvals. Submit evidence that a State licensed [hazardous]waste transporter is being used.

3.12.4 Salvage Rights

The Contractor retains the rights to salvage value of recycled or reclaimed product and metal not turned in to the DLA Disposition Services or otherwise identified, so long as the requirements of 40 CFR 266 and 40 CFR 279, or the applicable State requirements are met. At the end of the contract, provide documentation on the disposition of salvaged materials.

3.12.5 Manifest Records

****

NOTE: Manifests are required only when the tank contents are a RCRA regulated hazardous waste. If the tank contents are a DOT hazardous material but not a RCRA regulated hazardous waste, there are Bill of Lading requirements. Edit this paragraph accordingly.

****

Maintain records of all waste determinations, including appropriate results of analyses performed, substances and sample location, the time of collection, and other pertinent data as required by 40 CFR 280, Section 74 and 40 CFR 262 Subpart D. Also record transportation, treatment, disposal methods and dates, the quantities of waste, the names and addresses of each transporter and the disposal or reclamation facility, and available for inspection, as well as copies of the following documents:

a. Manifests.

b. Waste analyses or waste profile sheets.

c. Certifications of final treatment/disposal signed by the responsible disposal facility official.

d. Land disposal notification records required under 40 CFR 268for hazardous wastes.

Provide records in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Upon contract close out, the records will become the property of the Government.

3.12.6 Hazardous/Special Waste Manifests

Provide manifesting conforming to the requirements specified in Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.

3.12.7 Documentation of Treatment or Disposal

Take wastes, other than recyclable or reclaimable product or metal, to a treatment, storage, or disposal facility which has EPA or appropriate state permits and [hazardous] [or special] waste identification numbers and complies with the provisions of the disposal regulations. Furnish [documentation of acceptance of special waste by] [the original return copy of the hazardous waste manifest, signed by the owner or operator of] a facility legally permitted to treat or dispose of those materials are to be furnished to the Contracting Officer not later than [5] [_____] working days following the delivery of those materials to the facility; and include a copy in the Tank Closure Report. Furnish a statement of agreement from the proposed treatment, storage or disposal facility and certified transporters to accept [hazardous] [or special] wastes [in the Work Plan] [to the Contracting Officer not less than 14 days before transporting any wastes]. If the Contractor selects a different facility than is identified in the [contract] [Work Plan], provide documentation for approval to certify that the facility is authorized and meets the standards specified in 40 CFR 264.

3.13 SPILLS

Use appropriate vehicles and operating practices to prevent spillage or leakage of contaminated materials from occurring during operations. Inspect vehicles leaving the area of contamination to ensure that no contaminated materials adhere to the wheels or undercarriage. Take immediate containment actions as necessary to minimize effect of any spill or leak. Cleanup in accordance with applicable Federal, State, local laws and regulations, and district policy at no additional cost to the Government. Refer to Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS for spill response and reporting requirements.

3.14 INSPECTIONS

Arrange for and perform required inspections. Provide copies of inspections to Contracting Officer.

3.15 TANK CLOSURE REPORT

****

NOTE: Execute Subtitle C tank closures in accordance with previously prepared closure plans and 40 CFR 264, Section 197. Some states have forms and/or requirements that must be included.

The number of copies required is dependent on how many the state requires, what the installation requires, and what the Government wants. To avoid additional printing costs to the Government for unforeseen copies, get a realistic number.

Execute Subtitle I closures in accordance with 40 CFR 280 as well as applicable state regulations.

****

Submit a Site Assessment/Tank Closure Report in a single binder notebook containing a collection of reports, records, starting and ending dates of reporting period, inspections, documentation, and data as follows:

a. Complete UST Notification Form (within 30 days of closure).

b. Description of work, including removal procedures, number of tanks removed, identification of tanks removed and disposed of (include site map showing location of tank and piping), cubic yards of excavated soil, location of disposal sites, and dates of excavation.

c. Site plan, including location of tanks and piping, limits of excavation, sampling points, results of excavation, and depths.

d. Laboratory and field testing reports, copies of data and test results from testing laboratory and the chain-of-custody records.

e. Tank disposal paperwork ([_____] copies of UST Notification Form and method of conditioning tank for disposal), contaminated soil disposal paperwork (include laboratory testing reports), and contaminated water disposal paperwork (include laboratory testing reports).

f. Certifications required by implementing agency.

g. Building permit[, inspection permits,] and other permitsrequired for underground tank removal, notifications, and inspection reports.

[h. Cumulative quantities of soil excavated, beginning with start date for each tank and associated piping.

] Include in Tank Closure Reports the following information as a minimum:

a. A cover letter signed by a [responsible company official] [Professional Engineer registered in the State of [_____]] certifying that all services involved have been performed in accordance with the terms and conditions of this specification.

b. A narrative report describing what was encountered at each site, including:

   (1) condition of the UST.

   (2) any visible evidence of leaks or stained soils.

   (3) results of vapor monitoring readings.

   (4) actions taken including quantities of materials treated or removed.

   (5) reasons for selecting sample locations.

   (6) sample locations.

   (7) collection data such as time of collection and method of preservation.

   (8) reasons for backfilling site.

   (9) whether or not groundwater was encountered.

c. Copies of all analyses performed for disposal.

d. Copies of all waste analyses or waste profile sheets.

e. Copies of all certifications of final disposal signed by the responsible disposal installation official.

f. Information on who sampled, analyzed, transported, and accepted all wastes encountered, including copies of manifests, waste profile sheets, land disposal restriction, notification and certification forms, certificates of disposal, and other pertinent documentation.

g. Copies of all analyses performed for confirmation that underlying soil is not contaminated, with copies of chain-of-custody for each sample. Analyses must give the identification number of the sample used. Sample identification numbers are to correspond to those provided on the one-line drawings.

h. Scaled one-line drawings showing tank locations, limits of excavation, limits of contamination, underground utilities within 15 m 50 feet, sample locations, and sample identification numbers.

i. Progress Photographs. Take a minimum of 4 views of the site showing such things as the location of each tank, entrance/exit road, and any other notable site condition before work begins. After work has been started at the site, photographically record activities at each work location daily. Photographs are to be 89 x 127 mmdigital and include:

(1) Soil removal, handling, and sampling.

(2) Unanticipated events such as discovery of additional contaminated areas.

(3) Soil stockpile area.

(4) Tank.

(5) Site or task-specific employee respiratory and personal protection.

(6) Fill placement and grading.

(7) Post-construction photographs. After completion of work at each site, take a minimum of four (4) views of the site. Pictures are to be digital illustrate the condition and location of work and the state of progress. Each picture must contain a caption with the following information:

(8)

Project No.	Contract No.
Location	
Contractor/Photographer	
Photograph No.	Date/Time:
Description	
Direction of View	

j. [_____] copies of the report for each UST site opened, prepared in a standard 3-ring binder, within 14 days of completing work at each site. Label each binder with contract number, project name, location and tank number; each binder must be indexed. Furnish a copy of the report to the Installation Environmental Coordinator.

3.16 COMPACTION, FINISH GRADING, and SEEDING

Provide backfill, compaction, grading, and seeding in accordance with Section 31 00 00 EARTHWORK.[Line the excavation with two plastic sheets before backfilling.]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-02 66 13 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 66 13 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 02 66 13

SELECT FILL AND TOPSOIL FOR LANDFILL COVER

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USACE / NAVFAC / AFCEC **UFGS-02 66 13 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-02 66 13 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 02 66 13

SELECT FILL AND TOPSOIL FOR LANDFILL COVER

02/25

****

NOTE: This guide specification covers the requirements for select fill and topsoil layers for landfill cover systems. Select fill is the term used to describe soil layers (other than low permeability clay barrier layers placed above a gas collection layer) placed directly on geosynthetic materials.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: These paragraphs should be edited based on whether the contract will use a single job price or unit prices. If there is a separate Measurement and Payment section, edited versions of these paragraphs should be inserted in that section.

****

Base measurement and payment for "select fill" and "topsoil" on the respective unit prices for each cubic meter cubic yard of "select fill" and "topsoil" in place. Include the cost for development of borrow sources, cost of materials, excavation, hauling, equipment, placement, testing, and other work required to construct the "select fill" or "topsoil" layers in the unit cost.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification

	System)
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D2974	(2020; E 2020) Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4972	(2018) Standard Test Methods for pH of Soils
ASTM D6913/D6913M	(2017) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO ISO/IEC 17025	(2017) General Requirements for the Competence of Testing and Calibration Laboratories

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

1.3 SYSTEM DESCRIPTION

****

NOTE: Describe other components of the cover system and reference specification Sections that contain the requirements for these components. Other

specification sections that may be included in a landfill cover project are: 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT, 02 56 13.19 GEOSYNTHETIC CLAY LINER WASTE CONTAINMENT, 02 66 13 SELECT FILL AND TOPSOIL FOR LANDFILL COVER, and 02 66 16 TEST FILL.

****

Construct a landfill cover consisting of [_____] mm [_____] inch thick layer of compacted select fill covered by a [_____] mm [_____] inch thick layer of topsoil.

[1.4 PRE-INSTALLATION MEETING

****

NOTE: Delete this paragraph if a separate specification section is developed for the entire project to cover pre-installation meetings and other administrative requirements. Test(DJB)

****

Conduct a pre-installation meeting at the jobsite[at least five business days prior to the start of earthwork operations on the project][_____]. The pre-installation meeting is to be arranged by the Contractor and is to follow the written pre-installation meeting agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Project Superintendent, earthwork subcontractor's Project Manager and Site Foreman, Contractor's Geotechnical Engineer and Testing Agency, Government Geotechnical Engineer and Civil Engineer, and Government Construction Manager and Engineering Technician.

Record pre-installation meeting minutes and publish via email within 48 hours to all attendees. The minutes must be re-published within 48 hours via email pending any subsequent comments from the attendees.

]1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Installation Meeting Agenda

Pre-Installation Meeting Minutes; G, [_____]

Materials Handling Plan; G [_____]

Borrow Source Assessment Report; G, [_____]

SD-04 Samples

Select Fill

Topsoil

SD-06 Test Reports

Water Supply Analysis

Select Fill and Topsoil Material Tests

Moisture Content and Density Tests of In-Place Select Fill

Geotechnical Evaluation Report; G, [_____]

SD-07 Certificates

Qualifications; G, [_____]

Certificate Of Subgrade Acceptance; G, [_____]

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

****

NOTE: Regulatory requirements will be location specific and may include local ordinances and State

regulatory requirements. At a minimum, an approved Soil Erosion and Sediment Control Plan will be required by the local Soil Conservation District.

For sites addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), administrative permit requirements for on-site activities are not required, though the substantive requirements may need to be met. The permits or permit equivalents may include those addressing air emissions, water discharge, stormwater pollution prevention, and possibly others. Permitting requirements known to have substantive requirements should be listed here. If permit requirements are covered in other specifications, such as 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, delete this section.

****

Obtain all State and Local [permits][permit equivalents] required to perform the work.

1.6.2 Qualifications

1.6.2.1 Geotechnical Engineer

Provide a Professional Geotechnical Engineer licensed in the[applicable jurisdiction][state that work is being performed] to provide inspection of the select fill layer and topsoil layer throughout construction. The Geotechnical Engineer must have [five][_____] years of experience in design, construction, Quality [Assurance][Control], or certification of [landfill][dump] liners or covers. The Geotechnical Engineer is responsible for performing pre-construction, periodic during construction, and final at completion of construction site visits to inspect and [approve][certify] that the select fill and topsoil layers meet specifications. The Geotechnical Engineer is responsible for preparing and updating the Materials Handling Plan and Borrow Source Assessment Report as construction progresses to reflect changing conditions and submit updated plans if necessary. Submit a [monthly][_____] Geotechnical Evaluation Report, informing the Contractor and Contracting Officer of the status of the plans and an accounting of the Contractor's adherence to the plans addressing any present or potential problems. The Contractor is responsible for arranging meetings with the Geotechnical Engineer and Contracting Officer throughout the contract duration.

1.6.2.2 Qualified Technician

Provide a Qualified Technician to inspect, monitor, sample, and perform field testing. The technician qualifications need to be one of the following: a current National Institute for Certification in Engineering Technologies (NICET) Level II minimum certification in Construction Materials Testing Soils; Professional Civil or Geotechnical Engineer with minimum [two][_____] years of experience in design, construction, Quality [Assurance][Control], or certification of [landfill][dump] liners or caps.

1.6.2.3 Lab Validation

Perform testing by an accredited commercial testing laboratory meeting the requirements listed below. Items a. through c. apply to testing laboratories used for soil geotechnical testing (all tests other than chemical contamination tests). Item d. applies to testing laboratories used for chemical contamination tests. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

a. Comply with applicable requirements of ASTM E329

b. Testing laboratory must be licensed to operate in the State of [_____]. Third party laboratory testing must be conducted by a laboratory either validated by the USACE Materials Testing Center or have an AASHTO Materials Reference Laboratory (AMRL) certification for the required tests.

c. Testing equipment used by laboratory must be calibrated at maximum intervals of twelve months by devices of accuracy traceable to one of the following: NIST Standard Reference Materials, ISO ISO/IEC 17025, certified by state or local bureau.

d. Perform the testing in paragraph CHEMICAL CONTAMINATION TESTING by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory meeting the requirements of[Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.7   DELIVERY, STORAGE, AND HANDLING

1.7.1   Delivery

Deliver select fill and topsoil to the site in trucks that meet all local, state, and federal transportation regulations[and have added containment of material in the form of a fabric cover to prevent spillage].

1.7.2   Storage

Store select fill and topsoil in stockpiles. Keep stockpiles separate and in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations. Protect stockpiles from contamination from unsuitable materials, including but not limited to soils not meeting the definition of Select Fill or Topsoil defined in this specification, volunteer vegetation growth, or windblow waste [material][debris], which may destroy the quality and fitness of the select fill and topsoil materials. If the Contractor fails to protect the stockpiles, and any select fill or topsoil material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources. Unsatisfactory materials include materials which do not comply with the requirements for satisfactory materials in this section, and also include man-made fills, trash, refuse, backfills from previous construction, roots, and other organic matter or frozen material. Do not place stockpiles on prepared subgrade, any select fill lifts, or topsoil lifts. Place a[geotextile][geocomposite][_____] beneath stockpiles and between stockpiles of dissimilar material to keep materials separated. Provide stormwater sediment and erosion controls in accordance with[Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS][_____]. Do not allow water to pond in the stockpile areas.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

Do not install the select fill or topsoil when temperatures are below freezing or during precipitation events. Any relaxation of this requirement must be approved by the Contracting Officer.

1.8.2 Existing Conditions

****

NOTE: Existing conditions are site specific and are generally shown on the plans and provided in design or investigation documents prepared for the site. If there are specific conditions the Contractor should be made aware of that are contained in plans or documents provided, describe here.

****

The existing site conditions are presented[in Appendix [_____]][on the plans]. Immediately notify the Contracting Officer if there are discrepancies between the existing site conditions as presented and field conditions discovered during execution.

PART 2 PRODUCTS

2.1 EQUIPMENT

Use equipment to place the select fill and topsoil layers as described in the approved Materials Handling Plan. The ground pressure of the equipment must be no greater than [49][_____] kPa [7][_____] psi. Do not operate equipment by accelerating or braking suddenly, turning sharply, or traveling at speeds exceeding 8 km per hour 5.0 miles per hour.

2.2 MATERIALS

2.2.1 Select Fill

****

NOTE: The default maximum allowable particle size is 25 mm 1 inch. The maximum particle size should be reduced to 13 mm 0.5 inches in the select fill layer to prevent puncturing of the geomembrane if the select fill layer is placed directly on top of a geomembrane. Manufacturers should be consulted for recommendations on select fill maximum allowable particle size when select fill is placed on top of other geosynthetics.

Selection of suitable select fill should be based on the type and availability of soils at or close to the site. The designer must verify that these soils will not clog underlying drainage layers. The soil types listed in Table 1 are generally acceptable for use as select fill.

Sands must be analyzed to ensure they are internally stable. A soil is internally stable if it is

self-filtering (i.e., the fine particles do not move through the pores of the coarser fraction). Federal Highway Administration Publication No. FHWA-HI-95-038 describes procedures for determining the clogging potential and internal stability of soil.

The Design Engineer must also ensure the select fill is compatible with the underlying filter. For landfill applications, the filter is typically a geotextile. Filter design is based on a comparison of the grain size distribution (ASTM D7928) of the select fill and the apparent opening size (AOS) of the underlying geotextile. Geotextile filter design procedures are outlined in Federal Highway Administration Publication No. FHWA-HI-95-038.

Criteria for Atterberg limits are sometimes included in Table 1 to control the properties of the select fill.

Hydraulic conductivity criteria may also need to be added to Table 1 for the select fill soil. The hydraulic conductivity of the select fill layer controls the rate at which precipitation infiltrates into the underlying drainage layer.

****

Provide select fill in compliance with the criteria listed in Table 1 and free of debris, frozen materials, angular rocks, roots, and organics. Submit a minimum of 23 kg 50 pounds of select fill from each proposed borrow source to the Government at least [15][_____] business days prior to placement; this material is for possible Government Quality Assurance testing and not the Quality Control testing required by the Contractor.

2.2.2 Topsoil

Provide topsoil consisting of natural, friable soil that is representative of soils in the vicinity which produce heavy growths of crops, grass, or other vegetation and is reasonably free from underlying subsoil, clay lumps, objectionable weeds, litter, brush, matted roots, toxic substances, or any material that might be harmful to plant growth or be a hindrance to grading, planting, or maintenance operations as determined by the Geotechnical Engineer, Qualified Technician [, or Government Quality Assurance Representative]. Submit a minimum of 2 kg 5 pounds of topsoil from each proposed borrow source to the Government at least [15][_____] business days prior to placement; this material is for possible Government Quality Assurance testing and not the Quality Control testing required by the Contractor. Also, provide topsoil complying with the criteria listed in Table 1.

TABLE 1 - REQUIRED PHYSICAL PROPERTIES OF SELECT FILL AND TOPSOIL

PROPERTY	TEST VALUE	TEST METHOD
Select Fill		

TABLE 1 - REQUIRED PHYSICAL PROPERTIES OF SELECT FILL AND TOPSOIL

PROPERTY	TEST VALUE	TEST METHOD
Soil classification	Lean clay (CL) Clayey sand (SC) Clayey gravel (GC) [_____]	ASTM D2487
Percent Passing 0.075-um (No. 200 sieve)	[_____]	ASTM D1140
Maximum Liquid Limit	[50][_____]	ASTM D4318
Plastic Limit	[_____]	ASTM D4318
Plastic Index	[_____]	ASTM D4318
Max. particle size	[25][_____] mm [1.0][_____] inch	ASTM D6913/D6913M
In Contact with Geomembrane Max. particle	[13][_____] mm [1/2][_____] inch	ASTM D6913/D6913M
Topsoil		
Max. particle size	[25][_____] mm [1.0][_____] inch	ASTM D6913/D6913M
Soil Classification	[_____]	ASTM D2487
pH	[5-7] [_____]	ASTM D4972
Organic content (percent)	[5-20] [_____]	ASTM D2974

2.2.3 Water

****

NOTE: Two options are provided. The first option is to only allow the Contractor to use potable water. The second option allows the Contractor to use non-potable water, but includes a testing requirement to limit the chance that the Contractor supplies a water that could introduce contaminants into the select fill or topsoil layers. The first option is simpler, but could lead to higher project costs if the volume of water needed is significant and/or potable water sources are not readily available. When specifying the criterion to be met for water, the Designer should consider if there are other standards which are more appropriate for the specific project (e.g. state groundwater cleanup criteria).

****

Supply water used to increase moisture content of the select fill and topsoil layers for the sake of compaction during installation. Maintain an accurate record of water usage.[Use only potable water from a regulated public water system.][If non-potable water is to be used, provide water that does not contain oils, acids, salts, alkalis, organic matter, solids or other substances at concentrations that could be detrimental. Also characterize non-potable water prior to its use by collecting a sample from the water source and analyzing according to Table 2. Submit a Water Supply Analysis demonstrating that water meets requirements.

TABLE 2 - MOISTURE CONDITIONING AND DUST CONTROL WATER CRITERIA

ANALYTICAL METHOD NUMBER (From EPA SW-846; use current version)	ANALYSIS TYPE	CRITERIA TO BE MET
6010 [and 7470A]	Metals [and Mercury]	[Less than Maximum Contaminant Level (MCL)] [_____]
8260	Volatile Organics	
8270	Semi-volatile Organics	
8082	PCBs	
1633	PFAS	
8081	Pesticides	
Within each Analytical Method, only analyze for analytes which have an [MCL][_____].		

]

2.3 TESTS, INSPECTION, AND VERIFICATIONS

2.3.1 Select Fill

****

NOTE: Shear strength testing is often required for landfill covers and liners which contain geosynthetics. Testing should be conducted on all potential slip interfaces. Criteria for shear strength testing (also referred to as interface friction testing)are described in Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT or Section 02 56 13.19 GEOSYNTHETIC CLAY LINER WASTE CONTAINMENT.

If hydraulic conductivity of the select fill layer needs to be specified based on the design, requirements from Section 02 56 13.16 CLAY WASTE CONTAINMENT can be incorporated into this section.

****

Use[test pits][borings] placed in a grid pattern to characterize each proposed borrow source. Extend the[test pits][borings] to the full depth of the proposed borrow source. Perform visual classification as described in ASTM D2488 over the full depth of each[test pit][boring] by the[Geotechnical Engineer described in paragraph GEOTECHNICAL ENGINEER][Qualified Technician described in paragraph QUALIFIED TECHNICIAN]. Group soils into "principal types" based on visual classification.

2.3.1.1 Classification Testing

Perform borrow source assessment tests on each principal type and combination of materials proposed for use in the select fill layer to ensure compliance with specified requirements. Perform one set of borrow assessment tests for each [400][_____] cubic meters [500][_____] cubic yards of each soil type and borrow source proposed for use; test for the select fill properties listed in Table 1. Perform at least three borrow assessment tests for each soil type and borrow source. Based on borrow source assessment testing, classify soils in accordance with ASTM D2487.

2.3.1.2 Moisture-Density (Compaction) Testing

Test a representative sample from each principal type and combination of borrow materials to establish compaction curves using ASTM D698. Perform one compaction test for each [400][_____] cubic meters [500][_____] cubic yards of each borrow source proposed. Perform at least three compaction tests for each soil type and borrow source. Use a minimum of [five][_____] points to develop each compaction curve. During construction, conform to the following requirements for placement of select fill:

a. Minimum allowable dry density less than [90][_____] percent of maximum dry density is not acceptable.

b. The allowable moisture content range must be [+/-3][_____] percent of optimum.

2.3.2 Topsoil

Test representative samples of each principal type and combination of topsoil materials. Perform one set of tests for each [400][_____] cubic meters [500][_____] cubic yards of each borrow source proposed; test for the topsoil properties listed in Table 1. Perform at least three sets of tests for each borrow source. Based on borrow source assessment testing, classify soils in accordance with ASTM D2487.

2.3.3 Chemical Contamination Testing

****

NOTE: This section includes a requirement to prepare a UFP-QAPP to define chemical contamination testing. Alternatively, this section may reference a separate specification section in the project requiring preparation of a UFP-QAPP. If that is the case, ensure that UFP-QAPP requirements from this section are appropriately incorporated into the separate specification section.

Suggested chemical analyses, sampling frequency, sample collection methods, and chemical concentration screening level standards are included as optional requirements to be considered in the UFP-QAPP. The Designer can include more specific requirements in the list of UFP-QAPP elements to be addressed. Individual states where work is being completed may have requirements that should also be considered.

The Designer should take care that requirements are not too strict for what is considered "clean" soils. Natural and anthropogenic background concentrations of chemicals should be considered in addition to health-based screening levels defined by regulatory agencies. The Designer may wish to use alternative methods instead of conducting project-specific specific chemical contamination testing; alternative methods could include using previously approved borrow sources where chemical contamination testing has already been conducted or using borrow sources where chemical contamination is not suspected based on knowledge of land use, etc .

****

2.3.3.1 Uniform Federal Policy Quality Assurance Project Plan

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with the requirements set forth in EPA 505-B-04-900A and using the UFP-QAPP WKSTS. Submit the UFP-QAPP within [30][_____] calendar days after notice to proceed. Do not perform chemical contamination testing until the UFP-QAPP is approved. Prepare[draft for Government review][draft-final for[regulatory][_____] review] and final versions of the UFP-QAPP. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] calendar days for comment resolution following each review and preparing the next version of the document. Tailor the content to the requirements of the project and the site conditions. The UFP-QAPP must specifically address the following elements:

a. Chemical analyses: Specify the chemicals to be analyzed in each sample.[At minimum the following analyses must be included:[target compound list volatile organic compounds][target compound list semi-volatile organic compounds][target analyte list metals][pesticides/polychlorinated biphenyls][______].]

b. Acceptable chemical concentrations for the select fill and topsoil layer soils.[At minimum the following standards must be considered:[U.S. Environmental Protection Agency Regional Screening Levels][state-specific screening levels defined at [______]][background chemical concentrations defined at [______].]]

c. Chemical contamination sampling frequency. Assume a minimum sampling frequency of one sample for every [2,000][_____] cubic meters [2,500][_____] cubic yards of select fill and topsoil brought on site. Consider other sampling frequency requirements such as state regulations or guidance.

d. Sample collection method (e.g. discrete grabs, composites, incremental samples).

e. Borrow source chemical contamination acceptance criteria, indicating how sample results will be compared to acceptable chemical concentrations to determine if the borrow source is acceptable (e.g. each sample must meet acceptable concentrations, average of samples must meet acceptable concentrations).

2.3.3.2 Chemical Contamination Sampling and Analysis

Sample and analyze each principal type and combination of select fill and topsoil from each proposed borrow source for chemical contamination in accordance with [the UFP-QAPP][_____]. Any deviations to sampling frequency, number of samples, or sample collection methods must be[established in the approved[UFP-QAPP][_____]][approved by the Contracting Officer].

2.3.4 Borrow Source Assessment Report

Submit a Borrow Source Assessment Report at least [15][_____] business days prior to select fill and topsoil placement. Do not place select fill or topsoil until the Borrow Source Assessment Report is approved. Include the following in the report:

a. Location of each borrow source.

b. Plan view and estimated quantity of borrow available.

c. Locations and logs of subsurface explorations.

d. Laboratory test results.

e. Chemical testing data demonstrating that select fill and topsoil is acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Select Fill Layer Subgrade

****

NOTE: Subgrade for the select fill layer should consist of a geosynthetic. The following paragraph includes a requirement for completing a Certificate of Subgrade Acceptance; this activity ensures that soils are not placed over a geosynthetic that has not been fully inspected, tested, and determined to meet requirements.

****

Each day during placement of the select fill layer, the Qualified Technician[and Government QA representative] must inspect the subgrade geosynthetic to verify it is acceptable for placement of the select fill layer. Submit a Certificate of Subgrade Acceptance each day that the select fill layer is placed. Examine the subgrade for compliance with the items in the list below:

a. A project-qualified land surveyor has verified the lines and grades of the subgrade meet project design.

b. All construction quality control and construction quality assurance of the underlying geosynthetics has been completed and results have been accepted by the Contracting Officer.

c. The subgrade is free of irregularities, protrusions, loose soil, and abrupt changes in grade.

d. All tools, equipment, and temporary covers have been removed from the geosynthetic.

3.1.2 Topsoil Subgrade

****

NOTE: Subgrade for the topsoil layer will either be select fill or common fill. If subgrade is not suitable to install the topsoil layer, require the subgrade to be reworked in accordance with the Specification Section that addresses subgrade preparation. The Certificate of Subgrade Acceptance is provided as an optional requirement for the topsoil layer as it is deemed less essential than for the select fill layer. Requiring this submittal creates more work for the Contractor's Quality Control program and Government's Quality Assurance activity; however it provides a checkpoint to verify that QA/QC testing has been performed on the subgrade or previously installed select fill lifts, limiting the chance for re-work.

****

Inspect the topsoil layer subgrade to verify it is acceptable for placement of the topsoil layer. The subgrade must be free of vegetation and ruts and must not be wet or frozen. If subgrade is not suitable to place the topsoil layer, rework subgrade in accordance with this section.[Submit a Certificate of Subgrade Acceptance completed by the Qualified Technician[and Government QA representative] each day that topsoil layer is placed.]

3.2 INSTALLATION

3.2.1 Materials Handling Plan

Submit a Materials Handling Plan at least [15][_____] business days prior to select fill or topsoil layer placement. Do not place select fill or topsoil until the Materials Handling Plan is approved. Include the following in the plan: processing and placement of the select fill or topsoil; type, model number, weight and critical dimensions of equipment to be used for soil processing and compaction.

3.2.2 Select Fill Placement

****

A temporary haul roads is required to allow access for large construction equipment during select fill placement. The haul roads are typically a minimum of 1 m 3 feet in thickness and are constructed using select fill.

A test fill should be required when needed to demonstrate placement technique or to determine cover or liner stability. Section 02 66 16 TEST FILL can be edited and included in the specification package if a test fill will need to be constructed.

****

Do not operate equipment directly on the top surface of geosynthetics without permission from the Contracting Officer. Push select fill out over geosynthetics in an upward tumbling motion so that wrinkles in geosynthetics do not fold over. Do not drop soil directly onto geosynthetics from a height greater than 915 mm[_____] 3 feet[_____]. On slopes, place select fill from the bottom of the slope upward.

3.2.2.1 Initial Lift of Select Fill Placed Over Geosynthetics

The first lift of soil placed over geosynthetics must be a minimum of [305][380][_____] mm [12][15][_____] inches in loose thickness. Use equipment with ground pressures less than [49][_____] kPa [7][_____] psi to place and traffic compact the first lift of select fill. Traffic compaction consists of a minimum of six one-way passes over all areas. Rubber-tire haul trucks can only operate over a geosynthetic if a haul road of minimum thickness 1 meter 3 feet is provided.

3.2.2.2 Subsequent Lifts of Select Fill

****

NOTE: Maximum loose lift thickness should be no greater than 200 mm 8 inches if a density criteria will be applied to the lift. The criteria for minimum number of passes can be omitted if the Contractor must meet a density criteria.

****

Do not provide a lift thickness of each subsequent lift greater than [205][305][_____] mm [8][12][_____] inches. Allow full scale placement and compaction equipment on areas underlain by geosynthetics after the[first][second] loose lift of soil has been placed. Rubber-tire haul trucks can only operate over a geosynthetic if a haul road of minimum thickness 1 meter 3 feet is provided.[Compaction consists of a minimum of six passes over all areas.]

3.2.3 Topsoil Placement

Place topsoil and evenly spread to a final compacted thickness as specified in paragraph SYSTEM DESCRIPTION. Traffic compact topsoil using approved placement equipment. On slopes, place topsoil from the bottom of the slope upward.

3.2.4 Construction Tolerances

****

NOTE: The U.S. Environmental Protection Agency document, EPA/600/R-93/182 Quality Assurance and Quality Control for Waste Containment Facilities discourages the use of grade stakes which penetrate the select fill layer to control lift thickness. Grade stakes can potentially damage underlying geosynthetic materials.

****

Provide finished surfaces that are uniformly graded and free from depressions, mounds, or windrows. Top surfaces of the select fill layer and topsoil layer greater than [76][_____] mm [3][_____] inches above the lines and grades shown on the drawings are prohibited. No minus tolerance will be permitted. Do not drive rigid grade stakes into the select fill layer to control placement.

3.3 FIELD QUALITY CONTROL

3.3.1 Select Fill and Topsoil Material Tests

During construction of the select fill layer, take representative samples for testing at the frequencies listed in Table 3[from the borrow source prior to placement][from stockpiled material prior to placement]. Test results must comply with the requirements listed in Part 2 PRODUCTS or the material will be rejected for use. Submit test results as specified.

TABLE 3 - SELECT FILL AND TOPSOIL MATERIAL TESTING FREQUENCIES

PROPERTY	FREQUENCY	TEST METHOD
Select Fill		
Grain size analysis	[1,500] [_____] cubic meters [2,000][_____] cubic yards	ASTM D6913/D6913M
Liquid Limit, Plastic Limit, Plastic Index	[1,500][_____] cubic meters[2,000][_____] cubic yards	ASTM D4318
Compaction (Note 1)	[4,000][_____] cubic meters[5,200][_____] cubic yards	ASTM D698
Topsoil		
Grain size analysis for maximum particle size	[1,500][_____] cubic meters[2,000][_____] cubic yards	ASTM D6913/D6913M
pH	[1,500][_____] cubic meters[2,000][_____] cubic yards	ASTM D4972
Organic content	[1,500][_____] cubic meters[2,000][_____] cubic yards	ASTM D2974
Note 1: Compare compaction test results with the results obtained during the borrow source assessment. When there are significant differences, adjustments to the acceptable moisture content or density ranges must be proposed by the Contractor for approval.		

3.3.2 Moisture Content and Density Tests of In-Place Select Fill

****

NOTE: Test results using ASTM D6938 may show a significant amount of scatter in some situations.

ASTM D4643 (microwave method) can be used as an alternative to ASTM D6938 for quick determinations of moisture content.
****

Perform moisture content and density tests for select fill in-place, in a grid pattern staggered for successive lifts, so that sampling points are not at the same location in each lift. Perform moisture content and density tests in accordance with Table 4. Submit test results as specified.

TABLE 4 - MOISTURE CONTENT AND DENSITY TESTS OF IN-PLACE SELECT FILL

PROPERTY	FREQUENCY PER LIFT	TEST METHOD
Nuclear moisture content	[925][____] square meters [7,000][____] square feet Minimum of three tests per day.	ASTM D6938
Standard moisture content	One for every 20 nuclear tests; minimum one test per day.	ASTM D2216
Nuclear density	[650][_____] square meters [7,000][_____] square feet Minimum of three tests per day.	ASTM D6938
Standard density	One for every 20 nuclear tests, minimum one test per day.	ASTM D1556/D1556M or ASTM D2167

3.3.2.1 Test Frequencies and Locations

Perform nuclear density and moisture content tests at locations that are representative of moisture and compaction based on visual observations during placement of the lift. Perform standard tests at locations which are underneath the nuclear gauge or as close as possible to the locations of the nuclear tests being checked.

3.3.2.2 Nuclear Density and Moisture Content Tests

Take nuclear density readings in the direct transmission mode. When ASTM D6938 is used, check and adjust the calibration curves using only the sand cone method as described in ASTM D1556/D1556M. ASTM D6938 results in a wet unit weight of soil and when using this method, use ASTM D6938 to determine the moisture content of the soil. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938; make the calibration checks of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer.

3.3.2.3 Test Results

Compare field moisture content and density test results to the compaction curve for the appropriate material type being tested. If test results are not within the acceptable range for moisture content or density, as described in subparagraph Moisture-Density (Compaction) Testing, repair the lift of soil out to the limits defined by the Qualified Technician based on visual observation, process monitoring, and additional nuclear testing. Retest the area as directed. Document repairs to the select fill layer including location and volume of soil affected, corrective action taken, and results of retests.

3.3.3 Government Quality Assurance Testing

****

NOTE: Quality assurance (QA) testing and inspections should be performed on all landfill construction as the liability is long term and cost due to failure is significant. Factors to consider include whether the Government has access to a laboratory that can analyze quality assurance samples in a timely manner to not delay the project execution. If conducting quality assurance testing, a separate third-party quality assurance contract should be considered based on the qualifications of the Government QA personnel and the size and importance of the project.

Use of quality assurance testing data also needs to be considered. A relatively straightforward data use is to compare quality assurance sample results to the project performance requirements, and failing result would be treated the same way as a failing Contractor test result. A more complicated data use is to compare results from quality assurance samples and contractor quality control samples for the purpose of determining if there is meaningful disagreement between the results. In this case, procedures would need to be developed for determining when there is a meaningful disagreement between quality assurance and quality control sample results; corrective actions for when a meaningful disagreement was identified would also need to be developed. The process of defining procedures for identifying and correcting meaningful differences should be documented in a project-specific CQA Plan or Quality Assurance Project Plan and referenced in this specification; the process is likely too complex to be adequately defined in this specification.

Two options are provided for defining Government Quality Assurance. The first option is to defer details of the Government QA to a separate CQA Plan. The CQA Plan would need to be developed and provided to the Contractor with the project specifications. This option would be preferred for large, complex projects where the clay barrier is one component of a larger waste containment system. A second, simpler option is provided to define Government QA testing frequency.

The Government's QA personnel should visit off-site borrow sources to assure that soils identified in the Borrow Source Assessment Report are being

utilized and no water is being added.
****

[Work will be monitored and tested in accordance with the requirements of the CQA Plan. Be aware of all monitoring and testing activities defined in the CQA Plan and account for these activities in the construction schedule. Quality Assurance testing and monitoring does not relieve the contractor of the responsibility to complete the quality control testing and monitoring defined in this specification section.

][[Provide][The Contracting Officer will provide] duplicate quality assurance samples to the Government's quality assurance laboratory at a frequency of one set of samples per [10][_____] sets of quality control tests performed. Quality assurance samples will be tested for the same parameters as the parent quality control sample. A failed quality assurance test will require the same corrective actions defined in this section as a failed Contractor quality control test. The Contracting Officer may require additional quality assurance tests as a result of failed quality assurance or quality control tests. Account for Government quality assurance testing in the construction schedule. Quality Assurance testing and monitoring does not relieve the contractor of the responsibility to complete the quality control testing and monitoring defined in this specification section.
]

3.4 PROTECTION

Protect newly placed select fill and topsoil from traffic, erosion, and settlements that may occur. Prevent damage by ineffective drainage or traffic by heavy equipment. Do not stockpile material on finished surfaces. Repair or reestablish damaged areas to specified requirements.

3.4.1 Damage

Repair erosion rills or other damage that occurs and re-establish grades. Document repairs to the select fill layer or topsoil layer including location and volume of soil affected, corrective action taken, and results of retests.

3.4.2 Stockpiles

Storage or stockpiling of material on the completed surface of the select fill or topsoil layers will not be permitted.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 66 16 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-02 66 10 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-02 66 16 (February 2021)**

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SECTION 02 66 16

TEST FILL

02/21

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NOTE: This guide specification covers the requirements for a test fill for a landfill liner or cover.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

****

NOTE: This guide specification must be used in conjunction with and coordinated with the referenced sections. Multiple borrow sources may be required for large projects; in that case, more than one test fill may need to be constructed. Test fills are generally listed as a lump sum item on the bidding schedule.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D5084	(2016a) Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D7928	(2017) Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

1.2 SYSTEM DESCRIPTION

Submit a construction plan for the test fill. Do not begin test fill construction until the test fill construction plan is approved. The materials proposed for use in the test fill and interface friction testing must also be approved prior to the start of test fill construction. The plan includes, but is not limited to, the following items:

a. Proposed modifications to the test fill design;

b. Placement sequence;

c. Surface water control and diversion;

d. Equipment to be used including operating speeds, traffic patterns, and number of passes;

e. Geosynthetics products to be used and geosynthetics manufacturer's equipment recommendations.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Construction Plan

QC Inspector

SD-06 Test Reports

Weekly Reports

Final Report

1.4 QUALITY ASSURANCE

****

NOTE: This paragraph and references to the QC inspector should be removed if a QC inspector will not be used.

****

The QC inspector must be present during test fill construction, review the Contractor's test data, and ensure that the Contractor has constructed each layer of the test fill as specified. The QC inspector must meet the qualifications identified in Section [02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT] [_____]. Submit the QC inspector qualifications, as specified.

PART 2 PRODUCTS

****

NOTE: Not all of the materials described below will be included in each test fill. Delete materials that are not applicable. The layer thicknesses specified should be modified on a site specific basis.

****

2.1 RANDOM FILL

Provide random fill consisting of a [300] [_____] mm [12] [_____] inch layer as specified in Section [31 00 00 EARTHWORK] [_____] and as shown on the drawings.

2.2 CLAY BARRIER LAYER

Provide clay barrier layer consisting of a [600] [_____] mm [24] [_____] inch compacted clay layer as specified in Section 02 56 13.16 CLAY WASTE CONTAINMENT and as shown on the drawings.

2.3 GEOMEMBRANE

Provide geomembrane barrier layer as specified in Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT and as shown on the drawings. Place a [smooth geomembrane] [geomembrane textured on the [top] [bottom] side] [geomembrane textured on both sides] in the test fill.

2.4 GEOSYNTHETIC CLAY LINER

Provide geosynthetic clay liner as specified in Section 02 56 13.19 GEOSYNTHETIC CLAY LINER WASTE CONTAINMENT and as shown on the drawings.

2.5 GEOSYNTHETIC DRAINAGE LAYER

Provide geosynthetic drainage layer as specified in Section 31 32 19.13 GEOSYNTHETIC DRAINAGE LAYER and as shown on the drawings.

2.6 GEOTEXTILE

Provide geotextile layer as specified in Section 31 32 19.16 GEOTEXTILE and as shown on the drawings.

2.7 GRANULAR DRAINAGE LAYER

Provide granular drainage layer consisting of a [300] [_____] mm [12] [_____] inch layer as specified in Section [32 11 13.13 LIME TREATED SUBGRADE] [_____] and as shown on the drawings.

2.8 SELECT FILL

****

NOTE: Top soil is usually not placed on the test fill. However, the weight of the top soil may be simulated by the placement of additional select fill.

****

Provide select fill consisting of a [600] [_____] mm [24] [_____] inch layer of select fill material as specified in Section 02 66 13 SELECT FILL AND TOPSOIL FOR LANDFILL COVER and as shown on the drawings.

2.9 EQUIPMENT

Construct the test fill to demonstrate that the proposed equipment and procedures are acceptable for construction of the full scale landfill [liner] [cover]. Use equipment as specified in the sections referenced. Contact the geosynthetics manufacturers for recommendations on geosynthetics and soil placement equipment.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Location

****

NOTE: The location of the test fill along with plan and section views should be included on the drawings.

****

Construct the test fill at the location shown on the drawings. Make [photographs] [and] [videotape] during construction of each layer of the test fill to document construction techniques.

3.1.2 Size

****

NOTE: The test fill should be a minimum of 3 to 4 times wider than the compaction equipment proposed. The demonstration area should be long enough to allow construction equipment to achieve normal operating speed for a distance of 8 m 25 feet.
****

The top surface of the test fill must be a minimum of [30] [_____] meters [100] [_____] feet long and [22] [_____] meters [70] [_____] feet wide. Extend the random fill layer a minimum of [1.5] [_____] meters [5] [_____] feet beyond the edge of the upper surface of the test fill.

3.1.3 Slope

****
NOTE: In situations where compaction of soil on side slopes is a concern, the specified slope for the test fill should represent the steepest designed slope.
****

Place the completed slope of each layer in the test fill [_____] horizontal on 1 vertical.

3.2 PLACEMENT

****
NOTE: Benches and haul roads are other potential components of a landfill cover that can be modeled by a test fill. A good deal of construction activity is required to construct benches. This increased construction activity may result in damage to the underlying cover system. The movement of large vehicles on haul roads may also cause damage to the cover system.
****

3.2.1 Clearing and Grubbing

Clear and grub the area beneath the test fill and [3] [_____] meters [10] [_____] feet beyond the edges of the test fill in accordance with Section 31 11 00 CLEARING AND GRUBBING.

3.2.2 Subgrade Compaction

After clearing and grubbing, compact the existing landfill surface beneath the test fill and [3] [_____] meters [10] [_____] feet beyond the edges of the test fill as described in Section [31 00 00 EARTHWORK] [_____].

3.2.3 Drainage Controls

Before beginning construction, construct drainage controls around the test fill to protect it from erosion damage. Maintain drainage control until completion of the post-construction monitoring period.

3.2.4 Anchor Trench

****
NOTE: Anchor trenches are often not required for

the construction of a test fill. An anchor trench allows specific interfaces to be tested for interface stability. Delete this paragraph when an anchor trench will not be a component of the test fill.
****

Construct an anchor trench along the full width of the top edge of the test fill to anchor the [geomembrane,] [geosynthetic drainage layer,] [geotextile,] and [_____]. Provide anchor trench that is a minimum of [450] [_____] mm [18] [_____] inches wide and [600] [_____] mm [24] [_____] inches deep. Backfill and compact the anchor trench as specified in Section [31 00 00 EARTHWORK] [_____].

3.2.5 Test Fill Placement

Construct all components of the test fill as described in the specification sections previously referenced. Extend geosynthetics a minimum of [300] [_____] mm [12] [_____] inches beyond the edge of the overlying layer.

3.2.6 Survey Control Points

****
NOTE: Control points should be shown on plan and section views of the test fill. Permanent marks should be placed on each geosynthetic layer which will be surveyed.
****

Provide the location of survey control points as shown on the drawings. For soil layers, survey control points consist of 450 mm 18 inch steel pins. Install steel pins without damaging underlying geosynthetics. Place three straight rows of control points horizontally across the test fill. The rows must be parallel to the top and bottom edges of the test fill. Ensure each row consists of the following:

a. Steel pins placed outside of the test fill, [3] [_____] meters [10] [_____] feet away from each side.

b. Steel pins placed in the select fill layer, [3] [_____] meters [10] [_____] feet from the outside edge of the select fill layer on both sides of the test fill.

c. Permanent marks on the upper surface of each geosynthetic layer, on both sides of the test fill.

3.2.7 Permanent Bench Mark

Tie surveys to a permanent bench mark outside the boundaries of the landfill.

3.3 TESTS

Test each layer of the test fill as specified below. For random fill, clay barrier layer, and select fill layers, rapid methods may be used to perform moisture and density tests in accordance with ASTM D6938, or ASTM D4643. However, perform at least [1] [_____] density test per lift using the methods described in ASTM D1556/D1556M or ASTM D2167 and perform at least [1] [_____] moisture content test per lift using the methods described in

ASTM D2216.

3.3.1 Random Fill Tests

Perform a minimum of [2] [_____] sets of classification tests on each lift of random fill placed. Perform classification tests in accordance with ASTM D7928 and ASTM D4318. Perform a minimum of [5] [_____] density and [5] [_____] moisture content tests per lift.

3.3.2 Clay Barrier Layer Tests

****

NOTE: Sealed double ring infiltrometer (SDRI) tests can be used to determine the hydraulic conductivity of the clay barrier layer. However, SDRI tests are not commonly performed due to the cost and length of time required to complete the test. SDRI tests should not be performed on slopes greater than 3 percent. EPA/600/R-93/182 provides additional information on double ring infiltrometer tests.

****

The QC Inspector must inspect the clay barrier layer during construction to verify material and placement methods are acceptable. Take a minimum of [5] [_____], 75 mm 3 inch Shelby tube samples from the completed clay layer at locations directed by the QC inspector. Extrude and visually examine Shelby tube samples for signs of inadequate bonding between lifts. Perform a set of classification tests and a hydraulic conductivity test on each Shelby tube sample taken. Perform classification tests in accordance with ASTM D7928 and ASTM D4318. Perform hydraulic conductivity tests in accordance with ASTM D5084. Perform a minimum of [5] [_____] field density tests and [5] [_____] moisture content tests on each lift of clay placed.

3.3.3 Geosynthetics Tests

****

NOTE: Geomembrane seam tests are sometimes performed on test fills. If seam tests are going to be performed, requirements for seam types and locations should be specified. Vertical pipes are also sometimes placed in the test fill to simulate gas vents in the cover system. A geomembrane boot is then installed around the pipe. Delete this paragraph if geomembrane seam tests will not be performed.

****

Perform [3] [_____] sets of quality control and [3] [_____] sets of quality assurance shear and peel tests on geomembrane seams at approved locations. Perform nondestructive testing for leaks on all geomembrane seams. Perform seam tests as specified in Section 02 56 13.13 GEOMEMBRANE WASTE CONTAINMENT.

3.3.4 Granular Drainage Layer Tests

****

NOTE: Granular drainage layer material is normally not compacted for landfill applications. Therefore, density tests are typically not required for a

granular drainage layer.
****

Perform a minimum of [2] [_____] sets of classification tests on each lift of the granular drainage layer, in accordance with ASTM D7928.

3.3.5 Select Fill Tests

****
NOTE: The select fill layer placed above geosynthetic layers can be constructed using both method and performance specifications. Modify this paragraph if a method specification will be used. The first lift of soil placed immediately above a geosynthetic layer is generally placed with low ground pressure equipment. No density testing requirements are generally specified for this first lift.
****

Perform a minimum of [2] [_____] sets of classification tests on each lift of select fill placed. Perform classification tests in accordance with ASTM D7928 and ASTM D4318. Perform a minimum of [5] [_____] density and [5] [_____] moisture content tests per lift. Density testing is not required on the first lift of soil placed above a geosynthetic layer.

3.3.6 Surveys

Perform the following surveys to monitor horizontal and vertical movement of the test fill. Provide horizontal and vertical accuracy of the surveys to the nearest [0.003] [_____] meter [0.01] [_____] foot.

a. During construction, survey all installed control points immediately after each layer is placed.

b. During the post-construction monitoring period, survey all control points once every [7] [_____] days.

3.3.7 Post-Construction Monitoring

****
NOTE: The duration of post-construction monitoring depends on the site specific testing which will be performed. If the only purpose of the test fill is to demonstrate construction methods and monitor for damage to geosynthetics, no post-construction monitoring period is necessary. A 14 to 60 day monitoring period is typical if surveys to monitor for horizontal movement will be performed.
****

Monitor the test fill for [_____] days following construction. Inspect the test fill daily and report its condition in the Construction Quality Control Daily Reports. After every precipitation event, inspect the condition of the test fill.

3.3.8 Weekly Reports

Include test results and survey data related to test fill construction and post-construction monitoring during the previous 7 days in weekly reports. The QC inspector must certify that the weekly reports are accurate. The presentation of survey data for control point monitoring includes tables and graphs which present down-slope and vertical displacement. Update these tables and graphs weekly. Submit weekly reports within [3] [_____] days of the end of the week in which data was obtained.

3.3.9 Final Geosynthetics Inspection

After the post-construction monitoring period, remove [select fill] [and] [granular drainage layer material] from a [3] [_____] by [6] [_____] meter [10] [_____] by [20] [_____] foot area of the test fill at a location selected by the QC inspector. Remove soils from the geosynthetics without damaging and maintain their relative positions. Visually inspect each layer of geosynthetics and document areas of damage. At the QC inspector's discretion, examine additional areas of the test fill in a similar manner. [Photograph] [and] [video tape] the inspection operation.

3.3.10 Final Report

Include the following in the final report: construction and monitoring test results; final geosynthetic inspection data; and conclusions related to test fill construction and monitoring. The QC inspector must review the final report and certify its accuracy. Include a copy of the [photographs] [and] [videotape] of the test fill construction and monitoring. Submit final report within [7] [_____] days of the completion of the "Final Geosynthetics Inspection". Allow [7] [_____] days for review and approval of the final report.

3.4 APPROVAL

Do not begin full-scale construction until the Contracting Officer has approved the final report. The test fill will be rejected if the Contractor's placement methods result in damage to system components or there is down-slope movement of any of the test fill survey control points. If rejected, remove the test fill. Submit a new test fill construction plan and construct and monitor another test fill at no additional cost to the Government. Use only materials, methods, and equipment from the approved test fill for full-scale construction.

3.5 REMOVAL

****

NOTE: In some cases, the test fill may be incorporated into the final cover or liner. Connection requirements should be specified if this option is utilized.

****

After approval of the final post-construction monitoring report, remove the test fill. [Select fill] [and] [granular drainage] material may be salvaged for use during full scale construction unless otherwise directed by the Contracting Officer. If reused, stockpile and protect these materials from contamination. Remove and discard the clay layer, or use as random fill. Remove and discard geosynthetics .

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-02 72 13.13 (February 2025)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 02 - EXISTING CONDITIONS

SECTION 02 72 13.13

POINT OF ENTRY TREATMENT FOR DRINKING WATER

02/25

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-02 72 13.13 (February 2025)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 02 72 13.13

POINT OF ENTRY TREATMENT FOR DRINKING WATER

02/25

****

NOTE: This guide specification covers the requirements for drinking water treatment via a point of entry treatment (POET) system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification is intended to be used when chemical contaminants have impacted a small potable water system such as an individual residence or small building. The chemical contaminants that are the focus of this specification include synthetic organic contaminants, of which organic solvents and per- and polyfluoroalkyl substances (PFAS) are most prevalent in Department of Defense (DoD) environmental restoration work. Other common contaminants that are known to be successfully treated by the POET systems covered in this specification section include arsenic, nitrate/nitrite, and perchlorate. The

treatment methods that are the focus of this specification include granular media such as activated alumina, ion exchange resins, and granular activated carbon. Reverse osmosis POET systems are not considered due to the limited water production capabilities of these systems and the large volumes of reject water that reverse osmosis systems generate. For more information on application of POETs, readers should consult EPA 815-R-06-010, Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems.

This specification section is intended to be used in a performance-based application where the same contractor is responsible for design, procurement, and installation of the POET system. The specification section would need to be modified if the Government has a specific POET system design that is to be installed.

This specification is not intended to be used for point-of-use (POU) treatment applications where water is treated at a single tap (typically a sink/faucet). POU treatment units generally cannot be installed on showers/bathtubs, hot-water lines to sinks, dishwashing machines, or toilets. Because of this, POU treatment units cannot address health risks for contaminants which present inhalation or contact exposure risks at untreated taps. Furthermore, design and installation of POU treatment units is much simpler than POET systems; selecting a POU treatment unit essentially involves picking a certified treatment unit that is rated for the contaminant concentrations, water flow rates/volumes, and pressures at the tap to be treated. Installation, operation, and maintenance of a POU treatment unit should be done in accordance with the unit manufacturer's instructions.

Federal and state regulations place certain requirements on public water systems that use POETs to comply with the Safe Drinking Water Act. For example, regulatory approved monitoring plans are required and mechanical warning systems must be in-place to automatically notify customers of operational problems. This guide specification section is not intended to produce a fully compliant POET system for use in a public water system as defined by state and/or federal regulations. This section would need to be revised on a case-by-case basis depending on the applicable state/federal regulations. The Safe Drinking Water Act defines public water systems for federal regulations (i.e. a system that serves at least 15 connections and/or 25 individuals - see 40 CFR 125.58 for a complete definition). States and local regulations may also define public water systems more strictly than federal regulations (for example the State of Washington defines any system serving more than a

single home as a public water system). See EPA 815-R-06-010, Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems for further discussion on regulation of POET units in public water systems.

The POET system considered in this guide specification section receives contaminated water from a source such as a groundwater well, spring, or surface water. Energy to move the water from the source through the POET system is provided by a pump, elevated storage tank, pressure tank, etc. Once water passes through the POET system it may pass through other treatment processes such as water softening before ultimately entering the distribution piping. This specification is limited to the POET system treatment processes. This specification does not cover requirements for all elements of a drinking water system, such as the wells, water storage equipment, common treatment processes like pH neutralization or softening, distribution piping, etc. Also note that the specification requires the contractor to develop an Operation and Maintenance Manual, but does not require the contractor to perform operations and maintenance (O&M) past the initial commissioning of the system.

Section 43 31 13.13 10 ACTIVATED CARBON-GAS AND LIQUID PURIFICATION FILTERS and Section 46 61 00 FILTRATION EQUIPMENT may provide supplementary information useful to designers editing this section.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the

basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.1.2	(2012; R 2017; R 2022) Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
ASME A112.1.3	(2000; R 2019) Air Gap Fittings for Use with Plumbing Fixtures, Appliances, and Appurtenances
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C710	(2020) Cold-Water Meters - Displacement Type, Plastic Main Case

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2024) International Plumbing Code

NSF INTERNATIONAL (NSF)

NSF/ANSI 55	(2024) Ultraviolet Microbiological Water Treatment Systems
NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 505-B-04-900A	(2005) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual
UFP-QAPP WKSTS	(2012) Intergovernmental Data Quality Task Force - Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.146	Permit-required Confined Spaces

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Meetings

****

NOTE: Pre-installation meetings (also known as

pre-design meetings) are highly encouraged prior to POET system installation because POET systems are often installed in locations where information about the water system and access to the water system is limited. A pre-installation meeting provides an opportunity to identify the location where the POET system components will be placed and discuss installation schedules and water outage durations. If any building modifications are needed to facilitate installation of the POET system, they can also be discussed during the pre-installation meeting.
****

Conduct one [_____] pre-installation meeting with the[Contracting Officer][and][Contractor][and][POET system installation subcontractor][and][resident][owner][_____] present. Discuss the following project elements during the Pre-Installation Meeting:

a. Proposed location of POET system components.

b. Any potential modifications to the building necessary to install the POET system.

c. Proposed schedule for installing the POET system including anticipated duration of water outage and how the [resident][owner] will be notified that they can resume use of the water system.

1.3 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification

and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications

Basis Of Design; G, [_____]

SD-06 Test Reports

Acceptance Test Report; G, [_____]

Inspection Report

SD-07 Certificates

Warranty

SD-10 Operation and Maintenance Data

Operation And Maintenance Manual; G, [_____]

SD-11 Closeout Submittals

Spare Parts

1.4 MAINTENANCE MATERIAL SUBMITTALS

1.4.1 Spare Parts

****

NOTE: The Designer should verify if requiring spare parts is allowed by the Government's contracting agency. Spare parts are generally not allowed. Reasons to consider requiring spare parts are if a POET system is connected to a critical water system that requires near continuous operation. Spare parts may include consumables such as particulate filter elements or ultraviolet lamps/sleeves, or unique/critical components such as treatment vessels or control heads. Specify the number of spare parts required.

****

a. Concurrent with delivery and installation of the POET system, furnish the following spare parts [_____].

b. Provide special tools if the POET system equipment manufacturers or vendors recommend any special tools necessary for adjustment, operation, maintenance, and disassembly of POET system equipment. Deliver special tools at the same time as the POET system equipment and hand over on completion of the work.

1.5 QUALITY CONTROL

1.5.1 Regulatory Requirements

****

NOTE: The Designer should be aware of state and local regulations regarding allowable equipment and components in POET systems. There are no federal regulatory requirements for private wells/water systems. Some states require the use of certified equipment and components, others do not. Because regulations change with time, Designers should verify if there are applicable regulations at the time of executing the project. For context, it is important to understand that the Safe Drinking Water Act (SDWA) does regulate POETs used in public water systems. The SDWA requires that public water systems use products certified to American National Standards Institute (ANSI) standards when such standards exist for POETs. Because of this precedent, this section requires use of products meeting ANSI standards.

Standards establish appropriate performance requirements for products and define means of testing products. The most prominent standards for water treatment and conveyance equipment used in POET systems are the National Sanitation Foundation (NSF)/ANSI standards. Certification is a process in which accredited, independent third-parties test products against standards. In the United States, ANSI accredits certification organizations. Some of the more well-known accredited certification organizations include NSF, UL, Water Quality Association (WQA), CSA Group, and International Association of Plumbing & Mechanical Officials (IAPMO). Designers and those executing projects should be aware that manufacturers may claim that their products meet standards without actually engaging an accredited organization to certify those products. Most certification organizations maintain lists of certified products; those lists should be consulted to verify if a product is in fact certified.

NSF/ANSI drinking water standards can generally be grouped into two categories. The first category of standards is meant to ensure that water treatment products do not impart undesirable or unacceptable qualities to the water being treated. This could occur if a product was constructed with hazardous chemicals that could leach from the product into water contacting the product. Standards in this category include NSF/ANSI/CAN 14, 372, 60, and 61. A product that is certified to only these standards

has no guarantee that it will reduce contaminants in water that it treats. The second category of standards focuses on treatment units that are meant to perform a function such as improve aesthetic qualities of water or reduce contaminants that create health effect issues. Products in these categories are typically rated at specific flow rates, pressures, and contaminant concentrations. Products in this second category are most often single-tap POU units as opposed to whole-home treatment units. Standards in this category include NSF/ANSI 42, 44, 53, 55, 58, and 62. Note that NSF/ANSI Standard 55 is for ultraviolet disinfection units that can be deployed as a component of a POET system.

****

Provide NSF/ANSI/CAN 61 certified products for all POET system equipment, components, and treatment media, unless a more-specific NSF/ANSI standard is specified for a product elsewhere in this section or other referenced sections.

1.5.2 Qualifications

****

NOTE: The Designer should edit the following subparagraphs to remove requirements not applicable to the project. Some requirements may be perceived as a burden for simple/small POET system installations, but the Designer should use caution when removing requirements for convenience. "Point-of-use/Point-of-entry for Drinking Water Treatment" by Lykins et.al. 1992 cited POET system installation failures caused by plumbers or water treatment dealers that had failed to read and follow instructions. Individual states may or may not require installers to be licensed and trained in water treatment when POET systems are being installed for private properties that are not associated with a public water system.

****

Submit Qualifications as required in the following subparagraphs.

1.5.2.1 Installer Qualifications

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NOTE: The Designer should be aware of state and local regulations related to private water systems. As previously noted, there are no federal regulatory requirements for private wells/water systems. State regulatory requirements vary in their scope; some states regulate individuals and companies that engage in treatment of private water systems, other states do not. It is also important to understand that while all states have some form of well driller regulations, those regulations often do not address water treatment that occurs downstream of the well

and pump, so a state-licensed well driller or pump installer may not have training and experience relevant to installation of a POET system. Note that some private organizations such as the Water Quality Association certify water treatment installers. An option is provided in the following paragraph requiring the installer to be certified; this could be in addition to state certification, or standalone in the event the POET system is being installed in a state that does not certify for private water treatment.

****

Installers are required to have a minimum of [2][_____] years experience in the installation of a minimum of [5][_____] similar POET systems. Installers are required to demonstrate satisfactory operation for a period not less than one year for each POET system counted toward meeting this requirement.[Installer must be licensed by [_____] to perform the work required by this specification section.][Installer must be professionally certified to [perform water treatment installations][_____] by [_____].] Submit information demonstrating conformance with the qualification requirements.

1.5.3 Lab Validation

Perform testing by a DoD Environmental Laboratory Accreditation Program (DoD ELAP) accredited commercial testing laboratory in accordance with[Section 01 45 00 QUALITY CONTROL][_____] and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until the Contracting Officer approves use of the testing laboratory.

1.6 DELIVERY, STORAGE, AND HANDLING

Cover all equipment and component openings during delivery and storage to prevent entrance of dirt, water, or debris. During delivery and storage, protect all equipment, components, and materials from the weather (humidity and temperature), dirt and dust, and other contaminants. Follow manufacturer's requirements for protecting equipment, materials, and components during delivery and storage. Reject any packages or containers of treatment media which are not properly labeled with the following information:[name of the material][name of the manufacturer][lot number][manufacture or filling date].

1.7 [PROJECT][SITE] CONDITIONS

[1.7.1 Environmental Requirements

****

NOTE: The following paragraph can be deleted if the Contractor is not required to determine the location of the POET system (i.e. the Government dictates the location of the POET system). POET systems should be installed in locations that have adequate space for the components, are accessible (no confined space), are not prone to flooding or excessive moisture, have adequate lighting, and have electrical supply if needed. POET systems should not be installed in locations that have no protection against

below-freezing temperatures. In some situations, there may not be an acceptable location in the interior of an existing structure to install a POET system; in these situations POET systems have been installed in enclosures built specifically for the system. Constructing an enclosure for a POET system is beyond the scope of this specification section; generally speaking designers need to ensure that an enclosure is appropriately insulated against freezing; structurally sound against wind, snow, and other loads; equipped with electrical power (if needed); large enough for equipment maintenance; and protected against excessive humidity.

****

Do not install the POET system in a location that is prone to flooding, excessive humidity, or freezing temperatures. Confirm that there is adequate physical space to install the POET system and do not install the POET system in a confined space as defined by 29 CFR 1910.146. If a location meeting the requirements in this paragraph cannot be found, notify the Contracting Officer [within 48 hours][_____].

]1.7.2 Existing Conditions

****

NOTE: Pertinent water system information should be summarized in this paragraph, placed in an appendix of the specifications, and/or described on drawings. Indicate the detail to which water system information has been investigated and indicate where obvious data gaps exist. The table should be edited with site-specific primary contaminants of concern (COCs).

The water quality data that is needed to appropriately design a POET system will depend mainly on the specific POET treatment technology being deployed; other factors to consider include the water source (groundwater, surface water, spring, etc.) and contaminants to be treated. If necessary water quality information is not available, provisions should be made to collect the information prior to finalizing POET system design and install.

Water demand as represented by average daily flow may not be known because many small/individual water systems are often not metered and do not keep water use data. If water demand is not known, literature references can generally be used by the designer. For residences, per capita water use is often represented in the range of 380-660 liters per capita per day 100-175 gallons per capita per day. Typical uses for other non-residential settings are given in EPA 570/9-91-004, Manual of Individual and Non-Public Water Supply Systems. One specific consideration for POET systems regarding water demand is potable vs. non-potable use. Every effort should be made to understand if there are

significant non-potable uses such as landscape watering, livestock watering, etc. These non-potable uses can require significant volumes of water at high flow rates, resulting in poorer than expected POET system performance if they are not understood and accounted for. In some instances, organizational policy or risk-informed decision making may also prohibit treating water used for non-potable purposes. In this case, the POET system installation would need to include modifications to the water system plumbing to separate potable and non-potable water feeds prior to the POET system.

Instantaneous flow rates and system pressures are important to understand when designing a POET system. For most small systems, flow and pressure are provided by a well pump that supplies a pressure/expansion tank. POET systems create additional pressure loss that the pump/pressure tank must overcome (for example a dual-vessel granular activated carbon system designed for 30 lpm 8 gpm has a pressure loss of approximately 70-100 kpa 10-15 psi. If the available flow and water pressure prior to the POET system installation are close to minimum values required for the water system, this may constrain the POET system design or may lead to requiring a new well pump or pressure tank. In very rare instances, system pressures may be high enough to approach/exceed allowable pressures for commercially available POET system components (e.g. pressures greater than 550 kpa 80 psi). In this case, a pressure reducing valve may be necessary; paragraph SYSTEM PIPING AND VALVES includes an optional requirement for a pressure reducing valve. Minimum allowable water pressures will vary; water pressures should never be less than 140 kpa 20 psi for sanitary purposes, and certain fixtures such as flush valves may not operate correctly at less than 210 kpa 30 psi. Desired pressures are typically 275-550 kpa 40-80 psi. Typical values for pump capacity, pressure tank size, and pressure are provided in EPA 570/9-91-004. For individual residences, typical maximum flow rates depend on the number of water fixtures and occupants but may be between 20-40 lpm 6-10 gpm as a general range. Local water supply well contractors or university extensions may be contacted for further information. For estimates of maximum flows for other small water systems, consult USACE Engineering Manual 1110-2-503, Chapter 4.

****

The existing conditions of the water system are presented[in Appendix [_____]][and][on the drawings][and][in the specifications]. These include[well construction][pump sizing][[pressure][expansion] tank details][presence of ancillary water treatment components][physical area available for POET system components][electrical outlet availability and type][wastewater collection point availability and type].

Known water quality and quantity parameters are given in [Table 1] [_____]. The existing conditions presented are the result of site investigations at specific times; variations in the existing site conditions could occur. Perform an independent interpretation of the existing condition data. Notify the Contracting Officer within [48 hours][_____] if discrepancies between the data provided and actual field conditions are discovered.

Table 1 - KNOWN WATER QUALITY AND QUANTITY PARAMETERS		
PARAMETER	CONDITION SUMMARY	NOTES
Primary COCs		
[_____]	[Range] [_____] - [_____] mg/L [Avg.] [_____] mg/L	
Water Quality Parameters		
Total Coliforms1		
Heterotrophic Plate Count	[Range] [_____] - [_____] CFU/mL	
Chlorine Residual	[Range] [_____] - [_____] mg/L [Avg.] [_____] mg/L	
Total Organic Carbon	[Range] [_____] - [_____] mg/L [Avg.] [_____] mg/L	
Total Suspended Solids	[Range] [_____] - [_____] mg/L [Avg.] [_____] mg/L	
pH	[Range] [_____] - [_____] S.U. [Avg.] [_____] S.U.	
Iron	[Range] [_____] - [_____] mg/L [Avg.] [_____] mg/L	
Manganese	[Range] [_____] - [_____] mg/L [Avg.] [_____] mg/L	
[_____]	[Range] [_____] - [_____] mg/L [Avg.] [_____] mg/L	
Water System Hydraulic Parameters		
Average Daily Flow	[_____] lpd [_____] gpd	
Maximum Flow	[_____] lpm [_____] gpm	
System Static Pressure	[_____] kpa [_____] psi	
System Dynamic Pressure	[_____] kpa [_____] psi	

Table 1 - KNOWN WATER QUALITY AND QUANTITY PARAMETERS		
PARAMETER	CONDITION SUMMARY	NOTES
Note 1: Indicate if any Total Coliform tests have had positive detections (e.g. Total Coliform greater than 0 colonies/100 mL)		

1.8 WARRANTY

****

NOTE: Modify the paragraph to only include the POET system components for which a warranty is desired and generally commercially available. Industry-standard warranty durations are likely to vary for the different POET system components, so a single duration may not be appropriate. Common warranty durations are: treatment vessels 5-10 years; control valves and vessel heads 3-5 years; UV system housings 10 years; UV system electrical 3 years; UV system bulbs, sleeves, sensors 1 year.

****

Provide a POET system with minimum warranties for the following components:

TABLE 2 - POET SYSTEM WARRANT COMPONENTS	
COMPONENT	WARRANTY DURATION
Treatment Vessel	[_____] Years
Treatment Vessel Control Head	[_____] Years
Particulate Filter Housing	[_____] Years
Ultraviolet System Housing	[_____] Years
Ultraviolet System Electrical Components	[_____] Years
Ultraviolet System Bulbs, Sleeves, Sensors	[_____] Years

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

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NOTE: Delete the first sentence if the Contractor will decide the type of treatment media/treatment process for the POET system.

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[Provide an[activated carbon][ion-exchange][_____] POET system.]Design, construct, and install the POET system to comply with the design and performance requirements specified in this specification section. Supply auxiliary systems and equipment required to maintain a complete and workable POET system, including, but not limited to, piping between units, auxiliary equipment for plumbing and power, and controls and interfaces between auxiliary equipment and the POET system. Construct the POET system[in the location specified on drawings][in the location determined during the PRE-INSTALLATION MEETING][_____]. Additional design requirements for specific components of the POET system are specified in the following subparagraphs.

2.1.1.1 Treatment Media Replacement Frequency

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NOTE: Treatment media replacement frequencies will vary depending on water use, contaminant concentrations, general water quality, and POET system design. Minimum treatment media replacement frequencies should consider how frequently O&M visits can be conducted, turnaround time on analytical sampling, etc. Very short replacement frequencies of 3-6 months should be avoided due to the operations and maintenance burden; very long replacement frequencies (>5 years) should also be avoided because treatment media can become solidified in vessels after very long periods and toward the end of a very long operating period, the treatment media may have little remaining treatment capacity to manage an unexpected increase in contaminant concentrations.

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Provide a POET system with an estimated treatment media replacement frequency of at least [_____] months. The treatment media replacement frequency is estimated in accordance with paragraph BASIS OF DESIGN.

2.1.1.2 Treatment Vessels

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NOTE: General best-practice for POET systems is to provide two treatment vessels that operate in series-configuration (also known as "lead-lag"). Each vessel is typically sized to individually meet the effluent criteria for the POET system, which creates treatment redundancy. Designers may consider adding a third treatment vessel; the third vessel provides a factor of safety that treatment requirements will be met while allowing the first two treatment vessels to be operated for longer duration (thus using more of the treatment capacity of the media in the first two treatment vessels). If using this approach, the primary considerations would be total system pressure loss and available space for multiple treatment vessels.

Backwash requirements should be carefully considered. It is common to frequently backwash the treatment media vessels in POET systems installed for purposes such as softening or general aesthetic treatment; however this type of frequent backwashing can be detrimental in POET systems designed to adsorb dissolved contaminants. Furthermore,

backwashing is not recommended at all for some kinds of treatment media such as IX resins manufactured for PFAS or perchlorate; the resin beads are all similarly sized so they can be randomly redistributed in the vessel after a backwash. Properly performed backwashes require careful control of the backwash flowrate and duration, which may not be possible from an automatic backwash system for a POET system. Improperly performed backwashes can randomly redistribute treatment media particles in the treatment vessel; treatment media particles which are saturated with contaminants and located at the top of the bed can be inadvertently moved to the bottom of the bed. If this occurs, contaminants can desorb out of the treatment media into the treated water.

The Designer should confirm that an upflow configuration is appropriate for the site before specifying this configuration. A primary concern with upflow applications for trace contaminant removal is the possibility of re-sorting the treatment media in the vessel if actual flow rates periodically exceed flow rates that fluidize the treatment media. This can lead to a random redistribution of the treatment media as described in the paragraph above. This potential for re-sorting can be avoided by creating a packed bed configuration either by eliminating head-space in the vessel or adding something to confine the treatment media in-place. Such a design would need to be reviewed with POET system component vendors.

****

Provide [2][_____] treatment vessels designed to operate in [downflow][upflow] mode. When multiple treatment vessels are provided, the system must operate in [series][parallel][series or parallel] configuration[and each vessel must be designed to individually meet the contaminant reductions in accordance with paragraph PERFORMANCE REQUIREMENTS].[Provide a system capable of[manual][automatic flow-based][automatic time-based][_____] backwash].

2.1.1.3 System Piping and Valves

****

NOTE: Installing piping for complete bypass of the POET system is recommended during POET system install; in the event that the POET system needs to be bypassed in the future (either temporarily or permanently), the bypass would be available, and the Government would not need to hastily move to install the bypass. The final sentence of this paragraph provides an option to divert untreated water supply to location(s) where the Government does not intend to receive treated water, such as landscape watering, livestock watering, hose bibbs, yard hydrants, agricultural water use, or other non-potable uses.

****

Provide piping and valves to completely bypass the POET system.[Provide piping and valves to individually isolate the POET system[treatment vessels][particulate filter(s)][disinfection unit]].[Provide piping and valves to divert the water delivered to [_____] such that this water does not pass through the POET system.][Provide pressure reducing valves as necessary to reduce system pressures to within acceptable limits of POET system components.]

2.1.1.4 Particulate Filter

****

NOTE: Particulate filters remove dirt, sediment, and debris that can otherwise become trapped in a treatment vessel and lead to poor performance. Particulate filters can also reduce or eliminate clogging in the treatment vessels, making backwashing un-necessary. Particulate filters located upstream of the treatment vessels are encouraged for POET systems. Less commonly, particulate filters are also placed downstream of treatment vessels if there is sensitive equipment such as a disinfection unit located further downstream or if there is concern about loss of fine particulates from the treatment vessels.

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Provide a particulate filter [before][and][after] the treatment vessels.

2.1.1.5 Disinfection Unit

****

NOTE: This paragraph assumes that a chlorine residual is not required for disinfection due to any state or local regulations (refer to the Part 1 Designer's Note for more discussion about regulations of POETs in Public Water Systems). The need to provide continuous disinfection of the water treated by a POET system is a topic that has been extensively considered. See "Point-of-use/Point-of-entry for Drinking Water Treatment", 1992, by Lykins, Clark, and Goodrich for further discussion. It is generally understood that POET systems can provide a growth medium for naturally present bacteria. Heterotrophic plate count (HPC) monitoring typically shows an increase in colonies in water treated by POET systems. The Safe Drinking Water Act states "The design and application of the POE device must consider the tendency for increase in heterotrophic bacteria concentrations in water treated with activated carbon. It may be necessary to use frequent backwashing, post contactor disinfection, and heterotrophic plate count (HPC) monitoring to ensure that the microbiological safety of the water is not compromised."

Ultraviolet (UV) light disinfection units are a relatively common component of POET systems.

Popularity of UV systems can be attributed to their relative simplicity compared to disinfection processes which involve chemical dosing. UV systems for POU/POET applications are also the only type of disinfection with an associated NSF/ANSI standard.

Generally speaking, the decision to provide disinfection does not rely upon water quality analysis of the source water. The reason for providing disinfection in a POET system should generally not be to treat source water that is known or suspected to be microbiologically unsafe. NSF/ANSI 330 provides a four-part definition of "microbiologically unsafe" waters. Although there are NSF/ANSI 55-certified UV disinfection units designed to treat microbiologically unsafe waters, the opportunity for growth of microbiological agents in the POET system components prior to the disinfection unit would be high. If a source water is known or suspected to be microbiologically unsafe, the preferred course of action is to find an alternative water source.

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Provide an ultraviolet disinfection unit as the final water treatment component of the POET system.

2.1.1.6 Basis of Design

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NOTE: An optional requirement is included in Item a. for the Contractor to determine a design maximum flowrate for the treatment system. Delete this requirement if the Government has sufficient information to specify a design maximum flowrate (which would be done in Paragraph PERFORMANCE REQUIREMENTS).

****

Submit a Basis of Design document no less than [60][_____] calendar days before the anticipated POET system installation date.[Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the Basis of Design.] Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review].[Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.] The Basis of Design must include, but is not limited to, the following:

a. Concept of Operation - Explain how the proposed POET system will operate and how each component will contribute to providing water treatment to meet the requirement of this specification section.[Identify a design maximum flowrate for the system and average daily consumption rate.][Provide estimates of replacement frequency for treatment media based on vendor information, performance of similar POET systems, or estimation methods in [textbooks][peer-reviewed] articles.]

b. Process & Instrumentation Diagram - Show all major components with controls, valves, and instrumentation for measuring [pressure][temperature][flow]. Identify connections to existing plumbing and any modifications that will alter how water is distributed to users.

c. POET System Layout Plan - Show proposed layout and anchorage of components; component relationship to other parts of the work; physical clearances for access to perform maintenance and operation.

d. Product Data - Provide manufacturer or vendor-created documents for all equipment, components, and material. Demonstrate that the proposed products meet the requirements of this specification section.

e. Building Modifications - Identify all building modifications necessary to install the POET system.

f. Installation and Commissioning Plan - Provide a schedule indicating anticipated duration of water system unavailability and overall installation and commissioning times. Identify all labor disciplines that will be involved in installation and commissioning.

g. O&M Consideration - Provide a basic consideration for how major O&M activities would be performed.

h. System Information Sheet - Develop a system information sheet that is no more than [2][_____] pages. Explain in plain language the purpose and function of the POET system, what O&M the Government will perform, any conditions which indicate an issue that should be reported to the Government, how the [resident][owner] can contact the Government[and the Government's designated O&M contractor] with any questions or problems, any actions to be taken if the POET system is unused for an extended period of time, and what O&M the [resident][owner] is authorized to perform.

2.1.1.7 Uniform Federal Policy Quality Assurance Project Plan

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NOTE: This section may reference a separate specification section requiring preparation of a quality assurance project plan or may be excluded entirely if the requirements are part of another specification section.

****

Prepare a Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) in accordance with the requirements set forth in EPA 505-B-04-900A and using the 2012 optimized UFP-QAPP worksheets (UFP-QAPP WKSTS). Submit the UFP-QAPP within [60][_____] calendar days before the anticipated POET system installation date. Do not perform work at the site, with the exception of site inspection and surveys, until the UFP-QAPP is approved.[Prepare[draft for Government review][draft-final for [regulatory][_____] review] and final versions of the UFP-QAPP.] Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review].[Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.] Tailor the content to the requirements of the project and the site conditions.

2.1.2 Performance Requirements

****

NOTE: This paragraph should be edited to identify the effluent requirements for the COCs, which are generally dictated by regulatory requirements. The performance requirement includes an option provision for specifying the design maximum flowrate (if the Government does not require the Contractor to do this as part of the Basis of Design). Design maximum flowrate should be specified based on a combination of the actual maximum flow for the water system prior to POET system installation as well as the theoretical maximum flow based on literature references (see Designer's Note in paragraph EXISTING CONDITIONS). For example consider a residence with a current maximum flow of 20 lpm 5 gpm (limited by the current well pump capacity), but enough plumbing fixtures to theoretically need 40 lpm 10 gpm. In this case it would be prudent to specify the design maximum flow at 40 lpm 10 gpm in the event that the well pump is upsized in the future.

POET systems can in some circumstances cause unacceptable or undesirable water quality for parameters other than the COCs, so this paragraph should be edited to identify effluent requirements for non-COCs. Some of the most common occurrences of POETs creating unacceptable water quality include: 1) treatment media may contain residual contaminants from the manufacturing process which need to be adequately flushed-out before placing the POET system in-service (for example granular activated carbon is known to leach arsenic upon startup); 2) POET systems may introduce microbiological contamination during installation or provide a growth medium for microbiological contamination during operation; 3) bacteria can colonize a POET system and convert nitrate into the more toxic nitrite.

The Table reflects the recommended approach that for POET systems with multiple treatment vessels, COCs are reduced to the Performance Criteria in the effluent for each treatment vessel. For Water Quality parameters and flow characteristics, Performance Criteria only need to be met in the POET system effluent.

****

Provide a POET system capable of producing treated water meeting the performance criteria specified in Table 3[for a design maximum flowrate of [_____] lpm [_____] gpm].

TABLE 3 - POET SYSTEM PERFORMANCE CRITERIA		
PARAMETER	PERFORMANCE CRITERIA	LOCATION(S) WHERE PERFORMANCE CRITERIA APPLY
PRIMARY COCS		
[_____]	[_____]	[Effluent of Each Treatment Vessel] [and] [POET System Effluent]
Water Quality Parameters		
Total Dissolved Solids	[500] [_____] mg/L	[POET System Effluent] [_____]
Total Coliform	[0 colonies/ 100 mL][_____]	[POET System Effluent] [_____]
Heterotrophic Plate Count	[500] CFU/mL	[POET System Effluent] [_____]
Nitrate	[10] [_____] mg/L	[POET System Effluent] [_____]
Nitrite	[1] [_____] mg/L	[POET System Effluent] [_____]
pH	[6.5 - 8.5 S.U.] [_____]	[POET System Effluent] [_____]
Iron	[0.3] [_____] mg/L	[POET System Effluent] [_____]
Manganese	[0.05] [_____] mg/L	[POET System Effluent] [_____]
Flow Characteristics		
Total Pressure Loss (clean bed)	< [100] [_____] kpa [15] [_____] psi at flowrate of [15] [_____] lpm [4] [_____] gpm	[POET System Effluent] [_____]

2.2 EQUIPMENT

Provide equipment that is the standard product of a manufacturer regularly engaged in the manufacture of such products. Standard products are those products which have been in satisfactory commercial or industrial use for [2][_____] years prior to bid opening, include applications of equipment and materials under similar circumstances and of similar size, and have been for sale on the commercial market through advertisements, manufacturers' catalogs (digital or print), or brochures during the [2][_____] year period. Provide nameplates for each of the following items of equipment [_____]. Provide the following information on each nameplate: manufacturer's name, manufacturer's address, product name, and model or serial number. Secure each nameplate to the item of equipment.

2.2.1 Treatment Vessels

****

NOTE: Items a - d are standard requirements. Item c. sets the minimum height of the tank necessary to allow the treatment media to vertically expand during the initial sorting backwash; 50% is a conservative value for most treatment media, but this value can be reduced (or eliminated) in certain circumstances based on manufacturer recommendations for the specific type of treatment media. To avoid inadvertent exclusion of products which would otherwise meet all other requirements in this section, no requirement is given for vessel materials of construction; however the Designer can add a requirement on a project-specific basis if desired.

Items e. and f. provide options to specify the minimum size of the treatment vessels and how much treatment media is installed. Specifying these items may restrict the freedom of the contractor to meet performance requirements through whatever means they deem sufficient; however, specifying minimum requirements can protect the Government from the possibility of a contractor installing a treatment system that fails to meet performance requirements or requires frequent maintenance (that is, a "small" POET system may meet performance requirements during the initial sampling event but will likely require more frequent treatment media replacements).

For Item e. typical empty bed contact times for larger-scale treatment systems (not POETS) and various contaminants are provided below. It is common in the POET industry to provide lower empty bed contact times for GAC; for example EBCTs of 2-4 minutes are common for GAC treatment applications of PFAS and VOCs. Certain vendors and consultants claim that lower EBCTs are justified because flow in POET systems is often not continuous, so water effectively has a longer residence time than what can be calculated using the maximum system flow rate. Benefits of providing larger EBCTs include reduced treatment media change-out frequency and smaller pressure losses due to lower hydraulic loading rates. A concern with providing very large EBCTs is that when POET system flows are significantly lower than design/maximum, flows may not evenly distribute through the media and "channel" as described in item f. below.

	GAC - EMPTY BED CONTACT TIME (MIN)	**IX RESIN - EMPTY BED CONTACT TIME (MIN)**	**ACTIVATED ALUMINA / GRANULAR FERRIC HYDROXIDE / SPECIALTY IRON-BASED - - EMPTY BED CONTACT TIME (MIN)**
PFAS	**10**	**1.5-2.5**	**N.A.**
VOCs	**5-7**	**N.A.**	**N.A.**
Chlorine	**2**	**N.A.**	**N.A.**
Perchlorate	**N.A.**	**1.5-2.5**	**N.A.**
Arsenic	**N.A.**	**2-5**	**7.5-10**
Radon	**5**	**N.A.**	**N.A.**

For Item f. hydraulic loading rates should generally not be higher or lower than what is recommended by media manufacturers because at low and high loading rates flow can "channel" through the media leading to reduced performance. For GAC, hydraulic loading rates are typically 0.14-0.68 cm/sec 2-10 gpm/ft2; for IX resin hydraulic loading rates are typically 0.42-1.25 cm/sec 6-18 gpm/ft2.

****

Provide treatment vessels meeting the following requirements:

a. Maximum operating pressure at least [850][_____] kpa [120][_____] psi

b. Maximum operating temperature at least [40][_____] degrees C [100][_____] degrees F

c. Minimum sidewall height large enough for [50 percent][_____] treatment media bed depth expansion during backwash

d. Supported in an upright position with a leveling stand of approved construction[and lateral support strap or adjustable clamp fixed to a structural member located in proximity to the vessel].

e. Minimum empty bed contact time: [_____] minutes

f. Hydraulic loading rate between [_____] - [_____] lpm gpm

2.2.2 Treatment Vessel Control Heads

Provide treatment vessel control heads that are compatible with the treatment vessels and meet or exceed the design maximum flowrate and maximum operating temperatures and pressures required for the treatment vessels.[Provide treatment vessel control heads with integrated bypass valves that allow for the vessel to by bypassed.][Provide treatment vessel control heads that are capable of [automatic][manual] backwash.]

2.2.3 Pipe and Fittings

****

NOTE: The type of pipe and fittings that is allowed or required will be as determined by local experience. UFGS Section 22 00 00 PLUMBING, GENERAL PURPOSE indicates preference for material in the following order: copper, galvanized steel, polyethylene pipe, polypropylene, and PVC. An option is given to specify the pipe and fitting material either by reference to Section 22 00 00 PLUMBING, GENERAL PURPOSE or by specifying directly in this section.

****

Provide pipe and fittings with internal diameters no smaller than the internal diameter of the existing plumbing system that the POET system is being installed into.[Provide pipe and fitting material in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.][Pipe and fitting material must be [_____] and must conform to the standard identified for the material in [ICC IPC][_____].]

2.2.4 Valves and Appurtenances

[Provide valves in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.][Provide valves constructed from [_____]. Valves must conform to the standard identified for the material in [ICC IPC][_____].] Provide [locks][and][tamper indication] for any valve which can create a bypass of the POET system, either in part or in whole.

2.2.5 Pressure Gauges

Place sufficient pressure gauges to measure pressure before and after each particulate filter and treatment vessel. Provide pressure gauges with a scale range of 0 to [700][_____] kpa [100][_____] psi. Provide pressure gauges in accordance with [ASME B40.100][_____].

2.2.6 Flow Meter

Place [1][_____] totalizing flow meter. Provide totalizing flow meter[s] in accordance with[Section 22 00 00 PLUMBING, GENERAL PURPOSE][AWWA C700 or AWWA C710]. Provide totalizing flow meters sized for the design maximum flowrate. Provide totalizing flow meters reading in [Cubic Meters][Cubic Feet][US Gallons].

2.2.7 Particulate Filter Housing

Provide a particulate filter housing that meets or exceeds the design maximum flowrate and maximum operating temperatures and pressures required for the treatment vessels. Provide a particulate filter housing that uses replaceable filter media consisting of either bags or cartridges. Provide a particulate filter housing that is compatible with the material selected for the piping and fittings, constructed of stainless steel or plastic, and built with a manually operated pressure relief valve. Provide a particulate filter housing with a maximum empty housing pressure loss of [_____] kpa psi at [_____] lpm gpm as certified by the [manufacturer][vendor].

2.2.8 Sample Ports

Place sample ports at the influent, between treatment vessels, and effluent [; place additional sample ports [_____]]. Provide sample ports comprised of pipe fittings, pipe, and [ball][gate][_____] valves which comply with material, temperature, and pressure requirements of the associated piping system as specified in this Section.[Provide a tethered dust cap for each sample port.]

2.2.9 Air Gap Fitting

****

NOTE: Delete this paragraph if the POET system will not include any drain lines. Whenever a drain line is connected to a POET system there is a risk of backsiphoning contaminated wastewater into the POET system. To prevent this from occurring, the drain line should be installed with an air gap. Air gaps can consist of either physical separation between a drain line and the wastewater receiving point or an in-line air gap device. Typical minimum air gap requirements are double the effective opening of the pipe. An air gap fitting is a device with an internal air gap which physically connects a drain line to a wastewater receiving point. An alternative to requiring an air gap fitting is to just require that the drain line is installed with a sufficient air gap in accordance with ASME A112.1.2. The benefit of requiring an air gap fitting is that the discharge line and receiving line are physically connected, ensuring that discharge water goes into the intended location.

****

For all drain lines connected to the POET system, provide an air gap fitting in accordance with[Section 22 00 00 PLUMBING, GENERAL PURPOSE][ASME A112.1.3].

2.2.10 Ultraviolet Disinfection Unit

Provide an ultraviolet disinfection unit certified to NSF/ANSI 55 and rated for the design maximum flowrate and maximum operating temperatures and pressures required for the treatment vessels. Provide an ultraviolet disinfection unit designed to operate with [120V-60Hz AC current][_____]. Provide all appurtenant wiring, controls, and piping necessary to provide function of the unit in accordance with manufacturer recommendations.

2.2.11 Flow Regulator

****

NOTE: System flows may need to be regulated to ensure that the POET system components function as intended. Excessive flowrates can lead to short residence times and poor performance of primary treatment units and disinfection units. Note that flow regulators/restrictors are required for NSF-certified ultraviolet disinfection systems.

Installing a flow regulator may be prudent even if the water system current maximum flowrate does not exceed the maximum flowrate of any POET system component. If a new pump/pressure tank with higher flowrate were added after installing the POET system, the flow regulator would already be in-place.

****

Provide a flow regulator rated at the smallest of the maximum flowrates for the POET system components. Place the flow regulator downstream of all other POET system components.

2.3 MATERIALS

2.3.1 Treatment Media

****

NOTE: The minimum requirement for any treatment media is that it will not introduce contaminants into the treated water at levels that could cause negative health effects. The NSF/ANSI 61 standard included in the paragraph below is the most widely used standard for this requirement. Only virgin treatment media should be used; regenerated/reactivated treatment media should not be used.

This paragraph should be edited to include additional treatment media requirements on a site-specific basis. Specific types of treatment media (e.g. coconut-shell based GAC, microporous IX resin, etc.) should only be required if site-specific information supports the requirement (for example if a treatability study has been completed). Note that specifying additional requirements on the type of treatment media restricts the freedom of the Contractor to meet Performance Requirements as they see fit.

For GAC, one more common requirement would be to specify that the GAC is acid-washed, a manufacturing process that removes some amount of ash/residual impurities from the GAC. Acid-washed GAC can require less flushing during installation compared to GAC that has not been acid-washed. Ion exchange resins can also impact initial water quality, but with different chemical impacts than GAC. For example, ion exchange resins can significantly lower the pH, raise chloride levels, and decrease sulfate levels. Although this is a transient condition, the Designer may wish to specify buffered ion exchange resins, which require less water to be flushed through them before effluent water reaches equilibrium with influent water. An optional requirement to this effect is provided.

****

Provide virgin treatment media.[Provide treatment media that is pre-conditioned to reduce the amount of on-site [flushing][soaking] needed prior to use (e.g. acid washed, buffered, or as appropriate for the specific treatment media).]

2.3.2 Particulate Filter Media

****

NOTE: This paragraph can be deleted if design of the particulate filter will be by the Contractor. Determining the appropriate particle size for a particulate filter can involve a variety of factors. Local well drillers or water treatment vendors can be an information resource for the Designer. Particle size distribution analysis (e.g. by Standard Method 2560) can also be performed on the water to be treated. In general, the Designer should avoid being overly conservative and selecting the smallest particle size available; the University of Nebraska - Lincoln Institute of Agriculture and Natural Resources Sediment Filtration NebGuide G1492 indicates that "If the pore size of the filter medium is too small or if the concentration of suspended solids in the water is too high, the filter may easily clog and require frequent replacement. In general, the largest rating size that will remove the intended contaminants will require the least maintenance."

The downstream components of the POET system that are being "protected" by the particulate filter may provide requirements for sizing the particulate filter. For example, an ion exchange resin vendor recommends a 5-micron filter in front of it's single-use PFAS-selective resin. Ultraviolet disinfection unit manufacturers also recommend or require particulate filters (typically in the 5-20 micron range). If source water is known or suspected to contain particles in a variety of sizes, options for particulate filtration can include installing two particulate filters in series (e.g. a 50-micron filter followed by a 10-micron filter) or specifying a depth-type filter which has graded opening sizes that decrease in size moving from the outside to the central core.

****

Provide filter material consisting of [acetate][acrylic][glass][nylon][polyester][polypropylene][rayon][saran][cotton][polyethylene][_____] construction. Provide filter pore size of: [0.1][0.2][0.45][1][3][10][30][50][75][100][200][_____] microns.

[2.3.3 Support Media

****

NOTE: This paragraph should only be retained if the treatment vessels will use a gravel support media. Many treatment vessels use man-made collection systems that do not require support media.

****

Provide support gravel consisting of hard, rounded stones with a specific gravity of not less than[2.5 for silica gravel or 3.8 for high-density gravel][_____]. Ensure no more than [5][_____] percent by weight has a specific gravity less than required. Ensure gravel contains no more than [2][_____] percent by weight of thin, flat, or elongated pieces (pieces in which the larges dimension exceeds three times the smallest dimension), and is free from shale, mica, clay, sand, loam, and organic impurities of any kind.

]PART 3 EXECUTION

3.1 EXAMINATION

****

NOTE: Water will be offline for some amount of time during initial installation. The amount of time that the water system is offline can range from several hours to several days. Water system users should be notified prior to performing work, and provisions should be made for either providing alternate water or temporarily vacating the facility.

****

Verify all dimensions in the field; verify there is adequate physical space to place the POET system components and connect to existing water system plumbing without making unplanned building modifications.[Verify that electrical power for the POET system operation is available.][Verify that access to a wastewater discharge location is available.][Verify that any provisions for water shut-off (e.g. providing bottled water, temporarily vacating premises) are in place.] Notify the Contracting Officer of any discrepancies between the provided data and field conditions before performing the work.

3.2 PREPARATION

3.2.1 Surface Preparation

****

NOTE: In some instances, more extensive surface preparation may be necessary to ensure that an adequate area is provided for the POET system components. This may include leveling a floor, building a stand/pedestal, or other site-specific modifications. To the extent possible, necessary modifications should be identified during the PRE-INSTALLATION MEETING. Refer to another specification section (e.g. 03 30 00 CAST-IN-PLACE CONCRETE if installing a new concrete pad) for extensive preparation/modification activities.

****

Relocate any movable materials blocking access to the location where the POET system components will be installed. Coordinate with the [Contracting Officer][property owner][_____] prior to relocating materials, temporarily disassembling items, or otherwise modifying the structure to provide access for installing the POET system. Provide a clean and clear surface for placing the POET system components by sweeping, shoveling, or otherwise removing any debris.

3.2.2 Temporary Water

Provide temporary water supply consisting of[bottled water][potable water tanks][_____] whenever the POET system installation will result in the water system being unavailable for greater than [_____] hours.

3.3 INSTALLATION

Maintain sanitary conditions when working on water-contacting components of the POET system; clean all tools and materials used during installation to avoid introducing any contaminants into the POET system. Install equipment in accordance with written instructions of the manufacturer and the Government-approved Basis of Design. The following sub-paragraphs provide minimum installation requirements; notify the Contracting Officer of any conflicts between this specification and manufacturer instructions.

3.3.1 Treatment Vessel Installation

****

NOTE: This paragraph includes a provision for securing the treatment vessel(s) to a structural support member. This is not common in industry, but is considered an inexpensive and easy to implement best practice against damage to the POET system due to tipping/movement of the vessels because of either incidental contact by persons or hazardous seismic activity.

****

Place treatment vessels[in the location specified in paragraph DESIGN REQUIREMENTS]. Ensure that the treatment vessels are level after placement.[Secure the treatment vessels to a structural support member using a [mounting][restraint] system which includes manufacturer instructions indicating acceptable methods for making connections to the structural support member and allowable loads. Follow manufacturer instructions. The [mounting][restraint] system must not exert pressure on the treatment vessel or be fastened to the vessel using screws, nails, bolts, etc. unless approved by the vessel manufacturer.]

3.3.2 Pipes, Valves, Fittings, Appurtenances Installation

Install piping, valves, fittings, and appurtenances in a neat manner with all joints tight and with no undue marring of finishes. Ensure that installed piping, valves, fittings, and appurtenances are free from strain and excessive stresses caused by weight or misalignment. Install in accordance with[Section 22 00 00 PLUMBING, GENERAL PURPOSE][_____].

3.3.3 Particulate Filter Installation

Install the particulate filter[s][upstream][and][downstream] of the primary treatment vessel[s]. Mount the particulate filter[s] in accordance with manufacturer written instructions and using manufacturer [provided][approved] mounting hardware.

3.3.4 Disinfection Unit Installation

Install the disinfection unit in accordance with manufacturer written instructions.

3.3.5 Drain Line Installation

Install the drain line connecting the treatment vessel[s] to the wastewater drain location. Provide an air gap in accordance with[local plumbing code][ASME A112.1.2][_____].

3.3.6 Electrical Work

[Connect electrically-powered POET system components to existing electrical outlets that meet the POET system component manufacturer requirements. Connect only to electrical outlets which have integral ground fault circuit interrupter protection and are UL-listed for use in "wet locations".][Install electrical outlets to provide power to POET system components. Perform electrical work in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.]

3.3.7 Disinfection of Equipment and Components

****

NOTE: The disinfection procedure specified in International Plumbing Code essentially involves filling the water system with a water/chlorine solution, allowing that solution to stand for a period of time, and flushing until the chlorine is purged. This procedure cannot be completed after activated carbon or certain ion exchange resins have been installed in treatment vessels because the activated carbon will neutralize the chlorine and not allow it to enter downstream components; IX resin can be damaged when exposed to chlorine.

****

After all equipment and components are installed and before treatment media is installed, purge and disinfect the water system per[the procedure specified in ICC IPC][_____]. If treatment media is installed in the treatment vessels off-site in accordance with paragraph TREATMENT MEDIA INSTALLATION, perform the disinfection procedure on the treatment vessels prior to installing the treatment media. Then complete disinfection of the water system by bypassing the treatment vessels and following the purging and disinfection procedure specified above.

3.3.8 Treatment Media Installation

****

NOTE: Designers should consider requiring the Contractor to install and condition treatment media off-site in a controlled setting such as a shop. The reasons to install and condition treatment media off-site include 1) ensuring that there is an adequate supply of water to install/condition the media and 2) minimizing disruptions to the owners/tenants that will use the POET system. Reasons to avoid installing and conditioning the treatment media off-site generally are limited to logistical challenges (e.g. the filled treatment vessels would be too heavy/difficult to handle, treatment media is being installed in a vessel that is already in-place, the POET system is being

installed in a very remote location and there is no off-site facility within reasonable distance).

The amount of water needed to install and commission treatment media will depend on a variety of factors. A POET system with 0.1 cubic meters 4 cubic feet of GAC media treating water for a single household could require as much as 5,700-11,400 liters 1,500-3,000 gallons of water for initial flushing. Many water sources such as small residential-type wells have difficulty producing this volume of water in a short time. This flushing water also must be disposed, which can create issues if the discharge is going to a septic system/drainfield with limited capacity. On-site installation and conditioning of treatment media also necessitates using the contaminated/impacted water that the POET system is intended to treat, which may not be ideal in all circumstances.

Certain POET system treatment media types also require wetting. GAC media needs to be wetted to purge air from the pores for as much as 24 hours or more. If installing the media on-site this may add another day to the installation process, burdening the resident/tenant. Some designers may also wish to conduct initial sampling of installed treatment media to verify that chemicals are not leaching from the media at unacceptable levels; this can also extend the installation period and cause disruptions.

****

Install treatment media[off-site at a location with adequate water supply and wastewater handling facilities to complete the work described in the following sub-paragraphs][on-site at the location the POET system will serve].

3.3.8.1 Treatment Media Placement

****

NOTE: Specify the quantity of treatment media only if using a prescriptive design approach. If treatment media quantities and freeboard are specified, coordinate with Paragraph TREATMENT VESSELS to ensure that requirements do not conflict. If design of the POET system is performance based, use the less prescriptive text that refers to the design and performance requirements.

****

Place treatment media[in accordance with vessel [and][or] treatment media manufacturer directions]. Store and handle the treatment media in a manner that avoids contamination. Clean and disinfect any equipment used in placing the treatment media. Leave a freeboard of [_____] m ft between the top of the treatment media and the top of the vessel. Gently vibrate the vessel periodically to ensure the treatment media settles without voids or bridging.[Place sufficient quantities of treatment media in accordance with paragraph DESIGN REQUIREMENTS and paragraph PERFORMANCE REQUIREMENTS.][Place treatment media to the quantities specified in the following table:

TABLE 4 - TREATMENT MEDIA PLACEMENT QUANTITIES	
Media Type	Quantity
[_____]	[_____]

]

3.3.8.2   Treatment Media Conditioning

****

NOTE: Specific steps for treatment media conditioning will vary based on the type of treatment media being used. However, there are general concepts of conditioning that apply to most granular treatment media.

Adequate contaminant removal by granular treatment media requires uniform flow through the media bed. Uniform flow can be disrupted in several ways. If gases are trapped in the treatment media, this will block some pathways for water flow, increasing the flow rates in the remaining pathways and effectively decreasing the residence time for contaminated water. Gases are removed during conditioning by wetting the treatment media; water soaks into the treatment media and displaces the gases that occupied the pore structure of the media. The 16 hour recommendation is based on a POET system using GAC; shorter timeframes may be used for other treatment media like IX resin depending on manufacturer recommendations.

Most treatment media consist of particles of varying size; to function best, the treatment media needs to be properly sorted by size in the vessel. Treatment media can become improperly sorted during shipment, handling, and placement treatment. An improperly sorted treatment media bed is more likely to have regions of excessively high or low flow, effectively decreasing the residence time for contaminated water. After treatment media is placed into a vessel, this improper sorting process is remedied by performing a sorting backwash. During a sorting backwash, water flows upward through the treatment media at a sufficient rate to suspend the treatment media particles in the flowing water (a process called fluidizing). The various treatment media particles are evenly sorted by size with smaller particles moving to the top of the bed and larger particles to the bottom. Sorting backwashes require water flow at a sufficient rate and time. Treatment media manufacturers will supply appropriate values, but for reference GAC media backwash flow rates are typically 0.2-0.54 cm/sec 3-8 gpm/square foot and times are 30-45 minutes. IX resin flows are typically 0.1-0.2 cm/sec 1.5-3.0 gpm/square foot and times are 15-20 minutes. The treatment vessel must also

have sufficient freeboard to allow the media to expand (typically 30 percent of bed height for GAC and 50-100 percent of bed height for resin). It should be noted that some IX resins do not require backwash during commissioning (e.g. IX resins for treating PFAS or perchlorate). Equally important, these types of IX resin should not be backwashed once they are placed in service.

All treatment medias should be assumed to have an initial equilibration period during which time the treatment media can impart undesirable or unacceptable qualities to the treated water. These undesirable/unacceptable qualities can be aesthetic (taste, odor, color) or chemical quality (leaching of specific chemicals at concentrations above regulatory standards). One of the most common occurrences is leaching of arsenic from GAC treatment media during conditioning. It is important to understand that these water quality impacts should be temporary and non-recurring if the treatment media has been properly selected, manufactured, and handled. Treatment media can also temporarily alter the chemistry of treated water, such as the change in pH that can temporarily occur with IX resins. Proper conditioning involves flushing a sufficient volume of water through the treatment media to waste, such that these water quality impacts are eliminated or reduced to acceptable levels. The volumes of water required for flushing vary widely depending on the treatment media type and characteristics of the water being used to flush the treatment media. Treatment medias can also be pre-conditioned by the manufacturer to reduce the amount of flushing needed during install and conditioning. A popular example is acid washing GAC media or buffering anion exchange resin. Ultimately, proper conditioning is verified by collecting samples of water passing through the POET system after conditioning is believed to be complete.
****

Perform the following treatment media conditioning steps in the sequence specified. For POET systems with multiple treatment vessels, perform the backwash and forward flush steps separately for each vessel; do not conduct the backwash or forward flush in series using the same water in both vessels. Follow manufacturer requirements if those requirements are more stringent than what is specified here:

a. Wetting: Wet the media for a minimum of [16][_____] hours. Ensure that the water level remains above the top of the media during wetting. Provide a continuous opening for gases to escape the vessel during wetting, but ensure the opening is covered with a gas-permeable [screen][filter] (e.g. fine mesh wire screen) to prevent foreign materials entering the vessel.

b. Backwash: Perform an upflow backwash at a flow rate of [_____] to [_____] cm/sec gpm/square foot for a duration of [_____] minutes. Slowly open the water supply valve when starting backwash and slowly close the water supply valve when ending backwash. Once the minimum specified backwash duration has been met, collect a small volume of backwash water and visually inspect for particles; if particles are observed, continue backwashing until the backwash water is visually free of particles. Direct backwash water to the designated wastewater disposal location.

c. Forward Flush: Flush water through the treatment media at a flowrate of [_____] to [______] lpm gpm. Flush a minimum of [_____] bed volumes of water through the treatment media.[After the minimum prescribed volume of water has been flushed through the treatment media, conduct the field water quality testing specified in paragraph FIELD WATER QUALITY TESTING. Continue to flush the treatment media if any of the field testing indicates unacceptable results.] Direct the flush water to the designated wastewater disposal location.

3.4 FIELD QUALITY CONTROL

Perform field tests and inspections[in the presence of the Contracting Officer] and provide labor, equipment, and incidentals required for the test. Provide for disposal of all waste residuals resulting from the test[offsite][onsite via existing solid waste and wastewater disposal resources]. Notify the Contracting Officer [_____] days prior to the date and time for the field tests and inspections. Rectify any deficiencies found and retest any work affected by such deficiencies.

3.4.1 Tests

3.4.1.1 Performance Tests

After installation of the complete POET system, complete an operating test to assure that the POET system operates properly. If any deficiencies are revealed during any tests, correct such deficiencies and repeat the test. Flow water through the POET system by opening downstream discharge points such as faucets, showers, etc. Conduct a performance test at a minimum of [2][_____] discharge points, with water flowing from each discharge point for at least [15][_____] minutes. Once a steady flowrate is observed and any entrained air has been purged, measure flowrates at each discharge point using a container and stopwatch over a period of [5][_____] minutes. Open additional taps if necessary to achieve a combined flowrate equal or greater than the flowrate given for the pressure loss requirement in paragraph PERFORMANCE REQUIREMENTS. Visually inspect the water recovered during the flow test; if particulates are observed in the water this represents a deficiency requiring correction. During the performance test measure pressure loss across the POET system; pressure loss exceeding the value in paragraph PERFORMANCE REQUIREMENTS represents a deficiency requiring correction.

[

For POET systems designed to be backwashed either automatically or manually, initiate a backwash cycle. Observe the backwash discharge piping for adequate flow and free discharge. Once the backwash cycle is over, observe treated water exiting the POET system to verify that there are no particulates present.]

3.4.1.2 Field Water Quality Testing

****

NOTE: Field water quality testing is an optional means of verifying that the treatment media has been

adequately installed and conditioned. If no field water quality testing will be performed, delete this paragraph and the associated text in paragraph TREATMENT MEDIA CONDITIONING. Some parameters to consider for field water quality testing include pH, turbidity, dissolved solids, and arsenic (for activated carbon); parameters to test for should be determined based on the site water quality and treatment media used in the POET system.
****

Conduct water quality tests in the field using[testing meters][and][field test kits]. Conduct field water quality testing as specified in the table:

Table 5 - Field Water Quality Testing

Parameter	Field Testing Method	Field Testing Frequency
pH	Multi-parameter Digital Water Quality Meter	After flushing minimum volume specified in paragraph TREATMENT MEDIA CONDITIONING
Dissolved Solids	Multi-parameter Digital Water Quality Meter	After flushing minimum volume specified in paragraph TREATMENT MEDIA CONDITIONING
Arsenic	Test Kit with Detection Range equal or less than 10 ug/L	After flushing minimum volume specified in paragraph TREATMENT MEDIA CONDITIONING
[_____]	[_____]	[_____]

3.4.1.3 Water Sampling and Analysis

After completing the required performance tests and correcting any deficiencies, collect water samples from the POET system. Collect samples from the[POET system influent,][between treatment vessels,][downstream of the final POET system component,][at a tap served by the POET system]. Collect, label, preserve, and transport water samples in accordance with[a project-specific UFP-QAPP][a basewide QAPP][_____]. Analyze water samples for the parameters listed in paragraph PERFORMANCE REQUIREMENTS. Failure to meet the performance requirements in paragraph PERFORMANCE REQUIREMENTS for any parameter represents a deficiency requiring correction.

3.4.1.4 Acceptance Test Report

Submit test reports demonstrating compliance with the Performance Requirements specified in this specification section.

3.4.2 Inspection

After completing the performance testing and water sampling described in Paragraph TESTS, complete a final inspection of the POET system. Carefully inspect all components for defects in workmanship and material. Clean debris and foreign matter from exterior surfaces. Operate all valves and other mechanisms to check their proper functioning. Check all connections for tightness. Assure that there is no uncharacteristic vibration or noise from any components. If any deficiencies are revealed during the inspection, correct such deficiencies. Submit an Inspection Report documenting completion of the inspection. Include sufficient photographs of the POET system to clearly identify each component.

3.4.3 Manufacturer Field Service

****

NOTE: Manufacturer field service may not be available depending on the manufacturer providing the POET system components. If the POET system is being installed by a properly licensed/trained individual, manufacturer field service may not be necessary. Delete this paragraph if manufacturer field service is not desired.

****

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative is required to supervise the installation, adjustment, and testing of the equipment. Include up to [5][7][10][_____] days of service.

3.5 CLOSEOUT ACTIVITIES

3.5.1 Operation and Maintenance Manual

****

NOTE: Delete specific requirements from the following list if they are not applicable to the POET system being installed. Some requirements such as the Concept of Operations and Product Data will largely duplicate information previously provided in the Basis of Design, but this is intentionally done to ensure that the Operation and Maintenance Manual provides a single, complete document of the POET system. Delete the Sampling and Analysis Plan if sampling of the POET system will be completed in accordance with a separately prepared UFP-QAPP, Basewide QAPP, etc. Development of the O&M manual should include consideration for how treatment media will be replaced. Off-site replacement is often preferred when it is feasible because it allows for more control of the conditions when removing, placing, and conditioning treatment media.

Ideally, POET systems should be regularly used to avoid water stagnation, which can lead to bacterial growth particularly within the treatment media. For additional discussion on bacterial growth in POET systems, see EPA 815-R-06-010, Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems. If there is an extended absence period when the POET system is not used, corrective actions will likely need to be taken before water from the POET system is used again. Extended absences may be defined as periods as short as one week or as long as three weeks. A common corrective

action is to flush several volumes of water through the POET system after the extended absence, although in some cases more extensive actions such as replacing the treatment media may be necessary. The Designer/Contractor should consider site-specific conditions, POET system design, and vendor recommendations when determining appropriate extended absence procedures.

****

Submit an Operation and Maintenance Manual no more than [45][_____] calendar days after installation of the POET system. Provide [two][_____] hard copies of the Operation and Maintenance Manual and an electronic copy (PDF).[Prepare[draft for Government review][draft-final for[regulatory][_____] review] and final versions of the Operation and Maintenance Manual. Allow [30][_____] calendar days for[Government] review[and [30][_____] calendar days for regulatory review]. Allow [45][_____] days for comment resolution following each review and preparing the next version of the document.] The Operation and Maintenance Manual must include, but is not limited to, the following:

a. Table of Contents

b. Revision Tracking Table

c. Safety Precautions

d. Concept of Operations - Narrative description of the sequence or sequences of operation of the overall POETs system.

e. As-built Drawings - Revised version of the Process Flow Diagram from the Basis of Design. Provide a unique identifier for each vessel, sampling port, valve, pressure gauge, flow meter, and any other piece of equipment which provides data regarding POET systems operation. Provide a valve sequence indicating the position of each valve for normal operation (treatment), POET system bypass, and any other unique operating mode.

f. Routine Maintenance Activities - Identify all routine maintenance activities; include procedures for performing each activity and [schedule][frequency] for performing each activity.

g. Treatment Media Replacement - Indicate what data/conditions will trigger treatment media replacement (e.g. sampling results, [pressure][flow] readings, time-in-service, etc.). Provide a detailed instruction for replacing spent treatment media. Define sanitary and disinfection procedures to be followed throughout the process and during specific steps. Indicate how the treatment vessel will be isolated and taken out of service; how treatment media will be removed from the vessel; empty vessel visual inspection procedures; treatment media placement procedures; treatment media conditioning procedures.

h. Possible Breakdowns, Repairs, and Troubleshooting

i. Extended Absence Procedures - Identify what length(s) of time constitute an extended absence (POET system not being used). Identify procedures for communicating extended absences. Specify actions to take to return the POET system to operation after an extended absence.

j. O&M Data Sheets - Provide separate data sheets for routine maintenance activities and treatment media replacement.

k. Product Data

l. Disposal - In accordance with applicable local and federal regulations, define any testing and waste characterization requirements for spent treatment media, wastewater generated during commissioning, and other wastes generated during operations and maintenance. Indicate proposed recycling and disposal locations to be used for the various waste streams.

m. System Shutdown - Identify conditions that would lead to the Government shutting down the POET system. Indicate if the POET system components would be removed or transferred to the [resident][property] owner.

[

n. Sampling and Analysis Plan]

3.5.2 Posting System Information Sheet

Post the system information sheet developed under paragraph Basis of Design [on][near][_____] the POET system. The system information sheet must be [laminated][under [glass][plexiglass]][_____]. Prior to posting the system information sheet, make revisions to reflect any changes to the system design after the Basis of Design document was finalized.

3.5.3 Training

****

NOTE: The need for training should be assessed based on the complexity of the POET system, level of engagement and interest of the resident/owner, and number of O&M activities that Government employees and resident/owner are expected to complete. In general, private property residents/owners SHOULD NOT (emphasis added) be expected to complete O&M activities because of their assumed lack of technical experience and the potential Government liabilities associated with the resident/owner altering the function of the POET system in a negative way.

****

After completing all required activities in paragraph FIELD QUALITY CONTROL, conduct an on-site training session for [Government representatives][and][the [resident][owner]]. The training session must cover each item contained in the Operations and Maintenance Manual.[Brief the [resident][owner] on the information provided in the System Information Sheet.]

3.6 PROTECTION

****

NOTE: The Designer should consult with decision makers and stakeholders to determine when the POET system is authorized for use after installation. A conservative approach is to not authorize use of water from the POET system until after initial Acceptance Testing results have been received,

reviewed for quality and usability, and most importantly found to meet the POET system's performance requirements. Variations of this approach include either not authorizing any water use or authorizing non-potable water uses such as flushing toilets, showering, etc. The burden of this approach is mainly felt by the resident/owner of the POET system due to the time that the water system will be unavailable for use. One important consideration is stagnation of water in the POET system if it is not used pending Acceptance Testing results. Some means should be provided to flush water through the POET system periodically until it is authorized for use. This could be accomplished with an automatic flushing control valve or manually (e.g. running water through a tap to waste). If the resident/owner of the POET system is expected to flush water through the system, this needs to be clearly communicated.

A less conservative approach is to authorize use of the water as soon as the POET system installation is complete and all FIELD QUALITY CONTROL activities have been performed and approved. Under this approach, the following paragraph could be deleted. This approach would ideally only be used if there is high confidence in the performance of the POET system (e.g. an identical system is being used for similar contaminants and water supply with success, the installer has extensive experience with the system, etc.)

****

Protect the water system from use[for potable purposes] during the period between when installation is completed and the Government approves the Acceptance Testing results. [The Government will inform][Inform] the [resident][owner] that the water is not to be used for[any purpose][potable purposes] until they are notified that the water system is ready to be used. Ensure that a minimum of [_____] liters gallons of water is flushed through the POET system to waste at least [weekly][_____] during this period.[Place tags on all[potable] water fixtures indicating that the "water is not to be used pending testing results"].

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 81 00 (November 2018)**

Preparing Activity: USACE **Superseding**
UFGS-02 81 00 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-02 81 00 (November 2018)**

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SECTION 02 81 00

TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS

11/18

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NOTE: This guide specification covers the requirements for transportation and disposal of hazardous material.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: This specification was developed for large management contracts where there is a technical evaluation in the selection process. For small purchases, portions of this specification may be applicable, but should be closely considered. This specification should be used in conjunction with the separate asbestos and PCB management specifications when work involves these hazardous materials.

For other than remedial action, corrective action, or disposal of ammunition contract, add DFAR clause 252.223.-7005

If work does not involve hazardous wastes,

submittals regarding the hazardous waste management plan, the EPA Biennial and State Annual Reports, exceptions reports, and records of inspection may be removed by the designer.

If work does not involve hazardous wastes, PCB waste, or asbestos containing waste, certificates of disposal may be removed by the designer.

Regarding pre-established spill reporting procedures, the designer should consult CEMP-RT memorandum of 20 July 1995, Subject: Spill Reporting Procedures for USACE Personnel Involved in HTRW Projects or updated memorandum scheduled to be available by Jan 2004.

Security planning requirements (49 CFR 172) contain responsibilities for both the offeror of the hazardous material as well as the transporter. Thus both the Government and Contractor have responsibilities for security planning that should be coordinated in the development of specific contract specifications. Implementation guidance is under development. The Government will NOT request development of, review, or approve the Contractors' security plans. This is a legal requirements placed upon hazmat employers and transporters by DOT. The Government will require the Contractor to certify to the Government that either a security plan is in place or to document exemption from the security plan requirement. In developing this specification, Designers should determine whether this specification requires modification to address Agency specific requirements for pre-transportation security requirements in addition to transportation related security requirements.

Regarding security plan certifications, for USACE the intent is to obtain a Contractor certification for pre-transportation activities as well as a separate certification from the initial transporter. Other agencies may take a different approach to implementing security planning requirements and specification should be modified accordingly.

USACE projects require certificates of disposal for all hazardous waste, CERCLA remediation wastes, PCBs, radionuclide containing waste, and asbestos as per Engineering Pamphlet 415-1-266.

****

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in

this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

IATA DGR	(2018) Dangerous Goods Regulations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EP 415-1-266	(2000) Construction -- Resident Engineer Management Guide (REMG) for Hazardous, Toxic, and Radioactive Waste (HTRW) Projects

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

DOT 4500.9R	Defense Transportation Regulation, Part 2, Cargo Movement, Chapter 204, Hazardous Material

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Programs: The Hazardous Waste Permit Program
40 CFR 279	Standards for the Management of Used Oil
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 178	Specifications for Packagings

1.2 DEFINITIONS

1.2.1 Hazardous Material

A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated pursuant to the Hazardous Materials Transportation Act, 49 U.S.C. Appendix Section 1801 et seq. The term includes materials designated as hazardous materials under the provisions of 49 CFR 172, Sections .101 and .102 and materials which meet the defining criteria for hazard classes and divisions in 49 CFR 173. EPA designated hazardous wastes are also hazardous materials.

1.2.2 Hazardous Waste

A waste which meets criteria established in RCRA or specified by the EPA in 40 CFR 261 or which has been designated as hazardous by a RCRA authorized state program.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal

items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Packaging Notifications

Hazardous Waste Management Plan; G, [_____]

Onsite Hazardous Waste Management; G, [_____]

Notices of Non-Compliance and Notices of Violation

SD-06 Test Reports

Recordkeeping; G, [_____]

Exception Report; G, [_____]

Spill Response

SD-07 Certificates

Transportation and Disposal Coordinator; G, [_____]

Training; G, [_____]

Certification

Shipping Documents and Packagings Certification; G, [_____]

Security Plan

Certificates of Disposal

Waste Minimization

1.4 QUALITY ASSURANCE

1.4.1 Transportation and Disposal Coordinator

Designate, by position and title, one person to act as the Transportation and Disposal Coordinator (TDC) for this contract. The TDC must serve as the single point of contact for all environmental regulatory matters and have overall responsibility for total environmental compliance at the site including, but not limited to, accurate identification and classification of hazardous waste and hazardous materials; determination of proper shipping names; identification of marking, labeling, packaging and placarding requirements; completion of waste profiles, hazardous waste manifests, asbestos waste shipment records, PCB manifests, bill of ladings, exception and discrepancy reports; and all other environmental documentation. The TDC must have, at a minimum, one year of specialized experience in the management and transportation of hazardous waste and have been Department of Transportation certified under 49 CFR 172, Subpart H.

1.4.2 Training

Hazardous materials employees must be trained, tested, and certified to safely and effectively carry out their assigned duties in accordance with [Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES] [_____]. Employees transporting hazardous materials or preparing hazardous materials for transportation, including samples, must be trained, tested, and certified in accordance with 49 CFR 172, Subpart H, including security awareness and any applicable security plans. Hazardous material employees must also be trained in accordance with IATA DGR when shipping hazardous materials by air. Employees must be trained, tested, and certified in accordance with 49 CFR 172, Subpart H to determine that shipments do not constitute DOT regulated hazardous materials.

1.4.3 Certification

The hazardous materials transporter must possess a current certificate of registration issued by the Research and Special Programs Administration (RSPA), U.S. Department of Transportation, when required by 49 CFR 107, Subpart G. Submit copies of the certificates or written statements certifying exemption from these requirements.

1.4.4 Laws and Regulations Requirements

Comply with Federal, state, and local laws and regulations which are applicable. These requirements are amended frequently and compliance with amendments is required as they become effective. Notify the Contracting Officer immediately if compliance exceeds the scope of work or conflicts with specific requirements of the contract.

PART 2 PRODUCTS

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NOTE: For US Army Corps of Engineer (USACE) Projects involving shipments containing radioactive nuclides, additional products such as special marking may apply. See USACE Engineering Pamphlet 415-1-266, Chapter 7, Resident Engineer Management Guide for Hazardous, Toxic, and Radioactive Waste Projects and Engineering Manual 1110-35-1, Management Guidelines for Working with Radioactive and Mixed Waste.

****

2.1 MATERIALS

Provide all the materials required for the packaging, labeling, marking, placarding and transportation of hazardous wastes and hazardous materials in conformance with Department of Transportation standards[and][IATA DGR][and][EP 415-1-266][_____]. Details in this specification must not be construed as establishing the limits of the Contractor's responsibility.

2.1.1 Packagings

Provide [bulk][non-bulk][bulk and non-bulk] containers for packaging hazardous materials/wastes consistent with the authorizations referenced in the Hazardous Materials Table in 49 CFR 172, Section .101, Column 8. Bulk and non-bulk packaging must meet the corresponding specifications in 49 CFR 173 referenced in the Hazardous Materials Table, 49 CFR 172, Section .101. Packaging must conform to the general packaging requirements of Subpart B of 49 CFR 173, to the requirements of 49 CFR 178 at the specified packing group performance level, to the requirements of special provisions of column 7 of the Hazardous Materials Table in 49 CFR 172, Section .101, and be compatible with the material to be packaged as required by 40 CFR 262. Also provide other packaging related materials such as materials used to cushion or fill voids in overpacked containers. The hazardous materials being packaged must not react dangerously with, decompose or ignite the sorbent packaging materials. Additionally, sorbents used to treat free liquids to be disposed of in landfills must be non-biodegradable as specified in 40 CFR 264, Section .314. In addition, packaging notifications will be provided to the Government in accordance with 49 CFR 172, Section .178.2(c) regarding type and dimensions of closures, including gaskets, needed to satisfy performance test requirements.

2.1.2 Markings

Provide markings for each hazardous material/waste package, freight container, and transport vehicle consistent with the requirements of 49 CFR 172, Subpart D and [40 CFR 262, Section .32 (for hazardous waste)][40 CFR 761, Section .45 (for PCBs)][40 CFR 61, Section .149(d) (for asbestos)][EP 415-1-266 (for FUSRAP radionuclides)]. Markings must withstanda 180 day exposure to conditions reasonably expected to be encountered during container storage and transportation, without deterioration or substantial color change.

2.1.3 Labeling

Provide primary and subsidiary labels for hazardous materials/wastes consistent with the requirements in the Hazardous Materials Table in 49 CFR 172, Section .101, Column 6. Labels must meet design specifications required by 49 CFR 172, Subpart E including size, shape, color, printing, and symbol requirements. Labels must be durable weather resistant and withstanding a 180 day exposure to conditions reasonably expected to be encountered during container storage and transportation, without deterioration or substantial color change.

2.1.4 Placards

For each offsite shipment of hazardous material/waste, provide primary and subsidiary placards consistent with the requirements of 49 CFR 172, Subpart F. Provide placards for each side and each end of bulk packaging, freight containers, transport vehicles, and rail cars requiring such placarding. Placards may be plastic, metal, or other material capable of withstanding, without deterioration, a 30 day exposure to open weather conditions and must meet design requirements specified in 49 CFR 172, Subpart F.

2.1.5 Spill Response Materials

Provide spill response materials including, but not limited to, containers, adsorbent, shovels, and personal protective equipment. Spill response materials must be available at all times when hazardous materials/wastes are being handled or transported. Spill response materials must be compatible with the type of material being handled.

2.2 EQUIPMENT AND TOOLS

Provide miscellaneous equipment and tools necessary to handle hazardous materials and hazardous wastes in a safe and environmentally sound manner.

PART 3 EXECUTION

3.1 HAZARDOUS WASTE MANAGEMENT PLAN

Prepare a Hazardous Waste Management Plan detailing the manner in which hazardous wastes will be managed and describing the types and volumes of hazardous wastes anticipated to be managed. The plan must address both onsite and offsite hazardous waste management. Describe the methods to be used to ensure accurate piece counts or weights of shipments; describe waste minimization methods; identify and describe facilities to be used for treatment, storage, and disposal (TSD); identify areas onsite where hazardous wastes are to be handled; and identify whether transfer facilities are to be used; and if so, how the wastes will be tracked to ultimate disposal. Submit the plan to the Contracting Officer for approval prior to start of work. Submit written documentation of weekly hazardous waste inspections on a [monthly][quarterly][_____] basis.

3.2 ONSITE HAZARDOUS WASTE MANAGEMENT

****

NOTE: When work on a site is being performed pursuant to the authorities of CERCLA, it may be eligible for the permit waiver of CERCLA Section 121(e) such that accumulation time restrictions or other requirements may not be applicable. In that case the designer, with assistance from agency counsel as necessary, should determine whether this paragraph requires revision accordingly.

****

Coordinate the onsite management of all hazardous materials and waste with the installation environmental function and the Contracting Officer. These paragraphs apply to Government owned waste only. The Contractor is responsible for ensuring compliance with Federal, state, and local hazardous waste laws and regulations and verifying those requirements when preparing reports, waste shipment records, hazardous waste manifests, or other documents. Identify hazardous wastes using criteria set forth in 40 CFR 261 or applicable state and local laws, regulations, and ordinances. Comply with generator requirements in [40 CFR 262][and][applicable state or local law or regulations] when accumulating hazardous waste onsite. Onsite accumulation times must be restricted to applicable time frames referenced in [40 CFR 262, Section .34][and][applicable state or local law or regulation]. Accumulation start dates commence when waste container is transferred into a 90 day accumulation site or permitted storage facility. Only use containers in good condition and compatible with the waste to be stored. Ensure containers are closed except when adding or removing waste, and immediately mark all hazardous waste containers with the words "hazardous waste" and other information required by [40 CFR 262, Section .32][and][applicable state or local law or regulation] as soon as the waste is containerized. An additional marking must be placed on containers of "unknowns" designating the date sampled, and the suspected hazard. Inspect containers for signs of deterioration and for responding to any spills or leaks. Inspect all hazardous waste areas weekly and provide written documentation of the inspection. Include date and time of inspection, name of individual conducting the inspection, problems noted, and corrective actions taken on the inspection logs.

3.2.1 Hazardous Waste Classification

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NOTE: If insufficient information exists to make a waste classification determination, the designer should develop contract clauses to provide for additional analysis.

****

Identify, in consultation with the [Contracting Officer][waste generator][_____], all waste codes applicable to each hazardous waste stream based on requirements in 40 CFR 261 or applicable state or local law or regulation. Also identify applicable treatment standards in 40 CFR 268 and state land disposal restrictions and make a determination as to whether or not the waste meets or exceeds the standards. Submit waste profiles, analyses, classification and treatment standards information to Contracting Officer for review and approval.

3.3 OFFSITE HAZARDOUS WASTE MANAGEMENT

****

NOTE: For US Army Corps of Engineer (USACE) Projects involving shipments containing radioactive nuclides, additional management requirements may apply. Designers should refer to USACE EP 415-1-266, Chapter 7, Resident Engineer Management Guide for Hazardous, Toxic, and Radioactive Waste Projects and EM 1110-35-1, Management Guidelines for Working with Radioactive and Mixed Waste. For example, a pink mark stating "Warning: Empty only at (destination)"

is required.

Designers should review new manifest requirements as they become available to ensure this specification remains consistency with regulatory changes.

****

Coordinate the off site transfer of all hazardous materials and waste with the installation environmental function and the Contracting Officer. Use RCRA Subtitle C permitted facilities which meet the requirements of 40 CFR 264 or facilities operating under interim status which meet the requirements of 40 CFR 265. Do not use offsite treatment, storage, and disposal facilities with significant RCRA violations or compliance problems (such as facilities known to be releasing hazardous constituents into ground water, surface water, soil, or air). Submit Notices of Non-Compliance and Notices of Violation by a Federal, state, or local regulatory agency issued to the Contractor in relation to any work performed under this contract. Immediately provide copies of such notices to the Contracting Officer. Also furnish relevant documents regarding the incident and any information requested by the Contracting Officer, and coordinate its response to the notice with the Contracting Officer or the designated representative prior to submission to the notifying authority. Also furnish a copy to the Contracting Officer of all documents submitted to the regulatory authority, including the final reply to the notice, and all other materials, until the matter is resolved.

3.3.1 Treatment, Storage, and Disposal Facility and Transporter

Provide the Contracting Officer with EPA ID numbers, names, locations, and telephone numbers of TSD facilities and transporters. This information must be contained in the Hazardous Waste Management Plan and be approved by the Contracting Officer prior to waste disposal.

3.3.2 Facility Status Information

Facilities receiving hazardous waste must be permitted in accordance with 40 CFR 270 or operating under interim status in accordance with 40 CFR 265 requirements, or permitted by a state authorized by the Environmental Protection Agency to administer the RCRA permit program. Additionally, prior to using a TSD Facility, contact the EPA Regional Offsite Coordinator specified in 40 CFR 300, Section .440, to determine the facility's status, and document all information necessary to satisfy the requirements of the EPA Offsite policy and submit this information to the Contracting Officer in the Hazardous Waste Management Plan.

3.3.3 Shipping Documents and Packagings Certification

Prior to shipment of any hazardous material offsite and a minimum of [14] [_____] days prior to anticipated pickup, provide for review written certification to the Contracting Officer that hazardous materials have been properly packaged, labeled, and marked in accordance with Department of Transportation and EPA requirements. Furnish designated disposal facility packaging assurances not later than 35 days after acceptance of the shipment. The Contractor's TDC must also provide written certification regarding waste minimization efforts documenting that efforts have been taken to reduce the volume and toxicity of waste to the degree economically practicable and that the method of treatment, storage, or disposal selected minimizes threats to human health and the environment.

3.3.4 Transportation

****

NOTE: When the additional cost of sending a qualified government representative to a remote location to sign a manifest for a small clean up project is unwarranted, the option of requiring the onsite Contractor to sign the manifests on behalf of the generator is permitted and should be considered. This option may only be exercised on a project specific basis, if prior to the solicitation process, written authorization of the customer and approval of the Chief, Construction Division at the executing district has been obtained, and the technical provisions of the contract solicitation provide competing Contractors notice of the requirement.

****

Prior to conducting hazardous materials activities, the Contractor responsible for pre-transportation activities must either certify to the Government that a Security Plan is in place which meets the requirements of 49 CFR 172, Subpart I or in the event that the types or amounts of hazardous materials are excluded from the security planning requirements, a written statement to that effect detailing the basis for the exception. Use manifests for transporting hazardous wastes as required by 40 CFR 263 or applicable state or local law or regulation. Transportation must comply with all requirements in the Department of Transportation referenced regulations in the 49 CFR series. Prepare hazardous waste manifests for each shipment of hazardous waste shipped offsite. Complete manifests using instructions in 40 CFR 262, Subpart B and applicable state or local law or regulation. Submit manifests and waste profiles to Contracting Officer for review and approval. Prepare land disposal restriction notifications as required by 40 CFR 268 or applicable state or local law or regulation for each shipment of hazardous waste. Submit notifications with the manifest to the Contracting Officer for review and approval. [In accordance with DOT 4500.9R, inspect motor vehicles used to transport hazardous materials in accordance the 49 CFR and DOT safety regulations and complete DDForm 626, Motor Vehicle Inspection][_____].

3.3.5 Treatment and Disposal of Hazardous Wastes

Coordinate any off site shipments of hazardous materials or hazardous wastes with the installation environmental function. Initial, or satellite hazardous waste accumulation is limited to 55 gallons (or 1 quart of acutely hazardous waste). Once a waste stream exceeds 55 gallons, it must be transferred to an on-site 90 day (180 day small quantity generator) accumulation area, or a permitted hazardous waste treatment, storage or disposal facility within three days. Ship hazardous wastes only to facilities which are properly permitted to accept the hazardous waste or operating under interim status. Ensure wastes are treated to meet land disposal treatment standards in 40 CFR 268 prior to land disposal. Propose TSD facilities via submission of the Hazardous Waste Management Plan, subject to the approval of the Contracting Officer. Submit Certificates of Disposal documenting the ultimate disposal, destruction or placement of [hazardous wastes,] [CERCLA remediation waste,] [polychlorinated biphenyls (PCBs),] [_____] and [asbestos] within [180][_____] days of initial shipment. Receipt of these certificates will be required for final payment.

3.4 RADIOACTIVE MATERIALS MANAGEMENT

****

NOTE: For US Army Corps of Engineer (USACE) Projects involving shipments containing radioactive nuclides, additional management requirements may apply. Designers should refer to USACE EP 415-1-266, Chapter 7, Resident Engineer Management Guide for Hazardous, Toxic, and Radioactive Waste Projects and EM 1110-35-1, Management Guidelines for Working with Radioactive and Mixed Waste. For example, a pink mark stating "Warning: Empty only at (destination)" is required.

****

Consult with the [Contracting Officer][generator][_____], to evaluate, prior to shipment of any material offsite, whether the material is regulated as a hazardous waste in addition to being regulated as a radioactive material. Perform the evaluation to determine proper shipping descriptions, marking requirements, and other criteria, as described below.

3.4.1 Identification of Proper Shipping Names

Use 49 CFR 172, Section .101 to identify proper shipping names for each hazardous material (including hazardous wastes) to be shipped offsite. Submit proper shipping names to the Contracting Officer in the form of draft shipping documents for review and approval.

3.4.2 Packaging, Labeling, and Marking

Package, label, and mark hazardous materials/wastes using the specified materials and in accordance with the referenced authorizations. Mark each container of hazardous waste of 416 L 110 gallons or less with the following:

"HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal.
If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.
Generator's name _____________________________________
Manifest Document Number ___________________________".

3.4.3 Shipping Documents

Ensure that each shipment of hazardous material sent offsite is accompanied by properly completed shipping documents. This includes shipments of samples that may potentially meet the definition of a Department of Transportation regulated hazardous material.

3.4.3.1 PCB Waste Shipment Documents

Prepare hazardous waste manifests for each shipment of PCB waste shipped offsite. Complete manifests using instructions in 40 CFR 761, Sections .207 and .208 and other applicable requirements. Submit documents to Contracting Officer for review and approval.

3.4.3.2 Asbestos Waste Shipment Documents

Prepare waste shipment records, as required by 40 CFR 61, for shipments of asbestos. Submit waste shipment records to the Contracting Officer for review and approval. Waste shipment records must be signed by the Contractor.

3.4.3.3 Other Hazardous Material Shipment Documents

****

NOTE: The designer should determine whether bill of lading certifications will be signed by the Government or the Contractor. This determination should be based on whether the Government or the Contractor is responsible for classifying, packaging, marking, labeling, and placarding the shipment.

****

Prepare a bill of lading for each shipment of hazardous material which is not accompanied by a hazardous waste manifest or asbestos waste shipment record which fulfills the shipping paper requirements. The bill of lading must satisfy the requirements of 49 CFR 172, Subpart C, [and 40 CFR 279 if shipping used oil] and applicable state or local law or regulation, and must be submitted to the Contracting Officer for review and approval. For laboratory samples and treatability study samples, prepare bills of lading and other documentation as necessary to satisfy conditions of the sample exclusions in 40 CFR 261, Section .4(d) and (e) and any applicable state or local law or regulation. Bill of ladings requiring shipper's certifications must be signed by the [Government][Contractor].

3.5 SPECIAL REQUIREMENTS FOR ASBESTOS WASTES

****

NOTE: If work involves asbestos containing wastes, designer should determine whether reference to a separate asbestos specification should be added.

****

If work involves asbestos containing wastes, manage these wastes in accordance with specification Section 02 82 00 ASBESTOS REMEDIATION.

3.6 WASTE MINIMIZATION

Minimize the generation of hazardous waste to the maximum extent practicable and take all necessary precautions to avoid mixing clean and contaminated wastes. Identify and evaluate recycling and reclamation options as alternatives to land disposal. Requirements of 40 CFR 266 apply to: hazardous wastes recycled in a manner constituting disposal; hazardous waste burned for energy recovery; lead-acid battery recycling; and hazardous wastes with economically recoverable precious metals. Submit written certification that waste minimization efforts have been undertaken to reduce the volume and toxicity of waste to the degree economically practicable and that the method of treatment, storage, or disposal selected minimizes threats to human health and the environment.

3.7 RECORDKEEPING

Maintain adequate records to support information provided to the Contracting Officer regarding exception reports, annual reports, and biennial reports; maintain asbestos waste shipment records for a minimum of 3 years from the date of shipment or any longer period required by applicable law or regulation or other provision of this contract; and maintain bill of ladings for a minimum of 375 days from the date of shipment or longer period required by applicable law or regulation or other provision of this contract. Submit information necessary to file state annual or EPA biennial reports for hazardous waste transported, treated, stored, or disposed of under this contract. Do not forward these data directly to the regulatory agency but to the Contracting Officer at the specified time. Submit the information necessary for filing of the formal reports in the form and format required by the governing Federal or state regulatory agency. A cover letter must accompany the data to include the contract number, Contractor name, and project location. In the events that a manifest copy documenting receipt of hazardous waste at the treatment storage and disposal facility is not received within 35 days of shipment initiation, or that a manifest copy documenting receipt of PCB waste at the designated facility is not received within 35 days of shipment initiation, prepare and submit an exception report to the Contracting Officer within 37 days of shipment initiation.

3.8 SPILL RESPONSE

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), or pollutant or contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), notify the Contracting Officer immediately. Direction from the Contracting Officer concerning a spill or release is not considered a change under the contract. If the spill exceeds a reporting threshold, follow the pre-established procedures for immediate reporting to the Contracting Officer. Comply with applicable requirements of Federal, state, or local laws or regulations regarding any spill incident.

3.9 EMERGENCY CONTACTS

Comply with the emergency contact provisions in 49 CFR 172, Section .604. Whenever the Contractor ships hazardous materials, provide a 24 hr emergency response contact and phone number of a person knowledgeable about the hazardous materials being shipped and who has comprehensive emergency response and incident mitigation information for that material, or has immediate access to a person who possesses such knowledge and information. Monitor the phone on a 24 hour basis at all times when the hazardous materials are in transportation, including during storage incidental to transportation. Ensure that information regarding this emergency contact and phone number are placed on all hazardous material shipping documents. Designate an emergency coordinator and post the following information at areas in which hazardous wastes are managed:

a. The name of the emergency coordinator.

b. Phone number through which the emergency coordinator can be contacted on a 24 hour basis.

c. The telephone number of the local fire department.

d. The location of fire extinguishers and spill control materials.

Attachment A SAMPLE OFF-SITE POLICY CERTIFICATION MEMO	
Project/Contract #:	
Waste Stream:	
Primary TSD Facility, EPA ID #	
Alter. TSD Facility, EPA ID # and	
EPA Region	Contact
I	888-372-7341
II	212-673-4040
III	800-438-2474 or 215-814-5000
IV	800-241-1754 or 404-562-9900
V	312-353-2000
VI	800-887-6063 or 214-665-2210
VII	800-223-0425
VIII	800-424-8802
IX	415-947-8713
X	800-424-4372 or 206-553-4973
EPA representative contacted:	
EPA representative phone number:	
Date contacted:	
Comment:	
The above EPA representative was contacted on ___________. As of that date the above sites were considered acceptable in accordance with the Off-Site Policy in 40 CFR 300.440.	
Date:	Signature:
Phone number:	

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-02 82 00 (November 2018)**
Change 1 - 11/19

Preparing Activity: NAVFAC **Superseding**
UFGS 02 82 13.00 10 (February 2010)
UFGS-02 82 16.00 20 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 02 82 00

ASBESTOS REMEDIATION

11/18, CHG 1: 11/19

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NOTE: This guide specification covers the requirements for safety procedures and requirements for the demolition, removal, encapsulation, and disposal of asbestos containing materials (ACM). This specification is used in conjunction with Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Federal regulations require EPA model accreditation plan training to edit this document. Furthermore, asbestos abatement designers must be accredited and licensed to design asbestos work in the location of the construction.

Nonfriable asbestos containing materials do not always require special handling. However, during demolition and removal of this material dust and airborne asbestos fibers will sometimes be released. If the project contains nonfriable asbestos which may release fibers when demolished

and removed, the nonfriable asbestos must be removed in the same way as friable asbestos. Friable ACM must always be removed prior to any building demolition.

OSHA regulations address worker protection, NESHAPS (EPA) regulations address disposal requirements, and they have different definitions as to what constitutes ACM in wallboard/joint compound systems. Therefore, where wallboard/joint compound are suspected to contain ACM, analyze both discrete samples (separate samples from wallboard and joint compound) to address worker protection and composite samples (wallboard system as a whole) to address disposal requirements. It is not unusual for the wallboard itself and the wallboard system (taken as a whole) to contain less than 1 percent asbestos, but the discrete joint compound samples to contain greater than 1 percent asbestos. Problems can arise if these materials are not properly categorized in the design. Also, if the material is applied as an "add on" or "skim coat", NESHAPS considers the layers separate and composite sampling is not appropriate.

Asbestos operations do not always indicate negative pressure enclosure type asbestos control with all of its attendant requirements. The location of the area, type of material, and initial as well as other exposure assessments for abatement workers and the environment must be reviewed and a judgment made by the designer as to the precise asbestos control techniques described herein that may be safely and legally used.

It is the policy of the Navy to eliminate the use of materials containing asbestos wherever possible. Therefore, the designer must not use asbestos containing materials wherever a substitute, suitable to the Navy, exists.

The limits and conditions of asbestos hazard abatement efforts must be indicated on the drawings or in the specification in sufficient detail for the Contractor to submit an accurate bid. Portions of the building where asbestos work will take place must be unoccupied during the removal operation. It is highly recommended that the entire building be unoccupied during asbestos hazard abatement operations. If portions of the building where asbestos hazard abatement is not taking place must remain occupied, additional requirements must be added for providing temporary heating/cooling and other utilities to the occupied portions of the building. The building heating/cooling system for example cannot be operated in the asbestos control area and due to wet removal procedures, electrical service to the asbestos control area may need to be shut off and resupplied through a ground fault

circuit interrupter. In addition, the rooms with openings into the room undergoing asbestos abatement must be empty with critical barriers installed to provide a buffer zone.

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NOTE: Provide the following information on the project drawings:

1. Clearly show location, extent, condition and form of asbestos materials to be controlled or in contact with other non-ACM removals or new work.

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NOTE: The work may involve a historic property. The designer must coordinate review of the proposed work with the appropriate cultural resources manager (CRM) and cultural resource laws and regulations, as part of the environmental review and permitting process. Consultation with stakeholders, including the state historic preservation office, may be required, and work involving historic properties will likely be required to confirm to the Secretary of the Interior's Standards for the Treatment of Historic Properties (usually at the REHABILITATION level). See https://www.nps.gov/tps/standards/four-treatments/treatment-rehabilitation.htm

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z9.2	(2018) Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems

ASTM INTERNATIONAL (ASTM)

ASTM C732	(2017; R 2022 Standard Test Method for Aging Effects of Artificial Weathering on Latex Sealants
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D4397	(2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E736/E736M	(2019) Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E1368	(2014) Visual Inspection of Asbestos Abatement Projects
ASTM E1494	(2012) Encapsulants for Spray- or Trowel-Applied Friable Asbestos-Containing Building Materials

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7	(2014) Compressed Air for Human Respiration; 6th Edition

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH NMAM	(2016; 5th Ed) NIOSH Manual of Analytical Methods

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 340/1-90/018	(1990) Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance
EPA 560/5-85-024	(1985) Guidance for Controlling Asbestos-Containing Materials in Buildings (Purple Book)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1926.51	Sanitation
29 CFR 1926.59	Hazard Communication
29 CFR 1926.103	Respiratory Protection
29 CFR 1926.200	Accident Prevention Signs and Tags
29 CFR 1926.1101	Asbestos
40 CFR 61-SUBPART A	General Provisions
40 CFR 61-SUBPART M	National Emission Standard for Asbestos
40 CFR 763	Asbestos
42 CFR 84	Approval of Respiratory Protective Devices
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for

Shipments and Packagings

U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

NAVFAC P-502	(2017) Asbestos Program Management
ND OPNAVINST 5100.23	(2005; Rev G) Navy Occupational Safety and Health (NAVOSH) Program Manual

UL SOLUTIONS (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units

1.2 DEFINITIONS

1.2.1 ACM

Asbestos Containing Materials.

1.2.2 Amended Water

Water containing a wetting agent or surfactant with a maximum surface tension of 2.9 Pa 0.00042 psi.

1.2.3 Area Sampling

Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.

1.2.4 Asbestos

The term asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, and actinolite asbestos and any of these minerals that has been chemically treated or altered. Materials are considered to contain asbestos if the asbestos content of the material is determined to be at least one percent.

1.2.5 Asbestos Control Area

That area where asbestos removal operations are performed which is isolated by physical boundaries which assist in the prevention of the uncontrolled release of asbestos dust, fibers, or debris.

1.2.6 Asbestos Fibers

Those fibers having an aspect ratio of at least 3:1 and longer than 5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.

1.2.7 Asbestos Permissible Exposure Limit

0.1 fibers per cubic centimeter of air as an 8-hour time weighted average measured in the breathing zone as defined by 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers health.

1.2.8 Authorized Person

Any person authorized by the Contractor and required by work duties to be present in the regulated areas.

1.2.9 Background

The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for other (contaminated) areas are measured in similar but asbestos free locations.

1.2.10 Competent Person (CP)

****

NOTE: Check state requirements for licensing and edit appropriately.

****

A person meeting the requirements for competent person as specified in 29 CFR 1926.1101 including a person capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, and is specifically trained in a training course which meet the criteria of EPA's Model Accreditation Plan (40 CFR 763) for project designer or supervisor, or its equivalent.[The competent person must have a current State of [_____] asbestos contractors or supervisors license.]

1.2.11 Contractor

The Contractor is that individual, or entity under contract to perform the herein listed work.

1.2.12 Disposal Bag

A 0.15 mm 6 mil thick, leak-tight plastic bag, pre-labeled in accordance with 29 CFR 1926.1101, used for transporting asbestos waste from containment to disposal site.

1.2.13 Disturbance

Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount which can be contained in one standard sized glovebag or waste bag, not larger than 1.5 m 60 inches in length and width in order to access a building component.

1.2.14 Encapsulation

The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.

1.2.15 Encapsulants

Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.

a. Removal Encapsulant (can be used as a wetting agent)

b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos containing material)

c. Penetrating Encapsulant (used to penetrate the asbestos containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)

d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos containing material has been removed).

1.2.16 Friable Asbestos Material

A term defined in 40 CFR 61-SUBPART M and EPA 340/1-90/018 meaning any material which contains more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Polarized Light Microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

1.2.17 Glovebag Technique

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NOTE: Verify with the State regulations that glovebag removal is an acceptable technique.

****

Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.

1.2.18 Government Consultant (GC)

That qualified person employed directly by the Government to monitor, sample, inspect the work or in some other way advise the Contracting Officer. The GC is normally a private consultant, but can be an employee of the Government.

1.2.19 HEPA Filter Equipment

High efficiency particulate air (HEPA) filtered vacuum and exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters must retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.

1.2.20 Model Accreditation Plan (MAP)

USEPA training accreditation requirements for persons who work with asbestos as specified in 40 CFR 763.

1.2.21 Negative Pressure Enclosure (NPE)

That engineering control technique described as a negative pressure enclosure in 29 CFR 1926.1101.

1.2.22 NESHAP

National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at 40 CFR 61-SUBPART M.

1.2.23 Nonfriable Asbestos Material

Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, removal, or mishap.

1.2.24 Permissible Exposure Limits (PELs)

1.2.24.1 PEL-Time Weighted Average(TWA)

Concentration of asbestos not in excess of 0.1 fibers per cubic centimeter of air (f/cc) as an 8-hour time weighted average (TWA).

1.2.24.2 PEL-Excursion Limit

An airborne concentration of asbestos not in excess of 1.0 f/cc of air as averaged over a sampling period of 30 minutes.

1.2.25 Personal Sampling

Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.

1.2.26 Private Qualified Person (PQP)

That qualified person hired by the Contractor to perform the herein listed tasks.

1.2.27 Qualified Person (QP)

A Registered Architect, Professional Engineer, Certified Industrial Hygienist, consultant or other qualified person who has successfully completed training and is therefore accredited under a legitimate State Model Accreditation Plan as described in 40 CFR 763 as a Building Inspector, Contractor/Supervisor Abatement Worker, and Asbestos Project Designer; and has successfully completed the National Institute of Occupational Safety and Health (NIOSH) 582 course "Sampling and Evaluating Airborne Asbestos Dust" or equivalent. The QP must be qualified to perform visual inspections as indicated in ASTM E1368.[The QP must be appropriately licensed in the State of [_____].]

1.2.28 TEM

Refers to Transmission Electron Microscopy.

1.2.29 Time Weighted Average (TWA)

The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.

1.2.30 Transite

A generic name for asbestos cement wallboard and pipe.

1.2.31 Wetting Agent

A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 2.9 Pa 0.00042 psi.

1.2.32 Worker

Individual (not designated as the Competent Person or a supervisor) who performs asbestos work and has completed asbestos worker training required by 29 CFR 1926.1101, to include EPA Model Accreditation Plan (MAP) "Worker" training; accreditation, if required by the OSHA Class of work to be performed or by the state where the work is to be performed.[The worker must be appropriately licensed in the State of [_____].]

1.3 REQUIREMENTS

1.3.1 Description of Work

****

NOTE: Specify the form, condition and approximate quantity square meters or linear meters square feet or linear feet of asbestos material to be controlled in the first blank and the location of the material in the second blank. Example: "The asbestos work includes the demolition and removal of 90 m of 200 mm 300 feet of 8 inch diameter asbestos insulation located on existing steam piping indicated to be removed in the boiler room." or "The asbestos work includes the encapsulation of 270 square meters 3,000 square feet of sprayed on asbestos containing fire proofing materials located above the ceiling throughout the structure."

The use of this section in the contract specification means that known asbestos material is involved. Estimate the quantity and specify as unit price items in Section 00 21 13, INSTRUCTIONS TO BIDDERS or Section 01 20 00 Price and Payment Procedures per standard practice of the activity preparing the contract.

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****

NOTE: Include reference to 40 CFR 763 when asbestos work occurs in a public or private school Grades K thru 12.

****

****

NOTE: Nonfriable ACM may not require special handling. However, during demolition and removal of this material dust and airborne asbestos fibers will sometimes be released. If the project contains nonfriable asbestos which may release fibers when demolished and removed, the nonfriable asbestos must be removed in the same way as friable asbestos. Include "Under normal... specified herein.", if

material traditionally defined as non-friable asbestos materials are to be removed.

****

****

NOTE: The appropriate engineering control technique must comply with the requirements outlined in 29 CFR 1926.1101 which is selected based on existing conditions, but must be that technique that provides the best control during abatement at most reasonable cost.

****

The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational procedures must be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the [demolition and removal][encapsulation] of [_____] located [_____] [which is governed by 40 CFR 763 and NAVFAC P-502].[Under normal conditions non-friable or chemically bound materials containing asbestos would not be considered hazardous; however, this material may release airborne asbestos fibers during demolition and removal and therefore must be handled in accordance with the removal and disposal procedures as specified herein.] Provide [negative pressure enclosure] [_____] techniques as outlined in this specification. The [building][work area] will be evacuated during the asbestos abatement work. A competent person must supervise asbestos removal work as specified herein.

1.3.1.1 Wallboard/Joint Compound

****

NOTE: When both composite and discrete sampling and testing is done on wallboard/joint compound, include and edit the following to address the site specific situation:

****

[Both composite samples of the wallboard and discrete samples of the components (wallboard and joint compound) have been tested and results are attached.

][Composite samples of the wallboard system were tested and found to contain [less than one percent asbestos] [_____]. Discrete samples of the wallboard were tested and found to contain [less than one percent asbestos] [_____]. Discrete samples of the joint compound were tested and found to contain [greater than one percent asbestos] [_____].

]1.3.2 Unexpected Discovery of Asbestos

****

NOTE: Discovery of Unexpected Asbestos: Suspect asbestos containing material that is discovered during demolition (in particular buildings constructed no later than 1980), which was previously inaccessible, must be sampled and

analyzed for its asbestos content. The Designer should anticipate additional sampling and analysis. The Designer should provide Unit Price options in the Bid Form. Coordinate with the Designer of Record. The number of additional samples should be based on the extent of demolition and previous survey data. Sampling activities undertaken to determine the presence of additional ACM should be conducted by personnel who have successfully completed the EPA Model Accreditation (MAP) training course and have EPA/State certification/license as an Asbestos Inspector.

****

Notify the Contracting Officer if any previously untested building components suspected to contain asbestos are impacted by the work.

1.3.3 Medical Requirements

Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.

1.3.3.1 Medical Examinations

Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination must be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."

1.3.3.2 Medical Records

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NOTE: Medical records must be retained at least 50 years. Some States require longer retention periods. Check with the State in which the project is located for the required retention time.

****

Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of [50 years][indefinite time] after termination of employment and make records of the required medical examinations and exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.

1.3.4 Employee Training

****

NOTE: Include bracketed sentence where required by law, regulation or statute.

****

Submit certificates, prior to the start of work but after the main abatement submittal, signed by each employee indicating that the employee has received training in the proper handling of materials and wastes that contain asbestos in accordance with 40 CFR 763; understands the health implications and risks involved, including the illnesses possible from exposure to airborne asbestos fibers; understands the use and limits of the respiratory equipment to be used; and understands the results of monitoring of airborne quantities of asbestos as related to health and respiratory equipment as indicated in 29 CFR 1926.1101 on an initial and annual basis. Organize certificates by individual worker, not grouped by type of certification.[Post appropriate evidence of compliance with the training requirements of 40 CFR 763.] Train personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. Document the training by providing: dates of training, training entity, course outline, names of instructors, and qualifications of instructors upon request by the Contracting Officer. Furnish each employee with respirator training and fit testing administered by the PQP as required by 29 CFR 1926.1101 and 29 CFR 1926.103. Fully cover engineering and other hazard control techniques and procedures.[Asbestos workers must have a current State of [_____] asbestos worker's license.]

1.3.5 Permits[, Licenses,] and Notifications

****

NOTE: The USEPA has delegated the responsibility of notification requirements to most States. Verify with the State and local authorities where the project is located whether the city, county, State, or USEPA has jurisdiction and whether a license is required.

Verify the specific notification requirements for the state where the work is being performed.

****

Prior to the start of work, obtain necessary permits[and licenses] in conjunction with asbestos removal, encapsulation, hauling, and disposition, and furnish notification of such actions required by Federal, State, regional, and local authorities. Notify the [Regional Office of the United States Environmental Protection Agency (USEPA)][State's environmental protection agency][local air pollution control district/agency] and the Contracting Officer in writing [10] [20] [_____] working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M[and [_____]]. Notify the Contracting Officer and other appropriate Government agencies in writing 20 working days prior to the start of asbestos work as indicated in applicable laws, ordinances, criteria, rules, and regulations. Submit copies of all Notifications to the Contracting Officer.[Notify the local fire department 3 days prior to removing fire-proofing material from the building including notice that the material contains asbestos.]

1.3.6 Environment, Safety and Health Compliance

****

NOTE: The designer must research the State, regional and local laws, regulations, statutes, and list by authority and document number in the blank spaces provided those which apply to the asbestos

work to be performed by the Contractor.
****

In addition to detailed requirements of this specification, comply with those applicable laws, ordinances, criteria, rules, and regulations of Federal, State, regional, and local authorities regarding handling, storing, transporting, and disposing of asbestos waste materials. Comply with the applicable requirements of the current issue of EM 385-1-1, 29 CFR 1926.1101, 40 CFR 61-SUBPART A, 40 CFR 61-SUBPART M, 40 CFR 763 and ND OPNAVINST 5100.23. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable laws, rules, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirement as defined by the Government apply. The following laws, ordinances, criteria, rules and regulations regarding removal, handling, storing, transporting and disposing of asbestos materials apply:

a. [_____]

b. [_____]

c. [_____].

1.3.7 Respiratory Protection Program

Establish and implement a respirator program as required by 29 CFR 1926.1101, and 29 CFR 1926.103. Submit a written description of the program to the Contracting Officer. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.

1.3.7.1 Respirator Program Records

Submit records of the respirator program as required by 29 CFR 1926.103, and 29 CFR 1926.1101.

1.3.7.2 Respirator Fit Testing

The Contractor's PQP must conduct a qualitative or quantitative fit test conforming to 29 CFR 1926.103 for each worker required to wear a respirator, and any authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test must be performed prior to initially wearing a respirator and every 12 months thereafter. If physical changes develop that will affect the fit, a new fit test must be performed. Functional fit checks must be performed each time a respirator is put on and in accordance with the manufacturer's recommendation.

1.3.7.3 Respirator Selection and Use Requirements

Provide respirators, and ensure that they are used as required by 29 CFR 1926.1101 and in accordance with CGA G-7 and the manufacturer's recommendations. Respirators must be approved by the National Institute for Occupational Safety and Health NIOSH, under the provisions of 42 CFR 84, for use in environments containing airborne asbestos fibers. For air-purifying respirators, the particulate filter must be high-efficiency particulate air (HEPA)/(N-,R-,P-100). The initial respirator selection and the decisions regarding the upgrading or downgrading of respirator type must be made by the Contractor's Designated IH based on the measured or anticipated airborne asbestos fiber concentrations to be encountered.

1.3.8 Asbestos Hazard Control Supervisor

The Contractor must be represented on site by a supervisor, trained using the model Contractor accreditation plan as indicated in the Federal statutes for all portions of the herein listed work.

1.3.9 Hazard Communication

Adhere to all parts of 29 CFR 1926.59 and provide the Contracting Officer with a copy of the Safety Data Sheets (SDS) for all materials brought to the site.

1.3.10 Asbestos Hazard Abatement Plan

Submit a detailed plan of the safety precautions such as lockout, tagout, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the [encapsulation] [removal] [and demolition] of materials containing asbestos. The plan, not to be combined with other hazard abatement plans, must be prepared, signed, and sealed by the PQP. Provide a Table of Contents for each abatement submittal, which follows the sequence of requirements in the contract. The plan must include but not be limited to the precise personal protective equipment to be used including, but not limited to, respiratory protection, type of whole-body protection[and if reusable coveralls are to be employed decontamination methods (operations and quality control plan)], the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, [removal] [encapsulation] method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos sealer to be used, locations of local exhaust equipment, planned air monitoring strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan must also include (both fire and medical emergency) response plans and an Activity Hazard Analyses (AHAs) in accordance with EM 385-1-1. The Asbestos Hazard Abatement Plan must be approved in writing prior to starting any asbestos work. The Contractor, Asbestos Hazard Control Supervisor,, CP and PQP must meet with the Contracting Officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Contracting Officer, the plan will be enforced as if an addition to the specification. Any changes required in the specification as a result of the plan must be identified specifically in the plan to allow for free discussion and approval by the Contracting Officer prior to starting work.

1.3.11 Testing Laboratory

Submit the name, address, and telephone number of each testing laboratory selected for the[sampling,] analysis, and reporting of airborne concentrations of asbestos fibers along with[evidence that each laboratory selected holds the appropriate State license and permits and] certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory

Accreditation Program (NVLAP) for asbestos analysis. The testing laboratory firm must be independent of the asbestos contractor and must have no employee or employer relationship which could constitute a conflict of interest.

1.3.12 Landfill Approval

****

NOTE: The USEPA has delegated the responsibility of approving landfills for the disposal of asbestos to most States. Verify with the State in which the project is located whether the State or USEPA has jurisdiction and what laws apply.

****

Submit written evidence that the landfill is approved for asbestos disposal by the U.S. Environmental Protection Agency, Region [3][_____], Air Enforcement Section [(38W12)][_____], and local regulatory agencies. Within three working days after delivery, submit detailed delivery tickets, prepared, signed, and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill. Submit a copy of the waste shipment records within one day of the shipment leaving the project site.

1.3.13 Transporter Certification

****

NOTE: Designer should utilize and reference, where appropriate, Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS as a part of the contract documents or include the appropriate Department of Transportation (DOT) requirements from 49 CFR 107, 171, 172, and 173. If Section 02 81 00 is not included, edit this paragraph to include the DOT references. The contract documents must address all applicable DOT requirements including those for shipping, training, certifications, packaging, markings, labelings, and placards for shippers and transporters in addition to Government, OSHA and EPA requirements.

****

Submit written evidence that the transporter is approved to transport asbestos waste in accordance with the DOT requirements of 49 CFR 171, 49 CFR 172 and 49 CFR 173 as well as registration requirements of 49 CFR 107 and all other State and local regulatory agency requirements.

1.3.14 Medical Certification

Provide a written certification for each worker and supervisor, signed by a licensed physician indicating that the worker and supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1926.103 as prescribed by law. Submit certificates prior to the start of work but after the main abatement submittal.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: The submittals required for each project are very dependent upon the removal method to be used. Edit the submittals paragraph accordingly.

****

SD-03 Product Data

Amended Water; G, [_____]

Safety Data Sheets (SDS) for All Materials; G, [_____]

Encapsulants; G, [_____]

Respirators; G, [_____]

Local Exhaust Equipment; G, [_____]

Pressure Differential Automatic Recording Instrument; G, [_____]

Vacuums; G, [_____]

[Glovebags; G, [_____]

] SD-06 Test Reports

Air Sampling Results; G, [_____]

Pressure Differential Recordings for Local Exhaust System; G, [_____]

[Encapsulation Test Patches; G, [_____]

] Clearance Sampling; G, [_____]

Asbestos Disposal Quantity Report; G, [_____]

SD-07 Certificates

****

NOTE: Verify and include contractor's and worker's licenses as required for the state where the work is being performed.

****

Employee Training; G, [_____]

Notifications; G, [_____]

Respiratory Protection Program; G, [_____]

Asbestos Hazard Abatement Plan; G, [_____]

Testing Laboratory; G, [_____]

Landfill Approval; G, [_____]

Delivery Tickets; G, [_____]

Waste Shipment Records; G, [_____]

Transporter Certification; G, [_____]

Medical Certification; G, [_____]

Private Qualified Person Documentation; G, [_____]

Designated Competent Person; G, [_____]

Worker's License; G, [_____]

Contractor's License; G, [_____]

Federal, State or Local Citations on Previous Projects; G, [_____]

Encapsulants; G, [_____]

Equipment Used to Contain Airborne Asbestos Fibers; G, [_____]

Water Filtration Equipment; G, [_____]

Vacuums; G, [_____]

Ventilation Systems; G, [_____]

SD-11 Closeout Submittals

Permits[and Licenses]; G, [_____]

Notifications; G, [_____]

Respirator Program Records; G, [_____]

[Protective Clothing Decontamination Quality Control Records; G, [_____]

][Protective Clothing Decontamination Facility Notification; G, [_____]

] Rental Equipment; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Private Qualified Person Documentation

****

NOTE: Edit requirement for private qualified person to have licensing.

****

Submit the name, address, and telephone number of the Private Qualified Person (PQP) selected to prepare the Asbestos Hazard Abatement Plan, direct monitoring and training, and documented evidence that the PQP has successfully completed training in and is accredited and where required is certified as, a Building Inspector, Contractor/Supervisor Abatement Worker, and Asbestos Project Designer as described by 40 CFR 763 and has successfully completed the National Institute of Occupational Safety and Health (NIOSH) 582 course "Sampling and Evaluating Airborne Asbestos Dust" or equivalent.[The PQP must be appropriately licensed in the State of [_____] as a Project Monitor]. The PQP and the asbestos contractor must not have an employee/employer relationship or financial relationship which could constitute a conflict of interest. The PQP must be a first tier subcontractor.

1.5.2 Designated Competent Person Documentation

****

NOTE: Edit requirement for licensing.

****

The Designated Competent Person must be experienced in the administration and supervision of asbestos abatement projects including exposure assessment and monitoring, work practices, abatement methods, protective measures for personnel, setting up and inspecting asbestos abatement work areas, evaluating the integrity of containment barriers, placement and operation of local exhaust systems, ACM generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements, notification of other employees onsite, [_____]. The Designated Competent Person must be on-site at all times when asbestos abatement activities are underway.Submit training certification and a current State of [_____] Asbestos Contractor's and Supervisor's License. Submit evidence that the Designated Competent Person has a minimum of [2] [_____] years of on-the-job asbestos abatement experience relevant to OSHA designated competent person requirements. The Designated Competent Person must be a first tier subcontractor.

1.5.3 Worker's License

****

NOTE: Edit requirement for licensing.

****

Submit documentation that workers meet the requirements of 29 CFR 1926.1101, 40 CFR 61-SUBPART M and have a current State of [_____] Asbestos Workers License.

1.5.4 Contractor's License

****

NOTE: Edit requirement for licensing.

****

Submit a copy of the asbestos contractor's license issued by the State of [_____]. Submit the following certification along with the license: "I certify that the personnel I am responsible for during the course of this project fully understand the contents of 29 CFR 1926.1101, 40 CFR 61-SUBPART MEM 385-1-1, and the Federal, State and local requirements for those asbestos abatement activities that they will be involved in." This certification statement must be signed by the Company's President or Chief Executive.

1.5.5 Air Sampling Results

****

NOTE: Normal practice is to have the Contractor hire one independent Private Qualified Person (the PQP) to perform all required functions. However, some applicable laws forbid this approach and will dictate when the PQP, the GC or both will be required to perform the function involved. However, the Contractor must always hire a PQP.

****

Complete fiber counting and provide results to the [PQP][and][GC] for review within 16 hours of the "time off" of the sample pump. Notify the Contracting Officer immediately of any airborne levels of asbestos fibers in excess of the acceptable limits. Submit sampling results to the Contracting Officer and the affected Contractor employees where required by law within three working days, signed by the testing laboratory employee performing air sampling, the employee that analyzed the sample, and the [PQP][and][GC]. Notify the Contractor and the Contracting Officer immediately of any variance in the pressure differential which could cause adjacent unsealed areas to have asbestos fiber concentrations in excess of 0.01 fibers per cubic centimeter or background whichever is higher. In no circumstance must levels exceed 0.1 fibers per cubic centimeter.

1.5.6 Pressure Differential Recordings for Local Exhaust System

****

NOTE: When an negative pressure enclosure is not required, delete the requirements for the local exhaust system and pressure differential recording.

****

****

NOTE: Normal practice is to have the Contractor hire one independent Private Qualified Person (the PQP) to perform all required functions. However, some applicable laws forbid this approach and will dictate when the PQP, the GC or both will be required to perform the function involved. However, the Contractor must always hire a PQP.

****

Provide a local exhaust system that creates a negative pressure of at least 0.51 mm 0.02 inches of water relative to the pressure external to the enclosure and operate it continuously, 24-hours a day, until the temporary enclosure of the asbestos control area is removed. Submit pressure differential recordings for each work day to the [PQP][and][GC] for review and to the Contracting Officer within 24-hours from the end of each work day.

[1.5.7 Protective Clothing Decontamination Quality Control Records

Provide all records that document quality control for the decontamination of reusable outer protective clothing.

][1.5.8 Protective Clothing Decontamination Facility Notification

Submit written evidence that persons who decontaminate, store, or transport asbestos contaminated clothing used in the performance of this contract were duly notified in accordance with 29 CFR 1926.1101.

]1.5.9 Federal, State or Local Citations on Previous Projects

Submit a statement, signed by an officer of the company, containing a record of any citations issued by Federal, State or local regulatory agencies relating to asbestos activities within the last 5 years (including projects, dates, and resolutions); a list of penalties incurred through non-compliance with asbestos project specifications, including liquidated damages, overruns in scheduled time limitations and resolutions; and situations in which an asbestos-related contract has been terminated (including projects, dates, and reasons for terminations). If there are none, a negative declaration signed by an officer of the company must be provided.

1.5.10 Preconstruction Conference

****

NOTE: Specify additional or modified requirements to be addressed in the preconstruction safety conference within the bracket if different from that described. Confer with the appropriate Construction Office and Safety and Occupational Health Office representatives to make this determination. For

Army projects refer to EP 415-1-260, Chapter 9, Resident Engineers Management Guide. If this conference is addressed in another specification section, reference the appropriate section.
****

Conduct a safety preconstruction conference to discuss the details of the Asbestos Hazard Abatement Plan, Accident Prevention Plan (APP) including the AHAs required in specification Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS [_____]. The safety preconstruction conference must include the Contractor and their Designated Competent Person, Designated IH and Project Supervisor and the Contracting Officer. Deficiencies in the APP will be discussed. Onsite work must not begin until the APP has been accepted. [_____]

1.6 SECURITY

****
NOTE: Specify onsite security requirements to be provided. Confer with the customer and the Contracting Officer for additional requirements.
****

[[_____] must be provided for each regulated area.]A log book must be kept documenting entry into and out of the regulated area. Entry into regulated areas must only be by personnel authorized by the Contractor and the Contracting Officer. Personnel authorized to enter regulated areas must be trained, medically evaluated, and wear the required personal protective equipment.

1.7 EQUIPMENT

1.7.1 Rental Equipment

Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.

PART 2 PRODUCTS

2.1 ENCAPSULANTS

Encapsulants must conform to current USEPA requirements, contain no toxic or hazardous substances as defined in 29 CFR 1926.59, and conform to the following performance requirements.

2.1.1 Removal Encapsulants

Requirement	Test Standard
Flame Spread - 25, Smoke Emission - 50	ASTM E84
Life Expectancy - 20 years	ASTM C732 Accelerated Aging Test
Permeability - Minimum 0.4 perms	ASTM E96/E96M

Requirement	Test Standard
Fire Resistance - Negligible affect on fire resistance rating over 3 hour test (Classified by UL for use over fibrous and cementitious sprayed fireproofing)	ASTM E119
Impact Resistance - Minimum 245.5 mm/N 43 in/lb	ASTM D2794 Gardner Impact Test
Flexibility - no rupture or cracking	ASTM D522/D522M Mandrel Bend Test

2.1.2 Bridging Encapsulant

Requirement	Test Standard
Flame Spread - 25, Smoke Emission - 50	ASTM E84
Life Expectancy - 20 years	ASTM C732 Accelerated Aging Test
Permeability - Minimum 0.4 perms	ASTM E96/E96M
Fire Resistance - Negligible affect on fire resistance rating over 3-hour test (Classified by UL for use over fibrous and cementitious sprayed fireproofing)	ASTM E119
Impact Resistance - Minimum 245.5 mm/N 43 in/lb	ASTM D2794 Gardner Impact Test
Flexibility - no rupture or cracking	ASTM D522/D522M Mandrel Bend Test

2.1.3 Penetrating Encapsulant

Requirement	Test Standard
Flame Spread - 25, Smoke Emission - 50	ASTM E84
Life Expectancy - 20 years	ASTM C732 Accelerated Aging Test
Permeability - Minimum 0.4 perms	ASTM E96/E96M
Cohesion/Adhesion Test - 729.5 N of force/meter 50 pounds of force/foot	ASTM E119

Requirement	Test Standard
Fire Resistance - Negligible affect on fire resistance rating over 3-hour test (Classified by UL for use over fibrous and cementitious sprayed fireproofing)	ASTM E119
Impact Resistance - Minimum 245.5 mm/N 43 in/lb	ASTM D2794 Gardner Impact Test
Flexibility - no rupture or cracking	ASTM D522/D522M Mandrel Bend Test

2.1.4 Lock-down Encapsulant

Requirement	Test Standard
Flame Spread - 25, Smoke Emission - 50	ASTM E84
Life Expectancy - 20 years	ASTM C732 Accelerated Aging Test
Permeability - Minimum 0.4 perms	ASTM E96/E96M
Fire Resistance - Negligible affect on fire resistance rating over 3-hour test (Tested with fireproofing over encapsulant applied directly to steel member)	ASTM E119
Bond Strength: 1459 N of force/meter 100 pounds of force/foot	ASTM E736/E736M
(Tests compatibility with cementitious and fibrous fireproofing)	

[2.2 ENCASEMENT PRODUCTS

****

NOTE: This technique is not used often. Before specifying, consult state requirements and ensure that the materials, use requirements and warranties are fully developed with the customer.

****

Encasement must consist of primary cellular polymer coat, polymer finish coat, and any other finish coat as approved by the Contracting Officer.

]2.3 DUCT TAPE

Industrial grade duct tape of appropriate widths suitable for bonding sheet plastic and disposal container.

2.4 DISPOSAL CONTAINERS

****

NOTE: Consult customer, federal, state, and local requirements for the type of disposal container allowed.

****

Leak-tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal containers must be provided for ACM wastes as required by 29 CFR 1926.1101. Disposal containers can be in the form of:

a. Disposal Bags

b. Fiberboard Drums

c. Cardboard Boxes

2.5 SHEET PLASTIC

****

NOTE: Consult customer, federal, state and local requirements. If necessary, specify the type of sheet to be used and select the color and surface treatment.

****

Sheet plastic must be polyethylene of 0.15 mm 6 mil minimum thickness and must be provided in the largest sheet size necessary to minimize seams. Film must be [clear][frosted][or][black] and conform to ASTM D4397, except as specified below

2.5.1 Flame Resistant

Where a potential for fire exists, flame-resistant sheets must be provided. Film must be [frosted][or][black] and must conform to the requirements of NFPA 701.

2.5.2 Reinforced

Reinforced sheets must be provided where high skin strength is required, such as where it constitutes the only barrier between the regulated area and the outdoor environment. The sheet stock must consist of translucent, nylon-reinforced or woven-polyethylene thread laminated between 2 layers of polyethylene film. Film must meet flame resistant standards of NFPA 701.

2.6 MASTIC REMOVING SOLVENT

Mastic removing solvent must be nonflammable and must not contain methylene chloride, glycol ether, or halogenated hydrocarbons. Solvents used onsite must have a flash point greater than 60 degrees C 140 degrees F.

2.7 LEAK-TIGHT WRAPPING

Two layers of 0.15 mm 6 mil minimum thick polyethylene sheet stock must be used for the containment of removed asbestos-containing components or materials such as large tanks, boilers, insulated pipe segments and other materials. Upon placement of the ACM component or material, each layer must be individually leak-tight sealed with duct tape.

2.8 VIEWING INSPECTION WINDOW

Where feasible, a minimum of one clear, 3 mm 1/8 inch thick, acrylic sheet, 450 by 610 mm 18 by 24 inches, must be installed as a viewing inspection window at eye level on a wall in each containment enclosure. The windows must be sealed leak-tight with industrial grade duct tape.

2.9 WETTING AGENTS

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NOTE: Review the abatement methods to be employed and edit the paragraph accordingly.

****

Removal encapsulant (a penetrating encapsulant) must be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. The removal encapsulant must be capable of wetting the ACM and retarding fiber release during disturbance of the ACM greater than or equal to that provided by amended water. Performance requirements for penetrating encapsulants are specified in paragraph ENCAPSULANTS above.

PART 3 EXECUTION

3.1 EQUIPMENT

****

NOTE: Modify the number of sets of protective equipment as required, depending on the size of the asbestos removal project. Larger projects may require more than two persons on an inspection team.

****

Provide the Contracting Officer or the Contracting Officer's Representative, with at least [two] [_____] complete sets of personal protective equipment [including decontaminating reusable coveralls]as required for entry to and inspection of the asbestos control area. Provide equivalent training to the Contracting Officer or a designated representative as provided to Contractor employees in the use of the required personal protective equipment. Provide manufacturer's certificate of compliance for all equipment used to contain airborne asbestos fibers.

3.1.1 Air Monitoring Equipment

The Contractor's PQP must approve air monitoring equipment. The equipment must include, but must not be limited to:

a. High-volume sampling pumps that can be calibrated and operated at a constant airflow up to 16 liters per minute.

b. Low-volume, battery powered, body-attachable, portable personal pumps that can be calibrated to a constant airflow up to approximately 3.5 liters per minute, and a self-contained rechargeable power pack capable of sustaining the calibrated flow rate for a minimum of 10 hours. The pumps must also be equipped with an automatic flow control unit which must maintain a constant flow, even as filter resistance increases due to accumulation of fiber and debris on the filter surface.

c. Single use standard 25 mm diameter cassette, open face, 0.8 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive extension cowl, and shrink bands for personal air sampling.

[d. Single use standard 25 mm diameter cassette, open face, 0.45 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive cowl, and shrink bands when conducting environmental area sampling using NIOSH NMAM Methods 7400 and 7402, (and the transmission electric microscopy method specified at 40 CFR 763 if required).

] e. A flow calibrator capable of calibration to within plus or minus 2 percent of reading over a temperature range of minus 20 to plus 60 degrees C minus 4 to plus 140 degrees F and traceable to a NIST primary standard.

3.1.2 Respirators

Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services.

3.1.2.1 Respirators for Handling Asbestos

Provide personnel engaged in pre-cleaning, cleanup, handling, [encapsulation][removal][and][or][demolition] of asbestos materials with respiratory protection as indicated in 29 CFR 1926.1101 and 29 CFR 1926.103. Breathing air must comply with CGA G-7.

3.1.3 Exterior Whole Body Protection

3.1.3.1 Outer Protective Clothing

Provide personnel exposed to asbestos with disposable "non-breathable,"[or reusable "non-breathable"] whole body outer protective clothing, head coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but must not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape.[Reusable whole body outer protective clothing must be either disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area or be properly decontaminated.]

3.1.3.2 Work Clothing

Provide cloth work clothes for wear under the outer protective clothing and foot coverings and either dispose of or properly decontaminate them as recommended by the [GC][PQP] after each use.

3.1.3.3 Personal Decontamination Unit

Provide a temporary, negative pressure unit with a separate decontamination locker room and clean locker room with a shower that complies with 29 CFR 1926.51(f)(4)(ii) through (V) in between for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal.[HEPA vacuum and remove asbestos contaminated reusable protective clothing while still wearing respirators at the boundary of the asbestos work area, seal in two impermeable bags, label outer bag as asbestos contaminated waste, and transport for decontamination.] Do not wear work clothing between home and work. Locate showers between the decontamination locker room and the clean locker room and require that all employees shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Wastewater filters must be installed in series with the first stage pore size [20] [_____] microns and the second stage pore size of [5] [_____] microns. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste[or properly decontaminate as specified in the Contractor's Asbestos Hazard Abatement Plan]. Keep the floor of the decontamination unit's clean room dry and clean at all times. Proper housekeeping and hygiene requirements must be maintained. Provide soap and towels for showering, washing and drying. Cloth towels provided must be disposed of as ACM waste or must be laundered in accordance with 29 CFR 1926.1101. Physically attach the decontamination units to the asbestos control area. Construct both a personnel decontamination unit and an equipment decontamination unit onto and integral with each asbestos control area.

[3.1.3.4 Decontamination of Reusable Outer Protective Clothing

When reusable outer protective clothing is used, transport the double bagged clothing to a previously notified commercial/industrial decontamination facility for decontamination. Perform non-destructive testing to determine the effectiveness of asbestos decontamination. If representative sampling is used, ensure the statistical validity of the sampling results. If representative sampling is used, reject any entire batch in which any of the pieces exceed 40 fibers per square millimeter. Inspect reusable protective clothing prior to use to ensure that it will provide adequate protection and is not or is not about to become ripped, torn, deteriorated, or damaged, and that it is not visibly contaminated. Notify, in writing, all personnel involved in the decontamination of reusable outer protective clothing as indicated in 29 CFR 1926.1101.

]3.1.3.5 Eye Protection

Provide eye protection that complies with ANSI/ISEA Z87.1 when operations present a potential eye injury hazard. Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.

3.1.4 Regulated Areas

All Class I, II, and III asbestos work must be conducted within regulated areas. The regulated area must be demarcated to minimize the number of persons within the area and to protect persons outside the area from exposure to airborne asbestos. Control access to regulated areas, ensure that only authorized personnel enter, and verify that Contractor required medical surveillance, training and respiratory protection program requirements are met prior to allowing entrance.

3.1.5 Load-out Unit

Provide a temporary load-out unit that is adjacent and connected to the regulated area[and][access tunnel]. Attach the load-out unit in a leak-tight manner to each regulated area.

3.1.6 Warning Signs and Labels

Provide[bilingual] warning signs[printed in English and [_____]] at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to the requirements are acceptable

3.1.6.1 Warning Sign

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NOTE: "WEAR RESPIRATORY PROTECTION AND PROTECTIVE CLOTHING IN THIS AREA" will be added to the warning sign when protective equipment is required.

****

Provide vertical format conforming to 29 CFR 1926.200, and 29 CFR 1926.1101 minimum 500 by 355 mm 20 by 14 inches displaying the following legend in the lower panel:

Legend	Notation
DANGER	25 mm one inch Sans Serif Gothic or Block
ASBESTOS	25 mm one inch Sans Serif Gothic or Block
MAY CAUSE CANCER	25 mm one inch Sans Serif Gothic or Block
CAUSES DAMAGE TO LUNGS	6 mm 1/4 inch Sans Serif Gothic or Block
AUTHORIZED PERSONNEL ONLY	6 mm 1/4 inch Sans Serif Gothic or Block
[WEAR RESPIRATORY PROTECTION AND PROTECTIVE CLOTHING IN THIS AREA]	6 mm 1/4 inch Sans Serif Gothic or Block

Spacing between lines must be at least equal to the height of the upper of any two lines.

3.1.6.2 Warning Labels

Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST AVOID CREATING DUST

3.1.7 Local Exhaust System

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NOTE: When a negative pressure enclosure is not required, delete the requirements for the local exhaust system and pressure differential recording.

****

Provide a local exhaust system in the asbestos control area in accordance with ASSP Z9.2 and 29 CFR 1926.1101 that will provide at least four air changes per hour inside of the negative pressure enclosure. Local exhaust equipment must be operated 24-hours per day, until the asbestos control area is removed and must be leak proof to the filter and equipped with HEPA filters. Maintain a minimum pressure differential in the control area of minus 0.51 mm 0.02 inch of water column relative to adjacent, unsealed areas. Provide continuous 24-hour per day monitoring of the pressure differential with a pressure differential automatic recording instrument. The building ventilation system must not be used as the local exhaust system for the asbestos control area. Filters on exhaust equipment must conform to ASSP Z9.2 and UL 586. Terminate the local exhaust system out of doors and remote from any public access or ventilation system intakes.

3.1.8 Tools

Vacuums must be leak proof to the filter and equipped with HEPA filters. Filters on vacuums must conform to ASSP Z9.2 and UL 586. Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation systems. Remove all residual asbestos from reusable tools prior to storage or reuse. Reusable tools must be thoroughly decontaminated prior to being removed from the regulated areas.

3.1.9 Rental Equipment

If rental equipment is to be used, furnish written notification to the rental agency concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.

[3.1.10 Glovebags

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NOTE: Include this paragraph if glovebag technique is permitted to be used in the project.

****

Submit written manufacturers proof that glovebags will not break down under expected temperatures and conditions.

]3.1.11 Single Stage Decontamination Area

A decontamination area (equipment room/area) must be provided for Class I work involving less than 7.5 m 25 feet or 0.9 square meters 10 square feet of TSI or surfacing ACM, and for Class II and Class III asbestos work operations where exposures exceed the PELs or where there is no negative exposure assessment. The equipment room or area must be adjacent to the regulated area for the decontamination of employees, material, and their equipment which could be contaminated with asbestos. The area must be covered by an impermeable drop cloth on the floor or horizontal working surface. The area must be of sufficient size to accommodate cleaning of equipment and removing personal protective equipment without spreading contamination beyond the area.

3.1.12 Decontamination Area Exit Procedures

Ensure that the following procedures are followed:

a. Before leaving the regulated area, remove all gross contamination and debris from work clothing using a HEPA vacuum.

b. Employees must remove their protective clothing in the equipment room and deposit the clothing in labeled impermeable bags or containers for disposal or laundering.

c. Employees must not remove their respirators until showering.

d. Employees must shower prior to entering the clean room. If a shower has not been located between the equipment room and the clean room or the work is performed outdoors, ensure that employees engaged in Class I asbestos jobs: a) Remove asbestos contamination from their work suits in the equipment room or decontamination area using a HEPA vacuum before proceeding to a shower that is not adjacent to the work area; or b) Remove their contaminated work suits in the equipment room, without cleaning worksuits, and proceed to a shower that is not adjacent to the work area.

3.2 WORK PROCEDURE

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NOTE: EPA NESHAP at 40 CFR 61, Subpart M and OSHA 29 CFR 1926.1101(g)(1)(ii) require adequately wet removal procedures. Use wet removal procedures in almost all cases. Wet removal is the preferred method and the least hazardous. Dry removal as an option can be used to allow the Contractor to use dry removal where wet removal may damage equipment or present an extreme hazard. Dry removal as the only method of removal should only be specified if freezing is likely to occur, safety hazards preclude the use of water, or severe water damage to equipment, would occur during wet removal. If dry removal alone is allowed, carefully edit the specification to remove all reference to amended water and wetting down procedures and to include a requirement for a written variance submitted by the Contractor along with the written approval of any regulatory authority having jurisdiction.

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NOTE: Negative pressure enclosure and glovebag techniques pertain to the two most general but yet essentially different asbestos control techniques used for asbestos removal. Encapsulation work practice techniques are listed here, also. The use of unlisted removal work practice techniques will be acceptable if they are proven at least as safe as the listed practices. The appropriate technique depends on existing conditions, but must be that technique that provides the best control during abatement at most reasonable cost.

****

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NOTE: Requirements for abatement of asbestos outdoors varies considerably with the work and the location involved. Specify minimum requirements for abatement of asbestos outdoors where construction of a containment is not practical. The designer will provide the best suited, specific requirements necessary for the particular project to prohibit or reduce asbestos exposure to other Contractor employees, customer resources and the general public.

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Perform asbestos related work in accordance with 29 CFR 1926.1101, 40 CFR 61-SUBPART M,[NAVFAC P-502,] and as specified herein. Use [[wet][or][if given prior EPA approval, dry] removal procedures][appropriate encapsulation procedures as listed in the asbestos hazard abatement plan] and [negative pressure enclosure] [_____] techniques. Wear and utilize protective clothing and equipment as specified herein. No eating, smoking, drinking, chewing gum, tobacco, or applying cosmeticsis permitted in the asbestos work or control areas. Personnel of other trades not engaged in the [encapsulation][removal and demolition] of asbestos containing material must not be exposed at any time to airborne concentrations of asbestos unless all the personnel protection and training provisions of this specification are complied with by the trade personnel.[Seal all roof top penetrations, except plumbing vents, prior to asbestos roofing work.] Shut down the building heating, ventilating, and air conditioning system, cap the openings to the system, [and provide temporary [heating,][and][ventilation,][and][air conditioning]] prior to the commencement of asbestos work. Power to the regulated area must be locked-out and tagged in accordance with 29 CFR 1910.147.[Disconnect electrical service when [encapsulation][wet removal] is performed and provide temporary electrical service with verifiable ground fault circuit interrupter (GFCI) protection prior to the use of any [water][encapsulant].] All electrical work must be performed by a licensed electrician. Stop abatement work in the regulated area immediately when the airborne total fiber concentration: (1) equals or exceeds 0.01 f/cc, or the pre-abatement concentration, whichever is greater, outside the regulated area; or (2) equals or exceeds 1.0 f/cc inside the regulated area. Correct the condition to the satisfaction of the Contracting Officer, including visual inspection and air sampling. Work must resume only upon notification by the Contracting Officer. Corrective actions must be documented. If an asbestos fiber release or spill occurs[outside of the asbestos control area], stop work immediately, correct the condition to the satisfaction of the Contracting Officer including clearance sampling, prior to resumption of work.

3.2.1 Building Ventilation System and Critical Barriers

Building ventilation system supply and return air ducts in a regulated area must be[shut down and isolated by lockable switch or other positive means in accordance with 29 CFR 1910.147.][isolated by airtight seals to prevent the spread of contamination throughout the system.] The airtight seals must consist of [air-tight rigid covers for building ventilation supply and exhaust grills where the ventilation system is required to remain in service during abatement][2 layers of polyethylene]. Edges to wall, ceiling and floor surfaces must be sealed with industrial grade duct tape.

a. A Competent Person must supervise the work.

b. For indoor work, critical barriers must be placed over all openings to the regulated area.

c. Impermeable dropcloths must be placed on surfaces beneath all removal activity.

3.2.2 Protection of Existing Work to Remain

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NOTE: Normal practice is to have the Contractor hire one independent Private Qualified Person (the PQP) to perform all required functions. However, some applicable laws forbid this approach and will dictate when the PQP, the GC or both will be required to perform the function involved. However, the Contractor must always hire a PQP.

****

Perform work without damage or contamination of adjacent work. Where such work is damaged or contaminated as verified by the Contracting Officer using visual inspection or sample analysis, it must be restored to its original condition or decontaminated by the Contractor at no expense to the Government as deemed appropriate by the Contracting Officer. This includes inadvertent spill of dirt, dust, or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, stop work immediately. Then clean up the spill. When satisfactory visual inspection and air sampling results are obtained from the [PQP][GC] work may proceed at the discretion of the Contracting Officer.

3.2.3 Furnishings

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NOTE: Choose one of the following options. In most projects, the Government will remove furniture and equipment before the Contractor begins work. In this case the first paragraph should be used. The third paragraph should only be used when existing furnishings have been contaminated with asbestos fibers and the Contractor will be required to clean these items. When the third paragraph is used, identify the furnishings and indicate the quantity of each.

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NOTE: The designer must decide if porous, non-solid surfaced items can be cleaned or must be disposed of as contaminated waste. If cleaning is chosen, specify methods.
****

[Furniture [,(_____)] and equipment will be removed from the area of work by the Government before asbestos work begins.

][Furniture [,(_____)] and equipment will remain in the building. Cover and seal furnishings with 0.15 mm 6-mil plastic sheet or remove from the work area and store in a location on site approved by the Contracting Officer.

][Furnishings listed below and located in the work area are considered to be contaminated with asbestos fibers. Transfer these items to an area on site approved by the Contracting Officer, decontaminate (wet methods where possible), and then store until the room from which they came is declared clean and safe for entry.[Carpets, draperies, and other items with porous, non-solid surfaces can not be suitably cleaned and must be properly disposed of as contaminated waste.] At the conclusion of the asbestos removal work and cleanup operations, transfer all objects so removed and cleaned back to the area from which they came and re-install them. Base bids on decontaminating:

a. [_____] Desks

b. [_____] Filing cabinets

c. [_____] Linear meters feet of shelving

d. [_____] Cubic meters feet of books, papers, files, [_____].

e. [_____].

]3.2.4 Precleaning

Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos prior to establishment of an enclosure.

3.2.5 Asbestos Control Area Requirements

****
NOTE: When negative pressure enclosure is infeasible, use paragraph GLOVEBAG and delete paragraph NEGATIVE PRESSURE ENCLOSURE. If the project has both areas which can be enclosed and areas which cannot be enclosed, retain the appropriate paragraphs and identify the areas which must be enclosed and the areas which cannot be enclosed.
****

3.2.5.1 Negative Pressure Enclosure

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NOTE: Describe the ACM that must be removed using a Negative Pressure Enclosure.
****

Removal of [asbestos contaminated acoustical ceiling tiles,] [spray applied fireproofing,] [thermal system insulation,] [gypsum wallboard/joint compound] [_____] require the use of a negative pressure enclosure. Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos negative pressure enclosure with the use of curtains, portable partitions, or other enclosures in order to prevent the escape of asbestos fibers from the contaminated asbestos work area. Negative pressure enclosure development must include protective covering of uncontaminated walls, and ceilings with a continuous membrane of two layers of minimum 0.15 mm 6-mil plastic sheet sealed with tape to prevent water or other damage. Provide two layers of 0.15 mm 6-mil plastic sheet over floors and extend a minimum of 300 mm 12 inches up walls. Seal all joints with tape. Provide local exhaust system in the asbestos control area. Openings will be allowed in enclosures of asbestos control areas for personnel and equipment entry and exit, the supply and exhaust of air for the local exhaust system and the removal of properly containerized asbestos containing materials. Replace local exhaust system filters as required to maintain the efficiency of the system.

3.2.5.2 Glovebag

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NOTE: Specify the asbestos material to be removed in the first blank and identify the location of the area which cannot be enclosed in the second blank. Verify State and local regulations allow the use of glovebags.

****

If the construction of a negative pressure enclosure is infeasible for the [removal] [encapsulation] of [_____] located [_____]. Use alternate techniques as indicated in 29 CFR 1926.1101. Establish designated limits for the asbestos regulated area with the use of rope or other continuous barriers, and maintain all other requirements for asbestos control areas. The PQP must conduct personal samples of each worker engaged in asbestos handling (removal, disposal, transport and other associated work) throughout the duration of the project. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers at any time exceeds background or 0.01 fibers per cubic centimeter whichever is greater, stop work, evacuate personnel in adjacent areas or provide personnel with approved protective equipment at the discretion of the Contracting Officer. This sampling may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those obtained by the Contractor, the Government will determine which results predominate. If adjacent areas are contaminated as determined by the Contracting Officer, clean the contaminated areas, monitor, and visually inspect the area as specified herein.

3.2.5.3 Regulated Area for Class II Removal

Removal of [asbestos containing floor tile/mastic,] [carpet/mastic,] [sealants,] [_____] are Class II removal activities. Establish designated limits for the asbestos regulated work area with the use of red barrier tape; install critical barriers, splash guards and signs, and maintain all other requirements for asbestos control area except local exhaust. Place impermeable dropcloths on surfaces beneath removal activity extending out 3 feet in all directions. A detached decontamination system may be used. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If workers the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.6 Removal Procedures

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NOTE: Choose REMOVAL PROCEDURES or ENCAPSULATION PROCEDURES as appropriate for the project.

****

Wet asbestos material with a fine spray of [amended water][a specific wetting agent such as light oil] during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 0.15 mm 6 mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water or wetting agent in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 0.15 mm 6 mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Contracting Officer for approval. For example, in the case where both piping and insulation are to be removed, the Contractor may elect to wet the insulation, wrap the pipes and insulation in plastic and remove the pipe by sections. Containerize asbestos containing material while wet. Do not allow asbestos material to accumulate or become dry. Lower and otherwise handle asbestos containing material as indicated in 40 CFR 61-SUBPART M.

3.2.6.1 Sealing Contaminated Items Designated for Disposal

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NOTE: Use this paragraph only when asbestos contaminated items are also designated for removal and disposal.

****

Remove contaminated architectural, mechanical, and electrical appurtenances such as venetian blinds, full-height partitions, carpeting, duct work, pipes and fittings, radiators, light fixtures, conduit, panels, and other contaminated items designated for removal by completely coating the items with an asbestos lock-down encapsulant at the demolition site before removing the items from the asbestos control area. These items need not be vacuumed. The asbestos lock-down encapsulant must be tinted a contrasting color and spray-applied by airless method. Thoroughness of sealing operation must be visually gauged by the extent of colored coating on exposed surfaces. Lock-down encapsulants must comply with the performance requirements specified herein.

3.2.6.2 Exposed Pipe Insulation Edges

Contain edges of asbestos insulation to remain that are exposed by a removal operation. Wet and cut the rough ends true and square with sharp tools and then encapsulate the edges with a 6 mm 1/4 inch thick layer of non-asbestos containing insulating cement troweled to a smooth hard finish. When cement is dry, lag the end with a layer of non-asbestos lagging cloth, overlapping the existing ends by at least 100 mm 4 inches. When insulating cement and cloth is an impractical method of sealing a raw edge of asbestos, take appropriate steps to seal the raw edges as approved by the Contracting Officer.

3.2.7 Methods of Compliance

3.2.7.1 Mandated Practices

The specific abatement techniques and items identified must be detailed in the Contractor's AHAP. Use the following engineering controls and work practices in all operations, regardless of the levels of exposure:

a. Vacuum cleaners equipped with HEPA filters.

b. Wet methods or wetting agents except where it can be demonstrated that the use of wet methods is unfeasible due to the creation of electrical hazards, equipment malfunction, and in roofing.

c. Prompt clean-up and disposal.

d. Inspection and repair of polyethylene.

e. Cleaning of equipment and surfaces of containers prior to removing them from the equipment room or area.

3.2.7.2 Control Methods

Use the following control methods:

a. Local exhaust ventilation equipped with HEPA filter;

b. Enclosure or isolation of processes producing asbestos dust;

c. Where the feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the PELs, use them to reduce employee exposure to the lowest levels attainable and must supplement them by the use of respiratory protection.

3.2.7.3 Unacceptable Practices

The following work practices must not be used:

a. High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.

b. Compressed air used to remove asbestos containing materials, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.

c. Dry sweeping, shoveling, or other dry clean up.

d. Employee rotation as a means of reducing employee exposure to asbestos.

3.2.8 Class I Work Procedures

****

Note: OSHA believes that most outdoor Class I work may be safely done without enclosures (ref. OSHA Instruction CPL 2-2.63, change 1, dated 9 January 1996); that is, OSHA does not require enclosures. An exposure assessment must be made prior to outdoor

work to determine other required controls. Remove this paragraph when not required in the project.
****

In addition to requirements of paragraphs MANDATED PRACTICES and CONTROL METHODS, the following engineering controls and work practices must be used:

a. A Competent Person must supervise the installation and operation of the control methods.

b. For jobs involving the removal of more than 7.5 m 25 feet or 0.9 square m 10 square feet of TSI or surfacing material, place critical barriers over all openings to the regulated area.

c. HVAC systems must be isolated in the regulated area by sealing with a double layer of plastic or air-tight rigid covers.

d. Impermeable dropcloths (0.15 mm6 mil or greater thickness) must be placed on surfaces beneath all removal activity.

e. Where a negative exposure assessment has not been provided or where exposure monitoring shows the PEL was exceeded, the regulated area must be ventilated with a HEPA unit and employees must use PPE.

3.2.9 Specific Control Methods for Class I Work

****
NOTE: Remove these paragraph or subparagraphs when not required in the project.
****

Use Class I work procedures, control methods and removal methods for the following ACM:

a. Spray Applied Fireproofing

b. Gypsum Wallboard and Joint Compound

c. Thermal System Insulation and Mudded Pipe Fittings

d. Plaster and Textured Ceilings and Walls

e. Vermiculite

3.2.9.1 Negative Pressure Enclosure (NPE) System

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NOTE: Before specifying a negative pressure enclosure system, the designer should determine if an enclosure system is feasible. The enclosure should be the minimum area to encompass all the working surfaces yet allow unencumbered movement by the workers, provide unrestricted air flow past the workers, and ensure walking surfaces can be kept free of tripping hazards.
****

The system must provide at least four air changes per hour inside the containment. The local exhaust unit equipment must be operated 24-hours per day until the containment is removed. The NPE must be smoke tested for leaks at the beginning of each shift and be sufficient to maintain a minimum pressure differential of minus 0.5 mm 0.02 inch of water column relative to adjacent, unsealed areas. Pressure differential must be monitored continuously, 24-hours per day, with an automatic manometric recording instrument and Records must be provided daily on the same day collected to the Contracting Officer. The Contracting Officer must be notified immediately if the pressure differential falls below the prescribed minimum. The building ventilation system must not be used as the local exhaust system for the regulated area. The NPE must terminate outdoors unless an alternate arrangement is allowed by the Contracting Officer. All filters used must be new at the beginning of the project and must be periodically changed as necessary and disposed of as ACM waste.

3.2.9.2 Glovebag Systems

Glovebags must be used without modification, smoke-tested for leaks, and completely cover the circumference of pipe or other structures where the work is to be done. Glovebags must be used only once and must not be moved. Glovebags must not be used on surfaces that have temperatures exceeding 66 degrees C 150 degrees F. Prior to disposal, glovebags must be collapsed using a HEPA vacuum. Before beginning the operation, loose and friable material adjacent to the glovebag operation must be wrapped and sealed in 2 layers of plastic or otherwise rendered intact. At least two persons must perform glovebag removal. Asbestos regulated work areas must be established for glovebag abatement. Designated boundary limits for the asbestos work must be established with rope or other continuous barriers and all other requirements for asbestos control areas must be maintained, including area signage and boundary warning tape.

a. Attach HEPA vacuum systems to the bag to prevent collapse during removal of ACM.

b. The negative pressure glove boxes must be fitted with gloved apertures and a bagging outlet and constructed with rigid sides from metal or other material which can withstand the weight of the ACM and water used during removal. A negative pressure must be created in the system using a HEPA filtration system. The box must be smoke tested for leaks prior to each use.

3.2.9.3 Mini-Enclosure

[Single bulkhead containment][Double bulkhead containment][or][Mini-containment (small walk-in enclosure)] to accommodate no more than two persons, may be used if the disturbance or removal can be completely contained by the enclosure. The mini-enclosure must be inspected for leaks and smoke tested before each use. Air movement must be directed away from the employee's breathing zone within the mini-enclosure.

3.2.9.4 Wrap and Cut Operation

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NOTE: When pipes are insulated with ACM, removal of the entire pipe may be more protective, easier, and more cost-effective than stripping the asbestos insulation from the pipe. The wrap and cut procedure consists of two distinct operations. The wrap portion requires the removal of small amounts of asbestos from either side of the pipe to be cut;

this will be a Class I or III operation depending on the amount of asbestos removed. Once the asbestos is removed and wrapped, the pipe is then cut. OSHA considers the cutting portion of the job as unclassified, as it does not involve asbestos removal. If the wrap and cut operation is conducted in a negative pressure enclosure system, the glovebag step is not required, although recommended.
****

Prior to cutting pipe, the asbestos-containing insulation must be wrapped with polyethylene and securely sealed with duct tape to prevent asbestos becoming airborne as a result of the cutting process. The following steps must be taken: install glovebag, strip back sections to be cut 150 mm 6 inches from point of cut, and cut pipe into manageable sections.

3.2.9.5 Class I Removal Method

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NOTE: The removal procedures described below are typical for asbestos abatement projects. Revise or add additional removal procedures as required to address the specific ACM to be abated. Consult with Federal, State and local regulations for additional information.
****

Class I ACM must be removed using a control method described above. Prepare work area as previously specified. Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area. Spread one layer of 0.15 mm 6-mil seamless plastic sheeting on the floor below the work area.[Remove asbestos containing spray applied fireproofing using a scraper and wet methods and immediately place into 0.15 mm 6-mil thickness disposal bag. After removal of the material use a wire brush to clean the exposed substrate to remove residual material. Continue wet cleaning until surfaces are free of visible debris.][Cut manageable sections of gypsum wallboard and joint compound and immediately place into a 0.15 mm 6-mil minimum thickness disposal bag or other approved container. Make every effort to keep the material from falling to the floor of the work area. Use a wire brush and wet clean to remove residual material from studs. Continue wet cleaning until the surface is clean of visible material and encapsulate stud walls.][Remove ACM thermal system insulation and mudded pipe fittings using mechanical means and wet methods and immediately place into 0.15 mm 6-mil thickness disposal bag. Continue wet cleaning until surfaces are free of visible debris.][Remove ACM plaster ceilings or walls using mechanical means and adequately wet methods and immediately place into 0.15 mm 6-mil thickness disposal bag. Make every effort to keep the material from falling to the floor of the work area. Continue wet cleaning until surfaces are free of visible debris.][Remove ACM textured ceiling finish using a scraper and wet methods and immediately place into 0.15 mm 6-mil thickness disposal bag. Floors are considered contaminated from fallen textured ceiling finish. Clean up debris on floor and dispose of [carpet]as asbestos contaminated material. After removal of the material use a wire brush to clean the exposed [concrete]ceiling to remove residual material. Continue wet cleaning until surfaces are free of visible debris.][Remove ACM vermiculite using mechanical means and adequately wet methods and immediately place into 0.15 mm 6-mil thickness disposal bag. Make every effort to keep the material from falling to the floor of the work area. Continue wet cleaning until surfaces are free of visible debris.] Bag all asbestos debris which has fallen to the floor as asbestos-containing debris. Place all debris in plastic disposal bags of 0.15 mm 6-mil minimum thickness. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 0.15 mm 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Lower and otherwise handle asbestos containing materials as indicated in 40 CFR 61-SUBPART M. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers or the designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work, and immediately correct the situation.

3.2.10 Class II Work Procedures

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NOTE: Class II work may also be performed using a method allowed for Class I work, except that glovebags and glove boxes are allowed if they fully enclose the Class II material to be removed. Remove this paragraph when not required in the project.

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In addition to the requirements of paragraphs MANDATED PRACTICES and CONTROL METHODS, the following engineering controls and work practices must be used:

a. A Competent Person must supervise the work.

b. For indoor work, critical barriers must be placed over all openings to the regulated area.

c. Impermeable dropcloths must be placed on surfaces beneath all removal activity.

3.2.11 Specific Control Methods for Class II Work

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NOTE: If the removal of the adhesive is necessary, wet methods should be used when removing residual adhesive. The adhesive must be either wet-scraped manually or removed using low speed floor machine (300 RPM or less) and wetted sand or a removal solution. The adhesive residues must be placed in an impermeable trash bag while still wet. Remaining water or dirt in the area must then be HEPA vacuumed.

Removal of "intact" cements, coatings, mastics, and flashings is not Class II work. ACM is not rendered non-intact simply by being separated into smaller pieces.

Remove these paragraph or subparagraphs when not

required in the project.
****

****
NOTE: The removal procedures described below are typical for asbestos abatement projects. Delete, revise or add additional removal procedures as required to address the specific ACM to be abated. Consult with Federal, State and local regulations for additional information.
****

3.2.11.1 [Vinyl and Asphaltic Flooring Materials] [Carpet and Mastic]

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. A detached decontamination system may be used. When removing [vinyl floor tile and mastic][carpet and mastic] which contains ACM, use the following practices. Remove [floor tile and mastic][carpet and mastic] using adequately wet methods. Remove [floor tiles][carpet and mastic] intact (if possible).[Wetting is not required when floor tiles are heated and removed intact.] Do not sand flooring or its backing. Scrape residual adhesive and backing using wet methods. Mechanical chipping is prohibited unless performed in a negative pressure enclosure. Dry sweeping is prohibited. Use vacuums equipped with HEPA filter, disposable dust bag, and metal floor tool (no brush) to clean floors. Place debris into a 0.15 mm 6-mil minimum thickness disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 0.15 mm 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Lower and otherwise handle asbestos containing materials as indicated in 40 CFR 61-SUBPART M. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If workers the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.11.2 Sealants and Mastic

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers and signs, and maintain all other requirements for asbestos control area except local exhaust. Spread 0.15 mm 6-mil plastic sheeting on the ground around the perimeter of the work area extending out in all directions. Using adequately wet methods, carefully remove the ACM sealants and mastics using a scraper of knife blade. As it is removed place the material into a disposal bag. Make every effort to keep the asbestos material from falling to the ground or work area floor below. Dry sweeping is prohibited. Use vacuums equipped with HEPA filter and disposable dust bag. Place debris into a 0.15 mm 6-mil minimum thickness disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 0.15 mm 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Lower and otherwise handle asbestos containing materials as indicated in 40 CFR 61-SUBPART M. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or at designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.11.3 Suspect Fire Doors

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. A detached decontamination system may be used. Spread 0.15 mm 6-mil plastic sheeting on the ground beneath the work area and around the perimeter of the work area extending out in all directions. Remove door intact from hinges and wrap with 6-mil plastic sheeting. Inspect the interior areas of the door to determine if ACM is present. If ACM is not present the door may be disposed of as general construction debris. If ACM is present place whole door in enclosed container for disposal. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.11.4 Roofing Materials

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NOTE: Removal or repair of sections of intact roofing less than 2.5 square meters 25 square feet in area does not require use of wet methods or HEPA vacuuming as long as manual methods, which do not render the material non-intact, are used to remove the material without creating visible dust. In determining whether a job involves less than 2.5 square meters 25 square feet, the designer should specify all removal and repair work to be performed on the same roof on the same day.

****

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. When removing roofing materials which contain ACM as described in 29 CFR 1926.1101 (g)(8)(ii), use the following practices. Roofing material must be removed in an intact state. Wet methods must be used to remove roofing materials that are not intact, or that will be rendered not intact during removal, unless such wet methods are not feasible or will create safety hazards. When removing built-up roofs, with asbestos-containing roofing felts and an aggregate surface, using a power roof cutter, all dust resulting from the cutting operations must be collected by a HEPA dust collector, or must be HEPA vacuumed by vacuuming along the cut line. Asbestos-containing roofing material must not be dropped or thrown to the ground, but must be lowered to the ground via covered, dust-tight chute, crane, hoist or other method approved by the Contracting Officer. Any ACM that is not intact must be lowered to the ground as soon as practicable, but not later than the end of the work shift. While the material remains on the roof it must be kept wet or placed in an impermeable waste bag or wrapped in plastic sheeting. Intact ACM must be lowered to the ground as soon as practicable, but not later than the end of the work shift. Unwrapped material must be transferred to a closed receptacle. Critical barriers must be placed over roof level heating and ventilation air intakes. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.11.5 Cementitious Siding and Shingles or Transite Panels

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NOTE: Alternate work practices which do not involve hand removal may be specified according to 29 CFR 1926.1101(g)(8)(vi), "Alternative Work Practices and Controls"; EPA 340/1-92/013 "A Guide to Normal Demolition Practices Under the Asbestos NESHAP"; EPA document Asbestos/Demolition Decision Tree (1994); state and local requirements. For application on multiple building demolition or siding removal, pilot tests to determine feasibility, practicality, and compliance are recommended.

****

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. When removing cementitious asbestos-containing siding, shingles or Transite panels use the following work practices. Intentionally cutting, abrading or breaking is prohibited. Each panel or shingle must be sprayed with amended water prior to removal. Nails must be cut with flat, sharp instruments. Unwrapped or unbagged panels or shingles must be immediately lowered to the ground via covered dust-tight chute, crane or hoist, or placed in an impervious waste bag or wrapped in plastic sheeting and lowered to the ground no later than the end of the work shift. Place debris into a 0.15 mm 6-mil minimum thickness disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 0.15 mm 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.11.6 Gaskets

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. Gaskets must be thoroughly wetted with amended water prior to removal and immediately placed in a disposal container. If a gasket is visibly deteriorated and unlikely to be removed intact, removal must be undertaken within a glovebag. Any scraping to remove residue must be performed wet. Place debris into a 0.15 mm 6-mil minimum thickness disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 0.15 mm 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

[3.2.12 Encapsulation Procedures

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NOTE: Choose REMOVAL PROCEDURES or ENCAPSULATION PROCEDURES as appropriate for the project.

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3.2.12.1 Preparation of Test Patches

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NOTE: Prior to preparing plans and specifications for an encapsulation project, the designer will have to ascertain that encapsulation is feasible at all. The foremost design criteria is the soundness of the existing asbestos containing matrix, i.e. the bond of the matrix to the substrate and the shear strength of the matrix itself. The designer should test the existing matrix in accordance with the ASTM E1494, using the Field Testing Provisions for the Adhesion Test.

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NOTE: Exercise discretion on the number and location of Contractor applied test patches. However, a minimum of three test patches should always be specified. Test locations, in areas of the matrix, that have a different appearance or raise doubts about their homogeneity. Specify number of test patches in first bracket and location in second bracket. Also show location on drawings.

****

Install [three] [_____] test patches of encapsulant in [_____], as indicated. Use airless spray at the lowest pressure and as recommended by the encapsulant manufacturer. Follow exactly the manufacturer's instructions for thinning recommendations, application procedures and rates. Curing time must be not less than five days or that recommended by the manufacturer, whichever is more. A test patch must be 0.8 square meter 9 square feet in size.

3.2.12.2 Field Testing

Field test the encapsulation test patches in accordance with ASTM E1494, paragraph "Required Field Test," in the presence of the Contracting Officer. Keep a written record of the testing procedures and test results. Upon successful testing of the encapsulant, submit a signed statement to the Contracting Officer certifying that the encapsulant is suitable for installation on the particular asbestos containing material.

3.2.12.3 Large-Scale Application

Apply encapsulant using the same equipment and procedures as employed for the test patches. Keep the encapsulant material stirred to prevent settling. Keep a clean work area. Change pre-filters in the ventilation equipment as soon as they appear clogged by encapsulant aerosol or pressure differential drops below 0.02 Hg.

]3.2.13 Abatement of Asbestos Contaminated Soil

Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. Asbestos contaminated soil must be removed from areas to a minimum depth of [50] [_____] mm [2] [_____] inches. Soil must be thoroughly dampened with amended water and then removed by manual shoveling into labeled containers. Place debris into a 0.15 mm 6-mil minimum thickness disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 0.15 mm 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.14 Air Sampling

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NOTE: Air sampling regimen is very dependent on removal method and applicable laws, edit accordingly.

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NOTE: Normal practice is to have the Contractor hire one independent Private Qualified Person (the PQP) to perform all required functions. However, some applicable laws forbid this approach and will dictate when the PQP, the GC or both will be required to perform the function involved. However, the Contractor must always hire a PQP.

****

Perform sampling of airborne concentrations of asbestos fibers in accordance with 29 CFR 1926.1101, the Contractor's air monitoring plan and as specified herein. Sampling performed in accordance with 29 CFR 1926.1101 must be performed by the PQP.[Sampling performed for environmental and quality control reasons must be performed by the [PQP][GC].] Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Monitoring may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate. Results of breathing zone samples must be posted at the job site and made available to the Contracting Officer. Submit all documentation regarding initial exposure assessments, negative exposure assessments, and air-monitoring results.

3.2.14.1 Sampling Prior to Asbestos Work

Provide area air sampling and establish the baseline one day prior to the masking and sealing operations for each [demolition] [removal] [encapsulation] site. Establish the background by performing area sampling in similar but uncontaminated sites in the building.

3.2.14.2 Sampling During Asbestos Work

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NOTE: Choose one of the following options. Normal practice is to have the Contractor hire one independent Private Qualified Person (the PQP) to perform all required functions. However, some applicable laws forbid this approach and will dictate when the PQP, the GC or both will be required to perform the function involved. However, the Contractor must always hire a PQP.

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NOTE: When an "enclosed" asbestos control area is not required, retain the appropriate portion in brackets.

****

[The PQP must provide personal and area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Breathing zone samples must be taken for at least 25 percent of the workers in each shift, or a minimum of two, whichever is greater. Air sample fiber counting must be completed and results provided within 24-hours (breathing zone samples), and [_____] hours (environmental/clearance monitoring) after completion of a sampling period. In addition, provided the same type of work is being performed, provide area sampling at least once every work shift close to the work inside the enclosure, outside the clean room entrance to the enclosure, and at the exhaust opening of the local exhaust system. If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the increase, and notify the Contracting Officer immediately.[Where alternate methods are used, perform personal and area air sampling at locations and frequencies that will accurately characterize the evolving airborne asbestos levels.] The written results must be signed by testing laboratory analyst, testing laboratory principal and the [Contractor's PQP][GC]. The air sampling results must be documented on a Contractor's daily air monitoring log.

][The PQP must provide personal sampling as indicated in 29 CFR 1926.1101. Breathing zone samples must be taken for at least 25 percent of the workers in each shift, or a minimum of two, whichever is greater. Breathing zone samples must be taken for at least 25 percent of the workers in each shift, or a minimum of two, whichever is greater. Air sample fiber counting must be completed and results provided within 24-hours (breathing zone samples), and [_____] hours (environmental/clearance monitoring) after completion of a sampling period. At the same time the GC will provide area sampling close to the work inside the enclosure, outside the clean room entrance to the enclosure, and at the exhaust opening of the local exhaust system. In addition, provided the same type of work is being performed, the GC will provide area sampling once every work shift close to the work inside the enclosure, outside the clean room entrance to the enclosure, and at the exhaust opening of the local exhaust system. If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the increase, and notify the Contracting Officer immediately.[Where alternate methods are used, perform personal and area air sampling at locations and frequencies that will accurately characterize the evolving airborne asbestos levels.] The written results must be signed by testing laboratory analyst, testing laboratory principal and the [Contractor's PQP][GC]. The air sampling results must be documented on a Contractor's daily air monitoring log.

]3.2.14.3 Final Clearance Requirements, NIOSH PCM Method

For PCM sampling and analysis using NIOSH NMAM Method 7400, the fiber concentration inside the abated regulated area, for each airborne sample, must be less than 0.01 f/cc. The abatement inside the regulated area is considered complete when every PCM final clearance sample is below the clearance limit. If any sample result is greater than 0.01 total f/cc, the asbestos fiber concentration (asbestos f/cc) must be confirmed from that same filter using NIOSH NMAM Method 7402 (TEM) at Contractor's expense. If any confirmation sample result is greater than 0.01 asbestos f/cc, abatement is incomplete and cleaning must be repeated at the Contractor's expense. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria must be done at the Contractor's expense.

3.2.14.4 Final Clearance Requirements, EPA TEM Method

For EPA TEM sampling and analysis, using the EPA Method specified in 40 CFR 763, abatement inside the regulated area is considered complete when the arithmetic mean asbestos concentration of the five inside samples is less than or equal to 70 structures per square millimeter (70 S/mm). When the arithmetic mean is greater than 70 S/mm, the three blank samples must be analyzed. If the three blank samples are greater than 70 S/mm, resampling must be done. If less than 70 S/mm, the five outside samples must be analyzed and a Z-test analysis performed. When the Z-test results are less than 1.65, the decontamination must be considered complete. If the Z-test results are more than 1.65, the abatement is incomplete and cleaning must be repeated. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria must be done at the Contractor's expense.

3.2.14.5 Sampling After Final Clean-Up (Clearance Sampling)

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NOTE: The designer must research the State, regional and local laws, regulations, statutes, to determine whether "aggressive" air sampling is

required. However, always use aggressive air sampling techniques after encapsulation type abatement efforts.

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NOTE: Normal practice is to have the Contractor hire one independent Private Qualified Person (the PQP) to perform all required functions. However, some applicable laws forbid this approach and will dictate when the PQP, the GC or both will be required to perform the function involved. However, the Contractor must always hire a PQP.

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NOTE: The designer must research the State, regional and local laws, regulations, statutes, to determine whether TEM analysis is required and the number of samples required.

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Provide area sampling of asbestos fibers[using aggressive air sampling techniques as defined in the EPA 560/5-85-024] and establish an airborne asbestos concentration of less than 0.01 fibers per cubic centimeter after final clean-up but before removal of the enclosure or the asbestos work control area. After final cleanup and the asbestos control area is dry but prior to clearance sampling, the [PQP][and][GC] must perform a visual inspection in accordance with ASTM E1368 to ensure that the asbestos control and work area is free of any accumulations of dirt, dust, or debris.[Prepare a written report signed and dated by the PQP documenting that the asbestos control area is free of dust, dirt, and debris and all waste has been removed.][Perform at least [_____] samples.][Use transmission electron microscopy (TEM) to analyze clearance samples and report the results in accordance with current NIOSH criteria.] The asbestos fiber counts from these samples must be less than 0.01 fibers per cubic centimeter or be not greater than the background, whichever is greater. Should any of the final samples indicate a higher value take appropriate actions to re-clean the area and repeat the sampling and [TEM] analysis at the Contractor's expense.

3.2.14.6 Air Clearance Failure

If clearance sampling results fail to meet the final clearance requirements, pay all costs associated with the required recleaning, resampling, and analysis, until final clearance requirements are met.

3.2.15 Lock-Down

Prior to removal of plastic barriers and after pre-clearance clean up of gross contamination, the [PQP][GC] must conduct a visual inspection of all areas affected by the [removal][encapsulation] in accordance with ASTM E1368. Inspect for any visible fibers[, and to ensure that encapsulants were applied evenly and appropriately].[Spray apply a post removal (lock-down) encapsulant to ceiling, walls, floors and other areas exposed in the removal area. The exposed areaincludes but is not limited to plastic barriers, furnishings and articles to be discarded as well as dirty change room, air locks for bag removal and decontamination chambers.]

3.2.16 Site Inspection

While performing asbestos engineering control work, the Contractor must be subject to on-site inspection by the Contracting Officer who may be assisted by or represented by safety or industrial hygiene personnel. If the work is found to be in violation of this specification, the Contracting Officer or his representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the violation must be at the Contractor's expense.

3.3 CLEAN-UP AND DISPOSAL

3.3.1 Housekeeping

Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the Contracting Officer will attest that the area is safe before the signs can be removed. After final clean-up and acceptable airborne concentrations are attained but before the HEPA unit is turned off and the enclosure removed, remove all pre-filters on the building HVAC system and provide new pre-filters. Dispose of filters as asbestos contaminated materials. Reestablish HVAC mechanical, and electrical systems in proper working order. The Contracting Officer will visually inspect all surfaces within the enclosure for residual material or accumulated dust or debris. The Contractor must re-clean all areas showing dust or residual materials. If re-cleaning is required, air sample and establish an acceptable asbestos airborne concentration after re-cleaning. The Contracting Officer must agree that the area is safe in writing before unrestricted entry will be permitted. The Government must have the option to perform monitoring to determine if the areas are safe before entry is permitted.

3.3.2 Title to Materials

All waste materials, except as specified otherwise, become the property of the Contractor and must be disposed of as specified in applicable local, State, and Federal regulations and herein.

3.3.3 Disposal of Asbestos

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NOTE: Disposal procedures and sites for asbestos materials vary considerably with each location. Contact local station Public Works and the NAVFAC Engineering Field Division Hazardous Waste Manager or Industrial Hygienist for local procedures.

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3.3.3.1 Procedure for Disposal

Coordinate all waste disposal manifests with the Contracting Officer and NAVFAC EV. Collect asbestos waste, contaminated waste water filters, asbestos contaminated water, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing which may produce airborne concentrations of asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 0.15 mm 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 0.15 mm 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag. Clearly indicate on the outside of each container the name of the waste generator and the location at which the waste was generated. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off Government property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be assigned by the Contracting Officer or his authorized representative. Comply with 40 CFR 61-SUBPART M, State, regional, and local standards for hauling and disposal. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags must remain in the drum and the entire contaminated drum must be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums must wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

3.3.3.2 Asbestos Disposal Quantity Report

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NOTE: Normal practice is to have the Contractor hire one independent Private Qualified Person (the PQP) to perform all required functions. However, some applicable laws forbid this approach and will dictate when the PQP, the GC or both will be required to perform the function involved. However, the Contractor must always hire a PQP.

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[Direct the PQP to record and report, to the Contracting Officer, the amount of asbestos containing material removed and released for disposal. Deliver the report for the previous day at the beginning of each day shift with amounts of material removed during the previous day reported in linear meters or square meters linear feet or square feet as described initially in this specification and in cubic meters feet for the amount of asbestos containing material released for disposal.

][Allow the GC to inspect, record and report the amount of asbestos containing material removed and released for disposal on a daily basis.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 83 00 (November 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-02 82 33.13 20 (August 2011)
UFGS-02 83 13.00 20 (August 2011)
UFGS-02 83 19.13 10 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION TABLE OF CONTENTS

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 83 00

LEAD REMEDIATION

11/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-02 83 00 (November 2018)**

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UFGS-02 83 19.13 10 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 02 83 00

LEAD REMEDIATION
11/18

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NOTE: This guide specification covers the requirements for protection of workers, disposal of lead, cadmium and chromium painted material, abatement of lead based paint hazards in target housing and child occupied facilities and limiting occupational and environmental exposure to lead-based paint or paint with lead (LBP/PWL).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This guide specification also provides guidelines/recommendations for cleanup of lead, cadmium and chromium on construction projects impacting material containing lead, cadmium and chromium or lead based paint.

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NOTE: Obtain project specific information and appropriate sampling of Paint with Lead (PWL) or

Material Containing Lead (MCL) that will be removed or disturbed.

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NOTE: This guide specification can be used in projects where LBP/PWL must be removed/controlled (including paint film stabilization) or lead-based paint hazards abated as defined by Public Law 102-550 Title X - Residential Lead-Based Paint Hazard Reduction Act of 1992. Local requirements may be substantially restrictive for the conduction of LBP or LBP hazard abatement projects.

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NOTE: This guide specification should be used with all of the requirements of 40 CFR 745 (or state/local requirements in states with authorized programs) for projects involving lead-based paint hazard abatement in target housing and child occupied facilities being transferred or resolving facility-related work due to an occupant child with an elevated blood lead. In these projects, it is required that the specification editor has appropriate training regarding lead-based paint activities. Certification as a project designer per 40 CFR 745 is required.

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NOTE: The classification of the lead-based paint or paint with lead as hazardous waste must be performed in accordance with 40 CFR 261, and in the design phase of the project. This classification is prerequisite to the requirement of special handling, storage, and disposal according to Federal, state and local hazardous waste management regulations.

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NOTE: When historic preservation work will disturb PWL, refer to the Secretary of the Interior's Standards for the Treatment of Historic Properties and Brief 37, "Appropriate Methods for Reducing Lead-Paint Hazards in Historic Housing" as appropriate.

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NOTE: The work may involve a historic property. The designer must coordinate review of the proposed work with the appropriate cultural resources manager (CRM) and cultural resource laws and regulations, as part of the environmental review and permitting process. Consultation with stakeholders, including the state historic preservation office, may be required, and work involving historic properties will likely be required to confirm to the Secretary

of the Interior's Standards for the Treatment of Historic Properties (usually at the REHABILITATION level). See https://www.nps.gov/tps/standards/four-treatments/treatment-rehabilitation.htm**.**

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NOTE: Projects involving housing improvement, maintenance, or repair are not considered a lead-based paint hazard abatement action even if the effect of the work removes (or reduces) lead exposure potentials to the occupants. However, appropriate precautions for protecting occupants and leaving the housing clean (clearance) after concluding any work disturbing lead must be considered. Specific training and certification requirements (40 CFR 745 or authorized state program requirements) may not be necessary for all projects. However, it is strongly recommended that the specification editor have appropriate training regarding lead.

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NOTE: Projects that involve cutting, sawing, sanding, scraping, needle gunning, abrasive blasting, high temperature removal, of lead-based paint/paint with lead and paints containing cadmium and chromium materials may result in exposures in excess of OSHA limits. Therefore, personal protective equipment should be used and controls implemented. Institute worker protection controls as indicated in 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 and herein. Also, some work practices are prohibited for LBP/LBP hazard abatement (e.g., machine sanding, abrasive blasting) unless used with HEPA exhaust controls (see 40 CFR 745.227).

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NOTE: To assure protection of workers and proper disposal of lead, cadmium and chromium based paint, this guide specification is to be used together with Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS.

This guide specification is not to be used for removal of lead-based paint from hydraulic structures, steel structures, or other similar structures. For these types of structures, the designer should use Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

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PART 1   GENERAL

1.1   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z9.2	(2018) Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems

ASTM INTERNATIONAL (ASTM)

ASTM E1613	(2012) Standard Test Method for Determination of Lead by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), Flame Atomic Absorption Spectrometry (FAAS), or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) Techniques
ASTM E1644	(2021) Standard Practice for Hot Plate Digestion of Dust Wipe Samples for the Determination of Lead
ASTM E1726	(2021) Standard Practice for Preparation of Soil Samples by Hotplate Digestion for Subsequent Lead Analysis
ASTM E1727	(2016) Standard Practice for Field Collection of Soil Samples for Subsequent Lead Determination
ASTM E1728/E1728M	(2024) Standard Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Lead Determination
ASTM E1792	(2024) Standard Specification for Wipe Sampling Materials for Lead in Surface Dust

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

HUD 6780	(1995; Errata Aug 1996;Rev Ch. 7 - 1997) Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.21	Safety Training and Education
29 CFR 1926.33	Access to Employee Exposure and Medical Records
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts, and Mists
29 CFR 1926.59	Hazard Communication
29 CFR 1926.62	Lead
29 CFR 1926.65	Hazardous Waste Operations and Emergency Response
29 CFR 1926.103	Respiratory Protection
29 CFR 1926.1126	Chromium
29 CFR 1926.1127	Cadmium
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 268	Land Disposal Restrictions

40 CFR 745	Lead-Based Paint Poisoning Prevention in Certain Residential Structures
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 178	Specifications for Packagings

U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

ND OPNAVINST 5100.23	(2005; Rev G) Navy Occupational Safety and Health (NAVOSH) Program Manual

UL SOLUTIONS (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units

1.2 DEFINITIONS

1.2.1 Abatement

Measures defined in 40 CFR 745, Section 223, designed to permanently eliminate lead-based paint hazards.

1.2.2 Action Level

Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour period; to an airborne concentration of cadmium of 2.5 micrograms per cubic meter of air averaged over an 8-hour period; to an airborne concentration of chromium (VI) of 2.5 micrograms per cubic meter of air averaged over an 8-hour period.

1.2.3 Area Sampling

Sampling of lead, cadmium, chromium concentrations within the lead, cadmium, chromium control area and inside the physical boundaries which is representative of the airborne lead, cadmium, chromium concentrations but is not collected in the breathing zone of personnel (approximately 1.5 to 1.8 meters 5 to 6 feet above the floor).

1.2.4 Cadmium Permissible Exposure Limit (PEL)

Five micrograms per cubic meter of air as an 8-hour time weighted average as determined by 29 CFR 1926.1127. If an employee is exposed for more than 8-hours in a work day, determine the PEL by the following formula:

PEL (micrograms/cubic meter of air) = 40/No. hrs worked per day

1.2.5 Certified Industrial Hygienist (CIH)

As used in this section refers to a person retained by the Contractor who is certified as an industrial hygienist and who is trained in the recognition and control of lead, cadmium and chromium hazards in accordance with current federal, State, and local regulations. CIH must be certified for comprehensive practice by the American Board of Industrial Hygiene. The Certified Industrial Hygienist must be independent of the Contractor and must have no employee or employer relationship which could constitute a conflict of interest.

1.2.6 Child-Occupied Facility

Real property which is a building or portion of a building constructed prior to 1978 visited regularly by the same child, six-years of age or under, on at least two different days within any week (Sunday through Saturday period), provided that each day's visit lasts at least 3-hours, and the combined annual visits last at least 60-hours. Child-occupied facilities include but are not limited to, day-care centers, preschools and kindergarten classrooms.

1.2.7 Chromium Permissible Exposure Limit (PEL)

Five micrograms per cubic meter of air as an 8-hour time weighted average as determined by 29 CFR 1926.1126. If an employee is exposed for more than 8-hours in a work day, determine the PEL by the following formula:

PEL (micrograms/cubic meter of air) = 40/No. hrs worked per day

1.2.8 Competent Person (CP)

As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead, cadmium and chromium hazards in accordance with current federal, State, and local regulations and has the authority to take prompt corrective actions to control the lead, cadmium and chromium hazard. The Contractor may provide more than one CP as required to supervise and monitor the work. The CP must be a Certified Industrial Hygienist (CIH) certified by the American Board of Industrial Hygiene or a Certified Safety Professional (CSP) certified by the Board of Certified Safety Professionals or a licensed lead-based paint abatement Supervisor/Project Designer in the State of [_____].

1.2.9 Contaminated Room

Refers to a room for removal of contaminated personal protective equipment (PPE).

1.2.10 Decontamination Shower Facility

That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.

1.2.11 Deleading

Activities conducted by a person who offers to eliminate lead-based paint or lead-based paint hazards or paints containing cadmium/chromium or to plan such activities in commercial buildings, bridges or other structures.

1.2.12 Eight-Hour Time Weighted Average (TWA)

Airborne concentration of lead, cadmium, chromium to which an employee is exposed, averaged over an 8-hour workday as indicated in 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127.

1.2.13 High Efficiency Particulate Air (HEPA) Filter Equipment

HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead, cadmium, chromiumcontaminated particulate. A high efficiency particulate filter demonstrates at least 99.97 percent efficiency against 0.3 micron or larger size particles.

1.2.14 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps. Excludes other forms of organic lead compounds. The use of the term Lead in this section also refers to paints which contain detectable concentrations of Cadmium and Chromium. For the purposes of the section lead-based paint (LBP) and paint with lead (PWL) also contains cadmium and chromium.

1.2.15 Lead-Based Paint (LBP)

Paint or other surface coating that contains lead in excess of 1.0 milligrams per centimeter squared or 0.5 percent by weight.

1.2.16 Lead-Based Paint Activities

In the case of target housing or child occupied facilities, lead-based paint activities include; a lead-based paint inspection, a risk assessment, or abatement of lead-based paint hazards.

1.2.17 Lead-Based Paint Hazards

Paint-lead hazard, dust-lead hazard or soil-lead hazard as identified in 40 CFR 745, Section 65. Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.

1.2.18 Lead, Cadmium, Chromium Control Area

A system[of control methods] to prevent the spread of lead, cadmium, chromium dust, paint chips or debris to adjacent areas that may include temporary containment, floor or ground cover protection, physical boundaries, and warning signs to prevent unauthorized entry of personnel. HEPA filtered local exhaust equipment may be used as engineering controls to further reduce personnel exposures or building/outdoor environmental contamination.

1.2.19 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8-hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than 8-hours in a work day, determine the PEL by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day

1.2.20 Material Containing Lead/Paint with Lead (MCL/PWL)

Any material, including paint, which contains lead as determined by the testing laboratory using a valid test method. The requirements of this section does not apply if no detectable levels of lead are found using a quantitative method for analyzing paint or MCL using laboratory instruments with specified limits of detection (usually 0.01 percent). An X-Ray Fluorescence (XRF) instrument is not considered a valid test method.

1.2.21 Personal Sampling

Sampling of airborne lead, cadmium, chromium concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127. Samples must be representative of the employees' work tasks. Breathing zone must be considered an area within a hemisphere, forward of the shoulders, with a radius of 150 to 225 mm 6 to 9 inches and centered at the nose or mouth of an employee.

1.2.22 Physical Boundary

Area physically roped or partitioned off around lead, cadmium, chromium control area to limit unauthorized entry of personnel.

1.2.23 Target Housing

Residential real property which is housing constructed prior to 1978, except housing for the elderly or persons with disabilities (unless any one or more children age 6-years or under resides or is expected to reside in such housing for the elderly or persons with disabilities) or any zero bedroom dwelling.

1.3 DESCRIPTION

****

NOTE: Specify the construction activities that will impact lead, cadmium and chromium based paint or lead containing material. Show the location of MCL/PWL impacted construction activities on the contract drawings and indicate its condition (well adhered sheets or wrappings, solid, aggregates, bricks or blocks, powdered, liquid, sludge). Example activities include: preparing surfaces for painting, saw cutting through painted material, sanding painted surfaces, scabbling painted or otherwise leaded concrete surfaces, blast cleaning painted surfaces, torch cutting through painted metal.

****

Construction activities impacting PWL or material containing lead, cadmium, chromium which are covered by this specification include the demolition or removal of material containing lead, cadmium, chromium in [_____] condition, located [_____] and as indicated on the drawings. [_____] The work covered by this section includes work tasks and the precautions specified in this section for the protection of building occupants and the environment during and after the performance of the hazard abatement activities.

1.3.1 Protection of Existing Areas To Remain

Project work including, but not limited to, lead, cadmium, chromium hazard abatement work, storage, transportation, and disposal must be performed without damaging or contaminating adjacent work and areas. Where such work or areas are damaged or contaminated, restore work and areas to the original condition.

1.3.2 Coordination with Other Work

Coordinate with work being performed in adjacent areas to ensure there are no exposure issues. Explain coordination procedures in the Lead, Cadmium, Chromium Compliance Plan and describe how the Contractor will prevent lead, cadmium and chromium exposure to other contractors and Government personnel performing work unrelated to lead, cadmium and chromium activities.

1.3.3 Sampling and Analysis

****

NOTE: Specify the sampling and analysis necessary to characterize effectiveness of equipment and procedures to prevent migration of contamination while lead, cadmium and chromium and lead hazard abatement activities are performed and to assure clearance/cleanup requirements have been achieved.

Select from the methods below to specify the sampling and analytical requirements for this project.

****

Submit a log of the analytical results from sampling conducted during the abatement. Keep the log of results current with project activities and brief the results to the Contracting Officer as analytical results are reported.

1.3.3.1 Dust Wipe Materials, Sampling and Analysis

Sampling must conform to [[ASTM E1728/E1728M][ASTM E1792]].[Analysis must conform to ASTM E1613 and ASTM E1644.]

1.3.3.2 Soil Sampling and Analysis

Sampling must conform to ASTM E1727.[Analysis must conform to ASTM E1613 and ASTM E1726.]

1.3.3.3 Clearance Monitoring

****

NOTE: Review 40 CFR 745 (e)(8)(v)(A), (B) and (C) to determine the quantity and location of clearance samples for target housing, child occupied facilities.

****

a. Collect dust wipe samples inside the lead, cadmium and chromium hazard control area after the final visual inspection in the quantities and at the locations specified.

    (1) Floors [_____].
    (2) Interior Window Sills [_____].
    (3) Window Troughs [_____].

b. Collect exterior bare soil samples inside the lead, cadmium and chromium hazard control area after the final visual inspection in the quantities and at the locations specified.

(1) Near the building foundation [_____].
(2) Nearby Play areas [_____].

1.3.4 Clearance Requirements

****

NOTE: Clearance criteria are as follows:

Target housing and child occupied facilities.

a) Building Interior:

Floors - 40 micrograms/square foot.
Interior Window Sills - 250 micrograms/square foot.
Window Troughs - 800 micrograms/square foot.

b) Building Exterior:

Bare soils in play areas used by children under the age of 6 - 400 mg/kg.
Bare soils, all other areas - 1200 mg/kg

It is recommended that the designer check with the project customer and state regulators to assure that the clearance criteria in this note are consistent with customer needs and state specific requirements.

****

Target housing and child occupied facilities clearance levels.

(1) Floors [_____].
(2) Interior Window Sills [_____].
(3) Window Troughs [_____].
(4) Bare soils in play areas accessible by children [_____].
(5) Bare soils in all other areas [_____].

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Competent Person Qualifications; G, [_____]

Training Certification; G, [_____]

Occupational and Environmental Assessment Data Report; G, [_____]

Medical Examinations; G, [_____]

Lead, Cadmium, Chromium Waste Management Plan; G, [_____]

Licenses, Permits and Notifications; G, [_____]

Occupant Protection Plan; G, [_____]

Lead, Cadmium, Chromium Compliance Plan; G, [_____]

[Initial Sample Results; G, [_____]

] Written Evidence of TSD Approval; G, [_____]

SD-03 Product Data

Respirators; G, [_____]

Vacuum Filters; G, [_____]

Negative Air Pressure System; G, [_____]

Materials and Equipment; G, [_____]

Expendable Supplies; G, [_____]

Local Exhaust Equipment; G, [_____]

Pressure Differential Automatic Recording Instrument; G, [_____]

Pressure Differential Log; G, [_____]

SD-06 Test Reports

Sampling and Analysis; G, [_____]

Occupational and Environmental Assessment Data Report; G, [_____]

Sampling Results; G, [_____]

Pressure Differential Recordings For Local Exhaust System; G, [_____]

SD-07 Certificates

Testing Laboratory; G, [_____]

[Third Party Consultant Qualifications; G, [_____]

][Occupant Notification; G, [_____]

][Notification of the Commencement of [LBP] Hazard Abatement; G, [_____]

]

****

NOTE: See Criteria Notes in paragraphs AIR AND WIPE SAMPLING and CLEARANCE CERTIFICATION to determine whether these items should be included in the project.

****

Clearance Certification; G, [_____]

SD-11 Closeout Submittals

Hazardous Waste Manifest; G, [_____]

[Turn-In Documents or Weight Tickets; G, [_____]

]1.5 QUALITY ASSURANCE

1.5.1 Qualifications

1.5.1.1 Competent Person (CP)

Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph COMPETENT PERSON (CP) RESPONSIBILITIES. Provide documented construction project-related experience with implementation of OSHA's Lead in Construction standard (29 CFR 1926.62), Chromium standard (29 CFR 1926.1126), Cadmium standard (29 CFR 1926.1127) which shows ability to assess occupational and environmental exposure to lead, cadmium, chromium; experience with the use of respirators, personal protective equipment and other exposure reduction methods to protect employee health. Demonstrate a minimum of [3][5][_____] years experience implementing OSHA's Lead in Construction standard (29 CFR 1926.62), Chromium standard (29 CFR 1926.1126), and Cadmium standard (29 CFR 1926.1127). Submit proper documentation that the CP is trained [and licensed][and certified] in accordance with federal, State [_____] and local laws.[The competent person must be a licensed lead-based paint abatement Supervisor/Project Designer in the State of [_____]].

1.5.1.2 Training Certification

****

NOTE: State or local regulations may consider lead, cadmium and chromium, LBP/PWL or MCL removal work as "lead based paint hazard reduction activities" even if the work does not include lead based paint. The training provider may be required to be "accredited" by either the State or the United States Environmental Protection Agency (USEPA).

****

Submit a certificate for each worker and supervisor, signed and dated by the[accredited] training provider, stating that the employee has received the required lead, cadmium and chromium training specified in 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 [40 CFR 745][and is certified to perform or supervise deleading, lead removal or demolition activities][in the State of [_____]].

1.5.1.3 Testing Laboratory

Submit the name, address, and telephone number of the testing laboratory selected to perform the air[soil][and wipe] analysis, testing, and reporting of airborne concentrations of lead, cadmium and chromium. Use a laboratory participating in the EPA National Lead Laboratory Accreditation Program (NLLAP) by being accredited by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis. Laboratories selected to perform blood lead analysis must be OSHA approved.

[1.5.1.4 Third Party Consultant Qualifications

****

NOTE: See Criteria Notes in paragraphs AIR AND WIPE SAMPLING and CLEARANCE CERTIFICATION to determine whether this paragraph should be included in the project.

****

Submit the name, address and telephone number of the third party consultant selected to perform the wipe sampling for determining concentrations of lead, cadmium and chromium in dust. Submit proper documentation that the consultant is trained and certified as an inspector technician or inspector/risk assessor by the USEPA authorized State (or local) certification and accreditation program.

]1.5.1.5 Certified Risk Assessor

The Certified Risk Assessor must be certified pursuant to 40 CFR 745, Section 226 and be responsible to perform the clearance sampling, clearance sample data evaluation and summarize clearance sampling results in a section of the abatement report. The risk assessor must sign the abatement report to indicate clearance requirements for the contract have been met.

1.5.2 Requirements

1.5.2.1 Competent Person (CP) Responsibilities

a. Verify training meets all federal, State, and local requirements.

b. Review and approve Lead, Cadmium, Chromium Compliance Plan for conformance to the applicable referenced standards.

c. Continuously inspect LBP/PWL or MCL work for conformance with the approved plan.

d. Perform (or oversee performance of) air sampling. Recommend upgrades or downgrades (whichever is appropriate based on exposure) on the use of PPE (respirators included) and engineering controls.

e. Ensure work is performed in strict accordance with specifications at all times.

f. Control work to prevent hazardous exposure to human beings and to the environment at all times.

g. Supervise final cleaning of the lead, cadmium, chromium control area, take clearance wipe samples if necessary; review clearance sample results and make recommendations for further cleaning.

h. Certify the conditions of the work as called for elsewhere in this specification.

i. The CP must be certified pursuant to 40 CFR 745, Section 226 and is responsible for development and implementation of the occupant protection plan, the abatement report and supervise lead, cadmium and chromium hazard abatement work activities.

1.5.2.2 Lead, Cadmium, Chromium Compliance Plan

****

NOTE: State or local regulations may have specific requirements for written project designs. Research specific State or local requirements for public, commercial buildings or structures. Consider the bracketed occupant protection plan for high profile sensitive work such as present in family housing, childcare facilities, administrative buildings, kitchens.

****

Submit a detailed job-specific plan of the work procedures to be used in the disturbance of lead, cadmium and chromium, LBP/PWL or MCL. Include in the plan a sketch showing the location, size, and details of lead, cadmium, chromium control areas, critical barriers, physical boundaries, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include a description of equipment and materials, work practices, controls and job responsibilities for each activity from which lead, cadmium, chromium is emitted. Include in the plan, eating, drinking, smoking, hygiene facilities and sanitary procedures, interface of trades, sequencing of lead, cadmium, chromium related work, collected waste water and dust containing lead, cadmium, chromium and debris, air sampling, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that lead, cadmium, chromium is not released outside of the lead, cadmium, chromium control area. Include site preparation, cleanup and clearance procedures. Include occupational and environmental sampling, training and strategy, sampling and analysis strategy and methodology, frequency of sampling, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan. Include a description of arrangements made among contractors on multicontractor worksites to inform affected employees and to clarify responsibilities to control exposures.

[The plan must be developed and signed by a certified Lead Project Designer in the State of [_____]. The plan must include the name and certification number of the person signing the plan.

][In occupied buildings, the plan must also include an occupant protection program that describes the measures that will be taken during the work to[notify and] protect the building occupants.

]1.5.2.3 Occupational and Environmental Assessment Data Report

****

NOTE: Sampling results of previous jobs or initial monitoring during the job determine the requirements for further monitoring and the need to fully implement the control and protective requirements. Some LBP/PWL or MCL work may not require full implementation of the requirements of 29 CFR 1926.62. Based on the experience of the Contractor or the use of a specific process or method for performing the work, the Contractor may be able to provide historic data (previous 12 months) to demonstrate that airborne exposures are controlled below the action level. Such methods or controls must be fully presented in the Lead, Cadmium, Chromium Compliance Plan.

****

If initial monitoring is necessary, submit occupational and environmental sampling results to the Contracting Officer within three working days of collection, signed by the testing laboratory employee performing the analysis, the employee that performed the sampling, and the CP.

[In order to reduce the full implementation of 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 the Contractor must provide documentation. Submit a report that supports the determination to reduce full implementation of the requirements of 29 CFR 1926.62,29 CFR 1926.1126, 29 CFR 1926.1127 and supporting the Lead, Cadmium, Chromium Compliance Plan.

] a. The initial monitoring must represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures per 29 CFR 1926.62,29 CFR 1926.1126, 29 CFR 1926.1127. The data must represent the worker's regular daily exposure to lead, cadmium, chromium for stated work.

b. Submit worker exposure data gathered during the task based trigger operations of 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 with a complete process description. This includes manual demolition, manual scraping, manual sanding, heat gun, power tool cleaning, rivet busting, cleanup of dry expendable abrasives, abrasive blast enclosure removal, abrasive blasting, welding, cutting and torch burning where lead, cadmium and chromium containing coatings are present.

c. The initial assessment must determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the lead, cadmium, chromium compliance plan per 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127.

1.5.2.4 Medical Examinations

Submit pre-work blood lead levels and post-work blood lead levels for all workers performing lead, cadmium, chromium activities during the execution of the work. Initial medical surveillance as required by 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 must be made available to all employees exposed to lead, cadmium, chromium at any time (one day) above the action level. Full medical surveillance must be made available to all employees on an annual basis who are or may be exposed to lead, cadmium and chromium in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127. Adequate records must show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 and 29 CFR 1926.103. Provide medical surveillance to all personnel exposed to lead, cadmium, chromium as indicated in 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127. Maintain complete and accurate medical records of employees for the duration of employment plus 30 years.

1.5.2.5 Training

Train each employee performing work that disturbs lead, cadmium, chromium, who performs LBP/MCL/PWL disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127, 40 CFR 745 and State [_____] and local regulations where appropriate.

1.5.2.6 Respiratory Protection Program

a. Provide each employee required to wear a respirator a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127.

b. Establish and implement a respiratory protection program as required by 29 CFR 1926.103, 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 and 29 CFR 1926.55.

1.5.2.7 Hazard Communication Program

Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.

1.5.2.8 Lead, Cadmium, Chromium Waste Management

****

NOTE: Research local requirements. The EPA has clarified waste requirements where lead-based paint debris generated by contractors in households is excluded from RCRA Subtitle C hazardous waste regulations. Contractors may dispose of LBP-wastes as household wastes subject to applicable State

regulations. Determination of the expected waste materials as hazardous or solid waste for disposal should be performed in conjunction with site work. Some construction waste contains lead at lower concentrations, which may be disposed of at local sanitary landfills or Construction and Demolition (C&D) landfills, which are not approved by EPA.
****

The Lead, Cadmium, Chromium Waste Management Plan must comply with applicable requirements of federal, State, and local hazardous waste regulations and address:

a. Identification and classification of wastes associated with the work.

b. Estimated quantities of wastes to be generated and disposed of.

c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location[and operator] and a 24-hour point of contact. Furnish two copies of [USEPA] [State (in accordance with [_____])][and][local] hazardous waste [permit applications][permits][manifests][and][USEPA Identification numbers].

d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.

e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.

f. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.

g. Work plan and schedule for waste containment, removal and disposal. Proper containment of the waste includes using acceptable waste containers (e.g., 55-gallon drums) as well as proper marking/labeling of the containers. Clean up and containerize wastes daily.

h. Include any process that may alter or treat waste rendering a hazardous waste non hazardous.

i. Unit cost for hazardous waste disposal according to this plan.

1.5.2.9 Environmental, Safety and Health Compliance

****
NOTE: Include applicable State, regional, and local laws, regulations, and statutes. Do careful research since not all State and local laws are similar. Verify with the State or local authorities whether the city, county, State or the USEPA has jurisdiction and whether licensing or certification is required. Also identify the authority or code sponsor and the laws, regulations and statutes cited under paragraph REFERENCES using complete title and number.
****

In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, State, and local authorities regarding lead, cadmium and chromium. Comply with the applicable requirements of the current issue of 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127, EM 385-1-1, ND OPNAVINST 5100.23. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirements apply. The following [local][and][State] laws, ordinances, criteria, rules and regulations regarding removing, handling, storing, transporting, and disposing of lead, cadmium and chromium-contaminated materials apply:

a. [_____]

b. [_____]

c. [_____]

[d. [Licensing][and certification] in the state of [_____] is required.

]1.5.3 Pressure Differential Recordings for Local Exhaust System

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NOTE: When an negative pressure enclosure is not required, delete the requirements for the local exhaust system and pressure differential recording.

****

****

NOTE: Normal practice is to have the Contractor hire one independent Private Qualified Person (the PQP) to perform all required functions. However, some applicable laws forbid this approach and will dictate when the PQP, the GC or both will be required to perform the function involved. However, the Contractor must always hire a PQP.

****

Provide a local exhaust system that creates a negative pressure of at least 0.51 mm 0.02 inches of water relative to the pressure external to the enclosure and operate it continuously, 24-hours a day, until the temporary enclosure of the lead, cadmium, chromium control area is removed. Submit pressure differential recordings for each work day to the [PQP][and][GC] for review and to the Contracting Officer within 24-hours from the end of each work day.

1.5.4 Licenses, Permits and Notifications

****

NOTE: Consult with the customer, district engineering, construction and safety offices and all outside regulatory authorities (EPA, state, county, city) having jurisdiction over any part of the project to determine whether a license or permit is required and who is responsible for submitting required notifications to various agencies. The designer then must make the decision if the required permits are to be obtained by the Contractor or the

Government. If the Contractor is to provide the permits, include this paragraph and choose the appropriate bracketed items. If the Government is to obtain the permits/licenses, delete this entire paragraph.
****

Certify and submit in writing to the [Regional Office of the EPA] [state's environmental protection agency responsible for lead hazard abatement activities] [_____] [and the Contracting Officer] at least [10] [_____] days prior to the commencement of work that [_____] licenses, permits and notifications have been obtained. All associated fees or costs incurred in obtaining the licenses, permits and notifications are included in the contract price.

1.5.5 Occupant Protection Plan

The certified project designer must develop and implement an Occupant Protection Plan describing the measures and management procedures to be taken during lead, cadmium and chromium hazard abatement activities to protect the building occupants/building facilities and the outside environment from exposure to any lead, cadmium and chromium contamination while lead, cadmium and chromium hazard abatement activities are performed.

1.5.6 Pre-Construction Conference

Along with the CP, meet with the Contracting Officer to discuss in detail the Lead, Cadmium, Chromium Waste Management Plan and the Lead, Cadmium, Chromium Compliance Plan, including procedures and precautions for the work.

1.6 EQUIPMENT

1.6.1 Respirators

Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead, cadmium and chromium dust, fume and mist. Respirators must comply with the requirements of 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127.

1.6.2 Special Protective Clothing

Personnel exposed to lead, cadmium, chromiumcontaminated dust must wear proper [disposable] [uncontaminated, reusable] protective whole body clothing, head covering, gloves, eye, and foot coverings as required by 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.

1.6.3 Rental Equipment Notification

If rental equipment is to be used during PWL or MCL handling and disposal, notify the rental agency in writing concerning the intended use of the equipment.

1.6.4 Vacuum Filters

UL 586 labeled HEPA filters.

1.6.5 Equipment for Government Personnel

****

NOTE: Verify the number of sets required with the Contracting Officer.

****

Furnish the Contracting Officer with [two] [_____] complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the lead, cadmium and chromium removal work within the lead, cadmium and chromium controlled area. Personal protective equipment must include disposable whole body covering, including appropriate foot, head, eye, and hand protection. PPE remains the property of the Contractor. The Government will provide respiratory protection for the Contracting Officer.

1.6.6 Abrasive Removal Equipment

The use of powered machine for vibrating, sanding, grinding, or abrasive blasting is prohibited unless equipped with local exhaust ventilation systems equipped with high efficiency particulate air (HEPA) filters.

1.6.7 Negative Air Pressure System

****

NOTE: Negative Air Pressure Systems are typically required only for projects using powered floor sanding or abrasive blasting techniques. Both techniques may have application for historical restoration, but are not typically used as lead, cadmium and chromium hazard abatement techniques. Remove the following two paragraphs if negative air pressure systems are not necessary for the project.

****

1.6.7.1 Minimum Requirements

Do not proceed with work in the area until containment is set up and HEPA filtration systems are in place. The negative air pressure system must meet the requirements of ASSP Z9.2 including approved HEPA filters in accordance with UL 586. Negative air pressure equipment must be equipped with new HEPA filters, and be sufficient to maintain a minimum pressure differential of minus 0.005 kPa 0.02 inch of water column relative to adjacent, unsealed areas. Negative air pressure system minimum requirements are listed as follows:

a. The unit must be capable of delivering its rated volume of air with a clean first stage filter, an intermediate filter and a primary HEPA filter in place.

b. The HEPA filter must be certified as being capable of trapping and retaining mono-disperse particles as small as 0.3 micrometers at a minimum efficiency of 99.97 percent.

c. The unit must be capable of continuing to deliver no less than 70 percent of rated capacity when the HEPA filter is 70 percent full or measures 0.625 kPa 2.5 inches of water static pressure differential on a magnehelic gauge.

d. Equip the unit with a manometer-type negative pressure differential monitor with minor scale division of 0.005 kPa 0.02 inch of water and accuracy within plus or minus 1.0 percent. The manometer must be calibrated daily as recommended by the manufacturer.

e. Equip the unit with a means for the operator to easily interpret the readings in terms of the volumetric flow rate of air per minute moving through the machine at any given moment.

f. Equip the unit with an electronic mechanism that automatically shuts the machine off in the event of a filter breach or absence of a filter.

g. Equip the unit with an audible horn that sounds an alarm when the machine has shut itself off.

h. Equip the unit with an automatic safety mechanism that prevents a worker from improperly inserting the main HEPA filter.

1.6.7.2 Auxiliary Generator

Provide an auxiliary generator with capacity to power a minimum of 50 percent of the negative air machines at any time during the work. When power fails, the generator controls must automatically start the generator and switch the negative air pressure system machines to generator power. The generator must not present a carbon monoxide hazard to workers.

1.6.8 Vacuum Systems

Vacuum systems must be suitably sized for the project, and filters must be capable of trapping and retaining all mono-disperse particles as small as 0.3 micrometers (mean aerodynamic diameter) at a minimum efficiency of 99.97 percent. Properly dispose of used filters that are being replaced.

1.6.9 Heat Blower Guns

Heat blower guns must be flameless, electrical, paint-softener type with controls to limit temperature to 590 degrees C 1,100 degrees F. Heat blower must be (grounded) 120 volts ac, and must be equipped with cone, fan, glass protector and spoon reflector nozzles.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Protection of Existing Work to Remain

Perform work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better as determined by the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Keep materials and equipment needed to complete the project available and on the site. Submit a description of the materials and equipment required; including Safety Data Sheets (SDSs) for material brought onsite to perform the work.

2.1.1 Expendable Supplies

Submit a description of the expendable supplies required.

2.1.1.1 Polyethylene Bags

Disposable bags must be polyethylene plastic and be a minimum of 0.15 mm 6 mils thick (0.1 mm4 mils thick if double bags are used) or any other thick plastic material shown to demonstrate at least equivalent performance; and capable of being made leak-tight. Leak-tight means that solids, liquids or dust cannot escape or spill out.

2.1.1.2 Polyethylene Leak-tight Wrapping

Wrapping used to wrap lead, cadmium, chromium contaminated debris must be polyethylene plastic that is a minimum of 0.15 mm 6 mils thick or any other thick plastic material shown to demonstrate at least equivalent performance.

2.1.1.3 Polyethylene Sheeting

Sheeting must be polyethylene plastic with a minimum thickness of 0.15 mm 6 mil, or any other thick plastic material shown to demonstrate at least equivalent performance; and be provided in the largest sheet size reasonably accommodated by the project to minimize the number of seams. Where the project location constitutes an out of the ordinary potential for fire, or where unusual fire hazards cannot be eliminated, provide flame-resistant polyethylene sheets which conform to the requirements of NFPA 701.

2.1.1.4 Tape and Adhesive Spray

Tape and adhesive must be capable of sealing joints between polyethylene sheets and for attachment of polyethylene sheets to adjacent surfaces. After dry application, tape or adhesive must retain adhesion when exposed to wet conditions, including amended water. Tape must be minimum 50 mm 2 inches wide, industrial strength.

2.1.1.5 Containers

When used, containers must be leak-tight and be labeled in accordance with EPA, DOT and OSHA standards.

2.1.1.6 Chemical Paint Strippers

Chemical paint strippers must not contain methylene chloride and be formulated to prevent stain, discoloration, or raising of the substrate materials.

2.1.1.7 Chemical Paint Stripper Neutralizer

Neutralizers for paint strippers must be compatible with the substrate and suitable for use with the chemical stripper that has been applied to the surface.

2.1.1.8 Detergents and Cleaners

Detergents or cleaning agents must not contain trisodium phosphate and have demonstrated effectiveness in lead, cadmium and chromium control work using cleaning techniques specified by HUD 6780 guidelines.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

3.1.1.1 Notification

a. Notify the Contracting Officer [20] [_____] days prior to the start of any lead, cadmium and chromium work.

[b. Occupant Notification

****

NOTE: Projects in target housing involving improvement, or maintenance (renovation or repair), that disrupt more than 2 square feet of painted surface while being occupied requires occupant notification prior to work.

****

Submit occupant written acknowledgment of the delivery of lead hazard information pamphlet (EPA 747-K-99-001 "Protect Your Family From Lead in Your Home") prior to commencing the renovation work for each affected unit using language provided in 40 CFR 745 Subpart E.

][c. Notification of the Commencement of [LBP] Hazard Abatement

****

NOTE: In some states, notification of lead-based paint hazard abatement work by the contractor must be made prior to work. Research if prior notification is required for the locality where work is conducted.

****

[Submit a copy of the notification of the commencement of[LBP] hazard abatement to [_____] according to the procedures established by [_____].

]]3.1.1.2 Lead, Cadmium, Chromium Control Area

a. Physical Boundary - Provide physical boundaries around the lead, cadmium, chromium control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that lead, cadmium and chromium will not escape outside of the lead, cadmium and chromium control area. Prohibit the general public from accessing the lead, cadmium, chromium control areas.

b. Warning Signs - Provide warning signs at approaches to lead, cadmium, chromium control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs must comply with the requirements of 29 CFR 1926.62.

3.1.1.3 Furnishings

****

NOTE: Verify with the activity furniture or

equipment requirements.
****

[The Government will remove furniture and equipment from the building before lead, cadmium and chromium work begins.

][Furniture [_____] and equipment will remain in the [building][lead, cadmium, chromium control area]. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the Contracting Officer.

][Existing [furniture][and][equipment] is lead, cadmium and chromium contaminated, [decontaminate][dispose of as lead, cadmium, chromium contaminated waste].

]3.1.1.4 Heating, Ventilating and Air Conditioning (HVAC) Systems

Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead, cadmium, chromium control areas. Seal intake and exhaust vents in the lead, cadmium, chromium control area with 0.15 mm 6 mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead, cadmium, chromium control area.[Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead, cadmium, chromium control area.]

3.1.1.5 Local Exhaust System

****
NOTE: When a negative pressure enclosure is not required, delete the requirements for the local exhaust system and pressure differential recording.
****

Provide a local exhaust system in the lead, cadmium, chromium control area in accordance with ASSP Z9.2, 29 CFR 1926.62, 29 CFR 1926.1126 and 29 CFR 1926.1127 that will provide at least [4][_____] air changes per hour inside of the negative pressure enclosure. Local exhaust equipment must be operated 24-hours per day, until the lead, cadmium, chromium control area is removed and must be leak proof to the filter and equipped with HEPA filters. Maintain a minimum pressure differential in the lead, cadmium, chromium control area of minus 0.51 mm 0.02 inch of water column relative to adjacent, unsealed areas. Provide continuous 24-hour per day monitoring of the pressure differential with a pressure differential automatic recording instrument. The building ventilation system must not be used as the local exhaust system for the lead, cadmium, chromium control area. Filters on exhaust equipment must conform to ASSP Z9.2 and UL 586. Terminate the local exhaust system out of doors and remote from any public access or ventilation system intakes.

3.1.1.6 Negative Air Pressure System Containment

****
NOTE: Require containment to be equipped with negative air pressure control equipment specified in paragraph NEGATIVE AIR PRESSURE SYSTEM in PART 2 and operated as specified below if lead, cadmium, chromium hazard control activities require blasting or power sanding techniques to remove lead, cadmium, chromium. Remove this paragraph if not required in

the project.
****

a. Operate the negative air pressure systems to provide at least [4][10][_____] air changes per hour inside the containment. Operate the local exhaust unit equipment continuously until the containment is removed. Smoke test the negative air pressure system for leaks at the beginning of each shift. The certified supervisor is responsible to continuously monitor and keep a pressure differential log with an automatic manometric recording instrument. Notify the Contracting Officer immediately if the pressure differential falls below the prescribed minimum. Submit the continuously monitored pressure differential log, as specified. Do not use the building ventilation system as the local exhaust system. Terminate the local exhaust system out of doors unless the Contracting Officer allows an alternate arrangement. All filters must be new at the beginning of the project and be periodically changed as necessary to maintain specified pressure differential and disposed of as lead, cadmium and chromium contaminated waste.

b. Discontinuing Negative Air Pressure System. Operate the negative air pressure system continuously during abatement activities unless otherwise authorized by the Contracting Officer. At the completion of the project, units must be run until full cleanup has been completed and final clearance testing requirements have been met. Dismantling of the negative air pressure systems must [conform to written decontamination procedures] [be approved by the Contracting Officer] be as presented in the Lead, Cadmium, Chromium Compliance Plan. Seal the HEPA filter machine intakes with polyethylene to prevent environmental contamination.

3.1.1.7 Decontamination Shower Facility

Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127.

3.1.1.8 Eye Wash Station

Provide suitable facilities within the work area for quick drenching or flushing of the eyes where eyes may be exposed to injurious corrosive materials.

3.1.1.9 Mechanical Ventilation System

a. Use adequate ventilation to control personnel exposure to lead, cadmium and chromium in accordance with 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127. To the extent feasible, use local exhaust ventilation or other collection systems, approved by the CP. Evaluate and maintain local exhaust ventilation systems in accordance with 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127.

b. Vent local exhaust outside the building and away from building ventilation intakes or ensure system is connected to HEPA filters.

c. Use locally exhausted, power actuated tools or manual hand tools.

3.1.1.10 Personnel Protection

Personnel must wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead, cadmium, chromium control area. No one will be permitted in the lead, cadmium, chromium control area unless they have been appropriately trained and provided with protective equipment.

3.2 ERECTION

3.2.1 Lead, Cadmium, Chromium Control Area Requirements

****

NOTE: Choose the first paragraph if PWL or MCL will be removed by means that will not create airborne, dust containing lead, cadmium, chromium (such as carefully unfastening sheets containing lead, cadmium, chromium from walls). Choose the second paragraph if removal practice will create airborne, dust containing lead, cadmium, chromium (such as sanding, sawing, grinding, thermal cutting or digging or demolition activities). Select the control method that will ensure efficiency and prevents lead, cadmium, chromium from escaping outside of the lead, cadmium, chromium control area.

****

[Establish a lead, cadmium, chromium control area by completely establishing barriers and physical boundaries around the area or structure where PWL or MCL removal operations will be performed.
]

****

NOTE: The Designer should consider the use of viewing ports for lead, cadmium and chromium control areas under 100 square meters 1,000 square feet to save inspection time.

****

[Full containment - Contain removal operations by the use of[critical barriers][and HEPA filtered exhaust][a negative pressure enclosure system with decontamination facilities and with HEPA filtered exhaust if required by the CP]. For containment areas larger than 100 square meters 1,000 square feet install a minimum of two 450 mm 18 inch square viewing ports. Locate ports to provide a view of the required work from the exterior of the enclosed contaminated area. Glaze ports with laminated safety glass.

]3.3 APPLICATION

3.3.1 Lead, Cadmium, Chromium Work

Perform lead, cadmium, chromium work in accordance with approved Lead, Cadmium, Chromium Compliance Plan. Use procedures and equipment required to limit occupational exposure and environmental contamination with lead, cadmium, chromium when the work is performed in accordance with 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127[or 40 CFR 745], and as specified herein. Dispose of all PWL or MCL and associated waste in compliance with federal, State, and local requirements.

3.3.2 Paint with Lead, Cadmium, Chromium or Material Containing Lead, Cadmium, Chromium Removal

****

NOTE: Use bracketed prohibition on manual and power sanding/grinding of lead, cadmium, chromium surfaces/materials when appropriate. Large scale manual or power sanding/grinding of lead, cadmium, chromium containing surfaces should never be allowed in family housing, child care facilities, administrative buildings, galleys, barracks, due to problems associated with the resulting dust fallout/contamination of crevices and cracks which may retain unseen quantities of lead, cadmium, chromiumcontaminated dust. Use of these techniques for exteriors should be limited because the resulting airborne dust could result in significant contamination of the ground in the immediate vicinity of the facility. Manual or power sanding/grinding of lead, cadmium, chromium containing surfaces may be an acceptable work method only if appropriate engineering controls for personnel/environmental protection are in place.

****

****

NOTE: For commercial/public buildings and industrial buildings, the designer will have to ascertain appropriate procedures, methods and techniques to control lead, cadmium, chromium hazards. The use of enclosure or soil barriers as a control system requires the input of engineering/ architectural experts familiar with these controls. Add additional paragraphs to address unique local or state requirements.

****

[Manual or power sanding or grinding of lead, cadmium, chromium surfaces or materials is not permitted unless tools are equipped with HEPA attachments or wet methods. The dry sanding or grinding of surfaces that contain lead, cadmium, chromium is prohibited.]Provide methodology for removing lead, cadmium, chromium in the Lead, Cadmium, Chromium Compliance Plan. Select lead, cadmium, chromium removal processes to minimize contamination of work areas outside the control area with lead, cadmium, chromium contaminated dust or other lead, cadmium, chromium contaminated debris or waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead, cadmium, chromium. Describe this removal process in the Lead, Cadmium, Chromium Compliance Plan. [_____]

[Avoid [flash rusting][deterioration] of the substrate. Provide surface preparations for painting in accordance with Section 09 90 00 PAINTS AND COATINGS.

]

****

NOTE: Listed below are various types of paint removal techniques. Designer may be required to specify a particular technique in order to limit potential conflicts or problems.

1. Wood, Drywall, Interior Partitions
a. Scraping
b. Heat Stripping
c. Chemical Stripping
d. Power Tool Cleaning (least acceptable)
e. Wet Abrasive Blasting
Chemical stripping should be carefully researched as a removal method for soft wood (e.g., pine or redwood) substrates. The wrong chemical strippers can increase the risk of residual lead, cadmium, chromium contamination in the substrate.
2. Steel and Metal Surfaces (Industrial)
a. Power/Hand Tool Cleaning (least acceptable)
b. Dry Abrasive Blast with Water Ring (Wet "Halo")
c. Wet Abrasive Blast
d. Low Volume High Pressure Water Blast
e. Chemical Stripping
f. Vacuum Blast

The following practices are restricted during lead, cadmium and chromium hazard abatement work on housing per 40 CFR 745: Open flame burning or torching is prohibited; machine sanding or grinding or abrasive blasting on LBP is prohibited unless used with High Efficiency Particulate Air (HEPA) exhaust control; dry scraping in conjunction with heat guns, or around electrical outlets, is permitted if limited to no more than 2 square feet in any one room (20 square feet on exterior surfaces); heat guns must operate at a temperature below 1100 degrees Fahrenheit.

****

****

NOTE: For lead, cadmium and chromium hazard abatement work in housing or child occupied facilities, consult the risk assessment report to select abatement or interim control techniques to be used in target housing. For commercial/public buildings and industrial buildings, the designer will have to ascertain appropriate procedures, methods and techniques to control lead, cadmium and chromium hazards. The use of encapsulation, enclosure, or soil barriers as an abatement/control system requires the input of engineering/ architectural experts familiar with these controls. Encapsulation should not be specified for areas where water damage exists or could easily occur. The designer may need to test the existing substrates to ascertain that encapsulation is feasible at all. Methods listed or taken from the current HUD Guidelines may be considered. Add additional paragraphs to address unique local or state requirements.

****

Provide methodology for lead, cadmium and chromium, LBP/PWL [removal][abatement/control] and processes to minimize contamination of work areas outside the control area with lead, cadmium, chromium contaminated dust or other lead, cadmium, chromium contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead, cadmium, chromium. Describe this lead,, cadmium and chromium, LBP/PWL removal/control process in the Lead, Cadmium, Chromium Compliance Plan. [_____]

3.3.2.1 Paint with Lead, Cadmium, Chromium or Material Containing Lead, Cadmium, Chromium - Indoor Removal

Perform [manual][mechanical] removal[and thermal cutting] in the lead, cadmium, chromium control areas using enclosures, barriers or containments[and powered locally exhausted tools equipped with HEPA filters]. Collect residue and debris for disposal in accordance with federal, State, and local requirements.

3.3.2.2 Paint with Lead, Cadmium, Chromium or Material Containing Lead, Cadmium, Chromium - Outdoor Removal

Perform outdoor removal as indicated in federal, State, and local regulations and in the Lead, Cadmium, Chromium Compliance Plan. The worksite preparation (barriers or containments) must be job dependent and presented in the Lead, Cadmium, Chromium Compliance Plan.

3.3.3 Personnel Exiting Procedures

Whenever personnel exit the lead, cadmium, chromium controlled area, they must perform the following procedures and must not leave the work place wearing any clothing or equipment worn in the control area:

a. Vacuum all clothing before entering the contaminated change room.

b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.

****

NOTE: Showering is the preferred method of personal decontamination. However, extenuating circumstances may prevent the use of a shower at the work site. In that event, choose the alternate selection. Note that the alternate is generally a very expensive method and should be used only when showering at the site is unfeasible.

****

[c. Shower.

][d. Wash hands and face at the site, don appropriate disposable or uncontaminated reusable clothing, move to an appropriate shower facility, shower.

] e. Change to clean clothes prior to leaving the clean clothes storage area.

3.4 FIELD QUALITY CONTROL

3.4.1 Tests

3.4.1.1 Air and Wipe Sampling

Conduct sampling for lead, cadmium, chromium in accordance with

29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 and as specified herein. Air and wipe sampling must be directed or performed by the CP.

a. The CP must be on the job site directing the air and wipe sampling and inspecting the PWL or MCL removal work to ensure that the requirements of the contract have been satisfied during the entire PWL or MCL operation.

b. Collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least twenty-five percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.

c. Submit results of air samples, signed by the CP, within 72-hours after the air samples are taken.

d. Conduct area air sampling daily, on each shift in which lead, cadmium and chromium and lead-based paint removal operations are performed, in areas immediately adjacent to the lead, cadmium and chromium control area. Conduct sufficient area monitoring to ensure unprotected personnel are not exposed at or above 30 micrograms of lead per cubic meter of air or 2.5 micrograms of cadmium/chromium per cubic meter of air. If 30 micrograms of lead per cubic meter of air or 2.5 micrograms of cadmium/chromium per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the Contracting Officer immediately. Determine if condition(s) require any further change in work methods. Resume removal work only after the CP and the Contracting Officer give approval.

****

NOTE: Include the following paragraph for high profile, sensitive work such as present in family housing, child care facilities, administrative buildings, kitchens, barracks. Use the following paragraph along with clearance certification by a third party consultant specified in paragraph CLEARANCE CERTIFICATION to determine if significant contamination was due to the contract work. Surface dust sampling to determine clearance (i.e., that the work has not contaminated surfaces within and adjacent to the control area) should be performed by a third party to reduce a conflict of interest. Samples must be conducted by an individual not paid or employed or otherwise compensated by the lead Contractor. State or local regulations may require third party.

****

[e. Before any work begins,[a third party consultant must] collect and analyze baseline wipe[and soil] samples in accordance with methods defined by federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead, cadmium and chromium disturbance or removal. Provide Initial Sample Results to the Contracting Officer before work begins.
]

****

NOTE: Lead, cadmium, chromium hazard control area

containment adequacy should be checked by surface wipe sampling of floors in all buildings that are or will be occupied. The exceptions being buildings to be demolished or industrial buildings.
****

[f. Surface Wipe Samples - Collect surface wipe samples on floors at a location no greater than 3 m 10 feet outside the lead, cadmium, chromium control area at a frequency of once per day while lead, cadmium, chromium removal work is conducted in occupied buildings. Surface wipe samples or Micro Vacuum surface sample results must meet criteria in paragraph CLEARANCE CERTIFICATION.

]3.4.1.2 Sampling After Removal

After the visual inspection,[conduct soil sampling if bare soil is present during external removal operations and] collect wipe[and soil] samples according to the HUD protocol contained in HUD 6780 to determine the lead, cadmium and chromium content of settled dust in micrograms per square meter foot of surface area[and micrograms per gram (ug/g) parts per million (ppm) for soil].

[3.4.1.3 Testing of Material Containing Lead, Cadmium, Chromium Residue

****
NOTE: Include this paragraph when the residue is questionable with respect to its lead, cadmium, chromium content, otherwise delete.
****

Test residue in accordance with 40 CFR 261 for hazardous waste.

]3.5 CLEANING AND DISPOSAL

3.5.1 Cleanup

Maintain surfaces of the lead, cadmium, chromium control area free of accumulations of dust and debris. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use pressurized air to clean up the area. At the end of each shift and when the lead, cadmium, chromium operation has been completed, clean the controlled area of all visible contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the Lead, Cadmium, Chromium Compliance Plan. Reclean areas showing dust or debris. After visible dust and debris is removed, wet wipe and HEPA vacuum all surfaces in the controlled area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP must then certify in writing that the area has been cleaned of lead, cadmium and chromium contamination before clearance testing.

3.5.1.1 Clearance Certification

****
NOTE: The second paragraph must be used for high profile, sensitive work such as present in family housing, child care facilities, kitchens. For work in administrative buildings or the conversion of industrial lead, cadmium and chromium work areas

(e.g., firing ranges) into non-industrial work areas open for public access, use the third paragraph otherwise delete. For industrial buildings, use visual clearance only. Surface dust sampling to determine clearance (i.e., that the work has not contaminated surfaces within and adjacent to the control area) should be performed by a third party to reduce a conflict of interest.

****

The CP must certify in writing that air samples collected outside the lead, cadmium, chromium control area during paint removal operations are less than 30 micrograms of lead per cubic meter of airand less than 2.5 micrograms of cadmium/chromium per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127; and that there were no visible accumulations of material and dust containing lead, cadmium, chromium left in the work site. Do not remove the lead, cadmium, chromium control area or roped off boundary and warning signs prior to the Contracting Officer's acknowledgement of receipt of the CP certification.

[The third party consultant must certify surface wipe sample results collected inside and outside the work area are[less than 40 micrograms of lead per 0.1 square meter square foot on floors, less than 250 micrograms of lead per 0.1 square meter square foot on interior window sills and less than 400 micrograms of lead per 0.1 square meter square foot on window troughs][not significantly greater than the initial surface loading determined prior to work].

][The third party consultant must certify surface wipe sample or Micro Vacuum surface sample results collected inside and outside the work area are less than 200 micrograms of lead per 0.1 square meter square foot on floors or horizontal surfaces. Micro Vacuum technique should be used on rough or porous surfaces which are difficult to achieve clearance by the wipe sampling methodology.

][Certify surface wipe samples are not significantly greater than the initial surface loading determined prior to work.

][Clear the lead, cadmium, chromium control area in industrial facilities of all visible dust and debris.

][For exterior work, soil samples taken at the exterior of the work site must be used to determine if soil lead, cadmium, chromium levels have increased at a statistically significant level (significant at the 95 percent confidence limit) from the soil lead, cadmium, chromium levels prior to the operation. If soil lead, cadmium, chromium levels either show a statistically significant increase above soil lead, cadmium, chromium levels prior to work or soil lead, cadmium, chromium levels above any applicable federal or state standard for lead, cadmium, chromium in soil, the soil must be remediated.

][For lead, cadmium and chromium-based paint hazard abatement work, surface wipe and soil sampling must be conducted and clearance determinations made according to the work practice standards presented in 40 CFR 745.227.

]3.5.2 Disposal

****

NOTE: Notify the activity that Federal regulations (40 CFR 260-265) require a USEPA generator identification number for use on the Uniform Hazardous Waste Manifest prior to commencement of removal work. A USEPA generator identification number will not be required if it is certain that the work will not generate HW.

****

****

NOTE: Research State, regional, and local laws, regulations, and statutes and revise the specifications accordingly. Proper segregation and handling of waste can significantly reduce the generated volume (and cost) of disposing hazardous wastes.

****

****

NOTE: Research State, regional, and local requirements regarding the recycling of lead, cadmium and chromium wastes. Ensure that other hazardous components are not present. The entire waste stream or discreet portions of the waste may be appropriately packaged and transported for recycling (Consider Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL). If waste is eligible for sanitary landfill or C&D landfill disposal, some of these requirements are not applicable.

****

a. Dispose of material, whether hazardous or non-hazardous in accordance with all laws and provisions and all federal, State or local regulations. Ensure all waste is properly characterized. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

b. Contractor is responsible for segregation of waste. Collect lead, cadmium, chromium contaminated waste, scrap, debris, bags, containers, equipment, and lead, cadmium, chromiumcontaminated clothing that may produce airborne concentrations of lead, cadmium, chromium particles. Label the containers in accordance with 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 and 40 CFR 261, 40 CFR 262 and corresponding state regulations.

c. Dispose of lead, cadmium, chromiumcontaminated material classified as hazardous waste at an [EPA][or][State] approved hazardous waste treatment, storage, or disposal facility off Government property.

d. Accumulate waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon drums or appropriately sized container for smaller volumes. Properly label each drum to identify the type of hazardous material (49 CFR 172). For hazardous waste, the collection container requires marking/labeling in accordance with 40 CFR 262 and corresponding state regulations during the accumulation/collection timeframe. The Contracting Officer or an authorized representative will assign an area for accumulation of waste containers. Coordinate authorized accumulation volumes and time limits with the host installation environmental function.

e. Handle, store, transport, and dispose lead, cadmium, chromium or lead, cadmium, chromium contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.

f. All lead, cadmium, and chromium waste generation, management,and disposal will be coordinated with the host installation environmental function.

3.5.2.1 Disposal Documentation

****

NOTE: Include the following paragraph if the Contractor is to dispose of waste.

****

Coordinate all disposal or off-site shipments of lead, cadmium, and chromium waste with the host installation environmental function. Submit written evidence of TSD approval to demonstrate the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead, cadmium, chromium disposal by the EPA, State or local regulatory agencies. Submit one copy of the completed hazardous waste manifest, signed and dated by the initial transporter in accordance with 40 CFR 262. Provide a certificate that the waste was accepted by the disposal facility.[Provide turn-in documents or weight tickets for non-hazardous waste disposal.]

3.5.2.2 Payment for Hazardous Waste

Payment for disposal of hazardous and non-hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility is received and approved by the Contracting Officer. The manifest must detail and certify the amount of lead, cadmium, chromium containing materials or non-hazardous waste delivered to the treatment or disposal facility.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-02 84 16 (November 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-02 84 16 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 84 16

HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY

11/22

PART 1 GENERAL

PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-02 84 16 (November 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-02 84 16 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 02 84 16

HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY

11/22

****

NOTE: This guide specification covers the requirements for requirements for removal and disposal of polychlorinated biphenyl (PCB) containing lighting ballasts and mercury containing lamps, and the handling of resulting wastes.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Do not use this section if, in addition to ballasts, other PCB removal and disposal is included in the job, but use Section 02 84 33 REMOVAL AND DISPOSAL OF POLYCHLORINATED BIPHENYLS (PCBS) and include the removal and disposal of the ballasts in that section. Also, use Section 02 84 33 where a significant number of ballasts are known to be leaking.

****

PART 1   GENERAL

1.1   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Programs: The Hazardous Waste Permit Program
40 CFR 273	Standards for Universal Waste Management

40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 178	Specifications for Packagings

1.2 REQUIREMENTS

Removal and disposal of PCB containing lighting ballasts and associated mercury-containing lamps. Contractor may encounter leaking PCB ballasts.

1.3 DEFINITIONS

1.3.1 Certified Industrial Hygienist (CIH)

A industrial hygienist hired by the contractor must be certified by the American Board of Industrial Hygiene.

1.3.2 Leak

Leak or leaking means any instance in which a PCB article, PCB container, or PCB equipment has any PCBs on any portion of its external surface.

1.3.3 Lamps

Lamp is defined as the bulb or tube portion of an electric lighting device. A lamp is specifically designed to produce radiant energy, most often in the ultraviolet, visible, and infra-red regions of the electromagnetic spectrum. Examples of common electric lamps include, but are not limited to, fluorescent, high intensity discharge, neon, mercury vapor, high pressure sodium, and metal halide lamps.

1.3.4 Polychlorinated Biphenyls (PCBs)

PCBs as used in this specification mean the same as PCBs, and all related items, as defined in 40 CFR 761, Section 3, Definitions.

1.3.5 Spill

Spill means both intentional and unintentional spills, leaks, and other uncontrolled discharges when the release results in any quantity of PCBs running off or about to run off the external surface of the equipment or other PCB source, as well as the contamination resulting from those releases.

1.3.6 Universal Waste

Universal Waste means any of the following hazardous wastes that are managed under the universal waste requirements 40 CFR 273:

(1) Batteries as described in Sec. 273.2 of this chapter;

(2) Pesticides as described in Sec. 273.3 of this chapter;

(3) Mercury containing equipment as described in Sec. 273.4 of this chapter; and

(4) Lamps as described in Sec. 273.5 of this chapter.

1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

Perform PCB related work in accordance with 40 CFR 761.[Perform mercury-containing lamps storage and transport in accordance with 40 CFR 261, 40 CFR 264, 40 CFR 265, 40 CFR 273.]

1.4.2 Training

Instruction and certification of training of all persons involved in the removal of PCB containing lighting ballasts and mercury-containing lamps is the responsibility of the Certified Industrial Hygienist (CIH). Include in the instruction: The dangers of PCB and mercury exposure, decontamination, safe work practices, and applicable OSHA and EPA regulations. The CIH must review and approve the PCB and Mercury-Containing Lamp Removal Work Plans.

1.4.3 Regulation Documents

Maintain at all times one copy each at the office and one copy each in view at the job site of 29 CFR 1910.1000, 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 265, 40 CFR 268, 40 CFR 270, 40 CFR 273 and of the Contractor removal work plan and disposal plan for PCB and for associated mercury-containing lamps.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Qualifications of CIH; G, [_____]

Training Certification; G, [_____]

PCB and Lamp Removal Work Plan; G, [_____]

PCB and Lamp Disposal Plan; G, [_____]

SD-11 Closeout Submittals

Transporter Certification of notification to EPA of their PCB waste activities and EPA ID numbers; G, [_____]

Certification of Decontamination

Certificate of Disposal and/or recycling. Submit to the Government before application for payment within 30 days of the date that the disposal of the PCB and mercury-containing lamp waste identified on the manifest was completed.

DD Form 1348-1

[Testing Results

]1.6 ENVIRONMENTAL REQUIREMENTS

Use special clothing:

a. Disposable gloves (polyethylene)

b. Eye protection

c. PPE as required by CIH

1.7 SCHEDULING

Notify the Contracting Officer 20 days prior to the start of PCB and mercury-containing lamp removal work.

1.8 QUALITY ASSURANCE

1.8.1 Qualifications of CIH

Submit the name, address, and telephone number of the Industrial Hygienist selected to perform the duties in paragraph CERTIFIED INDUSTRIAL HYGIENIST. Submit training certification that the Industrial Hygienist is certified, including certification number and date of certification or re certification.

1.8.2 PCB and Lamp Removal Work Plan

Submit a job-specific plan within [20] [_____] calendar days after award of contract of the work procedures to be used in the removal, packaging, and storage of PCB-containing lighting ballasts and associated mercury-containing lamps. Include in the plan: Requirements for Personal Protective Equipment (PPE), spill cleanup procedures and equipment, eating, smoking and restroom procedures. The plan must be approved and signed by the Certified Industrial Hygienist. Obtain approval of the plan by the Contracting Officer prior to the start of PCB and/or lamp removal work.

1.8.3 PCB and Lamp Disposal Plan

****

NOTE: If Government disposal of PCB waste is available by the station, then omit this paragraph. Verify that Government disposal is available and make arrangements if so.

****

Submit a PCB and lamp Disposal Plan within [45] [_____] calendar days after award of contract, complying with the applicable requirements of federal, state, and local PCB and Universal waste regulations and address:

a. Estimated quantities of wastes to be generated, disposed of, and recycled.

b. Names and qualifications of each Contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location. Furnish two copies of EPA and state PCB and mercury-containing lamp waste permit applications and EPA identification numbers, as required.

c. Names and qualifications (experience and training) of personnel who will be working on-site with PCB and mercury-containing lamp wastes.

d. Spill prevention, containment, and cleanup contingency measures to be implemented.

e. Work plan and schedule for PCB and mercury-containing lamp waste removal, containment, storage, transportation, disposal and or recycling. Clean up and containerize wastes daily.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 WORK PROCEDURE

Furnish labor, materials, services, and equipment necessary for the removal of PCB containing lighting ballasts, associated mercury-containing fluorescent lamps,[and high intensity discharge (HID) lamps] in accordance with local, state, or federal regulations. Do not expose PCBs to open flames or other high temperature sources since toxic decomposition by-products may be produced. Do not break mercury containing fluorescent lamps or high intensity discharge lamps.

3.1.1 Work Operations

Ensure that work operations or processes involving PCB or PCB-contaminated materials are conducted in accordance with 40 CFR 761, 40 CFR 262 40 CFR 263, and the applicable requirements of this section, including but not limited to:

a. Obtaining suitable PCB and mercury-containing lamp storage sites.

b. Notifying Contracting Officer prior to commencing the operation.

c. Reporting leaks and spills to the Contracting Officer.

d. Cleaning up spills.

e. Inspecting PCB and PCB-contaminated items and waste containers for leaks and forwarding copies of inspection reports to the Contracting Officer.

f. Maintaining inspection, inventory and spill records.

3.2 PCB SPILL CLEANUP REQUIREMENTS

3.2.1 PCB Spills

Immediately report to the Contracting Officer any PCB spills.

3.2.2 PCB Spill Control Area

Rope off an area around the edges of a PCB leak or spill and post a "PCB Spill Authorized Personnel Only" caution sign. Immediately transfer leaking items to a drip pan or other container.

3.2.3 PCB Spill Cleanup

40 CFR 761, subpart G. Initiate cleanup of spills as soon as possible, but no later than 24 hours of its discovery. Mop up the liquid with rags or other conventional absorbent. Properly contain and dispose of spent absorbent as solid PCB waste.

3.2.4 Records and Certification

Document the cleanup with records of decontamination in accordance with 40 CFR 761, Section 125, Requirements for PCB Spill Cleanup. Provide test results of cleanup and certification of decontamination.

3.3 REMOVAL

3.3.1 Ballasts

****

NOTE: Ballasts produced after 1998 do not contain PCBs.

If there are less than 1600 lighting ballasts to be removed and disposed, delete the bracketed sentence.

****

As ballast are removed from the lighting fixture, inspect label on ballast. Ballasts without a "No PCB" label must be assumed to contain PCBs and containerized and disposed of as required under paragraphs STORAGE FOR DISPOSAL and DISPOSAL. If there are less than 1600 "No PCB" labeled lighting ballasts, dispose of them as normal demolition debris.[If there are more than 1600 "No PCB" labeled ballasts, establish whether the "No PCB" labeled ballasts contain diethylhexyl phthalate (DEHP) either by test or by checking with the ballast manufacturer indicated on the label. Submit testing results and/or written confirmation from the manufacturer to the Contracting Officer. If the ballasts do not contain DEHP, dispose of them as normal construction debris. If they do contain DEHP, dispose of them as hazardous material in accordance with Federal, State, and local regulations. As a basis of bid assume ballasts with "No PCB" labels do not contain DEHP and may disposed of as normal construction debris. If 1600 or more DEHP ballasts are disposed of in a 24 hour period, notify the National Response Team at 800-424-8802.]

3.3.2 Lighting Lamps

Remove lighting tubes/lamps from the lighting fixture and carefully place (unbroken) into appropriate containers (original transport boxes or equivalent). In the event of a lighting tube/lamp breaking, sweep and place waste in double plastic taped bags and dispose of as universal waste as specified herein.

3.4 STORAGE FOR DISPOSAL

3.4.1 Storage Containers for PCBs

49 CFR 178. Store PCB in containers approved by DOT for PCB.

3.4.2 Storage Containers for lamps

Store mercury containing lamps in appropriate DOT containers. Store and label boxes for transport in accordance with 40 CFR 273.

3.4.3 Labeling of Waste Containers

Label with the following:

a. Date the item was placed in storage and the name of the cognizant activity/building.

b. "Caution Contains PCB," conforming to 40 CFR 761, CFR Subpart C. Affix labels to PCB waste containers.

c. Label mercury-containing lamp waste in accordance with 40 CFR 273. Affix labels to all lighting waste containers.

3.5 DISPOSAL

Dispose of off Government property in accordance with EPA, DOT, and local regulations at a permitted site.

3.5.1 Identification Number

Federal regulations 40 CFR 761, and 40 CFR 263 require that generators, transporters, commercial storers, and disposers of PCB waste posses U.S. EPA identification numbers. Verify that the activity has a U.S. EPA generator identification number for use on the Uniform Hazardous Waste manifest. If not, advise the activity that it must file and obtain an I.D. number with EPA prior to commencement of removal work. For mercury containing lamp removal, Federal regulations 40 CFR 273 require that large quantity handlers of Universal waste (LQHUW) must provide notification of universal waste management to the appropriate EPA Region (or state director in authorized states), obtain an EPA identification number, and retain for three years records of off-site shipments of universal waste. Verify that the activity has a U.S. EPA generator identification number for use on the Universal Waste manifest. If not, advise the activity that it must file and obtain an I.D. number with EPA prior to commencement of removal work.

3.5.2 Transporter Certification

****

NOTE: Choose this option and subparagraphs if the Contractor is to dispose of PCB waste.

****

Comply with disposal and transportation requirements outlined in 40 CFR 761 and 40 CFR 263. Before transporting the PCB waste, sign and date the manifest acknowledging acceptance of the PCB waste from the Government. Return a signed copy to the Government before leaving the job site. Ensure that the manifest accompanies the PCB waste at all times. Submit transporter certification of notification to EPA of their PCB waste activities (EPA Form 7710-53).

3.5.2.1 Certificate of Disposal and/or Recycling

40 CFR 761. Include in the certificate for the PCBs and PCB items disposed:

a. The identity of the disposal and or recycling facility, by name, address, and EPA identification number.

b. The identity of the PCB waste affected by the Certificate of Disposal including reference to the manifest number for the shipment.

c. A statement certifying the fact of disposal and or recycling of the identified PCB waste, including the date(s) of disposal, and identifying the disposal process used.

d. A certification as defined in 40 CFR 761.

3.5.3 Disposal by the Government

****

NOTE: Choose this option and subparagraphs if PCB waste transportation and disposal has been arranged with PWD/PWC and PCB waste is to be delivered to suitable storage site. Verify procedures with PWD/PWC. Omit paragraph when the Government will pick up PCB waste at the project site.

****

Comply with disposal and transportation requirements outlined in 40 CFR 761 and 40 CFR 263. Coordinate delivery of PCBs on-site with local Environmental for subsequent disposal on Defense Logistics Agency Disposition Services (DLA DS) contracts. If the primary [_____] site is filled to capacity, contact the Contracting Officer. The transport distance to any storage site will not exceed the distance between the project site and the DLA DS storage site at [_____].

3.5.3.1 [Delivery] [Government Pick Up]

****

NOTE: Choose the option for Government pick up if arrangements have been made for the Government to pick up the PCB waste at the project site. This will be required when DLA DS does not have a suitable storage site and the PCB waste must be picked up by the Government's PCB disposal contractor.

****

Contact DLA DS at least 5 working days in advance to make arrangements for [delivery of PCB to the storage site.] [pick up of PCB waste by the Government.] Phone [_____] or write to:

Defense Logistics Agency Disposition

[_____]

[_____]

3.5.3.2 DD Form 1348-1

Prepare DD Form 1348-1 Turn-in Document (TID), which will accompany the PCB to the storage site. Ensure that a responsible person from the activity that owns the PCB signs the DD Form 1348-1.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 84 33 (November 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-02 84 33 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 84 33

REMOVAL AND DISPOSAL OF POLYCHLORINATED BIPHENYLS (PCBs)

11/22

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-02 84 33 (November 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-02 84 33 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 02 84 33

REMOVAL AND DISPOSAL OF POLYCHLORINATED BIPHENYLS (PCBs)

11/22

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NOTE: This guide specification covers the requirements for the removal and disposal of polychlorinated biphenyls (PCBs) and the handling of PCB containing materials.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification is intended for use in projects where PCBs or materials containing PCB at concentrations of 50 parts per million (ppm) and above are to be removed and disposed of.

****

****

NOTE: A generator of PCB wastes who relinquishes control over the wastes by transporting, or offering for transport by his own vehicle or by a vehicle owned by another person, or relinquishing for commercial off-site storage or off-site disposal must prepare a manifest on EPA Form 8700-22 in accordance with 40 CFR 761, Part 207. The generator must specify on the manifest:

1. For each bulk load of PCBs, the identity of the PCB waste, the earliest date of removal from service for disposal, and the weight in kilograms of the PCB waste.

2. For each PCB Article Container or PCB Container, the unique identifying number, type of PCB waste (e.g., soil, debris, small capacitors), earliest date of removal from service for disposal, and weight in kilograms of the PCB waste contained.

3. For each PCB Article not in a PCB Container or PCB Article Container, the serial number if available, or other identification if there is no serial number, the date of removal from service for disposal, and weight in kilograms of the PCB waste in each PCB Article.

4. One off-site commercial storage or disposal facility approved for the commercial storage or disposal of the PCBs and PCB Items described on the manifest.

It is recommended that 40 CFR 761, Subpart K be read prior to the removal of PCB waste. Note: Contractor will not accept PCB waste for storage or disposal unless it is accompanied by a signed manifest by the generator.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.145	Specifications for Accident Prevention Signs and Tags
29 CFR 1910.1000	Air Contaminants
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 174	Carriage by Rail
49 CFR 175	Carriage by Aircraft
49 CFR 176	Carriage by Vessel
49 CFR 177	Carriage by Public Highway
49 CFR 178	Specifications for Packagings
49 CFR 179	Specifications for Tank Cars

1.2 REQUIREMENTS

The work includes the removal and disposal of [_____]. Perform work in accordance with 40 CFR 761 and the requirements specified herein.

1.3 DEFINITIONS

1.3.1 Leak

Leak or leaking means any instance in which a PCB Article, PCB Container, or PCB Equipment has any PCBs on any portion of its external surface.

1.3.2 PCBs

PCBs as used in this specification mean the same as PCBs, PCB Article, PCB Article Container, PCB Container, PCB Equipment, PCB Item, PCB Transformer, PCB-Contaminated Electrical Equipment, as defined in 40 CFR 761, Section 3, Definitions.

1.3.3 Spill

Spill means both intentional and unintentional spills, leaks, and other uncontrolled discharges when the release results in any quantity of PCBs running off or about to run off the external surface of the equipment or other PCB source, as well as the contamination resulting from those releases.

1.4 QUALITY ASSURANCE

1.4.1 Training

Instruct employees on the dangers of PCB exposure, on respirator use, decontamination, and applicable OSHA and EPA regulations.

1.4.2 Certified Industrial Hygienist (CIH)

Obtain the services of an industrial hygienist certified by the American Board of Industrial Hygiene to certify training, review and approve the PCB removal plan, including determination of the need for personnel protective equipment (PPE) in performing PCB removal work.

1.4.3 Regulation Documents

Maintain at all times one copy each at the office and one copy each in view at the job site 29 CFR 1910.1000, 40 CFR 761, and Contractor work practices for removal, storage and disposal of PCBs.

1.4.4 Surveillance Personnel

Surveillance personnel may enter PCB control areas for brief periods of time provided they wear disposable polyethylene gloves and disposal polyethylene foot covers, as a minimum. Additional protective equipment may be required if respiratory hazard is involved or if skin contact with PCB is involved.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

PCB Removal Work Plan

PCB Disposal Plan

SD-07 Certificates

Training certification

Qualifications of CIH

Notification

Transporter Certification of notification to EPA of their PCB waste activities and EPA ID numbers

Certification of Decontamination for PCB Spill

Post Cleanup Sampling Data

Certificate of Disposal

1.6 EQUIPMENT

1.6.1 Special Clothing

Work clothes consist of PPE as required by OSHA regulations, including, but not limited to the following:

a. Disposable coveralls

b. Gloves (Disposable rubber gloves may be worn under these)

c. Disposable foot covers (polyethylene)

d. Chemical safety goggles

e. Half mask cartridge respirator.

1.6.2 Special Clothing for Government Personnel

Provide PPE specified in paragraph SPECIAL CLOTHING to the Contracting Officer as required for inspection of the work.

1.6.3 PCB Spill Kit

Assemble a spill kit to include the following items:

ITEM	MINIMUM QUANTITY
1. Disposable gloves (polyethylene)	6 prs
2. Gloves with a high degree of impermeability to PCB	6 prs
3. Disposable coveralls with permeation resistance to PCB	4 ea
4. Chemical safety goggles	2 ea
5. Disposable foot covers (polyethylene)	6 prs
6. PCB Caution Sign: "PCB Spill--Authorized Personnel Only"	2 ea
7. Banner guard or equivalent banner material	30 m 100 feet
8. Absorbent material	5 bags
9. Blue polyethylene waste bags	5 ea
10. Cloth backed tape	1 roll
11. Area access logs, blank	10 ea
12. Brattice cloth, 2 m x 2 m 6' x 6'	1 piece
13. Rags	20 ea
14. Ball point pens	20 ea
15. Herculite, 1.5 m x 1.5 m and 3 m x 3 m 4' x 4' and 8' x 8'	2 ea and 1 ea
16. Blank metal signs and grease pencils	2 ea
17. Waste containers 208 liters 55 gallon drum, may be used as container for kit	[1] [_____] ea

1.7 QUALITY ASSURANCE

1.7.1 Training Certification

Submit certificates, prior to the start of work but after the main abatement submittals, signed and dated by the CIH and by each employee stating that the employee has received training. Organize certificates by individual worker, not grouped by type of certificates.

1.7.2 Qualifications of CIH

Submit the name, address, and telephone number of the Industrial Hygienist selected to perform the duties in paragraph CERTIFIED INDUSTRIAL HYGIENIST. Submit proper documentation that the Industrial Hygienist is certified, including certification number and date of certification/recertification.

1.7.3 PCB Removal Work Plan

****

NOTE: Edit removal plan requirements to suit the project. Modify or delete decon and change rooms, showers, and ventilation. Delete air sampling requirements except for work at elevated temperatures sufficient to vaporize PCB or for work involving PCB contaminated dust or particulate generation such as grinding, sawing, or sweeping.

****

Submit a detailed job-specific plan of the work procedures to be used in the removal of PCB-containing materials, not to be combined with other hazardous abatement plans. Provide a Table of Contents for each abatement submittal which follows the sequence of requirements in the contract. Include in the plan a sketch showing the location, size, and details of PCB control areas[, location and details of decontamination rooms, change rooms, shower facilities, and mechanical ventilation system]. Include in the plan, eating, drinking, smoking and restroom procedures, interface of trades, sequencing of PCB related work, PCB disposal plan, respirators, protective equipment, and a detailed description of the method of containment of the operation to ensure that PCB contamination is not spread or carried outside of the control area.[Include provisions to ensure that airborne PCB concentrations of 0.50 milligrams per cubic meter 3.10 E-08 pound per cubic feet of air are not exceeded outside of the PCB control area. Include air sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of air monitoring personnel in the air sampling portion of the plan.] Obtain approval of the plan prior to the start of PCB removal work.

1.7.4 PCB Disposal Plan

****

NOTE: Delete this paragraph if the Government is to dispose of PCB waste. Verify that Government disposal is available and make arrangements if so.

****

Submit a PCB Disposal Plan within 45 calendar days after award of contract for Contracting Officer's approval. Comply with applicable requirements of Federal, State, and local PCB waste regulations and address:

a. Identification of PCB wastes associated with the work.

b. Estimated quantities of wastes to be generated and disposed of.

c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and a 24-hour point of contact. Furnish two copies of [EPA] [State] [and] [local] PCB waste [permit applications] [permits] [and]

[EPA Identification numbers].

d. Names and qualifications (experience and training) of personnel who will be working on-site with PCB wastes.

e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.

f. Spill prevention, containment, and cleanup contingency measures to be implemented.

g. Work plan and schedule for PCB waste containment, removal and disposal. Clean up and containerize wastes daily.

1.7.5 Notification

Notify the Contracting Officer 20 days prior to the start of PCB removal work.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Decontamination Room, Clean Room and Shower Facilities

****

NOTE: Include this paragraph only if work involves cleanup of large PCB spills or if airborne contamination exists. Consult cognizant Industrial Hygienist for recommendations.

****

a. Provide material and labor for construction of a decontamination room, a clean room, and shower facilities. Provide rooms with doors and attach to the exit ways of PCB work areas. Provide rooms of sufficient size to accommodate the Contractor's operation within.[Existing facilities with water closets, urinals, wash basins and showers may be used if available.][Provide portable toilet and shower facilities. Locate shower facilities between the clean room and decontamination room.] Provide separate clothing lockers or containers in each room to prevent contamination of street and work clothes.

b. Remove PCB-contaminated PPE in the decontamination room before proceeding to showers. Workers must shower before lunch and at the end of each day's work. Hot water, towels, soap, and hygienic conditions are the responsibility of the Contractor.

3.1.2 PCB Control Area

Isolate PCB control area by physical boundaries to prevent unauthorized entry of personnel. Food, drink and smoking materials are not permitted in areas where PCBs are handled or PCB items are stored.

3.1.3 Personnel Protection

Workers must wear and use PPE, as recommended by the Industrial Hygienist, upon entering a PCB control area. If PPE is not required per the CIH, specify in the PCB removal work plan.

3.1.4 Footwear

Work footwear remains inside work area until completion of the job.

3.1.5 Permissible Exposure Limits (PEL)

PEL for PCBs is 0.5 mg/m3 3.1 E-08 lb/cubic foot on an 8-hour time weighted average basis.

3.1.6 Special Hazards

a. Do not expose PCBs to open flames or other high temperature sources since toxic decomposition by-products may be produced.

b. Do not heat PCBs to temperatures of 55 degrees C 135 degrees F or higher without Contracting Officer's concurrence.

3.1.7 PCB Caution Label

40 CFR 761, Subpart C. Affix labels to PCB waste containers and other PCB-contaminated items. Provide label with sufficient print size to be clearly legible, with bold print on a contrasting background, displaying the following: CAUTION: Contains PCBs (Polychlorinated Biphenyls).

3.1.8 PCB Caution Sign

29 CFR 1910.145. Provide signs at approaches to PCB control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area.

3.2 WORK PROCEDURE

Furnish labor, materials, services, and equipment necessary for the complete removal of PCBs located at the site as indicated or specified in accordance with local, State, or Federal regulations. Package and mark PCB as required by EPA and DOT regulations and dispose of off Government property in accordance with EPA, DOT, and local regulations at a permitted site.

3.2.1 No Smoking

Smoking is not permitted within 15 m 50 feet of the PCB control area. Provide "No Smoking" signs as directed by the Contracting Officer.

3.2.2 Work Operations

Ensure that work operations or processes involving PCB or PCB-contaminated materials are conducted in accordance with 40 CFR 761 and the applicable requirements of this section, including but not limited to:

a. Obtaining advance approval of PCB storage sites.

b. Notifying Contracting Officer prior to commencing the operation.

c. Reporting leaks and spills to the Contracting Officer.

d. Cleaning up spills.

e. Maintaining an access log of employees working in a PCB control area and providing a copy to the Contracting Officer upon completion of the operation.

f. Inspecting PCB and PCB-contaminated items and waste containers for leaks and forwarding copies of inspection reports to the Contracting Officer.

g. Maintaining a spill kit as specified in paragraph PCB SPILL KIT.

h. Maintaining inspection, inventory and spill records.

3.3 PCB TRANSFORMERS

3.3.1 Draining of Transformer Liquid

Perform work in accordance with 49 CFR 171, 49 CFR 172, 49 CFR 173, 49 CFR 174, 49 CFR 175, 49 CFR 176, 49 CFR 177, 49 CFR 178, and 49 CFR 179, Subchapter C and as specified herein. Drain the transformer, switches, and regulators of free flowing liquid prior to transportation. Place the drained liquids in DoT Spec drums. The drums must not contain more than 190 liters 50 gallons of oil. If the equipment cannot be drained, then place it in DoT Spec drums. DoT drum specifications must meet UN 1A1/Y1.6 (steel drum) or UN 1H1/Y1.6 (plastic drum).

****

NOTE: Choose this option and subparagraphs if the Contractor is to dispose of PCB waste.

****

3.3.2 Markings

Provide drums and drained PCB-contaminated electrical equipment with caution label markings as specified in paragraph PCB CAUTION LABEL.

****

NOTE: Choose this option and subparagraphs if PCB waste transportation and disposal has been arranged with PWD/PWC (Defense Logistics Agency Disposition Services (DLA DS)).

****

3.3.3 Laboratory Analysis

Provide all transformers with a laboratory analysis for turn-in. DLA DS prefers a gas chromatograph test. The only two exceptions to this rule are:

a. The transformer is hermetically sealed (solder sealed or fusion sealed. No access ports or openings).

b. The name plate states that the transformer contains Pyranol, Interteen, etc.

Attach a copy of the lab analysis to both the DD 1348-1 and the transformer itself.

3.3.4 Markings

3.3.4.1 Transformers, Less Than 50 ppm

Add absorbent material to absorb residue oil remaining after draining. Write the date drained on the transformer. Turn in transformers to DLA DS.

3.3.4.2 Transformers, 50-499 ppm

Same procedure as transformers in the less than 50 ppm range.

3.3.4.3 Transformers, Greater Than 500 ppm

Stencil date drained on the transformer. Turn in transformer to DLA DS.

3.3.4.4 Drums

Stencil on DOT-approved 208 liter 55 gallon drums containing PCB liquid the following:

a. ppm

b. Date drum filled

c. Serial number of transformer liquid came from

d. National Stock Number

    (1) "9999-00-OIL" for <50 ppm

    (2) "9999-00-CONPCB" for 50-499 ppm

    (3) "9999-00-PCBOIL" for >500 ppm

Do not mix different ppms in the same drum. Drums must have a 50 mm 2 inch ullage space from the top of the drum.

3.4 PCB REMOVAL

Select PCB removal procedure to minimize contamination of work areas with PCB or other PCB-contaminated debris/waste. Handle PCBs such that no skin contact occurs. PCB removal process should be described in the work plan.

3.4.1 Confined Spaces

As feasible, do not carry out PCB handling operations in confined spaces. A confined space means a space having limited means of egress and inadequate cross ventilation.

3.4.2 Control Area

Establish a PCB control area around the PCB item as specified in paragraph PCB CONTROL AREA. Only personnel briefed on the elements in the paragraph TRAINING and on the handling precautions are allowed into the area.

3.4.3 Exhaust Ventilation

If used, discharge exhaust ventilation for PCB operations to the outside and away from personnel.

3.4.4 Temperatures

As feasible, handle PCBs at ambient temperatures and not at elevated temperatures.

3.4.5 Solvent Cleaning

Clean contaminated tools, containers, etc., after use by rinsing three times with an appropriate solvent or by wiping down three times with a solvent wetted rag. Suggested solvents are Stoddard solvent or hexane.

3.4.6 Drip Pans

Drip pans are required under portable PCB transformers and rectifiers in use or stored for use. Provide the pans with a containment volume of at least one and one-half times the internal volume of PCBs in the item.

3.4.7 Evacuation Procedures

Provide written procedures for evacuation of injured workers. Do not delay aid for a seriously injured worker for reasons of decontamination.

3.5 PCB SPILL CLEANUP REQUIREMENTS

3.5.1 PCB Spills

Immediately report to the Contracting Officer any PCB spills on the ground or in the water, PCB spills in drip pans, or PCB leaks.

3.5.2 PCB Spill Control Area

Rope off an area around the edges of a PCB leak or spill and post a "PCB Spill Authorized Personnel Only" caution sign. Immediately transfer leaking items to a drip pan or other container.

3.5.3 PCB Spill Cleanup

40 CFR 761, Subpart G. Initiate cleanup of spills as soon as possible, but no later than 48 hours of its discovery.[To clean up spills, personnel must wear the PPE prescribed in paragraph SPECIAL CLOTHING of this section.] If misting, elevated temperatures or open flames are present, or if the spill is situated in a confined space, notify the Contracting Officer. Mop up the liquid with rags or other conventional absorbent. Properly contain and dispose of spent absorbent as solid PCB waste.

3.5.4 Records and Certification

Document the cleanup with records of decontamination in accordance with 40 CFR 761, Section 125, Requirements for PCB Spill Cleanup. Provide certification of decontamination.

3.5.5 Sampling Requirements

Perform post cleanup sampling as required by 40 CFR 761, Section 130, Sampling Requirements. Do not remove boundaries of the PCB control area until site is determined satisfactorily clean by the Contracting Officer.

3.6 STORAGE FOR DISPOSAL

3.6.1 Storage Containers for PCBs

49 CFR 178. Store liquid PCBs in Department of Transportation (DOT) Specification 17E containers. Store nonliquid PCB mixtures, articles, or equipment in DOT Specification 5, 5B, or 17C containers with removable heads.

3.6.2 Waste Containers

Label with the following:

a. "Solid (or Liquid) Waste Polychlorinated Biphenyls"

b. The PCB Caution Label, paragraph PCB CAUTION LABEL

c. The date the item was placed in storage and the name of the cognizant activity/building.

3.6.3 PCB Articles and PCB-Contaminated Items

Label with items b. through c. above.

3.6.4 Approval of Storage Site

Obtain in advance Contracting Officer approval using the following criteria without exception.

a. Adequate roof and walls to prevent rainwater from reaching the stored PCBs.

b. An adequate floor which has continuous curbing with a minimum 150 mm 6 inch high curb. Such floor and curbing must provide a containment volume equal to at least two times the internal volume of the largest PCB article or PCB container stored therein or 25 percent of the total internal volume of all PCB equipment or containers stored therein, whichever is greater.

c. No drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from the curbed area.

d. Floors and curbing constructed of continuous smooth and impervious materials such as portland cement, concrete or steel to prevent or minimize penetrations of PCBs.

e. Not located at a site which is below the 100-year flood water elevation.

f. Post each storage site with the PCB Caution Sign, paragraph PCB CAUTION SIGN.

3.7 CLEANUP

Maintain surfaces of the PCB control area free of accumulations of PCBs. Restrict the spread of dust and debris; keep waste from being distributed over work area.

Do not remove the PCB control area and warning signs prior to the Contracting Officer's approval. Reclean areas showing residual PCBs.

3.8   DISPOSAL

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NOTE: Federal regulations (40 CFR 761) require that generators, transporters, commercial storers, and disposers of PCB waste possess U.S. EPA identification numbers. Verify that the activity has a U.S. EPA generator identification number for use on the Uniform Hazardous Waste Manifest. If not, the activity must file and obtain an I.D. number with EPA prior to commencement of removal work.

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NOTE: Choose this option and subparagraphs if the Contractor is to dispose of PCB waste.

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NOTE: Research State, regional, and local laws, regulations, and statutes.

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Comply with disposal requirements and procedures outlined in 40 CFR 761. Do not accept PCB waste unless it is accompanied by a manifest signed by the Government. Before transporting the PCB waste, sign and date the manifest acknowledging acceptance of the PCB waste from the Government. Return a signed copy to the Government before leaving the job site. Ensure that the manifest accompanies the PCB waste at all times. Submit transporter certification of notification to EPA of their PCB waste activities.

3.8.1   Certificate of Disposal

40 CFR 761. Submit to the Government within 30 days of the date that the disposal of the PCB waste identified on the manifest was completed. Include in the certificate for the PCBs and PCB items disposed:

a. The identity of the disposal facility, by name, address, and EPA identification number.

b. The identity of the PCB waste affected by the Certificate of Disposal including reference to the manifest number for the shipment.

c. A statement certifying the fact of disposal of the identified PCB waste, including the date(s) of disposal, and identifying the disposal process used.

d. A certification as defined in 40 CFR 761, Section 3.

3.8.1.1   Payment Upon Furnishing Certificate of Disposal of PCBs

Payment will not be made until the certificate of disposal has been furnished to the Contracting Officer.

3.8.2 Disposal by the Government

****

NOTE: Choose this option and subparagraphs if PCB waste transportation and disposal has been arranged with PWD/PWC and PCB waste is to be delivered to suitable storage site. Verify procedures with PWD/PWC. Omit paragraph when the Government will pick up PCB waste at the project site.

****

Coordinate delivery of PCBs on-site with local Environmental for subsequent disposal on DLA DS contracts. If the primary [_____] site is filled to capacity, contact the Public Works Center Hazardous Waste Branch Environmental Engineer at [_____] to determine an alternate storage site. The transport distance to any storage site must not exceed the distance between the project site and the DLA DS storage site at [_____].

3.8.2.1 [Delivery] [Government Pick Up]

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NOTE: Choose the option for Government pick up if arrangements have been made for the Government to pick up the PCB waste at the project site. This will be required when DLA DS does not have a suitable storage site and the PCB waste must be picked up by the Government's PCB disposal contractor.

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Contact DRMO at least 5 working days in advance to make arrangements for [delivery of the PCBs to the storage site.] [pick up of PCB waste by the Government.] Phone: [_____] or write to:

Defense Reutilization and Marketing Office

[_____]

[_____]

3.8.2.2 DD Form 1348-1

Prepare DD Form 1348-1 Turn-in Document (TID), which will accompany the PCBs to the storage site. Ensure that a responsible person from the activity that owns the PCBs signs the DD Form 1348-1.

3.8.2.3 Payment Upon Furnishing DD Form 1348-1

Payment will not be made until a completed DD Form 1348-1 has been furnished to the Contracting Officer.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-02 85 00 (November 2018)**
Change 1 - 05/22

Preparing Activity: NAVFAC **Superseding**
UFGS-02 85 00.00 20 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 02 - EXISTING CONDITIONS

SECTION 02 85 00

MOLD REMEDIATION

11/18, CHG 1: 05/22

PART 1 GENERAL

ATTACHMENTS:

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-02 85 00 (November 2018)**
Change 1 - 05/22

Preparing Activity: NAVFAC **Superseding**
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SECTION 02 85 00

MOLD REMEDIATION
11/18, CHG 1: 05/22

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NOTE: This section covers the requirements for the demolition, cleaning, removal, and disposal of mold contaminated materials.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: The Contracting Officer shall furnish the Contractor, in the contract documents, an initial Microbial Assessment Survey with containment categories and remediation methods specified for each work area and material within the work area.

The Contracting Officer's initial Microbial Assessment Survey specified below shall be furnished and certified by a qualified assessor authorized by the Contracting Officer to do such work. The initial survey shall be included in the solicitation documents at the end of this specification section.

The Contracting Officer shall ensure that in the initial survey a cost analysis that identifies the potential for replacement of the contaminated items versus remediation is provided. This information shall not be shared with the contractor.

The Contracting Officer must require that the microbial assessor provide documentation proving that the assessor meets at least one of the following criteria:

1. Bachelor's degree from an accredited university or college with a major in engineering, architecture, building construction, occupational health, microbiology, occupational safety, or a related natural or physical science. Additionally, two years experience in conducting microbial investigations is required.

2. Associates degree from an accredited university or college with a concentration in environmental, natural or physical sciences. Additionally, four years experience in conducting microbial investigations is required.

3. Certification as an industrial hygienist (CIH) as certified by the American Board of Industrial Hygienists, safety professional (CSP) as certified by the Board of Certified Safety Professionals or engineer (PE). Additionally, one year experience in conducting microbial investigations is required.

4. Certification by the American Council for Accredited Certification (ACAC) as a Council-Certified Indoor Environmental Consultant (CIEC), Council-Certified Indoor Environmentalist (CIE), Council-Certified Microbial Consultant (CMC), Council-Certified Microbial Investigator (CMI), Council-Certified Residential Mold Inspector (CRMI), Council-Certified Microbial Remediation Supervisor (CMRS) or Council-Certified Microbial Remediator (CMR).

The procedures detailed in this specification are intended to be used for mold remediation projects in buildings occupied by the general population. This specification section may be a starting point for a project specification covering the requirements for removal of mold contaminated materials in facilities where sensitive populations will re-occupy the facility after remediation. Designer/Specifier will consult with the customer to determine if sensitive populations are present in the facility.

Sensitive populations as used here include those with health deficiencies such as people with immune deficiencies. Facilities where they are found include hospital wings and medical clinics.

Children in day care centers or senior citizens in nursing homes are also examples of sensitive populations.

For application to such sensitive facilities, the requirements for clearance and verification of removal of mold contaminated materials must meet the more stringent sampling requirements of Appendix B.

Prior to completing these specifications for facilities with sensitive populations, designer/specifier should consult with doctors, infection control, and risk management staff, Government Industrial Hygienist and Occupational, and Environmental Medicine Physician from the supporting Military Treatment Facility (MTF) familiar with or responsible for operation of the facilities.

Information regarding the types of mold found growing in the spaces may be used by the medical staff to determine the level of risk of the population, and help determine the requirements for verification of the remediation project.

Review and repair, if necessary, of HVAC and Building Envelope systems to prevent moisture incursions which could create conditions suitable for future mold growth must be included as part of any mold remediation project, but are not included as part of this specification.

The following information shall be shown on the project drawings:

The project drawings shall clearly show the location and extent of mold contamination and the materials to be removed.

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NOTE: The Designer should include unit price items to address mold remediation. Include unit price items for removal and cleaning (e.g., drywall removal, ceiling tile removal, carpet removal, non-porous surface cleaning, semi-porous surface cleaning). Estimate the quantity and specify as unit price items in Section 00 21 13, INSTRUCTIONS TO BIDDERS or Section 01 20 00 Price and Payment Procedures per standard practice of the activity preparing the contract.

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NOTE: The work may involve a historic property. The designer must coordinate review of the proposed work with the appropriate cultural resources manager (CRM) and cultural resource laws and regulations, as part of the environmental review and permitting

process. Consultation with stakeholders, including the state historic preservation office, may be required, and work involving historic properties will likely be required to confirm to the Secretary of the Interior's Standards for the Treatment of Historic Properties (usually at the REHABILITATION level). See https://www.nps.gov/tps/standards/four-treatments/treatment-rehabilitation.htm

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN COLLEGE OF RADIOLOGY (ACR)

ACR	MRI Accreditation Program Requirements, Latest Edition

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)

AIHA IMOM08-679	(2008) Recognition, Evaluation, and Control of Indoor Mold

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z9.2	(2018) Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems

INSTITUTE OF INSPECTION, CLEANING, AND RESTORATION CERTIFICATION (IICRC)

ANSI/IICRC S520	(2015) Standard and Reference Guide for Professional Mold Remediation
IICRC S100	(2015) S100 Standard and R100 Reference Guide for Professional Cleaning of Textile Floor Covering
IICRC S500	(2015) Standard and Reference Guide for Professional Water Damage Restoration

NAVY AND MARINE CORPS PUBLIC HEALTH CENTER (NMCPHC)

IHFOM, CH 13, Sec. 3	(2015) Mold Cleanup, Remediation, and Clearance Sampling

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection
29 CFR 1926.59	Hazard Communication
29 CFR 1926.62	Lead
29 CFR 1926.1101	Asbestos
29 CFR 1926.1126	Chromium
29 CFR 1926.1127	Cadmium

UL SOLUTIONS (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units

1.2 DEFINITIONS

1.2.1 AIHA

American Industrial Hygiene Association.

1.2.2 AIHA EMLAP

American Industrial Hygiene Association's Environmental Microbiology Laboratory Accreditation Program

1.2.3 AFU

Air filtration unit with High Efficiency particulate air (HEPA) filtered vacuum and exhaust ventilation equipment with a filter system capable of collecting and retaining microbial contamination ASSP Z9.2. Filters must retain 99.97 percent of particles 0.3 microns 0.000012 inches or larger as indicated in UL 586.

1.2.4 Categories of Water

Category 1 Water: Water that originates from a sanitary water source and does not pose a substantial risk from dermal, ingestion, or inhalation exposure. IICRC S500

Category 2 Water: Water that contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans. Can contain potentially unsafe levels of microorganisms or nutrients for microorganisms as well as other organic or inorganic matter. IICRC S500

Category 3 Water: Water that is grossly contaminated and can cause significant adverse reactions to humans if contacted or consumed. IICRC S500

1.2.5 Certified Industrial Hygienist (CIH)

An individual that has been certified by the American Board of Industrial Hygiene (ABIH), with professional qualifications and experience as required for an industrial hygienist, as presented in the definition of "Industrial Hygienist."

1.2.6 Complete Interior Building Demolition (Complete Gut)

Interior finishes of the building have been removed to expose basic structural elements.

1.2.7 Containment

Physical separation and engineering controls required to prevent contamination of undamaged materials and occupied areas. The level of containment varies depending on the extent of the contamination.

1.2.7.1 Source Containment

Use when the contaminated surface area is less than 0.93 square meters 10 square feet, in both residential and non-residential buildings. At a minimum, source containment will include the following (ANSI/IICRC S520):

a. Isolation of Work Areas. Install polyethylene barriers to isolate the areas or material to be demolished / remediated from non-remediation areas.

b. Floor protection. Maintain protection for finished floors through all construction activities.

c. HEPA vacuum to control dust created during the demolition. Hold HEPA vac intake at source of dust.

1.2.7.2 Limited Containment

Use when contaminated surface area is between 0.93 square meters and 9.3 square meters 10 square feet and 100 square feet per room in both residential and non-residential buildings. At a minimum, limited containment includes the following (ANSI/IICRC S520):

a. Containment. For residential buildings, a containment includes the entire room where work is being performed. The containment does not extend past the extents of the room unless there are instances of contamination extending from one room to the next. For non-residential buildings, the containment includes the area to be remediated, plus enough additional area to allow for all equipment and work activities.

b. Isolation of Work Areas. Install polyethylene barriers to isolate the areas to be demolished / remediated.

c. Floor protection. Maintain protection for finished floors through all construction activities.

d. Air Filtration / Pressurization Control. Install AFUs with HEPA filters in the containment. Configure the AFUs with splitters / diverters to allow some of the air to recirculate within the containment. Discharge the remainder of the air directly to the outside to maintain an overall negative pressure in the containment of 5 pascals 0.02 inch water column minimum to 10 pascals 0.04 inch water column maximum relative to the outside and other adjacent spaces not undergoing remediation(AIHA IMOM08-679). AFUs must filter a minimum of four air changes per hour and a maximum of six air changes per hour (ANSI/IICRC S520).

e. Protection for all items remaining in the containment. Protective devices must prevent physical damage (e.g., scratches and dents) and must provide a positive seal to prevent dust from settling in or on the items.

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NOTE: The designer/specifier must consider the need for a decontamination air lock system.

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[f. Decontamination. Construct a decontamination airlock for entry into and exit from the work area. HEPA vacuum the sealed bags of contaminated debris within the airlock. When possible, locate the decontamination airlock so that the sealed bags can be passed directly from the airlock to the outside, through a door or window.

] g. Containment Entrance. Install a triple-flap poly "door" to be used during demolition to provide a good separation between containment and occupied areas of the house / building.

h. HVAC System. Seal off all supply and return vents. HVAC may need to be shut down to ensure proper seal of the vents.

1.2.7.3 Full Containment

Use when contaminated surface area is greater than 9.3 square meters 100 square feet in both residential and nonresidential buildings. At a minimum, full containment includes the following(ANSI/IICRC S520):

a. Containment. For residential buildings, a containment includes the entire room where work is being performed. The containment does not extend past the extents of the room unless there are instances of contamination extending from one room to the next. For non-residential buildings, the containment includes the area to be remediated, plus enough additional area to allow for all equipment and work activities.

b. Isolation of Work Areas. Construct polyethylene barriers to isolate the areas to be demolished / remediated.

c. Floor protection. Maintain protection for finished floors through all construction activities.

d. Air Filtration / Pressurization Control. Install AFUs with HEPA filters in the containment. Configure the AFUs with splitters / diverters to allow some of the air to recirculate within the containment. Discharge the remainder of the air directly to the outside to maintain an overall negative pressure in the containment of 5 pascals 0.02 inch water column minimum to 10 pascals 0.04 inch water column maximum relative to the outside and other adjacent spaces not undergoing remediation (AIHA IMOM08-679). AFUs must filter a minimum of four air changes per hour and a maximum of six air changes per hour (ANSI/IICRC S520).

e. Protection for all items remaining in the containment. Protective devices must prevent physical damage (e.g., scratches and dents) and must provide a positive seal to prevent dust from settling in or on the items.

f. Decontamination. Construct a decontamination airlock for entry into and exit from the work area. HEPA vacuum the sealed bags of contaminated debris within the airlock. When possible, locate the decontamination airlock so that the sealed bags can be passed directly from the airlock to the outside, through a door or window.

g. Containment Entrance. Install a triple-flap poly "door" at the entrance to the airlock, and between the airlock and the work area during demolition to provide a good separation between containment and occupied areas of the house / building.

h. HVAC System. Seal off all supply and return vents. HVAC may need to be shut down to ensure proper seal of the vents.

1.2.7.4 Unoccupied Building Containment

Use when a building is unoccupied and large amounts of mold growth are present throughout the building:

a. Containment. The containment consists of the entire building. Install AFUs with HEPA filters in the building. Configure the AFUs to recirculate within the active remediation area. AFUs must filter a minimum of four air changes per hour and a maximum of six air changes per hour based on the size of the area undergoing active remediation (ANSI/IICRC S520).

b. Isolation of Work Areas. Install polyethylene barriers to isolate remediation areas from non-remediation areas. AFU discharge may be used to positively pressurize non-remediation areas from areas undergoing remediation to prevent the movement of spores into "clean" areas.

c. Floor Protection. Maintain protection for finished floors through all construction activities.

d. Protection for all items remaining in the containment. Protective devices must prevent physical damage (e.g., scratches and dents) and must provide a positive seal to prevent dust from settling in or on the items.

e. Decontamination. Construct a decontamination airlock for entry into and exit from the building.

f. Containment Entrance. Install a triple-flap poly "door" to be used during demolition to provide a good separation between containment and non-remediation areas of the house / building.

g. HVAC System. Seal off all supply and return vents. HVAC may need to be shut down to ensure proper seal of the vents.

1.2.7.5 Cleaning Containment

For items being salvaged, set up a temporary containment structure to clean items removed from the containment. At a minimum, the cleaning area must contain:

a. Two chambers. Construct walls with polyethylene. Clean the items in the first chamber. Store the clean items in the second chamber.

b. Air Filtration / Pressurization Control Cleaning Chamber. Install AFUs with HEPA filters in the cleaning chamber. Configure the AFUs with splitters / diverters to allow some of the air to recirculate within the containment. Discharge the remainder of the air directly to the outside to maintain an overall negative pressure in the containment of 5 pascals 0.02 inch water column minimum to 10 pascals 0.04 inch water column (maximum) relative to the storage chamber (AIHA IMOM08-679).

c. Air Filtration, Storage Chamber. Install AFUs with HEPA filters in the storage chamber. Configure the AFUs to allow air to recirculate within the chamber. AFUs must provide air filtration at a rate of between four and six air changes per hour (ANSI/IICRC S520).

d. Containment Entrance. Install a triple-flap poly "door" at the entrance to the cleaning chamber, between the cleaning and storage chambers, and at the exit of the storage chamber to provide a good separation between the chambers.

1.2.8 Decontamination Unit (Airlock)

An enclosed area adjacent to, and connected to, a regulated work area. It consists of various rooms that are used for the decontamination of workers, equipment, and materials.

1.2.9 Dehumidifier

Mechanism or machine to remove moisture from the air.

1.2.10 Detergent

A cleaning agent. The term refers to a prepared compound that may include surfactants, builders, dry solvents, softeners, etc, but does not include true soap.

1.2.11 Disinfectants or Biocide Sanitizing Solutions

One of three groups of antimicrobials registered by the EPA for public health uses. The EPA considers an antimicrobial to be a disinfectant when it destroys or irreversibly inactivates infectious or other undesirable organisms, but not necessarily their spores.

1.2.12 EPA

U.S. Environmental Protection Agency.

1.2.13 Fungal Growth Structures

Portions of fungi indicating active fungal growth is present on a surface. These include spores, conidiophores, hyphae, hyphal fragments, and mycelium.

1.2.14 Fungicidal Agents, (EPA)

An EPA registered fungicide that inhibits the spread and growth of mold with the ability to withstand moist and humid conditions.

1.2.15 HEPA Filter

A High Efficiency Particulate Air (HEPA) filter capable of trapping and retaining 99.97 percent of all particulate larger than 0.3 microns 0.000012 inches.

1.2.16 HVAC

Heating, Ventilating, and Air Conditioning (System).

1.2.17 Industrial Hygienist (IH)

An individual designated and provided by the Contractor that is a professional qualified by education, training, and experience to anticipate, recognize, evaluate, and develop controls for occupational and indoor air quality hazards. Education must include a minimum 12 semester hours or quarter hour equivalent of chemistry and 18 additional semester hours or quarter hour equivalent of courses in any combination of chemistry, physics, engineering, health physics, environmental health, biostatistics, biology, physiology, toxicology, epidemiology, or industrial hygiene. The Industrial Hygienist must be a CIH or under the supervision of a Certified Industrial Hygienist.

1.2.18 Microbial Remediation Supervisor

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NOTE: State Certification requirements for mold remediation contractors and supervisors must be met. Modify and supplement the certification requirements specified in this paragraph if not equal to state requirements.

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Individual responsible for the execution of the microbial remediation work as defined by the scope of work. This individual must have documented training in microbial remediation and have at least three years experience in microbial remediation work. Remediation contractor's on-site supervisor must have one of the following certifications: Council-Certified Microbial Remediator (CMR), or Council-Certified Microbial Remediation Supervisor (CMRS) as certified by the American Council for Accredited Certification, or Applied Microbial Remediation Specialist (AMRS), Institute of Inspection, Cleaning, and Restoration Certification (IICRC) or Contracting

Officer approved equivalent.

1.2.19 Non-Porous Material

A material that does not absorb nor is easily penetrated by liquids, especially water. Generally, non-porous materials have a permeable factor of less than one. Some examples are metal, glass, plastic, ceramic tile.

1.2.20 Occupied Spaces (Areas)

The phrase "occupied space" within this specification refers to spaces that are occupied by unprotected non-remediation personnel while work is in progress. It also refers to areas adjacent to work areas that are not currently undergoing remediation.

1.2.21 Personal Protective Equipment (PPE)

Any material or device worn to protect a worker from exposure to, or contact with, any harmful material or force. PPE must be cleaned or disposed of prior to removal from the remediation work area.

1.2.22 Poly

Polyethylene sheet with a minimum thickness of 0.15 millimeter 6 mils (IHFOM, CH 13, Sec. 3).

1.2.23 Porous Material

Permeable materials having the physical properties that allow liquids or gasses to pass through. These materials include but are not limited to the following: gypsum wall board, insulation, wallpaper, ceiling material, carpet, padding, paper goods (i.e., cardboard boxes, loose paper, books), stuffed furniture, wicker, fabrics.

1.2.24 Pressure Differential Measuring Instrument

Device used to measure the relative pressure difference between the work area/containment and areas outside the work area. For mold remediation, the device must measure accurately in the 0 to 10 Pascal 0 to 0.04 inch of water range.

1.2.25 Semi-porous Material

A material that can absorb liquids if exposed over long periods of time. These materials include but are not limited to wood, concrete, linoleum, vinyl wall covering, wooden or hardboard furniture, plaster.

1.2.26 Ventilation System Mold Remediator Qualifications (VSMR)

An individual certified by the North American Duct Cleaning Association (NADCA) to clean HVAC systems.

1.2.27 Work Area

The area where remediation operations are actively performed and controlled to prevent the spread of dust / spores and entry by unauthorized personnel. A work area is the space, group of spaces, or the building, as defined by the Microbial Assessment Survey.

1.3 REQUIREMENTS

1.3.1 Description of Work

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NOTE: Specify the form, condition and approximate quantity square meters square feet of mold contaminated material to be controlled in the first blank, the type of material in the second blank, and the location of the material in the third blank. Example: "The mold contaminated material removal work includes the demolition and removal of 270 square meters 3,000 square feet of gypsum wallboard located on the first floor of the structure." The use of this section in the contract specification means that known mold contaminated material is involved. Estimate the quantity and specify as unit price items Contract's price schedule or Section 01 20 00 PRICE AND PAYMENT PROCEDURES per standard practice of the activity preparing the contract.

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The Contracting Officer will furnish the Contractor, in the contract documents, an initial Microbial Assessment Survey with containment categories and remediation methods specified for each work area and material within the work area.

a. The Contracting Officer's initial Microbial Assessment Survey specified below must be furnished and certified by a qualified assessor authorized by the Contracting Officer to do such work. The initial survey is included in the solicitation documents at the end of this specification section.

b. Provide mold remediation work including the handling and control of mold contaminated materials and the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with mold products and spores. The work also includes the disposal of any mold contaminated materials generated by the work. The mold removal work includes the demolition and removal of [_____] of [_____] located [_____]. Provide containment and engineering control techniques as outlined in this specification. All mold contaminated material removal work must be supervised by a microbial remediation supervisor as specified herein.

c. No work in this specification section can be provided by any person, contractor, or contracting entity involved in the preparation of the contract documents of which this specification section is a part.

d. The following microbial remediation specifications apply to the cleaning / removal and disposal of fungally-contaminated porous, semi-porous and non-porous surfaces within various types of structures. The level of containment and requirements for cleaning and remediation of materials will depend on the condition of the space and materials being remediated.

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NOTE: The following paragraph directs the Contractor to inspect the premises and develop a work plan based on the amount of mold contaminated

materials found. Depending on the source of the moisture (flood, rainwater leaks), the amount of mold growth in the building may have increased since the Government-provided initial survey of the building. If there is a significant increase in the amount of work required of the Contractor, the Contracting Officer will likely have to modify the contract.

****

e. Immediately after award of the contract, prepare a preliminary visual assessment report using the standard microbial assessment form (Appendix A) to document the differences in the pre-remediation condition of the work areas as compared to the government provided Microbial Assessment Survey.Coordinate inspection with contracting officer. Only address the differences between the pre-remediation condition of the work areas and the government provided Microbial Assessment Survey. If required to indicate the differences, include the HVAC systems inspection required elsewhere in this specification section. Submit this written pre-remediation condition report to the Contracting Officer for approval and instructions to proceed.

f. After approval of the preliminary visual assessment report and having instructions from the Contracting Officer to proceed, prepare a microbial remediation plan for approval by the Contractor's Certified Industrial Hygienist. Include an assessment of the risk for people occupying areas adjoining the remediation area while remediation work is occurring in the microbial remediation plan . Upon the Contractor's CIH approval of the plan, submit the plan to the Contracting Officer for approval.

g. The Contractor's CIH or IH must monitor the site on a daily basis while remediation work is in progress, identifying work and work practices that are not in compliance with the approved microbial remediation plan, and performing all inspections required by this specification. The Contracting Officer may require the removal of any individual for non-compliance with quality requirements specified in the contract.

h. This specification section includes the protocol regarding proper disposal of the removed building material components from within the work site.

i. Use proper cleaning procedures, engineering controls, and apply best management practices to remove microbial growth and spore fallout from all surfaces and building materials to minimize the further release of microbial spores. Address semi-porous and nonporous surfaces within the facility in each cleaning phase of the project. Damp wipe and HEPA vacuum all surfaces, at a minimum. Remove and dispose of porous building materials that are supporting microbial growth.

1.3.2 Security Requirements

Prior to granting access to any work area (i.e., building, area, room, or space) for mold remediation work, a determination must be made by the government agency whether classified or controlled unclassified information (paper material or electronic media) or equipment is contained in the work area(s).

It may be necessary depending on the sensitivity of the work area or the information contained in the area to authorize the Government activity or tenant command responsible for the work area to provide their own appropriately cleared military or government personnel to properly remove or secure any classified or controlled unclassified information, electronic media or equipment located in their work area(s). Prior authorization would be required and the area would need to be evaluated to ensure it is safe for personnel to enter and all personnel must utilize the required PPE to safely enter the work area.

a. If Contractor personnel require access to classified information or spaces to perform mold remediation work, the Government must issue the Contractor facility a Facility Clearance Level (FCL) (Contract Security Classification Specification) prior to the initiation of the work under the contract. If the Contractor facility does not possess a valid FCL issued by the Defense Security Service (DSS), the Government will be required to submit a sponsorship request to DSS requesting that the Contractor be processed for and issued a current FCL at the appropriate level.

b. Access to classified information (paper material, electronic media, and equipment) must only be granted to authorized and appropriately cleared government and U.S. contractor personnel that possess a personnel security clearance commensurate with the level of information contained in the work area that requires a mold remediation effort.

c. Access to Controlled Unclassified information (i.e., For Official Use Only, Sensitive but Unclassified, Privacy Act Information, Export Controlled unclassified) can be granted to DOD cleared contractors, consultants and grantees that are conducting official business for the DOD or DON. Non-cleared U.S. contractor personnel who only require access to controlled unclassified information can be granted access if they get a favorable trustworthiness determination on an individual Favorable Tier 1 investigation and fingerprint result submitted on their behalf by the government agency issuing the contract.

d. Classified information and controlled unclassified information must be safeguarded / secured, reproduced, and destroyed in accordance with SECNAV M-5510.36.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

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NOTE: The submittals required for each project are very dependent upon the removal method to be used. Edit the submittals paragraph accordingly.
****

SD-01 Preconstruction Submittals

Ventilation System Mold Remediator Qualifications (VSMR); G, [_____]

Preliminary Visual Assessment Report; G, [_____]

Microbial Remediation Plan; G, [_____]

Respiratory Protection Program; G, [_____]

Worker Records;

Certified Industrial Hygienist (CIH)/Industrial Hygienist (IH) Qualifications; G, [_____]

Microbial Remediation Supervisor Qualifications; G, [_____]

SD-03 Product Data

Disinfectants or Biocide Sanitizing Solutions; G, [_____]

Fungicidal Agents, (EPA); G, [_____]

Personal Protective Equipment (PPE); G, [_____]

Pressure Differential Measuring Instrument;

Safety Data Sheets (SDS) for All Materials; G, [_____]

Dehumidifiers;

Air Filtration Units;

SD-06 Test Reports

IH Daily Reports; G, [_____]

SD-11 Closeout Submittals

Submittals at Completion of Remediation Work; G, [_____]

1.4.1 Preconstruction Submittals

Within 10 days from the award of the contract and prior to the start of the work, submit to the Contracting Officer six copies of the following items for review and permanent file.

1.4.1.1 Preliminary Visual Assessment Report

A written report to document the pre-remediation condition of the work areas compared to the government provided Microbial Assessment Survey and the results of the HVAC systems inspection.

1.4.1.2 Microbial Remediation Plan

Submit a job-specific,[detailed][abbreviated] plan Approved by the Contractor's CIH to the Contracting Officer for final approval prior to start of work. The plan must address the following items at a minimum:

a. Description of materials to be remediated, providing location and quantities (map if available), and methods to be used for remediation.

b. Products: Disinfectants, detergents, biocides, sanitizing solutions, and fungicidal agents, (EPA).

c. Containment procedures to include description and locations of engineering controls and decontamination unit to include entry and exit procedures (provide sketch of floor plan showing location of containment barriers and decontamination units). Include locations of AFUs and AFU discharges to the outside.

d. Description of personal protective equipment to be used during the remediation.

e. Construction barricades and barriers in occupied areas.

f. HVAC Shut down and start-up procedures.

g. HVAC Evaluation and remediation procedures.

h. Moisture and relative humidity control procedures and equipment.

i. Packaging and disposal procedures.

j. Safety Precautions to include lockout / tag-out, fall protection, confined space entry procedures, and fire protection.

k. Description of the method to be employed to control cross contamination of areas not in the work area. Include a risk assessment related to the suitability of people to occupy areas adjoining the remediation area while remediation activities are ongoing.

l. IH Quality Control procedures to include visual inspection.

m. Procedures to control, abate, and dispose of Asbestos Containing Materials (ACM), Presumed Asbestos Containing Materials (PACM) and Lead Based Paint (LBP) coincident with microbial remediation. ACM, PACM, and LBP must be identified before work begins; Identify the presence, location, and quantity of ACM,PACM, and LBP therein pursuant to paragraphs (g),(k)(1) of 29 CFR 1926.1101 and for lead 29 CFR 1926.62.

1.4.1.3 Respiratory Protection Program

Provide written copy of Contractor's Respiratory Protection program.

1.4.1.4 Worker Records

Provide the following documents for all workers, including supervisory personnel. If new workers are added to the crew, provide the same documentation for them.

Employee Instruction and Release Form: Provide documentation showing that each employee has been instructed on the following items:

a. Use and fit of respirators (for employees entering and working in the containment).

b. Protective clothing.

c. Protective measures.

d. Safety and Emergency Egress Procedures.

e. Site specific fall protection plan and training.

f. Microbial remediation hazards and practices including engineering controls and isolation. Training should include "hands on" training for microbial remediation supervisors.

g. Workers' release forms stating the potential hazards involved with the scope of the work.

Worker Training Certification: Submit copies of training certificates for each employee indicating that the employee has received training at the appropriate level for the work prescribed in the description of work.

1.4.1.5 Certified Industrial Hygienist (CIH)/Industrial Hygienist (IH) Qualifications

Submit the name, address, and telephone number of the Certified Industrial Hygienist (CIH) and Industrial Hygienist (IH). Provide copies of board certificates, resume to document field experience, and evidence that the CIH and IH have successfully completed training in microbial investigation and remediation.

1.4.1.6 Microbial Remediation Supervisor Qualifications

Onsite supervisor must have one of the following certifications: Certified Microbial Remediator (CMR), Certified Microbial Remediation Supervisor (CMRS), or Applied Microbial Remediation Specialist (AMRS). Submit copies of supervisory training certificates.

1.4.2 Product Data

Within 10 days of contract award, submit product data for items identified for use in Microbial Remediation Plan.

1.4.3 IH Daily Reports

Prepare a written IH Daily Report for each day that microbial remediation work is being accomplished. Submit the IH Daily Report to the Contracting Officer by 1000 hours of the following day. The IH Daily Report at a minimum must include measurements of differential pressure and temperature and relative humidity in work areas, and detail any non-compliance issues observed.

1.4.4 Submittals at Completion of Remediation Work

Within 14 days of completion, provide the following information:

a. Daily Project Logs.

b. IH Daily Reports.

c. Photographic Logs.

d. Contractor's Industrial Hygienist Report certifying the microbial remediation is complete.

1.5 RECORD KEEPING

A Daily Project Log must form a permanent record of the project. Secure and maintain these logs and any other required documentation as part of the permanent project file.

1.5.1 Daily Project Log

The Microbial Remediation Supervisor must maintain a Daily Project Log. The Daily Project Log must be used each day of the project to document the following information.

a. Date.

b. Name of Microbial Remediation Supervisor.

c. Name of Industrial Hygienist monitoring work area.

d. Number of workers on site.

e. Equipment utilized.

f. Brief description of daily work activities.

g. Listing of any non-compliance noted, emergencies, stop work orders (with detailed explanation),[exhaust system pressure differential recordings] and descriptions of any other significant events.

PART 2 PRODUCTS

2.1 DISINFECTANTS, BIOCIDES, SANITIZING SOLUTIONS AND FUNGICIDAL AGENTS, (EPA)

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NOTE: Designer/specifier must make a determination if biocides will be used for remediation activities. Edit the paragraph below to reflect the determination.

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Must be EPA Registered for the use detailed in the Microbial Remediation Plan and used in accordance with the manufacturer's specifications.. Provide SDS sheets to the Contracting Officer for any chemicals that will be used during the performance of the work for approval.

2.2 HAZARD COMMUNICATION

Adhere to all parts of 29 CFR 1926.59 and provide the Contracting Officer with a copy of the Safety Data Sheets (SDS) for all materials brought to the site.

PART 3 EXECUTION

3.1 EQUIPMENT

Provide manufacturer's certificate of compliance for all equipment used to contain the microbial contamination.

3.1.1 Respirators

Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services. Provide personnel engaged in set-up, pre-cleaning, cleanup, handling, and removal of contaminated materials with the appropriate respiratory protection as specified in 29 CFR 1910.134. Microbial remediation plan must consider Table 17.1 in AIHA IMOM08-679 "Recognition, Evaluation, and Control of Indoor Mold", which lists the minimum levels of respiratory protection based on the activity and size of the remediated area.

3.1.2 Protective Clothing

Provide all workers with protective clothing as appropriate for the work being accomplished, as required by the Microbial Remediation Plan.

3.1.3 Warning Signs and Labels

Provide bilingual warning signs printed in English and [_____] at all approaches to the work areas IICRC S500. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Warning signs may be in the form of continuous plastic tape. The warning signs must have black characters on a yellow background.

WARNING
DO NOT ENTER
MICROBIAL REMEDIATION WORK IN PROGRESS

Alternate wording for the warning signs will be approved by the Contracting Officer.

3.1.4 Dehumidifiers

Install and use dehumidifiers as needed during the remediation to maintain relative humidity below 60 percent in the work area. Drain the condensate water to a permanent drain, or empty as needed to prevent water overflowing from the dehumidifiers. IHFOM, CH 13, Sec. 3

3.1.5 Air Filtration Units (AFU)

Install and use AFUs with HEPA filters, and manufacturer specified pre-filters, as part of the exhaust ventilation system to develop and maintain the specified desired air pressure differential inside the enclosed work area relative to the outside areas. Acquire and pay for any licenses needed for use of any equipment, including but not limited to, air pressure differential systems and air filtration systems.

a. Replace HEPA filters and pre-filters for AFUs as required to maintain pressurization performance requirements during demolition and cleaning. Do not reuse filters. Bag used filters at a minimum in clear 0.15 millimeter 6 mil (IHFOM, CH 13, Sec. 3) polyethylene bags within the containment and disposed as contaminated waste.

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NOTE: Some air from the AFUs may be allowed to recirculate into the remediation area only. The intent is to maintain the work area under a negative pressure relative to non-work areas. Excessive negative pressure will allow outside air to infiltrate into the building, either into the work area directly, or into other areas of the building. In humid climates, this outside air may bring in large amounts of moisture, and cause additional mold growth. Air discharged from the AFU may not be supplied to an occupied area.

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b. Discharge air from any AFUs located in the work area containment to the outside environment when creating a negative pressure containment to create a negative pressure relative to the outside and adjacent work areas not undergoing active remediation of 5 pascals 0.02 inch H2O to 10 pascals 0.04 inch H20 AIHA IMOM08-679. Discharge air in excess of that required for creating the proper negative pressure to the work area. The AFUs must provide four to six air changes per hour in the work area (ANSI/IICRC S520). Under no circumstances may air from AFUs discharge to an occupied area. Coordinate location of window sashes or doors required for discharge openings with the Contracting Officer. Exhaust discharge openings may be constructed of plywood, and the seals around such opening must be airtight.

c. Seal all exhaust and intake openings in AFUs with one layer of 0.15 millimeters 6 mil (IHFOM, CH 13, Sec. 3) polyethylene sheeting when not in use.

3.1.6 Vacuum Cleaners Equipped with HEPA Filters

Provide vacuum cleaners equipped with HEPA filters designed for continuous operation in order to complete the work in a timely and efficient manner.

a. Provide nozzle attachments as required to adequately remove all dust. As a minimum, nozzle attachments must include crevice and extended bristle brush nozzles. Any vacuum that is not equipped with a HEPA filter must not be used at anytime.

b. Provide sufficient vacuum cleaners equipped with HEPA filters designed for continuous operation in the work area during microbial remediation inside the containment area.

c. Provide additional vacuum cleaners equipped with HEPA filters in the enclosed work area during remediation or cleaning work as required by the size (area) of the containment and to maintain timely progress of the work.

3.2 GENERAL REQUIREMENTS

3.2.1 Pre-Microbial Remediation Work Conference

Meet with the Contracting Officer prior to beginning work to discuss in detail the Microbial Remediation Plan, including work procedures and safety precautions. Once approved by the Contracting Officer, the plan will be enforced as if a part of this specification. Any variances to the specification as a result of the plan must be specifically identified to allow for free discussion and approved by the Contracting Officer in writing prior to starting work. Before work in areas with Asbestos Containing Materials (ACM), Presumed Asbestos Containing Materials (PACM) and Lead begins, identify the presence, location, and quantity of ACM, PACM and Lead. Ensure proper notification of regulatory authorities. Consult with Contracting Officer to obtain facility ACM / LBP surveys. Mitigate any disturbance of painted/coated surfaces in accordance with 29 CFR 1926.62, 29 CFR 1926.1126 and 29 CFR 1926.1127.

3.2.2 Containment Entry / Exit Procedure

Ensure that each worker and authorized visitor follows entry and exit procedures detailed in the Microbial Remediation Plan.

3.3 REMOVAL PROCEDURES

3.3.1 Protection of Existing Work Areas

Perform work in a manner to minimize the damage or contamination to areas outside or directly adjacent to the work area. Inspect areas inside and outside proposed work areas to identify existing damage and notify Contracting Officer prior to start of work.

Where materials outside work area are damaged or contaminated as a result of the Contractors work efforts as verified by the Contracting Officer using visual inspection or sample analysis, it must be restored to its original condition or decontaminated by the Contractor at no expense to the Government as deemed appropriate by the Contracting officer. Should adjacent or outside areas become contaminated as a result of the Contractors work efforts, stop work immediately. Clean the newly contaminated areas at no additional expense to the Government. The work may proceed at the discretion of the Contracting Officer once the area has been verified by visual inspection as restored.

3.3.2 Remediation of Fungally Contaminated Building Materials

The removal of contaminated materials must follow in general the listed sequence of work. The Contractor may make changes to improve work flow with the approval of the Contracting Officer.

a. Provide level of containment and PPE required by the Microbial Remediation Plan.

b. Disable all HVAC units and exhaust fans in the area to be remediated. Cover and seal all supply vents, return vents, and air handling units in the project area using two layers of 0.15 millimeter 6 mil poly (IHFOM, CH 13, Sec. 3).

c. Protect materials to remain in work area. Where possible, clean all materials to be salvaged in place to prevent possible cross-contamination created by moving materials through non-remediation areas.

d. Remove undamaged items and materials to be cleaned and salvaged from the work area. Store materials in an area with relative humidity maintained below 60 percent and where temperatures will not damage the material. Notify Contracting Officer of existing damage to items prior to removal.

e. Set up containments, including protection of materials remaining within the containment and AFUs. Notify Contracting Officer that the area is prepared for remediation activities.

f. Pre-demolition inspection by the Contracting Officer.

g. Demolition and removal / cleaning of contaminated materials.

h. Post-remediation inspection by the Contracting Officer.

i. Perform final cleaning in the containment.

j. Clean carpet in the containment if salvageable.

k. Clearance inspection by the Contracting Officer.

l. Duct and HVAC cleaning, if necessary.

m. Deconstruction of containment, removal of AFUs.

n. Return previously items that were removed and cleaned to the occupied area.

3.3.3 Remediation Procedures

3.3.3.1 Remediation of Non-Porous Materials

Method of remediating non-porous items:

a. HEPA vacuum all surfaces.

b. Damp wipe all surfaces using clean water or a detergent solution.

c. Ensure all cleaned surfaces are dried thoroughly.

3.3.3.2 Semi-Porous Materials (Unfinished Wood)

Use this method for remediating unfinished wood-based items, including wood and wood framing in wall cavities:

a. Cleaning

   (1) HEPA vacuum all surfaces.

   (2) Scrub surfaces with a brush and detergent to remove mold.

   (3) Ensure all cleaned surfaces are dried thoroughly.

   (4) HEPA vacuum all surfaces to remove dust.

   (5) Repair finishes as required to match original.

b. Removal

c. Where unfinished wood product has been structurally damaged, remove and replace with an equivalent product. This includes wall studs and sheathing, such as OSB used in flooring, wall, or roof construction. Lightly mist mold contaminated material before removal.

3.3.3.3 Semi-Porous Materials

Use this method for surface cleaning semi-porous materials such as concrete, vinyl wall covering, linoleum, leather furniture, and finished wood products:

a. HEPA vacuum all surfaces.

b. Damp wipe surfaces using clean water or a detergent solution. Avoid over-wetting the material. Ensure all materials are dried thoroughly

3.3.3.4 Porous Materials

a. Carpet

   (1) Removal: Remove carpet that has remained wet for 48-hours or longer (AIHA IMOM08-679). If carpet has dried out, lightly mist before removal.

   (2) Cleaning (for carpet that has been wet for less than 48-hours) AIHA IMOM08-679: Use a dry absorbent compound cleaning method as designated by IICRC S100. This method uses an absorbent compound to dissolve, suspend and absorb carpet soils. It does not add moisture back into the carpet. Ensure carpet is dried thoroughly after cleaning

b. Gypsum Wallboard (GWB)

   (1) Removal: Remove Gypsum Wallboard that has remained wet for 48-hours or longer (AIHA IMOM08-679), or has visible mold growth.

Where removal of GWB exposes insulation, remove the insulation. Lightly mist all contaminated materials before removal.

(2) Surface Cleaning: Where GWB has a small amount of surface mold growth and the GWB is structurally sound, a surface cleaning method may be used with the permission of the Contracting Officer. HEPA vacuum all surfaces and wipe down with a detergent solution. Do not use surface cleaning where mold growth penetrates wallboard substrate. Thoroughly dry the cleaned areas and paint to lock down any residual spores.

c. Ceiling Tile

(1) Removal: Remove ceiling tile that has remained wet for 48-hours or longer, or has visible mold growth (AIHA IMOM08-679). If ceiling tile has dried out lightly mist before removal.

d. Paper/Electronic Media and Sensitive Equipment

e. Classified and Controlled Unclassified Information whether it is paper, electronic media or equipment must be properly safeguarded / secured until it is properly destroyed in accordance with SECNAV M-5510.36 and it cannot be discarded without utilizing the proper destruction methods. Contractor personnel cannot be granted access to classified information or Controlled Unclassified Information until they have met the security requirements stated in the paragraph SECURITY REQUIREMENTS.

(1) Removal: Only papers or documents that are unclassified and do not contain controlled unclassified information can be discarded in the trash. Classified and Controlled Unclassified information must be destroyed by appropriately cleared military, government or contractor personnel using an approved DOD destruction method for that specific level of information. Discard paper materials that have remained wet for 48-hours or longer, or that have visible mold growth. Paper materials that have been wet for less than 48-hours may be allowed to dry if approved by the Contracting Officer.

(2) Containment: Where paper materials, such as personnel records must be retained, the following containment methods may be used with the permission of the Contracting Officer. The method of containment for paper products shall be:

(a) Thoroughly dry the paper material. Classified and Controlled Unclassified Information must be safeguarded at all times in a GSA approved security container, restricted area, vault, or under the direct physical control of appropriately cleared personnel.

(b) Where routine access to the material is required, a copy shall be made. Contractor personnel shall not reproduce copies of classified information or controlled unclassified information without the prior written approval of the Contracting Officer and the Government Agency Security department with responsibility for the work area. If approval is obtained, only appropriately cleared Contractor personnel shall be authorized to reproduce the information and they must use only DOD authorized reproduction equipment.

(c) When not in use, the classified and controlled unclassified information must be secured in an approved GSA security container, restricted area, or vault. Limit access to the container to only appropriately cleared personnel. Implement an access procedure involving opening the container in a secure area with provision for capturing mold spores and respiratory protection for workers opening the container for these materials. Store the container in an area where the relative humidity is maintained below 60 percent to prevent further mold growth.

f. Textiles

(1) Discard textiles with visible mold growth.

(2) Clean textile based items, including clothing, linens, and toys that do not have visible mold growth, but have been wet, in standard commercial or residential washing machines with standard washing machine detergent.

(3) Dry all items completely before returning to the building / house.

(a) When possible, use dryers to dry items.

(b) If dryers will cause irreversible harm to the item, hang the item on a drying rack in a temperature and humidity controlled space. Discard items not dry within 48-hours (AIHA IMOM08-679).

g. Upholstered Furniture

(1) Removal: Discard upholstered furniture that has remained wet for 48-hours or longer (AIHA IMOM08-679), or that have visible mold growth.

(2) Cleaning: Clean upholstered furniture that has been exposed to mold spores but does not have visible mold growth by HEPA vacuuming upholstery and wood or metal structure, followed by a damp wipe of semi-porous or non-porous portions of the furniture. Dry furniture thoroughly after cleaning.

3.4 DETAILED SEQUENCE OF WORK FOR MOLD REMOVAL UNDER CONTAINMENT

3.4.1 Preparation for Remediation Work

a. Provide level of containment and PPE required for the remediation based on the Microbial Remediation Plan.

b. Disable all HVAC units and exhaust fans in the area to be remediated.

c. Remove undamaged materials from the work area if they are to be salvaged but cannot be cleaned in place. Store materials in an area with relative humidity maintained below 60 percent (IHFOM, CH 13, Sec. 3) and where temperatures will not damage the material. Notify Contracting Officer of existing damage to items prior to removal. Clean materials using procedures detailed in Remediation Procedures.

d. Remove supply diffusers, return grilles and exhaust grilles. Clean diffusers and grilles using procedures detailed in Remediation

Procedures.

e. Construct containment barriers. Existing walls can be used as a portion of the containment barriers if existing openings in walls (such as doors, wall openings, vents) are sealed using 0.15 millimeter 6 mil polyethylene.

f. Install the AFUs and dehumidifiers.

g. Seal supply, return, and exhaust openings with 0.15 millimeter 6 mil polyethylene sheeting and protect intakes to air handling units. Air handling units are to remain off.

h. Install all equipment needed for removal work in the containment area to minimize egress during demolition.

i. The Contracting Officer will inspect the containment to verify that the containment is properly constructed and the containment area has an overall negative pressure of 5 to 10 pascals 0.02 to 0.04 inch water column AIHA IMOM08-679 relative to the outside and adjacent work areas not undergoing active remediation, prior to beginning demolition work.

3.4.2 Demolition

a. Remove mold contaminated materials to be discarded, such as paper, and furniture. Double bag material in 0.15 millimeter 6 mil (IHFOM, CH 13, Sec. 3) poly bags. Seal poly bags using duct tape inside the containment. HEPA vacuum bags before removing them from the containment or airlock. When possible, pass the bags directly from the containment or airlock to the outside. Transport bags to a dumpster. Do not leave the bags at the building / house.

b. Lightly mist all contaminated materials that are being discarded to minimize generation of airborne mold spores during demolition/removal.

c. Remove contaminated gypsum wallboard (GWB) at the preliminary limits of demolition specified in the Microbial Remediation Plan. Inspect back side of removed GWB. If mold is observed on the back side of the GWB, report this condition to the Contracting Officer. After obtaining Contracting Officer approval, continue removing GWB until no mold is observed. If hidden mold is discovered that will extend past the extents of the containment, stop work immediately and reconstruct the containment to extend past the suspected contamination. Re-evaluate level of containment and PPE. Continue to operate AFUs during reconfiguring of containment.

d. Remove drywall by cutting in pieces as large as possible to minimize aerosolization of fungal spores. Drywall screws can either be backed out during removal or later during cleanup.

e. Use dust collection attachments on all power tools, such as sanders, saws, to capture dust created when using the tools. Outlet of dust collector should discharge into inlet of AFU.

f. Remove fiberglass insulation behind removed gypsum board.

g. If wood studs are contaminated, HEPA vacuum all surfaces, scrub them with a brush and detergent to remove mold. After scrubbing studs, HEPA vacuum again to remove any remaining dust. Replace wood studs with damage severe enough to reduce the structural capacity of the member. Prior to removal of any structural member consult with the Contracting Officer.

h. Clean all metal framing with a dilute detergent solution. Clean metal framing with light rust using steel wool and coat with a rust inhibiting paint. Replace metal framing with rust damage severe enough to reduce the structural capacity of the member. Prior to removal of any structural material, consult with the Contracting Officer.

i. Remove contaminated carpet scheduled for removal.

j. Place removed gypsum board, insulation, carpet and remaining debris in two layers of 0.15 millimeter 6 mil (IHFOM, CH 13, Sec. 3) poly bags. Seal poly bags using duct tape inside the containment. HEPA vacuum bags before removing them from the containment or airlock. When possible pass the bags directly from the containment or airlock to the outside. Transport bags to a dumpster. Do not leave the bags at the building / house.

k. Remediation workers must HEPA vacuum their PPE, then remove their PPE within the airlock chamber. Discard disposable coverall suits into a 0.15 millimeter 6 mil (IHFOM, CH 13, Sec. 3) poly bag.

3.4.3 Post-Demolition Inspection

a. The Contracting Officer will inspect the containment area to verify that all contaminated materials have been removed.

b. Allow a minimum of 12-hours after completion of removal work, with AFUs operating, for airborne dust in the containment to settle or be removed by the AFUs.

3.4.4 Cleaning after Demolition, and Cleaning of Settled Spores from Porous / Non-Porous Materials

a. Continue to operate AFUs during cleaning.

b. Clean exposed surfaces.

   (1) HEPA vacuum all surfaces.

   (2) Damp wipe all non-porous exposed surfaces including polyethylene sheets used to protect materials, external surfaces of ductwork, studs, and floors with clean rag and clean potable water or detergent solution.

   (3) Remove poly sheeting inside the containment.

   (4) HEPA vacuum all surfaces protected by poly sheeting.

   (5) Damp wipe non-porous surfaces protected by poly sheeting with clean water or a detergent solution.

   (6) Clean carpet using procedures previously specified in paragraph POROUS MATERIALS above.

c. Final clearance inspection will be conducted by Contracting Officer. Clearance inspections will be performed using the procedures detailed in Post-Remediation Inspection. If areas fail final clearance inspections, additional corrective actions taken by the contractor will be at no additional cost to the Government. Maintain containments in place until spaces are inspected and accepted by the Government as being fully remediated. The Government will determine whether additional cleaning is required by the Contractor and whether the clearance process will be repeated.

3.5 DUCT AND HVAC SYSTEM CLEANING

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NOTE: Designer/specifier must quantify HVAC materials to be removed or cleaned. Quantities must be included on design drawings or in specification.

****

3.5.1 Contractor Qualifications

a. The HVAC cleaning contractor must be a certified member of NADCA.

b. The HVAC cleaning contractor must have at least one individual with Ventilation System Mold Remediator Qualifications certified by NADCA onsite during duct and HVAC system cleaning.

3.5.2 Inspection

IH must visually inspect the HVAC system serving all work areas (or as required in the initial Microbial Assessment Survey performed by the Government), and determine if additional remediation is needed to clean the HVAC system, thus preventing re-contamination. Coordinate inspection with the contracting officer. Notify the Contracting Officer of the inspection results. The Contractor must receive written approval from the Contracting Officer before proceeding with HVAC microbial remediation.

3.5.3 HVAC Microbial Remediation

Conduct the following actions if authorized by the Contracting Officer.

a. Follow requirements of the NADCA ACR "Standard for Assessment, Cleaning, and Restoration of HVAC Systems".

b. Using a "gassing" or "fogging" method of cleaning with gaseous chlorine dioxide or ozone is not allowed.

c. Disable all HVAC equipment prior to cleaning any component of the system.

d. Use this method for cleaning the air handling units, terminal units, blowers and exhaust fans:

    (1) Construct a limited containment around equipment to be cleaned. Provide appropriate PPE for workers.

    (2) Remove filters. Seal filters in 0.15 millimeter 6 mil (IHFOM, CH 13, Sec. 3) poly bags for disposal.

    (3) Disassemble units as necessary to clean components. Contractor is responsible for correctly reassembling equipment after cleaning.

(4) Clean disassembled components within the containment or in a separate two chamber cleaning containment. Seal disassembled components in 0.15 millimeter 6 mil (IHFOM, CH 13, Sec. 3) poly bags for transport out of building / house. HEPA vacuum bags before removing them from the containment or airlock.

(5) HEPA vacuum all surfaces.

(6) Damp wipe all non-porous surfaces and components with clean water or a detergent solution.

e. Use this method for cleaning HVAC coils:

(1) Clean coils using a method which will render the coil visibly clean. Coil cleaners must be non-acidic / alkaline, detergent based. Clean condensate drain pans. The drain for the condensate drain pan must be operational during the cleaning.

(2) Rinse coils and drain pans with clean water to remove any latent residues.

(3) Cleaning methods must not cause damage to the coil surface or fins.

(4) Cleaning must restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed. If the original pressure drop is not known, the coil is considered clean only if the coil is free of foreign matter and chemical residue.

f. Use this method for cleaning the duct system:

(1) During cleaning, connect a vacuum collection system to the downstream end of the section being cleaned. The vacuum collection device must be of sufficient power to render all areas of duct being cleaned under negative pressure relative to rooms and areas of duct not being cleaned. Negative pressure must be verified at the furthest point from the collection system with a micromanometer and verification measurements included in the IH Daily Report.

(2) Equip the vacuum collection systems with HEPA filters. Exhaust the vacuum collection systems directly to the outside.

(3) Use mechanical agitation devices to dislodge debris adhered to the ductwork, such that debris may be safely conveyed to vacuum collection devices. Cleaning methods must not damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork.

(4) HEPA vacuum duct surfaces.

(5) When possible, damp wipe metal duct surfaces with clean water or detergent solution. Do not wet fibrous glass thermal or acoustical insulation.

(6) Identify areas where there is evidence of damage to or uncleanable mold in duct insulation. The Contracting Officer will make the decision to discard the insulation, if necessary.

g. Final clearance of HVAC and duct system will be based on a visual assessment (no visible dust, no visible mold) by Contracting Officer. If HVAC fails final clearance inspection, additional corrective actions taken by the contractor will be at no additional cost to the Government.

3.6 FIRE PROTECTION

Provide portable fire extinguishers within the containment area and outside the decontamination unit. Fire extinguishers Must be rated for the class of fire hazards in the work area and must be sized for coverage of the areas within the containment. At a minimum, one 4.5 kg 10 pound ABC fire extinguisher for every 930 square meters 1,000 square feet must be strategically placed around the containment. Personnel must be trained for emergency egress and the use of fire extinguishers. Notify fire officials of work activities as required. IICRC S500

3.7 CONSTRUCTION BARRIERS

a. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain. Shoring, bracing or support will be necessary when structural wood studs or metal framing need to be removed and replaced when they cannot be cleaned.

b. Do not disturb microbial-contaminated building materials while isolating work areas. This precaution prevents the release of microbial spores.

c. Workers must wear respirators and other PPE as outlined in the microbial remediation plan when installing critical barriers where microbial contaminated surfaces (walls or surfaces with visible settled dusts) are likely to be disturbed. Operate an AFU if disturbance is likely during setup.

d. Monitor the air pressure differential across work area containments. The monitoring system must be in place before the start of remedial activities. Verification by the Industrial Hygienist is required prior to the start of the microbial remediation.

3.8 QUALITY ASSURANCE / QUALITY CONTROL REQUIREMENTS

3.8.1 Contractor Qualifications

Work must be performed by a qualified remediation contractor. Contractor must carry insurance that specifically covers mold remediation.

a. Remediation contractor's on-site supervisor must have one of the following certifications: Certified Microbial Remediator (CMR), Certified Microbial Remediation Supervisor (CMRS), or Applied Microbial Remediation Specialist (AMRS). Qualified supervisor must be onsite whenever active remediation is being performed. Set-up activities may be performed without supervisor present; qualified supervisor must review set-up prior to start of work.

b. Mold remediation workers must be given training in PPE and mold remediation activities as required for their particular job. Microbial remediation plan must provide details of worker training.

3.8.2 Waste Management and Removal

Keep the site and work area free from accumulations of dust, waste materials, or rubbish caused by Contractor operations and free from any flammable materials or other sources of fire hazard. Remove all waste materials and rubbish from and about the work site in strict accordance with the specifications and applicable codes and regulations.

3.8.3 Post-Remediation Inspection

Clean up all debris and dust in interior spaces outside the work area resulting from the Contractor's remediation work.

After all visible accumulations of material and debris are removed from the containment, provide the Contracting Officer a 24-hour notice for a final clearance visual inspection. The Contracting Officer and Contractor's Industrial Hygienist must conduct a thorough visual inspection of the work area. If during this inspection any visible debris or microbial contamination are observed, the Contractor must re-clean the work area without additional cost to the Government.

3.8.3.1 Clearance

a. Clearance Criteria

b. Clearance will be based on visual assessment (all visible mold removed, all visible dust removed, based on a "white glove" test) by Contracting Officer. "White glove" test will consist of wiping the surface with a clean cloth of color suitable to reveal expected type of dust. For most surfaces, a white cloth is suitable. For GWB dust, a dark cloth may be more appropriate.

c. Failed remediation areas will be recleaned at no additional cost to the Government and the AFUs kept in operation another 12-hours, followed by another visual assessment. Subsequent failures will follow the same routine until a pass condition is secured.

3.9 CLEAN-UP AND DISPOSAL

3.9.1 Disposal of Material

Dispose of contaminated bagged waste materials removed during this remediation as general construction debris. Follow all applicable local, State, and Federal requirements for the disposal of this material.

3.9.2 Material Packaging

Place waste, as waste is removed, into a disposal container promptly. Disposal containers must consist of at a minimum, two layers of clear 0.15 millimeter 6 mil (IHFOM, CH 13, Sec. 3) polyethylene bags. Tape bags in a gooseneck fashion to form an airtight seal and label appropriately. Bag waste from vacuums equipped with HEPA filters in 0.15 millimeter 6 mil (IHFOM, CH 13, Sec. 3) polyethylene bags.

3.9.3 Building Exit (Waste Disposal)

HEPA vacuum and damp wipe bags of contaminated waste material prior to removal from the building.. When possible pass the bags directly from the containment or airlock to the outside. Transport bags to a dumpster.

3.9.4 Hazardous Material

Should the Contractor encounter any hazardous materials, notify the Contracting Officer immediately for direction.

3.10 APPENDICES

Appendix A - Microbial Assessment Visual Field Report Form

Appendix B - Sample Mold Remediation Clearance Criteria For Buildings Housing Sensitive Populations

Appendix A

Microbial Assessment Visual Field Report Form

TO DOWNLOAD THIS FORM, SEE UFGS FORMS, GRAPHICS AND TABLES
Go to
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Appendix B

Sample Mold Remediation Clearance Criteria For Buildings Housing Sensitive Populations

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Note: These sample clearance criteria involving the use of fungal air, bulk, and surface sampling are provided as guidelines for the development of detailed clearance contract requirements specific to the particular project. This criteria is intended to supplement the basic specification section and should not be added without thorough review and editing to suit the specific project requirements. Consult with the cognizant occupational medical physicians, infection control, and industrial hygiene, as a minimum, to ensure sampling and clearance criteria added to the contract are appropriate for the affected sensitive or high risk population.

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Note a. Add the following as subparagraphs to paragraph 1.2 DEFINITIONS:

Fungal Growth Structures
Portions of fungi indicating active fungal growth is present on a surface. These include spores, conidiophores, hyphae, hyphal fragments, and mycelia.

AIHA EMLAP
American Industrial Hygiene Association's Environmental Microbiology Laboratory Accreditation Program

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Note: b. Add the following to paragraph 1.4 SUBMITTALS:

In Paragraph SD-01 Preconstruction Submittals:

Testing Laboratory Qualifications; G

Microbial Assessor Qualifications; G

In Paragraph SD-11 Closeout Submittals:

Clearance Fungal Sampling Results; G

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Note c. Add the following subparagraphs to Paragraph 1.4.1 Preconstruction Submittals:

Clearance Sampling Results: Clearance sampling results per the Paragraph CLEARANCE must be submitted to the Contracting Officer the day following receipt.

1.4.1.7 Testing Laboratory Qualifications

Submit for approval the name, address, and telephone number of each laboratory selected for the analysis and reporting of sample results. Each laboratory must be accredited by the AIHA under the EMLAP for the specific field of testing method(s) used. Accreditation must be verified by valid EMLAP certificate or listing in the AIHA Accredited Microbiology Laboratory list. If the Contractor establishes a mobile lab, the parent laboratory must be AIHA EMLAP accredited.

1.4.1.8 Microbial Assessor Qualifications

Submit for approval documentation that the microbial assessor meets at least one of the following criteria:

1. Bachelor's degree from an accredited university or college with a major in engineering, architecture, building construction, occupational health, microbiology, occupational safety, or a related natural or physical science. Additionally, two years experience in conducting microbial investigations is required.

2. Associate's degree from an accredited university or college with a concentration in environmental, natural or physical sciences. Additionally, four years experience in conducting microbial investigations is required.

3. Certification as an industrial hygienist (CIH) as certified by the American Board of Industrial Hygienists, safety professional (CSP) as certified by the Board of Certified Safety Professionals or engineer (PE). Additionally, one year experience in conducting microbial investigations is required.

4. Certification by the American Council for Accredited Certification (ACAC) as a Council-Certified Indoor Environmental Consultant (CIEC), Council-Certified Indoor Environmentalist (CIE), Council-Certified Microbial Consultant (CMC), Council-Certified Microbial Investigator (CMI), Council-Certified Residential Mold Inspector (CRMI),

Council-Certified Microbial Remediation Supervisor (CMRS) or Council-Certified Microbial Remediator (CMR).

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Note d. Replace Paragraph CLEARANCE CRITERIA with the following paragraphs and renumber subsequent paragraphs as necessary.

For paragraph (3) Air Sampling Clearance Criteria and subsequent paragraphs, these paragraphs should only be required for mold remediation projects in buildings that will be occupied by sensitive or high risk populations, such as hospitals, child care centers, certain treatment centers, or when specified by the local medical support staff.

The following steps in subparagraphs (3)(a), (3)(b) and (3)(c) should be part of any air sampling clearance criteria plan.

For subparagraphs (3)(d), (3)(e) and (3)(f), determine the source of makeup air to the remediation area. The sampling protocol must be structured to compare the airborne fungal concentrations of the air entering the remediation work area, prior to commencement of remediation work, with the concentrations found in the work area after remediation is complete. Sampling times must be limited to prevent drying out of the media being used. Consult with the laboratory performing the analysis of samples to determine the appropriate sampling methods and times.

3.8.3.1 Clearance

a. Clearance Criteria

Clearance will be based on visual assessment, and surface and air sampling for fungi. Clearance fungal sampling results are included in the respective paragraphs below.

(1) Visual Assessment. Contracting Officer will verify that all visible mold and all visible dust has been removed. Contracting Officer may use a "white glove" test to verify that mold and dust have been removed. "White glove" test will consist of wiping the surface with a clean cloth of color suitable to reveal expected type of dust. For most surfaces, a white cloth is suitable. For GWB dust, a dark cloth may be more appropriate.

(2) Surface Sampling. Contracting Officer will collect tape-lift surface samples to determine if fungal growth structures are still present on surfaces. Results of tape lift samples will be considered acceptable if fungal growth structures

are not present. Detail quantity and location of tape surface samples in Microbial Remediation Plan. The Designer should research and verify an appropriate number of clearance samples is specified to ensure the protection of the sensitive population. A minimum of 5 samples per 93 square meters 1000 square feet of gypsum wallboard removed must be collected. For ductwork, one sample for every 10 variable air volume terminals and one sample for every 18.6 square meters 200 square feet of ductwork must be collected. These sample numbers should be adjusted for the specific application.

(3) Air Sampling Clearance Criteria

(a) Prior to the remediation process, microbial assessor must collect baseline bulk or surface samples from contaminated materials for culture on fungal growth media for laboratory analysis to determine the predominant fungal species growing in the areas being remediated. The predominant fungal species are the "marker" species for clearance air sampling after remediation. Consult with the laboratory performing the analysis of samples to determine the appropriate marker species in the sample data.

(b) In consultation with the laboratory performing the analysis, microbial assessor must determine the appropriate sampling method, including sample media and sample time and culture temperature for the marker species.

(c) In consultation with the laboratory performing the analysis, medical health professionals, infection control staff, industrial hygienists and microbial assessor must determine the clearance criteria for the marker species. The clearance criteria will be based on the limits of detection possible with the sampling method used and the occupant population expected after remediation is complete.

(d) After remediation is complete, but prior to removing AFUs, collect air samples in the areas remediated,[in adjacent areas providing makeup air to the remediation area,] and in the outdoor air for laboratory analysis. Adjust sampling times in the remediation area samples to account for the expected low particle counts in the air.

(e) For ductwork cleaning projects, supply clean filtered air from an AFU to the ductwork-do not use air from the air handling unit or room air. Samples must be collected using a hood or other device that allows sampling of air that comes from the ductwork and not from the room.

(f) Compare results of remediation area samples with

the results of samples collected in outdoor air[and adjacent areas providing makeup air]. Concentrations of fungal species in the remediation areas must be less than the clearance criteria determined in the paragraph AIR SAMPLING CLEARANCE CRITERIA.

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-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 01 00 (February 2018)**

Preparing Activity: USACE **Superseding**
UFGS-03 01 30.71 (April 2006)
UFGS-03 01 30 (November 2009)
UFGS-03 01 32 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03 01 00

REHABILITATION OF CONCRETE

02/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-03 01 00 (February 2018)**

Preparing Activity: USACE
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UFGS-03 01 30.71 (April 2006)
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UFGS-03 01 32 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 03 01 00

REHABILITATION OF CONCRETE
02/18

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NOTE: This guide specification covers the requirements for repair of portland cement concrete using epoxy resin grouts, mortars and concretes.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 SCOPE

This specification governs the rehabilitation of structural concrete.

1.2 DEFINITIONS

1.2.1 Bracing

Temporary supplemental members used to avoid local or global instability during construction, evaluation, or repair that are intended to be removed after completion of construction.

1.2.2 Delamination

A planar separation in a material that is roughly parallel to the surface of the material.

1.2.3 Rehabilitation

Repairing or modifying an existing structure to a desired useful condition.

1.2.4 Repair

The reconstruction or renewal of concrete parts of an existing structure for its maintenance or to correct deterioration, damage, or faulty construction of members or systems of a structure.

1.2.5 Shoring

Props or posts of timber or other material in compression used for the temporary support of excavations, formwork, or unsafe structures; the process of erecting shores.

1.2.6 Termination Joint

The interface where a placement of repair material meets existing concrete, the edge of an expansion joint, or other existing surfaces.

1.2.7 Unsound Concrete

Concrete that is fractured, delaminated, spalled, deteriorated, defective, contaminated or otherwise damaged.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 440.5	(2008) Specification for Construction with Fiber-Reinforced Polymer Reinforcing Bars
ACI 440.6	(2008) Specification for Carbon and Glass Fiber-Reinforced Polymer Bar Materials for Concrete Reinforcement
ACI 440.8	(2013) Specification for Carbon and Glass Fiber-Reinforced Polymer (FRP) Materials Made by Wet Layup for External Strengthening of Concrete and Masonry Structures
ACI 503.2-503.4	(2010, R 2003) Three Epoxy Specifications
ACI 503.3	(2010) Specification for Producing a Skid-Resistant Surface on Concrete by the Use of Epoxy and Aggregate
ACI 503.7	(2007) Specification for Crack Repair by Epoxy Injection
ACI 548.4	(2011) Standard Specification for Latex-Modified Concrete (LMC) Overlays
ACI 548.8	(2007) Specification for Type EM (Epoxy Multi-Layer) Polymer Overlay for Bridge and Parking Garage Decks
ACI 548.9	(2008) Specification for Type ES (Epoxy Slurry) Polymer Overlay for Bridge and Parking Garage Decks
ACI 548.10	(2010) Specification for Type MMS (Methyl Methacrylate Slurry) Polymer Overlays for Bridge and Parking Garage Decks
ACI 548.12	(2012) Specification for Bonding Hardened Concrete and Steel to Hardened Concrete with an Epoxy Adhesive

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE/SEI 37	(2015) Design Loads on Structures During Construction

ASTM INTERNATIONAL (ASTM)

ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A934/A934M	(2022) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C387/C387M	(2023) Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar
ASTM C496/C496M	(2017) Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C882/C882M	(2024) Standard Test Method for Bond Strength of Bonding Systems Used With Concrete by Slant Shear
ASTM C928/C928M	(2020a) Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs
ASTM C1059/C1059M	(2024) Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1438	(2013; R 2017) Standard Specification for Latex and Powder Polymer Modifiers for use in Hydraulic Cement Concrete and Mortar
ASTM C1583/C1583M	(2013) Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)

ASTM C1600/C1600M	(2017) Standard Specification for Rapid Hardening Hydraulic Cement
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D93	(2019) Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D323	(2015a) Vapor Pressure of Petroleum Products (Reid Method)
ASTM D450/D450M	(2007; R 2018) Standard Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing
ASTM D542	(2014) Index of Refraction of Transparent Organic Plastics
ASTM D1078	(2011) Standard Test Method for Distillation Range of Volatile Organic Liquids
ASTM D2103	(2015) Standard Specification for Polyethylene Film and Sheeting
ASTM D2822/D2822M	(2005; R 2011; E 2011) Standard Specification for Asphalt Roof Cement, Asbestos-Containing
ASTM D3418	(2015) Transition Temperatures of Polymers by Differential Scanning Calorimetry
ASTM D4016	(2014) Viscosity of Chemical Grouts by Brook field Viscometer (Laboratory Method)
ASTM D4580/D4580M	(2012) Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding
ASTM D4869/D4869M	(2016a) Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI 310.2R	(2013) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications; G, [_____]

Work Plan; G, [_____]

Quality Control Plan; G, [_____]

SD-03 Product Data

Conventional Concrete

Polymers

Miscellaneous Materials And Equipment

SD-04 Samples

Reinforcement And Reinforcement Supports

[Polymers]

[Miscellaneous Materials And Equipment]

SD-05 Design Data

Formwork And Shoring; G, [_____]

Repair Procedures; G, [_____]

Mixture Proportioning; G, [_____]

SD-06 Test Reports

Mixture Proportioning

Quality Control

[Tolerence Report]

[Reinforcement And Reinforcement Supports]

[Conventional Concrete]

[Polymers]

[Miscellaneous Materials And Equipment]

SD-07 Certificates

Qualifications

Reinforcement And Reinforcement Supports

[Conventional Concrete]

[Polymers]

SD-08 Manufacturer's Instructions

[Equipment For Concrete Preparation]

[Conventional Concrete]

[Polymers]

[Miscellaneous Materials And Equipment]

1.5 QUALITY ASSURANCE

1.5.1 General Requirements

a. Follow the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE for Work involving portland cement concrete.

b. To protect personnel from overexposure to toxic materials, conform to the applicable manufacturer's Safety data sheets or local regulations. Submit manufacturer's Safety Data Sheets for all polymers as well as other potentially hazardous materials.

c. Submit the repair procedures for executing the work as well as the test data and documentation on materials used for repair. Submittal must include component materials, mixture proportions, and supplier's quality control program.

d. Inspection and testing of surface preparation as well as placement of reinforcing steel must be in accordance with provisions included herein and the Contract Document.

e. Sampling and testing of materials, as well as inspection and testing of work, must be in accordance with established procedures, manufacturer's instructions, specific instructions from the Contracting Officer if given, or recommended practices as referenced herein and the Contract Documents.

f. Trial batches and testing requirements for various repair materials specified are the responsibility of the Contractor.

g. The testing agency must inspect, sample, and test repair materials and concrete production as required. When it appears that material furnished or work performed by Contractor fails to conform to Contract Documents the testing agency will immediately report such deficiency.

1.5.2 Quality Control Plan

Submit a quality control plan as specified in Sections 01 45 00 QUALITY CONTROL [and] [03 30 00 CAST-IN-PLACE CONCRETE].

1.5.3 Qualifications

The submittals must where applicable, identify agencies and individuals who will be working on this contract and their relevant experience. Do not make changes in approved agencies or personnel without prior approval of the Contracting Officer.

1.5.3.1 Testing Agencies

In addition to the requirements of Section 01 45 00 QUALITY CONTROL, agencies that test concrete materials must meet the requirements of ASTM C1077. Testing agencies that test or inspect placement of reinforcing steel must meet the requirement of ASTM E329. Submit data on qualifications of Contractor's proposed testing agency for acceptance.

1.5.3.2 Quality Control Personnel

Field tests of repair materials required must be made by an ICRI Concrete Surface Repair Technician Tier 2. Submit resumes, pertinent information, past experience, training and education of all operators of specialized demolition equipment if needed for this and the three paragraphs above.

1.5.3.3 Contractor Qualifications

The contractor performing the repair work must have been involved in a minimum of [three][_____] concrete repair projects similar in size and scope to this project for at least [five][_____] years. Submit information, including name, dollar value, date, and point-of-contact for similar projects which demonstrates the required experience and/or training.

1.5.3.4 Worker Qualifications

a. Each worker engaged in the use of specialized removal or application equipment, including [saw operators] [milling machine operators,] [hydromilling equipment operators,] [epoxy injection] [_____], must have satisfactorily completed an instruction program and three years of experience in the operation of the equipment. [The worker must have active experience with the equipment within five years of the project.]

b. Workers installing adhesive anchors must be ACI Adhesive Anchor Installer certified or equivalent.

****

NOTE: Add worker qualification requirements for the usage of specialized equipment if needed. The instruction program for workers engaged in the use of grout injection equipment must have included theory on the nature and causes of cracking in concrete, the technical aspects of correct material selection and use, and the operation, maintenance, and troubleshooting of equipment used in the repair work.

****

1.5.3.5 Regulatory Requirements

Perform all work in accordance with applicable Federal, State, and local safety, health, and environmental requirements. The Contractor is responsible for obtaining all permits required by Federal, State, and local agencies for the performance of the work.

[1.5.4 Pre-Construction Conference

****

NOTE: Appropriate technical representatives for specialized repair materials should be required to meet with the Government and Contractor representatives to ensure that all parties involved are knowledgeable of the material properties and application requirements.

****

[Conduct a pre-construction conference to discuss repair materials performance requirements, control provisions, and roles and responsibilities for the Work to ensure that the Contractor's personnel understand all aspects of the repair material, its properties and application procedures. The conference must include the Contracting Officer or authorized representative, the Contractor's field superintendent and foreman, and a competent Technical Representative of the material manufacturer, and other involved trades or supplier representatives. The Technical Representative must be fully qualified to perform the work.]

]1.5.5 Work Plan

Prepare a work plan describing the methods of concrete removal and repair, including methods, equipment and materials to be used for each feature. Submit the work plan for approval at least 30 days prior to the start of the work. The plan must include, but not be limited to, repair materials to be used with specific information on products and/or constituents, and requirements for handling, storage, etc., equipment to be used, surface preparation, and requirements for placement, finishing, curing and protection specific to the materials used. Include a description of field demonstrations in the work plan. Do not commence work until the work plan and field demonstration representative of the type of work are approved.

1.6 ACCEPTANCE OF REHABILITATION WORK

1.6.1 General Requirements

a. Completed concrete rehabilitation work must conform to applicable requirements of Contract Document and this specification. The Contractor is responsible to bring Work into compliance with requirements of Contract Documents if the Concrete repair work fails to meet one or more requirements of Contract Documents.

b. Correct rejected repair work by removing and replacing or by strengthening with additional construction acceptable to the Contracting Officer. Use repair methods that meet applicable requirements for function, durability, dimensional tolerances, and appearance.

c. Submit proposed work plan, repair methods, materials, and modifications to the Work needed to correct rejected repair work to meet the requirements of Contract Documents.

1.6.2 Tolerances

a. Construction tolerances for repairs must conform to [ACI 117][_____]. Where existing conditions do not allow tolerances to conform to [ACI 117][_____], use the details and materials for such conditions as indicated in the Contract Documents. For conditions not shown or that are different than indicated in the Contract Documents, notify the Contracting Officer before proceeding with the work at those locations.[Provide a tolerence report as required by Section 03 30 00 CAST-IN-PLACE CONCRETE.]

b. Inaccurately formed concrete surfaces resulting in concrete members with dimensions that exceed [ACI 117][_____] tolerances are subject to rejection.

1.6.3 Appearance

Concrete surfaces not meeting the requirements of the Contract Documents must be brought into compliance.

1.7 PROTECTION OF COMPLETED REHABILITATION WORK

a. Do not allow construction loads to exceed the loads that a structural member or structure is safely capable of supporting without damage. Provide supplemental support if construction loads are expected to exceed safe load capacity.

b. Protect repaired and adjacent areas from damage by construction traffic, equipment, and materials. During the curing period, protect repair materials from damage by mechanical disturbances, including load-induced stresses, shock, and vibration.

c. Protect repair materials from environmental damage by weather events during the length of the curing period.

PART 2 PRODUCTS

****

NOTE: Unconventional products and materials could sometimes be the best solutions for repairs. Since the repair industry is evolving, products and materials not listed in this document that have had a record of success in the field could be allowed on a project. The Contracting Officer must permit the usage of those materials prior to application. Additional submittals for those materials should also be requested as needed.

****

Products or materials used must conform to the requirements included herein as well as the Contract Documents. The usage of other products or materials not covered by this requirement or specified in the Contract Documents are permitted upon approval by the Contracting Officer. Additional information and submittals for products and materials not included in this document including product data, samples, design data, test reports, certificates, manufacturer's instructions, and field reports must be submitted as requested by the Contracting Officer.

2.1 MATERIALS FOR SHORING AND BRACING

2.1.1 Shoring and Bracing Systems

Use commercially manufactured and engineered shoring and bracing systems and components, except where custom built assemblies of lumber or other suitable materials are permitted by the Contracting Officer.

2.1.2 Design Requirements

The design of the bracing and shoring must be based on ASCE/SEI 37.

a. Non-manufactured shoring and bracing systems must have calculations signed and sealed by a Licensed Design Professional.

b. Members of non-manufactured shoring systems, must be designed in accordance with the provisions of the governing building code for the specific material of the member.

c. Members of manufactured shoring systems, consisting of pre-engineered components designed and produced specifically for structural shoring, must be used in accordance with the manufacturer's recommendations.

2.2 EQUIPMENT FOR CONCRETE PREPARATION

****

NOTE: Refer to ACI 546R and ICRI 310.2R for more

detail guidance on methods discussed in this paragraph.

****

Means and methods used for concrete removal and surface preparation must be selected and used such as to minimize damage to the structure and to the concrete substrate that remains.

2.2.1 Equipment for Concrete Removal

Removal equipment and techniques must be suitable to produce concrete surface profiles and level of cleanliness in designated areas as required by this specification and the contract Documents.

[2.2.1.1 Cutting Equipment

****

NOTE: Cutting equipment and methods are used to cut and remove concrete sections. Include this paragraph if cutting equipment and methods are required or permitted for concrete removal.

****

a. The following cutting equipment are permitted: [High-pressure water jet without abrasives][Saw cutting][Diamond wire cutting][Mechanical shearing][Stitch drilling][_____].

****

NOTE: Refer to ACI 546R for details on selecting the different equipment and methods for cutting concrete.

****

b. Cutting, lifting, and transporting equipment must be adequate to cut, support, and transport concrete sections without incurring any damage to the existing structure.

]2.2.1.2 Concrete Breakers

****

NOTE: concrete breakers are also known as impact methods. These are the most commonly used methods for concrete removal.

****

a. Provide sharp tips on breaker equipment to minimize microcracking damage in partial depth removal.

****

NOTE: Sharp-pointed tools tend to reduce the potential for microcracking of the surface concrete left in place.

****

b. The use of the following impact equipment and methods is permitted: [Hand-held breakers][Boom-mounted breakers][Scabblers][Needle scalers][Scarifiers][Milling methods][_____].

c. [The maximum breaker size is [_____]][_____].

****

NOTE: Use the information provided in this note and ACI 546R to select the suitable type and size of impact breakers allowed on the project (bullet point b and c). Note that you can include different types and sizes of breakers for a job and specify where each should be used. Using large breakers increases the potential for microcracking, and that is why a suitable size (or limits) should be specified.

Hand-held breakers (chipping hammers): size ranges from 8 to 90 lbs (3.5 to 41 kg). Smaller hand-held breakers are commonly used in partial depth removal of sound and unsound concrete and concrete removal around reinforcing steel because they minimize damage to the existing concrete and reinforcing steel. Larger breakers are used for removal of large volumes of concrete. For example, a 14 kg (30 lbs) breaker can be specified for removal of concrete above reinforcing steel while a smaller 7 kg (15 lbs) hammer can be specified to remove concrete around reinforcing steel.

Boom-mounted breakers: is like the hand-held breaker except that it is mechanically operated and considerably larger than a handheld breaker.
Boom-mounted breakers differ from hand-held breakers as they function on the principle of high energy and low frequency rather than low energy and high frequency, and are driven by compressed air or hydraulic pressure. The reach of the hydraulic arm enables the breaker to be used on vertical or overhead surfaces at a considerable distance above and below the machine level.
The boom-mounted breaker is a highly productive means of removing concrete; however, the high-cycle impact energy delivered to a structure by the breaker generates forces that may damage the existing concrete and reinforcing steel and adversely affect the integrity of the structure.
For boom-mounted breakers, limits specified are based on energy not weight (example 205 N-m or 150 ft-lbs).

Milling methods can remove a specified amount of concrete from large areas of horizontal or vertical surfaces. The removal depth typically ranges from 1/4 to 4 in. (6 to 100 mm). Removal depth is determined by the number and size of teeth. Milling operations typically leave a sound surface with fewer microfractures than impact methods.
Rotary head milling equipment is used for uniform depth removal on horizontal or vertical surfaces.
Boom-mounted milling head are used typically for vertical surfaces.

For information on Scabblers, Needle scalers, and Scarifiers refer to ACI 546R.

****

[2.2.1.3 Hydromilling Equipment

****

NOTE: Delete this paragraph if water blasting equipment is not allowed on the job. For more information on hydrodemolition refer to ACI 546R and ICRI 310.3R.

****

a. Hydromilling equipment must include a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water re-supply equipment. The water tank and auxiliary re-supply equipment must be of sufficient capacity to permit continuous operations.

b. Hydrodemolition for concrete removal is permitted in the following locations: [_____]

****

NOTE: Specify where (the locations) hydrodemolition is permitted to be used for concrete removal.

****

c. Use protective covers and barriers to protect adjacent surfaces not intended to be repaired from water blasting and over-spray.

d. Use equipment capable of delivering pressures of 35 MPa 5000 psi to 275 MPa 40,000 psi at 7.5 liters/min 2 gal/min to 190 liters/min 50 gal/min for concrete removal and surface preparation.

e. [Noise resulting from hydrodemolition operations must be at a noise level of less than [90 decibels][_____] at a distance of [15 m 50 ft.][_____].]

****

NOTE: Hydrodemolition does not produce significant sound that is transmitted through a structure; however, the noise from the hydrodemolition unit in the work area is sufficiently loud and may be objectionable to the public. If noise resulting from hydrodemolition operations need to be controlled, then add the above requirement and make changes to it as needed

****

]2.2.2 Surface preparation and cleaning equipment

[2.2.2.1 Abrasive Blasting

a. Use [dry][wet][dry or wet] oil-free abrasive blasting capable of removing loose micro-fractured (bruised) or otherwise damaged or pulverized concrete surfaces, and rust from exposed steel reinforcement, and providing a surface profile in compliance with the Contract Documents.

****

NOTE: Choose if dry or wet abrasive blasting can be

used. Refer to ACI 546R for more information on the topic.

****

b. [Use the following abrasive blasting methods: [Sandblasting] [Shotblasting] [_____]]

****

NOTE: Add this requirement if methods of abrasive blasting need to be specified. This requirement can be expanded to include locations where certain methods of abrasive methods should be used. If this is needed, then specify the method along with the location that it should be used.

****

][2.2.2.2 Low Pressure Water Cleaning

Use equipment capable of delivering 7 MPa 1000 psi to 35 MPa to 5000 psi at 7.5 liters/min 2 gal/min to 38 liters/min 10 gal/min for cleaning loose material from repair areas.

]2.2.2.3 Other Cleaning Equipment

Use equipment that delivers oil free air capable of cleaning loose material and debris from repair areas. If necessary to dry the concrete surface, [gas-fired torches or] clean, dry, compressed air may be used. Also, use vacuums capable of removing loose material and debris.

2.3 MATERIALS FOR FORMWORK AND EMBEDDED ITEMS

a. Formwork and embedded items must meet the requirements specified in Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][_____].

****

NOTE: Formwork requirements for repairs are similar to requirements for new construction. Formwork should be designed to support repair material pressures as well as pressure resulting from placement and consolidation vibrations. Formwork should also be designed to maintain specified dimensional tolerances.

****

b. Install and remove formwork without damaging or staining the existing structure or repair material.

c. Forms used for polymer concrete/mortars must be tight enough to hold the material that is used without leaking. All surfaces where bond is not desired, but which are exposed to the monomer or resin, must be treated with a form release agent.

****

NOTE: Some polymers/resins/monomers have low viscosity and might require tighter forms than what is usually used for portland cement concrete.

****

2.4 REINFORCEMENT AND REINFORCEMENT SUPPORTS

2.4.1 Steel Bars, Wires, and Fiber-reinforced Concrete

a. Reinforcement and reinforcement support must meet the requirements specified in Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][_____].

****

NOTE: Conventional reinforcement used for repairs is no different than reinforcement used for new construction.

****

b. Repair coating damage incurred during shipment, storage, handling, and placing of reinforcing bars in accordance with [the appropriate ASTM standard practices for repair of damaged reinforcement][ASTM A780/A780M][ASTM A775/A775M][ASTM A934/A934M][_____]. Damaged areas must not exceed 2 percent of surface area in each linear foot of each bar.

****

NOTE: Coated reinforcing bars often incur damage during transportation and handling. Coated reinforcing bars are used to mitigate corrosion and that is why it is important to ensure that they are not damaged and the cause of future localized corrosion failures.

ASTM has several documents that discuss practices for repair of damaged bars. ASTM A780/A780M discusses the repair Zinc-coated reinforcing bars, while ASTM A775/A775M and ASTM A934/A934M discuss practices for repair of epoxy-coated bars (See ASTM standards for other types of bar repairs). Specify a standard for repair of bars as needed in your project. If the statement "...in accordance with the appropriate ASTM standard practices for repair of damaged reinforcement" is selected, then it will be up to the Contractor to choose the ASTM standard for repair when multiple standards exist.

****

c. Mechanical splices for coated reinforcement must have compatible coatings, in accordance with manufacturer's instructions. Splices for galvanized reinforcement must be galvanized or coated with dielectric material. Splices used with epoxy-coated or dual-coated reinforcement must be coated with dielectric material.

d. Submit mill certificates and shop drawings as requirement by Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][_____].

2.4.2 Fiber-Reinforced Polymers

****

NOTE: Fiber-Reinforced Polymers (FRP) include FRP bars and FRP laminates. FRP bars are used inside (and sometimes outside) the concrete to replace

conventional steel reinforcement. FRP laminates are attached outside concrete members mainly for strengthening purposes. For more information on FRP bars and laminates, refer to ACI 440 documents.
****

a. Fiber-Reinforced Polymers (FRP) bars used as internal reinforcement in concrete and their supports must meet the product requirements of ACI 440.5 and conform to [ACI 440.6][_____].

****
NOTE: ACI 440.5 and ACI 440.6 are two ACI specifications related to the use of FRP bars in concrete. ACI 440.5 is a construction standard, while ACI 440.6 is a material standard. ACI 440.6 was written by an ACI committee as the basis of a future ASTM standard. If ACI 440.6 is withdrawn and adopted by ASTM, refer to the ASTM material standard instead of ACI 440.6.
****

b. Submit test reports and certificates for FRP bars as required by ACI 440.5 and the Contract Documents.

c. Fiber-Reinforced Polymer (FRP) laminate materials externally bonded to concrete made by wet layup must meet the requirements of ACI 440.8 and the Contract Documents. Submit product data sheets for materials used for FRP layup systems as described in ACI 440.8.

d. The use of externally bonded FRP systems other than wet layup systems are permitted upon approval by the Contracting Officer. Submit product and materials data, design data, test reports, certificates, manufacturer's instructions, and field reports for those systems as requested by the Contracting Officer and required by Contract Documents.

****
NOTE: To learn more about commercially available externally bonded FRP systems refer to ACI 440.2R.
****

2.5 CONVENTIONAL CONCRETE

****
NOTE: Conventional concrete used for repairs has the same base requirements as concrete used for new construction.
Additional requirements to consider in material selection include:
- Good tensile bond, to have a strong bond between the repair and substrate.
- Modulus of elasticity similar to substrate.
- Low drying shrinkage so that the material does not lose volume over time.
- Matching coefficient of thermal expansion with the substrate by using similar coarse aggregate type. Materials with different coefficients of thermal expansion will shrink/expand at different rates and cause cracking or spalling.
- Low creep so that the repair does not relax over

time due to loads.
Note that these material requirements and properties should have been considered in the design phase.
Refer to ACI 546R, ACI 546.3R, and ICRI 320.2R. for more information the selection of materials for repair.

****

a. Portland cement concrete materials must meet the requirements specified in Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][_____].

b. Materials for shotcrete must meet the requirements of Section 03 37 13 SHOTCRETE.

c. [For cement based bonding systems use neat portland cement or a blend of portland cement and an ASTM C33/C33M fine aggregate filler proportioned one to one by mass. The water-to-cement ratio of the bonding mixture must be [equal to the water-to-cement ratio of concrete used as a repair or overlay material][_____]. Water used must meet ASTM C1602/C1602M requirements.]

****

NOTE: If the use of cement based bonding agent is not permitted, delete this requirement. If it is permitted, then specify the water-to-cement ratio for that mixture.

****

d. [Use cementitious materials indicated in the Contract Documents.][Use cementitious materials of the same brand and type from the same manufacturing plant as the cementitious materials used in the concrete represented by the submitted field test records or used in trial mixtures.][_____]

****

NOTE: If information on cementitious materials is provided in the Contract Documents, then the first part of the requirement should be sufficient. If the information on cementitious materials is not provided, the second part of the requirement will require the use of materials that match the existing concrete (substrate).
Using similar cementitious materials is prescribed to have compatibility between the repair material and the existing substrate. The use of incompatible materials can cause deterioration at the interface between the existing and new concrete due to differential volume changes.
Note that this requirement is only applicable if the materials originally used for the substrate were adequate and not the cause of deterioration.
Material selection should have been considered in the design phase of the repair.

****

e. Aggregates used in concrete must be obtained from the same sources [,be of the same type][and have the same size range] as aggregates used in the concrete represented by submitted historical data or used in trial mixtures.

****

NOTE: Like cementitious materials requirements, aggregates used for concrete need to be compatible with the existing concrete.

Only require the same size range of aggregate if it is appropriate for the repair. Remember that the maximum coarse aggregate size should not exceed three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs, overlays, or partial depth repairs.

****

f. Refer to Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][03 37 13 SHOTCRETE][_____] for details on submittals involving conventional concrete.

2.6 POLYMERS

****

NOTE: For more information on polymers and their use in repair, refer to ACI 503, 546, 548, RAP (Repair Application Procedures) documents and ICRI 320.2R.

When selecting polymers for repairs, select the material based on the desired properties. Some polymers like epoxies are well defined and standardized which makes specifying them much easier. Other materials like urethanes are not well standardized for usage in construction. These should only be specified after reviewing information obtained from the material manufacturer and comparing that to the desired properties needed for the repair.

Some of the properties to consider when specifying these materials are: working time of the material, curing times and requirements, viscosity and the ability to penetrate cracks, resistance to temperature changes, sensitivity to light (UV rays) and other exposures, thickness of material required, strength, flexibility and rigidity, and compatibility with other materials.

****

a. The requirements for the properties of polymers and aggregates used in polymers must meet the requirements specified in this paragraph as well as the properties specified in the referenced specifications and the Contract Documents.

b. Polymers used must be compatible with other polymers and materials used on the project. Unless repair materials are specified in the contract documents, the Contractor is responsible for verifying material compatibilities.

****
NOTE: Material compatibility is vital in repairs. Make sure that you specify materials that will work well together and work well with concrete.
****

c. Submit product data, manufacturer's Safety Data Sheets,samples, design data, test reports, certificates, manufacturer's instructions, and field reports for materials as required by this document as well as the referenced specifications and the Contract Documents.

2.6.1 Epoxies

****
NOTE: Epoxy mortars and concrete do not have thermal characteristics compatible with portland cement concrete. This thermal incompatibility should be carefully considered before specifying epoxy mortar or concrete for exterior concrete surface repairs.
For example, when used to repair cracks, limit their use to cracks ranging from 0.002 to 0.25 in. (0.05 to 6 mm) wide; a thicker cross section of the epoxy in a crack exposed to large temperature variations can cause internal stresses in the repaired concrete. Moreover, epoxy should not be used to repair active cracks (still moving) because cracks parallel to the original cracks are likely to occur.

For more information on epoxies and crack repair refer to ACO 546R, ACI 546.3R, and ACI 548.1R.

****

a. Epoxy mortars and epoxy compounds must conform to ASTM C881/C881M [.][,Type [_____]; Class [_____]; Grade [_____]; [_____].]

b. Epoxy mortars used for repairing defects in hardened portland cement concrete must meet the requirements of ACI 503.2-503.4.

c. Epoxy used for crack repair must meet the requirements of ACI 503.7.

****
NOTE: Epoxy is one of the main polymer materials used for crack repairs. Crack repair are usually either for structural purposes (strength related) or for sealing cracks (stop water and other materials from passing through). Because of their bond strength, epoxies are the main materials used for structural crack repairs. They should however not be used with active cracks. Refer to ACI 546R and 546.3R for more details.

Also, note that ASTM C881/C881M, Type IV, Grade 1 is good for repairing crack sizes from 0.005 to 0.010 in. (0.13 to 0.25 mm). Smaller cracks may not need repair. For larger cracks, a more viscous epoxy may

be appropriate (ACI RAP 1 and ACI 503.7).

****

d. Epoxy used to produce a skid-resistant surface on hardened concrete must meet the requirements of ACI 503.3.

e. Epoxy used for overlays must meet the requirements of [ACI 548.8][ACI 548.9].

****

NOTE: ACI 548.8 covers Epoxy multi-layer overlays while ACI 548.9 covers epoxy slurry overlays (for Bridge and Parking Garage Decks). Refer to those documents for more details.

****

f. Epoxy used for bonding freshly mixed concrete and hardened concrete must meet the requirements of ASTM C881/C881M, Type [II][V], Grade [2][3], Class [A][B][C].

****

NOTE: Type II adhesives are used in non-load-bearing applications, whereas Type V are for load-bearing uses. Grade 1 materials are low viscosity (not to be used for this application). Grade 2 materials are medium viscosity. Grade 3 materials have a non-sagging consistency. Class A materials are used when temperatures are below 40°F (4°C), Class B materials are used when temperatures are typically between 40 and 60°F (4 and 16°C), and Class C materials are used when temperatures are above 60°F (16°C) with upper limits set by the manufacturer.

Refer to ASTM C881/C881M for more information about types, grades, and classes of epoxies.

Refer to ACI 548.11R for more information about epoxy used as bonding agent.

****

g. Epoxy used for bonding hardened concrete and steel to hardened concrete must meet the requirements of ACI 548.12.

2.6.2 Latexes

a. Latex used in polymer modified portland cement concrete/mortar must meet the requirements of ASTM C1438.

b. Latex used in polymer modified portland cement concrete overlays must meet the requirements of ACI 548.4.

c. Latex used for bonding freshly mixed concrete and hardened concrete must meet the requirements of ASTM C1059/C1059M, Type II.

****

NOTE: Refer to ASTM C1059 for more information about latex used as bonding agent. Also, refer to

ACI 548.12 for information about use and application of this material.

****

2.6.3 Methacrylates

****

NOTE: Per ACI 546R, methacrylates have high adhesive strength and can bond cracks as a structural repair. Methacrylates can therefore be used to restore strength (like epoxies) to a structural as well as for sealing cracks.

****

a. Methyl methacrylate slurry (MMS) used for overlays must meet the requirements of ACI 548.10.

b. High molecular weight methacrylate (HMWM) must be a 2-component, rapid curing, and solvent-free system.

c. HMWM monomers must be a high molecular weight or substituted methacrylate that conforms the following properties:

d.

Physical Properties of HMWM Monomer		
Property	Test Method	Criteria
Vapor Pressure Flash Point Density	ASTM D323 ASTM D93	Less than 133 Pa at 25 degrees C Greater than 93 degrees C Greater than 1.0 g per cubic cm at 25 degrees C Less than 0.02 psi at 77 degrees F Greater than 200 degrees F Greater than 8.4 lbs. per gal. at 77 degrees F
Viscosity Index of Refraction Boiling point @ 133 Pa 0.02 psi Shrinkage on cure	ASTM D4016 ASTM D542 ASTM D1078	0.012 ± 0.004 Pas at 23 degrees C; 1.470 ± 0.002 70 degrees C Less than 11 percent 12 ± 4 cps at 73 degrees F 1.470 ± 0.002 158 degrees F Less than 11 percent
Glass Transition Temperature (DSC)	ASTM D3418	57.2 degrees C 158 degrees F
Curing Time (100 g mass)	ASTM D3418	Greater than 40 minutes at 25 degrees C, with 4 percent cuemene hydroperoxide Greater than 40 minutes at 73 degrees F, with 4 percent cuemene hydroperoxide
Bond Strength	ASTM C882/C882M	Greater than 10.3 mPa Greater than 1,500 psi

e. The initiator/promoter system for HMWM must be capable of providing a surface cure time of not less than 40 minutes nor more than 3 hours at the surface temperature of the concrete during application. The initiator/promoter system must be such that the gel time may be adjusted to compensate for changes in temperature that may occur throughout the treatment application.

f. The initiator/promoter system for HMWM must meet the following criteria: (1)

Initiator Cuemene Hydroperoxide	78 percent
Promoter Cobalt Napthenate	6 percent

[2.6.4 Other Polymers

****

NOTE: There are many types of polymers that could be used for concrete repair. Some of them however can vary a lot in properties and are not well defined or standardized in the construction industry. These materials should only be used after understanding their properties. Refer to ACI 546R and 546.3R for more information.

Note that not all polymers have similar properties and thus are usage specific. For example, while a polyurethane grout could be used to seal cracks, it will not restore structural strength like epoxies or methacrylates do. The polyurethane however could be a better choice than an epoxy if a crack is active and the only reason for using the polyurethane is to seal cracks and stop water from going through.

****

The use of [urethanes][silicones][acrylics][_____] is permitted.

****

NOTE: Choose the types of polymers (other than epoxies, latexes, and methacrylates) that can be used on your project. You could also add to this the locations where those materials could be used and where they should not.

****

Submit [product data], [samples], [design data], [test reports], [certificates], [manufacturer's instructions] for acceptance by the Contracting Officer.

****

NOTE: Based on the materials being specified, specify the submittals required by the Contractor.

****

]2.6.5 Aggregate

a. Unless otherwise specified or recommended by the polymer material manufacturer, aggregate used with polymers must meet ASTM C33/C33M requirements.

b. Aggregate properties and proportions used with polymers must meet the requirements of the polymer material manufacturer, the requirements of the referenced polymer standard, and the Contract Documents.

c. Aggregate used with polymers must be dry and free of dirt, asphalt, and other organic materials. Aggregate moisture content must be less than [0.2][1][_____] percent by weight.

****

NOTE: If a specific moisture content for aggregate is required, add this requirement in c. ACI 548.1R recommends a moisture content of less than 1 percent for use with polymers. Note that some referenced standards do have limits specified.

****

d. For patch repairs, the maximum-sized aggregate must not be greater than one third the depth of the patch area.

2.7 MISCELLANEOUS MATERIALS AND EQUIPMENT

2.7.1 Packaged and proprietary materials

****

NOTE: Material properties and durability requirements for this material should be included in the Contract Documents. Specify submittals required for those materials.

****

The required properties for the materials listed in this paragraph must meet the properties specified in the Contract Documents. Submit [Product data], [samples,] [design data,] [test reports,] [certificates,] [manufacturer's instructions], [and field reports] as required by the Contracting Officer and the Contract Documents.

a. Packaged, rapid hardening concrete repair materials must conform to ASTM C928/C928M.

b. Packaged, mortar and concrete must conform ASTM C387/C387M.

c. Rapid hardening cement must conform to ASTM C1600/C1600M.

Water used with packaged and proprietary materials must meet ASTM C1602/C1602M requirements. Aggregates must meet the repair material manufacturer's requirements if available and ASTM C33/C33M if such requirements are not specified.

2.7.2 Bond Breakers

****

NOTE: Bond breakers are used as separator layers between existing concrete and overlays in unbonded overlay construction. The performance of unbonded resurfacing of concrete pavements depends largely upon obtaining effective separation between the two

pavements. Because unbonded resurfacing is generally for concrete pavements in a more advanced state of deterioration, distresses in the underlying pavement can reflect through the resurfacing and compromise its performance if not addressed. To minimize the effect of the distresses in the underlying pavement on the performance of the unbonded resurfacing, a separator layer is placed so that the two pavements act independently of each other. It may be less expensive and enhance longevity to simply fill low spots with concrete in the resurfacing process. A wide variety of materials have been used as separator layers, including polyethylene sheeting, wax-based curing compounds, liquid asphalts, and hot-mix asphalt materials. The most common successful used separator layer is 1 in. (2.5 cm) of asphalt. Less than 1 in. (2.5 cm) thick asphaltic separator layers, such as slurry seals, have worked well in some cases, but are generally not recommended because they do not eliminate mechanical interlock, they erode near the joints, and they do not effectively separate the two layers. Polyethylene sheeting and curing compounds are also not recommended. They do not prevent working cracks from reflecting through the resurfacing and they trap moisture in the concrete, which may accelerate freeze-thaw damage. Typically, a fine-graded asphalt surface mixture has been used for the separator layer. On most pavements, a nominal 1 in. (2.5 cm) thick layer provides adequate coverage over irregularities in the existing pavement. The thickness could be slightly increased when irregularities are large enough to impact placement operations. The separator layer does not provide significant structural enhancement; therefore, the placement of an excessively thick layer should be avoided.

For more information on overlays, refer to ACI 325.13.

****

a. Bond breaker materials must meet the requirements of [ASTM D2822/D2822M], [ASTM D4869/D4869M], [ASTM D226/D226M, Type I], ASTM D2103, and must have a minimum thickness of [0.25 mm 0.010 in.][_____], [AASHTO M 288, Erosion Control, Class B], [ASTM D450/D450M, Type II].

****

NOTE: ASTM D2822/D2822M is an asphalt roofing cement, ASTM D226/D226M and ASTM D4869/D4869M are asphalt saturated organic felt. ASTM D2103 is polyethylene sheet. AASHTO M 288 is geotextile. ASTM D450/D450M is a bituminous coating.

Note that the choice of material and thickness should have been accounted for in the design of the overlay.

****

b. Bond breaker materials used must not have detrimental effects on portland cement concrete and reinforcement.

2.7.3 Structural steel

Structural steel used for repairs must meet the requirements of 05 12 00 STRUCTURAL STEEL.

2.7.4 Concrete Accessories

****

NOTE: Any accessories specified in other sections (used for new construction) and not listed in this section should be referenced in this paragraph.

****

All concrete accessories not included in this document must meet the requirements specified in Section 03 30 00 CAST-IN-PLACE CONCRETE [and 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE].

2.7.5 Miscellaneous Equipment

a. Equipment designed specifically for the application of repair materials must be used as required by the repair material manufacturer and the referenced specification.

b. Equipment not listed in this specification but referenced or used for repairs must be clean and in good operating condition.

c. All supplies and equipment must be available in sufficient quantities to allow continuity in the installation project and quality assurance.

2.8 MIXTURE PROPORTIONING

a. Portland cement-based concrete mixtures must be in accordance with the requirements of Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][03 37 13 SHOTCRETE].

b. Polymer concrete/mortar/resin/monomer proportioning, handling, and mixing procedures as well as equipment used for mixing these materials must conform to the requirements of the referenced material specifications and the repair material manufacturer's directions.

****

NOTE: Polymers have different requirements for proportioning and mixing. This information is usually provided by the material manufacturer or in the referenced specification.

For example, for epoxies used for crack repairs, the ACI standard requires the following: "Use equipment for the two components of the injection adhesive that can establish and maintain a ratio of the components within the tolerance specified by the manufacturer of the injection adhesive over the full range of operating pressures and temperatures. If the manufacturer of the adhesive does not specify a tolerance for the mixture ratio, maintain a mixture ratio within ±3 percent of the nominal mixture ratio

specified by the manufacturer of the adhesive."
****

c. Polymer-modified portland cement concrete proportioning, handling, and mixing procedures as well as equipment used for mixing these materials must conform to the requirements provided by the repair material manufacturer as well as ACI 548.4 when such materials are used for overlays.

d. Proportioning and mixing materials not specified above must follow the requirements provided by the repair material manufacturer.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Examination

Locate area of unsound concrete or delamination using hammer sounding or chain drag sound methods in accordance to ASTM D4580/D4580M. Denote and mark perimeter boundaries and notify the Contracting Officer to approve the unsound concrete layout boundaries.

3.1.2 Protection

Protect pedestrians, motorized traffic, mechanical, electrical, and plumbing equipment, surrounding construction, project site, landscaping, and surrounding buildings from damage or injury resulting from concrete rehabilitation work.

a. Construct dust and debris barriers surrounding repair work perimeter to control dust and to protect and control construction traffic.

b. Dispose of runoff from wet demolition or surface preparation operations in accordance with all local ordinances. Disposal methods must avoid soil erosion, avoid undermining pavements and foundations, damage to landscaping and vegetation, and minimize water penetration through other parts of buildings.

c. Collect and neutralize alkaline wastes and acid wastes and dispose in accordance with local, state, and federal regulations.

d. Comply with local noise ordinances during demolition operations.

e. Perform demolition work and surface preparation work in a manner that minimizes disturbances of operations. Coordinate work with the Contracting Officer.

f. Submit a proposed protection plan for approval by owner representative and Licensed Design Professional.

3.1.3 Formwork and Shoring

Execution of formwork and shoring must meet the requirements specified in Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][_____].

3.1.3.1 Formwork

a. Construct forms to sizes, shapes, lines, and dimensions to match existing adjacent surfaces and textures. Provide forms that match openings, offsets, chamfers, anchorages, inserts and other features as described on Contract Documents. Construct forms to accommodate installation of products by other trades. Provide forms for easy removal to minimize damage to concrete surfaces and adjacent surfaces. Apply form release coating over formwork surfaces prior to each concrete placement. Form release agents must not be applied to or come in contact with the repair area concrete substrate or reinforcement.

b. Do not damage repair material during removal of formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete or repair material. Perform needed repair and treatment required on vertical surfaces at once and follow immediately with specified curing. Remove all formwork anchors embedded in existing concrete. Fill anchor holes and repair all damage to existing concrete at anchor holes.

3.1.3.2 Shoring

a. Provide shoring in accordance with the shoring drawings prior to performing work to brace the substrate structure temporarily while repair work is proceeding. Shoring must be designed, documented, and stamped by a Licensed Design Professional. Shoring designs must be submitted to and approved by the Contracting Officer prior to work commencing.

b. Leave formwork and shoring in place to support existing loads, construction loads and weight of repair material in beams, slabs, and other structural members until in-place strength of repair material determined in accordance with the Contract Documents. For post-tensioned construction, leave formwork and shoring in place until stressing is complete. When shores and other supports are arranged to allow removal of form-facing material without allowing structural slab or member to deflect, form-facing material and its horizontal supporting members may be removed at an earlier age.

****

NOTE: Formwork and shoring requirements for repairs are like requirements for new construction. Requirements unique to repair are provided here. The need for shoring is determined during the design phase. Construction loads and sequence of construction must be communicated in the Contract Documents.

****

3.1.4 Concrete preparation

a. Remove concrete as needed per the removal requirements of this section. Limits on removal equipment are specified in the paragraph titled EQUIPMENT FOR CONCRETE PREPARATION.

b. Remove foreign material, such as dirt, oil, grease, or other chemicals, from the cracks before injection using compressed air, low-pressure water, or vacuuming. Allow wet surfaces to dry at least 24 hours.

c. Immediately before placing the repair material or installing formwork, make the repair area available for inspection by the Contracting Officer. Obtain acceptance by the Contracting Officer of surface preparation before proceeding with Work. If the Work is rejected, perform additional operations to the satisfaction of Contracting Officer.

d. [Perform tensile pull-off tests in accordance with ASTM C1583/C1583M and guidance at [location]. Pull-off strength must meet or exceed [250 psi 1.7 MPa][_____]. [Test a minimum of 3 specimens at locations no greater than 420 square meters 500 square yards of prepared surface.]]

****

NOTE: If the adequacy of the prepared substrate is required, add the tensile pull-off test. Additional guidance is provided in ICRI 210.3R. The surface profile is determined by the designer for the repair. This may vary for the different repair methods and for the same repair method within same project. ICRI 310.2R and ACI 546R provide guidance on selecting surface profiles for various repairs. The profile is often stated in the Contract Documents along with the repair method, repair material, extent of repair, and sequence of Work.

****

e. [The prepared surface must have a concrete surface profile equivalent to CSP [_____] as defined by ICRI 310.2R].

****

NOTE: If a specified Concrete Surface Profiles (CSP) is desired, specify surface profiles based on ICRI 310-2R. CSP 1:acid-etched ; CSP 2:grinding ; CSP 3:light shotblast ; CSP 4:light scarification ; CSP 5:medium shotblast ; CSP 6:medium scarification ; CSP 7:heavy abrasive blast ; CSP 8:scabbled ; CSP 9:heavy scarification—rotomilled ; CSP 10:handheld concrete breaker followed by abrasive blasting. Refer to ICRI 310-2R for more details on surface profiles.

****

3.1.5 Quality Control

3.1.5.1 Quality control of surface preparation

Evaluation of prepared substrate must be continuously monitored to assure that the prepared substrate surface meets project requirements.

3.1.5.2 Quality control of repair overlays

All components of overlay PPCC materials must be certified by the material manufacturer or aggregate supplier to meet all project testing requirements. During the PPCC overlay, take mixed samples and check that the materials are mixed properly. Confirm that the right PC overlay thickness was applied by recording the volume of PC overlay materials and the substrate surface area covered by the overlay.

3.1.6 Curing

a. For portland cement concrete Work, follow the requirements indicated in [03 30 00 CAST-IN-PLACE CONCRETE][_____].

b. For polymer concrete/mortar Work, follow [manufacturer's requirements for curing][_____]

****

NOTE: Polymers have curing requirements different than portland cement concrete. Follow manufacturer's requirement in addition to ACI specifications for that specific polymer if available. Refer to ACI 548 documents for additional information or referenced specification

****

c. For polymer modified portland cement concrete Work follow [manufacturer's requirements for curing][_____].

****

NOTE: ACI 548.4 covers latex-modified concrete overlays. Refer to ACI 548.4 and the manufacturer's requirements if using latex modified concrete for overlays.

****

3.1.7 Clean up

a. Clean and remove all spills and leaks of injection adhesive and stains caused by the injection adhesives.

b. Dispose wastewater used for cutting and cleaning without staining or damaging the existing surfaces of the structure or the environment of the project area. The method of disposal must meet all the requirements of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

3.1.8 Safety

a. Provide Material Safety Data Sheets (MSDS) for products on site reviewing them before work begins.

b. Provide safety guards, maintenance, and warnings for all machinery and equipment.

c. Have personal protection equipment practice in place - eye protection and face guards.

d. Have all workers in contact with wet cementitious material wear protective gloves and clothing.

e. Provide eyewash facilities on-site with location signage.

f. Provide dust masks for workers operating mixers.

g. Have confined space procedures in place including adequate ventilation in closed spaces before operating equipment or using products that emit potentially dangerous or toxic exhaust, fumes, or dust.

h. Provide secured storage available for all hazardous or flammable materials.

i. Conduct safety meetings prior to beginning repair operations.

3.2 CRACK REPAIR

3.2.1 Preparation

3.2.1.1 General Requirements

a. Clean all cracks in accordance with the paragraph titled Concrete Preparation.

b. Do not repair cracks when the temperature of the concrete is below freezing and moisture conditions indicate the possibility of ice on the internal surfaces of the crack.

c. Do not apply adhesive if the temperature of the concrete is not within the range of application temperatures recommended by the manufacturer of the adhesive.

3.2.1.2 Crack routing

Inspect surfaces adjacent to crack to receive repair material. If deteriorated, route a V-groove section at the crack face until sound concrete is reached.

3.2.1.3 Sealing

a. For epoxy injection, apply a surface seal over all exterior faces of the crack that can be reached to contain the injection adhesive in the crack.

b. For gravity fill repairs, apply a surface seal along the bottom surface of the element that can be reached to contain the repair material in the crack.

3.2.2 Application

3.2.2.1 Epoxy Injection

a. Install the injection entry and venting ports using flush mounted or drilled fittings per proprietary manufacturer's instructions.

b. Space the ports at [a distance equal to the thickness of the member] [200 mm 8 in.].

c. Inject the epoxy using material manufacturer's recommended equipment.

d. Apply recommended manufacturer's injection pressure.

e. For vertical or inclined cracks, apply injection by pumping epoxy into entry ports at the lowest elevation, cap, and move upward.

f. For horizontal cracks, apply injection by proceeding from one end of the crack to the other until the crack is fully sealed.

g. [After 10 min., repeat injection procedure until all ports refuse injection.]

h. [Remove ports and remove the surface seal by [heat,] chipping, or grinding or other acceptable means after the injected epoxy has cured.]

****

NOTE: Epoxy injection is a structural repair of the concrete. Epoxy resin is a thermosetting polymer that cures when mixed with a catalyzing agent or hardener. Once cured, epoxies have exceptional physical properties. Epoxies are recognized for their superior bond strength to concrete, which typically exceeds the tensile strength of normal concrete. Epoxies are used to repair cracks that typically range from 0.002 to 0.25 in. (0.05 to 6 mm) wide. Epoxy resin should only be used in nonmoving or dormant cracks. Reference ACI RAP-1, ICRI 210.1R, and ACI 503.7.

****

3.2.2.2 Gravity fill

a. Mix resin or monomer per material manufacturer's instructions.

b. Pre-fill cracks at least 3 mm 0.125 in. wide with aggregate.

c. Pour resin or monomer onto the surface, over the cracks and spread with brooms, rollers, or squeegees.

d. Work material back and forth over the cracks to maximize fill in crack.

e. Allow at least [20 minutes][_____] for material to penetrate cracks.

f. Remove excess material once cracks have been filled to refusal.

g. [Broadcast [0.5 to 1.0 kg per square meter 1 to 2 lbs per square yard][_____] of sand.]

h. Allow material to cure per material manufacturer's recommendations.

i. [Remove sealant and grind smooth.]

****

NOTE: The primary objective of this repair is to fill the crack and structurally bond the concrete on both sides of the crack. This repair is to seal cracks that are not moving. By penetrating and filling the cracks, the resin can form a polymer plug that seals the crack, keeping out water, chlorides, carbon dioxide, sulfates, and other aggressive liquids and gases. This repair can only be applied to horizontal concrete elements such as slabs. The two most common polymer materials used for gravity feed crack repairs are epoxies and high molecular weight methacrylates (HMWM); more information on material selection is given in PRODUCTS. Use sand if a skid-resistant surface is desired or grind for a smooth surface. Reference ACI RAP-2, ACI RAP-13, and ACI 546R.

****

3.2.3 Quality Control

a. [Conduct quality [and control] tests for metering accuracy and mixing effectiveness of the continuous mixing pump in accordance with ACI 503.7.]

b. Qualify the test injection procedures in accordance with ACI 503.7.

3.2.4 Acceptance Criteria

3.2.4.1 Core Sampling

a. Obtain core samples in accordance with ASTM C42/C42M.

b. Allow 24 hours after injection before coring.

c. Obtain cores in a manner that includes as much of the bond line of the repaired concrete as possible. Replace cores that do not intersect the crack for at least 75 percent of the length of the core.

d. Obtain three diameter core from first 30 m 100 ft. and one core for each 30 m 100 ft. thereafter.

e. If cores would sever reinforcing steel or other embedded items, do not core, and notify the Contracting Officer so that an alternative location can be chosen.

f. Obtain cores at least 50 mm 2 in. in diameter for visual inspections and at least 100 mm 4 in. in diameter for the splitting tensile test. Perform a splitting tensile test on one core from the first 30 m 100 ft. and one core for each 75 m 250 ft. thereafter.

g. Fill core holes with [non-shrink grout][_____].

****

NOTE: In some cases, a 50 mm (2 in.) diameter cores may not be wide enough to intersect cracks that may not be perpendicular to the surface where the core is drilled.

****

3.2.4.2 Core Testing

a. Test a portion of the core samples for the splitting tensile strength in accordance with ASTM C496/C496M.

b. Allow 72 hours after injection before beginning splitting tensile tests

c. Prepare core sample per ASTM C42/C42M.

d. Align the core so that the crack is in a plane as close to vertical as possible.

****

NOTE: Testing for the splitting tensile strength is only necessary for structural repairs, where returning the concrete to its original strength is required by the project.

****

3.2.4.3 Acceptance

Work is acceptable if at least 90 percent of the depth of the crack in each core is filled with adhesive [and a or b is met][_____].

a. [The splitting tensile strength of the core is at least 90 percent of the splitting tensile strength of a core taken from an uncracked area within 300 mm 12 in. of the repaired crack.]

b. [A splitting tensile test of the core indicates that no more than 10 percent of the bonded area of the crack in each core exhibits combined areas of separation of the adhesive from the concrete or cohesive failure within the adhesive.]

3.3 CORROSION AND SURFACE REPAIR

3.3.1 Preparation

3.3.1.1 Identification of Extent of Concrete Removal

a. Configure geometry of removal area to maximize the use of right-angle geometry, avoiding reentrant corners, and to obtain uniformity of depth. Determine the depth, location, and size of reinforcing bars prior to removal of concrete.

b. [Perform visual inspection and hammer tapping, chain drag sounding, or other methods acceptable by the Contracting Officer to identify cracked, delaminated, spalled, disintegrated, and otherwise unsound concrete for removal. Mark boundaries of repair area before concrete removal.] [_____]

****

NOTE: The methods listed above are the basic methods commonly used to detect delamination. For more specialized methods refer to ACI 228.2R and add the desired methods above.

****

c. Inspect the marked boundaries with the Contracting Officer prior to commencing with the concrete removal. Revise the repair area boundaries as instructed by the Contracting Officer.

3.3.1.2 Shoring and Formwork

a. Provide shoring and formwork per the paragraph titled Formwork and Shoring.

b. For post-tensioned concrete, detension strands and wires as required by Contract Documents prior to repair.

3.3.1.3 Concrete Removal

a. Remove concrete from repair areas to indicated depth and profile. Notify Contracting Officer if additional delaminated, fractured, or unsound concrete is present.

b. Do not damage embedded reinforcing and adjacent concrete. The removal methods must produce minimal microcracking (bruising) of the prepared substrate surfaces. Avoid directly striking reinforcing steel with impact tools used for concrete removal.

c. Provide perpendicular edges at perimeter of repair area. The perimeter of the repair areas must be saw cut to a depth of 0.50 to 0.75 in. 15 to 20 mm. [For vertical or overhead surfaces, provide 45-degree slope at repair boundaries to facilitate air and rebound escape.] Do not cut or damage embedded reinforcement or other embedded items. If embedded reinforcing steel or other embedded items are too close to the surface to provide the perpendicular edge cut, notify the Contracting Officer for direction before proceeding.

d. Extend concrete removal along the corroded reinforcing steel to a point where there is no further delamination, concrete cracking, or reinforcing steel corrosion, and where the reinforcement is bonded to the surrounding concrete.

e. Remove concrete around the exposed layer of reinforcement to a uniform depth beyond within the repair areas to provide a minimum clearance between exposed reinforcing steel and surrounding concrete of [0.75 in. 20 mm][_____], or at least 0.25 in. 5 mm larger than the maximum nominal size of the coarse aggregate in the repair material.

f. [Do not remove concrete behind vertical reinforcing bars in columns.]

****

NOTE: Indicate conditions where it is allowable to remove concrete behind vertical reinforcing in columns such as for lightly loaded or non-structural columns or if other methods such as phased repairs or supplemental restraint of bars to prevent buckling are incorporated to facilitate such removal.

****

3.3.1.4 Preparation of Concrete Substrate Surface

a. Confirm perpendicular edges at repair area perimeter, and reinstate if damaged by concrete removal process. Remove loosely bonded concrete, bruised or fractured concrete, and bond-inhibiting materials such as dirt, concrete slurry, or any other detrimental materials from the concrete substrate using approved methods. Where concrete has been removed by impact methods, abrasive blasting must be used to prepare the surface and remove bruised concrete.

b. Provide substrate surface profiles as specified in the Contract Documents.

c. Visually inspect and sound substrate surface to confirm that no further delaminations or otherwise unsound concrete remains. If encountered, notify the Contracting Officer.

d. Clean the substrate per the paragraph titled Concrete preparation.

3.3.2 Application

[3.3.2.1 Existing Reinforcement Preparation

a. Clean existing reinforcement that will remain. Remove corrosion and/or other laitance and notify the Contracting Officer if section loss is greater than [20%][_____].

b. [Replace coating on reinforcement per [ASTM A780/A780M][ASTM A775/A775M][ASTM A934/A934M][_____]. Exposed areas must not exceed 2 percent of surface area in each linear foot of each bar.]

c. [Permit evaluation of existing reinforcement and placement of new reinforcement by the Contracting Officer.]

][3.3.2.2 Placement of New Reinforcement

Placement of new reinforcement

a. Placement of new reinforcement to replace or strengthen existing reinforcement is like new construction. Placement, splicing, and handling of new reinforcement must meet the requirements specified in Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][_____].

b. Reinforcement must be free of materials deleterious to bond. New reinforcement with rust, mill scale, or a combination of both will be considered satisfactory, provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of a hand-wire-brushed test specimen are not less than applicable ASTM specification requirements.

]3.3.2.3 Placement of Concrete

a. [If portland cement concrete is used as the repair material, follow the requirements indicated in [03 30 00 CAST-IN-PLACE CONCRETE][_____] as well the Contract Document for proportioning, mixing, and placing concrete. For all other materials, follow material manufacturer's recommendations.][_____]

****

NOTE: The same requirements that apply to concrete in new construction also apply to concrete being used as repair material. For other materials, such as polymer-modified concrete or polymer concrete, follow manufacturer recommendations.

****

b. [For vertical and overhead applications of portland cement concrete, use shotcrete. Follow the requirements indicated in [03 37 13 SHOTCRETE][_____]].

****

NOTE: In some cases, such as vertical and overhead applications using shotcrete might be the best way of placing concrete. Include this provision (as presented here or modified) if shotcrete is required to be used on the project.

****

c. [A bonding agent [must be used][must not be used][_____].]

****

NOTE: Choose whether or not a bonding agent should be used to bond existing concrete to the repair

material. See PRODUCTS for discussion on use of bonding agents.

****

d. [Apply [corrosion inhibitors][sacrificial anodes][_____] as designated by the Contract Documents.]

****

NOTE: Specify if any corrosion inhibitors, sacrificial anodes, or other material should be installed prior to placement of concrete or repair material.

****

e. [Bristle broom a thin coat of the repair material into the saturated surface dry substrate filling roughened surface pores before placing the repair material in the repair area. Do not allow thin coat to dry before placing repair material.][_____]

****

NOTE: This requirement only applies when bonding agents are not used

****

f. [Consolidate the repair material after placement with a vibrating screed or internal vibrator.][_____]

****

NOTE: Specify if any alternative method of consolidation should be used.

****

g. Finish the surface to match surface finish and texture requirements indicated in the Contract Document. [Screed, float and trowel the repair material or broom the surface for non-slip texture. Follow the requirements of 03 30 00 CAST-IN-PLACE CONCRETE][For shotcrete, apply finishing techniques and requirements indicated in 03 37 13 SHOTCRETE][_____].

****

NOTE: Add requirements related to finishing concrete if needed.

****

3.3.2.4 Placement of Other Repair Materials

a. Equilibrate repair material(s) and substrate to the temperature, cleanliness of substrate and reinforcement, and moisture requirements of the repair material manufacturer's requirements.

b. Comply with the repair material manufacturer's requirements for batching, mixing, placing and curing repair materials.

c. Review consistency of the mixed repair material(s) relative to the parameters documented in the repair material manufacturer product data sheet. If non-conforming, adjust consistency in compliance with the repair material manufacturer's requirements.

d. Apply or install repair material(s) within the application time frame (pot life) requirements of the repair material manufacturer's requirements, and place and consolidate to provide well-compacted repair.

e. Finish and tool repair materials, finished in accordance with the repair material manufacturer's written instructions and as indicated in Contract Documents.

f. Protect installed repair material(s) from damage, exposure to environmental conditions that are detrimental to the uncured or cured properties of the material. Cure in accordance with the requirements of the repair material manufacturer's requirements.

3.3.3 Quality Control

a. Protect concrete surfaces, beyond limits of surfaces receiving bonding agent adhesive, against spillage. Immediately remove any bonding agent adhesive that has spilled beyond desired area. Perform cleanup with material designated by bonding agent adhesive manufacturer. Avoid contamination of work area.

b. [The bond strength between the existing concrete and the repair material must be a minimum of [1.7 MPa 250 psi][_____] per [ASTM C1583/C1583M][_____]. [Test a minimum of 3 specimens at locations no greater than 420 square meters 500 square yards of prepared surface.]]

****

NOTE: Bond tests are usually performed to evaluate bond strength between the existing concrete and the repair material. 250 psi (1.8 MPa) is a value obtained from ACI 548.10. Alternatively, the soundness of the repair can be evaluated by hammer-sounding or other non-destructive methods; hollow sounds may represent poor bond to substrate.

The testing frequency is acceptable for large repair areas, for smaller repair area specify a requirement for testing appropriate for the repair.

****

3.4 OVERLAYS

****

NOTE: Prior to specifying a certain type of overlay, the existing concrete slab must be evaluated. It is also important to understand what the different types of overlays are and when each should be used. If you would like to learn more about overlays (sometimes also referred to as "toppings"), refer to ACI 224R, ACI 302.1R, ACI 360R, ACI 325.13R, and ACI 546R. For information about polymer concrete overlays refer to ACI 548 documents.

****

3.4.1 Preparation

****

NOTE: Overlays must be properly designed and constructed for their application. Overlays are typically bonded or unbonded. If the surface is not properly designed or prepared, it can result in a partially bonded overlay. Partially bonded overlays can exhibit unanticipated random cracking and higher than expected curling/warping due to unplanned bonded and unbonded areas. For this reason, it is important for the Contracting Officer to verify that a surface was properly prepared before an overlay is placed.

****

[3.4.1.1 Bonded Overlays

****

NOTE: Bonded overlays are generally used to strengthen existing concrete surfaces or improve surface abrasion or impact resistance. The thickness of a bonded overlay as well as the type of material used should be accounted for in the design of the overlay. Materials used for bonded overlays include portland cement concrete, polymer modified concrete, and polymer concrete/mortars. In general, surface preparation requirements for bonded overlays are the same regardless of the type of material used for the overlay. Proper surface preparation is essential for the success of bonded overlays.

****

a. Provide surface preparation as required in this Section.

****

NOTE: Choose one or more mechanical abrasion method to prepare the surface of the existing slab. The surface preparation technique used should not be so aggressive that it damages the underlying pavement. An aggressive preparation technique will create a weak layer in the existing slab immediately below the bond interface that might cause the overlay to fail. For additional guidance on surface preparation, refer to ACI 546R.

If the slab being prepared for an overlay is supported, loads from equipment should have been considered as part of the design; shoring should be provided as needed.

****

b. [Repair cracks and patch deteriorated concrete prior to final surface preparation.]

c. Apply additional preparation requirements specified by the overlay material manufacturer

][3.4.1.2 Unbonded Overlays

****

NOTE: Unbonded overlays surface preparation mainly consists of installing a bond breaker (Separation Layer) over the existing concrete slab before the overlay is placed.
Per ACI 224R and ACI 302.1R, unbonded overlays are used where severe cracking is present in the base, where cracking can later develop, or when contamination of the existing slab prevents complete bond with the overlay. Unbonded overlays are not used to strengthen existing slabs and must be sufficiently thick to resist loads on their own. Per ACI 302.1R, unbonded overlays should have a minimum thickness of 3 in. (75 mm) for foot-traffic, and a minimum thickness of 4 in. (100 mm) if the surface is to be subjected to vehicular traffic. Because of the thickness requirements, unbonded overlays are usually portland cement concrete based and include a type of reinforcement.

****

a. Repair distresses that cause a major loss of structural integrity when present[.][, including [_____]]

****

NOTE: In the blank above add any observed distress that needs to be repaired prior to the installation of the overlay. Unbonded concrete overlays generally require minimal pre-overlay repairs; repairs are only done for severe distresses.
For example, shattered slabs are usually replaced and full depth repairs are performed for punchouts, high-severity transverse cracks with ruptured steel, and unstable slabs or pieces of slabs with large deflections or pumping.

****

b. Clean the existing slab and remove any loose materials.

****

NOTE: Either a mechanical sweeper or an air blower may be used to clean the slab.

****

c. Install the separator layer as required by the Contract Documents and recommended by the material manufacturer.

]3.4.2 Application

3.4.2.1 Portland Cement Concrete

a. [Apply the specified bonding agent. Follow the requirements of 3.4.2.4.]

****

NOTE: Delete the above requirement if bonding agents are not to be used on the project.

****

b. Follow the requirements of Section [03 30 00 CAST-IN-PLACE CONCRETE] [_____] and the Contract Documents for installing forms, placing reinforcement, placing and consolidating concrete, and finishing concrete.

****

NOTE: Application (Mixture, placement, consolidation, finishing, etc...) requirements for portland cement concrete overlays do not differ from conventional portland cement concrete. The same requirements that apply for conventional concrete slabs, apply to overlays.

For bonded concrete overlays, if you are using a bonding agent, see the paragraph on bonding agents.

For unbonded concrete overlays, reinforcement, such as deformed bars, welded wire fabric, bar mats, or fibers should be placed in the overlay in sufficient quantities to reduce the width of shrinkage cracks and to bridge existing cracks in the base slab. Reinforcement in unbonded topping slabs is essential due to increased curling stresses and potential bridging of existing cracks in the base slab.

****

3.4.2.2 Polymer-modified Portland Cement Concrete

****

NOTE: ACI 548.4 covers latex-modified concrete overlays. Refer to ACI 548.4 and the manufacturer's requirements if using latex modified concrete.

****

For polymer modified portland cement concrete overlays follow [ACI 548.4 requirements][manufacturer's requirements][_____] for placing and finishing the overlay.

3.4.2.3 Polymer Concrete/Mortar

****

NOTE: Placement requirements for polymers depend on the type of polymer being used. Follow manufacturer's requirement in addition to ACI specifications for that specific polymer if available. ACI 548.10 is written above as an example, see other ACI 548 documents for specifications that match the type of overlay required.

****

For polymer concrete overlays, follow [manufacturer's requirements][ACI 548.8 requirements][ACI 548.9 requirements][ACI 548.10 requirements][_____] for placing and finishing the overlay.

[3.4.2.4 Bonding Agents

****

NOTE: A bonding agent is a material used to improve the bonding between the overlay and the underlying material (concrete). A bonding agent can be used, but success has been seen without its use.

Use bonding agents with caution. Bonding agents should not be allowed to dry too early and form a skin that can act like a bond breaker that reduces the bond strength rather than increase it.

****

a. Use a [cement slurry][epoxy bonding agent][latex bonding agent][_____] to improve the bonding between the overlay and the existing concrete.

****

NOTE: Choose the type of bonding agent to improve the bond between the overlay and the existing concrete.
A cement slurry is a neat portland cement or blend of portland cements and fine aggregate filler approximately proportioned one-to-one by mass.
The rest of the bonding agents are polymer-based materials, see ACI 548 documents for more details.

****

b. [Follow material manufacturer's instructions for mixing, preparing, and applying bonding agent. Do not exceed the manufacturer’s thickness recommendations][_____].

****

NOTE: Polymer based bonding agents have their own application instructions, follow manufacturers instruction for those materials.
If a cement slurry is used however, it is suggested to add the following sentence instead "Apply cement slurry just prior to overlay placement with a stiff-bristled broom"

****

c. [Condition materials and the existing concrete surface to a temperature consistent with manufacturer’s recommendations at the time of installation.]

d. [Do not allow bond agents to dry before placement of repair material.]

]

****

NOTE: The above requirement applies primarily to polymer-based bonding agents.

****

3.4.3 Quality Control

****

NOTE: Strength and durability requirements should be defined in the general concrete specifications. For polymer concrete overlays, refer to PRODUCTS requirements and the referenced standards.

****

a. [Concrete overlays must meet all the strength and durability requirements of 03 30 00 CAST-IN-PLACE CONCRETE][Material properties must meet the requirements defined in PRODUCTS.][_____].

b. [The bond strength between the existing concrete and the overlay must be a minimum of [1.8 MPa 250 psi][_____] per [ASTM C1583/C1583M][_____]. [Test a minimum of 3 specimens at locations no greater than 420 square meters 500 square yards of prepared surface.]]

****

NOTE: This requirement is for bonded overlays only. Bond tests are usually performed to evaluate bond strength between the existing concrete and the overlay. 250 psi (1.8 MPa) is a value obtained from ACI 548.10. Refer to ICRI 210.3R for more details.

Before bond tests are performed, proper bonding can be evaluated by non-destructive methods. Acoustic impact methods such as chain drag sounding, hammer sounding, electromechanical sounding, and rotary percussion methods are commonly used. Refer to ICRI 210.4 for more details.

****

3.4.4 Joints

****

NOTE: The performance of a bonded overlay depends on creating a monolithic structure, the joints in the overlay should match the joints in the underlying pavement. Matched joints help to ensure that the two layers of the pavement structure can move together, helping to maintain bond between them. Matched joints also help to prevent reflection cracking. Because of the importance of matched joints, not only should the location of the joint be matched, but also the joint width and type; that is, if there is an expansion joint in the underlying pavement, it should be recreated in the overlay.

For unbonded overlays, additional joints may be recommended depending on the overlay thickness. This information should be included in drawings or contract document.

****

a. [Place joints as indicated in [03 30 00 CAST-IN-PLACE CONCRETE] [and as shown on the drawings] [_____].]

****

NOTE: The requirement above applies to unbonded concrete overlays but not for bonded overlays. Requirements for unbonded overlays should not be different from new concrete slab construction.

Some of the requirements below could apply to unbonded overlays, but they are mainly present in

this paragraph for bonded overlays.

****

b. [Construct expansion and contraction joints in concrete overlay at the locations shown. Maintain alignment of control joints within 6 mm 1/4 in., to either side, of the required joint alignment.]

c. [Construct expansion and contraction joints at the locations shown and in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.]

d. [Construct expansion joints in the overlay at existing joint locations in the base slab while maintaining joint width and type[.][, and extending the full depth of the overlay.]]

****

NOTE: Extending a joint to the full depth of the overlay applies to bonded overlays. For unbonded overlays, follow the same procedure used for new concrete construction.

****

e. [Construct control joints by tooling the plastic concrete, then sawcutting at the appropriate time. Saw control joints to a minimum [depth of [_____] mm in.] [of 25 percent of the thickness of the slab]. Maintain an ample supply of saw blades on the job before concrete placement is started, and have at least one standby sawing unit in good working order available at the jobsite at all times during the sawing operations. Begin sawcutting as soon as it is possible to saw the concrete without damaging adjacent concrete.]

f. [Inspect the faces of joints during sawcutting for undercutting or washing of the concrete due to early sawing. Complete sawcutting within 16 hours of concrete placement. Continue sawcutting regardless of weather conditions. Delay sawing if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint or chipping, tearing, or spalling of the concrete occurs at the surface. Discontinue sawing when a crack develops ahead of the saw cut.]

g. [Immediately after the joint is sawed, flush the saw cut and adjacent concrete surface thoroughly with water until all residue from sawing is removed from the joint. Control and dispose of waste water from sawcutting and cleanup in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.]

3.5 CONCRETE STRENGTHENING

****

NOTE: The goal of strengthening concrete is to increase a structure's or member's capacity in flexure, shear, axial, confinement, and stiffness. Refer to ICRI Guideline No. 03742 for more information about strengthening

****

a. For enlargement of slabs using overlays see the paragraph titled OVERLAYS.

****

NOTE: Bonded overlays are used for strengthening

slabs; unbonded are not.

****

b. For all other types of strengthening follow the requirements contained in this paragraph.

3.5.1 Preparation

****

NOTE: The preparation phase is very critical to the success of the operation; an improperly prepared surface can result in debonding or delamination.

****

a. [Use equipment and methods specified in the paragraph titled EQUIPMENT FOR CONCRETE PREPARATION and the Contract Documents to produce a sound, rough, open-pore surface at locations where bonding between existing and new concrete is required.]

****

NOTE: Surfaces that need to be enlarged should be rough enough to provide good bonding between the existing concrete and the new concrete.

The engineer should specify the surface profile required for the repair/strengthening job based on the type of strengthening method used.

****

b. [Round members of existing concrete with corners to minimum 13 mm ½ in. radius. Roughened corners must be smoothed with putty]

****

NOTE: This requirement applies to strengthening using FRP laminates. Delete this requirement if not needed

****

c. Clean all surfaces from contaminant and remove unsound concrete using the prescribed cleaning equipment and methods in the paragraphs titled PRODUCTS. All laitance, dust, dirt, oil, curing compound, existing coatings, and any other matter that could interfere with bonding concrete to the repair material must be removed.

d. Follow the procedures of the paragraphs titled CRACK REPAIR and CORROSION AND SURFACE REPAIR. The concrete surface must be in good condition and all cracking, surface repair, and corrosion related problems must be adequately addressed prior to proceeding with concrete strengthening procedures.

e. Insure that materials used for repairs are compatible with materials used for strengthening. Consult with the repair material manufacturers for information concerning material compatibility.

f. Surfaces not intended to be strengthened must be covered as needed to protect against contamination and spills.

g. Surfaces intended to be strengthened must be protected before application so that no materials that can interfere with bond are redeposited on the surface.

3.5.2 Application

3.5.2.1 Section enlargement

a. Install dowel reinforcement as required by the Contract Documents. Follow the [adhesive][mechanical anchor] manufacturer's procedures for installing dowels.

b. Install formwork and shoring following the requirements of this section.

c. Install reinforcement and reinforcement supports. Follow the requirements specified in Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][_____].

d. Follow the requirements of Section [03 30 00 CAST-IN-PLACE CONCRETE][03 37 13 SHOTCRETE][_____] to place, consolidate, and finish concrete.

3.5.2.2 Externally bonded systems

3.5.2.2.1 Steel Plates

a. Bond steel plates to concrete using the methods and materials specified in the Contract Documents.

b. For bonding steel plates to concrete using an epoxy resin follow the requirements and procedures of ACI 548.12.

c. For bonding steel plates to concrete using mechanical or adhesive anchors, follow the procedures provided by the material manufacturer.

3.5.2.2.2 Fiber-reinforced Polymer Laminates

****

NOTE: Refer to ACI 440.2R for more information about strengthening using externally bonded FRP

****

The following procedures are general procedures used for the installation of FRP laminates. If the FRP system used requires conflicting procedures, consult with the Contracting Officer before proceeding.

a. Insure that all surfaces that will receive FRP are clean, dry, and free of contaminants.

b. Insure that the workplace is well ventilated and that the repair material is applied at a time when the air temperature, concrete surface temperature, and the relative humidity are as required by the repair material manufacturer.

****

NOTE: Primers, saturating resins, and adhesives should generally not be applied to cold or frozen surfaces. When the surface temperature of the concrete surface falls below a minimum level as specified by the FRP system manufacturer, improper saturation of the fibers and improper curing of the resin constituent materials can occur, compromising

the integrity of the FRP system. An auxiliary heat source can be used to raise the ambient and surface temperature during installation.

****

c. Temporary protection of the Work area is required during installation and until the resins have cured. If temporary shoring is required, the FRP system must be fully cured before removing the shoring and allowing the structural member to carry the design loads.

d. [If a primer is required, the primer must be applied uniformly to all areas on the concrete surface where the FRP system is to be placed at the manufacturer’s specified rate of coverage. Protect the primer from dust, moisture, and other contaminants before applying the FRP system]

****

NOTE: Keep the above requirement if a primer is needed for the FRP system being used.

****

e. [Putty must be used in an appropriate thickness and sequence with the primer as recommended by the FRP manufacturer. The system-compatible putty must be used only to fill voids and smooth surface discontinuities before the application of other materials. Rough edges or trowel lines of cured putty must be ground smooth before continuing the installation. Allow the putty to cure as specified by the FRP system manufacturer before proceeding.]

****

NOTE: Keep the above requirement or edit it as required by the FRP system being used.

****

f. Proportion, mix, and apply resins components in accordance with the FRP system manufacturer’s recommended procedures.

g. Install and cure the FRP system per the manufacturer's recommendations.

h. [During installation of wet layup FRP systems, entrapped air between layers must be released or rolled out before the resin sets. Sufficient saturating resin must be applied to achieve full saturation of the fibers. Furthermore, successive layers of saturating resin and fiber materials must be placed before the complete cure of the previous layer of resin. If previous layers are cured, interlayer surface preparation, such as light sanding or solvent application as recommended by the system manufacturer, is required.]

****

NOTE: The above requirement is for wet layup system. If other systems are used, either delete above requirement and just follow the manufacturer's recommendation (as stated by g), or refer to ACI 440.2R for general procedures of other commonly used FRP systems.

****

i. Follow the FRP material manufacturer's recommendations for the application of protective coatings. Do not clean the installed FRP with a solvent before a protective coating is installed.

3.5.3 Quality Control

****

NOTE: The requirements of this paragraph only apply to strengthening using FRP.

****

The cured FRP system must be evaluated for delaminations or air voids between multiple plies or between the FRP system and the concrete. Methods such as acoustic sounding (hammer sounding), ultrasonics, and thermography can be used to detect delaminations. The following requirements apply to wet layup systems:

a. Small delaminations less than 2 square inch 1300 square millimeter each are permissible as long as the delaminated area is less than 5 percent of the total laminate area and there are no more than 10 such delaminations per 10 square feet square meter.

b. Large delaminations, greater than 25 square inch 16,000 square millimeter, can affect the performance of the installed FRP and must be repaired by selectively cutting away the affected sheet and applying an overlapping sheet patch of equivalent plies.

c. Delaminations less than 25 square inch 16,000 square millimeter must be repaired by resin injection or ply replacement.

For other FRP systems, delamination must be evaluated and repaired in accordance with the material manufacturer direction. Upon completion of the Work, the laminate must be reinspected to verify that the repair was properly accomplished.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-03 11 19.00 (August 2022)**

Preparing Activity: USACE **Superseding Without Revision**
UFGS-03 11 19.00 10 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 03 11 19.00

INSULATING CONCRETE FORMING

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USACE / NAVFAC / AFCEC **UFGS-03 11 19.00 (August 2022)**

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References are in agreement with UMRL dated January 2025

****

SECTION 03 11 19.00

INSULATING CONCRETE FORMING

08/22

****

NOTE: This guide specification covers the requirements for Insulating Concrete Forming (ICF).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification will normally be used in conjunction with the following Section as applicable to the project:
Section 03 30 00 CAST-IN-PLACE CONCRETE

ICFs are used as stay-in-place forms for structural concrete, load-bearing and nonload-bearing walls, below grade and above grade walls. The forms remain in place after placement and curing of concrete and must be protected by approved interior and exterior finish materials.

The three most common systems are FLAT (ICF panels create a uniformly thick concrete wall), GRID (ICF panels create a waffle pattern of circular vertical

and horizontal concrete elements), and POST-AND-BEAM (ICF panels create discrete circular columns and beams). This guide specification is written for FLAT ICF wall systems based upon ASTM E2643. However, an option is provided in the Paragraph "ICF Manufacturer Qualification" for the manufacturer to certify code compliance via either ICC-ES Evaluation Report or certification showing conformance to ASTM E2634.

ICF products are manufactured using Expanded Polystyrene (EPS) panels. However, Extruded Polystyrene (XPS) panels are permissible if the ICF wall system meets the requirements of ASTM E2634.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2020) Specifications for Structural Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)

ASTM INTERNATIONAL (ASTM)

ASTM C177	(2019; E 2023) Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C203	(2005a; R 2017) Standard Test Methods for Breaking Load and Flexural Properties of Block-type Thermal Insulation
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622/D1622M	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D7611/D7611M	(2013; E 2014) Standard Practice for Coding Plastic Manufactured Articles for Resin Identification
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E2129	(2024) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM E2634	(2018; R 2022) Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED BD+C	(2009; R 2010) Leadership in Energy and Environmental Design(tm) Building Design and Construction (LEED-NC)

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Insulating Concrete Form; G, [_____]

Local/Regional Materials; LEED BD+C

Environmental Data

Accessories

SD-04 Samples

Mock-Up Installation of ICF; G, [_____]

SD-06 Test Reports

ICC ES Evaluation Report

SD-07 Certificates

3rd Party Agency Certification

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance Data

Plastic Identification

1.3 QUALITY ASSURANCE

1.3.1 Insulation Concrete Form (ICF) Manufacturer Qualification

Manufacturer who has been successfully producing ICF products for a period of not less than 5 years and who has experience similar to this project in size, scope and complexity. Manufacturer must have an ICC-ES Evaluation Report or certification showing conformance to ASTM E2634 as evidence that the Insulating Concrete Forming (ICF) units are code-compliant.

1.3.2 Installer Qualification

Installer must be trained by the ICF manufacturer or an ICF Technical Advisor to ensure product is installed in accordance with the manufacturer's published installation instructions. Installer must have experience in ICF wall systems and successfully completed at least [three] [_____] projects that are similar to this project in size, scope and complexity.

1.3.3 Pre-Installation Meetings

****

NOTE: When the construction consist largely of Insulating Concrete Forming, it is suggested that a pre-installation meeting be required. Otherwise, if the construction is primarily another building material the pre-installation meeting may be omitted.

****

Prior to commencement of ICF installation and associated work, conduct a meeting at project site with the Contracting Officer, ICF manufacturer's representative, and trades responsible for installing forms, concrete, and reinforcement.

1.3.4 Mock-Ups

****

NOTE: Complexity of work and scope of quality control should be carefully evaluated before requiring Contractor to construct a mock-up. Delete paragraph if mock-up is not required.

****

Complete Mock-Up Installation of ICF with full-size erected assemblies with details including at least one window. Provide mock-up to establish that proposed materials and construction techniques provide acceptable visual effect. Use materials for mock-up that are proposed for actual construction and meet the following requirements:

a. Locate mock-up installation in the location as directed by the Contracting Officer.

b. Demonstrate the required concrete thickness, insulation and workmanship.

c. Demonstrate window openings with sill, head and jambs.

d. Do not proceed with the remaining work until mock-up is approved by the Contracting Officer.

e. When directed, demolish and remove the mock-up from the site.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver products in original factory packaging, bearing listing and labeling identification of product, manufacturer and lot number. Handle and store products in location to prevent physical damage and soiling. Ensure that UV protection is provided for material stored on site beyond 30 days.

1.5 FIELD/SITE CONDITIONS

Conform to ACI 305R and ACI 306R for hot and cold weather concreting requirements.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

1.6.1 Local/Regional Materials

****

NOTE: Using local materials can help minimize transportation impacts, including fossil fuel consumption, air pollution, and labor. Using materials harvested and manufactured within an 800 km 500 mile radius from the project site contributes to the following LEED credit: MR5. Coordinate with Section 01 33 29 SUSTAINABILITY REPORTING. Use second option if Contractor is choosing local products in accordance with Section 01 33 29 SUSTAINABILITY REPORTING. Do not use the first option for USACE projects. Include second option in Army projects only if pursuing this LEED credit.

Include this submittal only if pursuing LEED credit MR5.

****

[Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [800][_____] km [500][_____] mile radius from the project site, if available from a minimum of three sources.] [See Section 01 33 29 SUSTAINABILITY REPORTING for cumulative total local material requirements. Insulating Concrete Forming materials may be locally available.] Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

1.6.2 Environmental Data

****

NOTE: ASTM E2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products.

****

Submit manufacturer's descriptive data. Documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project. [Submit Table 1 of ASTM E2129 for the following products: [_____].]

1.6.3 Plastic Identification

****

NOTE: The marking system indicated below is intended to provide assistance in identification of products for making subsequent decisions as to handling, recycling, or disposal.

****

Verify that plastic products to be incorporated into the project are labeled in accordance with ASTM D7611/D7611M. Where products are not labeled, provide product data indicating polymeric information in the Operation and Maintenance Manual and in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Type 1	Polyethylene Terephthalate (PET, PETE)
Type 2	High Density Polyethylene (HDPE)
Type 3	Vinyl (Polyvinyl Chloride or PVC)
Type 4	Low Density Polyethylene (LDPE)
Type 5	Polypropylene (PP)
Type 6	Polystyrene (PS)
Type 7	Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination. Provide the package make up.

PART 2   PRODUCTS

2.1   SYSTEM DESCRIPTION

****

NOTE: ICF products are manufactured using Expanded Polystyrene (EPS) panels. However, Extruded Polystyrene (XPS) panels are permissible if the ICF wall system meets the requirements of ASTM E2634.

****

The ICFwall system consists of two panels of molded expanded polystyrene (EPS) insulation connected by cross ties to act as permanent formwork for cast-in-place reinforced concrete beams, lintels, non-load-bearing walls, load-bearing walls, foundation walls, and retaining walls while provide insulating characteristics.

2.1.1   Design Requirements

Design, engineer, and construct the ICF wall system in accordance with the manufacturer's instructions for anticipated loads, lateral pressures, and stresses, and capable of withstanding the pressures resulting from placement and vibration of concrete. Monitor the adequacy of design and construction prior to and during concrete placement as part of the approved Quality Control Plan.

2.1.2   Performance Requirements

The Insulating Concrete Form (ICF) wall system must provide a minimum[100 mm 4 inches] [150 mm 6 inches] [200 mm 8 inches] [250 mm 10 inches] [305 mm 12 inches] nominal wall width; not less than 12 mm 1/2-inch less nor 6 mm 1/4-inch more than the nominal width indicated. Provide cross ties in the ICF wall system at 200 mm 8 in on center maximum with a tolerance of plus or minus 6 mm 1/4-inch. ICF wall system must have vertical fastening strips 25 mm 1 inch minimum flange width that align vertically within 12 mm 1/2-inch horizontally between stacked blocks or panels for the full height of the wall to fasten exterior and interior wall finishes. Vertical gap between fastening strips of stacked blocks or panels must not exceed 38 mm 1-1/2 inches. Space fastening strips at a maximum of 405 mm 16 inches on center horizontally with a tolerance of plus or minus 6 mm 1/4-inch. Wall system must provide accurate positioning of concrete reinforcing bars within the form cavity conforming to ACI 318. Submit manufacturer's literature describing product, materials, installation procedure and accessories.

2.2   MANUFACTURED UNITS

2.2.1   Description

The ICF wall system includes an expanded polystyrene forming unit used to construct a monolithic reinforced concrete wall. The forms remain in place, providing a concrete wall to be finished with conventional interior and exterior wall coverings. Provide form unit types and sizes as determined by the ICF manufacturer to provide walls indicated. Provide form materials in accordance with the manufacturer, other specifications herein, and the following:

2.2.2 Performance/Design Criteria

****

NOTE: Some ICF's are available with a 45 mm 1-3/4 inch EPS option. These forms are an economical option for interior demising walls and environments where high thermal insulation values are not as important. The typical R-value of a 45 mm 1-3/4 inch EPS ICF is R-14. Also, ICF manufacturer's typically do not have all form types in every core thickness. Usually straight and 90 degree corner units are available in each core thickness.

STC 50 may not be attainable for a 100 mm 4 inch ICF wall system.

****

With the ICF wall system provide a minimum[100 mm 4 inch] [150 mm 6 inch] [200 mm 8 inch] [250 mm 10 inch] [305 mm 12 inch] concrete "flat" cross section. Use preformed forms with interlocking edges to facilitate course-to-course bonding to prevent uplift and lateral failure. Provide manufacturer form unit types for straight, 90 degree corners, 45 degree corners, brick ledges, and tapered top forms. ICF unit must provide a minimum R-value of [R-22] [_____] as tested in accordance with Test Method ASTM C518/ASTM C177. EPS must provide a maximum vapor permeation of 0.09 perm-meter 3.5 perm-inch. Finish wall assembly must have a minimum rating of Sound Transmission Class (STC) [50][___] sound attenuation performance as tested in accordance with Test Method ASTM E90. The fire resistive-rated construction of the complete ICF wall assembly including EPS, cross tie material, and concrete must be in accordance with Test Methods ASTM E119.

Conform the Insulating Concrete Forming System to the following minimum requirements:

TABLE 1 - PROPERTIES

Properties	ASTM Test	Value
Density	ASTM D1622/D1622M	24 kg/m3 1.5 lbs/ft3
Thermal Resistance	ASTM C177	0.275 m2.C/W per cm (min)4.0 F.ft2.h/Btu per in (min)
Compressive Strength	ASTM D1621	103 kPa15.0 psi
Flexural Strength	ASTM C203	276 kPa (min.)40.0 psi (min)
Flame Spread	ASTM E84	25 maximum
Smoke Developed	ASTM E84	450 maximum

2.3 MATERIALS

****

NOTE: ICF products are manufactured using Expanded Polystyrene (EPS) panels. However, Extruded Polystyrene (XPS) panels are permissible if the ICF

wall system meets the requirements of ASTM E2634.

****

Submit 3rd party agency certification stating that product supplied meets the requirements of ASTM E2634.

2.3.1 Expanded Polystyrene (EPS)

****

NOTE: Some ICF Manufacturers have 50 mm 2 inches thick EPS panels for their 100 mm 4 inch wide ICF wall systems. Designer should confirm EPS panel thickness provides the appropriate R-value for this project. Some ICF's are available with a 45 mm 1-3/4 inch EPS option. These forms are an economical option for interior demising walls and environments where high thermal insulation values are not as important.

****

Expanded Polystyrene must conform to ASTM C578. Provide Type II EPS panels, Flame Resistant with[63 mm 2-1/2 inch][45 mm 1-3/4 inch][_____] thick minimum EPS panels.

2.3.2 Cross Ties and Fastening Strips

****

NOTE: ICF Forms are widely available that include fastening strip recessed from 6 mm 1/4 inch up to 38 mm 1-1/2 inches below the outside surface of the EPS panels. The deeper recesses help facilitate the placement of electrical and plumbing utilities within the wall. 13 mm 1/2 inch recess appears to be standard for most ICF Manufacturers.Designer may include a range of recess depths, i.e., 13mm 1/2 inch to 38 mm 1-1/2 inches

****

Use plastic or metal cross ties spaced at 200 mm 8 inches on center maximum with a tolerance of plus or minus 6 mm 1/4-inch. Cross ties must allow for multiple reinforcement placement positions to meet the structural design. Provide fastening strips with 25 mm 1 inch minimum flange width that align vertically within 12 mm 1/2-inch horizontally between stacked blocks or panels for the full height of the wall to fasten exterior and interior wall finishes. Vertical gap between fastening strips of stacked blocks or panels must not exceed 38 mm 1-1/2 inches. Space fastening strips at a maximum of 4056 mm 16 inches on center horizontally with a tolerance of plus or minus 6 mm 1/4-inch. Recess the fastening strips[6 mm 1/4 inch][13 mm 1/2 inch][38 mm 1-1/2 inches][_____] below the outside surface of the panels. Clearly mark the flanges on the surface of the EPS panels. Provide a fastening strip in the corners of corner forms.

2.4 ACCESSORIES

2.4.1 Bracing, Scaffolding, and Wall Alignment

Support ICF wall system prior to the attachment of permanent structural elements to protect the ICF components from damage during construction.

2.4.2 Door and Window Bucks

Use extruded vinyl, pressure treated wood, or metal buck material to frame door and window openings.

2.4.3 Waterproofing

Waterproofing material must be compatible with EPS system and as specified in Section [07 13 53 ELASTOMERIC SHEET WATERPROOFING] [07 14 00 FLUID-APPLIED WATERPROOFING]

2.4.4 Fasteners

Fasteners of interior and exterior wall finishes to ICF wall system must conform to ASTM E2634. Use corrosion-resistant fasteners of sufficient length to penetrate the flanges of the fastening strips.

PART 3 EXECUTION

3.1 EXAMINATION

Verify that footings and slabs are installed level and true to the structural design. Ensure dimensions and steel reinforcement are as indicated.

3.2 PREPARATION

Clean top of footings and slabs of all foreign substances, frost, ice, and standing or running water prior to starting installation of ICF wall system. Use methods and materials approved by ICF manufacturer.

3.3 INSTALLATION

Install ICF wall system in accordance with the manufacturer's installation and technical manual; submit a copy of the manual. In accordance with ACI 301, provide bracing and shoring to ensure stability of formwork to prevent overstressing of ICF units due to construction loads. Install ICF wall system in running bond pattern. Anchor formwork to supporting surfaces to prevent lateral movement of the ICF units during concrete placement. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for support of adjoining work before concrete placement. Align fastener strips to facilitate interior and exterior wall finishes. Install concrete reinforcement according to the structural drawings at all walls, lintels, beams, and around openings. Install window and door bucks at each location where an opening is required. Install the first ICF course on the footing in accordance with the manufacturer's instructions to ensure that base of wall does not become misaligned during concrete placement. Install alignment bracing around the entire wall of the structure to ensure the ICF wall system is straight and plumb before and during concrete placement.

3.3.1 ICF Wall System Length

Within plus or minus 4.2 mm per m 0.05 inches per foot of the intended length.

3.3.2 ICF Wall System Height

Within plus or minus 1.6 mmm per m 0.06 inches per foot of the intended height.

3.4 CONCRETE PLACEMENT

****

NOTE: Designer should indicate on the drawings location of construction joints and provide the necessary details, including any required dowels or keyways. Refer to ACI 318 for additional information for construction joints in structural members.

****

Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures. If concrete cannot be placed in continuous pour, provide construction joints [as indicated] [as approved by the Designer of Record] [as on the approved concrete placement plan]. Consolidate placed concrete in accordance with the manufacturer's instructions. Where no guidance is provided, consolidate placed concrete with mechanical vibrating equipment conforming to ACI 301. Variations from plumb and designated building lines cannot exceed the tolerances specified in ACI 117.

3.5 FIELD QUALITY CONTROL

The ICF manufacturer's representative or technical advisor must provide on-site training to installer to ensure familiarity of ICF manufacturer's installation procedures and technical manual. Inspect erected formwork, reinforcement placement, door and window opening construction, concrete placement, and alignment and bracing system to ensure that work is in accordance with drawings. Installer to ensure that the cast-in-place concrete walls are level, plumb, square, and straight and that all dimensions conform to the drawings and are within required tolerances. Notify the Contracting Officer in writing of defective forms within 7 working days of the date of ICF inspection.

3.6 CLEANING

Clean formed cavities, within ICF units, of debris and foreign matter prior to concrete placement. Clean up and properly dispose of all debris remaining on job site related to the installation of the ICF wall system, recycling materials as required.

3.7 PROTECTION

Provide temporary coverage of installation of ICF wall system to reduce exposure to ultraviolet light should final finish application be delayed longer than 60 days.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-03 23 00 (May 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS--03 23 00 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 03 23 00

STRESSED TENDON REINFORCING

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USACE / NAVFAC / AFCEC **UFGS-03 23 00 (May 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS--03 23 00 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 03 23 00

STRESSED TENDON REINFORCING

05/16, CHG 1: 08/18

****
NOTE: This guide specification covers the requirements for furnishing all equipment, materials, techniques and labor for providing and installing steel stressing tendons and accessories for the construction of prestressed concrete. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 LUMP SUM PRICES

****
NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (LUMP SUM PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs should be inserted into Section 01 20 00.
****

1.1.1 Steel Stressing Tendons and Accessories for Prestressed Concrete

1.1.1.1 Payment

Payment will constitute full compensation for furnishing all plant, labor, materials and equipment and performing all operations necessary for steel stressing tendons and accessories for prestressed concrete.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A421/A421M	(2021) Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed

	Concrete
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)

POST-TENSIONING INSTITUTE (PTI)

PTI M10.3	(2000) Field Procedures Manual for Unbonded Single Strand Tendons
PTI M50.3	(2012) Guide Specification for Grouted Post-Tensioning
PTI M55.1	(2019; Errata 2020) Specification for Grouting of Post-Tensioned Structures
PTI-CRT-20 G1-1015	(2015) Manual for Certification of Plants Producing Unbonded Single Strand Tendons

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G, [_____]

Procedures for Grouting Operations

SD-03 Product Data

Prestressing Method and Equipment; G, [_____]

Materials Disposition Records

Prestressing Operations Records

Recycled Content for Steel; S

SD-06 Test Reports

Stressing Tendons and Accessories

SD-07 Certificates

Tendon Installer Qualifications

1.4 QUALITY ASSURANCE

1.4.1 Tendon Installer Qualifications

1.4.1.1 Unbonded Tendons

Installation crew must have at least two PTI Level 2 certified installers and all other personnel must be PTI Level 1 certified installers. Submit PTI certifications.

[1.4.1.2 Bonded Tendons

The direct supervisor of the Post-Tensioning operations must be certified as PTI Level 2 Bonded PT Field Specialist. The foreman of each installation and stressing crew must be certified as PTI Level 2 Bonded PT Field Specialist. The foreman of each grouting crew must be certified as PTI Level 2 PT Field Specialist and ASBI Certified Grouting Technician. At least 25 percent of each crew must be certified in PTI Level 1 Bonded PT-Field Installation. Submit PTI certifications.

]1.4.2 Installation Drawings

Submit detailed installation drawings for stressing tendons and accessories approved prior to commencing the work and showing the type and size of stressing tendons and anchorages, tendon profiles, erection methods, sequence of stressing and stressing calculations.

1.4.3 PTI Certified Plants

Fabrication plant must be certified by PTI-CRT-20 G1-1015.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials suitably wrapped, packaged or covered at the factory to prevent being affected by dirt, water and rust. Protect materials against abrasion or damage during shipment and handling. Place materials stored at the site above the ground on elevated, covered platforms.

PART 2 PRODUCTS

2.1 MATERIALS

Stressing tendons and accessories must conform to the requirements of ACI 318M ACI 318 except as specified. Submit certified materials test reports for all required materials tests; note the specific standards followed in the performance of tests, show that materials comply with the applicable specifications for each material shipment, and identified with specific lots prior to use of materials in the work.

2.1.1 Material Recycled Content

For products in this section, where applicable and to extent allowed by performance criteria, provide minimum 75 percent recycled content for steel

2.1.2 Stressing Tendons

Stressing tendons must be clean and free of loose rust, scale and pitting. Permanently protect unbonded tendons from corrosion with an approved applied coating.

2.1.2.1 Seven-Wire Stress-Relieved Strand and Strand Assemblies

Seven-wire stress-relieved strand and strand assemblies must conform to ASTM A416/A416M, Grade [1725 (250)] [1860 (270)], strand diameter as indicated. Strand assemblies may be field assembled with anchor fittings positively attached to strands for bonded tendons only.

2.1.2.2 Stress-Relieved Wire and Wire Assemblies

Stress-relieved wire and wire assemblies must conform to ASTM A421/A421M, Type BA or WA, wire diameter as shown. Wire assemblies must be shop assembled with anchor fittings positively attached to wires.

2.1.2.3 High-Strength Steel Bars

High-strength steel bars must conform to ASTM A722/A722M, Type I or II, Grade 1035 (150) meeting all supplementary requirements.

2.1.3 Accessories

2.1.3.1 Ducts

****

NOTE: Use this paragraph for grouted tendons.
****

Provide tendon ducts of galvanized sheet steel or plastic, capable of transmitting forces from grout to the surrounding concrete, flexible enough to conform to the tendon profile and strong enough to maintain their shape without deforming, sagging, or collapsing during concrete placement and vibration. The inside diameter of the ducts must be large enough to provide an internal area at least two and a half times the gross area of multiple wire, bar or strand assemblies and must be at least 13 mm 1/2-inch larger than the diameter of a single wire, bar or strand placed in the ducts. Design ducts for watertight connections with all fittings.

****
NOTE: Use the next two paragraphs for unbonded tendons.
****

2.1.3.2 Tendon Sheathing

Tendon sheathing must have a minimum thickness of 1.25 mm 0.050 inch for polyethylene or polypropylene with a minimum density of 0.9 g/cm^3 0.034 lb/in^3. The sheathing must be continuous over the length of the tendon [to provide watertight encapsulation of strand] [between anchorages to prevent intrusion of cement paste or loss of coating for a non-encapsulated system.]

2.1.3.3 Tendon Coating

For unbonded tendons provide a compound with friction-reducing, moisture-displacing, and corrosion-inhibiting properties that is chemically stable and nonreactive with prestressing steel, nonprestressed reinforcement, sheathing material and concrete. The compound must have a minimum coating weight of[1.14 kg 2.5 lb for 12 mm 0.5 inch][1.36 kg 3 lb for 15 mm 0.6 inch] diameter strand per 30 m 100 feet of strand. Completely fill the annular space between the strand and sheathing over the entire tendon length with the tendon coating.

2.1.3.4 Anchorages and Couplers

Anchorages and couplers must be metal of proven corrosion resistance and compatible with the stressing tendons, capable of developing 95 percent of the actual breaking strength of the strands. Anchorages must be the button-head, wedge, nut and thread, grip nut, thread-bar, threaded plate or other approved type and must be provided with bearing plates bars, rings, bells or other positive-attaching anchor fittings. Provide couplers with housings long enough to permit the necessary movements and fittings which allow complete grouting of all components. Bar couplers must meet the requirements of ASTM A722/A722M and develop 100 percent of the minimum bar ultimate tensile strength.

2.1.3.5 Grout

****
NOTE: Use this paragraph for bonded tendons.
****

****

NOTE: Class A grout is for indoor applications and outdoor nonaggressive exposures. Class B grout is for aggressive exposures such as areas subjected to wet/dry cycles, marine environments or deicing salts. Class C grout can be used for either nonaggressive or aggressive exposure. Class D grout is a specialized grout used in critical applications where the properties of the grout are specified by the engineer.

****

Grout for grouting post-tensioned tendons must be a Class [A][B][C][D] in accordance with PTI M55.1. The minimum 7-day compressive strength of 50 mm 2-inch grout cubes, molded, cured and tested in accordance with ASTM C109/C109M must be 20.7 MPa 3000 psi.

2.1.3.6 Encapsulation System

****

NOTE: Include this paragraph for unbonded tendons in aggressive exposures.

****

Watertight encapsulation of prestressing strand consisting of the following:

2.1.3.6.1 Wedge-Cavity Caps

Attached to anchorages with a positive mechanical connection and completely filled with tendon coating.

2.1.3.6.1.1 Caps for Fixed- and Stressing-End Anchorage Devices

Designed to provide watertight encapsulation of wedge cavity. Sized to allow required extension of strand past the wedges. Attach cap for fixed-end anchorage device in fabricating plant.

2.1.3.6.1.2 Caps at Intermediate Anchorages

Open to allow passage of strand.

2.1.3.6.2 Sleeves

Attached to anchorage device with positive mechanical connection; overlapped a minimum of 100 mm 4 inches with sheathing and completely filled with tendon coating.

2.1.3.7 Nonprestressed Steel Bars

Provide reinforcing bars in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Coordinate placement of nonprestressed steel reinforcement with installation of tendons.

2.1.3.8 Pocket Formers

Pocket formers must be capable of completely sealing wedge cavity and be sized to provide the required cover of the anchorage and allow access for cutting strand tail.

2.1.3.9 Sheathing Repair Tape

Repair tape must be elastic, self-adhesive, moisture proof tape with a minimum width of 50 mm 2 inches, in contrasting color to tendon sheathing. Repair tape must be nonreactive with the sheathing, coating, or prestressing steel.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

Perform required material tests on stressing tendons and accessories by an approved laboratory to demonstrate that the materials are in conformance with the specifications. These tests are at the Contractor's expense.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Include bracketed lines for bonded tendons. Refer to "Selected Post-Tensioning Protection Levels" by L.B. Krauser for guidance for the selection of Tendon Protection Level for specific post-tensioning applications.

****

Install or place stressing tendons and accessories as specified and as shown on contract and approved installation drawings. Installation details of stressing tendons and accessories not specified or shown must be in accordance with ACI SP-66, ACI 318M ACI 318 and PTI M10.3. Maintain a minimum radius of curvature of 480-stand diameters for lateral deviations to avoid openings, ducts, and embedded items. Limit tendon bundles to [five][____] tendons. Maintain a minimum of 300 mm 12 inches between center of adjacent bundles. Welding must not be performed near or adjacent to stressing tendons. Do not install stressing tendons until all welding has been completed on supports or any part which might be in contact with the tendons. Securely support unbonded tendons at regular intervals not to exceed 1220 mm 48 inches.[Grouted tendons must meet protection level [1A][1B][2][3] per PTI M50.3.] Place nonprestressed steel bars in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.1.1 Anchorages

Set anchorages in a plane normal to the axis of the tendons such that uniform bearing on the concrete is assured. Do not switch fixed- and stressing-end anchorage locations from that shown on the approved installation drawings. Use positive connecting anchorages rather than gripping types for anchoring embedded ends of tendons. Permanently protect anchorages and anchor fittings against corrosion. Recess parallel wire anchorage wedges or cores within the members.

3.1.2 Stressing Tendons and Ducts for Grouted Post-Tensioned Systems

****

NOTE: Use this paragraph for bonded tendons only.

****

Remove protective coverings and wrappings, closely inspect each stressing tendon to see that nicks, scoring, pits or other damage does not exist, and closely inspect high strength steel bars to assure that they are not bent and that threaded ends are in satisfactory condition immediately prior to installation. Strand, wire and bar tendons must be shop or field assembled as required and positively attached to anchorages. Anchor type WA wire assemblies only with wedge type anchorages. Assemble stressing tendons and ducts to required shapes and dimensions and place them where indicated on drawings within specified tolerances and adequately supported. Securely support ducts to be grouted at regular intervals not exceeding 1220 mm 48 inches for round galvanized metal duct and steel pipes, 610 mm 24 inches for round plastic ducts and flat ducts with strand preinstalled and 305 mm 12 inches for flat ducts with strand preinstalled and grout openings and vents must be securely anchored to ducts and to either the forms or reinforcing steel to prevent displacement during concrete placing. The ends of ducts must be effectively protected to prevent entry of water, concrete, grout or debris. Wires of parallel-wire assemblies must not be spliced. Steel bar tendons may be joined by couplers where shown or approved. Strands to be spliced must have the same lay or direction of twist and the ends must be cut by shears or abrasive grinders. No more than one strand may be spliced in any one member where single strand tensioning is employed. Strand splices must be capable of developing the full ultimate strength of the strand. Check for slippage of the splice and correct for differential slippage. Where multiple strand tensioning is used, not more than 10 percent of the strands in any member may be spliced.

3.1.3 Sheathing Inspection and Repair

Inspect sheathing for damage after installing tendons. Repair damaged areas by restoring tendon coating and repairing or replacing tendon sheathing. Follow tape repair procedures in PTI M10.3.

3.1.4 Prestressing Method and Equipment

Submit descriptions of the proposed prestressing methods and equipment approved prior to the start of prestressing operations and indicating the manufacturer of all prestressing equipment, including tensioning jacks, stress measurement gages, dynamometers and load cells or other devices for measuring stressing loads. Descriptions must include certified calibration records for each set of jacking equipment and testing curves for stress measurement gages which show that the gages have been calibrated for the jacks for which they are to be used.

3.1.5 Tensioning Tendons

****

NOTE: Determination of the initial prestress force must consider prestress losses in accordance with ACI 318M/ACI 318, Section 18.6.

****

Tension stressing tendons as specified and indicated. Determine the stress induced in the tendons by any method of tensioning independently by both (1) measurement of tendon elongation and (2) direct measurement of force using a pressure gauge or load cell. If the results of these two measurements do not check each other and the theoretical values are not within 7 percent, carefully check the operation and determine and correct the source of error before proceeding further. Concrete cylinder tests must indicate a breaking strength of at least [_____] MPa psi before transfer of stress to ensure that the concrete strength is adequate for the requirements of the anchorages or for transfer through bond as well as meet camber or deflection requirements. The final prestress load in each unit after seating must be as indicated. Take safety measures to prevent accidental injury caused by failure of a stressing tendon or tendon component. Protect the exposed ends of stressing tendons and anchorages from damage during stressing operations to prevent failure.

3.1.5.1 Post-Tensioning

Do not perform tensioning until the concrete has reached the required strength at transfer of stress. Measure the force corresponding to the initial tension by a dynamometer or other approved method as a starting point in determining final elongation. The units must be tensioned until the proper elongations and jacking pressures are attained and reconciled within the limits stated above.

3.1.6 Grouting Post-Tensioned Tendons

At least four weeks prior to the start of construction submit written procedures for grouting operations for approval. Perform grouting between each tendon and its enclosing duct within 7 days after completion of the tensioning operation. Do not perform grouting if air temperature below 7.2 degrees C 45 degrees F is anticipated within 48 hours after grouting unless an approved method of temperature control is used. Mix the grout in a mechanical mixer of a type that will produce uniformly and thoroughly mixed grout. First, place water in the mixer followed by cement and admixture. Continuously agitate frout until it is pumped. Discard grout that has not been used within 30 minutes of the first addition of water to ensure the flowability of the grout. Just before grouting, blow the ducts clear by compressed air. With the grout vent open at one end of duct, apply grout continuously under moderate pressure at the other end until all entrapped air is forced out as indicated by a uniform flow of grout from the discharge vent. Close the injection point by an approved means to prevent any loss of grout. For a period of at least 3 days after grouting the tendons, the prestressed members must not have equipment or other loads placed on them. A longer period may be required, depending upon the method of curing and magnitude of imposed stresses.

3.1.7 Accuracy of Stress and Elongation Measurement

3.1.7.1 Stress Measurement

Hydraulic gauges, dynamometers, load cells or other devices for measuring stressing load must have an accuracy of reading within two percent for stress measurement. Gauges are required to have been calibrated for the jacks for which they are used within a period not exceeding six months. Perform recalibration at any time that a gaging system shows indication of erratic results in the opinion of the Contracting Officer. Gauges must indicate loads directly in kN pounds or be accompanied by a chart which converts dial readings into kN pounds.

3.1.7.2 Elongation Measurement

After the initial force has been applied to a tendon, establish reference points for measuring elongation due to additional tensioning forces. They must be located according to the method of tensioning and type of equipment. The system used must be capable of measuring the true elongation plus or minus 2 mm 1/16-inch.

3.1.8 Prestressing Operations Records

Compile and submit complete prestressing operations records showing the manufacturer, identification and description of materials and equipment including prestressing tendons and jacking and load measuring equipment; location of prestressing tendons; initial design tensioning loads, final design tensioning loads and actual tensioning loads for tendons; dates tensioning loads applied; and theoretical and actual elongations for tendons before completion of the contract.

3.1.9 Tendon Finishing

Do not cut strand tails or cover anchorages until stressing records have been reviewed and approved. Cut strand tail between 13 and 19 mm 1/2 and 3/4 inch from wedges as soon as possible after approval of elongations. Do not damage tendon or concrete during removal of strand tail. Acceptable methods of cutting strand tail include oxyacetylene flame, abrasive wheel, hydraulic shears or plasma cutting. Patch stressing pocket within one day of cutting strand tail. Clean inside surface of pocket to remove laitance or tendon coating before installing patch material. Finish patch material flush with adjacent concrete.

3.2 INSPECTION

The Contractor's facilities must be open for inspection by the Contracting Officer at any time.

3.3 MATERIALS DISPOSITION RECORDS

Compile accurate materials disposition records, identifying all materials incorporated into the work and showing the disposition of specific lots of approved tested materials. Submit records which identify the incorporation of approved materials into the work before completion of the contract.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 30 00 (February 2019)**
Change 9 - 08/24

Preparing Activity: NAVFAC
Superseding
UFGS-03 30 00 (May 2014)
UFGS-03 11 13.00 10 (May 2014)
UFGS-03 11 19.00 10 (May 2014)
UFGS-03 15 00.00 10 (May 2014)
UFGS-03 20 00.00 10 (May 2014)
UFGS-03 30 00.00 10 (May 2014)
UFGS-03 31 01.00 10 (May 2014)
UFGS-03 35 00.00 10 (May 2014)
UFGS-03 39 00.00 10 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 03 30 00

CAST-IN-PLACE CONCRETE

02/19, CHG 9: 08/24

PART 1 GENERAL

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USACE / NAVFAC / AFCEC **UFGS-03 30 00 (February 2019)**
Change 9 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-03 30 00 (May 2014)
UFGS-03 11 13.00 10 (May 2014)
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UFGS-03 20 00.00 10 (May 2014)
UFGS-03 30 00.00 10 (May 2014)
UFGS-03 31 01.00 10 (May 2014)
UFGS-03 35 00.00 10 (May 2014)
UFGS-03 39 00.00 10 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 03 30 00

CAST-IN-PLACE CONCRETE
02/19, CHG 9: 08/24

****

NOTE: This guide specification covers the requirements for cast-in-place concrete not exposed to a marine or high chloride environment. For concrete exposed to a marine or high chloride environment, use Section 03 31 30 MARINE CONCRETE.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Show the following information on the project drawings:

1. Loading assumptions.

2. Assumed temperature range when temperature

stresses are a factor in design.

3. Material strengths used in design for each element, f'c.

4. Yield strength of reinforcement required 420 MPa 60,000 psi or other grades available.

5. Details of concrete sections, showing dimensions, reinforcement cover, and required camber.

6. Locations where structural lightweight concrete or lightweight insulation or fill concrete are used.

7. Details which require a depressed structural slab for static-disseminating and spark-resistant tile, terrazzo, or other floor finishes in order to provide finished surfaces at the same elevations.

8. Indicate the locations in the finished structure, when exposed concrete surfaces are specified. Indicate the type and location, if other than cast finish is required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary

ACI 121R	(2008) Guide for Concrete Construction Quality Systems in Conformance with ISO 9001
ACI 213R	(2014; E2017) Guide for Structural Lightweight-Aggregate Concrete
ACI 301	(2020) Specifications for Structural Concrete
ACI 302.1R	(2015) Guide for Concrete Floor and Slab Construction
ACI 304.2R	(2017) Guide to Placing Concrete by Pumping Methods
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305.1	(2014) Specification for Hot Weather Concreting
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 308.1	(2023) Specification for Curing Concrete
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete
ACI MNL-2	(2019; 11th Edition) ACI Manual of Concrete Inspection
ACI MNL-15	(2020) Field Reference Manual: Specifications for Concrete Construction ACI 301-20 with Selected ACI References

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A184/A184M	(2024) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A767/A767M	(2019) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A820/A820M	(2022) Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
ASTM A884/A884M	(2019; Errata 1) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934/A934M	(2022) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A955/A955M	(2020c) Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement
ASTM A970/A970M	(2018) Standard Specification for Headed Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1022/A1022M	(2016b) Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement
ASTM A1044/A1044M	(2016a; Errata 1) Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete
ASTM A1055/A1055M	(2022) Standard Specification for Zinc and Epoxy Dual Coated Steel Reinforcing Bars
ASTM A1060/A1060M	(2016b) Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1064/A1064M	(2024) Standard Specification for

	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1094/A1094M	(2020) Standard Specification for Continuous Hot-Dip Galvanized Steel Bars for Concrete Reinforcement
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C311/C311M	(2024) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete

ASTM C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C567/C567M	(2019) Determining Density of Structural Lightweight Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C803/C803M	(2023) Standard Test Method for Penetration Resistance of Hardened Concrete
ASTM C845/C845M	(2018) Standard Specification for Expansive Hydraulic Cement
ASTM C873/C873M	(2015) Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds
ASTM C900	(2015) Standard Test Method for Pullout Strength of Hardened Concrete
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1012/C1012M	(2024) Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
ASTM C1074	(2019; E 2021) Standard Practice for Estimating Concrete Strength by the Maturity Method
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1116/C1116M	(2023) Standard Specification for Fiber-Reinforced Concrete
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement

ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1293	(2008; R 2015) Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1778	(2023) Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2628	(1991; R 2016) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D2835	(1989; R 2017) Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D3042	(2017) Standard Test Method for Insoluble Residue in Carbonate Aggregates
ASTM D5759	(2012; R 2020) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash

	for Potential Uses
ASTM D6690	(2021) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E1155	(2020) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E1643	(2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
ASTM E1745	(2017; R 2023) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
ASTM E1993/E1993M	(1998; R 2020) Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A135.4	(2012; R2020) Basic Hardboard

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2018; Errata 2019) Manual of Standard Practice
CRSI RB4.1	(2016) Supports for Reinforcement Used in Concrete

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1	(2009) DOC Voluntary Product Standard PS 1-07, Structural Plywood

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-200	(Rev E; Notice 1; Notice 2) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

1.2 DEFINITIONS

a. "Cementitious material" as used herein includes all portland cement, pozzolan, fly ash, slag cement[, and silica fume].

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Supplementary cementing materials" (SCM) include coal fly ash, [silica fume,]slag cement, natural or calcined pozzolans, and ultra-fine coal ash when used in such proportions to replace the portland cement that result in improvement to sustainability and durability and reduced cost.

e. "Design strength" (f'c) is the specified compressive strength of concrete at time(s) specified in this section to meet structural design criteria.

f. "Mass Concrete" is any concrete system that approaches a maximum temperature of 70 degrees C 158 degrees F within the first 72 hours of placement. In addition, it includes all concrete elements with a section thickness of 1 meter 3 feet or more regardless of temperature.

g. "Mixture proportioning" is the process of designing concrete mixture proportions to enable it to meet the strength, service life and constructability requirements of the project while minimizing the initial and life-cycle cost.

h. "Mixture proportions" are the masses or volumes of individual ingredients used to make a unit measure (cubic meter or cubic yard) of concrete.

i. "Pozzolan" is a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

j. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

[Concrete Curing Plan

] Quality Control Program; G, [_____]

Quality Control Personnel Certifications; G, [_____]

Quality Control Organizational Chart

Laboratory Accreditation; G, [_____]

[Form Removal Schedule; G, [_____]

]   Maturity Method Data

SD-02 Shop Drawings

****
NOTE: Shop drawings for formwork may be required for unusually complicated structures, for structures whose designs were predicted on a particular method of construction, for structures in which the forms impart a desired architectural finish, for folded plates, for thin shells, and for long-span roof structures if required.
****

[Formwork

]   Reinforcing Steel; G, [_____]

SD-03 Product Data

Joint Sealants; S

Joint Filler; S

Formwork Materials

Recycled Aggregate Materials; S

Cementitious Materials; S

Vapor Retarder[and Vapor Barrier]

Concrete Curing Materials

Reinforcement; S

Liquid Chemical Floor Hardeners and Sealers

Admixtures

Reinforcing Fibers

Mechanical Reinforcing Bar Connectors

Waterstops

Local/Regional Materials; S

Biodegradable Form Release Agent

****
NOTE: Include following submittals when job complexity justifies the additional cost associated with these requirements.
****

[Pumping Concrete

][Finishing Plan

] Nonshrink Grout

SD-04 Samples

****

NOTE: Where flat surface finishing is important ask for a sample installation to train the crew.

****

[Slab Finish Sample

][Surface Finish Samples

] SD-05 Design Data

Concrete Mix Design; G, [_____]

****

NOTE: Formwork design calculations only need to be submitted for large complex projects.

****

[Formwork Calculations

] SD-06 Test Reports

Concrete Mix Design; G, [_____]

Fly Ash

Pozzolan

Slag Cement

Aggregates

[Fiber-Reinforced Concrete; G, [_____]

][Tolerance Report

] Compressive Strength Tests; G, [_____]

[Unit Weight of Structural Concrete

][Chloride Ion Concentration

] **

NOTE: Require air content test results to be submitted when the air percentage is critical to slab finishes such as shake or hardener finishes and the total air content must NOT EXCEED a certain percentage.

Air content should be tested for minimum air entrainment in freeze/thaw areas.

****

[Air Content

] Slump Tests

Water

SD-07 Certificates

Reinforcing Bars

Welder Qualifications

****

NOTE: Include following submittals when job complexity justifies the additional cost associated with these requirements.

****

[Silica Fume Manufacturer's Representative

][VOC Content for Form Release Agents, Curing Compounds, and Concrete Penetrating Sealers

][Safety Data Sheets

] Forest Stewardship Council (FSC) Certification

Field Testing Technician and Testing Agency

SD-08 Manufacturer's Instructions

Liquid Chemical Floor Hardeners and Sealers

Joint Sealants; S

[Curing Compound

]1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

****

NOTE: Materials which are woven, fibrous, or porous in nature have a high capacity to adsorb VOC emissions; for instance, acoustical ceilings, carpet, textiles, and unprimed gypsum wall board.

****

Follow ACI 301, ACI 304R and ASTM A934/A934M requirements and recommendations. Do not deliver concrete until vapor retarder,[vapor barrier,] forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions, including [_____]. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

[1.5.1.1 Epoxy Coated Reinforcing Steel

Record coating lot on each shipping notice and carefully identify and re-tag bar bundles from bending plant. Provide systems for handling coated bars which have padded contact areas such as, nylon slings, all free of dirt and grit. Lift bundled coated bars with strong back, multiple supports, or platform bridge to prevent sagging and abrasion. Pad bundling bands where in contact with bars. Do not drop or drag bars or bundles. Store coated bars both in shop and in field, aboveground, on wooden or padded cribbing. Space the dunnage close enough to prevent excessive sags. Stack large quantities of straight bars with adequate protective blocking between layers. Schedule deliveries of epoxy coated bars to the job site to avoid the need for long term storage. Protect from direct sunlight and weather. Cover bars to be stored longer than 12 hours at the job site with opaque polyethylene sheeting or other suitable equivalent protective material.

]1.6 QUALITY ASSURANCE

1.6.1 Design Data

[1.6.1.1 Formwork Calculations

ACI 347R. Include design calculations indicating arrangement of forms, sizes and grades of supports (lumber), panels, and related components. Furnish drawings and calculations of shoring and re-shoring methods proposed for floor and roof slabs, spandrel beams, and other horizontal concrete members. Indicate in calculations concrete pressure with both live and dead loads, along with material types.

]1.6.1.2 Concrete Mix Design

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit all documentation required in ACI 301 Section 4 and as specified in this section. Submit a complete list of materials including type; brand; source and amount of cement, supplementary cementitious materials,[fibers,] and admixtures; and applicable reference specifications. Submit mill test and all other test for cement, supplementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. Required average strength can be documented by field experience if field strength test data are available and represent a single group of at least 10 consecutive strength tests for one mixture, using materials and conditions similar to those expected for work, and encompassing a period of not less than 45 days. The average of field strength tests must equal or exceed fcr'. Changes in materials, conditions, and proportions within the test record must not have been more closely restricted than those for the proposed work. Test records must not be more than 24 months old. Obtain mix design approval from the contracting officer prior to concrete placement.

1.6.2 Shop Drawings

[1.6.2.1 Formwork

Drawings showing details of formwork including, but not limited to; joints, supports, studding and shoring, and sequence of form and shoring removal. Indicate placement schedule, construction, location and method of forming control joints. Include locations of inserts, conduit, sleeves and other embedded items. Reproductions of contract drawings are unacceptable. Submit form removal schedule indicating element and minimum length of time for form removal.

Design, fabricate, erect, support, brace, and maintain formwork so that it is able to support, without failure, all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.

]1.6.2.2 Reinforcing Steel

Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Reproductions of contract drawings are unacceptable.

[1.6.3 Control Submittals

[1.6.3.1 Concrete Curing Plan

Submit proposed materials, methods and duration for curing concrete elements in accordance with ACI 308.1.

][1.6.3.2 Pumping Concrete

Submit proposed materials and methods for pumping concrete. Include mix designs, pumping equipment including type of pump and size and material for pipe, and maximum length and height concrete is to be pumped.

][1.6.3.3 Silica Fume Manufacturer's Representative

****

NOTE: A pre-construction meeting with the concrete supplier, contractor, finisher, admixture supplier, and Contracting Officer should be required for projects which require silica fume, corrosion inhibitors, or high-range water reducers (superplasticizers). An initial sample pour with the proposed concrete mix and methods of placing,

finishing and curing may be beneficial to ensure concrete quality.
****

The manufacturer's representative must be present at mix plant to ensure proper mix, including high range water reducer, and batching methods during the first 3 [_____] days of concrete mix preparation and placement. After which the manufacturer's representative must designate a representative at the concrete producer's plant to ensure the concrete mix procedures meet the silica fume manufacturer's recommendations.[Representative to attend and advise at finishing of sample slab.]

][1.6.3.4 Finishing Plan

****
NOTE: Include when finishing or special flatness are critical.
****

Submit proposed material and procedures to be used in obtaining the finish for the [_____] floors. Include qualification of person to be used for obtaining floor tolerance measurement, description of measuring equipment to be used, and a sketch showing lines and locations the measuring equipment will follow.

][1.6.3.5 VOC Content for form release agents, curing compounds, and concrete penetrating sealers

Submit certification for the form release agent, curing compounds, and concrete penetrating sealers that indicate the VOC content of each product.

]1.6.3.6 Safety Data Sheets

Submit Safety Data Sheets (SDS) for all materials that are regulated for hazardous health effects. SDS must be readily accessible during each work shift to employees when they are at the construction site.

]1.6.4 Test Reports

1.6.4.1 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date.

1.6.4.2 Slag Cement

Submit test results in accordance with ASTM C989/C989M for slag cement. Submit test results performed within 6 months of submittal date.

1.6.4.3 Aggregates

Submit test results in accordance with ASTM C33/C33M, or ASTM C330/C330M for lightweight aggregate, and ASTM C1293 or ASTM C1567 as required in the paragraph titled ALKALI-AGGREGATE REACTION.

[1.6.4.4 Fiber-Reinforced Concrete

Test to determine flexural toughness index I5 in accordance with ASTM C1116/C1116M.

]1.6.5 Field Samples

[1.6.5.1 Slab Finish Sample

Install minimum of 3000 mm by 3000 mm 10 foot by 10 foot slab. Slab finish sample must not be part of the final project. Finish as required by specification.[Silica fume manufacturer's representative must attend and advise.]

][1.6.5.2 Surface Finish Samples

****

NOTE: Include when either job complexity or aesthetics justify the additional cost associated with these requirements.

****

Provide a minimum of three sample concrete panels for each finish for each mix design, 1 m by 1 m, 75 mm 3 feet by 3 feet, 3 inches thick. Use the approved concrete mix design(s). Provide sample panels on-site at locations directed. Once approved, each set of panels are representative of each of the finishes specified and of the workmanship and finish(es) required. Do not remove or destroy samples until directed by the Contracting Officer.

]1.6.6 Quality Control Program

****

NOTE: The objective of the concrete quality control program is for the Contractor to outline the procedures that will be used to construct a structure that will obtain the design service life.

****

Develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and as specified herein. Include approved laboratories. Provide direct oversight for the concrete qualification program inclusive of associated sampling and testing. Provide all quality control reports to the Contracting Officer, Quality Manager and Concrete Supplier. Maintain a copy of ACI MNL-15 and CRSI 10MSP at project site.

1.6.7 Quality Control Personnel Certifications

Submit for approval the responsibilities of the various quality control personnel, including the names and qualifications of the individuals in those positions and a quality control organizational chart defining the quality control hierarchy and the responsibility of the various positions. Quality control personnel must be employed by the Contractor.

Submit American Concrete Institute certification for the following:

a. CQC personnel responsible for inspection of concrete operations.

b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.

c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade

I.

1.6.7.1 Quality Manager Qualifications

Holds a current license as a professional engineer in a U.S. state or territory with experience on at least five similar projects. Evidence of extraordinary proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

1.6.7.2 Field Testing Technician and Testing Agency

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

a. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI MNL-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI MNL-2.

b. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.

c. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.

1.6.8 Laboratory Qualifications for Concrete Qualification Testing

The concrete testing laboratory must have the necessary equipment and experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077 and be Cement and Concrete Reference Laboratory (CCRL) inspected.

1.6.9 Laboratory Accreditation

Laboratory and testing facilities are provided by and at the expense of the Contractor. The laboratories performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation must be current and must include the required test methods, as specified. Furthermore, comply with the following requirements:

****

NOTE: Use second set of brackets for OCONUS projects to specify alternate licensing requirement where a registered U.S. professional would not be feasible.

****

a. Aggregate Testing and Mix Proportioning: Studies performed by an accredited laboratory and under the direction of a[registered professional engineer in a U.S. state or territory competent in concrete materials] [_____] who is competent in concrete materials and must sign all reports and designs.

b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M.

c. Contractor Quality Control: All sampling and testing must be performed by an approved, onsite, independent, accredited laboratory.

1.7 ENVIRONMENTAL REQUIREMENTS

****

NOTE: In some regions, choose the most appropriate option(s) for ventilation. For instance, high-humidity regions may generate too much condensate when using 100 percent outside air.

****

Provide space ventilation according to material manufacturer recommendations, at a minimum, during and following installation of concrete curing compound and sealer. Maintain one of the following ventilation conditions during the curing period or for 72 hours after installation:

a. Supply 100 percent outside air 24 hours a day.

b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 13 degrees C 55 degrees F and 29 degrees C 84 degrees F and humidity is between 30 percent and 60 percent.

c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.7.1 Submittals for Environmental Performance

a. Provide data indication the percentage of post-industrial pozzolan (fly ash, slag cement) cement substitution as a percentage of the full product composite by weight.

b. Provide data indicating the percentage of post-industrial and post-consumer recycled content aggregate.

c. Provide product data indicating the percentage of post-consumer recycled steel content in each type of steel reinforcement as a percentage of the full product composite by weight.

d. Provide product data stating the location where all products were manufactured

e. For projects using FSC certified formwork, provide chain-of-custody documentation for all certified wood products.

f. For projects using reusable formwork, provide data showing how formwork is reused.

g. Provide SDS product information data showing that form release agents meet any environmental performance goals such as using vegetable and soy based products.

h. Provide SDS product information data showing that concrete adhesives meet any environmental performance goals including low emitting, low volatile organic compound products.

1.8 SUSTAINABLE DESIGN REQUIREMENTS

1.8.1 Local/Regional Materials

****

NOTE: Using local materials can help minimize transportation impacts, including fossil fuel consumption, air pollution, and labor. Using materials harvested and manufactured within a 500-mile radius from the project site contributes to the following LEED credit: MR5. Coordinate with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Use second option if Contractor is choosing local materials in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Use second option for USACE projects. for Army projects, include option only if pursuing this LEED credit.

****

[Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [805][_____] kilometer [500][_____] mile radius from the project site, if available from a minimum of three sources.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total local material requirements. Concrete materials may be locally available.][Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.]

1.8.2 Forest Stewardship Council (FSC) Certification

Use FSC-certified wood where specified. Provide letter of certification signed by lumber supplier. Indicate compliance with FSC STD 01 001 and identify certifying organization. Submit FSC certification numbers; identify each certified product on a line-item basis. Submit copies of invoices bearing the FSC certification numbers.

1.9 QUALIFICATIONS FOR WELDING WORK

Welding procedures must be in accordance with AWS D1.4/D1.4M.

Verify that Welder qualifications are in accordance with AWS D1.4/D1.4M for welding of reinforcement or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

PART 2 PRODUCTS

2.1 FORMWORK MATERIALS

****

NOTE: Delete the brackets from the requirements below if you do not want to limit options for form-facing materials. In that case the requirement should be: "Form-facing material in contact with concrete must be lumber, plywood, tempered

concrete-form-grade hardboard, metal, plastic, or treated paper that creates specified appearance and texture of concrete surface".

****

a. Form-facing material in contact with concrete must be[lumber,][plywood,][tempered concrete-form-grade hardboard,][metal,][plastic,][or][treated paper that creates specified appearance and texture of concrete surface]. Submit product information on proposed form-facing materials if different from that specified herein.

b. Design formwork, shores, reshores, and backshores to support loads transmitted to them and to comply with applicable building code requirements.

c. Design formwork and shoring for load redistribution resulting from stressing of post-tensioned reinforcement. Ensure that formwork allows movement resulting from application of prestressing force.

d. Design formwork to withstand pressure resulting from placement and vibration of concrete and to maintain specified tolerances.

e. Design formwork to accommodate waterstop materials in joints at locations indicated in Contract Documents.

f. Provide temporary openings in formwork if needed to facilitate cleaning and inspection.

g. Design formwork joints to inhibit leakage of mortar.

****

NOTE: Use a 1/240 as a limit for structural concrete and 1/400 for architectural concrete

****

h. Limit deflection of facing materials for concrete surfaces exposed to view to[1/240][1/400] [____] of center-to-center spacing of facing supports.

[i. Do not use earth cuts as forms for vertical or sloping surfaces.

] j. Submit product information on proposed form-facing materials if different from that specified herein.

[k. Submit shop drawings for formwork, shoring, reshoring, and backshoring, signed and sealed by a licensed design engineer.

][l. Submit design calculations for formwork, shoring, reshoring, and backshoring, signed and sealed by a licensed design engineer.

] m. Submit procedure for reshoring and backshoring, including drawings signed and sealed by a licensed design engineer. Include on shop drawings the formwork removal procedure and magnitude of construction loads used for design of reshoring or backshoring system. Indicate in procedure the magnitude of live and dead loads assumed for required capacity of the structure at time of reshoring or backshoring.

n. Submit manufacturer's product data on form liner proposed for use with each formed surface.

2.1.1 Wood Forms

Use lumber as specified in Section 06 10 00 ROUGH CARPENTRY and as follows. Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with NIST PS 1, B-B concrete form panels or better or ANSI/CPA A135.4, hardboard for smooth form lining.[Submit data verifying that composite wood products contain no urea formaldehyde resins.][Virgin wood used must be FSC-certified.]

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 16 mm 5/8-inch thick.

2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to NIST PS 1, B-B, high density form overlay, not less than 16 mm 5/8-inch thick.

2.1.2 Plastic Forms

Plastic lumber as specified in Section 06 10 00 ROUGH CARPENTRY. Provide plastic forms that contain a minimum of[50][100] percent post-consumer recycled content, or a minimum of[50][100] percent post-industrial recycled content.

2.1.3 Carton Forms

Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete until initial set. Provide carton forms that contain a minimum of[5][10] [_____] percent post-consumer recycled content, or a minimum of[20][40] [_____] percent post-industrial recycled content.

2.1.4 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.2 FORMWORK ACCESSORIES

a. Use commercially manufactured formwork accessories, including ties and hangers.

b. Form ties and accessories must not reduce the effective cover of the reinforcement.

2.2.1 Form Ties

****

NOTE: Form ties: a mechanical connection in tension used to prevent concrete forms from spreading due to the fluid pressure of fresh concrete.

****

a. Use form ties with ends or end fasteners that can be removed without damage to concrete.

b. Where indicated in Contract Documents, use form ties with integral water barrier plates or other acceptable positive water barriers in walls.

****

NOTE: Specify alternative breakback distance for ferrous ties if needed.

****

c. The breakback distance for ferrous ties must be at least [50 mm] [19 mm] [2 in.] [3/4 in.] [_____] for Surface Finish-2.0 or Surface Finish-3.0, as defined in ACI 301.

[d. If the breakback distance is less than 19 mm 3/4 in., use coated or corrosion-resistant ties.

] e. Submit manufacturer's data sheet on form ties.

2.2.2 Waterstops

****

NOTE: waterstop: a thin sheet of metal, rubber, plastic, or other material inserted across a joint, or material adhered within a joint, to obstruct the seepage of water through the joint.

****

Submit manufacturer's data sheet on waterstop materials and splices.

2.2.2.1 PVC Waterstop

Conform to COE CRD-C 572.

2.2.2.2 Rubber Waterstop

Conform to COE CRD-C 513.

2.2.2.3 Thermoplastic Elastomeric Rubber Waterstop

Conform to ASTM D471.

2.2.2.4 Hydrophilic Waterstop

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water must conform to the following requirements when tested in accordance to ASTM D412: Tensile strength 2.4 MPa 350 psi minimum; ultimate elongation 600 percent minimum. Hardness must be 50 minimum on the type A durometer and the volumetric expansion ratio in distilled water at 20 degrees C 70 degrees F must be 3 to 1 minimum.

2.2.3 Biodegradable Form Release Agent

****

NOTE: The 2002 Farm Bill - Section 9002, Federal Procurement of Biobased Products, requires each Federal Agency to develop a procurement program which ensures that items composed of biobased products are be purchased to the maximum extent

practicable and which is consistent with applicable provisions of Federal procurement law.

****

a. Provide form release agent that is colorless, biodegradable, and[rapeseed oil-based][soy oil-based][water-based], with a[low (maximum of 55 grams/liter (g/l))][zero] VOC content.[A minimum of[85] [_____] percent of the total product must be biobased material.]

b. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

c. Provide form release agent that reduces formwork moisture absorption, and does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene. Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.

d. Submit manufacturer's product data on formwork release agent for use on each form-facing material.

2.2.4 Chamfer Materials

****

NOTE: Chamfer strip: either a triangular or curved insert placed in an inside form corner to produce either a rounded or flat chamfer or to form a rustication. Also called cant strip, fillet, dummy joint, and skew back.

****

Use lumber materials with dimensions of 19 x 19 mm 3/4 x 3/4 in.

2.2.5 Construction and Movement Joints

****

NOTE: Indicate in Contract Documents the locations of required movement joints, keyways, and the locations where waterstops are required in joints.

****

a. Submit details and locations of construction joints in accordance with the requirements herein.

b. Locate construction joints within middle one-third of spans of slabs, beams, and girders. If a beam intersects a girder within the middle one-third of girder span, the distance between the construction joint in the girder and the edge of the beam must be at least twice the width of the larger member.

c. For members with post-tensioning tendons, locate construction joints where tendons pass through centroid of concrete section.

d. Locate construction joints in walls and columns at underside of slabs, beams, or girders and at tops of footings or slabs.

e. Make construction joints perpendicular to main reinforcement.

f. Provide movement joints where indicated in Contract Documents or in accepted alternate locations.

g. Submit location and detail of movement joints if different from those indicated in Contract Documents.

h. Submit manufacturer's data sheet on expansion joint materials.

i. Provide keyways where indicated in Contract Documents.[Longitudinal keyways indicated in Contract Documents must be at least 37.5 mm 1-1/2 in. deep, measured perpendicular to the plane of the joint.]

2.2.6 Other Embedded items

****

NOTE: Specify materials and design for sleeves, inserts, anchors, and other embedded items if not included in the Contract Documents.

****

Use sleeves, inserts, anchors, and other embedded items of material and design indicated in Contract Documents.

2.3 CONCRETE MATERIALS

2.3.1 Cementitious Materials

****

NOTE: Typical mixtures of concrete contain either an ASTM C150 cement plus one or more supplementary cementitious material (fly ash, slag, silica fume, etc.) or a blended cement that meets ASTM C595/C595M or ASTM C1157/C1157M.

For more information on cements and cementitious materials refer to ACI E3 "Cementitious Materials for Concrete" and ACI 225R "Guide to the Selection and Use of Hydraulic Cements".

****

****

NOTE: Coal fly ash, slag, cenospheres, and silica fumes are EPA designated products to be ingredients in concrete and cement. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING and include additive options unless designer determines that justification for non-use exists.

****

2.3.1.1 Portland Cement

****

NOTE: ASTM C150 cements are as follows:
- Type I: For use when the special properties specified for any other type are not required.
- Type II: For general use, more especially when moderate sulfate resistance is desired.
- Type II(MH): For general use, more especially when

moderate heat of hydration and moderate sulfate resistance are desired.
- Type III: For use when high early strength is desired.

Type I cement is the default option. Commercially available cements can sometimes meet the requirements of Type I and Type II cements. These cements are labeled as Type I/II cements.

Type III cement is not commonly used for cast-in-place concrete. It is a cement mostly available and used in precast operations. Type III could be used if high early strength is desired but using it will significantly increase the likelihood of thermal cracking. Type III cement should not be specified for flatwork.

Type IV cement (low heat of hydration) is not listed as an option because it is usually not produced by cement plants and is not available in U.S markets. A combination of Type II(MH) and a supplementary cementitious material such as fly ash is typically specified when low heat of hydration is required for a structure/member.

Type V cement is a sulfate resistant cement. Refer to the paragraph on SULFATE RESISTANCE (under durability) for more information on when to specify sulfate resistant cement.

Low-alkali cements are no longer defined in portland cement specifications because specifying low-alkali cement is not necessarily sufficient to mitigate alkali-silica reaction (ASR). To mitigate ASR, refer to paragraph ALKALI-AGGREGATE REACTION.

For more information and options refer to ASTM C150/C150M.

****

a. Unless otherwise specified, provide cement that conforms to ASTM C150/C150M Type[I][II][II(MH)][III][IV][V] [_____].

b. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

c. [For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch.][Supplier must certify that no hazardous waste is used in the fuel mix or raw materials.][Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants are discharged.]

d. Submit information along with evidence demonstrating compliance with referenced standards. Include types of cementitious materials, manufacturing locations, shipping locations, and certificates showing compliance.

e. Store cementitious materials and keep dry and free from contaminants.

[2.3.1.2 Blended Cements

****

NOTE: There are many options to choose from in ASTM C595. Here are some naming designations used:
- IP: portland-pozzolan cement
- IS: portland blast-furnace slag cement
- IL: portland limestone cement
- MS: moderate sulfate resistance
- HS: high sulfate resistance
- MH: moderate heat of hydration
- LH: low heat of hydration

ASTM C1157 blended cements include the following:
- Type GU: Hydraulic cement for general construction
- Type HE: High Early-Strength
- Type MS: Moderate Sulfate Resistance
- Type HS: High Sulfate Resistance
- Type MH: Moderate Heat of Hydration

See ASTM C595/C595M and ASTM C1157/1157M for additional blended cement requirements, special properties, and options.

****

a. Conform to ASTM C595/C595M Type[IP][IS][IT][IP(MS)][IS(MS)][IT(MS)][IP(MH)][IS(MH)][IT(MH)][IP(LH)][IS(LH)][IT(LH)][IL][_____] or ASTM C1157/C1157M Type[GU][MS][MH][HE].

b. Slag cement added to the Type IS or Type IT blended cements must meet ASTM C989/C989M.

c. The pozzolan added to the Type IP or Type IT blended cements must meet ASTM C618[Class F,][Class C,][or][Class N] and interground with the cement clinker. The manufacturer must state in writing that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of pozzolan used in the blend must not change from that submitted for the aggregate evaluation and mixture proportioning.

]2.3.1.3 Fly Ash

****

NOTE: Fly ash, silica fume, slag, and other SCMs may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Fly ashes meeting the specified test results, which are more stringent than ASTM C618, should provide acceptable end results. It is suggested that fly ash be used as a replacement for 35 percent of the cement.

Using Class C fly ash is not recommended, Class F fly ash is preferred. The performance of Class C ashes should be evaluated before use because some Class C ashes could help improve performance while

others could cause a reduction in concrete quality and durability. For example, some Class C fly ashes may improve sulfate resistance, while others may actually reduce sulfate resistance and accelerate deterioration. Class C should not be used to mitigate ASR unless mortar bars made with the fly ash meet the expansion requirements of ASTM C1567. For more information on the use of fly ash in concrete refer to ACI 232.2R.

****

a. ASTM C618,[Class F][Class C], except that the maximum allowable loss on ignition must not exceed[3][6] percent.

****

NOTE: The minimum fly ash content should not be less than 15 percent.

****

b. If fly ash is used it must range from 15 to[20][30][35][40] percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Do not use fly ash when it cannot meet the minimum level. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.3.1.4 Slag Cement

ASTM C989/C989M, Grade[100][120].

2.3.1.5 Silica Fume

****

NOTE: Guidance for use of silica fume should be sought from the agency's Subject Matter Expert in Concrete Materials.

****

****

NOTE: The initial cost of the concrete will increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWRA must be used with silica fume, the slump can be increased 50 to 125 mm 2 to 5 inches without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.

****

Silica fume must conform to ASTM C1240, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as slurry. Proper mixing is essential to accomplish proper distribution of the silica fume and avoid agglomerated silica fume which can react with the alkali in the cement resulting in premature and extensive concrete damage. Supervision at the batch plant, finishing, and curing is essential.[Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume.][Use a High Range Water Reducing admixture (HRWRA) when silica fume is the only pozzolan used.]

2.3.1.6 Other Supplementary Cementitious Materials

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age at least 95 percent of the control specimens.

b. The average particle size not exceed 6 microns.

c. The sum of SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 77 percent.

2.3.2 Water

a. Water or ice must comply with the requirements of ASTM C1602/C1602M.

b. Minimize the amount of water in the mix. Improve workability by adjusting the grading of the aggregate and using admixture rather than by adding water.

c. Provide water[potable][from rainwater collection][from graywater][from recycled water]; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

d. Protect mixing water and ice from contamination during storage and delivery.

e. Submit test report showing water complies with ASTM C1602/C1602M.

[f. When nonpotable source is proposed for use, submit documentation on effects of water on strength and setting time in compliance with ASTM C1602/C1602M.

]2.3.3 Aggregate

2.3.3.1 Normal-Weight Aggregate

****

NOTE: ASTM C33/C33M provides many requirements for concrete aggregates. Requirements such as soundness and the presence of deleterious substances should strictly be adhered to. Grading requirements on the other hand could be evaluated based on the overall mixture design and not based on each individual aggregate source.

Aggregate grading can be evaluated using methods such as 0.45 power chart, the coarseness factor chart, the "percent retained" or "18-8" method, and others. Quality concrete can be produced without meeting the grading requirements of ASTM C33/33M.

****

a. Conform to ASTM C33/C33M[unless otherwise specified in the Contract Documents or approved by the contracting officer] [_____].

****

NOTE: Specify a nominal maximum size aggregate if needed. Note that the maximum size aggregate can differ for different portions of the structure.

Nominal Maximum Size: the smallest sieve opening through which the entire amount of the aggregate is permitted to pass.

Delete the requirement below if you do not want to specify a maximum size aggregate. Note that the paragraph titled CONCRETE MIX DESIGN limits the nominal maximum size of aggregate based on the dimension of a member and spacing of reinforcement.

****

b. Obtain aggregates used in concrete from the same sources and have the same size range as aggregates used in concrete represented by submitted field test records or used in trial mixtures.

****

NOTE: Calcium carbonate sands (limestone or dolomitic limestone) are softer than siliceous sands; when subject to abrasion, limestone sands in concrete polish and cause skid problems. To ensure that soft manufactured calcium carbonate sands are blended with harder sands (such as a natural siliceous sands), specify a 50 percent acid insoluble sand requirement when concrete is subject to abrasion (ex: pavements).

Note that for blended sands, the limit is for the blend of sand and not for each individual source of sand. Concrete produced with manufactured sands might require a higher w/c ratio, higher cement content, or higher admixture dosages to obtained the required workability and instability; Most hardened concrete properties (strength and durability) however will not be affected by the usage of 100 percent manufactured sand. If finishability is an issue, then consider specifying 50 percent natural sand.

****

c. [Provide sand that is at least 50 percent acid insoluble based on ASTM D3042.][Provide sand that is at least 50 percent natural sand.]

d. Store and handle aggregate in a manner that will avoid segregation and prevents contamination by other materials or other sizes of aggregates. Store aggregates in locations that will permit them to drain freely. Do not use aggregates that contain frozen lumps.

e. Submit types, pit or quarry locations, producers' names, aggregate supplier statement of compliance with ASTM C33/C33M, and ASTM C1293 expansion data not more than 18 months old.

2.3.3.2 Lightweight Aggregate

Lightweight aggregate in accordance with ASTM C330/C330M.

2.3.3.3 Recycled Aggregate Materials

****

NOTE: Use of materials with recycled content, calculated based on post-industrial and post-consumer percentage content, contributes to the following LEED credit: MR4. Coordinate with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

Use a minimum of[25] [_____] percent recycled aggregate, depending on local availability and conforming to requirements of the mix design. Recycled aggregate to include: [recovered glass][recovered concrete][recovered porcelain][recovered stone] [_____] that meets the aggregate requirements specified. Submit recycled material request with the aggregate certification submittals and do not use until approved by the Contracting Officer.

2.3.4 Admixtures

****

NOTE: There are 4 main classes of admixtures for concrete:

- Water Reducers: Used to reduce the quantity of mixing water required to produce concrete of a given consistency.

- Set Control: to retard or accelerate concrete setting time.

- Durability Enhancing: to enhance the durability of concrete. These include air entraining admixture, corrosion inhibitors, ASR inhibitors, Shrinkage reducers, and others.

- Miscellaneous admixtures: these include coloring admixtures, foaming agents, viscosity modifiers, etc.

Specifying water reducers or set control admixtures is not necessary. The contractor should choose the combination of these admixtures as needed and as recommended by the admixture manufacturer. Air-entraining admixture dosage is controlled by the air content requirements specified in the paragraph titled DURABILITY. Thus, the specifier does not need to specify when an air-entraining admixture should be used. Other specialty admixtures however, such as corrosion inhibitors, ASR inhibitors, or shrinkage reducers should be specified in this paragraph if needed.

For more information on concrete admixtures refer to ACI 212.

****

a. Chemical admixtures must conform to ASTM C494/C494M.

b. Air-entraining admixtures must conform to ASTM C260/C260M.

c. Do not use calcium chloride admixtures[.][unless approved by the contracting officer.]

****

NOTE: A corrosion-inhibiting admixture provides supplemental corrosion protection, specify if such an admixture is required under exposure C1 or C2.

An ASR-inhibiting admixture provides supplemental protection to concrete when reactive aggregate is used. Specify if the usage of ASR-inhibiting admixtures is required.

Specify if, when, and where any other specialty admixtures are required. Note that such requirements could also be specified in the paragraph titled CONCRETE MIX DESIGN.

****

d. [Use a corrosion-inhibiting admixture for concrete classified under exposure category[C1][C2].][Use an ASR-inhibiting admixture for concrete containing aggregate susceptible to ASR.] [_____]

e. Admixtures used in concrete must be the same as those used in the concrete represented by submitted field test records or used in trial mixtures.

f. Protect stored admixtures against contamination, evaporation, or damage.

g. To ensure uniform distribution of constituents, provide agitating equipment for admixtures used in the form of suspensions or unstable solutions. Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.

h. Submit types, brand names, producers' names, manufacturer's technical data sheets, and certificates showing compliance with standards required herein.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Concrete Curing Materials

Provide concrete curing material in accordance with ACI 301 Section 5 and ACI 308.1 Section 2. Submit product data for concrete curing compounds. Submit manufactures instructions for placement of curing compound.

2.4.2 Nonshrink Grout

Nonshrink grout in accordance with ASTM C1107/C1107M.

2.4.3 Floor Finish Materials

2.4.3.1 Liquid Chemical Floor Hardeners and Sealers

a. Hardener must be a colorless aqueous solution containing a blend of inorganic silicate or siliconate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of liquid chemical floor hardener.

b. Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content. Submit manufactures instructions for placement of sealers.

2.4.3.2 Abrasive Aggregate for Nonslip Aggregate Finish

****

NOTE: When abrasive aggregate is required, delete one of the following two paragraphs as required. Aluminum oxide and emery abrasive grits are blackish-gray and nonsparkling; silicon carbide abrasive grits are black and sparkling.

****

[Aggregate must be packaged, factory-graded fused aluminum oxide grits, or crushed emery containing not less than 40-percent aluminum oxide and not less than 25-percent ferric oxide. Aggregate must be rust proof, nonglazing and unaffected by freezing, moisture, and cleaning materials.

][Aggregate must be packaged, factory-graded, silicon carbide grits. Aggregate must be rust proof and unaffected by freezing, moisture, and cleaning materials.

][Aggregate must be well-graded in size from particles retained on 600 micrometer sieve No. 30 sieve 0.0236 inch to particles passing 2.36 mm sieve No. 8 sieve 0.0929 inch.

]2.4.3.3 Dry Materials for Colored Wear-Resistant Finish

****

NOTE: When color must be indicated, available colors are natural, bright red, dark red, terra cotta, green, and gray.

****

[Provide materials that are packaged, dry, and a combination of materials formulated for producing colored and wear-resistant monolithic surface treatments; they must include portland cement, graded-quartz aggregate, coloring pigments, and dispersing agents. Provide coloring pigments that are finely ground, nonfacing mineral oxides prepared especially for the purpose and interground with the cement.

]2.4.3.4 Aggregate for Heavy-Duty Wear-Resistant Finish

****

NOTE: When heavy-duty, wear-resistant finish is required, delete first paragraph. Delete following paragraphs when mineral aggregate is not required. Delete second paragraph when iron aggregate is not

required.
****

[Provide aggregate that is traprock or emery, as follows:

[Traprock must be packaged, crushed, natural, fine-to-medium-grained, igneous rock, such as diabase, basalt, or black granite. Provide traprock aggregate that is well-graded in size from particles retained on 4.75 mm sieve No. 4 sieve 0.187 inch to particles passing 9.5 mm 3/8-inch sieve.]

[Emery must be packaged, factory-graded, crushed, natural-emery ore, cubical or polyhedral in form, containing not less than 35-percent aluminum oxide and not less than 24-percent ferric oxide. Provide emery aggregate that is well graded in size from particles retained on 300 micrometer sieve No. 50 sieve 0.0118 inch to particles passing 2.36 mm sieve No. 8 sieve 0.0929 inch.
]

][Provide iron aggregate, as follows:

Iron must be packaged, ground and graded cubicle iron particles with dispersing agents, formulated to blend with portland cement for producing wear-resistant monolithic surface treatments. Provide aggregate that is free of nonferrous metals, oil, grease, soluble alkaline compounds, rust, and impurities and that is well-graded in size from particles retained on 300 micrometer sieve No. 50 sieve 0.0118 inch to particles passing 2.36 mm sieve No. 8 sieve 0.0929 inch.

]2.4.3.5 Aggregate for Heavy-Duty Floor Topping

Provide emery (or may be traprock or traprock-screenings) fine aggregates, as specified.

Provide emery that is packaged, factory-graded, crushed natural emery ore containing not less than 35-percent aluminum oxide and not less than 24-percent ferric oxide. Provide aggregate that is cubical or polyhedral in form and does not change its physical or chemical nature in the presence of moisture. Grade aggregate to a fineness modulus of 3.9 to 4.0, with 100 percent passing 9.5 mm 3/8-inch sieve and not less than 95 percent retained on 150 micrometer No. 100 sieve. Deliver emery in moisture-resistant bags.

Provide traprock that is packaged, crushed, natural, fine- to medium-grained igneous rock such as diabase, basalt, or black granite. Uniformly grade coarse aggregate with 100 percent passing 12.5 mm 1/2-inch sieve, 30 to 50 percent passing 9.5 mm 3/8-inch sieve, 0 to 15 percent passing 4.75 mm No. 4 sieve, and 0 to 5 percent passing 2.36 mm No. 8 sieve.

Provide fine aggregate using traprock that conforms to ASTM C33/C33M, except gradation. Grade fine aggregate within the following limits:

SIEVE	PERCENT PASSING
9.5 mm 3/8 in.	100
4.75 mm No. 4	95 to 100
2.36 mm No. 8	65 to 80
1.18 mm No. 16	45 to 65
600 micrometer No. 30	25 to 45

SIEVE	PERCENT PASSING
300 micrometer No. 50	5 to 15
150 micrometer No. 100	0 to 5

Deliver traprock coarse aggregate and fine aggregate in moisture-resistant bags.

2.4.4 Expansion/Contraction Joint Filler

[ASTM D1751][or][ASTM D1752] [Type I][or][Type II] [_____]. Provide material 13 mm 1/2 inch thick[, unless otherwise indicated].

2.4.5 Joint Sealants

****

NOTE: Using low-VOC products contributes to the following LEED credit: EQ4. Include VOC submittal if pursuing this LEED credit, and coordinate with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

[Submit manufacturer's product data, indicating VOC content.

]2.4.5.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D6690 or ASTM C920, Type M, Class 25, Use T.

2.4.5.2 Vertical Surfaces Greater Than 3 Percent Slope

****

NOTE: Specify ASTM C920 for vertical surfaces greater than 3 percent slope and not subject to jet fuel, gasoline, fuel oil, or other caustic liquids. For vertical surfaces greater than 3 percent slope and subject to jet fuel, specify FS SS-S-200, no sag.

****

ASTM C920, Type M, Grade NS, Class 25, Use T[NT].[FS SS-S-200, no sag.]

2.4.5.3 Preformed Polychloroprene Elastomeric Type

ASTM D2628.

2.4.5.4 Lubricant for Preformed Compression Seals

ASTM D2835.

2.4.6 Vapor Retarder[and Vapor Barrier]

****

NOTE: Edit title to correct choice. Use first paragraph where vapor retarder is required to minimize vapor transmission through the concrete and a permanent vapor barrier is not required. Select second bracketed option where permanent vapor barrier is required. Vapor barriers should only be

used where required due to the required moisture content of the slab for floor covering adhesion and as required for quality concrete, see ACI 360R, figure 4.7 for guidance when a vapor retarder is needed. For protection against hydrostatic pressure or conditions of excessive dampness, specify an appropriate waterproofing membrane in Division 7.

****

ASTM E1745 Class A[B][C] polyethylene sheeting, minimum 0.25 mm 10 mil[0.38 mm 15 mil] thickness or other equivalent material with a maximum permeance rating of 0.04 perms per ASTM E96/E96M.

[ASTM E1745 Class A[B][C] polyethylene sheeting, minimum 0.38 mm 15 mil thickness or ASTM E1993/E1993M bituminous membrane or other equivalent material with a maximum permeance rating of 0.01 perms per ASTM E96/E96M.

] Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.4.7 Dovetail Anchor Slot

Preformed metal slot approximately 25 mm by 25 mm 1 inch by 1 inch of not less than 22 gage galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

2.5 CONCRETE MIX DESIGN

2.5.1 Properties and Requirements

****

NOTE: Selecting concrete proportions involves balance among requirements for placeability, workability, finishability, strength, durability, density, appearance, economy of the resulting mixture, and other desired properties.

Properties specified in this paragraph such as strength, slump, aggregate size, etc. will be used to proportion concrete mixtures and/or order ready-mix concrete. For more on ready-mix concrete see paragraph on READY-MIX CONCRETE and ASTM C94/C94M. Note that the required information for ordering concrete is discussed in section 6 of ASTM C94/C94M.

****

a. Use materials and material combinations listed in this section and the contract documents.

****

NOTE: A minimum cementitious material content limit for concrete is generally not required for most portions of a structure. In the case of floors/slabs, a minimum content of cement could be required to improve the finishability of the surface. A finishing crew might have a hard time finishing a surface made with a lean concrete

mixture; in such cases a minimum content of cementitious materials should be required.

****

b. Cementitious material content must be adequate for concrete to satisfy the specified requirements for strength, w/cm, durability, and finishability described in this section and the contract documents.

[c. The minimum cementitious material content for concrete used in floors must meet the following requirements:

Nominal maximum size of aggregate, mm in.	**Minimum cementitious material content, kg per cubic meter pounds per cubic yard**
37.5 1-1/2	280 470
25 1	310 520
19 3/4	320 540
9.5 3/8	360 610

]

****

NOTE: This requirement for slump is a general requirement for all concrete members. If specific requirements are needed for a portion of the structure then add those requirements to the table located at the end of this paragraph.

****

d. Selected target slump must meet the requirements of this section, the contract documents, and must not exceed 230 mm 9 in. Concrete must not show visible signs of segregation.

e. Enforce the target slump for the duration of the project. Determine the slump by ASTM C143/C143M. Slump tolerances must meet the requirements of ACI 117.

f. The nominal maximum size of coarse aggregate for a mixture must not exceed three-fourths of the minimum clear spacing between reinforcement, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

****

NOTE: Exposure Class F1, F2, or F3 are defined in the paragraph titled DURABILITY.

****

g. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3, with the total air content in accordance with the requirements of the paragraph titled DURABILITY.

h. Measure air content at the point of delivery in accordance with ASTM C173/C173M or ASTM C231/C231M.

i. Concrete for slabs to receive a hard-troweled finish must not contain an air-entraining admixture or have a total air content greater than 3 percent.

****

NOTE: Specify the properties and requirements needed for each portion of the structure. Note that the values given for the first entry "Footings" is an example to illustrate how this table should be used. Modify this table by adding or deleting information and rows as needed for your project.

- Minimum f'c (compressive strength): Specify the required compressive strength value and age for each portion of the structure. The strength value specified should be based on the value used for structural strengths or durability requirements, whichever controls. The age (7, 28, 56, 90) should be specified based on the needs of the project. 28-day strength is most commonly specified (default age for compressive strength). 7-day strength is specified only when high early strength is required on a project. 56- and 90-day strength requirements are specified for mixtures with relatively higher contents of pozzolanic materials because these mixtures require more time to gain strength. A higher compressive strength may be required for durability considerations. For floors, the specified compressive strength f'c will generally depend upon the intended use and expected wear unless durability considerations dictate higher strengths. If the floor will be exposed to abrasive wear from early construction traffic, consider requiring a minimum compressive strength at 3 days of 1800 psi or higher. Refer to ACI 302.1R for guidance on compressive strengths to specify for various classes of floors.

- Information on exposure categories can be found in the paragraph titled DURABILITY and Chapter 19 of ACI 318. Choose the exposure categories for each portion of the structure as needed. Note that F0, C0, S0, and W0 are exposure categories that have no additional durability requirements and could be considered as default values.

- Misc. Requirements: Add any requirement or property other than compressive strength, including aggregate size or gradation, w/c ratio and/or air content (if either is different than durability requirements), slump limits, fiber dosages, etc. Note that the default information in this table is given as an example of information that could be added; modify the table as needed.

-For information on lightweight concrete see ACI 213R.

****

j. Concrete properties and requirements for each portion of the structure are specified in the table below. Refer to the paragraph titled

DURABILITY for more details on exposure categories and their requirements.

	Minimum *f'c* MPa psi	**Exposure Categories^**	**Miscellaneous Requirements**
Footings	[35] [19] [_____] [5000] [3000] [_____] at [7] [28] [56] [90] days	[S0] [S1] [S2] [S3]; [C0] [C1] [C2]; [W0] [W1] [W2]; [F0] [F1] [F2] [F3]	[Max. slump: [15 cm] [6 in.] [_____]] [Nominal maximum aggregate size must be [12.5 mm][19 mm][25 mm] [1/2 in.][3/4 in.][1 in.] [_____]]
Columns and walls	[35] [19] [_____] [5000] [3000] [_____] at [7] [28] [56] [90] days	[S0] [S1] [S2] [S3]; [C0] [C1] [C2]; [W0] [W1] [W2]; [F0] [F1] [F2] [F3]	[Nominal maximum aggregate size must be [12.5 mm][19 mm][25 mm] [1/2 in.][3/4 in.][1 in.] [_____]]
Beams and elevated slabs	[35] [19] [_____] [5000] [3000] [_____] at [7] [28] [56] [90] days	[S0] [S1] [S2] [S3]; [C0] [C1] [C2]; [W0] [W1] [W2]; [F0] [F1] [F2] [F3]	[Nominal maximum aggregate size must be [12.5 mm][19 mm][25 mm] [1/2 in.][3/4 in.][1 in.] [_____]]
Slabs-on-ground	[35] [19] [_____] [5000] [3000] [_____] at [7] [28] [56] [90] days	[S0] [S1] [S2] [S3]; [C0] [C1] [C2]; [W0] [W1] [W2]; [F0] [F1] [F2] [F3]	[Min. dosage [0.9] [1.5] [_____] (kg per cubic meter) (pounds per cubic yard) for synthetic micro-fiber] [Min. dosage [2.4][4] [_____] (kg per cubic meter) (pounds per cubic yard) for synthetic macro-fiber] [Min. dosage [30] [50] [_____] (kg per cubic meter) (pounds per cubic yard) for steel fibers]
Lightweight concrete suspended slab	[5000] [3000] [_____] [35] [19] [_____] at [7] [28] [56] [90] days	[S0] [S1] [S2] [S3]; [C0] [C1] [C2]; [W0] [W1] [W2]; [F0] [F1] [F2] [F3]	[Max. density of [1840] [115] [1680] [105] [_____] (kg per cubic meter) (pounds per cubic foot)]

	Minimum *f'c* MPa psi	**Exposure Categories^**	**Miscellaneous Requirements**
Concrete Toppings	[5000] [3000] [_____] [35] [19] [_____] at [7] [28] [56] [90] days	[S0] [S1] [S2] [S3]; [C0] [C1] [C2]; [W0] [W1] [W2]; [F0] [F1] [F2] [F3]	[Max. slump: [15 cm] [6 in.] [_____]]

2.5.2 Durability

****

NOTE: Proportions required for durable concrete may take precedence over those for strength. Durability can be more important than strength to the overall performance of the completed work. Concrete should be proportioned to resist the effects of exposures that can deprive it of serviceability. Durability is related to strength, but is also affected by factors which strength alone does not indicate. Strength tests alone are not a good predictor of durability. Additional durability tests on concrete and its components could be performed to insure that durable concrete is produced.

****

2.5.2.1 Alkali-Aggregate Reaction

Do not use any aggregate susceptible to alkali-carbonate reaction (ACR). Use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction (ASR):

a. For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 must not exceed 0.04 percent at one year.

b. For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 must not exceed 0.10 percent at an age of 16 days.

****

NOTE: Alkali content in concrete (LBA), which is sometimes referred to as alkali loading in concrete, is a function of how reactive an aggregate is to alkalis. A lower LBA should be used with highly reactive aggregate.

The limit required below was obtained from ACI 301 and should cover most available aggregates. Limits specific to certain aggregates could be obtained by testing a combination of cementitious materials and reactive aggregate being considered. If a highly reactive aggregate is being considered for a project, the value of LBA being specified should be verified or determined for that specific aggregate.

****

c. Alkali content in concrete (LBA) must not exceed [2.4 kg per cubic meter] [4 pounds per cubic yard] [_____] for moderately reactive aggregate or [1.8 kg per cubic meter] [3 pounds per cubic yard] [_____] for highly reactive aggregate. Determine reactivity by testing in accordance with ASTM C1293 and categorize in accordance with ASTM C1778. Alkali content is calculated as follows:
LBA = (cement content, kg per cubic meter pounds per cubic yard) × (equivalent alkali content of portland cement in percent/100 percent)

2.5.2.2 Freezing and Thawing Resistance

a. Provide concrete meeting the following requirements based on exposure class assigned to members for freezing-and-thawing exposure in Contract Documents:

Exposure class	**Maximum *w/cm****	**Minimum *f'c*, MPa psi**	**Air content**	**Additional Requirements**
F0	N/A	17 2500	N/A	
F1	0.55	24 3500	Depends on aggregate size	N/A
F2	0.45	31 4500	Depends on aggregate size	See limits on maximum cementitious material by mass
F3	0.40	35 5000	Depends on aggregate size	See limits on maximum cementitious material by mass
F3 plain concrete	0.45	31 4500	Depends on aggregate size	See limits on maximum cementitious material by mass

*The maximum *w/cm* limits do not apply to lightweight concrete.

b. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3. Meet the requirements of the following table:

Nominal maximum aggregate size, mm in.	**Total air content, percent*^**	
	Exposure Class F2 and F3	**Exposure Class F1**
9.5 3/8	7.5	6.0
12.5 1/2	7.0	5.5
19.03/4	6.0	5.0
25.0 1	6.0	4.5

Nominal maximum aggregate size, mm in.	**Total air content, percent*^**	
	Exposure Class F2 and F3	**Exposure Class F1**
37.5 1-1/2	5.5	4.5
50 2	5.0	4.0
75 3	5.5	3.5

*Tolerance on air content as delivered must be plus/minus 1.5 percent.

^For f'c greater than 5000 psi, reducing air content by 1.0 percentage point is acceptable.

c. Submit documentation verifying compliance with specified requirements.

d. For sections of the structure that are assigned Exposure Class F3, submit certification on cement composition verifying that concrete mixture meets the requirements of the following table:

Cementitious material	**Maximum percent of total cementitious material by mass***
Fly ash or other pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989/C989M	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or other pozzolans, slag cement, and silica fume	50^
Total of fly ash or other pozzolans and silica fume	35^

*Total cementitious material also includes ASTM C150/C150M, ASTM C595/C595M, ASTM C845/C845M, and ASTM C1157/C1157M cement. The maximum percentages above must include:

i. Fly ash or other pozzolans present in ASTM C1157/C1157M or ASTM C595/C595M Type IP or Type IT blended cement.

ii. Slag cement present in ASTM C1157/C1157M or ASTM C595/C595M Type IS or Type IT blended cement.

iii. Silica fume conforming to ASTM C1240 present in ASTM C1157/C1157M or ASTM C595/C595M Type IP or Type IT blended cement.

^Fly ash or other pozzolans and silica fume must constitute no more than 25 percent and 10 percent, respectively, of the total mass of the cementitious materials.

2.5.2.3 Corrosion and Chloride Content

a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members requiring protection against reinforcement corrosion in Contract Documents.

b. Submit documentation verifying compliance with specified requirements.

c. Determine water-soluble chloride ion content contributed from constituents including water, aggregates, cementitious materials, and admixtures for the concrete mixture by ASTM C1218/C1218M at age between 28 and 42 days.

d. The maximum water-soluble chloride ion (Cl-) content in concrete, percent by mass of cement is as follows:

Exposure class	**Maximum *w/cm****	**Minimum f'c, MPa psi**	**Maximum water-soluble chloride ion (CL-) content in concrete, percent by mass of cement**
Reinforced concrete			
C0	N/A	17 2500	1.00
C1	N/A	17 2500	0.30
C2	0.4	35 5000	0.15
Prestressed concrete			
C0	N/A	17 2500	0.06
C1	N/A	17 2500	0.06
C2	0.4	35 5000	0.06

*The maximum w/cm limits do not apply to lightweight concrete.

2.5.2.4 Sulfate Resistance

a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members for sulfate exposure.

Exposure class	**Maximum w/cm**	**Minimum f'c, MPa psi**	**Required cementitious materials-types**			**Calcium chloride admixture**
			ASTM	**ASTM**	**ASTM**	
S0	N/A	17 2500	N/A	N/A	N/A	No restrictions
S1	0.50	28 4000	II*^	Types with (MS) designation	MS	No restrictions
S2	0.45	31 4500	V^	Types with (HS) designation	HS	Not permitted
S3	0.45	31 4500	V + pozzolan or slag cement**	Types with (HS) designation plus pozzolan or slag cement**	HS + pozzolan or slag cement**	Not permitted

Exposure class	**Maximum w/cm**	**Minimum f'c, MPa psi**	**Required cementitious materials-types**			**Calcium chloride admixture**
			ASTM	**ASTM**	**ASTM**	
S3	0.40	34 5000	V***	Types with (HS) designation	HS	Not permitted

* For seawater exposure, other types of portland cements with tricalcium aluminate (C3A) contents up to 10 percent are acceptable if the w/cm does not exceed 0.40.

** The amount of the specific source of the pozzolan or slag cement to be used must be at least the amount determined by test or service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slag used must not be less than the amount tested in accordance with ASTM C1012/C1012M and meeting the requirements maximum expansion requirements listed herein.

*** If Type V cement is used as the sole cementitious material, the optional sulfate requirement of 0.040 percent maximum expansion in ASTM C150/C150M is required.

^ Other available types of cement, such as Type III or Type I, are acceptable in exposure classes S1 or S2 if the C3A contents are less than 8 or 5 percent, respectively.

b. The maximum w/cm limits for sulfate exposure do not apply to lightweight concrete.

c. Alternative combinations of cementitious materials of those listed in this paragraph are acceptable if they meet the maximum expansion requirements listed in the following table:

Exposure class	**Maximum expansion when tested using ASTM C1012/C1012M**		
	At 6 months	**At 12 months**	**At 18 months**
S1	0.10 percent	N/A	N/A
S2	0.05 percent	0.10 percent^	N/A
S3	N/A	N/A	0.10 percent

^The 12-month expansion limit applies only when the measured expansion exceeds the 6-month maximum expansion limit.

2.5.2.5 Concrete Temperature

****

NOTE: Specify alternative maximum concrete temperature. If concrete delivered in hot weather with a temperature higher than 35°C 95°F has been used successfully in given climates or situations, the higher temperature may be specified in place of the 35°C 95°F limit.

Review ACI 305R for guidance on specifying a higher temperature limit.

****

The temperature of concrete as delivered must not exceed[35 degrees C 95 degrees F] [_____].

2.5.2.6 Concrete Permeability

a. Provide concrete meeting the requirements of the following table based on exposure class assigned to members requiring low permeability in the Contract Documents.

Exposure class	**Maximum *w/cm****	**Minimum f'c, MPa psi**	**Additional minimum requirements**
W0	N/A	17 2500	None
W1	0.5	28 4000	None
W2	0.50	28 4000	None

*The maximum w/cm limits do not apply to lightweight concrete.

b. Submit documentation verifying compliance with specified requirements.

2.5.3 Contractor's Option for Material Only

****

NOTE: Fill in appropriate state and title of referenced specification where work is to be accomplished. If a special class of aggregate and a choice of other materials exists in the state specification, specify that class of aggregate and choice of material. Fill in applicable strength class or other appropriate identification of concrete strength specified in state Department of Transportation specifications. Do not use for NAVFAC LANT projects.

****

At the option of the Contractor, those applicable material sections of [_____] DOT RBS for Class[A] [_____] strength concrete govern in lieu of this specification for concrete. Do not change the selected option during the course of the work.

2.5.4 Trial Mixtures

In accordance with ACI 301.

2.5.5 Ready-Mix Concrete

****

NOTE: ASTM C94 covers requirements for ready-mix concrete but does not cover requirements for placement, consolidation, curing, or protection of the concrete after delivery to the purchaser.

****

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94/C94M:

a. Type and brand cement

b. Cement and supplementary cementitious materials content in 43-kilogram 94-pound bags per cubic meter yard of concrete

c. Maximum size of aggregate

d. Amount and brand name of admixtures

e. Total water content expressed by water cementitious material ratio

2.6   REINFORCEMENT

Shop Fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

a. Bend reinforcement cold. Reinforcement must be bent cold in the shop to shapes as indicated. Rebending of a reinforcing bar that has been bent incorrectly is not permitted. Bending must be in accordance with the standard approved practice and by approved machine methods. Provide hooks and bends that are in accordance with the Contract Documents. Fabricate reinforcement in accordance with fabricating tolerances of ACI 117.

b. Submit manufacturer's certified test report for reinforcement.

c. Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.

d. Submit request with locations and details of splices not indicated in Contract Documents.

e. Submit request to place column dowels without using templates.

****
NOTE: Specify if and where (locations) field bending or straightening of reinforcing bars is permitted.
****

[f. Submit request and procedure to field-bend or straighten reinforcing bars partially embedded in concrete at locations not indicated in Contract Documents. Field bending or straightening of reinforcing bars is permitted[where indicated in the Contract Documents][in the following locations: [_____]]

][g. Submit request for field cutting, including location and type of bar to be cut and reason field cutting is required.

] Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

2.6.1 Reinforcing Bars

****

NOTE: ASTM A706/A706M bars are mainly used in seismic design or for welding. Include ASTM A767/A767M for galvanized reinforcing bars.

****

****

NOTE: Use second recycled content option throughout this section if Contractor is choosing recycled content products in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

a. Deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.

b. ASTM A615/A615M with the bars marked S, Grade [420][550][690] [60][80][100]; or ASTM A996/A996M with the bars marked R, Grade [350][420] [50][60], or marked A, Grade [300][420] [40][60].[Cold drawn wire used for spiral reinforcement must conform to ASTM A1064/A1064M.][Provide reinforcing bars that contain a minimum of [100][_____] percent recycled content.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements.]

c. [Reinforcing bars may contain post-consumer or post-industrial recycled content.][Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.]

d. Submit mill certificates for reinforcing bars.

2.6.1.1 Galvanized Reinforcing Bars

****

NOTE: Class 1 has a zinc coating that is thicker than Class 2. For Class 1 bars, fabrication can be performed before or after coating. If fabrication is performed after coating then damage caused by fabrication should be repaired according to ASTM A767/767M.

If needed, add any requirements for bars that require special finished bend diameters and indicate their locations.

ASTM A1094 provides 2 mils of coating and can be fabricated after coating. Any damage should be repaired according to ASTM A1094/A1094M. The systems are not equals and the designer should choose based on the requirements of the project.

****

a. Provide zinc-coated (galvanized) reinforcing bars that conform to[ASTM A767/A767M,[Class 1][Class 2][with galvanizing[before][after] fabrication] as required by the contract Documents][or][ASTM A1094/A1094M].

b. Repair coating damage incurred during shipment, handling, and placing of zinc-coated (galvanized) reinforcing bars in accordance with ASTM A780/A780M. If damaged areas on bars exceed 2 percent of surface area in each linear foot, bar must not be used. The 2 percent limit on maximum allowed damaged coating area includes previously repaired areas damaged before shipment as required by ASTM A767/A767M.

2.6.1.2 Epoxy-Coated Reinforcing Bars

****

NOTE: ASTM A775/A775M are coated in a straight and then bent as needed while ASTM A934/A934M are bent prior to coating. Bending after coating might result in the epoxy coating to crack or debond from steel.

****

a. Provide epoxy-coated reinforcing bars that conform to[ASTM A775/A775M][ASTM A934/A934M], Grade[60][80][100].

b. Apply coatings in plants that are certified in accordance with Concrete Reinforcing Steel Institute (CRSI) Epoxy Coating Plant Certification Program or an equivalent program acceptable to the contracting officer.

c. Repair coating damage incurred during shipment, storage, handling, and placing of epoxy-coated reinforcing bars. Repair damaged coating areas with patching material conforming to ASTM A775/A775M or ASTM A934/A934M as applicable and in accordance with material manufacturer's written recommendations. If damaged coating area on bars exceed 2 percent of surface area in each linear foot, bar must not be used. The 2 percent limit on damaged coating area includes repaired areas damaged before shipment as required by ASTM A775/A775M or ASTM A934/A934M as applicable. Fading of coating color is not a cause for rejection of epoxy-coated reinforcing bars.

d. [Submit concrete Reinforcing Steel Institute (CRSI) Epoxy Coating Plant Certification][inspection and quality-control program of plant applying epoxy coating if proposed plant is not certified in accordance with CRSI Epoxy Coating Plant Certification Program].

e. Handle and store coated reinforcing bars in accordance with[ASTM A775/A775M][or][ASTM A934/A934M]. If the manufacturer stores bars outdoors for more than 2 months, cover coated reinforcement with opaque protective material.

2.6.1.3 Dual-coated Reinforcing Bars

a. Zinc and epoxy dual-coated reinforcing bars must conform to ASTM A1055/A1055M

b. Repair coating damage incurred during shipment, storage, handling, and placing of zinc and epoxy dual-coated reinforcing bars. Repair damaged coating areas with patching material conforming to ASTM A1055/A1055M and in accordance with material manufacturer's written recommendations. If damaged coating area on bars exceed 2 percent of surface area in each linear foot, bar must not be used. The 2 percent limit on damaged coating area includes repaired areas damaged before shipment as required by ASTM A1055/A1055M. Fading of coating color is not a cause for rejection of zinc and epoxy dual-coated reinforcing bars.

2.6.1.4 Stainless Steel Reinforcing Bars

Meet the requirements of ASTM A955/A955M.

2.6.1.5 Headed Reinforcing Bars

Conform to ASTM A970/A970M including Annex A1, and other specified requirements.

2.6.1.6 Bar Mats

a. Conform to ASTM A184/A184M.

b. If coated bar mats are required, repair damaged coating as required in the paragraph titled GALVANIZED REINFORCING BARS EPOXY-COATED REINFORCING BARS and DUAL-COATED REINFORCING BARS.

2.6.1.7 Headed Shear Stud Reinforcement

Headed studs and headed stud assemblies must conform to ASTM A1044/A1044M.

2.6.2 Mechanical Reinforcing Bar Connectors

a. Provide 125 percent minimum yield strength of the reinforcement bar.

b. Mechanical splices for galvanized reinforcing bars must be galvanized or coated with dielectric material.

c. Mechanical splices used with epoxy-coated or dual-coated reinforcing bars must be coated with dielectric material.

d. Submit data on mechanical splices demonstrating compliance with this paragraph.

2.6.3 Wire

****

NOTE: Include in your Contract Documents the wire size, yield strength or grade, and any additional requirements not specified here for wires.

For more information on wire reinforcement refer to WRI (Wire Reinforcement Institute) documents.

****

a. [Provide wire reinforcement that contains a minimum of[100] [_____] percent recycled content.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements. Wire reinforcement may contain post-consumer or post-industrial recycled content.] Provide flat sheets of welded wire reinforcement for slabs and toppings.

b. Plain or deformed steel wire must conform to ASTM A1064/A1064M.

c. Stainless steel wire must conform to ASTM A1022/A1022M.

d. Epoxy-coated wire must conform to ASTM A884/A884M. Repair coating damage incurred during shipment, storage, handling, and placing of epoxy-coated wires must be repaired. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire, wire must not be used. The 2 percent limit on damaged coating area includes repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color is not a cause for rejection of epoxy-coated wire reinforcement.

2.6.4 Welded Wire Reinforcement

****

NOTE: Include in your Contract Documents the welded wire yield strength or grade, size and spacing, and any additional requirements not specified here for wires.

****

a. Use welded wire reinforcement specified in Contract Documents and conforming to one or more of the specifications given herein.

b. Plain welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 300 mm 12 in. apart in direction of principal reinforcement.

c. Deformed welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 400 mm 16 in. apart in direction of principal reinforcement.

d. Epoxy-coated welded wire reinforcement must conform to ASTM A884/A884M. Repair coating damage incurred during shipment, storage, handling, and placing of epoxy-coated welded wire reinforcement in accordance with ASTM A884/A884M. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area includes repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color is not a cause for rejection of epoxy-coated welded wire reinforcement.

e. Stainless steel welded wire reinforcement must conform to ASTM A1022/A1022M.

f. Zinc-coated (galvanized) welded wire reinforcement must conform to ASTM A1060/A1060M. Repair coating damage incurred during shipment, storage, handling, and placing of zinc-coated (galvanized) welded wire reinforcement in accordance with ASTM A780/A780M. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area includes repaired areas damaged before shipment as required by ASTM A1060/A1060M.

2.6.5 Reinforcing Bar Supports

****

NOTE: Include in your Contract Documents the types of reinforcement supports and location used within the structure. Refer to Chapter 3 in CRSI MSP 2.

****

a. Provide reinforcement support types within structure as required by Contract Documents. Conform to CRSI RB4.1. Submit description of reinforcement supports and materials for fastening coated reinforcement if not in conformance with CRSI RB4.1.

b. [For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar support.][For zinc-coated reinforcement, use galvanized wire or dielectric-polymer coated wire bar supports.]

****

NOTE: Supports must be coated when using epoxy-coated reinforcing bars.

****

c. Legs of supports in contact with formwork may be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

d. [Minimum[5][10] [_____] percent post-consumer recycled content, or minimum[20][40] [_____] percent post-industrial recycled content.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements. Plastic and steel may contain post-consumer or post-industrial recycled content.]

2.6.6 Reinforcing Fibers

****

NOTE: Only use fiber reinforcement when approved by the designer. Drawings should indicate where fiber reinforced concrete is located. Fiber reinforcing is used to help: control cracking due to plastic shrinkage; reduce permeability; and increase impact capacity; shatter resistance, abrasion resistance, and toughness. Fiber reinforcing does not: control cracking due to structural stresses; significantly increase strength; control curling or creeping; justify reducing structural members; eliminate control joints; or replace any moment or structural steel reinforcement. Include flexural toughness tests when reinforcement fibers are used to increase toughness and when justified by size and importance of job, but not when fibers are used only to control plastic shrinkage cracking. Include technical representative when warranted by size and importance of job.

For more information on fibers and their use in concrete, refer to ACI 544 documents.

****

2.6.6.1 Synthetic Fibers

In addition to the requirements specified above, provide fiber reinforced concrete in accordance with ASTM C1116/C1116M Type III, synthetic fiber reinforced concrete, and as follows. Provide synthetic reinforcing fibers of[100 percent virgin] monofilament polypropylene fibers[, with a minimum of[5][10] [_____] percent post-consumer recycled content, or a minimum of[20][40] [_____] percent post-industrial recycled content].[See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements. Fibers may contain post-consumer or post-industrial recycled content.]

Provide fibers that have a specific gravity of 0.9, a minimum tensile strength of 480 MPa 70 ksi, graded per manufacturer, and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. Add fibers at the batch plant.[Toughness indices must meet requirements for performance level I.][Provide the services of a qualified technical representative to instruct the concrete supplier in proper batching and mixing of materials to be provided.]

2.6.6.2 Steel Fibers

If steel fiber-reinforced concrete is specified in Contract Documents for providing shear resistance, steel fibers must be deformed and conform to ASTM A820/A820M. Provide steel fibers with a length-to-diameter ratio of at least 50 and not exceed 100.

2.6.7 Dowels for Load Transfer in Floors

Provide greased dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to ASTM A615/A615M, Grade 40. Provide dowel pipe that is steel conforming to ASTM A53/A53M.

[Plate dowels must conform to ASTM A36/A36M, and of size and spacing indicated. Minimize shrinkage restraint in plate dowel system by[using a tapered shape][or][formed void][or][by having compressible material on the vertical faces with a thin bond breaker on the top and bottom dowel surfaces].

]2.6.8 Welding

a. Provide weldable reinforcing bars that conform to ASTM A706/A706M and ASTM A615/A615M and Supplement S1, Grade 420 60, except that the maximum carbon content must be 0.55 percent.

b. Comply with AWS D1.4/D1.4M unless otherwise specified. Do not tack weld reinforcing bars.

c. Welded assemblies of steel reinforcement produced under factory conditions, such as welded wire reinforcement, bar mats, and deformed bar anchors, are allowed.

d. After completing welds on zinc-coated (galvanized), epoxy-coated, or zinc and epoxy dual-coated reinforcement, coat welds and repair coating damage as previously specified.

PART 3 EXECUTION

3.1 EXAMINATION

a. Do not begin installation until substrates have been properly constructed; verify that substrates are level.

b. If substrate preparation is the responsibility of another installer, notify Contracting Officer of unsatisfactory preparation before processing.

c. Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Contracting Officer and wait for instructions before beginning installation.

3.2 PREPARATION

****

NOTE: Options for uses of excess concrete include: additional paving, post footing anchorage, swale riprap reinforcing, mud slab, flowable fill, footing bottom, retaining wall footing ballast, storm structure covers, underground utility pipe kickers, storm pipe flared end section, toe wash protection, and shoulder and toe outfall restraints for temporary erosion pipes. Diverting waste from the landfill contributes to the following LEED credit: MR2. Coordinate with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

a. Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

b. Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

a. When subgrade material is semi-porous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited, or seal subgrade surface by covering surface with specified vapor retarder.

b. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder.

3.2.3 Subgrade Under Slabs on Ground

a. Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

b. Clean previously constructed subgrade or fill of foreign materials.

c. Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of 6.4 mm 1/4 inch when tested with a 3000 mm 10-foot straightedge parallel with and at right angles to building lines.

d. Finished surface of subgrade or fill under exterior slabs on ground must not be more than 6.10 mm 0.02-foot above or 30.50 mm 0.10-foot below elevation indicated.

3.2.4 Edge Forms and Screed Strips for Slabs

a. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface, strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment.

b. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.5 Reinforcement and Other Embedded Items

a. Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

b. When concrete is placed, reinforcement must be free of materials deleterious to bond. Reinforcement with rust, mill scale, or a combination of both will be considered satisfactory, provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of a hand-wire-brushed test specimen are not less than applicable ASTM specification requirements.

3.3 FORMS

****

NOTE: For more information on formwork construction and best practices refer to ACI SP-004 "Formwork for Concrete" or ACI 347R "Guide to Formwork for Concrete".

****

a. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade.

b. Chamfer above grade exposed joints, edges, and external corners of concrete 20 mm 0.75 inch. Place chamfer strips in corners of formwork to produce beveled edges on permanently exposed surfaces.[Do not bevel reentrant corners or edges of formed joints of concrete.]

c. Provide formwork with clean-out openings to permit inspection and removal of debris.

d. Inspect formwork and remove foreign material before concrete is placed.

e. At construction joints, lap form-facing materials over the concrete of previous placement. Ensure formwork is placed against hardened concrete so offsets at construction joints conform to specified tolerances.

f. Provide positive means of adjustment (such as wedges or jacks) of shores and struts. Do not make adjustments in formwork after concrete has reached initial setting. Brace formwork to resist lateral deflection and lateral instability.

g. Fasten form wedges in place after final adjustment of forms and before concrete placement.

h. Provide anchoring and bracing to control upward and lateral movement of formwork system.

i. Construct formwork for openings to facilitate removal and to produce opening dimensions as specified and within tolerances.

j. Provide runways for moving equipment. Support runways directly on formwork or structural members. Do not support runways on reinforcement. Loading applied by runways must not exceed capacity of formwork or structural members.

k. Position and support expansion joint materials, waterstops, and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with removable material to prevent concrete entry into voids.

l. Clean surfaces of formwork and embedded materials of mortar, grout, and foreign materials before concrete placement.

3.3.1 Coating

****

NOTE: Coating forms with a film-forming material such as epoxy or polyurethane, along with the use of a proper release agent, will make stripping easier and allow more reuses of the forms. It is important however to not allow the release agent to reach the reinforcement because it would hinder the formation of a bond between concrete and the reinforcement.

****

a. Cover formwork surfaces with an acceptable material that inhibits bond with concrete.

b. If formwork release agent is used, apply to formwork surfaces in accordance with manufacturer's recommendations before placing reinforcement. Remove excess release agent on formwork prior to concrete placement.

c. Do not allow formwork release agent to contact reinforcement or hardened concrete against which fresh concrete is to be placed.

3.3.2 Reshoring

****

NOTE: Reshores, as defined in ACI 347R, are shores placed snugly under a stripped concrete slab or other structural member after the original forms and

shores have been removed from a full bay, requiring the new slab or structural member to deflect and support its own weight and existing construction loads applied before installation of the reshores. Such reshores are provided to transfer additional construction loads to other slabs or members and/or to impede deflection due to creep that might otherwise occur.

****

a. Do not allow structural members to be loaded with combined dead and construction loads in excess of loads indicated in the accepted procedure.

b. Install and remove reshores or backshores in accordance with accepted procedure.

c. For floors supporting shores under newly placed concrete, either leave original supporting shores in place, or install reshores or backshores. Shoring system and supporting slabs must resist anticipated loads. Locate reshores and backshores directly under a shore position or as indicated on formwork shop drawings.

d. In multistory buildings, place reshoring or backshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads.

3.3.3 Reuse

a. Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

b. Wood forms must not be clogged with paste and must be capable of absorbing high water-cementitious material ratio paste.

c. Remove leaked mortar from formwork joints before reuse.

3.3.4 Forms for Standard Rough Form Finish

****

NOTE: According to ACI 301, surface finish-1.0 (SF-1.0) has the following requirements:
(a) No formwork facing material is specified
(b) Patch voids larger than 1-1/2 in. wide or 1/2 in. deep
(c) Remove projections larger than 1-in.
(d) Tie holes need not be patched
(e) Surface tolerance Class D as specified in ACI 117
(f) Mockup not required

****

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-1.0, for formed surfaces that are to be concealed by other construction.

3.3.5 Forms for Standard Smooth Form Finish

****

NOTE: When exposed to view, formed surfaces require

a special architectural finish such as textured form finishes, sculptured inserts, special panel finish, and aggregate transfer finish. Specify requirements for such formwork. Select bracketed line for no mockup of the form finish otherwise mockup is required per ACI 301.

According to ACI 301, surface finish-3.0 (SF-3.0) has the following requirements:
(a) Patch voids larger than 3/4 in. wide or 1/2 in. deep
(b) Remove projections larger than 1/8 in.
(c) Patch tie holes
(d) Surface tolerance Class A as specified in ACI 117
(e) Provide mockup of concrete surface appearance and texture
****

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-3.0, for formed surfaces that are exposed to view.[Do not provide mockup of concrete surface appearance and texture.]

3.3.6 Form Ties

a. For post-tensioned structures, do not remove formwork supports until stressing records have been accepted by the Contracting Officer.

b. After ends or end fasteners of form ties have been removed, repair tie holes in accordance with ACI 301 Section 5 requirements.

3.3.7 Forms for Concrete Pan Joist Construction

Factory-fabricate pan-form units for one-way or two-way concrete joist and slab construction of the approximate section indicated, consisting of steel or molded fiberglass concrete form pans. Furnish closure units as required.

3.3.8 Tolerances for Form Construction

a. Construct formwork so concrete surfaces conform to tolerances in ACI 117.

b. Position and secure sleeves, inserts, anchors, and other embedded items such that embedded items are positioned within ACI 117 tolerances.

c. To maintain specified elevation and thickness within tolerances, install formwork to compensate for deflection and anticipated settlement in formwork during concrete placement. Set formwork and intermediate screed strips for slabs to produce designated elevation, camber, and contour of finished surface before formwork removal. If specified finish requires use of vibrating screeds or roller pipe screeds, ensure that edge forms and screed strips are strong enough to support such equipment.

3.3.9 Removal of Forms and Supports

a. If vertical formed surfaces require finishing, remove forms as soon as removal operations will not damage concrete.

b. Remove top forms on sloping surfaces of concrete as soon as removal will not allow concrete to sag. Perform repairs and finishing operations required. If forms are removed before end of specified curing period, provide curing and protection.

c. Do not damage concrete during removal of vertical formwork for columns, walls, and sides of beams. Perform needed repair and finishing operations required on vertical surfaces. If forms are removed before end of specified curing period, provide curing and protection.

[d. Leave formwork and shoring in place to support construction loads and weight of concrete in beams, slabs, and other structural members until in-place required strength of concrete is reached.

] e. Form-facing material and horizontal facing support members may be removed before in-place concrete reaches specified compressive strength if shores and other supports are designed to allow facing removal without deflection of supported slab or member.

3.3.10 Strength of Concrete Required for Removal of Formwork

****

NOTE: Supporting forms and shores should not be removed from beams, floors, and walls until these structural units are strong enough to carry their own weight and any approved super-imposed load. In no case should supporting forms and shores be removed from horizontal members before the concrete has achieved the specified stripping strength. Shores supporting post-tensioned construction should not be removed until sufficient tensioning force is applied to support the dead load, formwork, and anticipated construction loads.

****

If removal of formwork, reshoring, or backshoring is based on concrete reaching a specified in-place strength, mold and field-cure cylinders in accordance with ASTM C31/C31M. Test cylinders in accordance with ASTM C39/C39M. Alternatively, use one or more of the methods listed herein to evaluate in-place concrete strength for formwork removal.

a. Tests of cast-in-place cylinders in accordance with ASTM C873/C873M. This option is limited to slabs with concrete depths from 12.5 to 30 cm 5 to 12 in.

b. Penetration resistance in accordance with ASTM C803/C803M.

c. Pullout strength in accordance with ASTM C900.

d. Maturity method in accordance with ASTM C1074. Submit maturity method data using project materials and concrete mix proportions used on the project to demonstrate the correlation between maturity and compressive strength of laboratory cured test specimens to the Contracting Officer.

3.4 WATERSTOP INSTALLATION AND SPLICES

a. Provide waterstops in construction joints as indicated.

b. Install formwork to accommodate waterstop materials. Locate waterstops in joints where indicated in Contract Documents. Minimize number of splices in waterstop. Splice waterstops in accordance with manufacturer's written instructions. Install factory-manufactured premolded mitered corners.

c. Install waterstops to form a continuous diaphragm in each joint. Make adequate provisions to support and protect waterstops during progress of work. Protect waterstops protruding from joints from damage.

3.4.1 PVC Waterstop

Make splices by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. Reform waterstops at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled, must show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

3.4.2 Rubber Waterstop

Spliced using cold bond adhesive as recommended by the manufacturer.

3.4.3 Thermoplastic Elastomeric Rubber Waterstop

Shop made fittings using a machine specifically designed to mechanically weld the waterstop. Use a portable power saw to miter or straight cut the ends to be joined to ensure good alignment and contact between joined surfaces. Maintain continuity of the characteristic features of the cross section of the waterstop (for example ribs, tabular center axis, and protrusions) across the splice.

3.4.4 Hydrophilic Waterstop

Miter cut ends to be joined with sharp knife or shears. Adhere ends with adhesive.

3.5 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

a. Unless otherwise specified, place reinforcement and miscellaneous materials in accordance to ACI 301. Provide bars, welded wire reinforcement, wire ties, supports, and other devices necessary to install and secure reinforcement.

b. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

c. Nonprestressed cast-in-place concrete members must have concrete cover for reinforcement given in the following table:

Concrete Exposure	**Member**	**Reinforcement**	**Specified cover, mm in.**
Cast against and permanently in contact with ground	All	All	75 3
Exposed to weather or in contact with ground	All	No. 19 6 through No. 57 18 bars	50 2
		No. 16 5 bar, MW200 W31 or MD200 D31 wire, and smaller	40 1-1/2
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 43 14 and No. 57 18 bars	40 1-1/2
		No. 36 11 bar and smaller	20 3/4
	Beams, columns, pedestals, and tension ties	Primary reinforcement, stirrups, ties, spirals, and hoops	40 1-1/2

d. Cast-in-place prestressed concrete members must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

Concrete	**Member**	**Reinforcement**	**Specified**
Cast against and permanently in contact with ground	All	All	75 3
Exposed to weather or in contact with ground	Slabs, joists, and walls	All	25 1
	All other	All	40 1-1/2

Concrete	**Member**	**Reinforcement**	**Specified**
Not exposed to weather or in contact with ground	Slabs, joists, and walls	All	20 3/4
	Beams, columns, and tension ties	Primary reinforcement	40 1-1/2
		Stirrups, ties, spirals, and hoops	25 1

e. Precast nonprestressed or prestressed concrete members manufactured under plant conditions must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

Concrete Exposure	**Member**	**Reinforcement**	**Specified cover, mm in.**
Exposed to weather or in contact with ground	Walls	No. 43 14 and No. 57 18 bars; tendons larger than 40 mm 1-1/2 in. diameter	40 1-1/2
		No. 36 11 bars and smaller; MW200 W31 and MD200 D31 wire, and smaller; tendons and strands 40 mm 1-1/2 in.	20 3/4
	All other	No. 43 14 and No. 57 18 bars; tendons larger than 40 mm 1-1/2 in.	50 2
		No. 19 6 through No. 36 11 bars; tendons and strands larger than 16 mm 5/8 in. diameter through 40 mm 1-1/2 in.	40 1-1/2
		No. 16 5 bar, MW200 W31 or MD200 D31 wire, and smaller; tendons and strands 16 mm 5/8 in. diameter and smaller	30 1-1/4

Concrete Exposure	**Member**	**Reinforcement**	**Specified cover, mm in.**
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 43 14 and No. 57 18 bars; tendons larger than 40 mm 1-1/2 in. diameter	30 1-1/4
		Tendons and strands 40 mm 1-1/2 in. diameter and smaller	20 3/4
		No. 36 11 bar, MW200 W31 or MD200 D31	16 5/8
	Beams, columns, pedestals, and tension ties	Primary reinforcement	Greater of bar diameter and 16 5/8 and need not exceed 40 1-1/2
		Stirrups, ties, spirals, and hoops	10 3/8

3.5.1 General

Provide details of reinforcement that are in accordance with the Contract Documents.

3.5.2 Vapor Retarder[and Vapor Barrier]

****

NOTE: Locate vapor retarder below the slab-on-grade per ACI 360R, figure 4.7.

****

a. Install in accordance with ASTM E1643. Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 300 mm 12 inches and tape.

b. Remove torn, punctured, or damaged vapor retarder[and vapor barrier] material and provide with new vapor retarder[and vapor barrier] prior to placing concrete. Concrete placement must not damage vapor retarder[and vapor barrier material].[Place a 50 mm 2 inch layer of clean concrete sand on vapor retarder[and vapor barrier] before placing concrete.][Place vapor barrier directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, a thin layer of approximately 13 mm 1/2 inch of fine graded material should be rolled or compacted over the fill before installation of the vapor barrier to reduce the possibility of puncture. Control concrete placement so as to prevent damage to the vapor barrier.]

3.5.3 Perimeter Insulation

****

NOTE: When this paragraph is used, ensure that drawings indicate location and extent of perimeter insulation.

****

Install perimeter insulation at locations indicated. Adhesive must be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

3.5.4 Reinforcement Supports

****

NOTE: ACI 301 requirements have change for welded wire reinforcement support. If reinforcement less than W4.0 or D4.0 is specified, the continuous support spacing should be less than or equal to 30 cm 12 in.

****

Provide reinforcement support in accordance with CRSI RB4.1 and ACI 301 Section 3 requirements. Also, coat supports for coated or galvanized bars with electrically compatible material for a distance of at least 50 mm 2 inches beyond the point of contact with the bars.

[3.5.5 Epoxy Coated Reinforcing

Meet the requirements of[ASTM A934/A934M including Appendix X2,] "Guidelines for Job Site Practices" except as otherwise specified herein.

3.5.5.1 Epoxy Coated Reinforcing Steel Placement and Coating Repair

Carefully handle and install bars to minimize job site patching. Use the same precautions as described in the paragraph titled EPOXY-COATED REINFORCING BARS. Do not drag bars over other bars or over abrasive surfaces. Keep bar free of dirt and grit. When possible, assemble reinforcement as tied cages prior to final placement into the forms. Support assembled cages on padded supports. It is not expected that coated bars, when in final position ready for concrete placement, are completely free of damaged areas; however, excessive nicks and scrapes which expose steel is cause for rejection. Criteria for defects which require repair and for those that do not require repair are as indicated. Inspect for defects and provide required repairs prior to assembly. After assembly, reinspect and provide final repairs.

a. Immediately prior to application of the patching material, manually remove any rust and debonded coating from the reinforcement by suitable techniques employing devices such as wire brushes and emery paper. Exercise cars during this surface preparation so that the damaged areas are not enlarged more than necessary to accomplish the repair. Clean damaged areas of dirt, debris, oil, and similar materials prior to application of the patching material.

b. Do repair and patching in accordance with the patching material manufacturer's recommendations. Have these recommendations, including cure times, available at the job site at all times.

c. Allow adequate time for the patching materials to cure in accordance with the manufacturer's recommendation prior to concrete placement.

[d. Rinse placed reinforcing bars with fresh water to remove chloride contamination prior to placing concrete.

]]3.5.6 Splicing

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NOTE: When indicated, include ASTM A767/A767M and ASTM A780/A780M for zinc-coated (galvanized) bars.

****

As indicated in the Contract Documents. For splices not indicated follow ACI 301. Do not splice at points of maximum stress. Overlap welded wire reinforcement the spacing of the cross wires, plus 50 mm 2 inches.[AWS D1.4/D1.4M. Approve welded splices prior to use.][Repair the cut ends of hot-dipped galvanized reinforcement steel to completely coat exposed steel, ASTM A780/A780M.]

3.5.7 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.5.8 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement and support against displacement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.5.9 Inspection of Reinforcement

Inspect and verify proper reinforcement grade, shape, cross section and condition. Do not use reinforcement with the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances.

b. Bends or kinks not indicated on drawings or approved shop drawings.

c. Bars with reduced cross section due to rusting or other cause.

3.5.10 Placing Reinforcement

Place reinforcement in accordance with ACI 301.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than 25 mm 1 inch from concrete surfaces that are exposed to view or to be painted may be precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 90 by 90 mm, 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

a. Provide supports for reinforcing bars that are sufficient in number and have sufficient strength to carry the reinforcement they support, and in accordance with ACI 301 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

b. Equip supports on ground and similar surfaces with sand-plates.

c. Support welded wire reinforcement as required for reinforcing bars.

d. Secure reinforcements to supports by means of tie wire. Provide black, soft iron wire, not less than 1.6 mm 16 gage.

e. Accurately place reinforcement, securely tie at intersections, and hold in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to the Contract Documents.

f. Bending of reinforcing bars partially embedded in concrete is permitted only as specified in the Contract Documents.

3.5.11 Spacing of Reinforcing Bars

a. As indicated in the Contract Documents.

b. Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to preapproval by the Contracting Officer.

3.5.12 Concrete Protection for Reinforcement

****

NOTE: If the required concrete protection for reinforcement is greater than the thicknesses specified in the ACI building code requirements for reinforced concrete, (such as in extremely corrosive atmospheres or other severe exposures, for fire protection covering, and for concrete surface to receive exposed aggregate or tooled finish), such concrete protection for reinforcement must be indicated in the Contract Documents. ACI 201.2R and

ACI 303R require additional concrete protection for severe exposure conditions. Also, refer to ACI 515.2R "Guide to Selecting Protective Treatments for Concrete" for more information about providing additional protection to concrete and reinforcing steel.

****

In accordance with the Contract Documents.

3.5.13 Welding

In accordance with AWS D1.4/D1.4M.

3.6 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

In accordance with ASTM C94/C94M, ACI 301, ACI 302.1R and ACI 304R, except as modified herein. Utilize batching equipment such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.6.1 Measuring

Make measurements at intervals as specified in paragraphs SAMPLING and TESTING.

3.6.2 Mixing

a. Mix concrete in accordance with ASTM C94/C94M, ACI 301 and ACI 304R.

****

NOTE: Include optional sentence if greater than 90 minutes will be allowed for concrete placing.

****

b. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within[90] minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates.[If discharge is acceptable after more than 90 minutes the air content, slump, and concrete temperature shall be tested and shall be within the specified limits.] A retarder shall be used to facilitate placing and finishing when concrete temperature is 30 degrees C 85 degrees F or greater.

c. [If the entrained air content falls below the specified limit, add a sufficient quantity of admixture, within the manufacturer's recommended dosage, to bring the entrained air content within the specified limits.] Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch. Do not reconstitute concrete that has begun to solidify.

d. When fibers are used, add fibers together with the aggregates and never as the first component in the mixer. Dispense fibers into the mixing system using appropriate dispensing equipment and procedure as recommended by the manufacturer.

3.6.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.7 PLACING CONCRETE

****

NOTE: When necessary to deposit concrete under water, use specifications 03 31 30 MARINE CONCRETE.

****

Place concrete in accordance with ACI 301 Section 5. Place concrete within 15 minutes of discharge into non-agitating equipment.

[3.7.1 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 100 mm 4 inches greater than indicated.

][3.7.2 Pumping

****

NOTE: Pumping, especially lightweight concrete, requires careful attention to mix designs and pumping procedures. Allow pumping when other means of placement are impractical or more expensive.

****

ACI 304R and ACI 304.2R. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 50 mm 2 inches at discharge/placement. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well-rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

[3.7.2.1 Pumping Lightweight Concrete

****

NOTE: Specify minimum of 330 kg per cubic meter 564 pounds per cubic yard unless structural considerations require higher cement content. Require field trial run only when justified by job complexities or size.

****

In accordance with ACI 213R unless otherwise specified. Presoak or presaturate aggregates. Cement content must be minimum of [330 kg per cubic meter] [564 pounds per cubic yard] [_____] and be sufficient to accommodate a 100 to 150 mm 4 to 6 inch slump.[Make field trial run in accordance with ACI 213R.]

]]3.7.3 Cold Weather

****
NOTE: The major difference between ACI 301 and ACI 306.1 is that ACI 306.1 requires the contractor to submit detailed procedures (a plan) for cold weather concrete.
****

Meet the requirements of[ACI 301][ACI 306.1] unless otherwise specified. Do not allow concrete temperature to decrease below 10 degrees C 50 degrees F. Obtain approval prior to placing concrete when the ambient temperature is below 4 degrees C 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 10 degrees C 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 3 degrees C 5 degrees F in any one hour and 10 degrees C 18 degrees F per 24 hours after heat application.

3.7.4 Hot Weather

****
NOTE: The major difference between ACI 301 and ACI 305.1 is that ACI 305.1 requires the contractor to submit detailed procedures (a plan) for hot weather concrete.
****

[Meet the requirements of[ACI 301][ACI 305.1] unless otherwise specified.]Maintain required concrete temperature using Figure 4.2 in ACI 305R to prevent the evaporation rate from exceeding 1 kg per square meter 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.7.5 Bonding

Roughen and clean surfaces of set concrete at joints of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

a. At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; dampen but do not saturate roughened and cleaned surface of set concrete immediately prior to placing fresh concrete.

b. At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; dampen but do not saturate the roughened and cleaned surface of set concrete and cover with a cement grout coating.

c. Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 22.5 liters 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1.6 mm 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

3.8 WASTE MANAGEMENT

Provide as specified in the Waste Management Plan and as follows.

3.8.1 Mixing Equipment

Before concrete pours, designate[Contractor-owned site meeting environmental standards][on-site area to be paved later in project] for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

****

NOTE: The use of crushed waste concrete as an aggregate in the production of new concrete should follow the recommendations of ACI 555R.

****

3.8.2 Hardened, Cured Waste Concrete

[Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement.][Use hardened, cured waste concrete as aggregate in concrete mix if approved by Contracting Officer.]

3.8.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.8.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material.[Return excess cement to supplier.][Institute deconstruction and construction waste separation and recycling for use in manufacturer's programs. When such a program is not available, seek local recyclers to reclaim the materials.]

3.9 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.9.1 Defects

Repair surface defects in accordance with ACI 301 Section 5.

3.9.2 Not Against Forms (Top of Walls)

Finish surfaces not otherwise specified with wood floats to even surfaces. Match adjacent finishes.

3.9.3 Formed Surfaces

3.9.3.1 Tolerances

Tolerances in accordance with ACI 117 and as indicated.

3.9.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view a surface finish SF-1.0. Patch holes and defects in accordance with ACI 301.

3.9.3.3 Standard Smooth Finish

Provide for surfaces exposed to public view a surface finish SF-3.0. Patch holes and defects in accordance with ACI 301.

3.9.4 [Smooth-Rubbed][Grout-Cleaned Rubbed][Cork-Floated][Exposed Aggregate]Finish

****

NOTE: Add information where special type of finish is desired. See ACI 301 for information on smooth rubbed finish, grout cleaned finish, cork floated finish, and exposed aggregate. Areas requiring special finish should be clearly indicated on the drawings and coordinated with the specifications.

****

[Provide a smooth-rubbed finish per ACI 301 Section 5 in the locations indicated.][Provide a grout-cleaned rubbed finish per ACI 301 Section 5 in the locations indicated.][Provide a cork-floated finish per ACI 301 Section 5 in the locations indicated.][Provide an exposed aggregate finish per ACI 301 Section 5 in the locations indicated.]

3.10 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

****

NOTE: Where floor flatness is critical use paragraph FLAT FLOOR FINISHES. Coordinate concrete finish with applicable architectural finish material to be installed over concrete floor. For thin-set tile, coordinate with Section 09 30 10 CERAMIC, QUARRY, AND GLASS TILING

****

In accordance with ACI 301 and ACI 302.1R, unless otherwise specified. Slope floors uniformly to drains where drains are provided.[Depress the concrete base slab where quarry tile, ceramic tile,[or] [_____] are indicated.][Steel trowel and fine-broom finish concrete slabs that are to receive quarry tile, ceramic tile, or paver tile [_____].] Where straightedge measurements are specified, provide straightedge.

3.10.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater. Do no use grate tampers ("jitterbugs").

3.10.1.1   Scratched

Use for surfaces intended to receive bonded applied cementitious applications. Finish concrete in accordance with ACI 301 Section 5 for a scratched finish.

3.10.1.2   Floated

Use for[surfaces to receive[roofing,][waterproofing membranes,][sand bed terrazzo,]] [_____][and][exterior slabs where not otherwise specified.] Finish concrete in accordance with ACI 301 Section 5 for a floated finish.

[3.10.1.3   Concrete Containing Silica Fume

Finish using magnesium floats or darbies.[Finish using techniques demonstrated in the sample installation.]

]3.10.1.4   Steel Troweled

****

NOTE: ACI 302.1R suggests power troweling three times for Class 5 floors and where increased wear resistance is needed.

****

Use for floors intended as walking surfaces[,][and] for reception of floor coverings[, and] [_____]. Finish concrete in accordance with ACI 301 Section 5 for a steel troweled finish.

[3.10.1.5   Nonslip Finish

****

NOTE: Include when nonslip finish using dry shake aggregate is desired.

****

Use on surfaces of exterior platforms, steps, and landings; and on exterior and interior pedestrian ramps. Finish concrete in accordance with ACI 301 Section 5 for a dry-shake finish. After the selected material has been embedded by the two floatings, complete the operation with a[broomed][floated][troweled] finish.

]3.10.1.6   Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Finish concrete in accordance with ACI 301 Section 5 for a broomed finish.

3.10.1.7   Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by[belting. Lay belt flat on the concrete surface and advance with a sawing motion; continue until a uniform but gritty nonslip surface is obtained.][a burlap drag. Drag a strip of clean, wet burlap from 900 to 3000 mm wide and 600 mm longer 3 to 10 feet wide and 2 feet longer than the pavement width across the slab. Produce a fine, granular, sandy textured surface without disfiguring marks.] Round edges and joints with an edger having a radius of 3 mm 1/8 inch.

3.10.1.8 Concrete Toppings Placement

The following requirements apply to the placement of toppings of concrete on base slabs that are either freshly placed and still plastic, or on hardened base slabs.

a. Placing on a Fresh Base: Screed and bull float the base slab. As soon as the water sheen has disappeared, lightly rake the surface of the base slab with a stiff bristle broom to produce a bonding surface for the topping. Immediately spread the topping mixture evenly over the roughened base before final set takes place. Give the topping the finish[indicated on the drawings][specified herein].

b. Bonding to a Hardened Base: When the topping is to be bonded to a floated or troweled hardened base, roughen the base by scarifying, grit-blasting, scabbling, planing, flame cleaning, or acid-etching to lightly expose aggregate and provide a bonding surface. Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the clean base wet for a period of 12 hours preceding the application of the topping. Remove excess water and apply a 1:1:1/2 cement-sand-water grout, and brush into the surface of the base slab. Do not allow the cement grout to dry, and spread it only short distances ahead of the topping placement. Do not allow the temperature differential between the completed base and the topping mixture to exceed 5 degrees C 9 degrees F at the time of placing. Place the topping and finish as[indicated][specified herein].

3.10.1.9 Chemical-Hardener Treatment

****

NOTE: Indicate slab surfaces requiring a chemical hardener. Such treatment is suitable for surfaces of concrete floors in equipment rooms and on other floor surfaces that are subject to light foot traffic only and must not be covered with resilient flooring, paint, or other finish coating.

****

[Apply liquid-chemical floor hardener where indicated after curing and drying concrete surface. Dilute liquid hardener with water and apply in three coats. Apply first coat at one-third strength, second coat one-half strength, and third coat two-thirds strength. Apply each coat evenly and allow to dry 24 hours between coats.

Apply approved proprietary chemical hardeners in accordance with manufacturer's printed directions.

]3.10.1.10 Colored Wear-Resistant Finish

****

NOTE: Indicate slab surfaces requiring colored, wear-resistant finish. Such finish is suitable for

exterior and interior slabs that are subject to medium-heavy foot traffic.
****

[a. Give finish to monolithic slab surfaces where indicated.

b. Apply dry shake materials for colored wear-resistant finish at the rate of 29 kilogram per 10 square meter 60 pounds per 100 square feet of surface.

c. Immediately following first floating operation, distribute approximately two-thirds of specified weight of dry shake material uniformly over surface and embedded by means of power floating. After first dry-shake application has been embedded, uniformly distribute remainder of dry-shake material over surface at right angles to first dry-shake application and embed by means of power floating. Trueness of surface and other requirements for floating operations not specified in this paragraph are as specified for float finish.

d. After completion of float finish, apply a trowel finish as specified.

]3.10.1.11 Heavy-Duty Wear-Resistant Finish

****
NOTE: Delete paragraph heading and following paragraphs when not applicable. Indicate slab surfaces requiring heavy-duty wear-resistant finish. Traprock and emery aggregate finish are suitable for exterior and interior slabs that are subject to abrasive wear. Iron aggregate finish is suitable for interior slabs that are not subject to excessive amounts of moisture and are subject to abrasive wear and some impact.
****

a. Give finish to slab surfaces where indicated.

b. Dry-shake material for heavy-duty, wear-resistant finish must consist of a mixture of standard portland cement and aggregate for heavy-duty, wear-resistant finish proportioned by weight as follows:

One part standard portland cement and[two parts traprock aggregate for heavy-duty wear-resistant finish][four parts emery aggregate for heavy-duty wear-resistant finish][two parts by weight iron aggregate for heavy-duty, wear-resistant finish].

c. Apply blended dry-shake material as follows:

****
NOTE: Select type of aggregate.
****

Maximum type of aggregate in dry shake	**Amount per 100 square meter feet of Surface**
Traprock	73 kilogram 160 pounds

Maximum type of aggregate in dry shake	**Amount per 100 square meter feet of Surface**
Emery	59 kilogram 130 pounds
Iron	59 kilogram 130 pounds

d. Immediately following the first floating operation, approximately one-half the specified weight of blended, uniformly distribute dry-shake materials over the surface and embedded by means of power floating. After the first dry-shake application has been embedded, uniformly distribute the remaining one-half of the blended dry-shake material over the surface at right angles to the first dry-shake application and embedded by means of power floating. Trueness of surface and other requirements for floating operations not specified in this paragraph are as specified for float finish.

e. After completion of the float finish, trowel finish the surface as specified.

[3.10.2 Flat Floor Finishes

****

NOTE: Use these paragraphs where floor flatness is critical. Indicate areas where these requirements apply. Flatness affects the appearance and function of finishes applied to the concrete and in situations such as large or long expanses of glossy floor materials. Low tolerance for product (for example thin set tile and wood gymnasium floors) and equipment dictates to the designer to specify higher than normal flatness requirements. The numbers provided in brackets are typical numbers, but A/E should research and select F numbers high enough to get desired results but not so high as to cause undue cost increases and construction problems. Ff/FL 20/15 is equivalent to 8 mm in 5.05 mm 5/16 inches in 10 feet. This test method is not suitable for unshored deck. Fitted partitions need FL greater than or equal to 25.

When specifying floors where flatness is important, adhere primarily to good concrete fundamentals, including equalizing hydration on top and bottom, reducing shrinkage prone cement paste content, and paying attention to curing protocol (slower is better).

****

ACI 302.1R. Construct in accordance with one of the methods recommended in Table 10.15.3a, "Slab-on-ground flatness/levelness construction guide" or Table 10.15.3b, "Suspended slab flatness/levelness construction guide" appropriate for the type of construction. ACI 117 for tolerance tested by ASTM E1155.

a. Specified Conventional Value:

Floor Flatness (Ff) [20] [_____] [13] [_____] minimum

Floor Levelness (FL) [15] [_____] [10] [_____] minimum

b. Specified Industrial:

Floor Flatness (Ff) [30] [_____] [15] [_____] minimum

Floor Levelness (FL) [20] [_____] [10] [_____] minimum

3.10.2.1 Measurement of Floor Tolerances

Test slab within 24 hours of the final troweling. Provide tests to Contracting Officer within 12 hours after collecting the data. Floor flatness inspector is required to provide a tolerance report which includes:

a. Key plan showing location of data collected.

b. Results required by ASTM E1155.

3.10.2.2 Remedies for Out of Tolerance Work

Repair and retest any floors not meeting specified tolerances. Prior to repair, submit and receive approval for the proposed repair, including product data from any materials proposed. Repairs must not result in damage to structural integrity of the floor. For floors exposed to public view, repairs must prevent any uneven or unusual coloring of the surface.

]3.10.3 Concrete Walks

Provide 100 mm 4 inches thick minimum. Provide contraction joints spaced every 1500 lineal mm 5 linear feet unless otherwise indicated. Cut contraction joints 25 mm 1 inch deep, or one fourth the slab thickness whichever is deeper, with a jointing tool after the surface has been finished. Provide 13 mm 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 15 m 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 6 mm in 1500 mm 1/4 inch in 5 feet.

3.10.4 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.10.5 Curbs[and Gutters]

Provide contraction joints spaced every 3 m 10 feet maximum unless otherwise indicated. Cut contraction joints 20 mm 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 13 mm 1/2 inch thick and spaced every 30 m 100 feet maximum unless otherwise indicated. Perform pavement finish.

[3.10.6 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, 600 mm long, 300 mm wide and 100 mm thick 24 inches long, 12 inches wide and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

]3.11 JOINTS

3.11.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Make joints perpendicular to main reinforcement. Continue and develop reinforcement across construction joints. Locate construction joints as follows:

3.11.1.1 Construction Joints for Constructability Purposes

a. In walls, at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall.

b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier.

c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

Provide keyways at least 40 mm 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

3.11.2 Isolation Joints in Slabs on Ground

****

NOTE: If inserts are to be used for slab on ground contraction joint use bracketed paragraph and remove paragraph related to sawcut joints.

****

a. Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

b. Fill joints with premolded joint filler strips 13 mm 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 19 mm 3/4 inch in depth where joint is sealed with sealing compound and not less than 6 mm 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Clean groove of foreign matter and loose particles after surface has dried.

3.11.3 Contraction Joints in Slabs on Ground

a. Provide joints to form panels as indicated.

b. Under and on exact line of each control joint, cut 50 percent of welded wire reinforcement before placing concrete.

c. Sawcut contraction joints into slab on ground in accordance with ACI 301

Section 5.

[d. Provide joints 4 mm 1/8-inch wide by 1/5 to 1/4 of slab depth and form by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. After concrete has cured for at least 7 days, remove inserts and clean groove of foreign matter and loose particles.

] **

NOTE: Use the following bracketed sentence for projects in Hawaii.

****

[e. Sawcutting will be limited to within 12 hours after set and at 1/4 slab depth.

]3.11.4 Sealing Joints in Slabs on Ground

a. Seal contraction and control joints which are to receive finish flooring material with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

b. Leave sealed groove ready to receive filling material that is provided as part of finish floor covering work.

3.12 CONCRETE FLOOR TOPPING

3.12.1 Standard Floor Topping

****

NOTE: When standard floor topping is specifically required, indicate the location of standard floor topping.

****

Provide topping for treads and platforms of metal steel stairs and elsewhere as indicated.

3.12.1.1 Preparations Prior to Placing

a. When topping is placed on a green concrete base slab, screed surface of base slab to a level not more than 38 mm 1-1/2 inches nor less than 25 mm 1 inch below required finish surface. Remove water and laitance from surface of base slab before placing topping mixture. As soon as water ceases to rise to surface of base slab, place topping.

b. When topping is placed on a hardened concrete base slab, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from base slab surface, leaving a clean surface. Prior to placing topping mixture, 64 mm 2-1/2-inches minimum, dampen slab surface and leave free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Do not allow cement grout to set or dry before topping is placed.

c. When topping is placed on a metal surface, such as metal pans for steel stairs, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from metal surface.

3.12.1.2 Placing

Spread standard topping mixture evenly on previously prepared base slab or metal surface, brought to correct level with a straightedge, and struck off. Topping must be consolidated, floated, checked for trueness of surface, and refloated as specified for float finish.

3.12.1.3 Finishing

Give trowel finish standard floor topping surfaces.

****

NOTE: Indicate standard floor topping surfaces requiring an applied finish such as a chemical-hardener, non-slip aggregate finish, colored wear-resistant finish, sealers, or heavy-duty, wear-resistant finish.

****

Give other finishes standard floor topping surfaces as indicated.

3.12.2 Heavy-Duty Floor Topping

****

NOTE: Indicate location of heavy-duty floor topping. Heavy-duty floor topping is suitable for an industrial floor subject to continuous severe abrasion and impact such as steel-tire vehicles.

****

Provide topping where indicated.

3.12.2.1 Heavy-duty Topping Mixture

Provide mixture that consists of 1 part portland cement and 2-1/2 parts emery aggregate or 1 part fine aggregate and 1-1/2 parts traprock coarse aggregate, by volume. Exact proportions of mixture must conform to recommendations of aggregate manufacturer. Mixing water must not exceed 14.2 liter per 43 kilogram 3-1/4 gallons per 94-pound sack of cement including unabsorbed moisture in aggregate. Maximum slump must be 25 mm 1 inch.

3.12.2.2 Base Slab

a. Screed surface of slab to a level no more than 38 mm 1-1/2 inches nor less than 25 mm 1 inch below grade of finished floor.

b. Give slab a scratch finish as specified.

c. Preparations prior to placing.

Remove dirt, loose material, oil, grease, asphalt, paint and other contaminants from base slab surface. Prior to placing topping mixture, dampen slab surface and leave free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Allow cement grout to set or dry before topping mixture is placed.

3.12.2.3 Placing

Spread heavy-duty topping mixture evenly on previously prepared base slab, and bring to correct level with a straightedge, and strike off. Provide topping that is consolidated, floated, and checked for trueness of surface as specified for float finish, except that power-driven floats is the impact type.

3.12.2.4 Finishing

Give trowel finish heavy-duty floor topping surfaces. Provide trowel finish as specified, except that additional troweling after first power troweling must be not less than three hand-troweling operations.

3.13 CURING AND PROTECTION

****

NOTE: Add to "Curing and Protection" when using silica fume.

Prevent concrete with silica fume from drying by one or more of the following:

1. **Misting surface of concrete with fog nozzle;**

2. **Liquid membrane-forming compound;**

3. **Pervious or impervious sheeting.**

Increase curing time per manufacturer's recommendations.

****

Curing and protection in accordance with ACI 301 Section 5, unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer, hardener, or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs, including [_____].

3.13.1 Requirements for Type III, High-Early-Strength Portland Cement

The curing periods are required to be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

3.13.2 Curing Periods

ACI 301 Section 5, except 10 days for retaining walls, pavement or chimneys. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.13.3 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.13.4 Curing Unformed Surfaces

a. Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

[b. Accomplish final curing of unformed surfaces by any of curing methods specified, as applicable.

] c. Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.13.5 Temperature of Concrete During Curing

When temperature of atmosphere is 5 degrees C 41 degrees F and below, maintain temperature of concrete at not less than 13 degrees C 55 degrees F throughout concrete curing period or 7 degrees C 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 27 degrees C 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 3 degrees C 5 degrees F in any one hour nor 27 degrees C 49 degrees F in any 24-hour period.

3.13.6 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.13.7 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.14 FIELD QUALITY CONTROL

3.14.1 Aggregate Testing

3.14.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there must be one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, immediately resample and retest the fine aggregate. If there is another failure on any sieve, immediately report the fact to the Contracting Officer, stop concreting, and take immediate steps to correct the grading.

3.14.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, provide a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor is responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations must show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, immediately resample and retest the coarse aggregate. If the second sample fails on any sieve, report that fact to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation will be considered out of control and reported to the Contracting Officer. Stop concreting and take immediate steps to correct the grading.

3.14.2 Concrete Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

3.14.3 Concrete Testing

3.14.3.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement/discharge. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cementitious material ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made[, and for each [_____] cubic meters cubic yards (maximum) of concrete].

3.14.3.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 10 degrees C and above 27 degrees C below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 16 cubic meters 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.14.3.3 Compressive Strength Tests

****

NOTE: When the same mix design is used for multiple elements such as slabs, beams, and walls, the design element type may be specified in lieu of or in addition to the mix design in order to better identify deficient concrete.

Use eight cylinders when specifying 56 or 90 day strengths. Use 6x12 cylinders for better prediction of strength and consistency.

****

ASTM C39/C39M. Make[six][eight] 150 mm by 300 mm 6 inch by 12 inch or[nine][12] 100 mm by 200 mm 4 inch by 8 inch test cylinders for each set of tests in accordance with ASTM C31/C31M, ASTM C172/C172M and applicable requirements of ACI 305R and ACI 306R. Take precautions to prevent evaporation and loss of water from the specimen. Test two 150 mm by 300 mm 6 inch by 12 inch or three 100 mm by 200 mm 4 inch by 8 inch cylinders at 7 days, two 150 mm by 300 mm 6 inch by 12 inch or three 100 mm by 200 mm 4 inch by 8 inch cylinders at 28 days,[two 150 mm by 300 mm 6 inch by 12 inch or three 100 mm by 200 mm 4 inch by 8 inch cylinders at 56 days][two 150 mm by 300 mm 6 inch by 12 inch or three 100 mm by 200 mm 4 inch by 8 inch cylinders at 90 days][and hold two 150 mm by 300 mm 6 inch by 12 inch or three 100 mm by 200 mm 4 inch by 8 inch cylinders in reserve]. Take samples for strength tests for each concrete mixture placed each day not less than once a day, nor less than once for each 115 cubic meters 150 cubic yards of concrete, nor less than once for each 450 square meters 5000 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two 150 mm by 300 mm 6 inch by 12 inch or three 100 mm by 200 mm 4 inch by 8 inch cylinders from the same concrete sample tested at 28 days[56 days][90 days] [_____]. Concrete compressive tests must meet the requirements of this section, the Contract Document, and ACI 301.

[3.14.3.4 Air Content

ASTM C173/C173M or ASTM C231/C231M for normal weight concrete[and ASTM C173/C173M for lightweight concrete]. Test air-entrained concrete for air content at the same frequency as specified for slump tests.

][3.14.3.5 Unit Weight of Structural Concrete

ASTM C567/C567M and ASTM C138/C138M. Determine unit weight of lightweight and normal weight concrete. Perform test for every 15 cubic meters 20 cubic yards maximum.

][3.14.3.6 Chloride Ion Concentration

****

NOTE: Include only when justified by size of job or

when quality of concrete is questionable.
****

Meet the requirements of the paragraph titled CORROSION AND CHLORIDE CONTENT. Determine water soluble ion concentration in accordance with ASTM C1218/C1218M. Perform test once for each mix design.

]3.14.3.7 Strength of Concrete Structure

The strength of the concrete structure will be considered to be deficient if any of the following conditions are identified:

a. Failure to meet compressive strength tests as evaluated.

b. Reinforcement not conforming to requirements specified.

c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.

d. Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified.

e. Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.

f. Poor workmanship likely to result in deficient strength.

Where the strength of the concrete structure is considered deficient submit a mitigation or remediation plan for review and approval by the Contracting Officer.

3.14.3.8 Non-Conforming Materials

Factors that indicate that there are non-conforming materials include (but not limited to) excessive compressive strength, inadequate compressive strength, excessive slump, excessive voids and honeycombing, concrete delivery records that indicate excessive time between mixing and placement, or excessive water was added to the mixture during delivery and placement. Any of these indicators alone are sufficient reason for the Contracting Officer to request additional sampling and testing.

Conduct investigations into non-conforming materials at the Contractor's expense. The Contractor is responsible for the investigation and must make written recommendations to adequately mitigate or remediate the non-conforming material. The Contracting Officer may accept, accept with reduced payment, require mitigation, or require removal and replacement of non-conforming material at no additional cost to the Government.

3.14.3.9 Testing Concrete Structure for Strength

****
NOTE: If the government is going to take cores and test them then include the bracketed paragraph.
****

When there is evidence that strength of concrete structure in place does not meet specification requirements or there are non-conforming materials, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C42/C42M, and as follows:

a. Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

b. Test cores after moisture conditioning in accordance with ASTM C42/C42M if concrete they represent is more than superficially wet under service.

c. Air dry cores, (16 to 27 degrees C60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

d. Strength of cores from each member or area are considered satisfactory if their average compressive strength is equal to or greater than 85 percent of the design compressive strength, and if no single core strength is less than 75 percent of the design compressive strength. Additional testing of cores extracted from locations represented by erratic core strength results will be permitted only when approved by the Contracting Officer.

[e. Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.

] Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.15 REPAIR, REHABILITATION AND REMOVAL

Before the Contracting Officer accepts the structure, inspect the structure for cracks, damage and substandard concrete placements that may adversely affect the service life of the structure. Prepare a report documenting these defects which includes recommendations for repair, removal or remediation and submit to the Contracting Officer for approval before any corrective work is accomplished.

****

NOTE: Include this paragraph if the concrete structure is a water tank designed in accordance with ACI 530.

****

[3.15.1 Crack Repair

Prior to final acceptance, document all cracks in excess of 0.50 mm 0.02 inches wide and repair. Submit the proposed method and materials to repair the cracks to the Contracting Officer for approval. Address the amount of movement expected in the crack due to temperature changes and loading.

]3.15.2 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Concrete surfaces with weak surfaces less than 6 mm 1/4 inch thick must be diamond ground to remove the weak surface. Surfaces containing weak surfaces greater than 6 mm 1/4 inch thick must be removed and replaced or mitigated in a manner acceptable to the Contracting Officer.

3.15.3 Failure of Quality Assurance Test Results

****
NOTE: Test results accomplished on concrete samples during concrete production that fall short of the acceptance criteria alert the Contractor to something in the production and placement process that has drifted out of calibration or that an error has been made. The goal is to track down the problem and correct it as quickly as possible. Unless the concrete producer makes a large error in batching or in placing, the chance that hardened concrete needs to be removed is remote. Removal and replacement is a last resort.
****

Proposed mitigation efforts must be approved by the Contracting Officer prior to proceeding.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-03 30 53 (May 2014)**

Preparing Activity: USACE **Superseding**
UFGS-03 30 53 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE

05/14

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USACE / NAVFAC / AFCEC **UFGS-03 30 53 (May 2014)**

Preparing Activity: USACE **Superseding**
UFGS-03 30 53 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE
05/14

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NOTE: This guide specification covers the requirements for projects involving amounts of concrete less than 380 cubic meters 500 cubic yards. This section was originally developed for USACE Civil Works projects. This section may not be applicable to NAVFAC projects without extensive editing to meet NAVFAC requirements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This specification requires furnishing all material and equipment, and performing all labor for the manufacturing, transporting, placing, finishing, and curing of concrete for recreation sites, road relocations, or other structures such as culvert headwalls, comfort stations, residences, or low head gate structures. Consideration should be given to using Section 03 30 00 CAST-IN-PLACE CONCRETE when the quantity of concrete is 380 cubic meters 500 cubic yards or greater per structure.

****

1.1 SUMMARY

Perform all work in accordance with ACI 318MACI 318.

1.2 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph, title UNIT PRICES, should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

****

1.2.1 Concrete Payment

Payment will cover all costs associated with[manufacturing,] furnishing, delivering, placing, finishing, and curing of concrete for the various items of the schedule, including the cost of all formwork. Payment for concrete, for which payment is made as a lump sum, [is] [is not] to be included in this unit price payment item. Payment for grout, preformed expansion joints, field-molded sealants, waterstops, reinforcing steel bars or wire reinforcement [is] [is not] to be included in this unit price payment item.

1.2.2 Measurement

Concrete will be measured for payment on the basis of the actual volume of concrete within the pay lines of the structures as indicated. Measurement of concrete placed against the sides of any excavation without the use of intervening forms will be made only within the pay lines of the structure. No deductions will be made for rounded or beveled edge, for space occupied by metal work, for electrical conduits or timber, or for voids or embedded items that are either less than 0.14 cubic meter 5 cubic feet in volume or 0.1 square meter 1 square foot in cross section.

1.2.3 Unit of Measure

Unit of measure: cubic meter yard.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2020) Specifications for Structural Concrete
ACI 301M	(2020) Metric Specifications for Structural Concrete
ACI 302.1R	(2015) Guide for Concrete Floor and Slab Construction
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C685/C685M	(2024) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D98	(2015) Calcium Chloride
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E1155	(2020) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E1155M	(2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers (Metric)
ASTM E1643	(2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
ASTM E1745	(2017; R 2023) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
ASTM E1993/E1993M	(1998; R 2020) Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

Air-Entraining Admixture
Accelerating Admixture
Water-Reducing or Retarding Admixture
Curing Materials
Expansion Joint Filler Strips, Premolded
Joint Sealants - Field Molded Sealants
Waterstops
Chemical Floor Hardener
Batching and Mixing Equipment
Conveying and Placing Concrete
Formwork
Mix Design Data; G, [_____]
Ready-Mix Concrete
Curing Compound
Mechanical Reinforcing Bar Connectors

SD-06 Test Reports

Aggregates
Concrete Mixture Proportions; G, [_____]
Measurement of Floor Tolerances
Compressive Strength Testing; G, [_____]
Slump; G, [_____]
Air Content
Water

SD-07 Certificates

Cementitious Materials
Pozzolan
CPG for recycled materials or appropriate Waiver Form
Aggregates
Delivery Tickets

SD-08 Manufacturer's Instructions

Chemical Floor Hardener
Curing Compound

1.5 QUALITY ASSURANCE

Indicate specific locations of [Concrete Placement] [Forms] [Steel Reinforcement] [Accessories] [Expansion Joints] [Construction Joints] [Contraction Joints] [Control Joints] on installation drawings and include, but not be limited to, square meters feet of concrete placements, thicknesses and widths, plan dimensions, and arrangement of cast-in-place concrete section.

1.5.1 Regulatory Requirements

****

NOTE: This section relates to the implementation of RCRA of 1976 as amended (42 USC 6901) which requires that EPA designated items be used to the maximum extent practicable.

One of the requirements of 40 CFR 247 is that agencies promote the use of products containing recycled materials. Parts of this guide specification are only promotional in nature in that they recommend or encourage, in lieu of requiring, the Contractor to use products containing recycled materials. Coordinate this section with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING in every project where 40 CFR 247 is applicable.

Include the applicable state highway department document title in which an acceptable gradation for the concrete aggregate is presented.

****

The state statutory and regulatory requirements: [_____] form a part of this specification to the extent referenced. Submit CPG for recycled materials or appropriate Waiver Form.

1.5.2 Flatness and Levelness of Floor Slabs

Conduct floor flatness and levelness test, (FF and FL respectively), on floor slabs in accordance with the provisions set forth in ASTM E1155M or ASTM E1155. Make floor tolerance measurements by the approved laboratory and inspection service within 24 hours after completion of final troweling operation and before forms and shores have been removed. Provide results of floor tolerance tests, including formal notice of acceptance or rejection of the work, to the Contracting Officer within 24 hours after data collection.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The Government retains the option to sample and test [joint sealer, joint filler material, waterstop,] aggregates and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary to assist the Government in procurement of representative test samples. Obtain samples of aggregates at the point of batching in accordance with ASTM D75/D75M. Sample concrete in accordance with ASTM C172/C172M. Determine slump and air content in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively, when cylinders are molded. Prepare, cure, and transport compression test specimens in accordance with ASTM C31/C31M. Test compression test specimens in accordance with ASTM C39/C39M. Take samples for strength tests not less than once each shift in which concrete is produced [from each strength of concrete required]. Provide a minimum of four 150 x 300 mm6 x 12 inch or six 100 x 200 mm4 x 8 inch specimens from each sample; two 150 x 300 mm6 x 12 inch or three 100 x 200 mm4 x 8 inch to be tested at 28 days (90 days if pozzolan or slag cement is used) for acceptance. Two 150 x 300mm6 x 12 inch or three 4 x 8 inch will be tested at 7 days for information.

2.1.1 Strength

Acceptance test results are the average strengths of two 150 x 300 mm6 x 12 inch or three 100 x 200 mm4 x 8 inch specimens tested at 28 days (90 days if pozzolan or slag cement is used). The strength of the concrete is considered satisfactory so long as the average of all three consecutive acceptance test results equal or exceed the specified compressive strength, f'c, and no individual acceptance test result falls below f'c by more than 3.4 MPa 500 psi.

2.1.2 Construction Tolerances

Apply a Class "C" finish to all surfaces except those specified to receive a Class "D" finish. Apply a Class "D" finish to all post-construction surfaces which will be permanently concealed. Surface requirements for the classes of finish required are as specified in ACI 117.

2.1.3 Concrete Mixture Proportions

****

NOTE: The nominal maximum size of the coarse aggregate is as specified in ACI 318, Chapter 3 and ACI 318M. Guidelines for the maximum water cementitious material ratio and air content can be found in ACI 318 Chapter 4.

****

Concrete mixture proportions are the responsibility of the Contractor. Mixture proportions must include the dry weights of cementitious material(s); the nominal maximum size of the coarse aggregate; the specific gravities, absorptions, and saturated surface-dry weights of fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per cubic meter yard of concrete. Provide materials included in the mixture proportions of the same type and from the same source as will be used on the project. The specified compressive strength f'c is [20.7] [_____] MPa [3,000] [_____] psi at 28 days (90 days if pozzolan is used). The maximum nominal size coarse aggregate is [19] [25] [37.5] mm [3/4] [1] [1-1/2] inch, in accordance with ACI 304R. The air content must be between 4.5 and 7.5 percent with a slump between 50 and 125 mm 2 and 5 inches. The maximum water-cementitious material ratio is [0.50] [_____]. Submit the applicable test reports and mixture proportions that will produce concrete of the quality required, ten days prior to placement of concrete.

2.1.4 Slag Cement

Slag Cement must conform to ASTM C989/C989M, [Grade 80], [Grade 100] [or] [Grade 120].

2.2 MATERIALS

Submit manufacturer's literature from suppliers which demonstrates compliance with applicable specifications for the specified materials.

2.2.1 Cementitious Materials

Submit Manufacturer's certificates of compliance, accompanied by mill test reports, attesting that the concrete materials meet the requirements of the specifications in accordance with the Special Clause "CERTIFICATES OF COMPLIANCE". Also, certificates for all material conforming to EPA's Comprehensive Procurement Guidelines (CPG), in accordance with 40 CFR 247. Provide cementitious materials that conform to the appropriate specifications listed:

2.2.1.1 Portland Cement

****

NOTES: Limit the use of air-entraining cement to concrete placements where separate batching of air-entraining admixture is not practical.

If high early strength concrete is required, specify Type III after consulting the agency's Subject Matter Expert in Concrete Materials.

Tricalcium aluminate, for sulfate resistance, is limited to Type III cement. If high early strength is not required, specify Type II rather than Type I when moderate sulfate resistance is required, or Type V when high sulfate resistance is required.

Specify low-alkali cement when the aggregate is either silica or carbonate reactive.

****

ASTM C150/C150M, Type [I][II][III][V], [low alkali] [including false set requirements] with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na2Oe (sodium oxide) equivalent.

[2.2.1.2 Blended Hydraulic Cement

****

NOTES: Limit the use of air-entraining cement to concrete placements where separate batching of air-entraining admixture is not practical.

Specify low-alkali cement when reactive aggregates are to be used.

****

Provide blended cement conforming to ASTM C595/C595M and ASTM C1157/C1157M, Type IP, IL or IS, including the optional requirement for mortar expansion [and sulfate soundness] and consist of a mixture of ASTM C150/C150M Type I, or Type II cement and a complementary cementing material. The slag added to the Type IS blend must be ASTM C989/C989M ground granulated blast-furnace slag. The pozzolan added to the Type IP blend must be ASTM C618 Class F, interground with the cement clinker. Provide the manufacturer's written statement that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. Do not change the percentage and type of mineral admixture used in the blend from that submitted for the aggregate evaluation and mixture proportioning.

]2.2.1.3 Pozzolan

Provide pozzolan that conforms to ASTM C618, Class F, including requirements of Tables 1A and 2A.

2.2.2 Aggregates

****

NOTE: This note may be disregarded for regions

where Alkali-Silica Reactivity (ASR) is not a concern. Some aggregate sources may exhibit an ASR potential. ASR is a potentially deleterious reaction between alkalis present in concrete and some siliceous aggregates, reference EM 1110-2-2000 paragraph 2-3b(6) and appendix D. Where ASR is known or suspected to pose a concern for concrete durability, it is recommended that aggregates proposed for use in concrete be evaluated to determine ASR potential and an effective mitigation. EM 1110-2-2000, provides recommendations for evaluating and mitigating ASR in concrete mixtures. Aggregate evaluations may not be practical for projects requiring small quantities of concrete (less than 190 cubic meters 250 cubic yards).

Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS, paragraph ALKALI-SILICA REACTIVITY, provides a specification method for the Contractor to evaluate and mitigate ASR in concrete mixtures. The expansion limits specified in Section 32 13 14.13 are requirements for pavements and exterior slab construction. For structural concrete applications the measured expansion must be less than 0.10 percent. It may not be economical or practical to specify different test limit requirements for use on the same project, in which case the lower limit is required by the application

The designer may use the specification method in Section 32 13 14.13 by incorporating the relevant paragraphs into this specification, or may use the following requirements (retain either the 0.10 or the 0.08 percent expansion limits as appropriate).

****

For fine and coarse aggregates meet the quality and grading requirements of ASTM C33/C33M[and test and evaluate for alkali-aggregate reactivity in accordance with ASTM C1260. Perform evaluation of fine and coarse aggregates separately and in combination, matching the proposed mix design proportioning. All results of the separate and combination testing must have a measured expansion less than 0.08 percent at 28 days after casting. If the test data indicates an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1260 and ASTM C1567. Perform the additional testing using ASTM C1260 and ASTM C1567 using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. Use GGBF slag in the range of 40 to 50 percent of the total cementitious material by mass. Use Class F fly ash in the range of 25 to 40 percent of the total cementitious material by mass]. Submit certificates of compliance and test reports for aggregates showing the material(s) meets the quality and grading requirements of the specifications under which it is furnished.

2.2.3 Admixtures

Provide admixtures, when required or approved, in compliance with the appropriate specification listed. Retest chemical admixtures that have been in storage at the project site, for longer than 6 months or that have been subjected to freezing, at the expense of the Contractor at the request of the Contracting Officer and will be rejected if test results are not satisfactory.

2.2.3.1 Air-Entraining Admixture

Provide air-entraining admixture that meets the requirements of ASTM C260/C260M.

[2.2.3.2 Accelerating Admixture

Provide calcium chloride meeting the requirements of ASTM D98. Other accelerators must meet the requirements of ASTM C494/C494M, Type C or E.

]2.2.3.3 Water-Reducing or Retarding Admixture

Provide water-reducing or retarding admixture meeting the requirements of ASTM C494/C494M, Type A, B, or D. [High-range water reducing admixture Type F [or G] may be used only when approved, approval being contingent upon particular placement requirements as described in the Contractor's Quality Control Plan.]

2.2.4 Water

Mixing and curing water in compliance with the requirements of ASTM C1602/C1602M; [potable, and] free of injurious amounts of oil, acid, salt, or alkali. Submit test report showing water complies with ASTM C1602/C1602M.

[2.2.5 Reinforcing Steel

****

NOTE: Delete this paragraph if fibercrete is accepted for use by the Contracting Officer.

****

Provide reinforcing bars conforming to the requirements of ASTM A615/A615M, Grade 60, deformed. Provide welded steel wire reinforcement conforming to the requirements of ASTM A1064/A1064M. Detail reinforcement not indicated in accordance with ACI 301M ACI 301 and ACI SP-66. Provide mechanical reinforcing bar connectors in accordance with ACI 301M ACI 301 and provide 125 percent minimum yield strength of the reinforcement bar.

][2.2.6 Expansion Joint Filler Strips, Premolded

Expansion joint filler strips, premolded of sponge rubber conforming to ASTM D1752, Type I.

][2.2.7 Joint Sealants - Field Molded Sealants

****

NOTES: Use ASTM C920 for field-molded sealants in small hydraulic structures.

****

Conform to ASTM C920, Type M, Grade NS, Class 25, use NT for vertical joints and Type M, Grade P, Class 25, use T for horizontal joints. Provide polyethylene tape, coated paper, metal foil, or similar type bond breaker materials. The backup material needs to be compressible, nonshrink, nonreactive with the sealant, and a nonabsorptive material such as extruded butyl or polychloroprene foam rubber. Immediately prior to installation of field-molded sealants, clean the joint of all debris and further cleaned using water, chemical solvents, or other means as recommended by the sealant manufacturer or directed.

][2.2.8 Formwork

Design and engineer the formwork as well as its construction in accordance with ACI 301M ACI 301 Section 2 and 5 and ACI 347R. Fabricate of wood, steel, or other approved material. Submit formwork design prior to the first concrete placement.

][2.2.9 Form Coatings

Provide form coating in accordance with ACI 301M ACI 301.

][2.2.10 Vapor Retarder[and VaporBarrier]

[ASTM E1745 Class [C] [A] [B] polyethylene sheeting, minimum [0.25] [0.38] mm [10] [15] mil thickness or other equivalent material with a maximum permeance rating of 0.04 perms per ASTM E96/E96M.] [ASTM E1745 Class [C] [A] [B] polyethylene sheeting, minimum [0.25] [0.38] mm [10] [15] mil thickness or ASTM E1993/E1993M bituminous membrane or other equivalent material with a maximum permeance rating of 0.01 perms per ASTM E96/E96M.]

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

]2.2.11 Curing Materials

Provide curing materials in accordance with ACI 301M ACI 301, Section 5.

2.3 READY-MIX CONCRETE

Provide ready-mix concrete with mix design data conforming to ACI 301M ACI 301 Part 4. Submit delivery tickets in accordance with ASTM C94/C94M for each ready-mix concrete delivery, include the following additional information: .

a. Type and brand cement

b. Cement content in 43 kilogram 94-pound bags per cubic meter yard of concrete

c. Maximum size of aggregate

d. Amount and brand name of admixture

e. Total water content expressed by water cementitious material ratio

2.4 ACCESSORIES

2.4.1 Waterstops

2.4.1.1 PVC Waterstop

Polyvinylchloride waterstops conforming to COE CRD-C 572.

2.4.1.2 Rubber Waterstop

Rubber waterstops conforming to COE CRD-C 513.

2.4.1.3 Thermoplastic Elastomeric Rubber Waterstop

Thermoplastic elastomeric rubber waterstops conforming to ASTM D471.

2.4.1.4 Hydrophilic Waterstop

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water conforming to ASTM D412 as follows: Tensile strength 2.9 MPa 420 psi minimum; ultimate elongation 600 percent minimum. Minimum hardness of 50 on the type A durometer and the volumetric expansion ratio in distilled water at 20 degrees C 70 degrees F; 3 to 1 minimum.

2.4.2 Chemical Floor Hardener

Provide hardener which is a colorless aqueous solution containing a blend of inorganic silicate or siliconate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of liquid chemical floor hardener.

2.4.3 Curing Compound

Provide curing compound conforming to ASTM C309. Submit manufactures instructions for placing curing compound.

PART 3 EXECUTION

3.1 PREPARATION

Prepare construction joints to expose coarse aggregate. The surface must be clean, damp, and free of laitance. Construct ramps and walkways, as necessary, to allow safe and expeditious access for concrete and workmen. Remove snow, ice, standing or flowing water, loose particles, debris, and foreign matter. Satisfactorily compact earth foundations. Make spare vibrators available. Placement cannot begin until the entire preparation has been accepted by the Government.

3.1.1 Embedded Items

Secure reinforcement in place after joints, anchors, and other embedded items have been positioned. Arrange internal ties so that when the forms are removed the metal part of the tie is not less than 50 mm 2 inches from concrete surfaces permanently exposed to view or exposed to water on the finished structures. Prepare embedded items so they are be free of oil and other foreign matters such as loose coatings or rust, paint, and scale. The embedding of wood in concrete is permitted only when specifically authorized or directed. Provide all equipment needed to place, consolidate, protect, and cure the concrete at the placement site and in good operating condition.

3.1.2 Formwork Installation

Forms must be properly aligned, adequately supported, and mortar-tight. Provide smooth form surfaces, free from irregularities, dents, sags, or holes when used for permanently exposed faces. Chamfer all exposed joints and edges , unless otherwise indicated.

[3.1.3 Vapor Retarder[and Vapor Barrier] Installation

****

NOTE: Use a vapor barrier only when it is desirable to prevent migration of moisture through slabs of buildings.

****

Install in accordance with ASTM E1643. Apply vapor retarder[andbarrier] over gravel fill. Lap edges not less than 300 mm 12 inches. Seal all joints with pressure-sensitive adhesive not less than 50 mm 2 inches wide. Protect the vapor barrier at all times to prevent injury or displacement prior to and during concrete placement.

]3.1.4 Production of Concrete

3.1.4.1 Ready-Mixed Concrete

Provide ready-mixed concrete conforming to ASTM C94/C94M except as otherwise specified.

3.1.4.2 Concrete Made by Volumetric Batching and Continuous Mixing

Conform to ASTM C685/C685M.

[3.1.4.3 Batching and Mixing Equipment

The option of using an on-site batching and mixing facility is available. The facility must provide sufficient batching and mixing equipment capacity to prevent cold joints. Submit the method of measuring materials, batching operation, and mixer for review, and manufacturer's data for batching and mixing equipment demonstrating compliance with the applicable specifications. [Provide an Onsite Plant conforming to the requirements of either ASTM C94/C94M or ASTM C685/C685M.]

][3.1.5 Waterstops

Install and splice waterstops as directed by the manufacturer.

]3.2 CONVEYING AND PLACING CONCRETE

Convey and place concrete in accordance with ACI 301M ACI 301, Section 5.

3.2.1 Cold-Weather Requirements

Place concrete in cold weather in accordance with ACI 306R

3.2.2 Hot-Weather Requirements

Place concrete in hot weather in accordance with ACI 305R

3.3 FINISHING

3.3.1 Temperature Requirement

Do not finish or repair concrete when either the concrete or the ambient temperature is below 10 degrees C 50 degrees F.

3.3.2 Finishing Formed Surfaces

Remove all fins and loose materials , and surface defects including filling of tie holes. Repair all honeycomb areas and other defects. Remove all unsound concrete from areas to be repaired. Ream or chip surface defects greater than 13 mm 1/2 inch in diameter and holes left by removal of tie rods in all surfaces not to receive additional concrete and fill with dry-pack mortar. Brush-coat the prepared area with an approved epoxy resin or latex bonding compound or with a neat cement grout after dampening and filling with mortar or concrete. Use a blend of portland cement and white cement in mortar or concrete for repairs to all surfaces permanently exposed to view so that the final color when cured is the same as adjacent concrete.

3.3.3 Finishing Unformed Surfaces

Finish unformed surfaces in accordance with ACI 301M ACI 301, Section 5.

FINISH	LOCATION
Float	
Trowel	
Broom or Belt	

3.3.3.1 Flat Floor Finishes

****

NOTE: Floor flatness and floor levelness affects the appearance and function of finishes applied to the concrete and in situations such as large or long expanses of glossy floor materials. Low tolerances for subsequent finish materials (for example, thin set ceramic and porcelain tile and wood gymnasium floors) require the designer to specify higher than normal floor flatness requirements. Higher "F" ratings are more stringent and tighter tolerances of F numbers stop at 100. The numbers provided in brackets are typical numbers, but A/E should research and select F numbers high enough to get desired results but not so high as to cause undue cost increases and construction issues. An FF20/FL15 is equivalent to 8 mm in 3 meters 5/16 inches in 10 feet. This test method is not suitable for unshored decks. Fitted partitions need an FL greater than or equal to 25.

The F-numbers are given below for purposes of illustration only.

****

In accordance with ACI 302.1R, construct in accordance with one of the methods recommended in Table 7.15.3, "Typical Composite FF/FL Values for Various Construction Methods." ACI 117 for tolerances tested by ASTM E1155M or ASTM E1155. These requirements are based upon the latest FF/FL method.

3.3.3.1.1 Floor Slabs

Conform floor slabs on grade to the following ACI F-number requirements unless noted otherwise:

Specified Overall Values	FF30/FL23 minimum [FF_____/FL_____]
Minimum Local Values	FF17/FL15 minimum [FF_____/FL_____]

3.3.3.1.2 Subject to Vehicular Traffic

Conform floor slabs on grade subject to vehicular traffic or receiving thin-set flooring to the following ACI F-number requirements:

Specified Overall Values	FF35/FL25 minimum [FF_____/FL_____]
Minimum Local Values	FF25/FL17 minimum [FF_____/FL_____]

3.3.3.2 Measurement of Floor Tolerances

Test floor slabs within 24 hours of the final troweling. Submit test results to Contracting Officer within 12 hours after collecting data. Floor flatness inspector mustl provide a tolerance report which includes:

a. Name of Project

b. Name of Contractor

c. Date of Data Collection

d. Date of Tolerance Report

e. A Key Plan Showing Location of Data Collected

f. Results Required by ASTM E1155M ASTM E1155

[3.3.3.3 Expansion and Contraction Joints

****

NOTES: Refer to ACI 224.3R for guidance on expansion joints.

The depth of contraction joints must be 1/4 to 1/3 of the thickness of the slab.

The maximum spacing (in mm feet) between adjacent joints must be 30 times the concrete thickness (in mm feet) for slabs exposed to the environment.

****

Make expansion and contraction joints in accordance with the details shown or as otherwise specified. Provide 13 mm 1/2 inch thick transverse expansion joints where new work abuts an existing concrete. Provide expansion joints at a maximum spacing of 10 m 30 feet on center in sidewalks [and at a maximum spacing of [_____] meters feet in slabs], unless otherwise indicated. Provide contraction joints at a maximum spacing of [2] [_____] linear meters [6] [_____] linear feet in sidewalks [and at a maximum spacing of [_____] meters feet in slabs], unless otherwise indicated. Cut contraction joints at a minimum of [25] [_____] mm [1] [_____] inch(es) deep with a jointing tool after the surface has been finished.

]3.4 CURING AND PROTECTION

Cure and protect in accordance with ACI 301M ACI 301, Section 5.

3.5 FORM WORK

Provide form work in accordance with ACI 301M ACI 301, Section 2 and Section 5.

3.5.1 Removal of Forms

Remove forms in accordance with ACI 301M ACI 301, Section 2.

3.6 STEEL REINFORCING

Reinforcement must be free from loose, flaky rust and scale, and free from oil, grease, or other coating which might destroy or reduce the reinforcement's bond with the concrete.

3.6.1 Fabrication

Shop fabricate steel reinforcement in accordance with ACI 318 and ACI SP-66. Provide shop details and bending in accordance with ACI 318 and ACI SP-66.

3.6.2 Splicing

Perform splices in accordance with ACI 318 and ACI SP-66.

3.6.3 Supports

Secure reinforcement in place by the use of metal or concrete supports, spacers, or ties.

3.7 EMBEDDED ITEMS

Before placing concrete, take care to determine that all embedded items are firmly and securely fastened in place. Provide embedded items free of oil and other foreign matter, such as loose coatings of rust, paint and scale. Embedding of wood in concrete is permitted only when specifically authorized or directed.

3.8 CHEMICAL FLOOR HARDENER

****

NOTE: Clearly indicate slab surfaces requiring a chemical hardener. Such treatment is suitable for surfaces of concrete floors in equipment rooms and on other floor surfaces that are subject to light foot traffic only and will not be covered with resilient flooring, paint, or other finish coating.

****

Apply Chemical Floor Hardener where indicated, after curing and drying concrete surface. Dilute liquid hardener with water and apply in three coats. First coat is one-third strength, second coat one-half strength, and third coat two-thirds strength. Apply each coat evenly and allow it to dry 24 hours before applying next coat. Apply proprietary chemical hardeners in accordance with manufacturer's printed directions.

3.9 TESTING AND INSPECTING

Report the results of all tests and inspections conducted at the project site informally at the end of each shift. Submit written reports weekly. Deliver within three days after the end of each weekly reporting period. See Section 01 45 00 QUALITY CONTROL.

3.9.1 Field Testing Technicians

The individuals who sample and test concrete must have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

3.9.2 Preparations for Placing

Inspect foundation or construction joints, forms, and embedded items in sufficient time prior to each concrete placement to certify that it is ready to receive concrete.

3.9.3 Sampling and Testing

a. Obtain samples and test concrete for quality control during placement. Sample fresh concrete for testing in accordance with ASTM C172/C172M. Make six test cylinders.

b. Test concrete for compressive strength at 7 and 28 days for each design mix and for every 77 cubic meters 100 cubic yards of concrete. Test two cylinders at 7 days; two cylinders at 28 days; and hold two cylinders in reserve. Conform test specimens to ASTM C31/C31M. Perform compressive strength testing conforming to ASTM C39/C39M.

c. Test slump at the [plant] [site of discharge] for each design mix in accordance with ASTM C143/C143M. Check slump [once] [twice] during each shift that concrete is produced [for each strength of concrete required].

d. Test air content for air-entrained concrete in accordance with ASTM C231/C231M. Test concrete using lightweight or extremely porous aggregates in accordance with ASTM C173/C173M. Check air content at least [once] [twice] during each shift that concrete is placed [for each strength of concrete required].

e. Determine temperature of concrete at time of placement in accordance with ASTM C1064/C1064M. Check concrete temperature at least [once] [twice] during each shift that concrete is placed [for each strength of concrete required].

3.9.4 Action Required

3.9.4.1 Placing

Do not begin placement until the availability of an adequate number of acceptable vibrators, which are in working order and have competent operators, has been verified. Discontinue placing if any lift is inadequately consolidated.

3.9.4.2 Air Content

Whenever an air content test result is outside the specification limits, adjust the dosage of the air-entrainment admixture prior to delivery of concrete to forms.

3.9.4.3 Slump

Whenever a slump test result is outside the specification limits, adjust the batch weights of water and fine aggregate prior to delivery of concrete to the forms. Make the adjustments so that the water-cementitious material ratio does not exceed that specified in the submitted concrete mixture proportion and the required concrete strength is still met.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 31 29 (May 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-03 31 29 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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05/24

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USACE / NAVFAC / AFCEC **UFGS-03 31 29 (May 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-03 31 29 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 03 31 29

MARINE CONCRETE WITH SERVICE LIFE MODELING
05/24

****

NOTE: This guide specification covers the requirements for reinforced concrete exposed to marine and chloride environments for projects with a defined service life. In addition, use this guide specification for projects with concrete exposed to weather in locations with Environmental Severity Classifications (ESC) of C4 and C5 and where deicing salts are used on the structure, where service life modeling is appropriate. See UFC 1-200-01 for determination of the ESC for project locations.

The defined service life approach mandates that the Government define the service life expectations of the structure (in years) prior to design. This document is a combination of prescriptive and performance based specifications. It contains specific requirements for quality control (actions taken by the Contractor) and quality assurance (actions that may be taken by the Government).

This guide specification includes provisions for performing concrete service life modeling. If it is determined that concrete service life modeling is not required for the project, then Section 03 31 30 Marine Concrete (without Service Life Modeling) should be used.

It is recommended that every significant structure employ service life modeling. Generally, significant structures are defined as having at least one of the following characteristics:

o Required Service Life: Greater than 60 years; or

o Volume of Concrete Works: Greater than 10,000 cubic yards; or

o Monetary Construction Value of the entire project: Greater than $15M; or

o Service life modeling is required by the Government.

For projects meeting the above criteria, enhanced durability is required, and therefore, service life design aided by service life modeling as described in the specification must be performed.

Other criteria to consider when evaluating the applicability of service life design, and if Service Life Modeling is required, include:

o Mission Criticality based on the Mission Dependency Index (MDI) Score. For example, consider service life modeling for an MDI score higher than 54.

o Consequences of Failure: Consider service life modeling for UFC 3-301-01 Risk Categories IV or higher.

The performance-based portion of this document includes requirements to predict the service life of the candidate concrete mixtures prior to proceeding with construction. During construction, concrete cylinders are made from the production concrete at intervals specified by the Engineer of Record to measure transport properties and for microscopic examination of the hardened concrete to verify that the concrete quality remains consistent and acceptable. Conventional requirements for compressive strength and slump remain the same. Service life modeling software is a tool that, when used in combination with other tools and good engineering judgment, enhances the Contractor's and Government's confidence that the completed structure will perform for the defined service life. TR-NAVFAC ESC-CI-1215, the "Navy User's Guide to Quality Assurance of New Concrete Construction" provides a commentary for the user of this methodology. Generally, this version of the marine concrete UFGS is for major projects. For smaller marine concrete projects and for projects without a defined service life the Specifier can consider use of Section 03 31 30 MARINE CONCRETE that excludes service life modeling requirements and testing for transport properties during construction.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in

respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Development team of this section considered the International Green Construction Code, which is "the first model code that includes sustainability measures for the entire construction project and its site - from design through construction, certificate of occupancy and beyond. The new code is expected to make buildings more efficient, reduce waste, and have a positive impact on health, safety and community welfare."
http://www.iccsafe.org/cs/igcc/pages/default.aspx
****

****
NOTE: The following information must be shown on the project drawings:

1. Design assumptions.

2. Assumed temperature range when temperature stresses are a factor in design.

3. Material strengths used in design, f'c.

4. Yield strength of reinforcement required (414 mPa 60,000 psi or other grade as available).

5. Details of concrete sections, showing dimensions, reinforcement cover, and required camber.

6. Joint details, showing locations and dimensions.

7. Details and locations of critical construction joints, including water stop locations and splices, keys, and dowels when required, and location of fiber-reinforced concrete elements.

8. A list of the project structures that are covered by this specification.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
AASHTO R 80	(2017; R 2021) Standard Practice for Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 121R	(2008) Guide for Concrete Construction Quality Systems in Conformance with ISO 9001
ACI 201.2R	(2016) Guide to Durable Concrete
ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 301	(2020) Specifications for Structural Concrete
ACI 301M	(2020) Metric Specifications for Structural Concrete
ACI 304.2R	(2017) Guide to Placing Concrete by Pumping Methods

ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 308.1	(2023) Specification for Curing Concrete
ACI 309R	(2005) Guide for Consolidation of Concrete
ACI 311.4R	(2005) Guide for Concrete Inspection
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete
ACI MNL-2	(2019; 11th Edition) ACI Manual of Concrete Inspection
ACI MNL-15	(2020) Field Reference Manual: Specifications for Concrete Construction ACI 301-20 with Selected ACI References
ACI MNL-66	(2020) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA PS 1	(2009) Structural Plywood (with Typical APA Trademarks)

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2024) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete

	Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A767/A767M	(2019) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A882/A882M	(2020) Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Steel Strand
ASTM A884/A884M	(2019; Errata 1) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A886/A886M	(2024) Standard Specification for Steel Strand, Indented, Seven-Wire Stress-Relieved for Prestressed Concrete
ASTM A934/A934M	(2022) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A955/A955M	(2020c) Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement
ASTM A970/A970M	(2018) Standard Specification for Headed Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1022/A1022M	(2016b) Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement
ASTM A1035/A1035M	(2024) Standard Specification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement
ASTM A1044/A1044M	(2016a; Errata 1) Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete
ASTM A1055/A1055M	(2022) Standard Specification for Zinc and Epoxy Dual Coated Steel Reinforcing Bars

ASTM A1060/A1060M	(2016b) Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C157/C157M	(2024; E 2024) Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311/C311M	(2024) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C457/C457M	(2024) Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
ASTM C469/C469M	(2022) Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C496/C496M	(2017) Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C642	(2021) Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C672/C672M	(2012) Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals
ASTM C805/C805M	(2018) Standard Test Method for Rebound Number of Hardened Concrete
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for

	Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1074	(2019; E 2021) Standard Practice for Estimating Concrete Strength by the Maturity Method
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1152/C1152M	(2020) Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1202	(2022; E 2022) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1231/C1231M	(2023) Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1610/C1610M	(2021) Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique
ASTM C1611/C1611M	(2021) Standard Test Method for Slump Flow of Self-Consolidating Concrete
ASTM C1621/C1621M	(2017; R 2023) Standard Test Method for

	Passing Ability of Self-Consolidating Concrete by J-Ring
ASTM C1778	(2023) Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
ASTM C1792	(2014) Standard Test Method for Measurement of Mass Loss versus Time for One-Dimensional Drying of Saturated Concretes
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D512	(2012) Chloride Ion in Water
ASTM D516	(2016) Standard Test Method for Sulfate Ion in Water
ASTM D1179	(2016) Standard Test Methods for Fluoride Ion in Water
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D3867	(2016)Standard Test Methods for Nitrite-Nitrate in Water
ASTM D6690	(2021) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM D7957/D7957M	(2017) Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2018; Errata 2019) Manual of Standard Practice
CRSI RB4.1	(2016) Supports for Reinforcement Used in Concrete

INTERNATIONAL FEDERATION FOR STRUCTURAL CONCRETE (fib)

fib Bulletin 34	(2006) Model Code for Service Life Design

NORDTEST (NT)

NT Build 492	(1999) Concrete, Mortar and Cement-Based Repair Materials: Chloride Migration Coefficient from Non-Steady-State Migration Experiments

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 39	(1981) Test Method for Coefficient of Linear Thermal Expansion of Concrete
COE CRD-C 61	(1989A) Test Method for Determining the Resistance of Freshly Mixed Concrete to Washing Out in Water
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-200	(Rev E; Notice 1; Notice 2) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

TR-NAVFAC ESC-CI-1215	(2012) Navy User's Guide for Quality Assurance of New Concrete Construction

1.2 DEFINITIONS

a. "Aging factor" is used to estimate the change in the diffusion or migration coefficient over time.

b. "Atmospheric zone" is any portion of the waterfront structure above the splash zone.

c. "Boundary Condition" is the environmental conditions in contact with the concrete. The service life modeling tool must account for the environmental conditions at the boundary interface between the specific concrete element and the environment, including wetting and drying due to daily tidal cycles and/or changes over its lifecycle.

d. "Buried zone" is any portion of the waterfront structure permanently buried in soil.

e. "Cementitious material" as used herein must include portland cement and any pozzolanic material such as fly ash, natural pozzolans, slag cement and silica fume.

f. "Chloride threshold" (CTH) is the concentration of chloride ions in concrete that is generally assumed to be the minimum necessary to initiate corrosion of the reinforcing steel when all other necessary conditions are satisfied. The threshold value is expressed in parts per million (ppm) by mass of concrete, unless otherwise indicated in this specification.

g. "Chloride migration coefficient" is the main parameter describing the concrete transport properties in the time to corrosion model presented in Appendix B2 of fib Bulletin 34. It is measured using the NT Build 492 test method.

h. "Concrete System" is the term describing a structural element comprised of concrete, reinforcing steel and concrete cover.

i. "Corrosion initiation period" (Ti) is the number of years assumed before the chloride ion reaches the chloride threshold for the reinforcing steel at the depth of the steel. The corrosion initiation period will be determined by numerical modeling in accordance with this specification.

j. "Corrosion Propagation period" (Tp) is the number of years after the corrosion initiation period until corrosion manifests as visible cracking and spalling of the concrete cover to a degree that will require extensive concrete repair. Based on evidence provided by the Contractor and reviewed by the agency's Subject Matter Expert in Concrete Materials, on a case-by-case basis the Contracting Officer may approve extension to the typical corrosion propagation period of 10 to 15 years. Use of supplemental corrosion protection methods and benign environmental conditions are two ways to extend the assumed propagation period.

k. "Design strength" (f'c) is the specified compressive strength of concrete at time(s) specified by Contracting Officer to meet structural design criteria. Typical duration is 28 days; however, the Contracting Officer and Engineer of Record are encouraged to consider specifying strength at 56 or 90 days. For concrete mixtures containing 35 percent fly ash or more, the duration must be a minimum of 56 days.

l. "Effective Diffusion Coefficient" (D_{eff}) is, in the STADIUM® software, a coefficient that combines the ionic diffusion coefficient D_{oh} and volume of permeable voids.

m. "Exposure Conditions" are the environmental parameters used in service life modeling for each type of concrete element based on the structure location and anticipated boundary conditions.

n. "Field test strength" (fcr) is the required compressive strength of concrete to meet structural and durability criteria. Determine (fcr) during mixture proportioning process.

o. "High-volume fly ash (HVFA) concrete" has a minimum of 35 percent Class F fly ash as a partial replacement to portland cement.

p. "Ionic Diffusion Coefficient" (D_{oh}) is, in the STADIUM® software, the ionic diffusion coefficient as determined per the ionic diffusion coefficient migration testing for the service life modeling.

q. "Marine concrete" is all concrete that will be in contact with seawater or brackish water, tidal variations, splash, or spray from water in navigable waterways. Piles driven on land that extend below the water table that contains saltwater or brackish water must be designed using marine concrete. Components of a marine structure that are permanently buried in soil must be considered marine concrete. In addition, structures may need to be designed using these criteria even though they are not adjacent to the waterfront. For example, structures located several hundred yards from the waterfront often deteriorate prematurely due to salt spray and salt fog brought to the structure by prevailing winds. An assessment of existing structures near the construction site can be an excellent indicator for the Engineer of Record and Contracting Officer to decide if the proposed structure should follow the guidelines for marine concrete.

r. "Mass Concrete" is any concrete system that approaches a maximum temperature of 70 degrees C 158 degrees F within the first 72 hours of placement. In addition, it includes all concrete elements with a section thickness of 1 meter 3 feet or more regardless of temperature.

s. "Mixture proportioning" is the process of designing concrete mixture proportions to enable it to meet the strength, service life and constructability requirements and of the project while minimizing the initial and life-cycle cost.

t. "Mixture proportions" are the masses or volumes of individual ingredients used to make a unit measure (cubic yard or meter) of concrete.

u. "Moisture Transport Coefficient" (MTC) is, in the STADIUM® software, the value determined per the moisture transport coefficient drying test.

v. "Permeability" (K) is, in the STADIUM® software, the intrinsic permeability of the concrete evaluated from the moisture transport coefficient drying test.

w. "Pozzolan" is a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

x. "Process control sampling" is sampling and testing conducted by the Contractor to monitor the quality of materials or processes. Process control sampling is intended to indicate the quality of materials at critical steps in production that allow intervention prior to using a material on the project.

y. "Quality Acceptance Limit" (QAL) is the limiting value of a test result that indicates acceptable material quality. Quality acceptance limits are based on design criteria that may be either upper-bound limits where smaller values indicate acceptable material; or lower-bound limits where larger values indicate acceptable material, such as compressive strength.

z. "Quality acceptance sampling" is sampling and testing conducted by the Contractor, or an independent testing agency, to evaluate the quality of materials used on the project. Quality acceptance sampling is conducted at regular intervals identified as "lots" to represent the quality of that portion of the material used in the project.

aa. "Required compressive strength" (f'c) is the mean compressive strength of concrete required to meet structural criteria. The required strength is the mean concrete strength for tests of properly batched concrete at the age specified herein.

ab. "Service life" is the Contracting Officer's stated expectation for the number of years that the structure will function without needing major concrete rehabilitation. Service life is defined as the number of years before major restoration is necessary given minimal maintenance to the structure during its life. Major restoration is defined as extensive areas that require extensive repairs using a jack hammer or other destructive means to prepare the concrete for rehabilitation. Service life is further defined as the summation of the corrosion initiation period (Ti) and the corrosion propagation period (Tp) for a given concrete system.

ac. "Service Life Modeling" in the context of this document refers to a rational numerical approach to predict the time before the chloride ion contamination will reach a content, at the depth of the reinforcing steel, that is likely to result in the initiation of steel corrosion. Service life modeling is a tool to be used with engineering judgment to aid in the design, material selection, and construction methods to produce a durable structure. Two service life modeling tools are covered herein, including the STADIUM® software and the time to corrosion model presented in Appendix B2 of fib Bulletin 34.

ad. "Specified Effective Diffusion Coefficient" (D_{spec}) is, in the STADIUM® software, the calculated effective diffusion coefficient at which the service life is achieved.

ae. "Splash zone" is the portion of the structure just above the tidal zone. This portion of the structure is predominantly dry, but is likely to intermittently wet by wave action and wind driven spray. For the purposes of this specification, the splash zone is defined as follows:

(1) for locations protected by seawalls or otherwise sheltered from open-ocean waves, the 2 meters 6 feet area just above the tidal zone;

(2) for unprotected locations, the 6 meters 20 feet area just above the tidal zone.

af. "Submerged zone" is defined as the submerged portion of the structure. For the purposes of this specification, any element or portion thereof that is located below Mean Lower Low Water (MLLW). In areas with minimal tides, it would be defined as that portion of the element below Mean Sea Level (MSL).

ag. "Supplemental Corrosion Protection" includes (but not limited to) fusion-bonded epoxy-coated steel reinforcing, galvanized steel reinforcing, stainless reinforcing, corrosion inhibitors, barrier coatings to the concrete surface, and cathodic protection.

ah. "Supplementary cementing materials" (SCM) include coal fly ash, slag cement, natural or calcined pozzolans, and ultra-fine coal ash when used in such proportions to replace the portland cement that result in considerable improvement to sustainability, durability and in some cases a reduction in initial cost.

ai. "Test Section" is a slab or wall separate from the main structure and constructed prior to main construction as an all-inclusive demonstration of methods and materials. The adequacy of the Test Section must be approved by the Contracting Officer's representative prior to construction of the project.

aj. "Tidal zone" is defined as the portion of the structure regularly wetted by wave action. For the purposes of this specification, any element or portion thereof that is located between Mean Lower Low Water (MLLW) and Mean Higher High Water (MHHW) is in the tidal zone. In areas with minimal tides, this would be defined as the area located between Mean Sea Level (MSL) and Mean High Water (MHW).

ak. "Tolerance Limit" is defined for each transport parameter as the characteristic value that will be surpassed in 1 of 10 batches, at a 90 percent confidence level. This definition is provided for reference only, additional documentation and evaluation is needed prior to it being suggested as prescriptive criteria.

al. "Transport properties" refers to the properties that characterize the rate of chloride penetration into a concrete element. These properties include for the STADIUM® software: volume of permeable voids (phi), ionic diffusion coefficient (D_{oh}), aging factor, and moisture transport coefficient (MTC) These properties include for the time to corrosion model presented in Appendix B2 of fib Bulletin 34: chloride migration coefficient.

am. "Transport property testing" refers to the testing procedures that characterize the rate of chloride penetration into a concrete element. These properties are used as input data for the service life modeling.

an. "Volume of Permeable Voids" (phi) is, in the STADIUM® software, the porosity of the concrete as determined by ASTM C642.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy

and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Concrete Curing Plan

Concrete Qualification Program; G, [_____]

Concrete Quality Control Program; G, [_____]

Concrete Placement and Compaction

Concrete Pumping

Curing Concrete Elements

Form Removal Schedule

Laboratory Qualifications; G, [_____]

Quality Control Personnel Qualifications; G, [_____]

SD-02 Shop Drawings

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NOTE: Reproductions of contract drawings are unacceptable.
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Contraction and Expansion Joints; G

Formwork and Falsework

Precast Elements; G, [_____]

Reinforcing Steel; G, [_____]

Construction Joints; G, [_____]

SD-03 Product Data

Admixtures; G, [_____]

Air Entraining, e.g., Corrosion Inhibitors, Anti-washout; G,

[_____]

Aggregates; G, [_____]

Corrosion Inhibitors; G, [_____]

Joint Filler

Joint Sealants

Materials for Curing Concrete

Material Safety Data Sheets

Mechanical Reinforcing Bar Connectors; G, [_____]

Non-Shrink Grout

Preformed Joint Filler

Prestressing Steel; G, [_____]

Reinforcing Bars; G, [_____]

Reinforcement and Protective Coating; G, [_____]

Reinforcement Supports

Sealer-Hardener

Waterstops

Welded Wire Reinforcement

SD-04 Samples

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NOTE: Where flat surface finishing is important, provide a sample installation to train the crew.

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Mass Concrete Mock-up

Test Section

SD-05 Design Data

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NOTE: Concrete Mixture Requirements document the required criteria controlling the design of a particular concrete mix design while the Mixture Design documents the constituent materials used and the achieved performance during pre-construction phase.

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Concrete Mixture Requirements; G, [_____]

Mixture Design Report

Mass Concrete Temperature Control Plans; G, [_____]

SD-06 Test Reports

Mass Concrete Mock-up

Air Entraining

Aggregates

Admixtures

As-Built Report

Cement

Concrete Mixture Proportions

Concrete Test Reports

Durability Modeling Report

Fresh Concrete Properties

Hardened Concrete Properties

Mechanical Reinforcing Bar Connectors

Reinforcing Bars

Reinforcement and Protective Coating

Silica Fume

Supplementary Cementing Materials

Water

SD-07 Certificates

Admixtures

Cementitious Materials

Cementitious Material Mill Certificates

Field Testing Technician and Testing Agency

SD-08 Manufacturer's Instructions

Coatings

SD-11 Closeout Submittals

Aggregate Moisture Content

Aggregate Sampling

As-Built Report including Observed Defects ans Transport Property Test Results

Concrete Test Reports

Quality Control Charts

Daily Inspection Reports

Quality Team Meetings

Sampling Logs

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory, as though the word "must" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, PLACING, STORAGE, AND HANDLING OF CONCRETE

Follow ACI 301M ACI 301, ACI 304R, and ASTM A934/A934M requirements and recommendations. Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed.

1.6 CONCRETE QUALITY CONTROL

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NOTE: Service Life Design Framework and Service Life Modeling

The fib Bulletin 34 methodology is the overall service life design framework implemented in this specification. This framework includes two basic durability strategies: the avoidance approach and the design to resist approach. Two sub-levels of the design to resist approach are implemented here including the deemed-to-satisfy approach and, what is referred to here as, the service life modeling approach. Two service life modeling tools are acceptable to the Navy: the STADIUM® software and the time to corrosion model presented in Appendix B2 of the fib Bulletin 34. The service life modeling tools output requirements to the concrete cover thickness and performance requirements for the concrete mixture as described here.

This methodology enhances the Navy's confidence that the structure will perform without major repairs for the defined service life. It is recommended that every significant marine structure employ this section inclusive of service life modeling.

The Contracting Officer, the Engineer of Record, [and][or] the Contracting Officer must determine if this approach is applicable. Additional information is provided in TR-NAVFAC ESC-CI-1215.

The goal is to provide quality concrete with the specified concrete cover to protect the steel, which provides the primary protection mechanism against chemical deterioration and corrosion related damage. Other corrosion protection strategies are considered to be supplemental and include (but are not limited to): barrier coatings to the concrete surface, fusion-bonded epoxy-coated steel, corrosion inhibitors, galvanized, stainless, MMFX, Z-bar reinforcing and cathodic protection. All of which may provide some life extension but by how much is considered to be speculation for real structures exposed to chloride environments. If the available materials in the region of the project are inadequate to meet the requirements for shrinkage, compressive strength, constructability and service life then the Contractor must prepare a recommendation for review by the agency's Subject Matter Expert in Concrete Materials and approval by the Contracting Officer and Engineer of Record on a case-by-case basis to use supplemental corrosion protection to meet project requirements.

Where they are available, specify only ACI certified personnel. Check the American Concrete Institute (ACI) website for local availability: https://www.concrete.org/certification.

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The objective of the concrete quality control program is for the Contractor to outline the procedures that will be used to construct a structure that will obtain the design service life. The Contractor must develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and as specified herein. The plan must include approved laboratories. The Contractor must provide direct oversight for the concrete qualification program inclusive of service life modeling, associated sampling and testing. If concrete cylinders tested during production indicate inadequate strength, excessive ion-transport properties, or inadequate mixing, then the Contracting Officer may require the Contractor to extract concrete core samples from the hardened concrete for analysis at Contractor's expense to assure that the quality of the concrete as placed and cured will satisfy the defined service life.

Develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and able to meet the defined service life using the methodology herein. Maintain a copy of ACI MNL-15 and CRSI 10MSP at the project site.

1.6.1 Quality Control Personnel

The contractor must submit for approval an organizational chart defining the quality control hierarchy, the responsibilities of the various positions, including the names and qualifications of the individuals in those positions.

Submit American Concrete Institute certification for the following:

a. CQC personnel responsible for inspection of concrete operations.

b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.

c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

d. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and Laboratory Testing Technician, Grade I or II.

e. If using STADIUM® for service life modeling: STADIUM® certified laboratory and users of STADIUM® software.

f. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager Certification at the Plant Manager level.

1.6.1.1 Quality Manager Qualifications

The quality manager must hold a current license as a professional engineer in a U.S. state or territory with experience on at least five similar projects. Evidence of extraordinary proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

1.6.1.2 Field Testing Technician and Testing Agency

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

a. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI MNL-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI MNL-2.

b. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.

c. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.

d. Testing agencies or engineering companies that characterize the transport properties of the concrete and/or conduct service life modeling analysis must be pre-approved by the Contracting Officer with concurrence of the agency's Subject Matter Expert in Concrete Materials.

1.6.2 Laboratory Qualifications for Concrete Qualification Testing

The concrete testing laboratory must have the necessary equipment and experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077 and be Cement and Concrete Reference Laboratory (CCRL) inspected. If STADIUM® soft ware is used, the laboratory must be a STADIUM® certified laboratory. If the time to corrosion model presented in

Appendix B2 of fib Bulletin 34 is used, the laboratory must be equipped and experienced in the use of the NT Build 492 test.

1.6.3 Laboratory Accreditation

Laboratory and testing facilities must be provided by and at the expense of the Contractor. The laboratories performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation must be current and must include the required test methods, as specified.

a. Aggregate Testing and Mix Proportioning: Aggregate testing and mixture proportioning studies must be performed by an accredited laboratory and under the direction of a licensed/registered civil engineer in a U.S. state or territory, who must sign all reports and designs.

b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M.

c. Contractor Quality Control: All sampling and testing must be performed by an approved, onsite, independent, accredited laboratory.

1.7 CONCRETE DURABILITY

1.7.1 Service Life Design

Unless otherwise specified, the concrete structures must be designed for a 75-year service life. The total service life is the summation of the corrosion initiation period (Ti) and the corrosion propagation period (Tp).

The modeling for the corrosion initiation period (Ti) must use a full probabilistic approach. The corrosion initiation time must meet a target reliability index of 1.3. The corrosion propagation period can be determined using a deterministic approach.

The modeling of the corrosion initiation period (Ti) must be in accordance with one of the following service life modeling tools:

a. The STADIUM® software: Only certified STADIUM® laboratories and users can perform the testing and modeling.

b. Time to corrosion model presented in Appendix B2 of fib Bulletin 34: The model used for the corrosion initiation period (Ti) must be a full probablistic approach as per Appendix B2. The choice of each input parameter must be documented in the Durability Modeling Report; it must be demonstrated how the choice of input parameters is reasonable and applicable to the project. Calculations must be checked, the Contracting Officer may request a copy of the calculations for review. Testing of the concrete transport property, the chloride migration coefficient, must be in accordance with the NT Build 492 test method.

Regardless of the selected service life modeling tool, applicable deterioration mechanisms other than chloride-induced reinforcement corrosion must be listed in the Durability Modeling Report and mitigated using the deemed-to-satisfy or avoidance durability strategy within the fib Bulletin 34 framework. The use of supplemental corrosion protection must not be used in lieu of the fundamental requirement to meet the defined service life. Extensions to corrosion propagation period may be approved by the Contracting Officer based on evidence provided by the Contractor and reviewed by the agency's Subject Matter Expert in Concrete Materials on a case-by-case basis.

The Contractor must forward a Durability Modeling Report prepared by the consultant that conducts the service life assessment of the proposed concrete system for each concrete mixture. The Durability Modeling Report must present the service life design including the corrosion initiation time modeling. As a minimum, the report must contain:

a. Durability-related requirements for the concrete mixture proportions.

b. The concrete cover to reinforcing steel. The cover to all reinforcing bars must be clearly delineated with allowance for placement tolerances per ACI 117.

c. The environmental exposure conditions and associated applicable deterioration mechanisms for each type of concrete element.

d. The selected durability strategies (i.e., avoidance or deemed-to-satisfy) and mitigation measures to address applicable deterioration mechanism(s) other than chloride-induced reinforcement corrosion. Selected mitigation measures must be supported by design codes and guidelines, including but not limited to ACI 201.2R, ACI 301M ACI 301, AASHTO R 80, and ASTM C1778.

e. The concrete transport properties and materials characteristics that, for the specified exposure zones, satisfies the minimum required service life of the structural element. Variability of transport properties during production is to be an input parameter in the service life modeling tool and need not be verified during the trial batch process.

f. A narrative describing the modeling process including assumptions and recommendations to accomplish the service life using quality concrete and specified cover. In the event that locally available materials cannot be shown to accomplish the service life then the Contractor must prepare a proposal for review by the agency's Subject Matter Expert in Concrete Materials and approval by the Contracting Officer to use alternative sources of materials and/or supplemental corrosion protection methods.

g. If using the STADIUM® software: Letter regarding the certificate of completion for the STADIUM® training.

h. The UFGS Laboratory Certification letter for the accredited laboratory.

1.7.2 Project Environment

1.7.2.1 Location Details

The values of Table 1 define the location and exposure conditions to be used in service life modeling. The Engineer of Record must define these values. Alternatively, the use of default values in accordance with the STADIUM® software or the time to corrosion model in Appendix B2 of fib Bulletin 34 may be approved by the Engineer of Record.

Table 1 - Environmental Design Conditions	
Latitude	[_____] degrees Y' Z" [N][S]
Longitude	[_____] degrees Y' Z" [E][W]
MLLW Elevation, meter feet	[_____] meter feet
MHHW Elevation, meter feet	[_____] meter feet
Anticipated severity of exposure to de-icing chemicals	[N/A][Moderate][Severe]
Annual mean water temperature, C F	[_____] Degrees C F
Annual maximum ambient temperature, C F	[_____] Degrees C F
Annual mean ambient temperature, C F	[_____] Degrees C F
Annual minimum ambient temperature, C F	[_____] Degrees C F
Annual mean relative humidity, percent	[_____] percent
If using STADIUM software:	
Salinity, ppt (Submerged zone)	[_____] ppt
Salinity, ppt (Tidal zone)	[_____] ppt
Salinity, ppt (Splash zone)	[_____] ppt
Salinity, ppt (Atmospheric zone)	[_____] ppt
If using the time to corrosion model in Appendix B2 of fib Bulletin 34:	
Chloride surface concentration (Submerged zone)	[_____] percent by mass of total cementitious materials
Chloride surface concentration (Tidal zone)	[_____] percent by mass of total cementitious materials
Chloride surface concentration (Splash zone)	[_____] percent by mass of total cementitious materials
Chloride surface concentration (Atmospheric zone)	[_____] percent by mass of total cementitious materials

1.7.2.2 Exposure Conditions by Element

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NOTE: Information on sulfate exposure categories can be found in Chapter 19 of ACI 318.

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The Contractor must use service life modeling and exposure conditions listed above to provide concrete system(s) that meet or exceed the service life requirement. Evaluate the service life of each element for its severest service condition.

Concrete elements permanently buried in soil or seabed must be considered in the [S0][S1][S2][S3] exposure class.

1.7.3 Concrete Mixture Proportions

At least 60 days prior to concrete placement, submit Concrete Mixture Proportions, including ingredient material certificates and test data, and trial batch test data for each class of concrete proposed for use on the project. Submittal must clearly indicate where each mixture will be used when more than one mixture design is submitted. Obtain approval from Contracting Officer prior to placement.

1.7.4 Concrete Design Requirements

Proportion concrete mixtures to meet the requirements listed in Table 2 in accordance with the procedures outlined in ACI 201.2R and ACI 211.1.

The mixture proportions for concrete must be developed by the Contractor to produce the required compressive strength (f'c), drying shrinkage, and constructability for mixtures that have the potential to accomplish a structure with the design service life.

For concrete elements permanently buried in soil or seabed, provide concrete meeting the requirements in ACI 301M ACI 301 for the sulfate exposure class assigned.

Table 2 - Concrete Design Requirements

Prescriptive requirements	Minimum	Maximum
ASTM C666/C666M Method A Durability Factor at 300 cycles	90	--
Concrete ASTM C157/C157M Drying Shrinkage percent. Samples must be cured for 28 days except for high volume fly ash (HVFA) which must be cured for 56 days.	--	0.05 percent after 28 days drying
Initial acid-soluble chloride ion content in cast-in-place concrete per ASTM C1152/C1152M, percent/cement	--	0.10
Initial acid-soluble chloride ion content in prestressed concrete determined following ASTM C1152/C1152M, percent/cement	--	0.08
Average spacing factor following ASTM C457/C457M (inch)	--	0.008 with no value greater than 0.010
Concrete chloride ion transport properties: test methods and requirements as per the Durability Modeling Report.		
ASTM C672/C672M Scaling resistance, visual rating after 50 cycles	--	3

1.7.5 Concrete Mixture Qualifications

Proportion concrete mixtures to achieve fresh and hardened concrete properties in the paragraph CONCRETE QUALIFICATION PROGRAM. Qualification of concrete mixtures must be demonstrated through one of the following means:

1.7.5.1 Previously Approved Concrete Mixtures

For identical concrete mixtures previously approved for use within the past 18 months, the previous mixture qualification submittal may be re-submitted without further trial batch testing if accompanied by:

a. A copy of the prior approvals indicating the project name, project number, and location.

b. Ingredient material test data conducted within 6 months of the submittal date.

c. Copies of the previously approved trial batch test data, including concrete transport properties and tests required in Table 2.

d. A log containing at least 15 sequential test results (i.e., results from 15 consecutive tested concrete batches) with the calculated mean and standard deviation of the production concrete for air content, compressive strength and concrete transport properties.

If the Contractor changes material type, class, sources, or suppliers; chemical composition; and/or mix proportions, the Contractor must provide a written opinion of the significance of the change(s). The change(s) may require additional testing at the discretion of the Contracting Officer in consultation with the agency's Subject Matter Expert in Concrete Materials.

1.7.5.2 New Concrete Mixtures

a. Submit complete ingredient material test data, including applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes.

b. Submit copies of test reports by independent test lab conforming to ASTM C1077 showing that the mixture has been successfully tested to produce concrete with the properties specified and that mixture will be suitable for the job conditions as described. Test reports must be submitted along with the concrete mixture proportions. Obtain approval before concrete placement.

c. Test a minimum of one trial batch of production concrete to establish the specified transport properties. The transport properties measured from the trial batch must meet the input values assumed in the service life calculations. If batching facilities are located such that the haul-time will exceed 30 minutes, a simulated haul time must be included in the trial batch.

d. If the concrete mixture for construction is proposed to contain corrosion inhibitors then transport properties in item (4)(b) and (5) below must be conducted from concrete with and without corrosion inhibitor added. The Contractor must obtain approval from the Contracting Officer for use of corrosion inhibitors.

Trial batch testing must include, as a minimum:

(1) Test and report fresh concrete property tests of each trial batch as follows:

  (a) Slump in accordance with ASTM C143/C143M.

  (b) Air content in accordance with ASTM C231/C231M or ASTM C173/C173M.

  (c) Unit weight in accordance with ASTM C138/C138M.

  (d) Temperature in accordance with ASTM C1064/C1064M.

  (e) If applicable, tests of self-consolidating concrete listed in Section 1.7.6.1.c.

(2) Cast specimens, test, and report hardened concrete property tests of each trial batch as follows:

  (a) Compressive strength at 3, 7, 28, 56 and 90 days in accordance with ASTM C39/C39M. Use of unbonded caps in accordance with ASTM C1231/C1231M is permitted.

  (b) Drying shrinkage may be determined from three samples cast from one batch of a given mixture design.

  (c) Tensile strength (if required) may be determined using specimens cast from one batch of a given mixture design. The required number of specimens must be agreed with the Contracting Officer.

  (d) Freeze-thaw durability factor (if required) must be determined as the mean of three test specimens cast from one batch of a given mixture design.

  (e) Initial chloride ion content may be determined from a minimum of one sample from one batch of a given mixture design.

  (f) Spacing factor (if required)may be determined using two separate specimens cast from one batch of a given mixture design.

  (g) Scaling resistance (if required) may be determined from a minimum of two specimens from one batch of a given mixture design.

(3) Moist cure concrete intended for cast-in-place applications in accordance with the standard moist curing conditions described in ASTM C192/C192M unless otherwise specified. Moist cure concrete intended for precast applications in the manner proposed for use on the project.

(4) If using the STADIUM® software: Cast twelve 100 by 200 mm 4 by 8 inch cylinders from the trial batch concrete, test and report ion transport properties as follows:

  (a) Determine the porosity at 28-days and 90-days of standard moist curing. Two cylinders must be tested at each age.

Calculate the mean porosity at each test age.

(b) Determine the D_{oh} at 28-days and 90-days of standard moist curing. Two cylinders must be tested at each age. Calculate the mean D_{oh} at each test age.

(c) Determine the MTC at 28-days of standard moist curing.

(d) Calculate the aging coefficient as the ratio of the mean 90-day, or longer, D_{oh} to the mean 28-day standard moist cure D_{oh}.

(e) Retain unused specimens in storage. These specimens may be tested later to refine the actual aging factor. This is advisable in the event that any production concrete falls short of the service life as it will provide evidence to better predict the service life.

(5) If using the time to corrosion model presented in Appendix B2 of fib Bulletin 34: Cast three 100 by 200 mm 4 by 8 inch cylinders from the same concrete batch, test and report ion transport properties as follows:

(a) Determine the chloride migration coefficient at 28 days as per NT Build 492 test procedure.

(6) Special handling will be necessary for shipments of transport property specimens. These cylinders must be wrapped completely with slightly damp paper towels with distilled water only. The wrapped cylinders must be placed in either a vacuum package or double layers of sealed plastic bags. Package the test cylinders to prevent damage and ship to an approved testing laboratory.

e. For concrete mixtures that are proposed to contain corrosion inhibitors, the Contractor must submit 28-day values for transport properties (D_{oh} for the STADIUM® software or chloride migration coefficient for time to corrosion model presented in Appendix B2 of fib Bulletin 34) from at least three batches of the mixture with and without the admixture making appropriate adjustments to maintain constant water to cementitious ratio. The purpose is to establish a correlation with respect to an adjusted value for production tested values.

f. At the option of the Contractor, a revised service life submittal may be provided as a value engineering proposal using refined properties calculated from production data. Extensions to corrosion propagation period may be reviewed by the agency's Subject Matter Expert in Concrete Materials and approved by the Contracting Officer based on evidence provided by the Contractor on a case-by-case basis.

1.7.6 Concrete Qualification Program

1.7.6.1 Fresh Concrete Properties

a. Air Content: Concrete that is air entrained must conform to the air limits specified in ACI 301M ACI 301 for exposure and the aggregate size used and tested in accordance with ASTM C231/C231M. Variations outside the limits specified must not be the reason to reject the concrete in locations not subject to freeze-thaw conditions.

b. Slump: The concrete mixture must be proportioned to have, at the point of deposit, a maximum slump of 100 mm 4 inches as determined by ASTM C143/C143M when admixtures that affect slump are not used. Where an ASTM C494/C494M, Type F or G admixture is used, the slump after the addition of the admixture must not exceed 200 mm 8 inches. Slump tolerances must comply with the requirements of ACI 117.

c. Self-Consolidating Concrete: When self-consolidating concrete is proposed for use, the mixture must be proportioned and tested for qualification using:

  (1) ASTM C1611/C1611M slump flow must not be greater than 609.6 mm 24 inches, with visual stability index not greater than 1.

  (2) ASTM C1621/C1621M Passing ability using the J-ring. Spread within 25.4 mm 1 inch less than the slump flow.

  (3) Passing ability using the L-Box between 4 and 8 seconds

  (4) ASTM C1610/C1610M, static segregation must be less than 4.0 percent.

d. For process control sampling, the slump flow limit as determined by ASTM C1611/C1611M must be no greater than 609.6 mm 24 inches and the visual stability index limit must be no greater than 1.0.

e. Underwater concrete: When the concrete is intended for placement under water using the tremie technique, the concrete must be proportioned to be cohesive and flow with minimal out segregation. Viscosity modifying admixtures are permitted for underwater concrete. Proportioning guidance in ACI 304R must be considered. Concrete mixtures must be qualified for tremie placement methods based on a trial placement approved by the Contracting Officer.

1.7.6.2 Hardened Concrete Properties

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NOTE: Navy waterfront structures typically take a year or more to complete. With time, all concrete continues to gain strength. The Engineer of Record is encouraged to design the structural elements based on the compressive strength that will be achieved at 56 or 90 days rather than at 28 days. Doing so will better allow the Contractor to develop and place concrete mixtures with less portland cement. Excessive use of cement may lead to more cracking and potential for associated deterioration. Embracing this approach will result in structures that are less expensive, greener, and more sustainable.

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a. Compressive Strength: The structural engineer must specify the minimum compressive strength results at [28][56] days. Determine compressive strength (f'cr) for qualification of concrete mixtures and for quality acceptance testing. A compressive strength test result is defined as the mean of three properly conducted tests on 100 by 200 mm 4 by 8 inch cylinders in accordance with ASTM C39/C39M. Alternatively and for concrete mixtures containing a maximum size aggregate greater than 25.4 mm 1 inch, a strength test result must be defined as the mean of two properly conducted 28-day tests on 150 by 300 mm 6 by 12 inch cylindrical specimens in accordance with ASTM C39/C39M. In addition:

(1) Specified Compressive Strength: For structural concrete elements exposed in a marine environment, the minimum specified [28][56] day design strength is denoted as (f'c). Strength of concrete containing 35 percent or more fly ash must be specified at a minimum of 56 days.

(2) Required Average Compressive Strength (f'cr): The concrete must be proportioned such that the minimum required average compressive strength (f'cr) exceeds the specified design strength (f'c) as per ACI 301M ACI 301.

(3) The average compressive strength may not exceed the specified strength at the same age by more than 20 percent unless approved by the Engineer of Record.

(4) Strength of any individual concrete placement must be considered satisfactory if both the following requirements are met:

  (a) The arithmetic mean of any three consecutive lot strength tests is between 1.0 and 1.2 f'c, and;

  (b) No individual strength test result is less than 0.90 f'c.

(5) In the event that a placement is represented by single sampling lot, strength must be considered satisfactory if either:

  (a) The mean of the initial test is between 1.0 and 1.2 f'c, or;

  (b) The mean of the initial test and retest is between 1.0 and 1.2 f'c, and neither strength test result is less than 0.90 f'c.

(6) For underwater concrete, cast compressive strength samples by placing concrete in four 5-gallon buckets below water using similar placement as the project. Permanently mark buckets as "3 days," "7 days," "[28][56] days," and "Extra." Include date and station. Provide specimen sets at every [76.5 cubic meters] [100 cubic yards] of concrete for the first [382.3 cubic meters] [500 cubic yards], then every [382.3 cubic meters] [500 cubic yards] thereafter with a minimum of one set per day of underwater concrete placement.

  (a) Retrieve buckets at specified intervals and extract three cores from each bucket. Conduct compressive strength test in accordance with ASTM C42/C42M.

  (b) Strength of underwater concrete must be satisfactory if the compressive strength result from extracted cores at the age of the specified strength is between 0.85 and 1.2 f'c with no individual strength test result less than 0.75 f'c.

b. Drying Shrinkage: Determine drying shrinkage for qualification of concrete mixtures prior to the fabrication of the Test Section and from samples made during the fabrication of the Test Section. Test results must not exceed 0.05 percent. A drying shrinkage test result must be the mean value from three or more individual specimens constituting a test set. If an individual specimen's measurements deviate from the mean value by more than 0.009 percent length change, the specimen's measurements must be discarded and a new average established. Casting more than three specimens for each set is permitted. Test procedures and test specimens must conform to the following:

(1) Drying shrinkage specimens, typically 75 by 75 by 285.8 mm 3 by 3 by 11.25 inch prisms for 25.4 mm 1 inch maximum size aggregate or smaller, must be fabricated, cured, dried, and measured after 28 days of drying in the manner delineated in ASTM C157/C157M. Samples must be cured for 28 days, except for high-volume fly ash (HVFA) which must be cured for 56 days.

c. Tensile strength: Determine splitting-tensile strength of concrete only for qualification of concrete mixtures. Determine and report the splitting-tensile strength result of each class of concrete in accordance with ASTM C496/C496M as the mean of three properly conducted tests at the age specified for f'c and again at 90-days age for information only.

d. Freeze-thaw durability: Determine the freeze-thaw durability factor of concrete for qualification of concrete mixtures, if required by environmental conditions. Determine and report the freeze-thaw durability factor of each class of concrete in accordance with ASTM C666/C666M Method-A. Start testing after [28] days of moist curing. The minimum acceptable durability factor after 300 cycles of rapid freezing and thawing is 90 percent.

e. Acid Soluble Chloride Ion Content: Determine the chloride ion content only for qualification of concrete mixtures. Determine acid soluble chloride ion content in accordance with ASTM C1152/C1152M. The limits for allowable acid-soluble chloride ion concentrations in hardened concrete are listed in Table 2.

f. Scaling resistance: Determine the scaling resistance only for qualification of concrete mixtures. Determine scaling resistance in accordance with ASTM C672/C672M. The limits are listed in Table 2.

g. Silica fume must only be used for OCONUS projects where Class F fly ash and slag cement are not available, and when approved by the Contracting Officer. If justified by service life modeling the mixture may contain a maximum of 7 percent silica fume by mass of total cementitious materials. Concrete mixtures containing any percentage of silica fume must be evaluated at every [76.5] cubic meters [100] cubic yards of concrete for the first [382.3] cubic meters [500] cubic yards, then every [382.3] cubic meters [500] cubic yards thereafter to ensure that the silica fume is properly dispersed in hardened concrete samples. A qualified laboratory must microscopically examine a sectioned sample and document the results. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume.

h. Transport Properties if using STADIUM® software: Determine ion transport properties of the concrete in accordance with test procedures outlined by SIMCO, maker of STADIUM® software. Ion Transport properties are required as inputs for service life modeling and include: the volume of permeable voids (porosity); the ion diffusion coefficient (D_{oh}); the moisture transport coefficient (MTC), and an aging factor. A brief description of the test procedures is provided below. See TR-NAVFAC ESC-CI-1215 for further details.

(1) Porosity: The volume of permeable voids (porosity) of concrete is determined in accordance with ASTM C642. Porosity is determined for qualification of concrete mixtures and for quality acceptance testing.

(2) Ion Diffusion Coefficient (D_{oh}): This test is a modified version of ASTM C1202 and uses an electrical field to migrate chloride ions through a vacuum saturated concrete specimen for approximately 14 days. The electrical charge flowing through the concrete is related to the diffusion coefficient of ionic species in cementitious materials. A test is defined as the average of two specimens run together and whose results are analyzed together to produce a single D_{oh} value. The service life modeling software uses the cementitious materials proportions and porosity measurements to analyze the electrical measurements and determine the D_{oh}. The D_{oh} is determined for qualification of concrete mixtures and for quality acceptance testing.

(3) Moisture Transport Test: The ASTM C1792 test determines the drying rate of pre-saturated cementitious materials by measuring the evaporative mass loss of concrete slices with different thickness exposed to constant temperature and relative humidity environment. The moisture transport coefficient (MTC) is then determined by analyzing the mass loss data from ASTM C1792 testing using the STADIUM® software.

(4) This test is only used for qualification of concrete mixtures, not for production concrete.

(5) Aging factor: The aging factor is a necessary value to estimate the change in diffusion coefficient over time. The aging factor is defined as the ratio of the ultimate D_{oh} to the 28-day D_{oh} per TR-NAVFAC ESC-CI-1215. Since we cannot wait for two or more years to characterize project concrete, a surrogate aging factor is used in this specification. This surrogate aging factor is calculated as the ratio of 90-day, or longer, D_{oh} to the 28-day D_{oh}. The aging factor is determined only for qualification of concrete mixtures in compliance with TR-NAVFAC ESC-CI-1215.

i. Transport Properties if using the time to corrosion model in Appendix B2 of fib Bulletin 34: Determine the transport properties of the concrete in accordance with test procedures outlined by fib Bulletin 34. Transport properties are required as inputs for service life modeling and include: the chloride migration coefficient measured as per the NT Build 492 test procedure. The NT Build 492 test is performed at 28 maturity days on a 50 mm 2 inch thick sample sliced from a standard test cylinder. The sample is immersed in a saline solution to which a voltage is applied to accelerate the penetration of chlorides through the concrete for a period of generally 24 hours. At this time, the sample is split in half across its diameter and the depth of the chloride penetration is measured at seven points along the fractured surface. This data is used to calculate the rate at which chlorides penetrate the concrete. This rate is called the chloride migration coefficient and is a direct input value into the service life modeling. One NT Build 492 test is defined as the average of three specimens run together and whose results are averaged together to produce a single chloride migration coefficient value. The chloride migration coefficient is determined for qualification of concrete mixtures and for quality acceptance testing.

j. During trial batch testing, the chloride migration coefficient value must be less than or equal to the maximum allowable migration coefficient. The maximum allowable migration coefficient is equivalent to the mean chloride migration coefficient value determined through service life modeling.

1.7.6.3 Reinforcing Steel Corrosion Properties

The corrosion properties of the reinforcing steel used for service life modeling must be as follows unless otherwise approved by the Contracting Officer after review by the agency's Subject Matter Expert in Concrete Materials:

Table 3 - Chloride Threshold Level at the Reinforcing Steel Depth and Corrosion Propagation Time

Description	UNS Alloy	EN No.	Chloride Threshold (CTH), ppm	Corrosion Propagation Period (Tp) max, years
ASTM A706/A706M (Low alloy carbon steel)	[______]	[______]	500 or as specified in fib Bulletin 34	10
ASTM A615/A615M (Carbon steel)	[______]	[______]	500 or as specified in fib Bulletin 34	10
ASTM A416/A416M (carbon steel 7-wire strand)	[______]	[______]	500 or as specified in fib Bulletin 34	10
ASTM A882/A882M (indented 7-wire strand)*	[______]	[______]		
ASTM A886/A886M (epoxy-filled 7-wire strand)*	[______]	[______]		
ASTM A934/A934M (Purple Epoxy)*	[______]	[______]		
ASTM A775/A775M (Green Epoxy) Not allowed	[______]	[______]		
ASTM A767/A767M (Galvanized Class 1)*	[______]	[______]		
ASTM A1035/A1035M (MMFX2 bars)*	[______]	[______]		

Table 3 - Chloride Threshold Level at the Reinforcing Steel Depth and Corrosion Propagation Time				
Description	UNS Alloy	EN No.	Chloride Threshold (CTH), ppm	Corrosion Propagation Period (Tp) max, years
ASTM A1055/A1055M (Z bars)*	[_____]	[_____]		
ASTM A955/A955M (as applicable) XM Stainless Grades				
XM-28 (Nitronic 32)	S24100		500	15
XM-29 (Nitronic 33)	S24000		500	15
XM-19 (Nitronic 50)	S20910		500	15
ASTM A276/A276M Austenitic Stainless 304L	S30403	1.4307	3000	15
ASTM A276/A276M Duplex Stainless 2304	S32304	1.4362	4000	15
ASTM A955/A955M Austenitic Stainless 316L	S31603	1.4404	5000	15
ASTM A955/A955M Austenitic Stainless 316LN	S31653	1.4429	5000	15
ASTM A276/A276M Duplex Stainless 2205	S31803 S32205	1.4462	5000	15
*See TR-NAVFAC ESC-CI-1215				
** All other reinforcement not listed require approval of agency's Subject Matter Expert in Concrete Materials				

1.7.6.4 Supplemental Corrosion Protection

If the available materials in the region of the project cannot practically be made to meet the service life based on testing and service life modeling without the use of supplemental corrosion protection, then the Contractor must prepare a recommendation on how to accomplish the service life using imported materials and/or supplemental corrosion protection. With input from the agency's Subject Matter Expert in Concrete Materials, the Contracting Officer must consider approval of the Contractor's recommendation on a case-by-case basis.

1.7.7 Mass Concrete Temperature Control Plans

a. Thirty days minimum prior to concrete placement, submit for approval a mass concrete temperature control plan that includes:

   (1) Location and identification of temperature monitoring sensors.

(2) Product data for automated temperature sensors and recording equipment.

(3) Cooling pipe layout diagram with sizes and materials, if used.

(4) Proposed insulation materials and associated R-values.

(5) Anticipated form removal schedule and curing procedures.

(6) Maximum allowable concrete placement temperature for the range of anticipated ambient temperatures based on thermal modeling.

(7) Monitoring procedures and contingency plans.

Concrete placement temperature must be based on results of thermal modeling for the element incorporating: the heat of hydration and specific heat capacity for the concrete mixture, solar gain, and heat transfer to the environment through formwork, insulation, and cooling techniques.

Mass concrete temperature control must be monitored using automated temperature recording devices that allow wireless transmission of data to an on-site host computer for real-time monitoring of temperatures.

Temperature control sensor layout for each placement must be provided with individual sensor ID identified.

Minimum sensor requirements include at least two sensors for each placement located as follows:

(8) The geometric center of the element cross-section.

(9) Within 76.2 mm 3 inches of the side forms at mid-height.

(10) Within 76.2 mm 3 inches of the top surface located directly above the center sensors.

(11) Within 76.2 mm 3 inches from the top corner at the intersection of side forms.

(12) Ambient temperature sensors placed in a shaded location.

Procedures for installing, protecting sensors during placement, and testing sensors a minimum of 24 hours prior to concrete placement must be provided. Initiate sensor recording at least 2 hours prior to placement. Verify function of all sensors prior to and upon completion of concrete placing operations. Provide additional sensors for placements greater than 305.8 cubic meters 400 cubic yards at each location.

Submit procedures for controlling concrete temperatures within the following limits:

(13) Maximum temperature must be less than 70 degrees C 158 degrees F.

(14) Maximum temperature differential between the mean of all functioning center sensor temperatures to any individual surface or corner sensor must be less than 20 degrees C 36 degrees F.

(15) Temperature control procedures must remain in effect until the differential between the ambient low temperature and mean of all functioning center sensor temperatures is less than 20 degrees C 36 degrees F.

(16) An additional submittal must be provided for the Contracting Officer's approval in the event the Contractor fails to control temperatures within the limits listed above. The submittal must include documentation of any cracks that develop, identify revisions to control procedures to prevent future cracking, and procedures to seal or otherwise mitigate defects.

b. Mass Concrete Mock-up: For concrete mixtures intended for mass concrete, cast thirty-one 100 by 200 mm 4 by 8 inch cylinder specimens in accordance with ASTM C192/C192M, three 75 by 75 by 285.8 mm 3 by 3 by 11.25 inch concrete prisms in accordance with ASTM C157/C157M, and at least one semi-adiabatic cube from a trial batch.

The semi adiabatic cube must have a minimum dimension of 1.0 m 3.0 feet per side, and must be insulated all sides with a minimum R-value of 30. Install pairs of thermocouples at the center of mass, the middle of each side, the top surface, and the top corner. Automatically record the temperature of each sensor hourly for one week. Additional cubes may be cast to calibrate active cooling system performance.

(1) Conduct compressive strength development testing at 3, 7, [28,][56,] and 90 days age using three specimens per age in accordance with ASTM C39/C39M, and develop a compressive strength prediction equation for the concrete mixture in accordance with ASTM C1074.

(2) Conduct tensile strength tests at 3, 7, [28,][56,] and 90 days on two specimens per age in accordance with ASTM C496/C496M, and develop a tensile strength prediction equation for the concrete mixture in accordance with ASTM C1074.

(3) Conduct elastic modulus tests at 3, 7, [28,][56,] and 90 days on two specimens per age in accordance with ASTM C469/C469M, and develop an elastic modulus prediction equation for the concrete mixture in accordance with ASTM C1074.

Conduct coefficient of thermal expansion testing in accordance with COE CRD-C 39 after 28 days of moist curing. Test specimens in a saturated condition.

Report all test results and predictive equations in the Mass Concrete Mock-up submittal. The predictive equations may be used by the Contractor to establish the duration of temperature control and form removal based on the allowable temperature differential between the concrete core and ambient low temperature.

1.8 CONCRETE

1.8.1 Drawings

Fabrication Drawings for concrete formwork, reinforcement materials, precast elements, wall forms, and bulkhead forms must indicate concrete pressure calculations with both live and dead loads, along with material types. Provide design calculations by a registered Civil or Structural

Engineer for the formwork.

1.8.1.1 Formwork

Prior to commencing work, submit drawings for approval showing details of formwork including, but not limited to: joints, supports, studding and shoring, and sequence of form and shoring removal. Reproductions of contract drawings are unacceptable.

Design, fabricate, erect, support, brace, and maintain formwork so that it is capable of supporting without failure all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.

ACI 347R. Include design calculations indicating arrangement of forms, sizes, species, and grades of supports (lumber), panels, and related components. Indicate placement schedule, construction, and location and method of forming control joints. Include locations of inserts, pipe work, conduit, sleeves, and other embedded items. Furnish drawings and descriptions of shoring and reshoring methods proposed for slabs, beams, and other horizontal concrete members.

1.8.1.2 Reinforcing Steel

ACI MNL-66. Provide bending and cutting diagrams, assembly diagrams, splicing placement and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Only complete drawings will be accepted.

1.8.1.3 Precast Elements

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NOTE: Modify requirements based on the scope of the project.

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Submit drawings and design calculations indicating complete information for the fabrication, handling, and erection of the precast elements. Drawings must not be reproductions of contract drawings.

1.8.1.4 Joints

Submit a plan indicating the type and location of each construction joint. Final joint locations are subject to Government approval.

1.8.2 Pre-Construction Submittals

1.8.2.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.8.2.2 Concrete Curing Plan

Submit proposed materials, methods, and duration for curing and cooling concrete elements in accordance with ACI 308.1.

Minimum moist curing duration must be seven days.

Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

1.8.2.3 Form Removal Schedule

Submit schedule for form removal indicating element and minimum length of time for form removal. Submit technical literature of forming material or liner, form release agent, form ties, and gasketing to prevent leakage at form and construction joints. Provide a full description of materials and methods to be used to patch form-tie holes.

1.8.2.4 Concrete Placement and Compaction

a. Submit technical literature for equipment and methods proposed for use in placing concrete. Include concrete pumping or conveying equipment including type, size and material for pipe, valve characteristics, and the maximum length and height concrete will be pumped. Adjustments must not be made to the mixture design to facilitate pumping.

b. Submit technical literature for equipment and methods proposed for vibrating and compacting concrete. Submittal must include technical literature describing the equipment including vibrator diameter, length, frequency, amplitude, centrifugal force, and manufacturer's description of the radius of influence under load. Where flat work is to be cast, provide similar information relative to the proposed compacting screed or other method to ensure dense placement.

1.8.2.5 Coatings

Coatings are considered to be "supplemental corrosion protection". Surface preparation and installation of any coatings on concrete must be conducted in strict compliance with written manufacturer instructions. Submit the product data and written manufacturer instructions. A manufacturer representative must train installers, witness initial installation, and certify that the installation was conducted in accordance with the instructions.

1.8.2.6 Preconstruction Testing of Materials

All sampling and testing must be performed by, and at the expense of, the Contractor. Use an approved commercial laboratory or, for cementitious materials and chemical admixtures, a laboratory maintained by the manufacturer of the material. Material must not be used until notice of acceptance has been given. The Contractor will not be entitled to any additional payment or extension of time due to failure of any material to meet project requirements, or for any additional sampling or testing required. Additional tests may be performed by the Government at the discretion of the Contracting Officer; such Government testing will not relieve the Contractor of any testing responsibilities.

1.8.2.7 Material Safety Data Sheets

Submit Material Safety Data Sheets (SDS) for all materials that are regulated for hazardous health effects. Prominently post the SDS at the construction site.

1.8.2.8 Mixture Design Report

Provide a detailed report of materials and methods used, test results, and the field test strength (fcr) for marine concrete required to meet structural and durability requirements. An individual Mixture Design Report must be provided for each concrete mixture.

A cover letter signed and stamped by a registered Professional Engineer must be included certifying compliance with the present specification, including required average compressive strength (f'cr), drying shrinkage, transport properties, and constructability, for mixtures that have the potential to accomplish a structure with the design service life.

1.8.3 Sampling

The Contractor is responsible for conducting concrete production process control sampling and testing in compliance with this specification.

1.8.3.1 Ingredient Material Sampling

a. Cementitious material mill certificates and test reports must be provided for each shipment. Record the date delivered and quantity of material represented by the certificate.

b. Conduct and log aggregate moisture content at a minimum frequency of twice daily for each day's production. Use of moisture sensors in storage bins is recommended practice, but does not satisfy this requirement.

c. Aggregate sampling for gradation and dry-rodded unit weight must be conducted for each 100 tons delivered for use on the project, or portion thereof.

1.8.4 Reporting

1.8.4.1 Daily Inspection Reports

Contractor must prepare daily inspection reports for all inspection activities such as base preparation, formwork preparation, reinforcement installation, concrete placement log, and temperature control activities. Submit sample forms and describe the procedure used to organize, archive, and retrieve inspection records in the Quality Program submittal.

1.8.4.2 Sampling Logs

Contractor must maintain a concrete placement log as an electronic spreadsheet or database identifying each placement date, placement location, volume of concrete, batch ticket numbers, lot identification code, fresh concrete properties, compressive strength results, transport properties, inspection comments, and acceptance status. Contractor must provide/transmit the concrete testing log to the Contracting Officer weekly. The Contractor must provide copies of supporting documents for any placement requested by the Contracting Officer immediately upon request.

1.8.4.3 Quality Control Data

The Contractor must prepare, maintain, and report separate quality control charts illustrating the slump, temperature, air content, compressive strength test results, and transport property results for each lot of each concrete mixture used on the project.

1.8.4.4 Quality Team Meetings

The contractor must conduct regular quality control team meetings to review plans for future placements, review test results, and discuss dispensation of non-conforming materials. The quality team must include the Contractor's quality manager, the project manager, the project superintendent, the Contracting Officer, and representatives of the testing agency and concrete producer, or approved substitutes. It is recommended that the meetings be held on a weekly or bi-weekly basis during the service life modeling submittal phases and then monthly, as the construction progresses. The transition from the weekly or bi-weekly meetings to the monthly meetings must be with the Contracting Officer's approval.

The Contractor must prepare quality control team meeting minutes for each meeting. The minutes must include the date of each meeting, attendees, key discussion points, findings, recommendations, assigned tasks, assigned personnel, task completion dates and status of each task.

1.8.4.5 Non-conforming materials

The exact location of non-conforming concrete as placed must be identified and the Contracting Officer and Engineer of Record must be notified immediately. There are numerous possible indicators that the as-placed concrete is non-conforming including (but not limited to) excessive compressive strength, inadequate compressive strength, excessive slump, transport properties out of limits, excessive voids and honeycombing, and concrete delivery records that indicate excessive time between mixing and placement and/or excessive water was added to the mixture during delivery and placement. Any of these indicators alone are sufficient reason for the Contracting Officer to request additional sampling, testing, and service life modeling to quantify the concrete properties. If justified, cores may be extracted for testing, and an investigation into the cause for non-conformance must be conducted. The investigation may include statistical analysis of the test data collected to date; appropriateness of the pre-defined QAL based on statistical analysis of production data; the impact of the non-conforming material on the structure strength and/or service life; and recommendations for concrete production process improvements, mitigation, or remediation, as appropriate.

Investigations into non-conforming materials must be conducted at the Contractor's expense. The Contractor is responsible for the investigation and must make written recommendations to adequately mitigate or remediate the non-conforming material. The Contracting Officer may accept, accept with reduced payment, require mitigation, or require removal and replacement of non-conforming material at no additional cost to the Government.

1.8.5 Test Reports

Concrete Test Reports must be identified by a sequential report identification code. Each report must identify the placement date, placement location, weather, name of testing technician, time of sampling, batch ticket number, fresh concrete test results, and hardened concrete test results.

1.8.5.1 Concrete Mixture Requirements

a. Submit copies of test reports conforming to ASTM C1077 showing that the mixture has been successfully tested to produce concrete with the properties specified and that mixture will be suitable for the job conditions. Test reports must be submitted along with the concrete mixture proportions. Obtain approval before concrete placement.

b. Fully describe the processes and methodology whereby mixture proportions were developed and tested and how proportions will be adjusted during progress of the work to achieve, as closely as possible, the designated levels of relevant properties.

c. Submit copies of the Durability Modeling Report with laboratory analysis and modeling results indicating contract-goal service life will be met.

1.8.5.2 Supplementary Cementing Materials

Submit test results in accordance with ASTM C618 and the physical and chemical analysis in accordance with applicable ASTM standards such as ASTM C311/C311M for fly ash. Submit test results performed within 6 months of submittal date. Update this report during construction as necessary to assure that the supplementary cementing materials used on the projects meets the ASTM criteria and the report on file is never older than 6 months.

1.8.5.2.1 Slag Cement

Submit test results in accordance with ASTM C989/C989M. Submit test results performed within 6 months of submittal date. Update this report during construction as necessary to assure that the report on file is never older than 6 months.

1.8.5.2.2 Ultra Fine Fly Ash or Pozzolan

Submit test results in accordance with ASTM C618 as a Class F fly ash or Class N pozzolan with the following additional requirements:

a. The strength activity index at 28 days must be at least 95 percent of the control.

b. The average particle size must not exceed 6 microns.

c. The sum SiO_2 plus Al_2O_3 plus Fe_2O_3 must be greater than 77 percent.

Submit test results performed within 6 months of submittal date. Update this report during construction as necessary to assure that the report on file is never older than 6 months.

1.8.5.3 Silica Fume

Submit test results in accordance with ASTM C1240 for silica fume. Data must be based upon tests performed within 6 months of submittal. Update this report during construction as necessary to assure that the report on file is never older than 6 months.

1.8.5.4 Aggregates

Aggregate samples must be obtained in accordance with ASTM D75/D75M and must be representative of the materials to be used for the project. Submit test results for aggregate quality in accordance with ASTM C33/C33M, and the combined gradation curve proposed for use in the work and used in the mixture qualification, and ASTM C295/C295M for results of petrographic examination. Confirm that the potential for alkali-silica reaction are within allowable limits by conducting tests in accordance with ASTM C1260. Submit results of all tests during progress of the work in tabular and graphical form as noted above, describing the cumulative combined aggregate grading and the percent of the combined aggregate retained on each sieve. Submit test results performed within 12 months of submittal date.

1.8.5.5 Admixtures

Submit test results in accordance with ASTM C494/C494M and ASTM C1017/C1017M for concrete admixtures, ASTM C260/C260M for air-entraining admixture, and manufacturer's literature and test reports for corrosion inhibitors and anti-washout admixture. Submitted data must be based upon tests performed within 6 months of submittal. Submit certified copies of test results for the specific lots or batches to be used on the project. Test results must be not more than 6 months old prior to use in the work. Chemical admixtures that have been in storage at the project site for longer than 6 months or that has been subjected to freezing will be retested at the expense of the Contractor.

1.8.5.6 Portland Cement

Portland cement[, slag cement,][and pozzolan] will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports showing that the material in each shipment meets the requirements of the specification under which it is furnished. Mill test reports must be no more than one month old, prior to use in the work. No cementitious material must be used until notice of acceptance has been given by the Contracting Officer. Cementitious material may be subjected to check testing by the Government from samples obtained at the mill, at transfer points, or at the project site. If tests prove that a cementitious material that has been delivered is unsatisfactory, it must be promptly removed at Contractor's expense from the site of the work. Cementitious material that has not been used within 6 months after testing must be retested at the Contractor's expense and must be rejected if test results are not satisfactory. Submit test results in accordance with ASTM C150/C150M portland cement and/or ASTM C595/C595M and ASTM C1157/C1157M for blended cement.

1.8.5.7 Testing During Construction

During construction, the Contractor is responsible for sampling and testing aggregates, cementitious materials, and concrete as specified herein. The Government will sample and test concrete and ingredient materials as considered appropriate. Provide facilities and labor as may be necessary for procurement of representative test samples. Testing by the Government will in no way relieve the Contractor of the specified testing requirements.

1.8.5.8 Test Section

a. Horizontal Placements. No more than 90 days prior to construction, construct a Test Section 3048 mm by 3048 mm by 203.2 mm 10 by 10 feet by 8 inches thick near the job site, but not as part of the structure. The Test Section must meet all specification requirements and be acceptable to the Contracting Officer in all respects, including but not limited to delivery time, placement, consolidation, curing and surface texture. Use the Test Section to develop and demonstrate to the satisfaction of the Contracting Officer the proposed techniques of mixing, hauling, placing, consolidating, finishing, curing, initial saw cutting, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. The mixing plant must be operated and equipment calibrated prior to start of placing the Test Section. Use the same equipment, materials, and construction techniques on the Test Section as will be used in all subsequent work. Concrete production, placing, consolidating, curing, construction of joints, and all testing must be in accordance with applicable provisions of this specification. At a minimum of three days after completion of the Test Section, extract a sufficient number of concrete cores 100 by 200 mm 4 by 8 inch to conduct tests to evaluate; strength, homogeneity, consolidation, segregation, air void spacing factor, and transport properties. Test Results that are unacceptable Test Section will necessitate construction of an additional Test Section at no additional cost to the Government.

b. Vertical Placements. No more than 90 days prior to construction, construct a Test Section that represents the vertical placements, (if applicable) near the job site, but not as part of the structure. Test Section must meet all specification requirements and being acceptable to the Contracting Officer in all respects, including but not limited to delivery time, placement, consolidation, curing and surface texture. Use the Test Section to develop and demonstrate to the satisfaction of the Contracting Officer the proposed techniques of mixing, hauling, placing, consolidating, finishing, curing, initial saw cutting, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. The mixing plant must be operated and equipment calibrated prior to start of placing the Test Section. Use the same equipment, materials, and construction techniques on the Test Section as will be used in all subsequent work. Concrete production, placing, consolidating, curing, construction of joints, and all testing must be in accordance with applicable provisions of this specification. At a minimum of three days after completion of the Test Section, extract a sufficient number of concrete cores to evaluate strength, homogeneity, consolidation, segregation, air void spacing factor, and transport properties. If any of the test results are unacceptable, the Contracting Officer may require that a new Test Section be accomplished at no additional cost to the Government.

1.8.5.9 Acceptability of Work

The materials and the structure itself will be accepted on the basis of tests made by the Contractor and must be in compliance with the criteria herein. The Government may make check tests at its expense to validate the results of the Contractor's testing. Testing performed by the Government will in no way relieve the Contractor from the specified testing requirements.

PART 2 PRODUCTS

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NOTE: Delete any reference to any products which are not to be used on the project. Coordinate all product requirements with the appropriate agency's Contracting Officer.

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2.1 CEMENTITIOUS MATERIALS

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NOTE: Edit these paragraphs as appropriate for the particular project. Guidance for use of cementitious materials should be sought from the agency's Subject Matter Expert in Concrete Materials. Consideration should be given to the use of fly ash or slag cement for partial replacement of portland cement up to 50 percent. Type III cement should not be specified without concurrence of the agency's Subject Matter Expert in Concrete Materials. Laboratory mixtures, proportioning studies, and tests during the design stage of the project should be inclusive of service life modeling.

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NOTE: Supplementary Cementitious Materials (SCM)

When slag cement, coal fly ash, and natural pozzolans are used as cementing materials for replacement of portland cement in a concrete mixture, and if by doing so the sustainability, durability and the initial cost of the concrete mixture show considerable improvement then these materials are called "supplementary cementitious materials" (SCM).

The Engineer of Record is encouraged to specify the use of supplementary cementing materials. For example, 50 percent replacement of the portland cement using Class F fly ash has been successfully demonstrated to offer the required compressive strength (f'cr), drying shrinkage, lower permeability, constructability, and the potential to accomplish a structure with the design service life while being less expensive with a smaller carbon footprint.

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Cementitious materials must be portland cement or cement blended with supplementary cementing materials. New submittals are required when the cementitious materials change sources or types.

The Contractor must provide cementitious materials meeting the requirements of the applicable specification, and as modified herein. Provide mill certificates and test results conducted within six-months of the submittal date as part of the concrete mixture qualification submittal.

Provide a single manufacturer of cementitious material for each type of cement and supplementary cementing materials supplied to the project.

2.1.1 Portland Cement

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NOTE: Use Type II or Type V cement in project

locations with Environmental Severity Classifications (ESC) of C3 thru C5 or where deicing salts are used on the structure. See UFC 1-200-01 for determination of ESC for project locations.

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Provide portland cement conforming to ASTM C150/C150M, Type [I][II][V],[including early stiffening requirements] with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na_2O_{eq} (sodium oxide) equivalent. Type III cement must be used only with concurrence of the agency's Subject Matter Expert in Concrete Materials. When HVFA mixtures are specified they should be blended with Type II portland cement. HVFA is encouraged instead of using Type V cement in high-sulfate areas. If the proposed aggregates are found to be expansive, additional requirements to cement in accordance with AASHTO R 80 or ASTM C1778 must be imposed.

ASTM C150/C150M cements must be combined with supplementary cementing materials in the concrete mixture.

2.1.2 Blended Cements

Blended cement must conform to ASTM C595/C595M, Type IL, IP, IS, or IT including the optional requirement for sulfate resistance, indicated by MS or HS designations. Any fly ash used in Type IP cement must be ASTM C618 Class F fly ash. A statement from the cement manufacturer, indicating that the finished cement will not vary more than the percentages listed in Table 5 of ASTM C595/C595M with a 99 percent probability of compliance between lots or within a lot, must be included in the Mixture Designs report. The type and percentage of supplementary cementitious materials or limestone used in the blend must not change from that submitted for the aggregate evaluation and mixture proportioning.

2.1.3 Pozzolan

2.1.3.1 Fly Ash

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NOTE: Class C fly ash is not permitted.

Use loss on ignition not exceeding 3 percent for frost areas to reduce carbon interference with air entraining admixture.

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Fly ash must conform to ASTM C618, Class F, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and must have a loss on ignition not exceeding [3][6] percent. Class F fly ash for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 8 percent and a total equivalent alkali content less than 1.5 percent. Add with cement.

2.1.3.2 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and must have an on ignition loss not exceeding 3 percent. Class N pozzolan for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 13 percent and total equivalent alkali content less than 3 percent.

2.1.3.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.

b. The average particle size must not exceed 6 microns.

c. The sum of $SiO_2 + Al_2O_3 + Fe_2O_3$ must be greater than 77 percent.

2.1.4 Slag Cement

Slag cement must conform to ASTM C989/C989M[, Grade 100 or Grade 120]. Add with cement.

2.1.5 Silica Fume

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NOTE: Silica Fume must only be used for OCONUS projects where Class F fly ash and slag cement are not available, and when approved by the Contracting Officer. Guidance for use of silica fume should be sought from the agency's Subject Matter Expert in Concrete Materials.

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Silica fume must conform to ASTM C1240, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as slurry. Proper mixing is essential to accomplish proper distribution of the silica fume and avoid agglomerated silica fume which can react with the alkali in the cement resulting in premature and extensive concrete damage. Supervision at the batch plant, finishing, and curing is essential. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume. A High Range Water Reducer (HRWR) must be used with silica fume. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.

2.1.6 Supplementary Cementitious Materials (SCM) Content

The concrete mix must always contain supplementary cementing materials whether or not the aggregates are found to be reactive in accordance with the paragraph AGGREGATES. Concrete mixtures must be designed and proportioned to meet the requirements for strength, constructability, shrinkage, and service life.

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NOTE: This specification requires that the structural requirements (f'c) be met and concrete strength is between 1.0 f'c and 1.2 f'c. If the prequalified mixture as approved by the Engineer of Record should produce a higher design strength

(fcr), that strength must be used instead of f'c. Maintain required w/cm ratio regardless of strength requirements.

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2.2 AGGREGATES

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NOTE: The largest possible aggregate size that meets the nominal maximum size requirements of ACI 318 should be used. Larger aggregates permit a leaner mixture with low paste content while maintaining workability.

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NOTE: In some tropical locations where standard aggregate such as gravel or manufactured aggregates are not readily available, the use of coral aggregate is acceptable. The specific gravity of any coralline material must not be less than 2.40. Specify coral aggregates with higher specific gravity wherever available. Wash aggregates dredged from the ocean or lagoons with fresh water to remove as much salt as possible. Include bracketed paragraph where coral will be used as an aggregate.

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Comply with ASTM C33/C33M Class 4S, except as modified herein. The maximum aggregate size for each concrete mix must be in accordance with Table 4.

Table 4 - Maximum Aggregate Size

Concrete Mix Design and Component	Maximum Aggregate Size (mm inches)
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

The quantities to be retained on each sieve may be adjusted only where available aggregates are elongated or slivered and cause interference with mix mobility, or available aggregate gradations do not comply with the 18-8 requirement. When necessary to satisfy local conditions and when permitted, the combined aggregate percentages may be changed to not more than 22 percent nor less than 6 percent retained on any individual sieve. The combined aggregates in the mixture (coarse, intermediate, and fine) must be well graded with no more than 18 percent nor less than 8 percent of the combined aggregate retained on any individual sieve, unless satisfactory performance can be demonstrated. The 300 micrometers No. 50 sieve may have less than 8 percent retained; sieves finer than 300 micrometers No. 50 must have less than 8 percent retained, and the coarsest sieve may have less than 8 percent retained. Use intermediate sizes for blending where necessary, to provide a well graded combined aggregate.

a. Provide gradation of individual aggregate sizes using standard concrete aggregate sieves including 37.5 mm, 25 mm, 19 mm, 12.5 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 micrometers, 300 micrometers, and 150 micrometers 1-1/2 inches, 1.0 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, and No. 100.

b. Provide aggregates for exposed concrete from one source. Aggregate reactivity must be limited per the paragraph AGGREGATES. Provide aggregate containing no deleterious material properties as identified by ASTM C295/C295M.

c. Where a size designation is indicated, that designation indicates the nominal maximum size of the coarse aggregate.

d. Aggregate tests must be conducted within 6 months from the date of concrete mixture submittal.

e. Provide ASTM C1260 or ASTM C1567 test results conducted within 6 months of the submittal date showing the proposed coarse and fine aggregates are either: innocuous to alkali silica reaction; or that reactivity has been mitigated by the proposed cementitious materials as modified herein. Fine and coarse aggregates to be used in all concrete must be evaluated and tested for alkali-aggregate reactivity.

f. Should the test data indicate a potential for alkali-aggregate reaction, aggregates must be rejected or procedures from AASHTO R 80 or ASTM C1778 must be followed.

[g. Coral may be used as a coarse aggregate when conventional concrete aggregate is not available. Coral aggregate must be washed to eliminate chloride ions from the aggregate. Specific gravity of coral must be at least 2.40.

]2.3 WATER

Water must comply with the requirements of ASTM C94/C94M and ASTM C1602/C1602M, except that the chloride and sulfate limits as tested in accordance with ASTM D512 and ASTM D516 must not exceed 500 parts per million chloride ion and not more than 1000 parts per million of sulfate ion as SO4. Water must be free from injurious amounts of oils, acids, alkalis, salts, and organic materials. Where non-potable water or water from reprocessed concrete is proposed for use in the work, submit results of tests in accordance with ASTM C1602/C1602M. Submit test results in accordance with ASTM D512 and ASTM D516.

2.4 ADMIXTURES

a. Provide certifications that chemical admixtures comply with the requirements shown in Table 5 and are compatible with each other. Use admixtures in accordance with manufacturer's recommendations, as appropriate for the climatic conditions and construction needs.

b. Do not use calcium chloride or admixtures containing chloride ion content in more than trace amounts from impurities in admixture ingredients or potable water. Provide maximum concentrations of corrosion-inducing chemicals as shown in Table 5. For concrete that may be in contact with prestressing steel tendons, the concentration must not exceed 60 percent of the limits given in Table 5. For the concentration in grout for prestressing ducts, do not exceed 25 percent of the limits in Table 5.

Table 5 - Limits on Corrosion-Inducing Chemicals

Chemical*	Limits, Percent**	Test Method
Chlorides	0.10	ASTM D512
Fluorides	0.10	ASTM D1179
Nitrates	0.17	ASTM D3867

* Limits refer to water-soluble chemicals

** Limits are expressed as a percentage of the mass of the total cementitious materials.

c. Provide anti-washout or viscosity modifying admixtures for underwater concrete placement. Provide certification that the admixture is compatible with the cementitious materials and other chemical admixtures in the proposed concrete mixture. The use of anti-washout or viscosity modifying admixture requires approval by the Contracting Officer and a proven record of performance with a minimum of five similar projects must be submitted. Test per COE CRD-C 61 to determine cumulative mass loss must be performed once for each 267.6 cubic meters 350 cubic yards of underwater concrete and results submitted to Contracting Officer for approval prior to continued use.

d. The total alkali contribution of chemical admixtures must not increase the total sodium-oxide equivalent content of the concrete mixture by more than 0.3 kg/m3 0.5 lb/yd3.

2.4.1 Air Entraining

Provide air entraining admixtures conforming to ASTM C260/C260M.

2.4.2 Accelerating

ASTM C494/C494M, Type C.

2.4.3 Retarding

ASTM C494/C494M, Type B, D, or G.

2.4.4 Water Reducing

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NOTE: The use of high range water reducers can be used to reduce the water-cementitious materials ratio which will produce a more dense concrete matrix and improve resistance to chloride ion penetration in the concrete.

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ASTM C494/C494M, Type A, E, or F.

High Range Water Reducer (HRWR) must be ASTM C494/C494M, Type F and

ASTM C1017/C1017M.

2.4.5 Corrosion Inhibitors

Corrosion inhibitors are considered "supplemental corrosion protection". Adjust the quantity of concrete mixing water for the mass of water in the admixture. Accelerating and set adjusted versions are acceptable Concrete setting time and mixture workability must be evaluated. The use of supplemental corrosion protection must not be used in lieu of the fundamental requirement to meet the defined service life using quality concrete with specified concrete cover over the steel reinforcing. Changes to the corrosion propagation period that is calculated for quality concrete due to the use of supplemental corrosion protection materials may be approved by the Contracting Officer based on evidence provided by the Contractor and reviewed by the agency's Subject Matter Expert in Concrete Materials on a case-by-case basis.

2.4.6 Shrinkage-Reducing Admixture

ASTM C494/C494M, Type S.

[2.4.7 Waterproofing/Hydrophobic Admixture

Waterproofing/hydrophobic admixture is considered "supplemental corrosion protection". If used, adjust the quantity of concrete mixing water for the mass of water in the admixture. Concrete setting time and mixture workability must be evaluated.

]2.5 NON-SHRINK GROUT

ASTM C1107/C1107M.

2.6 MATERIALS FOR FORMS

Provide wood, plywood, or steel. Use plywood or steel forms where a smooth form finish is required. Lumber must be square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects.

Plywood: APA PS 1, B-B concrete form panels or better. Steel form surfaces must not contain irregularities, dents, or sags.

2.6.1 Form Ties and Form-Facing Material

a. Provide a form tie system that does not leave mild steel after break-off or removal any closer than 50 mm 2 inches from the exposed surface. Do not use wire alone. Form ties and accessories must not reduce the effective cover of the reinforcement.

b. Form-facing material must be structural plywood or other material that can absorb air and some of the high water-cementitious materials ratio surface paste that may be trapped in pockets between the form and the concrete. Maximum reuse is three times. Provide forms with a form treatment to prevent bond of the concrete to the forms. Use a controlled permeability form liner in strict accordance with the manufacturer's recommendations.

2.7 REINFORCEMENT

a. Bend reinforcement cold. Fabricate reinforcement in accordance with fabricating tolerances of ACI 117.

b. When handling and storing coated reinforcement, use equipment and methods that do not damage the coating. If stored outdoors for more than 2 months, cover coated reinforcement with opaque protective material.

c. Submit manufacturer's certified test report for reinforcement.

d. Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Placing drawings must indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.

e. Submit request with locations and details of splices not indicated in Contract Documents.

f. Submit request to place column dowels without using templates.

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NOTE: Specify if and where (locations) field bending or straightening of reinforcing bars is permitted.

****

[g. Submit request and procedure to field-bend or straighten reinforcing bars partially embedded in concrete at locations not indicated in Contract Documents. Field bending or straightening of reinforcing bars is permitted[where indicated in the Contract Documents][in the following locations: [_____]].

] h. Submit request for field cutting, including location and type of bar to be cut and reason field cutting is required.

2.7.1 Prestressing Steel

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NOTE: Use prestressing in fender and bearing piles and deck soffits wherever possible. Post-tensioning of pile caps and decks is recommended where feasible. Do not mix coated prestressing strands and plain prestressing strands. This will produce a large corrosion cell between the plain strand and any defect in the coated strand.

****

Use seven-wire stress-relieved or low-relaxation strand conforming to ASTM A416/A416M, Grade 270. Use of indented seven-wire stress-relieved or low-relaxation strand conforming to ASTM A882/A882M, Grade 270; or epoxy-filled seven-wire stress-relieved or low-relaxation strand conforming to ASTM A886/A886M, Grade 270 is permitted in lieu of prestressing steel conforming to ASTM A416/A416M. Use prestressing steel free of grease, oil, wax, paint, soil, dirt, and loose rust. Do not use prestressing strands or wire having kinks, bends, or other defects.

2.7.2 Reinforcing Bars

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NOTE: It is intended that plain steel rebar with

specified concrete cover of 75 mm 3.0 inches must normally be specified according to applicable codes. Predictive modeling can confirm that the candidate concrete mixture, type of steel and concrete cover will yield the required service life for the particular structural element under consideration. For the purpose of predicting the service life of the concrete, the design must meet the required service life without relying on a barrier such as epoxy or zinc coating of the steel rebar or passive cathodic protection for additional life extension. The use of galvanized rebar and epoxy-coated rebar are acceptable for use, but it is difficult to justify a specific life extension from either without conclusive research data.

ASTM A706/A706M bars are mainly used in seismic design or for welding. Do not mix coated rebar and plain reinforcing bars. This may produce a large corrosion cell between the plain bar and any defect in the coated bar.

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NOTE: Use second recycled content option througout this section if Contractor is choosing recycled content products in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

The reinforcing selected must match the structural properties of the reinforcing specified. Alternative reinforcing bars must have similar structural properties to the specified reinforcing and may be used with the Contracting Officer's approval.

a. Reinforcing bars must be deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.

b. ASTM A615/A615M with the bars marked S, Grade [420][550][690][60][80][100]; or ASTM A996/A996M with the bars marked R, Grade [350][420][50][60], or marked A, Grade [300][420][40][60].[Cold drawn wire used for spiral reinforcement must conform to ASTM A1064/A1064M.][Provide reinforcing bars that contain a minimum of [100][_____] percent recycled content.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements.]

c. [Reinforcing bars may contain post-consumer or post-industrial recycled content.][Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.]

d. Submit mill certificates for reinforcing bars.

2.7.2.1 Reinforcement and Protective Coating

If applicable, provide coating manufacturer's and coating applicator's test data sheets certifying that applied coating meets the requirements of the concrete system specified on the Plans.

2.7.2.2   Galvanized Reinforcing Bars

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NOTE: Class 1 has a zinc coating that is thicker than Class 2. For Class 1 bars, fabrication can be performed before or after coating. If fabrication is performed after coating then damage caused by fabrication should be repaired according to ASTM A767/A767M. If needed, add any requirements for bars that require special finished bend diameters and indicate their locations.

****

a. Provide zinc-coated (galvanized) reinforcing bars that conform to ASTM A767/A767M,[Class 1][Class 2][with galvanizing [before][after] fabrication] as required by the contract Documents.

b. Coating damage incurred during shipment, handling, and placing of zinc-coated (galvanized) reinforcing bars must be repaired in accordance with ASTM A780/A780M. Damaged areas must not exceed 2 percent of surface area in each linear foot of each bar or bar must not be used. The 2 percent limit on maximum allowed damaged coating area must include previously repaired areas damaged before shipment as required by ASTM A767/A767M.

2.7.2.3   Epoxy-Coated Reinforcing Bars

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NOTE: ASTM A775/A775M are coated when straight and then bent as needed and are not allowed while ASTM A934/A934M are bent prior to coating. Bending after coating might result in the epoxy coating to crack or debond from steel.

****

a. Provide epoxy-coated reinforcing bars that conform to ASTM A934/A934M, Grade [60][80][100].

b. Coatings must be applied in plants that are certified in accordance with Concrete Reinforcing Steel Institute (CRSI) Epoxy Coating Plant Certification Program or an equivalent program acceptable to the contracting officer.

c. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated reinforcing bars must be repaired. Repair damaged coating areas with patching material conforming to ASTM A934/A934M as applicable and in accordance with material manufacturer's written recommendations. Damaged coating area must not exceed 2 percent of surface area in each linear foot of each bar or bar must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A934/A934M as applicable. Fading of coating color is not cause for rejection of epoxy-coated reinforcing bars.

d. [Submit concrete Reinforcing Steel Institute (CRSI) Epoxy Coating Plant Certification][inspection and quality-control program of plant applying epoxy coating if proposed plant is not certified in accordance with CRSI Epoxy Coating Plant Certification Program].

2.7.2.4 Dual-coated Reinforcing Bars

a. Zinc and epoxy dual-coated reinforcing bars must conform to ASTM A1055/A1055M.

b. Coating damage incurred during shipment, storage, handling, and placing of zinc and epoxy dual-coated reinforcing bars must be repaired. Repair damaged coating areas with patching material conforming to ASTM A1055/A1055M and in accordance with material manufacturer's written recommendations. Damaged coating area must not exceed 2 percent of surface area in each linear foot of each bar or bar must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A1055/A1055M. Fading of coating color is not cause for rejection of zinc and epoxy dual-coated reinforcing bars.

2.7.2.5 Low-carbon, Chromium, Steel Bars

Low-carbon, chromium, steel bars must conform to ASTM A1035/A1035M.

2.7.2.6 Stainless Steel Reinforcing Bars

Stainless steel bars must meet the requirements of ASTM A955/A955M.

2.7.2.7 Headed Reinforcing Bars

Headed reinforcing bars must conform to ASTM A970/A970M including Annex A1, and other specified requirements.

2.7.2.8 Bar Mats

a. Bar mats must conform to ASTM A184/A184M.

b. If coated bar mats are required, repair damaged coating as required in paragraphs GALVANIZED REINFORCING BARS, EPOXY-COATED REINFORCING BARS, and DUAL-COATED REINFORCING BARS.

2.7.2.9 Headed Shear Stud Reinforcement

Headed studs and headed stud assemblies must conform to ASTM A1044/A1044M.

[2.7.2.10 Glass Fiber Reinforced Polymer (GFRP) Bars

Glass fiber reinforced polymer (GFRP) bars meeting the requirements of ASTM D7957/D7957M are a permitted alternative. The structure design must consider the use of GFRP bars, noting that GFRP bar is not an in-kind replacement of steel bars.

]2.7.3 Mechanical Reinforcing Bar Connectors

a. Provide 125 percent minimum yield strength of the reinforcement bar being spliced.

b. Mechanical splices for galvanized reinforcing bars must be galvanized or coated with dielectric material.

c. Mechanical splices used with epoxy-coated or dual-coated reinforcing bars must be coated with dielectric material.

d. Mechanical splices for reinforcing bars not indicated in Contract Documents must not be used unless accepted by the Contracting Officer.

e. Remove coating on reinforcing bar in area of mechanical splice if required by splice manufacturer. After installing mechanical splices on zinc-coated (galvanized), epoxy-coated, or zinc and epoxy dual-coated reinforcing bars, repair damaged coating and areas of removed coating in accordance with paragraphs GALVANIZED REINFORCING BARS, EPOXY-COATED REINFORCING BARS, and DUAL-COATED REINFORCING BARS, respectively. Coat exposed parts of mechanical splices used on coated bars with same material used to repair damaged coating.

f. Submit data on mechanical splices demonstrating compliance with this paragraph.

2.7.4 Wire

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NOTE: Include in your Contract Documents the wire size, yield strength or grade, and any additional requirements not specified here for wires. For more information on wire reinforcement refer to WRI (Wire Reinforcement Institute) documents.

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a. [Provide wire reinforcement that contains a minimum of [100][_____] percent recycled content.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements. Wire reinforcement may contain post-consumer or post-industrial recycled content.] Provide flat sheets of welded wire reinforcement for slabs and toppings.

b. Plain or deformed steel wire must conform to ASTM A1064/A1064M.

c. Stainless steel wire must conform to ASTM A1022/A1022M.

d. Epoxy-coated wire must conform to ASTM A884/A884M. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated wires must be repaired. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire, wire must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color must not be cause for rejection of epoxy-coated wire reinforcement.

2.7.5 Welded Wire Reinforcement

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NOTE: Include in your Contract Documents the welded wire yield strength or grade, size and spacing, and any additional requirements not specified here for wires.

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a. Use welded wire reinforcement specified in Contract Documents and conforming to one or more of the specifications given herein.

b. Plain welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 300 mm 12 in. apart in direction of principal reinforcement.

c. Deformed welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 400 mm 16 in. apart in direction of principal reinforcement.

d. Epoxy-coated welded wire reinforcement must conform to ASTM A884/A884M. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated welded wire reinforcement must be repaired in accordance with ASTM A884/A884M. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color must not be cause for rejection of epoxy-coated welded wire reinforcement.

e. Stainless steel welded wire reinforcement must conform to ASTM A1022/A1022M.

f. Zinc-coated (galvanized) welded wire reinforcement must conform to ASTM A1060/A1060M. Coating damage incurred during shipment, storage, handling, and placing of zinc-coated (galvanized) welded wire reinforcement must be repaired in accordance with ASTM A780/A780M. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A1060/A1060M.

2.7.6 Reinforcing Bar Supports

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NOTE: Include in your Contact Documents the types of reinforcement supports and location used within the structure. Refer to Chapter 3 in CRSI MSP 2.

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a. Provide reinforcement support types within structure as required by Contract Documents. Reinforcement supports must conform to CRSI RB4.1. Submit description of reinforcement supports and materials for fastening coated reinforcement if not in conformance with CRSI RB4.1.

b. [For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar support.][For zinc-coated reinforcement, use galvanized wire or dielectric-polymer coated wire bar supports.]

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NOTE: Supports must be coated when using epoxy-coaed reinforcing bars.

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c. Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

d. [Minimum [5][10][_____] percent post-consumer recycled content, or minimum [20][40][_____] percent post-industrial recycled content.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements. Plastic and steel may contain post-consumer or post-industrial recycled content.]

2.7.7 Welding

a. Provide weldable reinforcing bars that conform to ASTM A706/A706M and ASTM A615/A615M and Supplement S1, Grade 420 60, except that the maximum carbon content must be 0.55 percent.

b. Comply with AWS D1.4/D1.4M unless otherwise specified. Do not tack weld reinforcing bars.

c. Welded assemblies of steel reinforcement produced under factory conditions, such as welded wire reinforcement, bar mats, and deformed bar anchors, are allowed.

d. After completing welds on zinc-coated (galvanized), epoxy-coated, or zinc and epoxy dual-coated reinforcement, coat welds and repair coating damage as previously specified.

2.8 ACCESSORY MATERIALS

2.8.1 Polyvinylchloride Waterstops

COE CRD-C 572.

2.8.2 Materials for Curing Concrete

2.8.2.1 Impervious Sheeting

ASTM C171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.8.2.2 Pervious Sheeting

AASHTO M 182 or carpet covering the free surface and kept continuously wet throughout the curing period.

2.8.2.3 Liquid Membrane-Forming Compound

Comply with ASTM C309, white-pigmented, Type 2, Class B.

2.8.3 Liquid Chemical Sealer-Hardener Compound

Provide magnesium fluosilicate compound which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound must not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.8.4 Expansion/Contraction Joint Filler

Comply with ASTM D1751 or ASTM D1752, 13 mm 1/2 inch thick unless otherwise indicated.

2.8.5 Joint Sealants

2.8.5.1 Horizontal Surfaces

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NOTE: For horizontal surfaces subject to jet fuel, specify section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT.

****

Horizontal surfaces are defined as all surfaces with a 3 percent maximum slope. ASTM D6690 or ASTM C920, Type M, Class 25, Use T.

2.8.5.2 Vertical Surfaces

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NOTE: Specify ASTM C920 for vertical surfaces greater than 3 percent slope and not subject to jet fuel, gasoline, fuel oil, etc. For vertical surfaces greater than 3 percent slope and subject to jet fuel, specify FS SS-S-200, no sag.

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Vertical surfaces are defined as all surfaces with a slope greater than 3 percent. ASTM C920, Type M, Grade NS, Class 25, Use T. FS SS-S-200, no sag.

PART 3 EXECUTION

3.1 FORMS

a. Provide formwork with clean-out openings to permit inspection and removal of debris. Formwork must be gasketed or otherwise rendered sufficiently tight to prevent leakage of paste or grout under heavy, high-frequency vibration. Use a release agent that does not cause surface dusting. Limit reuse of plywood to no more than three times. Reuse may be further limited by the Contracting Officer if it is found that the pores of the plywood are clogged with paste so that the wood does not absorb air and some of the high water-cementitious materials ratio paste that may be trapped in pockets between the form and the concrete.

b. Comply with ACI 301M ACI 301. Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 100 mm 4 inches greater than indicated. Set forms rigidly, mortar-tight, and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 20 mm 0.75 inch unless otherwise indicated. Forms submerged in water must be watertight.

c. Patch form tie holes with a no shrink patching material in accordance with the manufacturer's recommendations and subject to approval.

3.1.1 Coating

Before concrete placement, coat the contact surfaces of forms with a no staining mineral oil, no staining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.1.2 Removal of Forms and Supports

After placing concrete, forms must remain in place for the time periods specified in ACI 347R, except for concrete placed underwater, forms must remain in place a minimum of 48 hours. Prevent concrete damage during form removal.

3.1.2.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if ASTM C39/C39M test results of field-cured samples from a representative portion of the structure or other approved and calibrated non-destructive testing techniques show that the concrete has reached a minimum of 85 percent of the design strength.

3.1.3 Reshoring

Do not allow construction loads to exceed the superimposed load that the structural member, with necessary supplemental support, is capable of carrying safely and without damage. Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, slabs and beams over 3 meters 10 feet in span and cantilevers over 1.2 meters 4 feet must be reshored for the remainder of the specified time period in accordance with paragraph REMOVAL OF FORMS AND SUPPORTS. Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Reshoring elements must have the same load-carry capabilities as original shoring and must be spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.2 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

a. Unless otherwise specified, placing reinforcement and miscellaneous materials must be in accordance with ACI 301M ACI 301. Provide bars, welded wire reinforcement, wire ties, supports and other devices necessary to install and secure reinforcement.

b. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area of the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

c. Inspect and verify proper reinforcement grade, quantity, spacing, and clearance requirements prior to concrete placement. Inspect placed steel reinforcing for coating damage, if applicable, prior to placing concrete. Repair all visible damage.

3.2.1 General

Provide details of reinforcement that are in accordance with the Contract Documents.

3.2.2 Coated Reinforcing

If coated reinforcement is used, record coating lot on each shipping notice and carefully identify and retag bar bundles from bending plant. Provide systems for handling coated bars that have padded contact areas, nylon slings, etc., to keep bars free of dirt and grit.

Carefully handle and install bars to minimize job site patching including lifting and supporting bundled coated bars with strong back, multiple supports, or platform bridge to prevent sagging and abrasion. When possible, assemble reinforcement as tied cages prior to final placement into the forms. Bundling bands must be padded where in contact with bars. Do not drop or drag bars or bundles. Store coated bars both in shop and in field, aboveground, on wooden or padded cribbing with adequate protective blocking between layers. Schedule deliveries of coated bars to the job site to avoid the need for long term storage. Protect from direct sunlight and weather. Bars to be stored longer than 12 hours at the job site must be covered with opaque polyethylene sheeting or other suitable equivalent protective material.

Epoxy Coated Reinforcing must meet the requirements of ASTM A934/A934M including Appendix X2, "Guidelines for Job Site Practices" except as otherwise specified herein.

Inspect for defects and provide required repairs prior to assembly. After assembly, reinspect and provide final repairs. Excessive nicks and scrapes that expose steel is cause for rejection.

a. Immediately prior to application of the patching material, any rust and debonded coating must be manually removed from the reinforcement by suitable techniques employing devices such as wire brushes and emery paper. Care must be exercised during this surface preparation so that the damaged areas are not enlarged more than necessary to accomplish the repair. Damaged areas must be clean of dirt, debris, oil, and similar materials prior to application of the patching material.

b. Repair and patching must be done in accordance with the patching material manufacturer's recommendations. These recommendations, including cure times, must be available at the job site at all times.

c. Allow adequate time for the patching materials to cure in accordance with the manufacturer's recommendation prior to concrete placement.

d. Rinse placed reinforcing bars with ASTM C1602/C1602M compliant water to remove chloride contamination prior to placing concrete.

3.2.3 Reinforcement Supports

Provide reinforcement support in accordance with CRSI RB4.1 and ACI 301M ACI 301 Section 3 requirements.

Place reinforcement and secure with non-corrodible chairs, spacers, and hangers. Metal hangers may be used, but must be of similar material to the reinforcing. Support reinforcement on the ground with concrete or other non-corrodible material, having a compressive strength equal to or greater than the concrete being placed and having permeability equal or less than the concrete being placed.

Coated reinforcing bars supported from formwork must rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable material. Wire bar supports must be coated with dielectric material, compatible with concrete, for a minimum distance of 50 mm 2 inches from the point of contact with the coated reinforcing bars. Reinforcing bars used as support bars must be coated with the same material as the reinforcing. Spreader bars, where used, must be coated. Non-coated combination bar clips and spreaders used in construction with coated reinforcing bars must be made corrosion resistant or coated with dielectric material. Coated bars must be tied with plastic-coated tie wire or other materials acceptable to the Contracting Officer.

3.2.4 Splicing

As indicated in the Contract Drawings. For splices not indicated, comply with ACI 301M ACI 301. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 50 mm 2 inches. Welded splices must comply with AWS D1.4/D1.4M and be approved prior to use. Repair the cut ends of Galvanized Reinforcing Bars to completely coat exposed steel, ASTM A780/A780M.

3.2.5 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Bolt threads must match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.2.6 Cover

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NOTE: Uniform, high quality concrete cover over the steel reinforcement is critically important for long-term durability.

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As a minimum, comply with ACI 318M ACI 318 for concrete cover over the steel reinforcement. The cover may be greater than that required by ACI 318M ACI 318 based on the results from service life modeling. Tolerances for the placement of the steel reinforcement must comply with the service life modeling and ACI 117. When predicting service life, the cover thickness must be modelled considering the specified cover and construction tolerances per ACI 117. Steel shapes that are embedded in the concrete must have at least the cover required for concrete reinforcement.

3.2.7 Setting Miscellaneous Material and Prestress Anchorages

Place and secure anchors, bolts, pipe sleeves, conduits, and other such items in position before concrete placement and support against displacement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete. Electrically isolate exposed steel work and its anchor systems from the primary steel reinforcement with at least 50 mm 2 inches of concrete. Coat exposed steel work to reduce corrosion. Take particular care to ensure against corrosion on edges and horizontal surfaces. Use epoxy coatings for protection of carbon steel plates and fittings.

3.2.8 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

a. Provide fabrication tolerances that are in accordance with ACI 117.

b. Provide hooks and bends that are in accordance with the Contract Documents.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not to be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances.

b. Bends or kinks not indicated on drawings or approved shop drawings.

c. Bars with reduced cross-section due to rusting or other cause.

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.2.9 Placing Reinforcement

Place reinforcement in accordance with ACI 301M ACI 301.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than 25 mm 1 inch from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 90 by 90 mm 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

a. Provide supports for reinforcing bars that are sufficient in number and have sufficient strength to carry the reinforcement they support, and in accordance with ACI 301M ACI 301 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

b. Equip supports on ground and similar surfaces with sand-plates.

c. Support welded wire reinforcement as required for reinforcing bars.

d. Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 1.6 mm 16 gage.

e. Reinforcement must be accurately placed, securely tied at intersections, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to the Contract Documents.

f. Bending of reinforcing bars partially embedded in concrete is permitted only as specified in the Contract Documents.

3.2.10 Spacing of Reinforcing Bars

a. Spacing must be as indicated in the Contract Documents.

b. Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to preapproval by the Contracting Officer.

3.2.11 Welding of Reinforcement

Welding of reinforcement, where permitted, must be in accordance with AWS D1.4/D1.4M.

3.2.12 Construction Joints

If construction joints are shown on the plans: Place all concrete between consecutive joints in a continuous operation. Continue reinforcement across joints unless otherwise indicated.

If construction joints are not shown on the plans: Prior to ordering concrete the contractor must locate joints to least impair strength and must provide substantiating calculations for government review and approval.

Construction joints must be oriented normal to the main reinforcement. Construction joint spacing must not exceed 24.4 m 80 feet, unless approved in writing.

Form construction joints using bulkheads with keyways. Locate keyways clear of exposed surfaces by approximately one-third the thickness of the joint-adjacent concrete pour to take place after a minimum of 7 days to allow for initial shrinkage.

Dampen the surface of the concrete to achieve a saturated surface dry condition at the horizontal construction joints immediately before placing adjoining concrete.

Avoid joints in cantilevered members. Where practical, avoid horizontal joints in pile caps, bulkheads, and retaining walls, otherwise locate horizontal joints 600 mm 2 feet or more above the MHHW elevation. If the work is unexpectedly interrupted by breakdowns, storms, or other causes, rearrange the freshly deposited concrete to provide a suitable construction joint. If this joint occurs at a section with shear stress, prevent a plane of weakness by providing an adequate mechanical bond across the joint by forming a keyway, inserting reinforcing steel, or by some other means satisfactory to the Contracting Officer.

3.2.13 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 13 mm 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Place contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Sawed joints must be completed within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.2.14 Waterstop Splices

Fusion weld in the field.

3.2.15 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.3 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C94/C94M, ACI 301M ACI 301, and ACI 304R, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch tickets imprinted with mix identification, batch size, batch design and measured weights, moisture in the aggregates, and time batched for each load of ready mix concrete. When a pozzolan is batched cumulatively with the cement, it must be batched after the cement has entered the weight hopper.

3.3.1 Measuring

Make measurements at intervals as specified in paragraphs SAMPLING and TESTING.

Adjust batch proportions to replicate the mixture design using methods provided in the approved quality assurance plan. Base the adjustments on results of tests of materials at the batch plant for use in the work. Maintain a full record of adjustments and the basis for each.

3.3.2 Mixing

Comply with ASTM C94/C94M and ACI 301M ACI 301. If time of discharge exceeds time required by ASTM C94/C94M, submit a request along with description of precautions to be taken.

3.3.3 Transporting

Comply with ACI 304R.

3.4 PLACING CONCRETE

Comply with ACI 304R and ACI 304.2R. Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 1.0 m 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other or lifts for vertical construction. Position grade stakes on 6 m 20 feet centers maximum for exterior slabs.

3.4.1 Vibration

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NOTE: The requirement for vibrator spacing must be considered in the reinforcing steel design by the engineer of record. ACI MNL-66 requires that bar bundling be done by the design engineer. It is very important to provide space for placement and consolidation of concrete.

****

Comply with the requirements of ACI 309R[and ASTM A934/A934M for epoxy-coated bar] using vibrators with a minimum frequency of 9000 vibrations per minute (VPM). Use only high cycle or high frequency vibrators. Motor-in-head 60 cycle vibrators may not be used. For walls and deep beams, use a minimum of two vibrators with the first to melt down the mixture and the second to thoroughly consolidate the mass. Provide a spare vibrator at the casting site whenever concrete is placed. Place concrete in 500 mm 18 inches maximum vertical lifts. Insert and withdraw vibrators approximately 500 mm 18 inches apart. Penetrate at least 200 mm 8 inches into the previously placed lift with the vibrator when more than one lift is required. Extract the vibrator using a series of up and down motions to drive the trapped air out of the concrete and from between the concrete and the forms.

For slab construction, use vibrating screeds designed to consolidate the full depth of the concrete. Where beams and slabs intersect, use an internal vibrator to consolidate the beam. Do not vibrate concrete placed with anti-washout admixtures. Vibrators must be equipped with rubber vibrator heads.

3.4.2 Cold Weather

Comply with ACI 306R. Do not allow concrete temperature to decrease below 10 degrees C 50 degrees F. Obtain approval prior to placing concrete when ambient temperature is below 4 degrees C 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Placement of concrete must be halted whenever the ambient temperature drops below 5 degrees C 40 degrees F. When the ambient temperature is less than 10 degrees C 50 degrees F the temperature of the concrete when placed must be not less than 10 degrees C 50 degrees F or more than 25 degrees C 75 degrees F. Heating of the mixing water or aggregates may be necessary to regulate the concrete placing temperature. An accelerating admixture may be used when the ambient temperature is below 10 degrees C 50 degrees F. Covering and other means must be provided for maintaining the concrete at a temperature of at least 10 degrees C 50 degrees F for not less than 7 days after placing, and at a temperature above freezing for the remainder of the curing period.

3.4.3 Hot Weather

Comply with ACI 305R. Maintain required concrete temperature using Figure 4.1.4, "Effect of Concrete and Air Temperatures, Relative Humidity, and Wind Speeed on the Rate of Evaporation of Surface Moisture From Concrete" in ACI 305R to prevent the evaporation rate from exceeding 1.0 kg per square meter 0.2 pound of water per square foot of exposed concrete per hour. If necessary, cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. If the evaporation rate exceeds 0.5 kg per square meter 0.1 pound of water per square foot per hour, fog spray the exposed concrete surfaces until active moist curing is applied. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.4.4 Prevention of Plastic Shrinkage Cracking

During weather with low humidity, and particularly with high temperature and appreciable wind, develop and institute measures to prevent plastic shrinkage cracks from developing. If plastic shrinkage cracking occurs, halt further placement of concrete until protective measures are in place to prevent further cracking. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Figure 4.1.4 of ACI 305R. In addition to the protective measures concrete placement must be further protected by erecting shades and windbreaks and by applying fog sprays of water, the addition of monomolecular films, or wet covering. When such water treatment is stopped, curing procedures must be immediately commenced. The methods and materials to remove or repair areas affected by plastic shrinkage cracks must be suggested by the Contractor, reviewed by the agency's Subject Matter Expert in Concrete Materials, and approved by the Contracting Officer. Cracks must never be troweled over or filled with cement slurry.

3.4.5 Mass Concrete

All mass concrete elements must be placed per the requirements of the Mass Concrete Temperature Control Plan.

3.4.6 Depositing Concrete Under Water

ACI 301M ACI 301 methods and equipment used must prevent the washing of the cement from the mixture, minimize the formation of laitance, prevent the flow of water through the concrete before it has hardened, and minimize disturbance to the previously placed concrete. Tremies, if used, must be watertight and sufficiently large to permit a free flow of concrete. Keep the discharge end continuously submerged in fresh concrete. Keep the shaft full of concrete to a level well above the water surface. Discharge and spread the concrete by raising the tremie to maintain a uniform flow. Place concrete without interruption until the top of the fresh concrete is at the required height.

3.5 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT

3.5.1 Defects

Repair formed surfaces by removing minor honeycombs, bugholes, blisters, pop-outs, and pits greater than 600 square mm 1.0 square inch surface area or 6 mm 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with non-shrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects that affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI 347R. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise indicated.

3.5.2 Formed Surfaces

3.5.2.1 Tolerances

Comply with ACI 117 and as indicated.

3.5.2.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 6 mm 0.25 inch in height.

3.5.2.3 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Material with raised grain, torn surfaces, worn edges, patches, dents, or other defects that will impair the texture of the concrete surface must not be used. Patch tie holes and defects and completely remove fins.

3.6 FINISHES FOR HORIZONTAL CONCRETE SURFACES

3.6.1 Finish

Comply with ACI 301M ACI 301. Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.6.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. After the concrete has been placed, consolidated, struck off, and leveled, the surface must be roughened with stiff brushes or rakes before final set.

3.6.1.2 Floated

Exterior slabs where not otherwise specified. After the concrete has been placed, consolidated, struck off, and leveled, do not work the concrete further, until ready for floating. Whether floating with a wood, magnesium, or composite hand float, with a bladed power trowel equipped with float shoes, or with a powered disc, floating must begin when the surface has stiffened sufficiently to permit the operation.

3.6.1.3 Broomed

Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.6.1.4 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by a burlap drag. Drag a strip of clean, wet burlap from 900 to 3000 mm wide and 600 mm longer 3 to 10 feet wide and 2 feet longer than the pavement width across the slab. Produce a fine, granular, sandy textured surface without disfiguring marks. Round edges and joints with an edger having a radius of 3 mm 1/8 inch.

3.6.1.5 Concrete Toppings Placement

Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the base wet for a period of 12 hours preceding the application of the topping. Remove excess water prior to the topping placement. Do not allow temperature differential between the completed base and the topping to exceed 6 degrees C 10 degrees F at the time of placing. Place the topping and finish as specified for pavement.

3.7 CURING AND PROTECTION

Comply with ACI 301M ACI 301 and ACI 308.1 unless otherwise specified. Prevent concrete from drying by misting surface of concrete. Begin curing immediately following final set.

Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, by rain or running water, adverse weather conditions, and any other activity resulting in ground vibrations during curing. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains during curing.

Do not allow concrete to dry out from time of placement until the expiration of the specified curing period.

Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded.

If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Do not interrupt curing for more than 60 minutes during form removal. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating.

Approved equipment and materials for curing must be on-site and available for immediate use before placing concrete.

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NOTE: When the use of alkali-reactive aggregates is permitted, add the following paragraph.

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Furnish ASTM C39/C39M test results to verify the anticipated rate of strength development for the proposed concrete design mixture. Submit an increased curing period and minimum time to strip formwork based upon the reduced rate of strength development.

3.7.1 Wet Curing

Wet cure marine concrete using ASTM C1602/C1602M compliant water for a minimum of 7 days. Do not allow construction loads to exceed the superimposed load that the structural member, with necessary supplemental support, is capable of carrying in current condition safely and without damage.

Leaving the forms in place for seven days is a suitable alternative to wet curing.

3.7.1.1 Ponding or Immersion

Continually immerse the concrete throughout the seven-day curing period. Water must not be 11 degrees C 20 degrees F less than the temperature of the concrete. For temperatures between 4 and 10 degrees C 40 and 50 degrees F, increase the curing period by 50 percent.

3.7.1.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 4 and 10 degrees C 40 and 50 degrees F, increase the curing period by 50 percent.

3.7.1.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 150 mm 6 inches over adjacent sheeting. Sheeting must be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete or over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period. Anchor the wet sheeting to provide continuous contact with the concrete surface.

3.7.1.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 300 mm 12 inches minimum. Provide sheeting not less than 450 mm 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.7.2 Liquid Membrane-Forming Curing Compound

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NOTE: Stay in place forms and moist curing are the preferred method for curing concrete. Use of a liquid membrane-forming curing compound is only permitted when approved by the Contracting Officer.

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Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. The liquid membrane-forming compound must meet the requirements of ASTM C309 Type 1-D or Type 2 Class A. The compound must form a uniform, continuous, coherent film that will not check, crack, or peel during the curing period. It must not peel under traffic after 24 hours drying time. The compound must not react deleteriously with concrete or its constituents. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 4.1.4, "Effect of Concrete and Air Temperatures, Relative Humidity, and Wind Speed on the Rate of Evaporation of Surface Moisture From Concrete" in ACI 305R indicates that hot weather conditions will cause an evaporation rate exceeding 1.0 kg of water per square meter per hour 0.2 pound of water per square foot per hour.

3.7.2.1 Application

Apply in accordance with the recommendations of the manufacturer immediately after any water sheen that may develop after finishing has disappeared from the concrete surface.

Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats must be 5 square meters maximum per L 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. Immediately apply an additional coat of compound to areas where the film is defective. Respray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.7.2.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.7.3 Curing Periods

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NOTE: Add the following if concrete will be underwater:[Cure land-cast elements for a minimum of 7 days prior to submerging.]

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Moist cure concrete using ASTM C1602/C1602M compliant water for a minimum of 7 days. Continue additional curing for a total period of 21 days. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing must be subject to approval by the Contracting Officer.

3.7.4 Protection

3.7.4.1 Thermal Protection Against Cold Weather

Protect concrete against cold weather conditions in accordance with ACI 306R. Concrete must achieve a compressive strength of minimum 24.5 MPa 3500 psi prior to removal of thermal protection in cold weather conditions. Removal of thermal protection must be carried out as to reduce potential crack-inducing differential strains per ACI 306R.

3.7.4.2 Liquid Chemical Sealer-Hardener

Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer-hardener must not be applied until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.8 FIELD QUALITY CONTROL

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NOTE: Consider the size and complexity of job to determine if all tests are required.

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3.8.1 Fresh Concrete Properties

For each concrete mixture, the Contractor must take samples in accordance with ASTM C172/C172M, test and record the slump, and temperature. If the slump deviates from the previous batch by more than 25.4 mm 1.0 inch, air content must also be determined. Adjustment of air content and/or slump with chemical admixture is permitted provided the water to cementitious material ratio is not exceeded.

3.8.1.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved high range water reducing (HRWR) admixture provided that the water-cementitious ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 40 cubic meters 50 cubic yards (maximum) of concrete. If concrete does not pass slump test, adjust using a HRWR and test every concrete batch until two consecutive batches meet slump without adjustment.

3.8.1.2 Temperature Tests

a. Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions below 10 degrees C and above 27 degrees C below 50 degrees F and above 80 degrees F for each batch (minimum) or every 40 cubic meters 50 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

b. Determine temperature of each concrete sample in accordance with ASTM C1064/C1064M. Temperatures must comply with the Mass Concrete Temperature Control Plans.

3.8.1.3 Air Content Tests

ASTM C231/C231M or ASTM C173/C173M. Perform tests at commencement of concrete placement each day, when test cylinders are made, and if slump test varies by more than 25.4 mm 1.0 inch from previous results or concrete does not pass slump test.

3.8.1.4 Unit Weight Test

ASTM C138/C138M. Take concrete samples during concrete placement. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 38.2 cubic meters 50 cubic yards (maximum) of concrete.

3.8.2 Hardened Concrete Properties

****

NOTE: The Engineer of Record must specify the frequency of testing during the construction phase. Sufficient testing must be done to maintain confidence that the concrete, as delivered and placed, remains consistent. For example: sample and test every 75 cubic meters 100 cubic yards for the first 382 cubic meters 500 cubic yards, then every 382 cubic meters 500 cubic yards once confidence is established in uniformity. However, this is only a guideline, and the Contracting Officer and Engineer of Record should agree on the frequency of sampling as best suits the particulars of each project and budget.

For example, a sampling interval for a new pier may be as follows:

o During the first week of casting piles
o During the second week of casting piles
o Midway through the casting of all piles
o During the final week of casting piles
o At the first pile cap and every tenth bent thereafter
o During the two first concrete deck pours
o During the final concrete deck pour

****

Sample and test each lot at [75] cubic meters [100] cubic yards for the first [382] cubic meters [500] cubic yards, then every [382] cubic meters [500] cubic yards thereafter.

Cast and cure specimens in accordance with ASTM C172/C172M, ASTM C31/C31M, and applicable requirements of ACI 305R and ACI 306R.

For each lot, record the date and time sampled, the batch ticket code, cylinder ID code the location of placement, total volume of concrete represented by the sample, and fresh concrete properties; ASTM C143/C143M for slump or ASTM C1611/C1611M for slump flow and visual stability index (VSI), ASTM C231/C231M for air content, ASTM C1064/C1064M for temperature, and ASTM C138/C138M unit weight.

For each lot sample, cast twelve 150 by 300 mm 6 by 12 inch cylinder specimens for strength and seven 100 by 200 mm 4 by 8 inch cylinder specimens for transport property testing. Special handling will be necessary for shipments of transport property specimens. These cylinders must be wrapped completely with slightly dampened paper towels with water only. The wrapped cylinders must be placed in either a vacuum package or double layers of sealed plastic bags. Package cylinders to prevent damage and ship to the approved testing laboratory.

In the event the results of cylinder tests fail to satisfy transport properties, then an additional pair of specimens must be tested. In the event quality acceptance test results and retest results fail to meet the quality acceptance criteria, the entire lot must be considered non-conforming material, refer to paragraph REPAIR, REHABILITATION AND REMOVAL.

3.8.2.1 Compressive Strength Tests

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NOTE: When the same mix design is used for multiple elements such as slabs, beams, and walls, the design element type may be specified in addition to the mix design to better identify deficient concrete.

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ACI 214R tests for strength - conduct strength tests of concrete during construction in accordance with the following procedures:

a. Test cylinders in accordance with ASTM C39/C39M. Test three cylinders at 3 days, three cylinders at 7 days, and three cylinders at the age when the compressive strength requirement was specified. Hold the remaining three cylinders in storage. If one specimen in a test shows evidence of improper sampling, molding or testing, discard the specimen and consider the strength of the remaining cylinder to be the test result. If more than one specimen shows excess defects, the Contracting Officer may allow the entire test to be discarded. Test results must not exceed the specified compressive strength by more than 20 percent for the age specified.

b. If the average strength test results are less than the specified strength (f'c) extract three core samples from the structure in accordance with ASTM C42/C42M, from the area that correlates to the low test results. These extracted cores must not contain steel reinforcing. Repair core holes with non-shrink grout. Match color and finish of adjacent concrete. For concrete not meeting strength criteria, the Contractor must prepare a remediation strategy for the review by the Contracting Officer.

c. Strength test reports must be provided within 7 days of test completion.

3.8.2.2 Transport Property Tests

The Contractor must monitor the transport properties throughout the duration of the project and prepare an as-built report documenting the transport property test results. The report must include a chart or table of the relevant transport property from the service life modeling tool used in the Durability Modeling Report versus the specified value over the duration of the placement for each concrete, indicate the concrete placed outside of the tolerance limits, describe any mitigation measures taken to ensure the service life specified, and estimate the service life of the various concretes, as placed.

If using STADIUM® software: Test cylinder concrete for porosity and ion diffusion coefficient at 28 days. Calculate the D_{eff} with the determined ionic diffusion coefficient (D_{oh}) and volume of permeable voids (porosity).

If using the time to corrosion model in Appendix B2 of fib Bulletin 34: Test cylinder concrete for chloride migration coefficient at 28 days in accordance with NT Build 492. The tolerance limit for chloride migration coefficient at 28 days is that the three test running average is less than or equal to the specified limit, with no individual test >20% above the specified limit.

Concrete representative of the tested concrete with values non-conforming with the quality acceptance values determined in the service life modeling will require retesting using spare samples. If the retest exceeds the quality acceptance limit, concrete placement must be stopped to review quality control issues.

3.8.2.3 Chloride Ion Content

Comply with Table 2 requirements. Determine acid soluble chloride ion content per ASTM C1152/C1152M. Perform test once for each mix design.

3.8.2.4 Anti-Washout Admixture

Comply with COE CRD-C 61. Determine cumulative mass loss. Perform test once for each 267.6 cubic meters 350 cubic yards of underwater concrete.

3.8.2.5 Non-Destructive Tests

Use of a rebound hammer to obtain data on the strength of the concrete surface must be in accordance with ASTM C805/C805M. Test results from the rebound hammer and other non-destructive testing may be helpful in selecting areas to extract concrete cores for destructive testing.

3.8.3 Core Samples and Compressive Strength Testing

Obtain and test cores in accordance with ASTM C42/C42M.

If concrete in the structure is dry under service conditions, air dry cores (temperature 16 to 27 degrees C 60 to 80 degrees F, relative humidity less than 60 percent) for 7 days before testing and test dry. Otherwise, test the cores, after moisture conditioning, in accordance with ASTM C42/C42M.

Acceptance criteria for cylinder compressive strength are provided in paragraph ACCEPTANCE OF CONCRETE STRENGTH.

Take at least three representative cores from each member or area of concrete in place that is considered potentially strength deficient. Impair the strength of the structure as little as possible. If, before testing, extracted cores show evidence of having been damaged subsequent to or during removal from the structure, take replacement cores.

Fill core holes with low slump concrete or mortar of a strength equal to or greater than the original concrete.

The Contracting Officer will evaluate and validate core tests in accordance with the specified procedures.

3.8.4 Acceptance of Concrete Strength

3.8.4.1 Standard Molded and Cured Strength Specimens

The acceptance of concrete strengths must be based on averages of results from three consecutive compressive strength tests. When the averages of all sets of three consecutive compressive strength test results are between 1.0 and 1.2 times the field test strength (fcr), and no individual strength test falls below fcr by more than 3.45 MPa 500 psi, the strength of the concrete is satisfactory. These criteria also apply when accelerated strength testing is specified unless another basis for acceptance is specified.

3.8.4.2 Non-Destructive Tests

Non-destructive tests may be used when permitted to evaluate concrete where standard molded and cured cylinders have yielded results not meeting the criteria.

3.8.4.3 Extracted Core Tests

When the average compressive strengths of the representative cores are between 0.85 fcr and 1.2 fcr and if no single core is less than 0.75 fcr, the strength of concrete is satisfactory.

3.8.5 Inspection

ACI 311.4R. Inspect concrete placed under water with qualified divers.

3.9 REPAIR, REHABILITATION AND REMOVAL

Before the Contracting Officer accepts the structure and final payment is made the Contractor must inspect the structure for cracks, damage, and substandard concrete placements that may adversely affect the service life of the structure. A report documenting these defects must be prepared that includes recommendations for repair, removal, and/or remediation, which will be reviewed by the agency's Subject Matter Expert in Concrete Materials and submitted to the Contracting Officer for approval before any corrective work is accomplished. Costs for repair must be borne by the Contractor.

3.9.1 Crack Repair

Prior to final acceptance, all cracks in excess of 0.25 mm 0.01 inches wide must be documented and repaired. The proposed method and materials to repair the cracks must be submitted to the Contracting Officer for approval. The proposal must address the amount of movement expected in the crack due to temperature changes and loading.

After completing all curing operations and allowing the pier deck to thoroughly dry, the contractor must seal the following areas with a high molecular weight methacrylate (HMWM) sealer, clear color. Flood the cracked areas with the sealer and squeegee off the excess material before opening pier to operation.

a. Transverse joints in the deck.

b. Longitudinal joints in the deck.

c. Longitudinal joints between the deck and safety curb, barriers, and parapets, etc.

d. Cracks discovered in the deck of the top and bottom surfaces before opening the deck to traffic, that are 0.25 mm 0.010 inches or less in width.

3.9.2 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Concrete surfaces with weak surfaces less than 6 mm 1/4 inch thick must be diamond ground to remove the weak surface. Surfaces containing weak surfaces greater than 6 mm 1/4 inch thick must be removed and replaced or mitigated in a manner acceptable to the Contracting Officer.

3.9.3 Failure of Quality Assurance Test Results

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NOTE: Test results accomplished on concrete samples during concrete production that fall short of the acceptance criteria alert the Contractor to something in the production and placement process that has drifted out of calibration or that an error has been made. The goal is to track down the problem and correct it as quickly as possible. Unless the concrete producer makes a large error in batching or in placing, the chance that hardened concrete needs to be removed is remote. Removal and replacement is a last resort.

For those areas adversely affected by substandard concrete new numerical service life modeling simulations can be helpful to evaluate the effectiveness of the proposed remediation strategies.

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Proposed mitigation efforts by the Contractor to restore the service life must be reviewed by the agency's Subject Matter Expert in Concrete Materials and approved by the Contracting Officer prior to proceeding.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 31 30 (May 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-03 31 30 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 03 31 30

MARINE CONCRETE
05/24

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NOTE: This guide specification covers the requirements for reinforced concrete exposed to marine and chloride environments for projects with no specific requirements for service life design. In addition, use this guide specification for projects with concrete exposed to weather in locations with Environmental Severity Classifications (ESC) of C4 and C5 and where deicing salts are used on the structure. See UFC 1-200-01 for determination of the ESC for project locations.

This guide specification provides prescriptive requirements for marine concrete. It contains specific requirements for quality control (actions taken by the Contractor) and quality assurance (actions that may be taken by the Government). This guide specification is for projects where service life modeling is not required or deemed beneficial by the Government. If it is determined that concrete service life modeling is required, then Section 03 31 29 MARINE CONCRETE WITH SERVICE LIFE MODELING should be used.

This guide specification should be considered for projects that meet the following conditions:

o Required service life: equal to or less than 60 years; and

o Volume of concrete works: equal to or less than 10,000 cubic yard; and

o Monetary construction value of the entire project: equal to or less than $15M; and

o Service life modeling is not required by the Government.

Other criteria to consider when evaluating the

applicability of service life design include:

o Mission Criticality based on the Mission Dependency Index (MDI) Score. For example, a MDI score between 1 to 54 should assess if service life modeling is beneficial. MDI scores greater than 54 should incorporate service life modeling unless there is a specific determination made by the Government not to.

o Consequences of failure: UFC 3-301-01 Risk Categories I, II, or III should assess if service life modeling is beneficial. Higher risk categories should incorporate service life modeling unless there is a specific determination made by the Government not to.

The criteria listed above are provided as guidance to the specifier as to the applicability of this guide specification. Specific project characteristics should be evaluated and the decision to implement service life modeling will ultimately depend upon the project specific requirements and the determination of the Contracting Officer, Engineer of Record, [and][or] Contracting Officer.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Development team of this section considered the International Green Construction Code, which is "the first model code that includes sustainability measures for the entire construction project and its site - from design through construction, certificate of occupancy and beyond. The new code is expected to make buildings more efficient, reduce waste, and have a positive impact on health, safety, and community welfare."
http://www.iccsafe.org/cs/igcc/pages/default.aspx

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NOTE: The following information must be shown on

the project drawings:

1. Design assumptions.

2. Assumed temperature range when temperature stresses are a factor in design.

3. Material strengths used in design, f'c.

4. Yield strength of reinforcement required 414 mPa 60,000 psi or other grade as available.

5. Details of concrete sections, showing dimensions, reinforcement cover, and required camber.

6. Joint details, showing locations and dimensions.

7. Details and locations of critical construction joints, including water stop locations and splices, keys, and dowels when required, and location of fiber-reinforced concrete elements.

8. A list of the project structures that are covered by this specification.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for

	Burlap Cloth Made from Jute or Kenaf and Cotton Mats
AASHTO R 80	(2017; R 2021) Standard Practice for Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction
AASHTO T 358	(2021) Standard Method of Test for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 121R	(2008) Guide for Concrete Construction Quality Systems in Conformance with ISO 9001
ACI 201.2R	(2016) Guide to Durable Concrete
ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 301	(2020) Specifications for Structural Concrete
ACI 301M	(2020) Metric Specifications for Structural Concrete
ACI 304.2R	(2017) Guide to Placing Concrete by Pumping Methods
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 308.1	(2023) Specification for Curing Concrete
ACI 309R	(2005) Guide for Consolidation of Concrete
ACI 311.4R	(2005) Guide for Concrete Inspection
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code

	Requirements for Structural Concrete & Commentary
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete
ACI MNL-2	(2019; 11th Edition) ACI Manual of Concrete Inspection
ACI MNL-15	(2020) Field Reference Manual: Specifications for Concrete Construction ACI 301-20 with Selected ACI References
ACI MNL-66	(2020) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA PS 1	(2009) Structural Plywood (with Typical APA Trademarks)

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2024) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A767/A767M	(2019) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A882/A882M	(2020) Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Steel Strand
ASTM A884/A884M	(2019; Errata 1) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement

ASTM A886/A886M	(2024) Standard Specification for Steel Strand, Indented, Seven-Wire Stress-Relieved for Prestressed Concrete
ASTM A934/A934M	(2022) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A955/A955M	(2020c) Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement
ASTM A970/A970M	(2018) Standard Specification for Headed Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1022/A1022M	(2016b) Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement
ASTM A1035/A1035M	(2024) Standard Specification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement
ASTM A1044/A1044M	(2016a; Errata 1) Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete
ASTM A1055/A1055M	(2022) Standard Specification for Zinc and Epoxy Dual Coated Steel Reinforcing Bars
ASTM A1060/A1060M	(2016b) Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural

	Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C157/C157M	(2024; E 2024) Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311/C311M	(2024) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C457/C457M	(2024) Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
ASTM C469/C469M	(2022) Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C496/C496M	(2017) Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C805/C805M	(2018) Standard Test Method for Rebound Number of Hardened Concrete
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1074	(2019; E 2021) Standard Practice for Estimating Concrete Strength by the Maturity Method
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1152/C1152M	(2020) Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1202	(2022; E 2022) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1231/C1231M	(2023) Standard Practice for Use of

	Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1610/C1610M	(2021) Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique
ASTM C1611/C1611M	(2021) Standard Test Method for Slump Flow of Self-Consolidating Concrete
ASTM C1621/C1621M	(2017; R 2023) Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring
ASTM C1778	(2023) Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D512	(2012) Chloride Ion in Water
ASTM D516	(2016) Standard Test Method for Sulfate Ion in Water
ASTM D1179	(2016) Standard Test Methods for Fluoride Ion in Water
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D3867	(2016)Standard Test Methods for Nitrite-Nitrate in Water

ASTM D6690	(2021) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM D7957/D7957M	(2017) Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2018; Errata 2019) Manual of Standard Practice
CRSI RB4.1	(2016) Supports for Reinforcement Used in Concrete

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 39	(1981) Test Method for Coefficient of Linear Thermal Expansion of Concrete
COE CRD-C 61	(1989A) Test Method for Determining the Resistance of Freshly Mixed Concrete to Washing Out in Water
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-200	(Rev E; Notice 1; Notice 2) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

1.2 DEFINITIONS

a. "Atmospheric zone" is any portion of the waterfront structure above the splash zone.

b. "Buried zone" is any portion of the structure permanently buried in soil.

c. "Cementitious material" as used herein must include portland cement and any pozzolanic material such as fly ash, natural pozzolans, slag cement and silica fume.

d. "Concrete System" is the term describing a structural element comprised of concrete, reinforcing steel and concrete cover.

e. "Design strength" (f'c) is the specified compressive strength of concrete at time(s) specified by Contracting Officer to meet structural design criteria. Typical duration is 28 days; however, the Contracting Officer and Engineer of Record are encouraged to consider specifying strength at 56 or 90 days. For concrete mixtures containing 35 percent fly ash or more, the duration must be a minimum of 56 days.

f. "Field test strength" (fcr) is the required compressive strength of concrete to meet structural and durability criteria. Determine (fcr) during mixture proportioning process.

g. "High-volume fly ash (HVFA) concrete" has a minimum of 35 percent Class F fly ash as a partial replacement to portland cement.

h. "Marine concrete" is all concrete that will be in contact with seawater or brackish water, tidal variations, splash, or spray from water in navigable waterways. Piles driven on land that extend below the water table that contains saltwater or brackish water must be designed using marine concrete. Components of a marine structure that are permanently buried in soil must be considered marine concrete. In addition, structures may need to be designed using these criteria even though they are not adjacent to the waterfront. For example, structures located several hundred yards from the waterfront often deteriorate prematurely due to salt spray and salt fog brought to the structure by prevailing winds. An assessment of existing structures near the construction site can be an excellent indicator for the Engineer of Record and Contracting Officer to decide if the proposed structure should follow the guidelines for marine concrete.

i. "Mass Concrete" is any concrete system that approaches a maximum temperature of 70 degrees C 158 degrees F within the first 72 hours of placement. In addition, it includes all concrete elements with a section thickness of 1 meter 3 feet or more regardless of temperature.

j. "Mixture proportioning" is the process of designing concrete mixture proportions to enable it to meet the strength, durability and constructability requirements and of the project while minimizing the initial and life-cycle cost.

k. "Mixture proportions" are the masses or volumes of individual ingredients used to make a unit measure (cubic yard or meter) of concrete.

l. "Pozzolan" is a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

m. "Process control sampling" is sampling and testing conducted by the Contractor to monitor the quality of materials or processes. Process control sampling is intended to indicate the quality of materials at critical steps in production that allow intervention prior to using a material on the project.

n. "Quality Acceptance Limit" (QAL) is the limiting value of a test result that indicates acceptable material quality. Quality acceptance limits are based on design criteria that may be either upper-bound limits where smaller values indicate acceptable material or lower-bound limits where larger values indicate acceptable material, such as compressive strength.

o. "Quality acceptance sampling" is sampling and testing conducted by the

Contractor, or an independent testing agency, to evaluate the quality of materials used on the project. Quality acceptance sampling is conducted at regular intervals identified as "lots" to represent the quality of that portion of the material used in the project.

p. "Required compressive strength" (f'c) is the mean compressive strength of concrete required to meet structural criteria. The required strength is the mean concrete strength for tests of properly batched concrete at the age specified herein.

q. "Service life" is the Contracting Officer's stated expectation for the number of years that the structure will function without needing major concrete rehabilitation. A service life of 75 years for pile supported piers, wharves and bridges is a reasonable objective. Service life is defined as the number of years before major restoration is necessary given minimal maintenance to the structure during its life. Major restoration is defined as extensive areas that require extensive repairs using a jack hammer or other destructive means to prepare the concrete for rehabilitation. Service life is further defined as the summation of the corrosion initiation period (Ti) and the corrosion propagation period (Tp) for a given concrete system.

r. "Service Life Modeling" in the context of this document refers to a methodology to predict the length of time in service at which a defined level of deterioration will occur. Service life modeling is not required in this specification.

s. "Splash zone" is the portion of the structure just above the tidal zone. This portion of the structure is predominantly dry, but is likely to intermittently wet by wave action and wind driven spray. For the purposes of this specification, the splash zone is defined as follows:

(1) for locations protected by seawalls or otherwise sheltered from open-ocean waves, the 2 meters 6 feet area just above the tidal zone;

(2) for unprotected locations, the 6 meters 20 feet area just above the tidal zone.

t. "Submerged zone" is defined as the submerged portion of the structure. For the purposes of this specification, any element or portion thereof that is located below Mean Lower Low Water (MLLW). In areas with minimal tides, it would be defined as that portion of the element below Mean Sea Level (MSL).

u. "Supplemental Corrosion Protection" includes (but is not limited to) fusion-bonded epoxy-coated steel reinforcing, galvanized steel reinforcing, stainless reinforcing, corrosion inhibitors, barrier coatings to the concrete surface, and cathodic protection.

v. "Supplementary cementing materials" (SCM) include coal fly ash, granulated blast-furnace slag cement, natural or calcined pozzolans, and ultra-fine coal ash when used in such proportions to replace the portland cement that result in considerable improvement to sustainability, durability and in some cases a reduction in initial cost.

w. "Test Section" is a slab or wall separate from the main structure and constructed prior to main construction as an all inclusive demonstration of methods and materials. The adequacy of the Test Section must be approved by the Contracting Officer's representative prior to construction of the project.

x. "Tidal zone" is defined as the portion of the structure regularly wetted by wave action. For the purposes of this specification, any element or portion thereof that is located between Mean Lower Low Water (MLLW) and Mean Higher High Water (MHHW) is in the tidal zone. In areas with minimal tides, this would be defined as the area located between Mean Sea Level (MSL) and Mean High Water (MHW).

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Concrete Curing Plan

Concrete Qualification Program; G, [_____]

Concrete Quality Control Program; G, [_____]

Concrete Placement and Compaction

Concrete Pumping

Curing Concrete Elements

Form Removal Schedule

Laboratory Qualifications; G, [_____]

Quality Control Personnel Qualifications; G, [_____]

SD-02 Shop Drawings

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NOTE: Reproductions of contract drawings are unacceptable.

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Contraction and Expansion Joints

Construction Joints; G

Formwork and Falsework

Precast Elements; G, [_____]

Reinforcing Steel; G, [_____]

SD-03 Product Data

Admixtures; G, [_____]

Air Entraining; G, [_____]

Corrosion Inhibitors; G, [_____]

Aggregates; G, [_____]

Joint Filler

Joint Sealants

Materials for Curing Concrete

Material Safety Data Sheets

Mechanical Reinforcing Bar Connectors; G, [_____]

Non-Shrink Grout

Preformed Joint Filler

Prestressing Steel; G, [_____]

Reinforcing Bars; G, [_____]

Reinforcement and Protective Coating; G, [_____]

Reinforcement Supports

Sealer-Hardener

Waterstops

Wire

SD-04 Samples

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NOTE: Where flat surface finishing is important, provide a sample installation to train the crew.
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Mass Concrete Mock-up

Test Section

SD-05 Design Data

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NOTE: Concrete Mixture Requirements document the required criteria controlling the design of a particular concrete mix design while the Mixture Design documents the constituent materials used and the achieved performance.
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Concrete Mixture Requirements; G, [_____]

Mixture Designs

Mass Concrete Temperature Control Plans; G, [_____]

SD-06 Test Reports

Mass Concrete Mock-up

Air Entraining

Aggregates

Admixtures

Cement

Concrete Mixture Proportions

Concrete Test Reports

Fresh Concrete Properties

Hardened Concrete Properties

Mechanical Reinforcing Bar Connectors

Reinforcing Bars

Reinforcement and Protective Coating

Silica Fume

Supplementary Cementing Materials

Water

SD-07 Certificates

Admixtures

Cementitious Materials

Cementitious Material Mill Certificates

Field Testing Technician and Testing Agency

SD-08 Manufacturer's Instructions

Coatings

SD-11 Closeout Submittals

Aggregate Moisture Content

Aggregate Sampling

Concrete Test Reports

Quality Control Charts

Daily Inspection Reports

Quality Team Meetings

Sampling Logs

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory, as though the word "must" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, PLACING, STORAGE, AND HANDLING OF CONCRETE

Follow ACI 301M ACI 301, ACI 304R, and ASTM A934/A934M requirements and recommendations. Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed.

1.6 CONCRETE QUALITY CONTROL

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NOTE: The goal is to provide quality concrete with the specified concrete cover to protect the steel, which provides the primary protection mechanism against chemical deterioration and corrosion related damage. All other corrosion protection strategies are considered to be supplemental and include (but are not limited to): barrier coatings to the concrete surface, fusion-bonded epoxy-coated steel, corrosion inhibitors, galvanized, stainless, MMFX, Z-bar reinforcing and cathodic protection. All of which may provide some life extension but by how much is difficult to predict on a numerical basis for real structures exposed to chloride environments. If the available materials in the region of the project are inadequate to meet the requirements for shrinkage, compressive strength, constructability and service life then the Contractor must prepare a recommendation for review by the agency's Subject Matter Expert in Concrete Materials and approval by the Contracting Officer and Engineer of Record on a case-by-case basis to use supplemental corrosion protection to meet project requirements.

Where they are available, specify only ACI certified personnel. Check the American Concrete Institute (ACI) website for local availability: https://www.concrete.org/certification.

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The objective of the concrete quality control program is for the Contractor to outline the procedures that will be used to construct a structure that will meet the project criteria. The Contractor must develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and as specified herein. The plan must include approved laboratories. The Contractor must provide direct oversight for the concrete qualification program inclusive of associated sampling and testing. If concrete cylinders tested during production indicate inadequate strength, excessive chloride ion penetration, or inadequate mixing, then the Contracting Officer may require the Contractor to extract concrete core samples from the hardened concrete for analysis at Contractor's expense to assure that the quality of the concrete as placed and cured will satisfy the project criteria.

Develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R. Maintain a copy of ACI MNL-15 and CRSI 10MSP at the project site.

1.6.1 Quality Control Personnel

The contractor must submit for approval an organizational chart defining the quality control hierarchy, the responsibilities of the various positions, including the names and qualifications of the individuals in those positions.

Submit American Concrete Institute certification for the following:

a. CQC personnel responsible for inspection of concrete operations.

b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.

c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

d. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and Laboratory Testing Technician, Grade I or II.

e. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager Certification at the Plant Manager level.

1.6.1.1 Quality Manager Qualifications

The quality manager must hold a current license as a professional engineer in a U.S. state or territory with experience on at least five similar projects. Evidence of extraordinary proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

1.6.1.2 Field Testing Technician and Testing Agency

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

a. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI MNL-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI MNL-2.

b. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.

c. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.

1.6.2 Laboratory Qualifications for Concrete Qualification Testing

The concrete testing laboratory must have the necessary equipment and experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077, and be Cement and Concrete Reference Laboratory (CCRL) inspected.

1.6.3 Laboratory Accreditation

Laboratory and testing facilities must be provided by and at the expense of the Contractor. The laboratories performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation must be current and must include the required test methods, as specified.

a. Aggregate Testing and Mix Proportioning: Aggregate testing and mixture proportioning studies must be performed by an accredited laboratory and under the direction of a licensed/registered civil engineer in a U.S. state or territory, who must sign all reports and designs.

b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M.

c. Contractor Quality Control: All sampling and testing must be performed by an approved, onsite, independent, accredited laboratory.

1.7 CONCRETE DURABILITY

1.7.1 Concrete Mixture Proportions

At least 60 days prior to concrete placement, submit concrete mixture proportions, ingredient material certificates and test data, and trial batch test data for each class of concrete proposed for use on the project. Submittal must clearly indicate where each mixture will be used when more than one mixture design is submitted. Obtain approval from Contracting Officer prior to placement.

1.7.2 Concrete Design Requirements

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NOTE: Information on sulfate exposure categories can be found in Chapter 19 of ACI 318.

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Proportion concrete mixtures to meet the requirements listed in Table 1 in accordance with the procedures outlined in ACI 201.2R and ACI 211.1.

The mixture proportions for concrete must be developed by the Contractor to produce the required compressive strength (f'c), drying shrinkage, durability, and constructability. The amount of cementitious material in the mixture can be minimized as long as the concrete still meets the mixture design requirements for durability and strength.

The mixture proportions and Water-Cementitious Materials Ratio for marine concrete must be developed by the Contractor to produce the design strength (f'c) and to provide durability, workability, and mixture consistency to facilitate placement, compaction into the forms and around reinforcement without segregation or bleeding. The requirements for durability specified in Table 1 and Table 2 below must be incorporated in the mixture proportions. Concrete elements permanently buried in soil or seabed must be considered in the [S0][S1][S2][S3] exposure class and concrete must meet the requirements in ACI 301M ACI 301 for the sulfate exposure class assigned.

Silica fume must only be used for OCONUS (outside continental United States) projects where Class F fly ash and slag cement are not available, and when approved by the Contracting Officer. If needed, the mixture may contain a maximum of 7 percent silica fume by mass of total cementing material. Concrete mixtures containing any percentage of silica fume must be evaluated at every [76.5] cubic meters [100] cubic yards of concrete for the first [382.3] cubic meters [500] cubic yards, then every [382.3] cubic meters [500] cubic yards thereafter to ensure that the silica fume is properly dispersed in hardened concrete samples. A qualified laboratory must microscopically examine a sectioned sample and document the results. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume.

The concrete mixture must contain one of the CCM/SCM listed in Table 3, or a linear combination thereof. The minimum amount of portland cement is 50 percent of the total mass of cementitious material.

Air content: Concrete must be air entrained and must conform to the air limits specified in ACI 301M ACI 301 for exposure and the aggregate size used and tested in accordance with ASTM C231/C231M. The average spacing factor for three consecutive tests must not exceed 0.008 in with no individual test exceeding 0.010 in as determined by ASTM C457/C457M. Variations outside the limits specified must not be the reason to reject the concrete in locations not subject to freeze-thaw conditions.

Slump: The concrete mixture must be proportioned to have, at the point of deposit, a maximum slump of 100 mm 4 inches as determined by ASTM C143/C143M when admixtures that affect slump are not used. Where an ASTM C494/C494M, Type F or G admixture is used, the slump after the addition of the admixture must not exceed 200 mm 8 inches. Slump tolerances must comply with the requirements of ACI 117.

Table 1 - Concrete Design Requirements

Prescriptive requirements	Minimum	Maximum
ASTM C666/C666M Method A Durability Factor at 300 cycles	90	--
Concrete ASTM C157/C157M Drying Shrinkage percent. Samples must be cured for 28 days except for high volume fly ash (HVFA) which must be cured for 56 days.	--	0.05 percent after 28 days drying
Initial acid-soluble chloride content in cast-in-place concrete per ASTM C1152/C1152M, percent/cement	--	0.10
Initial acid-soluble chloride content in prestressed concrete determined following ASTM C1152/C1152M, percent/cement	--	0.08
Average spacing factor for three specimen following ASTM C457/C457M inch	--	0.008 with no value greater than 0.010
Chloride ion penetrability ASTM C1202 at 56 days, Coulombs	--	1000

Table 1 - Concrete Design Requirements

Prescriptive requirements	Minimum	Maximum
Alternatively to ASTM C1202, the concrete surface resistivity AASHTO T 358 at 56 days can be measured, kohm-cm	20	--

Table 2 - Concrete Quality Requirements

Zone	Exposure Condition	Maximum W/CM
Submerged zone, Tidal Splash Zone	(a) Directly exposed to salt water	0.40
	(b) Subject to severe abrasion	0.40
Atmospheric Zone	(a) Directly exposed to marine atmosphere	0.40
	(b) Protected from direct exposure to marine atmosphere	0.45
Buried Zone	(a) Permanently buried in soil	0.40

Table 3 - Supplementary Cementing Material Requirements

SCM	Minimum Content
Class N Pozzolan or Class F Fly Ash SiO_2 plus Al_2O_3 plus Fe_2O_3 > 65 percent or where exposed to sulphates as defined in ACI 318 Table 4.2.1	30 percent
Class N Pozzolan or Class F Fly Ash SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 70 percent	25 percent
Class N Pozzolan or Class F Fly Ash SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 80 percent	20 percent
Class N Pozzolan or Class F Fly Ash SiO_2 plus Al_2O_3 plus Fe_2O_3 greater than 90 percent	15 percent
Ultra fine fly ash/Pozzolan	7 percent
Slag cement	40 percent

1.7.3 Concrete Mixture Qualifications

1.7.3.1 Previously Approved Concrete Mixtures

For identical concrete mixtures previously approved for use within the past 18 months, the previous mixture qualification submittal may be re-submitted without further trial batch testing if accompanied by:

a. A copy of the prior approvals indicating the project name, project number, and location.

b. Ingredient material test data conducted within 12 months of the submittal date.

c. Copies of the previously approved trial batch test data.

d. A log containing at least 15 sequential test results with the calculated mean and standard deviation of the production concrete for air content, and compressive strength.

If the Contractor changes material type, class, sources, or suppliers; chemical composition; and/or mix proportions, the Contractor must provide a written opinion of the significance of the change(s). The change(s) may require additional testing at the discretion of the Contracting Officer in consultation with the agency's Subject Matter Expert in Concrete Materials.

1.7.3.2 New Concrete Mixtures

a. Submit complete ingredient material test data, including applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes.

b. Submit copies of test reports by independent test lab conforming to ASTM C1077 showing that the mixture has been successfully tested to produce concrete with the properties specified and that mixture will be suitable for the job conditions as described. Test reports must be submitted along with the concrete mixture proportions. Obtain approval before concrete placement.

c. Test a minimum of one trial batch of production concrete. If batching facilities are located such that the haul-time will exceed 30 minutes, a simulated haul time must be included in the trial batch.

    (1) Test and report fresh concrete property tests of each trial batch as follows:

        (a) Slump in accordance with ASTM C143/C143M.

        (b) Air content in accordance with ASTM C231/C231M or ASTM C173/C173M.

        (c) Unit weight in accordance with ASTM C138/C138M.

        (d) Temperature in accordance with ASTM C1064/C1064M.

        (e) If appropriate, tests of self-consolidating concrete listed in paragraph FRESH CONCRETE PROPERTIES, item c.

    (2) Cast specimens, test, and report hardened concrete property tests of each trial batch as follows:

        (a) Compressive strength at 3, 7, 28, 56 and 90 days in accordance with ASTM C39/C39M. Use of unbonded caps in accordance with ASTM C1231/C1231M is permitted.

        (b) Drying shrinkage.

        (c) Tensile strength (if required).

(d) Freeze-thaw durability factor (if required) must be determined as the mean of six test specimens comprised of at least two specimens cast from each batch.

(e) Initial chloride ion content.

(f) Spacing factor in accordance with ASTM C457/C457M.

(g) Chloride ion penetrability in accordance with ASTM C1202.

(3) Moist cure concrete intended for cast-in-place applications in accordance with the standard moist curing conditions described in ASTM C192/C192M unless otherwise specified. Moist cure concrete intended for precast applications in the manner proposed for use on the project.

d. For concrete mixtures that are proposed to contain corrosion inhibitors, the Contractor must submit the chloride ion penetration values from at least one batch of the mixture with and without the admixture making appropriate adjustments to maintain constant water to cementitious materials ratio. The purpose is to establish a correlation with respect to an adjusted value for production chloride ion penetration.

1.7.4 Concrete Qualification Program

1.7.4.1 Fresh Concrete Properties

a. Air Content: The mixture must be proportioned and tested for qualification.

b. Slump: The mixture must be proportioned and tested for qualification.

c. Self-Consolidating Concrete: When self-consolidating concrete is proposed for use, the mixture must be proportioned and tested for qualification using:

(1) ASTM C1611/C1611M slump flow must not be greater than 610 mm 24 inches, with visual stability index not greater than 1.

(2) ASTM C1621/C1621M Passing ability using the J-ring. Spread within 25 mm 1 inch less than the slump flow.

(3) Passing ability using the L-Box between 4 and 8 seconds

(4) ASTM C1610/C1610M, static segregation must be less than 4.0 percent.

For process control sampling, the slump flow limit as determined by ASTM C1611/C1611M must be no greater than 610 mm 24 inches and the visual stability index limit must be no greater than 1.0.

d. Underwater concrete: When the concrete is intended for placement under water using the tremie technique, the concrete must be proportioned to be cohesive and flow with minimal segregation. Anti-washout or viscosity modifying admixtures are permitted for underwater concrete. Proportioning guidance in ACI 304R must be considered. Concrete mixtures must be qualified for tremie placement methods based on a trial placement approved by the Contracting Officer.

1.7.4.2 Hardened Concrete Properties

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NOTE: Navy waterfront structures typically take a year or more to complete. With time all concrete continues to gain strength. The Engineer of Record is encouraged to design the structural elements based on the compressive strength that will be achieved at 56 or 90 days rather than at 28 days. Doing so will better allow the Contractor to develop and place concrete mixtures with less portland cement. Excessive use of cement may lead to more cracking and potential for associated deterioration. Embracing this approach will result in structures that are less expensive, greener and more sustainable.

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a. Compressive Strength: The structural engineer must specify the minimum compressive strength results at [28][56] days. Determine compressive strength (f'cr) for qualification of concrete mixtures and for quality acceptance testing. A compressive strength test result is defined as the mean of three properly conducted tests on 100 by 200 mm 4 by 8 inch cylinders in accordance with ASTM C39/C39M. Alternatively and for concrete mixtures containing a maximum size aggregate greater than 25.4 mm 1 inch, a strength test result must be defined as the mean of two properly conducted 28-day tests on 150 by 300 mm 6 by 12 inch cylindrical specimens in accordance with ASTM C39/C39M. In addition:

(1) Specified Compressive Strength: For structural concrete elements exposed in a marine environment, the minimum specified [28][56] day design strength is denoted as (f'c). Strength of concrete containing 35 percent or more fly ash must be specified at a minimum of 56 days.

(2) Required Average Compressive Strength: The concrete must be proportioned such that the minimum required average compressive strength (f'cr) exceeds the specified design strength (f'c) as per ACI 301M ACI 301.

(3) The average compressive strength may not exceed the specified strength at the same age by more than 20 percent unless approved by the Engineer of Record.

(4) Strength of any individual concrete placement must be considered satisfactory if both the following requirements are met:

(a) The arithmetic mean of any three consecutive lot strength tests is between 1.0 and 1.2 f'c, and;

(b) No individual strength test result is less than 0.90 f'c.

(5) In the event that a placement is represented by single sampling lot, strength must be considered satisfactory if either:

(a) The mean of the initial test is between 1.0 and 1.2 f'c, or;

(b) The mean of the initial test and retest is between 1.0 and 1.2 f'c, and neither strength test result is less than 0.90 f'c.

(6) For underwater concrete, cast compressive strength samples by placing concrete in four 5-gallon buckets below water using similar placement as the project. Permanently mark buckets as "3 days," "7 days," "[28][56] days," and "Extra." Include date and station. Provide specimen sets at every [76.5 cubic meters] [100 cubic yards] of concrete for the first [382.3 cubic meters] [500 cubic yards], then every [382.3 cubic meters] [500 cubic yards] thereafter with a minimum of one set per day of underwater concrete placement.

(a) Retrieve buckets at specified intervals and extract three cores from each bucket. Conduct compressive strength test in accordance with ASTM C42/C42M.

(b) Strength of underwater concrete must be satisfactory if the compressive strength result from extracted cores at the age of the specified strength is between 0.85 and 1.2 f'c with no individual strength test result less than 0.75 f'c.

b. Drying Shrinkage: Determine drying shrinkage for qualification of concrete mixtures prior to the fabrication of the Test Section and from samples made during the fabrication of the Test Section (see paragraph TEST SECTION). No test results must exceed the limits in Table 1. A drying shrinkage test result must be the mean value from three or more individual specimens constituting a test set. If an individual specimen's measurements deviate from the mean value by more than 0.009 percent length change, the specimen's measurements must be discarded and a new average established. Casting more than three specimens for each set is permitted. Test procedures and test specimens must conform to the following:

c. Drying shrinkage specimens, typically 75 by 75 by 285.8 mm 3 by 3 by 11.25 inch prisms for 25.4 mm 1 inchmaximum size aggregate or smaller, must be fabricated, cured, dried, and measured at 28 days in the manner delineated in ASTM C157/C157M. Mixtures containing 50 percent or more supplementary cementing materials must meet the shrinkage criteria at 56 days.

d. Tensile strength: Determine splitting-tensile strength of concrete only for qualification of concrete mixtures. Determine and report the splitting-tensile strength result of each class of concrete in accordance with ASTM C496/C496M as the mean of three properly conducted tests at the age specified for f'c and again at 90-days age for information only.

e. Freeze-thaw durability: Determine the freeze-thaw durability factor of concrete for qualification of concrete mixtures, if required by environmental conditions. Determine and report the freeze-thaw durability factor of each class of concrete in accordance with ASTM C666/C666M Method-A. Start testing after 28 days of moist curing. The minimum acceptable durability factor must be as per Table 1.

f. Acid Soluble Chloride Ion Content: Determine the chloride ion content only for qualification of concrete mixtures. Determine acid soluble chloride ion content in accordance with ASTM C1152/C1152M. The limits for allowable acid-soluble chloride ion concentrations in hardened concrete are listed in Table 1.

g. Chloride Ion Penetrability: Determine the resistance of concrete to the penetration of chloride ions in accordance with ASTM C1202 during the prequalification phase. The average of three samples must meet the limit specified Table 1.

1.7.4.3 Supplemental Corrosion Protection

Requirements for the use of supplemental corrosion protection, if any, must be indicated on the plans.

1.7.5 Mass Concrete Temperature Control Plans

a. Thirty days minimum prior to concrete placement, submit for approval a mass concrete temperature control plan that includes:

(1) Location and identification of temperature monitoring sensors.

(2) Product data for automated temperature sensors and recording equipment.

(3) Cooling pipe layout diagram with sizes and materials, if used.

(4) Proposed insulation materials and associated R-values.

(5) Anticipated form removal schedule and curing procedures.

(6) Maximum allowable concrete placement temperature for the range of anticipated ambient temperatures based on thermal modeling.

(7) Monitoring procedures and contingency plans.

Concrete placement temperature must be based on results of thermal modeling for the element incorporating: the heat of hydration and specific heat capacity for the concrete mixture, solar gain, and heat transfer to the environment through formwork, insulation, and cooling techniques.

Mass concrete temperature control must be monitored using automated temperature recording devices that allow wireless transmission of data to an on-site host computer for real-time monitoring of temperatures.

Temperature control sensor layout for each placement must be provided with individual sensor ID identified.

Minimum sensor requirements include at least two sensors for each placement located as follows:

(8) The geometric center of the element cross-section.

(9) Within 76.2 mm 3 inches of the side forms at mid-height.

(10) Within 76.2 mm 3 inches of the top surface located directly above the center sensors.

(11) Within 76.2 mm 3 inches from the top corner at the intersection of

side forms.

(12) Ambient temperature sensors placed in a shaded location.

Procedures for installing, protecting sensors during placement, and testing sensors a minimum of 24 hours prior to concrete placement must be provided. Initiate sensor recording at least 2 hours prior to placement. Verify function of all sensors prior to and upon completion of concrete placing operations. Provide additional sensors for placements greater than 305.8 cubic meters 400 cubic yards at each location.

Submit procedures for controlling concrete temperatures within the following limits:

(13) Maximum temperature must be less than 70 degrees C 158 degrees F.

(14) Maximum temperature differential between the mean of all functioning center sensor temperatures to any individual surface or corner sensor must be less than 20 degrees C 36 degrees F.

(15) Temperature control procedures must remain in effect until the differential between the ambient low temperature and mean of all functioning center sensor temperatures is less than 20 degrees C 36 degrees F.

(16) An additional submittal must be provided for the Contracting Officer's approval in the event the Contractor fails to control temperatures within the limits listed above. The submittal must include documentation of any cracks that develop, identify revisions to control procedures to prevent future cracking, and procedures to seal or otherwise mitigate defects.

b. Mass Concrete Mock-up: For concrete mixtures intended for mass concrete, cast thirty-one 100 by 200 mm 4 by 8 inch cylinder specimens in accordance with ASTM C192/C192M, three 75 by 75 by 285.8 mm 3 by 3 by 11.25 inch concrete prisms in accordance with ASTM C157/C157M, and at least one semi-adiabatic cube from a trial batch.

The semi adiabatic cube must have a minimum dimension of 1.0 m 3 feet per side, and must be insulated all sides with a minimum R-value of 30. Install pairs of thermocouples at the center of mass, the middle of each side, the top surface, and the top corner. Automatically record the temperature of each sensor hourly for one week. Additional cubes may be cast to calibrate active cooling system performance.

(1) Conduct compressive strength development testing at 3, 7, [28][56], and 90 days age using three specimens per age in accordance with ASTM C39/C39M, and develop a compressive strength prediction equation for the concrete mixture in accordance with ASTM C1074.

(2) Conduct tensile strength tests at 3, 7, [28][56], and 90 days on two specimens per age in accordance with ASTM C496/C496M, and develop a tensile strength prediction equation for the concrete mixture in accordance with ASTM C1074.

(3) Conduct elastic modulus tests at 3, 7, [28][56], and 90 days on two specimens per age in accordance with ASTM C469/C469M, and

develop an elastic modulus prediction equation for the concrete mixture in accordance with ASTM C1074.

Conduct coefficient of thermal expansion testing in accordance with COE CRD-C 39 after 28 days of moist curing. Test specimens in a saturated condition.

Report all test results and predictive equations in the mock-up submittal. The predictive equations may be used by the Contractor to establish the duration of temperature control and form removal based on the allowable temperature differential between the concrete core and ambient low temperature.

1.8   CONCRETE

1.8.1   Drawings

Fabrication Drawings for concrete formwork, reinforcement materials, precast elements, wall forms, and bulkhead forms must indicate concrete pressure calculations with both live and dead loads, along with material types. Provide design calculations by a registered Civil or Structural Engineer for the formwork.

1.8.1.1   Formwork

Prior to commencing work, submit drawings for approval showing details of formwork including, but not limited to: joints, supports, studding and shoring, and sequence of form and shoring removal. Reproductions of contract drawings are unacceptable.

Design, fabricate, erect, support, brace, and maintain formwork so that it is capable of supporting without failure all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.

ACI 347R. Include design calculations indicating arrangement of forms, sizes, species, and grades of supports (lumber), panels, and related components. Indicate placement schedule, construction, and location and method of forming control joints. Include locations of inserts, pipe work, conduit, sleeves, and other embedded items. Furnish drawings and descriptions of shoring and reshoring methods proposed for slabs, beams, and other horizontal concrete members.

1.8.1.2   Reinforcing Steel

ACI MNL-66. Provide bending and cutting diagrams, assembly diagrams, splicing placement and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Only complete drawings will be accepted.

1.8.1.3   Precast Elements

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NOTE: Modify requirements based on the scope of the project.

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Submit drawings and design calculations indicating complete information for the fabrication, handling, and erection of the precast elements. Drawings must not be reproductions of contract drawings.

1.8.1.4 Joints

Submit a plan indicating the type and location of each construction joint. Final joint locations are subject to Government approval.

1.8.2 Pre-Construction Submittals

1.8.2.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.8.2.2 Concrete Curing Plan

Submit proposed materials, methods, and duration for curing and cooling concrete elements in accordance with ACI 308.1.

Minimum moist curing duration must be seven days.

Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

1.8.2.3 Form Removal Schedule

Submit schedule for form removal indicating element and minimum length of time for form removal. Submit technical literature of forming material or liner, form release agent, form ties, and gasketing to prevent leakage at form and construction joints. Provide a full description of materials and methods to be used to patch form-tie holes.

1.8.2.4 Concrete Placement and Compaction

a. Submit technical literature for equipment and methods proposed for use in placing concrete. Include concrete pumping or conveying equipment including type, size and material for pipe, valve characteristics, and the maximum length and height concrete will be pumped. No adjustments must be made to the mixture design to facilitate pumping.

b. Submit technical literature for equipment and methods proposed for vibrating and compacting concrete. Submittal must include technical literature describing the equipment including vibrator diameter, length, frequency, amplitude, centrifugal force, and manufacturer's description of the radius of influence under load. Where flat work is to be cast, provide similar information relative to the proposed compacting screed or other method to ensure dense placement.

1.8.2.5 Concrete Report

Provide a Report inclusive of materials and methods used, test results, and the field test strength (fcr) for concrete that shows compliance with the structural and durability requirements.

1.8.2.6 Coatings

Coatings are considered to be "supplemental Corrosion Protection". Surface preparation and installation of any coatings on concrete must be conducted in strict compliance with written manufacturer instructions. Submit the product data and written manufacturer instructions. A manufacturer representative must train installers, witness initial installation, and certify that the installation was conducted in accordance with the instructions.

1.8.2.7 Preconstruction Testing of Materials

All sampling and testing must be performed by, and at the expense of, the Contractor. Use an approved commercial laboratory or, for cementitious materials and chemical admixtures, a laboratory maintained by the manufacturer of the material. No material must be used until notice of acceptance has been given. The Contractor will not be entitled to any additional payment or extension of time due to failure of any material to meet project requirements, or for any additional sampling or testing required. Additional tests may be performed by the Government at the discretion of the Contracting Officer; such Government testing will not relieve the Contractor of any testing responsibilities.

1.8.2.8 Material Safety Data Sheets

Submit Material Safety Data Sheets (SDS) for all materials that are regulated for hazardous health effects. Prominently post the SDS at the construction site.

1.8.2.9 Mixture Designs

Provide a detailed report of materials and methods used, test results, and the field test strength (fcr) for marine concrete required to meet structural and durability requirements.

1.8.3 Sampling

The Contractor is responsible for conducting concrete production process control sampling and testing in compliance with this specification.

1.8.3.1 Ingredient Material Sampling

a. Cementitious material mill certificates and test reports must be provided for each shipment. Record the date delivered and quantity of material represented by the certificate.

b. Conduct and log aggregate moisture content at a minimum frequency of twice daily for each day's production. Use of moisture sensors in storage bins is recommended practice, but does not satisfy this requirement.

c. Aggregate sampling for gradation and dry-rodded unit weight must be conducted for each 100 tons delivered for use on the project, or portion thereof.

1.8.4 Reporting

1.8.4.1 Daily Inspection Reports

Contractor must prepare daily inspection reports for all inspection activities such as base preparation, formwork preparation, reinforcement installation, concrete placement log, and temperature control activities. Submit sample forms and describe the procedure used to organize, archive, and retrieve inspection records in the Quality Program submittal.

1.8.4.2 Sampling Logs

Contractor must maintain a concrete placement log as an electronic spreadsheet or database identifying each placement date, placement location, volume of concrete, batch ticket numbers, lot identification code, fresh concrete properties, compressive strength results, transport properties, inspection comments, and acceptance status. Contractor must provide/transmit the concrete testing log to the Contracting Officer weekly. The Contractor must provide copies of supporting documents for any placement requested by the Contracting Officer immediately upon request.

1.8.4.3 Quality Control Data

The Contractor must prepare, maintain, and report separate quality control charts illustrating the slump, temperature, plastic air content, compressive strength, and chloride ion penetration test results for each lot of each concrete mixture used on the project.

1.8.4.4 Quality Team Meetings

The contractor must conduct regular quality control team meetings to review plans for future placements, review test results, and discuss dispensation of non-conforming materials. The quality team must include the Contractor's quality manager, the project manager, the project superintendent, the Contracting Officer, and representatives of the testing agency and concrete producer, or approved substitutes. It is recommended that the meetings be held on a weekly or bi-weekly basis during preconstruction phases and then monthly, as the construction progresses. The transition from the weekly or bi-weekly meetings to the monthly meetings must be with the Contracting Officer's approval.

The Contractor must prepare quality control team meeting minutes for each meeting. The minutes must include the date of each meeting, attendees, key discussion points, findings, recommendations, assigned tasks, assigned personnel, task completion dates, and status of each task.

1.8.4.5 Non-conforming materials

The exact location of non-conforming concrete as placed must be identified and the Contracting Officer and Engineer of Record must be notified immediately. There are numerous possible indicators that the as-placed concrete is non-conforming including (but not limited to) excessive compressive strength, inadequate compressive strength, excessive slump, chloride ions penetration out of limits, excessive voids and honeycombing, and concrete delivery records that indicate excessive time between mixing and placement [and][or] excessive water was added to the mixture during delivery and placement. Any of these indicators alone are sufficient reason for the Contracting Officer to request additional sampling and testing to quantify the concrete properties. If justified, cores may be extracted for testing, and an investigation into the cause for non-conformance must be conducted. The investigation may include statistical analysis of the test data collected to date; appropriateness of the pre-defined QAL based on statistical analysis of production data; the impact of the non-conforming material on the structure strength and/or service life; and recommendations for concrete production process improvements, mitigation, or remediation, as appropriate.

Investigations into non-conforming materials must be conducted at the Contractor's expense. The Contractor is responsible for the investigation and must make written recommendations to adequately mitigate or remediate the non-conforming material. The Contracting Officer may accept, accept with reduced payment, require mitigation, or require removal and replacement of non-conforming material at no additional cost to the Government.

1.8.5 Test Reports

Concrete Test Reports must be identified by a sequential report identification code. Each report must identify the placement date, placement location, weather, name of testing technician, time of sampling, batch ticket number, fresh concrete test results, and hardened concrete test results.

1.8.5.1 Concrete Mixture Requirements

a. Submit copies of test reports conforming to ASTM C1077 showing that the mixture has been successfully tested to produce concrete with the properties specified and that mixture will be suitable for the job conditions. Test reports must be submitted along with the concrete mixture proportions. Obtain approval before concrete placement.

b. Fully describe the processes and methodology whereby mixture proportions were developed and tested and how proportions will be adjusted during progress of the work to achieve, as closely as possible, the designated levels of relevant properties.

1.8.5.2 Supplementary Cementing Materials

Submit test results in accordance with ASTM C618 and the physical and chemical analysis in accordance with applicable ASTM standards such as ASTM C311/C311M for fly ash. Submit test results performed within 6 months of submittal date. Update this report during construction as necessary to assure that the supplementary cementing materials used on the projects meets the ASTM criteria and the report on file is never older than 6 months.

1.8.5.2.1 Slag Cement

Submit test results in accordance with ASTM C989/C989M. Submit test results performed within 6 months of submittal date. Update this report during construction as necessary to assure that the report on file is never older than 6 months.

1.8.5.2.2 Ultra Fine Fly Ash or Pozzolan

Submit test results in accordance with ASTM C618 as a Class F fly ash or Class N pozzolan with the following additional requirements:

a. The strength activity index at 28 days must be at least 95 percent of the control.

b. The average particle size must not exceed 6 microns.

c. The sum SiO_2 plus Al_2O_3 plus Fe_2O_3 must be greater than 77 percent.

Submit test results performed within 6 months of submittal date. Update this report during construction as necessary to assure that the report on file is never older than 6 months.

1.8.5.3 Silica Fume

Submit test results in accordance with ASTM C1240 for silica fume. Data must be based upon tests performed within 6 months of submittal. Update this report during construction as necessary to assure that the report on file is never older than 6 months.

1.8.5.4 Aggregates

Aggregate samples must be obtained in accordance with ASTM D75/D75M and must be representative of the materials to be used for the project. Submit test results for aggregate quality in accordance with ASTM C33/C33M, and the combined gradation curve proposed for use in the work and used in the mixture qualification, and ASTM C295/C295M for results of petrographic examination. Confirm that the potential for alkali-silica reaction are within allowable limits by conducting tests in accordance with ASTM C1260. Submit results of all tests during progress of the work in tabular and graphical form as noted above, describing the cumulative combined aggregate grading and the percent of the combined aggregate retained on each sieve. Submit test results performed within 12 months of submittal date.

1.8.5.5 Admixtures

Submit test results in accordance with ASTM C494/C494M and ASTM C1017/C1017M for concrete admixtures, ASTM C260/C260M for air-entraining admixture, and manufacturer's literature and test reports for corrosion inhibitors and anti-washout admixture. Submitted data must be based upon tests performed within 6 months of submittal. Submit certified copies of test results for the specific lots or batches to be used on the project. Test results must be not more than 6 months old prior to use in the work. Chemical admixtures that have been in storage at the project site for longer than 6 months or that has been subjected to freezing will be retested at the expense of the Contractor.

1.8.5.6 Portland Cement

Portland cement[, slag cement,][and pozzolan] will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports showing that the material in each shipment meets the requirements of the specification under which it is furnished. Mill test reports must be no more than 1 month old, prior to use in the work. No cementitious material must be used until notice of acceptance has been given by the Contracting Officer. Cementitious material may be subjected to check testing by the Government from samples obtained at the mill, at transfer points, or at the project site. If tests prove that a cementitious material that has been delivered is unsatisfactory, it must be promptly removed at Contractor's expense from the site of the work. Cementitious material that has not been used within 6 months after testing must be retested at the Contractor's expense and must be rejected if test results are not satisfactory. Submit test results in accordance with ASTM C150/C150M portland cement and/or ASTM C595/C595M and ASTM C1157/C1157M for blended cement.

1.8.5.7 Testing During Construction

During construction, the Contractor is responsible for sampling and testing aggregates, cementitious materials, and concrete as specified herein. The Government will sample and test concrete and ingredient materials as considered appropriate. Provide facilities and labor as may be necessary for procurement of representative test samples. Testing by the Government will in no way relieve the Contractor of the specified testing requirements.

1.8.5.8 Test Section

a. Horizontal Placements. No more than 90 days prior to construction, construct a Test Section 3048 mm by 3048 mm by 203.2 mm 10 by 10 feet by 8 inches thick near the job site, but not as part of the structure. The Test Section must meet all specification requirements and be acceptable to the Contracting Officer in all respects, including but not limited to delivery time, placement, consolidation, curing and surface texture. Use the Test Section to develop and demonstrate to the satisfaction of the Contracting Officer the proposed techniques of mixing, hauling, placing, consolidating, finishing, curing, initial saw cutting, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. The mixing plant must be operated and equipment calibrated prior to start of placing the Test Section. Use the same equipment, materials, and construction techniques on the Test Section as will be used in all subsequent work. Concrete production, placing, consolidating, curing, construction of joints, and all testing must be in accordance with applicable provisions of this specification. At a minimum of three days after completion of the Test Section, extract a sufficient number of concrete cores 100 by 200 mm 4 by 8 inch to conduct tests to evaluate strength, air void spacing factor, homogeneity, consolidation, segregation, and chloride ion penetration properties. Test Results that are unacceptable Test Section will necessitate construction of an additional Test Section at no additional cost to the Government

b. Vertical Placements. No more than 90 days prior to construction, construct a Test Section that represents the vertical placements, (if applicable) near the job site, but not as part of the structure. Test Section must meet all specification requirements and being acceptable to the Contracting Officer in all respects, including but not limited to delivery time, placement, consolidation, curing and surface texture. Use the Test Section to develop and demonstrate to the satisfaction of the Contracting Officer the proposed techniques of mixing, hauling, placing, consolidating, finishing, curing, initial saw cutting, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. The mixing plant must be operated and equipment calibrated prior to start of placing the Test Section. Use the same equipment, materials, and construction techniques on the Test Section as will be used in all subsequent work. Concrete production, placing, consolidating, curing, construction of joints, and all testing must be in accordance with applicable provisions of this specification. At a minimum of three days after completion of the Test Section, extract a sufficient number of concrete cores to evaluate strength, air void spacing factor, homogeneity, consolidation, segregation, and chloride ion penetration properties.

If any of the test results are unacceptable, the Contracting Officer may require that a new Test Section be accomplished at no additional cost to the Government.

1.8.5.9 Acceptability of Work

The materials and the structure itself will be accepted on the basis of tests made by the Contractor and must be in compliance with the criteria herein. The Government may make check tests at its expense to validate the results of the Contractor's testing. Testing performed by the Government will in no way relieve the Contractor from the specified testing requirements.

PART 2 PRODUCTS

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NOTE: Delete any reference to any products that are not to be used on the project. Coordinate all product requirements with the appropriate agency's Contracting Officer.

****

2.1 CEMENTITIOUS MATERIALS

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NOTE: Edit these paragraphs as appropriate for the particular project. Guidance for use of cementitious materials should be sought from the agency's Subject Matter Expert in Concrete Materials. Consideration should be given to the use of fly ash or slag cement for partial replacement of portland cement up to 50 percent. Type III cement should not be specified without concurrence of the agency's Subject Matter Expert in Concrete Materials.

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NOTE: Supplementary Cementitious Materials (SCM)

When slag cement, coal fly ash, and natural pozzolans are used as cementing materials for replacement of portland cement in a concrete mixture, and if by doing so the sustainability, durability and the initial cost of the concrete mixture show considerable improvement then these materials are called "supplementary cementitious materials" (SCM).

The Engineer of Record is encouraged to specify the use of supplementary cementing materials. For example, 50 percent replacement of the portland cement using Class F fly ash has been successfully demonstrated to offer the required compressive strength (f'cr), drying shrinkage, lower permeability, constructability, and the potential to accomplish a structure with the design service life while being less expensive with a smaller carbon footprint.

****

Cementitious materials must be portland cement or cement blended with supplementary cementing materials. New submittals are required when the cementitious materials change sources or types.

The Contractor must provide cementitious materials meeting the requirements of the applicable specification, and as modified herein. Provide mill certificates and test results conducted within six-months of the submittal date as part of the concrete mixture qualification submittal.

Provide a single manufacturer of cementitious material for each type of cement and supplementary cementing materials supplied to the project.

2.1.1 Portland Cement

****

NOTE: Use Type II or Type V cement in project locations with Environmental Severity Classifications (ESC) of C3 thru C5 or where deicing salts are used on the structure. See UFC 1-200-01 for determination of ESC for project locations.

****

Provide portland cement conforming to ASTM C150/C150M, Type [I][II][V],[including early stiffening requirements] with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na_2O_{eq} (sodium oxide equivalent). Type III cement must be used only with concurrence of the agency's Subject Matter Expert in Concrete Materials. When HVFA mixtures are specified, they should be blended with Type II portland cement. HVFA is required instead of using Type V cement in high-sulfate areas. If the proposed aggregates are found to be expansive, additional requirements to cement in accordance with AASHTO R 80 or ASTM C1778 must be imposed.

ASTM C150/C150M cements must be combined with supplementary cementing materials in the concrete mixture.

2.1.2 Blended Cements

Blended cement must conform to ASTM C595/C595M, Type IL, IP, IS, or IT including the optional requirement for sulfate resistance indicated by MS or HS designations. Any fly ash used in Type IP cement must be ASTM C618 Class F fly ash. A statement from the cement manufacturer indicating that the finished cement will not vary more than the percentage listed in Table 5 of ASTM C595/C595M with a 99 percent probability of compliance between lots or within a lot must be included in the Mixture Designs report. The type and percentage of supplementary cementitious materials or limestone used in the blend must not change from that submitted for the aggregate evaluation and mixture proportioning.

2.1.3 Pozzolan

2.1.3.1 Fly Ash

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NOTE: Class C fly ash is not permitted. Use loss on ignition not exceeding 3 percent for frost areas to reduce carbon interference with air entraining admixture.

****

Fly ash must conform to ASTM C618, Class F, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and must have a loss on ignition not exceeding [3][6] percent. Class F fly ash for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 8 percent and a total equivalent alkali content less than 1.5 percent. Add with cement.

2.1.3.2 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and must have a loss on ignition not exceeding 3 percent. Class N pozzolan for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 13 percent and total equivalent alkali content less than 3 percent.

2.1.3.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.

b. The average particle size must not exceed 6 microns.

c. The sum of $SiO_2 + Al_2O_3 + Fe_2O_3$ must be greater than 77 percent.

2.1.4 Slag Cement

Slag cement must conform to ASTM C989/C989M,[Grade 100 or Grade 120]. Add with cement.

2.1.5 Silica Fume

****

NOTE: Silica Fume must only be used for OCONUS projects where Class F fly ash and slag cement are not available, and when approved by the Contracting Officer. Guidance for use of silica fume should be sought from the agency's Subject Matter Expert in Concrete Materials.

****

Silica fume must conform to ASTM C1240, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as slurry. Proper mixing is essential to accomplish proper distribution of the silica fume and avoid agglomerated silica fume, which can react with the alkali in the cement resulting in premature and extensive concrete damage. Supervision at the batch plant, finishing, and curing is essential. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume. A High Range Water Reducer (HRWR) must be used with silica fume. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.

2.1.6 Supplementary Cementitious Materials (SCM) Content

The concrete mix must always contain supplementary cementing materials whether or not the aggregates are found to be reactive in accordance with the paragraph AGGREGATES. Concrete mixtures must be designed and proportioned to meet the requirements for strength, constructability, shrinkage, and durability.

****

NOTE: This specification requires that the structural requirements (f'c) be met and concrete strength is between 1.0 f'c and 1.2 f'c. If the prequalified mixture as approved by the Engineer of Record should produce a higher design strength (fcr), that strength must be used instead of f'c. Maintain required w/cm ratio regardless of strength requirements.

****

2.2 AGGREGATES

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NOTE: The largest possible aggregate size that meets the nominal maximum size requirements of ACI 318 should be used. Larger aggregates permit a leaner mixture with low paste content while maintaining workability.

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NOTE: In some tropical locations where standard aggregate such as gravel or manufactured aggregates are not readily available, the use of coral aggregate is acceptable. The specific gravity of any coralline material must not be less than 2.40. Specify coral aggregates with higher specific gravity wherever available. Wash aggregates dredged from the ocean or lagoons with fresh water to remove as much salt as possible. Include bracketed paragraph where coral will be used as an aggregate.

****

Comply with ASTM C33/C33M Class 4S, except as modified herein. The maximum aggregate size permitted for each concrete mix must be in accordance with Table 4.

Table 4 Maximum Aggregate Size

Concrete Mix Design and Component	Maximum Aggregate Size (mm) (inches)
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

Table 4 Maximum Aggregate Size	
[_____]	[_____]

The quantities to be retained on each sieve may be adjusted only where available aggregates are elongated or slivered and cause interference with mix mobility, or available aggregate gradations do not comply with the 18-8 requirement. When necessary to satisfy local conditions and when permitted, the combined aggregate percentages may be changed to not more than 22 percent nor less than 6 percent retained on any individual sieve. The combined aggregates in the mixture (coarse, intermediate, and fine) must be well graded with no more than 18 percent nor less than 8 percent of the combined aggregate retained on any individual sieve, unless satisfactory performance can be demonstrated. The 300 micrometers No. 50 sieve may have less than 8 percent retained; sieves finer than 300 micrometers No. 50 must have less than 8 percent retained, and the coarsest sieve may have less than 8 percent retained. Use intermediate sizes for blending where necessary, to provide a well graded combined aggregate.

a. Provide gradation of individual aggregate sizes using standard concrete aggregate sieves including 37.5 mm, 25 mm, 19 mm, 12.5 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 micrometers, 300 micrometers, 150 micrometers 1-1/2 inches, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, and No. 100.

b. Provide aggregates for exposed concrete from one source. Aggregate reactivity must be limited per the paragraph AGGREGATES. Provide aggregate containing no deleterious material properties as identified by ASTM C295/C295M.

c. Where a size designation is indicated, that designation indicates the nominal maximum size of the coarse aggregate.

d. Aggregate tests must be conducted within 6 months from the date of concrete mixture submittal.

e. Provide ASTM C1260 or ASTM C1567 test results conducted within 6 months of the submittal date showing the proposed coarse and fine aggregates are either: innocuous to alkali silica reaction; or that reactivity has been mitigated by the proposed cementitious materials as modified herein. Maximum allowable expansion is 0.08 percent at 14 days per ASTM C1260. If this is not met, then maximum allowable expansion for the proposed concrete mixture/s must be 0.08 percent at 14 days per ASTM C1567. All aggregate sources must be tested. Also, provide documentation that the aggregate has no history of chemical deterioration in concrete. Fine and coarse aggregates to be used in all concrete must be evaluated and tested for alkali-aggregate reactivity.

f. Should the test data indicate a potential risk of alkali-aggregate reaction, the aggregate(s) must be rejected or procedures from AASHTO R 80 or ASTM C1778 must be followed.

g. Coral may be used as a coarse aggregate when conventional concrete aggregate is not available. Coral aggregate must be washed to eliminate chloride ions from the aggregate. Specific gravity of coral must be at least 2.40.

2.3 WATER

Water must comply with the requirements of ASTM C94/C94M and ASTM C1602/C1602M, except that the chloride and sulfate limits as tested in accordance with ASTM D512 and ASTM D516 must not exceed 500 parts per million chloride ion and not more than 1000 parts per million of sulfate ion as SO4. Water must be free from injurious amounts of oils, acids, alkalis, salts, and organic materials. Where non-potable water or water from reprocessed concrete is proposed for use in the work, submit results of tests in accordance with ASTM C1602/C1602M. Submit test results in accordance with ASTM D512 and ASTM D516.

2.4 ADMIXTURES

a. Provide certifications that chemical admixtures comply with the requirements shown in Table 5 and are compatible with each other. Use admixtures in accordance with manufacturer's recommendations, as appropriate for the climatic conditions and construction needs.

b. Do not use calcium chloride or admixtures containing chloride ion content in more than trace amounts from impurities in admixture ingredients or potable water. Provide maximum concentrations of corrosion-inducing chemicals as shown in Table 5. For concrete that may be in contact with prestressing steel tendons, the concentration must not exceed 60 percent of the limits given in Table 5. For the concentration in grout for prestressing ducts, do not exceed 25 percent of the limits in Table 5.

Table 5 - Limits on Corrosion-Inducing Chemicals

Chemical*	Limits, Percent**	Test Method
Chlorides	0.10	ASTM D512
Fluorides	0.10	ASTM D1179
Nitrates	0.17	ASTM D3867

* Limits refer to water-soluble chemicals

** Limits are expressed as a percentage of the mass of the total cementitious materials.

c. Provide anti-washout or viscosity modifying admixtures for underwater concrete placement. Provide certification that the admixture is compatible with the cementitious materials and other chemical admixtures in the proposed concrete mixture. The use of anti-washout or viscosity modifying admixture requires approval by the Contracting Officer and a proven record of performance with a minimum of five similar projects must be submitted. Test per COE CRD-C 61 to determine cumulative mass loss must be performed once for each 267.6 cubic meters 350 cubic yards of underwater concrete and results submitted to Contracting Officer for approval prior to continued use.

d. The total alkali contribution of chemical admixtures must not increase the total sodium-oxide equivalent content of the concrete mixture by more than 0.3 kg/m3 0.5 lb/yd3.

2.4.1 Air Entraining

Provide air entraining admixtures conforming to ASTM C260/C260M.

2.4.2 Accelerating

ASTM C494/C494M, Type C.

2.4.3 Retarding

ASTM C494/C494M, Type B, D, or G.

2.4.4 Water Reducing

****

NOTE: The use of high range water reducers can be used to reduce the water-cementitious materials ratio which will produce a more dense concrete matrix and improve resistance to chloride ion penetration in the concrete.

****

ASTM C494/C494M, Type A, E, or F.

High Range Water Reducer (HRWR) must be ASTM C494/C494M, Type F and ASTM C1017/C1017M.

2.4.5 Corrosion Inhibitors

Corrosion inhibitors are considered "supplemental corrosion protection". If used, adjust the quantity of concrete mixing water for the mass of water in the admixture. Accelerating and set adjusted versions are acceptable. Concrete setting time and mixture workability must be evaluated.

2.4.6 Shrinkage-Reducing Admixture

ASTM C494/C494M, Type S.

2.4.7 Waterproofing/Hydrophobic Admixture

Waterproofing/hydrophobic admixture is considered "supplemental corrosion protection". If used, adjust the quantity of concrete mixing water for the mass of water in the admixture. Concrete setting time and mixture workability must be evaluated.

2.5 NON-SHRINK GROUT

ASTM C1107/C1107M.

2.6 MATERIALS FOR FORMS

Provide wood, plywood, or steel. Use plywood or steel forms where a smooth form finish is required. Lumber must be square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects.

Plywood: APA PS 1, B-B concrete form panels or better. Steel form surfaces must not contain irregularities, dents, or sags.

2.6.1 Form Ties and Form-Facing Material

a. Provide a form tie system that does not leave mild steel after break-off or removal any closer than 50 mm 2 inches from the exposed surface. Do not use wire alone. Form ties and accessories must not reduce the effective cover of the reinforcement.

b. Form-facing material must be structural plywood or other material that can absorb air and some of the high water-cementitious materials ratio surface paste that may be trapped in pockets between the form and the concrete. Maximum reuse is three times. Provide forms with a form treatment to prevent bond of the concrete to the forms. Use a controlled permeability form liner in strict accordance with the manufacturer's recommendations.

2.7 REINFORCEMENT

a. Bend reinforcement cold. Fabricate reinforcement in accordance with fabricating tolerances of ACI 117.

b. When handling and storing coated reinforcement, use equipment and methods that do not damage the coating. If stored outdoors for more than 2 months, cover coated reinforcement with opaque protective material.

c. Submit manufacturer's certified test report for reinforcement.

d. Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Placing drawings must indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.

e. Submit request with locations and details of splices not indicated in Contract Documents.

f. Submit request to place column dowels without using templates.

****

NOTE: Specify if and where (locations) field bending or straightening of reinforcing bars is permitted.

****

[g. Submit request and procedure to field-bend or straighten reinforcing bars partially embedded in concrete at locations not indicated in Contract Documents. Field bending or straightening of reinforcing bars is permitted[where indicated in the Contract Documents][in the following locations: [_____]].

] h. Submit request for field cutting, including location and type of bar to be cut and reason field cutting is required.

2.7.1 Prestressing Steel

****

NOTE: Use prestressing in fender and bearing piles and deck soffits wherever possible. Post-tensioning of pile caps and decks is recommended where feasible. Do not mix coated prestressing strands

and plain prestressing strands. This will produce a large corrosion cell between the plain strand and any defect in the coated strand.
****

Use seven-wire stress-relieved or low-relaxation strand conforming to ASTM A416/A416M, Grade 270. Use of indented seven-wire stress-relieved or low-relaxation strand conforming to ASTM A882/A882M, Grade 270; or epoxy-filled seven-wire stress-relieved or low-relaxation strand conforming to ASTM A886/A886M, Grade 270 is permitted in lieu of prestressing steel conforming to ASTM A416/A416M. Use prestressing steel free of grease, oil, wax, paint, soil, dirt, and loose rust. Do not use prestressing strands or wire having kinks, bends, or other defects.

2.7.2 Reinforcing Bars

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NOTE: It is intended that plain steel rebar with specified concrete cover of 75 mm 3.0 inches must normally be specified according to applicable codes.

ASTM A706/A706M bars are mainly used in seismic design or for welding. Do not mix coated rebar and plain reinforcing bars. This may produce a large corrosion cell between the plain bar and any defect in the coated bar.
****

****
NOTE: Use second recycled content option throughout this section if Contractor is choosing recycled content products in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.
****

The reinforcing selected must match the structural properties of the reinforcing specified. Alternative reinforcing bars must have similar structural properties to the specified reinforcing and may be used with the Contracting Officer's approval.

a. Reinforcing bars must be deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.

b. ASTM A615/A615M with the bars marked S, Grade [420][550][690][60][80][100]; or ASTM A996/A996M with the bars marked R, Grade [350][420][50][60], or marked A, Grade [300][420][40][60].[Cold drawn wire used for spiral reinforcement must conform to ASTM A1064/A1064M.][Provide reinforcing bars that contain a minimum of [100][_____] percent recycled content.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements.]

c. [Reinforcing bars may contain post-consumer or post-industrial recycled content.][Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.]

d. Submit mill certificates for reinforcing bars.

2.7.2.1 Reinforcement and Protective Coating

If applicable, provide coating manufacturer's and coating applicator's test data sheets certifying that applied coating meets the requirements of the concrete system specified on the Plans.

2.7.2.2 Galvanized Reinforcing Bars

****

NOTE: Class 1 has a zinc coating that is thicker than Class 2. For Class 1 bars, fabrication can be performed before or after coating. If fabrication is performed after coating, then the damage caused by fabrication should be repaired according to ASTM A767/767M. If needed, add any requirements for bars that require special finished bend diameters and indicate their locations.

****

a. Provide zinc-coated (galvanized) reinforcing bars that conform to ASTM A767/A767M,[Class 1][Class 2][with galvanizing [before][after] fabrication] as required by the contract Documents.

b. Coating damage incurred during shipment, handling, and placing of zinc-coated (galvanized) reinforcing bars must be repaired in accordance with ASTM A780/A780M. Damaged areas must not exceed 2 percent of surface area in each linear foot of each bar or bar must not be used. The 2 percent limit on maximum allowed damaged coating area must include previously repaired areas damaged before shipment as required by ASTM A767/A767M.

2.7.2.3 Epoxy-Coated Reinforcing Bars

****

NOTE: ASTM A775/A775M are coated when straight and then bent as needed and are not allowed while ASTM A934/A934M are bent prior to coating. Bending after coating might result in the epoxy coating to crack or debond from steel.

****

a. Provide epoxy-coated reinforcing bars that conform to ASTM A934/A934M, Grade [60][80][100].

b. Coatings must be applied in plants that are certified in accordance with Concrete Reinforcing Steel Institute (CRSI) Epoxy Coating Plant Certification Program or an equivalent program acceptable to the contracting officer.

c. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated reinforcing bars must be repaired. Repair damaged coating areas with patching material conforming to ASTM A934/A934M as applicable and in accordance with material manufacturer's written recommendations. Damaged coating area must not exceed 2 percent of surface area in each linear foot of each bar or bar must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A934/A934M as applicable.

Fading of coating color must not be cause for rejection of epoxy-coated reinforcing bars.

d. [Submit concrete Reinforcing Steel Institute (CRSI) Epoxy Coating Plant Certification][inspection and quality-control program of plant applying epoxy coating if proposed plant is not certified in accordance with CRSI Epoxy Coating Plant Certification Program].

2.7.2.4 Dual-coated Reinforcing Bars

a. Zinc and epoxy dual-coated reinforcing bars must conform to ASTM A1055/A1055M.

b. Coating damage incurred during shipment, storage, handling, and placing of zinc and epoxy dual-coated reinforcing bars must be repaired. Repair damaged coating areas with patching material conforming to ASTM A1055/A1055M and in accordance with material manufacturer's written recommendations. Damaged coating area must not exceed 2 percent of surface area in each linear foot of each bar or bar must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A1055/A1055M. Fading of coating color must not be cause for rejection of zinc and epoxy dual-coated reinforcing bars.

2.7.2.5 Low-carbon, Chromium, Steel Bars

Low-carbon, chromium, steel bars must conform to ASTM A1035/A1035M.

2.7.2.6 Stainless Steel Reinforcing Bars

Stainless steel bars must meet the requirements of ASTM A955/A955M.

2.7.2.7 Headed Reinforcing Bars

Headed reinforcing bars must conform to ASTM A970/A970M including Annex A1, and other specified requirements.

2.7.2.8 Bar Mats

a. Bar mats must conform to ASTM A184/A184M.

b. If coated bar mats are required, repair damaged coating as required in paragraphs GALVANIZED REINFORCING BARS, EPOXY-COATED REINFORCING BARS, and DUAL-COATED REINFORCING BARS.

2.7.2.9 Headed Shear Stud Reinforcement

Headed studs and headed stud assemblies must conform to ASTM A1044/A1044M.

2.7.2.10 Glass Fiber Reinforced Polymer (GFRP) Bars

Glass fiber reinforced polymer (GFRP) bars meeting the requirements of ASTM D7957/D7957M are a permitted alternative. The structure design must consider the use of GFRP bars, noting that GFRP bar is not an in-kind replacement of steel bars.

2.7.3 Mechanical Reinforcing Bar Connectors

a. Provide 125 percent minimum yield strength of the reinforcement bar being spliced.

b. Mechanical splices for galvanized reinforcing bars must be galvanized or coated with dielectric material.

c. Mechanical splices used with epoxy-coated or dual-coated reinforcing bars must be coated with dielectric material.

d. Mechanical splices for reinforcing bars not indicated in Contract Documents must not be used unless accepted by the Contracting Officer.

e. .Remove coating on reinforcing bar in area of mechanical splice if required by splice manufacturer. After installing mechanical splices on zinc-coated (galvanized), epoxy-coated, or zinc and epoxy dual-coated reinforcing bars, repair damaged coating and areas of removed coating in accordance with paragraphs GALVANIZED REINFORCING BARS, EPOXY-COATED REINFORCING BARS, and DUAL-COATED REINFORCING BARS, respectively. Coat exposed parts of mechanical splices used on coated bars with same material used to repair damaged coating.

f. Submit data on mechanical splices demonstrating compliance with this paragraph.

2.7.4 Wire

****

NOTE: Include in your Contract Documents the wire size, yield strength or grade, and any additional requirements not specified here for wires. For more information on wire reinforcement refer to WRI (Wire Reinforcement Institute) documents.

****

a. [Provide wire reinforcement that contains a minimum of [100][_____] percent recycled content.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements. Wire reinforcement may contain post-consumer or post-industrial recycled content.] Provide flat sheets of welded wire reinforcement for slabs and toppings.

b. Plain or deformed steel wire must conform to ASTM A1064/A1064M.

c. Stainless steel wire must conform to ASTM A1022/A1022M.

d. Epoxy-coated wire must conform to ASTM A884/A884M. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated wires must be repaired. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire, wire must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color must not be cause for rejection of epoxy-coated wire reinforcement.

2.7.5 Welded Wire Reinforcement

****

NOTE: Include in your Contract Documents the welded wire yield strength or grade, size and spacing, and

any additional requirements not specified here for wires.
****

a. Use welded wire reinforcement specified in Contract Documents and conforming to one or more of the specifications given herein.

b. Plain welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 300 mm 12 in. apart in direction of principal reinforcement.

c. Deformed welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 400 mm 16 in. apart in direction of principal reinforcement.

d. Epoxy-coated welded wire reinforcement must conform to ASTM A884/A884M. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated welded wire reinforcement must be repaired in accordance with ASTM A884/A884M. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color must not be cause for rejection of epoxy-coated welded wire reinforcement.

e. Stainless steel welded wire reinforcement must conform to ASTM A1022/A1022M.

f. Zinc-coated (galvanized) welded wire reinforcement must conform to ASTM A1060/A1060M. Coating damage incurred during shipment, storage, handling, and placing of zinc-coated (galvanized) welded wire reinforcement must be repaired in accordance with ASTM A780/A780M. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A1060/A1060M.

2.7.6 Reinforcing Bar Supports

****
NOTE: Include in your Contract Documents the types of reinforcement supports and location used within the structure. Refer to Chapter 3 in CRSI MSP 2.
****

a. Provide reinforcement support types within structure as required by Contract Documents. Reinforcement supports must conform to CRSI RB4.1. Submit description of reinforcement supports and materials for fastening coated reinforcement if not in conformance with CRSI RB4.1.

b. [For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar support.][For zinc-coated reinforcement, use galvanized wire or dielectric-polymer coated wire bar supports.]

****
NOTE: Supports must be coated when using epoxy-coated reinforcing bars.
****

c. Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

d. [Minimum [5][10][_____] percent post-consumer recycled content, or minimum [20][40][_____] percent post-industrial recycled content.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements. Plastic and steel may contain post-consumer or post-industrial recycled content.]

2.7.7 Welding

a. Provide weldable reinforcing bars that conform to ASTM A706/A706M and ASTM A615/A615M and Supplement S1, Grade 420 60, except that the maximum carbon content must be 0.55 percent.

b. Comply with AWS D1.4/D1.4M unless otherwise specified. Do not tack weld reinforcing bars.

c. Welded assemblies of steel reinforcement produced under factory conditions, such as welded wire reinforcement, bar mats, and deformed bar anchors, are allowed.

d. After completing welds on zinc-coated (galvanized), epoxy-coated, or zinc and epoxy dual-coated reinforcement, coat welds and repair coating damage as previously specified.

2.8 ACCESSORY MATERIALS

2.8.1 Polyvinylchloride Waterstops

COE CRD-C 572.

2.8.2 Materials for Curing Concrete

2.8.2.1 Impervious Sheeting

ASTM C171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.8.2.2 Pervious Sheeting

AASHTO M 182 or carpet covering the free surface and kept continuously wet throughout the curing period.

2.8.2.3 Liquid Membrane-Forming Compound

Comply with ASTM C309, white-pigmented, Type 2, Class B.

2.8.3 Liquid Chemical Sealer-Hardener Compound

Provide magnesium fluosilicate compound which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound must not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.8.4 Expansion/Contraction Joint Filler

Comply with ASTM D1751 or ASTM D1752, 13 mm 1/2 inch thick unless otherwise indicated.

2.8.5 Joint Sealants

2.8.5.1 Horizontal Surfaces

****

NOTE: For horizontal surfaces subject to jet fuel, specify section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT.

****

Horizontal surfaces are defined as all surfaces with a 3 percent maximum slope. ASTM D6690 or ASTM C920, Type M, Class 25, Use T.

2.8.5.2 Vertical Surfaces

****

NOTE: Specify ASTM C920 for vertical surfaces greater than 3 percent slope and not subject to jet fuel, gasoline, fuel oil, etc. For vertical surfaces greater than 3 percent slope and subject to jet fuel, specify FS SS-S-200, no sag.

****

Vertical surfaces are defined as all surfaces with a slope greater than 3 percent. ASTM C920, Type M, Grade NS, Class 25, Use T. FS SS-S-200, no sag.

PART 3 EXECUTION

3.1 FORMS

a. Provide formwork with clean-out openings to permit inspection and removal of debris. Formwork must be gasketed or otherwise rendered sufficiently tight to prevent leakage of paste or grout under heavy, high-frequency vibration. Use a release agent that does not cause surface dusting. Limit reuse of plywood to no more than three times. Reuse may be further limited by the Contracting Officer if it is found that the pores of the plywood are clogged with paste so that the wood does not absorb air and some of the high water-cementitious materials ratio paste that may be trapped in pockets between the form and the concrete.

b. Comply with ACI 301M ACI 301. Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 100 mm 4 inches greater than indicated. Set forms rigidly, mortar-tight, and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 20 mm 0.75 inch unless otherwise indicated. Forms submerged in water must be watertight.

c. Patch form tie holes with a no shrink patching material in accordance with the manufacturer's recommendations and subject to approval.

3.1.1 Coating

Before concrete placement, coat the contact surfaces of forms with a no staining mineral oil, no staining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.1.2 Removal of Forms and Supports

After placing concrete, forms must remain in place for the time periods specified in ACI 347R, except for concrete placed underwater, forms must remain in place a minimum of 48 hours. Prevent concrete damage during form removal.

3.1.2.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if ASTM C39/C39M test results of field-cured samples from a representative portion of the structure or other approved and calibrated non-destructive testing techniques show that the concrete has reached a minimum of 85 percent of the design strength.

3.1.3 Reshoring

Do not allow construction loads to exceed the superimposed load that the structural member, with necessary supplemental support, is capable of carrying safely and without damage. Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, slabs and beams over 3 meters 10 feet in span and cantilevers over 1.2 meters 4 feet must be reshored for the remainder of the specified time period in accordance with paragraph REMOVAL OF FORMS AND SUPPORTS. Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Reshoring elements must have the same load-carry capabilities as original shoring and must be spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.2 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

a. Unless otherwise specified, placing reinforcement and miscellaneous materials must be in accordance with ACI 301M ACI 301. Provide bars, welded wire reinforcement, wire ties, supports and other devices necessary to install and secure reinforcement.

b. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area of the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

c. Inspect and verify proper reinforcement grade, quantity, spacing, and clearance requirements prior to concrete placement. Inspect placed steel reinforcing for coating damage, if applicable, prior to placing concrete. Repair all visible damage.

3.2.1 General

Provide details of reinforcement that are in accordance with the Contract Documents.

3.2.2 Coated Reinforcing

If coated reinforcement is used, record coating lot on each shipping notice and carefully identify and retag bar bundles from bending plant. Provide systems for handling coated bars that have padded contact areas, nylon slings, etc., to keep bars free of dirt and grit.

Carefully handle and install bars to minimize job site patching including lifting and supporting bundled coated bars with strong back, multiple supports, or platform bridge to prevent sagging and abrasion. When possible, assemble reinforcement as tied cages prior to final placement into the forms. Bundling bands must be padded where in contact with bars. Do not drop or drag bars or bundles. Store coated bars both in shop and in field, aboveground, on wooden or padded cribbing with adequate protective blocking between layers. Schedule deliveries of coated bars to the job site to avoid the need for long term storage. Protect from direct sunlight and weather. Bars to be stored longer than 12 hours at the job site must be covered with opaque polyethylene sheeting or other suitable equivalent protective material.

Epoxy Coated Reinforcing must meet the requirements of ASTM A934/A934M including Appendix X2, "Guidelines for Job Site Practices" except as otherwise specified herein.

Inspect for defects and provide required repairs prior to assembly. After assembly, reinspect and provide final repairs. Excessive nicks and scrapes that expose steel is cause for rejection.

a. Immediately prior to application of the patching material, any rust and debonded coating must be manually removed from the reinforcement by suitable techniques employing devices such as wire brushes and emery paper. Care must be exercised during this surface preparation so that the damaged areas are not enlarged more than necessary to accomplish the repair. Damaged areas must be clean of dirt, debris, oil, and similar materials prior to application of the patching material.

b. Repair and patching must be done in accordance with the patching material manufacturer's recommendations. These recommendations, including cure times, must be available at the job site at all times.

c. Allow adequate time for the patching materials to cure in accordance with the manufacturer's recommendation prior to concrete placement.

d. Rinse placed reinforcing bars with ASTM C1602/C1602M compliant water to remove chloride contamination prior to placing concrete.

3.2.3 Reinforcement Supports

Provide reinforcement support in accordance with CRSI RB4.1 and ACI 301M ACI 301 Section 3 requirements.

Place reinforcement and secure with non-corrodible chairs, spacers, and hangers. Metal hangers may be used, but must be of similar material to the reinforcing. Support reinforcement on the ground with concrete or other non-corrodible material, having a compressive strength equal to or greater than the concrete being placed and having permeability equal or less than the concrete being placed.

Coated reinforcing bars supported from formwork must rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable material. Wire bar supports must be coated with dielectric material, compatible with concrete, for a minimum distance of 50 mm 2 inches from the point of contact with the coated reinforcing bars. Reinforcing bars used as support bars must be coated with the same material as the reinforcing. Spreader bars, where used, must be coated. Non-coated combination bar clips and spreaders used in construction with coated reinforcing bars must be made corrosion resistant or coated with dielectric material. Coated bars must be tied with plastic-coated tie wire or other materials acceptable to the Contracting Officer.

3.2.4 Splicing

As indicated in the Contract Documents. For splices not indicated, comply with ACI 301M ACI 301. Do not splice at points of maximum stress. Overlap welded wire reinforcement the spacing of the cross wires, plus 50 mm 2 inches. Welded splices must comply with AWS D1.4/D1.4M and be approved prior to use.

3.2.5 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Bolt threads must match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.2.6 Cover

****

NOTE: Uniform, high quality concrete cover over the steel reinforcement is critically important for long-term durability.

****

Provide concrete cover thickness as shown on the Plans. If no concrete cover is specified, as a minimum, comply with ACI 318M ACI 318 for concrete cover over the steel reinforcement. Use ACI 117 to determine allowable tolerances for the placement of the steel. Steel shapes that are embedded in the concrete must have at least the cover specified for concrete reinforcement.

3.2.7 Setting Miscellaneous Material and Prestress Anchorages

Place and secure anchors, bolts, pipe sleeves, conduits, and other such items in position before concrete placement and support against displacement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete. Electrically isolate exposed steel work and its anchor systems from the primary steel reinforcement with at least 50 mm 2 inches of concrete. Coat exposed steel work to reduce corrosion. Take particular care to ensure against corrosion on edges and horizontal surfaces. Use epoxy coatings for protection of carbon steel plates and fittings.

3.2.8 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

a. Provide fabrication tolerances that are in accordance with ACI 117.

b. Provide hooks and bends that are in accordance with the Contract Documents.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not to be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances.

b. Bends or kinks not indicated on drawings or approved shop drawings.

c. Bars with reduced cross-section due to rusting or other cause.

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.2.9 Placing Reinforcement

Place reinforcement in accordance with ACI 301M ACI 301.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than 25 mm 1 inch from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 90 by 90 mm 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

a. Provide supports for reinforcing bars that are sufficient in number and have sufficient strength to carry the reinforcement they support, and in accordance with ACI 301M ACI 301 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

b. Equip supports on ground and similar surfaces with sand-plates.

c. Support welded wire reinforcement as required for reinforcing bars.

d. Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 1.6 mm 16 gage.

e. Reinforcement must be accurately placed, securely tied at intersections, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to the Contract Documents.

f. Bending of reinforcing bars partially embedded in concrete is permitted only as specified in the Contract Documents.

3.2.10 Spacing of Reinforcing Bars

a. Spacing must be as indicated in the Contract Documents.

b. Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to preapproval by the Contracting Officer.

3.2.11 Welding of Reinforcement

Welding of reinforcement, where permitted, must be in accordance with AWS D1.4/D1.4M.

3.2.12 Construction Joints

If construction joints are shown on the plans: Place all concrete between consecutive joints in a continuous operation. Continue reinforcement across joints unless otherwise indicated.

If construction joints are not shown on the plans: Prior to ordering concrete the contractor must locate joints to least impair strength and must provide substantiating calculations for government review and approval.

Construction joints must be oriented normal to the main reinforcement. Construction joint spacing must not exceed 24.4 m 80 feet, unless approved in writing.

Form construction joints using bulkheads with keyways. Locate keyways clear of exposed surfaces by approximately one-third the thickness of the joint-adjacent concrete pour to take place after a minimum of 7 days to allow for initial shrinkage.

Dampen the surface of the concrete to achieve a saturated surface dry condition at the horizontal construction joints immediately before placing adjoining concrete.

Avoid joints in cantilevered members. Where practical, avoid horizontal joints in pile caps, bulkheads, and retaining walls, otherwise locate horizontal joints 0.6 m 2 feet or more above the MHHW elevation. If the work is unexpectedly interrupted by breakdowns, storms, or other causes, rearrange the freshly deposited concrete to provide a suitable construction joint. If this joint occurs at a section with shear stress, prevent a plane of weakness by providing an adequate mechanical bond across the joint by forming a keyway, inserting reinforcing steel, or by some other means satisfactory to the Contracting Officer.

3.2.13 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 13 mm 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Place contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Sawed joints must be completed within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.2.14 Waterstop Splices

Fusion weld in the field.

3.2.15 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.3 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C94/C94M, ACI 301M ACI 301, and ACI 304R, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch tickets imprinted with mix identification, batch size, batch design and measured weights, moisture in the aggregates, and time batched for each load of ready mix concrete. When a pozzolan is batched cumulatively with the cement, it must be batched after the cement has entered the weight hopper.

3.3.1 Measuring

Make measurements at intervals as specified in paragraphs SAMPLING and TESTING.

Adjust batch proportions to replicate the mixture design using methods provided in the approved quality assurance plan. Base the adjustments on results of tests of materials at the batch plant for use in the work. Maintain a full record of adjustments and the basis for each.

3.3.2 Mixing

Comply with ASTM C94/C94M and ACI 301M ACI 301. If time of discharge exceeds time required by ASTM C94/C94M, submit a request along with description of precautions to be taken.

3.3.3 Transporting

Comply with ACI 304R.

3.4 PLACING CONCRETE

Comply with ACI 304R and ACI 304.2R. Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 1 m 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other or lifts for vertical construction. Position grade stakes on 6 m 20 foot centers maximum for exterior slabs.

3.4.1 Vibration

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NOTE: The requirement for vibrator spacing must be considered in the reinforcing steel design by the engineer of record. ACI MNL-66 requires that bar bundling be done by the design engineer. It is very important to provide space for placement and consolidation of concrete.

****

Comply with the requirements of ACI 309R[and ASTM A934/A934M for epoxy-coated bar] using vibrators with a minimum frequency of 9000 vibrations per minute (VPM). Use only high cycle or high frequency vibrators. Motor-in-head 60 cycle vibrators may not be used. For walls and deep beams, use a minimum of two vibrators with the first to melt down the mixture and the second to thoroughly consolidate the mass. Provide a spare vibrator at the casting site whenever concrete is placed. Place concrete in 500 mm 18 inch maximum vertical lifts. Insert and withdraw vibrators approximately 500 mm 18 inches apart. Penetrate at least 200 mm 8 inches into the previously placed lift with the vibrator when more than one lift is required. Extract the vibrator using a series of up and down motions to drive the trapped air out of the concrete and from between the concrete and the forms.

For slab construction, use vibrating screeds designed to consolidate the full depth of the concrete. Where beams and slabs intersect, use an internal vibrator to consolidate the beam. Do not vibrate concrete placed with anti-washout admixtures. Vibrators must be equipped with rubber vibrator heads.

3.4.2 Cold Weather

Comply with ACI 306R. Do not allow concrete temperature to decrease below 10 degrees C 50 degrees F. Obtain approval prior to placing concrete when ambient temperature is below 4 degrees C 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Placement of concrete must be halted whenever the ambient temperature drops below 5 degrees C 40 degrees F. When the ambient temperature is less than 10 degrees C 50 degrees F the temperature of the concrete when placed must be not less than 10 degrees C 50 degrees F or more than 25 degrees C 75 degrees F. Heating of the mixing water or aggregates may be necessary to regulate the concrete placing temperature. An accelerating admixture may be used when the ambient temperature is below 10 degrees C 50 degrees F. Covering and other means must be provided for maintaining the concrete at a temperature of at least 10 degrees C 50 degrees F for not less than 7 days after placing, and at a temperature above freezing for the remainder of the curing period.

3.4.3 Hot Weather

Comply with ACI 305R. Maintain required concrete temperature using Figure 4.1.4, "Effect of Concrete and Air Temperatures, Relative Humidity, and Wind Speed on the Rate of Evaporation of Surface Moisture From Concrete" in ACI 305R to prevent the evaporation rate from exceeding one kg per square meter 0.2 pound of water per square foot of exposed concrete per hour. If necessary, cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. If the evaporation rate exceeds 0.5 kg per square meter 0.1 pound of water per square foot per hour, fog spray the exposed concrete surfaces until active moist curing is applied. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.4.4 Prevention of Plastic Shrinkage Cracking

During weather with low humidity, and particularly with high temperature and appreciable wind, develop and institute measures to prevent plastic shrinkage cracks from developing. If plastic shrinkage cracking occurs, halt further placement of concrete until protective measures are in place to prevent further cracking. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Figure 4.1.4 of ACI 305R. In addition to the protective measures concrete placement must be further protected by erecting shades and windbreaks and by applying fog sprays of water, the addition of monomolecular films, or wet covering. When such water treatment is stopped, curing procedures must be immediately commenced. The methods and materials to remove or repair areas affected by plastic shrinkage cracks must be suggested by the Contractor, reviewed by the agency's Subject Matter Expert in Concrete Materials, and approved by the Contracting Officer. Cracks must never be troweled over or filled with cement slurry.

3.4.5 Mass Concrete

All mass concrete elements must be placed per the requirements of the Mass Concrete Temperature Control Plan.

3.4.6 Depositing Concrete Under Water

ACI 301M ACI 301 methods and equipment used must prevent the washing of the cement from the mixture, minimize the formation of laitance, prevent the flow of water through the concrete before it has hardened, and minimize disturbance to the previously placed concrete. Tremies, if used, must be watertight and sufficiently large to permit a free flow of concrete. Keep the discharge end continuously submerged in fresh concrete. Keep the shaft full of concrete to a level well above the water surface. Discharge and spread the concrete by raising the tremie to maintain a uniform flow. Place concrete without interruption until the top of the fresh concrete is at the required height.

3.5 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT

3.5.1 Defects

Repair formed surfaces by removing minor honeycombs, bugholes, blisters, pop-outs, and pits greater than 600 square mm one square inch surface area or 6 mm 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with non-shrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects that affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI 347R. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise indicated.

3.5.2 Formed Surfaces

3.5.2.1 Tolerances

Comply with ACI 117 and as indicated.

3.5.2.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 6 mm 0.25 inch in height.

3.5.2.3 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Material with raised grain, torn surfaces, worn edges, patches, dents, or other defects that will impair the texture of the concrete surface must not be used. Patch tie holes and defects and completely remove fins.

3.6 FINISHES FOR HORIZONTAL CONCRETE SURFACES

3.6.1 Finish

Comply with ACI 301M ACI 301. Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.6.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. After the concrete has been placed, consolidated, struck off, and leveled, the surface must be roughened with stiff brushes of rakes before final set.

3.6.1.2 Floated

Exterior slabs where not otherwise specified. After the concrete has been placed, consolidated, struck off, and leveled, do not work the concrete further, until ready for floating. Whether floating with a wood, magnesium, or composite hand float, with a bladed power trowel equipped with float shoes, or with a powered disc, floating must begin when the surface has stiffened sufficiently to permit the operation.

3.6.1.3 Broomed

Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.6.1.4 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by a burlap drag. Drag a strip of clean, wet burlap from 900 to 3000 mm wide and 600 mm longer 3 to 10 feet wide and 2 feet longer than the pavement width across the slab. Produce a fine, granular, sandy textured surface without disfiguring marks. Round edges and joints with an edger having a radius of 3 mm 1/8 inch.

3.6.1.5 Concrete Toppings Placement

Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the base wet for a period of 12 hours preceding the application of the topping. Remove excess water prior to the topping placement. Do not allow temperature differential between the completed base and the topping to exceed 6 degrees C 10 degrees F at the time of placing. Place the topping and finish as specified for pavement.

3.7 CURING AND PROTECTION

Comply with ACI 301M ACI 301 and ACI 308.1 unless otherwise specified. Prevent concrete from drying by misting surface of concrete. Begin curing immediately following final set. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, by rain or running water, adverse weather conditions, and any other activity resulting in ground vibrations during curing. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains during curing.

Do not allow concrete to dry out from time of placement until the expiration of the specified curing period.

Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded including construction joints.

If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Do not interrupt curing for more than 60 minutes during form removal. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating.

Approved equipment and materials for curing must be on-site and available for immediate use before placing concrete.

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NOTE: When the use of alkali-reactive aggregates is permitted, add the following paragraph.

****

Furnish ASTM C39/C39M test results to verify the anticipated rate of strength development for the proposed concrete design mixture. Submit an increased curing period and minimum time to strip formwork based upon the reduced rate of strength development.

3.7.1 Wet Curing

Wet cure marine concrete using ASTM C1602/C1602M compliant water for a minimum of 7 days. Do not allow construction loads to exceed the superimposed load that the structural member, with necessary supplemental support, is capable of carrying in current condition safely and without damage.

Leaving the forms in place for seven days is a suitable alternative to wet curing.

3.7.1.1 Ponding or Immersion

Continually immerse the concrete throughout the seven-day curing period. Water must not be 11 degrees C 20 degrees F less than the temperature of the concrete. For temperatures between 4 and 10 degrees C 40 and 50 degrees F, increase the curing period by 50 percent.

3.7.1.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 4 and 10 degrees C 40 and 50 degrees F, increase the curing period by 50 percent.

3.7.1.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 150 mm 6 inches over adjacent sheeting. Sheeting must be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete or over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period. Anchor the wet sheeting to provide continuous contact with the concrete surface.

3.7.1.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 300 mm 12 inches minimum. Provide sheeting not less than 450 mm 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.7.2 Liquid Membrane-Forming Curing Compound

****

NOTE: Stay in place forms and moist curing are the preferred method for curing concrete. Use of a liquid membrane-forming curing compound is only permitted when approved by the Contracting Officer.

****

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. The liquid membrane-forming compound must meet the requirements of ASTM C309 Type 1-D or Type 2 Class A. The compound must form a uniform, continuous, coherent film that will not check, crack, or peel during the curing period. It must not peel under traffic after 24 hours drying time. The compound must not react deleteriously with concrete or its constituents. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 4.1.4, "Effect of Concrete and Air Temperatures, Relative Humidity, and Wind Speed on the Rate of Evaporation of Surface Moisture From Concrete" in ACI 305R indicates that hot weather conditions will cause an evaporation rate exceeding 1.0 kg of water per square meter per hour 0.2 pound of water per square foot per hour.

3.7.2.1 Application

Apply in accordance with the recommendations of the manufacturer immediately after any water sheen that may develop after finishing has disappeared from the concrete surface. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats must be 5 square meters maximum per L 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. Immediately apply an additional coat of compound to areas where the film is defective. Respray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.7.2.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.7.3 Curing Periods

****
NOTE: Add the following if concrete will be underwater:[Cure land-cast elements for a minimum of 7 days prior to submerging].
****

Moist cure concrete using ASTM C1602/C1602M compliant water for a minimum of 7 days. Continue additional curing for a total period of 21 days. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing must be subject to approval by the Contracting Officer.

3.7.4 Protection

3.7.4.1 Thermal Protection against Cold Weather

Protect concrete against cold weather conditions in accordance with ACI 306R. Concrete must achieve a compressive strength of minimum 24.5 MPa 3500 psi prior to removal of thermal protection in cold weather conditions. Removal of thermal protection must be carried out as to reduce potential crack-inducing differential strains per ACI 306R.

3.7.4.2 Liquid Chemical Sealer-Hardener

Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer-hardener must not be applied until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.8 FIELD QUALITY CONTROL

****
NOTE: Consider the size and complexity of job to determine if all tests are required.
****

3.8.1 Fresh Concrete Properties

For each concrete mixture, the Contractor must take samples in accordance with ASTM C172/C172M, test and record the slump, and temperature. If the slump deviates from the previous batch by more than 25.4 mm 1 inch, air content must also be determined. Adjustment of air content and/or slump with chemical admixture is permitted provided the water to cementitious material ratio is not exceeded.

3.8.1.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved high range water reducing (HRWR) admixture provided that the water-cementitious ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 40 cubic meters 50 cubic yards (maximum) of concrete. If concrete does not pass slump test, adjust using a HRWR and test every concrete batch until two consecutive batches meet slump without adjustment.

3.8.1.2 Temperature Tests

a. Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions below 10 degrees C and above 27 degrees C below 50 degrees F and above 80 degrees F for each batch (minimum) or every 40 cubic meters 50 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

b. Determine temperature of each concrete sample in accordance with ASTM C1064/C1064M. Temperatures must comply with the Concrete Temperature Control Plans.

3.8.1.3 Air Content Tests

ASTM C231/C231M or ASTM C173/C173M. Perform tests at commencement of concrete placement each day, when test cylinders are made, and if slump test varies by more than 25.4 mm 1 inch from previous results or concrete does not pass slump test.

3.8.1.4 Unit Weight Test

ASTM C138/C138M. Take concrete samples during concrete placement. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 38.2 cubic meters 50 cubic yards (maximum) of concrete.

3.8.2 Hardened Concrete Properties

****

NOTE: The Engineer of Record must specify the frequency of testing during the construction phase. Sufficient testing must be done to maintain confidence that the concrete, as delivered and placed, remains consistent. For example: sample and test every 75 cubic meters 100 cubic yards for the first 382 cubic meters 500 cubic yards, then every 382 cubic meters 500 cubic yards once confidence is established in uniformity. However, this is only a guideline, and the Contracting Officer and Engineer of Record should agree on the frequency of sampling as best suits the particulars of each project and budget.

For example, a sampling interval for a new pier may be as follows:

o During the first week of casting piles
o During the second week of casting piles
o Midway through the casting of all piles
o During the final week of casting piles
o At the first pile cap and every tenth bent thereafter
o During the two first concrete deck pours
o During the final concrete deck pour

****

Sample and test each lot at [75] cubic meters [100] cubic yards for the first [382] cubic meters [500] cubic yards, then every [382] cubic meters [500] cubic yards thereafter.

Cast and cure specimens in accordance with ASTM C172/C172M, ASTM C31/C31M, and applicable requirements of ACI 305R and ACI 306R.

For each lot, record the date and time sampled, the batch ticket code, cylinder ID code the location of placement, total volume of concrete represented by the sample, and fresh concrete properties; ASTM C143/C143M for slump or ASTM C1611/C1611M for slump flow and visual stability index (VSI), ASTM C231/C231M for air content, ASTM C1064/C1064M for temperature, and ASTM C138/C138M unit weight.

For each lot sample, cast twelve 150 by 300 mm 6 by 12 inch cylinder specimens for strength and three 100 by 200 mm 4 by 8 inch cylinder specimens for chloride ion penetration testing. These cylinders must be wrapped completely with slightly damped paper towels with water only. The wrapped cylinders must be placed in either a vacuum package or double layers of sealed plastic bags. Package cylinders to prevent damage and ship to the approved testing laboratory.

In the event quality acceptance test results and retest results fail to meet the quality acceptance criteria, the entire lot must be considered non-conforming material, refer to paragraph REPAIR, REHABILITATION AND REMOVAL.

3.8.2.1 Compressive Strength Tests

****

NOTE: When the same mix design is used for multiple elements such as slabs, beams, and walls, the design element type may be specified in addition to the mix design to better identify deficient concrete.

****

ACI 214R tests for strength - conduct strength tests of concrete during construction in accordance with the following procedures:

a. Test cylinders in accordance with ASTM C39/C39M. Test three cylinders at 3 days, three cylinders at 7 days, and three cylinders at the age when the compressive strength requirement was specified. Hold the remaining three cylinders in storage. If one specimen in a test shows evidence of improper sampling, molding or testing, discard the specimen and consider the strength of the remaining cylinder to be the test result. If more than one specimen shows excess defects, the Contracting Officer may allow the entire test to be discarded. Test results must not exceed the specified compressive strength by more than 20 percent for the age specified.

b. If the average strength test results are less than the specified strength (f'c) extract three core samples from the structure in accordance with ASTM C42/C42M, from the area that correlates to the low test results. These extracted cores must not contain steel reinforcing. Repair core holes with non-shrink grout. Match color and finish of adjacent concrete. For concrete not meeting strength criteria, the Contractor must prepare a remediation strategy for the review by the Contracting Officer.

c. Strength test reports must be provided within 7 days of test completion.

3.8.2.2 Chloride Ion Penetration Test

Test cylinder concrete for chloride ion penetration at 56 days. Concrete representative of the tested concrete with values greater than the quality acceptance values determined in Table 1, will require retesting using spare samples. If the retest exceeds the quality acceptance limit, concrete placement must be stopped to review quality control issues.

3.8.2.3 Chloride Ion Concentration

Comply with ACI 318M Table 1. Determine water soluble chloride ion concentration. Perform test once for each mix design.

3.8.2.4 Anti-Washout Admixture

Comply with COE CRD-C 61. Determine cumulative mass loss. Perform test once for each 267.6 cubic meters 350 cubic yards of underwater concrete.

3.8.2.5 Non-Destructive Tests

Use of a rebound hammer to obtain data on the strength of the concrete surface must be in accordance with ASTM C805/C805M. Test results from the rebound hammer and other non-destructive testing may be helpful in selecting areas to extract concrete cores for destructive testing.

3.8.3 Core Samples and Compressive Strength Testing

Obtain and test cores in accordance with ASTM C42/C42M.

If concrete in the structure is dry under service conditions, air dry cores (temperature 16 to 27 degrees C 60 to 80 degrees F, relative humidity less than 60 percent) for 7 days before testing and test dry. Otherwise, test the cores, after moisture conditioning, in accordance with ASTM C42/C42M.

Acceptance criteria for cylinder compressive strength are provided in paragraph ACCEPTANCE OF CONCRETE STRENGTH.

Take at least three representative cores from each member or area of concrete in place that is considered potentially strength deficient. Impair the strength of the structure as little as possible. If, before testing, extracted cores show evidence of having been damaged subsequent to or during removal from the structure, take replacement cores.

Fill core holes with low slump concrete or mortar of a strength equal to or greater than the original concrete.

The Contracting Officer will evaluate and validate core tests in accordance with the specified procedures.

3.8.4 Acceptance of Concrete Strength

3.8.4.1 Standard Molded and Cured Strength Specimens

The acceptance of concrete strengths must be based on averages of results from three consecutive compressive strength tests. When the averages of all sets of three consecutive compressive strength test results are between 1.0 and 1.2 times the field test strength (fcr), and no individual strength test falls below fcr by more than 3.45 MPa 500 psi, the strength of the concrete is satisfactory. These criteria also apply when accelerated strength testing is specified unless another basis for acceptance is specified.

3.8.4.2 Non-Destructive Tests

Non-destructive tests may be used when permitted to evaluate concrete where standard molded and cured cylinders have yielded results not meeting the criteria.

3.8.4.3 Extracted Core Tests

When the average compressive strengths of the representative cores are between 0.85 fcr and 1.2 fcr and if no single core is less than 0.75 fcr, the strength of concrete is satisfactory.

3.8.5 Inspection

ACI 311.4R. Inspect concrete placed under water with qualified divers.

3.9 REPAIR, REHABILITATION AND REMOVAL

Before the Contracting Officer accepts the structure and final payment is made the Contractor must inspect the structure for cracks, damage, and substandard concrete placements that may adversely affect the service life of the structure. A report documenting these defects must be prepared that includes recommendations for repair, removal and/or remediation which, will be reviewed by the agency's Subject Matter Expert in Concrete Materials and submitted to the Contracting Officer for approval before any corrective work is accomplished. Costs for repair must be borne by the Contractor.

3.9.1 Crack Repair

Prior to final acceptance, all cracks in excess of 0.25 mm 0.01 inches wide must be documented and repaired. The proposed method and materials to repair the cracks must be submitted to the Contracting Officer for approval. The proposal must address the amount of movement expected in the crack due to temperature changes and loading.

After completing all curing operations and allowing the pier deck to thoroughly dry, the contractor must seal the following areas with a high molecular weight methacrylate (HMWM) sealer, clear color. Flood the top surface the cracked areas with the sealer and squeegee off the excess material before opening pier to operation.

a. Transverse joints in the deck.

b. Longitudinal joints in the deck.

c. Longitudinal joints between the deck and safety curb, barriers, and parapets, etc.

d. Cracks discovered in the deck of the top and bottom surfaces before opening the deck to traffic, that are 0.25 mm 10 mils or 0.010 inches or less in width.

3.9.2 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Concrete surfaces with weak surfaces less than 6 mm 1/4 inch thick must be diamond ground to remove the weak surface. Surfaces containing weak surfaces greater than 6 mm 1/4 inch thick must be removed and replaced or mitigated in a manner acceptable to the Contracting Officer.

3.9.3 Failure of Quality Assurance Test Results

****

NOTE: Test results accomplished on concrete samples during concrete production that fall short of the acceptance criteria alert the Contractor to something in the production and placement process that has drifted out of calibration or that an error has been made. The goal is to track down the problem and correct it as quickly as possible. Unless the concrete producer makes a large error in batching or in placing, the chance that hardened concrete needs to be removed is remote. Removal and replacement is a last resort.

****

Proposed mitigation efforts by the Contractor to restore the original design intent must be reviewed by the agency's Subject Matter Expert in Concrete Materials and approved by the Contracting Officer prior to proceeding.

-- End of Section --

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Preparing Activity: USACE **Superseding**
UFGS--03 33 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 03 33 00

CAST-IN-PLACE ARCHITECTURAL CONCRETE

11/09

****

NOTE: This guide specification covers the requirements for cast-in-place architectural concrete.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 301	(2020) Specifications for Structural Concrete
ACI 301M	(2020) Metric Specifications for Structural Concrete
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

1.2 SYSTEM DESCRIPTION

All materials, procedures, and requirements specified in Section 03 30 00 CAST-IN-PLACE CONCRETE fully apply to cast-in-place architectural concrete, except as otherwise specified.

1.2.1 Concrete Mix Design

****
NOTE: If it is determined that the concrete mix requires plasticizers, the requirements will be added in this paragraph. Slumps for plasticized concrete may range as high as 250 mm 10 inches.
****

Design the concrete mix in accordance with ACI 211.1 and ACI 211.2 including consideration of the finishes required.

1.2.2 Formwork Design

Design formwork conforming to ACI 301MACI 301 and ACI 347R.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-04: The materials used in architectural concrete vary from one project to another. For most projects, samples for all materials are not required. A list of suggested samples is given below:

Form Ties
Form Liners
Cement Colors
Coarse Aggregates
Reinforcing Chairs
Sample panels should not be required for small projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings.

SD-04 Samples

Materials

Panels

1.4 QUALITY ASSURANCE

1.4.1 Detail Drawings

Submit detail drawings conforming to ACI SP-66 and ACI 318M ACI 318. Show location of cast-in-place elements in the work, building elevations, formwork fabrication details, reinforcements, embedments, dimensions, concrete strength, interface with adjacent materials, and special placing instructions, in sufficient detail to cover fabrication, placement, stripping, and finishing.

1.4.2 Panels

Provide sample panels 1.8 m 6 feet long and 1.2 m 4 feet high with the thickness to match building conditions for each type of architectural concrete and finish, located where directed. Panel forms include a typical joint between form panels, form tie conditions and finishes. Protect panels from weather, and other damage until acceptance of work. Use sample panels as job standards throughout construction. Submit a sample panel for approval.

PART 2 PRODUCTS

2.1 MATERIALS

Submit samples of materials listed below, indicating sizes, shapes, finishes, color, and pertinent accessories: [_____].

2.1.1 Aggregates

****

NOTE: If a specific type or size of aggregate is required for a desired finish, whether it be for a facing mix or the entire thickness, the additional requirements will be added in this paragraph.

****

Provide aggregates conforming to [_____].

2.1.2 Reinforcing Steel

Provide galvanized reinforcing steel if clearance to an exterior face is 25 mm 1 inch or less.

2.1.3 Tie Wire

Provide soft monel or 18-8 stainless steel tie wire.

2.1.4 Plates, Angles, Anchors, and Embedments

Provide plates, angles, anchors, and embedments conforming to ASTM A36/A36M, and prime paint with inorganic zinc primer.

2.1.5 Formwork

Use approved formwork for special effects.

2.1.6 Form Release Agents

Provide manufacturer's standard form release agents that are nonstaining, nonpetroleum based, and compatible with surface sealer finish coating.

2.1.7 Surface Sealer

Provide surface sealer consisting of methyl methacrylate polymer acrylic emulsion, clear color.

PART 3 EXECUTION

3.1 FORMWORK ERECTION

Erect formwork in accordance with the detail drawings to ensure that the finished concrete members conform accurately to the indicated dimensions, lines, elevations, and finishes. Deflection exceeding 1/360th of each component span or distance between adjacent supports is not acceptable. Cumulative deflections and tolerance is not acceptable. Install form lines as necessary to provide the required finish. Coat forms with form release agents before reinforcement is placed. Provide formwork conforming to ACI 301MACI 301 and ACI 347R.

3.2 CONCRETE FINISHES

****

NOTE: The types of possible finishes for concrete faces are virtually limitless. The requirements for the project will be specified in this paragraph.

****

Concrete finishes must conform to the approved finishes. Accomplish finishing at the time of concrete placement or immediately after formwork removal, as follows:

a. Smooth finish: (1) As cast using flat smooth nonporous forms. (2) As cast using fluted, sculptured, board finish or textured form liners.

b. Textured finish: (1) Textured form liners applied to inside of forms. (2) Distress finish by breaking off portion of face of raised portion of unit.

c. Exposed aggregate finish: (1) Finish obtained by applying even coat of retardant to face of form, removing forms after concrete hardens, and exposing coarse aggregate to a depth of [_____] mm inches by washing and brushing or lightly sandblasting away surface mortar. (2) Finish obtained by treating surface of unit with brushes which have been immersed in acid solution.

Use the following procedures for cast-in-place concrete elements which are to have a finish other than the surface produced from standard formwork: [_____].

3.3 JOINT SEALING

Perform joint sealing as specified in Section 07 92 00 JOINT SEALANTS.

3.4 CLEANING

No sooner than 72 hours after joints are sealed, wash down, clean with soap and apply water with a soft bristle brush to faces and other exposed surfaces of cast-in-place concrete, then wash down again with clean water, or clean by other approved procedures. Consider discolorations which cannot be removed by these procedures defective work. Perform cleaning work when temperature and humidity conditions are such that surfaces dry rapidly. Take care during cleaning operations to protect adjacent surfaces from damage.

3.5 SURFACE SEALING

After cleaning, give indicated exterior exposed architectural concrete surfaces one coat of surface sealer, spray apply unless otherwise approved. Protect adjacent surfaces to prevent damage from the surface sealer.

3.6 PROTECTION OF WORK

Protect work against damage from subsequent operations.

3.7 DEFECTIVE WORK

Repair or replace defective work, as directed, using approved procedures.

-- End of Section --

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ATTACHMENTS:

concrete aggregates sources

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SECTION 03 37 00

PREPLACED-AGGREGATE CONCRETE

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NOTE: This guide specification covers the requirements for furnishing, hauling, and preplacing aggregate concrete incidental to the drilling and the grouting. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The content of this specification is such that guidance given in EM 1110-2-2000, "Standard Practice for Concrete", is applicable.

****

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the

remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
****

1.1.1 Payment

Payment will be made for all costs associated with unloading, handling, and storage of all aggregate, cement, [pozzolan,] fluidifier, and chemical admixture used in the work, including all costs of labor and the use of all equipment, tools, 150 by 300 mm 6 by 12 inch cylinder molds, and other materials required to complete the work, excluding cost of reinforcement and embedded parts which are specified to be paid for separately.

1.1.2 Measurement

Preplaced-Aggregate Concrete will be measured for payment based on the actual volume placed within the paylines of the structures as indicated.

1.1.3 Unit of Measure

Unit of measure: cubic meter yard.

1.2 REFERENCES

****
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for

	Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe

ASTM INTERNATIONAL (ASTM)

ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	(2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C40/C40M	(2020) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C87/C87M	(2023) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2023) Standard Test Method for Lightweight Particles in Aggregate
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement

ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C441/C441M	(2017) Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2016; R 2024) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C937	(2023) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C938	(2024) Standard Practice for Proportioning Grout Mixtures for Preplaced-Aggregate Concrete
ASTM C939/C939M	(2022) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C943	(2024) Standard Practice for Making Test Cylinders and Prisms for Determining Strength and Density of Preplaced-Aggregate Concrete in the Laboratory

ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 94	(1995) Corps of Engineers Specification for Surface Retarders
COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1997) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Grout Mixture Proportioning

Grout Mixer

Equipment

Vibrators

Testing and Quality Verification for Contractor Quality Control

Curing and Protection; G, [_____]

Cold-Weather Placing; G, [_____]

Hot-Weather Placing; G, [_____]

SD-04 Samples

Aggregates; G, [_____]

Cementitious Materials, Admixtures, and Curing Compound; G, [_____]

SD-06 Test Reports

Quality of Aggregates; G, [_____]

Testing and Quality Verification for Contractor Quality Control

SD-07 Certificates

Cementitious Materials

Impervious-Sheet Curing Materials

Air-Entraining Admixture

Nonshrink Grout

Grout Fluidifier

Membrane-Forming Curing Compound

1.4 QUALITY ASSURANCE

The individuals who sample and test concrete or the constituents of concrete as required in this specification have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete construction have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of [Concrete Transportation Construction Inspector (CTCI)] [Concrete Construction Inspector (CCI)], Level II.

1.4.1 Government Preconstruction Sampling and Testing

1.4.1.1 Aggregates

****

NOTES: The Designer should consult the appropriate DM, identify the sources for aggregates, and include them in the Aggregate Sources Template attached to the end of this section. Contact the Division Laboratory for information to fill in the blanks below.

****

The aggregate sources listed at the end of this section have been tested and, at the time testing was performed, were capable of producing materials of a quality required for this project, provided suitable processing is performed. The Contractor may furnish materials from a listed source or from a source not listed. Deliver samples from any source of coarse aggregate and any source of fine aggregate, consisting of not less than

[70] [_____] kg [150] [_____] pounds of each coarse aggregate and [35] [_____] kg [75] [_____] pounds taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100 to [_____] within 15 days after notice to proceed. Sampling and shipment of samples is at the Contractor's expense. [_____] days will be required to complete evaluation of the aggregates. Testing will be performed by and at the expense of the Government in accordance with COE CRD-C 114 or ASTM test methods. The cost of testing one source for each size of aggregate will be borne by the Government. If the Contractor selects more than one source for each aggregate size or selects a substitute source for any size aggregate after the original source was tested, the cost of that additional testing will be borne by the Contractor. Tests to which aggregate may be subjected are listed in paragraph QUALITY OF AGGREGATES in PART 3. Provide material from the proposed source meeting the quality requirements of this paragraph. The Government's test data and other information on aggregate quality of those sources listed at the end of this section are included in the Design Memorandum and are available for review in the district office. Quality Assurance testing of aggregates by the Government does not relieve the Contractor of quality control requirements as outlined in paragraph TESTING AND QUALITY VERIFICATION FOR CONTRACTOR QUALITY CONTROL in PART 3.

1.4.1.2 Cementitious Materials, Admixtures, and Curing Compound

****

NOTE: When the optional sentence below is deleted, the corresponding manufacturer's certification should be used. EM 1110-2-2000, "Standard Practice for Concrete", provides guidance in selecting the options for Government or for Contractor testing.

****

At least 60 days in advance of concrete placement, notify the Contracting Officer of the source of materials, along with sampling location, brand name, type, and quantity to be used in the manufacture and/or curing of the concrete. [Sampling and testing will be performed by and at the expense of the Government except as otherwise specified. Do not use material until notice has been given by the Contracting Officer that test results are satisfactory. Submit samples of materials for Government testing and approval. The Government will sample and test other chemical admixtures, curing compounds, and cementitious materials].

a. Chemical Admixtures - Retest chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing at the expense of the Contractor when directed by the Contracting Officer and reject if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with the requirements in paragraph CHEMICAL ADMIXTURES in PART 2.

[b. Cement and Pozzolan - If cement or pozzolan is to be obtained from more than one source, state the estimated amount to be obtained from each source and the proposed schedule of shipments in the initial notification.]

****

NOTE: Delete this paragraph if materials are to be accepted on the basis of a manufacturer's certification of compliance and mill test reports. See the appropriate DM or consult the Materials Engineer to select prequalified sources, (1) and

(2), sealed bins, (3) and (4), or both options, (1), (2), (3), and (4). Selection of the sealed bin method, subparagraphs (3) and (4), must be fully justified in the appropriate DM.

****

[(1) Prequalified Cement Sources: Deliver and use cement directly from a mill of a producer designated as a qualified source. Samples of cement for check testing will be taken at the project site or concrete-producing plant by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified cement sources is available from Director, U.S. Army Engineer Waterways Experiment Station (USACE-WES), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.]

[(2) Prequalified Pozzolan Sources: Deliver and use pozzolan directly from a producer designated as a qualified source. Samples of pozzolan for check testing will be taken at the project site by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified pozzolan sources is available from the Director, USACE-WES, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.]

[(3) Nonprequalified Cement Sources: Cement, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of testing. Sampling, testing, and the shipping inspection from the point of sampling, when the point is other than at the site of the work, will be made by or under the supervision of the Government and at its expense. Do not use cement until notice has been given by the Contracting Officer that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the Contractor's request and expense. When the point of sampling is other than at the site of the work, the fill gates of the sampled bin and conveyances used in shipment will be sealed under Government supervision and kept sealed until shipment from the bin has been completed. If tested cement is rehandled at transfer points, the extra cost of inspection is at the Contractor's expense. The cost of testing cement excess to project requirements is also at the expense of the Contractor. The charges for testing cement at the expense of the Contractor will be deducted from the payments due the Contractor at a rate of [_____] dollars per ton of cement represented by the tests.]

****

NOTE: To fill in the blank for cost of testing excess cement, contact the Structures Laboratory, Concrete Technology Division, WES.

****

[(4) Nonprequalified Pozzolan Sources: Pozzolan, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of certain tests. Pozzolan will also be sampled at the site when determined necessary. All sampling and testing will be by and at the expense of the Government. Release for shipment and approval for use will be based on compliance with 7-day lime-pozzolan strength requirements and other physical and chemical and uniformity requirements for which tests can be completed by the time the 7-day lime-pozzolan strength test is completed. Release for shipment and approval for use on the above basis will be contingent on continuing compliance with the other requirements of the specifications. If a bin fails, the contents may be resampled and tested at the Contractor's expense. In this event, the pozzolan may be sampled as it is loaded into cars, trucks, or barges provided they are kept at the source until released for shipment. Unsealing and resealing of bins and sealing of shipping conveyances will be done by or under the supervision of the Government. Shipping conveyances will not be accepted at the site of the work unless received with all seals intact. If pozzolan is damaged in shipment, handling, or storage, promptly remove it from the site of the work. Retest pozzolan that has not been used within 6 months after testing at the expense of the Contractor when directed by the Contracting Officer and reject if the test results are not satisfactory. If tested pozzolan is rehandled at transfer points, the extra cost of inspection is at the Contractor's expense. The cost of testing excess pozzolan is at the Contractor's expense at a rate of [_____] cents per ton of pozzolan represented by the test. The amount will be deducted from payment to the Contractor.]

1.4.2 Construction Testing by Government

The Government will sample and test aggregates, grout, and preplaced-aggregate concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of placement in accordance with COE CRD-C 100. Grout will be sampled after the agitator and tested for flow in accordance with ASTM C939/C939M and air content in accordance with ASTM C231/C231M. Unconfined compressive strength test specimens will be made and cured in accordance with ASTM C943 and tested in accordance with ASTM C39/C39M.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide steel bars, welded steel wire fabric and accessories for concrete reinforcement in compliance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide concrete formwork complying with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.1 Design of Preplaced Aggregate

****

NOTE: Consult the Structural Design Engineer and the appropriate DM to fill in the blanks.

****

Specified compressive strength is as follows:

COMPRESSIVE STRENGTH (MPa)	STRUCTURE OR PORTION OF STRUCTURE
34.5 MPa 5,000 psi @ [_____] days	[_____]

COMPRESSIVE STRENGTH (MPa)	STRUCTURE OR PORTION OF STRUCTURE
27.6 MPa 4,000 psi @ [_____] days	[_____]
20.7 MPa 3,000 psi @ [_____] days	[_____]
17.2 MPa 2,500 psi @ [_____] days	[_____]

2.1.2 Maximum Water-Cement Ratio (W/C)

****

NOTE: Consult EM 1110-2-2000 and the appropriate DM to fill in the blanks and to select the appropriate W/C. When cementitious materials other than portland cement are used, see paragraph GROUT MIXTURE PROPORTIONING in PART 2 for definitions of W/C.

****

Maximum W/C is as follows:

WATER-CEMENT RATIO, BY MASS	STRUCTURE OR PORTION OF STRUCTURE
0.40	[_____]
0.45	[_____]
0.50	[_____]
0.55	[_____]
0.60	[_____]
0.65	[_____]

These W/Cs may cause higher strengths than required by above paragraph.

2.2 MATERIALS

2.2.1 Cementitious Materials

****

NOTE: See the appropriate DM to select the proper requirements for the Cementitious Materials Options. Other cementitious materials may be added if specifically recommended and approved in the concrete materials DM.

Delete the requirements for certificates for air-entraining admixtures, other chemical admixtures, curing compounds, portland cement, and pozzolan if the optional parts of paragraph CEMENTITIOUS MATERIALS, ADMIXTURES, AND CURING

COMPOUND (above) are used.
****

Provide cementitious materials that is portland cement or portland cement in combination with pozzolan [or [_____]] and conforming to appropriate specifications listed below. Do not use cementitious materials until notice of acceptance has been given by the Contracting Officer. Cementitious materials will be subject to check testing from samples obtained at the mill, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Promptly remove material not meeting specifications from the site of work. Submit manufacturer's certification of compliance, accompanied by mill test reports attesting that materials meet the requirements of the specification under which they are furnished. Provide certification and mill test reports that are from samples taken from the particular lot furnished. Submit certificate of compliance for the following: Impervious-Sheet Curing Materials, Air-Entraining Admixture, Nonshrink Grout, Grout Fluidifier, and Membrane-Forming Curing Compound.

2.2.1.1 Portland Cement

ASTM C150/C150M, Type I or II, except that the maximum amount of tricalcium aluminate (C3A) in Type I cement consisting of 15 percent [including the heat of hydration at 7 days] [including false set requirements] [low alkali when used with aggregates listed at the end of this section which require it.] [In lieu of low-alkali cement, the Contractor may use a combination of portland cement that does not meet the low-alkali requirement with a pozzolan or slag provided the following requirement is met. The expansion of the proposed combination when tested in accordance with ASTM C441/C441M must be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C150/C150M when tested in general conformance with ASTM C441/C441M. Run the expansion tests concurrently at an independent laboratory that is nationally recognized to perform such tests. The Government reserves the right to confirm the test results and to adjust the percentage of pozzolan or slag in the combination to suit other requirements.]

2.2.1.2 Pozzolan

Provide pozzolan conforming to ASTM C618, Class [C], [F], [N], with the optional requirements for multiple factor, drying shrinkage, and uniformity [and [moderate] [severe] sulfate resistance requirements] of Table 2A. Table 1A requirement for maximum alkalis applies when used with aggregates listed at the end of this section to require low-alkali cement.

2.2.1.3 [Ground Granulated Blast-Furnace Slag

Provide ground granulated blast-furnace slag conforming to ASTM C989/C989M, Grade [_____].]

2.2.2 Aggregates

****
NOTE: This note may be disregarded for regions where Alkali-Silica Reactivity (ASR) is not a concern. Some aggregate sources may exhibit an ASR potential. ASR is a potentially deleterious reaction between alkalis present in concrete and

some siliceous aggregates, reference EM 1110-2-2000 paragraph 2-3b(6) and appendix D. Where ASR is known or suspected to pose a concern for concrete durability, it is recommended that aggregates proposed for use in concrete be evaluated to determine ASR potential and an effective mitigation. EM 1110-2-2000, provides recommendations for evaluating and mitigating ASR in concrete mixtures. Aggregate evaluations may not be practical for projects requiring small quantities of concrete (less than 200 cubic meters 250 cubic yards).

Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS, paragraph Alkali-Silica Reactivity, provides a specification method for the Contractor to evaluate and mitigate ASR in concrete mixtures. The expansion limits specified in Section 32 13 14.13 are requirements for pavements and exterior slab construction. For structural concrete applications the measured expansion must be less than 0.10 percent. It may not be economical or practical to specify different test limit requirements for use on the same project. In which case the lower limit required by the application should be used.

The designer may use the specification method in Section 32 13 14.13 by incorporating the relevant paragraphs into this specification, or may use the following requirements (retain either the 0.10 or the 0.08 percent expansion limits as appropriate) included in the paragraph below. Delete the following paragraph if not required in the project.

****

Alkali-Silica Reactivity: Test and evaluate fine and coarse aggregates proposed for use in concrete for alkali-aggregate reactivity in accordance with ASTM C1260. Evaluate the fine and coarse aggregates separately and in combination, matching the Contractor's proposed mix design proportioning. All results of the separate and combination testing must have a measured expansion less than 0.10 (0.08) percent at 16 days after casting. Should the test data indicate an expansion of 0.10 (0.08) percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1260 and ASTM C1567. Perform the additional testing using ASTM C1260 and ASTM C1567 using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. Use GGBF slag in the range of 40 to 50 percent of the total cementitious material by mass. Use Class F fly ash in the range of 25 to 40 percent of the total cementitious material by mass.

2.2.2.1 Listed Sources

****

NOTE: The list of sources and required tests and test limits will be taken from the concrete materials DM.

****

Concrete aggregates may be furnished from any source capable of meeting the quality requirements as stated in paragraph QUALITY OF AGGREGATES in PART 3. The sources listed at the end of this section were evaluated during the design phase of the project in [_____] and were found at that time capable of meeting the quality requirements when suitably processed. No guarantee is given or implied that any of the listed sources are currently capable of producing aggregates that meet the required quality specified above. A Design Memorandum containing the results of the Government investigation and test results is available for review in the [_____] district office. Contact [_____] at [_____] to arrange for review of the memorandum. Consider the test results and conclusions valid only for the sample tested and do not take them as an indication of the quality of all material from a source nor for the amount of processing required.

2.2.2.2 Fine-Aggregate Grading

Provide grading and uniformity of the fine aggregate conforming to the following requirements as delivered to the grout mixer:

U. S. STANDARD SIEVE SIZE	PERCENT BY MASS, PASSING
2.36 mmNo. 8	100
1.18 mmNo. 16	95 - 100
600 µmNo. 30	55 - 80
300 µmNo. 50	30 - 55
150 µmNo. 100	10 - 30
75 µmNo. 200	0 - 10

In addition to the grading limits specified above, provide fine aggregate with a fineness modulus of not less than 1.30 nor more than 2.10. Control the grading of the fine aggregate so that the fineness moduli of at least four of any five consecutive test samples does not vary more than 0.15 from the average fineness modulus of all samples previously taken.

2.2.2.3 Coarse-Aggregate Grading

Provide grading of the coarse aggregate conforming to the following requirements:

	PERCENT BY MASS, PASSING	
U.S. STANDARD SIEVE SIZE	19.0 mm 3/4 inch to 37.5 mm 1-1/2 inch	37.5 mm 1-1/2 inch to 75 mm 3 inches
75 mm3 inches		95 - 100
50 mm2 inches	100	20 - 55
37.5 mm1-1/2 inch	95 - 100	0 - 5

PERCENT BY MASS, PASSING		
U.S. STANDARD SIEVE SIZE	19.0 mm 3/4 inch to 37.5 mm 1-1/2 inch	37.5 mm 1-1/2 inch to 75 mm 3 inches
25.0 mm1 inch	40 - 80	0 - 2
19.0 mm3/4 inch	20 - 45	
12.5 mm1/2 inch	0 - 5	
9.5 mm3/8 inch	0 - 2	

2.2.2.4 Coarse-Aggregate Particle Shape

The quantity of flat and elongated particles of the coarse aggregate, as defined and determined by ASTM D4791, must not exceed 25 percent.

2.2.2.5 Concrete Aggregate Sources

****

NOTE: If an aggregate source is provided by the Government, the appropriate paragraphs from Section 03 70 00 MASS CONCRETE should be used.

****

2.2.2.5.1 List of Sources

The concrete aggregates sources may be selected from sources listed at the end of this section.

2.2.2.5.2 Selection of Source

After the award of the contract, designate in writing only one source or combination of sources from which to furnish aggregates. If the Contractor proposes to furnish aggregates from a source or from sources not listed at the end of this section, designate only a single source or single combination of sources for aggregates. If a source for coarse or fine aggregates does not meet the quality requirements stated in paragraph QUALITY OF AGGREGATES in PART 3, the Contractor may not submit for approval other nonlisted sources but furnish the coarse or fine aggregate, as the case may be, from sources listed at the end of this section at no additional cost to the Government.

2.2.2.6 Coarse-Aggregate Quality

****

NOTES: The tests selected should be those which are applicable to the concrete to be used in the project. These tests may include those listed below in addition to others not listed. See Chapter 2 of EM 1110-2-2000 for discussion of tests.

A list of properties and test values are unique to each project and should be taken from the concrete

materials design memorandum. Delete the quality tests not required in the DM.

Use the petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.

Depending upon the quality of aggregates available, some tests may not be required. Refer to EM 1110-2-2000 for the purpose of each test.
****

Deliver aggregates to the mixer that meet the following requirements:

	TEST LIMITS		
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Specific Gravity	[_____]	[_____]	ASTM C127 ASTM C128
Absorption	[_____]	[_____]	ASTM C127 ASTM C128
Durability Factor	[_____]	[_____]	COE CRD-C 114 ASTM C666/C666M
Clay Lump and Friable Particles	[_____]	[_____]	ASTM C142/C142M
Material Finer than 75-µm (No. 200) Sieve	[_____]	[_____]	ASTM C117
Organic Impurities	Not darker than No. 3 Not less than 95 percent	[_____]	ASTM C40/C40M ASTM C87/C87M
L.A. Abrasion	[_____]	[_____]	ASTM C131/C131M ASTM C535
Soft Particles	[_____]	[_____]	COE CRD-C 130
Petrographic Examination	List unwanted deleterious materials and their limits	[_____]	ASTM C295/C295M
[Chert, Less than 2.40 specific gravity]	[_____]	[_____]	ASTM C123/C123M

	TEST LIMITS		
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
[Coal and Lignite, less than 2.00 specific gravity]	[_____]	[_____]	ASTM C123/C123M

2.2.3 Chemical Admixtures

Use chemical admixtures, when required or permitted, conforming to the appropriate specification listed.

2.2.3.1 Air-Entraining Admixture

Provide air-entraining admixture conforming to ASTM C260/C260M.

2.2.3.2 Grout Fluidifier

Provide grout fluidifier conforming to ASTM C937.

2.2.3.3 Water-Reducing or Retarding Admixtures

Provide water-reducing or retarding admixtures meeting the requirements of ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived.

2.2.4 Curing Materials

2.2.4.1 Impervious-Sheet Curing Materials

Provide impervious-sheet curing materials conforming to ASTM C171, type optional, except do not use polyethylene film.

2.2.4.2 Membrane-Forming Curing Compound

Furnish membrane-forming curing compound that meets the requirements of ASTM C309, Type 1-D or 2, except use a styrene acrylate or chlorinated rubber compound meeting Class B requirements for surfaces that are to be painted. Select curing compound that is compatible with any subsequent paint specified. Use nonpigmented compound containing a fugitive dye and has the reflective requirements in ASTM C309 waived.

2.2.4.3 Burlap

Use burlap for curing that conforms to AASHTO M 182.

2.2.5 Water

Use water for mixing and curing that is fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that nonpotable water may be used if it meets the requirements of COE CRD-C 400.

2.2.6 Nonshrink Grout

Furnish nonshrink grout conforming to ASTM C1107/C1107M and is a commercial formulation suitable for the application proposed.

2.3 GROUT MIXTURE PROPORTIONING

Submit determined grout mixture proportions for review, including the quantities of all ingredients per cubic meter yard and stating the grading of the fine aggregate size that will be used in the manufacture of each quantity of concrete. Include test reports from a laboratory complying with ASTM C1077 which show that proportions thus selected will produce preplaced-aggregate concrete of the qualities indicated. Provide grout mixture proportioning meeting the following requirements:

2.3.1 Quality of Mixture

For each portion of the structure, select mixture proportions so that the strength and water-cement ratio requirements listed in paragraph DESIGN OF PREPLACED AGGREGATE in PART 1 are met. State the source of materials and proportions of portland cement, [pozzolan], fluidifier, fine aggregate, and water. Determine the grout proportions for the preplaced-aggregate concrete in accordance with ASTM C938. Use grout proportions for the preplaced-aggregate concrete meeting the specified strength as determined by specimens molded in accordance with ASTM C943 and tested in accordance with ASTM C39/C39M. Convert the maximum water-cement ratios required in paragraph MAXIMUM WATER-CEMENT RATIO (W/C) in PART 1 to a ratio by mass of water to cement plus pozzolan or GGBF slag by mass equivalency as described in ACI 211.1. In the case where GGBF slag is used, include the mass of the slag in the equations for the term P, which is used to denote the mass of pozzolan. If pozzolan is used in the concrete mixture, use pozzolan with a minimum pozzolan content that is 15 percent of the total cementitious material. Make no substitution in the source or type of materials used in the work without additional tests to show that the new quality of materials and concrete are satisfactory.

2.3.2 Air Content

The air content of the grout mixture as determined by ASTM C231/C231M within 15 minutes after mixing must be 9.0 plus or minus 1.0 percent.

2.3.3 Grout Flow

Use grout flow of 18.0 plus or minus 2.0 seconds when sampled from the agitator and test in accordance with ASTM C939/C939M.

2.4 EQUIPMENT

Submit data on the pumping equipment and methods for pumping and delivering the grout for preplaced-aggregate concrete for review by the Contracting Officer, including the methods for transporting, handling, and depositing the coarse aggregate, the location, arrangement, and size of the pipe and inserts, sequence of pumping, method of withdrawal of injection pipe, and the rate of grout injection. Also include methods for venting of air from under embedded projections.

2.4.1 Capacity

****

NOTE: Refer to the appropriate DM for the capacity. Guidance is also found in EM 1110-2-2000.

****

Provide mixing and pumping equipment with a capacity of at least [_____] cubic meters yards per hour.

2.4.2 Batching Equipment

Mechanically batch all materials by mass except the water and admixture which may be batched by volume.

2.4.2.1 Scales

Use equipment for determining mass conforming to the applicable requirements of NIST HB 44, except that the accuracy must be plus or minus 0.2 percent of scale capacity. Provide standard test reference masses and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. Make tests at the frequency required in paragraph TESTING AND QUALITY VERIFICATION FOR CONTRACTOR QUALITY CONTROL in PART 3, in the presence of a Government representative.

2.4.2.2 Batching Tolerances

2.4.2.2.1 Tolerances on Mass

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	0 to plus 2
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

2.4.2.2.2 Volumetric Tolerances

For volumetric batching equipment, the following tolerances apply to the required volume of material being batched: Water: plus or minus 1 percent. Chemical admixtures: Zero to plus 6 percent.

2.4.2.3 Grout Mixer

Provide a machine especially designed for the mixing of grout, capable of mixing grout mechanically to a uniform consistency. Maintain the mixer in satisfactory operating condition and kept free of hardened grout. Should any grout mixer at any time produce unsatisfactory results, promptly discontinue its use until the condition is corrected. Provide the grout mixer with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. Use of revolving-drum concrete mixers will not be permitted. Submit Grout-mixer data including the make, type, and capacity of grout mixers, grout agitators, tank, pump, and pipe system proposed for producing the grout for preplaced-aggregate concrete.

2.4.2.4 Agitator Tank

Furnish agitator tank that has at least the same capacity as the mixer and equip to agitate the grout effectively and continuously. Pass all grout entering the tank through a wire sieve. A sieve size less than 4.75 mm No. 4 and greater than 9.5 mm 3/8 inch is not permitted.

2.4.2.5 Grout Pump

Furnish grout pump that operates by positive displacement or progressive cavity. Equip the pump with a by-pass line connecting the discharge and inlet or provide circulation into the agitator for continuous operation if line blockage or temporary shutdown of grouting operation occurs. Install a pressure gauge on the pump discharge line to indicate incipient line blockage or a plugged insert pipe. Provide standby pumping equipment.

2.4.3 Grout Pipe System

2.4.3.1 Delivery Pipes

Provide main delivery line carrying grout from the grout pump to the vicinity of the insert pipes of such diameters that grout velocity at the planned operating rate will range between 0.6 and 1.2 meters 2 and 4 feet per second. All pipe fittings must be watertight. Provide unions for quick disconnect to facilitate pipe cleanup when required. A manifold system, in which more than one grout insert is operative at the same time, will not be permitted.

2.4.3.2 Grout Insert Pipes

Provide pipes that are [19] [25] [40] mm [3/4] [1] [1-1/2] inch in diameter conforming to ASME B36.10M Schedule 40. Standard pipe couplings may be used if the couplings are to be withdrawn not more than 4.5 m 15 feet through the preplaced aggregate. Where pipe couplings are required for greater depths of preplaced aggregate, use flush-coupled pipe conforming to ASME B36.10M Schedule 160. Make connections between grout delivery hoses and insert pipes using quick-opening fittings. Quick-disconnect pneumatic fittings will not be permitted for this purpose. Provide valves in the pipe system that are plug or ball type, quick-opening, and which can be easily taken apart and cleaned. Stem lubricate valves over 25 mm 1 inch in diameter.

2.4.3.3 Sounding Wells

Provide sounding wells that are 50 mm 2 inch diameter steel pipe provided with milled (not burned) 13 mm 1/2-inch open slots 150 mm 6 inches long with 300 mm 12 inches between slots. Ream the pipe and remove burrs before installation. Equip the sounding line with a 25 mm 1 inch diameter float having a mass so as to sink in water, yet float on the grout surface within the slotted pipe.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACEMENT

3.1.1 Embedded Items

Before placement of coarse aggregate for preplaced-aggregate concrete, take care to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Provide embedded items that are free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Fill voids in sleeves, inserts, and anchor slots temporarily with readily removable materials to prevent the entry of grout into voids. Welding, including tack welding, will not be permitted on embedded metals within 600 mm 2 feet of the surface of the preplaced-aggregate concrete.

3.1.2 Concrete on Earth Foundations

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NOTE: The Designer should insert the appropriate Section number and title below.

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Use earth surfaces upon which preplaced-aggregate concrete is to be placed that are clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of coarse aggregate, satisfactorily compact the earth foundation in accordance with the provisions of [Section 31 00 00 EARTHWORK] [_____].

3.1.3 Concrete on Rock Foundations

Use rock surfaces upon which coarse aggregate for preplaced-aggregate concrete is to be placed that are clean, free from oil, standing or running water, ice, mud, drummy rock, coating, debris, and loose, semidetached, or unsound fragments. Clean joints in rock to a satisfactory depth, as determined by the Contracting Officer, and to firm rock on the sides. Immediately before the coarse aggregate is placed, clean all rock surfaces thoroughly by the use of air-water jets or sandblasting as defined in paragraph CONSTRUCTION JOINT TREATMENT below.

3.1.4 Underwater Placement

Place coarse aggregate for underwater preplaced-aggregate concrete on rock surfaces which are clean, free from drummy rock, coatings, debris, and loose semidetached or unsound fragments.

3.1.5 Concrete Surfaces

Use concrete surfaces on which coarse aggregate is to be placed or preplaced-aggregate concrete surfaces between stages that are clean and free from foreign material. Remove excessive accumulation of fine material on the surface with high-pressure water jets or other approved methods.

3.1.6 Construction Joint Treatment

3.1.6.1 Joint Preparation

a. If grout in a preplaced-aggregate placement is not brought to the surface in order to form a construction joint, stop the intrusion grout rise 300 mm 12 inches below the aggregate surface. Do not allow dirt and debris to collect on the aggregate surface or to filter down to the grout surface. Pull the insert pipes just above the grout surface before the grout stiffens and rodded clear. When pumping is ready to resume, work the insert pipes back to near contact with the hardened grout surface and then slowly resume pumping for a few minutes.

b. Prepare preplaced-aggregate concrete in which the grout has been brought to the surface and any other concrete surfaces to which preplaced-aggregate concrete is to be bonded for receiving the next lift or adjacent preplaced-aggregate concrete by cleaning with air-water cutting, sandblasting, high-pressure water jet, or other approved method. Air-water cutting will not be permitted on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces must be free from all laitance and inferior concrete so that clean, well-bonded coarse aggregate is exposed uniformly throughout the lift surface. Do not undercut the edges of the coarse aggregate. Wash clean the surface again as the last operation prior to placing the next lift.

3.1.6.2 Air-Water Cutting

Perform air-water cutting of a construction joint at the proper time and only on horizontal construction joints. Use an air pressure in the jet of 690 kPa 100 psi plus or minus 70 kPa 10 psi, and use a sufficient water pressure to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, furnish samples of the material to be used and demonstrate the method to be used in applications. After cutting, wash and rinse the surface as long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure water jet or sandblasting will be required as the last operation before placing the next lift.

3.1.6.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 20.7 MPa 3,000 psi may be used for cleaning. Delay its use until the concrete is sufficiently hard so that only the surface skin or mortar is removed, and there is no undercutting of coarse-aggregate particles. If the water jet is incapable of a satisfactory cleaning, clean the surface by sandblasting.

3.1.6.4 Wet Sandblasting

This method may be used when the concrete has reached sufficient strength to prevent undercutting of the coarse-aggregate particles. Then wash the surface of the concrete thoroughly to remove all loose materials.

3.1.6.5 Waste Disposal

Use a method in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal is subject to approval.

3.2 COARSE-AGGREGATE AND GROUT PLACEMENT

3.2.1 Coarse-Aggregate Washing and Screening

Wash, screen, and immediately saturate coarse aggregate before placement. Washing of the aggregate in the forms will not be permitted. If more than one size of coarse aggregate is used, weigh, batch, and mix the aggregate in the proper proportions onto the wash screen. The wash screen may be a vibrating deck or revolving.

3.2.2 Transporting and Placing Coarse Aggregate

Transport coarse aggregate to the forms and place in substantially horizontal layers by means which will prevent objectionable segregation and breakage. Remove foreign material and excessive accumulation of fine material on the lift surface before placing the next lift. Place coarse aggregate under water continuously in each stage or lift until placement in that stage or lift is completed. When the coarse aggregate is to be placed in the dry, there must be no vertical drop greater than 1.5 m 5 feet except where suitable equipment is provided to prevent breakage and segregation and where specifically authorized. Vehicle traffic on top of preplaced-coarse aggregate is not permitted.

3.2.3 Cold-Weather Placing of Preplaced-Aggregate Concrete

When the cold-weather placing of preplaced-aggregate concrete is likely to be subjected to freezing temperatures before the expiration of the curing period, place concrete in accordance with the approved procedures. Submit for approval the proposed materials, methods, and protection if preplaced-aggregate concrete is to be placed under cold-weather conditions. Use an ambient temperature of the space adjacent to the preplaced-aggregate concrete placement and surfaces to receive preplaced-aggregate concrete that is above 0 degrees C 32 degrees F. Use a placing temperature of the preplaced aggregate concrete having a minimum dimension less than 300 mm 12 inches between 13 and 24 degrees C 55 and 75 degrees F when measured in accordance with ASTM C1064/C1064M. Use a placing temperature of the preplaced-aggregate concrete having a minimum dimension greater than 300 mm 12 inches between 10 and 21 degrees C 50 and 70 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. Ensure materials entering the grout mixer are free from ice, snow, or frozen lumps. Do not mix salt, chemicals, or other materials with the grout to prevent freezing. Provide forms that are free of frost, and use aggregate, when deposited in the form, that is free of ice, snow, and frozen lumps.

3.2.4 Hot-Weather Placing of Preplaced-Aggregate Concrete

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NOTE: See the appropriate DM for the proper placing temperature.

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Properly perform hot-weather placing of preplaced-aggregate concrete and finish per the approved procedures. Submit for review and approval by the Contracting Officer the proposed materials and methods, if preplaced-aggregate concrete is to be placed under hot-weather conditions. Preplaced-aggregate concrete temperature exceeding [_____] degrees C F when measured in accordance with ASTM C1064/C1064M is not acceptable. Cooling of the mixing water may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph WATER-REDUCING OR RETARDING ADMIXTURES in PART 2, may be used to facilitate placing and finishing. Cool steel forms and reinforcement prior to concrete placement when steel temperatures are greater than 49 degrees C 120 degrees F.

3.2.5 Grout Mixing and Pumping

3.2.5.1 Charging Sequence

The order of placing material in the mixer is as follows:

a. Water, or premixed water and fluidifier, if the fluidifier is in a liquid form.

b. Cement, or preblended cement and fluidifier, if the fluidifier is in a powder form.

c. Remaining ingredients.

3.2.5.2 Mixing Time

After all solids are in the mixer, mix each batch for at least 2 minutes. Provide the mixer with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. Do not charge the mixer in excess of the capacity recommended by the manufacturer nor operate it at a speed in excess of the manufacturer's recommendation.

3.2.5.3 Pumping Procedure

Before starting to mix and pump grout, disconnect the grout hoses from inserts or from inlet points and flush the lines with water. Clear excess water from the pumps and lines. At the start of grouting, with the grout delivery lines disconnected at the inserts, pump and waste grout until grout exiting the line is the same uniform consistency as that being discharged from the mixer. The coarse aggregate within the forms must be in a moist condition at the time of intrusion. Start the intrusion at the lowest point in the aggregate. Perform uniform pumping and at the rate that will permit the grout to fill all voids and avoid displacing the aggregate. After being discharged into the agitator tank, continuously agitate each batch of grout until that batch is fully discharged into the pump. Properly arrange and space insert pipes to ensure a relatively level uniform grout surface. Initially the outlet end of the intrusion lines must penetrate the aggregate mass to within 50 mm 2 inches of the base of the aggregate, unless otherwise directed. Raise the outlets as the grout rises, and after grouting has progressed sufficiently to so permit, extend the outlets into the grout no less than 300 mm 12 inches. Provide satisfactory means for venting the underside of embedded projections with procedures previously submitted in accordance with paragraph SUBMITTALS. Continue grouting until grout of the specified quality is returned from the vent pipes, thereby indicating completeness of grout injection. During the intrusion procedure, externally vibrate the forms in the vicinity of the grout surface. Provide sounding wells or other approved means of accurately locating the grout surface without interrupting the intrusion procedure for observation and regulation of the level of the grout. Provide continuous agitation of grout during any shutdown of the intrusion procedure. When there is a lapse in the operation of intrusion in excess of 15 minutes, recirculate the grout through the pump, or agitator and pump. Flush the grout delivery lines with clean water if they become blocked. Disconnect them from grout insert pipe before the flushing operation is performed and do not reconnect to grout insert pipe after flushing until pumping is resumed and grout appears. Do not use grout after appreciable stiffening of the grout mixture has occurred. [When placed underwater, begin intrusion while aggregates are being placed and follow closely behind aggregate placement unless otherwise approved. Do not bring the grout surface closer than 300 mm 1 foot of the lowest point of the aggregate lift prior to topping out.]

3.2.5.4 Blocked Pipes

Exercise care to avoid blocking grout insert pipes by avoiding interruptions in pumping; however, when a pipe becomes blocked, withdraw it immediately until the end is at least 600 mm 2 feet above the level of the grout before an attempt is made to unblock it by washing out the line. Do not attempt washing with the end of the grout line inserted in the grout.

3.2.5.5 Placing Temperature

Do not place intrusion grout when the ambient temperature is below 2 degrees C 35 degrees F, unless specifically approved by the Contracting Officer. Do not subject preplaced-aggregate concrete, without special protection, to freezing temperatures before grout reaches a unconfined compressive strength of 3500 kPa 500 psi. Grout which is intruded during cold weather must have a temperature of not less than 5 degrees C 40 degrees F nor more than 15 degrees C 60 degrees F. Heating of the mixing water or fine aggregate will not be permitted until the temperature of the grout has decreased to 7 degrees C 45 degrees F. All methods and equipment for heating are subjected to approval.

3.3 FINISHING

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NOTE: Consult the appropriate DM for those surfaces to receive a trowel finish, abrasive aggregate finish, or broom finish. Be sure those special finishes are shown.

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An ambient temperature of spaces adjacent to surfaces being finished less than 10 degrees C 50 degrees F is not permitted. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 1 kg/square meter 0.2 psf per hour, make provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material in advance of placement. Take such protective measures as quickly as finishing operations will allow. Provide a float finish for all unformed surfaces that are not to be covered by additional concrete or backfill. Provide additional finishing as specified below and true to the elevation shown in the drawings. Bring surfaces to receive additional concrete or backfill to the elevation shown in the drawings and leave true and regular. Slope exterior surfaces for drainage unless otherwise shown in the drawing or as directed.

3.3.1 [Formed Top Surface

Use a venting form constructed of muslin to produce the finished surface. Place the venting form on top of the aggregate and back up by fly screen, diamond metal lath, and sheeting boards spaced from 13 to 25 mm 1/2 to 1 inch apart. Tie down the form against uplift pressure.]

3.3.2 [Screeded or Trowelled Surface

Bring the grout up to flood the aggregate surface and any remove diluted surface grout by brooming. Following this, work a thin layer of pea gravel or 9.5 to 12.5 mm 3/8 to 1/2 inch crushed aggregate down into the surface by tamping and raking. When the surface is sufficiently hardened to permit working, screed, float, or trowel the surface to the specified finish.]

3.4 CURING AND PROTECTION

Submit curing medium and methods to be used, for review and approval. Provide curing and protection conforming to the following requirements:

3.4.1 Duration

Determine the length of the curing period by the type of cementitious material, as specified below. Cure concrete by an approved method.

CONCRETE CURING PERIOD	
Type I portland cement	7 days
Type II portland cement	14 days
Portland cement blended with 25 percent or less fly-ash	14 days
Portland cement blended with more than 25 percent Fly-ash	21 days

Immediately after placement, protect preplaced-aggregate concrete from premature drying, extremes in temperatures, rapid temperature change, and mechanical damage. Make all materials and equipment needed for adequate curing and protection available and at the placement site to the start of grouting. Protect preplaced-aggregate concrete from the damaging effects of rain for 12 hours and from flowing water for 14 days. Fire or excessive heat, including welding, is not permitted near or in direct contact with concrete or concrete embedments at any time.

3.4.2 Moist Curing

Maintain preplaced-aggregate concrete that is moist-cured continuously, not periodically, wet for the entire curing period. If water or curing materials stain or discolor concrete surfaces that are to be permanently exposed, clean them as required in paragraph APPEARANCE, below. Where wooden form sheathing is left in place during curing, keep the sheathing wet at all times. Where steel forms are left in place during curing, carefully braek the forms loose from the hardened concrete and continuously apply curing water into the void to continuously saturate the entire concrete surface. Horizontal surfaces may be moist cured by ponding, by covering with a minimum uniform thickness of 50 mm 2 inches of continuously saturated sand, or by covering with saturated nonstaining burlap or cotton mats. Rinse burlap and cotton mats to remove soluble substances before using. Furnish water for curing in compliance with the requirements of paragraph WATER in Part 2.

3.4.3 Curing with Membrane-Forming Curing Compound

Concrete may be cured with an approved membrane-forming curing compound in lieu of moist curing, except that membrane curing will not be permitted on any surface to which a grout-cleaned finish is to be applied or other concrete is to be bonded, on any surface containing protruding steel reinforcement, on an abrasive aggregate finish, or any surface maintained at curing temperature by use of free steam. A styrene acrylate or chlorinated rubber compound may be used for surfaces that are to be painted. Select curing compound that is compatible with any subsequent paint specified.

3.4.3.1 Pigmented Curing Compound

A pigmented curing compound meeting the requirements of paragraph MEMBRANE-FORMING CURING COMPOUND in PART 2, may be used on surfaces that will not be exposed to view when the project is completed.

3.4.3.2 Nonpigmented Curing Compound

A nonpigmented curing compound containing a fugitive dye may be used on surfaces that will be exposed to view when the project is completed. Concrete cured with nonpigmented curing compound must be shaded from the sun for the first 3 days when the ambient temperature is 32 degrees C 90 degrees F or higher.

3.4.3.3 Application

Apply the curing compound to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Thoroughly moisten the surfaces with water, and apply the curing compound as soon as free water disappears. Apply the curing compound to unformed surfaces as soon as free water has disappeared. Apply the curing compound in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 520 kPa 75 psi, at a uniform coverage of not more than 10 square meters/L 400 square feet/gallon for each coat, and apply the second coat perpendicular to the first coat. Respray concrete surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied by the method and at the coverage specified. Adequately protect all concrete surfaces on which the curing compound has been applied for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause that will disrupt the continuity of the curing membrane.

3.4.4 Impervious-Sheet Curing

Horizontal surfaces may be cured using impervious sheets. Provide sheets that comply with the requirements of ASTM C171, except do not use polyethylene film. Thoroughly wet all surfaces and be completely cover with waterproof paper, or with polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Lapcovering no less than 300 mm 12 inches and securely weigh down or lap no less than 100 mm 4 inches and tape to form a continuous cover with completely closed joints. Provide weighted sheet to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Fold cover down over exposed edges of the slabs and secure by approved means. Immediately repair or replace sheets if tears or holes appear during the curing period.

3.4.5 Cold-Weather Curing and Protection

When the daily outdoor low temperature is less than 0 degrees C 32 degrees F, manitain the temperature of the concrete above 5 degrees C 40 degrees F for the first 7 days after placing. In addition, during the period of protection removal, control the air temperature adjacent to the concrete surfaces so that concrete near the surface will not be subjected to a temperature differential of more than 15 degrees C 25 degrees F. Determine this by observation of ambient and concrete temperatures indicated by suitable temperatures measuring devices furnished by the Government as required and installed adjacent to the concrete surface and 50 mm 2 inches inside the surface of the concrete. Install thermometers at such locations as may be directed.

3.4.6 Appearance

Clean permanently exposed surfaces, if stained or otherwise discolored, by a method that does not harm the concrete and that is approved.

3.5 TESTING AND QUALITY VERIFICATION FOR CONTRACTOR QUALITY CONTROL

Submit statements attesting that the concrete testing technicians and the concrete inspectors meet the specified requirements, also Contractor quality control test results and inspection reports daily and weekly as required. With the testing and quality verification, conform to the following requirements.

3.5.1 General

Perform the inspection and tests described below, and based upon the results of these inspections and tests, take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the preplaced-aggregate concreting operations are out of control, cease aggregate and intrusion grouting. Perform tests using an onsite laboratory and conforming with ASTM C1077. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C1077.

3.5.2 Testing and Inspection Requirements

3.5.2.1 Fine Aggregate

3.5.2.1.1 Grading

At least once during each shift when the grout plant is operating, perform one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M and COE CRD-C 104 for the fine aggregate. The grading must conform to requirements in paragraph FINE-AGGREGATE GRADING in PART 2. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

3.5.2.1.2 Corrective Action for Fine-Aggregate Grading

When the amount passing on any sieve is outside the specification limits, resample and retest the fine aggregate immediately. If there is another failure on any sieve, report the fact immediately to the Contracting Officer.

3.5.2.1.3 Moisture Content Testing

Perform at least four tests for moisture content in accordance with ASTM C566 during each 8-hour period of mixing plant operation. Select random times for the tests within the 8-hour period. Make an additional test whenever the grout flow is out of control or excessive variation in consistency is reported by the placing foreman. Use the results of tests for moisture content to adjust the added water in the control of the grout mixing.

3.5.2.1.4 Moisture Content Corrective Action

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, adjust the scale settings for the fine-aggregate batcher and water batcher (directly or by means of a moisture compensation device), if necessary to maintain the specified flow.

3.5.2.2 Coarse Aggregate

3.5.2.2.1 Gradinge

At least once during each shift in which the coarse aggregate is being placed in the forms, perform a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. Furnish coarse aggregates conforming to the requirements found in paragraph COARSE-AGGREGATE GRADING in PART 2. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. Maintain a test record of samples of aggregate taken at the same locations showing the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control which are coarser than the specification limits for samples taken at locations other than as delivered to the forms to allow for degradation during handling.

3.5.2.2.2 Corrective Action for Grading

When the amount passing any sieve is outside the specification limits, immediately resample and retest the coarse aggregate. If the second sample fails on any sieve, report that fact to the Contracting Officer. Where two consecutive averages of five tests are outside specification limits, consider the operation out of control and report it to the Contracting Officer. Stop aggregate placement and take immediate steps to correct the grading.

3.5.2.3 Quality of Aggregates

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NOTES: Depending upon the quality of aggregates available, some tests may not be required. Refer to EM 1110-2-2000 for the purpose of each test.

Use the petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.

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Submit aggregate quality test results, at least 30 days prior to start of preplaced-aggregate concrete placement. Provide quality of aggregates meeting the following requirements.

3.5.2.3.1 Frequency of Quality Tests

Thirty days prior to the start of preplaced-aggregate concrete placement perform all tests for aggregate quality listed on the following page. In addition, after the start of concrete placement, perform tests for aggregate quality in accordance with the frequency schedule. Take samples of fine aggregate tested after the start of concrete placement immediately prior to entering the grout mixer. Take samples of coarse aggregate tested after the start of concrete placement immediately prior to entering the forms.

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Absorption	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Durability Factor using, Procedure A	Every 12 months	Every 12 months	COE CRD-C 114 ASTM C666/C666M
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C142/C142M
Material Finer than the 75 µm No. 200 Sieve	Every 3 months	Every 3 months	ASTM C117
Organic Impurities	Every 3 months	Not applicable	ASTM C40 ASTM C87/C87M
L.A. Abrasion	Not applicable	Every 6 months	ASTM C131/C131M ASTM C535
Soft and Friable (Scratch Hardness)	Not applicable	Every 6 months	COE CRD-C 130
Petrographic Examination	Every 6 months	Every 6 months	ASTM C295/C295M
[Chert, less than 2.40 specific gravity]	Every 6 months	Every 6 months	ASTM C123/C123M
[Coal and Lignite, less than 2.00 specific gravity]	Every 6 months	Every 6 months	ASTM C123/C123M

3.5.2.3.2 Corrective Action for Aggregate Quality

If the result of a quality test fails to meet the requirements for quality immediately prior to start of preplaced-aggregate concreting operations, change production procedures or change materials and perform additional tests until the material meets the quality requirements prior to proceeding with either mixture proportioning studies or starting preplaced-aggregate concreting operations. After preplaced-aggregate concreting operations commences, whenever the result of a test for quality fails the requirements, rerun the test immediately. If the second test fails the quality requirement, report the fact to the Contracting Officer and take immediate steps to rectify the situation.

3.5.2.4 Scales

3.5.2.4.1 Accuracy in Determination of Mass

Check the accuracy of the scales by reference masses prior to start of grouting operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT in PART 2. Also make such tests as directed whenever there are variations in properties of the fresh grout that could result from batching errors.

3.5.2.4.2 Scales Corrective Action

When the accuracy of determination of mass does not comply with specification requirements, do not perform grouting until necessary adjustments or repairs have been made. Correct discrepancies in recording accuracies immediately and report to the Contracting Officer.

3.5.2.5 Grout Plant Control

Continuously control the measurement of all constituent materials including cementitious materials, aggregate, water, and admixtures. Adjust the fine aggregate mass and amount of added water as necessary to compensate for free moisture in the fine aggregate. Adjust the amount of air-entraining agent to control air content within specified limits. Prepare a report indicating type and source of cement used, type and source of pozzolan used, amount and source of admixtures used, aggregate source, the required aggregate and water in mass per cubic meter, amount of water as free moisture in the fine aggregate, and the batch aggregate and mass of water per cubic meter for each mixture batched during grouting operations.

3.5.2.6 Grout Mixture

3.5.2.6.1 Air-Content Testing

Make air-content tests when test specimens are fabricated. In addition, make at least two tests for air content on randomly selected batches of each separate grout mixture produced during each 8-hour period of grout production. Make additional tests when excessive variation in consistency is reported by the placing foreman or Government quality assurance representative. Make tests in accordance with ASTM C231/C231M. Plot test results on control charts which will at all times be readily available to the Government. Keep copies of the current control charts in the field by the Contractor's quality control representatives and plot results as tests are made. When a single test result reaches the upper or lower action limit, make a second test immediately. Average the results of the two tests. Use this average as the air content of the batch to plot on the control chart for air content and on the control chart for range and to determine the need for any remedial action. Plot the result of each test, or average as noted in the previous sentence, on a separate chart for each mixture on which an average line is set at the midpoint of the specified air-content range from paragraph AIR CONTENT in PART 2. Set an upper warning limit and a lower warning limit line 1.0 percentage point above and below the average line. Set an upper action limit and a lower action limit line 1.5 percentage points above and below the average line, respectively. Plot the range between each two consecutive tests on a control chart for range where an upper warning limit is set at 2.0 percentage points and up upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer; however, the Contractor is responsible for delivering the grout to the placement site at the stipulated flow. If the Contractor's materials or transportation methods cause flow loss between the mixer and the placement, take correlation samples at the placement site as required by the Contracting Officer and control the air content at the mixer as directed.

3.5.2.6.2 Air-Content Corrective Action

Whenever points on the control chart for percent air reach either warning limit, make an adjustment immediately in the amount of air-entraining admixture batched. As soon as is practical after each adjustment, make another test to verify the result of the adjustment. Whenever a point on the control chart range reaches the warning limit, recalibrate the admixture dispenser to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, consider the air content out of control and immediately halt the concreting operation until the air content is under control. make additional air-content tests when grout mixing is restarted. All this will be at no extra cost to the Government.

3.5.2.7 Test for Grout Flow

3.5.2.7.1 Tests

Make at least two tests on randomly selected batches of grout mixture during each shift's production in accordance with ASTM C939/C939M. Make additional tests when excessive variation in flow of grout mixture is reported by the grout foreman or Government inspector. Plot test results on control charts which will at all times be readily available to the Government. Keep copies of the current control charts in the field by the Contractor's quality control representatives and plot results as tests are made. When a single-flow test reaches or goes beyond the upper or lower action limit, make a second test immediately on the same batch of concrete. Average the results of the two tests. Use this average as the flow of the batch to plot on the control chart for flow and the chart for range and to determine the need for any remedial action. Set an upper warning limit at 1 second below the maximum allowable flow on separate control charts for flow used for each type of mixture, and set upper and lower action limit lines at the maximum and minimum allowable flows, respectively. Plot the range between each consecutive flow test for each type of mixture on a single control chart for range on which an upper action limit is set at 2 seconds. Take samples for flow at the agitator; however, the Contractor is responsible for delivering the grout to the placement site at the stipulated flow. If the Contractor's materials or transportation methods cause flow loss between mixer and the placement, takecorrelation samples at the placement site as required by the Contracting Officer and control the flow at the mixer as directed.

3.5.2.7.2 Grout Flow Corrective Action

Whenever points on the control chart for flow reach the upper warning limit, make an adjustment immediately in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum W/C specified, based upon aggregates which are in a saturated surface-dry condition. When a single flow reaches the upper or lower action limit, do not deliver further grout to the placing site until proper adjustments have been made. Immediately after each adjustment, make another test to verify the correctness of the adjustment. Whenever two consecutive flow tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, halt the grouting operation immediately, and take appropriate steps to bring the flow under control. Also, make additional flow tests as directed. All this will be at no additional cost to the Government.

3.5.2.7.3 Temperature

Measure the temperature of the grout when compressive strength specimens are fabricated. Measure temperature in accordance with ASTM C1064/C1064M. Report the temperature along with the compressive strength data.

3.5.2.7.4 Compressive-Strength Specimens

Make at least one set of test specimens each day on each different preplaced-aggregate concrete mixture placed during the day. Make additional sets of test cylinders, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. Develop a random grout sampling plan and obtain approval prior to the start of construction. Assure that sampling is done in a completely random and unbiased manner. Provide a set of test specimens for concrete with a 28-day specified strength, in accordance with paragraph DESIGN OF PREPLACED AGGREGATE in Part 1, consisting of six cylinders, three to be tested at 7 days and three at 28 days. Provide a set of test specimens for concrete with a 90-day strength, in accordance with the same paragraph, consisting of nine cylinders, three tested at 7 days, three at 28 days, and three at 90 days. Mold and cure specimens in accordance with ASTM C943 and test in accordance with ASTM C39/C39M. Report all compressive-strength tests immediately to the Contracting Officer. Keep quality control charts for individual strength tests, moving average for strength, and moving average for range for each mixture, that are similar to those found in ACI 214R.

3.5.2.8 Inspection Before Pumping Grout

Inspect foundation or construction joints, forms, and embedded items for quality in sufficient time prior to each grout placement to certify to the Contracting Officer that they are ready to receive grout. Report the results of each inspection in writing.

3.5.2.9 Grout Pumping

3.5.2.9.1 Placing Inspection

The placing foreman will supervise all placing operations, will determine that the correct quality of grout is placed in each location as directed by the Contracting Officer, and is responsible for measuring and recording grout temperatures and ambient temperature hourly during placing operations, weather conditions, time of grout placement, amount of grout placed, and method of placement.

3.5.2.9.2 Pumping Corrective Action

Do not permit grouting operations to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. If any batch of grout fails to meet the temperature requirements, take immediate steps to improve temperature controls. Submit data on the size, frequency, and amplitude of the external vibrators for review.

3.5.2.10 Curing

3.5.2.10.1 Moist-Curing Inspections

At least once each shift and once per day on nonwork days, inspect all areas subject to moist curing. Note and record surface moisture condition.

3.5.2.10.2 Moist-Curing Corrective Action

When a daily inspection report lists an area of inadequate curing, take immediate corrective action, and extend the required curing period for such areas by 1 day.

3.5.2.10.3 Membrane-Curing Inspection

Do not apply curing compound until the Contractor's authorized representative has verified that the compound is properly mixed and ready for spraying. At the end of each operation, estimate the quantity of compound used by measurement of the container and the area of concrete surface covered and compute the rate of coverage in square meters/L square feet/gallon. Note whether or not coverage is uniform.

3.5.2.10.4 Membrane-Curing Corrective Action

When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, spray the entire surface again.

3.5.2.10.5 Sheet-Curing Inspection

At least once each shift and once per day on nonwork days, inspect all areas being cured using material sheets. Note and record the condition of the covering and the tightness of the laps and tapes.

3.5.2.10.6 Sheet-Curing Corrective Action

When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, promptly repair the tears and holes or replace the sheets, close the joints, and extend the required curing period for those areas by 1 day.

3.5.2.11 Cold-Weather Protection and Sealed Insulation Curing

At least once each shift and once per day on nonwork days, inspect all areas subject to cold-weather protection. Inspect the protection system for holes, tears, unsealed joints, or other deficiencies that could result in damage to the concrete. Take special attention at edges, corners, and thin sections. Note, correct, and report any deficiencies.

3.5.2.12 Cold-Weather Protection Corrective Action

When a daily inspection report lists any holes, tears, unsealed joints, or other deficiencies, correct the deficiency immediately and extend the period of protection 1 day.

3.5.3 Reports

Informally report all results of tests or inspections conducted as they are completed and in writing daily. Prepare a weekly report for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, make reports of pertinent temperatures daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-03 37 13 (February 2018)**

Preparing Activity: USACE **Superseding**
UFGS-03 37 13 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-03 37 13 (February 2018)**

Preparing Activity: USACE **Superseding**
UFGS-03 37 13 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 03 37 13

SHOTCRETE
02/18

****

NOTE: This guide specification covers the requirements for materials, proportioning, application, and curing of shotcrete.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The content of this specification is such that guidance given in EM 1110-2-2005, STANDARD PRACTICE FOR SHOTCRETE, is applicable.

****

1.1 SCOPE

1.1.1 Work Specified

This Specification covers the requirements for shotcrete as specified by the Contracting Officer. Included are the requirements for materials; proportioning; and application of [structural] [nonstructural] [fiber-reinforced][wet-mixture][dry-mixture] shotcrete.

****

NOTE: The successful use of shotcrete in structural sections requires careful planning, forming, skill, and continuous care in application. The nozzle size and rate of feed should be limited as necessary to permit full nozzle control and produce a uniform, dense application, even in tight places. For this reason, selecting structural as opposed to nonstructural will provide greater quality of placement as prescribed in the paragraph titled "QUALIFICATIONS".

Dry-mix shotcrete is shotcrete in which most of the mixing water is added at the nozzle. Dry-mix is commonly used for placing mixtures containing lightweight aggregates or refractory materials. Wet-mix shotcrete is shotcrete in which all the ingredients, including water, are mixed before introduction into the delivery hose; compressed air is introduced to the material flow at the nozzle. Compared to dry-mix, wet-mix shotcrete gives better assurance that the mixing water is thoroughly mixed with other ingredients. The paragraph titled "MIXTURE PROPORTIONS" requires the water-cementitious materials ratio (w/cm) for wet-mixture shotcrete to be submitted.
If you want to leave it up to the contractor to decide which type of shotcrete to use then delete both [wet-mixture][dry-mixture] options so the contractor is not limited.

Fibers can provide improved flexural and shear toughness, and impact resistance. For refractory shotcrete, stainless steel fibers increase resistance to thermal shock, temperature cycling damage, and crack development. Some specific applications where fiber-reinforced shotcrete can be cost effective are slope protection, ground support in tunnels and mines, concrete repair, swimming pools, thin shell configurations, and refractory applications such as boilers, furnaces, coke ovens, and petrochemical linings. Synthetic fibers may reduce the susceptibility of shotcrete to plastic shrinkage cracking. In addition to reducing plastic shrinkage, steel fibers can also improve flexural toughness.
If fiber-reinforcing is selected, additional testing for fibers and shotcrete properties will be required. Additional qualifications described in the paragraph titled "QUALIFICATIONS" will also be required.

****

1.1.2 Unit of Measure

Unit of measure: [cubic meter yard][square meter feet].

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2020) Specifications for Structural Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C457/C457M	(2024) Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C642	(2021) Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C685/C685M	(2024) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C928/C928M	(2020a) Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1059/C1059M	(2024) Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1116/C1116M	(2023) Standard Specification for Fiber-Reinforced Concrete
ASTM C1140/C1140M	(2011; R 2019) Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panels
ASTM C1141/C1141M	(2015) Standard Specification for

	Admixtures for Shotcrete
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1293	(2008; R 2015) Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C1315	(2019) Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
ASTM C1385/C1385M	(2010; R 2017) Standard Practice for Sampling Materials for Shotcrete
ASTM C1399/C1399M	(2010; R 2015) Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete
ASTM C1436	(2013) Standard Specification for Materials for Shotcrete
ASTM C1480/C1480M	(2007; R 2012) Standard Specification for Packaged, Pre-Blended, Dry, Combined Materials for Use in Wet or Dry Shotcrete Application
ASTM C1550	(2012) Standard Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1583/C1583M	(2013) Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1604/C1604M	(2005; R 2012) Standard Test Method for Obtaining and Testing Drilled Cores of Shotcrete
ASTM C1609/C1609M	(2024) Standard Test Method for Flexural

	Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Landing)
ASTM C1778	(2023) Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete

1.3 DEFINITIONS

1.3.1 Accepted

Determined to be satisfactory by the Contracting Officer.

1.3.2 Contractor

The person, firm, or corporation with whom the Contracting Officer enters into an agreement for construction of the Work.

1.3.3 Fiber-Reinforced Shotcrete (FRS)

Shotcrete containing discontinuous discrete fibers.

1.3.4 Gun finish

Undisturbed final layer of shotcrete as applied from a nozzle without further finishing.

1.3.5 Overspray

Waste shotcrete material deposited away from intended receiving surface.

1.3.6 Permitted

Accepted by or acceptable to the Contracting Officer; usually pertains to a request by Contractor, or when specified in contract documents.

1.3.7 Predampening

In the dry-mixture process, adding water to the aggregate before mixing to bring its moisture content to a specified amount, usually 3 to 6 percent.

1.3.8 Rod finish

A sharp-edged cutting screed to be used to trim shotcrete forms or ground wires.

1.3.9 Shotcrete

Concrete or mortar conveyed through a hose and pneumatically projected at high velocity onto a surface to achieve compaction.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

[Preconstruction Testing]

Testing During Construction; G, [_____]

Aggregate

Water

Mixture Proportions; G, [_____]

Repair Of Shotcrete; G, [_____]

Resistance To Alkali-Silica Reaction

SD-07 Certificates

Qualifications; G, [_____]

Cement

Supplementary Cementitious Materials

Admixtures; G, [_____]

[Fibers]

Reinforcement

Curing Materials

Testing Agency; G, [_____]

1.5 QUALIFICATIONS

Submit qualifications and experience of the proposed workers including the supervisor, nozzlemen, and crew. For structural or FRS shotcrete, submit evidence of ACI certification of nozzlemen proposed for the Work.

****

NOTE: Requirements of the paragraphs titled "Structural Concrete" and "Nonstructural Concrete" are determined by the selection made in the paragraph titled "Work specified". Structural shotcrete and FRS require careful planning, forming, skill, and continuous care in application, hence why ACI certification is required.

****

1.5.1 Structural Concrete

Submit proof of experience for the Contractor and the shotcrete crew foreman to include at least five projects of similar size and complexity. Include a description of previous project's size, density of reinforcing materials, and volume of shotcrete placed.

1.5.2 Nonstructural Concrete

Submit proof that the Contractor and crew foreman have at least 3 years' experience in that type of shotcrete application.

1.6 [PRECONSTRUCTION TESTING]

****

NOTE: It is not practical to conduct laboratory trial mixtures for dry-mix shotcrete. There are also problems in duplicating as-shot conditions for the wet-mix shotcrete. Therefore, field trials and preconstruction testing, should be used for qualifying mixture proportions. Preconstruction testing procedures using the personnel, materials, and equipment to be used on the project are outlined in this paragraph Tests should be conducted under similar conditions expected to be experienced in the actual application.

****

1.6.1 [General Requirements]

a. [Testing of materials required as part of the preconstruction program must be conducted by the Contractor's testing agency. Agency selection must be acceptable to the Contracting Officer.

b. Notify the Contracting Officer of the time and place of preconstruction testing and provide the Contracting Officer with copies of testing reports.

c. Construct preconstruction test panels for examination by the Contracting Officer prior to project shotcrete placement. Perform preparation and testing in compliance with ASTM C1140/C1140M. Provide mixture proportions meeting the requirements of the paragraph titled "MIXTURE PROPORTIONS".

d. Construct test panels for each proposed shotcrete mixture, each anticipated shooting orientation, and each proposed nozzleman.

e. Testing required as part of the preconstruction test program must be provided by the Contractor's testing agency.

f. Test specimens cored or sawed from the panels for compliance with the specified compressive strength in accordance with ASTM C1604/C1604M.

g. [Provide flexural strength in accordance with ASTM C78/C78M with beams obtained by ASTM C42/C42M]

****

NOTE: Test flexural properties using ASTM C78/C78M when FRS is not specified. Welded-wire fabric has commonly been used in shotcrete tunnel linings to provide ductility to the shotcrete lining. welded-wire reinforcement is increasingly being replaced by fibers. When fibers are used in panels, delete this provision and use the one below.

****

h. [Test flexural strength, toughness, and other flexural properties using samples from test panels in accordance with the requirements of the paragraph titled "flexural strength and properties". Obtain beams by ASTM C42/C42M][_____]

****

NOTE: This requirement applies to Fiber-reinforced shotcrete (FRS). See the paragraph titled "Flexural strength and properties" for details on test methods used for flexural and FRS

****

i. [Prepare additional panels with the specified reinforcement. Core panels in accordance with ASTM C1140/C1140M. Provide cores containing reinforcement to the Contracting Officer for visual examination to determine acceptance. Provide cores for examination with a minimum diameter of 95 mm 3.75 in and are the full thickness of the panel.]

****

NOTE: In preconstruction testing only, additional panels could be constructed with reinforcement. The reinforcement should be constructed to represent the reinforcement that will be used in the actual structure.

****

j. If the initial prequalification test panel is rejected, a second panel may be shot and tested. If this panel is acceptable, Work may proceed. If the second panel is not acceptable, change procedures, mixture proportions, nozzlemen, or shotcrete equipment as necessary before repeating the preconstruction testing. Do not proceed with Work until preconstruction test results are satisfactory to Contracting Officer.]

1.6.2 [Preplacement Verification]

a. [Provide forms that are to line and grade and have adequate support to remain rigid during shooting.

b. The formwork, substrata preparation, and cleanliness must be the same as specified herein.

c. The reinforcement type, size, grade, amount, placement, cleanliness, and other requirements must be the same as specified [herein][the same size and spacing as the existing structure].

d. The placement of and clearance around reinforcement must permit complete encasement of reinforcement with shotcrete.

e. The mixture proportions must be the same as the approved submittal [and need not include admixtures].]

****

NOTE: Requirement e could also include admixtures, refer the paragraph titled "Admixtures" for this option.

****

1.7 TESTING DURING CONSTRUCTION

1.7.1 Quality Assurance

Provide submittals for the "Quality Control Plan", "Quality Control Personnel Certifications", and Laboratory Qualifications for Concrete Qualification Testing per section 03 30 00 CAST-IN-PLACE CONCRETE.

1.7.2 Testing Shotcrete

a. Compressive strength samples: [Obtain test specimens from job-site test panels.][Use in-place shotcrete test specimens.][_____]

****

NOTE: Test samples can be obtained from test panels (1st choice) or cored from the structure being built with shotcrete (2nd choice)

****

b. Test samples: Sample shotcrete in accordance with ASTM C1385/C1385M. The Contractor is responsible for the curing and protection of test panels on site prior to the time that they are transported to the testing agency's laboratory.

c. [Only use test panels for flexural strength, flexural parameter, or toughness requirements.][_____]

d. Air content of mixture: For wet-mixture shotcrete test air content at

discharge from the truck chute in accordance with ASTM C231/C231M prior to placement.
[For dry-mix shotcrete, test air content in hardened concrete using ASTM C457/C457M][_____]

****

NOTE: Specifying air entrainment for dry-mixture shotcrete is not common but has been satisfactorily used for severe freezing-and-thawing exposures. For dry-mix shotcrete, air content is tested on hardened concrete.

****

e. Temperature of shotcrete mixture: Determine the temperature of the mixture using material sampled prior to discharge from the truck chute into the pump for wet-mixture shotcrete or the shotcrete machine for dry-mix shotcrete. Complete testing in accordance with ASTM C1064/C1064M.

1.7.3 [Test Panels]

a. [Construct a test panel for each mixture, each nozzleman, and each work day or for every [38 cubic meter 50 cubic yard][185 square meter 2000 square feet][_____] placed, whichever results in the most panels. The face dimensions of a test panel must be a minimum of 400 x 400 m 16 x 16 in. with a minimum depth of 125 mm 5 in. For toughness testing in accordance with ASTM C1550, the face dimension must be 800 mm 30.5 in. in diameter and 75 mm 3 in. thick. The test panels will be shot in a [vertical][_____] orientation.

****

NOTE: A test panel could be fabricated for each shooting position to be encountered in the structure such as horizontal, vertical, or overhead. If this is needed, then add those shooting positions to this paragraph

****

b. Condition test panels in accordance with ASTM C1140/C1140M until transported to the testing agency's laboratory.

c. Obtain test specimens from test panels using procedures outlined in ASTM C1140/C1140M or ASTM C1604/C1604M. Cores will be a nominal 75 mm 3 in. diameter.

d. Test shotcrete specimens for compliance in accordance with ASTM C1604/C1604M for compressive strength.

e. [Test boiled absorption and volume of permeable voids in accordance with ASTM C642.][_____]

f. [Test flexural parameters in accordance with methods specified in the paragraph titled "flexural strength and properties"][_____]]

1.7.4 [Testing In-Place Shotcrete]

a. [Obtain core specimens from locations designated by the Contracting Officer in accordance with ASTM C1140/C1140M.

****

NOTE: Cores from the actual structure should be obtained and tested when the contracting officer suspects a lower strength or deficiency in quality. Test panels are the main quality control/assurance method; obtaining and testing cores are not typically done, unless the placement is in doubt.

****

b. [Condition test specimens by soaking as specified in ASTM C1604/C1604M.]

c. Test specimens in accordance with the paragraph titled "Testing Shotcrete".]

1.7.5 [Testing Shotcrete Bond to Substrate]

[Conduct bond testing of the shotcrete to the substrate in accordance with ASTM C1583/C1583M.]

1.7.6 Reporting of Quality Assurance Test Results

Provide copies of any test results generated for quality assurance to the Contractor, Contracting Officer, and concrete supplier.

1.7.7 Action Required for Shotcrete Defects

Submit repair of shotcrete procedures for defects for the Contracting Officer's acceptance. Refer to the paragraph titled "REPAIR OF SHOTCRETE" for details.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cement

Provide cement in compliance with [ASTM C150/C150M Type I][ASTM C595/C595M][ASTM C1157/C1157M][_____].
Submit cement test reports showing manufacturing location, and compliance with applicable ASTM standards.

****

NOTE: Most shotcrete is produced with Type I or I-II cements conforming to ASTM C150 or ASTM C595. Other cementitious materials, such as blended hydraulic cements, should meet ASTM C1157. The type of cement used for a structure must consider the exposure requirements of the concrete being placed. Refer to ACI 318 or ACI 350 material durability requirements to determine cement requirements or supplementary cementitious requirements discussed in paragraph titled "Supplementary cementitious materials".

****

2.1.2 Supplementary Cementitious Materials

Provide supplementary cementitious materials (SCMs) complying with [ASTM C618 for fly ash and natural pozzolans] [ASTM C989/C989M for slag cement] [ASTM C1240 for silica fume].

[The types and dosages of supplementary cementing material must meet ACI 301 requirements][_____].
[[A minimum of] [_____] percent of [_____] is required as supplementary cementing material][_____].
Submit supplementary cementitious materials types, test reports showing manufacturing location, and compliance with applicable ASTM standards.

****

NOTE: SCMs can be used in shotcreting. SCMs can enhance workability or pumpability of some wet-mix shotcrete. They may provide more resistance to sulfate attack and to alkali-silica reactivity if reactive aggregates are used. The use of SCMs on an equal weight replacement for cement may result in slower early strength gain. Natural pozzolans and fly ash should meet the requirements of ASTM C618. Other pozzolans should meet the appropriate ASTM specifications. Both silica fume and metakaolin should meet the requirements of ASTM C1240.

Slag cement should meet the requirements of ASTM C989. There are three grades of slag. Generally, higher-grade slag will be finer and have greater strength development.

Silica fume comes in three forms: slurry, undensified, and densified. All three forms are acceptable for use in shotcrete. When using slurry, the water portion of the slurry should be compensated for in the w/cm; that is, the water in the slurry counts as mixing water for both dry-mix and wet-mix shotcrete. Undensified silica fume is mainly used in premixed dry-bag shotcrete products. Densified fume is best used in wet-mix shotcrete.

Specify if the SCM limits meet ACI 301 (Table 4.2.1.1) requirements or other alternative specifications.
Specify the type (Class F, or C fly ash; slag cement; silica fume; or other SCMs) and the minimum percent cement replacement requirements based on ACI 318 or ACI 350 requirements (if required).

****

2.1.3 Aggregate

Aggregates must comply with [ASTM C33/C33M][_____] for [normal weight][_____] aggregates. The combined aggregate gradation must comply with [grading No. 2 of ASTM C1436][_____].
Submit aggregate source, producers' names, gradations, specific gravities, compliance with [ASTM C33/C33M][_____], and evidence that this data is not more than 1 year old.
[Submit aggregate absorption in accordance with ASTM C127 for coarse aggregate and ASTM C128 for fine aggregate.]

****

NOTE: Aggregate absorbs water, which reduces the plasticity of the mixture. Specify when aggregate absorption testing is required. The absorption

values may be used to correct for absorbed moisture in the calculation of w/cm. For more details refer to ACI 211.1, ASTM C127/127M, and ASTM C128/128M.

****

2.1.4 Water

[Water must be potable][Water must be potable or nonpotable and comply with ASTM C1602/C1602M requirements. Wash water is not permitted unless accepted by Contracting Officer.][_____]
[For nonpotable water, submit the source and reports confirming compliance with ASTM C1602/C1602M.]

2.1.5 Admixtures

Provide admixtures in compliance with ASTM C1141/C1141M or, for hydration control admixtures, with ASTM C494/C494M.[The following admixtures are also permitted [_____]][_____].

Submit admixture types, brand names, producers, manufacturer's technical data sheets describing technical properties and performance in shotcrete and showing compatibility with each other and the project cementitious materials.

[Assess admixture in the prequalification test program described in the paragraph titled "PRECONSTRUCTION TESTING".]

****

NOTE: Specify limits and types of other acceptable admixtures if needed or specify maximum dosages if important.
Admixtures may be used in shotcrete construction to enhance certain shotcrete properties for special shotcrete applications and for certain conditions of shotcrete placement. Admixtures in shotcrete should be tested before large-scale use (during prequalification testing) to determine that the expected advantages can be obtained. Admixtures for shotcrete generally fall into the categories of accelerators, air-entrainers, water-reducers, and retarders.
Calcium chloride accelerators are not recommended for reinforced shotcrete structures. Refer to tables in ACI 201.2R and ACI 318 or ACI 350 for limits. If specified, calcium chloride should conform to ASTM D98.

****

2.1.6 [Fibers]

[Use the following types, material, and sizes of fibers:[_____]]. Provide FRS conforming to ASTM C1116/C1116M.
Submit compressive strength test results and, flexural strength and flexural parameters as specified in the paragraph titled "flexural strength and properties". Submit manufacturer's technical data sheets and data on fiber material, length or lengths, and fiber content used for the mixture.

****

NOTE: As discussed in the paragraph titled "work specified" notes, fibers can enhance the properties of shotcrete. The available types of fibers include steel, glass, synthetic, and natural fibers.

To select the type of fiber required for a job, obtain information about the fiber materials available for shotcrete in the designated area. Knowing what materials are available and the desired properties, follow the recommendations of ACI 506R, ACI 506.1 and ACI 544.1 to select the fiber to be used on the job.

****

2.1.7 Reinforcement

Follow the requirements included in the contract documents [as well as] [03 30 00 CAST-IN-PLACE CONCRETE] [_____] for non-fiber types of reinforcement.

Submit mill certificate showing conformance for reinforcing steel or welded wire reinforcement.

2.1.8 Curing Materials

2.1.8.1 Sheet Materials

Provide sheet materials for curing in compliance with ASTM C171.

2.1.8.2 Curing Compounds

Provide curing compounds in compliance with ASTM C309 or ASTM C1315. Provide volatile organic compounds (VOC) content in compliance with local air quality standards if those requirements are more stringent.

2.1.8.3 Architectural Finishes

Do not use curing materials that cause stains for shotcrete having an architectural finish.

2.1.9 [Packaged Shotcrete Materials]

[Provide packaged, preblended, dry combined materials complying with [ASTM C1480/C1480M][_____].]

****

NOTE: Select this option to allow packaged Shotcrete Materials. Also, specify any standards, requirements, or limitations for those materials

****

2.2 SHOTCRETE PROPERTIES

2.2.1 Compressive Strength

The required compressive strength is [_____].

****

NOTE: Specify the required compressive strength of concrete based on the design requirements. Per ACI

506.2, the 28-day compressive strength must not be less than 4000 psi (28 MPa). Assess the compressive strength in accordance with ACI 301.

****

[2.2.2 Flexural Strength and Properties

[The required flexural strength is [_____].] Use [ASTM C78/C78M][ASTM C1609/C1609M][_____] to test flexural strength.

The required residual strength using [ASTM C1609/C1609M][ASTM C1399/C1399M][_____] is [_____].

[The required toughness per [ASTM C1550][_____] is [_____].]
[_____]

****

NOTE: In the first part of this paragraph specify the flexural strength value and test method required. Per ACI 506.2, flexural strength must not be less than 400 psi (2.8 MPa) at 28 days for FRS. ASTM C78/C78M is used for non-fiber reinforced concrete while ASTM C1609/1609M is a test method used for evaluating strength and other flexural parameters of FRS.

If you are specifying FRS, then specify your project requirements for residual strength, flexural toughness, or other mechanical properties if needed. For more information on test methods, properties, and requirements for FRS and fiber-reinforced concrete (FRC)in general, refer to ACI 544.9R and ACI 506.1R.

****

][2.2.3 Water-Cementitious Ratio

The maximum w/cm based on project service conditions is [_____].

****

NOTE: Specify the maximum w/cm based on project service conditions. Refer to ACI 318 or 350 to determine project requirements. Guidance regarding freezing and thawing can be obtained from ASTM C33/C33M.
Note that paragraph titled "MIXTURE PROPORTIONS", only requires the submittal of water-cementitious materials ratio (w/cm) for wet-mixture shotcrete. Delete this paragraph for dry-mix shotcrete.

****

]2.2.4 Air Content

The percent air content of concrete is [_____] plus or minus (±) 1.0 percent.

****

NOTE: Air entrainment may be required where the shotcrete is exposed to freeze/thaw, seawater, or deicing salts. Specify minimum air void parameters based on project service conditions. Refer to ACI

318 or ACI 350 to determine project requirements. Guidance on the need for air entrainment to protect against freezing and thawing can be found in ASTM C33/C33M. Also, specify the frequency of air testing in the paragraph titled "Testing Shotcrete".

Per ACI 506.2, shotcrete placement reduces entrained air content such that shotcrete with a 7 percent or higher air content prior to shooting will have an entrained air content of approximately 3 to 4 percent after placement. Wet-mixture shotcrete exposed to moderate or severe freezing-and-thawing conditions should have an entrained air content of at least 6 to 7 percent prior to shooting. Obtaining greater than 4 percent air in the in-place material is difficult. For wet-mix shotcrete, air content is tested in plastic concrete.
Specifying air entrainment for dry-mixture shotcrete is not common but has been satisfactorily used in severe freezing-and-thawing exposures. For dry-mix shotcrete, air content is tested on hardened concrete using methods such as Petrographic Examination.

****

[2.2.5 Chloride Content

[The maximum water-soluble chloride ion content based on project service conditions is [_____]. Determine chloride content per [ASTM C1218/C1218M].]

****

NOTE: For corrosion protection of the reinforcement in the shotcrete, the maximum water-soluble chloride-ion concentration in hardened shotcrete should not exceed a certain limit. This limit is based on the type of reinforcement used. Refer to ACI 318 or ACI 350 for recommended limits.

****

][2.2.6 Voids and Absorption Properties

Measure the voids and absorption properties using [ASTM C642][_____] and do not exceed [_____].

Provide test reports for shotcrete boiled absorption and volume of permeable voids showing compliance with the specified properties.

****

NOTE: The absorption test (ASTM C642) may be conducted on hardened shotcrete to provide an overall indication of the quality of the shotcrete, especially in dry-mix shotcrete where the results are largely influenced by the w/cm. The absorption value and the volume of permeable voids are useful in identifying poorly compacted shotcrete or shotcrete with a weak or damaged microstructure.

Per ACI 506.2, typical values for quality shotcrete are a Maximum of 8 percent boiled absorption and 15 percent volume of permeable voids.

Results vary depending on the absorptive characteristics of the aggregate. Lightweight aggregate has high absorption. The absorption of a shotcrete specimen is usually proportional to its w/cm. A low w/cm will yield a relatively low volume of permeable voids or low absorption values, which is an indication of a good quality shotcrete. A mixture shot too dry, however, will yield a relatively high volume of permeable voids or high absorption values due to the stiffness of the plastic shotcrete. Impact velocity is another important parameter that influences the porosity of the hardened shotcrete. Insufficient impact velocity will not provide adequate compaction, resulting in high permeability and high absorption values.

ASTM C457/C457M can also be used to determine parameters of the air-void system in hardened concrete.

****

][2.2.7 Bond Strength

Perform testing for bond strength on a minimum of three core samples and the strength is the average of all samples. The average bond strength is [_____].

****

NOTE: Bond strength is usually measured by shear or direct tension using a pull-off test (ASTM C1583/C1583M). Properly applied shotcrete with sufficient consolidation on a properly prepared substrate usually develops bond strength of over 145 psi (1 MPa).

****

][2.2.8 Resistance to Alkali-Silica Reaction

[Use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction.]

a. For each aggregate used in concrete, do not exceed 0.04 percent at 1 year for the expansion result determined in accordance with ASTM C1293.

b. For each aggregate used in concrete, do not exceed 0.10 percent at an age of 16 days for the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567.

c. Alkali content in concrete must not exceed 2.35 kilograms per cubic meters 4 pounds per cubic yard for moderately reactive aggregate or 1.78 kilograms per cubic meters 3 pounds per cubic yard for highly reactive aggregate. Determine reactivity determined by testing in accordance with ASTM C1293 and categorized in accordance with ASTM C1778.

]2.3 MIXTURE PROPORTIONS

Proportion shotcrete mixture [by mass complying with ASTM C94/C94M][by volume complying with ASTM C685/C685M], to satisfy the specified properties. For FRS, proportion in compliance with ASTM C1116/C1116M.

Submit shotcrete mixture proportions. Show constituent proportions by mass in the case of batching by weight or proportions by volume in the case of volumetric batching in submittals. For prepackaged materials meeting ASTM C1480/C1480M, submit suppliers' technical data showing compliance with requirements. Submit water-cementitious materials ratio (w/cm) for wet-mixture shotcrete only.

****

NOTE: Shotcrete mixtures are usually proportioned in accordance with ASTM C94/C94M or C685/C685M to attain a specified compressive strength. The main reasons for variations of in-place strength are the nature of the shotcrete process, type of delivery equipment, and quality of workmanship. This is especially true of dry-mix shotcrete, where the nozzleman is not only responsible for the proper placement technique but also regulates and controls the water content-a variable that can cause fluctuations in strength and durability.
There is no recognized rational method of proportioning dry-mix shotcrete for strength or durability. Water is injected into the preproportioned cementitious material mixture stream at the nozzle by the nozzleman, so it is not possible to design dry-mix shotcrete based on w/cm. Dry-mix shotcrete has been proportioned based by weight, typically having a cementitious material to aggregate ratio of 1:4.
On the other hand, wet-mix shotcrete is typically proportioned using volumetric methods such as ACI 211.1 (just like regular types of concrete). Refer to ACI 506R for more details on proportioning shotcrete.

****

2.4 BATCHING, MIXING, AND DELIVERY

Batch, mix, and deliver wet-mixture shotcrete in accordance with ASTM C94/C94M, ASTM C685/C685M, or ASTM C1116/C1116M as applicable. For dry-mixture, batch, mix and deliver in accordance with ASTM C685/C685M or ASTM C1116/C1116M.
Use predampening or other methods suitable for prewetting the dry materials with packaged preblended material for dry-mixture shotcrete.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE TO RECEIVE SHOTCRETE

3.1.1 Earth

Prepare surfaces to line and grade. Dampen surfaces immediately prior to shooting. Standing water is not acceptable.

3.1.2 Concrete, Masonry, and Shotcrete

Remove all deteriorated, loose, unsound material or contaminants that will inhibit bonding. Dampen receiving surface and allow to dry to a saturated surface-dry (SSD) condition just prior to shotcrete application. Further surface preparations include:

a. Chipping surfaces to receive shotcrete to remove offsets causing abrupt changes in thickness.

b. Roughening receiving surfaces that have been saw cut.

3.1.3 Rock

Remove loose material, mud, or other foreign material that will inhibit bonding. Clean surface prior to shotcrete placement. Dampen surface in accordance with the paragraph titled "Earth".

3.1.4 Reinforcement

3.1.4.1 Surface Condition

The surface of the reinforcement must be free of overspray or other deleterious materials that inhibit development of bond with the shotcrete.

3.1.4.2 Reinforcement Laps

Laps must be noncontact and [separate with a clearance of at least three times the diameter of the largest reinforcing bar; three times the maximum size aggregate; or 50 mm 2 in., whichever is least][_____]. Do not space bars spliced by noncontact lap splices in flexural members transversely farther apart than [the smaller of 1/5 the required lap splice length and 150 mm 6 in][_____]. The use of contact lap splices necessary for support of the reinforcing is permitted when approved by the Contracting Officer. Place lapped bars in the same plane and parallel to the direction of shooting. Welded splices are permitted.
Secure reinforcement to prevent movement. The use of mechanical splices is permitted when approved.

3.1.5 Forms

Use material of adequate thickness for formwork to resist movement during shooting. Reinforce, secure, and brace forms to minimize the effects of vibration during shooting. Construct forms to allow escape of placement air, overspray, and rebound. Use form-release coating material on removable forms unless the formed surface is to subsequently receive an additional coating.

3.2 JOINTS

3.2.1 Construction Joints

Taper construction joints at approximately 45 degrees from receiving surface. Form joints by cutting plastic shotcrete. Make joints at slab intersections at 90 degrees. Roughen shotcrete in the joint face while it is still plastic.

3.2.2 Control Joints

Place control joints as indicated in the Contract Document [Discontinue reinforcement at control joints] [_____].

3.3 ALIGNMENT CONTROL

To establish thickness and plane of required surface, install taut ground wires or other means to guide the nozzleman. Install alignment control means at corners or offsets not established by forms.

3.4 APPLICATION

3.4.1 Placement Techniques

a. [Use the same shotcrete mixture and equipment that was used during prequalification testing for the production shotcrete.]

b. Use temporary coverings to protect adjacent surfaces from the deposit of overspray or impact from the nozzle stream.

c. Install sufficient lighting and ventilation to provide the shotcrete crew with a clear view of the shooting area. Suspend Work and adopt corrective measures if visibility is unsuitable for the application of quality shotcrete.

d. Provide a working surface that permits nozzlemen unobstructed access to the receiving surface. Place shotcrete first in corners, recesses, and other areas where rebound or overspray cannot easily escape.

e. Supply shotcrete material and air pressure at the nozzle uniformly, providing a steady, continuous flow of shotcrete with no detrimental surging or pulsing. Maintain the velocity and consistency of shotcrete exiting the nozzle at a uniform rate appropriate for the given job conditions so that satisfactory material consolidation and minimum rebound is achieved.

f. Place shotcrete perpendicular to the receiving surface with the nozzle held at such a distance to produce maximum consolidation of the shotcrete and full encapsulation of the reinforcement.

g. Shoot dry-mixture shotcrete material within 45 min after batching or, in the case of prepackaged material, within 45 min after predampening. Shoot wet-mixture shotcrete material within the time limits in ASTM C94/C94M.

h. Apply shotcrete using a circular or elliptical motion of the nozzle while building the required thickness.

i. Use sufficient material velocity, material consistency, and distance from the end of the nozzle to the receiving surface to produce maximum consolidation of the shotcrete and full encapsulation of the reinforcing steel.

j. In corners, direct the nozzle to bisect the corner angle. Apply shotcrete so sagging or sloughing does not occur. Where there is potential for accumulated rebound or overspray material to be incorporated into the Work at congested areas of steel reinforcement, embedded obstructions, corners, and recesses, use a compressed air blow pipe to remove loose material from the Work.

k. Discontinue placement of shotcrete or shield the nozzle stream if wind causes separation of ingredients in the nozzle stream.

l. Do not reuse rebound or overspray in the Work.

m. Remove laitance from shotcrete surfaces that are to receive additional shotcrete layers.

n. Surface preparation prior to the shooting of shotcrete must comply with [the paragraph titled PREPARATION OF SURFACE TO RECEIVE SHOTCRETE][_____].

****

NOTE: For repair jobs, refer to the section on repairs for surface preparation.

****

o. Do not apply shotcrete to surfaces with standing or flowing water.

p. Remove hardened overspray and rebound from adjacent surfaces, including exposed reinforcement.

3.4.2 Intermediate Surfaces

a. When applying more than one layer of shotcrete, use a cutting rod, brush with a stiff bristle, or other suitable equipment to remove all loose material, overspray, laitance, or other material that may compromise the bond of the subsequent layer of shotcrete. Conduct removal immediately after shotcrete reaches initial set.

b. Allow shotcrete to stiffen sufficiently before applying subsequent layers. If shotcrete has hardened, clean the surface of all loose material, laitance, overspray, or other material that may compromise the bond of subsequent layers. Bring the surface to a saturated surface-dry condition at the time of application of the next layer of shotcrete.

3.4.3 Encasement of Reinforcement

a. Place shotcrete to encase reinforcement and other embedments, and provide a minimum cover of [_____].

****

NOTE: Refer to ACI 318 and ACI 350 for concrete cover requirements

****

b. Adjust air volume, material feed volume, and distance of the nozzle from the Work as necessary to encase reinforcement.

c. Keep the front face of the reinforcement clean during shooting operations so that shotcrete builds up from behind to encase the reinforcement without the formation of shadows or voids.

d. Continuously remove accumulations of rebound and overspray using a compressed air blowpipe, or other suitable device, in advance of deposition of new shotcrete.

3.4.4 Hot Weather Shotcreting

Do not place shotcrete when shotcrete temperature is above [35°C 95°F][_____], unless PREQUALIFICATION TESTING shows that the required quality of materials can be achieved at higher temperatures. A temperature of reinforcement and receiving surfaces greater than [32°C 90°F][_____] prior to shotcrete placement is prohibited.

****

NOTE: If hot weather concrete needs to be considered, then a separate specification that covers hot weather concrete such as ACI 305.1 should be included in the project.

****

3.4.5 Cold Weather Shotcreting

Shooting may proceed when ambient temperature is [4°C 40°F][_____] and rising. Stop shooting when ambient temperature is [4°C 40°F][_____] and falling, unless measures are taken to protect the shotcrete. Shotcrete material temperature, when shot, less than [10°C 50°F][_____] is prohibited. Do not place shotcrete against frozen surfaces.

****

NOTE: If cold weather concrete needs to be considered, then a separate specification that covers cold weather concrete such as ACI 306.1 should be included in the project.

****

3.5 FINISH

[3.5.1 Gun Finish

Leave finished shotcrete surface as gun finish.

][3.5.2 Cutting Screed

After the surface has taken its initial set (crumbling slightly when cut), slice off excess material outside the forms and ground wires with a downward cutting motion using a sharp-edged cutting screed. Then remove ground wires and float the irregularities.

][3.5.3 Flash Coat

Apply a thin coat of shotcrete containing finer sand applied from a distance greater than normal to the surface as soon as possible after the screeding.

][3.5.4 Float and Trowel Finish

Provide final surface finish using [wood float] [rubber float] [steel trowel]. Avoid troweling of thin sections of shotcrete unless both troweling and commencement of moisture curing take place within a relatively short period after placement of shotcrete.

][3.5.5 Fiber-Reinforced Shotcrete

****

NOTE: Include this paragraph if the exposed fibers pose a safety hazard.

****

Finish the outer surface of the structure with a layer of nonfiber-reinforced shotcrete and provide an appropriate finish as denoted.

]3.6 CURING

When the daily mean temperature is above 4°C 40°F, cure continuously for a minimum of 7 consecutive days or for the time necessary to attain 70 percent of the specified compressive or flexural strength, whichever period is less.
If shotcrete is placed with daily mean temperatures 4°C 40°F or lower, provide cold weather protection until the shotcrete achieves 70 percent of the specified strength.
Complete moist curing by one of the following methods:

a. Ponding or continuous sprinkling for a minimum of 7 days;

b. Covering with an absorptive mat or sand that is kept continuously wet;

c. Covering with impervious sheet material;

d. Use of curing compounds; apply twice the rate for formed surfaces as recommended by manufacturer if the surface is a gun finish.

Do not use natural curing in lieu of that specified in this paragraph unless the relative humidity of the air in contact with the shotcrete remains at or above 85 percent and such curing is authorized by Contracting Officer.
Submit curing materials and curing procedures for shotcrete including product data sheets indicating conformance with specification requirements.

3.7 PROTECTION

Immediately after placement, protect shotcrete from premature drying or excessively hot or cold temperatures and mechanical injury.
Maintain shotcrete protection to prevent freezing of the shotcrete and to ensure the necessary strength development for structural safety. Remove protection in such a manner that the maximum decrease in temperature measured at the surface of the shotcrete in a 24-hour period does not exceed the following:

a. 10°C 50°F for sections less than 300 mm 12 in. in the least dimension;

b. 4°C 40°F for sections from 300 to 900 mm 12 to 36 in. in the least dimension.

Protect surfaces not intended for shotcrete placement against deposit of rebound and overspray or impact from nozzle stream.

[3.8 TOLERANCES

Provide dimensional tolerances of shotcrete in compliance with [ACI 117][the contract document][_____]

****

NOTE: ACI 117 provides a guide for construction tolerances of concrete structures. Although shotcrete is concrete, ACI 117 specifically excludes shotcrete.
Tolerances provide an indication of the finished product expected by the owner, but meeting tolerances may require additional effort and cost.

Tolerances given by ACI 117.1R, for placement of reinforcing steel, cover over reinforcing steel, and overall alignment of cast-in-place structural members should be generally the same for shotcrete. Tolerances that require distinct values for shotcrete construction are cross-sectional dimensions, cover, and surface finish (or flatness). Therefore, specifying tolerances that can be consistently achieved are needed so that project expectations can be met at a reasonable cost. Specified tolerances should be based on use and function and can be the same as concrete, but are typically broader. Some finished surface tolerances may be waived to achieve proper coverage over existing reinforcement.
For some structures, such as tunnels, only cover thickness is required and tolerances are not specified unless project-specific requirements dictate. Sometimes shotcrete tolerances are increased by a factor of 2 from those in ACI 117. Refer to ACI 506R for more details on shotcrete tolerances. Refer to ACI 318 or ACI 350 to determine project requirements.

****

]3.9 REPAIR OF SHOTCRETE

3.9.1 General

a. Submit repair procedure for shotcrete defects for the Contracting Officer's acceptance. Include proposed materials, surface preparation, bonding procedures, and final surface finish.

b. Remove voids, shadows, sagging, or other defects in the hardened shotcrete using light-duty chipping hammers [maximum 8 kg 18 lb][_____] followed by high-pressure water blasting or grit blasting to remove bruised shotcrete surface.

c. Conduct removal of defective shotcrete without the creation of feather edges.

****
NOTE: Edges of the repair area should not be feather-edged. Common methods used for edge preparation include saw-cutting, chipping, grinding, sandblasting, hydro-milling, or other means to a depth of 1/2 to 1 in. (1.25 to 2.5 cm) normal to the surface of the member. Note: if saw-cutting or grinding is used, care should be taken to ensure reinforcing steel is not cut or damaged
****

d. In the repair of core hole surfaces and saw cut edges, roughen the core hole or cut surface and predampen prior to repair.

3.9.2 Shotcrete Repair with Commercial Patching Products

Repair shotcrete with commercial patching products, including:

a. Portland cement mortar, modified with a latex bonding agent conforming to ASTM C1059/C1059M, Type II;

b. Packaged, dry concrete repair materials conforming to ASTM C928/C928M.

3.9.3 Removal of Stains, Rust, Efflorescence, and Surface Deposits

Remove stains, rust, efflorescence, and surface deposits considered objectionable by Contracting Officer by methods acceptable to the Contracting Officer.

3.10 ACCEPTANCE OF WORK

3.10.1 General

a. Remove and replace defective areas [larger than 31,000 square mm 48 square inches or 50 mm 2 inches deep][_____]. Defects in shotcrete include honeycombing, laminations, dry patches, voids, or sand pockets. Remove defective areas in accordance with the procedures described in paragraph titled "REPAIR OF SHOTCRETE".

****

NOTE: Specify acceptance criteria for degree of reinforcement encasement or severity of defects. Shotcrete that exhibits laminations and voids, exceeding the specified quality, should be removed, replaced, or repaired. ACI 506.4R provides guidance for engineers, inspectors, contractors, and others involved in accepting, rejecting, or evaluating in-place dry-mix or wet-mix shotcrete.

****

b. Shotcrete Work that meets specifications will be accepted.

c. Shotcrete Work that has previously failed to meet one or more requirements, but has been repaired to bring it into compliance will be accepted.

d. The Contracting Officer will either accept or reject Shotcrete Work that fails to meet one or more requirements and that cannot be brought into compliance. Implement .odifications to the mixture proportions or the shotcreting procedures to assure that remaining Work complies with the requirements.

e. The basis for acceptance or rejection of shotcrete properties is the specified compressive or flexural strength. When additional criteria, properties, or both are required in the contract documents, acceptance criteria includes compliance with those requirements.

3.10.2 Compliance with Test Properties

3.10.2.1 Compressive Strength

Consider the compressive strength adequate if the average of the three cores from a test panel or from in-place shotcrete exceeds 85 percent of the specified compressive strength and no single core is less than 75 percent of the specified compressive strength.

[3.10.2.2 Flexural Strength

The average flexural strength of a set of three test beams from one panel must equal or exceed the specified flexural strength in the paragraph titled "flexural strength and properties".

][3.10.2.3 Boiled Absorption and Volume of Permeable Voids

The average of tests on three specimens from a test panel, or from in-place shotcrete, must be less than or equal to the specified boiled absorption and specified volume of permeable void limits at the specified test age with no single test greater than the specified boiled absorption plus 1 percent.

][3.10.2.4 Flexural Parameters

For FRS, provide flexural parameters and toughness requirements complying with the requirements specified in the paragraph titled "flexural strength and properties".

][3.10.2.5 Bond

The average of the bond strength of the specified number of cores must exceed the specified minimum strength requirement of the paragraph titled "Bond strength", with no single core bond strength less than 75 percent of the specified strength.

][3.10.2.6 Alkali-silica Reactivity

Provide concrete and concrete materials meeting one of the three requirements specified in the paragraph titled "Resistance to alkali-silica reaction"

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 37 23 (November 2009)**

Preparing Activity: USACE **Superseding**
UFGS-03 37 23 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 03 37 23

ROLLER-COMPACTED CONCRETE FOR MASS CONCRETE CONSTRUCTION

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PART 1 GENERAL

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 03 37 23

ROLLER-COMPACTED CONCRETE FOR MASS CONCRETE CONSTRUCTION

11/09

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NOTE: This guide specification covers the requirements for furnishing, hauling, placing, and roller-compacting concrete for mass concrete construction. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 UNIT PRICES

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NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

See appropriate Design Memorandum (DM) for concrete items that are to be measured by the neat line, batch or lump sum.

****

1.1.1 Roller-Compacted Concrete (RCC) in [_____]

****

NOTE: Repeat this bid item and its respective subparagraphs for each bid item of concrete, renumbering the bid items appropriately.

See the Design Memorandum on the use of the optional item on air entrainment.

If bedding concrete is to be paid for as a separate bid item, delete the optional words, "Bedding concrete and", below.

****

1.1.1.1 Payment

Payment will be made for costs associated with completing the concrete work for roller-compacted concrete placed in the [_____], including all aggregate [, air-entraining admixture,] and the use of all equipment and tools to complete the concrete work. However, these costs will not include the cost of the cement, pozzolan, [water-reducing admixture,] and embedded parts that are specified to be paid for separately. [Bedding concrete and] bedding mortar [is] [are] incidental to the RCC and will be paid for as part of the RCC within the neat lines. [Joint materials, waterstops, sealants, and bond breakers are incidental to the concrete and will be paid for as part of the RCC.] No payment will be made for concrete, as such, that is placed in structures of which payment is made as a lump sum.

1.1.1.2 Measurement

Roller-compacted concrete will be measured for payment on the basis of the actual volume of RCC within the pay lines of the structures as indicated on the drawings. Measure RCC placed against the sides of any excavation without the use of intervening forms only within the pay lines of the structure. No deductions will be made for rounded or beveled edges, space occupied by metal work, electrical conduits or reinforcing steel, nor for voids or embedded items that are either less than 0.14 cubic meter 5 cubic feet in volume or 0.09 square meter 1 square foot in cross section.

1.1.1.3 Unit of Measure

Unit of measure: cubic meter yard.

[1.1.2 Dental Concrete

1.1.2.1 Payment

Payment will be made for costs associated with placing dental concrete.

1.1.2.2 Measurement

Dental concrete will be measured for payment based upon the actual volume of dental concrete placed. The dental concrete volume in cubic meters yards will be computed from the mass weight of the material batched at the batch plant using the theoretical mass per meter weight per yard as determined from the design mixture. Any concrete which is wasted or placed in violation of the specifications will not be measured for payment.

1.1.2.3 Unit of Measure

Unit of measure: cubic meter yard.

][1.1.3 Bedding Concrete

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NOTE: If bedding concrete is to be paid for as a separate bid item, delete the optional wording "Bedding concrete and" in Bid Item "(1) Roller-Compacted Concrete (RCC) in [_____]", above.

****

1.1.3.1 Payment

Payment will be made for costs associated with placing bedding concrete.

1.1.3.2 Measurement

Bedding concrete will be measurement for payment based upon the actual volume of bedding concrete placed. The bedding concrete volume in cubic meters yards will be computed from the mass weight of the material batched at the batch plant using the theoretical mass/meter weight/yard as determined from the design mixture. Any concrete which is wasted or placed in violation of the specifications will not be measured for payment.

1.1.3.3 Unit of Measure

Unit of measure: cubic meter yard.

]1.1.4 Portland Cement

1.1.4.1 Payment

Payment will be made for costs associated with portland cement, including the cost of required unloading, hauling, handling, and storage at the site, of all portland cement used in the work for all of the concrete bid items.

1.1.4.2 Measurement

Portland cement will be measured for payment based upon the number of tons (metric) (2,000 pounds) of portland cement used, excluding amount specifically excepted, wasted, or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the approved batch mass in kg/cubic meter weight in pounds per cubic yard of portland cement in each type of concrete used by the number of cubic meters yards of concrete types placed within the pay lines of the structure, as determined in accordance with the concrete bid items, and dividing by 1000 2,000.

1.1.4.3 Unit of Measure

Unit of measure: tons (metric) (2,000 pounds).

1.1.5 Pozzolan

1.1.5.1 Payment

Payment will be made for costs associated with pozzolan, including the cost of required unloading, hauling, handling, and storage at the site, of all pozzolan used in the concrete bid items.

1.1.5.2 Measurement

Pozzolan will be measured for payment based upon the number of cubic meters feet solid volume of pozzolan used unless specifically excepted, wasted, or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the approved batch mass in kg/cubic meter weight in pounds per cubic yard of pozzolan in each type of concrete used by the number of cubic meters yards of concrete of the types placed within the pay lines of the structure, as determined in accordance with the concrete bid items, and dividing by the product of the average specific gravity of the pozzolan multiplied by 1000 kg/cubic meter 62.4 pcf. The average specific gravity is the average of the test results for all material accepted during the period covered by the payment.

1.1.5.3 Unit of Measure

Unit of measure: cubic meter foot solid volume.

1.1.6 Water-Reducing Admixture (WRA)

1.1.6.1 Payment

[Payment will be made for costs associated with water-reducing admixture (WRA) at the applicable contract unit price per cubic yard of concrete containing water-reducing admixture.][Payment will be made for costs associated with water-reducing admixture (WRA) at the applicable contract unit cost of concrete containing water-reducing admixture for:

a. "Bid Item [_____]a., first [_____] cubic meters yards".

b. "Bid Item [_____]b., all over [_____] cubic meters yards".]

1.1.6.2 Measurement

Water-reducing admixture (WRA) will be measured for payment based upon the actual volume of roller-compacted concrete containing the admixture and within the pay lines of the structures, as determined in accordance with the concrete bid items.

1.1.6.3 Unit of Measure

Unit of measure: cubic meter yard.

1.1.7 RCC Test Section

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NOTE: The Test Section may be paid for as a lump sum pay item provided test section requirement are clearly specified.

****

1.1.7.1 Payment

Payment will be made for costs associated with completing the roller-compacted test section, including equipment and tools needed to complete the test section.

1.1.7.2 Measurement

Roller-compacted concrete test section will be measurement for payment based upon the actual number of test sections taken.

1.1.7.3 Unit of Measure

Unit of measure: each.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for

	Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	(2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C40/C40M	(2020) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C87/C87M	(2023) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2023) Standard Test Method for Lightweight Particles in Aggregate
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete

ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C441/C441M	(2017) Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2016; R 2024) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1040/C1040M	(2024) Standard Test Methods for In-Place Density of Unhardened and Hardened Concrete, Including Roller Compacted Concrete, by Nuclear Methods
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate

	(Accelerated Mortar-Bar Method)
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000; R 2006) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 53	(2001) Test Method for Consistency of No-Slump Concrete Using the Modified Vebe Apparatus
COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1997) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Batch Plant; G, [_____]

Compaction Equipment; G, [_____]

Aggregate Production Schedule; G, [_____]

Regular Lift-Joint Treatment; G, [_____]

Curing and Protection; G, [_____]

Cold-Weather Protection; G, [_____]

Hot-Weather Protection; G, [_____]

Contraction Joints

Gallery

Vertical Facings for RCC Construction; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Preconstruction Government Testing

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NOTE: Contact the division laboratory for guidance in filling in the blanks.

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The aggregate sources listed in paragraph COMMERCIAL CONCRETE AGGREGATE SOURCES in PART 2, have been tested and, at the time testing was performed, were capable of producing materials of the quality required for this project, provided suitable processing is performed. Deliver samples from any source selected, whether listed or not listed, consisting of not less than [_____] kg pounds of each size coarse aggregate and [_____] kg pounds of fine aggregate, and taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100, to [_____] within 15 days after Notice to Proceed. Sampling, shipment, and testing of samples is at the Contractor's expense. [_____] days will be required to complete evaluation of the aggregates. All quality assurance testing will be performed by the Government in accordance with the applicable COE CRD-C or ASTM test methods. Use material from the proposed source that meet the quality requirements of this paragraph for this project. The Government test data and other information on aggregate quality of those sources listed in PART 2 are included in the Design Memorandum and are available for review in the district office. Quality assurance testing of aggregates by the Government does not relieve the Contractor of quality control requirements.

1.4.2 Cementitious Materials and Admixtures

[At least [_____] days in advance of submitting samples for mixture proportioning studies,] [Not later than [_____] days after Notice to Proceed] notify the Contracting Officer of the source, brand name, type, and quantity of all materials (other than aggregates) to be used in the manufacture and curing of the concrete. Assist the Contracting Officer in obtaining samples of each material. Sampling and testing, as determined appropriate, will be performed by and at the expense of the Government. If cement or fly ash are to be obtained from more than one source, state the estimated amount of cement or fly ash to be obtained from each source and the proposed schedule of shipments in the notification. When pozzolan other than fly ash is used, it must be from one source.

1.4.3 Government Testing During Construction

The Government will sample and test cementitious materials, admixtures, aggregates, and concrete during construction as considered appropriate to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with COE CRD-C 100. Slump and air content of conventional concrete will be determined in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively, except the point of sampling will be as specified in paragraph TESTS AND INSPECTIONS in PART 3. Compression test specimens of conventional concrete will be made and laboratory cured in accordance with ASTM C31/C31M and will be tested in accordance with ASTM C39/C39M. Consistency of the RCC will be determined by the Government using the modified Vebe apparatus in accordance with paragraph CONSISTENCY OF RCC above. Compression test specimens of RCC will be made and tested by the Government. Density of the compacted RCC will be checked by the Government as considered appropriate.

1.4.3.1 Aggregates Testing

Testing performed by the Government will not relieve the Contractor of its responsibility for testing under paragraph TESTS AND INSPECTIONS in PART 3. During construction, aggregates will be sampled for acceptance testing as delivered to the mixer to determine compliance with specification provisions. Provide necessary facilities and labor for the ready procurement of representative samples under Government supervision. The Government will test such samples at its expense using the specified COE CRD-C and ASTM methods.

1.4.3.2 Cementitious Materials

Cement or pozzolan will be sampled at the mill, shipping point, or site of the work by the Government. A list of prequalified cement sources and prequalified pozzolan sources is available from the Commander and Director, U.S. Army Engineer Waterways Experiment Station (CEWES-SC-MP), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199. If tests prove that a material which has been delivered is unsatisfactory, promptly remove it from the site of the work. Cementitious materials that have not been used within 6 months after being tested will be retested by the Government at the expense of the Contractor when directed by the Contracting Officer.

1.4.3.3 Prequalified Cement Sources

Deliver and use cement directly from a mill of a producer designated as a prequalified source for the type of cement being used. Samples of cement for quality-assurance testing will be taken at the project site or cement-producing plant by the Contracting Officer for testing at the expense of the Government. Furnish a copy of the mill tests from the cement manufacturer for each lot.

1.4.3.4 Prequalified Pozzolan Sources

Deliver and use pozzolan directly from a producer designated as a prequalified source. Samples of pozzolan for check testing will be taken at the project site by the Contracting Officer for testing at the expense of the Government. Furnish a copy of the test results from the pozzolan manufacturer for each lot.

1.4.3.5 Nonprequalified Cement Sources

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NOTE: The Contractor's expense rate for excess testing of cement and Pozzolan by the Government can be obtained from the Structures Laboratory, U.S. Army Engineer Waterways Experiment Station (CEWES-SC-MP), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199.

****

Cement, if not from a prequalified source, will be sampled and tested by or under the supervision of the Government and at its expense. Do not use cement until notice has been given by the Contracting Officer that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the request of the Contractor and at the Contractor's expense. The fill gate or gates of the sampled bin will be sealed and kept sealed until shipment from the bin has been completed. Sealing of the fill gate or gates and of conveyances used in shipment will be done by or under the supervision of the Government. Conveyances will not be accepted at the site of the work unless received with all seals intact. If tested cement is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of testing cement excess to project requirements will also be at the Contractor's expense and will be deducted from payments due the Contractor at a rate of [_____] dollars per test.

1.4.3.6 Nonprequalified Pozzolan Sources

Pozzolan, if not from a prequalified source, will be sampled at the source or at the site of the work and will be stored in sealed bins pending completion of acceptance tests. Pozzolan may be resampled at the site when determined necessary. All sampling and testing will be performed by and at the expense of the Government. Release for shipment and approval for use will be based on compliance with 7-day lime-pozzolan strength requirements and other physical, chemical, and uniformity requirements for which tests can be completed by the time the 7-day lime-pozzolan strength test is completed. Release for shipment and approval for use on this basis will be contingent on continuing compliance with the other requirements of the specifications. If test results of a bin fail, the contents may be resampled and tested at the Contractor's expense. The Government will supervise or perform the unsealing and resealing of bins and shipping conveyances. If tested pozzolan is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of testing excess pozzolan in excess of project requirements will be at the Contractor's expense at a rate of [_____] dollars per test. The amount will be deducted from payment to the Contractor.

1.4.3.7 Admixtures

Provide satisfactory facilities for ready procurement of adequate test samples. All sampling and testing of an admixture will be by and at the expense of the Government. Tests will be conducted on the same materials which will be shipped to the project.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Cementitious Materials

1.5.1.1 Transportation

When bulk cement or pozzolan is not unloaded from primary carriers directly into weather-tight hoppers at the batching plant, accomplish transportation from the railhead, mill, or intermediate storage to the batching plant in adequately designed weather-tight trucks, conveyors, or other means that will protect the material from exposure to moisture.

1.5.1.2 Storage

Furnish cementitious materials in bulk. Immediately upon receipt at the site of the work, store all cementitious materials in a dry, weather-tight, and properly ventilated structure. All storage facilities must permit easy access for inspection and identification. Store sufficient materials for at least two operating days of continuous placement. In order that cement may not become unduly aged after delivery, use any cement that has been stored at the site for 60 days or more before using cement of lesser age.

1.5.2 Aggregate Storage

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NOTE: Consult the materials engineer to select the appropriate optional phrase and to fill in the blank.

****

Store fine aggregate and each size of coarse aggregate in separate size groups adjacent to the batch plant and in such a manner as to prevent the intermingling of size groups or the inclusion of foreign materials in the aggregate. Maintain sufficient fine and coarse aggregate at the site for at least [30] [_____] operating days of continuous placement.

1.5.3 Chemical Admixtures

Do not use any admixture that has been in storage at the project site for longer than recommended by the manufacturer or that has been subjected to freezing in the work and remove from the site.

1.6 ENVIRONMENTAL REQUIREMENTS

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NOTE: Make sure the climatological data is included if that optional sentence is included.

****

If unusual adverse weather, such as heavy rain, severe cold, high winds, heavy snow, etc., occurs or is forecast to occur during placement, suspend the placement operation until conditions improve. [A sample of available climatological data for this project based on historical information is contained herein for general information only. However, it is the responsibility of the Contractor to maintain the construction schedule at no additional cost to the Government.]

1.6.1 Cold-Weather Placement

In Cold-weather placement, do not place the RCC when the ambient air temperature drops below 0 degrees C 32 degrees F. If the ambient air temperature does drop below 0 degrees C 32 degrees F, the surface of any recently placed (within the previous 72 hours) and exposed horizontal RCC surface must not remain exposed for more than 4 hours. Protect surfaces that will be exposed for longer times as specified in paragraph COLD-WEATHER PROTECTION in PART 3 as a measure to maintain RCC temperatures above 0 degrees C 32 degrees F until after the ambient air temperature rises to above 0 degrees C 32 degrees F and is expected to remain above 0 degrees C 32 degrees F until the end of the curing and protection period, or until covered by another lift.

1.6.2 Placing During Rain

Do not place RCC during rainfall of 2.5 mm/hr 0.1 inch/hr or more. During periods of lesser rainfall, placement of RCC may continue if, in the opinion of the Contracting Officer, no damage to the RCC is occurring. Commence work only after excess free surface water and contaminated paste or RCC have been removed and the surface has gained sufficient strength (no less than 4 hours after the RCC placement was suspended) to prevent rutting, pumping, intermixing of rainwater with the RCC, or other damage to the RCC. When the RCC surface has been contaminated or damaged in any manner, wash the RCC to break up and remove laitance and/or mud-like coatings from the surface. Remove any undercut coarse aggregate. Remove and dispose of all waste in an approved manner.

1.6.3 Hot-Weather Placement

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NOTE: Refer to the concrete materials DM for use of the optional sentences and the correct placing temperature.

****

In hot-weather placement control the temperature of the RCC so that it does not exceed [25] [_____] degrees C [75.0] [_____] degrees F when placed. Suspend placement as soon as the RCC temperature exceeds [25] [_____] degrees C [75] [_____] degrees F. Measures that can be taken to prevent temperatures exceeding [25] [_____] degrees C [75] [_____] degrees F include, but are not limited to, chilling mixing water, sprinkling aggregate stockpiles, use of a canopy to shade the RCC placement areas, placing during nighttime and early morning hours, or restricting placements to cloudy days. Do not use any of these systems as reason for extension of completion dates specified in these specifications. [In addition, to prevent potential damage to the RCC due to hot-weather related placement conditions, suspend all RCC operation between [_____] [June 15th] and [October 31st] [_____]].

PART 2 PRODUCTS

2.1 RCC SYSTEM

****

NOTE: Contact the materials engineer or the concrete materials DM for information on filling in the blanks.

****

2.1.1 General Requirements

Perform all work in accordance with EM 385-1-1. Provide RCC composed of cementitious materials, water, fine and coarse aggregates, and possibly admixtures. The cementitious material must be portland cement, or portland cement in combination with pozzolan. An admixture, when approved or directed, will be a water-reducing/retarding admixture. Air-entraining admixture will be used in the bedding concrete and other conventional concrete.

2.1.2 Mixture Proportions and Studies

RCC mixtures and all conventional concrete mixtures that interface with the RCC (such as facing concrete and bedding mixtures) will be proportioned by the Contracting Officer [except that slipformed facing concrete mixture will be proportioned by the Contractor]. There will be one primary RCC mixture used for the mass of the dam [, _____,] [and _____]. The primary mixture will contain approximately [_____] to [_____] kg pounds water, [_____] kg pounds portland cement and [_____] kg pounds pozzolan per cubic meter yard. [Secondary RCC mixtures requiring higher portland cement and pozzolan contents (approximately [_____] to [_____] kg pounds per cubic meter yard) will be used for [_____] [, _____,] [and _____].] There also will be a "bedding mortar" and "bedding concrete." The bedding mortar is a broomable mixture containing approximately 280 to 355 kg 475 to 600 pounds of portland cement and 135 to 180 kg 225 to 300 pounds pozzolan per cubic meter yard. The bedding mortar will have 9.5 mm 3/8-inch nominal maximum size aggregate and a slump, when placed, of 175 to 225 mm 7 to 9 inches. The bedding concrete, 75 to 100 mm 3 to 4 inch slump conventional concrete, must contain 19.0 mm 3/4-inch nominal maximum size aggregate and approximately [_____] kg pounds of portland cement and pozzolan per cubic meter yard. The air content of the bedding concrete as delivered to the placement site must be between 4.5 and 7.5 percent. [Preliminary mixture proportioning studies are available for review in the District office.] Use concrete mixtures for [the upstream face] [, and _____,] and other conventional concrete mixtures that contain from [_____] to [_____] kg pounds of cementitious materials and the slump must be between 25 and 100 mm 1 and 4 inches.

2.1.3 Proportioning Responsibility

The proportions of all materials entering the RCC and the conventional concrete will be furnished. The proportions will be changed as necessary by the Government. Adjustments will be made to the batch weights, including cement, pozzolan, and water, to maintain the necessary consistency to prevent segregation within the RCC and allow full compaction as determined. Frequent changes to the batch weights are considered usual and can be expected to occur frequently during the course of each day's placement depending on such variables as humidity, wind velocity, temperature, and cloud cover. Such changes will be as directed. The Contractor will be responsible for adjusting the added water to compensate for changes in aggregate moisture content and to adjust the amount of air-entraining admixture (if used) to keep the percent of air within the specified range.

2.1.4 Nominal Maximum Size of Aggregate

Use nominal maximum size of coarse aggregate in the various parts of the work in accordance with following:

FEATURES	NOMINAL MAXIMUM SIZE AGGREGATE
[RCC used in the main concrete gravity dam]	75 mm3 inches
[RCC used in construction of the [_____]]	
[Conventional concrete for the upstream face]	
[Conventional concrete for the [_____]]	
[RCC used in the [_____]]	37.5 mm1-1/2 inch
[RCC used in the [_____]]	

FEATURES	NOMINAL MAXIMUM SIZE AGGREGATE
[Conventional concrete for [_____]]	
[Conventional concrete bedding mixture]	19.0 mm3/4 inch
[Bedding mortar]	4.75 mmNo. 4
Note: The nominal maximum size aggregate may be changed for applications requiring a special quality of concrete as directed.	

2.1.5 Consistency of RCC

The Contracting Officer will determine at the placement site on a continuing basis the proper consistency necessary for adequate hauling, spreading, and compacting and will direct all necessary changes to achieve the proper RCC consistency. Changes will be directed based on visual examination of the RCC during the spreading and compaction process and on the Vebe time when it varies outside the range considered ideal for compaction, as determined by the Government using the modified Vebe apparatus, in accordance with COE CRD-C 53.

2.1.6 Materials for Mixture-Proportioning Studies

****

NOTE: Contact the Division Lab to fill in the blanks.

****

At least [_____] days in advance of the time when placing of concrete is expected to begin, deliver samples of representative materials proposed for this project and meeting all the requirements of this specification to [_____] by the Contractor at its expense. Take samples of aggregates under the supervision of the Contracting Officer in accordance with COE CRD-C 100, accompanied by test reports indicating conformance with grading and quality requirements hereinafter specified. Use samples of materials other than aggregates that are representative of those proposed for the project and submit accompanied by manufacturer's test reports indicating compliance with applicable specified requirements. Quantities of materials required are as follows:

MATERIAL	QUANTITY
75 mm 3 inches nominal maximum size coarse aggregate	[_____] kg pounds
37.5 mm 1-1/2 inch nominal maximum size coarse aggregate	[_____] kg pounds
19 mm 3/4 inch nominal maximum size coarse aggregate	[_____] kg pounds
Fine aggregate	[_____] kg pounds

MATERIAL	QUANTITY
Cement	[_____] kg pounds
Pozzolans	[_____] cu meters feet
Admixtures (each)	[_____] L gallons

Mixture-proportioning studies will be made by the Government at its expense.

2.2 MATERIALS

2.2.1 Cementitious Materials

****

NOTE: See the appropriate concrete aggregates DM or thermal study to select the proper requirements for cementitious materials options.

****

2.2.1.1 Portland Cement

Provide portland cement conforming to ASTM C150/C150M, Type [_____], [low alkali when it is to be used with aggregates listed to require it in the paragraph COMMERCIAL CONCRETE AGGREGATE SOURCES below or when directed if a nonlisted source is permitted.] [the heat of hydration requirement at 7 days must be no greater than [_____] calories per gram] [including false-set requirement]. [In lieu of low-alkali cement, the Contractor may use a combination of portland cement that does not meet the low-alkali requirement with a suitable pozzolan or ground granulated blast-furnace slag (GGBFS) provided the following requirement is met. The expansion of the proposed combination must be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C150/C150M when tested in conformance with ASTM C441/C441M. Perform these two tests concurrently at an independent certified laboratory at the Contractor's expense. The Government reserves the right to confirm the test results and to adjust the percentage of pozzolan or GGBFS in the combination to suit other requirements at no additional cost to the Government.] Furnish portland cement in bulk.

2.2.1.2 Pozzolan

Provide pozzolan conforming to ASTM C618, Class C or F, including low alkali [multiple factor,] [drying shrinkage,] [uniformity,][and][moderate] [severe] sulfate resistance requirements of Table 2A. Uniformity Requirements (for air content) applies to all fly ash. [Table 1A, Supplementary Optional Chemical Requirement for Maximum Alkalies, applies when it is to be used with aggregates listed to require low-alkali cement]. Furnish pozzolan in bulk.

2.2.1.3 Ground Granulated Blast-Furnace (GGBF) Slag

Provide ground granulated blast-furnace slag conforming to ASTM C989/C989M, Grade 100 or Grade 120.

2.2.1.4 Temperature of Cementitious Materials

The temperature of the cementitious materials as delivered to the site must not exceed 65 degrees C 150 degrees F.

2.2.2 Admixtures

Furnish all liquid chemical admixtures in a solution of suitable viscosity and dilution for field use as determined by the Contracting Officer.

[2.2.2.1 Water-Reducing Admixture (WRA)

Provide WRA meeting the requirements of ASTM C494/C494M, Type D, except that the 6-month and 1-year compressive strength tests are waived. The admixture may be added to the concrete mixture only when its use is approved or directed and after mixture proportioning studies.

]2.2.2.2 Air-Entraining Admixture

Provide air-entraining admixture conforming to ASTM C260/C260M.

2.2.3 Water

Use water for washing aggregates and for mixing and curing concrete that is free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances and complies with COE CRD-C 400.

2.2.4 Aggregates

****

NOTE: See the concrete materials DM to select the aggregate composition options.

This note may be disregarded for regions where Alkali-Silica Reactivity (ASR) is not a concern. Some aggregate sources may exhibit an ASR potential. ASR is a potentially deleterious reaction between alkalis present in concrete and some siliceous aggregates, reference EM 1110-2-2000 paragraph 2-3b(6) and appendix D. Use of cementitious materials meeting the low alkali requirement may be effective in some applications, and insufficient in others. In regions where imposing the low alkali requirement has not been effective in controlling ASR, additional effort for evaluation and mitigation may be required. In which case, the alternate procedures to proportion cementitious materials to meet the low alkali requirement in paragraph PORTLAND CEMENT should not be used with the following requirements. Where ASR is known or suspected to pose a concern for concrete durability, it is recommended that aggregates proposed for use in concrete be evaluated to determine ASR potential and an effective mitigation. EM 1110-2-2000, provides recommendations for evaluating and mitigating ASR in concrete mixtures. Aggregate evaluations may not be practical for projects requiring small quantities of

concrete (less than 200 cubic meters 250 cubic yards).

Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS, paragraph ALKALI-SILICA REACTIVITY, provides a specification method for the Contractor to evaluate and mitigate ASR in concrete mixtures. The expansion limits specified in Section 32 13 14.13 are requirements for pavements and exterior slab construction. For structural concrete applications the measured expansion must be less than 0.10 percent. It may not be economical or practical to specify different test limit requirements for use on the same project. In which case the lower limit required by the application should be used.

The designer may use the specification method in Section 32 13 14.13 by incorporating the relevant paragraphs into this specification, or may use the following requirements (retain either the 0.10 or the 0.08 percent expansion limits as appropriate).included in the set of brackets highlighted thus "[ ]".

****

2.2.4.1 Composition

[Use fine aggregate consisting of natural sand, manufactured sand, or a combination of natural and manufactured sands. Use coarse aggregate consisting of [gravel], [crushed gravel], [crushed stone], [air-cooled blast-furnace slag], or a combination thereof.] "[Test and evaluate fine and coarse aggregates proposed for use in concrete for alkali-aggregate reactivity in accordance with ASTM C1260. Evaluate the fine and coarse aggregates separately and in combination, which matches the Contractor's proposed mix design proportioning. All results of the separate and combination testing must have a measured expansion less than 0.10 (0.08) percent at 16 days after casting. Should the test data indicate an expansion of 0.10 (0.08) percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1260 and ASTM C1567. Perform additional testing using ASTM C1260 and ASTM C1567 using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. Use GGBF slag in the range of 40 to 50 percent of the total cementitious material by mass. Use Class F fly ash in the range of 25 to 40 percent of the total cementitious material by mass.]"

2.2.4.2 Quality

****

NOTE: The tests selected should be those which are applicable to the concrete to be used in the project. These tests may include those listed below in addition to others not listed. See EM 1110-2-2000 for schedule of tests.

Only a limited number of laboratories are now running ASTM C123/C123M due to the toxic chemicals required. Recommend that ASTM C295/C295M/C295M be specified.

A list of properties and test values are unique to each project and should be taken from the concrete materials DM. Delete the quality tests not required in the DM.

Use the petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.
****

Deliver aggregates to the mixer t6hat meet the following requirements:

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Specific Gravity	[_____]	[_____]	ASTM C127 ASTM C128
Absorption	[_____]	[_____]	ASTM C127 ASTM C128
Flat and Elongate	[_____]	25 percent max.	ASTM D4791
Durability Factor using Procedure A	[_____]	[_____]	COE CRD-C 114 ASTM C666/C666M
Clay Lumps and Friable Particles	[_____]	[_____]	ASTM C142/C142M
Material Finer than 75 µm No. 200 Sieve	[_____]	[_____]	ASTM C117
Liquid Limit and Plastic Limit on material passing the 75 µm No. 200 sieve size	LL 30 max., PI 10 max.	[_____]	ASTM D4318
Organic Impurities	Not Darker than No. 3, Not less than 95 percent	[_____]	ASTM C40/C40M ASTM C87/C87M
L.A. Abrasion	[_____]	[_____]	ASTM C131/C131M ASTM C535
Soft Particles	[_____]	[_____]	COE CRD-C 130

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Petrographic Examination	List unwanted deleterious materials and their limits	[_____]	ASTM C295/C295M
Percent coarse aggregate with 2 or more fractured faces	[_____]	20 percent min.	[_____]
Chert, less than 2.40 specific gravity	[_____]	[_____]	ASTM C123/C123M ASTM C295/C295M
[Coal and Lignite, less than 2.00 specific gravity]	[_____]	[_____]	ASTM C123/C123M or ASTM C295/C295M

2.2.4.3 Grading

****
NOTE: See DM for appropriate fine aggregate options.
****

a. Fine Aggregate - The grading of the fine aggregate as delivered to the mixer for the RCC must be such that the individual percent retained on any sieve does not vary more than 3 percent from the percent retained on that sieve in a fixed grading selected by the Contractor after the first 30 days of concrete placement. The minimum percent retained on each of the 2.36 mm No. 8 through 75 µm No. 200 sieve sizes must be 5 percent. In addition to the grading limits, the fine aggregate, as delivered to the mixer, must have a fineness modulus of no less than 2.10 nor more than 2.75. Also control the grading of the fine aggregate so that the fineness moduli for at least four of five consecutive test samples of the fine aggregate as delivered to the mixer does not vary more than 0.10 from the fineness modulus of the fixed grading selected by the Contractor, and approved. Determine the fineness modulus in accordance with COE CRD-C 104. At the option of the Contractor, fine aggregate may be separated into two or more sizes or classifications, but control the uniformity of the grading of the separate sizes so that they may be combined throughout the job in fixed proportions established during the first 30 days of RCC placement. The grading of the fine aggregate for the bedding concrete and all other conventional concrete must conform to the requirements of [ASTM C33/C33M]. [Section 03 30 00 CAST-IN-PLACE CONCRETE] The fixed grading and the results of individual tests during the first 30 days must fall within the following limits:

b.

SIEVE DESIGNATION U.S. STANDARD SQUARE MESH	PERMISSIBLE LIMITS PERCENT BY MASS, PASSING
9.5 mm3/8 inch	100
4.75 mmNo. 4	95 - 100
2.36 mmNo. 8	75 - 95
1.18 mmNo. 16	55 - 80
600 µmNo. 30	35 - 60
300 µmNo. 50	24 - 40
150 µmNo. 100	12 - 28
75 µmNo. 200	*8 - 18
* The required fines smaller than the 75 µm No. 200 sieve size may substituted with Class F fly ash, at no additional cost to the Government.	

c. Coarse Aggregate - The grading of the coarse aggregate within the separate size groups must conform to the following requirements as delivered to the mixer.

d.

PERCENT BY MASS PASSING INDIVIDUAL SIEVES			
U.S. STANDARD SIEVE SIZE	4.75 mm No. 4 to 19.0 mm 3/4 inch	19.0 mm 3/4 inch to 37.5 mm 1-1/2 inch	37.5 mm 1-1/2 inch to 75 mm 3 inch
100 mm4 inch			100
75 mm3 inch			90 - 100
50 mm2 inch		100	20 - 55
37.5 mm1-1/2 inch		90 - 100	0 - 10
25 mm1 inch	100	20 - 45	0 - 5
19.0 mm3/4 inch	90 - 100	0 - 10	
9.5 mm3/8 inch	20 - 55	0 - 5	
4.75 mmNo. 4	0 - 10		
2.36 mmNo. 8	0 - 5		

2.2.4.4 Particle Shape

Use particles of the fine aggregate and of the coarse aggregate that are generally spherical or cubical in shape. The quantity of flat and elongated particles at a length-to-width or width-to-thickness ratio greater than 3 in the separated size groups of coarse aggregate, as defined and determined by ASTM D4791, must not exceed 25 percent in any size group.

2.2.4.5 Moisture Content

Do not place fine aggregate in bins at the batch plant until it is in a stable state of moisture content. A stable moisture content is reached when the variation in the percent of total moisture tested in accordance with ASTM C566 and when sampled at the same location will not be more than 0.5 percent during one (1) hour of the two (2) hours prior to placing the material in the batch plant bins and the variation in moisture content when sampled at the same location must not be more than 2.0 percent during the last 8-hour period that the aggregate remains in the stockpile. Deliver coarse aggregate to the mixers with the least amount of free moisture and the least variation in free moisture practicable under the job conditions. Do not deliver the coarse aggregate to the mixer "dripping wet" under no conditions.

[2.2.4.6 Commercial Concrete Aggregate Sources

****

NOTE: The list of sources and required tests will be taken from the concrete materials DM.

****

Concrete aggregates may be furnished from any source capable of meeting the quality requirements stated in paragraph QUALITY above. The following sources were evaluated during the design phase of the project in [_____] and were found at that time capable of meeting the quality requirements when suitably processed. No guarantee is given or implied that any of the following listed sources are currently capable of producing aggregates that meet the required quality stated above. A DM containing the results of the Government investigation and test results is available for review in the [_____] District Office. Contact [_____] at [_____] to arrange for review of the DM. Consider test results and conclusions valid only for the sample tested and do not take as an indication of the quality of all material from a source nor for the amount of processing required.

a. List of Sources

****

NOTE: The concrete materials DM will list those sources requiring low-alkali cement, which must be noted herein.

****

b.

FINE AGGREGATE	COARSE AGGREGATE
F1: [_____] [1/]	C1: [_____] [1/]
F2: [_____]	C2: [_____]
F3: [_____]	C3: [_____]
[1/ Low-alkali cement must be used with these sources.]	

c. Selection of Source - After the award of the contract, designate in writing only one source or combination of sources from which to furnish aggregates. If the Contractor proposes to furnish aggregates from a source or sources not listed above, he may designate only a single source or single combination of sources for aggregates. Regardless of the source selected, provide samples for quality-assurance testing as required by paragraphs PRECONSTRUCTION GOVERNMENT TESTING and MIXTURE PROPORTIONS AND STUDIES. If a source for coarse or fine aggregate so designated by the Contractor does not meet the quality requirements stated in paragraph QUALITY above, the Contractor may not submit for approval any other unlisted sources but must furnish the coarse or fine aggregate, as the case may be, from sources listed, provided it meets the requirements of the same paragraph, at no additional cost to the Government.

][2.2.4.7 Government-Furnished Concrete Aggregate Source

****

NOTE: The specification writer should ascertain that restoration of the pit or quarry site is specified under other sections.

****

a. Location - The deposits are [owned] [controlled] by the Government and are made available to the Contractor free of charge for production of aggregate required under this contract. Within the designated area, an adequate supply of material is available from which concrete aggregate meeting the requirement of these specifications can be produced with suitable processing. The Government guarantees that a sufficient amount of material of suitable quality for production of all of the concrete aggregate required is available within the deposit and that concrete aggregates of suitable quality can be produced with a properly designed and operated plant [without hand-picking or similar operations]. However, the amount of work involved or the amount of unsatisfactory materials required to be wasted to produce a sufficient quantity of suitable concrete aggregate is the responsibility of the Contractor, and the Government will not be held liable for costs resulting from such work or waste. Produce the concrete aggregate from the following sites as shown in the drawings:

b.

	QUARRY SITE	BAR	TERRACE	COORDINATES	DIST. and DIRECTION
G1					
G2					
G3					

c. Explorations - The deposits listed above have been explored by the Government to determine the character and extent of the materials available. The locations of the explorations are shown in the contract drawings. The logs of the exploratory holes are also shown in the drawings. Samples of materials secured are available for inspection at [_____]. The results of explorations are furnished for information only. These data are the result of limited explorations and tests conducted by and for the Government and are accurate to the extent of the scope of the investigations conducted. The Government will not be responsible for any deduction, interpretation, or conclusion drawn therefrom by the Contractor.

]2.3 PLANT AND EQUIPMENT

2.3.1 Concrete Plant

****

NOTE: See the concrete materials DM or EM 1110-2-2000 for the plant size requirements.

See EM 1110-2-2000 and the concrete materials DM for selection of automatic or semiautomatic plant and for use of the rescreening and washing plant.

****

Use concrete plant, conveying, placing, compaction, and cleanup systems with a capacity of at least [_____] cubic meters yards per hour. Use a batch or a continuous mixing concrete plant.

2.3.2 Location

Locate the concrete plant at the site of the work in the general area indicated in the drawings[, or locate offsite].

2.3.3 Bins and Silos

Provide separate bins, compartments, or silos for each size or classification of aggregate and for each of the cementitious materials. Provide compartments of ample size and constructed so that the various materials will be maintained separately under all working conditions.

2.3.4 Bulk Cement or Pozzolan

Separate all compartments containing bulk cement or pozzolan from each other by a free-draining air space. Equip cement and pozzolan bins with filters which allow air passage but preclude the venting of cement or pozzolan into the atmosphere. Clearly mark all filling ports with a permanent sign stating the contents.

2.3.5 Batch Plant

Submit details and data on the concrete plant [[_____] days prior to assembly] [not later than 30 days after Notice to Proceed] for review by the Contracting Officer. Final acceptance of any piece of plant is subject to satisfactory performance during operations. The batch plant should meet the following requirements.

2.3.5.1 Batchers

Weigh aggregate in separate weigh batchers with individual scales [or may be batched cumulatively]. Weigh bulk cement and other cementitious materials on a separate scale in a separate weigh batcher. Measure water by weight or by volume, but do not weigh or measure it cumulatively with another ingredient. Measure ice separately by weight. Batch admixtures separately and batch by weight or by volume in accordance with the manufacturers recommendations.

2.3.5.2 Water Batcher

Provide a suitable water-measuring and batching device that will be capable of measuring and batching the mixing water within the specified tolerances for each batch. Use mechanism for delivering water to the mixers that is free from leakage when the valves are closed. Interlock the filling and discharge valves for the water batcher so that the discharge valve cannot be opened before the filling valve is fully closed. When a water meter is used, provide a suitable strainer ahead of the metering device.

2.3.5.3 Admixture Dispensers

Provide a separate batcher or dispenser for each admixture. Equip each plant with the necessary calibration devices that will permit convenient checking of the accuracy of the dispensed volume of the particular admixture. Provide batching or dispensing devices capable of repetitively controlling the batching of the admixtures to the accuracy specified. Provide piping for liquid admixtures that is free from leaks and properly valved to prevent backflow or siphoning. Provide dispensing system which includes a device or devices that detect and indicate the presence or absence of the admixture or provide a convenient means of visually observing the admixture in the process of being batched or discharged. Ensure each system is capable of ready adjustment to permit varying the quantity of admixture to be batched. Interlock each dispenser with the batching and discharge operations so that each admixture is added separately to the batch in solution in a separate portion of the mixing water in a manner to ensure uniform distribution of the admixtures throughout the batch during the required mixing period. Store and handle admixtures in accordance with the manufacturer's recommendations.

2.3.5.4 Moisture Control

Provide plant that is capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched. Provide a moisture meter complying with the provisions of COE CRD-C 143 for measurement of moisture in the fine aggregate. Arrange sensing element so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.

2.3.5.5 Scales

Provide adequate facilities for the accurate measurement and control of each of the materials entering each batch of concrete. Provide weighing equipment and controls conforming to the applicable requirements of NIST HB 44, except that the accuracy must be within 0.2 percent of the scale capacity. Provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device. Make tests at the frequency required in paragraph TESTS AND INSPECTIONS in PART 3 and in the presence of a Government inspector. Include a visible indicator that indicates the scale load at all stages of the weighing operation and shows the scale in balance at zero load with each weighing unit. Arrange weighing equipment so that the concrete plant operator can conveniently observe the indicators.

2.3.5.6 Operation and Accuracy

[The weighing operation of each material must start automatically when actuated by a single starter switch and end automatically when the designated amount of each material has been reached. These requirements can be met by providing an automatic batching system as defined in the NRMCA CPMB 100.] [The weighing operation of each material must begin automatically when actuated by one or more starter switches and end when the designated amount of each material has been reached. These requirements can be met by providing a semiautomatic or automatic batching system as defined by the NRMCA CPMB 100.] There must be equipment to permit the selection of [_____] preset mixtures each by the movement of not more than two switches or other control devices. Construct and arrange weigh batchers so that the sequence and timing of batcher discharge gates can be controlled to produce a ribboning and mixing of the aggregates, water, admixtures, and cementitious materials as the materials pass through the charging hopper into the mixer. Include provisions to facilitate the inspection of all operations at all times. Deliver materials from the batching equipment within the following limits of accuracy:

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	0 to +2
Water	±1
Aggregate smaller than 37.5 mm 1-1/2 inch size	±2
Aggregate larger than 37.5 mm 1-1/2 inch size	±3
Chemical admixtures	0 to +6
Note: When water or chemical admixtures are measured by volume, they must meet the same tolerance percent as stated in the chart.	

2.3.5.7 Interlocks

Interlock batchers and mixers so that:

a. The charging device of each batcher cannot be actuated until all scales have returned to zero balance within plus or minus 0.2 percent of the scale capacity and each volumetric device has reset to start or has signaled empty.

b. The charging device of each batcher cannot be actuated if the discharge device is open.

c. The discharge device of each batcher cannot be actuated if the charging device is open.

d. The discharge device of each batcher cannot be actuated until the indicated material is within the allowable tolerances.

e. Admixtures are batched automatically and separately with the water.

f. The mixers cannot be discharged until the required mixing time has elapsed.

2.3.5.8 Recorder

Provide an accurate recorder or recorders conforming to the following detailed requirements:

a. Produce a graphical or digital record on a single visible chart or tape of the weight or volume of each material in the batchers at the conclusion of the batching cycle. Produce the record prior to delivery of the materials to the mixer. After the batchers have been discharged, show the return to empty condition.

b. Completely house graphical recording or digital printout unit in a single cabinet that is capable of being locked.

c. Mark the chart or tape so that each batch may be permanently identified and so that variations in batch weights of each type of batch can be readily observed. Use chart or tape that is easily interpreted in increments not exceeding 0.5 percent of each batch weight.

d. Show time of day at intervals of no more than 15 minutes.

e. The recorder chart or tape will become the property of the Government.

f. Place the recorder in a position convenient for observation by the concrete plant operator and the Government inspector.

g. The recorded weights or volumes when compared to the weights or volumes actually batched must be accurate within plus or minus 2 percent.

2.3.5.9 Batch Counters

Include devices for automatically counting the total number of batches of all concrete batched and the number of batches of each preset mixture.

[2.3.5.10 Rescreening Plant

Locate, arrange, and operate a rescreening plant in a manner that all coarse aggregate will be routed through the plant and that its operation will ensure delivery to the mixers of graded coarse aggregate free from variation and conforming to the size groups and grading of paragraph AGGREGATES above and with moisture content conforming to the provisions of paragraph TESTS AND INSPECTIONS in PART 3. Coarse aggregate may be rescreened and delivered to the batch plant bins one size group at a time or two or more adjacent size groups at a time. Simultaneous rescreening of nonadjacent size groups is not permitted. All material passing the bottom screen of the smallest size of coarse aggregate being screened must be wasted.

][2.3.5.11 Washing Plant

Wash all coarse aggregates immediately prior to entering the rescreening plant. The washing plant must contain adequate water nozzles and vibrating screens to remove foreign materials and coatings from aggregate particles. Use water for washing that meets the requirements of paragraph WATER above.

]2.3.5.12 Batch Plant Trial Operation

No less than 7 days prior to commencement of placing the test section, make a test of the batching and mixing plant in the presence of a representative of the Contracting Officer to check operational adequacy. Produce the number of full-scale concrete batches required in trial runs as directed, do not exceed 20, and proportion as directed by the Contracting Officer. Waste or use all concrete produced in these tests for purposes other than inclusion in structures covered by this specification. Correct all deficiencies found in plant operation to the satisfaction of the Contracting Officer prior to the start of concrete placing operations. No separate payment will be made to the Contractor for labor or materials required by provisions of this paragraph. Mixer uniformity testing, in accordance with paragraph TESTS AND INSPECTIONS in Part 3, will be performed by the government near the end of this trial operation period. Notify the Contracting Officer of the trial operation not less than 7 days prior to the start of the trial operation.

2.3.5.13 Protection

Protect weighing, indicating, recording, and control equipment against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equipment.

2.3.6 Continuous Mixing Plant(s)

****

NOTE: See the concrete materials DM or consult the materials engineer to fill in the blanks.

****

Provide a continuous mixing plant(s) that is capable of producing RCC of the same quality and uniformity as would be produced in a conventional batch plant and capable of producing a uniform continuous product (at both maximum and minimum production rates) that is mixed so that complete intermingling of all ingredients occurs without balling, segregation, and wet or dry portions.

2.3.6.1 Operation and Accuracy

Provide an electronic control system. Provide control system with the capability of changing mixtures instantaneously, producing at least [_____] different mixtures, producing any of the mixtures at a variable rate, and tracking a mixture change to a hopper or a conveyor system. The control panel must display for each ingredient the designed formula values and the instantaneous percentage values and record the instantaneous values at a preset time interval or on demand with a multiple copy printer/recorder.

The recorder must note formula changes and print total quantities of each ingredient and total amounts produced on command. Provide weighing devices (belt scale or other) for continuous weighing of individual ingredients and total ingredients. The plant control must not require manual devices to adjust the material flow. The plant must be capable of total manual control operation for a single product at a limited production for short-time durations in the event of loss of electronic control. Incorporate modular replaceable components to reduce down time in the event of control system malfunction. Maintain an inventory of such replaceable components. Provide a device to monitor the fine aggregate content immediately prior to dispensing into the mixing plant dispensing system. The accuracy of the plant dispensing systems must be within the following limits:

MATERIAL	PERCENT OF REQUIRED MASS
Pozzolan	0 to +2 percent
Cement	0 to +2 percent
Water	± 1 percent
Aggregate smaller than 37.5 mm 1-1/2 inch size	± 2 percent
Aggregate larger than 37.5 mm 1-1/2 inch size	± 3 percent
Admixtures	0 to +6 percent
Note: Calibrate the continuous feeders for each of the ingredients in accordance with the manufacturer's specifications. Maintain devices and tools at the plant location to check the feeder's calibration at the Contracting Officer's request. Provide a technician that is skilled in calibration of the feed devices and the maintenance and repair of the plant control system. The technician must be available within 30 minutes notice during all scheduled plant operations. The technician could be one or more of the Contractor's personnel.	

2.3.6.2 Cement, Pozzolan, and Aggregate Feed

Feed cement, pozzolan, and aggregate uniformly, continuously, and simultaneously (at the proper ratios and quantity for the mixture required) into the mixer by belt, auger, vane feeder, or other acceptable method. Keep feed bins or silos for each ingredient sufficiently full and must be of sufficient size to ensure a uniform flow at a constant rate for a specific mixture. The feed bins must have a low-level indicator that both warns the operator and can shut the plant down if insufficient material is available for a uniform and continuous flow.

2.3.6.3 Water and Admixture Dispensers

Provide liquid-dispensing devices capable of metering and dispensing within the specified requirements. Provide liquid valves that are free from leakage in the closed position. Use dispensers with attachments and/or install in such a manner that will permit convenient checking of their accuracy. Ensure plumbing is leak-free and properly valved to prevent backflow and siphoning. Interlock dispenser with the electronic plant control to warn the operator and shut down the plant if insufficient liquid is available. Properly locate separate nozzles for each liquid at the mixer to assure uniform distribution of each liquid to the materials entering the mixer.

2.3.6.4 Continuous Mixer(s)

Provide continuous mixer(s) that have proper introduction of ingredients as specified by the manufacturer and do not charge in excess of the manufacturer's recommended capacity. Provide mixer(s) that are capable of combining the materials into a uniform homogeneous mixture and of discharging this mixture without segregation. Operate mixer(s) at the blade speed designated by the manufacturer and mixer(s) must be capable of changing retention time of the ingredients in the mixer. This should be accomplished by manually resetting the mixer(s) blade angles. Predicate mixing time (ingredient retention time in the mixer) upon the uniformity, homogeneity, and consistency of the resultant mixture. Take samples for uniformity testing at 2-minute intervals and test in accordance with COE CRD-C 55 and paragraph MIXER UNIFORMITY REQUIREMENTS below. Maintain mixer(s) in satisfactory operating condition and keep mixer blades free of hardened concrete. Should mixer(s) at any time produce unsatisfactory results, promptly discontinue its use until it is repaired. Provide suitable facilities for obtaining representative samples of concrete for testing. Provide all necessary platforms, shelters, tools, labor, and equipment for obtaining samples.

2.3.6.5 Segregation

Use a means to reduce and minimize segregation and waste which would otherwise result from the continuous stream of concrete being fed into the batch haul devices (concrete buckets, dump trucks, etc.). Provide equipment which retains the concrete between tracks or other means of transport to prevent the need for stopping the mixer. These devices could include, but not be limited to, small-volume conveyor discharge hopper with a large gate that is automatically opened on a timed interval, thereby dumping a series of small batches into larger batch hoppers, trucks, or truck beds

2.3.6.6 Trial Operation

No less than 7 days prior to commencement of concrete placing, make a test of the plant in the presence of a representative of the Contracting Officer to check operational adequacy. Produce the number of cubic meters yards required in trial runs directed, but do not exceed 40 cubic meters 50 cubic yards and proportion as directed by the Contracting Officer. Waste or use all concrete produced in these tests for purposes other than inclusion in structures covered by this specification. Correct all deficiencies found in plant operation to the satisfaction of the Contracting Officer prior to the start of concrete placing operations. Mixer uniformity tests by the Government will be performed near the end of this trial period. No separate payment will be made to the Contractor for labor or materials required by provisions of this paragraph. Notify the Contracting Officer of the trial operation not less than 7 days prior to the start of the trial operation.

2.3.6.7 Protection

Protect weighing, indicating, recording, and control equipment against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equipment.

2.3.7 Laboratory Areas

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NOTE: The specification writer should use this paragraph unless a laboratory building is to be government furnished.

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Provide a [room] [separate building] adjacent to the plant to house the moisture and grading testing equipment for aggregate and to provide working space for the Government representative. Provide another room for testing fresh concrete and for fabricating and initial curing (approximately 72 hours) of concrete test specimens in accordance with ASTM C31/C31M. The size, arrangement, and location of these rooms will be subject to approval by the Contracting Officer. Provide electricity, air-conditioning, heat, and water as required for use in these laboratory areas.

2.3.8 Mixers

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NOTE: See the concrete materials DM for information on mixer selection and concrete mixers. Truck mixers are allowed for mixing or transporting RCC or conventional concrete with less than 50 mm 2 inch slump or greater than 38 mm 1-1/2 inch nominal maximum size aggregate (NMSA).

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Provide stationary mixers or pugmill mixers. [Truck mixers may be used for conventional concrete]. Mixers may be batch or continuous mixing. Combine the materials into a uniform mixture and discharge this mixture without segregation. Do not charge mixers in excess of the capacity recommended by the manufacturer on the nameplate. Excessive overmixing requiring additions of water will not be permitted. Maintain mixers in satisfactory operating condition, and keep mixer drums free of hardened concrete. Replace mixer blades or paddles when worn down more than 10 percent of their depth when compared with the manufacturer's dimension for new blades. Should any mixer at any time produce unsatisfactory results, promptly discontinue its use until it is repaired or replaced.

[2.3.9 Truck Mixers

Provide truck mixers and the mixing of concrete therein conforming to the requirements of ASTM C94/C94M. A truck mixer may be used for conventional concrete complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Equip each truck with two counters to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed. Do not use truck mixers to mix or agitate concrete with greater than 37.5 mm 1-1/2 inches NMSA or concrete with a slump of 50 mm 2 inches or less. Determine acceptability of truck mixers for uniform mixing by uniformity tests in accordance with ASTM C94/C94M.

]2.3.10 Pugmill Mixers

Provide a batch or continuous mixing twin-shaft pugmill mixer capable of producing RCC of the same quality and uniformity as would be produced in a conventional plant that meets all the requirements of these specification. All pugmill mixers must meet the requirements of paragraph CONTINUOUS

MIXING PLANT(S) above.

2.3.11 Mixer Uniformity Requirements

All mixers, except for truck mixers, will be tested by the Government in accordance with this paragraph and in accordance with COE CRD-C 55. When regular testing is performed, the conventional concrete must meet the limits of any five of the six applicable uniformity requirements, and the RCC must meet the limits of any three of the four applicable uniformity requirements. When abbreviated testing is performed, the concrete must meet only those requirements listed for abbreviated testing. The initial mixer evaluation test must be a regular test and perform prior to the start of concrete placement. Use concrete proportions the evaluation that contain the largest size aggregate on the project as directed by the Contracting Officer. Regular testing consists of performing all tests on three batches of concrete. The range for regular testing is the average of the ranges of the three batches. Abbreviated testing consists of performing the required tests on a single batch of concrete. The range for abbreviated testing is the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, etc., the results of tests on one of the mixers apply to the others, subject to the approval of the Contracting Officer. Perform mixer evaluations by the Government. Provide labor and equipment as directed by the Contracting Officer to assist the Government in performing the tests.

PARAMETER	REGULAR TESTS ALLOWABLE MAXIMUM RANGE FOR AVERAGE OF 3 BATCHES	ABBREVIATED TESTS ALLOWABLE MAXIMUM RANGE FOR 1 BATCH
Unit weight of air-free mortar, 1)	16 kg/cu m2.0 lb/cu ft	16 kg/cu m2.0 lb/cu ft
Air content	1.0 percent	--
Slump, 1)	25 mm1 inch 1.0	--
Coarse aggregate, 1),2)	6.0 percent	6.0 percent
Compressive strength at 7 days, 1),2)	10.0	10.0
Water content, 1), 2)	1.5 percent	1.5 percent
Consistency, modified Vebe, 2) second	7.0	--
Note: 1) = Test for conventional concrete mixed in stationary mixer, 2) = Test for RCC		

A regular test will be performed before concrete production begins and when the Contractor requests a reduced mixing time. Perform an abbreviated test every 3 months when concrete is being placed. If a mixer fails the abbreviated test, a regular test will be performed. Cost of testing when the Contractor requests a reduced mixing time will be paid by the Contractor.

2.3.12 Sampling Facilities

2.3.12.1 Sampling Concrete

Provide suitable facilities and labor for obtaining representative samples of concrete in accordance with ASTM C172/C172M for Contractor quality control and Government quality assurance testing.

2.3.12.2 Sampling Aggregates

Provide suitable facilities for readily obtaining representative samples of aggregates for test purposes immediately prior to the material entering the mixer.

2.3.13 Transporting and Conveying Equipment

Provide transporting and conveying equipment conforming to the following requirements.

a. Convey concrete mixtures (RCC, bedding mortar, concrete, and any other concrete that will interface with the RCC) from the plant mixer(s) to placement as rapidly and as continuously as practical by methods which limit segregation, contamination, and surface drying.

b. Convey RCC from the mixing plant to the structure by means of main-line conveyor, end-dump truck, front-end loader, or a combination thereof.

c. Conventional concrete may be transported by ready-mix truck, conveyor, or agitator truck, or properly designed nonagitating truck.

d. Provide indicating and signaling devices for the control and identification of types or classes of concrete as they are mixed and discharged for transfer to the placement site.

e. Identify each type or class of concrete visually by placing a colored tag or other marker as it leaves the mixing plant so that the concrete may be positively identified and placed in the structure in the desired position.

2.3.13.1 Trucks

Use truck mixers or agitators for transporting central-mixed conventional concrete which conform to the applicable requirements of ASTM C94/C94M. Do not use truck mixers to transport concrete with larger than 37.5 mm 1-1/2-inch nominal maximum size aggregate (NMSA) or 50 mm 2 inch slump, or less. Nonagitating trucks may be used for transporting conventional central-mixed concrete over a smooth road when the hauling time is less than 15 minutes and the slump is less than 75 mm 3 inches. Bodies of nonagitating trucks must be smooth, water-tight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation.

2.3.13.2 Belt Conveyors

Design and operate belt conveyors to assure a uniform flow of concrete from mixer or delivery truck to final place of deposit without segregation of ingredients or loss of mortar and provide with positive means for preventing segregation of the concrete or loss of mortar at transfer points and the point of placing. The NMSA required in mixture proportions furnished by the Government will not be changed to accommodate the belt width.

2.3.14 Spreading and Remixing Equipment

Use spreading and remixing equipment conforming to the following requirements:

a. Use dozer to accomplish primary spreading procedure. Graders or other equipment not specified may be used to facilitate the RCC spreading process only when approved.

b. For open, unrestricted areas, use dozer of a minimum size and weight equivalent to a Caterpillar D-6. For restricted placement areas, such as placement of RCC near the dam crest or next to abutments, use dozer of a minimum size and weight equivalent to a Caterpillar D-4.

c. A minimum of one operating dozer for each 150 cubic meters 200 cubic yards of RCC placed each hour. Equip dozers with well maintained grousers. A front-end loader with operator must be available to assist with deposition and spreading of RCC as needed in confined areas.

d. Maintain equipment in good operating condition. The equipment must not leak or drip oil, grease, or other visible contaminants onto the RCC surface.

e. Clean all equipment used for spreading and remixing that leaves the surface of the structure for maintenance or repairs or, for any other reason, of all contaminants by an approved method before returning to the structure surface. Do not operate a dozer or other tracked vehicle on other than fresh uncompacted RCC except to facilitate startup operations for each lift and by approved procedures.

2.3.15 Compaction Equipment

Submit a listing of the equipment proposed for transporting, handling, depositing, spreading, and compacting the concrete for review by the Contracting Officer [[_____] days before concrete placement begins.] [not later than 30 days after Notice to Proceed.] Include site drawings or sketches with locations of equipment and placement site. The compaction equipment must conform to the following requirements.

2.3.15.1 Primary Rollers

Use double-drum self-propelled vibratory rollers for primary rolling. Transmit a dynamic impact to the surface through a smooth steel drum by means of revolving weights, eccentric shafts, or other equivalent methods. Provide compactor with a minimum gross mass of 9000 kg 20,000 pounds and produce a minimum dynamic force of 60 000 N/m 350 pounds/linear inch of drum width. Use a variable operating frequency in the approximate range of 1,700 to 3,000 cycles per minute. Use an adjustable amplitude between 0.4 and 1.0 mm 0.015 and 0.04 inches. Provide roller capable of full compaction in both forward and reverse directions. Operate roller at speeds not exceeding 0.7 m/s 2.2 ft/s. Within the range of the operating capability of the equipment, the Contracting Officer may direct or approve variations to the frequency, amplitude, and speed of operation which result in the specified density at the fastest production rate.

2.3.15.2 Small Vibratory Rollers

Use small vibratory rollers to compact the RCC where the larger vibratory rollers specified above cannot maneuver. Compact the RCC to the required density and demonstrate during construction of the test section. Small vibratory rollers cannot compact the RCC to the same density and thickness as the primary rollers; therefore, when small rollers are used, reduce total lift thickness of the RCC layer or lift to no more 150 mm 6 inches uncompacted thickness to permit adequate compaction. Provide rollers with independent speed and vibration controls and are capable of a wide range of speed adjustments.

2.3.15.3 Tampers (Rammers)

Compact the RCC to the required density and demonstrate during construction of the test section. Tampers cannot compact the RCC to the same density and thickness as the primary rollers; therefore, when tampers are used, reduce thickness of each RCC layer that is to be compacted to no more than 150 mm 6 inches uncompacted thickness to assure adequate compaction.

2.3.15.4 Other Requirements

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NOTE: See the concrete materials DM or the materials engineer to fill in the blanks.

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Maintain at least [_____] self-propelled vibratory rollers, at least [_____] small rollers, and at least [_____] tampers meeting these requirements full time at the site and ready for service at all times during production and placement.

2.3.16 Truck-Mounted Vacuum Pickup System

Provide a truck-mounted vacuum pickup system for various cleanup operations from the beginning of foundation cleanup to final placement of job RCC. The unit(s) must be capable of pumping 125 cubic meters 4,500 cubic feet of air per minute through an 200-mm 8-inch diameter opening and capable of pumping water at a minimum rate of 125 L/s 2,000 gpm. Maintain equipment in good operating condition. The equipment must not leak cleanup water and other debris during equipment operation or transit. The equipment must not leak or drip oil, grease, or other visible contamination onto the RCC.

2.3.17 Other Motorized Equipment

All other equipment (backhoe with vibratory plate, backhoe with immersion vibrators, backhoe with mandrel for inserting contraction joint plates, wash trucks, etc.) necessary for the successful completion of RCC production, but not previously discussed within these specifications (or determined to be necessary during the course of the work), must be approved prior to actual use. Such equipment must not result in any damage to the RCC, must be maintained in good operating condition, and must be operated by skilled contractor-provided personnel.

2.3.18 Nuclear Density Gauge

Make tests to determine the density of both the uncompacted and compacted RCC using a two-probe nuclear density gauge supplied by the Contractor. Use nuclear density gauge meeting the applicable requirements of

ASTM C1040/C1040Mand capable of taking readings along a horizontal path between the probes at 50-mm 2-inch increments from 50 mm 2 inches from the surface to 600 mm 24 inches below the surface. Make gauge and operator available to the Government until completion of all RCC production at no additional cost. Obtain all permits and certifications for the equipment and the operators.

2.3.19 Calibration

Provide factory calibrated nuclear gauges within 6 months of RCC placement. Construct, at no additional costs to the Government, three conventional concrete test blocks using RCC coarse aggregates and RCC fine aggregate, and with dimensions 300 mm 12 inches larger than the gauge dimensions. Formulate concrete to have densities of approximately 2100, 2300, and 2600 kg/cu m 130, 145, and 160 lb/cu ft using the RCC materials and so far as possible, similar relative proportions. Weigh and measure completed blocks to determine unit weight. Adjust gauge calibration constants for performance on these blocks at least 7 days prior to the evaluation of test strips. Remedy any inconsistencies in gauge performance prior to the start of RCC placement. After the start of RCC placement, field calibrate gauges against cast blocks every 24 hours.

2.3.20 Vibrators

Use internal vibrators of the proper size, frequency, and amplitude for the work being performed as indicated in the chart below to consolidate conventional concrete and the interface between conventional concrete and RCC. Provide vibrators for the conventional concrete/RCC interface consisting of a minimum of four vibrators "gang-mounted" in a line on the boom of a backhoe or similar chassis. Use gang-mounted vibrators that are the large (80 to 150 mm) (3 to 6 inch) models of that listed below:

APPLICATION	HEAD DIAMETER (mm) (inch)	FREQUENCY (VPM)	AMPLITUDE (mm) (inch)
RCC interface	80 to 1503 to 6	7,000 to 10,500	0.75 to 1.50 0.03 to 0.06
General construction	50 to 902 to 3-1/2	8,000 to 12,000	0.65 to 1.25 0.025 to 0.05
Thin walls	32 to 651-1/4 to 2-1/2	9,000 to 13,500	0.50 to 1.00 0.02 to 0.04

Determine the frequency and amplitude in the presence of a Government representative in accordance with COE CRD-C 521.

[2.3.21 Slipforming Equipment

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NOTE: Consult the materials engineer or the concrete materials DM for whether slipforming is to be allowed or required.

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Use slipforming equipment capable of slipforming facing elements as specified at a minimum rate of 7.5 mm/s 1.5 ft/min. Provide slip-former with an automated guidance system which guides the slip-former within the specified tolerances. Provide slipformer with the capability of turning and guiding the form without damage to the RCC and facing element. Provide slipform mold that is at least 1 m 3 feet long to allow the slipform to track easily and to minimize surface tearing caused by friction between the mold and the concrete. Design mold to be mortar-tight and to contain the concrete so that it can be fully consolidated.

]PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

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NOTE: Refer to the appropriate DM and the project coordinator for filling in the correct dates and to choose the optional sentences.

****

3.1.1 Placing Schedule

Start RCC Placement for the main structure no later than [_____] and no earlier than [_____]. Complete placement of all RCC by [_____]. Before starting RCC production, submit a detailed schedule indicating intended daily and weekly production rates that, when followed, will meet the beginning and ending specified RCC production dates. After initiation of RCC production, update and adjust the Contractor's schedule on a weekly basis for the duration of the RCC placement. If it becomes apparent for any reason that the Contractor is not pursuing a schedule that will meet the specified RCC production dates, take actions necessary to increase the production rate so that production is once again on schedule, within [_____] calendar days after written notice. Also, if not back on schedule by the end of the [_____] days calendar period, the Government reserves the right at this time to direct the Contractor, at no additional cost to the Government, to increase the amount and size of crews and equipment.

3.1.2 RCC Orientation Session

Prior to or in conjunction with the construction of the RCC test section, supervisors and all other Contractor personnel which are expected to participate in the production of RCC for this job (including laborers, equipment operators, foremen, and QC and inspection staff) must participate in a 2-hour orientation session organized by the Contracting Officer. Provide a facility suitable for slide and videotape presentation. The intent is to orient all individuals on the goals of the RCC placement process, provide clarification of specification requirements if requested, and be provided orientation as to what constitutes good construction practices. Additional orientation sessions will also be made available to, and must be attended by, all new Contractor personnel who are subsequently hired and that will be involved with the production of the RCC.

3.1.3 Aggregate Production Schedule

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NOTE: See the appropriate DM or the materials engineer to fill in the blanks.

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Begin aggregate production and initial stockpiling and produce acceptable material by no later than [_____] days in advance of the time when placement of the RCC test section is expected to begin. Manufacture and stockpile at least [_____] percent of all RCC aggregates for each size group necessary for the completed RCC construction prior to start of placement of RCC for the permanent RCC structures. Submit descriptions and details for all methods and operations proposed for aggregate and concrete operations including daily and weekly production rates, [not later than [_____] days after Notice to Proceed] for review and approval for conformance with specifications.

3.1.4 RCC Test Section

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NOTE: See the materials engineer for information for filling in the blanks.

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Prior to placement of any RCC, construct a test section. The purpose of the test section is to demonstrate the suitability of the Contractor's equipment, methods, and personnel. The test section must be at least [5] [_____] lifts in height and be at least [60] [_____] m [200] [_____] feet long and [12] [_____] m [40] [_____] feet wide at the top. The site of the test section must be approved. After evaluation and assessment of the test section by the Contracting Officer, dispose of the test section in an approved manner. Under no circumstances must the test section be incorporated into or become a part of the permanent RCC structure. Demonstrate sustained plant production rates, and batching, mixing, transporting, spreading, and compaction procedures. Also demonstrate the vertical face construction method along one side, the sloped face construction method along another side, procedures for foundation and concrete surface preparation and cleanup, procedures for placement of bedding concrete, bedding mortar, and other conventional concrete, and the installation of any contraction joints and waterstops. Do not begin RCC operations for the main structure until testing and evaluations by the Government have been completed, and it has been demonstrated to the satisfaction of the Contracting Officer that all specification requirements were met. Following completion of test section construction, allow [10] [_____] calendar days for testing and evaluations. If the Contractor does not meet requirements as specified, construct an additional test section or sections at no additional cost to the Government. Provide date of the test section construction at least 7 days in advance.

3.1.5 Surface Preparation

3.1.5.1 Cleaning

Clean all lift surfaces including any RCC, dental concrete, bedding concrete, bedding mortar, or other conventional concrete placed adjacent to and at the same time as the RCC prior to placing any additional concrete thereon. After cleaning, bedding concrete and bedding mortar are to be used specifically for achieving bond between different types of concrete and/or foundation and eliminating and preventing segregation or voids along margins or RCC placements. Do not cover surfaces to receive bedding concrete or bedding mortar with RCC until the prepared surfaces have been accepted in writing and that acceptance has been recorded on an approved checkout form. All surfaces upon which RCC or any bedding mortar or bedding mix is placed must be moist (but contain no visible free water). Prior to placing any concrete adjacent to and at the same time as the RCC, ensure all surfaces are clean and free of loose, unkeyed, or deteriorated rock; all mud and silt accumulations; vegetation; laitance; puddles or ponds of free surface water; coatings; and any other detrimental materials. Use high-pressure water jetting, and/or wet sandblasting, followed by mild high-volume, low-pressure washing, on all hardened concrete surfaces (cold joints) as necessary for the removal of laitance, coatings, stains, or other difficult-to-remove contaminants. High-volume low-pressure water washing and/or water jetting may be used for removal of loose materials. Keep adequate equipment with operators on hand at the site to clean all surfaces in conformance with these specifications without disrupting in any way the RCC production as scheduled.

3.1.5.2 High-Volume Low-Pressure Washing

Washing of loose materials can be accomplished with high-volume low-pressure water washing and/or air water jetting using equipment of similar design to that used in large-scale foundation cleanups. Provide air-water jets with 40-mm 1-1/2-inch nozzles, a water supply of at least 2 L/s 30 gpm, and compressed air at the jet of 550 to 850 kPa 80 to 120 psi. Provide low-pressure water jets with 25-mm 1-inch nozzles available and a capacity of at least 13 L/s 200 gpm for truck-mounted devices.

3.1.5.3 High-Pressure Water Jet

Use a stream of water under a pressure of no less than 10.3 MPa 1,500 psi for RCC and use 27.6 MPa 4,000 psi for conventional concrete to clean all cold joint surfaces, or surfaces with laitance, mortar coatings, stains, or other difficult-to-remove contaminants. Do not undercut coarse-size aggregates. Remove aggregate particles that are undercut. For cleaning large open areas larger than [_____] square meters feet, use a truck-mounted high-pressure water jet system. For cleaning small or confined areas, use a portable high-pressure water jet system.

3.1.5.4 Wet Sandblasting

This method may be used when the RCC has reached sufficient strength to prevent undercutting of coarse aggregate particles. Continue wet sandblasting until all accumulated laitance, coatings, stain, or other difficult-to-remove contaminants are removed. Wet sandblasting may be used in lieu of or in combination with the high-pressure water jet.

3.1.5.5 Waste Disposal

Any waste water employed in cutting, washing, and rinsing of concrete surfaces, and any other surface water must not stain, or affect exposed surfaces of the structure(s) or damage the environment of the project area. The method of disposal is subject to approval.

3.2 PLACING

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NOTE: Consult the concrete materials DM for the use of optional sentences and filling in the blanks.

****

3.2.1 Procedures

It is the intent of this contract to raise the structure at essentially the same level across the entire horizontal surface area. For a dam, proceed placement from abutment to abutment and from downstream to upstream. Complete each lift in its entirety across the full surface of the mass. As the advancing edge of the lift progresses, keep the exposed leading edges "live" by progressively placing out from the advancing edge in a sloping and uniform fan-like manner. Deposit RCC (from the conveyor, end-dump truck, or front-end loader) on the uncompacted RCC of the advancing edge in a forward direction from the dump pile. Do not place RCC in consecutive or consistent lanes. Vary dump location to avoid "lane" construction. [See Contract Drawing [_____] showing typical depositing, spreading, and remixing operations.] The interval between batch plant mixing and final RCC compaction must be no greater than 45 minutes for 300 mm 12 inch lifts and 75 minutes for 600 mm 24 inch lifts. Final compaction is defined as: Any RCC lift composed of layers that have been worked twice by dozer grousers, receives four passes with the vibratory roller, and meets the density requirements.

3.2.2 Bedding Mortar

Apply bedding mortar to the existing surface following any required cleanup. Apply bedding mortar no more than 15 minutes ahead of RCC placement, unless otherwise approved. Use bedding mortar between hardened conventional concrete and RCC, between different RCC placements where cold joints occur, and other locations as directed or as shown in the drawings. The bedding mortar must have an average thickness after application of between 6 and 13 mm 1/4 and 1/2 inch and cover 100 percent of the lift area.

3.2.3 Bedding Concrete

Use bedding concrete, a conventional concrete mixture, at the abutment-RCC interface, and except for cast-in-place concrete for the upstream face, between the RCC and any formed sloping or vertical surface and other locations as directed or as shown in the drawings. Place the bedding mixture only after all required surface preparations have been completed.

3.2.4 Lift Thickness

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NOTE: See the concrete materials DM for the lift thickness.

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The total lift thickness after final compaction by the vibratory roller must be [300] [_____] mm [12] [_____] inches.

3.2.5 Depositing, Spreading, and Remixing

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NOTE: See the appropriate Design Memorandum for use of the alternate optional paragraphs below.

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After the RCC has been deposited, spread the RCC by dozers into gently sloping layers, approximately 150 mm 6 inches thick, that will, after final compaction of the several layers by the vibratory roller, result in the specified lift thickness. During the spreading process, continuously work the RCC surfaces with the dozer blade and grousers in a manner to remix any RCC that may contain pockets of segregated material and to compact the material. Make at least two passes with the grousers to all surfaces of each layer. Operate dozers continuously during the spreading process, even if this action results in more than two passes. Provide a front-end loader with operator to assist with depositing and spreading RCC as needed in confined areas, at the abutments, and at other locations approved or directed. Do not allow the RCC, bedding mixes, or bedding mortar to dry.

Do not operate dozer or other tracked vehicle on other than fresh uncompacted RCC except at the start of each lift placement to facilitate startup operations, and then only by an approved procedure. Do not place RCC or other concrete on a previous lift which has not met specification. Remove unacceptable material.

3.2.6 Compaction/Consolidation

After spreading and working with the dozers, compact the top surface of each lift with a minimum of four, plus as many additional passes with a self-propelled double-drum vibratory roller operating in the vibratory mode as are required to obtain a minimum of 98 percent of the theoretical density. Count a round trip over the same material as two passes (i.e., from point A to point B and return to point A by the same route is two passes). Do not operate rollers in the vibratory mode unless they are moving. Consolidate bedding concrete and any other conventional concrete that interfaces with the RCC with internal vibrators.

3.2.6.1 Theoretical Density (TD) Determination

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NOTE: See the appropriate DM to fill in the blanks.

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The TD is defined as the theoretical density (unit weight) of the concrete, kg pounds per cubic meter foot, computed to include an air content of [_____] percent. The TD value to be used during construction will be determined using job mixture proportions and Contractor supplied materials; and, using compaction techniques suitable for RCC, and following the appropriate testing procedures used to determined theoretical unit weight of concrete as described as in ASTM C138/C138M.

3.2.6.2 Required Compaction Density

Compact all RCC to a minimum of 98 percent of the TD value. The anticipated TD, estimated from laboratory test data is approximately [_____] kg pounds per cubic meter foot.

3.2.6.3 Density Determination of Compacted RCC

Measure density using a nuclear density meter in accordance with ASTM C1040/C1040M. Make RCC density value determinations throughout the course of RCC placement to assure that the RCC is compacted to a minimum 98 percent of the TD and detect segregation and/or voids throughout the RCC.

3.2.6.4 Additional Compaction

If more than four passes are required to achieve the required density, make additional passes at no additional cost to the Government.

3.2.6.5 Consolidation of Bedding and Other Conventional Concrete

IDo not use vibrators to transport concrete. Insert vibrator vertically at uniform spacing over the entire area of conventional concrete placement area. Make insertions at a distance approximately one and one-half times the radius of action of the vibrator. The vibrator must penetrate rapidly to the bottom of the layer and at least 150 mm 6 inches into any preceding plastic layer if such exists. Hold vibrator stationary until the entrapped air is forced to the surface (up to 6 seconds) and the concrete is consolidated and then withdrawn slowly. Keep an adequate number of vibrators on hand to meet placing requirements and spare vibrators available to maintain production in the event of breakdown.

3.2.7 Lift Joints

pLACE entire RCC mass with sufficient continuity so that it hardens and acts as one monolithic block without discontinuous joints or potential planes of separation. Keep all lift joints clean, uncontaminated, free from ponded water, and continuously moist until placement of the succeeding RCC or other concrete.

3.2.7.1 Regular Lift-Joint Treatment

Give lift joints that have not hardened or dried and are less than 72 hours old the regular lift-joint treatment. Submit the method and equipment proposed for joint cleanup and waste disposal for review by the Contracting Officer [[_____] days before concrete placement begins] [not later than [_____] days after Notice to Proceed] for conformance with specifications. Regular lift-joint treatment and maintenance must include:

a. Maintaining 100 percent of each compacted lift-joint surface continuously moist,

b. If necessary, removing all loose contaminants or deteriorated RCC by low-pressure washing and/or vacuuming, and

c. Application of a 6 to 13 mm 1/4 to 1/2 inch thick bedding mortar over the entire placement surface area immediately before placement of the next lift.

For regular lift-joint treatment, no washing or vacuuming will be necessary provided damage or contamination of the lift surface is prevented.

3.2.7.2 Cold Joints

A cold joint is any vertical or horizontal RCC surface:

a. That does not receive the next RCC lift within 72 hours,

b. In which the RCC has been allowed to dry, or

c. That has been contaminated to the extent that contaminants cannot be removed using low-pressure water.

Prepare cold joints for the next lift by the methods and procedures in paragraph SURFACE PREPARATION above, prior to resumption of RCC placement. Following this initial preparation, keep the cold-joint surface continuously moist until application of the bedding mortar. Whenever a cold joint at any edge or end of any lift occurs, locate it at least 10 m 30 feet from the location of other cold joints that may have previously occurred in the same direction along previous lifts.

3.2.7.3 Vertical Joints

Joints for sloping, near-vertical or vertical RCC surfaces are considered to be vertical joints. A vertical joint most often will occur when an RCC placement is terminated before the entire RCC placement for that lift has been completed. When it does become apparent that placement of RCC will be terminated prior to completion of a lift, adjust the RCC spreading procedure at the leading zone of the placement to provide a gradual tapered slope to complete that lift. The taper must be no steeper than 25 horizontal on 1 vertical. Where the tapered slope meets the underlying hardened lift surface, take care to prevent or remove any segregated or uncompacted material. Compact tapered surface in accordance with paragraph COMPACTION/CONSOLIDATION above. Prior to resumption of RCC placements, prepare tapered surface in accordance with paragraph SURFACE PREPARATION above.

3.2.8 Downstream Face

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NOTE: See the concrete materials DM to select one of the two optional systems for the downstream face.

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[3.2.8.1 Using Sacrificial Concrete

Construct downstream sloped face of the dam and the exposed slopes of the stilling basin training walls using sacrificial RCC on [[_____] vertical to [_____] horizontal slope] [1 vertical to 0.85 horizontal slope]. Construct slope to the tolerances specified. Overbuild each RCC lift at least 300 mm 12 inches, and subsequently trim to the surface smoothness tolerance. Trim before the RCC is more than 48 hours old. Demonstrate process during the test section. Trim in such a manner to prevent damage to the surface and interior RCC.

][3.2.8.2 Using Conventional Concrete

Construct downstream face of conventional concrete in accordance with paragraph VERTICAL FACINGS FOR RCC CONSTRUCTION below.

]3.3 CURING AND PROTECTION

Submit the curing media and methods to be used for review to the Contracting Officer [[_____] days before concrete placement begins] for conformance with specifications.

3.3.1 Curing

Keep surface of every RCC lift continuously moist, commencing immediately after compaction, by use of water trucks equipped with fog sprayers for 14 days or until the surface is covered with the next lift. The sloping downstream surface of the Dam, [and the [_____]] if constructed of uncompacted sacrificial RCC, need not be cured. Curing and protection for all conventional concrete used in the construction of the vertical faces and any horizontal RCC surfaces that will not receive a subsequent concrete covering must be moist cured. Moist cure conventional concrete made with Type II portland cement, or any type of portland cement with pozzolan, and all RCC for 14 days. Moist cure conventional concrete made with Type I portland cement for 7 days. Moist cure conventional concrete by covering with saturated nonstaining burlap or cotton mats. Rinse new burlap or cotton mats to remove soluble substances before using. Maintain concrete that is moist cured continuously, not periodically, wet for the duration of the entire curing period. Use water for curing in compliance with the requirements of paragraph WATER in PART 2. If the water or mats cause staining or discoloration of permanently exposed concrete surfaces, clean the surfaces by a method approved by the Contracting Officer. When wood or metal forms are left in place during curing, keep the forms continuously wet, except for sealed insulation curing in cold weather. RCC may be cured with saturated cotton or burlap mats in lieu of the approved fog spraying equipment.

3.3.2 Cold-Weather Protection

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NOTE: See the concrete materials DM or thermal study for the optional numbers.

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Maintain air and forms in contact with the RCC and any conventional concrete at a temperature above 0 degrees C 32 degrees F for [14] [_____] days. In addition, at the time insulation or protection is removed, control the air temperature adjacent to the RCC surfaces so that the concrete near the surface will not be subjected to a temperature differential of more than 15 degrees C 25 degrees F (as determined by observation of ambient air and concrete temperatures). Submit a description of the materials and methods proposed for protection of the concrete, when concrete is to be placed under cold-weather conditions, to the Contracting Officer for review [_____] days in advance of anticipated need date.

3.3.3 Special Cold-Weather Insulation Protection

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NOTE: See the appropriate DM for use of this paragraph and to fill in the blanks.

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In addition to the requirements specified above, all RCC and any conventional concrete placed at the same time and in direct contact with the RCC must receive special insulation protection as described for the following time periods:

a. [_____].

b. [_____].

Provide insulation with an R value no less than [_____] square meter degree Celsius per watt hour square foot degree Fahrenheit per BTU.

3.3.4 Hot-Weather Protection

When ambient air temperatures exceeds 30 degrees C 90 degrees F and as soon as the conventional concrete and RCC is sufficiently hard to withstand washing of surface mortar, apply water by fog spraying in a controlled manner to provide evaporative cooling. Apply water at such a rate that it quickly evaporates and such that the surface remains continuously moist without ponding. In addition, when surface materials begin to dry and while the RCC placement, spreading, and compaction process is still underway and until the concrete has sufficiently hardened to permit the above water spray, apply hand-held fog spraying to the concrete surfaces as directed to prevent drying out of concrete materials and replace moisture lost to evaporation. These hot-weather protection procedures will require additional labor(s) to assure complete coverage of the entire surface areas to prevent unacceptable damage to the RCC and conventional concrete. Submit a description of the materials and methods proposed for protection of the concrete, when concrete is to be placed under hot-weather conditions, to the Contracting Officer for review [_____] days in advance of anticipated need date.

3.4 VERTICAL FACINGS FOR RCC CONSTRUCTION

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NOTE: See the concrete materials DM to select the appropriate method or methods specified below. It should be noted that the method used for other vertical conventional concrete work may be different from the method used for construction of the upstream face. See paragraphs GALLERY and SPILLWAY CONSTRUCTION, below.

****

The vertical faces of the RCC structure are to be constructed using [a form and cast-in-place conventional concrete system] [a slipform facing system] [a precast concrete panel system] as shown and specified. Submit details of the construction methods and equipment for review within [_____] days after Notice to Proceed. Demonstrate vertical facings system on one side of the RCC test section.

[3.4.1 Form and Cast-in-Place Conventional Concrete

Provide vertical and near-vertical facings as shown in the drawings. The contract drawings are based on designs whereby all vertical and near-vertical faces are constructed of conventional slump concrete at the same time and rate as used in placement of each RCC lift. In construction of vertical facings, place a 0.75 to 1.25 meter 2.5 to 4.0 foot wide zone of conventional concrete against the forms or other hard surface. The design and engineering of the formwork, as well as its construction, is the responsibility of the Contractor. Design formwork for loads, lateral pressure, and allowable stresses in accordance with Chapter 1 of ACI 347R. Use forms of sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and sufficient rigidity to maintain specified tolerances. The required sequence of construction operations after all forms and concrete surface preparations have been approved is: place conventional concrete full height of each RCC lift and full width against the forms; using dozer action, spread each thin RCC layer into and abutting against the conventional concrete while at the same time tracking the interface between the two with dozer grousers; after full-lift thickness of the RCC is in place next to the conventional concrete, consolidate 100 percent of the conventional concrete and the interface; and finally, compact the RCC (to include the interface) using the vibratory roller. Consolidate and "knit" together the interface between the RCC and conventional concrete using the gang heavy-duty, machine-mounted, immersion vibrators. Take extreme care to stage activities to assure all time restrictions are met and to prevent the occurrence of any openwork, honeycombing, or voids at the conventional concrete/RCC interface. Thoroughly consolidate and intermix all conventional concrete and bedding concrete placed along the RCC and the interface using immersion vibrators. Demonstrate satisfactorily the Contractor's construction techniques and equipment used during construction of the test section.

][3.4.2 Slipformed Facing Elements

Construct a slipformed conventional concrete face on the upstream face of the dam [and [_____]]. Provide concrete for the slipformed facing elements conforming to requirements of this section. The configuration for the facing elements are as shown. The concrete mixture for the facing elements must be proportioned by the Contractor to be formed by a slipform curbing machine and to have sufficient early strength to allow compaction for RCC against its surface within 4 hours.

3.4.2.1 Prequalification of Equipment

Prior to placing any slipformed facing elements for incorporation into the dam, perform a demonstration of the slipform equipment and concrete mixture as a part of the test section. Form one side of the test section using his proposed slipforming equipment, in accordance with paragraph RCC TEST SECTION above. If necessary, adjust the concrete mixture and make any adjustments or modifications to the slipforming equipment and concrete supply procedures and equipment as may be required to produce a satisfactory slipformed facing element. Construct a starting block to enable the first facing element to be formed without modification to the slipform.

3.4.2.2 Slipform Operations

Operate equipment in such a manner as to prevent damage to the RCC surface and facing element. The slipformer must carry a surge hopper of sufficient capacity to enable the slipformer to continue to extrude facing element between concrete deliveries. If the slipformer is stopped, consolidate concrete thoroughly, make a joint, and remove unacceptable concrete from the mold. Use slipformer with an automated guidance system which guides the slipformer within the specified tolerances. Achieve a smooth, mortar-tight joint between successive elements. Keep molds and vibrators available in sufficient quantities to replace worn or damaged ones. Use vibrators that are capable of being adjusted and relocated to achieve complete consolidation.

3.4.2.3 Slipforming - Preparation for Placing

Do not begin placement until after all preparations are complete and the authorized representative of the Contracting Officer has approved in writing completion of all preparations for that placement. Do not place facing element concrete until the surfaces to receive facing element concrete are free of deleterious substances including but not limited to: uncompacted, loose, deteriorated, or improperly cured RCC or facing element concrete, laitance, dirt, ice, curing compounds, and visible free surface water.

3.4.2.4 Slipforming - Placing

All joint surfaces more than 24 hours old, or in any other way damaged or not meeting the specification requirements, must be wet sandblasted, washed with air-water jets, and surface dried prior to placement of adjoining facing elements. Keep molds for the slipform continually full, and concrete vibrated, to prevent voids. Ensure slipformed facing element is uniform, dense, and free of surface blemishes and tears.

3.4.2.5 Slipforming - Finishing

The class of finish and the requirements for finishing of slipformed facing elements must be as specified in this paragraph, paragraph CONSTRUCTION TOLERANCES, and as indicated. The finished surface must be smooth and free from rock pockets and surface voids. Light surface pitting (voids up to 6 mm 1/4 inch diameter) and light slipforming marks are not considered objectionable. Where the surface produced meets specified requirements, no further finishing operations will be required.

][3.4.3 Precast Reinforced Panels

Design the precast panel systems as specified in [Section 03 41 33 PRECAST STRUCTURAL PRETENSIONED CONCRETE] [03 45 00 PRECAST ARCHITECTURAL CONCRETE] [03 45 33 PRECAST [PRESTRESSED] STRUCTURAL CONCRETE] [_____]. Provide typical panel systems consisting of interlocked panels measuring 1 m 4 ft by as much as 5 m 16 ft, 4 inches thick (min.), and anchored at four locations. Provide anchor bars, straps, and connections that are oversized or treated to compensate for deterioration due to exposure to moisture. Brace panels adequately with either external strongbacks or by staggering panel placement and connection to adjacent panels. By design, assure the safety and immobility of the panel system. Include upstream face [, downstream face] [, spillway crest] [, spillway training wall] [, and stilling basin training wall panels]. Match panel joints with pier noses, spillway cap, intake structure, and transverse joints.

3.4.3.1 Leveling Pad

No concrete leveling pad for setting panels is required unless the panel design so requires, however, embed the base of the panels at least 300 mm 1 foot into concrete, RCC, or backfill material. Brace, align, and level initial row of panelsadequately.

3.4.3.2 Alignment

Install panels so that horizontal joint lines of the upstream and downstream faces and the spillway crest panel joints align and meet the tolerances in paragraph CONSTRUCTION TOLERANCES.

]3.5 CONTRACTION JOINTS

****

NOTE: See the appropriate DM to fill in the blanks.

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Form contraction joints by inserting plates into non-compacted full lift thickness RCC at locations as shown on the drawings. The plates, when installed adjacent to each other (at the same structure stationing within each lift) must form a bond breaker that serves as a contraction joint. Provide plates that are [900] [_____] mm [36] [_____] inches wide, [300] [_____] mm [12] [_____] inches deep, up to 6 mm 1/4 inch thick, and made out of [_____]. Install plates vertically into the RCC by means of a vibrating plate mounted on a backhoe. Submit the exact details for the design of the contraction joints, as well as installation and methods of maintaining tolerances, alignment, etc., within [_____] days after the Notice to Proceed. Control plate alignment by laser or other approved survey technique. Provide waterstops, drains, and contraction joints within any conventional concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE and as indicated.

[3.6 GALLERY

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NOTE: See the concrete materials DM for use of this optional paragraph and to select the optional

methods.
****

Submit details of the construction methods within [_____] days after the Notice to Proceed. Construct gallery using one of the following schemes or combination thereof, the details which are the Contractor's responsibility:

a. Precast gallery segments,

b. Removable rigid forms against which conventional concrete, or RCC is placed, and

c. A noncementing fill as a temporary filler in the gallery area and removing it to form the gallery after the RCC has gained sufficient strength to be self-supporting.

Regardless of which procedure is used, slope the gallery to drain and include a gutter along the downstream gallery wall as shown in the drawings. Do not allow the gallery floor surface to pond more than 25 mm 1 inch of water. The size and shape of the gallery must be as shown in the drawings.

[3.6.1 Precast Gallery Segments

If stay-in-place precast gallery units are used to form the gallery, construct them in accordance with [Section 03 41 33 PRECAST STRUCTURAL PRETENSIONED CONCRETE] [03 45 33 PRECAST [PRESTRESSED] STRUCTURAL CONCRETE] [_____]. Submit design for review and comment. Design the sections to carry the full load of the vibratory roller over the first lift of fresh RCC above the ceiling section with a safety factor of 4 and to carry the vibrating load of subsequent compaction without excessive deflection that could damage the previously placed RCC. For each lift, place a ribbon of bedding concrete, approximately 0.09 cubic meter per linear meter 1 cubic foot per linear foot of precast panel, between the RCC and panels. Vibrate RCC bedding concrete interface thoroughly with immersion vibrators to eliminate any voids or segregation within the RCC. A permanent reinforced precast slab may be used to construct the gallery ceiling section in combination with other gallery construction schemes chosen by the contractor.

][3.6.2 Temporary Forms

The design of any temporary gallery form system and its adequacy is the responsibility of the Contractor. Provide forms in compliance with the requirements of 03 30 00 CAST-IN-PLACE CONCRETE, except that they need not be mortar-tight, and they must meet the tolerances in paragraph CONSTRUCTION TOLERANCES. Design ceiling form such that it can safely carry the load of the vibratory roller with a safety factor of 4 and is stiff enough to prevent damage to the fresh RCC from elastic deflection and rebound while compaction is being accomplished. Do not remove forms until the RCC has gained sufficient strength to be self supporting (estimated to be 90 days) and not until at least 10 m 40 feet of RCC has been placed above the gallery ceiling.

][3.6.3 Noncementing Fill Method

The gallery section may be constructed by placing a noncementitious fill in the cross-sectional area where the gallery is to be located, compacting it at the same time that the adjacent RCC is compacted, and later removing the fill. Submit details of how this procedure will be followed, what the noncementitious will consist of, how the fill will be removed later, and how the gallery doors will be set for review and comment in accordance with paragraph SUBMITTALS. To form the outline of the gallery, place braced partitions (or forms) along the perimeter of the gallery section between the RCC and non-cementitious fill. Install separate partitions (or forms) for each lift, of such size and configuration, and position on the previous lift's partitions (or forms) to ultimately form the gallery section. Removed braced partitions during the excavation process. Alignment of partitions (or forms) must not result in offsets and irregularities that exceed construction tolerances specified in paragraph CONSTRUCTION TOLERANCES. The noncementitious fill material may be one or more of the standard RCC aggregates or any other approved fill material, without portland cement or pozzolan; however, nominal maximum-size aggregate must not exceed 19.0 mm (3/4 inch). Do not start excavation of the gallery fill until the RCC has gained sufficient strength to be self supporting (a minimum of 30 days) and until at least 10 m 35 feet of RCC has been placed above the gallery section. As soon as the strength and cover requirements have been met, begin removal of the gallery. Dispose excavated fill material in an approved manner.

]][3.7 SPILLWAY CONSTRUCTION

3.7.1 Spillway Chute and Ogee Section

Construct spillway floor as shown. The drawings are based on a design whereby the spillway is constructed at the same time and rate as used in placement of each RCC lift. Use the same technology and construction procedures as used in the construction of the vertical upstream face. The major difference being, instead of placing conventional concrete for the floor against vertical cantilevered forms, conventional concrete will be placed against sloping cantilevered forms to form the spillway chute. The design and engineering of the formwork, as well as its construction and methods of maintaining tolerances, etc., is the responsibility of the Contractor. Design formwork for loads, lateral pressures, and allowable stresses in accordance with Chapter 1 of ACI 347R. Provide forms of sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and sufficient rigidity to maintain specified tolerances. Take extreme care to prevent the occurrence of any permanent openwork, honeycombing, or voids at the conventional concrete/RCC interface, or next to the forms. Demonstrate construction techniques satisfactorily during placement of the test section. The unformed portion of the spillway will be finished by placing concrete slightly above grade and striking off to grade by accurate screeding. Finish surface as specified in paragraph FLOAT FINISH below.

3.7.2 Training Walls

Provide concrete for training walls as shown in the drawings and as specified in paragraph VERTICAL FACINGS FOR RCC CONSTRUCTION above.

3.7.3 Finishing

3.7.3.1 General

The ambient temperature of spaces adjacent to surfaces being finished must be no less than 10 degrees C 50 degrees F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 1 kg/sq m 0.2 lb/sq ft per hour, make provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material in advance of placement, and take such protective measures as quickly as finishing operations will allow. Float finish all unformed surfaces that are not to be covered by additional concrete or backfill, unless a trowel finish is specified, and finish true to the elevation shown. Bring surfaces to receive additional concrete or backfill to the elevation shown in the drawings and leave true and regular. Slope exterior surfaces for drainage unless otherwise shown or as directed. Make joints carefully with a jointing or edging tool. Protect finished surfaces from stains or abrasions.

3.7.3.2 Float Finish

Surfaces must be screeded and darbied or bullfloated to bring the surface to the required finish level with no coarse aggregate visible. Do not add water, cement, or mortar to the surface during the finishing operation. Float concrete, while still green but sufficiently hardened to bear a man's weight without deep imprint, to a true and even plane. Floating may be performed by use of suitable hand floats or power-driven equipment. Use magnesium or aluminum hand floats. Tolerance for a floated finish must be true plane within 8 mm in 3000 mm 5/16 inch in 10 feet as determined by a 3-m 10-foot straightedge placed anywhere on the slab in any direction.

]3.8 CONSTRUCTION TOLERANCES

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NOTE: Delete any of the following tables that are not applicable. Most projects will require several tables to cover all parts of the structure.

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The definitions of the terms used in the following tables are as defined in ACI 117. Make level and grade tolerance measurements of slabs as soon as possible after finishing. When forms or shoring are used, make measurements prior to removal. Tolerances are not cumulative. The most restrictive tolerance controls. Tolerances must not extend the structures beyond legal boundaries. Except as specified otherwise, plus tolerance increases the amount or dimension to which it applies or raises a level alignment, and minus tolerance decreases the amount or dimension to which it applied or lowers a level alignment. A tolerance without sign means plus or minus. Where only one signed tolerance is specified, there is no limit in the other direction.

3.8.1 Conventional Concrete Surfaces

TOLERANCES FOR CAST-IN-PLACE, VERTICALLY SLIPFORMED BUILDING ELEMENTS	
Vertical alignment Translation and rotation from a fixed point at the base of the structure:	
For heights 30 m or less	50 mm2 inches
For heights greater than 30 m, 1/600 times the height but not more than	200 mm8 inches

Lateral alignment Between adjacent elements	50 mm2 inches
Cross-sectional dimensions Wall thickness	plus 19 mm 3/4 inch minus 10 mm 3/8 inch
Relative alignment Formed surface slope with respect to the plane indicated	18 mm in
TOLERANCES FOR CONCRETE STRUCTURES OTHER THAN BUILDINGS	
Vertical alignment	
Visible surfaces	30 mm1-1/4 inch
Concealed surfaces	65 mm2-1/2 inches
Side walls for radial gates and similar water-tight joints	5 mm3/16 inch
Lateral alignment	
Visible surfaces	30 mm1-1/4 inch
Concealed surfaces	65 mm2-1/2 inches
Level alignment	
Visible flatwork and formed surfaces	13 mm1/2 inch
Concealed flatwork and formed surfaces	25 mm1 inch
Sills for radial gates and similar water-tight joints	5 mm3/16 inch
Relative alignment: Formed surface slope with respect to the specified plane.	
Slopes in lateral and level alignments	
Visible surfaces	6 mm in 3000 mm1/4 inch in 10 feet
Concealed surfaces	12 mm in 3000 mm1/2 inch in 10 feet
Slopes in vertical alignment	
Visible surfaces	12 mm in 3000 mm1/2 inch in 10 feet
Concealed surfaces	25 mm in 3000 mm1 inch in 10 feet
TOLERANCE FOR FINISHED OR FORMED CONVENTIONAL CONCRETE SURFACES	
Vertical alignment Formed surfaces slope with respect to the specified plane	
Vertical alignment of exposed corner columns and control joint grooves in concrete exposed	9 mm in 3000 mm3/8 inch in 10 feet
All other conditions	12 mm in 3000 mm1/2
Abrupt variation in spillway surface: The offset between concrete surfaces under adjacent pieces of formwork	3 mm1/8 inch

Gradual variation: Surface finish tolerances as measured by placing a freestanding (unleveled), 1500-mm or 5-ft straightedge for plane surface or curved template for curved surface anywhere on the surface and allowing it to rest upon two high spots within 72 hr after concrete placement. The gap at any point between the straightedge or template and the	6 mm1/4 inch
Offsets of adjacent precast gallery segments must not exceed	25 mm1 inch

3.8.2 RCC Surfaces

a. Variations from the lines and grades of the gallery walls and ceiling from that shown in the drawings must not exceed plus or minus 75 mm 3 inches except keep tolerances at the gallery entrances within the limits necessary for the bulkheads and doorways to fit and function as designed.

b. Allowable variation from lines and grades of the downstream face of the dam (measured in any direction) must be minus zero (-0) (no under build allowed) and plus 100 mm 4 inches, [except that the elevation and shape of the spillway stilling basin training walls must be such that the training walls match with the downstream face as shown in the drawings or otherwise provided for]. See additional restrictions in paragraph DOWNSTREAM FACE in Part 3.

c. The thickness of compacted lifts of RCC must be within plus or minus 50 mm 2 inches of that specified.

d. The elevation of the surfaces of RCC lifts upon which subsequent RCC or conventional concrete is placed must not vary more than 150 mm 0.5 ft from the design elevation, except that the elevation of the top three lifts of the dam must be within 60 mm 0.2 ft of that shown.

e. The location of anchor bars, waterstops, contraction joints, and drain holes must be within 150 mm 0.5 ft of the designated locations shown.

f. The spacing of individual reinforcing steel bars in RCC must be within 50 mm 2 inches of that shown.

g. Tolerances for exposed surfaces of upstream face concrete [, the face of the spillway chute,] and any other conventional concrete that interfaces with the RCC must be in accordance with paragraph CONVENTIONAL CONCRETE SURFACES above.

3.9 TESTS AND INSPECTIONS

3.9.1 General

Perform the inspection and tests as described below, and based upon the results of these inspections and tests, take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, cease concrete placement. The laboratory performing the tests must be on-site and conform with ASTM C1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification will have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individual who performs the inspection will have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of [Concrete Transportation Construction Inspector (CTCI)] [Concrete Construction Inspector (CCI)], Level II. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C1077.

3.9.2 Testing and Inspection Requirements

3.9.2.1 Fine Aggregate

3.9.2.1.1 Grading

At least once during each shift when the concrete plant is operating, make one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M, ASTM C117, and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. Record results on a sheet on which are also shown the specification limits applicable to the project.

3.9.2.1.2 Fineness-Modulus Control Chart

Group results for fineness modulus in sets of three consecutive tests, and plot the average and range of each group on a control chart. Draw the upper and lower control limits for average 0.10 units above and below the target fineness modulus, and the upper control limit for range is 0.20.

3.9.2.1.3 Corrective Action for Fine Aggregate Grading

When the amount passing on any sieve is outside the specification limits, resample and retest the fine aggregate immediately. If there is another failure on any sieve, report the fact immediately to the Contracting Officer. Whenever a point on the fineness modulus control chart, either for average or range, is beyond one of the control limits, double the frequency of testing. If two consecutive points are beyond the control limits, consider the process out of control and stop concreting. Notify the Contracting Officer, and take immediate steps to rectify the situation. After two consecutive points have fallen within the control limits, testing at the normal frequency may be resumed.

3.9.2.1.4 Moisture Content Testing

When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, perform at least four tests for moisture content in accordance with ASTM C566 during each 8-hour period of mixing plant operation. Randomly select times for the tests within the 8-hour period. Make an additional test whenever the slump is out of control or excessive variation in workability is reported by the placing foreman. When an electric moisture meter is operating satisfactorily, make at least two direct measurements of moisture content per week to check the calibration of the meter. Use results of tests for moisture content to adjust the added water in the control of the batch plant.

3.9.2.1.5 Moisture Content Corrective Action

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more from the previous sample, adjust the scale settings for the fine aggregate batcher and water batcher (directly or by means of a moisture compensation device).

3.9.2.2 Coarse Aggregate

3.9.2.2.1 Grading

At least once during each shift in which the concrete plant is operating, perform a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. A test record of samples of aggregate taken at the same locations must show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When facilities are available to test samples five times as large as those required in ASTM C136/C136M, no averaging is permitted.

3.9.2.2.2 Corrective Action for Grading

When the amount passing any sieve is outside the specification limits, resample and retest the coarse aggregate immediately. If the second sample fails on any sieve, report that fact to the Contracting Officer. Where two consecutive averages of five tests (or two consecutive tests where large samples are used) are outside specification limits, consider the operation out of control, and report that fact to the Contracting Officer, stop concreting, and take immediate steps to correct the grading.

3.9.2.2.3 Coarse Aggregate Moisture Content

Make a test for moisture content of each size group of coarse aggregate at least once a shift. When two consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, increase frequency of testing to that specified previously for fine aggregate.

3.9.2.2.4 Coarse Aggregate Moisture Corrective Action

Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more from the previous sample, adjust the scale setting for the coarse aggregate batcher and the water batcher to compensate for this.

3.9.2.2.5 Material Finer than the 75 µm No. 200 Sieve

When in the opinion of the Contracting Officer, a problem exists in connection with the cleanliness of the coarse aggregate, make tests in accordance with ASTM C117. Testing frequency nust be as directed.

3.9.2.2.6 Corrective Action for material finer than the 75 µm No. 200 Sieve

When material finer than the No. 200 sieve exceeds 1.0 percent of the weight of the coarse aggregate finer than 37.5 mm 1-1/2 inch or 0.5 percent of the weight of the aggregate coarser than 37.5 mm 1-1/2 inch, notify the Contracting Officer, and initiate steps, such as washing or other corrective action, immediately.

3.9.2.3 Quality of Aggregates

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NOTES: Tests should be those listed in paragraph QUALITY in PART 2. Use the petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.

Only a limited number of laboratories are now running ASTM C123/C123M due to the toxic chemicals required. Recommend that ASTM C295/C295M/C295M be specified.

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3.9.2.3.1 Frequency of Quality Tests

Prior to submitting samples for mixture proportioning studies, perform the tests for aggregate quality in the following list. In addition, after the start of concrete placement, perform tests for aggregate quality during concrete or aggregate production, in accordance with the following frequency schedule. Samples tested after the start of concrete placement must be taken immediately prior to entering the concrete mixer.

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Absorption	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Flat and Elongate	Not applicable	Every 3 months	ASTM D4791
Durability Factor using Procedure A	Every 12 months	Every 12 months	COE CRD-C 114 ASTM C666/C666M
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C142/C142M
Material Finer than the 75 µm No. 200 Sieve	Not applicable	Every 3 months	ASTM C117
Organic Impurities	Every 3 months	Not applicable	ASTM C40 ASTM C87/C87M
L.A. Abrasion	Not applicable	Every 6 months	ASTM C131/C131M ASTM C535
Liquid Limit and Plasticity Limits of -75 m No. 200 Sieve Size	Every 3 months	Not applicable	[_____]

	FREQUENCY		
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Soft and Friable (Scratch Hardness)	Not applicable	Every 6 months	COE CRD-C 130
Petrographic Examination	Every 6 months	Every 6 months	[_____]
[Chert, less than 2.40 specific gravity]	Every 6 months	Every 6 months	ASTM C123/C123M
[Coal and Lignite, less than 2.00 specific gravity]	Every 6 months	Every 6 months	ASTM C123/C123M or ASTM C295/C295M

3.9.2.3.2 Corrective Action for Aggregate Quality

If the result of a quality test fails to meet the requirements for quality during submittal of samples for mixture-proportioning studies or immediately prior to start of concrete placement, change production procedures or materials and perform additional tests until the material meets the quality requirements prior to proceeding with either mixture-proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, rerun the test immediately. If the second test fails the quality requirement, report the fact to the Contracting Officer and immediate steps taken to rectify the situation.

3.9.2.4 Scales

3.9.2.4.1 Weighing Accuracy

Check the accuracy of the scales by test weights at least once a month for conformance with the applicable requirements of paragraphs BATCH PLANT and CONTINUOUS MIXING PLANT both in PART 2. Also make such tests as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

3.9.2.4.2 Batching and Recording Accuracy

Check the accuracy of each batching and recording device once a week during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. Confirm that the calibration devices described in paragraph BATCH PLANT in PART 2 for checking the accuracy of dispensed admixtures are operating properly. If a continuous mixing plant is provided, check the accuracy and operation of all feeding and dispensing units before the start of operation each day.

3.9.2.4.3 Scales Corrective Action

When the weighing accuracy or batching accuracy does not comply with specification requirements, do not operate the plantuntil necessary adjustments or repairs have been made. Correct discrepancies in recording accuracies immediately.

3.9.2.5 Concrete Plant Control

Continuously control the measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures. Adjust aggregate weights and amount of added water as necessary to compensate for free moisture in the aggregates. Prepare a report indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the as-mixed aggregate and water weights per cubic meter yard for each class of concrete placed during plant operation.

3.9.2.6 Concrete

3.9.2.6.1 Conventional Concrete Slump Testing

Make at least two slump tests in accordance with ASTM C143/C143M on each conventional concrete mixture, including bedding mortar produced during each 8-hour period or less of concrete production each day. Make additional tests when excessive variation in workability is reported by the placing foreman or Government inspector. Plot the result of each test for each mixture on a control chart on which the upper and lower limits are set as specified in paragraph MIXTURE PROPORTIONS AND STUDIES in PART 1. Plot the range on a control chart on which the upper control limit is 50 mm 2.0 inches. Take samples for slump at the mixer, however the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the placement, take samples at the placement site as often as required by the Contracting Officer.

3.9.2.6.2 Slump Corrective Action

Whenever points on the control chart approach the upper or lower control limits, make an adjustment in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount specified in the mixture proportions provided by the Contracting Officer based on the free water available with the aggregates and that amount of water batched. If the adjustments to the batch weights of water and aggregates do not satisfactorily produce the required slump, the Contracting Officer may adjust the mixture proportions if the fine-aggregate moisture content is found to be stable and within the required limits. When a single slump is outside the control limits, such adjustment is mandatory. As soon as practical after each adjustment, make another test to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range above the upper control limits, consider the slump to be out of control, halt concreting operation, and undertake additional testing for required aggregate moisture content, and take action immediately to correct the problem.

3.9.2.6.3 Air Content

Make at least one test for air content of conventional concrete on a randomly selected batch of each concrete mixture produced during each 8-hour period of concrete production. Make additional tests when excessive variation in workability is reported by the placing foreman or Government inspector. Make tests in accordance with ASTM C231/C231M. Plot the average of each test for each mixture on control charts on which the average percent and upper and lower limits are set in accordance with paragraph MIXTURE PROPORTIONS AND STUDIES. Plot the range between two consecutive tests for each mixture on a control chart on which the upper control limits is 3.0 percent.

3.9.2.6.4 Air Content Corrective Action

Whenever points on the control chart approach the upper or lower control limits, an adjustment should be made in the amount of air-entraining admixture batched. If a single test result is outside the specification limit, immediate adjustment is mandatory. As soon as practical after each adjustment, make another test to verify the correction of the adjustment. Whenever a point falls above the upper control for range, calibrate the dispenser to ensure that it is operating correctly and with good reproducibility. Whenever two consecutive points either for average or range are outside the control limits, notify the Contracting Officer.

3.9.2.7 Field Density

3.9.2.7.1 Testing and Checking

Determine density for [each 450 square meters 5,000 square feet of completed lift] [at least eight locations per RCC lift] with a calibrated nuclear density gauge in accordance with ASTM C1040/C1040M. Take densities at depths of 100 and 200 mm 4 and 8 inches. If the densities at 100 and 200 mm 4 and 8 inches conflict, acceptance must be at the 200 mm 8 inch depth.

3.9.2.7.2 Action Required

Whenever the nuclear gauge indicates density less than the specified density, make a retest. If the retest indicates unacceptable density, notify the Contracting Officer's Representative, provide additional rolling immediately, and make a determination as to whether the lower density resulted from insufficient passes of the roller or a change in the mix properties. If the mix properties have changed, make adjustments such as increasing or decreasing the moisture content at the batch plant. If the problem persists, the Contracting Officer may adjust the proportions of aggregates, cement, and/or pozzolan. If the lower density is the result of incomplete rolling, notify the operator and the Contracting Officer may require removal of the incompletely compacted material at no cost to the Government.

3.9.2.8 Inspection Before Placing

Inspect foundation or construction joints, forms, and embedded items in sufficient time prior to each concrete placement to certify to the Contracting Officer that they are ready to receive concrete. Report results of each inspection in writing. The inspection of the lift surfaces of the RCC will be a continuing activity and will be accomplished in accordance with paragraph REGULAR LIFT-JOINT TREATMENT above.

3.9.2.9 Placing Inspection

3.9.2.9.1 Inspection

Provide full time supervision of all placing operations to insure that the correct quality of RCC, conventional concrete, or grout is placed in each location and that all other aspects of the placing operation are performed in accordance with the contract. During placing operations, the quality control staff must measure and record concrete temperatures in accordance with ASTM C1064/C1064M, ambient temperature hourly, record weather conditions, time of placement, yardage placed, and method of placement.

3.9.2.9.2 Corrective Action

Do not permit placing to begin until verification of an adequate number of vibrators, spreaders, and compactors in working order and with competent operators are available. Do not continue placing if any conventional concrete is inadequately consolidated or if any lift of RCC is not fully compacted. Perform additional compaction, if necessary, in accordance with paragraph ADDITIONAL COMPACTION above. If any batch of conventional concrete fails to meet the temperature requirements, take immediate steps to improve temperature controls.

3.9.2.10 Vibrator Tests

3.9.2.10.1 Vibrator Testing and Use

Determine the frequency and amplitude of each vibrator in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Make additional tests as directed when a vibrator does not appear to be adequately consolidating the concrete. Determine the frequency while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. Determine the amplitude with the head vibrating in air. Take two measurements, one near the tip and another near the upper end of the vibrator head, and average these results. Report the make, model, type, and size of the vibrator and frequency and amplitude results in writing. In addition, check the self-propelled vibratory rollers, as specified in PART 2, paragraph PRIMARY ROLLERS, for frequency and amplitude prior to use and once every 3 months when RCC is being placed.

3.9.2.10.2 Vibrator Corrective Action

Remove any vibrator not meeting the requirements of paragraph VIBRATORS immediately from service and repair or replace.

3.9.2.11 Curing Inspection

3.9.2.11.1 Moist Curing Inspections

At least twice each shift, and twice per day on nonwork days inspect all areas subject to moist curing. Note and record the surface moisture condition.

3.9.2.11.2 Moist Curing Corrective Action

When a daily inspection report lists an area of inadequate curing, take immediate corrective action, and extend the required curing period for those areas by one day.

3.9.2.12 Cold-Weather and Hot-Weather Protection

At least once each shift and once per day on nonwork days inspect all areas subject to cold-weather or hot-weather protection. Note, correct, and report any deficiencies.

3.9.2.13 Cold-Weather and Hot-Weather Protection Corrective Action

When a daily inspection report lists deficiencies, correct the deficiency immediately and extend the period of protection for one day.

3.9.3 Reports

Report all results of tests or inspections conducted informally as they are completed and in writing daily. Prepare a weekly report for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, make reports of pertinent temperatures daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 37 29 (November 2009)**
Change 1 - 11/23

Preparing Activity: USACE **Superseding**
UFGS-03 37 29 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-03 37 29 (November 2009)**

Change 1 - 11/23

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SECTION 03 37 29

CONCRETE FOR CONCRETE CUTOFF WALLS
11/09, CHG 1: 11/23

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NOTE: This guide specification covers the requirements for concrete cutoff wall structures. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

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NOTE: The content of this specification is such that guidance given in EM 1110-2-2000, "Standard Practice for Concrete", is applicable.

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1.1 UNIT PRICES

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NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below

should be inserted into Section 01 20 00.

With the exception of coring concrete in completed panels, all costs in connection with this section, including all materials, will be included in the payment item(s) specified.

Core recovery percentage for each boring should be a high number such as 90 to 95, since it is expected that a competent concrete material is being cored. The deviation of the core hole should be in relation to the smallest dimension of the panels that will be produced for each jobsite.

****

1.1.1 Coring Concrete in Completed Panels

1.1.1.1 Payment

Payment will be made for costs associated with Coring Concrete in Completed Panels and backfilling the core holes. This price will constitute full compensation for mobilizing and demobilizing and furnishing all equipment and supplies necessary to perform all operations specified. No payment will be made for coring and backfilling at a location where the coring reveals the presence of "unacceptable concrete", as specified in paragraphs QUALITY ASSURANCE and CONCRETE PLACEMENT. All costs incurred, including the initial core boring and as many additional core borings as may be required to delineate the limits of the unacceptable concrete and the repair of the cutoff wall, are borne by the Contractor and will not result in any additional cost to the Government.

1.1.1.2 Measurement

Coring Concrete in Completed Panels will be measured for payment from the top of the panel to the bottom of the core hole. If overall core recovery for a boring is less than [_____] percent or the boring deviates from the cutoff wall prior to reaching a depth of [_____] meters feet, redrill and backfill the boring at no additional cost to the Government.

1.1.2 Unit of Measure

Unit of measure: per linear meter foot of cored hole.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40/C40M	(2020) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C70	(2020) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C87/C87M	(2023) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2023) Standard Test Method for Lightweight Particles in Aggregate
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse

	Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C441/C441M	(2017) Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2016; R 2024) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag

	Cement for Use in Concrete and Mortars
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates

NATIONAL DRILLING ASSOCIATION (NDA)

DCDMA TM	(1991; Reviewed 2012) DCDMA Technical Manual

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000; R 2006) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 112	(1969) Method of Test for Surface Moisture in Aggregate by Water Displacement
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for

Automatic Indication of Moisture in Fine Aggregate

COE CRD-C 400 (1963) Requirements for Water for Use in Mixing or Curing Concrete

1.3 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete Mixture Proportions; G, [_____]

Batch Plant

Concrete Mixers

Capacity

Conveying Equipment

Plant and Equipment

Tests and Inspections

Vertical Construction Joints; G, [_____]

Curing and Protection; G, [_____]

SD-04 Samples

Cementitious Materials; G, [_____]

Admixtures; G, [_____]

SD-06 Test Reports

Aggregates

Quality of Aggregates; G, [_____]
Mixer Uniformity

Tests and Inspections

Unacceptable Concrete

SD-07 Certificates

Cementitious Materials; G, [_____]

Air-Entraining Admixture

Accelerators

Other Chemical Admixtures

1.4 QUALITY ASSURANCE

"Unacceptable Concrete" is concrete that is honeycombed, segregated, uncemented, or contains voids greater than the diameter of the core boring. When such concrete is encountered in any panel, replace or repair the unacceptable concrete in accordance with paragraph CONCRETE PLACEMENT. Submit a copy of the records and Contractor tests, as well as the records of the corrective action taken where testing has determined that concrete in completed panels is unacceptable, as directed by the Contracting Officer.

1.4.1 Government Testing and Sampling

Provide facilities and labor as may be necessary for procurement of representative test samples. The Government will sample and test aggregates and concrete to determine compliance with the specifications. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D75/D75M. Concrete will be sampled in accordance with ASTM C172/C172M.

1.4.2 Preconstruction Sampling and Testing

1.4.2.1 Aggregates

****

NOTE: The Designer should consult the appropriate DM, identify the sources for aggregates, and attach them to the end of this section. A Format Template for Aggregate Sources is located in the Template Menu of UFGS. Contact the Division Laboratory for information to fill in the blanks below.

****

The aggregate sources listed at the end of this section have been tested and at the time testing was performed were capable of producing materials of a quality required for this project provided suitable processing is performed. The Contractor may furnish materials from a listed source or from a source not listed. Deliver samples from any source of coarse aggregate and any source of fine aggregate selected by the Contractor, consisting of not less than [_____] [70 kg 150 pounds] of each size coarse aggregate and [_____] [35 kg 75 pounds] of fine aggregate taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100 to [_____] within 15 days after notice to proceed. Sampling and shipment of samples are at the Contractor's expense. [_____] days will be required to complete evaluation of the aggregates. Testing will be performed by and at the expense of the Government in accordance with the applicable COE CRD-C or ASTM test methods. The cost of testing one source for each size of aggregate will be borne by the Government. If the Contractor selects more than one source for each aggregate size or selects a substitute source for any size aggregate after the original source was tested, the cost of that additional testing will be borne by the Contractor. Tests to which aggregate may be subjected are listed in paragraph QUALITY in PART 2. Provide material from the proposed source meeting the quality requirements of this paragraph. The Government's test data and other information on aggregate quality of those sources listed at the end of this section are included in the DM and are available for review in the district office. Testing of aggregates by the Government does not relieve the Contractor of the requirements outlined in paragraph TESTS AND INSPECTIONS in PART 3.

1.4.2.2 Cementitious Materials and Admixtures

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NOTE: EM 1110-2-2000, "Standard Practice for Concrete", provides guidance in selecting the options for Government or for Contractor testing.

****

At least 60 days in advance of concrete placement, notify the Contracting Officer of the source of materials, along with sampling location, brand name, type, and quantity to be used in the manufacture and/or curing of the concrete.

1.4.3 Construction Testing by the Government

[Sampling and testing will be performed by and at the expense of the Government except as otherwise specified. Do not use material until notice has been given by the Contracting Officer that test results are satisfactory.] [The Government will sample and test chemical admixtures, curing compounds, and cementitious materials].

1.4.3.1 Chemical Admixtures Requirements

Retest chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing at the expense of the Contractor when directed by the Contracting Officer and reject if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with paragraph CHEMICAL ADMIXTURES of PART 2.

1.4.3.2 Cement and Pozzolan

****

NOTES: Delete this paragraph if materials are to be accepted on the basis of a manufacture's certification of compliance and mill test reports, and the optional sentence in paragraph SUBMITTALS, SD-07 Certificates, will be used. See the appropriate DM or consult the Materials Engineer to select prequalified sources, subparagraphs "a" and "b" below, or sealed bins, subparagraphs "c" and "d" below, or both options, subparagraphs "a" and "b" and "c" and "d". Selection of the sealed bin method, subparagraphs "c" and "d", must be fully justified in the appropriate DM.

In subparagraph "c" below, to fill in the blank for cost of testing excess cement, contact the Structures Laboratory, Concrete Technology Division, WES.

****

If cement or pozzolan is to be obtained from more than one source, state the estimated amount to be obtained from each source and the proposed schedule of shipments in the initial notification.

[1.4.3.2.1 Prequalified Cement Sources

Deliver and use cement directly from a mill of a producer designated as a qualified source. Samples of cement for check testing will be taken at the project site or concrete-producing plant by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified cement sources is available from Director, U.S. Army Corps of Engineers, Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.

][1.4.3.2.2 Prequalified Pozzolan Sources

Deliver and use pozzolan directly from a producer designated as a qualified source. Samples of pozzolan for check testing will be taken at the project site by the Contracting Officer for testing at the expense of the Government. A list of prequalified pozzolan sources is available from the Director, U.S. Army Corps of Engineers, Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.

][1.4.3.2.3 Nonprequalified Cement Sources

Cement, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of testing. Sampling, testing, and the shipping inspection from the point of sampling, when the point is other than at the site of the work, will be made by or under the supervision of the Government and at its expense. Do not use cement until notice has been given by the Contracting Officer that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the request and expense of the Contractor. When the point of sampling is other than at the site of the work, the fill gates of the sampled bin and conveyances used in shipment will be sealed under Government supervision and kept sealed until shipment from the bin has been completed. If tested cement is rehandled at transfer points, the extra cost of inspection is at the Contractor's expense. The cost of testing cement excess to project requirements is also be at the expense of the Contractor. The charges for testing cement at the expense of the Contractor will be deducted from the payments due the Contractor at a rate of [_____] dollars per ton of cement represented by the tests.

][1.4.3.2.4 Nonprequalified Pozzolan Sources

Pozzolan, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of certain tests. Pozzolan will also be sampled at the site when determined necessary. All sampling and testing will be by and at the expense of the Government. Release for shipment and approval for use will be based on compliance with 7-day lime-pozzolan strength requirements and other physical and chemical and uniformity requirements for which tests can be completed by the time the 7-day lime-pozzolan strength test is completed. Release for shipment and approval for use on the above basis will be contingent on continuing compliance with the other requirements of the specifications. If a bin fails, the contents may be resampled and tested at the Contractor's expense. In this event, the pozzolan may be sampled as it is loaded into cars, trucks, or barges provided they are kept at the source until released for shipment. Unsealing and resealing of bins and sealing of shipping conveyances will be by or under the supervision of the Government. Shipping conveyances will not be accepted at the site of the work unless received with all seals intact. If pozzolan is damaged in shipment, handling, or storage, promptly remove it from the site of the work. Retest pozzolan that has not been used within 6 months after testing at the expense of the Contractor when directed by the Contracting Officer and reject if the test results are not satisfactory. If tested pozzolan is rehandled at transfer points, the extra cost of inspection is at the Contractor's expense. The cost of testing excess pozzolan is at the Contractor's expense at a rate of [_____] cents per ton. The amount will be deducted from payment to the Contractor.

]1.4.3.3 Concrete Tests

Provide facilities and labor as necessary for procurement of representative test samples. The Government will sample and test concrete to determine compliance with the specifications. Concrete will be sampled in accordance with ASTM C172/C172M. Slump and air content will be determined in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively. Compression test specimens will be made and laboratory cured in accordance with ASTM C31/C31M, and compression test specimens tested in accordance with ASTM C39/C39M, but results will be used only for determination of the uniformity of the mixture produced.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

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NOTE: Well-rounded natural aggregates are preferred due to the increased flowability of concrete containing these aggregates. If crushed aggregates are used, the fine aggregate and cementitious materials contents may have to be increased to achieve satisfactory flowability. If crushed aggregate is used, increase the specified minimum cement content to 335 kg per cubic meter 564 pounds per cubic yard.

****

Submit concrete mixture proportions as determined by the Contractor for review. State concrete mixture quantities of all ingredients per cubic meter yard and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete. Indicate the mass of cement, pozzolan, slag cement when used, and water; the mass of aggregates in a saturated surface-dry condition; and the quantities of admixtures. Include test reports from a laboratory complying with ASTM C1077 which show that proportions thus selected will produce concrete of the qualities indicated. Make no substitution in the source or type of materials used in the work without additional tests to show that the quality of the new materials and concrete are satisfactory. Perform concrete mixture proportioning conforming to the following:

2.1.1 Maximum Water-Cement Ratio

The maximum water-cement ratio by weight of equivalent portland cement must be 0.50, unless otherwise approved in writing.

2.1.2 Cement Content

The cement content of the concrete must be within the range from a minimum of [279 kg] [470 pounds] [_____] to a maximum of 446 kg/cubic meter 752 pounds/cubic yard. When a pozzolan is used, the total absolute volume of cementitious material must be within the same range in absolute volume as previously specified. Of the total absolute volume of cementitious materials, between 20 and 30 percent may be pozzolan that meets the requirements of paragraph POZZOLAN, OTHER THAN SILICA FUME in PART 2. [If slag cement is used, do not exceed 25 percent by absolute volume, and percentage must be as approved before mixture proportioning studies commence.]

2.1.3 Nominal Maximum-Size Coarse Aggregate

The nominal maximum-size coarse aggregate is [19.0 mm 3/4 inch] [25.0 mm 1 inch].

2.1.4 Fine Aggregate

Fine aggregate comprises approximately 40 to 50 percent, by volume, of the total aggregate.

2.1.5 Air Content

Air Content as determined by ASTM C231/C231M to be 6.0 ± 1.5 percent.

2.1.6 Slump

Determined by ASTM C143/C143M between 150 and 225 mm 6 and 9 inches.

2.1.7 Responsibility of Mixture Proportioning

Proportioning of concrete for use in construction of the cutoff wall is the responsibility of the Contractor and to be performed by a laboratory complying with ASTM C1077.

2.1.8 Concrete Proportioning

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NOTE: There is no requirement for fc'. The results of trial mixture should be basis for QC.

****

Trial batches and testing requirements for concrete are the responsibility of the Contractor. Obtain samples of approved aggregates in accordance with the requirements of ASTM D75/D75M. Use samples of materials other than aggregate that are representative of those proposed for the project and provide manufacturer's test reports indicating compliance with applicable specified requirements. Make trial mixtures having proportions, slumps, and air content suitable for the work based on ACI 211.1. The maximum water-cement ratio required in the paragraph MAXIMUM WATER-CEMENT RATIO above will be converted to a weight ratio of water to cement plus pozzolan or slag cement by mass equivalency as described in ACI 211.1. In the case where GGBFS is used, include the mass of the slag in the equation for the term P, which is used to denote the mass of pozzolan. Proportion trial mixtures for specified slump and air content. Report the temperature of concrete in each trial batch. If a chemical admixture is used, report slump loss versus time in each trial batch. For each trial mixture, make at least three test cylinders for each test age and cure in accordance with ASTM C192/C192M. Test cylinders at 7 and 28 days in accordance with ASTM C39/C39M, or if a pozzolan or slag cement is used, test cylinders at 7, 28, and 90 days. Submit results of these compressive strength tests but use only for quality control purposes. Submit all results of mixture proportioning studies at least 10 days prior to commencing concrete placement.

2.2 MATERIALS

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NOTE: Delete the requirements for Certificates for air entrainment admixtures, other chemical admixtures, curing compounds, portland cement, and pozzolan if the optional parts of paragraph CEMENTITIOUS MATERIALS below, is used.

****

Submit certificate of compliance with all specification requirements for the following: Air-Entraining Admixture, Accelerators, and other Chemical Admixtures.

2.2.1 Cementitious Materials

****

NOTE: See the appropriate DM to select the proper requirements for the Cementitious Materials Options. Other cementitious materials may be added if specifically recommended and approved in the concrete materials DM.

****

Cementitious Materials are portland cement or portland cement in combination with pozzolan or GGBFS [or [_____]] conforming to appropriate specifications listed below. Do not use cementitious materials until notice of acceptance has been given by the Contracting Officer. Cementitious materials will be subject to check testing from samples obtained at the source, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Promptly remove not meeting specifications from the site of work. Submit the manufacturer's certification of compliance, accompanied by mill test reports that materials meet the requirements of the specification under which they are furnished, for cementitious materials, including Cement and Pozzolan, [and GGBFS]. Certification and mill test reports must be from samples taken from the particular lot furnished.

2.2.1.1 Portland Cement

ASTM C150/C150M, Type I or II, except that the maximum amount of C3A in Type I cement must be 15 percent [including the heat of hydration at 7 days] [including false set requirements] [low alkali when used with aggregates listed at the end of this section which require it]. [In lieu of low-alkali cement, the Contractor may use a combination of portland cement that does not meet the low-alkali requirement with a pozzolan or GGBFS provided the following requirement is met. The expansion of the proposed combination when tested in accordance with ASTM C441/C441M must be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C150/C150M when tested in general conformance with ASTM C441/C441M. Run the expansion tests concurrently at an independent laboratory that is nationally recognized to perform such tests. The Government reserves the right to confirm the test results and to adjust the percentage of pozzolan or slag in the combination to suit other requirements.]

2.2.1.2 Pozzolan, Other than Silica Fume

Provide pozzolan conforming to ASTM C618, Class [C], [F], with the optional requirements for multiple factor, drying shrinkage, and uniformity [and [moderate] [severe] sulfate resistance requirements] of Table 2A. Apply Table 1A requirement for maximum alkalis when used with aggregates listed at the end of this section to require low-alkali cement.

2.2.1.3 Ground Granulated Blast-Furnace (GGBF) Slag

Provide ground granulated blast-furnace slag conforming to ASTM C989/C989M, Grade 100 or Grade 120.

2.2.1.4 Blended Hydraulic Cement

Portland-Limestone cement must conform to ASTM C595/C595M, Type IL.

2.2.2 Aggregates

****

NOTE: This note may be disregarded for regions where Alkali-Silica Reactivity (ASR) is not a concern. Some aggregate sources may exhibit an ASR potential. ASR is a potentially deleterious reaction between alkalis present in concrete and some siliceous aggregates, reference EM 1110-2-2000 paragraph 2-3b(6) and appendix D. Where ASR is known or suspected to pose a concern for concrete durability, it is recommended that aggregates proposed for use in concrete be evaluated to determine ASR potential and an effective mitigation. EM 1110-2-2000, provides recommendations for evaluating and mitigating ASR in concrete mixtures. Aggregate evaluations may not be practical for projects requiring small quantities of concrete (less than 200 cubic meters 250 cubic yards).

Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS, paragraph 2.3.1.2 Alkali-Silica Reactivity, provides a specification method for the Contractor to evaluate and mitigate ASR in concrete mixtures. The expansion limits specified in Section 32 13 14.13 are requirements for pavements and exterior slab construction. For structural concrete applications the measured expansion must be less than 0.10 percent. It may not be economical or practical to specify different test limit requirements for use on the same project. In which case the lower limit required by the application should be used.

The designer may use the specification method in Section 32 13 14.13 by incorporating the relevant paragraphs into this specification, or may use the following requirements (retain either the 0.10 or the 0.08 percent expansion limits as appropriate) included in the paragraph below. Delete the following paragraph if not required in the project.

****

Alkali-Silica Reactivity: Test and evaluate fine and coarse aggregates proposed for use in concrete for alkali-aggregate reactivity in accordance with ASTM C1260. Evaluate the fine and coarse aggregates separately and in combination, which matches the Contractor's proposed mix design proportioning. All results of the separate and combination testing must have a measured expansion less than 0.10 (0.08) percent at 16 days after casting. Should the test data indicate an expansion of 0.10 (0.08) percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1260 and ASTM C1567. Perform additional testing using ASTM C1260 and ASTM C1567 using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. Use GGBF slag in the range of 40 to 50 percent of the total cementitious material by mass. Use Class F fly ash in the range of 25 to 40 percent of the total cementitious material by mass.

2.2.2.1 Listed Sources

****

NOTE: The list of sources and required tests and test limits will be taken from the concrete materials DM.

****

Concrete aggregates may be furnished from any source capable of meeting the quality requirements as stated in paragraph QUALITY below. The sources listed at the end of this section were evaluated during the design phase of the project in [_____] and at that time were capable of meeting the quality requirements when suitably processed. No guarantee is given or implied that any of the listed sources are currently capable of producing aggregates that meet the required quality stated in paragraph QUALITY below. A DM containing the results of the Government's investigation and test results is available for review in the [_____] District Office. Contact [_____] at [_____] to arrange for review of the memorandum. Consider the test results and conclusions valid only for the sample tested and do not take as an indication of the quality of all material from a source nor for the amount of processing required. Provide fine and coarse aggregates conforming to the grading requirements of ASTM C33/C33M. The nominal maximum size is as listed in subparagraph NOMINAL MAXIMUM-SIZE COARSE AGGREGATE of 1.3, 'c'.

2.2.2.2 Concrete Aggregate Sources

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NOTE: If an aggregate source is provided by the Government, the appropriate paragraphs from Section 03 70 00 should be used.

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2.2.2.2.1 List of Sources

The concrete aggregates sources may be selected from sources listed at the end of this section.

2.2.2.2.2 Selection of Source

After the award of the contract, designate in writing only one source or combination of sources from which he proposes to furnish aggregates. If the Contractor proposes to furnish aggregates from a source or from sources not listed at the end of this section, then designate only a single source or single combination of sources for aggregates. Regardless of the source, provide selected samples for acceptance testing as required by paragraph GOVERNMENT TESTING AND SAMPLING in PART 1. If a source for coarse or fine aggregates so designated by the Contractor does not meet the quality requirements stated in the paragraph below, the Contractor may not submit for approval other nonlisted sources but furnish the coarse or fine aggregate, as the case may be, from sources listed at the end of this section at no additional cost to the Government.

2.2.2.3 Quality

****

NOTES: The tests selected should be those which are applicable to the concrete to be used in the

project. These tests may include those listed below in addition to others not listed. See EM 1110-2-2000 for schedule of tests.

Depending upon the quality of aggregates available, some tests may not be required. Refer to EM 1110-2-2000 for the purpose of each test.

A list of properties and test values are unique to each project and should be taken from the concrete materials DM. Delete the quality tests not required in the DM.

Use the petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.

In selecting deleterious substances, it should be borne in mind that cutoff walls are to be treated as structures not exposed to weather.

****

Deliver aggregates to the mixer meeting the following requirements:

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Specific Gravity	[_____]	[_____]	ASTM C127 ASTM C128
Absorption	[_____]	[_____]	ASTM C127 ASTM C128
Clay Lumps and Friable Particles	[_____]	[_____]	ASTM C142/C142M
Material Finer than 75-µm No. 200 Sieve	[_____]	[_____]	ASTM C117
Organic Impurities	Not darker than No. 3 Not less than 95 percent		ASTM C40/C40M ASTM C87/C87M
L.A. Abrasion	[_____]	[_____]	ASTM C131/C131M ASTM C535
Soft Particles	[_____]	[_____]	[COE CRD-C 130]
Petrographic Examination	Listed unwanted deleterious materials and their limits		ASTM C295/C295M

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Coal and Lignite, less than 2.00 specific gravity	[_____]	[_____]	ASTM C123/C123M

2.2.2.4 Fine Aggregate Grading and Moisture Content

Determine the sieve analysis and fineness modulus of fine aggregate in accordance with ASTM C136/C136M and COE CRD-C 104, respectively. Determine the moisture content with an electric moisture meter in accordance with COE CRD-C 143. When in the Contracting Officer's opinion the electric moisture meter is not operating satisfactorily, determine the moisture content in accordance with either ASTM C70, ASTM C566, or COE CRD-C 112.

2.2.2.5 Coarse Aggregate Grading and Moisture Content

For each size group of coarse aggregate, determine the sieve analysis in accordance with ASTM C136/C136M. Determine the moisture content of each size group of the coarse aggregate in accordance with ASTM C566 or COE CRD-C 112.

2.2.3 Chemical Admixtures

Provide admixtures complying with the following.

2.2.3.1 Air-Entraining Admixture

Provide air-entraining admixture conforming to ASTM C260/C260M and consistently cause the concrete to have an air content in the specified ranges under field conditions.

2.2.3.2 Accelerating Admixture

Provide accelerators meeting the requirements of ASTM C494/C494M, Type C or E, except do not use calcium chloride or admixtures containing calcium chloride.

2.2.3.3 Flowing Concrete Admixtures

Provide other chemical admixtures for use in producing flowing concrete in compliance with ASTM C1017/C1017M, Type I or II. Use these admixtures only if the proposed admixture shows no deleterious effects when used with all other project materials during mixture proportioning studies.

2.2.4 Water

Use water for mixing and curing that is fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that nonpotable water may be used if it meets the requirements of COE CRD-C 400.

2.3 PLANT AND EQUIPMENT

Submit data on all placing equipment and methods for review by the Contracting Officer.

2.3.1 Capacity

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NOTE: Experience has shown that to reduce problems associated with placement rates, the minimum capacity should be 77 cubic meters per hour 100 cubic yards per hour.

****

Furnish batching and mixing equipment with a capacity of at least [_____] cubic meters yards per hour.

2.3.2 Batch Plant

Conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required. Submit batch plant data to the Contracting Officer for review for conformance with applicable specifications.

2.3.2.1 Batching Equipment

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NOTE: Refer to the appropriate DM to choose the appropriate alternates.

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Provide batching controls that are [partially automatic], [semiautomatic], [or] [automatic]. [Provide the semiautomatic batching system with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance.] Equip the batching system with an accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. Provide separate bins or compartments for each size group of aggregate and cement, pozzolan, and GGBFS. Weigh aggregates either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Do not weigh aggregate in the same batcher with cement, pozzolan, or GGBFS. If both cement and pozzolan or GGBFS are used, they may be batched cumulatively provided that the portland cement is batched first. If measured by mass, do not batch the mass of the water cumulatively with another ingredient. Provide interlocked water batcher filling and discharging valves so that the discharge valve cannot be opened before the filling valve is fully closed. Provide an accurate mechanical device for measuring and dispensing each admixture. Interlock each dispenser with the batching and discharging operation of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Do not combine admixtures prior to introduction in water. Arrange the plant so as to facilitate the inspection of all operations at all times. Provide suitable facilities for obtaining representative samples of aggregates from each bin or compartment. Clearly mark all filling ports for cementitious materials bins or silos with a permanent sign stating the contents.

2.3.2.2 Scales

Provide equipment for batching by mass conforming to the applicable requirements of NIST HB 44, except that the accuracy must be plus or minus 0.2 percent of scale capacity. Provide standard reference masses and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. Make tests at the frequency required in paragraph TESTS AND INSPECTIONS, in PART 3, and in the presence of a Government inspector.

2.3.2.3 Batching Tolerances

Tolerances on determination of mass:

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	-0 to +2
Aggregate	± 2
Water	± 1
Chemical admixture	-0 to +6

For volumetric batching equipment, the following tolerances apply to the required volume of material being batched:

Water	Plus or minus 1 percent
Chemical admixtures	Zero to plus 6 percent

2.3.2.4 Moisture Control

Provide plant that is capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched. [Provide an electric moisture meter complying with the provisions of COE CRD-C 143 for measuring moisture in the fine aggregate. Arrange the sensing element so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.]

2.3.3 Concrete Mixers

Do not charge the concrete mixers in excess of the capacity recommended by the manufacturer. Operate the mixers at the drum or mixing blade speed designated by the manufacturer. Maintain the mixers in satisfactory operating condition, and keep the mixer drums free of hardened concrete. Should any mixer at any time produce unsatisfactory results, promptly discontinue its use until it is repaired. Submit concrete mixer data including the make, type, and capacity of concrete mixers proposed for mixing concrete in conformance with specified requirements.

2.3.3.1 Stationary Mixers

Provide tilting, nontilting, horizontal-shaft, vertical-shaft, or pugmill concrete plant mixers with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. Provide mixing time and uniformity conforming to all the requirements in ASTM C94/C94M applicable to central-mixed concrete.

2.3.3.2 Truck Mixers

Provide truck mixers, the mixing of concrete, and concrete uniformity conforming to the requirements of ASTM C94/C94M. A truck mixer may be used for complete mixing or to finish the partial mixing begun in a stationary mixer. Equip each truck with two counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

2.3.4 Conveying Equipment

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NOTE: Experience has shown that to reduce problems associated with placement rates, the minimum conveying capacity should be 75 cubic meters per hour 100 cubic yards per hour.

****

Furnish conveying equipment with a capacity of at least [_____] cubic meters yards per hour. Convey concrete from mixer to trench as rapidly as practicable and within the time interval specified in paragraph PLACING, in PART 3, by methods that will prevent segregation or loss of ingredients. Pass any concrete transferred from one conveying device to another through a hopper that is conical in shape and do not drop vertically more than 1.5 m 5 feet, except where suitable equipment is provided to prevent segregation and where specifically authorized. Submit data on the conveying equipment and methods for transporting, handling, and depositing the concrete.

2.3.4.1 Buckets

Provide an interior hopper slope no less than 58 degrees from the horizontal; provide a clear gate opening with a minimum dimension of at least five times the nominal maximum-size aggregate and an area no less than 0.2 square meters 2 square feet. Maximum dimension of the gate opening greater than twice the minimum dimension is not permitted. Provide bucket gates that are essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that manually operated buckets larger than 1.5 cubic meters 2 cubic yards are not acceptable. Provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

2.3.4.2 Trucks

Furnish truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete conforming to the requirements of ASTM C94/C94M. Do not use nonagitating equipment for transporting concrete.

2.3.4.3 Chutes

When concrete can be placed directly from a truck mixer or agitator, the chutes attached to this equipment by the manufacturer may be used. Use a discharge deflector when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

2.3.4.4 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. TProvide piston or squeeze pressure pumping equipment. Provide pipeline consisting of rigid steel pipe or heavy-duty flexible hose. Furnish pipe with an inside diameter that is at least three times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped, but no less than 100 mm 4 inches. Do not use aluminum pipe. Do not reduce the nominal maximum-size coarse aggregate to accommodate the pumps. The distance to be pumped must not exceed limits recommended by the pump manufacturer. Supply the concrete to the concrete pump continuously. When pumping is completed, eject concrete remaining in the pipeline without contamination of concrete in place. After each operation, thoroughly clean equipment, and waste flushing water outside of the forms.

PART 3 EXECUTION

3.1 PLACING

Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement. Deposit concrete in the tremie hopper with no vertical drop greater than 1.5 m 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Provide sufficient placing capacity so that concrete placement can be kept plastic and free of horizontal cold joints while concrete is being placed. Prior to placement, submit the method and equipment proposed for vertical construction joints cleanup and waste disposal, for review and approval by the Contracting Officer.

3.1.1 Time Interval Between Mixing and Placing

Place concrete within 30 minutes after mixing or agitating ceases. When concrete is truck mixed or when a truck mixer or agitator is used for transporting concrete mixed by a concrete plant mixer, deliver the concrete to the site of the work, and complete discharge within 45 minutes after introduction of the cement to the aggregates.

3.1.2 Placing Temperature

When deposited in the slurry, provide concrete with a temperature of no less than 5 degrees C 40 degrees F. Heating of the mixing water or aggregates is not be permitted until the temperature of the concrete has decreased to 7 degrees C 45 degrees F. Provide materials that are free from ice, snow, and frozen lumps before entering the mixer. Use placing equipment and methods that are subject to [approval] [review]. When heating is necessary to keep the concrete temperature above 5 degrees C 40 degrees F, regulate it so that the concrete temperature does not exceed 15 degrees C 60 degrees F. Do not exceed 32 degrees C 90 degrees F for concrete that is deposited in the slurry. Cooling of the mixing water and/or aggregates may be required to obtain an adequate placing temperature.

3.1.3 Concrete Deposited in Cutoff Trench

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NOTE: The hopper on top of the tremie pipe must be of a size capable of receiving and passing concrete into the tremie pipe at the capacity rate of the batching, mixing, and conveying equipment.

Depending upon the quality of aggregates available, some tests may not be required. Refer to EM 1110-2-2000 for the purpose of each test.

****

Deposit concrete placed for the cutoff wall in a bentonite slurry-filled trench by a tremie or by a valved tremie. The methods and equipment used are subject to approval. Concrete buckets will not be permitted for placement of concrete in the slurry trench, although they may be used to transport concrete to the tremie hoppers. Provide watertight tremie that is sufficiently large to permit a free flow of concrete, and no less than 250 mm 10 inches in diameter. A funnel-shaped hopper of at least [_____] cubic meters yards in volume is required at the top of the tremie. Do not construct neither the tremie pipe nor the hopper of aluminum. Make hoisting equipment for raising and lowering the tremie pipe as the concrete is placed and tools for connecting the tremie pipe sections continuously available and on hand. In lieu of use of a tremie, concrete may be placed using a positive displacement pump and pump line provided the entire operation is approved in writing after a demonstration of its use.

3.1.4 Concrete Placement

Suitably secure tremie pipe sections together and use a gasket at each joint to prevent leakage. A retrievable traveling plug (go-devil) or a dry pipe with a plate and gasket wired to the bottom to prevent contact of the concrete and the slurry in the tremie is required to start each placement. Lower the tremie assembly to rest within 150 mm 6 inches of the bottom of the trench prior to beginning placement. During placement of the concrete, avoid any unnecessary movement of the pipe. Keep the bottom of the tremie pipe submerged in fresh concrete at all times to a depth that will produce the flat test surface slope that can practically be achieved. A depth less than 3 m 10 feet or more than 9 m 30 feet except when beginning placement at the bottom of a panel is not acceptable. Supply batches of concrete to the tremie pipe at a uniform rate for a continuous flow. Lift the tremie pipe during placement at a rate that will maintain the bottom of the pipe embedded in fresh concrete to a level that will produce the desired surface slope and rate of flow within the limits specified above. It may be necessary to reduce the amount of embedment as the differential head decreases between the concrete in the tremie pipe and the concrete in the panel. Minimize the repeated raising and lowering of the tremie pipe in the fresh concrete to facilitate placement. Proceed with placement without interruption until the concrete has been brought to the required height. Continuously measure and record the flow and slopes during placement with the use of a sounding line. Do not move the tremie horizontally during a placing operation, except that as the required height is reached, the tremie pipes may be moved to the corners and low areas between the tremie pipes to bring the lift to final elevation. Provide a sufficient number of tremies so that the concrete does not flow horizontally a distance of more than 2.1 m 7 feet from a tremie; i.e., place tremies a maximum of 4.2 m 14 feet on centers. Where more than one tremie pipe is used in the same placement simultaneously, maintain the concrete level at each pipe position nearly level with respect to the other. Take special care to ensure that the bottom of the tremie pipe is not lifted out of the fresh concrete. If this occurs, remove the tremie pipe, insert a dry pipe with a temporary bottom plug, and restart the placement. Also, as soon as practical, drill a NX-size core boring through the center of the cutoff wall to a depth of at least 3 m 10 feet below the depth where the bottom of the tremie pipe was lifted out of the fresh concrete. Repair unacceptable zones of concrete such as honeycombed, segregated, or uncemented zones found within the core boring immediately or remove and replace by an appropriate means. All cost incurred because of this failure, including the initial core boring and as many additional core borings as may be required to delineate the limits of the unacceptable concrete and the repair of the cutoff wall, are borne by the Contractor and will not result in any additional cost to the Government. Submit a plan for repairing or removing and replacing the unacceptable concrete. Placement delays are not permitted for periods of time longer than 30 minutes.

3.1.5 Required Height of Concrete

Place concrete that is free of laitance, scum, slurry, or other contaminants at the top of the wall. Remove all scum, laitance, and contaminated concrete from the top of the concrete as the placement is nearing completion and dispose of in the spoil areas. Finish the top surface to grade by screeding spoil areas.

3.2 CURING AND PROTECTION

Moist cure exposed concrete for 14 days. Immediately after placement, protect concrete from premature drying, extremes in temperatures, rapid temperature change, and mechanical damage. Make all materials and equipment needed for adequate curing and protection available and at the placement site prior to the start of concrete placement. Protect concrete from the damaging effects of rain for 12 hours and from flowing water for 14 days. Fire or excessive heat including welding is not permitted near or in direct contact with concrete or concrete embedments at any time. Submit the curing medium and methods to be used for review and approval.

3.3 TESTS AND INSPECTIONS

Submit statements asserting that the concrete testing technicians and the concrete inspectors meet the specified requirements; also test results and inspection reports daily and weekly as required.

3.3.1 General

Perform the inspection and tests described in the following paragraphs and, based upon the results of these inspections and tests, take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, cease concrete placement. Perform tests by onsite laboratory and in conformance with ASTM C1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification will have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete construction will have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Construction Inspector, Level II. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C1077.

3.3.2 Testing and Inspection Requirements

3.3.2.1 Fine Aggregate

3.3.2.1.1 Grading

At least once during each shift when the concrete plant is operating, perform one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M and COE CRD-C 104 for the fine aggregate or for each size range of fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

3.3.2.1.2 Corrective Action for Fine Aggregate Grading

When the amount passing on any sieve is outside the specification limits, immediately resample and retest the fine aggregate. If there is another failure on any sieve, report the fact immediately to the Contracting Officer.

3.3.2.1.3 Moisture Content Testing

When, in the opinion of the Contracting Officer, the electric moisture meter is not operating satisfactorily, perform at least four tests for moisture content in accordance with ASTM C566 during each 8-hour period of mixing plant operation. Randomly select the times for the tests within the 8-hour period. Make an additional test whenever the slump is out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, make at least two direct measurements of moisture content per week to check the calibration of the meter. Use the results of tests for moisture content to adjust the added water in the control of the batch plant.

3.3.2.1.4 Moisture Content Corrective Action

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, adjust the scale settings for the fine-aggregate batcher and water batcher (directly or by means of a moisture compensation device) if necessary to maintain the specified slump.

3.3.2.2 Coarse Aggregate

3.3.2.2.1 Grading

At least once during each shift in which the concrete plant is operating, perform a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. Maintain a test record of samples of aggregate taken at the same locations showing the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control which are coarser than the specification limits for samples taken at locations other than as delivered to the mixer to allow for degradation during handling.

3.3.2.2.2 Corrective Action for Grading

When the amount passing any sieve is outside the specification limits, immediately resample and retest the coarse aggregate. If the second sample fails on any sieve, report that fact to the Contracting Officer. Where two consecutive averages of five tests are outside specification limits, consider the operation out of control and report it to the Contracting Officer. Stop concreting and take immediate steps to correct the grading.

3.3.2.2.3 Coarse Aggregate Moisture Content

Make a test for moisture content of each size group of coarse aggregate in accordance with ASTM C566 or COE CRD-C 112 at least once during a shift. When two consecutive readings for smallest-size coarse aggregate differ by more than 1.0 percent, increase frequency of testing to that specified above for fine aggregate, until the difference falls below 1.0 percent.

3.3.2.2.4 Coarse Aggregate Moisture Corrective Action

Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more, adjust the scale setting for the coarse aggregate batcher and the water batcher if necessary to maintain the specified slump.

3.3.2.3 Quality of Aggregates

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NOTES: Tests should be those listed in paragraph QUALITY. Use the petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.

Depending upon the quality of aggregates available, some tests may not be required. Refer to EM 1110-2-2000 for the purpose of each test.

****

Submit aggregate quality tests results at least 30 days prior to start of concrete placement.

3.3.2.3.1 Frequency of Quality Tests

Thirty days prior to the start of concrete placement perform all tests for aggregate quality listed below. In addition, after the start of concrete placement, perform tests for aggregate quality in accordance with the frequency schedule shown below. Test samples that were taken after the start of concrete placement immediately prior to entering the concrete mixer.

	FREQUENCY		
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Absorption	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C142/C142M
Material Finer than the 75 µm No. 200 Sieve	Every 3 months	Every 3 months	ASTM C117
Organic Impurities	Every 3 months	Not applicable	ASTM C40/C40M ASTM C87/C87M
L.A. Abrasion	Not applicable	Every 6 months	ASTM C131/C131M ASTM C535

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Soft Particles	Not applicable	Every 6 months	COE CRD-C 130
Petrographic Examination	Every 6 months	Every 6 months	ASTM C295/C295M
Coal and Lignite, less than 2.00 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M or ASTM C295/C295M

3.3.2.3.2 Corrective Action for Aggregate Quality

If the result of a quality test fails to meet the requirements for quality immediately prior to start of concrete placement, change production procedures or materials and perform additional tests until the material meets the quality requirements prior to proceeding with either mixture proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, rerun the test immediately. If the second test fails the quality requirement, report the fact to the Contracting Officer, and take immediate steps rectify the situation.

3.3.2.4 Deleterious Substances

3.3.2.4.1 Testing

When, in the opinion of the Contracting Officer, a problem exists in connection with deleterious substances in fine or coarse aggregates, make tests in accordance with ASTM C33/C33M at a frequency as directed, but no less than once per week. Report results of tests in writing.

3.3.2.4.2 Corrective Action for Deleterious Substances

When the results for a deleterious substance are out of the specification limit, resample and retest the aggregate for the deleterious substance that failed. If the second sample fails, report that fact to the Contracting Officer. When material finer than 75-µm (No. 200) sieve for coarse aggregate exceeds the specification limit, initiate immediate steps, such as washing or other corrective actions.

3.3.2.5 Scales

3.3.2.5.1 Accuracy

Checked by test weights prior to start of concrete operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT. Make such tests as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

3.3.2.5.2 Batching and Recording Accuracy

Once a week, check the accuracy of each batching and recording device during a weighing operation by noting and recording the required weight, recorded weight, and the actual mass batched. Confirm that the calibration devices described in paragraph BATCH PLANT in PART 2 for checking the accuracy of dispensed admixtures are operating properly.

3.3.2.5.3 Scales Corrective Action

When either the weighing accuracy or batching accuracy does not comply with specification requirements, do not operate the plant until necessary adjustments or repairs have been made. Correct discrepancies in recording accuracies immediately.

3.3.2.6 Batch-Plant Control

Continuously control the measurement of quantities of all constituent materials batched including cementitious materials, each size of aggregate, water, and admixtures. Adjust the aggregate quantities and amount of added water as necessary to compensate for free moisture in the aggregates. Adjust the amount of air-entraining agent to control air content within specified limits. Prepare a report indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water amounts per cubic meter yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water amounts per cubic meter yard for each class of concrete batched during plant operation. Submit the report to the Contracting Officer.

3.3.2.7 Concrete Mixture

3.3.2.7.1 Air Content Testing

Make air content tests when test specimens are fabricated. In addition, make at least two tests for air content on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Make additional tests when excessive variation in workability is reported by the placing foreman or Government quality assurance representative. Make tests in accordance with ASTM C231/C231M. Plot test results on control charts which will at all times be readily available to the Government. Keep copies of the current control charts in the field by the Contractor's quality control representatives and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, make a second test immediatelye. Average the results of the two tests, and use this average as the air content of the batch to plot on the control charts for air content and range and to determine the need for any remedial action. Plot the result of each test, or average as noted in the previous sentence, on a separate chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from subparagraph AIR CONTENT. Set an upper warning limit and a lower warning limit line 1.0 percentage point above and below the average line. Set an upper action limit and a lower action limit line 1.5 percentage points above and below the average line, respectively. Plot the range between each two consecutive tests on a control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer; however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, take correlation samples at the placement site as required by the Contracting Officer and the air content at the mixer controlled as directed.

3.3.2.7.2 Air Content Corrective Action

Whenever points on the control chart for percent air reach either warning limit, make an adjustment immediately in the amount of air-entraining admixture batched. As soon as is practical after each adjustment, make another test to verify the result of the adjustment. Whenever a point on the control chart range reaches the warning limit, recalibrate the admixture dispenser to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content is considered out of control and halt the concreting operation immediately until the air content is under control. Make additional air content tests when concreting is restarted. All this is at no extra cost to the Government.

3.3.2.7.3 Slump Testing

In addition to slump tests which are made when test specimens are fabricated, make at least four slump tests on randomly selected batches in accordance with ASTM C143/C143M for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, make additional tests when excessive variation in workability is reported by the placing foreman or Government's quality assurance representative. Plot test results on control charts which will at all times be readily available to the Government. Keep copies of the current control charts in the field by the Contractor's quality control representatives and plot results as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, make a second test immediately on the same batch of concrete. Average the results of the two tests and use this average as the slump of the batch to plot on the control charts for percent air and for range and to determine the need for any remedial action. Set an upper warning limit at 13 mm 1/2 inch below the maximum allowable slump on separate control charts for percent air used for each type of mixture as specified in subparagraph SLUMP, and set upper and lower action limit lines at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. Plot the range between each consecutive slump test for each type of mixture on a single control chart for range on which an upper action limit is set at 50 mm 2 inches. Take samples for slump at the mixer; however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between mixer and the placement, take correlation samples at the placement site as required by the Contracting Officer and control the slump at the mixer as directed.

3.3.2.7.4 Slump Corrective Action

Whenever points on the control chart for slump reach the upper warning limit, make an adjustment immediately in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum water-cement ratio specified, based upon aggregates which are in a saturated surface-dry condition. When a single slump reaches the upper or lower action limit, deliver no further concrete to the placing site until proper adjustments have been made. Immediately after each adjustment, make another test to verify the correctness of the adjustment. Whenever two consecutive slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, halt the concreting operation immediately, and take appropriate steps to bring the slump under control. Also, make additional slump tests as directed. All this is at no additional cost to the Government.

3.3.2.7.5 Compressive Strength

At least once during each shift, fabricate and cure, in accordance with ASTM C192/C192M, four 150 by 300 mm 6 by 12 inch test specimens. Test two specimens at 7 days and two at 28 days. If pozzolan or slag cement is used, fabricate six specimens and test two at 7 days, two at 28 days, and two at 90 days. Perform testing in accordance with ASTM C39/C39M. The results of compressive strength tests will not be used for acceptance. Results will be for record purposes and to evaluate the uniformity of concrete production. Average the results of each set of specimens tested at each age to produce one "test result". Plot these "test results" on control charts for each age. One control chart must consist of each "test result" plotted consecutively. One control chart must consist of the range from the "test result" for any one day to that of the next day. When the range exceeds 6.9 MPa 1,000 psi, notify the Contracting Officer and modify the operation to produce better uniformity.

3.3.2.7.6 Temperature

Measure the temperature of the concrete when compressive strength specimens are fabricated. Measure in accordance with ASTM C1064/C1064M. Report the temperature along with the compressive strength data.

3.3.2.8 Placing

3.3.2.8.1 Preparation for Placing

Inspect each section of wall in sufficient time prior to concrete placement to certify to the Contracting Officer that it is ready to receive concrete. Report the results of each inspection in writing.

3.3.2.8.2 Placing

The placing foreman supervises all placing operations, determines that the correct quality of concrete is placed in each location as directed by the Contracting Officer, and is responsible for measuring and recording concrete temperatures, weather conditions, time of placement, quantity placed, method of placement, depths of tremie pipes and concrete at regular intervals, and loss of concrete. Submit a written report recording these data daily.

3.3.2.8.3 Placing Corrective Action

Do not continue placing if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, take immediate steps to improve temperature controls.

3.3.2.9 Curing

3.3.2.9.1 Moist-Curing Inspections

At least once each shift and once per day on nonwork days, inspect all areas subject to moist curing. Note and record the surface moisture condition.

3.3.2.9.2 Moist-Curing Correction Action

When a daily inspection report lists an area of inadequate curing, take immediate corrective action, and extend the required curing period for such areas by 1 day.

3.3.2.10 Mixer Uniformity

Conform to the following:

3.3.2.10.1 Stationary Mixers

At the start of concrete placing and at least once every 6 months when concrete is being placed, determine uniformity of concrete. Perform tests in accordance with ASTM C94/C94M. Whenever adjustments in mixer or increased mixing times are necessary because of failure of any mixer to comply, retest the mixer after adjustment. Submit in writing the results of the initial mixer uniformity tests at least 5 days prior to the initiation of placing.

3.3.2.10.2 Truck Mixers

At the start of concrete placing and at least once every 6 months when concrete is being placed, determine uniformity of concrete in accordance with ASTM C94/C94M. Select the truck mixers srandomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of blades may be regarded as satisfactory. Report result of tests in writing.

3.3.2.10.3 Mixer Uniformity Concrete Action

When a mixer fails to meet mixer uniformity requirements, increase the mixing time or make adjustments to the mixer until compliance is achieved.

3.3.3 Reports

Report all results of tests and inspections as required. Include the updating of control charts covering the entire period from the start of the construction season through the current week in each report. During periods of cold-weather protection, make reports of pertinent temperatures daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Contracting Officer has the right to examine all Contractor quality control records.

3.3.4 Concrete Coring

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NOTES: The number of the test panels to be cored should be determined by each district office as

necessary to give a representation of the work that was done. The core boring of these test panels should be done after the concrete has developed sufficient strength to allow cores of properly placed concrete to be retrieved.

The spacing and timing of the core borings of the concrete cutoff wall should be arranged to retrieve properly placed concrete cores. The concrete should be allowed to develop sufficient strength to allow cores of competent concrete to be retrieved. The spacing of the core holes should be representative of the particular job to give confidence in the work that was performed. The wall construction should not be allowed to get too far ahead of the core boring. This will allow problems discovered by the core boring to be corrected or changed and these changes incorporated in the cutoff wall construction that follows.

****

3.3.4.1 Concrete Coring in Completed Panels

Drill one NX core boring (or one core boring approximately NX) through the concrete in each of the first [_____] test panels. Complete these borings during the installation of the first [_____] linear meters feet of cutoff wall and prior to commencement of the remainder of the wall. Thereafter, drill an NX boring through one panel selected by the Contracting Officer for every [_____] linear meters feet of wall, within [_____] days after completion of each [_____] meter foot section. Additional core borings may be directed by the Contracting Officer. Locate the borings in the center of each panel unless otherwise directed by the Contracting Officer. While coring the completed panels, prepare a log including the elevation of any drill fluid loss, soft zones, drill tool drops, or zones of core loss and provide the log to the Contracting Officer immediately after coring is complete. Do not backfill the core holes until approved by the Contracting Officer. [If the Contracting Officer decides to have falling head permeability tests or other tests conducted due to core results, do not use this as basis for a claim.] Fill core holes deviating through the side of the panel and drill a new core hole at no additional cost to the Government.

3.3.4.2 Method of Drilling

Drill cores by any approved standard and accepted method of rotary rock core wireline drilling using diamond-set coring bits by means of which continuous and complete cores of standard diameter for the specified bit size can be obtained.

3.3.4.3 Equipment and Supplies

Equipment to be furnished by the Contractor for core drilling includes diamond core-drilling machinery of a type or types approved by the Contracting Officer, complete with all accessories for taking continuous cores of a diameter consistent with specified bit size to the depths specified. Provide core drill that is the product of one of the standard core drill manufacturing companies designed primarily for this type of work. Use a ball-bearing, swivel-type, double-tube NX core barrel or manufacturers' equivalent meeting standards established by DCDMA TM. Provide capacity of barrels not exceeding 4.6 m 15 feet of core, and equip with diamond-set core bits and standard core lifters. Include all casing, drill rods, core barrels, diamond-set coring bits, piping, pumps, water, tools, core boxes, and power required for drilling. Set bits with the proper size stones for drilling the concrete and bed rock.

3.3.4.4 Core Boxes

Use longitudinally partitioned wooden core boxes constructed of dressed lumber or other approved materials in general accordance with arrangement and dimensions shown in the drawing included at the end of this section of the specifications for all cores. Use as many core boxes as may be required in submitting each concrete or rock core or group of cores. Equip core boxes completely with all necessary partitions, covers, hinges, and hasps for holding down the cover. To prevent undue core breakage (while it is being placed in boxes) and to allow for ease of access to core in the specified core boxes, determine the maximum amount of core to be placed in any one box by the Government core drill inspector during the drilling operations. Normally, it is expected that an average of approximately 3.7 m 12 feet of core can be placed in each box. In addition to the spacer blocks shown in the drawing, provide, as required, lengths of 29 by 54 mm 1-1/8 by 2-1/8 inch wood, painted red on one side, cut into 100 mm 4-inch lengths, mark with appropriate depths, and insert in the proper positions in core boring samples to show the location and actual extent of voids and core losses. Mark all core boxes with the appropriate hole number, box number, and depths.

3.3.4.5 Disposition of Core Samples

Upon completion of core drilling and sampling operations for each hole, deliver core boxes containing cores to a storage facility to be designated at the project site. Deliver core boxes containing cores in accordance with schedules prepared by the Contracting Officer. All packing, handling, and transportation of samples are considered as subsidiary obligations of the Contractor.

3.3.4.6 Backfilling Core Holes

Upon completion of core sampling, backfill the holes under gravity pressure with portland cement grout or mortar as directed by the Contracting Officer. Pump the grout into the hole through drill rods or plastic hose set to within 1.5 m 5 feet of the bottom of the hole. The bottom of the core hole is defined as being a point in bedrock 900 mm 3 feet below the bottom of the panel or the point at which the boring deviates from the cutoff wall.

3.3.5 Evaluation and Acceptance

Concrete will be evaluated by examination of cores drilled by the Contractor from completed panels as specified in paragraph CORING CONCRETE IN COMPLETED PANELS in PART 1, and unacceptable concrete is defined in paragraphs QUALITY ASSURANCE and CONCRETE PLACEMENT. Repair or remove concrete determined to be unacceptable and replace as specified in paragraph CONCRETE PLACEMENT above.

_________, 20__ LIST OF FINE AND COARSE AGGREGATE SOURCES		
LAT/LONG	PIT LOCATION, ADDRESS AND TELEPHONE NUMBER	MAIN OFFICE, ADDRESS AND TELEPHONE NUMBER
FINE AGGREGATE		
___/___		
___/___		
___/___		
___/___		
___/___		
COARSE AGGREGATE		
___/___		
___/___		
___/___		
___/___		
___/___		
___/___		

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 41 16.08 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-03 41 16.08 (May 2015)
UFGS-03 41 16 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03 41 16.08

PRECAST CONCRETE ROOF SLABS (MAX. SPAN 8 FEET O.C.)

11/19

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-03 41 16.08 (November 2008)**

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SECTION 03 41 16.08

PRECAST CONCRETE ROOF SLABS (MAX. SPAN 8 FEET O.C.)

11/19

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NOTE: This guide specification covers the requirements for flat-shaped or channel-shaped roof slabs, max. span 8 feet o.c. placed over purlins or joists spaced not more than 2.5 meter 8 feet on center that receive insulation board and built-up roofing.

Include on the drawings, the following:

Complete design indicating the character of the work to be performed and giving the roof framing, type, and sizes of purlins or joists, thrust angles at walls, bearing angles at ridges for sloping roofs, end bearing plates, dimensions of roof slab units, details of precast cant units, details of cast-in-place concrete cants and other sloping surfaces, details of openings, and sufficient dimensions to convey adequately the quantity and nature of the required roof decking.

Design loads and other design data as may be required for the proper preparation of shop drawings.

Precast concrete slabs for clear spans exceeding 2.5 meter 8 feet are specified in Section 03 41 33 PRECAST STRUCTURAL PRETENSIONED CONCRETE.

A structural steel roof framing system, including steel purlins and framing for openings larger than 1/2 width of roof slabs in any dimension, is specified in Section 05 12 00 STRUCTURAL STEEL.

An open-web steel joist roof framing system is specified in Section 05 21 00 STEEL JOIST FRAMING.

Fire resistance-rated roof and ceiling constructions using precast concrete roof decking are described in Underwriters Laboratories, Inc., "Fire Resistance Ratings (BXUV)" contained in UL FRD and the "Fire

Resistance Ratings" contained in AIA CO-1. Fire resistance rated construction limits the type and spacing of the roof framing system; type of roof slab units and method of fastening the roof slabs to the supporting frame; ceiling construction; and roof construction.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**..**

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for Burlap Cloth Made from Jute or Kenaf and

Cotton Mats

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.2.6	(2010; Supp 2011) Fasteners for Use in Structural Applications
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.6.7M	(1999; R 2010) Metric Machine Screws
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA BOOK	(2015) AWPA Book of Standards

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C387/C387M	(2023) Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1704/C1704M	(2016) Standard Test Method for Sampling and Testing Structural Cementitious Panels
ASTM C1705/C1705M	(2016) Standard Specification for Structural Cementitious Panels

ASTM D312/D312M	(2016a) Standard Specification for Asphalt Used in Roofing

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS UU-B-790	(Rev A; Notice 2) Building Paper Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant)

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings[; G, [_____]]

Installation Drawings[; G, [_____]]

SD-03 Product Data

Clips[; G, [_____]]

Nails[; G, [_____]]

Threaded Fasteners[; G, [_____]]

Joint Sealing Compounds[; G, [_____]]

Precast Concrete Roof Slabs[; G, [_____]]

Precast Curb Units[; G, [_____]]

Packaged Concrete Materials[; G, [_____]]

Absorption Cover[; G, [_____]]

Moisture-Retaining Cover[; G, [_____]]

Bituminous Joint Sealing Materials

SD-05 Design Data

Design Analysis[; G, [_____]]

Calculations[; G, [_____]]

SD-06 Test Reports

Nail Driving and Nail Pulling Tests[; G, [_____]]

Strength Tests[; G, [_____]]

SD-07 Certificates

Precast Concrete Roof Slabs[; G, [_____]]

Precast Curb Units[; G, [_____]]

Clips

Nails

Threaded Fasteners

Cement Grout Joint Sealing Materials[; G, [_____]]

Bituminous Joint Sealing Materials

Certificates of Compliance for Precast Concrete Roof Slabs

Certificates of Compliance for Precast Curb Units

Certificates of Compliance for Bituminous Joint Sealing Materials

SD-08 Manufacturer's Instructions

Installation Instructions

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit fabrication drawings for precast concrete deck units. On the drawings, provide dimensions, size, and number of openings to be cut.

Provide and submit installation drawings for precast concrete roof slabs and cast-in-place curb units. On the drawings, provide details and layouts indicating structural framing, location and length of concrete slabs corresponding with the sequence and procedure to be followed in placing and fastening roof slabs, and location and type of fasteners. Ensure that drawings also show details of curb units indicating location of cants, crickets, drainage saddles, and other sloping surfaces.

2.1.1 Sub Title

Text

2.2 COMPONENTS

Provide manufacturer's catalog data for all accessories including nails, threaded fasteners, and joint sealing compounds.

2.2.1 Clips and Nails

Use zinc- or cadmium-plated steel strip clips, not less than 0.76 millimeter 0.0299 inch thick. Ensure clips are formed to fit the top flange of steel beam purlins or steel joists having steel angle top chords, and of design recommended by the precast concrete roof slab manufacturer.

Use roofing nails that are 32 millimeter 1 1/4 inches long, galvanized steel, conforming to ASTM C514, Type II, Style 20.

Submit certificates of compliance for clips and nails showing conformance with referenced standards contained in this section.

2.2.2 Threaded Fasteners

Provide fasteners that consist of machine screws, nuts, and washers.

Use slotted, flathead, galvanized, carbon steel machine screws conforming to ASME B18.6.7M ASME B18.6.3, Type I, Style 2s.

Use hexagon, galvanized, carbon steel nuts conforming to ASME B18.2.6 ASME B18.2.2, Type II, Style 10.

Provide round-type, galvanized, carbon steel, general-purpose assembly washers conforming to ASME B18.22M ASME B18.21.1, Type A, Grade I, Class A.

Submit certificates of compliance for threaded fasteners showing conformance with referenced standards contained in this section.

2.3 MATERIALS

****

NOTE: Indicate precast-concrete roof slab dimensions.

****

2.3.1 Precast Concrete Roof Slabs

****

NOTE: Delete the following paragraphs when channel roof slabs are required.

****

Submit design analysis and calculations for precast concrete roof slabs.

Submit certificates of compliance for precast concrete roof slabs showing conformance with referenced standards contained in this section.

****

NOTE: Delete when using channel roof slab.

****

Ensure roof slabs are flat or plank-shaped and conform to ASTM C1705/C1705M, Type I or Type II, with the following modifications:

a. Ensure flat slabs have wire mesh reinforcing in both top and bottom of the slab.

b. Slabs have nailing edges.

****

NOTE: Delete one of the following two paragraphs as applicable to the project. When spacing of the structural framing members is less than 1.5 meter 5-feet, delete the first of the following paragraphs. When spacing of the structural framing members exceeds 1.5 meter 5-feet, delete the second of the following paragraphs.

****

c. Ensure flat slabs have tongue-and-groove edges on sides and square edges on ends, except that edges for exposed roof sides are square.

d. Ensure flat slabs have tongue-and-groove edges on sides and ends, except that edges for exposed roof sides and ends are square.

****

NOTE: Delete the following paragraphs when flat or plank roof slabs are required.

****

Use channel shaped precast concrete roof slabs conforming to ASTM C1705/C1705M, Type I or Type II, with the following modifications:

a. Reinforce channel slabs with steel-wire mesh in the web section and a minimum of one 12.7 millimeter No. 4 steel reinforcing bar in each flange.

b. Ensure slabs have nailing edges.

****

NOTE: The following paragraph applies to both flat and channel roof slabs.

****

c. Ensure that roof slabs, not suitable for nailing, have wood inserts. Pressure treat wood using a water-borne preservative and attain the minimum net retention of the solid preservative for lumber used in protected locations, in accordance with AWPA BOOK. Ensure that inserts are at least 50 by 75 millimeter (nominal), 37.5 by 62.5 millimeter(dressed) 2 by 3 inches (nominal), 1.5 by 2.5 inches(dressed), in section, placed in rows 600 millimeter 24 inches on center, and parallel with the roof slope. Ensure inserts are set flush with surfaces of slabs and rigidly secured in place with anchors designed and spaced to provide the holding strength required for subsequent nailing of roofing.

[2.3.2 Precast Curb Units

****

NOTE: Delete paragraph heading and the following paragraphs when precast curb units, such as curbs for vents, skylights, and other units not in the same plane as the roof decking, are not required.

****

Construct curb units of the same material and strength requirements as precast concrete roof slabs. Design precast curb units to fit securely in the anchorage provided by structural framing members.

Submit manufacturer's catalog data for all accessories including nails, threaded fasteners, and joint sealing compounds.

Submit certificates of compliance for precast curb units showing conformance with referenced standards contained in this section.

]2.3.3 Cement Grout Joint Sealing Materials

[Provide blended hydraulic cement that conforms to ASTM C595/C595M, Type [IS, IP].

][Provide portland cement that conforms to ASTM C150/C150M, Type I.

] Ensure that aggregate for cement grout is clean, sharp, uniformly graded, natural or manufactured sand conforming to ASTM C33/C33M.

Submit manufacturer's catalog product data for cement grout joint sealing materials.

2.3.4 Bituminous Joint Sealing Materials

Provide bituminous cement that is steep asphalt for use in constructing built-up roof coverings conforming to ASTM D312/D312M, Type IV.

Compose joint-sealing tape of two layers of uncreped kraft paper united by steep asphalt with approximately 13 by 8 millimeter 1/2 by 1/3 inch glass-fiber reinforcement embedded in the asphalt laminate. Tape to meet requirements of FS UU-B-790, Type I, Grade C, Style 4, with the following modifications:

a. Ensure that width is 150 millimeter 6 inches.

b. Dry tensile strength cannot be less than 6150 newton per meter 35 pounds per inch width, both directions.

Submit manufacturer's catalog product data for bituminous joint sealing materials.

Submit certificates of compliance for bituminous joint sealing materials showing conformance with referenced standards contained in this section.

2.3.5 Packaged Concrete Materials

Ensure that concrete materials are packaged, dry, combined materials for concrete conforming to ASTM C387/C387M, lightweight concrete (using natural sand), and have the following properties:

Property	**Value**
Compressive strength at 28 days	Not less than 20 Megapascal
Maximum aggregate size	9.5 millimeters
Slump	Not more than 75 millimeters
Total air content by volume	6 to 10 percent

Property	**Value**
Compressive strength at 28 days	Not less than 3,000 psi
Maximum aggregate size	3/8 inch
Slump	Not more than 3 inches
Total air content by volume	6 to 10 percent

[Ensure that materials used as ingredients include: [Blended hydraulic cement conforming to ASTM C595/C595M] [Fly ash conforming to ASTM C618, Class C or F] [Ground granulated blast furnace slag conforming to ASTM C989/C989M, [Grade 120.]]

]2.3.6 Water for Mixing Cement Grout and Concrete

Use potable water for mixing cement grout and concrete.

2.3.7 Concrete Curing Materials

Ensure that the absorption cover for curing concrete is burlap cloth made from jute or kenaf, conforming to AASHTO M 182, Class 3.

Ensure that the moisture-retaining cover for curing concrete is white waterproof paper or white opaque polyethylene sheet conforming to ASTM C171.

PART 3 EXECUTION

Install precast roof slabs and accessories in accordance with the approved drawings and as specified.

3.1 PREPARATION

Ensure that the supporting walls, purlins or joists, and other supporting members are in place before the placing of precast roof slabs is started. Do not place roof slabs during, or while there is a threat of, rain or snow.

3.1.1 Concrete Roof Slab Placement

Place each roof slab on structural framework to bear on at least two structural framing members. Ensure that the end bearing is not less than 50 millimeter 2 inches. For roof slabs having square edges, ensure the ends occur over a structural framing member. Where installation requires cutting roof slabs, ensure the cut ends occur over supports at the wall or at openings. Cut roof slabs as specified.

****

NOTE: Delete following paragraph when the spacing of the structural framing members exceeds 1.5 meter 5 feet, or when flat slabs having tongue-and-groove edge on ends are not required.

****

Ends of roof slabs having tongue-and-groove edges on ends do not need to occur over a structural framing member; stagger such end joints in adjacent rows.

Align roof slabs in each row end to end, with adjacent rows parallel. Alignment does not depend on adjacent walls or structural framing members being accurately square.

3.2 INSTALLATION

Provide installation instructions that indicate the manufacturer's recommended installation methods and sequence.

Submit test reports for precast concrete roof slabs regarding nail driving and nail pulling tests and strength tests in accordance with ASTM C1704/C1704M.

3.2.1 Fastening Roof Slabs

Fasten roof slabs to each structural framework member by means of clips and nails. Where possible, alternate clips in position so that each clip is facing in the opposite direction of the next clip. Secure clips to roof slabs with one nail per clip and fit to the top flange or chord of structural framework member by slots in the clips formed for this purpose.

When the roof slope is greater than a 1 to 4 ratio, fasten roof slabs to supporting members by threaded fasteners in addition to the clips specified. Ensure that the threaded fasteners are not less than 13 millimeter 1/2 inch in diameter. Use countersunk fastener heads. Attach fasteners to the top flange or chord of supporting members by means of offset clips or other approved method. Ensure that the threaded fasteners are at least one fastener per 3 square meter 30 square feet of roof area.

3.2.2 Cutting and Fitting

****

NOTE: Frame openings in precast roof slabs larger than one-half the roof slab width in any dimension with supporting members that are provided as a part of the roof framing system.

****

Perform roof slab cutting and fitting as required by the approved drawings for passage of other work projecting through or adjacent to the roof decking. Ensure that the cuts are straight and clean through roof slabs and at 90 degrees to severed surfaces without breaking, spalling, or appreciable crumbling at edges.

3.2.3 Sealing Joints

After roof slabs have been placed and fastened, seal the top portion of joints as specified.

Fill joints at ridges and hips and tongue-and-groove joints with cement grout. Provide cement grout that consists of portland cement, sand, and water mixed to manufactures instructions. Place grout so as to be even with the top surface of roof slabs. Remove excess grout and give grout surface a smooth finish.

Seal other joints with specified bituminous joint sealing materials. Center joint sealing tape over the joint and embedded in hot bituminous cement applied at the rate of 6 to 8 kilogram per 10 square meter 15 to 20 pounds per 100 square feet of joint sealing tape. Provide end laps that are less than 100 millimeter 4 inches. Remove excess bitumen and ensure that the joint sealing tape surface is smooth and free of wrinkles.

3.2.4 Installation Of Precast Curb Units

****

NOTE: Delete paragraph heading and following paragraph when precast curb units are not required.

****

Install precast curb units in accordance with approved drawings.

3.2.5 Fill for Sloping Surfaces

Ensure that the fill for curb cants and other sloping surfaces consists of the specified packaged concrete materials mixed with water.

Mix concrete either manually or by mechanical mixer, using the quantity of water indicated on packaged concrete materials. Accurately measure water used in manual mixing. Equip mechanical mixer with a device to measure and control the amount of water used. Keep mixer drums, mixing boxes, tools, and other mixing equipment clean and free from hardened lumps of concrete.

Handle concrete mixture from the point of mixing and transferred to concrete conveying equipment and to locations of final deposit as rapidly as possible by methods that prevent segregation and loss of concrete mix materials. Ensure that the mechanical equipment for conveying concrete mixtures is of such size and design as to ensure a uniform, continuous flow of concrete mixture at the delivery end. For concrete conveying equipment, maintain the inner surfaces free of hardened concrete, debris, water, snow, ice, or other deleterious materials.

Place and screed concrete mixture in a continuous operation until placing a section is completed. Ensure that the finished surface is free of humps or hollows; sloped to drains; uniform, smooth, even plane; and of granular texture.

Immediately following the concrete finishing operation, ensure that the concrete is kept continuously moist for at least 72 hours by covering the concrete surface with a specified absorptive cover for curing concrete, or kept continuously wet, by covering concrete surface with a specified moisture-retaining cover for curing concrete, or by a combination of both curing methods.

During the concrete curing period, protect concrete from damage caused by rain or running water, by excessively cold or hot temperatures, and from damaging mechanical disturbances.

3.2.6 Cold-Weather Limitations

Do not perform joint sealing, concrete mixing, or placing when the ambient temperature is 5 degrees C 40 degrees F or below.

3.3 ADJUSTING AND CLEANING

Upon completion of roof decking work, sweep roof surfaces clean of debris and other foreign matter and in a condition ready to receive roofing.

3.4 PROTECTION

Protect finished roof decking from damage by weather and construction operations until roofing is installed.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 41 33 (November 2016)**
Change 1 - 11/18

Preparing Activity: USACE **Superseding**
UFGS-03 41 33 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-03 41 33 (November 2016)**
Change 1 - 11/18

Preparing Activity: USACE **Superseding**
UFGS-03 41 33 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 03 41 33

PRECAST STRUCTURAL PRETENSIONED CONCRETE
11/16, CHG 1: 11/18

****
NOTE: This guide specification covers the requirements for fabrication and erection of precast structural concrete framing elements, floor units, and roof units for buildings including, as required by the project, the following:

Precast conventionally reinforced concrete floor and roof units for clear spans up to 10.5 meter 35 feet.

Precast conventionally reinforced concrete columns, joists, beams, and other structural framing elements.

Precast prestressed concrete single- and double-tee slabs, hollow-cored flat slabs, tee- or keystone-joists, columns, and other structural elements.

Precast concrete cellular floor units with cells suitable for use as electrical raceways.

Include in drawings a complete design indicating the character of the work to be performed and giving the following:

Assumed loads, including floor live load, roof live load, wind load, concentrated loads such as partitions, and equipment mounted on or suspended from precast concrete construction, concrete floor topping weight, and other design data as may be required for meeting building codes and the proper preparation of shop drawings.

Layout of the framing system indicating the relative location of the various precast structural concrete sections, floor elevations, column centers and offsets, openings, and sufficient dimensions to adequately convey the quantity and nature of the required precast structural concrete framing system.

Details of all precast structural concrete sections

indicating cross-sections and dimensions.

Location of precast structural concrete sections having an architectural finish on exposed-to-view surfaces when required.

Details of reinforcement indicating reinforcing-bar schedules; location and size of welded-wire fabric; and tenons for prestressed concrete indicating the final stressing force in kips, as required.

Details of connections indicating end bearing minimums and anchorage devices and other items embedded in the precast structural concrete sections.

Location and details of concrete floor topping, when required.

Details of openings including the size of steel framing members as required.

Details of precast concrete filler blocks, as required.

Details of hangers for suspended ceilings, ducts, piping, lighting fixtures, conduit, or other construction, as required.

Precast concrete floor-unit cells that will be used for electrical raceways, when required.

When both fire-resistance-rated construction and non fire resistance-rated construction are required, the location of fire-resistance-rated construction.

Cast-in-place normal-weight concrete, including concrete floor topping, is specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

Precast conventionally reinforced concrete wall panels, solid-section type, are specified in Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE.

Precast-concrete roof slabs placed over purlings or joists spaced not more than 8 feet on center are specified in Section 03 41 16.08 PRECAST CONCRETE SLABS (MAX. SPAN 8 FEET O.C.).

Sealing joints in exposed-to-view surfaces of precast concrete slabs, such as at ceilings and walls, is specified in Section 07 92 00 JOINT SEALANTS.

Painting exposed-to-view surfaces of precast concrete units such as ceilings and walls, is specified in Section 09 90 00 PAINTS AND COATINGS.

When cells of precast concrete cellular floor units will be used for electrical raceways, the inspection

of cells to be used for electrical raceways, cutting the floor units for inserts, and electrical raceway fittings are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Fire-resistance-rated construction using precast structural concrete sections is described in Underwriters Laboratories, Inc., "Fire Resistance Ratings (BXUV)" included in UL Fire Resistance Directory and the "Fire-Resistance Ratings" contained in AIA CO-1. Fire-resistance-rated construction limits the types of precast structural concrete sections; the requirements for end restraint; the concrete materials and proportions of concrete mix for floor top fill; the requirements for grouting and sealing joints; and the type of roof insulation and roof covering.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 200	(1973; R 2012) Standard Specification for Epoxy Protective Coatings

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI SP-66	(2004) ACI Detailing Manual
ACI/MCP-2	(2015) Manual of Concrete Practice Part 2
ACI/MCP-3	(2015) Manual of Concrete Practice Part 3
ACI/MCP-4	(2015) Manual of Concrete Practice Part 4

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BTH-1	(2014) Design of Below-the-Hook Lifting Devices

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM A322	(2024) Standard Specification Steel Bars, Alloy, Standard Grades
ASTM A370	(2024) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A421/A421M	(2021) Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A675/A675M	(2014) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A767/A767M	(2019) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	(2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C70	(2020) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C114	(2024) Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C115/C115M	(2010; E 2013) Standard Test Method for Fineness of Portland Cement by the Turbidimeter
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123	(2014) Standard Test Method for Lightweight Particles in Aggregate
ASTM C126	(2022) Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland

	Cement
ASTM C151/C151M	(2023) Standard Test Method for Autoclave Expansion of Hydraulic Cement
ASTM C157/C157M	(2024; E 2024) Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C183/C183M	(2022) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C185	(2020) Standard Test Method for Air Content of Hydraulic Cement Mortar
ASTM C191	(2021) Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C204	(2024) Standard Test Methods for Fineness of Hydraulic Cement by Air Permeability Apparatus
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C232/C232M	(2021) Standard Test Method for Bleeding of Concrete
ASTM C233/C233M	(2018) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C266	(2020) Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
ASTM C330	(2023) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C403/C403M	(2023) Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C404	(2024) Standard Specification for

	Aggregates for Masonry Grout
ASTM C451	(2021) Standard Test Method for Early Stiffening of Hydraulic Cement (Paste Method)
ASTM C535	(2016; R 2024) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D312/D312M	(2016a) Standard Specification for Asphalt Used in Roofing
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D573	(2004; R 2019) Standard Test Method for Rubber - Deterioration in an Air Oven
ASTM D1149	(2018) Standard Test Method for Rubber Deterioration - Cracking in an Ozone Controlled Environment
ASTM D2103	(2015) Standard Specification for Polyethylene Film and Sheeting
ASTM D2240	(2015; E 2017) Standard Test Method for

	Rubber Property - Durometer Hardness
ASTM D3744/D3744M	(2011a) Standard Test Method for Aggregate Durability Index
ASTM D4397	(2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A135.4	(2012; R2020) Basic Hardboard

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2018; Errata 2019) Manual of Standard Practice

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(2021) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 5th Edition
PCI MNL-120	(2021) PCI Design Handbook - Precast and Prestressed Concrete, 8th Edition

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS UU-B-790	(Rev A; Notice 2) Building Paper Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant)

UL SOLUTIONS (UL)

UL Electrical Construction	(2012) Electrical Construction Equipment Directory
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

Use the "S" Classification only in SD-11 Closeout Submittals. The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, [_____]

Installation Drawings; G, [_____]

SD-05 Design Data

Normal-Weight Concrete; G, [_____]

Lightweight Structural Concrete; G, [_____]

SD-06 Test Reports

Air Content of Mortar; G, [_____]

Normal-Weight Concrete Air Content; G, [_____]

Lightweight Structural Concrete Air Content; G, [_____]

Air Entrainment for Normal-Weight Concrete; G, [_____]

Air Entrainment for Lightweight Structural Concrete; G, [_____]

Lightweight Structural Concrete Compressive Strength; G, [_____]

Normal-Weight Concrete Compressive Strength; G, [_____]

Slump for Normal-Weight Concrete; G, [_____]

Slump for Lightweight Structural Concrete; G, [_____]

Moisture Content; G, [_____]

Design Mix; G, [_____]

Unit Weight; G, [_____]

Anchorages

Nondestructive Testing; G, [_____]

SD-07 Certificates

Qualifications for Welding Work; G, [_____]

Installers

Manufacturer

Normal-Weight Concrete Aggregate; G, [_____]

Lightweight Structural Concrete Aggregate; G, [_____]

Pretensioning

Detensioning

Welding Procedures

SD-08 Manufacturer's Instructions

Installation Instructions

Welding Sequence and Procedure

Epoxy-Resin Grout

Epoxy-Resin Adhesive

1.3 QUALITY CONTROL

1.3.1 Qualifications for Precast-Concrete Manufacturer

Provide precast structural concrete sections manufactured by an organization experienced in the manufacture of precast concrete.

Submit a written description of the manufacturer giving the qualifications of personnel, location of plant, concrete batching facilities, manufacturing equipment and facilities, list of projects similar to specified work[and [_____]].

Produce sections/units under plant-controlled conditions conforming to

PCI MNL-116 by a firm certified under the PCI Plant Certification Program and specializing in providing precast/prestressed products and related services.

1.3.2 Qualifications for Installer

Install members by using an organization experienced in the installation of precast structural-concrete sections.

Submit a written description of installers giving the qualifications of personnel, handling and erection equipment, list of projects similar to specified work[and [_____]].

1.3.3 Qualifications for Welding Work

Submit certificates of Compliance for the following items:

a. Qualifications of personnel

b. A list of projects similar to specified work

c. Performance requirements

[Section 05 05 23.16 STRUCTURAL WELDING applies to work specified in this section.

] Ensure all welding procedures are in accordance with AWS D1.1/D1.1M, and welders are qualified by tests in accordance with AWS D1.1/D1.1M.

[Ensure welders make only those types of weldments for which each is specifically qualified.

] Provide installation instructions for the welding sequence and procedure which indicates the manufacturer's recommended sequence and method of installation.

1.3.4 Concrete Sampling and Testing

Submit test reports. Include within each report the following items:

a. Project name and number, date, name of Contractor

b. Name of precast-concrete manufacturer, name of concrete testing service,

c. Type of concrete

d. Structural-member identification letter and number

e. Design compressive strength at 28 calendar days

f. Concrete-mix proportions and materials

g. Compressive breaking strength and type of break

h. A record of gage pressures or dynamometer readings,

i. Compression strength of concrete at time of detensioning, and type of reinforcement

Submit design mix reports for approval at least 15 calendar days prior to start of work.

1.3.4.1 Tests for Concrete Materials

****

NOTE: Delete the following materials and tests that are not required.

****

Sample and test concrete materials proposed for use in the work as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete aggregates for normal-weight concrete	Sampling	ASTM D75/D75M	One for each material source and grading size
	Sieve analysis	ASTM C136/C136M	
	Calculating fineness modulus	ASTM C126	
	Amount of material passing No. 200 sieve	ASTM C117	
	Amount of friction particles	ASTM C142/C142M	
	Amount of organic impurities	ASTM C40	
	Amount of coal and lignite	ASTM C123	
	Magnesium sulfate soundness test	ASTM C88	
	Aggregate durability	ASTM D3744/D3744M	
	Compact unit weight of slag (course aggregate)	ASTM C29/C29M	
	Resistance to abrasion test of small size coarse aggregate	ASTM C131/C131M or ASTM C535	
Lightweight aggregates	Sampling	ASTM D75/D75M	One for each material source and grading size
	Sieve analysis	ASTM C136/C136M ASTM C330	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Compact unit Unit weight (loose)	ASTM C29/C29M and	
Lightweight structural concrete using the proposed lightweight aggregates	Specimen preparation	ASTM C192/C192M and ASTM C330	As required for each type of test to determine conformance
	Compressive strength	ASTM C39/C39M	
	Unit weight	ASTM C330	
	Shrinkage	ASTM C157/C157M and ASTM C330	
Hydraulic cement	Sampling	ASTM C183/C183M	One for each material source, type, and color
	Chemical analysis	ASTM C114	
	Finess	ASTM C115/C115M or ASTM C204	
	Autoclave expansion	ASTM C151/C151M	
	Time of setting	ASTM C191 or ASTM C266	
	Air content of mortar	ASTM C185	
	Compressive Strength	ASTM C109/C109M	
	Heat of hydration	ASTM C185	
	False set	ASTM C451	
Air entrained concrete using air entraining admixture made of the proposed concrete materials	Materials for tests	ASTM C233/C233M	One set of tests for each type of portland cement proposed for use and for each type of concrete
	Number of specimens	ASTM C233/C233M, Table 1	
	Bleeding	ASTM C232/C232M	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Time of setting	ASTM C403/C403M and ASTM C233/C233M	
	Compressive Test Specimen	ASTM C192/C192M and ASTM C233/C233M	
	Compressive Strength test at 3, 7, and 28 calendar days	ASTM C39/C39M and ASTM C233/C233M	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete aggregates for normal-weight concrete	Sampling	ASTM D75/D75M	One for each material source and grading size
	Sieve analysis	ASTM C136/C136M	
	Calculating fineness modulus	ASTM C126	
	Amount of material passing No. 200 sieve	ASTM C117	
	Amount of	ASTM C142/C142M	
	Amount of organic impurities	ASTM C40	
	Amount of coal and lignite	ASTM C123	
	Magnesium sulfate soundness test	ASTM C88	
	Aggregate durability	ASTM D3744/D3744M	
	Compact unit weight of slag (course	ASTM C29/C29M	
	Resistance to abrasion test of small size coarse aggregate	ASTM C131/C131M or ASTM C535	
Lightweight aggregates	Sampling	ASTM D75/D75M	One for each material source and grading size
	Sieve analysis	ASTM C136/C136M ASTM C330	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Compact unit Unit weight (loose)	ASTM C29/C29M and	
lightweight structural concrete using the proposed lightweight aggregates	Specimen preparation	ASTM C192/C192M and ASTM C330	As required for each type of test to determine conformance
	Compressive	ASTM C39/C39M	
	Unit weight	ASTM C330	
	Shrinkage	ASTM C157/C157M and ASTM C330	
Hydraulic cement	Sampling	ASTM C183/C183M	One for each material source, type, and color
	Chemical analysis	ASTM C114	
	Fineness	ASTM C115/C115M or ASTM C204	
	Autoclave expansion	ASTM C151/C151M	
	Time of setting	ASTM C191 or ASTM C266	
	Air content of mortar	ASTM C185	
	Compressive Strength	ASTM C109/C109M	
	Heat of hydration	ASTM C185	
	False set	ASTM C451	
Air entrained concrete using air entraining admixture made of the proposed concrete	Materials for tests	ASTM C233/C233M	One set of tests for each type of portland cement proposed for use and for each type of concrete
	Number of specimens	ASTM C233/C233M, Table 1	
	Bleeding	ASTM C232/C232M	
	Time of setting	ASTM C403/C403M	
	Compressive Test	ASTM C192/C192M	

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Compressive Strength test at 3, 7, and 28 calendar days	ASTM C39/C39M and ASTM C233/C233M	

1.3.4.2 Concrete Design Mixes

Submit design mix data.

****

NOTE: Delete the following types of concrete and tests not required.

****

Determine and test concrete Design Mix for concrete used as follows:

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Normal-weight concrete	Specific gravity and absorption of fine aggregate	ASTM C128	As required for the concrete aggregates for each trial mix
	Specific gravity and absorption of coarse aggregate	ASTM C127	
	Moisture content of both fine and coarse aggregate	ASTM C70 and ASTM C566	
	Dry rodded unit weight of coarse aggregate	ASTM C29/C29M	
	Trial mixes using at least three different water/cement ratios, minimum allowable slump; all with air entrainment for normal-weight concrete	ACI 211.1	As required to determine the concrete mix having the properties specified in paragraph QUALITY OF CONCRETE
	Making and curing concrete specimens in the	ASTM C192/C192M	Two sets of three specimens for each design
	Sampling fresh concrete in the laboratory	ASTM C192/C192M	One for each set of design mix specimens

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Slump for normal-weight concrete	ASTM C143/C143M	
	Normal-weight concrete air content	ASTM C231/C231M	
	Yield	ASTM C138/C138M	
	Compressive strength	ASTM C39/C39M	Three Specimens tested at 28 calendar days
Lightweight structural concrete	Dry loose unit weight of aggregates	ASTM C29/C29M and ASTM C330	As required for the lightweight aggregate for each trial mix
	Moisture content of aggregate	ASTM C566	
	Trial mixes using at least three different water/cement ratios, maximum allowable slump; both with and without air entrainment for lightweight structural concrete	ACI 211.1	As required to determine the concrete mix having the properties specified in paragraph QUALITY OF CONCRETE
	Making and curing concrete in the laboratory	ASTM C192/C192M	Two sets for each design mix
	Sampling fresh concrete in the laboratory	ASTM C192/C192M	One for each set of design mix specimens
	Slump for lightweight structural concrete	ASTM C143/C143M	
	Light weight structural concrete air content	ASTM C173/C173M	
	Yield	ASTM C138/C138M	
	Compressive strength	ASTM C39/C39M	Three specimens tested at 7 calendar days and three specimens tested at 28 calendar days

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Air-dried unit weight	ASTM C330	Two specimens tested after curing 28 calendar days

****
NOTE: Delete the following paragraph when normal-weight concrete is not required.
****

From the results of the tests for normal-weight concrete, plot a curve showing the relationships between water/cement ratios and compressive strengths. When producing a design-minimum laboratory Compressive Strength at 28 calendar days, do not exceed the maximum water/cement ratio specified for normal-weight concrete properties shown by the curve.

****
NOTE: Delete the following paragraph when lightweight structural concrete is not required.
****

From the results of the tests for lightweight structural concrete, plot a curve showing the relationships between cement contents and compressive strengths. When producing a design-minimum laboratory compressive strength at 28 calendar days, do not provide less then the minimum cement content specified for lightweight structural properties shown by the curve.

1.3.4.3 Quality Control Testing During Fabrication

****
NOTE: Delete the following types of concrete not required by the project.
****

Sample and test concrete for quality control during fabrication as follows:

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Normal-weight concrete	Sampling of fresh concrete	ASTM C172/C172M except modified for slump per ASTM C94/C94M	As required for each test
	Slump Test	ASTM C143/C143M	One for each concrete load at point of discharge and one for each set of compressive strength tests
	Air content by pressure method	ASTM C231/C231M	One for each set of compressive strength tests

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
	Compression test Specimens	ASTM C31/C31M	One set of six standard cylinder specimens for each compressive
			Ensure Curing of Compression Test Specimens are the same as the curing method used for the precast-concrete structural
	Concrete temperature		Each time a set of compression test specimens is made
	Compressive strength tests	ASTM C39/C39M	One set for every ten structural members, or fraction thereof, cast in any one day; two specimens tested at 7 calendar days, three specimens tested at 28 calendar days and one specimen retained in
Lightweight structural concrete	Sampling fresh concrete	ASTM C172/C172M except as modified for slump per ASTM C94/C94M	As required for each test.
	Slump Test and unit weight of fresh concrete	ASTM C143/C143M ASTM C138/C138M	One for each concrete load at point of discharge and one for each set of compressive strength tests
	Air content by volumetric method	ASTM C173/C173M	One for each set of compressive strength tests
	Compressive test specimens	ASTM C31/C31M	One of six standard cylinder specimens for each compressive

TYPE OF CONCRETE	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
			Ensure the curing of Compressive Strength test specimens are the same as the curing method used for the precast-concrete structural members.
	Concrete temperature		Each time a set of compression test specimens is made
	Compressive strength tests	ASTM C39/C39M	One set for every ten structural members, or fraction thereof, cast in any one day; two specimens tested at 7 calendar days, three specimens tested at 28 calendar days and one specimen retained in reserve for
	Air dried Unit Weight at 28 calendar days	ASTM C330	One for each compressive strength test

Submit test results on the same day that tests are made.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit fabrication drawings. Show type and location of all reinforcement, size and spacing of welds within Fabrication Drawings.

Submit installation drawings indicating type and location of all anchorage devices, size and spacing of all welded connections, grouting and joint sealant details, and dimensions and locations of all openings in structural concrete sections.

2.1.1 Quality Of Concrete

2.1.1.1 Normal-Weight Concrete Properties

****

NOTE: Delete paragraph heading and the following

paragraphs when normal-weight concrete will not be required.

****

PROPERTY	VALUE
Design normal-weight concrete compressive strength at 28 calendar days	Not less than 34.5 Megapascal
Maximum normal-weight concrete aggregate size	19 millimeter
Maximum water/cement ratio	16 liters per 42.5 kilogram sack of cement
Slump at point of concrete discharge	Not to exceed 75 millimeters
Total air content by volume at point of concrete discharge	Not less than 4 percent; not more than 8 percent

PROPERTY	VALUE
Design normal-weight concrete compressive strength at 28 calendar days	Not less than 5000 psi
Maximum normal-weight concrete aggregate size	3/4-inch
Maximum water/cement ratio	4.25 gallons per 94 pound sack of cement
Slump at point of concrete discharge	Not to exceed 3-inches
Total air content by volume at point	Not less than 4 percent; not more

2.1.1.2 Lightweight Structural Concrete Properties

****

NOTE: Delete paragraph heading and the following paragraphs when light-weight structural concrete will not be required.

****

PROPERTY	VALUE
Design lightweight structural concrete compressive strength at 28 calendar days	Not less than 34.5 Megapascal
Maximum lightweight structural concrete aggregate size	19 millimeter
Maximum water/cement ratio	Seven 42.5 kilogram sacks of cement per 0.75 cubic meter
Slump at point of concrete discharge	Not to exceed 75 millimeters
Total air content by volume at point of concrete discharge	Not less than 4 percent; not more than 8 percent

PROPERTY	VALUE
Air-dry density at 28 calendar days	Not less than 1440 nor more than 1840 kilograms per cubic meter

PROPERTY	VALUE
Design lightweight structural concrete compressive strength at 28 calendar days	Not less than 5000 psi
Maximum lightweight structural concrete aggregate size	3/4-inch
Maximum water/cement ratio	Seven 94 pound sacks of cement per cubic yard
Slump at point of concrete discharge	Not to exceed 3-inches
Total air content by volume at point of concrete discharge	Not less than 4 percent; not more than 8 percent
Air-dry density at 28 calendar days	Not less than 90 nor more than 115 pounds per cubic foot

2.1.2 Performance Requirements

2.1.2.1 Design Methods

Design in accordance with ACI/MCP-3, ACI 318, ACI 318M and PCI MNL-120.

2.1.2.2 Allowable Design Loads and Deflections

****

NOTE: Allowable design loads indicated and include dead loads, live loads, stationary loads, concentrated moving loads, deflection of roof slab sections, etc.

Recommended design loads are found in ASCE 7-10.

****

Allowable design loads and deflections as indicated.

2.1.2.3 UL Fire-Resistance Listing and Label

****

NOTE: Delete paragraph heading and the following paragraph when UL-listed fire-resistant precast structural concrete sections are not required. The UL lists several manufacturers of prestressed precast-concrete, hollow-core flat slabs, and single-tee and double-tee slabs. Indicate location and fire-resistance classification of fire-resistant-rated structural sections.

****

Indicate sections requiring a fire-resistance classification as listed in UL Fire Resistance part, PRECAST CONCRETE UNITS (CFTV), and bear the UL label and marking.

2.1.2.4 Electrical Raceway UL Listing and Label

****

NOTE: Delete paragraph heading and the following paragraph when hollow-core floor-slab precast structural sections will not be used for electrical raceways, either under this contract or in the future. Indicate location of electrical raceway structural sections.

****

List the hollow-core floor slabs indicated as electrical raceways in UL Electrical Construction part, RACEWAYS (RGKT) CELLULAR CONCRETE FLOOR (RGYR), and bear the UL label and marking.

2.2 FABRICATION

2.2.1 Fabrication Tolerances

****

NOTE: Delete the following fabrication tolerances that are not required by the project.

****

Fabricate sections within the following tolerances:

Overall dimensions	Plus or minus 3 millimeter per 3048 millimeter but not greater than 19.1 millimeter overall
Cross-sectional dimensions of up to	Plus or minus 3 millimeter
Over 150 to 460 millimeter	Plus or minus 4.8 millimeter
Over 460 to 915 millimeter	Plus or minus 6.4 millimeter
Over 915 millimeter	Plus or minus 9.5 millimeter
Deviation from straight line parallel to centerline of section up to 12.2 meters in length	Not over 9.5 millimeter
12.2 to 18.3 meter in length	Not over 12.7 millimeter
Over 18.3 meter in length	Not over 19.1 millimeter
Deviation from camber indicated on	Plus or minus 3 millimeter per 3
Ends out of square, up to 305	0.80 millimeter per 25.4 millimeter
Over 300 millimeter in width or	0.80 plus 0.40 millimeter per 25.4
Position of block-outs	Plus or minus 12.7 millimeter
Position of voids in hollow cored flat slabs, for both vertical and horizontal dimensions	Plus or minus 12.7 millimeter
Concrete cover over reinforcement	Plus 6.4, minus 0 millimeter

Overall dimensions	Plus or minus 3 millimeter per 3048 millimeter but not greater than 19.1 millimeter overall
Position of tendons for prestressed concrete	Plus or minus 3.2 millimeter
Position of deflection points for deflected strand tendons for prestressed concrete	Plus or minus 152 millimeter
Position of weld plates	Plus or minus 25.4 millimeter
Position of lateral anchorage points	Plus or minus 25.4 millimeter
Position of pickup devices	Plus or minus 152 millimeter

Overall dimensions	Plus or minus 1/8-inch per 10-feet
Cross-sectional dimensions of up to 6-inches	Plus or minus 1/8-inch
Over 6 to 18-inches	Plus or minus 3/16-inch
Over 18 to 36-inches	Plus or minus 1/4-inch
Over 36-inches	Plus or minus 3/8-inch
Deviation from straight line parallel to centerline of section up to 40-feet in length	Not over 3/8-inch
40 to 60-feet in length	Not over 1/2-inch
Over 60-feet in length	Not over 3/4-inch
Deviation from camber indicated on the drawings	Plus or minus 1/8-inch per 10-feet
Ends out of square, up to 12-inches in width or depth	0.80 millimeter per 1/32-inch of width or depth
Over 12-inches in width or depth	1/32-inch plus 1/64-inch per inch of width or depth
Position of block-outs	Plus or minus 1/2-inch
Position of voids in hollow cored flat slabs, for both vertical and horizontal dimensions	Plus or minus 1/2-inch
Concrete cover over reinforcement	Plus 1/4, minus 0 inch
Position of tendons for prestressed concrete	Plus or minus 1/8-inch
Position of deflection points for deflected strand tendons for prestressed concrete	Plus or minus 6-inches
Position of weld plates	Plus or minus 1-inch
Position of lateral anchorage points	Plus or minus 1-inch

Overall dimensions	Plus or minus 1/8-inch per 10-feet
Position of pickup devices	Plus or minus 6-inch

2.2.2 Forms

****

NOTE: Indicate structural-section dimensions, cross-sections, and other details as required by the project.

****

Use forms and form-facing materials that are nonreactive with concrete such as wood, metal, plastic, or other approved materials and are within the limits of the specified fabrication tolerances. Conform to the shapes, lines, and dimensions indicated.

2.2.3 Reinforcement

****

NOTE: Indicate reinforcement types, sizes, and arrangement as required for structural strength after the structural sections have been installed.

****

Provide types, sizes, and arrangement as indicated on the approved drawings. Detail reinforcement in accordance with ACI/MCP-3 and ACI 318.

Place and secure steel bars, welded-wire fabric, and other reinforcement by means of metal bar supports and spacers.

****

NOTE: Delete the following paragraph when prestressed structural-concrete sections are not required by the project.

****

Place tendons and anchorages in accordance with ACI/MCP-3 and ACI 318. Provide anchorages that are permanently protected with concrete; free of loose rust, grease, oil, paint, and other foreign matter. Ensure bearing surface is between anchorages and concrete; perpendicular to and concentric with the tendons and the line of action prestressing force.

****

NOTE: Revise or delete the following paragraph when not applicable to the project. Indicate concrete cover for reinforcement.

****

Provide concrete cover for reinforcement in accordance with ACI/MCP-3 and ACI 318.

2.2.4 Built-In Anchorage Devices

****

NOTE: Indicate anchorage devices that are to be embedded in the precast structural concrete

sections. Anchorage devices include weld plates, bearing plates and steel shapes.
****

Position, anchor, and locate anchorage devices where they do not affect the position of the main reinforcement or placing concrete. Set bearing plates level, aligned properly, and anchor in the exact location indicated.

2.2.5 Lifting Devices

Provide lifting devices designed in accordance with ASME BTH-1, and of materials sufficiently ductile to ensure visible deformation before fracture.

2.2.6 Blockouts

****
NOTE: Blockouts are openings in slabs that would require the cutting of primary reinforcement if such openings were to be cut in the field. Ensure openings are cast in the unit during fabrication and indicated. The maximum size of field-cut openings may be from 150 to 300 millimeter 6 to 12 inches depending on the type of unit used such as the inside diameter of the voids in hollow cored flat slabs and the spacing of reinforcement.
****

Provide blockouts as indicated on drawings.

2.2.7 Pretensioning

****
NOTE: Delete paragraph heading and the following paragraph when prestressed structural-concrete sections are not required by the project.
****

Pretensioning of tendons may be accomplished either by the single-strand or multiple-strand tensioning method. Determine the prestressing force by measuring the tendon elongation, either by checking the jack pressure on a recently calibrated gage or by use of a recently calibrated dynamometer. Correct any discrepancy that exceeds 5 percent. Base elongation requirements on the load-elongation curves for the type of tendon used. The total loss of prestress due to unreplaced broken tendons is not to exceed 2 percent of the total prestress.

2.2.8 Concrete Mixing and Conveying

Measure concrete materials, concrete batching plant, concrete mixers, and concrete mixing in accordance with ASTM C94/C94M.

Handle concrete to prevent segregation and loss of concrete mix materials.

2.2.9 Preparations for Placing Concrete

Keep form interiors and reinforcement free of accumulations of hardened concrete, form-parting compound, standing water, ice, snow, or other deleterious substances. Secure in position, inspect and approve reinforcement and other embedded items.

2.2.10 Weather Limitations

Do not place concrete when temperature of the atmosphere is below 5 degrees C 40 degrees F nor during rain, sleet, and snow unless adequate protection is provided. Provide protection during inclement weather; prevent the entry of rain, sleet, or snow into the forms or into the fresh concrete.

2.2.11 Concrete Placing

Deposit concrete so that no concrete is placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness. Consolidate concrete in a manner that will prevent segregation and will produce concrete free of honeycomb or rock pockets and with the required surface finish.

2.2.12 Identification Markings

Clearly mark each structural section in a permanent manner to indicate its location and orientation in the building and the pickup points.

Ensure each structural section has the date of casting plainly indented in the unexposed face of the concrete.

2.2.13 Finishing Unformed Surfaces

Trowel finish unformed surfaces unless otherwise specified. Provide smooth surface free of trowel marks, uniform in texture and appearance, and be plane to a tolerance not exceeding 3.2 millimeter in 3048 millimeter 1/8-inch in 10-feet when tested with a 3000 millimeter 10-foot straightedge.

Provide top surfaces of sections that are to receive concrete topping after installation with a transversely scarified scratch finish and remove laitance.

2.2.14 Curing

Cure concrete by keeping the concrete damp for not less than 7 calendar days if made of Type I portland cement and for not less than 3 calendar days if made of Type III portland cement. For each decrease of 3 degrees below 21 degrees C 5 degrees below 70 degrees F in the average curing temperature, increase the curing period by 4 calendar days for concrete made of Type I portland cement and by 2 calendar days for concrete made of Type III portland cement.

Curing by low-pressure steam, steam vapor, radiant heat and moisture, or other acceptable process may be employed provided that the compressive strength of the concrete is equal to that obtained by moist curing and the 28-day compressive strength of the concrete meets the requirements specified, as determined by test cylinders of the same concrete cured by the same curing process.

Do not remove sections from their casting beds until the curing period is completed or concrete has attained at least 75 percent of its design compressive strength.

2.2.15 Protection of Concrete After Placing

Meet protection requirements of ACI/MCP-2 for hot or cold weather, as applicable.

2.2.16 Detensioning

****
NOTE: Delete paragraph heading and the following paragraphs when prestressed structural-concrete sections are not required by the project.
****

Do not detension tendons until the concrete compressive strength, as indicated by test cylinders, is as follows:

TYPE OF REINFORCEMENT	COMPRESSIVE STRENGTH OF CONCRETE
Concentrically stressed sections	Not less than 20 Megapascal
Eccentrically stressed sections	Not less than 24.1 Megapascal
Beams or other sections in which camber must be minimized	Not less than 27.6 Megapascal

TYPE OF REINFORCEMENT	COMPRESSIVE STRENGTH OF CONCRETE
Concentrically stressed sections	Not less than 3,000 psi
Eccentrically stressed sections	Not less than 3,500 psi
Beams or other sections in which camber must be minimized	Not less than 4,000 psi

Remove test cylinders to be used to establish the compressive strength of the concrete from the casting bed at least 1 hour prior to the start of the detensioning operation. Allow test cylinders from heat-cured casting beds to cool for approximately 1/2 hour prior to capping, and allow caps of sulfur compound to cure for 1/2 hour prior to the compressive-strength test.

If concrete has been heat cured, ensure the detensioning operation is done following the curing period while the concrete is still warm and moist to avoid cracking or undesirable stresses in the concrete.

Ensure prior to detensioning operations, forms, ties, inserts, holddowns, or other devices that would restrict the longitudinal movement of the sections along the casting bed are removed or loosened to provide free movement of the structural section. Alternately, perform detensioning so that longitudinal movement is precluded.

In detensioning operations, ensure prestressing forces are kept nearly symmetrical about the vertical axis of the section and applied in a manner that will minimize sudden or shock loading. Limit maximum eccentricity about the vertical axis to one strand. Detensioning of pretensioned tendons may be accomplished either by gradual release of the tensioning jacks or by heat-cutting the tendons in accordance with an approved pattern and sequence to prevent severe unbalancing of the loading.

2.2.17 Finishing Formed Surfaces

Upon removal of forms, repair and patch defective areas. Limit defective areas to holes left by tie rods and other temporary inserts and to honeycomb or rock pockets not deep enough to expose the reinforcement and not located in bearing areas. Cut out defective areas to sound concrete and clean. Ensure patches on lower side of sections, near the center or in areas of variable tensile strength, are bonded by a two-component epoxy-polysulfide or epoxy-polyamine bonding adhesive. Other areas will be dampened with water and patched with portland cement grout. Where the concrete surface will be exposed to view, match the patches, when dry, to the surrounding concrete.

Formed surfaces of sections that will be concealed by other construction can have the standard smooth finish having the texture imparted by the forms. Repair and patch defective areas as specified and remove fins and other projections.

****

NOTE: Delete the following paragraph and specify the required finish when an architectural finish is required. For an exposed-aggregate finish refer to Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE. Indicate the location of precast structural concrete sections having an architectural finish.

****

Provide grout finish on formed surfaces of sections that are to be exposed-to-view after installation. Ensure final color of the grout, when dry, is the same for all concrete surfaces. Spread over dampened concrete surface with clean burlap pads, carpet, or sponge rubber floats to fill pits, air bubbles, and surface holes. Remove excess grout by scraping and then rubbing the surface with clean burlap or carpet to remove visible grout film. In hot dry weather, kept grout damp by means of fog-spraying during the setting period.

2.3 MATERIALS

2.3.1 Concrete Materials

2.3.1.1 Normal-Weight Aggregates

****

NOTE: Delete paragraph heading and the following paragraphs when precast structural-concrete sections will be fabricated of lightweight structural concrete. Fabricate precast concrete elements exposed to the weather of normal-weight concrete. When an architectural finish, such as exposed aggregate, is required for exposed-to-view surfaces, refer to Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE for concrete aggregate specifications.

****

Provide fine and coarse aggregates conforming to ASTM C33/C33M and the following:

a. Where a structural member is exposed to the weather, and for all concrete aggregates where surface appearance of the concrete is important, meet the requirements of ASTM C33/C33M for fine aggregate subject to abrasion, for coarse aggregate subject to severe exposure.

b. Maximum size of coarse aggregate is as specified.

2.3.1.2 Lightweight Aggregates

****

NOTE: Delete paragraph heading and the following paragraph when all precast structural-concrete sections will be fabricated of normal-weight concrete. Fire-resistance-rated structural sections may be fabricated of lightweight structural concrete, especially when the fire-resistance rating exceeds 2 hours.

****

Conform to ASTM C330.

2.3.1.3 Portland Cement

****

NOTE: If high early strength concrete is required, add Type III.

****

[Portland cement conforms to ASTM C150/C150M, Type [_____].

][Blended hydraulic cement conforms to ASTM C595/C595M, Type [_____].

] Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.3.1.4 Fly Ash

Use fly ash as an admixture, conforming to ASTM C618, Class [C or F], with 4 percent maximum loss on ignition and between 15 to 35 percent maximum cement replacement by weight.

****

NOTE: Ground granulated blast furnace slag is one of the materials listed in the EPA's Comprehensive Procurement Guidelines (CPG)
https://www.epa.gov/smm/comprehensive-procurement-guidelines-construction-prod

If the Architect/Engineer determines that use of certain materials meeting the CPG content standards and guidelines would result in inadequate competition, do not meet quality/ performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/Engineer may submit written justification and supporting documentation for not procuring designated items containing recovered material.

****

2.3.1.5 Ground Granulated Blast Furnace (GGBF) Slag

GGBF slag [is required] [used] as an admixture [and] conforming to ASTM C989/C989M, Grade [120] with between 25 to 50 percent maximum cement replacement by weight.

2.3.1.6 Air-Entraining Admixture

Use an admixture free of sodium chloride and nitrates, conforming to ASTM C260/C260M.

2.3.1.7 Water

Use potable water.

2.3.2 Reinforcement Materials

****

NOTE: Delete the following reinforcement materials that are not required. Concrete reinforcement materials are required for both conventionally reinforced and prestressed precast structural-concrete sections.

****

2.3.2.1 Reinforcement Bars

Provide deformed bars conforming to ASTM A615/A615M, Grade 60, except that 9.5 millimeter 0.375 inches diameter bars may be Grade 40.

****

NOTE: Delete the following paragraph when galvanized reinforcing bars for concrete reinforcement is not required. Galvanizing is recommended when the concrete cover over reinforcing bars is less than 38 millimeter 1-1/2 inches for structural sections exposed to the weather.

****

Galvanize bars for structural sections exposed to the weather in accordance with ASTM A767/A767M.

2.3.2.2 Cold-Drawn Steel Wire

Provide wire conforming to ASTM A1064/A1064M.

2.3.2.3 Welded-Wire Fabric

Provide uncoated wire fabric conforming to ASTM A1064/A1064M. Provide galvanized wire fabric in structural sections exposed to the weather.

2.3.2.4 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcement bars and wire in place.

Provide wire supports conforming to ACI/MCP-4, ASTM E648, ACI SP-66 and CRSI 10MSP.

Ensure legs of supports in contact with formwork for sections that will be exposed to weather are hot-dip galvanized after fabrication, plastic coated, or corrosion-resistant steel bar supports.

2.3.3 Prestressing Materials

****

NOTE: Delete paragraph heading and the following paragraphs when prestressed structural-concrete sections are not required.

****

2.3.3.1 Strand Tendons

****

NOTE: Strand tendons for prestressed concrete are primarily intended for use in pretensioned, bonded, prestressed concrete construction. Use galvanized tendons in project locations with Environmental Severity Classifications (ESC) of C4 or C5. See UFC 1-200-01 for determination of ESC for project locations.

****

Provide [uncoated][galvanized], 7-strand, stress-relieved, steel wire conforming to ASTM A416/A416M.

2.3.3.2 Wire Tendons

****

NOTE: Delete paragraph heading and the following paragraph when wire tendons for prestressed concrete will not be required. Prestressing steel wire is commonly used in prestressed linear concrete construction in which the steel wire ends are anchored by cold-end deformation (that is, button anchorage) or in which the steel wire ends are anchored by wedges.

****

Provide tendons conforming to ASTM A421/A421M, Type BA or Type WA, as required to suit the steel-wire anchorage method used.

2.3.3.3 Steel-Bar Tendons

****

NOTE: Delete paragraph heading and the following paragraphs when steel-bar tendons for prestressed concrete will not be required. Steel bars are principally used in post tensioning.

****

Provide uncoated round steel bars conforming to ASTM A322.

Tensile properties of the bars after processing, when tested in accordance with ASTM A370, as follows:

****

NOTE: Select one of the following values of tensile

property and value as applicable to the project.
****

TENSILE PROPERTY	VALUE NO. 1	VALUE NO. 2
Ultimate tensile strength	1000 Megapascal min	1100 Megapascal min
Yield strength (0.2-percent offset)	900 Megapascal min	970 Megapascal min
Elongation at rupture in 20 diameters	4 percent min	4 percent min
Reduction on area at rupture	25 percent min	20 percent min

TENSILE PROPERTY	VALUE NO. 1	VALUE NO. 2
Ultimate tensile strength	145,000 psi min	160,000 psi min
Yield strength (0.2-percent offset)	130,000 psi min	140,000 psi min
Elongation at rupture in 20 diameters	4 percent min	4 percent min
Reduction on area at rupture	25 percent min	20 percent min

2.3.3.4 Tendon Anchorages for Pretensioning

Provide tendon anchorages capable of anchoring reinforcement without slippage after seating.

Proof test by the manufacturer, steel cases for prestressing steel strand to at least 90 percent of the ultimate tensile strength of the strand.

2.3.3.5 Tendon Anchorages for Post Tensioning

****
NOTE: Delete paragraph heading and the following paragraphs when tendon anchorages for post tensioning will not be required. Normally, pretensioning only is required for prestressed precast structural concrete sections for building construction. Post tensioning may be required for field connections.
****

Provide anchorages capable of developing 100 percent of the guaranteed ultimate tensile strength of the reinforcement for prestressed concrete without excessive deformation. Provide anchorage plates of sufficient size to keep bearing pressures within the stress allowed by ACI/MCP-3 and ACI 318 for the specified concrete strength at stressing.

Submit test data confirming the adequacy of anchorages.

2.3.4 Connection Materials

2.3.4.1 Steel Plates, Shapes, and Bars

Ensure plates conform to ASTM A283/A283M, Grade C, or to ASTM A36/A36M.

Ensure structural-steel shapes conform to ASTM A36/A36M.

Ensure bar shapes, flats, and rounds conform to ASTM A675/A675M, Grade 65, or ASTM A36/A36M.

Where connectors are recessed, allow a minimum 64 millimeters 2-1/2 inches of concrete cover for epoxy resin filler. Do not use welded or bolted metal connectors where exposed to the weather, unless such components are of stainless steel, galvanized steel or fusion-bonded epoxy coated steel.

2.3.4.2 Steel Anchor Bolts

****

NOTE: Delete paragraph heading and the following paragraph when anchor bolts will not be required. Anchor bolts are normally required for precast concrete column base connections.

****

Provide anchor bolts made of steel, with steel hexagon nuts and steel washers.

2.3.4.3 Electrodes for Welding

****

NOTE: Delete paragraph heading and the following paragraphs when welded connections are not required.

****

Provide electrodes for manual shielded metal-arc welding connections consisting of structural quality carbon-steel members conforming to the AWS Code and be covered mild-steel electrodes conforming to AWS A5.1/A5.1M, E60 series.

Provide electrodes for welding steel bars for concrete reinforcement conforming to AWS D1.4/D1.4M.

2.3.4.4 Flexible Bearing Pads

****

NOTE: Delete one of the following paragraphs as applicable to the project. Delete paragraph heading and the following paragraphs when flexible bearing pads are not required. Hardboard bearing pads are recommended for gravity connections having a bearing load not exceeding 1725 kilopascal 250 pounds per square inch (psi). Elastomeric nonlaminated bearing pads are recommended for gravity connections having a bearing load not exceeding 5500 kilopascal 800 psi. Where the bearing load exceeds 5500 kilopascal 800 psi or where there are small rotations, ensure laminated type bearing pads designed and constructed to meet the requirements for loading and movement is

considered. Indicate the location and size of flexible bearing pads.

****

Provide tempered hardboard pads not less than 3 millimeter 1/8-inch in thickness, smooth-two-sides, conforming to ANSI/CPA A135.4.

Provide pads molded or cut from elastomeric material. Provide pad dimensions as indicated and within the following tolerances: thickness, plus or minus 1.5 millimeter 1/16-inch; width, minus 3 to plus 6.5 millimeter 1/8-to plus 1/4-inch; length, plus or minus 3 millimeter 1/8-inch. Material: vulcanized, chloroprene elastomeric compound conforming to the following tests:

PROPERTY	TEST METHOD	PERFORMANCE
Hardness Shore A durometer	ASTM D2240	70 plus or minus 5 points
Tensile strength	ASTM D412 Die C	Not less than 17.2 Megapascal
Ultimate elongation	ASTM D412 Die C	Not less than 300
Resistance to oil aging: change in volume after 70-hour immersion in ASTM oil No. 3 at 100 degrees C	ASTM D471	Not more than plus 120 percent
Resistance to heat aging: change in original properties after 70 hours at 100 degrees C tensile strength ultimate elongation hardness	ASTM D573	Plus 15 percent, minus 40 percent, 0 to plus 15 points
Resistance to permanent set: compression set after 22 hours at 100 degrees C	ASTM D395 Method B	Not more than 35 percent
Resistance to ozone: condition after exposure of a sample kept under a surface tensile strain of 20 percent to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 40	ASTM D1149	No cracks
		Not less than 91 kilogram per 25 linear millimeter

PROPERTY	TEST METHOD	PERFORMANCE
Hardness Shore A durometer	ASTM D2240	70 plus or minus 5 points
Tensile strength	ASTM D412 Die C	Not less than 2,500 psi
Ultimate elongation	ASTM D412 Die C	Not less than 300 percent
Resistance to oil aging: change in volume after 70-hour immersion in ASTM oil No. 3 at 212 degrees F	ASTM D471	Not more than plus 120 percent
Resistance to heat aging: change in original properties after 70 hours at 212 degrees F tensile strength ultimate elongation hardness	ASTM D573	Plus 15 percent, minus 40 percent, 0 to plus 15 points
Resistance to permanent set: compression set after 22 hours at 212 degrees F	ASTM D395 Method B	Not more than 35 percent
Resistance to ozone: condition after exposure of a sample kept under a surface tensile strain of 20 percent to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 104 degrees F	ASTM D1149	No cracks
		Not less than 200 pounds per linear inch

2.3.5 Grouting Materials

****
NOTE: Delete the following paragraphs that are not applicable to the project. When fire-resistance rated precast structural-concrete sections are required, the applicable fire agency's requirements for grouting materials are consulted.
****

****
NOTE: Ground granulated blast furnace slag is one of the materials listed in the EPA's Comprehensive Procurement Guidelines (CPG)
https://www.epa.gov/smm/comprehensive-procurement-guidelines-construction-prod
If the Architect/Engineer determines that use of certain materials meeting the CPG content standards

and guidelines would result in inadequate competition, do not meet quality/ performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/Engineer may submit written justification and supporting documentation for not procuring designated items containing recovered material.

****

Provide Portland cement conforming to ASTM C150/C150M, Type I.

Provide Blended hydraulic cement conforming to ASTM C595/C595M, Type [_____].

Provide Aggregate for cement grout conforming to ASTM C404, Size No. 2.

For shrinkage-resistant grouting compound, use premixed and packaged ferrous aggregate conforming to ASTM C1107/C1107M, for expansive grouts.

Use potable water.

Provide two-component, mineral-filled, epoxy-polysulfide epoxy-resin grout conforming to ASTM C881/C881M, [Type I][Type II][____].

Provide two-component, epoxy-polyamide cured type epoxy-resin adhesive conforming to AASHTO M 200.

2.3.6 Bituminous Joint Sealing Materials

****

NOTE: Delete paragraph heading and the following paragraphs when single- or double-tee roof slab structural sections are not required.

****

Use asphalt bituminous cement conforming to ASTM D312/D312M, Type IV.

Provide joint sealing tape 15.24 cm 6-inches wide, multilayered, asphalt treated, glass-fiber reinforced, conforming to [ASTM D2103] [ASTM D4397] [FS UU-B-790, Type I, Grade C, Style 4,] with the following modification:

> Dry tensile strength not be less than 6130 newton per meter 35 pounds per inchwidth, both directions.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Anchorage Items Embedded In Other Construction

****

NOTE: Delete the paragraph heading and the following paragraph when precast structural-concrete sections will not be connected to cast-in-place concrete construction or masonry construction. Such anchorage items include anchor bolts, steel dowels, and steel bearing plates.

****

Deliver items to the work site before the start of other construction. Provide setting drawings, templates, instructions, and directions for the installation of anchorage items.

****

NOTE: Ensure where architectural finishes such as exposed-aggregate finish are specified for exposed-to-view surfaces, such surfaces are cleaned as specified in Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE.

****

Protect exposed-to-view surfaces against staining and other damage until completion of the work.

3.2 INSTALLATION

Install precast sections in accordance with the drawings and as specified.

3.2.1 Welded Connections

****

NOTE: Welded connections are the most commonly used type of connection. Other types of connections that may be employed are gravity, structural-steel bolted, post-tensioned, cast-in-place reinforced-concrete, and doweled connections. Ensure connection details are indicated.

****

Ensure welding reinforcing steel, metal inserts, and connections in precast-concrete structural-member construction are in accordance with AWS D1.4/D1.4M.

Ensure welding structural steel connections are in accordance with AWS D1.1/D1.1M.

3.2.2 Installation of Flexible Bearing Pads

****

NOTE: Delete paragraph heading and the following paragraphs when flexible bearing pads are not required. Ensure bearing pads are indicated.

****

Install pads into cast-in-place concrete where indicated; set in correct position, and have a uniform bearing. Keep in the correct position while placing sections.

3.2.3 Strength of Structural Precast Sections at Installation

****

NOTE: Delete one of the following paragraphs as applicable to the project. Select the first paragraph except when the project schedule indicates installation of 28-day structural sections.

****

Do not install precast sections until concrete has attained the specified minimum laboratory strength at 28 calendar days.

Do not install precast sections before 28 calendar days from the date of casting has elapsed unless approval has been obtained to make one compressive-strength test, ASTM C39/C39M, and one flexural strength test using simple beam with third point loading, ASTM C78/C78M`, on field cured concrete test specimens, ASTM C31/C31M, for each individual structural section to determine the strength of the concrete.

3.2.4 Installation Tolerances

Install precast sections within the following tolerances:

Deviation in location from indicated	Plus or minus 6.4 millimeter
Deviation from plumb for columns in any story or 6.1 meter maximum	Not over 6.4 millimeter
In 12.2 meter or more	Not over 12.7 millimeter
Deviation from elevations indicated for girders, beams, joists, and slabs in any bay or 6.1 meter maximum	Not over 6.4 millimeter
In 12.2 meter or more	Not over 12.7 millimeter
Difference between adjacent structural sections in erected position	Plus or minus 1.6 millimeter per 3000 millimeter but not greater than 6.4 millimeter overall

Deviation in location from indicated	Plus or minus 1/4-inch
Deviation from plumb for columns in any story or 20-feet maximum	Not over 1/4-inch
In 40-feet or more	Not over 1/2-inch
Deviation from elevations indicated for girders, beams, joists, and slabs in any bay or 20-feet maximum	Not over 1/4-inch
In 40-feet or more	Not over 1/2-inch
Difference between adjacent structural sections in erected position	Plus or minus 1/16-inch per 10-feet but not greater than 1/4-inch overall

3.2.5 Placing Framing Structural Sections

****

NOTE: Delete paragraph heading and the following paragraphs when framing structural sections such as columns, beams, girders, and joists will not be required.

****

Place supporting sections, including anchorage items attached to or embedded in other construction before placing of precast sections is started.

****
NOTE: Delete the following paragraphs when precast concrete columns with attached steel bearing plates will not be required.
****

Installation of precast concrete columns with attached steel bearing plates is as follows:

a. Ensure concrete and steel plate bearing surfaces are cleaned of laitance, dirt, oil, grease, and other foreign materials. Roughen concrete surface.

b. Space between the top of the concrete bearing surface and the bottom of the steel plate is approximately 1/24 of the width of the bearing plate, but not less than 12.7 millimeter 1/2-inch for bearing plate that is less than 300 millimeter 12-inches wide. Support and align bearing plate on steel wedges or shims.

c. After precast concrete columns have been positioned and braced and anchor bolts tightened, grout the space between the top of the bearing surface and the bottom of the steel bearing plate.

Do not remove wedges or shims but, when protruding, cut off flush with the edge of the steel bearing plate prior to grouting.

Install sections plumb, level, and in alignment within the limits of the installation tolerances specified.

3.2.6 Placing Slab Structural Sections

****
NOTE: Delete the paragraph heading and the following paragraphs when slab structural sections, such as single- and double-tee slabs and hollow-cored flat slabs will not be required. Slab structural-sections may be placed over structural-steel framing members, precast structural-concrete framing sections, cast-in-place structural-concrete framing sections, or bearing walls, or a combination thereof.
****

Ensure supporting sections, including bearing pads or plates, are in place before placing of precast sections is started. Slab structural sections are placed on supporting construction with ends bearing on the structural framing sections or bearing walls as indicated. End bearings cannot be less than75 millimeter 3-inches. Accurately align slabs end to end with sides and ends butted together. Provide grouting void at sides and ends of the slabs as indicated.

****
NOTE: Delete the following paragraph when electrical-raceway hollow-cored flat-slab structural sections will not be required.
****

Place electrical raceway hollow-cored flat-slab structural sections in straight alignment for the entire length of run of the hollow cores and with close alignment between hollow cores at the ends of abutting slab structural sections.

3.2.7 Grouting Connections and Joints

****

NOTE: Delete paragraph heading and the following paragraphs when precast structural-concrete framing sections or floor-slab structural sections or both will not be required. When fire-resistance-rated precast structural-concrete sections are required, consult the applicable fire agency's requirements for grouting joints.

****

After precast sections have been placed and connected, grout open spaces at connections and joints.

****

NOTE: Delete the following paragraph when shrink-resistant grout only is required.

****

Ensure cement grout is 1 part cement, 2-1/2 parts of specified aggregate for cement grout, and not more than 17 liter 4-1/2 gallons of water per 42.6 kilogram 94-pound sack of cement.

****

NOTE: Delete the following paragraph when cement grout only is required.

****

Mix shrink-resistant grout compound with potable water to provide a flowable mixture without segregation or bleeding.

Provide forms or other approved methods to retain the grout in place. Pack spaces with grout until the voids are completely filled. At slab structural section interfaces, finish the grout flush with top surface of the slab and remove excess. Keep grout damp for not less than 24 hours.

****

NOTE: Delete the following paragraphs when cement grout only is required or when epoxy-resin grout or adhesive instead of shrink-resistant grout is not required.

****

Epoxy-resin grout or adhesive may be used in lieu of shrink-resistant grout. Ensure installation of epoxy-resin grout or adhesive is in accordance with the manufacturer's printed instructions.

****

NOTE: Delete the following paragraph when electrical raceway hollow-cored flat-slab structural sections are not required.

****

Ensure open spaces at abutting ends of electrical raceway hollow-cored flat-slab structural sections are sealed with pressure-sensitive tape. Keep free from grout and other foreign materials hollow cores use for electrical raceways.

3.2.8 Sealing Joints in Roof Slabs

****

NOTE: Delete paragraph heading and the following paragraphs when roof slab structural sections will not be required. Ensure where fire-resistance-rated roof slab structural sections are required, the applicable fire agency's requirements for sealing joints is consulted.

****

After precast-concrete roof slab sections have been placed and connected, seal open spaces at connections and the top portion of joints.

Fill keyways and joints at ridges, hips, and connections with cement grout. Finish grout level with the top surfaces of slabs, remove excess grout, and apply a smooth finish.

Seal other joints with bituminous joint-sealing material. Center joint-sealing tape over the joint and fill joint with hot bituminous cement. Lap ends not less than 100 millimeter 4-inches. Remove excess bitumen and provide a smooth tape surface.

3.2.9 Field Cut Openings in Slab Structural Sections

****

NOTE: The maximum size of field-cut openings is governed by the spacing of reinforcement and the inside diameter of the voids in hollow-cored flat slabs.

****

Cut and fit sections as required for other work projecting through, or adjacent to, the members. Ensure cuts are straight and at 90 degrees to the surfaces without breaking or spalling the edges. Do not cut reinforcing bars, strands, or wires. Do not allow cut size to exceed inside diameter of voids in hollow core flat slabs.

****

NOTE: Use the following paragraph when hollow-cored flat-slab structural sections are not required. Ensure openings larger than the width of a slab structural section are framed with supporting members.

****

Ensure openings in hollow-core flat-slab sections having any dimension more than the inside diameter of the hollow cores and not exceeding the width of the slab structural section are reinforced by means of hung steel angle saddle headers. Ensure headers are shop prime-coat painted and as indicated on the approved drawings.

3.2.10 Touchup Painting

****
NOTE: Delete paragraph heading and the following paragraph when precast structural-concrete sections will not be supported by steel structural members.
****

Ensure after sections have been installed, scarred surfaces on steel supporting members and weld plates are wire brushed, cleaned, and touchup painted.

3.2.11 Cleaning

Upon completion of installation, swept clean and leave ready slab surfaces to receive concrete floor topping, roofing, or other covering.

3.3 FIELD QUALITY CONTROL

3.3.1 Evaluation of Compressive Strength Tests

Concrete quality control tests will be evaluated as specified.

****
NOTE: Delete the following paragraph when normal-weight concrete will not be required.
****

Do not use normal-weight concrete delivered to the point of placement having a slump or total air content outside the values specified.

****
NOTE: Delete the following paragraph when lightweight structural concrete will not be required.
****

Do not use lightweight structural concrete delivered to the point of placement having a unit weight of fresh concrete that varies more than 2 percent from the design mix wet unit weight or having a slump or total air content outside the values specified.

Compressive-strength tests will be considered satisfactory if the average of any group of 5 consecutive compressive-strength tests that may be selected is in each instance equal to or greater than the 28-day design compressive strength or if not more than one compressive-strength test in 10 has a value less than 90 percent of the 28-day design compressive-strength.

If the compressive-strength tests fail to meet the minimum requirements specified, the fabricated concrete sections represented by such tests will be considered deficient in strength and subject to the provisions specified in the supplemental testing paragraph below.

3.3.2 Dimensional Tolerances

Members having any dimension outside the limits for fabrication tolerances specified will be rejected.

3.3.3 Surface-Finish Requirements

Sections will be rejected for any of the following surface-finish deficiencies:

****

NOTE: Delete the first of the following paragraphs when architectural finishes such as exposed-aggregate finish, are not required for exposed-to-view surfaces.

****

a. Exposed-to-view surfaces having architectural finishes that do not match the color, aggregate size and distribution, and texture of the approved sample for the exposed-to-view finish

b. Exposed-to-view formed surfaces that contain cracks, spalls, air bubbles, honeycomb, rock pockets, or stains or other discoloration that cannot be removed by cleaning

c. Concealed formed surfaces that contain cracks in excess of 0.25 millimeter 0.01 inch wide; cracks or any other surface deficiency that penetrates to the reinforcement regardless of the width of crack or size of other deficiency; honeycomb and rock pockets located in bearing surfaces; and spalls except minor breakage at corners

d. Unformed surfaces that contain cracks and other surface deficiencies as specified for concealed formed surfaces

3.3.4 Strength of Structural Members

Strength of precast structural-concrete sections will be considered deficient if they fail to comply with the requirements that control the strength of the structural members, including the following conditions:

a. Failure to meet compressive strength tests

b. Reinforcement and pretensioning and detensioning of tendons of prestressed concrete not conforming to the requirements specified

c. Concrete curing and protection of structural sections against extremes in temperature during curing not conforming to the requirements specified

d. Structural sections damaged during handling and erection

3.3.5 Supplemental Testing of Deficient Structural Sections for Strength

When there is evidence through concrete cylinder testing that the strength of precast structural-concrete sections do not meet specification requirements, make supplemental compressive strength determinations through the use of cores drilled into the hardened concrete in accordance with ASTM C42/C42M and as follows:

a. Take at least three representative cores from the precast structural concrete sections that are considered potentially deficient. Do not cut reinforcing bars, strands, or wires.

b. Test cores saturated-surface-dry if the concrete they represent will be wet at all times during the use of the completed structure.

c. Test cores air-dry if the concrete they represent will be dry at all times during the use of the completed structure.

d. Strength of cores will be considered satisfactory if their average is equal to or greater than the 28-day design compressive strength of 150 by 300 millimeter 6-by 12-inch cylinders.

Fill core holes solidly with patching mortar and finished to match the adjacent concrete surfaces.

If the results of the core tests are unsatisfactory or if core tests are impractical to obtain, make static load tests of a structural section and evaluated in accordance with ACI/MCP-3 and ACI 318, except that the superimposed test load is as specified for the proof-test method of strength design.

Ensure sections that are found inadequate by the core tests or by the results of static load tests are replaced with sections that meet the specified requirements.

3.3.6 Inspection of Welding

****

NOTE: Delete paragraph heading and the following paragraphs when inspection of welding will not be required.

****

Perform inspection of welding in accordance with[AWS D1.1/D1.1M, Section 6][AWS D1.4/D1.4M, Section 7], and as follows:

****

NOTE: Delete the following paragraphs that are not applicable to the project. Ensure the location of welds requiring inspection and the type of inspection are indicated. The liquid-penetration inspection of welds is the most economical and commonly used method.

****

Ensure liquid-penetration inspection of welds conforms to ASTM E165/E165M.

Conduct Magnetic-particle inspection of welds in conformance with ASTM E709.

3.3.6.1 Weld Acceptance

****

NOTE: Drawings or the text of the contract specifications must specify the weld requirements: tensile strength, elongation, shear strength, size, length, type, and location. Complete penetration welds subject to primary tensile stress or cyclic loading must be identified in the contract drawings for purpose of selecting the correct NDT acceptance criteria.

****

Conform dimensional tolerances for welded construction, details of welds, and quality of welds with the applicable requirements of AWS D1.4/D1.4M and the contract drawings. Perform nondestructive testing by visual inspection [and ultrasonic,] [magnetic particle,] [or] [dye penetrate] methods. The minimum extent of nondestructive testing is a random [_____] percent of welds or joints, as indicated on the drawings. Submit all records of nondestructive testing.

Nondestructive Testing

The welding is subject to inspection and tests in the mill, shop, and field. Inspection and tests in the mill or shop does not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment. Any indication of a defect is regarded as a defect, unless re-evaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

3.3.7 Structural Sections-in-Place

Sections-in-place will be rejected for any one of the following deficiencies:

a. Sections not conforming to the requirements for installation tolerances specified

b. Sections that are damaged during construction operations

c. Sections having exposed-to-view surface finishes that develop surface finish deficiencies specified

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-03 42 13.00 10 (May 2016)**

Preparing Activity: USACE **Superseding**
UFGS-03 40 00.00 10 (August 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 03 - CONCRETE

SECTION 03 42 13.00 10

PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION

05/16

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-03 42 13.00 10 (May 2016)**

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****

SECTION 03 42 13.00 10

PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION
05/16

****

NOTE: This guide specification covers the requirements for precast, non-prestressed concrete products used for below grade construction (Sewage Systems, Subdrainage Systems, Storm Drainage Systems, Utility and Communications Structures, etc.).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

ACPA 01-102	(2000) Concrete Pipe Handbook
ACPA 01-110	(1984) Design Manual for Sulfide and Corrosion Prediction and Control
ACPA QPC	(2021) QCast Plant Certification Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A767/A767M	(2019) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884/A884M	(2019; Errata 1) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing

	Concrete
ASTM C443	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C443M	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM C857	(2016) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C858	(2010; E 2012) Standard Specification for Underground Precast Concrete Utility Structures
ASTM C877	(2021) Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C877M	(2021) Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections (Metric)
ASTM C891	(2020) Standard Practice for Installation of Underground Precast Concrete Utility Structures
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C923	(2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C923M	(2008b; R 2013) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric)
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C990M	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

ASTM C1116/C1116M	(2023) Standard Specification for Fiber-Reinforced Concrete
ASTM C1244	(2020) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM C1244M	(2020) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill (Metric)
ASTM C1478	(2019) Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals
ASTM C1478M	(2019) Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes and Laterals (Metric)

CSA GROUP (CSA)

CSA A23.4	(2016; R 2021) Precast Concrete - Materials and Construction

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

NPCA QC Manual	(2017) Quality Control Manual for Precast and Prestressed Concrete Plants

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy

and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Procedures

SD-02 Shop Drawings

Standard Precast Units; G, [_____]

Custom-Made Precast Units; G, [_____]

Special Finishes

SD-03 Product Data

Standard Precast Units

Proprietary Precast Units

Embedded Items

Accessories

SD-05 Design Data

Design Calculations; G, [_____]

Concrete Mix Proportions

SD-06 Test Reports

Test Reports

SD-07 Certificates

Quality Control Procedures

SD-11 Closeout Submittals

Recycled content for fly ash and pozzolan; S

Recycled content for Ground Iron Blast-Furnace Slag; S

Recycled content for Silica Fume; S

Recycled content for Synthetic Fiber Reinforcement; S

Recycled content for steel; S

1.3 QUALITY ASSURANCE

Demonstrate adherence to the standards set forth in NPCA QC Manual or ACPA QPC. Meet requirements written in the subparagraphs below.

1.3.1 NPCA and ACPA Plant Certification

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NOTE: The use of this paragraph may limit competition. Verify the availability of NPCA and ACPA certified precasters in the bidding area.

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The precast concrete producer must be certified by the National Precast Concrete Association's or the American Concrete Pipe Association's Plant Certification Program prior to and during production of the products for this project.

1.3.2 Qualifications, Quality Control and Inspection

1.3.2.1 Qualifications

Select a precast concrete producer that has been in the business of producing precast concrete units similar to those specified for a minimum of 3 years. The precast concrete producer must maintain a permanent quality control department or retain an independent testing agency on a continuing basis.

1.3.2.2 Quality Control Procedures

Submit quality control procedures established by the precast manufacturer in accordance with NPCA QC Manual and ACPA QPC. Show that the following QC tests are performed as required and in accordance with the ASTM standards indicated.

1.3.2.2.1 Slump

Perform a slump test for each 115 cubic m 150 cu yd of concrete produced, or once a day, whichever comes first. Perform slump tests in accordance with ASTM C143/C143M.

1.3.2.2.2 Temperature

Measure the temperature of fresh concrete when slump or air content tests are made and when compressive test specimens are made in accordance with ASTM C1064/C1064M.

1.3.2.2.3 Compressive Strength

Make at least four compressive strength specimens for each 115 cubic m 150 cubic yards of concrete of each mix in accordance with the following Standards: ASTM C31/C31M, ASTM C192/C192M, ASTM C39/C39M.

1.3.2.2.4 Air Content

Perform tests for air content on air-entrained, wet-cast concrete for each 115 cubic m 150 cu yd of concrete, but not less often than once each day when air-entrained concrete is used. Determine the air content in accordance with either ASTM C231/C231M or ASTM C173/C173M for normal weight aggregates and ASTM C173/C173M for lightweight aggregates.

1.3.2.2.5 Unit Weight

Perform tests for unit weight a minimum of once per week to verify the yield of batch mixes. Perform unit weight tests for each75 cubic m 100 cu yd of lightweight concrete in accordance with ASTM C138/C138M.

1.3.2.3 Inspection

The Contracting Officer may place a Government Quality Assurance inspector in the plant when the units covered by this specification are being manufactured. The precast concrete producer must give notice 14 days prior to the time production of the units will commence, as well as 14 days prior to when the completed units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.3.2.4 Test Reports

Submit the following:

1.3.2.4.1 Material Certifications or Laboratory Test Reports

Include mill tests and all other test data, for portland cement, blended cement, pozzolans, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

1.3.2.4.2 Mix Test

Submit reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Such tests may include compressive strength, flexural strength, plastic or hardened air content, freeze thaw durability, abrasion and absorption. Clearly detail in the specifications special tests for precast concrete or cast-in items.

1.3.2.4.3 Self-Consolidating Concrete

Submit sufficient documentation, when the use of self-consolidating concrete (SCC) is proposed, showing a minimum of 30-days production track records demonstrating that SCC is appropriate for casting of the product.

1.3.2.4.4 In-Plant QA/QC Inspection Reports

Submit inspection reports upon the request of the Contracting Officer.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver precast units to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite, all precast concrete units will be inspected by the Contracting Officer for quality and final acceptance.

1.4.2 Storage

Store units off the ground or in a manner that minimizes potential damage.

1.4.3 Handling

Handle, transport, and store products in a manner to minimize damage. Lifting devices or holes must be consistent with industry standards. Perform lifting with methods or devices intended for this purpose as indicated on shop drawings.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Furnish precast concrete units designed and fabricated by an experienced and acceptable precast concrete manufacturer who has been, for at least three years, regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings. Coordinate precast work with the work of other trades. Below grade structures must comply with ASTM C858.

2.1.1 Standard Precast Units

Design standard precast concrete units to withstand indicated design load conditions in accordance with applicable industry design standards ACI 318M ACI 318, ASTM C857[, ACPA 01-102, Chapter 7-Design for Sulfide Control]. Design must also consider stresses induced during handling, shipping and installation as to avoid product cracking or other handling damage. Indicate design loads for precast concrete units on the shop drawings. Submit drawings for standard precast concrete units furnished by the precast concrete producer for approval by the Contracting Officer. These drawings must demonstrate that the applicable industry design standards have been met. Include installation and construction information on shop drawings. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings. Submit cut sheets, for standard precast concrete units, showing conformance to project drawings and requirements, and to applicable industry design standards listed in this specification.

2.1.2 Custom-Made Precast Units

Submit design calculations for custom-made precast units, prepared and sealed by a registered professional engineer, for approval prior to fabrication. Include in the calculations the analysis of units for lifting stresses and the sizing of lifting devices. Submit drawings furnished by the precast concrete producer for approval by the Contracting Officer. Show on these drawings complete design, installation, and construction information in such detail as to enable the Contracting Officer to determine the adequacy of the proposed units for the intended purpose. Include details of steel reinforcement size and placement as well as supporting design calculations, if appropriate. Produce precast concrete units in accordance with the approved drawings.

2.1.3 Proprietary Precast Units

Products manufactured under franchise arrangements must conform to all the requirements specified by the franchiser. Items not included in the franchise specification, but included in this specification, must conform to the requirements in this specification. Submit standard plans or informative literature, for proprietary precast concrete units. Make available supporting calculations and design details upon request. Provide sufficient information as to demonstrate that such products will perform the intended task.

2.1.4 Joints and Sealants

Provide joints and sealants between adjacent units of the type and configuration indicated on shop drawings meeting specified design and performance requirements.

2.1.5 Concrete Mix Design

2.1.5.1 Concrete Mix Proportions

Base selection of proportions for concrete on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportions using the same type and brand of cement, the same type and brand of pozzolan, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete containing reinforcing steel or other embedded metal items. At a minimum of thirty days prior to precast concrete unit manufacturing, the precast concrete producer will submit a mix design and proportions for each strength and type of concrete that will be used. Furnish a complete list of materials, including quantity, type, brand and applicable data sheets for all mix design constituents as well as applicable reference specifications. The use of self-consolidating concrete is permitted, provided that mix design proportions and constituents meet the requirements of this specification.

2.1.5.2 Concrete Strength

Provide precast concrete units with a 28-day compressive strength (f'c) of [_____] MPa psi.

2.1.5.3 Water-to-Cement Ratio

Where exposed to freezing and thawing, furnish concrete containing entrained air and with a water-cementitious ratio of 0.45 or less. Where not exposed to freezing, but required to have a low permeability, furnish concrete with a water-cementitious ratio of 0.48 or less. Where exposed to deicer salts, brackish water, or seawater, furnish concrete with a water-cementitious ratio of 0.40 or less, for corrosion protection.

2.1.5.4 Air Content

The air content of concrete that will be exposed to freezing conditions must be within the limits given below.

	AIR CONTENT PERCENT	
NOMINAL MAXIMUM AGGREGATE SIZE	EXPOSURE CLASS F1	EXPOSURE CLASSES F2 and F3
10 mm3/8 inch	6.0	7.5
13 mm1/2 inch	5.5	7.0
19 mm3/4 inch	5.0	6.0
25 mm1.0 inch	4.5	6.0
38 mm1.5 inch	4.5	5.5
Note: For specified compressive strengths greater than 34.5 MPa 5000 psi, air content may be reduced 1 percent		

2.1.5.5 Corrosion Control for Sanitary Sewer Systems

Follow design recommendations outlined in Chapter 7 of ACPA 01-102 or the ACPA 01-110 when hydrogen sulfide is indicated as a potential problem.

2.2 MATERIALS

Except as otherwise specified in the following paragraphs, conform material to Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.2.1 Material Sustainability Criteria

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan
b. Recycled content for Ground Iron Blast-Furnace Slag
c. Recycled content for Silica Fume
d. Recycled content for Synthetic Fiber Reinforcement
e. Recycled content for steel, 75 percent minimum

2.2.2 Pigments

Non-fading and lime-resistant

2.2.3 Reinforcement

2.2.3.1 Reinforcing Bars

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NOTE: Specify ASTM A706/A706M reinforcing where welding or bending of reinforcement bars is important. In addition, ASTM A775/A775M epoxy coated reinforcing may be specified where extra reinforcement corrosion protection is required.

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a. Deformed Billet-steel: ASTM A615/A615M

b. Deformed Low-alloy steel: ASTM A706/A706M

2.2.3.2 Reinforcing Wire

a. Plain Wire: ASTM A1064/A1064M

b. Deformed Wire: ASTM A1064/A1064M

2.2.3.3 Welded Wire Reinforcement

a. Plain Wire: ASTM A1064/A1064M

b. Deformed Wire: ASTM A1064/A1064M

2.2.3.4 Epoxy Coated Reinforcement

a. Reinforcing Bars: ASTM A775/A775M

b. Wires and Welded Wire: ASTM A884/A884M

2.2.3.5 Galvanized Reinforcement

Provide galvanized reinforcement conforming to ASTM A767/A767M.

2.2.4 Synthetic Fiber Reinforcement

Provide fiber reinforced concrete in accordance with ASTM C1116/C1116M Type III, synthetic fiber reinforced concrete, and as follows. Synthetic reinforcing fibers must be [100 percent virgin] monofilament polypropylene fibers[, with a minimum of [5][10][_____] percent post-consumer recycled content, or a minimum of [20][40][_____] percent post-industrial recycled content]. Provide fibers that have a specific gravity of 0.9, a minimum tensile strength of 480 MPa 70 ksi, graded per manufacturer, and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. [Toughness indices must meet requirements for performance level I.]

2.2.5 Inserts and Embedded Metal

All items embedded in concrete must be of the type required for the intended task, and meet the following standards.

a. Structural Steel Plates, Angles, etc.: ASTM A36/A36M

b. Hot-dipped Galvanized: ASTM A153/A153M

c. Proprietary Items: In accordance with manufacturers published literature

2.2.6 Accessories

Submit proper installation instructions and relevant product data for items including, but not limited to, sealants, gaskets, connectors, steps, cable racks and other items installed before or after delivery.

a. Rubber Gaskets for Circular Concrete Sewer Pipe and Culvert Pipe: ASTM C443M ASTM C443.

b. External Sealing Bands for Noncircular Sewer, Storm Drain and Culvert Pipe: ASTM C877M ASTM C877.

c. Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections: ASTM C990M ASTM C990.

d. Elastomeric Joint Sealants: ASTM C920

2.2.7 Pipe Entry Connectors

Pipe entry connectors must conform to ASTM C923M ASTM C923 or ASTM C1478M ASTM C1478.

2.2.8 Grout

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NOTE: Delete air-entraining requirements when the project is located in a nonfreezing climate.

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Nonshrink Grout must conform to ASTM C1107/C1107M. Cementitious grout must be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. [Provide air entrainment for grout exposed to the weather.]

PART 3 EXECUTION

3.1 FABRICATION AND PLACEMENT

Perform fabrication in accordance with NPCA QC Manual or ACPA QPC unless specified otherwise.

3.1.1 Forms

Use forms, for manufacturing precast concrete products, of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Construct forms so that the forces and vibrations to which the forms will be subjected can cause no product damage. Clean forms of concrete build-up after each use. Apply form release agents according to the manufacturers recommendations and do not allow to build up on the form casting surfaces.

3.1.2 Reinforcement

Follow applicable ASTM Standard or ACI 318MACI 318 for placement and splicing. Fabricate cages of reinforcement either by tying the bars, wires or welded wire reinforcement into rigid assemblies or by welding, where permissible, in accordance with AWS D1.4/D1.4M. Position reinforcing as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover must be one-third of that specified but not more than 13 mm 1/2 inch. Provide concrete cover not less than 13 mm 1/2 inch. Take positive means to assure that the reinforcement does not move significantly during the casting operations.

3.1.3 Embedded Items

Position embedded items at locations specified in the design documents. Perform welding in accordance with AWS D1.1/D1.1M when necessary. Hold rigidly in place inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products so that they do not move significantly during casting operations. Submit product data sheets and proper installation instruction for anchors, lifting inserts and other devices. Clearly indicate the products dimensions and safe working load.

3.1.4 Synthetic Fiber Reinforced Concrete

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NOTE: Synthetic fiber reinforcement may be used in concrete as an aid in preventing plastic or shrinkage cracking in placements susceptible to this condition. Fiber reinforcement will not be used as a substitute for wire mesh and where service temperature may exceed 150 degrees C 300 degrees F. Concentrations above 0.1 percent by volume are not cost-effective.

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Add fiber reinforcement to the concrete mix at the batch plant in accordance with the applicable sections of ASTM C1116/C1116M and the recommendations of the manufacturer. Use a minimum of 0.9 kg of fibers per cubic meter 1.5 pounds of fibers per cubic yard of concrete.

3.2 CONCRETE

3.2.1 Concrete Mixing

Mixing operations must produce batch-to-batch uniformity of strength, consistency, and appearance.

3.2.2 Concrete Placing

Deposit concrete into forms as near to its final location as practical. Keep the free fall of the concrete to a minimum. Consolidate concrete in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Use vibrators to consolidate concrete with frequencies and amplitudes sufficient to produce well consolidated concrete.

3.2.2.1 Cold Weather Concreting

Perform cold weather concreting in accordance with ACI 306.1.

a. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.

b. All concrete materials, reinforcement, forms, fillers, and ground with which concrete is to come in contact must be free from frost.

c. Do not use frozen materials or materials containing ice.

d. In cold weather the temperature of concrete at the time of placing must not be below8 degrees C 45 degrees F. Discard concrete that freezes before its compressive strength reaches 3.45 MPa 500 psi.

3.2.2.2 Hot Weather Concreting

Follow recommendations for hot weather concreting in ACI 305R. During hot weather, give proper attention to constituents, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing must not exceed 32 degrees C 90 degrees F.

3.2.3 Concrete Curing

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NOTE: Due to the immediacy of form removal, dry-cast products have a tendency to undergo undesirable accelerated drying. Consequently, early curing periods are most critical to ensure protection from extreme temperatures and dryness. Dry-cast products must be protected from drafts to prevent cracking.

****

Commence curing immediately following the initial set and completion of surface finishing.

3.2.3.1 Curing by Moisture Retention

Prevent moisture evaporation from exposed surfaces until adequate strength for stripping is reached by one of the following methods:

a. Cover with polyethylene sheets a minimum of 0.15 mm 6 mils thick in accordance with ASTM C171.

b. Cover with burlap or other absorptive material and keep continually moist.

c. Use a membrane-curing compound, conforming to ASTM C309 and applied at a rate not less than 19 square m/4L 200 square ft/gallon, or in accordance with manufacturers' recommendations.

3.2.3.2 Curing with Heat and Moisture

****

NOTE: Cure surfaces that will be exposed to weather during service, a minimum of 3 days. Forms should be considered effective in preventing evaporation from the contact surfaces. If air temperature is below 10 degrees C 50°F the curing period must be extended.

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Do not subject concrete to steam or hot air until after the concrete has attained its initial set. Apply steam, if used, within a suitable enclosure, which permits free circulation of the steam in accordance with CSA A23.4. If hot air is used for curing, take precautions to prevent moisture loss from the concrete. The temperature of the concrete must not be permitted to exceed 65 degrees C 150 degrees F. These requirements do not apply to products cured with steam under pressure in an autoclave.

3.2.4 Surface Finish

Finish unformed surfaces of wet-cast precast concrete products as specified. If no finishing procedure is specified, finish such surfaces using a strike-off to level the concrete with the top of the form.

3.2.4.1 Formed Non-Architectural Surfaces

Cast surfaces against approved forms following industry practices in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be accepted but no major imperfections, honeycombs or other major defects will be permitted.

3.2.4.2 Unformed Surfaces

Finish unformed surfaces with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be accepted. Major imperfections, honeycombs, or other major defects are not permitted.

3.2.4.3 Special Finishes

Troweled, broom or other finishes must be according to the requirements of project documents and performed in accordance with industry standards or supplier specifications. Submit finishes for approval when required by the project documents. The sample finishes must be approved prior to the start of production.

3.2.5 Stripping Products from Forms

Do not remove products from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal.

3.2.6 Patching and Repair

No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.

3.2.6.1 Repairing Minor Defects

Defects that will not impair the functional use or expected life of a precast concrete product may be repaired by any method that does not impair the product.

3.2.6.2 Repairing Honeycombed Areas

When honeycombed areas are to be repaired, remove all loose material and cut back the areas into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Use proprietary repair materials in accordance with the manufacturer's instructions. If a proprietary repair material is not used, saturate the area with water. Immediately prior to repair, the area should be damp, but free of excess water. Apply a cement-sand grout or an approved bonding agent to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

3.2.6.3 Repairing Major Defects

Evaluate, by qualified personnel, defects in precast concrete products which impair the functional use or the expected life of products to determine if repairs are feasible and, if so, to establish the repair procedure.

3.2.7 Shipping Products

Do not ship products until they are at least five days old, unless it can be shown that the concrete strength has reached at least 75 percent of the specified 28-day strength, or that damage will not result, impairing the performance of the product.

3.3 INSTALLATION

3.3.1 Site Access

It is the Contractor's responsibility to provide adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.

3.3.2 General Requirements

a. Install precast concrete products to the lines and grades shown in the contract documents or otherwise specified.

b. Lift products by suitable lifting devices at points provided by the precast concrete producer.

c. Install products in accordance with the precast concrete producer's instructions. In the absence of such instructions, install underground utility structures in accordance with ASTM C891. Install pipe and manhole sections in accordance with the procedures outlined by the American Concrete Pipe Association.

d. Field modifications to the product will relieve the precast producer of liability even if such modifications result in the failure of the product.

3.3.3 Water Tightness

Where water tightness is a necessary performance characteristic of the precast concrete product's end use, watertight joints, connectors and inserts should be used to ensure the integrity of the entire system.

3.4 FIELD QUALITY CONTROL

****

NOTE: Manholes should be tested prior to backfilling to verify the integrity of the installed product. Testing prior to backfilling facilitates quick and easy repair when required. When vacuum testing a backfilled manhole, appropriate adjustments must be made to the testing procedure to account for site conditions such as high water tables as to avoid over loading boots and connectors. Prior to vacuum testing, make calculations to ensure that connectors and boots are not loaded past the design limit as indicated in ASTM C923.

****

3.4.1 Site Tests

When water tightness testing is required for an underground product, use one of the following methods:

3.4.2 Vacuum Testing

Prior to backfill vacuum test system according to ASTM C1244M ASTM C1244.

3.4.3 Water Testing

Perform water testing according to the contract documents and precast concrete producer's recommendations.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-03 44 00 (February 2013)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-03 44 00 (February 2013)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 03 44 00

REINFORCED AUTOCLAVE AERATED CONCRETE PANELS
02/13

****
NOTE: This guide specification covers the requirements for fabrication and erection of reinforced precast autoclave aerated concrete (PAAC) panels, used as structural floor units, and roof units and wall units for buildings.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: Precast autoclave aerated concrete (PAAC) floor, roof, and wall units for clear spans up to 5.94 meters 19 feet 6 inches

Drawings must include a complete design indicating the character of the work to be performed and giving the following:

Assumed loads, including floor live load, roof live load, wind load, concentrated loads such as partitions, and equipment mounted on or suspended from precast concrete construction, concrete floor

topping weight, and other design data as may be required for the proper preparation of shop drawings.

Layout of the framing system indicating the relative location of the structural PAAC sections, floor elevations, column centers and offsets, openings, and sufficient dimensions to adequately convey the quantity and nature of the required structural PAAC framing system.and/or elements.

Details of all structural PAAC Sections indicating cross-sections and dimensions.

Location of structural PAAC Sections having an architectural finish on exposed-to-view surfaces when required.

;Details of reinforcement indicating smooth welded wire reinforcing schedule for PAAC panels as required

Details of connections indicating end bearing minimums and anchorage devices in the structural PAAC sections.

Location and details of concrete floor topping, when required.

Details of openings including the size of steel framing members as required.

Details of precast concrete filler blocks, as required.

Details of hangers for suspended ceilings, ducts, piping, lighting fixtures, conduit, or other construction, as required.

When both fire-resistance-rated construction and nonrated construction are required, the location of fire-resistance-rated construction.

Cast-in-place normal-weight concrete, including concrete floor topping, is specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

Precast conventionally reinforced concrete wall panels, solid-section type, are specified in Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE.

Precast-concrete roof slabs placed over purlins or joists spaced not more than 2.4 m 8 feet on center are specified in Section 03 41 16.08 PRECAST CONCRETE SLABS (MAX. SPAN 8 FEET 0.C).

Sealing joints in exposed-to-view surfaces of PAAC slabs, such as at ceilings and walls, is specified in Section 07 92 00 JOINT SEALANTS.

Painting exposed-to-view surfaces of PAAC units such

as ceilings, is specified in Section 09 90 00 PAINTS AND COATINGS.

Fire-resistance-rated construction using PAAC sections is described in Underwriters Laboratories, Inc., "Fire Resistance Ratings (BXUV)" included in UL Fire Resistance Directory and the "Fire-Resistance Ratings" contained in AIA CO-1. Fire-resistance-rated construction limits the types of structural PAAC sections; the requirements for end restraint; the PAAC materials and proportions of concrete mix for floor top fill; the requirements for grouting and sealing joints; and the type of roof insulation and roof covering.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 200	(1973; R 2012) Standard Specification for Epoxy Protective Coatings

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 523.4R	(2009) Guide for Design and Construction with Autoclaved Aerated Concrete Panels
ACI 530/530.1	(2013) Building Code Requirements and

	Specification for Masonry Structures and Related Commentaries
ACI/MCP-2	(2015) Manual of Concrete Practice Part 2
ACI/MCP-3	(2015) Manual of Concrete Practice Part 3

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A675/A675M	(2014) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C404	(2024) Standard Specification for Aggregates for Masonry Grout
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars

ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1452	(2000; R 2006) Standard Specification for Reinforced Autoclaved Aerated Concrete Elements
ASTM C1660	(2010) Standard Specification for Thin-bed Mortar for Autoclaved Aerated Concrete (AAC) Masonry
ASTM C1693	(2011) Standard Specification for Autoclaved Aerated Concrete (AAC)
ASTM C1694	(2009) Standard Specification for Reinforced Autoclaved Aerated Concrete (AAC) Elements
ASTM D312/D312M	(2016a) Standard Specification for Asphalt Used in Roofing
ASTM D2103	(2015) Standard Specification for Polyethylene Film and Sheeting
ASTM D4397	(2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS MMM-A-001993	(1978; Rev A) Adhesive, Epoxy, Flexible, Filled (For Binding, Sealing, and Grouting)
FS UU-B-790	(Rev A; Notice 2) Building Paper Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant)

UL SOLUTIONS (UL)

UL Fire Resistance	(2014) Fire Resistance Directory

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Conference

Prior to installation of reinforced PAAC panels, schedule and hold a pre-installation conference to review scope of the work. Attendees will include a representative from each subcontractor involved with reinforced PAAC panels and adjacent construction material installation. Notify Contracting Officer at least seven days prior to the meeting.

1.2.2 Sequencing and Scheduling of PAAC element Installation

1.2.2.1 Panel Loadign

Loading AAC wall panels is prohibited prior to the following:

Uniform floor or roof loads	12 hours, minimum
Concentrated loads	Three days, minimum

1.2.2.2 Construction Activities Coordination

a. Work required under this Section includes chase and routing coordination with construction activities specified in other Specification Sections.

b. As panel installation is completed, coordinate with work required in other Specification Sections for chases or routing areas required in AAC panels for electrical, plumbing, and other items.

c. Request relevant construction activities to mark actual routing or chase locations; include required depth.

d. Filling in chases and routed areas specified in other Specification Sections.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification

and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, [_____]

Installation Drawings; G, [_____]

Reinforcement; G, [_____]

SD-04 Samples

PAAC Framing Mock-up; G, [_____]

SD-05 Design Data

Design Mix; G, [_____]

SD-06 Test Reports

Fabrication

Compressive Strength

Moisture Content

Dry Bulk Density

Drying Shrinkage

Modulus of Elasticity

SD-07 Certificates

PAAC Manufacturer

Installer

Qualifications for Welding Work

SD-08 Manufacturer's Instructions

Welding Sequence and Procedure

Epoxy-Resin Grout

1.4 PERFORMANCE REQUIREMENTS

1.4.1 Design Methods

For PAAC elements, design in accordance with ACI 523.4R. Also design PAAC wall elements in accordance with ACI 530/530.1, Chapter 11 entitled "Strength Design of Autoclaved Aerated Concrete Masonry". Determine Weld-Point Shear Strength in the reinforcement of PAAC panels in accordance with ASTM C1694, Section 8, and conform to the requirements in ASTM C1694, Table 2.

1.4.2 Allowable Design Loads and Deflections

****

NOTE: Allowable design loads must be indicated and include dead loads, live loads, stationary loads, concentrated moving loads, deflection of roof slab sections, etc.

Recommended design loads are specified in article ix of the National Building Code, recommended by the American Insurance Association AIA CO-1 and ANSI A58.1.

****

Allowable design loads and deflections are as indicated.

1.4.3 UL Fire-Resistance Listing and Label

****

NOTE: Delete paragraph heading and the following paragraph when UL-listed fire-resistant structural PAAC sections are not required. The UL lists several manufacturers of PAAC panels. Location and fire-resistance classification of fire-resistant-rated structural sections must be indicated.

****

Sections indicated requiring a fire-resistance classification must be listed in UL Fire Resistance, part entitled, "Precast Concrete Units (CFTV)," and bear the UL label and marking.

1.5 DRAWINGS

Show type and location of all reinforcement, size and spacing of welds within Fabrication Drawings. Indicate loads used for the design of reinforced AAC panels.

Indicate type and location of all anchorage devices, size and spacing of all welded connections, grouting and joint sealant details, and dimensions and locations of all openings in structural concrete sections within Installation Drawings. Indicate dimensions of panels, arrangement of joints, reinforcement, and erection details. Include location of openings fabricated in panels. Identify reinforced AAC panels with mark used on shop drawings. Locate identifying marks on surfaces not visible in installed configuration. Indicate AAC Strength Class - AC4, AC4.4 or AC6.

1.6 QUALITY CONTROL

1.6.1 Qualifications for PAAC Manufacturer

Provide structural PAAC sections manufactured by an organization experienced in the manufacture of reinforced PAAC sections. Submit a written description of the manufacturer giving the qualifications of personnel, location of plant, concrete batching facilities, manufacturing equipment and facilities, list of projects similar to specified work, and that the PAAC material and panels are manufactured in accordance with ASTM C1693, and ASTM C1694. (these ASTM specs supersede ASTM C1452).

1.6.2 Qualifications For Installer

Install members by an organization experienced in the installation of precast PAAC members, if applicable. Submit a written description of installers giving the qualifications of personnel, handling and erection equipment, list of projects similar to specified work, and other information as may be required.

1.6.3 Qualifications For Welding Work

[Section 05 05 23.16 STRUCTURAL WELDING applies to work specified in this section.][[Perform welding procedures in accordance with AWS D1.1/D1.1M.] [Provide welders that are qualified by tests in accordance with AWS D1.1/D1.1M.] [Welders are to make only those types of weldments for which each is specifically qualified.]]

Provide installation instructions for the Welding Sequence and Procedure which indicates the manufacturer's recommended sequence and method of installation.

1.6.4 Concrete Sampling and Testing

1.6.4.1 Tests for Concrete Materials

****

NOTE: Manufacturers of precast Autoclaved Aerated Concrete(PAAC) typically have proprietary mixes/recipes to produce AAC material for meeting the various ASTM-designated strength classifications, and therefore have various inspection and testing requirements unique to their raw materials and proprietary recipe specifications. The following are a list of sample raw material testing requirements for PAAC. (Note: some requirements may be satisfied by a "certificate of analysis" from the raw material supplier based on testing performed prior to shipment of material to PAAC manufacturer).

****

Sample and test concrete materials proposed for use in the work as follows:

MATERIAL		
REQUIREMENT	TEST METHOD	NUMBER OF TESTS
QUICKLIME FOR AAC		
Total Calcium Oxide	"certificate of analysis" from the supplier	certificate per truck delivered to the manufacturer
Total Magnesium Oxide Content	"certificate of analysis" from the supplier	certificate per truck delivered to the manufacturer
Percent retained on 90 µm No. 170	"certificate of analysis" from the supplier	certificate per truck delivered to the manufacturer
Temperature rise during wet slaking process	"certificate of analysis" from the supplier	certificate per truck delivered to the manufacturer
CEMENT FOR AAC		
Total CaO content	"certificate of analysis" from the supplier	certificate monthly from each supplier
Equivalent Alkali content	"certificate of analysis" from the supplier	certificate monthly from each supplier
Blaine Fineness	"certificate of analysis" from the supplier	certificate monthly from each supplier
Mill Report from supplier certifying it meets ASTM C150/C150M, Table 1, for Type I/II cement	"certificate of analysis" from the supplier	certificate monthly from each supplier
SAND FOR AAC		
SiO2 content	"certificate of analysis" from the supplier	certificate every 90 days per each source
Clay content	manufacturer proprietary requirement	test each delivery of sand received
Alkali (Na2O and K2O) content	"certificate of analysis" from the supplier	certificate every 90 days per each source
Percent retained on 2.8 mm No. 7	"certificate of analysis" from the supplier	test each delivery of sand received
Percent retained on 1 mm No. 18	"certificate of analysis" from the supplier	test each delivery of sand received
GYPSUM OR ANHYDRITE FOR AAC		

MATERIAL		
REQUIREMENT	TEST METHOD	NUMBER OF TESTS
SO3 content	"certificate of analysis" from the supplier	certificate every 90 days per each source
Blended Gypsum and Anhydrite	"certificate of analysis" from the supplier	certificate every 90 days per each source
Percent retained on 90 µm No. 170	"certificate of analysis" from the supplier	certificate every 90 days per each source
SLAG FOR AAC		
Sulfide Sulfur (S) content	"certificate of analysis" from the supplier	certificate every 90 days per each source
Sulfur Trioxide (SO3) content	"certificate of analysis" from the supplier	certificate every 90 days per each source
Slag Activity Index, percent, @ 7 days,	"certificate of analysis" from the supplier	certificate every 90 days per each source
Slag Activity Index, percent, @ 28 days	"certificate of analysis" from the supplier	certificate every 90 days per each source
Percent retained on 45 µm No. 325 sieve	"certificate of analysis" from the supplier	certificate every 90 days per each source
Air content	"certificate of analysis" from the supplier	certificate every 90 days per each source
Mill Report certifying it meets ASTM C989/C989M (for "Ground Granulated Blast Furnace Slag for Use in Concrete and Mortars"	"certificate of analysis" from the supplier	certificate every 90 days per each source
ALUMINUM POWDER FOR AAC		
Meet PAAC manufacturer specifications	"certificate of analysis" from the supplier	certificate per each source per batch delivered to manufacturer
RECYCLE SLURRY FOR AAC		
Density	manufacturer requirements for using recycle slurry in AAC in accordance with proprietary recipe requirements	test recycle slurry each mixing day, prior to using it in recipes that day

MATERIAL		
REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Moisture	manufacturer requirements for using recycle slurry in AAC in accordance with proprietary recipe requirements	test recycle slurry each mixing day, prior to using it in recipes that day

1.6.4.2 Concrete Design Mixes

****

NOTE: Delete the types of concrete and tests not required.

****

Determine and test concrete design mix for autoclaved aerated concrete used as follows. Include within each test report the project name and number, date, name of Contractor, name of PAAC manufacturer, name of concrete testing service, strength class of PAAC mix, identification /mark numbers of structural-members cast with tested batch

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Proprietary mix to meet specified strength class requirements for compressive strength and dry bulk density	manufacturer's proprietary recipe	various certifications and testing of raw material and mixed AAC material
Compressive strength (typically tested 1 to 7 days after casting)	ASTM C1693	3 cube specimens, per autoclave-cured batch, for each strength class of AAC material cured in that autoclave
Compressive strength (typically tested 1 to 3 days after casting; this is additional testing by manufacture to verify density sooner than 7 days)	ASTM C1693, except specimens are larger than the 4 inch cubes noted in ASTM C1693.	3 specimens tested from each autoclave-cured batch, for each strength class of AAC material cured in that autoclave
Moisture content (typically tested 1 to 7 days after casting)	ASTM C1693	3 cube specimens, per autoclave-cured batch, for each strength class of AAC material cured in that autoclave

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Dry bulk density (typically tested 1 to 7 days after casting)	ASTM C1693	3 cube specimens, per autoclave-cured batch, for each strength class of AAC material cured in that autoclave
Dry bulk density (typically tested 1 to 3 days after casting; this is additional testing by manufacturer to verify density sooner than 7 days)	ASTM C1693, except specimens are larger than the 4 inch cubes noted in ASTM C1693.	3 specimens tested from each autoclave-cured batch, for each strength class of AAC material cured in that autoclave
Drying shrinkage	ASTM C1693	annual test for each strength class recipe made by the manufacturer
Modulus of elasticity	ASTM C1693	annual test for each strength class recipe made by the manufacturer

[1.6.5 PAAC Framing Mock-up

Build a mock-up demonstrating the following features:

a. Mortar joints.
b. Control joint complete with joint sealant.
c. Workmanship.
[d. Reinforcement in joints.]
e. Flashing.
f. Exterior finishes.
g. Interior finishes.

Prepare mock-up at least 14 days prior to beginning PAAC unit work. Should mock-up be disapproved, prepare additional mock-ups until approved. Maintain mock-up throughout work as a standard of PAAC unit work. Do not destroy mock-up until directed.

]1.7 DELIVERY, STORAGE, AND HANDLING PAAC ELEMENTS

1.7.1 Packing and Shipping of PAAC Elements:

Transport and handle reinforced AAC panels with equipment designed to protect panels from strain, warping, cracking, chipping, or staining. Placing reinforced AAC panels in direct contact with earth is prohibited.

1.7.2 Storage and Protection of PAAC Elements:

Store to protect from strain, warping, cracking, chipping, or staining. Store in same position as transported. Store on firm, level, smooth surface. Place so identification marks are easily discernible.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

2.1.1 Aggregates

Size aggregates in accordance with the AAC manufacturer specification, using ASTM C33/C33M for reference.

2.1.2 Portland Cement

Provide portland cement conforming to ASTM C150/C150M, as set forth in Table 1 for Type I/II cement. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.1.3 Ground Granulated Blast Furnace (GGBF) Slag

****

NOTE: Ground granulated blast furnace slag is one of the materials listed in the EPA's Comprehensive Procurement Guidelines(CPG)(http://www.epa.gov/cpg/). If the Architect/Engineer determines that use of certain materials meeting the CPG content standards and guidelines would result in inadequate competition, do not meet quality/performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/Engineer may submit written justification and supporting documentation for not procuring designated items containing recovered material.

****

GGBF slag [is required as an admixture and] [used as an admixture] must conform to ASTM C989/C989M to the extent identified by the AAC manufacturer, in addition to conforming to other specifications required by the AAC manufacturer's proprietary mix design.

2.1.4 Air Entraining Admixture

Provide admixture that is free of sodium chloride and nitrates and conforms to ASTM C260/C260M.

2.1.5 Water

Use potable water.

2.2 REINFORCEMENT MATERIALS

****

NOTE: Delete the following reinforcement materials that are not required. Concrete reinforcement materials are required for both conventionally reinforced and structural PAAC sections.

****

2.2.1 Reinforcement Bars

Provide deformed bars conforming to ASTM A615/A615M, Grade 60, except that

9.5 millimeter diameter Number 3 bars may be Grade 40.

2.2.2   Cold-Drawn Steel Wire

Provide wire reinforcement conforming to ASTM A1064/A1064M and the requirements in ASTM C1694, Table 1. Weld-Point Shear Strength in the reinforcement must conform to the requirements in ASTM C1694, Table 2. Apply a corrosion protective coating of appropriate material for reinforcement for PAAC elements. Determine the effectiveness of the corrosion protection for the steel reinforcement as noted in ASTM C1694.

2.3   CONNECTION MATERIALS

2.3.1   Steel Plates

Provide plates conforming to ASTM A283/A283M, Grade C[, or to ASTM A36/A36M].

2.3.2   Steel Shapes

Provide structural-steel shapes conforming to ASTM A36/A36M.

2.3.3   Steel Bars

Provide bar shapes, flats, and rounds conforming to ASTM A675/A675M, Grade 65[, or ASTM A36/A36M].

2.4   GROUTING MATERIALS

****

NOTE: Delete the following paragraphs that are not applicable to the project. When fire-resistance rated structural PAAC sections are required, the applicable fire agency's requirements for grouting materials must be consulted.

****

****

NOTE: Ground granulated blast furnace slag is one of the materials listed in the EPA's Comprehensive Procurement Guidelines (CPG)(http://www.epa.gov/cpg/). If the Architect/Engineer determines that use of certain materials meeting the CPG content standards and guidelines would result in inadequate competition, do not meet quality/ performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/Engineer may submit written justification and supporting documentation for not procuring designated items containing recovered material.

****

[2.4.1   Cement Grout

[Portland cement must conform to ASTM C150/C150M, Type I.][Blended hydraulic cement must conform to ASTM C595/C595M, Type [_____].] Aggregate for cement grout must conform to ASTM C404, Size No. 2.

][2.4.2 Shrink-Resistant Grout

Provide premixed and packaged ferrous aggregate shrinkage-resistant grouting compound conforming to ASTM C1107/C1107M, for expansive grouts.

][2.4.3 Epoxy-Resin Grout

[Provide two-component, mineral-filled, epoxy-polysulfide epoxy-resin grout conforming to FS MMM-A-001993, Type I.][Provide two-component, epoxy-polyamide cured type epoxy-resin adhesive conforming to AASHTO M 200.]

]2.5 BITUMINOUS JOINT SEALING MATERIALS

****

NOTE: Delete this paragraph when single- or double-tee roof slab structural sections are not required.

****

Use asphalt bituminous cement conforming to ASTM D312/D312M, Type IV. Use 150 millimeter 6 inches wide joint sealing tape; multilayered, asphalt treated, glass-fiber reinforced, conforming to [ASTM D2103] [ASTM D4397] [FS UU-B-790, Type I, Grade C, Style 4,]. However, a dry tensile strength less than 6130 Newton per meter 35 pounds per inch width, both directions, is not acceptable.

2.6 FABRICATION

2.6.1 Fabrication Tolerances

Fabricate sections within the following tolerances as stated in ASTM C1694

Length	Plus or minus 5 mm 0.2 inch
Width	Plus or minus 3 mm 1/8 inch
Thickness	Plus or minus 3 mm 1/8 inch
Tongue/Groove Alignment	Plus or minus 3 mm 1/8 inch

2.6.2 Forms

****

NOTE: Structural-section dimensions, cross-sections, and other details as required by the project must be indicated.

****

Use forms and form-facing materials that are nonreactive with concrete. Conform to the shapes, lines, and dimensions indicated and adhere to the specified fabrication tolerances.

2.6.3 Reinforcement

****

NOTE: Reinforcement types, sizes, and arrangement as required for structural strength after the

structural sections have been installed must be indicated.

Revise the following paragraphs when not applicable to the project. Concrete cover for reinforcement must be indicated.
****

Provide types, sizes, and arrangement as indicated. Submit details of reinforcement in accordance with ACI/MCP-3 and ACI 318, unless otherwise specified.

Use metal bar supports and spacers when placing and securing steel bars, welded-wire fabric, and other reinforcement. Provide concrete cover for reinforcement in accordance with ACI/MCP-3 and ACI 318.

2.6.4   Lifting Devices

Provide lifting devices designed for 100-percent impact, and of materials sufficiently ductile to ensure visible deformation before fracture.

2.6.5   Concrete Mixing and Conveying

Measure concrete materials, concrete batching plant, concrete mixers, and concrete mixing in accordance with ASTM C94/C94M. Handle concrete to prevent segregation and loss of concrete mix materials.

2.6.6   Preparations for Placing Concrete

Keep form interiors and reinforcement free of accumulations of hardened concrete, form-parting compound, standing water, ice, snow, or other deleterious substances. Secure in position, inspect and approve reinforcement and other embedded items.

2.6.7   Weather Limitations

Do not place concrete when temperature of the atmosphere is below 5 degrees C 40 degrees F nor during rain, sleet, and snow unless adequate protection is provided. Protection during inclement weather must prevent the entry of rain, sleet, or snow into the forms or into the fresh concrete.

2.6.8   Concrete Placing

Depost concrete so that no concrete is placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness. Consolidate concrete in a manner that will prevent segregation and will produce concrete free of honeycomb or rock pockets and with the required surface finish.

2.6.9   Identification Markings

Clearly mark each structural section in a permanent manner to indicate its location and orientation in the building

For reinforced PAAC elements, clearly mark each structural section in a permanent manner to indicate its location and orientation in the building. Locate identifying marks, consistent with those shown on the Shop Drawings and the Panel Schedule on surfaces of PAAC elements not visible in their installed configuration. Indent marks for identification and quality tracking on a surface of every reinforced PAAC element not visible in their installed configuration. These marks will be coded to determine, at a minimum, the following identification and quality control tracking information for the panel: 1. Panel identification. 2. Compressive strength and density classification. 3. Production date. 4. Position of the panel in the mold.

2.6.10 Finishing Unformed Surfaces

Trowel finish unformed surfaces unless otherwise specified. Provide smooth surface free of trowel marks, uniform in texture and appearance, and be plane to a tolerance not exceeding 3.2 millimeter in 3048 millimeter 1/8 inch in 10 feet when tested with a 3000 millimeter 10-foot straightedge. Provide top surfaces of sections that are to receive concrete topping after installation with a transversely scarified scratch finish and remove laitance.

2.6.11 Protection of Concrete After Placing

Protect in accordance with ACI/MCP-2, particularly with regards to hot or cold weather conditions.

2.6.12 Finishing Formed Surfaces

Upon removal of forms, repair and patch defective areas. Limit defective areas to holes left by tie rods and other temporary inserts and to honeycomb or rock pockets not deep enough to expose the reinforcement and not located in bearing areas. Cut out defective areas to solid concrete and cleaned. Where the concrete surface will be exposed to view, the patches, when dry, must match the surrounding concrete.

2.6.12.1 Concealed Formed Surfaces

Formed surfaces of sections that will be concealed by other construction can have the standard smooth finish having the texture imparted by the forms. Repair and patch defective areas as specified and all fins and other projections removed.

2.6.12.2 PAAC Element Patching

Make patches on lower side of sections, near the center or in areas of variable tensile strength, or at bearing areas, with AAC panel repair mortar specified by the AAC manufacturer. Other areas can be patched with the same material, or with AAC "block patch" or Portland cement grout.

2.6.12.3 Finishing Exposed-To-View

****

NOTE: Delete the following paragraph and specify the required finish when an architectural finish is required. For an exposed-aggregate finish refer to Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE. The location of precast structural concrete sections having an architectural finish must be indicated.

****

Provide grout finish on formed surfaces of sections that are to be exposed-to-view after installation. Final color of the grout, when dry, must be the same for all concrete surfaces. Spread over dampened concrete surface with clean burlap pads, carpet, or sponge rubber floats to fill pits, air bubbles, and surface holes. Remove excess grout by scraping and then rubbing the surface with clean burlap or carpet to remove visible grout film. In hot dry weather, kept grout damp by means of fog-spraying during the setting period.

2.7 QUALITY OF CONCRETE

2.7.1 Quality Control Testing During Fabrication

Sample and test concrete for quality control during fabrication as follows. Submit test results on the same day that tests are made.

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Proprietary mix to meet specified AAC strength class requirements for AAC compressive strength and AAC dry bulk density as defined by ASTM C1693	ASTM C1693	See paragraph CONCRETE SAMPLING AND TESTING
PAAC manufacturer's Quality Control Manual		See paragraph CONCRETE SAMPLING AND TESTING
PAAC manufacturer's certification of quarterly inspection of Quality Control process by a qualified third-party agency such as UL	on-site inspection by qualified third-party agency	quarterly, i.e. at least once every 90 days

2.7.2 Autoclaved Aerated Concrete Properties

PROPERTY	VALUE
Compressive strength	as specified for the Strength Classification in accordance with ASTM C1693
Dry bulk density	within range shown for the specified Strength Classification in accordance with ASTM C1693
Drying shrinkage	within range shown for the specified Strength Classification/Dry Bulk Density in accordance with ASTM C1693

PART 3 EXECUTION

3.1 ANCHORAGE ITEMS EMBEDDED IN OTHER CONSTRUCTION

****

NOTE: Delete the paragraph heading and the following paragraph when structural PAAC sections will not be connected to cast-in-place concrete construction or masonry construction. Such anchorage items include anchor bolts, steel dowels,

and steel bearing plates, steel studs, and steel straps.
****

Deliver items to the site before the start of other construction. Provide setting drawings, templates, instructions, and directions for the installation of anchorage items.

3.2 STRENGTH OF STRUCTURAL SECTIONS AT INSTALLATION

Do not install sections until PAAC concrete has attained the specified minimum laboratory strength at 1 to 7 calendar days.

3.3 INSTALLATION TOLERANCES

Install PAAC sections within the following tolerances:

Deviation from plumb	Not over 10 mm in 4.8 m 1/4 inch in 10 feet, but not greater than 10 mm in 6.4 m 3/8 inch in 20 feet
Deviation from level	Not over 5 mm in 4.8 m 1/4 inch in 20 feet, but not greater than 10 mm in 9.6 m 1/2 inch in 40 feet
Deviation from linear building line from location indicated	Not over 6 mm 1/4 inch at base of wall

3.4 PLACING FRAMING STRUCTURAL SECTIONS

****
NOTE: Delete paragraph heading and the following paragraphs when framing structural sections such as columns, beams, girders, and joists will not be required
****

Place supporting sections, including anchorage items attached to or embedded in other construction before placing sections is started.

3.4.1 Placing PAAC Framing Sections

a. For mortared joints specified between PAAC elements, only use "thin-bed mortar" for AAC masonry manufactured in accordance with ASTM C1660.

b. For mortared joints used as leveling material for PAAC elements, use large grain mortar as specified by the PAAC manufacturer or mortar specified by the Engineer-of-Record.

c. Secure reinforced PAAC panels in place as indicated on approved shop drawings. Provide temporary bracing as required to resist construction loads, including wind, especially for wall panels.

d. Provide supplemental steel framing at openings in PAAC wall and/or floor and/or roof systems.

3.4.2 Cold Weather Precautions When Utilizing Thin Bed Mortar Joints

Do not install panels when temperature of AAC panel is below -6 degrees C 20 degrees F. Remove visible ice on AAC panel prior to installation. Heat mortar sand or mixing water to produce mortar temperatures between 4 degrees C and 50 degrees C 40 degrees F and 120 degrees F at time of mixing. Maintain mortar temperature above freezing until placed.

3.4.2.1 Ambient Temperature Requirements

a. Between -4 degrees C and -7 degrees C 25 degrees F and 20 degrees F: Use heat sources on both sides of AAC panels under construction. Install wind breaks when wind velocity is in excess of 24 km/hr 15 mph.

b. Below - 7 degrees C 20 degrees F: Provide enclosure for AAC panels under construction. Use heat sources to maintain temperatures above 0 degrees C 32 degrees F within enclosures.

3.4.2.2 Daily Mean Temperature Requirements for Cold Weather

a. Between 4 degrees C and 0 degrees C 40 degrees F and 32 degrees F: Protect completed AAC panels from rain or snow by covering with weather resistive membrane for a minimum of 24 hours after construction.

b. Between 0 degrees C and - 4 degrees C 32 degrees F and 25 degrees F: Completely cover completed AAC panels with weather resistive membrane for a minimum of 24 hours after construction.

c. Between -4 degrees C and -7 degrees C 25 degrees F and 20 degrees F: Completely cover completed AAC panels with insulating blankets or equal protection for a minimum of 24 hours after construction.

d. Below -7 degrees C 20 degrees F: Maintain AAC panel construction environment above 0 degrees C 32 degrees F for 24 hours after completion by an enclosure(s) with supplementary heat, electric heating blankets, infrared heat lamps, or other acceptable methods outlined to Contracting Officer's Representative.

3.4.3 Hot Weather Precautions When Utilizing Thin Bed Mortar Joints

When erected in ambient air temperature of 37 degrees C 100 degrees F or ambient air temperature of 32 degrees C 90 degrees F with wind velocity in excess of 13 km/hr 8 mph, implement the following:

a. Spreading mortar beds more than 1200 mm 4 feet ahead of AAC panels is prohibited.

b. Installing AAC panel more than two minutes after spreading mortar is prohibited.

3.5 PLACING STRUCTURAL PAAC FLOOR OR ROOF SLAB SECTIONS

****

NOTE: Delete the paragraph heading and the following paragraphs when slab structural sections, such as PAAC floor or roof panels will not be required. PAAC floor or roof panels may be placed over structural-steel framing members, precast structural-concrete framing sections, cast-in-place structural-concrete framing sections, or bearing walls, or a combination thereof.

****

Place supporting sections, including bearing pads or plates before placing sections.

a. Place slab structural sections on supporting construction with ends bearing on the structural framing sections or bearing walls as indicated. End bearings less than 75 millimeter 3 inches are not acceptable.

b. Accurately align slabs end to end with sides and ends spaced as shown on shop drawings.

c. Provide grouting void at sides and ends of the slabs.

d. Secure reinforced PAAC panels in place as indicated on approved shop drawings. Provide temporary bracing as required to resist construction loads, including wind.

e. Provide supplemental steel framing at openings in PAAC wall and/or floor and/or roof systems.

3.6 GROUTING CONNECTIONS AND JOINTS

****

NOTE: Delete paragraph heading and the following paragraphs when precast structural-concrete framing sections or floor-slab structural sections or both will not be required. When fire-resistance-rated precast structural-concrete sections are required, consult the applicable fire agency's requirements for grouting joints.

****

After sections have been placed and connected, grout open spaces at connections and joints. Reinforce and grout cells at joints between PAAC wall panels, as specified and shown in structural drawings and shop drawings. Fill joints between reinforced PAAC floor or roof panels using reinforcing bars and grout, as specified in structural drawings and shop drawings.

3.6.1 Cement Grout

Provide cement grout consisting of 1 part cement, 2-1/2 parts of specified aggregate, and not more than 17 L 4-1/2 gallons of water per 42.6 kg 94-pound sack of cement.

3.6.2 Shrink-Resistant Grout

Mix shrink-resistant grout compound with water to provide a flowable mixture without segregation or bleeding. Provide forms or other approved methods to retain the grout in place. Pack spaces with grout until the voids are completely filled. Flush grout at slab structural sections with top surface of the slab and remove excess. Keep grout damp for not less than 24 hours.

3.6.3 Epoxy-Resin Grout

Epoxy-resin grout or adhesive may be used in lieu of shrink-resistant grout. Install epoxy-resin grout or adhesive in accordance with the manufacturer's printed instructions.

3.7 SEALING JOINTS IN ROOF SLABS

****

NOTE: Delete paragraph heading and the following paragraphs when roof slab structural-sections will not be required. Where fire-resistance-rated roof slab structural sections are required, the applicable fire agency's requirements for sealing joints must be consulted.

****

After PAAC roof slab sections have been placed and connected, seal open spaces at connections and the top portion of joints.

a. Fill keyways and joints at ridges, hips, and connections with cement grout. Level with the top surfaces of slabs, remove excess grout, and apply a smooth finish.

b. Fill keyways and joints between reinforced PAAC floor or roof panels using reinforcing bars and grout, as specified in structural drawings and shop drawings.

c. Seal other joints with bituminous joint-sealing material. Center joint-sealing tape over the joint and embedded in hot bituminous cement. Lap Ends not less than 100 mm 4 inches. Remove excess bitumen and provide a smooth tape surface.

3.8 OPENINGS IN SLAB STRUCTURAL SECTIONS

****

NOTE: In PAAC flat slabs, the maximum size of field-cut openings is governed by approval of the PAAC panel Manufacturer, based on spacing and reinforcing in the panel. Maximum size and relative location of such openings must be communicated to the PAAC panel manufacturer prior to initiation of the shop drawings. Regardless of reinforcing, the maximum size of an opening or notch within a single PAAC panel, in the direction of panel width, is typically limited to 25 percent of the panel width.

****

Cut and fit sections as required for other work projecting through, or adjacent to, the members. Cut straight and at 90 degrees to the surfaces without breaking or spalling the edges.

****

NOTE: Openings larger than 300 mm 12 inches in the panel width direction must be framed with supporting members.

****

a. Reinforce openings in sections having a dimension more than 300 mm 12 inches in the panel width direction by means of hung steel angle saddle headers or additional framing. Headers must be shop prime-coat painted.

b. Provide headers at penetrations in floor and roof systems as detailed by the AAC Panel Manufacturer.

3.9 TOUCHUP PAINTING

****

NOTE: Delete this paragraph when precast structural members will not be supported by steel structural members.

****

Wire brush, clean, and touchup paint scarred surfaces on steel supporting members and weld plates after sections have been installed.

3.10 PROTECTION AND CLEANING

****

NOTE: Where architectural finishes such as exposed-aggregate finish are specified for exposed-to-view surfaces, such surfaces must be cleaned as specified in Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE.

****

a. Patch spalls and chips in reinforced AAC panels in accordance with AAC panel manufacturer's recommendations.

b. Upon completion of installation, sweep clean and leave ready slab surfaces to receive concrete floor topping, roofing, or other covering.

c. Protect exposed-to-view surfaces against staining and other damage until completion of the work.

3.11 INSPECTION AND ACCEPTANCE PROVISIONS

3.11.1 Dimensional Tolerances

Members having any dimension outside the limits for fabrication tolerances specified will be rejected.

3.11.2 Surface-Finish Requirements

Sections will be rejected for any of the following surface-finish deficiencies:

****

NOTE: Delete the first of the following paragraphs when architectural finishes such as exposed-aggregate finish, are not required for exposed-to-view surfaces.

****

a. Exposed-to-view surfaces having architectural finishes that do not match the color, aggregate size and distribution, and texture of the approved sample for the exposed-to-view finish

b. Exposed-to-view formed surfaces that contain cracks, spalls, air bubbles, honeycomb, rock pockets, or stains or other discoloration that cannot be removed by cleaning

c. Concealed formed surfaces that contain cracks in excess of 0.25 millimeter 0.01 inch wide; cracks or any other surface deficiency that penetrates to the reinforcement regardless of the width of crack or size of other deficiency; honeycomb and rock pockets located in bearing surfaces; and spalls except minor breakage at corners

d. Unformed surfaces that contain cracks and other surface deficiencies as specified for concealed formed surfaces

3.11.3 Strength of Structural Members

Strength of structural PAAC sections will be considered potentially deficient if they fail to comply with the requirements that control the strength of the structural members, including the following conditions:

a. Failure to meet compressive strength tests

b. Reinforcement of PAAC section not conforming to the requirements specified

c. Concrete curing and protection of structural sections against extremes in temperature during curing not conforming to the requirements specified

d. Structural sections damaged during handling and erection

e. Reinforcement and Weld-Point Shear Strength of Precast Autoclaved Aerated Concrete (PAAC) panels not conforming to the requirements specified

3.11.4 Testing Structural Sections for Strength

When there is evidence that the strength of precast structural-concrete sections does not meet specification requirements, cores drilled in hardened concrete for compressive strength determination must be made in accordance with ASTM C42/C42M and as follows:

a. Take at least three representative cores from the precast structural concrete sections that are considered potentially deficient.

    (1) Test cores saturated-surface-dry if the concrete they represent will be wet at all times during the use of the completed structure.

    (2) Test cores air-dry if the concrete they represent will be dry at all times during the use of the completed structure.

b. Strength of cores will be considered satisfactory if their average is equal to or greater than the Minimum Compressive Strength (f'AAC)specified for the AAC Strength Class material intended for the PAAC sections, per the Shop Drawings and Panel Schedule

c. Fill core holes solidly with patching mortar and finished to match the adjacent concrete surfaces.

d. If the results of the core tests are unsatisfactory or if core tests are impractical to obtain, perform static load tests of a structural section. The test will be evaluated in accordance with ACI/MCP-3 and ACI 318, except that the superimposed test load must be as specified for the proof-test method of strength design.

Replace sections that are found inadequate by the core tests or by the results of static load tests with sections that meet the specified requirements.

3.11.5 Inspection of Welding

Perform inspection of weldingin accordance with AWS D1.1/D1.1M, Section entitled, "Inspection," and as follows:

****

NOTE: Delete the following paragraphs that are not applicable to the project. The location of welds requiring inspection and the type of inspection must be indicated. The liquid-penetration inspection of welds is the most economical and commonly used method.

****

a. Liquid-penetration inspection of welds must conform to ASTM E165/E165M.

b. Magnetic-particle inspection of welds must conform to ASTM E709.

3.11.6 Structural Sections-in-Place

Sections-in-place will be rejected for any one of the following deficiencies:

a. Sections not conforming to the requirements for installation tolerances specified

b. Sections that are damaged during construction operations

c. Sections having exposed-to-view surface finishes that develop surface finish deficiencies specified

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-03 45 00 (May 2016)**
Change 2 - 11/21

Preparing Activity: NAVFAC **Superseding**
UFGS-03 45 00 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC	**UFGS-03 45 00 (May 2016)** **Change 2 - 11/21** **-----------------------------------**
Preparing Activity: NAVFAC	**Superseding** **UFGS-03 45 00 (November 2011)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 03 45 00

PRECAST ARCHITECTURAL CONCRETE

05/16, CHG 2: 11/21

****

NOTE: This guide specification covers the requirements for architectural precast concrete products, that through their finish, shape, color, or texture contribute to a structure's architectural expression. These products may be custom designed or feature standard shapes. They may be manufactured with conventional mild-steel reinforcement, or they may be pretensioned or posttensioned. These products typically have more stringent requirements for dimensional tolerances, finish variations, and color consistency. Architectural precast concrete products includes wall panels, mullions, bollards, urns, railings, sills, copings, benches, planters, pavers, and other types of miscellaneous shapes.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The panels specified are intended for attachment of the building framing system at each floor elevation and at the roof elevation. The panels may be provided with built-in anchorage

devices for the attachment of thermal insulation blankets to the interior face of the wall panels and for the attachment of metal flashing after the wall panels have been installed.

****

****

Note: Drawings should include a complete design indicating the character of the work to be performed and the following:

1. Location and details of wall panels and precast units, showing all dimensions, and size and type of reinforcement.

2. Details of joints between wall panel and precast units, showing sealant or gasket shape, dimensions, and location.

3. Details showing both the location and type of anchorage devices of the precast units to the building framing system and the connection of other materials (reglets, insulation nailers, etc.) to the precast units. Indicate gravity loads, live loads, dynamic loads, and stresses inherent in the structure for the manufacturer to provide embedded precast units anchorage.

4. Locations where flashing reglets are required.

5. Locations of inserts (wedge type, slotted type, etc.) cast into the precast concrete units.

6. Location of each type of surface finish, with details of transitions between different types of surface finishes.

7. Indicate integral color(s) of precast units.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 251	(2006; R 2011) Standard Specification for Plain and Laminated Elastomeric Bridge Bearings

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 301	(2020) Specifications for Structural Concrete
ACI 301M	(2020) Metric Specifications for Structural Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI MNL-66	(2020) ACI Detailing Manual

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108/A118/A136.1	(2024) American National Standard Specifications for the Installation of Ceramic Tile

ANSI A118.7	(2010) American National Standard Specifications for High Performance Cement Grouts for Tile Installation

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA U1	(2024) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete

ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C67/C67M	(2024) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C78/C78M	(2022) Standard Test Method for Flexural

	Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C144	(2024) Standard Specification for Aggregate for Masonry Mortar
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C185	(2020) Standard Test Method for Air Content of Hydraulic Cement Mortar
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C311/C311M	(2024) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C650	(2004; R 2014) Standard Test Method for Resistance of Ceramic Tile to Chemical Substances
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C979/C979M	(2024) Standard Specification for Pigments for Integrally Colored Concrete

ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1149	(2018) Standard Test Method for Rubber Deterioration - Cracking in an Ozone Controlled Environment
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D5759	(2012; R 2020) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A135.4	(2012; R2020) Basic Hardboard

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-117	(2013) Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, 3rd Edition
PCI MNL-122	(2007) Architectural Precast Concrete, 3rd Edition

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Installation Meeting

SD-02 Shop Drawings

Precast Drawings; G, [_____]

SD-03 Product Data

Cast-In Embedded Items And Connectors; G, [_____]

Connection Devices; G, [_____]

Admixtures

Gasket

Thin Brick Veneer

Bearing Pads

SD-04 Samples

Concrete Wall Panel Surface Finish; G, [_____]

Mock-up

Brick Color Chips

Form Liner

[Full Size Sample Wall Panel

] SD-05 Design Data

Design Calculations; G, [_____]

Contractor-Furnished Mix Design; G, [_____]

Concrete Mix Design for Repair of Surface Defects; G, [_____]

Thermal Calculations; G, [_____]

SD-06 Test Reports

Strength Tests; G, [_____]

Slump

Air Content

Test for Concrete Materials

Water

Testing Precast Units for Strength

SD-07 Certificates

Manufacturer's Qualifications; G, [_____]

Fabricator Quality Certifications

Erector Certification

[Erector's Post Audit Declaration

] SD-08 Manufacturer's Instructions

Installation; G, [_____]

Cleaning; G, [_____]

Thin Brick

SD-11 Closeout Submittals

Concrete Batch Ticket Information; G, [_____]

Recycled Content for Fly Ash and Pozzolan; S

Recycled Content for Ground Iron Blast-Furnace Slag; S

Recycled Content for Silica Fume; S

1.3 MODIFICATION OF REFERENCES

In the referenced ACI and PCI publications, consider the advisory provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.4 GENERAL REQUIREMENTS

Precast concrete units must be designed and fabricated by an experienced and certified precast concrete manufacturer. The manufacturer needs to have been regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings for at least 3 years. The Contractor must submit a statement detailing the Manufacturer's Qualifications. Coordinate precast work with the work of other trades.

1.5 DESIGN

1.5.1 Standards and Loads

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NOTE: Design loads will be shown on the drawings. Criteria for design loads are contained in ASCE 7-16 and UFC 3-301-07. The differential temperature of 89 degrees C 160 degrees F is based on extreme values of 40 degrees C 40 degrees F below zero to 49 degrees C 120 degrees F above zero; it should be used for computing volume changes due to temperature variations. Other values, greater or smaller, should be used instead whenever justified by climatic conditions at the jobsite. For in-house design delete all references to design by others.

****

Precast unit design must conform to ASCE 7-16, ACI 318M ACI 318 and PCI MNL-122. Indicate design loads for precast concrete on the drawings. A differential temperature of [89] [_____] degrees C [192] [_____] degrees F, between interior and exterior faces of the units, must be considered in the design. Stresses due to restrained volume change caused by shrinkage and temperature differential, handling, transportation and erection must be accounted for in the design.

1.5.2 Connections

Connection of units to other members, or to other units must be of the type and configuration indicated. The design and sizing of connections for all design loads will be completed by the Contractor.

1.5.3 Concrete Proportion

Base the selection of proportions for concrete on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportion using the same type and brand of cement, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete and admixtures containing chloride ions, nitrates, or other substances that are corrosive will not be used in prestressed concrete.

1.5.4 Design Calculations

Calculations for design of members, connections and embedments not shown must be made by a registered professional engineer experienced in the design of precast architectural concrete. Calculation will include the analysis of member for lifting stresses and the sizing of the lifting inserts. Submit calculations for review and approval prior to fabrication, signed and sealed by the registered design professional who prepared the design.

1.5.5 Thermal Calculations

Submit thermal calculations prepared and sealed by a registered professional engineer for review complying with ASHRAE 90.1 - SI ASHRAE 90.1 - IP, for the steady state thermal resistance for the precast concrete wall panels. Thermal calculations must demonstrate the thermal conductivity of all components, the spacing of all connectors, the percent area of the wall that is solid concrete, and the thermal resistance of all components.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials, except for wall panels, to the project site in the original, unbroken packages or containers, each bearing a label clearly identifying manufacturer's name, brand name, weight or volume, and other pertinent information. Store packaged materials, and materials in containers, in a weathertight and dry place until ready for use.

Store products in manufacturer's unopened packaging in dry storage area, with ambient temperature between minus 1 degree C and 41 degrees C 30 degrees F and 120 degrees F, until installation.

1.7 STORAGE AND INSPECTION AT MANUFACTURER'S PLANT

Protect precast units temporarily stored at the manufacturer's plant from damage in accordance with PCI MNL-117 and PCI MNL-122. Immediately prior to shipment to the jobsite, all precast concrete units must be inspected for quality to insure all precast units conform to the requirements specified. Inspection for quality will include, but will not be limited to, the following elements: color, texture, dimensional tolerances, chipping, cracking, staining, warping and honeycombing. Replace or repair all defective precast concrete units as approved.

1.8 PLANT INSPECTION

[At the option of the Contracting Officer, precast units may be inspected.] [Precast units must be inspected by the QC representative prior to being transported to the job site.] The Contractor is to give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.8.1 Fabricator Quality Certifications

Plants must be certified by the PCI Plant Certification Program for Group A, Category A1, or Architectural Precast Association (APA) certification or National Precast Concrete Association (NPCA). When plants are not currently enrolled in one of the three certification programs listed above then they must provide a product quality control system in accordance with PCI MNL-117 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory.

1.9 ERECTOR CERTIFICATION

Erector with erecting organization and all erecting crews certified and designated by PCI's Certificate of Compliance to erect Category [A (Architectural Systems) for non-load][S2 (Complex Structural Systems) for load]-bearing members.

[1.10 ERECTOR QUALIFICATIONS

****

NOTE: Use the following paragraph when a PCI Certified erector is not available in the project location.

****

A precast erector that is not certified by PCI who retains a PCI-Certified Field Auditor, at the erector's expense, to conduct a field audit of a project in the same category as this project prior to start of precast concrete erection and must submit the Erector's Post Audit Declaration to be considered qualified.

]1.11 CONCRETE SAMPLING AND TESTING

1.11.1 Test for Concrete Materials

Sample and test concrete materials proposed for use in the work in accordance with PCI MNL-117.

Submit reports for each material sampled and tested prior to the start of work. Reports must contain the project name and number, date, name of Contractor, name of precast unit manufacturer, name of concrete testing service, source of concrete aggregates, generic name of aggregate, and values specified.

1.11.2 Quality Control Testing During Fabrication

Sample and test concrete for quality control during fabrication as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Sampling fresh concrete	ASTM C172/C172M except modified for slump per ASTM C94/C94M	As required for each test
Slump test	ASTM C143/C143M	One for each concrete load at point of discharge and one for each set of compressive strength tests
Air Content by pressure method	ASTM C231/C231M	One for each set of compressive strength tests
Compressive test specimens	ASTM C31/C31M	One set of six specimens for each Compressive Strength test, one set per day or for every 15 cubic meters 20 cubic yards of concrete placed, whichever is greater.

Compression test specimens may be either standard 150 by 300 millimeter 6 by 12 inch cylinders or 100 millimeter 4-inch cubes. Cubes may be molded individually or cut from slabs. Preparation and testing of cube specimens must be as nearly consistent with the test methods specified as possible, with the exception that the concrete will be placed in a single layer.

Curing of compression test specimens must be the same as the curing method used for the precast concrete wall panels until panels are stripped of forms and then standard moist cure will continue.

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete temperature		Each time a set of compression test specimens is made

Compressive strength tests	ASTM C39/C39M	One set of facing strength tests mix and one set of backing mix for every ten panels or fraction thereof cast in any one day; two specimens in each set tested at 7 calendar days; three specimens in each set tested at 28 calendar days, and one specimen in each set retained in reserve for testing if required

Evaluate compression test results at 28 days in accordance with ACI 214R using a coefficient of variation of 20 percent. Evaluate the strength of concrete by averaging the test results (two specimens) of standard cylinders tested at 28 days. Not more than 20 percent of the individual tests can have an average compressive strength less than the specified ultimate compressive strength. Submit test reports on the same day that tests are made.

Reports for Compressive Strength tests need to contain the project name and number, date of concrete placement, name of Contractor, name of precast concrete wall panel manufacturer, name of concrete testing service, panel identification letter and number, use of concrete mixture (facing or backing), design compressive strength at 28 calendar days, concrete-mix proportions and materials, and compressive breaking strength and type of break.

If 100 millimeter 4-inch cubes are used for compressive strength specimens, average strength of the cubes at any test age must be multiplied by the factor of 0.8 to arrive at an estimate of the corresponding 150 by 300 millimeter 6 by 12 inch cylinder strength. Report both of these values .

1.12 QUALITY ASSURANCE

1.12.1 Precast Drawings

Submit precast drawings with the following information:

a. Precast dimensions, cross-section, and edge details; location, size, and type of reinforcement, including reinforcement necessary for safe handling and erection of precast units and other embedded items. Comply with ACI MNL-66.

b. Layout, dimensions, and identification of each precast unit, corresponding to installation sequence.

c. Setting drawings, instructions, and directions for installation of concrete inserts.

d. Location and details of anchorage devices and lifting devices embedded in panels, and connection details to building framing system.

[e. Location of embedded brick work including joint locations, joint widths, brick coursing, brick coursing alignment across panel joints and reveal and false-joint locations and dimensions.

]1.12.2 Concrete Wall Panel Surface Finish Sample

Submit a concrete wall panel sample 300 mm by 300 mm 12 inches by 12 inches by approximately 40 mm 1 1/2 inches in thickness, to illustrate quality, color, and texture of both exposed-to-view surface finish and finish of panel surfaces that will be concealed by other construction.[Obtain approval prior to submission of sample panels.]

After approval of the surface, Contractor must provide one full size sample Wall Panel. Approved sample may be used in construction when properly identified.

1.12.3 Required Records

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.12.4 Mock-Up

Provide mock-up to establish that proposed materials and construction techniques provide acceptable visual effect. Materials used for mock-up should be those proposed for actual construction. Include all anchors, connections, flashing and joint fillers. Apply specified products to determine acceptability of appearance and optimum coverage rate required for application

Provide mock-up sections of building and structures which typify the most difficult areas to build.

a. Finish areas designated by Contracting Officer.

b. Apply water repellent in accordance with manufacturer's instructions.

c. After materials have cured, water test surface to determine that sufficient water repellent has been applied.

d. Do not proceed with remaining work until workmanship, color, and detail are approved by Contracting Officer.

e. Modify mock-up area as required to produce acceptable work.

Job Mock Up Panel: Minimum 1.2 meters by 1.2 meters 4 feet by 4 feet

a. Incorporate edge, reveal[, and brick coursing detail] as shown on drawings.

[b. Utilize full range of brick sizes, variance of brick size, general color of brick and variance in color and texture of brick.

][c. Show clean, pressure washed brick and concrete surface.

][d. Utilize full range of color of concrete mortar joints.

] e. Maintain Mock Up for comparison with finished work.

After approval by Contracting Officer, transport mock-up to job-site and erect where directed by [Contracting Officer][_____].

1.12.5 Pre-Installation Meeting

Hold a meeting at the job site with representative of the manufacturer[and the applicator prior to application of water repellents] and all other trades that may be effected by work of this section. Notify the Contracting Officer at least 3 days in advance of the time of the meeting.

1.13 TOLERANCES

Dimensions of the finished panel, at the time of erection in the structure, must conform to the tolerances for precast, non-prestressed elements in PCI MNL-117, unless otherwise specified by the Architect.

PART 2 PRODUCTS

2.1 CONCRETE

2.1.1 Contractor-Furnished Mix Design

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NOTE: If gap-graded or one size architectural aggregates are used in a high coarse aggregate mix, delete the air percentage requirements and use the second bracketed sentence.

****

ACI 211.1 and ACI 301M ACI 301. The Contractor must submit the mix design report giving the maximum nominal coarse aggregate size, the proportions of all ingredients and the type and amount of any admixtures that will be used in the manufacture of each strength and type of concrete, a minimum of sixty days prior to commencing operations. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. Plot a curve for each concrete mixture, showing the relationships between water-cementitious material ratios and compressive strengths. Maximum permissible water-cementitious material ratio must be that value not exceeding the maximum water-cementitious material ratio specified, indicated by the curve to produce a design minimum laboratory compressive strength at 28 calendar days not less than that specified. The mix design report is to contain the project name and number, date, name of Contractor, name of precast concrete wall panel manufacturer, name of concrete testing service, use of concrete mixture (facing or backing), source of concrete aggregates for each mixture. Submit certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, and aggregates. The statement must be accompanied by test results from an approved testing laboratory, certifying that the proportions selected will produce concrete of the properties required. Make no substitutions without additional tests to verify that the concrete properties are satisfactory. Concrete must have a 28-day compressive strength of 28 MPa [4000] [_____] psi.[Air content of plastic concrete must be between 4 and 6 percent air by volume.][Provide a dosage of air entraining agent which will produce 19 plus or minus 3 percent air in a 1 to 4 by weight standard sand mortar in accordance ASTM C185.]

If, the compressive strength falls below that specified, adjust the mix proportions and water content and make necessary changes in the temperature, moisture, and curing procedures to secure the specified strength. Notify the Contracting Officer of all changes.

[2.1.2 Exposed-to-View Facing Mixture

Provide aggregates for exposed-to-view facing mixture; white, gray, or buff portland cement or a blend of two or more portland cements; [air-entraining admixture;] and water. Provide exact proportions of facing mixture to produce concrete having the specified properties and capable of obtaining the approved surface color and finish.

]2.1.3 Backing Mixture

Provide the approved mix design.

2.2 MATERIALS

2.2.1 Material Sustainability Criteria

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan

b. Recycled content for Ground Iron Blast-Furnace Slag

c. Recycled content for Silica Fume

2.2.2 Fine Aggregates

****

NOTE: Choose appropriate gradation based upon use of concrete. Where concrete is for back-up and separate facing aggregate is used, a gradation or maximum aggregate size may be specified.

****

ASTM C33/C33M. The optional method of reducing the No. 50 and No. 100 sieve aggregates does not apply. The restriction to use only fine aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply.

2.2.3 Coarse Aggregate

****

NOTE: Choose appropriate gradation based upon use of concrete. Where concrete is for back-up and separate facing aggregate is used, a gradation or maximum aggregate size may be specified. Class 5S is for exposed architectural concrete.

****

ASTM C33/C33M, Size No. [57] [67], Class 5S. The restriction to use only coarse aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply. Aggregate must not contain slag or crushed concrete.

2.2.4 Exposed Aggregate

****

NOTE: Choose appropriate gradation based upon use of concrete. Where concrete is for back-up and separate facing aggregate is used, a gradation or maximum aggregate size may be specified.

****

In addition to the above, facing mixture aggregate, and aggregate for homogeneous panels with exposed aggregate finish, will be [gravel] [crushed gravel] [crushed stone] of size and color to produce exposed surfaces to match the color and texture of the sample on file with the Contracting Officer.

****

NOTE: Aggregates for exposed-to-view facing mixture may be natural mineral particles, natural building stone particles, or combinations thereof, or synthetic materials such as glass or plastic; natural aggregates may be crushed or gravel. Delete the following paragraph when crushed natural aggregate is not required by the project. Specify the mineral or rock generic name, color, particle shape, size range of particles, and other information relative to the appearance of the exposed-to-view finish surface as applicable to the project.

****

Crush coarse aggregate by a means that will produce material of cubical shape with a minimum of elongated, thin, or partially fractured particles. Material or crushing methods that produce particles classified by petrographic examination as being weak, highly fractured or somewhat friable, or both, in excess of 16 percent of the particles in any whole sample will be rejected. Material for coarse aggregate must be free of substances that change color on oxidation. Obtain material used for the work from the same basic source and stratum. Quarry material to produce a uniformly colored aggregate that does not change color upon weathering. During quarrying operations, the uniformity of rock face color must be verified by periodically comparing the rock face color to the approved coarse aggregate sample.

****

NOTE: Revise the following paragraph when fine white-quartz aggregate is not required by the project.

****

Fine aggregate will be white quartz natural sand or stone screenings, or manufactured sand produced from white quartz. Aggregate must be free of substances that change color on oxidation. Color must conform to the approved sample.

2.2.5 Cementitious Materials

****

NOTE: Acceptable types of cement are as follows:

ASTM C150/C150M Portland	ASTM C595/C595M Blended	Use
Type I	Type IP, IS, IL, or IT	For general use in construction.
Type II	Type IP, IS, IL, or IT (MS) or (MH)	For general use in construction where concrete is exposed to moderate sulfate action or where moderate heat of hydration is required. ASTM C595/C595M (blended hydraulic cements): add the suffix MS or MH where either moderate sulfate resistance or moderate heat of hydration, respectively, is required.
Type III	Type IP, IS, IL, or IT (HE)	For use when high early strength is required. ASTM C595/C595M (blended hydraulic cements): add the suffix HE where high early strength is required. Confer with the agency's Subject Matter Expert in Concrete Materials before specifying High early strength cement.
Type V	Type IP, IS, IL, or IT (HS)	For use when high sulfate resistance is required. ASTM C595/C595M (blended hydraulic cements): add the suffix HS where high sulfate resistance is required.

For concrete subjected to salt water, near salt water or exposed to alkali/sulfate soils refer to specification Section 03 31 30 MARINE CONCRETE for additional criteria.
****

****
NOTE: For NAVFAC LANT: Typically allow Type II, IP(MS), or IS(MS). May use Type I if Type II not locally available and no sulfate problems expected (i.e. not near seawater or sulfate soils). Type III is for high early strength. Type V, IP (HS), IS (HS), IL (HS), and IT (HS) are for high sulfate resistance.
****

****
NOTE: Coal fly ash, slag, cenospheres, and silica fumes are EPA designated products to be ingredients in concrete and cement. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING and include additive options unless designer determines that justification for non-use exists.

****

For exposed concrete, use one manufacturer and one source for each type of cement, ground slag, fly ash, and pozzolan.

2.2.5.1 Fly Ash

****

NOTE: Fly ash, pozzolan, and slag cement may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Fly ash or pozzolan meeting the specified test results, which are more stringent than ASTM C618, should provide acceptable end results. It is suggested that fly ash be used as a replacement for 35 percent of the cement. Class C fly ash is not permitted.

****

ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed [3][6] percent.

Add with cement. Fly ash content must be a minimum of [15] [20] [30] [35] [40] [_____] percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.2.5.2 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.

2.2.5.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.

b. The average particle size must not exceed 6 microns.

c. The sum of $SiO_2 + Al_2O_3 + Fe_2O_3$ must be greater than 77 percent.

2.2.5.4 Ground Granulated Blast-Furnace Slag

ASTM C989/C989M, Grade [100] [120]. Slag content must be a minimum of [25][50][70] percent by weight of cementitious material.

[2.2.5.5 Silica Fume

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NOTE: Silica fume must only be used for OCONUS projects where Class F fly ash and GGBF slag are not available, and when approved by the Contracting Officer. Guidance for use of silica fume should be

sought from the agency's Subject Matter Expert in Concrete Materials.

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NOTE: The initial cost of the concrete must increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWR must be used with silica fume, the slump can be increased 50 to 125 mm 2 to 5 inches without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.

****

Silica fume must conform to ASTM C1240, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as slurry. Proper mixing is essential to accomplish proper distribution of the silica fume and avoid agglomerated silica fume which can react with the alkali in the cement resulting in premature and extensive concrete damage. Supervision at the batch plant, finishing, and curing is essential. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume. A High Range Water Reducer (HRWR) must be used with silica fume.

]2.2.5.6 Portland Cement

****

NOTE: If high early strength concrete is required, specify Type III after consulting the agency's Subject Matter Expert in Concrete Materials.

When concrete is exposed to sea water use specification Section 03 31 30 MARINE CONCRETE.

When high-volume fly ash mixtures, mixtures where fly ash replacement of portland cement is greater than 50 percent by weight, are specified they may be blended with Type II or Type III cement for higher early strength. Consult the agency's Subject Matter Expert in Concrete Materials prior to using Type III cement.

****

Provide cement that conforms to ASTM C150/C150M, Type [I][II][III], [including false set requirements] with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na2Oe (sodium oxide) equivalent. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

[For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch.][Supplier must certify that no hazardous waste is used in the fuel mix or raw materials.][Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants are discharged.]

2.2.5.7 Blended Cements

a. Blended cements must conform to ASTM C595/C595M Type [IP,] [IS,] [IL,] [IT,] [IP (MS),] [IS (MS),] [IL (MS),] [IT (MS),] [IP (MH),] [IS (MH),] [IL (MH),] [IT (MH),] [IP (LH),] [IS (LH),] [IL (LH),] [IT (LH),] [IP (HS),] [IS (HS),] [IL (HS),] [IT (HS),] [IP (HE),] [IS (HE),] [IL (HE),] [IT (HE),] or ASTM C1157/C1157M Type [GU][MS] [MH] [HE].

b. Slag cement added to the Type IS blend must meet ASTM C989/C989M.

c. The pozzolan added to the Type IP blend must be ASTM C618 [Class F,] [Class C,][or][Class N] and must be interground with the cement clinker. The manufacturer must state in writing that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of pozzolan used in the blend must not change from that submitted for the aggregate evaluation and mixture proportioning.

2.2.6 Admixtures

ASTM C260/C260M for air-entraining admixtures. Other admixtures: ASTM C494/C494M.[Certify that admixtures are free of chlorides.] [Coloring Admixture: ASTM C979/C979M, synthetic or natural mineral oxide or colored water reducing admixtures, temperature stable, and non-fading. [Certify that coloring admixtures are free of chlorides.]]

2.2.7 Water

Water must comply with the requirements of ASTM C1602/C1602M. Minimize the amount of water in the mix. Improve workability by adjusting the grading rather than by adding water. Water must be [potable][from rainwater collection][from graywater][from recycled water]; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete. Submit test report showing water complies with ASTM C1602/C1602M.

2.2.8 Reinforcement

****

NOTE: Specify ASTM A775/A775M for epoxy-coated reinforcing bars or ASTM A767/A767M and ASTM A780/A780M for zinc-coated (galvanized) bars. Define where coated bars are to be used, if not for entire project. Include ASTM publications in paragraph REFERENCES:

A 767: Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

A 775: Epoxy-Coated Reinforcing Bars

A 780: Repair of Damaged Hot-Dip Galvanized Coatings

****

All exposed steel must be phosphate treated, primed, and coated to prevent rust.

2.2.8.1 Reinforcing Bars

ACI 301MACI 301 unless otherwise specified. ASTM A615/A615M, Grade [400] [60], [ASTM A706/A706M, Grade [400] [60], or ASTM A996/A996M, Grade [300] [40], or ASTM A996/A996M, Grade [400] [60].]

2.2.8.2 Welded Wire Reinforcement

ASTM A1064/A1064M.

2.2.8.3 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening in place in accordance with PCI MNL-117.

2.2.9 Prestressing Strands

****

NOTE: This paragraph will be retained only when prestressed units are permitted or required.

****

Prestressing strands need to conform to ASTM A416/A416M Grade 1860 Grade 270.

2.2.10 Tie Wire

Tie wire must be soft monel or 18-8 stainless steel.

2.2.11 Plates, Angles, Anchors and Embedment

ASTM A36/A36M, ferrous metal plate connectors for attachment to the structural framing using manufacturer standard construction procedures. Headed studs will use 400 MPa 60,000 psi steel with construction conforming to AWS D1.1/D1.1M, Type B. Deformed bar anchors must conform to ASTM A1064/A1064M. Coat steel items, other than stainless, with a rust-inhibiting paint or provide hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

Furnish and install anchors, inserts, lifting devices, and other accessories which are to be embedded in the precast units in accordance with the approved detail drawings. Embedded items must be accurately positioned in their designed location, and have sufficient anchorage and embedment to satisfy design requirements.

2.2.12 Form Release Agent

Release agent must be manufacturer's standard non-staining type.

2.2.13 Grout

Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107/C1107M and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218/C1218M.

2.3 CAST-IN EMBEDDED ITEMS AND CONNECTORS

2.3.1 Inserts

2.3.1.1 Threaded-Type Concrete Inserts

ASTM A47/A47M, Grade 22010 Grade 32510 or 35018, or may be medium strength cast steel conforming to ASTM A27/A27M, Grade 415-205 Grade U-60-30. Provide[galvanized] ferrous casting having enlarged base with two nailing lugs minimum length less than the thickness of panel less 20 mm 3/4 inch, and internally threaded to receive 20 mm 3/4 inch diameter machine bolt. Ferrous castings must be ferritic malleable iron.[Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.]

2.3.1.2 Wedge-Type Concrete Inserts

Provide galvanized, box-type ferrous castings with integral anchor loop at back of box to accept 20 mm 3/4 inch diameter bolts having special wedge-shaped head. Provide ferrous castings [ASTM A47/A47M, Grade 22010, Grade 32510 or 35018, ferritic malleable iron][or][ASTM A27/A27M, Grade 415-205, Grade U-60-30, medium-strength cast steel].[Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.]

2.3.1.3 Slotted-Type Concrete Inserts

Provide pressed steel plate, welded construction, box type with slot to receive 20 mm 3/4 inch diameter square head bolt, and provide lateral adjustment of bolt. Length of insert body, less anchorage lugs, must be 110 mm 4 1/2 inches minimum. Provide insert with knockout cover. Steel plate must be 3 mm 1/8 inch minimum thickness, ASTM A283/A283M, Grade C.[Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.]

2.3.1.4 Wood Nailer Inserts

****

NOTE: Location and size of wood nailer inserts must be indicated.

NOTE: AWPA use category UC3A is for wood that is exposed to all weather cycles but not exposed to prolonged wetting. AWPAA use category UC3B is for wood that is exposed to all weather cycles including prolonged wetting.

****

Inserts will be kiln-dried "standard" grade Douglas fir or "No. 2" grade southern pine, surfaced 4 sides, and sized as indicated. Treat with waterborne pressure-preservative in accordance with AWPA U1, use category [UC3A][UC3B]. All wood needs to be air or kiln dried after treatment. Verify specific treatments by the report of an approved independent inspection agency. The AWPA U1 Quality Mark ["UC3A"]["UC3B"] on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

2.3.1.5 Flashing Reglets

****

NOTE: Location of flashing reglets embedded in

precast-concrete panels must be indicated.
****

Reglets must be sheet metal open-type with continuous groove not less than 30 millimeter deep by 5 millimeter wide 1-1/8 inches deep by 3/16-inch wide at opening and sloped upward, designed to anchor snap-lock counter flashing.

****
NOTE: Delete the following paragraphs if not applicable to the project.

When visible staining from the flashing reglets can occur, corrosion-resisting chromium-nickel steel only must be specified.

When the precast units will be subjected to a sea coast atmosphere, galvanized carbon steel flashing reglets must not be specified.
****

Metal must be minimum 0.28 millimeter 0.011-inch thick conforming to ASTM A666, Type 302 or 304, No. 1 finish, soft temper.

[Metal must be copper strip weighing a minimum of 4.8 kilogram per square meter 16 ounces per square foot, and conforming to ASTM B370, cold-rolled temper.

][Metal is to be 0.55 millimeter 26-gage galvanized steel sheet conforming to ASTM A653/A653M, Z275 G90.

]2.3.2 Connection Devices

2.3.2.1 Clip Angles

ASTM A36/A36M steel, galvanized after fabrication in accordance with ASTM A153/A153M.

2.3.2.2 Ferrous Casting Clamps

ASTM A47/A47M, Grade 22010, Grade 32510 or Grade 35018 malleable iron or cast steel, or ASTM A27/A27M, Grade 415-205 Grade 60-30, cast steel casting, hot-dip galvanized in accordance with ASTM A153/A153M.

2.3.2.3 Threaded Fasteners

Provide galvanized machine bolts, washers and, when required, nuts.

a. Bolts: ASTM A449, 20 mm 3/4 inch diameter machine bolts with hexagon head.

b. Washers: ASME B18.21.1, medium or heavy lock-spring washers.

c. Nuts: ASTM A563M ASTM A563, Grade C, heavy, hexagon-type nuts.

d. Square Nuts: ASTM A563M ASTM A563, Grade A, plain, square-type nuts where required for slotted-type concrete inserts.

2.4 PRECAST ELEMENT FABRICATION

2.4.1 Formwork and Fabrication Tolerances

Provide forms and form-facing materials of wood, metal, plastic, or other approved material to produce concrete having the specified finish. Construct forms mortar-tight and of sufficient strength to withstand all pressures due to concrete placing operations and temperature changes. Brace and stiffen against deformation. Provide form liners where required to produce indicated finish. Provide dimensional tolerances per PCI MNL-117.

2.4.2 Reinforcement

ACI 301MACI 301. Place reinforcing bars and welded wire reinforcement. Secure in position with tie wires, bar supports, and spacers.

2.4.3 Preparation for Placing Concrete

Remove hardened concrete, excess form parting compound, standing water, ice, snow, or other deleterious substances from form interiors and reinforcement before concrete placement. Secure reinforcement and embedded items.

2.4.4 Concrete Mixing and Conveying

2.4.4.1 Batch Plant, Mixer, Mixing, and Measuring of Materials

ASTM C94/C94M.

2.4.4.2 Conveying

Prevent segregation and loss of materials.

2.4.5 Concrete Placing

ACI 304R. Deposit concrete in the forms continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the precast concrete units. Place concrete at a constant temperature of between 10 and 32 degrees C 50 and 90 degrees F throughout fabrication of each unit. Make temperature of forms or molds the same as or close to the concrete temperature. For hot or cold weather, use methods recommended by ACI 305R and ACI 306.1. Vibrate and consolidate concrete to prevent segregation and to produce a high-density concrete free of honeycomb and rock pockets. When specified, the exposed-to-view facing mixture is required to be a minimum thickness of 20 mm 3/4 inches. Place backing mixture before facing mixture attains initial set.

2.4.6 Identification Markings

Permanently mark each precast unit to indicate pick-up points, location, orientation in the building, and date of casting. Identification markings need to correlate with approved detail drawings. Do not locate in exposed-to-view finished surfaces.

2.4.7 Finishing

2.4.7.1 Unformed Concealed Surfaces (Standard Smooth Finish)

Provide a trowel finish. Level surface with a straightedge, and strike off. After surface water has disappeared, float and trowel surface. Provide smooth finished surface, free of trowel marks, and uniform in texture and appearance.

2.4.7.2 Smooth, Exposed-to-View Surfaces

Provide a standard smooth finish to all exposed-to-view surfaces of panels, unless otherwise indicated. Provide a concrete surface having the texture imparted by a steel form or other approved smooth surfaces form-facing material.

2.4.7.3 Exposed Aggregate Finish

Provide for exposed-to-view surfaces of panels, including chamfers, edges, recesses, and projections, unless otherwise indicated. Provide standard smooth finish with outer skin of mortar removed, before concrete has hardened, and exposing coarse aggregate. A chemical retarder may be used on exposed face to facilitate removal of mortar. Match finish of the approved surface finish sample. Expose aggregates as soon after concrete placing as practicable [by wire brushing, sand blasting, or bush hammering][or][by washing the concrete surface with a diluted solution of muriatic acid to thoroughly clean exposed aggregate. Rinse concrete surface with fresh, clean water to remove traces of acid].

2.4.7.4 Other Surfaces

Surfaces of precast units not exposed to view or not otherwise indicated to be finished are to be finished in accordance with ACI 301M ACI 301 for a Surface Finish of 1.0.

2.4.8 Curing

Provide moist or steam curing or curing compound. Do not remove precast units from forms; prevent moisture loss and maintain 10 degrees C 50 degrees F minimum for at least 24 hours after finishing. Maintain precast units in a surface damp condition at 10 degrees C 50 degrees F minimum until concrete has attained 75 percent minimum of the design compressive strength.[Do not use steam curing with wood forms or in connection with chemically retarded exposed aggregate surfaces].

2.4.9 Repair of Surface Defects

Cut out defective areas to solid concrete, with edges of cuts perpendicular to the surface of the concrete, and clean thoroughly. Dampen area to be patched and brush-coat with nonshrink grout or bonding agent. Patch the surface in accordance with procedures previously submitted by the Contractor and approved by the Contracting Officer. Where exposed to view, the patches, when dry, needs to be indistinguishable from the surrounding surfaces.

2.4.9.1 Smooth, Concealed Surfaces

Acceptable defective area will be limited to holes left by rods and other temporary inserts, and to honeycomb or rock pockets of 6 mm 1/4 inch diameter maximum. Remove fins and other projections on the surfaces.

2.4.9.2 Exposed-to-View Surfaces

The combined area of acceptable defective areas must not exceed 0.2 percent of the exposed-to-view surface area and will be limited to holes of 6 mm 1/4 inch diameter maximum.

2.4.10 Stripping

Do not remove precast concrete units from forms until units develop sufficient strength to safely strip the formwork and to remove the precast concrete units from the forms to prevent damage to the units from overstress or chipping.

2.4.11 Built-In Anchorage Devices

****

NOTE: Anchorage devices to be embedded in the panels must be indicated. Anchorage devices include threaded concrete inserts for bolted connections; wood nailers to receive thermal insulation that will be applied to the panel; and flashing reglets to receive sheetmetal counter flashing.

****

Accurately position and securely anchor all anchorage devices. Openings in anchorage devices must be filled temporarily to prevent entry of concrete.

2.4.12 Lifting Devices

Lifting devices must be provided, and designed for a safety factor of 4, which includes 100 percent impact. Do not use brittle material.

2.4.13 Finishing for Formed Surfaces

Upon removal of forms, repair and patch defective areas. Where the finished surface will be exposed to view, the combined area of defective areas must not exceed 0.2 percent of the surface and will be limited to honeycomb or rock pockets not deep enough to expose the reinforcement. Where the finished surface will be concealed by other construction, defective areas are limited to holes left by the rods and other temporary inserts and honeycomb or rock pockets not deep enough to expose the reinforcement. Defective areas must be cut out to solid concrete, cleaned, and patched with grout. Where concrete surface will be exposed to view, the patches, when dry, must be indistinguishable from the surrounding surfaces.

****

NOTE: Delete the following paragraph, and specify the required finish or finishes when an exposed-aggregate finish is not required for exposed-to-view panel surfaces. Other finishes include textured form finishes, sculptured inserts, rubbed finishes, and combinations thereof; such finishes may require the specified exposed-to-view facing mixture.

It is recommended that a sample of the required

exposed-to-view finish be on display where it may be seen by bidders during the bidding period.
****

[Exposed-aggregate finish must match the finish of the approved sample. Aggregates in exposed-to-view surfaces will be exposed as soon after concrete placing as practical by power sanders, wire brushes, or other acceptable methods. Give surfaces one or more washings with a dilute solution of muriatic acid, then washed with fresh, clean water to remove all traces of the acid.

][Create an abrasive-blast finish using an abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.

][Create an acid-etched finish using acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.

][Create a honed finish using a continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.

][Create a polished finish using a continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.

]2.5 JOINT MATERIALS

****
NOTE: Cross sections of gaskets with dimensions must be indicated.
****

Gasket must be elastomeric material, premolded to cross section indicated.

Material must be a vulcanized closed-cell expanded chloroprene conforming to ASTM D1056, Grade No. 2A2, with the following additional properties:

a. Brittleness temperature will be minus 5 degrees C 40 degrees F when tested in accordance with ASTM D746.

b. Flammability resistance needs to be self-extinguishing when tested in accordance with ASTM D635.

c. Resistance to ozone must be "no cracks" after exposure of a sample, at 20 percent elongation, to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 40 degrees C 104 degrees F when tested in accordance with ASTM D1149.

2.6 MISCELLANEOUS ARCHITECTURAL PRECAST CONCRETE SYSTEMS

2.6.1 Thin Brick Veneer

Not less than 13 mm 1/2 inch or more than 25 mm 1 inch thick, and as follows:

a. Dimensional Tolerances: Plus 0 mm 0 inch or minus 1.6 mm 1/16 inch for any dimension 203 mm 8 inches or less and plus 0 mm 0 inch or minus 2.4 mm 3/32 inch for any dimension more than 203 mm 8 inches.

b. Out-of-Square Tolerance: Plus or minus 1.6 mm 1/16 inch.

c. Warpage Tolerance: Plus 0 mm 0 inch or minus 1.6 mm 1/16 inch.

d. Variation of Shape from Specified Angle: Plus or minus one degree.

e. Modulus of Rupture: Not less than 1.7 MPa 250 psi when tested according to ASTM C67/C67M.

f. Tensile Bond Strength: Not less than 1.0 MPa 150 psi when tested before and after freeze-thaw test according to ASTM E488/E488M as modified: Adhere a steel plate with a welded rod on a single thin-brick face with epoxy for each test.

g. 24-Hour Cold-Water Absorption: Not more than 6 percent when tested according to ASTM C67/C67M.

h. Freeze-Thaw Resistance: No detectable disintegration or separation after 300 freezing-and-thawing cycles when tested according to ASTM C666/C666M, Method B.

i. Chemical Resistance: Tested according to ASTM C650 and rated "not affected."

j. Efflorescence: Tested according to ASTM C67/C67M and rated "not effloresced."

k. Surface Coating: Thin brick with colors or textures applied as coatings must withstand 50 cycles of freezing and thawing; ASTM C67/C67M with no observable difference in applied finish when viewed from 3 m 10 feet.

l. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.

m. Face Size: [57 mm2-1/4 inches high by 194 mm 7-5/8 inches long][57 mm 2-1/4 inches high by 295 mm 11-5/8 inches long][92 mm3-5/8 inches high by 194 mm 7-5/8 inches long][92 mm3-5/8 inches high by 295 mm 11-5/8 inches long][_____].

Submit the following for thin brick veneer:

a. Brick Color chips representing color and size of each brick type to be used.

b. Form Liner Samples representing all brick inlay form liners which will be used.

c. Bond breaker sample on brick chip representing bond breaker which will be used.

d. Printed product data and installation instructions for brick inlay form liner system, and brick.

****

NOTE: Use the following paragraph when filling thin-brick joints with mortar before placing precast concrete.

****

2.6.1.1 Sand-Cement Mortar

Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.

2.6.1.2 Pointing Grout

****

NOTE: Use the following paragraph when filling thin-brick joints with pointing grout after precast concrete panel production.

****

Packaged, polymer-modified, sanded grout complying with ANSI A118.7.

2.6.1.3 Thin Brick Facing

a. Place form liner templates accurately to provide grid for thin-brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.

b. Securely place thin-brick units face down into form liner pockets and place concrete backing mixture.

****

NOTE: Delete the following two paragraphs if joint cavities are filled with concrete instead of using mortar or pointing grout.

****

c. Completely fill joint cavities between thin-brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.

d. Mix and install pointing grout according to ANSI A108/A118/A136.1. Completely fill joint cavities between thin-brick units with pointing grout, and compress into place without spreading grout onto faces of thin-brick units. Remove excess grout immediately to prevent staining of thin brick.

2.7 BEARING PADS

Submit product data for all bearing pads being used.

2.7.1 Elastomeric

AASHTO M 251, for plain neoprene bearings.

2.7.2 Hardboard (Interior Only)

ANSI/CPA A135.4, class as specified by the precast manufacturer.

2.7.3 Random-Oriented, Fiber-Reinforced Elastomeric Pads

Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer according to ASTM D2240. Capable of supporting a compressive stress of 20.7 Mpa 3000 psi with no cracking, splitting or delaminating in the internal portion of the pad.

2.7.4 Cotton-Duck-Fabric-Reinforced Elastomeric Pads

Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer according to ASTM D2240. Conforming to Division II, Section 18.10.2 of AASHTO LRFD Bridge Design Specifications or Military Specification MIL-C-882E.

2.7.5 Frictionless Pads

Polytetrafluoroethylene (PTFE), glass-fiber reinforced, bonded to stainless or mild-steel plates, or random-oriented, fiber-reinforced elastomeric pads, of type required for in-service stress.

2.7.6 High-Density Plastic

Multimonomer, nonleaching, plastic strip capable of supporting loads with no visible overall expansion.

2.8 INSULATED PANEL ACCESSORIES

2.8.1 Molded-Polystyrene (EPS) Board Insulation

ASTM C578, [Type XI, 12 kg/cu. m 0.70 lb/cu. ft][Type I, 15 kg/cu. m 0.90 lb/cu. ft][Type VIII, 18 kg/cu. m 1.15 lb/cu. ft][Type II, 22 kg/cu. m 1.35 lb/cu. ft][Type IX, 29 kg/cu. m 1.80 lb/cu. ft].

2.8.2 Extruded-Polystyrene (XPS) Board Insulation

ASTM C578, [Type X, 21 kg/cu. m 1.30 lb/cu. ft][Type IV, 25 kg/cu. m 1.55 lb/cu. ft][Type VI, 29 kg/cu. m 1.80 lb/cu. ft][Type VII, 35 kg/cu. m 2.20 lb/cu. ft][Type V, 48 kg/cu. m 3.00 lb/cu. ft].

2.8.3 Polyisocyanurate Board Insulation

ASTM C591, [Type I, 29 kg/cu. m 1.8 lb/cu. ft][Type II, 40 kg/cu. m 2.5 lb/cu. ft][Type III, 48 kg/cu. m 3.0 lb/cu. ft].

PART 3 EXECUTION

3.1 PREPARATION

Deliver anchorage devices to the site in time to be installed before the start of concrete placing or during steel erection. Contractor must provide setting drawings, instructions, and directions for the installation of anchorage devices.

3.2 EXAMINATION

Do not begin installation until supporting structures have been properly prepared.

Verify that all parts of the supporting structure are complete and ready to receive the precast units and that site conditions are conducive to proper installation.

If support structure is the responsibility of another installer, notify Contracting Officer of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

Install precast concrete units and accessories in accordance with approve detail drawings and descriptive data, and as specified below.

3.3.1 Building Framing System

Provide supporting members, including anchorage items attached to or embedded in building structural elements, prior to placement of precast units.

3.3.2 Concrete Strength at Time of Precast Unit Installation

****

NOTE: Delete one of the following paragraphs as applicable to the project. First paragraph will be selected except when the project schedule indicates installation of 28-day units.

****

Do not install precast units until concrete has attained the minimum laboratory compressive strength at 28 calendar days specified.

Do not install precast units before 28 calendar days from the date of casting unless approval has been obtained to make one compressive strength test, ASTM C39/C39M, and one flexural strength test using simple beam with third-point loading, ASTM C78/C78M, on field cured concrete test specimens, ASTM C31/C31M, for each individual precast unit to determine the strength of the concrete.

3.3.3 Erection

Erect precast units in accordance with the detail drawings and without damage to other units or to adjacent members. Set units true to alignment and level, with joints properly spaced and aligned both vertically and horizontally. Erection tolerances must be in accordance with the requirements of PCI MNL-117 and PCI MNL-122. As units are being erected, shims and wedges will be placed as required to maintain correct alignment. After final attachment, grout precast units as shown. After erection, clean and touch-up welds and abraded surfaces of steel with a zinc-rich paint. Welds must be made by a certified welder in accordance with the manufacturer's erection drawings. Finish pickup points, boxouts, inserts, and similar items to match adjacent areas after erection. Erection of precast units must be supervised and performed by workmen skilled in this type of work. Welding and the qualifications of welders must be in accordance with AWS D1.1/D1.1M.

3.3.4 Erection Tolerances

Erect architectural precast concrete units level, plumb, square and in alignment without exceeding the noncumulative erection tolerances of PCI MNL-117, Appendix I.

3.3.5 Joints

Joint widths between precast units will be as specified unless otherwise indicated.

3.3.5.1 Joint Sealing

Joint sealing will be as specified in Section 07 92 00 JOINT SEALANTS.

3.3.6 Protection

Protect exposed-to-view facing from staining and other damage from subsequent operations. Do not allow laitance to penetrate, stain, or harden on exposed surfaces.

3.4 DEFECTIVE WORK

Repair precast concrete units damaged during erection as soon after occurrence as possible or replaced, as directed, using approved procedures. All repairs to precast concrete units must match the adjacent surfaces in color and texture, as approved. Unless otherwise approved, repair procedures will conform to PCI MNL-117.

3.5 JOINTS AND GASKETS

Joints between precast units must be the width indicated and within limits of installation tolerances.

Install gaskets in joints as indicated, continuous throughout the joint length, and compressed at least 25 percent by volume.

3.6 INSPECTION AND ACCEPTANCE PROVISIONS

3.6.1 Dimensional Tolerances

Precast units having dimensions outside the limits for fabrication tolerances will be rejected.

3.6.2 Surface Finish Requirements

Precast units will be rejected for the following surface finish deficiencies:

a. Exposed-to-view surfaces that do not match the color, aggregate size and distribution, and texture of the approved sample

b. Exposed-to-view surfaces that contain defects that affect the appearance of the finish, such as cracks, spalls, honeycomb, rock pockets, or stains and discoloration of aggregate or matrix that cannot be removed by cleaning

c. Concealed surfaces that contain cracks in excess of 0.2 millimeter 0.01 inch wide, cracks that penetrate to the reinforcement regardless of width, honeycomb, rock pockets, and spalls except minor breakage at corners and edges

3.6.3 Strength of Precast Units

Strength of precast concrete units will be considered potentially deficient if the units fail to comply with the requirements that control the strength of the units, including the following conditions:

a. Failure to meet compressive strength tests

b. Reinforcement not conforming to the requirements specified

c. Concrete curing and protection of precast units against extremes of temperature during curing not conforming to the requirements specified

d. Precast units damaged during handling and erection

3.6.4 Testing Precast Units for Strength

When there is evidence that the strength of precast concrete units does not meet specification requirements, cores drilled from hardened concrete for compressive strength determination must be made in accordance with ASTM C42/C42M and as follows:

a. Take at least three representative cores from the precast-concrete units that are considered potentially deficient.

b. Test cores with the saturated surface dry.

c. Strength of cores will be considered satisfactory if their average is equal to or greater than 90 percent of the 28-day design compressive strength of 150 by 300 millimeter 6 by 12 inch cylinders.

Submit test reports on the same day that tests are made. Reports must contain the project name and number, date, name of contractor, name of precast concrete wall units manufacturer, name of concrete-testing service, identification letter and number of units represented by core tests, nominal maximum size of aggregate, design compressive strength of concrete at 28 calendar days, compressive breaking strength and type of break, length of core test specimen before capping, compressive strength after correcting for length diameter ratio, direction of application of the load on the core test specimen with respect to the horizontal plane of the concrete as placed, and the moisture condition of the core test specimen at time of testing.

If the results of the core tests are unsatisfactory or if core tests are impractical to obtain, a static load tests of a precast unit will be evaluated in accordance with ACI 318M ACI 318.

Replace precast units used for core tests or static load tests with units that meet the requirements of this section.

3.7 SAMPLING AND TESTING

3.7.1 Rejection

Precast units in place may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished. "Visible" means visible to a person with normal eyesight when viewed from a distance of 6 m 20 feet in broad daylight.

a. Nonconformance to specified tolerances.

b. Air voids (bugholes or blowholes) larger than 10 mm 3/8 inch diameter.

c. Visible casting lines.

d. Visible from joints.

e. Visible irregularities.

f. Visible stains on precast unit surfaces.

g. Visible differences between precast unit and approved sample.

h. Visible non-uniformity of textures or color.

i. Visible areas of backup concrete bleeding through the facing concrete.

j. Visible foreign material embedded in the face.

k. Visible repairs.

l. Visible reinforcement shadow lines.

m. Visible cracks.

n. Precast units that are damaged during construction operations.

3.7.2 Field Quality Control

Perform field inspection of precast unit connections. Notify the Contracting Officer in writing of defective welds, bolts, nuts and washers within 7 working days of the date of inspection. All defective connections or welds are to be removed and re-welded or repaired as required by the Contracting Officer.

3.7.2.1 Welded Connection Visual Inspection

AWS D1.1/D1.1M, furnish the services of AWS-certified welding inspector for erection inspections. Welding inspector must visually inspect all welds and identify all defective welds.

3.8 CLEANING

Clean exposed-to-view surfaces of precast units thoroughly with detergent and water; use a brush to remove foreign matter. Remove stains that remain after washing in accordance with recommendations of the precast manufacturer. Surfaces must be clean and uniform in color. Include precast concrete wall panel manufacturer's written recommendations for installation and cleaning.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 45 33 (May 2016)**
Change 1 - 11/21

Preparing Activity: NAVFAC **Superseding**
UFGS-03 45 33 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 03 - CONCRETE

SECTION 03 45 33

PRECAST[PRESTRESSED] STRUCTURAL CONCRETE

05/16, CHG 1: 11/21

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PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-03 45 33 (May 2016)**
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****

SECTION 03 45 33

PRECAST[PRESTRESSED] STRUCTURAL CONCRETE

05/16, CHG 1: 11/21

****

NOTE: This guide specification covers the requirements for precast non-prestressed and precast prestressed concrete used for structural purposes (floor units, roof units, joists, beams, planks, columns, single- and double-tee slabs, hollow-cored flat slabs, tee- or keystone-joists, and other structural framing elements, etc.) and for minor architectural purposes (copings, window sills, etc.) in building and waterfront facilities construction.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification does not cover precast concrete wall panels (Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE), major precast non-prestressed architectural concrete, post tensioned concrete, or precast concrete which is site manufactured and must not be used for bridge or roadway construction. Precast concrete sound fences should be considered in lieu of block walls for use where sound barriers are used for noise abatement.

****

****

NOTE: The following information must be shown on the project drawings:

1. Live and dead loads, and whether the topping is included in the dead load.

2. Details of fitting, bearing, and connections.

3. Location of expansion and control joints.

4. Layout of the framing system indicating the relative location of the various precast structural concrete sections, floor elevations, column centers and offsets, openings, and sufficient dimensions to adequately convey the quantity and nature of the required precast structural concrete framing system.

5. Details of all precast structural concrete sections indicating cross-sections and dimensions.

6. Location of precast structural concrete sections having an architectural finish on exposed-to-view surfaces when required.

7. Details of openings including the size of steel framing members as required.

8. Style and area of steel welded wire reinforcement in areas where required. Kind and size of reinforcing bars and spacing.

9. Strength and type of concrete.

10. Detail of placement of sealant or fillers in joints.

11. Fire rating.

12. Lightweight concrete unit weight.

13. Special requirements for concrete cover over reinforcing.

14. Areas where toppings are required, indicate areas where the full thickness of the topping is not present.

15. Camber.

16. Tendon types, physical properties, and allowable design stresses.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LRFDCONS	(3rd Edition; 2010, 2011, 2012, 2014, 2015, and 2016 Int) Bridge Construction Specifications
AASHTO M 251	(2006; R 2011) Standard Specification for Plain and Laminated Elastomeric Bridge Bearings
AASHTO T 259	(2002; R 2017) Standard Method of Test for Resistance of Concrete to Chloride Ion Penetration

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A421/A421M	(2021) Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing

	Concrete
ASTM A767/A767M	(2019) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A934/A934M	(2022) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C311/C311M	(2024) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1202	(2022; E 2022) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D5759	(2012; R 2020) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A135.4	(2012; R2020) Basic Hardboard

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(2021) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 5th Edition
PCI MNL-120	(2021) PCI Design Handbook - Precast and

	Prestressed Concrete, 8th Edition
PCI MNL-124	(2011) Design for Fire Resistance of Precast Prestressed Concrete, Third Edition
PCI MNL-135	(2000) Tolerance Manual for Precast and Prestressed Concrete Construction

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-882	(1989; Rev E) Cloth, Duck, Cotton or Cotton-Polyester Blend, Synthetic Rubber, Impregnated, and Laminated, Oil Resistant

UL SOLUTIONS (UL)

UL Fire Resistance	(2014) Fire Resistance Directory

1.2 MODIFICATION TO REFERENCE

In the ACI publications, reference to the "Building Official," the "Structural Engineer" and the "Architect/Engineer" must be interpreted to mean the Contracting Officer.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings of Precast Members; G, [_____]

Drawings of Precast Prestressed Concrete Members; G, [_____]

SD-03 Product Data

Anchorage and Lifting Inserts and devices

Bearing Pads

SD-04 Samples

[Surface Finish

] SD-05 Design Data

[Precast][Prestressed] Concrete Members Design Calculations; G, [_____]

Concrete Mix Design; G, [_____]

SD-06 Test Reports

Concrete Mix Design; G, [_____]

Fly Ash

Pozzolan

[Ground Granulated Blast-Furnace Slag

][Aggregates

][Concrete and Aggregate Quality Control Testing

][Water

] SD-07 Certificates

Quality Control Procedures

[Construction Records; G, [_____]

][Epoxy-Coated Steel Bars

][Erector's Post Audit Declaration

] SD-11 Closeout Submittals

Concrete Batch Ticket Information

Recycled Content for Fly Ash and Pozzolan; S

Recycled Content for Ground Iron Blast-Furnace Slag; S

Recycled Content for Silica Fume

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 Manufacturer Qualifications

****

NOTE: Use first bracketed paragraph unless no PCI certified plant are available. Then select the second paragraph.

Category C1: Mild steel reinforced precast concrete element. Category C2: Prestress hollow core and repetitive products. Category C3: Prestressed Straight Strand Structural Members. Category C4: Prestressed Deflected Strand Structural Members.

****

[PCI MNL-116. Plants must be certified by the PCI Plant Certification Program for Category [C1] [C2] [C3] [C4] work. At the Contracting Officer's option, PCI Plant quality control program records must be available for review.

][PCI MNL-116. Where panels are manufactured by specialists in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

]1.4.1.2 Erector Certification

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NOTE: Use Category S1 for horizontal decking members such as hollow core slabs. Use Category S2 for total precast concrete systems, vertical and horizontal load bearing members, and single- or multistory loadbearing members, including those with architectural finishes.

****

Erector with erecting organization and all erecting crews certified and designated by PCI's Certificate of Compliance to erect Category[S1 (Simple Structural Systems)][S2 (Complex Structural Systems)].

[1.4.1.3 Erector Qualifications

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NOTE: Use the following paragraph when a PCI Certified erector is not available in the project location.

****

A precast erector that is not certified by PCI must retain a PCI-Certified Field Auditor, at the erector's expense, to conduct a field audit of a project in the same category as this project prior to start of precast concrete erection and must submit the Erector's Post Audit Declaration to be considered qualified.

]1.4.1.4 Welding Qualifications

Provide AWS D1.1/D1.1M qualified welders who are currently certified at contract award date and have maintained their certificates over the past year.

1.4.2 Regulatory Requirements

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NOTE: Modify to add any local codes and regulations.

****

Provide precast [prestressed] members in conformance with ACI 318M ACI 318 and PCI MNL-120.

1.4.3 Concrete Mix Design

****

NOTE: Normal precast design is based on concrete having a compressive strength of 35 MPa 5000 psi at 28 days. Some precast manufacturers like to speed up production by using Type III (high early strength) concrete. For marine exposure, (or moderate and severe sulfate exposure) include last bracketed sentence, which limits the water-cement ratio to a maximum of 0.40.

****

****

NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.

****

ACI 318MACI 318. The minimum compressive strength of concrete at [28] [_____] days must be 35 MPa 5000 psi [_____], unless otherwise indicated.[Add air-entraining admixtures at the mixer to produce between 4 and 6 percent air by volume.][For marine exposure, ensure a dense concrete free of shrinkage cracks, with a minimum degree of permeability. The maximum water cement ratio must be 0.40].

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, complementary cementitious materials, [polypropylene fibers], and admixtures; and applicable reference specifications. Submit mill test and all other test for cement, complementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. For previously approved concrete mix designs used within the past twelve months, the previous mix design may be re-submitted without further trial batch testing if accompanied by material test data conducted within the last six months. Obtain mix design approval from the contracting officer prior to concrete placement.

1.4.4 Certificates: Record Requirement

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Transportation

1.5.1.1 Transporting Members

Transport members in a manner to avoid excessive stresses that could cause cracking or other damage.

1.5.1.2 Lateral Deflection or Vibration

Any noticeable indication of lateral deflection or vibration during transportation must be corrected by rigid bracing between members or by means of lateral trussing.

1.5.2 Storage

1.5.2.1 Storage Areas

Storage areas for precast [prestressed] members must be stabilized, and suitable foundations must be provided, so differential settlement or twisting of members will not occur.

1.5.2.2 Stacked Members

Stack members with adequate dunnage and bracing to control cracking, distortion, warping or other physical damage. Stack members such that lifting devices will be accessible and undamaged.

1.5.3 Handling of Members

The location of pickup points for handling of the members and details of the pickup devices must be shown in shop drawings. Members must be handled only by means of approved devices at designated locations. Members must be maintained in an upright position at all times and picked up and supported as shown in approved shop drawings.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The work includes the provision of precast[non-prestressed concrete herein referred to as precast members][and][precast, prestressed concrete herein referred to as prestressed members][except that precast concrete wall panels must be provided as specified in Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE]. [Precast][and][Prestressed] members must be the product of a manufacturer specializing in the production of precast [prestressed] concrete members.

****

NOTE: When concrete toppings are indicated, they are normally allowed to be used in establishing the design strength of the precast [prestressed] member. However, areas where the topping is not the full thickness, and areas without topping located inside of larger areas with topping need to be indicated so that the topping is not used in the untopped areas to establish the design strength of the precast [prestressed] members.

****

2.1.1 Design Requirements

Design precast [prestressed]members in accordance with ACI 318M ACI 318 and the PCI MNL-120. Design precast [prestressed] members (including connections) for the design load conditions and spans indicated, and handling and erection stresses, and for additional loads imposed by openings and supports of the work of other trades. Design precast[prestressed] members for handling without cracking in accordance with the PCI MNL-120. [Concrete toppings must [not] be used in establishing the design strength of the precast[prestressed] members.]

****

NOTE: Evaluate the loading requirements for the member design including all dead and live loads, and other specified loads for member, where applicable. Show design loads on the drawings. The designer of the precast [prestressed] members should also consider the effects of initial handling and erection stress in the final design of the elements.

****

2.1.1.1 Loads

Loadings for members and connections must include all dead load, live load, applicable lateral loads such as wind and earthquake, applicable construction loads such as handling, erection loads, and other applicable loads.

2.1.1.2 Drawing and Design Calculation Information

****

NOTE: Modify requirements based on the scope of the project.

****

Submit drawings and design calculations indicating complete information for the fabrication, handling, and erection of the precast[prestressed] member. Include a cover page with the design calculations, signed and sealed by the registered design professional who prepared the design. Drawings must not be reproductions of contract drawings. Design calculations[, drawings of precast members][[, and]drawings of precast prestressed concrete members] (including connections) must be made by a registered professional engineer experienced in the design of precast [prestressed]concrete members, and submitted for approval prior to fabrication. The drawings must indicate, as a minimum, the following information:

a. Plans, elevations and other drawing views showing the following:

    (1) Member piece marks locating and defining products furnished by the manufacturer.

    (2) Headers for openings.

    (3) Location and size of openings [that cut prestressing strands or require the location of prestressing strands to miss field cut openings].

    (4) Relationships to adjacent material.

    (5) Joints and openings between members and between members and other construction.

    (6) Location of field installed anchors.

    (7) Erection sequences and handling requirements

[(8) Areas receiving toppings and magnitude of topping thickness. Identify areas where topping is an integral part of the structural capacity of the precast members.

] (9) Lifting and erection inserts

b. Elevations, sections and other details for each member showing the following:

    (1) Connections between members and connections between members and other construction.

    (2) Connections for work of other trades and cast-in items and their relation to other trades.

    (3) Dimensioned size and shape for each member with quantities, position and other details of reinforcing steel, anchors, inserts and other embedded items.

    (4) Lifting, erection and other handling devices and inserts.

    (5) Surface finishes of each member.

    (6) Estimated cambers

[c. Magnitude, schedule and sequence of tensioning and detensioning prestressing strands.

] d. Strength properties for concrete, steel and other materials.

e. Methods for storage and transportation.

f. Description of loose, cast-in and field hardware.

g. All dead, live, handling, erection and other applicable loads used in the design.

h. Signature and seal of the registered design professional who prepared the design.

2.1.2 Performance Requirements

****

NOTE: Edit when precast [prestressed] members are to be fire rated. On most large jobs, not all members will have the same fire rating, so fire ratings for each specific member should be indicated for clarity.

****

Precast[prestressed] members [where indicated] must have a fire rating [of [_____]-hours] [as indicated] in accordance with UL Fire Resistance, or as designed in accordance with PCI MNL-124.

2.2 MATERIALS

2.2.1 Material Sustainability Criteria

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan

b. Recycled content for Ground Iron Blast-Furnace Slag

c. Recycled content for Silica Fume

2.2.2 Cementitious Materials

****

NOTE: Acceptable types of cement are as follows:

ASTM C150/C150M Portland	**ASTM C595/C595M Blended**	**Use**
Type I	**Type IP, IS, IL, or IT**	**For general use in contruction**

ASTM C150/C150M Portland	ASTM C595/C595M Blended	Use
Type II	Type IP, IS, IL, or IT (MS) or (MH)	For general use in construction where concrete is exposed to moderate sulfate action or where moderate heat of hydration is required. ASTM C595/C595M (blended hydraulic cements): add the suffix MS or MH where either moderate sulfate resistance or moderate heat of hydration, respectively, is required.
Type III	Type IP, IS, IL, or IT (HE)	For use when high early strength is required. ASTM C595/C595M (blended hydraulic cements): add the suffix HE where high early strength is required. Confer with the agency's Subject Matter Expert in Concrete Materials before specifying High early strength cement.
Type V	Type IP, IS, IL, or IT (HS)	For use when high sulfate resistance is required. ASTM C595/C595M (blended hydraulic cements): add the suffix HS where high sulfate resistance is required.

For concrete subjected to salt water, near salt water or exposed to alkali/sulfate soils refer to specification Section 03 31 30 MARINE CONCRETE for additional criteria.
****

****
NOTE: For NAVFAC LANT: Typically allow Type II, IP (MS), or IS (MS). May use Type I if Type II not locally available and no sulfate problems expected (i.e., not near seawater or sulfate soils). Type III is for high early strength. Type V, IP (HS), IS (HS), IL (HS), and IT (HS) are for high sulfate resistance.
****

****
NOTE: Coal fly ash, slag, cenospheres, and silica fumes are EPA designated products to be ingredients

in concrete and cement. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING and include additive options unless designer determines that justification for non-use exists.

****

For exposed concrete, use one manufacturer and one source for each type of cement, ground slag, fly ash, and pozzolan.

2.2.2.1 Fly Ash

****

NOTE: Fly ash, pozzolan, and slag cement may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Fly ash or pozzolan meeting the specified test results, which are more stringent than ASTM C618, should provide acceptable end results. It is suggested that fly ash be used as a replacement for 35 percent of the cement. Class C fly ash is not permitted.

****

ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed [3][6] percent.

Add with cement. Fly ash content must be a minimum of [15][20][30][35][40][_____] percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.2.2.2 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.

2.2.2.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.

b. The average particle size must not exceed 6 microns.

c. The sum of $SiO_2 + Al_2O_3 + Fe_2O_3$ must be greater than 77 percent.

2.2.2.4 Ground Granulated Blast-Furnace Slag

ASTM C989/C989M, Grade [100][120]. Slag content must be a minimum of [25][50][70] percent by weight of cementitious material.

[2.2.2.5 Silica Fume

****

NOTE: Silica Fume must only be used for OCONUS projects where Class F fly ash and GGBF slag are not available, and when approved by the Contracting Officer. Guidance for use of silica fume should be sought from the agency's Subject Matter Expert in Concrete Materials.

****

****

NOTE: The initial cost of the concrete must increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWR must be used with silica fume, the slump can be increased 50 to 125 mm 2 to 5 inches without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.

****

Silica fume must conform to ASTM C1240, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as slurry. Proper mixing is essential to accomplish proper distribution of the silica fume and avoid agglomerated silica fume which can react with the alkali in the cement resulting in premature and extensive concrete damage. Supervision at the batch plant, finishing, and curing is essential. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume. A High Range Water Reducer (HRWR) must be used with silica fume.

]2.2.2.6 Portland Cement

****

NOTE: If high early strength concrete is required, specify Type III after consulting the agency's Subject Matter Expert in Concrete Materials.

When concrete is exposed to sea water use specification Section 03 31 30 MARINE CONCRETE.

When high-volume fly ash mixtures, mixtures where fly ash replacement of portland cement is greater than 50 percent by weight, are specified they may be blended with Type II or Type III cement for higher early strength. Consult the agency's Subject Matter Expert in Concrete Materials prior to using Type III cement.

****

Provide cement that conforms to ASTM C150/C150M, Type [I][II][III], [including false set requirements] with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na2Oe (sodium oxide) equivalent. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

[For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch.][Supplier must certify that no hazardous waste is used in the fuel mix or raw materials.][Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants are discharged.]

2.2.2.7 Blended Cements

a. Blended cements must conform to ASTM C595/C595M Type [IP,] [IS,] [IL,] [IT,] [IP (MS),] [IS (MS),] [IL (MS),] [IT (MS),] [IP (MH),] [IS (MH),] [IL (MH),] [IT (MH),] [IP (LH),] [IS (LH),] [IL (LH),] [IT (LH),] [IP (HS),] [IS (HS),] [IL (HS),] [IT (HS),] [IP (HE),] [IS (HE),] [IL (HE),] [IT(HE),] or ASTM C1157/C1157M Type [GU][MS] [MH] [HE].

b. Slag cement added to the Type IS blend must meet ASTM C989/C989M.

c. The pozzolan added to the Type IP blend must be ASTM C618 [Class F,] [Class C,][or][Class N] and must be interground with the cement clinker. The manufacturer must state in writing that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of pozzolan used in the blend must not change from that submitted for the aggregate evaluation and mixture proportioning.

2.2.3 Water

Water must comply with the requirements of ASTM C1602/C1602M. Minimize the amount of water in the mix. Improve workability by adjusting the grading rather than by adding water. Water must be [potable][from rainwater collection][from graywater][from recycled water]; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete. Submit test report showing water complies with ASTM C1602/C1602M.

2.2.4 Aggregates

ASTM C33/C33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement. Submit test report showing compliance with ASTM C33/C33M.

Fine and coarse aggregates must show expansions less than 0.08 percent at 28 days after casting when testing in accordance with ASTM C1260. Should the test data indicate an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1567 using the Contractor's proposed mix design. In this case, include the mix design low alkali portland cement and one of the following supplementary cementitious materials:

a. GGBF slag at a minimum of 40 percent of total cementitious

b. Fly ash or natural pozzolan at a minimum of total cementitious of

    (1) 30 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 65 percent or more,

    (2) 25 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 70 percent or more,

(3) 20 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 80 percent or more,

(4) 15 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 90 percent or more.

[c. Silica fume at a minimum of 7 percent of total cementitious.

] If a combination of these materials is chosen, the minimum amount must be a linear combination of the minimum amounts above. Include these materials in sufficient proportion to show less than 0.08 percent expansion at 28 days after casting when tested in accordance with ASTM C1567.

Aggregates must not possess properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C295/C295M.

[2.2.4.1 Aggregates for Lightweight Concrete

ASTM C330/C330M.

]2.2.5 Grout

2.2.5.1 Nonshrink Grout

ASTM C1107/C1107M.

2.2.5.2 Cementitious Grout

****

NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.

****

Must be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method.[Provide air entrainment for grout exposed to the weather.]

2.2.6 Admixtures

[2.2.6.1 Air-Entraining

****

NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.

****

ASTM C260/C260M.

]2.2.6.2 Accelerating

ASTM C494/C494M, Type C or E.

2.2.6.3 Water Reducing

ASTM C494/C494M, Type A, E, or F.

2.2.7 Reinforcement

2.2.7.1 Reinforcing Bars

****

NOTE: Specify ASTM A706/A706M reinforcing where welding or bending of reinforcement bars is important. In addition in locations where reinforcing maybe subject to corrosive environmental conditions such as bridge decking use either epoxy coated reinforcement, epoxy coated prefabricated steel reinforcing bars or zinc-coated (galvanized) bars, ASTM A775/A775M epoxy coated reinforcing, ASTM A934/A934M epoxy coated prefabricated steel reinforcing bars or ASTM A767/A767M respectively may be specified where extra reinforcement protection is required.

****

ASTM A615/A615M, Grade [280] [420] [40] [60]; [ASTM A706/A706M, Grade 420 60;] or ASTM A996/A996M, Grade [350][420] [50] [60].

[Epoxy-coated steel bars must comply with the requirements of [ASTM A775/A775M][ASTM A934/A934M], including written certifications for coating material and coated bars, sample of coating material, and 700 g 0.5 pounds of patching material. Submit written certification with the delivery of the bars.

][Zinc-coated (galvanized) bars must comply with the requirements of ASTM A767/A767M, Class II coating, galvanized after fabrication.

]2.2.7.2 Wire

ASTM A1064/A1064M.

2.2.7.3 Welded Wire Reinforcement

ASTM A1064/A1064M.

2.2.7.4 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcement bars and wire in place.

Ensure legs of supports in contact with formwork for sections that will be exposed to weather are hot-dip galvanized after fabrication, plastic coated, or corrosion-resistant steel bar supports.

[2.2.8 Prestressing Strands

[Uncoated, 7-wire strand stress- relieved, ASTM A416/A416M, Grade 1725 250 1860 270, strand diameter as shown.

][Single wire stress- relieved, ASTM A421/A421M for low relaxation wire.

][High-strength steel bars must conform to ASTM A722/A722M, Type I or II, meeting all supplementary requirements.

]]2.2.9 Metal Accessories

Provide ASTM A123/A123M or ASTM A153/A153M galvanized.

2.2.9.1 Inserts

ASTM A47/A47M, Grade 22010 32510, or ASTM A27/A27M Grade 415-205 60-30. Submit product data.

2.2.9.2 Structural Steel

ASTM A36/A36M.

2.2.9.3 Bolts

ASTM A307; ASTM A325M ASTM A325.

2.2.9.4 Nuts

ASTM A563MASTM A563.

2.2.9.5 Washers

ASTM F844 washers for ASTM A307 bolts, and ASTM F436M ASTM F436 washers for ASTM A325M ASTM A325bolts.

2.2.10 Bearing Pads

Submit product data for all bearing pads being used.

2.2.10.1 Elastomeric

AASHTO M 251, for plain neoprene bearings.

2.2.10.2 Hardboard (Interior Only)

ANSI/CPA A135.4, class as specified by the precast manufacturer.

2.2.10.3 Random-Oriented, Fiber-Reinforced Elastomeric Pads

Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer according to ASTM D2240. Capable of supporting a compressive stress of 20.7 Mpa 3000 psi with no cracking, splitting or delaminating in the internal portion of the pad.

2.2.10.4 Cotton-Duck-Fabric-Reinforced Elastomeric Pads

Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer according to ASTM D2240. Conforming to Division II, Section 18.10.2 of AASHTO LRFDCONS Bridge Design Specifications or Military Specification MIL-C-882.

2.2.10.5 Frictionless Pads

Polytetrafluoroethylene (PTFE), glass-fiber reinforced, bonded to stainless or mild-steel plates, or random-oriented, fiber-reinforced elastomeric pads, of type required for in-service stress.

2.2.10.6 High-Density Plastic

Multimonomer, nonleaching, plastic strip capable of supporting loads with no visible overall expansion.

2.3 PRODUCTION QUALITY CONTROL PROCEDURES

****

NOTE: Refer to PCI for tolerance information. Modify to add critical tolerance if different than PCI.

****

PCI MNL-116 unless specified otherwise. Submit quality control procedures established in accordance with PCI MNL-116 by the precast manufacturer.

2.3.1 Forms

Brace forms to prevent deformation. Forms must produce a smooth, dense surface. Use forms and form-facing materials that are nonreactive with concrete such as wood, metal, plastic, or other approved materials. Conform to the shapes, lines, and dimensions indicated and are within the limits of the specified fabrication tolerances. Chamfer exposed edges of columns and beams 200 mm 3/4 inch, unless otherwise indicated. Provide threaded or snap-off type form ties.

2.3.2 Tolerances

Fabricate structural precast concrete members of shapes, lines and dimensions indicated, so each finished member complies with PCI MNL-135 product tolerances as well as position tolerances for cast-in items.

2.3.3 Reinforcement Placement

ACI 318MACI 318 and PCI MNL-116 for placement and splicing. Place and secure steel bars, welded-wire reinforcement, and other reinforcement by means of metal bar supports and spacers. Reinforcement may be preassembled before placement in forms. Provide exposed connecting bars, or other approved connection methods, between precast [prestressed]and cast-in-place construction. Remove any excess mortar that adheres to the exposed connections.[Provide curvature or drape of the prestressing strands using approved hold-down devices.]

[2.3.4 Inserts

When the ends of the prestressed member will be exposed, recess the prestressing stands using inserts. After detensioning, remove inserts and fill the recess with nonshrink grout.

]2.3.5 Built-In Anchorage Devices

****

NOTE: Indicate anchorage devices that are to be embedded in the precast structural concrete sections. Anchorage devices include weld plates, bearing plates and steel shapes.

****

Position, anchor, and locate anchorage devices where they do not affect the position of the main reinforcement or placing concrete. Bearing plates; set level, aligned properly, and anchored in the exact location indicated.

2.3.6 Lifting Devices

Provide lifting devices designed for 100-percent impact, and of materials sufficiently ductile to ensure visible deformation before fracture.

2.3.7 Blockouts

****

NOTE: Blockouts or openings in slabs that would require the cutting of primary reinforcement if such openings were to be cut in the field ensure openings are cast in the unit during fabrication and indicated. The maximum size of field-cut openings may be from 150 to 300 millimeter 6 to 12 inches depending on the type of unit used such as the inside diameter of the voids in hollow core flat slabs and the spacing of reinforcement.

****

Provide blockouts as indicated.

2.3.8 Identification Markings

Clearly mark each structural section in a permanent manner to indicate its location and orientation in the building and the pickup points.

Ensure each structural section has the date of casting plainly indented in the unexposed face of the concrete.

2.3.9 Concrete

2.3.9.1 Concrete Mixing

ASTM C94/C94M. Mixing operations must produce batch-to-batch uniformity of strength, consistency, and appearance.

2.3.9.2 Concrete Placing

PCI MNL-116.

2.3.9.3 Concrete Curing

PCI MNL-116.

[2.3.10 Prestressing

****

NOTE: For normal prestressing use a release strength of 23 MPa 3500 psi, unless the design requires a higher release strength. Some release strengths are indicated in the PCI Design Handbook for selected prestressed members based on different load conditions, strand patterns, and span lengths.

****

PCI MNL-116. Do not transfer prestressing forces during detensioning until the concrete has reached a minimum compressive strength of [24 MPa] [3500 psi] [_____], unless a higher strength is required by the Contractor furnished design.

]2.3.11 Surface Finish

Repairs located in a bearing area must be approved by the Contracting Officer prior to repairs. Defects must be repaired or rejected as specified in paragraph ACCEPTANCE/REJECTION OF DEFECTS.

****

NOTE: Sample panels should only be required when a finish Grade A or better is specified.

****

[Submit two 300 by 300 by 50 mm 12 by 12 by 2 inch thick sample panels representative of the color and finish for each type of precast member requiring a finish Grade [A][_____] surface finish.

]2.3.11.1 Unformed Surfaces

Provide a [floated] [steel troweled] finish.

2.3.11.2 Formed Surfaces

****

NOTE: PCI MNL-116 different grades of formed surface finishes:

Commercial Grade: Concrete produced in forms that produce a rough finish. Fins are removed and large surface blemishes filled. Sharp edges that will be visible in the finished structure are ground down.

Standard Grade: Same finish as commercial grade, except the forms do not produce a texture on the concrete. Surface can be painted, but will have surface voids.

Finish Grade B: Same as standard grade, except all surface blemishes should be filled or finished to provide a smooth surface or uniform appearance if painted.

Finish Grade A: Same as Finish Grade B, except that the components of the completed structure, where exposed, must be reasonably color matched. This finish is difficult to obtain.

****

PCI MNL-116, Appendix C, for grades of surface finishes.

a. Unexposed Surfaces: Provide a [commercial] [standard] grade surface finish.

b. Exposed Surfaces: Provide a [standard grade] [finish Grade B] [_____] surface finish.[The combined area of acceptable defective areas must not exceed 0.2 percent of the exposed to view surface area, and the patches must be indistinguishable from the surrounding surfaces when dry.][In addition to a Grade B surface finish, members must have a smooth rubbed finish.]

2.3.11.3 Architectural Finish

Provide a [finish Grade A] [_____] surface finish to those members indicated.

2.3.12 Acceptance/Rejection of Defects

2.3.12.1 Minor Defects

All honeycombed areas, chipped corners, air pockets over 6 mm 1/4 inch in diameter, and other minor defects involve less than 900 mm^2 36 square inches of concrete must be repaired. Form offsets of fins over 3 mm 1/8 inch must be ground smooth. All unsound concrete must be removed from defective areas prior to repairing. All surfaces permanently exposed to view must be repaired by a blend of portland cement and white cement properly proportioned so that the final color when cured will be the same as adjacent concrete. Precast [prestressed]members containing hairline cracks which are visible and are less than 0.25 mm 0.01 inches in width, may be accepted, except that cracks larger than 0.1 mm 0.005 inches in width for surfaces exposed to the weather must be repaired.

2.3.12.2 Major Defects

Major defects are those which involve more than 900 mm^2 36 square inches of concrete or expose stressing tendons or reinforcing steel. If one or more major defects appear in a member, it will be rejected. Cracks of a width of more than 0.25 mm 0.01 inch will be cause for rejection of the member.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

****

NOTE: If marine environment or exposed to severe environmental conditions, recommend including chloride ion penetration requirements.

****

[2.4.1 Chloride Ion Concentration Test

Sampling and determination of water soluble chloride ion content in accordance with ASTM C1218/C1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures must not exceed 0.06 percent by weight of cement.

][2.4.2 Chloride Ion Penetration Test

To ensure the durability of concrete in marine environment, concrete must be proportioned to have the chloride ion penetration test in accordance with ASTM C1202, and be below 1500 coulombs for concrete specimens tested at 28 days.[Alternatively, a ponding test in accordance with AASHTO T 259 may be performed to validate chloride ion penetration in accordance with ASTM C1202.]

]2.4.3 Factory Inspection

****

NOTE: Check with the designer and Resident in Charge of Construction and edit appropriately.
****

At the option of the Contracting Officer, [precast[prestressed] units may be inspected by the Contracting Officer] [precast[prestressed] units must be inspected by the QC Representative] prior to being transported to the job site. The Contractor must give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to erection, and again after installation, precast[prestressed] members must be checked for damage, such as cracking, spalling, and honeycombing. As directed by the Contracting Officer, precast[prestressed] members that do not meet the surface finish requirements specified in paragraph SURFACE FINISH must be repaired, or removed and replaced with new precast [prestressed]members.

3.2 ERECTION

Precast [prestresed]members must be erected after the concrete has attained the specified compressive strength, unless otherwise approved by the precast[prestressing] manufacturer. [In addition, prestressed members must not be rigidly fixed in position until the prestressed member has "aged" [90] [_____] days after detensioning.] Erect in accordance with the approved shop drawings. PCI MNL-135 for tolerances. Provide a 1:500 tolerance, if no tolerance is specified. Brace precast [prestressed]members, unless design calculations submitted with the shop drawings indicate bracing is not required. Follow the manufacturer's recommendations for maximum construction loads. Place precast[prestressed] members level, plumb, square, and true within tolerances. Align member ends.

3.3 BEARING SURFACES

Must be flat, free of irregularities, and properly sized. Size bearing surfaces to provide for the indicated clearances between the precast[prestressed] member and adjacent precast[prestressed] members or adjoining field placed surfaces. Correct bearing surface irregularities with nonshrink grout. Provide bearing pads where indicated or required. Do not use hardboard bearing pads in exterior locations. Place precast[prestressed] members at right angles to the bearing surface, unless indicated otherwise, and draw-up tight without forcing or distortion, with sides plumb.

3.4 ANCHORAGE

Provide anchorage for fastening work in place. Conceal fasteners where practicable. Make threaded connections up tight and nick threads to prevent loosening.

3.5 WELDING

AWS D1.1/D1.1M, AWS D1.4/D1.4M for welding connections and reinforcing splices. [Do not weld prestressing strands.]Protect the concrete and other reinforcing from heat during welding. Weld continuously along the entire area of contact.[Grind smooth visible welds in the finished installation.] Welding of epoxy-coated reinforcing is not allowed.

3.6 OPENINGS

Holes or cuts requiring [reinforcing][prestressing steel]to be cut, which are not indicated on the approved shop drawing, must only be made with the approval of the Contracting Officer and the precast manufacturer. Drill holes less than 300 mm 12 inches in diameter with a diamond tipped core drill. Ensure cuts are straight and at 90 degrees to the surfaces without breaking or spalling the edges.

3.7 GALVANIZING REPAIR

Repair damage to galvanized coatings using ASTM A780/A780M zinc rich paint for galvanized surfaces damaged by handling, transporting, cutting, welding, bolting, or acid washing. Do not heat surfaces to which repair paint has been applied.

3.8 GROUTING

Clean and fill [indicated] keyways between precast[prestressed] members, and other indicated areas, solidly with nonshrink grout or cementitious grout. Provide reinforcing where indicated. Remove excess grout before hardening.

3.9 SEALANTS

Provide as indicated and as specified in Section 07 92 00 JOINT SEALANTS.

3.10 PROTECTION AND CLEANING

****

NOTE: Ensure where architecturalfinishes such as exposed-aggregate finish are specified for exposed-to-view surfaces, such surfaces are cleaned as specified in Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE.

****

Protect exposed-to-view surfaces against staining and other damage until completion of the work.

Upon completion of installation, swept clean and leave ready slab surfaces to receive concrete floor topping, roofing, or other covering.

[3.11 CONCRETE TOPPING

Provide as indicated and as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

][3.12 CONSTRUCTION RECORDS

Complete construction records must be kept of the manufacturing, handling, and erection of the precast-prestressed concrete members and submitted. Records must be kept for, but not limited to, the following items:

a. Specifications of material used in the manufacture of the members.

b. Time-temperature history of the concrete members from casting to the transfer of the prestress force.

c. Records of the tendon stressing operation including initial prestress force, measured elongation, how it was measured, and how the tendons were stressed and destressed.

d. Records of inspection of the members before and after the prestress force is transferred to the members.

e. Records of the inspection of the members each time they are moved.

f. Records of any defects in the member and any corrective measures taken.

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-03 47 13 (August 2016)**

Preparing Activity: USACE **Superseding**
UFGS-03 47 13 (August 2008)
UFGS-03 47 00.00 40 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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TILT-UP CONCRETE

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USACE / NAVFAC / AFCEC **UFGS-03 47 13 (August 2016)**

Preparing Activity: USACE
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 03 47 13

TILT-UP CONCRETE

08/16

****

NOTE: This guide specification covers the requirements for tilt-up concrete wall panels precast on a previously prepared casting bed, usually the floor slab, and erection with a crane by tilting to a near vertical position, lifting free of the floor, and placing in final location.

This section includes various materials such as release agents, lifting and bracing inserts, cast-in accessories, special finishes, and installation as related to tilt-up construction. This section also includes form liners, placing concrete, tolerances, and erection and cleanup of panels.

This section does not include concrete materials common to all concrete work such as cements, aggregates, and lime.

Ensure drawings illustrate a complete design, indicating sizes of panels, reinforcing, locations of lifting inserts, connections details, and relative location of various structural members to which panels are connected, with sufficient dimensions to convey adequately the quantity and nature of the required work. Verify that drawings indicate whether the interior or exterior surface is cast face up.

Ensure bolted and welded joints and connections are indicated when these connections are required to resist applied loads.

Ensure architectural concrete wall panels are indicated.

Formwork, reinforcing steel, and concrete are specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

Section 05 05 23.16 STRUCTURAL WELDING, Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, and Section 07 92 00 JOINT SEALANTS, along with ACI 551.1R and ACI CP-50 apply to work specified in this section.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 302.1R	(2015) Guide for Concrete Floor and Slab Construction
ACI 551.1R	(2014) Tilt-up Concrete Construction Guide
ACI CP-50	(2007) Tilt-Up Supervisor & Technician

Reference Guide

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Meetings

No later than [30] [_____] days after Contract Award, the Contracting Officer will schedule a pre-installation meeting. Bring to attention of the Contracting Officer any discrepancies found in the architectural and structural drawings. Submit the following:

a. Submit Fabrication Drawings signed and sealed by a registered professional engineer. Include dimensions of panels and size and location of openings for concrete formwork on the fabrication drawings. Show connection details, reinforcing details, and lifting devices on the installation drawings, used for the following items:

   (1) Panels

   (2) Reinforcement and Embedded Items

b. Submit certificates for the following items showing conformance with referenced standards contained in this section:

   (1) Facing Aggregate

   (2) Concrete Aggregates

   (3) Chemical Admixtures

   (4) Release Agent

   (5) Pick-Up Inserts

   (6) Bracing Inserts

   (7) Reglets

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

Panels

Reinforcement and Embedded Items

SD-04 Samples

Concrete Panel Sample; G, [_____]

Exposed Aggregate; G, [_____]

SD-07 Certificates

Facing Aggregate

Concrete Aggregates

Chemical Admixtures

Release Agent

Pick-Up Inserts

Bracing Inserts

Reglets

1.4 QUALITY CONTROL

1.4.1 Erector Qualifications

Provide an experienced supervisor for panel construction and erection having at least [2] [_____] years of successful experience in tilt-up construction, similar to the size and amount required for this project. Personnel working pursuant to this section, may at the Contracting Officer's option, be required to demonstrate technical competence by performing sample work [and/or by displaying their state qualifications/certificates], at no additional cost to the Government.

1.4.2 Tolerances

Apply the following tolerances to this work:

****

NOTE: Tolerances may need to be changed depending on location of work.

****

a. Dimensional tolerances: Plus or minus 3.2 millimeter 1/8 inch in length and height, 4.8 millimeter 3/16 inch across diagonals

b. Bowing or warpage tolerance: Plus or minus 12.7 millimeter in 3050 millimeter 1/2[_____] inch in 10 feet

c. Thickness tolerance: Plus 12.7, minus 3.2 millimeter 1/2, minus 1/8 inch

[1.4.2.1 Samples

Cast a 1200 by 1200 millimeter 4 by 4 foot Concrete Panel sample on a casting slab to demonstrate releasing ability of release agent and architectural effects. Also provide three, 300 by 300 millimeter 12 by 12 inches test panels of Exposed Aggregate.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Water Absorption

****

NOTE: Maximum absorption is 2 percent but not less than the percentage obtained by testing the facing aggregates in the sample panel.

****

Ensure water absorption of facing aggregates is not less than the percentage obtained by testing the facing aggregates in the approved sample panel.

2.2 EQUIPMENT

2.2.1 Form Liners

****
NOTE: Delete the paragraph heading and the following sentence when form liners are not required. If required, select type of liner from list below.
****

Provide [rubber matting][wood board][plywood panel][nailed-on inserts][fiberglass][plastic sheets][pattern as shown on drawings] form liners.

2.3 MATERIALS

2.3.1 Chemical Admixtures

****
NOTE: Specify admixtures when they are not included under cast-in-place concrete.
****

[Provide admixture conforming to ASTM C494/C494M, Type B for retarder.

][Provide admixture conforming to ASTM C494/C494M, Type C for accelerator.

]2.3.2 Release Agent

****
NOTE: Ensure additional finishes are specified. Ensure resin type agents are used for panels to receive additional finishes.
****

[Use resin type release agent, containing no materials that could affect bond of subsequent finishes or natural appearance of exposed concrete surfaces.

][Use paraffin type release agent.

]2.3.3 Facing Aggregate

****
NOTE: Delete paragraph heading and the following sentence when facing aggregates are not required. Select applicable option(s).
****

Provide [gravel][limestone][quartz][marble][granite][glass][ceramic] aggregate. Match color and gradation appearance of facing aggregates of panels to the accepted sample panel.

2.3.4 Concrete Aggregates

Provide concrete aggregates conforming to Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE for concrete aggregates, except that coarse aggregate ranges from 31.5 to 9.5 millimeter 1-1/4 to 3/8 inch in size.

2.4 CAST-IN ACCESSORIES

2.4.1 Pick-Up Inserts

[Provide [double] [single] type inserts.

][Provide [corrosion-resistant steel] [hot-dip galvanized]inserts.

]2.4.2 Bracing Inserts

Provide [corrosion-resistant steel] [hot-dip galvanized] inserts with a height corresponding to the thickness of the panel.

2.4.3 Reglets

****

NOTE: Select either metal or polyvinylchloride reglets. If metal reglets are required, specify either corrosion-resistance steel or hot-dip galvanized. Minimum thickness for metal reglets is 0.38 millimeter 0.015 inch.

****

[Provide [corrosion-resistant] [hot-dip galvanized-] steel, 0.48 millimeter 28-gage, metal reglets with styrofoam rigid filler.

][Provide extruded polyvinylchloride reglets with styrofoam rigid filler.

]2.4.4 Sleeves

****

NOTE: Delete paragraph heading and the following two sentences if sleeves are specified under another section or if they are not required.

****

[Provide pipe sleeves, size as indicated.

][Provide sheetmetal sleeves, size as indicated.

]2.4.5 Lifting Devices

Provide hot-dipped galvanized [angle] [swivel] type lifting devices.

PART 3 EXECUTION

3.1 PREPARATION

Clean forms and the casting slab of extraneous materials. Locate the casting area for the panel in an area were floor joints are preferably avoided or at least minimize the impact to the panel being casted. Spackle and/or caulk floor joints and temporarily patch floor openings that occur in the casting area.

****

NOTE: Specify and/or verify at the time of submittal review that the releasing agent is compatible with the final finish, such as sealants,

paints, etc.

****

Treat casting slab with a release agent before placing reinforcing and embedded items. Use care not to scuff the release agent when placing reinforcing and embedded items.

Re-treat scuffed areas with the release agent, using care not to coat reinforcing and embedded items. Repair holes and spalling within the slab surface from previous cast and allow to cure before applying a new coat of releasing agent.

****

NOTE: Include concrete requirements for tilt-up panels within Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE. These may include joint locations, Slab thickness, Levelness, embed locations, etc.

****

Field verify and correct any errors in the footings and foundations such as levelness, embed locations, etc. prior to lifting. Refer to Section 03 33 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE for additional requirements.

3.2 INSTALLATION

3.2.1 Reinforcement And Embedded Items

Accurately locate reinforcing and items to be embedded in the panels in accordance with approved drawings and place into forms.

****

NOTE: Delete the following paragraph when the supporting members are not poured-in-place columns.

****

[Extend horizontal reinforcing rods at sides of panels a minimum of 300 millimeter 12 inches into column forms.

]3.2.2 Casting

****

NOTE: When structurally possible the panel thickness should be equal to nominal thickness of wood members to improve installation and cost efficacy.

****

Cast panels individually on a temporary casting slab or on the concrete floor slab of the building. Refer to Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE and comply with ACI 302.1R. Vibrate concrete to produce the maximum density without voids throughout the entire panel thickness. Do not displace reinforcement or inserts, or cause scoring of forms, liners, or the casting slab.

[Install [_____] millimeter inch cant strip along edges of formwork.

][Install strong backs at locations were panel legs are less then [_____]

millimeter inches in width.

] Furnish plastic or plastic tipped steel chairs for placement of reinforcing.

3.2.3 Finishes

Finish exposed face surfaces of panels to match the approved sample panel.

****

NOTE: Select finish required for inside surface of panels.

Unexposed panel backs usually have a smooth float finish or a broom finish. When the inside surfaces are exposed, the panels can receive a smooth steel-trowel finish or light broom finish.

****

Provide exposed panels with a [smooth trowel] [light broom] [exposed aggregate] [[brick][stone] pattern] finish.

Provide architectural accents and reveals per construction drawings.

Provide unexposed panel backs with a [smooth float] [broom] finish.

Cracks, voids, protrusions, spalls, or nonuniform color or texture are not acceptable. Patch and repair minor defects from casting to match adjacent final finish.

3.2.4 Curing

After casting, form-cure panels until sufficient strength has developed to permit handling the units without damage.

****

NOTE: The number of days for moisture curing may be changed to meet project requirements.

****

After removal of forms, moist-cure panels for a minimum of 6 calendar days.

3.3 FIELD QUALITY CONTROL

****

NOTE: Specify higher-strength concrete if required.

****

Do not start erection of panels until representative concrete test cylinders have a minimum compressive strength as specified on the drawings.

Locate pickup points in concrete panels so that concrete tensile stresses during erection do not exceed 10 percent of the cylinder compressive strength at time of erection.

3.4 ERECTION

Level the setting bed for wall panels using high-strength mortar so that the panel in place will have a level tolerance within 1 to 500.

Erect panels using spreader bars, chockers with equalizer sheaves, adjustable bracing, and other erecting accessories as required to place panels in location. Ensure bracing equipment meets applicable codes.

Tilt panels from the casting platform to slope within 1 horizontal to 6 vertical ratio.

Plumb initial setting of panels within 75 millimeter 3 inches of true.

Plumb final setting of panels with adjustable braces to vertical tolerance of 1 to 500, leaving braces in place until panels are secured in their final location as indicated.

****

NOTE: Panels may be connected to steel columns, precast concrete columns, or cast-in-place concrete columns. Ensure details of connecting panels to supporting structures are indicated. Delete paragraphs which are not applicable.

****

Bolt panels to the supporting structure with high-strength bolts as specified in Section 05 12 00 STRUCTURAL STEEL.

Weld panels to the supporting structure.

****

NOTE: Include all the following paragraphs for welded panels.

****

Ensure welding meets the requirements of AWS D1.1/D1.1M.

Before welding, clean surfaces of loose scale, slag, rust, grease, and other foreign substances that could affect the strength of the welds.

Weld connections with weld materials that correspond to the steel being welded.

Use and maintain shielded metal arc welding.

Provide inspection gages for checking the size, length, and quality of welds.

Correct or replace welds having cracks, surface porosity, slag accumulation, insufficient throat, or concavity.

Remove weld splatter from steel surfaces to be painted.

Brace panels with adjustable turnbuckle pipe braces or timber braces.

****

NOTE: Select either plastic or portland mortar. Portland mortar (dry-packing) is recommended for tighter joints.

****

Pack joints between wall panels and foundation and wall panels and columns with [portland cement] [plastic] mortar.

3.5 PATCHING

Dry pack holes in panels left after lifting rigging has been removed with nonshrink mortar to match adjacent surfaces.

****

NOTE: Select one of the following paragraphs.

Specify sack-rubbed cleaning when surface air pockets and minor rust stains occur.

Specify acid-cleaning solution when stains are caused by rust from reinforcing and impurities in curing water.

****

[Wet stained surfaces, coat surfaces with a thick mortar mixture, and rub the area with burlap pads to remove the excess mortar and fill surface voids.

][Remove surface stains with diluted muriatic acid, scrubbing with stiff brushes and flushing with clean water.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-03 51 13 (May 2016)**

Preparing Activity: USACE **Superseding**
UFGS-03 51 01 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03 51 13

CEMENTITIOUS WOOD FIBER DECKS

05/16

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-03 51 13 (May 2016)**

Preparing Activity: USACE **Superseding**
UFGS-03 51 01 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 03 51 13

CEMENTITIOUS WOOD FIBER DECKS
05/16

****
NOTE: This guide specification covers the requirements for cementitious wood fiber decks.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA PS 2	(2010; R 2014) Performance Standard for Wood-Based Structural Use Panels

ASTM INTERNATIONAL (ASTM)

ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E1349	(2006; R 2013) Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry

1.2 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roof Decking Installation; G, [_____]

1.3 DELIVERY, STORAGE, AND, HANDLING

Store roof decking units off the ground and protect from weather, marring, damage, or overload. Provide adequate ventilation to prevent condensation. Provide temporary plank walkways or platforms for distributing the weight of materials that are required to be placed upon or transported over the roof decking.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

****

NOTE: Because there is a limited number of manufacturers of these units, there are no national standards governing the design or manufacture of these units. Designer should consult manufacturers' literature for additional information.

****

Roof decking units must be factory-produced items of a firm specializing in cementitious wood fiber decking. Design of the roof decking must be for the load conditions and spans indicated and any additional load imposed by openings; work of other trades; and all loading and restraining conditions from fabrication, handling, and erection. Deflection must not exceed L/240 of span. Submit detail drawings showing roof decking installation, including framing at all openings for support of roof units. The detail drawings must be accompanied by setting details, design calculations showing that the roof decking installation meets material and design requirements, a descriptive list of materials, and the manufacturer's current printed installation instructions.

2.2 DECK UNITS

****

NOTE: Type of units specified will be limited by design requirements. Thickness and other dimensions, if essential to the design, will be indicated. Cement-fiber deck units are available with foam insulation attached. If roof is to be insulated, the use of these units should be investigated.

****

Fabrication of roof deck units must be under plant controlled conditions. Provide openings for mechanical and utility systems and for architectural purposes as indicated. Special shapes must be fabricated as indicated or required. Surfaces to receive subsequent application must be suitable for the purpose intended and free of any coatings that would interfere with adhesion or bond. Surfaces showing as exposed ceilings must have a light reflection of 60 percent in accordance with ASTM E1349.

2.2.1 Structural Cementitious Wood Fiber Roof Decking

Structural cementitious wood fiber roof decking must be shaped under pressure to required dimensions from a mixture of wood fibers and cementitious materials in proportions to produce deck units meeting the loading conditions specified. Exterior surfaces must be suitable for applying roof. Metal edge members, if furnished with units, must be galvanized. Flame spread must not exceed 25 and smoke developed rating must not exceed 50 when tested in accordance with ASTM E84. [Roof decking must achieve a noise reduction coefficient (NRC) of [NRC 0.55][NRC 0.60][NRC 0.65][NRC 0.70][NRC 0.75][NRC 0.80] in accordance with ASTM C423.]

2.2.1.1 Monolithic Cementitious Wood Fiber Plank Units

Manufacturer's standard, tongue-and-groove-edged, cementitious wood fiber units with a plank thickness of[51 mm 2 inches][63 mm 2-1/2 inches][76 mm 3 inches]. Planks to have the manufacturer's standard [natural][or][prime-painted] finish. [Provide channel reinforced planks with factory-installed, cold formed, 1.5 mm 0.060 inch thick, galvanized steel channel set in grooved edge.][Provide planks with edges kerfed, back rabbeted, and beveled for a concealed tee system.]

2.2.1.2 Composite Cementitious Wood Fiber Plank Units

2.2.1.2.1 Insulated Composite Plank

Manufacturer's standard factory laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood fiber plank base with a thickness of[38 mm 1-1/2 inches][51 mm 2 inches][63 mm 2-1/2 inches][76 mm 3 inches], ASTM C578, [Type IV extruded-polystyrene insulation][Type I expanded-polystyrene insulation] with a thickness of[38 mm 1-1/2 inch][51 mm 2 inches][76 mm 3 inches][102 mm 4 inches][127 mm 5 inches][152 mm 6 inches][177 mm 7 inches][202 mm 8 inches], and a top layer of APA-rated oriented-strand-board sheathing, Exposure 1 complying with APA PS 2, 11 mm 7/16 inch thick.

2.2.1.2.2 Composite Nailable Surface Plank

Manufacturer's standard factory laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood fiber plank base with a thickness of[63 mm 2-1/2 inches][76 mm 3 inches][89 mm 3-1/2 inches][102 mm 4 inches], insulation, and a top layer of APA-rated oriented-strand-board sheathing, Exposure 1 complying with APA PS 2, 11 mm 7/16 inch thick.

2.2.1.3 Composite Wood Fiber Tile Units

2.2.1.3.1 Monolithic Tile

Manufacturer's standard, rabbet-edged, cementitious wood fiber units with a thickness of[38 mm 1-1/2 inches][51 mm 2 inches][63 mm 2-1/2 inches][76 mm 3 inches][89 mm 3-1/2 inches][102 mm 4 inches][127 mm 5 inches]and a nominal width of[610 mm 24 inches][813 mm 32 inches][1219 mm 48 inches] and length indicated. Tiles to have the manufacturer's standard [natural][or][prime-painted] finish.

2.2.1.3.2 Insulated Composite Tile

Manufacturer's standard factory laminated composite deck units consisting of a rabbet edged, cementitious wood fiber tile base with a thickness of[38 mm 1-1/2 inches][51 mm 2 inches][63 mm 2-1/2 inches][76 mm 3 inches], ASTM C578, Type IV extruded-polystyrene insulation with a thickness of[38 mm 1-1/2 inch][51 mm 2 inches][76 mm 3 inches][102 mm 4 inches][127 mm 5 inches][152 mm 6 inches][177 mm 7 inches][202 mm 8 inches], and a top layer of APA-rated oriented-strand-board sheathing, Exposure 1 complying with APA PS 2, 11 mm 7/16 inch thick. Tiles must have a nominal width of[610 mm 24 inches][813 mm 32 inches][1219 mm 48 inches] and length indicated. Tiles to have the manufacturer's standard [natural][or][prime-painted] finish.

2.3 STRUCTURAL STEEL SUBPURLINS

Steel for structural subpurlin members, if required, must conform to [the manufacturer's standard] [_____]. Subpurlins must span over at least three supports.

2.4 ANCHORAGE

Fasteners must be of steel, zinc-coated or equivalent protective metallic coatings.

2.5 JOINT MATERIAL

Joint material must be a gypsum concrete grout that is factory-packaged and of a formulation recommended by the cementitious wood fiber unit manufacturer with a minimum compressive strength of 3.45 MPa 500 psi.

PART 3 EXECUTION

3.1 INSTALLATION

Installation must be in accordance with the submitted and approved detail drawings. Installation of equipment required by other trades must be accomplished as the work progresses if required by the design. Field-cut openings for utilities penetrations must be accomplished in accordance with the manufacturer's recommendations. Roof deck must be straight and true, and when laid in place must present a flat, level surface suitable for application of roofing. All roof decking units must bear on at least two structural framing members with a 25 mm 1 inch minimum bearing. Any cantilever plank must not exceed the design span. Installation must require a minimum of cutting. Cutting, where required, must be at a true angle to the top of the unit. All units must be made to fit around openings and projections, valleys, walls, and curbs, so that cut ends occur on supports and in a manner that will not damage the units. Mechanically fasten the roof decking to the support structure. No attachment for carrying loads must be made directly to the roof decking or subpurlins.

3.1.1 Subpurlins

Align subpurlins to the required spacing and bear evenly on structural framing members. End bearings must be a minimum of 25 mm 1 inch. Subpurlin ends must have at least 3 mm 1/8 inch clearance to allow for expansion. Weld subpurlins to each structural framing member at every point of crossing, over supporting member with a 19 mm 3/4 inch long fillet weld on alternate sides of the flange except at ends, where both sides must be welded. Conform to AWS D1.1/D1.1M for welding subpurlins.

3.1.2 Joint Treatment

Job-mixed materials must be screeded to true, even surfaces and protected until sufficiently hardened to withstand traffic and freezing temperatures. Fill joints at hips and ridges with the specified joint material finished in true planes with tops of units and with surfaces to receive roofing.

3.2 CLEANING AND PROTECTION

The complete decking must be kept clean and free of damaged or defaced units, and left ready to receive roofing. The installed roof decking units must be protected from damage by weather and construction operations by a temporary cover until application of roofing.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 53 14 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-03 53 14.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 03 - CONCRETE

SECTION 03 53 14

LIGHT REFLECTIVE NONFERROUS METALLIC AGGREGATE FLOOR SYSTEM

08/21

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-03 53 14 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-03 53 14.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 03 53 14

LIGHT REFLECTIVE NONFERROUS METALLIC AGGREGATE FLOOR SYSTEM
08/21

****

NOTE: This guide specification covers the requirements for light reflective, non-oxidizing, metallic (not silica or quartz) dry shake surface hardener for concrete floor finish. This is intended to be an interior application utilized in warehouses, maintenance facilities and hangars in which a light colored, dense, hard, low-dusting concrete surface is desired. This system should not be used in locations subjected to acids.

Other concrete floor hardeners with silica or quartz additives are located within products of Section 03 33 00 CAST-IN-PLACE CONCRETE. This nonferrous metallic aggregate is greatly more robust for abrasion resistance when compared to silica or quartz additives.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

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****

PART 1 GENERAL

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 308.1	(2023) Specification for Curing Concrete
ACI 308R	(2016) Guide to External Curing of Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C779/C779M	(2019) Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces
ASTM C1315	(2019) Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

1.2 PRE-INSTALLATION MEETING

Upon approval of preconstruction submittals and before placing concrete, conduct a meeting to review the quality control requirements specifically for the application of the floor hardener. This meeting may be conducted in coordination with the Preparatory Meeting required for Section 03 30 00 CAST-IN-PLACE CONCRETE. Attendees must include the Quality Control Manager and other Contractor personnel directly responsible for the application of the floor hardener material, Contracting Officer's Representative, the Designer of Record and a representative of the floor hardener system manufacturer. Include discussion points specific to the floor hardener system in the notes to document Preparatory Meeting. Notify the Contracting Officer at least 10 days in advance of the scheduled meeting date.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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SD-01 Preconstruction Submittals

Application Plan; G, [_____]

SD-03 Product Data

Non-oxidizing Metallic Aggregate surface hardener; G, [_____]

SD-04 Samples

Initial Application

Material Sample

SD-11 Closeout Submittals

Video Recording

1.3.1 Application Plan

Submit a written plan describing in detail all phases of floor hardener system application. Address work sequencing, floor hardener system application, cure time projections, curing activities, protection of surfaces during the curing period, as well as how each step will be controlled, tested, and evaluated. For each process, provide procedures that include appropriate work instructions, material and equipment to be used, controls, and process verification procedures. Address safety measures, work scheduling around weather, and record keeping. Plan must adhere to the manufacturer's instructions and Contract requirements outlined herein. Assign one supervisor to the job who is to remain at the site throughout all phases of work and who is to act as the Contractor's primary point of contact. Identify this person in the submitted plan.

1.3.2 Initial Application

Finish a minimum of 9.3 square meters 100 square feet of the [hangar] [_____] floor slab in a location approved by the Contracting Officer. The initial application must be witnessed by the manufacturer's representative and may become part of the permanent structure with written approval by the manufacturer's representative and Contracting Officer. Color, texture and installation procedures must be approved by the manufacturer's technical representative and Contracting Officer before proceeding with additional application. Upon approval, the initial application will be used as the standard for workmanship for future work.

1.3.3 Material Sample

Submit samples of materials, color, and finish type to the Contracting Officer for approval.

1.4 DELIVERY AND STORAGE

Deliver product in sealed moisture-resistant packages. Protect packages from damage. Store in an enclosed area. Replace damaged packages with new packages. Provide manufacturer's information regarding date of manufacture, shelf life and date of purchase no later than the date delivered on site. Products must be identifiable by lot numbers.

1.5 WARRANTY

Provide a manufacturer's standard warranty stating that the material is free of defects and that when applied in accordance with the manufacturer's instructions, the product will perform as specified herein. The manufacturer's standard warranty must not contain any disclaimers, limiting their responsibility to the purchase price of the material. The manufacturer must state in the warranty that they will contribute to replacing defective materials, as determined by accepted test methods.

PART 2 PRODUCTS

****

NOTE: Coordinate with Section 03 30 00, CAST-IN-PLACE CONCRETE to ensure requirements of ACI 117, ACI 212.3R, ACI 301, ACI 302.1R, ACI 304R, ACI 318 and ACI 318M are included.

****

2.1 CONCRETE

Provide concrete materials as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE, in addition to items required by this section and the following:

The concrete mix, including admixtures and plasticizers, must be in strict compliance with the aggregate surface hardener manufacturer's recommendations and must be approved in conjunction by both the Contracting Officer and the manufacturer's technical representative prior to the placement of concrete.

2.2 NON-FERROUS, NON-OXIDIZING METALLIC AGGREGATE, DRY-SHAKE SURFACE HARDENER

Provide a surface hardener system consisting of specially processed, non-ferrous, malleable, non-oxidizing, metallic aggregates, specially graded cementitious binder, plasticizer, and water-reducing admixtures, formulated and processed under the stringent quality control of the manufacturer. Provide hardener that is proportioned and sealed in standard moisture-resistant bags. The manufacturer must guarantee the aggregate to be free of rust, corrosive materials, oil, petroleum, or other water-based materials, when delivered. The manufacturer must replace any material found to contain any such materials, or any other material which is deemed unsatisfactory. The manufacturer must provide a technical representative, qualified in designing and adjusting concrete mixes, to assist in the application of the aggregate surface hardener system.

Provide floor hardener system with minimum compressive strength at 28 days of 75.6 MPA 11,000 psi in accordance with ASTM C109/C109M. System must also achieve minimum relative abrasion resistance at 28 days (abrasion at 60 minutes) of 0.8 mm 0.03 inches in accordance with ASTM C779/C779M.

2.3 SURFACE EVAPORATION RETARDANT

Provide a mono molecular surface evaporation retardant film, as recommended by ACI 305R and ACI 308R, for use under drying conditions, due to high concrete or ambient temperatures, low humidity, or high winds. This includes work in heated interiors during cold weather, to aid in the maintaining of concrete moisture during the early placement stages of plastic concrete. Provide a retarder certified by the manufacturer to be compatible with the surface hardener and provide in accordance with the manufacturer's recommendations.

2.4 CURING AND SEALING

Curing and sealing materials and procedures must be as recommended by the manufacturer of the aggregate surface hardener system and must comply with

ASTM C309 or ASTM C1315.

PART 3 EXECUTION

3.1 CONCRETE PLACEMENT

For concrete placement, refer to Section 03 30 00 CAST-IN-PLACE CONCRETE in addition to items required by this section and the following:

a. Maximum slump must be 89 mm 3.5 inches, when peak ambient temperatures are anticipated to be in excess of 18.33 degrees Celsius 65 degrees Fahrenheit, and must be no greater than 96.2 mm 4 inches, when such temperatures are below 29.4 degrees Celsius 85 degrees Fahrenheit. Water reducing admixtures compatible with the surface hardener's written product information and instructions can be used to aid in workability without affecting dry shake hardener.

b. Maximum total air content must not exceed 3 percent.

c. As previously noted, water-reducing additives can be used. Provider must certify that the water reducer will not contribute to or cause increased air content.

d. Do not use calcium chloride or set accelerating admixtures, containing calcium chloride.

Place base slab between screed points to minimize handling. Move concrete into place with square-tipped shovels; do not use rakes. Vibrators, when used, must be inserted and withdrawn vertically. Strike concrete to the specified level. Further level and consolidate concrete with wood bull float or wood darby. Complete floating before free moisture rises to the surface (bleeding). Begin floating adjacent to columns, forms, and walls.

3.1.1 Application of Surface Hardener

Apply first shake to floated concrete adjacent to forms, entry ways, columns and walls, where moisture will be lost first. Apply two-thirds of the specified total shake immediately following the floating of total area. Apply material at a minimum rate of 9.76 kg/square meter 2 pounds per square foot of slab. Bleed water must not be present during or following the application of this shake. Distribute Evenly. Apply by means of calibrated mechanical spreader except small areas not accessible to mechanical spreader may be hand applied. Wood bull floats can be used as soon as the shake has absorbed moisture (indicated by the darkening of the surface). Float just sufficiently to bring moisture from base slab through the shake. Use finishing machines with float blades to "open" the surface, prior to the application of the remaining one-third of the total specified shake, and also use to incorporate this second shake. Provide further surface compaction by a second mechanical floating, if time and setting characteristics of the concrete will allow, without removing the cement surface paste from the metallic aggregate system. AT NO TIME MUST WATER BE ADDED TO THE SURFACE. As surface further stiffens, indicated by loss of sheen, hand or mechanically trowel with blades relatively flat. Run trowel blades as slowly as possible, to achieve the desired finish. Excessive trowel blade speed will "burn" or darken the floor surface resulting in a possible loss of the desired even surface color. Remove all marks and pinholes in the raised trowel operation. DO NOT OVER FINISH. Do not burnish trowel. Type or texture of surface must conform to job mock-up.

3.1.2 Field Quality Control

Provide a manufacturer's representative at the job site a minimum of three times during the application of the floor hardener for the purposes of monitoring the quality of the application process and floor hardener materials to ensure proper application. Site visits must occur during the initial (sample) application, at mid-point of the overall application and the final application. After each site visit, submit a report signed by the manufacturer's representative within 3 working days. The report must document that all work was completed satisfactorily in accordance with the manufacturer's instructions.

[3.1.3 Video Recording

****

NOTE: Include this paragraph to require digital video recording of the application when the project is at a remote location or when a Government representative will not be present during construction.

****

As directed by the Contracting Officer, provide a digital video recording of the actual application of the floor surface hardener material and finishing process. Video must clearly show the material being applied with an even distribution and the concrete being finished. Provide a separate video recording for each day the floor surface hardener is applied and finished. Submit the videos to the Contracting Officer electronically as directed.

]3.1.4 Curing and Protection (Water Based Wax Emulsion)

Refer to ACI 308.1. Cure floors, finished with the non-rusting, metallic-aggregate surface hardener, as recommended by the manufacturer of the surface hardener. When high efficiency membrane curing compound is recommended, apply the membrane curing compound immediately after the floor surface has hardened sufficiently, so surface will not be marred by the application. Apply compound uniformly over the entire surface, to meet the required moisture retention of ASTM C1315, at a maximum rate of 6.136 square meters per liter250 square feet per gallon. When dry, protect the coating from droppings of plaster, paint, dirt, and other debris, by a covering of scuff-proof building paper. Make provisions for maintaining the concrete temperature at 10 degrees Celsius 50 degrees Fahrenheit, or above during the curing period. Floor must remain covered and be kept free of traffic and loads for at least 10 days after completion. At the direction of the Contracting Officer, remove the curing compound between 2 and 4 weeks after placement.

3.2 CURTAIL SURFACE ACTIVITY

After installation of the product, the slab and hardener must cure for 28 days in which construction equipment, hoists, overhead access equipment, and material storage must remain off the slab. Follow specific instructions given by the manufacturer's representative at the pre-installation conference.

3.3 CLEANING AND SURFACE PREPARATION

After the aggregate surface hardener system has cured for 28 days, clean and buff the floor surfaces in accordance with the manufacturer's recommendations. Perform the cleaning and surface preparation to remove projections that permit soil and foreign bodies to embed into the floor and to permit easier cleaning of a less porous, more densified concrete surface.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 62 16 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-03 62 16 (February 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03 62 16

METALLIC NON-SHRINK GROUTING

08/23

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-03 62 16 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-03 62 16 (February 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 03 62 16

METALLIC NON-SHRINK GROUTING
08/23

****

NOTE: This guide specification covers the requirements for the material and application of expansive grout to ensure structural integrity of construction.

Associated work found in other sections includes preparation of surfaces to receive grout. Indicate areas of application on the drawings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.5R	(2014) Guide for Submittal of Concrete Proportions
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 311.4R	(2005) Guide for Concrete Inspection
ACI MCP SET	(2017) Manual of Concrete Practice

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Grout Placement and Inspection Reports; G, [_____]

SD-04 Samples

Aggregates; G, [_____]

Expansive Admixtures; G, [_____]

SD-06 Test Reports

Expansion; G, [_____]

Compressive Strength; G, [_____]

Grout Placement and Inspection Reports; G, [_____]

Expansive Grout; G, [_____]

Portland Cement; G, [_____]

SD-07 Certificates

Portland Cement; G, [_____]

Expansive Admixtures; G, [_____]

Expansive Grout; G, [_____]

Aggregates; G, [_____]

1.3 QUALITY CONTROL

1.3.1 Grout Placement Plan and Inspection Reports

Provide examples of grout placement and inspection reports in accordance with ACI 214R, ACI 211.5R, ACI 311.4R and ACI MCP SET. Show details of proposed methods of application, with written instructions from the manufacturer for the use of expansive admixture at least [45] [_____] calendar days before the start of expansive concrete operations.

Include a copy of records of inspections and tests, as well as the records of corrective action taken. Include descriptions of preparation of cavities for placement of grout; and proper mixing, placement, and curing of grout with methods of preventing discoloration.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Portland Cement

Provide portland cement grout conforming to ASTM C150/C150M for Cement, Type I.

2.1.2 Aggregates

Submit samples conforming to ASTM C33/C33M for aggregates and the gradation as directed.

2.1.3 Water

Provide potable water.

2.1.4 Expansive Admixtures

****

NOTE: Select one of next two paragraphs, depending on type of expansive admixture required.

Select the first paragraph for Type A expansive grout, described below.

****

[Use admixture consisting of an oxidizable metallic aggregate.

][Use admixture consisting of a metallic aluminum powder.

] Submit samples to the Contracting Officer before commencement of work for review and acceptance.

2.1.5 Expansive Grout

****

NOTE: Select one of the following two paragraphs, depending on the type of grout required. Last paragraph is applicable to either selection. Types are described as follows:

Type A grout derives its expansive properties from

oxidation of metallic aggregate. Oxidation and consequent expansion may be expected to continue either until the aggregate has been completely oxidized or until the grout, in plane, has been sealed off from further contact with oxygen.

Type B grout derives its expansive properties from the liberation of gas into the mixture during and after mixing. Chemical reaction causes evolution of hydrogen gas. Expansion may be expected to continue either until the gas-liberating mechanism has been exhausted or until the mixture has solidified to such an extent that the tendency for evolving gas to expand is effectively resisted by the stiffness of the grout.

****

[Provide Type A grout containing an oxidizable metallic aggregate and an oxidation-promoting ingredientin accordance with manufacturer's instructions.

][Provide Type B grout containing a metallic aluminum powder with alkali hydroxides in solution. Do not exceed 0.3 percent by weight or as recommended by the grout manufacturer.

]PART 3 EXECUTION

3.1 PREPARATION

****

NOTE: Verify that the section cited below is included in specification.

****

Prepare cavities for grouting by cleaning away foreign matter, laitance, dirt, grease, or oil in accordance with manufacturer's instructions. Clean all contact surfaces of concrete and masonry no less than 24 hours before grout application.

3.1.1 Mixing

Mix grout ingredients for both cementitious grout and epoxy grout in accordance with the manufacturer's instructions and recommendations.

Mix grout materials withproperly sized and powered mechanical mixers.

Mix grout as close to the work area as possible.

3.2 APPLICATION

3.2.1 Placing Grout

Place grout in accordance with the manufacturer's installation instructions and recommendations. Do not use grout that has begun to set or if more than one hour has elapsed after initial mixing.

Fill blind cavities by pressure injection under controlled venting. Provide continuous injection with vent open until waste grout is expelled through the vent with the same consistency. Then block the vent for pressurization to 413 kilopascal 60 psi. Use lower pressures when damage to construction may result.

3.3 FIELD QUALITY CONTROL

Provide testing and submit test reports in accordance with ASTM C1107/C1107M for the expansive grout to meet the following performance requirements:

Expansion: 28 calendar days - Percent maximum: 0.3

- Percent minimum: 0.0

Compressive Strength: 34 [_____] Megapascal 5,000 [_____] psi

3.4 PROTECTION

Protect freshly placed grout from premature drying and excessive cold or hot temperatures. Comply with manufacturer's instructions for cold-weather and hot-weather protection during curing.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-03 70 00 (February 2010)**
Change 2 - 08/20

Preparing Activity: USACE **Superseding**
UFGS-03 70 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03 70 00

MASS CONCRETE

02/10, CHG 2: 08/20

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-03 70 00 (February 2010)**
Change 2 - 08/20

Preparing Activity: USACE **Superseding**
UFGS-03 70 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 03 70 00

MASS CONCRETE

02/10, CHG 2: 08/20

****

NOTE: This guide specification covers the requirements for large projects containing mass concrete or mass and structural concrete, and major projects where the government retains the responsibility for concrete mixture proportioning. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: The content of this specification is such that guidance given in EM 1110-2-2000, "Standard Practice for Concrete" is applicable.

****

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project

specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

Consult the concrete materials design memorandum to choose the appropriate cementitious materials and admixtures for measurement and payment.

When silica fume is used in the project, the Specifier should include both bid items, "Silica Fume, Dry" and "Silica Fume, Slurry", to give the Contractor the option of supplying the material in dry form or in slurry form.

****

1.1.1 Concrete for [_____]

****

NOTE: Repeat this bid item and its respective subparagraphs for each bid item of concrete, renumbering the bid items appropriately.

****

1.1.1.1 Payment

Payment will be made for costs associated with completing the concrete work for concrete placed in the [_____]. However, these costs will not include the cost of the cement, pozzolan, [slag,] reinforcement, [water-reducing admixture,] [high range water reducer,] [silica fume,] and embedded parts that are specified to be paid for separately. No payment will be made for concrete, as such, that is placed in structures of which payment is made as a lump sum.

1.1.1.2 Measurement

Concrete will be measurement for payment based upon the actual volume of concrete within the pay lines of the structures as indicated on the drawings. Measure concrete placed against the sides of any excavation without the use of intervening forms only within the pay lines of the structure. Do not make deductions for rounded or beveled edges, space occupied by metal work, electrical conduits or reinforcing steel, nor for voids or embedded items that are either less than 0.14 cubic meters 5 cubic feet in volume or 0.09 square meter 1 square foot in cross section.

1.1.1.3 Unit of Measure

Unit of measure: cubic meters yards.

[1.1.2 Concrete in Blockouts

[1.1.2.1 Payment

Payment will be made for costs associated with concrete placed in the blockouts.

][1.1.2.2 Measurement

Concrete will be measurement for payment based upon the actual volume of concrete placed in the blockouts as indicated on the drawings.

][1.1.2.3 Unit of Measure

Unit of measure: cubic meters yards.

]]1.1.3 Portland Cement

****

NOTE: List all other cementitious materials (except pozzolan), such as portland-pozzolan cement, slag cement, or portland blast-furnace cement, separately similar to this bid item, and the bid items renumbered appropriately.

****

1.1.3.1 Payment

Payment will be made for costs associated with Portland cement, which includes the cost of required unloading, hauling, handling, and storage at the site, of all portland cement used in the work.

1.1.3.2 Measurement

Portland cement will be measured for payment based upon the number of tons of portland cement used unless specifically excepted, wasted, or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the approved batch weight in kg/cubic meter pounds/cubic yard of portland cement in each type of concrete used by the number of cubic meters yards of concrete types placed within the pay lines of the structure, as determined in accordance with the concrete bid items, and dividing by 1000 2,000.

1.1.3.3 Unit of Measure

Unit of measure: tons (metric) (2000 lb).

1.1.4 Pozzolan (Except Silica Fume)

1.1.4.1 Payment

Payment will be made for costs associated with pozzolan, which includes the cost of required unloading, hauling, handling, and storage at the site, of all pozzolan used in the concrete bid items.

1.1.4.2 Measurement

Pozzolan, except silica fume, will be measured for payment based upon the number of cubic meters feet solid volume of pozzolan used unless specifically excepted, wasted, or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the approved batch weight in kg/cubic meter pounds/cubic yard of pozzolan in each type of concrete used by the number of cubic meters yards of concrete of the types placed within the pay lines of the structure, as determined in accordance with the concrete bid items, and dividing by the product of the average specific gravity of the pozzolan multiplied by 1000 kg/cubic meter 62.4 pounds/cubic foot. The average specific gravity is the average of the test results for all material accepted during the period covered by the payment.

1.1.4.3 Unit of Measure

Unit of measure: cubic meters feet solid volume.

1.1.5 Ground Granulated Blast-Furnace Slag

1.1.5.1 Payment

Payment will be made for costs associated with ground granulated blast-furnace slag, which includes the cost of required unloading, hauling, handling, and storage at the site, of all ground granulated blast-furnace slag used in the concrete bid items.

1.1.5.2 Measurement

Ground granulated blast-furnace slag will be measured for payment based upon the number of tons of ground granulated blast-furnace slag used excluding the amount specifically excepted, wasted, or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the approved batch weight in kg/cubic meter pounds/cubic yard of ground granulated blast-furnace slag in each type of concrete used by the number of cubic meters yards of concrete types placed within the pay lines of the structure, as determined in accordance with the concrete bid items, and dividing by 1000 2,000.

1.1.5.3 Unit of Measure

Unit of measure: tons (metric) (2000 lb).

1.1.6 Water-Reducing Admixture (WRA)

1.1.6.1 Payment

[Payment will be made for costs associated with water-reducing admixture (WRA) at the applicable contract unit price per cubic meter yard of concrete containing water-reducing admixture.] [Payment will be made for costs associated with water-reducing admixture (WRA) at the applicable contract unit cost of concrete containing water-reducing admixture for:

a. "Bid Item [_____]a., first [_____] cubic meters yards."

b. "Bid Item [_____]b., all over [_____] cubic meters yards."]

1.1.6.2 Measurement

Water-reducing admixture (WRA) will be measured for payment based upon the actual volume of concrete containing the admixture and within the pay lines of the structures, as determined in accordance with the concrete bid items.

1.1.6.3 Unit of Measure

Unit of measure: cubic meters yards.

1.1.7 High-Range Water-Reducing Admixture (HRWR)

1.1.7.1 Payment

[Payment will be made for costs associated with high-range water-reducing admixture (HRWR) at the applicable contract unit price per cubic meter yard of concrete containing water-reducing admixture.] [Payment will be made for costs associated with high-range water-reducing admixture (HRWR) at the applicable contract unit cost of concrete containing water-reducing admixture for:

a. "Bid Item [_____]a., first [_____] cubic meters yards."

b. "Bid Item [_____]b., all over [_____] cubic meters yards."]

1.1.7.2 Measurement

High-Range water-reducing admixture (HRWR) will be measured for payment based upon the actual volume of concrete containing the admixture and within the pay lines of the structures, as determined in accordance with the concrete bid items.

1.1.7.3 Unit of Measure

Unit of measure: cubic meters yards.

[1.1.8 Silica Fume, Dry

[1.1.8.1 Payment

Payment will be made for costs associated with silica fume, dry, which includes price batching and recording equipment for dry silica fume used in the concrete bid items. Payment will be made at the contract price per kilogram hundredweight of dry silica fume for:

a. "Bid Item [_____]a., first [_____] kilograms hundredweight."

b. "Bid Item [_____]b., all over [_____] kilograms hundredweight."

][1.1.8.2 Measurement

Silica fume, dry, will be measured for payment based upon the number of kilograms hundredweight of silica fume used in the concrete, excluding the amount wasted or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kilograms pounds of silica fume per cubic meter yard by the number of cubic meters yards of silica fume concrete placed within the pay lines of the structure as determined in accordance with the concrete bid items., divided by 100.

][1.1.8.3 Unit of Measure

Unit of measure: kilograms hundredweight (100 pounds).

]][1.1.9 Silica Fume, Slurry

[1.1.9.1 Payment

Payment will be made for costs associated with silica fume, slurry, which includes the cost of silica fume, slurry; providing admixtures such as HRWR admixtures that are a component of the slurry; and furnishing storage, batching, and recording equipment for silica fume, slurry, used in the concrete bid items. Payment for silica fume, slurry, will be made at the contract price per hundredweight of dry silica fume for:

a. "Bid Item [_____]a., first [_____] kilograms hundredweight."

b. "Bid Item [_____]b., all over [_____] kilograms hundredweight.

][1.1.9.2 Measurement

Silica fume, slurry, will be measured for payment based upon the number of kilograms hundredweight of silica fume used in the concrete, excluding the amount wasted or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kilograms pounds of silica fume per cubic meter yard by the number of cubic meters yards of silica fume concrete placed within the pay lines of the structure as determined in accordance with the concrete bid items , divided by 100. The dry weight will be determined by supplier's certificate.

][1.1.9.3 Unit of Measure

Unit of measure: kilograms hundredweight (100 pounds).

]]1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary

ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40/C40M	(2020) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C87/C87M	(2023) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2023) Standard Test Method for Lightweight Particles in Aggregate
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete

ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C441/C441M	(2017) Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2016; R 2024) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C928/C928M	(2020a) Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs
ASTM C937	(2023) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1059/C1059M	(2024) Standard Specification for Latex Agents for Bonding Fresh to Hardened

	Concrete
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000; R 2006) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 94	(1995) Corps of Engineers Specification for Surface Retarders
COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1997) Test Method for Soundness of

	Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 144	(1992) Standard Test Method for Resistance of Rock to Freezing and Thawing
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Concrete Lifts; G, [_____]

Equipment; G, [_____]

SD-03 Product Data

Batch Plant; G, [_____]

Mixers

Construction Joint Treatment; G, [_____]

Curing and Protection; G, [_____]

Cold-Weather Protection; G, [_____]

Hot-weather Placing; G, [_____]

Special Temperature-Controlled Concrete; G, [_____]

SD-07 Certificates

Sheet Curing

Nonshrink Grout; G, [_____]

Bonding Agents

Expansive Admixture

1.4 QUALITY ASSURANCE

1.4.1 Government Preconstruction Testing

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NOTE: Contact the Engineer Research and Development Center, 3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199, ATTN: CEERD-SC for guidance in filling in the blanks.

****

1.4.1.1 Aggregate Sources

The aggregate sources listed in paragraph COMMERCIAL CONCRETE AGGREGATE SOURCES, have been tested, and at the time testing was performed, these sources were capable of producing materials of the quality and quantity required for this project provided suitable processing is performed. Deliver samples from any source selected consisting of no less than [_____] kg pounds of each size of coarse aggregate and [_____] kg pounds of fine aggregate, taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100, to [_____] within 15 days after notice to proceed. Sampling and shipment of samples is the Contractor's expense. [_____] days will be required to complete evaluation of the aggregates.

Testing will be performed by the Government in accordance with the applicable COE CRD-C or ASTM test methods. Tests to which aggregate may be subjected are listed in paragraph AGGREGATES. The material from the proposed source must meet the quality requirements of this paragraph to be used for the project. The Government test data and other information on aggregate quality of those sources listed in paragraph COMMERCIAL CONCRETE AGGREGATE SOURCES, and are available for review in the District Office. Quality assurance testing of aggregates by the Government does not relieve the Contractor of quality control requirements.

1.4.1.2 Cementitious Materials, Admixtures, and Curing Materials

Notify the Contracting Officer of the source, brand name, type, and quantity of all materials (other than aggregates) to be used in the manufacture and curing of the concrete at least 60 days in advance of submitting samples for mixture proportioning studies. Assist the Contracting Officer in obtaining samples of each material. Sampling and testing as determined appropriate will be performed by and at the expense of the Government. If cement or pozzolan are to be obtained from more than one source, state the estimated amount of cement or pozzolan to be obtained from each source and the proposed schedule of shipments in the notification. When pozzolan other than fly ash is used, it must be from one source.

1.4.1.3 Materials for Mixture-Proportioning Studies

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NOTE: Contact the Engineer Research and Development Center, 3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199, ATTN: CEERD-SC to fill in the blanks. At the end of the following table, insert other cementitious materials, including silica fume, as appropriate.

****

At least [_____] days in advance of the time when placing of concrete is expected to begin, deliver samples of representative materials proposed for this project and meeting all the requirements of this specification to [_____] by the Contractor at its expense. Take samples of aggregates under the supervision of the Contracting Officer in accordance with COE CRD-C 100, accompanied by test reports indicating conformance with grading and quality requirements hereinafter specified. Provide samples of materials other than aggregates that are representative of those proposed for the project and submit accompanied by manufacturer's test reports indicating compliance with applicable specified requirements. Quantities of materials required are as follows:

MATERIAL	QUANTITY
150 mm 6 inch nominal maximum-size coarse aggregate	[_____] kg pounds
75 mm 3 inch nominal maximum-size coarse aggregate	[_____] kg pounds
37.5 mm 1-1/2 inch nominal maximum-size coarse aggregate	[_____] kg pounds

MATERIAL	QUANTITY
19 mm 3/4 inch nominal maximum-size coarse aggregate	[_____] kg pounds
Fine aggregate	[_____] kg pounds
Cement	[_____] kg pounds
Pozzolans	[_____] cubic m feet
Air-entraining admixture	[_____] L quarts
Other admixtures (each)	[_____] L gallons

Mixture-proportioning studies will be made by the Government.

1.4.2 Construction Testing by the Government

1.4.2.1 General

The Government will sample and test cementitious materials, admixtures, aggregates, and concrete during construction as considered appropriate to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with COE CRD-C 100. Slump and air content will be determined in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively, except the point of sampling will be as directed. Compression test specimens will be made and laboratory cured in accordance with ASTM C31/C31M and will be tested in accordance with ASTM C39/C39M.

1.4.2.2 Testing Aggregates

Testing performed by the Government will not relieve the Contractor of its responsibility for testing as appropriate for quality control. During construction, aggregates will be sampled for acceptance testing as delivered to the mixer to determine compliance with specification provisions. Provide necessary facilities and labor for the ready procurement of representative samples under Contracting Officer supervision. The Government will test such samples at its expense using appropriate COE CRD-C and ASTM methods.

1.4.2.3 Cementitious Materials

Furnish cement or pozzolan or both from a prequalified source or, if not, it (they) will be sampled at the mill, shipping point, or site of the work by the Contracting Office. A list of prequalified cement sources and prequalified pozzolan sources is available from the Director, U.S. Army Corps of Engineers, Engineer Research and Development Center - Structures Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEERD-SC. If tests prove that a material which has been delivered is unsatisfactory, promptly remove it from the site of the work. Cementitious materials that have not been used within 6 months after being tested will be retested by the Government at the expense of the Contractor when directed.

1.4.2.4 Cement from Prequalified Sources

Deliver and use cement directly from a mill of a producer designated as a prequalified source for the type of cement being used. Samples of cement for quality-assurance testing will be taken at the project site or cement-producing plant by the Contracting Officer for testing at the expense of the Government. Furnish a copy of the mill tests from the cement manufacturer to the Contracting Officer for each lot.

1.4.2.5 Pozzolan from Prequalified Sources

Deliver and use pozzolan directly from a producer designated as a prequalified source. Samples of pozzolan for check testing will be taken at the project site by the Contracting Officer for testing at the expense of the Government. Furnish a copy of the test results from the pozzolan manufacturer to the Contracting Officer for each lot.

1.4.2.6 Cement from Nonprequalified Sources

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NOTE: The Contractor's expense rate for excess testing of cement and pozzolan by the Government can be obtained from the Structures Laboratory, U.S. Army Engineer Waterways Experiment Station (CEWES-SC-MP), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199.

****

Cement, if not from a prequalified source, will be sampled and tested by or under the supervision of the Contracting Officer and at Government expense. Do not use cement until notice has been given by the Contracting Officer that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the request of the Contractor and at the Contractor's expense. When the point of sampling is other than at the site of the work, the fill gate or gates of the sampled bin will be sealed and kept sealed until shipment from the bin has been completed. The fill gate or gates of conveyances used in shipment will be sealed by or under the supervision of the Contracting Officer. Conveyances will not be accepted at the site of the work unless received with all seals intact. If tested cement is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of testing cement excess to project requirements will also be at the Contractor's expense and will be deducted from payments due the Contractor at a rate of [_____] dollars per test.

1.4.2.7 Pozzolan from Nonprequalified Sources

Pozzolan, if not from a prequalified source, will be sampled at the source or at the site of the work and will be stored in sealed bins pending completion of acceptance tests. Pozzolan may be resampled at the site when determined necessary. All sampling and testing will be performed by and at the expense of the Government. Release for shipment and approval for use will be based on compliance with seven day lime-pozzolan strength requirements and other physical, chemical, and uniformity requirements for which tests can be completed by the time the seven day lime-pozzolan strength test is completed. Release for shipment and approval for use on this basis will be contingent on continuing compliance with the other requirements of the specifications. If test results of a bin fail, the contents may be resampled and tested at the Contractor's expense. The

Government will supervise or perform the unsealing and resealing of bins and shipping conveyances. If tested pozzolan is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of testing excess pozzolan in excess of project requirements will be at the Contractor's expense at a rate of [_____] dollars per test. The amount will be deducted from payment to the Contractor.

[1.4.2.8 Ground Granulated Blast-Furnace Slag

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NOTE: If any other cementitious materials, including silica fume, are to be allowed, an additional paragraph should be added similar to this paragraph, with the name of the cementitious material substituted for "Ground Granulated Blast-Furnace Slag".

****

Ground granulated blast-furnace slag will be sampled and tests at the mill or shipping point by and at the expense of the Government to determine that the material meets the requirements of the specification under which it is furnished. Do not use ground granulated blast-furnace slag until notice of acceptance has been given by the Contracting Officer. Ground granulated blast-furnace slag will be subject to check testing from samples obtained at the project site, as scheduled, and such sampling will be by or under the supervision of the Contracting Officer and at Government expense. Remove material not meeting specifications promptly from the site of work.

]1.4.2.9 Chemical Admixtures

Provide satisfactory facilities for ready procurement of test samples. All sampling and testing of a chemical admixture will be by and at the expense of the Government. Tests will be conducted using samples of materials proposed for the project.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Cementitious Materials

1.5.1.1 Transportation

When bulk cement, pozzolan, dry silica fume, or ground granulated blast-furnace slag is not unloaded from primary carriers directly into weather-tight hoppers at the batching plant, accomplish transportation from the railhead, mill, or intermediate storage to the batching plant in weather-tight trucks, conveyors, or other means that will protect the material from exposure to moisture. Transportation facilities for dry bulk silica fume must be approved in advance.

1.5.1.2 Storage

Furnish cementitious materials in bulk except that cement used for finishing and patching may be packaged, and silica fume may be packaged or in slurry form. Immediately upon receipt at the site of the work, store all cementitious materials in separate dry, weather-tight, and properly ventilated structures. All storage facilities must permit easy access for inspection and identification. Maintain sufficient materials in storage to complete any lift of concrete started. In order that cement may not become unduly aged after delivery, use any cement that has been stored at the site for 60 days or more before using cement of lesser age. Do not use silica fume in slurry form that has been in storage at the project site for longer than recommended by the manufacturer or that has been subjected to freezing in the work and remove from the site.

1.5.1.3 Separation of Materials

Provide separate facilities for unloading, transporting, and handling each cementitious material. Provide separate appropriate storage facilities for each type of cement and each source of pozzolan, dry bulk silica fume, or slag. Plainly mark the contents of each storage facility marked with a large permanent sign posted near the loading port.

1.5.2 Aggregates Storage

Store fine aggregate and each size of coarse aggregate in separate size groups adjacent to the batch plant and in such a manner as to prevent the intermingling of size groups or the inclusion of foreign materials in the concrete. Maintain sufficient fine and coarse aggregate at the site at all times to permit continuous placement and completion of any lift of concrete started.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide concrete composed of cementitious materials, water, fine and coarse aggregates, and admixtures. Use cementitious materials that are [portland cement], [portland cement in combination with pozzolan], [portland cement in combination with [_____]], [portland blast-furnace slag cement] [portland cement in combination with ground granulated blast-furnace slag] [portland cement in combination with silica fume] [portland-pozzolan cement]. Use an air-entraining admixture [or an air-entraining admixture plus] [a retarding admixture], [a WRA], [a HRWRA], [or an accelerating admixture]. A retarding admixture may be used at the request of the Contractor when approved. Do not use chemical admixtures other than those listed above.

2.1.1 Proportioning Responsibility

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NOTE: The last optional sentence should be used if slow strength gain cementitious materials are to be used.

****

The concrete mixtures will be proportioned by the Contracting Officer. [Preliminary mixture-proportioning studies or thermal studies which include mixture proportions are available for review in the District Office.] [Some mixtures, especially those containing higher amounts of pozzolans, may have slow strength gain which may impact form design and form removal time.]

2.1.2 Design Requirements

****

NOTE: See the concrete materials design memorandum to select the optional cementitious materials.

****

The proportions of all material entering into each concrete mixture will be furnished to the Contractor. The proportions will be changed by the Contracting Officer as necessary. Make adjustments to the batch weights of aggregates and water as necessary to compensate for free moisture in the aggregates. Adjust the quantity of air-entrainment admixture to maintain the specified air content.

2.1.3 Air Content

Determine the air content by volume by ASTM C231/C231M. When the nominal maximum size of coarse aggregate is 37.5 mm 1-1/2 inches or larger, the air content of the sample measured in accordance with ASTM C231/C231M must be 5-1/2 ± 1-1/2 percent. When the nominal maximum-size coarse aggregate is 19 mm 3/4 inch, the air content must be 6 ± 1 percent. The specified air content must be present in the concrete when the concrete has been placed in the forms.

2.1.4 Slump

Determine slump in accordance with ASTM C143/C143M of 50 mm 2 inches ± 25 mm 1 inch for massive features and between 25 and 100 mm 1 and 4 inches for all others except where placement by pump is approved, in which case the slump must be 114 mm 4-1/2 ± 38 mm 1-1/2 inches. In addition, the range of each set of two consecutive tests for each mixture must be no more than 50 mm 2 inches. The above specified slump is that required at the forms.

2.1.5 Construction Tolerances

Make level and grade tolerance measurements of slabs as soon as possible after finishing. When forms or shoring are used, make the measurements prior to removal. Tolerances are not cumulative. The most restrictive tolerance controls. Do not allow tolerances to extend the structure beyond legal boundaries. Except as specified otherwise, plus tolerance increases the amount or dimension to which it applies, or raises a level alignment and minus tolerance decreases the amount or dimension to which it applied, or lowers a level alignment. A tolerance without sign means plus or minus. Where only one signed tolerance is specified, there is no limit in the other direction. Finish unformed finished surfaces subject to high-velocity flow (12 m/s) (40 fps) to meet the tolerances for A-HV surfaces specified in Table, "TOLERANCES FOR FINISHED FORMED CONCRETE SURFACES".

2.1.6 Tabulations and Definitions

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NOTE: Delete any of the following tables that are not applicable. Most projects will require several tables to cover all parts of the structure.

****

The definitions of the terms used in the following tabulations are used as defined and used in ACI 117. Make level and grade tolerance measurements of slabs as soon as possible after finishing.

TOLERANCES FOR FOUNDATIONS		
(1)	Lateral alignment	
	As cast to the center of gravity as specified; 0.02 times width of footing in direction of misplacement but not more than	50 mm2 inches
	Supporting masonry construction	13 mm1/2 inch
(2)	Level alignment	
	Top of footings supporting masonry	13 mm1/2 inch
	Top of other footings	+13 mm, -50 mm +1/2 inch, -2 inch
(3)	Cross-sectional dimensions	
	Horizontal dimensions of formed members	+50 mm, -13 mm +2 in.,-1/2
	Horizontal dimensions of unformed members cast against soil	
	600 mm 2 feet or less	+75 mm, -13 mm +3 in., -1/2 in.
	Greater than 600 mm 2 feet but less than 1800 mm 6 feet	+150 mm, -13 mm+6 in.,
	Over 1800 mm 6 feet	+300 mm, -13 mm+12 in., -1/2 in.
	Vertical dimension (thickness)	-5 percent
(4)	Relative alignment	
	Slope of footing side and top surfaces with respect to the specified plan	25 mm/3000 mm 1 in./10 ft

TOLERANCES FOR CAST-IN-PLACE REINFORCED CONCRETE FOR BUILDINGS			
(1)	Vertical alignment		
	For heights30 m 100 feet		
		Lines, surfaces, and arrises	25 mm1 inch
		Outside corner of exposed corner columns and control joint grooves in concrete exposed to	13 mm1/2 inch
	For heights greater than 30 m 100 ft		
		Lines, surfaces, and arrises, 1/1,000 times the height at any point but not more than	150 mm6 inches
		Outside corner of exposed corner columns and control joint grooves in concrete, 1/2,000 times the height at any point but not more	75 mm3 inches
(2)	Lateral alignment		
	Members		25 mm1 inch
	In slabs, centerline location of openings 12 in. or smaller and edge location of larger openings		13 mm1/2 inch
	Sawcuts, joints, and weakened plane embedment in slabs		19 mm3/4 inch
(3)	Level alignment		
	Top of slabs		
		Elevation of slabs-on-grade	19 mm3/4 inch
		Elevation of top surfaces of formed slabs before removal of supporting shores	19 mm3/4 inch
	Elevation of formed surfaces before removal of shores		19 mm3/4 inch
	Lintels, sills, parapets, horizontal grooves, and other lines exposed to view		13 mm1/2 inch
(4)	Cross-sectional dimensions		
	Members, such as columns, beams, piers, walls (thickness only) and slabs (thickness only)		
		300 mm 12 inches dimension or less	+10, -6 mm +3/8, -1/4 inch
		More than 300 mm 12 inches but not over 900 mm 3 feet dimension	+13, -10 mm +1/2, -3/8 inch
		Over 900 mm 3 feet dimension	+25, -19 mm +1, -3/4

TOLERANCES FOR CAST-IN-PLACE REINFORCED CONCRETE FOR BUILDINGS			
(5)	Relative alignment		
	Stairs		
		Different in height between adjacent risers	3 mm1/8 inch
		Different in width between adjacent treads	6 mm1/4 inch
	Grooves		
		Specified width 50 mm 2 inches or less	3 mm1/8 inch
		Specified width more than 50 mm 2 inches but not more than 300 mm 12 inches	6 mm1/4 inch
	Sawcuts, joints, and weakened plane on slab		
		Lateral, gradual	19 mm in 3000 mm3/4 inch in 10
		Lateral, abrupt	0 mm inch
(6)	Openings through members		
	Cross-sectional size of opening		+25 mm, -6 mm+1, -1/4
	Location of centerline of opening		13 mm1/2 inch

TOLERANCE FOR FINISHED FORMED CONCRETE SURFACES		
(1)	Vertical alignment: Formed surfaces slope with respect to the specified plane	
	Vertical alignment of outside corner of exposed corner columns and control joint grooves in concrete exposed to view	7 mm in 3000 mm1/4 in. in 10 ft
	All other conditions	10 mm in 3000 mm3/8 in. in 10 ft

TOLERANCE FOR FINISHED FORMED CONCRETE SURFACES		
(2)	Abrupt variation: The offset between concrete surfaces under adjacent pieces of formwork for the following classes of surface: (For Class A-HV, positive means raise of elevation in the direction of waterflow, negative means drop of elevation in the direction of waterflow)	
	Class A-HV, in the direction of waterflow	+0, -3 mm -1/8 inch
	*Class A-HV, perpendicular to the direction of waterflow	3 mm1/8 inch
	Class A	3 mm1/8 inch
	Class B	6 mm1/4 inch
	Class C	6 mm1/4 inch
	Class D	25 mm1 inch
(3)	Gradual variation: Surface finish tolerances as measured by placing a freestanding (unleveled), 1.5 m 5 foot straightedge for plane surface or curved template for curved surface anywhere on the surface and allowing it to rest upon two high spots within 72 hr after concrete placement. The gap at any point between the straightedge or template and the surface must not exceed:	
	*Class A (including Class A-HV)	3 mm1/8 inch
	Class B	6 mm1/4 inch
	Class C	13 mm1/2 inch
	Class D	25 mm1 inch
*Includes any high-velocity flow surface.		

TOLERANCES FOR CAST-IN-PLACE, VERTICALLY SLIPFORMED BUILDING ELEMENTS		
(1)	Translation and rotation from a fixed point at the base of the structure:	
	For heights 30 m 100 feet or less	50 mm2 inches
	For heights greater than 30 m 100 feet, 1/600 times the height but not more than	205 mm8 inches
(2)	Lateral alignment	
	Between adjacent elements	50 mm2 inches
(3)	Cross-sectional dimensions	
	Wall thickness	+19 mm, -10 mm +3/4 inch, -3/8 inch

TOLERANCES FOR CAST-IN-PLACE, VERTICALLY SLIPFORMED BUILDING ELEMENTS		
(4)	Relative alignment	
	Formed surface slope with respect to the specified plane	19 mm in 3000 mm3/4 in. in 10 ft

TOLERANCES FOR MASS CONCRETE STRUCTURES OTHER THAN BUILDINGS			
(1)	Vertical alignment		
	Visible surfaces		30 mm1-1/4 inch
	Concealed surfaces		65 mm2-1/2 inches
	Side walls for radial gates and similar watertight joints		5 mm3/16 inch
(2)	Lateral alignment		
	Visible surfaces		30 mm1-1/4 inch
	Concealed surfaces		65 mm2-1/2 inches
(3)	Level alignment		
	Visible flatwork and formed surfaces		13 mm1/2 inch
	Concealed flatwork and formed surfaces		25 mm1 inch
	Sills for radial gates and similar watertight joints		5 mm3/16 inch
(4)	Relative alignment: Formed surface slope with respect to the specified plane		
	Slopes in lateral and level alignments		
		Visible surfaces	7 mm in 3000 mm1/4 in. in 10 ft
		Concealed surfaces	13 mm in 3000 mm1/2 in. in
	Slopes in vertical alignment		
		Visible surfaces	13 mm in 3000 mm1/2 in. in 10 ft
		Concealed surfaces	25 mm in 3000 mm1 in. in 10 ft

TOLERANCES FOR CANAL LINING		
(1)	Lateral alignment	
	Alignment of tangents	50 mm2 inches
	Alignment of curves	100 mm4 inches
	Width of section at any height	0.0025W + 25 mm 1 inch
(2)	Level alignment	
	Profile grade	25 mm1 inch
	Surface of invert	6 mm1/4 inch
	Surface of side slope	13 mm1/2 inch
	Height of lining	0.005H + 25 mm 1 inch
(3)	Cross-sectional dimensions	
	Thickness of lining cross section: percent of specified thickness provided average thickness is maintained as determined by daily batch volumes	10

TOLERANCES FOR TUNNEL LININGS, CONDUITS, AND FILLING AND EMPTYING CULVERTS			
(1)	Lateral alignment		
	Centerline alignment		
		Water conveying tunnels, conduits, and culverts	13 mm1/2 inch
		Other	25 mm1 inch
	Inside dimensions		0.005 times inside dimension
(2)	Level alignment		
	Profile grade		
		Water conveying tunnels, conduits, and culverts	13 mm1/2 inch
		Other	25 mm1 inch
	Surface of invert		6 mm1/4 inch
	Surface of side slope		13 mm1/2 inch

(3)	Cross-sectional dimension		
	Thickness at any point		
		Tunnel and culvert lining	-0 mm inch
		Conduits	+5 percent thickness but not less than 13 mm 1/2 inch
			-2.5 percent thickness but not less than 6 mm 1/4 inch

2.2 MATERIALS

2.2.1 Cementitious Materials

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NOTE: See the appropriate concrete aggregates design memorandum or thermal study to select the proper requirements for cementitious materials options, pozzolan, and silica fume.

****

2.2.1.1 Portland Cement

Provide portland cement conforming to ASTM C150/C150M, Type [_____], [low-alkali when used with aggregates listed to require it in paragraph COMMERCIAL CONCRETE AGGREGATE SOURCES below, or when directed if a nonlisted source is permitted.] [including the heat of hydration requirement at 7 days] [including false-set requirement]. [In lieu of low-alkali cement, the Contractor may use a combination of portland cement that does not meet the low-alkali requirement with a pozzolan or slag provided the following requirement is met. The expansion of the proposed combination must be equal to or less than the expansion of a low-alkali cement meeting the requirements of this paragraph when tested in general conformance with ASTM C441/C441M. Run expansion tests concurrently at an independent laboratory that is nationally recognized to perform such tests. The Government reserves the right to confirm the test results and to adjust the percentage of pozzolan or slag in the combination to suit other requirements.] [Provide white portland cement meeting these requirements except that it may be Type I, Type II, or Type III [low alkali].] [Type III may be used only in specific areas of the structure, when approved in writing.]

[2.2.1.2 Pozzolan Other than Silica Fume

Provide pozzolan other than silica fume conforming to ASTM C618, Class C or F, including low alkali [multiple factor,] [drying shrinkage,] [uniformity,] [and [moderate] [severe] sulfate resistance requirements] of Table 2A. Uniformity Requirements (for entrained air) must apply to all fly ash. [Table 1A., Supplementary Optional Chemical Requirement for Maximum Alkalis, applies when used with aggregates listed to require low-alkali cement].

][2.2.1.3 Ground Granulated Blast-Furnace Slag

Provide ground granulated blast-furnace slag conforming to ASTM C989/C989M, Grade [_____].

][2.2.1.4 Silica Fume

****

NOTE: Include optional Table 2 in ASTM C1240 when used with aggregates listed to require low-alkali cement. Other requirements in Table 4 may be specified if necessary. Refer EM 1110-2-2000 for guidance.

****

Silica fume may be furnished as a dry, densified material or as a slurry. Silica fume, unprocessed, or before processing into a slurry or a densified material, must conform to ASTM C1240 with [Table 2 and] the Specific Surface Area and Uniformity Requirements in Table 4 invoked. Provide the services of a manufacturer's technical representative, experienced in mixture proportioning, placement procedures, and curing of concrete containing silica fume. The manufacturer's representative must be available for consultation by both the Contractor and the Contracting officer during mixture proportioning, planning, and production of silica-fume concrete and onsite immediately prior to and during at least the first placement of concrete containing silica fume, and at other times if directed.

]2.2.1.5 Temperature of Cementitious Materials

The temperature of the cementitious materials as delivered to the site must not exceed 65 degrees C 150 degrees F.

2.2.2 Admixtures

All chemical admixtures furnished as liquids must be in a solution of suitable viscosity for field use as determined by the Contracting Officer.

2.2.2.1 Air-Entraining Admixtures

Provide air-entraining admixture conforming to ASTM C260/C260M and consistently entrain air in the specified ranges under field conditions.

2.2.2.2 [Accelerating Admixture

Do not use calcium chloride. Use accelerators that meet the requirements of ASTM C494/C494M, Type C [(or Type E)].]

[2.2.2.3 Retarding Admixture

****

NOTE: A retarding admixture should not be used where high early strength is desirable so that form stripping may proceed expeditiously. Before listing items consult the concrete materials design memorandum to determine areas where retarders may be necessary.

****

Provide retarding admixture meeting the requirements of ASTM C494/C494M, Type B, or D, except that the 6-month and 1-year compressive strength tests are waived. The admixture may be added to the concrete mixture only when approved[, except for the following structural items where a retarding admixture are not to be used: [_____]]. Do not use Type D as the reason to reduce the cementitious material content unless used in mixture proportioning studies.

][2.2.2.4 Water-Reducing Admixture

Provide a water-reducing admixture meeting the requirements of ASTM C494/C494M, Type A [or D], except that the 6-month and 1-year compressive strength tests are waived. The admixture may be added to the concrete mixture only when its use is approved or directed and after mixture proportioning studies.

][2.2.2.5 High-Range Water-Reducing Admixture (HRWRA)

Use high-range water-reducing admixture that meets the requirements of ASTM C494/C494M, Type F [or G], except the 6-month and 1-year strength requirements are waived.[The admixture may be used only after mixture proportioning studies and when approved.] [Provide the services of a manufacturer's technical representative experienced in mixture proportioning and placement procedures of concrete containing HRWRA. The technical representative must be available for consultation during mixture proportioning and on-site for the first placement of concrete containing HRWRA.]

][2.2.2.6 Expansive Admixture

****

NOTE: Delete this paragraph and paragraph BLOCK-OUT CONCRETE in Part 3 if block-out concrete is not used.

****

Submit manufacturer's descriptive literature and certification for fluidifier to be used as expansive admixture in block-out concrete, 60 days prior to its use. Use expansive admixture in block-out concrete conforming to ASTM C937.

]2.2.3 Curing Materials

[2.2.3.1 Sheet Materials

Provide sheet curing materials conforming to ASTM C171, type optional, except do not use polyethylene sheet. Submit a manufacturer's certificate certifying that the materials comply with the requirements of ASTM C171, if sheet curing is used.

]2.2.3.2 Membrane-Forming Curing Compound

Provide membrane-forming curing compound conforming to ASTM C309, Type 1D or 2, except a styrene acrylate or chlorinated rubber compound meeting ASTM C309, Class B, requirements may be used for surfaces that are to be painted or are to receive subsequent coatings, or floors that are to receive adhesive applications of resilient flooring. Select curing compound selected that is compatible with any subsequent paint, roofing, coating, or flooring specified.

2.2.3.3 Burlap

Provide burlap for curing purposes conforming to AASHTO M 182.

2.2.4 Water

Use water for washing aggregates and for mixing and curing concrete that is free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances and in compliance with COE CRD-C 400.

2.2.5 Aggregates

****

NOTE: See the concrete materials design memorandum to select the aggregate composition options.

This note may be disregarded for regions where Alkali-Silica Reactivity (ASR) is not a concern. Some aggregate sources may exhibit an ASR potential. ASR is a potentially deleterious reaction between alkalis present in concrete and some siliceous aggregates, reference EM 1110-2-2000 paragraph 2-3b(6) and appendix D. Use of cementitious materials meeting the low alkali requirement may be effective in some applications, and insufficient in others. In regions where imposing the low alkali requirement has not been effective in controlling ASR, additional effort for evaluation and mitigation may be required. In which case, the alternate procedures to proportion cementitious materials to meet the low alkali requirement in paragraph PORTLAND CEMENT should not be used with the following requirements. Where ASR is known or suspected to pose a concern for concrete durability, it is recommended that aggregates proposed for use in concrete be evaluated to determine ASR potential and an effective mitigation. EM 1110-2-2000, provides recommendations for evaluating and mitigating ASR in concrete mixtures.

Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS, paragraph ALKALI-SILICA REACTIVITY, provides a specification method for the Contractor to evaluate and mitigate ASR in concrete mixtures. The expansion limits specified in Section 32 13 14.13 are requirements for pavements and exterior slab construction. For structural concrete applications the measured expansion must be less than 0.10 percent. It may not be economical or practical to specify different test limit requirements for use on the same project. In which case the lower limit required by the application should be used.

The designer may use the specification method in UFGS Section 32 13 14.13 by incorporating the relevant paragraphs into this specification, or may use the following requirements (retain either the

0.10 or the 0.08 percent expansion limits as appropriate) included in the set of brackets highlighted thus "[.]".

****

2.2.5.1 Aggregate Composition

[Provide fine aggregate consisting of natural sand, manufactured sand, or a combination of natural and manufactured sands. Provide coarse aggregate consisting of gravel, crushed gravel, crushed stone, air-cooled blast-furnace slag, or a combination thereof.] "[Test and evaluate fine and coarse aggregates proposed for use in concrete for alkali-aggregate reactivity in accordance with ASTM C1260. Evaluate fine and coarse aggregates separately and in combination, which matches the Contractor's proposed mix design proportioning. All results of the separate and combination testing must have a measured expansion less than 0.10 (0.08) percent at 16 days after casting. Should the test data indicate an expansion of 0.10 (0.08) percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1260 and ASTM C1567. Perform additional testing using ASTM C1260 and ASTM C1567 using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. Use GGBF slag in the range of 40 to 50 percent of the total cementitious material by mass. Use Class F fly ash in the range of 25 to 40 percent of the total cementitious material by mass.]"

2.2.5.2 Quality of Aggregates

****

NOTES: The tests selected should be those which are applicable to the concrete to be used in the project. These tests may include those in the following list in addition to others not listed. See EM 1110-2-2000 for schedule of tests.

A list of properties and test values are unique to each project and should be taken from the concrete materials design memorandum. Delete the quality tests not required in the design memorandum.

Use petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.

****

Deliver aggregates to the mixer meeting the following requirements:

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Specific Gravity	[_____]	[_____]	ASTM C127 ASTM C128
Absorption	[_____]	[_____]	ASTM C127 ASTM C128

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Durability Factor using Procedure A	[_____]	[_____]	COE CRD-C 114 ASTM C666/C666M
Clay Lumps and Friable Particles	[_____]	[_____]	ASTM C142/C142M
Material Finer than 75 µ No. 200 Sieve	[_____]	[_____]	ASTM C117
Organic Impurities	Not Darker than No. 3, Not less than 95 percent		ASTM C40/C40M ASTM C87/C87M
L.A. Abrasion	[_____]	[_____]	ASTM C131/C131M ASTM C535
Soft Particles	[_____]	[_____]	COE CRD-C 130
Petrographic Examination	List unwanted deleterious materials and their limits	[_____]	ASTM C295/C295M
Chert, less than 2.40 specific gravity	[_____]	[_____]	ASTM C123/C123M
[Coal and Lignite, less than 2.00 specific gravity]	[_____]	[_____]	ASTM C123/C123M

2.2.5.3 Grading

****

NOTES: The Designer should invoke the optional requirement limiting the amount of material passing the 75-µm No. 200 sieve when manufactured sand is specified and may invoke the option when natural sand is specified. If the limitation is invoked here, it must be listed for fine aggregate in paragraph AGGREGATES above.

See the concrete materials design memorandum for the approved gradings. Delete gradings not required.

****

2.2.5.3.1 Fine Aggregate

Deliver fine aggregate to the mixers with a grading such that the individual percent retained on any sieve does not vary more than 3 percent from the percent retained on that sieve in a fixed grading selected by the Contractor with the approval of the Contracting Officer. The fixed grading may be selected at the start of concrete placement and based upon 30 days fine aggregate production or selected after the first 30 days of concrete placement. The minimum individual percent retained on the 2.36 mm (No. 8) sieve must be 5 percent and on all smaller sieves[, except the 75 µm (No. 200),] must be 10 percent. In addition to the grading limits, the fine aggregate, as delivered to the mixer, must have a fineness modulus of no less than 2.25 nor more than 2.85. Also control the grading of the fine aggregate so that the fineness moduli groups (average of the current test and the previous two tests) of the fine aggregate as delivered to the mixer do not vary more than 0.10 from the target fineness modulus of the fixed grading selected by the Contractor and approved by the Contracting Officer. The range of each group must not exceed 0.20. Determine the fineness modulus in accordance with COE CRD-C 104. At the option of the Contractor, fine aggregate may be separated into two or more sizes or classifications, but control the uniformity of grading of the separate sizes so that they may be combined throughout the job in fixed proportions established during the first 30 days of concrete placement. The selected fixed grading must be within the following limits, except any individual test result may be outside these limits if within the allowable 3 percent variation from the selected grading.

SIEVE DESIGNATION U.S. STANDARD SQUARE MESH	PERMISSIBLE LIMITS PERCENT BY MASS, PASSING
9.5 mm3/8 inch	100
4.75 mmNo. 4	95 - 100
2.36 mmNo. 8	80 - 95
1.18 mmNo. 16	60 - 80
600 µmNo. 30	35 - 60
300 µmNo. 50	15 - 30
150 µmNo. 100	5 - 10
75 µmNo. 200	0 - 5

2.2.5.3.2 Coarse Aggregate

Rescreen coarse aggregate just prior to delivery to the concrete batch plant bins. The grading of the coarse aggregate within the separate size groups must conform to the following requirements as delivered to the mixer.

PERCENT BY MASS PASSING INDIVIDUAL SIEVES				
U.S. STANDARD SIEVE SIZE	4.75 mm No. 4 to 19.0 mm 3/4 inch	19.0 mm 3/4 inch to 37.5 mm 1-1/2 inch	37.5 mm 1-1/2 inch to 75 mm 3 inch	75 mm 3 inch to150 mm 6 inch
175 mm7 inch				100
150 mm6 inch				90 - 100
100 mm4 inch			100	20 - 55

PERCENT BY MASS PASSING INDIVIDUAL SIEVES				
U.S. STANDARD SIEVE SIZE	4.75 mm No. 4 to 19.0 mm 3/4 inch	19.0 mm 3/4 inch to 37.5 mm 1-1/2 inch	37.5 mm 1-1/2 inch to 75 mm 3 inch	75 mm 3 inch to150 mm 6 inch
75 mm3 inch			90 - 100	0 - 15
50 mm2 inch		100	20 - 55	0 - 5
37.5 mm 1-1/2 inch		90 - 100	0 - 10	
25 mm1 inch	100	20 - 45	0 - 5	
19.0 mm3/4 inch	90 - 100	0 - 10		
9.5 mm3/8 inch	20 - 55	0 - 5		
4.75 mmNo. 4	0 - 10			
2.36 mmNo. 8	0 - 5			

2.2.5.4 Particle Shape

The quantity of flat and elongated particles in the separate size groups of coarse aggregate, as determined by ASTM D4791, using a value of 3 for width-thickness ratio and length-width ratio must not exceed 25 percent in any size group.

2.2.5.5 Nominal Maximum-Size of Aggregate

Use nominal maximum-size of coarse aggregate in the various parts of the work in accordance with the following tabulation except as directed. The NMSA may be changed for sections requiring a special quality of concrete as directed.

FEATURES	NOMINAL MAXIMUM-SIZE AGGREGATE
Sections 190 mm 7-1/2 inches or less in width or slabs 100 mm 4 inches or less in thickness or any section with a clear distance between reinforcement less than 55 mm 2-1/4 inches	19 mm3/4 inch
Sections over 190 mm 7-1/2 inches or slabs at least 100 mm 4 inch in thickness. However, do not use this size in any section in which the clear distance between reinforcement is less than 55 mm 2-1/4 inch	40 mm1-1/2 inch

FEATURES	NOMINAL MAXIMUM-SIZE AGGREGATE
Unreinforced sections over 300 mm 12 inches in width and reinforced sections over 450 mm 18 inches in width or slabs 255 mm 10 inches or greater in thickness. However, do not use this size in any section in which the clear distance between reinforcing bars is less than 115 mm 4-1/2 inches	75 mm3 inches
Massive sections exceeding 1.8 m 6 feet in width and slabs 600 mm 24 inches in thickness, in which the clear distance between reinforcing bars is at least 225 mm 9 inches	150 mm6 inches

2.2.5.6 Moisture Content

Do not place fine aggregate in bins at the batch plant until it is in a stable state of moisture content. Reach a stable moisture content when the variation in the percent of total moisture tested in accordance with ASTM C566 and when sampled at the same location will not be more than 0.5 percent during 1 hour of the 2 hours prior to placing the material in the batch plant bins and the variation in moisture content when sampled at the same location must not be more than 2.0 percent during the last 8 hour period that the aggregate remains in the stockpile. Deliver coarse aggregate to the mixers with the least amount of free moisture and the least variation in free moisture practicable under the job conditions. Under no conditions deliver coarse aggregate to the mixer "dripping wet".

[2.2.5.7 Commercial Concrete Aggregate Sources

****

NOTE: The list of sources and required tests will be taken from the concrete materials design memorandum.

****

Concrete aggregates may be furnished from any source capable of meeting the quality requirements stated in paragraph AGGREGATES above. The following sources were evaluated during the design phase of the project in [_____] and were found at that time capable of meeting the quality requirements when suitably processed. No guarantee is given or implied that any of the following listed sources are currently capable of producing aggregates that meet the required quality stated above. A Design Memorandum containing the results of the Government investigation and test results is available for review in the [_____] District Office. Contact [_____] at [_____] to arrange for review of the memorandum. Consider test results and conclusions valid only for the sample tested and do not take as an indication of the quality of all material from a source nor for the amount of processing required.

a. List of Sources
b.

FINE AGGREGATE		COARSE AGGREGATE	
F1	[_____] [1/]	C1	[_____] [1/]
F2	[_____]	C2	[_____]
F3	[_____]	C3	[_____]
[1/ Low-alkali cement or the approved alternate must be used with these sources.]			

****

NOTE: The concrete materials design memorandum will list those sources requiring low-alkali cement, which must be noted herein.

****

c. Selection of Source - After the award of the contract, designate in writing only one source or combination of sources from which the Contractor proposes to furnish aggregates. If the Contractor proposes to furnish aggregates from a source or sources not listed in subparagraph "a.", LIST OF SOURCES, above, designate only a single source or single combination of sources for aggregates. Regardless of the source selected, provide samples for quality-assurance testing as required by paragraphs GOVERNMENT PRECONSTRUCTION TESTING and MATERIALS FOR MIXTURE-PROPORTIONING STUDIES IN part 1. If a source for coarse or fine aggregate so designated by the Contractor does not meet the quality requirements stated above, do not submit for approval other sources but furnish the coarse or fine aggregate, as the case may be, from one or a combination of the sources listed at no additional cost to the Government.

]2.2.5.8 Government Furnished Concrete Aggregate Source

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NOTE: The Specification Writer should ascertain that restoration of the pit or quarry site is specified under other sections.

****

2.2.5.8.1 Location

The deposits are [owned] [controlled] by the Government and are made available to the Contractor free of charge for production of aggregate required under this contract. Within the designated area, a supply of material is available from which concrete aggregate meeting the requirement of these specifications can be produced with suitable processing. The Government guarantees that a sufficient amount of material of suitable quality for production of all of the concrete aggregate required is available within the deposit and that concrete aggregates of suitable quality can be produced with a properly designed and operated plant [without hand-picking or similar operations]. However, the amount of work involved or the amount of unsatisfactory materials required to be wasted to produce a sufficient quantity of suitable concrete aggregate is the responsibility of the Contractor, and the Government will not be held liable for costs resulting from such work or waste. Produce the concrete aggregate from the following sites as shown:

	QUARRY SITE	BAR	TERRACE	COORDINATES	DIST. AND DIRECTION
G1	[_____]	[_____]	[_____]	[_____]	[_____]
G2	[_____]	[_____]	[_____]	[_____]	[_____]
G3	[_____]	[_____]	[_____]	[_____]	[_____]

[2.2.5.8.2 Explorations

The deposits listed have been explored by the Government to determine the character and extent of the materials available. The locations of the explorations are shown in the contract drawings. The logs of the exploratory holes are also shown in the drawings. Samples of materials secured are available for inspection at [_____]. The results of explorations are furnished for information only. These data are the result of limited explorations and tests conducted by and for the Government and are accurate to the extent of the scope of the investigations conducted. The Government will not be responsible for any deduction, interpretation, or conclusion drawn therefrom by the Contractor.

]2.2.6 Nonshrink Grout

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NOTE: Grade of nonshrink grout will be specified based on the application, exposure conditions, and manufacturer's recommendation.

****

Use nonshrink grout for use in setting base plates and machinery conforming to ASTM C1107/C1107M, Grade [_____], and is a commercial formulation suitable for the application proposed. Submit descriptive literature of the grout proposed for use containing certified laboratory test results showing that it meets ASTM C1107/C1107M 60 days prior to its use together with a certificate from the manufacturer stating that the grout is suitable for the application or exposure for which it is being considered. In addition, a detailed plan for review, showing equipment and procedures for use in mixing and placing the grout.

2.2.7 Packaged Dry Repair Materials

Provide packaged dry rapid-hardening cementitious materials for concrete repairs that is a commercial formulation conforming to ASTM C928/C928M requiring only the addition of water.

2.2.8 Bonding Agents

Submit descriptive literature and certification in advance of their use. Bonding agents must meet the following requirements:

2.2.8.1 Latex Bonding Agent

Provide latex agents for bonding fresh to hardened concrete conforming to ASTM C1059/C1059M, Type II.

2.2.8.2 Epoxy Resin

Provide epoxy resins for use in repairs conforming to ASTM C881/C881M, Type V, Grade I or II.

2.2.9 Surface Retarder

Provide surface retarder conforming to COE CRD-C 94.

2.3 PLANT AND EQUIPMENT

****

NOTE: See the concrete materials design memorandum or EM 1110-2-2000 for the plant size requirements.

****

Provide batching, mixing, conveying, and placing systems with a capacity of at least [_____] cubic meters yards per hour. Submit the methods and description of the equipment proposed for transporting, handling, and depositing the concrete for review, 60 days before concrete placement begins. Include site drawings or sketches with locations of equipment and placement site.

2.3.1 Batch Plant

****

NOTE: See EM 1110-2-2000, and the concrete materials design memorandum for selection of automatic or semiautomatic plant.

****

Submit details and data on the concrete plant, within 60 days prior to assembly, to the Contracting Officer for conformance review with the requirements of paragraph PLANT AND EQUIPMENT. Batch plant must meet the following requirements:

2.3.2 Location

The concrete plant [will] [may] be located at the site of the work in the general area indicated on the drawings, [or may be located offsite].

2.3.3 Bins and Silos

Provide separate bins, compartments, or silos for each size or classification of aggregate and for each of the cementitious materials. Provide compartments of ample size and constructed so that the various materials will be maintained separately under all working conditions. Separate all compartments containing bulk cement, pozzolan, ground granulated blast-furnace slag, or silica fume from each other by a free-draining air space. Clearly mark all filling ports with a permanent sign stating the contents.

2.3.4 Batching Equipment

2.3.4.1 Batchers

Weigh aggregate in separate weigh batchers with individual scales. Weigh each bulk cement and/or other cementitious materials on a separate scale in a separate weigh batcher. Measure water by weight or by volume. If measured by weight, do not weigh cumulatively with another ingredient. Measure ice separately by weight. Batch admixtures separately and batch by weight or by volume in accordance with the manufacturer's recommendations.

2.3.4.2 Water Batcher

Provide a suitable water-measuring and batching device that will be capable of measuring and batching the mixing water within the specified tolerances for each batch. Use mechanism for delivering water to the mixers that is free from leakage when the valves are closed. Interlock the filling and discharge valves for the water batcher so that the discharge valve cannot be opened before the filling valve is fully closed. When a water meter is used, provide a suitable strainer ahead of the metering device.

2.3.4.3 Admixture Dispensers

Provide a separate batcher or dispenser for each admixture. Equip each plant with the necessary calibration devices that will permit convenient checking of the accuracy of the dispensed volume of the particular admixture. Use batching or dispensing devices capable of repetitively controlling the batching of the admixtures to the accuracy specified. Use piping for liquid admixtures that are free from leaks and properly valved to prevent backflow or siphoning. Include a device or devices that will detect and indicate the presence or absence of the admixture or provide a means of visually observing the admixture in the process of being batched or discharged in the dispensing system. Ensure each system is capable of ready adjustment to permit varying the quantity of admixture to be batched. Interlock each dispenser with the batching and discharge operations so that each admixture is added separately to the batch in solution in a separate portion of the mixing water or in fine aggregate in a manner to ensure uniform distribution of the admixtures throughout the batch during the required mixing period. Store and handle admixtures in accordance with the manufacturers recommendations.

2.3.4.4 Moisture Control

Provide plant which is capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the weights of the materials being batched. Provide a moisture meter complying with the provisions of COE CRD-C 143 for measurement of moisture in the fine aggregate. Arrange the sensing element so that the measurement is made near the batcher charging gate of the fine aggregate bin or in the fine aggregate batcher.

2.3.4.5 Scales

Provide facilities for the accurate measurement and control of each of the materials entering each batch of concrete. Use weighing equipment and controls conforming to the applicable requirements of NIST HB 44, except that the accuracy must be within 0.2 percent of the scale capacity. Provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device. Make tests at the frequency required in paragraph TESTS AND INSPECTIONS in PART 3, and in the presence of a Government quality assurance representative. Include a visible indicator for each weighing unit that indicates the scale load at all stages of the weighing operation and shows the scale in balance at zero load. Arrange weighing equipment so that the concrete plant operator can observe the indicators.

2.3.4.6 Operation and Accuracy

[Start weighing operation of each material automatically when actuated by a single starter switch and end automatically when the designated amount of each material has been reached. These requirements can be met by providing an automatic batching system as defined in NRMCA CPMB 100.] [Start weighing operation of each material automatically when actuated by one or more starter switches and end when the designated amount of each material has been reached. These requirements can be met by providing a semiautomatic or automatic batching system as defined by NRMCA CPMB 100.] Provide equipment to permit the selection of [_____] preset mixes each by the movement of not more than two switches or other control devices. Cumulative weighing will not be permitted. Construct and arrange weigh batchers so that the sequence and timing of batcher discharge gates can be controlled to produce a ribboning and mixing of the aggregates, water, admixtures, and cementitious materials as the materials pass through the charging hopper into the mixer. TInclude provisions to facilitate the inspection of all operations at all times. Deliver materials from the batching equipment within the following limits of accuracy:

MATERIAL	PERCENT
Cementitious materials	± 1
Water	± 1
Aggregate smaller than 37.5 mm 1-1/2 inch size	± 2
Aggregate larger than 37.5 mm 1-1/2 inch size	± 3
Chemical admixtures	± 3

2.3.4.7 Interlocks

Interlock batchers and mixers so that:

a. The charging device of each batcher cannot be actuated until all scales have returned to zero balance within ± 0.2 percent of the scale capacity and each volumetric device has reset to start or has signaled empty.

b. The charging device of each batcher cannot be actuated if the discharge device is open.

c. The discharge device of each batcher cannot be actuated if the charging device is open.

d. The discharge device of each batcher cannot be actuated until the indicated material is within the allowable tolerances.

e. One admixture is batched automatically with the water.

f. Each additional admixture is batched automatically with a separate portion of the water or with the fine aggregate.

g. The mixers cannot be discharged until the required mixing time has elapsed.

2.3.4.8 Recorder

Provide an accurate recorder or recorders conforming to the following detailed requirements:

a. Produce a graphical or digital record on a single visible chart or tape of the weight or volume of each material in the batchers at the conclusion of the batching cycle. Produce record prior to delivery of the materials to the mixer. After the batchers have been discharged, show the return to empty condition.

b. House graphical recording or digital printout unit completely in a single cabinet that is capable of being locked.

c. Mark the chart or tape so that each batch may be permanently identified and so that variations in batch weights of each type of batch can be readily observed. Provide chart or tape which is easily interpreted in increments not exceeding 0.5 percent of each batch weight.

d. Show time of day at intervals of no more than 15 minutes.

e. The recorder chart or tape will become the property of the Government.

f. Place recorder in a position convenient for observation by the concrete plant operator and the Government inspector.

g. The recorded weights or volumes when compared to the weights or volumes actually batched must be accurate within ± 2 percent.

2.3.4.9 Batch Counters

Include devices for automatically counting the total number of batches of all concrete batched and the number of batches of each preset mixture.

2.3.4.10 Rescreening Plant

Locate, arrange, and operate rescreening plant in a manner that all coarse aggregate will be routed through the plant and that its operation will ensure delivery to the mixers of graded coarse aggregate free from excessive variation and conforming to the size groups and grading of paragraph AGGREGATES above and with moisture content conforming to the provisions of paragraph MOISTURE CONTENT above. Coarse aggregate may be rescreened and delivered to the batch plant bins one size group at a time or two or more adjacent size groups at a time. Simultaneous rescreening of nonadjacent size groups is not permitted. Waste all material passing the bottom screen of the smallest size of coarse aggregate being screened.

2.3.4.11 Washing Plant

Wash all coarse aggregates immediately prior to entering the rescreening plant. Provide rewashing plant containing water nozzles and vibrating screens to remove foreign materials and coatings from aggregate particles. Use water for washing meeting the requirements of paragraph WATER above.

2.3.4.12 Trial Operation

Not less than 7 days prior to commencement of concrete placing, make a test of the batching and mixing plant in the presence of the Contracting Officer to check operational adequacy. Produce the number of full-scale concrete batches required in trial runs as directed, do not exceed 20, and proportion as directed. Waste or use all concrete produced in these tests for purposes other than inclusion in structures covered by this specification. Correct all deficiencies found in plant operation prior to the start of concrete placing operations. No separate payment will be made to the Contractor for labor or materials required by provisions of this paragraph. Notify the Contracting Officer of the trial operation not less than 7 days prior to the start of the trial operation.

2.3.4.13 Protection

Protect weighing, indicating, recording, and control equipment against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equipment.

2.3.5 Laboratory Areas

****

NOTE: The editor should use the alternate sentence and fill in the correct Section number unless a laboratory building is to be government furnished.

****

Provide a room in the plant to house the moisture and grading testing equipment for aggregate and to provide working space. Provide another room for testing fresh concrete and for fabricating and initial curing of concrete test specimens in accordance with ASTM C31/C31M. The size, arrangement, and location of these rooms will be subject to approval. Provide electricity, air conditioning, heat, and water as required for use in these laboratory areas.

[2.3.6 Plant Layout Drawings

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NOTE: The paragraph should be included in projects for which "onsite" plant is a requirement. The wording should be modified as necessary to suit the particular requirements of each project. Drawings submitted in compliance with this paragraph will enable the Contracting Officer to determine in advance of erection whether or not the plant meets the requirements of these specifications.

****

Submit drawings, in triplicate, showing the layout of the plant the Contractor proposes to use on the work for review. Show the locations of the principal components of the construction plant; offices; shop and storage building; housing facilities, if any; and storage areas and yards which the Contractor proposes to construct at the site of the work and elsewhere. Also furnish for review drawings, in triplicate, showing the general features of his aggregate processing plant; aggregate transporting; storage and reclaiming facilities; aggregate rinsing and dewatering plant, if required; coarse aggregate rescreening plant, if required; concrete batching and mixing plant; concrete conveying and placing plant; and when precooling of concrete is required, the cooling plant. Appropriately show the capacity of each major feature of the plant including the rated capacity of the aggregate production plant in tons (metric) (2000 lb) per hour of fine and coarse aggregates; rated capacity of the aggregate transporting, storage and reclaiming facilities; volume of aggregate storage; capacity of cement and pozzolan storage; rated capacity of the concrete batching and mixing plant in cubic meters yards per hour; rated capacity of the concrete transporting and placing plant in cubic meters yards per hour; and when used rated capacity of plant for precooling of concrete. Submit drawings in triplicate showing any changes in plant made during design and erection or after the plant is in operation for review. Two sets of the drawings will be retained and one set will be returned to the Contractor with comments.

]2.3.7 Mixers

****

NOTE: See the concrete materials design memorandum for information on mixer selection and concrete mixers. Truck mixers are not allowed for mixing or transporting concrete with less than 50 mm 2 in. slump or greater than 37 mm 1-1/2 in. nominal maximum size aggregate (NMSA).

****

Provide stationary mixers [or truck mixers]. Each mixer must combine the materials into a uniform mixture and discharge this mixture without segregation. Do not charge mixers in excess of the capacity recommended by the manufacturer on the nameplate. Excessive over-mixing requiring introduction of additional water will not be permitted. Maintain mixers in satisfactory operating condition, and keep mixer drums free of hardened concrete. Replace mixer blades or paddles when worn down more than 10 percent of their depth when compared with the manufacturer's dimension for new blades. Should any mixer at any time produce unsatisfactory results, discontinue its use promptly ntil it is repaired or replaced. Submit the make, type, capacity, and number of the concrete mixers proposed for use, 60 days prior to installation for review by the Contracting Officer for conformance with the requirements of paragraph PLANT AND EQUIPMENT.

2.3.7.1 Stationary Mixer Uniformity Requirements

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NOTE: The option for the government to perform the initial mixer evaluation may be invoked.

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Adjust the size of the batch, the mixing time, the charging sequence, and other factors to provide concrete that meets the uniformity limits specified herein and in paragraph MIXER UNIFORMITY IN PART 3. Perform all testing in accordance with COE CRD-C 55. When regular testing is performed, the concrete must meet the limits of any five of the six uniformity requirements. When abbreviated testing is performed, the concrete must meet only those requirements listed for abbreviated testing. The initial mixer evaluation test is a regular test and perform prior to the start of concrete placement. Use concrete proportions for the evaluation that contains the largest size aggregate on the project and as directed. Regular testing consists of performing all six tests on three batches of concrete. The range for regular testing is the average of the ranges of the three batches. Abbreviated testing consists of performing the three required tests on a single batch of concrete. The range for abbreviated testing is the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, etc., the results of tests on one of the mixers applies to the others, subject to approval. Perform mixer evaluations as specified herein. [However, the initial evaluation will be performed by the Government. Provide labor and equipment as directed to assist the Government in performing any evaluation made by the Government.]

	ABBREVIATED	
PARAMETER	REGULAR TESTS ALLOWABLE MAXIMUM RANGE FOR AVERAGE OF	TESTS ALLOWABLE MAXIMUM RANGE FOR 1 BATCH
Unit weight of air-free mortar, kg/m^3 lb/cu ft	322.0	322.0
Air content, percent	1.0	---
Slump, mm inches	251.0	---
Coarse aggregate, percent	6.0	6.0
Compressive strength at 7 days, percent	10.0	10.0
Water content, percent	1.5	---

[2.3.7.2 Truck Mixers

Provide truck mixers and the mixing of concrete therein conforming to the requirements of ASTM C94/C94M. A truck mixer may be used for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Equip each truck with two counters from which it is possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed. Do not use truck mixers to mix or agitate concrete with greater than 37.5 mm 1-1/2 inch nominal maximum-size aggregate or concrete with a slump of 50 mm 2 inches or less. Determine the acceptability of truck mixers by uniformity tests in accordance with ASTM C94/C94M.

]2.3.8 Sampling Facilities

Provide suitable facilities and labor for obtaining representative samples of concrete in accordance with ASTM C172/C172M for Contractor quality control (QC) and Government quality control (QA) testing.

2.3.9 Coarse Aggregate

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NOTE: The automatic sampling plant should be required for aggregates in concrete containing larger than 75 mm 3 inch NMSA. For aggregates in concrete containing 75 mm 3 inch NMSA, a cost analysis should be made before specifying the automatic sampling plant. The automatic sampling plant should not be specified for aggregates in concrete containing 75 or 150 mm 3 or 6 inch NMSA. Note that the quarry sloping screens on the automatic plant will require slightly larger screens than those used for tests by ASTM C136/C136M for comparable results.

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Provide suitable facilities for readily obtaining representative samples of coarse aggregate for test purposes immediately prior to the material entering the mixer. [Include automatic equipment capable of obtaining, sieving, and weighing samples of the coarse aggregate as follows:

AGGREGATE SIZE (mm) (inch)	APPROXIMATE SIZE OF SAMPLE (kg) (lb)
4.75 to 19.0No. 4 to 3/4	250500
19.0 to 37.53/4 to 1-1/2	250500
37.5 to 751-1/2 to 3	5001000
75 to 1503 to 6	10002000

Provide equipment that is capable of running a complete sieving, of any required sample, without the necessity of intermittent loading. Design the assembly to permit selection, screening, and weighing of any individual sample in 10 minutes or less. Provide equipment designed by a company engaged in the design and manufacture of aggregate sieving devices. Provide equipment that will accomplish the desired purpose. Use sieves that meet the applicable requirements of ASTM E11, except for the frame size requirements. Arrange equipment so that all controls will be enclosed and operable from a single position commanding a view of the screen device and the scale or scales. Provide communication from the batch plant operation to this control area. The Contractor is responsible for charging of the assembly as directed, disposal of waste material, and proper service and maintenance of the assembly. Provide each sieve with individual controls for frequency and angle. Run correlation tests with equipment as used for ASTM C136/C136M before concrete placement begins and at least every 60 days while concrete is being placed. The correlation test will determine the optimum angle, volume of feed, and the frequency for each sieve.]

2.3.10 Transporting Equipment

Design, operate, and maintain transporting equipment so that it does not cause or permit segregation or loss of material. Do not drop concrete vertically more than 1.5 m 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized.

2.3.10.1 Buckets

Use bottom-dump buckets conforming to the following requirements: the interior hopper slope must be no less than 70 degrees from the horizontal; the minimum dimension of the clear gate opening must be at least five times the nominal maximum size of the aggregate, and the area of the gate opening must not be less than 0.2 square meters 2 square feet; the bucket gates must be grout-tight when closed, the double clamshell type, and manually, pneumatically, or hydraulically operated; and design the gate-opening mechanism to close the gates automatically when the control is released or when the air or hydraulic line is broken. If gate actuation is dependent on integral air or hydraulic reservoirs, the capacity of the reservoirs must be sufficient to open and close the gates three times without recharging the reservoir.

2.3.10.2   Trucks

Use truck mixers or agitators for transporting central-mixed concrete conforming to the applicable requirements of ASTM C94/C94M. Do not use truck mixers to transport concrete with larger than 37.5 mm 1-1/2 inch nominal maximum-size aggregate or 50 mm 2 inch or lower slump. Nonagitating trucks may be used for transporting central-mixed concrete over a smooth road when the hauling time is less than 15 minutes and the slump is less than 75 mm 3 inches. Bodies of nonagitating trucks must be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

2.3.10.3   Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating truck, the chutes supplied by the truck manufacturer as standard equipment may be used. Use a discharge deflector when required by the Contracting Officer. Separate chutes and other similar equipment are not permitted for conveying concrete except when specifically approved and do not increase slump to accommodate their use.

2.3.10.4   Belt Conveyors

Design and operate belt conveyors to assure a uniform flow of concrete from mixer or delivery truck to final place of deposit without segregation of ingredients or loss of mortar and provide with positive means for preventing segregation of the concrete or loss of mortar at the transfer point(s) and the point of placing. Do not exceed idler spacing of 900 mm 36 inches. Use a minimum belt speed of 90 m 300 feet per minute and a maximum of 230 m 750 feet per minute. Belt width must be a minimum of 600 mm 24 inches if the NMSA is 150 mm 6 inches and must be a minimum of 400 mm 16 inches if the NMSA is 75 mm 3 inches or less. The NMSA required in mixture proportions furnished by the Government will not be changed to accommodate the belt width.

2.3.10.5   Pump Placement

Concrete may be conveyed by positive-displacement pump when approved. Pump placement will be approved only for areas where placement by bucket or conveyor is difficult or impractical. Provide piston or squeeze-pressure type pumping equipment. Provide rigid-steel pipe or heavy-duty flexible hose pipeline. Do not use aluminum pipe. Use pipe with an inside diameter at least 3 times the nominal maximum size of the coarse aggregate in the concrete to be pumped but no less than 100 mm 4 inches.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

3.1.1 Vibrators

Keep an adequate number of vibrators on hand to meet placing requirements, and spare vibrators available to maintain production in the event of breakdown. Make adequate air pressure available for air vibrators and adequate voltage for electric vibrators. Use vibrators of the proper size, frequency, and amplitude for the type of work being performed in conformance with the following requirements:

APPLICATION	HEAD DIAMETER (mm) (inch)	FREQUENCY VPM	AMPLITUDE (mm) (inch)
Thin walls, beams, etc.	32 - 641-1/4 - 2-1/2	9,000 - 13,500	0.5 - 1.00.020 - 0.04
General construction	50 - 882 - 3-1/2	8,000 - 12,000	0.6 - 1.20.025 - 0.05
Heavy sections	75 - 1503 - 6	7,000 - 10,500	0.75 - 1.50.030 - 0.06
Mass concrete	125 - 1755 - 7	5,500 - 8,500	1.0 - 2.00.04 - 0.08

Use frequency and amplitude within the range indicated in the tabulation as determined in accordance with paragraph TESTS AND INSPECTIONS below.

3.1.2 Embedded Items

Before placing concrete, take care to determine that all embedded items are securely fastened in place as indicated in the drawings or required. Provide embedded items that are free of oil and other foreign matter such as loose coatings of rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Provide any air or water lines or other materials embedded in structures, as authorized construction expedients, conforming to the above requirements and upon completion of their use backfill with concrete or mortar as directed. Welding will not be permitted on embedded or otherwise exposed metals which are in contact with concrete surfaces. Tack welding of or to embedded items will not be permitted.

3.1.3 Concrete on Earth Foundations

Place concrete on earth foundations that are clean, damp, and free from frost, ice, and standing or running water. Prior to placement of concrete, compact the earth foundation satisfactorily in accordance with the provisions of Section 31 00 00 EARTHWORK.

3.1.4 Concrete on Rock Foundations

Place concrete on rock surfaces that are clean and free from oil, standing or running water, ice, mud, drummy rock, coatings, debris, and loose, semidetached, overhanging, or unsound fragments. Clean faults or joints to a satisfactory depth and to firm rock on the sides as directed by the Contracting Officer. Immediately before concrete is placed, clean all rock surfaces thoroughly by the use of air-water jet, high-pressure water jet, or sandblasting as described in the paragraph below. Keep all rock surfaces continuously wet for at least 24 hours immediately prior to placing concrete thereon. Cover all approximately horizontal surfaces immediately before the concrete is placed with a 13 mm 1/2 inch layer of mortar composed of the same sand and cementitious materials used in the concrete. The sand-cementitious materials ratio and the water-cementitious material ratio of the mortar must be approximately the same as those used in the concrete mixture. Cover mortar with concrete before the mortar has reached its initial time of setting.

3.1.5 Construction Joint Treatment

Submit the method and equipment proposed for joint cleanup and waste disposal, for review 30 days before concrete placement begins.

3.1.5.1 Joint Preparation

Prepare concrete surfaces to which other concrete is to be bonded for receiving the next lift or adjacent concrete by cleaning by sandblasting, high-pressure water jet, or air-water cutting. Surface cutting by air-water jets will not be permitted for concrete surfaces congested with reinforcing steel or if they are relatively inaccessible. If, for any other reason, it is considered undesirable to disturb the surface of a lift before it has hardened, the use of sandblasting or high-pressure water jet after hardening will be required. Regardless of the method used, the resulting surface must be free from all laitance and inferior concrete so that clean, well-bonded coarse aggregate particles are exposed uniformly over the lift surface. Apply joint treatment method such that the edges of the larger particles of aggregate are not undercut. Where joint preparation occurs more than 2 days prior to placing the next lift or where the work in the area subsequent to the joint preparation causes dirt or debris to be deposited on the surface, clean the surface as the last operation prior to placing the next lift. Keep the surface of the construction joint continuously wet for the first 12 hours of the 24 hours prior to placing concrete, except that the surface must be damp with no free water at the time of placement.

3.1.5.2 Air-Water Cutting

Perform air-water cutting of a construction joint at the proper time, generally between 4 and 12 hours after placement and only on horizontal construction joints. This period may be modified if a retarder is used to prolong the setting of the cement at surface of the concrete. Use an air pressure of 620 to 760 kPa 90 to 110 psi in the jet, and use sufficient water pressure to bring the water into effective influence of the air pressure. When approved a surface retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, furnish samples of the material to be used and demonstrate the method to be used in its application. After cutting, wash and rinse the surface until the wash water is no longer cloudy. If air-water cutting does not produce acceptable results, prepare the surface by high-pressure water jet or sandblasting.

3.1.5.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 21 MPa 3,000 psi may be used for cleaning. Delay its use until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the high-pressure water jet is incapable of a satisfactory cleaning, clean the surface by sandblasting.

3.1.5.4 Wet Sandblasting

This method of joint preparation may be used when the concrete has reached sufficient strength to prevent undercutting of coarse aggregate particles. Continue the operation until all accumulated laitance, coatings, stains, debris, and foreign materials are removed. Then wash the surface of the concrete thoroughly to remove all loose material. This method may be used on both horizontal and vertical surfaces.

3.1.5.5 Waste Water Disposal

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NOTE: Specification Writer will fill in the section number for the Environment Protection Plan.

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Use a method in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal must meet all requirements of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

3.2 TRANSPORTING AND PLACING

3.2.1 Transporting

Methods and equipment for conveying and depositing the concrete into the form are subject to approval. Provide transporting system with sufficient capacity to supply concrete at a rate to prevent cold joints forming during placement. A properly designed and sized elephant trunk and rigid drop chute bottom section which will prevent free-fall within the elephant trunk and rigid drop chute will be used if concrete is to drop more than 1.5 m 5 feet. If concrete is to be placed through installed horizontal or sloping reinforcing bars, discharge the concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars to within 1.5 m 5 feet of the placing surface. In no case will concrete be discharged to free fall through the reinforcing bars.

3.2.1.1 Transporting by Bucket

Provide indicating and signaling devices to control the identification of types or classes of concrete as they are mixed and discharged into buckets for transfer to the forms. Identify each type or class of concrete visually by placing a colored tag or marker on a bucket as it leaves the mixing plant so that the concrete may be positively identified in the forms and placed in the structure in the desired position.

3.2.1.2 Transporting by Pump

The nominal maximum-size coarse aggregate will not be reduced or mixture proportions changed to accommodate a pump except as specifically determined appropriate. The distance and height to be pumped must not exceed limits recommended by the pump manufacturer. Supply concrete to the pump continuously. When pumping is completed, eject concrete remaining in the pipeline without contamination of concrete in place. After each operation clean the equipment thoroughly and waste flushing water outside the forms.

3.2.1.3   Transporting by Belt Conveyor

Methods and equipment for transporting the concrete by belt conveyor into the form are subject to approval.

3.2.2   Placing

Provide placing system with sufficient capacity to supply concrete at a rate which will prevent cold joints in any placement. Work concrete into the corners and angles of the forms and around all reinforcement and embedded items without permitting the material to segregate. Deposit concrete as close as possible to its final position in the forms, and in so depositing, there must be no vertical drop greater than 1.5 m 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Regulate depositing of concrete so that it will be effectively placed and consolidated in horizontal layers not exceeding 1.5 m 5 feet in thickness with a minimum of lateral movement. Deposit amount of concrete such that it can be readily and thoroughly consolidated and do not exceed 3 cubic meters 4 cubic yards in one pile. All concrete-placing equipment and methods are be subject to approval. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation.

3.2.2.1   Time Interval Between Mixing and Placing

Place concrete mixed in stationary mixers and transported by nonagitating equipment within 30 minutes after it has been mixed, unless otherwise authorized. When concrete is truck mixed or when a truck mixer or agitator is used for transporting concrete mixed by stationary mixers, deliver the concrete to the site of the work, and complete discharge within 1 hour after introduction of the cement to either the water or aggregate.

3.2.2.2   Hot-Weather Placing

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NOTE: See EM 1110-2-2000 for the proper placing temperature.

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The temperature of the concrete when deposited in the forms during hot weather must not exceed [_____] degrees C F except as further required above. An approved retarding admixture may be used in accordance with paragraph RETARDING ADMIXTURE to facilitate placing and finishing. Cool steel forms and reinforcement and conveying and placing equipment if necessary to assist in maintaining specified concrete-placing temperature. Measure the temperature of the fresh concrete in accordance with ASTM C1064/C1064M. Submit a description of the materials and methods proposed for protection of the concrete 60 days in advance of anticipated need date for review, when concrete is to be placed under hot-weather conditions.

3.2.2.3   Cold Weather Placing

The temperature of the concrete when deposited in the forms must not be less than 5 degrees C 40 degrees F. The ambient temperature of the placement area and all surfaces to receive concrete must be above 0 degrees C 32 degrees F. Materials entering the mixer must be free from ice, snow, and frozen lumps. Closely regulate heating of mixing water or aggregates necessary to keep the concrete temperature above 5 degrees C 40 degrees F so that the concrete temperature does not exceed 15 degrees C 60 degrees F. An accelerator may be used when approved in advance.

[3.2.2.4 Special Temperature-Controlled Concrete

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NOTE: See the appropriate concrete materials design memorandum or thermal study to fill in blanks

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Special temperature control is applicable to concrete in the following structures: [_____]; [_____]; [_____]. Regardless of requirements specified above, the concrete must have a temperature of no more than [_____] degrees C F and no less than 5 degrees C 40 degrees F when measured at least 20 minutes after mixing. Heating of the mixing water or aggregates will not be permitted until the temperature of the concrete has decreased to 7 degrees C 45 degrees F. Heat materials in such a manner that they will be free from ice, snow, and frozen lumps before entering the mixer. Submit methods and equipment for review and comment 60 days in advance of anticipated date required for use, when special temperature controls are required.

]3.2.2.5 Concrete Lifts

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NOTE: The required construction joints should be shown in the drawings.

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The depth of concrete placed in each lift will be as shown in the drawings. Deposit all concrete in approximately horizontal layers about 0.5 m 1-1/2 feet in thickness in stepped progression at such a rate that the formation of cold joints will be prevented. Place slabs in one lift, unless 0.8 m 2.5 foot or more deep. Where 2.3 m 7.5 foot or greater lift depths are permitted, furnish approved cantilever forms that are jointed or hinged approximately midheight to facilitate placement against surfaces sloping more than 10 degrees from vertical. At the beginning of the placing of a lift, retract the top half of a hinged or jointed form to such a position that it does not interfere with the operation of buckets placing concrete adjacent to the form. Use a minimum of five successive horizontal layers in stepped progression for 2.3 m 7.5 foot lifts. Where 1.5 m 5 foot lifts are required, use a minimum of three successive horizontal layers in stepped progression. Place each new layer of concrete on the oldest exposed layer. Do not exceed 12 m 40 feet maximum exposed bulkhead face of concrete between adjacent monoliths except as otherwise approved. Submit a lift drawing and bill of materials for each lift of concrete. (Show only one lift on a drawing). These drawings must be to scale and show all embedded items in sufficient detail for the proper installation and prosecution of the work. Identify all embedded electrical and/or mechanical items. The drawings must not be less than 594 by 841 mm 22 by 34 inches in size and use a sufficiently large scale to clearly show all details of the structure covered by these drawings. Include a note on each lift drawing indicating all contract drawings from which the lift drawing was prepared. Submit [_____] copies of each drawing for review at least 60 days prior to scheduling the lift for placement.

3.2.2.6 Consolidation

Immediately after placing, consolidate each layer of concrete by internal vibrating equipment. Do not use vibrators to cause concrete to flow for significant distances within the forms. Hand spading may be used if necessary together with internal vibration along formed surfaces permanently exposed to view. Do not use form vibrators unless forms are specifically designed for this use and unless specifically approved. Insert vibrator vertically at uniform spacing over the entire area of placement. Use distance between insertions that is approximately 1.5 times the radius of action of the vibrator. The vibrator must penetrate rapidly to the bottom of the layer and at least 150 mm 6 inches into the preceding unhardened layer if such exists. Hold it stationary until the concrete is consolidated and then withdraw slowly. Consolidate slabs 200 mm 8 inches or less in depth by approved methods.

[3.2.2.7 Placing Concrete in Unformed Curved Sections

Finish the unformed portion of the ogee crest, spillway bucket, and similar features by placing concrete slightly above grade, consolidating and striking off to grade by accurate screeding. Screeding may be accomplished by semimechanical devices or by a mechanical screed that consolidates and screeds the surface in one operation. Ribs embedded in the fresh concrete as guides for screeds will not be permitted.

][3.2.2.8 Placing Concrete Underwater

Deposit concrete, described in Bid Item [_____], through water by a tremie or concrete pump. Submit the methods and equipment used in advance of placement for review. Concrete buckets may be used only to charge the hopper on top of the tremie. Do not lower concrete buckets under water and discharge the concrete subaqueously. Ensure tremie is watertight and sufficiently large to permit a free flow of concrete. Keep discharge end of the pump line or tremie pipe submerged continuously in the concrete after placement starts. Effect underwater seal in a manner that will not produce undue contamination of the concrete or turbulence in the water. Placement must proceed without interruption until the concrete has been brought to the required height. Do not move tremie or pump lines horizontally during a placing operation, unless removed, moved, and properly restarted, and provide a sufficient number of tremies or pump lines so that the maximum horizontal flow will be limited to 4.5 m 15 feet.

]3.3 FINISHING

3.3.1 Unformed Surfaces

The ambient temperature of spaces adjacent to surfaces being finished must be no less than 5 degrees C 40 degrees F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 1.0 kg/square meter 0.2 psf per hour, make provisions for windbreaks, shading, fog spraying, or evaporation retarding film in advance of placement to prevent plastic shrinkage cracks, and take such protective measures before, during, and immediately after finishing as operations require. All unformed surfaces of concrete that are not to be covered by additional concrete or backfill must have a float finish, unless a trowel finish is specified, and must be true to elevation as shown on the drawings. Bring surfaces to receive additional concrete or backfill to the elevation shown and leave true and regular. Slope exterior surfaces for drainage unless otherwise shown in the drawing or directed. Make joints carefully with a jointing or edging tool. Protect finished surfaces from stains or abrasions. Consolidate concrete thoroughly before finishing operations commence or before leaving it for future concrete or backfill placement.

3.3.1.1 Float Finish

Surfaces to receive a float finish must be screeded and darbied or bullfloated to bring the surface to the required finish level with no coarse aggregate visible. Do not add water, cement, or mortar to the surface during the finishing operation. Floating may be performed by use of suitable hand floats or power-driven equipment. Use aluminum or magnesium hand floats. After the water sheen has disappeared, float the concrete, while still green but sufficiently hardened to bear a man's weight without deep imprint, to a true even plane.

3.3.1.2 Trowel Finish

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NOTE: Refer to the appropriate design memorandum for surfaces to be trowel finished. Be sure these are shown in the drawings.

****

Apply a trowel finish to the following surfaces [_____]; [_____]; [_____]. First, give concrete surfaces a float finish. After surface moisture has disappeared, trowel the surface to a smooth, even, dense finish, free from blemishes, including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling must be done by hand. Make joints carefully with a jointing or edging tool. Protect finished surfaces from stains or abrasions. Protect surface or edges likely to be injured during the construction period from damage.

[3.3.1.3 Broom Finish

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NOTE: Refer to the appropriate design memorandum for surfaces to be broom finished. Be sure these are shown in the drawings.

****

Apply a broom finish to the following surfaces: [_____]; [_____]; [_____]. The concrete surface to be broom finished must first be given a float finish. The surface must then be broomed with a [stiff fiber-bristle broom] [hair broom in a direction transverse to that of the traffic].

][3.3.1.4 Abrasive Aggregate Finish

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NOTE: Refer to the appropriate design memorandum for surfaces to receive the abrasive aggregate finish. Be sure this is shown in the drawings.

****

Apply an abrasive aggregate finish to the following surfaces: [_____]; [_____]; [_____]. First, give concrete surface a float finish. Sprinkle abrasive aggregate uniformly over the surface immediately after floating, at a rate of no less than 1.22 kg/square meter 1/4 psf. Refloate the surface and then trowel to a smooth even finish that is uniform in texture and appearance including trowel marks. Immediately after curing, remove cement coating or laitance covering the abrasive aggregate by wire brushing, rubbing with abrasive stone, or sandblasting to expose the abrasive particles.

][3.3.1.5   High Velocity Finishes

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NOTE: Refer to the appropriate design memorandum for surfaces to receive high velocity finishes. Be sure these are shown in the drawings.

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Unformed surfaces subjected to high velocity flow (12 m/s) (40 fps) must receive a trowel finish.

]3.3.2   Formed Surface Repair

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NOTE: Refer to EM 1110-2-2000 for direction on class of finish. Please note that definitions for class of finish have been changed recently. Class of finish must also be shown in the drawings. Paragraph CONSTRUCTION TOLERANCES, in PART 2, presents surface tolerances. Section 03 30 00 CAST-IN-PLACE CONCRETE presents materials for each class.

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After removal of forms, remove all ridges, lips, and bulges on surfaces permanently exposed. Complete all repairs within 48 hours after form removal.

3.3.2.1   Classes A, A-HV, & B Finishes

For surfaces listed in Section 03 30 00 CAST-IN-PLACE CONCRETE, paragraph [_____], and as shown in the drawings to have classes A, A-HV, and B finishes, repair surface defects as follows: chip defective areas, voids, and honeycombs smaller than 10 000 square mm 16 square inches in area and less than 13 mm 1/2 inches deep; bug holes exceeding 13 mm 1/2 inch in diameter and fill with dry-packed mortar; ream holes left by removal of tie rods and fill with the below specified material; define defective and unsound concrete areas larger than described by 13 mm 1/2 inch deep dovetailed saw cuts in a rectangular pattern with lines parallel to the formwork, remove the defective concrete by chipping and repair the void with replacement concrete. Brush-coat the prepared area with an epoxy resin meeting the requirements of ASTM C881/C881M, Type V; a latex bonding agent meeting the requirements of ASTM C1059/C1059M, Type II; or a neat cement grout after dampening the area with water. Fill the void with replacement concrete in accordance with the paragraph MATERIAL AND PROCEDURE FOR REPAIRS below.

3.3.2.2   Class C Finish

For surfaces listed in Section 03 30 00 CAST-IN-PLACE CONCRETE, paragraph [_____], and as shown in the drawings, repair defects as follows: chip defective areas, voids, and honeycombs smaller than 15 000 square mm 24 square inches and less than 50 mm 2 inches deep; bug holes exceeding 38 mm

1-1/2 inches in diameter and fill with dry-packed mortar; and ream holes left by removal of the tie rods and fill with dry-packed mortar. Define defective and unsound concrete areas larger than 15,000 square mm 24 square inches and deeper than 38 mm 1-1/2 inches by 13 mm 1/2 inch deep dovetailed saw cuts in a rectangular pattern, remove the defective concrete by chipping, and repair the void with replacement concrete. Brush-coat the prepared area with an epoxy resin meeting the requirements of ASTM C881/C881M, Type V; a latex bonding agent meeting the requirements of ASTM C1059/C1059M, Type II; or a neat cement grout after dampening the area with water. Fill the void with replacement concrete in accordance with the paragraph below.

3.3.2.3 Class D Finish

For surfaces listed in Section 03 30 00 CAST-IN-PLACE CONCRETE, paragraph [_____], and as shown in the drawings to have class D finish, repair surface defects as follows: define defective areas, voids, and honeycombs greater than 30,000 square mm 48 square inches in area or more than 50 mm 2 inches deep by 13 mm 1/2 inch deep dovetailed saw cuts in a rectangular pattern, remove the defective concrete by chipping and repair the void with replacement concrete. Brush-coat the prepared area with an epoxy resin meeting the requirements of ASTM C881/C881M, Type V; a latex bonding agent meeting the requirements of ASTM C1059/C1059M, Type II; or a neat cement grout after dampening the area with water. Fill the void with replacement concrete in accordance with the following paragraph.

3.3.2.4 Material and Procedure for Repairs

Use cement in the dry-packed mortar or replacement concrete that is a blend of the cement used for production of project concrete and white portland cement properly proportioned so that the final color of the mortar or concrete will match adjacent concrete. Use trial batches to determine the proportions required to match colors. Provide dry-packed mortar consisting of one part cement to two and one-half parts fine aggregate. Use fine aggregate for production of project concrete. Remix the mortar over a period of at least 30 minutes without addition of water until it obtains the stiffest consistency that will permit placing. Compact mortar thoroughly into the prepared void by tamping, rodding, ramming, etc. and struck off to match adjacent concrete. Produce replacement concrete using project materials and proportion as directed by the Contracting Officer. Thoroughly compact it into the prepared void by internal vibration, tamping, rodding, ramming, etc. and strike off and finish to match adjacent concrete. Use forms to confine the concrete. If an expanding agent is used in the repair concrete, confine the repair thoroughly on all sides including the top surface. Do not use metal tools to finish permanently exposed surfaces. Cure repaired areas for 7 days. The temperature of the in situ concrete, adjacent air, and replacement mortar or concrete must be above 5 degrees C 40 degrees F during placement, finishing, and curing. Packaged materials meeting the requirements of ASTM C928/C928M may be used in lieu of dry-packed mortar when approved. Other methods and materials for repair may be used only when approved in writing. Repairs of the so called "plaster-type" will not be permitted.

3.3.3 Grout-Cleaned Finish

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NOTE: See the appropriate design memorandum and EM 1110-2-2000 for surfaces to receive a grout cleaned finish. Be sure this is shown in the drawings.

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Give the surfaces of [_____] a grout-cleaned finish as hereinafter described, as approved by the Contracting Officer and after all required curing, cleaning, and repairs have been completed. Moist cure surfaces to be grout-cleaned for the required period of time before application of the grout-cleaned finish. Delay grout-cleaning until near the end of construction on all surfaces not to be painted to achieve uniformity of appearance and reduce the chance of discoloring caused by subsequent construction operations. The temperature of the air adjacent to the surface must be no less than 5 degrees C 40 degrees F for 24 hours prior to and 72 hours following the application of the finish. Complete finish for any area in the same day, and make the limits of a finished area at natural breaks in the finished surface. Wet surface to receive grout-cleaned finish thoroughly to prevent absorption of water from the grout but have no free water present. Then coat the surface with grout. Apply grout as soon as the surface of the concrete approaches surface dryness and vigorously and thoroughly rub over the area with clean burlap pads, cork floats, or stones to fill all voids. Compose grout of one part portland cement as used on the project, to two parts by volume of well-graded sand passing a 600-µm (No. 30) sieve mixed with water to the consistency of thick paint. Use white cement for all or part of the cement as approved to give the desired finish color. Apply uniform coating, completely filling all pits, air bubbles, and surface voids. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, burlap pad, or other means. Then, after the surface whitens from drying (about 30 minutes at normal temperature), rub vigorously with clean burlap pads. Immediately after rubbing is completed, moist cure the finished surface continuously for 72 hours. Use burlap pads for this operation consisting of burlap stretched tightly around a board to prevent dishing the mortar in the voids.

3.4 CURING AND PROTECTION

Submit the curing media and methods to be used for review 30 days before concrete placement begins.

3.4.1 Curing Time

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NOTE: Curing time may be extended if required by the thermal study. See the concrete materials design memorandum for the approved types of cementitious materials.

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Cure all concrete by one of the following methods or combination of methods for the period of time given below corresponding to the cementing materials used in the concrete:

Type III portland cement	3 days
Type I portland cement	7 days
Portland cement in combination with silica fume	7 days
Type II portland cement	14 days

Type III portland cement	3 days
Portland cement blended with 25 percent or less fly-ash or GGBF slag	14 days
Portland cement blended with more than 25 percent fly-ash or GGBF slag	21 days

Begin curing immediately after placing. Provide all equipment needed for curing and protection of the concrete on hand and ready to install before actual concrete placement begins. Use curing medium and method, or the combination of media and methods, as approved in accordance with paragraph SUBMITTALS, SD-03 Product Data, submittal item "Curing".

3.4.2 Moist Curing

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NOTE: This requirement is for hot weather curing only and has to be used under certain conditions only. Thermal cracking can occur when the difference in temperature between the interior concrete is more than 11 degrees C 20 degrees F higher than the surface temperature of a concrete placement. Tepid water is water at a temperature no more than 11 degrees C 20 degrees F cooler than the surface of the concrete placement. For massive placements, thermal insulation should be provided to reduce the temperature gradient between the interior and exterior of the placement.

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[Moist cure concrete containing silica fum.] Moist cure horizontal and nearly horizontal surfaces by ponding, by covering with a minimum uniform thickness of 50 mm 2 inches of continuously saturated sand, or by covering with saturated nonstaining burlap or cotton mats. Rinse burlap and cotton mats to remove soluble substances before using. Moist cure other surfaces when approved or directed. Maintain concrete that is moist cured continuously, not periodically, wet for the duration of the entire curing period. Use water for curing complying with the requirements of the paragraph WATER in PART 2. If the water, sand, mats, etc. cause staining or discoloration of permanently exposed concrete surfaces, clean the surfaces by an approved method. When wood forms are left in place during curing, keep the forms continuously wet except for sealed insulation curing in cold weather. When steel forms are left in place on vertical surfaces during curing of concrete, [when using high-strength concrete] [when concrete being cured has a water-cement ratio less than 0.40] [placements with a minimum dimension greater than 600 mm 2 feet] carefully break loose the forms from the hardened concrete and continuously introduce curing water into the void. The temperature of the water should be tepid. Allow horizontal construction joints to dry sufficiently to remove free water immediately prior to placing the next lift.

3.4.3 Membrane Curing

Membrane curing may be used on surfaces that are not specified or directed to receive moist curing and that are not to receive a grout-cleaned finish. Do not use membrane-forming curing compound on surfaces that contain protruding steel reinforcing, that are heated by free steam, that will have additional concrete bonded to them, or that are to be grout-cleaned.

3.4.3.1 Pigmented Curing Compound

Pigmented compound conforming to ASTM C309, Type 2, Class A, may be used on surfaces that will not be exposed to view when the project is completed. Only pigmented compound of the styrene acrylate or chlorinated rubber formulation conforming to ASTM C309, Class B, requirements may be used on surfaces that are to be painted or to receive bituminous roofing or water proofing or floors that are to receive adhesive applications of resilient flooring. Select curing compound for such use that is compatible with any subsequent paint, roofing, coating, or flooring specified elsewhere in the contract.

3.4.3.2 Nonpigmented Curing Compound

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NOTE: See the concrete materials design memorandum for guidance on the optional sentence.

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Nonpigmented compound conforming to ASTM C309, Type ID, containing a fugitive dye may be used on surfaces that will be exposed to view when the project is completed. The reflective requirements of ASTM C309 are waived. [Shield surfaces cured with nonpigmented compound from direct rays of the sun for 3 days.]

3.4.3.3 Application

Apply curing compound to formed surfaces immediately after the forms are removed. Moisten surfaces thoroughly with water, and apply the curing compound as soon as free water disappears. Apply curing compound to unformed surfaces as soon as free water has disappeared provided steps have been taken when necessary to prevent premature loss of free water due to excessive evaporation as described in paragraph UNFORMED SURFACES above. Apply curing compound in a two-coat continuous operation by motorized power-spraying equipment or pressure-tank equipment operating at a minimum pressure of 520 kPa 75 psi with provisions for continuous agitation. The application equipment must be approved in advance. Do not use hand-operated pressure applicators ("garden sprayers") except in small, isolated areas as approved. Apply compound at a uniform coverage of no more than 10 square meters/L 400 square feet/gallon for each coat. Apply the second coat perpendicular to the first coat. Respray concrete surfaces that have been subjected to rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified. Protect all concrete surfaces on which the curing compound has been applied for the duration of the entire curing period from pedestrian and vehicular traffic and from any other influence that will disrupt the continuity of the curing membrane.

[3.4.4 Sheet Curing

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NOTE: The only concrete that may be cured using sheet should be horizontal or nearly horizontal finished surfaces such as roof slabs, uncolored floors or the first course of two-course floors, or

floors that are to be covered with tile or resilient flooring.
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The following concrete surfaces may be cured using sheets: [_____]; [_____]; [_____]. Use sheets only on horizontal or near horizontal surfaces. Use sheets complying with the requirements of ASTM C171, except do not use polyethylene sheet. Wet all surfaces thoroughly and completely cover with waterproof paper, or polyethylene-coated burlap. Lay covering with light-colored side up. Lap covering no less than 100 mm 4 inches and tape to form a continuous cover with completely closed joints. Use weighted sheet to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Fold coverings down over exposed edges of slabs and secure by approved means. Repair sheets immediately or replace if tears or holes appear during the curing period.

]3.4.5 Sealed Insulation Curing

Between dates listed in paragraph COLD WEATHER PROTECTION below where cold weather protection is provided entirely by insulation, seal all joints in the insulation to retard moisture loss and maintain a seal throughout the curing period.

3.4.6 Protection

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NOTE: Add more sophisticated requirements for vibration control where appropriate.
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No fire or excessive heat is permitted near or in direct contact with concrete at any time. Do not operate vibratory earth compaction equipment or pile-driving equipment within 30 m 100 feet horizontally of concrete less than 5 days old. Blasting is not permitted within 30 m 100 feet horizontally of concrete less than 90 days old. Blasting plans must be approved by the Contracting Officer. Keep all galleries, conduits, and other openings through the concrete closed or sealed during the entire construction period. Protect the surface of the concrete from rain or snow during placing.

3.4.7 Cold Weather-Protection

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NOTE: The editor must insert the insulating value and the calendar dates in the appropriate blanks. The values will be taken from the thermal study that was performed during design of the structure. The paragraph may be revised or expanded to provide varying insulating values and dates for various concrete features of the project in accordance with the thermal study.
****

Between [_____] of each year and [_____] of the following year, cover all concrete [less than 30 days old] [immediately after placing] for a period of [_____] days with insulation that provides an R value no less than [_____] square meter degree Celsius per watt hour square foot degree Fahrenheit per BTU. Submit a description of the materials and methods proposed for protection of the concrete, 60 days in advance of anticipated need date for review, when concrete is to be placed under cold-weather conditions.

a. Maintain insulation in such a condition that the R value does not diminish during the period of protection. Protect edges and corners of the placement with a double layer of the insulation specified above for a minimum distance of 0.6 m 2 feet in all directions.

b. Insulate concrete placed prior to the starting date from the starting date until it reaches an age of [_____] days. Insulate concrete placed after the starting date continuously during and subsequent to placement [until it reaches an age of [_____] days or] until the end of the protection period [, whichever comes first].

c. Insulate forms in such a manner that the combined form-insulation system has a thermal resistance (R value) no less than that specified. Keep insulation and the combined form-insulation system in place for at least 5 days after placement of the concrete. After 5 days, forms and insulation on vertical surfaces may be removed for periods not to exceed 4 hours in a 24 hour period to allow forms to be moved, and insulation on horizontal surfaces may be removed for periods not to exceed 8 hours in a 24 hour period to allow reinforcement to be installed, insulation to be installed, lift joints to be prepared, etc. provided that suitable precautions are taken to prevent the concrete from being subjected at any time to ambient temperatures of minus 7 degrees C 20 degrees F or below.

d. Insulate the first 1.8 m 6 feet of all steel protruding from insulated concrete with material having an R value as stated. Insulate all form bolts and metal ribs on the forms in a like manner. During the period of protection there must be no holes or openings in the insulation or between the insulation and concrete which permit ambient air to penetrate the insulation except as noted for construction purposes. Give special attention to seams, corners, and edges to prevent holes or openings in the insulation.

3.5 BASE PLATES AND BEARING PLATES

3.5.1 Setting of Plates

After being plumbed and properly positioned, provide full bearing column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates using nonshrink grout. The space between the top of the concrete bearing surface and the bottom of the plate must not be less than 1/24 of the width of the plate or 13 mm 1/2 inch, whichever is greater. Concrete surfaces must be clean, free of oil, grease, and laitance, and damp. Metal surfaces must be clean and free of oil, grease, and rust.

3.5.2 Nonshrink Grout

Use nonshrink grout conforming to the requirement of paragraph NONSHRINK GROUT. Water content must be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.5.2.1 Mixing and Placing

Perform mixing and placing in conformance with the material manufacturer's instructions and as specified. Dry-mix ingredients thoroughly before adding water. After adding water, mix the batch for 3 minutes. Size batches to allow continuous placement of freshly mixed grout. Discard grout not used within 30 minutes after mixing. Fill the space between the top of the concrete or masonry bearing surface and the plate with the grout. Use forms consisting of wood or other suitable material for retaining the grout and remove after the grout has hardened. If Grade "A" grout is used, form all surfaces, including top surfaces, to provide restraint. Work placed grout to eliminate voids; however, avoid overworking and breakdown of the initial set. Do not retemper or subject grout to vibration from any source. Where clearances are unusually small, make placement under pressure with a grout pump. Maintain temperature of the grout, and of surfaces receiving the grout, at 20 to 30 degrees C 65 to 85 degrees F until after setting.

3.5.2.2 Treatment of Exposed Surfaces

Those types of grout containing metallic aggregate, Grade B or C grout, must, after setting, have exposed surfaces under cut back 1 inch from the edge of the base plate and immediately cover with a thick coat of mortar proportioned by weight of one part portland cement, two parts sand, and sufficient water to make the mixture placeable. The parge coat must have a smooth, dense finish. The exposed surface of other types of nonshrink grout must have a smooth, dense finish.

3.5.2.3 Curing

Cure grout and parge coats in conformance with paragraph CURING AND PROTECTION above.

[3.6 BLOCK-OUT CONCRETE

[3.6.1 Composition and Proportions

Provide block-out concrete composed of portland cement, water, fine and coarse aggregate, and admixtures. The concrete mixture proportions, including admixture, will be provided by the Contracting Officer. Use an expansive admixture to cause the blockout concrete to expand to fit snugly in the space that confines it. Use expansive admixture conforming to the requirements of ASTM C937 for grout fluidifier. Waste any block-out concrete not placed within 30 minutes after contact of the cement and admixture. Confine block-out on all sides to provide restraint.

][3.6.2 Placing Block-out Concrete

Provide block-outs as shown on the plans for the embedment of gate seal seats, gate guides, bulkhead guides, beams embedded for bulkhead seals, crane rails, and other embedded metalwork as appropriate. Prior to installation of embedded items, clean the block-outs or recesses in accordance with applicable requirements of the paragraph on construction joint treatment. After installation of embedded items and prior to placing any forms, clean all surfaces of the block-outs or recesses and surfaces of items to be embedded thoroughly of all loose material, oil, grease, and other contaminants which might reduce the bond between the surfaces of the blockouts or recesses and new concrete. Exercise extreme caution in placing block-out concrete to avoid distortion or displacement of the embedded items.

]]3.7 TESTS AND INSPECTIONS

3.7.1 General

Perform the following inspection and tests as described, and, based upon the results of these inspections and tests, take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, cease concrete placement. The laboratory performing the tests must be onsite and conform with the requirements given in ASTM C1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification will have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C1077. The individual who performs the inspection will have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of [Concrete Transportation Construction Inspector (CTCI)] [Concrete Construction Inspector (CCI)].

3.7.2 Testing and Inspection Requirements

3.7.2.1 Fine Aggregate

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NOTE: If the optional requirement to limit the amount of material passing the 75 µm No. 200 sieve was invoked in paragraph AGGREGATES in PART 2, the requirement to perform ASTM C117 must be invoked in subparagraph a.

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3.7.2.1.1 Grading

At least once during each shift when the concrete plant is operating, there make one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M [, ASTM C117] and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. Recoed the results on a sheet on which are also shown the specification limits applicable to the project.

3.7.2.1.2 Fineness Modulus Control Chart

Group results for fineness modulus in sets of three consecutive tests, and plot the average and range of each group on a control chart. Draw the upper and lower control limits for average 0.10 units above and below the target fineness modulus, and the upper control limit for range 0.20 units above the target fineness modulus.

3.7.2.1.3 Corrective Action for Fine Aggregate Grading

When the amount passing any sieve is outside the specification limits, resample and retest the fine aggregate immediately. If there is another failure for any sieve, report the fact immediately. Whenever a point on the fineness modulus control chart, either for average or range, is beyond one of the control limits, double the frequency of testing. If two consecutive points are beyond the control limits, consider the process out of control and stop concreting. Notify the Contracting Officer, and take immediate steps to rectify the situation. After two consecutive points have fallen within the control limits, testing at the normal frequency may be resumed.

3.7.2.1.4 Moisture Content Testing

When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, perform at least four tests for moisture content in accordance with ASTM C566 during each 8-hour period of mixing plant operation. Select times for the tests randomly within the 8-hour period. Make an additional test whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When an electric moisture meter is operating satisfactorily, make at least two direct measurements of moisture content per week to check the calibration of the meter. Use results of tests for moisture content to adjust the added water in the control of the batch plant.

3.7.2.1.5 Moisture Content Corrective Action

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, adjust the scale settings for the fine-aggregate batcher and water batcher (directly or by means of a moisture compensation device).

3.7.2.2 Coarse Aggregate

3.7.2.2.1 Grading

At least once during each shift in which the concrete plant is operating, perform a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor is responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations must show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When facilities are available to test samples five times as large as those required in ASTM C136/C136M, averaging is not permitted.

3.7.2.2.2 Corrective Action for Grading

When the amount passing any sieve is outside the specification limits, resample and retest the coarse aggregate immediately. If the second sample fails on any sieve, report that fact. Where two consecutive averages of five tests (or two consecutive tests where large samples are used) are outside specification limits, consider the operation out of control, and report that fact, stop concreting, and take immediate steps to correct the grading.

3.7.2.2.3 Coarse Aggregate Moisture Content

Make a test for moisture content of each size group of coarse aggregate at least once a shift. When two consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, increase frequency of testing to that specified previously for fine aggregate.

3.7.2.2.4 Coarse Aggregate Moisture Corrective Action

Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more, adjust the scale setting for the coarse aggregate batcher and the water batcher to compensate for this.

3.7.2.2.5 Particle Shape Testing

When directed, a problem exists in connection with aggregate particle shape, make tests in accordance with ASTM D4791. Testing frequency must not be ess than one per day, when directed.

3.7.2.2.6 Particle Shape Corrective Action

When testing for particle shape is required, report two consecutive failures in the same sieve size immediately, and determine what corrective action is needed.

3.7.2.2.7 Material Finer than the 75-µm No. 200 Sieve

When in the opinion of the Contracting Officer, a problem exists in connection with the cleanliness of aggregate, make tests in accordance with ASTM C117. Testing frequency must be as directed.

3.7.2.2.8 Corrective Action for Material Finer than the 75-µm No. 200 Sieve

When material finer than the 75-µm No. 200 sieve exceeds 1.0 percent of the weight of the aggregate finer than 37.5 mm 1-1/2 inches or 0.5 percent of the weight of the aggregate coarser than 37.5 mm 1-1/2 inches, notify the Contracting Officer and initiate steps, such as washing or other corrective action, immediately.

3.7.2.3 Quality of Aggregates

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NOTES: Tests should be those listed in paragraph QUALITY OF AGGREGATES.

Use petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.

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3.7.2.3.1 Frequency of Quality Tests

Prior to submitting samples for mixture proportioning studies and 30 days prior to the start of concrete placement, perform the tests for aggregate quality in the following list. In addition, after the start of concrete placement, perform tests for aggregate quality in accordance with the following frequency schedule. Take samples tested after the start of concrete placement immediately prior to entering the concrete mixer.

PROPERTY	FINE AGGREGATE	FREQUENCY COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Absorption	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Durability (Procedure A)	Factor using Every 12 months	Every 12 months	COE CRD-C 144 ASTM C666/C666M
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C142/C142M
Material Finer than the 75-µm (No. 200) Sieve	Every 3 months	Every 3 months	ASTM C117
Organic Impurities	Every 3 months	Not applicable	ASTM C40/C40M
L.A. Abrasion	Not applicable	Every 6 months	ASTM C131/C131M ASTM C535
Soft and Friable (Scratch Hardness)	Not applicable	Every 6 months	COE CRD-C 130
Petrographic Examination	Every 6 months	Every 6 months	ASTM C295/C295M
Chert, less than 2.40 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M
Coal and lignite, less than 2.00 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M

3.7.2.3.2 Corrective Action for Aggregate Quality

If the result of a quality test fails to meet the requirements for quality during submittal of samples for mixture-proportioning studies or immediately prior to start of concrete placement, change production procedures or materials and perform additional tests until the material meets the quality requirements prior to proceeding with either mixture-proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, rerun the test immediately. If the second test fails the quality requirement, report the fact and take immediate steps to rectify the situation.

3.7.2.4 Scales

3.7.2.4.1 Weighing Accuracy

Check accuracy of the scales by test weights at least once a month for conformance with the applicable requirements of paragraph PLANT AND

EQUIPMENT. Also make such tests as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

3.7.2.4.2 Batching and Recording Accuracy

Check the accuracy of each batching and recording device once a week during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. Confirm that the calibration devices described in paragraph PLANT AND EQUIPMENT in PART 2, for checking the accuracy of dispensed admixtures, are operating properly.

3.7.2.4.3 Scales Corrective Action

When either the weighing accuracy or batching accuracy does not comply with specification requirements, do not operate the plant until necessary adjustments or repairs have been made. Correct discrepancies in recording accuracies immediately.

3.7.2.5 Batch-Plant Control

Control the measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures continuously. Adjust aggregate weights and amount of added water as necessary to compensate for free moisture in the aggregates. Adjust the amount of air-entraining agent to control air content within specified limits. Prepare a report indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic meter yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic meter yard for each class of concrete batched during plant operation.

3.7.2.6 Concrete

3.7.2.6.1 Air Content

Make at least two tests for air content on randomly selected batches of each concrete mixture produced during each 8 hour period of concrete production. Make additional tests when excessive variation in workability is reported. Make tests in accordance with ASTM C231/C231M. Plot the average of each set of two tests for each mixture on control charts on which the average percent and upper and lower limits are set in accordance with paragraph MATERIALS FOR MIXTURE PROPORTIONING STUDIES, in PART 1, for each NMSA. Plot the range between two consecutive tests for each mixture on a control chart on which the upper control limit is 3.0 percent. Normally take samples for air content at the mixer, however the Contractor is responsible for delivering the concrete to the forms at the proper air content. Take samples at the placement site as often as required, depending on the Contractor's delivery method, to determine any air loss.

3.7.2.6.2 Air Content Corrective Action

Whenever points on the control chart approach the upper or lower control limits, an adjustment should be made in the amount of air-entraining admixture batched. If a single test result is outside the specification limit, immediate adjustment is mandatory. As soon as practical after each adjustment, make another test to verify the correction of the adjustment. Whenever a point falls above the upper control for range, calibrate the dispenser to ensure that it is operating correctly and with good reproducibility. Whenever two consecutive points either for average or range are outside the control limits, notify the Contracting Officer.

3.7.2.6.3 Slump Testing

Make at least two slump tests in accordance with ASTM C143/C143M on each concrete mixture produced during each 8-hour period or less of concrete production each day. Make additional tests when excessive variation in workability is reported. Plot the result of each test for each mixture on a control chart on which the upper and lower limits are set as specified in paragraph SLUMP. Plot the range on a control chart on which the upper control limit is 50 mm 2 inches. Take samples for slump at the mixer, however the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the placement, take samples at the placement site as often as required by the Contracting Officer.

3.7.2.6.4 Slump Corrective Action

Whenever points on the control chart approach the upper or lower control limits, make an adjustment in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount specified in the mixture proportions provided based on the free water available with the aggregates and that amount of water batched. If the adjustments to the batch weights of water and aggregates do not satisfactorily produce the required slump, the Contracting Officer may adjust the mixture proportions if the fine-aggregate moisture content is stable and within the required limits. When a single slump is outside the control limits, such adjustment is mandatory. As soon as practical after each adjustment, make another test to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range above the upper control limits, consider the slump to be out of control, halt the concreting operation, and undertake additional testing for aggregate moisture content required, and take action immediately to correct the problem.

3.7.2.6.5 Compression Test Cylinders

Make at least one set of test cylinders each shift on each different concrete mixture placed during the shift. Make additional sets of test cylinders, as directed, when the mixture proportions are changed or when low strengths have been detected. Develop a random sampling plan for approval by the Contracting Officer prior to start of construction. Assure that sampling is done in a completely random and unbiased, not just haphazard, manner. Provide a set of test cylinders for structural concrete containing Type I or Type II portland cement only consisting of four cylinders, two to be tested at 7 days and two at 28 days. Provide a set of test cylinders for all other concrete consisting of six cylinders, two to be tested at 7 days, two at 28 days, and two at 90 days. In addition, for all concrete except that containing Type I or Type II portland cement only, every 2 months make four additional cylinders and test two at 6 months of age and test two at 12 months of age. Mold and cure all test specimens in accordance with ASTM C31/C31M and test in accordance with ASTM C39/C39M. Report all compressive strength tests immediately. Keep quality control charts for individual strength tests, moving average for strength and moving average for range for each mixture. The charts must be similar to those found in ACI 214R.

3.7.2.7 Inspection Before Placing

Inspect foundation or construction joints, forms, and embedded items in sufficient time prior to each concrete placement in order to certify that they are ready to receive concrete. Report results of each inspection in writing.

3.7.2.8 Concrete Placement

3.7.2.8.1 Placing Inspection

The placing foreman must supervise all placing operations, must determine that the correct quality of concrete or grout is placed in each location as directed, and is responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume yardage placed, and method of placement.

3.7.2.8.2 Placing Corrective Action

Do not permit placing to begin until an adequate number of vibrators in working order with competent operators are available is verified. Do not continue placing if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, take immediate steps to improve temperature controls.

3.7.2.9 Vibrators

3.7.2.9.1 Vibrator Testing and Use

Determine frequency and amplitude of each vibrator in accordance with COE CRD-C 521prior to initial use and at least once a month when concrete is being placed. Make additional tests as directed when a vibrator does not appear to be adequately consolidating the concrete. Determine the frequency while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. Determine the amplitude with the head vibrating in air. Take two measurements, one near the tip and another near the upper end of the vibrator head, and average these results. Report make, model, type, and size of the vibrator and frequency and amplitude results in writing.

3.7.2.9.2 Vibrator Corrective Action

Remove any vibrator not meeting the requirements of paragraph PREPARATION FOR PLACING above immediately from service and repair or replace.

3.7.2.10 Curing

3.7.2.10.1 Moist Curing Inspections

At least twice each shift, and twice per day on nonwork days, inspect all areas subject to moist curing. Note and record the surface moisture condition.

3.7.2.10.2 Moist Curing Corrective Action

When a daily inspection report lists an area of inadequate moistness, take immediate corrective action, and extend the required curing period for those areas by one (1) day.

3.7.2.10.3 Membrane Curing Inspection

Do not apply curing compound until the Contractor's authorized representative has verified that the compound is properly mixed and ready for spraying. At the end of each operation, estimate the quantity of compound used by measurement of the container and the area of concrete surface covered and compute the rate of coverage in square meters/L square feet per gallon. Note whether or not coverage is uniform.

3.7.2.10.4 Membrane Curing Corrective Action

When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, spray the entire surface again.

3.7.2.10.5 Sheet Curing Inspection

At least once each shift and once per day on nonwork days, inspect all areas being cured using sheets. Note and record the condition of the covering and the tightness of the laps and tapes.

3.7.2.10.6 Sheet Curing Corrective Action

When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, repair the tears and holes promptly or replace the sheets, close the joints, and extend the required curing period for those areas by one day.

3.7.2.11 Cold Weather Protection and Sealed Insulation Curing

At least once each shift and once per day on nonwork days inspect all areas subject to cold weather protection. Inspect the protection system for holes, tears, unsealed joints, or other incongruities which could result in damage to the concrete. Take special attention at edges, corners, and thin sections. Note, correct, and report any deficiencies.

3.7.2.12 Cold Weather Protection Corrective Action

When a daily inspection report lists any holes, tears, unsealed joints, or other incongruities, correct the deficiency immediately and extend the period of protection for one (1) day.

3.7.2.13 Mixer Uniformity

****

NOTE: The optional phrases should be used if the Contractor is to perform the initial test. Correlate with paragraph PLANT AND EQUIPMENT in PART 2.

****

3.7.2.13.1 Stationary Mixers

[Prior to the start of concrete placing and] once every 3 months when concrete is being placed, or once for every 57,000 cubic meters 75,000 cubic yards of concrete placed, whichever results in the longest time, determine interval uniformity of concrete mixing in accordance with paragraph PLANT AND EQUIPMENT in PART 2. [The initial and] every fourth set of tests must be regular tests performed on three batches of concrete. Intermediate uniformity tests must be abbreviated tests performed on a single batch of concrete. If the mixer fails the abbreviated test, perform a regular test immediately. Whenever adjustments in a mixer or increased mixing time are required because of failure of a uniformity test, reevaluate the mixer by a regular test after the adjustments have been completed. If the Contractor proposes to reduce a mixing time, perform a regular test to evaluate the proposed time. Perform additional testing when directed when there is visible evidence of possible improper mixer performance. Report results of all uniformity tests in writing.

3.7.2.13.2 Truck Mixers

Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, determine uniformity of concrete in accordance with ASTM C94/C94M. Select truck mixers randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory. Report results of tests in writing.

3.7.2.14 Mixer Uniformity Corrective Action

When a mixer fails to meet mixer uniformity requirements, either increase the mixing time, change batching sequence, reduce batch size, or make adjustments to the mixer until compliance is achieved.

3.7.3 Reports

Report all results of tests or inspections conductedinformally as they are completed and in writing daily. Prepare a weekly report for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold weather protection, make daily reports of pertinent temperatures. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-04 01 20.73 (November 2015)**
Change 1 - 08/17

Preparing Activity: USACE **Superseding**
UFGS-04 01 20 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 04 - MASONRY

SECTION 04 01 20.73

MASONRY STRENGTHENING USING FRP BARS

11/15, CHG 1: 08/17

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-04 01 20.73 (November 2015)**
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****

SECTION 04 01 20.73

MASONRY STRENGTHENING USING FRP BARS

11/15, CHG 1: 08/17

****

NOTE: This guide specification covers the requirements for strengthening of masonry walls and is intended for use in defining those requirements for procurment of structural strengthening using fiber reinforced polymer (FRP) composit systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: In general, reinforced masonry is defined as masonry construction that contains vertical bar reinforcement, horizontal bar reinforcement, mortar, and grout combined so that the component materials will act together to resist the design loading conditions. Under certain circumstances, joint reinforcement may be designed as structural reinforcement to resist applied loads, but is typically used only to resist shrinkage cracking in concrete masonry.

Masonry not meeting the above definition but bonded

together with mortar and containing, if necessary, the minimum amount of reinforcement for crack control and vertical stiffeners, is classified as non-reinforced or unreinforced masonry (URM).

The project drawings should show all necessary details, architectural and structural, including wall sections, masonry bond and pattern, control joint locations, joint dimensions, reinforcement locations, anchors, bond beam and special units, masonry dimensions, and FRP composite details to complement this section.

It may be useful to include the SUMMARY article at the beginning of this specification section:

****

[1.1 SUMMARY

This section includes design, performance, and construction requirements for strengthening masonry walls by adding near-surface fiber reinforced polymer (FRP) bars in mortar joints. The scope includes assessment of existing masonry conditions, including cracks, and providing (furnishing and installing) materials, labor, equipment and other items necessary for masonry strengthening as indicated.

]1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 440.2R	(2017) Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures

ACI 440.7R	(2010) Guide for the Design and Construction of Externally Bonded Fiber-Reinforced Polymer Systems for Strengthening Unreinforced Masonry Structures
ACI 503.1-503.4	(1993, R 2003) Four Epoxy Specifications

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0116	(2016) TLVs and BEIs

ASTM INTERNATIONAL (ASTM)

ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2563	(2008) Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D3039/D3039M	(2017) Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
ASTM D3171	(2011) Standard Test Method for Constituent Content of Composite Materials
ASTM D3916	(2008; R 2016) Standard Test Method for Tensile Properties of Pultruded Glass-Fiber-Reinforced Plastic Rod
ASTM D4501	(2001; R 2014) Adhesive Bonds Between Rigid Substrates by the Block-Shear Method

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC ES AC125	(2014; R 2015) Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber-reinforced Polymer (FRP) Composite Systems
ICC ES AC178	(2013; R 2017) Acceptance Criteria for Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening Using Fiber-reinforced Polymer (FRP) Composite Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1200	Hazard Communication

1.3 PRE-INSTALLATION MEETING

****

NOTE: Add requirements for Special Inspector qualifications, observations, and testing of this FRP composite system to Section 01 45 35 SPECIAL INSPECTIONS.

****

Prior to commencement of work, arrange and conduct a meeting between the Contracting Officer, Contractor, and the Special Inspector to discuss the project requirements.

a. Review the requirements of the Specification and overall project requirements.

b. Review and discuss all aspects of the project, including containment, environmental control, surface preparation, strengthening system application, quality assurance, schedule requirements, and safety.

c. Request clarification of ambiguities and advise the Contracting Officer of potential conflicts and/or any technical requirements that appear improper or inappropriate.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

For non-Design-Build type contracts, Shop Drawings

and Design Data should be provided by the Government.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G, [_____]
System Manufacturer
Contractor Qualifications; G, [_____]
Contractor's Field Representative Qualifications; G, [_____]

SD-02 Shop Drawings

FRP Composite System; G, [_____]

SD-03 Product Data

Safety Data Sheets (SDS)
FRP Rods And Shapes; G, [_____]
Structural Paste/Adhesive Material; G, [_____]

SD-04 Samples

Materials; G, [_____]
FRP Rods And Shapes; G, [_____]
Structural Paste/Adhesive Material; G, [_____]

SD-05 Design Data

Design Calculations; G, [_____]

SD-06 Test Reports

Wall Tests
Wall Test Reports; G, [_____]
FRP Rods And Shapes
Structural Paste/Adhesive Material
Laboratory Testing
Field Testing

SD-07 Certificates

Regulatory Requirements
Pastes/Adhesives
Applicators
Applicator Training

SD-08 Manufacturer's Instructions

FRP Composite System; G, [_____]
Manufacturer's Installation Instructions; G, [_____]

SD-10 Operation and Maintenance Data

Record Maintenance; G, [_____]
Maintenance; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Quality Control Plan

Submit a quality control plan for installation and curing of materials, personnel safety, installer certification, application and inspection of the FRP system, structural paste/adhesive curing provisions, means to assure clean, dry masonry surfaces, quality control samples and cleanup. Indicate the testing that will be performed and identify the party or parties responsible for this testing.

1.5.2 Regulatory Requirements

a. Submit certification that structural pastes/adhesives proposed for use meet Federal VOC regulations and those of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located.

b. Use bonding materials that do not release volatile organic compounds (VOC) into the air in excess of the most restrictive of NIOSH RELs, OSHA PELs or ACGIH TLVs for worker or occupant exposure during installation and/or over the useful life of the structure. If VOCs exceed any of these exposure limits during installation or use, provide additional ventilation for the duration of the excess outgassing. At no time will they exceed STEL, even if additional ventilation or air supply is provided; provide the necessary equipment to comply with these requirements. Once cured, the FRP composite system must not exhibit any detectable odor at a distance of 300 mm one foot from the FRP surface.

c. Inform workers, having access to the work area, of the contents of the applicable safety data sheets (SDS) and of potential health and safety hazard and protective controls associated with materials used on the project. Submit data sheets for all materials to be used at the job site in accordance with OSHA and 29 CFR 1910.1200. Train workers in the safe handling and application, and the exposure limit, for each material that the worker will use or otherwise be exposed to during the course of the project. Instruct personnel having a need to use respirators and masks in the use and maintenance of such equipment.

1.5.3 Qualifications

1.5.3.1 System Manufacturer Experience

Submit a certified list of a minimum five successfully completed FRP composite strengthening projects completed with the manufacturer's composite system. Include the following information, at a minimum:

a. The dates of work
b. Type, description and amount of work performed
c. Point of contact for an owner representative to include:
    (1) Name
    (2) Address
    (3) Company/Agency name

    (4) Telephone number

1.5.3.2 Contractor Qualifications

Submit a list of a minimum five FRP composite strengthening projects completed by the Contractor on masonry surfaces, with a minimum of three of those jobs using the manufacturer's composite system. Include the following information, at a minimum:

a. The dates of work
b. Type, description and amount of work performed
c. Point of contact for an owner representative to include:
    (1) Name
    (2) Address
    (3) Company/Agency name
    (4) Telephone number

1.5.3.3 Contractor's Field Representative Qualifications

Provide a Field Representative who will be present on site during installation of the FRP system. Submit the name of the Contractor's Field Representative that will perform the actual work supervision and a list of a minimum of five FRP composite strengthening projects supervised by that Field Representative, at least three of which use the manufacturer's composite system. Include the following information, at a minimum:

a. The dates of work
b. Type, description and amount of work performed
c. Point of contact for an owner representative to include:
    (1) Name
    (2) Address
    (3) Company/Agency name
    (4) Telephone number

1.5.3.4 Applicators

1.5.3.4.1 Applicator Training

Submit certification for the FRP composite applicators who have completed, as a minimum, a course provided by the FRP manufacturer which includes hands-on application of FRP systems to masonry substrates. Submit the course syllabus.

Train workers in the safe handling and application, and the exposure limit, for each material that the worker will use or otherwise be exposed to during the course of the project.

1.5.3.4.2 Experience

Only assign qualified applicators meeting these requirements and those having prior experience in the specified application preparation to perform the work described herein.

1.5.4 Laboratory

****

NOTE: If rectangular FRP shapes are specified to be used, the laboratory should have experience using test method ASTM D3039/D3039M. If FRP bars are

specified, ASTM D3916 should be cited.
****

Provide a testing laboratory experienced in testing FRP materials and having performed [ASTM D3039/D3039M] [ASTM D3916] wall tests for at least three different Contractors prior to this contract.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 FRP Reinforcing Bars and Shapes

****
NOTE: FRP reinforcing bars are susceptible to surface damage. Puncturing their surface can significantly reduce the strength capacity of the FRP reinforcements. In the case of glass FRP rods, the surface damage can cause a loss of durability due to infiltration of alkalis.
****

Comply with the following handling guidelines to minimize damage to the FRP bars and workers handling them:

a. Handle FRP reinforcing bars with work gloves to avoid personal injuries from either exposed fibers or sharp edges;

b. Do not store the FRP bars on the ground. Place pallets under the bars to keep them clean and to provide easy handling;

c. Avoid high temperatures, ultraviolet rays, and chemical substances because they can damage FRP bars;

d. Occasionally, bars become contaminated with form releasing agents or other substances. Substances that decrease bond should be removed by wiping the bars with solvents before placing them in the masonry;

e. It may be necessary to use a spreader bar so that the FRP bars can be hoisted without excessive bending.

f. Conduct construction activities in such a way that potential damage to the FRP bars and shapes is minimized.

1.6.2 Structural Pastes/Adhesives

1.6.2.1 Labeling

Deliver structural pastes/adhesives in original factory-sealed containers with the manufacturer's labels intact and legible with verification of product nomenclature, manufacturer's name, product identification and batch number, date of manufacture and shelf life or expiration date. Do not use adhesive materials that have exceeded the shelf life.

1.6.2.2 Storage

Store all structural paste/adhesive materials in a covered, well-ventilated area and protected from exposure to any detrimental conditions including: airborne contaminants, dirt, dust, sunlight, temperatures lower than 4 degrees C 40 degrees F or greater than 38 degrees C 100 degrees F, rainfall, sparks or flame and in accordance with the manufacturer's

requirements.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Environmental Requirements

Do not install the FRP composite if the ambient air temperature or substrate surface temperature is outside the range recommended by the system manufacturer. Submit manufacturer's requirements for ambient, surface, and component temperatures at the time of mixing of the structural paste/adhesive.

Do not install the FRP composite when surface moisture is present on the substrate or when rainfall or condensation is anticipated in the work areas.

a. When the air or substrate temperature is outside the prescribed range, do not proceed with work unless other measures approved by the Contracting Officer are employed.

b. Do not apply structural pastes/adhesives to cold or frozen surfaces. When the surface temperature of the masonry surface falls below a minimum level, as specified by the FRP system manufacturer, cease work until both the air and masonry temperature rise above the specified minimum. Do not use supplemental sources of heat to raise the air or masonry surface temperature unless approved by the FRP composite system manufacturer.

c. When the surface temperature of the masonry and/or the air temperature rises above the maximum level, as specified by the FRP system manufacturer, cease work until both the air temperature and masonry temperature cool below the specified maximum.

d. Unless they have been formulated for such applications, do not apply structural pastes/adhesives to damp or wet surfaces.

e. Should the potential for adverse temperatures occur during installation, stop the application of FRP until temperatures return to within the range specified in the Manufacturer's Instructions. Obtain written approval of the FRP manufacturer and the Contracting Officer before using supplemental heating or cooling sources.

f. Should the potential for direct contact by rain, dust, dirt, excessive sunlight, high humidity, or vandalism occur during installation, provide temporary protection, such as tents and/or plastic screens, until the construction pastes/adhesives have cured. Cure the structural paste/adhesive before removal of temporary protection or allowing the structure to be exposed to new loads. In the event of suspected damage to the FRP system during installation, notify the Contracting Officer as soon as possible. Should the damage be caused by the Contractor's negligence, perform repairs at no additional cost to the Government.

1.7.2 Existing Conditions

As-built drawings of the structure [are attached] [can be accessed at [_____]].

1.8 WARRANTY

Furnish manufacturer's standard warranty for FRP composite system installation, including the FRP composite system [design,] installation, bond to the substrate, and interlaminar bond, as well as mechanical property retention, and bar-adhesive compatibility. Provide a warranty period of not less than 5 years from the date of Government's acceptance.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 System Definition

Provide an FRP systems that consists of procured composite rods and shapes, manufactured in the system supplier's facility and shipped to the job site, and a structural paste/adhesive to bond the precured rods and shapes into grooves cut in the masonry surface. Ensure that materials supplied for the work of this section are from a single system manufacturer. Substitution of FRP rods or shapes, and substitution of structural pastes/adhesives that differ from those which comprise the approved manufacturer's FRP system are not allowed.

2.1.2 Performance Requirements

****

NOTE: Provide the parameters of strength or force that must be provided by the FRP system application. The following variables must be considered in determining the enhanced performance requirements: the load on the wall, the size of the wall, the wall aspect ratio, wall openings, etc.

****

Provide the FRP composite system with [seismic] [wind] [and] [blast] strengthening for [clay brick] [concrete] masonry walls by [[_____]percent] [the quantity indicated on the Drawings]. Provide a system that transfers [seismic] [wind] [and] [blast] loading, in concert with the existing masonry, to the building foundation.

2.1.3 FRP Composite System Design Requirements

2.1.3.1 Design Basis

Design the FRP composite system in conformance with ACI 440.2R and ACI 440.7R to provide [seismic] [wind] [and] [blast] strengthening for clay brick and concrete masonry walls. Design walls with the FRP system to fail by cracking through the masonry units and mortar prior to debonding or rupture of the FRP composite system.

2.1.3.2 Shop Drawings

Submit complete FRP composite system shop drawings for each installation of the composite system including details of the fiber reinforcement type, dimensions, end details, proposed connections to the diaphragms and adjacent walls, and locations to be applied as specified. Include calculations prepared by or on behalf of the Contractor to determine the layout of the FRP materials to be installed.

2.1.3.3 Design Calculations

Submit design calculations for the FRP composite system stamped by a registered professional civil or structural engineer. Submit calculations conforming to requirements set forth in the ICC ES AC125; Acceptance Criteria based on tension force and strain limits.

2.2 MATERIALS

****

NOTE: The values listed in the following tables should be those values and assumptions that were used in developing the preliminary rehab/strengthening design. Those items in Table 1 below will be the minimum acceptable property values for the FRP bars and shapes to be installed. Those items in Table 2 will be the minimum acceptable properties for the structural paste/adhesive.

For tests with two methods listed, the first refers to round shapes such as FRP bars and the second pertains to rectangular cross-sectional shapes.

The arbitrary selection of a fiber reinforcement and an adhesive material from different manufacturers or systems can lead to failure of the installed FRP system due to possible matrix-reinforcement incompatibility.

****

2.2.1 FRP Composite System

2.2.1.1 System Materials

Provide an FRP system consisting of [glass] [carbon] [aramid] [rods] [rectangles] [grids] with a resin matrix of [vinyl ester] [polyester] [epoxy] [urethane] [specialty resin] binder and an [epoxy] [urethane] [______] structural adhesive. Formulate the structural paste/adhesive for use as an embedding material to bond masonry and FRP materials and, once cured, protect the FRP shapes from the environment. Provide a structural paste/adhesive that is suitable for use in both non-load bearing and load bearing applications.

2.2.1.2 System Submittals

2.2.1.2.1 Wall Test Reports

Submit results of testing, performed by an independent testing facility, on walls that are representative of the actual configuration and loading conditions for this contract to demonstrate structural equivalency of the proposed system to the properties specified herein. Currently, no standard tests exist; therefore, submit testing for approval by the Contracting Officer. Include the following information in the test report:

a. FRP System nomenclature
b. Testing facility name
c. Testing facility address
d. Testing facility telephone number
e. Testing facility point of contact

f. Test wall substrate material
g. Test wall aspect ratio
h. FRP orientation and frequency/location
i. FRP composite shape and cross-sectional area
j. Cyclic in-plane test results in accordance with ICC ES AC125 to include the following:
    (1) Description of test setup
    (2) Rate and method of loading
    (3) Deformation and strain measurements
    (4) Modes of failure

2.2.1.2.2 Manufacturer's Installation Instructions

Submit manufacturer's printed installation instructions for the FRP Composite System, including the following:

a. Brand name
b. Catalog number
c. Names of manufacturer for each material to be used. Include with instructions the estimated quantity of each material to be used on the job.
d. Detailed mixing and application instructions to include:
    (1) Mixing instructions
    (2) Curing times between coats or layers
    (3) Application procedures for surface coatings
    (4) Cold weather installation to include the minimum application temperature recommended by the FRP system manufacturer or 4 degrees C 40 degrees F whichever is higher. Advise the minimum Shore Hardness for application at temperatures below 4 degrees C 40 degrees F for approval by the Contracting Officer.
    (5) Hot weather installation to include the maximum application temperature recommended by the FRP system manufacturer or 38 degrees C 100 degrees F whichever is lower. Advise the niminum Shore Hardness for application at temperatures above 38 degrees C 100 degrees F for approval by the Contracting Officer.
    (6) Inclement weather installation
    (7) Application procedures of top coating material

2.2.2 FRP Rods and Shapes

2.2.2.1 Material Properties

Provide FRP [rods] [shapes] conforming to the material properties listed in Table 1.

TABLE 1: Properties of Pre-formed FRP Rods and Shapes

COMPOSITE PROPERTY	FRP TEST REQUIREMENT	METHOD (shape)
Elongation: max.	[_____] percent	ASTM D3916 (round) ASTM D3039/D3039M (rectangular)
Visual Defects	Acceptance Level [_____]	ASTM D2563 (all)
Guaranteed Tensile Strength, min.,	[_____] kPa psi	ASTM D3916 (round) ASTM D3039/D3039M (rectangular)

TABLE 1: Properties of Pre-formed FRP Rods and Shapes		
COMPOSITE PROPERTY	FRP TEST REQUIREMENT	METHOD (shape)
Tensile Modulus of Elasticity, min.	[_____] kPa psi	ASTM D3916 (round) ASTM D3039/D3039M (rectangular)
Cross-sectional Area	[_____] square mm square inches	ASTM D3916 (round) ASTM D3039/D3039M (rectangular)
Fiber Volume Fraction	[_____] percent	ASTM D3171 (all)

2.2.2.2 Rods and Shapes Submittals

a. Submit a sample FRP bar, 300 mm 12 inches long.

b. Submit material property test reports indicating the following physical properties of the FRP bar or shape.

(1) Tensile strength, as determined in accordance with ASTM D3916 for FRP rods or ASTM D3039/D3039M for flat or rectangular shaped FRP reinforcement.

(2) Design elastic modulus by the strength and rupture strain values. Determine ultimate tensile strength and rupture strain values by subtracting three standard deviations from the average values of 20 or more tensile tests.

c. Submit product data with documented evidence that the [rods] [shapes] meet the requirements of Table 1.

2.2.3 Structural Paste/Adhesive Material

2.2.3.1 Material Properties

Provide structural paste/adhesive that conforms to the material properties listed in Table 2.

TABLE 2 Minimum Properties of Structural Pastes/Adhesives/Polymer Adhesives		
COMPOSITE PROPERTY	FRP TEST REQUIREMENT	METHOD
Elongation:	[_____] percent	ASTM D882
Ultimate Tensile Strength, min.,	[_____] kPa psi	ASTM D638
Modulus of Elasticity, min.	[_____] kPa psi	ASTM D638
Bond Strength	[_____] kPa psi	ASTM D4501

2.2.3.2 Structural Paste/Adhesive Material Submittals

a. Submit a sample plate of cured structural paste/adhesive 75 x 75 mm 3 x 3 inches.

b. Submit test results of shore hardness tests at 3 and at 24 hours in ten degree intervals between 4 and 38 degrees C 40 and 100 degrees F for structural pastes/adhesives used. Also submit system environmental durability test results conducted and reported by an independent testing facility. Include the following information in test reports:

    (1) FRP System nomenclature
    (2) Testing facility name
    (3) Testing facility address
    (4) Testing facility telephone number
    (5) Testing facility point of contact
    (6) Freeze-thaw test results
    (7) 2000 hour UV exposure test results
    (8) Fire resistance test results
    (9) Seven day exposure at 100 percent humidity test results
    (10) 3000 hour test results for ozone exposure, for alkali exposure, for salt water immersion, and for 60 degrees C 140 degrees F exposure

c. Submit product data with documented evidence that the structural paste/adhesive meets the requirements of Table 2.

2.2.4 Accessories

Provide all other materials as needed for the proper installation of the complete composite system as specified.

2.3 MIXES

Perform mixing of structural paste/adhesive materials in accordance with the FRP system manufacturer's recommended procedure. Ensure that adhesive components are at a proper temperature and mixed in the correct ratio until there is a complete mixing of components and a uniform color. Mix each batch of adhesive materials in quantities sufficiently small to ensure that the mixed structural paste/adhesive can be used within its pot life. Do not use mixed structural paste/adhesive that exceeds its pot life, as defined by the system manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

Examine existing conditions to assess the quality of the masonry substrate, identify potential obstructions, and verify dimensions/geometries shown on shop drawings.

Ensure that other scheduled masonry repairs are complete and cured prior to starting the work of this Section. Provide mortar surfaces, to which the FRP system is to be applied, that are free of loose and unsound materials and other conditions that would inhibit bond, such as oil, efflorescence and moisture.

3.2 PREPARATION

3.2.1 Protection

Coordinate the work to minimize exposure of building occupants, other personnel, and visitors to dust, mists, and odors from preparation, FRP system application and clean-up operations.

3.2.2 FRP Material Verification

Prior to starting the project and together with the Special Inspector, ensure that delivered FRP materials meet the specified requirements. This will require the following laboratory testing by the Special Inspector.

a. Determine the tensile strength and tensile modulus of elasticity for each batch of FRP bars or shapes used. Reject materials that do not meet the minimum requirements of Table 1.

b. Determine the gel time, pot life, and cured hardness of the structural paste/adhesive. Determine the tensile strength, bond strength, modulus of elasticity, and elongation of the structural paste/adhesive. Reject materials that do not meet the minimum requirements of Table 2.

3.2.3 Surface Preparation

3.2.3.1 Surface

****

NOTE: Select the bracketed option that accurately describes the masonry condition prior to the start of the Work of this Section.

****

[The mortar joints to receive FRP composite are relatively sound structurally.] [There are known problems associated with the condition of the original masonry and the masonry substrate that can compromise the integrity of the FRP system.] [Remove areas of loose or spalling mortar material and repoint in accordance with Section 04 03 00 UNIT MASONRY CLEANING AND RESTORATION.]

3.2.3.2 Subsurface

Do not apply FRP systems to masonry substrates containing corroded reinforcing steel. Note evidence of localized cracking and/or spalling at grouted cells and rust stains and report them to the Contracting Officer. Do not proceed with Work until the cause(s) of the corrosion is(are) addressed and the corrosion-related deterioration repaired.

3.2.3.3 Obstructions

Prior to installing the FRP system, modify or remove obstructions and embedded objects that affect performance of the FRP system. Obtain Contracting Officer's approval before performing such modifications and removals.

3.3 FRP SYSTEM INSTALLATION

3.3.1 General

Do not make modifications to the manufacturer's installation procedures or to the design and shop drawings without the written approval of the Contracting Officer.

3.3.2 Embedment Slot Preparation

Lay out embedment slot locations on the wall surface at the specified locations. Prepare containment to catch dust and masonry chips generated during the embedment slot cutting/grinding.

3.3.2.1 Slot Cutting

Using a grinder or saw with a blade manufactured to cut substrate, cut slots in the masonry to the width and depth recommended by the FRP manufacturer. Take special care to avoid local fracture of the masonry.

3.3.2.2 Slot Finishing

Provide masonry slot surfaces to receive FRP composite that are free from fins, and protrusions that may prevent the FRP [bars] [shapes] from being embedded to the specified depth in the wall. Dry the contact surfaces as recommended by the FRP system manufacturer. Evaluate moisture content in accordance with ACI 503.1-503.4 standard specification applicable to the application. Provide contact surfaces that have no loose particles, paint, oil, dirt, dust, efflorescence, mildew or free moisture on them at the time of application. Do not use solvent or chemical cleaning methods to clean surfaces. Clean contact surfaces by hand using wire brushes or by using compressed air. [Using masking tape or other suitable adhesive tape, fix a strip at each edge of the slots.]

3.3.3 Cutting FRP Bars and Shapes

Perform cutting of the FRP bars with a high-speed grinding cutter or a fine blade saw. Do not shear FRP bars.

3.3.4 Application of Structural Paste/Adhesive

Mix the structural paste/adhesive according to the specifications prescribed by the manufacturer. Place a layer of structural paste/adhesive uniformly in the slots cut in the masonry substrate.

Depending on the type of structural paste/adhesive used, ventilate work areas during structural paste/adhesive application so that worker exposure to chemical substances will not exceed limits as established by ACGIH 0116, or as required by a more stringent applicable local regulation. Ventilate interior work zones having a volume of 280 cubic meters 10,000 cubic feet or less with a minimum of two air exchanges per hour. Maintain ventilation in larger work zones by means of mechanical exhaust. Exhaust solvent vapors outdoors, away from air intakes and workers. Temporarily seal return air inlets in the work zone before start of work and maintain until the structural paste/adhesive has cured.

3.3.5 FRP Reinforcing Bar/Shape Installation

Press the FRP reinforcing bar/shape into the slot so that the surface of the [bar] [shape] is fully embedded in the paste/adhesive and does not protrude to the surface of the wall. Completely fill the slot with the structural paste/adhesive to encapsulate the bar and strike the surface even with the surface of the masonry.

3.3.6 Curing

Maintain structural paste/adhesive curing temperatures within the required temperature range designated by the manufacturer for the formulation used for the manufacturer specified time. Protect the composite system from contact by moisture for a minimum period of 24 hours.

3.3.7 Finish

Once cure is complete, remove any masking tape applied around the edges of the slots taking care not to damage the structural paste/adhesive. [[Stain] [Paint] the structural paste/adhesive according to the Shop Drawings in accordance with the manufacturer's instructions.]

3.3.8 Movement Joints

3.3.8.1 Control Joints

Maintain all control joints. Do not bridge existing control joints with the FRP composite.

3.3.8.2 Expansion Joints

Maintain all expansion joints. Do not bridge existing expansion joints with the FRP composite.

3.4 FIELD QUALITY CONTROL

3.4.1 General Requirements

Maintain quality control (QC) programs and criteria provided in the pre-construction submittals. Comply with the approved quality control plan.

Submit inspection and progress reports daily to the Contracting Officer.

3.4.2 Field Testing During Construction

3.4.2.1 Mixed Structural Paste/Adhesive Hardness and Curing

3.4.2.1.1 Sample Preparation

****

NOTE: The required resin samples are a minimum of 6 mm 0.25-inch in thickness, whereas FRP placed on a wall is much thinner, typically 3 mm 1/8-inch or less. During initial stages of curing, thicker cross sections tend to be softer than thin ones. There is, therefore a variation in the required hardness to account for this phenomenon.

****

During installation, prepare two samples of mixed structural paste/adhesive per shift from two, separate, [nonconsecutive batches] [tube sets] of structural paste/adhesive. Provide structural paste/adhesive samples that are a minimum of 6 mm 1/4-inch thick and 50 mm 2-inches in diameter for testing, by the Special Inspecor, to evaluate curing progress.

3.4.2.1.2 Curing and Hardness Evaluation

Evaluate relative curing progress of the resin on the job site by measuring the hardness of the resin sample at 3 hours and 24 hours of cure in accordance with provisions of ASTM D2240. Take measurements at a minimum of three different points distributed over the surface of the structural paste/adhesive at least 6 mm 0.25 inch apart from each other.

3.4.2.1.3 Field Testing Report by Special Inspector

Report the mean hardness value obtained, structural paste/adhesive identification, manufacturer, and batch number, structural paste/adhesive mixing date and time, test date and time minimum air temperature during the curing evaluation time, and the type and serial number of the durometer used. Report whether the shore hardness measurements exceed the minimum hardness values submitted by the materials manufacturer, based on the lowest air temperature during the curing period evaluated.

3.4.2.1.4 Resolution of Noncompliances

In the event that curing does not meet the minimum values submitted by the materials manufacturer, take remedial measures as specified in paragraph REMEDIAL MEASURES.

3.4.2.2 In-Place Structural Paste/Adhesive Hardness

3.4.2.2.1 Testing Frequency

During installation, perform a minimum of one test on each 152 m 500 linear feet or portion thereof of FRP bar installed at 3 hours after installation and at 24 hours after installation.

3.4.2.2.2 Curing Evaluation

Evaluate relative curing progress of the in-place FRP resin using the Shore hardness test described in ASTM D2240. The shore hardness measurements must exceed the minimum hardness values submitted by the materials manufacturer based on the minimum substrate temperature observed during the evaluation period.

3.4.2.2.3 Field Testing Report

Report both the individual and mean hardness values obtained, the locations where each hardness test was performed, the FRP application date, test date and time, air and substrate temperature when the FRP was applied, air and substrate temperature when testing was performed, and the type and serial number of durometer used. Report whether the shore hardness measurements exceed the minimum hardness values submitted by the materials manufacturer, based on the lowest air temperature during the curing period evaluated.

3.4.2.2.4 Resolution of Noncompliances

In the event that curing does not meet the minimum values submitted by the materials manufacturer, take remedial measures as specified in paragraph REMEDIAL MEASURES.

3.4.2.3 Remedial Measures

For strengthened sections where testing indicates that the installed composite system has material properties below the minimum specified values, remove the installed FRP composite and replace it with FRP composite meeting or exceeding the minimum specified values. Remove unacceptable FRP composite, repair damaged masonry as a result of the FRP removal, and install replacement FRP composite at no cost to the Government.

3.4.3 Inspection

****

NOTE: Add requirements for special inspection of masonry strengthening using FRP Bars to Section 01 45 35 SPECIAL INSPECITONS, including aspects of the work to be observed and documented, frequency, and record keeping.

Include in Section 01 45 35 the extent of observation of field testing to be performed by the Special Inspector.

****

Provide a Special Inspector, who is trained and certified by the FRP system manufacturer and approved by the Contracting Officer, to perform inspections in accordance with this specification, SECTION 01 45 35 SPECIAL INSPECTIONS, and ICC ES AC178. Provide a Special Inspector who is not be an employee of the Contractor nor financially associated with the Contractor beyond the inspection contract.

3.4.4 Record Maintenance

Retain samples of mixed structural paste/adhesive and maintain a record of the placement of each batch. Submit the record at the end of the project.

3.5 ADJUSTING AND CLEANING

3.5.1 Repairs

Repair all defects according to the FRP maintenance and repair procedure provided by the system manufacturer.

3.5.2 Work Area Clean Up

Upon completion of the work, remove staging, scaffolding, and containers from the site or destroy them in an approved manner. Remove FRP composite, structural paste/adhesive, and other deposits on adjacent surfaces. Leave the project site cleaned to equal or better condition to that prior to the start of the job. Place cloths, cotton waste and other debris, which might constitute a fire hazard, in closed metal containers and remove at the end of each day. Store, transport, and dispose of adhesives properly as indicated on the SDS sheets. Contain masonry dust and chips and dispose of properly, as required by local authorities. Contain material to be disposed of at the site until proper disposition is achieved.

3.6 MAINTENANCE

Submit procedures to properly maintain the installed FRP system and written manufacturer recommended repair procedures for damage to the in-place FRP system.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-04 01 20.75 (November 2015)**
Change 2 - 05/21

Preparing Activity: USACE **Superseding**
UFGS-04 01 21 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 04 - MASONRY

SECTION 04 01 20.75

MASONRY STRENGTHENING USING SURFACE APPLIED FRP COMPOSITES

11/15, CHG 2: 05/21

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-04 01 20.75 (November 2015)**
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****

SECTION 04 01 20.75

MASONRY STRENGTHENING USING SURFACE APPLIED FRP COMPOSITES

11/15, CHG 2: 05/21

****

NOTE: This guide specification covers the requirements for strengthening of masonry walls and is intended for use in defining those requirements for procurement of structural strengthening using fiber reinforced polymer (FRP) composite systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: In general, reinforced masonry is defined as masonry construction containing vertical bar reinforcement, horizontal bar reinforcement , mortar, and grout combined so that the component materials will act together to resist the design loading conditions. Under certain circumstances, joint reinforcement may be designed as structural reinforcement to resist applied loads, but is typically used only to resist shrinkage cracking in concrete masonry.

Masonry not meeting the above definition, but bonded

together with mortar and containing, if necessary, the minimum amount of reinforcement for crack control, is classified as unreinforced masonry (URM).

The project drawings should show all necessary details, architectural and structural, including wall sections, masonry bond and pattern, control joint locations, joint dimensions, reinforcement locations, anchors, bond beam and special units, masonry dimensions, and FRP composite details to complement this section.

The masonry to be strengthened with surface-applied FRP composites should first be assessed for suitability. Considerations include the extent of repairs that might be required to provide a suitable surface for achieving bond, the effect of reduced vapor permeability of the masonry, and the design requirements for covering the composite surface, both for visual aesthetics and fire resistance (when required). The presence of efflorescence or corrosion may inhibit bond of the FRP composite. Simply cleaning the staining addresses the symptom only and does not correct the cause of the problem.

****

[1.1 SUMMARY

****

NOTE: It may be useful to include this SUMMARY Article at the beginning of this Specification Section.

****

This section includes design, performance, and construction requirements for strengthening masonry walls by adding near-surface fiber reinforced polymer (FRP) bars in mortar joints. The scope includes assessment of existing masonry conditions, including cracks, and providing (furnishing and installing) materials, labor, equipment and other items necessary for masonry strengthening as indicated.

]1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 440.3R	(2012) Guide Test Methods for Fiber-Reinforced Polymer (FRP) for Reinforcing or Strengthening Concrete Structures
ACI 440.7R	(2010) Guide for the Design and Construction of Externally Bonded Fiber-Reinforced Polymer Systems for Strengthening Unreinforced Masonry Structures
ACI 503.1-503.4	(1993, R 2003) Four Epoxy Specifications

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0116	(2016) TLVs and BEIs

ASTM INTERNATIONAL (ASTM)

ASTM C581	(2020) Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures, Intended for Liquid Service
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2563	(2008) Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D3039/D3039M	(2017) Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
ASTM D3045	(1992; R 2010) Practice for Heat Aging of Plastics Without Load
ASTM D3171	(2011) Standard Test Method for Constituent Content of Composite Materials
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM G154	(2023) Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC ES AC125	(2014; R 2015) Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber-reinforced Polymer (FRP) Composite Systems
ICC ES AC178	(2013; R 2017) Acceptance Criteria for Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening Using Fiber-reinforced Polymer (FRP) Composite Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1200	Hazard Communication

1.3 PRE-INSTALLATION MEETING

****

NOTE: Add requirements for Special Inspector qualifications, observations, and testing of this FRP composite system to Section 01 45 35 SPECIAL INSPECTIONS.

****

Prior to commencement of work, arrange and conduct a meeting between the Contracting Officer, Contractor, and the Special Inspector to discuss the project requirements.

a. Review the requirements of the Specification and overall project requirements.

b. Review and discuss all aspects of the project, including containment, environmental control, surface preparation, strengthening system application, quality assurance, schedule requirements, and safety.

c. Request clarification of ambiguities and advise the Contracting Officer of potential conflicts and/or any technical requirements that appear improper or inappropriate.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G, [_____]

SD-02 Shop Drawings

FRP Composite System; G, [_____]

SD-03 Product Data

Safety Data Sheets (SDS)
System Properties; G, [_____]

SD-04 Samples

System Material Sample; G, [_____]
Anchors; G, [_____]

SD-05 Design Data

Design Calculations; G, [_____]
Hygrothermal Analysis; G, [_____]

SD-06 Test Reports

Laboratory Testing During Construction
Witness Panel Test Report
Field Testing

Mixed Resin Hardness Test Report
Shore Hardness Values
Delaminations; G, [_____]

SD-07 Certificates

Regulatory Requirements
Manufacturer Qualifications
Contractor Qualifications
Field Representative Qualifications
Installers' Qualifications
Laboratory Qualifications
System Properties
Finish Coat Compatibility Letter from FRP Manufacturer
Finish Coat Compatibility Letter from Finish Coat Manufacturer

SD-08 Manufacturer's Instructions

System Installation Instructions; G, [_____]
Repair Methods for Application Defects; G, [_____]

SD-10 Operation and Maintenance Data

Record Retention; G, [_____]
Maintenance Procedures; G, [_____]

1.5 QUALITY CONTROL

1.5.1 Quality Control Plan

Submit a Quality Control Plan for installation and curing of FRP materials, including personnel safety, installer certification, application and inspection of the FRP system, location and placement of splices, curing provisions, means to assure dry surfaces, quality assurance samples and cleanup.

1.5.2 Regulatory Requirements

Submit Safety Data Sheets (SDS) to demonstrate that the composite system will not release volatile organic compounds (VOC) into the air in excess of the most restrictive of NIOSH RELs, OSHA PELs or ACGIH TLVs for worker or occupant exposure during installation and/or over the useful life of the structure. If VOCs exceed any of these exposure limits during installation or use, provide additional ventilation for the duration of the excess outgassing. Ensure that at no time will they exceed STEL, even if additional ventilation or air supply is provided. Provide the necessary equipment to comply with these requirements. Once cured, ensure the FRP composite system does not exhibit detectable odor at a distance of 300 mm one foot from the FRP surface.

Submit certification that resins proposed for use meet Federal VOC regulations and those of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located.

1.5.3 Qualifictions

1.5.3.1 Manufacturer Qualifications

Submit documentation that the FRP composite system manufacturer has used the proposed materials system on a minimum of ten completed strengthening projects. Certification submittal must include: the dates of work, type, description and amount of work performed, as well as a point of contact for the Contractor doing the work, and an owner representative identified by name, address and telephone number.

1.5.3.2 Contractor Qualifications

Submit documentation that the Contractor has completed a minimum of five FRP composite strengthening projects on masonry surfaces and a minimum of three of those jobs using the manufacturer's composite system. Certification submittal must include the dates of work, type, description and amount of work performed, the FRP system installed for each project, and the name and telephone number of a contact person or owner for whom the work was completed.

1.5.3.3 Installers' Qualifications

1.5.3.3.1 Training

a. FRP composite applicators must have completed, as a minimum, a certification course provided by the FRP manufacturer or as an alternative, a list of experience, which includes hands-on application of FRP systems to masonry substrates.

b. A field representative who has completed the course of instruction and has completed a minimum of ten FRP composite strengthening projects, three (3) using the manufacturer's composite system, must be present onsite during all installation of the FRP system. Submit the Field Representative Qualifications, including the name of the person who will perform the actual work supervision and a list of a minimum of ten completed FRP composite strengthening projects of similar applications using the manufacturer's composite system. Include the dates of work, type, description and amount of work performed, and the name and telephone number of a contact person or owner for whom the work was completed.

c. Inform workers having access to the work area of the contents of the applicable safety data sheets (SDS) and of potential health and safety hazards and protective controls associated with materials used on the project. Provide SDS that are in accordance with 29 CFR 1910.1200. The work area is one that may receive mists and odors from the FRP system application and curing operations. Train workers in the safe handling and application of FRP materials and the exposure limit for each material that the worker will use or otherwise be exposed to during the course of the project. Instruct personnel having a need to use respirators and masks in the use and maintenance of such equipment.

1.5.3.3.2 Experience

Assign only qualified applicators meeting these requirements and those having prior experience in the specified surface preparation and coating applications to perform the work described herein. Submit a listing of past application projects completed by the applicators, including the dates of work, type, description and amount of work performed, and the name and telephone number of a contact person or owner for whom the work was completed.

1.5.3.3.3 Laboratory Qualifications

****

NOTE: Due to the sensitivity of ASTM D3039/D3039M, not all testing laboratories are capable of performing this test. The testing laboratory used must have a history of performing ASTM D3039/D3039M tests prior to the contract.

****

Submit documentation that the laboratory has experience in testing FRP materials and has performed ASTM D3039/D3039M wall tests for at least three different Contractors prior to this contract. Include the results of the wall tests in the laboratory certification of qualifications.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Labeling

Deliver polymer resin materials in original factory-sealed containers with the manufacturer's labels intact and legible with verification of product nomenclature, manufacturer's name, product identification and batch number, date of manufacture and shelf life or expiration date. Do not use polymer resin materials that have exceeded the shelf life.

1.6.2 Storage

Store materials in a covered, well-ventilated area protected from exposure to detrimental conditions including: airborne contaminants, dirt, dust, sunlight, temperatures lower than 4 or greater than 38 degrees C 40 or greater than 100 degrees F, rainfall, sparks or flame and in accordance with the manufacturer's requirements. Store polymer resins and hardeners in a separate area from construction materials that can absorb odors.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Environmental Requirements

1.7.1.1 Application Temperature

1.7.1.1.1 Cold Surfaces

Do not apply primers, saturating resins and adhesives to cold or frozen surfaces. When the surface temperature of the masonry surface falls below a minimum level, as specified by the FRP system manufacturer, stop work until both the air and masonry temperature rise above the specified minimums. Do not use supplemental sources of heat to raise the air or masonry surface temperature unless approved by the FRP composite system manufacturer.

1.7.1.1.2 Hot Surfaces

When the surface temperature of the masonry and/or the air temperature rise above the maximum level, as specified by the FRP system manufacturer, stop work until both the air temperature and masonry temperature cool below the specified maximum.

1.7.1.1.3 Wet or Damp Surfaces

Unless they have been formulated for such applications, do not apply resins and adhesives to damp or wet surfaces.

1.7.1.2 Environmental Temperature

Should the potential for adverse temperatures occur during installation, stop the application of FRP until temperatures return to within the range specified in the Manufacturer's Instructions. Obtain approval from the FRP manufacturer and the Contracting Officer before using supplemental heating or cooling sources.

1.7.1.3 Other Environmental Factors

Provide temporary protection from direct contact by rain, dust and dirt, excessive sunlight, and high humidity during installation and until the resins have cured. Provide and install tents and/or plastic screens as required to protect the FRP system as it cures. Assure resins are cured before removal of temporary shoring or allowing the structure to be exposed to new loads. In the event of suspected damage to the FRP system during installation, notify the Contracting Officer..

1.7.2 Existing Conditions

As-built drawings of the structure [are attached] [can be accessed at [_____]].

1.8 WARRANTY

Furnish a warranty for FRP composite system installation. Ensure the warranty covers the FRP composite system [design,] installation, bond to the substrate, and interlaminar bond, as well as mechanical property retention, and fabric-resin compatibility. Furnish the warranty for a period of not less than 5 years from the date of Government's acceptance.

PART 2 PRODUCTS

****

NOTE: FRP system forms can be categorized based on how they are delivered to the work site and installed. Externally applied FRP composite systems come in a variety of forms including wet lay-up systems, prepreg systems, and precured systems.

Wet lay-up FRP systems consist of dry unidirectional or multi-directional fiber sheets or fabrics that are impregnated onsite with a saturating resin. The saturating resin is used to bond the sheets to the masonry surface. Wet lay-up systems are saturated with resin and cured in place and in this sense are analogous to cast-in-place concrete. For dry lay-up systems, the fabric is placed on the wall and then saturated in-place with resin and cured in place.

Prepreg FRP systems consist of unidirectional or multidirectional fiber sheets or fabrics that are preimpregnated with a saturating resin in the supplier's facility. Prepreg systems are bonded to

the concrete surface with or without an additional resin application, depending upon specific system requirements. Prepreg systems are saturated offsite and, like wet lay-up systems, are cured in place. Prepreg systems usually require heat for cure.

Precured FRP systems consist of composite shapes (plates, strips, ribbons, and bars configured as an open mesh grid or solid laminate) manufactured in the system supplier's facility and shipped to the job site. Typically, an adhesive is used to bond the precured shapes to the masonry surface.

A single system manufacturer should supply all materials and system components (reinforcements, resins and adhesives) for a specific job. The arbitrary selection of a fiber reinforcement and a resin/matrix material can lead to failure of the FRP composites system due to matrix-reinforcement incompatibilities and are, therefore, not allowed.

****

2.1 SYSTEM DESIGN AND PERFORMANCE

2.1.1 Design Requirements

****

NOTE: The resin system used in the FRP composite system seals up the surface of the wall where it is applied and can impede air and moisture migration through a wall. If the wall should not be sealed tight, full coverage of the wall with the FRP system should be avoided thus allowing normal air and water vapor transmission.

****

a. Design the FRP composite system in conformance with ACI 440.7R to provide [seismic] [wind] [and] [blast] strengthening for [clay] [and] [concrete] masonry walls.

b. Submit complete shop drawings for each installation of the composite system showing details of fiber architecture, fiber type, dimensions, number and thickness of layers, direction of fiber layers, sequence of layer applications, lap splices, joint and end details, anchorage of the FRP composite system, proposed connections to diaphragms and adjacent walls, and locations to be applied as specified.

c. Submit design calculations for the FRP composite system, prepared by or on behalf of the Contractor and stamped by a licensed professional engineer, for approval of the Contracting Officer. Develop an FRP layout that does not adversely affect moisture permeation through the masonry walls. Include a hygrothermal analysis of the wall system in its environment to assess the impact of reducing air and vapor transmission by the application of the proposed FRP system.

2.1.2 Performance Requirements

****

NOTE: Provide the parameters of strength or force

that must be provided by the FRP composite application. The following variables must be considered in determining the enhanced performance requirements: the load on the wall, the size of the wall, the wall aspect ratio, wall openings, etc.

****

Provide the FRP composite system with [seismic] [wind] [and] [blast] strengthening for [clay] [concrete] masonry walls to provide the flexure and shear demand indicated [on the Drawings][on the shop drawings]. Provide a system that transfers [seismic] [wind] [and] [blast] loading in concert with the existing masonry to the building foundation.

2.2 FRP SYSTEM

2.2.1 General Requirements

Ensure that all FRP system components are provided by a single manufacturer of FRP systems. Do not substitute the submitted reinforced FRP composite system or any of its components during the course of the project.

Assure that delivered FRP materials meet the specified requirements prior to starting the project. Submit certificates of compliance. Reject all materials that do not meet the minimum requirements, as specified in Table 1 and by the Contracting Officer. In addition, determine the setting time, pot life, and curing hardness of the resins.

2.2.2 FRP Composite System

****

NOTE: Select the appropriate system from the three choices below and delete the others.

****

[2.2.2.1 Wet Lay-up System

A wet lay-up FRP system consists of [glass] [carbon] [aramid] fiber in [an epoxy] [a polyester] [a polyurethane] resin.

][2.2.2.2 Prepreg System

A prepreg FRP system consists of [glass] [carbon] [aramid] fiber in an uncured polymer resin.

][2.2.2.3 Precured System

A precured FRP system consists of [glass] [carbon] [aramid] fiber, fabricated as [strips] [plates] [ribbons] [bars] in [an open mesh grid] [a solid laminate] configuration with a resin matrix of [vinyl ester] [polyester] [epoxy] [polyurethane] [specialty resin] applied to the surface of the masonry wall using [a polyurethane] [an epoxy] structural adhesive.

]2.2.3 FRP Composite System Properties

****

NOTE: The values listed in the following table should be provided by the design engineer and be based on the values and assumptions that were used in developing the design. The items in Table 1

below will be the minimum acceptable property values for the FRP system to be installed and potential FRP systems submitted which do not meet these minimums should be rejected.

****

2.2.3.1 Property Requirements

Table 1 lists the minimum allowable gross laminate properties for the cured [glass] [carbon] [aramid] [hybrid] reinforced FRP composite system.

Proposed FRP systems must utilize the same primary fiber reinforcement type (e.g., carbon fiber, aramid fiber, or E-glass fiber) as the specified system.

TABLE 1

	FRP COMPOSITE REQUIREMENT	TEST METHOD
Elongation: max.	[_____] percent	ASTM D3039/D3039M
Guaranteed Tensile Strength, min., in primary fiber direction	[_____] kPa psi	ASTM D3039/D3039M
Ult. Breaking Load, min., in primary fiber direction width	[_____] kg/mm lb/in	ASTM D3039/D3039M
Modulus of Elasticity, min. based on cross sectional area of primary fibers	[_____] kPa psi	ASTM D3039/D3039M
Percent Tensile Strength Retained after: 7 days exposure at 100 percent humidity	[_____] percent	ASTM G154
2,000 hours exposure to UV	[_____] percent	ASTM G154
3,000 hours exposure to ozone	[_____] percent	ASTM C581
3,000 hours exposure to alkali	[_____] percent	ASTM C581
3,000 hours exposure to salt water	[_____] percent	ASTM C581
3,000 hours exposure at 60 C 140 F	[_____] percent	ASTM D3045
Guaranteed Tensile Strength at 90 degrees to primary fibers, min.	[_____] kPa psi	ASTM D3039/D3039M

TABLE 1

	FRP COMPOSITE REQUIREMENT	TEST METHOD
Ultimate Tensile Strength of Lap Splices in Primary Fiber Direction	[______] kPa psi	ASTM D3039/D3039M
Ply Thickness	[______] mm inch	ASTM D3039/D3039M
Fiber Volume Fraction	[______] percent	ASTM D3171
Visual Defects	Acceptance Level [______]	ASTM D2563

2.2.3.2 FRP System Submittals

2.2.3.2.1 Product Data Sheets

Submit manufacturer's product data sheets indicating physical, mechanical, and chemical characteristics of materials used in the FRP system application and certification from the system manufacturer of the guaranteed material and section properties for the supplied material.

2.2.3.2.2 System Material Sample

The required system sample material submittal is an FRP plate 300 x 300 mm 12 x 12 inch or plate of equivalent area when one of the fiber reinforcing dimensions is less than 300 mm 12 inches.

2.2.3.2.3 System Properties

Submit documented evidence that the proposed system meets the requirements of Table 1. Determine elastic modulus by the strength and rupture strain values. Determine ultimate tensile strength and rupture strain values by subtracting three standard deviations from the average values of 20 or more tensile tests. Provide test report.

2.2.3.2.4 System Durability

System environmental durability test results conducted and reported by an independent testing facility. Include the following information in the report:

(1) FRP System nomenclature
(2) Testing facility name
(3) Testing facility address
(4) Testing facility telephone number
(5) Testing facility point of contact
(6) Freeze-thaw test results
(7) UV test results
(8) Fire resistance test results

2.2.3.2.5 System Performance

Test results by an independent testing facility on walls which are representative of the actual configuration and loading conditions for this contract, showing the following information:

(1) FRP System nomenclature
(2) Primer/filler system nomenclature
(3) Coating/finishing system nomenclature
(4) Testing facility name
(5) Testing facility address
(6) Testing facility telephone number
(7) Testing facility point of contact
(8) Test wall substrate material
(9) Test wall aspect ratio
(10) FRP fiber orientation and fiber density
(11) FRP composite application process
(12) Cyclic in-plane test results in accordance with ICC ES AC125 to include the following:

    (a) Description of test setup.
    (b) Rate and method of loading.
    (c) Deformation and strain measurements.
    (d) Modes of failure.

2.2.3.2.6 System Installation Instructions

Submit manufacturer's printed installation instructions, including the following:

(1) Brand name
(2) Catalog numbers
(3) Names of manufacturers for each material to be used. Include with instructions the estimated quantity of each material to be used on the job.
(4) Detailed mixing and application instructions to include:

    (a) Mixing instructions
    (b) Curing times between coats or layers
    (c) Application procedures for surface coatings
    (d) Cold weather installation to include the minimum application temperature recommended by the FRP system manufacturer or 4 degrees C 40 degrees F whichever is higher. Application at temperatures below 4 degrees C 40 degrees F must be approved by the Contracting Officer and the minimum Shore hardness for the lower temperatures will be provided.
    (e) Hot weather installation to include the maximum application temperature recommended by the FRP system manufacturer or 38 degrees C 100 degrees F whichever is lower. Application at temperatures above 38 degrees C 100 degrees F must be approved by the Contracting Officer and the minimum Shore hardness for the higher temperatures will be provided.
    (f) Inclement weather installations
    (g) Application procedures of top coating material

2.3 COMPONENTS

2.3.1 Primer/Filler

Provide a primer/filler, for the protective seal coat and for filling voids, that consists of a thickened [epoxy] [polyester].

2.3.2 Finish and Coating

Perform final finish and apply architectural coatings as prescribed in architectural specifications and drawings [_____].

a. Finish coat compatibility letter from FRP manufacturer: Submit letter from FRP system manufacturer stating that the finish coating is compatible with the FRP System.

b. Finish coat compatibility letter from finish coat manufacturer: Submit letter from finish coat manufacturer stating that the finish coating is compatible with the FRP System.

[2.3.2.1 Flame Spread/Fire Protection

****

NOTE: Include the following paragraph unless the FRP materials are installed on the exterior of a structure, or if a flame barrier is installed between living space and the FRP materials system, or unless stated otherwise by the local fire building code.

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Meet requirements for Class 1 fire rating in accordance with ASTM E84 and meet or exceed local building code requirements for flame spread and smoke generation.

]2.4 MIXES

Mix [Resins] [Adhesive] in accordance with the FRP system manufacturer's recommended procedure. Assure that [resin] [adhesive] components are at a proper temperature and are mixed in the correct ratio until there is a complete mixing of components and a uniform color. Mix each batch of [resin] [adhesive] in quantities sufficiently small to ensure that the mixed [resin] [adhesive] can be used within the [resin] [adhesive] pot life. Do not use mixed [resin] [adhesive] that exceeds its pot life, as defined by the system manufacturer.

2.5 ACCESSORIES

Provide anchors for the FRP system as prescribed by the FRP system manufacturer and designated in the Shop Drawings. Submit two of each type of anchor to be used.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Verification

Examine existing conditions to assess the quality of the masonry substrate, identify potential obstructions, and verify dimensions/geometries shown on shop drawings.

3.1.2 Surface Moisture

Ensure that all surfaces to receive the strengthening system are as dry as recommended by the FRP system manufacturer. Evaluate moisture content in accordance with the requirements of ACI 503.1-503.4 standard specification applicable to the application.

3.2 PREPARATION

3.2.1 Protection

Protect building occupants, other Contractor personnel, and visitors from exposure to FRP system dust and mists from preparation, FRP system application and clean-up operations.

3.2.2 Worksite Ventilation

Ventilate work areas during FRP application so that worker exposure to chemical substances does not exceed limits established by ACGIH 0116, or required by a more stringent applicable local regulation. Ventilate interior work zones having a volume of 280 cubic m 10,000 cubic ft or less at a minimum of 2 air exchanges per hour. Maintain ventilation in larger work zones by means of mechanical exhaust. Exhaust solvent vapors outdoors, away from air intakes and workers. Temporarily seal return air inlets in the work zone before start of work until the polymer resin has cured.

3.2.3 Substrate Repair

3.2.3.1 Surface Conditions

****

NOTE: If the masonry surface to be treated has been inspected and found to not need repair, select the first bracketed option. If the masonry surface to be treated has been inspected and found to have distress that requires repair, but the repairs have not be identified, select the second bracketed option. Select the third and fourth bracketed options only when these repair approaches have been determined to be appropriate and applicable to the masonry surface to be treated.

****

[The area to receive FRP composite is relatively sound structurally.] [There are known problems associated with the condition of the original masonry and the masonry substrate that can compromise the integrity of the FRP system.] [Fill surface cracks greater than 1.6 mm 1/16-inch to a minimum depth of 25 mm 1 inch.] [Remove areas of loose or spalling masonry material.]

3.2.3.2 Sub-Surface Conditions

Do not apply externally bonded FRP systems to areas of substandard masonry exhibiting lack of structural integrity (such as signs of corroded embedded steel elements, excessive cracking and spalling, excessive deflections, etc.). Stop work in these areas, notify the Contracting Officer, and indicate the locations and type of masonry distress. Do not proceed with work until directed to do so by the Contracting Officer.

3.2.4 Surface Preparation

3.2.4.1 Surface Cleaning

Remove loose and unsound materials and other conditions that would inhibit bond, such as laitance, dust, dirt, oil, curing compound, existing paint or coatings, efflorescence, and other matter that could interfere with the bond of the FRP system to the masonry or repaired surfaces to which the FRP system is to be applied.

3.2.4.2 New Masonry Preparation

Unspoiled new masonry only requires wire brushing to remove loose surface particles.

3.2.4.3 Old Clay Masonry Preparation

Prepare surface of older clay masonry using hand tools, power tools or water blasting techniques. Do not use abrasive blasting.

3.2.4.4 Old Concrete Masonry Preparation

Concrete masonry may be blasted using a light blast abrasive or cleaned using hand tools, power tools or water blasting techniques.

3.2.4.5 Cleaned Surface Protection

After the cleaning operations are complete, protect the surface prior to FRP installation so that no materials that may interfere with bond are redeposited on the surface. Apply the FRP composite system to the prepared wall within 72 hours of performing the surface preparation.

3.2.5 Mortar Joint Preparation

3.2.5.1 Tooled Mortar Joints

Fill tooled mortar joints with putty or another epoxy-based paste to make mortar joints flush with the masonry units. Ensure that localized out-of-plane variations between masonry units do not exceed 1.6 mm 1/16-inch or the tolerances recommended by the FRP system manufacturer, whichever is smaller. Smooth localized out-of-plane variations in the masonry units using putty as needed. It is not necessary to screed filler onto the surface to fill all bug holes. Fill larger holes greater than 6 mm 1/4 inch in diameter and other voids with putty.

3.2.5.2 Untooled Mortar Joints

Grind or chisel untooled mortar joints that protrude beyond the masonry surface or other protuberances or irregularities flush with the surface.

3.2.5.3 Putty/Filler

Ensure putty/filler used is compatible with the masonry and the FRP strengthening system and complies with the FRP system manufacturer's specifications. Use putty or another epoxy-based paste with adequate bonding properties to masonry only to fill voids and smooth surface discontinuities prior to application of other materials. Allow putty to cure to the degree specified by the FRP manufacturer before applying subsequent materials. Grind rough edges or trowel lines of cured putty smooth prior to continuing the installation.

3.2.6 Obstructions, Corners and Non-Planar Surfaces

Obstructions, re-entrant corners, concave surfaces and embedded objects can affect the performance of the FRP system. Modify surfaces scheduled to receive RFP system until localized out-of-plane variations between masonry units do not exceed 1.6 mm 1/16-inch or the tolerance recommended by the FRP system manufacturer, whichever is smaller. Movable obstructions and embedded objects may need to be removed prior to installing the FRP system. [Give special care to re-entrant corner detailing and concave surface detailing to ensure that the bond of the FRP system to the substrate is maintained.]

3.3 FRP INSTALLATION

3.3.1 General

Do not install the FRP composite if environmental conditions are outside the permitted range defined by the FRP system manufacturer.

[3.3.2 Primer

****

NOTE: Wet lay-up systems typically require a primer to saturate and penetrate the masonry surface and enhance the bond strength of the FRP system. Adhesives used with pre-cured systems, depending upon its chemistry, may not require use of a primer.

Include this paragraph unless the project utilizes a pre-cured system that does not require a primer.

****

a. Mix primers according to the FRP system manufacturer's installation instructions. Assure resin components are at a proper temperature and mixed in the Manufacturer's prescribed mix ratio for its prescribed mixing time until there is a uniform and complete mixing of components.

b. Apply primers to areas on the masonry surface where the FRP system is to be placed. Place primer uniformly on the prepared surface at the manufacturer's specified rate of coverage. Allow primer to cure to the degree specified by the FRP manufacturer before applying subsequent materials.

]3.3.3 System Installation

3.3.3.1 Wet Lay-Up and Prepreg Systems

Install the FRP system in strict accordance with the FRP system manufacturer's recommendations. Apply sufficient saturating resin to achieve full saturation of the fibers in accordance with the manufacturer's specifications. Release or roll out entrapped air between layers before the resin sets. Place successive layers of saturating resin and fiber materials before complete cure of the previous layer of resin. Handle sheet and fabric materials in a manner to maintain the fiber straightness and orientation. Remove and repair fabric kinks, folds, or other forms of severe waviness.

Precured Systems

Install the FRP system in strict accordance with the FRP system manufacturer's recommendations. Uniformly apply adhesives to the prepared surfaces where pre-cured systems are to be placed. Apply adhesives at a rate recommended by the FRP manufacturer to ensure full bonding of successive layers. Release or roll out entrapped air between layers before the adhesive sets.

3.3.4 Splices

Locate splices in accordance with the approved Shop Drawings. [Stagger lap splices unless noted otherwise in the Shop Drawings and by the Contracting Officer.] [Lap splices are not permitted except as shown in the Shop Drawings.]

3.3.5 Curing of Resins

Inspect the primer and FRP resin to ensure proper cure according to the manufacturer's recommendation. Do not modify resin chemistry in the field.

[3.3.6 Surface Finish - Coating Application

****

NOTE: Determine what finishes are required for appearance, fire protection, UV protection, etc. If coatings will be used, keep the following two paragraphs.

****

3.3.6.1 Preparation

Apply paints and coatings prior to final resin cure for best results. After the FRP resin has cured, the coating can be applied by performing a light dust blast of 30-mesh silica sand (or equivalent method) to break the gloss finish in preparation of a finish coating. Remove dust and residue from all surfaces by flushing with clean water before applying the coating. Ensure all surfaces are dry before applying the surface finish coating.

3.3.6.2 Multiple Coats

Use coatings compatible with the FRP strengthening system and applied in accordance with the manufacturer's recommendations. Apply two finish layers of coating according to the coating manufacturer's instructions prior to full cure of the FRP system.

]3.3.7 Installation Procedure Modification

Installation procedures may be modified to achieve maximum results, subject to approval by the Contracting Officer prior to implementation.

3.3.8 Interface with Wall Features

3.3.8.1 Weeps

Maintain all weeps. Do not cover existing weeps with the FRP composite and prevent resin from entering weeps.

3.3.8.2 Movement Joints

[3.3.8.2.1 Control Joints

Maintain all concrete masonry control joints. Ensure that the FRP composite does not bridge existing control joints.

][3.3.8.2.2 Expansion Joints

Evaluate design loads to determine whether or not to maintain existing clay masonry expansion joints.

][3.3.8.3 Diaphragms

Anchor the FRP system into the floor, ceiling and roof diaphragms in accordance with the Shop Drawings. Ensure anchorage does not create local stresses that may locally fracture the walls when deflection occurs due to out-of-plane loading.

]3.4 FIELD QUALITY CONTROL

Comply with the approved Quality Control Plan.

3.4.1 Laboratory Testing During Construction

3.4.1.1 Witness Panels

3.4.1.1.1 Wet Lay-up and Prepreg

Fabricate witness panels onsite using installation procedures identical to the method used to install the FRP system to the masonry surfaces. Fabricate two witness panels for each day of production or one for each 46 square m 500 square feet of production whichever is more. From a standard polymer resin mix, saturate a 300 x 300 mm 12 x 12 inch piece of fabric according to specified fiber-resin ratio. On a smooth, flat, level surface covered with polyethylene sheeting or 0.4 mm 16-mil plastic film, prime the surface with polymer resin and then prepare the witness panel by placing two layers of saturated fabric oriented in the same direction on the flat surface. Apply an additional topping of polymer resin and cover the completed sample with plastic film and squeegee out all bubbles. Store samples in a sample box at the work site and do not move them for a minimum 48 hours after casting. Mark the panels with the date of fabrication, location of application, number of plies and primary fiber direction. Ship the samples within two weeks of fabrication to the pre-approved testing laboratory for evaluation.

3.4.1.1.2 Precured

Witness panel samples for precured sheet and strip material are the width of the procured sheet and a length sufficient to achieve 92,900 square mm 144 square inches in total area taken randomly from the material received at the job site.

3.4.1.2 Witness Panel Testing

Determine lap splice strength, tension strength, and elastic modulus of FRP materials. Test not fewer than two (2) coupons from each witness panel in the laboratory in accordance with ASTM D3039/D3039M. If one coupon from a witness panel fails to meet the minimum strength specified in Table 1, test five additional coupons from the witness panel with the failed coupon. If a second one fails, test five coupons from all panels for that day of production. Take appropriate remedial measures to ensure integrity of the FRP system applied for the day the failed witness panels were prepared. In addition, test a minimum of five coupons from each witness panel for the remainder of the job or until ten successive witness panels are tested with no coupon failures. Then two coupon tests per witness panel may be resumed. The Contracting Officer may waive or alter the frequency of testing.

3.4.1.3 Witness Panel Test Report

Prepare a laboratory report to document the mechanical properties of the witness panels, in accordance with ASTM D3039/D3039M. Submit a copy of the report to the Contracting Officer and Special Inspector for review.

3.4.2 Field Testing

3.4.2.1 Mixed Resin Hardness

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NOTE: The term "resins" include primers, saturating resins, binders, and adhesive components.

The required resin samples are a minimum of 6 mm 1/4-inch in thickness, whereas FRP placed on a wall is much thinner, typically 3 mm 1/8-inch or less. During initial stages of curing, thicker cross sections tend to be softer than thin ones. There is, therefore a variation in the required hardness to account for this phenomenon.

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3.4.2.1.1 Mixed Resin Hardness Sample Preparation

Prepare two samples of each mixed resin, primers, binders, saturants, and adhesives, per day from two, separate, nonconsecutive batches of each. The required resin sample size is a minimum of 6 mm 1/4-inch thick and 50 mm 2 inches in diameter. Retain the mixed resin samples for testing to evaluate curing progress.

3.4.2.1.2 Mixed Resin Hardness Testing

Evaluate relative curing progress of the resin on the job site by measuring the hardness of the resin sample at 24 hours and 48 hours of cure in accordance with provisions of ASTM D2240. Ensure the polymer resin exceeds the Shore hardness reported by the manufacturer evaluated at the lowest air temperature for the curing time period. Take measurements at a minimum of three different points distributed over the resin specimen's surface at least 6 mm 1/4-inch apart from each other.

3.4.2.1.3 Mixed Resin Hardness Test Report

Report the mean hardness value obtained, resin identification and manufacturer, resin batch number, resin mixing date and time, test date and time, air temperature when the resin was mixed, air temperature when the testing was performed, the minimum air temperature for the curing period, and the type and serial number of durometer used. Submit test reports as specified.

3.4.2.1.4 Resolution of Noncompliance

In the event that measured hardness is less than the manufacturer's reported hardness for the temperature range, comply with paragraph REMEDIAL MEASURES under paragraph IN-PLACE FRP HARDNESS.

3.4.2.2 In-Place FRP Hardness

3.4.2.2.1 In-Place FRP Hardness Testing

Evaluate relative curing progress of the in-place FRP resin at 24 hours and at 48 hours using the Shore Hardness test in ten-degree intervals between 4 and 38 degrees C 40 and 100 degrees F for both neat resin and for FRP laminate on masonry substrate, as described in ASTM D2240. Perform a minimum of five tests on each 9 square m 100 square ft of wall or portion thereof with FRP composite applied to it. Ensure the Shore Hardness exceeds the manufacturer's values for the time period measured and the lowest air temperature during that time period. Submit minimum Shore Hardness values for fully cured resin and fully cured FRP laminate on masonry substrate.

3.4.2.2.2 In-Place FRP Hardness Test Report

Report both the individual and mean hardness values obtained, the locations where each hardness test was performed, the FRP application date, test date and time, air temperature when the FRP was applied, air temperature when testing performed, and the type and serial number of durometer used.

3.4.2.2.3 Remedial Measures

In the event that hardness is less than the manufacturer's reported hardness for the temperature range, take remedial measures as follows. Where testing indicates that the installed composite system does not meet the minimum specified hardness values, immediately halt the FRP installation and notify the Contracting Officer. Remove the affected, installed FRP composite at no expense to the Government and replace with FRP composite meeting or exceeding the minimum hardness values.

3.4.2.3 Adhesion Strength

3.4.2.3.1 Adhesion Testing

a. Using the method described by ACI 440.3R or ASTM D4541 conduct direct tension adhesion testing of cored samples. Perform a minimum of three tests for each day of production or for each 46 square m 500 square ft of FRP application, whichever is less. Perform pull-off tests on each area of fiber sheet installed on a single day. Perform tests on each type of masonry substrate or for each surface preparation technique used.

b. Allow the FRP system to cure a minimum of 24 hours before execution of the direct tension pull-off test. Select locations for the pull-off tests that are representative and on flat surfaces. If possible, conduct the tests on areas of the FRP system subjected to relatively low stress during service. The minimum acceptable value for any single tension test is 1.2 MPa 175 psi. The minimum acceptable average adhesion strength of the three tests at each location is 1.38 MPa 200 psi. Acceptable tension adhesion tests exhibit failure of the masonry substrate, indicated by a layer of masonry, on at least 80 percent of the underside of the test puck following the test.

3.4.2.3.2 Adhesion Strength Test Report

Report the adhesive strength values for each test and the average strength for each day's production. Report the type of failure for each. Report percentage of masonry on the FRP surface adhered to the test puck to the Contracting Officer.

3.4.2.3.3 Resolution of Noncompliances

In the event that the adhesive strength does not meet the minimum allowable strength, take remedial measures. Halt FRP installation and notify the Contracting Officer. Remove affected, installed FRP composite. Clean the substrate surface and apply FRP composite that meets or exceeds the minimum specified values.

3.4.2.3.4 Repair After Adhesion Test

After testing, fill the hole in the FRP composite with putty and smooth it. Apply a 100 mm 4-inch or more overlapping sheet patch of equivalent plies over the location where the sample was taken.

3.4.3 INSPECTION

Provide full inspection of the surface preparation and composite system application to ensure full compliance with the specified requirements.

3.4.3.1 Special Inspector

****

NOTE: Modify Section 01 45 35 SPECIAL INSPECTIONS to include the inspection requirements of ICC ES AC178. Include in Section 01 45 35 the extent of observation of field testing to be performed by the Special Inspector.

Ensure that the following information is included in Section 01 45 35 SPECIAL INSPECTIONS:

Inspect the FRP composite overlay during and immediately following application of the composite. Inspect FRP systems and all associated work as required by the applicable codes and as described in the QC plan. Observe all aspects of onsite preparation and material application including surface preparation, resin component mixing, application of primer, application of resin and fiber sheet, curing of composite, and the application of protective coatings. Require compliance with the design drawings and specifications.

Include in daily inspection records:

a. Date and time of installation;
b. Ambient temperature, relative humidity, and general weather observations;

c. Surface temperature of the masonry receiving the FRP composite system;
d. Surface dryness;
e. Surface preparation methods;
f. Surface cleanliness;
g. Type of auxiliary heat source, if applicable;
h. Fiber or pre-cured laminate batch number(s) and location in structure;
i. Batch numbers, mix ratios, mixing times, and mixed color of all resins, including primers, putties, saturants, adhesives, and coatings mixed for the day;
j. Observations of progress of cure of resins;
k. Conformance with installation procedures;
l. Pull-off test results: bond strength, failure mode, and location;
m. FRP system properties from witness panel tests, if required;
n. Location and size of any delaminations or air voids;
o. General progress of work.

****

Provide a Special Inspector, trained and certified by the FRP system manufacturer and approved by the Contracting Officer, to perform inspections in accordance with Section 01 45 35 SPECIAL INSPECTIONS and ICC ES AC178. Provide a Special Inspector who is not an employee of the Contractor or is financially associated with the Contractor beyond the inspection contract.

3.4.3.2 Void Detection

After allowing at least 24 hours for initial resin cure to occur, perform a visual and acoustic tap test inspection of the layered surface. Other methods for detecting voids may be employed provided that all parties concerned agree upon these methods prior to the submission of bids or proposals. Together with the Special Inspector, mark voids requiring corrective action in accordance with the specified FRP maintenance and repair procedure. Acoustic Guided Wave (AGW) inspection technology has been shown to be an objective method for detecting voids.

3.4.3.3 Delaminations

Together with the Special Inspector, evaluate the cured FRP system for delaminations and air voids between multiple plies or between the FRP system and the masonry. Use inspection methods capable of detecting delaminations of 1300 square mm 2 square inches or greater. Submit identification of delaminations and other anomalies for evaluation. Acoustic Guided Wave (AGW) inspection technology has been shown to be an objective method for detecting delaminations.

3.4.3.3.1 Wet Lay-Up and Prepreg Systems

****

NOTE: Determine and correct the cause of delamination prior to application of the patch.

****

a. Small delaminations and air voids less than 1300 square mm 2 square inches each are permissible, so long as the delaminated area is less than 5 percent of the total laminate area and there are no more than 10 such delaminations or air voids per 0.93 square m 10 square ft.

b. Delaminations and air voids less than 16,000 square mm 25 square inches may be repaired by resin injection or ply replacement, depending upon the size and number of delaminations and their locations. With the Contractor's Engineer of Record, determine the cause of the delamination and an appropriate repair. Obtain the Contracting Officer's approval of the repair method.

c. For large delaminations and air voids, greater thanDelaminations or air voids less than 16,000 square mm 25 square inches, determine the cause of the defect and design an appropriate repair using the Contractor's Engineer of Record. Obtain the Contracting Officer's approval of the repair method.

3.4.3.3.2 Pre-Cured Systems

For pre-cured FRP systems, evaluate each delamination and air void and, with the Contractor's Engineer of Record, design an appropriate repair. Obtain the Contracting Officer's approval of the repair method.

3.4.3.4 Fiber Orientation

Together with the Special Inspector, evaluate fiber or pre-cured laminate orientation by visual inspection during application. Evaluate for fiber waviness, a localized appearance of fibers that deviate from the general straight-fiber line in the form of kinks or waves. Report fiber or pre-cured laminate misalignment of more than 5 degrees from that specified on the design drawings (approximately 80 mm/m 1 in/ft) to the Contracting Officer.

3.4.3.5 Record Retention

Retain the records of inspection and witness panels throughout the warranty period. Retain samples of mixed resin and maintain a record of the placement of each batch. Upon completion of repairs, re-inspect the laminate to verify that the repair was properly accomplished. Evaluate the FRP systems and accept/reject based on conformance or nonconformance with the design drawings and specifications. Include FRP system material properties, as-built fiber orientation, presence of delaminations, cure of resins, and adhesion to substrate in the evaluation. Submit these records upon completion of the project.

3.5 ADJUSTING AND CLEANING

3.5.1 Identification and Repair of Defects

3.5.1.1 Repair Methods for Application Defects

Repair defects spanning more than 5 percent of the surface area according to the FRP maintenance and repair procedure that is prepared by the system manufacturer and submitted for approval. There are two types of repairs; resin injection and removal followed by reapplication of the FRP system.

3.5.1.2 Tears in the Reinforcing Fibers

Repair tears in the reinforcing fibers that cross fiber rows greater than

50 mm 2 inches in length by adding additional plies of FRP material.

3.5.1.3 Adhesion Defects

Review and get approval of anchor details for correcting deficient adhesion from the Contracting Officer prior to installation. Should the Contracting Officer determine that anchors are inappropriate, remove the FRP composite and replace with new composite meeting the minimum adhesion requirements.

3.5.2 Work Area Clean Up

Upon completion of the work, remove staging, scaffolding, and containers from the work site or destroy them in an approved manner. Remove FRP composite, resin, and other deposits on adjacent surfaces and leave the entire job cleaned to equal or better condition to that prior to the start of the job. Place cloths, cotton waste and other debris, which might constitute a fire hazard, in closed metal containers removed at the end of each day. Dispose of resins and adhesives properly as indicated on the SDS sheets. Store and transport resins and adhesives as indicated in SDS directions. Contain and dispose of spent abrasive blast media properly as required by local authorities. Contain material to be discarded at the site until properly disposed of.

3.6 MAINTENANCE PROCEDURES

Submit procedures to properly maintain the installed FRP system and written manufacturer recommended repair procedures for damage to the in-place FRP system.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-04 03 00 (November 2017)**

Preparing Activity: USACE **Superseding**
UFGS-04 01 20.70 (November 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 04 - MASONRY

SECTION 04 03 00

CONSERVATION TREATMENT FOR PERIOD MASONRY

11/17

PART 1 GENERAL

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USACE / NAVFAC / AFCEC **UFGS-04 03 00 (November 2017)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 04 03 00

CONSERVATION TREATMENT FOR PERIOD MASONRY
11/17

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NOTE: This guide specification covers the requirements for restoration and cleaning of masonry in historic structures.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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PART 1 GENERAL

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NOTE: Where the words "as indicated" are used, ensure that sizes, positions and other designated information are indicated on the design drawings.

The following publications, from the United States Department of the Interior - National Park Service, provide useful guidance in the restoration of historic masonry and may be included as addenda to the specifications.

The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings (1995).

Preservation Brief #1 - (2000) Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings

Preservation Brief #2 - (1998) Repointing Mortar Joints in Historic Brick Buildings

Preservation Brief #6 - (1979) Dangers of Abrasive Cleaning to Historic Buildings

Preservation Brief #7 - (1979) The Preservation of Historic Glazed Architectural Terra-Cotta

Preservation Brief #22 - (1990) The Preservation and Repair of Historic Stucco

Preservation Brief #38 - (1995) Removing Graffiti from Historic Masonry

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100	(2017; Suppl 2020) Documentation of the Threshold Limit Values and Biological Exposure Indices

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

ASTM C34	(2023) Standard Specification for Structural Clay Loadbearing Wall Tile
ASTM C67/C67M	(2024) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C170/C170M	(2024a) Standard Test Method for Compressive Strength of Dimension Stone
ASTM C207	(2024) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C216	(2024) Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C926	(2024) Standard Specification for Application of Portland Cement-Based Plaster
ASTM C1196	(2014) Standard Test Method for In Situ Compressive Stress Within Solid Unit Masonry Esitmated Using Flatjack Measurements
ASTM C1197	(2014) Standard Test Method for In Situ Measurement of Masonry Deformability Properties Using the Flatjack Method
ASTM C1324	(2020) Standard Test Method for Examination and Analysis of Hardened Masonry Mortar
ASTM C1364	(2023; E 2024) Standard Specification for Architectural Cast Stone
ASTM C1489	(2015; R 2022) Standard Specification for Lime Putty for Structural Purposes
ASTM C1531	(2015) Standard Test Methods for In Situ Measurement of Masonry Mortar Joint Shear Strength Index
ASTM C1601	(2014) Standard Test Method for Field Measurement of Water Penetration of Masonry Wall Surfaces
ASTM C1713	(2012) Standard Specification for Mortars for the Repair of Historic Masonry
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E2260	(2012) Standard Guide for Repointing (Tuckpointing) Historic Masonry
ASTM E2659	(2018; R 2024) Standard Practice for Certificate Programs

NATIONAL PARK SERVICE (NPS)

NPS Hist Prop	(2017) National Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings
NPS TPS Brief 1	(2000) Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings
NPS TPS Brief 2	(1998) Repointing Mortar Joints in Historic Masonry Buildings

THE MASONRY SOCIETY (TMS)

TMS MSJC	(2016) Masonry Standard Joint Committee's (MSJC) Book - Building Code Requirements and Specification for Masonry Structures, Containing TMS 402/ACI 530/ASCE 5, TMS 602/ACI 530.1/ASCE 6, and Companion Commentaries

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

GSA HPTP 07656-01	Installing Lead Stone Flashing to Protect Masonry Joints

1.2 DEFINITIONS

Terms are defined below as applicable to this project.

1.2.1 Aggregates

The sand component of mortar.

1.2.2 Biocides

A chemical treatment that inhibits, deters, or controls organic growth. Such growth is typically removed by cleaning following biocide treatment..

1.2.3 Binder

The component of mortar that binds together the aggregate particles into a cohesive material.

1.2.4 Dispersed Lime Crack Injection

A repair method in which dispersed lime material is injected into small cracks ranging in width from hairline to 3.2 mm 1/8 in by use of needle or syringe.

1.2.5 Consolidant

A chemical product meant to strengthen loose or deteriorated stone.

1.2.6 Dutchman

A repair method in which deteriorated stone is removed in part and replaced with salvaged, harvested or new stone to make a seamless patch.

1.2.7 Harvested

Units removed from inconspicuous areas of the building.

1.2.8 In situ

A term referencing a repair procedure in which the masonry units and mortar remain in place and are repaired without removal from the wall system

1.2.9 Joint Sealant

A flexible, chemical product that is used to create a weather-tight seal at the boundary of masonry units with other units or dissimilar materials.

1.2.10 Lead Flashing

An extruded lead material that is inserted into joints to assist in precluding water entry into the masonry.

1.2.11 Lime Wash

A protective surface treatment comprised of calcium hydroxide particles in suspension in water, along with small amounts of calcium carbonate, silica particles and other minerals.

1.2.12 Mockup

Specific area on the building approved by Contracting Officer to demonstrate the ability to apply, match and install specified materials.

1.2.13 Mortar

A mixture of binders, aggregates, and pigments used for reconstruction, repointing or stucco applications.

1.2.14 New Elements

New, non-historic materials added to masonry structures to aid in their ability to resist loads (typically seismic) or to resist water infiltration.

1.2.15 Patch

The use of substitute repair materials to treat damaged or deteriorated masonry units in situ.

1.2.16 Remediate

An intervention of a historic masonry structure and its component materials with the intent to maintain the original fabric to the greatest extent possible.

1.2.17 Remove

Specifically for historic masonry materials, the term means to detach an item from existing construction to the limits indicated.

1.2.18 Replace

To reinstall an item in its original position (or where indicated) after remedial treatment, or to duplicate and reinstall an entire item with new material; with the original item serving as the pattern for creating the duplicate.

1.2.19 Repoint

To remove existing mortar joints to the specified depth and replace with a mortar that matches in color, texture, and performance with water vapor transmission, bond, hardness, and flexibility compatible with original mortar, as assessed in accordance with ASTM C1713.

1.2.20 Retool

A repair method in which a chisel is used to re-create the surrounding stone texture finish by removing loose pieces of stone.

1.2.21 Stucco

A mixture of binders and aggregates, sometimes including animal hair or fibers used for the repair treatment of existing stucco.

1.2.22 Surface Treatment

The application of traditional materials or contemporary chemical products to the surface of masonry to provide protection to the masonry units and mortar and/or reduce water infiltration.

1.2.23 Test Panel

Specific area on the building approved by the Contracting Officer to demonstrate individual applicator competency and workmanship proficiency prior to the start of restoration work.

1.2.24 Tuckpointing

Often called skim-coating, an American practice of surface repairing mortar joints without the required removal of existing deteriorated mortar beneath. This practice is not recommended for mortar joint repair work on historic masonry. There is also an acceptable British form of tuckpointing practice that involves careful thin penciling of smaller joints within larger ones to give the wall the appearance of an ashlar finish.

1.2.25 Water Repellent

A surface-applied chemcial intended to reduce liquid water entry into a masonry wall without significantly affecting the vapro transmission properties of the original material.

1.2.26 Wall System

A term used to address the fact that masonry structures are comprised of different materials but function holistically, requiring that all restoration and cleaning process take into account the implications of the treatment to the adjacent materials and the building as a whole.

1.2.27 Masonry Treatment Requirement (MTR)

Defined treatments that are required by the specification (contract) documents for project specific repairs to masonry.

1.2.28 Saturated Surface Dry (SSD)

Condition of the wall surface after water has been applied sufficient to saturate more than the surface, then allowed to dry until the surface is dry but the body of the masonry still has moisture.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meeting

Prior to beginning the work of this Section, convene a meeting with the Contracting Officer's Representative(s) to review the requirements of the Quality Control Plan, Project Training Program, installation procedures, location of required mockup areas, and all job conditions and processes. All subcontracting firms involved with this work must participate in this meeting.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G, [_____]

Project Training Program; G, [_____]

Qualifications; G, [_____]

SD-02 Shop Drawings; G, [_____]

Photographic Documentation

Structural Upgrades; G, [_____]

SD-03 Product Data

Qualifications

Cleaning and Restoration Methods; G, [_____]

Cleaning Materials; G, [_____]

Biocides

Replacement Mortar And Stucco; G, [_____]

Mortar Mix; G, [_____]

Water Repellents Infiltration; G, [_____]

Stone Consolidants; G, [_____]

SD-04 Samples

Mock-ups; G, [_____]

SD-05 Design Data

Calculations for Structural Upgrades; G, [_____]

SD-06 Test Reports

Testing and Matching

Existing Sealants for Asbestos and PCBs

SD-07 Certificates

Repair Materials

1.5 QUALITY CONTROL

1.5.1 Quality Control Plan

[Prior to beginning restoration and cleaning work, submit a written Quality Control Plan.][Include a separate section in the overall project Quality Control Plan specifically addressing this restoration and cleaning work.] Do not proceed without written approval of the Quality Control Plan. At a minimum, include the following items in the Quality Control Plan:

a. Describe methods of dust containment during the work specific to the work of this section.

b. Describe the methods of protecting surrounding masonry, windows, doors, roof, and building trim as well as surrounding landscape. Provide drawings of protection when requested.

c. Describe the work procedures, materials, and proposed tools to use for each Masonry Treatment Requirement (MTR) specified.

d. Describe the sequence of each MTR.

e. Describe how each MTR sequence and the overall construction schedule changes with weather variations and how completed work will be protected.

f. Describe the methods for surveying original layout and collecting datum points and plumb lines for rebuilding masonry.

g. Describe the methods for shoring and providing a safe working environment.

h. Describe the methods for select deconstruction of individual masonry units and tools/methods for cleaning the masonry for reuse.

i. Describe the method and approach to mortar joint removal.

j. Describe the method and approach for assuring repair material compatibility with original materials.

k. Describe the method and approach to cleaning mortar, coating, smears and old patching materials from the masonry surfaces.

l. Describe, in detail, the procedures relating to techniques and tools proposed for masonry matching.

m. Describe the complete masonry removal and matching procedures; include equipment, approach, length of time the masonry will be out of the wall, documentation on mapping the location, and where (on-site or in shop) the masonry units will be repaired.

n. Describe the procedure for matching of different colors at different locations.

o. Describe the procedure for mixing and matching of repair materials.

p. Describe the methods and system by which the use of reclaimed masonry units can be utilized.

q. Describe the methods for setting masonry back into its original position and maintaining the original bond patterns and joint width.

r. Describe the methods of transition points where replacement/preservation work will meet the original historic work.

s. Describe the on-site project training program. Provide the opportunity for workers to be trained in each masonry treatment requirement (MTR) as work proceeds.

1.5.2 Qualifications

1.5.2.1 Historic Masonry Consultant

a. Secure the services of a historic masonry consultant with a minimum of 10 years experience applying NPS Hist Prop as they relate to the work in this section.

b. Submit a resume that describes five relevant projects within that period and include how NPS Hist Prop was applied to the work of similar scope and scale and what jurisdiction or agency was involved in approving the work..

c. The consultant's services include:

(1) Investigating the condition of the masonry materials and mortar.

(2) Arranging for material analysis in the laboratory

(3) Recommending appropriate cleaning methods and materials

(4) Recommending restoration options.

(5) Providing project specific specifications.

(6) Providing an on-site training program.

(7) Providing quality control services during construction.

(8) Recommending appropriate repair and restoration materials.

1.5.2.2 Masonry Firm

a. The firm performing the masonry work must have a minimum of five years experience on relevant projects.

b. The firm must have completed work similar in material, design, and extent to that indicated for this Project and demonstrate a record of successful in-service performance.

c. Proven implementation of NPS Hist Prop and related Preservation Briefs are required.

d. Submit a resume that describes the required experience.

1.5.2.3 Field Supervisor

Retain an experienced full-time supervisor on the project site at all times when masonry restoration is in progress. A single individual must be responsible for supervising the historic masonry restoration work throughout the duration of the project.

Submit a resume that describes the required experience.

1.5.2.4 Masonry Applicator

a. Employ craftspeople who are experienced with and specialize in restoration work of the types they will be performing.

b. All masonry restoration treatments must be performed by a craftsperson that is familiar with historic masonry construction and has worked on historic masonry projects for at least five years.

c. Only skilled technicians who are familiar and experienced with the materials and methods specified may be used.

d. Submit resumes for all historic masonry applicators, demonstrating the required experience.

1.5.3 Project Training Definition and Use

In addition to five years demonstrable experience on masonry restoration projects, offer workers project training certificate(s) within the framework of ASTM E2659. Project training certificates are earned by individual workers and issued with the understanding that they are for limited time use, enforceable only to this specific project and for a specific MTR. It is not necessary, nor a requirement of this specification, that all restoration workers obtain all project training certificates offered. Rather it is desirable that workers be trained for each project specific task they will perform to ensure the highest quality results from the cleaning and restoration program.

1.5.4 Mortar Analyst

Laboratory mortar analysis equipment should be operated by and results analyzed by trained personnel experienced with analysis of historic masonry mortar.

1.5.5 Documentation

Submit digital photographic documentation of the all phases of masonry restoration, including prior to the start of restoration work.

Provide thorough photo documentation of the project and project details and targeted areas.

1.5.6 Cleaning and Restoration Methods

1.5.6.1 General Procedure

a. Submit the cleaning and restoration methods, and materials selected for a specific structure for approval before work starts.

b. Take into account the total construction system of the building to be worked upon, including different masonry and mortar materials, as well as non-masonry elements which may be affected by the work.

c. Utilize mockups to identify the appropriate cleaning and restoration treatment and materials and set the standard for each project task.

d. Demonstrate the correct execution of the approved cleaning and restoration methods and materials during the on-site workmanship training program within the framework of ASTM E2659.

1.5.6.2 Cleaning Products and Procedures

1.5.6.2.1 General Cleaning Requirements

a. Establish cleaning products and procedures during the mockup process.

b. Select the least aggressive method used to achieve the desired level of cleanliness.

c. Where chemical products are selected for cleaning, use them in accordance with the manufacturer's instructions.

1.5.6.2.2 Cleaning Mock-Ups

a. Demonstrate the materials, equipment, and methods to be used in cleaning in a test section approximately 1 meter by 1 meter 3 feet by 3 feet.

b. Locate test patches in inconspicuous areas of the building. The areas tested are subject to approval by the Contracting Officer. The areas tested must exhibit soiling characteristics representative of those larger areas to be cleaned.

c. Adjust the cleaning process as required and the test section rerun until an acceptable process is obtained.

d. Conduct tests on areas to be stripped of paint.

e. Allow tested areas to dry before a determination is made on the effectiveness of a particular treatment.

1.5.7 Masonry Restoration Products and Procedures

1.5.7.1 General Restoration Requirements

a. Do not use masonry or mortar in the work until the mock-ups and the represented material and workmanship have been submitted and approved.

b. Demonstrate the methods and quality of workmanship to be performed in each masonry treatment requirement (MTR). Provide a mock-up for each MTR indicated.

1.5.7.2 General Restoration Mock-Up Requirements

a. Throughout restoration, retain approved mock-up panels in undisturbed condition, suitably marked, as a standard for judging completed work.

b. Review manufacturer's product data sheets to determine suitability of each product for each surface.

c. Apply products using manufacturer-approved application methods, determining actual requirements for application.

d. Obtain approval as to the preservation treatment approach, design, and workmanship to include, but not limited to the verification of all material applications and finishes as specified to the requirements of color, texture, profiles, and finishes before proceeding with work.

1.5.7.2.1 Mock-ups

May be performed on inconspicuous sections of actual construction under the same weather conditions expected the remainder of the work.

a. Location and number as directed[, but no more than [_____]].

b. Size: 1 m by 1 m 3 feet by 3 feet or as appropriate for the repair specified.

c. Repair unacceptable work.

1.5.7.3 Restoration Mock-Ups

1.5.7.3.1 Repointing

Repoint mortar joints, minimum acceptable mock up dimensions: twelve feet in length - 2/3 horizontal joints and 1/3 vertical joints. Demonstrate method for cutting out mortar joints, preparing wall for repointing, mixing mortar, installing mortar and curing the mortar. Prepare and place repointing mortar in accordance with NPS TPS Brief 2 and in compliance with NPS Hist Prop.

1.5.7.3.2 Retooling Stone Masonry In Situ

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NOTE: Common historic finish textures include, but are not limited to, corduroy and point chisel finishes.

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Demonstrate treatment technique and methods to retool three deteriorated stone faces in situ in all known historic profile textures identified.

1.5.7.3.3 Masonry Removal and Replacement

Fully remove masonry and replace to specified dimensions and texture. Select size of masonry units representing typical conditions. Return one masonry unit to same location, set to surrounding profile joint width and bond pattern. Set masonry unit using specified mortar. Confirm with Contracting Officer's Representative that the replacement masonry units meet specification requirements for matching and that sufficient quantity required for the work have been identified. Leave one stone dry-set into opening set on wood shims for evaluation and approval of preparation conditions.

1.5.7.3.4 Repair Material

1.5.7.3.4.1 Patching

Apply repair material on at least two masonry units for repair. Include one masonry unit on which to demonstrate proficiency in removing previous patching material and repairing with new substitute repair material. Include the removal of metal anchors at two locations and fill in the holes with repair material on the second masonry unit (where applicable).

1.5.7.3.4.2 Dutchman

Undertake dutchman repairs in two locations, including one that is only cut and prepared for application. Demonstrate the quality of the stone insert, as well as the workmanship and techniques to be performed in the dutchman repairs. Do not proceed with other dutchman repairs until the technique has been approved.

1.5.7.3.5 Crack Repair

Repair one crack, 600 mm 2 feet in length, using mortar. Repair one crack, 600 mm 2 feet in length, using dispersed hydrated lime injection technique with appropriate repair material.

1.5.7.3.6 Surface Treatments

Install a minimum 1.5 square meter 16 square foot mockup for each surface treatment on each substrate to be treated. For stucco, demonstrate the means for installing each coat; including mechanical support systems such as wood or metal lath. For water repellents and/or consolidants, demonstrate the equipment and installation procedure. Allow 48 hours for limewash applications to dry to their final color and appearance.

1.5.7.3.7 New Masonry Elements

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NOTE: Consideration of new elements on a historic structure should only be undertaken once the addition is approved by the Contracting Officer. New accessories are intended to provide structural strengthening or facilitate weather protection.

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Install new components in a manner demonstrating their final installation on the structure.

1.6 DELIVERY, STORAGE, AND HANDLING

a. Furnish cement in suitable bags used for packaging cements.

b. Provide packages with labeling that clearly defines contents, manufacturer, and batch identification.

c. Provide detergents, masonry cleaners, paint removers, solvents, epoxies and other chemicals used for masonry cleaning in sealed containers that legibly show the designated name, formula or specification number, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer.

d. Store materials in weathertight structures which will protect all materials from moisture and contaminants.

e. Store accessories to avoid contamination and deterioration.

f. Do not use admixtures which have been in storage onsite for six months or longer, or which have been subjected to freezing, unless retested and proven to meet the specified requirements.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Environmental Requirements

a. Do not place materials when weather conditions adversely affect the quality of the finished product.

b. Do not place masonry or mortar when the air or surface temperature is below 5 degrees C 40 degrees F in the shade and will remain so for at least 48 hours after completion of the work. Heated enclosures may be used to overcome ambient weather restrictions, where such enclosures are feasible.

c. Do not place masonry or mortar when air or surface temperature is above 35 degrees C 90 degrees F with a wind speed above13 kilometers per hour 8 miles per hour and will remain so for at least 48 hours after completion of the work.

d. Do not place masonry or mortar when air or surface temperature is above 38 degrees C100 degrees F with or without wind and will remain so for at least 48 ours after completion of the work.

e. Do not product or place materials during periods of rain or other precipitation. Stop material placements, and protect all in-place material from exposure, during periods of rain or other precipitation.

f. Clean masonry surfaces when air temperatures are above 5 degrees C 40 degrees F and will remain so until masonry has dried out, but for not less than 7 days after completion of the work.

g. Do not perform work in wind conditions that may blow materials onto surfaces not intended to be treated.

1.7.2 Masonry Installation Requirements

a. Phase work during hot weather by performing work on the shady side(s) of the building during daylight hours and on the daylight side(s) of the building during cooler evening hours to prevent premature evaporation of the water from the mortar.

b. Do not use frozen materials or materials mixed or coated with ice or frost. Do not apply materials to frozen surfaces; allow complete thawing prior to installation.

c. Do not lower the freezing point of mortar by the use of admixtures or anti-freeze agents. Do not add chlorides or admixtures containing greater than 0.2 percent chlorides to the mortar, per TMS MSJC.

d. Prevent mortar from staining the face of the masonry or other exposed surfaces. Immediately remove mortar that comes in contact with such surfaces. Cover partially completed work when work is not in progress. Protect sills, ledges and projections from mortar droppings. Building damage resulting from work of this Section is the Contractor's responsibility. Restore damaged areas to the satisfaction of the Owner at no expense to the Owner. Do not apply products under conditions outside product manufacturer's requirements.

1.8 WARRANTY

1.8.1 Cleaning Warranty

Warrant cleaning procedures for a period of two years against harm to substrate (masonry and mortar) or to adjacent materials including, but not limited to discoloration of substrate from improper procedures or usage, chemical damage from inadequate rinse procedures, and abrasive damage from improper procedures.

1.8.2 Repair Warranty

Warrant repair procedures, including repointing, for a period of two years against: discoloration or mismatch of new mortar to adjacent original historic mortar, discoloration or damage to masonry from improper mortar clean-up, loss of bond between masonry and mortar, fracturing of masonry edges from improper mortar joint preparation procedures or improper mortar formulation, and occurrence of efflorescence from improper repair procedures.

PART 2 PRODUCTS

2.1 CLEANING MATERIALS

2.1.1 General Requirements

Selection of appropriate cleaning products requires a clear understanding of the masonry materials to be cleaned, a rationale for the cleaning, and an understanding of the anticipated level of cleanliness expected from the cleaning program. Overly aggressive cleaning methods and materials can cause subtle, long-term damage to masonry units. Use products that have a minimum 5 year performance record on relevant projects. Select the products predicated on long-term negative effects to the masonry rather than current level of cleanliness of the comparable structure.

2.1.2 Paint Removers

a. Provide chemical paint removers that are water soluble, low toxicity products, effective for removal of paint on masonry without altering, damaging, or discoloring the masonry surface.

b. Provide commercially available poulticing materials designed to adhere to and peel off paint without damaging the underlying masonry or project specific mixtures that include absorbent materials and cleaning solutions which can be demonstrated to do no harm to the masonry.

2.1.3 Chemical Cleaners

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NOTE: Chemical cleaners range from acidic to alkaline in their chemcial makeup. Selected products must be suitable for the type of masonry units to be cleaned.

****

a. Provide commercially available products that have a proven record of cleaning masonry without altering, damaging or discoloring the masonry units, mortar or surrounding materials.

b. Provide the associated pre and post treatment material to neutralize the long term effects of the chemicals.

2.1.4 Biocides

Provide commercially available biocides with accompanying product literature containing information on the product as well as the expected service life of the material and any detrimental effects it may have on the masonry or mortar.

2.1.5 Liquid Strippable Masking Agent

Provide manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished stone surfaces from the damaging effect of acidic and alkaline masonry cleaners.

2.1.6 Cleaning Implements

Furnish brushes that contain natural or nylon fiber bristles only. Do not use metallic wire brushes. Use scrapers and application paddles made of wood with rounded edges. Metallic tools are not permitted.

2.1.7 Water

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NOTE: Filtering and neutralizing pH is rarely conducted for masonry cleaning, except for statues or museum pieces.

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Obtain potable water from a local source. [Filter to remove minerals resulting in a neutral pH, prior to application.]

2.2 REPAIR MATERIALS

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NOTE: Use materials, physical and chemical properties, and composition of masonry and mortar in renovation work that match the original existing masonry and mortar to be repaired, unless samples and testing determine that existing mixtures and materials are faulty or nonperforming. Match masonry materials used for repair and renovation to the original existing historic materials as closely as possible in composition, color, texture, strength, size, finishing and porosity. Refer to ASTM C1713 for matching mortar.

****

2.2.1 General

Use repair materials of one type and from one source, when used in repair treatments that will have surfaces exposed in the finished structure.

2.2.2 Mortar and Stucco

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NOTE: Mortar types L and K are not included in ASTM

C270. Type L mortar uses only hydrated lime or lime putty as binder. Type K mortar has typical proportions in the range of 1 part cement, 2 to 3 parts lime, and 2 1/4 to 3 times the combined cement and lime components as sand.

****

2.2.2.1 Testing and Matching

a. Take test specimens of existing mortar and stucco from a sound and intact representative portion of the structure, at locations [indicated][or][by the Contracting Officer's Representative] and assess in accordance with ASTM C1713 and ASTM C1324.

b. Subject a part of the historic mortar sample to petrographic examination and differential thermal analysis, or X-ray diffraction, or analytical chemistry to determine the binder components.

c. Aggregate Analysis

    (1) Separate aggregate of the mortar sample from the binder [by taking the crushed mortar sample and either gently blowing away the fine binder material, placing the crushed sample in a centrifuge, or chemically separating the aggregate from the binder].

    (2) Rinse the separated aggregate clean with water and dry. [Examine the aggregate with a magnifying glass, and record the component materials as to range of materials, sizes, colors, as well as the presence of other materials.]

    (3) Perform sand analysis using a sieve analysis of the aggregate as part of the ASTM C1324 process.

d. Match the replacement mortar and stucco to the original existing material in color, texture and tooling.

2.2.2.2 Replacement Mortar and Stucco

Provide replacement mortar and stucco that will:

a. Coexist with the old in a sympathetic, supportive and, if necessary, sacrificial capacity.

b. Have greater vapor permeability and be softer (measured in compressive strength) than the masonry units.

    (1) Measure water vapor transmission in accordance with ASTM E96/E96M.

    (2) Prepare ASTM E96/E96M water vapor transmission specimens with thickness similar to that expected in service, or a maximum of 13 mm 1/2 inch, whichever is thinner.

c. Be as vapor permeable, and as soft, or softer, (measured in compressive strength) than the existing historic mortar or stucco.

2.2.2.3 Binder Content

****

NOTE: Historic mortars can represent four different

binder types, or combination of them, depending on the time period of construction. A building constructed in the early 1800s is likely built with a straight lime putty binder type because the discovery of natural cement binder types had not occurred until the early 1820s. A building constructed in 1940 might be built with portland cement (1871) and hydrated lime (1930s). The historic binder types include: non-hydraulic lime (fat lime, lime putty or hydrated lime); hydraulic lime (feebly, NHL 2, moderately, NHL 3.5, and imminently, NHL 5.0); natural cement; and portland cement. The binder types are all derived from limestone. Each successive type is fired at higher temperatures in a kiln to the point of vitrification or liquid phase (1204-1540 degrees C2200-2800 degrees F) when Portland cement is developed. Lime can be slaked into a hydrate powder or putty form by adding water due to the lower firing temperatures (900-1093 degrees C1650-2000 degrees F), while cement products must be crushed mechanically into a powder form before use. Each binder type has its own unique performance properties in relation to historic masonry units and the building wall design. A mortar formula made from lime putty (low compressive strength) will accommodate building movement in load-bearing masonry much more effectively than a portland cement formula of much higher compressive strength. Identify performance characteristics of the replacement mortar carefully based upon evaluation of the existing historic mortar.

****

Provide binder type or mixture of mortar (and stucco) with a cement, lime, or combination thereof consistent with the original existing mortar (and stucco) content in order to provide uniform durability, weathering characteristics, and the same, or better, life-cycle performance expectations.

2.2.2.4 Repointing Mortar

****

NOTE: If mortar testing is performed prior to project bidding and the compatible mortar type is known, select from the following choices. Otherwise, delete the following paragraph and allow mortar to be determined by the above described testing.

****

[Pre-blend repointing mortar in single containers in a factory-controlled environment.][Repointing mortar may be site mixed, Type S, Type N, Type L, Type O and Type K.][Use lime for repointing mortar that conforms to ASTM C207, Type S, or ASTM C1489 or unless otherwise specified.]

2.2.2.5 Admixtures

Do not use admixtures in the mortar or stucco unless specifically approved in writing by the Contracting Officer.

2.2.3 Crack Injection

****

NOTE: Dispersed hydrated lime (specified herein) is suitable for injection of cracks up to 3.2 mm1/8 inch wide for architectural purposes (sealing, restoring appearance, preventing moisture infiltration) but has low bond and is not the best material for structural repairs. Masonry injection grouts (not specified herein) may be more suitable for structural repairs.

****

a. Comply with the dispersed hydrated lime manufacturer's written instructions.

b. Inject cracks that are no greater than 3 mm 1/8 inch in width and masonry is soundly bonded but cracked.

c. Inject the full length of the cracks unless specifically instructed otherwise.

2.2.4 Replacement Masonry Materials

2.2.4.1 Clay Brick

a. Provide replacement brick matching color, shape, size, texture, appearance, and thermal expansion properties of the existing historic brick.

b. Test brick in comparison to the original existing historic brick using ASTM C67/C67M.

c. Do not use reclaimed brick unless approved by Contracting Officer.

d. Provide brick meeting the requirements of ASTM C216 Grade SW, including a rating of "not effloresced", unless otherwise specified.

2.2.4.2 Stone

a. Provide replacement sotne matching type, color, shape, size, texture, finish-profile, and compressive strength of the existing historic stone units.

b. Test replacement stone in comparison to the existing historic stone using ASTM C170/C170M.

2.2.4.3 Terra Cotta

a. Provide replacement terra cotta matching color, shape, size, texture and finish-profile of the existing historic terra cotta units.

b. Test replacement terra cotta in comparison to the existing historic terra cotta using ASTM C34.

2.2.4.4 Architectural Precast Stone

a. Provide replacement architectural precast stone matching color, shape, size, texture and finish-profile of the existing historic architectural precast stone units.

b. Test replacement architectural precast stone in comparison to the existing historic architectural precast stone using ASTM C1364.

2.2.5 Surface Treatments

2.2.5.1 General

Provide commercially available coatings with water vapor permeabillity of 0.98 or greater, as measured in accordance with ASTM E96/E96M, including silanes and siloxanes.

2.2.5.2 Consolidants

Provide commercially available consolidants designed to strengthen loose or deteriorated stone without damaging intact stone or reducing water vapor permeability below 0.98, as measured in accordance with ASTM E96/E96M.

2.2.5.3 Water Repellents

Provide commercially available water repellents designed to preclude water droplet entry into the masonry walls without reducing water vapor permeability below 0.98. as measured in accordance with ASTM E96/E96M.

2.2.6 Miscellaneous Materials

2.2.6.1 Cementitious Grout

Use cementitious grout, recommended by the manufacturer for the application, to bond steel anchors to masonry.

2.2.6.2 Metal Attachments

a. Provide threaded or deformed stainless steel anchors for spall repairs, size as indicated.

b. Provide other plates, angles, anchors, and embedments conforming to ASTM A36/A36M, prime painted with inorganic zinc primer.

2.2.6.3 Lead Flashing

Provide commercially available lead flashing conforming to GSA HPTP 07656-01.

2.3 EQUIPMENT

2.3.1 Cleaning Equipment

Provide cleaning equipment that does not cause staining, erosion, marring, or other damage or changes in the appearance of the surfaces to be cleaned.

2.3.1.1 Sandblasting

Use of sandblasting equipment is not allowed for cleaning masonry surfaces.

2.3.1.2 Water Blasting

a. Provide water blasting equipment including a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water re-supply equipment.

b. Do not operate the equipment at a pressure which will cause etching or other damage to the masonry surface or mortar joints. Operate the equipment at a discharge capacity of 0.38 to 3.0 MPa 55 to 400 psi and 9.5 to 11.4 L/m 2.5 to 3 gpm for general surface cleaning operations.

c. Provide water tank and auxiliary re-supply equipment of sufficient capacity to permit continuous operations.

d. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

2.3.1.3 Alternative Blasting Equipment

a. Alternative blasting methods require equipment designed to discharge sponges, walnut shells, ice, soda and other friable materials.

b. Operate equipment in accordance with manufacturer's recommendations and maintain in good working order.

c. Do not operate equipment at a pressure which will cause etching or other damage to the masonry surface or mortar joints.

d. Determine discharge capacity on a case by case basis during the mockup test panel demonstration and approval process.

e. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

2.3.2 Spray Equipment

a. Provide spray equipment for chemical cleaners with low-pressure tanks or chemical pumps suitable for chemical cleaner indicated, and equipped with stainless steel, cone-shaped spray-tip.

b. Disperse water through a fan-shaped spray tip at an angle of not less than 15 degrees.

c. Deliver water at a pressure not greater than 3.0 MPa 400 psi and at a volume between 9.5 and 11.4 L/m 2.5 and 3 gpm.

d. Deliver heated water at flow rates indicated maintaining between 60 and 82 degrees C 140 and 180 degrees F.

2.3.3 Drilling Equipment

a. Use standard small, powered, handheld masonry drills, commonly used for drilling small holes in concrete and masonry to drill holes in masonry for patch anchors and other applications.

b. Use drills in rotary mode only. Do not use impact type drills.

2.3.4 Compressed Air Supplies

a. Use compressed air equipment that delivers clean, oil and moisture free compressed air at the surface to be cleaned. Use a minimum of two in-line air filters to remove oil and moisture from the air supply.

b. Test the compressed air supply during each shift for the presence of oil and moisture.

2.3.5 Material Handling and Associated Equipment

2.3.5.1 Mixing, Transporting, and Placing Job Materials

a. Provide equipment used for mixing, transporting, placing, and confining masonry and mortar placements capable of satisfactorily mixing material and supporting uninterrupted placement operations.

b. Provide equipment used for mixing, conveying, and placing of materials that is clean, free of old materials and contaminants, and in conformance with material manufacturer's recommendations.

2.3.5.2 Associated Equipment

Provide associated equipment, such as mixer timing equipment, valves, pressure gauges, pressure hoses, other hardware, and tools, as required to ensure a continuous supply of material and operation control.

2.4 Mortar Mix

2.4.1 General

a. Proportion materials appropriately with regard to the effect of moisture content on the individual components (cement, sand and lime).

b. Batch materials using volumetric measurement devices and consistently consolidate the material in these devices to ensure the uniformity of the mortar. Do not batch by shovel counts.

2.4.2 Batching

a. Utilize a calibrated measuring device for batching Portland cement.

b. Utilize a calibrated measuring device for batching hydrated lime or lime putty.

c. Utilize a calibrated measuring device for batching the sand.

2.4.3 Cement and Lime Proportions

a. Fill the measuring device with portland cement, hydrated lime or lime putty.

b. Briskly strike the bottom of the measuring device against the ground a minimum of ten times and then strike the top flush.

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NOTE: Dry hydrate lime experiences a significant volumetric loss when converted to a wet paste during mixing. Volume changes that occur when dry hydrated

lime is converted to a wet paste can cause sizable errors in proportioning mortar formulations. Because mortar ingredients are often measured dry in restoration work, the most likely error is over-sanding. A given amount of hydrated lime occupies far more volume as a dry powder than it does after mixing with water. Thus, when lime is measured as a dry powder, less is actually put into the mixture than is used if the lime is measured as putty. When wetted, dry hydrate lime will typically contract, on average, to 75 percent of the original dry volume. Using a nominal 1:2:9 mixture (Type O) cement/lime/sand, the variation caused by wet verses dry measure of the lime results in a 1:1.5:9 mixture. This ratio exceeds the allowable sand content in ASTM C270 of 2.5 to 3 times the binder, and is 3.75 times the cement plus lime; thus an unintended over-sanded mixture results. To avoid this problem an additional amount of dry hydrate lime (25 percent) must be added to all formulations during the proportioning stage. Volume loss occurs when dry hydrate lime is mixed to a paste that is more than 42 percent solid. Note: Portland cement does not experience this volumetric loss when converted to a wet paste during mixing.

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c. For dry hydrate lime, fill the measuring device using a minimum of three lifts, strike the bottom of the measuring device against the ground a minimum of ten times for each lift and then strike the top flush. Mix dry hydrate lime to a wet paste that is 40 to 42 percent solid.

d. For lime putty briskly strike the bottom of the measuring device against the ground a minimum of ten times and then strike the top flush. No additional lime is required when measuring from putty.

2.4.4 Sand Proportions

a. Proportion sand when the sand is in saturated surface dry (SSD), loose damp condition.

b. Proportion the sand by filling a measuring device using a minimum of three lifts, striking the sides a minimum of ten times, and then striking the top flush.

PART 3 EXECUTION

3.1 EXAMINATION

a. Undertake masonry renovation only after complete evaluation and analysis of the areas to be repaired are completed, including sampling and testing of the existing mortar to determine its composition and qualities. Do not start repair work until conditions that have caused masonry deterioration have been identified and corrected.

b. Use the gentlest means to perform the work and take the greatest of care to ensure that the historic materials are not damaged in the process of the work, as established by mock-ups and testing.

c. In addition to requirements in this Section, comply with NPS Hist Prop.

3.1.1 Field (In Situ) Mortar Examination

a. Detect cracks, degradation and de-bonding from the surrounding masonry.

b. Determine previous surface coating treatments that may be contributing to the current conditions.

c. Compare the bedding mortar with the pointing mortar and determine the cross-sectional characteristics of the wall.

d. Determine the level of moisture movement in the in situ mortar, and if the mortar or masonry units are handling the brunt of the water movement through the wall.

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NOTE: Mortar shear strength may be needed for structural masonry walls that resist in-plane loads (wind or seismic).

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e. Evaluate in situ mortar joint shear strength in accordance with ASTM C1531.

3.1.2 Taking and Preparation of Samples

a. Take and analyze samples of unweathered original historic mortar and different types of mortar in the structure in order to match the new mortar to be used for repointing.

b. Remove three or four samples of each type of mortar to be matched with a hand chisel from several locations on the building. Mortar samples to be intact pieces with a minimum size of 28 grams1 ounce.

c. Set aside the largest sample for comparison with the repointing mortar.

d. Place the remaining samples in labeled, sealed sample bags for transport to the laboratory for evaluation per Part 2 of this Specification.

3.2 PREPARATION

3.2.1 Protection

a. Protect persons, motor vehicles, adjacent surfaces, surrounding buildings, equipment, and landscape materials from chemicals used and runoff from cleaning and paint removal operations.

b. Erect temporary protection covers, which will remain in operation during the course of the work, over pedestrian walkways and at personnel and vehicular points of entrance and exit.

c. Protect the interior of buildings from the weather, cleaning, and repair operations at all times.

d. Do not expose workers to chemical substances in excess of the limits established by ACGIH 0100. Comply with more stringent regulations where applicable.

3.2.2 Surface Preparation

a. Do not proceed with cleaning until mock-ups have been approved.

b. Do not proceed with repointing or stucco until existing mortar and stucco have been analyzed and suitable repair materials have been determined.

c. Do not proceed with restoration work until the cause of observed distresses have been identified and corrected.

d. Do not proceed with surface treatments until all other restoration work has been completed.

3.2.3 Equipment and Techniques Demonstration

a. Demonstrate equipment and techniques of operation in an approved location.

b. Assemble dependable and sufficient equipment, appropriate and adequate to accomplish the work specified, at the work site with sufficient lead time before the start of the work to permit inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required.

c. Maintain the equipment in good working condition throughout the project.

3.3 MASONRY CLEANING

3.3.1 General

a. Exercise caution against over-cleaning of surfaces, which may be detrimental, and which may remove desirable historic surface details or patinas. For example, if cleaning reveals unexpected joint painting or historic signage; suspend the cleaning action, protect the exposed area and notify the Contracting Officer.

b. Do not damage or mar historic materials in the process of cleaning.

c. Perform cleaning per NPS TPS Brief 1.

d. Protect open joints to prevent water and cleaner intrusion into the interior of the structure.

e. Protect non-masonry materials and severely deteriorated masonry by approved methods prior to initiation of cleaning operations.

f. Remove all organic and inorganic contaminants from the surface and pores of the substrate, without causing any short or long-term negative consequences.

g. Clean surfaces evenly with no evidence of streaking or bleaching.

h. Do not affect the density, porosity, or color of the existing masonry or mortar.

i. Maintain a neutral pH on surface of cleaned masonry units.

j. Use the gentlest methods possible for cleaning historic masonry to achieve the desired results.

k. Proceed with cleaning in an orderly manner, working from top to bottom of each scaffold width and from one end of each elevation to the other.

l. Perform cleaning in a manner which results in uniform coverage of all surfaces, including corners, moldings, interstices and which produces an even effect without streaking or damage to masonry.

m. Use the following sequence of methods to determine the least aggressive, effective cleaning method:

    (1) Water with non-metallic brushes (cold water).
    (2) Water with mild soap
    (3) Water with stronger soap
    (4) Water with stronger soap plus ammonia
    (5) Water with stronger soap plus vinegar (but not on calcareous masonry)
    (6) Stronger chemical cleaners, only when above methods are determined to be ineffective by the Contracting Officer

3.3.2 Chemical Cleaners

a. Do not use chemical cleaners without approval from the Contracting Officer.

b. Do not use acidic chemical cleaners on limestone, marble, concrete and other calcareous (calcium containing) masonry materials. If chemical cleaners are used on such materials, use alkaline based cleaners with neutralizing afterwashes.

3.3.3 Paint Removal

a. Prior to removal, test existing paint for lead in accordance with Section 02 83 00 LEAD REMEDIATION.

b. Clean areas where paint is to be removed with water and detergent solution to remove surface dirt. Rinse and allow to dry.

c. Remove paint and other coatings from masonry surfaces in areas indicated prior to general cleaning.

d. Do not damage or mar masonry in the process of paint removal.

e. Apply chemical paint removers in accordance with manufacturer's instructions.

f. Protect surrounding painted surfaces from exposure to chemical paint removers to avoid damage.

g. Remove paint containing lead in accordance with Section 02 83 00 LEAD REMEDIATION.

3.3.4 Water Cleaning

3.3.4.1 Pressure Spraying

a. Spray apply water to masonry surfaces to comply with requirements indicated by test patches for location, purpose, water temperature, pressure, volume, and equipment.

b. Unless otherwise indicated, wash the surface with clean, low pressure water (pressure of less than 0.38 MPa 55 psi and 9.5 to 11.4 L/m 2.5 to 3 gpm discharge) and hold spray nozzle not less than 300 mm 12 inches from surface of masonry.

c. Apply water side to side and top to bottom in overlapping bands to produce uniform coverage.

3.3.4.2 Hand Scrubbing

a. Scrub surfaces to be cleaned to remove surface contaminants.

b. Pre-wet surfaces and use hand-held natural bristle or nylon brushes.

c. Do not use wire brushes.

3.3.4.3 Rinsing

a. Rinse scrubbed surfaces clean of all contaminants and cleaning solutions with water in a low-to-moderate pressure spray, working from top to bottom of each treated area.

b. Remove all traces of contaminants and cleaning solutions.

3.3.5 Chemical Cleaning

3.3.5.1 General

a. Chemical cleaning is the use of any product in addition to water, including detergents, ammonia, vinegar, and bleach.

b. Use gentlest means possible to achieve the desired result as determined by test patches.

c. Proceed in an orderly manner, working from top to bottom of each scaffold width and from one end of each elevation to the other.

d. Provide uniform coverage of all surfaces, including corners, moldings, interstices and produce an even effect without streaking or damage to masonry.

e. Do not apply chemical cleaners to the same masonry surfaces more than twice.

3.3.5.2 Surface Prewetting

a. Wet masonry surfaces to be cleaned with chemical cleaners with water using a low pressure spray before application of any cleaner.

b. Prewet walls working from top to bottom, except work bottom to top on one-story walls.

c. Do not prewet masonry surface prior to applying biocides.

3.3.5.3 Acidic Chemical Cleaning

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NOTE: Buffered acidic cleaners are generally safer for masonry substrates.

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a. Apply acidic chemical cleaners according to manufacturer's instructions.

b. Do not apply acidic chemical cleaners to masonry with high calcium content (e.g. marble, limestone.

c. Apply acidic cleaners to masonry surfaces by low pressure spray 0.35 MPa 50 psi max., roller, or brush.

d. Leave cleaner on on masonry surface for the time period recommended by the manufacturer.

e. Employ manual scrubbing by brushes as indicated by test patches for the specific location.

f. Rinse cleaned surfaces with a low-to-moderate pressure spray of water to remove all traces of chemical cleaner.

3.3.5.4 Alkaline Chemical Cleaning

3.3.5.4.1 Prewash Phase

a. Apply alkaline chemical cleaners to masonry surfaces according to manufacturer's instructions, by low pressure spray 0.35 MPa 50 psi max., roller, or brush.

b. Leave cleaner on masonry surface for the time period recommended by the manufacturer.

c. Employ manual scrubbing by brushes as indicated by test patches for the specific location.

d. Rinse cleaned surfaces with a low-to-moderate pressure spray of water.

3.3.5.4.2 Afterwash Phase

a. Immediately after rinsing of alkaline cleaned surfaces, apply a neutralizing afterwash to the cleaned masonry areas.

b. Apply neutralizing afterwash according to manufacturer's instructions, by low pressure spray 0.35 MPa 50 psi max., roller, or brush.

c. Leave afterwash on masonry surface for the time period recommended by manufacturer.

d. Rinse cleaned surfaces with a low-to-moderate pressure spray of water to remove all traces of chemical cleaners.

3.3.5.5 Rinsing and pH Testing

a. Determine the pH of masonry surfaces that have been chemically cleaned using pH monitoring pencils or papers.

b. Rinse chemically cleaned masonry, using a low pressure spray, until a neutral pH (7) reading is obtained from the masonry unit surface.

3.4 MASONRY REPAIR

****

NOTE: Provide missing information; if a reference is added, revise paragraph REFERENCES accordingly.

****

3.4.1 General

a. Match repaired surfaces with adjacent existing surfaces in all respects.

b. Demonstrate the materials, methods and equipment proposed for use in the repair work in mock-ups, as specified in PART 2.

c. Use products in accordance with the manufacturer's instructions.

d. Proceed with masonry repair only after the cause of deterioration has been corrected.

e. Assist Historic Masonry Consultant with performing field investigation to determine the causes and extent of degradation. Utilize the following techniques.

   (1) Employ a field microscope to closely assess the conditions at the surface of the mortar and masonry units. Detect cracks and assess for degradation and debonding from the surrounding masonry. Detect previous surface coating treatments on the mortar and masonry that may be contributing to the current conditions.

   (2) Employ a boroscope to examine mortar deeper in the joint. Compare the bedding mortar with the pointing mortar and ascertain the cross-sectional characteristics of the wall.

   (3) Employ moisture meters to determine the level of moisture in the mortar and masonry, and if the mortar or masonry units are handling the brunt of the water movement through the wall. Infrared thermography, employed by a trained investigator, can provide additional information on the moisture conditions.

   (4) Employ RILEM tubes using the method of RILEM II.4 or water penetration testing in accordance with ASTM C1601 to determine the rate of water uptake into the masonry.

   (5) To access the physical characteristics of hard mortar, use a spring loaded or pendulum impact device to determine surface hardness as an indicator of relative compressive strength. For evaluating softer mortars, mortar integrity deeper in the wall, and the condition of the masonry units, use a drill resistance tool by an experienced consultant.

   (6) Utilize technologies such as ground penetrating radar or metal

detection equipment to map metal reinforcement and embedments in the wall.

(7) Use flat jack or jacks and rams to gather information on in situ compressive stress (ASTM C1196, masonry compressive response ASTM C1197, and mortar joint shear strength ASTM C1531.

3.4.2 Repointing Masonry

Repoint masonry in accordance with NPS TPS Brief 2, using ASTM E2260 as a reference guide.

3.4.2.1 Wall Preparation

a. Remove old caulking, grout, or non-original mortar from previously repaired joints to a minimum depth of 2.5 times the width of the joint. Cut all joints (unless otherwise noted) back to sound, solid, back up material. Leave a clean, square face at the back of the joint to provide for maximum contact of repointing mortar.

b. Shallow or feather edging is not permitted. Remove loose particles from joints. Clean joints, followed by blowing with filtered, dry, compressed air or vacuum.

c. Cut out existing horizontal mortar joints (bed joints) that are filled with a hard Portland mortar using a diamond blade that is narrower than the joint width. Cut out the middle one-third of the mortar joint using a rotary power saw. Remove the remaining mortar from the masonry joints by hand using masonry chisels or pneumatic carving tools.

d. Do not use rotary power saws to cut out vertical joints (head joints) . Remove all vertical head joints by hand using a pneumatic carving tool, or hammer and chisel.

e. Remove existing historic lime-based mortar using only small-headed chisels that are no wider than half the width of the existing masonry joints. Pneumatic air carving chisels are permitted as are specially designed mortar removal reciprocating tools (i.e. Arbortech Saw).

f. Do not widen the existing masonry joints. Do not chip or spall the surrounding masonry edges in the process of mortar removal. Damage to surrounding masonry units resulting from rotary blade over running is not permitted. Damages to adjacent materials exceeding 3.2 mm1/8 inch in size are the responsibility of the contractor and must be repaired by removal and replacement of damaged materials.

g. Permit applicators to be trained at the project site in this masonry treatment requirement.

3.4.2.2 Presoaking Masonry / Mortar Consistency / Lifts

a. Use the same mortar as the repointing mortar for setting the replacement masonry.

b. Soak exposed surfaces of historic masonry adjacent to joint with water prior to repointing.

c. Allow time for excess water to run off and evaporate prior to repointing. Joint surfaces must be damp but free from standing water.

d. Maintain a water sprayer on site at all times during the repointing process.

e. The mortar material must resemble the consistency of brown sugar during installation. This drier consistency enables the material to be tightly packed into the joint, allows for cleaner work, and prevents shrinkage cracks as the mortar cures.

f. Allow mixed repointing mortar to stand for not less than one-half hour and not more than one and one-half hours for pre-hydration to reduce post-curing shrinkage. After this time, water can be added to small batches by hand to bring the mortar to a stiff yet workable consistency. Use repointing mortar within two and one-half hours after initial mixing and within one hour after adding water to bring the mortar to a working consistency. Retempering of the mortar to replace evaporated water is permitted within these time frames.

g. Point joints in layers or "lifts" where the joints are deeper than 32 mm 1-1/4 inch. Apply in layers not less than 1/2 the depth but not more than 32 mm 1-1/4 inch or until a uniform depth is formed.

3.4.2.3 Compression / Joint Finish / Curing

a. Compress each layer thoroughly.

b. When mortar is thumbprint hard at the surface of the wall, finish the joints to match the original historic joint profile.

c. For Type L mortar:

   (1) Allow water evaporation from the freshly repointed walls in order to initiate the carbonation process in high lime content mortars. The carbonation of lime mortar initially requires wet-and-dry cycles, which can be created by water misting the joints after the mortar application when dry weather conditions prevail. Finish the joint profile before these cycles are started.

   (2) Depending on the environmental conditions (temperature and humidity), carry out water misting until a full nine alternating wet-and-dry cycles are completed.

   (3) Adjust curing methods to ensure that the repointing mortar is damp without eroding the surface of the mortar.

3.4.2.4 Protection

a. Keep the mortar from drying out too quickly or from becoming too wet.

b. Protect mortar from direct sun and high winds for the first 72 hours after installation or from driving rain for the first 24 hours, using plastic sheeting if necessary. Do not create a greenhouse effect by sealing off air movement in an attempt to protect the wall with plastic. Allow for air circulation to facilitate the carbonation process.

3.4.3 Retooling Stone Masonry In situ

a. Scale off all loose pieces of original stone from masonry intended to remain in place, including surface material in powder or granular form and detachments of planer elements, spalls and chips.

b. Assess all stone on building by sounding (tapping with a small hammer) or by using impact echo (for massive stones), surface penetrating radar, or infrared thermography in order to distinguish fully intact stone from those in which delamination may be hidden or pieces of unstable material may not be immediately visible.

c. Remove and replace stone units that are designated for retooling in situ, but develop a solid stone substrate that is no longer in plane or plumb with the surrounding stone masonry surfaces after chiseling is complete.

3.4.4 Masonry Removal and Replacement

a. Before removing any deteriorated masonry units, establish bonding patterns, levels and coursings. Remove masonry that has deteriorated or is damaged beyond repair, as determined through investigation and evaluation. Carefully demolish or remove entire units from joint to joint, without damaging surrounding units in a manner that permits replacement with full-size units. Support and protect remaining masonry work that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition. Notify Contracting Officer of unforeseen detrimental conditions including voids, cracks, bulges, and loose masonry units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items. Remove as many whole masonry units as possible without damage.

b. Remove mortar, loose particles, and soil from masonry by cleaning with hand chisels, non-metallic brushes, and water.

c. Remove sealants by cutting close to masonry units with utility knife and cleaning with solvents. Clean surrounding masonry areas by removing mortar, dust, and loose particles in preparation for replacement.

d. Replace removed masonry with masonry units removed from inconspicuous areas of the building, where possible, or with new masonry units matching the existing units. Butter vertical joints for full width before setting and set units in full bed of mortar, unless otherwise indicated. Remove mortar used for laying/setting masonry units before mortar sets to the repointing depth of the surrounding area. Repoint new mortar joints in repaired area to comply with requirements for repointing at existing masonry units.

e. If a few isolated masonry units are to be replaced, remove each without disturbing the surrounding masonry. Remove deteriorated masonry units and mortar requiring replacement by hand chiseling. Do not damage adjoining masonry units during the removal of deteriorated units and mortar.

f. Test the new element for fitting into its space without mortar. Use wedges made from non-expanding, non-corrosive material such as plastic to support and align the new unit, cover them with at least 38 mm 1-1/2 inches of mortar when pointing is complete.

g. Cover the four sides of the space with sufficient mortar to ensure that there will be no air spaces when the new unit is set. Fill the back of the space with mortar only if it matches existing construction.

h. Line up and set the new unit by tapping it into place with a wooden or rubber mallet. Align the face of new unit with that of existing masonry.

i. Repoint joints to match the rest of the wall after new units have been properly installed and adjusted.

j. Clean replacement areas with a non-metallic brush and water to remove excess mortar.

3.4.5 Material Repair

Repair or replace original historic masonry materials only if surfaces are extensively deteriorated (surface missing to a depth of 100 mm 4 inches or more) or are threatening the safety of the structure or individuals. If additional damage is found, notify the Contracting Officer. Repairs and replacements must match the materials, colors, and finish of the existing historic masonry as closely as possible.

3.4.5.1 Selective Demolition

a. Remove unsound, weak, or damaged masonry and mortar in areas as indicated.

b. Remove loose particles, laitance, spalling, cracked, or debonded masonry and mortar and foreign materials with hand tools unless otherwise noted.

c. Clean surfaces prepared for repair free of dust, dirt, masonry chips, oil or other contaminants, rinsed with water, and dried before repair work is begun.

d. Protect surfaces of the structure, and surfaces adjacent to the work area from damage which may result from removal, cleaning, and repair operations.

3.4.5.2 Application of Substitute Repair Materials

****

NOTE: Use repair materials as a last resort after all other repair treatments are determined to be ineffective or cost prohibitive.

****

a. Place repair materials to rebuild spalled or damaged areas to match the original surface finish, level, texture, bonding patterns, color and porosity. Match the finished appearance of the substitute repair material patch with the adjacent existing surface. Apply samples to the masonry units in situ.

b. Do not install repair material in thicknesses exceeding 50 mm 2 inches. Utilize a Dutchman repair approach or replacement unit for masonry repairs in excess of 50 mm 2 inches.

c. Remove loose mortar and masonry prior to installation of the repair material. "Sound" the masonry with a hammer to verify its integrity.

If necessary, cut away an additional 12.7 mm 1/2 inch of the masonry substrate to ensure the surface to be repaired is solid and stable.

d. Remove all deteriorated stone, mortar, sealant residue, and previous repair materials back to sound substrate using hammer and chisel or power equipment. Finish edges square to a minimum depth of 12.7 mm1/2 inch. Do not feather edges. Roughen substrate surface to achieve surface roughness required by manufacturer for good bond, but do not overly damage the substrate surface.

e. Remove sealant residue. Cut out used anchors, threaded rod anchors and/or dowels within the damaged masonry area. Any anchors that are free of rust, solidly embedded, and do not project beyond the solid masonry surface may remain.

f. Using clean water and a non-metallic scrub brush, clean dust from surface and pores of the substrate.

g. Pre-wet the substrate with water prior to the application of the repair material to prevent the substrate from drawing out the moisture too quickly. Re-wet the surface with water again immediately before applying the repair material. Use methods approved by the repair material manufacturer to deliver the substitute repair work as demonstrated.

h. Follow manufacturers' instructions pertaining to the placement of materials. If the manufacturer requires that installers of a specified product be trained, provide this documentation to the Contracting Officer. Training certificates previously issued by product companies for the application of specified products cannot be substituted for the Project Training "Substitute Repair Material Certificate" on this project.

i. Masonry and Material Repair Finishes and Color

   (1) Match the exposed surfaces of masonry and substitute material repair finish, color, texture, and surface detail with the original surface. Mechanical finishing and texturing may be required to produce the required finish and appearance.

   (2) Conceal bond lines between the repaired area and adjacent surfaces.

   (3) Replicate all surface details, including tooling and machine marks.

   (4) Use low-impact energy type equipment in finishing and texturing, which will not weaken the patch or damage the patch bond and the adjacent masonry.

3.4.5.3 Patch Anchors

a. Provide patch anchors to ensure that the patch is tied to the existing masonry structure at a frequency of at least one patch anchor per 2580 square mm 4 square inches of patch plan surface area; specific locations for patch anchors must be as indicated.

b. Use small handheld, low-speed rotary masonry drills to produce holes in the existing masonry, within the limits for the patch anchor installation.

(1) Drill holes into the existing substrate material of the masonry using rotary (non-hammer) drills making holes with a diameter of 3 mm 1/8 inch larger than the anchor diameter and a depth of 101 mm 4 inches, except as otherwise indicated or directed.

(2) Drill holes must not penetrate completely through the masonry, and must provide at least 25 mm 1 inch of cover around the drill hole.

(3) Clean holes by water blasting to remove drill dust and other debris and then blow dry with filtered, dry, compressed air.

(4) Condition drill holes in accordance with the epoxy adhesive manufacturer's recommendations.

c. Clean anchors to remove all contaminants which may hinder epoxy bond.

d. Pressure inject adhesive into the back of the drilled holes.

(1) Fill holes without spilling excess grout when the anchors are inserted.

(2) Insert anchors immediately into the holes.

(3) Set back anchors from the exterior face at least 25 mm 1 inch.

(4) Install anchors without breaking or chipping the exposed masonry surface.

(5) Use socked or screen tube anchors where voids exist in the masonry units or between the wythes.

3.4.5.4 Cleanup

a. Protect masonry surfaces from excess grount adhesive and spills.

b. Leave the surface of the masonry in a clean and uncontaminated condition.

3.4.6 Dutchman Repairs

****

NOTE: A Dutchman repair is a process of removing damaged stone to a specified depth and inserting a new piece of stone to fit in the opening to create the appearance of a seamless patch. The process involves careful and precise removal of select deteriorated stone material, usually in a larger stone.

****

a. Select stone for Dutchman repairs from the following three sources listed in order of priority:

(1) Stone harvested from the same elevation and stone type.

(2) Approved salvaged stone.

(3) New stone made from a similar stone type.

b. Fit the new piece into place with tolerances of no more than plus or minus 1.6 mm 1/16-inch.

c. Provide supporting rods of stainless steel as necessary for the extent of the repair and the location.

d. Closely blend repairs in with the surrounding original materials.

3.4.7 Crack Injection with Dispersed Hydrated Lime (DHL)

3.4.7.1 General

a. Notify the Contracting Officer as to when and where the installation will occur at least 48 hours prior to start.

b. Provide samples to the Government representative from the dispenser during the course of the injection.

c. Apply in accordance with the manufacturer's instructions.

3.4.7.2 Application of DHL

a. Drill 3.2 mm 1/8-inch diameter, downward-sloping injection holes. For transverse cracks less than 3.2 mm 1/8 inch wide, drill holes through center of crack at 25 to 40 mm 1 to 1.5 inches on center.

b. Clean out drill holes and cracks with compressed air and potable water. Remove dirt and organic matter, loose material, sealants, and failed crack repair materials.

c. Inject Dispersed Hydrated Lime using hypodermic needles or pressure ports through holes sequentially, beginning at one end of area and working to opposite end. Do not exceed 0.069 MPa10 psi injection pressure. Where possible begin at lower end of injection area and work upward. Inject Dispersed Hydrated Lime until it extrudes from adjacent holes. After Dispersed Hydrated Lime has set, remove excess material and patch injection holes and surface of cracks with appropriate surface treatment.

3.4.7.3 Tools and Equipment

Do not use tools and equipment that have not been cleaned of set dispersed hydrated lime.

3.4.8 Surface Treatments

3.4.8.1 Stucco

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NOTE: The correct finish is project specified. Specify the desired finish as appropriate for the project... Possible finishes include; tight-trowel, smooth; wet/damp sponge; or dry wood float. In rare cases, a pebble-dash finish may be required where screened aggregates are cast into the wet finish coat and pressed back with a wood float or left exposed. Historic stuccos may also include animal hair for reinforcement. Ox or cattle hair is the preferred choice, but horse or goat hair may be used.

****

a. Apply stucco on a clean surface in accordance with ASTM C926 at a thickness matching surrounding historic surfaces.

b. Soak the substrate with water to saturated surface dry (SSD) condition prior to application of scratch-coat.

c. Apply the scratch-coat and allow to partially-set on the wall surface.

d. Use a scratch rake to create the keys into the scratch coat for acceptance of the finish coat.

e. Apply the finish coat approximately 24 hours after the scratch coat application.

f. Soak the scratch coat with water to SSD condition prior to the application of the finish coat.

g. Apply the textured finish and profile [to match the surrounding historic surfaces].

3.4.8.2 Limewashes

a. Apply limewash using fiber brushes in three thin coats on saturated surface dry (SSD) raw masonry surfaces.

b. Do not allow the material to dry out before it has had a chance to absorb into the masonry surfaces.

c. Work from top to bottom of the wall working from the dry-edge.

d. Allow six hours drying time between coats

e. Where colors are desired, use natural earth pigments.

f. Verify all applications, materials and colors through mock ups panels applied to the substrate prior to the start of the work.

3.4.8.3 Water Repellents Infiltration

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NOTE: Water proofing, for the purposes of this specification, is considered any continuous chemical coating designed to sit on the surface of the masonry and preclude water movement through the pore structure of the masonry units, mortar or at their intersection. Historic Masonry structures were typically intended to manage moisture movement by allowing water vapor transmission through the pores and by allowing the dew point to move in the wall. While water proofing may preclude water ingress into the masonry system, it also precludes water vapor egress and is therefore not acceptable.

Water repellents are designed to resist water infiltration through the pore structure of masonry while allowing water vapor transmission. Unfortunately, evidence exists that some water

repellents do not perform as advertised and can impede vapor transmission. Only when all other water infiltration control methods have been considered carefully and disqualified, and the extreme decision has been reached to potentially risk a loss of historic material, will water repellents be allowed.

****

Application of water proofing is not allowed.

Application of water repellents may be performed upon Contracting Officer approval of the recommendation and justification, by the historic masonry consultant, that no other means will control water infiltration. Apply water repellents per manufacturer's instructions.

3.4.8.4 Stone Consolidants

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NOTE: Consolidants are chemical treatments designed to replace the natural cementing materials in stone. Stone formation in nature is a complex process of chemical reactions, pressure and time which consolidants are not able to successfully duplicate.

****

Use of stone consolidants requires Contracting Officer approval of the historic masonry consultants recommendation, including justifying data. Apply stone consolidants per manufacturer's instructions.

3.5 INSTALLATION OF NEW ELEMENTS

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NOTE: Issues such a seismic upgrades and remediating ongoing water infiltration issues may lead to the introduction of new elements to historic structures. Consult with the Historic Preservation Officer when such additions are being considered. New materials and components can have both functional and aesthetic impacts on historic structures and must be considered carefully.

****

Evaluate new materials and components for both functional and aesthetic impacts on historic structures.

3.5.1 Structural Upgrades

For mechanical anchors used to reinforce masonry structures, provide design by a registered professional structural engineer. Strengthening measures must take into account the current loads and stresses in the structure and the nature in which the building has historically managed thermal and other environmental changes or cycles.

Submit manufacturers literature, design analysis and detail drawings for the proposed additional materials.

3.5.2 Joint Sealant and Lead Flashing

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NOTE: Joint sealant is a flexible material that may be found in historic structures as a replacement for the original material used in construction. Typically, it is used in lieu of mortar around windows and in masonry joints and in masonry joints between stone elements at vulnerable areas such as copings and sills..

****

a. Test existing sealants for asbestos and PCBs before performing demolition.

b. Provide joint sealing as specified in Section 07 92 00 JOINT SEALANTS.

    (1) Augmentation with lead flashing is allowed for upward facing joints exposed to weather.

    (2) Install sealants and lead flashing in accordance with manufacturer's recommendations.

3.6 FINAL CLEANING

a. No sooner than 72 hours after completion of the repair work and after joints are sealed, wash down faces and other exposed surfaces of masonry with water applied with a soft bristle brush, then rinse with clean water.

b. Discolorations that cannot be removed by these procedures, are considered defective work.

c. Perform cleaning work when temperature and humidity conditions allow the surfaces to dry rapidly.

d. Protect adjacent surfaces from damage during cleaning operations.

3.7 PROTECTION OF WORK

Protect work against damage from subsequent operations.

3.8 DEFECTIVE WORK

Repair or replace defective work as directed by Contracting Officer, using approved procedures.

3.9 FINAL INSPECTION

Following completion of the work, inspect the structure for damage, staining, and other distresses. Inspect the patches for cracking, crazing, delamination, unsoundness, staining and other defects. Inspect the finish, texture, color and shade, and surface tolerances of the patches to verify that all requirements have been met. Repair surfaces exhibiting defects as directed.

a. Following completion of the work, inspect the structure for damage, staining, and other distresses.

    (1) Inspect patches for cracking, crazing, delamination, unsoundness, staining and other defects.

    (2) Inspect finish, texture, color and shade, and surface tolerances of the patches to verify that all requirements have been met.

b. Repair surfaces exhibiting defects as directed by Contracting Officer.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-04 20 00 (November 2015)**
Change 2 - 05/19

Preparing Activity: USACE **Superseding**
UFGS-04 20 00 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 04 - MASONRY

SECTION 04 20 00

UNIT MASONRY

11/15, CHG 2: 05/19

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-04 20 00 (November 2015)**
Change 2 - 05/19

Preparing Activity: USACE **Superseding**
UFGS-04 20 00 (February 2011)

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****

SECTION 04 20 00

UNIT MASONRY
11/15, CHG 2: 05/19

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NOTE: This guide specification covers the requirements for reinforced and nonreinforced masonry. This includes reinforced single wythe masonry walls, cavity walls, masonry veneer, composite walls, partition walls and other masonry wall types.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This guide specification covers reinforced and unreinforced masonry and must be tailored to reflect the type of construction used in the design.

In general, reinforced masonry is defined as masonry construction which contains vertical bar reinforcement, horizontal bar or joint reinforcement, mortar, and grout combined in a manner that the component materials will act together (where masonry resists the compression and reinforcement resists the tension) to resist the design loading conditions. Design will conform to

TMS MSJC, Masonry Standard Joint Committee's (MSJC) Book.

Masonry not meeting the above definition but bonded together with mortar and containing, if necessary, the minimum amount of reinforcement for crack control and vertical stiffeners, is classified as unreinforced masonry.

Masonry design must comply with UFC 3-301-01 Structural Engineering. Following are some pertinent modifications to the 2012 ICC IBC from that UFC standard.

a. Masonry may be designed by allowable stress design or strength design, but empirical design is not permitted.

b. Masonry must be designed as reinforced unless the element is isolated from the structure so that vertical and lateral forces are not imparted to the element.

c. Coupling beams must be designed in accordance with paragraph 14.4.5.3 of ASCE 7-16.

d. Shear walls are required to be in running bond construction.

e. Below-grade masonry walls and elevator shaft masonry walls must be grouted solid.

f. Corrugated metal brick ties are not permitted.

g. Horizontal joint reinforcement is required to be continuous around corners and through wall intersections, unless the intersecting walls are separated. Splicing of joint reinforcement in accordance with TMS MSJC provides continuity.

h. Concrete masonry control joint spacing and placement are required to comply with NCMA TEK 10-2C or 10-3.

i. Clay brick masonry expansion joint spacing, placement, and size are required to comply with BIA Technical Notes 18 and 18A.

j. The lateral deflection for framing supported brick veneer is required to be limited to L/600.

k. Details for masonry veneer/steel stud wall assemblies should comply with BIA Technical Note 28B.

UFC 3-301-01 Appendix B also provides the following "best practices".

a. The base of masonry veneer should be placed on a shelf angle or a foundation ledge that is at least

100 mm 4 inches lower than the base of the steel stud wall. The width of this shelf angle or foundation ledge must accommodate the masonry veneer and cavity, and should not be less than two-thirds of the veneer thickness plus the minimum air space.

b. Shelf angles should be hot-dip galvanized structural steel members. Angles should be provided approximately 3 m 10 feet long segments, with gaps between segments. Gaps should be detailed to allow for thermal expansion and contraction of the steel in angle runs and at building corners. At building corners, corner pieces with each leg no less than 1.2 m 4 feet in length should be detailed, where possible. Limit deflection of horizontal legs of shelf angles to 1.6 mm 1/16 inch at the end of the horizontal leg. Include rotation of the shelf angle support in the deflection limit calculation.

Masonry design in DOD buildings must comply with UFC 3-301-01, Seismic design of Buildings. Following are some pertinent modifications to the 2012 ICC IBC from that UFC standard.

a. Design anchors in masonry in accordance with TMS MSJC. Additionally, at least one of the following must be satisfied.

b. Design anchors to be governed by the tensile or shear strength of a ductile steel element.

c. Design anchors for the maximum load that can be transmitted to the anchors from a ductile attachment, considering both material overstrength and strain hardening of the attachment.

d. Design anchors for the maximum load that can be transmitted to the anchors by a non-yielding attachment.

e. Design anchors for the maximum load obtained from design load combinations that include E, with E multiplied by Omega_0.

f. Post-installed anchors in masonry must be prequalified for seismic applications in accordance with approved qualification procedures.

g. Reinforcement must be continuous around wall corners and through wall intersections, unless the intersecting walls are separated. Reinforcement that is spliced in accordance with applicable provisions of TMS MSJC is considered continuous.

h. Only include horizontal reinforcement that is continuous in the wall or element in computing the area of horizontal reinforcement. Intermediate bond beam steel properly designed at control joints is considered continuous.

i. Where concrete abuts structural masonry, and the joint between the materials is not designed as a separation joint, the joint must conform to the requirements of ASCE 7-16 Section 14.4.3.1.

Masonry design must meet the requirements of the following UFCs if applicable: UFC 3-340-01 "Design and Analysis of Hardened Structures to Resist conventional Weapons Effects; UFC 3-340-02 "Structures to Resist the Effects of Accidental Explosions"; and UFC 4-023-03 "Design of Buildings to Resist Progressive Collapse"

Show the following information on the project drawings:

1. Locations and dimensions of each type of masonry work; wall sections and anchor details.

2. Color, texture, and size of brick and color of mortar if other than natural gray.

3. Bond pattern if other than running bond.

4. All flashing locations and details.

5. Control joint and expansion joint locations and details.

6. Special brick shapes if required.

7. Compressive strength (f'm) of units, mortar, grout, or entire assembly and fy of reinforcement.

8. Reinforcement lateral tie, splice, and bond beam details.

9. Size and location of any pipes, ducts, door and window framing, or other embedded items.

10. Equivalent thickness, in accordance with ACI216.1, or UL assembly for fire rated walls.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 216.1	(2014) Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A951/A951M	(2011) Standard Specification for Steel Wire for Masonry Joint Reinforcement

ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C27	(1998; R 2022) Fireclay and High-Alumina Refractory Brick
ASTM C55	(2023) Standard Specification for Concrete Building Brick
ASTM C62	(2023) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C67/C67M	(2024) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C73	(2023) Standard Specification for Calcium Silicate Brick (Sand-Lime Brick)
ASTM C90	(2024) Standard Specification for Loadbearing Concrete Masonry Units
ASTM C126	(2022) Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
ASTM C129	(2023) Standard Specification for Nonloadbearing Concrete Masonry Units
ASTM C207	(2024) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C216	(2024) Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C315	(2007; R 2021) Standard Specification for Clay Flue Linings and Chimney Pots
ASTM C476	(2023) Standard Specification for Grout for Masonry

ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C586	(2011) Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
ASTM C616/C615M	(2011) Standard Specification for Granite Dimension Stone
ASTM C616/C616M	(2010) Standard Specification for Quartz-Based Dimension Stone
ASTM C641	(2023) Standard Test Method for Iron Staining Materials in Lightweight Concrete Aggregates
ASTM C652	(2022) Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
ASTM C744	(2021) Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units
ASTM C780	(2023) Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C979/C979M	(2024) Standard Specification for Pigments for Integrally Colored Concrete
ASTM C1019	(2024) Standard Test Method for Sampling and Testing Grout
ASTM C1314	(2014) Standard Test Method for Compressive Strength of Masonry Prisms
ASTM C1384	(2012a) Standard Specification for Admixtures for Masonry Mortars
ASTM C1405	(2015) Standard Specification for Glazed Brick (Single Fired, Brick Units)
ASTM C1611/C1611M	(2021) Standard Test Method for Slump Flow of Self-Consolidating Concrete
ASTM C1634	(2011) Standard Specification for Concrete Facing Brick
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2287	(2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E514/E514M	(2020) Standard Test Method for Water

Penetration and Leakage Through Masonry

THE MASONRY SOCIETY (TMS)

TMS MSJC	(2016) Masonry Standard Joint Committee's (MSJC) Book - Building Code Requirements and Specification for Masonry Structures, Containing TMS 402/ACI 530/ASCE 5, TMS 602/ACI 530.1/ASCE 6, and Companion Commentaries

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cut CMU Drawings; G, [_____]

Reinforcement Detail Drawings; G, [_____]

SD-03 Product Data

Hot Weather Procedures; G, [_____]

Cold Weather Procedures; G, [_____]

Clay or Shale Brick; G, [_____]

Glazed Structural Clay Facing Tile; G, [_____]

Glazed Brick; G, [_____]

Salvaged Brick; G, [_____]

Cement; G, [_____]

Cementitious Materials; G, [_____]

Insulation; G, [_____]

SD-04 Samples

Mock-Up Panel; G, [_____]

Clay or Shale Brick; G, [_____]

Glazed Structural Clay Facing Tile; G, [_____]

Glazed Brick; G, [_____]

Concrete Masonry Units (CMU); G, [_____]

Concrete Brick; G, [_____]

Dimension Stone Units; G, [_____]

Admixtures for Masonry Mortar; G, [_____]

Anchors, Ties, and Bar Positioners; G, [_____]

Joint Reinforcement; G, [_____]

Clay Masonry Expansion-Joint Materials; G, [_____]

Insulation; G, [_____]

SD-05 Design Data

Masonry Compressive Strength; G, [_____]

Fire-Rated Concrete Masonry Units

Bracing Calculations; G, [_____]

SD-06 Test Reports

Efflorescence Test

Fire-Rated Concrete Masonry Units

Field Testing of Mortar

Field Testing of Grout

Prism Tests

Single-Wythe Masonry Wall Water Penetration Test

SD-07 Certificates

Special Masonry Inspector Qualifications

Clay or Shale Brick

Glazed Structural Clay Facing Tile

Glazed Brick

Concrete Masonry Units (CMU)

Concrete Brick

Precast Concrete Units

Cementitious Materials

Admixtures for Masonry Mortar

Admixtures for Grout

Anchors, Ties, and Bar Positioners

Joint Reinforcement

Insulation

Insulation

SD-08 Manufacturer's Instructions

Admixtures for Masonry Mortar

Admixtures for Grout

SD-10 Operation and Maintenance Data

Take-Back Program

SD-11 Closeout Submittals

Recycled Content of Clay Units; S

Recycled Content of Cement; S

1.3 QUALITY ASSURANCE

1.3.1 Masonry Mock-Up Panels

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NOTE: A sample panel is a small element of constructed masonry units, usually 1.22 m x 1.22 m 4 ft x 4 ft. A mock-up is a wall segment constructed to show all materials used in the construction as well as typical workmanship. Mock-up panels will be required for structures having over 185 square meters 2,000 square feet of exterior wall area, including openings, and for smaller structures where appearance is important. The list of items to be shown by the sample panel will be edited to provide only the representative items. Typical installation of electrical conduit and boxes may be illustrated by the sample panel when deemed appropriate.

****

1.3.1.1 Mock-Up Panel Location

After material samples are approved and prior to starting masonry work, construct a mock-up panel for each type and color of masonry required. At least 48 hours prior to constructing the panel or panels, submit written notification to the Contracting Officer. Do not build-in mock-up panels as part of the structure; locate mock-up panels where directed. Construct portable mock-up panels or locate in an area where they will not be disrupted during construction.

1.3.1.2 Mock-Up Panel Configuration

Construct mock-up panels L-shaped or otherwise configured to represent all of the wall elements. Construct panels of the size necessary to demonstrate the acceptable level of workmanship for each type of masonry represented on the project. Provide a straight panel or a leg of an L-shaped panel of minimum size 2.5 m 8 feet long by [1.2] [1.8] m [4] [6] feet high.

1.3.1.3 Mock-Up Panel Composition

Show full color range, texture, and bond pattern of the masonry work. Demonstrate mortar joint tooling; grouting of reinforced vertical cores, collar joints, bond beams, and lintels; positioning, securing, and lapping of reinforcing steel; positioning and lapping of joint reinforcement (including prefabricated corners); and cleaning of masonry work during the construction of the panels. Also include installation or application procedures for anchors, wall ties, CMU control joints, brick expansion joints, insulation, flashing, brick soldier, row lock courses and weeps. Include a [a masonry bonded corner] [a stacked bond corner] [a bond beam corner] [and] [parging] [and] [installation of electrical boxes and conduit]. When the panel represents reinforced masonry, include a 610 by 610 mm 2 by 2 foot opening placed at least 610 mm 2 feet above the panel base and 610 mm 2 feet away from all free edges, corners, and control joints. Provide required reinforcing around this opening as well as at wall corners and control joints.

1.3.1.4 Mock-Up Panel Construction Method

Where anchored veneer walls or cavity walls are required, demonstrate and receive approval for the method of construction; i.e., either bring up the two wythes together or separately, with the insulation and appropriate ties placed within the specified tolerances across the cavity. Demonstrate provisions to preclude mortar or grout droppings in the cavity and to provide a clear open air space of the dimensions shown on the drawings. Where masonry is to be grouted, demonstrate and receive approval on the method that will be used to bring up the masonry wythes; support the reinforcing bars; and grout cells, bond beams, lintels, and collar joints using the requirements specified herein. When water-repellent is specified to be applied to the masonry, apply the approved product to the mock-up panel. Construct panels on a properly designed concrete foundation.

1.3.1.5 Mock-Up Panel Purpose

The completed panels is used as the standard of workmanship for the type of masonry represented. Do not commence masonry work until the mock-up panel for that type of masonry construction has been completed and approved. Protect panels from the weather and construction operations until the masonry work has been completed and approved. Perform cleaning procedures on the mockup and obtain approval of the Contracting Officer prior to cleaning the building. After completion of the work, completely remove the mock-up panels, including all foundation concrete, from the construction site.

1.3.2 Special Masonry Inspector Qualifications

Refer to Section 01 45 35 SPECIAL INSPECTIONS for qualifications and responsibilities of the masonry special inspector.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver, store, handle, and protect material to avoid chipping, breakage, and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

1.4.1 Masonry Units

Cover and protect masonry units from precipitation. Conform to handling and storage requirements of TMS MSJC.

a. Pack glazed brick, glazed structural clay tile, and prefaced concrete masonry units in the manufacturer's standard paper cartons, trays, or shrink wrapped pallets with a divider between each unit. Do not stack pallets. Do not remove units from cartons until cartons are placed on scaffolds or in the location where units are to be laid.

b. Mark prefabricated lintels on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.4.2 Reinforcement, Anchors, and Ties

Store steel reinforcing bars, coated anchors, ties, and joint reinforcement above the ground. Maintain steel reinforcing bars and uncoated ties free of loose mill scale and loose rust.

1.4.3 Cementitious Materials, Sand and Aggregates

Deliver cementitious and other packaged materials in unopened containers, plainly marked and labeled with manufacturers' names and brands. Store cementitious material in dry, weathertight enclosures or completely cover. Handle cementitious materials in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Store sand and aggregates in a manner to prevent contamination and segregation.

1.5 PROJECT/SITE CONDITIONS

Conform to TMS MSJC for hot and cold weather masonry erection.

1.5.1 Hot Weather Procedures

When ambient air temperature exceeds 38 degrees C 100 degrees F, or exceeds 32 degrees C 90 degrees F and the wind velocity is greater than 13 km/h 8 mph, comply with TMS MSJC Article 1.8 D for: preparation prior to conducting masonry work; construction while masonry work is in progress; and protection for newly completed masonry.

1.5.2 Cold Weather Procedures

When ambient temperature is below 4 degrees C 40 degrees F, comply with TMS MSJC Article 1.8 C for: preparation prior to conducting masonry work; construction while masonry work is in progress; and protection for newly completed masonry.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design - Specified Compressive Strength of Masonry

The specified compressive strength of masonry, f'm, is [_____] [as indicated for each type of masonry] [indicated in a schedule in this Specification].

2.1.2 Performance - Verify Masonry Compressive Strength

****

NOTE: The Unit Strength Method can be used for clay masonry with units conforming to ASTM C216, ASTM C62, or ASTM C652, with bed joints not exceeding 16 mm 5/8 inch, and with grout conforming to ASTM C476, where grout compressive strength is at least equal to f'm. It can also be used for concrete masonry with units conforming to ASTM C90 or ASTM C55, with bed joints and grout same as clay masonry. The Prism Test Method must be used when the Unit Strength Method, which is conservative, is insufficient to verify compliance and when the above-listed parameters are not met. The Prism Test Method may be used at any time, at the Contractor's option.

****

Verify specified compressive strength of masonry using the "Unit Strength Method" of TMS MSJC. Submit calculations and certifications of unit and mortar strength.

Verify specified compressive strength of masonry using the "Prism Test Method" of TMS MSJC when the "Unit Strength Method" cannot be used. Submit test results.

2.2 MANUFACTURED UNITS

2.2.1 General Requirements

Do not change the source of materials, which will affect the appearance of the finished work, after the work has started except with Contracting Officer's approval. Submit test reports from an approved independent laboratory. Certify test reports on a previously tested material as the same materials as that proposed for use in this project. Submit certificates of compliance stating that the materials meet the specified requirements.

2.2.2 Clay or Shale Brick

****

NOTE: The manufacturer's name and color number or color range will be indicated on the drawings along with the following note: "Colors or color ranges indicated are for identification purposes only and are not intended to limit selection of similar color or color range from other manufacturers."

Grade SW brick provides a high degree of resistance to frost action and deterioration by weathering. Grade MW brick provides a moderate degree of resistance and is only suitable for exterior use in certain parts of the country. Refer to ASTM C216.

Types FBS and HBS brick are for general use where normal size variation and chippage is acceptable. Types FBX and HBX permit less variation in size and chippage and are; therefore, more expensive. Types FBA and HBA permit larger variations for special architectural effect.

Bricks of various sizes are available and, if for architectural reasons, other sized bricks are included in the design, specify the size by listing the specified (not nominal) dimensions and not by name because names can vary. If larger units are required, change the specified dimensions. Nominal dimensions should not be used as they may result in confusion with specified size.

****

2.2.2.1 General

2.2.2.1.1 Sample Submittal

Submit brick samples as specified, showing the color range and texture of clay or shale brick. Limit units used on the project to those that conform to the approved sample. Submit sample of colored mortar with applicable masonry unit and color samples of three stretcher units and one unit for each type of special shape.

2.2.2.1.2 Uniformity

[Manufacture bricks at one time and from the same run.]Deliver clay or shale brick units factory-blended to provide a uniform appearance and color range in the completed wall.

[2.2.2.1.3 Recycled Content

****

NOTE: Use of materials with recycled content, calculated on the basis of post-industrial and post-consumer percentage content, contributes to meeting the requirements of Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Designer must verify that products meeting the indicated minimum recycled content are available, preferably from at least three sources, to ensure adequate competition. Use this paragraph if choosing recycled content.

****

Provide clay units containing a minimum of [0] [5] [_____] percent post-consumer recycled content, and a minimum of [10] [20] [_____] percent post-industrial recycled content.

]2.2.2.1.4 Efflorescence Test

****

NOTE: Delete this paragraph in areas where efflorescence has not been a problem. Efflorescence is generally the result of poor design and detailing. Properly covered or flashed walls are generally free of efflorescence. Efflorescence testing is generally not required.

****

Test clay brick that will be exposed to weathering for efflorescence in accordance with ASTM C67/C67M. Schedule tests far enough in advance of starting masonry work to permit retesting if necessary. Units meeting the definition of "effloresced" are subject to rejection.

2.2.2.2 Solid Clay or Shale Brick

****

NOTE: Specify ASTM C216 facing brick where aesthetic value is a prime consideration or to match existing construction. ASTM C216 may be replaced with ASTM C62 for projects where brick conforming to ASTM C62 provides aesthetic appearance that does not detract from the design, is generally available and predominantly used in the area, and the specific brick will blend with existing or adjacent architecture.

If larger units, such as closure size (92 mm x 92 mm x 194 mm3-5/8 inch x 3-5/8 inch x 7-5/8 inch) or utility size (92 mm x 92 mm x 295 mm3-5/8 inch x

3-5/8 inch x 11-5/8 inch) brick, are required, change the specified dimensions. Consider the use of closure or utility size brick when it is architecturally acceptable. The cost per square foot of wall is generally less when using larger units. Use paragraph titled "Closure or Utility Brick" below.

Compressive strength of the brick units only needs to be specified when it is used structurally; a veneer wythe is nonstructural. Ccommonly available face brick are produced to much higher compressive strength than the minimum required by ASTM C216.

****

Provide solid clay or shale brick that conforms to [ASTM C216, Type [FBS] [FBA] [FBX]] [ASTM C62]. [Provide brick with minimum compressive strength of [_____] MPa psi.] Where brick cores, recesses, or deformation would be exposed to view, provide 100 percent solid units. Provide brick with texture and color tange to match the brick [on display at [_____]] [indicated].

Provide brick with specified sizes.

[a. Modular size, 92 mm 3-5/8 inches thick, 57 mm 2-1/4 inches high, and 194 mm 7-5/8 inches long.

][b. Closure size, 92 mm 3-5/8 inches thick, 92 mm 3-5/8 inches high, and 194 mm 7-5/8 inches long.

][c. Utility size, 92 mm 3-5/8 inches thick, 92 mm 3-5/8 inches high, and 295 mm 11-5/8 inches long.
]

2.2.2.3 Hollow Clay or Shale Brick

****

NOTE: For exposed exterior and interior masonry, Type HBX brick is manufactured to tighter tolerances and less chippage than Type HBS, but is also more expensive. Type HBS is for general use where greater variation is allowed. For architectural effects resulting from nonuniformity in size, use Type HBA. Use Type HBB where color and texture are not a consideration and a greater variation in size is permitted.

Commonly available hollow brick are produced to much higher compressive strength than the minimum required by ASTM C652.

****

Provide hollow clay or shale brick that conforms to ASTM C652, Type [HBS] [HBX] [HBA] [HBB].

a. Provide brick size of [_____] mm inches thick, [_____] mm inches high, and [_____] mm inches long.

b. Where vertical reinforcement is shown in hollow brick, provide hollow brick designed to provide precise vertical alignment of the cells, with minimum cell dimension of 64 mm 2-1/2 inches.

c. Provide hollow brick with minimum compressive strength of [_____] MPa psi.

2.2.2.4 Refractory Brick

Provide brick units that comply with ASTM C27, low-duty type, [_____] mm inches thick, [_____] mm inches high, and [_____] mm inches long.

2.2.2.5 Glazed Brick and Glazed Structural Clay Facing Tile

****

NOTE: Indicate the designation of ceramic glazed brick and glazed structural clay facing tile on the project drawings, or use the schedule to indicate locations. Delete the schedule if it is not used.

ASTM C1405 applies to brick units fired with a glaze in a single process; ASTM C126 applies to brick units fired then fired again with a glaze. ASTM C126 also applies to hollow facing tiles. For both standards, specify Grade SS (select) for walls laid in stack bond; Grade S (standard) is supplied if nothing is specified. Type I indicates a single glazed face while Type II is double faced. Type I is the default.

Normally, prefaced ASTM C1634 concrete masonry units will be specified as a Contractor's option to ceramic glazed structural clay facing units. Structurally, the units will be considered as equal.

****

Provide [ceramic glazed brick] [glazed facing tile] indicated as [_____], conforming to ASTM C1405 [ASTM C126], Type I, Grade [SS] [S], glaze as indicated. In two-faced walls, Type II units may be used for the base course. Provide all shapes and sizes for a complete installation. Use bullnose units along sills and caps and at vertical external corners including door jambs, window jambs, and other such openings. Provide coved base units to meet finished floor surfaces where ceramic tile floor occurs.

a. Where backs of units will be exposed in unfinished rooms, provide smooth backs, free from glaze. Where backs of units will receive plaster, provide scored, combed, or otherwise roughened backs.

b. Provide unit surfaces, to receive mortar, reasonably free from glaze and suitable for receiving mortar.

c. Provide tile for fire rated walls with the percent of solid required for that rating.

****

NOTE: Appropriate information should be indicated. Include this schedule for information when it is not convenient to indicate on the project drawings. Select colors from manufacturer's standard colors.

****

d. Structural Clay Facing Tile Schedule

Location	Nominal Face Dimensions	Color of Field	Color of Base
[_____]	[_____]	[_____]	[_____]

2.2.2.6 Salvaged Brick

****

NOTE: Use of salvaged/recovered materials contributes to meeting the requirements of Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

Include bracketed wording if bricks will be in structures used for children or residences. Indicate on drawings locations where salvaged brick is acceptable.

****

Use [lead-free] salvaged bricks and other masonry units in place of new bricks or masonry units as indicated. [Wash bricks salvaged from foundries or industrial buildings with appropriate metal-dust removing cleaner.] When using salvaged brick, select salvaged exterior face bricks from exterior locations.

Provide salvaged bricks that meet standards of new bricks otherwise used in application, and cleaned of all mortar prior to use. Submit documentation certifying products are from salvaged/recovered sources. Indicate relative dollar value of salvaged content products to total dollar value of products included in project.

2.2.2.7 Flue Linings and Thimbles

Provide units that comply with ASTM C315, and are free from fractures. Provide sizes and shapes as indicated.

2.2.3 Concrete Units

2.2.3.1 Aggregates

****

NOTE: Where sufficient evidence based on previous construction experience indicates concrete masonry units manufactured from aggregate from a specific source may be subject to excessive popouts and/or staining, contract specifications may be written to exclude such aggregate. Delete this article when the concrete units will not be exposed to view.

****

Test lightweight aggregates, and blends of lightweight and heavier aggregates in proportions used in producing the units, for stain-producing iron compounds in accordance with ASTM C641,visual classification method. Do not incorporate aggregates for which the iron stain deposited on the filter paper exceeds the "light stain" classification.

Use industrial waste by-products (air-cooled slag, cinders, or bottom ash), ground waste glass and concrete, granulated slag, and expanded slag in aggregates.

2.2.3.2 Concrete Masonry Units (CMU)

****

NOTE: Concrete units may be produced in three weight classifications. It is important that the weight classification desired be designated.

Low alkali cement maybe specified for use in CMU if efflorescence caused by the use of available cement is a problem. However, these cements are difficult to obtain in some regions where sulfates are not an issue. Also, alkali-silica reactivity (ASR) is not as big an issue in concrete masonry units as it is in cast-in-place concrete. If efflorescence is not a problem, or if the CMU will not be exposed to weather, delete the first sentence.

Specify lightweight aggregate where required for fire-resistive or "U" value purposes. Coordinate with structural and mechanical designers. Otherwise, unit density is at the option of the contractor, including single wythe, grouted walls.

For single-wythe, concrete masonry unit exterior walls, specify water-repellant admixture for both the masonry units and the mortar.

See addition information regarding use of recycled content materials in Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

[2.2.3.2.1 Cement

Use only cement that has a low alkali content and is of one brand.

]2.2.3.2.2 Recycled Content

[Provide units with a minimum of [5] [10] [_____] percent post-consumer recycled content, or a minimum of [20] [40] [_____] percent post-industrial recycled content, based on mass, cost, or volume.][Units may contain post-consumer or post-industrial recycled content.]

2.2.3.2.3 Size

Provide units with specified dimension of [_____] mm inches wide, [_____] mm inches high, and [_____] mm inches long.

2.2.3.2.4 Surfaces

[For units that are to be plastered or stuccoed, provide surfaces that are sufficiently rough to provide bond.] [[Elsewhere, provide][Provide] units with exposed surfaces that are smooth and of uniform texture.]

2.2.3.2.5 Weather Exposure

Provide concrete masonry units with water-repellant admixture added during manufacture where units will be exposed to weather.

2.2.3.2.6 Unit Types

****

NOTE: The weight of concrete masonry units is not important except as it effects porosity, the heavier the block the less porous it will be. Direct design and production of masonry units towards reducing shrinkage, porosity, and absorption. However, heavier units will effect masons' production rates as they prefer the lightest possible units to lay. Proper vibration and autoclave curing of CMU in the manufacturing process will provide better quality units. Admixture to densify units is recommended. Specify loading-bearing type masonry units in exterior walls or interior walls subject to moist environments. Only specify Non-Load-bearing Units for interior partitions.

****

a. Hollow Load-Bearing Units: ASTM C90, lightweight [or medium weight] [or normal weight]. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.

b. Hollow Non-Load-Bearing Units: ASTM C129, lightweight [or medium weight] [or normal weight]. Load-bearing units may be provided in lieu of non-load-bearing units.

c. Solid Load-Bearing Units: ASTM C90, lightweight [or medium weight] [or normal weight] units. Provide solid units as indicated.

2.2.3.2.7 Jamb Units

Provide jamb units of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved.

Provide sash jamb units with a 19 by 19 mm 3/4 by 3/4 inch groove near the center at end of each unit.

2.2.3.3 Architectural Units

****

NOTE: Where architectural units are used, local sources should be checked to determine available shapes, sizes, patterns, and colors. Desired unit pattern should be clearly indicated. Delete integral coloring if units will be painted or if natural color is satisfactory. Concrete masonry veneer wythes should be 100 percent solid units to minimize trapping water which could lead to damage from freezing, mildew, and efflorescence.

****

Provide architectural units with patterned face shell: [fluted] [vertical scored] [split ribbed] [_____].

Provide units that are integrally colored during manufacture, with color [_____].

2.2.3.4 Patterned, Decorative Screen Units

****

NOTE: Manufacturer's catalogs will be consulted for patterned units that are locally available. Optional designs of patterned units will be shown as necessary for competitive bidding.

Concrete masonry units conforming to applicable requirements of ASTM C129 are suitable for interior nonload-bearing screens, and may be specified where required.

****

Provide patterned, decorative screen units that conform to [ASTM C90] [ASTM C129]. Provide units that have uniform through-the-wall pattern, color, and texture.

2.2.3.5 Fire-Rated Concrete Masonry Units

****

NOTE: The thickness of fire-rated walls as well as the required fire rating will be indicated on the drawings. Such walls will be shown as continuous from floor to deck above. Sections and details of these walls will clearly indicate the extent of such walls. Solid grouted hollow concrete units and concrete brick masonry 150 mm 6 inches or greater in thickness will be considered a 4-hour fire-rated wall regardless of aggregate type.

****

For indicated fire-rated construction, provide concrete masonry units of minimum equivalent thickness for the fire rating indicated and the corresponding type of aggregates indicated in TABLE I. Units containing more than one of the aggregates listed in TABLE I will be rated by linear interpolation based on the percent by dry-rodded volume of each aggregate used in manufacturing the units.

TABLE I
FIRE-RATED CONCRETE MASONRY UNITS

Aggregate Type	Minimum Equivalent Thickness for Fire-Resistance Rating, mm inch						
	1/2 hour	3/4 hour	1 hour	1-1/2 hour	2 hours	3 hours	4 hours
Calcareous or siliceous gravel (other than limestone)	50.82.0	70.02.4	71.1 2.8	91.4 3.6	106.7 4.2	134.6 5.3	157.5 6.2
Limestone, cinders, or air-cooled slag	48.31.9	58.42.3	68.6 2.7	86.4 3.4	101.6 4.0	1275.0	149.9 5.9

TABLE I
FIRE-RATED CONCRETE MASONRY UNITS

Aggregate Type	Minimum Equivalent Thickness for Fire-Resistance Rating, mm inch					
Expanded clay, expanded shale, or expanded slate	45.71.8	55.92.2	66.0 2.6	83.8 3.3	91.4 3.6	111.8 4.4	129.5 5.1
Expanded slag or pumice	38.11.5	48.31.9	53.3 2.1	68.6 2.7	81.3 3.2	101.6 4.0	119.4 4.7

Determine equivalent thickness in accordance with ACI 216.1. Where walls are to receive plaster or be faced with brick, or otherwise form an assembly; include the thickness of plaster or brick or other material in the assembly in determining the equivalent thickness. Submit calculation results.

2.2.3.6 Prefaced Concrete Masonry Units

****

NOTE: Bullnose units will be specified only in cases where sharp corners are considered objectionable, such as in heavy traffic areas. If bullnose units are specified, the locations of use will be detailed on the drawings and/or listed in this paragraph.

****

Prefaced concrete masonry units [may] [may not] be provided in lieu of ceramic glazed structural clay facing tile units. Where prefaced concrete masonry units are provided, concrete masonry unit backing may be omitted when the nominal thickness of the prefaced concrete masonry units is the same as the total indicated nominal thickness of the facing tile plus the backing.

a. Provide prefaced concrete masonry units conforming to ASTM C744 using masonry units conforming to ASTM C90, with the facing turned over the edges and ends of the unit at least 9.5 mm 3/8 inch in the direction of the thickness of the unit to form a lip at least 1.6 mm 1/16 inch thick. Limit variation in color and texture to that in the approved sample.

b. Provide all shapes and sized for a complete installation. Use bullnose units along sills and caps and at vertical external corners including door jambs, window jambs, and other such openings with a bullnose radius of 25 mm 1 inch. Cove base units to meet finished floor surfaces where ceramic tile floor occurs.

2.2.3.7 Concrete Brick

****

NOTE: ASTM C1634 concrete brick are used for high strength and resistance to moisture penetration. Split face brick (solid concrete facing units), where required by design, should be added to this paragraph. A particular color and texture may be specified when locally available and competitively

priced. Sizes may be specified for brick or split face brick where required by the design.

ASTM C55 concrete brick are used for lesser strength and moisture resistance, and where appearance is of low importance.

ASTM C73 sand-lime brick may be used on the interior or exterior. Where limited to interior use, Grade MSW may be specified as an option to Grade SW.

****

2.2.3.7.1 Common Concrete Brick

Provide common concrete brick conforming to ASTM C55. Common concrete brick may be used where necessary for filling out in concrete masonry unit construction.

2.2.3.7.2 Concrete Brick for Facing

Provide concrete brick for exposed applications that conforms to ASTM C1634. Submit samples as specified.

2.2.3.7.3 Sand-Lime Brick

Provide calcium-silicate (sand-lime) that conforms to ASTM C73, Grade SW, approximately 92 mm thick, 57 mm high, 194 mm long 3-5/8 inches thick, 2-1/4 inches high, and 8 inches long or modular, with smooth surfaces and natural color.

2.2.4 Precast Concrete Units

****

NOTE: Architectural Cast Stone is a refined architectural concrete building unit manufactured to simulate natural cut stone and may be specified in lieu of precast concrete. It exceeds minimum requirements for compressive strength and weathering qualities essential for common installations and may be a suitable replacement for natural cut limestone, brownstone, sandstone, bluestone, granite, slate, keystone, travertine, and other natural building stones. When specified for use in climates that experience freeze-thaw, its durability can be demonstrated by field performance of similar products in similar exposures for many years, or it can be tested by a modified version of ASTM C666, Procedure A, per Cast Stone Institute literature. Cast stone masonry products may be used as architectural feature, trim, and ornament, facing or other non-structural use in buildings and other structures.

****

2.2.4.1 General

a. Provide precast concrete trim, lintels, copings, splashblocks and sills that are factory-made units in a plant regularly engaged in producing precast concrete units. Unless otherwise indicated, provide precast concrete with minimum [28] [20] MPa [4,000] [3000] psi compressive strength, conforming to Section 03 30 00 CAST-IN-PLACE CONCRETE using 13 mm 1/2 inch to No. 4 nominal-size coarse aggregate, and with reinforcement required for handling of the units. Maintain minimum clearance of 19 mm 3/4 inch between reinforcement and faces of units.

b. Unless precast-concrete items have been subjected during manufacture to saturated-steam pressure of at least 827 kPa 120 psi for at least 5 hours, either damp-cure for 24 hours or steam-cure and then age under cover for 28 days or longer. In precast concrete members weighing over 35 kg 80 pounds provide built-in loops of galvanized wire or other approved provisions for lifting and anchoring.

c. Fabricate units with beds and joints at right angles to the face, with sharp true arises and with drip grooves on the underside where units overhang walls. Form exposed-to-view surfaces free of surface voids, spalls, cracks, and chipped or broken edges and with uniform appearance and color. Unless otherwise specified, provide units with a smooth dense finish.

d. Prior to installation, wet and inspect each unit for crazing. Items showing evidence of dusting, spalling, crazing, or having surfaces treated with a protective coating will be rejected.

e. Submit specified factory certificates.[

f. Provide architectural cast stone masonry trim, copings, heads, and sills that are manufactured in a plant by a producer regularly engaged in producing cast stone. Provide cast stone units that comply with ASTM C1364. Submit test reports and three exemplars of the same cast stone product installed in similar projects in similar climatic conditions.]

2.2.4.2 Precast Concrete Lintels

****

NOTE: Insert strength of concrete; precast lintels usually range from 17 to 25 MPa 2500 to 3500 psi. Alternatively, reinforced masonry lintels may be designed in conformance with TMS MSJC.

****

Provide precast concrete lintels, unless otherwise shown, of a thickness equal to the wall and reinforced with minimum two No. 4 bars for the full length. Provide top and bottom bars for lintels over 914 mm 36 inches in length. Provide at least 200 mm 8 inches bearing at each end. Label the top of lintels and clearly mark each lintel to show location in the structure. Design reinforced lintels in conformance with ACI 318M ACI 318 for flexural and shear strength, using concrete with a minimum 28 day compressive strength of [_____] MPa psi. Limit lintel deflection due to dead plus live load to L/600 or 7.6 mm 0.3 inches.

2.2.4.3 Precast Concrete Sills and Copings

****

NOTE: Lug sills, which are longer than the window opening, eliminate the vulnerable head joint that occurs at the end of slip sills, which are the same length as the window opening.

****

Cast sills and copings washes. For windows having mullions, cast sills in sections with head joints at mullions and a 6 mm 1/4 inch allowance for mortar joints. Roughen the ends of sills, except a 19 mm 3/4 inch wide margin at exposed surfaces, for bond. Provide rounded nosings on treads of door sills. [Reinforce sills with not less than two No. 15 No. 4 bars.]

2.2.5 DIMENSION STONE UNITS

****

NOTE: The stone specified herein is for structures requiring a limited quantity of cut stone. Where previous experience indicates difficulty in obtaining precast concrete trim of the specified quality, stone may be specified as a Contractor's option.

****

Provide dimension stone for trim, sills, lintels, and copings cut to the design shown and conforming to:

Limestone	ASTM C586	Standard buff color with a smooth machine finish free from tool marks
Sandstone	ASTM C616/C616M	Standard grade, buff, gray, or buff brown, with a smooth finish free from clay pits and tool marks
Granite	ASTM C616/C615M	Commercial grade of medium or moderately coarse grain, with a light or medium gray or light pink color

Provide a smooth machine finish on washes, 4-cut finish on treads, and 6-cut or equivalent machine finish on other exposed surfaces. Except when supported by a steel member, provide lintels 100 mm 4 inches or more in thickness from face to back edge and of the depth required to support the masonry over the opening. Fabricate stone with beds and joints at right angles to the face, and with sharp, true arises. Provide copings and sills with washes, and where overhanging the walls, with drips cut on the underside. Submit samples as specified.

2.3 EQUIPMENT

****

NOTE: The requirement for spare vibrator may be deleted on small projects.

****

2.3.1 Vibrators

Maintain at least one spare vibrator on site at all times.

2.3.2 Grout Pumps

Pumping through aluminum tubes is not permitted.

2.4 MATERIALS

2.4.1 Mortar Materials

****

NOTE: Refer to ASTM C270 for specifying mortar, which allows mortar to be specified by proportions (ASTM C270 Table 1) or properties (ASTM C270 Table 2) but not both. Acceptable cementitious materials are listed in the standard, though not all are appropriate for all applications. For instance, some cements are used for high early strength or for sulfate resistance. See Table Hydraulic Cements for Masonry Mortar below for comparable designations between different cement specifications. Also, ASTM C270 Appendix X1 contains guidance on selection and use of mortar for unit masonry by location (exterior, interior, above grade, below grade) and building segment type (wall, partition, foundation, etc.).

Mortar that complies with ASTM C1714 for Unit Masonry, meets the requirements of ASTM C270. These mortars are preblended dry in a factory and delivered to the job-site in packages (bags or silos or trucks).

A good rule of thumb is to specify the weakest mortar that will perform adequately, not the strongest. In accordance with TMS MSJC, mortar in masonry elements that are part of the seismic force-resisting system in Seismic Design Category D or higher must be Type S or Type M, and must use portland cement/lime or mortar cement as their cementitious material (masonry cement is not permitted). Therefore, these masonry members must be indicated on the Drawings. Type O mortar should not be used in new construction.

Laboratory testing of mortar is only required for acceptance of mortar mixes under the property specifications of ASTM C270. Field testing of mortars, conducted under ASTM C780, is used to verify consistency of materials and procedures, not mortar strength. While field testing of mortar strength is not recommended, it can provide information about degree of quality control exercised during mortar production at the construction site if compared to preconstruction test values. However, compressive test results for mortar are evaluated after 28 days, so mortar-aggregate ratio testing per ASTM C780, which can take as little as four hours, may be more useful for evaluating mortar consistency. Observation of mortar mixing, to verify proper proportioning, is the best evaluator of mortar consistency and quality.

For white mortar, specify white cement. For colored mortar, white cement or gray cement may be

specified, depending on the desired color. Color is achieved by adding pigments at the time of mixing or by selecting preblended colored cementitious materials or preblended colored mortar materials. Excessive use of pigments to achieve mortar color may reduce both compressive and tensile strengths of masonry. Conformance to maximum percentages indicated will limit loss of strength to acceptable amounts. Due to their fine particle size, coloring pigments increase water demand.

Where efflorescence is a concern, techniques for minimizing its occurrence are described in ASTM C1400. Techniques include: minimizing water penetration into the wall, such as by use of overhangs; facilitating drainage of water in the wall; avoiding contact between dissimilar masonry units; and minimizing potential efflorescence compounds in the wall materials.

****

2.4.1.1 Cementitious Materials

****

NOTE: See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING and include additive options unless designer determines that justification for non-use exists. Supplementary cementitious materials are often included as ingredients in mortar that conforms to ASTM C595 blended cements or ASTM C1157 hydraulic cements. See "Hydraulic Cements for Masonry Mortar" table below for different ASTM C150, C595, and C1157 cements that are allowed in masonry mortar by ASTM C270. For example, high-early strength cement may be used when constructing in cold weather. Contractors select cementitious materials based on performance, availability, and familiarity, and the Contracting Officer should be aware that more than one cement designation can satisfy the same need, such as high early strength.

Hydraulic Cements for Masonry Mortar			
	Cement Specification[+]		
	ASTM C150 portland cements	**ASTM C595 blended hydraulic cements ***	**ASTM C595 blended hydraulic cements ***
General Purpose	**I**	**IL IS(<70) IP IT(S<70)**	**GU**

Hydraulic Cements for Masonry Mortar			
	Cement Specification+		
	ASTM C150 portland cements	**ASTM C595 blended hydraulic cements ***	**ASTM C595 blended hydraulic cements ***
Moderate heat of hydration	**II(MH)**	**IL(MH) IS(<70)(MH) IP(MH) IT(S<70)(MH)**	**MH**
High early strength	**III**	**-**	**HE**
Low heat of hydration	**IV**	**IL(LH) IS(<70)(LH) IP(LH) IT(S<70)(LH)**	**LH**
Moderate sulfate resistance	**II, II(MH)**	**IS(<70)(MS) IP(MS) IT(S<70)(MS)****	**MS**
High sulfate resistance	**V**	**IS(<70)(HS) IP(HS) IT(S<70)(HS)****	**HS**
***Type IT(S<70) cements are ternary blended cements with less than 70 percent by mass slag cement content. For this table, this includes ternary blended cements with pozzolans and limestone (no slag cement) as the non-portland ingredients.**			
****Type IT cements with between 5 and 15 percent (by mass) limestone content are not permitted to be used in sulfate exposure applications, pending results of research.**			
+Air-entrained counterparts for cements listed are also allowed in masonry mortar per the proportioning requirements of ASTM C270.			

****

Provide cementitious materials that conform to those permitted by ASTM C270.

2.4.1.2 Hydrated Lime and Alternates

****

NOTE: Higher lime content increases workability and water retentivity. Allowable lime materials include ASTM C207 hydrated lime and ASTM C5 quicklime.

****

Provide lime that conforms to one of the materials permitted by ASTM C207 for use in combination with portland cement, hydraulic cement, and blended hydraulic cement. Do not use lime in combination with masonry cement or mortar cement.

2.4.1.3 Colored Mortar

****

NOTE: Indicate on the drawings locations of colored mortar. Maximum allowable pigment dosages are based on ASTM C270 Appendix X1 and TMS MSJC Article 2.6 A.2. When pigments that comply with ASTM C979 are used at maximum permitted dosage, 28-day strength of colored mortar is not less than 90 percent of the control mix and water-cementitious materials ratio is no more than 110 percent of the control mix.

****

Use mortar pigment that conforms to ASTM C979/C979M. Add pigment to mortar to produce a uniform color matching [_____]. Furnish pigments in accurately pre-measured and packaged units that can be added to a measured amount of cementitious materials or supply pigments via preblended cementitious materials or dry mortar mix.

a. In masonry cement or mortar cement, do not exceed [5][_____] percent of cement weight for mineral oxide pigment; do not exceed [1][_____] percent of cement weight for carbon black pigment.

b. In cement-lime mortar mix, do not exceed [10][_____] percent of cementitious materials' weight for mineral oxide pigment; do not exceed [2][_____] percent of cementitious materials' weight for carbon black pigment.

2.4.1.4 Admixtures for Masonry Mortar

****

NOTE: Admixtures can improve performance of mortar and are specified for beneficial purposes, but potential negative side effects include an increased risk of efflorescence, reduced strength of mortar, and corrosion of embedded steel items. Admixtures that comply with ASTM C1384 have limited negative side effects and meet the minimum requirements for improvement in performance of the desired attribute, such as rate of set, water-repellency, or bond.

Showers, kitchens, and single-wythe concrete masonry unit exterior walls should be built with concrete block containing integral water-repellent admixture. When water repellents are used in concrete masonry, the mortar should contain a compatible water-repellent admixture. A complementary material from the same manufacturer and of the same brand is designed to be compatible with the block admixture.

****

In cold weather, use a non-chloride based accelerating admixture that conforms to ASTM C1384, unless Type III portland cement is used in the mortar.

In showers and kitchens, use mortar that contains a water-repellent admixture that conforms to ASTM C1384. Provide a water-repellent admixture, conforming to ASTM C1384 and of the same brand and manufacturer as the block's integral water-repellent, in the mortar used to place concrete masonry units that have an integral water-repellent admixture.

2.4.1.5 Aggregate and Water

Provide aggregate (sand) and water that conform to materials permitted by ASTM C270.

2.4.2 Grout and Ready-Mix Grout Materials

****

NOTE: Acceptable cements for masonry grout are listed in ASTM C476 and are summarized in Table "Hydraulic Cements for Masonry Grout Construction in ASTM C476" below. Check the local availability of specific cements as all cements are not available everywhere. Per ASTM C476, other acceptable cementitious materials for masonry grout are fly ash and slag and small quantities of lime. Note that masonry cement and mortar cement are not permitted to be used in grout. When high-early strength cement, such as Type III Portland cement, is used for cold weather construction, the protection period for grouted masonry may be reduced.

Hydraulic Cements for Masonry Grout Construction in ASTM C476

Cement specification*	**General Purpose**	**High early strength**	**Moderate sulfate resistance**	**High sulfate resistance**
ASTM C150 portland cements	**I**	**III**	**II**	**-**
ASTM C595 blended hydraulic cements**	**IS(<70)** **IP**	**-**	**IS(<70)(MS)**	**-**
ASTM C1157 hydraulic cements	**GU**	**HE**	**MS**	**HS**
*** Air-entrained counterparts for these cements listed are also allowed in masonry grout. However, use of air-entrainment is not recommended when the grout will be used to bond reinforcement to the masonry units.**				
******				

****

2.4.2.1 Cementitious Materials for Grout

Provide cementitious materials that conform to those permitted by ASTM C476.

2.4.2.2 Admixtures for Grout

****

NOTE: Admixtures, including air entrainment, may contribute to efflorescence and may adversely affect the strength of the mix or the protection of embedded steel items. Admixtures that comply with C494/C494M Type F or G water reducing admixtures and

viscosity-modifying admixtures are permitted, but others, such as integral waterproofing compounds, accelerators, and others, require approval from purchaser.

When concrete masonry and clay brick units are highly absorbent, a grouting aid admixture may be desirable to reduce early water loss, promote bonding, and produce slight expansion to help ensure complete filling of cavities.

****

Water-reducing admixtures that conform to ASTM C494/C494M Type F or G and viscosity-modifying admixtures that conform to ASTM C494/C494M Type S are permitted for use in grout. Other admixtures require approval by the Contracting Officer.

In cold weather, a non-chloride based accelerating admixture may be used subject to approval by the Contracting Officer; use accelerating admixture that is non-corrosive and conforms to ASTM C494/C494M, Type C.

2.4.2.3 Aggregate and Water

Provide fine and coarse aggregates and water that conform to materials permitted by ASTM C476.

2.5 MORTAR AND GROUT MIXES

****

NOTE: Some preblended mortars may require special mixing procedures. If so, follow manufacturers published recommendations.

Indicate seismic force-resisting masonry elements on the Drawings.

****

2.5.1 Mortar Mix

a. Provide mortar Type [N] [S] [M] unless specified otherwise herein. [Do not use masonry cement in the mortar.] [Do not use air-entrainment in the mortar.]

b. Use ASTM C270 Type [S] [M] cement-lime mortar or mortar cement mortar for seismic-force-resisting elements indicated.[

c. Provide mortar that conforms to ASTM C270. Use Type [M] [S] [N] mortar [for foundation walls] [, basement walls,] [and in piers].][

d. Provide Type N or S mortar for non-load-bearing, non-shear-wall interior masonry.][

e. Provide approved commercial fire clay mortar or refractory cement (calcium-aluminate) mortar for fire brick and flue liners.]

f. [c][d][e][f]. For field-batched mortar, measure component materials by volume. Use measuring boxes for materials that do not come in packages, such as sand, for consistent batching. Mix cementitious materials and aggregates between 3 and 5 minutes in a mechanical batch mixer with a sufficient amount of water to produce a workable consistency. Do not hand mix mortar unless approved by the Contracting Officer. Maintain workability of mortar by remixing or retempering. Discard mortar that has begun to stiffen or is not used within 2-1/2 hours after initial mixing.

g. [d][e][f][g]. For preblended mortar, follow manufacturer's mixing instructions.

2.5.2 Grout and Ready Mix Grout Mix

****

NOTE: Grout strength must be at least as great as the specified compressive strength of masonry (f'm) but not less than 14 MPa 2000 psi at 28 days. Revise specification when grout compressive strength is required to be in excess of 14 MPa 2000 psi.

Choice of fine or coarse grout depends on width of grout space and pour height; tabulated limitation can be found in TMS MSJC. The Contractor usually has the option to select grout type, but under special circumstances, the Engineer-of-Record may want to define grout type.

****

Use grout that conforms to ASTM C476, [fine] [coarse]. Use conventional grout with a slump between 203 and [279] mm 8 and [11] inches. Use self-consolidating grout with slump flow of 610 to 762 mm 24 to 30 inches and a visual stability index (VSI) not greater than 1. Provide minimum grout strength of [14][_____] MPa [2000][_____] psi in 28 days, as tested in accordance with ASTM C1019. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless additional evidence is furnished that grout meets the specified requirements. Use ready-mixed grout that conforms to ASTM C476.

2.6 ACCESSORIES

2.6.1 Grout Barriers

Grout barriers for vertical cores that consist of fine mesh wire, fiberglass, or expanded metal.

2.6.2 Anchors, Ties, and Bar Positioners

****

NOTE: By definition, ties are connections between masonry wythes, anchors connect masonry to the structure and connect veneer to its backing, and fasteners are for attachment of non-masonry items to masonry. The anchors and ties specified in this paragraph are primarily used to laterally tie masonry veneer to backup elements. Anchors and ties not incorporated in the design should be deleted. If special anchors or ties are required by the design, they will be specified to meet the necessary requirements. Standard anchors and ties can be used in cavities up to 114 mm 4.5 inches wide.

The required minimum zinc coating thicknesses for wire ties, anchors, and joint reinforcement are shown in the following table and are based on exposure:

Exposure	**Finish**	**Wt. of Coating in Gram Per Sq. Meter Oz. Per Sq. Foot**
Joint reinforcement, interior walls	**ASTM A641/A641M**	**31 0.1**
Wire ties or anchors	**ASTM A53/A153M**	**458 1.50**
Steel plates and bars	**ASTM A153/A153M Class B or ASTM A123/A123M as applicable to size and form**	
Joint reinforcement in exterior walls or interior walls exposed to moist environments (e.g. natatoria and food processing)	**ASTM A153/A153M**	**458 1.50**
Sheet metal ties or anchors in masonry exposed to weather	**ASTM A153/A153M Class B**	**458 1.50**
Sheet metal ties or anchors	**ASTM A653/A653M (Class G60)**	**180 .60**

****

2.6.2.1 General

a. Fabricate anchors and ties without drips or crimps. Size anchors and ties to provide a minimum of 16 mm 5/8 inch mortar cover from each face of masonry.

b. Fabricate steel wire anchors and ties from wire conforming to ASTM A1064/A1064M and hot-dip galvanize in accordance with ASTM A153/A153M.

c. Fabricate joint reinforcement in conformance with ASTM A951/A951M. Hot dip galvanize joint reinforcement in exterior walls and in interior walls exposed to moist environment in conformance with ASTM A153/A153M. Galvanize joint reinforcement in other interior walls in conformance with ASTM A641/A641M; coordinate with paragraph JOINT REINFORCEMENT below.

d. Fabricate sheet metal anchors and ties in conformance with ASTM A1008/A1008M. Hot dip galvanize sheet metal anchors and ties in exterior walls and in interior walls exposed to moist environment in compliance with ASTM A153/A153M Class B. Galvanize sheet metal anchors and ties in other interior walls in compliance with ASTM A653/A653M, Coating Designation G60.

e. Submit two anchors, ties and bar positioners of each type used, as samples.

2.6.2.2 Wire Mesh Anchors

****

NOTE: Wire mesh anchors will only be used to connect interior non-bearing walls to other intersecting interior non-bearing masonry walls.

****

Provide wire mesh anchors of 6 mm 1/4 inch mesh galvanized hardware cloth, conforming to ASTM A185/A185M, with length not less than 305 mm 12 inches, at intersections of interior non-bearing masonry walls.

2.6.2.3 Wall Ties for Multi-Wythe Masonry Construction

****

NOTE: Wall ties will be specified to provide an option to the typically used continuous joint reinforcement to anchor the outer wythe to the inner wythe of multiple wythe masonry construction. Vertical spacing will normally be 400 mm 16 inches on center and horizontal spacing of the unit ties will normally be 600 mm 24 inches on center.

Rectangular ties may be used with either solid or hollow units. The maximum wall area per rectangular tie of wire size MW11 W1.7 is 0.25 m2 2-2/3 ft2; when the wire size is MW18 W2.8 the maximum wall area per tie is 0.42 m2 4.5 ft2. There are additional requirements for wall ties based on how the masonry is designed (veneer or engineered non-composite), spacing, and seismic design category of buildings with veneer.

Adjustable wall ties are normally used when constructing one wythe independent of the other. The preferred method of construction, however, is to bring the wythes up together. Delete the sentences pertaining to adjustable ties when they are not permitted.

****

Provide rectangular-shaped wall ties, fabricated of hot-dipped galvanized [

MW11W1.7][MW18W2.8] diameter steel wire. Provide rectangular wall ties no less than 100 mm 4 inches wide.

Provide adjustable type wall ties, if approved for use, that consist of two essentially U-shaped elements fabricated of minimum MW18 W2.8 diameter steel wire or pintle type ties that are inserted to eyes of horizontal joint reinforcement, hot-dip galvanized. Provide adjustable ties with double pintle legs and allows a maximum offset of 32 mm 1-1/4 inch between each element of the tie and maximum distance between connecting parts no more than 2 mm 1/16 inch. Form the pintle and eye elements so that both can be in the same plane. Wall ties may also be of a continuous type conforming to paragraph JOINT REINFORCEMENT.

2.6.2.4 Dovetail Anchors

Provide dovetail anchors of 5 mm 3/16 inch diameter steel wire, triangular shaped, and attached to a 12 gauge 12 gauge or heavier steel dovetail section. Use these anchors to connect the exterior masonry wythe as it passes over the face of concrete columns, beams, or walls. Fill cells immediately above and below these anchors unless solid units are used. Furnish dovetail slots, which are specified to be installed by others, in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.6.2.5 Adjustable Anchors

****

NOTE: Adjustable anchors will be used to anchor masonry to structural steel columns or beams. Such anchors will be either be detailed on the drawings, or the capacity requirements will be given in the specification and the contractor will be required to submit test data to verify compliance. Select the appropriate option.

Adjustable anchors may also be used to connect veneer to its backing. Adjustable anchors are required when the backing for the veneer is steel stud framing or concrete.

****

2.6.2.5.1 Anchorage to Structural Steel

Provide [hot-dip galvanized] [stainless steel] adjustable anchors for connecting masonry walls to the structural steel frame [as detailed on the drawings] [that have [_____] kg pounds capacity in both tension and compression for the span indicated when placed at [_____] mm inches on center; submit test data to verify compliance]. [Provide zinc-rich paint for touching up paint after welding galvanized anchors to structural steel.]

2.6.2.5.2 Anchorage of Veneer to Light Gauge Steel or Concrete Backing

Use one of the following types of adjustable anchors to connect veneer to light gauge steel or concrete backing:

a. sheet metal at least 22 mm 7/8 inch wide, 1.5 mm 0.06 inch thick, and with corrugations having a wavelength of 7.6 to 12.7 mm 0.3 to 0.5 inch and an amplitude of 1.5 to 2.5 mm 0.06 to 0.10 inch or bent, notched or punched to provide equivalent performance;

b. wire anchors of minimum size MW11 W1.7 with ends bent to form a minimum 50 mm 2 inches extension and without drips;

c. or wire pintle anchors used in conjunction with joint reinforcement.

Do not exceed 1.6 mm 1/16 inch clearance between connecting parts of the tie. Assemble adjustable anchors to prevent disengagement. Provide pintle anchors with one or more pintle legs of wire size MW18 W2.8 and an offset not exceeding 32 mm 1-1/4 inch.

2.6.2.6 Veneer Anchor Screws

****

NOTE: This paragraph should be edited to reflect the design option selected.

****

Provide screws for attachment of veneer anchors to cold-formed steel framing members of size [No. 12] [as indicated] [as required by design to provide the needed pullout load capacity but not less than No. 12]. Provide length of screws such that the screws penetrate the holding member by not less than 16 mm 5/8 inch.

2.6.2.7 Bar Positioners

Factory-fabricate bar positioners, used to prevent displacement of reinforcing bars during the course of construction, from 9 gauge steel wire or equivalent, and hot-dip galvanized. Bar positioners must be suitable for intended use and be corrosion resistant steel. Bar positioners not fully contained within the wythe must be hot-dip galvanized.

2.6.3 Joint Reinforcement

****

NOTE: Location of horizontal joint reinforcement should be shown on the drawings. Reinforcement will have one longitudinal wire in each mortar bed. Truss-type joint reinforcement will not be used. Adjustable joint reinforcement assemblies may be used in certain types of construction where it is feasible to construct one wythe independent of the other. If the type of design does not permit this type of construction, delete the sentences pertaining to adjustable joint reinforcement assemblies.

Various combinations of wire sizes are available and are usually designated as follows:

	Long. wires	**Cross wires**
Standard	**3.8 mm9 gauge (0.1483 inch)**	**3.8 mm9 gauge (0.1483 inch)**

	Long. wires	**Cross wires**
Heavy Duty	**4.8 mm3/16 inch (0.1875 inch)**	**3.8 mm9 gauge (0.1483 inch)**
Extra Heavy Duty	**4.8 mm3/16 inch (0.1875 inch)**	**4.8 mm3/16 inch (0.1875 inch)**

****

Factory fabricate joint reinforcement in conformance with ASTM A951/A951M, welded construction. Provide ladder type joint reinforcement, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units and with all wires a minimum of [9][_____] gauge. Size joint reinforcement to provide a minimum of 16 mm 5/8 inch cover from each face. Space crosswires not more than 400 mm 16 inches. Provide joint reinforcement for straight runs in flat sections not less than 3 m 10 feet long. Provide joint reinforcement with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features. Submit one piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

2.6.4 Reinforcing Steel Bars

****

NOTE: ASTM A615/615M is typically used. Only use weldable bars if welding is unavoidable.

****

Provide reinforcing steel bars and rods conforming to ASTM A615/A615M or ASTM A996/A996M, Grade 60.

2.6.5 Concrete Masonry Control Joint Keys

****

NOTE: Control joint keys are generally not required vertically when the concrete masonry spans vertically and no shear transfer is required across control joints. Delete paragraph when not required. Control joints will be detailed on the drawings. When control joint keys are not required by design, such as at reinforced bond beams, the control joint detail will show the head joint completely filled with mortar for the width of the wythe; but joints will be flush, raked, or raked and sealed as required.

****

Provide control joint keys of a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D2000 M2AA-805 with a minimum durometer hardness of 80 or polyvinyl chloride conforming to ASTM D2287 Type PVC 654-4 with a minimum durometer hardness of 85. Form the control joint key with a solid shear section not less than 16 mm 5/8 inch thick and 10 mm 3/8 inch thick flanges, with a tolerance of plus or minus 1.5 mm 1/16 inch, to fit neatly, but without forcing, in masonry unit jamb sash grooves.

2.6.6 Clay Masonry Expansion-Joint Materials

****

NOTE: Using interior low-VOC products contributes to meeting the requirements of Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

Provide backer rod and sealant, adequate to accommodate joint compression and extension equal to 50 percent of the width of the joint. Provide the backer rod of compressible rod stock of closed cell polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Provide sealant in conformance with Section 07 92 00 JOINT SEALANTS[with a maximum volatile organic compound (VOC) content of 600 grams/liter].

Submit one piece of each type of material used.

2.6.7 Through Wall Flashing and Weeps

****

NOTE: Require flashing in exterior masonry walls, including single-wythe construction, at all obstructions such as bond beams, sills, lintels, shelf angles, and concrete tie beams. The wall design and detailing must conform to National Concrete Masonry Association (NCMA) publications: TEK 19-2B, "Design for Dry Single-Wythe Concrete Masonry Walls"; TEK 19-4A, "Flashing Strategies for Concrete Masonry Walls"; TEK 19-5A, "Flashing Details for Concrete Masonry Walls"; TEK 10-2C, "Control Joints for Concrete Masonry Walls"; and BIA Technical Notes 7 Water Penetration, Resistance. Show locations and details on project drawings. This is a regional requirement which must be used, when applicable, for NAVFAC SE projects; when appropriate, the requirements may be used for projects in other areas.

Copper may stain masonry and deteriorate in high chloride environments. Deformed copper may be specified only when mortar must bond to the flashing, such as under copings without dowels.

Through wall flashing of single wythe walls is not appropriate for all applications. Omit this section when design requires seismic shear resistance of the masonry wall.

****

2.6.7.1 General

Provide coated copper, copper or stainless steel sheet, self-adhesive rubberized sheet, or reinforced membrane sheet flashing [except that flashing indicated to terminate in reglets must be metal or coated-metal flashing] [and] [except that the material must be one which is not adversely affected by dampproofing material.]

2.6.7.2 Coated-Copper Flashing

Provide 0.2 kg 7 ounce, electrolytic copper sheet, uniformly coated on both sides with acidproof, alkaliproof, asphalt impregnated kraft paper or polyethylene sheets.

2.6.7.3 Copper or Stainless Steel Flashing

Provide copper sheet, complying with ASTM B370, minimum 450 kg 16 ounce weight; or stainless steel, ASTM A167, Type 304 or 316, 0.4 mm 0.015 inch thick, No. 2D finish. [Where indicated, provide with factory-fabricated deformations that mechanically bond flashing against horizontal movement in all directions, where deformations consist of dimples, diagonal corrugations, or a combination of dimples and transverse corrugations.]

[2.6.7.4 Reinforced Membrane Flashing

Provide polyester film core with a reinforcing fiberglass scrim bonded to one side. Provide membrane that is impervious to moisture, flexible, is not affected by caustic alkalis, and after being exposed for not less than 1/2 hour to a temperature of 0 degrees C 32 degrees F, shows no cracking when, at that temperature, it is bent 180 degrees over a 2 mm 1/16 inch diameter mandrel and then bent at the same point over the same size mandrel in the opposite direction 360 degrees.

]2.6.7.5 Rubberized Flashing

Provide self-adhesive rubberized asphalt sheet flashing consisting of 0.8 mm 32-mil thick pliable and highly adhesive rubberized asphalt compound bonded completely and integrally to 0.2 8-mil thick, high density, cross-laminated polyethylene film to produce an overall thickness of 1 mm 40 mils. Provide rubberized, asphalt-based mastic and surface conditioner that are each approved by flashing manufacturer for use with flashing material.

2.6.7.6 Weep Ventilators

Provide weep ventilators that are prefabricated from stainless steel or plastic. Provide inserts with grill or louver-type openings designed to allow the passage of moisture from cavities and to prevent the entrance of insects, and with a rectangular closure strip to prevent mortar droppings from clogging the opening. Provide ventilators with compressible flanges to fit in a standard 10 mm 3/8 inch wide mortar joint and with height equal to the nominal height of the unit.

2.6.7.7 Single-Wythe Exterior Wall CMU Flashing System

In single-wythe exterior CMU walls, provide a system of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. For exterior CMU walls, provide a flashing/weep system in open cores that do not receive grout. Cell flashing pans are to have integral weep spouts built into mortar bed joints that extend into the cell to prevent clogging with mortar.

2.6.7.8 Metal Drip Edge

Provide stainless steel drip edge, 0.4 mm 15-mil thick, hemmed edges, with down-turned drip at the outside edge and upturned dam at the inside edge for use with membrane flashings.

2.6.8 RIGID BOARD-TYPE INSULATION

****

NOTE: Insert the appropriate thickness and R-Value to be used for the insulation. The total R-value for the insulation and the total thickness of the insulation must be coordinated to fit the space provided within the wall cavity. The thickness of the insulation must allow for not less than 19 mm 3/4 inch air space between the insulation and the facing veneer. This will limit the insulation thickness to 50 mm 2 inches in a 70 mm 2-3/4 inch) cavity space. If greater insulation thickness is required the masonry wall must be designed to provide a larger cavity.

To assure adequate competition, an R-value should be chosen that allows several products to meet the specified thickness. The range of design R-values (in IP units) for foam insulations given by ASHRAE is 5 to 7 per inch. Verify range available from manufacturers. An aged R-value in SI units of 2 IP units of 11) can be readily achieved with 50 mm 2 inches of insulation.

Cellular plastic insulations (polystyrene, polyurethane and polyisocyanurate) are thermally efficient, however, certain precautions should be observed in their use due to high smoke development and toxicity of the smoke generated by the burning of these materials. Cellular plastic insulations should only be used in anchored veneer masonry walls where the insulation is completely isolated from the interior of the building by masonry, including all penetrations of the interior wythe.

****

Provide rigid board-type insulation as specified in Section 07 21 13 BOARD AND BLOCK INSULATION.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to start of work, verify the applicable conditions as set forth in TMS MSJC, inspection.

3.2 PREPARATION

3.2.1 Stains

Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

3.2.2 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.2.3 Concrete Surfaces

Where masonry is to be placed, clean concrete of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least 3 mm 1/8 inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

3.2.4 Shelf Angles

Adjust shelf angles as required to keep the masonry level and at the proper elevation.

3.2.5 Bracing

****

NOTE: TMS MSJC, Article 3.3 E Commentary references "Standard Practice for Bracing Masonry Walls Under Construction" for guidance on wall bracing requirements. Design wind pressure for bracing design is lower than that required by building code for long term building performance.

****

Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by OSHA and local codes and submit bracing calculations, sealed by a registered professional engineer. Do not remove bracing in less than 10 days.

3.3 ERECTION

****

NOTE: Specify bond pattern for each type of masonry. Where more than one bond pattern is required, the drawings should indicate the location and extent of each bond pattern. Bond patterns for reinforced hollow masonry construction should be such that cores of units will be in vertical alignment. Perfect vertical alignment of cells may require special masonry units. Where stacked bond is specified in reinforced hollow masonry, provide horizontal reinforcing bars at maximum 1220 mm 4 foot intervals or horizontal joint reinforcement must be required in every other horizontal joint to provide mechanical bond between adjacent units. When veneer is specified to be laid in stack bond and the project is in Seismic Design Category E or higher, horizontal joint reinforcement consisting of a single wire size MW11 W1.7 is required at a maximum spacing of 460 mm 18 inches. The use of stacked bond is discouraged and should only be permitted for small wall areas to give an architectural feature, such as for a building entrance detail.

****

3.3.1 General

a. Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Lay masonry units in [running] [stacked] [the indicated] bond pattern. Lay facing courses level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances is plus or minus 13 mm 1/2 inch. Adjust each unit to its final position while mortar is still soft and has plastic consistency.

b. Remove and clean units that have been disturbed after the mortar has stiffened, and relay with fresh mortar. Keep air spaces, cavities, chases, expansion joints, and spaces to be grouted free from mortar and other debris. Select units to be used in exposed masonry surfaces from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work.

c. When necessary to temporarily discontinue the work, step (rack) back the masonry for joining when work resumes. Toothing may be used only when specifically approved by the Contracting Officer. Before resuming work, remove loose mortar and thoroughly clean the exposed joint. Cover the top of walls subjected to rain or snow with nonstaining waterproof covering or membrane when work is not in process. Extend the covering a minimum of 610 mm 2 feet down on each side of the wall and hold securely in place.

d. Ensure that units being laid and surfaces to receive units are free of water film and frost. Lay solid units in a nonfurrowed full bed of mortar. Bevel mortar for veneer wythes and slope down toward the cavity side. Shove units into place so that the vertical joints are tight. Completely fill vertical joints between solid units with mortar, except where indicated at control, expansion, and isolation joints. Place hollow units so that mortar extends to the depth of the face shell at heads and beds, unless otherwise indicated. Mortar will be permitted to protrude up to 13 mm 1/2 inch into the space or cells to be grouted. Provide means to prevent mortar from dropping into the space below or clean grout spaces prior to grouting.

e. In multi-wythe construction with collar joints no more than 20 mm 3/4 inch wide, bring up the inner wythe not more than 400 mm 16 inches ahead of the outer wythe. Fill collar joints with mortar during the laying of the facing wythe, and do not lag the laying of the facing wythe by back-buttering each unit as it is laid.

3.3.1.1 Jointing

Tool mortar joints when the mortar is thumbprint hard. Tool horizontal joints after tooling vertical joints. Brush mortar joints to remove loose and excess mortar.

3.3.1.1.1 Tooled Joints

****

NOTE: Tooling any joint densifies the mortar bonding. Joints in exterior masonry walls exposed to weather will be tooled with an approved mortar jointer, typically a concave jointer. Other joints that are suitable for weathertight construction and

may be considered for architectural purposes are: Vee, Beaded, or Weathered types. Exposed to view or painted interior masonry walls will also be tooled, typically with a slightly concaved joint, but may also be tooled with other joint types as architecturally desired.
****

Tool mortar joints in exposed exterior and interior masonry surfaces [concave] [_____], using a jointer that is slightly larger than the joint width so that complete contact is made along the edges of the unit. Perform tooling so that the mortar is compressed and the joint surface is sealed. Use a jointer of sufficient length to obtain a straight and true mortar joint. No exterior joints are to be left un-tooled.

3.3.1.1.2 Flush Joints

****
NOTE: Label "wet areas" on the drawings.
****

Flush cut mortar joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas. Finish flush cut joints by cutting off the mortar flush with the face of the wall. Point joints in unparged masonry walls below grade tight. For architectural units, such as fluted units, completely fill both the head and bed joints and flush cut.

3.3.1.1.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, rake joints between frames and abutting masonry walls to a depth of 10 mm 3/8 inch. On the exterior side of exterior frames,rake joints between frames and abutting masonry walls to a depth of 10 mm 3/8 inch.

3.3.1.1.4 Joint Widths

a. Construct brick masonry with mortar joint widths equal to the difference between the specified and nominal dimensions of the unit, within tolerances permitted by TMS MSJC.

b. Provide 10 mm 3/8 inch wide mortar joints in concrete masonry, except for prefaced concrete masonry units.

c. Provide 10 mm 3/8 inch wide mortar joints on unfaced side of prefaced concrete masonry units and not less than 5 mm 3/16 inch nor more than 6 mm 1/4 inch wide on prefaced side.

d. Maintain mortar joint widths within tolerances permitted by TMS MSJC

3.3.1.2 Cutting and Fitting

Use full units of the proper size wherever possible, in lieu of cut units. Locate cut units where they would have the least impact on the architectural aesthetic goals of the facility. Perform cutting and fitting, including that required to accommodate the work of others, by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Before being placed in the work, dry wet-cut units to the same surface-dry appearance as uncut units being laid in the wall. Provide cut edges that are clean, true and sharp.

a. Carefully make openings in the masonry so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Provide reinforced masonry lintels above openings over 300 mm 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

b. Do not reduce masonry units in size by more than one-third in height and one-half in length. Do not locate cut products at ends of walls, corners, and other openings.

3.3.1.3 Unfinished Work

Rack back unfinished work for joining with new work. Toothing may be resorted to only when specifically approved by the Contracting Officer. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

3.3.1.4 Clay Masonry Expansion Joints

****

NOTE: Expansion joints in clay or shale masonry will be located and detailed on the drawings. The wall design and detailing must conform to BIA Technical Notes 18A Accommodating Expansion of Brickwork.

****

Provide clay masonry expansion joints as indicated. Construct by [leaving a gap] [filling with a compressible foam pad]. Ensure that no mortar or other noncompressible materials are within the joint. Install backer rod and sealant in accordance with Section 07 92 00 JOINT SEALANTS.

3.3.1.5 Control Joints

****

NOTE: Control joints will be located and detailed on the drawings. The wall design and detailing for movement control must conform to National Concrete Masonry Association (NCMA) publications: TEK 10-01A, and 10-02C or 10-03 or 10-04, as applicable. When control joint keys are required, it is the Contractor's option to use either special control joint units or sash jamb units with control joint keys. If one is preferred over the other in the design, edit this paragraph accordingly and provide specific details on the drawings. Standard industry practice is to discontinue horizontal reinforcement at control joints except at floor and roof diaphragms, where the reinforcement must be continuous. Where horizontal shear reinforcement is needed by design, however, the reinforcement must be continuous through the control joint. Select the appropriate option.

****

Provide control joints in concrete masonry as indicated. Construct by [raking out mortar within the head joint] [using special control-joint units] [using sash jamb units with control joint key] [using open end stretcher units placed with the closed end at the joint] in accordance with the details shown on the Drawings. Form a continuous vertical joint at control joint locations, including through bond beams, by utilizing half blocks in alternating courses on each side of the joint. Interrupt the control joint key in courses containing continuous bond beam reinforcement. [Do not interrupt the horizontal reinforcement and grout at the control joint.] [Interrupt the horizontal reinforcement and grout in bond beams at the control joint except in bond beams at the floor and roof diaphragms.]

Where mortar was placed in the joint, rake both faces of the control joints to a depth of 19 mm 3/4 inch. Install backer rod and sealant on both faces in accordance with Section 07 92 00 JOINT SEALANTS.

3.3.1.6 Decorative Architectural Units

Place decorative masonry units with the patterned face shell properly aligned in the completed wall.

3.3.2 Clay or Shale Brick Masonry

****

NOTE: Specify type of bond required, if other than running bond is desired.

****

3.3.2.1 Brick Placement

Blend all brick at the jobsite from several cubes to produce a uniform appearance when installed. An observable "banding" or "layering" of colors or textures caused by improperly mixed brick is unacceptable. Lay brick facing with the better face exposed. Lay brick in running bond with each course bonded at corners, unless otherwise indicated. Lay molded brick with the frog side down. Do not lay brick that is cored, recessed, or has other deformations in a manner that allows those deformations to be exposed to view; lay 100 percent solid units in these areas. Completely fill head and bed joints of solid units with mortar. Lay hollow units with mortar joints as specified for concrete masonry units. [Lay fire brick by dipping each brick in a soft mixture of fire clay and water and then rubbing the brick into place with joints as thin as practicable or provide refractory mortar with joints not more than 10 mm 3/8 inch thick.]

Place exterior face of salvaged bricks towards the exterior.

3.3.2.2 Wetting of Units

****

NOTE: If clay, shale brick, or hollow brick is specified, include wetting requirements for units having an initial rate of absorption (IRA) of more than 0.155 gm per minute per square cm 1 gm per minute per square inch of bed surface.

IRA is measured in the laboratory and reported in test results. However, the IRA can increase under hot weather conditions in the field. The wax pencil test can approximate the field IRA condition.

****

Wet clay, shale brick, or hollow brick units having an initial rate of absorption of more than 0.155 gm per minute per square cm 1 gram per minute per square inch of bed surface in conformance with ASTM C67/C67M. Ensure that each unit is nearly saturated when wetted but surface dry when laid.

Test clay or shale brick daily on the job, prior to laying, as follows: Using a wax pencil, draw a circle the size of a quarter on five randomly selected bricks. Apply 20 drops of water with a medicine dropper to the surface within the circle on each brick. If the average time that the water is completely absorbed in the five bricks is less than 1-1/2 minutes, wet bricks represented by the five bricks tested.

3.3.2.3 Brick Sills

****

NOTE: Brick sills are more susceptible to freeze-/thaw damage and should be carefully considered in freezing climates.

****

Lay brick on edge, slope not less than 19 mm 3/4 inch downward to the outside, and project not less than 13 mm 1/2 inch beyond the face of the wall to form a wash and drip. Fill all joints solidly with mortar and tool.

3.3.2.4 Reinforced Brick Walls

****

NOTE: Multi-wythe walls with masonry headers are more susceptible to water penetration and efflorescence.

Show required length of reinforcing bar lap splices on the Drawings or by a schedule in the Specification. Required lap length of bars may be different depending on whether the masonry is designed by allowable stress or by strength.

****

Provide two wythes of brick separated by a [_____] mm inch wide continuous space filled with [grout] [bricks "floated" in grout] and reinforced as indicated. Bevel mortar beds away from grout space to prevent projection into grout space when bricks are shoved in place. Deeply furrowed bed joints will not be permitted. Lay exterior wythe of brick to the height of each grout pour in advance of interior wythe. Clean grout space and set reinforcing before laying interior wythe. Provide metal ties to prevent spreading of the wythes and to maintain vertical alignment of walls. Place reinforcement and grout in accordance with paragraph BAR REINFORCEMENT INSTALLATION and paragraph PLACING GROUT in this Section.

3.3.2.5 Chimneys

****

NOTE: If a chimney wall is 200 mm 8 inches or less in thickness, the space between the flue liner and brickwork should be kept clean and clear to avoid cracking the brickwork.

****

Construct chimneys of brick with clay flue linings of the sizes indicated. Extend flue linings from 300 mm 12 inches below the smoke inlet to 100 mm 4 inches above the chimney cap. Place thimbles as indicated, flush with inside of or up to 25 mm one inch into the flue lining. Set linings in fire clay mortar or refractory mortar and fill and smooth the joints on the inside. Set each section of flue lining before surrounding brickwork reaches top of flue lining section below. Build brickwork around lining, and [fill the space] [leave a 25 mm one inch airspace] between lining and brickwork [with grout]. [Seal top of airspace before installing chimney cap.] Do not cut linings after they are installed in chimney. Unless indicated otherwise, provide a chimney cap of air-entrained concrete. Slope cap to a minimum edge thickness of 50 mm 2 inches and reinforce with two rings of No. 3 gage galvanized steel wire.

3.3.2.6 Partitions

****

NOTE: Walls and partitions that serve as fire walls or fire-rated walls will be shown. Sections and details of these walls will clearly indicate the extent of such walls. Non-structural masonry partition walls will not be tied in any way to structural or exterior masonry walls. Isolation joints will be used at these intersections. When 100 mm 4 inch masonry partitions are not used, delete reference to these units and their intersections.

****

a. Construct partitions continuous from floor to underside of floor or roof deck where shown. Fill openings in firewalls around joists and other structural members as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 100 mm 4 inches above the ceiling level. Construct an isolation joint in the intersection between partitions and structural or exterior walls.

b. Tie interior partitions having 100 mm 4 inch nominal thickness units to intersecting partitions of 100 mm 4 inch units, 125 mm 5 inches into partitions of 150 mm 6 inch units, and 175 7 inches into partitions of 200 mm 8 inch or thicker units. Fill cells within vertical plane of ties solid with grout for full height of partition or solid masonry units may be used. Tie interior partitions over 100 mm 4 inches thick together with joint reinforcement. Provide joint reinforcement with prefabricated pieces at corners and intersections of partitions.

c. Double-Faced Bases or Partitions: Construct double-faced clay unit bases and partitions of two-unit construction. Bond units by overlapping from opposite faces of the wall, 50 mm for 150 mm 2 inches for 6 inch thick partitions and 100 mm for 200 mm 4 inches for 8 inch thick or greater. A single wythe prefaced concrete masonry base or partition may be made with double faced units.

3.3.3 Anchored Veneer Construction

****

NOTE: The air space behind the veneer should be a minimum of 25 mm 1 inch. The maximum distance

between the inside face of veneer and outside face of backing (concrete surface, masonry surface, or wood or steel stud face) should be 114 mm 4.5 inches, unless specially designed anchors are used. Coordinate cavity dimensions with standard lintel and shelf angle dimensions.

Bond pattern should be running bond unless there are compelling architectural reasons to select another pattern.

Adjustable assemblies are normally used when constructing one wythe independent of the other. If the design does not permit this type of construction, delete the reference pertaining to adjustable joint reinforcement assemblies. The preferred method of construction, however, is to bring the wythes up together. Typically, continuous joint reinforcement is used to tie the two wythes together as well as providing for shrinkage cracking control. Continuous joint reinforcement, used as wall ties, will typically be spaced not over 400 mm 16 inches on center vertically. Spacing of joint reinforcement will be shown on the contract drawings.

Refer to "Maximum Spacing and Wall Area for Veneer Anchors" table for required wall area per anchor, and maximum vertical and horizontal spacing of veneer anchors based on anchor type, wind loads, and seismic loads per TMS MSJC.

Maximum Spacing and Wall Area for Veneer Anchors					
Masonry Design Approach	**Unit Anchor Type and Size**				
	Adjustable	**Non-Adjustable**	**Non-Adjustable**	**Joint Reinforcement**	**Sheet Metal**
	MW18W2.8 Wire	**MW11W1.7 Wire**	**MW18W2.8 Wire**	**MW11W1.7 Wire**	**$\geq$ 1.5mm 0.06 inch**
Anchored Veneer - prescriptive requirements where qz does not exceed 1.92 kPa 40 psf					
Maximum Area per Tie	**0.25 m^2 2.67 ft^2**	**0.25 m^2 2.67 ft^2**	**0.33 m^2 3.50 ft^2**	**0.25 $m^2$2.67 ft^2**	**0.33 m^2 3.50 ft^2**
Maximum Horizontal Spacing	**813 mm32 inch**	**813 mm32 inch**	**813 mm32 inch**	**406 mm16 inch**	**813 mm32 inch**
Maximum Vertical Spacing	**635 mm25 inch**	**635 mm25 inch**	**635 mm25 inch**	**635 mm25 inch**	**635 mm25 inch**
Anchored Veneer - prescriptive requirements where qz exceeds 1.92 kPa 40 psf but does not exceed 2.63 kPa 55 psf and the building's mean roof height does not exceed 18.3 m 60 feet					

Maximum Spacing and Wall Area for Veneer Anchors					
Masonry Design Approach	**Unit Anchor Type and Size**				
	Adjustable	**Non-Adjustable**	**Non-Adjustable**	**Joint Reinforcement**	**Sheet Metal**
	MW18W2.8 Wire	**MW11W1.7 Wire**	**MW18W2.8 Wire**	**MW11W1.7 Wire**	**≥ 1.5mm 0.06 inch**
Maximum Area per Tie	**0.18 m^2 1.87 ft^2**	**0.18 m^2 1.87 ft^2**	**0.23 m^2 2.45 ft^2**	**0.18 $m^2$1.87 ft^2**	**0.23 m^2 2.45 ft^2**
Maximum Horizontal Spacing	**457 mm18 inch**	**457 mm18 inch**	**457 mm18 inch**	**457 mm18 inch**	**457 mm18 inch**
Maximum Vertical Spacing	**457 mm18 inch**	**457 mm18 inch**	**457 mm18 inch**	**457 mm18 inch**	**457 mm18 inch**
Anchored Veneer - prescriptive requirements in SDC D, E, and F**					
Maximum Area per Tie	**0.19 m^2 2.00 ft^2**	**0.19 m^2 2.00 ft^2**	**0.25 $m^2$2.63 ft^2**	**0.19 $m^2$2.00 ft^2**	**0.25 m^2 2.63 ft^2**
Maximum Horizontal Spacing	**813 mm32 inch**	**813 mm32 inch**	**813 mm32 inch**	**406 mm16 inch**	**813 mm32 inch**
Maximum Vertical Spacing	**635 mm25 inch**	**635 mm25 inch**	**635 mm25 inch**	**635 mm25 inch**	**635 mm25 inch**
****In Seismic Design Categories E and F, a continuous single wire joint reinforcement of wire size MW 11 W1.7 at a maximum vertical spacing of 457 mm 18 inch is required.**					

For the additional anchors (ties) around openings, the maximum permitted spacing is reduced under high wind (over 1.92 kPa 40 psf) conditions and when the building's mean roof height does not exceed 18.3 m 60 feet; select the smaller spacing option when the veneer is subject to high winds.

****

a. Construct exterior masonry wythes to the thickness indicated on the drawings. Provide a minimum [_____] mm inch air space behind the masonry veneer. Provide means to ensure that the cavity space and flashings are kept clean of mortar droppings and other loose debris. Maintain chases and raked-out joints free from mortar and debris.

b. Place masonry [in running bond pattern.] [in stacked bond pattern.] [Place longitudinal reinforcement, consisting of at least one continuous hot-dip galvanized MW11 W 1.7 (9gauge) steel wire, in the veneer wythe when laid in stack bond.]

c. For veneer over stud framing, do not install veneer until the exterior sheathing, moisture barrier, veneer anchors and flashing have been installed on the backing. Take extreme care to avoid damage to the moisture barrier and flashing during construction of the masonry veneer. Repair or replace portions of the moisture barrier and flashing that are damaged prior to completion of the veneer. Provide a continuous cavity as indicated.

d. For veneer with a masonry backup wythe, lay up both the inner and the outer wythes together except when adjustable joint reinforcement assemblies are approved for use. When both wythes are not brought up together, install through-wall flashings with the exterior wythe, securing the top edge of the flashing with a termination bar and sealant, or protect flashings that are installed with the interior wythe from damage until they are fully enclosed in the wall.

e. Provide anchors (ties) to connect the veneer to its backing in sufficient quantity to comply with the following requirements: maximum wall area per anchor {tie) of [_____], and maximum vertical spacing of [_____], and maximum horizontal spacing of [_____]. Provide additional anchors around openings larger than 406 mm 16 inch in either direction. Space anchors around perimeter of opening at a maximum of [0.91 m3 feet][610 mm24 inches] on center. Place anchors within 305 mm 12 inches of openings. Anchors with drips are not permitted.

f. With solid units, embed anchors in mortar joint and extend into the veneer a minimum of 38 mm 1-1/2 inch, with at least 16 mm 5/8 inch mortar cover to the outside face.

g. With hollow units, embed anchors in mortar or grout and extend into the veneer a minimum of 38 mm 1-1/2 inch, with at least 16 mm 5/8 inch mortar or grout cover to outside face.

3.3.4 Composite Walls

Tie masonry wythes together with joint reinforcement or with unit wall ties. Embed wall ties at least 38 mm 1-1/2 inch into mortar of solid units and at least 13 mm 1/2 inch into the mortar of the outer face shell of hollow units. Provide at least one tie every 0.25 square m 2.67 square feet for wire size MW11 W1.7 and at least one tie every 0.42 square m 4.50 square feet for wire size MW18 W2.8. Space ties at a maximum of 900 mm 36 inches horizontally and 610 mm 24 inches vertically. Do not cross expansion joints or control joints with ties. Fill collar joints between masonry facing and masonry backup solidly with grout.

3.3.5 Reinforced, Single Wythe Concrete Masonry Units Walls

****

NOTE: For single-wythe, concrete masonry unit exterior walls, specify water-repellant application for the constructed masonry walls or specify integral water repellent admixture for both the masonry units and the mortar. Units with an impervious coating, such as glazed-faced units, do not require a water-repellent. This is a regional requirement which must be used, when applicable, for NAVFAC SE projects; when appropriate, the requirements may be used for projects in other areas.

Show required length of reinforcing bar lap splices on the Drawings or by a schedule in the Specification. Required lap length of bars may be different depending on whether the masonry is designed by allowable stress or by strength.

****

3.3.5.1 Concrete Masonry Unit Placement

a. Fully bed units used to form piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout in mortar under both face shells and webs. Provide mortar beds under both face shells for other units. Mortar head joints for a distance in from the face of the unit not less than the thickness of the face shell.

b. Solidly grout foundation walls below grade.

c. Stiffen double walls at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of each wall within the double wall. Adequately reinforce walls and partitions for support of wall-hung plumbing fixtures when chair carriers are not specified.

d. Submit drawings showing elevations of walls exposed to view and indicating the location of all cut CMU products.

3.3.5.2 Preparation for Reinforcement

Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be grouted. Remove mortar protrusions extending 13 mm 1/2 inch or more into cells before placing grout. Position reinforcing bars accurately as indicated before placing grout. Where vertical reinforcement occurs, fill cores solid with grout in accordance with paragraph PLACING GROUT in this Section.

3.3.6 Cavity Walls (Multi-Wythe Noncomposite Walls

****

NOTE: Include dampproofing or air barrier requirements in geographic areas where these are required or as an acceptable practices. Now that masonry wall cavities are usually at least half full of rigid board insulation, and the backup wythe is usually completed before the brickwork is started, the wood strip method of keeping the cavities clean is neither practicable nor effective. A mortar divertingal placed at the bottom of the cavity will provide a path for water to drain through the weep holes. The specified method for concrete masonry unit and brick cavity wall is effective, but may be deleted if the specifier is reluctant to require it. Care must be taken (1) to prevent damage to mortar joints, especially adjacent to the washout holes, and (2) to prevent accumulation of water at the bottom of the wall. The cavities must be inspected to verify that they are clean and functional.

Refer to "Maximum Spacing and Wall Area for Ties" table for maximum wall area per tie, and maximum vertical and horizontal spacing of ties based on tie type per TMS MSJC.

Maximum Spacing and Wall Area for Veneer Anchors

Masonry Design Approach	Unit Anchor Type and Size				
	Adjustable	Non-Adjustable	Non-Adjustable	Joint Reinforcement	Sheet Metal
	All Sizes	MW11W1.7 Wire	MW18W2.8 Wire	MW11W1.7 Wire	≥ 1.5mm 0.06 inch
Allowable Stress Design, Strength Design and Prestressed Design					
Maximum Area per Tie	0.16 m^2 1.77 ft^2	0.25 m^2 2.67 ft^2	0.42 m^2 4.50 ft^2	Same as non-adjustable unit ties of same wire size	Not permitted
Maximum Horizontal Spacing	406 mm16 inch	914 mm36 inch	914 mm36 inch	406 mm16 inch	
Maximum Vertical Spacing	406 mm16 inch	610 mm24 inch	610 mm24 inch	610 mm24 inch	

For NAVFAC SE projects, use second bracketed statement in the eighth sentence.

****

Provide a continuous cavity as indicated. Bevel mortar beds away from cavity to prevent projection into cavity when bricks are shoved in place. Keep cavities clear and clean of mortar droppings. [At the bottom of cavity walls, in the course immediately above the through-wall flashing, temporarily omit one brick every 1200 mm 4 feet. Clean mortar droppings and debris out of the cavity through the temporary openings at least once each day masonry is laid, and more often when required to keep the cavities clean. Fill in the openings with bricks and mortar after the wall is complete and the cavity has been inspected and found clean.] [Dampproof cavity face of interior wythe in accordance with Section 07 11 13 BITUMINOUS DAMPPROOFING.]

Securely tie the two wythes together with horizontal joint reinforcement, or provide ties to connect the masonry wythes in sufficient quantity to comply with the following requirements: maximum wall area per tie of [_____], and maximum vertical spacing of [_____], and maximum horizontal spacing of [_____]. Provide additional ties around openings larger than 405 mm 16 inches in either direction. Space ties around perimeter of opening at a maximum of 910 mm 3 feet on center. Place ties within 305 mm 12 inchesof openings. Ties with drips are not permitted.

3.3.7 ANCHORAGE

****

NOTE: If spacing of anchors varies from that specified, edit these paragraphs accordingly.

For intersecting structural masonry walls, delete the types of anchorage that are not permitted for

the project.
****

3.3.7.1 Anchorage to Concrete

Anchor masonry to the face of concrete columns, beams, or walls with dovetail anchors spaced not over 400 mm 16 inches on centers vertically and 600 mm 24 inches on center horizontally.

3.3.7.2 Anchorage to Structural Steel

Anchor masonry to vertical structural steel framing with adjustable steel wire anchors spaced not over 400 mm 16 inches on centers vertically, and if applicable, not over 600 mm 24 inches on centers horizontally.

3.3.7.3 Anchorage at Intersecting Walls

Provide wire mesh anchors at maximum 400 mm 16 inches spacing at intersections of interior non-bearing masonry walls.

****
NOTE: Details will be shown on the drawings which illustrate corners and intersections of structural bond beam reinforcement and factory-formed joint reinforcement. When joint reinforcement is not used, delete prefabricated corners or tee pieces.
****

Anchor structural masonry walls with [reinforced bond beams spaced no more than [_____] mm feet on center] [horizontal joint reinforcement spaced no more than [_____] mm feet on center] [overlapping masonry units] [strap anchors of minimum size 6 mm 1/4 inch x 38 mm 1-1/2 inch x 710 mm 28 inches including 50 mm 2 inch) 90 degree bends at each end to form U or Z shape at maximum spacing 1220 mm 48 inches, grouted into the wall], unless the drawings indicate a movement joint at the intersection.

3.3.8 Lintels

3.3.8.1 Masonry Lintels

Construct masonry lintels with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated. Extend lintel reinforcement beyond each side of masonry opening 40 bar diameters or 600 mm 24 inches, whichever is greater. Support reinforcing bars in place prior to grouting and locate 13 mm 1/2 inch above the bottom inside surface of the lintel unit.

3.3.8.2 Precast Concrete and Steel Lintels

Provide precast concrete and steel lintels as shown on the Drawings. Set lintels in a full bed of mortar with faces plumb and true. Provide steel and precast lintels with a minimum bearing length of 200 mm 8 inches unless otherwise indicated. In partially grouted masonry, provide fully grouted units under the full lintel bearing length, unless otherwise indicated.

3.3.9 Sills and Copings

****
NOTE: Coping and sills exceeding 1200 mm 4 feet

should be mechanically anchored and detailed on the project drawings. Where such anchors penetrate through-wall flashing, sealing of the penetration should be required.
****

Set sills and copings in a full bed of mortar with faces plumb and true. Slope sills and copings to drain water. Mechanically anchor copings and sills longer than 1200 mm 4 feet as indicated.

3.4 INSTALLATION

3.4.1 Bar Reinforcement Installation

3.4.1.1 Preparation

Submit detail drawings showing bar splice locations. Identify bent bars on a bending diagram and reference and locate such bars on the drawings. Show wall dimensions, bar clearances, and wall openings. Utilize bending details that conform to the requirements of ACI SP-66. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, resubmit the approved shop drawings with the additional openings shown along with the proposed changes. Clearly highlight location of these additional openings. Provide wall elevation drawings with minimum scale of 1 to 50 1/4 inch per foot. Submit drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; lintels; and wall openings.

Clean reinforcement of loose, flaky rust, scale, grease, mortar, grout, and other coatings that might destroy or reduce its bond prior to placing grout. Do not use bars with kinks or bends not shown on the approved shop drawings. Place reinforcement prior to grouting. Unless otherwise indicated, extend vertical wall reinforcement to within 50 mm 2 inches of tops of walls.

3.4.1.2 Positioning Bars

****
NOTE: Positioning of bars will be shown on the drawings.
****

a. Accurately place vertical bars within the cells at the positions indicated on the drawings. Maintain a minimum clearance of 13 mm 1/2 inch between the bars and masonry units. Provide minimum clearance between parallel bars of13 mm 1/2 inch between the bars and masonry units for coarse grout and a minimum clearance of 6 mm 1/4 inch between the bars and masonry units for fine grout. Provide minimum clearance between parallel bars of 25 mm 1 inch or one diameter of the reinforcement, whichever is greater. Vertical reinforcement may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement or by other means to prevent displacement beyond permitted tolerances. As masonry work progresses, secure vertical reinforcement to prevent displacement beyond allowable tolerances.

b. Wire column and pilaster lateral ties in position around the vertical reinforcing bars. Place lateral ties in contact with the vertical reinforcement and do not place in horizontal mortar bed joints.

c. Position horizontal reinforcing bars as indicated. Stagger splices in adjacent horizontal bars, unless otherwise indicated.

d. Form splices by lapping bars as indicated. Do not cut, bend or eliminate reinforcing bars. Foundation dowel bars may be field-bent when permitted by TMS MSJC.

3.4.1.3 Splices of Bar Reinforcement

****

NOTE: The designer must determine the required lap splice lengths and indicate on the project documents. Required lap splice length may vary depending upon whether the masonry is designed by allowable stress or strength.

****

Lap splice reinforcing bars as indicated. When used, provide welded or mechanical connections that develop at least 125 percent of the specified yield strength of the reinforcement.

3.4.2 Placing Grout

****

NOTE: Mechanical consolidation of self-consolidating grout should not be performed because it may cause segregation. When placing self-consolidating grout, the properties listed in ASTM C476 should be verified.

****

3.4.2.1 General

Fill cells containing reinforcing bars with grout. Solidly grout hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces. Solidly grout cells under lintel bearings on each side of openings for full height of openings. Solidly grout walls below grade, lintels, and bond beams. Units other than open end units may require grouting each course to preclude voids in the units.

Discard site-mixed grout that is not placed within 1-1/2 hours after water is first added to the batch or when the specified slump is not met without adding water after initial mixing. Discard ready-mixed grout that does not meet the specified slump without adding water other than water that was added at the time of initial discharge. Allow sufficient time between grout lifts to preclude displacement or cracking of face shells of masonry units. Provide a grout shear key between lifts when grouting is delayed and the lower lift loses plasticity. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, tear down the wall and rebuild.

3.4.2.2 Vertical Grout Barriers for Multi-Wythe Composite Walls

In multi-wythe composite walls, provide grout barriers in the collar join not more than 9 m 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.4.2.3 Horizontal Grout Barriers

Embed horizontal grout barriers in mortar below cells of hollow units receiving grout.

3.4.2.4 Grout Holes and Cleanouts

3.4.2.4.1 Grout Holes

Provide grouting holes in slabs, spandrel beams, and other in-place overhead construction. Locate holes over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Provide additional openings spaced not more than 400 mm 16 inches on centers where grouting of hollow unit masonry is indicated. Fom such openings not less than 100 mm 4 inches in diameter or 75 by 100 mm 3 by 4 inches in horizontal dimensions. Upon completion of grouting operations, plug and finish grouting holes to match surrounding surfaces.

3.4.2.4.2 Cleanouts for Hollow Unit Masonry Construction

For hollow masonry units. provide cleanout holes at the bottom of every grout pour in cores containing vertical reinforcement when the height of the grout pour exceeds 1.6 m 5 feet 4 inches. Where all cells are to be grouted, construct cleanout courses using bond beam units in an inverted position to permit cleaning of all cells. Provide cleanout holes at a maximum spacing of 800 mm 32 inches where all cells are to be filled with grout.

Establish a new series of cleanouts if grouting operations are stopped for more than 4 hours. Provide cleanouts not less than 75 by 75 mm 3 by 3 inch by cutting openings in one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Do not cleanout holes until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, close cleanout holes in an approved manner to match surrounding masonry.

3.4.2.4.3 Cleanouts for Multi-Wythe Composite Masonry Construction

Provide cleanouts for construction of walls that incorporate a grout filled cavity between solid masonry wythes, provide cleanouts at the bottom of every pour by omitting every other masonry unit from one wythe. Establish a new series of cleanouts if grouting operations are stopped for more than 4 hours. Do not plug cleanout holes until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, close cleanout holes in an approved manner to match surrounding masonry.

3.4.2.5 Grout Placement

****

NOTE: The requirements listed are for normal grouting procedures. Other options, such as higher grout lifts, higher grout pours, or alternate methods of keeping the grout space clean, may be acceptable if proven through the process of constructing and examining a grout demonstration

panel.

A grout pour is the total height of masonry to be grouted prior to erection of additional masonry. A grout lift is an increment of grout placement within a grout pour. A grout pour is filled by one or more lifts of grout. Maximum grout pour height is based on grout type (fine or coarse) and dimensions of grout space, per TMS MSJC Table 7. Fine grout has sand as the only aggregate while coarse grout uses both sand and pea gravel up to 10 mm 3/8 inch diameter. Coarse grout is preferred when grout will be placed in relatively large cross-sectional areas because shrinkage of the grout is reduced.

By following the TMS grout pour and lift recommendations and using grout of the proper consistency, grout placement occurs at a rate that does not cause displacement of masonry due to hydrostatic pressure of grout. Self-consolidating grout (SCG) attains its flow primarily from superplasticizing admixtures, not water, so it exerts a lower hydrostatic pressure than conventional grout during placement. Grout should be placed as rapidly as practical by methods that do not cause segregation and that minimize splatter on reinforcement and surrounding masonry. Conventional grout lifts should be consolidated (and reconsolidated) by mechanical vibration before the next lift is placed. SCG does not need to be consolidated.

****

A grout pour is the total height of masonry to be grouted prior to erection of additional masonry. A grout lift is an increment of grout placement within a grout pour. A grout pour is filled by one or more lifts of grout.

a. Lay masonry to the top of a pour permitted by TMS MSJC Table 7, based on the size of the grout space and the type of grout. Prior to grouting, remove masonry protrusions that extend 13 mm 1/2 inch or more into cells or spaces to be grouted. Provide grout holes and cleanouts in accordance with paragraph GROUT HOLES AND CLEANOUTS above when the grout pour height exceeds 1.6 m 5 feet 4 inches. Hold reinforcement, bolts, and embedded connections rigidly in position before grouting is started. Do not prewet concrete masonry units.

b. Place grout using a hand bucket, concrete hopper, or grout pump to fill the grout space without segregation of aggregate. Operate grout pumps to produce a continuous stream of grout without air pockets, segregation, or contamination.

c. If the masonry has cured at least 4 hours, grout slump is maintained between 250 and 275 mm 10 to 11 inches, and no intermediate reinforced bond beams are placed between the top and bottom of the pour height, place conventional grout in lifts not exceeding 3.9 m 12 feet 8 inches. For the same curing and slump conditions but with intermediate bond beams, limit conventional grout lift to the bottom of the lowest bond beam that is more than 1.6 m 5 feet 4 inches above the bottom of the lift, but do not exceed 3.9 m 12 feet 8 inches. If masonry has not cured at least 4 hours or grout slump is not maintained between 250 and 275 mm 10 to 11 inches, place conventional grout in lifts not exceeding 1.6 m 5 feet 4 inches.

d. Consolidate conventional grout lift and reconsolidate after initial settlement before placing next lift. For grout pours that are 300 mm 12 inches or less in height, consolidate and reconsolidate grout by mechanical vibration or puddling. For grout pours that are greater than 300 mm 12 inches in height, consolidate and reconsolidate grout by mechanical vibration. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation. If previous lift is not permitted to set, dip vibrator into previous lift. Do not insert vibrators into lower lifts that are in a semi-solidified state. If lower lift sets prior to placement of subsequent lift, form a grout key by terminating grout a minimum of 38 mm 1-1/2 inch below a mortar joint. Vibrate each vertical cell containing reinforcement in partially grouted masonry. Do not form grout keys within beams.

e. If the masonry has cured 4 hours, place self-consolidating grout (SCG) in lifts not exceeding the pour height. If masonry has not cured for at least 4 hours, place SCG in lifts not exceeding 1.6 m 5 feet 4 inches. Do not mechanically consolidate self-consolidating grout. Place self-consolidating grout in accordance with manufacturer's recommendations.

f. Upon completion of each day's grouting, remove waste materials and debris from the equipment, and dispose of outside the masonry.

3.4.3 Joint Reinforcement Installation

****

NOTE: Location of horizontal joint reinforcement should be shown on the drawings with the maximum vertical spacing normally being 400 mm 16 inches. A 150 mm 6 inch lap splice length is sufficient for joint reinforcement whose only purpose is shrinkage control. Joint reinforcement that is used structurally may need longer lap splices.

****

Install joint reinforcement at 400 mm 16 inches on center unless otherwise indicated. Lap joint reinforcement not less than [150][_____] mm [6][_____] inches. Install prefabricated sections at corners and wall intersections. Place the longitudinal wires of joint reinforcement in mortar beds to provide not less than 16 mm 5/8 inch cover to either face of the unit.

3.4.4 Bond Beams

****

NOTE: Bond beams that are continuous over openings will be reinforced to serve as lintels.

Bond beams at floor lines and roofs, where the beam acts as a tension tie for the diaphragm, are typically reinforced continuously through masonry movement joints, and the mortar is raked back and

finished with backer rod and sealant. Intermediate bond beams are typically detailed with the reinforcement interrupted, but doweled, at control joints and again finished with raked back mortar, backer rod and sealant.

Interior control joints are raked to weaken the joint to focus cracks in the control joint and caulked so that 1) cracks don't show and 2) provide a second line of defense should moisture try to travel through the cracks in the control joint.

****

Reinforce and grout bond beams as indicated and as described in paragraphs above. Install grout barriers under bond beam units to retain the grout as required, unless wall is fully grouted or solid bottom units are used. For high lift grouting in partially grouted masonry, provide grout retaining material on the top of bond beams to prevent upward flow of grout. Ensure that reinforcement is continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated.

3.4.5 Flashing and Weeps

****

NOTE: Locate weeps and ventilators to ensure that in severe weather, wind driven water does not enter and drain into the interstitial space. Indicate acceptable locations on drawings.

Weep spacing of 610 mm 24 inches is appropriate for open head joint weeps and weep vents. When smaller weeps are used, the spacing should be reduced to 406 mm 16 inches.

Provide a flashing/weep system for open cores (non-grouted) of exterior single wythe CMU walls.

****

a. Install through-wall flashing at obstructions in the cavity and where indicated on Drawings. Ensure continuity of the flashing at laps and inside and outside corners by splicing in a manner approved by the flashing manufacturer. Ensure that the top edge of the flashing is sealed by [turning the flashing 13 mm 1/2 inch into the mortar bed joint of backup masonry] [attaching a termination bar and applying compatible sealant at the top edge of the termination bar] [lapping a minimum of 150 mm 6 inches under the weather resistive barrier] [securing the sheet metal flashing into a reglet cast into the concrete backup]. Terminate the horizontal leg of the flashing [by extending the sheet metal 13 mm 1/2 inch beyond the outside face of masonry and turning downward with a hemmed drip] [terminating the fabric flashing 13 mm 1/2 inch short of the outside face of masonry and adhering the flashing to a sheet metal drip edge] [extending the fabric flashing beyond the outside face of masonry and, when construction is complete, cutting the flashing flush with the face of masonry]. Provide sealant below the drip edge of through-wall flashing.

b. Wherever through-wall flashing occurs, provide weep holes to drain flashing to exterior at acceptable locations as indicated. Provide weeps of [open head joints][weep ventilators]. Locate weeps not more than 600 mm 24 inches on centers in mortar joints of the exterior wythe directly on the horizontal leg of through-wall flashing over foundations, bond beams, and any other horizontal interruptions of the cavity. Place weep holes perfectly horizontal or slightly canted downward to encourage water drainage outward and not inward. Other methods may be used for providing weeps when spacing is reduced to406 mm 16 inches on center and approved by the Contracting Officer. Maintain weeps free of mortar and other obstructions.

[c. Install single-wythe CMU flashing system in bed joints of CMU walls where CMU cells are open. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall on the exterior side. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

]3.5 APPLICATION

3.5.1 Insulation

****

NOTE: Specify taping or sealing of board joints when the insulation must act as the air or vapor barrier.

****

Insulate cavity walls (multi-wythe noncomposite masonry walls), where shown, by installing board-type insulation on the cavity side of the inner wythe. Apply board type insulation directly to the masonry or thru-wall flashing with adhesive. Neatly fit insulation between obstructions without impaling insulation on ties or anchors. Apply insulation in parallel courses with vertical joints breaking midway over the course below and in moderate contact with adjoining units without forcing. Cut to fit neatly against adjoining surfaces. [Tape or seal the joints between the boards.]

3.5.2 Interface with Other Products

****

NOTE: Label "wet locations" on the drawings.

****

3.5.2.1 Built-In Items

Fill spaces around built-in items with mortar. Point openings around flush-mount electrical outlet boxes in wet locations with mortar. Embed anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in as the masonry work progresses. Fully embed anchors, ties and joint reinforcement in the mortar. Fill cells receiving anchor bolts and cells of the first course below bearing plates with grout, unless otherwise indicated.

3.5.2.2 Door and Window Frame Joints

On the exposed interior and exterior sides of exterior frames, rake joints between frames and abutting masonry walls to a depth of 10 mm 3/8 inch.

3.5.2.3 Bearing Plates

****

NOTE: The bearing details must be shown on the drawings. The thermal effects must be considered for steel beams bearing on masonry to prevent cracking of masonry walls due to thermal expansion of steel framing members.
****

Set bearing plates for beams, joists, joist girders and similar structural members to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Provide bedding mortar and non-shrink grout s specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5.3 Tolerances

Lay masonry plumb, true to line, with courses level within the tolerances of TMS MSJC, Article 3.3 F.

3.6 FIELD QUALITY CONTROL

3.6.1 Tests

3.6.1.1 Field Testing of Mortar

****
NOTE: Field testing of mortar should be limited or avoided. Better information can be obtained by observing mortar batching to confirm that proper proportions and mixing procedures have been followed. When field testing is required, verification of proportions is preferred to mortar compressive strength testing. Results are available in a matter of hours rather than days or weeks. Proportions of fresh mortars can be determined by running the mortar aggregate ratio test of ASTM C780 Appendix A4. Mortar compressive strength, tested in accordance with ASTM C780 Appendix 6, is not required or expected to meet the property requirements of ASTM C270 Table 2 and has more meaningful comparisons to preconstruction test values to evaluate consistency. Therefore, when mortar is tested for compressive strength, testing must be performed prior to construction as well as during construction. Frequency of testing, if any, depends on the size and complexity of the project. Modify paragraph below to advise required frequency of testing and type(s) of testing required.
****

Perform mortar testing at the following frequency: [_____] times per [_____]. For each required mortar test, provide a minimum of three mortar samples. Perform initial mortar testing prior to construction for comparison purposes during construction.

Prepare and test mortar samples for mortar aggregate ratio in accordance with ASTM C780 Appendix A4. [Prepare and test mortar compressive strength specimens in accordance with ASTM C780 Appendix A6.]

3.6.1.2 Field Testing of Grout

****

NOTE: Field testing of grout involves measuring temperature, slump of conventional grout, slump flow of SCG, visual stability index of SCG, and compressive strength. Field testing of grout is not required when masonry compressive strength is verified by the prism test method.

Frequency of testing depends on the size and complexity of the project. Minimum requirements for testing frequency are provided in TMS MSJC Tables 1.19.1, 1.19.2, and 1.19.3 depending upon how the masonry is designed (prescriptive or engineered) and the Risk Category of the project. Modify paragraph below to advise required frequency of testing.

****

a. Perform grout testing at the following frequency: [_____] times per [_____]. For each required grout property to be evaluated, provide a minimum of three specimens.

b. Sample and test conventional and self-conslidating grout for compressive strength and temperature in accordance with ASTM C1019.

c. Evaluate slump in conventional grout in accordance with ASTM C1019.

d. Evaluate slump flow and visual stability index of self-consolidating grout in accordance with ASTM C1611/C1611M.

[3.6.1.3 Clay Brick Efflorescence Test

****

NOTE: Delete this paragraph in areas where efflorescence has not been a problem. Efflorescence is generally the result of poor design and detailing and/or poor quality of construction. Properly covered and/or flashed walls with a good drainage and weep system are generally free of efflorescence. Efflorescence testing is generally not required.

****

Test clay brick that will be exposed to weathering for efflorescence in accordance with ASTM C67/C67M. Schedule tests far enough in advance of starting masonry work to permit retesting if necessary. Units meeting the definition of "effloresced" are subject to rejection.

][3.6.1.4 Prism Tests

****

NOTE: Prism testing will only be required for structures requiring masonry compressive strengths higher than those indicated by the conservative values derived by the Unit Strength Method. When the compressive strength of masonry can be verified by the Unit Strength method, prism testing normally will not be required. Delete this paragraph when

prism testing is not required. When prism test results are lower than the specified compressive strength, handling and testing of the prism specimens should be reviewed for compliance to the requirements contained in the ASTM standard.

Indicate the specified compressive strength of masonry in paragraph SYSTEM DESCRIPTION or on the Drawings.

****

Perform at least one prism test sample for each 465 square meters 5,000 square feet of wall but not less than three such tests for any building. Evaluate three prisms in each test. Fabricate, store, handle, and test prisms in accordance with ASTM C1314.

Seven-day tests may be used provided the relationship between the 7- and 28-day strengths of the masonry is established by the tests of the materials used. If the compressive strength of any prism falls below the specified value by more than 3.5 MPa 500 psi, take steps to assure that the load-carrying capacity of the structure is not jeopardized. If the likelihood of low-strength masonry is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled, or prisms sawed, from the area in question may be required. In such case, take three specimens for each prism test more than 3.5 MPa 500 psi below the specified value. Masonry in the area in question will be considered structurally adequate if the average compressive strength of three specimens is equal to or exceeds the specified value. Additional testing of specimens extracted from locations represented by erratic core or prism strength test results will be permitted.

]3.6.1.5 Single-Wythe Masonry Wall Water Penetration Test

****

NOTE: Include masonry wall water penetration testing only for single-wythe masonry wall constructions where wall water penetration will impair mission-critical operations, create an immediate safety hazard, or have a detrimental impact on interior finishes. Testing evaluates the assembled wall test panel and does not assure compliant wall construction in the field. As an option additional testing may be performed on the actual wall construction in accordance with ASTM C1601.

****

Prior to start of field construction of the single-wythe concrete masonry wall, perform masonry wall water penetration test on mock-up wall assemblies consisting of the identical design, materials, mix, and construction methods as the actual wall construction and in accordance with ASTM E514/E514M. Prepare a minimum of three specimens and cure for minimum 28 days prior to testing. Construct panels by the same methods, processes, and applications to be used on the project's construction site. Spray test for 6 hours on each specimen. If water is visible on back of test panels during the test and areas of dampness on the backside of the test panels do not exceed 25 percent of the wall area, the panels will be considered to have passed. Dampness is defined as any area of surface darkening or discoloration due to moisture penetration or accumulation below the observed surface.

Construct additional test panels for each failed test performed until three test panels pass the test. Factors that can affect test performance include materials, mixing, and quality of application and workmanship. Materials, mixing, and methods adjustments may be necessary in order to provide construction that passes the water penetration test. Document and record the test specimen construction materials and application and provide written test report in accordance with ASTM E514/E514M, supplemented by a detailed discussion of the specifics of test panel construction, application methods and processes used, quality of construction, and any variances or deviations that may have occurred between test panels during test panel construction. For failed test panels, identify in the supplemental report the variances, deficiencies or flaws that contributed to test panel failure and itemize the precautions to be taken in field construction of the masonry wall to prevent similar deficiencies and assure the wall construction replicates test panel conditions that pass the water penetration test. Submit the complete, certified test report, including supplemental report, to the Contracting Officer prior to start of single-wythe concrete masonry wall construction. Significant changes to materials, proportions, or construction techniques from those used in the passing water penetration test are grounds for performing new tests, at the discretion of the Contracting Officer.

3.6.2 Special Inspection

****

NOTE: The designer must indicate on the drawings all locations and all features for which special inspection and testing is required. This includes indicating the locations of all structural components and connections requiring inspection.

****

Perform special inspections and testing in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

3.7 POINTING AND CLEANING

****

NOTE: Cleaning of masonry using water pressure may be necessary, but the pressure used should be the minimum required to successfully clean the masonry surface. Saturating the masonry wall in the cleaning process should be avoided.

****

After mortar joints have attained their initial set, but prior to hardening, completely remove mortar and grout daubs and splashings from masonry-unit surfaces that will be exposed or painted. Before completion of the work, rake out defects in joints of masonry to be exposed or painted, fill with mortar, and tool to match existing joints. Immediately after grout work is completed, remove scum and stains that have percolated through the masonry work using a low pressure stream of water and a stiff bristled brush. Do not clean masonry surfaces, other than removing excess surface mortar, until mortar in joints has hardened. Leave masonry surfaces clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Do not use metal tools and metal brushes for cleaning.

3.7.1 Dry-Brushing Concrete Masonry

Dry brush exposed concrete masonry surfaces at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.7.2 Clay Brick Surfaces

Clean exposed clay brick masonry surfaces to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. Perform cleaning in accordance with the approved cleaning procedure demonstrated on the mockup.

After cleaning, examine the sample panel of similar material for discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, change the method of cleaning to ensure that the masonry surfaces in the structure will not be adversely affected. Water-soak exposed masonry surfaces and then clean with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay brick manufacturer and manufacturer of the cleaning product. Apply the solution with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Use proprietary cleaning agents in conformance with the cleaning product manufacturer's printed recommendations. Remove efflorescence in conformance with the brick manufacturer's recommendations.

3.8 CLOSE-OUT TAKE-BACK PROGRAM

****

NOTE: Take-back programs refer to programs in which the product manufacturer "takes-back" scrap material and/or packaging associated with its product.

****

Collect information from manufacturer for take-back program options. Set aside [masonry units, full and partial] [scrap] [packaging] [_____] to be returned to manufacturer for recycling into new product. When such a service is not available, seek local recyclers to reclaim the materials. Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

3.9 PROTECTION

****

NOTE: Covering masonry walls is required for protection from detrimental moisture intrusion, which can result in efflorescence, or as required by cold weather masonry construction provisions. In certain geographical areas, vertical reinforcement may be placed prior to installation of masonry units, which can significantly interfere with covering masonry walls.

****

Protect facing materials against staining. Cover top of walls with nonstaining waterproof covering or membrane to protect from moisture intrusion when work is not in progress. Continue covering the top of the unfinished walls until the wall is waterproofed with a complete roof or parapet system. Extend covering a minimum of 600 mm 2 feet down on each side of the wall and hold securely in place. Before starting or resuming work, clean top surface of masonry in place of loose mortar and foreign material.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-04 23 00 (November 2015)**

Preparing Activity: USACE **Superseding**
UFGS-04 23 00 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 04 - MASONRY

SECTION 04 23 00

GLASS UNIT MASONRY

11/15

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PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-04 23 00 (November 2015)**

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SECTION 04 23 00

GLASS UNIT MASONRY

11/15

****

NOTE: This guide specification covers the requirements for glass unit masonry work.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: The following information should be shown on the project drawings:

1. Head, jamb, sill, and intermediate support construction details.

2. Clearances required for deflection and expansion.

Refer to manufacturer's data and TMS MSJC for glass unit panel size restrictions, limitations, and details. Refer to TMS MSJC for construction requirements for glass unit masonry.

****

1.1 SUMMARY

This section includes glass masonry units, hollow or solid, including mortar, joint reinforcement, and other accessories for constructing glass unit masonry panels.t

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM A951/A951M	(2011) Standard Specification for Steel Wire for Masonry Joint Reinforcement
ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C1384	(2012a) Standard Specification for Admixtures for Masonry Mortars
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1187/D1187M	(1997; R 2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal

ASTM D1227	(2013; 2019) Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing
ASTM D4819	(2013) Standard Specification for Flexible Cellular Materials Made From Polyolefin Plastics

THE MASONRY SOCIETY (TMS)

TMS MSJC	(2016) Masonry Standard Joint Committee's (MSJC) Book - Building Code Requirements and Specification for Masonry Structures, Containing TMS 402/ACI 530/ASCE 5, TMS 602/ACI 530.1/ASCE 6, and Companion Commentaries

UL SOLUTIONS (UL)

UL 9	(2009; Reprint Oct 2024) Standard for Fire Tests of Window Assemblies

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Glass Masonry Units
Water Repellent Additive or Admixture
Joint Reinforcement
Perimeter Anchorage
Panel Anchors
Expansion Strip

SD-04 Samples

Glass Masonry Units
Joint Reinforcement
Perimeter Anchorage
Panel Anchors
Expansion Strip

SD-07 Certificates

Glass Masonry Units
Water Repellent Additive or Admixture
Mortar

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver cement, lime, and other cementitious materials to the site in unbroken containers, labeled with the manufacturers' names and brands. Store mortar materials in a manner to prevent the inclusion of foreign materials and damage by water or dampness. Avoid chipping, cracking and breakage of glass masonry units. Protect glass masonry units from contact with earth and exposure to the weather, and keep dry until used. Do not use materials containing frost or ice. Handle glass masonry units with care to avoid damage.

1.5 PROJECT/SITE CONDITIONS

Do not lay glass masonry units when the air temperature is 5 degrees C 40 degrees F and falling, or when it appears probable that temperatures below 5 degrees C 40 degrees F will be encountered before the mortar has set, unless protection is provided to prevent freezing. For protection, maintain the temperature of glass masonry units and mortar materials between 5 and 50 degrees C 40 and 160 degrees F. After erection, maintain air temperature above 5 degrees C 40 degrees F on both sides of glass masonry units for not less than 48 hours. Do not work with or on frozen materials. Cover the top of unfinished masonry work to protect it from the weather.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

****

NOTE: The desired physical characteristics (Light

transmittance, reflectivity, pattern, size, etc.) should be described. The most commonly used glass masonry unit is nominally 200 mm 8 inch by 200 mm 8 inch by 100 mm 4 inch thick. Other square sizes, nominally 150 mm 6 inch by 150 mm 6 inch and 300 mm 12 inch by 300 mm 12 inch, are available, as well as rectangular sizes including 100 mm 4 inch by 200 mm 8 inch and 150 mm 6 inch by 200 mm 8 inch. The three most commonly specified patterns are listed by name, but other patterns are available.

Thin hollow units, which are common to residential construction, are not listed because published physical properties of glass units are based on testing of standard hollow units and thin solid units.

****

2.1.1 Glass Masonry Units

Provide glass masonry units of type[s], size, pattern and style specified. Do not change source of supply for material which will affect the appearance of the finished work after work has started. Keep on hand extra units amounting to [5] [_____] percent of the number of units incorporated in the work. Use extra units to replace units found to be defective. Provide units in which the surfaces intended to be in contact with mortar are treated with polyvinyl butyral edge coating or latex-based paint.

2.1.1.1 Standard Hollow Glass Masonry Units

Provide hollow glass lock units that are partially evacuated and have a minimum average glass face thickness of 5 mm 3/16 inches. Provide [DECORA] [VUE] [ARGUS] [_____] pattern [with LX] [without] fibrous glass insert, [_____] sized [197 by 197] [_____] by 98 mm [7-3/4 by 7-3/4] [_____] by 3-7/8 inches. Where units are designated as "reflective glass masonry unit", provide a highly reflective oxide surface coating of a [gray] [_____] color. Provide units with [75] [____] percent light transmission.

2.1.1.2 Thin Solid Glass Masonry Units

Provide clear [VISTABRIK] [_____] or Stippled pattern, 194 by 194 by 76 mm 7-5/8 by 7-5/8 by 3 inches. Provide units with [75] [____] percent light transmission.

2.1.1.3 Fire Rated Glass Masonry Units

****

NOTE: Although walls are rated for fire resistance, windows (including glass unit masonry) are rated for fire protection. Although walls are tested for fire resistance, smoke resistance, and heat resistance, windows are only tested for fire and smoke resistance (not heat). Glass unit masonry can be rated for 45 minutes (up to 3 m by 3.7 m 10 ft by 12 feet); 60 minutes (up to 9.3 m2 100 sf or 3 m 10 ft maximum); and 90 minutes (up to 9.3 m2 100 sf or 3 m 10 ft maximum).

NFPA 80 requires that fire rated glass block units be listed by UL and tested per UL 9.

****

Where walls and partitions are indicated on the drawings to be fire rated and contain rated glass masonry unit window assemblies, use listed glass masonry units that have been fire tested in accordance with UL 9 to the indicated rating.

2.2 MORTAR

****

NOTE: A water-repellent additive (included in the manufacture of the cement) or a water-repellent admixture (added by the contractor during mortar mixing) should be required when the glass unit masonry panel will be exposed to the exterior.

****

2.2.1 Mortar

Comply with ASTM C270, Type S or N mortar, using white cementitious materials.

2.2.2 Water Repellent Additive or Admixture

Provide water repellent admixture, complying with ASTM C1384, in the mortar. Omit water repellent admixture if the cementitious materials include a water repellent additive..

2.2.3 Admixtures

Do not use admixtures unless approved by the Contracting Officer.

2.3 MORTAR MIXING

Mix cementitious materials and aggregate between 3 and 5 minutes in a mechanical batch mixer with a reduced amount of water to account for the lack of absorption of glass units. Hand mixing may be used only when specifically approved by the Contracting Officer.

2.4 ACCESSORIES

2.4.1 Joint Reinforcement

Comply with ASTM A951/A951M and, after fabrication, provide zinc coating by the hot-dip process conforming to ASTM A153/A153M, 458 g/m2 1.50 oz/ft2, or fabricate from wire complying with ASTM A580/A580M. Provide reinforcement with two parallel longitudinal wires of size[MW11 W1.7][3.4 mm 0.1483 inch] and butt-welded cross wires of size[MW11 W1.7][3.4 mm 0.1483 inch] at not greater than 406 mm 16 inches on center. Provide longitudinal wires spaced 50 mm 2 inches apart when used with standard hollow glass units and 41 mm 1-5/8 inches apart when used with thin solid glass units. Provide joint reinforcement in flat sections, not less than 2.4 m 8 feet long, except that prefabricated corner reinforcements and other special shapes may be shorter.

2.4.2 Perimeter Anchorage

****

NOTE: Glass unit masonry panels must be laterally

supported at the top and sides by either panel anchors or channel restraints. The channel restraint may be designed as one piece or two pieces of angle stock. Channel-type restraints must be oversized to accommodate expansion material in the opening, and packing and sealant between the framing restraints and the glass unit masonry perimeter units. Lateral supports must be designed to resist applied loads or a minimum of 29919 N/m 200 lb/ft, per TMS MSJC
****

2.4.2.1 Panel Anchors

Perforated steel strip not less than 0.9 mm 20 gauge, minimum of 44 mm wide by 610 mm long 1-3/4 inches wide by 24 inches long, punched with three staggered rows of elongated holes, and hot-dipped galvanized conforming to ASTM A153/A153M after fabrication; or perforated stainless steel strap not less than 0.8 mm 22 gauge, minimum of 44 mm wide by 610 mm long 1-3/4 inches wide by 24 inches long. Provide two fasteners per panel anchor, each capable of resisting a load of [_____] N pounds.

2.4.2.2 Channel-Type Anchorage

Clear anodized aluminum channels, 114 mm by 50 mm by 3 mm thick 4-1/2 inches by 2 inches by 1/8 inch thick for use with standard hollow glass units and 102 mm by 50 mm by 3 mm thick 4 inches by 1-1/2 inches by 1/8 inch thick or 95 mm by 50 mm by 3 mm thick 3-3/4 inches by 2 inches by 1/8 inch thick for use with thin solid glass masonry units. Provide channels with bituminous coating on surfaces that will contact dissimilar metals.

2.4.3 Expansion Strip

Strip of closed cell polyethylene foam conforming to ASTM D4819, Type II, or strip of sponge rubber conforming to ASTM D1056; 9 mm 3/8 inches thick.

2.4.4 Asphalt Emulsion

Asphalt emulsion conforming to ASTM D1187/D1187M, Type II for use on metal surfaces; and asphalt emulsion conforming to ASTM D1227, Type III, Class I for use on porous surfaces.

2.4.5 Sealant and Backer Rod

Comply with Section 07 92 00 JOINT SEALANTS.

PART 3 EXECUTION

3.1 PREPARATION

Before placing the mortar bed for the first course of glass masonry units, apply a heavy coat of asphalt emulsion to sill surfaces and allow to thoroughly dry.

3.2 INSTALLATION

3.2.1 Tolerances

Erect glass unit masonry within site tolerances of TMS MSJC, Article 3.3 F.

3.2.2 Mortar Preparation

Keep mortar boxes, pans, and mixer drums clean and free of debris and dried mortar. Do not retemper mortar after initial set. Discard mortar that has not been placed in final position within 1-5 hours after initial mixing.

3.2.3 Mortar Joints

Construct mortar joints 6 mm 1/4 inch wide when laying standard hollow glass masonry units, and 10 mm 3/8 inch wide when laying thin solid glass masonry units. Fill head and bed joints completely and evenly and do not furrow the mortar. Remove loose and excess mortar. The practice of buttering at the corners of the unit and then throwing mortar or scrapings into the empty joints will not be permitted. Maintain joint tolerances in accordance with TMS MSJC.

In joints to be reinforced, place half the thickness of mortar, press in the reinforcing, then apply the second half of mortar on top so that the reinforcing is in the middle of the mortar joint. Place full mortar bed for joints not requiring reinforcing.

3.2.4 Glass Masonry Unit Installation

Do not use steel tools to tap glass units into position. Place rubber crutch tips at the ends of trowels to tap glass masonry units.

Lay glass masonry units [in stacked bond] [_____]. Do not realign, tap or otherwise move glass masonry units after initial placement.

3.2.5 Joint Reinforcement

Embed reinforcement in mortar bed joints at a maximum spacing of 400 mm centers 16 inch centers continuously from end to end of panel, except at expansion joints. Provide additional courses of joint reinforcement above and below openings within the glass masonry unit panel. Lap reinforcing not less than 150 mm 6 inches at splices where more than one length of reinforcement is used.

3.2.6 Lateral Support of Glass Masonry Unit Panels

3.2.6.1 General

Anchor walls and partitions to adjoining construction to provide lateral stability, but permit unrestricted deflection of construction above, using either channel type restraints or panel anchors.

3.2.6.2 Panel Anchors

Except where channel-type restraints are used, space panel anchors a maximum of 400 mm 16 inches apart at jambs (in same joint as panel reinforcing), and 400 mm 16 inches apart at heads. Embed panel anchors in the mortar joints a minimum of 300 mm 12 inches, except where panel dimension is less than 600 Mm 2 feet. Provide a minimum embedment of 150 mm 6 inches when the panel dimension is less than 600 Mm 2 feet. Provide two fasteners per panel anchor.

3.2.7 Expansion Joints

Provide space indicated to permit expansion at heads and jambs of glass masonry unit panels. Maintain expansion joints at head, jambs and at intermediate supports free of mortar.

3.2.8 Mortar Joint Tooling

After initial set of mortar, tool exposed joints and compress with a rounded jointer. Provide finished surface of joint that is concave, smooth, and non-porous.

3.2.9 Sealing of Expansion Joints

After final set of mortar, remove mortar from expansion joints. Seal expansion joints at head, jamb and intermediate supports with sealant and backer rod specified in Section 07 92 00 JOINT SEALANTS, at least 24 hours after curing of the mortar.

3.3 ADJUSTING AND CLEANING

3.3.1 Repair of Defective Work

Upon completion of glass masonry unit erection, cut out defective mortar joints and tuck point joints solidly with mortar. Replace damaged glass masonry units by breaking out both faces of the unit and carefully removing the surrounding mortar and glass frames, making sure to avoid damage to adjacent units. Butter all edges of the replacement glass unit and place it in the opening. Using a tuckpointing trowel, push mortar through the joints from both sides of the panel, until joints are full, then tool when thumbprint hard.

3.3.2 Cleaning

Protect work that may be damaged, stained, or discolored by cleaning operations. Remove excess mortar from glass masonry units with damp cloth or sponge before set occurs. Clean exposed surfaces with clear water and stiff fiber brushes, and rinse with clear water. Where stains, mortar, or other soil remain, continue cleaning with warm water and soap. Do not use abrasive cleaners (steel wool, wire brush) or acids in conjunction with removing mortar or dirt from the glass masonry unit faces. Restore damaged, stained, or discolored work to original condition or provide new work.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-05 05 20 (May 2022)**
Change 1 - 08/24

Preparing Activity: NAVFAC **Superseding without Revision**
UFGS-05 05 20.00 27 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 05 20

POST-INSTALLED CONCRETE AND MASONRY ANCHORS

05/22, CHG 1: 08/24

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-05 05 20 (May 2022)**
Change 1 - 08/24

Preparing Activity: NAVFAC **Superseding without Revision**
UFGS-05 05 20.00 27 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 05 05 20

POST-INSTALLED CONCRETE AND MASONRY ANCHORS

05/22, CHG 1: 08/24

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NOTE: This specification covers the requirements for post-installed concrete and masonry anchors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: Show the following information on the project drawings:

Anchor type, diameter, effective embedment, spacing, critical edge distances used in the design. Proof load and/or capacity should be shown on the drawings or edited into this specification. Horizontal, inclined, or overhead anchors supporting sustained tension loads should be identified on the drawings for additional installer qualifications and QA/QC requirements.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 355.2	(2007) Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary
ACI 355.4	(2011) Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4) and Commentary

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements

ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 APPLICABILITY

This guide specification covers the requirements for all anchors that are post-installed into hardened concrete, concrete masonry, or brick. This guide specification does not cover through bolts, powder or pneumatic actuated nails, or cast in anchors. Refer to Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS for requirements of through bolts, powder or pneumatic actuated nails, or cast in anchors.

1.3 DEFINITIONS

1.3.1 Anchor

"Anchor" includes steel elements post-installed into hardened concrete, concrete masonry, or brick and used to transmit applied loads.

1.3.2 Periodic Special Inspections

"Periodic Special Inspection" as used herein means that, as a minimum, the Post-Installed Anchor Special Inspector must perform inspections in accordance with this specification.

1.3.3 Continuous Special Inspections

"Continuous Special Inspection" as used herein means that the Post-Installed Anchor Special Inspector observes the drilling and cleaning of holes, the injection of adhesive into the holes, and the insertion of anchors into the holes. When applicable for the type of installation, or as indicated in the project drawings, "Continuous Special Inspection" also includes observation of measures to secure the anchor during the adhesive curing period.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications; G, [_____]

Post-Installed Anchor Special Inspector Qualifications; G, [_____]

SD-03 Product Data

Mechanical Anchors in Concrete; G, [_____]

Adhesive Anchor System in Concrete; G, [_____]

Mechanical and Adhesive Anchors in Masonry; G, [_____]

Non-Shrink, Non-Metallic Grout; G, [_____]

SD-06 Test Reports

Post-Installed Anchor Special Inspections Report; G, [_____]

SD-07 Certificates

Post-Installed Anchor Certification; G, [_____]

SD-08 Manufacturer's Instructions

Manufacturer's Printed Installation Instructions; G, [_____]

Non-Shrink, Non-Metallic Grout; G, [_____]

Manufacturer's Safety Data Sheets

1.5 QUALITY ASSURANCE

Perform all work in accordance with EM 385-1-1 and all manufacturer's instructions and recommendations. To protect personnel from overexposure to toxic materials, conform to the applicable manufacturer's Safety Data Sheets (SDS) or local regulation. Submit the SDS for epoxies and other potentially hazardous materials.

1.5.1 Qualifications

The submittals must identify individuals who will be working on this contract and their relevant experience and training. Do not make changes in approved personnel without prior approval of the Contracting Officer.

1.5.1.1 Installer Qualifications

****

NOTE: Installation of post-installed anchors must be performed by personnel certified by an applicable certification program (such as ACI/CRSI Adhesive Anchor Installer), or equivalent instruction program through the manufacturer or manufacturer's representative. The acceptability of certification other than the ACI/CRSI Adhesive Anchor Installer Certification is the responsibility of the licensed design professional.

****

Each worker engaged in the installation of post-installed anchors must have satisfactorily completed an applicable certification program or equivalent instruction program through the manufacturer or manufacturer's representative for all anchoring products they will install. A manufacturer's representative must train all installers per the installation instructions as listed in the ICC-ES Evaluation Report for the anchor being installed. Training must consist of a review and performance test of the complete installation process, including but not limited to:

(1) Hole drilling procedure

(2) Hole preparation & cleaning technique

[(3) Adhesive injection technique & dispenser training / maintenance

][(4) Anchor/threaded rod preparation and installation

][(5) Rebar dowel preparation and installation

][(6) Proof loading/torquing

][(7) Installation in horizontal and upward orientations

] Submit certification for each worker showing that they have completed the above training within three years prior to onsite work. Certification must include organization or manufacturer's name, instructor's name and qualifications, trainee's name, list of instruction received, date of instruction, and confirmation of successful performance tests.

1.5.1.2 Post-Installed Anchor Special Inspector Qualifications

****

NOTE: While inspector certification programs have been developed (such as ACI/CRSI Adhesive Anchor Installation Inspector), these programs are not readily available. At a minimum, the inspectors must have training as post-installed anchor installers and have sufficient relevant experience as an inspector.

****

The Contractor must retain the services of a third party Special Inspector independent of the installing contractor and manufacturer. The individual(s) who perform special inspections for post-installed anchors must meet all Installer Qualification requirements and have a minimum of [1][3][5] year[s] of experience as a Special Inspector on previous projects involving similar scope of work. Submit resumes, pertinent information, past experience, and training.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packing, Shipping, Handling, and Unloading

Deliver products to job site in manufacturer's or distributor's original packaging undamaged, complete with installation instructions. Inspect materials delivered to site for damage. Unload and store with minimal handling.

1.6.2 Storage

Protect, store, and handle materials in accordance with manufacturer's recommendations to prevent damage or deterioration. Do not allow chemical materials to freeze. Remove materials that have not be stored in accordance with the manufacturer's recommendations, including expired materials, from the job site.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Post-Installed Anchors

Provide anchors of the type, effective embedment, and diameter indicated on contract drawings. Minimum spacing and concrete edge distances must be as shown on contract drawings. Design values listed must be as tested according to ASTM E488/E488M for the substrate type, substrate moisture condition, concrete aggregate type (normal weight or lightweight concrete), and concrete/masonry strength. Minimum [allowable strength][ultimate strength] tension and shear values must be as indicated on contract drawings. If more than one type of anchor is to be used on a project, clearly indicate on the submittal where each type of anchor will be used.

2.1.1.1 Post-Installed Anchor Certification

Submit product information with recommended design values and physical characteristics for each type anchor shown on the drawings.

Provide certified test reports showing compliance with specified performance characteristics and physical properties. Anchors must have one of the following certifications:

(1) ICC-ES Evaluation Report indicating conformance with current applicable ICC ES Acceptance Criteria

(2) Third party Evaluation Report in conformance with ACI 355.2 or ACI 355.4, as applicable. Third party must be accredited under ISO/IEC 17025 by a recognized accreditation body conforming to the requirements of ISO/IEC 17011 in accordance with ACI 355.4."

2.1.1.2 Manufacturer's Printed Installation Instructions

Submit manufacturer's instructions for each anchor type shown on the drawings.

2.1.1.3 Mechanical Anchors in Concrete

Anchors must have been tested and qualified for performance in cracked and uncracked concrete in accordance with ACI 355.2.

Anchors must be galvanized in accordance with ASTM A153/A153M or stainless steel in accordance with ASTM A193/A193M unless otherwise indicated.

2.1.1.4 Adhesive Anchor System in Concrete

Use an adhesive to bond steel anchors to concrete. The adhesive must be a moisture insensitive, structural adhesive. Anchors must have been tested and qualified for performance in cracked and uncracked concrete, horizontal and overhead applications, and long term creep in accordance with ACI 355.4.

Threaded rod anchors must meet the requirements of [ASTM F1554 Grade [36][55][105]][ASTM A36/A36M][ASTM A193/A193M Grade B7][_____]. Threaded rods must be galvanized in accordance with ASTM A153/A153M or stainless steel in accordance with ASTM A193/A193M unless otherwise indicated. Reinforcing bars must meet the requirements of ASTM A615/A615M Grade [60][75][100].

****

NOTE: The temperature ranges listed in the below sentence, and anchor sizes and bond strengths listed in the below table, should be modified for your specific project as stated in the ICC-ES Evaluation Report used in your calculations. It is recommended that you research the temperatures ranges and bond strength capacities listed in multiple manufacturer's ICC-ES Evaluation Reports and include a range of acceptable values. This will allow flexibility based on product availability. Recommend deleting anchor sizes not used on your specific project.

****

Adhesive anchors must have the below characteristic bond strengths for uncracked and cracked concrete in [_____] MPa [_____] psi concrete with maximum short term temperatures of[_____] degrees C [_____] degrees F and maximum long term temperatures of[_____] degrees C [_____] degrees F:

ANCHOR	Tau,uncr (characteristic bond strength, uncracked concrete)	Tau,cr (characteristic bond strength, cracked concrete)
	(psi)	(psi)
[___" diameter threaded rod]	[_____]	[_____]
[#___ reinforcing bar]	[_____]	[_____]

2.1.1.5 Mechanical and Adhesive Anchors in Masonry

Anchors must have been tested and qualified, by a third party, specifically for performance in [hollow concrete masonry][filled concrete masonry][brick] to match the project's actual base material.

Adhesives must be moisture insensitive, low creep, structural adhesive. Threaded rods must meet the requirements of [ASTM F1554 Grade [36][55][105]][ASTM A36/A36M][ASTM A193/A193M Grade B7][_____].

Anchors must be galvanized in accordance with ASTM A153/A153M or stainless steel in accordance with ASTM A193/A193M unless otherwise indicated.

2.2 EQUIPMENT

Assemble at the site of the work, sufficient equipment that is dependable, appropriate and adequate to accomplish the work specified. Maintain the equipment in good working condition.

PART 3 EXECUTION

3.1 ANCHORING AND REINFORCING

Install anchors in accordance with the spacing and edge clearances indicated on the drawings. Anchor capacity is also highly dependent on proper installation. Follow all manufacturer and Evaluation Report installation instructions.

3.1.1 Drilling and Installing Mechanical Anchors

Drill holes for anchors using drilling equipment and bits suitable for the intended purpose, in accordance with Manufacturer's published installation instructions. Diameter of holes must be as recommended by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes must be drilled perpendicular to the concrete surface. Deviations more than 6 degrees from perpendicular are not acceptable. Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Mechanical anchors must not be installed in concrete that is less than 7 days old.

Clean holes, install anchors and set anchors in place in accordance with the manufacturer's recommendations. Protect threads and anchor from damage during anchor installation. Ensure proper embedment and placement in accordance with contract documents and all other work. Aim wedges away from any concrete edges that are less than 9 inches from centerline of hole.

Tighten nuts against smooth washers to the manufacturer's recommended torque, using a calibrated torque wrench. Following attainment of 10 percent of the specified torque, 100 percent of the specified torque must be reached within 7 or less complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor must be removed and replaced unless otherwise directed by the Engineer of Record.

3.1.2 Drilling and Installing Adhesive Anchors

Drill holes for anchors using drilling equipment and bits suitable for the intended purpose, in accordance with Manufacturer's Printed Installation Instructions and Evaluation Report installation instructions. Diameter of holes must be as recommended by the anchor manufacturer. Unless otherwise shown on the drawings, all holes must be drilled perpendicular to the concrete surface. Deviations more than 10 degrees from perpendicular are not acceptable. Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Adhesive anchors must not be installed in concrete that is less than 21 days old.

Clean holes, place grout, and install anchors in accordance with anchor manufacturer's recommendations. Remove excess adhesive after the anchor has been set in place. Remove spills on adjacent surfaces.[When installing resin cartridges or capsules in submerged conditions, place properly proportioned resin material in bottom of hole using a mixing tube prior to inserting the cartridge or capsule.] Protect threads and anchor from damage during anchor installation. Ensure proper embedment and placement in accordance with contract documents and all other work. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

Adhesives must be stored at temperatures prescribed by the manufacturer and must not be used beyond the expiration date.

3.1.3 Unused or Repairs to Drilled Holes

Any holes made for anchors that are not used must be filled with non-shrink, non metallic grout suitable for the orientation and size of hole and have a minimum compressive strength of 4000 psi. Repair must completely fill hole and be flush with existing concrete or masonry. Place in accordance with manufacturer's recommended instructions. Final anchor positions must not be within 25 mm1 inch of repair patches.

3.2 EMBEDDED ITEMS

Existing reinforcing bars or other embedded items in the structure may conflict with specified anchor locations. Existing reinforcing and embedded items must not be damaged during installation of post-installed anchors.

The contractor must review the [project][as-built] drawings [and must use Radar detection systems (such as Hilti Ferroscan), X-Ray, or other appropriate means]to accurately locate the position of [existing]reinforcing bars and embedded items at the locations of the anchors in the field.[Scanning method must provide enough accuracy and precision to locate the space between rebar. Structural integrity of existing concrete or masonry must not be impaired by investigating method.]

Create a template at each anchor connection location prior to fabricating holes in connection plates. Template must be made by locating existing reinforcing with an approved reinforcement detection system.

3.3 TESTS AND INSPECTIONS

3.3.1 Mechanical Anchors

For mechanical anchors, periodic special inspections are required. Inspections must be in accordance with ICC IBC and the Evaluation Report.

Mechanical Anchors must be inspected during installation, to verify anchor type, anchor dimensions, base material type, drill bit, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, base material thickness, base material age, effective embedment, tightening torque, adherence to the manufacturer's printed installation instructions, and any additional items recommended in the Evaluation Report.

For mechanical anchors whose strength is dependent on a minimum installation torque, the [installer under the supervision of the Special Inspector][Special Inspector] must torque test the anchors with a calibrated torque wrench. Perform torque testing immediately on the first three anchors of each type and size, for each installer, and a minimum of [5][10] percent of randomly selected anchors. Anchor selection will be determined by the [Post-Installed Anchor Special Inspector][Contracting Officer][Engineer of Record].

For mechanical anchors whose strength is not dependent on a minimum installation torque, the Special Inspector must perform proof loading on the first three anchors of each type and size, for each installer and a minimum of [5][10] percent of randomly selected anchors. Anchor selection will be determined by the [Post-Installed Anchor Special Inspector][Contracting Officer][Engineer of Record]. Perform confined tension proof load testing in accordance with ASTM E488/E488M. Use incremental loading for tensile test. Maintain proof load for a minimum of 10 seconds. Consider anchors to have failed if displacement exceeds 2.5 mm 0.1 inch D/10, where D is the nominal anchor diameter, or if any of the failure modes listed in ASTM E488/E488M occur.

Proof loads must be the minimum of the value shown on the Drawings, the values shown in the table below, or 50 percent of the tension capacity of the anchor:

****

NOTE: The following table should be modified for your specific project and the capacities and anchors required.

****

ANCHOR	EFFECTIVE EMBEDMENT	CONFINED TENSION PROOF LOAD
	(inches)	(pounds)
[Concrete Screw Anchor, ___" diameter]	[_" to _" in Concrete]	[_____]
[Masonry Screw Anchor, ___" diameter]	[_" in Masonry]	[_____]

3.3.2 Adhesive Anchors

For adhesive anchors, periodic special inspection are required as a minimum. Where adhesive anchors are used to resist sustained tension in horizontal or upwardly inclined orientations, or where the findings of the Evaluation Report for the adhesive anchor product require it, continuous special inspection is needed. Inspections must be in accordance with ICC IBC and the Evaluation Report.

Adhesive anchors must be inspected during installation, to verify anchor type, anchor dimensions, base material type, base material age, drill bit, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, base material thickness, effective embedment, tightening torque, adhesive mixing, filling of the hole with adhesive, adherence to the manufacturer's printed installation instructions, and any additional items recommended in the Evaluation Report.

The Special Inspector must perform proof loading on the first three anchors of each type and size, for each installer, and a minimum of [5][10] percent of randomly selected anchors. Anchor selection will be determined by the [Post-Installed Anchor Special Inspector][Contracting Officer][Engineer of Record]. Perform confined tension proof load testing in accordance with ASTM E488/E488M. Use incremental loading for tensile test. Maintain proof load for a minimum of 10 seconds. Consider anchors to have failed if displacement exceeds 2.5 mm 0.1 inch D/10, where D is the nominal anchor diameter, or if any of the failure modes listed in ASTM E488/E488M occur.

Adhesive anchors and capsule anchors must not be torque tested.

Proof loads must be the minimum of the value shown on the Drawings, the values shown in the table below, or 50 percent of the tension capacity of the anchor:

****

NOTE: The following table should be modified for your specific project and the capacities and anchors required. The proof load levels must not exceed the lesser of the required anchor strength, 50 percent of the expected peak load based on adhesive bond strength, or 80 percent of the anchor yield strength per ACI 355.4, section 13.3.4.

****

ANCHOR	EFFECTIVE EMBEDMENT	CONFINED TENSION PROOF LOAD
	(inches)	(pounds)
[Adhesive anchor, ___" diameter rod]	[_____" to _____"]	[_____]
[Adhesive anchor, #___ reinforcing bar]	[_____" to _____"]	[_____]

3.3.3 Action Required from Failed Tests/Inspections

Immediately report failed anchor locations and test results to the Contracting Officer. Anchors that fail to meet proof/torque load or installation requirements must be regarded as malfunctioning. Do not re-use holes unless specifically allowed by manufacturer's published instructions and approved by the Post-Installed Anchor Special Inspector.

If any of the tested anchors fail to achieve the specified torque or proof load within the limits of the contract documents, test a minimum of two adjacent anchors for each anchor that fails.

Continuously special inspect and proof load/torque test any replacement anchors.

Fill unused anchor holes and patch failed anchor locations in accordance with this specification. Prior to performing the repair, the Contractor must submit to the Contracting Officer for approval, the proposed fill and patch materials.

Additional tests, repairs, delays, or modification of work to accommodate failed tests will be at no cost to the Government.

3.3.4 Post-Installed Anchor Special Inspections Report

Report the results of all inspections [daily][weekly][biweekly]. Submit report as an electronic PDF file to the Contracting Officer for review by the Engineer of Record. The report must include the following:

(1) Exact locations of the inspected and tested work

(2) Inspector's name

(3) Date of inspection

(4) Summary of work completed during the inspection period

(5) Test results

(6) Statement by the Special Inspector that clearly identifies the tested anchors as being acceptable or rejected.

(7) Statement by the Special Inspector confirming that the materials and installation procedures conform with the approved contract documents and the manufacturer's published installation instructions.

3.4 DUST CONTROL

Control dust resulting from demolition to prevent the spread of dust and avoid creation of a nuisance in the surrounding area. Do not use water when it will result in, or create, hazardous or objectionable conditions such as ice, flooding, or pollution.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-05 05 23.13 10 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-05 05 23.13 10 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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ULTRASONIC INSPECTION OF WELDMENTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-05 05 23.13 10 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-05 05 23.13 10 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 05 05 23.13 10

ULTRASONIC INSPECTION OF WELDMENTS
08/18

****
NOTE: This guide specification covers the requirements for ultrasonic inspections of weldments; including qualifications and procedures.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

1.2 DEFINITIONS

1.2.1 A Scan

Method of data presentation on a electronic screen using rectangular coordinates in which a horizontal base line indicates elapsed time when reading from left to right. A vertical deflection in the base line indicates reflect signal amplitude.

1.2.2 Acoustically Similar Material

Material the same as that to be inspected; or another material proven to have acoustical velocity within plus or minus 3 percent and an attenuation within plus or minus 0.009843 dB/mm 0.25 dB/inch of the inspected material for the inspection frequency and wave mode, using the same mode as that to be used for inspection.

1.2.3 Amplitude

When referring to an indication in A scan presentation, amplitude is the vertical height of the indication measured from peak-to-peak for radio frequency indications and trace-to-peak for video indications.

1.2.4 Attenuation

Dissipation or loss of energy as ultrasonic vibrations travel through the material. Attenuation is caused almost entirely by scattering of the ultrasonic vibrations generated by the search unit.

1.2.5 Back Reflection or End Reflection

Reflection from the opposite side, end, or boundary of the material into which the ultrasonic energy was introduced.

1.2.6 Calibration

Process of comparing an instrument or device with a standard to determine accuracy or produce a scale.

1.2.7 Couplant

Any material, usually a liquid or semiliquid, used between the search unit and the inspection surface to exclude air and to convey the ultrasonic vibrations between the search unit and the material being inspected.

1.2.8 Digital Display

Display capable of presenting multi-function a-scan, b-scan, c-scan or s-scan responses. This also includes instruments settings and parameters.

1.2.9 Decibel (dB)

Units for the logarithmic expression of the ratio of power levels. Power levels can be functions of voltage, current, or impedance, for example. Decibel units having no values of their own are only significant when a reference is stated, as 10 dB above one reference level or 6 dB below another reference level.

1.2.10 Discontinuity

Anything within a material that causes a detectable interruption in an ultrasonic beam.

1.2.11 Examination

Within the context of this specification, examination is equivalent to the word "inspection."

1.2.12 Hertz

One complete set of recurrent values of a periodic quantity comprises a cycle. In other words, any one set of periodic variations starting at one condition and returning once to the same condition is a cycle.

1.2.13 Immersion Techniques

Test methods in which the part to be tested and the search units are immersed in water or other suitable liquid couplant. A mechanical device is used to firmly hold and direct the wave angle of the search unit. The search unit does not contact the item being inspected.

1.2.14 Indication

Visual presentation on the digital display screen resulting from a sound beam reflection from a boundary surface or discontinuity.

1.2.15 Linearity

Property of an instrument revealed by a linear change in reflected signal or displacement. The vertical linearity is determined by plotting the change in ratios of signal amplitude from two adjacent reflections from an area of known size. The horizontal linearity is determined by plotting the distance the signal is displaced along the sweep against the change in material thickness or by noting the spacing of multiple back reflections.

1.2.16 Longitudinal or Compressional Waves

Simple compression-rare-fraction waves in which particle motion within a material is linear and in the direction of wave propagation. Also called straight beams, or compressional or normal waves.

1.2.17 Longitudinal Wave Inspection

Ultrasonic technique, normally using straight beam methods, in which longitudinal waves are the dominant form.

1.2.18 Mid-Screen Reflection

Reflection whose amplitude is equal to one-half the useable screen height on the digital display.

1.2.19 Megahertz (MHz)

One million hertz per second frequency.

1.2.20 Pulse Repetition Rate

Number of spaced pulses of sound per second sent into the material being inspected.

1.2.21 Reflector

Boundary, consisting of an opposite side, crack, or separation, or a distinct change in material such as slag or porosity that reflects the ultrasonic energy the same as a mirror reflects light.

1.2.22 Refracted Waves

Waves that have undergone change of velocity and direction by passing from one material to another material with different acoustical properties. Refraction occurs wherever the angle of the incident wave to the interface is other than perpendicular.

1.2.23 Resolution

Ability to clearly distinguish signals obtained from two reflective surfaces with a minimum separation distance. Near-surface resolution is the ability to clearly distinguish a signal from a reflector at a minimum distance under the contact or near surface without interference from the initial pulse signal. Far-surface resolution is the ability to clearly distinguish signals from reflectors displaced at minimum distances from the far or back surface when the sound beam is normal to that back surface.

1.2.24 Search Unit

Device containing a piezoelectric material used for introducing vibrations into a material to be inspected or for receiving the vibrations reflected from the material. The active element of the search unit is defined as the effective transmitting area. Search units are also called transducers or probes. They may be single or dual and contain one or two piezoelectric elements, respectively, for transmission and reception. The single search unit is sometimes enclosed in a transducer wheel or search unit wheel. The search unit may be manually handled and placed in direct contact with the material to be inspected or may be held in a fixture for immersion techniques.

1.2.25 Sensitivity

Measure of the ultrasonic equipment's ability to detect discontinuities. Quantitatively, it is the level of amplification of the receiver circuit in the ultrasonic instrument necessary to produce the required indication on the scope from the reference hole in the reference block. Also see "Standard Reference Level."

1.2.26 Shear Waves

Waves in which the particles within the material vibrate perpendicularly to the direction in which the wave travels or propagates. Also called transverse waves.

1.2.27 Standard Reference Level

Mid-screen height reflection when beaming at the 1.52 mm 0.06 inch hole in the primary reference block or the reference hole in the secondary standard.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Personnel Qualification; G, [_____]

Procedure description; G, [_____]

SD-03 Product Data

Equipment and accessories

SD-06 Test Reports

Equipment Qualifications

Inspection Test Reports

1.4 QUALITY ASSURANCE

1.4.1 Personnel Qualification

The three levels of responsibility associated with ultrasonic inspection are defined in ANSI/ASNT CP-189. Personnel performing NDT should be level II or Level I with direct supervision. For qualification to perform ultrasonic inspection, certify personnel in accordance with ANSI/ASNT CP-189 within a period of 1 year before the date of contract. Submit inspector qualifications per ANSI/ASNT CP-189. Other qualification or certification may be accepted at the Contracting Officer's discretion. Personnel with only an operator or inspector trainee certification will not be considered qualified to pass judgment on the acceptability of inspected items, but may work under the direct supervision of a qualified ultrasonic inspector. Qualified ultrasonic inspectors must be able to judge the acceptability of the item in accordance with paragraph ACCEPTANCE-REJECTION CRITERIA. Only serialized NIST traceable calibration standards are to be used. The procedures to be used for personnel and equipment qualification, equipment calibration, and inspection, at least 30 days prior to their intended use. Approval by the Government will in no way affect the obligation of the Contractor to employ qualified personnel, equipment, and procedures, and to perform the inspection as specified.

1.4.2 Examinations

If the Contracting Officer doubts an individual's ability as an operator, inspector, or supervisor, recertify the individual in accordance with ANSI/ASNT CP-189, using the practical exam. At the option of the Government, the Contracting Officer may witness the examination and in evaluating the results.

1.4.3 Reference Standards

Use reference standards to calibrate the inspection equipment, test its operating condition, and record the sensitivity or response of the equipment during the inspection in accordance with paragraph EQUIPMENT

QUALIFICATIONS. The standards comprise a standard reference block and reference specimens as noted below.

a. Provide the standard reference block or primary standard consisting of the IIW block in AWS D1.1/D1.1M, Clause 6, Part F. Also use the standard reference block in any reinspection on the same basis as the original inspection, even though the reinspection is to be performed by other ultrasonic instruments and accessories.

b. As an option, use other recognized working standards detailed with the IIW block in AWS D1.1/D1.1M such as the Sensitivity Calibration (SC) block. However, reference such blocks to the IIW block as noted in paragraph EQUIPMENT CALIBRATION. Include details of their use in the submitted procedure description. These blocks are the secondary standards. They must be of acoustically similar material to the welds to be inspected. The secondary standards must be suited for the applicable tests specified in paragraph EQUIPMENT QUALIFICATIONS and are used as follows, except where the IIW block is specifically required:

    (1) To assure adequate penetration of the base material.
    (2) To provide a secondary field standard.
    (3) To calibrate the equipment and establish the standard reference level.

1.4.4 Resolution Test Block

Furnish a resolution test block in accordance with the details shown in AWS D1.1/D1.1M, Clause 6, Part F.

1.4.5 Equipment Qualifications

Calibrate and recalibrate all NDT equipment in accordance with AWS D1.1/D1.1M requirements.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Welded joints to be inspected will be shown on the drawings, stated in other sections, or added to this paragraph. Because accessibility and geometry of the joint are factors in obtaining adequate ultrasonic penetration, consider these factors in the design of the joint. Drawings or listings in the specifications must clearly indicate which weld joints are to be inspected ultrasonically.

The use of advanced ultrasonic techniques in lieu of conventional UT will require the engineer to consider the establishment of an acceptance criteria in accordance with AWS D1.1. Prior to proposing the use of advanced UT (phased array, TOFD etc) or prior to accepting the proposed use of advanced UT by the fabricator/contractor, the engineer will need to establish an acceptance criteria and require an additional procedure submittal for the use of advanced ultrasonic techniques.

****

2.1.1 Procedures and Methods

Use the pulse echo contact method with an A scan presentation for the ultrasonic inspection of welded joints, except that immersion techniques may be used for some applications when approved by the Contracting Officer. Use the procedures, methods, standards, and description of equipment specified herein for inspection of weldments. Include the following in the submitted procedure description:

a. Couplant.

b. Search unit characteristics including angle, size, shape, nominal frequency, type designation.

c. Method and type of wave.

d. Equipment and accessories including manufacturer, model number, date of manufacture, last date of calibration, and the manufacturer's electrical, physical, and performance specifications.

e. Decibel (dB) compensation system for distance-amplitude correction.

2.1.2 Wave Types

The types of waves and the conditions under which they are used are specified below. Unless conditions prohibit, use shear waves. A longitudinal wave procedure may be used instead, if approved by the Contracting Officer.

2.1.2.1 Shear Waves

Use refracted waves between 40 degrees and 70 degrees except where different angles are indicated in approved procedures, such as for materials less than 13 mm 1/2 inch thick, for materials with sound velocities greater than in steel, when the weldments are not readily accessible, or when existing backing rings or backing strips are not removed. For inspection of weldments containing backing rings or backing strips, adjust the instrument and select the refracted angles in a way to separate the weldment and the backing ring reflections. Establish the search unit angle and the resulting shear wave angle in the material to be inspected for each application and include this information in the procedure submitted for approval.

2.1.2.2 Longitudinal Waves

Specifically develop the procedure to suit the application and attain the prior approval of the Contracting Officer.

2.1.3 Changes in Procedure

Should application of an approved procedure not provide for good resolution or adequate ultrasonic penetration in the items to be inspected (see paragraph EQUIPMENT QUALIFICATIONS), make changes in procedure or equipment such as frequency, pulse repetition rate, angle of search unit, couplant, or oscilloscope. Demonstrate adequacy of the new procedure to the Contracting Officer. The Government reserves the right to require a change in test equipment during these tests if any of the following test system characteristics fall below the levels listed in paragraph EQUIPMENT QUALIFICATIONS: sensitivity, amplitude and distance linearity, signal-to-noise ratio, entry and back surface resolution and penetration.

2.1.4 Ultrasonic Equipment

Provide ultrasonic equipment conforming to the requirements listed in AWS D1.1/D1.1M Clause 6, Part F, with the following exceptions:

a. The ultrasonic test instruments must be able to generate, receive, and to present pulses in the frequency range from 1 to 10 megahertz (MHz).

b. Measure the horizontal linearity of the ultrasonic instrument in accordance with paragraph EQUIPMENT QUALIFICATIONS.

c. In addition to the resolution test specified in AWS D1.1/D1.1M, Clause 6, Part F, conduct both near- and far-surface resolution tests in accordance with the tests specified for these characteristics in the paragraph EQUIPMENT QUALIFICATIONS.

PART 3 EXECUTION

3.1 PREPARATION OF MATERIALS FOR INSPECTION

Surfaces must be free of the following:

3.1.1 Weld Spatter

Remove spattering or any roughness that interferes with free movement of the search unit or impairs transmission of the ultrasonic vibrations.

3.1.2 Irregularities

Those which could mask or be confused with defect indications.

3.1.3 Weld Backing Strips

Remove strips that are not to remain in place and eliminate all sharp edges and valleys by grinding or other mechanical means.

3.1.4 Dirt

Remove all loose scale, rust, paint, and dirt from the coupling surface.

3.2 EQUIPMENT CALIBRATION

Calibrate equipment in accordance with AWS D1.1/D1.1M, Clause 6, Part F.

3.3 INSPECTION PROCEDURE

****

NOTE: When necessary, the designer should indicate on the drawing the area to be examined, the contact surface, and if welds are to be inspected from one or both sides.

****

Inspect welds in accordance with AWS D1.1/D1.1M, Clause 6, Part F.

****

NOTE: Where welds are subjected to cyclic loading identify them on the construction documents and include Table 6.3 in the paragraph below.

****

3.4 ACCEPTANCE - REJECTION CRITERIA

In accordance with AWS D1.1/D1.1M, Table [6.2] [or 6.3].

3.4.1 Inspection Test Reports

Submit test reports containing the following information:

3.4.1.1 Identification and Location of Inspection

Connection identification and location of the inspected item, the person performing the inspection, and the date of inspection.

3.4.1.2 Detail of Inspections

Details of methods, types of waves used, search units, frequencies, inspection equipment identification, and calibration data with enough information to permit duplication of the inspection at a later date.

3.4.1.3 Identification of Unacceptable Areas

Locations, dimensions, types, and area of unacceptable defects and discontinuities giving reflections over 50 percent of the reject/repair line. Note on a sketch or marked-up drawing.

3.4.1.4 Record of Repair Areas

A record of repaired areas must be furnished as well as test results for the repaired areas.

3.4.2 Inspection of Repairs

All repairs undergo the same inspection procedure that originally revealed the discontinuities. Before acceptance, the welds must meet the standards required for the original weld.

-- End of Section --

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UFGS-05 05 23.16 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 05 05 23.16

STRUCTURAL WELDING
08/18

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NOTE: This guide specification covers the requirements for (1) qualifying welding procedures, welders and welding operators, and (2) the fabrication, welding and inspection of carbon steel, low alloy steel, extra-high-strength quenched and tempered low alloy steels, and austenitic stainless steel materials for structural steel for buildings, other structures and non-structural use.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: This specification can be used for other structures with similar types of live loads by implementing the requirements of AWS D1.1/D1.1M, as applicable, in the design of the weldments, and deleting the references to AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel
AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel
AWS D1.8/D1.8M	(2016) Structural Welding Code—Seismic Supplement
AWS D14.4/D14.4M	(2012) Specification for Welded Joints for Machinery and Equipment
AWS QC1	(2016) Specification for AWS Certification

	of Welding Inspectors
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welding Quality Assurance Plan; G, [_____]

SD-03 Product Data

Welding Procedure Qualifications; G, [_____]

Welder, Welding Operator, and Tacker Qualification

Previous Qualifications

Pre-Qualified Procedures; G, [_____]

Welding Electrodes and Rods

SD-06 Test Reports

Nondestructive Testing

Weld Inspection Log

SD-07 Certificates

Certified Welding Procedure Specifications (WPS)

Certified Brazing Procedure Specifications (BPS)

Certified Procedure Qualification Records (PQR)

Certified Welder Performance Qualifications (WPQ)

Certified Brazer Performance Qualifications (BPQ)

Certified Welding Inspector

Nondestructive Testing Personnel

1.3 QUALITY ASSURANCE

Except for pre-qualified (in accordance with AWS D1.1/D1.1M) and previously qualified procedures, each Contractor performing welding must record in detail and qualify the welding procedure specification for any welding procedure followed in the fabrication of weldments. Conform welding procedure qualifications to AWS D1.1/D1.1M[, AWS D1.8/D1.8M] and to the specifications in this section. Submit for approval copies of the welding procedure specification and the procedure qualification records for each type of welding being performed. Submission of the welder, welding operator, or tacker qualification test records is also required. Approval of any procedure, however, does not relieve the Contractor of the sole responsibility for producing a finished structure meeting all the specified requirements. Submit this information on the forms in Annex M of AWS D1.1/D1.1M. Individually identify and clearly reference on the detail drawings and erection drawings all welding procedure specifications, or suitably key them to the contract drawings. In case of conflict between this specification and AWS D1.1/D1.1M, this specification governs.

1.3.1 General Requirements

****

NOTE: AISC has a certification program in effect that confirms that a certified structural steel

fabricating facility has the personnel, organization, experience, procedures, knowledge, equipment, capability, and commitment to produce fabricated steel of the required quality for a given category of structural steel framing. Consider deleting this paragraph if there is a minimal amount of steel on the job.

****

Fabricate work in an AISC Certified Fabrication Plant, Category BU. Erect work by an AISC Certified Erector, Category CSE.

a. For Structural Projects, provide documentation of the following:

(1) Component Thickness 3 mm 1/8 inch and greater: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.1/D1.1M [and AWS D1.8/D1.8M].

(2) Component Thickness Less than 3 mm 1/8 inch: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.3/D1.3M.

(3) Reinforcing Steel: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.4/D1.4M.

b. For other applications, provide documentation of the following:

(1) Submit [two] [_____] copies of the Certified Welding Procedure Specifications (WPS), Certified Brazing Procedure Specifications (BPS) and Certified Procedure Qualification Records (PQR) to the Contracting Officer for [approval] [review].

(2) Submit [two] [_____] copies of the Certified Welder Performance Qualifications (WPQ)and Certified Brazer Performance Qualifications (BPQ) to the Contracting Officer for [approval] [review] within [fifteen] [_____] calendar days prior to any employee welding on the project material.

(3) Machinery: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D14.4/D14.4M.

1.3.2 Previous Qualifications

Welding procedures previously qualified by test in accordance with AWS D1.1/D1.1M, may be accepted for this contract without re-qualification, upon receipt of the test results, if the following conditions are met:

a. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.

c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.3.3 Pre-qualified Procedures

[Welding procedures which are considered pre-qualified as specified in AWS D1.1/D1.1M will be accepted without further qualification. Submit for approval a listing or an annotated drawing to indicate the joints not pre-qualified. Procedure qualification is mandatory for these joints.] [No pre-qualified welding procedures are allowed. Qualify the welding procedures and welders by tests prescribed in the applicable code or specification not withstanding the fact the code or specification may allow pre-qualified procedures.]

1.3.4 Welder, Welding Operator, and Tacker Qualification

****

NOTE: Insert additional requirements if necessary. Determine and specify the methods of nondestructive testing required.

****

Each welder, welding operator, and tacker assigned to work on this contract must be qualified in accordance with the applicable requirements of AWS D1.1/D1.1M[, AWS D1.8/D1.8M] and as specified in this section. Welders, welding operators, and tackers who make acceptable procedure qualification test welds will be considered qualified for the welding procedure used within the applicable essential variables for welder qualification.

1.3.4.1 Previous Personnel Qualifications

At the discretion of the Contracting Officer, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this contract without re-qualification if all the following conditions are met:

a. Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are submitted and approved in accordance with the specified requirements for detail drawings.

b. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.3.4.2 Certificates

Before assigning any welder, welding operator, or tacker to work under this contract, submit the names and certification that each individual is qualified as specified. State in the certification the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person certifying the qualification tests. Keep the certification current, on file, and furnish 3 copies.

1.3.4.3 Renewal of Qualification

Re-qualification of a welder or welding operator is required under any of the following conditions:

a. It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.

b. There is specific reason to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.

c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract, and a qualification test has not been taken within the past 12 months. Submit as evidence of conformance all records showing periods of employment, name of employer where welder, or welding operator, was last employed, and the process for which qualified.

d. A tacker who passes the qualification test is considered eligible to perform tack welding indefinitely in the positions and with the processes for which he/she is qualified, unless there is some specific reason to question the tacker's ability or there has been a gap greater than 6 months since he/she last used the process. In such a case, the tacker is required to pass the prescribed tack welding test.

1.3.5 Inspector Qualification

****

NOTE: Insert additional requirements if necessary. Determine and specify the methods of nondestructive testing required. If quality control inspection is to be the responsibility of the Government, delete this paragraph.

****

Submit certificates indicating that certified welding inspectors meet the requirements of AWS QC1. Submit qualifications for nondestructive testing personnel in accordance with the requirements of ANSI/ASNT CP-189 for Levels I or II in the applicable nondestructive testing method. Level I inspectors must have direct supervision of a Level II inspector.

1.3.6 Symbols and Safety

Use symbols in accordance with AWS A2.4, unless otherwise indicated. Follow safe welding practices and safety precautions during welding in conformance with AWS Z49.1.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Check the drawings to ensure that any supplementary information required by the paragraph has been shown and that there is no conflict between the drawings and the specifications. Clearly show on the drawings complete information about location, type, size, and extent of all welds and nondestructive testing, where required. When welding is to be covered by more than one section in the contract specifications, this section covers all

structural welding; the other sections cover the utilities or special equipment required inside the structure. Welding of utilities or special equipment to structural members must be done carefully so that the overall structure is not weakened. Clearly show on the drawings or cover by the contract specification the extent of the welding required. Revise this paragraph to clearly define the welding that is covered. Specify the strength of the base material on drawings or other section of the specifications.

Specify on the drawings or the text of the specifications the weld requirements: tensile strength, elongation, shear strength, size, length, type, and location.

****

Conform the design of welded connections to AISC 360, unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Perform welding as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Do not commence welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Perform all testing at or near the work site. Maintain records of the test results obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

2.1.1 Pre-erection Conference

****

NOTE: Use ASTM A992/A992M steel for all buildings which have groove welds in their lateral force resisting systems, and are either in Seismic Design Categories D, E and F or in Category C and are Risk Category III; this and the following paragraph will be retained for this type of building.

Government personnel attending the pre-erection conference should include all field Quality Assurance (QA) inspectors, the building designer, the Engineer of Record (EOR) (if different form the designer) and the Project Manger (PM).

****

Hold a pre-erection conference prior to the start of the field welding, to bring all affected parties together and to gain a naturally clear understanding of the project and the Welding Procedure Specifications (WPS) (submitted for all welding, including welding done using pre-qualified procedures). Mandatory attendance is required by all Contractor's welding production and inspection personnel and appropriate Government personnel. Include as items for discussion: responsibilities of various parties; welding procedures and processes to be followed; welding sequence (both within a joint and joint sequence within the building); inspection requirements and procedures, both visual and nondestructive testing; welding schedule; and other items deemed necessary by the attendees.

2.2 WELDING EQUIPMENT AND MATERIALS

****

NOTE: Normally, the Contractor (fabricator) selects the specific electrode material for weldments based on the WPS for the project. If in special cases the selection of the proper electrode is critical to the design, the designer may specify the electrode to be used in this or other sections. In special cases, it may also be necessary to specify the welding process.

****

Provide all welding equipment, welding electrodes and rods, welding wire, and fluxes capable of producing satisfactory welds when used by a qualified welder or welding operator. [Use [_____] welding electrodes.] [Perform welding using the [_____] process.] Provide welding equipment and materials that comply with the applicable requirements of AWS D1.1/D1.1M[and AWS D1.8/D1.8M]. Submit product data on welding electrodes and rods.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

3.1.1 Requirements

Conform workmanship and techniques for welded construction to the requirements of AWS D1.1/D1.1M[, AWS D1.8/D1.8M] and AISC 360. When AWS D1.1/D1.1M[, AWS D1.8/D1.8M] and the AISC 360 specification conflict, the requirements of AWS D1.1/D1.1M[, AWS D1.8/D1.8M] govern.

3.1.2 Identification

Identify all welds in one of the following ways:

a. Submit written records to indicate the location of welds made by each welder, welding operator, or tacker.

b. Identify all work performed by each welder, welding operator, or tacker with an assigned number, letter, or symbol to identify welds made by that individual. The Contracting Officer may require welders, welding operators, and tackers to apply their symbol next to the weld by means of rubber stamp, felt-tipped marker with waterproof ink, or other methods that do not cause an indentation in the metal. Place the identification mark for seam welds adjacent to the weld at 1 m 3 foot intervals. Identification with die stamps or electric etchers is not allowed.

3.2 QUALITY CONTROL

****

NOTE: AWS D1.1 requires 100% visual inspection of all welds. The requirement to utilize a Certified Welding Inspector to perform visual inspection is included in the specification as AWS does not require this inspection be performed by a Certified Welding Inspector. AWS D1.1 does not require NDT for any welds. The engineer or specification writer

must specify what welds require NDT in addition to visual. The methods of nondestructive testing required must be determined and specified by the designer. Determine the type of nondestructive testing (NDT) method to be used, considering joint design, material thickness, and accessibility to the joint. UT and RT are volumetric testing methods applicable to CJP groove welds. PT and MT are nonvolumetric testing methods applicable for PJP and Fillet welds. Determine joints critical to the structure which should be subjected to additional NDT. Clearly indicate in the specifications or on the drawings which welded joints require 100 percent NDT, which joints require random inspection, and which NDT method(s) are to be used for each joint.

The percentage of joints tested should be randomized throughout the structure unless specific locations require NDT as determined by the engineer of record. Joints not inspected by magnetic particle, liquid penetrant, or ultrasonic or radiographic methods are subject to visual inspections only. If quality control is to be primarily the Contractor's responsibility and the inspection and tests are adequately called out, then acceptance by the Government can rely on the Contractor's work and records -- with some spot checking to verify the results.

If the Contractor must perform nondestructive inspection other than visual, or inspection other than that covered by Section 6 of AWS D1.1/D1.1M, add these requirements to this paragraph. Clearly show the extent of inspection either on the drawings or by this or other sections of the specifications. Edit the bracketed portion of the paragraph to define the extent of nondestructive testing required.

All welded connections per AWS D1.1 will be tested to the static acceptance criteria by default. Connections that require testing to cyclic criteria must be specified by the engineer of record.
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Perform testing using an approved inspection or testing laboratory or technical consultant; or if approved, the Contractor's inspection and testing personnel may be used instead of the commercial inspection or testing laboratory or technical consultant. A Certified Welding Inspector must perform visual inspection on 100 percent of all welds. Document this inspection in the Visual Weld Inspection Log. Test [50%][_____] of CJP welds using ultrasonic testing per Table [6.2] [or 6.3] of AWS D1.1/D1.1M. Randomly test [50%][_____] of all PJP and fillet welds or as indicated by magnetic particle or dye penetrant testing. Verify the welds conform to paragraph STANDARDS OF ACCEPTANCE. Conform procedures and techniques for inspection with applicable requirements of AWS D1.1/D1.1M[, AWS D1.8/D1.8M], ASTM E165/E165M, and ASTM E709. Submit a Welding Quality Assurance Plan and records of tests and inspections.

3.3 STANDARDS OF ACCEPTANCE

****

NOTE: Specify on the drawings or the text of the contract specifications must specify the weld requirements: tensile strength, elongation, shear strength, size, length, type, and location. Identify in the contract drawings complete penetration welds subject to primary tensile stress or cyclic loading for the purpose of selecting the correct NDT acceptance criteria.

****

Conform dimensional tolerances for welded construction, details of welds, and quality of welds with the applicable requirements of AWS D1.1/D1.1M[, AWS D1.8/D1.8M] and the contract drawings. Submit all records of nondestructive testing.

3.3.1 Nondestructive Testing

The welding is subject to inspection and tests in the mill, shop, and field. Inspection and tests in the mill or shop do not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment. Any indication of a defect is regarded as a defect, unless re-evaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present. Submit all records of nondestructive testing in accordance with paragraph STANDARDS OF ACCEPTANCE.

3.3.2 Destructive Tests

Make all repairs when metallographic specimens are removed from any part of a structure. Employ only qualified welders or welding operators, and use the proper joints and welding procedures, including peening or heat treatment if required, to develop the full strength of the members and joints cut and to relieve residual stress.

3.4 GOVERNMENT INSPECTION AND TESTING

In addition to the inspection and tests performed by the Contractor for quality control, the Government will perform inspection and testing for acceptance to the extent determined by the Contracting Officer. The work may be performed by the Government's own forces or under a separate contract for inspection and testing. The Government reserves the right to perform supplemental nondestructive and destructive tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

3.5 CORRECTIONS AND REPAIRS

If inspection or testing indicates defects in the weld joints, repair defective welds using a qualified welder or welding operator as applicable. Conduct corrections in accordance with the requirements of AWS D1.1/D1.1M[, AWS D1.8/D1.8M] and the specifications. Repair all defects in accordance with the approved procedures. Repair defects discovered between passes before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, blend the affected area into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before re-welding, examine the area by suitable methods to ensure that the defect has been eliminated. Repaired welds must meet the inspection requirements for the original welds.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-05 12 00 (August 2018)**
Change 2 - 05/21

Preparing Activity: NAVFAC **Superseding**
UFGS-05 12 00 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-05 12 00 (August 2018)**

Change 2 - 05/21

Preparing Activity: NAVFAC **Superseding**

UFGS-05 12 00 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 05 12 00

STRUCTURAL STEEL

08/18, CHG 2: 05/21

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NOTE: This guide specification covers requirements for structural steel used in building construction. Review the following publications for material selection and additional specification requirements before using this guide specification for the following types of construction:

This specification does not cover Highway Bridges or Railroad bridges due to the fracture critical requirements for bridges. For bridge design considerations see AASHTO or AREMA.

Tower Construction - Telecommunications Industry Association (TIA), TIA-222-G-2, "Structural Standard for Antenna Supporting Structures and Antennas."

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Ensure the following information is shown on the project drawings:

1. The extent and location of structural steel;

2. Designations of steel members;

3. Type and yield strength of steel used in design;

4. Locations where galvanized steel will be used;

5. Types of connections (welded and bolted);

6. Locations where high-strength bolts and slip critical connections are required and the loads and stresses required if steel connection design is provided by Contractor; and

7. The location of welds requiring nondestructive testing, along with the type of testing required.

8. Type of steel coating and limits of coating application; and

9. Type of coating for hardware.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LRFD	(8th Edition; 2017) Bridge Design Specifications

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 207	(2016; R 2017) Certification Standard for Steel Fabrication and Erection, and Manufacturing of Metal Components
AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 341	(2016) Seismic Provisions for Structural Steel Buildings
AISC 360	(2016) Specification for Structural Steel Buildings
AISC 420	(2010) Certification Standard for Shop Application of Complex Protective Coating Systems
AISC DESIGN GUIDE 10	(1997) Erection Bracing of Low-Rise Structural Steel Buildings
ANSI/AISC 303	(2022) Code of Standard Practice for Structural Steel Buildings and Bridges

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.8/D1.8M	(2016) Structural Welding Code—Seismic Supplement
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2024b) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A29/A29M	(2023) Standard Specification for General Requirements for Steel Bars, Carbon and

	Alloy, Hot-Wrought
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143/A143M	(2007; R 2020) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM A1085/A1085M	(2015) Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)

ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C827/C827M	(2023) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F436/F436M	(2024) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F959/F959M	(2017a; R 2023) Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series
ASTM F1136/F1136M	(2011) Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F2329/F2329M	(2015; R 2023) Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
ASTM F2833	(2011; R 2017) Standard Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC Paint 20	(2019) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic)
SSPC Paint 29	(2002; E 2004) Zinc Dust Sacrificial Primer, Performance-Based
SSPC SP 3	(2024) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR Part 1926, Subpart R	Steel Erection

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Erection and Erection Bracing Drawings; G, [_____]

SD-02 Shop Drawings

Fabrication Drawings Including Details of Connections; G, [_____]

SD-03 Product Data

Shop Primer

Welding Electrodes and Rods

Direct Tension Indicator Washers

Non-Shrink Grout

Tension Control Bolts

Recycled Content for Structural Steel; S

Recycled Content for Structural Steel Tubing; S

Recycled Content for Steel Pipe; S

SD-05 Design Data

[Design Calculations for Steel Connections; G, [_____]

][Shoring and Temporary Bracing; G, [_____]

] SD-06 Test Reports

Class B Coating

Bolts, Nuts, and Washers

Weld Inspection Reports

Direct Tension Indicator Washer Inspection Reports

Bolt Testing Reports

[Embrittlement Test Reports

] SD-07 Certificates

Steel

Bolts, Nuts, and Washers

[Galvanizing

][Pins and Rollers

][AISC Structural Steel Fabricator Quality Certification

][AISC Structural Steel Erector Quality Certification

] Welding Procedures and Qualifications

Welding Electrodes and Rods

Certified Welding Inspector

NDT Technician

Welding Procedure Specifications (WPS)

[Overhead, Top Running Crane Rail Beam

][1.3 AISC QUALITY CERTIFICATION

****

NOTE: AISC has a certification program in effect that confirms that a certified structural steel fabricating facility has the personnel, organization, experience, procedures, knowledge, equipment, capability, and commitment to produce fabricated steel of the required quality for a given category of structural steel framing. Consider deleting this paragraph if there is a minimal amount of steel on the job. MBMA has a certification program in effect that confirms that a certified metal building manufacturer's fabrication facility has the quality management system ensuring continual compliance with requirements for Metal Building Systems.

****

Work must be fabricated by an AISC Certified Structural Steel Fabricator, in accordance with AISC 207, Category BU. Submit AISC Structural Steel Fabricator quality certification.

Work must be erected by an AISC Structural Steel Certified Erector, in accordance with AISC 207, Category CSE. Submit AISC Structural Steel erector quality certification.

][1.4 SEISMIC PROVISIONS

****

NOTE: Delete this paragraph when the steel seismic force resisting system is classified as a steel system not specifically detailed for seismic resistance in accordance with ASCE 7-16, Table 12.2-1.

****

Provide the structural steel system in accordance with AISC 341, Chapter J as amended by UFC 3-301-01.

]1.5 QUALITY ASSURANCE

1.5.1 Preconstruction Submittals

1.5.1.1 Erection and Erection Bracing Drawings

****

NOTE: Include the last line when delegated design is performed by the contractor.

****

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing. The erection drawings must conform to ANSI/AISC 303.[Erection drawings must be reviewed, stamped and sealed by a registered professional engineer.]

1.5.2 Fabrication Drawing Requirements

****

NOTE: Include the requirement for fabrication drawings to be signed and sealed when delegated design is performed by the contractor.

****

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with ANSI/AISC 303, AISC 326 and AISC 325. Fabrication drawings must not be reproductions of contract drawings.[Sign and seal fabrication drawings by a registered professional engineer.] Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols.[Shoring and temporary bracing must be designed and sealed by a registered professional engineer and submitted for record purposes[, with calculations,] as part of the drawings.] Clearly highlight any deviations from the details shown on the contract drawings highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

[1.5.3 Delegated Connection Design

****

NOTE: Include this paragraph when delegated design is performed by the contractor.

Provide connection loads on the drawings and indicate whether the loads are LRFD, ASD, or Combined.

****

Design structural steel connection indicated in the contract documents per ANSI/AISC 303, Option 3, using the connection loads indicated. Submit design calculations for steel connections signed and sealed by a registered professional engineer.

]1.5.4 Certifications

1.5.4.1 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests.[If the qualification date of the welder or welding operator is more than 6 months old, the welding operator's qualification certificate must be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.]

Conform to all requirements specified in AWS D1.1/D1.1M[and AWS D1.8/D1.8M].

****

NOTE: Include the following paragraph when there is a top running bridge crane in the project.

NAVINST 11230.1F refers to CMAA for new equipment installation.

****

[1.5.4.2 Overhead, Top Running Crane Rail Beam

Submit written field survey results for overhead, top running crane rail beam verifying tolerance requirements per CMAA 70.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Check the design to ensure that adequate supports at appropriate spacings have been provided for the installation of piping, expansion tanks, unit heaters, suspended ceilings and similar items.

Consider provisions for using self-locking nuts where shock or vibration would be a problem.

****

Provide the structural steel system, including [shop primer] [galvanizing], complete and ready for use. Provide structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing in accordance with ANSI/AISC 303, AISC 360, [AISC 341,]and UFC 3-301-01 except as modified in this contract.

2.2 STEEL

****

NOTE: Select materials appropriate to the design and delete remaining materials.

Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of

recycling and conserve natural resources.

****

****

NOTE: Designs requiring notch strength or installation and operation at low temperatures will require special material selections. Notch strength will be required based on design geometry or for dynamically loaded structures. When notch toughness is required, the supplementary requirements of the ASTM specification for the steel being considered should be reviewed and the appropriate supplementary requirements (ASTM A6/A6M) specified. In designs where the material will be exposed to temperatures below freezing, check the material type against the proposed ambient and working temperatures for resistance to brittle fracture.

****

2.2.1 Structural Steel

****

NOTE: ASTM A992/A992M covers W shapes (rolled wide flange shapes) intended for use in building framing. Specify ASTM A36 for S, M, and HP shapes, channels, angles, and plates.

Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Where minimums are stated, research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets and delete the first set of brackets. AISC 2017 white paper "More than Recycled Content: The Sustainable Characteristics of Structural Steel" indicates that the industry average recycled content is 93 percent.

****

Wide flange and WT shapes, ASTM A992/A992M. Angles, Channels and Plates, ASTM A36/A36M. Provide structural steel containing a minimum of [80][_____] percent recycled content. Submit data identifying percentage of recycled content for structural steel.

2.2.2 Structural Steel Tubing

****

NOTE: ASTM A500/A500M tubing is available in Grades A, B, C, and D with minimum yield strengths of 230, 290, 317, and 250 MPa 33, 42, 46, and 36 ksi for round structural tubing and 269, 317, 345, and 250

MPa 39, 46, 50, and 36 ksi for square or rectangular shaped structural tubing, respectively. ASTM A500/A500M tubing may not be suitable for dynamically loaded structures or applications requiring notch strength.

ASTM A1085 provides tighter shape tolerance over ASTM A500 and minimum yield strength of 345 MPa 50 ksi and a maximum yield strength of 485 MPa 70 ksi for all round, square and rectangular shapes. ASTM A1085/A1085M also provides standard requirements for charpy V-notch toughness.

Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Where minimums are stated, research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets and delete the first set of bracket. AISC 2017 white paper "More than Recycled Content: The Sustainable Characteristics of Structural Steel" indicates that if the rolled coil used to form HSS shapes is from a basic oxygen furnace then the recycled content will be near 25 percent, but if the coil is from an electric arc furnace then the recycled content will be in 90 percent to 100 percent range.

****

ASTM A500/A500M, Grade [C][_____].[ASTM A1085/A1085M.] Provide structural steel tubing containing a minimum of [25][90][_____] percent recycled content. Submit data identifying percentage of recycled content for structural steel tubing.

2.2.3 Steel Pipe

****

NOTE: ASTM A53/A53M pipe, Type E (Electric-resistance Welded) and Type S (Seamless), Grade B, has a minimum yield strength of 245 MPa 35 ksi and is available in the following weight classes: STD (Standard), XS (Extra Strong), and XXS (Double-extra Strong).

Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Where minimums are stated, research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets and delete the first set of brackets.
****

ASTM A53/A53M, Type E or S, Grade B, weight class [STD (Standard) or as indicated][_____]. Provide steel pipe containing a minimum of [50][_____] percent recycled content. Submit data identifying percentage of recycled content for steel pipe.

2.3 BOLTS, NUTS, AND WASHERS

Submit the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

2.3.1 Common Grade Bolts

2.3.1.1 Bolts

****
NOTE: When galvanizing ASTM A307 bolts specify either hot-dip process in ASTM F2329/F2329M or zinc-coated by the mechanical-deposition process in accordance with ASTM B695, Class 55.
****

ASTM A307, Grade A, plain finish [hot dipped zinc coating][mechanically deposited zinc coating]. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.3.1.2 Nuts

ASTM A563ASTM A563M, Grade A, heavy hex style.

[2.3.1.3 Self-Locking Nuts

****
NOTE: Drawings or specifications should identify where these items are used.
****

Provide nuts with a locking pin set in the nut. The locking pin must slide along the bolt threads, and by reversing the direction of the locking pin, the nut can be removed without damaging the nut or bolt. Provide stainless steel locking pins.

]2.3.1.4 Washers

ASTM F844.

2.3.2 High-Strength Bolts

High strength bolts and nuts must be shipped together in the same shipping container. Fasteners indicated to be galvanized shall be tested by the supplier to show that the galvanized nut with the supplied lubricant provided may be rotated from the snug tight condition well in excess of the rotation required for pretentioned installation without stripping. The supplier shall supply nuts that have been lubricated and tested with the supplied bolts.

2.3.2.1 Bolts

****

NOTE: Do not galvanize Grade F2280 bolts.

****

****

NOTE: Do not mix bolt Grade A325M A325 and Grade A490M A490 on the same diameter bolts in high strength connections. The Grade A325M A325 and Grade A490M A490 bolts specified are for a maximum diameter of M36 1.5 inch. If larger bolts are required, include the following ASTM publications in reference article:

ASTM A354 - Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

ASTM A449 - Quenched and Tempered Steel Bolts and Studs.

Type 1 bolts are carbon steel. Type 3 bolts are weathering steel.

****

ASTM F3125/F3125M, Grade A325M A325 [A490M A490], Type 1 [3] Heavy Hex Head Style, plain finish [hot dipped zinc coating][mechanically deposited zinc coating].

2.3.2.2 Nuts

ASTM A563M ASTM A563, Grade and Style as specified in the applicable ASTM bolt standard.

2.3.2.3 Direct Tension Indicator Washers

****

NOTE: If direct tension indicator washers are not used then tension control bolts are required per UFC 3-301-01. Use the Tension Control Bolts paragraph and delete the BOLTS, NUTS AND DIRECT TENSION INDICATOR WASHERS paragraph.

Include bracketed phrase if tension indicator washers are to be galvanized.

****

ASTM F959/F959M.[Provide ASTM B695, Class 55, Type 1 galvanizing.] Submit product data for direct tension indicator washers.

2.3.2.4 Washers

ASTM F436/F436M, plain carbon steel.

2.3.3 Tension Control Bolts

****

NOTE: Use Grade F1852 where high strength bolts (AISC Group A) with a minimum tension strength of 120 ksi are required. Use Grade F2280 where high strength bolts (AISC Group B) with a minimum tension strength of 150 ksi are required. Grade F2280 tension control bolts only have a plain assembly finish.

****

ASTM F3125/F3125M, Grade [F1852][F2280], Type 1, twistoff style assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon steel nuts, and hardened carbon steel washers. Assembly finish must be [plain][mechanically deposited zinc coating]. Submit product data for tension control bolts.

2.3.4 Foundation Anchorage

****

NOTE: For most jobs, ASTM F1554 36 ksi anchor rods are used. If high tensile loads are anticipated, consider the use of 55 ksi or 105 ksi ASTM F1554 anchor rods. If stainless steel is considered, select from material in ASTM A193/A193M.

****

2.3.4.1 Anchor Rods

ASTM F1554 Gr 36 [55][105], Class 1A[2A].[Stainless steel ASTM A193/A193M.]

2.3.4.2 Anchor Nuts

ASTM A563 ASTM A563M, Grade A, hex style.[Stainless steel ASTM A193/A193M.]

2.3.4.3 Anchor Washers

ASTM F844.[Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M.]

2.3.4.4 Anchor Plate Washers

ASTM A36/A36M[Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M].

2.4 STRUCTURAL STEEL ACCESSORIES

2.4.1 Welding Electrodes and Rods

****

NOTE: Include AWS D1.8/D1.8M when required for seismic resisting systems.

****

AWS D1.1/D1.1M[and AWS D1.8/D1.8M]. Submit product data for welding electrodes and rods.

2.4.2 Non-Shrink Grout

****

NOTE: Some nonshrink grouts derive their nonshrink properties from an increase in volume of metal due to oxidation. Where oxidation is not desired for appearance sake, specify nonmetallic grout.

****

ASTM C1107/C1107M, with no ASTM C827/C827M shrinkage.[Grout must be nonmetallic.] Submit product data for non-shrink grout.

2.4.3 Welded Shear Stud Connectors

ASTM A29/A29M, Grades 1010 through 1020. AWS D1.1/D1.1M, Table 7.1, Type B.

[2.4.4 Pins and Rollers

ASTM A668/A668M, Class C, D, F, or G; ASTM A108, Grades 1016 to 1030. Provide as specified in AASHTO LRFD, Section 6.4.2, except provide pins in lengths to extend a minimum of 6 mm 0.25 inch beyond the outside faces of the connected parts.

][2.5 GALVANIZING

****

NOTE: Most structural steel is painted. If galvanized items are required, they must be indicated or specified. The galvanizing specified is by the hot-dip process. This process requires large amounts of energy and unevenly heats steel sections that are either large or thick, occasionally warping the steel sections. Using zinc coating by thermal spraying (metallizing) as an alternative to hot-dip galvanizing should be considered for certain steel sections. Consult the following American Welding Society (AWS) publications for further information:

TS-85 - Thermal Spraying - Practice, Theories, and Application

C2.2-67 - Recommended Practices for Metallizing with Aluminum and Zinc for Protection of Iron and Steel.

****

ASTM F2329/F2329M, ASTM F1136/F1136M, ASTM F2833 or ASTM B695 for threaded parts or ASTM A123/A123M for structural steel members, as applicable, unless specified otherwise galvanize after fabrication where practicable.

]2.6 FABRICATION

Fabrication must be in accordance with the applicable provisions of AISC 325. Fabrication and assembly must be done in the shop to the greatest extent possible. Punch, subpunch and ream, or drill bolt [and pin] holes perpendicular to the surface of the member.

Compression joints depending on contact bearing must have a surface roughness not in excess of 13 micrometer 500 micro inch as determined by ASME B46.1, and ends must be square within the tolerances for milled ends specified in ASTM A6/A6M.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

****

NOTE: Include the following paragraph where there are truss chord splices on the project.

****

[Do not splice truss top and bottom chords except as approved by the Contracting Officer. Provide chord splices at panel joints at approximately the third point of the span. The center of gravity lines of truss members must intersect at panel points unless otherwise approved by the Contracting Officer. When the center of gravity lines do not intersect at a panel point, make provisions for the stresses due to eccentricity. Camber of trusses must be 3 mm 1/8 inch in 3.048 meters 10 feet unless otherwise indicated.

]2.6.1 Markings

Prior to erection, identify members by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections must be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations.[Affix embossed tags to hot-dipped galvanized members.]

****

NOTE: SPE-P1 is for enclosed paint shop, SPE-P2 is for an outside but covered paint shop and SPE-P3 is for an outside paint shop. There are other paint shop qualification including NACE and SSPC which exceed AISC paint endorsements.

****

2.6.2 Shop Primer

****

NOTE: Generally, for interior use, standard structural steel with a minimum coating system of a shop primer is adequate. For exterior environments or areas open to the exterior, use coated galvanized steel or a zinc rich coating system described in UFC 3-190-06, Protective Coatings and Paints.

****

SSPC Paint 20 or SSPC Paint 29, (zinc rich primer). Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, galvanized surfaces,[surfaces to receive sprayed-on fireproofing,][surfaces to receive epoxy coatings,][surfaces designed as part of a composite steel concrete section,] or surfaces within 13 mm 0.5 inch of the toe of the welds prior to welding (except surfaces on which metal decking and shear studs are to be welded). If flash rusting occurs, re-clean the surface prior to application of primer. Apply primer [in accordance with endorsement "SPE-P1"["SPE-P2"]["SPE-P3"] of AISC 420 or approved equal NACE or SSPC certification] [_____]to a minimum dry film thickness of 0.05 mm 2.0 mil. Submit shop primer product data.

Prime slip critical surfaces with a Class B coating in accordance with AISC 325. Submit test report for Class B coating.

Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 7 degrees C or over 35 degrees C 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 4 degrees C 40 degrees F within 48 hours after application, unless approved otherwise by the Contracting Officer. Repair damaged primed surfaces with an additional coat of primer.

2.6.2.1 Cleaning

SSPC SP 6/NACE No.3, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

[2.6.3 [Fireproofing] [and] [Epoxy] Coated Surfaces

Clean and prepare surfaces to receive [sprayed-on fireproofing] [epoxy] coatings in accordance with the manufacturer's recommendations, and as specified in Section 07 81 00 SPRAY-APPLIED FIREPROOFING.

][2.6.4 Surface Finishes

****

NOTE: AISC states "finished" surfaces, where identified, should have a maximum roughness of 500. For pins and bearing surfaces, a maximum roughness of 125, in lieu of 500, is recommended.

****

ASME B46.1 maximum surface roughness of 125 for pin, pinholes, and sliding bearings, unless indicated otherwise.

]2.7 DRAINAGE HOLES

Drill adequate drainage holes to eliminate water traps. Hole diameter must be 13 mm 1/2 inch and location indicated on the detail drawings. Hole size and locations must not affect the structural integrity.

PART 3 EXECUTION

3.1 ERECTION

****

NOTE: For low-rise structural steel buildings, design the structure to be erected in accordance with AISC DESIGN GUIDE 10.

****

a. Erection of structural steel, except as indicated in item b. below, must be in accordance with the applicable provisions of AISC 325, ANSI/AISC 303 and 29 CFR Part 1926, Subpart R.

b. For low-rise structural steel buildings (18 m 60 feet tall or less and a maximum of 2 stories), erect the structure in accordance with AISC DESIGN GUIDE 10.

After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

3.1.1 STORAGE

Store the material out of contact with the ground in such manner and location as to minimize deterioration.

3.2 CONNECTIONS

Except as modified in this section, design connections indicated in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Holes must not be cut or enlarged by burning. Bolts, nuts, and washers must be clean of dirt and rust, and lubricated immediately prior to installation.

3.2.1 Common Grade Bolts

Tighten ASTM A307 bolts to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.2.2 High-Strength Bolts

****

NOTE: If only tension control bolts are used, delete this paragraph.

****

Provide direct tension indicator washers in all ASTM F3125/F3125M, Grade A325M A325 and Grade A490M A490 bolted connections. Bolts must be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, fully tension bolts, progressing from the most rigid part of a connection to the free edges.

Fastener components shall be protected from dirt and moisture in closed containers at the site of the installation. Fastener components that are not incorporated into the work shall be returned to protected storage at the end of the work shift.

3.2.2.1 Installation of Direct Tension Indicator Washers (DTIW)

Where possible, install the DTIW under the bolt head and tighten the nut. If the DTIW is installed adjacent to the turned element, provide a flat washer between the DTIW and nut when the nut is turned for tightening, and between the DTIW and bolt head when the bolt head is turned for tightening. In addition to the LIW, provide flat washers under both the bolt head and nut when ASTM F3125/F3125M, Grade A490M A490 bolts are used.

3.2.3   Tension Control Bolts

Bolts must be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, fully tension bolts, progressing from the most rigid part of a connection to the free edges.

3.3   GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors is not permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.4   WELDING

****

NOTE: Include AWS D1.8/D1.8M when required for seismic resisting systems.

****

Welding must be in accordance with AWS D1.1/D1.1M[and AWS D1.8/D1.8M].[Grind exposed welds smooth as indicated.] Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

Develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Submit for approval all WPS, whether prequalified or qualified by testing.

3.4.1   Removal of Temporary Welds, Run-Off Plates, and Backing Strips

****

NOTE: Include last bracketed statement where required by prequalified connection requirements in AISC 358.

****

[Removal is not required][Remove only from finished areas].[Remove backing strips from bottom flange of moment connections, backgouge the root pass to sound weld metal and reinforce with a 8 mm 5/16 inch fillet weld minimum.]

3.5   SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

3.5.1   Field Priming

Field prime steel exposed to the weather, or located in building areas without HVAC for control of relative humidity. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat must be cleaned and primed with paint of the same quality as that used for the shop coat.

[3.6   GALVANIZING REPAIR

Repair damage to galvanized coatings using ASTM A780/A780M zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

]3.7 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing[, except that electric power for field tests will be furnished as set forth in Division 1]. Notify the Contracting Officer in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of the inspection.

3.7.1 Welds

3.7.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. A Certified Welding Inspector must perform visual inspection on 100 percent of all welds. Document this inspection in the Visual Weld Inspection Log. Submit certificates indicating that certified welding inspectors meet the requirements of AWS QC1.

[Inspect proper preparation, size, gaging location, and acceptability of all welds; identification marking; operation and current characteristics of welding sets in use.

]3.7.1.2 Nondestructive Testing

****

NOTE: Indicate the location of test welds and types of testing desired. The following information is presented as guidance. Dye penetrant testing detects small surface defects by enhancing the visibility of the flaw. Magnetic particle testing detects surface cracks and near-surface cracks; this test provides more information than the dye penetrant testing, and for approximately the same cost. Ultrasonic testing detect surface and internal cracks, delaminations, lack of fusion, and density and thickness variations. Generally, fillet welds can only be dye penetrant or magnetic particle tested. All complete penetration welds should be ultrasonically tested. See AWS D1.1/D1.1M for other methods of NDT that can be used for testing welds.

Include AWS D1.8/D1.8M when required for seismic resisting systems.

AWS D1.1 does not require any NDT other than visual inspection unless specified by the Engineer. AWS D1.8 specifically required NDT for seismic connections. The engineer must specify which welds require inspection.

For statically loaded welds test per Table 6.2 of AWS D1.1. For cyclically loaded welds test per Table 6.3 of AWS D1.1. Where welds are subjected to cyclic loading identify them on the construction documents.

****

Nondestructive testing must be in accordance with AWS D1.1/D1.1M[and AWS D1.8/D1.8M]. Ultrasonic testing must be performed in accordance with Table [6.2] [or 6.3] of AWS D1.1/D1.1M. Test locations must be [as indicated][selected by the Contracting Officer]. All personnel performing NDT must be certified in accordance with ANSI/ASNT CP-189 in the method of testing being performed. Submit certificates showing compliance with ANSI/ASNT CP-189 for all NDT technicians. If more than [20] [_____] percent of welds made by a welder contain defects identified by testing, then all groove welds made by that welder must be tested by ultrasonic testing, and all fillet welds made by that welder must be inspected by magnetic particle testing (MT) or dye penetrant testing (PT) as approved by the Contracting Officer. When groove welds made by an individual welder are required to be tested, magnetic particle or dye penetrant testing may be used only in areas inaccessible to ultrasonic testing. Retest all repaired areas. Submit weld inspection reports.

Testing frequency: Provide the following types and number of tests:

Test Type	Number of Tests
Ultrasonic	[_____]50 percent of CJP Welds
Magnetic Particle	[_____]50 percent of PJP and Fillet Welds
Dye Penetrant	[_____]50 percent of PJP and Fillet Welds
[_____]	[_____]

****

NOTE: If only tension control bolts are used, delete this paragraph.

****

3.7.2 Direct Tension Indicator Washers

3.7.2.1 Direct Tension Indicator Washer Compression

Test direct tension indicator washers in place to verify that they have been compressed sufficiently to provide the 0.38 mm 0.015 inch gap, as required by ASTM F959/F959M. Submit direct tension indicator washer inspection reports.

[3.7.2.2 Direct Tension Indicator Gaps

****

NOTE: Use this paragraph on large complex structural steel systems or on jobs where minimal on site inspection is expected.

****

In addition to the above testing, an independent testing agency as approved by the Contracting Officer, must test in place the direct tension indicator gaps on 20 percent of the installed direct tension indicator washers to verify that the ASTM F959/F959M direct tension indicator gaps have been achieved. If more than 10 percent of the direct tension indicators tested have not been compressed sufficiently to provide the average gaps required by ASTM F959/F959M, test all in place direct tension indicator washers to verify that the ASTM F959/F959M direct tension indicator gaps have been achieved. Test locations must be selected by the Contracting Officer.

]3.7.3 High-Strength Bolts

3.7.3.1 Testing Bolt, Nut, and Washer Assemblies

Test a minimum of [3] [_____] bolt, nut, and washer assemblies from each mill certificate batch in a tension measuring device at the job site prior to the beginning of bolting start-up. Demonstrate that the bolts and nuts, when used together, can develop tension not less than the provisions specified in AISC 360, depending on bolt size and grade. The bolt tension must be developed by tightening the nut. A representative of the manufacturer or supplier must be present to ensure that the fasteners are properly used, and to demonstrate that the fastener assemblies supplied satisfy the specified requirements. Submit bolt testing reports.

3.7.3.2 Inspection

Inspection procedures must be in accordance with AISC 360. Confirm and report to the Contracting Officer that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

[Inspect calibration of torque wrenches for high-strength bolts.

]3.7.3.3 Testing

The Government has the option to perform nondestructive tests on [5] [_____] percent of the installed bolts to verify compliance with pre-load bolt tension requirements. Provide the required access for the Government to perform the tests. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations must be selected by the Contracting Officer. If more than [10] [_____] percent of the bolts tested contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, must be tested at the Contractor's expense. Retest new bolts after installation at the Contractor's expense.

[3.7.4 Testing for Embrittlement

ASTM A143/A143M for steel products hot-dip galvanized after fabrication. Submit embrittlement test reports.

]3.7.5 Inspection and Testing of Steel Stud Welding

Perform verification inspection and testing of steel stud welding conforming to the requirements of AWS D1.1/D1.1M, Stud Welding Clause. The Contracting Officer will serve as the verification inspector. Bend test studs that do not show a full 360 degree weld flash or have been repaired by welding as required by AWS D1.1/D1.1M, Stud Welding Clause. Studs that crack under testing in the weld, base metal or shank will be rejected and replaced by the Contractor at no additional cost.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-05 14 00.13 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-05 14 00.13 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 14 00.13

WELDING STRUCTURAL ALUMINUM FRAMING

11/19

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-05 14 00.13 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-05 14 00.13 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 05 14 00.13

WELDING STRUCTURAL ALUMINUM FRAMING
11/19

****

NOTE: This guide specification covers the requirements for minimum requirements for qualifying welding procedures, welders, and welding operators for making and inspecting welds in structural and non-structural fabrications of weldable aluminum materials.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This section does not cover welding of aluminum pressure vessels or pressure piping.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in

this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors
AWS QC7	(1993; Suppl G) Standard for AWS Certified Welders
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM E164	(2024) Standard Practice for Contact Ultrasonic Testing of Weldments
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E1032	(2019) Standard Practice for Radiographic Examination of Weldments Using Industrial X-Ray Film

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 51B	(2024) Standard for Fire Prevention During Welding, Cutting, and Other Hot Work

1.2 DEFINITIONS

Establish levels of fabrication using the following classifications:

1.2.1 Class A Fabrication

Class A fabrication includes complete penetration weld joints only, and applies to those welds in critical applications where failure would cause a loss of the system and be hazardous to personnel. Classify welds as a Class A fabrication for highly stressed dynamic and cyclic loading. Characterize welds as a single point of failure with no redundancy for the redistribution of stress into another member.

1.2.2 Class B Fabrication

Class B fabrication includes complete and partial penetration groove weld joints and fillet weld joints, and applies to those welds in semi-critical applications where failure would reduce the overall efficiency of the system but loss of system or hazard to personnel would not be experienced.

1.2.3 Class C Fabrication

Class C fabrication includes complete and partial penetration groove weld joints and fillet weld joints, and applies to those welds in non-critical applications where failure would not affect the efficiency of the system nor create hazard to personnel. Classify welds as a Class C fabrication for connections of secondary members not subject to dynamic action and low stressed miscellaneous applications.

1.2.4 Class D Fabrication

Plug and slot weld joints may be used for subcritical construction joints, when the joints meet the design and fabrication requirements of AWS D1.2/D1.2M.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meetings

Within [30][_____] days of Contract Award, submit an operating safety plan to the Contracting Officer indicating all work will conform to the requirements of AWS Z49.1, section 1.6 of AWS D1.2/D1.2M, and NFPA 51B.

Also submit the following certificates:

a. Certified Welding Procedure Specifications (WPS)

b. Certified Procedure Qualification Records (PQR)

c. Certified Welder Performance Qualifications (WPQ)

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Operating Safety Plan[; G, [_____]]

SD-07 Certificates

Certified Welding Procedure Specifications (WPS)[; G, [_____]]

Certified Procedure Qualification Records (PQR)[; G, [_____]]

Certified Welder Performance Qualifications (WPQ)[; G, [_____]]

1.5 QUALITY CONTROL

1.5.1 Certificates

Submit certificates verifying that the welders performing the work hold current certification in accordance with AWS QC7. Do not allow pre-qualified welding procedures. Provide documentation of qualified welding procedures, welders and welding inspectors in accordance with Sections 3 and 5 of AWS D1.2/D1.2M and AWS QC1.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION

Perform pre-weld inspection of all components. Report in writing all deficiencies or discrepancies to the Contracting Officer. Commencement of welding procedures validates acceptance of existing conditions.

3.2 PREPARATION

3.2.1 Protection

Protect all adjacent surfaces and equipment prior to commencement of welding work, in conformance with NFPA 51B and approved Operating Safety Plan.

3.2.2 Surface Preparation

Prepare all surfaces to be welded in conformance with AWS D1.2/D1.2M.

3.2.3 Welding Equipment

Provide all welding equipment, electrodes, welding wire, fluxes, preparatory tools and equipment, and any other accessories required to perform the work.

3.2.4 Heat Input Requirements

****

NOTE: Welding a material which is at an initial temperature below 38 degrees C 100 degrees F may require localized preheating to remove moisture from the surface of the material.

****

3.2.4.1 Preheat

Do not weld at an ambient temperature below 0 degrees C 32 degrees F, or when the surfaces are wet or exposed to rain, snow, or high wind. Verify that the minimum temperature of the metals in the area of welding is 10 degrees C 50 degrees F. When the ambient conditions are such that the normal temperature of the base metal is below 10 degrees C 50 degrees F, preheat the area surrounding the joint to provide a base metal temperature of 38 degrees C 100 degrees F for a distance of at least 75 millimeter3 inch in all directions from the joint to be welded.

3.2.4.2 Interpass

In a multipass weld, ensure that the interpass temperature is the temperature of the weld metal before the next pass is started.

3.2.4.3 Postweld

Postweld heat treatment of weldments is prohibited unless noted in the applicable [[_____] approved]Code qualified/certified welding documentation, Certified Welding Procedure Specifications (WPS).

3.3 FIELD QUALITY CONTROL

3.3.1 Class A Fabrication

Use complete penetration groove weld joints only. Fabricate weldment in accordance with AWS D1.2/D1.2M.

3.3.2 Class B Fabrication

Fabricate weldment in accordance with AWS D1.2/D1.2M.

3.3.3 Class C Fabrication

Fabricate weldment in accordance with AWS D1.2/D1.2M.

3.3.4 Class D Fabrication

Apply the requirements of AWS D1.2/D1.2M for welding of plugs and slot joints.

3.3.5 Inspection/Nondestructive Examination (NDE)

****

NOTE: Inspection and acceptance requirements of these Codes and Standards are the minimum requirements. Additional inspections and tighter acceptance requirements may be used, but the specifier is to note the additional NDE requirements in the specifications/drawings.

****

3.3.5.1 Inspection

Perform fabrication/erection inspection to ensure that materials and workmanship meet the minimum requirements of the contract documents.

Final acceptance of all welded joints will be by the Contracting Officer.[Additional testing and inspection as determined by the Contracting Officer may be done by the Government at the Government's expense.]

Repair all unacceptable welds and make ready for Government reinspection at no additional cost to the Government.

After weld joints have been satisfactorily completed and accepted by the Contracting Officer, clean the joint area to a bright, unpitted, and unscarred surface and protect in accordance with the applicable contract documents.

3.3.5.2 Methods of Non-Destructive Examination (NDE)

Perform NDE examination/inspection of structural aluminum weldments in accordance with AWS D1.2/D1.2M.

If more than [20] [_____] percent of welds made by a welder contain defects identified by testing, then all groove welds made by that welder must be tested by ultrasonic testing, and all fillet welds made by that welder must be inspected by magnetic particle testing (MT) or dye penetrant testing (PT) as approved by the Contracting Officer. When the groove welds made by an individual welder are required to be tested, magnetic particle or dye penetrant testing may be used only in areas inaccessible to ultrasonic testing.Retest all repaired areas. Submit the weld inspection reports.

Review the drawings, weld position, and direction of travel prior to welding. Verify that the materials purchased match the specification and are free from rust, scale, mill or lamination.

Inspect for proper fit, alignment, cleanliness, preparation, size, gaging location, and acceptability of all welds; identification marking; operation and current characteristics of welding sets in use and the use of pre-heat. Inspect the equipment for damage, arc voltage, and amperage in accordance with specifications.

a. Visual Inspection (VT)

A Certified Welding Inspector must perform visual inspection on 100 percent of all welds. Document this inspection in the Visual Weld Inspection Log.

Verify the electrode size, type and storage comply with specifications. During welding, watch each pass paying close attention to root pass for any irregularities.

After completion of welding, use gauges to verify weld sizes, check finish and contour for acceptability, check for any defects including cracks, also look for overlap and undercut.

Enhance Visual Inspection (VT) for cracks and other discontinuities with a magnifying lens of [5X][10X]power wherever required to discern indications or defects otherwise not clear. Provide minimum light level of at least1,000 LUX (100 foot-candles). Measure size and contour of welds with suitable gages.

b. Liquid Penetrant Inspection (PT)

Perform Liquid Penetrant Inspection (PT) of welds in accordance with ASTM E165/E165M.

c. Radiographic Inspection (RT)

Perform Radiographic Inspection (RT) of welds in accordance with the requirements of ASTM E1032.

d. Ultrasonic Inspection (UT)

When ultrasonic testing is required by the contract documents, specify the extent of testing, the procedure, and the acceptance criteria in accordance with ASTM E164.

3.3.5.3 Levels of Examination

a. Level I Examination

Level I examination requires 100 percent VT, and 100 percent RT. Where RT is not practical, perform PT of the root pass and the final surface of each weld joint.

Where applicable, each radiograph is to provide a minimum of the following additional information permanently included in the image:

(1) Agency Weld No. (including repair cycle no.)

(2) Agency Drawing No.

(3) Agency View No.

(4) Agency Contract No.

Final interpretation and acceptance of all radiographs of welded joints is performed by the Contracting Officer.

b. Level II Examination

Level II examination requires 100 percent VT, and PT of the final surface of each weld joint.

c. Level III Examination

Level III examination requires 100 percent VT of each weld joint.

3.3.5.4 Acceptance Requirements

[a. Class A Fabrication

Ensure Class A fabrication receives a Level I examination, requiring weldments in accordance with AWS D1.2/D1.2M.

][b. Class B Fabrication

Ensure Class B fabrication requires a Level II examination, requiring weldments in accordance with AWS D1.2/D1.2M.

][c. Class C & D Fabrication

Ensure Class C & D fabrication receives a Level III examination, requiring weldments in accordance with AWS D1.2/D1.2M.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-05 21 00 (May 2015)**

Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-05 21 13 (August 2009)
UFGS-05 21 16 (August 2009)
UFGS-05 21 19 (July 2007)
UFGS-05 21 23 (July 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 21 00

STEEL JOIST FRAMING

05/15, CHG 1: 08/18

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-05 21 00 (May 2015)**

Change 1 - 08/18

Preparing Activity: USACE

Superseding
UFGS-05 21 13 (August 2009)
UFGS-05 21 16 (August 2009)
UFGS-05 21 19 (July 2007)
UFGS-05 21 23 (July 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 05 21 00

STEEL JOIST FRAMING
05/15, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for steel joist framing and accessories and includes the following components: Open Web Steel Joists (K-Series and KCS), Longspan Steel Joists (LH-Series), Deep Longspan Steel Joists (DLH-Series), Joist Girders, Composite Steel Joists (CJ-Series), and Nonstandard Joists and Joist Girders.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Show the following information on the project drawings:

1. Joist series and size, joist spacing, and kN (kip) load on each panel point, span, and slope.

2. Design loads, including net uplift and lateral forces in addition to gravity (dead and live) loads.

3. Method of anchoring, framing at openings, spacing and type of bridging.

4. Accessory details as applicable.

Mechanical and Electrical layout drawings and specifications for ceiling suspensions must contain notes indicating that hangar loads between panel points in excess of 445 N 100 pounds must have the excess hangar loads suspended from panel points.

When joists or girders are to be designed to resist net uplift and/or lateral forces, such joists and girders and the forces they must resist must be indicated on the drawings. Also, indicate all proper anchorages and bracing designed to resist those forces, as required.

The standard joist tables cannot be used verbatim when the depth of the joist is reduced near the ends to accommodate two-way top chord slopes in excess of 10 mm per meter 1/8 inch per foot. Before using standard designations for these joists, the designer must verify the adequacy of the joist members.

For additional information on the use of joists and joist girders see SJI Technical Digests covering ponding loading, vibrations, uplift, welding, fire resistant assemblies, lateral load resisting frames using steel joists and joist girders and evaluation and modification of open web steel joists and joist girders.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC Paint 15	(1999; E 2004) Steel Joist Shop Primer/Metal Building Primer
SSPC SP 2	(2024) Hand Tool Cleaning

STEEL JOIST INSTITUTE (SJI)

SJI COMPOSITE JOISTS	(2007; Supplement 1 2010) Standard Specifications for Composite Steel Joist Catalog
SJI LOAD TABLES	(2020) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders - 45th Edition
SJI MANUAL	(2009) 80 Years of Open Web Steel Joist Construction

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.756	Steel Erection; Beams and Columns
29 CFR 1926.757	Steel Erection; Open Web Steel Joists

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welder Qualification

SD-02 Shop Drawings

Steel Joist Framing; G, [_____]

SD-03 Product Data

Recycled Content Of Steel Products; S

SD-05 Design Data

Design Calculations; G, [_____]

SD-06 Test Reports

Erection Inspection

Welding Inspections

SD-07 Certificates

Certification of Compliance

1.3 QUALITY ASSURANCE

Perform all work in compliance with the requirements set forth in 29 CFR 1926.

1.3.1 Drawing Requirements

Submit drawings of steel joist framing including fabrication, specifications for shop painting, and identification markings of joists [and joist girders]. Show joist type and size, layout in plan, all applicable loads, deflection criteria, and erection details including methods of anchoring, framing at openings, type, size, and location and connections for and spacing of bridging, requirements for field welding, and details of accessories as applicable. [Show profiles for nonstandard joist configurations.][Show steel joist field splice locations and details.]

1.3.2 Certification of Compliance

****

NOTE: Use the SJI MANUAL reference for projects involving existing joist girder and joist systems.

****

Prior to construction commencement, submit certification for welder qualification, in compliance with AWS D1.1/D1.1M, welding operation, and tacker, stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. Submit certification of compliance for the following:

[a. SJI MANUAL

] b. [a][b]. Steel Joist Institute Member Fabricator

c. [b][c]. 29 CFR 1926

d. [c][d]. 29 CFR 1926.757

e. [d][e]. Statement from steel joist manufacturer, that work was performed in accordance with approved construction documents and with SJI standard specifications, in accordance with ICC IBC Section 1704.2.5.2.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, transport, and store joists [and joist girders] in a manner to prevent damage affecting their structural integrity. Verify piece count of all joist products upon delivery and inspect all joists products for damage. Report any damage to the joist supplier. Store all items off the ground in a well drained location protected from the weather and easily accessible for inspection and handling. Store joists with top chord down and with joists in a vertical position. Store deep joists horizontally if they were shipped on their sides.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: The structural steel design must meet the requirements of OSHA Steel Erection Standard, 29 CFR Part 1926, Subpart R-Steel Erection and 29 CFR 1926.757.

****

Designate steel joists [and joist girders] on the drawings in accordance with the standard designations of the Steel Joist Institute. Joists of other standard designations or joists with properties other than those shown may be substituted for the joists designated provided the structural properties are equal to or greater than those of the joists shown and provided all other specified requirements are met.

2.2 STEEL JOISTS [AND JOIST GIRDERS]

Provide steel joists [and joist girders] conforming to SJI LOAD TABLES. Design joists designated K, KCS, LH and DLH to support the loads given in the applicable standard load tables of SJI LOAD TABLES. Submit design calculations for [joist girders,][special steel joists,][composite steel joists,] net uplift loads, non-SJI standard details, and field splices. Include cover letter signed and sealed by the joist manufacturer's registered design professional.

2.2.1 Steel Joist Camber

Camber joists [according to SJI LOAD TABLES][as indicated]. [Do not camber joists.]

2.2.2 Special Steel Joists

****

NOTE: Provide load diagrams on structural drawings for all loading conditions including net wind uplift on special joists.

For roof joists, specify live-load deflection criteria of L/360 for conditions where plaster ceiling is attached or suspended. Specify L/240 for all other cases.

****

Provide special joists and connections capable of withstanding the design loads indicated with a live-load deflection less than [L/360][L/240] for roof joists and L/360 for floor joists.

2.2.3 Steel Joist Substitutes and Outriggers

Provide joist substitutes and outriggers conforming to SJI LOAD TABLES with steel angle or channel members.

2.2.4 Composite Steel Joists

Provide composite steel joists conforming to SJI COMPOSITE JOISTS.

2.2.5 Joist Girders

Provide joist girders capable of withstanding the design loads indicated with a live-load deflection less than [L/360][L/240] for roof girders and L/360 for floor girders. [Where joist girders are part of the lateral load resisting system, design girder for the end moments indicated for wind [and seismic].]

****

NOTE: Include this paragraph when joists will be bolted to the joist girder as the holes require special consideration in the design of the joist girder.

****

[Provide holes in top chord members for connecting and securing other construction to the joist girders.]

Camber joist girders [according to SJI LOAD TABLES][as indicated]. [Do not camber joist girders.]

2.3 RECYCLED CONTENT

****

NOTE: Coordinate the level of recycled content with sustainability requirements for the project.

****

Provide products with an average recycled content of steel products of postconsumer recycled content plus one half of preconsumer recycled content not less than [25] [_____] percent.

2.4 ACCESSORIES AND FITTINGS

2.4.1 Bridging

Provide bridging of material, size, and type required by SJI LOAD TABLES for type of joist, chord size, spacing and span. Furnish additional erection bridging if required for stability.

2.4.2 Bearing Plates

Fabricate steel bearing plats from ASTM A36/A36M steel of size and thickness indicated.

2.4.3 Ceiling Extensions

Furnish ceiling extensions, either bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 13 mm 1/2 inch of finished wall surface unless otherwise indicated.

2.5 SHOP PAINTING

****

NOTE: The requirements of this paragraph will be coordinated with the requirements of Section 09 90 00 PAINTS AND COATINGS. In crawl spaces and other high humidity areas where greater protection than

that provided by a primer paint is required and the joists or girders will not be finish painted, the paragraph will be revised to require that the joists or girders be shop painted with a corrosion resistant type paint as recommended by SSPC.

****

SSPC Paint 15. Shop prime joists, except as modified herein, in accordance with SSPC PA 1. Clean joists in accordance with SSPC SP 2 before priming. [Do not prime joists to receive sprayed-on fireproofing.] If flash rusting occurs, re-clean the surface prior to application of primer. For joists [and joist girders] which require finish painting under Section 09 90 00 PAINTS AND COATINGS, the primer paint must be compatible with the finish paint.

PART 3 EXECUTION

3.1 ERECTION

****

NOTE: Use 29 CFR 1926.756 when joist lengths exceed 43,900 mm 144 feet.

****

Install joists [and joist girders] in conformance with SJI LOAD TABLES for the joist series indicated, and the requirements of 29 CFR 1926 and 29 CFR 1926.757[and 29 CFR 1926.756]. Handle and set joists [and joist girders] avoiding damage to the members. Place the "tag end" of joists as shown on the joists placement plans. Ensure that square-end joists are erected right side up. [Place joists on joist girders in accordance with the joist placement plan, noting that in many instances joist may not need to be placed at a joist girder panel point.] Distribute temporary loads so that joist capacity is not exceeded. Remove damaged joists [and joist girders] from the site, except when field repair is approved and such repairs are satisfactorily made in accordance with the manufacturer's recommendations. Do not repair, field modify, or alter any joists [or joist girder] without specific written instructions from the Designer of Record and/or joist manufacturer.

Install and connect bridging concurrently with joist erection, before construction loads are applied. Do not apply loads to bridging. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams. Do not cut away vertical leg of bridging where bridging makes an elevation transition; weld a separate piece of bridging at the transition. Perform all welding in accordance with AWS D1.1/D1.1M.

[3.2 BEARING PLATES

****

NOTE: Use this paragraph for masonry or cast-in-place concrete applications only.

****

Provide bearing plates to accept full bearing after the supporting members have been plumbed and properly positioned, but prior to placing superimposed loads. The area under the plate must be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Provide bedding mortar and grout as specified in Section 03 30 00

CAST-IN-PLACE CONCRETE.

]3.3 PAINTING

3.3.1 Touch-Up Painting

After erection of joists [and joist girders], touch-up connections and areas of abraded shop coat with paint of the same type used for the shop coat.

[3.3.2 Field Painting

****

NOTE: Omit bracketed text when field painting is not required.

****

Paint joists [and joist girders] requiring a finish coat in conformance with the requirements of Section 09 90 00 PAINTS AND COATINGS.

]3.4 VISUAL INSPECTIONS

Perform the following visual inspections:

a. Verify that all joists are spaced properly.

b. Verify that there is sufficient joist bearing on steel beams, concrete, and masonry.

c. Verify all bridging lines are properly spaced and anchored.

d. Verify that damage has not occurred to the joists [and joist girder] during erection.

e. Verify the joists are aligned vertically and there is no lateral sweep in the joists.

f. Where concentrated loads are present on the joists verify that they are located in accordance with the joists placement plan.

g. Verify welding of bridging and joist seats in accordance with AWS D1.1/D1.1M, Section 6. Perform erection inspection and field welding inspections with AWS certified welding inspectors.

h. Verify proper bolting of diagonal bridging and joist seats where the bolts are snug-tight.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-05 30 00 (May 2015)**
Change 2 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-05 30 00 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-05 30 00 (May 2015)**
Change 2 - 08/18

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****

SECTION 05 30 00

STEEL DECKS

05/15, CHG 2: 08/18

****

NOTE: This guide specification covers the requirements for steel floor and roof decks, including accessories.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Determine which roof areas on the structure are considered by the structural engineer as functioning as diaphragms for the lateral force resisting system.

Composite decks and diaphragm acting decks, including connections, should be designed by the structural engineer according to the Steel Deck Institute. Refer to the International Building Code (ICC IBC) and ICC-ES Evaluation Service Reports (ESR) based on AC43, Acceptance Criteria for Steel Deck Roof and Floor Systems, including diaphragm decks in seismic areas.All connections must be shown. Drawings must show wind uplift loads for roof joist design in addition to the items listed below.

For non-diaphragm acting, non-composite decks, the contractor may provide the deck design and connections. In this case, the drawings must show roof live loads, including snow loads, and wind loads, including internal and external pressures and high intensity zones. Consider showing a roof uplift and snow load plan on the drawings.

In addition to the above, show the following information on the project drawings:

1. Structural properties (height, sheet thickness, and section moduli or moment of inertia).

2. Floor and roof deck penetrations.

3. Location, spacing, and size of hanger clips or loops.

4. Closure plates.

5. Location of cellular decking and whether it is to be used as electrical raceway.

6. Weld or fastener spacing.

7. Whether construction is based on shored construction.

Design steel deck to carry the concrete and steel deck dead loads, and the live loads during construction before the concrete sets. Additional concrete dead load due to deflection of the deck shall be considered when necessary to prevent excessive stresses or deflections in the deck.

****

PART 1 GENERAL

****

NOTE: The structural steel design must meet the requirements of OSHA Steel Erection Standard, 29 CFR Part 1926, Subpart R-Steel Erection.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI D100	(2017) Cold-Formed Steel Design Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM D746	(2014) Standard Test Method for

	Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1149	(2018) Standard Test Method for Rubber Deterioration - Cracking in an Ozone Controlled Environment
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/
FM DS 1-28R	(1998) Data Sheet: Roof Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 20	(2019) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic)

STEEL DECK INSTITUTE (SDI)

ANSI/SDI C	(2017) Standard for Composite Steel Floor Deck - Slabs
ANSI/SDI NC	(2017) Standard for Non-Composite Steel Floor Deck
ANSI/SDI QA/QC	(2017) Standard for Quality Control and Quality Assurance for Installation of Steel Deck
ANSI/SDI RD	(2017) Standard for Steel Roof Deck
SDI DDM04	(2015; Errata 1-3 2016; Add 1 2015; Add 2 20162006) Diaphragm Design Manual; 4th Edition
SDI DDP	(1987; R 2000) Deck Damage and Penetrations
SDI MOC3	(2016) Manual of Construction with Steel Deck (3rd Edition)

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction

UL SOLUTIONS (UL)

UL 209	(2011; Reprint Apr 2024) UL Standard for Safety Cellular Metal Floor Raceways and Fittings
UL 580	(2006; Reprint Apr 2024) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, [_____]

SD-03 Product Data

Accessories

Deck Units

Galvanizing Repair Paint

[Mechanical Fasteners

]

Touch-Up Paint

Sound Absorbing Materials

Welding Equipment

Welding Rods and Accessories

Recycled Content of Steel Products; S

SD-04 Samples

Metal Roof Deck Units

Cellular Metal Floor Deck Units

Flexible Closure Strips

Acoustical Material

SD-05 Design Data

Deck Units; G, [_____]

SD-07 Certificates

Powder-Actuated Tool Operator

Welder Qualifications

Welding Procedures

Fire Safety

Wind Storm Resistance

Manufacturer's Certificate

Stud Manufacture's Certification

Stud Manufacture's Test Reports

1.3 QUALITY ASSURANCE

1.3.1 Deck Units

Furnish deck units and accessory products from a manufacturer regularly engaged in manufacture of steel decking. Provide manufacturer's certificates attesting that the decking material meets the specified requirements.

1.3.2 Certification of Powder-Actuated Tool Operator

Provide manufacturer's certificate attesting that the operators are authorized to use the low velocity powder-actuated tool.

1.3.3 Qualifications for Welding Work

Follow Welding Procedures of AWS D1.3/D1.3M for sheet steel and AWS D1.1/D1.1M for stud welding.

****

NOTE: Making of test specimens in the presence of the Contracting Officer is required when the building meets one of the following:
1. Seismic Design Category D, E or F and Risk Category III, IV or V.
2. Building height is greater than 75 feet and Seismic Design Category D, E or F.
3. Nominal wind speed is greater than 110 mph (49 m/s) and Risk Category III, IV or V.
4. Building height is greater than 75 feet and the nominal wind speed is greater than 110 mph (49 m/s).

****

Submit qualified Welder Qualifications in accordance with AWS D1.3/D1.3M for sheet steel and AWS D1.1/D1.1M for stud welding, or under an equivalent approved qualification test. Perform tests on test pieces in positions and with clearances equivalent to those actually encountered. [Test specimens shall be made in the presence of Contracting Officer and shall be tested by an approved testing laboratory at the Contractor's expense.] If a test weld fails to meet requirements, perform an immediate retest of two test welds until each test weld passes. Failure in the immediate retest will require the welder be retested after further practice or training, performing a complete set of test welds.

Submit manufacturer's catalog data for Welding Equipment and Welding Rods and Accessories.

1.3.4 Regulatory Requirements

****

NOTE: For roofing systems with insulation/ underlayment applied directly to deck, include applicable paragraph/sentence for fire rated and/or windstorm resistance. Specify roof assemblies that are in consonance with other roof components (Supports, deck, adhesives, bitumen, fasteners and attachments, vapor retarders, insulation, membrane, and surfacing) so that the roof construction assembly results in UL or FM fire-resistance and windstorm resistance classification required by

project criteria.
****

1.3.4.1 Fire Safety

Test roof deck as a part of a roof deck construction assembly of the type used for this project, listing as fire classified in the UL Fire Resistance, or listing as Class I construction in the FM APP GUIDE, and so labeled.

1.3.4.2 Wind Storm Resistance

****
NOTE: Select the appropriate wind uplift pressure based on wind speeds used by the structural designer in accordance with UFC 3-301-01, "Structural Engineering". UFC 3-301-01 is based on ultimate wind loads, convert the ultimate wind load to a nominal wind load before inserting into the paragraph below. The uplift wind pressure indicated in this paragraph must include a factor of safety of 2 for Factory Mutual.
****

Provide roof construction assembly capable of withstanding a nominal uplift pressure of [3] [5] [_____] kPa [60] [90] [_____] pounds per square foot when tested in accordance with the uplift pressure test described in the FM DS 1-28R or as described in UL 580 and in general compliance with UFC 3-301-01.

1.3.5 Fabrication Drawings

Show type and location of units, location and sequence of connections, bearing on supports, methods of anchoring, attachment of accessories, adjusting plate details, cant strips, ridge and valley plates, metal closure strips, size and location of holes to be cut and reinforcement to be provided, the manufacturer's erection instructions and other pertinent details.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver deck units to the site in a dry and undamaged condition. Store and handle steel deck in a manner to protect it from corrosion, deformation, and other types of damage. Do not use decking for storage or as working platform until units have been fastened into position. Exercise care not to damage material or overload decking during construction. The maximum uniform distributed storage load must not exceed the design live load. Stack decking on platforms or pallets and cover with weathertight ventilated covering. Elevate one end during storage to provide drainage. Maintain deck finish at all times to prevent formation of rust. Repair deck finish using touch-up paint. Replace damaged material.

1.5 DESIGN REQUIREMENTS FOR ROOF DECKS

1.5.1 Properties of Sections

Properties of metal roof deck sections must comply with engineering design width as limited by the provisions of AISI D100.

1.5.2 Allowable Loads

Indicate total uniform dead and live load for detailing purposes.

PART 2 PRODUCTS

2.1 DECK UNITS

Submit manufacturer's design calculations, or applicable published literature for the structural properties of the proposed deck units.

Provide products with an average recycled content of steel products so postconsumer recycled content plus one half of preconsumer recycled content not less than [25] [_____] percent.

****

NOTE: Minimum metal thickness should be 0.35 mm (0.014 inch) for form decks and 0.75 mm (0.0295 inch) for roof and composite decks. However, for corrosive exposures, consider 0.91 mm (0.0358 inch) minimum thickness.

Specify coated steel for most floor decks and all roof decks. Use Z275 (G90) galvanized coating or galvalume ASTM A792/A792M for severe corrosive conditions and with concrete or spray applied fire protection. Use Z180 (G60) when severe conditions do not exist. Prime painted, not coated, should be specified only for low-budget jobs where deck is not critical.

The steel deck shall be designed according to ANSI/SDI C, ANSI/SDI NC or ANSI/SDI RD. Verify grades of steel are appropriate for design. SDI allows ASTM A653/A653M, Grade 230 (Grade 33); ASTM A1008/A1008M, Grades C and D; or ASTM A792/A792M. Phosphatized and painted coating is not recommended for the majority of applications. The steel deck specified in this guide specification will be used in conjunction with insulation and built-up roofing in accordance with UFC 3-110-03, "Roofing", or will be used as a permanent form for concrete or as part of a composite deck assembly. Drawings should show location and extent of steel deck, complete structural support including openings greater than 300 mm (12 inch), type and location of accessories, uniformly distributed live loads (positive and negative) in kPa (psf), thickness, and required values for section modulus and moment of inertia per mm (foot) of width. Moments of inertia and section modulus values will be designed based on procedures set forth in ANSI/SDI C, ANSI/SDI NC and ANSI/SDI RD. Steel decks used as diaphragms must meet the requirements of UFC 1-200-01, "General Building Requirements" and UFC 3-301-01, "Structural Engineering". Subsystems for fire-rated construction, including roof deck, joists, insulation, built-in roofing, and ceiling material will be indicated. When the finished installations

will be exposed to high humidity, seacoast atmosphere or corrosive chemical fumes special care in specifying the finish should be used and individual manufacturers should be consulted for the specific application. Notes on the drawings should indicate the attachment method to be used, and should give the size and spacing for perimeter, side lap, intermediate supports, and end lap attachments.

****

2.1.1 Roof Deck

****

NOTE: The epoxy coating is expensive and should only be considered for corrosive environments where justified by a cost analysis.

****

Conform to ASTM A792/A792M or ASTM A1008/A1008M for deck used in conjunction with insulation and built-up roofing. Fabricate roof deck units of [[0.75] [_____] mm [0.0295] [_____] inch design thickness or thicker steel] [the steel design thickness required by the design drawings] and [shop painted] [galvanized] [painted with an epoxy coating or equivalent applied to prime-coating in accordance with manufacturer's standard] [zinc-coated in conformance with ASTM A653/A653M, Z275 G90 coating class or aluminum-zinc coated in accordance with ASTM A792/A792M Coating Designation AZM165 AZ55]. Furnish sample of Metal Roof Deck Units used to illustrate actual cross section dimensions and configurations.

[2.1.2 Acoustical Roof Deck

****

NOTE: Include requirements for acoustical steel deck when required by the design, otherwise delete. Acoustical steel deck is designed to serve as a sound absorbing ceiling as well as a structural deck. Acoustical noncellular steel roof deck is identical in appearance to standard steel roof deck (noncellular) except that the webs of the ribs are perforated to receive fiber glass sound absorbing material, in roll form, placed between the perforated ribs. Acoustical noncellular roof deck should not be used without modifying FM or UL requirements for roof decks in Division 07. Acoustical cellular steel deck is identical in appearance to cellular steel deck, except that the steel bottom plate (ceiling) is perforated. In addition, acoustical deck serves as both a deck and acoustical ceiling (in lieu of a separate finished acoustical ceiling) where noise levels are to be controlled. Include cover plates when cellular deck is specified. Include 50 mm (2 inch) end laps for non-cellular deck.

****

****

NOTE: A noise reduction coefficient of 0.70 is a commonly used coefficient. The coefficient can also be obtained from manufacturer's literature.

However, specific design requirements must be considered and the appropriate value inserted. The manufacturer's standard acoustical steel deck shall be provided where indicated.
****

Provide a Noise Reduction Coefficient (NRC) rating of not less than [0.70] [_____], when tested in accordance with ASTM C423. Provide sound absorbing materials with either [glass fiber in roll or premolded form for acoustical steel deck (noncellular)] [and] [or] [glass fiber rigid strip for acoustical steel deck (cellular)] in accordance with manufacturer's standards.

]2.1.3 Composite Deck

****
NOTE: Where deck design is based on shored construction, edit and include requirements in the last bracketed sentence and indicate on structural drawings that decking must be shored during placement and curing of concrete.
****

[Conform to ASTM A653/A653M or ASTM A1008/A1008M for composite deck assembly. Fabricate deck used as the tension reinforcing in composite deck of [0.75][_____] mm [0.0295] [_____] inch design thickness or thicker steel with integrally embossed or raised pattern ribs.] [The steel design thickness required by the design drawings. Zinc-coat in conformance with ASTM A653/A653M, [G60][G90] coating class.][Shore composite deck until the concrete has reached [75][_____] percent of its specified strength.]

2.1.4 Cellular Metal Floor Deck Units

****
NOTE: Coordinate cellular deck wire raceways with appropriate sections in Division 16 and add information where needed.

Cellular and noncellular decking may or may not be combined into one deck system.
****

Provide decking as wire raceways conforming to NFPA 70. Conform to [ASTM A653/A653M, SS, Grade 230, Grade 33]; [ASTM A1008/A1008M Coated Carbon Steel Sheets, Grade C, 228 mPa 33,000 psi minimum yield strength]; or [ASTM A792/A792M Coated Steel Sheets, Grade 33] for formed [cellular] [and] [non-cellular] decking and accessories. Provide nominal thickness of the steel sheets, before galvanizing, a minimum 1.3 millimeter 18-gage for the upper element of the floor deck unit, and a minimum 1.6 millimeter 16-gage for the lower element of the floor deck unit [as required by the design drawings]. [Furnish one sample of each type of Metal Floor Deck Units used to illustrate the actual cross section dimensions and configuration.]

2.1.5 Form Deck

Conform to ASTM A653/A653M or ASTM A1008/A1008M for deck used as formwork for concrete. Fabricate form deck of[[0.38] [_____] mm [0.015] [_____] inch design thickness or thicker steel.] [the steel design thickness required by the design drawings.] [Paint with one coat of manufacture's standard paint.] [Zinc-coat in conformance with ASTM A653/A653M,[Z180 G60][Z275 G90] coating class.]

Provide sufficient welds, forming the steel sheets into the cellular floor deck unit, to develop the full horizontal shear at the plane where the steel sheets are joined.

****

NOTE: Delete inapplicable paragraphs. When fire-resistance-rated construction is required, the fire rating agency's specifications for the applicable floor or roof and ceiling construction must be consulted.

****

Cellular metal floor deck units must be fluted section cells combined [on a flat plate][with a matching fluted bottom section] having interlocking type sidelaps. Provide depth, width of unit, number of cells per unit, and width of cells as indicated.

Use panels of maximum possible lengths to minimize end laps. Fabricate deck units in lengths to span 3 or more supports with flush, telescoped, or nested 50 mm 2 inch laps at ends, and interlocking, or nested side laps, unless otherwise indicated. [Factory apply a standard, phosphatized and painted, baked-on enamel finish to underside of steel decking.] [[Floor] [and] [Roof] deck system design is based on shored construction.]

[2.1.6 Non-Composite Vented Form Deck

****

NOTE: Include this paragraph on projects where lightweight insulating concrete roof systems are used. Verify that deck size specified is available as vented.

****

To ensure positive venting from the underside, provide slotted or perforated steel deck to receive concrete fill, overlay, or a poured concrete deck. Provide deck with side lap venting clips, formed in side lap vents, or vent slots in the corrugation. Vent area shall be at least 700 square mm per square m 0.10 square inch per square foot of roof deck area.

]2.1.7 Length of Deck Units

Provide deck units of sufficient length to span three or more spacings where possible.

[2.1.8 Shop Priming

****

NOTE: Specify shop priming when decking will receive field applied finish painted. Paint will not adhere to passivating or stabilizing treatment commonly used on galvanized steel surfaces to prevent "white rust." Coordinate requirements for finishes with requirements for fireproofing and field finish painting.

****

Shop prime accessories and [underside of] deck at the factory after coating. Clean surfaces in accordance with the manufacturer's standard procedure followed by a spray, dip or roller coat of rust-inhibitive primer, oven cured.

]2.1.9 Touch-Up Paint

Provide a high zinc-dust content paint for regalvanizing welds in galvanized steel conforming to ASTM A780/A780M.

Provide touch-up paint for shop-painted units [of the same type used for the shop painting] [_____], and touch-up paint for zinc-coated units of [an approved galvanizing repair paint with a high-zinc dust content] [_____]. Touch-up welds with paint conforming to SSPC Paint 20 in accordance with ASTM A780/A780M. Maintain finish of deck units and accessories by using touch-up paint whenever necessary to prevent the formation of rust.

2.2 ACCESSORIES

Provide accessories of same material as deck, unless specified otherwise. Provide manufacturer's standard type accessories, as specified.

2.2.1 Adjusting Plates

Provide adjusting plates, or segments of deck units, of same thickness and configuration as deck units in locations too narrow to accommodate full size units. Provide factory cut plates of predetermined size where possible.

2.2.2 End Closures

Fabricated of sheet metal by the deck manufacturer. Provide end closures minimum 0.75 mm 0.0295 inch thick to close open ends at [exposed edges of floors,] [parapets,] [end walls,] [eaves,] [and] openings through deck.

2.2.3 Partition Closures

****

NOTE: Coordinate options in paragraphs PARTITION CLOSURES and CLOSURES ABOVE PARTITIONS. When a suspended acoustical ceiling is provided below the metal deck, the closures above partitions may be eliminated for acoustical purposes provided the acoustical properties of the ceiling are adequate to restrict sound transmission to a level consistent with the facility design criteria.

****

****

NOTE: Drawings shall show closures above interior partitions where required. On fire partitions, metal closures will be used on both sides of the wall or use firestopping.

****

Provide closures for closing voids above interior walls and partitions that are perpendicular to the direction of the configurations. [Provide rubber, plastic, or sheet steel closures above typical partitions.] [Provide minimum one inch thick soft composition rubber closures above walls and partitions contiguous to acoustical steel deck.] [Provide sheet steel closures above fire-resistant interior walls and partitions located on both sides of wall or partition.] [Provide glass fiber blanket insulation in the space between pairs of closures at acoustical partitions.]

2.2.4 Flexible Closure Strips for Roof Decks

Provide strips made of vulcanized, closed-cell, synthetic rubber material specified and premolded to the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking. [Furnish one sample of each type Flexible Closure Strips, 300 millimeter 12 inch long.]

Conforming to ASTM D1056, Grade 2A1, with the following additional properties:

Brittleness temperature of minus 40 degrees C minus 40 degrees F when tested in accordance with ASTM D746.

Flammability resistance with a flame spread rating of less than 25 when tested in accordance with ASTM E84.

Resistance to ozone must be "no cracks" after exposure of a sample kept under a surface tensile strain of 25 percent to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 40 degrees C 104 degrees F and tested in accordance with ASTM D1149.

Provide a elastomeric type adhesive as recommended by the manufacturer of the flexible closure strips.

2.2.5 Closure Plates for Composite Deck

Support and retain concrete at each floor level. Provide edge closures at all edges of the slab of sufficient strength and stiffness to support the wet concrete. Provide metal closures for all openings in composite steel deck 6 mm 1/4 inch and over.

2.2.6 Sheet Metal Collar

Where deck is cut for passage of pipes, ducts, columns, etc., and deck is to remain exposed, provide a neatly cut sheet metal collar to cover edges of deck. Do not cut deck until after installation of supplemental supports.

2.2.7 Cover Plates

Sheet metal to close panel edge and end conditions, and where panels change direction or butt. Polyethylene-coated, self-adhesive, 50 mm 2 inch wide joint tape may be provided in lieu of cover plates on flat-surfaced decking butt joints.

Fabricate cover plates for abutting floor deck units from the specified structural-quality steel sheets not less than nominal 1.3 millimeter 18 gage thick before galvanizing. Provide 150 millimeter 6 inch wide cover plates and form to match the contour of the floor deck units.

2.2.8 Roof Sump Pans

****

NOTE: Coordinate sump pans with type of roof drain specified.

****

Sump pans must be provided for roof drains and must be minimum 2 mm 0.075 inch thick steel, [flat] [recessed] type. Shape sump pans to meet roof slope by the supplier or by a sheet metal specialist. Provide bearing flanges of sump pans to overlap steel deck a minimum of 75 mm 3 inch. Shape, size, and reinforce the opening in bottom of the sump pan to receive roof drain.

2.2.9 Column Closures

Sheet metal, minimum 0.85 mm 0.0358 inch thick or metal rib lath.

2.2.10 Access Hole Covers

Sheet metal, minimum 1.2 mm 0.0474 inch thick.

2.2.11 Hanger

****

NOTE: Location, spacing, and size of hangar clips or loops must be indicated or specified, as applicable to the project.

****

Provide clips or loops for [utility systems] [and] [suspended ceilings] of one or more of the following types:

a. Lip tabs or integral tabs where noncellular decking or flat plate of cellular section is 1.2 mm 0.0474 inch thick or more, and a structural concrete fill is used over deck.

b. Slots or holes punched in decking for installation of pigtails.

c. Tabs driven from top side of decking and arranged so as not to pierce electrical cells.

d. Decking manufacturer's standard as approved by the Contracting Officer.

2.2.12 Shear Connectors

****

NOTE: Designer shall determine the necessity for shear connectors as per AISC 360. Designer shall show the size, spacing, and location of the shear connectors.

****

Provide shear connectors in accordance with AWS D1.1/D1.1M headed stud Type B. Submit stud manufacture's certification that the studs delivered conform to the material requirements. Submit stud manufacture's test reports for the last completed in-plant quality control mechanical tests.

2.2.13 Cant Strips for Roof Decks

****

NOTE: When cant strips exceeding the dimensions

specified in the following paragraph are required, the steel sheet quality and thickness must be revised as required.
****

Fabricate cant strips from the specified commercial-quality steel sheets not less than nominal 0.91 millimeter 0.0358 inch thick before galvanizing. Bend strips to form a 45-degree cant not less than 125 millimeter 5 inch wide, with top and bottom flanges a minimum 75 millimeter 3 inch wide. Length of strips 3000 millimeter 10 feet.

2.2.14 Ridge and Valley Plates for Roof Decks

Fabricate plates from the specified structural-quality steel sheets, not less than nominal 0.91 millimeter 0.0358 inch thick before galvanizing. Provide plates of minimum 120 millimeter 4-1/2 inch wide and bent to provide tight fitting closures at ridges and valleys. Provide a minimum length of ridge and valley plates of 3000 millimeter 10 feet.

2.2.15 Metal Closure Strips for Roof Decks

Fabricate strips from the specified commercial-quality steel sheets not less than nominal 0.91 millimeter 0.0358 inch thick before galvanizing. Provide strips from the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

2.2.16 Galvanized Steel Angles for Roof Decks

Provide hot-rolled carbon steel angles conforming to ASTM A36/A36M, and hot-dip galvanized in accordance with ASTM A123/A123M.

[2.2.17 Sound Absorbing Material

****
NOTE: Include requirements for acoustical steel deck when required by the design, otherwise delete. Acoustical steel deck is designed to serve as a sound absorbing ceiling as well as a structural deck. Acoustical noncellular steel roof deck is identical in appearance to standard steel roof deck (noncellular) except that the webs of the ribs are perforated to receive fiber glass sound absorbing material, in roll form, placed between the perforated ribs. Acoustical noncellular roof deck should not be used without modifying FM or UL requirements for roof decks in Division 07. Acoustical cellular steel deck is identical in appearance to cellular steel deck, except that the steel bottom plate (ceiling) is perforated. In addition, acoustical deck serves as both a deck and acoustical ceiling (in lieu of a separate finished acoustical ceiling) where noise levels are to be controlled. Include cover plates when cellular deck is specified. Include 50 mm (2 inch) end laps for non-cellular deck.
****

Provide [glass fiber in roll or premolded form for acoustical noncellular steel roof deck] [and] [glass fiber rigid strip for acoustical cellular steel deck] in accordance with the manufacturer's standards. Provide a sample of acoustical material to be used.

][2.2.18 Mechanical Fasteners

****

NOTE: Delete this paragraph when only welding is allowed.

****

Provide mechanical fasteners, such as powder actuated fasteners, pneumatically driven fasteners or self-drilling screws, for anchoring the deck to structural supports and adjoining units[as indicated][that are designed to meet the loads indicated].

]2.2.19 Miscellaneous Accessories

****

NOTE: Ensure that items listed in this paragraph are indicated on the project drawings.

****

Furnish the manufacturer's standard accessories to complete the deck installation. Furnish metal accessories of the same material as the deck and with the minimum design thickness as follows: saddles, 1.204 mm 0.0474 inch welding washers, 1.519 mm 0.0598 inch other metal accessories, 0.909 mm 0.0358 inch unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to installation of decking units and accessories, examine worksite to verify that as-built structure will permit installation of decking system without modification.

3.2 INSTALLATION

****

NOTE: Use ANSI/SDI C, ANSI/SDI NC or ANSI/SDI RD for all decks except those designed for diaphragm action. Use SDI DDM04 with Appendix VI and Errata or ICC-ES Evaluation Service Reports (ESR) based on Acceptance Criteria (AC) 43 diaphragm testing. Indicate cellular deck to be used as wiring raceways on the project drawings if included below.

The designer must determine if there are shoring requirements for composite decks. For most applications the design is selected so that shoring is not required. Shoring requirements shall be detailed on the design drawings.

If studs are being welded to the top flanges of beams, the deck ends should be butted. If not, deck ends should be lapped.

****

Install steel deck units in accordance with 29 CFR 1926, Subpart R – Steel Erection, ANSI/SDI QA/QC, [ANSI/SDI C][ANSI/SDI NC][ANSI/SDI RD][SDI DDM04] and approved shop drawings. Place units on structural supports, properly adjusted, leveled, and aligned at right angles to supports before permanently securing in place. Damaged deck and accessories including material which is permanently stained or contaminated, deformed, or with burned holes shall not be installed. Extend deck units over three or more supports unless absolutely impractical. Report inaccuracies in alignment or leveling to the Contracting Officer and make necessary corrections before permanently anchoring deck units. Locate deck ends over supports only. [Lap 50 mm 2 inch] [Butted] deck ends. Do not use unanchored deck units as a work or storage platform. [Do not fill unanchored deck with concrete.] Permanently anchor units placed by the end of each working day. Do not support suspended ceilings, light fixtures, ducts, utilities, or other loads by steel deck unless indicated. Distribute loads by appropriate means to prevent damage.[Prepare shoring in position before concrete placement begins in composite or form deck.][Size cellular decking provided as electrical raceways to accommodate indicated wiring systems. Chip off burrs and eliminate sharp edges which may damage wiring. Mesh decking panels accurately and place in accordance with UL 209.][Neatly fit acoustical material into the rib voids.]

3.2.1 Attachment

****

The fasteners shall provide minimum required pull-out, pull-over and shear resistance based upon test results of the specific steel deck and fastener as listed in the current edition of the Factory Mutual Approval Guide and Factory Mutual Data Sheet 1-28 or manufacturer's data sheets. Fasteners for roof insulations are specified in Section 07 22 00 ROOF AND DECK INSULATION.

****

****

NOTE: Refer to ANSI/SDI C, ANSI/SDI NC and ANSI/SDI RD for shear capacity, flexibility, connection details, size and spacing of welds and attachments, and concrete fill requirements.

For diaphragm acting decks, refer to Steel Deck Institute's SDI DDM04, "Diaphragm Design Manual".

Where welding only is allowed, delete the first two bracketed phrases and include the last bracketed phrase.

****

Immediately after placement and alignment, and after correcting inaccuracies, permanently fasten steel deck units to structural supports and to adjacent deck units by welding with normal 16 mm 5/8 inchdiameter puddle welds,[fastened with screws, powder-actuated fasteners, or pneumatically driven fasteners] as indicated on the design drawings and in accordance with manufacturer's recommended procedure[and ANSI/SDI C, ANSI/SDI NC or ANSI/SDI RD]. Clamp or weight deck units to provide firm contact between deck units and structural supports while performing welding [or fastening].[Anchoring the deck to structural supports with powder-actuated fasteners or pneumatically driven fasteners is prohibited.] Attachment of adjacent deck units by button-punching is prohibited.

3.2.1.1 Welding

****

NOTE: Show location, size, and spacing of attachments on the drawings for composite and diaphragm-acting decks. If they are not shown, delete the first bracket and include the second bracket. Coordinate finish repair with finish requirements. Welding washers shall be used at welded connections when deck thickness is less than 0.711 mm (0.028 inch).

****

Perform welding in accordance with AWS D1.3/D1.3M using methods and electrodes recommended by the manufacturers of the base metal alloys being used. Ensure only operators previously qualified by tests prescribed in AWS D1.3/D1.3M make welds. Immediately recertify, or replace qualified welders, that are producing unsatisfactory welding. [Indicate] [Conform to the recommendations of the Steel Deck Institute and the steel deck manufacturer]for location, size, and spacing of fastening. [Do][Do not] use welding washers at the connections of the deck to supports. Do not use welding washers at sidelaps. Holes and similar defects will not be acceptable. Attach all partial or segments of deck units to structural supports in accordance with Section 2.5 of SDI DDM04. [Attach shear connectors as shown and welded as per AWS D1.1/D1.1M [through the steel deck to the steel member] [directly to the steel member]]. Immediately clean welds by chipping and wire brushing. Heavily coat welds, cut edges and damaged portions of [coated finish with zinc-dust paint conforming to ASTM A780/A780M] [shop [primed] [painted] finish with the manufacturer's standard touch-up paint].

[3.2.1.2 Mechanical Fastening

****

NOTE: Delete this paragraph when only welding is allowed.

****

Anchor deck to structural supports and adjoining units with mechanical fasteners. [Drive the powder-actuated fasteners with a low-velocity piston tool by an operator authorized by the manufacturer of the powder-actuated tool.][Drive pneumatically driven fasteners with a low-velocity fastening tool and comply with the manufacturer's recommendations.][Drive screws to properly clamp deck to supporting steel.]

]3.2.1.3 Sidelap Fastening

Lock sidelaps between adjacent floor deck units together by welding or screws as indicated.

3.2.2 Openings

****

NOTE: Include bracketed phrases when design is based on seismic requirements. When cells of cellular steel floor decking will be used for air ducts, the cutting of decking units for connections to air distribution ductwork, outlets, and system

accessories must be coordinated with and specified in applicable sections of the mechanical specifications.

When cells of cellular metal floor decking will be used for electrical raceways, the inspection of these cells, cutting for inserts, and installation of electrical outlets, fittings, or grounding of the metal floor decking, be coordinated with and specified in applicable sections of the electrical specifications.
****

Cut or drill all holes and openings required and be coordinated with the drawings, specifications, and other trades. Frame and reinforce openings through the deck in conformance with SDI DDP. Reinforce [holes and openings 150 to 300 mm 6 to 12 inch across by 1.204 mm 0.0474 inch thick steel sheet at least 300 mm 12 inch wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 150 mm 6 inch on center. Reinforce holes and openings larger than 300 mm 12 inch by steel channels or angles installed perpendicular to the steel joists and supported by the adjacent steel joists. Install steel channels or angles perpendicular to the deck ribs and fasten to the channels or angles perpendicular to the steel joists.][Deck manufacturer shall approve holes or openings larger than 150 mm 6 inch in diameter prior to drilling or cutting.] [Openings must not interfere with seismic members such as chords and drag struts.]

3.2.3 Deck Damage

SDI MOC3, for repair of deck damage.

3.2.4 Touch-Up Paint

3.2.4.1 Roof Deck

After roof decking installation, wire brush, clean, and touchup paint the scarred areas on top and bottom surfaces of metal roof decking. The scarred areas include welds, weld scars, bruises, and rust spots. Touchup galvanized surfaces with galvanizing repair paint. Touchup painted surfaces with repair paint of painted surfaces.

3.2.4.2 Floor Deck

For floor decking installation, wire brush, clean, and touchup paint the scarred areas on the top and bottom surfaces of the metal floor decking and on the surface of supporting steel members. Include welds, weld scars, bruises, and rust spots for scarred areas. Touched up the galvanized surfaces with galvanizing repair paint. Touch up the painted surfaces with paint for the repair of painted surfaces.

3.2.5 Accessory Installation

3.2.5.1 Adjusting Plates

Provide in locations too narrow to accommodate full-size deck units and install as shown on shop drawings.

3.2.5.2 End Closures

Provide end closure to close open ends of cells at columns, walls, and openings in deck.

3.2.5.3 Closures Above Partitions

****

NOTE: Coordinate options in paragraphs PARTITION ENCLOSURES and CLOSURES ABOVE PARTITIONS. When a suspended acoustical ceiling is provided below the metal deck, the closures above partitions may be eliminated for acoustical purposes provided the acoustical properties of the ceiling are adequate to restrict sound transmission to a level consistent with the facility design criteria.

****

Provide for closing voids between cells over partitions that are perpendicular to direction of cells. Provide a one-piece closure strip for partitions 100 mm 4 inch nominal or less in thickness and two-piece closure strips for wider partitions. [Provide sheet metal closures above fire-rated partitions at both sides of partition with space between filled with fiberglass insulation.] [Provide flexible rubber closures above acoustic-rated partitions at both sides of partition with space between filled with blanket insulation.]

3.2.5.4 Cover Plates

[Provide metal cover plates, or joint tape, at joints between cellular decking sheets to be used as electrical raceways.] [Where concrete leakage would be a problem, provide metal cover plates, or joint tape, at joints between decking sheets, cellular or noncellular, to be covered with concrete fill.]

[3.2.5.5 Column Closures

****

NOTE: Delete this paragraph if steel floor decks are not included.

****

Provide for spaces between floor decking and columns which penetrate the deck. Field cut closure plate to fit column in the field and tack weld to decking and columns.

]3.2.5.6 Access Hole Covers

Provide access hole covers to seal holes cut in decking to facilitate welding of the deck to structural supports.

3.2.5.7 Hangers

****

NOTE: Location, spacing, and size of hanger clips or loops must be indicated or specified, as applicable to the project.

****

Provide as indicated to support [utility system] [and] [suspended ceilings]. Space devices [as indicated] [so as to provide one device per 0.60 square meters 6.25 square feet].

[3.2.6 Sound Absorbing Material

****

NOTE: Include this paragraph when required by the design for acoustical deck.

****

Install sound absorbing [glass fiber roll or premolded form, neatly in voids between perforated webs of acoustical noncellular steel deck] [and] [glass fiber rigid strip, in cells of acoustical cellular steel deck]. Keep sound absorbing material dry before, during and after installation.

][3.2.7 Concrete Work

****

NOTE: Ensure that admixtures containing chloride salts are not used in concrete placed on steel deck. Coordinate with Section 03 30 00 CAST-IN-PLACE CONCRETE. Delete this paragraph if concrete is not cast on metal decking.

****

Prior to placement of concrete, inspect installed decking to ensure that there has been no permanent deflection or other damage to decking. Replace decking which has been damaged or permanently deflected as approved by the Contracting Officer. Place concrete on metal deck in accordance with Construction Practice of ANSI/SDI C or ANSI/SDI NC.

]3.2.8 Preparation of Fire-Proofed Surfaces

Provide deck surfaces, both composite and noncomposite, which are to receive sprayed-on fireproofing, galvanized and free of all grease, mill oil, paraffin, dirt, salt, and other contaminants which impair adhesion of the fireproofing. Complete any required cleaning prior to steel deck installation using a cleaning method that is compatible with the sprayed-on fireproofing.

3.3 ROOF SUMP PANS

Place sump pans over openings in roof decking and fusion welded to top surface of roof decking. Do not exceed spacing of welds of 300 millimeter 12 inch with not less than one weld at each corner. Field cut opening in the bottom of each roof sump pan to receive the roof drain as part of the work of this section.

3.4 CANT STRIPS FOR ROOF DECKS

Provide strips to be fusion welded to surface of roof decking, secured to wood nailers by galvanized screws or to steel framing by galvanized self-tapping screws or welds. Do not exceed spacing of welds and fasteners of 300 millimeter 12 inch. Lap end joints a minimum 75 millimeter 3 inch and secure with galvanized sheet metal screws spaced a maximum 100 millimeter 4 inch on center.

3.5 RIDGE AND VALLEY PLATES FOR ROOF DECKS

Provide plates to be fusion welded to top surface of roof decking. Lap end joints a minimum 75 millimeter 3 inch. For valley plates, provide endlaps to be in the direction of water flow.

3.6 CLOSURE STRIPS FOR ROOF DECKS

Provide closure strips at open, uncovered ends and edges of the roof decking and in voids between roof decking and top of walls and partitions where indicated. Install closure strips in position in a manner to provide a weathertight installation.

3.7 ROOF INSULATION SUPPORT FOR ROOF DECKS

Provide metal closure strips for support of roof insulation where rib openings in top surface of metal roof decking occur adjacent to edges and openings. Weld metal closure strips in position.

3.8 CLEANING AND PROTECTION FOR ROOF DECKS

Upon completion of the deck, sweep surfaces clean and prepare for installation of the roofing.

3.9 FIELD QUALITY CONTROL

3.9.1 Headed Stud Inspection

In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.9.2 Deck Weld Inspection

Visual inspect welds in accordance with AWS D1.3/D1.3M.

[3.9.3 Decks Not Receiving Concrete

****

NOTE: Include this paragraph when roof decks that are not receiving concrete are in the project. Coordinate paragraph with requirements for roofing membrane.

****

Inspect the decking top surface for distortion after installation. For roof decks not receiving concrete, verify distortion by placing a straight edge across three adjacent top flanges. The maximum allowable gap between the straight edge and the top flanges should not exceed manufacturing and construction tolerances of supporting members. When gap is more than the allowable, provide corrective measures or replacement. Reinspect decking after performing corrective measures or replacement.

]   -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-05 40 00 (May 2015)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-05 40 00 (May 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 40 00

COLD-FORMED METAL FRAMING

05/15, CHG 1: 08/18

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-05 40 00 (May 2015)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 05 40 00

COLD-FORMED METAL FRAMING
05/15, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for framing components and erection of load-bearing cold-formed metal framing and trusses.

Edit section for one of the following:

1. Describe the components of the design performed by the designer of record.

2. Prescribe the design of all components to the Contractor.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The following information shall be shown on the project drawings:

1. The extent and location of all framing indicating thickness, size, section modulus, and other structural properties required.

2. Connections and other installation details.

3. Indicate concentrated loads, e.g., pipe supports, that may overstress a flange or connection.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2012) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI S110	(2007; Suppl 1; Reaffirmed 2012) Standard for Seismic Design of Cold-Formed Steel Structural Systems - Special Bolted Moment Frames
AISI S200	(2007) North American Standard for Cold-Formed Steel Framing - General Provision
AISI S201	(2007) North American Standard for Cold-Formed Steel Framing - Product Data
AISI S202	(2011) Code of Standard Practice for Cold-formed Steel Structural Framing

AISI S211	(2007) North American Standard for Cold-Formed Steel Framing - Wall Stud Design
AISI S212	(2007) North American Standard for Cold-Formed Steel Framing - Header Design
AISI S213	(2007; Suppl 1 2009) North American Standard for Cold-Formed Steel Framing - Lateral Design
AISI S214	(2012) North American Standard for Cold-Formed Steel Framing – Truss Design

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A370	(2024) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1003/A1003M	(2023; E 2024) Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members
ASTM C955	(2024) Standard Specification for Cold-Formed Steel Structural Framing Members
ASTM C1007	(2020) Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories

ASTM C1513	(2024) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F1941	(2010) Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw Threads (UN/UNR))
ASTM F2329/F2329M	(2015; R 2023) Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Framing Components; G, [_____]

SD-03 Product Data

Steel Studs, Joists, Tracks, Bracing, Bridging and Accessories

Recycled Content of Steel Products; S

[SD-05 Design Data

****

NOTE: Require calculations for items considered critical by the designer. Delete paragraph if calculations are not necessary.

****

Metal Framing Calculations; G, [_____]

] SD-07 Certificates

Load-Bearing Cold-Formed Metal Framing

Welds

1.3 DELIVERY, STORAGE, AND HANDLING

Steel framing and related accessories shall be stored and handled in accordance with the AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

1.4 LOAD-BEARING COLD-FORMED METAL FRAMING

****

NOTE: Include the second set of brackets when design is to be performed by the contractor.

Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD references ASTM C754 for partition framing which provides tables for allowable partition stud heights. For partition heights greater than 15 feet or when lateral partition loads are greater than 5 psf special consideration needs to be taken beyond the standard 3 5/8" stud.

****

Include[top and bottom tracks,] bracing, fastenings, and other accessories necessary for complete installation. Framing members shall have the structural properties indicated. Where physical structural properties are not indicated, they shall be as necessary to withstand all imposed loads.[Design framing in accordance with AISI S100.][Non-load-bearing metal framing, furring, and ceiling suspension systems are specified in Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD.][Metal suspension systems for acoustical ceilings are specified in Section 09 51 00 ACOUSTICAL CEILINGS.]

Submit mill certificates or test reports from independent testing agency, qualified in accordance with ASTM E329, showing that the steel sheet used in the manufacture of each cold-formed component complies with the minimum yield strengths and uncoated steel thickness specified. Test reports shall be based on the results of three coupon tests in accordance with ASTM A370.

1.5 MAXIMUM DEFLECTION

****

NOTE: Delete paragraph if design was performed by the designer of record. Modify to suit project requirements.

****

Deflections of structural members shall not exceed the more restrictive of the limitations of ICC IBC and UFC 3-301-01.

[For scissor roof trusses limit the horizontal deflection at supports to less than [32 mm 1-1/4 inches][_____].

]1.6 QUALITY ASSURANCE

****

NOTE: Delete paragraph "a" ENGINEERING RESPONSIBILITY, the bracketed section of paragraph DRAWING REQUIREMENTS and paragraph DESIGN DATA REQUIRED if design was performed by the designer of record.

****

a. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a registered professional engineer.

b. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 for testing indicated.

c. Product Tests: Mill certificates or data from a qualified independent testing agency[, or in-house testing with calibrated test equipment] indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

d. Welding Qualifications: Qualify procedures and personnel according to the following:

  (1) AWS D1.1/D1.1M, "Structural Welding Code - Steel".

  (2) AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel".

e. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E119 by, and displaying a classification label from, a testing and inspecting agency acceptable to authorities having jurisdiction.

f. AISI Specifications and Standards: Comply with:

  (1) AISI S100, "North American Specification for the Design of Cold-Formed Steel Structural Members".

  (2) AISI S110, "Standard for Seismic Design of Cold-Formed Steel Structural Systems - Special Bolted Moment Frames".

  (3) AISI S200, "North American Standard for Cold-Formed Steel Framing - General Provision".

  (4) AISI S201, "North American Standard for Cold-Formed Steel Framing - Product Data".

  (5) AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

  (6) AISI S211, "North American Standard for Cold-Formed Steel Framing - Wall Stud Design".

  (7) AISI S212, "North American Standard for Cold-Formed Steel Framing - Header Design".

  (8) AISI S213, "North American Standard for Cold-Formed Steel Framing - Lateral Design".

  (9) AISI S214, "North American Standard for Cold-Formed Steel Framing - Truss Design".

1.6.1 Drawing Requirements

Submit framing components to show sizes, thicknesses, layout, material designations, methods of installation, and accessories including the following:

a. Cross sections, plans, and/or elevations showing component types and locations for each framing application; including shop coatings and material thicknesses for each framing component.

b. Connection details showing fastener type, quantity, location, and other information to assure proper installation.

c. Drawings depicting panel configuration, dimensions, components, locations, and construction sequence if the Contractor elects to install prefabricated/prefinished frames.

[Sign and seal fabrication drawings by a registered professional engineer.

][1.6.2 Design Data Required

Submit metal framing calculations with design criteria and structural loading to verify sizes, thickness, and spacing of members and connections signed and sealed by a registered professional engineer. Show methods and practices used in installation.

]PART 2 PRODUCTS

2.1 STEEL STUDS, JOISTS, TRACKS, BRACING, BRIDGING AND ACCESSORIES

Framing components shall comply with ASTM C955 and the following.

a. Provide products with an average recycled content of steel products so postconsumer recycled content plus one half of preconsumer recycled content not less than [25][_____] percent.

b. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

  (1) Grade: [ST33H (ST230H)][ST50H (ST340H)][[_____]][As required by structural performance].

  (2) Coating: [G60 (Z180), A60 (ZF180), AZ50 (AZ150), or GF30 (ZGF90)][G90 (Z275)][[_____]].

c. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

  (1) Minimum Base-Metal Thickness: [0.84 mm 0.0329 inch][1.09 mm 0.0428 inch][1.37 mm 0.0538 inch][1.72 mm 0.0677 inch][2.45 mm 0.0966 inch].

  (2) Flange Width: [35 mm 1-3/8 inches][41 mm 1-5/8 inches][51 mm 2 inches][63 mm 2-1/2 inches].

d. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

  (1) Minimum Base-Metal Thickness: [0.84 mm 0.0329 inch][1.09 mm 0.0428 inch][1.37 mm 0.0538 inch][1.72 mm 0.0677 inch][2.45 mm 0.0966 inch][Matching steel studs].

  (2) Flange Width: [[32 mm] [_____] [1-1/4 inches] [_____]].

e. Roof Truss Members: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:

  (1) Minimum Base-Metal Thickness: [0.84 mm 0.0329 inch][1.09 mm

0.0428 inch][1.37 mm 0.0538 inch][1.72 mm 0.0677 inch][2.45 mm 0.0966 inch][Matching steel studs].

(2) Flange Width: [[41 mm] [_____] [1-5/8 inches] [_____]], minimum at top and bottom chords connecting to sheathing or directly fastened construction.

f. Floor Truss Members: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:

(1) Minimum Base-Metal Thickness: [0.84 mm 0.0329 inch][1.09 mm 0.0428 inch][1.37 mm 0.0538 inch][1.72 mm 0.0677 inch][2.45 mm 0.0966 inch][Matching steel studs].

(2) Flange Width: [[41 mm] [_____] [1-5/8 inches] [_____]], minimum at top and bottom chords connecting to sheathing or directly fastened construction.

****

NOTE: It is assumed that members will be protected from the weather. If members will be exposed or subject to moisture directly, by water infiltration, or via vapor transmission and condensation or indirectly in a corrosive atmosphere, delete carbon steels (painted) and specify coating Class Z275 (G90) for such members. Specify G40 for brick ties and screw fasteners. See special option below for deflection limit on exterior wall brick construction. Grades specified are normally used for this type of framing. See manufacturer's current literature for other grades and section properties available.

****

2.1.1 Studs and Joists of 1.37 mm 54 mils (0.054 Inch) and Heavier

Galvanized steel, ASTM A653/A653M and ASTM A1003/A1003M, SS Grade 50, [Z180] [Z275] [G60] [G90].

2.1.2 Studs and Joists of 1.09 mm 43 mils (0.043 Inch) and Lighter

Studs and Joists of 1.09 mm 43 mils (0.043 Inch) and Lighter, Track, and Accessories (All thicknesses): Galvanized steel, ASTM A653/A653M and ASTM A1003/A1003M, SS, Grade 345 230 MPa Grade 33 33,000 psi Z180 G60.

2.1.3 Sizes, Thickness, Section Modulus, and Other Structural Properties

Size and thickness [as indicated][as required].

2.2 MARKINGS

Studs and track shall have product markings stamped on the web of the section. The markings shall be repeated throughout the length of the member at a maximum spacing of 1200 mm 4 feet on center and shall be legible and easily read. The product marking shall include the following:

a. An ICC number.

b. Manufacturer's identification.

c. Minimum delivered uncoated steel thickness.

d. Protective coating designator.

e. Minimum yield strength.

2.3 CONNECTIONS

2.3.1 Steel-To-Concrete Connections

a. Anchor Rods: ASTM F1554, [Grade 36][Grade 55]; galvanized per ASTM A153/A153M.

b. Post-Installed Concrete Anchors: Adhesive or expansion anchors fabricated from corrosion-resistant materials with allowable load capacities in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.

****

NOTE: The use of power-actuated fasteners is not recommended where the construction activity is in close proximity of occupied spaces due to the "gunshot"-like sound that the tool emits. This "gunshot"-like sound can be disturbing to personnel, especially experienced warfighters.

****

c. Power-Actuated Fasteners: Fabricated from corrosion-resistant materials with allowable load capacities in accordance with ICC-ES AC 70 greater than or equal to the design load as determined by testing per ASTM E1190 conducted by a qualified testing agency.

2.3.2 Steel-To-Steel Connections

a. Screws: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping steel screws of the type and size indicated. Provide low-profile head beneath sheathing and manufacturer's standard elsewhere. Electroplated to a minimum of 5 micron zinc coating per ASTM F1941 or hot-dipped galvanized per ASTM A123/A123M or ASTM A153/A153M.

b. Bolts: ASTM A307 coated by hot-dip process per ASTM F2329/F2329M or zinc-coated by mechanical-deposition process per ASTM B695, Class 55.

c. Welding Electrodes: Comply with AWS standards.

2.4 PLASTIC GROMMETS

Supply plastic grommets for stud webs as recommended by stud manufacturer, to protect electrical wires and plumbing piping. Prevent metal-to-metal contact between wiring/piping and studs.

2.5 SEALER GASKET

Closed-cell neoprene foam, 6.4 mm 1/4-inch thick, selected from manufacturer's standard widths to match width of bottom track on concrete slab or foundation.

PART 3 EXECUTION

3.1 TRUSS FABRICATION

a. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

b. Truss must be fabricated either on site or off site prior to erection.

c. Fabricate trusses using jigs or templates.

d. Splices can only occur at joints.

e. Cut truss members by sawing or shearing: do not torch cut.

f. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.

g. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

h. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses to prevent damage or permanent distortion.

3.2 FASTENING

Fasten framing members together by welding or by using self-drilling, self-tapping screws. Electrodes and screw connections shall be as required and indicated in the design calculations.

3.2.1 Welds

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NOTE: The welding of cold-formed steel should be performed by qualified workmen. The Contractor, Subcontractor, or Fabricator shall provide verification that welders are qualified in accordance with AWS D1.3/D1.3M.

****

All welding shall be performed in accordance with AWS D1.3/D1.3M, as modified by AISI S100. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3/D1.3M. Submit certified copies of welder qualifications test records showing qualification in accordance with AWS D1.3/D1.3M. All welds shall be cleaned and coated with rust inhibitive galvanizing paint. Do not field weld materials lighter than 1.09 mm 43 mils.

3.2.2 Screws

Screws shall be of the self-drilling self-tapping type, size, and location [as indicated][as required]. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacings and edge distances for screws shall be as specified in AISI S100. Screws covered by sheathing materials shall have low profile heads.

3.2.3 Anchors

Anchors shall be of the type, size, and location [as indicated][as required].

3.2.4 Powder-Actuated Fasteners

Powder-actuated fasteners shall be of the type, size, and location [as indicated][as required].

3.3 INSTALLATION

Install cold-formed framing in accordance with ASTM C1007 and AISI S200.

Install cold-formed steel framing according to AISI S202 and to manufacturer's written instructions unless more stringent requirements are indicated.

3.3.1 Tracks

Provide accurately aligned runners at top and bottom of studs. Install sealer gasket under bottom of track on concrete slab or foundation. Anchor tracks as indicated in design calculations. Butt weld joints in tracks or splice with stud inserts. Fasteners shall be at least 75 mm 3 inches from the edge of concrete slabs.

3.3.2 Studs

Cut studs square and set with firm bearing against webs of top and bottom tracks. Position studs vertically in tracks and space as indicated in design. Do not splice studs. Provide at least two studs at jambs of doors and other openings 600 mm 2 feet wide or larger. Provide jack studs over openings, as necessary, to maintain indicated stud spacing. Provide tripled studs at corners, positioned to receive interior and exterior finishes. Fasten studs to top and bottom tracks by welding or screwing both flanges to the tracks. Framed wall openings shall include headers and supporting components as shown on the drawings. Headers shall be installed in all openings that are larger than the stud spacing in a wall. In curtain wall construction, provide for vertical movement where studs connect to the structural frame. Provide horizontal bracing in accordance with the design calculations and AISI S100. Bracing shall be not less than the following:

LOAD	HEIGHT	BRACING
Wind load only	Up to 3000 mm 10 feet	One row at mid-height
	Over 3000 mm 10 feet	Rows 1500 mm 5'-0" o.c. maximum
Axial load	Up to 3000 mm 10 feet	Two rows at 1/3 points

LOAD	HEIGHT	BRACING
	Over 3000 mm 10 feet	Rows 900 mm 3'-4" o.c. maximum

3.3.3 Joists and Trusses

a. Provide a stud directly under each joist or truss. The maximum spacing of studs as indicated shall be maintained.

b. Install, bridge, and brace cold-formed steel trusses according to AISI S200, AISI S214, AISI's "Code of Standard Practice for Cold-Formed Steel Structural Framing," and manufacturer's written instructions unless more stringent requirements are indicated.

c. Install temporary bracing and supports. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

d. Do not alter, cut, or remove framing members or connections of trusses.

3.3.4 Erection Tolerances

a. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:

    (a) 1) Layout of walls and partitions: 6 mm 1/4 inch from intended position;

    (b) 2) Plates and runners: 6 mm in 2400 mm 1/4 inch in 8 feet from a straight line;

    (c) 3) Studs: 6 mm in 2400 mm 1/4 inch in 8 feet out of plumb, not cumulative; and

    (d) 4) Face of framing members: 6 mm in 2400 mm 1/4 inch in 8 feet from a true plane.

b. Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive shall be within the following limits:

    (a) 1) Layout of walls and partitions: 6 mm 1/4 inch from intended position;

    (b) 2) Plates and runners: 3 mm in 2400 mm 1/8 inch in 8 feet from a straight line;

    (c) 3) Studs: 3 mm in 2400 mm 1/8 inch in 8 feet out of plumb, not cumulative; and

    (d) 4) Face of framing members: 3 mm in 2400 mm 1/8 inch in 8 feet from a true plane.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-05 50 13 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 50 13 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

08/24

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-05 50 13 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 50 13 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

08/24

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NOTE: This guide specification covers requirements for miscellaneous metalwork.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This section includes metal items which require specific fabrication to meet the desired project requirements.

Consult the Key Word Index of the CSI "Masterformat" for the proper location of most items. Loose items fabricated from structural shapes and not directly attached to major structural steel items may be included in this section, especially when a structural steel section is not included.

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NOTE: Show the following information on the drawings:

1. Location and configuration of all metalwork.

2. All sizes and dimensions.

3. Special fastenings, attachments or anchoring.

4. Location and size of expansion anchors larger than 10 mm 3/8 inch in diameter.

5. Location of products to be galvanized.

6. Location and special details of expansion joint covers.

7. Connection details, other than manufacturer's standard, of grating.

8. Location and details of all structural steel door frames.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

ANSI/AISC 303	(2022) Code of Standard Practice for Structural Steel Buildings and Bridges

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.6.2	(2020) Square Head Set Screws and Slotted Headless Set Screws (Inch Series)
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.21.2M	(1999; R 2014) Lock Washers (Metric Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.3	(2020) Safety Requirements for Powder-Actuated Fastening Systems American National Standard for Construction and Demolition Operations

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron

	Castings
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A467/A467M	(2020) Standard Specification for Machine Coil Chain
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A786/A786M	(2015; R 2021) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C1513	(2024) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM D1187/D1187M	(1997; R 2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for Metal

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2017) Metal Bar Grating Manual
NAAMM MBG 532	(2019) Heavy Duty Metal Bar Grating Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC SP 3	(2024) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Structural Steel Door Frames, Fabrication Drawings; G, [_____]

] Cover Plates and Frames, Installation Drawings; G, [_____]

Expansion Joint Covers, Installation Drawings; G, [_____]

[Floor Gratings, Installation Drawings; G, [_____]

][Roof Walkways, Installation Drawings; G, [_____]

] Sill Angle, Installation Drawings; G, [_____]

[Bollards/Pipe Guards; G, [_____]

][Wheel Guards, Installation Drawings; G, [_____]

][Window[and Door] Guards, Installation Drawings; G, [_____]

] Embedded Angles and Plates, Installation Drawings; G, [_____]

[Roof Hatches, Installation Drawings; G, [_____]

] SD-03 Product Data

[Corner Guards

] Cover Plates and Frames; G, [_____]

Expansion Joint Covers; G, [_____]

[Floor Gratings; G, [_____]

][Roof Walkways; G, [_____]

][Structural Steel Door Frames; G, [_____]

][Wheel Guards

][Window[and Door] Guards; G, [_____]

][Roof Hatches; G, [_____]

][Each Downspout Terminations Type; G, [_____]

] Recycled Content; S

SD-04 Samples

Expansion Joint Covers

SD-07 Certificates

[Certificates of Compliance; G, [_____]

][Certified Mill Test Reports for Chemistry and Mechanical Properties; G, [_____]

]1.3 QUALIFICATION OF WELDERS

****

NOTE: For jobs in Iceland, in lieu of AWS welders and inspectors, use "Technological Institute of Iceland" certified welders and inspectors.

****

Qualify procedures and personnel according to the following:

a. AWS D1.1/D1.1M Structural Welding Code - Steel.

b. AWS D1.2/D1.2M Structural Welding Code - Aluminum.

1.4 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

1.5 MISCELLANEOUS REQUIREMENTS

1.5.1 Fabrication Drawings

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in ANSI/AISC 303.

1.5.2 Installation Drawings

Submit templates, erection, and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation in relation to the building construction.

PART 2 PRODUCTS

****

NOTE: Paragraphs shown in brackets are optional and should be removed if not required in respective project.

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NOTE: Base product selections on aesthetic values, reliability, sustainability, and cost. Delete alternate requirements where they occur.

Include bracketed sentence for Army projects only.

****

2.1 SUSTAINABLE DESIGN REQUIREMENTS

See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for sustainable design requirements for the following, except as modified here:

2.1.1 Recycled Content

Provide products with recycled content.[Provide certificates of compliance for recycled content.]

2.2 MATERIALS

****

NOTE: Choose the bracketed item for projects that do not include Section 05 12 00 STRUCTURAL STEEL.

****

Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals). Coordinate color and finish with the material to which fastenings are applied.[Submit the manufacturer's certified mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied materials.]

2.2.1 Structural Carbon Steel

Provide in accordance with ASTM A36/A36M.

2.2.2 Stainless Steel Bars and Shapes

****

NOTE: Retain Type 304, but use Type 316L in corrosive environments

****

ASTM A276/A276M, [Type 304][Type 316L].

2.2.3 Structural Tubing

Provide in accordance with ASTM A500/A500M.

2.2.4 Steel Pipe

Provide in accordance with ASTM A53/A53M, Type E or S, Grade B.

2.2.5 Fittings for Steel Pipe

Provide standard malleable iron fittings in accordance with ASTM A47/A47M.

2.2.6 Gratings

****

NOTE: Use NAAMM MBG 531 for gratings for pedestrian grates and use NAAMM MBG 532 for vehicular grates not specified elsewhere. Grating and floor plates exposed to AFFF- in Aircraft Hangars must be ductile iron and meet loading and performance requirements defined in UFC 4-211-01 and ASTM A536.

****

a. Provide gray cast iron in accordance with ASTM A48/A48M, Class 40.

b. Provide metal plank grating, non-slip requirement,[ductile iron in accordance with ASTM A536, class F][aluminum in accordance with ASTM B209/B209M, 6061-T6][steel in accordance with ASTM A653/A653M, Z275 G90].

c. Provide metal bar type grating in accordance with [NAAMM MBG 531][and][NAAMM MBG 532].

2.2.7 Floor Plates

a. Provide patterned floor plate in accordance with ASTM A786/A786M. Provide steel plate not less than 1.9 mm 14 gauge.

b. Provide abrasive-surface floor plate: Steel plate [with abrasive granules rolled into surface][or][with abrasive material metallically bonded to steel].

2.2.8 Anchor Bolts

Provide in accordance with ASTM F1554. Where exposed, provide anchor bolts of the same material, color, and finish as the metal to which they are applied.

2.2.8.1 [Expansion Anchors][Sleeve Anchors][Adhesive Anchors]

Provide [_____] mm [_____]in. diameter[expansion anchors][sleeve anchors][adhesive anchors]. Minimum[concrete][masonry] embedment of [_____] mm [_____] in. Design values listed are as tested in accordance with ASTM E488/E488M.

a. Provide minimum[ultimate][allowable] pullout value of [_____] kN [_____] lb. Calculate pullout capacity according to ACI 318.

b. Provide minimum[ultimate][allowable] shear value of [_____] kN [_____] lb. Calculate shear capacity according to ACI 318.

2.2.8.2 Lag Screws and Bolts

Provide in accordance with ASME B18.2.1, type and grade best suited for the purpose.

2.2.8.3 Toggle Bolts

Provide in accordance with ASME B18.2.1.

2.2.8.4 Bolts, Nuts, Studs and Rivets

Provide in accordance with ASME B18.2.2 or ASTM A307.

2.2.8.5 Powder Actuated Fasteners

Follow safety provisions in accordance with ASSP A10.3.

2.2.8.6 Screws

Provide in accordance with ASME B18.2.1, ASME B18.6.2, ASME B18.6.3 and ASTM C1513.

2.2.8.7 Washers

Provide plain washers in accordance with ASME B18.22M, ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers in accordance with ASME B18.21.2M, ASME B18.21.1.

2.2.9 Aluminum Alloy Products

Provide in accordance with ASTM B209/B209M for sheet plate, ASTM B221M, ASTM B221M, ASTM B221 for extrusions, and ASTM B26/B26M or ASTM B108/B108M for castings. Provide aluminum extrusions at least 3 mm 1/8 inch thick and aluminum plate or sheet at least 1.3 mm 0.050 inch thick.

2.3 FABRICATION FINISHES

****

NOTE: The Safety Data Sheets (SDS) for coating

materials must show exclusion or replacement of the following materials as intended ingredients: asbestos, benzene, chromium compounds, coal tar, 2-ethoxyethanol and 2-methoxyethanol and their acetates, halogenated hydrocarbons, and lead compounds. The content of volatile organic compounds (VOC), and marking, must be in compliance with air quality regulations for the type of application and jurisdiction where used.

****

2.3.1 Galvanizing

****

NOTE: Specify galvanizing for items installed in exterior exposures subject to salt spray or corrosive fumes and interior areas subject to continual wetting or high humidity.

****

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Provide galvanizing in accordance with ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M, or ASTM A924/A924M, Z275 G90.

2.3.2 Galvanize

Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

[2.3.3 Repair of Zinc-Coated Surfaces

****

NOTE: Delete this paragraph when no galvanized items are specified.

****

Repair damaged surfaces with galvanizing repair method and paint in accordance with ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat, with a torch, surfaces to which stick or paste material will be applied. Heat to a temperature sufficient to melt the metals in the stick or paste. Spread molten material uniformly over surfaces to be coated and wipe off excess material.

]2.3.4 Shop Cleaning and Painting

****

NOTE: Shop painting herein is for structural steel protected from the weather and not subjected to corrosive environments. For steel which will be exposed to the weather or corrosive environments, modify the shop painting accordingly.

****

2.3.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete must be free of dirt and grease prior to embed. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints. Shop coat these surfaces with rust prevention.

2.3.4.2 Pretreatment, Priming and Painting

****

NOTE: Use manufacturer's standard treatment when painting and finishing is required.

****

Apply pre-treatment, primer, and paint in accordance with manufacturer's printed instructions.[On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 0.03 mm 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.]

2.3.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.3.6 Aluminum Surfaces

2.3.6.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.3.6.2 Aluminum Finishes

Unexposed sheet, plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified, provide all other aluminum items with a[standard mill finish][hand sanded or machine finish to a 240 grit][anodized finish]. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations. Provide in accordance with AA DAF45. Provide a polished satin finish on items to be anodized.

[2.4 CORNER GUARDS

For jambs and sills of openings and edges of platforms provide steel shapes and plates anchored in masonry or concrete with welded steel straps or end-weld stud anchors. Where indicated, form corner guards with glazed or ceramic tile finish on walls with 1.6 mm 0.0625 inch thick corrosion-resisting steel with[polished][or][satin] finish, extend 1.5 m 5 feet above the top of cove base or to the top of the wainscot, whichever is less, and securely anchor to the supporting wall. Provide[galvanized] [_____] corner guards on exterior.[Provide interior corner guards as indicated in Section 10 26 00 WALL AND DOOR PROTECTION.]

]2.5 COVER PLATES AND FRAMES

****

NOTE: Insert required live load value in the blank space. Select requirements for floor plate removal method. Do not indicate specific pattern unless required for matching purposes or to meet design requirements.

****

Where indicated, fabricate cover plates of [6][_____] mm [1/4][_____] inch thick rolled steel weighing not more than 45 kg 100 pounds per plate with a[selected raised pattern nonslip top surface][slip-resistant, carbon steel in accordance with ASTM A283/A283M. Provide aluminum oxide or silicon carbide on wearing surfaces]. Provide[galvanized][shop painted] plate. Reinforce to sustain a live load of [_____] MPa [_____] pounds per square foot. Provide structural steel shapes and plates for frames,[with bent steel bars or headed anchors welded to frame for anchoring to concrete][securely fastened to the structure as indicated]. Miter and weld all corners. Butt joint straight runs. Allow for expansion on straight runs over 4500 mm 15 feet.[Provide holes for lifting tools.][Provide flush drop handles for removal where indicated; form from 6 mm 1/4 inch round stock.][Provide holes and openings with 13 mm 1/2 inch clearance for pipes and equipment.] Remove sharp edges and burrs from cover plates and exposed edges of frames. Weld all connections and grind top surface smooth. Weld bar stops every 152 mm 6 inches. Provide 3 mm 1/8 inch clearance at edges and between cover plate and frames after fabrication.

[2.6 FLOOR GRATINGS AND ROOF WALKWAYS

****

NOTE: Insert required live load value in the blank space.

****

****

NOTE: Consider gratings for treads and landings for maintenance walkways, anti-skid platforms, maintenance and inspection walkways, mezzanine flooring, rooftop walkways, storage areas, catwalks and staging platforms. Grating tread type has openings thru the surface; consider footwear worn by personnel using these facilities. Select frame anchorage for the applicable installation. Where banding is required to be load bearing, drawings must detail the welding of banding to bearing bars. Walkways must be designed to allow roof movements and to resist wind forces and creep. Specify building expansion joints. Size supports to distribute walkway loads to the roof material. Where not specified elsewhere, use NAAMM MBG 532 when grating supports vehicular traffic.

****

Design[steel][aluminum] grating in accordance with NAAMM MBG 531[and NAAMM MBG 532] for bar type gratings, or in accordance with manufacturer's charts for plank grating.[Galvanize steel floor gratings.]

a. Design floor gratings to support a stress live load of [_____] MPa [_____] pounds per square foot for the spans indicated, with maximum deflection of L/240.

[b. In accordance with NAAMM MBG 531[, NAAMM MBG 532], band edges of grating with bars of the same size as the bearing bars. Weld banding in accordance with the manufacturer's standard for trim[unless otherwise indicated]. Design tops of bearing bars, cross or intermediate bars to be in the same plane and to match grating finish.

][c. NAAMM MBG 531[, NAAMM MBG 532], band ends of gratings with bars of the same or greater thickness than the metal used for grating. Weld banding bars to bearing bars or channels at least every fourth bar or channel and in every corner. Tack weld intervening bars or channels. Band diagonal or round cuts by welding bars of the same or greater thickness as the grating and in accordance with the manufacturer's standard for trim [unless otherwise indicated].

][d. [Attach gratings to structural members with welded-on anchors.][Anchor gratings to structural members with bolts, toggle bolts, or expansion shields and bolts.][Attach grating in accordance with manufacturer's roof attachment system.]

] **

NOTE: US Access Board standards require ground and floor surfaces to be slip resistant, however, they no longer specify a minimum level of slip resistance or coefficient of friction because there is no consensus regarding test procedures. Therefore coefficient of friction requirements have been removed. Designer must verify slip resistance characteristics of products submitted for approval.

****

[e. Provide slip resistant surface finishes.

][f. Rooftop walkway: Minimum 600 mm 2 feet wide, 1.8 mm 14 gauge, ASTM A653/A653M, Z275 G-90, steel with slip resistant surface. Furnish all brackets, connectors and other accessories. Support at minimum 1500 mm 5 foot intervals on hard rubber pads in accordance with manufacturer's instructions.

]][2.7 BOLLARDS/PIPE GUARDS

Provide [_____] mm [_____] inch[galvanized][prime coated][standard][extra strong] weight steel pipe in accordance with ASTM A53/A53M. Anchor posts in concrete[as indicated] and fill solidly with concrete.

][2.8 DOWNSPOUT TERMINATIONS

Provide [102 by 102 mm] [102 by 152 mm] [and][or] [152 by 152 mm] [4 by 4 inch] [4 by 6 inch] [and][or] [6 by 6 inch] [_____] aluminum downspout tile adapter with[mill][manufacturer's standard powder coated] finish. Weld all seams for units.

Provide[nickel bronze][polished bronze][chrome plated] cast downspout nozzle and flange.

Provide [100 by 76 mm] [125 by 100 mm] [and][or] [100 mm diameter] [4 by 3 inch] [5 by 4 inch] [and][or] [4 inch diameter] [_____][cast iron][galvanized cast iron] downspout boot with cleanout access and manufacturer's standard cast iron strap.

]2.9 MISCELLANEOUS PLATES AND SHAPES

****

NOTE: Indicate construction details on the drawings for clarification of the type and the arrangement of miscellaneous metal.

****

Submit installation drawings for and provide items that do not form a part of the structural steel framework, such as lintels, sill angles,[masonry relief angles][support framing for ceiling-mounted toilet partitions,] and miscellaneous mountings and frames. Provide lintels fabricated from structural steel shapes over openings in masonry walls and partitions[as indicated and] as required to support wall loads over openings. Provide with connections and[fasteners][welds]. Construct to have at least [200][_____] mm [8][_____] in bearing on masonry at each end.

Provide angles and plates in accordance with ASTM A36/A36M, for embedment as indicated. Galvanize embedded items exposed to the elements in accordance with ASTM A123/A123M.

[2.10 SAFETY CHAINS

Construct safety chains of galvanized steel, straight link type, minimum 5 mm 3/16 inch diameter, with a minimum of twelve links per 300 mm one foot, and snap hooks on each end. Test safety chain in accordance with ASTM A467/A467M, Class CS. Provide boat type snap hooks. Provide galvanized 10 mm 3/8 inch bolt with 20 mm 3/4 inch eye diameter for attachment of chain, anchored as indicated. Supply two chains, 100 mm 4 inches longer than the anchorage spacing, for each guarded area.

][2.11 SECURITY GRILLES

Fabricate of channel frames with not less than two masonry anchors at each jamb and 12 mm 1/2 inch hardened steel bars spaced not over 100 mm 4 inches both ways and welded to frame. Provide 18 by 16 mesh screen and two layers of 6 mm 1/4 inch hardware cloth clamped to frame.

][2.12 STEEL PLATE WAINSCOTS FOR CONCRETE OR MASONRY COLUMNS

Shop bend to radius for round columns and at right angles for square and rectangular columns with slight 6 mm 1/4 inch radius on corners, with no horizontal joints and not more than two vertical joints single strapped and butt welded with a thickness of [_____].

][2.13 STRUCTURAL STEEL DOOR FRAMES

****

NOTE: Select the applicable paragraph(s) from the following:

****

[a. Provide frames as indicated. Unless otherwise indicated, construct frames of structural shapes, or shape and plate composite, to form a full depth channel shape with at least 40 mm 1-1/2 inch outstanding legs. For single swing doors, provide continuous 16 by 40 mm 5/8 by 1-1/2 inch bar stock stops at head and jambs. For freight elevator hoistway entrance, include a non-skid metal sill. Provide extruded metal frames as required by the elevator manufacturer.

] b. Provide support where track, guides, hoods, hangers, operators, and other accessories are required.

c. Provide jamb anchors near top, bottom, and at not more than 600 mm 24 inch intervals. Provide the bottom of each jamb member with a clip angle welded in place with two 12 mm 1/2 inch diameter floor bolts for adjustment.

[d. Provide spreaders between bottoms of floor jamb members. When floor construction permits, spreaders may be left in place and concealed in the floor.
]

****

NOTE: Or select the following paragraph.

****

[Provide frames of rolled shapes as indicated. Miter and weld heads to jambs, or provide riveted clip angle connections concealed in the finished work. Provide frames for swinging doors with 16 by 40 mm 5/8 by 1-1/2 inch solid bar stops secured to the frame by welding or by 6 mm 1/4 inch diameter countersunk machine screws spaced not more than 300 mm 12 inches on centers. Stiffen head openings greater than 900 mm 3 feet as necessary to limit deflection to not more than 2 mm 1/16 inch. Secure frames to masonry with zinc-coated metal anchors spaced not more than 750 mm 30 inches on centers. Where necessary to engage the threads of machine screws for fastening hardware, back frames on inside faces with steel plates of suitable thickness. Tap frames and reinforcing plates as necessary for the installation of hardware and other work. Countersink rivets and screw heads where they will be exposed in the finished work. Grind welds smooth.

]][2.14 WHEEL GUARDS

Provide wheel guards of hollow, heavy-duty type cast iron in accordance with ASTM A48/A48M, with shaped, [rounded][half round][three quarters round]top, at least 450 mm 18 inches high, and designed to provide a minimum of 150 mm 6 inches of protection.

][2.15 ROOF HATCHES (SCUTTLES)

Provide [aluminum][zinc-coated steel] sheets not less than 1.9 mm 14 gauge with 75 mm 3 inch beaded flange, welded and ground at corners. Provide a minimum clear opening of 760 by 900 mm 30 by 36 inches. Insulate cover and curb with 25 mm 1 inch thick rigid fiberboard insulation, covered and protected by [aluminum sheet][zinc-coated steel liner] of not less than 0.45 mm 26 gauge. Provide with 300 mm 12 inches high curb, formed with 75 mm 3 inch mounting flanges with holes for securing to the roof deck.

][2.16 WINDOW[AND DOOR] GUARDS, DIAMOND-MESH TYPE

****

NOTE: Select mesh size for woven wire. Include expanded metal option when 40 mm 1-1/2 inch mesh is specified. Delete remaining bracketed portions. Edit choices for interior or exterior installations.

****

Provide diamond-mesh window[and door] guards constructed of woven steel wire[or expanded metal] framed with hot-rolled or cold-formed structural steel shapes. Provide woven wire panels of 3.3 mm, 40 mm mesh 10 gauge, 1-1/2 inch mesh secured through weaving bar to 25 by 12 by 3 mm 1 by 1/2 by 1/8 inch thick channel frame.[Provide expanded metal panels in accordance with ASTM F1267.] Miter and weld corners of frames.[Mount window[and door] guards on interior of window[and door] frame with not less than two tamperproof hinged butts mounted on wood jambs with 6 mm 1/4 inch lag bolts, to masonry jamb with toggle bolts, or welded to metal jambs.][Mount window[and door] guards on exterior of window frame with not less than two tamperproof hinged butts mounted on 25 by 12 by 3 mm 1 by 1/2 by 1/8 inch jamb channel attached as indicated to 50 by 6 mm 2 by 1/4 inch plate anchored to wood jamb with 6 mm 1/4 inch lag bolts; to masonry jamb with toggle bolts, or to concrete jambs and solid masonry jambs with expansion shields and bolts.] Provide one additional butt for each 900 mm 3 foot internal length of guard over 1500 mm 5 feet. Provide one tamperproof hasp and padlock, with access from the interior, for each butt used and installed on the jamb opposite to that hinged.[Provide galvanized guards and accessories.]

][2.17 WINDOW[AND DOOR] GUARDS

Provide woven wire window[and door] guards of size as necessary to completely fill opening. Construct guards with 10 mm 3/8 inch round rod frame and 40 mm 1-1/2 inch diamond-mesh of No. 10 U.S. Gage 3.4 mm 0.135 diameter wire. Provide all materials with zinc coating. Provide a minimum of three hinge side clips on one side and two lock ring hasps on the opposite side.

][2.18 CHIMNEYS, VENTS, AND SMOKESTACKS

Provide chimneys and vents in accordance with NFPA 211. Form chimney connectors of minimum 1.01 mm 20 gauge galvanized steel. Design and construct stacks to withstand a wind velocity of [_____] km/h [_____] mph in accordance with ASCE 7-16. Construct unlined stacks of black-steel plates not less than 5 mm 3/16 inch thick in accordance with ASTM A36/A36M. Weld seams and joints. Provide angle flanges for connections to boilers, other equipment, and stack supports.

][2.19 CLEANOUT DOORS

Provide[galvanized][cast iron] cleanout doors with frames, sized to match flues unless otherwise indicated. Provide continuous flange and anchors for securing frames to masonry. Provide smokeproof, hinged doors with[lockable] fastening devices to hold doors closed[and secured].

][2.20 COAL HOPPER DOORS

Provide coal hopper doors of[galvanized][_____] steel plates and shapes. Provide complete assemblies including frames, stops, wall boxes, hinges, and hasp or lock-type latches. Weld joints and attachments.

][2.21 GUY CABLES

Provide guy cables as pre-stretched, galvanized wire rope of sizes indicated. Provide wire rope in accordance with ASTM A475, high strength grade with Class A coating. Guys must have a factory attached clevis top-end fitting, a factory attached open-bridge strand socket bottom-end fitting, and must be complete with oval eye, threaded anchor rods. Provide hot-dip galvanized fittings and accessories.

][2.22 WINDOW SUB-SILL

Provide window sub-sill of extruded aluminum alloy, standard mill finish, of size(s) and design(s) indicated. Provide a minimum of two anchors per window section for securing to mortar joints of masonry sill course. Provide sills with protective coating for shipment, of two coats of a clear, colorless, methacrylate lacquer applied to all surfaces of the sills.

][2.23 WINDOW WELLS

Provide window wells in a minimum 1.5 mm 16 gauge, corrugated sheet steel, hot-dip galvanized after fabrication, with top edge of window well walls with a 19 mm 3/4 inch bead or rolled top. Provide windows wells with radiused corners and of sizes that overlap each window by a minimum of 75 mm 3 inches on each side. Provide removable covers, hot-dipped galvanized after fabrication, consisting of steel bar grate, with bars spaced at not more than 50 mm 2 inch centers and welded to 25 by 6 mm 1 by 1/4 inch frame. Frames must fit into, and rest on top edge of, window wells.

]PART 3 EXECUTION

****

NOTE: Paragraphs shown in brackets are optional and should be removed if not required in respective project.

****

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated in accordance with manufacturer's instructions. Verify all field dimensions prior to fabrication. Include materials and parts necessary to complete each assembly, whether indicated or not. Miss-alignment and miss-sizing of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Joints exposed to weather must be watertight.

3.2 WORKMANSHIP

Provide miscellaneous metalwork that is true and accurate in shape, size, and profile. Make angles and lines continuous and straight. Make curves consistent, smooth and unfaceted. Provide continuous welding along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections. Unless otherwise indicated and approved, provide a smooth finish on exposed surfaces. Provide countersunk rivets where exposed. Provide coped and mitered corner joints aligned flush and without gaps. Do not weld, cut or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are bolted or screwed field connections.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

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NOTE: Where Headed shear studs are used, edit this section to indicate installation requirements specific to the project or reference drawings or manufacturer's tested assemblies.

****

****
NOTE: Choose the bracketed item for projects that do not include Section 05 12 00 STRUCTURAL STEEL.
****

Provide anchorage as necessary, whether indicated or not, for fastening miscellaneous metal items securely in place. Include slotted inserts, expansion shields, powder-driven fasteners, toggle bolts (when approved for concrete), through bolts for masonry, headed shear studs, machine and carriage bolts for steel, through bolts, lag bolts, and screws for wood. Do not use wood plugs. Provide non-ferrous attachments for non-ferrous metal. Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals), that generally match in color and finish the surfaces to which they are applied. Conceal fastenings where practicable. Provide all fasteners flush with the surfaces they fasten, unless indicated otherwise.[Test a minimum of two bolt, nut, and washer assemblies from each certified mill batch in a tension measuring device at the job site prior to the beginning of bolting start-up.]

3.4 BUILT-IN WORK

Where necessary and not otherwise indicated, form built-in metal work for anchorage with concrete or masonry. Provide built-in metal work in ample time for securing in place as the work progresses.

3.5 WELDING

Perform welding, welding inspection, and corrective welding in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation. Provide welded headed shear studs in accordance with AWS D1.1/D1.1M, Clause 7, except as otherwise specified. Provide in accordance with the safety requirements of EM 385-1-1.

3.6 DISSIMILAR METALS

Where dissimilar metals are in contact, protect surfaces with a coating in accordance with MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect in accordance with ASTM D1187/D1187M, asphalt-base emulsion. Clean surfaces with metal shavings from installation at the end of each work day.

3.7 PREPARATION

[3.7.1 Material Coatings and Surfaces

****
NOTE: Delete this paragraph when Section 09 90 00 PAINTS AND COATINGS is included in the project specifications.
****

Remove rust preventive coating just prior to field erection, using a remover approved by the metal manufacturer. Surfaces, when assembled, must be free of rust, grease, dirt and other foreign matter.

]3.7.2 Environmental Conditions

Do not clean or paint surfaces when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than minus 15 degrees C minus 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 7 degrees C or over 35 degrees C below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer. Metal surfaces to be painted must be dry for a minimum of 48 hours prior to the application of primer or paint.

3.8 EXPANSION JOINT COVERS

Provide in accordance with manufacturer's written instructions[and with seismic requirements indicated]. Verify installation allows specified movement prior to completion of work

[3.9 COVER PLATES AND FRAMES

Provide tops of cover plates and frames flush with finished surface. Test for trip hazards and adjust for any encountered lippage.

][3.10 WHEEL GUARDS

Anchor guards to concrete or masonry in accordance with manufacturer's instructions. Fill hollow cores solid with concrete with minimum compressive strength of 17 MPa 2500 psi.

][3.11 ROOF HATCH (SCUTTLES)

****

NOTE: When specifying roof hatches, coordinate guardrails around them by detail them on the drawings and by editing specification SECTION 05 52 00 METAL RAILINGS.

****

Construction and accessories as follows:

a. Provide insulated cover and curb with mounting flanges for securing to roof deck. Provide curbs with integral metal cap flashing of the same gauge and metal as the curb, fully welded and ground at corners for weather tightness.

b. Provide hatches completely assembled, with pintle hinges, compression spring operators enclosed in telescopic tubes, positive snap latches with turn handles on inside and outside, and neoprene draft seals. Provide fasteners for padlocking from the inside. Provide covers with automatic hold-open arms complete with grip handle to permit one hand release. Cover action must be smooth through its entire range of motion with an operating pressure of approximately 130 N 30 pounds.

][3.12 INSTALLATION OF CHIMNEYS, VENTS, AND SMOKESTACKS

Install chimneys and vents in accordance with NFPA 211. Provide cleanout openings with a tight-fitting, hinged, cast-iron door and frame at the base of each smokestack. Provide a top band on stacks for attachment of painter's rigging in accordance with structural requirements. Provide roof housing, rain cap, downdraft diverter, fire damper, and other accessories required for a complete installation. Join sections of prefabricated lined stacks with acid-resisting high temperature cement and steel draw bands. Flash as necessary to prevent accumulation of water in the smokestack.

][3.13 DOOR GUARD FRAME

Mount door guard frames over glazed openings using 6 mm 1/4 inch lag bolts on the interiors of wood doors or tamperproof through bolts on the interiors of metal doors.

][3.14 INSTALLATION OF BOLLARDS/PIPE GUARDS

****

NOTE: Details of pipe guard installation must be shown on the drawings.

****

Set bollards/pipe guards vertically in concrete piers. Fill hollow cores with concrete having a compressive strength of 21 MPa 3000 psi.

][3.15 INSTALLATION OF DOWNSPOUT TERMINATIONS

Secure downspouts terminations to downspouts and substrate per manufacturer's instructions.

][3.16 MOUNTING OF SAFETY CHAINS

Provide safety chains where indicated. Mount the top chain 1050 mm 3 feet 6 inches [_____] above the[floor][ground] and mount the lower chain 600 mm 2 feet [_____] above the[floor][ground].

][3.17 STRUCTURAL STEEL DOOR FRAMES

Secure door frames to the floor slab by means of angle clips and expansion bolts. Provide any necessary reinforcements and drill and tap frames as required for hardware. Clean metal shavings from finished surfaces at the end of each work day.

For freight elevator hoistway entrances, include a non-skid metal sill installed in accordance with the elevator manufacturer's written installation instructions.

][3.18 INSTALLATION OF WHEEL GUARDS

Fill wheel guards with concrete and anchor to slab in accordance with manufacturer's recommendations.

][3.19 BAR-GRILLE WINDOW GUARDS

Securely anchor bar-grille window guards to masonry with 13 mm 1/2 inch diameter prison-type screws or bolts and expansion shields, or other type of fastenings if the ends of such fastenings are welded to the adjoining metal grilles or otherwise made tamperproof in manner as approved by the Contracting Officer. Spanner-head screws or bolts are not considered prison-type fasteners.

][3.20 DIAMOND MESH WINDOW [AND DOOR]GUARDS

Provide diamond mesh window guards on[interior window frames with not less than two tamperproof hinged butts mounted on wood jambs.][exterior of window frames with not less than two tamperproof hinged butts mounted on 25 by 300 by 3 mm 1 by 12 by 1/8 inch jamb channel attached to 50 by 6 mm 2 by 1/4 inch plate anchored][to wood jambs with 6 mm 1/4 inch lag bolt,] to masonry jamb with toggle bolts[, or to concrete jambs and solid masonry jambs with expansion shields and bolts]. Provide one additional butt for each 900 mm 3 foot internal length of guard over 1500 mm 5 feet. Install hasp and padlock jamb opposite the hinged side.

][3.21 INSTALLATION OF WINDOW WELLS

Provide window wells with walls securely anchored to foundation surface. Excavate the area within the well to the bottom of the well and cover with a 100 mm 4 inch thick layer of coarse gravel or crushed rock.

][3.22 INSTALLATION MISCELLANEOUS PLATES AND SHAPES

Provide lintels fabricated from structural steel shapes over openings in masonry walls and partitions[as indicated and] as required to support wall loads over openings. Provide with connections and[fasteners][welds]. Construct to have at least 200 mm 8 inches bearing on masonry at each end.

]3.23 REPAIRS

a. Touchup Painting:

   (1) Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC PA 1 for touching up shop-painted surfaces.

b. Galvanized Surfaces:

   (1) Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-05 50 14 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-05 50 14 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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UFGS-05 50 14 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 05 50 14

STRUCTURAL METAL FABRICATIONS

08/18

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NOTE: This guide specification covers the requirements for general workmanship applicable to the fabrication, assembly and testing custom fabricated or machined assemblages requiring strict tolerances and specific expertise in detailing, fabrication, and installation. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA ISO 22849-A12	(2012) Design Recommendations for Bevel Gears
AGMA ISO 23509-A08	(2008) Bevel and Hypoid Gear Geometry
ANSI/AGMA 6001	(2008E; R 2014) Design and Selection of Components for Enclosed Gear Drives

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B4.1	(1967; R 1994; R 2004; R 2009; R 2020) Preferred Limits and Fits for Cylindrical Parts
ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc

	(Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A380/A380M	(2017) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B177/B177M	(2011; R 2021) Standard Guide for Engineering Chromium Electroplating
ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM D962	(1981; R 2014) Aluminum Powder and Paste Pigments for Paints
ASTM E94/E94M	(2022) Standard Guide for Radiographic Examination Using Industrial Radiographic Film
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E446	(2020) Standard Reference Radiographs for Steel Castings Up to 2 In. (51mm) in Thickness
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Welding Procedures; G, [_____]

Welding Repair Plan

Castings

SD-03 Product Data

Filler Metal

Lubricant

SD-06 Test Reports

Tests, Inspections, and Verifications

SD-07 Certificates

Welding Qualifications

Application Qualification for Steel Studs; G, [_____]

Welding of Aluminum

Weld Inspection Log

Certified Welding Inspector

Nondestructive Testing Personnel

1.3 QUALITY ASSURANCE

1.3.1 Detail Drawings

Submit detail drawings for metalwork and machine work, prior to fabrication, include within the detail drawings catalog cuts, templates, fabrication and assembly details and type, grade and class of material as appropriate. Indicate methods of protecting the work during shipping, storage, field assembly, and installation.

1.3.2 Welding Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. [If the qualification date of the welder or welding operator is more than 6 months old, accompany the welding operator's qualification certificate with a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.]

Conform to all requirements specified in [AWS D1.1/D1.1M] and [AA ADM] [or AWS D1.2/D1.2M].

PART 2 PRODUCTS

2.1 FABRICATION

2.1.1 Structural Fabrication

Material must be straight before being laid off or worked. Perform straightening, if necessary, by methods that will not impair the metal. Sharp kinks or bends are cause for rejection of the material. Material with welds will not be accepted except where welding is definitely specified, indicated or otherwise approved. Make bends using approved dies, press brakes or bending rolls. Where heating is required, take precautions to avoid overheating the metal and allow it to cool in a manner that will not impair the original properties of the metal. Proposed flame cutting of material, other than structural steel, is subject to approval and must be indicated on detail drawings. Shearing must be accurate and all portions of the work neatly finished. Make corners square and true unless otherwise shown. Fillet re-entrant cuts to a minimum radius of 19 mm 3/4 inch unless otherwise approved. Provide finished members free of twists, bends and open joints. Tighten bolts, nuts and screws.

2.1.1.1 Dimensional Tolerances for Structural Work

Measure dimensions using an approved calibrated steel tape of approximately the same temperature as the material being measured. The overall dimensions of an assembled structural unit must be within the tolerances indicated on the drawings or as specified in the particular section of these specifications for the item of work. Where tolerances are not specified in other sections of these specifications or shown, an allowable variation of 1 mm 1/32 inch is permissible in the overall length of component members with both ends milled; component members without milled ends must not deviate from the dimensions shown by more than 2 mm 1/16 inch for members 9 m 30 feet or less in length, and by more than 3 mm 1/8 inch for members over 9 m 30 feet in length.

2.1.1.2 Structural Steel Fabrication

Structural steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Prepare surfaces and edges in accordance with AWS D1.1/D1.1M, Prequalification of WPSs Clause. Where structural steel is not to be welded, chipping or grinding will not be required except as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Chip, grind or machine to sound metal hand-guided cuts which are to be exposed or visible.

2.1.1.3 Structural Aluminum Fabrication

Lay out and cut aluminum in accordance with the AA ADM, Section 6.

2.1.2 Welding

****

NOTE: The welding requirements provided are applicable primarily to structural grade steel, low carbon steel castings and aluminum. Where welding of other grades of steel, castings or non-ferrous metals is contemplated, insert the additional provisions necessary for the welding of these particular metals.

****

2.1.2.1 Welding of Structural Steel

2.1.2.1.1 Welding Procedures for Structural Steel

Use prequalied welding procedures for structural steel as described in AWS D1.1/D1.1M, Prequalification of WPSs Clause or qualify by tests as prescribed in AWS D1.1/D1.1M, Qualification Clause. For welding procedures qualified by tests, the coupon welding and specimen testing will be witnessed and the test report document signed by the Contracting Officer. Approval of any welding procedure does not relieve the Contractor of the responsibility for producing a finished structure meeting all requirements of these specifications. The Contractor will be directed or authorized to make any changes in previously approved welding procedures that are deemed necessary or desirable by the Contracting Officer.

a. Submit a complete schedule of welding procedures for each steel structure to be welded prior to commencing fabrication. Provide the schedule in conformance with the requirements specified in the provisions of AWS D1.1/D1.1M

b. Provide within the schedule detailed procedure specifications and tables or diagrams showing the procedures to be used for each required joint. Include in the welding procedures filler metal, preheat, interpass temperature and stress-relief heat treatment requirements. Clearly identify each welding procedure as being prequalified or required to be qualified by tests.

c. Show types and locations of welds designated or in the specifications to receive nondestructive testing in the welding procedures.

2.1.2.1.2 Welding Process

Perform welding of structural steel by an electric arc welding process using a method which excludes the atmosphere from the molten metal and conforms to the applicable provisions of AWS D1.1/D1.1M. Minimize residual stresses, distortion and shrinkage from welding.

2.1.2.1.3 Welding Technique

****

NOTE: Vibratory type stress-relief treatment should not be approved as an alternate stress relieving means for applications covered by this specification.

****

2.1.2.1.3.1 Filler Metal

Provide the electrode, electrode-flux combination and grade of filler metal conforming to the appropriate AWS specification for the base metal and welding process being used or be as shown where a specific choice of AWS specification allowables is required. Submit filler metal product data. Include the AWS designation of the electrodes to be used in the schedule of welding procedures. Use only low hydrogen electrodes for manual shielded metal-arc welding regardless of the thickness of the steel. Use a controlled temperature storage oven at the job site as prescribed by AWS D1.1/D1.1M, Fabrication Clause to maintain low moisture of low hydrogen electrodes.

2.1.2.1.3.2 Preheat and Interpass Temperature

Perform preheating as required by AWS D1.1/D1.1M, Fabrication Clause or as otherwise specified except that the temperature of the base metal must be at least 20 degrees C 70 degrees F. Slowly and uniformly preheat the joint area by approved means to the prescribed temperature, held at that temperature until the welding is completed and then permitted to cool slowly in still air.

2.1.2.1.3.3 Stress-Relief Heat Treatment

Where stress relief heat treatment is specified or shown, perform in accordance with the requirements of AWS D1.1/D1.1M, Fabrication Clause unless otherwise authorized or directed.

2.1.2.1.4 Workmanship

Perform welding workmanship in accordance with AWS D1.1/D1.1M, Fabrication Clause and other applicable requirements of these specifications.

2.1.2.1.4.1 Preparation of Base Metal

Prior to welding inspect surfaces to be welded to ensure compliance with AWS D1.1/D1.1M, Fabrication Clause.

2.1.2.1.4.2 Temporary Welds

Make temporary welds, required for fabrication and erection, under the controlled conditions prescribed for permanent work. Make temporary welds using low-hydrogen welding electrodes and by welders qualified for permanent work as specified in these specifications. Conduct preheating for temporary welds as required by AWS D1.1/D1.1M for permanent welds except that the minimum temperature must be 50 degrees C 120 degrees F in any case. In making temporary welds, do not strike arcs in other than weld locations. Remove each temporary weld and grind flush with adjacent surfaces after serving its purpose.

2.1.2.1.4.3 Tack Welds

Tack welds that are to be incorporated into the permanent work are to exhibit the same quality requirements as the permanent welds; clean and thoroughly fuse them with permanent welds. Perform preheating as specified above for temporary welds. Provide cascaded ends on multiple-pass tack welds. Remove defective tack welds before permanent welding.

2.1.2.2 Welding of Steel Castings

Remove unsound material from the surfaces of steel castings, to be incorporated into welded connections, by chipping, machining, air-arc gouging or grinding. Do not weld major connections designed for transfer of stresses if the temperature of the casting is lower than 40 degrees C 100 degrees F. Preheat castings containing over 0.35 percent carbon or over 0.75 percent manganese to a temperature not to exceed 230 degrees C 450 degrees F and conduct welding while the castings are maintained at a temperature above 180 degrees C 350 degrees F. Welding is not permitted on castings containing carbon in excess of 0.45 percent except on written authorization. Castings requiring welding repairs after the first annealing and castings involving welding fabrication must be stress-relieved annealed prior to receiving final machining unless otherwise permitted.

2.1.2.3 Welding of Steel Studs

Welding of steel studs must conform to the requirements of AWS D1.1/D1.1M, Stud WeldingClause, except as otherwise specified for the procedures for welding steel studs to structural steel, including mechanical, workmanship, technique, stud application qualification, production quality control and fabrication and verification inspection procedures.

2.1.2.3.1 Application Qualification for Steel Studs

As a condition of approval of the stud application process, submit certified test reports and certification that the studs conform to the requirements of AWS D1.1/D1.1M, Stud Welding Clause, certified results of the stud manufacturer's stud base qualification test, and certified results of the stud application qualification test as required by AWS D1.1/D1.1M, Stud Welding Clause, prior to commencing fabrication, except as otherwise specified.

2.1.2.3.2 Production Control

Production control of stud welding must conform to the requirements of AWS D1.1/D1.1M, Stud Welding Clause, except as otherwise specified for quality control for production welding of studs. Weld studs on which pre-production testing is to be performed must be in the same general position as required on production studs (flat, vertical, overhead or sloping). If the reduction of the length of studs becomes less than normal as they are welded, stop welding immediately and do not resume until the cause has been corrected.

2.1.2.4 Welding of Aluminum

Welding of aluminum must conform to the requirements of [AA ADM] [and] [AWS D1.2/D1.2M]. Submit a certified report giving the results of the qualifying tests, and a complete schedule of the welding process for each aluminum fabrication to be welded prior to commencing fabrication.

2.1.3 Bolted Connections

2.1.3.1 Bolted Structural Steel Connections

Provide bolts, nuts and washers of the type specified or indicated. Equip all nuts with washers except for high strength bolts. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where the use of high strength bolts is specified or indicated, conform the materials, workmanship and installation to the applicable provisions of ASTM F3125/F3125M. Install High Strength Bolts ASTM F3125/F3125M Grade A325 or Grade A490 in accordance with the requirements of RCSC A348. All High Strength Bolted Connections are fully pretensioned to the minimum pretension as specified in RCSC A348. Follow the pre-installation verification procedures outlined in RCSC A348. All other bolted connections are snug tight in accordance with RCSC A348.

a. Accurately locate bolt holes, smooth, perpendicular to the member and cylindrical.

b. Drill or subdrill holes for regular bolts and ream in the shop and not more than 2 mm 1/16 inch larger than the diameter of the bolt.

c. Match-ream or drill holes for fitted bolts in the shop. Remove burrs resulting from reaming. Keep bolt threads entirely outside of the holes. The body diameter of bolts must have tolerances as recommended by ASME B4.1 for the class of fit specified. Place fitted bolts in reamed holes by selective assembly to provide an LN-2 fit.

d. Holes for high strength bolts must not have diameters more than 2 mm 1/16 inch larger than bolt diameters. If the thickness of the material is not greater than the diameter of the bolts, the holes may be punched. If the thickness of the material is greater than the diameter of the bolts the holes may be drilled full size or subpunched or subdrilled at least 3 mm 1/8 inch smaller than the diameter of the bolts and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting occurring during assembly cannot distort the metal or enlarge the holes. Reaming to a larger diameter of the next standard size bolt will be allowed for slight mismatching.

2.1.3.2 Bolted Aluminum Connections

Conform to the requirements of AA ADM, Section J.3 and M.10 for bolted aluminum connections.

2.1.4 Riveted Aluminum Connections

Conform to the requirements of AA ADM, Section J.4 and M.11 for riveted aluminum connections.

2.1.5 Patterns

****

NOTE: Generally retain the first bracketed option in this paragraph (third sentence) since in most cases it will be to the advantage of the Government not to retain any patterns, or core boxes or templates, and save the expense of repairs, shipment and storage. If the Government has patterns available for loan to the Contractor, include subparagraph AVAILABLE PATTERNS, with the appropriate information provided in the bracketed underlined spaces. If the first bracketed option is used and the Government has patterns available for loan to the Contractor, subparagraphs DISPOSITION OF PATTERNS, CORE BOXES, AND TEMPLATES should be suitably modified and included. If the second bracketed option (fourth sentence) is used, include subparagraphs FABRICATION OF PATTERNS AND CORE BOXES and DISPOSITION OF PATTERNS, CORE BOXES AND TEMPLATES.

****

Take care to avoid sharp corners or abrupt changes in cross section; ample fillets are to be used in the construction of patterns. Add, as required, draft and increases in pattern thicknesses to conform to the standard foundry practice applied and as necessary to ensure that all metal thicknesses of the finished castings conform to the dimensions shown and are within the tolerances specified in paragraph INSPECTION OF STEEL CASTINGS. [All patterns [, except those loaned to the Contractor by the Government,] remain the property of the Contractor.] [Patterns for those parts listed below are furnished by the Contractor, become the property of the Government and cannot be used for work under any other contract unless specifically authorized. All other patterns [, except those loaned to the Contractor by the Government,] remain the property of the Contractor.]

[2.1.5.1 Fabrication of Patterns and Core Boxes

Substantially make patterns and core boxes that become the property of the Government from thoroughly seasoned Grade B or better sugar pine, northern white pine or an approved equal. Securely glue and screw together built-up patterns and core boxes. Use approved high grade, water resistant glue that is suitably treated for resistance to fungus and insect infestation. Only light sections are permitted to be nailed. Counterbore and neatly fill screw holes with wood plugs. Dovetail or fasten with pull-out dowels loose pieces. Split patterns and core boxes must have metal dowels at partings. Skelton or sweep patterns will not be accepted unless specifically authorized. Fill all nail and tool marks on molding surfaces with beeswax and sand all surfaces with No. 0 grade sandpaper. Finish patterns with not less than three coats of an approved phenolic-resin sealer colored in accordance with the standard trade practices for pattern colors. Stamp each pattern, core box and loose piece with the part mark shown. Provide patterns complete with necessary core boxes and templates.

][2.1.5.2 Available Patterns

****

NOTE: Clearly indicate the serviceability and general condition of each pattern under the heading of "CONDITION."

****

The patterns listed below are available for loan to the Contractor. They are stored at [_____] and may be secured f.o.b. their place of storage upon request.

PART NO.	PATTERN NO.	CONDITION
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

The Contractor assumes responsibility for the accuracy and adaptability of all parts made with the above listed patterns, as if the parts had been made from new patterns produced under this contract, and bears the expense of correcting any inaccuracies found in them.

][2.1.5.3 Disposition of Patterns, Core Boxes, and Templates

Substantially make and put together with screws the boxes and crates for the packing and shipment of patterns, core boxes and templates so that they can be used several times. Plainly mark each box and crate to indicate its contents. Thoroughly clean all patterns, core boxes and templates [including those loaned to the Contractor by the Government] used, crate and deliver in first-class condition with a list of same in duplicate to [_____] before final payment is made. The Contracting Officer reserves the right to withhold payment for final parts made from any pattern until such pattern is delivered. Varnish patterns and core boxes and give all templates a coat of an approved paint before being crated. Replace any pattern, core box or template lost in shipment or damaged.

]2.1.6 Castings

Each casting and castings weighing more than 225 required kg 500 required pounds must bear cast or stamped heat numbers. Submit detail drawings for each casting. Deviations from the dimensions of castings shown must not exceed amounts that impair the strength of castings by more than 10 percent as computed from the dimensions shown. Dimensions of castings shown on approved detail drawings are finished dimensions. Castings that are warped or otherwise distorted or that are oversize to an extent that interfere with proper fit with other parts of the machinery or structure will be rejected. The structure of metal in castings must be homogeneous and free from excessive nonmetallic inclusions. Excessive segregation of impurities or alloys at critical points in castings will be cause for rejection. Do not make repairs to castings prior to approval. Minor surface imperfections not affecting the strength of casting may be welded in the "green" if approved. Surface imperfections will be considered minor when the depth of the cavity prepared for welding is the lesser of 20 percent of the actual wall thickness or 25 mm 1 inch. Defects other than minor surface imperfections may be welded only when specifically authorized in accordance with the following requirements:

a. The defects have been entirely removed and are judged not to affect the strength, use or machineability of the castings when properly welded and stress relieved.

b. The proposed welding procedure, stress relief and method of examination of the repair work have been submitted and approved.

2.1.7 Machine Work

****

NOTE: Delete paragraphs, PIN HOLES, GEARS, SHAFTING when the details specified are provided in the machinery section.

****

Tolerances, allowances and gauges for metal fits between plain, non-threaded, cylindrical parts conform to ASME B4.1 for the class of fit shown or required unless otherwise shown on approved detail drawings. Where fits are not shown they will be suitable as approved. Tolerances for machine-finished surfaces designated by non-decimal dimensions must be within 400 µm 1/64 inch. Sufficient machining stock will be allowed on placing pads to ensure true surfaces of solid material. Provide finished contact or bearing surfaces true and exact to secure full contact. Polish journal surfaces and finish all surfaces with sufficient smoothness and accuracy to ensure proper operation when assembled. Accurately machine parts entering any machine and all like parts be interchangeable except that parts assembled together for drilling or reaming of holes or machining will not be required to be interchangeable with like parts. Accurately locate all drilled bolt holes.

2.1.7.1 Finished Surfaces

Provide surface finishes, indicated or specified, in accordance with ASME B46.1. Values of required roughness heights are arithmetical average deviations expressed in micrometers microinches. These values are maximum. Lesser degrees will be satisfactory unless otherwise indicated. Compliance with surface requirements is determined by sense of feel and visual inspection of the work compared to Roughness Comparison Specimens in accordance with the provisions of ASME B46.1. Values of roughness width and waviness height must be consistent with the general type of finish specified by roughness height. Where the finish is not indicated or specified use that which is most suitable for the particular surface, provide the class of fit required and be indicated on the detail drawings by a symbol which conforms to ASME B46.1 when machine finishing is provided. Flaws such as scratches, ridges, holes, peaks, cracks or checks which make the part unsuitable for the intended use will be cause for rejection.

2.1.7.2 Unfinished Surfaces

Lay out all work to secure proper matching of adjoining unfinished surfaces unless otherwise directed. Where there is a large discrepancy between adjoining unfinished surfaces chip and grind smooth or machine to secure proper alignment. Unfinished surfaces must be true to the lines and dimensions shown and be chipped or ground free of all projections and rough spots. Fill in depressions or holes not affecting the strength or usefulness of the parts in an approved manner.

2.1.7.3 Pin Holes

Pin holes are to be bored true to gauges, smooth, straight and at right angles to the axis of the member. Do the boring after the member is securely fastened in position.

2.1.7.4 Gears

Provide gears that have machine cut teeth of a form conforming to applicable design requirements of AGMA ISO 22849-A12, AGMA ISO 23509-A08 and ANSI/AGMA 6001 unless otherwise specified or shown.

2.1.7.5 Shafting

Turn or grind shafting with hot-rolled or cold-rolled steel, as required, unless otherwise specified or authorized. Provide fillets where changes in section occur. Cold-finished shafting may be used where keyseating is the only machine work required.

2.1.7.6 Bearings

Bearings may be lined with babbit or bronze unless otherwise specified or shown. Where the bearing pressure is in excess of 1400 kPa 200 psi, line bearings with bronze. Pressures on lined bearings must not exceed [_____] kPa psi of projected area unless otherwise required or authorized. Anti-friction bearings of approved types and of sizes not less than those recommended by the bearing manufacturer for the duty intended will be permitted subject to approval. Properly align all bearings provided with a suitable means of lubrication. Install anti-friction bearings as required to provide for retention of the lubricant and to exclude dirt and grit.

2.1.8 Miscellaneous Provisions

2.1.8.1 Metallic Coatings

a. Zinc Coatings - Apply zinc coatings in a manner and of a thickness and quality conforming to ASTM A123/A123M. Where zinc coatings are destroyed by cutting, welding or other causes regalvanize the affected areas. Regalvanize coatings 50 g 2 ounces or heavier with a suitable low-melting zinc base alloy similar to the recommendations of the American Hot-Dip Galvanizers Association to the thickness and quality specified for the original zinc coating. Repair coatings less than 50 g 2 ounces in accordance with ASTM A780/A780M.

b. Cadmium Coatings - Provide cadmium coatings of a quality and thickness conforming to the requirements of ASTM B766 and inspections conforming to the requirements of ASTM E165/E165M, Type [_____].

c. Chromium Coatings - Apply chromium coatings for engineering in conformance with ASTM B177/B177M.

2.1.8.2 Cleaning of Corrosion-Resisting Steel

Remove oil, paint and other foreign substances from corrosion-resisting steel surfaces after fabrication. Perform cleaning by vapor degreasing or by the use of cleaners of the alkaline, emulsion or solvent type. After the surfaces have been cleaned give a final rinsing with clean water followed by a 24 hour period during which the surfaces are intermittently wet with clean water and then allowed to dry for the purpose of inspecting the clean surfaces. Visually inspect the surfaces for evidence of paint, oil, grease, welding slag, heat treatment scale, iron rust or other forms of contamination. If evidence of foreign substance is found, clean again in accordance with the applicable provisions of ASTM A380/A380M. Furnish the proposed method of treatment for approval. Visually reinspect after treatment. Use only stainless steel or nonmetallic bristle brushes to remove foreign substances. Remove any contamination occurring subsequent to the initial cleaning by one or more of the methods indicated above.

2.1.8.3 Lubrication

Provide the arrangement and details for lubrication as indicated. Thoroughly clean and lubricate, with an appropriate lubricant, all bearing surfaces before erection or assembly. Prior to use of the lubricant submit for approval product data supporting its use in the assembly that includes the following lubricating properties as they apply, temperature range, protection against corrosion, ability to remain in bearing, ability to seal out contaminants, cooling and friction.

2.1.9 Shop Assembly

****

NOTE: List structural and machinery units if required by first sentence of this paragraph.

****

Assemble [only those machinery and structural units listed below] [each machinery and structural unit furnished] in the shop to determine the correctness of the fabrication and matching of the component parts unless otherwise specified. Do not exceed those tolerances shown. Closely check each unit assembled to ensure that all necessary clearances have been provided and that binding does not occur in any moving part. Assembly in the shop must be in the same position as final installation in the field unless otherwise specified. Perform assembly and disassembly work in the presence of the Contracting Officer unless waived in writing. Immediately remedy errors or defects disclosed by the Contractor without cost to the Government. Before disassembly for shipment match-mark each piece of a machinery or structural unit to facilitate erection in the field. Indicate the location of match-marks by circling with a ring of white paint after the shop coat of paint has been applied or as otherwise directed.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

Perform material tests and analyses certified by an approved laboratory to demonstrate that materials are in conformity with the specifications. These tests and analyses must be performed and certified at the Contractor's expense. Perform tests, inspections, and verifications conforming to the requirements of the particular sections of these specifications for the respective items of work unless otherwise specified or authorized. Conduct tests in the presence of the Contracting Officer if so required. Furnish specimens and samples for additional independent tests and analyses upon request by the Contracting Officer. Properly label specimens and samples and prepare for shipment. Submit certified test reports for materials with all materials delivered to the site.

2.2.1 Nondestructive Testing

When doubt exists as to the soundness of any material part, such part may be subjected to any form of nondestructive testing determined by the Contracting Officer. This may include ultrasonic, magnaflux, dye penetrant, x-ray, gamma ray or any other test that will thoroughly investigate the part in question. The cost of such investigation will be borne by the Government if the part is found to be sound and by the Contractor if the part is found to be defective. Any defects will be cause for rejection; replace and retest rejected parts at the Contractor's expense.

2.2.2 Tests of Machinery and Structural Units

The details for tests of machinery and structural units must conform to the requirements of the particular sections of these specifications covering these items. Assemble each complete machinery and structural unit and test them in the shop, in the presence of the Contracting Officer, unless otherwise directed. Waiving of tests does not relieve the Contractor of responsibility for any fault in operation, workmanship or material that occurs before the completion of the contract or guarantee. After being installed at the site, operate each complete machinery or structural unit through a sufficient number of complete cycles to demonstrate to the satisfaction of the Contracting Officer that it meets the specified operational requirements in all respects.

2.2.3 Inspection of Structural Steel Welding

Nondestructive testing of designated welds will be required. Supplemental examination of any joint or coupon cut from any location in any joint may also be required.

2.2.3.1 Visual Examination

All visual inspection will be conducted in accordance with AWS D1.1/D1.1M, by a Certified Welding Inspector. Document this inspection in the Visual Weld Inspection Log. Submit certificates indicating that certified welding inspectors meet the requirements of AWS QC1.

2.2.3.2 Nondestructive Testing

Perform as designated or described in the sections of these specifications, the nondestructive testing of shop and field welds covering the particular items of work. Record final nondestructive testing results in the Weld Inspection Log which identifies final NDT inspection of all welds requiring inspection and submit the log.

2.2.3.2.1 Testing Agency

The nondestructive testing of welds and the evaluation of tests as to the acceptability of the welds must be performed by a testing agency adequately equipped and competent to perform such services or by the Contractor using suitable equipment and qualified personnel. All personnel performing nondestructive testing must be certified Level I or II in the method of NDT being utilized in accordance with ANSI/ASNT CP-189. Level I inspectors must have direct supervision of a Level II inspector. Submit certification for nondestructive testing personnel prior to all testing. In either case, written approval of the examination procedures is required and performance of the examination tests must be done in the presence of the Contracting Officer. The evaluation of tests are subject to the approval and all records become the property of the Government.

2.2.3.2.2 Examination Procedures

Conform to the following requirements.

****

NOTE: Where welds are subjected to cyclic loading identify them on the construction documents and include cyclically in the paragraph below.

****

2.2.3.2.2.1 Ultrasonic Testing

Examine, evaluate and report ultrasonic testing of welds in conformance to the requirements of AWS D1.1/D1.1M, Inspection Clause, for [statically] [cyclically] loaded connections. Provide ultrasonic equipment capable of making a permanent record of the test indications. Make a record of each weld tested.

2.2.3.2.2.2 Magnetic Particle Inspection

Conform magnetic particle inspection of welds to the applicable provisions of ASTM E709.

2.2.3.2.2.3 Dye Penetrant Inspection

Perform dye penetrant inspection of welds conforming to the applicable provisions of ASTM E165/E165M.

2.2.3.2.3 Welds to be Subject to Nondestructive Testing

****

NOTE: List here the type, location and extent of welds to be subjected to nondestructive testing. The welds so listed should also be shown using the appropriate designation of AWS A2.4 "Standard Symbols for Welding, Brazing and Nondestructive Examination".

Limit complete nondestructive testing of welds to welds upon which the structure is dependent. Use spot nondestructive examination of welds to ensure adequate welding quality and water tightness of seams where required.

Use ultrasonic testing for groove welds in tee, corner or buttjoints.

Magnetic particle inspection may be used for the detection of cracks and other discontinuities at or near the surface of root and surface passes and intermediate layers not exceeding 6 mm 1/4 inch thickness in ferritic steel only.

Use dye penetrant inspection only for detection of discontinuities that are open to the surface in single pass fillet welds.

Omit this paragraph where nondestructive testing is covered in other sections of the specifications.

The engineer should determine the appropriate table from AWS D1.1/D1.1M for UT inspection, Static Table 6.2 or Cyclic Table 6.3. Identify cyclically loaded welds on the construction documents.

****

Test [50%][_____] of CJP welds using ultrasonic testing per Table [6.2] [or 6.3] of AWS D1.1/D1.1M. Randomly test [50%][_____] of all PJP and fillet welds or as indicated by magnetic particle or dye penetrant testing.

2.2.3.3 Test Coupons

****

NOTE: For supply contracts a provision similar to that given under contract clauses should be written into this paragraph.

****

The Government reserves the right to require the Contractor to remove coupons from completed work when doubt as to soundness cannot be resolved by nondestructive testing. When coupons are removed from any part of a structure, repair the members cut in a neat manner with joints of the proper type to develop the full strength of the members. Peen repaired joints as approved or directed to relieve residual stress. The expense for removing and testing coupons, repairing cut members and the nondestructive testing of repairs is borne by the Government or the Contractor in accordance with the Contract Clauses INSPECTION AND ACCEPTANCE.

2.2.3.4 Supplemental Examination

When the soundness of any weld is suspected of being deficient due to faulty welding or stresses that might occur during shipment or erection, the Government reserves the right to perform nondestructive supplemental examinations before final acceptance. The cost of such inspection will be borne by the Government.

2.2.4 Welding Repair Plan

Repair defective welds in accordance with AWS D1.1/D1.1M, Fabrication Clause. Remove defective weld metal to sound metal by use of air carbon-arc or oxygen gouging. Thoroughly clean surfaces before welding. Retest welds that have been repaired by the same methods used in the original inspection. Except for the repair of members cut to remove test coupons and found to have acceptable welds costs of repairs and retesting will be borne by the Contractor. Submit welding repair plans for steel, prior to making repairs.

2.2.5 Inspection and Testing of Steel Stud Welding

Perform fabrication and verification inspection and testing of steel stud welding conforming to the requirements of AWS D1.1/D1.1M, Welding Clause except as otherwise specified. The Contracting Officer will serve as the verification inspector. Bend or torque test one stud in every 100, including studs that do not show a full 360 degree weld flash, have been repaired by welding or whose reduction in length due to welding is less than normal as required by AWS D1.1/D1.1M, Stud Welding Clause. If any of these studs fail, bend or torque test two additional studs. If either of the two additional studs fails, all of the studs represented by the tests will be rejected. Studs that crack under testing in the weld, base metal or shank will be rejected and replaced by the Contractor at no additional cost.

2.2.6 Inspection of Steel Castings

****

NOTES: Limit radiographic inspection of castings to castings upon which the structural integrity of the structure is dependent. The drawings should indicate which castings and what areas are to be radiographed. Radiographic inspection must be done at the casting plant and not on site.

Insert applicable type and severity level in the bracketed spaces of the table in this paragraph.

****

Perform radiographic inspection of steel castings at the casting plant as designated and as described in the section of these specifications covering the particular item of work. The procedure for making, evaluating and reporting the radiographic inspection must conform to the requirements of ASTM E94/E94M. The castings will be unacceptable if shown to have defects of greater severity than the applicable reference standard specified in the following table:

DISCONTINUITY TYPE	SEVERITY LEVELS OR CLASSES
[_____]	[_____]
[_____]	[_____]

Use the applicable referenced standards as illustrated in ASTM E446. The evaluation of the radiographs will be subject to approval and all records become the property of the Government.

PART 3 EXECUTION

3.1 INSTALLATION

Thoroughly clean all parts to be installed. Remove packing compounds, rust, dirt, grit and other foreign matter. Clean holes and grooves for lubrication. Examine enclosed chambers or passages to make sure that they are free from damaging materials. Where units or items are shipped as assemblies they will be inspected prior to installation. Disassembly, cleaning and lubrication will not be required except where necessary to place the assembly in a clean and properly lubricated condition. Do not use pipe wrenches, cold chisels or other tools likely to cause damage to the surfaces of rods, nuts or other parts used for assembling and tightening parts. Tighten bolts and screws firmly and uniformly but take care not to overstress the threads. When a half nut is used for locking a full nut place the half nut first followed by the full nut. Lubricate threads of all bolts except high strength bolts, nuts and screws with an appropriate lubricant before assembly. Coat threads of corrosion-resisting steel bolts and nuts with an approved antigalling compound. Driving and drifting bolts or keys will not be permitted.

3.1.1 Alignment and Setting

Accurately align each machinery or structural unit by the use of steel shims or other approved methods so that no binding in any moving parts or distortion of any member occurs before it is fastened in place. The alignment of all parts with respect to each other must be true within the respective tolerances required. Set true machines to the elevations shown.

3.1.2 Blocking and Wedges

Remove all blocking and wedges used during installation for the support of parts to be grouted in foundations before final grouting unless otherwise directed. Blocking and wedges left in the foundations with approval must be of steel or iron.

3.1.3 Foundations and Grouting

****

NOTE: Required special provisions relative to concreting and grouting machinery foundations and bases should be inserted in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

****

Provide concrete subbases and frames and final grout under parts of machines in accordance with the procedures as specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

3.2 TESTS

3.2.1 Workmanship

Workmanship must be of the highest grade and in accordance with the best modern practices to conform with the specifications for the item of work being furnished.

3.2.2 Production Welding

Perform production welding conforming to the requirements of AWS D1.1/D1.1M or AWS D1.2/D1.2M, as applicable. Studs, on which pre-production testing is to be performed, must be welded in the same general position as required on production items (flat, vertical, overhead or sloping). Test and production stud welding will be subjected to visual examination or inspection. If the reduction of the length of studs becomes less than normal as they are welded, stop welding immediately and do not resume until the cause has been corrected.

3.3 PROTECTION OF FINISHED WORK

3.3.1 Machined Surfaces

Thoroughly clean foreign matter off machined surfaces. Protect all finished surfaces. Oil and wrap unassembled pins and bolts with moisture resistant paper or protect them by other approved means. Wash finished surfaces of ferrous metals to be in bolted contact, with an approved rust inhibitor and coat them with an approved rust resisting compound for temporary protection during fabrication, shipping and storage periods. Paint finished surfaces of metals which will be exposed after installation, except corrosion resisting steel or nonferrous metals as specified in

Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.3.2 Lubrication After Assembly

After assembly fill all lubricating systems with the appropriate lubricant and apply additional lubricant at intervals as required to maintain the equipment in satisfactory condition until acceptance of the work.

3.3.3 Aluminum

Protect aluminum that will be in contact with grout or concrete from galvanic or corrosive action, with a coat of zinc-chromate primer and a coat of aluminum paint. Protect aluminum in contact with structural steel against galvanic or corrosive action with a coat of zinc-chromate primer and a coat of aluminum paint. Provide aluminum paint consisting of a aluminum paste conforming to ASTM D962, spar varnish and thinner compatible with the varnish. Field mix the aluminum paint in proportion of 1 kg 2 pounds of paste, not more than 4 L one gallon of spar varnish and not more than 500 mL one pint of thinner.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-05 50 15 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-05 50 04 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 05 - METALS

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PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-05 50 15 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-05 50 04 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 05 50 15

CIVIL WORKS FABRICATIONS
08/18

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NOTE: This guide specification covers the requirements for providing all equipment, materials, and labor for fabricating, furnishing, and installing miscellaneous metal materials, standard metal articles, and shop fabricated items for Civil Works type structures. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.6.2	(2020) Square Head Set Screws and Slotted Headless Set Screws (Inch Series)
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers
ASME B18.27	(1998; R 2017) Tapered and Reduced Cross

	Section Retaining Rings (Inch Series)
ASME B27.7	(1977; R 2017) General Purpose Tapered and Reduced Cross Section Retaining Rings

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.3	(2020) Safety Requirements for Powder-Actuated Fastening Systems American National Standard for Construction and Demolition Operations

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1	(2000; R 2018) Standard Specification for Carbon Steel Tee Rails
ASTM A20/A20M	(2018) Standard Specification for General Requirements for Steel Plates for Pressure Vessels
ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A109/A109M	(2024) Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or

	High-Temperature Service, or Both
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A263	(2012; R 2019) Standard Specification for Stainless Chromium Steel-Clad Plate
ASTM A264	(2012; R 2019) Standard Specification for Stainless Chromium-Nickel Steel-Clad Plate
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A467/A467M	(2020) Standard Specification for Machine Coil Chain
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM A484/A484M	(2024b) Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A504/A504M	(2018; R 2023) Standard Specification for Wrought Carbon Steel Wheels
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A519/A519M	(2024) Standard Specification for Seamless Carbon and Alloy Steel Mechanical Tubing
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)

ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588/A588M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A786/A786M	(2015; R 2021) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM A1085/A1085M	(2015) Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM B6	(2023) Standard Specification for Zinc
ASTM B21/B21M	(2020) Standard Specification for Naval Brass Rod, Bar, and Shapes
ASTM B23	(2020) Standard Specification for White Metal Bearing Alloys (known Commercially as "Babbitt Metal")
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B36/B36M	(2023) Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar
ASTM B62	(2017) Standard Specification for

	Composition Bronze or Ounce Metal Castings
ASTM B121/B121M	(2023) Standard Specification for Leaded Brass Plate, Sheet, Strip, and Rolled Bar
ASTM B124/B124M	(2020) Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B138/B138M	(2011; R 2024) Standard Specification for Manganese Bronze Rod, Bar and Shapes
ASTM B148	(2024) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B150/B150M	(2012; R 2017) Standard Specification for Aluminum Bronze Rod, Bar, and Shapes
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B176	(2018; R 2024) Standard Specification for Copper-Alloy Die Castings
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B211/B211M	(2023) Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B241/B241M	(2022) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B271/B271M	(2023) Standard Specification for Copper-Base Alloy Centrifugal Castings
ASTM B308/B308M	(2010; R 2020) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429/B429M	(2010; E 2012) Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B505/B505M	(2023) Standard Specification for Copper Alloy Continuous Castings
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications

ASTM B749	(2020) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM B763/B763M	(2023) Standard Specification for Copper Alloy Sand Castings for Valve Application
ASTM B806	(2023) Standard Specification for Copper Alloy Permanent Mold Castings for General Applications
ASTM B824	(2017) Standard Specification for General Requirements for Copper Alloy Castings
ASTM C1513	(2024) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM D1187/D1187M	(1997; R 2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F436/F436M	(2024) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2017) Metal Bar Grating Manual
NAAMM MBG 532	(2019) Heavy Duty Metal Bar Grating Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 20	(2019) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic)
SSPC Paint 29	(2002; E 2004) Zinc Dust Sacrificial Primer, Performance-Based

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005	(Basic; Notice 2) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole
FS RR-C-271	(Rev H; Am 1) Chains and Attachments, Carbon And Alloy Steel
FS RR-W-410	(2022; Rev J) Wire Rope and Strand

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Fabricated Metal Items; G, [_____]

SD-03 Product Data

Expansion Anchors

Sleeve Anchors

Adhesive Anchors

Powder Driven Fasteners

Wire Rope

Gratings

Stairs

Ladders

Shop Fabricated Metal Items; G, [_____]

SD-04 Samples

Shop Fabricated Metal Items; G, [_____]

SD-06 Test Reports

Hardness Check

Rotational Capacity

SD-07 Certificates

Welder Certifications

1.3 QUALITY ASSURANCE

a. Form miscellaneous metalwork to shape and size, with sharp lines and angles and true curves. Drill and punch producing clean true lines and surfaces. Provide exposed surfaces of work in place with a smooth finish, and unless otherwise approved. Where tight fits are required, mill joints. Cope or miter corner joints, well formed, and in true alignment. Accurately set work to established lines and elevations and securely fastened in place. Install in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

b. Perform welding continuously along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections of work in place. Grind exposed welds smooth.

c. Qualify welders, perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work. Submit welder certifications for each welder stating the type of welding and position qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. [If the qualification date of the welding operator is more than 6 months old, the welding operator's qualification certificate must be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.]

1.4 ENVIRONMENTAL REQUIREMENTS

Do not clean or paint surface when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than 3 degrees C 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 7 degrees C 45 degrees F or over 35 degrees C 95 degrees F, unless approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 MISCELLANEOUS METALS AND STANDARD METAL ARTICLES

Conform to the respective specifications and other designated requirements for miscellaneous metal materials and standard metal articles. Size as specified or indicated. Where material requirements are not specified, furnish materials suitable for the intended use and subject to approval.

2.1.1 Structural Steel

[[ASTM A36/A36M] [ASTM A992/A992M] [ASTM A572/A572M] Grade [_____], Type [_____]] [ASTM A588/A588M, Grade [_____]].

2.1.2 Steel Plates

2.1.2.1 Structural

[ASTM A572/A572M, Grade 50] [ASTM A36/A36M].

2.1.2.2 Pressure Vessel

ASTM A516/A516M, Grade [_____], and meet the requirements of the Charpy V-notch impact tests and the drop-weight tests as specified in ASTM A20/A20M.

2.1.3 Steel Tubing

2.1.3.1 Structural

ASTM A500/A500M, Grade B, [ASTM A1085/A1085M] [seamless] [welded], [outside diameter] [outside dimensions] and nominal wall thickness as shown.

2.1.3.2 Mechanical

ASTM A519/A519M [seamless carbon] [alloy steel mechanical tubing], [hot finished] [cold finished], Conditions [_____] and [_____], Grade dimensions as shown.

2.1.4 Steel Pipes and Pipe Fittings

2.1.4.1 Pipes

ASTM A53/A53M, Type [E][S], Grade [A][B], [seamless] [electric-resistance welded], [black] [galvanized], nominal size and weight class or outside diameter and nominal wall thickness as shown, [plain] [threaded] [threaded and coupled] ends.

2.1.4.2 Pipe Fittings

a. Flanged - ASME B16.5, Class [_____], faced and drilled.

b. Screwed - ASME B16.3, Type [_____].

c. Butt-welding - ASME B16.9.

2.1.5 Stainless Steel

****

NOTE: UNS S30400, S40500, and S41000 are low strength alloys suitable for use in welded assemblies. UNS S21800 is an intermediate strength alloy with excellent anti-galling characteristics. UNS S17400 and S45000 are high strength alloys. Avoid welding of UNS S21800, S17400, and S45000.

****

2.1.5.1 Plate, Sheet, and Strip

ASTM A240/A240M, UNS [S30400,] [S40500] or [S41008]. Plate finish must be hot-rolled and annealed or heat treated, and blast cleaned or pickled. Provide No. 1 sheet and strip finish.

2.1.5.2 Clad Plate

****

NOTE: Thickness of cladding may have to be changed for some applications.

****

ASTM A263, with cladding conforming to ASTM A240/A240M, UNS S40500 or S41008; or ASTM A264, with cladding conforming to ASTM A240/A240M, UNS S30400. Bond cladding on one side of base metal. Nominal thickness of the cladding must be 10 percent of the nominal total plate thickness or 2 mm 1/16 inch, whichever is greater. Do not vary the thickness of the cladding under the thickness specified by more than 2 percent of the nominal thickness of the clad plate. Provide sandblasted, pickled, or, blast-cleaned and pickled plate finish. Stainless steel plate specified above in paragraph PLATE, SHEET, AND STRIP may be used in lieu of clad plate at the option of the Contractor.

2.1.5.3 Bars and Shapes

Conform to the following, as specified or shown, for stainless steel bars and shapes:

a. ASTM A276/A276M, UNS [S30400, S40500, or S41000 with a maximum carbon content of 0.08 percent] [S21800], Condition A, hot-finished or cold-finished, Class C.

b. ASTM A564/A564M, UNS S17400 or S45000, age-hardened heat treatment condition, hot-finished or cold-finished, Class C.

2.1.5.4 Plates, Bars and Shapes for Roller and Track Systems

****

NOTE: Rollers and track plates on gates and in gate slots which are subjected to hydraulic loads from water during operation of gates should be hardened by heat treatment as specified below in subparagraph GATE ROLLERS AND BOLTED TRACK PLATES. Hardened track plates are not suitable for welding and should be bolted in place. Track plates which are lightly loaded, such as gate upstream track plates, should conform to subparagraph WELDED SEAL PLATES AND BARS; WELDED ROLLER GUIDE BARS; AND WELDED TRACK PLATES below and be welded in place.

****

2.1.5.4.1 Gate Rollers and Bolted Track Plates

ASTM A564/A564M, UNS S17400 or S45000, age-hardened heat treated to obtain a Brinell hardness range of 331 minimum to 401 maximum, hot-finished or cold-finished, Class C. Do not commence heat treatment of rollers and plates until the heat treatment procedure and the test reports for other required material tests are approved. After heat treating and final machining, each roller and track plate must be free of scale and cracks, as determined by ultrasonic, magnetic particle or dye penetrant inspection tests.

2.1.5.4.2 Hardness Check Tests

Test suitable 13 mm 1/2 inch thick samples of the material from each heat to determine the hardness in both the solution-annealed and age-hardened conditions. Where the oven-batch heat- treating process is used, perform hardness check tests on material of each heat in each oven batch. Where a continuous heat-treating process is used, perform three check tests on material of each heat: one on the first material through the process, one at the middle of the run, and one on the last material through the process. Submit test report for hardness check.

2.1.5.4.3 Fasteners for Bolted Track Plates and Guide Bars

Conform to ASTM A193/A193M or ASTM A320/A320M, Class 2 for bolting materials, Grade B8, Conform to ASTM A194/A194M, Grade 8A for nuts.

2.1.5.4.4 Gate Roller Links and Pins

2.1.5.4.4.1 Links

ASTM A276/A276M, UNS S30400 or S41000, Condition A, hot-finished or cold-finished, Class A.

2.1.5.4.4.2 Pins

****

NOTE: It is contemplated that the pin diameter and tolerances shown will be the minimum size and tolerances as given in ASTM A484/A484M for cold finished round bars. Machined pins should have a surface roughness of not exceeding 1.6 micrometers 63 microinches. Minimum diameter of holes in bars

should be the maximum pin size plus an allowance of 0.2 mm 0.008 inch for a free fit. Minimum diameter of holes in rollers should be the nominal diameter of the pin plus 1 mm 1/32 inch. Base the length of the pin between retainer ring grooves on the maximum width of the roller, the maximum thickness of the hot-finished bars rolled to the tolerances given in ASTM A484/A484M plus a clearance of approximately 1 mm 0.040 inch to avoid binding between bars, or binding between bars and rollers.

****

ASTM A276/A276M, UNS S21800, Condition A, cold-finished or hot-rolled and machine-finished to the tolerances specified in ASTM A484/A484M for cold-finished round bars, Class C.

2.1.5.4.5 Retaining Rings

Provide corrosion resistant steel retaining rings for gate roller links conforming to ASME B27.7ASME B18.27, BASIC external series type with nominal ring size of [_____] mm inches.

2.1.5.4.6 Seal Plates, Bars, and Retainers; Roller Guide Bars; and Track Plates

2.1.5.4.6.1 Welded Seal Plates and Bars; Welded Roller Guide Bars; and Welded Track Plates

ASTM A240/A240M, UNS [S40500] [S41008] [S30400], Hot-Rolled and Annealed or Heat Treated, and Blast Cleaned or Pickled Finish; or ASTM A276/A276M, UNS S30400, S40500, or S41000 with a maximum carbon content of 0.08 percent, Condition A, Hot-Finished or Cold-Finished, Class C.

2.1.5.4.6.2 Bolted Seal Plates, Bars, and Retainers; and Bolted Roller Guide Bars

ASTM A240/A240M, UNS [S40500] or [S41008] [S30400], Hot-Rolled and Annealed or Heat Treated, and Blast Cleaned or Pickled finish; or ASTM A276/A276M, UNS S30400, S40500, or S41000, Condition A, hot-finished or cold-finished, Class C.

2.1.5.5 Pipe

ASTM A312/A312M, [seamless] [welded], UNS S30400, NPS and schedule number or outside diameter and nominal wall thickness as shown, [plain] [threaded] [threaded and coupled] ends.

2.1.6 Steel Forgings

2.1.6.1 General Industrial Use

ASTM A668/A668M, Class [_____], carbon content not exceeding 0.35 percent, and an overall chemical composition which results in satisfactory weldability.

2.1.6.2 Railway Use

ASTM A668/A668M, Grade [_____], carbon content not exceeding 0.35 percent and an overall chemical composition which results in satisfactory weldability.

2.1.7 Steel Castings

ASTM A27/A27M, Grade [_____], Class [_____], or ASTM A148/A148M, Grade [_____].

2.1.8 Steel Strips

ASTM A109/A109M, [oiled] [not oiled], Temper [_____] Edge [_____], Finish [_____].

2.1.9 Aluminum

2.1.9.1 Sheets and Plates

ASTM B209M ASTM B209, Alloy [_____], Temper [_____].

2.1.9.2 Bars, Rods and Wire

ASTM B211/B211M, Alloy [_____], Temper [_____].

2.1.9.3 Structural Shapes

ASTM B308/B308M, Alloy [_____], Temper [_____].

2.1.9.4 Castings

ASTM B26/B26M, Alloy [_____], Temper [_____].

2.1.9.5 Pipes and Tubes

ASTM B241/B241M, Alloy 6063, Temper [_____], size and schedule number or outside diameter and wall thickness as shown.

2.1.10 Bronze

2.1.10.1 Copper Alloy Castings

****

NOTE: After the specific ASTM casting specification and Alloy UNS Number has been selected, specify the general requirements of ASTM B824 as needed based upon the application and importance of the component. ASTM B828 establishes a group of general requirements common to the ASTM Copper Alloy Casting specifications. These requirements might include pressure tests, certification, or witness. Additionally, some of the specific copper alloy casting specifications have optional requirements which should be added if they are determined necessary. These optional requirements can include, but are not limited to, soundness, mechanical properties, and chemical analysis of residual elements.

****

[ASTM B148] [ASTM B62] [ASTM B176] [ASTM B271/B271M] [ASTM B505/B505M] [ASTM B584] [ASTM B763/B763M] [ASTM B806], Copper Alloy UNS No. [_____].

a. General requirements of ASTM B824:

   (1) Hydrostatic tests

   (2) Certification

   (3) Soundness tests

   (4) [_____]

b. Optional requirements of [ASTM B148] [ASTM B62] [ASTM B176] [ASTM B271/B271M] [ASTM B505/B505M] [ASTM B584] [ASTM B763/B763M] [ASTM B806] [ASTM B824].

   (1) Soundness

   (2) Mechanical properties

   (3) Chemical analysis of residual elements

   (4) [_____]

2.1.10.2 Aluminum Bronze Castings

[ASTM B148] [ASTM B271/B271M] [ASTM B505/B505M] [ASTM B763/B763M] [ASTM B806], Copper Alloy UNS No. [_____].

2.1.10.3 Aluminum Bronze Rods, Bars, and Shapes

ASTM B150/B150M, Copper Alloy UNS No. [_____], Temper [_____].

2.1.10.4 Manganese Bronze Castings

[ASTM B176] [ASTM B271/B271M] [ASTM B505/B505M] [ASTM B584] [ASTM B763/B763M], Copper Alloy UNS No. [_____].

2.1.10.5 Rolled Manganese Bronze and Manganese Bronze Forgings

ASTM B138/B138M ASTM B138/B138M, Class [_____], Temper [_____].

2.1.10.6 Manganese Bronze Rods, Bars, and Shapes

ASTM B138/B138M ASTM B138/B138M, Copper Alloy UNS No. [_____], Temper [_____].

2.1.11 Brass

2.1.11.1 Sheet, Plates, and Bars

[ASTM B36/B36M] [ASTM B121/B121M], Composition [_____], Temper [_____].

2.1.11.2 Castings

[ASTM B62] [ASTM B176] [ASTM B271/B271M] [ASTM B505/B505M] [ASTM B584] [ASTM B763/B763M] [ASTM B806], Copper Alloy UNS No. [_____].

2.1.11.3 Naval Brass

[ASTM B21/B21M,] [ASTM B124/B124M,] Composition [_____], Temper [_____].

2.1.12 Copper Flat Products

ASTM B152/B152M, Temper [_____].

2.1.13 Lead Sheet

ASTM B749, Alloy UNS No. [_____], Type [L_____].

2.1.14 Zinc

ASTM B6, [Special High Grade] [High Grade] [Prime Western].

2.1.15 Babbit Metal

ASTM B23, Alloy UNS No. [_____].

2.1.16 Bolts, Nuts, and Washers

Provide bolts, nuts, and washers of the material, grade, type, class, style and finish indicated or best suited for intended use.

2.1.16.1 High-Strength Bolts, Nuts, and Washers

a. ASTM F3125/F3125M Grade [A325][A490], [hot-dip galvanized].

b. Conduct Rotational-capacity testing for all fastener assemblies in accordance with ASTM F3125/F3125M. Test as an assembly each combination of bolt production lot, nut lot, and washer lot. Assign a rotational-capacity lot number to each combination of lots tested. Test bolts in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device. Submit test report for rotational capacity.

2.1.16.2 Bolts, Nuts, and Washers (Other Than High-Strength)

a. Bolts and Nuts - ASTM A307, Grade A, [hot-dip galvanized] or ASTM A320/A320M, [Ferritic Steel, Grade [_____]] [Austenitic Steel, Class [_____]].

b. Bolts - ASME B18.2.1.

c. Nuts - ASME B18.2.2.

d. Washers

    (1) Plain Washers - ASME B18.22M ASME B18.21.1, Type B.

    (2) Lock Washer - ASME B18.21.1.

    (3) Beveled Washers - ASTM F436/F436M, Type [_____], Beveled.

2.1.16.3 Foundation Anchorage

****

NOTE: For most jobs, ASTM F1554 248 MPa 36 ksi anchor bolts are used. If high tensile loads are

anticipated, consider the use of 379 MPa or 724 MPa 55 ksi or 105 ksi ASTM F1554 anchor bolts. If stainless steel is considered, select from material in ASTM A193/A193M.

****

2.1.16.3.1 Anchor Rods

ASTM F1554 Gr 36 [55] [105], Class 1A [2A]. [Stainless steel ASTM A193/A193M.]

2.1.16.3.2 Anchor Nuts

ASTM A563M (ASTM A563), Grade A, hex style. [Stainless steel ASTM A193/A193M.]

2.1.16.3.3 Anchor Washers

ASTM F844. [Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M.]

2.1.16.3.4 Anchor Plate Washers

ASTM A36/A36M [Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M.]

2.1.17 [Expansion Anchors] [Sleeve Anchors] [Adhesive Anchors]

Provide [_____] mm inch diameter [expansion anchors][sleeve anchors][adhesive anchors]. Minimum [concrete][masonry] embedment must be [_____] mm in. Design values listed must be as tested according to ASTM E488/E488M.

a. Minimum [ultimate][allowable] pullout value: [_____] kN lb.

b. Minimum [ultimate][allowable] shear value: [_____] kN lb.

2.1.18 Lag Screws and Bolts

ASME B18.2.1, type and grade best suited for the purpose.

2.1.19 Toggle Bolts

ASME B18.2.1.

2.1.20 Powder Driven Fasteners

Follow safety provisions of ASSP A10.3.

2.1.21 Screws

ASME B18.2.1, ASME B18.6.2, ASME B18.6.3 and ASTM C1513.

2.1.22 Safety Treads

Provide slip-on skid resistant treads made from [rubber] [vinyl] [aluminum alloy] [cast iron] as best suited for the intended location.

2.1.23 Wire Rope

****

NOTE: Identify the requirements for wire rope by inserting number of wires, material, type of core, lay, coating, and whether preformed or not.

****

FS RR-W-410, Type [_____], Class [_____], Construction [_____], [wire sizes] [strand seizing] as shown.

2.1.24 Chains and Attachments

FS RR-C-271, Type [_____], Grade [_____], Class [_____], Style [_____], Size [_____], Finish [_____].

2.1.25 Steel Rails

ASTM A1, [No. 1] [No. 2].

2.1.26 Cast Iron Frames and Covers

CID A-A-60005, Type [_____], Style [_____] frame, type [_____] cover.

2.1.27 Steel Wheels

ASTM A504/A504M, Class [_____], design and rough bore size as shown.

2.1.28 Gratings

****

NOTE: Use NAAM MBG 531 for gratings for pedestrian grates and use NAAM MBG 532 for vehicular grates not specified elsewhere.

****

a. Gray cast iron ASTM A48/A48M, Class 40.

b. Metal plank grating, non-slip requirement, aluminum ASTM B209M, ASTM B209, 6061-T6; steel ASTM A653/A653M, Z275 G90.

c. Metal bar type grating NAAMM MBG 531[NAAMM MBG 532].

2.1.29 Floor Plates, Patterned

Floor plate ASTM A786/A786M. Steel plate must not be less than 1.9 mm 14 gage.

2.1.30 Submittals Requirements

This applies to SHOP FABRICATED METAL ITEMS also. Submit the following:

a. Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Include in the drawings catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates. Detail drawings for the following items: [______]

b. Lists of materials, and records which identify the disposition of approved material and fabricated items in the work.

c. Samples of the following items: [_____]. Provide full size samples of standard or fabricated items, taken from manufacturer's stock, and complete as required for installation in the structure. Samples may be installed in the work, provided each sample is clearly identified and its location recorded.

2.2 SHOP FABRICATED METAL ITEMS

Conform shop fabricated metal items to the requirements and details as specified or shown and to the workmanship provisions and other applicable fabrication requirements as specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.2.1 Railings

Provide railings as type specified and show, furnish, and install complete with all fittings, brackets, fasteners, sleeves, anchors, and other appurtenances as shown and as required for proper installation. Design handrails to resist a minimum concentrated load of 890 N 200 lbf in any direction at any point of the top of the rail or 75 kg/m 50 lb/ft applied in any direction at the top of the rail, whichever is more severe.

2.2.1.1 Materials

Steel handrails, including inserts in concrete, provide [steel pipe conforming to ASTM A53/A53M] [or] [structural tubing conforming to ASTM A500/A500M, Grade A or B of equivalent strength] [ASTM A1085/A1085M]. Provide steel railings with [38] [20] mm [1-1/2] [2] inch nominal size. Hot-dip galvanize [and] [shop paint] railings. Provide pipe collars of [steel.] [hot-dip galvanized steel.] [stainless steel.] Provide aluminum handrails of [[38] [50] mm [1-1/2] [2] inch nominal Schedule 40 pipe ASTM B429/B429M] [45 mm 1-3/4 inch square aluminum semi-hollow tube with rounded corners ASTM B221]. Railings and pipe collars must be [mill finish] [anodized] [aluminum [_____] color]. Provide all fasteners of Series 300 stainless steel.

2.2.1.2 Fabrication

****

NOTE: Specify flush-finished joints for railings when a good appearance is desired.

****

Rigid joints in railings must be of welded, threaded, or slip-on fittings assembly [and be flush-finished]. Reinforce welded joints with tight-fitting interior sleeves assembled by welding rails and posts to flush-type fittings, or by mitering and welding joining rails and posts. Exposed threads are not permitted on assembled threaded joints. Use tight fitting slip-on fittings. Provide self-locking, concealed type fasteners for slip-on fittings. Provide aluminum or stainless steel fasteners for aluminum fittings. Provide stainless steel fasteners for steel fittings. Expansion joints in railings must be an [inner-sleeved] [outer-sleeved] [outer-sleeved or inner-sleeved] slip-joint, with one end of the sleeve secured to one rail and the ends of the adjoining rails separated a minimum of 25 mm 1 inch in the installed position. Locate expansion joints in rails near the intersection of rails and posts. Make bends in railings in a manner that railings are not crushed and maintain their original cross-sectional shape. Ground welds smooth. Provide railings free of burrs, sharp corners, and sharp edges.

2.2.2 Gratings and Cover Plates

Provide grating and cover plates of the material and size shown, and fabricated in sectional panels of the width and length shown, or as appropriate, to accurately fit within the supporting recess frames. Provide openings through panels as shown or as required. [Provide hinged panels with hinges of the type shown or suitable for the application.] [Galvanize steel gratings and cover plates after fabrication.]

2.2.2.1 Grating

Gratings are as specified in previous paragraph GRATINGS. Band edges of gratings and openings through gratings which require the cutting of more than one bearing bar. Provide fasteners of the type recommended by the manufacturer and approved. [Provide nonslip nosing on stair tread gratings.]

2.2.2.2 Cover Plates

Provide cover plates as specified in paragraph FLOOR PLATES, PATTERNED. Provide cover plate panels with [holes for insertion of removal tool] [6 mm 1/4 inch bar, flush, drop handles for removal] as shown or as required. Remove sharp edges and burrs from plates.

2.2.3 Steel Stairs

Provide steel stairs complete with structural or formed channel stringers, [steel plate treads and risers,] [metal pan cement-filled treads,] [grating treads,] [slip-resistant metallic treads,] landings, columns, handrails, and necessary bolts and other fastenings as indicated. Close exposed ends of stringers [and continue around landings which they support]. Conform to ASTM A36/A36M for structural steel. Stairs and accessories must be [galvanized after fabrication] [_____]. Form risers on stairs with metal pan treads to form a sanitary cove to retain the tread concrete. Integral nosings must have braces extended into the concrete fill. [Fabricate stair treads [and landings] of steel gratings of the type specified in paragraph GRATING. Provide grating treads with slip-resistant nosings.]Provide bolts, nuts and other fastenings as shown and as required for proper installation. Use lock washers under all nuts. [Anchor railings of the type specified above in paragraph RAILINGS to stairs as shown.]

****

NOTE: For industrial or heavy duty stairs use live load = 5 times the expected load and a concentrated load of 2 kN 1000 lbs. For standard applications, use a live load of 500 kg per square m 100 psf and a concentrated load of 1.3 kN 300 lbs applied over and area of 50 mm by 50 mm 2 inches by 2 inches.

****

Design stairs to sustain a live load of not less than [_____] kg per square meter pounds per square foot, or a concentrated load of [_____] kN lbs applied over and area of 50 mm by 50 mm 2 inches by 2 inches where it is most critical. Conform to AISC 360 with the design and fabrication of steel stairs, other than a commercial product.

2.2.4 Recess Frames

Fabricate recess frames of structural shapes of the type shown. Grind welded joints in frames smooth. [Galvanize steel frames after fabrication.] Anchor frames to supports in the manner shown and not be continuous across contraction or expansion joints.

2.2.5 Ladders

Provide fixed-rail metal ladders conforming to the requirements of EM 385-1-1 and to details shown. Fabricate ladders of [structural steel as shown and be galvanized after fabrication] [aluminum as shown]. Fabricate ladders of solid-section rod rungs fitted into holes in bar side rails and weld. Make splices in side rails using full penetration welds and provide a flush and smooth transition between connecting ends. Grind all welds smooth. Weld ladder rails to bent-bar supporting brackets anchored to supporting structure as shown.

2.2.6 [Ladder Rungs] [Grab Bars] [Pulling Irons] [Mooring Rings]

Fabricate [Ladder rungs], [grab bars], [pulling irons], [mooring rings] from steel rods in accordance with the details and be galvanized after fabrication.

2.2.7 Lock Wall Armor

Fabricate lock wall armor tees and preformed corner protection plates from steel conforming to ASTM A36/A36M or ASTM A572/A572M. Tees may be commercially rolled sections or may be fabricated from steel plates provided they have a nominal weight of not less than 42.0 kg/m 28.2 pounds/foot and conform essentially to details shown. Conform installation to details shown. Erect tees and preformed plates true to line and grade. The continuous edges of exposed faces must not have a vertical or horizontal distortion from a straight line greater than 2 mm/m 0.025 inch/foot of length. Distortion for any single section must not exceed 36 mm 1.4 inches. Where there is a warp in the installed tees or preformed plates greater than 2 mm 1/16 inch, install an extra anchor at the proper location to draw the section into position. Counter sink bolt heads on exposed faces and fit so that they are flush with the finished surfaces. Make joints between abutting sections square and saw or otherwise made smooth and regular the butting ends.

2.2.8 Lock Wall Line Hooks and Check Posts

Fabricate lock wall line hooks and check posts of alloy steel mechanical tubing as specified in paragraph MECHANICAL. Dimensions are as shown, including outside diameter and wall thickness, and anchor bars.

2.2.9 Guy Cables

Prestretched, galvanized wire rope of the sizes indicated. Conform wire rope to ASTM A475, high strength grade with Class A coating. Provide guys with a factory attached clevis top-end fitting and a factory attached open-bridge strand socket bottom-end fitting; complete with oval eye, threaded anchor rods. Hot-dip galvanize fittings and accessories.

2.2.10 Safety Chains

Galvanized welded steel, proof coil chain tested in accordance with

ASTM A467/A467M, Class CS; straight link style, 5 mm 3/16 inch diameter, minimum 12 links per foot; and with bolt type snap hooks on each end. Eye bolts for attachment of chains must be galvanized 10 mm 3/8 inch bolt with 19 mm 3/4 inch eye, anchored as indicated. Furnish two chains for each guarded opening.

2.2.11 Surface Finishes

2.2.11.1 Galvanizing and Zinc Repair

Hot-dip galvanize items specified to be galvanized, when practicable and not indicated otherwise, after fabrication. Galvanize in accordance with ASTM A123/A123M, ASTM A653/A653M, or ASTM A924/A924M, as applicable. Regalvanize areas where zinc coatings are destroyed by cutting, welding or other causes. Regalvanize coatings 50 g 2 ounces or heavier with a suitable low-melting zinc base alloy similar to the recommendations of the American Hot-Dip Galvanizers Association to the thickness and quality specified for the original zinc coating. Repair coatings less than 50 g 2 ounces in accordance with ASTM A780/A780M.

2.2.11.2 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.2.11.3 Aluminum Surfaces

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces. Unexposed sheet, plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium matte, AA DAF45. Unless otherwise specified, provide all other aluminum items with [standard mill finish.] [hand sanded or machine finish to a 240 grit.] [anodized finish.] Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or Architectural Class I type finish for items used in exterior locations in AA DAF45. Items to be anodized receive a polished satin finish.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Exposed fastenings must be compatible materials, generally match in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports provide strength and stiffness. Form joints exposed to the weather to exclude water. Items listed below require additional procedures.

3.2 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening miscellaneous metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion anchors, and powder-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.3 FINISHES

3.3.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to SSPC Paint 20 or SSPC Paint 29 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

3.3.2 Field Preparation

Remove rust preventive coating just prior to field erection, using a remover approved by the rust preventive manufacturer. Provide surfaces, when assembled, free of rust, grease, dirt and other foreign matter.

3.4 ATTACHMENT OF HANDRAILS

Set railing posts anchored to concrete surfaces perpendicular to the posts [in sleeve inserts anchored in the concrete, and fill the space between posts and sleeves with a sealant or a quick-setting hydraulic cement and cover with standard collar fittings secured to the posts. Drill a 6 mm 1/4 inch drain hole near the bottom of each post.] [rigidly secured to flange fittings anchored to concrete with expansion anchors.] Railing posts anchored to concrete surfaces parallel to the posts must [have the sides of posts continuously welded to base plates] [be rigidly secured to flange fittings] anchored to concrete with expansion anchors. Railing posts anchored to structural metal must be [welded to base plates] [rigidly secured to flange fittings] [[bolted] [welded] to structural metal]. Rigidly secure ends of rails anchored to concrete or masonry to flange fittings anchored to concrete or masonry with expansion anchors. Install toeboards and brackets where indicated. Splice, where required, at expansion joints. Install removable sections as indicated.

3.4.1 Installation of Steel Handrails

Perform installation by means of pipe sleeves secured to [wood with screws.] [masonry with expansion anchors or toggle bolts.] [base plates bolted to stringers or structural steel framework.] Secure rail ends by steel pipe flanges [anchored by expansion anchors.] [through-bolted to a back plate or by 6 mm 1/4 inch lag bolts to studs or solid backing.]

3.4.2 Installation of Aluminum Handrails

Perform installation by means of [flanges anchored to concrete or masonry by expansion shields] [base plates or flanges bolted to stringers or structural steel framework] [flanges through-bolted to a back plate or by 6 mm 1/4 inch lag bolts to studs or other structural members]. Provide stainless steel bolts used to anchor aluminum alloy flanges of a size appropriate to the standard product of the manufacturer. Provide neoprene washers and sleeves between dissimilar metals. Where aluminum or alloy fittings or extrusions are to be in contact with dissimilar metals or portland cement concrete, give the contact surface a heavy coating of bituminous paint or asphalt varnish.

3.5 MOUNTING OF SAFETY CHAINS

Mount safety chains 1 m 3 feet 6 inches and 600 mm 2 feet above the floor.

3.6 COVER PLATES AND FRAMES

Install the tops of cover plates and frames flush with floor.

3.7 LADDERS

Secure to the adjacent construction with the clip angles attached to the stringer. [Secure to masonry or concrete with not less than two 13 mm 1/2 inch diameter expansion anchors.] Install intermediate clip angles not over 1200 mm 48 inches on center. Install brackets as required for securing of ladders welded or bolted to structural steel or built into the masonry or concrete. In no case rest ends of ladders rest upon [finished roof] [floor].

3.8 STEEL STAIRS

Provide anchor bolts, grating fasteners, washers, and all parts or devices necessary for proper installation. Provide lock washers under nuts.

3.9 INSTALLATION OF GUARD POSTS (BOLLARDS/PIPE GUARDS)

****

NOTE: Ensure details of pipe guard installation are shown on the drawings.

****

Set pipe guards vertically in concrete piers. Construct piers of, and the hollow cores of the pipe filled with, concrete [specified in Section 03 30 00 CAST-IN-PLACE CONCRETE] [having a compressive strength of 21 MPa 3000 psi].

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-05 51 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 51 00 (February 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 51 00

METAL STAIRS

08/23

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-05 51 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 51 00 (February 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 05 51 00

METAL STAIRS
08/23

****

NOTE: This guide specification covers the requirements for steel stair systems which are not a part of any other metals system of the specification.

Associated work found in Division 5, "Metals," includes:

Structural welding

Structural steel

Miscellaneous metal fabrications

Structural metal fabrications

Metal ladders

Metal railings

Decorative metal specialties

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: If Section 05 05 23.16 STRUCTURAL WELDING is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.

****

[Section 05 05 23.16 STRUCTURAL WELDING applies to work specified in this section.
]

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 314	(1990; R 2013) Standard Specification for Steel Anchor Bolts

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121	(2007) Standard Definitions for Use in the Design of Steel Structures

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.6.1	(2016) Wood Screws (Inch Series)
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.6.5M	(2000; R 2010) Standard Specification for Metric Thread-Forming and Thread-Cutting Tapping Screws
ASME B18.6.7M	(1999; R 2010) Metric Machine Screws
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2024b) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A29/A29M	(2023) Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2022) Standard Specification for Gray

	Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A512	(2006; R 2012) Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E303	(2022) Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F568M	(2007) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 898-1	(2013) Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel — Part 1: Bolts, Screws and Studs with Specified Property Classes — Coarse Thread and Fine Pitch Thread

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2017) Metal Bar Grating Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Iron and Steel Hardware; G, [_____]

Steel Shapes, Plates, Bars, and Strips; G, [_____]

Metal Stair System; G, [_____]

Fabrication Drawings; G

SD-03 Product Data

Concrete Inserts; G, [_____]

Masonry Anchorage Devices; G, [_____]

Protective Coating; G, [_____]

Steel Pan Stairs; G, [_____]

Steel Stairs; G, [_____]

Steel Stairs, Circular; G, [_____]

SD-05 Design Data

Design Calculations For Steel Connections; G

SD-06 Test Reports

Mill Test Reports; G

SD-07 Certificates

[Welding Procedures; G, [_____]

][Welder Qualification; G, [_____]

] SD-08 Manufacturer's Instructions

Protective Coating; G, [_____]

Masonry Anchorage Devices; G, [_____]

1.3 QUALITY CONTROL

1.3.1 Qualifications for Welding Work

[Submit welding procedures in accordance with AWS D1.1/D1.1M. Make test specimens in the presence of the Contracting Officer, and have the specimens tested by an approved testing laboratory at the Contractor's expense.

][Certify welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, ensure that two test welds are retested immediately and that each test weld is made and passes. Failure in the immediate retest requires that the welder be retested after further practice or training and a complete set of test welds be made.

]

1.4 QUALITY ASSURANCE

1.4.1 Fabrication Drawing Requirements

****

NOTE: Include the requirement for fabrication drawings to be signed and sealed when delegated design is performed by the contractor.

****

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 325, AISC 326, ASCE 7-22, and State of [ ] Building Code. Fabrication drawings will not be reproductions of contract drawings.[Sign and seal fabrication drawings by a registered professional engineer.] Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Clearly highlight any deviations from the details shown on the contract drawings highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

[1.4.2 Delegated Connection Design

****

NOTE: Include this paragraph when delegated design is performed by the contractor.

Provide connection loads on the drawings and indicate whether the loads are LRFD, ASD, or Combined.

****

Design structural steel connection indicated in the contract documents per AISC 360. Submit design calculations for steel connections signed and sealed by a registered professional engineer.

]

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit complete and detailed fabrication drawings for all iron and steel hardware, and for all steel shapes, plates, bars, and strips used in accordance with the design specifications referenced in this section.

2.2 FABRICATION

Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning and treating surfaces and applying surface finishes, including zinc coatings.

2.2.1 General Fabrication

Prepare and submit metal stair system shop drawings with detailed plans and elevations at scales not less than 1 to 12 scale 1 inch to 1 foot and with details of sections and connections at scales not less than 1 to 4 scale 3 inches to 1 foot. Also detail the placement drawings, diagrams, and templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchorage devices.

Use materials of size and thicknesses indicated or, if not indicated, of the size and thickness necessary to produce a finished product that is strong enough and durable enough for its intended use. Work the materials to the dimensions indicated on approved detail drawings, using proven methods of fabrication and support. Use the type of materials indicated or specified for the various components of work.

Form exposed work true to line and level, with accurate angles and surfaces and with straight sharp edges. Ease exposed edges to a radius of approximately 0.8 millimeter 1/32 inch, and bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Continuously weld corners and seams in accordance with the recommendations of AWS D1.1/D1.1M. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use Phillips flat-head (countersunk) screws or bolts.

Provide and coordinate anchorage of the type indicated for the supporting structure. Fabricate anchoring devices, and space them as indicated and as necessary to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified as fabricated from cold-finished or cold-rolled stock.

2.2.2 Steel Pan Stairs

2.2.2.1 General

Joining pieces by welding. Fabricate units so that bolts and other fastenings do not appear on finished surfaces. Make joints true and tight, and connections between parts lighttight. Grind continuous welds smooth where exposed.

Construct metal stair units to sizes and arrangements indicated to support a minimum live load of 500 kilogram per square meter 100 pounds per square foot. Provide framing, hangers, columns, struts, clips, brackets, bearing plates, and other components as required for the support of stairs and platforms.

2.2.2.2 Stair Framing

Fabricate stringers of structural steel channels, or plates, or a combination thereof as indicated. Provide closures for exposed ends of strings.

Construct platforms of structural steel channel headers and miscellaneous framing members as indicated. Bolt headers to stringers and newels, and bolt framing members to stringers and headers.

2.2.2.3 Riser, Subtread, and Subplatform Metal Pans

[Form metal pans of 2.8 millimeter 0.1084-inch (12-gage) structural steel sheets, conforming to ASTM A1011/A1011M, Grade 36. Shape the pans to the configuration indicated.

][Form metal pans of 2.8 millimeter 0.1084-inch (12-gage) galvanized structural steel sheets, conforming to ASTM A653/A653M, Grade A, with zinc coating conforming to ASTM A653/A653M and ASTM A924/A924M. Shape the pans to the configuration indicated.

] Construct risers and subtread metal pans with steel angle supporting brackets, of the size indicated, welded to stringers. Secure metal pans to brackets with rivets or welds. Secure subplatform metal pans to platform frames with welds.

2.2.2.4 Metal Safety Nosings

Between stringers, provide abrasive cast metal safety nosings, 4 inches wide by the full length of the step. Fabricate nosings to the thickness, profile, and surface pattern indicated. Equip each nosing with integral anchors for embedding in the pan fill material, and space the anchors not more than 100 millimeter 4 inches from each end and not more than 380 millimeter 15 inches on center.

2.2.2.5 Steel Floor Plate Treads and Platforms

Provide raised-pattern steel floor plate fabricated from steel complying with ASTM A36/A36M. Provide the pattern indicated or, if not indicated, as selected from the manufacturer's standard patterns.

Form treads of 6 millimeter 1/4-inch thick steel floor plate with integral nosing and back-edge stiffener. Weld steel supporting brackets to strings, and weld treads to brackets.

[Fabricate platforms of steel floor plate to the thickness indicated. Provide nosing that match treads at landings. Secure floor plates to platform framing members with welds.

]2.2.2.6 Safety Nosings for Concrete Treads

****

NOTE: Cast iron nosings may be specified where heavy use is anticipated. They should not be used where appearance is important since they tend to discolor or rust. Check for availability. Cast aluminum nosings may cost more than cast iron nosings, but may be more readily available. Specify where appearance is important.

****

[Provide safety nosings of [cast aluminum] [cast iron] with [cross-hatched] [plain] abrasive surfaces, or extruded aluminum with abrasive inserts, at least 100 mm 4 inches wide and 6 mm 1/4 inch thick [and terminating at not more than 150 mm 6 inches from the ends of treads] [for metal-pan cement-filled treads extending the full length of the tread] for stairs and [as indicated] for platforms and landings. Provide safety nosings with anchors embedded a minimum of 20 mm 3/4 inch in the concrete and with tops flush with the top of the traffic surface.

]2.2.2.7 Safety Treads

****

NOTE: Select and indicate tread type. Delete

remaining tread types.

NAAMM MBG 531:

W - welded (steel)
P - pressure locked (steel or aluminum)
R - riveted (steel or aluminum)

ASTM A653/A653M W welded (steel) or ASTM B209M ASTM B209 B bolted (steel or aluminum); or for concrete-filled metal pan-treads ASTM A1011/A1011M, ASTM A568/A568M, steel.

****

****
NOTE: Each tread and the top landing of a stairway where vertical risers are used should have a nose that extends 12 to 25 mm 1/2 inch to 1 inch beyond the face of the lower riser. Include large-scale details of stairs and safety nosings on the drawings.
****

[NAAMM MBG 531 [aluminum] [steel], Type [_____]] [Plank grating ASTM A653/A653M, Z275 G-90] [aluminum ASTM B209M, ASTM B209] [ASTM A1011/A1011M, steel pan for concrete tread.

]2.2.2.8 Steel Framing for Concrete Stairs

When necessary, modify fabricated units to fit actual dimensions of the supporting structure. Join steel components by welding. Provide 2 millimeter 14-gage steel risers unless otherwise indicated. Arrange components to receive finish materials as indicated.

2.2.3 Floor Grating Treads and Platforms

****
NOTE: Use galvanized treads and platforms for exterior stairs.
****

Provide floor grating treads and platforms conforming to ASTM A6/A6M, ASTM A29/A29M and NAAMM MBG 531, "Metal Bar Grating Manual." Provide the pattern, spacing, and bar sizes as indicated:

[a. Galvanized finish, conforming to ASTM A123/A123M.

][b. Manufacturer's baked-on primer for painted finishes.

] Fabricate grating treads with steel plate nosings on one edge and with steel angle or steel plate carriers at each end for string connections. Secure treads to strings with bolts.

Match the nosings of grating platforms with the nosing of grating treads at landings. Provide toeplates where the open-sided edges of floor grating meet platform framing members.

2.2.4 Protective Coating

[Shop-prime steelwork as indicated in accordance with AISC/AISI 121, except surfaces of steel encased in concrete; welded surfaces; high-strength, bolt-connected surfaces; and surfaces of crane rails.

][Hot-dip galvanize steelwork as indicated in accordance with ASTM A123/A123M. Touch up abraded surfaces and cut ends of galvanized members with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.

]2.3 COMPONENTS

2.3.1 Steel Stairs

****

NOTE: Design fire escapes of the type and arrangement to conform to Fire Escape Stairs, Section 5, of NFPA 101, Code for Safety to Life.

****

****

NOTE: Consider the footwear typically worn by personnel using grating treads and landings with openings through the surface.

****

Provide steel stairs complete with stringers, [steel-plate treads and risers,] [metal-pan concrete-filled treads,] [grating treads,] [nonskid metallic treads,] [precast concrete treads,] landings, columns, handrails, and necessary bolts and other fastenings. [Hot-dip-galvanize] [Shop-paint] steel stairs and accessories.

2.3.1.1 Design Loads

****

NOTE: For industrial or heavy-duty stairs use a live load of five times the expected load and a concentrated load of 2 kN 1000 lb. For standard applications, use a live load of 500 kg per square m 100 psf and a concentrated load of 1.3 kN 300 lb.

****

Design stairs to sustain a live load of not less than [_____] kg per square meter pounds per square foot, or a concentrated load of [_____] applied where it is most critical. Except for a commercial product, design and fabricate steel stairs to conform to AISC 360. [Design fire stairs to conform to NFPA 101.]

2.3.1.2 Materials

****

NOTE: Provide each tread, and the top landing of a stairway where vertical risers are used, with a nose that extends 12 to 25 mm 1/2 inch to 1 inch beyond the face of the lower riser. Include large-scale details of stairs and safety nosings on the drawings.

****

****

NOTE: Select and indicate tread types.
****

Provide steel stairs of welded construction except that bolts may be used where welding is not practicable. Do not use screw or screw-type connections.

a. Structural Steel: ASTM A36/A36M.

b. Gratings for Treads and Landings: [NAAMM MBG 531] [or] [Plank grating; ASTM A653/A653M, Z275 G-90 for steel; ASTM B209M ASTM B209 for aluminum.] [Provide gratings with nonslip nosings.] [with slip resistance exceeding a static coefficient of friction, both wet and dry, of [0.5] [0.6] as tested in accordance with ASTM E303.]

c. Support [steel floor plate] [metal pan for concrete fill] [steel grating] on angle cleats welded to stringers or treads with integral cleats, welded or bolted to the stringer. [Provide sheet-steel landings with angle stiffeners welded on.] Close exposed ends. [For exterior stairs, form all exposed joints to exclude water.]

[d. Ensure that precast concrete treads are factory-built as specified in Section 03 45 33 PRECAST[PRESTRESSED] STRUCTURAL CONCRETE.

] e. Before fabrication, obtain necessary field measurements and verify drawing dimensions.

f. Clean metal surfaces free of mill scale, flake rust, and rust pitting before shop finishing. Weld permanent connections. Finish welds flush and smooth on surfaces that will be exposed after installation.

2.3.2 Steel Stairs, Circular

Provide standard open riser constructed of steel, with a minimum outside diameter of 1800 mm 6 feet and with 12 treads to the circle. Construct the center pole from one continuous length of circular, cold-drawn, seamless tube with a minimum outside diameter of 90 mm 3 1/2 inches and with caps at the top plate and base plate having countersunk machine screws and expansion shields for fastening to the concrete floor slab. Construct treads and platforms from steel grating conforming to NAAMM MBG 531. [Provide nonslip nosings for gratings.] [Design slip-resistant gratings to exceed a static coefficient of friction of 0.5 [0.6] as tested in accordance with ASTM E303.]

2.3.3 Soffit Clips

Provide clips with holes for attaching metal furring for plastered soffits. Space the clips not more than 300 millimeter 12 inches on center, and weld them to stair treads and platforms as required.

2.3.4 Concrete Inserts

****
NOTE: Use inserts for fastening steel stair items to cast-in-place concrete construction subjected to direct pullout loadings such as shelf angles and supports attached to concrete slab ceilings. Indicate locations of inserts.
****

[Threaded-type concrete inserts consisting of galvanized ferrous castings, internally threaded to receive M20 3/4-inch diameter machine bolts; either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M, and hot-dip-galvanized in accordance with ASTM A153/A153M.

][Wedge-type concrete inserts consisting of galvanized box-type ferrous castings designed to accept M20 3/4-inch diameter bolts having special wedge-shaped heads; either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M and hot-dip-galvanized in accordance with ASTM A153/A153M.

][Carbon steel bolts having special wedge-shaped heads, nuts, washers, and shims and galvanized in accordance with ASTM A153/A153M. Provide slotted-type concrete inserts consisting of galvanized 3 millimeter 1/8-inch thick pressed steel plate conforming to ASTM A283/A283M; of box-type welded construction with slot designed to receive M20 3/4-inch diameter square-head bolt with knockout cover; and be hot-dip-galvanized in accordance with ASTM A123/A123M.

]2.3.5 Masonry Anchorage Devices

****

NOTE: Use only masonry anchorage devices for fastening steel stair items to solid masonry and concrete when the anchor is not subjected to pullout loads or vibration in shear loads.

****

Provide masonry anchorage devices consisting of expansion shields complying with AASHTO M 314, ASTM E488/E488M and ASTM C514 as follows:

[a. Lead expansion shields for machine screws and bolts 6 millimeter 1/4 inch and smaller; head-out embedded-nut type, single unit class, Group I, Type 1, Class 1.

][b. Lead expansion shields for machine screws and bolts larger than 6 millimeter 1/4 inch in size; head-out embedded-nut type, multiple unit class, Group I, Type 1, Class 2.

][c. Bolt anchor expansion shields for lag bolts; zinc-alloy, long-shield anchors class, Group II, Type 1, Class 1.

][d. Bolt anchor expansion shields for bolts; closed-end bottom-bearing class, Group II, Type 2, Class 1.

]

****

NOTE: Use toggle bolts for anchoring steel stair items to hollow masonry and stud partitions.

****

Use toggle bolts of the tumble-wing type, conforming to ASTM A325M ASTM A449, ASTM C636/C636M, and ASTM F3125/F3125M, type, class, and style as required.

2.3.6 Fasteners

****

NOTE: Select the fasteners that are consistent with the stair system design.

****

Select galvanized zinc-coated fasteners conforming to ASTM A153/A153M for exterior applications or where the fasteners are built into exterior walls or floor systems. Select the fasteners for the type, grade, and class required for the installation of steel stair items:

a. Standard/regular hexagon-head bolts and nuts, conforming to ASTM F568M, ASTM A307, Grade A.

b. Square-head lag bolts conforming to ISO 898-1, ASME B18.2.1.

c. Cadmium-plated steel machine screws, conforming to ASME B18.6.7M, ASME B18.6.3.

d. Flat-head carbon steel wood screws, conforming to ASME B18.6.5M, ASME B18.6.1.

e. Plain, round, general-assembly-grade, carbon steel washers, conforming to ASME B18.22M ASME B18.21.1.

f. Helical-spring, carbon steel lockwashers, conforming to ISO 898-1 ASME B18.2.1.

2.4 MATERIALS

2.4.1 Structural Steel Plates, Shapes and Bars

Structural size shapes and plates, conforming to ASTM A36/A36M, unless otherwise noted, except bent or cold-formed plates.

Steel plates - bent or cold-formed, conforming to ASTM A283/A283M, Grade C.

Steel bars and bar-size shapes, conforming to ASTM A36/A36M, unless otherwise noted for steel bars and bar-size shapes.

2.4.2 Structural Steel Tubing

****

NOTE: Includes square, rectangular, round, and specially shaped structural steel tubing.

****

Provide the following:

[a. Structural steel tubing, hot-formed, welded or seamless, conforming to ASTM A500/A500M, Grade B, unless otherwise noted.

][Structural steel tubing, hot-formed, welded or seamless, conforming to [_____] Grade [_____].

]2.4.3 Hot-Rolled Carbon Steel Bars

Provide the following:

[a. Hot-rolled carbon steel bars and bar-size shapes, conforming to ASTM A575, grade as selected by the fabricator.

][b. Hot-rolled carbon steel bars and bar-size shapes, conforming to

[_____], grade as selected by the fabricator.

]2.4.4 Cold-Finished Steel Bars

Provide the following:

[a. Cold-finished steel bars conforming to ASTM A108, grade as selected by the fabricator.

][b. Cold-finished steel bars conforming to [_____], grade as selected by the fabricator.

]2.4.5 Hot-Rolled Carbon Steel Sheets and Strips

Provide the following:

[a. Hot-rolled carbon sheets and strips conforming to ASTM A568/A568M and ASTM A1011/A1011M, pickled and oiled.

][b. Hot-rolled carbon sheets and strips conforming to [_____].

]2.4.6 Cold-Rolled Carbon Steel Sheets

Provide the following:

[a. Cold-rolled carbon steel sheets conforming to ASTM A1008/A1008M.

][b. Cold-rolled carbon steel sheets conforming to [_____].

]2.4.7 Galvanized Carbon Steel Sheets

Provide the following:

[a. Galvanized carbon steel sheets conforming to ASTM A653/A653M, with galvanizing conforming to ASTM A653/A653M and ASTM A924/A924M.

][b. Galvanized carbon steel sheets conforming to [_____], with galvanizing conforming to [_____].

]2.4.8 Cold-Drawn Steel Tubing

Provide the following:

[a. Cold-drawn steel tubing conforming to ASTM A512, sunk drawn, butt-welded, cold-finished, and stress-relieved.

][b. Cold-drawn steel tubing conforming to [_____], [_____].

]2.4.9 Gray Iron Castings

Provide the following:

[a. Gray iron castings conforming to ASTM A48/A48M, Class 30.

][b. Gray iron castings conforming to [_____], Class [_____].

]2.4.10 Malleable Iron Castings

Provide the following:

[a. Malleable iron castings conforming to ASTM A47/A47M, grade as selected.

][b. Malleable iron castings conforming to [_____], grade as selected.

]2.4.11 Steel Pipe

Provide the following:

[a. Steel pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

][b. Steel pipe conforming to [_____], type as selected, Grade [_____]; primed finish, unless galvanizing is required; [standard weight (Schedule 40)] [_____].

]2.5 Mill Test Reports

Provide mill test reports for [structural steel plates, shapes, and bars][structural steel tubing][hot-rolled carbon steel bars][cold-finished steel bars][hot-rolled carbon steel sheets and strips][cold-rolled carbon steel sheets][galvanized carbon steel sheets][cold-drawn steel tubing][grey iron castings][malleable iron castings]. Mill test report will include but is not limited to material heat number, material grade, edition year and type of specification met, material dimension, mechanical properties, chemical analysis, heat treatment (if applicable), and certified inspector signature.

PART 3 EXECUTION

3.1 PREPARATION

Clean surfaces thoroughly before installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions. Examine materials upon arrival at site. Notify the carrier and manufacturer of any damage.

Protect installed products until completion of project. Touch up, repair or replace, damaged products before substantial completion

3.2 INSTALLATION

Install in accordance with the manufacturer's instructions and approved submittals. Install in proper relationship with adjacent construction.

Install items at locations indicated, according to the manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Ensure that exposed fastenings are compatible with generally match the color and finish of, and harmonize with the material to which they are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Select thickness of metal and details of assembly and supports that adequately strengthen and stiffen the construction. Form joints exposed to the weather to exclude water.

3.2.1 Field Preparation

Remove rust-preventive coating just before field erection, using a remover approved by the coating manufacturer. Provide surfaces, when assembled, free of rust, grease, dirt and other foreign matter.

3.2.2 Field Welding

Comply with AWS D1.1/D1.1M in executing manual shielded-metal arc welding, (for appearance and quality of new welds) and in correcting existing welding.

3.2.3 Safety Nosings

Completely embed nosing in concrete before the initial set of the concrete occurs and finish flush with the top of the concrete surface.

[3.2.4 Touchup Painting

****

NOTE: Delete this paragraph if touchup painting is excluded from the steel stair erector's work.

****

Immediately after installation, clean all field welds, bolted connections, and abraded areas of the shop-painted material, and repaint exposed areas with the same paint used for shop painting. Apply paint by brush or spray to provide a minimum dry-film thickness of 0.051 millimeter 2 mils.

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-05 51 33 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 51 33 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-05 51 33 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 51 33 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 05 51 33

METAL LADDERS
08/24

****

NOTE: This guide specification covers requirements for metal ladders.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Show the following information on the drawings:

1. Location and configuration of all metalwork.

2. All sizes and dimensions.

3. Special fastenings, attachments or anchoring.

4. Location of products to be galvanized.

5. Location and support detail of ladders.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN LADDER INSTITUTE (ALI)

ALI A14.3	(2008; R 2018) Ladders - Fixed - Safety Requirements

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z359.16	(2016) Safety Requirements for Climbing Ladder Fall Arrest Systems

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe,

	Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM D1187/D1187M	(1997; R 2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for Metal

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3	(2024) Power Tool Cleaning

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-200-01	(2022; with Change 4, 2024) DoD Building Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23	(Nov 2016) Ladders
29 CFR 1910.25	(Dec 2019)Stairways
29 CFR 1910.28	(Nov 2016)Duty to Have Fall Protection and Falling Object Protection
29 CFR 1910.29	(Nov 2016) Fall Protection System and Falling Object Protection - Criteria and Practices

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Ladders, Installation Drawings

Ship Stair / Ship Alternating Tread-Type Stair (With or Without Guards), Installation Drawings

SD-03 Product Data

Ladders

Ship Stair / Ship Alternating Tread-Type Stair (With or Without Guards)

Ladder Safety Devices (Climbing Ladder Fall Arrest Systems)

SD-07 Certificates

Fabricator Certification for Ladder Assembly

Fabricator Certification for Ship Stair / Ship Alternating Tread-Type Stair Assembly

1.3 CERTIFICATES

Provide fabricator certification for ladder assembly stating that the ladder and associated components have been fabricated according to the requirements of 29 CFR 1910.23.

Provide fabricator certification for Ship Stair / Ship Alternating Tread-Type Stair assembly stating that the Ship Stair / Ship Alternating Tread-Type Stair and associated components have been fabricated according to the requirements of 29 CFR 1910.25.

1.4 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.5 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

****

NOTE: Product selections should be based on esthetic values, reliability and cost. Delete alternate requirements where they occur.

****

2.1 SUSTAINABILITY REQUIREMENTS AND REPORTING

See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for sustainable design requirements for the following, except as modified herein.

2.1.1 Recycled Content of Products

Provide products with post-consumer recycled content plus one-half of pre-consumer recycled content to the greatest extent possible, but not less than 10 percent

2.2 MATERIALS

2.2.1 Structural Carbon Steel

ASTM A36/A36M.

2.2.2 Structural Tubing

ASTM A500/A500M.

2.2.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.2.4 Fittings for Steel Pipe

Standard malleable iron fittings ASTM A47/A47M.

2.2.5 Aluminum Alloy Products

Conform to ASTM B209/B209M for sheet plate, ASTM B221M ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 3 mm 1/8 inch thick and aluminum plate or sheet at least 1.3 mm 0.050 inch thick.

2.3 FABRICATION FINISHES

****

NOTE: In the Safety Data Sheets (SDS) for coating materials show exclusion or replacement of the following materials as intended ingredients: asbestos, benzene, chromium compounds, coal tar, 2-ethoxyethanol and 2-methoxyethanol and their acetates, halogenated hydrocarbons, and lead compounds. The content of volatile organic compounds (VOC), and marking, must be in compliance with air quality regulations for the type of application and jurisdiction where used.

****

2.3.1 Galvanizing

****

NOTE: Specify galvanizing for items installed in exterior exposures subject to salt spray or corrosive fumes and interior areas subject to continual wetting or high humidity. Applicability

of material and finishes must be based on UFC 1-200-01, including but not limited to, identifying corrosion prone locations and their applicability within the specification, and ensuring current mitigation measures are captured within the guide specification.

****

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, Z275 G90, as applicable.

2.3.2 Galvanize

Anchor bolts, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

[2.3.3 Repair of Zinc-Coated Surfaces

****

NOTE: Delete this paragraph when no galvanized items are specified.

****

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread molten material uniformly over surfaces to be coated and wipe off excess material.

]2.3.4 Shop Cleaning and Painting

****

NOTE: Shop painting herein is for steel protected from the weather and not subjected to corrosive environments. For steel which will be exposed to the weather or corrosive environments, modify the shop painting accordingly.

****

2.3.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean.

2.3.4.2 Pretreatment, Priming and Painting

****

NOTE: Use manufacturers standard treatment when painting and finishing is required.

****

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions.[On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 0.03 mm 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.]

2.3.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.3.6 Aluminum Surfaces

2.3.6.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.3.6.2 Aluminum Finishes

Unexposed plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified, provide all other aluminum items with[standard mill finish][hand sanded or machine finish to a 240 grit]. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF45.[For selection of a specific finish or coating based on corrosion resistance requirements and environmental severity class (ESC) in UFC 1-200-01, refer to AA DAF45].

2.4 LADDERS

****

NOTE: Indicate on the drawings ladder locations and details of critical dimensions and materials, all which must meet 29 CFR 1910.23 and ALI A14.3. For ladders that require a "Safety Device", select the "dynamic loading" second option.

****

Fabricate vertical ladders conforming to 29 CFR 1910.23 and Section 5 of ALI A14.3. Design assembly, including rung connections and methods of attachment, to support a live load of 1.33 kilonewtons 1300 N 300 pounds per rung, or 4.45 kilonewtons 1000 pounds point load, or 4.79 kilopascals 100 pounds per square foot load applied downward.[Use 65 by 10 mm 2 1/2 by 3/8 inch steel flats for stringers and 20 mm 3/4 inch diameter steel rods for rungs.][Ladders requiring a "Safety Device" must have stringers and rungs that meet the minimum strength requirements of the Safety Device anchor points dynamic loading.] Ladder rungs, step and cleats must be spaced not less than 25 cm 10 inches and not more than 400 mm 16 inches wide (measured before installation of ladder safety system), spaced no more than 36 cm 14 inches apart, plug welded or shouldered and headed into stringers. Install ladders so that the maximum perpendicular distance from the centerline of the steps or rungs, or grab bars, or both, to the nearest permanent object in the back of the ladder or to the finished wall surface will not be less than 175 mm 7 inches, except for the elevator pit ladders, which have a minimum perpendicular distance of 11 cm 4.5 inches. Provide heavy clip angles riveted or bolted to the stringer and drilled[for not less than two 12 mm 1/2 inch diameter expansion bolts] as indicated.

Provide intermediate clip angles not over 1200 mm 48 inches on centers. The top rung of the ladder must be level with the top of the access level, parapet or landing served by the ladder except for hatches or wells. Extend the side rails of through or side step ladders 105 centimeters 42 inches above the access level. Provide ladder access protective swing gates at the top of access/egress level. The drawings must indicate ladder locations and details of critical dimensions and materials.

2.4.1 Phasing out of Ladder Cages and Wells (29 CFR 1910.28, Nov 2016)

****

NOTE: Delete this paragraph when the length of climb is 6000 mm 20 feet or less. Cages or wells are not considered adequate fall protection regardless of climb height for Navy/ Marine Corps facilities.

****

Conform to 29 CFR 1910.28 (Nov 2016).

****

NOTE: For Navy projects refer to Department of the Navy Fall Protection Guide, July 2017, section 8.2.4.6 "Ladder Cages." Ladder cages are not an acceptable form of fall protection in Navy projects. OSHA also does not consider ladder cages an acceptable form of fall protection. Any existing ladder that has a safety cage is to be provided with a ladder safety system if the ladder or the safety cage is being replaced.

****

Each newly installed fixed ladder over 6,000 mm 20 feet in length must be equipped with a personal fall arrest system or climbing ladder fall arrest system (ladder safety device), cages and wells can still be utilized, but will not qualify as fall protection. When a fixed ladder, cage, or well, or any portion of a section thereof, is replaced, a personal fall arrest system or climbing ladder fall arrest system (ladder safety device) must be installed in at least that section of the fixed ladder, cage, or well where the replacement is located. The minimum strength requirements of the safety device anchor points dynamic loading must be coordinated with existing rungs and stringers to confirm they have capacity. On and after November 18, 2036, all fixed ladders must only be equipped with a personal fall arrest system or a ladder safety device (climbing ladder Fall Arrest System).

2.4.2 Ladder Safety Devices (Climbing Ladder Fall Arrest Systems)

****

NOTE: Delete this paragraph when the length of climb is 6000 mm 20 feet or less.

****

Conform to 29 CFR 1910.29, Section 7 of ALI A14.3 and ASSP Z359.16. Install ladder safety devices on ladders over 6000 mm 20 feet long or more. The ladder safety systems must meet the design requirement of the ladders which they serve. The ladder safety system must be capable of sustaining a minimum static load of four personnel that may be attached to the fall safety device and climb the ladder at one time. The ladder must have ladder members or anchor points that meet the minimum loading requirements as defined by the safety device and the ladder must be designed to handle the dynamic load being applied in the event of a fall Each ladder safety system must allow the worker to climb up and down using both hands and does not require the employee continuously, hold, push, or pull any part of the system while climbing. The connection between the carrier or lifeline and the point of attachment to the body harness does not exceed 23 cm 9 inches. The ladder safety system consists of a rigid or flexible carrier. Mountings for the rigid carries are attached at each end of the carrier, with intermediate mountings spaced as necessary, along the entire length of the carrier. Mountings for flexible carrier are attached at each end of the carrier and cable guides for flexible carriers are installed at least 7.6 m 25 feet apart but not more than 12.2 m 40 feet apart along the entire length of the carrier. The design and installation of mountings and cable guides does not reduce the design strength of the ladder.

2.4.3 Ladder Security Gate

For ATFP Security Upgrade projects, provide existing ladders with either a ladder security guard door or ladder cage security guard gate. Ladder guard doors and gates are to be a minimum height of 1829 mm 6 feet 0 inches and constructed of 16 gauge galvanized steel. Provide a minimum of two hinges that are 100 mm by 100 mm by 3 mm 4 inches by 4 inches by 1/8 inch zinc-coated plates steel with a 6 mm 1/4 inch minimum diameter pin.

2.4.4 Ship Stair / Ship Alternating Tread-Type Stair

Fabricate stringers and framing of steel plate or shapes. Bolt, rivet or weld connections and anchor to supporting construction. Provide treads with non-slip surface as specified for safety treads.[Aluminum ladders may be provided, subject to approval of treads, materials, and shop drawings. Requirements shown or specified for steel apply. Provide anchor items of zinc-coated steel.] Design assembly, including tread connections and methods of attachment, to support a live load of 1300 N 300 pounds per tread. Provide railings as specified for metal handrails.

2.4.5 Existing Roof Access Ladder ATFP Security Upgrade (Ladder Security Door or Ladder Cage Security Gate)

Fabricate security door of steel plate or shapes to be 1829 mm 6 feet 0 inch long minimum, match width and anchor to existing ladder stringers with hinges and a hasp for locking in the closed position. Fabricate cage security gate of steel plate or shapes with a 152 mm 6 inch maximum gap between bars and sized to match the diameter of existing cage. Gate to be attached to the cage with hinge(s) and a hasp for locking in the closed position

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Provide exposed fastenings of compatible materials, generally matching in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners will be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports must provide strength and stiffness. Formed joints exposed to the weather to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

Metalwork must be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching must produce clean true lines and surfaces. Continuously weld along the entire area of contact. Do not tack weld exposed connections of work in place. Grind exposed welds smooth. Provide smooth finish on exposed surfaces of work in place, unless otherwise approved. Where tight fits are required, mill joints. Cope or miter corner joints, well formed, and in true alignment. Install in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion anchors, and powder-actuated fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine bolts, carriage bolts and powder-actuated threaded studs for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.4 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.5 FINISHES

3.5.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

[3.5.2 Field Preparation

****

NOTE: Delete this paragraph when Section 09 90 00, PAINTS AND COATINGS is included in the project specifications.

****

Remove rust preventive coating just prior to field erection, using a remover approved by the rust preventive manufacturer. Surfaces, when assembled, must be free of rust, grease, dirt and other foreign matter.

][3.5.3   Environmental Conditions

****
NOTE: Delete this paragraph when Section 09 90 00, PAINTS AND COATINGS is included in the project specifications.
****

Do not clean or paint surface when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than minus 15 degrees C 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 7 degrees C or over 35 degrees C 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

]3.6   LADDERS

Secure to the adjacent construction with the clip angles attached to the stringer.[Secure to masonry or concrete with not less than two 12 mm 1/2 inch diameter expansion bolts.] Install intermediate clip angles not over 1200 mm 48 inches on center. Install brackets as required for securing of ladders welded or bolted to structural steel or built into the masonry or concrete. Ends of ladders must not rest upon[finished roof][floor].

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-05 52 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 52 00 (February 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 05 52 00

METAL RAILINGS

08/23

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USACE / NAVFAC / AFCEC **UFGS-05 52 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 52 00 (February 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 05 52 00

METAL RAILINGS
08/23

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NOTE: This guide specification covers the requirements for metal railing systems which are not a part of any other metals system of the specification.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Associated work found in Division 05, "Metals," includes:

Structural welding

Structural steel

Miscellaneous metal frabrications

Steel stairs

Metal ladders

Decorative metal specialties

Installation of inserts and anchorage devices

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 180	(2012; R 2017) Standard Specification for Corrugated Sheet Steel Beams for Highway Guardrail
AASHTO M 314	(1990; R 2013) Standard Specification for Steel Anchor Bolts

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.3.8M	(1981; R 2005) Metric Hex Lag Screws
ASME B18.6.1	(2016) Wood Screws (Inch Series)
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.6.5M	(2000; R 2010) Standard Specification for Metric Thread-Forming and Thread-Cutting Tapping Screws
ASME B18.6.7M	(1999; R 2010) Metric Machine Screws
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel

	Hardware
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A467/A467M	(2020) Standard Specification for Machine Coil Chain
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A512	(2006; R 2012) Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B429/B429M	(2010; E 2012) Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements

ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 898-1	(2013) Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel — Part 1: Bolts, Screws and Studs with Specified Property Classes — Coarse Thread and Fine Pitch Thread

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 521	(2001; R 2012) Pipe Railing Systems Manual

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Preinstallation Meetings

Within [30] [_____] days of contract award, submit fabrication drawings [to the Contracting Officer] for the following items:

[a. Iron and steel hardware

][b. Steel shapes, plates, bars and strips

][c. Steel railings and handrails

][d. Aluminum railings and handrails

] e. Anchorage and fastening systems

Submit manufacturer's catalog data, including two copies of manufacturers specifications, load tables, dimension diagrams, and anchor details for the following items:

[a. Structural-steel plates, shapes, and bars

][b. Structural-steel tubing

][c. Cold-finished steel bars

][d. Hot-rolled carbon steel bars

][e. Cold-drawn steel tubing

][f. Concrete inserts

][g. Masonry anchorage devices

][h. Protective coating

][i. Steel railings and handrails

][j. Aluminum railings and handrails

] k. Anchorage and fastening systems

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, [_____]

Iron and Steel Hardware; G, [_____]

Steel Shapes, Plates, Bars and Strips; G, [_____]

SD-03 Product Data

Concrete Inserts; G, [_____]

Masonry Anchorage Devices; G, [_____]

Protective Coating; G, [_____]

Steel Railings and Handrails; G, [_____]

Aluminum Railings and Handrails; G, [_____]

Anchorage and Fastening Systems; G, [_____]

SD-05 Design Data

Design Calculations For Steel Connections; G

SD-06 Test Reports

Welding Inspections; G

Mill Test Reports; G

SD-07 Certificates

Welder Qualification; G, [_____]

SD-08 Manufacturer's Instructions

Installation Instructions

1.4 QUALITY CONTROL

1.4.1 Welding Procedures

****

NOTE: If Section 05 05 23.16 STRUCTURAL WELDING is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.

****

[Section 05 05 23.16 STRUCTURAL WELDING applies to work specified in this section.

] Submit results of welding inspections testing in accordance with AWS D1.1/D1.1M by an approved testing laboratory at the Contractor's expense. Provide laboratory welding inspection results to Contracting Officer.

1.4.2 Welder Qualification

Submit certified welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, conduct an immediate retest of two test welds and ensure that each test weld passes. Failure in the immediate retest will require that the welder be retested after further practice or training and make a complete set of test welds.

1.5 QUALITY ASSURANCE

1.5.1 Fabrication Drawing Requirements

****

NOTE: Include the requirement for fabrication drawings to be signed and sealed when delegated design is performed by the contractor.

****

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 325, AISC 326, ASCE 7-22, and State of [ ] Building Code. Fabrication drawings will not be reproductions of contract drawings.[Sign and seal fabrication drawings by a registered professional engineer.] Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Clearly highlight any deviations from the details shown on the contract drawings highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

[1.5.2 Delegated Connection Design

****

NOTE: Include this paragraph when delegated design is performed by the contractor.

Provide connection loads on the drawings and indicate whether the loads are LRFD, ASD, or Combined.

****

Design structural steel connection indicated in the contract documents per AISC 360. Submit design calculations for steel connections signed and sealed by a registered professional engineer.
]

PART 2 PRODUCTS

2.1 FABRICATION

Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning, treating, and applying surface finishes, including zinc coatings.

Provide railing and handrail detail plans and elevations at not less than 1 to 12 scale 1 inch to 1 foot. Provide details of sections and connections at not less than 1 to 4 scale 3 inches to 1 foot. Also detail setting drawings, diagrams, templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchors.

Use materials of size and thicknesses indicated or, if not indicated, of the size and thickness necessary to produce adequate strength and durability in the finished product for its intended use. Work the materials to the dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use the type of materials indicated or specified for the various components of work.

Form exposed work true to line and level, with accurate angles and surfaces and straight sharp edges. Ensure that all exposed edges are eased to a radius of approximately 0.8 millimeter 1/32 inch. Bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Weld corners and seams continuously and in accordance with the recommendations of AWS D1.1/D1.1M. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form the exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use countersunk Phillips flathead screws or bolts.

Provide anchorage of the type indicated and coordinated with the supporting structure. Fabricate anchoring devices and space as indicated and as required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified to be fabricated from cold-finished or cold-rolled stock.

2.1.1 Aluminum Railings

Fabrication: Provide fabrication jointing by one of the following methods:

a. Use flush-type rail fittings, welded and ground smooth with splice locks secured with 10 mm 3/8 inch recessed-head set screws.

b. Ensure that mitered and welded joints made by fitting; post to top rail; intermediate rail to post; and corners, are groove welded and ground smooth. Where allowed by the Contracting Officer, provide butt splices reinforced by a tight-fitting dowel or sleeve not less than 150 mm 6 inches in length. Tack-weld or epoxy-cement the dowel or sleeve to one side of the splice.

c. Assemble railings using slip-on aluminum-magnesium alloy fittings for joints. Fasten fittings to pipe or tube with 6 or 10 mm 1/4 or 3/8 inch stainless-steel recessed-head setscrews. Provide assembled railings with fittings only at vertical supports or at rail terminations attached to walls. Provide expansion joints at the midpoint of panels. Provide a setscrew in only one side of the slip-on sleeve. Provide alloy fittings to conform to ASTM B26/B26M.

[Provide removable railing sections as indicated. [Provide toe-boards and brackets where indicated, using flange castings as appropriate.]

]2.1.2 Steel Handrails

Fabricate joint posts, rail, and corners by one of the following methods:

a. Flush-type rail fittings of commercial standard, welded and ground smooth, with railing splice locks secured with 10 mm 3/8 inch hexagonal-recessed-head setscrews.

b. Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove-welding joints, and grinding smooth. Butt railing splices and reinforce them by a tight-fitting interior sleeve not less than 150 mm 6 inches long.

c. Railings may be bent at corners in lieu of jointing, provided that bends are made in suitable jigs and the pipe is not crushed.

[Provide removable sections as indicated.

][2.1.3 Protective Coating

[Shop-prime the steelwork as indicated in accordance with Section 09 90 00 PAINTS AND COATINGS except the following:

a. Steel surfaces encased in concrete

b. Steel surfaces for welding

c. High-strength bolt-connected contact surfaces

d. Crane rail surfaces

][Provide hot-dipped galvanized steelwork as indicated in accordance with ASTM A123/A123M. Touch up abraded surfaces and cut ends of galvanized members with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.

]]2.2 COMPONENTS

[2.2.1 Structural Steel Plates, Shapes and Bars

Provide structural-size shapes and plates, except plates to be bent or cold-formed, conforming to ASTM A36/A36M, unless otherwise noted.

Provide steel plates, to be bent or cold-formed, conforming to ASTM A283/A283M, Grade C.

Provide steel bars and bar-size shapes conforming to ASTM A36/A36M, unless otherwise noted.

][2.2.2 Structural-Steel Tubing

****

NOTE: Includes square, rectangular, round, and specially shaped structural-steel tubing.

****

Provide structural-steel tubing, hot-formed, welded or seamless, conforming to ASTM A500/A500M, Grade B, unless otherwise noted.

][2.2.3 Hot-Rolled Carbon Steel Bars

Provide bars and bar-size shapes conforming to ASTM A575, grade as selected by the fabricator.

][2.2.4 Cold-Finished Steel Bars

Provide cold-finished steel bars conforming to ASTM A108, grade as selected by the fabricator.

][2.2.5 Cold-Drawn Steel Tubing

Provide tubing conforming to ASTM A512, sunk-drawn, butt-welded, cold-finished, and stress-relieved.

][2.2.6 Steel Pipe

Provide pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

][2.2.7 Concrete Inserts

****

NOTE: Use inserts for fastening steel stair items to cast-in-place concrete construction subjected to direct pullout loadings such as shelf angles and supports attached to concrete slab ceilings. Indicate all locations of inserts.

****

[Provide threaded-type concrete inserts consisting of galvanized ferrous castings, internally threaded to receive M20 3/4 inch diameter machine bolts; either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M, hot-dip galvanized in accordance with ASTM A153/A153M.

][Provide wedge-type concrete inserts consisting of galvanized box-type ferrous castings designed to accept M20 3/4 inch diameter bolts having special wedge-shaped heads, made of either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M and hot-dip galvanized in accordance with ASTM A153/A153M.

][Provide carbon steel bolts having special wedge-shaped heads, nuts, washers, and shims, galvanized in accordance with ASTM A153/A153M. Provide slotted-type concrete inserts consisting of a galvanized 3 millimeter 1/8 inch thick pressed-steel plate conforming to ASTM A283/A283M, made of box-type welded construction with a slot designed to receive M20 3/4 inch diameter square-head bolt with knockout cover; and hot-dip galvanized in accordance with ASTM A123/A123M.

]][2.2.8 Masonry Anchorage Devices

****

NOTE: Use masonry anchorage devices only for fastening steel stair items to solid masonry and concrete when the anchor is not subjected to pullout loads or vibration in shear loads.

****

Provide masonry anchorage devices consisting of expansion shields complying with AASHTO M 314, ASTM E488/E488M and ASTM C514 as follows:

[Provide lead expansion shields for machine screws and bolts 6 millimeter 1/4 inch and smaller; head-out embedded nut type, single-unit class, Group I, Type 1, Class 1.

][Provide lead expansion shields for machine screws and bolts larger than 6 millimeter 1/4 inch in size; head-out embedded nut type, multiple-unit class, Group I, Type 1, Class 2.

][Provide bolt anchor expansion shields for lag bolts; zinc-alloy, long-shield anchor class, Group II, Type 1, Class 1.

][Provide bolt anchor expansion shields for bolts; closed-end bottom-bearing class, Group II, Type 2, Class 1.

]

****

NOTE: Use toggle bolts for anchoring steel stair items to hollow masonry and stud partitions.

****

[Provide tumble-wing-type toggle bolts conforming to ASTM A325M ASTM F3125/F3125M, ASTM A449 and ASTM C636/C636M, type, class, and style as required.

]

][2.2.9 Fasteners

Provide galvanized zinc-coated fasteners in accordance with ASTM A153/A153M used for exterior applications or where built into exterior walls or floor systems. Select fasteners for the type, grade, and class required for the installation of steel stair items.

[Provide standard hexagon-head bolts, conforming to ISO 898-1 ASTM A307, Grade A.

][Provide square-head lag bolts conforming to ASME B18.2.3.8M ASME B18.2.1.

][Provide cadmium-plated steel machine screws conforming to ASME B18.6.7M ASME B18.6.3.

][Provide flat-head carbon steel wood screws conforming to ASME B18.6.5M ASME B18.6.1.

][Provide plain round, general-assembly-grade, carbon steel washers conforming to ASME B18.22M ASME B18.21.1.

][Provide helical spring, carbon steel lockwashers conforming to ASME B18.2.3.8M ASME B18.2.1.

]][2.2.10 Steel Railings And Handrails

****

NOTE: Ensure that handrail design meets loads of the applicable building code, OSHA, and ADA. Decorative architectural handrail is not covered in this section. See NAAMM, "Pipe Railing Manual" for suggestions.

****

****

NOTE: Design grab bars, shower seats, and dressing room bench seat systems to resist a single concentrated load of 250 pounds (1.11 kN) applied in

any direction at any point.

****

Design handrails to resist a concentrated load of[890 N][200 lb] [_____] in any direction at any point of the top of the rail or[730 N/m][50 lb per foot] [_____] applied horizontally to the top of the rail, whichever is more severe. NAAMM AMP 521, provide the same size rail and post. Provide pipe collars of the same material and finish as the handrail and posts. [Provide series 300 stainless-steel pipe collars.]

2.2.10.1 Steel Handrails

****

NOTE: ASTM A53 pipe at the 30 mm 1 1/4 inch nominal diameter meets the minimum requirements since the outside diameter is 45 mm 1.66 inches.

****

Provide steel handrails, including inserts in concrete, [steel pipe conforming to ASTM A53/A53M] [or] [structural tubing conforming to ASTM A500/A500M, Grade A or B of equivalent strength]. Provide steel railings of [40] [50] mm [1 1/2] [2] inch nominal size,[hot-dip galvanized] [and] [shop-painted].

Provide kickplates between railing posts where indicated, and consisting of 4 millimeter 1/8 inch steel flat bars not less than 150 millimeter 6 inches high. Secure kickplates as indicated.

[Galvanize exterior railings, including pipe, fittings, brackets, fasteners, and other ferrous metal components. Provide black steel pipe for interior railings.

][Provide galvanized exterior and interior railings where indicated, including pipe, fittings, brackets, fasteners, and other ferrous metal components. Provide black steel pipe for interior railings not indicated as galvanized.

][Provide galvanized railings, including pipe, fittings, brackets, fasteners, and other ferrous metal components.

]][2.2.11 Aluminum Railings And Handrails

****

NOTE: Do not use slip-on fittings and set screws for locations subject to abusive use by building occupants. The less expensive Alloy 6061-T6 meets the strength requirements, but is not suitable for bending, and discolors when anodized. Handrail fastenings should be of Series 300 stainless steel. Specify No. 316 for marine environments.

****

Provide railings and handrails consisting of[[40] [50] mm [1 1/2] [2] inch nominal schedule 40 pipe ASTM B429/B429M],[45 mm 1 3/4 inch square aluminum semihollow tube with rounded corners ASTM B221M ASTM B221]. Provide [mill-finish] [anodized] aluminum [[_____] color] railings. Ensure that all fasteners are Series 300 stainless steel.

]2.2.12 Safety Chains [And Guardrails]

Provide safety chains of galvanized steel, straight-link type, 5 mm 3/16 inch diameter, with at least 12 links per 300 mm foot, and with snap hooks on each end. Test safety chain in accordance with ASTM A467/A467M, Class CS. Provide snap hooks of boat type. Provide galvanized 10 mm 3/8 inch bolt with 20 mm 3/4 inch eye diameter for attachment of chain, anchored as indicated. Supply two chains, 100 mm 4 inches longer than the anchorage spacing, for each guarded area. [Provide corrugated sheet steel beam guardrail conforming to the requirements of AASHTO M 180, Type [_____] of the class specified on the drawings. Provide bolts and nuts as indicated, conforming to the requirements of ASTM A307.] Locate [guardrails] safety chain where indicated. Mount the top chain [rail] 1050 mm feet 6 inches [_____] above the [floor] [ground] and mount the lower chain [rail] 600 mm 2 feet [_____] above the [floor] [ground].

2.3 Mill Test Reports

Provide mill test reports for [structural steel plates, shapes, and bars][structural steel tubing][hot-rolled carbon steel bars][cold-drawn steel tubing]. Mill test report will include but is not limited to material heat number, material grade, edition year and type of specification met, material dimension, mechanical properties, chemical analysis, heat treatment (if applicable), and certified inspector signature.

PART 3 EXECUTION

3.1 PREPARATION

Adjust stair railings and handrails before securing in place in order to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than [2440 millimeter] [_____] [8 feet] [_____] on center. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

[a. Anchor posts in concrete by means of pipe sleeves set and anchored into concrete. Provide sleeves of galvanized, standard-weight, steel pipe, not less than 150 millimeter 6 inches long, and having an inside diameter not less than 13 millimeter 1/2 inch greater than the outside diameter of the inserted pipe post. Provide steel plate closure secured to the bottom of the sleeve, with closure width and length not less than 25 millimeter 1 inch greater than the outside diameter of the sleeve. After posts have been inserted into sleeves, fill the annular space between the post and sleeve with nonshrink grout or a quick-setting hydraulic cement. Cover anchorage joint with a round steel flange welded to the post.

][b. Anchor posts to steel with oval steel flanges, angle type or floor type as required by conditions, welded to posts and bolted to the steel supporting members.

][c. Anchor rail ends into concrete and masonry with round steel flanges welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.

][d. Anchor rail ends to steel with oval or round steel flanges welded to tail ends and bolted to the structural-steel members.

] Secure handrails to walls by means of wall brackets and wall return fitting at handrail ends. Provide brackets of malleable iron castings, with not less than 75 millimeter 3 inch projection from the finished wall surface to the center of the pipe, drilled to receive one M10 3/8 inch bolt. Locate brackets not more than 1525 millimeter 60 inches on center. Provide wall return fittings of cast iron castings, flush type, with the same projection as that specified for wall brackets. Secure wall brackets and wall return fittings to building construction as follows:

[a. For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.

][b. For hollow masonry and stud partition anchorage, use toggle bolts having square heads.

] Install toe boards and brackets where indicated. Make splices, where required, at expansion joints. Install removable sections as indicated.

3.2 INSTALLATION

Submit manufacturer's installation instructions for the following products to be used in the fabrication of [steel] [_____] [stair railing] [and] [hand rail work]:

[a. Structural-steel plates, shapes, and bars

][b. Structural-steel tubing

][c. Cold-finished steel bars

][d. Hot-rolled carbon steel bars

][e. Cold-drawn steel tubing

][f. Protective coating

][g. Masonry anchorage devices

][h. Steel railings and handrails

][i. Aluminum railings and handrails

][j. Anchorage and fastening systems

] Provide complete, detailed fabrication and installation drawings for all iron and steel hardware, and for all steel shapes, plates, bars, and strips used in accordance with the design specifications cited in this section.

[3.2.1 Steel Handrail

Install handrail [in pipe sleeves embedded in concrete and filled with nonshrink grout or quick-setting anchoring cement with anchorage covered with standard pipe collar pinned to post.][by means of pipe sleeves secured to wood with screws.][by means of masonry with expansion shields and bolts or toggle bolts.][by means of base plates bolted to stringers or structural-steel frame work.] Secure rail ends by steel pipe flanges [anchored by expansion shields and bolts.] [through-bolted to a back plate or by 6 mm 1/4 inch lag bolts to studs or solid backing.]

][3.2.2 Aluminum Handrail

Affix to base structure by [flanges anchored to concrete or other existing masonry by expansion shields] [base plates or flanges bolted to stringers or structural-steel framework] [flanges through-bolted to a backing plate on the other side of a wall] [flanges lag-bolted to studs or other structural timbers]. Provide Series 300 stainless-steel bolts to anchor aluminum alloy flanges, of a size appropriate to the standard product of the manufacturer. Where aluminum or alloy fittings or extrusions are to be in contact with dissimilar metals or concrete, coat the contact surface with a heavy coating of bituminous paint.

][3.2.3 Touchup Painting

****

NOTE: Delete the paragraph and heading if touchup painting is to be excluded from the steel stair erector's work.

****

Immediately after installation, clean field welds, bolted connections, abraded areas of the shop paint, and exposed areas painted with the paint used for shop painting. Apply paint by brush or spray to provide a minimum dry-film thickness of 0.051 millimeter 2 mils.

]3.3 FIELD QUALITY CONTROL

3.3.1 Field Welding

Ensure that procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work comply with AWS D1.1/D1.1M.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-05 59 10 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-05 59 10 (August 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-05 59 10 (November 2022)**

Preparing Activity: USACE **Superseding**
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SECTION 05 59 10

ROLLING COVER FOR AVIATION REFUELING VAULTS

11/22

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NOTE: This guide specification covers the requirements for custom fabricated rolling covers installed on new or existing aircraft refueling system vaults constructed to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards. DoD Type III systems must conform to Standard Design AW 078-24-28 DOD PRESSURIZED HYDRANT FUELING SYSTEM TYPE III**. DoD Type IV/V systems must conform to** Standard Design AW 078-24-29 DOD STANDARD PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V**. Cut and Cover systems must conform to Standard Design AW 078-24-33 CUT AND COVER STANDARDS.**

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

This specification covers the factory fabrication, assembly, testing, and shipping requirements for custom fabricated rolling covers having steel or aluminum shells as indicated in the vault schedule on the vault drawings. Covers are to be field installed on variously sized new and/or existing hydrant fueling system vaults and tanks.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B4.1	(1967; R 1994; R 2004; R 2009; R 2020) Preferred Limits and Fits for Cylindrical Parts
ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A1085/A1085M	(2015) Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM F1136/F1136M	(2011) Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
ASTM F2329/F2329M	(2015; R 2023) Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
ASTM F2833	(2011; R 2017) Standard Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type

1.2 ADMINISTRATIVE REQUIREMENTS

Submit manufacturer's catalogue cuts and dimensional sheets. Include a description of the item, materials of construction, and dimensions. Provide data sufficient to indicate compliance with specifications. Mark items pertaining to specifications with a heavy black arrow.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Assembly Tests; G, [_____]

Acceptance Testing; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Wheel Assemblies; G, [_____]

Materials List; G, [_____]

Welding; G, [_____]

Welding of Aluminum; G, [_____]

Steel Welding Repairs; G, [_____]

SD-07 Certificates

Welder Qualifications

Welding of Aluminum

1.4 QUALITY ASSURANCE

1.4.1 Welder Qualifications

Submit certification stating that the welders, welding operators, and tack welders, who will perform structural steel welding, have been qualified for the particular type of work to be done in accordance with the requirements of AWS D1.1/D1.1M, Section 4, prior to commencing fabrication. The certificate must list the qualified welders by name, specify the code and procedures for which they are qualified, and provide the date of qualification. Prior qualification will be accepted if welders have performed satisfactory work under the code for which they have been qualified within the preceding three months. Welders will be required to repeat the qualifying tests when their work indicates a reasonable doubt as to proficiency. Those welders passing the requalification tests will be recertified. Those welders not passing will be disqualified until they have passed the requalification tests. All expenses in connection with qualification and requalification must be borne by the Contractor.

1.4.2 Workmanship

Workmanship must be of the highest grade and in accordance with the best modern practices to conform with the specifications for the item of work being furnished. Welding must be continuous along the entire area of contact, except where tack welding is permitted. Exposed connections of work in place must not be tack welded. Exposed welds must be ground smooth. Exposed surfaces of work in place must have a smooth finish.

1.4.3 Detail Drawings

Submit detail drawings for metalwork and machine work prior to fabrication. Submit a materials list for fabricated items with the detail drawings. Detail drawings for metalwork and machine work must include catalog cuts, templates, fabrication and assembly details, and type, grade, and class of material, as appropriate. Also include a sketch showing final wheel to axle mounting (i.e., washers, nuts, and spacers). Elements of fabricated items inadvertently omitted on contract drawings must be detailed by the fabricator and indicated on the detail drawings. Drawings must include all dimensional and tolerance data for each size of vault being fabricated.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Bolts and Cap Screws

All bolts must be steel and must conform to ASTM A307, Grade A, Hex.

2.1.2 Nuts

Must conform to ASTM A563, Grade A, Hex, and must be of the same finish as the fasteners they are used with.

2.1.3 Washers

Flat washers must conform to the requirements of ASTM A276/A276M (stainless steel).

2.1.4 Tube Steel

Structural tubing must conform to ASTM A1085/A1085M.

2.1.5 Structural Steel

Carbon steel must conform to ASTM A36/A36M

2.1.6 Rolling Cover Shell

Cover shell material must be as indicated on the drawings and specified as follows:

2.1.6.1 Aluminum

Aluminum sheets and strips must comply with ASTM B209, alloy and temper best suited for the purpose.

2.1.7 Wheel Assemblies

2.1.7.1 Wheels

Provide heavy duty industrial type wheels that are the product of a company regularly engaged in the production of wheels. The wheels must have solid rubber tires that are molded onto spoked or solid centers that are either cast, forged, or machined. The rubber must have a hardness rating of 80-95 Shore A durometer. Tires must not stretch or work loose from the metal center. The wheels must have roller bearings and must be pressure lubricated from a grease fitting when available. The wheels must work in a temperature range of -40 to +82 degrees C-40 to +180 degrees F. The entire wheel assembly must be symmetrical and must spin concentrically around the bearing. Finish metal centers with either an epoxy paint, a powder coating, or manufacture galvanized. The diameter of the carrier wheels must be 150 mm6 inches and the diameter of the side wheels must be 80 mm 3-1/4 inches. The fabricator must use appropriate washers and spacers to lock the inner bearing bushing to the axle. Wheels must be similar or equal to the following:

a. 150 mm Dia. x 50 mm wide6 inches Dia. x 2 inches wide

b. 80 mm Dia. x 40 mm wide3-1/4 inches Dia. x 1-1/2 inches wide

2.1.7.2 Axles

The axle assembly must be stainless steel and must be eccentrically machined. A slotted adjustment cam plate must be attached to the axle by welding, as indicated on the drawings. Eccentric offset must be a minimum of 6 mm1/4-inch. Diameter, tolerance, and finish of the mating axle shaft must be coordinated with the wheel manufacturer's diameters and tolerances for a close fit. Submit shop drawings showing all fits and tolerances. Material, weld, and nut must all be a 300 series stainless steel.

2.2 FABRICATION

2.2.1 General

Material must be straight before being laid off or worked. If straightening is necessary, it must be done by methods that will not impair the metal. Sharp kinks or bends must be cause for rejection of the material. Material with welds will not be accepted, except where welding is definitely specified, indicated, or otherwise approved. Bends must be made by approved dies, press brakes, or bending rolls. Where heating is required, precautions must be taken to avoid overheating or warping the metal, and it must be allowed to cool in a manner that will not impair the original properties of the metal. Proposed flame cutting of material other than structural steel must be subject to approval and must be indicated on detail drawings. Shearing must be accurate, and all portions of the work must be neatly finished. Corners must be square and true unless otherwise shown on the drawings. Re-entrant cuts must be filleted to a minimum radius of 20 mm3/4 inch unless otherwise approved. Finished members must be free of twists, bends, and open joints. Bolts, nuts, and screws must be tight.

2.2.2 Dimensional Tolerances

Dimensions must be measured by a calibrated steel tape of approximately the same temperature as the material being measured. The overall dimensions of an assembled structural unit must be within the tolerances indicated on the drawings or as specified in the particular section of these specifications for the item of work. Where tolerances are not specified in other sections of these specifications or shown on the drawings, an allowable variation of 1 mm1/32 inch is permissible in the overall length of component members with both ends milled. Component members without milled ends must not deviate from the dimensions shown by not more than 1.5 mm1/16 inch for members 30 feet or less in length and by more than 3 mm1/8 inch for members over 9 m30 feet in length.

2.2.3 Steel

Structural steel may be cut, when approved, by mechanically guided or hand-guided torches as long as an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Surfaces and edges to be welded must be prepared in accordance with AWS D1.1/D1.1M. Where structural steel is not to be welded, chipping or grinding will not be required, except as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Hand-guided cuts, which are to be exposed or visible, must be chipped, ground, or machined to sound metal.

2.2.4 Aluminum

Laying out and cutting of aluminum must be in accordance with AA ADM.

2.2.5 Bolted Connections

2.2.5.1 Bolted Steel Connections

Bolts, nuts, and washers must be of the type specified or indicated. Beveled washers must be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Bolt holes must be accurately located, smooth, perpendicular to the member, and cylindrical. Holes for bolts must be drilled or subdrilled and reamed in the shop and must not be more than 1.5 mm1/16 inch larger than the diameter of the bolt, unless otherwise approved, indicated on the drawings, or specified below. Poor matching of holes will be cause for rejection. Drifting occurring during assembly must not distort the metal or enlarge the holes. Reaming to a larger diameter of the next standard size bolt will be allowed for slight mismatching.

2.2.5.2 Bolted Aluminum Connections

Punching, drilling, reaming, and bolting for bolted aluminum connections must conform to the requirements of AA ADM.

2.3 MACHINE WORK

Tolerances, allowances, and gauges for metal fits between plain, non-threaded, cylindrical parts must conform to ASME B4.1 for the class of fit shown or required, unless otherwise shown on approved detail drawings. Where fits are not shown, they must be suitable as approved. Tolerances for machine-finished surfaces designated by non-decimal dimensions must be within 0.4 mm1/64 inch, unless otherwise indicated on the drawings. Sufficient machining stock must be allowed to ensure true surfaces of solid material. Assembled parts must be accurately machined, and all like parts must be interchangeable. All drilled holes must be accurately located.

2.3.1 Finished Surfaces

Surface finishes indicated or specified herein must be in accordance with ASME B46.1. Values of required roughness heights are arithmetical average deviations expressed in microinches. These values are maximum. Lesser degrees will be satisfactory unless otherwise indicated. Compliance with surface requirements must be determined by sense of feel and visual inspection of the work compared to Roughness Comparison Specimens in accordance with the provisions of ASME B46.1. Values of roughness width and waviness height must be consistent with the general type of finish specified by roughness height. Where the finish is not indicated or specified, the finish selected must be the most suitable for that particular surface. Provide the class of fit required and indicate it on the detail drawings with a symbol, which conforms to ASME B46.1 when machine finishing is provided. Flaws such as scratches, ridges, holes, peaks, cracks, or checks, which will make the part unsuitable for the intended use, will be cause for rejection.

2.3.2 Unfinished Surfaces

All work must be laid out to secure proper matching of adjoining unfinished surfaces, unless otherwise directed. Where there is a large discrepancy between adjoining unfinished surfaces, it must be chipped and ground smooth or machined to secure proper alignment. Unfinished surfaces must be true to the lines and dimensions shown and must be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts must be filled in an approved manner.

2.4 WELDING

****

NOTE: If the WPS is not prequalified, designate the submittal in the SUBMITTALS paragraph for Government approval. If it is prequalified, designate as for information only.

****

Submit the Welding Procedure Specification (WPS).

2.4.1 Welding of Structural Steel

Welding must be in accordance with AWS D1.1/D1.1M. Welding procedures which are considered prequalified as specified in AWS D1.1/D1.1M will be accepted without further qualification. Submit for approval a listing or an annotated drawing to indicate the joints not prequalified. Procedure qualification must be required for these joints.

2.4.2 Welding of Aluminum

Welding of aluminum must conform to AA ADM or AWS D1.2/D1.2M, Sections 1 through 5. The welding process and welding operators must be prequalified as required by AWS D1.2/D1.2M, Section 3 or AA ADM, in accordance with the methods described in ASME BPVC SEC IX. Submit a certified report giving the results of the aluminum welding qualification tests. Also, submit a complete schedule of the welding process for each aluminum fabrication to be welded prior to commencing fabrication.

2.4.3 Welding Inspection

Maintain an approved inspection system and perform required inspections in accordance with Section 01 45 35 SPECIAL INSPECTIONS. Welding must be subject to inspection to determine conformance with the requirements of AWS D1.1/D1.1M, the approved welding procedures, and provisions stated in other sections of these specifications.

2.4.3.1 Visual Examination

All completed welds must be cleaned and carefully examined for insufficient throat or leg sizes, cracks, undercutting, overlap, excessive convexity or reinforcement, and other surface defects to ensure compliance with the requirements of AWS D1.1/D1.1M, Section 5 and Section 10, Part D.

2.4.4 Steel Welding Repairs

Defective welds must be repaired in accordance with AWS D1.1/D1.1M, Section 7. Defective weld metal must be removed to sound metal by use of air carbon arc or oxygen gouging. The surfaces must be thoroughly cleaned before welding. Welds that have been repaired must be retested by the same methods used in the original inspection. Costs for repairs and retesting must be borne by the Contractor. Submit repair procedure prior to doing repair.

2.5 MISCELLANEOUS PROVISIONS

2.5.1 Galvanizing

ASTM F2329/F2329M, ASTM F1136/F1136M, ASTM F2833 or ASTM B695 for threaded parts.

ASTM A123/A123M for structural steel members, as applicable.
Unless specified otherwise, provide hot-dipped galvanization after fabrication where practical. Hot-dipped galvanizing must be applied in a manner and of a thickness and quality conforming to ASTM A123/A123M.

Where zinc coatings are destroyed by cutting, welding, or other causes, the affected areas must be regalvanized. Coatings 2 ounces or heavier must be regalvanized with a suitable low-melting zinc base alloy similar to the recommendations of the American Hot-Dip Galvanizers Association to the thickness and quality specified for the original zinc coating.

2.5.2 Cleaning of Stainless Steel

Oil, paint, and other foreign substances must be removed from stainless steel surfaces after fabrication. Cleaning must be done by vapor degreasing or by the use of cleaners of the alkaline, emulsion, or solvent type.

2.6 SHOP TESTING

2.6.1 Wheel Assembly Testing

The first wheel assembly must be tested for correct fit and operation in the presence of the Contracting Officer's Technical Representative (COTR), unless otherwise waived in writing. The wheel must rotate concentrically and smoothly on the bearings. The cam adjuster must provide at least 3 mm 1/8 inch of adjustment in each vertical direction. Waiving of tests will not relieve the Contractor of responsibility for any fault in operation, workmanship, or material that occurs before the completion of the contract or guarantee.

2.6.2 Assembly Tests

Each rolling cover, including the shell, carrier, frame, and temporary brackets, must be assembled in the shop to determine the correctness of the fabrication and matching of the component parts. Tolerances must not exceed those shown on the drawings. Each cover assembly must be closely checked to ensure that all necessary clearances have been provided and that binding does not occur in any moving part. Assembly in the shop must be done on a straight and level floor or platform; the frame must be mounted on temporary supports in a level position. The carrier must move smoothly and with minimal effort. Misalignment, poor operation, or disclosed defects must be immediately remedied by the Contractor without cost to the Government. Assembly, testing, and disassembly work must be performed in the presence of the Contracting Officer, unless waived in writing. Provide ten working days notice, in writing, of the first and each proceeding rolling cover assembly to the COTR.

2.7 PREPARATION FOR SHIPPING

Before disassembly for shipment, each rolling cover subassembly must be match-mark stamped (or as otherwise approved) to facilitate correct reassembly in the field. The location of stampings must be indicated by circling with a ring of white chalk after the shop finish has been applied or as otherwise directed. Each subassembly must be wood crated, slatted, skid mounted, or otherwise packaged such that abrasion does not occur during shipment.

PART 3 EXECUTION

3.1 ASSEMBLY

All parts to be assembled must be thoroughly cleaned. Packing compounds, rust, dirt, grit, and other foreign matter must be removed. Holes and grooves for lubrication must be cleaned. Enclosed chambers or passages must be examined to make sure that they are free from damaging materials. Where units or items are shipped as assemblies, they will be inspected prior to installation. Pipe wrenches, cold chisels, or other tools likely to cause damage to the surfaces of rods, nuts, or other parts must not be used for assembling and tightening parts. Bolts and screws must be tightened firmly and uniformly but care must be taken not to overstress the threads. When a half nut is used for locking a full nut, the half nut must be placed first and followed by the full nut. Threads of all bolts, nuts, and screws must be lubricated with a lubricant before assembly. Threads of corrosion-resisting steel bolts and nuts must be coated with an approved antigalling compound. Driving and drifting bolts or keys will not be permitted.

3.2 PROTECTION OF FINISHED WORK

3.2.1 Lubrication After Assembly

After assembly, all wheels must be pressure lubricated or oiled.

3.2.2 Aluminum

Aluminum in contact with structural steel in the area of the cover shell fastener angle clips must be protected against galvanic or corrosive action by being given a coat of zinc-chromate primer and a coat of aluminum paint.

3.3 ACCEPTANCE TESTING

The rolling cover must be field tested to ensure proper wheel adjustments to eliminate binding and track misalignment. In addition, demonstrate to the Contracting Officer that the cover and cover tracks are level. The rolling cover must be rolled the full distance of the tracks. The test must be repeated a sufficient number of times (minimum of three) to demonstrate proper operation. Misalignment, poor operation, or disclosed defects must be immediately remedied without cost to the Government. Provide all personnel necessary to conduct the tests. Testing must be performed in the presence of the Contracting Officer. Notify the Contracting Officer, in writing, at least 7 days prior to testing operations.

-- End of Section --

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 05 59 20

FABRICATION OF HYDRAULIC STEEL STRUCTURES

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USACE / NAVFAC / AFCEC **UFGS-05 59 20 (May 2021)**

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SECTION 05 59 20

FABRICATION OF HYDRAULIC STEEL STRUCTURES

05/21

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NOTE: This guide specification covers the requirements for general workmanship applicable to the fabrication, assembly and testing of fracture critical Hydraulic Steel Structures.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: This specification is intended for the fabrication of NEW Hydraulic Steel Structures. Fracture critical hydraulic steel structures (HSS) are critical life safety structures that require added quality control. Fracture critical HSS or components of HSS are those portions whose failure would lead to collapse of the structure and potential life loss.

The results of the Hydraulic Steel Structures inspection program, undertaken by USACE, has shown that fracture critical fabrication without added oversite has led to a lack of understanding of the

techniques required to ensure life safety.

This guide specification is intended to ensure fracture critical structures are properly manufactured according to updated welding criteria and ensures that quality control is exercised throughout the fabrication process in accordance with ER 1110-2-8157. This specification should be used for the design of fracture critical HSS structures and HSS structures subjected to dynamic loads. Bulkheads/stoplogs or other HSS structures, not fabricated with fracture critical components or subject to static load only, may be fabricated to this specification when an added level of quality control is required. Use of this specification for the repair of existing structures is not recommended and would require numerous modifications to ensure compatibility of existing steel with fracture critical requirements.

Take great care in adding references to additional steels (ASTM A36, A572, A992 etc.) as these steels do not provide toughness requirements for fracture critical structures and are NOT addressed as acceptable base metals in AWS D1.5M/D1.5. The following items are likely manufactured from steels that do not comply with AWS D1.5M/D1.5 and must be specifically addressed with a weld procedure generated for qualification such as:

1. **Rub/Guide Blocks**
2. **Chain**
3. **Pipe or Tubing for Guardrail etc.**
4. **Ancillary items such as anode attachments etc.**

In all instances where alternate materials, other than A709 steel are used, specific weld procedures must be generated to address the mixing of base metals in a given joint configuration. If the engineer chooses to add alternate basemetals to the list of approved basemetals then he/she must ensure that these metals are only permitted for individual components where these materials are required and must additionally ensure that pre-qualification records and qualified weld procedures for mixing basemetals are specifically required in the submittal section of this guide specification.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 360	(2016) Specification for Structural Steel Buildings
ANSI/AISC 303	(2022) Code of Standard Practice for Structural Steel Buildings and Bridges

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN WELDING SOCIETY (AWS)

AWS D1.5M/D1.5	(2020; Errata 1 2022) Bridge Welding Code
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors

ASTM INTERNATIONAL (ASTM)

ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids

ASTM D573	(2004; R 2019) Standard Test Method for Rubber - Deterioration in an Air Oven
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D1149	(2018) Standard Test Method for Rubber Deterioration - Cracking in an Ozone Controlled Environment
ASTM D1630	(2006; R 2012) Rubber Property - Abrasion Resistance (Footware Abrader)
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing
ASTM F436/F436M	(2024) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 SYSTEM DESCRIPTION

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NOTE: Insert a list of structures that will be fabricated according to this specification. Note that other Division 05 specifications (Miscellaneous metals etc.) would enable structures to be fabricated according to AWS D1.1 and would permit the use of basemetal without toughness requirements etc. If more than one Division 05 specification is included in the specification package, then any item not listed below will be fabricated to a separate specification.

AWS D1.5M/D1.5 Clause 1.1.3 specifies that all

references to "Engineer" approval in D1.5 refer to the State Bridge Engineer. The paragraph below addresses this to ensure that the proper authority/responsibility is given to the Engineer of record.
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Submit a detailed Work Plan for fabrication, including descriptions of shop facilities, equipment, number of personnel, and related information prior to the Prefabrication Conference, and procedures for safe conduct of the work, careful removal and disposition of materials, protection of property that is to remain undisturbed, and coordination with other work in progress. Include in the procedures a detailed description of the methods and equipment to be used for each operation, and the sequence of operations in accordance with EM 385-1-1 for all work that occurs on federal property. Include the recommended measuring system for ensuring dimensional tolerances in the Work Plan. Perform the fabrication of the following listed structures under this contract in accordance to this section of the specifications:

1. [Spillway Tainter Gates]
2. [Fishway Intake Bulkheads]
3. [Main Unit Head Gates]

a. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Do not begin welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and approved. Each Contractor performing welding must maintain records of the test results obtained in welding procedure, and welder, welding operator, and tacker performance qualifications.

b. As it is used in these specifications, "The Engineer" refers to the [District] or [AE] engineer of record. The AWS D1.5M/D1.5 definition of "The Engineer" as specified in AWS D1.5M/D1.5 Application Clause refers to the [District] or [AE] engineer of record in lieu of the state bridge engineer as specified in the Application Clause of AWS D1.5M/D1.5.

c. Schedule a Prefabrication Conference as soon as possible after Notice to Proceed and prior to any fabrication. Include the Prime Contractor, Fabricator, the Fabricator's primary QC representative, the Contracting Officer, and the Engineer of Record for the structure or structures being fabricated in the Prefabrication Conference, at a minimum. Hold the Prefabrication Conference at either the Fabrication Facilities or a similar location as deemed appropriate.

1.2.1 Weld Tracking Log Template

Submit for approval a weld tracking log template, a minimum of 30 days prior to commencement of fabrication, to identify all necessary components to be addressed in the tracking of all welds for the structures in question. A weld tracking log will be developed and maintained as described in the following paragraphs.

1.2.2 Weld Tracking Log

Submit a log capable of individually identifying and tracking every weld on the project. Member identification must follow the numbering scheme shown on the shop drawings. Include in the log the member to be welded, member type (FCM and Non-FCM), type of weld including temporary and tack welds, welding position, applicable WPS reference, AWS joint preparation designation, name or stamping designation of welder, welding operator or tacker, date and time of completion of welding and/or tacking, name and date of CWI visual inspection, NDT testing performed, including the type of inspection, date(s) of inspection, inspector name, and the acceptance criteria used, description of defects found and reason for non-compliance, corrective action taken, or whether the weld is acceptable. Weld identification on the shop drawing must match weld tracking log identification. Bind together a completed log for each structure and submit two copies to the Contracting Officer immediately upon completion of the fabrication of each structure. Furnish draft copies of NDT testing to the Contracting Officer upon request and have a copy available on the shop floor during any inspection.

1.2.3 Welding Procedure Specifications (WPS)

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NOTE: AWS D1.5 Clause 1.3.7 defines that Ancillary products can be welded without WPS. Ancillary products are defined as products not subjected to tensile stress when subjected to live load. This requires the Contractor to know what components of the structure are in tension. In addition, Clause 12 defines attachments less than 100 mm 4 inches as not fracture critical. Each engineer must define what ancillary attachments he/she is concerned about. An example of this would be the attachment of anodes on the tension flanges of a bulkhead. These attachments are usually short (50 mm2 inches) in length and usually "tack" welded on. Ancillary attachments, either subjected to tension or requiring additional inspection other than visual, need to be defined on the drawings and must be mentioned in the specifications as not being omitted from inspection as permitted in D1.5. Seal backing bars, anodes, guides etc. must be specifically excluded from being treated as ancillary items.

Be extremely careful with what items are added to the list below. Some items may not meet the requirements of AWS D1.5 and may need to be addressed separately.

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Submit a Welding Procedure Specification (WPS), with supporting Procedure Qualification Records and supporting test documentation on forms similar or equivalent to the sample forms in AWS D1.5M/D1.5for each weld, including prequalified welds, in accordance with paragraph Welded Connections approved before fabrication is commenced. Individually identify each Welding Procedure Specification and reference it on the shop drawings. In case of conflict between this specification and AWS D1.5M/D1.5 as applicable, this specification governs. The following items are not considered ancillary items as defined in AWS D1.5M/D1.5 Welding Processes Clause and are subjected to the same level of inspection required for primary welds under AWS D1.5M/D1.5:

a. [Sacrificial Anodes attached to the Gate]

b. [Guide Shoes]
c. [etc.]

1.2.4 Fracture Critical Members (FCM)

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NOTE: Toughness requirements are necessary to prevent fracture and are measured for the base metal and for the weld metal. The following paragraph defines the toughness requirements for the base metal. These tests are conducted in the mill, prior to shipment of the A709 plate to the fabricator. Recognize that the Zone of testing required for both completed welds and basemetal is a function of the service location of the structure. Please recognize that the table provided in EM-1110-2-2105 is out of date. It is recommend referencing the zone requirements of ASTM A709 for fracture critical members. Temperature zones for services temperature of your structure are defined in AASHTO LRFD Temperature Zone Designations for Charpy V-Notch Impact Requirements Table. Specifying a zone in lieu of an energy requirement is beneficial as it ensures that as the AASHTO code changes the energy requirement stays valid.

ALL FCM's must be designated on drawings. All Tension members and members subject to reversal of stress MUST be designated on the drawings. AWS D1.5 specifically requires this in Clause 12. Not specifying members as FCM on the drawings will change the testing requirements even if the specifications you have written here differ. There are numerous instances in AWS D1.5 (specifics include UT testing requirements) where testing must be performed to a certain level of acceptance for tension members - such as required in clause 6 UT testing table Notes regarding the subtracting of 4dB from indications found at the root of a weld "when such welds are designated as "tension welds" on the drawing.". Neglecting to label tension welds on the drawing will negate these code provisions.

Recognize that there may not be a splice or weld in a member as it was detailed, but that such member may later require splicing or attachments that would require welding to this member under modification. Neglecting to label this member as a tension member would preclude these welds from being properly tested according to D1.5.

Note that AWS D1.5 Clause 6 gives the Contractor considerable leeway regarding what percentage of welds are tested unless they are labeled fracture critical. As a result, if you want a weld to be fully tested as fracture critical you must label the weld fracture critical and if you want testing on any other critical welds you should designate the weld testing by item, both on the drawing and in the

specifications. While the standard specifications may require a percentage of welds to be tested, if you want specific welds to be subjected to MT, PT, or UT, ensure that these welds are specified on the drawings. Consider specifying test requirements in the tail of each weld that you want NDT on.

In addition, A709 requires that mill orders for materials designate whether the material is tension or compression (T or F). T refers to non fracture critical, F refers to fracture critical material. Steel that is ordered without the T or F designation will not be certified for toughness.

Note that A673 allows the mill to certify material for a lower service temperature than is being required. Tests may be performed at a lower service temperature in the mill and this is considered acceptable for higher service temperatures.

Refer to AWS D1.5, Clause 12 for minimum preheat requirements. Additionally note that preheat requirements are much higher for repair welds as defined in AWS D1.5, Clause 12 This requires minimum preheat and interpass of 161 degrees C 325 degrees F for material less than 38 mm 1-1/2 inch thickness. This requirement will dictate the heat requirements for the entire job and should be accounted for in construction QA visits. The fabricator must have the facilities to preheat higher than the minimum temperatures discussed below if weld repairs are required.

AWS D1.5 Clause 12 requires both RT and UT for testing of Tension Butt Joints and Repaired Groove Welds. Do not delete one of these two requirements for fracture critical structures. Both RT and UT are required by code.

Be careful of the use of the term "tack" weld. Note that AWS 3.0 does not provide a definition of a length or size for a tack weld. AWS 3.0 defines a tack weld as: "A weld made to hold the parts of a weldment in proper alignment until the final welds are made." Tack welds are permitted in AWS D1.5 and will be used by fabricators. AWS D1.5 does allow tack welds and does permit them to be made without preheat. All tack welds made must be remelted and incorporated into the final weld under SAW methods. This is further detailed in AWS D1.5 Clause 12. While the contractor will use tack welds in fabrication, it is not recommended to use the term tack weld on any drawings due to the ambiguous definition of tack welds described above.
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FCM are shown on the Contract Drawings and include all attachments and connections to these members as defined in AWS D1.5M/D1.5. All materials to be welded must be ASTM A709/A709M, killed steel, grade as specified or shown on the drawings. Use Grade 50 steel unless otherwise shown or specified. Mill repairs of base metal are prohibited. Unless otherwise indicated or specified, meet toughness requirements for fracture critical members in tension in accordance with ASTM A709/A709M for Zone [1][2][3]. All materials used for the construction of fracture critical components must meet the applicable requirements of ASTM A709/A709M for fracture critical components. Welding for fracture critical members must meet all requirements of AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause.

1.2.4.1 Fracture Control Plan (FCP)

Submit a Fracture Control Plan (FCP) for welding on all Fracture Critical Members (FCM) in accordance with AWS D1.5M/D1.5, AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Submit welding Procedures, qualifications, and certifications showing compliance with FCP requirements.

1.2.4.2 Repair Welding

Classify repair welds as "critical repairs" or "non-critical repairs" for all repair welding. Unless specified otherwise, follow the minimum provisions for repair procedures. Repair procedures must be qualified and approved and subject to the same QA/QC inspection requirements as other welds. Follow minimum preheat requirements, as defined in AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause, for repair welding. Consider all weld repairs to fracture critical members critical welds in accordance with AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause and must be approved by the Engineer of Record.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shop Drawings; G, [_____]

Welding Procedure Specifications (WPS); G, [_____]

Fracture Control Plan (FCP); G, [_____]

Weld Tracking Log Template; G, [_____]

Weld Tracking Log; G, [_____]

Qualification of Welders and Welding Operators; G, [_____]

Inspector Qualifications; G, [_____]

Qualification of Structural Steel Fabricator; G, [_____]

NDT Inspector Certification; G, [_____]

Welding Repairs - Non-Fracture Critical Members; G, [_____]

Welding Repairs - Fracture Critical Members; G, [_____]

Performance Qualification Records; G, [_____]

Ultrasonic Written Procedure; G, [_____]

SD-02 Shop Drawings

Assembly; G, [_____]

Delivery/Shipping Plan; G, [_____]

Erection Drawings; G, [_____]

SD-03 Product Data

Materials Disposition Record

Anti-Galling CompoundG, [_____]

SD-06 Test Reports

Certified Test Reports; G, [_____]

Witness Points

Repair of Mislocated or Misdrilled Holes; G, [_____]

Schedule of Random Testing; G, [_____]

Manufacturer Certified Test Reports; G, [_____]

Distributor Certified Test Reports; G, [_____]

SD-07 Certificates

Work Plan; G, [_____]

SD-09 Manufacturer's Field Reports

Control Dimensions; G, [_____]

1.4 QUALITY ASSURANCE

Establish Witness Points for the Initial QA Inspection, Intermediate QA Inspections, and Final Inspection as follows and submit a record of all witness points. Start the Initial QA Inspection after the Government has determined that there is substantial completion of components that comprise a reasonable sampling of each significant FCM and non-FCM details. Determine the extent of completion and details and the date of the Initial QA Inspection by the Government at the Prefabrication Conference after discussion with the Contractor. At that time, produce a detailed schedule showing the progression of work and completion of components. This schedule will be updated weekly and provided by e-mail to the Contracting Officer. Give the Contracting Officer two weeks notice prior to the predetermined date for the Initial QA Inspection, including adjustments for changes in schedule. Intermediate QA Inspections will be conducted on an as needed basis and at the discretion of the Government. All QA inspections will follow AWS D1.5M/D1.5. Provide unpainted components for each QA NDT and Visual Inspection. At these stages of construction, give the Contracting Officer three working days to inspect the structure. Do not begin the QA Inspection period until a minimum period of 72 hours after any welding. After the Contracting Officer and the Engineer of Record has inspected the structure, make any changes required to the structure as directed by the Contracting Officer before proceeding with any additional welding. Proceed with the construction until the next witness point is reached, unless it is waived in writing by the Contracting Officer. Each structure fabricated is subject to a Final Fabrication Inspection prior to painting. Conduct a Final Fabrication Inspection after the first structure is completed. Schedule and coordinate with the Contracting Officer and the Engineer of Record final
fabrication inspections of additional structures. Give the Contracting Officer a minimum notice of two weeks prior to the Final Fabrication

Inspection.

1.4.1 Qualification of Welders and Welding Operators

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NOTE: AWS D1.5 should remain referenced in this section of the specifications for the qualifications of welders. AWS D1.5 provides additional controls on the qualification of welders to include the prohibition of power tool cleaning between weld passes for the test. In addition, the reference to AWS D1.5 ensures that welders performing fracture critical welds are annually requalified according to AWS D1.5 Clause 12. AWS D1.1 requires a log showing that a welder who is qualified has continued to weld in this process in the past 6 months. AWS D1.5 Clause 12 stipulates that a welder must be qualified by test within 6 months prior to beginning any work. Initial qualification according to AWS D1.5. Clause 12. requires both RT and bend testing of welded samples. Note that Clause 5.23.1.1 allows a welder who follows a WPS produced for testing to be qualified for that weld and is NOT required to follow the initial qualification requirement of hand tools only. This means that a welder can qualify by submitting WPS's for testing and avoid the hand tool restriction if being tested according to AWS D1.5, non fracture critical welds. Referring to AWS D1.1 only ensures that the welder who is performing the welding has qualified at some point in his/her career. Welders working in a shop may have not welded a CJP overhead weld in 10 years but would still be qualified to perform welding provided someone has signed a log book saying that the welder has been using the process in the last 6 months. A welder who performs a 6 mm 1/4 inch fillet weld with FCAW who was previously qualified is still qualified according to perform CJP overhead welds provided that he/she has used the FCAW process in the past 6 months. This is an additional reason for referencing AWS D1.5 requirements.

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Submit welder, welding operator and tacker qualification certification for each welder, welding operator or tack welder for approval before fabrication is commenced in accordance with paragraph Welded Connections. An AWS Certified Welding Inspector (CWI) meeting the specified qualifications must approve all welder qualifications. Limit welders, welding operators, and tack welders to welding procedures for which they are certified. Prepare, weld, and test welds in accordance with the requirements of AWS D1.5M/D1.5. Before assigning any welder, welding operator, or tacker to work under this contract, submit the names and certification that each individual is qualified as specified. State the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person certifying the qualification tests on the certification. Keep the certification current for the duration of the contract. Submit welder and welding operator qualification test records on forms similar or equivalent to the sample forms in AWS D1.5M/D1.5. All welders must be qualified in accordance with the Qualification Clause of AWS D1.5M/D1.5. Welders performing fracture critical welds must meet the additional requirements of the AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause of AWS D1.5M/D1.5. Verify all qualifications are current prior to commencing any work. Submit a log for each welder showing that he/she is current in the process and procedures being proposed for this work.

1.4.2 Inspector Qualifications

All inspectors, performing structural steel visual inspection in accordance with these specifications, must be qualified and certified in conformance with AWS QC1. Provide an AWS Certified Welding Inspector (CWI) as the primary point of contact for quality control of welding. Designate one individual as having primary responsibility for all quality control in accordance with AWS D1.5M/D1.5 Inspection Clause when several CWI and NDT technicians are working. Do not use non-certified inspectors and certified associate weld inspectors (CAWI) for inspection under these specifications. All personnel who perform NDT must be qualified in accordance with: ANSI/ASNT CP-189 NDT Level II or III. Provide supervision by personnel possessing a Level III ASNT NDT certification for all personnel performing NDT, in accordance with AWS D1.5M/D1.5 Inspection Clause and the AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Submit copies of certificates showing evidence of qualifications or certifications for welding inspectors and NDT personnel.

1.4.3 Qualification of Structural Steel Fabricator

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NOTE: To find AISC certified contractors in the project's region go to:

www.aisc.org

At the first PDT meeting address the need for certified AISC fabricators. AWS D1.5M/D1.5 Clause 12 Certification and Qualification reads as follows: "Contractors must be certified under the AISC (American Institute of Steel Construction) Quality Certification Program Category III, Major Steel Bridges with Fracture Critical Rating, or an equivalent program accepted by the engineer". However, AISC has developed a new fabricator certification specifically for Hydraulic Steel Structures in 2017 that can be used along with ABR, CBR or IBR certification for all projects.

In order to perform fracture critical welding in accordance with AWS D1.5 the Contractor must be certified to this level. Do not wave this requirement.

The Contracting Officer may wish to address the value of this work in comparison to the number of fabricators available to perform this work, often suggesting that the fabrication of a small bulkhead should be set aside for a small Contractor. Using AISC certified fabricators ensures that the requirements of AWS D1.5 and these specifications

are not new to the Contractor.

The AISC fabricator may or may not possess a paint facility and may sub contract this work. The paint specification should be amended to require the paint applicator to either posses an AISC sophisticated paint system endorsement or be a certified contractor in accordance with SSPC as possessing either a QP 1 Certification (Field Application to Complex Industrial and Marine Structures) or QP 3 Certification Program (Shop Painting Certification Program).

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The fabricating plant and fabricator must be certified under the AISC (American Institute of Steel Construction) Quality Certification Program, and must be designated an AISC Certified Plant, Category CBR: Major Bridge Fabrication, IBR: Certified Bridge Fabricator - Intermediate, ABR: Certified Bridge Fabricator - Advanced or HYD: Certified Metal Hydraulic Fabricator with a fracture critical endorsement (FCE) at time of bid and for the duration of the contract. The fabricator or fabrication plant must possess five 5 years documented experience on projects of similar scope. Similar scope means projects of similar size and similar amounts of welding and detail types. Submit copies of the AISC certificate indicating that the fabrication plant meets the specified structural steelwork category and documented experience. The [insert items excluded from this requirement, such as wire rope slings, rubber seals etc.] are excluded from the AISC fabricator certification requirements.

1.4.4 Testing by the Government

Material component parts may be subjected to any form of nondestructive testing, as directed by the Contracting Officer. This may include any test that will thoroughly investigate the part in question. The cost of such investigation will be borne by the Government. Replace and retest all defects that are cause for rejection and rejected materials or parts at the Contractor's expense. The government reserves the right to perform quality assurance at any point during fabrication.

1.4.5 Shop Drawings

Prepare all shop drawings in accordance with ANSI/AISC 303, AISC 326, AISC 360, and AISC 325. Return elements of fabricated items inadvertently omitted on contract drawings to the Engineer of Record for detailing unless they are to be detailed by the fabricator and so indicated on the shop drawings. Cloud any and all details developed by the fabricator on the shop drawings for separate approval by the Engineer of Record. Any items designed by the Contractor must be prepared and sealed by a Registered Professional Engineer. All splices must be approved bythe Engineer of Record. Make all splices with complete joint penetration groove welds.Identify all field welds on the shop drawings. Provide a unique identifier to permit tracking on the weld tracking log for each weld, both shop and field welds. Prior to performing any fabrication of the HSS structures listed in paragraph System Description above, submit complete, detailed shop drawings for approval. Show complete details of materials, tolerances, connections, and proposed welding sequences on the shop drawings. Include catalog cuts, templates, fabrication and assembly details, and type, grade, and class of materials, as appropriate in the shop drawings. Identify all FCM, including attachments that meet the FCM definition, on the shop drawings as well as all temporary and tack welds. Identify each member following the numbering scheme shown on the drawings. Provide a table containing a list of all members and a reference to each material certificate and test report that applies to that member. Identify weld procedures and NDE required for each weld on shop drawings. Cloud any and all splices in the shop drawings for engineer approval.

1.4.6 Erection Drawings

Submit erection drawings showing complete information necessary for the erection of each component part of the HSS. Include the following:

a. Dimensions for alignment and elevations of each member.
b. Location of members and attachments by match-marking of piece numbers.
c. Type and location of each field connection.
d. Detail of each field connection or typical connection.
e. Anchor bolts and setting plans.

1.5 DELIVERY, STORAGE, AND HANDLING

Notify the Contracting Officer at least 28 days in advance of delivery of the structures. Shipping of the structures are at the Contractor's expense. Deliver all structures to the [*insert delivery address*]. Coordinate all deliveries through the [*District Name*] District Contracting Officer. Arrange the structures on the delivery vehicles such that no damage occurs during shipping. Direct all sling lifting lugs up. Submit a Delivery/Shipping Plan showing orientation and locations of structures on the delivery vehicles prior to shipment for Government approval. Submit drawings providing descriptions of methods of delivering the completed structural units, including details for support during shipment to prevent distortion or other damages, and orientation and location of the structure on transport equipment. Protect structural steel members and packaged materials from corrosion and deterioration. Store material in a dry area. Support materials stored outdoors above ground surfaces on wood runners and protect with acceptable effective and durable covers.

1.6 FIELD MEASUREMENTS

Consider all field conditions that affect the details and tolerances of the HSS. Contractor is responsible for accuracy and layout of work and must make necessary field measurements prior to preparation of shop drawings for the HSS.

PART 2 PRODUCTS

2.1 FABRICATION

2.1.1 Structural Fabrication

Material must be straight before being laid off or worked. Perform straightening by methods that will not impair the metal. Material will be rejected for sharp kinks or bends. Material with welds will not be accepted except where welding is definitely specified, indicated or otherwise approved. Use approved dies, press brakes or bending rolls to make bends. Take precautions to avoid overheating the metal where heating is required and allow it to cool in a manner that will not impair the original properties of the metal. Obtain approval prior to flame cutting material, other than structural steel, indicated on detail drawings. Accurately shear material and neatly finish all portions of the work.

Provide square and true corners unless otherwise shown. Fillet re-entrant cuts to a minimum radius of 25 mm 1 inch in accordance with AWS D1.5M/D1.5 Workmanship Clause unless otherwise indicated or approved. Provide finished members free of twists, bends and open joints.

2.1.1.1 Dimensional Tolerances for Structural Work

a. Measure dimensions by an approved measuring system. Submit the measuring system for approval with the work plan (i.e. calibrated steel tape of approximately the same temperature as the material being measured). The overall dimensions of an assembled structural unit must be within the tolerances indicated on the drawings or as specified for the item of work. Where tolerances are not specified in other sections of these specifications or shown, a variation of 0.8 mm 1/32 inch is permissible in the overall length of component members with both ends milled and component members without milled ends must not deviate from the dimensions shown by not more than 1.6 mm 1/16 inch for members 9 m 30 feet or less in length and by not more than 3 mm 1/8 inch for members over 9 m 30 feet in length.

b. Structure dimensions indicated are based on a structure temperature of 20 degrees C 70 degrees F. Perform dimensional adjustments to compensate for actual temperature variations during construction.

2.1.1.2 Structural Steel Fabrication

Structural steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Prepare surfaces and edges in accordance with AWS D1.5M/D1.5, Workmanship Clause. Hand-guided cuts must be chipped, ground or machined to sound metal.

2.1.2 Assembly

Submit Assembly Drawings indicating the sequence of fabrication and assembly and provide details for connecting the adjoining fabricated components in the shop. Identify assembly details in the required order of assembly and details of witness points as described in these specifications.

2.1.3 Materials Disposition Record

Submit three copies of all purchase and mill orders, shop orders for materials and work orders, including all new orders placed by Contractors and old orders extended for each supplier. Furnish, at the time of submittal of shop drawings, a list designating the material to be used for each item. Where mill tests are required, purchase orders must contain the test site address and the name of the testing agency. Furnish a shipping bill or memorandum of each shipment of finished pieces or members to the project site, giving the designation mark and weight of each piece, the number of pieces, the total weight, and if shipped by rail in carload lots, the car initial and number. Submit material records before the beginning of fabrication. Additional requirements for this submittal are listed below.

2.1.4 Welded Connections

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NOTE: The provisions outlined in this guide specification govern the construction of NEW HSS

using appropriately graded ASTM A709 steel with required toughness and weld provisions. The welding requirements specified may not be arbitrarily applied to older steels or steels not meeting toughness requirements (ASTM A36, ASTM A572, ASTM 992 etc.) Use caution when approving alternate base metals for use with AWS D1.5. Alternate base metals will require additional weld processes and testing for each basemetal and weld metal combination. For each alternate base metal specified, the following requirements must be added to this specification:

1. Charpy Testing in accordance with ASTM A709 Table 11 for the temperature zone where the structure will be used.

2. Base metal scanning for defects in accordance with ASTM A578.

3. Prohibition of base metal repairs as specified in paragraph 6.8 of ASTM A709.

4. Handling requirements to prevent damage

5. Prevention of base metal repairs performed by the mill. Fracture critical members produced in accordance with ASTM A709 are prohibited from having base metal repairs performed by the mill as described in AWS D1.5 in order to ensure that repairs meet toughness requirements. All alternate base metals specified must also be prohibited from base metal repairs performed by the mill and must be certified as being free from repairs.

6. Tracking and labeling requirements in accordance with ASTM A709 to ensure components supplied as tension elements meeting toughness requirements are identified and labeled for quality control tracking purposes.

7. A PQR and WPS for each approved alternate base metal and base metal combinations. Each configuration of combined material such as A709 plate spliced to A572 Grade 50 plate must have a unique PQR and WPS generated which shows that the completed weld meets toughness requirements.

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2.1.4.1 Welding Procedure

a. Perform welding in accordance with the applicable provisions of AWS D1.5M/D1.5. Prior to the start of production welding, submit a complete schedule of welding procedures for a typical structure that conforms to the requirements specified in the provisions of AWS D1.5M/D1.5. Provide detailed procedure specifications and tables or diagrams showing the procedures to be used for each required joint in the schedule.

b. Submit a Welding Procedure Specification (WPS) for each weld to be made. Submit Welding Procedure Specifications and Procedure Qualification Records (PQR) for approval before fabrication is commenced. Submit for approval copies of the Welding Procedure Specification and the results of the procedure qualification test for each type of welding which requires procedure qualification. Submit the WPS and PQR with the shop drawings. Prepare and qualify each WPS in accordance with the applicable provisions of AWS D1.5M/D1.5. Show types and locations of welds designated or specified to receive nondestructive examination and identify the weld as FCM when applicable in the welding procedure. A WPS is always required, even if the procedure is considered prequalified in accordance with AWS D1.5M/D1.5. Clearly identify each procedure as being either prequalified or qualified by tests. If a PQR is developed, a representative of the Government must witness the test plate welding and the specimen testing. Approval of any procedure, however, will not relieve the Contractor of the responsibility for producing a finished structure meeting all requirements of these specifications. Make copies of the WPS available for reference to the welders, welding operators and tack welders. An AWS CWI meeting the specified qualifications or welding engineer must approve all WPS's and PQR's.

2.1.4.2 Welder Performance Qualification of Welders and Welding Operators

Qualify and requalify welding operators, welders, and tack welders if necessary for the particular type of work to be done. Perform qualification in accordance with AWS D1.5M/D1.5. Before assigning any welder, welding operator, or tacker to work under this contract, submit the names and certification that each individual is qualified as specified. State the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, and the date qualified on the certification. The company employing the welder must certify by signature that the welder has passed all code required testing and meets the requirements for certification. Submit copies of the Performance Qualification records for approval before fabrication is commenced. The welder and welding operators may have to repeat the qualifying tests when, in the opinion of the Contracting Officer, the work indicates a reasonable doubt as to proficiency. In such cases, the welder must be recertified, as above, after successfully passing the retest; otherwise, he/she must be disqualified until successfully passing a retest. The period of effectiveness for all welder and welding operator performance qualifications must be in accordance with AWS D1.5M/D1.5. All welders performing the work must keep the certification current for the duration of the contract. All expenses are borne by the Contractor in connection with qualification and requalification.

2.1.4.3 Welding Process

Perform welding of structural steel in accordance with applicable provisions of AWS D1.5M/D1.5 by an electric arc welding process using a method which excludes the atmosphere from the molten metal for all welds. Minimize residual stresses, distortion and shrinkage during welding.

2.1.4.4 Welding Technique

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NOTE: AWS D1.5 Clause 12 allows electrodes with an "-R" designation to remain exposed to the atmosphere for up to 9 hours. Once redried, the exposure time reverts to table 4.7. Electrodes are still only allowed to redry once according to AWS D1.5, Clause 12

FCAW wire storage requirements are similar to low hydrogen SMAW electrodes. Requirements for storage are found in AWS D1.5 Clause 12 Duration of

exposure times are defined and all wire exposed for 24 hours is not to be used for fracture critical welding.

The SMAW electrodes indicated in Clause 12 are the ONLY procedures prequalified in AWS D1.5 Clause 12 for fracture critical welding. Reference Clause 12 for which electrodes are prequalified.

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2.1.4.4.1 Filler Metal

The electrode, electrode-flux combination and grade of weld metal must conform to the appropriate AWS specification for the base metal and welding process being used or must be as shown where a specific choice of AWS specification allowable is required. Follow the requirements of AWS D1.5M/D1.5 for matching filler metal. Include the AWS designation of the electrodes to be used in the schedule of welding procedures. Use only low hydrogen electrodes for manual shielded metal-arc welding regardless of the thickness of the steel. Maintain low moisture of low hydrogen electrodes using a controlled temperature storage oven at the job site as prescribed by AWS D1.5M/D1.5, AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Power controlled temperature storage ovens at all times. Subject FCAW filler metal to the storage and handling requirements defined in AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Do not combine filler metals and processes in the same joint or weld.

2.1.4.4.2 Preheat and Interpass Temperature

Perform preheating as required by the applicable provisions of AWS D1.5M/D1.5 for all welds except that the temperature of the base metal must be at least 20 degrees C 70 degrees F. Preheat fracture critical welds in accordance with M 270M/M 270 (A709/A709M) Gr. 250 (36), 345 (50), 345S (50S) Minimum Preheat and Interpass Temperatures Table and the PQR/WPS. Slowly and uniformly heat the weldments that are required to be preheated by approved means to the prescribed temperature, hold at that temperature until the welding is completed, and then permit the weldments to cool slowly as required and in accordance with the approved WPS in order to prevent cracking or distortion.

2.1.4.5 Workmanship

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NOTE: AWS D1.5/D1.5M, Clause 3.13.3 indicates that backing bars parallel to stress or not subjected to stress need not be removed unless specified on the contract drawings. The guide spec should require backing bars to be removed in order to facilitate inspection according to ER-1110-2-8157.

AWS D1.5 Clause 12 allows E7018M and E7018-R electrodes to be used for tack welding without preheat. This should be prohibited to avoid concern about tack welds or temporary welds or welds of ancillary items on fracture critical members. Low moisture electrodes are acceptable by the code in this instance because they are less likely to produce hydrogen cracking in the HAZ. AWS D1.5

requires that all tack welds be remelted and incorporated into the final weld. In order to ensure that the tack welds are incorporated and properly remelted the maximum size and minimum length are specified to ensure that small tack welds without preheat are not permitted.

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Perform welding in accordance with AWS D1.5M/D1.5, Workmanship Clause for all welds and other applicable requirements of these specifications.

2.1.4.5.1 Preparation of Base Metal

Prior to welding, inspect surfaces to be welded to assure compliance with the applicable Clauses of AWS D1.5M/D1.5.

2.1.4.5.2 Tack and Temporary Welds

Make tack and temporary welds required for fabrication and erection in accordance with AWS D1.5M/D1.5 under the controlled conditions prescribed herein for permanent work. Tack welds that are to be incorporated into the permanent work are subject to the same quality requirements as the permanent welds. Clean and fuse such tack welds thoroughly with the permanent welds. Multiple-pass tack welds must have cascaded ends. Remove defective tack welds before permanent welding. Make all welds using low-hydrogen welding electrodes and with welders qualified for permanent work as specified elsewhere in these specifications. Preheat as required by AWS D1.5M/D1.5 for permanent tack welds except that the minimum temperature must be 20 degrees C 70 degrees F in any case, regardless of electrode used. All tack welds which will be incorporated into the final weldment must be a maximum of 3 mm 1/8 inch with a minimum length of 25 mm 1 inch long spaced at a maximum of 150 mm 6 inch on center. In making temporary welds, arc strikes must not be struck in other than the weld joints. Remove each temporary weld as required by AWS D1.5M/D1.5, Workmanship Clause. Grind out and fill all arc strikes struck outside the weld zone, and inspect in accordance with AWS D1.5M/D1.5.

2.1.4.5.3 Weld Access Holes

Provide weld access hole as shown on contract drawings. Show all required weld access holes on shop drawings.. Notify the Contracting Officer for the approval of weld access hole additions if the oversite of intersecting out-of-plane welds is encountered. Payment for the addition of weld access holes not shown on contract drawings or shop drawings will be the Contractor's responsibility.

2.1.4.5.4 Weld Backing Removal

Unless otherwise indicated, remove all steel weld backing material from welded joints prior to testing.

2.1.5 Bolted Connections

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NOTE: Use of Grade A490M A490 bolts requires the following tension values:

16 mm 5/8 inch	**114 kN 24 kips**
20 mm 3/4 inch	**179 kN 35 kips**
22 mm 7/8 inch	**221 kN 49 kips**
24 mm 1 inch	**257 kN 64 kips**
27 mm 1-1/8 inch	**334 kN 80 kips**
30 mm 1-1/4 inch	**408 kN 102 kips**
36 mm 1-3/8 inch	**595 kN 121 kips**
1-1/2 inch	**148 kips**

The following information is required for Slip Critical Connections. Slip critical connections may exist in gate splices, lifting eyes, dogging brackets etc. These connections MUST be defined as slip critical on the drawings prior to adding these provisions to the specifications.

Bolts:
a. Proof load tests (ASTM F606 Method 1) are required. Minimum frequency of tests is as specified in ASTM F3125/F3125M.

b. Wedge tests on full size bolts (ASTM F606 paragraph 3.5) are required. Minimum frequency of tests is as specified in ASTM F3125/F3125M.

Nuts: Proof load tests (ASTM F606 paragraph 4.2) are required. Minimum frequency of tests is as specified in ASTM A563, paragraph 9.3.

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Install all high strength connections to a tension not less than that given below for ASTM F3125/F3125M Grade A325M A325 Bolts. Use turn-of-nut method, direct tension indicator, calibrated wrench, or alternative design bolt methods for tightening. The installation and verification of all bolted assemblies must follow the requirements of RCSC A348..

16 mm5/8 inch	91 kN19 kips
20 mm3/4 inch	142 kN28 kips
22 mm7/8 inch	176 kN39 kips
24 mm1 inch	205 kN51 kips
27 mm1-1/8 inch	267 kN56 kips
30 mm1-1/4 inch	326 kN81 kips

36 mm1-3/8 inch	475 kN97 kips
1-1/2 inch	118 kips

Tighten all other connections to the snug-tight condition. The snug-tight condition is defined as the tightness attained by either a few impacts of an impact wrench or the full effort of a worker with an ordinary spud wrench that brings the plies into firm contact. Perform snugging in a systematic manner starting at the most rigid part of the joint and working to the outside of the connection or the free edges. Install all bolts in a connection to a snug tight condition prior to pretensioning. Perform pretensioning in the same order as snug-tightening.

2.1.5.1 Bolts, Nuts, and Washers

Provide bolts, nuts and washers of the type specified or indicated. Use ASTM A563 nuts with high strength bolts. Equip all nuts with washers. Where the use of high strength bolts is specified or indicated the materials, workmanship and installation must conform to the applicable provisions of ASTM F3125/F3125M and RCSC Specifications for Structural Joints using Grade A325M A325 or Grade A490M A490 Bolts. Use ASTM F436/F436M washers with high strength bolts.

2.1.5.2 Bolt Holes

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NOTE: AWS D1.5 Clause 3.7.7 allows misdrilled bolt holes to be filled either by welding or by installation of a bolt or may be left open. This provision needs to be addressed in the guide specification to prevent holes in hydraulic structures. In addition, AWS D1.5 C-2.3.3 suggests that plug and slot welds should only be used for the transfer of shear forces due to the high risk of discontinuities in these welds. Reference the discussion above allowing the filling of misaligned holes with either a bolt or to be filled with weld metal. A misaligned overlapped joint with a single bolt hole in it would create a plug weld in this location.

AWS D1.5 Clause 2.9.7 requires that plug welds in material 16 mm (5/8 inch) and greater only need to be welded to 1/2 the thickness of the material but not less than 16 mm (5/8 inch). If Plug welds are being used for any reason, consider whether they need to be fully filled (such as when used as track plates or guides) and preclude the Clause 2.9.7 provisions from applying.

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Accurately locate bolt holes so that they are smooth, perpendicular to the member and cylindrical.

a. Drill or subdrill and ream holes for regular bolts in the shop not more than 2mm 1/16 inch larger than the diameter of the bolt.

b. Match-ream or drill holes for high strength fitted bolts. Remove burrs resulting from reaming. The threads of bolts must be excluded from the shear plane. Provide the body diameter of holes and bolts with the tolerances specified on the drawings.

c. The provisions of AWS D1.5M/D1.5 Workmanship Clause allowing misdrilled holes do not apply. Repair all misdrilled holes as directed by the Engineer. Submit repair of mislocated or misdrilled holes to the Government for approval.

2.1.5.3 Rotational Capacity Tests

The manufacturer or distributor must perform rotational-capacity tests in accordance with ASTM F3125/F3125M on all black or galvanized (after galvanizing) bolt, nut, and washer assemblies prior to shipping. The Contractor is responsible for assuring the rotational-capacity testing is performed by either the manufacturer or distributor prior to shipping. Submit Manufacturer Certified Test Reports and Distributor Certified Test Reports.

2.1.6 Miscellaneous Provisions

2.1.6.1 Weldments

Portions of the structure include thick weldments where locked in thermal stresses may make final dimensions unstable. Sequence the work and perform post weld heat treatment in accordance with the qualified WPS such that final machining achieves stable specified dimensions and tolerances.

2.1.6.2 Drain Holes

Locate drain holes as shown on the drawings, unless otherwise noted. Drill drain holes. Flame cutting of holes will not be permitted.

2.1.6.3 Seal Welds

Seal welds are required to maintain water tightness. Show and make all seal welds as indicated on the shop drawings. Make seal welds, when called for on the drawings, the minimum size fillet weld as required in AWS D1.5M/D1.5. In addition, seal welds may require weld wrapping around reentrant corners that is specifically prohibited in AWS D1.5M/D1.5. All seal welds on fracture critical members are subject to the minimum preheat requirements of AWS D1.5M/D1.5 Clause 12 as applicable. Subject all seal welds to the same testing requirements required for a fillet weld made to any fracture critical member according to AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause.

2.1.7 Shop Assembly

Perform fabrication and assembly in an indoor, climate controlled shop. Closely check each item to ensure that all necessary clearances have been provided and that binding does not occur in any moving part. All shop testing for assembly must be witnessed by the Government Representative. Immediately remedy disclosed errors or defects without cost to the Government.

2.1.8 Seals

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NOTE: Define seal requirements in the following paragraph recognizing that seal bars and keeper bars welded to fracture critical members are fracture critical welds.
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Provide each [structure] [_____] with bulb seals, rubber bearing blocks, and bearing seals as indicated. Compound bulb seals, rubber bearing blocks, and bearing seals of ethylene propylene dimonomer (EPDM) or neoprene (CR) conforming to ASTM D2240, ASTM D412, ASTM D573, ASTM D471, ASTM D1149, ASTM D395, ASTM D624 and ASTM D1630. Provide the surfaces of finished splices that are smooth and free of irregularities. Match-drill bolt holes in the rubber seals with the seal support and clamping bars, as applicable; to insure proper fit and spacing between holes of the completed seal assembly. Match finish seal support and clamping bars to conform to the configurations shown on the drawings. Install the seals and blocks after painting has been completed.

2.2 CERTIFIED TEST REPORTS

Submit reports of tests, inspections, and verifications of all materials used under this contract approved by the Government before incorporation into the structure.

2.2.1 General

Have required material tests and analyses performed at the Contractor's expense, to demonstrate that materials are in conformity with the specifications. Tests, inspections, and verifications must conform to the requirements of the particular sections of these specifications for the respective items of work unless otherwise specified or authorized. Conduct tests in the presence of the Contracting Officer. Furnish specimens and samples for additional independent tests and analyses upon request by the Contracting Officer.

2.2.2 Nondestructive Testing

When doubt exists as to the soundness of any material part, such part may be subjected to any form of nondestructive testing determined by the Contracting Officer. The cost of such investigation will be borne by the Government. Any defects will be cause for rejection and rejected parts must be replaced and retested by the same test method that located the defect at the Contractor's expense.

2.2.3 Inspection of Structural Steel Welding

Maintain an approved inspection system and perform required inspections. Inspect welding to determine conformance with the requirements of AWS D1.5M/D1.5 and the approved welding procedures and provisions stated in other sections of these specifications. Clean and carefully visually examine all completed welds for insufficient leg sizes, cracks, undercutting, overlap, excessive convexity or reinforcement and other surface defects to ensure compliance with the requirements of AWS D1.5M/D1.5, Inspection Clause and the additional requirements of AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause for the Fracture Control Plan. In addition, the Government may choose to hire a third party inspector to perform verification of this work. The Government's third party inspection will occur at various times throughout the duration of fabrication. The Contractor will be advised that third party inspection must be coordinated with the Contracting Officer, and the Contractor for all verification inspections selected by the Government.

2.2.3.1 Visual Examination

Prior to any welding, a certified weld inspector (CWI) supplied by the Contractor must visually inspect and document on the weld tracking log the preparation of material for welding at each weld or joint in order to assure compliance with AWS D1.5M/D1.5 and approved WPS. The CWI must also perform visual inspection on all completed welds throughout the welding process to assure compliance with AWS D1.5M/D1.5 and approved WPS. Clean all completed welds free of oxide, flux, scale, paint spatter, or other foreign matter before inspection. Document all non-destructive testing on the weld tracking log.

2.2.3.2 Nondestructive Examination

Perform the nondestructive examination of welds as specified or described on the drawings or as listed in the following paragraphs. Document all non-destructive testing on the weld tracking log.

2.2.3.2.1 Testing Agency

Perform the nondestructive examination of welds and the evaluation of examination tests as to the acceptability of the welds by a testing agency adequately equipped and competent to perform such services or by the Contractor using suitable equipment and qualified personnel. In either case written approval of the examination procedures is required and the examination tests must be made in the presence of the Contracting Officer. The evaluation of examination tests are subject to the approval of, and all records become the property of, the Government. Qualify and certify Certified Weld Inspectors (CWI) in accordance with the provisions of AWS QC1 and the CWI must be familiar with AWS D1.5M/D1.5 fracture critical member inspection as required in AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. The laboratory and all personnel performing nondestructive testing must be qualified as specified. Only individuals qualified for NDT Level II or Level III may perform nondestructive testing. The Level III NDT inspector who supervises all NDT must possess a currently valid American Society for Nondestructive Testing (ASNT) Level III certificate for each of the processes for which they are qualified. Include copies of the NDT inspector certifications, including the ASNT certificate of Level III NDT Technician that certified the Level II Technicians in the submittals.

2.2.3.2.2 Examination Procedure and Extent

Perform all nondestructive testing in accordance with AWS D1.5M/D1.5, Inspection Clause or AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause, as applicable. Perform testing as defined in the following paragraphs.

2.2.3.2.3 Acceptability of Welds

Welds will be unacceptable if shown to have defects prohibited by AWS D1.5M/D1.5.

2.2.3.2.4 Examination Procedures

Perform examination procedures to the following requirements:

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NOTE: List here the type, location and extent of welds to be subject to nondestructive examination. The welds so listed should also be shown using the appropriate designation of AWS A2.4 "Standard Symbols for Welding, Brazing and Nondestructive Examination".

If a weld is to be fully tested as fracture critical it must be labeled fracture critical and if testing on any other critical welds is needed, designate the weld testing by item, both on the drawing and on the specifications. While the standard specifications may require a percentage of welds to be tested, if specific welds are to be subjected to MT, PT, or UT, ensure that these welds are specified on the drawings. Consider specifying test requirements in the tail of each weld needing NDT on.

AWS D1.5M/D1.5 Clause C-2.1.5 indicates that all requirements for special inspections not covered by this code need to be specified in the contract documents. This ensures that required inspections and tests will be performed, avoiding disagreement over minimum weld quality and additional costs as described in D1.5M/D1.5 Clause 6.6.5. AWS D1.5 Clause 6.6.5 says that if NDT other than originally specified in the contract is requested by the Engineer, the Contractor must perform the requested inspection. The costs will be negotiated by the owner and the Contractor. The cost of extra work will be the responsibility of the owner, unless the testing reveals an attempt to defraud the owner. Ensure that all testing requirements are defined on the drawings or listed in these specifications. Do not assume that testing requirements can be amended after award without increased cost. Identifying all testing requirements is defined as the responsibility of the Engineer as referenced above. Specifying testing according to AWS D1.5 without specifically identifying what the Engineer wants tested will not produce a permanent record of the structure in accordance with ER-1110-2-8157.

Ultrasonic testing should be used for groove welds in butt, tee or corner joints.

Radiographic or ultrasonic testing should be used for groove welds in butt joints.

Both UT and RT should be used for fracture critical tension splices.

Magnetic particle inspection may be used for the detection of cracks and other discontinuities at or near the root and for the surface passes and intermediate layers not exceeding 6 mm 1/4 inch thickness of ferrous materials.

Dye penetrant inspection should be used only for detection of discontinuities that are open to the surface and for non ferrous material.

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2.2.3.2.4.1 Ultrasonic Testing (UT)

Perform ultrasonic testing of welds in accordance with the provisions of AWS D1.5M/D1.5. Make a record of each weld tested. Variations in ultrasonic testing procedures, equipment, and acceptance standards not included in Clause 8 of AWS D1.5 may be used with the approval of the Engineer. Such variations include curved scanning surfaces, other thicknesses, weld geometries, transducer sizes, frequencies, couplant, painted surfaces, testing techniques, etc. Record all approved variations in the inspection records.Perform all UT in conformance with a ultrasonic written procedurewhich contains a minimum of the following information regarding the UT method and examination techniques:

a. The types of weld joint configurations to be examined

b. Acceptance criteria for the types of weld joints to be examined.

c. Type of UT equipment (manufacturer, model number, serial number)

d. Type of transducer, including frequency, size, shape, angle and type of wedge.

e. Scanning surface preparation and couplant requirements

f. Type of calibration test block(s) with the appropriate reference reflectors

g. Method of calibration and calibration interval

h. Method for examining for laminations prior to weld evaluation.

i. Weld root index marking and other preliminary weld marking methods

j. Scanning pattern and sensitivity requirements

k. Methods for determining discontinuity location height, length and amplitude level

l. Method of verifying the accuracy of the completed examination. This verification may be by re-UT by others (audits), other NDE methods, macroetch specimen, gouging or other visual techniques as may be approved by the Engineer .

m. Documentation requirements for examinations, including any verifications performed

n. Documentation retention requirements

2.2.3.2.4.2 Radiographic Testing (RT)

Perform, evaluate and report radiographic testing in accordance with the applicable requirements of AWS D1.5M/D1.5.

2.2.3.2.4.3 Magnetic Particle Inspection (MT)

Perform magnetic particle inspection of welds in accordance with the provisions of ASTM E709 and AWS D1.5M/D1.5, Inspection Clause and AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause where applicable. Requirements of AWS D1.5M/D1.5 Inspection Clause do not apply to these specifications, such that secondary members are subject to MT sampling as required. MT by the prod method is prohibited.

2.2.3.2.4.4 Dye Penetrant Inspection (PT)

Perform dye penetrant inspection(PT) of welds in accordance with the applicable provisions of ASTM E165/E165M.

2.2.4 Welds to be Subject to Nondestructive Examination

2.2.4.1 Structural Steel Non-Fracture Critical Members

Complete Joint Penetration Groove Welds. Inspect welds in conformance with AWS D1.5M/D1.5, Inspection Clause. Perform testing with a representative sample of welds and weld types from all welders and each of the processes each welder used. Spread testing throughout the project. Test [100] [_____] percent of all Complete joint penetration groove welds on non-fracture critical members.

2.2.4.2 Structural Steel Non-Fracture Critical Member Fillet Welds and Partial Penetration Groove Welds

Randomly select a minimum of [50] [_____] percent of all fillet welds and partial penetration welds for examination by magnetic particle and or dye penetrant testing procedures described previously. The random testing includes a representative sample of welds and weld types from all welders and each of the processes each welder used. Spread the random testing throughout the project. Develop and submit a schedule of random testing for approval prior to fabrication.

2.2.4.3 Structural Steel Fracture Critical Member Welds

Test all welds on FCM in accordance with AWS D1.5M/D1.5, AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause. Subject 100 percent of all fracture critical complete joint penetration groove welds on fracture critical members to ultrasonic testing. Inspect all fracture critical welds to the tension criteria of the AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause of AWS D1.5M/D1.5. Perform all testing of fracture critical welds to the tension acceptance criteria of Inspection Clause. Inspect all partial joint penetration groove welds and fillet welds on fracture critical members with 100% MT in additional to visual inspection. Remove weld backing from all fracture critical welds prior to all NDE unless the weld backing member is permanent. The UT report for all groove welds must include non-rejectable indications with defect severity ratings within 5 db of being rejectable and must be fully recorded as to indication, rating, size, and location. In accordance with AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause, record all discontinuities found by UT.

2.2.5 Test Coupons

The Government reserves the right to require the Contractor to remove coupons from completed work when doubt as to soundness cannot be resolved by nondestructive examination. Repair all replaced members with complete joint penetration groove welds. Submit proposed repair work for approval before commencing work. Develop a plan to reduce residual stress in all repaired weldments. The expense for removing and testing coupons, xrepairing cut members and the nondestructive examination of repairs will be borne by the Government. If the coupons fail testing, repair costs as well as sampling costs, will be borne by the Contractor.

2.2.6 Supplemental Examination

****

NOTE: Consider adding Third Party testing in this section in lieu of "allowing" the Government to perform testing at our discretion. Consider stipulating that Third Party testing, either hired by the Contractor or hired by the Government, will be required to confirm inspection findings. Third party inspection can be used to check additional welds when indications are found or to confirm UT findings when questions arise regarding the evaluation of UT findings etc. Consider including both of these requirements in this specification. The problem with the statement "third party" is defining the impartiality of this testing agency. CENWP has had a recent experience where the fabrication shop was extremely busy so they hired an outside testing agency as a subcontractor to work in their fabrication shop. The fabricator then claimed that the testing agency was both the primary and third party testing agency. For this reason, it is recommended that each district hire an independent testing agency for a day to confirm the findings of the fabricators inspector. A typical day of UT inspection costs on the order of $1000. Each district should have a working relationship with the local testing agency from HSS inspections. Decide ahead of time how to handle independent evaluation of testing results. Having the ability to hire a testing agency ensures that the fabricator is aware of the potential to have an outside testing firm on site and allows a neutral party to evaluate inspection findings when a disagreement arises. These requirements for QA are discussed above under witness point but do not address the potential for bringing in outside assistance for conflict resolution. By bringing in an independent testing firm, anonymity can be maintained.

****

When the soundness of any weld is suspected of being deficient, due to faulty welding or stresses that might occur during shipment or erection, the Government reserves the right to perform nondestructive supplemental examinations before final acceptance. The cost of such inspection will be borne by the Government. If welds are found to be defective, repair of the defective work and cost of the reinspection will be borne by the Contractor.

2.2.7 Structural Steel Welding Repairs

Defective welds in the structural steel should be defined as critical repairs or non-critical repairs and must be repaired in accordance with AWS D1.5M/D1.5, Workmanship Clause for non-FCM and AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause for FCM. Make separate submittals for Welding Repairs - Non-Fracture Critical Members and Welding Repairs - Fracture Critical Members. Submit welding repair plans for steel and for fracture critical welds, approved prior to making repairs. Address weld repairs within the weld as well as weld repairs for base metal defects in the welding repair plan. All weld repairs to fracture critical members are considered critical welds in accordance with AWS D1.5M/D1.5 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members Clause and must be approved by the Contracting Officer. Weld repairs to mill defects in the base metal, repair of cracks, or a revised design to compensate for deficiencies require approval from the Government. The Contractor may prepare procedures and specifications for the repair of anticipated routine problems and submit them for approval before fabrication begins. Critical weld repairs require a WPS specific to the weld repair. Remove defective weld metal to sound metal by use of air carbon-arc gouging or by mechanical methods. Oxygen gouging for purposes of weld repair is not permitted. Thoroughly clean metal surfaces before welding. Inadequate removal of welds that damages the base metal are subject to replacement of the base metal, or compensation for the deficiency in a manner approved by the Contracting Officer. Retest repaired welds by the same methods used in the original inspection. Except for the repair of members cut to remove test coupons and found to have acceptable welds, costs of repairs and retesting are borne by the Contractor.

2.2.8 Control Dimensions

After fabrication of each structure, but prior to painting, record and submit on the "control dimensions" chart provided, the actual dimensions indicated on drawing [SXX]. Verify control dimensions prior to witness points defined under the schedule of witness points so that they may be verified during inspection and prior to either final assembly, painting, or installation of the structure. Verify and document all control dimensions prior to shipping the structure.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Cleaning

Thourougly clean all parts to be installed. Remove packing compounds, rust, dirt, grit and other foreign matter. Clean holes and grooves for lubrication. Examine enclosed chambers or passages to make sure that they are free from damaging materials. Where units or items are shipped as assemblies they will be inspected prior to installation. Disassembly, cleaning and lubrication will not be required except where necessary to place the assembly in a clean and properly lubricated condition. Do not use pipe wrenches, cold chisels or other tools likely to cause damage to the surfaces of rods, nuts or other parts for assembling and tightening parts. Tighten non-Structural bolts and screws firmly and uniformly but care must be taken not to overstress the threads. Place a half nut first when it is used for locking followed by the full nut. Lubricate threads of all bolts except high strength bolts, nuts and screws with an approved lubricant before assembly. Coat threads of corrosion-resisting steel bolts and nuts with an approved anti-galling compoundantigalling compound. Driving and drifting bolts or keys will not be permitted.

3.1.2 Alignment and Setting

Each machinery component or structural unit attached to structures fabricated according to this specification must be accurately aligned by the use of steel shims or other approved methods so that no binding in any moving parts or distortion of any member occurs before it is fastened in place. The alignment of all parts with respect to each other must be true within the respective tolerances required. Shims are to remain with the final installation where called for on the drawings. Apply anti seize compound to laying surfaces where parts are press-fit.

3.2 PROTECTION OF FINISHED WORK

Thouroughly clean machined surfaces of foreign matter. Protect all finished surfaces by suitable means. Oil and wrap with moisture resistant paper unassembled pins and bolts or protect by other approved means. Wash finished surfaces of ferrous metals to be in bolted contact with an approved rust inhibitor and coated with an approved rust resisting compound for temporary protection during fabrication, shipping and storage periods.

3.3 PAINTING

****

NOTE: Paint preparation is defined in the paint specifications. Consider that the level of preparation required is directly related to the quality of paint application as well as the cost of the project. Industry standards governing the description of surface preparation categories are published by the Society for Protective Coatings SSPC. For most HSS applications the preparation level should be SSPC-SP5 - White Metal Blast Cleaning. This level of preparation removes all contaminents from the surface of the steel. This preparation has limited exposure time (8 hours or less depending on relative humidity) and is therefore not included in this section. Grinding of plate edges and corners is recommended to remove hardness due to flame cutting. Hardness on the edges of plates (flanges of girder etc.) will result in insufficient roughness to permit proper paint adhesion. Grinding these areas to remove the oxygen cut area will produce proper adhesion and will also reduce the potential for hydrogen embrittlement.

****

Paint all exposed surfaces of the structure as specified in Section 09 97 02: PAINTING - HYDRAULIC STRUCTURES. Grind all edges of plate prior to coating. Perform grinding of plate edges before paint preparation in order to remove hardness as a result of flame cutting. Brake and grind all square edges and holes other than bolt holes to a 2 mm 1/16 inch radius prior to painting.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-05 72 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 72 00 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 05 - METALS

SECTION 05 72 00

DECORATIVE METAL SPECIALTIES

08/23

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-05 72 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-05 72 00 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 05 72 00

DECORATIVE METAL SPECIALTIES
08/23

****
NOTE: This guide specification covers the requirements for decorative metal products used in building construction for architectural and decorative effects.

In the project drawings include a complete design indicating the character of the work to be performed by providing the following:

Location and details of each metal item, indicating dimensions, shapes and sizes of members, connections, finishes, and the relation to other building components.

Anchorage and/or fastening devices embedded in other construction.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual
AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes
AA PK-1	(2015) Pink Sheets: Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings & Ingot

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.2.3.8M	(1981; R 2005) Metric Hex Lag Screws
ASME B18.2.6	(2010; Supp 2011) Fasteners for Use in Structural Applications
ASME B18.3.3M	(1986; R 2008) Hexagon Socket Head Shoulder Screws (Metric Series)

ASME B18.6.1	(2016) Wood Screws (Inch Series)
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.6.5M	(2000; R 2010) Standard Specification for Metric Thread-Forming and Thread-Cutting Tapping Screws
ASME B18.6.7M	(1999; R 2010) Metric Machine Screws
ASME B18.13	(2017; ERTA 2018) Screw and Washer Assemblies - Sems (Inch Series)
ASME B18.13.1M	(2011; R 2016; R 2022) Screw and Washer Assemblies: SEMS (Metric Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.21.2M	(1999; R 2014) Lock Washers (Metric Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers
ASME B18.24	(2023) Part Identifying Number (PIN) Code System Standard for B18 Fastener Products

AMERICAN WELDING SOCIETY (AWS)

AWS A5.3/A5.3M	(2023) Specification for Aluminum and Aluminum-Alloy Electrodes for Shielded Metal Arc Welding
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM B26/B26M	(2018; E 2018) Standard Specification for

	Aluminum-Alloy Sand Castings
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B211/B211M	(2023) Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B247	(2020) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM B247M	(2020) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings (Metric)
ASTM B316/B316M	(2020) Standard Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM D1730	(2009; R 2020) Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM G71	(1981; R 2024) Standard Guide for Conducting and Evaluating Galvanic Corrosion Tests in Electrolytes
ASTM G82	(1998; R 2021; E 2021) Standard Guide for Development and Use of a Galvanic Series for Predicting Galvanic Corrosion Performance

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

CS 23.00/AWS C2.23M/NACE #12	(2003) Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel
SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC PS 11.01	(1982; E 2004) Black (or Dark Red) Coal Tar Epoxy Polyamide Painting System

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Existing Conditions; G, [_____]

SD-02 Shop Drawings

Ornamental Metal Items; G, [_____]

Installation Drawings; G, [_____]

Shop and Field Connections; G, [_____]

Construction Details; G, [_____]

SD-03 Product Data

Materials; G, [_____]

Ornamental Metal Items; G, [_____]

Aluminum-Alloy Extrusions

Aluminum-Alloy Sheets And Plates

Aluminum-Alloy Castings

Aluminum-Alloy Forgings

SD-04 Samples

Manufacturer's Standard Color Charts; G, [_____]

Shop Paint; G, [_____]

Finish Paint; G, [_____]

Aluminum Finishes; G, [_____]

Anchorage Devices and Fasteners; G, [_____]

SD-06 Test Reports

Welding Tests; G, [_____]

SD-07 Certificates

Welding Procedures

Ornamental Metal Items; G, [_____]

Welder Qualifications

SD-08 Manufacturer's Instructions

Cleaning Materials

Preventative Maintenance and Inspection

Maintenance Instructions

Application Methods

1.3 QUALITY CONTROL

1.3.1 Samples

Submit samples for each type of anchorage devices and fasteners.

Submit samples for aluminum finishes, one for each type used in the project. Provide samples of standard size as used in construction. After approval, full-sized samples may be used in construction, provided that each sample is clearly identified and its location recorded.

1.3.2 Color Charts

Submit manufacturer's standard color charts for shop paint and finish paint for approval by the Contracting Officer before work begins.

1.3.3 Qualifications for Welding Work

****

NOTE: If Section 05 14 00.13 WELDING STRUCTURAL ALUMINUM FRAMING is not included in the project specification, applicable requirements thereof should be inserted and the following paragraph deleted.

****

[Section 05 14 00.13 WELDING STRUCTURAL ALUMINUM FRAMING applies to work specified in this section.

][Submit welding procedures and welding tests in accordance with AWS D1.2/D1.2M. Prepare all test specimens in the presence of the Contracting Officer and have specimens tested by an approved testing laboratory at the Contractor's expense.

][Submit certification of welder qualifications by tests in accordance with AWS D1.2/D1.2M. In addition, perform test on trail pieces in positions and with clearances equivalent to those actually encountered during construction. If a test weld fails to meet the requirements, complete an immediate retest of two test welds. Failure in either of the two immediate retests mandates that the welder be retested after further practice or training, and provide a complete new set of tests welds.

]1.3.4 Field Measurements

Records of existing conditions may be provided by the Contracting Officer before the start of work. Submit survey data showing existing conditions before preparation of shop drawings and fabrication.

1.4 DELIVERY, STORAGE, AND HANDLING

Store all architectural metal items off the ground on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer.

Keep materials free from dirt and grease and protected from corrosion.

Store packaged materials in their original, unbroken containers in a dry area, until ready for installation.

PART 2 PRODUCTS

2.1 MATERIALS

Submit manufacturer's catalog data for the following items, listing all ornamental metal accessories including casting, forgings, fasteners, and anchorage devices.

[2.1.1 Concrete Inserts

****

NOTE: Use concrete inserts for fastening ornamental metal items to cast-in-place concrete construction when the anchorage device will be subjected to direct pull-out loadings, such as fascia flanges for ornamental features.

Select one of the paragraphs below and delete the other for preplaced inserts

****

[Use galvanized wedge-type concrete inserts, and box-type, ferrous castings, with integral anchor loop at back of box and designed to accept bolts having special wedge-shape heads. Ensure that ferrous castings are malleable iron conforming to ASTM A47/A47M, Grade 32510 or Grade 35018, [Grade 22010 or Grade 24118,] or medium-strength cast steel conforming to ASTM A27/A27M, Grade U-60-30. Ensure that inserts are hot-dip galvanized after fabrication in accordance with ASTM A153/A153M. Provide hot-dip galvanized carbon steel bolts with special wedge-shape heads, nuts, washers, and shims, in accordance with ASTM A153/A153M.

][Provide slotted-type concrete inserts and hot-dip galvanized, welded-construction, box-type, pressed steel plate, with slots to receive square-head bolts and to provide lateral adjustment of the bolt. Ensure that the insert body less anchorage lugs is at least of 115 mm 4 1/2 inches long. Provide inserts with knockout cover. Use plate at least 1/8 inch thick conforming to ASTM A283/A283M, Grade C. Ensure that inserts are hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.

] Provide concrete inserts that are nonremovable when embedded in concrete of 20 Megapascal 3000-pounds per square inch compressive strength and subjected to a 26.7 kilonewton 6000-pound tension load test in an axial direction. Ensure that concrete indicates no evidence of failure attributable to the anchoring device itself.

][2.1.2 Masonry Anchorage Devices

****

NOTE: Use masonry anchorage devices for the fastening of ornamental metal items to solid masonry and concrete-in-place construction only when the anchorage device will not be subjected to direct pull-out loadings or to vibration. Masonry anchorage devices are to be used only for nonvibratory shear loads. Select the appropriate anchorage device, or insert an alternate type of masonry anchorage device, and delete the remaining options listed below.

****

Provide expansion shield masonry anchorage devices conforming to ASTM C514, Group, Type, and Class as follows:

[a. Lead expansion shields for machine screws and bolts 6 mm 1/4 inch and smaller, head-out embedded-nut type, single-unit class, conforming to Group I, Type 1, Class 1.

][b. Lead expansion shields for machine screws and bolts larger than 6 mm 1/4 inch, head-out embedded-nut type, multiple-unit class, conforming to Group I, Type 1, Class 2.

][c. Bolt anchor expansion shields for lag bolts, zinc-alloy long-shield anchors class, conforming to Group II, Type 1, Class 1.

][d. Bolt anchor expansion shields for bolts, closed-end bottom bearing class, conforming to Group II, Type 2, Class 1.

][e. [_____] type anchorage [______], conforming to [_____].

]][2.1.3 Toggle Bolts

****

NOTE: Specify toggle bolts for fastening ornamental metal items to hollow masonry and stud partitions.

****

Provide corrosion-resistant chromium-nickel steel conforming to AISI Type [303], [304], [___], [or 316] toggle bolts of the class and style best suited for the work, conforming to ASTM C636/C636M, Type II.

][2.1.4 Standard Bolts and Nuts

Provide standard bolts, regular hexagon-head, corrosion-resistant steel, coarse-thread series, conforming to ASME B18.3.3M ASME B18.2.1, Type II.

Provide standard nuts, plain hexagon, regular-style, corrosion-resistant steel, conforming to ASME B18.2.6 ASME B18.2.2, Type II, Style 4.

][2.1.5 Lag Bolts

Provide lag bolts, square-head, gimlet point or cone point, corrosion-resistant steel, conforming to ASME B18.2.3.8M ASME B18.2.1, Type I, Grade C.

][2.1.6 Machine Screws

Provide machine screws, corrosion-resistant steel, cross-recess drive, flathead, conforming to ASME B18.6.7M ASME B18.6.3, Type III, Style [2C] [3C].

][2.1.7 Wood Screws

Provide wood screws, corrosion-resistant steel, single-thread, flathead with cross-recess drive, conforming to ASME B18.6.5M ASME B18.6.1.

][2.1.8 Plain Washers

Provide plain washers, round, general-assembly, corrosion-resistant steel, conforming to ASME B18.22M ASME B18.21.1, Type A, Grade I, Class B.

][2.1.9 Lock Washers

Provide lock washers, helical-spring, corrosion-resistant steel (nonmagnetic), conforming to ASME B18.21.2M and ASME B18.13.1M ASME B18.13 and ASME B18.21.1.

][2.1.10 Welding Filler Metal

Provide aluminum-alloy welding filler metal for welding of aluminum alloys, conforming to AWS A5.3/A5.3M and as recommended by the aluminum producer for the work.

]2.2 FABRICATION

Submit fabrication drawings for ornamental metal items.

2.2.1 Workmanship

Fabricate metalwork to the shape and size, with lines, angles, and curves true to form. Provide necessary rabbets, lugs, and brackets so that the work can be assembled. Conceal fasteners where practical.

Design exterior ornamental metal items to withstand expansion and contraction of the component parts at an ambient temperature of 38 degrees C 100 degrees F without causing harmful buckling, opening of joints, overstressing of fasteners, or other harmful effects.

Ensure that the welded fabrication meets requirements as specified in AWS D1.2/D1.2M. Execute all welds behind finished surfaces without distortion or discoloration of the exposed side. Clean flux from welded joints and dress all exposed and contact surfaces.

Drill or punch holes for fasteners.

Mill joints to a close fit. Cope or miter the corner joints to a well-formed shape and true alignment with the adjacent item. Fabricate and form joints exposed to weather to prevent water intrusion.

Ensure that all castings are sound and free from warp or defects that impair their strength and appearance, with a smooth finish and sharp well-defined vertical and horizontal lines on all exposed surfaces.

****

NOTE: Delete the following metals that are not required for the items specified in paragraph "Ornamental Metal Items." The specified metals are only those that are common to several architectural metal items. Metals (and other materials) that are required only for a specific architectural metal item are specified in the paragraph for the item.

****

[2.2.2 Aluminum-Alloy Extrusions

Provide aluminum fabrications conforming to AA ADM and AA PK-1.

Provide 6063, temper T5 extrusions conforming to ASTM B221 ASTM B221M.

Provide aluminum-alloy and tempered extrusions recommended by the aluminum producer with the specified finish of integral-color anodized coating having mechanical properties equal to or exceeding those of aluminum alloy 6063, temper T5, conforming to ASTM B221 ASTM B221M.

][2.2.3 Aluminum-Alloy Sheets and Plates

[Provide aluminum alloy 3003, temper H16 sheets and plates, conforming to ASTM B209M ASTM B209 unless otherwise specified.

][Provide aluminum alloy 5005, temper H16 sheets and plates with a clear anodized coating conforming to ASTM B209M ASTM B209.

][Provide aluminum-alloy and tempered sheets and plates recommended by the aluminum producer with the specified finish of integral-color anodized coating having mechanical properties equal to or exceeding those of alloy 5005, temper H16, conforming to ASTM B209M ASTM B209.]

][2.2.4 Aluminum-Alloy Castings

[Provide aluminum alloy 5140, temper F sand castings, conforming to ASTM B26/B26M.

][Provide aluminum-alloy castings as recommended by the Aluminum Association with a clear anodized coating.

][Provide aluminum-alloy castings containing the casting alloy and condition recommended by the aluminum producer with the specified finish of integral-color anodized coating having mechanical properties equal to or exceeding those of alloy 5140, temper F, conforming to ASTM B26/B26M.

]][2.2.5 Aluminum-Alloy Forgings

[Provide aluminum-alloy 6061, temper T6 forgings, conforming to ASTM B247M ASTM B247.

][Provide aluminum-alloy and tempered forgings recommended by the aluminum producer with the specified finish of integral-color anodized coating having mechanical properties equal to or exceeding those of aluminum alloy 6061, temper T6, conforming to ASTM B247M ASTM B247.

]]2.2.6 Metals for Fasteners

Provide fastener identification conforming to ASME B18.24.

Provide aluminum-alloy bolts and screws made from rod conforming to ASTM B211/B211M, alloy 2024, and temper T351.

Provide aluminum-alloy nuts made from rod conforming to ASTM B211/B211M, alloy 6061, and temper T6.

Provide aluminum-alloy washers made from sheet conforming to ASTM B209M ASTM B209, alloy 2024, and temper T4.

Provide aluminum-alloy rivets made from rod or wire conforming to ASTM B316/B316M, alloy 6053, and temper T61.

Provide corrosion-resistant steel fasteners made of chromium-nickel steel, AISI Type [303], [304], [___], [or 316], with form and condition best suited for the application.

2.2.7 Shop Paint for Aluminum

Provide a shop paint with an inhibitive epoxy polyamide primer conforming to SSPC PS 11.01, CS 23.00/AWS C2.23M/NACE #12, ASTM G71 and ASTM G82.

2.2.8 Protection of Aluminum from Dissimilar Materials

Protect aluminum surfaces that will come in contact with dissimilar metals, or masonry, concrete, or wood, with epoxy polyamide conforming to SSPC PS 11.01, and topcoated with aliphatic polyurethane conforming to ASTM G71 and ASTM G82

Prepare aluminum surfaces to be painted by the acid pickling method conforming to ASTM D1730, Type B, Method 2 or Method 3.

Apply paint to dry, clean surfaces by brush or spraying to provide a minimum dry-film thickness of 0.038 mm 1.5 mils.

2.2.9 Aluminum Finishes

Provide a finish for exposed-to-view aluminum surfaces of architectural metal items conforming to AA DAF45 and finished as specified for each of the following items:

****

NOTE: Select the appropriate finish from the following, or insert alternate finish.

****

[a. Aluminum producer's "as-fabricated mill finish," conforming to AA M10, as specified in AA DAF45.

][b. Frosted finish with medium-matte chemical-etch finish with a clear, nonyellowing methacrylate lacquer coating, with a finish meeting the requirements to AA C22-R1X, as specified in AA DAF45, applied in two coats with interim drying, by brush, spraying, or other approved method to provide a continuous minimum dry film thickness of 0.015 mm 0.6 mil.

][c. Frosted finish Class II; clear anodized coating, medium-matte chemical-etch finish; Architectural Class II 0.010 to 0.018 mm 4 to 0.7 mil thick anodized coating producing natural aluminum color finish conforming to AA C22-A31, as specified in AA DAF45.

][d. Frosted finish Class I, clear anodized coating, medium-matte chemical-etch finish; Architectural Class I 0.018 mm 0.7 mil and greater thickness anodized coating producing natural aluminum color finish conforming to AA C22-A41, as specified in AA DAF45.

****

NOTE: The following polished, satin, and matte finishes generally are required for aluminum

ornamental items only.
****

][e. Polished finish Class II, clear anodized coating, smooth specular-buffed mechanical finish; Architectural Class II 0.010 to 0.018 mm 0.4 to 0.7 mil thick anodized coating producing natural aluminum color finish conforming to AA M21-A31, as specified in AA DAF45.

][f. Satin finish Class II; clear anodized coating, medium-satin directional textured mechanical finish and Architectural Class II 0.010 to 0.018 mm 0.4 to 0.7 mil thick anodized coating producing natural aluminum color finish conforming to AA M32-A31, as specified in AA DAF45.

][g. Matte finish Class II; clear anodized coating, medium-matte nondirectional textured mechanical finish and Architectural Class II 0.010 to 0.018 mm 0.4 to 0.7 mil thick anodized coating producing natural aluminum color finish conforming to AA M42-A31, as specified in AA DAF45.

****
NOTE: The following polished-frosted finishes are the finishes specified for aluminum doors and frames and aluminum curtain wall systems and apply to exterior architectural metal items requiring a matching finish. Select the desired coating thickness.
****

][h. Polished-frosted finish Class II; clear anodized coating, smooth specularbuffed mechanical finish, followed by a medium matte chemical etch finish, Architectural Class II 0.010 to 0.018 mm 0.4 to 0.7 mil thick anodized coating producing natural aluminum color finish conforming to AA M21-C22-A31, as specified in AA DAF45.

][i. Polished-frosted finish Class I, clear anodized coating smooth specular-buffed mechanical finish, followed by a medium-matte chemical-etch finish, Architectural Class I, 0.018 mm 0.7 mil and greater thickness of anodized coating producing natural aluminum color finish conforming to AA M21-C22-A41, as specified in AA DAF45.

****
NOTE: It is recommended that a sample of the required color be on display where it may be seen by bidders during the bidding period.
****

][j. Polished-frosted finish integral-color anodized coating, smooth specular-buffed mechanical finish, followed by a nonetching inhibitive alkaline cleaning, medium-matte, chemical-etch finish, Architectural Class 1, 0.018 mm 0.7 mil and greater thickness of anodized coating producing dark bronze integral-color finish conforming to AA DAF45.

][k. Match the finish color and appearance to that of the aluminum finish sample approved for each architectural metal item within the aluminum producer's standard color range.

]2.2.10 Ornamental Metal Items

****

NOTE: Additional paragraph headings and paragraphs specifying special ornamental metal items (such as aluminum sills for other than aluminum windows, aluminum mullions that are not a part of a curtain wall system, and any other item not specified) can be added as required.

****

2.2.10.1 Aluminum Joint Cover Assemblies

Design aluminum joint cover assemblies for horizontal movement and the joint width indicated.

Provide mill finish for exposed-to-view surfaces.

Provide floor joint cover assemblies consisting of a continuous frame unit on each side of floor-to-floor joints or on one side of floor-to-wall joints as required by construction conditions. Include floor cover plates, filler strips, anchors, and other accessories as required to complete the installation, and as follows:

Fabricate floor frame units from aluminum-alloy extrusions with an integral curb edge bar for the expansion joint edges. Provide integral grooves to receive anchor bolts, and floor cover plate with filler strip surfaces that will finish flush to the finished floor elevation when the floor cover assembly is installed. Provide corrosion-resistant coated aluminum alloy or steel anchor bolts and nuts, spaced not more than 75 mm 3 inches from each end and not more than 450 mm 18 inches on center between end anchors. Furnish coated steel anchor bolts and nuts conforming to SSPC PA 1. Provide frame splice connectors as required to complete the installation.

2.2.10.1.1 Floor Cover Plates

[Provide plain floor cover plates, aluminum-alloy extrusions with smooth surface.

][Provide recessed floor cover plates, aluminum-alloy extrusions with recess to receive resilient floor covering, with a recess depth as required to provide a resilient floor covering surface flush with the finished floor elevation.

][Provide nonslip floor cover plates, aluminum-alloy castings with abrasive grit embedded uniformly into the walking surface at the time of casting, with 20-grain aluminum oxide abrasive grit.

] Provide floor cover plates of the patterns and widths indicated, and lengths as long as practical, with metal thickness not less than 6 mm 1/4 inch. Drill and countersink fixed edge of floor cover plates to receive flathead screws, spaced not more than 75 mm 3 inches from each cover plate end and not more than 450 mm 18 inches on center between the end screw holes. Provide corrosion-resistant steel screws for securing floor cover plates.

2.2.10.1.2 Wall And Ceiling Joint Cover Assemblies

Provide rubber and cork composition tape filler strips with pressure-sensitive adhesive coating on one face and smooth suede surface on the exposed face, conforming to ASTM D1752, not less than 38 mm 1 1/2 inches wide and a depth as required to provide a surface flush with the finished floor elevation.

Provide wall and ceiling joint cover assemblies consisting of continuous anchor strips on one side of the wall or ceiling expansion joint; wall and ceiling cover plates; and seals, anchors, and other accessories as required to complete the installation, and as follows:

a. Provide aluminum-alloy wall and ceiling anchor strip extrusions fabricated to provide an integral curb bar edge and integral lugs to receive snap-on cover plates. Field-drill fixed edge of anchor strips with holes to receive screws, spaced not more than 75 mm 3 inches from each end and not more than 300 mm 12 inches on center between the end screw holes. Provide cadmium-plated screws with masonry anchorage devices or toggle bolts as required by construction conditions.

b. Provide aluminum-alloy wall and ceiling cover plate extrusions of the patterns and widths indicated, designed for snap-on application over anchor strips, fabricated with integral grooves to receive sealing gaskets, and having a smooth exposed-to-view surface.

Provide vinyl sealing gaskets for [exterior wall joint cover assemblies] [wall and ceiling joint cover assemblies].

2.2.10.1.3 Frosted Finish

[Provide a frosted finish with Class II clear anodized coating for exposed-to-view surfaces.

][Provide a frosted finish with lacquer coating for interior wall and ceiling joint cover assembly that are exposed-to-view surfaces.]

[Provide a frosted finish with Class II clear anodized coating for exterior wall joint cover assembly that are exposed-to-view surfaces.

]PART 3 EXECUTION

3.1 INSTALLATION

Submit installation drawings for ornamental metal items, shop and field connections and construction details showing location, dimensions, size, and weight or gauge as applicable of each ornamental item; type and location of shop and field connections; and other pertinent construction and erection details. Show on drawings location and details of anchorage devices embedded in cast-in-place concrete and masonry construction.

3.1.1 Anchorage Devices Embedded In Other Construction

Install decorative metal work in accordance with the approved shop drawings and descriptive data for each ornamental metal item, as specified.

Securely fasten decorative metal items plumb and true to horizontal and vertical lines and levels.

3.1.2 Holes for Other Work

Provide holes where indicated for securing other work to metal work.

3.1.3 Fastening to Construction-In-Place

Provide anchorage devices and fasteners where necessary for fastening ornamental metal items to construction-in-place. Include threaded fasteners for concrete inserts embedded in cast-in-place concrete; masonry anchorage devices and threaded fasteners for solid masonry and concrete-in-place; toggle bolts for hollow masonry and stud partitions; through-bolting for masonry and wood construction; lag bolts and wood screws for wood construction; and threaded fasteners for structural steel. Provide fastening as indicated and as specified. Do not fasten to wood plugs in masonry or concrete-in-place.

3.1.4 Cutting and Fitting

Perform required cutting, drilling, and fitting for the installation of ornamental metal work. Execute cutting, drilling, and fitting carefully; when required; fit in-place work before fastening.

3.1.5 Setting Masonry Anchorage Devices

Set all masonry anchorage devices in masonry or concrete-in-place construction in accordance with the anchorage device manufacturer's printed instructions. Drill anchorage holes to the depth, diameter, and size recommended by the manufacturer of the particular anchorage device used. Leave drilled anchorage holes rough, not reamed, and free of drill dust.

3.1.6 Threaded Connections

Countersink flat bolts and screw heads where anchors are exposed to view, and tightly secure threaded connections so that the threads are entirely concealed by fitting, unless otherwise specified.

3.2 FIELD QUALITY CONTROL

3.2.1 Finished Ornamental Metal Work Requirements

Ornamental metal work will be rejected for any of the following deficiencies:

a. Finish of exposed-to-view aluminum surfaces having color or appearance that is outside the color or appearance range of the approved samples for aluminum finish.

b. Installed ornamental metal items having stained, discolored, abraded, or otherwise damaged exposed-to-view aluminum surfaces that cannot be removed by cleaning or repairing.

c. Installed ornamental metal items that do not match the approved sample.

d. Aluminum surfaces in contact with dissimilar materials that are not protected as specified.

3.3 ADJUSTING AND CLEANING

Before final acceptance, wash exposed-to-view aluminum surfaces with clean water and soap and rinse with clean water. Do not use acid solutions, steel wool, or other harsh abrasives. Remove stains that remain after cleaning or restore the finish in accordance with the aluminum producer's recommendations

Perform all preventative maintenance and inspection in accordance with the aluminum producer's recommended cleaning materials and application methods including precautions in the use of cleaning materials that maybe detrimental to the aluminum finish when improperly applied.

3.4 MAINTENANCE INSTRUCTIONS

Submit the aluminum producer's recommended maintenance instructions for cleaning materials and application.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-06 10 00 (August 2016)**
Change 2 - 11/18

Preparing Activity: NAVFAC **Superseding**
UFGS-06 10 00 (February 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 10 00

ROUGH CARPENTRY

08/16, CHG 2: 11/18

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-06 10 00 (August 2016)**
Change 2 - 11/18

Preparing Activity: NAVFAC **Superseding**
UFGS-06 10 00 (February 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 06 10 00

ROUGH CARPENTRY
08/16, CHG 2: 11/18

****

NOTE: This guide specification covers framing, grounds, nailers, blocking, and sheathing of light wooden structures and includes the use of preassembled components and plastic lumber. Wood finished flooring, trim, millwork, siding, heavy timber work, custom woodwork, and finish carpentry are specified in other sections.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Design exterior envelope to meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including moisture control and thermal performance.

****

****

NOTE: The following information should be shown on the project drawings:

1. Sizes and spacing of all wood framing members including trussed rafters and trusses

2. Location, size, type, and thickness of all materials

3. Size and spacing of anchor bolts

4. Details of all connections and anchorage where special conditions exist such as high wind, hurricane, and earthquake areas

5. Design loads

6. Design unit stresses for structural lumber

7. Details of depressed floors to receive ceramic tile.

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC 111	(2005) Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection
AITC TCM	(2012) Timber Construction Manual, 5th Edition
ANSI/AITC A190.1	(2007) American National Standard, Structural Glued Laminated Timber

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

ALSC PS 20	(2021) American Softwood Lumber Standard

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2023) Manual for Railway Engineering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.5.2.1M	(2006; R 2011) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2010) Metric Round Head Square Neck Bolts
ASME B18.6.1	(2016) Wood Screws (Inch Series)

AMERICAN WOOD COUNCIL (AWC)

AWC NDS	(2018) National Design Specification (NDS) for Wood Construction
AWC WFCM	(2012) Wood Frame Construction Manual for One- and Two-Family Dwellings

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA BOOK	(2015) AWPA Book of Standards
AWPA M2	(2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use
AWPA M6	(2024) Brands Used on Preservative Treated Materials

AWPA P5	(2015) Standard for Waterborne Preservatives
AWPA P18	(2014) Nonpressure Preservatives
AWPA P49	(2015; R 2021) Standard for Fire Retardant FR-1
AWPA T1	(2024) Use Category System: Processing and Treatment Standard
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA E30	(2016) Engineered Wood Construction Guide
APA E445	(2002) Performance Standards and Qualification Policy for Structural-Use Panels (APA PRP-108)
APA EWS R540	(2013) Builder Tips: Proper Storage and Handling of Glulam Beams
APA EWS T300	(2007) Technical Note: Glulam Connection Details
APA F405	(19) Product Guide: Performance Rated Panels
APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood
APA S350	(2019) PS 2-18, Performance Standard for Wood-Based Structural-Use Panels

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C208	(2022) Standard Specification for Cellulosic Fiber Insulating Board
ASTM C1136	(2023) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

ASTM C1396/C1396M	(2024) Standard Specification for Gypsum Board
ASTM D198	(2015) Standard Test Methods of Static Tests of Lumber in Structural Sizes
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D1435	(2013) Standard Practice for Outdoor Weathering of Plastics
ASTM D1972	(1997; R 2005) Standard Practice for Generic Marking of Plastic Products
ASTM D2344/D2344M	(2016) Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM D2898	(2010; R 2017) Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM D3498	(2019a) Standard Specification for Adhesives for Field-Gluing Wood Structural Panels (Plywood or Oriented Stand Board) to Wood Based Floor System Framing
ASTM D6108	(2013) Standard Test Method for Compressive Properties of Plastic Lumber and Shapes
ASTM D6109	(2013) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber and Related Products
ASTM D6111	(2013a) Standard Test Method for Bulk Density and Specific Gravity of Plastic Lumber and Shapes by Displacement
ASTM D6112	(2013) Compressive and Flexural Creep and Creep-Rupture of Plastic Lumber and Shapes
ASTM D6117	(2016) Standard Test Methods for Mechanical Fasteners in Plastic Lumber and Shapes
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM F547	(2017) Standard Terminology of Nails for Use with Wood and Wood-Base Materials
ASTM F1667/F1667M	(2021a) Standard Specification for Driven

	Fasteners: Nails, Spikes, and Staples

CALIFORNIA AIR RESOURCES BOARD (CARB)

CARB 93120	(2007) Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A135.4	(2012; R2020) Basic Hardboard
ANSI/CPA A208.1	(2022) Particleboard

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FM GLOBAL (FM)

FM 4435	(2017) Roof Perimeter Flashing

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA Rules	(2023) Rules for the Measurement & Inspection of Hardwood & Cypress

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules	(2021) Standard Grading Rules for Northeastern Lumber

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

REDWOOD INSPECTION SERVICE (RIS) OF THE WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

RIS Grade Use	(2019) California Redwood Lumber Grades and Uses

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

SOUTHERN CYPRESS MANUFACTURERS ASSOCIATION (SCMA)

SCMA Spec	(1986; Supple. No. 1, Aug 1993) Standard Specifications for Grades of Southern Cypress

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003	(2021) Standard Grading Rules for Southern Pine Lumber

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

TRUSS PLATE INSTITUTE (TPI)

TPI 1	(2022) National Design Standard for Metal Plate Connected Wood Truss Construction
TPI HIB	(1991) Commentary and Recommendations for Handling, Installing and Bracing Metal Plate Connected Wood Trusses

U.S. DEPARTMENT OF COMMERCE (DOC)

DOC/NIST PS56	(1973) Structural Glued Laminated Timber
DOC/NIST PS58	(1973) Basic Hardboard (ANSI A135.4)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1923	(Rev A; Notice 1; Notice 2; Notice 3; Notice 4) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-1924	(Rev A; Notice 3) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors
CID A-A-1925	(Rev A; Notice 1; Notice 2; Notice 3; Notice 4) Shield Expansion (Nail Anchors)
FS UU-B-790	(Rev A; Notice 2) Building Paper Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 770	Formaldehyde Standards for Composite Wood Products

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17	(2015; R 2018) Standard Grading Rules for West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5	(2021) Western Lumber Grading Rules

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Structural Glued Laminated Members; G, [_____]

][Trussed Rafters; G, [_____]

][Trussed Joists; G, [_____]

][Fabricated Structural Members; G, [_____]

] Modifications of Structural Members; G, [_____]

Drawings of structural laminated members, fabricated wood trusses, engineered wood joists and rafters, and other fabricated structural members indicating materials, shop fabrication, and field erection details; including methods of fastening.

[Nailers and Nailing Strips; G, [_____]

Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual wind uplift rated systems specified in other Sections of these specifications.

] SD-03 Product Data

[Salvaged Lumber

][Recovered Lumber

][Underlayment

] Plastic Lumber

Fiberboard Wall Sheathing

Cellulose Honeycomb Panels

Fire-retardant Treatment

Structural-use and OSB Panels

Oriented Strand Board

Adhesives

[Biobased Content for Strawboard Panels; S

][Biobased Content for Cork Underlayment; S

][Recycled Content for Plastic Lumber; S

][Recycled Content for Fiberboard Underlayment; S

][Recycled Content for Cork Underlayment; S

][Recycled Content for Fiberboard Wall Sheathing; S

][Recycled Content for Cellulose Honeycomb Panels; S

] SD-05 Design Data

Modifications of Structural Members; G, [_____]

Design analysis and calculations showing design criteria used to accomplish the applicable analysis.

SD-06 Test Reports

Preservative-treated Lumber and Plywood

SD-07 Certificates

[Certificates of Grade

][Certified Sustainably Harvested Virgin Lumber; S

][Certified Sustainably Harvested Natural-decay and Insect-resistant Wood; S

][Certified Sustainably Harvested Framing Lumber; S

][Certified Sustainably Harvested Structural Glued Laminated Timber; S

][Certified Sustainably Harvested Plywood Subflooring; S

][Certified Sustainably Harvested Structural-use and OSB Panel Subfloor Sheathing; S

][Certified Sustainably Harvested Plywood Combination Subfloor Underlayment; S

][Certified Sustainably Harvested Plywood Wall Sheathing; S

][Certified Sustainably Harvested Structural-use and OSB Panel Wall Sheathing; S

][Certified Sustainably Harvested Plywood Roof Sheathing; S

][Certified Sustainably Harvested Plywood Diaphragm; S

][Certified Sustainably Harvested Structural-use and OSB Panel Diaphragm; S

][Certified Sustainably Harvested Plywood Shear Wall; S

][Certified Sustainably Harvested Structural-use and OSB Panel Shear Wall; S

][Certified Sustainably Harvested Plywood for Other Uses; S

][Certified Sustainably Harvested Structural-use and OSB Panels for Other Uses; S

][Certified Sustainably Harvested Plywood Underlayment; S

] Preservative Treatment

[Indoor Air Quality for Particleboard Underlayment; S

][Indoor Air Quality for Fiberboard Underlayment; S

][Indoor Air Quality for Strawboard Panels; S

][Indoor Air Quality for Fiberboard Wall Sheathing; S

][Indoor Air Quality for Aerosol Adhesives; S

][Indoor Air Quality for Non-aerosol Adhesives; S

] SD-10 Operation and Maintenance Data

Plastic

When not labeled, identify types in Operation and Maintenance Manual.

Take-back Program

Include contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling or reuse.

1.3 DELIVERY AND STORAGE

Deliver materials to the site in an undamaged condition. Store, protect, handle, and install prefabricated structural elements in accordance with manufacturer's instructions and as specified. Store materials off the ground to provide proper ventilation, with drainage to avoid standing water, and protection against ground moisture and dampness. Store materials with a moisture barrier at both the ground level and as a cover forming a well ventilated enclosure. Store wood I-beams and glue-laminated beams and joists on edge. Adhere to requirements for stacking, lifting, bracing, cutting, notching, and special fastening requirements. [Handle and store laminated timber in accordance with AITC 111 or APA EWS R540.] Do not use materials that have visible moisture or biological growth. Remove defective and damaged materials and provide new materials. Store separated reusable wood waste convenient to cutting station and area of work.

1.4 GRADING AND MARKING

1.4.1 Lumber

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NOTE: Finger-jointed lumber is not allowed for Air Force construction.

****

Mark each piece of framing and board lumber or each bundle of small pieces of lumber with the grade mark of a recognized association or independent inspection agency. Such association or agency must be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Surfaces that are to be exposed to view must not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

1.4.2 Structural Glued Laminated Timber

Mark each member with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of structural glued laminated timber products. The marking must indicate compliance with ANSI/AITC A190.1 and must include all identification information required by ANSI/AITC A190.1.[Structurally end-jointed lumber must also be certified and grade marked in accordance with ANSI/AITC A190.1.]

1.4.3 Plywood

Mark each sheet with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. The mark must identify the plywood by species group or span rating, exposure durability classification, grade, and compliance with APA L870. Surfaces that are to be exposed to view must not bear grademarks or other types of identifying marks.

1.4.4 Structural-Use and OSB Panels

Mark each panel with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the panel. The mark must indicate end use, span rating, and exposure durability classification. Oriented Strand Board (OSB), APA F405.

1.4.5 Preservative-Treated Lumber and Plywood

The Contractor is responsible for the quality of treated wood products. Each treated piece must be inspected in accordance with AWPA M2 and permanently marked or branded, by the producer, in accordance with AWPA M6. The Contractor must provide Contracting Officer's Representative (COR) with the inspection report of an approved independent inspection agency that offered products comply with applicable AWPA Standards. The appropriate Quality Mark on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.4.6 Fire-Retardant Treated Lumber

****

NOTE: Do not use fire-retardant treated plywood on Navy projects.

****

Mark each piece in accordance with AWPA M6, except pieces that are to be natural or transparent finished. In addition, exterior fire-retardant lumber must be distinguished by a permanent penetrating blue stain. Labels of a nationally recognized independent testing agency will be accepted as evidence of conformance to the fire-retardant requirements of AWPA M6.

1.4.7 Hardboard, Gypsum Board, and Fiberboard

Mark each sheet or bundle to identify the standard under which the material is produced and the producer.

1.4.8 Plastic Lumber

****

NOTE: The marking system indicated below is intended to provide assistance in identification of products for making subsequent decisions as to handling, recycling, or disposal.

****

Label plastic products to be incorporated into the project in accordance with ASTM D1972, or provide product data indicating polymeric information in the Operation and Maintenance Manual.

a. Type 1: Polyethylene Terephthalate (PET, PETE).
b. Type 2: High Density Polyethylene (HDPE).
c. Type 3: Vinyl (Polyvinyl Chloride or PVC).
d. Type 4: Low Density Polyethylene (LDPE).
e. Type 5: Polypropylene (PP).
f. Type 6: Polystyrene (PS).
g. Type 7: Other. Use of this code indicates that the package in question. is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

1.5 SIZES AND SURFACING

ALSC PS 20 for dressed sizes of yard and structural lumber. Lumber must be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes must be within manufacturing tolerances allowed by the standard under which the product is produced. Other measurements are IP or SI standard.

1.6 MOISTURE CONTENT

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products must be as follows at the time of delivery to the job site:

a. Framing lumber and board, 19 percent maximum

b. Timbers 125 mm 5 inches and thicker, 25 percent maximum

[c. Roof planking, 15 percent maximum

] d. Materials other than lumber; moisture content must be in accordance with standard under which the product is produced

1.7 PRESERVATIVE TREATMENT

****

NOTE: Water-borne preservatives are leach resistant, paintable, and easily worked. Whenever certain exposed uses require minimized swelling, shrinking, or splitting, then require that a water repellent be added to the treatment. Requirement of an independent inspection agency report or the AWPA Quality Mark verifies that the product was prepared

and treated in accordance with its appropriate AWPA Standard and other specification requirements. Consult the EFD applied biologist for further guidance regarding specific treatments listed or additional treatments that may be required for special use items. All lumber and woodwork in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5 must be preservative treated. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. As a substitute for treated lumber, plastic lumber and naturally durable heartwood reduces potential leaching of chemicals used in wood treatment.

****

****

NOTE: According to the IARC and TCLP, noncompliant products include, but are not limited to, Chromated Copper Arsenate (CCA) treatments, Ammoniacal Copper Zinc Arsenate (ACZA) treatments, and those using pentachlorophenol or creosote. Compliant pressure preservative treatments include, but are not limited to, Ammoniacal Copper Quaternary (ACQ), and Copper Boron Azole (CBA). Certified sustainably harvested wood processed as treated wood is available by special order.

ACQ pressure-injected wood does not contain arsenic or chromium and is not classified as hazardous waste by EPA. Due to copper toxicity to aquatic organisms, it is not recommended for use near bodies of water.

****

Treat wood products with waterborne wood preservatives conforming to AWPA P5. Pressure treatment of wood products must conform to the requirements of AWPA BOOK Use Category System Standards U1 and T1. Pressure-treated wood products must not contain arsenic, chromium, or other agents classified as carcinogenic, probably carcinogenic, or possibly carcinogenic to humans (compounds in Groups 1, 2A, or 2B) by the International Agency for Research on Cancer (IARC), Lyon, France. Pressure-treated wood products must not exceed the limits of the U.S. EPA's Toxic Characteristic Leaching Procedure (TCLP), and must not be classified as hazardous waste. Submit certification from treating plant stating chemicals and process used and net amount of preservatives retained are in conformance with specified standards. In accordance with AWPA U1 provide non-copper preservative treatment such as EL2, PTI or SBX,DOT for products in direct contact with sheet metal.

a. 4 kg per cubic meter 0.25 pcf intended for above ground use.

b. 6.4 kg per cubic meter 0.40 pcf intended for ground contact and fresh water use. 9.6 kg per cubic meter 0.60 pcf intended for Ammoniacal Copper Quaternary Compound (ACQ)-treated foundations. 12.8 to 16.1 kg per cubic meter 0.80 to 1.00 pcf intended for ACQ-treated pilings. All wood must be air or kiln dried after treatment. Specific treatments must be verified by the report of an approved independent inspection agency, or the AWPA Quality Mark on each piece.[Do not incise surfaces of lumber that will be exposed.] Minimize cutting and avoid breathing sawdust. Brush coat areas that are cut or drilled after treatment with either the same preservative used in the treatment or with a 2 percent copper naphthenate solution.[All lumber and woodwork must be preservative treated.] Plastic lumber must not be preservative treated. The following items must be preservative treated:

(1) Wood framing, woodwork, and plywood up to and including the subflooring at the first-floor level of structures having crawl spaces when the bottoms of such items are 600 mm 24 inches or less from the earth underneath.

(2) Wood members that are in contact with water.

(3) Exterior wood steps, platforms, and railings; and all wood framing of open, roofed structures.

(4) Wood sills, soles, plates, furring, and sleepers that are less than 600 mm 24 inches from the ground, furring and nailers that are set into or in contact with concrete or masonry.

(5) Nailers, edge strips, crickets, curbs, and cants for roof decks.

1.7.1 Existing Structures

****

NOTE: Permathrin is manufactured from water-based pyrethrum, degrades in sunlight, and affects air quality less than petroleum-based insecticides. Borate is considered safe for humans and other mammals, but is not for use in high-moisture areas.

****

Use borate, permathrin, or a sodium silicate wood mineralization process to treat wood. Use borate for interior applications only.

1.7.2 New Construction

****

NOTE: Boron-based preservative is not recommended for use of wood in direct contact with ground because of the potential for leaching out of the preservative. Boron-based preservative has nonrestrictive handling requirements and low mammalian toxicity.

****

Use a boron-based preservative conforming to AWPA P18, sodium silicate wood mineralization process, or Ammoniacal Copper Quaternary Compound to treat wood. Use boron-based preservatives for above-ground applications only.

1.8 FIRE-RETARDANT TREATMENT

****

NOTE: Items to be treated should be listed in this paragraph. Fire-retardant treatment should be specified when necessary to provide required fire resistance for the structure. Where wood will be

exposed to heat or high humidity, as well as where wood is exposed on the exterior of buildings, specify exterior fire retardant treatment. Do not use fire-retardant treated plywood on Navy projects.
****

Fire-retardant treated wood must be pressure treated with fire retardants conforming to AWPA P49. Fire retardant treatment of wood products must conform to the requirements of AWPA U1, Commodity Specification H and AWPA T1, Section H. Treatment and performance inspection must be by an independent and qualified testing agency that establishes performance ratings. Each piece or bundle of treated material must bear identification of the testing agency to indicate performance in accordance with such rating. Treated materials to be exposed to rain wetting must be subjected to an accelerated weathering technique in accordance with ASTM D2898 prior to being tested. Such items which will not be inside a building, and such items which will be exposed to heat or high humidity, must receive exterior fire-retardant treatment. [Fire-retardant-treated wood products must be free of halogens, sulfates, ammonium phosphate, and formaldehyde.]Items to be treated include the following:

a. [_____].

1.9 QUALITY ASSURANCE

1.9.1 Drawing Requirements

For fabricated structural members, trusses, qlu-lam members, indicate materials, details of construction, methods of fastening, and erection details. Include reference to design criteria used and manufacturers design calculations. Submit drawings for all proposed modifications of structural members. Do not proceed with modifications until the submittal has been approved.

1.9.2 Data Required

Submit calculations and drawings for all proposed modifications of structural members. Do not proceed with modifications until the submittal has been approved.

1.9.3 Humidity Requirements

****
NOTE: Comfort standards typically allow humidity to fluctuate to save energy costs. The amount of humidity control needed will vary with climate region and types of carpentry used.
****

Sequence work to minimize use of temporary HVAC to dry out building and control humidity.

1.9.4 Plastic Lumber Performance

Plastic lumber intended for use in exterior applications must have no fading or discoloration and no change in dimensional stability as tested in accordance with ASTM D1435 for a period of [1][3][5][_____] year[s].

1.10 ENVIRONMENTAL REQUIREMENTS

During and immediately after installation of treated wood, engineered wood products, and laminated wood products at interior spaces, provide temporary ventilation.

1.11 CERTIFICATIONS

[1.11.1 Certified Wood Grades

Provide certificates of grade from the grading agency on graded but unmarked lumber or plywood attesting that materials meet the grade requirements specified herein.

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

****

][1.11.2 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

]1.11.3 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

****

NOTE: Include the following section where these products are used on the interior of the building

(defined as inside of the weatherproofing system).
****

[1.11.3.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

]
****
NOTE: Include the following section where these products are used on the interior of the building (defined as inside of the weatherproofing system).
****

[1.11.3.2 Composite Wood, Wood Structural Panel and Agrifiber Products

For purposes of this specification, composite wood and agrifiber products include particleboard, medium density fiberboard (MDF), strawboard, panel substrates, and door cores. Provide products certified to meet requirements of both 40 CFR 770 and CARB 93120. Provide current product certification documentation from certification body.

]PART 2 PRODUCTS

2.1 MATERIALS

****
NOTE: Specify lower grades and engineered wood products for large-dimension timbers when appropriate.
****

2.1.1 Virgin Lumber

****
NOTE: Old growth timber comes from trees over 200 years old. In industry, it is high quality lumber in "upper" or "architectural" grades. Lumber suppliers should know which timber is old growth and which is not, but sources are not always tracked. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition for certified sustainably harvested virgin lumber before specifying this certification - if these conditions are verified for the project locale, include the bracketed statement.
****

Lumber fabricated from old growth timber is not permitted. Avoid companies who buy, sell, or use old growth timber in their operations, when possible.[Provide certified sustainably harvested virgin lumber.]

[2.1.2 Salvaged Lumber

****

NOTE: Salvaged lumber includes lumber from deconstruction or demolition of existing buildings or structures. Large-dimension timbers from first-growth trees are a limited resource; use in original dimensions if possible. Using salvaged materials contributes to maximizing sustainability on all projects. Include submittal and coordinate with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

Provide salvaged lumber where specified. Unless otherwise noted, salvaged lumber must be delivered clean, denailed, and free of paint, finish materials, and other contamination. Lumber must meet the other criteria within this section. Provide documentation certifying products are from salvaged lumber sources.

][2.1.3 Recovered Lumber

****

NOTE: Recovered lumber includes previously harvested lumber pulled from riverbeds or otherwise abandoned. Using recovered materials contributes to maximizing sustainability on all projects. Include submittal and coordinate with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

Use recovered lumber where practical. Unless otherwise noted, recovered lumber must be delivered clean and free of contamination. Provide grading certificates for any recovered wood materials used in structural applications. Lumber must meet the other criteria within this section. Provide documentation certifying products are from recovered lumber sources.

]2.1.4 Natural Decay- and Insect-Resistant Wood

****

NOTE: Naturally durable wood is a chemical-free alternative to treated wood. The heartwood of the following species is considered naturally durable wood. Decay resistant species include redwood, South American ipe, bald cypress, longleaf yellow pine, elm, cedar, black locust, American chestnut, angico, and black walnut. Termite resistant species include redwood and Eastern red cedar.

****

[Naturally durable wood must be certified sustainably harvested natural-decay and insect-resistant wood.]An occasional piece with corner sapwood is permitted if 90 percent or more of the width of each side on which the sapwood occurs is heartwood.[The primary species to use on this project is [redwood], [_____].]

[2.1.5 Plastic Lumber

****

NOTE: Plastic lumber is a durable, weather-resistant, recyclable, and low maintenance material. Plastic lumber is integrally colored and homogenous and so does not require painting. For lengths greater than 1.8 m 6 feet or where deflection and creep are significant considerations (e.g., fencing, decking, and bollards), consider plastic lumber with fiber such as recycled cellulose or glass to improve stability and resistance to screw pullout. Typical plastic lumber applications include dimensional lumber, landscape timber, decking, parking stops, speed bumps, benches, tables, waste receptacles, playground structures, fencing, and signage.

****

****

NOTE: Plastic lumber used for landscaping timbers and posts is an EPA designated product for recycled content. Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying this product. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows products are available from US national manufacturers above the minimum recycled content stated.

****

HDPE lumber must contain a minimum of 90 percent total recycled content. Mixed plastics and cellulose lumber must contain a minimum of 100 percent total recovered materials content, with a minimum of 50 percent post-consumer recycled content. HDPE/fiberglass lumber must contain a minimum of 95 percent total recovered materials content with a minimum of 75 percent post-consumer recycled content. Other mixed resin lumber must contain a minimum of 95 percent total recovered materials content with a minimum of 50 percent post-consumer recycled content. Provide data identifying percentage of recycled content for plastic lumber.

2.1.5.1 Shear Parallel to Length

Maximum 1,550 K/m2 1,000 psi in accordance with ASTM D2344/D2344M.

2.1.5.2 Density

ASTM D6111.

2.1.5.3 Compressive Strength

a. Secant Modulus: Minimum 108,511 K/m2 70,000 psi in accordance with ASTM D6108.

b. Stress at 3 percent strain: Minimum 2,325 K/m2 1,500 psi in accordance with ASTM D6108.

c. Compression Parallel to Grain: Minimum 4,650 K/m2 3,000 psi in accordance with ASTM D6112.

d. Compression Perpendicular to Grain: Minimum 1,550 K/m2 1,000 psi in accordance with ASTM D6112.

2.1.5.4 Flexural Strength

Minimum 3,100 K/m2 2,000 psi in accordance with ASTM D6109.

2.1.5.5 Tensile Strength

Minimum 1,938 K/m2 1,250 psi in accordance with ASTM D198.

2.1.5.6 Coefficient of Thermal Expansion

Maximum 0.000044 mm/mm/degree C 0.000080 in/in/degree F in accordance with ASTM D696.

2.1.5.7 Screw Withdrawal

0.35 K350 lbs in accordance with ASTM D6117.

2.1.5.8 Nail Withdrawal

0.15 K150 lbs in accordance with ASTM D6117.

]2.2 LUMBER

2.2.1 Structural Lumber

****

NOTE: When the minimum allowable unit stresses for structural lumber are not indicated on the drawings, check with the structural engineer. The following minimum allowable unit stresses are commonly used:

1. 7200 kPa Fb, 4800 kPa Ft, 5400 kPa Fc with 8300 MPa E 1050 Fb, 700 Ft, 780 Fc with 1,200,000E for engineered uses, i.e., structural lumber used in fabrication of bolted trusses and other fabricated structural members for engineered uses, except trussed rafters.

2. 8300 kPa Fb, with 8300 MPa E 1200 Fb, with 1,200,000E for repetition member uses, i.e., joists, rafters including trussed type, decking, and headers.

****

[Except where a specific grade is indicated or specified,] Any of the species and grades listed in AWC NDS that have allowable unit stresses in kPa pounds per square inch (psi) not less than [[_____] Fb, [_____] Ft, [_____] Fc, with [_____] E] [allowable unit stresses indicated]. Use for joists, rafters, headers, trusses, beams (except collar beams), columns, posts, stair stringers, girders, and all other members indicated to be stress rated.[Structural lumber exposed to view in [_____] must be appearance grade [of [_____] species][of any species] meeting the allowable unit stresses [specified][indicated].] Design of members and fastenings must conform to AITC TCM. Other stress graded or dimensioned items such as blocking, carriages, and studs must be standard or No. 2 grade except that studs may be Stud grade.

2.2.2 Framing Lumber

****
NOTE: Finger-jointed lumber is not allowed for Air Force construction.
****

****
NOTE: Except for projects requiring huge quantities of lumber, delete species and grades not normally used where project is located. Edit the listing to suit the locality and the project.
****

****
NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.
****

Framing lumber such as studs, plates, caps, collar beams, cant strips, bucks, sleepers, nailing strips, and nailers and board lumber such as subflooring and wall and roof sheathing must be one of the species listed in the table below. Minimum grade of species must be as listed. [Finger-jointed lumber may be used in the same applications as solid lumber of an equivalent species and grade, provided the finger-jointed lumber meets all the requirements of the certification and the quality control programs of the rules writing agency having jurisdiction and all applicable requirements of DOC/NIST PS56.][Provide certified sustainably harvested framing lumber.]

Table of Grades for Framing and Board Lumber			
Grading Rules	Species	Framing	Board Lumber
WWPA G-5 standard grading rules	Aspen, Douglas Fir-Larch, Douglas Fir South, Engelmann Spruce-Lodgepole Pine, Engelmann Spruce, Hem-Fir, Idaho White Pine, Lodgepole Pine, Mountain Hemlock, Mountain Hemlock-Hem-Fir, Ponderosa Pine-Sugar Pine, Ponderosa Pine-Lodgepole Pine, Subalpine Fir, White Woods, Western Woods, Western Cedars, Western Hemlock	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 3 m 10 feet and shorter)	All Species: No. 3 Common
WCLIB 17 standard grading rules	Douglas Fir-Larch, Hem-Fir, Mountain Hemlock, Sitka Spruce, Western Cedars, Western Hemlock	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 3 m 10 feet and shorter)	All Species: Standard

Table of Grades for Framing and Board Lumber			
Grading Rules	Species	Framing	Board Lumber
SPIB 1003 standard grading rules	Southern Pine	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 3 m 10 feet and shorter)	No. 2 Boards
SCMA Spec standard specifications	Cypress	No. 2 Common	No. 2 Common
NELMA Grading Rules standard grading rules	Balsam Fir, Eastern Hemlock-Tamarack, Eastern Spruce, Eastern White Pine, Northern Pine, Northern Pine-Cedar	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 3 m 10 feet and shorter)	All Species: No. 3 Common except Standard for Eastern White and Northern Pine
RIS Grade Use standard specifications	Redwood	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 3 m 10 feet and shorter)	Construction Heart

Table of Grades for Framing and Board Lumber			
Grading Rules	Species	Framing	Board Lumber
NHLA Rules rules for the measurement and inspection of hardwood and cypress lumber	Cypress	No. 2 Dimension	No. 2 Common

2.2.3 Structural Glued Laminated Timber

****

NOTE: Specify appearance grade of lumber in glued laminated members when required by aesthetic considerations. Insert stress requirements necessary when not indicated on drawings. Wet condition should be specified when moisture content of member in service will exceed 16 percent for repeated and prolonged periods. Architectural or Premium Appearance Grade should be specified only when appearance is of major importance. Special stains and sealers may be specified in lieu of a penetrating sealer when required by aesthetic considerations. Individual wrapping should be specified when protection during erection is necessary. Preservative treatment in lieu of sealing should be specified for exposure conditions named in ANSI/AITC A190.1.

****

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

****

NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the last bracketed statements requiring no added urea-formaldehyde resins.

****

ANSI/AITC A190.1, allowable working stress values for loads of normal duration in kPa pounds per square inch (psi) not less than the following:

Bending Members, [_____] Fb, [_____] Fv, [_____] E.
Compression Members, [_____] Fc, [_____] E.
Tension Members, [_____] Ft, [_____] E.

Fabricated with wet-use adhesives. Beams must use [glue-laminated][and] [laminated-strand][laminated-veneer] lumber. Posts and studs must use laminated-strand lumber. Joists must use laminated-veneer lumber. Members must be [Industrial] [Architectural] [Premium] Appearance Grade, sealed with a penetrating sealer, and [individually wrapped] [bundle wrapped] as standard with the manufacturer and approved. Members must be complete with hardware for joining laminated members and for their connection to other construction.[Provide certified sustainably harvested structural glued laminated timber.][When located on the interior of buildings, provide products with no added urea-formaldehyde resins.]

2.3 PLYWOOD, STRUCTURAL-USE, AND ORIENTED STRAND BOARD (OSB) PANELS

****

NOTE: Thicknesses and index or Span Rating numbers 16 ratings are used at 400 mm (modular SI spacing). Thickness and index or Span Rating number are minimums for usual loading and support spacing. Specific job conditions such as unusual loading, support spacing, surfacing material, and exposure may necessitate using other types of plywood or structural-use panels. Refer to American Plywood Association construction guides for additional guidance on specifying structural panel products.

****

****

NOTE: In humid locations or project locations with Environmental Severity Classifications (ESC) C3 thru C5, specify all plywood to have full penetration, preservative treatment. Except for special applications, use only exterior type plywood. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

****

NOTE: In humid locations or project locations with Environmental Severity Classifications (ESC) C4 and C5, do not use Particle Board or Oriented Strand Board (OSB) in locations exposed to weather. These products are unstable in wet and humid conditions and cannot be preservative treated. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

APA L870, APA S350, APA E445, and APA F405 respectively.

2.3.1 Subflooring

****

NOTE: Plywood, structural-use, and OSB panels, to receive floor finishes may be applied as (1) subflooring only; (2) combination

subfloor-underlayment; or (3) subflooring with underlayment applied over the subfloor.

Use subparagraph PLYWOOD or STRUCTURAL-USE AND OSB PANELS for plywood or structural-use or OSB panel subflooring to receive direct application of T&G finish wood flooring or to receive underlayment for floor covering such as carpet, resilient tile, linoleum, and other nonstructural floor finishes.

Use subparagraphs PLYWOOD and STRUCTURAL-USE AND OSB PANELS in conjunction with paragraphs UNDERLAYMENT and HARDBOARD UNDERLAYMENT when a separate underlayment application is desired.

****

2.3.1.1 Plywood

****

NOTE: Identification Index 32/16 or Span Rating 24/16 should be specified for supports 400 mm 16 inches o.c. and 48/24 should be specified for supports 600 mm 24 inches o.c. Plywood or structural-use panel subflooring to receive square-edge wood flooring must be specified to have T&G edges or edges to be supported by approved blocking or framing.

****

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

C-D Grade, Exposure 1 durability classification, Span rating of [24/16][48/24] or greater.[Provide certified sustainably harvested plywood subflooring.]

2.3.1.2 Structural-Use and OSB Panels

****

NOTE: Identification Index 32/16 or Span Rating 24/16 should be specified for supports 400 mm 16 inches o.c. and 48/24 should be specified for supports 600 mm 24 inches o.c. Plywood or structural-use panel subflooring to receive square-edge wood flooring must be specified to have T&G edges or edges to be supported by approved blocking or framing.

****

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before

specifying this certification.
****

Sheathing grade with durability equivalent to Exposure 1, Span Rating of [32/16] [48/24] or greater. OSB, APA E445, Rated Sturd-I-Floor.[Provide certified sustainably harvested structural-use and OSB panel subfloor sheathing.]

2.3.2 Combination Subfloor-Underlayment

****
NOTE: Use subparagraphs PLYWOOD and STRUCTURAL-USE AND OSB PANELS for combination subfloor-underlayment where application of an underlayment is not desired. This method is suitable for most types of finish flooring or floor covering and is normally more economical than an application of subflooring with an application of underlayment.
****

2.3.2.1 Plywood

****
NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.
****

[Underlayment Grade, Exposure 1][, or][Exterior Type, C-C (Plugged) Grade].[Provide certified sustainably harvested plywood combination subfloor underlayment.] Minimum thickness must be as listed below [except where indicated to have greater thickness].

Support Spacing	Underlayment Minimum Thickness
400 mm 16 inches	12.7 mm 1/2 inch for Group 1 species
	15 mm 19/32 inch for Group 2 and 3 species
	18 mm 23/32 inch for Group 4 species
600 mm 24 inches	18 mm 23/32 inch for Group 1 species
	22 mm 7/8 inch for Group 2 and 3 species
	25 mm 1 inch for Group 4 species

2.3.2.2 Structural-Use Panel

Combination subfloor-underlayment grade with durability equivalent to [Interior plywood with Exterior glue (Exposure 1)] [Exterior plywood], Span Rating of [16] [20] [24] [48] or greater.

2.3.3 Wall Sheathing

2.3.3.1 Plywood

****

NOTE: Plywood wall sheathing 9.5 mm 3/8 inch thick should be specified for supports spaced 400 mm 16 inches on center, and 12.7 mm 1/2 inch thick plywood wall sheathing should be specified for supports spaced 600 mm 24 inches on center.

****

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

C-D Grade, Exposure 1, and a minimum thickness of [9.5] [12.7] mm [3/8] [1/2] inch[, except where indicated to have greater thickness].[Provide certified sustainably harvested plywood wall sheathing.][Provide exterior grade material with phenol resin for interior and exterior applications.]

2.3.3.2 Structural-Use and OSB Panels

****

NOTE: Structural-use panels 9.5 mm 3/8 inch thick with a Span Rating of 16/0 or greater should be specified for supports 400 mm 16 inches o.c. and panels 11 mm 7/16 inch thick with a Span Rating of 24/0 or greater should be specified for supports 600 mm 24 inches o.c.

****

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Sheathing grade with durability equivalent to Exposure 1, Span Rating of [16/0] [24/0] or greater. OSB, APA Rated Sheathing. OSB must be a phenolic-glued board.[Provide certified sustainably harvested structural-use and OSB panel wall sheathing.]

2.3.4 Roof Sheathing

2.3.4.1 Plywood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before

specifying this certification.
****

C-D Grade, Exposure 1, with an Identification Index of not less than [24/0] [_____].[Provide certified sustainably harvested plywood roof sheathing.] Provide exterior grade material with phenol resin for all applications.

2.3.4.2 Structural-Use Panel

Sheathing grade with durability equivalent to Exposure 1, Span Rating of [24/0] [_____] or greater.

2.3.5 Diaphragms

2.3.5.1 Plywood

****
NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.
****

[Structural I][Structural II], [C-C][C-D] grade, Exposure 1, and a minimum thickness of [_____] mm inch.[Provide certified sustainably harvested plywood diaphragm.]

2.3.5.2 Structural-Use and OSB Panels

****
NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.
****

Sheathing grade with durability equivalent to Exposure 1 and a minimum thickness of [_____] mm inch.[Provide certified sustainably harvested structural-use and OSB panel diaphragm.]

2.3.6 Shear Walls

2.3.6.1 Plywood

****
NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.
****

[Structural I] [Structural II], [C-C] [C-D] [_____] Grade and a minimum thickness of [_____] mm inch.[Provide certified sustainably harvested plywood shear wall.]

2.3.6.2 Structural-Use and OSB Panels

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Sheathing grade with durability equivalent to Interior plywood with Exterior glue (Exposure 1) and a minimum thickness of [_____] mm inch.[Provide certified sustainably harvested structural-use and OSB panel shear wall.]

2.3.7 Other Uses

2.3.7.1 Plywood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Plywood for [_____]. C-D Grade, Exposure 1.[Provide certified sustainably harvested plywood for other uses.]

2.3.7.2 Structural-Use and OSB Panels

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Structural-use and OSB panels for [_____]. Sheathing grade with durability equivalent to Exposure 1 and a minimum thickness of [_____] mm inch.[Provide certified sustainably harvested structural-use and OSB panels for other uses.]

2.4 UNDERLAYMENT

****

NOTE: Underlayment will be limited to plywood in areas of high moisture or occasional wetting of the finished floor. Particle board is permitted on Army projects only.

****

****

NOTE: The 2002 Farm Bill - Section 9002, Federal Procurement of Biobased Products, requires each Federal Agency to develop a procurement program which will ensure that items composed of biobased

products will be purchased to the maximum extent practical and which is consistent with applicable provisions of Federal procurement law.

****

Underlayment must conform to one of the following:

2.4.1 Hardboard

ANSI/CPA A135.4 service class, sanded one side, 6 mm 1/4 inch thick, 1200 mm 4 feet wide.

[2.4.2 Particleboard

****

NOTE: The Buyers and Specifiers Guide for CPA contains useful information about product materials and VOC content.

****

****

NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the last bracketed sentences requiring products with indoor air quality certifications as defined in Part 1 of this specification.

****

ANSI/CPA A208.1, Grade 1-M-1, 6 mm 1/4 inch thick, 1200 by 1200 mm 4 by 4 feet. Compressed [straw] fibers with [phenol formaldehyde][polymeric methylene diisocyanate (PMDI)] resin binder.[Products must contain no added urea-formaldehyde resins. For products located on the interior of the building (inside of the weatherproofing system), provide certification of indoor air quality for particleboard underlayment.]

]2.4.3 Plywood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Plywood must conform to APA L870, underlayment grade with exterior glue, or C-C (Plugged) exterior grade 9 mm 11/32 inch thick, 1200 mm 4 feet wide.[Provide certified sustainably harvested plywood underlayment.]

2.4.4 Oriented Strand Board

OSB underlayment grade 6 mm 0.225 inch.

2.4.5 Fiberboard

****

NOTE: Fiberboard is an EPA designated product for recycled content. Use materials with recycled

content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these products. A resource that can be used to identify products with recycle content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

NOTE: Research shows products are available from US national manufacturers above the minimum recycled content stated.

****

****

NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the last bracketed sentences requiring products with indoor air quality certifications as defined in Part 1 of this specification.

****

Use [structural fiberboard, minimum 80 percent recycled newspaper.] [gypsum fiberboard, minimum 15 percent post-consumer newspaper.][Provide data identifying percentage of recycled content for fiberboard underlayment.][agrifiber particleboard.][particleboard or MDF.][Products must contain no added urea-formaldehyde resins. For products located on the interior of the building (inside of the weatherproofing system), provide certification of indoor air quality for fiberboard underlayment.]

[2.4.6 Strawboard Panels

****

NOTE: Strawboard panels must meet accepted industry standards at a minimum. Determine standards for reliable products and include in this paragraph, if currently referenced standards are not applicable.

****

****

NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the last bracketed sentences requiring products with indoor air quality certifications as defined in Part 1 of this specification.

****

Minimum 70 percent agricultural waste straw with no added formaldehyde binders. Submit data identifying percentage of biobased content for strawboard panels.[Products must contain no added urea-formaldehyde resins. For products located on the interior of the building (inside of the weatherproofing system), provide certification of indoor air quality for strawboard panels.]

][2.4.7 Cork

****
NOTE: Cork must meet accepted industry standards at a minimum. Determine standards for reliable products and include in this paragraph, if currently referenced standards are not applicable.
****

****
NOTE: Cork is an EPA designated product for recycled content. Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying this product. A resource that can be used to identify products with recycle content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov**. Other products with recycled content are also acceptable when meeting all requirements of this specification.**

Research shows products are available from US national manufacturers above the minimum recycled content stated.

Cork is recognized as a biobased material. Use materials with biobased content where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying product biobased content requirements. A resource that can be used to identify products with biobased content is the "Catalog" tab within the USDA's "Biopreferred" website at http://www.biopreferred.gov**. Other products with biobased content are also acceptable when meeting all requirements of this specification.**
****

Minimum 85 percent total recycled content. Provide data identifying percentage of recycled content for cork underlayment.[Minimum 85 percent biobased content. Provide data identifying percentage of biobased content for cork underlayment.]

]2.5 OTHER MATERIALS

2.5.1 Hardboard Underlayment

DOC/NIST PS58, service class, sanded on one side, 6 mm 1/4 inch thick 1200 mm 4 feet wide.

[2.5.2 Fiberboard Wall Sheathing

****
NOTE: Fiberboard is an EPA designated product for recycled content. Use materials with recycled content where appropriate for use. Verify

suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycle content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows products are available from US national manufacturers above the minimum recycled content stated. Some manufacturers and regions have higher percentages (for components that have a threshold less than 100 percent). Based on research, select or insert desired minimum percentages.

****

****

NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the last bracketed sentences requiring products with indoor air quality certifications as defined in Part 1 of this specification.

****

ASTM C208, 600 mm wide by [13 mm thick for supports 400 mm (o.c.)] [20 mm thick for supports 600 mm o.c.] or 1200 mm wide by [13 mm thick for supports 400 mm o.c.] [20 mm thick for supports 600 mm o.c.], except only 1200 mm wide by 13 mm thick sheathing over supports at 400 mm o.c. may be applied without corner bracing of framing. 2 feet wide by [1/2 inch thick for supports 16 inches (o.c.)] [25/32 inch thick for supports 24 inches o.c.] or 4 feet wide by [1/2 inch thick for supports 16 inches o.c.] [3/4 inch thick for supports 24 inches o.c.], except only 4 feet wide by 1/2 inch thick sheathing over supports at 16 inches o.c. may be applied without corner bracing of framing. Sheathing must be asphalt impregnated or asphalt coated to render the sheathing water resistant but vapor permeable. Structural fiberboard must contain a minimum of 80 percent recycled content. Non-structural fiberboard must contain a minimum of [100][_____] percent post-consumer recycled content. Provide data identifying percentage of recycled content for fiberboard wall sheathing.[Products must contain no added urea-formaldehyde resins. For products located on the interior of the building (inside of the weatherproofing system), provide certification of indoor air quality for fiberboard wall sheathing.]

]2.5.3 Gypsum Wall Sheathing

ASTM C1396/C1396M, 12.7 mm 1/2 inch thick [fire retardant (Type X) 16 mm 5/8 inch thick]; 1200 mm 4 feet wide with square edge [for supports 400 mm 16 inches o.c. with or without corner bracing of framing] [or] [for supports 600 mm 24 inches o.c. with corner bracing of framing]; 600 mm 2 feet wide with V-tongue and groove (T&G) edge for supports [400] [or] [600] mm [16] [or] [24] inches o.c. with corner bracing of framing.

2.5.4 Foil-Faced Insulative Sheathing

Wood fiber core, chemically treated for water resistance, with aluminum foil laminated under pressure to both sides with water-resistant adhesive; 1200 mm 48 inches or 48 3/4 inches wide; 2 mm 0.078 inch thick when used with corner bracing, 2.9 mm 0.115 inch thick with studs up to 400 mm 16 inches o.c. without corner bracing, or 3.5 mm 0.137 inch thick with studs up to 600 mm 24 inches o.c. without corner bracing. The sheathing and installation must have been accepted by ICC as conforming to ICC IBC. The sheathing alone must have a thermal resistance value (R value) of not less than 0.20.

2.5.5 Cellulose Honeycomb Panels

****

NOTE: Cellulose panels are EPA designated products for recycled content. Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycle content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows products are available from US national manufacturers with the minimum recycled content of the first bracket. Based on research, select or insert desired minimum percentages

****

ASTM C208. Panels must be made of [kraft paper] [fire retardant paper] [and must be impregnated with phenolic resins for moisture resistance].[Panels must contain a minimum of [100][_____] percent post-consumer recycled content. Provide data identifying percentage of recycled content for cellulose honeycomb panels.]

2.5.6 Building Paper

FS UU-B-790, Type I, Grade D, Style 1.

2.5.7 Trussed Rafters

Metal plate connected trusses designed in accordance with TPI 1 and TPI HIB and fabricated in accordance with TPI 1.

2.5.8 Trussed Joists

Metal plate connected parallel chord wood trusses designed and fabricated in accordance with TPI 1.

2.5.9 Roof Decking

****

NOTE: If a specific species is required for architectural purpose, the paragraph or drawings should reflect such a requirement. Roof decking is permitted on Army projects only.

****

[Roof decking must be [commercial][select] grade with minimum design value of [0.9] [7.6] MPa [130] [1100] psi in bending. Decking must be [50 mm 2 inches thick with single tongue and groove][100 mm 4 inches thick with double tongue and groove]; V-jointed, matched and dressed. As an option, fabricated laminated lumber decking with interlocking tongue and groove joints may be provided.

]2.5.10 Miscellaneous Wood Members

2.5.10.1 Nonstress Graded Members

Members must include bridging, corner bracing, furring, grounds, and nailing strips. Members must be in accordance with TABLE I for the species used. Sizes must be as follows unless otherwise shown:

Member	Size mm inch
Bridging	25 x 75 1 x 3 or 25 x 100 1 x 4 for use between members 50 x 300 2 x 12 and smaller; 50 x 100 2 x 4 for use between members larger than 50 x 300 2 x 12.
Corner bracing	25 x 100 1 x 4.
Furring	25 x [50] [75] 1 x [2] [3]
Grounds	Plaster thickness by 38.
Nailing strips	25 x 75 1 x 3 or 25 x 100 1 x 4 when used as shingle base or interior finish, otherwise 50 mm 2 inch stock.

2.5.10.2 Wood Bumpers

AREMA Eng Man, Industrial grade cross ties

2.5.10.3 Sill Plates

Sill plates must be standard or number 2 grade.

2.5.10.4 Blocking

Blocking must be standard or number 2 grade.

2.5.10.5 Rough Bucks and Frames

Rough bucks and frames must be straight standard or number 2 grade.

2.5.11 Adhesives

****

NOTE: If a project design includes use of adhesive

products on the building interior (inside the weatherproofing system), include the last bracketed sentences requiring products with indoor air quality certifications or validations as defined in Part 1 of this specification.
****

Comply with applicable regulations regarding toxic and hazardous materials and as specified.[Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building (inside of the weatherproofing system).]

2.6 ROUGH HARDWARE

****
NOTE: Any ferrous metal hardware used in humid locations or project locations with Environmental Severity Classification (ESC) of C3 thru C5 must be hot-dip galvanized. For extreme exposed locations, consider stainless steel as a more appropriate material. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.
****

Unless otherwise indicated or specified, rough hardware must be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials must be as recommended by the product manufacturer unless otherwise indicated or specified. Rough hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs must be hot-dip zinc-coated in accordance with ASTM A153/A153M.[Nails and fastenings for fire-retardant treated lumber and woodwork exposed to the weather must be copper alloy or hot-dipped galvanized fasteners as recommended by the treated wood manufacturer.]

2.6.1 Bolts, Nuts, Studs, and Rivets

ASME B18.2.1, ASME B18.5.2.1M, ASME B18.5.2.2M and ASME B18.2.2.

2.6.2 Anchor Bolts

ASTM A307, size as indicated, complete with nuts and washers.

2.6.3 Expansion Shields

CID A-A-1923, CID A-A-1924, and CID A-A-1925. Except as shown otherwise, maximum size of devices must be 10 mm 3/8 inch.

2.6.4 Lag Screws and Lag Bolts

ASME B18.2.1.

2.6.5 Wood Screws

ASME B18.6.1.

2.6.6 Nails [and Staples]

****

NOTE: Staples are permitted for Army projects only.

****

ASTM F547, size and type best suited for purpose[; staples must be as recommended by the manufacturer of the materials to be joined]. For sheathing and subflooring, length of nails must be sufficient to extend 25 mm 1 inch into supports. In general, 8-penny or larger nails must be used for nailing through 25 mm 1 inch thick lumber and for toe nailing 50 mm 2 inch thick lumber; 16-penny or larger nails must be used for nailing through 50 mm 2 inch thick lumber. Nails used with treated lumber and sheathing must be hot-dipped galvanized in accordance with ASTM A153/A153M. Nailing must be in accordance with the recommended nailing schedule contained in AWC WFCM. Where detailed nailing requirements are not specified, nail size and spacing must be sufficient to develop an adequate strength for the connection. The connection's strength must be verified against the nail capacity tables in AWC NDS. Reasonable judgment backed by experience must ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector must be used.

2.6.7 Wire Nails

ASTM F1667/F1667M.

2.6.8 Timber Connectors

Unless otherwise specified, timber connectors must be in accordance with TPI 1, APA EWS T300 or AITC TCM.

2.6.9 Clip Angles

Steel, 5 mm 3/16 inch thick, size [as indicated][best suited for intended use]; or zinc-coated steel or iron commercial clips designed for connecting wood members.

2.6.10 Joist Hangers

Steel or iron, zinc coated, sized to fit the supported member, of sufficient strength to develop the full strength of the supported member in accordance with ICC IBC, and furnished complete with any special nails required.

2.6.11 Tie Straps

For joists supported by the lower flange of steel beams, provide 3 by 40 mm 1/8 by 1-1/2 inch steel strap, 600 mm 2 feet long [, except as indicated otherwise].

2.6.12 Joist Anchors

For joists supported by masonry walls, provide anchors 5 by 40 mm 3/16 by 1 1/2 inch steel tee or strap, bent and of length to provide 100 mm 4 inches embedment into wall and 300 mm 12 inches along joist [except as indicated otherwise]. For joists parallel to masonry or concrete walls, provide anchors 6 by 30 mm 1/4 by 1-1/4 inch minimum cross-sectional area, steel strap, length as necessary to extend over top of first three joists and into wall [100] [200] mm [4] [8] inches, and with wall end of bend or pin type [, except as indicated otherwise].

2.6.13 Door Buck Anchors

Metal anchors, 3 by 30 mm 1/8 by 1-1/4 inch steel, 300 mm 12 inches long, with ends bent 50 mm 2 inches [, except as indicated otherwise]. Anchors must be screwed to the backs of bucks and built into masonry or concrete. Locate 200 mm 8 inches above sills and below heads and not more than 600 mm 24 inches intermediately between.[Anchorage of bucks to steel framing must be [as indicated][as necessary to suit the conditions].]

2.6.14 Metal Bridging

[Where not indicated or specified otherwise,] No. 16 U.S. Standard gage, cadmium-plated or zinc-coated.

2.6.15 Toothed Rings and Shear Plates

AWC NDS.

2.6.16 Beam Anchors

Steel U-shaped strap anchors 6 mm 1/4 inch thick by 40 mm 1-1/2 inches wide [, except as indicated otherwise].

2.6.17 Metal Framing Anchors

Construct anchors to the configuration shown using hot dip zinc-coated steel conforming to ASTM A653/A653M, Z275 G90.[Except where otherwise shown,] Steel must be not lighter than 18 gage. Special nails supplied by the manufacturer must be used for all nailing.

2.6.18 Panel Edge Clips

Extruded aluminum or galvanized steel, H-shaped clips to prevent differential deflection of roof sheathing.

2.7 AIR INFILTRATION BARRIER

****

NOTE: The drawings will indicate the location and extent of air infiltration barrier. Coordinate this paragraph or remove this paragraph if you have a separate air barrier specification.

****

Air infiltration barrier must be building paper meeting the requirements of ASTM C1136, Type IV, style optional or a tear and puncture resistant olefin building wrap (polyethylene or polypropylene) with a moisture vapor transmission rate of [125] [_____] g per square meter per 24 hours [125] [_____] g per square meter per 24 hours in accordance with ASTM E96/E96M, Desiccant Method at [23] [_____] degrees C or with a moisture vapor transmission rate of [670] [_____] g per square meter per 24 hours [670] [_____] g per square meter per 24 hours in accordance with ASTM E96/E96M, Water Method at [23] [_____] degrees C.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: NAHB guidelines were written for residential construction, but include techniques that can be used for wood framing in other types of construction as well. OVE uses engineering principles to minimize material usage while meeting model building code structural performance requirements. Using OVE techniques results in lower material and labor costs and improved energy performance for the building. While the system can be applied as a whole package, many of its components can be used independently, depending upon the specific needs of the project.

****

Do not install building construction materials that show visual evidence of biological growth.

Conform to AWC WFCM and install in accordance with the National Association of Home Builders (NAHB) Advanced Framing Techniques: Optimum Value Engineering, unless otherwise indicated or specified. Select lumber sizes to minimize waste. Fit framing lumber and other rough carpentry, set accurately to the required lines and levels, and secure in place in a rigid manner. Space plastic lumber boards as necessary to allow for lengthwise expansion and contraction. Do not splice framing members between bearing points. Set joists, rafters, and purlins with their crown edge up. Frame members for the passage of pipes, conduits, and ducts. Provide adequate support as appropriate to the application, climate, and modulus of elasticity of the product. Do not cut or bore structural members for the passage of ducts or pipes without approval. Reinforce all members damaged by such cutting or boring by means of specially formed and approved sheet metal or bar steel shapes, or remove and provide new, as approved. Provide as necessary for the proper completion of the work all framing members not indicated or specified. Spiking and nailing not indicated or specified otherwise must be in accordance with the Nailing Schedule contained in ICC IBC; perform bolting in an approved manner. Spikes, nails, and bolts must be drawn up tight. Install plastic lumber with screws or bolts; if nails are used, use ring shank or spiral shank nails. [Timber connections and fastenings must conform to AWC NDS.][Provide 50 mm 2 inch minimum clearance between chimneys and wood framing; provide 100 mm 4 inch minimum clearance at fireplaces. Fill the spaces with strips of approved noncombustible material.] Use slate or steel shims when leveling joists, beams, and girders on masonry or concrete. Do not use shimming on wood or metal bearings. When joists, beams, and girders are placed on masonry or concrete, a wood base plate must be positioned and leveled with grout. The joist, beam, or girder must then be placed on the plate. When joists, beams, and girders are set into masonry or concrete, a pocket must be formed into the wall. The joist, beam, or girder must then be placed into the pocket and leveled with a steel shim.

3.1.1 Sills

Set sills level and square and wedge with steel or slate shims; point or grout with non-shrinking cement mortar to provide continuous and solid bearing. Anchor sills to the foundations as indicated.[Where sizes and spacing of anchor bolts are not indicated, provide not less than 16 mm 5/8 inch diameter bolts at all corners and splices and space at a maximum of 1800 mm 6 feet o.c. between corner bolts. Provide at least two bolts for each sill member. Lap and splice sills at corners and bolt through the laps or butt the ends and through-bolt not more than 150 mm 6 inches from the ends.] Provide bolts with plate washers and nuts. Bolts in exterior walls must be zinc-coated.

3.1.1.1 Anchors in Masonry

[Except where indicated otherwise,] Embed anchor bolts not less than 400 mm 15 inches in masonry unit walls and provide each with a nut and a 50 mm 2 inch diameter washer at bottom end. Fully grout bolts with mortar.

3.1.1.2 Anchors in Concrete

[Except where indicated otherwise,] Embed anchor bolts not less than 200 mm 8 inches in poured concrete walls and provide each with a nut and a 50 mm 2 inch diameter washer at bottom end. A bent end may be substituted for the nut and washer; bend must be not less than 90 degrees. Powder-actuated fasteners spaced 900 mm 3 feet o.c. may be provided in lieu of bolts for single thickness plates on concrete.

3.1.2 Beams and Girders

Set beams and girders level and in alignment and anchor to bearing walls, piers, or supports with U-shaped steel strap anchors. Embed anchors in concrete or masonry at each bearing and through-bolt to the beams or girders with not less than two bolts. Provide bolts not less than 12 mm 1/2 inch in diameter and with plate washers under heads and nuts. Install beams and girders [not indicated otherwise] with 200 mm 8 inch minimum end bearing on walls or supports. Install beams and girders into walls with [12 mm 1/2 inch clearance at the top, end, and sides] [or] [standard steel wall-bearing boxes]. Provide joints and splices over bearings only and bolt or spike together.

3.1.3 Roof Framing or Rafters

Tops of supports or rafters must form a true plane. Valley, ridge, and hip members must be of depth equal to cut on rafters where practicable, but in no case less than depth of rafters and nominally 50 mm 2 inches thick. Rafters must [be notched and] have full and solid bearing on plates. Valleys, hips, and ridges must be straight and true intersections of roof planes. Necessary crickets and watersheds must be formed. Rafters, except hip and valley rafters, must be [spiked to wall plate and to ceiling joists with no less than three 8-penny nails] [bolted by angles]. Rafters must be toe-nailed to ridge, valley, or hip members with at least three 8-penny nails. Rafters must be braced to prevent movement until permanent bracing, decking or sheathing is installed. Hip and valley rafters must be secured to wall plates by clip angles. Openings in roof must be framed with headers and trimmers. Unless otherwise indicated, headers carrying more than two rafters and trimmers supporting headers carrying more than one rafter must be double. Hip rafters longer than the available lumber must be butt jointed and scabbed. Valley rafters longer than the available lumber must be double, with pieces lapped not less than 1200 mm 4 feet and well spiked together. Install trussed rafters in accordance with TPI HIB. Install engineered wood joists in accordance with distributor's instructions.

3.1.4 Joists

Provide joists of the sizes and spacing indicated, accurately and in alignment, and of uniform width. Joists must have full bearing on sills, [plates,] [beams,] [girders,] [and] [trusses]; provide laps over bearing only and spike. Where joists are of insufficient length to produce a 300 mm 12 inch lap, butt joists over bearing and provide wood scabs 2 nominal inches thick by depth of joists by 600 mm 24 inches long or metal straps 6 by 40 mm 1/4 by 1 1/2 inch by not less than 450 mm 18 inches long nailed to each joist with not less than four 10-penny nails, or approved sheet metal connectors installed in accordance with the manufacturer's recommendations. Provide joists built into masonry with [a beveled fire cut so that the top of the joist does not enter the wall more than 25 mm one inch] [or] [standard steel wall bearing boxes]. Provide metal hangers for joists framing into the side of headers, beams, or girders.[When a portion of the joist extends above the top flange of a steel beam or girder, provide a 10 mm 3/8 inch space between the top flange and the extended portion of the joists to allow for shrinkage of joists.] The minimum joist end bearing must be 100 mm 4 inches, and joists built into concrete or masonry must have a 12 mm 1/2 inch minimum clearance at the top, end, and sides. For joists approved to be bored for the passage of pipes or conduits, bore through the neutral axis of the joist.[Provide steel joist hangers of proper size and type to receive the ends of all framed joists.]

[3.1.4.1 Floor (Ceiling) Framing

Except where otherwise indicated joists must have bearings not less than 100 mm 4 inches on concrete or masonry and 40 mm 1-1/2 inches on wood or metal. Joists, trimmers, headers, and beams framing into carrying members at the same relative levels must be carried on joist hangers. Joists must be lapped and spiked together at bearings or butted end-to-end with scab ties at joint and spiked to plates. Openings in floors must be framed with headers and trimmers. Headers carrying more than two tail joists and trimmers supporting headers carrying more than one tail joist must be doubled, unless otherwise indicated. Joists built into masonry must be provided with [a beveled fire cut so that the top of the joist does not enter the wall more than 25 mm 1 inch] [or] [standard steel wall bearing boxes]. Install engineered wood joists in accordance with distributor's instructions.

]3.1.4.2 Doubled Joists

Provide under bearing walls and partitions running parallel with the floor joists[, around [stairways,] [chimneys,] [fireplaces,]] and at other openings where joists are cut and framed. Double, space for clearance, block apart 1200 mm 4 feet on center, rigidly frame, and spike together joists under partitions that are to receive ducts, pipes, and conduits.

3.1.4.3 Tie Straps

For joists supported by the lower flange of steel beams, provide straps at every fourth joist and the corresponding fourth joist on the opposite side.

Tie joists across the top of the steel beam with a steel strap. Form straps to lie flat across the top of the beam and twist at the ends to provide flat contact with the side of each joist. Nail each strap at each end with three 10-penny nails spaced 50 mm 2 inches o.c.

3.1.4.4 Joist Anchors

Provide anchors for each fourth joist supported by a masonry wall. Build wall end of anchors into the wall. Nail anchor to the joist with three 10-penny nails spaced 50 mm 2 inches o.c. Anchor the first three joists parallel to concrete or masonry walls at bridging points, but not less than 2400 mm 8 feet o.c. from end walls. Let anchors into the tops of each joist and spike to the top of joist with one 10-penny nail. Extend anchors at least [100] [200] mm [4] [8] inches into the wall.

3.1.5 Bridging

Provide bridging for floor and ceiling joists and for roof rafters having slopes of less than 1/3. Locate bridging as indicated and as specified herein. Provide bridging for spans greater than 1800 mm 6 feet, but do not exceed 2400 mm 8 feet maximum spacing between rows of bridging. Install rows of bridging uniformly. Provide metal or wood cross-bridging, except where solid bridging is indicated. Do not nail the bottom end of cross-bridging until the subfloor has been laid.

3.1.5.1 Wood Cross-Bridging

Provide wood cross-bridging not less than [1 by 3] [2 by 3] [2 by 4] nominal size. Nail wood cross-bridging at each end with [two 8-penny nails for one by thick material] [and] [three 8-penny nails for 2 by thick material.]

3.1.5.2 Metal Cross-Bridging

Must be the manufacturer's standard product, not less than 16 gage before forming and coating. Metal bridging must be the compression type, lodged into or nailed to the wide faces of opposite joists at points diagonally across from each other near the bottoms and tops of joists.

3.1.6 Subflooring

3.1.6.1 Plywood, Structural-Use, and OSB Panels

****

NOTE: Edges must be supported with blocking for square-edged wood finish flooring, unless a separate underlayment layer is installed.

****

Apply best side up with the grain of outer plies or the long dimension at right angles to joists. Stagger end joints and locate over the centerline of joists.[Support panel edges by nominal 2 by 4 members framed between joists so the edge joints of subfloor occur over the centerline of blocking.] Allow 3 mm 1/8 inch spacing at panel ends and 6 mm 1/4 inch at panel edges. Panels must be continuous over two or more spans. Nail panels 150 mm 6 inches o.c. at supported edges and 250 mm 10 inches o.c. over intermediate bearing. Nails must be 8-penny common or 6-penny threaded. Provide at least 12 mm 1/2 inch clearance between subflooring and masonry or concrete walls. Subflooring may be installed with adhesive conforming to ASTM D3498 and nails spaced at 300 mm 12 inches on center unless otherwise shown.

3.1.6.2 Combination Subfloor-Underlayment

****

NOTE: Edges must be supported with blocking for square-edged wood finish flooring, unless a separate underlayment layer is installed.

****

Apply with the grain of the face plies or the long dimension at right angles to joists. Panels ust be continuous over two or more spans. Stagger end joints of adjacent panels. Panel edges must be T&G or supported by 2 by 4 members framed between joists so the edge joints of subfloor-underlayment occur over the centerline of blocking. Provide end joints of panels over the centerline of joists. Allow 3 mm 1/8 inch spacing between panel edge and end joints. Nail panels 150 mm 6 inches o.c. at ends and edges and 250 mm 10 inches o.c. along intermediate bearings unless they are glue-nailed in accordance with APA E30. Nails must be 8-penny coated common or 6-penny threaded. Provide at least 12 mm 1/2 inch clearance between subfloor-underlayment and masonry or concrete walls.[Lightly sand all joints to receive [resilient flooring][_____].]

3.1.6.3 Wood

Subflooring must be applied diagonally with end joints made over supports. Each board must bear on at least three supports and must be nailed at each support using two nails for boards 150 mm 6 inches and less in width and three nails for boards more than 150 mm 6 inches in width.

3.1.6.4 Depressed Subfloors

Provide depressed subfloors to receive [ceramic] [and] [quarry] tile floors. Nail cleats or ledgers of one by four material to the sides of joists to support the flooring material. Place the cleats at a depth below the top of the joists sufficient to allow the installation of the subflooring below the tops of joists. Snugly fit subflooring as specified herein between joists.

3.1.7 Underlayment

Install underlayment over subfloor just prior to laying of [resilient flooring] [_____] and protect from water and physical damage. Stagger end joints of underlayment with respect to each other, and stagger all joints with respect to paralleling panel joints in subfloor. Space panels 2 mm 1/16 inch apart at ends and 3 mm 1/8 inch apart at edges and at least 12 mm 1/2 inch from concrete or masonry walls. Nail panels 150 mm 6 inches o.c. along edges and 150 mm 6 inches o.c. each way throughout panel, but not closer than 10 mm 3/8 inch to panel edges. Nails must be 4-penny annular ring or screw type and must be countersunk 2 mm 1/16 inch.[Lightly sand all joints to receive [resilient flooring][_____].]

3.1.8 Columns and Posts

Set columns and posts, plumb, in alignment, and with full and uniform bearing. Do not embed the bottom and bearing surfaces of [posts] [columns] in concrete or set in direct contact with concrete slabs on grade. [Provide post and beam construction with [wood bolsters] [steel post caps] in such a manner that the post above will tier directly over the one below; fabricate the assembly in a rigid and substantial manner using bolts or lag screws.]

3.1.9 Wall Framing

3.1.9.1 Studs

Select studs for straightness and set plumb, true, and in alignment. In walls and partitions more than 2400 mm 8 feet tall, provide horizontal bridging at not more than 2400 mm 8 feet o.c. using nominal 50 mm 2 inch material of the same width as the studs; install the bridging flat. Sizes and spacing of studs must be [_____] [as indicated]. Double studs at jambs and heads of openings and triple at corners to form corner posts. Frame corner posts to receive sheathing, lath, and interior finish. Truss over openings exceeding 1200 mm 4 feet in width or use a header of sufficient depth. Toe-nail studs to sills or sole plates with four 8-penny nails or fasten with metal nailing clips or connectors. Anchor studs abutting concrete or masonry walls thereto near the top and bottom and at midheight of each story using expansion bolts or powder-actuated drive studs.

3.1.9.2 Plates

Use plates for walls and partitions of the same width as the studs to form continuous horizontal ties. Splice single plates; stagger the ends of double plates. Double top plates in walls and bearing partitions, built up of two nominal 50 mm 2 inch thick members. Top plates for nonbearing partitions must be single or double plates of the same size as the studs. Nail lower members of double top plates and single top plates to each stud and corner post with two 16-penny nails. Nail the upper members of double plates to the lower members with 10-penny nails, two near each end, and stagger 400 mm 16 inches o.c. intermediately between. Nail sole plates on wood construction through the subfloor to each joist and header; stagger nails. Anchor sole plates on concrete with expansion bolts, one near each end and at not more than 1800 mm 6 feet o.c., or with powder-actuated fasteners, one near each end and at not more than 900 mm 3 feet o.c. Provide plates cut for the passage of pipes or ducts with a steel angle as a tie for the plate and bearing for joist.

3.1.9.3 Firestops

Provide firestops for wood framed walls and partitions and for furred spaces of concrete or masonry walls at each floor level and at the ceiling line in the top story. Where firestops are not automatically provided by the framing system used, they must be formed of closely fitted wood blocks of nominal 50 mm 2 inch thick material of the same width as the [studs] [and] [joists].[Lightweight concrete units may be used at the first-floor level to serve jointly as firestopping and ratproofing.]

3.1.9.4 Diagonal Bracing

Provide diagonal bracing at all external corners and internal angles and at maximum 12000 mm 40 foot centers in stud walls, except that bracing may be omitted where diagonally applied wood sheathing, plywood or structural-use panel sheathing, 1200 by 2400 mm 4 by 8 foot fiberboard sheathing, or gypsum board sheathing is used. Bracing must be of 1 by 6 material, let into the exterior face of studs. Extend bracing from top plates to sill at an angle of approximately 45 degrees and double nail at each stud. When openings occur near corners, provide diagonal knee braces extending from the corner post above headers to top plates and from below window sills to the main sill. Nail bracing at each bearing with two 8-penny nails.

3.1.10 Wall Sheathing

3.1.10.1 Plywood, Structural-Use, and OSB Panel Wall Sheathing

Apply horizontally or vertically. Extend sheathing over and nail to sill and top plate. Abut sheathing edges over centerlines of supports. Allow 3 mm 1/8 inch spacing between panels and 3 mm 1/8 inch at windows and doors. If sheathing is applied horizontally, stagger vertical end joints. Nail panels with 6-penny nails spaced 150 mm 6 inches o.c. along edges of the panel and 300 mm 12 inches o.c. over intermediate supports. Keep nails 10 mm 3/8 inches away from panel ledges. Provide 2 by 4 blocking for horizontal edges not otherwise supported.

3.1.10.2 Fiberboard Wall Sheathing

Apply fiberboard wall sheathing allowing a 3 mm 1/8 inch joint at edges to permit expansion, except at frames and openings where sheathing must be fitted snugly. Pre-expand sheathing before application, allowing sheathing to condition for humidity as recommended by the sheathing manufacturer. Provide 2 by 4 blocking for horizontal edges not otherwise supported.

a. Fiberboard wall sheathing used with diagonal-braced framing must be either 600 or 1200 mm 2 or 4 feet wide. Sheathing 600 mm 2 feet wide must have T&G or shiplapped edges and must be applied horizontally with vertical joints staggered. Apply sheathing with tongued edge up and nail at edges and intermediate bearings with 45 mm 1-3/4 inch long, zinc-coated steel roofing nails spaced on maximum 115 mm 4-1/2 inch centers. Apply sheathing 1200 mm 4 feet wide either horizontally or vertically. Nail sheathing with 45 mm 1-3/4 inch long, zinc-coated steel roofing nails spaced 100 mm 4 inches maximum o.c. at edges and 200 mm 8 inches maximum o.c. at intermediate bearings.

b. Fiberboard wall sheathing used with unbraced framing must be 1200 mm 4 feet wide. Apply sheathing vertically. Extend sheathing over and nail to sill and top plates. Locate joints over centerlines of supports. Nail sheathing with 40 mm 1-1/2 inch long, zinc-coated steel roofing nails with 9.5 mm 3/8 inch diameter heads. Space nails 75 mm 3 inches o.c. at edges and ends and 150 mm 6 inches o.c. at intermediate bearings.

3.1.10.3 Gypsum Sheathing Board

Apply gypsum sheathing board either horizontally or vertically. Butt joints and locate over the centerlines of supports. Horizontally applied sheathing must be T&G, applied with tongued edge up. Stagger vertical joints and abut sheet closely to frames of openings. Nail sheathing with 11 gage, 9.5 mm 3/8 inch head, zinc-coated nails 40 mm 1-1/2 inches long for 12.7 mm 1/2 inch sheathing and 45 mm 1-3/4 inches long for 16 mm 5/8 inch sheathing, spaced 10 mm 3/8 inch minimum from edges. Provide 2 by 4 blocking for horizontal edges of 1200 mm 4 foot wide panels not otherwise supported.

a. Gypsum Sheathing Board Used with Diagonal-Braced Framing: Sheathing must be either 600 or 1200 mm 2 or 4 feet wide. Apply sheathing 600 mm 2 feet wide horizontally. Nail 100 mm 4 inches maximum o.c. at edges and over intermediate bearings. Apply sheathing 1200 mm 4 feet wide either horizontally or vertically. Nail 150 mm 4 inches maximum o.c.

at edges and 200 mm 8 inches maximum o.c. at intermediate bearings.

b. Gypsum Sheathing Board Used with Unbraced Frames: Sheathing must be 1200 mm 4 feet wide and applied vertically. Extend sheathing over and nail to both sill and top plates. Nail 100 mm 4 inches maximum o.c. at edges and 200 mm 8 inches maximum o.c. at intermediate bearings.

3.1.10.4 Foil-Faced Insulative Sheathing

Apply sheathing vertically. Butt or overlap joints and locate over centerline of supports. Attach sheathing to framing with 30 mm 1-1/4 inch, large, flat-head, 11 gage, galvanized roofing nails or 16 gage, 11 mm 7/16 inch minimum crown, galvanized staples with 30 mm 1-1/4 inch legs. For nonstructural application (with corner bracing), space fasteners 150 mm 6 inches o.c. on all panel edges and 300 mm 12 inches o.c. on intermediate supports, regardless of sheathing thickness, for studs not more than 600 mm 24 inches o.c. For structural application (without corner bracing), for studs not more than 400 mm 16 inches o.c., space fasteners 75 mm 3 inches o.c. on all edges and 150 mm 6 inches o.c. on intermediate members using minimum 2.9 mm 0.115 inch thickness; for studs up to 600 mm 24 inches o.c., space fasteners 75 mm 3 inches o.c. on all edges and 75 mm 3 inches o.c. on intermediate supports using minimum 3.5 mm 0.137 inch thickness.

3.1.10.5 Particleboard

Install according to manufacturer's instructions and accepted industry standards.

3.1.10.6 Cellulose Honeycomb Panels

Install according to manufacturer's instructions and accepted industry standards.

3.1.11 Wood Sheathing

Sheathing end joints must be made over framing members and so alternated that there will be at least two boards between joints on the same support. Each board must bear on at least three supports. Boards must be nailed at each support using two nails for boards 150 mm 6 inches and less in width and three nails for boards more than 150 mm 6 inches in width. Roof sheathing must not be installed where roof decking is installed.

3.1.12 Building Paper

Provide building paper [where indicated] [on wood board sheathing for all types of exterior siding]. Apply paper shingle fashion, horizontally, beginning at the bottom of the wall. Lap edges 100 mm 4 inches, and nail with 25 mm one inch, zinc-coated roofing nails, spaced 300 mm 12 inches o.c. and driven through tin discs.

3.1.13 Ceiling Joists

Size as indicated and set accurately and in alignment. Toe-nail joists to all plates with not less than three 10-penny nails. Frame openings in ceilings with headers and trimmers.

3.1.14 Metal Framing Anchors

Provide framing anchors at every [other] [rafter] [or] [trussed rafter] to fasten [rafter] [or] [trussed rafter] to plates and studs against uplift movement and forces as indicated. Anchors must be punched and formed for nailing so that nails will be stressed in shear only. Nails must be zinc-coated; drive a nail in each nail hole provided in the anchor.

3.1.15 Trusses

Metal plate connected wood trusses must be handled, erected, and braced in accordance with TPI HIB and as indicated.

3.1.16 Structural Glued Laminated Timber Members

Brace members before erection. Align members and complete all connections before removal of bracing. Unwrap individually wrapped members only after adequate protection by a roof or other cover has been provided. Treat scratches and abrasions of factory applied sealer with two brush coats of the same sealer used at the factory.

3.1.17 Plywood and Structural-Use Panel Roof Sheathing

****

NOTE: The following requirements for size, type, and spacing of nails represent the minimum recommended by APA for roof sheathing. Modify these requirements to agree with UL or FM requirements for wind-tested roof assemblies.

****

Install with the grain of the outer plies or long dimension at right angles to supports. Stagger end joints and locate over the centerlines of supports. Allow 3 mm 1/8 inch spacing at panel ends and 6 mm 1/4 inch at panel edges. Nail panels with 8-penny common nails or 6-penny annular rings or screw-type nails spaced 150 mm 6 inches o.c. at supported edges and 300 mm 12 inches o.c. at intermediate bearings. Do not use staples in roof sheathing. Where the support spacing exceeds the maximum span for an unsupported edge, provide adequate blocking, tongue-and-groove edges, or panel edge clips, in accordance with APA E30.

3.1.18 Stair Framing

Cut carriages to exact shape required to receive treads and risers, with risers of uniform height and treads of uniform width. Provide trimmers, nailers, and blocking as required to support finish materials.

3.1.19 Plastic Lumber

In conjunction with above requirements, follow manufacturer's recommendations for plastic lumber installation, including requirements for structural support, thermal movement, working, fastening, and finishing. Use standard woodworking tools, including carbide tips, coarse saw blades, and routers with aggressive cutters. Follow manufacturer's recommendations for repair by melting.

3.2 MISCELLANEOUS

3.2.1 Wood Roof Nailers, Edge Strips, Crickets, Curbs, and Cants

Provide sizes and configurations indicated or specified and anchored securely to continuous construction.

3.2.1.1 Roof Nailing Strips

Provide roof nailing strips for roof decks as [indicated] [and] [specified herein]. Apply nailing strips in straight parallel rows in the direction and spacing[indicated][specified in [_____]]. Strips must be[surface applied][embedded in concrete].

a. Surface-Applied Nailers: Must be 75 mm 3 inches wide and of thickness to finish flush with the top of the insulation. Anchor strips securely to the roof deck with powder actuated fastening devices or expansion shields and bolts, spaced not more than 600 mm 24 inches o.c.[On decks with slopes of 25 mm one inch or more, provide surface applied wood nailers for securing insulation[and for nailing of roofing felts].]

b. Embedded Nailers: Must be nominal 50 by 75 with 20 mm 2 by 3 with 2 inch sides beveled. Set and anchor nailers to finish flush with the roof deck surface.

3.2.1.2 Roof Edge Strips and Nailers

****

NOTE: For NAVFAC SE, indicate the anchorage type and spacing for all nailer attachments on the project drawings.

****

Provide at perimeter of roof, around openings through roof, and where roofs abut walls, curbs, and other vertical surfaces. Except where indicated otherwise, nailers must be 150 mm 6 inches wide and the same thickness as the insulation. Anchor nailers securely to underlying construction. Anchor perimeter nailers in accordance with FM 4435.[Strips must be grooved [as indicated] for edge venting; install at walls, curbs, and other vertical surfaces with a 6 to 12 mm 1/4 to 1/2 inch air space.]

3.2.1.3 Crickets, Cants, and Curbs

Provide wood saddles or crickets, cant strips, [curbs for scuttles and ventilators,] [and wood nailers bolted to tops of concrete or masonry curbs] [and at expansion joints,] as indicated, specified, or necessary and of [lumber] [or [_____] mm inch thick exterior plywood].

3.2.2 Rough Wood Bucks

[Size as indicated] [50 mm 2 inch nominal thickness]. Set wood bucks true and plumb. Anchor bucks to concrete or masonry with steel straps extending into the wall 200 mm 8 inches minimum. Place anchors near the top and bottom of the buck and space uniformly at 600 mm 2 foot maximum intervals.

3.2.3 Wood Blocking

Provide proper sizes and shapes at proper locations for the installation and attachment of wood and other finish materials, fixtures, equipment, and items indicated or specified.

3.2.4 Wood Grounds

Provide for fastening wood trim, finish materials, and other items to plastered walls and ceilings. Install grounds in proper alignment and true with an 2400 mm 8 foot straightedge.

3.2.5 Wood Furring

Provide where shown and as necessary for facing materials specified. Except as shown otherwise, furring strips must be nominal one by 3, continuous, and spaced 400 mm 16 inches o.c. Erect furring vertically or horizontally as necessary. Nail furring strips to masonry. Do not use wood plugs. Provide furring strips around openings, behind bases, and at angles and corners. Furring must be plumb, rigid, and level and must be shimmed as necessary to provide a true, even plane with surfaces suitable to receive the finish required. Form furring for [cornices,] offsets and breaks in walls or ceilings on 1 by 4 wood strips spaced 400 mm 16 inches o.c.

3.2.6 Wood Bumpers

Dress to the sizes indicated, and bevel edges. Bore, countersink, and bolt bumpers in place.

3.2.7 Temporary Closures

Provide with hinged doors and padlocks and install during construction at exterior doorways and other ground level openings that are not otherwise closed. Cover windows and other unprotected openings with polyethylene or other approved material, stretched on wood frames. Provide dustproof barrier partitions to isolate areas as directed.

3.2.8 Temporary Centering, Bracing, and Shoring

Provide for the support and protection of masonry work during construction as specified in Section [_____]. Forms and centering for cast-in-place concrete work are specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.9 Wood Sleepers

Run wood sleepers in lengths as long as practicable and stagger end joints in adjacent rows.[Sleepers for gymnasium floors are specified in Section 09 64 66 WOOD ATHLETIC FLOORING.]

3.2.10 Diaphragms

****

NOTE: Select laying pattern, nail size, and spacing based on Chapter 23 of the ICC IBC. Also refer to APA E30.

****

Install plywood, structural-use, or OSB panels with the long dimension [parallel] [perpendicular] to supports. End joints must be [continuous] [staggered] and located over the centerline of supports. Longitudinal joints must be [continuous] [staggered] [and provided with blocking]. Nail panels with [6] [8] [10]-penny nails spaced not more than [_____] mm inches on centers around the diaphragm boundaries [and along continuous panel edges] and [_____] mm inches on centers at all other supported edges and 300 mm 12 inches o.c. over intermediate bearings.

3.2.11 Shear Walls

****

NOTE: Select nail size and spacing based on Chapter 23 of ICC IBC. Also refer to APA E30.

****

Install plywood or structural-use panels with long dimension parallel or perpendicular to supports. Provide blocking behind edges not located over supports. Nail panels with [6] [8] [10]-penny nails spaced not more than [_____] mm inches on centers along panel edges and 150 mm 6 inches o.c. over intermediate bearings.

3.2.12 Bridging

Wood bridging must have ends accurately bevel-cut to afford firm contact and must be nailed at each end with two nails. Indall metal bridging as recommended by the manufacturer. The lower ends of bridging must be driven up tight and secured after subflooring or roof sheathing has been laid and partition framing installed.

3.2.13 Corner Bracing

Indatall corner bracing when required by type of sheathing used or when siding, other than panel siding, is applied directly to studs. Corner bracing must be let into the exterior surfaces of the studs at an angle of approximately 45 degrees, must extend completely over wall plates, and must be secured at each bearing with two nails.

3.2.14 Sill Plates

Sill plates must be set level and square and anchor bolted at not more than 1800 mm 6 feet on centers and not more than 300 mm 12 inches from end of each piece. A minimum of two anchors must be used for each piece.

3.3 INSTALLATION OF TIMBER CONNECTORS

Install timber connectors in conformance with requirements of AWC NDS.

3.4 ERECTION TOLERANCES

a. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, must be within the following limits:

    (1) Layout of walls and partitions: 6 mm 1/4 inch from intended position;

    (2) Plates and runners: 6 mm in 2400 mm 1/4 inch in 8 feet from a straight line;

    (3) Studs: 6 mm in 2400 mm 1/4 inch in 8 feet out of plumb, not cumulative; and

    (4) Face of framing members: 6 mm in 2400 mm 1/4 inch in 8 feet from a true plane.

b. Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive must be within the following limits:

(1) Layout of walls and partitions: 6 mm 1/4 inch from intended position;

(2) Plates and runners: 3 mm in 2400 mm 1/8 inch in 8 feet from a straight line;

(3) Studs: 3 mm in 2400 mm 1/8 inch in 8 feet out of plumb, not cumulative; and

(4) Face of framing members: 3 mm in 2400 mm 1/8 inch in 8 feet from a true plane.

[3.5 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by FEMA P-750,"NEHRP Recommended Seismic Provisions".

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-301-01, "Structural Engineering".

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with FEMA P-750. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

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NOTE: Use this paragraph regarding special inspection and testing for Army projects only.

****

Special inspections and testing for seismic-resisting systems and components must be done in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

]3.6 WASTE MANAGEMENT OF WOOD PRODUCTS

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NOTE: Take-back programs refer to programs in which the product manufacturer "takes-back" scrap material and/or packaging associated with its product. Diverting waste from the landfill contributes maximizing sustainability on all projects. Coordinate with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL. Designer must verify that items are able to be disposed of as specified.

****

In accordance with the Waste Management Plan and as specified.[Separate and reuse scrap sheet materials larger than [0.2 square meters] [2 square feet] [_____], framing members larger than [406 mm] [16 inches] [_____], and multiple offcuts of any size larger than [305 mm] [12 inches] [_____].] Clearly separate damaged wood and other scrap lumber for acceptable alternative uses on site, including bracing, blocking, cripples, ties, and shims.

[Separate composite wood from other wood types and recycle or reuse.] [Coordinate with manufacturer for take-back program and submit manufacturer's policy statement on program.] [Set aside scrap [plastic lumber] and return to manufacturer for recycling into new product. When such a service is not available, local recyclers must be sought after to reclaim the materials.][Fold up metal banding, flatten, and recycle.]

Separate treated, stained, painted, and contaminated wood and place in designated area for hazardous materials. Dispose of according to local regulations.[Do not leave any wood, shavings, sawdust, or other wood waste buried in fill or on the ground[, unless for planned future use].][Prevent sawdust and wood shavings from entering the storm drainage system.] [Compost sawdust.]Do not burn scrap lumber that has been pressure treated, or lumber that is less than one year old.

3.7 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements. Typical conversion is as shown:

PRODUCTS	INCH-POUND Nominal	METRIC Conversion
Sawn lumber	2 by 4	38 by 89 mm
	1 by	19 mm by
Stud spacing	16 inches	400 mm
	If not 48 inches panel	406 mm
Plywood	48 by 96 inches	1200 mm by 2400 mm

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-06 13 33 (November 2016)**
Change 1 - 08/17

Preparing Activity: NAVFAC **Superseding**
UFGS-06 13 33 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-06 13 33 (November 2016)**
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SECTION 06 13 33

PIER TIMBERWORK
11/16, CHG 1: 08/17

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NOTE: This guide specification covers the requirements for timber piers and timber work on other than timber piers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This specification also includes requirements for framing of timber bearing and fender piles to other pier work where required. Specification requirements for timber bearing and fender piles will be found in Section 31 62 19 TIMBER PILES for fresh water use and in Section 31 62 19.13 TIMBER MARINE PILES for marine use. Due to the severity of salt water environment, glued laminated wood is not included in this guide specification.

****

****

NOTE: On the project drawings, show:

1. Location, size, thickness, and stress rating of timbers

2. Size and spacing of fasteners

3. Soil data, where required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA A3	(2015) Standard Method for Determining Penetration of Preservatives and Fire Retardants
AWPA M4	(2023) Standard for the Care of Preservative-Treated Wood Products
AWPA M6	(2024) Brands Used on Preservative Treated Materials
AWPA P1/P13	(2024) Standard for Creosote Preservative
AWPA P2	(2024) Standard for Creosote Solutions
AWPA P5	(2015) Standard for Waterborne Preservatives
AWPA P34	(2014) Standard for Copper Naphthenate, Waterbone (CuN-W)
AWPA T1	(2024) Use Category System: Processing and Treatment Standard

AWPA U1	(2024) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM D5643/D5643M	(2012) Standard Specification for Coal Tar Roof Cement, Asbestos Free

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-P-21035	(1991; Rev B; Notice 2 2003; Notice 3 2021) Paint, High Zinc Dust Content, Galvanizing Repair (Metric)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-W-410	(2022; Rev J) Wire Rope and Strand

WESTERN WOOD PRESERVERS INSTITUTE (WWPI)

WWPI Mgt Practices	(1996; R 2011) Best Management Practices for the Use of Treated Wood in Aquatic and Wetland Environments

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

****

NOTE: Do not require shop drawings on new construction unless the contract drawings show insufficient detail. Generally, on repair construction, no shop drawings are needed, except where drawings contain no details.

****

Pier Timberwork; G, [_____]

Submit drawings of treated timber showing dimensions of cut, framed, or bored timbers.

SD-06 Test Reports

Preservative Treatment - Pier Timberworks; G, [_____]

The Contractor must provide the Contracting Officer's Representative (COR) with the inspection report of an independent inspection agency, approved by the Contracting Officer, that offered products comply with applicable AWPA standards.

Delivery Inspection List; G, [_____]

SD-07 Certificates

SDS and CIS; G, [_____]

Pesticide Applicator Company Self-Certification; G, [_____]

Best Management Practices (BMPs); G, [_____]

1.3 DELIVERY, STORAGE, AND HANDLING

Handle and store piles in accordance with AWPA M4. Follow precautions identified in SDS and CIS provided by the supplier of treated wood products.

Open-stack untreated timber and lumber material on skids at least 300 mm 12 inches above ground, in a manner that will prevent warping and allow shedding of water. Close-stack treated timber and lumber material in a manner that will prevent long timbers or preframed material from sagging or becoming crooked. Keep ground under and within 1.5 m 5 feet of such piles free of weeds, rubbish, and combustible materials. Protect materials from weather. Handle treated timber with ropes or chain slings without dropping, breaking outer fibers, bruising, or penetrating surface with tools. Do not use cant dogs, peaveys, hooks, or pike poles. Protect timber and hardware from damage.

1.4 QUALITY ASSURANCE

1.4.1 Preservative Treatment - Pier Timberworks

The Contractor must be responsible for the quality of treated wood products. The Contractor must provide the Contracting Officer's Representative (COR) with the inspection report of an independent inspection agency, approved by the Contracting Officer, certifying that the offered products comply with applicable AWPA standards. Identify treatment on each piece by the quality mark of an agency accredited by the Board of Review of the American Lumber Standard Committee. Inspect all preservative-treated wood visually to ensure there are no excessive residual materials or preservative deposits. Material must be clean and dry or it will be rejected because of environmental concerns.

1.4.2 SDS and CIS

Provide Safety Data Sheets (SDS) and Consumer Information Sheets (CIS) associated with timber pile preservative treatment. Contractor must comply with all safety precautions indicated on SDS and CIS.

1.4.3 Delivery Inspection List

Field inspect and submit a verification list of each treated timber member and each strapped bundle of treated lumber indicating the wording and lettering of the quality control markings, the species and the condition of the wood. Do not incorporate materials damaged in transport from plant to site. Inspect all preservative-treated wood, visually to ensure there are no excessive residual materials or preservative deposits. Material must be clean and dry or it will be rejected due to environmental concerns.

****

NOTE: Consult with appropriate environmental office for possible local regulations or policies that restrict pile installation of the use of preservative products at the project location.

****

[1.4.4 Regulatory Requirements

[_____].

]1.4.5 Pesticide Applicator Company Self-Certification

Provide the Contracting Officer, a statement signed by the responsible site supervisor or higher company representative, certifying that the contractor will comply with all pesticide label instructions. The certification should identify by name all individuals (applicators) who will be working with wood preserving pesticide products on site.

1.4.6 Best Management Practices (BMPs)

The producer of the treated wood products must provide certification that WWPI Mgt Practices for the use of Treated Wood in Aquatic and Wetland Environments were utilized including a written description and appropriate documentation of the BMPs utilized.

[As part of the BMPs for CCA treated pier timberwork, certification must be provided that documents that the Chromotropic Acid Test (AWPA A3- Methods for Determination of the Presence of Hexavalent Chromium in Treated Wood) was performed on the timber and adequate fixation of the CCA treatment has been achieved prior to installation.

]PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Lumber and Timbers

****

NOTE: Specify stress rating or assure that stress rating is shown on the drawings. Allow a design factor for reduction of tensile strength due to preservative treatment.

****

Provide solid sawn lumber and timbers of stress-rated Southern Pine, Douglas Fir-Larch, or Red Pine with a stress rating [of [_____] MPa ([_____] psi)] [as indicated], and identified by the grade mark of a recognized association or independent inspection agency using the specific grading requirements of an association recognized as covering the species used. The association or independent inspection agency must be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. For secondary members use lumber or timbers rated No. 1 or better. Use commercial grade lumber for decking members.

2.1.2 Preservative Treatment

****

NOTE: Select preservative treatment of lumber or timber as follows (consult the nearest organizational Applied Biologist for specific requirements for specific locations):

1. Based on AWPA's Use Category System (UCS) wood and wood products exposed to salt or brackish water in U.S. Coastal Waters must fall under one of three Use Categories for Marine Use:

UC5A MARINE USE Northern Waters
UC5B MARINE USE Central Waters

UC5C MARINE USE Southern Waters

Use Category requirements are based on the presence of specific marine organisms in the waters that require higher preservative loadings for control. Refer to AWPA's U1, Commodity Specification G: Marine (Salt Water) Applications to determine the approximate geographical location for each Use Category.

Recommended preservative treatment type (ACZA, CCA, and Creosote), minimum preservative penetration, and retention requirements must be as specified by AWPA U1, Commodity Specification G based on wood species and Use Category.

NOTE: Consult with appropriate environmental office for possible local regulations or policies that restrict the use of creosote at the project site.

2. Based on AWPA's Use Category System (UCS) wood and wood products not exposed to salt or brackish water must fall under one of five Use Categories:

UC3A ABOVE GROUND Protected
UC3B ABOVE GROUND Exposed
UC4A GROUND CONTACT General Use
UC4B GROUND CONTACT Heavy Duty
UC4C GROUND CONTACT Extreme Duty

Use Category selections must be based on biodegradation hazard and product service life expectations for specific products and exposure conditions. Refer to AWPA's U1, Commodity Specification A: Sawn Lumber Products to determine preservative type, minimum preservative penetration, and retention requirements based on wood species and Use Category.

****

Fabricate lumber and timbers before preservative treatment. Each piece of treated lumber or timber must be branded, by the producer, in accordance with AWPA M6. The type of preservative, retention, and penetration must be based on Use Category and species and in accordance with AWPA U1 and AWPA T1. The Contractor must be responsible for the quality of treated wood products.

For wood in contact with brackish water, salt water, or saltwater splash, lumber and timber preservative treatment must be [Creosote or creosote solution in accordance with AWPA P1/P13 or AWPA P2, respectively] [Waterborne preservative in accordance with AWPA P5 (ACZA - Ammoniacal Copper Zinc Arsenate, CCA - Chromated Copper Arsenate)] [Dual treatment of creosote or creosote solution plus waterborne preservative in accordance with AWPA P1/P13 or AWPA P2, and AWPA P5].

For wood not in contact with brackish water, salt water, or salt water splash, treatment must be in accordance with AWPA U1 Commodity Specification A: Sawn Products with [water-borne preservative (AWPA P5) except that chromated zinc chlorides, pentachlorophenol-ammoniacal systems, and alkyl ammonium compounds will not be allowed] [creosote (AWPA P2)].

2.1.3 Field Treatment

Piles must be field treated in accordance with AWPA M4. All cuts, holes and injuries such as holes from removal of spikes or nails which may penetrate the treated zone must be field treated with copper naphthenate conforming to AWPA P34 [and coal-tar roofing cement conforming to ASTM D5643/D5643M].

2.1.4 Hardware

****

NOTE: Give special attention to corrosion protection of hardware used with timber preserved with water-borne salts. Specify protection ranging from simple coatings to changing of the hardware metals dependent upon the required use and critical features of the hardware. Hot-dip galvanized hardware and fasteners will usually suffice in such cases.

****

Pile hardware must consisting of bolts with necessary nuts and washers, timber connectors, drift pins, dowels, nails, screws, spikes, and other fastenings. Bolts and nuts must conform to ASTM A307. Provide cast-iron ogee, malleable iron washers, or plate or cut washers where indicated. Provide bolts with washers under nut and head. Provide timber connectors and other metal fastenings of type and size indicated. Hot-dip galvanize all hardware specified or indicated in accordance with ASTM A123/A123M or ASTM A153/A153M, as applicable.

[2.1.5 Wire Rope and Fittings

Wire ropes must be in accordance with FS RR-W-410 [Type III, Class 2] [Type III, Class 3] [Type I, Class 2]. All wire ropes must be zinc coated in accordance with ASTM A1023/A1023M. [Provide staples of 10 mm 0.375 inch diameter zinc-coated steel at least 125 mm 5 inches long.] [Provide clips or clamps of zinc-coated steel.]

]PART 3 EXECUTION

3.1 INSTALLATION

Cut, bevel, and face timbers prior to plant preservative treatment. In addition to the contract clause entitled "Accident Prevention" provide protective equipment for personnel fabricating, field treating, or handling materials treated with creosote or water-borne salts. Refer to paragraph SDS AND CIS.

3.1.1 Framing

Cut and frame lumber and timber so that joints will fit over contact surface. Secure timbers and piles in alignment. Open joints are unacceptable. Shimming is not allowed. Drill holes for drift pins and dowels with a bit 2 mm 1/16 inch less in diameter than the pin or dowel. Drill holes for truss rods or bolts with a bit 2 mm 1/16 inch larger in diameter than rod or bolt. Drill holes for lag screws in two parts. Make lead hole for shank the same diameter as shank. Make lead hole for the threaded portion approximately two-thirds of the shank diameter. Drill holes in small timbers for boat or wire spikes with a bit of the same diameter or smallest dimension of the spike to prevent splitting. Counterbore for countersinking wherever smooth faces are indicated or specified.

3.1.2 Fender Systems

Face fender piles to receive chocks. Use only full-length timbers for chocks and tightly fit against fender piles. Face fender piles to provide a flat bearing against wales. Splice wales in location in a manner [as existing] [as indicated]. Additional splicing of wales will not be permitted. Bevel tops of fender piles outboard as indicated. Wrap pile clusters with wire rope. Fasten wire rope with clips and staples.

3.1.3 Bulkheads

****

NOTE: Assure that the drawings show bulkheads of sufficient height and width to prevent damage from erosion both to the side and from beneath the bulkhead. Where soil pressure against the bulkhead is high, special anchorage measures may be needed, such as tiebacks with concrete or timber dead-men or bulkhead piles.

****

Make timber bulkheads at land end of pier of height and width indicated. Provide special anchorage such as bulkhead piles or dead-men, as indicated.

3.1.4 Framed Bents

3.1.4.1 Footings

Bed mudsills to bearing and tamp in place. Finish concrete pedestals for support of framed bents so that the sills will have even bearing.

3.1.4.2 Posts and Timbers

****

NOTE: Recommend use of 25 mm 1 inch diameter dowels, bolts, and drift bolts in underwater or splash zone conditions.

****

Provide even bearing for sills on mudsills, piles, or pedestals. Drift bolt sills to mudsills, piles, or pedestals with bolts of at least [20] [24] mm [3/4] [1] inch [the indicated] diameter that extend into mudsills, piles, or pedestals at least 150 mm 6 inches. Cast dowels or bolts into concrete pedestals. When indicated, remove earth from contact with sills to provide for free air circulation. Saw posts for framed bents to proper length (vertical or batter) and provide even bearing on pedestals or sills. Fasten posts to sills with dowels of at least [20] [25] mm [3/4] [1] inch [the indicated] diameter extending at least 150 mm 6 inches into posts.

3.1.5 Bracing

****

NOTE: Recommend use of 25 mm 1 inch diameter

dowels, bolts, and drift bolts in underwater or splash zone conditions.

****

Align bents before bracing is placed. Provide bracing of sufficient length to provide a minimum distance of 200 mm 8 inches between outside bolt and end of brace. Bracing and girts must bear firmly against piles or timber to which secured. Place fillers to avoid bending the bracing more than 25 mm 1 inch out of line when bracing bolts or other fastenings are drawn up tight. Built-up fillers will not be permitted. Make filler a single piece of the same treated lumber as that in the brace, with a width of at least 150 mm 6 inches and a length of at least 300 mm 12 inches. Bolt ends of bracing through pile, post, or cap with a bolt of at least [20] [25] mm [3/4] [1] inch [the indicated] diameter. Bolt or boat spike intermediate intersections as indicated.

3.1.6 Caps

****

NOTE: Recommend use of 25 mm 1 inch diameter dowels, bolts, and drift bolts in underwater or splash zone conditions.

****

****

NOTE: This paragraph is based on timber caps on timber piles. Delete or modify this paragraph as necessary to accommodate other systems.

****

Prior to placing caps, treat tops of posts or piles with copper naphthenate per AWPA M4. Place timber caps to secure bearing over tops of supporting posts or piles and to secure even alignment of their ends. Secure caps by drift bolts of at least [20] [25] mm [3/4] [1] inch [the indicated] diameter extending at least 225 mm 9 inches into posts or piles. Place drift bolts in the center of pile or post.

3.1.7 Stringers

Place crown up and, if possible, the better edge of deck stringers down. Tops of stringers must not vary from a plane more than will permit bearing of the floor on stringers. Butt-joint and splice outside stringers, but lap interior stringers to take bearing over full width of cap or floor beam at each end. Break joints if stringers cover two spans. Toenail or drift bolt stringers as indicated. Stringers may be of sufficient length to cover two spans, except on sharp horizontal curves. Between stringers, frame and toenail cross-bridging or solid-bridging at each end with at least two nails for cross-bridging and four nails for solid-bridging. Make size and spacing of bridging as indicated.

3.1.8 Decking

Make decking of a single thickness of plank supported by stringers or joists. Unless otherwise indicated, lay plank with heart side down and with tight joints. Spike each plank to each joist or nailing strip with at least two spikes. Provide spikes at least 101 mm 4 inches greater than the thickness of plank. Place spikes at least 63 mm 2-1/2 inches from edges of the plank. Cut ends of planks parallel to center line of pier. Grade planks as to thickness and lay so that adjacent planks vary less than 2 mm

1/16 inch.

3.1.9 Wheel Guard and Railing

Lay wheel guards in sections at least 3.6 m 12 feet long; bolt through floor plank and through outside stringer or nailing piece with 20 mm 3/4 inch bolts spaced 1.2 m 4 feet or less apart. Bevel wheel guards on pier side as shown. Provide wheel guard material surfaced on four sides (S4S) on the top edge and pier side. Provide surfaced (S4S) material for railings.

3.1.10 Fastening

Vertical bolts must have nuts on the lower end. Where bolts are used to fasten timber to timber, timber to concrete, or timber to steel, bolt members together when they are installed and retighten immediately prior to final acceptance of contract. Provide bolts having sufficient additional threading to provide at least 31 mm per m 3/8 inch per foot thickness of timber for future retightening. [Provide timber connectors of types indicated. Install split-ring and shear-plate connectors in pre-cut grooves of the dimensions [shown] [as recommended by the manufacturer]. Force toothed-ring and spike-grid connectors and clamping plates into the contact surfaces of timbers joined by means of proper pressure tools; at joints, embed connectors of these types simultaneously and uniformly.]

3.2 FIELD TREATMENT

3.2.1 Pier timberwork

Field treat all cuts, holes, bevels, notches, refacing, abrasions, and injuries such as abrasions or holes from removal of spikes or nails made in the field in treated piles or timbers in accordance with AWPA M4, SDS and CIS. Trim cuts and abrasions before field treatment. Depressions or openings around bolt holes, joints, or gaps including recesses formed by counterboring must be field treated with copper naphthenate conforming to AWPA P34; and after bolt or screw is in place, fill with coal-tar roofing cement conforming to ASTM D5643/D5643M.

3.2.2 Piling and Post Protection

After driving is completed, all piles must be "headed" or cut off normal at the cutoff elevation. Headed treated piles, including those to be capped with concrete, must be treated with copper naphthenate per AWPA M4. Piles driven in locations where they are constantly subject to water spray must be given this treatment immediately after they are cut off and before the cutoff surface has been wetted. Seal ends with a heavy application of coal-tar pitch or other appropriate sealer.

Cutoffs must become the property of the Contractor and must be removed at his expense.

3.2.3 Galvanized Surfaces

Repair and recoat zinc coating which has been field or shop cut, burned by welding, abraded, or otherwise damaged to such an extent as to expose the base metal. Thoroughly clean the damaged area by wire brushing and remove traces of welding flux and loose or cracked zinc coating prior to painting. Paint cleaned area with two coats of zinc oxide-zinc dust paint conforming to MIL-P-21035. Compound paint with a suitable vehicle in a ratio of one part zinc oxide to four parts zinc dust by weight.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-06 17 19 (November 2016)**
Change 2 - 05/21

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 17 19

CROSS-LAMINATED TIMBER

11/16, CHG 2: 05/21

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-06 17 19 (November 2016)**
Change 2 - 05/21

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 06 17 19

CROSS-LAMINATED TIMBER
11/16, CHG 2: 05/21

****

NOTE: This guide specification covers the requirements for fabrication and erection of cross laminated timber panels for walls, floors, roofs, partitions, and all metal shapes and hardware required for their installation. The term "cross laminated timber" comprises suitably selected and prepared layers of lumber bonded together with adhesives, the grain of which is oriented in accord with engineered wood specifications, typically with every other layer set perpendicularly to each other.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Cross laminated timber (CLT) is an engineered wood building system used to complement light-and heavy-timber framing options. Layers of lumber are laminated together in alternating directions to form a solid wood panel with high strength and dimensional stability. Typical lay-ups use an odd number of layers, resulting in a primary and

secondary structural axis. Manufactured panels are typically 2.4 to 3 m 8 to 10 feet wide, up to 510 mm 20 inches thick, and up to 20 m 64 feet long. 75 percent lighter than concrete, they can be used as an economical alternative to concrete slabs, masonry and steel in many building types. The manufacturing process has been standardized, but the panels are fabricated as needed to custom dimensions.

****

****

NOTE: Include in the drawings:

Details of all panels, showing cross sections and dimensions.

Include in designs, engineered wood specifications including F_h and Modulus of Elasticity for Laminated Veneer Lumber, and F_h and grading. Specifications to use National Design Standards.

Assumed loads, including floor live load, roof live load, wind load, and concentrated loads (partitions, and equipment mounted on or suspended therefrom).

Layout, showing location of laminated members and floor elevations, and identification of Appearance Grades.

Details of hangers for suspended ceilings, pipes, light fixtures, or other construction, as required.

Details of metal shapes and hardware required for connections.

Pressure preservative treatment for protection against decay and insects in accordance with AITC 109. It should be incorporated into specification when wet use conditions prevail.

****

1.1 REFERENCES

****

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be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Some referenced standards and criteria for Glued-Laminated Wood are being applied to Cross-Laminated Timber (CLT) as a similar material by reference in this section.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC 109	(2007) Standard for Preservative Treatment of Structural Glued Laminated Timber

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WOOD COUNCIL (AWC)

AWC NDS	(2018) National Design Specification (NDS) for Wood Construction

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA T1	(2024) Use Category System: Processing and Treatment Standard
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

ANSI/APA PRG 320	(2012) Standard for Performance Rated Cross-Laminated Timber
APA EWS S580D	(2013) Technical Note: Preservative Treatment of Glued Laminated Timber
APA EWS T300	(2007) Technical Note: Glulam Connection Details

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A276/A276M	(2024) Standard Specification for

	Stainless Steel Bars and Shapes
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
FPInnovations (FPI)	
SP-529E	(2013) CLT Handbook, Cross-Laminated Timber (U.S. Edition)
INTERNATIONAL CODE COUNCIL (ICC)	
ICC IBC	(2024) International Building Code
INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)	
ISO ISO/IEC 17020	(2012) Conformity Assessment - Requirements for the Operation of Various Types of Bodies Performing Inspection
ISO ISO/IEC 17065	(2012) Conformity Assessment - Requirements for Bodies Certifying Products, Processes and Services

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Custom Finishes; G, [_____]

SD-04 Samples

Exposed-To-View Surfaces; G, [_____]

SD-05 Design Data

Installation Drawings

SD-07 Certificates

AITC Quality Mark or APA-EWS Trademark

Cross-Laminated Timber Panels

Conformance Certification

SD-08 Manufacturer's Instructions

Erection Procedures

Handling

1.3 QUALITY ASSURANCE

1.3.1 Qualifications for Cross Laminated Timber (CLT) Manufacturer

Provide panels that meet ANSI/APA PRG 320 standards, factory produced by an American Institute of Timber Construction (AITC) or APA - The Engineered Wood Association (APA) licensed manufacturer. Factory mark every panel with AITC Quality Mark or APA-EWS trademark and provide a certificate of conformance. Marks must not be visible in final assembly. Manufacture of the panels must conform to AWC NDS and SP-529E.

1.3.2 Certifications

Submit certificates for cross-laminated timber panels. Include a product report or laboratory report issued by a U.S. product certification agency accredited under ISO ISO/IEC 17065 or a U.S. product inspection agency accredited under ISO ISO/IEC 17020. Include the following information in the certification:

a. CLT Manufacturer's Standards

b. CLT stress grade and appearance classification

c. Lay-up of wood, species and grades used

d. Connection Hardware Standards in accordance with CLT Manufacturer's specifications

e. Manufacturer's panel durability tests and testing results

Ensure material tested is typical of a production run of the same material used in the project. Conduct tests on the same production lot(s) for delivery of the panels.

1.3.3 Surfaces

Submit three samples, 100 millimeter 4 inches minimum square by three laminate thickness for industrial grade faced product and 300 millimeter 12 inches square by three laminate thickness sample for visual/architectural grade panels to illustrate the quality and color of exposed-to-view surfaces.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver the panels to the project site in covered or protected systems in accordance with manufacturer's standards or recommended instructions for proper handling and storage. Label and deliver in sequence of construction for the project, equipped with loading straps by the manufacturer, erected by certified crane operators and fabrication handlers and protected for prolonged inclement weather conditions after erected. Replace any damaged or deteriorated panels.

Submit manufacturer's instructions for handling, erection procedures, sequencing, administration of screws and attachments and recommended tools and tolerances. Note applicable safety precautions and standards. Have a copy of all instructions present on the project site.

PART 2 PRODUCTS

2.1 SYSTEM DESIGN

Verify all field measurements prior to preparation of fabrication and Installation drawings to ensure proper fitting of the work.

2.1.1 Drawings

Provide installation drawings for CLT panels showing sequence of placement, location, sizes, overall dimensions, reinforcement, screw and attachment locations, safe handling directions and any special erection instructions. Include any reinforcement necessary for safe handling and erection of panels. Identify each panel and the corresponding sequence and procedure followed during installation, and location and details of anchorage devices that are embedded in other construction on layout drawings.

2.1.2 Conformance Certification

Submit signed and sealed documentation prepared by a licensed professional [engineer] [architect] verifying conformance with ASCE 7-16, AWC NDS and

ICC IBC standards.

2.2 MATERIALS

2.2.1 General

Provide CLT Panels fabricated in accordance with ANSI/APA PRG 320.

2.2.2 Lumber

****

NOTE: Designer should determine the species and grade based on the design application and use, and delete the non-applicable selections below.

Select the appropriate stress grade from ANSI/APA PRG 320, or describe in detail an alternative grading required. (ANSI/APA PRG 320 grades are not mandatory to meet the standard. Alternative grading is allowed.) When CLT is used as a floor slab, ensure a grade is selected for the span to limit deflection to l/480 or a maximum of 13 mm a half of an inch.

Select one of the following appearance grades:

Architectural grade contains normal growth characteristics such as tight knots and medium seasoning checks. All knot holes and voids over 19mm 3/4 inch are filled.

Industrial grade has a greater number of open defects, including knot holes. Industrial grade is appropriate for industrial installations, floor beams, concealed construction, or other applications where appearance is not an important consideration.

****

2.2.2.1 Stress Grade

CLT panels must be [E1] [E2] [E3] [V1] [V2] [_____] stress grade, graded in accordance with ANSI/APA PRG 320.

2.2.2.2 Appearance Classification

CLT panels must meet the [Architectural] [Industrial] appearance classification in accordance with ANSI/APA PRG 320.

2.2.2.3 Moisture Content

Comply with ANSI/APA PRG 320 for moisture content, up to a maximum of 15 percent, and compatible with the criteria of the certified adhesive applied.

[2.2.3 Preservative[and Fire-Retardant] Treatment

****

NOTE: Include heading and following paragraphs when fire-retardant treatment is required to achieve a specified flame spread rating. Fire-retardant

treatment is intended and recommended only for interior use and in locations not subject to alternate wetting or drying action. AITC 109 and APA S580 are for preservative treated wood exclusively.
****

Wherever CLT is in the exterior of the conditioned building envelope; or in direct contact with the ground, building foundation, or concrete; or in damp or humid service conditions, use preservative treated wood.[Treat exposed structural panels with a fire retardant to attain a UL flame spread rating not greater than 25.] Pressure impregnate [preservative] [fire-retardant] treated wood with an approved process for the location in accordance with AITC 109 or APA EWS S580D, AWPA T1, and AWPA U1. Any strength or stiffness reduction due to treatment must be provided by the treater. Kiln dry all wood after treatment to remove the moisture added during treatment. Moisture content throughout material after drying must be less than 15 percent.

]2.2.4 Adhesive

Adhesives must be certified by test for use with the species to which it is applied in accordance with ANSI/APA PRG 320. Apply and allow set times as required by the adhesive manufacturer's instructions. Also, apply pressure on the panels and for the duration during manufacture as required by the adhesive manufacturer's instructions.

[2.2.5 Finishes

****
NOTE: Delete this when finishes are not required.

The blank set of brackets allows specification of color.
****

[No protective coating of the base panels is required.] [Submit custom finishes as specified by the designer and applied by the factory or on site.] [Provide cross-laminated timber members with standard factory wiped stain and clear varnish finish [as indicated by manufacturer's designations] [match sample] [as selected from manufacturer's full range] [_____]]

][2.2.6 Timber Hardware

****
NOTE: Delete this paragraph when timber hardware is not required.
****

Design connections to AWC NDS, and AISC 360 unless specifically detailed by the Engineer of Record, to resist shears, moments and forces indicated. Fabricate connective hardware in accordance with AISC 360.

Clean oil, dirt, rust, and foreign matter from all metal surfaces.

[2.2.6.1 Structural Steel

Provide structural steel shapes, plates, and flat bars as indicated for assembly and connection of members conforming to ASTM A36/A36M.

][2.2.6.2 Hot-Rolled Steel Sheet

Provide hot-rolled steel sheet complying with ASTM A1011/A1011M, structural steel, Type SS, Grade 33.

][2.2.6.3 Stainless Steel

[Provide stainless steel bars and shapes complying with ASTM A276/A276M [Type 304] [Type 316].

][Provide stainless steel plate, flat bars, and sheets complying with ASTM A666 [Type 304] [Type 316].]

]]PART 3 EXECUTION

3.1 PREPARATION

Clean oil, dirt, rust, and foreign matter from all metal surfaces.

3.2 INSTALLATION

Conform to spacing and placement of panels and installation methods in accordance with the manufacturer's instruction and APA EWS T300. Provide close fits and neat appearance of joints without binding or adding additional stresses to the panel. Hoist panels in place in accordance with the manufacturer's instructions using non-marring straps and connectors. Brace erected member so as to maintain a safe working environment and stable structure.

Avoid on-site cuts; however, if neccessary, only with the approval of the designer or engineer of record, except for fastener drilling and other minor cutting. Coat all cuts and inside surfaces of drilled holes with end sealer.

3.3 PROTECTION

After installation, cover each panel with temporary waterproof protection to maintain the low moisture content of the wood. Protect panels against excessive and repeated water deposits and standing water at all times. Maintain protection until members are enclosed within the building and final coats are ready for application. Take precautions to closely maintain the manufacturer's standard for moisture content. Elevate initial building heating/cooling gradually to the desired level. Do not reduce the relative humidity of the building rapidly.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-06 18 00 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-06 18 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 18 00

GLUED-LAMINATED CONSTRUCTION

08/23

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-06 18 00 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-06 18 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 06 18 00

GLUED-LAMINATED CONSTRUCTION
08/23

****
NOTE: This guide specification covers the requirements for fabrication and erection of laminated wood arches, beams, purlins, columns, and all metal shapes and hardware required for installation of wood components. The term "laminated wood" comprises suitably selected and prepared wood layers bonded together with adhesives, the grain of which is oriented in accord with engineered wood specifications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Typically, do not use glue laminated members in humid locations or project locations with Environmental Severity Classifications (ESC) of C4 and C5 where exposed to the weather. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Where used, detail glue laminated members to prevent direct contact by rainfall.
****

PART 1 GENERAL

****

NOTE: Include in drawings:

Details of all laminated wood members, showing cross sections and dimensions.

Engineered wood specifications including F_b and Modulus of Elasticity for Laminated Veneer Lumber, and F_b and grading for Glulam Members. Specifications to use ANSI/AWC National Design Specification for Wood Construction.

Design loads, including floor live load, roof live load, wind load, and concentrated loads (partitions, and equipment mounted on or suspended therefrom).

Layout, showing location of laminated members and floor elevations, and identification of Appearance Grades.

Details of hangers for suspended ceilings, pipes, light fixtures, or other construction, as required.

Details of metal shapes and hardware required for connections.

Associated work found in other sections includes pressure preservative treatment for protection against decay and insects per AITC 109 or APA EWS S580: It should be incorporated into specification when wet use conditions prevail.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC 109	(2007) Standard for Preservative Treatment of Structural Glued Laminated Timber
AITC 111	(2005) Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection
AITC 113	(2010) Standard for Dimensions of Structural Glued Laminated Timber
AITC 119	(1996) Standard Specifications for Structural Glued Laminated Timber of Hardwood Species

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN WOOD COUNCIL (AWC)

AWC NDS	(2018) National Design Specification (NDS) for Wood Construction

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA T1	(2024) Use Category System: Processing and Treatment Standard
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

ANSI 117	(2008) Standard Specifications for Structural Glued Laminated Timber of Softwood Species
ANSI 405	(2012) Standard for Adhesives for use in Structural Glued Laminated Timber
ANSI A190.1	(2012) Standard for Wood Products - Structural Glued Laminated Timber

APA E30	(2016) Engineered Wood Construction Guide
APA EWS R540	(2013) Builder Tips: Proper Storage and Handling of Glulam Beams
APA EWS T300	(2007) Technical Note: Glulam Connection Details
APA S580	(2013) Preservative Treatment of Glued Laminated Timber

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM D2559	(2012a; E 2016) Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions
ASTM D3737	(2018; E2018) Standard Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003	(2021) Standard Grading Rules for Southern Pine Lumber

U.S. NAVAL SEA SYSTEMS COMMAND (NAVSEA)

QPL-19140	(2024) Lumber and Plywood, Fire-Retardant Treated

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5	(2021) Western Lumber Grading Rules

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

Use the "S" Classification only in SD-11 Closeout Submittals. The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

Installation Drawings; G, [_____]

SD-04 Samples

Exposed-to-View Surfaces; G, [_____]

SD-07 Certificates

Glued-Laminated Structural Members

Structural Members

Design Load Compliance

SD-08 Manufacturer's Instructions

Laminated Wood Materials

Adhesive

1.3 QUALITY CONTROL

1.3.1 Qualifications for Laminating Wood Manufacturer

Provide factory glued-laminated structural wood members produced by an American Institute of Timber Construction (AITC) or (APA) Engineered Wood Association licensed manufacturer. Factory mark every member of the structural glued-laminated timber with AITC Quality Mark or APA trademark and provide a certificate of conformance. Manufacture the laminated timber meeting the requirements of [AITC 119],
APA E30, ASTM D3737, ANSI A190.1, and WWPA G-5.

1.3.2 Certifications

Submit certificates for glued-laminated structural members include a product report or laboratory report issued by a US Product certification Agency under ISO 17065 or a US inspection agency accredited under ISO 17020. Include the following information:

a. Glulam manufacturers' name

b. Glulam grade

Include in report the results of tests, shear strength, and durability of the glue line. Ensure compliance with the requirements of ASTM D3737. Ensure material tested is typical of a production run of the same material used in the project. Ensure tests are conducted from the same product lot prior to delivery of the wood.

Provide certification that structural members meet the requirements of ANSI A190.1 and ANSI 117.

Submit signed and sealed documentation prepared by a licensed professional [Engineer][Architect] verifying design load compliance with ASCE 7-22 and

ICC IBC.

1.3.3 Surfaces

Submit three samples; 300 millimeter 12 inches long of sufficient width and thickness to illustrate the quality and color of exposed-to-view surfaces.

1.4 DELIVERY, HANDLING, AND STORAGE

Deliver the glued-laminated wood structural members in quantities indicated and at construction scheduled times to ensure the continuity of the installation of the structural members and the progress of the erection schedules. Reference AITC 111 and APA EWS R540 for further information.

Deliver packaged or wrapped materials in their original, undamaged wrapping, bearing label clearly identifying manufacturer's name, grade and species of lumber, type of glue, and other pertinent data. Use nonmarring slings for loading, unloading, and handling members to prevent damage to surfaces or wrapping.

Store wrapped materials in their original wrapping until ready for installation.

Place members on level supports off ground, spaced and braced to allow through ventilation. Cover wood and keep free of dirt, grease, moisture, or foreign matter that could cause staining.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Drawings

Verify all field measurements prior to preparation of fabrication and installation drawings to ensure proper fitting of the work.

Submit fabrication drawings for glue-laminated structural units consisting of fabrication and assembly details performed in the factory.

2.2 MATERIALS

2.2.1 General

Provide structural glued-laminated timber complying with AITC 113, ANSI 117, and ANSI A190.1, AWC NDS,[and AITC 119].

Provide structural glued-laminated timber manufactured in accordance with ANSI 117, and ANSI A190.1.

****

NOTE: Designer should determine the species and grade based on the design application and use, and delete the non-applicable selections below.

****

2.2.1.1 Lumber

[Species and grade: [Insert Hardwood Species selected] in accordance with the provisions of AITC 119.

][Species and grade: [Douglas fir] [larch], graded in accordance with the grading provisions of WWPA G-5.

][Species and grade: Southern Pine, graded by the same basic provisions as used for solid sawn lumber in SPIB 1003.

][Provide species and grade meeting the structural requirements of ASTM D3737, AITC 113, [ANSI 117] [AITC 119] and [applicable building codes] [ASCE 7-22] [ICC IBC].

][Provide glued-laminated kiln-dried and stress-graded lumber meeting the requirements of [ANSI 117] [AITC 119].

][Determine species and grade combination by the design requirements for each component and as designated on the shop drawings. Use AITC lumber combination symbols for this identification.

] Use only glued-laminated structural members having a maximum moisture content of 15-percent throughout the entire piece before surfacing and bonding.

****

NOTE: Select one of the following appearance grades:

Premium grade has the finest appearance with a smooth surface free of knot holes and voids.

Architectural grade contains normal growth characteristics such as tight knots and medium seasoning checks.

Industrial grade has a greater number of open defects, including knot holes. Industrial grade is appropriate for industrial installations, floor beams, concealed construction, or other applications where appearance is not an important consideration.

Framing grade is used only in concealed constructions.

****

Provide glued-laminated structural members of ANSI A190.1 [Premium] [Architectural] [Industrial] [Framing] Grade,conforming to the applicable standards.

2.2.2 Preservative and Fire-Retardant Treatment

****

NOTE: Include heading and following paragraphs when fire-retardant treatment is required to achieve a specified flame spread rating. Fire-retardant treatment is intended and recommended only for interior use and in locations not subject to alternate wetting or drying action.

****

Pressure impregnate fire-retardant treated wood with an approved process in accordance with AITC 109, APA S580, AWPA T1, and AWPA U1.

Treat structural members to attain a UL flame spread rating not greater than 25, showing no evidence of progressive combustion when tested for 30 minutes in accordance with UL 723 and ASTM E84.

Ensure penetration of fire-retardant material in treated wood in accordance with QPL-19140. Determine depth of penetration by borer cores taken from 20 pieces of each charge and test. If 80 percent of the borings meet the penetration requirements, the charge is acceptable.

Kiln dry the wood after treatment to remove the moisture injected during treatment. Average moisture content is not to exceed 19 percent.

2.2.3 Adhesive

Bond glued-laminated members with a waterproof adhesive conforming to the test requirements of ASTM D2559 and ANSI 405 for exterior glue, shear strength and durability.

2.2.4 Finishes

****

NOTE: Delete the following paragraphs when finishes are not required

****

[Provide glued-laminated members with manufacturer's standard wiped stain finish, dry-appearance, penetrating acrylic stain and sealer; oven dried with mildew and fungus resistance.

][Provide glued-laminated members with manufacturer's standard clear finish, two-coat, clear conversion vanish finish; oven dried with mildew and fungus resistance.

][Provide glued-laminated members with one factory-applied coat of sealer to the ends of members immediately after trimming, and other surfaces dressed with one coat of penetrating clear sealer.

][Provide glued-laminated members with one factory-applied coat of sealer to the ends of members immediately after trimming. No other sealer is required.

][Provide unfinished glued-laminated members after final surfacing and sanding.

][Provide glued-laminated members with standard factory wiped stain and clear varnish finish[as indicated by manufacturer's designations] [match sample] [as selected from manufacturer's full range] [insert color].
]

****

NOTE: Delete the following paragraphs when timber hardware is not required

****

2.2.5 Timber Hardware

[Provide structural steel shapes, plates, and flat bars as indicated for assembly and connection of members conforming to ASTM A36/A36M.

][Provide hot-rolled steel sheet complying with ASTM A1011/A1011M, structural steel, Type SS, Grade 33.

][Provide stainless steel bars and shapes complying with ASTM A276/A276M [Type 304] [Type 316].

][Provide stainless steel plate, flat bars, and sheets complying with ASTM A666 [Type 304] [Type 316].
]

****

NOTE: Delete the following paragraphs when anchor bolts are not required. Anchor bolts are normally required for column base connections.

****

Provide low carbon steel anchor bolts with regular hexagon nuts and carbon steel washers. Provide anchor bolts and nuts conforming to ASTM A307.

Provide plain washers conforming to ASME B18.22MASME B18.21.1.

Clean oil, dirt, rust, and foreign matter from all metal surfaces. For exterior locations, provide hot-dipped galvanized hardware in accordance with ASTM A153/A153M, with coating weight as required for Class [A][B][C][D] material as described therein. Coat other metal surfaces with one coat of manufacturer's standard rust-resisting metal primer applied at a minimum dry-film thickness of 0.038 millimeter 1.5 mils.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Manufacturer's Information

Submit manufacturer's instructions for laminated wood materials and adhesive including special provisions required to install equipment components and system packages. Detail with special notices all impedances, hazards and safety precautions.

3.1.2 Installation Drawings

Submit installation drawings for glue-laminated structural units showing dimensions of laminated wood members, location, size, and type of reinforcement. Include any reinforcement necessary for safe handling and erection of structural members. Identify each structural member and the corresponding sequence and procedure followed during installation. Identify location and details of anchorage devices that are embedded in other construction on layout drawings.

3.1.3 Construction

Conform spacing and placement of members and installation methods in accordance with APA EWS T300.

Plan and execute erection procedures so that close fit and neat appearance of joints and structure as a whole is not impaired. When hoisting members into place, use padded or non-marring slings. Protect corners with wood blocking. Brace members as they are placed to maintain a safe position until full stability is achieved.

Avoid cutting Glulam members during erection to the greatest extent possible. Except for fastener drilling and other minor cutting, coat cuts with end sealer.

3.1.4 Protection

After installation, cover each member with a temporary waterproof protection to maintain the moisture content of the wood. Maintain protection until members are enclosed within the building and final coats are ready for application. Elevate initial building heat gradually to the desired level. To minimize checking do not reduce the relative humidity of the building rapidly.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS--06 20 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-06 20 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 20 00

FINISH CARPENTRY

08/24

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS--06 20 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-06 20 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 06 20 00

FINISH CARPENTRY
08/24

****

NOTE: This guide specification covers general exterior and interior finish carpentry in a condensed format and is therefore intended for use on small projects.

Consider specifying medium density fiberboard (MDF) composite materials in lieu of solid wood. Made from recycled wood fibers and resin, MDF is machine dried and pressed to produce dense, durable, dimensionally stable sheets that perform well in moderate heat and humidity. MDF is a cost effective alternative to wood, both initially and throughout its life cycle. MDF is also referred to herein as particleboard. Evaluate humidity requirements of the project before specifying MDF.

Adhere to UFC 1-300-02 Unified Facilities Guide **Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: On the drawings, show:

1. Location, size, type, and thickness of materials;

2. Size, type, and spacing of fasteners;

3. Details of millwork;

4. Color and pattern of prefinished material;

5. Profile and sizes of all trim components;

6. Species, color, and finish of all wood that is to be stained, installed in its natural finish, or to have a transparent finish.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

ALSC PS 20	(2021) American Softwood Lumber Standard

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications:

	Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.6.1	(2016) Wood Screws (Inch Series)

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M4	(2023) Standard for the Care of Preservative-Treated Wood Products
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA E445	(2002) Performance Standards and Qualification Policy for Structural-Use Panels (APA PRP-108)
APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood
APA S350	(2019) PS 2-18, Performance Standard for Wood-Based Structural-Use Panels

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

ANSI/AWI 0400	(2022) Factory Finishing Standard
ANSI/AWI 0620	(2018) Finish Carpentry/Installation Standard
ANSI/AWI 0641	(2019) Architectural Wood Casework Standard
ANSI/AWI 1232	(2022) Manufactured Wood Casework
ANSI/AWI 1236	(2022) Countertops Standard
AWI 100	(2018) Architectural Woodwork Institute Submittal Standards
AWI 200	(2018) Architectural Woodwork Institute Care & Storage Standards

ASTM INTERNATIONAL (ASTM)

ASTM D2898	(2010; R 2017) Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM F547	(2017) Standard Terminology of Nails for Use with Wood and Wood-Base Materials

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.9	(2020) Cabinet Hardware

CALIFORNIA AIR RESOURCES BOARD (CARB)

CARB 93120	(2007) Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A135.4	(2012; R2020) Basic Hardboard
ANSI/CPA A135.6	(2012; R2020) Engineered Wood Siding
ANSI/CPA A208.1	(2022) Particleboard

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

HARDWOOD PLYWOOD AND VENEER ASSOCIATION (HPVA)

ANSI/HPVA HP-1	(2020) American National Standard for Hardwood and Decorative Plywood

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

MOULDING AND MILLWORK PRODUCERS ASSOCIATION (MMPA)

WMMPA WM 6	Quality Industry Standards Booklet

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA Rules	(2023) Rules for the Measurement & Inspection of Hardwood & Cypress

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules	(2021) Standard Grading Rules for Northeastern Lumber

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

REDWOOD INSPECTION SERVICE (RIS) OF THE WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

RIS Grade Use	(2019) California Redwood Lumber Grades and Uses

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003	(2021) Standard Grading Rules for Southern Pine Lumber

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 770	Formaldehyde Standards for Composite Wood Products

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17	(2015; R 2018) Standard Grading Rules for West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5	(2021) Western Lumber Grading Rules

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

WDMA I.S.4	(2019) Preservative Treatment for Millwork

WOODWORK INSTITUTE (WI)

NAAWS 4.0	(2021 Errata Edition) North American

Architectural Woodwork Standards

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submittals to follow AWI 100 2018 standards.

SD-02 Shop Drawings

Detail Drawings Indicating All Wood Assemblies; G, [_____]

SD-03 Product Data

Wood Products; G, [_____]

Countertops; G, [_____]

Engineered Wood Products; G, [_____]

Treated Wood Products; G, [_____]

Soffits; G, [_____]

Fascias and Trim; G, [_____]

Hardware and Accessories; G, [_____]

[VOC Content for Siding; S

][Recycled Content for MDF/Particleboard; S

] SD-04 Samples

Samples; G, [_____]

SD-07 Certificates

Certificates of Grade; G, [_____]

[Certified Sustainably Harvested Wood for Trim and Frames; S

][Certified Sustainably Harvested Softwood Plywood; S

][Certified Sustainably Harvested Hardwood Plywood; S

][Certified Sustainably Harvested Hardboard; S

][Certified Sustainably Harvested Siding; S

][Indoor Air Quality for Hardwood Plywood; S

][Indoor Air Quality for MDF and Particleboard; S

][Indoor Air Quality for Non-aerosol Adhesives; S

][Indoor Air Quality for Aerosol Adhesives; S

]1.3 DETAIL DRAWINGS

Submit detail drawings indicating all wood assemblies proposed for use in the project. Indicate materials, species, grade, density, grain, finish details of construction, location of use in the project, finishes, types, method and arrangement of fasteners, and installation details. This includes all fabricated assemblies.

1.4 PRODUCT DATA

Submit Manufacturers printed data including proposed species, grade, density grain, and finish as applicable; sufficient to demonstrate compliance with this specification for each type of wood product specified. For treated wood products also provide documentation of environmentally safe preservatives for each type of wood product specified.

Provide Manufacturers printed data for hardware and all wood accessories including but not limited to edge banding, adhesives, and sealers.

1.5 SAMPLES

Samples indicating proposed species, grade, density grain, and finish for each type of wood product specified. Provide samples of sufficient size to show pattern and color ranges of proposed products.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver wood products to the jobsite in an undamaged condition. Stack materials to ensure ventilation and drainage. Protect against dampness before and after delivery. Store materials under cover in a well ventilated enclosure and protect against extreme changes in temperature and humidity. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or biological growth. Do not store products in building until wet trade materials are dry and humidity of the space is within wood manufacturer's tolerance limits for storage. Follow AWI 200 for care and storage.

1.7 QUALITY ASSURANCE

1.7.1 Certifications

1.7.1.1 Certified Wood Grades

Provide certificates of grade from the grading agency on graded but unmarked lumber or plywood attesting that materials meet the grade requirements specified herein.

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

****

[1.7.1.2 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

][1.7.1.3 Indoor Air Quality Certifications

1.7.1.3.1 Adhesives and Sealants

****

NOTE: Include the following section where these products are used on the interior of the building (defined as inside of the weatherproofing system).

****

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.7.1.3.2 Composite Wood Products

****

NOTE: Include the following section where these products are used on the interior of the building (defined as inside of the weatherproofing system).

****

For purposes of this specification, composite wood products include hardwood plywood, particleboard, medium density fiberboard (MDF), panel substrates, and door cores. Provide products certified to meet requirements of both 40 CFR 770 and CARB 93120. Provide current product certification documentation from certification body.

]1.7.2 Lumber

Identify each piece or each bundle of lumber, millwork, and trim by the grade mark of a recognized association or independent inspection agency certified by the Board of Review of the ALSC to grade the species.

1.7.3 Plywood

Provide each sheet of plywood with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. Provide marks that identify plywood by species group or span rating, exposure durability classification, grade, and compliance with APA L870.

1.7.4 Hardboard[and Particleboard]

Provide materials marks or written documentation identifying the producer and the applicable standard.

1.7.5 Pressure Treated Lumber and Plywood

Inspect each treated piece in accordance with AWPA U1.

1.7.6 Non-Pressure Treated Woodwork and Millwork

Mark, stamp, or label to indicate compliance with WDMA I.S.4.

1.7.7 Fire-Retardant Treated Lumber

Confirm each piece has an Underwriters Laboratories fire resistance label or comparable label of another nationally recognized independent fire retardant materials testing laboratory.

PART 2 PRODUCTS

2.1 WOOD PRODUCTS

2.1.1 Sizes and Patterns of Wood Products

Provide yard and board lumber sizes in accordance with ALSC PS 20. Provide shaped lumber and millwork in the patterns indicated and in standard patterns of the association covering the species. Size references, unless otherwise specified, are nominal sizes. Provide actual sizes within manufacturing tolerances allowed by the applicable standard.

2.1.2 Species and Grades

Provide in accordance with AWPA U1 Use Category System Tables unless otherwise specified herein.

2.1.3 Trim, Finish, and Frames

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Provide species and grades listed in the table below for all painted wood materials. Provide materials one grade higher than those listed in the table below for all stained materials with a natural or transparent finish. Provide trim, except window stools and aprons with hollow backs.[Provide certified sustainably harvested wood for trim and frames.]

****

NOTE: Edit table to delete unsuitable species. For small projects, species that are not readily available locally may be deleted.

****

TABLE OF GRADES FOR WOOD TO RECEIVE PAINT FINISH

Grading Rules	Species	Exterior and Interior Trim, Finish, and Frames
WWPA G-5 standard grading rules	Aspen, Douglas Fir-Larch, Douglas Fir South, Engelmann Spruce-Lodgepole Pine, Engelmann Spruce, Hem-Fir, Idaho White Pine, Lodgepole Pine, Mountain Hemlock, Mountain Hemlock-Hem-Fir, Ponderosa Pine-Sugar Pine, (Ponderosa Pine-Lodgepole Pine,) White Woods, (Western Woods,) Western Cedars, Western Hemlock	All Species: C & BTR. Select (Choice & BTR Idaho White Pine) or Superior Finish. Western Red Cedar can be graded C & BTR. Select or A & BTR in accordance with Special Western Red Cedar Rules.
WCLIB 17 standard grading rules	Douglas Fir-Larch, Hem-Fir, Mountain Hemlock, Sitka Spruce, Western Cedars, Western Hemlock	All Species: C & BTR VG, except A for Western Red Cedar
SPIB 1003 standard grading rules	Southern Pine	C & BTR
NHLA Rules	Cypress	C-Select
NELMA Grading Rules standard grading rules **	Balsam Fir, Eastern Hemlock-Tamarack, Eastern Spruce, Eastern White Pine, Northern Pine, Northern Pine, Northern White Cedar	All Species: C-Select except C & BTR for Eastern White Pine and Norway Pine
RIS Grade Use standard specifications	Redwood	Clear, Clear All Heart
NHLA Rules	Cypress	B Finish
	Red Gum, Soft Elm, Birch	Select or BTR (for interior use only)

Note: ** https://www.nelma.org/the-grade-rule-book/

2.1.4 Utility Shelving

Provide utility shelving in a suitable species equal to or exceeding the requirements of No. 3 common white fir under WWPA G-5, 25 mm 1 inch thick; or plywood, interior type, Grade A-B, 13 mm 1/2 inch thick, any species group.

2.1.5 Softwood Plywood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

****

NOTE: For projects where these products are located on the interior of the building (defined as inside of waterproofing system), include the last bracketed statement requiring no added urea-formaldehyde resins.

****

Provide in accordance with APA L870.[Provide certified sustainably harvested softwood plywood.][When located on the interior of buildings, provide products with no added urea-formaldehyde resins.]

a. Plywood for Soffits: Exterior type, B-B medium density overlay.

b. Plywood for Shelving: Interior type,[A-B][B-B] Grade, any species group.

c. Plywood for Countertops: Exterior type, A-C Grade.

2.1.6 Hardwood Plywood

****

NOTE: Retain bracketed option describing core construction if only hardwood veneer or lumber core construction is acceptable.

****

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

****

NOTE: In order to be in compliance with HPVA HP-1 noted below, national manufacturers of hardwood plywood are to produce their products in compliance with 40 CFR 770 and the California Air Resource Board (CARB) Regulation requirements regarding Volatile Organic Compounds (VOC) levels. For projects where these products are located on the interior of the building (defined as inside of waterproofing system), include the last bracketed statements requiring no added urea-formaldehyde resins and indoor air quality certification.

****

ANSI/HPVA HP-1, Type[Technical (Exterior)][I (Exterior)][II (Interior)] Common Veneer Species[Grade AA,][Grade A,][Grade B,][Grade C]; Decorative Softwood[Grade D,][Grade E,][Rustic Grade R,][Specialty Grade (SP)]; Lumber Cores[Clear Grade][Sound Grade],[Regular Grade,][Clear Edge,][Banded Core,] face veneers of [_____], of thickness indicated.[Provide certified sustainably harvested hardwood plywood.][When located on the interior of buildings, provide products with no added urea-formaldehyde resins. For products located on the interior of the building (inside of the weatherproofing system), provide certification of indoor air quality for hardwood plywood.]

2.1.7 Hardboard

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

ANSI/CPA A135.4,[standard][tempered][service] type, [3][6] mm [1/8][1/4] inch thick.[Provide certified sustainably harvested hardboard.]

[2.1.8 Medium Density Fiberboard (MDF) and Particleboard

****

NOTE: Particleboard is prohibited in some areas. Verify before using.

****

****

NOTE: Do not use particleboard in humid locations or project locations with Environmental Severity Classifications (ESC) of C4 and C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

****

NOTE: In order to be in compliance with ANSI/CPA A208.1 noted below, national manufacturers of Medium Density Fiberboard (MDF)/Particleboard are to produce their products in compliance with 40 CFR 770 and the California Air Resource Board (CARB) Regulation requirements regarding Volatile Organic Compounds (VOC) levels. For projects where these products are located on the interior of the building (defined as inside of waterproofing system), include the last bracketed statement requiring indoor air quality certification.

****

ANSI/CPA A208.1, Grade 1-M-2 or 2-M-2 or better.[For products located on the interior of the building (inside of the weatherproofing system), provide certification of indoor air quality for MDF and particleboard.]

****

NOTE: MDF/Particleboard is an EPA designated product for recycled content. Use materials with recycled content, calculated on the basis of post-industrial and post-consumer percentage content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying this product. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at https://www.epa.gov/. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows products are available from US national manufacturers above the minimum recycled content stated.

****

Provide products with 80 percent total recovered materials content. Provide data identifying percentage of recycled content for MDF/particleboard.

]2.1.9 Stairs

Treads 32 mm 1-1/4 inches thickness, clear red or white oak. Risers 19 mm 1 inch nominal finish lumber.

2.1.10 Shoe Mould

Clear red or white oak, 13 by 16 mm 1/2 by 5/8 inch unless otherwise indicated.

2.1.11 Wood Seats

Clear maple, oak, or other suitable hardwood, not less than 40 mm 1-5/8 inches thick, with rounded edges. Provide stainless steel stanchions or brackets.

2.1.12 Wood Bumpers

Clear oak[, maple][, birch][or] [_____], dressed to size indicated and with outer edges beveled.

2.1.13 Catwalks

Boards, 19 by 140 mm 1 by 6 inches nominal, species and grade equal to or exceeding 3 Common Hem-Fir under WWPA G-5.

2.1.14 Siding

****

NOTE: The use of wood shingles is now prohibited for all applications. This is due to fire and maintenance issues.

****

****
NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.
****

****
NOTE: Do not use hardboard siding in humid locations or project locations with Environmental Severity Classifications (ESC) of C4 and C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Manufactured from tempered hardboard, it is usually finished with a texture to simulate wood siding. It comes in sheets like plywood siding and installation is the same as for plywood. However, it cannot be treated against termites and, although it is not preferred over wood for food and nests, they will eat through it to find wood. If wood siding is desired, specify treated plywood siding.
****

****
NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the last bracketed statements requiring no added urea-formaldehyde resins and data indicating VOC content.
****

Provide hardboard, plywood, or wood for horizontal siding. Provide hardboard or plywood for panel siding.[Provide certified sustainably harvested siding.][When located on the interior of buildings, provide products with no added urea-formaldehyde resins. Provide data identifying VOC content for siding.]

2.1.14.1 Horizontal Hardboard Siding

ANSI/CPA A135.6, factory primed face and longitudinal edges, factory sealed back, lap type, [200][225][250][300] mm [8][9][10][12] inches wide, maximum practicable lengths, 9.5 or 11 mm 3/8 or 7/16 inch thick,[smooth][embossed][textured] face.

2.1.14.2 Panel Hardboard Siding

ANSI/CPA A135.6, factory primed face and longitudinal edges, factory sealed back, 1220 mm 4 feet wide, maximum practicable lengths, 9.5 or 11 mm 3/8 or 7/16 inch thick,[smooth][embossed] face[, and grooved as selected from manufacturer's standard patterns].

2.1.14.3 Horizontal Plywood Siding

APA L870, exterior,[medium density overlay] lap type, [150][200][300] mm

[6][8][12] inches wide, maximum practicable lengths, [9.5][11][12][13] mm [3/8][7/16][15/32][1/2] inch thick,[smooth][embossed][rough sawn texture][embossed] face.

2.1.14.4 Panel Plywood Siding

APA L870, exterior,[medium density overlay,] 1220 mm 4 feet wide, maximum practicable lengths, span rating of [400][600] mm [16][24] inches on center,[smooth][embossed][rough sawn texture][striated] face,[and grooved] as selected from manufacturer's standard patterns.

2.1.14.5 Horizontal Rated Siding

Qualified under APA E445, exterior type[medium density overlay], lap types, [150][200][250][300] mm [6][8][10][12] inches wide, maximum practicable lengths, [11][12][13] mm [7/16][15/32][1/2] inch thick,[smooth][embossed][rough sawn texture] face.

2.1.14.6 Panel Rated Siding

Qualified under APA E445, exterior type,[medium density overlay] 1220 mm 4 feet wide, maximum practicable lengths,[span rated at 400 mm 16 inch,][span rated at 600 mm 24 inch,][smooth][embossed][striated] face[, and grooves] as selected from manufacturer's standard patterns.

2.1.14.7 Wood Siding

Provide[horizontal bevel type, minimum 5 mm 3/16 inch thin edge by minimum 11 mm 7/16 inch thick edge,][horizontal plain lap type,][horizontal drop type,][vertical board, tongue and groove or shiplap on long edges,][vertical board and batten type,] 25 mm 1 inch thick, [150][200][250] mm [6][8][10] inches wide, maximum practicable lengths,[smooth][rough sawn texture].

2.1.14.8 Engineered Wood Structural Panels

Comply with ICC IBC, Chapter 23 Wood, and with APA S350, exterior, exposure[1][2],[single-faced][double-faced], 1200 mm 4 feet wide, maximum practicable lengths, selected from manufacturer's standard patterns to satisfy the wind load for the specified span.

2.1.14.9 Epoxy Coated Wood Panels

****

NOTE: Epoxy coated wood panels can be included in the design for architectural purposes and then only as accent and spandrel panels. If not included in the design, delete this information.

****

Provide prefinished epoxy coated wood panels consisting of an asbestos-free cement board base sheet with a factory applied surface of epoxy resin and decorative natural stone chips. Provide factory applied finish in a minimum 0.5 mm 20 mils thickness consisting of 100 percent solids, with a two component epoxy resin based coating followed by an application of inert aggregate. Provide stone color(s) and accessory colors as selected by Contracting Officer's Representative from manufacturer's full color and pattern ranges. Provide cement board base sheets in a minimum thickness of 6 mm 1/4 inch thick. Dimensionally stable finished panels are required.

Water absorption on the surfaced side of panels cannot exceed 0.20 percent after 24 hours of submergence in water. Provide accessories in manufacturer's standard extruded aluminum. Provide mouldings for meeting strips, end caps, inside corners, outside corners. Provide non-corrosive, self-tapping screw type fasteners finished to match the color of the panel surface. Provide caulking compounds that are color compatible, low modulus silicone or urethane types.

2.2 SOFFITS

2.2.1 Hardboard and Plywood

Provide hardboard and plywood soffits in siding grade hardboard, 10 or 11 mm 3/8 or 7/16 inch thick; plywood, APA L870, exterior type,[Grade A-C][plywood panel siding][rated siding],[9 mm 11/32 inch thick for 600 mm 24 inches on center][12 mm 15/32 inch thick for 800 mm 32 inches on center][15 mm 19/32 inches thick for 1200 mm 48 inches on center] maximum span with all edges supported.

2.3 FASCIAS AND TRIM

2.3.1 Wood

Provide species and grades for all fascia and trim, including exterior door and window casings, in accordance with AWPA U1 Use Category System Tables. Provide sizes indicated. Metal corners can be provided in lieu of wood corner boards for horizontal siding. If metal corners are used, provide galvanized steel or aluminum, completely coated with primer compatible for the specific metal substrate.

2.4 COUNTERTOPS

2.4.1 Laminated Plastic-faced Countertops

ANSI/NEMA LD 3.

2.4.1.1 Countertop Finishes

High pressure plastic laminate, Grade GP 50 or PF 42, satin or textured finish. Provide color and pattern [_____][as selected by Contracting Officer's Representative from manufacturer's full color and pattern ranges].

2.4.1.2 Backing Sheet

Heavy gauge, BK 20.

2.4.2 Solid Surface

For solid surface countertops refer to Section 06 61 16 SOLID SURFACING FABRICATIONS.

2.5 MOISTURE CONTENT OF WOOD PRODUCTS

Air dry or kiln dry lumber. Kiln dry treated lumber after treatment. All wood products at the time of delivery to the jobsite, and when installed to meet the maximum moisture contents listed below.

****

NOTE: At the text below, the lower percentages (6

and 8 percent) can be specified for interior woodwork to be located in spaces that will be dry due to heating and air conditioning.
****

a. Interior Paneling: [6][12] percent.

b. Interior Finish Lumber, Trim, and Millwork: 25 mm 1-1/4 Inches Nominal or Less in Thickness: [6][12] percent on 85 percent of the pieces and [8][15] percent on remainder.

c. Exterior Treated and Untreated Finish Lumber and Trim: 89 mm 4 inches Nominal or Less in Thickness: 19 percent.

d. Exterior Wood Siding: 15 percent.

e. Provide moisture content of other materials in accordance with the applicable standards.

2.6 PRESERVATIVE TREATMENT OF WOOD PRODUCTS

****
NOTE: Include the non-pressure treatment below for cabinets on projects in humid locations or project locations with Environmental Severity Classification (ESC) of C4 and C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Only the copper-8-quinolinolate is permitted for use on wood in contact with food.
****

2.6.1 Non-Pressure Treatment

Treat woodwork and millwork, such as [cabinets,]exterior trim, door trim, and window trim, in accordance with WDMA I.S.4, with either 2 percent copper napthenate, 3 percent zinc napthenate, or 1.8 percent copper-8-quinolinolate. Provide a liberal brush coat of preservative treatment to field cuts and holes.

2.6.2 Pressure Treatment

Treat lumber and plywood used on the exterior of buildings[or in contact with masonry or concrete] with a waterborne preservative listed in AWPA U1 (P series is included therein by reference) as applicable, and inspected in accordance with AWPA U1. Identify treatment on each piece of material by the quality mark of an agency accredited by the Board of Review of the American Lumber Standards Committee. Provide treated plywood to a reflection level as follows:

Provide all exterior wood moulding and millwork within 455 mm 18 inches of soil or in contact with water or concrete with preservative treatment in accordance with WMMPA WM 6. Provide a field treatment in accordance with AWPA M4 of exposed areas of treated wood that have been cut or drilled. Items of all-heart material of cedar, cypress, or redwood do not require preservative treatment except when in direct contact with soil.

[2.7 FIRE-RETARDANT TREATMENT

****

NOTE: List items to be treated in this paragraph. If fire-retardant treatment is not required, delete this paragraph and the following subparagraph. Specify fire-retardant treated plywood only for nonstructural applications not subject to elevated temperatures or high humidity. Do not specify fire-retardant treated plywood for any part of the roof or roofing system.

****

2.7.1 Wood Products

Provide a qualified independent testing agency that establishes performance ratings to inspect treatment and performance. Pressure treat fire-retardant treated lumber and plywood in accordance with AWPA U1. Comply with material use as defined in AWPA U1 for Interior Type [A][and][B] and Exterior Type. Subject treated materials that will be exposed to rain wetting to an accelerated weathering technique in accordance with ASTM D2898, Method A, prior to being tested for compliance with AWPA U1. For each piece or bundle of treated material, provide rating identification of the testing agency to indicate performance.

Treat the following items:

[_____].

]2.8 HARDWARE AND ACCESSORIES

Provide sizes, types, and spacings of hardware and accessories as recommended in writing by the wood product manufacturer, except as otherwise specified.

2.8.1 Wood Screws

ASME B18.6.1.

2.8.2 Bolts, Nuts, Lag Screws, and Studs

ASME B18.2.1 and ASME B18.2.2.

2.8.3 Nails

Use nails of a size and type best suited for each application and in accordance with ASTM F547. Use hot-dipped galvanized or aluminum nails for exterior applications. For siding, provide nails of sufficient length to extend 40 mm 1-1/2 inches into supports, including wood sheathing over framing. Where nailing is impractical, provide screws of a size and type best suited for each application.

2.8.4 Adjustable Shelf Standards

****

NOTE: See ANSI/BHMA A156.9 for types of hardware available.

****

ANSI/BHMA A156.9, Type [_____], with shelf rests Type [_____].

2.8.5 Vertical Slotted Shelf Standards

****

NOTE: See ANSI/BHMA A156.9 for types of hardware available.

****

ANSI/BHMA A156.9, Type [_____], with shelf brackets Type [_____].

2.8.6 Closet Hanger Rods

Chromium plated steel rods, not less than 25 mm 1 inch diameter by 1.3 mm thick 18 gage. Rods can be adjustable with integral mounting brackets if smaller tube is 25 mm by 1.3 mm thick 1 inch by 18 gauge. Provide intermediate support brackets for rods more than 1200 mm 48 inches long.

2.9 FABRICATION

2.9.1 Quality Standards (QS)

****

NOTE: Include this paragraph only if NAAWS 4.0 will be referenced in this section. See NAAWS 4.0 for definitions of quality grades.

If the Woodwork Institute Certified Compliance Program (CPP) is required, add requirements for certification herein. Evaluate added cost prior to requiring a CCP. For more information, see the Woodwork Institute CCP website.

****

2.9.1.1 Grades

The term "Premium" NAAWS 4.0. Provide items not otherwise specified in a specific grade as "Custom" grade.

2.9.1.2 Adhesives

Select adhesives for durability and permanent bonding. Address expansion and contraction, bond strength, fire rating, moisture resistance, and manufacturer's recommendations factors for all bonded materials.

****

NOTE: If a project design includes use of adhesive products on the building interior (inside the weatherproofing system), include the following bracketed sentences requiring products with indoor air quality certifications or validations as defined in Part 1 of this specification.

****

[Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building.

]2.9.2 Countertops

****

NOTE: Use a plastic laminate backing sheet for countertops exposed to excessive moisture.

****

Fabricate with lumber and a core of[exterior plywood][or][particleboard], glued and screwed to form an integral unit. Bond laminated plastic under pressure to exposed surfaces, using adhesive as recommended by the plastic manufacturer[, and bond a backing sheet under pressure to underside of countertop]. Provide countertop units as post-formed type, no-drip nose, cove mouldings, Style A backsplash, and surfaced with ANSI/NEMA LD 3, ANSI/AWI 1236 Grade PF 42 plastic. Provide backsplashes not less than 90 mm 3-1/2 inches nor more than 115 mm 4-1/2 inches high.

2.9.3 Cabinets

Unless specified otherwise, provide wall and base cabinets of the same construction, materials, and finishes as countertops. Fabricate cabinets with solid ends and frame fronts, or with frames all around. Provide frames of solid hardwood not less than 19 by 38 mm 3/4 by 1-1/2 inches. Provide ends, bottoms, backs, partitions, and doors as hardwood plywood. Mortise and tenon, dovetail, or dowel and glue joints to produce a rigid unit. Cover exposed edges of plywood with hardwood strips. Provide cabinet doors, frames, and solid exposed ends 19 mm 3/4 inch thick minimum. Provide cabinet bottoms, partitions, and framed ends to be 13 mm 1/2 inch minimum. Provide shelves to be 16 mm 5/8 inch thick minimum. Provide cabinet backs 6 mm 1/4 inch thick minimum.

2.9.3.1 Cabinet Hardware

****

NOTE: See ANSI/BHMA A156.9 for types of hardware available. Edit this paragraph to include hardware items needed for custom millwork such as custom wood wardrobes.

****

ANSI/BHMA A156.9. Provide cabinet hardware including two self, closing hinges for each door, two side mounted metal drawer slides for each drawer, and pulls for all doors and drawers as follows. Provide hardware exposed to view[as bright chromium plated] [_____]. Comply with the following requirements for all cabinet hardware:

a. Provide frameless concealed European style, back mounted hinges with 165 degree opening and a self closing feature when at less than 90 degrees open.

****

NOTE: Static drawer slide capacity of 444 N 100 lbs

are appropriate for housing kitchens, vanities, and light commercial construction. Specify a heavier capacity slide for more abusive situations or where heavier loading of drawers is anticipated.
****

b. Provide drawer slides having a static rating capacity of [444 N] [100 lbs.] [_____]. Slides to have a self closing/stay closed action, zinc or epoxy coated steel finish, ball bearing rollers, and positive stop with lift out design.

c. Provide drawer pulls as [wire type pulls with center-to-center dimension of not less than 89 mm 3-1/2 inches and a cross sectional diameter of 8 mm 5/16 inch]. Provide handle projections not less than[33 mm 1-5/16 inches]. [_____].

d. Provide heavy duty magnetic drawer catches.

2.9.3.2 Finish

Provide a clear factory finish in accordance with ANSI/AWI 0400 on wood surfaces after fabrication. Provide fabricator's standard natural finish equivalent to one coat of sealer, one coat of varnish on all surfaces and a second coat of varnish on surfaces exposed to view. Provide spar varnish in exterior or wet area applications. Sand lightly and wipe clean between coats.

2.9.4 Workbenches

Dovetail and glue drawer corners. Fasten frames with suitable wood screws or bolts. Sand exposed surfaces smooth, and ease exposed edges. Provide two side mounted, metal, ball bearing drawer slides[ANSI/BHMA A156.9, Type [_____],] for each drawer, and at least two surface mounted hinges[, Type [_____],] and a magnetic catch[, Type [_____],] for each door.

2.9.5 Casework with Transparent Finish (CTF)

2.9.5.1 AWI Quality Grade

Fabricate manufactured wood casework in compliance with ANSI/AWI 1232 - Manufactured Wood Casework. [Premium][Custom][Economy]grade ANSI/AWI 0641.

2.9.5.2 Construction

Provide[reveal overlay][flush overlay][exposed face frame] design details.

2.9.5.3 Exposed Parts

[_____] species, [_____] cut.

2.9.5.4 Semi-Exposed Parts

As specified in ANSI/AWI 0641 for the grade selected.

2.9.6 Casework with High Pressure Laminate Finish

2.9.6.1 AWI Quality Grade

[Premium][Custom]grade ANSI/AWI 0641[Grades shown on plans].

2.9.6.2 Construction

Provide[reveal overlay][flush overlay][exposed face frame] design details.

2.9.6.3 Exposed Surfaces

High pressure plastic laminate, color and pattern [_____][as selected by Contracting Officer's Representative from manufacturer's full range].

2.9.6.4 Semi-Exposed Surfaces

As specified in ANSI/AWI 0641 for the grade selected.

[2.9.6.5 Edge Banding

Provide edge banding for casework doors and drawer fronts in PVC vinyl [[0.5][3] mm [0.020][0.125] inch] [_____] thick. Provide width [23.8 mm] [15/16 inches] [_____].[Match color and pattern to exposed door and drawer front laminate pattern and color.][Provide color and pattern [_____].]

]PART 3 EXECUTION

Do not install building construction materials that show visual evidence of biological growth. Follow ANSI/AWI 0620 for installation of wood trim, paneling, casework, integrated door systems, countertops and other related interior finishes.

3.1 FINISH WORK

Apply primer to finish work before installing. Where practicable, shop assemble and finish millwork items. Construct joints tight and in a manner to conceal shrinkage but to avoid cupping, twisting and warping after installation. Miter trim and mouldings at exterior angles; cope at interior angles and at returns. Provide millwork and trim in maximum practical lengths. Fasten finish work with finish nails. Provide blind nailing where practicable. Set face nails for putty stopping.

3.1.1 Exterior Finish Work

Machine sand exposed flat members and square edges. Machine finish semi-exposed surfaces. Construct joints to exclude water. In addition to nailing, glue joints with waterproof glue as necessary for weather resistant construction. Evenly distribute end joints in built-up members. Provide shoulder joints in flat work. Reinforce backs of wide-faced miters with metal rings and waterproof glue. Unless otherwise indicated, provide fascia and other flat members 19 mm 3/4 inch thick minimum. Provide door and window trim in single lengths. Provide braced, blocked, and rigidly anchored cornices for support and protection of vertical joints. Provide soffits in largest practical size. Align joints of plywood over centerlines of supports. Fasten soffits with aluminum or stainless steel nails. Back prime all concealed surfaces of exterior trim.

3.1.2 Interior Finish Work

After installation, sand exposed surfaces smooth. Provide window and door trim in single lengths.

3.1.3 Door Frames

Set plumb and square. Provide solid blocking at not more than 400 mm 16 inches on center for each jamb. Position blocking to occur behind hinges and lock strikes. Double wedge frames and fasten with finish nails. Set nails for putty stopping.

3.1.4 Thresholds

Unless otherwise indicated, provide thresholds[16 mm 5/8 inch thick by 70 mm 2-5/8 inches wide with beveled sides] and cut to fit at jambs. Fasten thresholds with casing nails. Set nails for putty stopping.

3.1.5 Window Stools and Aprons

Provide stools with rabbets over window sills. Provide aprons with returns cut accurately to profile of member.

3.1.6 Bases

Provide flat member with a moulded top[and oak shoe mould]. Fasten base to framing or to grounds.[Nail shoe mould to base.] Set[shoe mould][one-piece wood base] after finish flooring is in place.

3.1.7 Finish Stair Work

Fit, nail, screw, bolt, and glue stair work together to form a strong, rigid structure without squeaks or vibrations. Anchor newels and posts securely to stair framing. Cut newels, posts, and drops accurately around floor construction to make a tight fit. Embed balusters into treads and landings and secure with glue. Provide railings with straight runs that follow the slope of the stairs and have smooth curved turns. Return railing profile at ends and secure joints with bolts and nuts in accordance with structural load requirements for railings. Secure railing to posts and newels with concealed anchors. Support wall rails on metal brackets spaced near ends and at not more than 1500 mm 5 feet on center.

3.2 SHELVING

Support 25 mm 1 inch nominal thick wood shelf material or 19 or 20 mm 3/4 or 23/32 inch thick plywood shelf material with end and intermediate supports arranged to prevent buckling and sagging.[Provide hook strips25 mm by 100 mm 1 by 4 inches nominal and cleats25 mm by 50 mm 1 by 2 inches nominal.] Provide cleats except where hook strips are specified or indicated.[Where adjustable shelving is indicated, provide standards and brackets or shelf rests for each shelf.][Anchor standards to wall at not more than 600 mm 2 feet on center.]

3.2.1 Linen Closets

Unless indicated otherwise, provide linen closets with a counter shelf 500 mm 20 inches wide located 900 mm 36 inches above the floor, a lower shelf approximately 450 mm 18 inches wide and 450 mm 18 inches above the floor, and three upper shelves 285 mm 11-1/4 inches wide located 350 mm 14 inches above the counter shelf and 350 mm 14 inches apart.

3.2.2 Storage Rooms

Unless otherwise indicated, provide storage rooms with shelves 285 mm 11-1/4 inches wide, bottom shelf 450 mm 18 inches above the floor, top shelf 450 mm 18 inches below the ceiling, and intermediate shelves approximately 450 mm 18 inches apart.

3.2.3 Room Closets

Provide two shelves 285 mm 11-1/4 inches wide. Support lower shelf by hook strips at back and ends, and provide full length wood or metal clothes hanger rods unless indicated otherwise.

3.2.4 Cleaning Gear Closets

Provide[shelves of size and arrangement indicated][two shelves 350 mm 14 inches wide].

3.3 CLOTHES HANGER RODS

Provide clothes hanger rods where indicated and in closets having hook strips. Set rods parallel with front edges of shelves and support by sockets at each end and intermediate brackets spaced not more than 1200 mm 4 feet on center.

3.4 MISCELLANEOUS

3.4.1 Countertops

Conceal fastenings where practicable. Fit counters tight to adjoining surfaces and scribe where necessary. Provide scribed joints neat and flush. Provide counter sections in longest lengths practicable with a minimum number of joints. Where joints are necessary, provide tight joints drawn up with concealed type heavy pull-up bolts. Glue joints with water resistant glue and make rigid with screws, bolts, or other approved fastenings.

3.4.2 Cabinets

Provide cabinets level, plumb, true, and tight to adjacent walls. Secure cabinets to walls with concealed toggle bolts. Secure top to cabinet with concealed screws.[Make cutouts for fixtures from templates supplied by fixture manufacturer. Locate cutouts for pipes so that edges of holes are covered by escutcheons after installation.]

3.4.3 Workbenches

Provide level, plumb, and tight to adjacent construction. Fasten workbenches to walls with screws or toggle bolts and to floors with expansion bolts.

3.4.4 Wood Seats

Support seats[on brackets spiked to the studs][on stanchions]. Secure seats to supports with[screws][bolts] as required; countersink heads of[screws][bolts] and fill holes with hardwood filler, finished flush with tops of seats.

3.4.5 Wood Bumpers

Bore, countersink, and bolt wood bumpers in place where indicated.

3.4.6 Catwalks in Attic Spaces

Lay boards with 25 mm 1 inch spaces between. Stagger end joints, with each joint on a support.

3.5 SIDING

3.5.1 Installation of Siding

Fit and position siding without springing or otherwise forcing panels into place.[For siding to have a stain finish, set nails and stop with nonstaining putty to match finished siding.][For siding to have a paint finish, drive nails flush.]

3.5.2 Horizontal Siding

****

NOTE: Only one nail at each support is used to attach 150 mm 6 inch or less wide siding. Edit last sentence accordingly.

****

Locate end joints over framing members and alternate such that there are a minimum of two boards between joints on the same support. Evenly distribute shorter pieces throughout the installation. Provide starter strips to establish proper cant for siding. Predrill ends of siding as necessary to prevent splitting when nailed.[Horizontal bevel or plain lap siding: Overlap and nail into each support in accordance with recommendations of siding manufacturer.][Horizontal drop siding: Work each course into top edge of previous course. Nail into each support with[two nails, one near lower edge to clear top of previous course, and one just above mid-height of course][one nail just above mid-height of course].]

3.5.3 Vertical Board Siding

****

NOTE: Only one nail at each support is used to attach 150 mm 6 inch or less wide siding. Edit last sentence accordingly.

****

Apply siding with horizontal joints only at locations indicated. Work each board into edge of previous course. Nail into supports at 600 mm 24 inches on center with[two nails, one blind if possible at or near joint with previous board, and one just outside board centerline][one nail just outside board center line].

3.5.4 Vertical Board and Batten Siding

Apply with horizontal joints only at locations indicated. Install each board with 13 mm 1/2 inch of space between boards. Nail at center of board and into supports at 600 mm 24 inches on center. Center battens over space between boards and nail down center at 400 mm 16 inches on center.

3.5.5 Panel Siding

Apply panels with edges at joints spaced in accordance with manufacturer's recommendations. For all materials covered by battens, provide shiplapped edges or square edges in a[primed for paint finish][sealed for stain finish]. Back all edges with framing members. Nail panels at edges 150 mm 6 inches on center and at intermediate supports 300 mm 12 inches on center. Locate edge nailing 10 mm 3/8 inch from edges. For shiplap joints, nail 10 mm 3/8 inch from visible joint and at a location to penetrate lap with previous panel. When panel siding is part of an engineered shear wall or used as wall bracing, nail shiplap joints to supports with double rows of nails. Space battens at [300][400] mm [12][16] inches on center and nail down center at 600 mm 24 inches on center.

3.5.6 Epoxy Coated Panels

Provide panels where indicated and install in accordance with panel manufacturer's written installation instructions.

3.6 SOFFITS

3.6.1 Wood

Provide panels with edges at joints spaced in accordance with manufacturer's written instructions and with all edges backed by framing members. Nail panels 10 mm 3/8 inch from edges at 150 mm 6 inches on center and at intermediate supports at 300 mm 12 inches on center. Provide panels in maximum practicable lengths.

3.7 FASCIA AND EXTERIOR TRIM

Construct, caulk, and machine sand exposed surfaces and edges to exclude water. In addition to nailing, glue joints as necessary for weather resistance. Evenly distribute end joints in built-up members. Shoulder joints in flat work. Reinforce backs of wide-faced miters with metal rings and glue. Provide fascia and other flat members in maximum practicable lengths. Braced, block, and rigidly anchor cornices for support and protection of vertical joints.

3.8 MOULDING AND INTERIOR TRIM

Install mouldings and interior trim straight, plumb, level and with closely fitted joints. Provide exposed surfaces machine sanded at the shop. Cope returns and interior angles at moulded items and miter external corners. Shoulder intersections of flatwork to ease any inherent changes in plane. Provide window and door trim in single lengths. Blind nail to the extent practicable. Set and stop face nailing with a nonstaining putty to match the applied finish. Use screws for attachment to metal; set and stop screws in accordance with the same quality requirements for nails.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-06 41 16.00 10 (August 2010)**
Change 1 - 11/18

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 41 16.00 10

PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

08/10, CHG 1: 11/18

-- End of Section Table of Contents --

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****

SECTION 06 41 16.00 10

PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

08/10, CHG 1: 11/18

****

NOTE: This guide specification covers the requirements for laminate clad architectural casework.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.

Executive Order No. 12873, dated 20 October 1993, requires that Federal Agencies use environmentally preferable products and services and implement cost-effective procurement preference programs favoring purchase of these products and services. "Environmentally preferable" products and services are those that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw

materials, components, acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, or disposal of the product or service.

Factors to consider include, but are not limited to:

1) Ease of repairability and high durability. A lesser frequency of replacement reduces landfill (i.e., need for more natural resources and energy) costs.

2) Manufacturer/fabricator programs in place that reduce energy required or re-cycle energy, water, by-products, or waste materials in production methods.

3) Low VOC's and off-gassing in the production, fabrication, assembly, and installation of materials and components.

Evaluation of the sustainable efforts of a manufacturer is subjective. There are no current measurable aspects of a sustainable program for casework materials which easily qualifies or disqualifies a manufacturer or fabricator. The submittal reviewer should use the information provided in the Department of Army ETL 1110-3-491 in conjunction with a common sense approach in making the evaluation.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A161.2	(1998) Decorative Laminate Countertops, Performance Standards for Fabricated High Pressure

ASTM INTERNATIONAL (ASTM)

ASTM D1037	(2012; R 2020) Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F547	(2017) Standard Terminology of Nails for Use with Wood and Wood-Base Materials

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.9	(2020) Cabinet Hardware

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A208.1	(2022) Particleboard
CPA A208.2	(2016) Medium Density Fiberboard (MDF) for Interior Applications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED BD+C	(2009; R 2010) Leadership in Energy and Environmental Design(tm) Building Design and Construction (LEED-NC)

UL ENVIRONMENT (ULE)

ULE Greenguard	UL Greenguard Certification Program

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

ANSI/WDMA I.S.1A	(2013) Interior Architectural Wood Flush Doors

WOODWORK INSTITUTE (WI)

NAAWS 4.0	(2021 Errata Edition) North American Architectural Woodwork Standards

1.2 SYSTEM DESCRIPTION

****

NOTE: The term "laminate clad architectural casework" as used herein includes all wood assembly components and specially designed and fabricated custom casework that requires a high pressure decorative laminate finish. This should include such items as restroom vanities, cabinets, and built-in shelving as detailed and located on the drawings. Items such as running trim, moldings, wood railings,and other wood decorative components should be specified in Section 06 20 00 FINISH CARPENTRY.

Solid polymer (solid surfacing) components of laminate architectural casework, such as countertops, will be constructed in accordance with Section 06 61 16 SOLID SURFACING FABRICATIONS.

****

Work in this section includes laminate clad custom casework [cabinets] [vanities] [_____] as shown on the drawings and as described in this specification. This Section includes high-pressure laminate surfacing and cabinet hardware. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Sand smooth and apply a clear finish of polyurethane to all exposed and semi-exposed surfaces, whose finish is not otherwise noted on the drawings or finish schedule. Wood finish may be shop finished or field applied in accordance with Section 09 90 00 PAINTS AND COATINGS.

1.3 SUSTAINABILITY REPORTING

****

NOTE: The bracketed items are representative of LEED material documentation and requirements that may apply to this project. These items should be edited to reflect the project requirements.

****

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for project LEED BD+C [local/regional materials,] [low-emitting materials,] [recycled content,] [certified wood] [____] [and][rapidly renewable materials] LEED documentation requirements.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings
Installation

SD-03 Product Data

Wood Materials
Wood Finishes
Finish Schedule
Certification

SD-04 Samples

Plastic Laminates
Cabinet Hardware

SD-07 Certificates

Quality Assurance
Laminate Clad Casework

SD-11 Closeout Submittals

LEED Documentation

1.5 QUALITY ASSURANCE

****

NOTE: This specification relies heavily on standards developed by the Architectural Woodwork Institute (AWI), a national not-for-profit organization of manufacturers of architectural woodwork, suppliers to the industry, and design professionals to provide specifications which accurately describe and quantify minimum standards for architectural woodwork.

AWI architectural woodwork quality standards for casework materials and fabrication lists three quality categories: premium, custom, and economy grade. The specifier must judge the level of quality required for the specific end use conditions. The specifier should become familiar with the differences between custom and premium grade quality differences before editing this specification.

To insure suitable durability and appearance it is recommended that either the custom or premium grade quality be selected. Economy grade should only be considered where severe funding limitations dictate this lesser quality be specified. AWI Sections 400G and 400B indicate the differences between grades regarding acceptable materials for substrates and components, fabrication methods, joinery, tolerances, and other factors.

****

1.5.1 General Requirements

Unless otherwise noted on the drawings, furnish all materials, construction methods, and fabrication conforming to and complying with the [premium] [custom] grade quality standards as outlined in NAAWS 4.0, Section for laminate clad cabinets. These standards apply in lieu of omissions or specific requirements in this specification. Contractors and their personnel engaged in the work must be able to demonstrate successful experience with work of comparable extent, complexity and quality to that shown and specified. Submit a quality control statement which illustrates compliance with and understanding of NAAWS 4.0 requirements, in general, and the specific NAAWS 4.0 requirements provided in this specification. The quality control statement must also certify a minimum of ten years Contractor's experience in laminate clad casework fabrication and construction. Provide a list of a minimum of five successfully completed projects of a similar scope, size, and complexity in the quality control statement.

1.5.2 Mock-ups

Prior to final approval of shop drawings, provide a full-size mock-up of a typical [vanity] [floor cabinet] [wall cabinet] [_____], including all components and hardware necessary to illustrate a completed unit with a minimum of one door and one drawer assembly. Include countertops and back splashes where specified. Utilize specified finishes in the patterns and colors [as indicated] [as indicated in Section 09 06 00 SCHEDULES FOR

FINISHES]. Upon disapproval, rework or remake the mock-up until approval is secured. Remove rejected units from the jobsite. Approved mock-up may remain as part of the finished work. Submit shop drawings showing all fabricated casework items in plan view, elevations and cross-sections to accurately indicate materials used, details of construction, dimensions, methods of fastening and erection, and installation methods proposed. Clearly cross-reference shop drawing casework items to casework items located on the project drawings. Shop drawings will include a color schedule of all casework items to include all countertop, exposed, and semi-exposed cabinet finishes to include finish material manufacturer, pattern, and color.

1.5.3 Sustainable Design Certification

****

NOTE: Products meeting the Gold standard will also meet the basic standard. Require Gold when the facility will be used by people sensitive to air quality conditions, such as child development centers and medical facilties.

****

Product must be third party certified in accordance with ULE Greenguard[Gold], SCS Scientific Certification Systems Indoor Advantage[Gold]or equal. Perform certification annually and keep current.

1.6 DELIVERY, STORAGE, AND HANDLING

Casework may be delivered knockdown or fully assembled. Deliver all units to the site in undamaged condition, stored off the ground in fully enclosed areas, and protected from damage. Ventilate the storage area and do not subject to extreme changes in temperature or humidity.

1.7 SEQUENCING AND SCHEDULING

Coordinate work with other trades. Do not install units in any room or space until painting, and ceiling installation are complete within the room where the units are located. Install floor cabinets before finished flooring materials are installed.

PART 2 PRODUCTS

2.1 WOOD MATERIALS

2.1.1 Lumber

a. Provide kiln-dried Grade III framing lumber to dimensions as shown on the drawings. Frame front, where indicated on the drawings, must be nominal 19 mm 3/4 inch hardwood.

b. Standing or running trim casework components, which are specified to receive a transparent finish, must be [_____] hardwood species, plain sawn. AWI grade must be [premium] [custom]. Indicate location, shape, and dimensions on the drawings.

2.1.2 Panel Products

****

NOTE: The plastic laminate industry recommends

using medium density fiber board (MDF) or medium density particleboard as suitable panel substrates. The use of plywood is discouraged whenever possible due to the potential for stress crack, shrink-back, and telegraphing problems.

****

2.1.2.1 Plywood

Use veneer core hardwood plywood, NAAWS 4.0 Grade AA panels for framing purposes. Indicate nominal thickness of plywood panels in this specification and on the drawings.

2.1.2.2 Particleboard

Provide industrial grade, medium density (640 to 800 kg per cubic meter 40 to 50 pounds per cubic foot), 19 mm 3/4 inch thick particleboard. Use a moisture-resistant particleboard in grade Type 2-M-2 or 2-M-3 as the substrate for plastic laminate covered [countertops] [backsplashes] [_____] [components as located on the drawings] and other areas subjected to moisture. Provide particleboard meeting the minimum standards listed in ASTM D1037 and ANSI/CPA A208.1.

2.1.2.3 Medium Density Fiberboard

Medium density fiberboard (MDF) must be an acceptable panel substrate where noted on the drawings. Provide medium density fiberboard meeting the minimum standards listed in CPA A208.2.

2.2 SOLID POLYMER MATERIAL

Provide solid surfacing casework components in conformance to the requirements of Section 06 61 16 SOLID SURFACING FABRICATIONS.

2.3 HIGH PRESSURE DECORATIVE LAMINATE (HPDL)

****

NOTE: The grades listed in this paragraph should be edited to include only those grades required for the specific end use of the casework and components. General characteristics and intended end uses are as follows:

Horizontal HGS grade is thicker and therefore the most durable. It is not intended to be post formed to a tight radius.

Vertical VGS grade is thinner and does not have the impact resistance of a horizontal grade.

Horizontal HGP and vertical VGP grades are thinner than their general purpose grade counterparts and are engineered specially for post forming to tight inside and outside bends.

Cabinet liner CLS grade is much thinner than general purpose vertical grade and is intended for light duty use on such surfaces as semi-exposed interior cabinet body and drawer interior surfaces.

Horizontal HGF and vertical VGF grades are specially formulated to provide a Class A flammability rating in accordance with ASTM E84-00a, where required.

Backing sheet BK grade is intended for use on the back side of laminated panels or components to prevent moisture and humidity absorption and minimize warpage, thereby maximizing dimensional stability of the laminated panel substrate material.
****

Provide plastic laminates meeting the requirements of ANSI/NEMA LD 3 and ANSI A161.2 for high-pressure decorative laminates. Indicate design, colors, surface finish and texture, and locations on [the drawings] [Section 09 06 00 SCHEDULES FOR FINISHES] [_____]. Submit two samples of each plastic laminate pattern and color. Samples less than 120 by 170 mm 5 by 7 inches in size are not acceptable. Provide plastic laminate types and nominal minimum thicknesses for casework components as indicated in the following paragraphs.

2.3.1 Horizontal General Purpose Standard (HGS) Grade

Provide horizontal general purpose standard grade plastic laminate that is 1.22 mm (plus or minus 0.127 mm) 0.048 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where postforming is not required.

2.3.2 Vertical General Purpose Standard (VGS) Grade

Provide vertical general purpose standard grade plastic laminate that is 0.71 mm (plus or minus 0.012 mm) 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade is intended for exposed exterior vertical surfaces of casework components where postforming is not required.

2.3.3 Horizontal General Purpose Postformable (HGP) Grade

Provide horizontal general purpose postformable grade plastic laminate that is 1.07 mm (plus or minus 0.127 mm) 0.042 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where post forming is required.

2.3.4 Vertical General Purpose Postformable (VGP) Grade

Provide vertical general purpose postformable grade plastic laminate that is 0.71 mm (plus or minus 0.012 mm) 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade is intended for exposed exterior vertical surfaces of components where postforming is required for curved surfaces.

2.3.5 Horizontal General Purpose Fire Rated (HGF) Grade

****
NOTE: Where fire rated assemblies are required, it is important to note that each material, including the finish, substrate, and other component materials must each be tested separately to conform with the required fire rating. Testing of assemblies as an integral system is not allowed.

****

Provide horizontal general purpose fire rated grade plastic laminate that is 1.22 mm (plus or minus 0.127 mm) 0.048 inches (plus or minus 0.005 inches) in thickness and a class 1, class A fire rating in accordance with ASTM E84.

2.3.6 Vertical General Purpose Fire Rated (VGF) Grade

Provide vertical general purpose fire rated grade plastic laminate that is 0.71 mm (plus or minus 0.012 mm) 0.028 inches (plus or minus 0.004 inches) in thickness and a class 1, class A fire rating in accordance with ASTM E84.

2.3.7 Cabinet Liner Standard (CLS) Grade

Provide cabinet liner standard grade plastic laminate that is 0.51 mm 0.020 inches in thickness. This laminate grade is intended for light duty semi-exposed interior surfaces of casework components.

2.3.8 Backing Sheet (BK) Grade

****

NOTE: All panel substrates not mechanically constrained, should be backed with a laminate manufacturer's backing sheet to minimize moisture absorption and provide substrate stabilization.

****

Undecorated backing sheet grade laminate is formulated specifically to be used on the backside of plastic laminated panel substrates to enhance dimensional stability of the substrate. Backing sheet thickness must be 0.51 mm 0.020 inches. Provide backing sheets for all laminated casework components where plastic laminate finish is applied to only one surface of the component substrate.

2.4 THERMOSET DECORATIVE OVERLAYS (MELAMINE)

****

NOTE: Thermoset decorative overlays are also called low pressure decorative laminate or melamine. This product is usually pre laminated by thermal fusion to particleboard, medium density fiber board or other cellulosic material to form a part of the manufactured panel. Performance characteristics are equal to a 0.5 mm 0.020 inch thick general purpose grade or liner grade HPDL laminate. Primary use is as an alternate solution for liner grade laminate for cabinet interiors. Drawback lies in limited color availability from most manufacturers compared to HPDL.

****

Use thermoset decorative overlays (melamine panels) for [casework cabinet interior] [drawer interior] [all semi-exposed] [_____] surfaces.

2.5 EDGE BANDING

****

NOTE: PVC edge banding for cabinet door and drawer front edges is a standard, industry-wide approved

and widely used alternative to using plastic laminate. Advantages include:

1) A more flexible material for better adhesion to substrate and minimization of delamination problems often occurring with laminate edges.

2) Solid color through the banding eliminates the contrasting dark line at door and drawer edges typically found when plastic laminate is used to finish the edges, especially with light and solid colored laminates.

3) PVC is more durable and less brittle under impact than laminate. Typical installation detail and product standard width allows the PVC edging to overlap the laminate edge on the front and back surfaces of the doors and drawers to protect and minimizes the chance of chipped door edges commonly seen with laminate edged installations.

The most common edge banding is 0.5 mm 0.020 inch in thickness and 24 mm 15/16 inch wide. This edge banding is available in almost all solid colors and many patterns and woodgrains to match all major laminate selections. If matching is desired, recommend coordination and selection during casework design to insure availability.

Edge banding is also available in other thicknesses for more durability, however, color selection is very limited in these greater thicknesses.

****

Provide PVC vinyl, [0.5 mm 0.020 inch] [3 mm 0.125 inch] [_____] thick, edge banding for casework doors and drawer fronts. Material width must be [23.8 mm 15/16 inches] [as indicated on the drawings] [_____]. Color and pattern must [match exposed door and drawer front laminate pattern and color] [be as indicated on the drawings] [_____].

2.6 VINYL COUNTERTOP EDGE

Where located on the drawings, use a tee-mould anchor type with a [flat] [radiused] [_____] edge profile vinyl edging for countertops. Finished width must be [as indicated on the drawings] [_____]. Indicate color on [the drawings] [Section 09 06 00 SCHEDULES FOR FINISHES] [_____].

2.7 CABINET HARDWARE

****

NOTE: To insure a minimum standard quality is met, every attempt should be made to utilize standard hardware components which can be found in ANSI/BHMA A156.9. Use the ANSI/BHMA numbering system to provide a BHMA number for each component which specifies the product class, base material, type of product, description, and grade.

Specially designed, custom, or proprietary hardware

should be thoroughly described and defined in this paragraph.

The basic hardware components listed and described below are not inclusive. The list should be edited to modify, delete, or add hardware components as necessary to provide the specifications required for each end use and casework function.

Hinge type will depend on cabinet construction style requiring flush, inset lipped, or overlay door design, and desired appearance. Wherever possible it is highly recommended that self-closing hinges be utilized to eliminate the need for door catches, latches, or magnets which require constant adjustment and have a high failure rate after extended use.

****

Submit one sample of each cabinet hardware item specified to include [hinges], [pulls], [drawer glides], and [_____]. Provide hardware conforming to ANSI/BHMA A156.9, unless otherwise noted, and consisting of the following components:

2.7.1 Door Hinges

[_____] type, BHMA No. [_____].

2.7.2 Cabinet Pulls

****

NOTE: Cabinet pulls come in a wide variety of styles, finishes, and sizes many of which do not fit a BHMA category. Where a BHMA number is not appropriate, provide a detailed description and commercial model number for reference.

****

[_____] type, BHMA No. [_____].

2.7.3 Drawer Slide

****

NOTE: For drawer stability, superior support, durability, and maximum load capability, only side mounted hinges should be specified. Full extension slides provide maximum utilization of drawer space and aid in cleaning.

Bottom or top center-mounted slides should only be specified where side clearance precludes the use of side-mounted slides.

****

Side mounted [_____] type, BHMA No. [_____] with [full] [_____] extension and a minimum [34 kg 75 pound] [45 kg 100 pound] [_____] load capacity. Include an [integral] [positive] stop to avoid accidental drawer removal.

2.7.4 Adjustable Shelf Support System

****

NOTE: Two methods for shelf support are approved by AWI. For premium grade AWI requires recessed (mortised) metal shelf standards with snap-in metal clips or multiple drilled holes with metal shelf rests. AWI custom grade allows only multiple drilled holes with shelf rests. Either system is satisfactory depending on the specifier's requirements. Surface mounted metal standards are not approved under AWI premium and custom grades. Choose a method from those shown below or permit Contractor option.

****

[Recessed (mortised) metal standards, BHMA No. BO4071, finish: [_____]. Support clips for the standards must be [open type, BHMA No. B04091] [closed type, BHMA No. B04081], finish: [_____]] [Multiple holes with [metal] [plastic] [wood] pin supports].

2.8 FASTENERS

Provide nails, screws, and other suitable fasteners that are the size and type best suited for the purpose and conforming to ASTM F547 where applicable.

2.9 ADHESIVES, CAULKS, AND SEALANTS

2.9.1 Adhesives

Use formula and type of adhesives recommended by AWI. Select adhesives for their ability to provide a durable, permanent bond and take into consideration such factors as materials to be bonded, expansion and contraction, bond strength, fire rating, and moisture resistance. Meet local regulations regarding VOC emissions and off-gassing.

2.9.1.1 Wood Joinery

Use Type II for interior use [urea-formaldehyde resin formula] [polyvinyl acetate resin emulsion] [_____] adhesives to bond wood members. Adhesives must withstand a bond test as described in ANSI/WDMA I.S.1A.

2.9.1.2 Laminate Adhesive

Adhesive used to join high-pressure decorative laminate to wood must be [a water-based contact adhesive] [_____] [adhesive consistent with AWI and laminate manufacturer's recommendations]. Adhere PVC edgebanding using a polymer-based hot melt glue.

2.9.2 Caulk

Use clear, 100 percent silicone caulk to fill voids and joints between laminated components and between laminated components and adjacent surfaces.

2.9.3 Sealant

Use sealant recommended by the substrate manufacturer to provide a moisture barrier at sink cutouts and all other locations where unfinished substrate edges may be subjected to moisture.

2.10 WOOD FINISHES

Paint, stain, varnish and perform applications required for laminate clad casework components [_____] [as indicated in Section 09 90 00 PAINTS AND COATINGS] [as indicated in Section 09 06 00 SCHEDULES FOR FINISHES]. Indicate color and location on the drawings.

2.11 ACCESSORIES

2.11.1 Glass and Glazing

****

NOTE: Specifier must select from glass types below or include specifications for other glass type as required for the project.

****

Reference glass required in laminated casework by type in accordance with Section 08 81 00 GLAZING. Glass must be one of the following:

a. Type [A] [_____].

b. [Float] [Patterned] glass: [Clear] [pattern] quality.

c. Safety glass: [Clear] [_____]; [heat strengthened] [fully tempered] [laminated] [_____]; [_____] mm inches thick minimum.

d. Wire Glass: [Clear] [_____], polished [both sides] [one side]; [square] [diagonal] [_____] mesh woven stainless steel wire of grid [_____] mm inches size; [_____] mm inches thick.

2.11.2 Grommets

Use [plastic] [metal] [rubber] [_____] material for cutouts with a diameter of [_____] mm inches. Indicate locations on the drawings.

2.12 FABRICATION

****

NOTE: Fabrication as described below is for typical casework cabinetry and restroom vanity construction. Techniques, methods, and materials would also apply to other laminated architectural casework fabrications such as built-in shelving, bookcases, and cafeteria counters. Where one or more options are shown, all options are acceptable for either AWI premium or custom grade unless other wise noted. The specification should be edited and tailored to describe the particular casework items being fabricated.

Shop fabrication and shop assembly of components should be maximized to the extent possible. Quality of fabrication and installation are generally superior when accomplished in a millwork shop facility as opposed to field work. Field fabrication and assembly should be limited to those

assemblies and final adjustments necessary to finish installation of the casework.
****

Verify field measurements as indicated in the shop drawings before fabrication. Accomplish fabrication and assembly of components at the shop site to the maximum extent possible. Meet or exceed the requirements for AWI [premium] [custom] grade unless otherwise indicated in this specification. Make cabinet style, in accordance with NAAWS 4.0, Section 400-G descriptions, [flush overlay] [reveal overlay] [flush inset without face frame] [flush inset with face frame] [as indicated on the drawings].

2.12.1 Base and Wall Cabinet Case Body

****
NOTE: Specifier must choose a material from those listed below for each component or permit Contractor option.
****

2.12.1.1 Cabinet Components

Use frame members that are glued-together, kiln-dried hardwood lumber. Brace top corners, bottom corners, and cabinet bottoms with either hardwood blocks or water-resistant glue and nailed in place metal or plastic corner braces. Construct cabinet components from the following materials and thicknesses:

2.12.1.1.1 Body Members (Ends, Divisions, Bottoms, and Tops)

19 mm 3/4 inch [particleboard] [medium density fiberboard (MDF)] [veneer core plywood] panel product

2.12.1.1.2 Face Frames and Rails

19 mm 3/4 inch [hardwood lumber] [panel product]

2.12.1.1.3 Shelving

19 mm 3/4 inch [particleboard] [medium density fiberboard (MDF)] [veneer core plywood] panel product

2.12.1.1.4 Cabinet Backs

6 mm 1/4 inch [particleboard] [medium density fiberboard (MDF)] [veneer core plywood] panel product

2.12.1.1.5 Drawer Sides, Backs, and Subfronts

13 mm 1/2 inch [hardwood lumber] [panel product]

2.12.1.1.6 Drawer Bottoms

6 mm 1/4 inch [particleboard] [medium density fiberboard (MDF)] [veneer core plywood] panel product

2.12.1.1.7 Door and Drawer Fronts

19 mm 3/4-inch [particleboard] [medium density fiberboard (MDF)] panel

product

2.12.1.2 Joinery Method for Case Body Members

****

NOTE: Specifier must choose a method from those listed below or permit Contractor option.

****

2.12.1.2.1 Tops, Exposed Ends, and Bottoms

a. Steel "European" assembly screws (37 mm 1-1/2 inch from end, 128 mm 5 inch on center, fasteners will not be visible on exposed parts).

b. Doweled, glued under pressure (approx. 4 dowels per 300 mm 12 inches of joint).

c. Stop dado, glued under pressure, and either nailed, stapled or screwed (fasteners will not be visible on exposed parts).

****

NOTE: The following method is approved for AWI custom grade only.

****

d. Spline or biscuit, glued under pressure.

2.12.1.2.2 Exposed End Corner and Face Frame Attachment

2.12.1.2.2.1 Mitered Joint

lock miter or spline or biscuit, glued under pressure (no visible fasteners)

2.12.1.2.2.2 Non-Mitered Joint (90 degree)

butt joint glued under pressure (no visible fasteners)

2.12.1.2.2.3 Butt Joint

****

NOTE: This method is approved for AWI custom grade only.

****

glued and nailed

2.12.1.2.3 Cabinet Backs (Wall Hung Cabinets)

****

NOTE: Specifier must choose a method from those listed below or permit Contractor option.

****

Wall hung cabinet backs must not be relied upon to support the full weight of the cabinet and its anticipated load for hanging/mounting purposes. Method of back joinery and hanging/mounting mechanisms should transfer the load to case body members. Use the following fabrication method:

2.12.1.2.3.1 Full Bound

Full bound, captured in grooves on cabinet sides, top, and bottom. Cabinet backs for floor standing cabinets must be side bound, captured in grooves; glued and fastened to top and bottom.

2.12.1.2.3.2 Full Overlay

Full overlay, plant-on backs with minimum back thickness of 13 mm 1/2 inch and minimum No. 12 plated (no case hardened) screws spaced a minimum 80 mm 3 inches on center. Do not expose edge of back on finished sides. Anchor strips are not required when so attached.

2.12.1.2.3.3 Side Bound

****

NOTE: This method is approved for AWI custom grade only.

****

Side bound, captured in groove or rabbetts; glued and fastened.

2.12.1.2.4 Cabinet Backs (Floor Standing Cabinets)

****

NOTE: Specifier must choose a method from those listed below or permit Contractor option.

****

2.12.1.2.4.1 Side Bound

Side bound, captured in grooves; glued and fastened to top and bottom.

2.12.1.2.4.2 Full Overlay

Full overlay, plant-on backs with minimum back thickness of 13 mm 1/2 inch and minimum No. 12 plated (no case hardened) screws spaced a minimum 80 mm 3 inches on center. Do not expose edge of back on finished sides. Anchor strips are not required when so attached.

2.12.1.2.4.3 Side Bound with Rabbetts

****

NOTE: This method is approved for AWI custom grade only.

****

Side bound, placed in rabbetts; glued and fastened in rabbetts.

2.12.1.2.5 Wall Anchor Strips

Wall Anchor Strips are required for all cabinets with backs less than 13 mm 1/2 inch thick. Use strips consisting of minimum 13 mm 1/2 inch thick lumber, minimum 60 mm 2-1/2 inches width; securely attache to wall side of cabinet back - top and bottom for wall hung cabinets, top only for floor standing cabinets.

2.12.2 Cabinet Floor Base

****

NOTE: Care should be taken in the selection of cabinet floor base materials in areas subjected to moisture (for example: adjacent flooring cleaned by wet-mopping or liquid cleaners, and where the finished base material does not provide a moisture barrier. Recommend treated lumber, or panel products specifically engineered to be moisture resistant, be used in these areas.

****

Mount floor cabinets on a base constructed of [nominal 50 mm 2 inch thick lumber] [19 mm 3/4 inch particleboard] [19 mm 3/4 inch fiberboard] [19 mm 3/4 inch veneer core exterior plywood]. Provide base assembly components that are [treated lumber] [a moisture-resistant panel product]. Make finished height for each cabinet base [no less than the full height of the installed, specified wall base] [as indicated on the drawings]. Make bottom edge of the cabinet door or drawer face [flush with top of base] [extend below the top of the base as indicated on the drawings].

2.12.3 Cabinet Door and Drawer Fronts

Fabricate door and drawer fronts from [19 mm 3/4 inch medium density particleboard] [19 mm 3/4 inch medium density fiberboard (MDF]. Surface all door and drawer front edges with [high pressure plastic laminate] [PVC edgebanding], color and pattern [to match exterior face laminate] [as indicated on the drawings] [as indicated in Section 09 06 00 SCHEDULES FOR FINISHES].

2.12.4 Drawer Assembly

****

NOTE: Specifier must choose the substrate material from those listed below based on the proposed finish for the component.

****

2.12.4.1 Drawer Components

Provide drawer components consisting of a removable drawer front, sides, backs, and bottom. Construct drawer components of the following materials and thicknesses:

2.12.4.1.1 Drawer Sides and Backs For Transparent Finish

13 mm 1/2 inch thick [solid hardwood lumber] [7-ply hardwood veneer core plywood (no voids), any species]

2.12.4.1.2 Drawer Sides and Backs For Laminate Finish

13 mm 1/2 inch thick 7-ply hardwood veneer core substrate

2.12.4.1.3 Drawer Sides and Back For Thermoset Decorative Overlay (Melamine) Finish

13 mm 1/2 inch thick medium density particleboard or MDF fiberboard substrate

2.12.4.1.4 Drawer Bottom

6 mm 1/4 inch thick [veneer core panel product for transparent or plastic laminate finish] [thermoset decorative overlay melamine panel product]

2.12.4.2 Drawer Assembly Joinery Method

****

NOTE: Specifier must choose a method from those listed below or permit Contractor option.

****

a. Multiple dovetail (all corners) or French dovetail front/dadoed back, glued under pressure.

b. Doweled, glued under pressure.

c. Lock shoulder, glued and pin nailed.

d. Set bottoms into sides, front, and back, 6 mm 1/4 inch deep groove with a minimum 9 mm 3/8 inch standing shoulder.

2.12.5 Shelving

2.12.5.1 General Requirements

Fabricate shelving from [19 mm 3/4 inch medium density particleboard] [19 mm 3/4 inch medium density fiberboard (MDF] [19 mm 3/4 inch veneer core plywood]. Finish all shelving top and bottom surfaces with [HPDL plastic laminate] [thermoset decorative overlay (melamine)]. Finish shelf edges in a [HPDL plastic laminate] [thermoset decorative overlay (melamine)] [PVC edgebanding].

2.12.5.2 Shelf Support System

****

NOTE: Specifier must choose a method from those listed below or permit Contractor option.

****

The shelf support system is as follows:

2.12.5.2.1 Recessed (Mortised) Metal Shelf Standards

Mortise standards flush with the finishes surface of the cabinet interior side walls, two per side. Pposition and space standards on the side walls to provide a stable shelf surface that eliminates tipping when shelf front is weighted. Install and adjust standards vertically to provide a level, stable shelf surface when clips are in place.

2.12.5.2.2 Pin Hole Method

Drill holes on the interior surface of the cabinet side walls. Evenly space holes in two vertical columns Space the holes in each column at [25 mm 1 inch] [_____] increments starting [150 mm 6 inches] [_____] from the cabinet interior bottom and extending to within [150 mm 6 inches] [_____] of the top interior surface of the cabinet. Drill holes to provide a level, stable surface when the shelf is resting on the shelf pins.

Coordinate hole diameter with pin insert size to provide a firm, tight fit.

2.12.6 Laminate Clad Countertops

Construct laminate countertop substrate of 19 mm 3/4 inch [particleboard] [medium density fiberboard (MDF)] [veneer core plywood]. Use a moisture-resistant substrate where countertops receive sinks, lavatories, or are subjected to liquids. Provide substrates that have sink cutout edges and seal with appropriate sealant against moisture. Do not make joints cutouts. A balanced backer sheet is required.

2.12.6.1 Edge Style

****

NOTE: Specifier should select from the general countertop edge types listed below or specify other types as needed.

****

Make front [and exposed side] countertop edges in shapes and to dimensions as shown on the drawings. Use the following countertop edge material:

2.12.6.1.1 Post Formed Plastic Laminate

Make laminate edge integral with countertop surface. Make shape and profile [bullnose] [waterfall] [as indicated] [_____] and to dimensions as indicated.

2.12.6.1.2 Hardwood

Indicate species, finish, profile, shape, and dimensions as indicated on the drawings. Lap hardwood edge over the exposed countertop laminate edge and install flush with the countertop laminate surface.

2.12.6.1.3 Vinyl

Provide vinyl tee-mould edge in shape, thickness, and color as indicated on the drawings. Lap tee mould edge over the exposed countertop laminate edge and install flush with the countertop laminate surface.

2.12.6.1.4 Plastic Laminate Self Edge

Flat, 90 degree "self " edge. Edge must be applied before top. Lap laminate edge over countertop laminate and ease to eliminate sharp corners.

2.12.6.2 Laminate Clad Splashes

Countertop splash substrate must be 19 mm 3/4 inch [particleboard] [MDF fiberboard] [veneer core plywood]. Laminate clad backsplash must be [integral with countertop, coved to radius and to dimensions as indicated on the drawings] [loose, to be installed at the time of countertop installation]. Provide and install loose, straight profile side splashes at the time of countertop installation. Match back and side splash laminate pattern and color to the adjacent countertop laminate.

2.12.7 Laminate Application

Apply laminate to substrates following the recommended procedures and instructions of the laminate manufacturer and ANSI/NEMA LD 3, using tools and devices specifically designed for laminate fabrication and application. Provide a balanced backer sheet (Grade BK) wherever only one surface of the component substrate requires a plastic laminate finish. Apply required grade of laminate in full uninterrupted sheets consistent with manufactured sizes using one piece for full length only, using adhesives specified herein or as recommended by the manufacturer. Fit corners and joints hairline. Machined flush, file, sand, or buff all laminate edges to remove machine marks and ease (sharp corners removed). Clean up at easing must be such that no overlap of the member eased is visible. Perform fabrication in conformance to ANSI A161.2. Provide laminate types and grades for component surfaces as follows unless otherwise indicated on the drawings:

2.12.7.1 Base/Wall Cabinet Case Body

a. Exterior (exposed) surfaces to include exposed and semi-exposed face frame surfaces: HPDL Grade [VGS] [VGP].

b. Interior (semi-exposed) surfaces to include interior back wall, bottom, and side walls: [HPDL Grade CLS] [Thermoset Decorative Overlay (melamine)].

2.12.7.2 Adjustable Shelving

2.12.7.2.1 Top and Bottom Surfaces

[HPDL Grade HGS] [Thermoset Decorative Overlay (melamine)]

2.12.7.2.2 All Edges

[HPDL Grade VGS] [Thermoset Decorative Overlay (melamine)][PVC edgebanding]

2.12.7.3 Fixed Shelving

2.12.7.3.1 Top and Bottom Surfaces

[HPDL Grade HGS] [Thermoset Decorative Overlay (melamine)]

2.12.7.3.2 Exposed Edges

[HPDL Grade VGS] [Thermoset Decorative Overlay (melamine)][PVC edgebanding]

2.12.7.4 Door, Drawer Fronts, Access Panels

2.12.7.4.1 Exterior (Exposed) and Interior (Semi-Exposed) Faces

HPDL Grade [VGS] [VGP]

2.12.7.4.2 Edges

[HPDL Grade VGS] [PVC edgebanding]

2.12.7.5 Drawer Assembly

All interior and exterior surfaces: [HPDL Grade CLS] [Thermoset Decorative Overlay (melamine)].

2.12.7.6 Countertops and Splashes

All exposed and semi-exposed surfaces: HPDL Grade HGS

2.12.7.7 Tolerances

Meet the NAAWS 4.0 [premium] [custom] grade requirements for flushness, flatness, and joint tolerances of laminated surfaces.

2.12.8 Finishing

2.12.8.1 Filling

Do not expose fasteners on laminated surfaces. Make all nails, screws, and other fasteners in non-laminated cabinet components countersunk and fill the holes with wood filler consistent in color with the wood species.

2.12.8.2 Sanding

Prepare all surfaces requiring coatings by sanding with a grit and in a manner that scratches will not show in the final system.

2.12.8.3 Coatings

Types, method of application and location of casework finishes must be in accordance with the finish schedule, drawings and Section 09 90 00 PAINTS AND COATINGS. Paint all cabinet reveals. Submit descriptive data which provides narrative written verification of all types of construction materials and finishes, methods of construction, etc. not clearly illustrated on the submitted shop drawings. Provide written verification of conformance with NAAWS 4.0 for the quality indicated to include materials, tolerances, and types of construction. Both the manufacturer of materials and the fabricator must submit available literature which describes re-cycled product content, operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.

PART 3 EXECUTION

3.1 INSTALLATION

Installation must comply with applicable requirements for NAAWS 4.0 [premium] [custom] quality standards. Install countertops and fabricated assemblies level, plumb, and true to line, in locations shown on the drawings. Attach and securely anchor cabinets and other laminate clad casework assemblies to the floor and walls with mechanical fasteners that are appropriate for the wall and floor construction.

3.1.1 Anchoring Systems

3.1.1.1 Floor

Utilize a floor anchoring system [as detailed on the drawings] for [base cabinets] [_____]. Anchoring and mechanical fasteners must not be visible from the finished side of the casework assembly. Attach [cabinet] [_____] assemblies to anchored bases without visible fasteners [as indicated in the drawings]. Where assembly abuts a wall surface, include a minimum 13 mm

1/2 inch thick lumber or panel product hanging strip, minimum 60 mm 2-1/2 inch width; securely attached to the top of the wall side of the cabinet back.

3.1.1.2 Wall

Utilize minimum 13 mm 1/2 inch thick lumber or panel product hanging strips, minimum 60 mm 2-1/2 inch width to wall mount [cabinet] [vanity] [_____]; securely attach to the wall side of the cabinet back, both top and bottom.

3.1.2 Countertops

Install countertops in locations as indicated on the drawings. Fasten countertops to supporting casework structure with mechanical fasteners, hidden from view. Fill all joints formed by the countertop or countertop splash and adjacent wall surfaces with a clear silicone caulk. Adhere loose [back] [side] splashes to both the countertop surface perimeter and the adjacent wall surface with adhesives appropriate for the type of materials to be adhered. Fill joints between the countertop surface and splash with clear silicone caulk in a smooth consistent concave bead. Bead size must be the minimum necessary to fill the joint and any surrounding voids or cracks.

3.1.3 Hardware

Install casework hardware in types and locations as indicated on the drawings. Where fully concealed European-style hinges are specified to be used with particleboard or fiberboard doors, use plastic or synthetic insertion dowels to receive 5 mm 3/16 inch "Euroscrews". The use of wood screws without insertion dowels is prohibited.

3.1.4 Doors, Drawers and Removable Panels

Accomplish the fitting of doors, drawers and removable panels within target fitting tolerances for gaps and flushness in accordance with NAAWS 4.0 [premium] [custom] grade requirements.

3.1.5 Plumbing Fixtures

Install sinks, sink hardware, and other plumbing fixtures in locations as indicated on the drawings and in accordance with [Section 22 00 00 PLUMBING, GENERAL PURPOSE] [_____].

3.1.6 Glass

Install glass and glazing in the casework using methods and materials specified in Section 08 81 00 GLAZING in locations as indicated on the drawings.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-06 61 16 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-06 61 16 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-06 61 16 (August 2020)**

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****

SECTION 06 61 16

SOLID SURFACING FABRICATIONS

08/20

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NOTE: This guide specification covers the requirements for solid polymer and quartz agglomerate (or "engineered quartz") fabrications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D790	(2017) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2583	(2013a) Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CSA GROUP (CSA)

CSA B45.5-17/IAPMO Z124	(2017; Errata 2017; Errata 2018) Plastic Plumbing Fixtures

INTERNATIONAL CAST POLYMER ASSOCIATION (ICPA)

ICPA SS-1	(2001) Performance Standard for Solid Surface Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NSF INTERNATIONAL (NSF)

NSF/ANSI 51	(2023) Food Equipment Materials

1.2 SYSTEM DESCRIPTION

****

NOTE: The term "solid surfacing material" encompasses many formulations, including 100 percent acrylic, and blends of acrylic/polyester called acrylic-modified, and other formulations which include such materials as fiberglass for strengthening and quartz agglomerates. Performance characteristics and cost will vary depending on the formulation. For the purposes of this specification, only solid polymer materials in 100 percent acrylic, acrylic-modified polyester formulations and quartz agglomerates will be considered. These three materials provide the best value in terms of performance and life-cycle cost. When specifying solid surfacing products other than solid polymer and quartz agglomerate, care should be taken to fully understand the limitations of these products compared to solid polymer and quartz agglomerates with regard to performance characteristics, fabrication, and installation.

Veneered products consisting of a thin top layer of solid surfacing material with a structural substrate of plywood or particleboard are not considered to be solid polymer with respect to this specification. When specifying a veneered product, care should be taken to fully understand the limitations of this product compared to solid polymer fabrications with regard to performance characteristics and installation.

This specification can be used for counter tops, counter tops with sinks, sinks or bowls, window stools, tub and shower walls, toilet and shower partitions, wainscoting, shelving, table tops, hot and cold cafeteria surfaces, flooring thresholds, wall panel wainscoting, and other applications where a hard, durable, stain resistant surface is desired. Facility types include, but are not limited to: healthcare, institutional, administrative, hospitality, retail, and laboratories. The use of solid surfacing material fabrications meets many health, hygiene, and

durability requirements due to its non-porous and abrasion resistant properties. Provide specific project uses in the brackets below.

****

a. Work under this section includes [_____] and other items utilizing solid surfacing material fabrications as indicated on the drawings and as described in this specification. Do not change source of supply for materials after work has started, if the appearance of finished work would be affected.

b. In most instances, installation of solid surfacing material fabricated components and assemblies requires strong correctly located structural support provided by other trades. To provide a stable, sound, secure installation, close coordination is required between the solid surfacing material fabricator/installer and other trades to ensure that necessary structural wall support, cabinet counter top structural support, proper clearances, and other supporting components are provided for the installation of wall panels, counter tops, shelving, and all other solid surfacing material fabrications to the degree and extent recommended by the solid surfacing material manufacturer.

c. Provide appropriate staging areas for solid surfacing material fabrications. Allow variation in component size and location of openings of plus or minus 3 mm 1/8 inch.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Fabrication Drawings; G, [_____]

Installation; G, [_____]

SD-03 Product Data

Solid Polymer; G, [_____]

Indoor air quality for solid surface seam and sealant products; S, [_____]

[Quartz Agglomerate Material; G, [_____]

] SD-04 Samples

Material; G, [_____]

Counter Tops; G, [_____]

SD-06 Test Reports

Test Report Results

SD-07 Certificates

Qualifications

Indoor Air Quality for solid surface fabrication products; S, [_____]

SD-10 Operation and Maintenance Data

Solid Polymer, Data Package 1; G, [_____]

[Quartz Agglomerate Material, Data Package 1; G, [_____]

]1.4 QUALITY ASSURANCE

****

NOTE: Although solid surfacing materials are fabricated by methods and with tools similar to wood fabrications, familiarity with and expertise in fabricating solid surfacing material items is essential to achieving high quality results. Cabinet or millwork shops, often associated with cabinet counter tops and other millwork fabrications do not necessarily possess this expertise. Proof of

qualification is therefore very important.
****

1.4.1 Qualifications

To ensure warranty coverage, provide manufacturer certified solid surfacing fabricators to fabricate the solid surfacing material being utilized. Mark all fabrications with the fabricator's certification label affixed in an inconspicuous location. Minimum of 5 years of experience working with solid surfacing materials is required of fabricators. Submit solid surfacing material manufacturer's certification attesting to fabricator qualification approval.

1.4.2 Mock-ups

****
NOTE: The counter top submittal sample, as described here, is intended for submittal review at the COE or AE reviewer's office. Where only field or onsite submittal reviews are provided and multiple units are to be installed, the Contractor can be given the requirement to provide a full size mock-up for inspection. A full size mock-up precludes the need for the counter top sample.
****

Submit Detail Fabrication Drawings indicating locations, dimensions, component sizes, fabrication and joint details, attachment provisions, installation details, and coordination requirements with adjacent work. Prior to final approval of shop drawings, provide a full-size mock-up of a typical [counter top] [shelving] [_____] where multiple units are required. Include all solid surfacing material components required to provide a completed unit. Utilize finishes in patterns and colors[as specified in Section 09 06 00 SCHEDULES FOR FINISHES.][as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.] in the mock-up. Should the mock-up not be approved, re-work or remake it until approval is secured. Remove rejected units from the jobsite. Approved mock-up may remain as part of the finished work.

1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver materials to project site until areas are ready for installation. Deliver components and materials to the site undamaged, in containers clearly marked and labeled with manufacturer's name. Store materials indoors and take adequate precautions to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation, for duration of project.

1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials[, excluding damages caused by physical or chemical abuse or excessive heat,] and workmanship for a period of [10][_____] years from date of final acceptance of the work.

PART 2   PRODUCTS

2.1   MATERIAL

****

NOTE: Standard thicknesses for solid surfacing material are 6 mm 1/4 inch, 13 mm 1/2 inch, or 19 mm 3/4 inch. Material 13 mm 1/2 inch thick is considered standard for most applications and is an adequate thickness for most counter top and horizontal surface use; this material does not ordinarily require any sheet underlayment, such as plywood or particle board, when properly spaced structural support is provided. The 6 mm 1/4 inch thick material is generally used only for vertical applications. Quartz agglomerate material minimum thickness 19 mm 3/4 inch.

The 19 mm 3/4 inch thick material is heavier than 13 mm 1/2 inch thick material and generally has a longer lead time and limited color selection. Quartz agglomerate material minimum thickness 19 mm 3/4 inch.

****

Submit detail fabrication drawings and installation drawings of each solid surfacing fabrication indicated. Include elevations, dimensions, clearances, details of construction and anchorage, and details of joints and connections.

Submit manufacturers' descriptive product data for [each type of] solid polymer fabrication [and quartz agglomerate fabrication] indicated. Include manufacturers' literature, finishes, profiles and thicknesses of materials.

Submit manufacturers' operations and maintenance data for [each type of] solid polymer fabrication [and quartz agglomerate material fabrication] in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

2.1.1   Solid Surfacing Material

Provide solid polymer[and][quartz agglomerate material] that is a homogeneous filled solid polymer; not coated, laminated or of a composite construction, complying with ICPA SS-1[and ICPA SS-1 for quartz agglomerate, except for composition]. Provide material that meets or exceeds the minimum physical and performance properties specified. Superficial damage to a depth of 0.25 mm 0.01 inch must be repairable by sanding or polishing. Material thickness is as[indicated below][indicated on the drawings]; required minimum thickness is 6 mm 1/4 inch. Submit a minimum 102 by 102 mm 4 inch by [4][_____] inch sample of each color and pattern for approval; include full range of color and pattern variation. Retain approved samples as a standard for this work. Submit test report results from an independent testing laboratory attesting that the submitted solid surfacing materials meet or exceed each of the specified performance requirements.

a. Horizontal Surfaces:[13 mm 1/2 inch thick material][19 mm 3/4 inch thick material][_____]

b. Vertical Surfaces:[6 mm 1/4 inch thick material][13 mm 1/2 inch thick material][_____]

c. Provide materials that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for solid surface fabrication products.

2.1.2 Cast, 100 Percent Acrylic Polymer Solid Surfacing Material

****

NOTE: Although acrylic-modified polyester polymer is included as an option below, cast, solid 100 percent acrylic polymer material has superior performance characteristics and is therefore considered a superior choice of materials. Cast, solid 100 percent acrylic polymer should always be selected unless cost or a particular pattern/color are considered a higher priority.

****

Cast, 100 percent acrylic solid polymer material composed of acrylic polymer, mineral fillers, and pigments. Provide acrylic polymer that meets or exceeds the following minimum performance requirements:

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Tensile Strength	291 kg/cm^2 4000 psi (max.)	ASTM D638
Hardness	55-Barcol Impressor (min.)	ASTM D2583
Thermal Expansion	.0000386cm/cm/deg C .000023 in/in/F (max.)	ASTM D696
Boiling Water Surface Resistance	No Change	ANSI/NEMA LD 3-3.05
High Temperature Resistance	No Change	ANSI/NEMA LD 3-3.06
Impact Resistance (Ball drop)		ANSI/NEMA LD 3-303
6 mm 1/4 inch sheet	914 mm, 227 g 36-inches, 1/2 lb ball, no failure	
13 mm 1/2 inch sheet	3556 mm, 227 g 140-inches, 1/2 lb ball, no failure	
19 mm 3/4 inch sheet	5080 mm, 227 g 200-inches, 1/2 lb ball, no failure	
Mold & Mildew Growth	No growth	ASTM G21
Bacteria Growth	No growth	ASTM G21

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Liquid Absorption (Weight in 24 hrs.)	0.1 percent max.	ASTM D570
Flammability		ASTM E84
Flame Spread	25 max.	
Smoke Developed	30 max.	
Sanitation	"Food Contact" approval	NSF/ANSI 51
Flexural Strength	[6,800][10,400] psi (min.)	ASTM D790

2.1.3 Acrylic-modified Polymer Solid Surfacing Material

Cast, solid polymer material composed of a formulation containing acrylic and polyester polymers, mineral fillers, and pigments. Provide acrylic polymer content not less than 5 percent and not more than 10 percent in order to meet the following minimum performance requirements:

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Tensile Strength	288 kg/cm^2 4100 psi (max.)	ASTM D638
Hardness	50-Barcol Impressor (min.)	ASTM D2583
Thermal Expansion	.0000386cm/cm/deg C .000023 in/in/F (max.)	ASTM D696
Boiling Water Surface Resistance	No Change	ANSI/NEMA LD 3-3.05
High Temperature Resistance	No Change	ANSI/NEMA LD 3-3.06
Impact Resistance (Ball drop)		ANSI/NEMA LD 3-303
6 mm 1/4 inch sheet	914 mm, 227 g 36 inches, 1/2 lb ball, no failure	
13 mm 1/2 inch sheet	3556 mm, 227 g 140 inches, 1/2 lb ball, no failure	
19 mm 3/4 inch sheet	5080 mm, 227 g 200 inches, 1/2 lb ball, no failure	
Mold & Mildew Growth	No growth	ASTM G21
Bacteria Growth	No growth	ASTM G21

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Liquid Absorption (Weight in 24 hrs.)	0.6 percent max.	ASTM D570
Flammability		ASTM E84
Flame Spread	25 max.	
Smoke Developed	100 max.	
Sanitation	"Food Contact" approval	NSF/ANSI 51
Flexural Strength	[6,800][10,400] psi (min.)	ASTM D790

[2.1.4 Quartz Agglomerate (or "Engineered Quartz") Solid Surfacing Material

Solid sheets consisting of quartz aggregates in an acrylic or polyester, or a combination of the two, resin binder (or matrix) that is solid and nonporous with integral color.

]2.1.5 Material Patterns and Colors

****

Editing of color reference sentence(s) must be coordinated with the Government. Generally Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an architect or interior designer. Color must be selected from manufacturers standard colors or identified as a manufacturers color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located in the drawings a note must be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

Availability of material patterns and colors within any particular manufacturer may vary depending on the material thickness. Scratches in some dark colored solids and patterns, while repairable, are highly visible until repair takes place. Color selection should be based on material availability and severity of end use condition.

The solid surfacing material manufacturing process for products with veining ("motion") often produces particulate distortion through the sheet thickness. The color/vein can drift through the full sheet thickness resulting in unexpected appearance when a stacked-edge buildup is used instead of a mitered edge.

****

Provide pattern and color for all solid surfacing material components and fabrications [as specified in Section 09 06 00 SCHEDULES FOR FINISHES.][as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.] Provide products with consistent patterned color throughout thickness of the product.

2.1.6 Surface Finish

****

NOTE: Matte finish is recommended for most horizontal surfaces such as counter tops. A matte finish is the best for masking surface scratches and is the best finish for facilitating repair of minor scratches, cuts, and abrasions. Semigloss and polished surface finishes are recommended only for very light-duty end use surfaces. Gloss ratings are based on standard glossometer readings made at a 60 degree angle of incidence.

Where semigloss or gloss finishes are specified, recommend these finishes be factory supplied in order to ensure a consistent gloss level of reflectance throughout the entire surface area.

****

Provide a uniform appearance on exposed finished surfaces and edges. Exposed surface finish is [matte; gloss rating of 5-20] [semigloss; gloss rating of 25-50] [polished; gloss rating of 55-80] [as indicated].

2.2 ACCESSORY PRODUCTS

Provide accessory products, as specified below, as manufactured by the solid surfacing material manufacturer or as approved by the solid surfacing material manufacturer for use with the solid surfacing materials being specified.

2.2.1 Adhesives

Provide a two-part seam adhesive kit to create permanent, inconspicuous, non-porous, hard seams and joints by chemical bond between solid surfacing materials and components to create a monolithic appearance of the fabrication. Provide adhesive approved by the solid surfacing material manufacturer. Color-match adhesive to the surfaces being bonded where solid-colored, solid surfacing materials are being bonded together. Provide clear or color matched seam adhesive where particulate patterned, solid surfacing materials are being bonded together.

2.2.2 Seam and Sealant Emissions

Provide seam and other accessory materials that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide validation of indoor air quality for solid surface seam and sealant products.

2.2.3 Silicone Sealant

Provide silicone sealant, mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, acid-curing; ASTM C920, Type S, Grade NS, Class 25, Use NT; clear formulation; approved for use by the solid surfacing material manufacturer.

2.2.4 Conductive Tape

Provide manufacturer's standard conductive foil tape, 0.1 mm 4 mils thick, applied around the edges of cut outs containing hot or cold appliances.

2.2.5 Insulating Tape

****

NOTE: This tape is not required for cooktops or ranges in family housing or other residential applications. Only commercial food wells create enough heat or cold to require extra insulation. Conductive tape is adequate for residential kitchen cooktop cutouts.

****

Provide manufacturer's standard insulating tape for use with drop-in food wells used in commercial food service applications to insulate solid surfacing material from hot or cold appliances.

2.2.6 Heat Reflective Tape

Provide heat reflective tape as recommended by the solid surfacing material manufacturer for use with cutouts for heat sources.

2.2.7 Mounting Hardware

Provide mounting hardware, including sink/bowl clips, inserts and fasteners for attachment of undermount sinks and lavatories.

2.3 FABRICATIONS

Provide factory or shop fabricate components to sizes and shapes indicated, to the greatest extent practical, in accordance with approved Shop Drawings and manufacturer's requirements. Provide factory cutouts for sinks, lavatories, and plumbing fixtures where indicated on the drawings. Contours and radii must be routed to template, with edges smooth. Defective and inaccurate work will be rejected. Submit product data indicating product description, fabrication information, and compliance with specified performance requirements for solid surfacing material, joint adhesive, sealants, and heat reflective tape.[Both the manufacturer of materials and the fabricator are required to submit a detailed description of operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.]

2.3.1 Joints and Seams

Form joints and seams between solid surfacing material components using manufacturer's approved seam adhesive. Provide inconspicuous joints in appearance without voids to create a monolithic appearance.

2.3.2 Edge Finishing

Rout and finish component edges to a smooth, uniform appearance and finish. Provide edge shapes and treatments, including any inserts, as detailed on the drawings. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

2.3.3 Counter Top Splashes

Fabricate backsplashes and end splashes from [13 mm 1/2 inch] [_____] thick solid surfacing material to be [[102 mm 4 inches] [_____] high] [in conformance with dimensions and shapes as indicated]. Provide backsplashes and end splashes [for all counter tops] [at locations indicated]. Shop fabricate backsplashes and provide [permanently attached] [loose, to be field attached].

2.3.3.1 Permanently Attached Backsplash

****

NOTE: Permanently attached backsplashes eliminate the maintenance associated with silicone caulk attachment. Straight attachment with joint adhesive results in a 90 degree square appearance in the counter top/backsplash transition. It is lower in cost than the coved transition method which involves shaping and adhering a strip of matching solid surfacing material into the transition.

****

Provide permanently attached backsplashes [straight with seam adhesive to form a 90 degree transition] [with seam adhesive and to form a radiused coved transition from counter top to backsplash].

2.3.3.2 End Splashes

Provide end splashes loose for installation at the jobsite after horizontal surfaces to which they are to be attached have been installed.

2.3.4 Shelving

Fabricate shelving [and wall support brackets] from [13 mm 1/2 inch] [_____] thick solid surfacing material; dimensions, edge shape, and other details as indicated.

2.3.5 Window Stools

****

NOTE: Many manufacturers of solid surfacing material offer a program of pre-fabricated window stools in selected patterns and colors, dimensions, thicknesses, and edge details. Use of these programs can result in considerable cost-savings over custom fabricated window stools. These programs should be utilized to the greatest extent possible.

****

Fabricate window stools from [13 mm 1/2 inch] [_____] thick solid surfacing material; dimensions, edge shape, and other details [as indicated] [as selected from manufacturer's available pre-fabricated standards] [equal to the width of the window opening by a 13 mm 1/2 inch overhang of the window sill depth] [_____]. Provide [square][bullnose][_____] edge profile.

2.3.6 Counter Tops

Fabricate all solid surfacing material, counter top components from[13 mm 1/2 inch][19 mm 3/4 inch [_____] thick material. Indicate details, dimensions, locations, and quantities on the drawings. Provide counter tops with[102 mm 4 inch] [_____] high [loose] [permanently attached, 90 degrees transition] [permanently attached with coved transition backsplash and loose endsplashes] [at all locations] as indicated]. Attach 51 mm 2 inch wide reinforcing strip of solid surfacing material under each horizontal counter top seam. Submit a minimum 305 mm 1 foot wide by 152 mm 6 inch deep, full size sample for each type of counter top shown on the project drawings; include the edge profile and backsplash as detailed on the drawings and at least one seam. Retain approved sample as standard for this work. Provide [square][bullnose][_____] edge profile.

2.3.6.1 Counter Tops with Sinks

****

NOTE: Rimless sink type is recommended with solid surfacing counter tops. Rimless installation provides superior counter top cleaning capability.

****

[a. Provide stainless steel or vitreous china sink; include cutouts to template for counter tops with sinks as furnished by the sink manufacturer. Provide manufacturer's standard sink mounting hardware for [stainless steel] [vitreous china] [rimless] [_____] installation. Seal between sink and counter top with specified silicone sealant. Provide sink, faucet, and plumbing requirements in accordance with Section 22 00 00 PLUMBING,GENERAL PURPOSE. [_____]

][b. Provide manufacturer's standard solid polymer sinks, pre-molded product specifically designed for attachment to solid surfacing material counter tops. See paragraph SOLID POLYMER SINKS for additional requirements.

]2.3.6.2 Counter Tops with Bowls

****

NOTE: Rimless sink type is recommended with solid

surfacing material counter tops. Rimless installation provides superior counter top cleaning capability.

****

[a. Include cutouts to template for counter tops with vitreous china bowls as furnished by the sink manufacturer. Provide manufacturer's standard sink mounting hardware for vitreous china [rimless] [_____] installation. Seal between sink and counter top with specified silicone sealant. Provide sink, faucet, and plumbing requirements in accordance with Section 22 00 00 PLUMBING,GENERAL PURPOSE. [_____].

][b. Provide manufacturer's standard solid polymer bowls, pre-molded product specifically designed for attachment to solid surfacing material counter tops. See paragraph SOLID POLYMER BOWLS for additional requirements

]

****

NOTE: Many manufacturers of solid polymer offer one-piece, prefabricated counter tops and bowls in various configurations and sizes. These pre-fabricated units can provide considerable cost savings over field fabricated units. Care should be taken when specifying one-piece units to coordinate the unit size designed with the available manufacturer's standard dimensions.

****

[c. Provide manufacturer's standard pre-fabricated one-piece counter top and bowl fabrications. Each unit includes a counter top with integral backsplash and sink bowl. See paragraph SOLID POLYMER BOWLS for additional requirements.

]2.3.6.3 Cafeteria Counter Tops

Include cutouts for cold or hot appliances to templates furnished by the equipment manufacturers. Reinforce joints and cutouts as recommended by the solid surfacing material manufacturer. Provide insulation between the solid surface material and all appliances, hot or cold. Thermally isolate hot applications from cold applications in accordance with the solid surfacing material manufacturer's recommendations. Provide expansion joints as necessary to accommodate hot appliances. Provide adequate ventilation for cabinets beneath counter tops to prevent heat build-up.

[2.3.7 Solid Polymer Sinks

Provide solid polymer sinks that are a standard product of the solid polymer manufacturer, in compliance with CSA B45.5-17/IAPMO Z124 requirements, designed specifically to be installed in solid surfacing material counter tops. Provide sinks of the same polymer composition as the adjoining counter top. Sink design must support a [seam adhesive undermount] [seam adhesive flush] installation method. Sinks must be [single bowl] [double bowl] [double bowl with molded drainboard] configuration. Bowl dimensions must be [as indicated][_____].

][2.3.8 Solid Polymer Bowls

Provide solid polymer bowls that are a standard product of the solid polymer manufacturer, in compliance with CSA B45.5-17/IAPMO Z124 requirements, designed specifically to be installed in solid surfacing material counter tops. Provide bowls of the same polymer composition as the adjoining counter top. Bowl design must support a [seam adhesive undermount] [seam adhesive flush] installation method. Bowl dimensions must be [as indicated][_____].

]2.3.9 Tub/Shower Wall Panel System

****

NOTE: Some solid surfacing material manufacturers offer standardized tub and shower surround kits that can be field cut to fit with minimum material waste. These standardized packages can provide significant cost savings over custom designed tub and shower panel applications.

****

Provide tub/shower wall enclosures with a system of solid surfacing material components to include: [panels] [corner trim] [soap dish] [shampoo shelf] [panel edge trim] [_____]; dimensions of all components are [as indicated] [standard manufacturer's dimensions to be field cut to fit]. Form panels from manufacturer's standard[6 mm 1/4 inch][13 mm 1/2 inch] [_____] thick sheet product. Provide panels full width and height with seams occurring only at the inside corners of the enclosure.[Provide soap dish and shampoo shelf of configuration, shape, and location [as indicated] [as standard with the manufacturer's system].]

2.3.10 Wall Cladding/Wainscoting

Provide solid surfacing material wall cladding or wainscoting to dimensions and in locations as indicated on the drawings. Fabricate panels from manufacturer's standard[6 mm 1/4 inch][13 mm 1/2 inch] [_____] thick sheet product. Provide panels to heights indicated on the drawings with no horizontal seaming; utilize the maximum panel dimension available to minimize vertical seams.

2.3.11 Toilet Partition System

****

NOTE: Some solid surfacing material manufacturers offer standardized partition kits that include all solid surfacing material components and installation hardware. These standardized packages can provide significant cost savings over custom designed partition systems and should be utilized wherever possible.

****

Refer to Section 10 21 13 TOILET COMPARTMENTS.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Components

Install all components and fabricated units plumb, level, and rigid. Make field joints between solid surfacing material components using solid surfacing material manufacturer's approved seam adhesives, to provide a monolithic appearance with joints inconspicuous in the finished work. Attach metal or vitreous china sinks and lavatory bowls to counter tops using solid surfacing material manufacturer's recommended clear silicone sealant and mounting hardware. Install solid polymer sinks and bowls using a color-matched seam adhesive.

3.1.1.1 Loose Counter Top Splashes

Mount loose splashes in the locations noted on the drawings. Adhere loose splashes to the counter top with a color matched silicone sealant when the solid surfacing material components are solid colors. Use a clear silicone sealant to provide adhesion of particulate patterned solid surfacing material splashes to counter tops.

3.1.1.2 Wall Panels & Panel Systems

Installation of wall panels and system components to substrates must include the use of a specified panel adhesive. Use specified seam adhesive to adhere all solid surfacing material components to each other with the exception of expansion joints and inside corners. All inside corners and expansion joints between solid surfacing material components must be joined with specified silicone sealant. All joints between solid surfacing material components and non-solid polymer surfaces must be sealed with specified silicone sealant.

3.1.2 Silicone Sealant

Use specified silicone sealant to seal all expansion joints between solid surfacing material components and all joints between solid surfacing material components and other adjacent surfaces such as walls, floors, ceiling, and plumbing fixtures. Provide sealant bead smooth and uniform in appearance and minimum size necessary to bridge any gaps between the solid surfacing material and the adjacent surface. Provide continuous bead and run the entire length of the joint being sealed.

3.1.3 Plumbing

Make plumbing connections to sinks and lavatories in accordance with Section [22 00 00 PLUMBING, GENERAL PURPOSE] [_____].

3.2 CLEAN-UP

Components must be cleaned after installation and covered to protect against damage during completion of the remaining project items. Damaged components must be repaired or replaced at the Contractor's sole expense.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-06 71 33 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-06 71 33 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025

****

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DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 71 33

FIBERGLASS REINFORCED PLASTIC (FRP) LADDERS

08/23

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-06 71 33 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-06 71 33 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025

****

SECTION 06 71 33

FIBERGLASS REINFORCED PLASTIC (FRP) LADDERS
08/23

****

NOTE: This guide specification covers fiberglass reinforced plastic (FRP) ladders, customarily manufactured to meet specific requirements in building construction and fabricated FRP items not a part of the structural FRP components or framework.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

Include in drawings a complete design indicating the character of the work to be performed and giving the following:

Location and details of each fabricated FRP ladder component showing all dimensions, shapes, and sizes of members, connections, and the relation of items to other building components.

Anchorage devices embedded in other construction, including but not limited to, precast concrete wall panels, precast concrete structural members, precast

concrete roof decking, brick and block masonry, and precast stone work.

Anchorage devices to structural steel framework, including, but not limited to, steel bar grating, steel floor plates, and structural steel roof or floor decking.

****

This Section includes, but is not limited to, new fiberglass reinforced plastic (FRP) ladder systems, including safety ladder cages, mounting systems and related accessories.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN LADDER INSTITUTE (ALI)

ALI A14.3	(2008; R 2018) Ladders - Fixed - Safety Requirements

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM D430	(2006; R 2012) Standard Test Methods for Rubber Deterioration - Dynamic Fatigue
ASTM D495	(1999; R 2004) Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation

ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D790	(2017) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D1148	(2013; R 2018) Standard Test Method for Rubber Deterioration—Discoloration from Ultraviolet (UV) or UV/Visible Radiation and Heat Exposure of Light-Colored Surfaces
ASTM D2344/D2344M	(2016) Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM D3039/D3039M	(2017) Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
ASTM D4000	(2016) Standard Classification System for Specifying Plastic Materials
ASTM D7264/D7264M	(2021) Standard Test Method for Flexural Properties of Polymer Matrix Composite Materials
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23	(Nov 2016) Ladders
29 CFR 1910.27	(Nov 2016) Scaffolds and Roope Descent Systems
29 CFR 1910.28	(Nov 2016)Duty to Have Fall Protection and Falling Object Protection
29 CFR 1926	Safety and Health Regulations for Construction

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Preinstallation Meetings

Within [30] [_____] calendar days of Contract Award, a preinstallation meeting will be scheduled by the Contracting Officer. Submit the following for review:

a. Qualification of Manufacturer

b. Qualification of Engineer of Record

c. Manufacturer's Catalog Data

Include two copies of manufacturer's specifications, load tables, dimension diagrams, and anchor details for the following items:

(1) FRP Ladders and Ladder Safety Cages

(2) Anchorage Materials

d. Fabrication and Installation Drawings and Details

Include plans, elevations, sections, and details of FRP fabrications and their connections. Show anchorage and all accessory items.

Provide templates for anchors and bolts specified for installation under other Sections.

Provide structural analysis data complying with design loads, signed and sealed by the qualified professional engineer responsible for their preparation.

e. Manufacturer's Recommendations

Provide shipping, handling, and erection procedures, along with instructions for care and maintenance after installation.

f. Manufacturer's Sample Warranty

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification of Manufacturer

Qualification of Engineer of Record

SD-02 Shop Drawings

Fabrication and Installation Drawings and Details; G, [_____]

SD-03 Product Data

Manufacturer's Catalog Data; G, [_____]

SD-06 Test Reports

Ultraviolet Testing; G, [_____]

Thermal Expansion; G, [_____]

Flame Spread; G, [_____]

SD-07 Certificates

Manufacturer's Sample Warranty

SD-08 Manufacturer's Instructions

Manufacturer's Recommendations

SD-11 Closeout Submittals

Manufacturer's Warranty

1.4 QUALITY CONTROL

In each of the NFPA standards referred to herein, the advisory provisions are mandatory, as though the word "shall" is substituted for the word "should" wherever it appears. Reference in these standards to the authority having jurisdiction is interpreted to mean the Contracting Officer.

1.4.1 Qualification of Manufacturer

Fiberglass reinforced plastic (FRP) manufacturer is required to have a minimum of [10][_____] years of experience in manufacturing FRP products.

[A record of a minimum of five separate, similar installations within the last [5] [10] [_____] years is required.

] Provide manufacturer's warranty for all FRP products against defects in material and workmanship for a minimum of [5] [_____] years.[Manufacturer to provide evidence of ISO 9001-2000 standard certification.]

1.4.2 Qualification of Engineer of Record

[Ensure that the Engineer of Record is currently licensed within the jurisdiction of the project.

][Provide documentation that the Engineer of Record is approved, authorized, and currently licensed by the State of [_____], and has a minimum of five years of experience as an approved Engineer for manufacturers of similar ladder systems. Supply the names and locations of five projects of similar size and scope for which the ER has provided engineering calculations using the manufacturer's products submitted for this project within the previous 3 years. Provide ER-certified engineering calculations and sealed documents for:

a. Meeting ASCE 7-22 requirements in accordance with the International Building Code

b. Fabrication and installation drawings and details

]

1.5 DELIVERY, HANDLING, AND STORAGE

Deliver all manufactured materials in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturers, clearly marked and identified relative to the complete system. Provide all adhesives, resins, and their catalysts and hardeners in clearly marked or noted crates or boxes. Store all manufactured materials in a dry indoor facility with a constant temperature range between 21.11 and 29.44 degrees C 70 and 85 degrees F until they are required.

Submit manufacturer's recommendations for shipping and handling. Handle all materials to prevent abrasion, cracking, chipping, twisting, or other deformations and other types of damage.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Ensure that all ladder side rails, rungs, mounting brackets, cage straps, and related safety rail system are FRP structural shapes manufactured to comply with or exceed the standards identified in this Section. Provide FRP ladders and ladder safety cages and anchorage materials, including cage hoops, brackets, and all other structural shapes composed of reinforced fiberglass components and resin in qualities, quantities, properties, arrangements, and dimensions as specified in the Contract Documents. Ensure that the complete assembly meets the minimum requirements of ASCE 7-22 and 29 CFR 1910.27.

2.1.1 Design Requirements

Ensure that fiberglass reinforcement is a combination of continuous roving, continuous strand mat, bidirectional roving mat, and surfacing veil in sufficient quantities as required by the application, the physical properties, or both. Clearly identify components as specified in ASTM D4000. Submit documentation verifying structural integrity in relation to thermal expansion.

Ensure that all finished surfaces of FRP items are smooth, resin-rich, and free of voids, dry spots, cracks, crazes or unreinforced areas. Provide a system that is completely covered with resin protection against wear, weathering, and damage from ultraviolet light. Submit ultraviolet testing (UV) results and documented protection with:

a. Integral UV inhibitors in the resin

b. A synthetic, resin-rich surfacing veil, meeting or exceeding the requirements of ASTM D1148.

Provide FRP products that have a tested flame spread rating of 25 or less as specified in ASTM E84 Tunnel Test, with a ladder system meeting the minimum requirements of ASTM D430 and ASTM D495.

Provide 316 stainless steel bolts for attaching ladder cage vertical bars to hoops, ladder hoops to brackets, ladder cage brackets to the ladder, wall brackets to the ladder, and landing safety rails to the system. Mechanically attach all rungs to the ladder with 18-8 stainless-steel rivets, and chemically bond with resin.

All ladder and cage components are to be integrally pigmented yellow. All wall and vertical rail base mount brackets are to be light gray.

2.1.2 Performance Requirements

Provide structural shapes in the ladder system meeting minimum longitudinal mechanical properties as follows:

Tensile Strength	ASTM D638	2.068427e+008 pascal
Tensile Modulus	ASTM D638	1.723689e+010 pascal
Flexural Strength	ASTM D790	2.068427e+008 pascal
Flexural Modulus	ASTM D790	1.241056e+010 pascal
Flexural Modulus-Full Section		1.930532e+010 pascal

Short Beam Shear	ASTM D2344/D2344M	3.102641e+007 pascal
Shear Modulus-Transverse		3.102641e+009 pascal
Coefficient of Thermal Expansion	ASTM D696	2.032e-005 cm/cm/m
Flame Spread	ASTM E84	2.032e-005 cm/cm/m

Tensile Strength	ASTM D3039/D3039M	30,000 psi
Tensile Modulus	ASTM D3039/D3039M	2,500,000 psi
Flexural Strength	ASTM D7264/D7264M	30,000 psi
Flexural Modulus	ASTM D7264/D7264M	1,800,000 psi
Flexural Modulus-Full Section		2,800,000 psi
Short Beam Shear	ASTM D2344/D2344M	4,500 psi
Shear Modulus-Transverse		450,000 psi
Coefficient of Thermal Expansion	ASTM D696	0.000008 in/in/F
Flame Spread	ASTM E84	25 or less

2.1.2.1 Structural Performance of Ladders

Provide ladders capable of withstanding the effects of gravity loads as specified in ASCE 7-22 and the International Building Code, as well as loads and stresses within limits and under conditions specified in 29 CFR 1910.27 and ALI A14.3.

Provide ladders that to support a concentrated vertical load of 34.02 kg [1200] [____] pounds applied at mid-span of the rung.

2.1.2.2 Thermal Movements

Provide exterior metal fabrications that withstand thermal movements resulting from maximum change (range) between 49 degrees C 120 degrees F, ambient, and 83 degrees C 180 degrees F, material surface. Specifically, prevent buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

2.1.2.3 Safety Performance of Ladders

Provide a ladder system that fully complies with NFPA 101, OSHA 29 CFR 1910.23, 29 CFR 1910.27, 29 CFR 1910.28, and ALI A14.3 for distance between rungs, cleats, and steps and for minimum clearances for cages and climbing space.

2.2 COMPONENTS

2.2.1 Ladders

Fabricate ladder side rails of a continuous pultruded, 4.5 cm 1 3/4 inch square tube with a minimum wall thickness of 0.635 cm 1/4 inch or greater. Fabricate ladder rungs to be 3.175 cm 1 1/4 inch diameter pultruded structural shapes, continuously fluted to provide a nonslip surface. Rungs that are gritted as a secondary operation are not permitted. Fit the rungs in the centerline of the side rails.

Fabricate ladder walls and floor mounts from pultruded angles,0.953 3/8 inch minimum thickness. Mechanically attach all ladder rungs to ladder side rails by use of stainless-steel rivets and a chemical bond of epoxy.

Protect all pultruded ladder components from ultraviolet (UV) attack by providing integral UV inhibitors in the resin and a synthetic surfacing veil to help produce a resin-rich surface.

2.2.2 Personal Fall Arrest System (PFAS) or Ladder Safety System (LSS) Requirements

2.2.2.1 New Ladders

Ladders installed on or after November 19, 2018 require a PFAS or LSS where an accident would result in a fall 24 foot or greater. Accidents resulting in a fall less than 24 foot should be considered on a case by case basis for additional protection by the Safety Officer, as specified in 29 CFR 1910.28.

2.2.2.2 Existing Ladders

When a fixed ladder, cage, or well, or any portion of a section, is replaced, install a PFAS or LSS in at least that section of the fixed ladder, cage or well where the replacement is located.

****

NOTE: Coordinate with the Contracting Officer's appointed Safety Officer to determine the requirement for a personal fall arrest or LSS on fixed ladders less than 24 foot in height as well as repair requirements for existing fixed ladders.

****

[2.2.3 Ladder Safety Cages

Ladder safety cages are not permitted as fall protection on newly installed or replaced fixed ladders installed after November 19, 2018. Phasing out of all ladder safety cages is in place until November 18, 2036. Following the phase out period, all fixed ladders must be equipped with a personal fall arrest system or a ladder safety system.

****

NOTE: Include the following for projects requiring ladder safety cages.

****

]PART 3 EXECUTION

3.1 INSTALLATION

Install fabricated FRP work in accordance with the approved detail drawings and descriptive data for each item of fabricated FRP, in conformance with 29 CFR 1926, and as specified.

Assemble and install ladder systems and all components in strict accordance with the manufacturer's assembly documentation. Seal cut or drilled surfaces in accordance with the manufacturer's instructions. Provide adequate ventilation during all drilling, cutting, and resin application procedures.

3.1.1 Fabrication

Ensure that the design and layout of ladders and safety cages complies with ALI A14.3 and OSHA 29 CFR 1910.27. Ensure that all ladder rungs penetrate the tube side wall of the ladder rails. Provide ladder rung connections that are both chemically locking epoxy and mechanically locking rivets.

Fully shop-assemble ladders. Test-assemble safety cages; drill and fit to ensure proper field assembly. Leave safety cage brackets attached with bolts to the ladder for shipping, but disassemble ladder cage components. Package and ship each set of cage components with each respective ladder.

Field-attach hoops to the brackets. Seal all cut, machined edges, holes, and notches to provide maximum corrosion resistance. Coat all field-fabricated cuts in accordance with the manufacturer's instructions.

3.1.2 Fastening to Construction-In-Place

Provide anchorage devices and fasteners where necessary for fastening fabricated FRP items to construction-in-place. Provide threaded fasteners for concrete inserts embedded in cast-in-place concrete; masonry anchorage devices and threaded fasteners for solid masonry and concrete-in-place; toggle bolts for hollow masonry and stud partitions; through-bolting for masonry and wood construction; lag bolts and wood screws for wood construction; and connections for structural steel.

3.2 CLOSEOUT ACTIVITIES

3.2.1 Manufacturer's Warranty

Submit [_____] copies of manufacturer's warranty [30][_____] calendar days before final inspection.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-06 73 01 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-06 73 01 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025

****

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DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 73 01

FIBERGLASS REINFORCED PLASTIC (FRP) GRATING

08/23

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-06 73 01 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-06 73 01 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025

****

SECTION 06 73 01

FIBERGLASS REINFORCED PLASTIC (FRP) GRATING
08/23

****

NOTE: This guide specification covers requirements for fiberglass reinforced plastic (FRP) gratings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Units of work normally included in this section should be FRP items that require specific fabrication to meet the desired project requirements.

****

****

NOTE: Show the following information on the drawings:

1. Location and configuration of all FRP grates.

2. All sizes and dimensions.

3. Special fastenings, attachments, or anchoring.

4. Location and special details of expansion joint covers.

5. Connection details, other than manufacturer's standard details for grating.

8. Locations and details of removable sections of handrails.

****

PART 1 GENERAL

This Section includes, but is not limited to, new fiberglass reinforced plastic (FRP) grating for elevated platforms and walkways.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

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ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D953	(2019) Standard Test Method for

	Pin-Bearing Strength of Plastics
ASTM D2344/D2344M	(2016) Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM D2863	(2019) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D3039/D3039M	(2017) Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
ASTM D7264/D7264M	(2021) Standard Test Method for Flexural Properties of Polymer Matrix Composite Materials
ASTM D7869	(2017) Standard Practice for Xenon Arc Exposure Test with Enhanced Light and Water Exposure for Transportation Coatings
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E662	(2021a; E 2021) Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
ASTM G154	(2023) Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

U.S. DEPARTMENT OF DEFENSE (DOD)

SMP 800-C	Bombardier Test Method for Toxic Gas Generation from Material Combustion

UL SOLUTIONS (UL)

UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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SD-02 Shop Drawings

Installation Drawings, Templates, and Directions; G, [_____]

SD-03 Product Data

FRP Grating; G, [_____]

Clips and Anchorage; G, [_____]

SD-06 Test Reports

Bearing Strength Testing

Flexural Properties

Ultraviolet Testing

Shear Strength

Tensile Properties

Toxicity Testing

Coefficient of Lineal Thermal Expansion

Flame Spread Testing

SD-07 Certificates

Manufacturer's Sample Warranty

[Manufacturer's Certification of State Product Approval

] Certification of Anchorage System compliance with ASCE 7-22

[Proof of Certification from a minimum of two quality assurance programs for its facilities or products (UL, DNV, ABS, USCG, AARR)

] SD-08 Manufacturer's Instructions

Shipping, Handling, and Erection Procedures

Care and Maintenance Instructions

SD-09 Manufacturer's Field Reports

Manufacturer's Certification of Installation

SD-11 Closeout Submittals

Manufacturer's Warranty

1.3 QUALITY CONTROL

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NOTE: For jobs in Iceland, in lieu of AWS welders and inspectors, use "Technological Institute of Iceland"-certified welders and inspectors.

****

Provide items by manufacturers having a minimum of [10][_____] years of experience in the design and manufacture of similar products and systems. In addition, if requested, provide a record of at least [five][_____] separate, similar, successful installations in the last [5][_____] years. Submit manufacturer's catalog data, to include two copies of the manufacturer's specifications, load tables, dimension diagrams, and anchor details for the following items:

a. FRP Grating

b. Clips and Anchorage

Provide [3][_____]-year manufacturer's limited warranty on all FRP products against defects in materials and workmanship. Submit the Manufacturer's Sample Warranty before work starts.

Submit installation drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are embedded in concrete or masonry.

Submit Certification of Anchorage System compliance with ASCE 7-22. Deliver such items to the Contracting Officer and the project site before installation starts.

[Ensure that the manufacturer is certified to ISO 9001-2008.[Submit the Manufacturer's Certification of State Product Approval.][Submit the Proof of Certification from a minimum of two quality assurance programs for its facilities or products (UL, DNV, ABS, USCG, AARR).

]]1.4 DELIVERY, HANDLING, AND STORAGE

Submit the manufacturer's recommendations for shipping, handling, and erection procedures, and care and maintenance instructions. Deliver manufactured materials in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Ensure that all adhesives, resins, and their catalysts and hardeners are crated or boxed separately, and noted as such.

Handle all materials to prevent abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store adhesives, resins and their catalysts in dry indoor facilities between 21 and 30 degrees C 70 and 85 degrees F until they are required.

PART 2 PRODUCTS

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NOTE: Select products based on esthetic values, reliability, and cost. Delete alternate requirements where they occur.

****

2.1 SYSTEM DESCRIPTION

Provide gratings composed of continuous roving fiberglass reinforcement and resin in qualities, quantities, properties, arrangements, and dimensions as necessary to meet the design requirements and dimensions as specified.

Provide resin of isophthalic polyester with chemical formulations as necessary to provide the corrosion resistance, strength, and other physical properties conforming to the specified requirements.

Ensure that all surfaces of FRP items and fabrications are [smooth] [nonslip grit], resin-rich, and free of voids, dry spots, cracks, and unreinforced areas. Completely cover all glass fibers with resin to protect against their exposure to ultraviolet light, wear, or weathering.

2.1.1 Design Requirements

Submit documentation for the following product tests before work starts:

Test	Standard	Structural Performance Requirements	Minimum Flexural Strength	Minimum Flexural Modulus
Bearing Strength Testing	ASTM D953			
Flexural Properties	ASTM D7264/D7264M		30,000 psi	(1.8 x 10 to power of 6) psi

Test	Standard	Structural Performance Requirements	Minimum Flexural Strength	Minimum Flexural Modulus
Ultraviolet Testing	ASTM D7869 ASTM G154			
Shear Strength	ASTM D2344/D2344M	4,500 psi		
Tensile Properties	ASTM D3039/D3039M	30,000 psi		
Toxicity Testing	SMP 800-C			
Coefficient of Lineal Thermal Expansion	ASTM D696	8.0 x 10 power minus 6 in/in/degree F		
Flame Spread Testing	ASTM D2863 ASTM E662 UL 94			

2.1.2 Performance Requirements

2.1.2.1 Structural Performance of Gratings

Provide gratings capable of withstanding the effects of gravity loads in accordance with ASCE 7-22, ICC IBC, and the following loads and stresses within the limits and under the conditions indicated:

[Walkways and Elevated Platforms Other Than Exits: Uniform load of 2.873 kilopascal 60 lb/square foot.

][Walkways and Elevated Platforms Used as Exits: Uniform load of 4.788 kilopascal 100 lb/square foot.

][High Load Capacity (HLC)Grating for AASHTO - H-20 LOADING: 14.515 kg 32,000 lb Axle Dual Wheels; minimum 3.8 to 5.1 cm 1.5 to 2 inch thickness.

][Automobile Traffic: 2268 kg 5000 lb vehicle

][Forklift: [4.54] [2.72] [.907] tonne [5] [3] [one] ton capacity
]

Provide grating products with a flame spread rating of 25 or less per ASTM E84 Tunnel Test. Test gratings for burn time of less than 30 seconds and an extent of burn rate of less than or equal to 10 millimeters per ASTM D635.

2.2 FABRICATION

2.2.1 Molded FRP Grating

Ensure that all field-fabricated and shop-fabricated grating cuts are coated with vinyl ester resin to provide maximum corrosion resistance in accordance with the manufacturer's instructions.

Provide grating made as one-piece molded construction with tops and bottoms of bearing bars and cross bars in the same plane with a rectangular mesh pattern providing unidirectional strength and reinforced with continuous roving of an equal number of layers in each direction. Ensure that the top layer of reinforcement is no more than 3 mm 1/8 inch below the top surface of the grating to provide maximum stiffness and prevent resin chipping of unreinforced surfaces having percentage of glass (by weight) not exceeding 35 percent.

Ensure that no dry glass fibers are visible on any surface of bearing bars or cross bars after molding, and that all bars are smooth and uniform, with no evidence of fiber orientation irregularities, interlaminar voids, porosity, resin-rich areas or resin-starved areas.

[Provide nonslip surfacing manufactured with a concave, meniscus profile on the top of each bar providing maximum slip resistance.

] Fillet grating bar intersections to a minimum radius of 1.6 mm1/16 inch to eliminate local stress concentrations and the possibility of resin cracking at these locations.

Provide fire-retardant grating with a tested flame spread rating of 25 or less when tested in accordance with ASTM E84.

2.2.2 Fasteners

Provide Type 316 stainless-steel fasteners, clips, and anchorage for exterior use. Select fasteners for type, grade, and class required.

PART 3 EXECUTION

3.1 INSTALLATION

Install items at locations indicated, according to the manufacturer's instructions.[Submit [_____] copies of manufacturer's Certification of Installation to the Contracting Officer.] Verify all measurements and take all field measurements necessary before fabrication. Include all materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines; and levels and free of rack. Comply with recommendations of cited bar grating standards, including installation clearances and standard anchoring details.

a. Attach removable units to supporting members with the type and size of clips and fasteners indicated or, if not indicated, as recommended by the grating manufacturer for the type of installation conditions shown.

b. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.1.1 Anchorage, Fastenings, and Connections

Provide anchorage where necessary for fastening miscellaneous FRP items securely in place.

3.2 CLOSEOUT ACTIVITIES

3.2.1 Manufacturer's Warranty

Submit original and [_____] copies of manufacturer's signed Warranty.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-06 82 14 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-06 82 14 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 82 14

FIBERGLASS REINFORCED PLASTIC (FRP) PIPE AND TUBE RAILINGS

08/23

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-06 82 14 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-06 82 14 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 06 82 14

FIBERGLASS REINFORCED PLASTIC (FRP) PIPE AND TUBE RAILINGS

08/23

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NOTE: This guide specification covers the requirements for fiberglass reinforced plastic (FRP) pipe and tube railings, customarily manufactured to meet specific requirements in building construction and fabricated FRP items, which are not a part of the structural FRP components or framework.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: Units of work normally included in this section should be FRP items that require specific fabrication to meet the desired project requirements.

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NOTE: Include in drawings a complete design indicating the character of the work to be performed and showing the following:

a. Location and details of each fabricated FRP pipe and tube railings components showing all dimensions, shapes, and sizes of members and connections, and

the relation of items to other building components.

b. All sizes and dimensions.

c. Special fastenings, attachments or anchoring, including anchorage devices embedded in other construction, including but not limited to, precast concrete wall panels, precast concrete structural members, precast concrete roof decking, brick and block masonry, and precast stone work; anchorage devices to structural steel framework, including, but not limited to, steel bar grating, steel floor plates, and structural steel roof or floor decking.

d. Location and special details of expansion joint covers.

e. Connection details, other than manufacturer's standard for pipe and tube railings.

f. Locations and details removable sections of handrails.

****

PART 1 GENERAL

This Section includes new fiberglass reinforced plastic (FRP) pipe and tube railing/guards, mounting systems and accessories.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum

	Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.6.2	(2020) Square Head Set Screws and Slotted Headless Set Screws (Inch Series)
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.21.2M	(1999; R 2014) Lock Washers (Metric Series)

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.3	(2020) Safety Requirements for Powder-Actuated Fastening Systems American National Standard for Construction and Demolition Operations

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D430	(2006; R 2012) Standard Test Methods for Rubber Deterioration - Dynamic Fatigue
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D790	(2017) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

ASTM D1148	(2013; R 2018) Standard Test Method for Rubber Deterioration—Discoloration from Ultraviolet (UV) or UV/Visible Radiation and Heat Exposure of Light-Colored Surfaces
ASTM D2344/D2344M	(2016) Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM D3039/D3039M	(2017) Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
ASTM D7264/D7264M	(2021) Standard Test Method for Flexural Properties of Polymer Matrix Composite Materials
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23	(Nov 2016) Ladders
29 CFR 1926	Safety and Health Regulations for Construction

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications of Manufacturer; G, [_____]

Qualifications of Engineer of Record; G, [_____]

SD-02 Shop Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

FRP Pipe and Tube; G, [_____]

Railings/Guards; G, [_____]

Anchorage Materials; G, [_____]

Adhesives; G, [_____]

Resins; G, [_____]

Hardeners; G, [_____]

Manufacturer's Sample Warranty

SD-06 Test Reports

Ultraviolet Test Reports

Thermal Expansion Test Reports

Flame Spread Test Reports

SD-07 Certificates

Manufacturer's Certification by the State of [_____] Product Approval

Proof of Certification from a minimum of two quality assurance programs for its facilities or products (UL, DNV, ABS, USCG, AARR)

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-09 Manufacturer's Field Reports

Manufacturer's Certification of Installation

SD-11 Closeout Submittals

Manufacturer's Warranty

1.3 QUALITY CONTROL

In each of the NFPA standards referred to herein, the advisory provisions are mandatory, as though the word "shall" is substituted for the word "should" wherever it appears. Reference in these standards to the authority having jurisdiction is interpreted to mean the Contracting Officer.

1.3.1 Qualifications of Manufacturer

Submit Qualifications Of Manufacturer documentation certifying that the Fiberglass Reinforced Plastic (FRP) manufacturer has a minimum of [10][_____] years of experience in manufacturing FRP products.

Provide items within this section from manufacturers having a minimum of [5] [10] [_____] years of experience in the design and manufacture of similar products and systems.

[Submit documentation proving a minimum of five separate, similar installations within the last [5] [10] [_____] years.

][Submit the Proof of Certification from a minimum of two quality assurance programs for its facilities or products (UL, DNV, ABS, USCG, AARR).

][Submit the manufacturer's certification by the State of [_____] Product Approval.

] Provide the manufacturer's sample warranty for all FRP products against defects in material and workmanship for a minimum of [5] [_____] years. Provide evidence of manufacturer's ISO 9001:2000 standard certification.

1.3.2 Qualifications of Engineer of Record

[Submit Qualifications of Engineer of Record documentation that the Engineer of Record is currently licensed within the jurisdiction of the project.

][Submit documentation that the Engineer of Record is approved, authorized, and currently licensed by the State of [_____], and has a minimum of [5] years of experience as an approved Engineer for manufacturers of similar pipe and tube railing systems. Require the Engineer of Record to supply the name and location of [five] projects of similar size and scope for which they have provided engineering calculations using the manufacturer's products submitted for this project within the previous [3] [_____] years. Provide certified and signed calculations prepared by Engineer for:

] a. The design in accordance with International Building Code and ASCE 7-22

b. Installation drawings

1.4 DELIVERY, HANDLING, AND STORAGE

Deliver all manufactured materials in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturers, clearly marked and identified relative to the complete system. Provide all adhesives, resins and their catalysts and hardeners in clearly marked or noted crates or boxes. Store all manufactured materials in dry indoor facilities with a constant temperature range between 21.11 and 29.44 degrees C 70 and 85 degrees F until they are required.

Handle all materials to prevent abrasion, cracking, chipping, twisting, or other deformations, and other types of damage.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Installation Drawings

Submit templates and erection and installation drawings indicating thickness, type, and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

Include plans, elevations, sections, details, and attachments to other work. Indicate for installed products to comply with design loads. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

2.1.2 Product Data

Submit the manufacturer's catalog data including two copies of manufacturer's specifications, load tables, dimension diagrams, and anchor details for the following items:

a. FRP Pipe and Tube

b. Railings/Guards

c. Anchorage Materials

d. Adhesives

e. Resins

f. Hardeners

2.1.3 Design Requirements

Ensure that all posts and rails are FRP structural shapes manufactured by the pultrusion process. Compose structural shapes of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements, and dimensions as necessary to meet the design requirements in accordance with ASCE 7-22, 29 CFR 1910.23, NFPA 101, and dimensions specified.

Ensure that fiberglass reinforcements are a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application required, the physical properties required, or both.

Provide resins, with appropriate hardeners, of isophthalic polyester, with the chemical formulation necessary for corrosion resistance, strength, and other physical properties.

Ensure that all finished surfaces of FRP items, including FRP pipe and tube, railings/guards, anchorage materials, and fabrications, are smooth, resin-rich, and free of voids, dry spots, cracks, and unreinforced areas. Provide complete coverage of all glass fibers with resin to protect against their exposure to wear or weathering.

Protect all pultruded structural shapes from ultraviolet (UV) attack with:

a. Integral UV inhibitors within the resin

b. Synthetic surfacing veil to help produce a resin-rich surface

c. UV-resistant coating for outdoor exposures

Provide FRP products that have a flame spread rating of 25 or less as specified in ASTM E84, Tunnel Test. Submit [_____] copies of Flame Spread Test Reports to the Contracting Officer.

Ensure that rails, posts, and kick plates are integrally pigmented yellow. Submit [_____] copies of Ultraviolet Test Reports for FRP material, similar to the requirements of ASTM D1148 for rubber deterioration, and ASTM D430, to the Contracting Officer. Submit testing data relating to Thermal Expansion Test Reports.

Provide structural shapes in the guardrail system to meet minimum longitudinal mechanical properties as follows:

Tensile Strength	ASTM D638	2.068427e+008 pascal
Tensile Modulus	ASTM D638	1.723689e+010 pascal
Flexural Strength	ASTM D790	2.068427e+008 pascal
Flexural Modulus	ASTM D790	1.241056e+010 pascal
Flexural Modulus-Full Section		1.930532e+010 pascal
Short Beam Shear	ASTM D2344/D2344M	3.102641e+007 pascal
Shear Modulus-Transverse		3.102641e+009 pascal
Coefficient of Thermal Expansion	ASTM D696	2.032e-005 cm/cm/m

Flame Spread	ASTM E84	2.032e-005 cm/cm/m

Tensile Strength	ASTM D3039/D3039M	30,000 psi
Tensile Modulus	ASTM D3039/D3039M	2,500,000 psi
Flexural Strength	ASTM D7264/D7264M	30,000 psi
Flexural Modulus	ASTM D7264/D7264M	1,800,000 psi
Flexural Modulus-Full Section		2,800,000 psi
Short Beam Shear	ASTM D2344/D2344M	4,500 psi
Shear Modulus-Transverse		450,000 psi
Coefficient of Thermal Expansion	ASTM D696	.000008 in/in/F
Flame Spread	ASTM E84	25 or less

2.1.4 Performance Requirements

2.1.4.1 Structural Performance of Pipe and Tube Railings

Provide a pipe and tube railing system capable of withstanding the effects of gravity loads in accordance with ASCE 7-22 and International Building Code, ICC IBC the State of [_____] Building Code, with the following loads and stresses within limits and under the conditions indicated:

a. Handrails:

  (1) Uniform load of 6.91 Kgf/m 50 lbf/foot applied in any direction.

  (2) Concentrated load of 90.72 Kgf 200 lbf applied in any direction.

  (3) Uniform and concentrated loads need not be assumed to act concurrently.

b. Top Rails of Guards:

  (1) Uniform load of 6.91 Kgf/m 50 lbf/foot applied in any direction.

  (2) Concentrated load of 90.72 Kgf 200 lbf applied in any direction.

  (3) Uniform and concentrated loads need not be assumed to act concurrently.

c. Infill of Guards:

  (1) Concentrated load of 6.91 Kgf/m 50 lbf applied horizontally on an area of 929 square centimeter 1 square foot.

  (2) Uniform load of 1.2 kilopascal 25 lbf/square foot applied horizontally.

(3) Infill load and other loads need not be assumed to act concurrently.

2.2 FABRICATION

Perform fabrication of the handrail post/rail connection such that the rails are unbroken and continuous through the post without the use of packs or splices. Install the bottom rail through the post at a prepared hole made to fit the outside dimensions of the rail, and the top rail fit into a machined, u-shaped pocket formed into the top of the post such that the rail is located at the center of the post. Radius all exposed corners to eliminate sharp edges. Join the rails to the post through a combination of bonding and riveting. Ensure that no sharp, protruding edges remain after assembly of the handrail. Space the posts no more than 1.83 m 72 inches apart. Attach post bases according to the construction contract drawings. Reinforce post bases to a height of 22 cm 8 1/2 inches. Coat all field-fabricated and shop-fabricated cuts with a vinyl ester resin to provide maximum corrosion resistance.

2.3 MATERIALS

2.3.1 Fasteners

Provide Type 316 stainless-steel concealed fasteners, unless unavoidable or standard for railings indicated.

2.3.2 Anchors

Provide cast-in-place epoxy mechanical anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the design load imposed when installed in unit masonry and equal to four times the design load imposed when installed in concrete, as determined by testing as specified in ASTM E488/E488M.

2.3.3 Grout And Anchoring Cement

Provide factory-packaged, nonshrink, nonmetallic grout complying with ASTM C1107/C1107M; or water-resistant, nonshrink anchoring cement; recommended by the manufacturer for exterior use. Ensure that all other adhesives conform to the manufacturer's recommendations and instructions.

2.3.4 Component Connections

2.3.4.1 Lag Screws and Bolts

Provide lag screws and bolts conforming to ASME B18.2.1, of the type and grade best suited for the purpose.

2.3.4.2 Toggle Bolts

Provide toggle bolts conforming to ASME B18.2.1.

2.3.4.3 Bolts, Nuts, Studs, and Rivets

Provide bolts, nuts, studs, and rivets conforming to ASME B18.2.2 and ASTM A307.

2.3.4.4 Powder-Driven Fasteners

Follow safety provisions of ASSP A10.3 .

2.3.4.5 Screws

Provide screws conforming to ASME B18.2.1, ASME B18.6.2, and ASME B18.6.3.

2.3.4.6 Washers

Provide plain washers conforming to ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers conforming to ASME B18.21.2M and ASME B18.21.1.

PART 3 EXECUTION

3.1 INSTALLATION

Install items in accordance with 29 CFR 1910.23 and 29 CFR 1926 at locations indicated, according to the manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Include all materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation. Submit [_____] signed copies of Manufacturer's Certification of Installation.

a. Set posts plumb within a tolerance of 1.6 mm 1/16 inch in 0.91 meter 3 feet.

b. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 6.4 mm 1/4 inch in 3.66 meter 12 feet.

3.1.1 Anchorage, Fastenings, and Connections

Provide anchorage where necessary for fastening miscellaneous FRP items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through-bolts for masonry; machine and carriage bolts for steel; through-bolts and screws. Conceal fastenings where practicable.

3.1.2 Workmanship

Ensure that FRP work is well formed to shape and size, with sharp lines and angles and true curves. Ensure that drilling and punching produces clean true lines and surfaces. Ensure that exposed surfaces of work-in-place to have smooth finishes. Mill joints where tight fits are required. Ensure that corner joints are coped or mitered, well formed, and in true alignment. Accurately set work to established lines and elevations and securely fasten in place. Ensure that the installation is in accordance with the manufacturer's installation instructions and the approved drawings, cuts, and details.

3.2 CLOSEOUT ACTIVITIES

3.2.1 Warranty

Submit [_____] signed copies of the Manufacturer's Warranty 30 calendar days before final inspection.

3.2.2 Manufacturer's Instructions

Submit the manufacturer's instructions for shipping and handling, and procedures for erection, care, and maintenance upon completion of installation.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 11 13 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 11 13 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 07 11 13

BITUMINOUS DAMPPROOFING

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USACE / NAVFAC / AFCEC **UFGS-07 11 13 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 11 13 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 07 11 13

BITUMINOUS DAMPPROOFING

08/23

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NOTE: This guide specification covers the requirements for bituminous dampproofing to resist passage of moisture/water in the absence of hydrostatic pressure. It is intended to be used where protection is required against ingress of water by capillary action resulting from occasional exposure to moisture or where reduced transfer of water vapor through the surface is necessary. Consider the use of bituminous dampproofing for conditions such as the following:

1. Exterior side of exterior concrete or masonry walls enclosing occupied spaces below grade where a head of water or unusually wet soil conditions are not present (use Section 07 12 00 BUILT-UP BITUMINOUS WATERPROOFING when head of water exists).

2. Backside of concrete or masonry retaining walls and stone facing where percolating of water through the wall or facing would produce objectionable staining.

3. Inside surface of single wythe, exterior, furred concrete or masonry walls above grade where reduction of transfer of water vapor through the wall is necessary.

4. Cavity face of interior wythe of masonry cavity walls.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C208	(2022) Standard Specification for Cellulosic Fiber Insulating Board
ASTM C728	(2017a; R 2022) Standard Specification for Perlite Thermal Insulation Board
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D43/D43M	(2000; R 2018) Standard Specification for Coal Tar Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D227/D227M	(2003; R 2018) Standard Specification for

	Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D449/D449M	(2003; R 2021) Standard Specification for Asphalt Used in Dampproofing and Waterproofing
ASTM D450/D450M	(2007; R 2018) Standard Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing
ASTM D1187/D1187M	(1997; R 2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM D1227/D1227M	(2013; R 2019; e1) Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing
ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4479/D4479M	(2007; R 2018) Standard Specification for Asphalt Roof Coatings-Asbestos-Free

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Materials

1.3 DELIVERY AND STORAGE

Deliver materials in sealed containers bearing manufacturer's original labels. Labels must include date of manufacture, contents of each container, performance standards that apply to the contents and recommended shelf life. While in storage, do not allow water based bituminous dampproofing to freeze.

[1.4 SAFETY AND HEALTH REQUIREMENTS

****
NOTE: Retain this paragraph only if coal-tar pitch materials are used.
****

If coal-tar pitch materials are used, conduct work in conformance with OSHA 29 CFR 1926 and General Industry Health Standards as well as state and local standards.

]PART 2 PRODUCTS

****
NOTE: When requiring the hot-application method for dampproofing, use the following paragraph for asphalt. Where dampproofing would be exposed to temperatures of more than 50 degrees C 122 degrees F after application, modify paragraph ASPHALT to specify Type III in lieu of Type II; delete paragraph COAL-TAR PITCH, and retain the paragraph FIBROUS ASPHALT without modification. Use paragraph COAL-TAR PITCH when high resistance to acids or salts is required or when hydrostatic pressure below grade is high.
****

[2.1 ASPHALT

ASTM D449/D449M, Type I or Type II.

]2.2 ASPHALT PRIMER

ASTM D41/D41M.

[2.3 CREOSOTE PRIMER

****

NOTE: When cavity walls are to be dampproofed, delete this paragraph.

****

ASTM D43/D43M.

][2.4 COAL-TAR PITCH

****

NOTE: When cavity walls are to be dampproofed, delete this paragraph.

****

ASTM D450/D450M, Type II or Type III.

][2.5 FIBROUS ASPHALT

****

NOTE: Use fibrous asphalt for the cold-application method of dampproofing when applied to the masonry or concrete interior wall wythe surfaces of exterior cavity walls.

****

ASTM D4479/D4479M, Type I for horizontal surfaces, Type II for vertical surfaces.

][2.6 EMULSION-BASED ASPHALT DAMPPROOFING

2.6.1 Fibrated Emulsion-Based Asphalt

****

NOTE: Type II, Class 1 fibrated emulsion-based asphalt is typically used as a protective coating against dampness on interior surfaces above grade and exterior surfaces of concrete, metal and wood above or below grade. Type II, Class 1 is also used as a vapor barrier when applied to interior surfaces.

****

Provide cold-applied fibrated emulsion-based asphalt dampproofing conforming to ASTM D1227/D1227M Type II, Class 1, asbestos-free, manufactured of refined asphalt, emulsifiers and selected clay, fibrated with mineral fibers. For spray or brush application, emulsion must contain a minimum of 59 percent solids by weight, 56 percent solids by volume. For trowel application, emulsion must contain a minimum of 58 percent solids by weight, 55 percent solids by volume.

2.6.2 Non-Fibrated Emulsion-Based Asphalt

****

NOTE: Non-fibrated emulsion-based asphalt is

typically used as a protective coating against dampness on interior surfaces of concrete, metal and wood above or below grade.
****

Provide cold-applied non-fibrated emulsion-based asphalt dampproofing conforming to ASTM D1187/D1187M Type II or ASTM D1227/D1227M Type III, manufactured of refined asphalt, emulsifiers and selected clay. Asphalt must contain a minimum 58 percent solids by weight, 55 percent solids by volume.

][2.7 SURFACE PROTECTION

****
NOTE: Use these paragraphs only when dampproofed surface against which backfill is to be placed will be exposed for an extended period of time or will be otherwise subjected to physical damage. Limit dampproofing material where protective covering is used to those materials which are applied hot. Heavier felt or mineral-surfaced roofing sheets, fiberboard, or perlite board may be specified as the protective covering where a higher degree of protection is necessary.
****

2.7.1 Saturated Felt

ASTM D226/D226M, Asphalt Saturated, Type I, 6.8 kilogram 15 pound; ASTM D227/D227M, Coal-Tar Saturated.

2.7.2 Protection Board

Wood Fiber Board, ASTM C208, or Perlite Board, ASTM C728.

]PART 3 EXECUTION

3.1 SURFACE PREPARATION

****
NOTE: Coordinate the requirements of this paragraph with other applicable sections, to assure that patching of holes and other operations necessary for providing a suitable base for dampproofing are adequately covered. Edit the concrete section to assure that concrete surfaces to be dampproofed are specified to be cured by water methods.
****

[Remove or cut form ties and repair surface defects as required in Section 03 30 00 CAST-IN-PLACE CONCRETE.]Clean [concrete and]masonry surfaces to receive dampproofing of foreign matter and loose particles. Apply dampproofing to clean dry surfaces. Moisture test in accordance with ASTM D4263. If test indicates moisture, allow a minimum of seven additional days after test completion for curing. If moisture still exists, redo test until substrate is dry.

[3.1.1 Metal Surfaces

Ensure metal surfaces are dry and free of rust, scale, loose paint, oil, grease, dirt, frost and debris.

]3.2 Protection of Surrounding Areas

Before starting the dampproofing work, protect the surrounding areas and surfaces from spillage and migration of dampproofing material onto other work.[Protect drains and conductors from clogging with dampproofing material.]

3.3 APPLICATION

****

NOTE: When cavity walls are to be dampproofed, delete first bracketed requirements and include second bracketed requirements.

****

[Use either hot-application or cold-application method. Use cold-application method in confined spaces where hot bitumen would be hazardous.][Prime surfaces to receive fibrous asphaltic dampproofing unless recommended otherwise by dampproofing materials manufacturer.]Apply dampproofing after priming coat is dry, but prior to any deterioration of primed surface, and when ambient temperature is above 4 degrees C 40 degrees F.

3.3.1 Surface Priming

****

NOTE: When cavity walls are to be dampproofed, delete first bracketed sentence and bracketed reference to asphalt in second sentence.

****

[Prime surfaces to receive coal-tar pitch dampproofing with creosote primer.][Prime surfaces to receive [asphalt or] [fibrous asphalt dampproofing with asphalt primer].]Apply primer when ambient temperature is above 4 degrees C 40 degrees F and at rate of approximately 4 liters per 10 square meters one gallon per 100 square feet, fully covering entire surface to be dampproofed.

[3.3.2 Hot-Application Method

****

NOTE: When cavity walls are to be dampproofed, delete this paragraph in projects.

****

Apply two mop coats of hot coal-tar pitch or two mop coats of hot asphalt to surfaces. Apply mop coats uniformly using not less than 12.2 kilograms 25 pounds of coal-tar pitch or 9.8 kilograms 20 pounds of asphalt per 10 square meters 100 square feet for each coat. Do not heat asphalt above 232 degrees C 450 degrees F. Do not heat coal tar pitch above 204 degrees C 400 degrees F. Have kettlemen in attendance at all times during heating to ensure that maximum temperature specified is not exceeded. Apply hot asphalt bitumen or coal tar pitch and fully bond to primed surface. Provide finished surface that is smooth, lustrous, and impervious to moisture. Recoat dull or porous spots.

]3.3.3 Cold-Application Method

****
NOTE: When cavity walls are to be dampproofed, include bracketed requirement in the paragraph for fibrous asphalt.
****

[3.3.3.1 Fibrous Asphalt

Apply two coats of fibrous asphalt to surfaces to be dampproofed. Apply each coat uniformly using not less than 4 liters one gallon fibrous asphalt per 5 square meters 50 square feet. Apply first coat by brush or spray to provide full bond with primed surface. Brush or spray second coat over thoroughly dry first coat[unless recommended otherwise by dampproofing materials manufacturer]. Provide finished surface that is of uniform thickness and impervious to moisture. Recoat porous areas.

][3.3.3.2 Emulsion-Based Asphalt

Do not perform emulsion-based asphalt dampproofing work in temperatures below 4 degrees C 40 degrees F. Emulsions must have a smooth and uniform consistency at time of application. Apply dampproofing materials in accordance with manufacturer's published instructions to produce a smooth uniform dry film of not less than 0.3 mm 12 mils thick without voids or defects. Recoat any dull or porous spots. Seal dampproofing materials tightly around pipes and other items projecting through dampproofing. Apply materials at rates as follows:

a. Primer: 0.2 liters per square meter 1/2 gallon per 100 square feet, cold-applied.

b. Fibrated Dampproofing: 0.8 liters per square meter 2 gallons per 100 square feet, cold-applied with spray, brush or trowel.

c. Non-fibrated Dampproofing: 0.8 liters per square meter 2 gallons per 100 square feet, cold-applied with spray, brush or trowel.

][3.4 PROTECTIVE COVERING

****
NOTE: Use this paragraph only when dampproofed surface against which backfill is to be placed will be exposed for an extended period of time or will be otherwise subjected to physical damage.
****

Protect dampproofed surfaces against which backfill will be placed with [one layer of 6.8 kilogram 15 pound saturated felt. Use asphalt-saturated felt where the dampproofing material is asphalt and use coal-tar-saturated felt where the dampproofing material is coal-tar pitch. Embed felts in the second coating of bitumen and lap edges and ends not less than 25 mm one inch] [13 mm1/2 inch thick wood fiberboard or perlite board].

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-07 12 00 (February 2016)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 12 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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02/16

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****

USACE / NAVFAC / AFCEC UFGS-07 12 00 (February 2016)

Preparing Activity: NAVFAC Superseding
UFGS-07 12 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 12 00

BUILT-UP BITUMINOUS WATERPROOFING
02/16

****

NOTE: This guide specification covers the requirements for built-up bituminous membrane waterproofing.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: This specification is intended for use where local practice and experience indicates, or where International Code Council (ICC), International Building Code (IBC), section Dampproofing and Waterproofing allows, that protection against hydrostatic pressure or conditions of excessive dampness can be achieved by using membrane waterproofing. For other acceptable methods of waterproofing, refer to the appropriate unified facilities guide specification.

NOTE: Verify compliance of the project with ICC IBC section Dampproofing and Waterproofing, particularly article 1805.3 which says "Where the ground water investigation required by Section 1803.5.4 indicates that if a hydrostatic pressure condition exists, and

the design does not include a ground water control system as described in Section 1805.1.3, walls and floors must be waterproofed in accordance with this section". If the project is not compliant with this requirement, do not use this specification section; choose appropriate resilient membrane waterproofing system instead.

****

PART 1 GENERAL

1.1 REFERENCES

****

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****

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ASTM INTERNATIONAL (ASTM)

ASTM C208	(2022) Standard Specification for Cellulosic Fiber Insulating Board
ASTM C726	(2024) Standard Specification for Mineral Wool Roof Insulation Board
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D173/D173M	(2003; R 2011; E 2012) Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D449/D449M	(2003; R 2021) Standard Specification for

	Asphalt Used in Dampproofing and Waterproofing
ASTM D517	(1998; R 2008) Asphalt Plank
ASTM D1327/D1327M	(2004; R 2020) Standard Specification for Bitumen-Saturated Woven Burlap Fabrics Used in Roofing and Waterproofing
ASTM D1668/D1668M	(1997a; R 2014; E 2014) Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
ASTM D2178/D2178M	(2015a; R 2021) Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

****

NOTE: Prefabricated laminated asphalt membrane waterproofing and copper fabric shower pans may be included as a Contractor's option for shower pans.

****

Manufacturer's Standard Details, G, [_____]

Protection Board; G, [_____]

[Prefabricated Laminated Asphalt Waterproofing; G, [_____]

][Prefabricated Copper Fabric; G, [_____]

] Membrane Fabric; G, [_____]

Reinforcing Fabric; G, [_____]

SD-06 Test Reports

****

NOTE: Bulk liquid asphalt may be included as a Contractor's option when the project is constructed within 160 kilometers 100 miles of a bulk liquid asphalt manufacturer's plant.

****

Bulk Liquid Asphalt Certified Laboratory Reports; G, [_____]

****

NOTE: Certificates are required for verification of materials complying with UFC 1-200-02 High Performance and Sustainable Building Requirements; edit as necessary.

****

SD-07 Certificates

Membrane Fabric; G, [_____]

Reinforcing Fabric; G, [_____]

Protection Board; G, [_____]

[Prefabricated Laminated Asphalt Waterproofing; G, [_____]

][Prefabricated Copper Fabric; G, [_____]

] Certificates of Compliance; G, [_____]

SD-08 Manufacturer's Instructions

Installation Instructions

SD-11 Closeout Submittals

Asphalt Shipment Records

Certificates of Compliance; S

Volatile Organic Compounds (VOC) Contents; S

Recycled Content; S

1.3 MANUFACTURER'S DETAIL

Submit manufacturer's standard details indicating methods of attachment and spacing, transition and termination conditions, installation details.

1.4 ENVIRONMENTAL CONDITIONS

Apply the primers and waterproofing specified herein when the ambient temperature is above 4 degrees C 40 degrees F.

1.5 DELIVERY AND STORAGE

1.5.1 Materials Packaging

Deliver materials in bundles, rolls, and sealed containers in accordance with manufacturer's printed handling instructions and bearing manufacturer's original labels. Material labels indicate dates for use or shelf life; remove outdated material, damaged, and deteriorated material from the jobsite. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or biological growth.

1.5.2 Materials Storage

1.5.2.1 Asphalt

Protect asphalt from freezing. Store asphalt in a weathertight enclosure, free from contact with soil. Store and maintain at not less than 10 degrees C 50 degrees F for at least 24 hours before use.

1.5.2.2 Reinforcement Fabrics

Handle and store reinforcement fabrics in accordance with manufacturer's printed instructions. Protect fabrics from moisture damage and absorption in a weathertight enclosure or off the ground on pallets, and covered on top and all sides with breathable-type canvas tarpaulins. Plastic sheets cause condensation buildup therefore do not use them to cover waterproofing materials.

[1.5.3 Bulk Liquid Asphalt

****

NOTE: Bulk liquid asphalt may be included as a Contractor's option when the project is constructed within 160 kilometers 100 miles of a bulk liquid asphalt manufacturer's plant.

****

Deliver bulk liquid asphalt in fully insulated, heated transport tanker vehicles with circulating pump devices. Maintain the temperature of the liquid asphalt between 204 and 232 degrees C 400 and 450 degrees F during storage, provided the transport and storage time does not exceed 12 hours. If the transport and storage time exceeds 12 hours, lower the temperature to between 150 and 165 degrees C 300 and 325 degrees F at the time the 12 hours are exceeded. Use liquid asphalt within 36 hours after loading in the transport tanker. Provide bulk liquid asphalt certified laboratory reports for results of tests performed on asphalt delivered to the construction site by bulk liquid asphalt tankers.

1.5.3.1 Asphalt Shipment Records

Obtain from the bulk liquid asphalt manufacturer a certified shipping statement for each asphalt shipment. Following completion of the waterproofing installation, submit certificates to the Contracting Officer for verification and recordkeeping. Indicate the following:

a. Manufacturer's name

b. Specification identification of asphalt

c. Quantity of asphalt

d. Documentation of transport tanker having been empty and free of foreign and incompatible materials at the time of loading

e. Date, time, and temperature of asphalt at time of loading

]1.6 Flame Heated Equipment

1.6.1 Fire Protection

Locate melt kettles no closer than 8 meters 25 feet from buildings or combustible materials. Provide and maintain two approved 4-A:40-B:C fire extinguishers within 8 meters 25 feet of each operating kettle. Fire extinguishers, operations and locations must comply with NFPA 1 Section Tar Kettles. Equip asphalt (tar) kettles with tight fitting lids.

1.6.2 Operational Requirements

Equip kettles with automatic thermostatic control capable of maintaining asphalt temperature. Calibrate and maintain controls in working order for the duration of the work. Equip kettles with means of agitation and ensure they are operating as necessary to produce a controlled uniform temperature throughout kettle contents to prevent spot heating. Do not heat contents above flash point. Do not place flame heated equipment on the roof.

1.6.3 Drippage of Bitumen

Seal joints in and at edges as necessary to prevent drippage of asphalt into the building or onto adjacent surfaces.

PART 2 PRODUCTS

****

NOTE: Specify sustainable materials in accordance with UFC 1-200-02 High Performance and Sustainable

Building Requirements. Reduce the environmental impact of materials by specifying products that have a lesser or reduced effect on human health and the environment such as low emitting materials and materials with high recycled content. Consider product life cycle and travel distance when compared with competing products or services serving the same purpose.

****

2.1 PRODUCT SUSTAINABILITY CRITERIA

Where allowed by performance criteria:

2.1.1 Reduce Volatile Organic Compounds (VOC) Contents

Provide products with reduced VOC content and provide certificates of compliance in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph REDUCE VOLATILE ORGANIC COMPOUNDS.

2.1.2 Recycled Content

Provide products with recycled content and provide certificates of compliance in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph RECYCLED CONTENT.

2.2 BITUMEN

****

NOTE: Type I is suitable for use below grade under uniformly moderate temperature conditions (foundations, tunnels, and subways); Type II is suitable for use above grade where not exposed to temperatures exceeding 50 degrees C 122 degrees F (railroad bridges, culverts, retaining walls, tanks, dams, conduits, and spray decks); Type III is suitable for use above grade on vertical surfaces exposed to direct sunlight or temperatures above 50 degrees C 122 degrees F.

****

Asphalt; ASTM D449/D449M, Type [I] [II] [III].

2.3 BITUMINOUS PLASTIC CEMENT

****

NOTE: Type I is made from asphalts characterized as self-healing adhesive and ductile and should be used where Types I and II asphalt (STM D449/D449M) are used. Type II cement has a high softening point and has relatively low ductility and should be used where Type III asphalt (ASTM D449/D449M) is used.

****

ASTM D4586/D4586M, Type [I] [II] for asphalt.

2.4 MEMBRANE FABRIC

****

NOTE: One of the following reinforcement fabrics may be selected by Designer or all fabrics may remain in section as Contractor options.
****

The following requirements apply:

Felt or Fabric Material	Saturant or Impregnant	Specification
Glass (felt) mat	Asphalt	ASTM D2178/D2178M, Type III
Cellulose fiber mat-based (organic) felt	Asphalt	ASTM D226/D226M
Reinforcing glass fabric	Asphalt	ASTM D1668/D1668M REV A, Type I
Reinforcing cotton fabric	Asphalt	ASTM D173/D173M
Reinforcing woven burlap fabric	Asphalt	ASTM D1327/D1327M

2.4.1 Cotton Fabrics

Provide cotton fabrics woven entirely of cotton in accordance with ASTM D173/D173M and thoroughly and uniformly saturated with asphalt.

2.4.2 Woven Burlap Fabrics

Provide woven burlap fabrics in accordance with ASTM D1327/D1327M composed of 100 percent jute fiber and two cotton threads at each selvage, and thoroughly and uniformly saturated with asphalt. Fabric cannot be completely closed or sealed by the process of saturation and is to have sufficient porosity to allow successive moppings of plying asphalt to seep through. Fabric surface cannot be coated or covered with talc or any other substance that interferes with the adhesion between fabric and plying asphalt. Provide fabric surface uniformly smooth and free of irregularities, folds, knots, ragged or untrue edges, breaks, cracks, and other visible defects.

2.5 NAILS

Provide galvanized roofing nails or nails in accordance with fabric and protection board manufacturer's written recommendations. If fabric contains metal, provide nails as necessary to avoid electrolytic action due to proximity of dissimilar metals.

2.6 PRIMER

ASTM D41/D41M for asphalt.

2.7 PROTECTION BOARD

ASTM D517, plain, asphalt plank; ASTM C208, construction grade building board, 12.7 mm 1/2 inch thick, asphalt saturated or coated; ASTM C726, 11 mm 7/16 inch thick, covered on one side with waterproof paper or asphalt-saturated felt.

[2.8 PREFABRICATED LAMINATED ASPHALT WATERPROOFING

****
NOTE: Prefabricated laminated asphalt membrane waterproofing and copper fabric shower pans may be included as a Contractor's option for shower pans.
****

Provide prefabricated laminated construction consisting of plies of kraft paper bonded by layers of bitumen reinforced with layers of fibrous glass and one layer of polyethylene facing. MProvide material and weight as follows:

a. One layer polyethylene facing, 13.6 kgs 30 lbs. ream weight; seven intermediate layers of bituminous-saturated kraft paper.

b. Seven layers of bitumen.

c. Three layers of 8.8 per 10 mm 20.20 fibrous glass mesh.

d. Bottom "cushion" sheet of crepe kraft paper.

e. Total minimum weight of materials of 1.95 kgs per square meter 0.40 lbs. per square foot.

f. Minimum bituminous content of 75 percent by weight.

g. Permanently pliable and impervious to mildew and other organic attack, including termites and rodents.

[h. Puncture resistant and self sealing.

]][2.9 PREFABRICATED COPPER FABRIC SHOWER PANS

****
NOTE: Prefabricated laminated asphalt membrane waterproofing and copper fabric shower pans may be included as a Contractor's option for shower pans.
****

A factory fabricated sheet of copper bonded to and between two layers of asphalt impregnated fiberglass or cotton fabric. Copper sheet to weigh [.92] [1.52] [2.14] kilograms per square meter [3] [5] [7] ounces per square foot.

]2.10 WOOD NAILERS

****
NOTE: Where treated wood is specified in areas to be waterproofed, waterproofing should not be applied in contact with wood treatment preservatives which may leach through and destroy the effectiveness of the asphalt.
****

Specified in Section 06 10 00 ROUGH CARPENTRY.

PART 3 EXECUTION

3.1 INSPECTION OF SURFACES

Before starting the work, inspect all surfaces that must be waterproofed to determine if in satisfactory condition. Check the location and setting of all embedded items. Place backing and blocking and perimeter framing for recessed items as required by the various trades on the project. Complete conduit, piping, and other required rough-in. Notify the Contracting Officer of serious defects or conditions that prevent satisfactory application. Start application after such defects and conditions have been corrected.

3.2 PREPARATION OF SURFACES

****

NOTE: Concrete surfaces to which membrane waterproofing is to be applied should be moist cured. Waterproofing should not be applied to surfaces which have been cured with membrane-forming compounds or other coatings which may reduce the bonding of the waterproofing to the concrete. Masonry over which waterproofing is to be applied should be specified to have flush mortar joints.

****

Ensure surfaces to receive treatment are clean and dry, smooth and free from deleterious and excess materials and projections. [Ensure masonry surfaces are free of oil, grease, dirt, laitance, loose and broken material, frost, debris and other contaminants.] [Ensure concrete surfaces are properly cured, free of release agents, oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Thoroughly wet holes, joints, cracks, and voids in concrete with water, then fill with Portland cement mortar, strike flush, and permit to dry.] Cut off or grind high spots smooth. [Ensure mortar joints in masonry walls are flush and free of extraneous mortar.] [Ensure metal surfaces are dry and free of rust, scale, loose paint, oil, grease, dirt, frost and debris.] Coat surfaces to receive asphalt membrane waterproofing with a priming coat of asphalt primer. Apply priming coat at a rate of not less than 4 liters per 10 square meters one gallon per 100 square feet, covering the entire waterproofedsurface. Allow primer to dry per manufacturer's printed instructions before applying waterproofing.

3.3 APPLICATION

3.3.1 Building Envelope Requirements

Provide a continuous waterproofing system at all material and building transitions. Lap, wrap, fasten and seal products in accordance with manufacturer's printed instructions. Locate waterproofing components within envelope assemblies in locations indicated on the Drawings. Envelope assembly variations are not permitted without written approval from the Contracting Officer's Representative.

****

NOTE: Prefabricated laminated asphalt membrane waterproofing and copper fabric shower pans may be included as a Contractor's option for shower pans.

****

3.3.2 General Installation Requirements

Provide waterproofing where indicated. [At the Contractor's option, shower pans of [prefabricated laminated asphalt waterproofing] [or] [prefabricated copper fabric shower pan], as specified herein, may be used instead of bituminous membrane waterproofing.] [Provide ventilation for enclosed spaces when using bituminous membrane waterproofing.]

3.3.3 Prefabricated Pan

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NOTE: Prefabricated laminated asphalt membrane waterproofing and copper fabric shower pans may be included as a Contractor's option for shower pans.

****

Provide [prefabricated laminated asphalt waterproofing] [or] [prefabricated copper fabric shower pan]. Form each shower pan from a single piece of the laminated material without joints and with no opening except for shower drain. Provide pan in accordance with manufacturer's printed instructions.

3.3.4 Protection of Surrounding Areas

Before starting waterproofing work, protect surrounding areas and surfaces from spillage and migration of asphalt onto other work. Provide non-combustible protective coverings at surfaces adjacent to hoists and kettles. Lap protective coverings at least 150 mm 6 inches, secure against wind, and vent to prevent collection of moisture on covered surfaces. Keep protective coverings in place for the duration of asphalt work.[Protect drains and conductors from clogging with asphalt.]

3.3.5 Heating and Application of Bitumen Coatings

****

NOTE: Bulk liquid asphalt may be included as a Contractor's option when the project is constructed within 160 kilometers 100 miles of a bulk liquid asphalt manufacturer's plant.

****

Heat solid bitumen in kettle equipped with an automatic heating device or control unit for positive control of the specified temperature. Provide an accurate and clearly readable thermometer on all kettles. [Bulk liquid asphalt may be heated using the heating equipment in the transport tanker vehicle or transferred to kettles and heated as specified for solid bitumen.] Heat bitumen to flow freely but not above 190 degrees C 375 degrees F. Apply bitumen over the primer, between each ply and as a top coating at the rate of not less than 10 kilograms 20 pounds of asphalt per 10 square meters 100 square feet of surface.

[3.3.6 Membrane Waterproofing

****

NOTE: Where waterproofing must be applied to concrete or masonry walls where settlement is likely to occur, use fabric type instead of felt type. Where rough masonry walls must be waterproofed, unless such walls can be made reasonably smooth with

parging of cement mortar, only fabric type should be specified. To determine number of plies of membrane for vertical application and number of moppings required for different water pressures:

NOTE: Do not install this system in waterlogged soils. Add requirements for drying/dewatering and written verification of dryness (moisture testing) prior to installation; coordinate with Division 31 dewatering requirements.

Head of Water (in millimeters) (in feet)	**Plies of Membrane**	**Moppings**
300-1050 1-3	**2**	**3**
1051-3200 4-10	**3**	**4**
3201-7000 11-25	**4**	**5**
7001-15000 20-50	**5**	**6**

****

3.3.6.1 Below Grade Wall Waterproofing

Provide [1-ply] [2-ply] [3-ply] [4-ply] [5-ply] hot-applied asphalt membrane system for foundation walls. Install fabrics in accordance with manufacturer's printed installation instructions. Caulk joints before applying primer. Apply primer at a rate of 0.2 liters per square meter 1/2 gallon per 100 square feet. Overlap fabrics at ends and stagger a minimum of[250 mm10 inch for 1-ply] [480 mm19 inch for 2-ply] [610 mm24 inch for 3-ply] [685 mm27 inch for 4-ply] [750 mm30 inch for 5-ply] system. End-to-end taping is not acceptable. Firmly embed each fabric in a solid uniform coating of hot asphalt at a rate of [0.98 kg per square meter] [20 lbs. per 100 square feet] [_____] kg per square meter [_____] lbs. per 100 square feet. Allow asphalt to penetrate each fabric and to provide required adhesion. Avoid excessive applications of asphalt between fabrics in order to prevent slippage. Provide waterproofing system consisting of two or more fabrics with fabric reinforcement at corners, angles, over construction joints, and in locations where subject to increased stress.

[3.3.6.2 Floor Waterproofing

Apply primer at a rate of 0.2 liters per square meter 1/2 gallon per 100 square feet. Do not allow primer to puddle. Confirm primer is dry to the touch before application of asphalt. Where slab abuts walls, extend first reinforcing fabric a minimum of 150 mm 6 inches on slabs and 200 mm 8 inches on walls. At vertical corners, extend first fabric a minimum of 125 mm 5 inches from corners on each side. Lap second fabric with the first fabric a minimum of 50 mm 2 inches. At floor drains, and elsewhere as indicated, extend fabric into a clamping device, set in a heavy coating of flashing cement, and securely clamp.

]]3.3.7 Fabric Membrane Reinforcement

Provide fabric membranes to reinforce felts at intersections. Provide reinforcement consisting of two plies of fabric membrane cemented in place and to each other with bituminous plastic cement not less than 2 mm 1/16 inch thick for each coating. At the intersection of slabs and vertical surfaces, extend the first ply at least 150 mm 6 inches on the slab and 100 mm 4 inches up the vertical surface. At intersections of two vertical surfaces, extend the first ply at least 250 mm 10 inches on each side of the intersection. Place second ply to lap the first by not less than 50 mm 2 inches.

3.3.8 Keyed Joint Footings

Provide membrane flashing, neatly formed, to the contours of keyed joints in foundation wall footings. Extend flashing to the outside edge of the footing, and turn the flashing down 100 mm 4 inches. Continue the flashing through the joint to the inside of the walls and lap the flashing into the waterproofing membrane under the slab. Protect the flashing until it is lapped by the waterproofing membranes for the subsurface floor slabs and foundation walls. Provide flashing membrane made up of the same number and type materials as the waterproofing membrane or a thermoplastic material compatible with the waterproofing materials, as recommended by the manufacturer in writing.

3.3.9 Flashing Flanges

Prime flashing flanges of pipe sleeves and ducts penetrating the waterproofing membrane. Allow primer to dry. Provide flanges with two fabric membrane collars cemented in place and to each other with bituminous plastic cement. Extend collars 100 and 150 mm 4 and 6 inches, respectively, beyond the edge of the flanges, cover the flanges, and fit the flanges tight against the sleeve. Extend waterproofing connected to work exposed to weather to the back of the adjoining work, or counter flash to form a watertight connection.

3.3.10 Clamping Devices

At floor drains and elsewhere, as indicated, extend membrane into clamping device set in heavy coating of bituminous plastic cement, and clamp securely.

3.3.11 Reglets

Install continuous reglets [as specified in Section [07 60 00 FLASHING AND SHEET METAL] [_____]] to receive the exposed edges of membrane waterproofing. After placement of waterproofing, completely fill reglets with bitumen.

****

NOTE: Coordinate and specify field test protocol in accordance with UFC 3-110-03 Roofing. Electric field vector mapping (EFVM) is recommended for roofing systems covered by other materials that make them inaccessible for subsequent roof inspections. Systems that would benefit from EFVM are assemblies such as vegetative, paver, and ballasted roofs. EFVM is not required on all roofing projects and due

to cost, may increase roof total ownership cost. Evaluate costs versus benefits for the project and specify files test protocol accordingly.
****

3.4 FIELD TEST

3.4.1 Sampling and Testing of Bulk Liquid Asphalt

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NOTE: Bulk liquid asphalt may be included as a Contractor's option when the project is constructed within 160 kilometers 100 milesof a bulk liquid asphalt manufacturer's plant.
****

Notify the Contracting Officer 5 working days prior to the delivery date of asphalt. Take a minimum of one quart sample of each shipment of bulk liquid asphalt when the shipment arrives at the construction site. Obtain samples in the presence of the Contracting Officer using clean one quart, friction lid cans. Label samples to indicate project contract number, location where used on project, and date and time of arrival of shipment from which sample is taken. Give samples to the Contracting Officer for safekeeping until picked up by the testing laboratory. Pay for the testing of the bulk liquid asphalt by an independent testing company. Samples tested that are found not in compliance with specified requirements will be rejected. Remove and replace with new materials all waterproofing components installed with asphalt from which the noncompliant samples were taken, at no cost to the Government.

3.4.2 Test of Membrane Waterproofing

Prior to concealment, plug the drain and cover membrane waterproofing on horizontal surfaces over finished spaces with [75] [100] mm [3] [4] inches of ponded water for 24 hours to test watertightness. Make careful measurement of the water level at the beginning and end of the 24-hour period. If water level falls, drain the water, and thoroughly dry and inspect the waterproofing membrane. Make repairs or replacement, as directed, and repeat test. Do not proceed with work that conceals membrane waterproofing before approval of test results.

3.5 PROTECTIVE COVERING

3.5.1 Vertical Surfaces

Protect membrane waterproofing against which backfill must be placed by providing protective covering pressed into the final mopping while the mopping of bitumen is still hot. Butt edges of protection board against adjacent edges of protection boards. Cover exposed surfaces with a coating of bitumen. Where surfaced fiberboard or mineral fiberboard is used, place surface side facing outward. Fit board around pipes and projections so as to cover the entire surface of the membrane waterproofing.

3.5.2 Horizontal Surfaces

Place protective covering over membrane immediately after application has thoroughly dried. Remove protective covering immediately before proceeding with work that will conceal the membrane waterproofing.

3.6 CLEAN UP

Use a cleaner recommended by the waterproofing manufacturer to clean other work surfaces that are stained with waterproofing material.

3.7 SCHEDULE OF MATERIALS

Some metric measurements in this section are based on mathematical conversion of inch-pound measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
Protection Board	1/2 inch	12.7 mm
	7/16 inch	11 mm
Polyethylene Sheet	30 lbs.	13.6 kg
Laminated Sheet	0.40 lbs. per sq. ft	1.95 kg per sq. m
Copper Sheet	3 oz/sq ft	0.92 kg/sq m
	5 oz/sq ft	1.52 kg/sq m
	7 oz/sq ft	2.14 kg/sq m

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 13 53 (February 2016)**
Change 1 - 08/17

Preparing Activity: NAVFAC **Superseding**
UFGS-07 13 53 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC | **UFGS-07 13 53 (February 2016)**
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SECTION 07 13 53

ELASTOMERIC SHEET WATERPROOFING
02/16, CHG 1: 08/17

****

NOTE: This guide specification covers the requirements for sheet applied elastomeric waterproofing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: This guide specification is intended for use where local practice and experience indicates, or where International Code Council (ICC), International Building Code (IBC), section Dampproofing and Waterproofing allows, that protection against hydrostatic pressure or conditions of excessive dampness can be achieved by using elastomeric waterproofing. Typical applications include, but are not limited to, wall and foundation waterproofing, waterproofing promenades and parking decks, waterproofing beneath shower pans, kitchens, toilet facilities, janitorial rooms, and indoor swimming pools.

NOTE: Where groundwater investigation required by IBC Section 1803.5.4 indicates that if a hydrostatic

pressure condition exists, and the design does not include a groundwater control system as described in Section 1805.1.3, waterproof walls and floors in accordance with this section.

NOTE: Where concrete vault magazines are designed below ground, provide butyl rubber, or elastomeric composite, thermoplastic waterproof sheeting.

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NOTE: On the drawings, show:

1. Extent of membrane waterproofing, substrates, termination details,termination details, flashing, and counterflashing, pipe and conduit penetrations, and junctions at walls and floors.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1305	(2008) Standard Test Method for Crack Bridging Ability of Liquid-Applied Waterproofing Membrane
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing

ASTM D146/D146M	(2004; E 2012; R 2012) Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D297	(2015; R 2019) Rubber Products - Chemical Analysis
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D429	(2014) Rubber Property-Adhesion to Rigid Substrates
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D573	(2004; R 2019) Standard Test Method for Rubber - Deterioration in an Air Oven
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM D903	(1998; R 2017) Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
ASTM D1004	(2013) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1149	(2018) Standard Test Method for Rubber Deterioration - Cracking in an Ozone Controlled Environment
ASTM D1204	(2014; R 2020) Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D1876	(2008; R 2015; E 2015) Standard Test Method for Peel Resistance of Adhesives (T-Peel Test)
ASTM D2136	(2002; R 2012) Coated Fabrics - Low-Temperature Bend Test

ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D3045	(1992; R 2010) Practice for Heat Aging of Plastics Without Load
ASTM D5385/D5385M	(1993; R 2014; E 2014) Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E154/E154M	(2008a; R 2019) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's Standard Details; G, [_____]

Elastomeric Waterproofing Sheet Material; G, [_____]

Protection Board; G, [_____]

Primers, Adhesives, and Mastics; G, [_____]

SD-06 Test Reports

Elastomeric Waterproofing Sheet Material; G, [_____]

Field Quality Control documentation; G, [_____]

Protective Covering; G, [_____]

****

NOTE: Certificates are required for verification of materials complying with UFC 1-200-02 HIGH PERFORMANCE AND SUSTAINABLE BUILDING REQUIREMENTS; edit as necessary.

****

SD-07 Certificates

Elastomeric Waterproofing Sheet Material; G, [_____]

Primers, Adhesives, and Mastics; G, [_____]

[Protective Coverings; G, [_____]

] Draft Special Warranties; G, [_____]

Final Special Warranties; G, [_____]

Certificates Of Compliance; G, [_____]

SD-08 Manufacturer's Instructions

Primers, Adhesives, and Mastics; G, [_____]

SD-11 Closeout Submittals

Certificates Of Compliance with sustainable requirements for items listed in SD-07; G, [_____]

1.3 MANUFACTURER'S DETAILS

Submit manufacturer's standard details indicating methods of attachment and spacing, transition and termination details, and installation details. Include verification of existing conditions.

1.4 PRODUCT DATA

Include data for material descriptions, recommendations for product shelf life, requirements for protective coverings, and manufacturer's Safety Data Sheets (SDS) for primers, adhesives, and mastics.

****

NOTE: Choose bracketed option if this project is required to comply with ICC IBC Section 1805 Dampproofing and Waterproofing.

****

[1.5 CODE REQUIREMENTS

Provide membrane waterproofing system in accordance with ICC IBC Section 1805 Dampproofing and Waterproofing.

]1.6 DELIVERY, STORAGE, HANDLING, IDENTIFICATION

Deliver and store materials in accordance with manufacturer's printed instructions, out of the weather, in manufacturer's original packaging with brand name and product identification clearly marked. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or biological growth. Do not permit unidentified materials in the work area or in the project.

1.7 ENVIRONMENTAL CONDITIONS

****

NOTE: When waterproofing will be installed indoors protected from the weather, delete the bracketed requirements for outdoor environmental conditions. Also, in geographical areas where the specifier determines it is routine to utilize artificial means of maintaining the surface and ambient temperatures above 4 degrees C 40 degrees F, include the conditions for waiver in the project specifications.

****

Do not apply waterproofing during inclement weather or when there is ice, frost, surface moisture, or visible dampness on the surface to receive waterproofing for when ambient and surface temperatures are 4 degrees C 40 degrees F or below. [The restriction on the application of waterproofing materials when ambient and surface temperatures are below 4 degrees C 40 degrees F will be waived if the Contractor devises a means, approved by the Contracting Officer in writing, of maintaining the surface and ambient temperatures above 4 degrees C 40 degrees F.]

1.8 SPECIAL WARRANTIES

1.8.1 Guarantee

Guarantee waterproofing membrane installation against failure due to leaks for a period of two years from the date of Beneficial Occupancy. Submit draft and final guarantees in accordance with Sections 01 78 00 CLOSEOUT

SUBMITTALS [and 01 78 23 OPERATION AND MAINTENANCE DATA].

1.8.2 Warranty

Provide manufacturer's material warranty for all system components for a period of ten years from the date of Beneficial Occupancy. Submit draft and final warranties in accordance with Sections 01 78 00 CLOSEOUT SUBMITTALS [and 01 78 23 OPERATION AND MAINTENANCE DATA].

PART 2 PRODUCTS

2.1 SUSTAINABILITY CRITERIA

Where allowed by performance criteria:

2.1.1 Reduced Volatile Organic Compound (VOC) Content

Provide products with reduced VOC content and provide certificates of compliance in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph REDUCE VOLATILE ORGANIC COMPOUNDS.

2.1.2 Recycled Content

Provide products with recycled content and provide certificates of compliance in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph RECYCLED CONTENT.

2.2 MATERIALS

Provide one of the types of elastomeric waterproofing sheet material and related primers, adhesives, and mastics as specified herein. Ensure compatibility of waterproofing materials with each other, and with materials on which they are applied. Provide materials that comply with applicable requirements cited below when tested in accordance with the referenced ASTM publications.

****

NOTE: Where concrete vault magazines are designed below ground, specify membrane sheeting. Do not apply primer or mastic until concrete has cured not less than 7 days, or as required by the manufacturer, remove all moisture, form oil and non-fungi curing agents.

NOTE: Specify a higher puncture resistance if waterproofing will be subject to abuse. Commercial membranes are available which exceed 890 N 200 pounds in puncture resistance.

****

2.3 BUTYL RUBBER SHEETING

Not less than 1.5 mm 60 mils minimum thickness.

2.3.1 Butyl Rubber Sheeting Performance Requirements

a. Thickness Tolerance, ASTM D412: Plus or minus 10 percent.

b. Specific Gravity, ASTM D297: 1.20, plus or minus 0.05.

c. Tensile Strength, ASTM D412: 7.7 MPa 1200 psi minimum.

d. Tensile Stress at 300 percent elongation, ASTM D412: 3.85 MPa 600 psi minimum.

e. Elongation, ASTM D412: 300 percent minimum.

f. Tear Resistance, Die C, ASTM D624: 26.3 Newtons per millimeter (N/mm) 150 pound force per inch (lbf/inch) minimum.

g. Shore A Hardness, ASTM D2240: 5-second interval before reading; 60 plus or minus 10.

h. Ozone Resistance, ASTM D1149: No cracks, 7 days - 50 pphm - 37.8 degrees C 100 degrees F, 20 percent elongation.

i. Heating Aging-Accelerated, ASTM D573: Tensile retention, 60 percent of minimum original elongation retention; 60 percent of minimum original requirement; 7 days, 115.6 degrees C 240 degrees F.

j. Butyl Identification, ASTM D471 REV A, Tricresyl Phosphate Immersion: Maximum volume swell 10 percent, 70 hrs, 100 degrees C 212 degrees F.

k. Low Temperature Flexibility, ASTM D746: No failure at minus 40 degrees C minus 40 degrees F.

l. Water Absorption, ASTM D471 REV A: Plus 1 percent maximum. 7 days,70 degrees C 158 degrees F.

m. Exposure to Fungi and Bacteria in Soil, ASTM E154/E154M REV A, Minimum 16 Weeks: Unaffected.

n. Water Vapor Transmission, 26.7 degrees C 80 degrees F Permeance, ASTM E96/E96M, Procedure B or BW: 8.58 by 10-7 g/Pa.s.m2 0.15 perms maximum.

2.3.2 Adhesive, Cement, and Tape for Use with Butyl Rubber

As recommended by the butyl rubber waterproofing membrane manufacturer.

2.4 THERMOPLASTIC MEMBRANE: POLYVINYL CHLORIDE (PVC)

Polyvinyl chloride (PVC) flexible sheets with non-woven fiberglass reinforcing not less than 1.5 mm 60 mils minimum thickness.

2.4.1 Thermoplastic Membrane Performance Requirements

a. Overall thickness, ASTM D751: 1.50 mm .059 inches minimum

b. Tensile strength, ASTM D638: 11.03 MPa 1600 psi minimum

c. Elongation at break, ASTM D638: 250 percent minimum

d. Seam strength, ASTM D638: 90 percent minimum of tensile strength

e. Retention of properties after heat aging, ASTM D3045

f. Tensile strength, ASTM D638: 95 percent of original

g. Elongation, ASTM D638: 95 percent of original

h. Tear resistance, ASTM D1004: 7.7 Kilogram Force 17 lbf

i. Low Temperature Bend, ASTM D2136: minus 40 degrees C minus 40 degrees F

j. Liner Dimensional Change, ASTM D1204: 0.002 percent

k. Weight Change After Immersion in Water, ASTM D570: 2.0 percent maximum

2.4.2 Adhesives

a. Adhesive for thermoplastic flashings as recommended by manufacturer.

b. Adhesive for Sub-Membrane Grid: 100 percent solids, two part urethane, with minimum tensile strength of 1.04 MPa 150 psi, in accordance with ASTM D412 and adhesion to concrete of 12 ply in accordance with ASTM D429 as recommended by manufacturer.

****

NOTE: Where recommended by the manufacturer for below ground membrane sheeting, provide securement strip at perimeter and at any penetrations(s) as well as any elevation changes.

****

2.4.3 Accessories

Securement Strip: 14 gauge stainless steel metal bar 2.54 cm 1 inch wide, pre-punched 2.54 cm 1 inch on center for securement.

2.5 COMPOSITE, SELF-ADHERING MEMBRANE SHEETING

Cold applied composite sheet consisting of rubberized asphalt and cross laminated, high density polyethylene film. Not less than 1.5 mm 60 mils minimum thickness is required.

2.5.1 Composite, Self-Adhering Sheeting Performance Requirements

a. Tensile Strength ASTM D412, Die C: 1.6 MPa 250 psi minimum.

b. Ultimate Elongation, ASTM D412, Die C: 200 percent minimum.

c. Water Vapor Transmission, ASTM E96/E96M 26.7 degrees C 80 degrees F Permeance, Procedure B: 5.72 by 10-7 g/Pa.s.m2 0.1 perm maximum.

d. Pliability degrees, ASTM D146/D146M: (180 degrees Bend Over 25 mm 1 Inch Mandrel): No cracks at minus 32 degrees C minus 25 degrees F.

e. Provide test report data for crack bridging ability: Either in accordance with ASTM C1305 as modified for a dry film thickness specified by the manufacturer and conducted at low temperature; or in accordance with a cycling over crack test also conducted for the specified dry film thickness at low temperature. Using either test, verify crack bridging up to 6 mm 1/4 inch without damage to the membrane system.

f. Puncture Resistance, ASTM E154/E154M REV A: 18 kg 40 lb minimum.

g. Lap Adhesion at Minimum Application Temperature, ASTM D1876 Modified, 880 N/m 5 lbs/in..

h. Peel Strength, ASTM D903: Modified 1576 N/m 9 lbs/in.

i. Resistance to Hydrostatic Head, ASTM D5385/D5385M: 70 m 231 ft of water.

j. Water Absorption, ASTM D570; 0.1 percent maximum.

2.5.2 Primers

Asphalt composition, ASTM D41/D41M, or synthetic polymer in solvent as recommended by the membrane manufacturer.

2.5.3 Mastics

Polymer modified asphalt in suitable solvent of trowel grade consistency and as recommended by the membrane manufacturer.

2.6 Protection Board

****

NOTE: Always require protection material separating waterproofing from fill material. Delete protection board option and require the polymeric grid option for earth covered magazines or facilities with routine ground water exposure.

NOTE: Fiberboard will not provide protection after it becomes wet. Do not use bituminous-impregnated protection board when in contact with polyvinyl chloride (PVC), which may be in composite membranes. Polystyrene is not compatible with petroleum products. The membrane and protection board must be compatible.

****

[Provide protection board that is compatible with the waterproofing membrane. Use a minimum 13 mm 1/2 inch thick fir bitumen impregnated board 25 mm 1 inch for polystyrene 3 mm 1/8 inch thick for vertical and 6 mm 1/4 inch for horizontal premolded bituminous protection board as recommended by the manufacturer.

][Three dimensional, high impact resistant polymeric grid with woven monofilament drainage fabric bonded to the grid.

]

PART 3 EXECUTION

****

NOTE: Do not install this system on top of waterlogged soils. Add requirements for drying/dewatering and written verification of dryness (moisture testing) prior to installation of sheet waterproofing; coordinate with Division 31 dewatering requirements.

****

3.1 VERIFICATION OF CONDITIONS

Before starting the work, verify surfaces that must be waterproofed are in satisfactory condition. Notify the Contracting Officer of defects or conditions anticipated to prevent a satisfactory application. Do not start application until defects and conditions have been corrected.

3.2 SURFACE PREPARATION

****

NOTE: Add a paragraph to Section 03 30 00 CAST-IN-PLACE CONCRETE requiring curing compound containing wax or oil to be removed prior to application of waterproofing.

****

Ensure surfaces to receive treatment are clean, dry, smooth, and free from deleterious materials and projections. [Thoroughly wet holes, joints, cracks, and voids in [masonry] [concrete] with water and fill with Portland cement mortar, strike flush, and permit to dry.] Cut off high spots or grind smooth. Finish top surfaces of projecting masonry or concrete ledges below grade, except footings, to a steep bevel with Portland cement mortar. Sweep surfaces to receive covering before applying waterproofing to remove dust and foreign matter. Cure concrete by a method compatible with the waterproofing system.

3.3 APPLICATION

****

NOTE: Delete requirements for cant strips if cant strips are not required.

****

3.3.1 Building Envelope Requirements

Provide a continuous waterproofing system at all material and building transitions. Lap, wrap, fasten and seal products in accordance with manufacturer's printed instructions. Envelope assembly variations are not permitted without written approval from the Contracting Officer's Representative.

3.3.2 General Installation Requirements

Provide sheet waterproofing in accordance with manufacturer's printed installation instructions. Ensure the surface to receive membrane is clean, smooth and dry without surface irregularities; correct deficiencies prior to installation. [Where indicated, mop continuous cant strips in place at vertical and horizontal corners before installing the waterproofing membrane. Do not use untreated wood or wood fiber cants.] When using solvent welding liquid, avoid prolonged contact with skin and breathing of vapor and provide adequate ventilation. Carry waterproofing of horizontal surfaces up abutting vertical surfaces and adhere solid to the substrate. Avoid wrinkles and buckles in applying membrane and joint reinforcement.

3.3.2.1 Non-Self-Adhering Membrane

Unroll membrane and allow to remain flat for at least one-half hour before application. Apply an asphalt concrete primer prior to application of asphaltic adhesive. Where solvent adhesive is applied, allow major portion of solvent to evaporate so that bonding adhesive does not stick to a dry finger touching it. Apply elastomeric waterproofing membrane in a full bed of adhesive at a uniform coverage rate in accordance with the membrane manufacturer's printed instructions. [Where membrane on horizontal surfaces are to receive concrete fill, apply adhesive in 100 mm 4 inch wide strips at 600 mm 2 feet on center.] Pull membrane tight without stretching. As soon as adhesive is fully set and dry, recheck lap splices. Where openings or fishmouths appear, reseal and reroll lap splices.

3.3.2.2 Self-Adhering Membrane

Apply composite, self-adhering membrane on surfaces primed at a uniform coverage rate in accordance with membrane manufacturer's printed instructions. Remove release sheet and apply with tacky surface in contact with dried primer.

3.3.2.3 Protection

Protect membrane over horizontal surfaces from traffic during installation. Use only equipment with rubber tires. Provide walkway protection where heavy traffic from other trades is expected. Do not store material on membrane.

3.3.3 Butyl Rubber

Lap sheets at sides and ends a minimum of 150 mm 6 inches over the preceding sheet. Apply lap splicing cement over entire 150 mm 6 inches splice area prior to application of sealant. Make sealant continuous along the entire length of the splice. Maintain a continuous bead of sealant at all membrane splices or as required by the manufacturer. Provide a tongue and groove cemented splice a minimum of 150 mm 6 inches wide with factory made heat vulcanized seam of not less than 50 mm 2 inches or as required by the manufacturer, when membrane is below water table.

3.3.4 Thermoplastic Membrane (PVC)

Consult with membrane manufacturer prior to grid application. Install 30.48 cm 12 inches wide sub-membrane containment grid as required by manufacturer. Provide the containment grid at intervals across the width and length of the substrate, at the base of all transitions, walls, curbs, penetrations, and at the perimeter of each deck/substrate section. Fully adhere strips to the deck in a full bedding of two-part urethane adhesive. Weld adjacent sheets in accordance with manufacturer's instructions. Hot-air weld all side and end lap joints. Provide lap area a minimum of 7.62 cm 3 inch wide when machine welding, and a minimum of 10.16 cm 4 inch wide when hand welding but not less than recommended by the manufacturer. Orient overlaps with the direction of flow of water.

3.4 COMPOSITE, SELF-ADHERING MEMBRANE

Lap sheets at edges and ends a minimum of 65 mm 2-1/2 inches over the preceding sheet. Provide all side laps a minimum 65 mm 2-1/2 inches and end laps 127 mm 5 inches. Provide self-adhesive, mastic laps in accordance with manufacturer's recommendation. Roll or firmly press to adhere membrane to substrate. Cover corners and joints with two layers of reinforcement by first applying a 300 mm 12 inch width of membrane centered along the axis. Flash drains and projections with a second ply of membrane for a distance of

150 mm 6 inches from the drain or projection. Finish exposed, terminated edges of membrane on horizontal or vertical surfaces with a toweled bead of mastic. Apply mastic around edges of membrane, and drains and projections. Apply mastic at end of each work day.

3.5 FLASHING

Flash penetrations through membrane. Seal all penetrations where reinforcing bars penetrate a waterproofing membrane with the appropriate sealant or mastic flashing component. Embed elastomeric membrane in a heavy coat of adhesive, except for self-adhering membrane. Position continuous metal reglets horizontally on footing and vertically on intersecting and connecting walls, and as specified in Section 07 60 00 FLASHING AND SHEET METAL. Metal reglets are to receive exposed edges of membrane waterproofing. Secure membrane into reglets by lead wedges and fill with cement as recommended in writing by manufacturer of waterproofing materials. Counterflash upper edge of membrane waterproofing and protective covering as specified in Section 07 60 00 FLASHING AND SHEET METAL.

****

NOTE: Coordinate and specify field test protocol in accordance with UFC 3-110-03 Roofing. Electric field vector mapping (EFVM) is recommended for roofing systems covered by other materials that make them inaccessible for subsequent roof inspections. Systems that would benefit from EFVM are assemblies such as vegetative, paver, and ballasted roofs. EFVM is not required on all roofing projects and due to cost, may increase roof total ownership cost. Evaluate costs versus benefits for the project and specify field test protocol accordingly.

****

3.6 FIELD QUALITY CONTROL

Notify the Contracting Officer 5 working days prior to date of performing tests. Before concealment, cover elastomeric waterproofing on horizontal surfaces over finished spaces with [75][100] mm [3][4] inches of ponded water for 24 hours. Do not add water after start of 24 hour period. Accurately measure water level at beginning and end of 24 hour period. If water level falls, remove water and inspect waterproofing membrane. Make repairs or replacement as directed, and repeat test. Do not proceed with work that conceals membrane waterproofing before receiving approval and acceptance of the Contracting Officer.

3.7 PROTECTIVE COVERING

After installation has been inspected and approved by the Contracting Officer, apply a protective covering to the membrane waterproofing prior to backfilling. Protect vertical membrane waterproofing with a 13 mm 1/2 inch minimum thickness of asphalt plank; 13 mm 1/2 inch minimum thickness of fiberboard; or 3 mm 1/8 inch minimum thickness of compatible water resistant bitumen type protection board with edges abutting adjacent edges and exposed surfaces covered by a taping system recommended by manufacturer of protection board. Cover horizontal membrane waterproofing with similar protection board and Portland cement mortar not less than 20 mm 3/4 inch thick; place uniformly and allow to set before installing subsequent construction.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 14 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 14 00 (February 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 07 14 00

FLUID-APPLIED WATERPROOFING

08/23

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 14 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
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****

SECTION 07 14 00

FLUID-APPLIED WATERPROOFING
08/23

****

NOTE: This guide specification covers the requirements for fluid-applied elastomeric waterproofing systems for horizontal applications where this membrane is protected by a separate wearing course.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: This guide specification should not be used to specify waterproofing of structures subject to hydrostatic pressure. Use Section 07 13 53 ELASTOMERIC SHEET WATERPROOFING to specify waterproofing structures subject to hydrostatic pressure. This waterproofing system includes the fluid-applied membrane, protection board, drainage layer, and insulation. It does not include structural deck, protection slab, or wearing course; these elements influence performance of the waterproofing system. See UFC 3-110-03, "Roofing" for design recommendations.

****

****

Technical Reference: ASTM C898, "Standard Guide for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with Separate Wearing Course." This document contains guidelines for design of the waterproofing system and may be used as a source of supplementary information.

1. Slope: Provide slope toward drains (after deflections due to applied load and creep) of not less than one percent 10 mm per meter 1/8 inch per foot. Slope should not exceed 20 mm per meter 1/4 inch per foot for structures subject to ASTM D5957 flood testing.

2. Wall Flashing: Extend wall flashing to at least 200 mm 8 inches above wearing surface for roof slopes exceeding 3:12 and to at least 150 mm 6 inches for slopes at or less than 3:12. Also, extend flashing minimum 300 mm 12 inches at roof hatch and skylight curbs. If top of flashing is recessed under a concrete wall, counterflashing is not necessary. Metal counterflashing is necessary at masonry wall intersections. Flash right-angle intersection of deck and wall with an elastomeric sheet.

****

****

NOTE: Sketches are available in association with this Section to assist in preparing project drawings. These sketches are available at the following location: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables. This section contains both metric and inch-pound graphics.

NUMBER	**TITLE**
1	**Basic Components of Cold Liquid-Applied Elastomeric Membrane Waterproofing System with Separate Wearing Course**
2	**Flashing at Cracks and Nonmoving Joints in the Concrete**
3	**Expansion Joint Flashing**
4	**Expansion Joint Flashing at Wall**
5	**Wall Flashing on Concrete Wall**
6	**Terminal Condition with Masonry Above Finish Wearing Surface at Grade**
7	**Wall - Deck Flashing**
8	**Penetration Flashing**

NUMBER	**TITLE**
9	**Drain Flashing**

DO NOT INCLUDE THE SKETCHES OR LIST OF SKETCHES IN THE PROJECT SPECIFICATIONS. USE SKETCHES FOR PREPARING DETAILS ON THE DRAWINGS.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C836/C836M	(2018; R 2022) Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use With Separate Wearing Course
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural

	Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D5957	(1998; R 2021) Standard Guide for Flood Testing Horizontal Waterproofing Installations
ASTM D7877	(2014) Standard Guide for Electronic Methods for Detecting and Locating Leads in Waterproof Membranes

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fluid-Applied Membrane

Membrane Primer

Elastomeric Sheet

Flexible Foam-Backed Elastomeric Sheet

Solvent

Moisture Meter

Protection Board

Bond Breaker

SD-06 Test Reports

Flood Testing; G, [_____]

Electronic Leak Testing; G, [_____]

SD-11 Closeout Submittals

Warranty

Information Card

Maintenance and Repair Training

Include copies of Safety Data Sheets for maintenance/repair materials.

1.3 PREWATERPROOFING CONFERENCE

****

NOTE: Include the requirement for a prewaterproofing conference when the waterproofing system will be used on large areas, e.g., promenade decks over occupied space, and will require work by other trades, e.g., mechanical subcontractors, electrical subcontractor, or tile setters on the membrane.

****

Prior to starting application of waterproofing system, arrange and attend a prewaterproofing conference to ensure a clear understanding of drawings and specifications. Give the Contracting Officer 7 days advance written notice of the time and place of meeting. Ensure that the mechanical and electrical subcontractor, flashing and sheetmetal subcontractor, and other trades that may perform other types of work on or over the membrane after installation, attend this conference.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver waterproofing materials in manufacturer's original, unopened containers, with labels intact and legible. Containers of materials covered by a referenced specification number must bear the specification number, type, and class of the contents. Deliver materials in sufficient quantity to continue work without interruption. Store and protect materials in accordance with manufacturer's instructions, and use within their indicated shelf life. When hazardous materials are involved, adhere to special precautions of the manufacturer, unless precautions conflict with local, state, and federal regulations. Promptly remove from the site materials or incomplete work adversely affected by exposure to moisture or freezing. Store materials on pallets and cover from top to bottom with canvas tarpaulins.

1.5 ENVIRONMENTAL CONDITIONS

Apply materials when ambient temperature is 4 degrees C 40 degrees F or above for a period of 24 hours prior to the application and when there is no ice, frost, surface moisture, or visible dampness on the substrate surface. Apply materials when air temperature is expected to remain above 4 degrees C 40 degrees F during the cure period recommended by the manufacturer. Moisture test for substrate is specified under paragraph MOISTURE TEST. Work may be performed within heated enclosures, provided the surface temperature of the substrate is maintained at a minimum of 4 degrees C 40 degrees F for 24 hours prior to the application of the waterproofing, and remains above that temperature during the cure period recommended by the manufacturer.

1.6 WARRANTY

Provide system material and workmanship warranties meeting specified requirements. Provide revisions or amendment to standard membrane manufacturer warranty to comply with the specified requirements. Provide a manufacturer's warranty that has no dollar limit, covers full system water-tightness, and has a minimum duration of 20 years.

1.6.1 Membrane Manufacturer Warranty

****

NOTE: Insulated and routinely occupied facilities or facilities containing sensitive equipment or operations require a warranty of not less than 15 years. Designer may specify 5- or 10-year manufacturer warranty on facilities of small roof area and of minor importance where interiors and contents are not severely impacted by potential water intrusion. Environmentally controlled interiors require minimum 10-year warranty regardless of small size.

****

Provide the membrane manufacturer's 20-year no dollar limit system materials and installation workmanship warranty, including flashing, insulation, and accessories necessary for a watertight system construction. Write the warranty directly to the Government commencing at time of Government's acceptance of the work. Provide the following statements for such warranty:

a. If within the warranty period the system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, blisters, splits, tears, cracks, delaminates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the system assembly and correction of defective workmanship are the responsibility of the membrane manufacturer. All costs associated with the repair or replacement work are the responsibility of the membrane manufacturer.

b. The warranty must remain in full force and effect, including emergency temporary repairs performed by others, when the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification.

1.6.2 Roofing System Installer Warranty

The system installer must warrant for a minimum period of two years that the system, as installed, is free from defects in installation workmanship, to include the membrane, flashing, insulation, accessories, attachments, and sheet metal installation integral to a complete watertight system assembly. Write the warranty directly to the Government. The system installer is responsible for correction of defective workmanship and replacement of damaged or affected materials. The system installer is responsible for all costs associated with the repair or replacement work.

1.6.3 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty period must be approved and accomplished in a manner so as to restore the integrity of the system assembly and validity of the membrane manufacturer warranty for the remainder of the manufacturer warranty period.

PART 2 PRODUCTS

2.1 FLUID-APPLIED MEMBRANE

****

NOTE: ASTM C836/C836M is a materials performance specification; it does not specify any particular elastomer or elastomeric-extender combination.

****

ASTM C836/C836M.

2.2 MEMBRANE PRIMER

As recommended by the fluid-applied membrane manufacturer unless specifically prohibited by the manufacturer of the fluid-applied membrane.

2.3 SEALANT

****

NOTE: Specify sealant conforming to FS TT-S-227 or FS TT-S-230 in Section 07 92 00 JOINT SEALANTS. If no such section is required, specify sealant in this section.

****

As specified in Section 07 92 00 JOINT SEALANTS.

2.4 SEALANT PRIMER

As specified in Section 07 92 00 JOINT SEALANTS.

2.5 BACKING MATERIAL

****

NOTE: Include the following paragraph in Section 07 92 00 JOINT SEALANTS.

"Special Backing Material: Backing materials used for sealants in conjunction with fluid-applied waterproofing are specified in this section."

****

Premolded, closed-cell, polyethylene, or polyurethane foam rod having a diameter 25 percent larger than joint width before being compressed into joint. Provide bond breaker of polyethylene film or other suitable material between backing material and sealant.

[2.6 JOINT FILLER

****

NOTE: Include this section where joints are required to be filled. Include the reference to Section 03 30 00 CAST-IN-PLACE CONCRETE where that specification includes the joint filler requirements. Include the appropriate ASTM here where the requirements are not in another spec section.

****

As specified in [Section 03 30 00 CAST-IN-PLACE CONCRETE,] [ASTM D1751] [or] [ASTM D1752].

]2.7 BOND BREAKER

As recommended by the fluid-applied membrane manufacturer. Bond breaker must not interfere with the curing process or other performance properties of the fluid-applied membrane. Submit material description and physical properties, application details, and recommendations regarding shelf life, application procedures, and precautions on flammability and toxicity.

2.8 ELASTOMERIC SHEET

Preformed; as recommended by the fluid-applied membrane manufacturer. Bond strength between the fluid-applied membrane and the preformed elastomeric sheet must be a minimum of 7 kPa one psi when tested in accordance with ASTM C836/C836M.

2.9 ELASTOMERIC SHEET ADHESIVE

As recommended by the elastomeric sheet manufacturer.

2.10 FLEXIBLE FOAM-BACKED ELASTOMERIC SHEET

Flexible foam-backed elastomeric sheet for protection over preformed elastomeric sheet at expansion joints must be 13 mm 1/2 inch thick, minimum, closed cell foam conforming to ASTM D1056, Type 2, Class B, Grades

2 or 3, factory-bonded to 2 mm 1/16 inch thick, minimum, preformed elastomeric sheet.

2.11 PROTECTION BOARD

Premolded bitumen composition board, 3 mm 1/8 inch minimum thickness or other composition board compatible with the fluid-applied membrane.

2.12 DRAINAGE COURSE AGGREGATE

ASTM C33/C33M, size No. 8.

2.13 INSULATION

Polystyrene foam conforming to ASTM C578, Class IV, thickness as [indicated] [required by indicated R-value].

PART 3 EXECUTION

3.1 PREPARATION

Coordinate work with that of other trades to ensure that components to be incorporated into the waterproofing system are available when needed. Inspect and approve surfaces immediately before application of waterproofing materials. Remove laitance, loose aggregate, sharp projections, grease, oil, dirt, curing compounds, and other contaminants which could adversely affect the complete bonding of the fluid-applied membrane to the concrete surface.

3.1.1 Flashings

Make penetrations through sleeves in structural slab watertight before application of waterproofing. After flashing is completed, cover elastomeric sheet with fluid-applied waterproofing during waterproofing application.

3.1.1.1 Drains

Make drain flanges flush with surface of structural slab. Apply a full elastomeric sheet around the drain, with edges fully adhered to drain flange and to structural slab. Do not adhere elastomeric sheet over joint between drain and concrete slab. Do not plug drainage or weep holes. Cover elastomeric sheet with fluid-applied waterproofing during waterproofing application. Lap elastomeric sheet a minimum of 100 mm 4 inches onto concrete slab.

3.1.1.2 Penetrations and Projections

Flash penetrations and projections through structural slab with an elastomeric sheet adhered to the concrete slab and the penetration. Leave elastomeric sheet unadhered for 25 mm one inch over joint between penetration and concrete slab. Adhere elastomeric sheet a minimum of 150 mm 6 inches onto horizontal deck.

3.1.1.3 Walls and Vertical Surfaces

Flash wall intersections which are not of monolithic pour or constructed with reinforced concrete joints with an elastomeric sheet adhered to both vertical wall surfaces and concrete slab. Flash intersections which are monolithically poured or constructed with reinforced concrete joints with either an elastomeric sheet or a vertical grade of fluid-applied waterproofing adhered to vertical wall surfaces and concrete slab. Leave sheet unadhered for a distance of 25 mm one inch from the corner on both vertical and horizontal surfaces.

3.1.2 Cracks and Joints

Prepare visible cracks and joints in substrate to receive fluid-applied waterproofing membrane by placing a bond breaker and an elastomeric slip sheet between membrane and substrate. Apply a 50 mm 2 inch bond breaker to cracks that show movement followed by an elastomeric sheet adhered to the deck. Nonmoving cracks must be double coated with fluid-applied waterproofing.

3.1.3 Priming

Prime surfaces to receive fluid-applied waterproofing membrane. Apply primer as required by membrane manufacturer's printed instructions.

3.2 SPECIAL PRECAUTIONS

Protect waterproofing materials during transport and application. Do not dilute primers and other materials, unless specifically recommended by materials manufacturer. Keep containers closed except when removing contents. Do not mix remains of unlike materials. Thoroughly remove residual materials before using application equipment for mixing and transporting materials. Do not permit equipment on the project site that has residue of materials used on previous projects. Use cleaners only for cleaning, not for thinning primers or membrane materials. Ensure that workers and others who walk on cured membrane wear clean, soft-soled shoes to avoid damaging the waterproofing materials.

3.3 APPLICATION

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NOTE: Select second set of brackets with thicker application for vegetative roofs, and select first set of brackets for most other applications. Insert desired thickness if different than these two options.

****

Over primed surfaces, provide a uniform, wet, monolithic coating of fluid-applied membrane, [1.5 mm 60 mils thick, plus or minus 0.125 mm 5 mils] [5.5 mm 215 mils minimum] [_____] by following manufacturer's printed instructions. Apply material by trowel, squeegee, roller, brush, spray apparatus, or other method recommended by membrane manufacturer. Check wet film thickness as specified in paragraph FILM THICKNESS and adjust application rate as necessary to provide a uniform coating of the thickness specified. Where possible, mark off surface to be coated in equal units to facilitate proper coverage. At expansion joints, control joints, prepared cracks, flashing, and terminations, carry membrane over preformed elastomeric sheet in a uniform 1.5 mm 60 mil thick, plus or minus 0.125 mm 5 mils, wet thickness to provide a monolithic coating. If membrane cures before next application, wipe previously applied membrane with a solvent to remove dirt and dust that could inhibit adhesion of overlapping membrane coat. Use solvent recommended by the membrane manufacturer, as approved.

3.3.1 Work Sequence

Perform work so that protection board is installed prior to using the waterproofed surface. Do not permanently install protection board until the membrane has passed the flood test specified under paragraph FLOOD TESTING. Move material storage areas as work progresses to prevent abuse of membrane and overloading of structural deck.

3.3.2 Protection Board

Protect fluid-applied membrane by placing protection board over membrane at a time recommended by the membrane manufacturer. Protect membrane application when protection board is not placed immediately. Butt protection boards together and do not overlap.

3.3.3 Drainage Course

Place drainage course where shown after flood tests are completed and concrete protection slab or wearing course is ready to be installed.

3.3.4 Insulation

Place insulation of thickness indicated, on top of drainage course just prior to placement of concrete protection slab.

3.4 FIELD QUALITY CONTROL

3.4.1 Moisture Test

Prior to application of fluid-applied waterproofing, measure moisture content of substrate with a moisture meter in the presence of the Contracting Officer. Do not begin application until meter reading indicates "dry" range as per manufacturer's installation instructions.

3.4.2 Film Thickness

Measure wet film thickness every 10 square meters 100 square feet during application by placing flat metal plates on the substrate or using a mil-thickness gage especially manufactured for the purpose.

3.4.3 Flood Testing

After application and curing is complete, flood test the waterproofed area in accordance with ASTM D5957. Flood test area with water to achieve a minimum cover of 25 mm one inch but not exceed a maximum depth of 100 mm 4 inches at the lowest point. Maintain water height so as not to exceed a minimum level of 50 mm 2 inches below the edge of flashings. Plug drains and fill waterproofed area with water to a depth of 50 mm 2 inches. A minimum 48-hour cure time, or longer cure time if recommended by the membrane manufacturer, is required prior to flood testing. Allow water to stand 24 hours. Test watertightness by measuring water level at beginning and end of the 24-hour period. If water level falls, drain water, allow installation to dry, and inspect. Make repairs or replace as required and repeat the test. Do not proceed with work before approval of repairs or replacement.

[3.4.4 Electronic Leak Testing

****

NOTE: Include this section to require electronic leak testing where spaces below the waterproofed area will be occupied or critical to operations.
****

After application and curing is complete, and prior to installation of any wearing course, conduct electronic testing to test for leaks in accordance with ASTM D7877. The test agency must be consulted prior to installation of the waterproofing system regarding issues such as conductivity, grounding, and insulating membranes to confirm requirements for the system to ensure safe and thorough electronic testing.

]3.5 MAINTENANCE AND REPAIR TRAINING

Provide written and verbal instructions on proper maintenance procedures to designated Government personnel. Verbal instructions must be provided by a competent representative of the membrane manufacturer and include a minimum of 4 hours on maintenance and emergency repair of the membrane. Include a demonstration of membrane repair, and give sources of required special tools. Provide information on safety requirements during maintenance and emergency repair operations.

3.6 INFORMATION CARD

For each system application, provide a minimum 215 mm 8-1/2 inch by 11 inch information card for facility records and a card laminated in plastic and framed for interior display at access point, or a photoengraved one mm 0.032 inch thick aluminum card for exterior display. Identify facility name and number; location; Contract number; approximate area; detailed system description, including deck type, membrane, number of plies, method of application, manufacturer, insulation and cover board system and thickness; presence of tapered insulation for primary drainage, presence of vapor retarder; date of completion; installing Contractor identification and Contract information; membrane manufacturer warranty expiration, warranty reference number, and contact information. Install card at system access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

FORM 1

FLUID-APPLIED WATERPROOFING SYSTEM COMPONENTS

1. Contract Number
2. Date Work Completed
3. Project Specification Designation
4. Substrate Material
5. Slope of Substrate
6. Drains Type/Manufacturer
7. Waterproofing
    a. Membrane
    b. Sealant
    c. Elastomeric Sheet
    d. Materials Manufacturer(s)
8. Protection Board
    a. Type
    b. Thickness
    c. Manufacturer's Name
9. Drainage Course Material Graduation
10. Insulation
    a. Type
    b. Thickness
    c. Manufacturer's Name
11. Protection Slab
    a. Material
    b. Thickness
    c. Support
    d. Joint System

FORM 1	
FLUID-APPLIED WATERPROOFING SYSTEM COMPONENTS	
12. Wearing Course	
a. Type	
b. Slope	
c. Joint System	
d. Sealant/Gasket Type	
13. Wearing Surface Type	
Manufacturer's Name	
14. Warranty	
a. Manufacturer warranty expiration	
b. Warranty reference number	
15. Statement of Compliance or Exception	
Contractor's Signature	Date Signed
Inspector's Signature	Date Signed

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-07 16 19 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 16 19 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 16 19

METALLIC OXIDE WATERPROOFING

08/23

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-07 16 19 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 16 19 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 07 16 19

METALLIC OXIDE WATERPROOFING
08/23

****
NOTE: This guide specification covers the requirements for metallic oxide waterproofing for application on interior face of concrete walls and floors below grade, to provide a barrier impervious to passage of water under hydrostatic pressure.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Surfaces other than concrete may be waterproofed by this method; consult manufacturer's literature or approved applicators.
****

****
1. Metallic waterproofing is rigid and susceptible to cracking during settlement or shrinkage of surfaces to which it is applied. On interior surfaces, it is readily accessible for repair by cutting out defective areas and applying new material.

2. Metallic waterproofing can be applied to exterior wall surfaces; however, more flexible materials may be more suitable and effective.

3. Metallic waterproofing compound consists of pulverized metallic (gray cast iron) aggregate, factory mixed with oxidizing agents. It is field mixed with portland cement, sand, and water and applied in two coats with stiff bristle brushes, wedging particles into, and filling, pores and apertures.

****

****

NOTE: On the drawings, show:

1. Location and extent of metallic waterproofing. If not shown, designate surfaces to be waterproofed in a paragraph entitled "Surfaces to be Waterproofed," inserted in Part 3.

2. Details of pipe and conduit penetrations through treated walls or floor.

3. Continuous groove or cove at juncture of floor and walls and at juncture of floor and columns 38 mm 1-1/2 inches in cross section, cut into floor, walls and columns. Indicate that groove is to be filled with metallic oxide waterproofing mortar.

4. Details of expansion and control joints.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C144	(2024) Standard Specification for Aggregate for Masonry Mortar
ASTM C150/C150M	(2024) Standard Specification for Portland Cement

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Metallic Waterproofing

SD-06 Test Reports

Iron Content of metallic waterproofing

Oxidizing Agent Content of metallic waterproofing

SD-08 Manufacturer's Instructions

Mixing

1.3 TESTING OF SAMPLES

Prepare a 100 gram sample. Using a magnet over a watch glass, transfer magnetic portion into separate pile leaving nonmagnetic behind. Weigh nonmagnetic portion.

a. Total iron content: Determine total iron by percentage of sample weight using standard qualitative chemical analysis procedures.

b. Oxidizing agent content: Determine percentage of oxidizing agent by standard qualitative chemical analysis technique. Provide certified statement attesting that chemical and physical composition of metallic waterproofing material have been determined by specified testing methods and material has been found to conform with specification requirements.

1.4 SAMPLE INSTALLATION

After submittals are approved and before work is started, apply metallic waterproofing to a test area not less than [10] [100] [_____] square meters feet, using methods and materials specified herein. Location to be selected by Contracting Officer. Waterproofing must be visually and physically examined for bonding and loose materials by waterproofing materials manufacturer or their representative. A wide-blade putty knife or similar tool will be used for inspection of bond. Failure of waterproofing to bond or appearance of excessive loose materials will be cause for disapproval of proposed material and method of application. Clean disapproved test area free of applied finish, leaving base clean and acceptable for new application. If test area is disapproved, make an additional test area. Do not apply waterproofing in other areas until application of test area has been approved by waterproofing materials manufacturer or their representative, and accepted by Contracting Officer. Approved installation must remain in place and open to observation as criteria for all metallic waterproofing under Contract.

1.5 DELIVERY AND STORAGE

Deliver materials to project site in original sealed containers with manufacturer's name and brand clearly identified. Store in dry locations with adequate ventilation and handle in a manner to prevent damage or contamination.

1.6 ENVIRONMENTAL CONDITIONS

Enclose or protect surfaces to be treated from excessive temperature changes. Ambient temperature must be above 10 degrees C 50 degrees F during application and for duration of curing period. Keep water level below location of surfaces being treated until completion of the treatment and curing period. Provide adequate ventilation to properly oxidize metallic waterproofing.

PART 2 PRODUCTS

2.1 PORTLAND CEMENT

ASTM C150/C150M, Type I.

2.2 FINE AGGREGATE

ASTM C144 (sand) for waterproofing coats and ASTM C33/C33M for protective coat.

2.3 WATER

Potable and free from injurious amounts of oil, alkalis, acids, organic matter, and other deleterious substances.

2.4 METALLIC WATERPROOFING COMPOUND

Clean, commercial, pulverized cast iron mixed in dust-confining container with chemical oxidizing agent such as sodium peroxide, potassium peroxide, or ammonium chloride.

2.4.1 Pulverized Cast Iron

85 percent minimum by weight of metallic iron of magnetic portion. Chemical oxidizing agent content must be a minimum of 3 percent and a maximum of 5 percent by weight of compound. Presence of dirt, paraffin, bitumen, or other foreign substances in excess of one percent by weight of waterproofing compound will be cause for rejection.

2.4.2 Iron Oxide Content

Do not exceed 5 percent by weight of magnetic iron. The magnetic portion of iron must not contain more than 0.05 percent by weight of oil.

2.4.3 Magnetic Iron Particles

Graded as follows:

Sieve size	Percent passing
No. 20 screen	100
No. 35 screen	95 to 100
No. 40 screen	90 to 100
No. 60 screen	65 to 100
No. 100 screen	45 to 70
No. 200 screen	10 to 25

2.5 CAULKING

Polyurethane foam sealant.

PART 3 EXECUTION

3.1 SURFACE CONDITION

Examine all surfaces to be waterproofed to ensure that concrete has properly cured, all shrinkage has occurred, laitance has been removed, cracks and honeycombs have been cut out and filled, and surfaces have been roughened to provide bond for waterproofing material. Correct all defects that will adversely affect proper completion of waterproofing.

3.2 SURFACE PREPARATION

3.2.1 Concrete Surfaces

****

NOTE: Coordinate with: (1) Division 3, CONCRETE, for surface preparation requirements, continuous grooves of junction between horizontal and vertical surfaces, cutting out of wire ties, honeycombs, and porous areas, installation of anchoring devices, built-in water stops, and concrete floor toppings; (2) Division 7, THERMAL AND MOISTURE PROTECTION, for resilient-joint caulking and plastic and metallic flashings; (3) Division 9, FINISHES, for plaster or similar wall finish; (4) Division 22, PLUMBING, for watertight connections, for piping sleeves, and drains; and (5) Division 26, ELECTRICAL, to provide that no wiring devices be installed in recesses until waterproofing work is complete. Similar notes may be required in other specification divisions for recessed anchor devices and other related work.

****

Roughen concrete wall and floor surfaces by light bushhammering, sandblasting, acid etching, or high-pressure water cleaning to provide firm, unspalled granular surface, clean and free from loose materials, debris, and detrimental substances such as dust, dirt, oil, grease, or other coatings.[Cut out wire ties to depth of 38 mm 1-1/2 inches. Cut out holes, honeycombs, open joints, and porous areas. Make all cuts square to a depth of 25 to 38 mm 1 to 1-1/2 inches. Do not cut V-grooves or cone-shaped recesses.]

3.2.2 Walls

Clean wall areas that have been cut out, moisten with water, and fill flush with a stiff mortar mix composed of one 42.6 kilogram 94 pound sack of portland cement, 85.3 kilograms 188 pounds of sand, and 6.8 kilograms 15 pounds of metallic oxide waterproofing compound. Apply filling and patching in layers not exceeding 19 mm 3/4 inch thickness, worked into voids, compacted, and finished flush with adjacent surfaces. Roughen patched areas to provide level, firm, granular surface.

3.2.3 Grooves, Joints, and Intersections

****

NOTE: Insert appropriate Section number and title in the blank below using format per UFC 1-300-02, "Unified Facilities Guide Specifications (UFGS) Format Standard".
****

Strip, clean, and remove all loose material from construction joints, grooved recesses, and intersections of vertical and horizontal surfaces. Pack joints with waterproofing mortar mixed in proportions of one 42.6 kilogram 94 pound sack of portland cement and 85.3 kilograms 188 pounds of sand, and 6.8 kilograms 15 pounds of metallic oxide waterproofing compound. Finish compacted mortar flush with adjacent surfaces; finish internal angles to a round cove. Grooves in construction joints, at intersections of horizontal and vertical surfaces, and fillers and water stops for expansion and contraction joints are specified under [_____].

3.2.4 Caulking

Apply caulking around all drains, pipes, and other items which penetrate the surfaces to be waterproofed.

3.2.5 Recesses

Waterproof recesses, but do not fill to a lesser opening than detailed.

3.2.6 Penetrations

Do not apply waterproofing until anchorage items or other items passing through or protruding from the surfaces have been installed. Treatment must be completed and approved prior to attachment of utilities to anchorage items.

3.3 MIXING

Follow mixing instructions supplied by the manufacturer.

3.4 APPLICATION

3.4.1 Limits of Application

Completely coat columns integral with exterior walls. Return wall waterproofing at least 600 mm 24 inches on interior concrete walls and 1200 mm 48 inches onto masonry walls that are in place at the time of the waterproofing application. Return floor waterproofing at least 300 mm 12 inches vertically up on the face of all interior walls, partitions, and interior columns in place at the time of waterproofing application.

3.4.2 Walls and Columns

Thoroughly dampen surfaces to receive waterproofing. Apply two coats of thick slurry to each 10 square meters 100 square feet of surface: first coat, consisting of 42.6 kilograms 94 pounds of portland cement, 85.3 kilograms 188 pounds of sand, and 4.5 kilograms 10 pounds of metallic oxide waterproofing compound; second coat, same mix as first coat except with 3.6 kilograms 8 pounds of metallic oxide waterproofing for each 42.6 kilograms 94 pounds of cement. Apply each coat by brushing with stiff bristle brushes to seal all pores. Allow sufficient time between coats to permit oxidation of material, but not more than 24 hours before application of subsequent treatment. Periodically spray each coat with fine fog spray during oxidation period to ensure thorough curing. Where air circulation is insufficient to properly oxidize waterproofing, provide fans or other means to ensure adequate circulation.

3.4.3 Floors

After surfaces are roughened and properly prepared, thoroughly wash and clean all surfaces prior to application of waterproofing treatment. Apply two coats of thick slurry as previously specified for walls and columns, each coat thoroughly scrubbed and broomed to completely coat floor surface.

3.4.4 Bond Coat

****

NOTE: If wall or floor finishes such as plaster or cement mortar floor toppings are shown on the drawings and specified in other specification sections, delete reference to protective finish coating. Walls and floors not specified or scheduled to receive other finishes must receive the Protective Finish Coating.

****

Prior to application [of plaster, cement mortar topping, or similar wall and floor finishes specified in other sections,] [of protective finish coating specified herein] apply a bond coat of metallic oxide waterproofing mixed in same proportions as specified for second coat on walls and columns. Prior to bond coat application, thoroughly broom previously treated surfaces with thick bristle brooms to remove all traces of unoxidized compound, and dampen with water. Apply bond coat immediately before finish coat to prevent premature curing or setting of bond coat before finish coat is applied.

[3.4.5 Protective Finish Coating

****

NOTE: If wall or floor finishes such as plaster or cement mortar floor toppings are shown on the drawings and specified in other specification sections, delete paragraphs PROTECTIVE FINISH COATING, WALLS AND COLUMNS, and FLOORS, as appropriate. Walls and floors not specified or scheduled to receive other finishes must receive the Protective Finish Coating.

****

Waterproofed surfaces which are not to receive plaster, floor topping, or other finish must receive a protective coating applied directly over the bond coat.

[3.4.5.1 Walls and Columns

After application of bond coat, apply protective coating to minimum thickness of 3 mm 1/8 inch. Mix coating in proportions by volume of one part portland cement to two and one-half parts fine aggregate conforming to ASTM C33/C33M. Float to smooth, even surface.

][3.4.5.2   Floors

After application of bond coat, apply protective topping of 38 mm 1-1/2 inch minimum thickness, consisting of one part portland cement, one part sand, and two parts fine aggregate conforming to ASTM C33/C33M and proportioned by volume. Mixing must be done in a mechanical batching-type mixer for not less than 3 minutes after all materials have been included, using not more than 15 liters 4 gallons of water for each bag of cement when floating is done by machine and 19 liters 5 gallons for each bag of cement when floating is done by hand. After screeding to established finish lines and levels, compact and then float with wood floats or power floating machines. After finish has sufficiently hardened to prevent excess fine material from being worked to surface, steel trowel to obtain smooth surface free from defects and blemishes. After topping has set to ring, trowel again to a burnished finish.

][3.4.5.3   Curing

Protect finish coating from loss of moisture and cure by periodic fog spraying and cover with impervious sheeting or other approved method until coating has set.

]]   -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-07 17 00 (February 2016)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 17 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 17 00

BENTONITE WATERPROOFING

02/16

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 17 00 (February 2016)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 17 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 17 00

BENTONITE WATERPROOFING

02/16

****

NOTE: This guide specification covers the requirements for bentonite waterproofing.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

Note: Where local practice and experience indicate, or where International Code Council (ICC), International Building Code (IBC), section Dampproofing and Waterproofing allows, that a high degree of protection against hydrostatic pressure has been obtained with bentonite waterproofing, it may be used as an alternative to a multi-ply membrane waterproofing system as specified in Section 07 12 00 BUILT-UP BITUMINOUS WATERPROOFING.

Where groundwater investigation required by IBC Section 1803.5.4 indicates that a hydrostatic pressure condition exists, and the design does not include a groundwater control system as described in IBC Section 1805.1.3, waterproof walls and floors in accordance with 1805.3 which requires a multi-ply membrane waterproofing system as specified in

Section 07 13 53 ELASTOMERIC SHEET WATERPROOFING.

****

****

NOTE: On the project drawings, show:

1. Location and extent of bentonite waterproofing.

2. Locations of construction joints and pipe conduit or similar through-wall openings.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D217	(2021a) Standard Test Methods for Cone Penetration of Lubricating Grease
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: If sustainable bentonite panel materials are available, choose bracketed option.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Bentonite Materials; G, [_____]

Bentonite Panels; G, [_____]

Accessories; G, [_____]

SD-08 Manufacturer's Instructions

Application

Protection

Corrections Procedures; G, [_____]

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle bentonite waterproofing materials in original manufacturer's packaging and in strict accordance with manufacturer's printed instructions. Do not place or store bentonite materials in wet areas or during precipitation. Protect materials and accessories from moisture. Remove and replace products that show evidence of exposure to moisture prior to completion of installation. Remove materials which show evidence of damage, deterioration, or contamination.

Provide bentonite products and containers with manufacturer's labels intact and identifying all materials.

PART 2 PRODUCTS

2.1 BENTONITE MATERIALS

2.1.1 Bulk Bentonite

Provide high swelling, sodium bentonite containing a minimum of 90 percent montmorillonite and a maximum of 10 percent unaltered volcanic ash or other native sediments.

2.1.2 Bentonite Properties

Provide material meeting the following requirements:

2.1.2.1 Free Swell Rating

Two grams of granular bentonite sifted into deionized water must swell to occupy a minimum volume of 16 cubic centimeters.

2.1.2.2 Active Ingredient

Hydrous silicate of alumina, composed of the following chemical percentages and their allowable deviations:

Silica	61.0 plus/minus 3.0
Alumina	19.5 plus/minus 1.5
Iron oxide	5.0 plus/minus 1.0
Magnesia	2.8 plus/minus 0.4
Soda and potash oxides	2.4 plus/minus 0.7
Calcium oxide	0.6 plus/minus 0.5
Molecular water	6.1 plus/minus 0.6
Minor	2.6 plus/minus 0.6

2.1.3 Bentonite Panels

Provide panels containing bentonite material sealed between two layers of absorbent material with a minimum of 4.9 kilograms 1 pound of evenly distributed bentonite per square meter foot. Provide bentonite panels with a minimum thickness of 1200 mm 48 inches square by minimum dry thickness of 5 mm 3/16 inch.

2.1.4 Bentonite Mineral Based Gel

Provide material in accordance with ASTM D217 for a worked penetration range of 215 to 275. Provide gel with a minimum of 45 percent controlled, partially hydrated, high swelling sodium bentonite by weight with a minimum pH of 8.8, no free water, and 25 percent or more residual swell.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Examine surfaces prior to treatment, eliminate irregularities and remove loose and foreign material.[Remove form tie rods.][Point cracks and honeycombs in concrete surfaces. Make surfaces of finished patches flush with adjacent concrete surfaces.][Allow cement mortar to dry for minimum of 72 hours prior to application of bentonite panels.]

3.2 APPLICATION

****

NOTE: Verify that location and extent of bentonite waterproofing, and location of construction joints and pipe conduit or similar through-wall openings are shown on the project drawings regardless of which option is chosen. Expansion joints require additional detailing and their watertightness is the responsibility of the designer.

****

Apply bentonite waterproofing [on exterior surfaces of below grade [masonry][and][concrete] walls[and wall footings]][and][under [concrete slabs,] [pile caps,] [grade beams,] [footings,] [elevator pits]] [and] [against bulkhead walls] [where indicated], in accordance with manufacturer's printed instructions. Securely fasten panels over all construction joints and all expansion joints. Thoroughly pack all through-wall openings and penetrations with bentonite gel, granular bentonite, or both, prior to placement of bentonite panels.

3.3 PROTECTION

Protect bentonite panels during backfilling and compaction in accordance with manufacturer's printed instructions. If backfill is not immediately applied, protect panels from precipitation by completely covering exposed panels with polyethylene; remove polyethylene immediately prior to backfilling. Replace damaged panels with new panels before and during backfilling and compaction.

3.4 BACKFILL

Backfill with smooth and uniform material with no sharp projections. Compact backfill to at least 85 percent of ASTM D1557 maximum density. Ensure backfill material is not contaminated with salt or other materials that could prevent bentonite from hydrating.

3.5 CORRECTIONS

Repair leaks and defective areas in accordance with manufacturer's printed instructions.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 19 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 19 00 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 19 00

WATER REPELLENTS

08/23

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 19 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 19 00 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 19 00

WATER REPELLENTS

08/23

****

NOTE: This guide specification covers the requirements for the application of water repellent coatings to above grade concrete, concrete masonry, and plaster surfaces.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Graffiti resistance and glossy surface finish are not obtained with these penetrant-type repellents.

****

****

NOTE: On the drawings, show location of each type of water repellent to be used. Designate by code.

****

PART 1 GENERAL

1.1 REFERENCES

****

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501.2	(2015) Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 259	(2002; R 2017) Standard Method of Test for Resistance of Concrete to Chloride Ion Penetration
AASHTO T 260	(2021) Standard Method of Test for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials

ASTM INTERNATIONAL (ASTM)

ASTM C140/C140M	(2024) Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C642	(2021) Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM D1653	(2013; R 2021) Standard Test Methods for Water Vapor Transmission of Organic Coating Films
ASTM D2369	(2020) Standard Test Method for Volatile Content of Coatings
ASTM D3278	(2021) Standard Test Methods for Flash

	Point of Liquids by Small Scale Closed-Cup Apparatus
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E514/E514M	(2020) Standard Test Method for Water Penetration and Leakage Through Masonry
ASTM G154	(2023) Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-03 Product Data

Water Repellents

SD-06 Test Reports

Water Absorption

Accelerated Weathering

Resistance to Chloride Ion Penetration

Moisture Vapor Transmission

Water Penetration and Leakage

SD-07 Certificates

Manufacturer's Qualifications

Applicator's Qualifications

Evidence of Acceptable Variation

Warranty

SD-08 Manufacturer's Instructions

Application Instructions

Manufacturer's Safety Data Sheets

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

a. Manufacturer's qualifications: Minimum five years record of successful in-service experience of water repellent treatments manufactured for [concrete,] [concrete masonry,] [plaster] application.

b. Applicator's qualifications: Minimum five years successful experience in projects of similar scope using specified or similar treatment materials and manufacturer's approval for application.

1.3.2 Performance Requirements

a. Water absorption: ASTM C140/C140M. Comparison of treated and untreated specimens.

b. Moisture vapor transmission: ASTM E96/E96M. Comparison of treated and untreated specimens.

c. Water penetration and leakage through masonry: ASTM E514/E514M.

d. Resistance to chloride ion penetration: AASHTO T 259 and AASHTO T 260.

e. Resistance to Accelerated weathering: ASTM G154

1.3.3 Evidence of Acceptable Variation

If a product proposed for use does not conform to requirements of the referenced specification, submit for approval to the Contracting Officer, evidence that the proposed product is either equal to or better than the product specified. Include the following:

a. Identification of the proposed substitution;

b. Reason why the substitution is necessary;

c. A comparative analysis of the specified product and the proposed substitution, including tabulations of the composition of pigment and vehicle;

d. The difference between the specified product and the proposed substitution; and

e. Other information necessary for an accurate comparison of the proposed substitution and the specified product.

1.4 SAMPLE TEST PANEL

The approved Sample Test Panel will serve as the standard of quality for all other water repellent coating work. Do not proceed with application until the sample panel has been approved by the Contracting Officer.

****

NOTE: Specify sample test panels as a part of the work included in Division 03, CONCRETE; Division 04, MASONRY; or in Division 09, FINISHES, as applicable.

****

1.4.1 Preparation of Sample Test Panel

****

NOTE: Insert appropriate Section number and title in the blank below using format per UFC 1-300-02, "Unified Facilities Guide Specifications (UFGS) Format Standard".

****

Prior to commencing work, including bulk purchase and delivery of material, apply water repellent treatment to a minimum 1200 mm 4 feet high by 1200 mm 4 feet long [concrete,] [concrete masonry,] [plaster] test-panel specified in [_____]. Provide a full height expansion joint at mid-panel length. Prepare and seal joint with materials approved for project use.

1.4.1.1 Testing

Similar to AAMA 501.2 hose testing, provide field water testing of water repellent treated surfaces in the presence of the Contracting Officer and the water repellent treatment manufacturer's representative as follows.

a. Apply water repellent to left side of mock-up and allow to cure prior to application of treatment to right side.

b. Twenty days after completion of application of treatment, test mock-up with 16 mm 5/8 inch garden hose, with spray nozzle, located 3 meters 10 feet from wall and aimed upward so water strikes wall at 45-degree downward angle. After water has run continuously for three hours observe back side of mock-up for water penetration and leakage. If leakage is detected, make changes as needed and retest.

c. Coordinate testing procedures and modify project treatment application as required to pass mock-up tests for water penetration and leakage resistance.

1.4.1.2 Approval

Proceed with water repellent treatment work only after completion of field test application and approval of mock-up and tests by the Contracting Officer.

1.4.2 Pre-Installation Meeting

a. Attend pre-installation meeting required prior to commencement of [concrete,] [concrete masonry,] [plaster] installation.

b. Review procedures and coordination required between water repellent treatment work and work of other trades which could affect work to be performed under this section of the work.

c. Convene additional pre-installation meeting prior to water repellent treatment application for coordination with work not previously coordinated including joint sealants.

1.5 REGULATORY REQUIREMENTS

****

NOTE: Include these paragraphs as required by Federal, State, or local jurisdictions.

****

1.5.1 Environmental Protection

****

NOTE: Include the second bracketed option for work in the State of California.

****

In addition to requirements specified in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS for environmental protection, provide coating materials that conform to the restrictions of the [Local Air Pollution Control jurisdiction] [CALIFORNIA AIR RESOURCES BOARD (CARB) and local Air Pollution Control District regional jurisdiction]. Notify the Contracting Officer of water repellent coating specified herein which fails to conform to the local Air Quality Management District Rules at the location of the Project. In localities where the specified coating is prohibited, the Contracting Officer may direct the substitution of an acceptable coating.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in original sealed containers, clearly marked with the manufacturer's name, brand name, type of material, batch number, percent solids by weight and volume, and date of manufacturer. Store materials off the ground, in a dry area where the temperature will be not less than 10 degrees C 50 degrees F nor more than 29 degrees C 85 degrees F.

1.7 SAFETY METHODS

Apply coating materials using safety methods and equipment in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, and the following:

1.7.1 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

a. The coating manufacturer when using solvents or other chemicals. Use impermeable gloves, chemical goggles or face shield, and other recommended protective clothing and equipment to avoid exposure of skin, eyes, and respiratory system. Conduct work in a manner to minimize exposure of building occupants and the general public.

b. 29 CFR 1910.1000.

c. Threshold Limit Values (R) of the American Conference of Governmental Industrial Hygienists.

d. Manufacturer's Safety Data Sheets.

1.8 ENVIRONMENTAL CONDITIONS

1.8.1 Weather and Substrate Conditions

Do not proceed with application of water repellents under any of the following conditions, except with written recommendations of manufacturer.

a. Ambient temperature is less than 4 degrees C 40 degrees F.

b. Substrate faces have cured less than one month.

c. Rain or temperature below 4 degrees C 40 degrees F are predicted for a period of 24 hours before or after treatment.

d. Earlier than three days after surfaces are wet.

e. Substrate is frozen or surface temperature is less than 4 degrees C 40 degrees F and falling.

1.8.2 Moisture Condition

Determine moisture content of substrate meets manufacturer's requirements prior to application of water repellent material.

1.9 SEQUENCING AND SCHEDULING

1.9.1 Masonry Surfaces

Do not start water repellent coating until all joint tooling, pointing and masonry cleaning operations have been completed. Allow masonry to cure for at least 60 days under normal weather conditions before applying water repellent.

1.9.2 Plaster Surfaces

Do not start water repellent coating until all shrinkage and stress cracks are repaired and sound, all surfaces are free of defects and cleaning operations have been completed. Allow plaster to cure for at least 30 days under normal weather conditions before applying water repellent.

1.9.3 Concrete Surfaces

Do not start water repellent coating until all patching, pointing and cleaning operations have been completed and concrete has cured a minimum of 30 days under normal weather conditions.

1.9.4 Sealants

Do not apply water repellents until the sealants for joints adjacent to surfaces receiving water repellent treatment have been installed and cured.

a. Water repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.

b. Provide manufacturers' test results of compatibility.

1.10 INSPECTIONS

Notify the manufacturer's representative a minimum of 72 hours prior to scheduled application of water repellents for field inspection. Inspect surfaces and obtain approval in writing from the manufacturer's representative prior to application of water repellent coating.

1.11 SURFACES TO BE COATED

Coat all exterior [concrete,] [masonry,] [or plaster] surfaces. This includes back faces of parapets, top of walls, edges and returns adjacent to windows and door frames and free-standing walls.

1.12 WARRANTY

Provide a warranty, issued jointly by the manufacturer and the applicator of the water repellent treatment against moisture penetration through the treated structurally sound surface for a period of five years. Warranty to provide the material, labor, and equipment necessary to remedy the problem. At the satisfactory completion of the work, complete the warranty sign, notarize, and submit to the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS

Provide a clear, non-yellowing, deep-penetrating, VOC compliant water repellent solution. Material must not stain or discolor and must produce a mechanical and chemical interlocking bond with the substrate to the depth of the penetration.

2.2 WATER REPELLENTS

****

NOTE: Delete following types not required.
****

2.2.1 Silane, 20 Percent Solids

Penetrating water repellent. A monomeric compound containing approximately 20 percent alkyltrialkoxysilanes with alcohol, mineral spirits, water, and other proprietary solvent carrier.

a. Composition: Modified alkylalkoxysilane.

b. Active alkylalkoxysilane content: ASTM D2369 20 percent by weight, plus or minus 1 percent.

c. Appearance: White, milky liquid.

d. Average depth of penetration: Up to 10 mm 3/8 inch depending on substrate.

e. VOC content: Less than 350 grams per liter.

f. Flash point, ASTM D3278.

g. Specific gravity, at 25 degrees C 78 degrees F: 0.96 to 0.98.

h. Density: .96 to .98 kilograms per liter .0 to 8.2 pounds per gallon.

2.2.2 Silane, 40 Percent Solids

Penetrating water repellent. A monomeric compound containing approximately 40 percent alkyltrialkoxysilanes with alcohol, mineral spirits, or water.

a. Composition: Modified alkylalkoxysilane.

b. Active alkylalkoxysilane content: ASTM D2369 40 percent by weight, plus or minus 1.5 percent.

c. Appearance: White, milky liquid.

d. Average depth of penetration: Up to 10 mm 3/8 inch depending on substrate.

e. VOC content: Less than 350 grams per liter.

f. Flash point, ASTM D3278.

g. Specific gravity, at 25 degrees C 78 degrees F: 0.94 to 0.97.

h. Density: .94 to .97 kilograms per liter 7.8 to 8.1 pounds per gallon.

2.2.3 Silane, 85 Percent Solids or Greater

Penetrating water repellent. A monomeric compound containing 85 percent or greater alkyltrialkoxysilanes with alcohol, mineral spirits, or water.

a. Composition: Modified alkylalkoxysilane.

b. Active alkylalkoxysilane content: ASTM D2369 85 percent by weight, plus or minus 1 percent.

c. Appearance: White, milky liquid.

d. Average depth of penetration: Up to 10 mm 3/8 inch depending on substrate.

e. VOC content: Less than 350 grams per liter.

f. Flash point, ASTM D3278.

g. Specific gravity, at 25 degrees C 78 degrees F: 0.96 to 0.98.

h. Density: .96 to .98 kilograms per liter 8.0 to 8.2 pounds per gallon.

2.2.4 Siloxanes

Penetrating water repellent. Alkylalkoxysiloxanes that are oligomerous with alcohol, ethanol, mineral spirits, or water.

a. Solids by weight: ASTM D2369, 7.5 to 16.0 percent.

b. Volatile Organic Content (VOC) after blending: Less than 175 grams per liter.

c. Density, activated: One kilogram per liter 8.4 pounds per gallon, plus or minus one percent.

d. Flash point, ASTM D3278: Greater than 100 degrees C 212 degrees F.

2.2.5 Low-Solids Acrylic

Water-clear, breathing coating of acrylic resins, water-based, solvent-based, or acrylic emulsions solution containing less than 15 percent solids by volume.

****

NOTE: Below may be used on concrete, exposed aggregate, stucco, masonry, or stone where wet sheen appearance or some darkening of surface is acceptable.

****

2.2.6 High-Solids Acrylic

Water-clear, breathing coating of acrylic resins, water-based, solvent-based, or acrylic emulsions solution containing 15 percent solids or more by volume.

2.2.7 VOC-Complying Water Repellents

Products certified by the manufacturer that they comply with local regulations controlling use of volatile organic compounds (VOC's).

2.3 PERFORMANCE CRITERIA

2.3.1 Silane, 20 Percent Solids

a. Water absorption test: ASTM C642 and ASTM E514/E514M.

b. Moisture vapor transmission: ASTM D1653, 28.33 perms or 51.61 percent maximum compared to untreated surfaces.

c. Resistance to chloride ion penetration: AASHTO T 259 and AASHTO T 260.

d. Water penetration and leakage through masonry, ASTM E514/E514M percentage reduction of leakage: 97 percent minimum.

e. Resistance to accelerated weathering, ASTM G154 testing 2,500 hours: No loss in repellency.

f. Drying time under normal conditions: Four hours per 24 degrees C 75 degrees F.

2.3.2 Silane, 40 Percent Solids

a. Average depth of penetration: 10 mm 3/8 inches depending on substrate

b. Resistance to chloride ion penetration, AASHTO T 259 and AASHTO T 260.

c. Water absorption test, ASTM E514/E514M: 0.42 percent per 48 hours; 1.2 percent per 50 days.

d. Moisture vapor transmission: ASTM D1653, 28.33 perms or 51.61 percent maximum compared to untreated surfaces.

e. Resistance to accelerated weathering, ASTM G154. Testing 2,500 hours: No loss in repellency.

f. Drying time under normal conditions: Four hours per 24 degrees C 75 degrees F.

2.3.3 Silane, 85 Percent Solids or Greater

a. Average depth of penetration: 10 mm 3/8 inches depending on substrate.

b. Resistance to chloride ion penetration, AASHTO T 259 and AASHTO T 260.

c. Water absorption test, ASTM E514/E514M: 0.42 percent per 48 hours; 1.2 percent per 50 days.

d. Moisture vapor transmission: ASTM D1653, 28.33 perms or 51.61 percent maximum compared to untreated surfaces.

e. Resistance to accelerated weathering, ASTM G154. Testing 2,500 hours: No loss in repellency.

f. Drying time under normal conditions: Four hours per 24 degrees C 75 degrees F.

2.3.4 Siloxanes

a. Dry time for recoat, if necessary: One to two hours depending on weather conditions.

b. Penetration: 10 mm 3/8 inch, depending on substrate.

c. Water penetration and leakage through masonry, ASTM E514/E514M, percentage reduction of leakage: 97.0 percent minimum.

d. Moisture vapor transmission, ASTM E96/E96M: 47.5 perms or 82 percent maximum compared to untreated sample.

e. Resistance to accelerated weathering, ASTM G154. Testing 2,500 hours: No loss in repellency.

f. Resistance to chloride ion penetration, AASHTO T 259 and AASHTO T 260.

PART 3 EXECUTION

3.1 EXAMINATION

Examine [concrete], [plaster], or [masonry] surfaces to be treated to ensure that:

a. All visible cracks, voids or holes have been repaired.

b. All mortar joints in masonry are tight and sound, have not been re-set or misaligned and show no cracks or spalling.

c. Moisture contents of walls does not exceed 15 percent when measured on an electronic moisture register, calibrated for the appropriate substrate.

d. Concrete surfaces are free of form release agents, curing compounds and other compounds that would prevent full penetration of the water repellent material.

Do not start water repellent treatment work until all deficiencies have been corrected, examined, and found acceptable to the Contracting Officer and the water repellent treatment manufacturer. Do not apply treatment to damp, dirty, dusty, or otherwise unsuitable surfaces. Comply with the manufacturer's recommendations for suitability of surface.

3.2 PREPARATION

3.2.1 Surface Preparation

Prepare substrates in accordance with water repellent treatment manufacturer's recommendation. Clean surfaces of dust, dirt, efflorescence, alkaline, and foreign matter detrimental to proper application of water repellent treatment.

3.2.2 Protection

Provide masking or protective covering for materials which could be damaged by water repellent treatment.

****

NOTE: Check manufacturer for items requiring protection.

****

a. Protect glass, glazed products, and prefinished products from contact with water repellent treatment.

b. Protect landscape materials with breathing-type drop cloths; plastic covers are not acceptable.

3.2.3 Compatibility

****

NOTE: Verify requirements below based on compatibility of water repellent treatment and sealants. Use one or both the second and third following paragraphs as required.

****

a. Confirm treatment compatibility with each type of joint sealer within or adjacent to surfaces receiving water repellent treatment in accordance with manufacturer's recommendations.

[b. When recommended by joint sealer manufacturer, apply treatment after application and cure of joint sealers. Coordinate treatment with joint sealers.

][c. Mask surfaces indicated to receive joint sealers which would be adversely affected by water repellent treatment where treatment must be applied prior to application of joint sealers.

]3.3 MIXING

Mix water repellent material thoroughly in accordance with the manufacturer's recommendations. Mix, in quantities required for that day's work, all containers prior to application. Mix each container the same length of time.

3.4 APPLICATION

In strict accordance with the manufacturers written requirements. Do not start application without the manufacturer's representative being present or their written acceptance of the surface to be treated. Submit manufacturer's instructions including preparation, application, recommended equipment to be used, safety measures, and protection of completed application.

3.4.1 Water Repellent Treatment

3.4.1.1 Spray Application

Spray apply water repellent material to exterior [concrete,] [plaster,] [and masonry] surfaces using low-pressure airless spray equipment in strict accordance with manufacturer's printed application, instructions, and precautions. Maintain copies at the job site. Apply flood coat in an overlapping pattern allowing approximately 200 to 250 mm 8 to 10 inch rundown on the vertical surface. Maintain a wet edge at all overlaps, both vertical and horizontal. Hold gun maximum 450 mm 18 inches from wall.

3.4.1.2 Brush or Roller Application

Brush or roller apply water repellent material only at locations where overspray would affect adjacent materials and where not practical for spray applications.

3.4.1.3 Covered Surfaces

Coat all exterior [concrete,] [plaster,] [or masonry] surfaces including back faces of parapets, tops of walls, edges and returns adjacent to window and door frames, window sills, and free-standing walls.

3.4.1.4 Rate of Application

Apply materials to exterior surfaces at the coverages recommended by the manufacturer and as determined from sample panel test. Increase or decrease application rates depending upon the surface texture and porosity of the substrate to achieve even appearance and total water repellency.

3.4.1.5 Number of Coats

The results of the sample panel test determines the number of coats required to achieve full coverage and protection.

3.4.1.6 Appearance

If unevenness in appearance, lines of work termination or scaffold lines exist, or detectable changes from the approved sample panel occur, the Contracting Officer may require additional treatment at no additional cost to the Government. Apply required additional treatment to a natural break off point.

3.5 CLEANING

Clean all runs, drips, and overspray from adjacent surfaces while the water repellent treatment is still wet in a manner recommended by the manufacturer.

3.6 FIELD QUALITY CONTROL

Do not remove drums containing water repellent material from the job site until completion of all water repellent treatment and until so authorized by the Contracting Officer.

3.6.1 Field Testing

At a time not less than twenty days after completion of the water repellent coating application, subject a representative wall area of the building to the Navy Hose Stream Field Test similar to AAMA 501.2 hose test to simulate rainfall for a period of three hours. Use a minimum 16 mm 5/8 inch diameter hose and a fixed lawn sprinkler spray head which will direct a full flow of water against the wall. Place the sprinkler head so that the water will strike the wall downward at a 45-degree angle to the wall. If the inside of the wall shows traces of moisture during or following the test, apply another coat of water repellent, at the manufacturer's recommended coverage rate to the entire building. Repeat testing and re-coating process until no moisture shows on the inside wall face. Accomplish required work retesting and re-coating at no additional cost to the Government.

3.6.2 Site Inspection

Inspect treatment in progress by manufacturer's representative to verify compliance with manufacturer instructions and recommendations.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-07 21 13 (August 2023)**

Preparing Activity: NAVFAC

Superseding
UFGS-07 21 13 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 21 13

BOARD AND BLOCK INSULATION

08/23

PART 1 GENERAL

PART 2 PRODUCTS

PART 3   EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC UFGS-07 21 13 (August 2023)

Preparing Activity: NAVFAC

Superseding
UFGS-07 21 13 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 21 13

BOARD AND BLOCK INSULATION

08/23

****

NOTE: This guide specification covers the requirements for board and block thermal insulation.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification is intended for both retrofit of existing buildings and new construction.

****

****

NOTE: Specify board-type insulations for masonry and concrete walls and under concrete floor slabs. Also specify board-type insulation where the type of construction favors their economical usage and their application would be less difficult than blanket or loose fill insulations.

****

****

NOTE: On the drawings, show:

1. Locations where insulation must be used.

2. Thermal resistance value (R-Value) for each location.

3. Location of vapor retarder, if required.

4. Method of attachment of insulation board.

5. Location and size of attic ventilation openings where required.

****

****

NOTE: Attic Ventilation

1. Provide net, unobstructed ventilation areas to attics over insulated ceilings as recommended by International Building Code (IBC) paragraph 1202.02 Roof Ventilation, ASHRAE Handbook of Fundamentals, Chapter 25, Heat, Air, and Moisture Control in Building Assemblies - Fundamentals, and as follows:

2. For attics with vapor retarder, provide 0.1 square meter one square foot of net ventilation area for each 30 square meters 300 square feet of attic floor area.

3. For attics without vapor retarder, provide 0.1 square meter one square foot of net ventilation area for each 15 square meters 150 square feet of attic floor area.

4. For insulation of cathedral ceilings, provide at least a 50 mm 2 inch gap between upper face of insulation and underside of roof sheathing. Provide ventilation openings at bottom and top of ventilated cavity; show on drawings.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C165	(2023) Standard Test Method for Measuring Compressive Properties of Thermal Insulations
ASTM C203	(2005a; R 2017) Standard Test Methods for Breaking Load and Flexural Properties of Block-type Thermal Insulation
ASTM C272/C272M	(2018; R 2024) Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C930	(2019) Standard Classification of Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories
ASTM C1289	(2023a) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C1902	(2022) Standard Specification for Cellular Glass Insulation Used in Building and Roof Applications
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D3833/D3833M	(1996; R 2019) Standard Test Method for Water Vapor Transmission of Pressure-Sensitive Tapes

ASTM D4397	(2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM E154/E154M	(2008a; R 2019) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T803 OM	(2010) Puncture Test of Container Board

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program

For Chemical Emissions For Building
Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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SD-02 Shop Drawings

Manufacturer's Standard Details; G, [_____]

SD-03 Product Data

Environmental Data for Materials; G, [_____]

Block or Board Insulation; G, [_____]

[Vapor Retarder; G, [_____]

] Pressure Sensitive Tape; G, [_____]

Protection Board or Coating; G, [_____]

Accessories including sealants; G, [_____]

[Energy Star Label For Insulation Product; S

] Recycled Content for Block or Board Insulation; S

SD-07 Certificates

Indoor Air Quality For Block Or Board Insulation; S

Acceptable Foam Blowing Agents; S

SD-08 Manufacturer's Instructions

Insulation Installation and Handling

Protection Board or Coating Installation

Adhesive

SD-11 Closeout Submittals

Draft Guarantee; G, [_____]

Final Guarantee; G, [_____]

Draft Warranty; G, [_____]

Final Warranty; G, [_____]

1.3 MANUFACTURER'S DETAILS

Submit manufacturer's standard details indicating methods of attachment and spacing, transition and termination details, and installation details. Include verification of existing conditions.

1.4 PRODUCT DATA

Include environmental data for materials descriptions, recommendations for product shelf life, requirements for protection board or coatings, and precautions for flammability and toxicity. Include data to verify compatibility of sealants with insulation.

1.5 CERTIFICATIONS

[1.5.1 Indoor Air Quality Certification

****

NOTE: Based on the type of insulation included in the project, Designer should research the Greenguard certified products available and include this paragraph if products can be obtained from three or more manufacturers. Recent research has shown that Greenguard certified products are available from at least two national manufacturers for both extruded preformed cellular polystyrene (XPS) and

polyisocyanurate insulation products.
****

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification documentation from certification body.

][1.5.2   Energy Star Label for Insulation Product

****
NOTE: Consider including this paragraph when extruded preformed cellular polystyrene (XPS) insulation is included in the project. Research has shown that at least two national manufacturers have Energy Star certified XPS products.
****

Provide an extruded preformed cellular polystyrene insulation product that is Energy Star labeled. Provide data identifying Energy Star label for insulation product.

]1.5.3   Acceptable Foam Blowing Agent Materials

Products that contain high ozone depleting or high Global Warming Potential (GWP) blowing agents are prohibited. For a list of acceptable substitute foam blowing agents for the type of insulation used see https://www.epa.gov/snap/foam-blowing-agents. Provide validation of acceptable foam blowing agents that no prohibited materials are used.

1.6   DELIVERY, STORAGE, AND HANDLING

1.6.1   Delivery

Deliver materials to the site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type, grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

1.6.2   Storage

Inspect materials delivered to the site for damage and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or biological growth. Comply with manufacturer's recommendations for handling, storage, and protection of materials before and during installation.

1.7   SAFETY PRECAUTIONS

[1.7.1   Respirators

****
NOTE: Include this paragraph only for installations in which mineral fibers are released into the

atmosphere, such as where mineral fiber boards are cut on the job site.
****

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by the National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) and in accordance with 29 CFR 1910.134.

]1.7.2 Other Safety Considerations

Comply with the safety requirements of ASTM C930.

1.8 SPECIAL WARRANTIES

1.8.1 Guarantee

Guarantee insulation installation against failure due to ultraviolet light exposure for a period of three years from the date of Beneficial Occupancy or Substantial Completion. Submit draft guarantee and final guarantee in accordance with Sections 01 78 00 CLOSEOUT SUBMITTALS [and 01 78 23 OPERATION AND MAINTENANCE DATA].

1.8.2 Warranty

Provide manufacturer's material warranty for all system components for a period of three years from the date of Beneficial Occupancy or Substantial Completion. Submit draft warranty and final warranty in accordance with Sections 01 78 00 CLOSEOUT SUBMITTALS [and 01 78 23 OPERATION AND MAINTENANCE DATA].

PART 2 PRODUCTS

****
NOTE: Specify sustainable materials in accordance with UFC 1-200-02 HIGH PERFORMANCE AND SUSTAINABLE BUILDING REQUIREMENTS. Reduce the environmental impact of materials by specifying products that have a lesser or reduced effect on human health and the environment such as low emitting materials and materials with high recycled content. Consider product life cycle when compared with competing products or services serving the same purpose.
****

2.1 BLOCK OR BOARD INSULATION

****
NOTE: Select material and type of insulation board based on project design and application requirements regarding strength, vapor resistance, water absorption, and manufacturer's recommendations.
****

Provide thermal insulating materials as recommended by manufacturer for each type of application indicated. Provide insulation with the following physical properties and in accordance with the following standards:

[a. Faced Rigid Cellular Polyisocyanurate and Polyurethane Insulation:

ASTM C1289 REV A

][(1) Type I Aluminum Foil on both major surfaces. [Class 1 - Non-reinforced core foam.][Class 2 - Glass fiber reinforced core.]

][(2) Type II Fibrous felt or glass fiber mat membrane on both major surfaces of the core foam.

][(3) Type III Perlite insulation board on one major surface of the core foam and a fibrous felt or glass fiber mat membrane on the other major surface of the core foam.

][(4) Type IV Cellulosic fiber insulating board on the one major surface of the core foam and fibrous felt or glass fiber mat membrane on the other major surface of the core foam.

][(5) Type V Oriented strand board or water board on one major surface of the core foam and fibrous felt or glass fiber mat membrane or aluminum foil on the other major surface of the core foam.

][(6) Type VI Perlite insulation board on both major surfaces of the core foam.

][b. Unfaced Preformed Rigid Polyurethane and Polyisocyanurate Board: ASTM C591

] **

NOTE: Select type of XPS insulation based on project requirements. The most common one is Type IV; other Types include X, VI, VII, and V with the primary difference being compressive resistance. XPS Types also have some differences in water vapor permeance, flexural strength and density.

****

[c. Extruded Preformed Cellular Polystyrene (XPS): ASTM C578 REV A, Type[IV][_____]

] **

NOTE: Select type of mineral fiber board insulation based on project requirements. The most common one is Type IVB; other Types include IA thru V with the primary difference being compressive resistance and density.

****

[d. Mineral Fiber Block and Board: ASTM C612, Type [IVB][_____]

][e. Cellular Glass: ASTM C1902

]2.1.1 Thermal Resistance

****

NOTE: Board and block thermal insulating materials have different thermal properties. Specify insulation to provide R-Values required to comply with UFC 3-101-01, Chapter Exterior Walls. Indicate R-values on the project drawings.

****

****

NOTE: Where board insulation is installed in masonry cavity walls, size the wall cavity to accommodate the insulation thickness required to provide the specified R-Value and a 25 mm one inch air space.

****

[Provide R-values as indicated on the drawings.

]2.1.2 Fire Protection Requirements

****

NOTE: Fire Safety Provisions

1. Most vapor retarder materials and some thermal insulations are combustible. Do not leave such material exposed to accessible spaces, but cover with fire retardant finish.

2. See UFC 3-600-01 Fire Protection Engineering for Facilities and local building codes for required fire retardant classifications, flame spread and smoke developed ratings, distance of insulation and vapor retarders from heat producing devices, and other fire protection requirements such as finish materials in various occupancies.

****

****

NOTE: Do not use cellular plastic insulation exposed to the building interior. Separate the insulation from the interior according to the requirements of ICC IBC Chapter 26 Plastics Section 2603.4 Thermal Barrier or by a minimum of a 15-minute fire separation; comply with the most restrictive requirement. If no separation can be provided, select cellular glass block insulation instead of cellular plastic insulation. Edit this paragraph and the paragraph INSULATION ON VERTICAL SURFACES as required.

****

****

NOTE: Specify insulated roof assemblies in accordance with UFC 1-200-01 Fire and Smoke Protection Features section, and UFC 3-600-01. Where requirements conflict between UFCs and IBC, UFC 3-600-01 takes precedence; edit the following section accordingly.

****

a. Flame spread index of 75 or less when tested in accordance with ASTM E84.

b. Smoke developed index of [450] [200] [150] [_____] or less when tested in accordance with ASTM E84.

c. Provide insulated assemblies in accordance ICC IBC Chapter Fire and

Smoke Protection Features.

2.1.3 Other Material Properties

****

NOTE: Include only those properties that are required for the particular application.

****

Provide thermal insulating materials with the following properties:

[a. Rigid cellular plastics: Compressive Resistance at Yield: Not less than [170] [_____] kilopascals (kPa) [10] [_____] pounds per square inch (psi) when measured according to ASTM D1621.

][b. Mineral fiber board: Compressive strength: Minimum load required to produce a reduction in thickness of 10 percent kilograms per square meter (kg/m2) pounds per square foot (lbf/sf): [120] [4900] [25] [1000] when tested according to ASTM C165.

][c. Block-type insulation: Block-type insulation: Flexural strength: Not less than [275] [_____] kPa [25] [_____] psi when measured according to ASTM C203 REV A.

] **

NOTE: Refer to UFC 3-101-01 and IBC Chapter 14 for analysis to determine required water vapor permeance.

****

[d. Water Vapor Permeance: Not more than [6.3 by 10-8] [_____] g/Pa.s.m2 [1.1] [_____] Perms or less when measured according to ASTM E96/E96M, desiccant method, in the thickness required to provide the specified thermal resistance, including facings, if any.

] **

NOTE: Specify allowable moisture content for rigid cellular plastic as absorption and for mineral fiber board as adsorption. Delete item e. or f. below if only one material is allowed.

****

[e. Water Absorption: Not more than [2] [_____] percent by total immersion, by volume, when measured according to ASTM C272/C272M.

][f. Water Adsorption: Not more than [1] [_____] percent by volume when measured in accordance with paragraph 14 of ASTM C553.

]2.1.4 Premolded Concrete Masonry Insert

Provide in accordance with ASTM C578 REV A. Provide inserts in concrete masonry units that are installed at the masonry unit manufacturing plant. Provide insert with thickness of not less than 32 mm 1 1/4 inches.

2.1.5 Recycled Materials

Provide thermal insulation containing recycled materials to the extent practicable, provided that the material meets all other requirements of this section. The minimum required recycled material contents (by weight, not volume) are:

Polyisocyanurate/Polyurethane:	9 percent
Phenolic Rigid Foam:	5 percent
Perlite Board:	23 percent post consumer paper

Provide data identifying percentage of recycled content for block or board insulation.

2.1.6 Indoor Air Quality

Provide certification of indoor air quality for block or board insulation.

2.1.7 Prohibited Materials

Do not provide materials containing asbestos.

[2.2 VAPOR RETARDER AND DAMPPROOFING

****

NOTE:

1. Determine the need for a water vapor retarder and its required permeance value based on project requirements and climate specific moisture analysis as required by UFC 3-101-01 Architecture. For guidance see ASHRAE Handbook of Fundamentals, Chapter 25, "Heat, Air, and Moisture Control in Building Assemblies - Fundamentals;" and ASTM C755, "Selection of Vapor Retarders for Thermal Insulations". The need for a vapor retarder and its permeance must be evaluated in the moisture analysis with the Air and Moisture Barrier system specified. The computer Program "MOIST" is a user-friendly tool based on hourly weather data that provides information on moisture content of materials and on the duration of high moisture content excursions. Traditionally, vapor retarders for walls and roofs were considered materials having a permeance of 5.72 by 10-8 g/Pa.s.m2 one Perm (grain/h*ft2*in.Hg) or less. Vapor retarders under slabs are typically specified as 1.14 by 10-8 g/Pa.s.m2 (0.2 Perm) or less. However, these values may not be adequate for a particular project or climate and in some instances a much lower value should be specified.

2. Vapor retarders, where required, can be provided as membranes or, alternatively, vapor retardant finishes labeled by the manufacturer as having a water vapor permeance of no more than the required value. Alternate materials include: coatings or foil-faced gypsum board. Specify these in Section 09 90 00 PAINTS AND COATINGS or Section 09 29 00 GYPSUM BOARD respectively, and delete all paragraphs and references relating to vapor retarders from this

section.

3. A vapor retarder is only effective if it prevents diffusion of water vapor as well as the passage of moisture laden air through openings and around material. Accordingly, proper installation to assure air tightness by sealing of joints, tears, and around utility penetrations is as important as proper selection of water vapor retarder materials. Coordinate specifications to comply with UFC 3-101-01 Architecture, Chapter Exterior Walls.

4. Vapor retarders not only retard movement of water vapor into building envelope assemblies and cavities, but also retard drying of moisture that may have infiltrated these areas. Therefore, use vapor retarders only when and where the moisture analysis indicates they are necessary.

****

2.2.1 Vapor Retarder in Framed Walls and Roofs

[a. 0.15 mm 6 mil thick polyethylene sheeting conforming to ASTM D4397 and having a water vapor permeance of 5.72 by 10-8g/Pa.s.m2 one Perm or less when tested in accordance with ASTM E96/E96M.

][b. Membrane with the following properties:

(1) Water Vapor Permeance: ASTM E96/E96M: 5.72 by 10-8 g/Pa.s.m2 [1] [_____] Perm

(2) Maximum Flame Spread: ASTM E84: [25] [50] [_____]

(3) Combustion Characteristics: Passing ASTM E136

(4) Puncture Resistance: TAPPI T803 OM: [15] [25] [50]

][2.2.2 Dampproofing for Masonry Cavity Walls

[Bituminous material is specified in Section 07 11 13 BITUMINOUS DAMPPROOFING.] [Parging material is specified in Section 04 20 00 MASONRY.]

][2.2.3 Vapor Retarder under Floor Slab

a. Water vapor permeance: 1.14 by 10-8 g/Pa.s.m2 0.2 Perm or less when tested in accordance with ASTM E96/E96M.

b. Puncture resistance: Maximum load no less than 18 kilograms 40 pounds when tested according to ASTM E154/E154M REV A.

]]2.3 PRESSURE SENSITIVE TAPE

As recommended by manufacturer of vapor retarder(s). Match water vapor permeance rating for each vapor retarder specified. Provide tape in accordance with ASTM D3833/D3833M.

2.4 PROTECTION BOARD OR COATING

As recommended by insulation manufacturer.

2.5 ACCESSORIES

2.5.1 Adhesive

As recommended by insulation manufacturer.

2.5.2 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

****

Note: For retrofit projects, inspect facility to determine conditions which may adversely affect execution of work or create safety hazard. Identify relevant conditions on the drawings and, if required, develop additional specification sections for corrective actions. Conditions that warrant investigation:

1. Discolorations or mold growth indicating previous water leaks.

2. Heat producing devices, such as recessed lighting fixtures, chimneys, and flues.

3. Faulty electrical systems:

(a) Lights dimming or flickering

(b) Fuses blowing

(c) Circuit breakers tripping frequently

(d) Electrical sparks and "glowing" from receptacles

(e) Cover plates on switches and outlets warm to touch.

****

Prior to installation, ensure all areas that will be in contact with the insulation are dry and free of projections that could cause voids, compressed insulation, or punctured vapor retarders. For foundation perimeter or under slab applications, check that subsurface fill is flat, smooth, dry, and well tamped. Do not proceed with installation if moisture or other conditions are present and notify the Contracting Officer of such conditions. Do not proceed with the work until conditions have been corrected and verified to be dry.

3.2 PREPARATION

3.2.1 Blocking Around Heat Producing Devices

Provide noncombustible blocking at all spaces between heat producing devices and the floors, ceilings and roofs through which they pass.

Provide in accordance with ICC IBC Section 2111.13 Fireplace Fireblocking and with the following clearances:

a. Recessed lighting fixtures, including wiring compartments, ballasts, and other heat producing devices, unless certified for installation surrounded by insulation: 75 mm 3 inches from outside face of fixtures and devices or as required by NFPA 70 and, if insulation is placed above fixture or device, 600 mm 24 inches above fixture.

b. Masonry chimneys or masonry enclosing a flue: 50 mm 2 inches from outside face of masonry. Masonry chimneys for medium and high heat operating appliances: Minimum clearances required by NFPA 211.

c. Vents and vent connectors used for venting products of combustion, flues, and chimneys other than masonry chimneys: Minimum clearances as required by NFPA 211.

d. Gas Fired Appliances: Clearances as required in NFPA 54.

e. Oil Fired Appliances: Clearances as required in NFPA 31.

Blocking is not required if chimneys or flues are certified in writing by the chimney or flue manufacturer for use in contact with specific insulating materials.

3.3 INSTALLATION

3.3.1 Insulation Installation and Handling

Provide insulation in accordance with the manufacturer's printed installation instructions. Keep material dry and free of extraneous materials.

3.3.2 Electrical Wiring

Do not install insulation in a manner that would enclose electrical conductors, that are not installed in conduit, between two layers of insulation.

[3.3.3 Cold Climate Requirement

****

NOTE: Include this paragraph in ASHRAE climate zones 4 and higher, as identified in ASHRAE 90.1.

****

Place insulation on the outside of pipes.

]3.3.4 Continuity of Insulation

Butt tightly against adjoining boards, studs, rafters, joists, sill plates, headers and obstructions. Provide continuity and integrity of insulation at corners, wall to ceiling joint, roof, and floor. Avoid creating thermal bridges and voids. Provide and verify continuity of insulative barrier throughout the building enclosure.

****

NOTE: Foil sided board reflects heat. Indicate on drawings the side on which the foil is to be faced.

Coordinate use with mechanical designer.

To avoid thermal bridging, verify the drawings provide a layer of continuous insulation over studs.

****

3.3.5 Coordination

Verify final installed insulation thicknesses comply with thicknesses indicated and with the approved insulation submittal(s).

3.4 INSTALLATION ON WALLS

3.4.1 Installation using Furring Strips

Install insulation [between] [on] members as recommended by insulation manufacturer.

3.4.2 Installation on Masonry Walls

****

NOTE: Use the first paragraph below for insulation on the outside or inside of masonry walls. Use the second paragraph for insulating individual masonry units within their hollow cores. Insulating just the cores can lead to thermal bridges and condensation at the web locations of the masonry units.

****

[Apply board directly to masonry with adhesive or fasteners as recommended by the insulation manufacturer. Fit between obstructions without impaling board on ties or anchors. Apply in parallel courses with joints breaking midway over course below. Place boards in moderate contact with adjoining insulation without forcing and without gaps. Cut and shape as required to fit around wall penetrations, projections or openings to accommodate conduit or other utilities. Seal around cutouts with sealant. Install insulation in wall cavities so that it leaves at least a nominal 25 mm one inch air space outside of the insulation to allow for cavity drainage.

][Insert premolded or board insulation into masonry unit hollow cores as recommended by the insulation manufacturer.

]3.4.3 Adhesive Attachment to Concrete and Masonry Walls

Apply adhesive to wall and completely cover wall with insulation.

[a. Full back bed method [or]

][b. Spot method: Provide at least six spots having diameter of approximately 100 mm 4 inches, located at each corner and mid points of each of the longer sides of each board.

][c. As recommended by the insulation manufacturer.

] d. Use only full back method for pieces of 0.1 square meter one square foot or less.

e. Butt all edges of insulation and seal edges with tape.

3.4.4 Mechanical Attachment on Concrete and Masonry Walls

Cut insulation to cover walls. Apply adhesive to wall and set clip or other mechanical fastener in adhesive as recommended by manufacturer. After curing of adhesive, install insulation over fasteners and bend split prongs to provide a flush condition with the insulation. Butt all edges of insulation and seal with tape.

[3.4.5 Protection Board or Coating Installation

Install protection board or coating in accordance with manufacturer's printed instructions. Install protection over all exterior exposed insulation and to 300 mm one foot below grade.

]3.5 INSTALLATION ON UNDERSIDE OF CONCRETE FLOOR SLAB

[3.5.1 Mechanically Fastened Systems

Size insulation to cover underside of slab. Apply adhesive to slab and set fasteners in adhesive as recommended by manufacturer. After curing of adhesive, install insulation over fasteners and bend split prongs to provide a flush condition with the insulation. Butt all edges of insulation and seal with tape.

][3.5.2 Adhesively Bonded Systems

Apply adhesive to underside of slab and completely cover wall with insulation.

[a. Full back bed method [or]

][b. Spot method: Provide at least six spots having a diameter of approximately 100 mm 4 inches, located at each corner and mid-point of each of the longer sides.

][c. As recommended by insulation manufacturer.

] d. Use full back method for insulation pieces 0.1 square meter one square foot or less.

e. Butt all edges of insulation and seal with tape.

]3.6 PERIMETER AND UNDER SLAB INSULATION

Install perimeter thermal insulation where heated spaces are adjacent to exterior walls, slab edges in slab-on-grade, or floating slab construction.

****

NOTE: Provide for and coordinate foundation draining as required by insulation manufacturer.

Provide R-Values and extent in accordance with the requirements of ASHRAE 90.1 for the project-specific climate zone.

****

3.6.1 Manufacturer's Instructions

Layout insulation, tape edges, provide vapor retarder and other required accessories to protect against vermin, insects, and damage in accordance with manufacturer's printed instructions.

[3.6.2 Insulation on Vertical Surfaces

Provide thermal insulation [on exterior of foundation walls] [on grade beams] [partially] [below grade] [and] [on edges of slabs-on-grade.] Fasten insulation with [adhesive] [or] [mechanical fasteners].

][3.6.3 Insulation Under Slab

Provide insulation horizontally under [entire] slab on grade[for a distance of [_____] mm feet from the edge of slab].[Turn insulation up at slab edge, and extend full height of slab.] Install insulation on top of vapor retarder and turn retarder up over the outside edge of insulation to top of slab.

][3.6.4 Protection of Insulation

Protect insulation from damage during construction and back filling by application of protection board or a coating. Do not leave installed vertical insulation unprotected overnight. Protect installed insulation from weather, including rain and ultraviolet light, from mechanical abuse, compression, and dislocation.[Install protection over entire exposed exterior insulation board.][Extend protection at least 300 mm one foot below grade.]

][3.7 VAPOR RETARDER

Apply vapor retarder continuous across all surfaces. Overlap all joints at least 150 mm 6 inches and seal with pressure sensitive tape. Seal at sills, header, windows, doors and utility penetrations. Repair punctures or tears with pressure sensitive tape.

][3.8 ACCESS PANELS AND DOORS

Attach insulation to all access panels greater than 0.1 square meter one square foot and all access doors in insulated floors and ceilings. Use insulation with same R-Value as that for the floor or ceiling in which each panel occurs.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 21 16 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 21 16 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 21 16 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
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****

SECTION 07 21 16

MINERAL FIBER BLANKET INSULATION

08/23

****

NOTE: This guide specification covers the requirements for mineral fiber blanket thermal insulation in attics, ceilings, walls, and floors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification is intended for both retrofit of existing buildings and new construction.

****

****

NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to ASHRAE 90.1 and IgCC governing energy efficiency and requirements for the components of building envelope design including moisture control and thermal performance.

****

****

NOTE: On the drawings, show:

1. Locations where insulation will be used.

2. Thermal resistance value (R-Value) for each location.

3. Location of vapor retarder, if required.

4. Location and size of attic ventilation openings where required.

****

****

NOTE: Attic Ventilation

1. Provide net, unobstructed ventilation areas to attics over insulated ceilings as recommended by International Building Code (IBC) paragraph 1202.2 Roof Ventilation, UFC 1-200-02 High Performance and Sustainable Building Requirements, "Optimize Energy Performance" and "Enhance Indoor Environmental Quality", and as follows:

2. For attics with vapor retarder, provide 0.1 square meter one square foot of net ventilation area for each 30 square meters 300 square feet of attic floor area.

3. For attics without vapor retarder, provide 0.1 square meter one square foot of net ventilation area for each 15 square meters 150 square feet of attic floor area.

4. For insulation of cathedral ceilings, provide a minimum 50 mm 2 inch air space between upper face of insulation and underside of roof deck for ventilation. Provide ventilation openings at the bottom and top of ventilation cavity; show depth of ventilation cavity and identify locations for bottom and top ventilation on drawings.

****

****

NOTE: Develop and specify density, type of material, and thickness of mineral fiber blanket insulation used for sound control based on acoustic analysis. For reduction of sound transmission through walls, select a blanket thickness 13 mm 1/2 inch greater than the wall cavity. Edit this specification accordingly.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C665	(2024) Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C930	(2019) Standard Classification of Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories
ASTM D3575	(2020) Standard Test Methods for Flexible Cellular Materials Made from Olefin Polymers
ASTM D3833/D3833M	(1996; R 2019) Standard Test Method for Water Vapor Transmission of Pressure-Sensitive Tapes
ASTM D4397	(2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D5359	(1998; R 2021) Standard Specification for Glass Cullet Recovered from Waste for Use in Manufacture of Glass Fiber
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building

	Materials
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T803 OM	(2010) Puncture Test of Container Board

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Blanket Insulation; G, [_____]

Recycled Content for Insulation Materials; S

Energy Star Label for Insulation Materials; S

[Sill Sealer Insulation

][Vapor Retarder

] Pressure Sensitive Tape

Accessories

SD-07 Certificates

[Indoor Air Quality for Insulation Materials; S

] Indoor Air Quality for Adhesives; S

SD-08 Manufacturer's Instructions

Insulation

1.3 CERTIFICATIONS

Submit required indoor air quality certifications and validations in one submittal package.

1.3.1 Insulation Products

Provide product certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification from certification body.

1.3.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials to site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type, grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

1.4.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

1.5 SAFETY PRECAUTIONS

1.5.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) in accordance with 29 CFR 1910.134.

1.5.2 Other Safety Concerns

Consider other safety concerns and measures as outlined in ASTM C930.

PART 2 PRODUCTS

2.1 BLANKET INSUALTION

****

NOTE: Fire Safety Requirements

1. Most vapor retarder materials and the binder used in some mineral fiber insulations are combustible. Do not leave such material exposed to accessible spaces, but cover with fire retardant finish.

2. See UFC 3-600-01, "Fire Protection Engineering for Facilities" and local building code for fire retardant classifications required, flame spread and smoke developed ratings, and other fire protection requirements, such as finish materials required in various occupancies.

****

ASTM C665, Type [I, blankets without membrane coverings] [and] [II, blankets with non-reflecting coverings] [and] [III, blankets with reflective coverings]; Class [A, membrane-faced surface with a flame spread of 25 or less] [B, membrane-faced surface with a flame propagation resistance; critical radiant flux of 0.12 W/cm2 0.11 Btu/ft2 or greater], except a flame spread rating of [25] [75] [100] or less [and a smoke developed rating of 150 or less] when tested in accordance with ASTM E84.

****

NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to ASHRAE 90.1 and IgCC documents governing energy efficiency and requirements for the components of building envelope design including thermal performance.

Select R-Value for Thermal Insulation required to meet the energy target/budget. Show R-Value on Drawings.

****

Provide insulation with R-Value as indicated on drawings

2.1.1 Recycled Materials

Provide insulation materials containing the following minimum percentage of recycled material content by weight:

a. Fiberglass: 20 percent glass cullet complying with ASTM D5359

b. Mineral wool: 75 percent recovered materials content from slag

Provide data identifying percentage of recycled content for insulation materials.

2.1.2 Energy Star

Provide insulation materials that are Energy Star labeled. Provide data identifying Energy Star label for insulation materials.

2.1.3 Prohibited Materials

Do not provide asbestos-containing materials.

[2.1.4 Reduced Volatile Organic Compounds (VOC) for Insulation Materials

****

NOTE: Include this paragraph when utilizing a fiberglass batt insulation, for which Greenguard certified products are widely available through national manufacturers. For use of mineral wool insulation, for which certified products are not as widely available, editor must first confirm the availability of Greenguard certified products prior to including this paragraph.

****

Provide certification of indoor air quality for insulation materials.

][2.2 SILL SEALER INSULATION

****

NOTE: Polyethylene foam sill sealer can be used to reduce air leakage between the foundation wall and sill plate. The sill sealer can also be used as a seal around window and door frames.

****

Provide polyethylene foam sill sealer [89] [139] [190] [241] millimeters [3.5] [5.5] [7.5] [9.5] inches in width with the following characteristics:.

Physical Properties	Test Method	Measurement
Nominal Thickness	ASTM D3575	4.76 mm 3/16 inch
Compressive Strength	ASTM D3575	8.27 kPa 1.2 psi
- Vertical Direction	Suffix D	
Tensile Strength	ASTM D3575	220 kPa 32 psi
	Suffix T	

]2.3 BLOCKING

Wood, metal, unfaced mineral fiber blankets in accordance with ASTM C665, Type I, or other approved materials. Use only non-combustible materials meeting the requirements of ASTM E136 for blocking around chimneys and heat producing devices.

[2.4 VAPOR RETARDER

****

NOTE:

1. Determine the need for a water vapor retarder and its required permeance value based on a project and climate specific moisture analysis as required by UFC 3-101-01 Architecture. For guidance, see ASHRAE Handbook of Fundamentals, Chapter 25, "Heat, Air, and Moisture Control in Building Assemblies - Fundamentals;" Chapter 26 "Heat, Air, and Moisture Control in Building Assemblies - Material Properties"; and ASTM C755, "Selection of Vapor Retarders for Thermal Insulations". The need for a vapor retarder and its' permeance must be evaluated in the moisture analysis with the Air and Moisture Barrier system specified. The computer Program "MOIST" is a user-friendly tool based on hourly weather data that provides information on moisture content of materials and on the duration of high moisture content excursions. Traditionally, vapor retarders were considered materials having a permeance of 5.72 by 10-8 g/Pa.s.m2 one perm (grain/h*ft2*in.Hg) or less. However, that value may not be adequate for the particular construction or climate and in some instances a much lower value should be specified.

2. Vapor retarders, where required, can be provided as membranes or, alternatively, vapor retardant finishes labeled by manufacturer as having a water vapor permeance of no more than the required value can be used. Alternate materials include: Paints, or foil-faced gypsum board. Specify these in Section 09 90 00 PAINTS AND COATINGS or Section 09 29 00 GYPSUM BOARD, respectively, and delete all paragraphs and references relating to vapor retarders from this section.

3. A vapor retarder is only effective if it prevents diffusion of water vapor as well as the passage of moisture laden air through openings and around material. Accordingly, proper installation to assure air tightness by sealing of joints, tears, and around utility penetrations is as important as proper selection of water vapor retarder materials.

4. Vapor retarders not only retard movement of water vapor into building envelope cavities, but also retard drying out of moisture that may have infiltrated the cavity. Accordingly, use vapor retarders only where their need is indicated by the moisture analysis.

****

[a. 0.15 mm 6 mil thick polyethylene sheeting conforming to ASTM D4397 and having a water vapor permeance of 57.2 ng/(Pa * s * m2) one perm or less when tested in accordance with ASTM E96/E96M.

][b. Membrane with the following properties:

[Water Vapor Permeance: ASTM E96/E96M: 57.2 ng/(Pa * s * m2) [1] [_____] perm

][Maximum Flame Spread: ASTM E84: [25] [50] [_____]

][Combustion Characteristics: Passing ASTM E136

][Puncture Resistance: TAPPI T803 OM: [15] [25] [50]

]]]2.5 PRESSURE SENSITIVE TAPE

As recommended by the vapor retarder manufacturer and having a water vapor permeance rating of 57.2 ng/(Pa * s * m2) one perm or less when tested in accordance with ASTM D3833/D3833M.

2.6 ACCESSORIES

2.6.1 Adhesive

As recommended by the insulation manufacturer. Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

2.6.2 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

2.6.3 Wire Mesh

Corrosion resistant and as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

****

Note: For retrofit projects, inspect facility to determine conditions which may adversely affect execution of work or create safety hazard. Identify relevant conditions on the drawings and, if required, develop additional specification sections for corrective actions. Conditions that warrant investigation:

1. Discolorations or mold growth indicating previous water leaks.

2. Heat producing devices, such as recessed lighting fixtures, chimneys, and flues.

3. Faulty electrical systems:

(a) Lights dimming or flickering

(b) Fuses blowing

(c) Circuit breakers tripping frequently

(d) Electrical sparks and "glowing" from receptacles

(e) Cover plates on switches and outlets warm to touch.

****

Before installing insulation, ensure that surfaces that will be in contact with the insulation are dry and free of projections which could cause voids, compressed insulation, or punctured vapor retarders. If moisture or other conditions are found that do not allow the workmanlike installation of the insulation, do not proceed but notify Contracting Officer of such conditions.

3.2 PREPARATION

3.2.1 Blocking at Attic Vents and Access Doors

Prior to installation of insulation, install permanent blocking to prevent insulation from slipping over, clogging, or restricting air flow through soffit vents at eaves.[Install permanent blocking around attic trap doors.][Install permanent blocking to maintain accessibility to equipment or controls that require maintenance or adjustment.]

3.2.2 Blocking Around Heat Producing Devices

Install non-combustible blocking around heat producing devices to provide the following clearances:

a. Recessed lighting fixtures, including wiring compartments, ballasts, and other heat producing devices, unless these are certified by the manufacturer for installation surrounded by insulation: 75 mm 3 inches from outside face of fixtures and devices or as required by NFPA 70 and, if insulation is to be placed above fixture or device, 600 mm 24 inches above fixture.

b. Masonry chimneys or masonry enclosing a flue: 50 mm 2 inches from outside face of masonry. Masonry chimneys for medium and high heat operating appliances: Minimum clearances required by NFPA 211.

c. Vents and vent connectors used for venting the products of combustion, flues, and chimneys other than masonry chimneys: Minimum clearances as required by NFPA 211.

d. Gas Fired Appliances: Clearances as required in NFPA 54.

e. Oil Fired Appliances: Clearances as required in NFPA 31.

Blocking around flues and chimneys is not required when insulation blanket, including any attached vapor retarder, passes ASTM E136, in addition to meeting other requirements stipulated in Part 2. Blocking is also not required if the chimneys are certified by the manufacturer for use in contact with insulating materials.

3.3 INSTALLATION

3.3.1 Insulation

Install and handle insulation in accordance with manufacturer's instructions. Keep material dry and free of extraneous materials. Any materials that show visual evidence of biological growth due to presence of moisture must not be installed on the building project. Ensure personal protective clothing and respiratory equipment is used as required. Observe safe work practices.

3.3.1.1 Electrical wiring

Do not install insulation in a manner that would sandwich electrical conductors, that are not installed in conduit, between two layers of insulation.

3.3.1.2 Continuity of Insulation

Install blanket insulation to butt tightly against adjoining blankets and to studs, rafters, joists, sill plates, headers and any obstructions. [Where insulation required is thicker than depth of joist, provide full width blankets to cover across top of joists.] Provide continuity and integrity of insulation at corners, wall to ceiling joints, roof, and floor. Avoid creating thermal bridges.

3.3.1.3 Installation at Bridging and Cross Bracing

****

NOTE: Specify only unfaced blankets in installations with bridging and cross bracing. If a vapor retarder is required, specify a separate vapor retarder.

****

Insulate at bridging and cross bracing by splitting blanket vertically at center and packing one half into each opening. Butt insulation at bridging and cross bracing; fill in bridged area with loose or scrap insulation.

[3.3.1.4 Cold Climate Requirement

****

NOTE: Include this paragraph in ASHRAE climate zones 4 and higher, as identified in ASHRAE 90.1.

****

Place insulation to the outside of pipes.

][3.3.1.5 Insulation Blanket with Affixed Vapor Retarder

Locate vapor retarder as indicated. Do not install blankets with affixed vapor retarders unless so specified. Unless the insulation manufacturer's instructions specifically recommend not to staple the flanges of the vapor retarder facing, staple flanges of vapor retarder at 150 mm 6-inch intervals flush with face or set in the side of truss, joist, or stud. Avoid gaps and bulges in insulation and "fishmouth" in vapor retarders. Overlap both flanges when using face method. Seal joints and edges of vapor retarder with pressure sensitive tape. Stuff pieces of insulation into small cracks between trusses, joists, studs and other framing, such as at attic access doors, door and window heads, jambs, and sills, band joists, and headers. Cover these insulated cracks with vapor retarder material and tape joints with pressure sensitive tape to provide air and vapor tightness.

][3.3.1.6 Insulation without Affixed Vapor Retarder

Provide snug friction fit to hold insulation in place. Stuff pieces of insulation into cracks between trusses, joists, studs and other framing, such as at attic access doors, door and window heads, jambs, and sills, band joists, and headers.

]3.3.1.7 Sizing of Blankets

Provide only full width blankets when insulating between trusses, joists, or studs. Size width of blankets for a snug fit where trusses, joists or studs are irregularly spaced.

[3.3.1.8 Special Requirements for Ceilings

Place insulation under electrical wiring occurring across joists. Pack insulation into narrowly spaced framing. Do not block flow of air through soffit vents. [Attach insulation to attic door by adhesive or staples.]

][3.3.1.9 Installation of Sill Sealer

Size sill sealer insulation and place insulation over top of masonry or concrete perimeter walls or concrete perimeter floor slab on grade. Fasten sill plate over insulation.

][3.3.1.10 Special Requirements for Floors

Hold insulation in place with corrosion resistant wire mesh, wire fasteners, or wire lacing.

][3.3.1.11 Access Panels and Doors

Affix blanket insulation to access panels greater than one square foot and access doors in insulated floors and ceilings. Use insulation with same R-Value as that for floor or ceiling.

][3.3.2 Installation of Separate Vapor Retarder

Apply continuous vapor retarder as indicated. Overlap joints at least 150 mm 6 inches and seal with pressure sensitive tape. Seal at sill, header, windows, doors and utility penetrations. Repair punctures or tears with pressure sensitive tape.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 21 23 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 21 23 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 07 21 23

LOOSE FILL THERMAL INSULATION

08/23

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 21 23 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 21 23

LOOSE FILL THERMAL INSULATION

08/23

****

NOTE: This guide specification covers the requirements for loose fill cellulosic and mineral fiber insulation materials in attics, ceilings, and framed walls and mineral granular in masonry walls.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification is intended for both retrofit of existing buildings and new construction.

****

****

NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements with UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to ASHRAE 90.1 and IgCC documents governing energy efficiency and requirements for the components of building envelope design including moisture control and thermal performance.

****

****

NOTE: On the drawings, show:

1. Locations where insulation will be used.

2. Thermal resistance value (R-Value) for each location.

3. Location of vapor retarder, if required.

4. Location and size of attic ventilation openings where required.

****

****

NOTE: Attic Ventilation

Provide net, unobstructed ventilation areas to attics over insulated ceilings as recommended by International Building Code (IBC) paragraph 1202.2 Roof Ventilation, UFC 1-200-02, High Performance and Sustainable Building Requirements, "Optimize Energy Performance" and "Enhance Indoor Environmental Quality", and as follows:

1. For attics with vapor retarder, provide 0.1 square meter one square foot of net ventilation area for each 30 square meters 300 square feet of attic floor area.

2. For attics without vapor retarder, provide 0.1 square meter one square foot of net ventilation area for each 15 square meters 150 square feet of attic floor area.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile

references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C516	(2019) Standard Specification for Vermiculite Loose Fill Thermal Insulation
ASTM C549	(2023) Standard Specification for Perlite Loose Fill Insulation
ASTM C665	(2024) Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C739	(2024) Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation
ASTM C764	(2019) Standard Specification for Mineral Fiber Loose-Fill Thermal Insulation
ASTM C930	(2019) Standard Classification of Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories
ASTM C1015	(2017) Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation
ASTM D3575	(2020) Standard Test Methods for Flexible Cellular Materials Made from Olefin Polymers
ASTM D3833/D3833M	(1996; R 2019) Standard Test Method for Water Vapor Transmission of Pressure-Sensitive Tapes
ASTM D4397	(2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T803 OM	(2010) Puncture Test of Container Board

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1209	Interim Safety Standard for Cellulose Insulation
16 CFR 1404.4	Requirements to Provide Performance and Technical Data by Labeling - Notice to Purchasers
29 CFR 1910.134	Respiratory Protection

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

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SD-03 Product Data

Loose Fill Insulation; G, [_____]

Recycled Content for Insulation Materials; S

[Sill Sealer Insulation

] Vapor Retarder

Pressure Sensitive Tape

SD-07 Certificates

Indoor Air Quality for Insulation Materials; S

SD-08 Manufacturer's Instructions

Loose Fill Insulation

[1.3 CERTIFICATIONS

****
NOTE: Include this paragraph when a fiberglass loose fill insulation product is desired, for which Greenguard certified products are available through national manufacturers. For use of mineral wool or cellulose insulation, for which certified products are not as widely available, editor must first confirm the availability of Greenguard certified products prior to including this paragraph.
****

Submit required indoor air quality certifications and validations in one submittal package.

Provide product certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification from certification body.

]1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials to the site in original sealed containers or packages, each bearing manufacturer's name and brand designation, referenced specification number, type, and class, as applicable; recommended method of installation (pneumatic or pouring); minimum net weight of insulation; coverage charts; R-values; and, for cellulose insulation, a label certifying that the product meets Consumer Product Safety Commission (CPSC) Interim Safety Standard for Cellulose Insulation, 16 CFR 1209, and cautionary label regarding potential fire hazard as required in 16 CFR 1404.4.

1.4.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

1.5 SAFETY PRECAUTIONS

1.5.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) in accordance with 29 CFR 1910.134.

1.5.2 Other Safety Concerns

Consider other safety concerns and measures as outlined in ASTM C930.

PART 2 PRODUCTS

2.1 LOOSE FILL INSULATION

****

NOTE: Cellulose insulation can absorb more moisture than mineral fiber. Include both insulation types in locations where moisture is not a problem. Specify mineral fiber for damp locations. Specify vermiculite or perlite only for masonry cavities or concrete block cores.

****

Provide loose fill insulation conforming to [one of] the following:

****

NOTE: The flame spread and smoke development rating will depend on the building occupancy in the areas where the insulation is located.

See UFC 3-600-01, "Fire Protection Engineering for Facilities" and local building code for fire retardant classifications required, flame spread and smoke developed ratings and distance of insulation and vapor retarder from heat producing devices and other fire protection requirements, such as finish materials required in various occupancies.

Most vapor retarder materials and some thermal insulations are combustible. Do not leave such materials exposed to accessible spaces, but cover with a fire retardant finish.
****

[a. Mineral Fiber Loose Fill: ASTM C764, Type I, for pneumatic application, or II, for poured application, category [1] [2].

][b. Cellulosic or Wood Fiber Loose Fill: ASTM C739 or 16 CFR 1209.

][c. Granular Mineral Loose Fill: ASTM C516 type II vermiculite or ASTM C549 types II or IV perlite.

] **
NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to ASHRAE 90.1 and IgCC documents governing energy efficiency and requirements for the components of building envelope design including thermal performance.

Select R-Value for Thermal Insulation required to meet the energy target/budget. Show R-Value on Drawings.
****

The R-Value must be as indicated on drawings. The R-value must be the value the product achieves after settlement.

2.1.1 Recycled Materials

****
NOTE: Certain insulation products are required to conform to the U.S. Environmental Protection Agency Comprehensive Procurement Guidelines (CPG) for Construction Products; the recycled content thresholds in this paragraph are based on the stated EPA requirements. These requirements can be found at https://www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at https://www.epa.gov/. Other products with recycled content are also acceptable when meeting all requirements of this specification. Research shows the products are available from U.S. national manufacturers above the minimum recycled content

stated. Some manufacturers and regions have higher percentages.
****

Based on material composition, provide insulation materials containing the following minimum percentage of recycled material content:

Rockwool:	75 percent slag
Fiberglass:	20 percent glass cullet
Cellulose:	75 percent post-consumer paper

Provide data identifying percentage of recycled content for insulation materials.

2.1.2 Prohibited Materials

a. Asbestos-containing materials

b. Urea Formaldehyde containing materials

c. Ammonium Sulfate containing material

2.1.3 Reduced Volatile Organic Compounds (VOC) for Insulation Materials

Provide certification of indoor air quality for insulation materials.

[2.2 SILL SEALER INSULATION

****
NOTE: Polyethylene foam sill sealer can be used to reduce air leakage between the foundation wall and sill plate. The sill sealer can also be used as a seal around window and door frames.
****

Provide polyethylene foam sill sealer [89] [139] [190] [241] millimeters [3.5] [5.5] [7.5] [9.5] inches in width with the following characteristics:

Physical Properties	Test Method	Measurement
Nominal Thickness	ASTM D3575	4.76 mm 3/16 inch
Compressive Strength	ASTM D3575	8.27 kPa 1.2 psi
- Vertical Direction	Suffix D	
Tensile Strength	ASTM D3575	220 kPa 32 psi
	Suffix T	

]2.3 BLOCKING

Wood, metal, unfaced mineral fiber blanket material in accordance with ASTM C665, Type I, or other approved materials. Provide only non-combustible materials (based on determination by ASTM E136 for blocking around chimneys and heat producing devices.

[2.4 VAPOR RETARDER

****

NOTE:

1. Determine the need for a water vapor retarder and its required permeance value based on a project and climate specific moisture analysis as required by UFC 3-101-01 Architecture. For further guidance see ASHRAE Handbook of Fundamentals, Chapter 25 "Heat, Air, and Moisture Control in Building Assemblies - Fundamentals", Chapter 26 "Heat, Air, and Moisture Control in Building Assemblies - Material Properties"; and ASTM C755, "Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation". The need for a vapor retarder and its' permeance must be evaluated in the moisture analysis with the Air and Moisture Barrier system specified. The computer Program "MOIST" is a user-friendly tool based on hourly weather data that provides information on moisture content of materials and on the duration of high moisture content excursions. Traditionally, vapor retarders were considered materials having a permeance of 5.72 by 10-8 g/Pa.s.m2 one perm (grain/h*ft2*in.Hg) or less. However, that value may not be adequate for the particular construction or climate and in some instances a much lower value should be specified.

As a schematic understanding and not to supersede the determination requirements stated above; within the United States, vapor retarders are typically installed on the warm side of insulation in the Department of Energy's Climate Zones, cold climate zones of 5, 6, 7 and Marine 4. In warm climate zones of 1, 2, 3, and 4 avoid the use of very low, less than 1 Perm vapor retarders on interior face of walls.

2. Vapor retarders, where required, can be provided as membranes or, alternatively, vapor retardant finishes labeled by manufacturer as having a water vapor permeance of no more than the required value can be used. Alternate materials include: foil-faced gypsum board. Specify these foil-faced gypsum boards in Section 09 29 00 GYPSUM BOARD, and delete all paragraphs and references relating to vapor retarders from this section.

3. A vapor retarder is only effective if it prevents diffusion of water vapor as well as the passage of moisture laden air through openings and around material. Accordingly, proper installation to assure air tightness by sealing of joints, tears, and around utility penetrations is as important as proper selection of water vapor retarder materials.

4. Vapor retarders not only retard movement of water vapor into building envelope cavities, but also retard drying out of moisture that may have infiltrated the cavity. Accordingly, use vapor retarders only where their need is indicated by the moisture analysis.
****

****
NOTE: Do not specify polyethylene membrane and other combustible membranes where they will be exposed to occupied or accessible spaces. Such vapor retarders must be covered to provide fire safety as required by applicable building codes.
****

[a. 0.15 mm thick polyethylene sheeting conforming to ASTM D4397 and having a water vapor permeance of 57.2 ng/(Pa*s*m2) or less when tested in accordance with ASTM E96/E96M.

][b. Membrane with following properties:

Permeance: ASTM E96/E96M, 57.2 ng/(Pa*s*m2)

[Maximum Flame Spread: ASTM E84, [25] [50] [_____]

][Combustion Characteristic: Meet ASTM E136

][Puncture Resistance: TAPPI T803 OM

][- [15] [25] [50] Beach Units (1 Beach Unit is 0.0299 joules)
]]
[a. 6 mil thick polyethylene sheeting conforming to ASTM D4397 and having a water vapor permeance of one perm (grains/(h*ft2*in.Hg) or less when tested in accordance with ASTM E96/E96M.

][b. Membrane with following properties:

Permeance: ASTM E96/E96M, [1] [_____] perm (grains/h*ft2*in.Hg

[Maximum Flame Spread: ASTM E84, [25] [50] [_____]

][Combustion Characteristic: Meet ASTM E136

][Puncture Resistance: TAPPI T803 OM

][- [15] [25] [50] Beach Units (1 Beach Unit is 2.205*10-10 foot/pounds)

]]]2.5 PRESSURE SENSITIVE TAPE

As recommended by the vapor retarder manufacturer and having a water vapor permeance rating of 57.5 ng/(Pa*s*.m2 one perm (grains/h*ft2*in.hg) or less when tested in accordance with ASTM D3833/D3833M.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

****

NOTE: For retrofit projects, inspect facility to determine conditions which may adversely affect execution of work or create safety hazard. Identify relevant conditions on the drawings and, if required, develop additional specification sections for corrective actions. Conditions that warrant investigation:

1. Discolorations or mold growth indicating previous water leaks.

2. Heat producing devices, such as recessed lighting fixtures, chimneys, and flues.

3. Faulty electrical systems:

(a) Lights dimming or flickering

(b) Fuses blowing

(c) Circuit breakers tripping frequently

(d) Electrical sparks and "glowing" from receptacles

(e) Cover plates on switches and outlets warm to the touch.

****

Before installing insulation, verify that all surfaces that will be in contact with the insulation are dry and free of projections which could cause voids, compressed insulation, or punctured vapor retarders. If moisture or other conditions are found that do not allow the workmanlike installation of the insulation, do not proceed but notify the Contracting Officer of such conditions.

3.2 PREPARATION

3.2.1 Blocking at Attic Vents and Access Doors

Prior to installation of insulation, install permanent blocking to prevent insulation from covering, clogging, or restricting air flow through soffit vents at eaves. [Install permanent blocking around attic trap doors.] [Install permanent blocking to maintain accessibility to equipment or controls that require maintenance or adjustment.]

3.2.2 Blocking Around Heat Producing Devices

Install non-combustible blocking around heat producing devices to provide the following clearances:

a. Recessed lighting fixtures, including wiring compartments, ballasts, and other heat producing devices, unless certified for installation surrounded by insulation: 75 mm 3 inches from outside face of fixtures and devices or as required by NFPA 70 and, if insulation is to be placed above fixture or device, 600 mm 24 inches above fixture.

b. Masonry chimneys or masonry enclosing a flue: 50 mm 2 inches from outside face of masonry. Masonry chimneys for medium and high heat operating appliances: Minimum clearances required by NFPA 211.

c. Vents and vent connectors used for venting the products of combustion, flues, and chimneys other than masonry chimneys: minimum clearances as required by NFPA 211.

d. Gas fired appliances: Clearances as required in NFPA 54.

e. Oil fired appliances: Clearances as required in NFPA 31.

Blocking around flues and chimneys is not required if the insulation and vapor retarder, when provided, passed ASTM E136, in addition to meeting other requirements stipulated in Part 2. The blocking is also not required when chimneys are certified by the manufacturer for use in contact with insulating materials.

3.2.3 Protection of Ventilation System

Prior to installation of insulation, inspect existing HVAC equipment and ductwork to ensure that insulation will not infiltrate the air distribution/ventilation system. Where potential infiltration sources have been identified do not install insulation until repairs/modifications have been made to rectify the problem.

3.3 INSTALLATION

3.3.1 Insulation

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NOTE: Include last sentence only in installations of mineral fiber or cellulose insulation.

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Install and handle insulation in accordance with applicable provisions of ASTM C1015, and manufacturer's instructions. Keep material dry and free of extraneous materials. Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project. Ensure personal protective clothing and respiratory equipment is used as required. Observe safe work practices. Use only pneumatic equipment compatible with insulation material. Operate equipment in accordance with the manufacturer's instructions. Do not tamp or rod insulation. [Install insulation using the amount (by weight) of material per square meter foot required to achieve the specified thermal resistance value.]

[3.3.2 [Attics] [and] [Ceilings]

Fill space between [and above] [ceiling joists] [and] [rafters] to provide the specified R-Value. For pneumatic installations, use lowest air pressure allowed by manufacturer's instructions. Do not blow insulation into electrical devices, [soffit vents,] [and] [mechanical vents] which open into attic or other spaces to receive insulation.

[3.3.2.1 Frame Walls

Completely fill wall cavities [except those which serve as air ducts for heating, ventilating, and air conditioning systems]. Locate entry holes in walls where required to permit the complete filling of wall cavities. After opening entry holes, check wall cavity for fire stops and other obstructions. When fire stops or other obstructions prevent complete filling of wall cavity, cut additional entry holes to fill the cavity. Close entry holes using materials compatible with original materials. [Seal entry holes in locations where they penetrate a vapor retarder.]

][3.3.2.2 Masonry Walls

Bring up granular insulation in not more than 600 mm 2 foot lifts as the wall is constructed. Allow the insulation to assume its natural density as it is placed.

]3.3.2.3 Electrical Wiring

Do not install insulation in a manner that would sandwich electrical conductors, that are not installed in conduit, between two layers of insulation.

[3.3.2.4 Cold Climate Requirement

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NOTE: Include this paragraph in ASHRAE climate zones 4 and higher, as identified in ASHRAE 90.1.

****

Place insulation to the outside of all pipes.

][3.3.2.5 Special Requirements for Ceilings

Place insulation under electrical wiring occurring across joists. Pack insulation into narrowly spaced framing. Do not block flow of air through soffit vents.

][3.3.2.6 Installation of Sill Sealer

Size sill sealer insulation and place insulation over top of masonry or concrete perimeter walls or concrete perimeter floor slab on grade. Fasten sill plate over insulation.

][3.3.2.7 Access Panels and Doors

Affix blanket insulation to all access panels and doors greater than 0.1 square meter one square foot in insulated floors and ceilings. Use insulation with same R-Value as that for floor or ceiling.

]][3.3.3 Installation of Vapor Retarder

Apply continuous vapor retarder as indicated. Overlap joints at least 150 mm 6 inches and seal with pressure sensitive tape. Seal at sill, header, windows, doors and utility penetrations. Repair punctures or tears with pressure sensitive tape. Do not install vapor retarders on both sides of insulation.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 22 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 22 00 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-07 22 00 (August 2023)**

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****

SECTION 07 22 00

ROOF AND DECK INSULATION

08/23

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NOTE: This guide specification covers the requirements for insulation materials used below low-slope built-up roofing and single ply roofing systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

Insulation materials applies to both organic and inorganic materials used for thermal protection as part of roofing assemblies or under decks.

In new construction, provide at least a 1 in 24 (40 mm per 1 M)(1/2 inch per foot) slope in the structural deck and use non-tapered insulation. When it is clearly impracticable to provide the required slope or in reroofing where there is insufficient slope, tapered insulation may be used. Also, use tapered insulation for the construction of saddles and crickets to provide slope to drains.

Insulation for steep-slope roof systems including

metal, shingles, slate and tile, and for prefabricated metal buildings is not included in this section. Insulation for Inverted Roof Membrane Assembly (IRMA) (Protected Roof Membrane (PMR)) is not included in this Section. Insulating sheathing, other materials which are not primarily thermal insulating materials, and insulating concrete are also not included. Such products are classified according to their primary use, and should be specified under the appropriate sections. Spray-applied polyurethane foam roof insulation is specified in Section 07 57 13 SPRAYED POLYURETHANE FOAM (SPF)

****

****

NOTE: On the drawings, show:

1. Extent and locations of work.

2. Dimensions when space limitations or construction features govern thickness of insulation materials.

3. Details at cants, edge strips, nailers, curbs, roof penetrations, and wall junctions.

4. Location and spacing of wood nailers.

****

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NOTE: UFC 1-200-02 promotes the use of cool roofing, and increased energy conservation through additional insulation. Design cool roofs following the requirements of UFC 3-110-03 "Roofing", Chapter, Cool Roofs. Design insulation for cool roofs to meet at a minimum the ASHRAE 90.1 Chapter 5 zone requirements. Poor design of cool roofs has resulted in unintended consequences such as condensation below the roofing membrane. Coordinate cool roof design with the mechanical engineer on the project to provide appropriate roof assembly, insulation thickness, surface finishes appropriate to the geographic location and humidity requirements of the project. Verify dewpoint and design the roof assembly accordingly.

Design mechanically-fastened single-ply roof systems following the requirements in UFC 3-110-03 "Roofing." Condensation on the underside of mechanically fastened systems can result in ice buildup in winter, mold growth on the facers, moisture dripping into the interior, and replacement of the roof with less than four years of service. See Appendix B of UFC 3-110-03 for more information.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2017) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM C208	(2022) Standard Specification for Cellulosic Fiber Insulating Board
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C728	(2017a; R 2022) Standard Specification for Perlite Thermal Insulation Board
ASTM C1177/C1177M	(2024) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C1278/C1278M	(2024) Standard Specification for Fiber-Reinforced Gypsum Panel
ASTM C1289	(2023a) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C1902	(2022) Standard Specification for Cellular Glass Insulation Used in Building and Roof Applications

ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D312/D312M	(2016a) Standard Specification for Asphalt Used in Roofing
ASTM D2178/D2178M	(2015a; R 2021) Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM D4601/D4601M	(2004; R 2020) Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
ASTM D4897/D4897M	(2016) Standard Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM 4450	(1989) Approval Standard for Class 1 Insulated Steel Deck Roofs
FM 4470	(2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1	(2021) Fire Code

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

UL SOLUTIONS (UL)

UL 1256	(2023) Fire Test of Roof Deck Constructions
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Insulation Board Layout and Attachment; G, [_____]

Verification of Existing Conditions; G, [_____]

SD-03 Product Data

Insulation; G, [_____]

Cover Board; G, [_____]

Fasteners; G, [_____]

Sheathing Paper; G, [_____]

Moisture Control; G, [_____]

[Asphalt Products; G, [_____]

] Recycled Content For Insulation; S

SD-05 Design Data

Wind Resistance; G, [_____]

SD-06 Test Reports

Flame Spread Rating; G, [_____]

SD-07 Certificates

Installer Qualifications; G, [_____]

Certificates Of Compliance For Felt Materials; G, [_____]

Indoor Air Quality For Insulation; S

Acceptable Foam Blowing Agents; S

SD-08 Manufacturer's Instructions

Nails and Fasteners; G, [_____]

Roof Insulation; G, [_____]

1.3 SHOP DRAWINGS

****

NOTE: Specify shop drawings for wood nailers when nailers are required for securing insulation on roofs sloped 1 in 24 (40 mm per 1 M) (1/2 inch per foot) or more.

Include requirement for backnailing of felts when specified for built-up roofing.

****

Submit insulation board layout and attachment indicating methods of attachment and spacing of fasteners on each board, transitions, tapered components, thicknesses of materials, and closure and termination conditions. Show locations of ridges, valleys, crickets, interface with, and slope to, roof drains. Base shop drawings on verified field measurements and include verification of existing conditions.[Show wood nailers.][Show location and spacing of wood nailers required for securing of insulation [and backnailing of roofing felts]].

1.4 PRODUCT DATA

Include data for material descriptions, recommendations for product shelf life, requirements for cover board or coatings, and precautions for flammability and toxicity. Include data to verify compatibility of sealants with insulation.

1.5 MANUFACTURER'S INSTRUCTIONS

Include field of roof, perimeter, and corner attachment requirements.

Provide a complete description of installation sequencing for each phase of the roofing system. Include weatherproofing procedures.

1.6 QUALITY CONTROL

Provide certification of installer qualifications from the insulation manufacturer confirming the specific installer has the required qualifications for installing the specific roof insulation system(s) indicated.

Provide certificates of compliance for felt materials.

[1.7 WIND RESISTANCE REQUIREMENTS

****

NOTE: FM Approval Guide includes requirements for fasteners for 1-60, 1-90, and 1-120 classifications for resistance to wind uplift pressures. Refer to UFC 3-301-01 "Structural Engineering" for wind loads and specify FM approval accordingly. Note, FM approval numbers do not correspond to wind speeds. Refer to FM Data Sheets for wind design.

****

The complete roof system assembly must be rated and installed to resist wind loads [indicated] [calculated in accordance with ASCE 7] and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Coordinate with roof covering attachment requirements and submit wind resistance test certification, attachment patterns for field, perimeter, and corner roof areas along with perimeter and corner boundary dimensions.

]1.8 FIRE PERFORMANCE REQUIREMENTS

1.8.1 Insulation in Roof Systems

****

NOTE: Include this requirement when insulation is installed over plywood, wood planks other than nominal 50 mm 2 inch thick, tongue-and-groove type, or steel deck.

Coordinate fire performance in insulated roof systems. At a minimum, comply with ICC IBC and UL1256. If the roof assembly requires FM approval, choose the bracketed options.

Thermal barriers are required for nearly all roofing applications where foam plastics are present. Confirm specific project requirements with ICC IBC. For roofing applications, smoke development rating does not apply. The elimination of the thermal barrier is allowed only under very specific conditions therefore do not eliminate unless specifically verified with applicable life safety codes.
****

Comply with the requirements of ICC IBC [or UL 1256] [or FM 4450][or FM 4470]. Roof insulation must have a flame spread rating of 75 or less when tested in accordance with ASTM E84. Additional documentation of compliance with flame spread rating is not required when insulation of the type used for this project as part of the specific roof assembly is listed and labeled as FM Class 1 approved.[Only roof assemblies that pass FM 4450 are permitted.]

1.8.2 Thermal Barrier Requirements

Separate [polyurethane][or][polystyrene] insulation from a [combustible][steel]deck with a thermal barrier of glass mat gypsum roof board or other approved barrier material in accordance with the requirements of the ICC IBC[or FM 4450][or FM 4470][or UL 1256].[Only roof assemblies that pass FM 4450 are permitted.]

****
NOTE: Specify insulated roof assemblies in accordance with UFC 1-200-01 "DoD Building Code", Fire and Smoke Protection section, and UFC 3-600-01 "Fire Protection Engineering for Facilities". Where requirements conflict between UFCs and IBC, UFC 3-600-01 takes precedence; edit the following section accordingly.
****

1.8.3 Fire Resistance Ratings for Roofs

Provide in accordance with ICC IBC Chapter 7 and Table 721.1(3) Min [Fire and Smoke] Protection For Floor and Roof Systems.

1.9 CERTIFICATIONS

Provide products certified to meet indoor air quality requirements by UL 2818(Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification documentation from certification body.

1.10 DELIVERY, STORAGE, AND HANDLING

1.10.1 Delivery

Deliver materials to the project site in manufacturer's unopened and undamaged standard commercial containers bearing the following legible information:

a. Name of manufacturer

b. Brand designation

c. Specification number, type, and class, as applicable, where materials are covered by a referenced specification

[d. Asphalt flashpoint (FP), equiviscous temperature (EVT), and finished blowing temperature (FBT).

] Deliver materials in sufficient quantity to allow continuity of the work.

1.10.2 Storage and Handling

Store and handle materials in accordance with manufacturer's printed instructions. Protect from damage, exposure to open flame or other ignition sources, wetting, condensation, and moisture absorption. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or biological growth. Store in an enclosed building or trailer that provides a dry, adequately ventilated environment.[Store felt rolls on ends. For the 24 hours immediately before application of felts, store felts in an area maintained at a temperature no lower than 10 degrees C 50 degrees F above grade and having ventilation on all sides.] Replace damaged material with new material.

1.11 ENVIRONMENTAL CONDITIONS

As per manufacturer's recommendations or Government's instructions, do not install roof insulation during inclement weather or when air temperature is below 4 degrees C 40 degrees F and interior humidity is 45 percent or greater, or when there is visible ice, frost, or moisture on the roof deck.

1.12 PROTECTION

****

NOTE: Where built-up roofing is applied over insulation, delete paragraphs FLAME HEATED EQUIPMENT through DRIPPAGE OF BITUMEN. Delete paragraphs FLAME HEATED EQUIPMENT, SPECIAL PROTECTION, and DRIPPAGE OF BITUMEN when roofing system or insulation does not require hot asphalt or torches for application.

****

[1.12.1 Flame Heated Equipment

1.12.1.1 Fire Protection

Locate melt kettles no closer than 8 meters 25 feet from buildings or combustible materials. Do not place kettles or other flame-heated equipment on roofs. Provide and maintain two approved 4-A:40-B:C fire extinguishers within 8 meters 25 feet of each operating kettle. Fire extinguishers, operations and locations must comply with NFPA 1 Section Tar Kettles. Equip asphalt (tar) kettles with tight fitting lids.

1.12.1.2 Operational Requirements

Equip kettles with automatic thermostatic control capable of maintaining asphalt temperature. Calibrate and maintain controls in working order for the duration of the work. Equip kettles with means of agitation and ensure they are operating as necessary to produce a controlled uniform temperature throughout kettle contents to prevent spot heating. Do not heat contents above flash point. Do not place flame heated equipment on the roof.

][1.12.2 Special Protection

Provide special protection as approved by the insulation manufacturer.

][1.12.3 Drippage of Bitumen

Seal joints in and at edges of deck as necessary to prevent drippage of asphalt into the building or onto adjacent surfaces.

]1.12.4 Completed Work

Cover completed work with cover board for the duration of construction. Avoid traffic on completed work particularly when ambient temperature is above 27 degrees C 80 degrees F. Replace crushed or damaged insulation prior to roof surface installation.

PART 2 PRODUCTS

****

NOTE: Specify sustainable materials in accordance with UFC 1-200-02 "High Performance and Sustainable Building Requirements." Reduce the environmental impact of materials by specifying products that have a lesser or reduced effect on human health and the environment such as low emitting materials and materials with high recycled content. Consider product life cycle and travel distances when compared with competing products or services serving the same purpose.

****

2.1 INSULATION

2.1.1 Insulation Types

****

NOTE: Specify all types of insulation listed as Contractor options, except where method of construction or special requirements prohibit use. Install thermal barrier of glass mat gypsum roof board or suitable roof insulation board directly on roof deck when polystyrene board will be applied over decks constructed of materials other than poured-gypsum; poured-concrete; nominal 50 mm 2 inch thick, tongue-and-groove wood plank or precast roof deck panels; or planks approved by FM as noncombustible roof deck construction.

Note that the type of insulation may be dictated by that required to receive the warranty from the roofing system manufacturer.

For NAVFAC SE projects, do not specify mineral fiber, glass fiber or cellular glass boards.

Roof insulation should be specified by thermal resistance (R-value) necessary to obtain required overall thermal transmittance (U-value) needed to satisfy design criteria for particular type of facility. Thickness of insulation will vary with type of material furnished in order to provide specified R-value. When thickness of insulating material is governed by space limitations or construction features, R-value and corresponding thickness should be coordinated with space available. Provide insulation of sufficient thickness to ensure that temperature of vapor retarder surface, when used, will be above dewpoint. R-value for insulation should never be less than R-value used in design of heating, ventilation and air conditioning systems.

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NOTE: Roof construction, air-to-air, may include finished ceilings provided ceilings extend over the entire roof area; and the space above the ceiling is neither vented to the exterior nor used as a return air plenum. Generally, roof insulation over mechanical rooms does not need to be increased in thickness when the mechanical room has no ceiling and the rest of the building has a ceiling. If designed roof insulation thickness varies over mechanical rooms or anywhere else in the building, confirm all dewpoints and coordinate locations of vapor barriers accordingly.

Designer will determine the required R-value and indicate on the drawings. Coordinate R-value with Energy Budget Analysis. The R-value of impermeable faced iso-foams and permeable faced polyisocyanurate components will be calculated using the aged R-value of 1.0 square meter K/W ("R" value 5.56) per 25 mm one inch of thickness; k = 0.31 W/m.k (k = 0.18).

The R-value of impermeable faced (ex. aluminum foil) polyisocyanurate components will be calculated using the aged R-value of 1.27 square meter k/w ("R" value 7.2) per 25 mm one inch of thickness; k = 0.24 W/m.k (k = 0.14).

Delete foil-faced board when roofing is single ply and fully adhered. Delete polystyrene and polystyrene composite when insulation will be applied with hot asphalt.

The recovered materials content levels specified below are based on the weight (not the volume) of the materials in the insulating core, excluding skins or facings.

Insulation must be a standard product of the manufacturer and factory marked with the manufacturer's name or trademark, the material

specification number, the R-value at 24 degrees C 75 degrees F, and the thickness. Minimum thickness as recommended by the manufacturer. Boards must be marked individually. The thermal resistance of insulation must not be less than the R-value shown on the drawings. Exclude chlorofluorocarbons (CFC's) in the insulation manufacturing process in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

Provide one, or an assembly of a maximum of three, of the following roof insulation materials. Provide roof insulation that is compatible with attachment methods for the specified insulation and roof membrane.

****

NOTE: Detailed information concerning U.S. Environmental Protection Agency (EPA) requirements on recycled/recovered materials is available at the following URL's: https://www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products **and then click on the appropriate item from the list (building insulation, for example):** https://www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products#01**.**

Using data from listed locations, fill in blank space (below and in subsequent paragraphs) for required percentage of recycled or recovered material. This is in accordance with the requirements of 40 CFR 247 and Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING, which should be included in all projects.

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****

NOTE: Delete foil-faced board when fully adhered, cold-applied single ply roofing is specified.

Blistering of roofing membranes has occurred over some polyurethane and composite (polyurethane) board insulation, possibly due to either release of gases from polyurethane, moisture entrapped in facing or plying felt, differential movement between roofing membrane and polyurethane resulting from thermal stresses on the materials, or inadequate brooming and mopping. When hot-applied built-up, modified bitumen sheet, or Polyisobutylene (PIB) sheet roofing is installed over insulation, provide a thin layer of expanded perlite board insulation, or glass mat gypsum roof board over the top surface of the polyurethane board, embedded in solid asphalt mopping with joints of perlite board, or glass mat gypsum roof board staggered in both directions with respect to the polyurethane board below. The same precautionary procedure should be followed when polyisocyanurate foam boards are specified even though there may not be documentation of similar

problems with these types.

Require compressive strength of polyisocyanurate board to be 172 kPa 25 psi when used without a coverboard; 140 kPa 20 psi is allowed when a coverboard of 13 mm 1/2 in minimum is also included in the roofing system.

****

a. Polyisocyanurate Board: Provide in accordance with ASTM C1289 REV A [Type I, foil faced both sides] [or] [Type II, fibrous felt or glass mat membrane both sides], except minimum compressive strength of [172] [140] kilopascal (kPa) [25] [20] pounds per square inch (psi).

****

NOTE: Delete non-composite polystyrene board when insulation will be applied with hot asphalt or used under hot asphalt-applied roofing. This type of insulation is sensitive to hot asphalt, various solvents, and certain single ply roofing membranes.

****

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NOTE: Extruded polystyrene insulation board is flexible enough for use on arched roofs. For this application, each layer must be thin enough to permit the required bending and each layer must be mechanically fastened. Check individual manufacturer requirement prior to application.

****

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NOTE: Consider Polystyrene as a roof insulation in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Polystyrene has a high heat resistance (R) value, is dense enough for foot traffic, and will not absorb water. Foam glass has higher initial cost, therefore it is not often used as a roof insulation. When a higher compressive resistance is required than provided by the XPS types listed, insert the required type.

****

b. Extruded Polystyrene (XPS) Board: In accordance with ASTM C578 REV A, Type IV or X.

****

NOTE: Delete polystyrene composite board when insulation will be applied with hot asphalt.

****

c. Composite Boards: Provide in accordance with ASTM C1289 REV A, [Type III, perlite insulation board faced on one side with fibrous felt or glass fiber mat membrane on opposite side.] [Type V, oriented strand board or waferboard on one side and fibrous felt or glass fiber mat membrane or aluminum foil on opposite side (Polyisocyanurate-perlite).]

****

NOTE: Do not specify perlite board in high wind areas.

****

d. Expanded Perlite Board: Provide in accordance with ASTM C728. Minimum 19 mm 3/4 inch thick when both top and bottom surfaces must be in contact with asphalt.

****

NOTE: Cellular glass roof insulation is not widely used due to its high cost. It is most commonly used in cold storage facilities and other areas where excessive amounts of moisture would degrade the insulating capabilities of other types of insulation. Select and insert the Type based on the compressive resistance and thermal resistance requirements for the roof.

****

e. Cellular Glass Boards: ASTM C1902, Type [_____].

2.1.2 Recycled Materials

Provide thermal insulation materials containing recycled content. Unless specified otherwise, the minimum required recycled content for listed materials are:

Perlite Composition Board:	23 percent postconsumer paper
Polyisocyanurate/polyurethane:	9 percent recovered material
Cellular Glass Insulation:	60 percent recovered content
Fiberglass Insulation:	25 percent recovered content
Fiber (felt) or Fiber composite:	75 percent recovered content

Provide data identifying percentage of recycled content for insulation.

2.1.3 Indoor Air Quality

Provide certification of indoor air quality for insulation.

2.1.4 Prohibited Materials

Products that contain high ozone depleting or high Global Warming Potential (GWP) blowing agents are prohibited. For a list of acceptable substitute foam blowing agents for the type of insulation used see https://www.epa.gov/snap/foam-blowing-agents. Provide validation of acceptable foam blowing agents that no prohibited materials are used.

2.1.5 Insulation Thickness

As necessary to provide the thermal resistance (R-value) indicated[for average thickness of tapered system]. Base calculation on the R-value for aged insulation.[For insulation over steel decks, satisfy both specified R-value and minimum thickness for width of rib opening recommended in insulation manufacturer's published literature].

[2.1.6 Tapered Roof Insulation

****

NOTE: Sloping substrate (structure) is the preferred method to achieve primary roof slope, however tapered insulation may be used when sloping substrate is not feasible. Where tapered roof insulation is used on a substrate sloped 1 in 48 (20 mm per 1 M) (1/4 inch per foot) and greater, insulation having a slope of 1 in 48 (20 mm per 1 M) (1/4 inch per foot) in the same direction as the substrate slope may be specified. Otherwise, specify tapered insulation having a slope of 1 in 24 (40 mm per 1 M) (1/2 inch per foot).

****

One layer of the tapered roof insulation assembly must be factory tapered to a slope of not less than one in [24] [48] [20 mm] [40 mm] per 1 M [1/4] [1/2] inch per foot. Factory fabricate mitered joints from two diagonally cut boards or one board shaped to provide required slopes.

][2.1.7 Cants and Tapered Edge Strips

****

NOTE: Generally, cant strips are not required for single ply roofing systems. However, if cant strips are necessary, coordinate their location with mechanical drawings to ensure that no projections, such as vent pipes and braces, will be constructed through cant strips or within 250 mm 10 inches from them. Specify wood cants, edge strips, and pressure preservative treatment in Section 06 10 00 ROUGH CARPENTRY.

****

Provide preformed cants and tapered edge strips of the same material as the roof insulation. When unavailable, provide pressure-preservative treated wood, or rigid perlite board cants and edge strips as recommended by the roofing manufacturer for the specific application, unless otherwise indicated. Face of cant strips to incline at 45 degrees with a minimum vertical height of 100 mm 4 inches. Taper edge strips at a rate of 85 to 125 mm per meter one to 1 1/2 inch per foot down to approximately 3 mm 1/8 inch thick.

][2.2 COVER BOARD

****

NOTE: Provide cover boards over roof insulation for hot-mopped, torched-down, or adhesive-applied roofing membrane. Cover boards may also be used for thermal barriers under the roof insulation.

****

For use as a thermal barrier (underlayment), fire barrier (overlayment), or cover board for hot-mopped, torched-down, or adhesive-applied roofing membrane over roof insulation.

[2.2.1 Glass Mat Gypsum Roof Board

****

NOTE: Specify glass mat gypsum roof board as a Contractor's option to wood fiberboard, expanded perlite, or other suitable material, when an underlayment or overlayment is required for the roof insulation board.

****

ASTM C1177/C1177M, 0 Flame Spread and 0 Smoke Developed when tested in accordance with ASTM E84, 3450 kPa 500 psi, Class A, non-combustible, [6][13][16] mm [1/4][1/2][5/8] inch thick, 1220 by 2440 mm 4 by 8 feet board size.

][2.2.2 Fiber-Reinforced Gypsum Board Panels

Provide non-glass-faced fiber-reinforced gypsum board panels in accordance with ASTM C1278/C1278M.

][2.2.3 High Density Wood Fiber Board

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NOTE: High density wood fiber board provides improved impact resistance to roof covers but is hygroscopic in nature.

****

Provide high density wood fiber board, Grade 2 in accordance with ASTM C208 with a transverse load of 53.4 N 12 lbf.

]][2.3 BITUMENS

****

NOTE: Where insulation is installed under roofing that does not require hot asphalt and vapor retarder is not required, delete ASPHALT PRIMER, ASPHALT ROOF CEMENT, and ASPHALT-SATURATED FELT BASE SHEET FOR SINGLE LAYER APPLICATION. Always mechanically secure first layer of insulation to steel decks. For installation over steel and other decks not requiring vapor retarders or where asphalt is not used in installing insulation, specify only mechanical fastening of insulation. Coordinate requirements of this section with section specifying the roofing; requirements must meet manufacturer's requirements to obtain the roofing system warranty.

****

[2.3.1 Asphalt Primer

Provide in accordance with ASTM D41/D41M.

][2.3.2 Asphalt

Provide in accordance with ASTM D312/D312M, Type III or IV. Asphalt flash point, finished blowing temperature, and equiviscous temperature (EVT) for mop and mechanical spreader application must be indicated on each container.

][2.3.3 Asphalt Roof Cement

Provide in accordance with ASTM D4586/D4586M, Type I, for horizontal surfaces and surfaces sloped from 0 by 76 mm per 1 M 0 to 3 inches per foot. Type II for vertical and surfaces sloped more than 76 mm per 1 M 3 inches per foot.

]][2.4 SHEATHING PAPER FOR WOOD DECKS

Rosin-sized building paper or unsaturated felt weighing not less than 2.5 kilograms per 10 square meters 5 pounds per 100 square feet.

]2.5 MOISTURE CONTROL

****

NOTE: Vapor retarder should be specified only where:

1. Outside, average January temperature is below 4 degrees C 40 degrees F, and expected winter interior relative humidity is 45 percent or greater;

2. Roofing system will be subject to continuing excessively high interior humidity; and

3. Results of detailed analysis indicate potential roofing problem resulting from water-vapor infiltration.

Delete Contractor's option for single-layer vapor retarder for roofs over areas having excessively high interior humidity such as swimming pools and laundries. Generally, vapor retarder should be in direct contact with deck. However, compute dewpoint temperature and location and locate vapor retarder below dewpoint location. Avoid use of vapor retarder over steel decks unless vapor retarder is determined to be absolutely necessary. Do not specify wood fiberboard or any type of insulation that is highly sensitive to moisture for layer directly on steel deck. Glass mat gypsum roof board is not sensitive to moisture and may be used in such situations. Specify installation of insulation over vapor retarder using hot asphalt to avoid puncturing vapor retarder. Combination of two or more layers of insulation should be of such thickness that dewpoint temperature will occur above vapor retarder located directly over first layer of insulation. Topside venting should always be provided by insulation vents and perimeter edge vents when vapor retarder is used. Specify venting requirements in roofing membrane specification section.

Unless otherwise directed, do not specify vapor retarder for projects in the NAVFAC SE area.

****

[2.5.1 Vapor Retarder

[2.5.1.1 Asphalt Saturated Felt Base Sheet for Single Layer Application

Provide in accordance with ASTM D4601/D4601M, weighing not less than 17.5 kilograms per 10 square meters 35 pounds per 100 square feet.

][2.5.1.2 Asphalt-Coated Glass Felt

Provide in accordance with ASTM D2178/D2178M, Type [IV] [VI].

]][2.5.2 Ventilating Felt for [Poured] [Precast] Concrete Decks

****

NOTE: Specify ventilating felt for new and existing concrete decks suspected of having retained moisture to aid in dissipation of any moisture retained in concrete. Do not consider this a vapor retarder.

****

Provide in accordance with ASTM D4897/D4897M, Type II, non-perforated, with spot mopping holes where specified.

]2.5.3 Organic Roofing

Provide in accordance with ASTM D226/D226M, Type I.

2.6 FASTENERS

Provide flush-driven fasteners through flat round or hexagonal steel or plastic plates. Provide zinc-coated steel plates, flat round not less than 35 mm 1 3/8 inch diameter, hexagonal not less than 0.4 mm 28 gage. Provide high-density plastic plates, molded thermoplastic with smooth top surface, reinforcing ribs and not less than 75 mm 3 inches in diameter. Fully recess fastener head into plastic plate after it is driven. Form plates to prevent dishing. Do not use bell or cup shaped plates. Provide fasteners in accordance with insulation manufacturer's recommendations for holding power when driven, or a minimum of [178] [534] N [40] [120] pounds each in steel deck, whichever is the higher minimum. Provide fasteners for steel or concrete decks in accordance with FM APP GUIDE (https://www.approvalguide.com/) for Class I roof deck construction, and spaced to withstand uplift pressure of [2.87] [4.3] [_____] kPa [60] [90] [_____] pounds per square foot.

2.6.1 Roofing Nails for Wood Decks

Barbed 3 mm 11 gage, zinc-coated nails with 11 to 16 mm 7/16 to 5/8 inch diameter heads or annular ring shank, square head, one piece composite nails. Provide nails long enough to penetrate wood deck at least 16 mm 5/8 inch without protruding through underside of decking.

2.6.2 Fasteners for Plywood Decks

Annular ring shank, square head, one-piece composite nails long enough to penetrate into plywood decks approximately 13 mm 1/2 inch without protruding through underside of decking.

2.6.3 Fasteners for Steel Decks

Approved hardened penetrating fasteners or screws in accordance with FM 4450 and listed in FM APP GUIDE for Class I roof deck construction. Quantity and placement to withstand a minimum uplift pressure of [2.87] [4.31] [_____] kPa [60] [90] [_____] psf in accordance with FM APP GUIDE.

2.6.4 Fasteners for Poured Concrete Decks

Approved hardened fasteners or screws to penetrate deck at least 25 mm one inch but not more than 38 mm 1 1/2 inches, in accordance with FM 4470, and listed in FM APP GUIDE for Class I roof deck construction. Quantity and placement to withstand an uplift pressure of [2.87] [4.31] [_____] kPa [60] [90] [_____] psf in accordance with FM APP GUIDE.

[2.7 FOAM ADHESIVE

****

NOTE: Include foam adhesive as an option when applying insulation over a concrete roof deck, or where a base layer is mechanically fastened and subsequent layers are installed with low-rise foam adhesive.

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Foam adhesive as recommended by the insulation manufacturer for adhering the insulation to concrete surfaces or underlying insulation layers and resist the required wind uplift pressure. Product must be compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

]2.8 [WOOD][ENGINEERED METAL FRAMING] NAILERS

****

NOTE: When roof slope exceeds 1 in 24 (40 mm in 1 M) (1/2 inch per foot), insulating materials beneath built-up roofing should be both mopped and held in place by treated wood nailers. Non-nailable decks should be provided with surface-applied nailing strips of same thickness as insulation. See built-up bituminous roofing specifications for requirements on nailing of roofing felts. For all insulated roof decks, treated wood nailers should be applied at eave edgings and sides of roofs and around curbs and elsewhere as necessary to provide nailing for gravel stops and flashings. Refer to FM Data Sheets for method of attachment of nailers. A water-borne preservative treatment should be specified in Section 06 10 00 ROUGH CARPENTRY for wood which will be in contact with bituminous materials.

Wood nailers are prohibited on heat or torch-applied roofing systems. Select engineered metal framing option for metal roofing systems or torch-applied roof systems.

****

[Pressure-preservative treated wood as specified in Section 06 10 00 ROUGH CARPENTRY.] [Provide galvanized steel or aluminum engineered metal framing for use as nailers and attached to substrate with self-tapping screws.]

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

3.1.1 Surface Inspection

****

NOTE: Unless otherwise directed, do not refer to vapor retarders for projects in the NAVFAC SE area. Vapor retarder may be specified for heated buildings where the average January temperature is below 5 degrees C 40 degrees F and the expected interior winter humidity exceeds 45 percent. Vapor retarder will be specified for heated buildings where a high humidity condition is expected, such as indoor swimming pool or laundry.

Where a vapor retarder is to be installed, the designer will make sure that the computations show that the dew point is on the cold side of the vapor retarder. Computations should use recognized methods in agreement with ASHRAE Handbook, Fundamentals.

****

Ensure surfaces are clean, smooth, and dry prior to application.[Ensure surfaces receiving vapor retarder are free of projections that might puncture the vapor retarder.] Check roof deck surfaces, including surfaces sloped to roof drains and outlets, for defects before starting work.

The [Contractor must] [Contracting Officer will] inspect and approve the surfaces immediately before starting installation. Prior to installing [vapor retarder] [ventilating felt] [insulation], perform the following:

[a. Examine wood decks to ascertain that deck boards have been properly nailed in accordance with IBC and wind uplift requirements and that exposed nail heads have been set.

][b. Examine steel decks to ensure that panels are properly secured to structural members and to each other and that surfaces of top flanges are flat or slightly convex.

][c. Examine precast concrete decks to ensure that joints between precast units are properly grouted and leveled to provide suitable surfaces for installation of [ventilating felt] [vapor retarder] [and] insulation.

][d. In the presence of the Contracting Officer perform the following surface dryness test on concrete substrates:

(1) Foaming: When poured on the deck, one pint of asphalt when heated in the range of 176 to 204 degrees C 350 to 400 degrees F, does not foam upon contact.

(2) Strippability: After asphalt used in the foaming test application has cooled to ambient temperatures, test coating for adherence.

Should a portion of the sample be readily stripped clean from surface, do not consider surface to be dry and do not start application. Should rain occur during application, stop work and do not resume until surface has been re-tested by method above and found dry.

][e. Prior to installing any roof system on a concrete deck, moisture test the deck in accordance with ASTM D4263. The deck is acceptable for roof system application when there is no visible moisture on underside of plastic sheet after 24 hours.

]3.1.2 Surface Preparation

To correct defects and inaccuracies in roof deck surface to eliminate poor drainage from hollow or low spots, perform the following:

a. Provide wood nailers of the same thickness as the insulation at eaves, edges, curbs, walls, and roof openings for securing of cant strips, gravel stops, [gutters,] flashing flanges, and curbs.[On decks with slopes of one in 12 (80 mm per 1 M) (one inch per foot) or more, install wood nailers perpendicular to slope for securing insulation [and for backnailing of roofing felts]. Space nailers in accordance with approved shop drawings.]

[b. Fill or cover cracks or knot holes larger than 13 mm 1/2 inch in diameter in wood decks as necessary to form an unyielding surface.

]

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NOTE: Include the following requirements when a vapor retarder is required over wood deck or when insulation is applied directly to the wood deck with hot asphalt.

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[c. Cover wood decks with a layer of rosin-sized building paper or unsaturated felt. Lap sides and ends not less than 75 mm 3 inches. Nail sufficiently to prevent tearing or buckling during installation.

][d. Cover steel decks with a layer of insulation board of sufficient width to span the width of a deck rib opening, and in accordance with fire safety requirements. Secure with piercing or self-drilling, self-tapping fasteners of quantity and placement in accordance with FM APP GUIDE. Locate insulation joints parallel to ribs of deck on solid bearing surfaces only, not over open ribs.

][e. Solidly apply asphalt primer to [poured] [precast] concrete decks at the rate of 4 liters per 10 square meters one gallon per 100 square feet of roof surface[, stopping approximately 100 mm 4 inches from joints between precast concrete units]. Allow primer to dry thoroughly.[Place felt strips, 100 mm 4 inches or more in width, over joints, 50 mm 2 inches on each side, between precast concrete units in a heavy coating of cold-applied asphalt roof cement.]

]3.2 INSTALLATION OF VAPOR RETARDER

****

NOTE: Unless directed otherwise, do not specify a vapor retarder for projects in the NAVFAC SE area.

Vapor retarder may be specified for heated buildings where the average January temperature is below 5 degrees C 40 degrees F and the expected interior winter humidity exceeds 45 percent. Vapor retarder will be specified for heated buildings where a high humidity condition is expected, such as indoor swimming pool or laundry.

Where a vapor retarder is to be installed, the designer will make sure that the computations show that the dew point is on the cold side of the vapor retarder. Computations should use recognized methods in agreement with ASHRAE Handbook, Fundamentals.

****

Install vapor retarder in direct contact with [roof deck surface] [ventilating felt] [insulation]. Unless otherwise specified, vapor retarder must consist of [either] two plies of No. 15 asphalt-saturated felt, two plies of asphalt-coated glass felt[, or one layer of asphalt-saturated felt base sheet]. Lay vapor retarder at right angles to direction of slope. Install first ply of felt [or base sheet] as specified herein for the specific deck. Apply second ply of 2-ply vapor retarder system using asphalt at rate of 10 to 18 kgs per 10 square meters 20 to 35 lbs per 100 square feet, applied within plus or minus 15 degrees C 25 degrees F of EVT. Do not heat asphalt above asphalt's FBT or 275 degrees C 525 degrees F, whichever is less. Use thermometers to check temperatures during heating and application. Completely seal side and end laps. Asphalt must be visible beyond all edges of each ply as it is being installed. Lay plies free of wrinkles, buckles, creases or fishmouths. Do not walk on mopped surfaces while asphalt is sticky. Press out air bubbles to obtain complete adhesion between surfaces. At walls, eaves, rakes, and other vertical surfaces, extend vapor retarder organic felts or separate plies 225 mm 9 inches, with not less than 225 mm 9 inches on the substrate, and the extended portion turned back and mopped in over the top of the insulation. At roof penetrations other than walls, eaves and rakes, and vertical surfaces, extend vapor retarder or separate plies 225 mm 9 inches to form a lap folded back over the edge of the insulation. Provide asphalt roof cement under the vapor retarder for at least 225 mm 9 inches from walls, eaves, rakes and other penetrations.

[3.2.1 Vapor Retarder on Poured or Precast Concrete Decks

Evenly mop primed substrate with asphalt at a rate of 10 to 18 kgs per 10 square meters 20 to 35 lbs per 100 square feet before installing vapor retarder. Lay first ply of two-ply system with each sheet lapping 480 mm 19 inches over the preceding sheet. Lap ends not less than 100 mm 4 inches. Stagger laps a minimum of 300 mm 12 inches.[For a vapor retarder consisting of one layer of asphalt base sheet, provide side and end laps not less than 100 mm 4 inches. Stagger laps a minimum of 300 mm 12 inches. Cement base sheets together with a solid mopping of asphalt.]

][3.2.2 Vapor Retarder on Wood Decks

****

NOTE: A vapor retarder should be specified only where:

1. The outside, average January temperature is below

4 degrees C 40 degrees F, and the expected winter interior relative humidity is 45 percent or greater;

2. The roofing system will be subject to continuing excessively high interior humidity; and

3. The results of a detailed analysis indicate a potential roofing problem resulting from water-vapor infiltration.

Delete Contractor's option for a single-layer vapor retarder for roofs over areas having excessively high interior humidity such as swimming pools and laundries. Generally, the vapor retarder should be in direct contact with deck. However, compute dewpoint temperature and location and locate vapor retarder below dewpoint location. Avoid use of vapor retarder over steel decks unless vapor retarder is determined to be absolutely necessary. Do not specify wood fiberboard or any other type of insulation sensitive to moisture for the layer directly on steel deck. Glass mat gypsum roof board is not sensitive to moisture and may be used in such situations. Specify installation of insulation over vapor retarder using hot asphalt to avoid puncturing the vapor retarder. The combination of two or more layers of insulation must be of such thickness that the dewpoint temperature will occur above vapor retarder located directly over first layer of insulation. Topside venting should always be provided by insulation vents and perimeter edge vents when a vapor retarder is used. Specify venting requirements in roofing membrane specification section.

****

Lay first ply of two-ply system dry with each sheet lapping 50 mm 2 inches over the preceding sheet. Lap ends not less than 100 mm 4 inches. Stagger laps a minimum of 300 mm 12 inches. Nail felt at 150 mm 6 inch intervals alongside laps and install two rows of nails approximately 275 mm 11 inches apart down longitudinal center of each sheet, with nails staggered at 450 mm 18 inches on center.[For vapor retarder consisting of one layer of asphalt base sheet, lap each sheet 100 mm 4 inches over the preceding sheet. Provide end laps not less than 100 mm 4 inches and stagger laps a minimum of 300 mm 12 inches.] Cement side and end laps together with solid mopping of asphalt or heavy coat of asphalt roof cement. Nail side laps at 150 mm 6 inch intervals. Apply asphalt mopping at a rate of 10 to 18 kgs per 10 square meters 20 to 35 lbs per 100 square feet. Install two rows of nails approximately 275 mm 11 inches apart down longitudinal center of each sheet, with nails staggered at 450 mm 18 inches on center.

][3.2.3 Vapor Retarder on Steel Decks

Even mop the mechanically secured insulation surface with asphalt before installing vapor retarder. For a two-ply vapor retarder, install each sheet lapping 480 mm 19 inches over the preceding sheet. Lap ends not less than 100 mm 4 inches. Stagger the laps a minimum of 300 mm 12 inches. Cement felts together with solid mopping of asphalt. Apply asphalt moppings at rate of 10 to 18 kgs per 10 square meters 20 to 35 lbs per 100 square feet.[For a vapor retarder consisting of one layer of asphalt base sheet, lap each sheet 100 mm 4 inches over preceding sheet. Lap ends not less than 100 mm 4 inches, and stagger laps a minimum of 300 mm 12 inches. Cement base sheets together with solid mopping of asphalt.]

]3.2.4 Over Gypsum Insulating Concrete or Lightweight Insulating Concrete

****

NOTE: Some types of lightweight insulating concrete may require bottom side deck venting; edit this paragraph accordingly if bottom side venting is used.

****

Lay one ply of venting inorganic base sheet, without mopping, at a right angle to the slope with 100 mm 4 inch side laps and 150 mm 6 inch end laps. Bond laps with hot asphalt. Stagger end laps.[Nail base sheet 220 mm 9 inches on center at side laps and in 2 rows 270 mm 11 inches apart down the center of the sheet with nails 450 mm 18 inches on centers and staggered][attach to the concrete deck in accordance with uplift requirements]. Apply 2-ply vapor retarder over the base sheet as specified above.

3.2.5 Over Concrete Decks and First Layer of Insulation on Steel Decks

Apply 2-ply vapor retarder as specified above except delete the venting inorganic base sheet.

3.2.6 Over Structural Concrete on Non-Venting Support

Lay one ply of venting inorganic base sheet with mopping holes at a right angle to the slope with 100 mm 4 inch side laps and 150 mm 6 inch end laps then apply the vapor retarder as specified.

[3.3 INSTALLATION OF VENTILATING FELT

****

NOTE: Specify ventilating felt for new and existing concrete decks suspected of having retained moisture to aid in dissipation of any moisture retained in concrete. Do not consider this felt a vapor retarder.

Include bracketed phrase only when insulation is to be applied with hot asphalt.

****

Apply ventilating felt in accordance with manufacturer's printed instructions[, spot mopped with asphalt to concrete deck]. Extend over roof cants, up vertical surfaces and terminate under cap flashing. At roof edges terminate under outside edge of perimeter edge nailers or under gravel stop fascia.

]3.4 INSULATION INSTALLATION

Apply insulation in two layers with staggered joints when total required thickness of insulation exceeds 13 mm 1/2 inch. Lay insulation so that continuous longitudinal joints are perpendicular to direction of [felts for the built-up] roofing, as specified in Section [_____], and end joints of each course are staggered with those of adjoining courses. When using multiple layers of insulation, provide joints of each succeeding layer that are parallel and offset in both directions with respect to the layer below. Keep insulation 13 mm 1/2 inch clear of vertical surfaces penetrating and projecting from roof surface. Verify required slopes to each roof drain.

[3.4.1 Installation Using Asphalt

Firmly embed each layer in solid asphalt mopping; mop only sufficient area to provide complete embedment of one board at a time. Provide 10 to 18 kgs 20 to 35 lbs of asphalt per 10 square meters 100 square feet of roof deck for each layer of insulation. Apply asphalt when temperature is within plus or minus 15 degrees C 25 degrees F of EVT. Do not heat asphalt above asphalt's FBT or 275 degrees C 525 degrees F, whichever is less, for longer than 4 consecutive hours. Use thermometers to check temperatures during heating and application.

][3.4.2 Installation Using Asphalt on Steel Decks

****

NOTE: Delete these requirements and include paragraph INSTALLATION USING ASPHALT when a vapor retarder is required over steel decks.

****

Secure first layer of insulation [and thermal barrier] to deck with piercing or self-drilling, self-tapping fasteners. Engage fasteners by driving them through insulation into top flange of steel deck. Use driving method prescribed by fastener manufacturer. Locate insulation joints parallel to ribs of deck on solid bearing surfaces only, not over open ribs. Secure succeeding layers with solid asphalt moppings. Where insulation is applied over steel deck, locate long edge joints so that they bear continuously on the steel deck. Insulation that can be readily lifted after installation is not considered adequately secured. Apply insulation only in quantities that can be entirely waterproofed the same day. Phased construction is not permitted. Apply impermeable faced insulation without damage to the facing.

][3.4.3 Installation of Protection for Asphalt Work

Before starting asphalt work, protect surrounding areas and surfaces from spillage and migration of asphalt onto other work. Provide non-combustible protective coverings at surfaces adjacent to hoists and kettles. Lap protective coverings at least 150 mm 6 inches, secure against wind, and vent to prevent collection of moisture on covered surfaces. Keep protective coverings in place for the duration of asphalt work.

][3.4.4 Installation Using Only Mechanical Fasteners

****

NOTE: Delete these requirements and include paragraph INSTALLATION USING ASPHALT when a vapor retarder is required over steel decks.

****

Secure total thickness of insulation with penetrating type fasteners.

][3.4.5 Installation Using Mechanical Fasteners and Foam Adhesive

****

NOTE: Include this section when base layer is mechanically fastened and subsequent layers are installed with low-rise foam adhesive.

****

Secure first layer of insulation [and thermal barrier] to deck with piercing or self-drilling, self-tapping fasteners. Engage fasteners by driving them through insulation into top flange of steel deck. Use driving method prescribed by fastener manufacturer. Locate insulation joints parallel to ribs of deck on solid bearing surfaces only, not over open ribs. Secure succeeding layers with foam adhesive using installation procedures as recommended by the insulation manufacturer for adhering the insulation and resisting the required wind uplift pressure. Installation must bond insulation securely to substrates without damaging insulation and substrates.

][3.4.6 Installation on Concrete Substrates

Install using foam adhesive using installation procedures as recommended by the insulation manufacturer for adhering the insulation to concrete surfaces and resist the required wind uplift pressure. Installation must bond insulation securely to substrates without damaging insulation and substrates.

]3.4.7 Special Precautions for Installation of Foam Insulation

[3.4.7.1 Polyisocyanurate Insulation

Where polyisocyanurate foam board insulation is provided, install cover board over top surface of foam board insulation. Stagger joints of insulation with respect to foam board insulation below.

][3.4.7.2 Polystyrene Insulation

****

NOTE: Include these requirements when polystyrene insulation is used under fully adhered EPDM, CPE, PIB, or PVC roofing.

****

a. Over the top surface of non-composite polystyrene board, install 13 mm 1/2 inch thick high density wood fiberboard, 19 mm 3/4 inch thick expanded perlite board insulation, glass mat gypsum roof board, or other overlayment approved by roofing sheet manufacturer. Tightly butt and stagger joints of field applied overlayment board at least 150 mm 6 inches with respect to the polystyrene board below. Apply 150 mm 6 inch wide glass fiber roofing tape centered over joints and edges of overlayment board.

b. Where composite boards consisting of polystyrene insulation are provided, apply 150 mm 6 inch wide glass fiber roofing tape centered over joints and edges of composite board. Apply joint strips as recommended by roofing sheet manufacturer.

]3.4.8 Cant Strips

****

NOTE: Generally, cant strips are not required for single ply roofing systems, however, if cant strips are necessary, coordinate location with mechanical drawings to ensure that no projections, such as vent pipes and braces, will be constructed through or within 250 mm 10 inches of cant strips. Specify wood cants, edge strips, and pressure preservative treatment in Section 06 10 00 ROUCH CARPENTRY. Delete reference to asphalt application unless asphalt is used in applying the insulation.

****

Where indicated, provide cant strips at intersections of roof with walls, parapets, and curbs extending above roof. Wood cant strips must bear on and be anchored to wood blocking. Fit cant strips flush to vertical surfaces. Where possible, nail cant strips to adjoining surfaces. Where cant strips are installed against non-nailable materials, install in [heavy mopping of asphalt or set in a heavy coating of asphalt roof cement] [an approved adhesive].

3.4.9 Tapered Edge Strips

****

NOTE: Delete reference to asphalt application unless asphalt is used in installing the insulation.

****

Where indicated, provide edge strips in the right angle formed by the juncture of roof and wood nailing strips that extend above the level of the roof. Install edge strips flush to vertical surfaces of wood nailing strips. Where possible, nail edge strips to adjoining surfaces. Where installed against non-nailable materials, install in [a heavy mopping of asphalt or set in a heavy coating of asphalt roof cement] [an approved adhesive].

3.5 PROTECTION

3.5.1 Protection of Applied Insulation

****

NOTE: Insert appropriate Section number and title in the blank below using format in accordance with UFC 1-300-02.

****

Completely cover each day's installation of insulation with finished roofing specified in [_____] on same day. Phased construction is not permitted. Protect open spaces between insulation and parapets or other walls and spaces at curbs, scuttles, and expansion joints, until permanent roofing and flashing are applied. Storing, walking, wheeling, or trucking directly on insulation or on roofed surfaces is not permitted. Provide smooth, clean board or plank walkways, runways, and platforms near supports, as necessary, to distribute weight in accordance with [indicated live load limits of roof construction] [a [_____] kg/sq. m psf live load limit]. Protect exposed edges of insulation with cutoffs at the end of each workday or whenever precipitation is imminent. Cutoffs must be two layers of bituminous-saturated felt set in plastic bituminous cement [or single ply] [or EPDM membrane] set in roof cement. Fill all profile voids in cutoffs to prevent trapping moisture below the membrane. Remove cutoffs when work resumes.

3.5.2 Damaged Work and Materials

Restore work and materials that become damaged during construction to original condition or replace with new materials.

3.6 INSPECTION

Establish and maintain inspection procedures to assure compliance of the installed roof insulation with Contract requirements. Remove, replace, correct in an approved manner, any work found not in compliance. Quality control must include, but is not limited to, the following:

****

NOTE: When justified by the amount or criticality of the insulation and roofing involved, and when requirements for a roof insulation technician are not established for the Contractor Quality Control organization, add the following requirement at the end of this paragraph: "A roof insulation technician, responsible directly to the Contractor and experienced in the installation of roof insulation and related work, must perform the inspection functions and be on the site whenever roof insulation operations are in progress."

****

a. Observation of environmental conditions; number and skill level of insulation workers; start and end time of work.

b. Verification of certification, listing or label compliance with FM Data Sheets.

c. Verification of proper storage and handling of insulation and vapor retarder materials before, during, and after installation.

d. Inspection of vapor retarder application, including edge envelopes and mechanical fastening.

e. Inspection of mechanical fasteners; type, number, length, and spacing.

f. Coordination with other materials, cants, sleepers, and nailing strips.

g. Inspection of insulation joint orientation and laps between layers, joint width and bearing of edges of insulation on deck.

h. Installation of cutoffs and proper joining of work on subsequent days.

i. Continuation of complete roofing system installation to cover insulation installed same day.

j. Verification of required slope to each roof drain.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 24 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 24 00 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-07 24 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 24 00 (May 2011)

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****

SECTION 07 24 00

EXTERIOR INSULATION AND FINISH SYSTEMS

08/23

****

NOTE: This guide specification covers the requirements for barrier-type and drainable exterior insulation and finish systems (EIFS), Classes PB and PM, which may be applied to concrete or brick masonry, or to wood or metal frame construction. EIFS are exterior finish systems that include an integral layer of thermal insulation.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Do not specify EIFS for areas below grade or in areas subject to abuse by moving vehicles or equipment, such as a loading dock. Avoid the use of EIFS in expected heavy pedestrian traffic areas. If such use cannot be avoided, select an appropriate high-impact resistant system. Avoid exposure of EIFS to standing water or prolonged contact with snow. Do not specify EIFS for other than vertical surfaces, except narrow ledges and windowsills where the minimum slope is 25 mm in 50 mm one inch in 2 inch. Flashing is required at parapet caps.

For EIFS directly applied over existing substrate (brick, concrete), specify preparation of substrate in this Section. For EIFS installed over new substrate, specify preparation of substrate under applicable section(s). Substrate must be sound, true, plumb, and within flatness tolerance of EIFS manufacturer, usually not more than 6 mm within 3000 mm 1/4 inch within 10 feet. If existing substrate cannot be brought up to these requirements, a new substrate should be provided.

For EIFS installed over new sheathing board, provide sheathing in this Section. If sheathing is to be installed on metal furring or studs, provide furring or studs in Section 05 40 00 COLD-FORMED METAL FRAMING, specifying EIFS manufacturer's tolerance requirements.

In marine environments, light gage metal framing is subject to corrosion if water infiltrating through the EIFS is allowed to accumulate in runners. In project locations with Environmental Severity Classifications (ESC) C4 and C5, do not use metal framing for the support of the substrate or detail carefully to prevent water accumulation. Refer to UFC 1-200-01 for the ESC's of DoD installations.

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NOTE: The coordination of work with other trades is important for the performance of the EIFS wall assembly, in particular the installation of flashing above windows and door heads, beneath window and door sills, at roof/wall intersections, decks, intersection of lower walls with higher ones, above projecting features, and at the base of the wall to ensure that where water is likely to penetrate the wall assembly, it will drain to the exterior at the source of the leak.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to ASHRAE 90.1 and IgCC requirements governing energy efficiency and requirements for the components of building envelope design including moisture control and thermal performance.

****

****

NOTE: EIFS provides insulation and exterior finish for both new and renovated buildings. The systems are available in two classes: PB and PM.

a. Class PB Systems are typically composed of a 2 mm to 6 mm 1/16 inch to 1/4 inch cementitious or non-cementitious base coat, one or more layers of

polymer-coated glass fiber mesh, and a non-cementitious finish coat. The Government requires EIFS systems to be Drainable systems. PB systems are most commonly used over molded expanded polystyrene (MEPS) insulation which is adhesively attached to the substrate. The non-cementitious base coat systems have good impact resistance but may be punctured by sharp objects. The MEPS insulation allows water vapor migration, which can either ventilate the system beneficially or allow moisture into the substrate. Class PB EIFS should not be used in first floor, high traffic areas, or in areas where pedestrians congregate. Where so used, they must have at least one layer of 567 g 20 ounce reinforcing fabric mesh followed by one layer of minimum 113 g 4 ounce reinforcing mesh. Class PB systems are the least expensive and most widely used of the two classes.

b. Class PM Systems are typically composed of a 6 mm to 9 mm 1/4 inch to 3/8 inch thick, rigid, polymer-modified cementitious base coat, a polymer-coated fiber mesh, and a cementitious finish coat. They are most commonly used over an extruded expanded-polystyrene (XEPS) insulation board which is mechanically attached to the substrate. Class PM systems have good puncture resistance, but are susceptible to damage from blunt impacts. The XEPS insulation allows less water vapor movement.

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NOTE: Drainable systems are available from most EIFS manufacturers. These drainable systems are either Class PB or Class PM systems that are designed to provide an avenue for flow and drainage of incidental moisture from the wall assembly.

Each manufacturer has taken a different design approach to achieve drainage of moisture from their systems. ASTM E2273, Standard Test Method for Determining the Drainage Efficiency of EIFS Clad Wall Assemblies has been published. Refer to the requirements of UFC 1-200-02 for further guidance on standards for moisture control of building envelopes and UFC 3-101-01, Architecture.

****

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NOTE: The following references may be used for additional information on EIFS:

Guide to EIFS with Drainage Detailing, EIFS Industry Members Association (EIMA), Morrow, GA, 2016.

Nelson, Peter, Exterior Insulation and Finish Systems - Then and Now, STP 1585, American Society for Testing and Materials, Philadelphia, 2016.

Thomas, Robert G. Jr., Exterior Insulation and Finish System Design Handbook, CMD Associates, Inc., Vashon Island, WA, 1992.

****

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NOTE: On the drawings, the following information must be shown:

1. Locations of EIFS.

2. Indicate PB or PM system, color and coarse, medium, or fine finish. Add notes and details to indicate Drainable EIFS system.

3. Wall sections with construction details, including flashings, terminations at openings perimeter, and joints with other materials.

4. Joint layout on elevations. The designer must locate joint spacing and areas within the recommendations of at least three qualified EIFS manufacturers. Show all expansion joints at building expansion joints, where substrates change, and where significant structural movement occurs.

5. Include location of control joints on the drawings, which are required for Class PM EIFS to help prevent lamina cracking. Individual areas must not exceed 14 square meters 150 square feet, with a maximum dimension not exceeding 5500 mm 18 feet and a maximum length to height ratio of 2.5 to 1.0. (Control joints are not typically required for Class PB EIFS. Consult manufacturer for any specific requirements.)

6. Joint details, showing back wrapping, base coat, backer rod, and sealant.

7. Corner details, including drips at edges of soffits and at undersides of EIFS projections, and details of flashing and its relation to the EIFS and to other building elements and parts.

8. Thermal resistance value (R-Value) for each location.

9. If different levels of Impact Resistance are specified, indicate locations where each is required.

10. If different thicknesses of insulation board are to be used for architectural details, indicate the locations and thicknesses where required. Provide details which show that additional thicknesses are achieved by adding insulation board on top of the continuous underlaying insulation board.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C67/C67M	(2024) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C473	(2024) Standard Test Methods for Physical Testing of Gypsum Panel Products
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C847	(2018; R 2024) Standard Specification for Metal Lath
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1177/C1177M	(2024) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C1186	(2022; E 2023) Standard Specification for Flat Fiber-Cement Sheets
ASTM C1278/C1278M	(2024) Standard Specification for

	Fiber-Reinforced Gypsum Panel
ASTM C1325	(2022; E 2023) Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D3273	(2021) Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E695	(2022) Standard Test Method of Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading
ASTM E2098/E2098M	(2013; R 2023) Standard Test Method for Determining Tensile Breaking Strength of Glass Fiber Reinforcing Mesh for Use in Class PB Exterior Insulation and Finish Systems (EIFS), after Exposure to a Sodium Hydroxide Solution
ASTM E2486/E2486M	(2022) Standard Test Method for Impact Resistance of Class PB and PI Exterior Insulation and Finish Systems (EIFS)
ASTM E2570/E2570M	(2007; R 2019) Standard Test Methods for Evaluating Water-Resistive Barrier (WRB) Coatings Used under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage

ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 268	(2022) Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source
NFPA 285	(2023) Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

1.2 SYSTEM DESCRIPTION AND REQUIREMENTS

The exterior insulation and finish system (EIFS) must be a job-fabricated, drainable, exterior wall covering consisting of sheathing, air and moisture barrier, insulation board, reinforcing fabric, base coat, finish coat, adhesive and mechanical fasteners as applicable. The system components must be compatible with each other and with the substrate as recommended or approved by, and the products of, a single manufacturer regularly engaged in furnishing Exterior Insulation and Finish Systems. All materials must be installed by an applicator approved by the system manufacturer. EIFS must be [Class PB] [or] [Class PM][as indicated] and must be [_____] color and [_____] finish.

1.2.1 System Requirements and Tests

****

NOTE: The overall performance requirements will vary with the design and geographic location of the building, as well as with occupation, type of construction, and other components specified. Include only those systems tests required for the particular building. Require full scale wall tests where prior tests on similar wall designs are not available or where the wall design differs significantly from the design tested. If testing for wind load, base the required pressure on wind speed specified in ICC IBC. Higher values may be used as required by applicable building code or based on local experience of wind forces at the site. Conduct tests both for positive and negative pressure.

Design must meet the requirements of UFC 3-101-01 Architecture. UFC 3-101-01 provides references to ASHRAE 90.1 and IgCC regarding energy efficiency and thermal properties related to the building envelope design including moisture control and thermal

performance.

****

The system must meet the performance requirements as verified by the tests listed below. Where a wall system of similar type, size, and design as specified for this project has been previously tested under the condition specified herein, the resulting test reports may be submitted in lieu of job specific tests.

1.2.1.1 Water Penetration

Test the system for water penetration by uniform static air pressure in accordance with ASTM E331. There must be no penetration of water beyond the plane of the base coat/EPS board interface after 15 minutes at 300 Pa 6.4 psf, or 20 percent of positive design wind pressure, whichever is greater.

1.2.1.2 Wind Load Test

Test the system for wind load by uniform static air pressure in accordance with ASTM E330/E330M (procedure A) to a minimum pressure of [_____] Pa [_____] psf. There must be no permanent deformation, delamination, or other deterioration.

1.2.1.3 Full Scale or Intermediate Scale Fire Test

Conduct wall fire test using apparatus, specimen, performance criteria, and procedure in accordance with NFPA 285 when required by ICC IBC 2603.5.5. The following requirements must be met:

a. No vertical spread of flame within core of panel from one story to the next.

b. No flame spread over the exterior surface.

c. No vertical flame spread over the interior surface from one story to the next.

d. No significant lateral spread of flame from compartment of fire origin to adjacent spaces.

[1.2.1.4 Mock-Up Installation of EIFS

****

NOTE: Specify mock-up installation only if required because of significance and prominence of project. A mock-up installation may also be justified where out of the ordinary finishes or other special features are specified. The sample installation should be at least one story in height and one bay wide.

****

Complete wall mock-up installation [_____] mm [_____] ft high by [_____] mm [_____] ft wide, including typical control joints [and at least one window opening]. Control joints to be filled with sealant of type, manufacturer, and color selected. Construct mock-up installation at [manufacturer's plant] [job site]. Build mock-up to comply with the following requirements, using materials indicated for the completed work:

a. Locate mock-up installation(s) in the location and size [indicated] [as directed by the Contracting Officer].

b. Demonstrate the proposed range of color, texture, thickness, insulation, and workmanship.

c. Obtain Contracting Officer's written approval of mock-up before starting fabrication of work.

d. Maintain mock-up installation(s) during construction as a standard for judging the completed work by protecting them from weather and construction activities.

[e. When directed, demolish and remove mock-up from the site.

]]1.2.2 Component Requirements and Tests

The components of the system must meet the performance requirements as verified by the tests listed below.

1.2.2.1 Surface Burning Characteristics

Conduct ASTM E84 test on samples consisting of base coat, reinforcing fabric, and finish coat. Cure for 28 days. The flame spread index must be 25 or less and the smoke developed index must be 450 or less.

1.2.2.2 Radiant Heat

The system must be tested in accordance with NFPA 268 on both the minimum and maximum thickness of insulation intended for use with no ignition during the 20-minute period.

1.2.2.3 Impact Resistance

****

NOTE: Select impact resistance for Class PB EIFS based on exposure of wall to potential impact hazard. Higher impact resistance may be limited to lower portion (e.g. on first floor only) of wall:

Standard impact resistance:	**3 to 6 J 25 to 49 inch-lbs**
Medium impact resistance:	**6 to 10 J 50 to 89 inch-lbs**
High impact resistance:	**10 to 17 J 90 to 150 inch-lbs**
Ultra high impact resistance:	**Over 17 J Over 150 inch-lbs**

Select lowest impact resistance for wall areas not accessible to public, (e.g., tower structures, air shafts). Select medium impact resistance for areas with limited access to public. Select high impact resistance for areas with general access to public,

(e.g., first floor walls). Select ultra high impact resistance in locations with constant access.

The thickness and hardness of Class PM EIFS lamina make these systems inherently more resistant than Class PB EIFS to impact failures (defined as penetration of the lamina) from a small or pointed object, as simulated by the probe-type indenture used in the EIMA test method 101.86. Class PM EIFS are more prone to impact failures (cracking or crushing of lamina) from heavy, blunt objects. ASTM E695 is a test method designed to test the whole wall assembly (including the substrate structural supports) and not specifically the impact resistance of Class PM EIFS. However, until a test method to measure the impact resistance for Class PM EIFS is developed, if ever, ASTM E695 provides some means of qualifying minimum performance for impact resistance of Class PM EIFS.

For Class PB EIFS, use paragraph a. Class PB Systems and delete paragraph b. Impact Mass. For Class PM EIFS, use paragraph b. Impact Mass and delete paragraph a. Class PB Systems. If selection of class is Contractor's option, retain both paragraphs and edit accordingly.

****

****

NOTE: If two or more impact resistance requirements are provided, repeat requirement. Indicate on the drawings where each requirement applies.

****

a. Class PB Systems: Hemispherical Head Test; 28 day cured specimen of PB EIFS in accordance with ASTM E2486/E2486M. The test specimen must exhibit no broken reinforcing fabric in accordance with ASTM E2486/E2486M at an impact of [_____] J [_____] in-lb.

b. Impact Mass: Test 28 day cured specimen of PM EIFS in accordance with ASTM E695. The test specimen must exhibit no cracking or denting after twelve impacts by 13.6 kg 30 lbs lead shot mass from 150 to 1800 mm 6 in to 6 ft drop heights in 150 mm 6 in intervals.

1.2.3 Sub-Component Requirements and Tests

Unless otherwise stated, the test specimen must consist of reinforcing mesh, base coat, and finish coat applied in accordance with manufacturer's printed recommendations to the insulation board to be used on the building. For mildew resistance, only the finish coat is applied onto glass slides for testing. The specimen must be suitably sized for the apparatus used and be allowed to cure for a minimum of 28 days prior to testing.

1.2.3.1 Abrasion Resistance

Test in accordance with ASTM D968, Method A. Test a minimum of two specimens. After testing, the specimens must show only very slight smoothing, with no loss of film integrity after 500 liters 132 gallons of sand.

1.2.3.2 Accelerated Weathering

Test in accordance with ASTM G153, Cycle 1. After 2000 hours specimens must exhibit no visible cracking, flaking, peeling, blistering, yellowing, fading, or other such deterioration.

1.2.3.3 Mildew Resistance

Test in accordance with ASTM D3273. The specimen must consist of the finish coat material, applied to clean 75 mm by 100 mm 3 inch by 4 inch glass slides and must be allowed to cure for 28 days. After 28 days of exposure, the specimen must not show any growth.

1.2.3.4 Salt Spray Resistance

Test in accordance with ASTM B117. The specimen must be a minimum of 100 mm by 150 mm 4 inch by 6 inch and must be tested for a minimum of 300 hours. After exposure, the specimen must exhibit no observable deterioration, such as chalking, fading, or rust staining.

1.2.3.5 Water Resistance

Test in accordance with ASTM D2247. The specimen must be a minimum of 100 mm by 150 mm 4 inch by 6 inch. After 14 days, the specimen must exhibit no cracking, checking, crazing, erosion, blistering, peeling, or delamination.

1.2.3.6 Absorption-Freeze-Thaw

Class PB systems must be tested in accordance with ASTM E2570/E2570M for 60 cycles of freezing and thawing. After testing, the specimen must exhibit no cracking, checking, or splitting, and negligible weight gain. Class PM systems must be tested in accordance with ASTM C67/C67M for 50 cycles of freezing and thawing. After testing, the specimens must exhibit no cracking or checking and have negligible weight gain.

1.2.3.7 Sample Boards

Unless otherwise stated, provide sample EIFS Component 300 by 600 mm 12 by 24 inches, on sheathing board, including finish color and texture, typical joints and sealant. If more than one color, finish, or pattern is used, provide one sample for each. The test specimen must consist of reinforcing mesh, base coat, and finish coat applied in accordance with manufacturer's printed recommendations to the insulation board to be used on the building.

1.2.4 Moisture Analysis

****

NOTE: Condensation of water vapor within the system or wall assembly can lead to performance problems. Condensation can cause leaks in the wall leading to damage to the wall structure such as rotting of wood studs, corrosion of metal framing, mold, staining and discoloration of interior finishes. Moisture, if trapped in EIFS, expands upon freezing, and it can damage the EIFS coatings. Should analysis determine that the project design is potentially

subject to condensation or mold problems, the installation of a vapor retarder, changing the insulation thickness, or selecting a different insulation material may be required.

Design to meet the requirements of UFC 1-200-02, High Performance and Sustainable Building Requirements, and UFC 3-101-01, Architecture.

For additional guidance see ASHRAE Handbook of Fundamentals, Chapters 25-27 Heat, Air and Moisture Control in Building Assemblies - Fundamentals, and ASTM C755, Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation. The computer program MOIST is a user-friendly tool based on hourly weather data that provides information on moisture content of building materials, the duration of high moisture content excursions, and on surface relative humidity.

The designer should consult with the system manufacturer when evaluating EIFS for condensation potential. Manufacturers typically offer water vapor transmission analysis services at no cost to designers and Contractors.
****

****
NOTE: The following analysis ensures the system performance if the Contractor's selected systems differ from the design.
****

Perform a job specific vapor transmission analysis based on project specific climate and specified wall components and materials. Indicate the temperatures and relative humidities for the inside and outside of the building; a complete listing of the building components, their thickness, thermal resistance and permeance, as well as building location and use. If a mathematical model was used for the analysis, include the name of the model and the supplier/developer.

1.3 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G, [_____]

SD-03 Product Data

Sheathing Board

Thermal Insulation

[Adhesive

] Mechanical Fasteners

Accessories

Base Coat

Portland Cement

Reinforcing Fabric

Finish Coat

Joint Sealant

Sealant Primer

Bond Breaker

Backer Rod

Insulation Board

[Recycled Content for Insulation Materials; S

] Warranty

SD-04 Samples

Sample Boards; G, [_____]

Color and Texture

[Mock-up Installation of EIFS; G, [_____]

] SD-05 Design Data

Moisture Analysis Calculations

SD-06 Test Reports

Abrasion Resistance

Accelerated Weathering

Impact Resistance

Mildew Resistance

Salt Spray Resistance

Water Vapor Transmission

Absorption-Freeze-Thaw

Wall Fire Test

Water Penetration

Water Resistance

Full Scale or Intermediate Scale Fire Test

Surface Burning Characteristics

Radiant Heat

Substrate

Wind Load Test

SD-07 Certificates

Qualifications of EIFS Manufacturer

Qualification of EIFS Installer

Qualification of Sealant Applicator

Qualifications of Third-Party Inspector

Inspection Checklist; G, [_____]

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

1.4 QUALITY CONTROL

1.4.1 Qualifications of EIFS Manufacturer

The EIFS must be the product of a manufacturer who has been in the practice of manufacturing and designing EIFS for a period of not less than 3 years, and has been involved in at least five projects similar to this project in size, scope, and complexity, in the same or a similar climate as this project.

1.4.2 Qualification of EIFS Installer

****

NOTE: Training is System (type/class) dependent.

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The EIFS Installer must be trained by the EIFS manufacturer to perform the installation of the System and must have successfully installed at least five projects at or near the size and complexity of this project. The Contractor must employ qualified workers trained and experienced in installing the manufacturer's EIFS.

1.4.3 Qualification of Sealant Applicator

The sealant applicator must be experienced and competent in the installation of high performance industrial and commercial sealants and must have successfully installed at least five projects at or near the size and complexity of this project. Also provide certification that sealant applicator is approved by the EIFS Manufacturer.

1.4.4 Qualifications of Third-Party Inspector

Submit evidence that third-party inspector has current certification from the Exterior Design Institute or equal inspector certification as inspector for the installation of EIFS.

1.4.5 Insulation Board

Insulation Board must be approved and labeled under third party quality program as required by applicable building code.

1.4.6 Shop Drawings

Submit shop drawings for EIFS. Show wall layout, construction and expansion joints, decorative grooves, layout of sheathing board, thermal insulation board, and reinforcing mesh and strip reinforcing fabric; joint and flashing details; details at wall penetrations; types and location of fasteners;[details at [windows][and][or][doors];] and details at [base,][roof,][parapet,][corners,][projecting features,][roof/wall intersections,][abutments of lower walls with higher walls,][_____].

1.4.7 Pre-Installation Conference

After approval of submittals and before commencing any work on the EIFS, including installation of any [sheathing board,] insulation, and associated work, the Contracting Officer will hold a pre-installation conference to review:

a. Drawings, specifications, and samples;

b. Procedure for on-site inspection and acceptance of EIFS substrate and pertinent details (for example, mock-up installation);

c. Contractor's plan for coordination of work of the various trades involved in providing EIF system and other components;

d. Inspection procedures; and

e. Safety requirements.

Pre-installation conference must be attended by the Contractor, [EIFS Q.C. Specialist (EIFS Inspector),] and all personnel directly responsible for installation of the EIF system, including sealant applicator, and personnel responsible for related work, such as flashing and sheet metal, windows and doors, and a representative of the EIFS manufacturer. Before beginning EIFS work, the Contractor must confirm in writing the resolution of conflicts among those attending the pre-installation conference.

1.5 DELIVERY AND STORAGE

Deliver materials to job site in original unopened packages, marked with manufacturer's name, brand name, and description of contents. Store materials off the ground and in accordance with the manufacturer's recommendations in a clean, dry, well-ventilated area. Protect stored materials from rain, sunlight, and excessive heat. Keep coating materials which would be damaged by freezing at a temperature not less than 4 degrees C 40 degrees F. Do not expose insulation board to flame or other ignition sources.

1.6 ENVIRONMENTAL CONDITIONS

a. Do not prepare materials or apply EIFS during inclement weather unless appropriate protection is provided. Protect installed materials from inclement weather until they are dry.

b. Apply sealants and wet materials only at ambient temperatures of 4 degrees C 40 degrees F or above, unless supplemental heat is provided. The system must be protected from inclement weather and maintain this temperature for a minimum of 24 hours after installation.

c. Do not leave insulation board exposed to sunlight after installation.

1.7 WARRANTY

Furnish manufacturer's standard warranty for the EIFS. Warranty must run directly to Government and cover a period of not less than 5 years from date Government accepted the work.

Warranty submittal must include joint and other details, such as end conditions, corners, windows, and parapet. Include shelf life and recommended cleaning solvents in data for sealants. Include Safety Data Sheets (SDS)for all components of the EIFS. The SDS must be available at the job site.

PART 2 PRODUCTS

2.1 COMPATIBILITY

Provide all materials compatible with each other and with the substrate, and as recommended by EIFS manufacturer.

2.2 SHEATHING BOARD

****

NOTE: Where local conditions require highly moisture resistant construction, specify cement-based Board only and delete Gypsum-based Board for applications of PB systems. Local experience is the best guide on where highly moisture resistant construction is required, but specify Cement-based Board for buildings in humid locations or project locations with Environmental Severity Classifications (ESC) of C4 and C5. See UFC 1-200-01 for determination of ESC for project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Include both Cement and Gypsum-based Sheathing Boards for applications where local conditions do not require highly moisture resistant construction.

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2.2.1 Fiber Reinforced Cement Sheathing Board

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NOTE: Cement sheathing boards meeting ASTM C1186 or ASTM C1325 are manufactured in two types A and B. Use only type A. Select grade and flexural strength to satisfy wind load calculations.

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a. Meet ASTM C1186, Type A, Grade [I] [_____], or.

b. Meet ASTM C1325, Type A, Flexural Strength [_____]

c. Non-combustible in accordance with ASTM E136.

d. Nail Pull Resistance: No less than 534 N 120 lb when tested in accordance with ASTM C473.

e. Thickness no less than 13 mm 1/2 inch.

f. Water Absorption not to exceed 17 percent.

[2.2.2 Glass Mat Gypsum Sheathing Board

a. Conform to ASTM C1177/C1177M; or.

b. ASTM C1278/C1278M, Water Resistant Exterior Type only

c. Flexural Strength [_____]

d. Nail Pull Resistance: No less than 534 N 120 lb when tested in accordance with ASTM C473.

][2.3 ADHESIVE

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NOTE: Delete the adhesive when using Class PM EIFS.

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Manufacturer's standard product, including primer as required, must be compatible with substrate and insulation board to which the system is applied.

]2.4 LATHING AND FURRING

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NOTE: EIFS are often used for retrofit over existing unit walls. When the bonding conditions of the retrofit is deemed poor for use with adhesively applied Class PB EIFS, a corrosion resistant, self-furring metal lath can be mechanically fastened to the masonry wall to support the adhesive. When specifying a drainage system with air barrier, specify adhesive application instead of mechanical fasteners, to avoid puncturing the air barrier. Delete this paragraph if metal lath is not required.

****

Conform to ASTM C847, 1.4 kg/sqm 2.5 lb/sqyd, self-furring, galvanized.

2.5 MECHANICAL FASTENERS

Corrosion resistant and as approved by EIFS manufacturer. Select fastener type and pattern based on applicable wind loads and substrate into which fastener will be attached, to provide the necessary pull-out, tensile, and shear strengths.

2.6 THERMAL INSULATION

2.6.1 Manufacturer's Recommendations

Provide only thermal insulation recommended by the EIFS manufacturer for the type of application intended.

2.6.2 Insulation Board

****

NOTE: Select R-Value for Thermal Insulation required.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to ASHRAE 90.1 and IgCC requirements governing energy efficiency and requirements for the components of building envelope design including moisture control and thermal performance.

Show R-Value on drawings.

Do not specify thermal insulation over 100 mm 4 inch thick as part of the EIFS. If the insulating value required to meet energy budget cannot be achieved within the 100 mm 4 inch limitation, provide additional insulation as separate item on interior of EIFS. Specify such insulation under appropriate separate specification section.

****

Insulation board must be standard product of manufacturer and must be compatible with other system components. Boards must be factory marked individually with the manufacturer's name or trademark, the material specification number, the R-value at 24 degree C 75 degree F, and thickness. No layer of insulation can be less than 20 mm 3/4 inch thick. The maximum thickness of all layers must not exceed 100 mm 4 inches. Insulation Board must be certified as aged, in block form, prior to cutting and shipping, a minimum of 6 weeks by air drying, or equivalent.

a. Thermal resistance: As indicated on drawings.

b. Insulating material: [ASTM C578] Type I as recommended by the EIFS manufacturer and treated to be compatible with other EIFS components. Age insulation by air drying a minimum of 6 weeks prior to cutting and shipping.

c. Drainage: Preform channels into the interior face of insulation board or provide polypropylene drainage lath spacer to provide water drainage system.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

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[d. Recycled Content: Provide insulation material that has minimum of 10 percent recycled material. Provide data identifying percentage of recycled content for insulation materials.

]2.7 BASE COAT

Manufacturer's standard product and compatible with other system components.

2.8 PORTLAND CEMENT

Conform to ASTM C150/C150M, Type I or II as required, fresh and free of lumps, and approved by the systems manufacturer.

2.9 REINFORCING FABRIC

Reinforcing fabric mesh must be alkali-resistant, balanced, open weave, glass fiber fabric made from twisted multi-end strands specifically treated for compatibility with the other system materials, and comply with ASTM E2098/E2098M and as recommended by EIFS manufacturer.

2.10 FINISH COAT

Manufacturer's standard product conforming to the requirements in the paragraph on Sub-Component Requirements and Tests. For color consistency, use materials from the same batch or lot number.

2.11 SEALANT PRIMER

Non-staining, quick-drying type recommended by sealant manufacturer and EIFS manufacturer.

2.12 ACCESSORIES

Conform to recommendations of EIFS manufacturer, including trim, edging, anchors, and expansion joints. All metal items and fasteners to be corrosion resistant.

2.13 JOINT SEALANT

Non-staining, quick-drying type meeting ASTM C920, as Type S or M, minimum Grade NS, minimum Class 25 and compatible with the finish system type and grade, and recommended by both the sealant manufacturer and EIFS manufacturer.

2.14 BOND BREAKER

As required by EIFS manufacturer and recommended by sealant manufacturer and EIFS manufacturer.

2.15 BACKER ROD

Closed cell polyethylene free from oil or other staining elements and as recommended by sealant manufacturer and EIFS manufacturer. Do not use absorptive materials as backer rod. Size the backer rod 25 percent larger than the width of the joint.

PART 3 EXECUTION

3.1 EXAMINATION

Examine substrate and existing conditions to determine that the EIFS can be installed as required by the EIFS manufacturer and that all work related to the EIFS is properly coordinated. Surface must be sound and free of oil, loose materials or protrusions which will interfere with the system installation. If deficiencies are found, notify the Contracting Officer and do not proceed with installation until the deficiencies are corrected. The substrate must be plane, with no deviation greater than 6 mm 1/4 inch when tested with a 3 m 10 foot straightedge. Determine flatness, plumbness, and any other conditions for conformance to manufacturer's instructions.

3.2 SURFACE PREPARATION

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NOTE: The paragraph below only specifies flatness of substrate to the EIFS manufacturer's requirements. Where, because of the prominence of the building, more stringent flatness requirements are necessary, these should be added to the

paragraph.
****

Prepare existing surfaces for application of the EIFS to meet flatness tolerances and surface preparation according to manufacturer's installation instructions [but provide a flatness of not more than [6] [_____] mm in 3000 mm [1/4] [_____] inch in 10 feet]. Provide clean surfaces free of oil and loose material without protrusions adversely affecting the installation of the insulation board. For adhesively attached EIFS, existing deteriorated paint must be removed. Due to substrate conditions or as recommended by the system manufacturer, a primer may be required. Apply the primer to existing surfaces as recommended by the manufacturer. Use masking tape to protect areas adjacent to the EIFS to prevent base or finish coat to be applied to areas not intended to be covered with the EIFS. The Contractor must not proceed with the installation until all noted deficiencies of the substrate are corrected.

3.3 INSTALLATION

Install EIFS as indicated, comply with manufacturer's instructions except as otherwise specified, and in accordance with the shop drawings. Submit manufacturer's standard printed instructions for the installation of the EIFS; include requirements for condition and preparation of substrate, installation of EIFS, and requirements for sealants and sealing. Also include detailed finish repair procedures and information regarding compatibility of sealants with base and finish coatings.

EIFS must be installed only by an applicator trained by the EIFS manufacturer. Specifically, include all manufacturer recommended provisions regarding flashing and treatment of wall penetrations. Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

[3.3.1 Sheathing Board

Edges and ends of boards must be butted snugly with vertical joints staggered to provide full and even support for the insulation. Do not align sheathing board joints with wall openings. Provide support at both vertical and horizontal joints. Attach sheathing board [to metal studs with self-tapping drywall screws] [to concrete or masonry with corrosion resistant metal fasteners]. Place fasteners sufficiently close to support imposed loads, but not more than:

[a. Maximum of 200 mm 8 inches apart on each supporting stud

][b. Maximum of 300 mm 12 inches apart horizontally and vertically into[concrete][masonry].

] Space fasteners more closely when required for negative wind load resistance.

]3.3.2 Insulation Board

Unless otherwise specified by the system manufacturer, place the long edge horizontally from level base line. Stagger vertical joints and interlock at corners. Butt joints tightly. Provide flush surfaces at joints. Offset insulation board joints from joints in sheathing by at least 200 mm 8 inches. Align drainage channels of integral drainage system or provide polypropylene drainage lath space to provide a path for any water weeped from behind the insulation to escape wall construction. Use L-shaped insulation board pieces at corners of openings. Joints of insulation must be butted tightly. Surfaces of adjacent insulation boards must be flush at joints. Gaps greater than 1.6 mm 1/16 inch between the insulation boards must be filled with slivers of insulation. Uneven board surfaces with irregularities projecting more than 1.6 mm 1/16 inch must be rasped in accordance with the manufacturer's instructions to produce an even surface. Attach insulation board as recommended by manufacturer. The adhered insulation board must be allowed to remain undisturbed for 24 hours prior to proceeding with the installation of the base coat/reinforcing mesh, or longer if necessary for the adhesive to dry. However, do not leave insulation board exposed longer than recommended by insulation manufacturer.

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NOTE: For PM systems, specify mechanical fastening of insulation board to the sheathing board. For PB systems mechanical attachment may be specified as an option.

****

[3.3.2.1 Mechanically Fastened Insulation Boards

Fasten with manufacturer's standard corrosion resistant anchors, spaced as recommended by manufacturer, but not more than 600 mm 2 feet horizontally and vertically.

][3.3.2.2 Adhesively Fastened Insulation Boards

Apply insulation board using adhesive spread with a notched trowel to the back of the insulation boards in accordance with the manufacturer’s instructions.

]3.3.3 Base Coat and Reinforcing Fabric Mesh,

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NOTE: Delete the inapplicable system (Class PM or Class PB EIFS).

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[3.3.3.1 Class PB Systems

Allow the adhered insulation board to dry for 24 hours, or longer if necessary, prior to proceeding with the installation of the base coat/reinforcing fabric mesh. Install reinforcing fabric in accordance with manufacturer's instructions. Mix base coat in accordance with the manufacturer's instructions and apply to insulated wall surfaces to the thickness specified by the system manufacturer and provide any other reinforcement recommended by EIFS manufacturer. Trowel the reinforcing fabric mesh into the wet base coat material. Fully embed the mesh in the base coat. When properly worked-in, the pattern of the reinforcing fabric mesh must not be visible. Provide diagonal reinforcement at opening corners. Back-wrap or edge wrap all terminations of the EIFS. Overlap the reinforcing fabric mesh a minimum of 60 mm 2.5 inches on previously installed mesh, or butted, in accordance with the manufacturer’s instructions.

][3.3.3.2 Class PM Systems

Mechanically fasten reinforcing fabric mesh to the insulated wall using the type and spacing of fasteners specified in the manufacturer’s instructions. Provide diagonal reinforcement at opening corners. Mix base coat in accordance with manufacturer's instructions. Apply base coat in accordance with manufacturer's instruction to provide a complete, tight coating of uniform thickness as specified by the manufacturer. Cover all fiberglass reinforcing fabric, including at back wrapped areas at panel joints and at fasteners.

]3.3.4 Finish Coat

The base coat/reinforcing mesh must be allowed to dry a minimum of 24 hours prior to application of the finish coat. Surface irregularities in the base coat, such as trowel marks, board lines, and reinforcing mesh laps, must be corrected prior to the application of the finish coat. Apply and level finish coat in one operation. Obtain final texture by trowels, floats, or by spray application as necessary to achieve the required finish matching approved [sample] [mock-up installation]. Apply the finish coat to the dry base coat maintaining a wet edge at all times to obtain a uniform appearance. The thickness of the finish coat must be in accordance with the system manufacturer’s current published instructions. Apply finish coat so that it does not cover surfaces to which joint sealants are to be applied.

3.4 JOINT SEALING

Seal EIFS at openings as recommended by the system manufacturer. Apply sealant only to the base coat with EIFS Manufacturer's color coating. Do not apply sealant to the finish coat.

3.4.1 Surface Preparation, Backer Rod, and Primer

Immediately prior to application, remove loose matter from joint. Ensure that joint is dry and free of finish coat, or other foreign matter. Install backer rod. Apply primer as required by sealant and EIFS manufacturer. Check that joint width is as shown on drawings but in no case can it be less than 13 mm 0.5 inch for perimeter seals and 20 mm 0.75 inch for expansion joints. The width must not be less than 4 times the anticipated movement. Check sealant manufacturer's recommendations regarding proper width to depth ratio.

3.4.2 Sealant

Do not apply sealant until all EIFS coatings are fully dry. Apply sealant in accordance with sealant manufacturer's instructions with gun having nozzle that fits joint width. Do not use sealant that has exceeded shelf life or cannot be discharged in a continuous flow. Completely fill the joint solidly with sealant without air pockets so that full contact is made with both sides of the joint. Tool sealant with a round instrument that provides a concave profile and a uniformly smooth and wrinkle free sealant surface. Do not wet tool the joint with soap, water, or any other liquid tooling aid. During inclement weather, protect the joints until sealant application. Use particular caution in sealing joints between window and door frames and the EIFS wall and at all other wall penetrations. Clean all surfaces to remove excess sealant.

3.5 FIELD QUALITY CONTROL

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NOTE: EIFS is applied in layers where installation

deficiencies can be hidden with the application of subsequent layers. Include in Section 01 45 00 QUALITY CONTROL, inspection requirements appropriate to the size and significance of the project. For all but minor projects, require a full-time on-site inspector during the installation of EIFS and its sealing. The inspector should have at least 2 years experience in the installation of the particular manufacturer's EIFS being installed and a total of not less than 3 years of EIFS inspection experience. Some EIFS manufacturers provide field inspection services during installation. Identify the EIFS inspector as a QC Specialist in Section 01 45 00 QUALITY CONTROL. For all but small jobs, the EIFS inspector should have no other duties than those of inspecting the installation. For major projects requiring a third-party inspector, include paragraph THIRD-PARTY INSPECTION below.

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Throughout the installation, the Contractor must establish and maintain an inspection procedure to assure compliance of the installed EIFS with Contract requirements. Work not in compliance must be removed and replaced or corrected in an approved manner. The inspection procedures, from acceptance of deliveries through installation of sealants and final acceptance must be performed by a qualified inspector trained by the manufacturer. No work on the EIFS is allowed unless the inspector is present at the job site.

[3.5.1 Third-Party Inspection

Provide full-time third-party inspection during the entire process of installing the EIFS, from examination through cleanup. The third-party inspector must be certified by the Exterior Design Institute (EDI), AWCI, or by an equivalent independent party and must be trained in the proper installation of EIFS.

]3.5.2 Inspection Checklist

During the installation and at the completion of installation, perform inspections covering at the minimum all applicable items enumerated on the attached checklist. The inspector must initial and date all applicable items, sign the checklist, and submit to the Contracting Officer daily.

CHECKLIST

Item	Description	Appr'd/Date
a.	Materials are handled and stored correctly.	
b.	Environmental conditions are within specified limits, including temperature not below 4 degrees C (40 degrees F), and the work is protected from the elements as required.	
c.	Preparation and installation is performed by qualified personnel using the correct tools.	
d.	Adjacent areas to which EIFS is not to be applied	

CHECKLIST

Item	Description	Appr'd/Date
	(such as on window and door frames) are protected with masking tape, plastic films, drop cloths, or other covering to prevent accidental application of EIFS materials.	
e.	Control, expansion and aesthetic joints are installed as indicated or recommended. Accessories are properly installed.	
f.	Substrate is in-plane, properly attached, clean, dry, and free of contaminants. Concrete substrate is free of efflorescence.	
g.	Materials are mixed thoroughly and in proper proportions.	
h.	Adhesive is applied in sufficient quantity with proper-size notched trowel.	
i.	Mechanical attachments have proper spacing, layout and fastener depth.	
j.	Insulation boards are tightly abutted, in running bond pattern, with joints staggered with the sheathing, board corners interlocked, L-shaped boards around openings, edges free of adhesive, and provision for joints. Gaps are filled and surfaces rasped.	
k.	Insulation adhesive must be allowed to dry (a minimum of 24-hours) prior to the application of the base coat.	
l.	Reinforcing fabric mesh is properly back-wrapped at terminations.	
m.	Reinforcing fabric mesh is fully embedded and properly placed. Corners are reinforced. Openings are diagonally reinforced. Mesh overlaps minimum 65 mm (2-1/2 inches).	
n.	Base coat thickness is within specified limits.	
o.	The base coat/reinforcing fabric mesh must be allowed to dry (a minimum of 24-hours) prior to the application of the finish coat.	
p.	Finish coat is applied with sufficient number of personnel and stopped at suitable points. Floats and methods of texturing are uniform.	
q.	All flashings are properly installed.	
r.	All joints are properly sealed in their entire length at time and under environmental conditions as specified by the manufacturer.	
s.	All scaffolding, equipment, materials, debris	

CHECKLIST

Item	Description	Appr'd/Date_
	and temporary protection are removed from site upon completion.	

Name of Inspector:________________ Signed:__________________ Date:________

3.6 CLEANUP

Upon completion, remove all scaffolding, equipment, materials and debris from site. Remove all temporary protection installed to facilitate installation of EIFS.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 27 10 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-07 27 10.00 10 (August 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 27 10

BUILDING AIR BARRIER SYSTEM

08/23

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USACE / NAVFAC / AFCEC **UFGS-07 27 10 (August 2023)**

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SECTION 07 27 10

BUILDING AIR BARRIER SYSTEM
08/23

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NOTE: This guide specification covers Contractor responsibilities, quality control, and maximum leakage requirements of the constructed air barrier system. This specification must be accompanied by plans showing and detailing the air barrier; it is not intended to stand alone in any set of construction documents. This specification is intended for use on new construction and additions, and on renovations involving major upgrade to the building envelope.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: UFC 3-101-01 Architecture gives air barrier system requirements for new construction and renovations.

Testing of the air barrier system is covered in the companion UFGS 01 91 19 **BUILDING ENCLOSURE COMMISSIONING. If air barrier system testing is**

required by the UFC, the testing specification must accompany this specification in the construction documents.

This specification is applicable to air barrier systems installed in new building construction and in major renovations involving upgrades to the building envelope; it is not applicable to unconditioned buildings. This specification is intended to define Contractor responsibilities for the construction of the air barrier system across the six sides of a building that when installed properly will control the infiltration or exfiltration of air through the air barrier system. A tight building is essential to a properly functioning HVAC system, to reduce energy consumption, and to prevent problems arising from excessive infiltration or exfiltration into or out of the environmentally conditioned spaces.

UFC 3-101-01 Architecture is recommended reading for the designer. Also recommended is "Air Barrier Systems in Buildings" by Wagdy Anis, FAIA; available at https://www.wbdg.org/resources/air-barrier-systems-buildings.

Additional resources include:

EP 415-1-261 Vol 6 BUILDING ENVELOPES for construction related aspects of the air barrier system and other building envelope components.

Annex 61 Deep Energy Retrofit Guide Chapter 10 and Appendix G Air Tightness for Guidance on Renovation and Retrofit Applications and Strategies.

AIR BARRIER SYSTEM CONCEPTS AND DESIGNER NOTES:

1. Design a continuous air barrier system to control air leakage into, or out of, the conditioned space.

2. On drawings dedicated to the air barrier system, identify the surface boundary of the building air barrier system in plan and in building section views. Think of the air barrier system as a sealed balloon.

3. Keep in mind that window and door components are part of the building air barrier system. One must be able to trace a continuous plane of air-tightness throughout each air barrier system envelope.

4. Of course, intake, exhaust, and relief dampers are part of the air barrier system. If these dampers are not located at or near the building wall, then the duct between the air barrier in the exterior wall and the damper is also part of the air barrier system and must be well sealed.

5. Walls of ventilated crawl spaces logically cannot be the boundary of the air barrier system. Nor can the roof above a ventilated attic be part of an air barrier system.

6. Defining the air barrier system boundary is the responsibility of the building designer. Plan views should show the horizontal outline (by dashed lines) of the air barrier system and any individual air barrier zones. Rooms with permanent fixed openings to the outdoor environment cannot be included in the air barrier envelope because such openings would represent a hole in the air barrier envelope (the balloon).

7. Building and wall sections should show the vertical outline (by dashed lines) of the air barrier system from floor to roof or ceiling.

8. Wall and roof sections and details should show the location of the air barrier membrane within the exterior building envelope.

9. For cavity wall construction utilizing insulation board inside the cavity, air barrier materials located on the outboard side of the wall system and the interior side of the insulation attached to a durable substrate is subject to less expansion and contraction than if located on the outer side. Additionally, this location is the proper hygrothermal location for the vapor plane of the wall assembly for stud cavity or masonry block walls.

10. The concrete material can act as the air/water/vapor barrier on pre-cast, cast-in-place concrete, and Insulated Concrete Form (ICF) walls.

11. Air barrier materials that also serve as interior finishes are discouraged because such materials are subject to damage, difficult to seal, and often compromised by occupant penetrations.

12. An air barrier material located on the outboard side of the exterior wall assembly can often serve as the air, vapor and water resistive layer of the wall system. Common stud cavity or masonry wall types must incorporate an air/water/vapor control layer on the outboard side of the wall assembly and when doing so, this should be a Class 1 vapor barrier/retarder by material permeance. Applying an air barrier will establish the vapor plane of the wall system in the correct location and allow inward and outward drying potential for the assembly from this plane. Consider the vapor permeance of all materials and their relative position within the exterior envelope to assure the increasing permeance of the materials from the vapor plane to the inner, conditioned space surface of the wall system. Particular attention should be paid to the climatic

conditions the wall system will be situated in and experience over the lifetime of the assembly. Air barrier materials may have low water vapor permeance and act as intended, or if located incorrectly, unintended vapor retarders or barriers. Other materials used with the envelope may also have low water vapor permeance. Careful consideration regarding the location of such materials is crucial to avoid vapor barrier temperature below the dew point temperature of the air on either side, and to avoid double vapor barriers that prevent inward drying to the conditioned space and can trap condensation within the thermal envelope. Such conditions can contribute to mold problems and material failure problems. The thermal resistance, vapor permeance, and relative thermal position of the component materials must be selected such that at all locations within the envelope, the dew point temperature is less than the local surface temperature.

If software such as WUFI hygrothermal modeling is available, use it to verify wall system performance or to model unique conditions or building applications that are atypical for a given condition or climate.

13. Keep in mind that air barrier membranes must withstand forces due to positive and negative pressures caused by wind and Stack Effect. As a point of reference, many roofs are designed for a wind uplift pressure of 4.3 kPa 90 lb/sq.ft. Building wraps are particularly susceptible to wind forces unless sandwiched between rigid wall components (example: sheathing and board insulation). Otherwise, wraps may experience excessive flexing and stressing and point loading of the securing fasteners.

14. On the drawings, identify each air barrier material, membrane, coating, window component, door component, dampers, and other components that compose the continuous air barrier envelope. Materials that are part of the designated continuous air barrier system must be identified as such. Although many materials used in exterior assemblies are airtight, they may or may not serve as part of the designated continuous air barrier system.

15. In a roof assembly, typically locate the air barrier material on the inside of the insulation and attached to a durable substrate. Design roof assemblies in accordance with UFC 3-110-03 Roofing.

16. Detail the connection of roof and wall air barrier materials. The roof-wall interface has been the source of major air infiltration and exfiltration in the past due to the many irregularly shaped decking and structural support members

intersecting at this point, and insufficient attention to detail to the air barrier system at this location. Although sequencing the connection of the roof-wall air barriers is the Contractor's responsibility, drawing notes suggesting a sequence of the trades may serve as helpful reminders to the installer.

17. Detail the connection of wall and floor air barrier materials.

18. Detail the connection of the wall air barrier materials to window and door components.

19. Detail the penetrations of the air barrier envelope by pipe, ducts, and conduit showing the method of sealing the penetration. Minimize air barrier penetrations to the greatest extent possible.

20. Detail the air barrier material to be continuous under or around electrical boxes and panels, plumbing fixture boxes, and other items affecting air barrier system continuity. Do not penetrate the air barrier envelope with lighting fixtures. Continuity and air tightness is easier to achieve when air barriers materials are located outboard of the cavities that contain wiring, conduit, and plumbing.

21. In other specification sections, specify the air barrier materials used in the system. As defined by the Air Barrier Association of America (ABAA) all air barrier materials must have an air permeance less than 0.02 L/s-m^2 0.004 CFM/sq-ft at 75 Pa when tested in accordance with ASTM E2178.

22. Identify the allowable leakage rates of windows, exterior doors, curtain wall assemblies, skylights, dampers, and all other such air barrier components in the specification sections covering these components.

23. Note that the Energy Star program has no air leakage requirement for windows and doors. However, ASHRAE 90.1 contains maximum leakage values for fenestration and doors determined in accordance with NFRC 400. These are minimal requirements and do not represent state of the art. The IECC standard contains leakage limits for doors and windows that may be useful as a guideline. Be sure the specifications for fenestration and doors include maximum air leakage values.

24. Leakage rates for sectional type overhead doors are published by manufacturers, however, there is no known manufacturer who publishes tested leakage performance for roll-up type overhead door assemblies. For roll-up type doors, specify the best weatherstripping available in the specification

section covering overhead doors and specify a maximum leakage when such ratings are available.

25. Where louvered smoke ventilation openings are used at the top of elevator shafts, provide a motorized damper which is sprung normally open and held closed by the damper actuator. Connect the actuator to the fire alarm system to open the damper upon a building alarm. Refer to IBC Chapter 30 Elevators and Conveying Systems.

26. Provide tight sealing dampers and controls to close all ventilation or make-up air intakes and exhausts during inactive or unoccupied periods. In the HVAC and building controls specification sections, specify all intake, relief, and exhaust dampers to be AMCA 511 leakage Class 1A (15.2 L/s/square meter@250 Pa(3 CFM/sq.ft. @ 1 in.w.c).

27. Often, there is but one air barrier envelope in a building and this single envelope may enclose the entire volume of the building or a portion of the building.

28. However, some buildings call for multiple air barrier envelopes. An example is in a vehicle maintenance facility; the air conditioned administrative office area must have an air barrier envelope system complete and separate from the air barrier envelope serving the maintenance area so that the admin area air barrier system is not nullified during warm weather when the vehicle maintenance bay doors are open. The common wall between the two areas is a part of the air barrier envelope for both areas. Therefore, the common wall must be tightly constructed and include an air barrier material. Note that, in this case, the common wall is included in the calculation of the air barrier surface area.

29. Sometimes the entire air barrier envelope cannot be tested at once. An example is a building with multiple living quarters separated by full height partitions and without an interior corridor. If there is no discernable air path connecting the rooms (such as interior doorways or common ceiling plenums), testing the entire building air barrier envelope is precluded.

30. In this case, portions of the air barrier envelope should be tested. Selected rooms must be air pressure tested to determine the leakage through the portion of the air barrier envelope shared by the selected rooms. On the drawings, identify representative rooms at the exterior corners and rooms not at building corners to be tested, and in this specification, give the room number air barrier envelope area and leakage requirements for each room to be tested. Note the air barrier envelope surface

area is only that portion of air barrier perimeter envelope shared by the room, it is not the entire room surface area. Testing in this situation requires pressurizing adjacent rooms so that there is no room-to-room air leakage. For a description of the test process, Refer to UFGS 01 91 19 BUILDING ENCLOSURE COMMISSIONING paragraph Pressure Testing a Multiple Isolated Zoned Building. Where a number of rooms have the same dimensions, the drawings should indicate that the test room will either be the room indicated or a room of the same size selected by the Contracting Officer.

31. On the drawings, the designer must identify the envelopes to be tested, usually by number. Refer to paragraph AIR BARRIER ENVELOPE SURFACE AREA AND LEAKAGE REQUIREMENTS.

32. Calculate the air barrier envelope surface area (sq. m(sq.ft.) for each envelope to be tested. This is the surface area of the volume enclosed by each air barrier envelope to be tested (includes floors, walls, fenestration, doors, and roof). On the drawings or in this specification, indicate the surface area for each air barrier envelope to be tested.

33. Two tests can be performed for the building envelope; an "Architectural Only Test", and an "Architectural Plus HVAC System Test". The Architectural Only Test calculates the leaking through the architectural portions of the envelope and allows some expedient sealing of many HVAC components to exclude any leakage through these items from test results.

The Architectural Plus HVAC System calculates the leakage from the entire building in a condition in which the HVAC system is off and allows no temporary masking or sealing of mechanical or HVAC components such as dampers, flues and vents. The Architectural plus HVAC System test should be included in the specifications of a Contract when the building is designed such that the HVAC system may operate intermittently and when dampers will be used to prevent air leakage out of the conditioned space through the HVAC system. The Architectural Plus HVAC System test may be applied to residential projects with intermittent HVAC system operation or a project in which there is a need to verify mechanical dampers in the HVAC system for leakage performance.

34. Indicate the allowable leakage rate of each air barrier envelope (___ L/s-m^2(___CFM/sq.ft. @ 75 Pa). Refer to UFC 3-101-01. Use the UFC maximum allowed values or less for the Architectural Only Test.

35. To the Architectural Only Test maximum leakage rate, add an allowance for the HVAC system leakage rate. An arbitrary allowance of 0.25 L/s-m^2 0.05 CFM/sq.ft. is suggested. This higher leakage rate is the Architectural Plus HVAC System Test maximum leakage rate. In other words, if the Architectural Only Test allowable leakage rate is X, the Architectural Plus HVAC System Test allowable leakage rate is X + 0.25 L/s-m^2 0.05 CFM/sq.ft.
Example:
- Architectural Only Test: 1.27 L/s-sq m 0.25 CFM/sq.ft. @ 75 Pa.
- Architectural Plus HVAC System Test: 1.5 L/s-m^2 0.30 CFM/sq.ft. @ 75 Pa.

36. Next, calculate and indicate the maximum test leakage in L/s (CFM) for each air barrier envelope and for each type test.

37. Renovations: Refer to UFC 3-101-01 for requirements. This specification is used on renovations if a major upgrade to the building envelope is involved. However, the UFC offers guidance on prioritizing the sealing of existing building envelopes based on funding.

38. Additions: Where a new addition shares a wall with an existing building, the designer has two options:
a) put an air barrier assembly in the common wall and treat the new addition as a separate test zone, or
b) indicate that doors and other openings in the common wall will be temporarily sealed during the test, and identify a portion of the existing building that can be closed and pressurized with separate pressurization equipment so that there is no differential pressure across the common wall during the test.

39. Special Design Conditions:

Humidified Rooms: A humidified space within an unhumidified building (example: computer equipment room) should be located as an interior room and not located on the building perimeter envelope. Otherwise pay close attention to the potential for condensation within the perimeter envelope during times of cold weather.

Removable Wall or Roof Panels for Equipment Installation: Removable wall and roof panels must maintain the same weather and air barrier qualities as the surrounding building materials. Removable sections must be detailed in a manner to be able to be resealed to the same level as originally installed.

Secure Rooms and Shielded Facilities: Coordinate

compatibility of Secure Room and Shielding details with the air barrier details. It is recommended to locate such facilities at interior building locations away from exterior walls or provide a separation space between the protected facility and the exterior wall. When using the Secure Room or shielded wall at exterior locations, care must be taken to maintain consistent wall/ceiling temperature and proper ventilation to avoid condensation and mold problems. Shielding materials must avoid use of organic adhesives, sealants, or other materials which promote mold growth. When using shielded assemblies as part of the exterior building shell assembly, it is recommended to use WUFI analysis to determine proper assembly of materials.

40. Copy and complete the checklist below and include it in the Architectural Design Analysis.
--

AIR BARRIER SYSTEM DESIGNER CHECKLIST

Drawings:

___ 1. Air barrier system drawings are included in the plans. (More than one drawing may be required. It may be necessary to provide a plan for each floor.)

___ 2. A reduced size plan and elevation views of the building indicating the desired perimeter boundary of each air barrier envelope is included.

___ 3. The air barrier envelopes to be tested are shown and given a unique number for reference as applicable.

___ 4. Details showing how the wall air barrier assembly is joined to the roof air barrier assembly are provided.

___ 5. Details showing how the wall air barrier material is joined to the floor / foundation are provided.

___ 6. Details showing how the wall air barrier material is joined to the window components are provided.

___ 7. Details showing how the wall air barrier material is joined to the door components are provided.

___ 8. Details are provided showing the air barrier system at expansion and isolation joints as applicable.

___ 9. Details are provided showing the method of sealing penetrations of the air barrier envelope at

the wall, roof, or floor by conduit, piping, and cables.

___ 10. Details showing how the air barrier materials are routed around wall and roof discontinuities are provided (such as soffits, overhangs, offsets, vestibules, gables, ridges, and eaves).

___ 11. In the wall and roof sections, materials and accessories that constitute the air barrier system are clearly identified. Examples: board materials, liquid applied coatings, spray applied foams, tape, calks, sealants.

___ 12. In the wall and roof sections, components and assemblies that constitute the air barrier system are clearly identified. Examples: windows, doors, skylights.

Note: The following are examples for air barrier materials:

- **Cast-in-place concrete**
- **Glass**
- **Metal**
- **Spray polyurethane foam**
- **Spray polyethylene foam**
- **Extruded polystyrene**
- **Low permeance building wrap products.**
- **Liquid applied one- and two- component materials**

Note: The following cannot serve as air barrier materials:

- **Concrete block**
- **Expanded polystyrene foam**
- **Building paper/felts**
- **Open cell foam**
- **High permeance house wraps**
- **Perlite board**
- **Fiberboard**
- **Un-treated sheathing**
- **Glass fiber rigid board**
- **Cellulose insulation**
- **Metal roof decking**
- **Standing seam roof**

Specifications:

___ 13. Air barrier membranes and their air permeance and water vapor permeance are specified in other specification sections. Examples: Mechanically fastened sheet films, fluid-applied membranes, self-adhering membranes, spray-applied foams.

Air barrier materials have a maximum air permeance

of 0.02 L/s-m^2 0.004 CFM/sq.ft. of surface area at a pressure difference of 75 Pa. Films, membranes, and coatings intended as air barrier components must meet this rating when tested in accordance with ASTM E 2178.

___ 14. The allowable leakage requirements of window, curtain wall, and door components is specified in other specification sections.

___ 15. The allowable leakage requirements of HVAC intake and exhaust dampers is specified in other specification sections.

Calculations:

___ 16. The surface area (sq. m(sq.ft.) of each air barrier envelope to be tested has been calculated.

___ 17. The maximum allowable leakage (L/s(CFM) for both the Architectural Only Test and the Architectural Plus HVAC System Test has been calculated and shown for each air barrier envelope to be tested.

___ 18. Moisture migration and dewpoint calculations have been performed. WUFI software available from Oak Ridge National Laboratory or similar moisture migration analysis software is recommended.

Note: Air barrier materials will have low air permeance by definition. However, beware of the vapor permeance of air barrier membranes. For example, if the air barrier material has a low vapor permeance, it may act as an effective vapor retarder. With this in mind, the location of the membrane within the wall or roof relative to the thermal insulation becomes important. Be sure that the vapor permeance and location has been considered by the design. Perform vapor transmission calculations or dew point calculations as required to assure that moisture condensation within the building envelope will not occur.

HVAC Note: The HVAC designer should coordinate with the architectural designer regarding the indoor temperature and humidity conditions and the simultaneously occurring outdoor air conditions. With this information the architectural designer can determine the envelope component configuration conducive to maintaining a dry thermal envelope.

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(End Designer Checklist)

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1.1 SUMMARY

This Section specifies the construction and quality control of the installation of an air barrier system. Construct the air barrier system indicated, taking responsibility for the means, methods, and workmanship of the installation of the air barrier system. The air barrier must be contiguous and connected across all surfaces of the enclosed air barrier envelope indicated. The maximum leakage requirements of individual air barrier components and materials are specified in the other specification sections covering these items.[

****

NOTE: Refer to UFC 3-101-01 to determine when testing is required. If testing is required, retain the bracketed paragraph below and include the referenced testing specification section in the construction documents.

****

This section also defines the maximum allowable leakage of the final air barrier system. The workmanship must be adequate to meet the maximum allowable leakage requirements of this specification. Test the assembled air barrier system to demonstrate that the building envelope is properly sealed and insulated. Passing the air barrier system leakage test and thermography test will result in system acceptance. Conform air barrier system leakage and thermography testing and reporting to the requirements of Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referenced within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor

	Transmission Rate of Materials
ASTM E2178	(2021a) Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials
ASTM E2357	(2018) Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 285	(2023) Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

1.3 DEFINITIONS

The following terms as they apply to this section:

1.3.1 Air Barrier Accessory

Products designated to maintain air tightness between air barrier materials, air barrier assemblies and air barrier components, to fasten them to the structure of the building, or both (e.g., sealants, tapes, backer rods, transition membranes, fasteners, strapping, primers).

1.3.2 Air Barrier Assembly

The combination of air barrier materials and air barrier accessories that are designated and designed within the environmental separator to act as a continuous barrier to the movement of air through the environmental separator.

1.3.3 Air Barrier Component

Pre-manufactured elements such as windows, doors, dampers and service elements that are installed in the environmental separator.

1.3.4 Air Barrier Envelope

The combination of air barrier assemblies and air barrier components, connected by air barrier accessories that are designed to provide a continuous barrier to the movement of air through an environmental separator. There may be more than one air barrier envelope in a single building. Also known as Air Barrier System.

1.3.5 Air Barrier Material

A building material that is designed, tested or produced to provide the primary resistance to airflow through an air barrier assembly of a building enclosure.

1.3.6 Air Barrier System

Same as AIR BARRIER ENVELOPE.

1.3.7 Air Leakage Rate

The rate of airflow (L/sCFM) driven through a unit surface area (sq. msq.ft.) of an assembly or system by a unit static pressure difference (Pa) across the assembly. (example: 1.27 L/s-m^{2}0.25 CFM/sq.ft. @ 75 Pa)

1.3.8 Air Leakage

The total airflow (L/sCFM) driven through the air barrier system by a unit static pressure difference (Pa) across the air barrier envelope. (example: 3070 L/s 6500 CFM @ 75 Pa)

1.3.9 Air Permeance

The tested rate of airflow (L/sCFM) through a unit area (sq. msq.ft.) of a material driven by unit static pressure difference (Pa) across the material (example: 0.02 L/s-m^2 0.004 CFM/sq.ft. @ 75 Pa) as established by ASTM E2178.

1.3.10 Environmental Separator

The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments. Also known as the Control Layer.

1.3.11 Vapor Permeance

Vapor permeance is separated into three classes based on the water vapor permeance of a material as tested via ASTM E96/E96M

Class I Vapor Barrier/Retarder	0.1 perm or less
Class II Vapor Barrier/Retarder	0.1 perm to 1.0 perm
Class III Vapor Barrier/Retarder	1.0 perm to 10 perm

1.4 PREPARATORY PHASE OR PRECONSTRUCTION CONFERENCE

Organize pre-construction conferences between the air barrier inspector and the sub-contractors involved in the construction of, or penetration of, the air barrier system to discuss where the work of each sub-contractor begins and ends, the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, penetrations and transitions between materials. Discuss the products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Air Barrier System Shop Drawings; G, [_____], Manufacturer produced warranted air barrier system

SD-03 Product Data

Air Barrier System Product Data; G, [_____]

SD-04 Samples

****
NOTE: Refer to UFC 3-101-01 for guidance on implementing mock-ups.
****

Mock-Up; G, [_____]

Material Samples For Air Barrier System; G, [_____]

SD-05 Design Data

Design Data And Calculations For The Air Barrier System; G, [_____]

SD-06 Test Reports

Design Review Report; G, [_____]

Testing and Inspection; G, [_____]

SD-07 Certificates

****

NOTE: Include submittals for Air Barrier Inspector Qualifications and for a Design Review Report whenever UFC 3-101-01 requires the air barrier system to be tested.

****

Air Barrier Inspector; G, RO

[1.6 AIR BARRIER ENVELOPE SURFACE AREA AND LEAKAGE REQUIREMENTS

****

NOTE: Include this paragraph defining the air barrier leakage requirements whenever UFC 3-101-01 requires the air barrier to be tested. If pressure testing of the air barrier system is not required, delete this paragraph. If pressure testing is required, on the drawings, identify the air barrier envelopes to be tested. Provide the area and leakage information for each six-sided air barrier envelope to be tested below. Optionally, include a table on the drawings summarizing the envelope information. If that is the approach, simply refer to the drawings at this point in the specification and delete the envelope area and leakage information below.

If only a portion of the air barrier envelope is being tested as in the case of the barracks building described in the opening notes above, indicate the test rooms; for example, change "Air Barrier Envelope 1", to "Room 214". For a description of the test process, Refer to UFGS 01 91 19 BUILDING ENCLOSURE COMMISSIONING paragraph Pressure Testing a Multiple Isolated Zoned Building. If an Air Barrier Envelope is an isolated zone within the larger building (e.g., single room in a barracks), and if it is impossible to test that isolated zone without sealing the HVAC ducts that interconnect adjacent rooms, perform the Architectural Only test and delete the Architectural Plus HVAC System test for that particular Air Barrier Envelope.

****

The building air barrier systems must meet the following leakage requirements. The allowable leakage rate and the maximum leakage are at a differential test pressure of 75 Pa.

****

NOTE: Add or delete air barrier envelopes to be tested as required.

****

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NOTE: Edit the Allowable air leakage rates as required by UFC 3-101-01 Architecture. A leakage value less than 0.25 CFM/SQFT for DoD facilities is recommended on projects where design and construction teams have experience in attaining lower rates of leakage to increase energy reduction, on projects with specific mission/functional requirements, or on building construction types (e.g., pre-cast concrete panels and insulated concrete forms) where low allowable leakage values are easily attained. Additionally, the leakage rate can be set to any leakage value less than 0.25 CFM/SQFT for DoD facilities if required to meet project specific energy targets. This should be correlated back to the energy model for validation.

****

Air Barrier Envelope 1	
Surface Area	[_____] square meter square feet
Architectural Only Test:	
Allowable leakage rate	[1.27][_____] L/s per square meter [0.25][_____] CFM/sq.ft
Maximum leakage	[_____] total L/s CFM
[Architectural Plus HVAC System Test:]	
[Allowable leakage rate]	[[1.52][_____] L/s per square meter [0.30][_____] CFM/sq.ft]
[Maximum leakage]	[[_____] total L/s CFM]

Air Barrier Envelope 2	
Surface Area	[_____] square meter square feet
Architectural Only Test:	
Allowable leakage rate	[1.27][_____] L/s per square meter [0.25][_____] CFM/sq.ft
Maximum leakage	[_____] total L/s CFM
[Architectural Plus HVAC System Test:]	
[Allowable leakage rate]	[[1.52][_____] L/s per square meter [0.30][_____] CFM/sq.ft]
[Maximum leakage]	[[_____] total L/s CFM]

Air Barrier Envelope 3

Surface Area	[_____] square meter square feet
Architectural Only Test:	
Allowable leakage rate	[1.27][_____] L/s per square meter [0.25][_____] CFM/sq.ft
Maximum leakage	[_____] total L/s CFM
[Architectural Plus HVAC System Test:]	
[Allowable leakage rate]	[[1.52][_____] L/s per square meter [0.30][_____] CFM/sq.ft]
[Maximum leakage]	[[_____] total L/s CFM]

][1.7 AIR BARRIER INSPECTOR

****

NOTE: Include the requirement for an AIR BARRIER INSPECTOR whenever UFC 3-101-01 requires the air barrier to be tested.

****

Employ a designated Air Barrier Inspector on this project. The Air Barrier Inspector performs a Design Review, oversees quality control testing specified in these specifications, performs quality control air barrier inspection as specified, interfaces with the designer and product manufacturer's representatives to assure installation requirements are met, and verifies that the constructed work is in accordance with both the manufacturer's recommendations for products used, the content of this specification and other Contract drawings or documents. Qualifications for the Air Barrier Inspector are as follows:

a. Training and certification as an Air Barrier Auditor from the Air Barrier Association of America (ABAA) or other third-party air barrier association.

b. Or, provide documentation in resume format that demonstrates that the individual proposed has the experience, knowledge, skills and abilities to fulfill the above stated duties as the air barrier inspector.

c. It is acceptable that this individual be employed by the firm performing the building pressurization test or another independent third-party entity, provided they meet the above requirements but must not be a member of the installing Contractor or firm.

Provide copies of Air Barrier Inspector qualifications 30 days after Notice to Proceed.

][1.8 DESIGN REVIEW

****

NOTE: Include the requirement for a DESIGN REVIEW whenever UFC 3-101-01 requires the air barrier to be tested.

This Design Review is conceptually similar to the Design Review Report required by the TESTING,

ADJUSTING, AND BALANCING FOR HVAC specification where the TAB specialist reviews the plans and specs and submits a report either indicating that the system can be balanced or describing deficiencies that preclude the TAB team from accomplishing their work and describing necessary changes. Similarly, with the air barrier system Design Review, the Contractor is asked to review the design and point out any deficiencies that prevent a successful air barrier system installation.
****

Review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the construction of an effective air barrier system. Provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for a proper air barrier system. Provide copies of the Design Review Report not later than [14] [_____] days after approval of the Air Barrier Inspector Qualifications. Submit design data and calculations for the Air Barrier System for a manufacturer produced and warranted air barrier system.

]PART 2 PRODUCTS

****
NOTE: Air barrier membranes and their air permeance and water vapor permeance are specified in other specification sections. Add specification sections as required. Examples: Self-adhered sheets, fluid-applied membranes, spray foams, boardstock air barrier materials, mechanically attached flexible sheet materials. The ABAA website is one source of air barrier material specifications. Indicate all pertinent material properties including air permeance, water vapor permeance, adhesion requirements, and flame and smoke spread requirements. Also, indicate that the manufacturer's instructions for the storage, installation, and application of air barrier products must be followed.

Air barrier materials have a maximum air permeance of 0.02 L/s-m^2 0.004 CFM/sq.ft. of surface area at a pressure difference of 75 Pa. Films, membranes, and coatings intended as air barrier components must meet this rating when tested in accordance with ASTM E2178.
****

2.1 AIR BARRIER

Provide air barrier system of compatible parts from one or several manufacturers coordinated by the Contractor or provide a single warranted system provided by a primary manufacturer. The air barrier system as part of a tested exterior wall assembly must meet the conditions of acceptance as tested in accordance with NFPA 285. Materials used for roof assembly air barrier must conform to the appropriate UL and FM wind and fire requirements for the specified roof assemblies.

If a complete air barrier system from a single manufacturer is utilized, whether warranted or not warranted, the air barrier system must conform to ASTM E2357.

Materials in the following categories, as used in the air barrier system or assembly of the exterior wall system, are tested and are required to conform to ASTM E2178: Self-adhered sheet membranes, fluid applied membranes, spray polyurethane foam, mechanically fastened commercial building wrap, factory bonded membranes to sheathing, and adhesive backed commercial building wrap and accessory products.

Other materials used as an air barrier such as concrete, glass, wood, metal or gypsum board may or may not conform to ASTM E2178 but are acceptable provided that when integrated into the air barrier system or assemblies they are not subject to material or environmental induced degradation in their final produced state once incorporated in the permanent construction.

All materials used must be identifiable through manufacturer testing data or literature to be compatible with all the attached or adjoining materials or substrates used in the system.

Provide Air Barrier System Shop Drawings, Material Samples for Air Barrier System and Air Barrier System Product Data.

PART 3 EXECUTION

3.1 QUALITY CONTROL

3.1.1 Documentation and Reporting

Document the entire installation process on daily job site reports. These reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results.

[3.1.2 Construction Mock-Up

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NOTE: Refer to UFC 3-101-01 for guidance on when to implement mock-ups. Delete this paragraph if a mock-up is not required.

****

Build mock-up prior to building envelope construction.

a. Prepare a construction mock-up to demonstrate proper installation of the air barrier assemblies and components. Include air barrier system connections between floor and wall, wall and window, and wall and roof. Also, include the sealing method between membrane joints at transitions from one material or component to another, at pipe or conduit penetrations of the wall and roof, and at duct penetration of the wall and roof. Work must not begin until the mock-up is satisfactory to the Contracting Officer.

b. Size the mock-up to approximately 2 m long by 2 m high 8 feet long by 8 feet high. The mock-up must be representative of primary exterior wall assemblies and glazing components including backup wall and typical penetrations as acceptable to the Contracting Officer. A corner of the actual building may be used as the mock-up.

c. Mock-Up Tests for Adhesion: Test the mock-up of materials for adhesion in accordance with manufacturer's recommendations. Perform the test after the curing period recommended by the manufacturer. Record the mode of failure and the area which failed in accordance with ASTM D4541. When the air barrier material manufacturer has established a minimum adhesion level for the product on the particular substrate, the inspection report must indicate whether this requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product/substrate combination, simply record the value.

]3.1.3 Quality Control Testing And Inspection

Conduct the following tests and inspections as applicable in the presence of the Contracting Officer during installation of the air barrier system, and submit quality control reports as indicated below.

a. Provide a Daily Report of Observations with a copy to the Contracting Officer.

b. Inspect to assure continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.

c. Inspect to assure structural support of the air barrier system to withstand design air pressures.

d. Inspect to assure masonry surfaces receiving air barrier materials are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.

e. Inspect and test to assure site conditions for application temperature, and dryness of substrates are within guidelines.

f. Inspect to assure substrate surfaces are properly primed, if applicable, and in accordance with manufacturer's instructions. Priming must extend at least 50 mm 2 inches beyond the air barrier material to make it obvious that the primer was applied to the substrate before the air barrier material.

g. Inspect to assure laps in materials are at least a 50-mm 2-inch minimum, shingled in the correct direction or mastic applied in accordance with manufacturer's recommendations, and with no fishmouths.

h. Inspect to assure that a roller has been used to enhance adhesion. Identify any defects such as fishmouths, wrinkles, areas of lost adhesion, and improper curing. Note the intended remedy for the deficiencies.

i. Measure application thickness of liquid applied materials to assure that manufacturer's specifications for the specific substrate are met.

j. Inspect to assure that the correct materials are installed for compatibility.

k. Inspect to assure proper transitions for change in direction and structural support at gaps.

l. Inspect to assure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

m. Perform adhesion tests for fluid-applied and self-adhered air barrier membranes to assure that the manufacturer's specified adhesion strength properties are met. Determine the bond strength of coatings to substrate in accordance with ASTM D4541.

n. Provide cohesion tests for spray polyurethane foam (SPF). [Perform the tests in accordance with the specification sections which specify these materials.] [Perform adhesion tests as follows: Using a coring tool remove a sample and determine the relative adhesion quality of the foam. If the foam is hard to remove and leaves small bits of foam on the substrate it is called cohesive foam failure and is considered the best adhesion. If the foam comes away from the substrate with some force but is clean, it is called a mechanical bond. If it comes away easily from the substrate, the adhesion is poor. Cohesive foam failure and a good mechanical bond are acceptable.]

o. Provide written test reports of all tests performed.

3.2 REPAIR AND PROTECTION

Upon completion of inspection, testing, sample removal and similar services, repair damaged construction and restore substrates, coatings and finishes. Protect construction exposed by or for quality control service activities, and protect repaired construction.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 27 19.01 (August 2023)**
Change 1 - 08/24

Preparing Activity: NAVFAC **Superseding:**
UFGS-07 27 19.01 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 07 27 19.01

SELF-ADHERING AIR BARRIERS

08/23, CHG 1: 08/24

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USACE / NAVFAC / AFCEC **UFGS-07 27 19.01 (August 2023)**
Change 1 - 08/24

Preparing Activity: NAVFAC **Superseding:**
UFGS-07 27 19.01 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 07 27 19.01

SELF-ADHERING AIR BARRIERS
08/23, CHG 1: 08/24

****

NOTE: This guide specification covers the requirements for self-adhering air barrier, for use inside exterior wall cavities. This air barrier will serve as the primary component of the air barrier system and, depending on the system specified, may also serve as a vapor retarder. The designer must determine whether a vapor permeable or a vapor retarding system is appropriate for the project. The designer must also verify the appropriate location within the wall assembly by using the tools described in UFC 3-101-01 Architecture, Section "Building Envelope Vapor Retarders".

Compatibility with other materials and components are critical to the success of the air barrier. Coordinate with other building enclosure components (such as wall assemblies, doors, and windows) to ensure a complete barrier system that adheres to performance requirements, primarily air leakage. Coordinate with materials that will penetrate the barrier such as flashing, embed items, and ties for brick veneer.

Use this section in conjunction with Section 07 27 10 BUILDING AIR BARRIER SYSTEM and Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING and coordinate requirements across these sections.

Performance requirements for products herein must contribute to the sustainable goals of the project, including but not limited to Energy Policy Act of 2005 (EPACT 2005), Energy Independence and Security Act of 2007 (EISA 2007), Executive Order (EO) 14057, UFC 1-200-02 High Performance and Sustainable Building Requirements, UFGS Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING, and other energy and water conservation requirements applicable to the project.

Specify self-adhering air barriers where the type of construction favors its economical use and where application would be less difficult than other air barrier applications. This product is susceptible to UV degradation, therefore specify product limit for full exposure in accordance with anticipated construction durations and include requirements for replacement if durations exceed exposed product life.

IBC includes requirements regarding the location within wall cavities of class I, II and III vapor retarders depending on the project's climate zone to avoid condensation within wall assemblies. See IBC Section 1404.3, and the International Energy Conservation Code (IECC) referenced by this section of the IBC, coordinate dewpoint with mechanical design, and specify type and location within the cavity accordingly.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: On the drawings, show:

1. Locations where various barriers, retarders and insulation will be used.

2. Transitions between various materials of the building air barrier system.

3. Method of attachment of barriers, retarders and insulation.

4. Location and size of ventilation openings where required.

5. Details for each type of penetration through the air barrier.

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR BARRIER ASSOCIATION OF AMERICA (ABAA)

ABAA Accreditation	Accreditation
ABAA QAP	Quality Assurance Program

ASTM INTERNATIONAL (ASTM)

ASTM D146/D146M	(2004; E 2012; R 2012) Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D903	(1998; R 2017) Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
ASTM D1876	(2008; R 2015; E 2015) Standard Test Method for Peel Resistance of Adhesives (T-Peel Test)
ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E154/E154M	(2008a; R 2019) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM E283/E283M	(2019) Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E2178	(2021a) Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials
ASTM E2357	(2018) Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 285	(2023) Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

1.2 RELATED REQUIREMENTS

****

NOTE: Include the bracketed option and include Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING when airtightness testing of the air barrier is required by UFC 3-101-01.

****

Coordinate the requirements of Section 07 27 10 BUILDING AIR BARRIER SYSTEM[, Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING] and other building enclosure sections to provide a complete building air barrier system. Submit all materials, components, and assemblies of the air barrier system together as one complete submittal package.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications of Manufacturer; G, [_____]

Qualifications of Installer; G, [_____]

SD-02 Shop Drawings

Self-adhering Air Barrier Shop Drawings; G, [_____]

SD-03 Product Data

Self-adhering Air Barrier; G, [_____]

Primers, Adhesives, and Mastics; G, [_____]

Safety Data Sheets; G, [_____]

SD-04 Samples

Self-adhering Air Barrier System Mockup; G, [_____]

SD-06 Test Reports

Field Peel Adhesion Test; G, [_____]

Flame Propagation of Wall Assemblies; G, [_____]

Site Inspections and Testing; G, [_____]

SD-08 Manufacturer's Instructions

Self-adhering Air Barrier Manufacturer's Printed Instructions; G, [_____]

Primers, Adhesives, and Mastics; G, [_____]

1.4 MISCELLANEOUS REQUIREMENTS

For self-adhering air barrier provide the following:

1.4.1 Shop Drawings

Submit self-adhering air barrier shop drawings showing locations and extent of air barrier assemblies and details of all typical conditions, intersections with other building enclosure assemblies and materials, and membrane counterflashings. Show details for bridging of gaps in construction, treatment of inside and outside corners, expansion joints, methods of attachment of materials covering the self-adhered barrier without compromising the barrier. Indicate how miscellaneous penetrations such as conduit, pipes, electric boxes, brick ties, and similar items will be sealed.

1.4.2 Product Data

Submit manufacturer's technical data indicating compliance with performance and environmental requirements in Part 2 of this specification. Also submit self-adhering air barrier manufacturer's printed instructions for evaluating, preparing, and treating substrates, temperature and other limitations of installation conditions, safety requirements for installation, and Safety Data Sheets. Indicate flame and smoke spread ratings for all products.

1.4.3 Mockup

Provide a self-adhering air barrier system mockup. Apply product in an area designated by the Contracting Officer. Apply an area of not less than 5 square meters 54 square feet. Include all components specified as representative of the complete system. Notify the Contracting Officer a minimum of 48 hours prior to the test application. Select a test area representative of conditions to be covered including window or door openings, wall to ceiling transitions, flashings, and penetrations, as applicable.

1.4.4 Test Reports

Submit test reports indicating that field peel-adhesion tests on all materials have been performed and the changes made, if required, in order to achieve successful and lasting adhesion. Submit test reports for flame propagation of wall assemblies tested in accordance with NFPA 285.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver and store materials in sufficient quantity to allow for uninterrupted flow of work. Inspect materials delivered to the site for damage and store out of weather. Deliver materials to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand designation, description of contents, and shelf life of containerized materials. Store and handle to protect from damage.

1.5.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling. Protect stored materials from direct sunlight. Keep materials sealed and separated from absorptive materials, such as wood and insulation.

1.6 AIR BARRIER TESTING

****

NOTE: Choose first bracketed specification section to address air barrier requirements of the building enclosure. Choose the second bracketed option for projects where pressure testing of the building enclosure for airtightness is required by UFC 3-101-01.

****

Perform air barrier testing in accordance with[Section 07 27 10 BUILDING AIR BARRIER SYSTEM][and Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING].

1.7 QUALITY ASSURANCE

1.7.1 Qualifications of Manufacturer

Submit documentation verifying that the manufacturer of the self-adhering air barrier is currently accredited by Air Barrier Association of America (ABAA Accreditation https://www.airbarrier.org/).

1.7.2 Qualifications of Installer

Submit documentation verifying that installers of the self-adhering air barrier are currently certified in accordance with the ABAA QAP Quality Assurance Program (https://www.airbarrier.org/qap/).

1.7.3 Field Peel Adhesion Test

Perform a field peel-adhesion test on the construction mockup. Test the self-adhering air barrier for adhesion in accordance with ASTM D4541 using a Type II pull tester except use a disk that is 100 mm 4 inches in diameter and cut through the membrane to separate the material attached to the dish from the surrounding material. Perform test after curing period in accordance with manufacturer's written recommendations. Record mode of failure and area which failed in accordance with ASTM D4541. Compare adhesion values with the manufacturer's established minimum values for the particular combination of material and substrate. Indicate on the inspection report whether the manufacturer's requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product and substrate combination, the inspector must record actual values.

1.8 PRECONSTRUCTION MEETING

Conduct a preconstruction meeting a minimum of two weeks prior to commencing work specified in this specification Section. Agenda must include, at a minimum, construction and testing of mockup, sequence of construction, coordination with substrate preparation, materials approved for use, compatibility of materials, coordination with installation of adjacent and covering materials, and details of construction. Attendance is required by representatives of related trades including covering materials, substrate materials, adjacent materials, and materials and components of the air barrier system.

1.9 ENVIRONMENTAL CONDITIONS

1.9.1 Temperature

Install air barrier within the range of ambient and substrate temperatures as recommended in writing by the air barrier manufacturer. Verify that the surface to receive self-adhering air barrier is dry for a minimum of 48 hours prior to the installation of the barrier. Do not apply air barrier to damp or wet substrates. Do not apply during inclement weather or when ice, frost, surface moisture, or visible dampness is present on surfaces to be covered, or when precipitation is imminent.

1.9.2 Exposure to Weather and Ultraviolet Light

Protect air barrier products from direct exposure to rain, snow, sunlight, mist, and other extreme weather conditions. Replace, at no additional cost to the Government, barrier products that have been exposed to ultraviolet (sun)light longer than allowed by manufacturer's written requirements.

PART 2 PRODUCTS

2.1 SELF-ADHERING AIR BARRIER

****

NOTE: IBC includes requirements regarding the location within wall cavities of class I, II and III vapor retarders depending on the project's climate zone to avoid condensation within wall assemblies. See IBC Section 1404.3, and the International Energy Conservation Code (IECC) referenced by this section of the IBC, coordinate dewpoint with mechanical design, and specify type and location within the cavity accordingly.

Provide vapor permeable or vapor retarding barrier in accordance with building enclosure analysis.

Choose first bracketed option for vapor permeable barriers. Choose second bracketed option for vapor retarding barriers.
****

Provide minimum 40 mils 0.040 inch thick self-adhering, vapor[permeable][retarding], air barrier membrane consisting of a cross-laminated high density polyethylene (HDPE) film, fully coated with rubberized butyl-based or acrylic-based adhesive. Provide membrane in rolls of various widths interleaved with disposable silicone release paper. Self-adhering air barrier must exhibit no visible water leakage when tested in accordance with ASTM E331 and must perform as a liquid water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Use regular or low temperature formulation depending on site conditions, within temperature ranges specified by manufacturer.

2.1.1 Physical Properties

a. Air Permeance (ASTM E2178): [In accordance with Section 07 27 10 BUILDING AIR BARRIER SYSTEM][Less than 0.02 L per s-m2 at 75 Pa 0.004 CFM per sf at 1.57 psf.]

b. Assembly Air Leakage (ASTM E2357, ASTM E283/E283M): [In accordance with Section 07 27 10 BUILDING AIR BARRIER SYSTEM[and Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING]][less than 0.2 L per s-m2 at 75 Pa 0.04 CFM per sf at 1.57 psf at 25 mm one inch].

c. Tensile Strength (ASTM D412 die C modified): Not less than 2.8 MPa 400 psi.

d. Tensile Elongation (ASTM D412 die C modified): Not less than 200 percent.

e. Puncture Resistance (ASTM E154/E154M): Not less than 178 N 40 lbs.

f. Pliability (ASTM D146/D146M): Unaffected at minus 32 degrees C minus 25 degrees F, 1.6 mm 0.063 inch mandrel.

g. Lap Adhesion (ASTM D1876 modified): Not less than 700 N per meter 4.0 lbs per inch.

h. Peel Adhesion (ASTM D903): Not less than 875 N per meter 5.0 lbs per inch.

****
NOTE: Choose first bracketed option for vapor permeable barriers. Choose second bracketed option for vapor retarding barriers.
****

[i. Water Vapor Permeance (Vapor Permeable Air Barrier) (ASTM E96/E96M, desiccant method B): greater than 570 ng/Pa s m2 10.0 perms.

][j. Water Vapor Permeance (Vapor Impermeable Air Barrier) (ASTM E96/E96M, desiccant method A): 5.7 ng/Pa s m2 0.1 perms or less.

] k. Water Absorption (ASTM D570): Not to exceed 0.12 percent by weight.

l. Flame propagation of wall assemblies (NFPA 285): Pass

2.2 PRIMERS, ADHESIVES, AND MASTICS

****

NOTE: Specify adhesives and mastics for substrates where adhesion to particular substrates may require such materials. Experience has shown that butyl-based and acrylic-based adhesives outperform rubberized asphalt adhesives over time. Require Contractor to provide in accordance with manufacturer's written recommendations for installation.

****

Provide primers, adhesives, mastics and other accessory materials as recommended in writing by the manufacturer of the self-adhering air barrier for adequate bonding to each type of substrate. Adhesive must be butyl- or acrylic-based.

2.3 SHEET METAL FLASHING

Provide as specified in Section 07 60 00 FLASHING AND SHEET METAL.

2.4 JOINT SEALANTS

Provide as specified in Section 07 92 00 JOINT SEALANTS. Verify compatibility with adjacent products that are or will be in contact with one another.

PART 3 EXECUTION

3.1 EXAMINATION

Before installing air barrier, examine substrates, areas, and conditions under which air barrier assemblies will be applied, with Installer present, for compliance with requirements. Ensure the following conditions are met:

a. Surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants.

b. Concrete surfaces are cured and dry, smooth without large voids, spalled areas or sharp protrusions.

c. Verify substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263 and take suitable measures until substrate passes moisture test.

d. Verify sealants used in sheathing are compatible with membrane proposed for use. Perform field peel adhesion test on materials to which sealants are adhered.

3.2 PREPARATION

Clean, prepare, and treat substrate in accordance with manufacturer's written instructions. Ensure clean, dust-free, and dry substrate for air barrier application.

a. Prime masonry and concrete substrates with conditioning primer.

b. Prime gypsum sheathing an adequate number of coats to achieve required bond, with adequate drying time between coats.

c. Prime wood, metal, and painted substrates with primer.

d. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through air barrier and at protrusions.

3.3 INSTALLATION

3.3.1 Installation of Self-adhering Air Barrier

Install materials in accordance with manufacturer's recommendations and the following:

a. Apply primer at rate recommended by manufacturer prior to membrane installation. Allow primer to dry completely before membrane application. Apply as many coats as necessary for proper adhesion.

b. When membrane is properly positioned, press into place and roll membrane with roller immediately after placement.

c. Apply membrane sheets to shed water naturally without interception by a sheet edge, unless that edge is sealed with permanently flexible termination mastic.

d. Position subsequent sheets of membrane applied above so that membrane overlaps the membrane sheet below by a minimum of 65 mm 2-1/2 inches, unless greater overlap is recommended by manufacturer. Roll into place with roller.

e. Make side laps a minimum of 65 mm 2-1/2 inches and end laps a minimum of 127 mm 5 inches, unless greater overlap is recommended by manufacturer. Roll seams with roller.

f. Roll membrane to adhere to substrate. Cover corners and joints with two layers of reinforcement by first applying a 300 mm 12 inch width of membrane centered along the axis. Flash drains and projections with a second ply of membrane for a distance of 150 mm 6 inches from the drain or projection.

g. Seal around all penetrations through the air barrier resulting from pipes, vents, conduit, electrical fixtures, structural members, or other construction passing through it. Seal with termination mastic, extruded silicone sealant, membrane counterflashing or other sealing methods in accordance with manufacturer's written recommendations.

h. Continuously connect the air barrier between walls, roof, floor and below grade assemblies to form a continuous integrated air barrier system around the entire building enclosure. Extend the air barrier membrane into rough openings such as doors, windows, louvers, and other exterior penetrations. Seal edges of barrier at junctures with rough openings.

i. At changes in substrate plane, provide transition material (e.g., bead of sealant, mastic, extruded silicone sealant, membrane counterflashing or other material recommended by manufacturer) under membrane to eliminate all sharp 90-degree inside corners and to make a smooth transition from one plane to another.

j. Provide mechanically fastened non-corrosive metal sheet to span gaps in substrate plane and to make a smooth transition from one plane to the other. Continuously support membrane with substrate.

k. At deflection and control joints, provide backup for the membrane to accommodate anticipated movement.

l. At expansion and seismic joints provide transition to the joint assemblies.

m. Apply a bead or trowel coat of mastic along membrane seams at reverse lapped seams, rough cuts, and as recommended by the manufacturer.

n. At end of each working day, seal top edge of membrane to substrate with termination mastic.

o. Do not allow materials to come in contact with chemically incompatible materials.

p. Counterflash upper edge of thru-wall flashing and air barrier. Counter flashing is specified in Section 07 60 00 FLASHING AND SHEET METAL. See applicable wall-type Sections for thru-wall flashing requirements.

3.4 FIELD QUALITY CONTROL

3.4.1 Site Inspections and Testing

****

NOTE: Include bracketed option and include Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING when airtightness testing of the air barrier is required by UFC 3-101-01.

****

Provide site inspections and testing in accordance with the manufacturer's instructions, Section 07 27 10 BUILDING AIR BARRIER SYSTEM[, Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING,] and this section.

a. Conduct inspections and testing at 5, 50, and 95 percent completion of this scope of work. Forward written site inspections and testing reports to the Contracting Officer within five working days of the inspection and test being performed.

b. If inspections reveal defects, promptly remove and replace defective work at no additional expense to the Government.

3.5 FIELD PEEL ADHESION TEST

Conduct in accordance with test protocol indicated in Part 1, paragraph FIELD PEEL ADHESION TEST.

3.6 PROTECTION AND CLEANING

3.6.1 Protection

3.6.1.1 Adjacent Surfaces

Protect exposed adjacent surfaces that could be damaged by primers and adhesives associated with air barrier membrane. Provide protection during application and the remainder of construction in accordance with manufacturer's written instructions.

3.6.1.2 The Air Barrier Assembly

Protect finished portions of the air barrier assembly from damage during ongoing application and throughout the remainder of the construction period in accordance with manufacturer's written instructions. Coordinate timing of installation of materials that will cover the air barrier membrane to ensure the exposure period does not exceed that recommended by the air barrier manufacturer's written installation instructions. Remove and replace, at no additional cost to the Government, membrane products that exceed the manufacturer's allowed exposure limits.

3.6.2 Cleaning

Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction and as acceptable to the primary material manufacturer.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 27 26 (August 2023)**

Preparing Activity: NAVFAC **Superseding:**
UFGS-07 27 26 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 27 26

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08/23

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 27 26 (August 2023)**

Preparing Activity: NAVFAC **Superseding:**
UFGS-07 27 26 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 07 27 26

FLUID-APPLIED MEMBRANE AIR BARRIERS

08/23

****

NOTE: This guide specification covers the requirements for fluid-applied membrane air barriers for use inside exterior wall cavities. This air barrier serves as the primary component of the air barrier system and, depending on the system specified, may also serve as a vapor retarder. The designer must determine whether a vapor permeable or a vapor retarding system is appropriate for the project. The designer must also verify the appropriate location within the wall assembly by using the tools described in UFC 3-101-01 Architecture, Section "Building Envelope Vapor Retarders."

Compatibility with other materials and components (roof/ceiling assemblies, soffit assemblies, and floor assemblies over exterior air spaces) is critical to the success of the project's air barrier. Coordinate with other building enclosure components (such as wall assemblies, doors, and windows) to ensure a complete barrier system that adheres to performance requirements, primarily air leakage. Coordinate with materials that penetrate the barrier such as flashing, embed items, and ties for brick veneer.

Use this section in conjunction with Section 07 27 10 BUILDING AIR BARRIER SYSTEM and Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING and coordinate requirements across these sections.

Performance requirements for products herein must contribute to the sustainable goals of the project, including but not limited to Energy Policy Act of 2005 (EPACT 2005), Energy Independence and Security Act of 2007 (EISA 2007), Executive Order (EO) 14057, UFC 1-200-02 High Performance and Sustainable Building Requirements, UFGS Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING, and other

energy and water conservation requirements applicable to the project.

Specify fluid-applied membrane air barriers where the type of construction favors its economical use, where application would be less difficult than other air barrier applications, and where inclement weather does not dominate site logistics.

When considering the use of vapor retarding air barriers, IBC includes requirements regarding the location within wall cavities of class I, II and III vapor retarders depending on the project's climate zone to avoid condensation within wall assemblies. See IBC Section 1404.3, and the International Energy Conservation Code (IECC) referenced by this section of the IBC, coordinate dewpoint with mechanical design, and specify type and location within the cavity accordingly.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

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NOTE: On the drawings, show:

1. Locations where various barriers, retarders and insulation are used.

2. Transitions between various materials of the building air barrier system.

3. Method of attachment of barriers, retarders and insulation.

4. Location and size of ventilation openings where required.

5. Details for each type of penetration through the air barrier.

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PART 1 GENERAL

1.1 REFERENCES

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ASTM C1305/C1305M	(2016) Standard Test Method for Crack Bridging Ability of Liquid-Applied Waterproofing Membrane
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ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D5590	(2017; R 2021) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
ASTM E96/E96M	(2024) Standard Test Methods for

	Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E283/E283M	(2019) Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E2178	(2021a) Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials
ASTM E2357	(2018) Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 285	(2023) Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

1.2 RELATED REQUIREMENTS

****

NOTE: Include the bracketed option and include UFGS 01 91 19 when airtightness testing of the air barrier is required by UFC 3-101-01.

****

Coordinate the requirements of Section 07 27 10 BUILDING AIR BARRIER SYSTEM[, Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING,] and other building enclosure sections to provide a complete building air barrier system. Submit all materials, components and assemblies of the air barrier system together as one complete submittal package.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications of Manufacturer; G, [_____]

Qualifications of Installer; G, [_____]

SD-02 Shop Drawings

Fluid-Applied Membrane Air Barrier Shop Drawings; G, [_____]

SD-03 Product Data

Fluid-Applied Membrane Air Barrier; G, [_____]

Transition Membrane; G, [_____]

Primers, Adhesives, and Mastics; G, [_____]

Reinforcement; G, [_____]

Safety Data Sheets; G, [_____]

SD-04 Samples

Fluid-Applied Membrane Air Barrier Mockup; G, [_____]

SD-06 Test Reports

Capillary Moisture Test; G, [_____]

Field Peel Adhesion Test; G, [_____]

Flame Propagation of Wall Assemblies; G, [_____]

Site Inspections Reports; G, [_____]

SD-08 Manufacturer's Instructions

Fluid-Applied Membrane Air Barrier Manufacturer's Printed Instructions; G, [_____]

Primers, Adhesives, and Mastics Printed Manufacturer's Instructions; G, [_____]

1.4 MISCELLANEOUS REQUIREMENTS

For fluid-applied membrane air barriers provide the following:

1.4.1 Shop Drawings

Submit fluid-applied membrane air barrier shop drawings showing locations and extent of barrier assemblies, transition membranes, details of all typical conditions, intersections with other envelope assemblies and materials, and membrane counterflashings. Show details for bridging of gaps in construction, treatment of inside and outside corners, expansion joints, methods of attachment of materials covering the self-adhered barrier without compromising the barrier. Indicate how miscellaneous penetrations such as conduit, pipes, electric boxes, brick ties, and similar items will be sealed.

1.4.2 Product Data

Submit manufacturer's technical data indicating compliance with performance and environmental requirements. Submit fluid-applied membrane air barrier manufacturer's printed instructions for evaluating, preparing, and treating substrates, temperature and other limitations of installation conditions, safety requirements for installation, and Safety Data Sheets. Also, submit primers, adhesives and mastics printed manufacturer's instructions for installation conditions and safety requirements. Indicate flame and smoke spread ratings for all products.

1.4.3 Mockup

Provide a mockup of the fluid-applied membrane air barrier. Apply product in an area designated by the Contracting Officer. Apply an area of not less than 5 square meters 54 square feet. Include all components specified as representative of the complete system. Notify the Contracting Officer a minimum of 48 hours prior to the test application. Select a test area representative of conditions to be covered including window or door openings, wall to ceiling transitions, flashings, and penetrations, as applicable.

1.4.4 Test Reports

Submit test reports indicating that capillary moisture tests and field peel adhesion tests on all substrate materials have been performed and the changes made, if required, in order to achieve successful and lasting adhesion. Submit test reports for flame propagation of wall assemblies tested in accordance with NFPA 285.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver and store materials in sufficient quantity to allow for uninterrupted flow of work. Inspect materials delivered to the site for damage and store out of weather. Deliver materials to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand designation, description of contents, and shelf life of containerized materials. Store and handle to protect from damage.

1.5.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling. Protect stored materials from direct sunlight.

1.6 CAPILLARY MOISTURE TEST

Perform a capillary moisture test by plastic sheet method in accordance with ASTM D4263 on the construction mockup and substrate materials. Perform test after curing period as recommended by the air barrier manufacturer. Record mode of failure and area which failed in accordance with ASTM D4263. Once the air barrier material manufacturer has established a minimum adhesion or moisture level for the product on the particular substrate, indicate on the inspection report whether this requirement has been met. Where the manufacturer has not declared a minimum adhesion or moisture value for their product and substrate combination, the inspector must record actual values.

1.7 FIELD PEEL ADHESION TEST

Perform a field peel adhesion test on a construction mockup. Test the applied product for adhesion in accordance with manufacturer's recommendations. Perform test after curing period recommended by the manufacturer. Record mode of failure and area which failed in accordance with ASTM D4541. When the manufacturer has established a minimum adhesion level for the product on the particular substrate, the inspection report must indicate whether this requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product/substrate combination, the inspector must record actual values.

1.8 AIR BARRIER TESTING

****

NOTE: Choose first bracketed specification section to address air barrier requirements of the building enclosure. Choose the second bracketed option for projects where pressure testing of the building enclosure for airtightness is required by UFC 3-101-01.

****

Perform air barrier testing in accordance with[Section 07 27 10 BUILDING AIR BARRIER SYSTEM][Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING].

1.9 QUALITY ASSURANCE

1.9.1 Qualifications of Manufacturer

Submit documentation verifying that manufacturer of fluid-applied membrane air barrier is currently accredited by the Air Barrier Association of America (ABAA Accreditation https://www.airbarrier.org/).

1.9.2 Qualifications of Installer

Submit documentation verifying that installers of the fluid-applied membrane air barrier are currently certified in accordance with the ABAA QAP Quality Assurance Program (https://www.airbarrier.org/qap/).

1.10 PRECONSTRUCTION MEETING

Conduct a preconstruction meeting a minimum of two weeks prior to commencing work specified in this specification Section. Agenda must include, at a minimum, construction and testing of construction mock-up, sequence of construction, coordination with substrate preparation, materials approved for use, compatibility of materials, coordination with installation of adjacent and covering materials, and details of construction. Attendance is required by representatives of related trades including covering materials, substrate materials, adjacent materials, and materials and components of the fluid-applied membrane air barrier.

1.11 ENVIRONMENTAL CONDITIONS

1.11.1 Temperature

Install fluid-applied membrane air barrier within the range of ambient and substrate temperatures as recommended in writing by the fluid-applied membrane air barrier manufacturer. Do not apply fluid-applied membrane air barrier to a damp or wet substrate. Do not apply during inclement weather or when ice, frost, surface moisture, or visible dampness is present on surfaces to be covered, or when precipitation is imminent.

1.11.2 Exposure to Weather

Protect fluid-applied membrane air barrier products from direct exposure to rain, snow, sunlight, mist, and other extreme weather conditions. Replace, at no additional cost to the Government, barrier products that have been exposed to ultraviolet (sun)light longer than allowed by manufacturer's written requirements.

PART 2 PRODUCTS

2.1 FLUID-APPLIED MEMBRANE AIR BARRIER

****

NOTE: IBC includes requirements regarding the location within wall cavities of class I, II and III vapor retarders depending on the project's climate zone to avoid condensation within wall assemblies. See IBC Section 1404.3, and UFC 1-200-02. Coordinate dewpoint with mechanical design, and specify type and location within the cavity accordingly.

Choose first bracketed option for vapor permeable barriers. Choose second bracketed option for vapor retarding barriers.
****

Provide a fluid-applied, vapor[permeable][retarding], air barrier. This barrier must exhibit no visible water leakage when tested in accordance with ASTM E331 and must perform as a liquid water drainage plane with thru-wall flashing to discharge incidental condensation and water penetration to the exterior of the building enclosure. Provide products suitable for use within temperature ranges specified by manufacturer for the location of the project.

2.1.1 Physical Properties

a. Air Permeance (ASTM E2178): [in accordance with Section 07 27 10 BUILDING AIR BARRIER SYSTEM][less than 0.02 L per s-m2 at 75 Pa 0.004 CFM per sf at 1.57 psf.]

****
NOTE: Choose first bracketed option for Section 07 27 10 BUILDING AIR BARRIER SYSTEM when only inspections of the air barrier are required according to UFC 3-101-01. Additionally include the second bracketed option and include Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING when airtightness testing of the air barrier is required by UFC 3-101-01.
****

b. Air Leakage (ASTM E2357, ASTM E283/E283M): [in accordance with Section 07 27 10 BUILDING AIR BARRIER SYSTEM[and Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING]][Less than 0.2 L per s-m2 at 75 Pa 0.04 CFM per sf at 1.57 psf at 25 mm one inch].

****
NOTE: Provide vapor permeable or vapor retarding barrier in accordance with building enclosure analysis. Choose first bracketed option for vapor permeable barriers. Choose second bracketed option for vapor retarding barriers.
****

[c. Water Vapor Permeance (Vapor Permeable Membrane) (ASTM E96/E96M, desiccant method A): 570 ng/Pa s m2 10.0 perms.

][d. Water Vapor Permeance (Vapor Impermeable Membrane) (ASTM E96/E96M, desiccant method A): 5.7 ng/Pa s m2 0.1 perms or less.

] e. Pull Adhesion (ASTM D4541): Not less than 103 kPa 15 psi.

f. Elongation (ASTM D412): Not less than 300 percent.

g. Low temperature Flexibility and Crack Bridging (ASTM C1305/C1305M): Pass at minus 26 degrees C minus 15 degrees F.

h. Solids by Volume: minimum 50 percent.

i. Flame propagation of wall assemblies (NFPA 285): Pass

j. Resistance to Mold, Mildew and Fungal Growth (ASTM D5590): 0, No growth.

2.2 PRIMERS, ADHESIVES, AND MASTICS

Provide primers, adhesives, mastics, sealants and other accessories as recommended by manufacturer of fluid-applied membrane air barrier for a complete installation.

2.3 TRANSITION MEMBRANE

****

NOTE: Transition membrane materials typically consist of self-adhering membrane products therefore specifier must also edit and include Section 07 27 19.01 SELF-ADHERING AIR BARRIERS.

****

Provide as specified in Section 07 27 19.01 SELF-ADHERING AIR BARRIERS.

2.4 SHEET METAL FLASHING

Provide as specified in Section 07 60 00 FLASHING AND SHEET METAL.

2.5 JOINT SEALANTS

Provide as specified in Section 07 92 00 JOINT SEALANTS.

2.6 REINFORCEMENT

Provide fiberglass mesh tape, or fluid-applied air barrier manufacturer's approved comparable equivalent product, reinforcement at seams, edges, projections and penetrations. Reinforce all joints exceeding 6 mm 1/4 inch with fiberglass mesh.

PART 3 EXECUTION

3.1 EXAMINATION

Before installing fluid-applied membrane air barrier, examine substrates, areas, and conditions under which fluid-applied membrane air barrier assemblies will be applied, with installer present, for compliance with requirements. Ensure the following conditions are met:

a. Surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants detrimental to the adhesion of the membranes.

b. Concrete and masonry surfaces are cured and dry, smooth without large voids, spalled areas or sharp protrusions. Do not proceed with installation until after minimum concrete curing period recommended by fluid-applied membrane air barrier manufacturer.

c. Fill voids, gaps and spalled areas in substrate to provide an even plane. Strike masonry joints full flush.

d. Verify substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263 and take suitable measures until substrate passes moisture test.

e. Verify sealants used in substrates, and in joints between substrates, are compatible with fluid-applied membrane air barrier.

3.2 PREPARATION

Clean, prepare, and treat substrate in accordance with manufacturer's written instructions. Ensure clean, dust-free, and dry substrate for fluid-applied membrane air barrier application.

a. Remove dust, dirt and other contaminants from joints and cracks before coating surfaces.

b. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through fluid-applied membrane air barrier.

c. At changes in substrate plane, provide transition material (bead of sealant, mastic, extruded silicone sealant, membrane counterflashing or other material recommended by manufacturer) under transition membrane to eliminate all sharp 90-degree inside corners and to make a smooth transition from one plane to another.

d. Provide mechanically fastened non-corrosive metal sheet to span gaps in substrate plane and to make a smooth transition from one plane to the other. Continuously support membrane with substrate.

e. For exterior sheathing substrates, ensure that exterior sheathing is stabilized, with corners and edges fastened with appropriate screws. Treat all joints in accordance with the air barrier manufacturer's instructions prior to application of air barrier material. Allow sufficient time for joint treatments to fully cure before application of transition membranes and fluid-applied membrane air barrier.

f. For concrete and masonry substrates, fill all voids and holes, particularly in mortar joints, with non-shrinking grout.

g. Mask off and cover adjacent surfaces to protect from spillage and overspray.

3.3 INSTALLATION

3.3.1 Installation of Transition Membrane

Install transition membrane materials in accordance with the details on the drawings, Section 07 27 19.01 SELF-ADHERING AIR BARRIERS, and the following:

a. Install transition membrane at all required locations (such as at any voids, gaps, or interstitial spaces that the fluid-applied air barrier cannot adequately protect) prior to installation of the fluid-applied membrane air barrier.

b. Verify transition membrane is fully adhered to substrate and that its surface is clean, dry and wrinkle free prior to installation of the fluid-applied membrane air barrier.

c. Verify transition membrane completely covers all transition areas and provides continuity of the finished fluid-applied membrane air barrier without gaps or cracks.

3.3.2 Installation of Flashing

Counterflash upper edge of thru-wall flashing and fluid-applied air barrier. Counter flashing is specified in Section 07 60 00 FLASHING AND SHEET METAL. See applicable wall-type Sections for thru-wall flashing requirements.

3.3.3 Installation of Fluid-Applied Membrane Air Barrier

****

NOTE: Select the bracketed option in item b with consideration of the following. Common required finished dry film minimum thickness for smooth surface substrates (e.g., gypsum sheathing) is 40 mils. For rough surface substrates (e.g., CMU block) the required measurable dry film thickness might be 60 mils in order to achieve 40 mil thickness in surface depressions. However, both can vary depending on product and manufacturer requirements. Wet film requirements to develop a required dry film thickness will vary based on the fluid-applied membrane product, application substrate and its surface roughness, application method (spray, roller, brush), and number of coats required by the product manufacturer for the substrate. A thicker wet film will typically be required to assure a minimum finished dry film across a rough surface substrate whereas a smooth surface might require a lesser wet film thickness to develop the required finished dry film. Not less than 40 mil finished dry film is recommended for smooth surfaces. Not less than 60 mil measurable dry film is recommended over rough surfaces to develop a sufficient full coverage within depressions of the rough surface where the film is not measurable and may be thinner.

****

Install materials in accordance with manufacturer's recommendations and the following:

a. Apply fluid-applied membrane air barrier in single or dual coat application by spray or roller. Apply fluid-applied membrane air barrier within manufacturer's recommended temperature range for application.

b. Apply fluid-applied membrane air barrier in manner and at rate and wet film thickness recommended by manufacturer to yield a finished dry film thickness of not less than [1][1.5][_____] mm [40][60][_____] mils or as otherwise required by the manufacturer for the application substrate material and surface roughness.

c. Apply fluid-applied membrane air barrier around all penetrations ensuring a complete and continuous air barrier. Lap fluid-applied membrane air barrier a minimum of 75 mm 3 inch over transition membrane to seal leading edge.

d. Seal membrane terminations, heads of mechanical fasteners, masonry tie fasteners, around penetrations, HVAC assemblies, plumbing and electrical assemblies, doors, windows, louvers, and other assemblies penetrating the fluid-applied membrane air barrier with a termination sealant recommended by the fluid-applied membrane air barrier manufacturer.

e. Notify the Contracting Officer and Testing Agency upon completion of fluid-applied membrane air barrier installation. Air barrier materials and assemblies must remain exposed until tested and inspected in accordance with the ABAA protocol.

f. Do not allow materials to come in contact with chemically incompatible materials.

3.3.4 Installation of Reinforcement

Install reinforcement at projections, corners, joints, and penetrations where applicable.

3.4 FIELD QUALITY CONTROL

3.4.1 Site Inspections and Testing

****

NOTE: Include bracketed option and include Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING when airtightness testing of the air barrier is required by UFC 3-101-01.

****

Provide site inspections and testing in accordance with the manufacturer's instructions, Section 07 27 10 BUILDING AIR BARRIER SYSTEM[, Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING,] and this Section.

a. Conduct inspections and testing at 5, 50, and 95 percent completion of this scope of work. Forward written inspection reports to the Contracting Officer within five working days of the inspection and test being performed.

b. If the inspections reveal defects, promptly remove and replace defective work at no additional expense to the Government.

3.5 PROTECTION AND CLEANING

3.5.1 Protection

Protect fluid-applied membrane air barrier assemblies from damage during application and remainder of construction in accordance with manufacturer's written instructions.

Coordinate installation, testing, and inspection procedures to ensure exposure period does not exceed that recommended by the product manufacturer. Remove and replace, at no additional cost to the government, membrane products that exceed manufacturer's allowed exposure limits.

3.5.2 Cleaning of Adjacent Surfaces

Clean excess product from adjacent construction using cleaning agents and procedures as recommended in writing by the manufacturer of each type of affected construction and as acceptable to same.

3.6 CLEANUP OF SPILLS

Conduct cleanup of uncured product spillage in accordance with manufacturer's written safe handling instructions.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 27 36 (August 2023)**

Preparing Activity: NAVFAC **Superseding:**
UFGS-07 27 36 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 07 27 36

SPRAY FOAM AIR BARRIERS

08/23

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 27 36 (August 2023)**

Preparing Activity: NAVFAC **Superseding:**
UFGS-07 27 36 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 07 27 36

SPRAY FOAM AIR BARRIERS

08/23

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NOTE: This guide specification covers the requirements for open cell and closed cell sprayed polyurethane foam (SPF) materials used in wall, ceiling, and roof assemblies. The spray foam barrier may serve one or more of the following functions: 1) as a thermal barrier, 2) a vapor barrier, and 3) as the primary component of the air barrier. The designer must determine whether a vapor permeable or a vapor retarding system is appropriate for the project.

If a vapor permeable barrier is required, do not use a closed cell SPF system. While open cell can be vapor permeable, it is not appropriate for use in humid site locations or building environments. Open cell SPF is only appropriate for use in arid climates, in well vented assemblies, where vapor permeability is permissible. Open cell SPF is cost effective and less toxic than closed cell SPF but has very limited appropriate use; specify accordingly. Closed-cell foam is water-resistant. In applications where the insulation may be in contact with water (below-grade or exterior applications), only closed-cell foam should be used.

Compatibility with other materials and components are critical to the success of the air barrier. Coordinate with other building enclosure components (such as wall assemblies, doors, and windows) to ensure a complete barrier system that meets assembly and system air leakage requirements. Coordinate with products and systems that will penetrate the air barrier such as flashing, embedded items, and ties for brick veneer.

Use this section in conjunction with Section 07 27 10 BUILDING AIR BARRIER SYSTEM and Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING and coordinate requirements across these sections. Also coordinate

this section with products and systems that will penetrate the air barrier such as flashing, embedded items, and ties for brick veneer.

This guide specification is intended for both new construction and renovation, repair, and retrofit of existing buildings. Performance requirements for products herein must contribute to the sustainable goals of the project, including but not limited to Energy Policy Act of 2005 (EPACT 2005), Energy Independence and Security Act of 2007 (EISA 2007), Executive Order (EO) 14057, UFC 1-200-02 High Performance and Sustainable Building Requirements, UFGS Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING, and other energy and water conservation requirements applicable to the project.

Specify SPF where the type of construction favors its economical use and where application would be less difficult than other air/vapor/thermal barrier applications. Due to the toxic and flammable nature of this product, specify it when the benefits of SPF surpass the benefits of other barrier systems. Coordinate encapsulation of the SPF application as required for the project and in accordance with architectural details. Follow strategies related to safe SPF Applications and specify accordingly. EPA has a tool to assist in identifying safe practices and technologies; this document can be found at: https://www.epa.gov/saferchoice/self-evaluation-tool-professional-spray-polyurethane-foam-contractors-and-project.

Do not use Section 07 11 13 BITUMINOUS DAMPPROOFING in conjunction with this section.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: The use of SPF must meet the Flame Spread (FS) and Smoke Developed (SD) index requirements for insulation in accordance with UFC 3-600-01 Fire Protection Engineering for Facilities. FS and SD

ratings must be no higher than 75 for FS and 150 for SD when tested in accordance with ASTM E84 (NFPA 255) or UL 723. The SD rating is more stringent than Class A ratings indicated in NFPA 101 or IBC and most SPF vendors cannot meet it. However, this UFC allows exceptions to these limits in certain types of installations and construction types. Exceptions are described in paragraphs directly below the primary paragraph in this UFC titled "Insulation" and the subparagraphs therein. For applications where these values are required, the product can still be used, however, it requires the addition of a thermal or an ignition barrier to encapsulate it. Thermal barriers are described in IBC Chapter 26 "Plastics." When such barriers are required, choose bracketed items throughout this specification section accordingly.

IBC includes requirements for the location within wall cavities of class I, II and III vapor retarders depending on the project's climate zone to avoid condensation within wall assemblies. See IBC Section 1404.3, and the International Energy Conservation Code (IECC) referenced by this section of the IBC, coordinate dewpoint with mechanical design, and specify type and location within the cavity accordingly. Also verify the cavity is sized to accommodate the barrier thickness required to provide the specified R-Value plus a minimum 25 mm one inch air space. R-value must reflect compliance with energy requirements of IgCC and ASHRAE 90.1 as mandated by UFC 1-200-02 High Performance and Sustainable Building Requirements.

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NOTE: Determine minimum required R-values and calculate the insulation thickness based on the aged R-value of 6.24 per 25 mm one inch thickness for closed cell SPF and 3.8 per 25 mm one inch for open cell SPF.

On the drawings, show:

1. Locations, type and permeance of barriers, retarders and insulation required.

2. Transitions between various materials of the building air barrier system.

3. Thermal resistance (R-value) and U-factor for each assembly and location. Provide long term thermal resistance (LTTR) values if available.

4. Locations of interfaces of SPF with other insulation systems, air barriers, and vapor retarders if applicable. Clearly define transition and sealing requirements between systems.

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NOTE: Ventilation

1. Provide net, unobstructed ventilation areas recommended by ASHRAE Handbook of Fundamentals, Chapter 21, 29 CFR 1910, 29 CFR 1926, and as follows:

2. For insulation of cathedral-type ceilings, provide at least a 50 mm 2 inch gap between upper face of barrier and underside of roof sheathing. Provide ventilation openings at bottom and top of ventilated cavity; show on drawings.

3. OSHA requires engineering controls to be used to reduce exposures to isocyanates (29 CFR 1910.1000 and 29 CFR 1926.55 - Air contaminants) which is the major component of SPF. Coordinate requirements accordingly: http://www.osha.gov/dep/greenjobs/weather_ventilation.html

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NOTE: Specific Safety Plans

1. Spontaneous combustion from exothermic heat build-up of SPF components during curing can occur when SPF is applied at pass thicknesses exceeding those defined in the manufacturer installation instructions. Require a written jobsite fire prevention plan; see Safety Provisions herein.

2. Due to the potential health hazards associated with installation of SPF systems, personal protective equipment (PPE) requirements are critical to worker protection. Require a respirator plan for SPF installation; see Safety Provisions herein.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR BARRIER ASSOCIATION OF AMERICA (ABAA)

ABAA Accreditation	Accreditation

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z9.2	(2018) Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems
ASSP Z88.2	(2015) American National Standard Practices for Respiratory Protection

ASTM INTERNATIONAL (ASTM)

ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C1029	(2020) Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
ASTM C1060	(2011a; R 2015) Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
ASTM C1153	(2023) Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
ASTM C1303/C1303M	(2022) Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation
ASTM C1338	(2019) Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622	(2020) Apparent Density of Rigid Cellular Plastics
ASTM D1623	(2017) Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid

	Cellular Plastics
ASTM D2126	(2020) Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D2842	(2019) Water Absorption of Rigid Cellular Plastics
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D6226	(2021) Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E283/E283M	(2019) Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E736/E736M	(2019) Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E2178	(2021a) Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials
ASTM E2357	(2018) Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies

INTERNATIONAL CODE COUNCIL (ICC)

ICC 1100	(2019) Standard for Spray-applied Polyurethane Foam Plastic Insulation
ICC IBC	(2024) International Building Code
ICC IECC	(2021) International Energy Conservation Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 10	(2022; ERTA 1 2021) Standard for Portable Fire Extinguishers
NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
NFPA 268	(2022) Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source
NFPA 275	(2022) Standard Method of Fire Tests for the Evaluation of Thermal Barriers
NFPA 285	(2023) Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

SPRAY POLYURETHANE FOAM ALLIANCE (SPFA)

SPFA TechDocs	(2015) SPFA Technical Documents Library, four categories: General, Insulation, Roofing, Specialty

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.132	Personal Protective Equipment
29 CFR 1910.133	Eye and Face Protection
29 CFR 1910.134	Respiratory Protection

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials

1.2 RELATED REQUIREMENTS

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NOTE: Include the first bracketed option and include Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING when airtightness testing of the air barrier is required by UFC 3-101-01. Include the other air barrier UFGS sections when those types of air barriers are in the project.

****

Coordinate the requirements of Section 07 27 10 BUILDING AIR BARRIER SYSTEM[, Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING][, Section 07 27 19.01 SELF-ADHERING AIR BARRIERS,][SECTION 07 27 26 FLUID-APPLIED MEMBRANE AIR BARRIERS,] and other building envelope sections to provide a complete air barrier system. Submit all materials, components, and assemblies of the air barrier system together as one complete submittal package.

1.3 DEFINITIONS

1.3.1 Long Term Thermal Resistance (LTTR)

The thermal resistance value of a closed cell foam insulation product measured using accelerated aging ASTM C1303/C1303M equivalent to the time-weighted average thermal resistance value over 15 years. Loss in thermal resistance is attributable to changes in cell gas composition caused by diffusion of air into and blowing agent out of the foam cells.

1.3.2 SPFA TechDocs

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NOTE: SPFA technical documents include definitions common to the industry. For a complete list of TechDocs, see https://www.sprayfoam.org/SPFA_techdocs

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Reformatted documents, named SPFA TechDocs (https://www.sprayfoam.org/SPFA_techdocs), is a repository of technical information containing common definitions used in this Section. The site is organized in four categories for easy reference and identification: Roofing, Insulation, Specialty and General.

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NOTE: Choose bracketed vapor below when using closed cell SPF.

****

Spray Polyurethane Foam: Thermal and air[/vapor] barrier system consisting of sprayed polyurethane foam (SPF).

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification of Manufacturer; G, [_____]

Qualification of Installer; G, [_____]

Quality Control Plan; G, [_____]

Safety Plan; G, [_____]

Fire Prevention Plan; G, [_____]

Respiratory Protection Plan; G, [_____]

SD-02 Shop Drawings

Spray Foam Air Barrier System Shop Drawings

Fire-Rated Assemblies; G, [_____]

SD-03 Product Data

Blowing Agents; G, [_____]

[Closed Cell SPF; G, [_____]

][Open Cell SPF; G, [_____]

] Transition Membrane; G, [_____]

Primers, Adhesives, and Mastics; G, [_____]

Sealants; G, [_____]

Safety Data Sheets; G, [_____]

[Thermal Barrier Materials; G, [_____]

][Ignition Barrier Coatings; G, [_____]

] Accessories; G, [_____]

[Recycled Content for Closed Cell Spray Foam Air Barrier; S

][Recycled Content for Open Cell Spray Foam Air Barrier; S

] SD-04 Samples

Spray Foam Air Barrier Mockup; G, [_____]

SD-06 Test Reports

Mockup Peel Adhesion Test; G, [_____]

Thermographic Test; G, [_____]

Air Barrier Test; G, [_____]

[Fire-Ratings Of [Thermal][Ignition] Barrier Materials; G, [_____]

] Flame Spread and Smoke Developed Index Ratings of SPF Products; G, [_____]

Flame Propagation of Wall Assemblies; G, [_____]

Site Inspections Reports; G, [_____]

SD-07 Certificates

Indoor Air Quality for Spray Foam Air Barrier; S

SD-08 Manufacturer's Instructions

SPF Handling, Storage, and Spray Procedures; G, [_____]

Substrate Preparation; G, [_____]

[Thermal Barrier; G, [_____]

][Ignition Barrier; G, [_____]

] Transition Membrane Manufacturer's Installation Instructions; G,

[_____]

Manufacturer's Printed Installation Instructions for Primers, Adhesives, and Mastics; G, [_____]

SD-09 Manufacturer's Field Reports

Core Samples; G, [_____]

Daily Work Record; G, [_____]

Visual Inspection and Thermal Scanning; G, [_____]

1.5 MISCELLANEOUS REQUIREMENTS

For the spray foam air barrier system provide the following:

1.5.1 Shop Drawings

Submit spray foam air barrier system shop drawings showing locations, detailing, and extent of spray foam air barrier assemblies. Provide details of all typical conditions, intersections with other envelope assemblies and materials, membrane counter-flashings. Provide details for fire-rated assemblies and indicate materials for [thermal barriers][ignition barriers]. Show details for bridging of gaps in construction, treatment of inside and outside corners, expansion joints, methods of attachment of materials covering the SPF without compromising the barrier. Indicate how miscellaneous penetrations such as conduit, pipes, electric boxes, brick ties, and similar items will be sealed.

1.5.2 Product Data

Submit manufacturer's technical data indicating compliance with performance and environmental requirements, manufacturer's printed instructions for evaluating, preparing, and treating substrates, temperature and other limitations of installation conditions, safety requirements for installation, and Safety Data Sheets. Indicate flame and smoke spread ratings for all products. Submit [thermal barrier][ignition barrier] literature including material description, physical properties, fire-ratings, and manufacturer's printed installation instructions. Also include manufacturer's printed installation instructions for primers, adhesives, and mastics.

1.5.3 Mockup

Provide a spray foam air barrier mockup of each foam system specified. Apply foam in an area designated by the Contracting Officer. Apply an area of not less than 5 square meters 50 square feet. Include all components specified for the finished assembly including primers, support components, expansion and contraction joints,[ignition barriers,][thermal barriers,] and other accessories as representative of the complete system. Isolate the area and protect workers as required by 29 CFR 1910.132, 29 CFR 1910.133 and 29 CFR 1910.134. Notify the Contracting Officer a minimum of 48 hours prior to the test application. Select a test area representative of conditions to be sprayed including window or door openings, wall to ceiling transitions, flashings, and penetrations, as applicable.

1.5.4 Test Reports

Submit test reports indicating that mockup peel adhesion tests on all materials have been performed and the changes made, if required, in order to achieve successful and lasting adhesion. Submit test reports for flame spread and smoke developed index ratings of SPF products tested in accordance with ASTM E84 or UL 723. Submit test reports for flame propagation of wall assemblies tested in accordance with NFPA 285.[Submit test reports for fire-ratings of [thermal][ignition] barrier materials tested in accordance with ASTM E84 or UL 723.]

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery

Deliver and store materials in sufficient quantity to allow for uninterrupted flow of work. Inspect materials delivered to the site for damage; unload and store out of weather. Deliver materials to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand designation, description of contents, and shelf life of containerized materials. Store and handle to protect from damage. Submit SPF Handling, Storage, and Spray Procedures in accordance with submittal procedures.

1.6.2 Storage

Store materials in clean, dry areas, away from excessive heat, sparks, and open flame. Maintain temperatures in the storage area below the materials' flash point(s) and within limits recommended by the manufacturer's printed instructions. Provide ventilation in accordance with ASSP Z9.2 to prevent build-up of flammable gases. Store all chemicals in locations that limit the risk of contact with water, acids, caustics (such as lye), alcohols, and strong oxidizing and reducing agents.

1.6.3 Handling

Handle materials and containers safely and in accordance with manufacturer's recommendations. Store liquids in airtight containers and keep containers closed except when removing materials. Do not use equipment or containers containing remains of dissimilar materials. Do not expose foam component containers to direct sunlight. Containers exposed to long periods of cold may also exhibit separation and poor performance. Do not use materials from containers with content temperatures exceeding limits specified in the manufacturers installation instructions.

Mark and remove from job site all chemicals which have been contaminated with moisture, that exceed shelf life limits, or that have been exposed to temperature extremes.

1.6.3.1 Venting and Handling of Material Containers

Partially unscrew material container and drum caps to gradually vent the containers prior to opening. Do not inhale vapors. Follow drum decontamination and disposal procedures recommended by the manufacturer or the American Chemistry Council's Center for the Polyurethanes Industry.

1.7 MOCKUP PEEL ADHESION TEST

Perform a field peel adhesion test on the construction mockup. Test the

SPF for adhesion in accordance with ASTM D4541 Method B using a Type II pull tester except use a disk that is 57 mm 2.25 inches in diameter and cut through the foam to separate the material attached to the disk from the surrounding material. Perform test after curing period in accordance with manufacturer's written recommendations. Record mode of failure and area which failed in accordance with ASTM D4541. Compare adhesion values with the manufacturer's established minimum values for the particular combination of material and substrate. Indicate on the inspection report whether the manufacturer's requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product and substrate combination, the inspector must record actual values.

1.8 AIR BARRIER TESTING

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NOTE: Choose first bracketed specification section to address air barrier requirements of the building enclosure. Choose the second bracketed option for projects where the particular Service branch requires pressure testing the building enclosure for airtightness. See UFC 3-101-01 for more information.

****

Perform air barrier testing in accordance with[Section 07 27 10 BUILDING AIR BARRIER SYSTEM][and Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING].

1.9 SAFETY PROVISIONS

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NOTE: Coordinate minimum quantities of fire extinguishers with the fire department having jurisdiction over the project.

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1.9.1 Fire Prevention

Provide a written fire prevention plan for the SPF application. Address specific fire hazards such as spontaneous combustion from exothermic heat build-up of SPF components during curing. Provide a continuous fire watch during mixing and spraying of SPF and for a minimum of [two hours][30 minutes] after completion of work at the end of each day. Maintain fire watch for additional time as required to ensure no potential ignition conditions exist.

1.9.1.1 Fire Extinguishers

Provide [two][_____] fire extinguishers of minimum 7 kg 15 pounds capacity each, in accordance with NFPA 10, in the immediate vicinity of the work. CAUTION: Do not discharge high pressure carbon dioxide extinguishers where explosive vapors exist since the discharge can cause a spark which will ignite the vapors.

1.9.2 Respiratory Protection Plan

Provide a written respiratory protection plan in accordance with OSHA regulation 29 CFR 1910.134 that protects installers during application and addresses separation of the area to prevent other workers from entering the work area during spraying.

1.9.3 Isolation

Isolate the work area as recommended by spray foam manufacturer's written requirements. Prevent workers without respiratory, skin, and eye Personal Protective Equipment (PPE) or training from entering the work area or otherwise being exposed to airborne chemicals from off-gassing of the insulation in excess of permissible exposure limits. Display appropriate warning signage at all work area entry points. Provide negative pressure ventilation of the spray area to minimize chemical exposure for all workers.

1.9.4 Respirators and Eye Protection

Respiratory protective devices (respirators) must meet the requirements of ASSP Z88.2. Eye and face protective equipment must meet the requirements of ANSI/ISEA Z87.1. Additionally, sprayers and workers in the immediate vicinity of the spray during indoor installation of high-pressure SPF must wear NIOSH-approved, full-face, supplied air respirators (SAR) or hoods operated in positive pressure or continuous flow mode. Workers not in the immediate vicinity of the sprayer must wear air purifying respirators (APR) with an organic gas / P100 particulate cartridge. During outdoor installation of high-pressure SPF, sprayers and workers in the immediate vicinity of the spray must wear air purifying respirators (APR) with an organic gas / P100 particulate cartridge.

Instruct personnel in the use of personal protective equipment. Maintain such equipment and inspect regularly. All workers using respirators are required to have undergone pulmonary function testing and fit testing and must provide certification that they have done so. Change APR cartridges in accordance with manufacturer's written recommendations.

1.9.5 Clothing and Gloves

Sprayers and workers must wear protective clothing and gloves in accordance with OSHA requirements during materials application. Disposable, chemically-resistant coveralls must be worn and must cover all exposed skin. Sprayers and workers must wear fabric gloves coated with nitrile, neoprene, butyl or PVC.

1.9.6 Additional Requirements

Require personnel to review the Health, Safety and Environmental Aspects of Spray Polyurethane Foam and Coverings published by the Spray Polyurethane Foam Alliance (SPFA) (https://www.sprayfoam.org/) and the American Chemistry Council Center for the Polyurethanes Industry. Verify compliance prior to allowing personnel on site for installation work.

1.10 QUALITY CONTROL

1.10.1 Qualification of Manufacturer

Submit documentation verifying that the manufacturer of the SPF is currently accredited by the Air Barrier Association of America (ABAA Accreditation https://www.airbarrier.org/) or by the Spray Polyurethane Foam Alliance (SPFA) Professional Certification Program (PCP).

1.10.2 Qualification of Installer

Submit documentation verifying that installers of the spray foam air barrier are currently certified to properly install SPF materials.

Acceptable certifications include those provided by the approved product manufacturer, by ABAA/BPQI (Building Performance Quality Institute) or by the Spray Polyurethane Foam Alliance (SPFA) Professional Certification Program (PCP). Installers must provide photo identification certification cards for inspection upon request.

1.10.3 General Quality Requirements

Provide all products and installation in accordance with the approved product manufacturer's installation instructions. SPFA TechDocs requirements (https://www.sprayfoam.org/SPFA_techdocs) may be used if manufacturers installation instructions do not address specific applications and documented best practices.

1.11 PRECONSTRUCTION MEETING

Conduct a preconstruction meeting after approval of submittals and a minimum of two weeks prior to commencing work specified in this Section. Attendance is required by the Contracting Officer's designated personnel, Contractor, and representatives of related trades including covering materials, substrate materials, adjacent materials, and materials and components of the air/vapor/thermal barrier system. Agenda must include, at a minimum, the following items:

a. Drawings, specifications and submittals related to the SPF work;

b. Sequence of construction;

c. Coordination with substrate preparation work and responsibility of repairing defects in substrates. Determine method of ensuring SPF work does not begin until substrates have been inspected and accepted;

d. Ensure that all penetrations of the substrate by other trades are completed prior to SPF air barrier installation where possible; responsibility of sealing penetrations after SPF air barrier installation should be addressed.

e. Compatibility of materials;

f. Construction and testing of construction mockup;

g. Application of self-adhering air barrier transition strips and primer as required for sealing the spray foam air barrier system at openings including but not limited to windows, doors and louvers;

h. Spray foam air barrier system installation; including methods to be used to provide a continuous barrier at thru-wall flashing, penetrations, and covering of embed items;

i. Quality control plan including methods of applying the product so that a consistent thickness across the face of the substrate is achieved.

j. Procedures for SPF manufacturer's technical representative's onsite inspection and acceptance of substrates, contact info for the representative, frequency of visits, and distribution of copies of inspection reports. Determine where core samples will be taken and review procedures for daily documentation of SPF application.

k. Property protection measures[, including isolation of the work,] and prevention of overspray and clean-up should overspray occur.

l. Safety requirements, including review of PPE, fire prevention, safety plan, respirator plan, ventilation and separation of the work area, fall protection, and posting of warning signs. Provide a complete schedule and a detailed, written fire protection plan[including temporary isolation of the product and the work area until permanent isolation or thermal barrier is in place].

1.12 PROJECT/SITE CONDITIONS

1.12.1 Temperature and Weather

Install SPF within the range of ambient and substrate surface temperatures in accordance with manufacturer's written instructions. Do not apply SPF to damp or wet substrates. Do not apply SPF during inclement weather or when ice, frost, surface moisture, or visible dampness is present on surfaces to be covered, or when precipitation is imminent. Do not apply SPF to exterior building surfaces when wind speeds exceed 40 kilometers 25 miles per hour. Use moisture measuring methods and equipment to verify that the moisture conditions of substrate surfaces are in accordance with SPF manufacturer requirements prior to application. Substrate temperatures must be within limits recommended by the manufacturer's printed instructions.

1.12.2 Conditions for Primers

Follow manufacturer's printed application and curing instructions regarding ambient temperature minimum limits.

1.12.3 Conditions for Ignition Barriers

Ensure that sprayed surfaces comply with manufacturer's written requirements for application coverage, thickness, and curing prior to application of ignition barrier coatings.

1.12.4 Temporary Ventilation

Provide temporary ventilation for work of this Section in accordance with manufacturer's written instructions and with OSHA requirements for this type of application.

1.13 FOAM SPRAY EQUIPMENT

1.13.1 Applicator

Install spray foam with a plural-component proportioner, hoses and spray gun system approved by the spray foam manufacturer

Use a foam spray gun approved by the foam manufacturer that does not require a flushing solvent during the spray operation.

1.13.2 Equipment Calibration

Fully calibrate the foam metering equipment to monitor each liquid component to within 2 percent of the SPF manufacturer's required metering ratio. Calibrate spray equipment each day at the start of operations, after each restart if spraying operations have been terminated for more than one hour, whenever there is a change in fan pattern or pressure, whenever slow curing areas are noticed, whenever a change is made in hose length or working height, and after changeover between materials. Calibration consists of demonstrating that the equipment is adjusted to deliver components in proper mix and proportion. Conduct calibration tests on cardboard or plywood on a wall adjacent to the area to be sprayed.

1.13.3 Metering Equipment Requirements

Use foam metering equipment capable of developing and maintaining the SPF manufacturer's required liquid component pressures and temperatures. Foam metering equipment must have gages for visual monitoring. Equipment must provide temperature control of foam components to within the temperature ranges recommended by the foam manufacturer's printed instructions.

1.13.4 Moisture Protection

Protect surfaces of supply containers and tanks used to feed foam metering equipment from moisture.

1.13.5 Compressed Air

Supply compressed air that is in contact with SPF during mixing or atomization through moisture traps that are continuously bled.

1.13.6 Dispense Excess Materials

Do not deposit materials used for cleaning of equipment or materials dispensed for calibration purposes and establishment of spray gun pattern onto the ground. Dispense such materials into scrap containers or onto plastic film, or cardboard, and dispose of in accordance with safety requirements and jobsite regulations.

PART 2 PRODUCTS

2.1 SPRAY FOAM AIR BARRIER

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NOTE: Use of SPF must meet the Flame Spread (FS) and Smoke Developed (SD) index requirements for insulation in accordance with UFC 3-600-01 Fire Protection Engineering for Facilities. FS and SD ratings must be no higher than 75 for FS and 150 for SD when tested in accordance with ASTM E84 (NFPA 255) or UL 723. The SD rating is more stringent than Class A ratings indicated in NFPA 101 or IBC and most SPF vendors cannot meet it. However, this UFC allows exceptions to these limits in certain types of installations and construction types. Exceptions are described in paragraphs directly below the primary paragraph in this UFC titled "Insulation" and the subparagraphs therein. For applications where these values are required, the product can still be used, however, it requires the addition of a thermal or an ignition barrier to encapsulate it. Thermal barriers are described in IBC Chapter 26 "Plastics." When such barriers are required, choose bracketed items throughout this specification section accordingly.

IBC includes requirements for the location within wall cavities of class I, II and III vapor retarders depending on the project's climate zone to avoid condensation within wall assemblies. See IBC Section 1404.3, and the International Energy Conservation Code (IECC) referenced by this section of the IBC, coordinate dewpoint with mechanical design, and specify type and location within the cavity accordingly. Also verify the cavity is sized to accommodate the barrier thickness required to provide the specified R-Value plus a minimum 25 mm one inch air space. R-value must reflect compliance with IgCC and ASHRAE 90.1 as mandated by UFC 1-200-02 High Performance and Sustainable Building Requirements.

****

2.1.1 General

Provide [an open cell,][a closed cell,] sprayed in place, SPF that forms a continuous air[/vapor]/thermal barrier at the building enclosure. Provide in accordance with ASTM C1029, with the requirements of UFC 3-600-01, ICC IBC Chapter 26, ICC 1100, and NFPA 285. In the event of a conflict, the most stringent requirement applies. Provide all system components necessary for a complete, code compliant installation, whether indicated or not, including material support components, expansion and contraction joints,[ignition barrier coatings,][thermal barrier materials,] and accessories.

2.1.2 Physical Properties

[Provide a closed cell product with the following characteristics:

a. Core Density (ASTM D1622): 24 to 40 Kg per m3 1.5 to 2.5 lb per cf, nominal

b. Thermal Resistance (ASTM C518)

   (1) Initial R-value per inch thickness: 1.2 K·m2 per W 7 sf·degrees F h per Btu

   (2) Aged R-value per inch thickness (180 days at 23 degrees C 76 degrees F): 1.17 square Km per W 6.6 sf·degrees F·h per Btu

c. Material Air Permeance (ASTM E2178): [In accordance with Section 07 27 10 BUILDING AIR BARRIER SYSTEM][Less than 0.02 L per s-m2 at 75 Pa 0.004 CFM per sf at 1.57 psf] at the minimum installed thickness.

****

NOTE: Choose first bracketed specification section to address air barrier requirements of the building enclosure. Choose the second bracketed option for projects where the particular Service branch requires pressure testing the building enclosure for airtightness. See UFC 3-101-01 for more information.

****

d. Assembly Air Leakage (ASTM E2357, ASTM E283/E283M): [In accordance with Section 07 27 10 BUILDING AIR BARRIER SYSTEM[and Section 01 91 19

BUILDING ENCLOSURE COMMISSIONING]][less than 0.2 L per s-m2 at 75 Pa 0.04 CFM per sf at 1.57 psf] at the minimum installed thickness.

e. Compressive Strength (ASTM D1621): Minimum 195 kPa 28.3 psi

f. Tensile Strength (ASTM D1623)

(1) Medium density: 103 kPa 15 psi

(2) Roofing: 276 kPa 40 psi

g. Water Vapor Permeance (ASTM E96/E96M, water method): less than 69 ng per Pa sm2 1.2 US Perms at 25 mm one inch thickness

h. Vapor Retarder (ICC IBC, ICC IECC) Class III

i. Surface Burning Characteristics (ASTM E84 or UL 723) 100 mm 4 inch thickness:

(1) Flame Spread (FS) Index Rating less than [75 [_____],][_____].

(2) Smoke Developed (SD) Index Rating less than [150. When fully encapsulated, SPF with an SD rating greater than 150 but less than 450 is permitted. Approval of SPF product is contingent upon approval of encapsulation products and assemblies.][_____].

j. Closed Cell Content (ASTM D6226): minimum 90 percent

k. Dimensional Stability (Humid Aging) (ASTM D2126): 15 percent at 28 days at 70 degrees C 158 degrees F with 97 percent relative humidity.

l. Water Absorption (ASTM D2842): Maximum 5.0 per volume

m. Fungi Resistance (ASTM C1338): Pass, with no growth

n. Recycled Content: Minimum 9 percent (pre- and post-consumer). Provide data identifying percentage of recycled content for closed cell spray foam air barrier.

][Provide an open cell product with the following characteristics:

a. Density (ASTM D1622): 6.4 to 24 Kg per m3 0.4 to 1.5 lb per cf, nominal

b. Thermal Resistance (ASTM C518)

(1) Initial R-value per inch thickness: .70 K·m2 per W 4 sf·degrees F·h per Btu)

(2) Aged R-value per inch thickness (180 days at 23 degrees C 76 degrees F): .68 K·m2 per W 3.8 sf·degrees F·h per Btu

c. Material Air Permeance (ASTM E2178): [In accordance with Section 07 27 10 BUILDING AIR BARRIER SYSTEM][less than 0.02 L per s-m2 at 75 Pa 0.004 CFM per sf at 1.57 psf] at the minimum installed thickness.

****

NOTE: Choose first bracketed specification section to address air barrier requirements of the building enclosure. Choose the second bracketed option for

projects where the particular Service branch requires pressure testing the building enclosure for airtightness. See UFC 3-101-01 for more information.
****

d. Assembly Air Leakage (ASTM E2357, ASTM E283/E283M): [In accordance with Section 07 27 10 BUILDING AIR BARRIER SYSTEM[and Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING]][Less than 0.2 L per s-m2 at 75 Pa 0.04 CFM per sf at 1.57 psf at] the minimum installed thickness.

e. Compressive Strength (ASTM D1621): 6.9-34 kPa 3-5 psi

f. Tensile Strength (ASTM D1623): minimum 2.3 kPa 1 psi

g. Water Vapor Permeance (ASTM E96/E96M, water method): Maximum 1300 ng per Pa sm2 22 Perms at 50 mm 2 inch thickness

h. Surface Burning Characteristics (ASTM E84 or UL 723) 100 mm 4 inch thickness:

    (1) Flame Spread (FS) Index Rating less than [75][_____].

    (2) Smoke Developed (SD) Index Rating less than [150. SPF with an SD rating greater than 150 but less than 450 may be used when fully encapsulated. Approval of SPF product is contingent upon approval of encapsulation products and assemblies.][_____].

i. Open Cell Content (ASTM D6226): Greater than 92 percent

j. Fungi Resistance (ASTM C1338): Pass, with no growth

k. Recycled Content: minimum 9 percent (pre- and post-consumer). Provide data identifying percentage of recycled content for open cell spray foam air barrier.

]2.1.3 Expansion and Contraction

Provide an assembly that allows for relative movement due to temperature, moisture, and air pressure changes. Provide expansion and contraction measures as required by the manufacturer's written recommendations.

2.1.4 Fire-ratings, Flame Spread and Smoke Developed Index Ratings

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NOTE: Where required by UFC 3-600-01 Fire Protection Engineering for Facilities (by way of reference when smoke developed index requirements cannot be met), provide an ignition barrier (intumescent coating specifically for SPF) or a thermal barrier (various sheathing type of options) as required by IBC Chapter 26 "Plastics". If the Authority Having Jurisdiction (AHJ) for the project does not recognize intumescent coatings as thermal or ignition barriers, do not use them to satisfy the requirements for thermal or ignition barriers. Choose bracketed options below.
****

Where fire-rated materials are indicated, provide products with the appropriate markings of a qualified testing agency on the containers. Submit fire-rating test reports. Fire-rating test reports must include flame spread (FS) and smoke developed (SD) index data. Where FS and SD values of foam products do not meet requirements, provide code-compliant [ignition][thermal] barrier products or alternate assemblies and verify complete encapsulation of the spray foam air barrier through product data or on shop drawings. Submit for approval in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

2.1.5 Prohibited Materials

Products that contain hexabromocyclododecane (HBCD) flame retardants are prohibited. Products that contain hydrochlorofluorocarbons (HCFCs), chlorofluorocarbons (CFCs), or other hydrofluorocarbons (HFCs), or other blowing agents with Ozone Depletion Potential (ODP) greater than 0.015 or Global Warming Potential (GWP) above 16 are prohibited. For a list of foam blowing agents with ODP and GWP values see https://www.epa.gov/snap/substitutes-rigid-polyurethane-spray. Provide validation of indoor air quality for spray foam air barrier that no prohibited materials are used.

2.1.6 [Thermal][Ignition] Barrier

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NOTE: Where required by UFC 3-600-01 Fire Protection Engineering for Facilities (by way of reference when smoke developed index requirements cannot be met), provide an ignition barrier (intumescent coating specifically for SPF) or a thermal barrier (various sheathing type of options) as required by IBC Chapter 26 "Plastics". If the Authority Having Jurisdiction (AHJ) for the project does not recognize intumescent coatings as thermal or ignition barriers, do not use them to satisfy the requirements for thermal or ignition barriers. Choose bracketed options below.

****

2.1.6.1 SPF at Exterior Wall Assemblies

At exterior walls which do not meet the exceptions listed in ICC IBC Chapter 26, separate the SPF from interior side of the wall assembly with continuous thermal barrier of 13 mm 1/2 inch glass mat gypsum wallboard (GWB) in accordance with ICC IBC Chapter 26 requirements. Provide assembly tested in accordance with NFPA 285 for fire propagation and no sustained ignition when tested in accordance with NFPA 268.

2.1.6.2 SPF at Other Locations

Provide a [thermal barrier][ignition barrier] in locations where SPF is exposed to the interior of the building, including attics and plenum spaces. Provide [thermal][ignition] barriers in accordance with ICC IBC Chapter 26 "Plastics," with ICC 1100, ASTM E736/E736M, and NFPA 275. Choose one or more of the following methods of separation:

a. Building interior, other than fire-rated enclosures: [Separate the SPF from the occupied interior of a building by a continuous thermal barrier of 13 mm 1/2 inch glass mat gypsum wallboard (GWB) in accordance with ICC IBC Chapter 26 requirements.][Separate the SPF from the occupied interior of a building by an intumescent thermal barrier coating or thermal barrier board identical to a third party tested thermal barrier to limit the average temperature rise of the surface of the SPF to not more than 120 degrees C 250 degrees F after 15 minutes of fire exposure (using the standard time-temperature curve of ASTM E119)]. Provide in accordance with NFPA 275.

b. Building interior, fire-rated enclosures: At walls, ceilings and floors that are required to be fire-rated, separate the SPF from the occupied interior of a building with an ignition barrier consisting of 16 mm 5/8 inch, Type X, fire-rated GWB in the number of layers corresponding to required ratings. Include all accessories as necessary for complete fire-rated assemblies.

c. Unoccupied attics, crawl spaces: Where fire-rated enclosures are not required, and where entry is made only for service of utilities, separate the SPF from the attic or crawl space with a continuous ignition barrier in accordance with ICC IBC Chapter 26 requirements, and as approved by the Contracting Officer's Representative. Provide one of the following:

  (1) 38 mm 1-1/2 inch thick mineral fiber insulation

  (2) 38 mm 1-1/2 inch thick cellulose insulation

2.2 TRANSITION MEMBRANE

****

NOTE: Transition membrane materials typically consist of self-adhering membrane products therefore specifier must also edit and include Section 07 27 19.01 SELF-ADHERING AIR BARRIERS.

****

Provide as specified in Section 07 27 19.01 SELF-ADHERING AIR BARRIERS.

2.3 PRIMERS, ADHESIVES, AND MASTICS

Provide primers, adhesives, mastics and other accessory materials as recommended by spray foam manufacturer's printed literature.

2.4 FLASHING

As specified in Section 07 60 00 FLASHING AND SHEET METAL.

2.5 JOINT SEALANTS

As specified in Section 07 92 00 JOINT SEALANTS. Verify compatibility with other system products.

PART 3 EXECUTION

3.1 EXAMINATION

****

Note: For retrofit projects, inspect facility to determine conditions which may adversely affect execution of work or create safety hazards. Identify relevant conditions on the drawings and, if

required, develop additional specification sections for corrective actions. Conditions that warrant investigation include, but are not limited to:

1. Discolorations or mold growth indicating previous water leaks.

2. Heat producing devices, such as recessed lighting fixtures, chimneys, and flues.

3. Faulty electrical systems:

(a) Lights dimming or flickering

(b) Fuses blowing

(c) Circuit breakers tripping frequently

(d) Electrical sparks and "glowing" from receptacles

(e) Cover plates on switches and outlets warm to touch.

****

Before installing the spray foam air barrier and with the installer present, examine substrates, areas, and conditions under which SPF will be applied, for compliance with requirements. Ensure that surfaces are structurally sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants. Ensure that concrete surfaces are cured and dry, smooth without large voids, spalled areas or sharp protrusions. Correct defects that adversely affect the spray foam application or performance. Verify that work by other trades is in place and complete prior to application of spray foam.

3.2 PREPARATION

3.2.1 Substrate Preparation

Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for spray foam application.

a. Prepare surfaces by brushing, scrubbing, scraping, or grinding to remove loose mortar, dust, oil, grease, oxidation, mill scale and other contaminants which will affect adhesion of the SPF.

b. Wipe down metal surfaces to remove release agents or other non-compatible coatings, using clean sponges or rags soaked in a solvent compatible with the SPF.

3.2.2 Protection

Protect adjacent areas and surfaces from spray applied materials in accordance with the following:

a. Mask and cover adjacent areas to protect from overspray.

b. Ensure required foam stops and back up materials are in place to achieve a complete seal.

c. Seal off ventilation equipment. Install temporary ducting and fans to provide required negative-pressure exhaust of spray fumes. Provide make-up air as required.

d. Erect barriers, isolate area, and post warning signs to notify non-protected personnel of the requirement to avoid the spray area.

3.2.3 Blocking Around Heat Producing Devices

Install non-combustible blocking around heat producing devices to provide the following clearances:

a. Recessed light fixtures, including wiring compartments, ballasts, and other heat producing devices, unless certified for installation surrounded by insulation: Minimum of [75 mm3 inches][_____] from outside face of fixtures and devices and in accordance with NFPA 70 and, if insulation is to be placed above fixture or device, 610 mm 24 inches above fixture.

b. Masonry chimneys or masonry enclosing a flue: a minimum of [51 mm2 inches][_____] from outside face of masonry. Masonry chimneys for medium and high heat operating appliances: Minimum clearances in accordance with NFPA 211.

c. Vents and vent connectors used for venting products of combustion, flues, and chimneys other than masonry chimneys: Minimum clearances in accordance with NFPA 211.

d. Gas Fired Appliances: Clearances in accordance with NFPA 54.

e. Oil Fired Appliances: Clearances in accordance with NFPA 31. Blocking is not required if chimneys or flues are certified by the manufacturer for use in contact with insulating materials.

3.2.4 Fire and Explosion Hazards

Prohibit open flames, sparks, welding, and smoking in the application area. Provide and maintain fire extinguishers of appropriate type, size and distance, as required by NFPA, in the application area. Apply SPF according to manufacturer's instructions regarding maximum pass thickness and curing time. Mix batches in small enough quantities to avoid spontaneous combustion from exothermic heat build-up of SPF components during curing.

3.2.5 Warning Signs

Post warning signs at ground level adjacent to the work area and a minimum of 45.72 meters 150 feet from the application area stating the area is off limits to unauthorized persons and warning of potential hazards. Place clearly visible and legible warning sign at entrance to primary road leading to the project facility warning of presence of combustible materials, irritating fumes, and potential of overspray damage.

3.2.6 Prime Substrate

Provide as recommended by the manufacturer for each substrate to be primed. Use primers at full strength. Do not dilute primers unless required and as recommended in writing by the manufacturer. Do not use cleaning solvents for thinning primers or other materials. Ensure that diluted primer(s) meet VOC requirements.

3.3 INSTALLATION

3.3.1 Sequencing and Coordination

Sequence the work to prevent access to the work area by other trades during foam application and curing. Limit access of non-essential workers during application. Notify the Contracting Officer 24 hours in advance of spraying operations.[Sequence spray foam work with other trades to permit continuous self-flashing of the spray foam air barrier.] Ensure expansion and control joints are provided as detailed on the manufacturer's shop drawings to accommodate the expansion of each layer of the air[/vapor]/thermal envelope.[Provide temporary fire protection of uncured foam, and isolate the work area, until foam application is covered with a permanent thermal or ignition barrier.]

3.3.2 Installation of Transition Membrane

Install transition membrane materials in accordance with the details on the drawings, Section 07 27 19.01 SELF-ADHERING AIR BARRIERS, and the following:

a. Install transition membrane at all required locations prior to installation of the SPF air barrier.

b. Verify transition membrane is fully adhered to substrate and that its surface is clean, dry and wrinkle free prior to installation of the fluid-applied membrane air barrier.

c. Verify transition membrane completely covers all transition areas and will provide continuity of the finished SPF air barrier without gaps or cracks.

Submit transition membrane manufacturer's installation instructions.

3.3.3 Installation of Spray Foam Air Barrier

Install materials in accordance with paragraph SAFETY PROVISIONS, in accordance with manufacturer's recommendations, and in accordance with the following:

a. Use spray equipment that complies with foam manufacturer's recommendations for the specific type of application, and as specified herein. Record equipment settings on the Daily Work Record. Each proportioned unit can supply only one spray gun.

b. Apply only when surfaces and environmental conditions are within limits prescribed by the material manufacturer.

c. Continuously connect the spray foam air barrier between walls, roof, floor, and below grade assemblies to form a continuous integrated air barrier system around the entire building enclosure. Extend the spray foam air barrier into rough openings such as doors, windows, louvers, and other exterior penetrations. Use self-adhering air barrier transition strips if necessary to achieve full extension and continuity of the barrier at these locations. Seal edges of barrier at junctures with rough openings.

d. Install within manufacturer's tolerances, but not more than minus 6 mm 1/4 inch or plus 13 mm 1/2 inch.

e. Sequence work to completely seal all penetrations resulting from pipes, vents, wires, conduit, electrical fixtures, structural members, or other construction. If penetrations through the spray foam air barrier are made after the initial SPF application, reapply in accordance with manufacturer's written instructions for such remedial work.

f. Do not install SPF within 75 mm 3 inches of heat emitting devices such as light fixtures and chimneys.

g. Finished surface of SPF must be free of voids and embedded foreign objects.

h. Remove masking materials and overspray from adjacent areas immediately after foam surface has hardened. Ensure cleaning methods do not damage work performed by other sections.

i. Trim, as required, any excess thickness that would interfere with the application of cladding and covering system by other trades.

j. Clean and restore surfaces soiled or damaged by work of other trades. Before cleaning and restoring damaged work, consult with other trades for appropriate and approved methods for cleaning and restoration to prevent further damage.

k. Complete connections to other components and repair any gaps, holes or other damage using material approved by the SPF manufacturer.

l. Provide expansion joints in the SPF application aligned with expansion joints in the building enclosure, where substrate materials change, and in accordance with manufacturer's recommendations.

m. Provide a continuous fire watch in accordance with paragraph SAFETY PROVISIONS.

3.4 FIELD QUALITY CONTROL

3.4.1 General Site Inspections and Testing

****

NOTE: Choose the bracketed option for projects where pressure testing the building enclosure for airtightness is required by UFC 3-101-01.

****

Provide site inspections and testing in accordance with the manufacturer's instructions, Section 07 27 10 BUILDING AIR BARRIER SYSTEM,[Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING,] and this Section.

a. Conduct inspections and testing at 5, 50, and 95 percent of completion of this scope of work. Forward written inspection reports to the Contracting Officer within 5 working days of the inspection and test being performed.

b. If inspections reveal defects, promptly remove and replace defective work at no additional expense to the Government.

3.4.2 Manufacturer Site Inspections

Manufacturer's technical representative must visit the site during the installation process to ensure the SPF and accessories are being applied in compliance with requirements. At a minimum, manufacturer's technical representative must be present at work startup and perform field inspection of the first day's completed application and at substantial completion, prior to demobilization. After each inspection, submit an inspection report signed by the manufacturer's technical representative, to the Contracting Officer within five working days. The inspection report must note overall quality of work, deficiencies, and recommended corrective actions in detail. Notify the Contracting Officer a minimum of two working days prior to site visits by manufacturer's technical representative.

3.4.3 Contractor's Site Inspections

Establish and maintain an inspection procedure to ensure compliance of the foam installation with Contract requirements. Conduct inspections and testing at 5, 50, and 95 percent completion of application. Forward written inspection reports to the Contracting Officer within five working days of the inspection and test being performed. Work not in compliance must be promptly removed and replaced or corrected, in an approved manner, at no additional cost to the Government. Quality control must include, but is not limited to, the following:

a. Observation of environmental conditions; number and skill level of insulation workers.

b. Verification of certification, listing, or label.

c. Verification of proper storage and handling of materials before, during, and after installation.

d. Inspection of SPF, support structure, primer, expansion joints,[ignition barrier,][thermal barrier,][vapor retarder,] and accessories.

3.4.4 Peel Adhesion Test

Conduct in accordance with test protocol indicated in Part 1 paragraph MOCKUP PEEL ADHESION TEST.

[3.4.5 Visual Inspection and Thermal Scanning

Following completion of installation, inspect the SPF surface or cavity using infrared (IR) scanning as specified in[ASTM C1060,][ASTM C1153][and]. Where the IR inspection indicates construction inconsistencies including wet insulation, remove inconsistent portions of the assembly and replace insulation to correct thermal anomalies. Reinspect and document corrections to the satisfaction of the Contracting Officer.

3.4.5.1 Thermographic Test Report

Include thermographs in color and a color temperature scale to define the temperature indicated by the various colors. Identify the high temperature reading, the outdoor air temperature, the building indoor air temperature, and the wind speed and direction. Note areas of compromise in the building enclosure, and note actions required and taken to correct those areas. Final thermography test report must demonstrate that the problem areas have been corrected. Submit the complete test and analysis.

]3.5 CORRECTION OF DEFICIENCIES

Upon completion of inspection, testing, or sample taking, repair damaged construction, restore substrates and finishes, and protect repaired construction. Deficiencies found during inspection must be corrected within[5 working days][48 hours][_____] following notification.

3.6 CLEANUP OF SPILLS

Conduct cleanup of uncured product spillage in accordance with paragraph SAFETY PROVISIONS and the manufacturer's written safe handling instructions and SDS. In the event of a conflict, the most stringent requirement governs.

3.7 PROTECTION AND CLEANING

3.7.1 Protection of Installed Work

Protect SPF installation from damage during application and remainder of construction period in accordance with manufacturer's written instructions. Repair damaged areas to new condition.

3.7.2 Cleaning of Adjacent Surfaces

Clean overspray from adjacent construction using cleaning agents and procedures as recommended in writing by the manufacturer of each type of affected construction and as acceptable to same.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 31 13 (August 2016)**
Change 2 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-07 31 13 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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ASPHALT SHINGLES

08/16, CHG 2: 08/18

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USACE / NAVFAC / AFCEC **UFGS-07 31 13 (August 2016)**
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****

SECTION 07 31 13

ASPHALT SHINGLES
08/16, CHG 2: 08/18

****
NOTE: This guide specification covers the requirements for asphalt shingle roofing, surfaced with mineral granules, including roofing felt, ridge vents, underlayments, and flashings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Design exterior envelope to meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including moisture control and thermal performance.
****

****
NOTE: For a more detailed description of asphalt shingle roofing and requirements for asphalt shingle reroofing over existing asphalt shingles, wood

shingles, roll roofing, or built-up roofing, see the "Residential Asphalt Roofing Manual," published by Asphalt Roofing Manufacturers Association (ARMA) and "The NRCA Steep Roofing Manual," published by the National Roofing Contractors Association (NRCA). Avoid reroofing with asphalt shingles over more than one layer of existing roofing material.

****

****

NOTE: On the drawings, show:

1. Pitch of substrate/shingle roofing

2. Detail of crickets and flashings at chimneys

3. Detail at eave/rake corner of roof including underlayment, drip edge, starter strip, shingle exposure, shingle courses, and fastener placement.

****

****

NOTE: Where project involves tear-off of existing asphalt roofing materials and it is desired for the Contractor to salvage roofing materials for milling and recycling, include this requirement in UFGS 02 41 00 [DEMOLITION][AND][DECONSTRUCTION].

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D1970/D1970M	(2019) Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D3018/D3018M	(2011; R 2017) Standard Specification for Class A Asphalt Shingles Surfaced With Mineral Granules
ASTM D3161/D3161M	(2020) Standard Test Method for Wind-Resistance of Steep Slope Roofing Products (Fan-Induced Method)
ASTM D3462/D3462M	(2019) Standard Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM D4869/D4869M	(2016a) Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing
ASTM D6380/D6380M	(2003; E 2013; R 2013) Standard Specification for Asphalt Roll Roofing (Organic Felt)
ASTM D7158/D7158M	(2016) Standard Test Method for Wind Resistance of Asphalt Shingles (Uplift Force/Uplift Resistance Method)

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0437	(2017) The NRCA Roofing Manual: Steep-slope Roof Systems

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 790	(2022) UL Standard for Safety Test Methods for Fire Tests of Roof Coverings
UL 2218	(2010; Reprint May 2024) UL Standard for Safety Impact Resistance of Prepared Roof

Covering Materials

1.2 DEFINITIONS

1.2.1 Top Lap

That portion of shingle overlapping shingle in course below.

1.2.2 Head Lap

The triple coverage portion of top lap which is the shortest distance from the butt edge of an overlapping shingle to the upper edge of a shingle in the second course below.

1.2.3 Exposure

That portion of a shingle exposed to the weather after installation.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-03 Product Data

Shingles

Energy Star Label for Asphalt Shingle; S

[Heat Island Reduction; S

][SD-04 Samples

****

NOTE: Select color according to local practice, except use light-reflective colors for air conditioned buildings. Where color is specified in paragraph entitled "Asphalt Shingles," delete the requirement for submittal of color charts.

****

Shingles; G, [_____]

Full shingle sample and manufacturer's standard size samples of materials and products requiring color or finish selection.

[Color Charts; G, [_____]

]] SD-08 Manufacturer's Instructions

Application

SD-11 Closeout Submittals

Manufacturer's Warranty

Contractor's Warranty

1.4 DELIVERY AND STORAGE

Deliver materials in the manufacturer's unopened bundles and containers bearing the manufacturer's brand name. Keep materials dry, completely covered, and protected from the weather. Store according to manufacturer's written instructions. Store roll goods on end in an upright position or in accordance with manufacturer's recommendations. Immediately before laying, store roofing felt for 24 hours in an area maintained at a temperature not lower than 10 degrees C 50 degrees F.

1.5 WARRANTIES

****

NOTE: The warranty clauses in this guide specification have been approved by the Government. The paragraphs may be used without any request for waiver.

****

Warranties must begin on the date of Government acceptance of the work.

1.5.1 Manufacturer's Warranty

****

NOTE: Specify 30-year warranty for projects remotely located and subject to severe wind loadings; for example, in Bermuda. Specify the 25-year warranty for other projects. Minimum warranty period must extend beyond one year.

****

Furnish the asphalt shingle manufacturer's standard [25 year] [30 year] [other] warranty for the asphalt shingles. The warranty must run directly to the Government.

1.5.2 Contractor's Warranty

Provide warranty for 5 years that the asphalt shingle roofing system, as installed, is free from defects in workmanship. When repairs due to defective workmanship are required during the Contractor's warranty period, the Contractor must make such repairs within 72 hours of notification. When repairs are not performed within the specified time, emergency repairs performed by others will not void the warranty.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Shingles

****

NOTE: For structures located adjacent to Air Force Facilities, high light reflectance colors should not be used where resultant glare would be objectionable to pilots.

Edit this paragraph for the correct weight of shingle required for the project. Heavyweight inorganic mat type shingles will be used for ARHOC 81 Barracks or similar designs for permanent construction which utilize shingles. Omit fungus resistance if not required.

Hip and ridge shingles may be made from the strip shingle tabs or may be of a separate design. Generally, hip and ridge shingles cut from self-sealing individual full shingle tabs perform best.

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NOTE: For projects located in coastal high wind areas, use the bracketed requirement for 14.2 kilogram 290 pound per 100 square feet shingles. The 290 pounds per 100 square feet is equivalent to 2.9 pounds per square foot.

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****

NOTE: Specify fungus-resistant shingles for

projects located in climates having high humidity most of the time.

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NOTE: In geographical areas of the United States prone to severe hail events, specify impact resistant shingles.

****

****

NOTE: Structural aspects for the designer should be addressed in accordance with ASCE 7-16, Minimum Design Loads for Buildings and Other Structures. With respects to the wind resistance class options below, the Class F option is for 110 miles per hour resistance. The Class H option is for 150 miles per hour resistance.

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****

NOTE: Certain roofing products are required to conform to public law (PL) 109-58 - Energy Policy Act of 2005 (EPAct05) by meeting or exceeding Energy Star or FEMP efficiency requirements at "energy-efficient products" at http://energy.gov/eere/femp/energy-and-water-efficient-products.

****

****

NOTE: Facilities with dominant cooling loads and/or in mild or warm climate zones are required to meet "cool roofing" requirements of FEMP. Cool roof design must follow the requirements in UFC 3-110-03 Roofing, Appendix B and ASHRAE 90.1 Chapter 5, for the design of insulation and energy performance of the building. The roofing system will need to include a top surface layer that meets the Energy Star criteria for Cool Roof Products see http://www.energystar.gov/products/certified-products/detail/roof-products.

NOTE: If a cool roof is not selected in ASHRAE zones 1 thru 3, design must meet one of the exception requirements listed in ASHRAE 90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Coordinate these requirements with insulation design and specifications.

Retain the next to last bracketed note for project with cool roof requirement. Retain the last bracketed sentence for project with sustainable third party certification credit requirement for reduced heat island effect.

****

Mineral granule-surfaced asphalt shingles, self-sealing, square tab, strip [, fungus-resistant] [impact resistant shingles conforming to UL 2218, Class 4.][ASTM D3018/D3018M, Type I, and ASTM D3462/D3462M] [, weighing not less than 10.3 kilograms per square meter 210 pounds per 100 square feet] [, architectural shingles weighing not less than 14.2 kilograms per square meter 290 pounds per 100 square feet]. Shingles must meet the fire resistance requirements of UL 790 for Class A and the wind resistance requirements of [ASTM D3161/D3161M, Class F][ASTM D7158/D7158M, Class H]. Color must be [_____] [as selected from the manufacturer's standard color charts]. Shingle color must be [in accordance with COLOR SCHEDULE] [_____]. Provide asphalt shingle that is Energy Star labeled. Provide data identifying Energy Star label for asphalt shingle product.[Provide solar reflectance product with an initial solar reflectance greater than or equal to 0.25 and a solar reflectance greater than or equal to 0.15 three years after installation under normal conditions.][Provide emittance and reflectance percentages, solar reflectance index values, [and] slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]

2.1.2 Mineral-Surfaced Asphalt Roll Roofing

ASTM D6380/D6380M.

2.1.3 Smooth-Surfaced Asphalt Roll Roofing

ASTM D6380/D6380M, Type II.

2.1.4 Underlayment

****

NOTE: Choose Type I or Type II from the text below. Type I is the minimum accepted. Type II is a heavy duty felt. Edit according to project requirements.

****

Asphalt-saturated felt conforming to ASTM D4869/D4869M or ASTM D226/D226M, [Type I, number 15,] [Type II, number 30,] without perforations or other material specified by the shingle manufacturer for use as underlayment.

2.1.4.1 Leak Barrier Underlayment

Self-adhering leak barrier or ice dam underlayment must comply with ASTM D1970/D1970M for sealability around nails.

2.1.5 Self-Adhering Membrane

Self-adhering rubberized asphaltic membrane, a minimum of 1 mm 40 mils thick, and recommended by the shingle manufacturer for use as eaves flashing.

2.1.6 Nails for Applying Shingles and Asphalt-Saturated Felt

Aluminum or hot-dipped galvanized steel or equivalent corrosion resistant with sharp points and flat heads 10 to 11 mm 3/8 to 7/16 inch in diameter. Shank diameter of nails must be a minimum of 2.67 mm 0.105 inch and a maximum of 3.43 mm 0.135 inch with garb or otherwise deformed for added pull-out resistance. Nails must be long enough to penetrate completely through or extend a minimum of 20 mm 3/4 inch into roof deck, whichever is less, when driven through materials to be fastened.

2.1.7 Asphalt Roof Cement

ASTM D4586/D4586M, Type II.

2.1.8 Asphalt Primer

ASTM D41/D41M.

2.1.9 Ventilators

****

NOTE: Drawings should detail type of ridge vent required. For aluminum ridge vents, see Section 07 60 00 FLASHING AND SHEET METAL.

Ventilation should be required with a total net free ventilating area of not less than 1 to 150 of the area of the space ventilated. The total area is permitted to be reduced to 1 to 300, provided at least 50 percent and not more than 80 percent of the required ventilating area is provided by ventilators located in the upper portion of the ventilated space at least 914 mm 3 feet above eave or cornice vents, with the balance of required ventilation provided by eave or cornice vents. As an alternative, the net free cross-ventilation area may be reduced to 1 to 300 when a vapor barrier having a transmission rate not exceeding 1 perm is located on warm side of the attic insulation.

****

2.1.9.1 Nailable Plastic Shingle Over Type Ridge Vents

Ridge vents must be constructed of UV stabilized nailable rigid polypropylene material, approximately 0.30 m 1 foot wide and 25 mm 1 inch thick, and must be in 1.2 m 4 foot long interlocking sections with self-aligning ends or corrugated polyethylene rigid roll or rigid strip ridge vent with aluminum wind deflectors on each side. Vents must be designed to prevent infiltration of insects, rain, and snow.

2.1.9.2 Nailable Mesh Shingle Over Type Ridge Vents

Ridge vents must be constructed of UV stabilized nailable polyester mesh material, approximately 0.30 m 1 foot wide. Vents must be designed to prevent infiltration of insects, rain, and snow.

PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

Do not install building construction materials that show visual evidence of biological growth.

Ensure that roof deck is smooth, clean, dry, and without loose knots. Roof surfaces must be firm and free from loose boards, large cracks, and projecting ends that might damage the roofing. Vents and other projections through roofs must be properly flashed and secured in position, and projecting nails must be driven flush with the deck.

3.2 SURFACE PREPARATION

Cover knotholes and cracks with sheet metal nailed securely to sheathing. Flash and secure vents and other roof projections, and drive projecting nails firmly home.

3.3 APPLICATION

Apply roofing materials as specified herein unless specified or recommended otherwise by shingle manufacturer's written instructions [or by NRCA 0437].

3.3.1 Underlayment

****

NOTE: Select the applicable paragraph(s) from the following.

****

****

The installation of asphalt strip shingles at maximum exposure is not recommended on roofs having a slope of less than 1:4.

In locations where the January mean temperature is minus 1 degree C 30 degrees F or less, a leak barrier underlayment membrane should be used. The leak barrier underlayment membrane may consist of: two plies of No. 15 asphalt saturated felt, one nailed to the deck and the second set in Type III or Type IV hot asphalt or asphalt lap cement; a heavyweight coated base sheet nailed to the deck and another felt ply or plysheet set in hot asphalt or asphalt lap cement; or a self adhering modified bitumen membrane.

NOTE: In locations where the average daily January temperature is minus 4 degrees C 25 degrees F or below, use the second optional paragraph instead of the first optional paragraph.

****

[Provide for roof slopes 1 in 3 4 inches per foot and greater. Apply one layer of shingle underlayment to roof deck. Lay underlayment parallel to roof eaves, starting at eaves. Provide minimum 50 mm 2 inch head laps, 100 mm 4 inch end laps, and 150 mm 6 inch laps from both sides over hips and ridges. Nail sufficiently to hold until shingles are applied. Turn up vertical surfaces a minimum of 100 mm 4 inches.
]

****

NOTE: These requirements are intended primarily for roof slopes between 1 in 6 and 1 in 3 2 and 4 inches per foot. They should not be specified for roof slopes 1 in 3 4 inches per foot and greater unless the condition of the note above is met. Delete bracketed sentence unless eave flashing is required.

****

[Provide for roof slopes [between 1 in 6 2 inches per foot and 1 in 3 4 inches per foot] [1 in 34 inches per foot and greater]. Apply two layers to roof deck. Provide a 480 mm 19 inch wide strip as starter sheet to maintain specified number of layers throughout roof. Lay parallel to eaves, starting at eaves. Provide minimum 480 mm 19 inch head laps, 150 mm 6 inch laps from both sides over hips and ridges, and 300 mm 12 inch end laps in the field of the roof. Nail sufficiently to hold until shingles are applied. Turn up vertical surfaces a minimum of 100 mm 4 inches. [When a self-adhering membrane is used for eave flashing, start underlayment from upper edge of eave flashing.]

]3.3.2 Drip Edges

****

NOTE: Specify 100 mm 4 inch spacing for nails for roofs in high wind areas.

****

Provide metal drip edges as specified in Section 07 60 00 FLASHING AND SHEET METAL applied directly on the wood deck at eaves and over the underlayment at rakes. Extend back from edge of deck a minimum of 75 mm 3 inches, and secure with nails spaced a maximum of [100] [250] millimeters [4] [10] inches o.c. along inner edge.

3.3.3 Starter Strip

****

NOTE: Delete the first bracketed phrase unless eave flashing is specified. Otherwise, delete the second bracketed phrase.

****

****

NOTE: Include the next to last bracketed sentence and delete the last bracketed sentence unless the project is located in Bermuda.

****

Apply starter strip at eaves, using 225 mm 9 inch wide strip of mineral-surfaced roll roofing of a color to match shingles. Optionally, use a row of shingles with tabs removed and trimmed to ensure that joints are not exposed at shingle cutouts. Apply starter strip along eaves, [overlaying and finishing even with lower edge of eave flashing strip] [overhanging the metal drip edge at eaves and rake edges 6 to 10 mm 1/4 inch to 3/8 inch]; fasten in a line parallel to and 75 to 100 mm 3 to 4 inches above eave edge. Place nails so top of nail is not exposed in cutouts of first course of shingles. [When roll roofing is provided, seal tabs of first course of shingles with asphalt roof cement.] [Fasten with 6 nails per strip of shingles or space nails at 150 mm 6 inches o.c. for roll roofing. Seal tabs of first course of shingles with asphalt roof cement as specified below.]

3.3.4 Shingle Courses

****

NOTE: Shingles with the correct recommended exposure must be applied in accordance with the manufacturer's printed instructions as they appear on the bundle wrapping.

****

Start first course with full shingle, and apply succeeding courses with joints staggered at thirds or halves. Butt-end joints of shingles must not align vertically more often than every fourth course. Apply shingle courses as follows:

a. Fastening: Do not drive fasteners into or above the factory-applied adhesive unless adhesive is located 16 mm 5/8 inch or closer to top of cutouts. Place fasteners so they are concealed by shingle top lap and penetrate the head lap.

****

NOTE: At the text below, for application of shingles on mansard roofs and other steep roofs with slopes more than 1.75 in 1 21 inches per foot, require that tabs be cemented with asphalt roof cement.

****

****

NOTE: Delete item "b" and include items "c" and "d" for projects located in Bermuda and where:

1. Basic wind speed is 161 kilometers per hour (kph) 100 miles per hour (mph) and eave is 6100 mm 20 feet or higher above grade; or

2. Basic wind speed is 177 kph 110 mph.

****

b. Shingles applied with nails: Nominal 125 mm 5 inch exposure. Apply each shingle with minimum of four nails. Place one nail 25 mm 1 inch from each end, and evenly space nails on a horizontal line a minimum of 16 mm 5/8 inch above top of cutouts. [Cement each tab with one spot of asphalt roof cement placed 25 to 50 mm 1 to 2 inches from bottom edge of shingle.]

[c. Nailing: Apply shingles with nominal 125 mm 5 inch exposure. Apply each shingle with minimum of six nails. Place one nail 25 mm 1 inch from each end and one nail on each side of each cutout, on a horizontal line 16 mm 5/8 inch above cutouts.

][d. Sealing: Seal each tab with continuous, 225 mm 9 inchlong, 6 mm 1/4 inch diameter bead of asphalt roof cement, applied to the surface of course below. Place bead on horizontal line 16 mm 5/8 inch above cutouts so bead will be 25 mm 1 inch from bottom edge of tab to be sealed and so bead will not show through cutouts. After nailing each shingle, press tabs down to ensure spreading and bonding of asphalt roof cement.

]3.3.5 Hips and Ridges

Form with 225 by 300 mm 9 by 12 inch individual shingles or with 300 by 300 mm 12 by 12 inch shingles cut from 300 by 900 mm 12 by 36 inch strip shingles. Bend shingles lengthwise down center with equal exposure on each side of hip or ridge. Lap shingles to provide a maximum 125 mm 5 inch exposure, and nail each side in unexposed area 140 mm 5-1/2 inches from butt and 25 mm 1 inch in from edge.

3.3.6 Valleys

****

NOTE: Closed cut and woven valleys are preferred method for strip shingles, but open roll roofing and open sheet metal valleys may also be specified as Contractor options.

****

[Provide either closed cut, woven, open roll roofing, or open sheet metal valleys.

]3.3.6.1 Closed Cut Valleys

Provide 900 mm 36 inch wide valley lining of single layer of smooth-surfaced or mineral-surfaced roll roofing, with mineral-surface facing down, for full length of valley as follows:

a. Center lining in valley over underlayment. Provide minimum 300 mm 12 inch end laps in the lining and seal laps with asphalt roof cement. Fasten lining to hold it in place until shingles are applied.

b. Apply first regular course of shingles along eaves of one of the intersecting roof planes and across valley. Extend course at least 300 mm 12 inches onto adjoining roof.

c. Apply succeeding courses in same manner as first course, extending across valley and onto adjoining roof.

d. Press shingles tightly into valley and nail in normal manner, except apply nails not closer than 150 mm 6 inches to valley centerline, and apply additional nail in top corner of each shingle crossing valley.

e. Apply shingles on the adjoining roof plane, starting along eaves and across valley onto previously applied shingles. Trim overlapping courses back to a line parallel to and a minimum of 50 mm 2 inches back from valley centerline.

f. Trim 25 mm 1 inch on a 45 degree angle from upper corner of each end shingle. Embed end shingles in a 75 mm 3 inch wide band of asphalt roof cement.

3.3.6.2 Woven Valleys

Provide valley lining as specified for closed cut valley. Lay valley shingles over lining by either of the following methods:

a. Method I: Apply regular shingles on both roofs simultaneously. Weave each course in turn over the valley. Lay the first regular course of shingles along eaves of roof up to and over valley. Extend course along adjoining roof deck at least 300 mm 12 inches. Carry first regular course of shingles of adjoining roof over valley on top of previously applied shingles. Lay succeeding courses alternately, weaving valley shingles over each other for full length of valley.

b. Method II: Apply regular shingles on each roof surface separately to a line about 900 mm 3 feet from center of valley, and weave valley shingles in place later, as specified for Method I.

In following either method, press shingles tightly into valley, and fasten in normal manner; except apply nails not closer than 150 mm 6 inches to valley centerline, and apply additional nail in top corner of terminal shingle on both sides of valley.

3.3.6.3 Open Roll Roofing Valleys

Provide 450 mm 18 inch wide strip of mineral-surfaced asphalt roll roofing, of a color to blend with asphalt shingles, and with granular surface facing down, for the full length of valley as follows:

a. Center roll roofing strip in valley over underlayment. Lay centered in valley over felt underlayment and with granular face down. Nail strip only enough to hold in place. Apply nails in rows 25 mm 1 inch from each edge. As fastening along second side proceeds, press strip firmly into valley.

b. Center second strip 900 mm 36 inches wide in valley and lay it over first strip with granular face exposed and nail as specified for 450 mm 18 inch strip.

c. Before applying roofing shingles, snap two chalk lines for full length of valley. Locate each line 75 mm 3 inches from centerline of valley at top, and increase width between lines by 25 mm for each 2440 mm 1 inch for each 8 feet of valley length, continuing to eaves.

d. Apply a 50 mm 2 inch band of asphalt roof cement along each edge of 900 mm 36 inch strip from edge to chalk line. Cut regular shingle courses true along valley chalk lines, and nail in normal manner.

3.3.6.4 Open Sheet Metal Valleys

Sheet metal flashing for valleys is specified in Section 07 60 00 FLASHING AND SHEET METAL. Before installing and fastening flashing in place with metal cleats:

a. Install single layer of 900 mm 36 inch wide, asphalt-saturated felt, centered on valley and extending entire length of valley over felt underlayment.

b. Cut regular shingle courses on each roof on true line 50 mm 2 inches from valley centerline at top of valley, and increase width between lines by 25 mm for each 2440 mm 1 inch for each 8 feet of valley length, continuing to eaves.

c. Apply 50 mm 2 inch band of asphalt roof cement over flashing, along and under side of shingles adjoining valley.

d. Press shingles tightly into cement, and nail in normal manner, except apply nails not closer than 125 mm 5 inches to valley centerline. Do not drive nails through valley flashing.

e. Provide a 100 mm 4 inch band of asphalt roof cement for fastening shingle tabs down along open metal gutters.

3.3.7 Flashing

3.3.7.1 Eave Flashing

****

NOTE: Select the applicable paragraph(s) from the following.

****

****

NOTE: Where the average daily January temperature is minus 4 degrees C 25 degrees F or below or where there is the chance of ice dams forming along the eaves, use the second optional paragraph instead of the first optional paragraph. In areas where the architect/engineer has determined that eave flashing is not commonly provided, do not include either paragraph.

****

[Provide for roof slopes 1 in 3 4 inches per foot and greater. Provide eave flashing strips consisting of smooth-surfaced roll roofing. Flashing strips must overhang metal drip edge 6 to 10 mm 1/4 inch to 3/8 inch and extend up the slope far enough to cover a point 300 mm 12 inches inside interior face of exterior wall. Where overhangs require flashings wider than 900 mm 36 inches, locate laps outside exterior wall face. Laps must be at least 50 mm 2 inches wide and cemented with asphalt roof cement over entire length of lap. Lap end 300 mm 12 inches and cement.
]

****

NOTE: The requirements below are intended primarily for roof slopes between 1 in 6 and 1 in 3 2 and 4 inches per foot. They should not be specified for roof slopes 1 in 3 4 inches per foot and greater unless the condition of note above is met.

****

[Provide for roof slopes [between 1 in 6 and 1 in 3 2 inches per foot and 4 inches per foot] [1 in 34 inches per foot and greater]. Provide either of the following types of eave flashing:

a. From the eaves to a point 600 mm 24 inches inside interior wall line, apply solid coating of asphalt roof cement between overlapping layers of underlayment. Spread cement to a uniform thickness at rate of 7.5 liters per 10 square meters 2 gallons per 100 square feet of cemented roof area.

b. From the eaves to a point 600 mm 24 inches inside interior wall line, apply one layer of self-adhering membrane. Follow membrane manufacturer's printed installation instructions.

]

3.3.7.2 Stepped Flashing

For sloping roofs which abut vertical surfaces, provide stepped metal flashing as specified in Section 07 60 00 FLASHING AND SHEET METAL.

3.3.7.3 Vent and Stack Flashing

Apply shingles up to point where vent or stack pipe projects through roof, and cut nearest shingle to fit around pipe. Before applying shingles beyond pipe, prepare flange of metal pipe vent flashing as specified in Section 07 60 00 FLASHING AND SHEET METAL, by applying a 3 mm 1/8 inch thick coating of asphalt roof cement on bottom side of flashing flange. Slip flashing collar and flange over pipe, and set coated flange in 2 mm 1/16 inch coating of asphalt roof cement. After applying flashing flange, continue shingling up roof. Lap lower part of flange over shingles. Overlap flange with side and upper shingles. Fit shingles around pipe, and embed in 2 mm 1/16 inch thick coating of asphalt roof cement where shingles overlay flange.

[3.3.7.4 Chimney Flashing

****

NOTE: Delete this paragraph unless a chimney is indicated on the project drawings. Coordinate with Sections 06 10 00 ROUGH CARPENTRY and 07 60 00 FLASHING AND SHEET METAL to ensure that crickets and metal chimney flashing are specified.

****

Provide treated wood crickets as specified in Section 06 10 00 ROUGH CARPENTRY. Provide metal base and counterflashing as specified in Section 07 60 00 FLASHING AND SHEET METAL. Uniformly coat masonry surfaces which are to receive flashing with asphalt primer applied at rate of 4 liters per 10 square meters 1 gallon per 100 square feet. Apply shingles over underlayment up to front face of chimney. Apply metal front base flashing with lower section extending at least 100 mm 4 inches over shingles. Set base flashing in a 2 mm 1/16 inch coating of asphalt roof cement on shingles and chimney face. Apply metal step flashing at sides in a coating of asphalt roof cement. Embed end shingles in each course that overlaps step flashing with asphalt roof cement. Apply metal rear base flashing over cricket and back of chimney in coating of asphalt roof cement. Apply end shingles in each course up to cricket, and cement in place. Lap base flashing minimum of 75 mm 3 inches with metal counterflashing.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 31 26 (August 2009)**

Preparing Activity: USACE **Nontechnical Title Revision (August 2015)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

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SECTION 07 31 26

SLATE SHINGLES

08/09

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 31 26 (August 2009)**

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 07 31 26

SLATE SHINGLES
08/09

****
NOTE: This guide specification covers the requirements for slate roofing on new construction and on historic buildings which require replacement, reinstallation, or repair of slate roofs.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C406/C406M	(2022) Standard Specification for Roofing Slate
ASTM D146/D146M	(2004; E 2012; R 2012) Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 3740	(2005) The NRCA Waterproofing Manual

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

1.2 SYSTEM DESCRIPTION

Salvage and reuse intact and serviceable existing slate materials whenever possible. Match new slate being incorporated into existing slate roofs as closely as possible. Use slate from the same quarry or manufacturer as the original, if possible. Establish units of work, including removal of existing materials, preparation of existing surfaces and application of underlayment, nailers, and related temporary and/or permanent flashing. Lay out the progression of work and present to the Contracting Officer to prevent other trades from working on or above completed roofing. Do no store materials on roof decks in such a manner as to overstress and/or damage the deck and supporting structure. Avoid placing of loads at midspans of framing so that superimposed loads are well distributed. For vertical surfaces which project through the roof surface at a right angle to the slope of the roof, build a cricket (sometimes referred to as a saddle) into the roof to divert water away from the back of the vertical member, as shown.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G, [_____]

SD-03 Product Data

Qualifications

SD-04 Samples

Slate

Accessories for Slate Roofs

Sealants

Underlayment Membrane

Fasteners

SD-07 Certificates

Materials

1.4 QUALITY ASSURANCE

Provide qualified workers, trained and experienced in installing slate roofing systems of this configuration, and submit documentation of 5 consecutive years of work of this type. Show familiarity with and perform work in accordance with [SMACNA 1793] [and] [NRCA 3740.] As proof of Qualifications, submit documentation showing qualifications of personnel proposed to perform the roofing work, and a list of installations made identifying when, where, and for whom the installations were made. Submit drawings showing slate installation and appearance details, flashing details, and nailing patterns for the slates.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials in manufacturer's unopened bundles and containers with the manufacturer's brand and name marked clearly thereon. Store shingles in accordance with manufacturer's printed instructions and roll goods on-end in an upright position. Immediately before laying, store roofing felt for 24 hours in an area maintained at a temperature not lower than 10 degrees C 50 degrees F.

1.6 PROJECT/SITE CONDITIONS

Perform slate roofing operations when existing and forecasted weather conditions permit work in accordance with manufacturer's recommendations and warranty requirements. Apply elastomeric membrane underlayment only in fair weather when air and surface temperatures are above 5 degrees C 40 degrees F. Provide temporary protection materials maintained on the site at all times for temporary roofing, flashing, and other protection when delays and/or changed weather conditions do not permit completion of each unit of work prior to the end of each working day. Remove and discard materials which have been used for temporary roofing, flashing and other protection.

1.7 WARRANTY

Furnish a warranty against defects in material and workmanship of slate roof assembly, including related metal flashing for a period of 10 years from date of final acceptance of the work. Contractor will inspect the completed project every 12 months for the first 3 years of the warranty period, at year 5 and a final inspection at year 10. Perform inspections from a remote access device such as a bucket lift or cherry picker and do not include any foot traffic on the slates.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Edit these paragraphs to meet project requirements.
****

Submit certificates of compliance attesting that the materials meet specification requirements.

2.1.1 Slate

Provide slate conforming to ASTM C406/C406M. Slate must be Grade A, (ASTM S1), hard, dense rock, punched or drilled for two nails each. Do not use cracked slate. Exposed corners must be full. Broken corners on covered ends which sacrifice nailing strength or the laying of a watertight roof will not be allowed. Submit three representative shingles to show color range.

2.1.1.1 Standard Thickness Roofing Slate

Slate must be [[smooth texture] [rough texture]] [5 to 6 mm 3/16 to 1/4 inch thickness] [all [_____] thickness] [[_____] and [_____] intermingled thicknesses]. Slate must be the following sizes: [[_____] by [_____]] [graduated lengths] [and] [random widths].

2.1.1.2 Graduated Roof Slate

Slate must be [[smooth texture] [rough texture]] and vary in thickness from [_____] at eave to [_____] at ridge; the percentage of each thickness to be respectively [_____]. Intermingle the thicknesses intermingled in the various courses, modulating from the heavier and thicker slates in the lower courses of the roof to the thinner slates at the ridge. Provide slate in standard random widths graduated in length from [_____] at eave to [_____] at ridge, and apply with standard 75 mm 3 inch lap and exposures.

2.1.1.3 Slate Colors

Provide [unfading] [semi-weathering] slate. Color must be [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____].

2.1.2 Underlayment Membrane

Cover the underlayment membrane on all surfaces with slate. Furnish membrane consisting of [asphalt-saturated felt] [or] [high strength composite self-adhering membrane]. Submit a 300 by 300 mm 1 by 1 foot section.

2.1.2.1 Roofing Felt

Provide roofing felt that is asphalt-saturated rag felt, Type II, No. 30 asphalt felt in accordance with ASTM D226/D226M.

2.1.2.2 Elastomeric Membrane Underlayment

Provide a cold applied composite self-adhering membrane of not less than 0.10 mm 0.004 inch high strength polyethylene film with slip resistant embossing, coated on one side with a thick layer of adhesive-consistency rubberized asphalt, interwound with a disposable silicone coated release sheet. Tensile strength and elongation values less than 1.7 MPa 250 psi when tested in accordance with ASTM D412 are not acceptable and do not affect pliability when testing in accordance with ASTM D146/D146M.

2.1.2.3 Elastomeric Membrane Accessories

Provide membrane manufacturer's approved two component urethane, mastic and primer. Provide membrane manufacturer's recommended flashing, expansion joint covers, temporary UV protection and corner fillets.

2.1.3 Nails

Provide large-headed slater's solid copper nails of Number 10 or 11 gauge metal. Nails must be 3d for slates 450 mm 18 inch or less in length; use 4d nails for slates 500 mm 20 inch or longer, and use 6d nails for slates on hips and ridges. Thicker slates require longer and heavier gauge nails. Determine the proper size by adding 25 mm 1 inch to twice the thickness of the slate. Provide nails that are long enough to adequately penetrate the roof sheathing. Use ring shank nails to retain copper flashing and slate at rake edges, hips, ridges, and eaves that are prone to wind damage.

2.1.4 Flashing

Flashing must be 0.57 kg 20 ounce, light cold-rolled temper (H00) copper conforming to ASTM B370. Provide flashing in accordance with the requirements as specified in Section 07 57 13 FLASHING AND SHEET METAL.

2.1.5 Elastic Cement

Provide an approved brand of waterproof elastic slater's cement and match color as nearly as possible to the general color of the slate.

2.1.6 Acid Neutralizing Wash

****

NOTE: In areas of the country where past burning of fossil fuels has caused acid staining of slate roofs and existing portions of the roof are being reused or are to remain in place, application of an acid neutralizing wash is recommended. Edit specification to meet project requirements.

****

Provide non-destructive wash formulated to neutralize the effects of acid deposits resulting from the past burning of fossil fuels (particularly coal). The wash must not change the color, appearance, or life of the slate roof, copper flashing and accessories, underlayment, adhesives or the wall surfaces of the building.

2.1.7 Sealants

Where required, provide sealanta in accordance with the slate manufacturer's recommendations. Submit 237 mL 8 ounces of each type.

2.2 ACCESSORIES FOR SLATE ROOFS

2.2.1 Crickets or Saddles

Provide crickets of light rafter construction covered with sheathing, underlayment, and copper sheet metal specified in Section 07 57 13 FLASHING AND SHEET METAL. If the cricket area is large and exposed to view, slate it the same as other roof areas.

2.2.2 Snow Guards

****

NOTE: Snow guards are necessary accessories for most slate roofs in sections of the country where masses of snow and ice accumulate on the roof that can slide from the roof onto lower roof surfaces and gutters. Snow guards are manufactured in various forms, and each type requires different methods of application. They may be obtained from slate distributors, quarriers of roofing slate, or manufacturers. Edit to meet project requirements.

****

Provide nonferrous metal snow guards, as indicated.

PART 3 EXECUTION

3.1 PROTECTION OF ROOF SURFACES

Use equipment (such as padded ridge ladders) and techniques to prevent damage to roof as a result of foot or material traffic. Contractor is responsible for controlling breakage of new or existing slate beyond what is indicated. Wear proper shoes which will not further damage slates, and with soles which will aid in preventing falls.

3.1.1 Installation Plan

Submit a detailed installation plan for approval prior to beginning the work indicating the methods to be used to apply the slates to the roof and protect the installed slates from damage. Include a narrative description and a drawing clearly depicting the layout for work access devices such as padded roof jacks for walkways, padded chicken walk placements between walkways, and other means of protecting newly installed slates and any existing slates to remain. Provide details that clearly indicate the installation/incorporation of work access devices and the sequence of work to include these devices. Do not allow foot traffic on newly installed slates or existing slates to remain. Indicate how the work access devices will keep foot traffic off the slates at all times.

3.1.2 Inspection

Perform Contractor's quality control inspections and inspections by the Government as the Work progresses to coordinate with the installation and removal of the work access devices. Notify the Contracting Officer a minimum of 48 hours in advance of requested inspections and maintain work access devices in place to provide access to uninspected areas until final acceptance by the Government.

3.2 SLATE REMOVAL

Where work involves partial replacement or repair of roof, verify each slate for tightness and continued use. Perform testing with broad, flat-nosed, slater's pliers. Mark slates which have been identified for replacement or re-installation with a non-destructive color mark removable by solvent, rather than water, and for approval within 30 days after Notice to Proceed. Re-fasten slates fastened with non-copper fasteners with proper copper fasteners. Submit representative samples of each fastener with identifying tags.

3.3 PREPARATION OF SURFACES

Roof deck surfaces must be smooth, clean, firm, dry, and free from loose boards, large cracks, and projecting ends that might damage the roofing. Clean oreign particles from interlocking areas to ensure proper seating and to prevent water damming. Prior to installation of slate, flash and secure vents and other projections through roofs in position, and firmly drive projecting nails home.

3.4 ROOFING FELT

Lay felt in horizontal layers with joints lapped toward eaves and at ends at least 50 mm 2 inches, and secured along laps and at ends as necessary to hold the felt in place and protect the structure until covered with the slate. Felt must be preserved unbroken, tight and whole. Lap felt at hips and ridges at least 300 mm 12 inches to form a double thickness and lap 50 mm 2 inches over the metal of valleys or built-in gutters.

3.5 ELASTOMERIC MEMBRANE UNDERLAYMENT

****

NOTE: A composite self-adhering membrane will be used in areas where ice build-up (ice dams) and wind driven rains are potential problems. In such areas, underlayment installation will be detailed on the drawings. Edit these paragraphs to meet project requirements.

****

3.5.1 Surface Preparation

Remove dust, dirt, loose nails or other protrusions. Priming is not required for wood or metal surfaces but is necessary on concrete or masonry surfaces.

3.5.2 Primer

Apply primer at a coverage rate of 6-9 sq. meters/L 250-350 sq. ft./gal. Spray or roll paint primer. Cover pine wood decks with minimum 6 mm 1/4 inch plywood prior to receiving membrane coverage.

3.5.3 Membrane Application

Apply membrane according to manufacturer's instructions and adhere it directly to roof deck. Cut the membrane into 3 to 4.5 meter 10 to 15 foot lengths and re-roll it. Peel back the release paper 300 to 600 mm 1 to 2 feet; align the membrane on the lower edge of the roof when the first 300 to 600 mm 1 to 2 feet are placed. Peel the release paper under the membrane from the membrane and press the membrane in place. Roll lower edges firmly with a wallpaper or hand roller. For ice dam protection, apply the membrane to reach a point above the highest expected level of ice dams; refer to drawings for extent. Overlap ends and edges a minimum of 150 mm 6 inches. Do not fold membrane onto an exposed face of the roof edge.

3.5.4 Valley and Ridge Application

Cut the membrane into 1.2 to 1.8 meter 4 to 6 foot lengths. Peel the release paper sheetand center over the valley or ridge, then drape and press in place, working from the center of the valley or ridge outward in each direction. For valleys, apply membrane starting at the low point and working upwards. Overlap all sheets a minimum of 150 mm 6 inches.

3.5.5 Vertical Membrane Flashings

Vertical wall installations must receive primer prior to the application of membrane. Apply primer at a coverage rate of 6-9 sq. meters/L 250-350 sq. ft./gal. Turn membrane up walls and dormers as indicated. Mechanically fasten vertical membrane terminations and apply a troweling of mastic as approved by the membrane manufacturer. Membrane may be folded onto the fascia, provided it will be covered by a gutter metal edge or other material.

3.5.6 Protection

Do not leave elastomeric membrane underlayment permanently exposed to sunlight. Cover membrane with exposed roofing materials as soon as possible. Patch membrane damaged due to exposure to sunlight prior to the application of final roof covering.

3.6 METAL FLASHING

Provide metal flashing as shown at intersections of vertical or projecting surfaces through the roof or against which the roof abuts, such as walls, parapets, dormers, and sides of chimneys. Install flashing in accordance with Section 07 57 13 FLASHING AND SHEET METAL.

3.7 SLATING

****

NOTE: The best guide to traditional slating installation procedures is "Slate Roofs", published in 1925 by the National Slate Association. A reprint was issued in 1977 by the Vermont Structural Slate Co. The Steep Roofing Section of the National Roofing Contractors Association Roofing Manual contains a section on Slate Roofing which is essentially an abridged and edited version of the original 1925 publication.

****

3.7.1 Repair and Replacement

Intermingle existing reusable slates removed from the repair area with new slates to provide a smooth visual transition between new and existing areas. Apply slating as indicated.

3.7.2 Slate Coursing

Project slate 50 mm 2 inches at the eaves and 25 mm 1 inch at gable ends, and lay in horizontal courses with 75 mm 3 inch headlap (unless otherwise indicated), and break joints with the preceding one by at least 75 mm 3 inches. Double and cant slates at the eaves or cornice line 6 mm 1/4 inch by a wooden cant strip, using same thickness slate for under-eaves at first exposed course. Under-eave slate must be approximately 75 mm 3 inches longer than exposure of first course. Through joints from the roof surface to the underlayment are prohibited.

3.7.3 Nailing

Fasten each slate with a minimum of two copper nails of sufficient length to penetrate the roof decking at least 19 mm 3/4 inch or through the decking thickness, whichever is less. Where the underside of roof decking is exposed to view, such as in overhanging eaves, provide nails long enough to penetrate the roof decking but not so long that they may be driven through the decking. The heads of slating nails must just touch the slate and do not drive "home" or draw the slate, but leave the heads just clearing the slate so that the slate hangs on the nail. Do not puncture the sheet metal with nails in slates overlapping sheet metalwork. Exposed nails are permissible only in top courses where unavoidable, but covered with elastic cement. Lay hip slates and ridge slates in elastic cement spread thickly over unexposed surface of under courses of slate, nail securely in place and pointd with elastic cement.

3.7.4 Vertical Surfaces

Fit slate neatly around pipes, ventilators, chimneys and other vertical surfaces.

3.7.5 Hips

Lay hips to form a [fantail] [saddle] [mitered] [Boston] hip[as indicated].

3.7.6 Ridges

Lay ridges to form [comb] [saddle] [strip saddle] ridges. Pass the nails of the combing slate through the joints of the slate below. Lay the combing slate with the same exposure as the next course down. Project combing slates sloping away from the direction of the prevailing storms 25 mm 1 inch above the combing slate on the opposite side of ridge.

3.7.7 Valleys

Lay valleys to form [closed] [open] [round] valleys. Form open-type valleys with the main roof at cricket areas. The size of the cricket is largely determined by the roof condition. Unless noted otherwise, the slope of the cricket must be the same as the slope of the roof.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 32 13 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-07320 (June 2005)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-07 32 13 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-07320 (June 2005)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 07 32 13

ROOF TILES

04/06

****

NOTE: This guide specification covers the requirements for clay and concrete roofing tiles and underlayments.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: "The NRCA Steep Roofing Manual," National Roofing Contractors Association, 6250 River Road, Rosemont, IL 60018, may be consulted by the designer for a more detailed description of the tile roofing installation.

****

****

NOTE: On the drawings, show:

1. Pitch of substrate/tile roofing.

2. Roof edge, rake, ridge, valley, and intersections with vertical surfaces.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes

ASTM INTERNATIONAL (ASTM)

ASTM C67/C67M	(2024) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C1167	(2022) Standard Specification for Clay Roof Tiles
ASTM C1177/C1177M	(2024) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D2178/D2178M	(2015a; R 2021) Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing

ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E108	(2024) Standard Test Methods for Fire Tests of Roof Coverings

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0437	(2017) The NRCA Roofing Manual: Steep-slope Roof Systems

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Clay Tile Roofing System

SD-03 Product Data

[Clay Tile

][Concrete Tile

] Underlayment Membrane

Flexible Hip and Ridge Flashing

Glass Mesh Mortar Units

Fiberglass-Faced Gypsum Roof Board

Submit data including tile properties , styles, and configurations.

SD-04 Samples

[Manufacturer's color charts for Clay Tile; G, [_____]

][Manufacturer's color charts for Concrete Tile; G, [_____]

][Clay Tile; G, [_____]

][Concrete Tile; G, [_____]

] Submit an appropriate number of tiles for each type to illustrate the full range of colors and surface finish.

SD-06 Test Reports

Self-Adhering Membrane Underlayment

Glass Mesh Mortar Units

Fiberglass-Faced Gypsum Roof Board

Preservative-Treated lumber

SD-07 Certificates

Qualifications of roofing personnel

SD-08 Manufacturer's Instructions

Installation

1.3 DELIVERY AND STORAGE

Deliver materials in the manufacturer's unopened bundles and containers bearing the manufacturer's brand name. Keep materials dry, completely covered, and protected from the weather. Store according to manufacturer's written instructions.

1.4 WARRANTIES

1.4.1 Contractor's Warranty

The Contractor shall warrant for 5 years that the tile roofing system, as installed, is free from defects in workmanship. When repairs due to defective workmanship are required during the Contractor's warranty period, the Contractor shall make such repairs within 72 hours of notification. When repairs are not performed within the specified time, emergency repairs performed by others will not void the warranty.

1.5 COORDINATION

Coordinate with the installation of flashing and gutters provided under Section 07 60 00 FLASHING AND SHEET METAL to ensure proper sequencing. Do not install roofing materials until vent stacks and other penetrations through roof deck have been installed.

1.6 EXTRA STOCK

Provide an extra two percent of each type and color of tile used in clean marked containers. In the extra stock provided, include hip, ridge, and other special shapes in the same proportion as used on the project.

1.7 QUALITY ASSURANCE

1.7.1 Qualifications of Roofing Personnel

Submit documentation showing qualifications of personnel proposed to perform the roofing work and a listing identifying prior installations completed by the Contractor.

1.7.2 Clay Tile Roofing System Drawings

Submit drawings showing clay tile roofing installation and details for appearance, flashing and fastening of tiles.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Roofing systems specified in this section have a life expectancy in excess of 50 years. Flashing materials should be selected with similar life expectancy.

****

[2.1.1 Clay Tile

ASTM C1167, Grade 1, Machine formed natural clay tiles, [One Piece "S" Mission] [Two Piece Spanish Mission consisting of a cover and pan tile] [Flat Bar Tile with interlocking edges], kiln-fired to vitrification and free from surface imperfections. Provide specially shaped, color-matched units [as indicated][in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] or required, including hip and ridge covers, rake covers and [birdstops]. Provide with fastening holes preformed at factory prior to firing.

][2.1.2 Concrete Tile

****

NOTE: Use only concrete roof tiles with integral color in areas where freeze/thaw cycles exceed 30 per year.

****

ASTM C67/C67M, ASTM E108, Extruded, interlocking concrete roofing tile units, shapes as indicated, with [integral color] [color slurry coat on exposed surfaces]. Include specially shaped, color-matched units as indicated or required for ridges, rakes and hips. Provide with cast-in anchor lugs, transverse weather checks and fastening holes.

]2.2 UNDERLAYMENT MEMBRANE

****

NOTE: If a felt membrane is desired solely or in combination with the elastomeric self-adhering membrane, please select either the asphalt glass felt or asphalt-saturated felt component.

****

Provide underlayment membrane on surfaces that will be covered with tile. Membrane shall consist of [asphalt glass felt][asphalt-saturated felt] [and] [high strength composite self-adhering membrane].

[2.2.1 Asphalt Glass Felt

ASTM D2178/D2178M, Type VI.

][2.2.2 Asphalt-Saturated Felt

Provide Type II, No. 30 asphalt felt in accordance with ASTM D226/D226M.

]2.2.3 Flexible Hip and Ridge Flashing

SBS modified rubberized asphalt adhesive on a lineal, low density polyethylene membrane with a 1.52 mm 60 mil total thickness.

2.2.4 Self-Adhering Membrane Underlayment

ASTM D412, high strength polyethylene-sheet-backed, rubberized asphalt membrane, 1.02 mm 40 mil thickness.

2.2.5 Primer for Self-Adhering Membrane Underlayment

VOC compliant primer as recommended by membrane manufacturer for application on concrete substrates.

2.3 SUBSTRATE PANELS (FOR APPLICATION OVER STRUCTURAL METAL DECK)

****

NOTE: Choose one of the following substrate panels.

****

2.3.1 Glass Mesh Mortar Units

ASTM E84, exterior type panels consisting of portland cement, light weight aggregate, with vinyl-coated woven glass fiber mesh imbedded in both surfaces, 11 mm 7/16 inch thickness by 900 mm 36 inch width by 1200, 1500, 1800, or 2400 mm 48, 60, 72 or 96 inch lengths.

2.3.2 Fiberglass-Faced Gypsum Roof Board

ASTM C1177/C1177M, non-structural, fiberglass faced, silicone treated core gypsum panels, 1200 by 2400 by 13 mm 48 by 96 by 1/2 inchthickness.

2.4 FASTENERS

2.4.1 Nails For Applying Felt Underlayment

Hot dip galvanized steel, 2.9 mm thick 11 gage, sharp pointed, conventional roofing nails with barbed shanks, minimum 9.5 mm 3/8 inch diameter head, and of sufficient length to penetrate [19 mm 3/4 inch into nailable concrete deck] [through plywood sheathing] [through substrate panels]. Verify that nails are compatible with flashing materials to prevent galvanic action.

2.4.2 Nails for Installation of Tile

Copper ring shank nails, 3.3 mm 10 gage, with minimum 11 mm 7/16 inch diameter head or 3.3 mm 10 gage stainless steel ring shank nails with minimum 9.5 mm 3/8 inch head and of sufficient length to penetrate 19 mm 3/4 inch into [wood ridge and hip boards] [battens]. Verify that chemicals used in pressure treatment of ridge and hip boards are compatible with copper nails.

2.4.3 Twisted-Wire Tie System

****

NOTE: This paragraph is applicable for the installation of clay tile on roofs with slopes in excess of 12:12.

****

Continuously twisted 3.3 mm 10 gage [copper][brass] [2.5 mm 12 gage galvanized steel]wire with loops formed at 150 mm 6 inches on center and with tie wires of 1.8 mm 14 gage [copper] [brass] [1.5 mm 16 gage galvanized steel] [9.4 mm 0.037 inch diameter stainless steel] wire. Provide clips for anchorage of twisted-wire tie system to substrate as recommended by manufacturer.

2.4.4 Single-Line Wire Tie System

****

NOTE: This paragraph is applicable for the installation of clay tile on roofs with slopes from 2:12 to 12:12.

****

[3.3 mm 10 gage copper] [3.3 mm 10 gage brass] [2.5 mm 12 gage galvanized steel] [2.13 mm 0.084 inch stainless steel] pre-formed wire ties with a hook on one end and a loop on the other end. Lengths as required for manufacturer's recommended exposure.

2.4.5 Wind Locks

****

NOTE: This paragraph is applicable for the installation of clay tiles for all slopes in high wind areas as designated by local codes.

****

[3.3 mm 10 gage copper] [3.3 mm 10 gage brass] [2.5 mm 12 gage galvanized steel] [2.13 mm 0.084 inch diameter stainless steel] formed wire clips. Select material type as recommended by manufacturer for specific locations.

2.4.6 Hurricane Clips

****

NOTE: The following paragraph is applicable for the installation of clay or concrete tiles for all slopes in high wind areas as designated by local codes.

****

Tile edge clips fabricated from [1.2 mm 18 gage brass] [1.05 mm 19 gage galvanized steel] [1.07 mm 0.042 inch, type 302 stainless steel] strips, 13 mm 1/2 inch wide. Provide with two nail holes in horizontal leg for anchorage to deck [substrate]. Select material type as recommended by manufacturer for specific locations.

2.5 PRESERVATIVE-TREATED LUMBER

AWPA C1, provide treated ridge and hip boards, [eave starter strips and battens].

[2.6 SHEET METAL BIRDSTOP FOR CONCRETE TILE

Formed 0.5 mm 26 gage galvanized steel "L" section with 75 mm 3 inch wide horizontal leg and vertical leg cut to conform with bottom profile of tile. Provide pre-finished to match tile color with drain holes punched in vertical leg prior to application of finish.

]2.7 MORTAR

ASTM C270, Proportion specification for Type M mortar mix.

2.8 ASPHALT PLASTIC CEMENT

ASTM D4586/D4586M, Type I.

PART 3 EXECUTION

3.1 EXAMINATION

Examine structural roof deck for compliance with requirements of selected system. Verify that roof penetrations and openings are installed in their proper location.

3.2 PREPARATION

3.2.1 Cleaning

Clean structural deck surfaces to receive substrate panels or underlayment.

3.3 INSTALLATION

Comply with manufacturer's installation instructions and recommendations, but not less than recommended by NRCA 0437. Comply with local building code requirements for special fastening requirements such as wind locks and hurricane clips in high wind areas.

3.3.1 Substrate Panels

Install [glass mesh mortar units] [fiberglass-faced gypsum roof boards] over corrugated metal structural deck as recommended by panel manufacturer.

3.3.2 Felt Underlayment

****

NOTE: This paragraph is applicable for tile roof installations over concrete and wood roof decks with a slope of 4:12 or greater.

****

Apply one layer of felt underlayment horizontally over entire surface to receive roofing tile, lapping succeeding courses a minimum of 50 mm 2 inches, end laps a minimum of 150 mm 6 inches, and hips and valleys a minimum of 300 mm 12 inches. Fasten felt with sufficient number of roofing nails to hold underlayment in place until roofing tile installation. [Provide additional layer of felt underlayment when recommended by roof tile manufacturer].

3.3.3 Self-Adhering Membrane Underlayment

****

NOTE: This paragraph is applicable for tile roof installations over all substrates with slopes up to 4:12 or for any slope where high wind or freeze/thaw conditions exist.

****

Apply self-adhering membrane over [wood deck] [concrete deck] [substrate panels] in accordance with manufacturers recommendations. Provide manufacturer recommended primer for application on concrete surfaces.

3.3.4 Clay Roofing Tile Installation

Beginning at eaves, install roofing tiles as indicated and in accordance with recommendations of the tile manufacturer and fastening system manufacturer. Sawcut tiles at hips valleys and ridges. Cut tile at valleys to form a straight border. Taper valleys from a 50 mm 2 inch exposure on each side of valley at top and increase exposure 25 mm one inch, each side, per 2400 mm 8 feet of valley length. [Set ridge and hip tile in a full bed of mortar and strike mortar flush with face of cover tiles.] [Apply flexible hip and ridge flashing over ridge and hip boards and top edge of tile. Apply asphalt plastic cement at lap between tiles at hip and ridge.] Nail hip and ridge tiles to hip and ridge boards.

3.3.5 Batten Installation for Concrete Roofing Tile

Install 19 by 38 mm one by 2 inches treated wood battens with 13 mm 1/2 inch drain slots at 1200 mm 4 feet o.c. horizontally. At eave provide 38 by 38 mm 2 by 2 inches treated wood starter strip. [Provide sheet metal birdstops at eave for "S" Type mission tile.] At metal structural decks, attach battens with self-tapping screws through substrate panels into metal deck.

3.3.6 Concrete Roofing Tile Installation

Beginning at eaves, install roofing tiles as indicated and in accordance with manufacturers recommendations. Hook mounting lugs over wood battens and nail through each tile into batten. Sawcut tiles at valleys to form a straight border. Taper valleys from a 50 mm 2 inch exposure on each side of valley at the top and increase exposure by 25 mm one inch, each side, per 2400 mm 8 feet of valley length. [Set ridge and hip tile in a full bed of mortar and strike mortar flush with face of cover tile.] [Apply flexible hip and ridge flashing over ridge and hip boards and top edge of tile. Apply asphalt plastic cement between tiles at hip and ridge.] Nail hip and ridge tiles to hip and ridge boards.

3.3.7 CLEANING

Remove mortar and asphalt plastic cement spatter from exposed surfaces of tiles. Upon completion of work, remove excess materials and all refuse generated by the work of this section.

3.4 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of English unit measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

Products	English Units	Metric Units
Nails - diameter	11 gage	2.9 mm
head diameter	3/8 inch	9.5 mm
Nails - diameter	10 gage	3.3 mm
head diameter	7/16 inch	11 mm
Wire	10 gage	3.3 mm
	12 gage	2.5 mm
	14 gage	1.8 mm
	0.037 inch	9.4 mm
	0.084 inch	2.13 mm
Edge Clips	18 gage	1.2 mm
	19 gage	1.05 mm
	0.042 inch	1.07 mm
	1/2 inch	13 mm
Birdstop	26 gage	0.5 mm

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 32 14 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-07321 (June 2005)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 07 32 14

CLAY TILE ROOFING REPLACEMENT OR REPAIR

04/06

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 32 14 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-07321 (June 2005)

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****

SECTION 07 32 14

CLAY TILE ROOFING REPLACEMENT OR REPAIR
04/06

****

NOTE: This guide specification covers the requirements for clay tile roofing on historic buildings which require replacement, reinstallation, or repair of clay tile roofs.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

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ASTM INTERNATIONAL (ASTM)

ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C1167	(2022) Standard Specification for Clay Roof Tiles
ASTM C1184	(2023) Standard Specification for Structural Silicone Sealants
ASTM D146/D146M	(2004; E 2012; R 2012) Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA RoofMan	(2020) The NRCA Roofing Manual

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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SD-02 Shop Drawings

Clay Tile Roofing Systems

Drawings showing clay tile installation and appearance details, flashing details, and fastening details for the tiles.

SD-03 Product Data

Clay Tile Roofing Systems

Manufacturer's catalog data and installation instructions.

Qualifications

Documentation showing qualifications of personnel proposed to perform the roofing work, and a listing identifying prior installations completed by the Contractor.

SD-04 Samples

Clay Roofing Tile

One representative tile of each type.

Sealant

237 mL 8 ounces of each type.

Underlayment Membrane

300 by 300 mm 1 by 1 foot section of each type.

Fasteners

Representative samples of each fastener with identifying tags.

SD-07 Certificates

Materials

Certificates of compliance attesting that the materials meet specification requirements.

1.3 QUALIFICATIONS

The Contractor shall provide qualified workers, trained and experienced in installing clay tile roofing systems of this configuration, and shall submit documentation of 5 consecutive years of work of this type. The Contractor shall be familiar with and shall perform work in accordance with [SMACNA 1793] [NRCA RoofMan]. A list of installations shall be provided which identifies when, where, and for whom the installations were made.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered in manufacturer's unopened bundles and containers with the manufacturer's brand and name marked clearly thereon. Tiles shall be stored in accordance with manufacturer's printed instructions. Roll goods shall be stored on end in an upright position. Immediately before laying, roofing felt shall be stored for 24 hours in an area maintained at a temperature not lower than 10 degrees C 50 degrees F.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

Clay tile roofing work shall proceed when existing and forecasted weather conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements.

1.5.2 Material Storage

Materials shall not be stored on roof decks in such a manner as to overstress and/or damage the deck and supporting structure. Placing of loads at midspans of framing shall be avoided. Superimposed loads shall be well distributed.

1.5.3 Units of Work

Units of work shall be established, including removal of existing materials, preparation of existing surfaces and application of underlayment and nailers, and related temporary and/or permanent flashing so that it can be completed prior to the end of each working day.

1.5.4 Temporary Protection Materials

Materials shall be provided and maintained on the site at all times for temporary roofing, flashing, and other protection when delays and/or changed weather conditions do not permit completion of each unit of work prior to the end of each working day. Materials which have been used for temporary roofing, flashing and other protection shall be removed and discarded.

1.6 WARRANTY

A material and labor warranty shall be furnished against defects in material and workmanship that affect the appearance, leak resistance, and attachment of clay tile roof assembly, including related metal flashing for a period of 10 years from date of final acceptance of the work. Warranty shall also cover the blow-off at wind gusts up to, and including, [_____] km/hour mph.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Edit these paragraphs to meet project requirements.

****

2.1.1 Existing Clay Tile

Intact and serviceable existing clay tiles shall be salvaged and reused whenever possible. New clay tiles being incorporated into existing clay tile roofs shall match existing as closely as possible. Clay tiles from the same manufacturer as the original shall be used if possible.

2.1.2 Clay Roofing Tile

Clay roofing tile shall be minimum Grade 1 tile conforming to ASTM C1167. Tile shall be [one-piece barrel] [two-piece barrel] [flat shingle] [interlocking shingle] type in the following pattern: [_____]. Tile shall be [glazed] [unglazed].

2.1.2.1 Colors

Clay tile color shall be [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____].

2.1.2.2 Fittings

Clay tile fittings shall be of the following types as required by manufacturer's instructions: eave - [eave closure] [under eave]; gable - [end band] [gable rake]; ridge - [ridge] [closed ridge end] [ridge/hip terminal]; hip - [cut hip] [hip roll] [hip starter] [ridge/hip terminal]; valley - [cut valley] [closed valley].

2.1.3 Underlayment Membrane

An underlayment membrane shall be furnished on surfaces to be covered with tile. Membrane shall consist of [asphalt-saturated felt] [and] [high strength composite self-adhering membrane].

2.1.3.1 Roofing Felt

Roofing felt shall be asphalt-saturated rag felt, Type II, No. 30 asphalt felt in accordance with ASTM D226/D226M.

2.1.3.2 Elastomeric Membrane Underlayment

Elastomeric membrane shall be a cold applied composite self-adhering membrane, minimum 0.10 mm 0.004 inch thick, high strength polyethylene film with slip resistant embossing, coated on one side with a thick layer of adhesive-consistency rubberized asphalt, interwound with a disposable silicone coated release sheet. The tensile strength and elongation values shall be not less than 1724 kPa 250 psi when tested in accordance with ASTM D412 and pliability shall be unaffected when tested in accordance with ASTM D146/D146M.

2.1.3.3 Elastomeric Membrane Accessories

Two component urethane, mastic and primer shall be as approved by the membrane manufacturer. Flashing, expansion joint covers, temporary UV protection and corner fillets shall be as recommended by the membrane manufacturer.

2.1.4 Fasteners

2.1.4.1 Nails

Nails shall be solid copper, Number 11 gauge nails, minimum 8 mm 5/16 inch head. Nails shall be of sufficient length to adequately penetrate the roof sheathing.

2.1.4.2 Miscellaneous Fasteners

Miscellaneous fasteners may include but are not limited to: wind locks, hurricane clips, tile attachment brackets, tile nails, twisted wire (tile-tie), deck anchor systems, and flashing cleats. Fasteners shall be made of solid copper (wind locks and hurricane clips can be made of stainless steel).

2.1.5 Flashing

Flashing shall be 0.57 kg 20 ounce, light cold-rolled temper (H00) copper conforming to ASTM B370. Like metals shall be used on all components of fastening systems and flashing in order to avoid galvanic action. Flashing shall be in accordance with the requirements as specified in Section 07 60 00 FLASHING AND SHEET METAL.

2.1.6 Plastic Cement

Plastic cement for gable rakes, hip rolls, ridges, stringers and other conditions shall be non-running, heavy body plastic cement composed of ingredients complying with ASTM D4586/D4586M.

2.1.7 Sealant

Sealant, when used in lieu of plastic cement, shall be silicone in accordance with ASTM C1184.

2.1.8 Mortar

Mortar for filling the openings of cut valley tiles shall consist of 1 part portland cement to 3 parts damp plaster sand, and shall be colored to the nearest possible match with the color of the tile.

2.1.9 Wood Strips

Wood strips for nailers, battens, cant strips, and eave strips shall be of foundation grade redwood or preservative treated Douglas fir. Sizes and lengths shall be provided per tile manufacturer's installation details.

2.1.10 Snow Guards

****

NOTE: Snow guards are necessary accessories for most tile roofs in sections of the country where masses of snow and ice accumulate on the roof that can slide from the roof onto lower roof surfaces and gutters. Snow guards are manufactured in various forms, and each type requires different methods of application. Edit to omit this paragraph if not necessary to meet project requirements.

****

Snow guards which are compatible with the roof tile shall be provided as indicated.

PART 3 EXECUTION

3.1 PROTECTION OF ROOF SURFACES

Equipment (such as padded ridge ladders) and techniques shall be used which prevent damage to roof as a result of foot or material traffic. Contractor shall be responsible for controlling breakage of new or existing tile beyond what is indicated. The progression of work shall be laid out and presented to the Contracting Officer to prevent other trades from working on or above completed roofing. Personnel who are working on the roof shall have proper shoes which will not further damage tiles and shoe soles shall be made of a material which will aid in preventing falls.

3.2 TILE REMOVAL

Where work involves partial replacement or repair of roof, Contractor shall verify each tile for tightness and continued use. Tiles which have been identified for replacement or re-installation shall be marked for approval within 30 days of Notice to Proceed. Tiles identified for removal shall be marked with a non-destructive color mark which can be easily removed. Tiles fastened with non-copper fasteners shall be re-fastened with proper copper fasteners.

3.3 PREPARATION OF SURFACES

Roof deck surfaces shall be smooth, clean, firm, dry, and free from loose boards, large cracks, and projecting ends that might damage the roofing. Foreign particles shall be cleaned from all interlocking areas to ensure proper seating and to prevent water damming. Prior to installation of tile, vents and other projections through roofs shall be properly flashed and secured in position, and projecting nails shall be driven firmly home.

3.4 ROOFING FELT

3.4.1 Standard Application

Felt shall be laid in horizontal layers on deck areas to be covered with tile. Two layers of No. 30 felt shall be applied. Two layers shall be run down valley, ridges, and hips. Applications shall be doubled on rough surfaces and overlapped 300 mm 12 inches on hips, valleys, and ridges. Membranes lapping valley felts shall be set in mastic. Joints shall be lapped 63 mm 2-1/2 inches horizontally and 150 mm 6 inches vertically. Felt shall be carried 150 mm 6 inches up vertical surfaces and 100 mm 4 inches over gutters. Edges shall be fastened with corrosion-resistant, 12 gauge, 9.5 mm 3/8 inch head standard roofing nails on 150 mm 6 inch centers. Felt shall be preserved unbroken.

3.4.2 Special Applications

Low pitch roofs shall have two layers of felt installed and shall be solidly mopped between felt layers and on top of felt layers with 11.3 kg per 9.3 sq. meter 25 pounds per square of hot asphalt.

3.5 ELASTOMERIC MEMBRANE UNDERLAYMENT

****

NOTE: A composite self-adhering membrane will be used in areas where ice build-up (ice dams) and wind driven rains are potential problems. In such areas, underlayment installation will be detailed on the drawings. Edit these paragraphs to meet project requirements.

****

3.5.1 Surface Preparation

Dust, dirt, loose nails or other protrusions shall be removed. Priming is not required for wood or metal surfaces but is necessary on concrete or masonry surfaces.

3.5.2 Primer

Primer shall be applied at a coverage rate of 6-9 sq. meters/L 250-350 sq. ft./gal. Primer shall be applied by spray or paint roller.

3.5.3 Temperature

Membrane shall be applied only in fair weather when air and surface temperatures are above 5 degrees C 40 degrees F.

3.5.4 Membrane Application

Membrane shall be applied according to manufacturer's instructions. Membrane shall be adhered directly to roof deck. Pine wood decks shall be covered with minimum 6 mm 1/4 inch plywood prior to receiving membrane coverage. Membrane shall be cut into 3 to 4.5 meter 10 to 15 foot lengths and shall be re-rolled. The release paper shall be peeled back 300 to 600 mm 1 to 2 feet and the membrane shall be aligned on the lower edge of the roof and the first 300 to 600 mm 1 to 2 feet shall be placed. The release paper under the membrane shall be pulled and peeled from the membrane. The membrane shall be pressed in place. Lower edges shall be rolled firmly with a wallpaper or hand roller. For ice dam protection, membrane shall be applied to reach a point above the highest expected level of ice dams. Ends and edges shall be overlapped a minimum of 150 mm 6 inches. Membrane shall not be folded onto an exposed face of the roof edge.

3.5.5 Valley and Ridge Application

The membrane shall be cut into 1.2 to 1.8 meter 4 to 6 foot lengths. The release paper shall be peeled and the sheet centered over the valley or ridge, draped and pressed in place working from the center of the valley or ridge outward in each direction. For valleys, membrane shall be applied starting at the low point and working upwards. Sheets shall overlap a minimum of 150 mm 6 inches.

3.5.6 Vertical Membrane Flashings

Vertical wall installations shall receive primer prior to the application of membrane. Primer shall be applied at a coverage rate of 6-9 sq. meters/L 250-350 sq. ft./gal. Membrane shall be turned up walls and dormers as indicated on the drawings. Vertical membrane terminations shall be mechanically fastened. Vertical terminations shall receive a troweling of mastic as approved by the membrane manufacturer. Membrane may be folded onto the fascia, provided it will be covered by a gutter metal edge or other material.

3.5.7 Protection

Elastomeric membrane underlayment shall not be left permanently exposed to sunlight. Membrane shall be covered with exposed roofing materials as soon as possible. Membrane damaged due to exposure to sunlight shall be patched prior to the application of final roof covering.

3.6 METAL FLASHING

Metal flashing shall be as shown at intersections of vertical or projecting surfaces through the roof or against which the roof abuts, such as walls, parapets, dormers, and sides of chimneys. Flashing installation shall be in accordance with Section 07 60 00 FLASHING AND SHEET METAL.

3.7 CLAY ROOFING TILE (GENERAL)

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NOTE: To ensure a watertight roof system, strict observance of minimum pitch requirement is necessary. Minimum roof pitches for the different types of clay tile shall be: one-piece barrel: 4:12; two-piece barrel: 5:12; flat shingle: 5:12; interlocking shingle: 3:12.

****

3.7.1 Repair and Replacement

Existing reusable clay tiles removed from the repair area shall be intermingled with new clay tiles to provide a smooth visual transition between new and existing areas.

3.7.2 High or Low Slope Pitches

Tiles [on roof slopes of less than 3:12 shall be applied over indicated underlayment on solid decking.] [on extremely steep or vertical applications, shall have the butt of each tile set with mastic or sealant, and placed where it will not be seen. The mastic or sealant shall not stain the surface of the tile. Copper "hurricane clips" may be installed instead of using mastic or sealant.]

3.7.3 Roof Decks and Fasteners

Tile shall be fastened to roof deck materials as follows:

DECK	FASTENER
Plywood	Slater's ring shank nail. Point shall just penetrate through underside of deck.
Plank board	Slater's plain shank nail, at least 25 m 1 inch or more in 37 mm 1-1/2 inch thickness shall not penetrate deck.
Gypsum plank or Nailable Concrete	Stainless steel or silicone bronze nails with spiral threads, 37 or 50 mm 1-1/2 or 2 inch long. Nail shall penetrate deck at least 1/2 thickness but no more than 3/4. Underside of deck shall not be penetrated. If deck material is old and excessively hard, smooth shank shall be used.
Metal	Sheet metal screw and mastic
Fibrous cement	Tile-tie system
Note: All fastening and flashing metals shall be of like material in order to avoid galvanic action.	

3.7.4 Poured Concrete Deck

Poured concrete decks shall have embedded 25 by 50 mm 1 by 2 inch beveled wood strips, extending from eave to ridge, spaced 500 mm 20 inches on centers. Concrete shall be smooth and flush with strips. Felts weighing 23 kg per 9.3 sq. meters 50 lbs. per 100 square feet shall be fastened with lath nailed over embedded strips. Twenty five by 50 mm One by 2 inch wood strips, spaced to suit tile, shall be applied horizontally across lath. Tile shall then be laid as directed for a sheathed roof.

3.7.5 Chalk Lines

Horizontal and vertical guide lines shall be chalked on the membrane to assure proper appearance. The chalk lines shall be spaced by measuring the delivered tiles for average length and width exposures. An exposure length of 6 mm 1/4 inch beyond the average shall not be exceeded.

3.8 ONE-PIECE BARREL TILE APPLICATION

3.8.1 Wood Strips

Wood stringers, 25 mm 1 inch wide and of proper height, shall be applied on hips and ridges to carry hip roll and ridge. A 25 by 50 mm 1 by 2 inch strip shall be applied for end bands. A 25 by 50 mm 1 by 2 inch cant strip shall be applied at eaves if eave closures are not specified.

3.8.2 Tile Application

a. Eave closures shall be installed first.

b. Tiles shall be laid to straight lines parallel to ground level and shall be lapped 75 mm 3 inches vertically.

c. Each tile shall be fastened with the quantity of nails, wind locks and/or hurricane clips recommended by the manufacturer for the specified roof slope, building height, and wind velocity.

d. Nails on tiles overlapping sheet metalwork shall not puncture the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

e. Gable rakes shall be cemented to field tiles and fastened with nails.

f. Hip rolls shall be cemented in laps and fastened with 50 mm 2 inch copper nails.

g. Ridges shall be cemented and fastened with 63 mm 2-1/2 inch copper nails in laps and where they rest on roof tiles.

h. Where tiles join hip stringers they shall be made waterproof with flashing cement.

i. When hip starter and closed ridge end fittings have not been specified, the voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

j. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

k. When ridge angles and hip/ridge terminals are not otherwise specified, they shall be mitered on job, nailed or wired, and set in plastic cement.

l. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 25 mm 1 inch adjustment of regular tile overhang at eave is sufficient.

3.9 TWO-PIECE BARREL TILE APPLICATION

3.9.1 Wood Strips

Wood stringers, 25 mm 1 inch wide and of proper height, shall be applied on hips and ridges to carry hip roll and ridge. A 25 by 88 mm 1 by 3-1/2 inch strip shall be applied and spaced appropriately for covers. When covers are laid at random exposure, strips shall be 25 by 100 mm 1 by 4 inches.

At first row of cover tile after gable roll, a regular nailing strip shall be applied with an adjacent 50 by 50 mm 2 by 2 inch nailing strip along rake side. A 25 by 50 mm 1 by 2 inch cant strip shall be applied at eaves if eave closures are not specified.

3.9.2 Tile Application

a. Eave closures shall be installed first.

b. Tiles shall be laid to straight lines parallel to ground level, and shall be lapped 75 mm 3 inches vertically.

c. Each tile shall be fastened with the quantity of nails, wind locks and/or hurricane clips recommended by the manufacturer for the specified roof slope, building height, and wind velocity.

d. Tiles overlapping sheet metalwork shall have the nails so placed as to avoid puncturing the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

e. When tile is applied tight method, short course covers shall be installed over regular pans at eave and regular covers over short course pans at ridge. Top edge of covers shall abut bottom edge of pans in the succeeding course throughout the roof.

f. When covers are laid at random exposure, 10 percent extra covers in the first three courses at eave shall be used to avoid horizontal and diagonal lines and maintain this effect throughout roof.

g. Gable rakes shall be cemented to field tiles and fastened with nails.

h. Hip rolls shall be cemented in laps and fastened with 50 mm 2 inch copper nails.

i. Ridges shall be cemented and fastened with 63 mm 2-1/2 inch copper nails in laps and where they rest on roof tiles.

j. Where tiles join hip stringers they shall be made waterproof with flashing cement.

k. When hip starter and closed ridge end fittings have not been specified, the voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

l. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

m. When ridge angles and hip/ridge terminals have not been specified, they shall be mitered on job, nailed or wired, and set in plastic cement.

n. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 25 mm 1 inch adjustment of regular tile overhang at eave is sufficient.

3.10 FLAT SHINGLE TILE APPLICATION

3.10.1 Wood Strips

Wood stringers, 25 mm 1 inch wide and of proper height, shall be applied on hips and ridges to carry hip roll and ridge. A 18 by 25 mm 3/4 by 1 inch cant strip shall be applied at eaves.

3.10.2 Tile Application

a. Tiles shall be laid to straight lines parallel to ground level, lapped 75 mm 3 inch vertically.

b. Each tile shall be fastened with the quantity of nails, wind locks and/or hurricane clips recommended by the manufacturer for the specified roof slope, building height, and wind velocity.

c. Nails on tiles overlapping sheet metalwork shall not puncture the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

d. Gable rakes shall be cemented to field tiles and fastened with nails.

e. Hip rolls shall be cemented in laps and fastened with 50 mm 2 inch copper nails.

f. Ridges shall be cemented and fastened with 63 mm 2-1/2 inch copper nails in laps and where they rest on roof tiles.

g. Where tiles join hip stringers they shall be made waterproof with flashing cement.

h. Voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

i. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

j. Ridge angles and hip/ridge terminals shall be mitered on job, nailed or wired, and set in plastic cement.

k. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 25 mm 1 inch adjustment of regular tile overhang at eave is sufficient.

3.11 INTERLOCKING SHINGLE TILE APPLICATION

3.11.1 Wood Strips

Wood stringers, 25 mm 1 inch wide and of proper height, shall be applied on hips and ridges to carry hip roll and ridge. A 22 by 25 mm 7/8 by 1 inch cant strip shall be applied at eaves.

3.11.2 Tile Application

a. Tiles shall be laid to straight lines parallel to ground level, lapped 75 mm 3 inches vertically.

b. Each tile shall be fastened with the quantity of nails, wind locks and/or hurricane clips recommended by the manufacturer for the specified roof slope, building height, and wind velocity.

c. Nails on tiles overlapping sheet metalwork shall not puncture the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

d. Gable rakes shall be cemented to field tiles and fastened with nails.

e. Hip rolls shall be cemented and fastened with 50 mm 2 inch copper nails in laps.

f. Ridges shall be cemented and fastened with 63 mm 2-1/2 inch copper nails in laps and where they rest on roof tiles.

g. Where tiles join hip stringers they shall be made waterproof with flashing cement.

h. Voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

i. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

j. Ridge angles and hip/ridge terminals shall be mitered on job, nailed or wired, and set in plastic cement.

k. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 25 mm 1 inch adjustment of regular tile overhang at eave is sufficient.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 41 13 (May 2011)**
Change 4 - 02/21

Preparing Activity: NAVFAC **Superseding**
UFGS-07 41 13 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-07 41 13 (May 2011)**
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SECTION 07 41 13

METAL ROOF PANELS

05/11, CHG 4: 02/21

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NOTE: This guide specification covers the requirements for both factory color and mill finish aluminum or steel non-structural metal roofing.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: Non-Structural Metal Roofing is also referred to as architectural metal roofing or hydrokinetic metal roofing. Seam profiles include standing seam and lapped seam. Apply roof panels over a solid substrate (roof deck) with an appropriate underlayment.

This specification may also be used for metal roof panels on auxiliary structures including light storage and open air shed roofs with some modification for application of corrugated or fluted panels over support structure without decking.

Structural standing seam panels, insulated sandwich panels and special systems such as copper, stainless steel, or terne metal are not covered in this guide

specification.

Coordinate this section with other system components specifications such as framing, decking, insulation and sheet metal flashing. Also coordinate with the criteria of UFC 3-110-03, "Roofing" as it relates to the specific project and Service Exceptions indicated therein.
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PART 1   GENERAL

1.1   REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 341	(2016) Seismic Provisions for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2012) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A424/A424M	(2009a; R 2016) Standard Specification for Steel Sheet for Porcelain Enameling
ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A755/A755M	(2018; R 2024) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B117	(2019) Standard Practice for Operating

	Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C286	(2022) Standard Terminology Relating to Porcelain Enamel and Ceramic-Metal Systems
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C792	(2023) Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D610	(2008; R 2019) Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1654	(2008; R 2016; E 2017) Standard Test

	Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D1970/D1970M	(2019) Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D4587	(2011; R 2019; E 2019) Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
ASTM D4637/D4637M	(2015) EPDM Sheet Used in Single-Ply Roof Membrane
ASTM D4869/D4869M	(2016a) Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing
ASTM D5894	(2016) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure

	Difference
ASTM E2140	(2001; R 2023) Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

FM GLOBAL (FM)

FM 4471	(2010) Class I Panel Roofs

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA RSDM	(2012) Metal Roofing Systems Design Manual

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0420	(2010) Architectural Metal Flashing, Condensation Control and Reroofing
NRCA RoofMan	(2020) The NRCA Roofing Manual

PORCELAIN ENAMEL INSTITUTE (PEI)

PEI 1001	(1996) Specification for Architectural Porcelain Enamel (ALS-100)
PEI CG-3	(2005) Color Guide for Architectural Porcelain Enamel

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 580	(2006; Reprint Apr 2024) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies
UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 DESCRIPTION OF METAL ROOF SYSTEM

1.2.1 Performance Requirements

Steel panels and accessory components must conform to the following standards:

ASTM A1008/A1008M

ASTM A123/A123M

ASTM A36/A36M

[ASTM A424/A424M, ASTM C286, PEI 1001, PEI CG-3 for Porcelain and Ceramic Enameling

][ASTM A463/A463M for aluminum coated steel sheet

][ASTM A755/A755M for metallic coated steel sheet for exterior coil prepainted applications.

][ASTM A924/A924M for metallic coated steel sheet

] ASTM D522/D522M for applied coatings

UL Bld Mat Dir

1.2.1.1 Hydrostatic Head Resistance

No water penetration when tested according to ASTM E2140. Submit leakage test report upon completion of installation.

1.2.1.2 Wind Uplift Resistance

Provide metal roof panel system that conform to the requirements of ASTM E1592 and UL 580. Uplift force due to wind action governs the design for panels. Submit wind uplift test report prior to commencing installation.

Provide roof system and attachments that resist the wind loads as determined by ASCE 7-16, in pounds per square foot. Metal roof panels and component materials must also comply with the requirements in FM 4471 as part of a panel roofing system as listed in Factory Mutual Guide (FMG) "Approval Guide" for class 1 or noncombustible construction, as applicable. Identify all materials with FMG markings.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roofing Panels; G, [_____]

Flashing and Accessories; G, [_____]

Gutter/Downspout Assembly; G, [_____]

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Roof Panels; G, [_____]

Recycled Content for Aluminum Roof Panels; S

Recycled Content for Steel Roof Panels; S

[Energy Star Label for Metal Roofing Product; S

][Heat Island Reduction; S

][Factory-Applied Color Finish; G, [_____]

] Accessories; G, [_____]

Fasteners; G, [_____]

Pressure Sensitive Tape; G, [_____]

Underlayments; G, [_____]

Gaskets and Sealing/Insulating Compounds; G, [_____]

[Coil Stock; G, [_____]

] Aluminized Steel Repair Paint; G, [_____]

Enamel Repair Paint; G, [_____]

Galvanizing Repair Paint; G, [_____]

SD-04 Samples

Roof Panels; G, [_____]

Factory-applied Color Finish, Samples, 23 cm 9 inch lengths, full width; G, [_____]

Accessories; G, [_____]

Fasteners; G, [_____]

Gaskets and Sealant/Insulating Compounds; G, [_____]

SD-05 Design Data

Engineering Calculations; G, [_____]

****

NOTE: Coordinate with requirements of "Wind Uplift" paragraph. Include bracketed requirement where non-rated systems may be permissible.

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Wind Uplift Resistance; G, [_____]

SD-06 Test Reports

Leakage Test Report; G, [_____]

Wind Uplift Test Report; G, [_____]

Fire Rating Test Report; G, [_____]

Factory Finish and Color Performance Requirements; G, [_____]

SD-07 Certificates

Roof Panels; G, [_____]

Coil Stock Compatibility; G, [_____]

[Self-Adhering Modified Bitumen Underlayment; G, [_____]

] Qualification of Manufacturer; G, [_____]

Qualification of Applicator; G, [_____]

SD-08 Manufacturer's Instructions

[Insulation; G, [_____]
]

Installation Manual; G, [_____]

[SD-09 Manufacturer's Field Reports

[Manufacturer's Field Inspection Reports; G, [_____]
]]

SD-11 Closeout Submittals

Warranties; G, [_____]

Information Card; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Manufacturer

****

NOTE: Specify 5 years manufacturer experience unless directed otherwise by the Government.

****

Submit documentation verifying metal roof panel manufacturer has been in the business of manufacturing metal roof panels for a period of not less than 5 [_____] years.

[1.4.1.1 Manufacturer's Technical Representative

****

NOTE: Include this paragraph where manufacturer inspection is required.

****

The manufacturer's technical representative must be thoroughly familiar with the products to be installed, installation requirements and practices, and with any special considerations in the geographical area of the project. The representative must perform field inspections and attend meetings as specified.

]1.4.1.2 Single Source

Provide roofing panels, clips, closures, and other accessories that are standard products of the same manufacturer, and the most recent design of the manufacturer to operate as a complete system for the intended use.

1.4.2 Qualification of Applicator

****

NOTE: Specify 3 years as an approved contractor unless directed otherwise by the Government

****

Metal roof system applicator must be approved, authorized, or licensed in writing by the roof panel manufacturer and have a minimum of [3][_____] years experience as an approved, authorized, or licensed applicator with that manufacturer, approved at a level capable of providing the specified warranty. Supply the names, locations and client contact information of 5 projects of similar size and scope constructed by applicator using the manufacturer's roofing products submitted for this project within the previous three years.

1.4.3 Field Verification

Prior to the preparation of drawings and fabrication, verify location of roof framing, roof openings and penetrations, and any other special conditions. Indicate all special conditions and measurements on final shop drawings.

1.4.4 Qualifications for Welding Work

Perform welding procedures in conformance to AWS D1.1/D1.1M for steel or AWS D1.2/D1.2M for aluminum.

Operators are permitted to make only those types of weldments for which each is specifically qualified.

1.4.5 Pre-roofing Conference

After approval of submittals and before performing roofing system installation work, hold a pre-roofing conference to review the following:

a. Drawings, specifications, and submittals related to the roof work. Submit, as a minimum; sample profiles of roofing panels, with factory-applied color finish samples, flashing and accessories, gutter/downspout assembly samples, typical fasteners and pressure sensitive tape, sample gaskets and sealant/insulating compounds. Also include data and 1/2 pint sample of [aluminized steel repair paint][enamel repair paint][galvanizing repair paint], and technical data on coil stock and coil stock compatibility, and manufacturer's installation manual.

b. Roof system components installation;

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representative;

d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing; and

e. Quality control plan for the roof system installation;

f. Safety requirements.

Coordinate pre-roofing conference scheduling with the Contracting Officer. Attendance is mandatory for the Contractor, the Contracting Officer's designated personnel, personnel directly responsible for the installation of metal roof system, flashing and sheet metal work, [[mechanical] [and] [electrical] work], other trades interfacing with the roof work, and representative of the metal roofing manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.4.6 Engineering Calculations

Provide engineering services by an authorized engineer, currently licensed in the geographic area of the project, with a minimum of five years experience as an engineer knowledgeable in roof wind design analysis, protocols and procedures for MBMA RSDM, ASCE 7-16, UL 580, and FM 4471. Engineer must provide certified engineering calculations for the project conforming to the stated references.

1.5 DELIVERY, HANDLING, AND STORAGE

Deliver, store, and handle panel materials, bulk roofing products, accessories, and other manufactured items in a manner to prevent damage and deformation, as recommended by the manufacturer, and as specified.

1.5.1 Delivery

Package and deliver materials to the site in undamaged condition. Provide adequate packaging to protect materials during shipment. Do not uncrate materials until ready for use, except for inspection. Immediately upon arrival of materials at jobsite, inspect materials for damage, deformation, dampness, and staining. Remove affected materials from the site and immediately replace. Remove moisture from wet materials not otherwise affected, restack and protect from further moisture exposure.

1.5.2 Handling

Handle materials in a manner to avoid damage. Select and operate material handling equipment so as not to damage materials or applied roofing.

1.5.3 Storage

Stack materials stored on site on platforms or pallets, and cover with tarpaulins or other weathertight covering which prevents trapping of water or condensation under the covering. Store roof panels so that water which may have accumulated during transit or storage will drain off. Do not store panels in contact with materials that might cause staining. Secure coverings and stored items to protect from wind displacement.

1.6 PROJECT CONDITIONS

Weather Limitations: Proceed with installation only when existing and forecast weather conditions permit metal roof panel work to be performed according to manufacturer's written instructions and warranty requirements, and specified safety requirements.

1.7 FABRICATION

Fabricate and finish metal roof panels and accessories on a [factory stationary industrial type][leased or installer owned portable] rolling mill to the greatest extent possible, per manufacturer's standard procedures and processes, and as necessary to fulfill indicated performance requirements. Comply with indicated profiles, dimensional and structural requirements.

Provide panel profile, as indicated on drawings [including major ribs][and intermediate stiffening ribs]for full length of panel. Fabricate panel side laps with factory installed [captive gaskets][separator strips] providing a weather tight seal and preventing metal-to metal contact, and minimizing noise from movements within the panel assembly.

1.7.1 Finishes

Finish quality and application processes must conform to the related standards specified within this section. Noticeable variations within the same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize any contrasting variations.

1.7.2 Accessories

Fabricate flashing and trim to comply with recommendations in SMACNA 1793 as applicable to the design, dimensions, metal, and other characteristics of the item indicated.

a. Form exposed sheet metal accessories which are free from excessive oil canning, buckling, and tool marks, and are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.[Rivet joints for additional strength.]

c. Sealed Joints: Form non-expansion, but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA 1793.

d. Conceal fasteners and expansion provisions where possible.[Exposed fasteners are not allowed on faces of accessories exposed to view.]

e. Fabricate cleats and attachments devices of size and metal thickness recommended by SMACNA or by metal roof panel manufacturer for application, but not less than the thickness of the metal being secured.

1.8 WARRANTIES

Provide metal roof system material and workmanship warranties meeting specified requirements. Provide revision or amendment to manufacturer's standard warranty as required to comply with the specified requirements.

1.8.1 Metal Roof Panel Manufacturer Warranty

****

Note: Select the appropriate warranty duration. Five and ten year warranties may be specified for facilities of small area and of minor importance. For occupied, sensitive, or large facilities, including warehousing, specify a minimum 20-year warranty unless directed otherwise by the Government.

****

Furnish the metal roof panel manufacturer's [5][10][_____][20][30]-year no dollar limit roof system materials and installation workmanship warranty, including flashing, [insulation,]components, trim, and accessories necessary for a watertight roof system construction. Make warranty directly to the Government, commencing at time of Government's acceptance of the roof work. The warranty must state that:

a. If within the warranty period, the metal roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, displaces, corrodes, perforates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the metal roof system and correction of defective workmanship is the responsibility of the metal roof panel manufacturer. All costs associated with the repair or replacement work are the responsibility of the metal roof panel manufacturer.

b. If the manufacturer or his approved applicator fail to perform the repairs within [24][48][72] hours of notification, emergency temporary repairs performed by others does not void the warranty.

[1.8.2 Manufacturer's Finish Warranty

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NOTE: Include the following paragraph when factory color finish panels are specified.

****

Provide a manufacturer's no-dollar-limit 20 year warranty for the roofing system. Issue the warranty directly to the Government at the date of Government acceptance, warranting that the factory color finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of 8 when measured in accordance with ASTM D4214; or fade or change colors in excess of 5 NBS units as measured in accordance with ASTM D2244.

]1.8.3 Metal Roof System Installer Warranty

****

NOTE: For Army projects use the first bracketed paragraph and delete the remainder of the installer warranty requirements.

For all other projects, delete the first bracketed paragraph. Use the second paragraph.

****

[Provide the "Contractors [Five (5)][Ten (10)][Twenty (20)] Year No Penal Sum Warranty for Non-Structural Metal Roof System" attached at the end of this section.[Provide a separate bond in an amount equal to the installed total material and installation roofing system cost in favor of the Government covering the installer's warranty responsibilities effective throughout the [5][10][20] year warranty period.]

][Provide roof system installer warranty for a period of not less than [2][5] years that the roof system, as installed, is free from defects in installation workmanship, to include the roof panel installation, flashing, [insulation,] accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Issue warranty directly to the Government. Correction of defective workmanship and replacement of damaged or affected materials is the responsibility of the metal roof system installer. All costs associated with the repair or replacement work are the responsibility of the installer.

]1.8.4 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty period must be approved, as required, and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the metal roof system manufacturer warranty for the remainder of the manufacturer warranty period.

1.9 CONFORMANCE AND COMPATIBILITY

Provide the entire metal roofing and flashing system in accordance with specified and indicated requirements, including wind resistance [and seismic per AISC 341]requirements. Perform work not specifically addressed and any deviation from specified requirements in general accordance with recommendations of the MBMA RSDM, NRCA RoofMan, the metal panel manufacturer's published recommendations and details, and compatible with surrounding components and construction. Submit any deviation from specified or indicated requirements to the Contracting Officer for approval prior to installation.

1.10 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of English unit measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

PRODUCTS	ENGLISH UNITS	METRIC UNITS
a. Sheet Aluminum	0.040 inch	1.0 mm
b. Panels	12 inches	300 mm
- vertical legs	2 inches	50 mm
- stiffening ribs	4 inches	100 mm
c. Screws	No. 14	0.242 mm
	No. 12	0.216 mm
d. Bolts	1/4 inch	6 mm
e. Studs	3/16 inch	5 mm
f. Fasteners	1/2 inch	13 mm
	One inch	25 mm
g. Rivets	1/16 inch	5 mm
	1/8 inch	3 mm

PART 2 PRODUCTS

2.1 ROOF PANELS

****

NOTE: Delete this paragraph when aluminum panels are not used in the project.

****

2.1.1 Aluminum Sheet Panels

****

NOTE: Do not use less than 18-gauge (1.27 mm) material in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Roll-form aluminum roof panels to the specified profile, with fy = [2.12][2.81][3.52][5.63] kscm[30][40][50][80] ksi, [0.81][1.02][1.27] mm [.032][.040][.050] inch thickness and depth as indicated.

Provide aluminum panels with a minimum recycled content of 30 percent. Provide data indicating percentage of recycled content for aluminum roof panels.

Material must be plumb and true, and within the tolerances listed:

a. Aluminum sheet conforming to ASTM B209M ASTM B209, and AA ADM

b. Individual panels to have continuous length sufficient to cover the entire length of any unbroken roof slope with no joints or seams and formed without warping, waviness, or ripples that are not a part of the panel profile and free from damage to the finish coating system.

c. Provide panels with thermal expansion and contraction consistent with the type of system specified, and the following profile:

[(1) profile and coverage to be a minimum height and width from the manufacturer's standard for the indicated roof slope.

][(2) profile to be a 3.81 cm 1-1/2 inch high rib at 30.48 cm 12 inches o.c. with small stiffening ribs, 96.5 cm 38 inch overall panel width with 91.4 cm 36 inch exposed panel and exposed fasteners.

][(3) profile to be a 3.81 cm 1-1/2 inch high rib at 18.3 cm 7.2 inches o.c.; 96.5 cm 38-7/8 inch overall width with 91.4 cm 36 inch exposed panel and exposed fasteners.

][(4) profile to be a 2.54 cm 1 inch high rib at 10.2 cm 4 inches o.c.; 126 cm 49-5/8 inch overall width with [122][112] cm [48][44] inch exposed panel and exposed fasteners.

][(5) profile to be a 2.54 cm 1 inch high rib at 20.4 cm 8 inches o.c.; 106 cm 41-5/8 inch overall width with 102 cm 40 inch exposed panel and exposed fasteners.

][(6) profile to be a 4.45 cm 1-3/4 inch high V-beam rib at 12.7 cm 5 inches o.c.; 114 cm 44-7/8 inch overall width with 107 cm 42 inch exposed panel and exposed fasteners.

][(7) profile to be a 2.22 cm 7/8 inch high corrugated rib at 5.08 cm 2 inches o.c., 98.75 cm 38-7/8 inch overall width with 91.44 cm 36 inch exposed panel and exposed fasteners.

][(8) profile to be a 7.62 cm 3 inch high standing seam, 60.96 cm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) profile to be a [2.54][4.45][5.08][6.35] cm [1][1-3/4][2][2-1/2] inch high standing seam, [30.48][40.64][45.72][60.96] cm [12][16][18][24] inch coverage with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(10) profile to be [smooth, flat][embossed pattern][textured]surface.

][(11) profile to be custom, as shown on drawings.

]2.1.2 Steel Sheet Panels

****

NOTE: Delete this paragraph when steel panels are not used in the project.

AZ 50 coating is allowed for factory-color-finished and not for mill finish.

Consider aluminum-coated steel materials for Army projects only.

****

****

NOTE: Do not use less than 24-gauge material in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Roll-form steel sheet roof panels to the specified profile, with fy =[30][40][50][80] ksi,[26][24][22][20][18] gauge and depth as indicated.

Provide steel panels with a minimum recycled content of 30 percent. Provide data indicating percentage of recycled content for steel roof panels.

Material must be plumb and true, and within the tolerances listed:

[a. Galvanized steel sheet conforming to ASTM A653/A653M and AISI SG03-3.

][b. Aluminum-Zinc alloy coated steel sheet conforming to ASTM A792/A792M and AISI SG03-3.

] c. Individual panels to have continuous length sufficient to cover the entire length of any unbroken roof slope with no joints or seams and formed without warping, waviness, or ripples that are not a part of the panel profile and free from damage to the finish coating system.

d. Provide panels with thermal expansion and contraction consistent with the type of system specified, and the following profile:

[(1) profile and coverage to be a minimum height and width from the manufacturer's standard for the indicated roof slope.

][(2) profile to be a 3.81 cm 1-1/2 inch high rib at 30.48 cm 12 inches o.c. with small stiffening ribs, 96.5 cm 38 inch overall panel width with 91.4 cm 36 inch exposed panel and exposed fasteners.

][(3) profile to be a 3.81 cm 1-1/2 inch high rib at 18.3 cm 7.2 inches o.c.; 96.5 cm 38-7/8 inch overall width with 91.4 cm 36 inch exposed panel and exposed fasteners.

][(4) profile to be a 2.54 cm 1 inch high rib at 10.2 cm 4 inches o.c.; 126 cm 49-5/8 inch overall width with [122][112] cm [48][44] inch exposed panel and exposed fasteners.

][(5) profile to be a 2.54 cm 1 inch high rib at 20.4 cm 8 inches o.c.; 106 cm 41-5/8 inch overall width with 102 cm 40 inch exposed panel and exposed fasteners.

][(6) profile to be a 4.45 cm 1-3/4 inch high V-beam rib at 12.7 cm 5 inches o.c.; 114 cm 44-7/8 inch overall width with 107 cm 42 inch exposed panel and exposed fasteners.

][(7) profile to be a 2.22 cm 7/8 inch high corrugated rib at 5.08 cm 2 inches o.c., 98.75 cm 38-7/8 inch overall width with 91.44 cm 36 inch exposed panel and exposed fasteners.

][(8) profile to be a [2.54][4.45][5.08][6.35] cm [1][1-3/4][2][2-1/2] inch high standing seam, [30.48][40.64][45.72][60.96] cm [12][16][18][24] inch coverage with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) profile to be [smooth, flat][embossed pattern][textured]surface.

][(10) profile to be custom, as shown on drawings.

]2.2 FACTORY FINISH AND COLOR PERFORMANCE REQUIREMENTS

****

NOTE: Specify factory color finish except when the buildings are to be used for temporary purposes or where mill finish aluminum or galvalume panels provide an acceptable appearance. If factory color finish is not required, document the rationale for the decision in the design analysis and delete this paragraphs and related subparagraphs.

The US metal building industry offers a variety of color finishes to protect the metal panels against chemical corrosion and ultraviolet radiation; to provide long life with minimum maintenance plus acceptable weathering and color retention; and to

assure chalk, fade, and mar resistance. Some of the most widely used coatings include, but are not limited to, the following:

a. Polyvinylidene fluoride (PVDF2); a nominal 0.025 mm one mil thick coating modified with a proprietary resin for toughness; it may be used in most environments.

b. Silicone-modified polyester (SMP); a thermoset coating system composed of polyester resin modified by copolymerization with a functional silicone resin intermediate designed for added protection against chemical corrosion and ultraviolet radiation.

c. Plastisol (PVC); a two-coat system consisting of a polyvinyl-chloride resin dispersed in a plasticizer top-coat over a corrosion-resistant primer; it is a high-performance, thick coating designed for highly aggressive and corrosive environments with excellent resistance to common acids, alkalis, and inorganic compounds.

Most coatings may be ordered extra-thick for buildings in direct contact with salt or chemical laden air or where a premium finish would be justified. The thicker coating provides additional primer and increases the coating's corrosion and abrasion resistance, but it requires a special run by the coil coater and additional delivery time. add appropriate specification requirements if thick film coatings are to be used. Clear coats may also be added to the finish color coated coil to enhance the coatings performance.

The baseline values included in this specification are for a standard 0.025 mm one mil PVDF2 (i.e., Kynar 500, Hylar 5000) coating system. If a different coating type or thickness is required, research the coating type and modify indicated values accordingly. Coordinate with the coating type specified elsewhere in this section.

Corrosion of galvanized steel panels, together with the fact that cut edges, scratches and penetrations of the panels expose the steel substrate, warrants consideration for the use of aluminum panels in salt spray and other corrosive environments; however, consider the greater expansion of aluminum in the design. Where steel panels are used in coastal environments, specify enhanced PVDF2 or other premium coatings. Increased PVDF2 coating thicknesses and or addition of a factory-applied clear coat over the color finish enhances coating system performance.

Roof panels are available in several standard colors. Specify custom color options only with Government approval. Where accent colors are

required, specify accordingly.

Coordinate color specification and selection with the user.

****

All panels are to receive a factory applied [polyvinylidene fluoride][Kynar 500/Hylar 5000] [_____] finish consisting of a baked topcoat with a manufacturer's recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with an acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. Oven cure the prime coat prior to application of the finish coat.

c. Exterior Finish Coating: Apply the exterior finish coating over the primer by roll coating to a dry film thickness of 0.80 plus 0.05 mils (3.80 plus 0.05 mils for Vinyl Plastisol) for a total dry film thickness of 1.00 plus 0.10 mils (4.00 plus 0.10 mils for Vinyl Plastisol). Oven cure this exterior finish coat.

d. Interior finish coating: Apply a wash coat on the reverse side over primer by roll coating to a dry film thickness of 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. Oven cure the wash coat.

e. Color: The exterior finish chosen from the manufacturer's standard color chart.

f. Physical Properties: Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

General:	ASTM D5894 and ASTM D4587
Abrasion:	ASTM D968
Adhesion:	ASTM D3359
Chalking:	ASTM D4214
Chemical Pollution:	ASTM D1308
Color Change and Conformity:	ASTM D2244
Creepage:	ASTM D1654
Cyclic Corrosion Test:	ASTM D5894

Flame Spread:	ASTM E84
Flexibility:	ASTM D522/D522M
Formability:	ASTM D522/D522M
Gloss at 60 and 85 degrees:	ASTM D523
Humidity:	ASTM D2247 and ASTM D714
Oxidation:	ASTM D610
Pencil Hardness:	ASTM D3363
Reverse Impact:	ASTM D2794
Salt Spray:	ASTM B117
Weatherometer:	ASTM G152, ASTM G153 and ASTM D822

2.2.1 Specular Gloss

****

NOTE: Specify the first bracketed option for most roof conditions.

For roofs of structures along airfields where glare would be objectionable and may be an operational hazard, the specular gloss value should be limited to 10 or less at an angle of 85 degrees. Limited paint systems can meet this reflectance value. Panel embossing also reduces the gloss, or reflectance value, and may be specified in combination with the paint system specification to meet the necessary requirement

****

Finished roof surfaces to have a specular gloss value of [30 plus or minus 5 at an angle of 60 degrees] [10 or less at an angle of 85 degrees] when measured in accordance with ASTM D523.

2.2.2 Energy [and Cool Roof] Performance

****

NOTE: If the product is installed on buildings and structures that are insulated, include the following paragraph.

NOTE: Facilities with dominant cooling loads or in mild or warm climate zones are required to meet "cool roofing" requirements of FEMP. Design cool roofs following the requirements in UFC 3-110-03 Roofing, Appendix B and ASHRAE 90.1 Chapter 5, for the design of insulation and energy performance of the building. The roofing system will need to include a top surface layer that meets the Energy

Star criteria for Cool Roof Products see http://www.energystar.gov/products/certified-products/detail/roof-products.

NOTE: Cool roofs will have color limitations from various manufacturers.

NOTE: If a cool roof is not selected in ASHRAE zones 1 thru 3, design in accordance with one of the exception requirements listed in ASHRAE 90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Coordinate these requirements with insulation design and specifications.

Retain the first 2 sentences when an Energy Star roof panel product is desired - perform research to confirm availability and adequate competition. Retain the next to last bracketed sentence for project with cool roof requirement. Retain the last bracketed sentence for project with sustainable third party certification credit requirement for reduced heat island effect.

****

[Provide a product that is Energy Star labeled and is produced and compatible with the requirements of this specification. Provide data identifying Energy Star label for metal roofing product.][The roofing system will need to include a top surface finish that meets the criteria for Cool Roof Products.][Provide emittance and reflectance percentages, solar reflectance index values,[and]slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]

2.3 MISCELLANEOUS METAL FRAMING

2.3.1 General

Provide cold formed metallic-coated steel sheet conforming to ASTM A653/A653M, AISI S100, and as specified in 05 40 00 COLD-FORMED METAL FRAMING unless otherwise indicated.

2.3.2 Fasteners and Miscellaneous Metal Framing

Provide compatible type, corrosion resistant, of sufficient size and length to penetrate the supporting element a minimum of one inch with other required properties to fasten miscellaneous metal framing members to substrates in accordance with the roof panel manufacturer's and ASCE 7-16 requirements.

2.3.2.1 Exposed Fasteners

Provide corrosion resistant [coated steel][aluminum][stainless steel][nylon capped steel] fasteners for roof panels, compatible with the sheet panel or flashing material and of the type and size recommended by the manufacturer to meet the performance requirements and design loads. Provide fasteners for accessories that are the manufacturer's standard. Provide an integral metal washer, matching the color of attached material with compressible sealing EPDM gasket approximately 3/32 inch thick for exposed fasteners.

2.3.2.2 Screws

Provide corrosion resistant screws, [coated steel][aluminum][stainless steel] of the type and size recommended by the manufacturer to meet the performance requirements.

2.3.2.3 Rivets

Provide closed-end type rivets, corrosion resistant [coated steel][aluminum][stainless steel] where watertight connections are required.

2.3.2.4 Attachment Clips

Provide [hot-dip galvanized, conforming to ASTM A653/A653M,][stainless steel, series 300] clips. Size, shape, thickness and capacity must meet the thickness and design load criteria specified.

2.3.3 Electrodes for Manual, Shielded Metal Arc Welding

Utilize electrodes for manual, shielded metal arc welding meeting the requirements of AWS D1.1/D1.1M, that are covered, mild-steel electrodes conforming to AWS A5.1/A5.1M.

2.4 ACCESSORIES

Provide accessories compatible with the metal roof panels. Sheet metal flashing, trim, metal closure strips, caps, and similar metal accessories must be not less than the minimum thicknesses specified for roof panels. Provide exposed metal accessories to match the panels furnished[, except as otherwise indicated]. Provide molded foam rib, ridge and other closure strips that are closed-cell or solid-cell synthetic rubber or neoprene premolded to match configuration of the panels and not absorb or retain water.

2.4.1 Pre-manufactured Accessories

****

NOTE: Include the following general paragraph.

Add subparagraphs for specific accessory materials requirements as required for the specific project and components to be installed.

Accessory components might include ridge vents, curbs, hatches, roof jacks, prefabricated flashing boots, walkways, snow guards, and other similar features.

****

Provide pre-manufactured accessories that are manufacturer's standard for intended purpose,[comply with applicable specification section,] compatible with the metal roof system and approved for use by the metal roof panel manufacturer. Construct curbs to match roof slope.

2.4.2 Metal Closure Strips

Provide factory fabricated [aluminum closure strips][steel closure strips] of the same [gauge][thickness], color, finish and profile as the specified roof panel.

2.4.3 Rubber Closure Strips

Provide closed-cell, expanded cellular rubber closure strips conforming to ASTM D1056 and ASTM D1667, extruded or molded to the configuration of the specified roof panel profile and in lengths supplied by roof panel manufacturer.

[2.4.4 Subgirts for Retrofits

Provide bar subgirts 38 by 3 millimeter 1-1/2 by 1/8 inch galvanized steel with slotted holes for welding to end of impaling clip spikes.

]2.5 JOINT SEALANTS

2.5.1 Sealants

Sealants are to be an approved gun type for use in hand or air pressure caulking guns at temperatures above 4 degrees C 40 degrees F (or frost-free application at temperatures above minus 12 degrees C 10 degrees F) with a minimum solid content of 85 percent of the total volume. Ensure sealant dries with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather tight joint. No migratory staining, in conformance with to ASTM C792, is permitted on painted or unpainted metal, stone, glass, vinyl or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the roof panel manufacturer.

2.5.1.1 Shop Applied Sealants

Provide sealant for shop-applied caulking that is an approved gun grade, non-sag one-component polysulfide or silicone conforming to ASTM C792 and ASTM C920, Type II, with a curing time which ensures the sealants plasticity at the time of field erection. Color to match panel color.

2.5.1.2 Field Applied Sealants

Provide sealants for field-applied caulking that is an approved gun grade, non-sag on-component polysulfide or two component polyurethane with an initial maximum Shore A durometer hardness of 25, conforming to ASTM C920, Type II. Color to match panel color.

2.5.1.3 Tape Sealants

Provide pressure sensitive, 100 percent solid tape sealant with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the roof panel manufacturer.

2.5.2 Sheet Metal Flashing and Trim

2.5.2.1 Fabrication, General

Custom fabricate sheet metal flashing and trim to comply with recommendations within the SMACNA 1793 that apply to design, dimensions, metal type, and other characteristics of design indicated. Shop fabricate items to the greatest extent possible. Obtain and verify field measurements for accurate fit prior to shop fabrication. Fabricate flashing and trim without excessive oil canning, buckling, and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.

2.5.2.2 Roof Drainage Sheet Metal Fabrications

Gutters: Fabricate to cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in minimum 244 cm 96 inch long sections. Fabricate expansion joints and accessories from the same metal as gutters, unless otherwise indicated.

Downspouts: Fabricate[circular][rectangular][square] downspouts complete with mitered elbows. Furnish with metal hangers of same material as downspouts and anchors.

2.6 INSULATION

****

NOTE: Include this paragraph only when the non-structural roof system assembly incorporates insulation above the roof deck or directly in contact with the roof panels. Coordinate with the appropriate insulation specification section.

Design vapor retarder to ensure coordination with the insulation requirements specified in the insulation section.

****

Provide insulation, facer material and attachment compatible with metal roof system specified, as approved by the roof panel manufacturer, and conform to ASTM C552 (cellular glass) or ASTM C553 (fiber blankets).

****

NOTE: Delete the following two paragraphs for non-rated roof panel systems.

****

[2.6.1 Fire Rated Assembly System

Provide semi-rigid glass-fiber insulation board conforming to ASTM C553, Form A, Class 1, Class A fire-hazard classification with a minimum density of 24.8 kilogram per cubic meter and 38 millimeter 1.55 pounds per cubic foot (pcf) and 1-1/2 inches thick. Thermal conductivity (K) must not exceed 0.42 watt per meter per degree K 0.24.

]2.6.2 Fire Rated Roof Panel Assembly

Provide materials for fire-rated roof panel construction as follows:

Provide impaling clips, accessories, and fasteners that are UL listed 40 U18.24 UL Bld Mat Dir galvanized steel sheet or impaling bolts welded to each wall unit joint and spaced not more than 1200 millimeter 48 inches on center.

Provide bar subgirts 38 by 3 millimeter 1-1/2 by 1/8 inch galvanized steel with slotted holes for welding to end of impaling clip spikes.

Provide galvanized steel structural angles and flashing angles, gage or thickness as indicated, or material as specified. Flashing angles must be not less than 1.3 millimeter thick No. 18 U.S. standard gage.

[Provide hot-dip galvanized steel metal facing conforming to ASTM A653/A653M, Grade A. Coating in conformance with ASTM A653/A653M and ASTM A924/A924M.

][Provide metal facing as indicated and fabricated of enamel-coated hot-dip galvanized steel conforming to ASTM A653/A653M, Grade A. Coating in conformance with ASTM A653/A653M and ASTM A924/A924M. Provide Class A fire hazard classification finish. Flame spread, fuel contributed, or smoke developed cannot exceed a value of 25.

] Submit fire rating test report to contracting officer for review and approval. Secure written approval prior to commencement of installation.

2.7 UNDERLAYMENTS

****

NOTE: Underlayments included in this section are for slopes of 3:12 or greater. For slopes less than 3:12 other underlayment materials should be used. Refer to MBMA RSDM and NRCA RoofMan for guidance.

Select proper underlayment or combination of underlayment materials. Delete other options.

Consider self-adhering modified bitumen underlayment for ice dam protection and ridge, hip, valley, and sidewall areas. Additionally, for severe weather locations, complex roofs, or high value contents consider the higher protection capacity of a self-adhering modified bitumen underlayment, where it will not create a condensation concern.

When low perm underlayment is used throughout the roof area, ensure its vapor retarding effects are considered such that its use does not create condensation issues. Consideration for predominant vapor drive action in hot and cold climates in combination with building use and location, insulation location, under deck or attic space venting, and vapor retarder needs and positioning should be considered in underlayment selection. Underlayment in conjunction with an underlying and properly positioned vapor retarder/barrier may be required in some circumstances.

For shed roofs, underlayment may be omitted.

****

[2.7.1 Felt Underlayment

Provide No. 30 asphalt-saturated organic , non-perforated felt underlayment in compliance with ASTM D226/D226M, Type II, or ASTM D4869/D4869M.

][2.7.2 Self-Adhering Modified Bitumen Underlayment

Provide self-adhering modified bitumen membrane underlayment material in compliance with ASTM D1970/D1970M, suitable for use as underlayment for metal roofing. Use membrane resistant to cyclical elevated temperatures for extended period of time in high heat service conditions. Provide membrane with integral non-tacking top surface of polyethylene film or other surface material to serve as separator between bituminous material and metal products to be applied above.

][2.7.3 EPDM Membrane

Ethylene Propylene Diene Terpolymer (EPDM), ASTM D4637/D4637M, Type I, non-reinforced, minimum 1.1 mm 0.045 inch thick.

][2.7.4 Slip Sheet

Provide 0.24 kg per square meter 5 pounds per 100 sf rosin sized unsaturated building paper for slip sheet.

]2.8 GASKETS AND SEALING/INSULATING COMPOUNDS

Provide gaskets and sealing/insulating compounds that are nonabsorptive and suitable for insulating contact points of incompatible materials. Utilize sealing/insulating compounds that are non-running after drying.

2.9 FINISH REPAIR MATERIAL

[Provide repair paint for color finish enameled roofing that is compatible paint of the same formula and color as the specified finish furnished by the manufacturer.

][Only use repair and touch-up paint supplied by the roof panel manufacturer and is compatible with the specified system.

]PART 3 EXECUTION

3.1 EXAMINATION

Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the work. Ensure surfaces are suitable, dry and free of defects and projections which might affect the installation.

Examine primary and secondary roof framing to verify that rafters, purlins, angels, channels, and other structural support members for panels and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer, UL, ASTM, and ASCE 7-16 [and applicable seismic] requirements.

Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking; and that installation is within flatness tolerances required by metal roof panel manufacturer.

Examine rough-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of panels prior to installation.

Submit a written report to the Contracting Officer, endorsed by the installer, listing conditions detrimental to the performance of the work. Proceed with installation only after defects have been corrected.

Do not install items that show visual evidence of biological growth.

3.2 INSTALLATION

Perform installation meeting specified requirements and in accordance with the manufacturer's installation instructions and approved shop drawings. Do not install damaged materials. Insulate dissimilar materials which are not compatible when contacting each other by means of gaskets or sealing/insulating compounds. Keep all exposed surfaces and edges clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Remove stained, discolored, or damaged materials from the site.

3.2.1 Preparation

****

NOTE: For roof panel installations which do not require insulation, delete the bracket containing insulation.

****

Clean all substrate substances which may be harmful to [insulation, and]roof panels including removing projections capable of interfering with [insulation, and]roof panel attachment.

Install sub-purlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written instructions.

3.2.2 Underlayment

****

NOTE: Coordinate underlayment application with materials specification in Part 2.

Show the extent and location of the appropriate underlayment on the drawings. The proper application of the underlayment ensures that any water penetrating below the roof panels will drain outside of the building envelope.

Include the bracketed option related to ice dam protection where ice damming is a concern.

Include the bracketed option in the last sentence when felt underlayment is used.

****

Install underlayment according to roof panel manufacturer's written recommendations and recommendation in NRCA "The NRCA Roofing and Waterproofing Manual".

[3.2.2.1 Single Layer Felt Underlayment for a Standard Slope Roof Deck

Install single layer of felt underlayment on roof deck perpendicular to roof slope in parallel courses. Lap sides a minimum of 5.1 cm 2 inches over underlying course. Lap ends a minimum of 10.2 cm 4 inches. Stagger end laps between succeeding courses a minimum of 183 cm 72 inches. Fasten with felt underlayment roofing nails.

[Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 7.62 cm 3 inches in a direction to shed water. Lap ends of felt not less than 15.3 cm 6 inches over self-adhering sheet underlayment.

]][3.2.2.2 Self-Adhering Sheet Underlayment

Install self-adhering sheet underlayment; wrinkle free on roof deck. Comply with low-temperature installation restrictions of manufacturer where applicable. Install at locations indicated on project drawings, lapped in a direction to shed water. Lap sides not less than 8.9 cm 3-1/2 inches. Lap ends not less than 15.3 cm 6 inches staggered 61 cm 24 inches between courses. Roll laps with roller. Cover underlayment within seven days.

][3.2.2.3 Slip Sheet

****

NOTE: Include first bracketed option when underlayment is used. Include second bracketed option when underlayment is omitted over deck substrate (e.g., shed roof over plywood decking).

****

[Apply specified slip sheet at time of roof panel installation when felt or other underlayment is used that may be in direct contact with and adhere to or adversely impact the underside of roof panels, and as otherwise recommended by the roof panel manufacturer.][Install slip sheet over deck substrates prior to roof panel installation.]

]3.3 INSULATION INSTALLATION

****

NOTE: Delete the following paragraph if the project does not require insulation above the roof deck.

****

Install insulation concurrently with metal roof panel installation, in thickness indicated, to cover entire roof, according to manufacturer's written instructions.

3.4 PROTECTION OF APPLIED MATERIALS

Do not permit storing, walking, wheeling, and trucking directly on applied roofing/insulation materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to applied roofing/insulation materials, and to distribute weight to conform to indicated live load limits of roof construction.

3.5 FASTENER INSTALLATION

Anchor metal roof panels and other components of the Work securely in place, using approved fasteners according to manufacturer's written instructions.

3.5.1 Welding

Perform procedures for manual, shielded metal-arc welding, the inspection and testing of welds made, and the methods used in correcting welding work in accordance with AWS D1.1/D1.1M.

3.6 FLASHING, TRIM, AND CLOSURE INSTALLATION

3.6.1 General Requirements

Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible. Set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently water tight and weather resistant. Work is to be accomplished to form weather tight construction without waves, warps, buckles, fastening stresses or distortion, and to allow for expansion and contraction. Perform cutting, fitting, drilling, and other operations in connection with sheet metal required to accomplish the work in conformance with the manufacturers written instructions.

3.6.2 Metal Flashing

Install exposed metal flashing at building corners, rakes, eaves, junctions between metal siding and roofing, valleys and changes off slope or direction in metal roofing, building expansion joints and gutters.

Utilize exposed metal flashing that is the same material, color, and finish as the specified metal roofing panels. Furnish flashing in minimum 2.44 m 8 foot lengths. Exposed flashing must have 1 inch locked and blind soldered end joints, with expansion joints at intervals of no greater than 4.88 m 16 feet.

Fasten flashing at not more than 8 inches on center for roofs, except where flashing is held in place by the same screws used to secure panels. Bed exposed flashing and flashing subject to rain penetration in specified joint sealant. Isolate flashing which is in contact with dissimilar metals by means of the specified asphalt mastic material to prevent electrolytic deterioration.

Form drips to the profile indicated, with the edge folded back 1.27 cm 1/2 inch to form a reinforced drip edge.

3.7 ROOF PANEL INSTALLATION

Provide metal roof panels of full length from eave to ridge or eave to wall as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels or other components of the Work securely in place, with provisions for thermal and structural movement in accordance with NRCA 0420.

[Steel Roof Panels: Use stainless steel fasteners for exterior surfaces and galvanized fasteners for unexposed surfaces.

][Aluminum Roof Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior and aluminum or galvanized steel fasteners for unexposed surfaces.

] Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using approved fasteners according to manufacturer's written instructions. Provide all blocking and nailers as required.

Metal Protection: Where dissimilar metals contact each other or possibly corrosive substrates, protect against galvanic action by [coating contact surfaces with a bituminous coating][applying rubberized asphalt underlayment to each contact surface][permanent separation as recommended by the metal roof panel manufacturer].

Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and required for weatherproof performance of metal roof panel system. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.

3.7.1 Handling and Erection

Erect roofing system in accordance with the approved erection drawings, printed instructions and safety precautions of the manufacturer.

Do not subject panels to overloading, abuse, or undue impact. Do not apply bent, chipped, or defective panels. Replace and remove from the site any damaged panels at the Contractor's expense. Erect panels true, plumb, and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with indicated rake, eave, and curb overhang. Allow for thermal movement of the roofing, movement of the building structure, and provide permanent freedom from noise due to wind pressure.

Do not permit storage, walking, wheeling or trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to the installed roofing materials, and to distribute weight to conform to the indicated live load limits of the roof construction.

Lay roof panels with corrugations in the direction of the roof slope. Lap ends of exterior roofing not less than 20.3 cm 8 inches; lap sides of standard exterior corrugated panels not less than 2-1/2 corrugations.

Field cutting of metal roof panels by torch is not permitted. Field cut only as recommended by manufacturer's written instructions.

3.7.2 Closure Strips

Install metal closure strips at open ends of metal ridge rolls; open ends of corrugated or ribbed pattern roofs, and at intersection of wall and roof, unless open ends are concealed with formed eave flashing; rake of metal roof unless open end has a formed flashing member; and in other required areas.

Install closure strips at intersection of the wall with metal roofing; top and bottom of metal siding; heads of wall openings; and in other required locations.

3.7.3 Workmanship

Make lines, arises, and angles sharp and true. Free exposed surfaces from any visible wave, warp, buckle and tool marks. Fold back exposed edges neatly to form a 1.27 cm 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections which might affect the application. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and as necessary to make the work watertight.

3.8 ACCEPTANCE PROVISIONS

3.8.1 Erection Tolerances

Erect metal roofing straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Horizontal lines must not vary more than 0.64 cm in 6.1 m or 0.95 cm in 12.2 m 1/4 inch in 20 feet or 3/8 inch in 40 feet.

3.8.2 Leakage Tests

Finished application of metal roofing is to be subject to inspection and test for leakage by the Contracting Officer or his designated representative, and Architect/Engineer. Inspection and tests will be conducted without cost to the Government.

Inspection and testing is to be made promptly after erection to permit correction of defects and removal/replacement of defective materials.

3.8.3 Repairs to Finish

Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials and as recommended by the metal roof panel manufacturer. Finished repaired surfaces must be uniform and free from variations of color and surface texture. Repaired metal surfaces that are not acceptable to the project requirements are to be immediately removed and replaced with new material.

3.8.4 Paint Finished Metal Roofing

Paint finished metal roofing will be tested for color stability by the Contracting Officer during the manufacturer's specified guarantee period. Remove and replace panels that indicate color changes, fading, or surface degradation, determined by visual examination with new panels at no expense to the Government. New panels will be subject to the specified tests for an additional year from the date of their installation.

3.9 CLEAN UP AND DISPOSAL

****

NOTE: Include optional last sentence for steel panels in salt spray environment (i.e., within 150 m 500 feet of waterfront) and other corrosive environments.

****

Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces must be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating. Touch up scratches in panel finish with manufacturer supplied touch-up paint system to match panel finish.[Treat exposed cut edges with manufacturer supplied [clear][_____]

coat.]

Collect all scrap/waste materials and place in containers. Promptly dispose of demolished and scrap materials. Do not allow scrap/waste materials to accumulate on-site; transport immediately from the government property and legally dispose of them.

3.10 FIELD QUALITY CONTROL

[3.10.1 Manufacturer's Inspection

****

NOTE: Include this paragraph when manufacturer's inspection of work is required. Select desired frequency of manufacturer inspection and coordinate with text of optional 2nd and 3rd bracketed sentences.

****

Manufacturer's technical representative must visit the site a minimum of [[three][_____] times][once per week] during the installation for purposes of reviewing materials installation practices and adequacy of work in place.[Make inspections during the first 20 squares of roof panel installation, at mid-point of the installation, and at substantial completion, at a minimum. Additional inspections are required for each 100 squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer.] After each inspection, submit a report, signed by the manufacturer's technical representative to the Contracting Officer within 3 working days. Note in the report overall quality of work, deficiencies and any other concerns, and recommended corrective action.

Submit three [_____] signed copies of the manufacturer's field inspection reports to the Contracting Officer within one week of substantial completion.

]3.11 INFORMATION CARD

For each roof, furnish a typewritten information card for facility records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved one mm 0.032 inch thick aluminum card for exterior display. Format as directed in paragraph FORM ONE.

Make card 215 mm by 275 mm 8 1/2 by 11 inches minimum, identifying facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, roof panel manufacturer and product name, type underlayment(s), date of completion; installing contractor identification and contact information; manufacturer warranty expiration, warranty reference number, and contact information. Install card at [interior roof top access point][location as directed by the Contracting Officer] and provide a paper copy to the Contracting Officer.

3.11.1 Form One

FORM 1 - PREFORMED [STEEL][ALUMINUM] PANEL ROOFING SYSTEM AND COMPONENTS

1. Contract Number:

2. Building Number & Location:

3. NAVFAC Specification Number:

4. Deck/Substrate Type:

5. Slopes of Deck/Roof Structure:

6. Insulation Type & Thickness:

7. Insulation Manufacturer:

8. Vapor Retarder: ( )Yes ( )No

9. Vapor Retarder Type:

10. Preformed Steel Standing Seam Roofing Description:

a. Manufacturer (Name, Address, & Phone No.):
b. Product Name: c. Width: d. Gage:
e. Base Metal: f. Method of Attachment:

11. Repair of Color Coating:

a. Coating Manufacturer (Name, Address & Phone No.):
b. Product Name:
c. Surface Preparation:
d. Recoating Formula:
e. Application Method:

12. Statement of Compliance or Exception:____________________________________
____
____

13. Date Roof Completed:

14. Warranty Period: From_______________ To_______________

15. Roofing Contractor (Name & Address):

16. Prime Contractor (Name & Address):

Contractor's Signature _________________________ Date:

Inspector's Signature _________________________ Date:Text

3.12 WARRANTY

****
NOTE: Include the attached four page warranty document for Army projects only. Coordinate with the warranty text in Part 1 of this specification.
****

CONTRACTOR'S [FIVE (5)][TEN (10)][TWENTY (20)] YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM

FACILITY DESCRIPTION____

BUILDING NUMBER:____

CORPS OF ENGINEERS CONTRACT NUMBER:__________________________________

CONTRACTOR

CONTRACTOR:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

OWNER

OWNER:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

CONSTRUCTION AGENT

CONSTRUCTION AGENT:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

CONTRACTOR'S [FIVE (5)][TEN (10)][TWENTY (20)] YEAR NO PENAL SUM WARRANTY FOR NON-STRUCTURAL METAL ROOF SYSTEM
(continued)

THE NON-STRUCTURAL METAL ROOF SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY _____________________________ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. THE NON-STRUCTURAL METAL ROOFING SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH UL 580. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHING INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE NON-STRUCTURAL METAL ROOFING SYSTEM.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE ASSOCIATED WITH THE NON-STRUCTURAL METAL ROOF SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON ____________________________ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

____
(Company President)   (Date)

CONTRACTOR'S [FIVE (5)][TEN (10)][TWENTY (20)] YEAR NO PENAL SUM WARRANTY FOR NON-STRUCTURAL METAL ROOFING SYSTEM

(continued)

THE CONTRACTOR MUST SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE NON-STRUCTURAL METAL ROOFING SYSTEM.SUBMIT ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR IS ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE NON-STRUCTURAL METAL ROOF DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN MUST INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.

6. THIS WARRANTY APPLIES TO THE NON-STRUCTURAL METAL ROOFING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

CONTRACTOR'S [FIVE (5)][TEN (10)][TWENTY (20)] YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM
(continued)

**REPORTS OF LEAKS AND ROOF SYSTEM DEFICIENCIES MUST BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE, BY TELEPHONE OR IN WRITING, FROM EITHER THE OWNER OR CONTRACTING OFFICER. INITIATE EMERGENCY REPAIRS TO PREVENT FURTHER ROOF LEAKS IMMEDIATELY; SUBMIT A WRITTEN PLAN FOR APPROVAL TO REPAIR OR REPLACE THIS ROOF SYSTEM WITHIN SEVEN (7) CALENDAR DAYS. COMMENCE ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE NON-STRUCTURAL METAL ROOF SYSTEM REPAIRED OR REPLACED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

POST A FRAMED COPY OF THIS WARRANTY IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 41 13.16 (August 2009)**

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-07 41 13.16 (August 2009)**

Preparing Activity: USACE **Nontechnical Title Revision (August 2015)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 41 13.16

COPPER ROOF PANELS

08/09

****

NOTE: This guide specification covers the requirements for copper roof system applied to solid roof decking.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification will be used in the preparation of project specifications for flat-seam, standing-seam, batten-seam, or custom-design type copper roofing installed over a substrate. The structural adequacy of the supporting system will be established prior to design of copper roof system.

Drawings will show scope of sheet metalwork and structural framing system, including type of decking and blocking, type of fire-retardant materials (if used), type and details of seams, and design requirements. When this specification is used for onsite fabricated copper roof, the Contractor may not be able to verify performance criteria such as

wind uplift. In such cases, drawing details of proven reliability and SMACNA recommended guidelines should be used and specified.

Copper roof systems in cold climates subjected to high snow accumulation must include snow guards, steep slopes (generally 6 on 12), and other approved details.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D1970/D1970M	(2019) Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2523/D2523M	(2013; E 2019; R 2019) Standard Practice for Testing Load-Strain Properties of Roofing Membranes
ASTM D4397	(2016) Standard Specification for

	Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D5147/D5147M	(2014) Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material
ASTM E28	(2018; R 2022) Softening Point of Resins Derived from Naval Stores by Ring and Ball Apparatus
ASTM E72	(2022) Conducting Strength Tests of Panels for Building Construction

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4050	(2016) Copper in Architecture - Design Handbook

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC48	(2012; R 2015) Acceptance Criteria for Self-adhered Roof Underlayment for Use as Ice Barriers

1.2 DESIGN REQUIREMENTS

Form copper to provide proper installation of elastomeric sealants. Form expansion joints of intermeshing hooked flanges not less than 25 mm 1 inch deep in accordance with CDA A4050.

1.2.1 Wind Uplift Loads

****

NOTE: Select the basic wind speed value from UFC 3-301-01. The importance and exposure factors will be obtained from ASCE 7-16.

****

Compute the design uplift pressures for the roof system and apply using a basic wind speed of [_____] km miles per hour (fastest km mile), an importance factor of [_____], and an exposure factor of [_____]. The design uplift force for each connection assembly must be that pressure given for the area under consideration, multiplied by the tributary load area of the connection assembly, and multiplied by the appropriate factor of safety, as follows:

Single fastener in each connection	3.0
wo or more fasteners in each connection	2.25

1.2.2 Panel and Clip Design

Panel and clip strength characteristics such as panel buckling strength, panel stiffness, side joint strength and clip/side joint must meet requirements of ASTM E72. For the clip-to-substrate fastener selection, incorporate a safety factor of 3.0 based on ultimate pull-out strength.

Consider the pry effect which the outstanding leg of clip exerts on the fastener. Design end-laps for thermal movement. Use concealed anchor clips, and submit two samples of each type.

1.2.3 Provisions for Expansion

****

NOTE: Select appropriate temperature range based on effects of direct sun and general climatic conditions of the project site.

****

Provide copper roof panels that are free to move in response to the expansion and contraction forces resulting from a total [110] [_____] degrees C [200] [_____] degrees F temperature range during the life of the structure.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Copper Roof System; G, [_____]

SD-03 Product Data

Sealant

Qualifications

SD-04 Samples

Accessories; G, [_____]

Roof Panels

Fasteners; G, [_____]

Concealed Anchor Clips; G, [_____]

SD-06 Test Reports

Field Testing; G, [_____]

SD-07 Certificates

Copper Roof System

1.4 QUALITY ASSURANCE

Submit Qualifications for the following, as specified:

1.4.1 Manufacturer

Copper roof system must be the product of a recognized copper roof system manufacturer who has been in the practice of manufacturing copper roof systems for a period of not less than [10] [_____] years and has been involved in at least 5 projects similar in size and complexity to this project. Submit design and erection drawings containing data necessary to clearly describe design, materials, sizes, layouts, seam configuration, construction details, provisions for thermal movement, line of panels, fastener sizes and spacings, sealants and installation procedures. Also submit certification that materials used in the copper roof system meet specified requirements.

1.4.2 Installer

The installer must be skilled in the installation of the type of copper roof system required for this project, have a minimum of [10] [_____] years of experience, and involved in installing at least 3 projects that are of comparable size, scope and complexity as this project for the particular roof system furnished.

1.4.3 Manufacturer's Representative

A representative of the copper roof system manufacturer, who is familiar with the design of the roof system supplied and experienced in the erection of roof systems similar in size to the one required under this contract, must be present at the project site during installation of the copper roof to ensure that the roof system meets the contract requirements.

1.4.4 Mock-Ups

****

NOTE: Complexity of work and scope of quality control should be carefully evaluated before requiring Contractor to construct a mock-up. Delete paragraph if mock-up is not required.

****

Before proceeding with final purchase of materials and fabrication of copper roofing components, construct a mock-up of the work at the site in the size and location directed, including at least one example of each critical detail (ridge, hip, valley, etc.) as required in the project. The approved mock-up will establish the minimum standard of quality required for copper roofing work.

1.5 DELIVERY, STORAGE AND HANDLING

Deliver materials to the project site in a dry and undamaged condition and stored them out of contact with the ground. Cover materials with weathertight coverings and kept dry. Furnish storage accommodations for materials that provide good air circulation and protection from twisting, bending, abrasion, discoloration or staining.

1.6 WARRANTY

Warrant the copper roofing installation for a period of 20 years against blow-off and leakage arising out of or caused by ordinary wear and tear by the elements. Permanently attach a sign to the building at the most likely roof access point advising of the existence of the warranty. The warranty must start upon final acceptance of the work or the date the Government takes possession, whichever is earlier. The warranty must guarantee that the design, detailing, materials, and accessories used for roofing work are approved by the roofing manufacturer and installed in accordance with specifications, drawings and other documents approved by manufacturer prior to installation.

PART 2 PRODUCTS

2.1 ROOF PANELS

Provide cold-rolled copper roofing sheets conforming to ASTM B370 temper designation, H00, minimum 4.9 kg per square meter 16 ounces per square foot containing 99.9 percent copper. Copper roof panels must be factory-fabricated in accordance with approved drawings and CDA A4050 recommendations. Form sections true to shape in the longest practical lengths, accurate in size and free of distortion and defects. Hem exposed edges on underside. Fabricate exposed copper work without excessive oil-canning, buckling, and tool marks. Submit one piece 225 mm 9 inches long, full width.

2.2 ACCESSORIES

Factory fabricate components required for a complete roofing system, including [trim,] [copings,] [fascias,] [corner units,] [ridge closures,] [clips,] [gutters,] [closure strips,] and similar items. Furnish clip bases that have factory punched or drilled holes for attachment. Make clips used with panel width greater than 305 mm 12 inches from multiple pieces with the allowance for the total thermal movement required to take place within the clip. Provide cleats which are interlockable with the panels and of type and size to meet design requirements. Accessories must be fabricated of type and thickness of sheet copper complying with CDA A4050. Submit one sample of each type of flashing, trim, closure, cap and similar items. Size must be sufficient to show construction and configuration.

2.3 SOLDER AND FLUX

Copper solder must conform to ASTM B32. Flux must be rosin, muriatic acid neutralized with zinc or an approved soldering paste.

2.4 SLIP SHEETS

Slip sheets must be smooth rosin-sized unsaturated building paper weighing a minimum of 295 grams per square meter 6 pounds per 100 square feet. Attach sheets with approved fasteners. Apply slip sheets over vapor retarder, where applicable.

2.5 VAPOR RETARDER

****

NOTE: Vapor retarder requirements will be shown on the drawings when required for local climatic conditions. In northern climates, where ice and snow are considerations, a waterproof secondary membrane may be specified. Delete this paragraph if not required.

****

Vapor retarder must be [non-perforated asphalt-saturated organic roofing felts conforming to ASTM D226/D226M, Type II (No. 30).] [polyethylene sheeting conforming to ASTM D4397. Provide a fully compatible tape which has equal or better water vapor control characteristics than the vapor retarder material.]Add a non-asphaltic underlayment as follows: Post consumer recycled content-35 percent; Thickness ASTM D5147/D5147M-30 mils min; Tensile strength ASTM D2523/D2523M -25 lbF/in min; Slip resistance ASTM D1970/D1970M; pass elongation ASTM D2523/D2523M; 20 percent min UV resistance ICC-ES AC48-210 hours @ 135-140 degrees F; tensile strength after UV resistance ASTM D2523/D2523M-25 lbF/in min. Also add a non-asphaltic self-adhered membrane as follows: Pass all ASTM D1970/D1970M tests plus: Post consumer recycled content-35 percent UV resistance ICC-ES AC48-210 hours @ 135-140 degrees F; tensile strength after UV resistance ASTM D2523/D2523M-25 lbF/in min thermal stability per ASTM E28 -260 degrees F.

2.6 BITUMINOUS COATING

Bituminous coating must be cold-applied inert-type noncorrosive compound, nominally free of sulfur components and other deleterious impurities.

2.7 SEALANT

Provide sealant in accordance with CDA A4050 and manufacturer's recommendations. Submit descriptive information.

2.8 FASTENERS

****

NOTE: For projects in hurricane areas, edit this paragraph to provide the higher quality fastener types recommended.

****

Fasteners in contact with copper must be copper, brass or Series 300 stainless steel capable of resisting the specified wind uplift and allowing for movement of roof panel system. Exposed fasteners must be copper and only use at batten caps and closures. Submit two samples of each type to be used, with statement regarding intended use. If requested, take random samples of each type of fastener delivered to the project site in the presence of the Contracting Officer and provide to the Contracting Officer.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Lumber and plywood in contact with copper will be non-treated or have a "non-corrosive" fire-retardant treatment.

****

Separate copper from noncompatible metal and corrosive substrates with permanent type separators recommended by manufacturer. Install roofing panels, flashings and related accessories with approved fasteners in accordance with approved drawings and CDA A4050. Set roofing components true to line and accurately fit together to form leak-proof joints. Fold panels back to form a hem on concealed side of exposed edges. Form exposed surfaces flat and free of buckles, waves, and tool marks. Make provision for thermal expansion and contraction. Make seams uniform and neat with minimum of solder, welds and sealant. Conceal fasteners and expansion provisions where possible in exposed work. Field-cutting of panels by torch is not permitted.

3.1.1 Tolerances

Shim panels and align within a tolerance of 9 mm in 12 meters 3/8 inch in 40 feet vertically and horizontally and within 3 mm 1/8 inch offset of adjoining surfaces and of vertical alignment of matching profiles.

3.1.2 Substrates

Make concrete substrates smooth with a wash of neat cement or with a heavy application of bituminous coating. If concrete is not nailable, set nailable inserts into the concrete. Substrates must be clean, smooth, sound, dry, and free of defects and projections which might affect the installation. Secure projecting nails and other types of fasteners and make flush with substrate. Securely set roof openings, pipes, vents, and other roof penetrations in place.

3.1.3 Vapor Retarder

****

NOTE: Delete this paragraph if vapor retarder is not required. If vapor retarder is required keep

the appropriate brackets for roofing felts or polyethylene.

****

[Install roofing felts in accordance with manufacturer's recommendations.] [Install a single ply of 0.254 mm 10 mil polyethylene sheet or, at the Contractor's option, a double ply of 0.152 mm 6 mil polyethylene sheet over the entire support surface. Use tape to seal the edges of the sheets to the support surface, or to the sheet below. Lap sheet edges no less than 150 mm 6 inches. Provide sufficient material to avoid inducing stresses in the sheets due to stretching or binding. Seal all tears or punctures that are visible in the finished surface at any time during the construction process with the tape.]

3.1.4 Slip Sheets

****

NOTE: Slip sheets are required for all installations. Slip sheets must be installed over vapor retarder when vapor retarder is specified.

****

Install slip sheets with joints overlapped a minimum of 50 mm 2 inches, and secured with approved fasteners.

3.2 FIELD TESTING

****

NOTE: Field testing may not be required for all projects. Delete if not required.

****

Conduct [_____] random fastener pull tests in areas designated by the Contracting Officer. Tensile and shear strength for structural connections less than 3.3 kN 750 pounds per fastener is not permitted. Submit test reports for uplift resistance of the copper roof system.

3.3 CLEANING

Upon completion of copper roofing work, remove grease and oil films, excess sealants and handling marks and clean the work in accordance with manufacturer's recommendations. Clean substances from copper surfaces that would interfere with uniform oxidation and weathering. Exposed copper surfaces must be free of dents, creases, waves, scratch marks, and solder or weld marks.

3.4 PROTECTION

Protect copper roofing work to ensure the roof is without damage or deterioration. Replace roof panels and other components, which have been damaged or have deteriorated beyond successful repair with new copper sheet metalwork. Storing, walking, wheeling or trucking directly on completed copper roofing work is not permitted. When required, use temporary walkways, runways and platforms fabricated of smooth clean boards to avoid damage to completed copper work. Maintain copper roofing work in a clean condition until final acceptance.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-07 41 63 (November 2016)**

Preparing Activity: USACE **Superseding**
UFGS-07 41 63 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATION

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-07 41 63 (November 2016)**

Preparing Activity: USACE **Superseding**
UFGS-07 41 63 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATION

References are in agreement with UMRL dated January 2025
****

SECTION 07 41 63

FABRICATED ROOF PANEL ASSEMBLIES
11/16

****
NOTE: This guide specification covers the requirements for both factory color and mill finish aluminum or steel fabricated roof panel assemblies.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: This section includes structural standing seam panels, insulated sandwich panels and special fabricated roof panel systems.

Coordinate this section with other system components specifications such as framing, decking, insulation and sheet metal flashing. Also coordinate with the criteria of Unified Facilities Criteria (UFC) 3-110-06, "Design: Roofing" **as it relates to the specific project and Service Exceptions indicated therein. For Army projects also refer to TI 809-29, "Structural Considerations for Metal Roofing".**
****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)	
AA ADM	(2020) Aluminum Design Manual
AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)	
AISC 341	(2016) Seismic Provisions for Structural Steel Buildings
AMERICAN IRON AND STEEL INSTITUTE (AISI)	
AISI D100	(2017) Cold-Formed Steel Design Manual
AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)	
ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures
AMERICAN WELDING SOCIETY (AWS)	
AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
ASTM INTERNATIONAL (ASTM)	
ASTM A36/A36M	(2019) Standard Specification for Carbon

	Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A424/A424M	(2009a; R 2016) Standard Specification for Steel Sheet for Porcelain Enameling
ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A606/A606M	(2023) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A755/A755M	(2018; R 2024) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B659	(1990; R 2021) Standard Guide for Measuring Thickness of Metallic and Inorganic Coatings

ASTM C273/C273M	(2020) Standard Test Method for Shear Properties of Sandwich Core Materials
ASTM C286	(2022) Standard Terminology Relating to Porcelain Enamel and Ceramic-Metal Systems
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1396/C1396M	(2024) Standard Specification for Gypsum Board
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622	(2020) Apparent Density of Rigid Cellular Plastics
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences

	from Instrumentally Measured Color Coordinates
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D6226	(2021) Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E2140	(2001; R 2023) Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

FM GLOBAL (FM)

FM 4471	(2010) Class I Panel Roofs
FM 4474	(2014) Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative

	Differential Pressures

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA RSDM	(2012) Metal Roofing Systems Design Manual

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0429	(2022) The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control and Reroofing
NRCA RoofMan	(2020) The NRCA Roofing Manual

PORCELAIN ENAMEL INSTITUTE (PEI)

PEI 1001	(1996) Specification for Architectural Porcelain Enamel (ALS-100)

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 9.01	(1982; E 2004) Cold-Applied Asphalt Mastic Painting System with Extra-Thick Film

UL SOLUTIONS (UL)

UL 580	(2006; Reprint Apr 2024) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies

1.2 DEFINITIONS

Fabricated Roof Panel Assembly: Metal roof and liner panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories shop-fabricated or field-assembled for a complete weathertight roofing system.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification of Manufacturer; G, [_____]

Qualification of Installer; G, [_____]

Qualifications for Welding; G, [_____]

Work Plan; G, [_____]

On-Site Inspection and Acceptance Procedure; G, [_____]

SD-02 Shop Drawings

Roofing Panels; G, [_____]

Flashing and Accessories; G, [_____]

Gutter/Downspout Assembly; G, [_____]

SD-03 Product Data

Sustainable Acquisition; G, [_____].

Coil Stock; G, [_____]

Factory Color Finish; G, [_____]

Sub-girts and Formed Shapes; G, [_____]

Closure Materials; G, [_____]

Insulation; G, [_____]

Pressure-Sensitive Tape; G, [_____]

Sealants and Caulking; G, [_____]

Rated Wall Assembly; G, [_____]

[Galvanizing Repair Paint; G, [_____]

][Enamel Repair Paint; G, [_____]

][Aluminized Steel Repair Paint; G, [_____]

] Accessories; G, [_____]

SD-04 Samples

Coil Stock; G, [_____]

Roofing Panels; G, [_____]

Fasteners; G, [_____]

Metal Closure Strips; G, [_____]

Insulation; G, [_____]

Manufacturer's Color Charts and Chips; G, [_____]

SD-05 Design Data

Wind Design Analysis

[Seismic Design Analysis

] SD-06 Test Reports

Leakage Tests; G, [_____]

[Fire Rating Test Report; G, [_____]

] Coatings and Base Metals of Metal Roofing; G, [_____]

Factory Finish and Color Performance Requirements; G, [_____]

[Wind Uplift Test Report; G, [_____]

][Seismic Test Report; G, [_____]

] SD-07 Certificates

Coil Stock

Fasteners

[Galvanizing Repair Paint

][Enamel Repair Paint

] Safety Data Sheets

Coating Physical Properties:

SD-08 Manufacturer's Instructions

Installation of Roof Panel Assemblies

SD-11 Closeout Submittals

Warranty

Information Form and Placard; G, [_____]

Manufacturer's Field Inspection Reports

Application Instructions

1.4 QUALITY CONTROL

1.4.1 Preroofing Conference

After submittals are received and approved but before roofing and insulation work, including associated work, is performed, the Contracting Officer will hold a preroofing conference to review the following:

a. The drawings and specifications:

(1) Fabrication and installation drawings for the following items are to indicate completely dimensioned structural frame and erection layouts, openings in the roof, special framing details and construction details at corners, ridges, eaves, building intersections, curbs and flashing, location and type of mastic and metal filler strips, location and erection of flashing and gutter/downspout assembly.

(2) Installation of roof panel assemblies

(3) Roofing panels, submit sample 30.5 cm 12 inches long by actual panel width

(4) Flashing and accessories, submit sample 25.4 cm 10 inches long of each type

(5) Gutter/downspout assembly

Submit certification from the coil stock manufacturer or supplier that the machinery used will form the provided coil stock without warping, waviness, or rippling that is not a part of the panel profile, and without damage, abrasion or marring of the finish coating, and certification of conformance with the standards specified herein. Submit a sample 30.5 cm 12 inches long by the actual panel width.

Submit the manufacturer's color charts and chips, approximately 10.2 by 10.2 cm 4 by 4 inches, showing the full range of colors, textures and patterns available for roof panels with the factory color finish.

Submit factory finish and color performance requirements verified by an independent testing agency.

Submit a wind design analysis from the manufacturer including wind speed, exposure category, coefficient, importance factor. Designate a type of facility, negative pressures for each zone, methods and requirements of attachment. Include a roof plan delineating dimensions and attachment patterns for each zone. Include a signed and sealed wind design analysis with a Licensed project engineer,in the geographic area where the construction will take place.

[(6) Wind Uplift Test Report

][(7) Seismic Design Analysis

][(8) Seismic Test Report

] (9) Fire Rating Test Report

b. Qualifications including:

(1) Qualification of Manufacturer

(2) Qualification of Installer

(3) Qualifications for Welding

c. Submit an on-site inspection and acceptance procedure of the roofing substrate and pertinent structural details relating to the roofing system, including:

(1) Safety Data Sheets

(2) Sub-girts and Formed Shapes

(3) Closure Materials

(4) Insulation

(5) Pressure-Sensitive Tape

(6) Sealants and Caulking

(7) Rated Wall Assembly

[(8) Galvanizing Repair Paint

][(9) Enamel Repair Paint

][(10) Aluminized Steel Repair Paint

] (11) Accessories

d. Submit a work plan for coordination of the various trades involved in providing the roofing system and other components secured to the roofing.

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications. Explicitly identify in writing the differences between the manufacturer's instructions and the specified requirements.

e. Safety requirements

f. Submit manufacturer's data indicating the percentage of recycle material in roofing panels to verify sustainable acquisition compliance.

1.4.2 Manufacturer's Technical Representative

Ensure the representative has authorization from the manufacturer to approve field changes and is thoroughly familiar with the products and installations in the geographical area where construction will take place.

1.4.3 Qualification of Manufacturer

Guarantee the metal roof panel system manufacturer possesses the following:

a. A minimum of five years of experience in manufacturing metal roof system and accessory products.

b. Engineering services of an authorized engineer; currently licensed in the geographical area where construction will take place, having a minimum of four years of experience as an engineer knowledgeable in roof wind design analysis, protocols and procedures for the MBMA RSDM; ASCE 7-16, UL 580 and FM 4474 FM wind design guide for metal roof systems.

c. Certified engineering calculations using the products submitted for wind uplift requirements in accordance with FM 4474 and ASCE 7-16.

1.4.4 Qualification of Installation Contractor

Confirm that the installation contractor is approved and certified by the roofing panel manufacturer before installing the metal roofing system.

1.4.5 Qualifications for Welding

Provide certification of welding procedures conforming to AWS A5.1/A5.1M and AWS D1.1/D1.1M

1.4.6 Single-Source

Obtain each type of metal roof and liner panels, clips, closures and other accessories from the standard products of the single-source manufacturer to ensure these items operate as a complete system for the intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver components, sheets, metal roof panels, and other manufactured items, handling them in a manner to prevent damage or deformation; package metal roof panels for protection during transportation and handling.

Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.

Stack metal roof panels on platforms or pallets, covered with a suitable weather-tight and ventilated covering; store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

Protect the strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for the period of metal roof panel installation.

Protect foam-plastic insulation as follows:

a. Do not expose the foam-plastic insulation to sunlight, except to extent necessary for period of installation and concealment.

b. Protect the foam-plastic insulation against ignition at all times. Do not deliver foam-plastic insulation materials to the project site before installation time.

Complete installation and concealment of plastic materials as rapidly as possible.

1.6 PROJECT/SITE CONDITIONS

Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal roof panel work to be performed according to the manufacturer's written instructions and warranty requirements.

Field Measurements: Verify th actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

1.7 WARRANTY

Furnish the metal roof panel manufacturer's [5][10][_____][20][30]-year roof system materials and installation workmanship warranty, including flashing, [insulation,]components, trim, and accessories necessary for a watertight roof system construction. Issue the warranty directly to the Government, such that the warranty takes effect at the time of the Government's acceptance of the roof work. Provide a warranty with the following conditions:

a. If within the warranty period, the metal roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes nonwater-tight, shows evidence of moisture intrusion within the assembly, displaces, corrodes, perforates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the metal roof system and correction of defective workmanship is the responsibility of the metal roof panel manufacturer. All costs associated with the repair or replacement work are the responsibility of the metal roof panel manufacturer. Conform galvanized repairs to ASTM A780/A780M.

b. If the manufacturer or the applicator approved by the manufacturer fail to perform the repairs within [24][48][72] hours of notification, emergency temporary repairs performed by others does not void the warranty.

[1.7.1 Manufacturer's Finish Warranty

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NOTE: Include the following paragraph when factory color finish panels are specified.

For NAVFAC projects, delete this paragraph and use the appropriate warranty forms included in the paragraph titled "FORM ONE".

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Issue the warranty directly to the Government at the date of Government acceptance, warranting that the factory color finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of 8 when measured in accordance with ASTM D4214; or fade or change colors in excess of 5 NBS units as measured in accordance with ASTM D2244.

]1.7.2 Metal Roof System Installer Warranty

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NOTE: For Army projects use the first bracketed paragraph and delete the remainder of the installer warranty requirements.

For all other projects, delete the first bracketed paragraph, and use the second paragraph.

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Provide the "Contractors [Five][Ten][Twenty] [5][10][20])-Year No Penalty Sum Warranty for Non-Structural Metal Roof System" attached at the end of this section. [Provide a separate bond in an amount equal to the installed total material and installation roofing system cost in favor of the Government covering the installer's warranty responsibilities effective throughout the [five][ten][twenty] [5][10][20])-year warranty period.]

Provide roof system installer warranty for a period of not less than [two][five] years that the roof system, as installed, is free from defects in installation workmanship, including the roof panel installation, flashing, [insulation,] accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Issue warranty directly to the Government. Issue a statement that correction of defective workmanship and replacement of damaged or affected materials is the responsibility of the metal roof system installer. Also state that all costs associated with the repair or replacement work are the responsibility of the installer.

1.7.3 Continuance of Warranty

Approve and accomplish repair or replacement work that becomes necessary within the warranty period to restore the integrity of the roof system assembly and maintain the validity of the metal roof system manufacturer's warranty for the remainder of the manufacturer warranty period.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Conformance and Compatibility

Provide an entire roofing and flashing system in accordance with specified and indicated requirements, including wind resistance [and seismic per AISC 341]requirements. Perform any work not specifically addressed, or any deviation from specified requirements in general accordance with recommendations of the MBMA RSDM, NRCA RoofMan, the metal panel manufacturer's published recommendations and details, and compatible with surrounding components and construction. Submit any deviation from specified or indicated requirements to the Contracting Officer for approval before installation.

2.1.2 Performance Requirements

a. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.

b. Wind-Uplift Resistance: Provide roof panel assemblies that comply with the requirements of the roof systems and attachments in accordance with ASTM E1592 and UL 580. Ensure that uplifting force caused by wind action governs the design for panels. Ensure that roof systems and attachments are to resist the wind loads as determined by ASCE 7-16.

c. FMG Listing: Provide FRP roof panels and component materials that comply with the requirements in FM 4471 as part of a panel roofing system. Identify materials with FMG markings.

d. Structural Performance: Provide roof panel assemblies capable of withstanding the effects of gravity loads and stresses within limits and under conditions indicated, based on testing according to ASTM E1592.

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NOTE: Include bracketed reference for seismic conditions.

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[e. Seismic Performance: Provide fabricated roof panel assemblies conforming to AISC 341 and the test data confirming compliance.

]2.1.3 Fire-Resistance

2.1.3.1 Surface-Burning Characteristics

Provide metal roof panels having insulation core material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with the appropriate markings of an applicable testing agency.

Flame-Spread Index: [25][_____] or less.

Smoke-Developed Index: [450][_____] or less.

2.1.3.2 Fire-Resistance Ratings

Where indicated, provide metal roof panels identical to those of assemblies tested for fire resistance by a qualified testing agency in accordance with ASTM E119. Identify products with the appropriate markings of the applicable testing agency.

Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency. Combustion Characteristics: ASTM E136.

2.2 FABRICATION

2.2.1 Fabrication

Fabricate and finish metal roof panels and accessories at the factory to the greatest extent possible, using the manufacturer's standard procedures and processes to fulfill the indicated performance requirements. Comply with indicated profiles, and dimensional and structural requirements conforming to AISI D100.

Provide a panel profile, including major ribs and intermediate stiffening ribs, if any, for the full length of panel.

Fabricate metal roof panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within the panel assembly.

Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of the item indicated.

Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks, and true to the line and levels indicated, with exposed edges folded back to form hems.

End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant, compliant with SMACNA 1793.

Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on the faces of accessories exposed to view.

Fabricate cleats and attachment devices of the size and metal thickness recommended by SMACNA 1793 or by the metal roof panel manufacturer for application, but not less than the thickness of the metal being secured.

2.2.2 Sheet Metal Flashing and Trim

2.2.2.1 Fabrication, General

Custom-fabricate sheet metal flashing and trim to comply with the recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of the items indicated. Shop-fabricate items where practicable. Obtain field measurements for an accurate fit before shop fabrication.

2.2.2.2 Roof Drainage Sheet Metal Fabrications

Fabricate gutters to the cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in 243.8 cm 96-inch long sections at a minimum. Fabricate expansion joints and accessories from the same metal as the gutters, unless otherwise indicated.

Fabricate [circular] [rectangular] downspouts complete with mitered elbows. Furnish with metal hangers, fabricated from the same material as the downspouts and anchors.

2.2.3 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

Appearance of Finished Work: Ensure that there are no noticeable variations in finish on the same piece. Variations in the appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

2.3 COMPONENTS

2.3.1 Miscellaneous Metal Framing

2.3.1.1 General

Provide cold-formed metallic-coated steel sheet conforming to AISI D100 and ASTM A653/A653M and specified in Section 05 40 00 COLD-FORMED METAL FRAMING unless otherwise indicated.

2.3.1.2 Fasteners for Miscellaneous Metal Framing

Provide fasteners of a type, material, corrosion resistance, size, and sufficient length to penetrate the supporting member a minimum of 2.54 cm 1 inch and possessing the other properties required to fasten miscellaneous metal framing members to substrates in accordance with the roof-panel manufacturer's and ASCE 7-16 requirements.

2.3.2 Fasteners

2.3.2.1 General

Provide fasteners of a type, material, corrosion resistance, size, and sufficient length to penetrate the supporting member a minimum of 2.54 cm 1 inch and possessing the other properties required to fasten miscellaneous metal framing members to substrates in accordance with the roof-panel manufacturer's and ASCE 7-16 requirements.

2.3.2.2 Exposed Fasteners

Provide corrosion-resistant coated steel, aluminum, stainless steel, or nylon-capped, steel-compatible exposed fasteners, with the sheet panel or flashing. Provide exposed fasteners of a type and size recommended by the manufacturer to meet the performance requirements and design loads specified. Provide the manufacturer's standard fasteners for accessories. Provide an integral metal washer that matches the color of material the washer is attached to with a compressible sealing EPDM gasket approximately .238 cm 3/32 inch thick.

2.3.2.3 Screws

Provide corrosion-resistant coated steel, aluminum or stainless steel screws of the type and size recommended by the manufacturer to meet the performance requirements.

2.3.2.4 Rivets

Provide closed-end rivets, made of corrosion-resistant coated steel, aluminum, or stainless steel where watertight connections are required.

2.3.2.5 Attachment Clips

Provide clips fabricated from steel hot-dipped galvanized in accordance with ASTM A653/A653M Z275 G 90 or Series 300 stainless steel. Ensure that the size, shape, thickness and capacity are as required to meet the insulation thickness and design load criteria specified.

2.4 MATERIALS

[2.4.1 Aluminum Sheet

Roll-form aluminum roof and liner panels to the specified profile, with fy equals [2.12][2.81][3.52][5.63] kscm to a [30] [40] [50] [80] ksi, [0.81][1.02][1.27] mm [.032][.040][.050] inch thickness and depth as indicated. Ensure that the material is plumb and true, and within the tolerances listed:

a. Aluminum Sheet conforming to ASTM B209, ASTM B209M, and AA ADM.

b. Ensure individual panels have continuous length to that covers the entire length of any unbroken roof slope with no joints or seams, formed without warping, waviness, or ripples that are not part of the panel profile, and free of damage to the finish coating system.

c. Provide panels with thermal expansion and contraction coefficients consistent with the type of system specified.

[(1) Provide profile and coverage of minimum height and width based on the manufacturer s standard for the indicated roof slope.

][(2) Provide a profile of 3.8 cm 1 1/2 inch high rib at 30.5 cm 12 inches o.c. with small stiffening ribs, 96.5 cm 38 inch overall width with 91.5 cm 36 inch coverage and exposed fasteners.

][(3) Provide a profile of 3.8 cm 1 1/2 inch high rib at 18.3 cm 7.2 inches o.c., 98.75 cm 38-7/8 inch overall width with 91.5 cm 36 inch coverage and exposed fasteners.

][(4) Provide a profile of 2.54 cm 1 inch high rib at 10.2 cm 4 inches o.c., 126 cm 49-5/8 inch overall width with [122][112] cm [48] [44] inch coverage and exposed fasteners.

][(5) Provide a profile of 2.54 cm 1 inch high rib at 20.3 cm 8 inches o.c., 106 cm 41-5/8 inch overall width with 102 cm 40 inch coverage and exposed fasteners.

][(6) Provide a profile of 4.45 cm 1 3/4 inch high V-beam rib at 12.7 cm 5 inches o.c., 114 cm 44 7/8 inch overall width with 107 cm 42 inch coverage and exposed fasteners.

][(7) Provide a profile of 2.22 cm 7/8 inch high corrugated rib at 5.08 cm 2 inches o.c., 98.74 cm 38 7/8 inch overall width with 91.44 cm 36 inch coverage and exposed fasteners.

][(8) Provide a profile of 7.6 cm 3 inch high standing seam, 61 cm 24 inch coverage, factory-caulked and with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) Provide a profile of [2.54][4.45][5.08][6.35] cm [1][1 3/4][2][2 1/2] inch high standing seam, [30.5][40.6][46] cm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(10) Provide a [smooth, flat] [embossed] surface texture.

]][2.4.2 Steel Sheet

Provide roll-form steel roof and liner panels to the specified profile, with fy equal to [30] [40] [50] [80] ksi, [26] [24] [22] [20] [18] gauge and depth as indicated, conforming to ASTM A1008/A1008M, ASTM A36/A36M. Ensure the material is plumb and true, and within the tolerances listed:

[a. Galvanized/Galvannealed steel sheet conforming to ASTM A123/A123M, ASTM A653/A653M, ASTM A792/A792M, and AISI D100.

] b. Metallic coated steel sheet in accordance with ASTM A924/A924M.

[c. Aluminum-Zinc Alloy-coated sheet steel in accordance with ASTM A463/A463M, ASTM A755/A755M, ASTM A792/A792M and AISI D100.

][d. Steel sheet with porcelain coating in accordance with ASTM A424/A424M, ASTM C286, and PEI 1001, or ASTM A606/A606M for improved atmospheric corrosion resistance.

] e. Provide individual panels with a continuous length that covers the entire length of any unbroken roof slope with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

f. Provide panels with thermal expansion and contraction consistent with the type of system specified.

[(1) Profile and coverage: a minimum height and width from manufacturer's standard for the indicated roof slope.

][(2) Profile: a 3.8 cm 1 1/2 inch high rib at 30.5 cm 12 inches o.c. with small stiffening ribs, 96.5 cm 38 inch overall width with 91.5 cm 36 inch coverage and exposed fasteners.

][(3) Profile: a 3.8 cm 1 1/2 inch high rib at 18.3 cm 7.2 inches o.c., 98.75 cm 38-7/8 inch overall width with 91.5 cm 36 inchcoverage and exposed fasteners.

][(4) Profile: a 2.54 cm 1 inch high rib at 10.2 cm 4 inches o.c., 126 cm 49-5/8 inch overall width with [122][112] cm [48] [44] inch coverage and exposed fasteners.

][(5) Profile: a 2.54 cm 1 inch high rib at 20.3 cm 8 inches o.c., 106 cm 41-5/8 inch overall width with 102 cm 40 inch coverage and exposed fasteners.

][(6) Profile: a 2.22 cm 7/8 inch high corrugated rib at 5.08 cm 2 inches o.c., 98.74 cm 38-7/8 inch overall width with 91.44 cm 36 inch coverage and exposed fasteners.

][(7) Profile: a 7.6 cm 3 inch high standing seam, 61 cm 24 inch coverage, factory-caulked and with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(8) Profile: a [2.54][4.45][5.08][6.35] cm [1][1 3/4][2][2 1/2] inch high standing seam, [30.5][40.6][46] cm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) Provide [smooth, flat] [embossed] surface texture.

]][2.4.3 Foam-Insulation Core Roof Panel

Provide factory-formed [aluminum] [steel] roof panel assembly fabricated from two sheets of metal with modified polyisocyanurate or polyurethane foam insulation core [foamed-in-place] [board] during fabrication with joints between panels designed to form weather-tight seals. Include accessories required for weather-tight installation.

a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.

b. Density: 32 to 42 kg/cu. m 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622.

c. Compressive Strength: Minimum 140 kPa 20 psi when tested according to ASTM D1621.

d. Shear Strength: 179 kPa 26 psi when tested according to ASTM C273/C273M.

]2.4.4 Insulated Panel Construction

Shop-fabricate or field-assemble insulated panel construction with specified exterior and interior [aluminum] [steel] sheet in accordance with manufacturer's printed instructions.

Provide pre-finished interior lath- or board-finished interior surfaces for panel assemblies in accordance with ASTM C1396/C1396M.

Provide [glass-fiber] [slag-wool-fiber] [rock-wool-fiber] insulation conforming to ASTM C553 and ASTM C612 of thickness and density as required for the geographical area where construction will take place. Glass-fiber and mineral-wool-fiber are materials listed in the EPA's Comprehensive Procurement Guidelines (CPG) https://www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products Submit a sample of insulation approximately 20 by 28 cm 8 inches by 11 inches.

Provide adhesively attached insulation fasteners plate-welded to projecting spindle anchors, capable of holding insulation of thickness indicated, secured in position with self-locking washers and complying with the following requirements:

a. Plate: Perforated galvanized carbon-steel sheet, 0.762 mm 0.030 inch thick by 50 m 2 inches square.

b. Spindle: Copper-coated, low-carbon steel; fully annealed; 2.67 mm 0.105 inch in diameter; length to suit depth of insulation indicated.

c. Insulation-Retaining Washers: Self-locking washers formed from 0.41-mm 0.016 inch thick galvanized steel sheet, with a beveled edge for increased stiffness, sized as required to hold insulation in place, but not less than 38 mm 1 1/2 inches square or in diameter.

d. Adhesive: Provide an anchor adhesive to bond insulation anchors to the substrates indicated without damaging insulation, fasteners, and substrates.

2.4.5 Finish

Ensure all panels receive a factory-applied [polyvinylidene fluoride] [Kynar 500/Hylar 5000] [_____] finish consisting of a baked-on top-coat and a manufacturer's recommended prime coat with to the following:

a. Metal Preparation: Prepare all metal surfaces for painting on a continuous process coil coating line by alkali cleaning, hot-water rinsing, application of chemical conversion coating, cold-water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: Apply a base-coat of epoxy paint, specifically formulated to interact with the top-coat, to the prepared surfaces by roll-coating the paint to a dry film thickness of 0.20 mils plus 0.05 mils. Ensure that the prime coat is oven-cured before the application of finish coat is applied.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll-coating the finish coating to a dry film thickness of 0.80 plus 5 mils (3.80 plus 0.50 mils for Vinyl Plastisol) for a total dry-film thickness of 1.00 mils plus 0.10 mils (4.00 mils plus 0.10 mils for Vinyl Plastisol). Ensure that the finish coat is oven-cured.

d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll-coating to a dry-film thickness of 0.30 mils plus 0.05 mils for a total-dry film thickness of 0.50 mils plus 0.10 mils. Ensure that the wash-coat is oven-cured.

e. Color: Ensure that the exterior finish is as chosen from the manufacturer's standard color chart.

f. Coating Physical Properties: Provide coating conforming to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

    (1) Chalking: ASTM D4214

    (2) Coating Thickness: ASTM B659

    (3) Color Change and Conformity: ASTM D2244

(4) Weatherometer: ASTM G152, ASTM G153 and ASTM D822

(5) Humidity: ASTM D2247 and ASTM D714

(6) Salt Spray: ASTM B117

(7) Chemical Pollution: ASTM D1308

(8) Gloss at 60: ASTM D523

(9) Pencil Hardness: ASTM D3363

(10) Reverse Impact: ASTM D2794

(11) Flexibility: ASTM D522/D522M

(12) Abrasion: ASTM D968

(13) Flame Spread: ASTM E84

2.5 ACCESSORIES

2.5.1 General

Provide only accessories which are compatible with the metal roof panels. Sheet metal flashing, trim, metal closure strips, caps and similar metal accessories can not be less than the minimum thickness specified for the roof panels. Submit a 10 inches long sample of each type. Ensure the exposed metal accessories and finishes match the panels furnished, except as otherwise indicated. Provide molded-foam rib, ridge and other closure strips which are non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match the configuration of the panels.

2.5.2 Rubber Closure Strips

Provide closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified roof panel and in lengths supplied by the roof-panel manufacturer.

2.5.3 Metal Closure Strips

Provide factory fabricated [aluminum] [steel] closure strips of the same [gauge] [thickness], color, finish and profile as the specified roof panel.

2.5.4 Joint Sealants

2.5.4.1 Sealants

Provide an approved gun-type sealant for use in hand- or air-pressure caulking guns at temperatures above 4 degrees C 40 degrees F (or frostfree application at temperatures above minus 12 degrees C 10 degrees F with minimum solid content of 85 percent of the total volume. Provide sealant that has a tough, durable, dry surface skin that permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the roof-panel manufacturer.

a. Shop-Applied Caulking: Use an approved gun-grade, non-sagging one-component polysulfide or silicone conforming to ASTM C920, Type II, with a curing time to ensure the sealant's plasticity at the time of field erection.

b. Field Applied Caulking: Use an approved gun-grade, non-sagging one-component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, conforming to ASTM C920, Type II. Match the color to the panel colors.

c. Tape Sealant: Use a pressure-sensitive, 100 percent solid with a release paper backing, permanently elastic, non-sagging, non-toxic and non-staining as approved by the roof-panel manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

The Contracting Officer may request verification and certification testing of coatings and base metals of metal roofing prior to installation. The following areas may be verified:

a. Examine substrates, areas, and conditions, with the installer present, for compliance with the requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the work.

b. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by the metal roof-panel manufacturer, and as required for the geographical area where construction has taken place.

c. Examine solid roof sheathing to verify that the sheathing joints are supported by framing or blocking and that the installation is within flatness tolerances required by themetal roof-panel manufacturer.

d. Examine roughing-in for components and systems penetrating the metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.

e. Submit to the Contracting Officer a written report, endorsed by the installer, listing conditions detrimental to performance of the work.

f. Proceed with the installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

Clean substrates of substances harmful to insulation, remove projections capable of interfering with insulation attachment.

Install sub-purlins, eave angles, furring, and other miscellaneous roof-panel support members and anchorage according to themetal roof-panel manufacturer's written instructions.

3.3 INSTALLATION

3.3.1 Workmanship

Ensure lines, arises, and angles are sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1.27 cm 1/2 inch hem on the concealed side. Ensure that sheet metal that is exposed to the weather is watertight, with provisions for expansion and contraction.

Ensure surfaces that are to receive sheet metal are plumb and true, clean, even, smooth, dry, and free of defects and projections that might affect the application. Install items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces, and wherever indicated and necessary to make the work watertight.

3.3.2 Roof Panels

Provide metal roof panels of full length from eave to ridge or eave to wall as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of the work in place, with provisions for thermal and structural movement in accordance with NRCA 0429.

[a. Steel Roof Panels: Use stainless-steel fasteners for exterior surfaces and galvanized steel fasteners for interior surfaces.

][b. Aluminum Roof Panels: Use aluminum or stainless-steel fasteners for exterior surfaces and aluminum or galvanized steel fasteners for interior surfaces.

][c. Anchor Clips: Anchor metal roof panels and other components of the work securely in place. Use the manufacturer's approved fasteners according to the manufacturer's written instructions.

] d. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating conforming to SSPC PS 9.01, by applying rubberized-asphalt underlayment to each contact surface, or with another means to separate the metals and contact surface as recommended by metal roof-panel manufacturer.

e. Joint Sealers: Install gaskets, joint fillers, and sealants where required for weatherproof performance of metal roof panel assemblies. Provide the types of gaskets, fillers, and sealants indicated; or if not indicated, provide types recommended by the metal roof panel-manufacturer.

Erect the roofing system in accordance with the approved erection drawings, the printed instructions and the safety precautions of the manufacturer.

Do not overload, abuse, or subject sheets to undue impact. Do not apply bent, chipped, or defective sheets.

Erect sheets true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated rake, eave, and curb overhang.

Allow for thermal movement of the roofing and movement of the building structure, and provide permanent freedom from noise caused by wind pressure.

Field cutting metal roof panels by torch is not permitted.

Lay roofing sheets with corrugations in the direction of the roof slope. End laps of exterior roofing cannot be less than 20.3 cm 8 inches; the side laps of standard exterior corrugated sheets cannot be less than 2-1/2 corrugations.

Do not permit storage, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to the installed roofing materials and to distribute weight to conform to the indicated live-load limits of roof construction.

3.3.3   Fasteners

Anchor metal roof panels and other components of the work in place using the manufacturer's approved fasteners according to the manufacturer's written instructions.

3.3.4   Flashing, Trim and Closure

3.3.4.1   General Requirements

Comply with performance requirements, the manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather-resistant.

Install sheet metalwork to form weathertight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Ensure sheet metal mechanics perform cutting, fitting, drilling, and other operations in connection with sheet metal work required to accommodate the work of other trades.

3.3.4.2   Metal Flashing

Install metal flashing at building corners, rakes and eaves, junctions between metal siding and roofing, valleys and changes of slope or direction in metal roofing, and building expansion joints and gutters.

Provide exposed metal flashing that is the same material, color, and finish as the specified metal roofing.

Fasten flashing at not more than 20.8 cm 8 inches on-center for roofs, except where flashing are held in place by the same screws that secure covering sheets.

Furnish flashing in at least 2.44 m 8 foot lengths. Provide exposed flashing that has 2.54 cm 1 inch locked and blind-soldered end joints, and expansion joints at intervals of not more than 4.88 m 16 feet.

Bed exposed flashing and flashing subject to rain penetration in the specified joint sealant.

To prevent electrolytic deterioration, isolate flashing that is in contact with dissimilar metals by means of the specified asphalt-mastic material.

Form drips to the profile indicated, with the edge folded back 1.27 cm 1/2 inch to form a reinforced drip edge.

3.3.4.3 Closures

Install metal closure strips at the open ends of corrugated or ribbed pattern roofs, and at the intersection of wall and roof unless open ends are concealed with formed eave flashing, at the rake of the metal roof unless the open end has a formed flashing member, and in other required areas.

Install mastic closure strips at the intersection of the wall with metal roofing, a the top and bottom of metal siding, at the heads of wall openings, and in other required locations.

3.3.5 Information Form and Placard

For each roof, furnish a typewritten information card for facility records and a card laminated in plastic and framed for interior display at the roof access point, or a photoengraved 1 mm 0.032 inch thick aluminum card for exterior display. Format the card as directed in paragraph FORM ONE.

Provide an information card 215 mm by 275 mm 8 1/2 inches by 11 inches minimum, identifying the facility name and number, location, contract number, approximate roof area, detailed roof system description, including deck type, roof panel manufacturer and product name, type underlayment, date of completion, installing contractor identification and contact information; manufacturer warranty expiration, warranty reference number, and contact information. Install the card at [interior roof top access point][_____] and provide a paper copy to the Contracting Officer.

3.4 FIELD QUALITY CONTROL

3.4.1 Acceptance Provisions

3.4.1.1 Erection Tolerances

Erect metal roofing straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Do not vary horizontal lines more than 0.32 cm in 12.2 m 1/8 inch in 40 feet.

3.4.1.2 Leakage Tests

Finished application of metal roofing is subject to inspection and test for leakage by the Contracting Officer, and architect/engineer. Conduct inspections and tests without cost to the Government.

Perform inspections and tests promptly after erection to permit correction of defects and the removal and replacement of defective materials.

3.4.1.3 Repairs to Finish

Repair scratches, abrasions, and minor surface defects in the finish with the specified repair materials. Ensure repaired finished surfaces are uniform and free from variations of color and surface texture.

Immediately remove and replace repaired metal surfaces that are not acceptable to the project requirements with new material.

3.4.1.4 Paint-Finish Metal Roofing

Test paint-finish metal roofing for color stability by the Contracting Officer during the manufacturer's specified guarantee period.

Remove and replace panels that have visual evidence of color changes, fading, or surface degradation, with new panels at no expense to the Government.

Replaced panels are subject to the specified tests for an additional year from the date of their installation.

[3.4.2 Manufacturer's Inspection

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NOTE: Include this paragraph when manufacturer's inspection of work is required. Select desired frequency of manufacturer inspection and coordinate with text of optional 2nd and 3rd bracketed sentences.

****

Ensure the manufacturer's technical representative visits the site a minimum of [[three][_____] times][once per week] during the installation to review material installation practices and to verify the adequacy of work in place.[Make inspections during the first 20 squares of roof panel installation, at mid-point of the installation, and at substantial completion, at a minimum. Additional inspections are required for each 100 squares of total roof area, with the exception that follow-up inspections of previously noted deficiencies or application errors are performed as requested by the Contracting Officer.] After each inspection, submit a report, signed by the manufacturer's technical representative, to the Contracting Officer within 3 working days. Note in the report the overall quality of work, deficiencies, and any other concerns, and recommended corrective action.

Submit three [_____] signed copies of the manufacturer's field inspection reports to the Contracting Officer within one week of substantial completion.

]3.4.3 Repair of Finish Protection

Provide repair paint for color-finish enameled roofing that is compatible with the paint of the same formula and color as the specified finish furnished by the roofing manufacturer.

3.5 ADJUSTING AND CLEANING

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings, and drilling debris and scrub the work clean. Ensure exposed metal surfaces are free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

Collect and place scrap/waste materials in containers. Dispose of demolished materials immediately. Do not allow demolished materials to accumulate on-site; transport demolished materials from government property and legally dispose of them.

3.6 SCHEDULES

3.6.1 Form One

FORM 1 - PREFORMED [STEEL][ALUMINUM] PANEL ROOFING SYSTEM AND COMPONENTS

1. Contract Number:

2. Building Number & Location:

3. NAVFAC Specification Number:

4. Deck/Substrate Type:

5. Slopes of Deck/Roof Structure:

6. Insulation Type & Thickness:

7. Insulation Manufacturer:

8. Vapor Retarder: ( )Yes ( )No

9. Vapor Retarder Type:

10. Preformed Steel Standing Seam Roofing Description:

a. Manufacturer (Name, Address, & Phone No.):
b. Product Name: c. Width: d. Gage:
e. Base Metal: f. Method of Attachment:

11. Repair of Color Coating:

a. Coating Manufacturer (Name, Address & Phone No.):
b. Product Name:
c. Surface Preparation:
d. Recoating Formula:
e. Application Method:

12. Statement of Compliance or Exception:____________________________________
____
____

13. Date Roof Completed:

14. Warranty Period: From_______________ To_______________

15. Roofing Contractor (Name & Address):

16. Prime Contractor (Name & Address):

Contractor's Signature __________________________ Date:

Inspector's Signature __________________________ Date:

3.6.2 Warranty

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NOTE: Include the attached four page warranty document for Army projects only. Coordinate with the warranty text in Part 1 of this specification.

UFGS

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CONTRACTOR'S [FIVE (5)][TEN (10)][TWENTY (20)] YEAR NO PENAL SUM WARRANTY FOR NON-STRUCTURAL METAL ROOF SYSTEM

FACILITY DESCRIPTION____

BUILDING NUMBER:____

CORPS OF ENGINEERS CONTRACT NUMBER:__________________________________

CONTRACTOR

CONTRACTOR:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

OWNER

OWNER:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

CONSTRUCTION AGENT

CONSTRUCTION AGENT:____

ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

CONTRACTOR'S [FIVE (5)][TEN (10)][TWENTY (20)] YEAR NO PENAL SUM WARRANTY FOR NON-STRUCTURAL METAL ROOF SYSTEM

(continued)

THE NON-STRUCTURAL METAL ROOF SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY _____________________________ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. FOR THE NON-STRUCTURAL METAL ROOFING SYSTEM COVERED UNDER THIS WARRANTY INCLUDE, BUT DO NOT LIMIT TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH UL 580. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHING INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE NON-STRUCTURAL METAL ROOFING SYSTEM.

REPAIR ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE ASSOCIATED WITH THE NON-STRUCTURAL METAL ROOF SYSTEM COVERED UNDER THIS WARRANTY AS APPROVED BY THE CONTRACTING OFFICER. IN THIS WARRANTY COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON ____________________________ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

____

(Company President) (Date)

CONTRACTOR'S [FIVE (5)][TEN (10)][TWENTY (20)] YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOFING SYSTEM
(continued)

ENSURE THE CONTRACTOR SUPPLEMENTS THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE NON-STRUCTURAL METAL ROOFING SYSTEM.SUBMIT ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR IS ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE NON-STRUCTURAL METAL ROOF DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. IN CONTRACTOR'S DESIGN ENSURE FREE DRAINAGE FROM THE ROOF AND DO NOT ALLOW PONDING WATER.

6. THIS WARRANTY APPLIES TO THE NON-STRUCTURAL METAL ROOFING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

CONTRACTOR'S [FIVE (5)][TEN (10)][TWENTY (20)] YEAR NO PENAL SUM WARRANTY
FOR
NON-STRUCTURAL METAL ROOF SYSTEM
(continued)

**RESPOND TO REPORTS OF LEAKS AND ROOF SYSTEM DEFICIENCIES WITHIN 48 HOURS OF RECEIPT OF NOTICE, BY TELEPHONE OR IN WRITING, FROM EITHER THE OWNER OR CONTRACTING OFFICER. INITIATE EMERGENCY REPAIRS TO PREVENT FURTHER ROOF LEAKS IMMEDIATELY; SUBMIT A WRITTEN PLAN FOR APPROVAL TO REPAIR OR REPLACE THIS ROOF SYSTEM WITHIN SEVEN (7) CALENDAR DAYS. COMMENCE ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE NON-STRUCTURAL METAL ROOF SYSTEM REPAIRED OR REPLACED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

UNDER THE CONTRACT DISPUTES ACT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. MAKE THE REQUEST FOR AN ARBITRATOR WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED, WITHIN TEN (10) DAYS, ENSURE THE PARTIES JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES TEN (10) DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR TO CONFER. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE (1) NAME REMAINS. THE REMAINING PERSON IS THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED, ETC., WILL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT PAYS FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. REQUEST A WRITTEN ARBITRATOR'S DECISION NO LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

POST A FRAMED COPY OF THIS WARRANTY IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 42 13 (May 2011)**
Change 2 - 02/18

Preparing Activity: NAVFAC **Superseding**
UFGS-07 42 13 (November 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 07 42 13

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 42 13 (May 2011)**

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SECTION 07 42 13

METAL WALL PANELS

05/11, CHG 2: 02/18

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NOTE: This guide specification covers the requirements for both factory color and mill finish aluminum or steel non-structural metal wall panels.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This section does not include light gage siding for temporary construction, housing, or pre-engineered metal buildings, or decorative wall panels.

Coordinate this section with other system components specifications such as framing, insulation and sheet metal flashing. Also coordinate with applicable Unified Facilities Criteria as it relates to the specific project.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual
AA ASD1	(2024) Aluminum Standards and Data

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501.1	(2017) Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
AAMA 800	(2016) Voluntary Specifications and Test Methods for Sealants

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 341	(2016) Seismic Provisions for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2012) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A424/A424M	(2009a; R 2016) Standard Specification for Steel Sheet for Porcelain Enameling
ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A606/A606M	(2023) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A755/A755M	(2018; R 2024) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet,

	Metallic-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C286	(2022) Standard Terminology Relating to Porcelain Enamel and Ceramic-Metal Systems
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D610	(2008; R 2019) Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride)

	Foam (Closed-Cell)
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D4587	(2011; R 2019; E 2019) Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
ASTM D5894	(2016) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM E72	(2022) Conducting Strength Tests of Panels for Building Construction
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light

	Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA MBSM	(2018) Metal Building Systems Manual

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

PORCELAIN ENAMEL INSTITUTE (PEI)

PEI 1001	(1996) Specification for Architectural Porcelain Enamel (ALS-100)
PEI CG-3	(2005) Color Guide for Architectural Porcelain Enamel

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2013) Leadership in Energy and Environmental Design(tm) New Construction Rating System

UL SOLUTIONS (UL)

UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 DEFINITIONS

Metal Wall Panel: Metal wall panels, attachment system components and accessories necessary for a complete weather-tight wall system.

1.3 DESCRIPTION OF WALL PANEL SYSTEM

****

NOTE: Coordinate with Part 2 materials specification.

In the first sentence, select finish type, metal type, attachment type and delete other options.

In the second sentence, select a combination of options as necessary to describe the generic profile required. Include the last bracketed option of the second sentence when generic profile is shown on

drawings. Show panel profile and dimensions on the drawings when a particular aesthetic appearance is desired.
****

[Factory color finished,][Mill finish][galvanized][galvalume][aluminum]metal wall panel system with[concealed fastening][exposed fastener] attachment. Panel profile must be[embossed][recessed seam lock][flush face][smooth face][recessed bead][raised bead][striated][square ribbed][beaded rib][roll lock seam][snap lock seam][box rib][corrugated][standing seam][batten seam][and with stiffening ribs in the flat of the panel][as shown on drawings].

1.3.1 Metal Wall Panel General Performance

Comply with performance requirements, conforming to AISI S100, without failure due to defective manufacture, fabrication, installation, or other defects in construction. Wall panels and accessory components must conform to the following standards:

ASTM A1008/A1008M

ASTM A123/A123M

ASTM A36/A36M

[ASTM A424/A424M, ASTM C286, PEI 1001, PEI CG-3 for Porcelain and Ceramic Enameling

] ASTM A653/A653M

[ASTM A463/A463M for aluminum coated steel sheet

] ASTM A606/A606M

[ASTM A755/A755M for metallic coated steel sheet for exterior coil pre-painted applications.

][ASTM A780/A780M for repair of damage or uncoated areas of hot-dipped galvanized coating.

][ASTM A924/A924M for metallic coated steel sheet

] ASTM D522/D522M for applied coatings

UL Bld Mat Dir

1.3.2 Structural Performance

Maximum calculated fiber stress must not exceed the allowable value in the AISI or AA manuals; a one third overstress for wind is allowed. Midspan deflection under maximum design loads is limited to L/180. Contract drawings show the design wind loads and the extent and general assembly details of the metal siding. Contractor must provide design for members and connections not shown on the drawings. Siding panels and accessories must be the products of the same manufacturer.

Provide metal wall panel assemblies complying with the load and stress requirements in accordance with ASTM E1592. Wind Load force due to wind action governs the design for panels.

Wall systems and attachments are to resist the wind loads as determined by ASTM E72 and ASCE 7-16 in the geographic area where the construction will take place, in pounds per square foot. Submit [five][_____] copies of wind load tests and seismic tests to the Contracting Officer.

[Provide metal wall panel assembly for seismic conditions complying with the applicable requirements of AISC 341.

]1.3.3 Air Infiltration

Air leakage must conform to the limits through the wall assembly area when tested according to ASTM E283.

1.3.4 Water Penetration Under Static Pressure

No water penetration when tested according to ASTM E331.

1.3.5 Water Penetration Under Dynamic Pressure

No evidence of water leakage when tested according to AAMA 501.1.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Documentation for the following items:

Qualification of Manufacturer; G, [_____]

Qualification of Installation Contractor; G, [_____]

[Qualification of Welders; G, [_____]

] Sample Warranty; G, [_____]

SD-02 Shop Drawings

Installation Drawings ; G, [_____]

SD-03 Product Data

Recycled Content; (LEED NC)

Submit Manufacturer's data indicating percentage of recycle material in wall panels to verify sustainable acquisition compliance.

Submit Manufacturer's catalog data for the following items:

Wall Panels ; G, [_____]

Factory Color Finish

Closure Materials

Pressure Sensitive Tape

Sealants and Caulking

Galvanizing Repair Paint

Enamel Repair Paint

Aluminized Steel Repair Paint

Accessories

SD-04 Samples

Submit as required each of the following samples:

Wall Panels, 30.5 cm 12 inches long by actual panel width; G, [_____]

Fasteners; G, [_____]

Metal Closure Strips, 2.50 cm 10 inches long of each type; G, [_____]

Color chart and chips ; G, [_____]

Submit manufacturer's color charts and chips, approximately 4 by 4 inches, showing full range of colors, textures and patterns available for wall panels with factory applied finishes.

SD-05 Design Data

Wind load design analysis ; G, [_____]

As applicable, submit the following wind load design analysis data, to include, but not limited to: wind speed, exposure category, co-efficient,importance factor, type of facility, negative pressures for each zone, methods and requirements of attachment.

SD-06 Test Reports

Submit test reports for the following in accordance with the referenced articles in this section.

Leakage Tests; G, [_____]

Wind Load Tests; G, [_____]

Coating Tests; G, [_____]

Chalking Tests; G, [_____]

[Seismic Tests; G, [_____]]

SD-07 Certificates

Submit certificates for the following items showing conformance with referenced standards contained in this section:

Coil Stock; G, [_____]

Fasteners; G, [_____]

Galvanizing Repair Paint; G, [_____]

Enamel Repair Paint; G, [_____]

SD-08 Manufacturer's Instructions

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications.

Installation of Wall panels; G, [_____]

SD-09 Manufacturer's Field Reports

Submit [_____] bound copies of the Manufacturer's Field Reports; G, [_____]

SD-11 Closeout Submittals

Warranty; G, [_____]

Maintenance Instructions; G, [_____]

20 year "No Dollar Limit" warranty for labor and material

1.5 QUALITY ASSURANCE

1.5.1 Pre-Installation Conference

Upon notification of submittal receipt and approval by the Contracting Officer; and prior to the commencement of the work, the Contractor must attend a pre-installation conference to review the following:

a. Drawings and Specifications.

b. Qualification of Installer[, Qualification of Welders].

c. Sustainable acquisition

d. Approved Warranty

e. Sample wall panels, 30.5 cm 12 inches long by actual panel width

f. Sample metal closure strips, 2.50 cm 10 inches long of each type

g. Color charts and chips

h. Coatings and base metal tests, chalking tests

i. Construction schedule, availability of materials, Installer's personnel, equipment and facilities required to progress with the work without delay.

j. Methods and procedures related to installation of wall panels, including manufacturer's written instructions. Explicitly identify in writing, differences between manufacturer's instructions and the specified requirements.

k. Support conditions for compliance with requirements, including alignment between and attachment to structural members.

l. Flashing, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.

m. Governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.

n. Temporary protection requirements for metal wall panel assembly during and after installation.

o. Wall panel observation and repair procedures after metal wall panel installation. Provide detailed written instructions including copies of Safety Data Sheets for maintenance and repair materials, and manufacturer's maintenance instructions.

1.5.1.1 Installation Drawings

Installation shop drawings for wall panels, flashing, accessories, and anchorage systems must indicate completely dimensioned structural frame and erection layouts, openings in the wall, special framing details, and construction details at corners, building intersections and flashing, location and type of mastic and metal filler strips.

1.5.1.2 Wind Load Design Analysis

Wind design analysis must include wall plan delineating dimensions and attachment patterns for each zone. Wind design analysis must be prepared and sealed by Licensed Project Engineer in the geographic area where the construction will take place.

1.5.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products and installations in the geographical area where construction will take place.

1.5.3 Qualification of Manufacturer

Certify that metal wall panel system manufacturer has a minimum of five years experience in manufacturing metal wall system and accessory products.

Manufacturer must also provide engineering services by an authorized engineer; currently licensed in the geographical area where construction will take place, having a minimum of four years experience as an engineer knowledgeable in wind load design analysis, protocols and procedures per MBMA MBSM, "Metal Building Systems Manual"; ASCE 7-16, and ASTM E1592[and seismic design conforming to AISC 341].

Provide certified engineering calculations, using the products submitted, for Wind load requirements in accordance with ASCE 7-16.

1.5.3.1 Manufacturer's Certificates

Also provide the following certifications from the manufacturer:

Coil Stock

Fasteners

Galvanizing Repair Paint

Enamel Repair Paint

Submit certification from coil stock manufacturer or supplier that the machinery used will form the provided coil stock without warping, waviness, or rippling that is not a part of the panel profile, and without damage, abrasion or marring of the finish coating.

Provide evidence that products used within this specification are manufactured in the United States.

1.5.4 Certified Qualification of Installation Contractor

The installation contractor must be approved and certified by the metal wall panel manufacturer prior to beginning the installation of the metal wall panel system. Subcontracting by Certified Contractor for the metal wall panel work is not permitted.

[1.5.4.1 Qualifications for Welding Work

Qualification of welders and welding must conform to AWS A5.1/A5.1M, AWS D1.1/D1.1Mfor steel or AWS D1.2/D1.2M for aluminum.

]1.5.5 Single Source

Obtain each type of metal wall panels, clips, closure materials and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.5.6 Manufacturer's Maintenance Instructions

Provide manufacturer's detailed written instructions including copies of Safety Data Sheets for maintenance and repair materials.

1.6 DELIVERY, HANDLING, AND STORAGE

Deliver and protect package components, sheets, metal wall panels, and other manufactured items to prevent damage or deformation during transportation and handling.

Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

Stack and store metal wall panels horizontally on platforms or pallets, covered with suitable weather-tight and ventilated covering to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

Retain strippable protective covering on metal wall panel until actual installation.

1.7 PROJECT CONDITIONS

1.7.1 Field Measurements

Verify locations of wall framing and opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.

1.7.2 Weather Limitations

Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into wall system or building.

1.8 WARRANTY

Warranty must conform to the Sample Warranty as reviewed and approved by the Contracting Officer.

1.8.1 20 Year "No Dollar Limit" Warranty for Labor and Material

Furnish manufacturer's no-dollar-limit warranty for the metal wall panel system. The warranty period is to be no less than 20 years from the date of Government acceptance of the work. The warranty is to be issued directly to the Government. The warranty is to provide that if within the warranty period the metal wall panel system shows evidence of corrosion, perforation, rupture or excess weathering due to deterioration of the wall panel system resulting from defective materials and correction of the defective workmanship is to be the responsibility of the metal wall panel system manufacturer. Repairs that become necessary because of defective materials and workmanship while metal wall panel system is under warranty are to be performed within 24 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 24 hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty.

PART 2 PRODUCTS

2.1 FABRICATION

Unless approved otherwise, fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated and specified performance requirements. Comply with indicated profiles and with dimensional and structural requirements. See section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements.

Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel. Fabricate metal wall panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within panel assembly.

2.1.1 Sheet Metal Accessories

Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: fabricate nonmoving end seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA 1793.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA 1793 or by metal wall panel manufacturer for application, but not less than thickness of metal being secured.

2.2 PANEL MATERIALS

[2.2.1 Aluminum Sheet

Roll-form aluminum wall panels to the specified profile, with fy = [2.12][2.81][3.52][5.63] kscm [30][40][50][80] ksi, [0.81][1.02][1.27] mm [.032][.040][.050] inches thickness and depth as indicated. Material must be plumb and true, and within the tolerances listed:

a. Aluminum Sheet conforming to ASTM B209M ASTM B209, AA ASD1 and AA ADM.

b. Individual panels must be have continuous length to cover the entire length of any wall area with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

c. Provide panels with thermal expansion and contraction consistent with the type of system specified.

[(1) Profile and coverage to be a minimum height and width from manufacturer's standard for the indicated wall area.

][(2) Profile to be a 3.81 cm 1-1/2 inch high rib at 30.48 cm 12 inches o.c. with small stiffening ribs, 96.52cm 38 inch overall width with 91.44 cm 36 inch coverage and exposed fasteners.

][(3) Profile to be a 3.81 cm 1-1/2 inch high rib at 18.29 cm 7.2 inches o.c., 96.52cm 38-7/8 inch overall width with 91.44 cm 36 inch coverage and exposed fasteners.

][(4) Profile to be a 2.54 cm 1 inch high rib at 10.16 cm 4 inches o.c., 126.05 cm 49-5/8 inch overall width with [122][112] cm [48][44] inch coverage and exposed fasteners.

][(5) Profile to be a 2.54 cm 1 inch high rib at 20.32 cm 8 inches o.c., 105.73 cm 41-5/8 inch overall width with 101.6 40 inch coverage and exposed fasteners.

][(6) Profile to be a 4.45 cm 1-3/4 inch high V-beam rib at 12.7 cm 5 inches o.c., 114 cm 44-7/8 inch overall width with 106.7 cm 42 inch coverage and exposed fasteners.

][(7) Profile to be a 2.22 cm 7/8 inch high corrugated rib at 5.08 cm 2 inches o.c., 96.52cm 38-7/8 inch overall width with 91.44 cm 36 inch coverage and exposed fasteners.

][(8) Profile to be a 7.62 cm 3 inch high standing seam, 60.96 cm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) Profile to be a [2.54][4.45][5.08][6.35] cm [1][1-3/4][2][2-1/2] inch high standing seam, [30.5][40.64][45.72] cm [12][16][18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(10) [Smooth, flat][Embossed]surface texture.

]][2.2.2 Steel Sheet

Roll-form steel wall panels to the specified profile, with fy= [2.12][2.81][3.52][5.63] kscm [30][40][50][80] ksi, [26] [24] [22] [20] [18] gauge and depth as indicated. Material must be plumb and true, and within the tolerances listed:

[a. Galvanized Steel Sheet conforming to ASTM A653/A653M and AISI SG03-3.

][b. Aluminum-Zinc Alloy-coated Steel Sheet conforming to ASTM A792/A792M and AISI SG03-3.

] c. Individual panels must be continuous length to cover the entire length of any unbroken wall area with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

d. Provide panels with thermal expansion and contraction consistent with the type of system specified.

[(1) Profile and coverage to be a minimum height and width from manufacturer's standard for the indicated wall area.

][(2) Profile to be a 3.81 cm 1-1/2 inch high rib at 30.48 cm 12 inches o.c. with small stiffening ribs, 96.52cm 38 inch overall width with 91.44 cm 36 inch coverage and exposed fasteners.

][(3) Profile to be a 3.81 cm 1-1/2 inch high rib at 18.29 cm 7.2 inches o.c., 96.52cm 38-7/8 inch overall width with 91.44 cm 36 inch coverage and exposed fasteners.

][(4) Profile to be a 2.54 cm 1 inch high rib at 10.16 cm 4 inches o.c., 126.05 cm 49-5/8 inch overall width with [122][112] cm [48][44] inch coverage and exposed fasteners.

][(5) Profile to be a 2.54 cm 1 inch high rib at 20.32 cm 8 inches o.c., 105.73 cm 41-5/8 inch overall width with 101.6 40 inch coverage and exposed fasteners.

][(6) Profile to be a 2.22 cm 7/8 inch high corrugated rib at 5.08 cm 2 inches o.c., 96.52cm 38-7/8 inch overall width with 91.44 cm 36 inch coverage and exposed fasteners.

][(7) Profile to be a 7.62 cm 3 inch high standing seam, 60.96 cm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][(8) Profile to be a [2.54][4.45][5.08][6.35] cm [1][1-3/4][2][2-1/2] inch high standing seam, [30.5][40.64][45.72] cm [12][16][18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) [Smooth, flat][Embossed]Surface Texture.

]]2.2.3 Factory Color Finish

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes. Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

All panels are to receive a factory-applied [polyvinylidene fluoride] [Kynar 500/Hylar 5000] [_____] finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat conforming to the following:

2.2.3.1 Metal Preparation

Carefully prepare all metal surface for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough drying.

2.2.3.2 Prime Coating

Apply a base coat of epoxy paint, specifically formulated to interact with the top-coat, to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. Prime coat must be oven cured prior to application of finish coat.

2.2.3.3 Exterior Finish Coating

Roll coat the finish coating over the primer by roll coating to dry film thickness of 0.80 plus 5 mils (3.80 plus 0.50 mils for Vinyl Plastisol) for a total dry film thickness of 1.00 plus 0.10 mils (4.00 plus 0.10 mils for Vinyl Plastisol). Oven-cure finish coat.

2.2.3.4 Interior Finish Coating

Apply a wash-coat on the reverse side over the primer by roll coating to a dry film thickness of 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. Oven-cured the wash coat.

2.2.3.5 Color

Provide exterior finish color as [selected by the Contracting Officer from the manufacturer's standard color chart][as specified].

2.2.3.6 Physical Properties

Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

General:	ASTM D5894 and ASTM D4587
Abrasion:	ASTM D968
Adhesion:	ASTM D3359
Chalking:	ASTM D4214
Chemical Pollution:	ASTM D1308
Color Change and Conformity:	ASTM D2244

Creepage:	ASTM D1654
Cyclic Corrosion Test:	ASTM D5894
Flame Spread:	ASTM E84
Flexibility:	ASTM D522/D522M
Formability:	ASTM D522/D522M
Gloss at 60 and 85 degrees:	ASTM D523
Humidity:	ASTM D2247 and ASTM D714
Oxidation:	ASTM D610
Pencil Hardness:	ASTM D3363
Reverse Impact:	ASTM D2794
Salt Spray:	ASTM B117
Weatherometer:	ASTM G152, ASTM G153 and ASTM D822

2.3 MISCELLANEOUS METAL FRAMING

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M and specified in Section 05 40 00 COLD-FORMED METAL FRAMING unless otherwise indicated.

2.3.1 Fasteners for Miscellaneous Metal Framing

Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 2.54 cm 1 inch with other properties required to fasten miscellaneous metal framing members to supporting members and substrates in accordance with the wall panel manufacturer's and ASCE 7-16 requirements.

2.4 FASTENERS

2.4.1 General

2.4.1.1 Exposed Fasteners

Provide corrosion resistant fasteners for wall panels, made of coated steel, aluminum, [300 - series corrosion resisting stainless steel][305 - series corrosion resisting stainless steel], or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads.

Fasteners for accessories must be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately 0.24 cm 3/32 inch thick.

2.4.1.2 Hidden Fasteners

Provide corrosion resistant fasteners recommended by the manufacturer to meet the performance requirements and design loads.

2.4.1.3 Screws

Screws to be corrosion resistant coated steel, aluminum and/or [300 - series][305 - series] stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

2.4.1.4 Rivets

Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

2.4.1.5 Attachment Clips

Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A653/A653M, Z275 G 90 or Series 300 stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.5 ACCESSORIES

2.5.1 General

All accessories must be compatible with the metal wall panels. Sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the wall panels. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips must be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

2.5.2 Rubber Closure Strips

Provide closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified wall panel and in lengths supplied by the wall panel manufacturer.

2.5.3 Metal Closure Strips

Provide factory fabricated[aluminum][steel] closure strips to be the same[gauge][thickness], color, finish and profile of the specified wall panel.

2.5.4 Joint Sealants

2.5.4.1 Sealants and Caulking

Provide approved gun type sealants for use in hand- or air-pressure caulking guns at temperatures above 4 degrees C 40 degrees F (or frost-free application at temperatures above minus 12 degrees C 10 degrees F with minimum solid content of 85 percent of the total volume. Sealants must dry with a tough, durable surface skin which permit remaining soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

Prime all joints receiving sealants with a compatible one-component or two-component primer as recommended by the wall panel manufacturer.

2.5.4.2 Shop-Applied

Sealant for shop-applied caulking must be non-curing butyl compliant with AAMA 800 to ensure the sealant's plasticity at the time of field erection.

2.5.4.3 Field-Applied

Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C920, Type II. Color to match panel colors.

2.5.4.4 Pressure Sensitive Tape

Provide pressure sensitive tape sealant, 100 percent solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the wall panel manufacturer.

2.6 SHEET METAL FLASHING AND TRIM

2.6.1 Fabrication

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.7 REPAIR OF FINISH PROTECTION

Repair paint for color finish enameled wall panel must be compatible paint of the same formula and color as the specified finish furnished by the wall panel manufacturer. Provide [_____][pints][quarts] of [aluminized steel repair paint][repair paint matching the specified wall panels].

PART 3 EXECUTION

3.1 EXAMINATION

Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of the Work.

Examine primary and secondary wall framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal wall panel manufacturer, UL, ASTM, ASCE 7-16 and as required for the geographical area where construction will take place.

Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

Submit to the Contracting Officer a written report, endorsed by Installer, listing conditions detrimental to performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment. Miscellaneous framing installation, including sub-purlins, girts, angles, furring, and other miscellaneous wall panel support members and anchorage must be according to metal wall panel manufacturer's written instructions.

3.3 WALL PANEL INSTALLATION

Provide full length metal wall panels, from sill to eave as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement in accordance with MBMA MBSM.

Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Bent, chipped, or defective sheets shall not be applied.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated eave, and sill.

Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

Field cutting metal wall panels by torch is not permitted.

[3.3.1 Steel Wall Panels

Use stainless-steel fasteners for exterior surfaces and galvanized steel fasteners for interior surfaces.

][3.3.2 Aluminum Wall Panels

Use aluminum or stainless-steel fasteners for exterior surfaces and aluminum or galvanized steel fasteners for interior surfaces.

][3.3.3 Anchor Clips

Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

]3.3.4 Metal Protection

Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

3.3.5 Joint Sealers

Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

3.4 FASTENER INSTALLATION

Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

3.5 FLASHING, TRIM AND CLOSURE INSTALLATION

3.5.1 General Requirements

Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams to form permanently watertight and weather resistant.

Install sheet metal work is to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

3.5.2 Metal Flashing

Install exposed metal flashing at building corners, sills and eaves, junctions between metal siding and walling. Exposed metal flashing must be the same material, color, and finish as the specified metal wall panel.

Fasten flashing at a minimum of 20.3 cm 8 inches on center, except where flashing is held in place by the same screws that secure covering sheets.

Flashing is to be furnished in at least 2.44 m 8 foot lengths. Exposed flashing is to have 2.54 cm 1 inch locked and blind-soldered end joints, and expansion joints at intervals of not more than 4.88 m 16 feet.

Exposed flashing and flashing subject to rain penetration to be bedded in the specified joint sealant.

Isolate flashing which is in contact with dissimilar metals by means of the specified asphalt mastic material to prevent electrolytic deterioration.

Form drips to the profile indicated, with the edge folded back 1.27 cm 1/2 inch to form a reinforced drip edge.

3.5.3 Closures

Install metal closure strips at open ends of corrugated or ribbed pattern walls, and at intersection of wall and wall unless open ends are concealed with formed eave flashing; and in other required areas.

Install mastic closure strips at intersection of the wall with metal walling; top and bottom of metal siding; heads of wall openings; and in other required locations.

3.6 WORKMANSHIP

Make lines, arises, and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1.27 cm 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections which might affect the application. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight.

3.7 ACCEPTANCE PROVISIONS

3.7.1 Erection Tolerances

Erect metal wall panels straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions.

3.7.2 Leakage Tests

Finished application of metal wall panels are to be subject to inspection and test for leakage by request of the Contracting Officer, Architect/Engineer. Conduct inspection and tests at no cost to the Government.

Inspection and testing is to be made promptly after erection to permit correction of defects and the removal and replacement of defective materials.

3.7.3 Repairs to Finish

Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials. Finished repaired surfaces must be uniform and free from variations of color and surface texture.

Repaired metal surfaces that are not acceptable to the project requirements [and][or] Contracting Officer are to be immediately removed and replaced with new material.

3.7.4 Paint-Finish Metal Siding

Paint-finish metal siding will be tested for color stability by the Contracting Officer during the manufacturer's specified guarantee period.

Panels that indicate color changes, fading, or surface degradation, determined by visual examination, must be removed and replaced with new panels at no expense to the Government.

New panels will be subject to the specified tests for an additional year from the date of their installation.

3.8 FIELD QUALITY CONTROL

3.8.1 Construction Monitoring

Make visual inspections as necessary to ensure compliance with specified requirements. Additionally, verify the following:

a. Materials comply with the specified requirements.

b. All materials are properly stored, handled and protected from damage. Damaged materials are removed from the site.

c. Framing and substrates are in acceptable condition, in compliance with specification, prior to application of wall panels.

d. Panels are installed without buckles, ripples, or waves and in uniform alignment and modulus.

e. Side laps are formed, sealed, fastened or seam locked as required.

f. The proper number, type, and spacing of attachment clips and fasteners are installed.

g. Installer adheres to specified and detailed application parameters.

h. Associated flashing and sheet metal are installed in a timely manner in accord with the specified requirements.

Provide [five][_____] bound copies of Manufacturer's Field Reports to the Contracting Officer [two][_____] weeks prior to project close-out.

3.9 CLEAN-UP AND DISPOSAL

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces must be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

Collect and place scrap/waste materials in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site; transport demolished materials from government property and legally dispose of them.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 42 63 (May 2011)**
Change 4 - 08/20

Preparing Activity: NAVFAC **Superseding**
UFGS-07 42 63 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 42 63

FABRICATED WALL PANEL ASSEMBLIES

05/11, CHG 4: 08/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 42 63 (May 2011)**
Change 4 - 08/20

Preparing Activity: NAVFAC **Superseding**
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SECTION 07 42 63

FABRICATED WALL PANEL ASSEMBLIES

05/11, CHG 4: 08/20

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NOTE: This guide specification covers the requirements for both factory color and mill finish fabricated aluminum or steel structural metal wall panel assemblies.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: Coordinate this section with other system components specifications such as framing, insulation and sheet metal flashing. Also coordinate with applicable Unified Facilities Criteria as it relates to the specific project.

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual
AA ASD1	(2024) Aluminum Standards and Data

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501.1	(2017) Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 341	(2016) Seismic Provisions for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2012) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding

	Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A424/A424M	(2009a; R 2016) Standard Specification for Steel Sheet for Porcelain Enameling
ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A606/A606M	(2023) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A755/A755M	(2018; R 2024) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum

	and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C273/C273M	(2020) Standard Test Method for Shear Properties of Sandwich Core Materials
ASTM C286	(2022) Standard Terminology Relating to Porcelain Enamel and Ceramic-Metal Systems
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622/D1622M	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2244	(2021) Standard Practice for Calculation

	of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D6226	(2021) Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA MBSM	(2018) Metal Building Systems Manual

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

PORCELAIN ENAMEL INSTITUTE (PEI)

PEI 1001	(1996) Specification for Architectural Porcelain Enamel (ALS-100)
PEI CG-3	(2005) Color Guide for Architectural Porcelain Enamel

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

UL ENVIRONMENT (ULE)

ULE Greenguard	UL Greenguard Certification Program

UL SOLUTIONS (UL)

UL 580	(2006; Reprint Apr 2024) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies
UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 DEFINITIONS

Fabricated Wall Panel Assembly: Metal wall and liner panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories shop fabricated or field assembled for a complete weather-tight wall system.

1.3 DESCRIPTION OF FABRICATED WALL PANEL ASSEMBLY SYSTEM

****

NOTE: Coordinate with Part 2 materials specification.

In the first sentence, select finish type, metal type, attachment type and delete other options.

In the second sentence, select a combination of options as necessary to describe the generic profile required. Include the last bracketed option of the

second sentence when generic profile is shown on drawings. Show panel profile, cross-section, and dimensions on the drawings when a particular aesthetic appearance is desired.
****

[Factory color finished,][Mill finish][galvanized][galvalume][aluminum] metal wall panel system with [concealed fastening][exposed fastener] attachment. Panel profile must be [embossed][recessed seam lock][flush face][smooth face][recessed bead][raised bead][striated][square ribbed][beaded rib][roll lock seam][snap lock seam][box rib][corrugated][standing seam][batten seam][and with stiffening ribs in the flat of the panel][as shown on drawings]. Interior finish of panel assembly to be [_____].

1.3.1 Metal Wall Panel General Performance

Comply with performance requirements, conforming to AISI S100, without failure due to defective manufacture, fabrication, installation, or other defects in construction. Wall panels and accessory components must conform to the following standards:

ASTM A1008/A1008M
ASTM A123/A123M
ASTM A36/A36M
[ASTM A424/A424M, ASTM C286, PEI 1001, PEI CG-3 for Porcelain and Ceramic Enameling
] ASTM A653/A653M
[ASTM A463/A463M for aluminum coated steel sheet
] ASTM A606/A606M
[ASTM A755/A755M for metallic coated steel sheet for exterior coil pre-painted applications.
][ASTM A780/A780M for repair of damage or uncoated areas of hot-dipped galvanized coating.
][ASTM A924/A924M for metallic coated steel sheet
] ASTM C273/C273M
ASTM D522/D522M for applied coatings
UL Bld Mat Dir

1.3.2 Structural Performance

Maximum calculated fiber stress must not exceed the allowable value in the AISI or AA manuals; a one third overstress for wind is allowed. Midspan deflection under maximum design loads is limited to L/180. Contract drawings show the design wind loads and the extent and general assembly details of the metal siding. Contractor must provide design for members and connections not shown on the drawings. Siding panels and accessories must be the products of the same manufacturer.

Provide metal wall panel assemblies complying with the load and stress requirements in accordance with ASTM E1592. Wind Load force due to wind action governs the design for panels.

Wall systems and attachments are to resist the wind loads as determined by UL 580 and ASCE 7-16 in the geographic area where the construction will take place, in pounds per square foot. Submit [five][_____] copies of wind load tests and seismic tests to the Contracting Officer.

[Provide metal wall panel assembly for seismic conditions complying with the applicable requirements of AISC 341.

]1.3.3 Air Infiltration

Air leakage must conform to the limits through the wall assembly area when tested according to ASTM E283.

1.3.4 Water Penetration Under Static Pressure

No water penetration when tested according to ASTM E331.

1.3.5 Water Penetration Under Dynamic Pressure

No evidence of water leakage when tested according to AAMA 501.1.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification of Manufacturer

Qualification of Installer

Qualifications for Welding Work

SD-02 Shop Drawings

Fabrication and Installation drawings for the following items are to indicate completely dimensioned structural frame and erection layouts, openings in the wall, special framing details, and construction details at corners, building intersections and flashing, location and type of mastic and metal filler strips.

Wall Panel Assemblies

Flashing and Accessories

Anchorage Systems

SD-03 Product Data

Certification

Submit Manufacturer's data indicating percentage of recycle material in wall panels to verify sustainable acquisition compliance.

Submit Manufacturer's catalog data for the following items:

Factory Color Finish

Sub-girts and Formed Shapes

Closure Materials

Insulation

Pressure Sensitive Tape

Sealants and Caulking

Rated Wall Assembly

Galvanizing Repair Paint

Enamel Repair Paint

Aluminized Steel Repair Paint

Accessories

SD-04 Samples

Submit as required each of the following samples:

Wall Panel Assemblies, 30.5 cm 12 inches long by actual panel width

Fasteners

Metal Closure Strips, 250 millimeters 10 inches long of each type

Insulation, approximately 200 by 280 millimeters 8 by 11 inches

Submit manufacturer's color charts and chips, approximately 10 by 10 cm 4 by 4 inches, showing full range of colors, textures and patterns available for wall panels with factory applied finishes.

SD-05 Design Data

Wind Design Analysis

SD-06 Test Reports

Submit test reports for the following in accordance with the referenced articles in this section.

Leakage Tests

Wind Load Tests

Seismic Tests

Coatings and base metals of metal wall type of test as specified in paragraphs STEEL SHEET MATERIALS and in various referenced standards in this section.

Factory Color Finish Performance Requirements

SD-07 Certificates

Submit certificates for the following items showing conformance with referenced standards contained in this section:

Fasteners

Galvanizing Repair Paint

Enamel Repair Paint

Provide evidence that products used within this specification are manufactured in the United States.

Submit the wall system assembly wind load and fire rating classification listings.

SD-08 Manufacturer's Instructions

Installation of Wall Panels

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications. Explicitly identify in writing, differences between manufacturer's instructions and the specified requirements.

SD-11 Closeout Submittals

Warranty

Instructions To:

Government and/or Contractor Personnel

Safety Data Sheets

Submit 20 year "No-Dollar-Limit" Warranty for labor and materials.

1.5 QUALITY ASSURANCE

1.5.1 Pre-Installation Conference

After submittals are received and approved but before wall panel and insulation work, including associated work, is performed, the Contracting Officer will hold a pre-siding conference to review the following:

a. The drawings, including Fabrication and Installation drawings,showing complete Wall Panel Assemblies, and specifications. Include details for the following for review:

flashing and accessories
anchorage systems
manufacturer's catalog data
Factory Color Finish

Submit manufacturer's color charts and chips, approximately 10 by 10 cm 4 by 4 inches, showing full range of colors, textures and patterns available for wall panels with factory applied finishes.

Sub-girts and Formed Shapes
Closure Materials, including metal closure strips.
Insulation
Pressure Sensitive Tape
Rated Wall Assembly test data
Accessories
Fasteners

b. Finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to metal wall panel installation, including manufacturer's written instructions for Installation of Wall panels, and verification of wall system assembly wind load and fire rating classification listings.

d. Support conditions for compliance with requirements, including alignment between and attachment to structural members. Provide details of wind design analysis including wind speed, exposure category, co-efficient, importance factor, designates type of facility, negative pressures for each zone, methods and requirements of attachment. Wind design analysis to include wall plan delineating dimensions and attachment patterns for each zone. Wind design analysis to be prepared and sealed by Licensed Project Engineer in the geographic area where the construction will take place.

e. Flashing, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.

f. Governing regulations and requirements for insurance, certificates, tests and inspections if applicable. Include certification for sustainable acquisition and wall system assembly wind load and fire rating classification. Safety plan review must include applicable Safety Data Sheets for maintenance/repair materials.

g. Temporary protection requirements for metal wall panel assembly during and after installation.

h. Wall panel observation and repair procedures after metal wall panel installation. Include review of sample [Galvanizing Repair Paint][Enamel Repair Paint][Aluminized Steel Repair Paint].

i. Sample [20 year "No-Dollar-Limit" warranty][Warranty].

1.5.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products and installations in the geographical area where construction will take place.

1.5.3 Qualification of Manufacturer

Metal wall panel system manufacturer must have:

a. A minimum of five (5) years experience in manufacturing metal wall system and accessory products.

b. Provide engineering services by an authorized engineer; currently licensed in the geographical area where construction will take place, having a minimum of four (4) years experience as an engineer knowledgeable in wind load design analysis, protocols and procedures for the MBMA MBSM; ASCE 7-16, and ASTM E1592.

c. Provide certified engineering calculations using the products submitted for:

    (1) Wind load requirements in accordance with FM Wind Design Guide and ASCE 7-16.

1.5.4 Qualification of Installer

The installation contractor must be approved and certified by the wall panel manufacturer prior to beginning the installation of the metal wall system.

1.5.4.1 Qualifications for Welding Work

Welding procedures must conform to AWS A5.1/A5.1M, AWS D1.1/D1.1M for steel or AWS D1.2/D1.2M for aluminum.

1.5.5 Single Source

Obtain each type of metal wall and liner panels, clips, closures and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.5.6 Surface-Burning Characteristics

Provide metal wall panels having insulation core material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: [25] [_____] or less.
b. Smoke-Developed Index: [450] [_____] or less.

1.5.7 Fire-Resistance Ratings

Where indicated, provide metal wall panels identical to those of assemblies tested for fire resistance per ASTM E119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
Combustion Characteristics: ASTM E136.

1.5.8 Fabrication

Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

Fabricate metal wall panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within panel assembly.

1.5.8.1 Sheet Metal Accessories

Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA or by metal wall panel manufacturer for application, but not less than thickness of metal being secured.

1.5.9 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

[1.5.10 Sustainable Design Certification

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NOTE: Products meeting the Gold standard will also meet the basic standard. Require Gold when the facility will be used by people sensitive to air quality conditions, such as child development centers and medical facilties.

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Product shall be third party certified in accordance with ULE Greenguard[Gold], SCS Scientific Certification Systems Indoor Advantage[Gold]or equal. Certification shall be performed annually and shall be current.

]1.6 DELIVERY, HANDLING, AND STORAGE

Deliver and package components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed and protected during transportation and handling.

Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

Stack and store metal wall panels horizontally on platforms or pallets, covered with suitable weather-tight and ventilated covering to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

Retain strippable protective covering on metal wall panel for period of metal wall panel installation.

Protect foam-plastic insulation as follows:

a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.

b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.

Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.7 PROJECT CONDITIONS

Weather Limitations: Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into existing walling system or building.

Field Measurements: Verify locations of wall framing and opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

Furnish manufacturer's no-dollar-limit warranty for the metal wall panel system. The warranty period is to be no less than twenty (20) years from the date of Government acceptance of the work. The warranty is to be issued directly to the Government. The warranty is to provide that if within the warranty period the metal wall panel system shows evidence of corrosion, perforation, rupture or excess weathering due to deterioration of the wall panel system resulting from defective materials and correction of the defective workmanship is to be the responsibility of the metal wall panel system manufacturer. Repairs that become necessary because of defective materials and workmanship while metal wall panel system is under warranty are to be performed within 24 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 24 hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty.

PART 2 PRODUCTS

2.1 PANEL MATERIALS

[2.1.1 Aluminum Sheet

Roll-form aluminum wall and liner panels to the specified profile, with fy = [30] [40] [50] [80] ksi, [.032] [.040] [.050] thickness and depth as indicated. Material must be plumb and true, and within the tolerances listed:

a. Aluminum Sheet conforming to ASTM B209M ASTM B209, AA ASD1 and AA ADM.

b. Individual panels to have continuous length to cover the entire length of any wall area with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

c. Provide panels with thermal expansion and contraction consistent with the type of system specified.

[(1) . Profile and coverage to be a minimum height and width from manufacturer s standard for the indicated wall area.

][(2) . Profile to be a 38 mm 1-1/2 inch high rib at 30.5 cm 12 inches o.c. with small stiffening ribs, 96.5 cm 38 inch overall width with 91.5 cm 36 inch coverage and exposed fasteners.

][(3) . Profile to be a 38 mm 1-1/2 inch high rib at 18.3 cm 7.2 inches o.c., 98.8 cm 38-7/8 inch overall width with 91.5 cm 36 inch coverage and exposed fasteners.

][(4) . Profile to be a 2.54 cm 1 inch high rib at 10 cm 4 inches o.c., 126.1 cm 49-5/8 inch overall width with [122] [112] cm[48] [44] inch coverage and exposed fasteners.

][(5) . Profile to be a 2.54 cm 1 inch high rib at 20.3 cm 8 inches o.c., 105.7 cm 41-5/8 inch overall width with 101.6 cm 40 inch coverage and exposed fasteners.

][(6) . Profile to be a 4.5 cm 1-3/4 inch high V-beam rib at 12.75 cm 5 inches o.c., 114 cm 44-7/8 inch overall width with 106.7 cm 42 inchcoverage and exposed fasteners.

][(7) . Profile to be a 22.6 mm 7/8 inch high corrugated rib at 50 mm 2 inches o.c., 98.8 cm 38-7/8 inch overall width with 91.5 cm 36 inchcoverage and exposed fasteners.

][(8) . Profile to be a 7.6 cm 3 inch high standing seam, 61 cm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) . Profile to be a [2.5] [4.5] [5] [6.4] cm [1] [1-3/4] [2] [2-1/2] inch high standing seam, [30.5] [40.6] [45.7] cm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

] (10) . [Smooth, flat][Embossed] surface texture.

][2.1.2 Steel Sheet

Roll-form steel wall and liner panels to the specified profile, with fy = [30] [40] [50] [80] ksi [26] [24] [22] [20] [18] gauge and depth as indicated. Material must be plumb and true, and within the tolerances listed:

[a. Galvanized Steel Sheet conforming to ASTM A653/A653M and AISI SG03-3.

][b. Aluminum-Zinc Alloy-coated Steel Sheet conforming to ASTM A792/A792M and AISI SG03-3.

] c. Individual panels to have continuous length to cover the entire length of any unbroken wall area with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

d. Provide panels with thermal expansion and contraction consistent with the type of system specified.

[(1) . Profile and coverage to be a minimum height and width from manufacturer's standard for the indicated wall area.

][(2) . Profile to be a 38 mm 1-1/2 inch high rib at 30.5 cm 12 inches o.c. with small stiffening ribs, 96.5 cm 38 inch overall width with 91.5 cm 36 inch coverage and exposed fasteners.

][(3) . Profile to be a 38 mm 1-1/2 inch high rib at 18.3 cm 7.2 inches o.c., 98.8 cm 38-7/8 inch overall width with 91.5 cm36 inch coverage and exposed fasteners.

][(4) . Profile to be a 2.54 cm 1 inch high rib at 10 cm 4 inches o.c., 126.1 cm 49-5/8 inch overall width with [122] [112] cm [48] [44] inch coverage and exposed fasteners.

][(5) . Profile to be a 2.54 cm 1 inch high rib at 20.3 cm 8 inches o.c., 105.7 cm 41-5/8 inch overall width with 101.6 cm 40 inch coverage and exposed fasteners.

][(6) . Profile to be a 22.6 mm 7/8 inch high corrugated rib at 50 mm 2 inches o.c., 98.8 cm 38-7/8 inch overall width with 91.5 cm 36 inch coverage and exposed fasteners.

][(7) . Profile to be a 7.6 cm 3 inch high standing seam, 61 cm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][(8) . Profile to be a [2.5] [4.5] [5] [6.4] cm[1] [1-3/4] [2] [2-1/2] inch high standing seam, [30.5] [40.6] [45.7] cm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

] (9) . [Smooth, flat][Embossed]surface texture.

][2.1.3 Foam-Insulation Core Wall Panel

Provide factory-formed[aluminum][steel] wall panel assembly fabricated from two sheets of metal with modified polyisocyanurate or polyurethane foam insulation core[foamed-in-place][board] during fabrication with joints between panels designed to form weather-tight seals. Include accessories required for weather-tight installation.

a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.

b. Density: 32 to 42 kg/cu. m 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622/D1622M.

c. Compressive Strength: Minimum 140 kPa 20 psi when tested according to ASTM D1621.

d. Shear Strength: 179 kPa 26 psi when tested according to ASTM C273/C273M.

]2.1.4 Insulated Panel Construction

Shop fabricate or field assemble insulated panel construction with specified exterior and interior[aluminum][steel] sheet in accordance with manufacturer's printed instructions.

Insulation to be[glass-fiber][slag-wool-fiber][rock-wool-fiber] conforming to ASTM C553 and ASTM C612 of thickness and density as required for the geographical area where construction will take place. Glass-Fiber and Mineral-Wool-Fiber are materials listed in the EPA's Comprehensive Procurement Guidelines (CPG) (http://www.epa.gov/cpg/).

Insulation fasteners to be adhesively attached, plate welded to projecting spindle anchors; capable of holding insulation of thickness indicated, secured in position with self-locking washer and complying with the following requirements:

a. Plate: Perforated galvanized carbon-steel sheet, 0.762 mm 0.030 inch thick by 50 mm 2 inches square.

b. Spindle: Copper-coated, low carbon steel; fully annealed; 2.67 mm 0.105 inch in diameter; length to suit depth of insulation indicated.

c. Insulation-Retaining Washers: Self-locking washers formed from 0.41 mm 0.016 inch thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 38 mm 1-1/2 inches square or in diameter.

d. Anchor adhesive to be a product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

2.1.5 Finish

All panels are to receive a factory-applied[polyvinylidene fluoride][Kynar 500/Hylar 5000] [_____] finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. This prime coat must be oven cured prior to application of finish coat.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll coating to dry film thickness of 0.80 plus 5 mils (3.80 plus 0.50 mils for Vinyl Plastisol) for a total dry film thickness of 1.00 plus 0.10 mils (4.00 plus 0.10 mils for Vinyl Plastisol). This finish coat must be oven-cured.

d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll coating to a dry film thickness of 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. The wash-coat must be oven-cured.

e. Color: The exterior finish chosen from the manufacturer's standard color chart.

f. Physical Properties: Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

Chalking:	ASTM D4214
Color Change and Conformity:	ASTM D2244
Weatherometer:	ASTM G152, ASTM G153 and ASTM D822
Humidity:	ASTM D2247 and ASTM D714
Salt Spray:	ASTM B117

Chemical Pollution:	ASTM D1308
Gloss at 60:	ASTM D523
Pencil Hardness:	ASTM D3363
Reverse Impact:	ASTM D2794
Flexibility:	ASTM D522/D522M
Abrasion:	ASTM D968
Flame Spread:	ASTM E84

2.2 MISCELLANEOUS METAL FRAMING

2.2.1 General

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M and specified in Division 05 Section 05 40 00 "Cold-Formed Metal Framing" unless otherwise indicated.

2.3 FASTENERS

2.3.1 General

Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 2.54 cm 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the wall panel manufacturer's and ASCE 7-16 requirements.

2.3.2 Exposed Fasteners

Fasteners for wall panels to be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads. Fasteners for accessories to be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately 2.3 mm 3/32 inches thick.

2.3.3 Screws

Screws to be corrosion resistant coated steel, aluminum and/or stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

2.3.4 Rivets

Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

2.3.5 Attachment Clips

Fabricate clips from steel hot-dipped galvanized in accordance with

ASTM A653/A653M, or Series [300][305] stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.4 ACCESSORIES

2.4.1 General

All accessories to be compatible with the metal wall panels. Sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the wall panels. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips to be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

2.4.2 Rubber Closure Strips

Closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified wall panel and in lengths supplied by the wall panel manufacturer.

2.4.3 Metal Closure Strips

Factory fabricated[aluminum][steel] closure strips to be the same[gauge][thickness], color, finish and profile of the specified wall panel.

2.4.4 Joint Sealants

2.4.4.1 Sealants and Caulking

Sealants are to be an approved gun type for use in hand- or air-pressure caulking guns at temperatures above 4 degrees C 40 degrees F (or frost-free application at temperatures above minus 12 degrees C 10 degrees F) with minimum solid content of 85 percent of the total volume. Sealant is to dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the wall panel manufacturer.

2.4.4.2 Shop-Applied

Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

2.4.4.3 Field-Applied

Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C920, Type II. Color to match panel colors.

2.4.4.4 Tape Sealant

Pressure sensitive, 100 percent solid with a release paper backing;

permanently elastic, non-sagging, non-toxic and non-staining as approved by the wall panel manufacturer.

2.5 SHEET METAL FLASHING AND TRIM

2.5.1 Fabrication

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.6 REPAIR OF FINISH PROTECTION

Repair paint for color finish enameled wall panel must be compatible paint of the same formula and color as the specified finish furnished by the wall panel manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of the Work.

B. Examine primary and secondary wall framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal wall panel manufacturer, UL, ASTM, ASCE 7-16 and as required for the geographical area where construction will take place.

C. Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

D. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

E. Submit to the Contracting Officer a written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

B. Miscellaneous Framing: Install sub-purlins, girts, angles, furring, and other miscellaneous wall panel support members and anchorage according to metal wall panel manufacturer's written instructions.

3.3 WALL PANEL INSTALLATION

Provide metal wall panels of full length from sill to eave as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement in accordance with MBMA Metal Building Systems Manual.

[a. Steel Wall Panels: Use stainless-steel fasteners for exterior surfaces and galvanized steel fasteners for interior surfaces.

][b. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for exterior surfaces and aluminum or galvanized steel fasteners for interior surfaces.

][c. Anchor Clips: Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturer's written instructions.

] d. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

e. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Bent, chipped, or defective sheets shall not be applied.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated eave, and sill.

Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

Field cutting metal wall panels by torch is not permitted.

3.4 FASTENER INSTALLATION

Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturer's written instructions.

3.5 FLASHING, TRIM AND CLOSURE INSTALLATION

3.5.1 General Requirements

Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

Sheet metalwork is to be accomplished to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

3.5.2 Metal Flashing

Exposed metal flashing is to be installed at building corners, sills and eaves, junctions between metal siding and walling.

Exposed metal flashing is to be the same material, color, and finish as the specified metal wall panel.

Flashing is to be fastened at not more than 20.3 cm 8 inches on center, except where flashing are held in place by the same screws that secure covering sheets.

Flashing is to be furnished in at least 2.4 m 8 foot lengths. Exposed flashing is to have 2.54 cm 1 inch locked and blind-soldered end joints, and expansion joints at intervals of not more than 4.9 m 16 feet.

Exposed flashing and flashing subject to rain penetration to be bedded in the specified joint sealant.

Flashing which is in contact with dissimilar metals to be isolated by means of the specified asphalt mastic material to prevent electrolytic deterioration.

Drips to be formed to the profile indicated, with the edge folded back 12.7 mm 1/2 inch to form a reinforced drip edge.

3.5.3 Closures

Install metal closure strips at open ends of corrugated or ribbed pattern walls, and at intersection of wall and wall unless open ends are concealed with formed eave flashing; and in other required areas.

Install mastic closure strips at intersection of the wall with metal walling; top and bottom of metal siding; heads of wall openings; and in other required locations.

3.6 WORKMANSHIP

Make lines, arises, and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 12.7 mm 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections which might affect the application. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight.

3.7 ACCEPTANCE PROVISIONS

3.7.1 Erection Tolerances

Erect metal wall panels straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Horizontal lines must not vary more than 3.175 mm in 12.2 m 1/8 inch in 40 feet.

3.7.2 Leakage Tests

Inspect and test finished application of metal wall panels when directed to do so by the Contracting Officer. Inspection and tests must be conducted without cost to the Government.

Inspection and testing is to be made promptly after erection to permit correction of defects and the removal and replacement of defective materials.

3.7.3 Repairs to Finish

Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials. Finished repaired surfaces must be uniform and free from variations of color and surface texture.

Repaired metal surfaces that are not acceptable to the project requirements are to be immediately removed and replaced with new material.

3.7.4 Paint-Finish Metal Siding

Paint-finish metal siding will be tested for color stability by the Contracting Officer during the manufacturer's specified guarantee period.

Panels that indicate color changes, fading, or surface degradation, determined by visual examination, must be removed and replaced with new panels at no expense to the Government.

New panels will be subject to the specified tests for an additional year from the date of their installation.

3.8 CLEAN-UP AND DISPOSAL

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

Collect and place scrap/waste materials in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site; transport demolished materials from government property and legally dispose of them.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 51 13 (May 2012)**
Change 2 - 11/18

Preparing Activity: NAVFAC **Superseding**
UFGS-07 51 13 (February 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 07 51 13

BUILT-UP ASPHALT ROOFING

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USACE / NAVFAC / AFCEC **UFGS-07 51 13 (May 2012)**
Change 2 - 11/18

Preparing Activity: NAVFAC **Superseding**
UFGS-07 51 13 (February 2012)

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SECTION 07 51 13

BUILT-UP ASPHALT ROOFING
05/12, CHG 2: 11/18

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NOTE: This guide specification covers the requirements for aggregate surfaced bituminous built-up roofing, and built-up roofing with granule-surfaced modified bitumen cap sheet for existing and new roof systems on slopes from 6 mm to 76 mm 1/4 inch to 3 inches per foot.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: The requirements for hot-mopped, four-ply, aggregate surfaced, built-up bituminous roofing systems and built-up bituminous roof systems consisting of three-ply felts and granule-surfaced modified bitumen cap sheet are included in this guide specification. This guide specification does not include the structural roof deck, insulation, or sheet metal fascias, gravel stops, and flashings.

Coordinate this section with other roof system components specifications such as rough carpentry, insulation and sheet metal flashing. Also coordinate this section with the criteria contained

in UFC 3-110-03 "Roofing", as it relates to the specific project and Service Exceptions indicated therein.

NOTE: In most cases, use aggregate surfacing or granule surfaced modified bitumen cap sheet surfacing in lieu of smooth surfaced built-up roofs. Generally, when properly applied and maintained, aggregate surfaced roofing will have greater life expectancy. Consider granulated cap sheet surfacing where:

1. There is danger of aggregate being drawn into air intakes of jet aircraft.

2. There is danger of wind blown aggregate jeopardizing property and life safety.

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

NOTE: Select one of the following references subject to design criteria and the particular materials selected for the application and remove the other two references sited below within the body of the text citing the applicable reference:

[ASTM D4869] [ASTM D6757/D6757M] [ASTM D1970/D1970M]

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum

	Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM C208	(2022) Standard Specification for Cellulosic Fiber Insulating Board
ASTM C728	(2017a; R 2022) Standard Specification for Perlite Thermal Insulation Board
ASTM C1153	(2023) Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D312/D312M	(2016a) Standard Specification for Asphalt Used in Roofing
ASTM D448	(2012; R 2017) Standard Classification for Sizes of Aggregate for Road and Bridge Construction
ASTM D517	(1998; R 2008) Asphalt Plank
ASTM D1863/D1863M	(2005; R 2011; E 2012) Mineral Aggregate Used on Built-Up Roofs
ASTM D1864/D1864M	(1989; E 2009; R 2009) Moisture in Mineral Aggregate Used on Built-Up Roofs
ASTM D1970/D1970M	(2019) Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2170/D2170M	(2018) Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)
ASTM D2178/D2178M	(2015a; R 2021) Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
ASTM D3617	(2007; R 2015; E 2015) Sampling and Analysis of New Built-Up Roof Membranes
ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4402/D4402M	(2015) Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free

ASTM D4601/D4601M	(2004; R 2020) Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
ASTM D4637/D4637M	(2015) EPDM Sheet Used in Single-Ply Roof Membrane
ASTM D4869/D4869M	(2016a) Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing
ASTM D4897/D4897M	(2016) Standard Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing
ASTM D6162/D6162M	(2016) Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements
ASTM D6163/D6163M	(2016) Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements
ASTM D6164/D6164M	(2016) Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements
ASTM D6757/D6757M	(2018) Standard Specification for Underlayment Felt Containing Inorganic Fibers Used in Steep-Slope Roofing
ASTM E108	(2024) Standard Test Methods for Fire Tests of Roof Coverings

FM GLOBAL (FM)

FM 4470	(2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA RoofMan	(2020) The NRCA Roofing Manual

SINGLE PLY ROOFING INDUSTRY (SPRI)

ANSI/SPRI RD-1	(2019) Performance Standard for Retrofit Drains

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 790	(2022) UL Standard for Safety Test Methods for Fire Tests of Roof Coverings
UL RMSD	(2012) Roofing Materials and Systems Directory

1.2 DESCRIPTION OF ROOF MEMBRANE SYSTEM[S]

****

NOTE: Coordinate requirements with Part 2 materials specification. Delete the bracketed option not applicable to the project.

****

Asphalt applied, [four-ply felt, aggregate surfaced][three-ply felt with granule-surfaced modified bitumen cap sheet] built-up roof membrane system.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wind Uplift Calculations; G, [_____]

Asphalt

Felts, including ply felt, base sheet and ventilating felt as applicable; G, [_____]

[Granule Surface Modified Bitumen Cap Sheet; G, [_____]

][Heat Island Reduction; S

][Energy Star Label for Top Coating Product; S

] Flashing Membrane; G, [_____]

Fasteners

Primer

Asphalt Roof Cement

Walkpad Materials

Cant Strips

Certificate attesting that the fiberboard furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

Pre-Manufactured Accessories to be incorporated in the system installation; G, [_____]

Roof Walkways

Sample Warranties certificates; G, [_____]

Submit all data required with requirements of this section. Include in Data written acceptance by the roof membrane manufacturer of the products and accessories provided. List products in the applicable wind uplift and fire rating classification listings, unless approved otherwise by the Contracting Officer.

SD-06 Test Reports

Samples of Built-Up Roofing

Submit test results on roofing field samples as required, verifying composition of sample. Submit six copies of laboratory analysis within 30 calendar days after samples are taken. Submit reports in accordance with ASTM D3617.

SD-07 Certificates

Bill of Lading

Submit when labels of asphalt containers do not indicate the finished blowing temperature, flash point and equiviscous temperature.

Qualifications of Applicator

Submit evidence of the roofing system manufacturer's approval.

SD-08 Manufacturer's Instructions

****

NOTE: Edit the manufacturers instructions submission requirements as necessary for the system specified. Include bracketed requirements only as applicable to the system being specified.

****

Felts; G, [_____]

Flashings; G, [_____]

[Modified Bitumen Cap Sheet; G, [_____]

Base Sheet attachment, including pattern and frequency of mechanical attachments required in field of roof, corners, and perimeters to provide for the specified wind resistance.

] Asphalt

Primer

Roof Cement

Fasteners

Cold Weather Conditions installation; G, [_____]

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications.[Include membrane manufacturer requirements for nailers and backnailing of roof membrane on steep slopes.] Explicitly identify in writing, differences between manufacturer's instructions and the specified requirements.

SD-11 Closeout Submittals

Warranty

Information Card

1.4 QUALITY ASSURANCE

****

NOTE: All projects with more than 1400 square meters 15,000 square feet of roof area or that is defined as critical use or mission critical in the project DD Form 1391 must have a Registered Roof Consultant (RRC) or a registered professional engineer (PE) or registered architect (RA) that derives his or her principal income from roofing design on the quality control staff of the design team.

****

1.4.1 Qualifications of Applicator

The roofing system applicator must be approved, authorized, or licensed in writing by the roofing system manufacturer and must have a minimum of 3 years experience as an approved, authorized, or licensed applicator with the manufacturer and be approved at a level capable of providing the specified warranty.

1.4.2 [Qualifications of Photovoltaics (PV) Rooftop Applicator

The PV rooftop applicator must be approved, authorized, or certified by a Roof Integrated Solar Energy (RISE) Certified Solar Roofing Professional (CSRP), and comply with applicable codes, standards, and regulatory requirements to maintain the weatherproofing abilities of both the integrated roof system and photovoltaic system.

]1.4.3 Fire Resistance

Complete roof covering assembly must:

****

NOTE: Specify Class B option only when Class A may not be attainable such as membrane system application directly to wood deck. Provide justification/rationale for Class B option with design submission

****

a. Be Class A rated in accordance with ASTM E108 , FM 4470, or UL 790; and

b. Be listed as part of Fire-Classified roof deck construction in UL RMSD, or Class I roof deck construction in FM APP GUIDE.

1.4.4 Wind Uplift Resistance

****

NOTE: Determine the required wind uplift resistance based on ASCE 7-16 wind loading calculations or applicable building code requirements. The specified FM rating incorporates a safety factor of 2 over the maximum calculated uplift pressure. Therefore, a FM rating of 1-90 correlates to a maximum uplift calculation of 2.2kPa 45 psf. When a rated system is specified, ensure the specified roof system is capable of meeting the wind uplift resistance specified. Utilize commercially

available sources such as Factory Mutual Roofnav https://www.roofnav.com to validate wind uplift rated systems. Use ASCE-7 for determining uplift requirements. Where non-rated systems may be permissible, or rated systems cannot be obtained such as a reroof, ensure that validated wind uplift calculations and substantiating data are provided by a licensed engineer.

Delineate calculated values in the roof specification and drawings. Utilize independently tested and rated roof systems, such as Factory Mutual (FM), Underwriters Laboratories (UL), and Single Ply Roofing Industry (SPRI).

****

Provide a complete roof system assembly that is rated and installed to resist wind loads [indicated][calculated in accordance with ASCE 7-16] and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Do not install non-rated systems except as approved by the Contracting Officer. Submit licensed engineer's wind uplift calculations and substantiating data to validate any non-rated roof system. Base wind uplift measurements on a design wind speed of[_____] km/h [_____] mph in accordance with ASCE 7-16 and other applicable building code requirements.

1.4.5 Preroofing Conference

After approval of submittals and before performing roofing [and insulation] system installation work, hold a preroofing conference to review the following:

a. Drawings and specifications and submittals related to the roof work;

b. Roof system components installation;

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representatives to roof manufacturer;

d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing; and

e. Quality control plan for the roof system installation;

f. Safety requirements.

Coordinate preroofing conference scheduling with the Contracting Officer. The conference must be attended by the Contractor, the Contracting Officer's designated personnel, and personnel directly responsible for the installation of roofing[and insulation], flashing and sheet metal work,[[mechanical][and][electrical] work,] other trades interfacing with the roof work,[Fire Marshall,] and a representative of the roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver materials in manufacturers' original unopened containers and rolls with manufacturer's labels intact and legible. Mark and remove wet or damaged materials from site. Where materials are covered by a referenced specification, container must bear specification number, type, and class, as applicable. Indicate on labels or bill of lading for roofing asphalt the asphalt type, finished blowing temperature (FBT), flash point (FP), and equiviscous temperature (EVT), that is, the temperature at which the viscosity is either 125 centistokes when tested in accordance with ASTM D2170/D2170M or 75 centipoise when tested in accordance with ASTM D4402/D4402M. Deliver materials in sufficient quantity to allow work to proceed without interruption.

1.5.2 Storage

Protect materials against moisture absorption, contamination, or other damage. Avoid crushing or crinkling of roll materials. Store roll materials on end on clean raised platforms in dry locations in enclosed buildings or trailers with adequate ventilation. Do not store roll materials in buildings under construction until concrete, mortar, and plaster work are finished and dry. Do not store materials outdoors unless approved by the Contracting Officer. Completely cover felts stored outdoors, on and off roof, with waterproof canvas protective covering. Do not use polyethylene sheet as a covering. Tie covering securely to pallets to make completely weatherproof and yet provide sufficient ventilation to prevent condensation. Maintain roll materials at temperature above 10 degrees C 50 degrees F for a 24-hour period immediately prior to application. Keep aggregate dry as defined by ASTM D1863/D1863M. Place only those materials to be used during one day's work on the roof at one time. Remove unused materials from the roof at the end of each day's work. Immediately remove wet, contaminated or otherwise damaged or unsuitable materials from the site. Damaged materials may be marked by the Contracting Officer.

1.5.3 Handling

Prevent damage to edges and ends of roll materials. Do not install damaged materials in the work. Select and operate material handling equipment so as not to damage materials or applied roofing.

1.6 ENVIRONMENTAL CONDITIONS

Do not install roofing during precipitation, or fog, or when air temperature is below 4 degrees C 40 degrees F, or when there is ice, frost, moisture or visible dampness on roof deck.[Restriction on application of roofing materials below 4 degrees C 40 degrees F may be waived if Contractor devises a means, satisfactory to Contracting Officer, of: (1) maintaining surrounding temperature above 4 degrees C 40 degrees F; (2) maintaining application temperature of heated materials without exceeding maximum specified heating temperature; and follows other recommendations of the membrane manufacturer for application in cold weather conditions.]

1.7 SEQUENCING

Coordinate the work with other trades to ensure that components which are to be secured to or stripped into the roofing system are available and that permanent flashing and counterflashing are installed as the work progresses. Ensure temporary protection measures are in place to preclude moisture intrusion or damage to installed materials.[Install roofing immediately following application of insulation as a continuous operation. Coordinate roofing operations with insulation work so that all roof insulation applied each day is covered with complete felt ply installation the same day.]

1.8 WARRANTY

Provide roof system material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard membrane manufacturer warranty to comply with the specified requirements. Provide a manufacturer's warranty that has no dollar limit, covers full system water-tightness and has a minimum duration of 20 years.

1.8.1 Roof Membrane Manufacturer Warranty

****

NOTE: Buildings with roof area of 700 sq. meters 7535 sq. feet 75 squares or greater, administrative, classroom and other high use facilities, and facilities with sensitive use, contents, equipment, or functions require minimum 20 year warranty. All environmentally controlled interiors require a minimum 10 year roof warranty. Designer may specify 5 or 10 year manufacturer warranty on facilities of small roof area and of minor importance where interiors and contents are not severely impacted by water.

****

Furnish the roof membrane manufacturer's 20-year no dollar limit roof system materials and installation workmanship warranty, including flashing, insulation, and accessories necessary for a watertight roof system construction. Write the warranty directly to the Government commencing at the time of Government's acceptance of the roof work. Provide the following statements for such warranty:

a. If within the warranty period the roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, blisters, splits, tears, delaminates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the roof system assembly and correction of defective workmanship are the responsibility of the roof membrane manufacturer. All costs associated with the repair or replacement work are the responsibility of the roof membrane manufacturer.

b. The warranty remains in full force and effect, including emergency temporary repairs performed by others, when the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification.

1.8.2 Roofing System Installer Warranty

The roof system installer must warrant for a minimum period of two years that the roof system, as installed, is free from defects in installation workmanship, to include the roof membrane, flashing, insulation, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Write the warranty directly to the Government. The roof system installer is responsible for correction of defective workmanship and replacement of damaged or affected materials. The roof system installer is responsible for all costs associated with the repair or replacement work.

1.8.3 Continuance of Warranty

Approve repair or replacement work that becomes necessary within the warranty period and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the roof membrane manufacturer warranty for the remainder of the manufacturer warranty period.

1.9 CONFORMANCE AND COMPATIBILITY

Provide the entire roofing and flashing system in accordance with specified and indicated requirements, including fire and wind resistance requirements. Work not specifically addressed and any deviation from specified requirements must be in general accordance with recommendations of the NRCA RoofMan, membrane manufacturer published recommendations and details, and compatible with surrounding components and construction. Submit any deviation from specified or indicated requirements to the Contracting Officer for approval prior to installation.

1.10 ELIMINATION, PREVENTION OR CONTROL OF FALL HAZARDS

****

NOTE: Any part or component of the building, facility, structure, or equipment requiring future maintenance work must incorporate in the design fall prevention methods or techniques to eliminate fall hazards, in accordance with ANSI/ASSE A1264.1. Fall prevention methods may include identifying, designing, and installing anchorages (hard points) for safe use of fall arrest equipment and systems. Select the materials to be used for metal compatibility in order to minimize corrosion, type 316 stainless steel is recommended.

****

1.10.1 Fall Protection

[_____]

PART 2 PRODUCTS

****

NOTE: Edit the materials specification requirements as necessary for the system(s) specified in PART 1 - DESCRIPTION OF ROOF MEMBRANE SYSTEM.

See the Note in PART 1 - DESCRIPTION OF ROOF MEMBRANE SYSTEM for useful information in editing

the membrane materials requirements.

Include bracketed requirements only as applicable to the system being specified (e.g., torch applied systems may not require asphalt in the installation; granule surfaced cap sheets do not require gravel or coating surfacing).

****

2.1 GENERAL

Furnish a combination of specified materials that comprise the membrane manufacturer's standard system of the number and type of plies specified. Provide materials approved by the roof membrane manufacturer and suitable for the service and climatic conditions of the installation.

2.1.1 Energy [and Cool Roof] Performance

****

NOTE: Standards such as UFC 1-200-02 promote the use of cool roofing, and increased energy conservation through additional insulation. Design cool roofs in accordance with the requirements in UFC 3-110-03 "Roofing" Chapter 1, Cool Roofs. Consider that when cool roofing is used with insulation R values greater than 24, the 'cool roof' surface has little if no influence on the energy performance of the building. Additionally, designers should be aware of the possible negative impacts of using cool roofing that may result in unintended consequences. Condensation on the underside of mechanically-fastened systems can result in ice build-up in winter, mold growth on the facers, moisture dripping into the interior, and replacement of the roofs with less than four years of service. See Appendix B of UFC 3-110-03 for more information. Inadequate design of cool roofs in ASHRAE climate zones 4 and higher have resulted in the unintended consequence of condensation below the membrane-a result of the material's inability to warm and drive moisture downward. Roofs that experience this condensation have had to be replaced. Other unintended consequences include the overheating of masonry walls, interior spaces, roof top piping and mechanical equipment as a result of the reflected UV rays.

NOTE: Designer to specify the roof performance by R-Value on the drawings or stated in other specification sections.

****

****

NOTE: Facilities with dominant cooling loads or in mild or warm climate zones are required to meet "cool roofing" requirements of FEMP. Design cool roofs in accordance with the requirements in UFC 3-110-03 Roofing, Appendix B and ASHRAE 90.1 Chapter 5, for insulation and energy performance of the

building.

NOTE: If a cool roof is not selected in ASHRAE zones 1 thru 3, design must meet one of the exception requirements listed in ASHRAE 90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Coordinate these requirements with insulation design and specifications.

Retain the next to last bracketed note for project with cool roof requirement. Retain the last bracketed sentence for project with sustainable third party certification credit requirement for reduced heat island effect.

****

Install a roof system that meets an overall performance as specified on the drawings or by insulation specified in other sections.[The roofing system will need to include a top surface finish that meets the criteria for Cool Roof Products.[Provide emittance and reflectance percentages, solar reflectance index values,[and]slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]]

2.2 FIBERGLASS FELT MATERIALS

****

NOTE: Select the base sheet option required and delete other base sheet options. Base sheets under insulation should be specified in the insulation specification section.

Perforated venting base sheet option should only be specified for application directly on concrete deck. Base sheets with perforations are rolled into place and then top mopped with hot asphalt. Base sheets without perforations are mechanically attached to nailable substrates.

****

[a. Venting Base Sheet: ASTM D4897/D4897M, Type II, [without][with] perforations and as approved by the roof membrane manufacturer.

][b. Fiberglass Felt Base Sheet: ASTM D4601/D4601M, Type II, [without][with] perforations and as approved by the roof membrane manufacturer.

] c. Ply Felt: ASTM D2178/D2178M, Type [IV][or][VI].

2.3 BASE FLASHING MEMBRANE

ASTM D6163/D6163M. Membrane manufacturer's standard, minimum two-ply modified bitumen membrane flashing system compatible with the built-up roof membrane and as recommended in membrane manufacturer's published literature. Provide a minimum base ply of flashing membrane of 1.8 mm 70 mils thick. Provide a minimum granule surface modified bitumen flashing cap sheet of 3 mm 120 mils thick on the selvage edge.

2.4 ASPHALT

****

NOTE: Specify asphalt type based on roof slope. Adhere to the following general requirements:

Roof Slope, mm/m in./ft	**Type Asphalt**
Less than 25 Less than 1/2	**Type II, Type III in hot climate**
25 to 50 1/2 to 1	**Type III**
50 to 75 1 to 1-1/2	**Type III, Type IV in hot climate**

In locations where ambient temperature frequently exceeds 38 degrees C 100 degrees F and roof slope is 15 mm 1/2 inch per foot or greater, specify Type IV asphalt.

****

ASTM D312/D312M, Type [II] [or] [III] [or] [IV], in accordance with membrane manufacturer requirements and compatible with the slope conditions of the installation.

2.5 SURFACING MATERIAL

****

NOTE: Do not use coral as a gravel surface in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Coral usually blackens with algae and deteriorates, becoming a growth medium for sprouting seeds. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

[2.5.1 Aggregate for Surfacing Built-up Roofing

Water-worn gravel, crushed stone, or crushed slag, conforming to ASTM D1863/D1863M, or marble, expanded slag, or expanded shale, conforming to ASTM D1863/D1863M except density not less than 880 kg per cubic meter 55 pcf. Aggregate conforming to gradation sizes No. 6, No. 7, and No. 67 in conformance with ASTM D448 is acceptable provided other requirements of ASTM D1863/D1863M are met. Provide 2 percent maximum moisture content as determined by ASTM D1864/D1864M. Provide light colored and opaque aggregate. Limestone, volcanic rock, crushed shells, and cinders are prohibited.

][2.5.2 Granule Surface Modified Bitumen Cap Sheet

****

NOTE: Do not use gravel surface cap sheet in humid locations or project locations with Environmental

Severity Classifications (ESC) of C4 and C5. See UFC 1-200-01 for determination of ESC for project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Use a reflective mineral surfaced cap sheet system or a reflective coated smooth surface system.

****

****

NOTE: Specify ASTM D6163/D6163M, fiberglass reinforced cap sheet, as a standard cap sheet. Also may include the alternate for ASTM D6162/D6162M cap sheet, combination fiberglass and polyester. For high puncture resistance and for high traffic roofs, specify ASTM D6164/D6164M only (polyester reinforced cap sheet).

****

[ASTM D6163/D6163M][ASTM D6162/D6162M][ASTM D6164/D6164M]; Type II, Grade G, minimum 3 mm (120 mils) thick at selvage edge, and as required to provide specified fire safety rating.

]2.6 PRIMER

ASTM D41/D41M for asphalt roofing systems and as approved by the membrane manufacturer.

2.7 ASPHALT ROOF CEMENT

ASTM D4586/D4586M for use with asphalt roofing systems, Type II for vertical surfaces and built-up bituminous flashings; Type I for horizontal surfaces and as recommended by the membrane manufacturer.

2.8 CANT STRIPS

****

NOTE: Use wood cant in non-supported flashing and wood blocking details (i.e., expansion joints, area dividers, and wall/roof intersections where roof deck is not supported by a wall).

****

Provide standard perlite cant strips conforming to ASTM C728[or wood fiber conforming to ASTM C208] treated with bituminous impregnation, sizing, or waxing and fabricated to provide maximum 45 degree change in direction of membrane. Provide minimum 38 mm 1-1/2 inch thick cant strips and provide for minimum 125 mm 5 inch face and 89 mm 3-1/2 inch vertical height when installed at 45 degree face angle, except where clearance restricts height to lesser dimension.

2.9 UNSATURATED FELT OR ROSIN-SIZED BUILDING PAPER

****

NOTE: Include requirement for unsaturated felt or rosin-sized building paper under base sheet on wood decks substrates to prevent bitumen drippage through deck joints.

****

Provide rosin-sized sheathing paper weighing minimum 3 kilogram per 10 square meter 5 pounds per 100 square feet or unsaturated felt weighing approximately 3.7 kilogram per 10 square meter 7-1/2 pounds per 100 square feet.

2.10 FASTENERS AND PLATES

Coated, corrosion resistant fasteners compatible with components being attached and contact surfaces. Conform to FM 4470 for fasteners for attachment to deck substrate of Class I roof deck construction and FM APP GUIDE for the wind resistance specified. Use hard copper fasteners in contact with copper; aluminum or stainless steel fasteners in contact with aluminum; and stainless steel fasteners in contact with stainless steel. For fastening only roofing felts, use fasteners driven through metal discs, or one-piece composite fasteners with heads not less than 25 mm 1 inch in diameter or 25 mm 1 inch square with rounded or 45-degree tapered corners.

[2.10.1 Wood Substrates and Nailers

Provide 11 gage annular threaded shank nails with 7/16 to 5/8 inch diameter heads; or one-piece composite nails with annular threaded shanks not less than 11 gage for securing felts and metal items. Provide fasteners long enough to penetrate minimum 25 mm 1 inch into or minimum 6 mm 1/4 inch through wood substrate materials. Do not penetrate wood decking exposed to view on the underside.

][2.10.2 Masonry or Concrete Walls and Vertical Surfaces

Provide hardened steel nails or screws with flat heads, diamond shaped points, and mechanically deformed shanks not less than 25 mm 1 inch long for securing felts, metal items, and accessories. Use power-driven fasteners only when approved in writing by Contracting Officer.

]2.10.3 Metal Plates

Flat corrosion-resistant round stress plates as recommended by the modified bitumen sheet manufacturer's printed instructions and meeting the requirements of FM 4470; minimum 50 mm 2 inch in diameter. Form discs to prevent dishing or cupping.

[2.11 PRE-MANUFACTURED ACCESSORIES

****

NOTE: Edit, delete, and insert accessory materials requirements as required for the specific project and components to be installed.

****

Pre-manufactured accessories must be manufacturer's standard for intended purpose,[comply with applicable specification section,] compatible with the membrane roof system and approved for use by the roof membrane manufacturer.

[2.11.1 Pre-fabricated Curbs

Provide [_____] gauge [G90 galvanized][AZ55 galvalume][_____] curbs with minimum 100 mm 4 inch flange for attachment to roof nailers. Provide minimum height of 250 mm 10 inch above the finished roof membrane surface.

][2.11.2 Photovoltaic (PV) Systems - Rack Mounted Systems

****

NOTE: The installation of a PV roof system over existing roof systems should be undertaken with extreme caution. Do not install PV systems on roofs with a shorter expected service life than the new PV system. Prior to the design of such systems the following must be undertaken:

a. Determine if the existing roof structure can handle the anticipated roof load increase.

b. Inspect and determine that the existing roof system has at least 10 years of service life remaining. If not, remove the existing roof and provide a new replacement roof system design in tandem with the photovoltaic system.

c. If 10 years remaining service life remains, ensure the design of the intersecting details, required roof protection, re-inspections, and warranty requirements for maintaining the roof system has been coordinated with theinstallation and manufacturers' warranties.

d. Design the roof related details for anticipated roof replacement work. Coordinate with the PV system designer to anticipate and plan for future roof replacement.

e. PV equipment on a rooftop creates additional roof protection requirements during initial installation and throughout the PV life-cycle. Ensure a roof protection program is specified during the PV system installation.

f. Permanenetly affix PV supports to stanchions which are anchored to the building structure.

****

Adhere to the following guidelines:

a. *Building Owners Guide to Roof-mounted PV Systems*, published by NRCA.

b. *Guidelines for Roof-Mounted PV Systems*, published by NRCA.

]][2.12 WALKPADS

****

NOTE: Use walkpads or walkways at roof access points and where the roof or areas of the roof are intended to bear foot traffic for maintenance or other purposes once a month or more frequently.

****

Provide polyester reinforced roof walkpads, granule-surfaced modified bitumen membrane material, ASTM D6162/D6162M or ASTM D6164/D6164M, minimum [_____] 5 mm [_____][200] mils thick, compatible with the roof membrane and as recommended by the roof membrane manufacturer. Do not exceed 1.2 meters 4 feet in length for each panel. Other walkpad materials require approval of the Contracting Officer prior to installation.

2.12.1 ROOF WALKWAYS

Provide 950 by 1830 millimeter by 15 millimeter 36 by 72 inch by 1/2 inch thick asphalt planks, consisting of a homogeneous core of asphalt, plasticizers, and fillers bonded between two saturated and coated facing sheets. Top side must be surfaced with ceramic granules. Conform to ASTM D517, mineral-surfaced asphalt.

][2.13 PAVER BLOCKS

****

NOTE: Use concrete pavers as walkways on aggregate surface roofs where the roof or areas of the roof are intended to bear foot traffic for maintenance or other purposes once a month or more frequently. Use paver blocks under heavy bearing components, irregular base bearings and for support and attachment of lightweight pipe, conduit, and drainage lines routed along roof surface.

****

Precast concrete, minimum 38 mm 1-1/2 inch thick, minimum 450 mm 18 inch square for walkways and minimum 150 mm by 300 mm 6-inch by 12-inch for use in supporting surface bearing components but extending not less than 50 mm 2 inch beyond all sides of surface bearing bases. Install walkpad material under all paver blocks.

][2.14 ROOF INSULATION BELOW MEMBRANE SYSTEM

****

NOTE: If the roofing system contains insulation, coordinate with the appropriate insulation specification section. The insulation specification should include materials and installation up to the substrate on which the roof membrane base sheet and or membrane layers are to be installed. Coordinate base sheet attachment (mechanically fastened or mopped) with FM or UL fire and wind uplift requirements.

****

Provide insulation compatible with the roof membrane, approved by the membrane manufacturer.

]2.15 MEMBRANE LINER

Self-adhering modified bitumen underlayment conforming to ASTM D1970/D1970M, EPDM membrane liner conforming to ASTM D4637/D4637M, or other waterproof membrane liner material conforming to ASTM D4869/D4869M, or ASTM D6757/D6757M, and as approved by the Contracting Officer.

[2.16 TOP COATING

****

NOTE: Top coatings can provide Energy Star classification when applied as final surface. Typical colors are white, tan, and other light colors. In review of the overall performance of the roof, color and materials specified earlier in this specification, the designer has the option to include Energy Star rating by including the paragraph below.

****

Provide a top coating product that is Energy Star labeled and is produced and compatible with the roof material of this specification. Provide data identifying Energy Star label for top coating product. Install to the manufacturer's written installation methods. Provide written confirmation that installation of a top coat will not modify or void the required roof warranty.

]PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

Before applying roofing materials, ensure that the following exist:

a. Do not install items that show visual evidence of biological growth.

b. [Drains,] [curbs,] [cants,] [control joints,] [expansion joints,] [perimeter walls,] [roof penetrating components,] [and] [equipment supports] are in place.

c. Surfaces are rigid, clean, dry, smooth, and free of cracks, holes, and sharp changes in elevation. Joints in substrate are sealed to prevent drippage of bitumen into building or down exterior walls. Inspect surfaces and approve immediately before application of roofing and flashings. Apply the roofing and flashings to a smooth and firm surface free from ice, frost, visible moisture, dirt, projections, and foreign materials.

d. The plane of the substrate does not vary more than 6 mm 1/4 inch within an area 3 by 3 meters 10 by 10 feet when checked with a 3 meter 10 foot straight edge placed anywhere on the substrate.

e. Substrate is sloped as indicated to provide drainage.

f. Walls and vertical surfaces are constructed to receive counterflashing and will permit mechanical fastening of the base flashing materials.

g. Treated wood nailers are in place on non-nailable surfaces, to permit nailing of base flashing at minimum height of 8 inch above finished roofing surface.

****

NOTE: Coordinate with Section 06 10 00 ROUGH CARPENTRY to ensure that waterborne preservative treatment is specified for wood which will be in contact with roofing components.

****

h. Treated wood nailers are fastened in place at eaves, gable ends, openings, and intersections with vertical surfaces for securing of felts, edging strips, attachment flanges of sheet metal, and roof fixtures.[Embedded nailers are flush with deck surfaces.][Surface-applied nailers are same thickness as roof insulation.]

****

NOTE: Wood cants should also be used where there are non-wall supported flashings at wood blocking forming area dividers and expansion joints, and at wall and roof intersections where roof deck is not supported on wall.

****

i. Cants are securely fastened in place in the angles formed by walls and other vertical surfaces. The angle of the cant is approximately 45 degrees and the height of the vertical leg is not less than nominal 89 mm 3-1/2 inch. Lay cants in a solid asphalt mopping or coat of asphalt cement just prior to laying the roofing plies.

****

NOTE: Include venting provision for wet fill substrate materials like lightweight cellular concrete.

****

[j. Venting is provided in accordance with the following:

[(1) Edge Venting: Perimeter nailers are kerfed across width of the nailers to permit escape of gaseous pressure at roof edges.

][(2) Underside Venting: Vent openings are provided in steel form decking for cast-in-place concrete substrate.

]]

****

NOTE: Coordinate with Section 06 10 00 ROUGH CARPENTRY, to ensure that waterborne preservative treatment is specified for wood which will be in contact with roofing components.

****

[k. Exposed nail heads in wood substrates are properly set. Warped and split [boards][sheets] have been replaced. There are no cracks or end joints 6 mm 1/4 inch in width or greater. Knot holes are covered with sheet metal and nailed in place. [Wood][Plywood] decks are covered with rosin paper or unsaturated felt prior to base sheet or roof membrane application.[Joints in plywood substrates are taped with 50 mm 2 inch wide masking tape to prevent air leakage from the underside.]

][l. Insulation boards are installed smoothly and evenly, and are not broken, cracked, or curled. There are no gaps in insulation board joints exceeding 6 mm 1/4 inch in width. Insulation is being roofed over on the same day the insulation is installed.

] m. [Cast-in-place concrete substrates have been allowed to cure and the surface dryness requirements specified under paragraph FIELD QUALITY CONTROL have been met.]No viable moisture present when conducting

ASTM D4263.

n. [Joints between precast concrete deck units, including weld plates, are grouted, leveled, and covered with 4 inch wide ply felt or other bituminous stripping membrane set in bituminous cement prior to applying other roofing materials over the area.]Prior to application of primer on precast concrete decks, cover joints with a minimum 100 mm 4 inch strip of felt or bituminous stripping membrane set in bituminous cement.

3.1.1 Summary Of Minimum Material Weights (Per 10 sq meter 100 sq ft)

Asphalt assembly:

[Sheathing paper] [Base sheet]	[_____kg] [_____pounds]
[Asphalt mopping] [Adhesive] to receive insulation	[_____kg] [_____pounds]
Vapor retarder	[_____kg] [_____pounds]
Roof insulation	[_____kg] [_____pounds]
Asphalt mopping to receive base sheet	[_____kg] [_____pounds]
Asphalt-saturated roofing felts ed roofing felts	[_____kg] [_____pounds]
Asphalt moppings between felts ([_____] at [_____] kg) pounds)	[_____kg] [_____pounds]
Cap sheet	[_____kg] [_____pounds]
Flood coat	[_____kg] [_____pounds]
[Gravel] [Slag] [Aggregate] surfacing	[_____kg] [_____pounds]
Approximate total weight	[_____kg] [_____pounds]

3.2 PREPARATION

Verify that work of other trades that penetrates the roof deck or requires men and equipment to traverse the roof deck is complete.

Examine deck surfaces for inadequate anchorage, foreign material, moisture, and unevenness which would prevent the execution and quality of application.

Proceed with the roofing application only after defects have been corrected.

Starting work designates acceptance of the surfaces by the Contractor.

3.2.1 Protection of Property

3.2.1.1 Protective Coverings

Install protective coverings at paving and building walls adjacent to hoists and kettles prior to starting the work. Lap protective coverings not less than six inch, secure against wind, and vent to prevent collection of moisture on covered surfaces. Keep protective coverings in place for the duration of the roofing work.

3.2.1.2 Bitumen Stops

Provide felt bitumen stops or other means to prevent bitumen drippage at roof edges, openings, and vertical projections before hot mopped application of the roofing membrane. Form felt bitumen stops with two 300 mm 12 inch wide strips of organic ply felt. Laminate with and set strips into a coating of asphalt roof cement with one-half of the width overhanging the edge of the roof or opening. Where nailers are provided, nail the strips with roofing nails spaced 300 mm 12 inch on center in addition to embedding in asphalt roof cement. Protect the free portion of each strip from damage throughout the roofing period. After the plies of felt are in place, fold free portion of the strips back over the roofing membrane and embed in a continuous coating of asphalt roof cement. Secure with roofing nails spaced 75 mm 3 inch on center.

3.2.2 Equipment

3.2.2.1 Mechanical Application Devices

Provide and maintain mechanical application devices with pneumatic tires that operate without damaging the insulation, roofing membrane, or structural components.

3.2.2.2 Flame-Heated Equipment

Do not place flame-heated equipment on roof. Provide and maintain a fire extinguisher adjacent to flame-heated equipment and on the roof.

[3.2.2.3 Open Flame Application Equipment

Use only open flame equipment recommended by the roofing materials manufacturer. Do not ignite open flame equipment when left unattended. Provide and maintain a fire extinguisher adjacent to open flame equipment on the roof.

]3.2.3 Priming of Surfaces

Prime all surfaces to be in contact with adhered membrane materials. Apply primer at the rate of 3 liters per 10 sq. meters 0.75 gallon per 100 sq. ft. or as recommended by roof membrane manufacturer's printed instructions to promote adhesion of membrane materials. Allow primer to dry prior to application of membrane materials to primed surface. Avoid flammable primer material conditions in torch applied membrane base flashing applications.

[3.2.3.1 Priming of Concrete and Masonry Surfaces

****

NOTE: Include this paragraph when roofing and base flashing are applied directly to concrete or masonry surfaces.

****

After surface dryness requirements have been met, coat concrete and masonry surfaces which are to receive roofing and base flashing uniformly with primer. Allow primer to dry before application of roofing and flashing materials.

]3.2.3.2 Priming of Metal Surfaces

Prime flanges of metal components to be embedded into the roofing system prior to setting in bituminous materials or stripping into roofing system.

3.2.4 Covering of Wood Substrate

Cover wood substrate with a layer of unsaturated felt or rosin-sized building paper lapped 50 mm 2 inch at sides and 100 mm 4 inch at ends. Nail to hold in place prior to application of roofing system.

3.2.5 Heating of Asphalt

Break up solid asphalt on a surface free of dirt and debris. Heat asphalt in kettle designed to prevent contact of flame with surfaces in contact with the asphalt. Provide visible working thermometer and thermostatic controls set to the temperature limits. Keep controls in working order and calibrated. Use immersion thermometer, accurate within a tolerance of plus or minus one degree C 2 degrees F, to check temperatures of the asphalt frequently. When temperatures exceed maximum specified, remove asphalt from the site. Do not permit cutting back, adulterating, or fluxing of asphalt.

3.2.5.1 Temperature Limitations for Asphalt

Heat and apply asphalt at the temperatures specified below unless specified otherwise by manufacturer's printed application instructions. Use thermometer to check temperature during heating and application. Have kettle attended constantly during heating process to ensure specified temperatures are maintained. Do not heat asphalt above its finished blowing temperature (FBT). Do not heat asphalt between 260 and 274 degrees C 500 and 525 degrees F for longer than four consecutive hours. Do not heat asphalt to the flash point (FP). Apply asphalt and embed membrane sheets when temperature of asphalt is within plus or minus 14 degrees C 25 degrees F of the equiviscous temperature (EVT). Before heating and application of asphalt refer to the asphalt manufacturer's label or bill of lading for FP, FBT, and EVT of the asphalt used.

3.3 APPLICATION

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NOTE: Include requirements for temporary roofing and flashing when construction will require considerable work on roof (that is, installing cooling towers, antennas, pipes, ducts, solar collectors) and temporary roofing is considered necessary to ensure that permanent roofing is not damaged during construction.

****

Apply roofing materials as specified unless approved otherwise by the Contracting Officer. Keep roofing materials dry before and during application. Except for aggregate surfacing, complete application of roofing in a continuous operation. Begin and apply only as much roofing in one day as can be completed that same day. Maintain specified temperature for asphalt. [Provide temporary roofing and flashing as specified herein prior to application of permanent roofing system.] Do not apply aggregate surfacing until the other roofing application procedures specified herein are completed.

3.3.1 Phased Membrane Construction

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NOTE: Include bracketed option only when granule-surfaced modified bitumen cap sheet is specified as the built-up roof surfacing.

****

Phased application of membrane plies is prohibited. [Any delay in modified bitumen cap sheet installation will result in thorough cleaning of the applied membrane material surface and drying immediately prior to cap sheet installation. Priming of the applied membrane surface may be required at the discretion of the Contracting Officer prior to cap sheet installation.]

[3.3.2 Temporary Roofing and Flashing

Provide watertight temporary roofing and flashing where considerable work by other trades, such as installing [cooling towers,] [antennas,] [pipes,] [ducts,] [_____,] is to be performed on the roof or where construction scheduling or weather conditions require protection of building interior before permanent roofing system can be installed. Do not install temporary roofing over permanently installed insulation. Provide rigid pads for traffic over temporary roofing.

3.3.2.1 Removal

Completely remove temporary roofing and flashing before continuing with application of permanent roofing system.

][3.3.3 Base Sheet Application - General

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NOTE: Include this paragraph when either base sheet or ventilating base sheet is specified in paragraph DESCRIPTION OF ROOF MEMBRANE SYSTEM.

Mechanically fastened base sheets are required when uninsulated roof membrane system is to be applied directly to nailable decks, excluding steel deck. Ventilating base sheet is required when roof membrane is applied directly to wet fill deck materials like lightweight insulating or cellular concrete and gypsum fill, and when applied over new poured concrete decks.

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NOTE: Select the applicable application method. Delete other options.

Delete requirements for adhered base sheets where the sheet is to be mechanically fastened through to nailable deck.

Apply base sheets at right angles to roof slope, except on insulated roofs where nailers (insulation

stops) have been applied at right angles to slope and on decks sloped 1:12 25 mm per meter 1 inch per foot or more, apply felts parallel to roof slope. Include requirements for applying felts to barrel-type roofs only when applicable.

****

[[Fully adhere][Spot adhere]base sheets in accordance with membrane manufacturer's printed instructions. [Provide spot adhesion with hot asphalt applied in 300 mm 12 inch diameter spots installed in two staggered rows, centered 300 mm 12 inch in from edge of the base sheet.] Roll and broom in the base sheet to ensure full contract with the hot asphalt application.] [On nailable substrates, mechanically fasten base sheet in conformance with specified wind resistance requirements and membrane manufacturer's printed instructions, and to include increased fastening frequency in corner and perimeter areas. Drive fasteners flush with no dishing or cupping of fastener plate. Where applicable, base sheet may be mechanically fastened in conjunction with insulation to the substrate, in accordance with membrane manufacturers printed instructions.] Apply sheets in a continuous operation. Apply sheets with side laps at a minimum of 50 mm 2 inch unless greater side lap is recommended by the manufacturer's standard written application instructions. Provide end laps of not less than 150 mm 6 inch and staggered a minimum of 1 meter 36 inch. Apply sheets [at right angles to the roof slope so that the direction of water flow is over and not against the laps] [parallel to the roof slope] [so that plies of sheets extend from eave line on one side of the barrel-type roof and 450 mm 18 inch over the center line of the crown of the roof. Apply sheets on the other side in the same manner, resulting in twice the normal amount of roofing sheets and asphalt at the crown]. Extend base sheets approximately 50 mm 2 inch above the top of cant strips at vertical surfaces and to the top of cant strips elsewhere. Trim base sheet to a neat fit around vent pipes, roof drains, and other projections through the roof. Retrofit roof drains must conform to ANSI/SPRI RD-1. Application must be free of ridges, wrinkles, and buckles.

[3.3.3.1 Ventilating Base Sheets

****

NOTE: Include this paragraph in conjunction with applicable portions of the above paragraph when ventilating base sheets are specified in paragraph DESCRIPTION OF ROOF MEMBRANE SYSTEM.

Where rigid roof insulation is a component of the roof system, specify ventilating base sheet in the appropriate roof insulation section.

****

Apply ventilating base sheet material recommended by the roof membrane manufacturer. Extend sheets over roof cants, up vertical surfaces, and terminate under cap flashing; at roof edges terminate sheets under outside edge of perimeter edge nailers or under gravel stop. [Top mop perforated ventilating base sheet with a full, continuous mopping of hot asphalt.]

]]3.3.4 Ply Felts

****

NOTE: Apply roofing felts at right angles to the roof slope, except that on insulated roofs where

surface-applied wood nailers (insulation stops) have been applied running at right angles to roof slope and on decks sloped 1:6 50 mm per meter 2 inch per foot or more, apply the roofing felts parallel to roof slope. Delete the add-on requirement for applying felts to barrel-type roofs when not applicable.

****

Ensure proper alignment of felts prior to installation. [Apply ply felts shingle fashion perpendicular to slope of roof, including application on areas of tapered insulation that change slope direction.][Apply ply felts parallel to slope of roof [so that plies of felt extend from eave line on one side of barrel-type roof and 450 mm 18 inch over center line of the crown of roof. Apply felts on other side in same manner, resulting in twice normal amount of roofing felts and asphalt at crown].] Bucking or backwater laps are prohibited. Apply felts in a continuous operation. Provide starter sheets of felt to maintain the specified number of plies throughout the roofing. Apply felts with side laps in accordance with the material manufacturer's printed instructions for the number of plies to be installed and in uniform alignment. Lap ends not less than 150 mm 6 inch and stagger one meter 36 inch minimum. Place the full width of each ply in hot bitumen immediately behind the bitumen applicator. Lay plies free of wrinkles, creases, ridges, or fishmouths. Extend felts approximately 50 mm 2 inch above top of cant strips at vertical surfaces and to top of cant strips elsewhere. Trim felts to a neat fit around vent pipes, roof drains, and other projections. Avoid traffic on mopped surfaces when the bitumen is fluid and for a minimum of one hour after ply application.

3.3.4.1 Hot-Mopping of Ply Felts

Bond plies to each other and to the [base sheets] [substrate] with hot asphalt. Apply felts immediately following application of asphalt. Do not work ahead with asphalt. At the instant felts come into contact with asphalt, asphalt must be completely fluid, with asphalt temperatures within specified EVT range. Apply asphalt uniformly in a full, continuous mopping and firmly bonding film. Apply asphalt at the rate of approximately 13 kg per 10 sq. meters 25 pounds per 100 sq. feet plus or minus 25 percent. Require application rate on the high end of the application range when mopping directly to absorptive insulation substrates of perlite and woodfiber. As felts are rolled into the hot asphalt, immediately squeegee, roll or broom down to eliminate trapped air and to provide tight, smooth laminations without wrinkles, buckles, kinks, or fish mouths. Bitumen must be visible beyond all edges of each ply as it is being installed. Install individual ply and the completed roof membrane system free of air pockets, felt delaminations, ridges, creases, fishmouths, dry laps, or blisters. Do not lay felts dry or turn back laps for mopping between plies.

[3.3.4.2 Backnailing of Ply Felts

****

NOTE: Backnailing is required generally for slopes of 25 mm 1 inch or greater for Type III asphalt, 15 mm 1/2 inch for Type I asphalt at a maximum backnail spacing of 305 mm 12 inches. However, due to technical improvements in today's materials and methodology, backnailing is becoming obsolete.

On low slope roofs 15 mm 1/2 inch to 1 inch per

foot,) depending on the products used, apply felts shingle fashion, perpendicular to slope, starting at the lowest point.

On slopes greater than 25 mm 1 inch, require backnailing and install nailers of the same thickness as the roof insulation. Run felts parallel to slope and nail through the back edge of the felts into the nailers

When roof slope exceeds 1:6 50 mm per meter 2 inch per foot include the applicable paragraphs on backnailing. For insulated roofs, delete the second bracketed option. For uninsulated roofs on nailable decks, delete the first bracketed option and include only the second.

****

Unless otherwise recommended by the roof membrane manufacturer and approved by the Contracting Officer, [provide minimum 90 mm 3-1/2 inch wide nailing strips matching insulation thickness and applied perpendicular to roof slope for backnailing of roof membrane. Space nailing strips as recommended by the membrane manufacturer, but not exceeding 5 meters 16 feet on center unless approved otherwise by the Contracting Officer. Coordinate the nailer installation with insulation requirements. As the felt plies are installed, nail each ply 25 mm 1 inch from the leading edge at each nailer line.] [fasten each felt ply 25 mm 1 inch from the leading edge and spaced at maximum 5 m 15 feet on center along the leading edge.] Provide fasteners with a 25 mm 1 inch diameter metal cap or fasten through 25 mm 1 inch diameter caps. Set fasteners firm and flush without puncturing felt ply. Conceal fasteners with succeeding plies of felt.

]3.3.4.3 Valleys and Ridges

Valleys: Apply roofing at valleys and waterways in the following manner:

Continue base sheets across valleys and terminate 450 millimeter 18 inch from the valley.

Continue felt plies across valleys and terminate 300 millimeter 12 inch from the valley. Terminate exposed laps on a line 300 millimeter 12 inch from, and parallel to, the gutter valley. Provide two plies of felt, 225 and 300 millimeter 9 and 12 inch wide, successively mop in over each felt line of the termination.

If the application can be completed without wrinkles, buckles, or fishmouths and if side laps do not face the direction of drainage, roofing felts and base sheets may be laid continuously across or parallel to shallow valleys such as those formed by reverse-slope roofs. For this application, reinforce valleys with one ply of felt, 900 millimeter 36 inch wide, center on the valley gutter and lay in a solid mopping of asphalt over the top ply of roofing.

3.3.5 Membrane Flashing

Provide two plies of modified bitumen membrane strip flashing and sheet flashing in the angles formed where the roof deck abuts walls, curbs, ventilators, pipes, and other vertical surfaces, and where necessary to make the work watertight. Top ply of flashing must be granule-surfaced modified bitumen membrane. Install flashing after plies of roof membrane felt have been applied but before aggregate surfacing is applied. Cut at a 45 degree angle across terminating end lap area of cap membrane prior to applying adjacent overlapping cap membrane. Press flashing into place to ensure full adhesion and avoid bridging. Ensure full lap seal in all lap areas. Mechanically fasten top edge of base flashing 150 mm 6 inch on center through minimum 25 mm 1 inch diameter tin caps with fasteners of sufficient length to embed minimum 25 mm 1 inch into attachment substrate.[Apply matching granules in any areas of asphalt bleed out while the asphalt is still hot.] Apply membrane liner over top of exposed nailers and blocking and to overlap top edge of base flashing installation at curbs, parapet walls, expansion joints and as otherwise indicated to serve as waterproof lining under sheet metal flashing components.

3.3.5.1 Strip Flashing

Set primed flanges of sheet metal flashings to be incorporated into roofing system in a uniform coating of asphalt roof cement not less than 1/16 inch thick applied over the ply felts. Strip-in with one layer of smooth surface modified bitumen membrane and cap with granule-surfaced modified bitumen membrane. Set strip flashing in hot asphalt or cement to the tops of the flanges, roofing membrane, and to each other. Use coatings of asphalt roof cement not less than 1/16 inch thick for ply felt. Use hot asphalt or modified bitumen cement for modified bitumen sheets. Extend first stripping ply not less than 100 mm 4 inch beyond outer edge of flange onto roof membrane. Extend each additional ply 100 mm 4 inch beyond the edge of the previous ply.

[3.3.5.2 Membrane Flashing at Roof Drain

****

NOTE: Include these requirements where roof drains are provided. Roof drains are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Flashings for roof drains are specified in Section 07 60 00 FLASHING AND SHEET METAL.

****

Extend roofing plies to edge of drain bowl opening at roof drain deck flange. Neatly fit and press primed roof drain flashing into heavy coat of asphalt roof cement applied to top of roofing plies. Strip in and completely cover flashing with two layers of modified bitumen sheet, extending the first sheet 150 mm 6 inch on the roofing beyond the edge of flashing. Extend the cap sheet 150 mm 6 inch beyond the previous flashing ply. Bond the two layers to the metal flashing and to each other with hot asphalt. Securely clamp membrane, metal flashing, and strip flashing in the flashing clamping ring. Secure clamps so that strip flashing and metal flashing are free from wrinkles and folds. Trim membrane, flashing, and stripping flush with inside of clamping ring.

][3.3.5.3 Pre-fabricated Curbs

Anchor prefabricated curbs securely to nailer or other base substrate as indicated and flash with modified bitumen flashing membrane.

]3.3.5.4 Set-On Accessories

Where pipe or conduit blocking, supports and similar roof accessories are set on the membrane, adhere walkpad material to bottom of accessories prior to setting on roofing membrane. Install set-on accessories to permit normal movement due to expansion, contraction, vibration, and similar occurrences without damaging roofing membrane. Do not mechanically secure set-on accessories through roofing membrane into roof deck substrate.

3.3.5.5 Lightning Protection

Flash or attach lightning protection system components to the roof membrane in a manner acceptable to the roof membrane manufacturer.

[3.3.6 Roof Walkpads

Install walkpads at roof access points and where otherwise indicated for traffic areas and for access to mechanical equipment, in accordance with the modified bitumen sheet roofing manufacturer's printed instructions. Provide minimum 150 mm 6 inch separation between adjacent walkpads to accommodate drainage. Provide walkpad [or an additional layer of cap sheet] under precast concrete paver blocks to protect the roofing.

][3.3.7 Elevated Metal [Walkways] [and] [Platforms]

Provide protection mat of walkpad material, or other material approved by the Contracting Officer, at all surface bearing support locations.

]3.3.8 Paver Blocks

Install paver blocks where indicated and as necessary to support surface bearing items traversing the roof area. Set paver block on a layer of walkpad [or modified bitumen cap sheet] applying over the completed roof membrane.

****

NOTE: Include only the applicable surfacing, delete the other option.

****

[3.3.9 Aggregate Surfacing

After completion of roof membrane ply and flashing installation, and correction of tears, gouges or other deficiencies in the installed work, apply aggregate surfacing. Uniformly flood coat the surface with hot asphalt at a rate of approximate 2.9 kg 60 pounds per square. While asphalt is still hot, apply gravel aggregate surfacing material at a rate of 19.5 kg 400 pounds per square. Provide for full and uniform coverage of the roof surface. Approximately 50 percent of the aggregate must be solidly adhered in the asphalt.

][3.3.10 Granule-Surfaced Modified Bitumen Cap Sheet

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NOTE: Include the option of hot asphalt or torch application of cap sheet where permissible. Torch applied cap sheet can be applied over hot mopped membrane plies.

Where finished appearance of the roof is of consequence, include the bracketed requirement for granule application in areas of bitumen bleed out.

****

Inspect underlying applied membrane and repair free of damage, holes, puncture, gouges, abrasions, and any other defects, and free of moisture, loose materials, debris, sediments, dust, and any other conditions required by the membrane manufacturer prior to cap sheet installation. Provide cleaning and artificial drying with heated blowers or torches to ensure clean, dry surface prior to cap sheet application. When delays in cap sheet installation may have occurred, do not apply cap sheet if underlying materials have been exposed to rain or frozen precipitation within the previous 24 hours. Unroll cap sheet membrane and allow to relax a minimum of 1 hour prior to installation and as otherwise recommended by the membrane manufacturer. Apply cap sheet in same direction as the underlying felt plies. Align cap membrane and apply with minimum 75 mm 3 inch side laps and minimum 150 mm 6 inch end laps and as otherwise required by membrane manufacturer. Set cap sheet in hot asphalt. Cap sheet may be torch applied with approval of the Contracting Officer and written approval of the felt membrane manufacturer, and as recommended by the modified bitumen membrane manufacturer. Cut at a 45 degree angle across selvage edge of cap membrane to be overlapped in end lap areas prior to applying overlapping cap membrane.[Apply matching granules in any areas of bitumen bleed out while the bitumen is still hot]. Minimize traffic on newly installed cap sheet membrane.

[3.3.10.1 Backnailing of Cap Sheet Membrane

****

NOTE: Include this paragraph for roof slopes greater than or equal to 1:6 50 mm per meter 2 inch per foot. Coordinate with insulation Section 07 22 00 ROOF AND DECK INSULATION and nailer requirements Section 06 10 00 ROUGH CARPENTRY to allow for backnailing of the membrane.

****

Unless otherwise recommended by the roof membrane manufacturer and approved by the Contracting Officer, install the modified bitumen cap sheet to provide for end laps at nailer locations. Nail the modified bitumen cap sheet at the end lap area across the width of the sheet. Nail within 25 mm 1 inch of each edge of the sheet and at 200 mm to 215 mm 8 to 8-1/2 inchon center across the width of the sheet in a staggered fashion. Provide nails with a 25 mm 1 inch diameter metal cap or nail through 25 mm 1 inch diameter caps. Cover nails by overlapping adjacent upslope sheet at the end lap area.

]]3.3.11 Correction of Deficiencies

Where any form of deficiency is found, take additional measures to determine the extent of the deficiency and perform corrective actions as directed by the Contracting Officer.[Where interply moppings are too light, apply additional two plies of felt in full moppings of asphalt. Apply with 100 mm4 inch side and end laps. Where free water, skips, excessive voids, dry laps, desponding or any form of delamination are discovered between the plies, remove and rebuild affected area. Correction of inadequate number of plies, improper lap widths, or non-uniform or excessive asphalt mopping must be as directed by the Contracting Officer.] Where insulation is found to be wet, remove insulation and provide new built-up roofing and insulation.

3.3.12 Clean Up

Remove debris, scraps, containers and other rubbish and trash resulting from installation of the roofing system from job site each day.

3.4 PROTECTION OF APPLIED ROOFING

3.4.1 Protection Against Moisture Absorption

When precipitation is imminent and at the end of each day's work, protect applied roofing as follows:

[3.4.2 Water Cutoffs

****

NOTE: Include this paragraph when roof insulation is a substrate for the modified bitumen sheet roofing.

****

Straighten insulation line using loose-laid cut insulation sheets and seal the terminated edge of modified bitumen roofing system in an effective manner.[Seal off flutes in metal decking along the cutoff edge.] Remove the water cutoffs to expose the insulation when resuming work, and remove the insulation sheets used for fill-in.

]3.4.3 Temporary Flashing for Permanent Roofing

Provide temporary flashing at drains, curbs, walls and other penetrations and terminations of roofing sheets until permanent flashings can be applied. Remove temporary flashing before applying permanent flashing.

3.4.4 Temporary Walkways, Runways, and Platforms

Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards, mats or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to live load limits of roof construction. Use rubber-tired equipment for roofing work.

[3.4.5 Glaze Coat

Use light glaze coating of bitumen to waterproof roof areas requiring extended time to complete. Glaze coating must be at the discretion of the Contracting Officer. Apply bitumen glaze coat on exposed felts at a rate of 0.25 kg to 0.50 kg per square meter 5 to 10 pounds per square. Lower application rates, in accordance with membrane manufacturer's recommendations, may be required when modified bitumen cap sheet surfacing is specified. Provide valleys and low areas that may pond water with glaze coating.

]3.5 FIELD QUALITY CONTROL

Perform field tests in the presence of the Contracting Officer. Notify the Contracting Officer one day before performing tests.

3.5.1 Test for Surface Dryness

Before application of insulation or membrane materials and starting work on the area to be roofed, perform test for surface dryness in accordance with the following:

a. Foaming: When poured on the surface to which materials are to be applied, one pint of asphalt when heated in the range of 176 to 204 degrees C 350 to 400 degrees F, must not foam upon contact.

b. Strippability: After asphalt used in the foaming test application has cooled to ambient temperatures, test coating for adherence. Should a portion of the sample be readily stripped clean from the surface, do not consider the surface to be dry and do not start application. Should rain occur during application, stop work and do not resume until surface has been tested by the method above and found dry.

c. Prior to installing any roof system on a concrete deck, conduct a test per ASTM D4263. The deck is acceptable for roof system application when there is no visible moisture on underside of plastic sheet after 24 hours.

3.5.2 Construction Monitoring

During progress of the roof work, perform visual inspections to ensure compliance with specified parameters. Additionally, verify the following:

a. Equipment is in working order. Metering devices are accurate.

b. Materials are not installed in adverse weather conditions.

c. Substrates are in acceptable condition, in compliance with specification, prior to application of subsequent materials.

    (1) Nailers and blocking are provided where and as needed.

    (2) Insulation substrate is smooth, properly secured to its substrate, and without excessive gaps prior to membrane application.

    (3) The proper number, type, and spacing of fasteners are installed.

    (4) Materials comply with the specified requirements.

    (5) All materials are properly stored, handled and protected from moisture or other damages.

    (6) Asphalt is heated and applied within the specified temperature parameters.

    (7) Hot asphalt application is provided uniformly for voidless coverage and as necessary to ensure full adhesion of materials. Materials are set in place while asphalt is within the specified temperature range.

    (8) The proper number and types of plies are installed, with the specified overlaps.

    (9) Applied membrane surface is inspected, cleaned, dry, and repaired as necessary prior to cap sheet installation.

    (10) Membrane is without ridges, wrinkles, kinks, fishmouths, or other voids or delaminations.

(11) Installer adheres to specified and detailed application parameters.

(12) Associated flashings and sheet metal are installed in a timely manner in accord with the specified requirements.

(13) Temporary protection measures are in place at the end of each work shift.

[3.5.2.1 Manufacturer's Inspection

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NOTE: Include this paragraph when manufacturer's inspection of work is required. Select desired frequency of manufacturer inspection and coordinate with text of optional 2nd and 3rd bracketed sentences.

****

Manufacturer's technical representative must visit the site a minimum of three [_____] times [once per week] during the installation for purposes of reviewing materials installation practices and adequacy of work in place.[Inspect during the first 20 squares of membrane installation, at mid-point of the installation, and at substantial completion prior to surfacing application, at a minimum. Additional inspections must not exceed one for each 100 squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer.] After each inspection, submit a report, signed by the manufacturer's technical representative to the Contracting Officer within 3 working days. The report must note overall quality of work, deficiencies and any other concerns, and recommended corrective action.

]3.5.3 Samples of Built-Up Roofing

****

NOTE: This requirement is included for optional enforcement at the discretion of the Contracting Officer. It is not the intent to require cut samples on all roof projects.

****

After application of specified roofing felts and prior to applying surfacing, take field samples of built-up roofing as directed by the Contracting Officer. Take and test samples in accordance with ASTM D3617 and at locations selected by the Contracting Officer immediately prior to cutting. Cut 100 mm by 1000 mm 4 inch by 40 inch samples across felt laps in a manner to expose the specified number of plies. The 100 mm 4 inch edge must coincide with an edge lap of felt and not be positioned over an end lap. Use 100 mm by 1000 mm 4 inch by 40 inch samples for visual inspection. The Contracting Officer will inspect the samples for the specified number of plies, bond between plies, skips in interply moppings, uniform asphalt mopping, presence of excessive voids or large voids in the ply construction, presence of harmful foreign materials, visible presence of moisture in the sandwich and wet insulation. Use 300 mm by 300 mm 12 inch by 12 inch cut samples to calculate bitumen quantities in accordance with ASTM D3617 and directed by the Contracting Officer. Do not proceed with surfacing until all deficiencies disclosed as a result of cut tests have been corrected and approved by the Contracting Officer. Where cuts are not retained by the Contracting Officer or disposed, set cut strip back in cut area and patch as specified.

3.5.3.1 Number of Cut Tests

Take cut samples as directed by the Contracting Officer for quality assurance validation or as necessary to determine the extent of deficiencies discovered in the construction. Except where cut samples are taken to investigate deficiencies, provide no more than two cut samples per 1000 square meters 100 squares or one cut sample from each day's work.

3.5.3.2 Sample Cutting Device

Provide a rectangular, 100 mm by 1000 mm 4 inch by 40 inch template and 300 mm by 300 mm 12 inch by 12 inch template, of a type that will permit accurate cutting of samples with standard roofing knives. Keep cutting edge of knife clean by washing in solvent after each cut.

3.5.3.3 Patching Cut-Out Area

Immediately after inspection, replace cut-out sample. When sample is needed for laboratory analysis or other circumstance makes it unavailable, substitute a new section of equivalent size and structure. For non-nailable decks, replace sample in hot asphalt. For nailable decks, insert one ply of ply felt into opening from which sample was taken and sprinkle nail to hold in place; coat felt heavily with asphalt roof cement and press cutout sample firmly into asphalt roof cement. Repair area of cut with new patch of the same number of plies as the primary roof membrane. Extend the first ply minimum 150 mm 6 inch all around the cut area. Extend each additional ply minimum 100 mm 4 inch beyond the previous ply.

[3.5.4 Roof Drain Test

****

NOTE: Include this paragraph when roof drains are required. Consult with structural engineer to verify loading capability of roof structural system.

****

After roofing system is complete except for surfacing, perform the following test of roof drains and adjacent roofing for watertightness. Plug roof drains and fill with water to edge of drain sump for 8 hours. Do not plug secondary overflow drains at same time as adjacent primary drain. To ensure some drainage from roof, do not test all drains at same time. Measure water at beginning and end of the test period. When precipitation occurs during test period, repeat test. When water level falls, remove water, thoroughly dry, and inspect the installation. Repair or replace roofing at drain to provide for a properly installed watertight flashing seal. Repeat test until there is no water leakage.

][3.6 INFRARED INSPECTION

****

NOTE: This optional requirement should be included only under special circumstances and on roof systems conducive to effective infrared scanning, or as otherwise instructed. This section may be necessary at project locations where infrared inspections

cannot be performed during construction due to climate or other adverse conditions.

****

[Eight][_____] months after completion of the roofing system, the Contractor must inspect the roof surface using infrared (IR) scanning as specified in ASTM C1153. Where the IR inspection indicates moisture intrusion, replace wet insulation and damaged or deficient materials or construction in a manner to provide watertight construction and maintain the specified roof system warranties.[Coordinate infrared inspections with building envelope commissioning activities.]

]3.7 INFORMATION CARD

For each roof, furnish a typewritten information card for facility records and a photoengraved 1 mm 0.032 inch thick aluminum card for exterior display. Card must be 215 mm by 275 mm 8-1/2 by 11 inch minimum, identifying facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, membrane, number of plies, method of application, manufacturer, insulation and cover board system and thickness; presence of tapered insulation for primary drainage, presence of vapor retarder; date of completion; installing contractor identification and contact information; membrane manufacturer warranty expiration, warranty reference number, and contact information. Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

-- End of Section --

****

USACE / NAVFAC / AFCEC

UFGS-07 52 00 (May 2012)
Change 5 - 11/19

Preparing Activity: NAVFAC

Superseding
UFGS-07 52 00 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

USACE / NAVFAC / AFCEC | **UFGS-07 52 00 (May 2012)**
Change 5 - 11/19
Preparing Activity: NAVFAC | **Superseding**
UFGS-07 52 00 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 52 00

MODIFIED BITUMINOUS MEMBRANE ROOFING

05/12, CHG 5: 11/19

****

NOTE: This guide specification covers the requirements for modified bitumen sheet roofing. Hot mopped asphalt, torch applied, hot air, and cold-applied adhesive applications are included on both existing and new roof systems with slopes from 6 mm to 76 mm 1/4 inch to 3 inches per foot. Both SBS and APP modified bitumen membranes are included.

Due to the potential for fires during roofing installations, torch application of the roofing system is prohibited when the roof deck and/or the materials used in the installation of the roofing system (wood blocking, cant strips, curbs, etc.) are "combustible" as defined by NFPA 101.

When combustible materials are used in the installation of roofing systems or are present on existing roofing conditions, delete all requirements related to torch applications, and select one of the alternate methods for installing Modified Bituminous Membrane Roofing systems.

Existing facilities may likely contain combustible materials underneath existing roofing systems. If the presence of combustible materials cannot be verified, delete all reference to torch applications and select one of the alternate methods of attachment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in

respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

Acids, hydrocarbons, oil, and cooking greases attack modified sheet roofing. When these contaminants may be a problem on a roof, contact modified bitumen sheet manufacturers for specific recommendations.

Coordinate this section with other roof system components specifications such as rough carpentry, electrical, mechanical, insulation and sheet metal flashing, and structure. Also coordinate this section with the criteria contained in UFC 3-110-03, "Roofing" as it relates to the specific project and Service Exceptions indicated therein.

Requirements for special conditions, including Hurricane force wind (uplift) and seismic design considerations are included in brackets. References and paragraphs which do not apply to specific projects should be deleted.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.24	(2022) Roofing - Safety Requirements for Low-Sloped Roofs

ASPHALT ROOFING MANUFACTURER'S ASSOCIATION (ARMA)

ARMA 410BUR88	(2001) Manual of Roof Maintenance and Repair
ARMA PMBRG98	(1998) Quality Control Guideline for the Application of Polymer Modified Bitumen Roofing

ASTM INTERNATIONAL (ASTM)

ASTM C208	(2022) Standard Specification for Cellulosic Fiber Insulating Board
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C726	(2024) Standard Specification for Mineral Wool Roof Insulation Board
ASTM C728	(2017a; R 2022) Standard Specification for Perlite Thermal Insulation Board
ASTM C1153	(2023) Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
ASTM C1289	(2023a) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D312/D312M	(2016a) Standard Specification for Asphalt Used in Roofing
ASTM D1668/D1668M	(1997a; R 2014; E 2014) Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
ASTM D1863/D1863M	(2005; R 2011; E 2012) Mineral Aggregate Used on Built-Up Roofs

ASTM D1970/D1970M	(2019) Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2170/D2170M	(2018) Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)
ASTM D2824/D2824M	(2018) Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Non-Fibered, and Fibered without Asbestos
ASTM D4073/D4073M	(2006; E 2019; R 2019) Standard Test Method for Tensile-Tear Strength of Bituminous Roofing Membranes
ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4402/D4402M	(2015) Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM D4601/D4601M	(2004; R 2020) Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
ASTM D4637/D4637M	(2015) EPDM Sheet Used in Single-Ply Roof Membrane
ASTM D4897/D4897M	(2016) Standard Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing
ASTM D5147/D5147M	(2014) Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material
ASTM D6162/D6162M	(2016) Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements
ASTM D6163/D6163M	(2016) Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements
ASTM D6164/D6164M	(2016) Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements
ASTM D6222/D6222M	(2016) Standard Specification for Atactic

	Polypropylene (ARP) Modified Bituminous Sheet Materials Using Polyester Reinforcements
ASTM D6223/D6223M	(2016) Standard Specification for Atactic Polypropylene (ARP) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements
ASTM D6298	(2016) Standard Specification for Fiberglass Reinforced Styrene-Butadiene-Styrene (SBS) Modified Bituminous Sheet with a Factory Applied Metal Surface
ASTM E108	(2024) Standard Test Methods for Fire Tests of Roof Coverings

FM GLOBAL (FM)

FM 4470	(2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices

MIDWEST ROOFING CONTRACTORS ASSOCIATION (MRCA)

CERTA	(2007) NRCA/MRCA Certified Roofing Torch Applicator Program

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code
NFPA 241	(2022) Standard for Safeguarding Construction, Alteration, and Demolition Operations

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA C3701	(1997) Repair Manual for Low Slope Membrane Roof Systems
NRCA CONDET	(2014) Construction Details Manual

NRCA RoofMan	(2020) The NRCA Roofing Manual

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SINGLE PLY ROOFING INDUSTRY (SPRI)

ANSI/SPRI/FM 4435/ES-1	(2017) Test Standard for Edge Systems Used with Low Slope Roofing Systems

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.12	Construction Work
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.16	Rules of Construction

UL SOLUTIONS (UL)

UL 790	(2022) UL Standard for Safety Test Methods for Fire Tests of Roof Coverings
UL RMSD	(2012) Roofing Materials and Systems Directory

1.2 DESCRIPTION OF ROOF MEMBRANE SYSTEM[S]

****

NOTE: Coordinate with Part 2 materials specification.

Where one membrane system is required for all roof areas, use the first paragraph. Where different systems are required, use the second paragraph successively and replace the open brackets with a description of the substrate(s) and area of the building or project where each system is to be applied.

Specify the three-ply option including base sheet, interply sheet and cap sheet when mechanical fastening of bottom ply is required either directly to nailable deck or over insulation substrate and into nailable deck, and when perforated base sheet is used. Otherwise, specify two-ply option including modified bitumen base sheet and cap sheet.

Two-ply option may also be considered when the mechanical fastening of the modified bitumen base ply is concealed in the finished base ply installation (i.e., no exposed fasteners in the base ply prior to application of cap sheet such as occurs in base sheets fastened only in the side lap area and where the overlapping adjacent base sheet is torch sealed over the fasteners in the lap area).

Do not specify one ply modified bitumen roof membrane without prior Government approval and only consider for application on open air sheds or light storage structures and ancillary buildings of little importance. One ply membrane includes application of a single ply directly to deck or insulation substrate or over mechanically fastened or perforated base sheets.

Specify SBS for all hot asphalt membrane applications. Torch applied and cold adhesive applications may include either or both SBS and APP, selected based on the specific application and service conditions intended. Torch applications are prohibited on combustible roof decks or when combustible materials are used in the installation of the roofing system.

Felt base sheet may be specified in a low to moderate service three-ply application. Specify venting base sheet for application directly to new concrete deck and over nailable lightweight fill substrate materials.

****

[[Minimum [two-ply][three-ply] SBS [or] [APP] [modified bitumen roof membrane consisting of [modified bitumen base sheet][fiberglass felt [venting]base sheet] [,interply sheet] and cap sheet. Modified bitumen roof membrane must be [set in hot asphalt][torch applied]][set in cold-applied adhesive].]

][[_____]: Minimum [two-ply][three-ply] SBS [or] [APP] modified bitumen roof membrane consisting of [modified bitumen base sheet][fiberglass felt [venting] base sheet] [,interply sheet] and cap sheet. Modified bitumen roof membrane must be [set in hot asphalt][torch applied][set in cold-applied adhesive].

] All work must follow the NRCA RoofMan guidelines and standards stated within this Section.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roof Plan; G, [_____] drawing depicting wind loads and boundaries of enhanced perimeter and corner attachments of roof system components, as applicable

Field Inspection and Existing Conditions Report

Identify all fire safety issues including exposed or concealed combustible materials, which may require additional protection during roof installation.

SD-03 Product Data

Modified Bitumen Sheets; G, [_____]

[Heat Island Reduction; S

][Energy Star Label for Top Coating; S

][Asphalt

][Cold-Applied Membrane Adhesive; G, [_____]

][Fiberglass Felt; G, [_____]

] Primer; G, [_____]

Modified Bitumen Roof Cement; G, [_____]

[Pre-Manufactured Accessories

] Fasteners And Plates; G, [_____]

Sample Warranty certificate; G, [_____]

Submit all data required by Section 07 22 00 ROOF AND DECK INSULATION, together with requirements of this section. Include in data written acceptance by the roof membrane manufacturer of the products and accessories provided. Provide oroducts as listed in the applicable wind uplift and fire rating classification listings, unless approved otherwise by the Contracting Officer.

SD-05 Design Data

****

NOTE: Coordinate with requirements of WIND UPLIFT paragraph. Include bracketed requirement where non-rated systems may be permissible.

****

Wind Uplift Calculations; G, [_____]

[Provide Engineering calculations, signed, sealed, and dated by a qualified Engineer validating the wind resistance per ASCE 7-16, ASTM D4073/D4073M, and ANSI/SPRI/FM 4435/ES-1 of non-rated roof system.

] SD-07 Certificates

Provide evidence that products used within this specification are manufactured in the United States.

Qualification of Manufacturer

Certify that the manufacturer of the modified bitumen membrane meets requirements specified under paragraph QUALIFICATION OF MANUFACTURER.

Qualification of Applicator

Certify that the applicator meets requirements specified under paragraph QUALIFICATION OF APPLICATOR.

****

NOTE: Include bracketed requirement when torch applications are permitted as an acceptable method of attachment.

****

[Qualification of Torch Operator; G, [_____]

Certify that the torch operator(s) meet requirements specified under paragraph QUALIFICATION OF TORCH OPERATOR. Submit a valid copy of each applicator's Certified Roofing Torch Applicator

(CERTA) card.

] Qualification of Engineer of Record

Certify that the Engineer of Record is fully qualified, competent, and currently licensed to practice in the project jurisdiction.

****

NOTE: Include bracketed requirement when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

****

[Bill of Lading

Submit bill of lading when labels of asphalt containers do not bear the flash point (FP), finished blowing temperature (FBT), and equiviscous temperature (EVT).

] Wind Uplift Resistance; G, [_____] classification, as applicable

Fire Resistance classification; G, [_____]

Submit the roof system assembly [wind uplift and] fire rating classification listings.

SD-08 Manufacturer's Instructions

****

NOTE: Edit the manufacturers instructions submission requirements as necessary for the system specified. Include bracketed requirements only as applicable to the system being specified (e.g., torch applied systems may not require asphalt in the installation).

****

Modified Bitumen Membrane Application; G, [_____]

Flashing; G, [_____]

[Temperature Limitations for Asphalt

][Torches

][Cold Adhesive Applied Modified Bitumen Membrane; G, [_____]

][Base Sheet attachment, including pattern and frequency of mechanical attachments required in field of roof, corners, and perimeters to provide for the specified wind resistance.

] Primer

Fasteners

Ventilating Base Sheets

[Coating Application; G, [_____]

] Cold Weather Installation; G, [_____]

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications.[Include membrane manufacturer requirements for nailers and backnailing of roof membrane on steep slopes.] Explicitly identify in writing, differences between manufacturer's instructions and the specified requirements.

SD-11 Closeout Submittals

Warranty

Information Card

Instructions To [Government][Contractor] Personnel

Include copies of Safety Data Sheets for maintenance/repair materials.

Submit 20 year "No-Dollar-Limit" warranty for labor and materials.

1.4 QUALITY ASSURANCE

****

NOTE: All projects with more than 1400 square meters 15,000 square feet of roof area or that is defined as critical use or mission critical in the project DD Form 1391 must have a Registered Roof Consultant (RRC) or a registered professional engineer (PE) or registered architect (RA) that derives his or her principal income from roofing design on the quality control staff of the design team.

****

1.4.1 Qualification of Manufacturer

****

NOTE: Specify minimum five years manufacturer experience unless directed otherwise by the Government

****

Modified bitumen sheet roofing system manufacturer must have a minimum of [5][_____] years experience in manufacturing modified bitumen roofing products.

1.4.2 Qualification of Applicator

****

NOTE: Specify minimum three years as an approved contractor unless directed otherwise by the Government

****

Roofing system applicator must be approved, authorized, or licensed in writing by the modified bitumen sheet roofing system manufacturer and have a minimum of [5][_____] years experience as an approved, authorized, or licensed applicator with that manufacturer and be approved at a level capable of providing the specified warranty. The applicator must supply the names, locations and client contact information of five projects of similar size and scope that the applicator has constructed using the manufacturer's roofing products submitted for this project within the previous three years.

1.4.3 Qualification of Torch Operator

****

NOTE: Specify a CERTA certified torch applicator when torch applications are permitted.

****

Torch applicators must be CERTA certified to operate torch equipment and must maintain and carry a valid Certified Roofing Torch Applicator (CERTA) card.

1.4.4 Qualifications of Photovoltaics (PV) Rooftop Applicator

The PV rooftop applicator must be approved, authorized, or certified by a Roof Integrated Solar Energy (RISE) Certified Solar Roofing Professional (CSRP), and comply with applicable codes, standards, and regulatory requirements to maintain the weatherproofing abilities of both the integrated roof system and photovoltaic system.

1.4.5 Qualification of Engineer of Record

[Engineer of Record must be currently licensed within the jurisdiction of the project.

][Engineer of Record must be approved, authorized, and currently licensed by the state of[Florida] [_____], and have a minimum of 5 years experience as an approved Engineer for manufacturers of similar roof systems. Engineer of Record must supply the names and locations of five projects of similar size and scope for which he has provided engineering calculations using the manufacturer's products submitted for this project within the previous three years. Engineer of Record must provide certified engineering calculations for:

a. [Wind uplift requirements][in accordance with][Local and State codes]

b. ASCE 7-16, in accordance with International Building Code

[c. Seismic requirements per[local][and state] building codes

][d. Seismic requirements per ICC IBC Chapter 16, Section 1608.3

][e. Snow load requirements per ICC IBC Chapter 16 Section 1608.3 and Section 7 of ASCE 7-16

]]

1.4.6 Fire Resistance

Complete roof covering assembly must:

****

NOTE: Specify Class B option only when Class A may not be attainable such as membrane system

application directly to wood deck. Provide justification/rationale for Class B option with design submission

****

a. Be Class A [or B] rated in accordance with ASTM E108, FM 4470, or UL 790; and

b. Be listed as part of Fire-Classified roof deck construction in UL RMSD, or Class I roof deck construction in FM APP GUIDE.

FM or UL approved components of the roof covering assembly must bear the appropriate FM or UL label.

1.4.7 Wind Uplift Resistance

****

NOTE: Determine the required wind uplift resistance based on ASCE 7-16 wind loading calculations or applicable building code requirements. The specified FM rating incorporates a safety factor of 2 over the maximum calculated uplift pressure. Therefore, a FM rating of 1-90 correlates to a maximum uplift calculation of 2.2 kPa 45 psf. When a rated system is specified, ensure the specified roof system is capable of meeting the wind uplift resistance specified. Where non-rated systems may be permissible, include the bracketed option.

Delineate calculated values in the roof specification or drawings. Utilize independently tested and rated roof systems, such as Factory Mutual (FM), Underwriters Laboratories (UL) and Single Ply Roofing Industry (SPRI).

****

Provide a complete roof system assembly that is rated and installed to resist wind loads [indicated] [calculated in accordance with ASCE 7-16] and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Do not install non-rated systems, except as approved by the Contracting Officer. Submit licensed engineer's Wind uplift calculations and substantiating data to validate any non-rated roof system. Base wind uplift measurements on a design wind speed of [_____] km/h [_____] mph in accordance with ASCE 7-16 and other applicable building code requirements.

1.4.8 Preroofing Conference

After approval of submittals and before performing roofing [and insulation] system installation work, hold a preroofing conference to review the following:

a. Drawings, including Roof Plan, specifications and submittals related to the roof work

b. Roof system components installation

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roof structure, and roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representatives to roof manufacturer

d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing

e. Quality control, (ARMA PMBRG98) plan for the roof system installation

f. Field inspection and existing conditions report identifying all fire safety issues including exposed or concealed combustible materials, which may require additional protection during roof installation

g. Safety requirements

Coordinate preroofing conference scheduling with the Contracting Officer. The conference must be attended by the Contractor, the Contracting Officer's designated personnel, and personnel directly responsible for the installation of roofing [and insulation], [torch operator,] flashing and sheet metal work, [[mechanical] [and] [electrical] work], other trades interfacing with the roof work, designated safety personnel trained to enforce and comply with ASSP A10.24,[Fire Marshall,] and a representative of the roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

****

NOTE: Include bracketed requirement when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

****

Deliver materials in manufacturers' original unopened containers and rolls with labels intact and legible. Mark and remove wet or damaged materials from the site. Where materials are covered by a referenced specification, the container must bear the specification number, type, and class, as applicable. [Labels or bill of lading for roofing asphalt must indicate asphalt type, FP, FBT, and EVT, that is, the temperature at which the viscosity is either 125 centistokes when tested in accordance with ASTM D2170/D2170M or 75 centipoise when tested in accordance with ASTM D4402/D4402M.] Deliver materials in sufficient quantity to allow work to proceed without interruption.

1.5.2 Storage

Protect materials against moisture absorption and contamination or other damage. Avoid crushing or crinkling of roll materials. Store roll materials on end on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer. Do not store roll materials in buildings under construction until concrete, mortar, and plaster work is finished and dry. Maintain roll materials at temperatures above 10 degrees C 50 degrees F for 24 hours immediately before application. Do not store materials outdoors unless approved by the Contracting Officer. Completely cover felts stored outdoors, on and off roof, with waterproof canvas protective covering. Do not use polyethylene sheet as a covering. Tie covering securely to pallets to make completely weatherproof. Provide sufficient ventilation to prevent condensation. Do not store more materials on roof than can be installed the same day and remove unused materials at end of each days work. Distribute materials temporarily stored on roof to stay within live load limits of the roof construction.

Maintain a minimum distance of 10.67 meters 35 foot for all stored flammable materials, including materials covered with shrink wraps, craft paper or tarps from all torch/welding applications.

Immediately remove wet, contaminated or otherwise damaged or unsuitable materials from the site. Damaged materials may be marked by the Contracting Officer.

1.5.3 Handling

Prevent damage to edges and ends of roll materials. Do not install damaged materials in the work. Select and operate material handling equipment to prevent damage to materials or applied roofing.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not install roofing system when air temperature is below 4.44 degrees C 40 degrees F, during any form of precipitation, including fog, or when there is ice, frost, moisture, or any other visible dampness on the roof deck. Follow manufacturer's printed instructions for Cold Weather Installation.

[1.7 [TORCH][HOT-MOPPED ASPHALT] APPLIED [(HEAT WELD)] MODIFIED BITUMEN MEMBRANE SAFETY

****

NOTE: Retain the respective brackets and paragraphs indicating a "Torch Applied" system from the following requirements when membrane or flashing is torch applied.

Retain the respective brackets and paragraphs indicating a "Hot-Mopped Asphalt" application from the following requirements when membrane or flashing is hot-mopped applied.

If a combination of both torch applied and hot mopped applied systems is used, retain both sets of paragraphs and brackets.

****

1.7.1 Property Protection

Take all precautions necessary to prevent ignition of combustible materials during [torch application][hot-mopped asphalt application] of roofing. Immediately call the fire department if a fire commences. Review all fire safety procedures as outlined at the pre-roofing conference.

****

NOTE: The following two paragraphs apply to both torch and hot-mopped application methods.

****

Install materials using the techniques recommended by CERTA NRCA/MRCA Certified Roofing Torch Applicator Program available from the National Roofing Contractors Association (NRCA) and the Midwest Roofing Contractors Association (MRCA) as endorsed by the Asphalt Roofing Manufacturers Association (ARMA) and the United Union of Roofers, Waterproofers and Allied Workers. Application procedures must comply with NFPA 241, OSHA 29 CFR 1910 and 29 CFR 1910.12, 29 CFR 1926.16, 29 CFR 1926 Subpart F.[, UL Fire Resistance Directory Volume No. 1, NRCA R&W Manual, and Florida Building Code Volume 2004.]

Do not store flammable liquids on the roof.

****

NOTE: Torch Applied

****

Provide a minimum of two 10 liter 2.65 gallon containers of water and two fully charged minimum [9.072 kg 20 pound CO2][9.072 kg 20 pound ABC (dry chemical)] fire extinguishers in separate, easily accessible locations on the roof and within [9.144 meters 30 foot][3.048 meters10 foot] of each [torch work area][hot-mopped kettle] at all times.

****

NOTE: Hot-Mopped Applied

****

No AsphaltKettles are allowed on roofs. Locate kettles and supply LP-Gas Cylinders safely and secured per NFPA 241 outside of the building's perimeter a minimum of 6.096 m 20 foot from the structure and any combustible materials.

Maintain a minimum separation of 6.096 m 20 foot between LP-Gas Cylinders and kettle. Provide protective fire retardant blanket barrier or shield between any building structure to a minimum height of 8 foot and a clear surround distance of 2.44 m 4 foot if operations force placement of kettle within a distance of 6.096 m 20 foot. Do not obstruct or place kettles or Cylinder storage within 3.048 m 10 foot of exits, means of egress, gates, roadways, entrances. Locate kettles downwind and away from any building air intakes.

Provide a minimum of two portable fully charged [9.072 kg 20 pound CO2] [9.072 kg 20 pound ABC (dry chemical)] fire extinguishers no closer than 1.524 m 5 foot and no further than 7.62 m 25 foot of horizontal travel distance from each kettle at all times while kettle is in operation, in easily accessible and identifiable locations. Also provide [a minimum of one][two] multipurpose 2-A:20-B:C portable fire extinguisher on the roof being covered or repaired.

Comply with the following safety procedures:

a. Fuel containers, burners, and related appurtenances of roofing equipment in which liquefied petroleum gas is used for heating must comply with the requirements of NFPA 58.

b. Fuel containers having capacities greater than one pound must be located a minimum of 3.048 m 10 foot clear distance from the burner flame.

c. Clearly label all LP-Gas Cylinders as "Flammable Gas", and secure to prevent accidental tip-over.

d. Check all pressure regulators and hoses prior to use for proper functioning and integrity.

e. Turn off fuel supply at LP Gas Cylinder when kettle is not in use.

f. Equip all kettles with a functioning temperature measuring device to ensure no heating in excess of 10 degrees C 50 degrees F below the flash point.

g. Provide covers, lid, or top which are close fitting, constructed of minimum No.14 manufacturer's gauge steel, and can be gravity closed on all kettles.

h. Clean all roofing mops and rags free of excess asphalt and store safely away from all combustible materials. Store discarded roofing mops and rags in a non-combustible container and remove from site each day.

i. Position all pump lines handling hot asphalt securely and equip all pump lines with a shut-off valve on each with a coupler which may be opened when lines are full. Do not subject pump lines to pressures in excess of safe and recommended NRCA and ARMA working pressures. Station an operator near the equipment to cut off flow and care for other emergencies while conducting heating, pumping and application operations.

j. Asphalt bucket used by roofers or workers in similar trades must be constructed of minimum No. 24 gauge or heavier sheet steel and have a metal bail of no less than 6.35 mm 1/4 inch diameter material. The bail is to be fastened to offset ears or equivalent which have been riveted, welded, or otherwise safely and securely attached to the bucket. Soldered bail sockets are prohibited. Position workers and other employees to avoid being struck by bucket or other roofing materials, which may accidentally fall while being hoisted, lowered, or used in the roofing operation. Provide safety barriers and caution signs at all skylights or other roof holes.

k. Do not use flammable liquids with a flash point below 37.78 degrees C 100 degrees F (gasoline and similar products) for cleaning purposes.

Do not use solid fuel or Class I liquids as fuel for roofing asphalt kettles. Provide a minimum of one employee fully knowledgeable of kettle operations and hazards to maintain constant surveillance during kettle operation within a minimum distance of 7.62 m 25 foot of the kettle.

****

NOTE: Torch Applied and Hot-Mopped Applied

****

Check all fire extinguishers prior to commencement of work, and upon completion of the day's work, to ensure fullness and operability.

Project supervisor must make daily inspections with the facility manager of all conditions and operations which could present hazards during [torching][hot-mopped] applications and issue directives to address all such concerns and items of the work and existing conditions.

Identify and protect all combustible roof components, possible fire traps, and hidden hazards. Seal off voids or openings in the substrate with non-combustible materials prior to installing [torch-applied][hot-mopped applied] materials in the area. Install protective fire retardant blankets and shields at building walls, eaves, parapets and equipments curbs constructed of combustible materials within 0.9144 meter 3 foot radius of the area of [torch work][hot-mopped kettle] prior to commencement of the work.

When working around intakes and openings, temporarily disconnect and block to prevent [flame of torch][fumes from kettle] from being drawn into the opening.[Provide non-combustible shielding or flame guard protection where gaps or voids occur in the construction in area of torch work.]

1.7.2 Fire Watch

****

NOTE: Torch Applied and Hot-Mopped Applied

****

All personnel on the roof during [torch application][hot-mopped application] must be properly trained to use a fire extinguisher. Provide a fire watch for a minimum of [two hours after completion of all torch work][30 minutes after completion of hot-mopped kettle operations] at the end of each work shift. Maintain the fire watch for additional time required to ensure no potential ignition conditions exist. [Utilize heat sensing meters to scan for hot spots in the work.][For torch applications, provide and utilize a minimum of one calibrated thermal imaging camera, minimum 160x120 thermal IR resolution per torch capable of detecting infrared (IR) spectrum heat emission that could indicate a potential fire during the fire watch to verify cool, safe and non-combustible conditions exist. Provide a minimum duration fire watch of two hours conducted by personnel properly trained in the use of the camera to survey the underside of the roof deck, attic, and plenum spaces (where possible) and the topside of possible smoldering elements. Camera must have a manufacturer's certificate of calibration, and the use of the camera must be in compliance with Installation security policies.]

****

NOTE: Torch Applied

****

Do not torch in areas of poor or no visibility (curbs, corners, eaves, expansions joints, flashing, other voids and small penetrations) which could allow a torch flame to ignite combustible material(s) hidden from view or within the underside of the roof deck or building interior. Use cold finish applications in these areas whenever possible and per manufacturer's printed instructions, NRCA 4002, MRCA R&NW manual for "cold adhered" materials.

****

NOTE: Torch Applied and Hot-Mopped Applied

****

Do not leave the rooftop unattended during breaks in work during a work shift. Walk and scan all areas of application checking for hot spots, fumes, or smoldering, especially at wall and curb areas, prior to departure at the end of each work shift. Ensure any and all suspect conditions are eliminated prior to leaving the site each work shift.

****
NOTE: Torch Applied
****

1.7.3 Open Flame Application (Torch) Equipment and Personnel Safety

Only NRCA/MRCA CERTA certified roofing applicators are allowed to operate any torching equipment. Verify that all such applicators maintain and are currently carrying a valid Certified Roofing Torch Applicator (CERTA) card.

****
NOTE: Torch Applied and Hot-Mopped Applied
****

Train all crew members in preventive measures for indirect and direct dangers and hazards associated with roofing work, which include, but are not limited to the following:

a. Heat Stress: Wear light colored clothing, a hat for ultra-violet protection, and other eye protective devices. Drink sufficient quantities of non-alcoholic, non-caffeine liquids. Stage shifts for crew members to allow for breaks from heat and sun exposure without interfering with work progress.

b. First Aid for Burns: Immediately call for an ambulance. Contact local Occupational Health Services (OHS).

All crew members must wear correct personal protective equipment (PPE), including, but not limited to the following items:

a. Long-sleeved shirts buttoned at the collar and cuffs, made of non-flammable materials. Polyester materials are not allowed.

b. Work boots covering ankles with rubber or composite soles.

c. Long pants without cuffs to extend over the top of the work boots, be made of non-flammable materials. No polyester allowed.

d. Heavy leather gloves and flame retardant gauntlets which must be worn during all handling of a torch, whether operating or not.

e. OSHA and ANSI/ISEA Z87.1 approved face shields, goggles or safety glasses to be worn during torching and any other applicable roofing functions.

f. OSHA and ANSI approved hard hats.

1.7.4 Wind Conditions

Use side shields with all torching operations when winds are occurring to prevent flame distortion of end burners. Use torch machine equipment with bottom shield plate to prevent flame spread on to roof deck and substrate. When high wind gusts are present, notify the safety officer and cease all use of torching equipment until wind conditions lower and authorization from the safety officer to proceed is received.

]1.8 SEQUENCING

Coordinate the work with other trades to ensure that components which are to be secured to or stripped into the roofing system are available and that permanent flashing and counter flashing, per NRCA CONDET, and are installed as the work progresses. Ensure temporary protection measures are in place to preclude moisture intrusion or damage to installed materials.[Apply roofing immediately following application of insulation as a continuous operation. Coordinate roofing operations with insulation work so that all roof insulation applied each day is covered with roof membrane installation the same day.]

1.9 WARRANTY

Provide roof system material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard membrane manufacturer warranty as required to comply with the specified requirements. Provide a manufacturer's warranty that has no dollar limit, covers full system water-tightness, and has a minimum duration of 20 years.

1.9.1 Roof Membrane Manufacturer Warranty

****

NOTE: Designer may specify 5 or 10 year manufacturer warranty on facilities of small roof area and of minor importance where interiors and contents are not severely impacted by water intrusion and any time a one-ply modified bitumen membrane system is specified. Environmentally controlled interiors with one-ply membrane require a minimum 10 year warranty.

****

Furnish the roof membrane manufacturer's 20-year no dollar limit roof system materials and installation workmanship warranty, including flashing, insulation in compliance with [ASTM C1289], and accessories necessary for a watertight roof system construction. Provide warranty directly to the Government and commence warranty effective date at time of Government's acceptance of the roof work. The warranty must state that:

a. If within the warranty period the roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, blisters, splits, tears, delaminates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the roof system assembly and correction of defective workmanship are the responsibility of the roof membrane manufacturer. All costs associated with the repair or replacement work are the responsibility of the roof membrane manufacturer.

b. When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others does not void the warranty.

c. Upon completion of installation, and acceptance by the [Contracting Officer] [, Architect][, Construction Manager] and Roofing System Engineer of Record, the manufacturer must supply the appropriate warranty to the Owner.

d. Installer must submit a minimum two year warranty to the membrane manufacturer from the date of acceptance, with a copy to the [Contracting Officer] [, Architect][, Construction Manager] and Roofing System Engineer of Record.

1.9.2 Roofing System Installer Warranty

The roof system installer must warrant for a period of two years that the roof system, as installed, is free from defects in installation workmanship, to include the roof membrane, flashing, insulation, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Write the warranty directly to the Government. The roof system installer is responsible for correction of defective workmanship and replacement of damaged or affected materials. The roof system installer is responsible for all costs associated with the repair or replacement work.

1.9.3 Continuance of Warranty

Repair or replacement work, ARMA 410BUR88, NRCA C3701 that becomes necessary within the warranty period and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the roof membrane manufacturer warranty for the remainder of the manufacturer warranty period.

1.10 CONFORMANCE AND COMPATIBILITY

Provide the entire roofing and flashing system in accordance with specified and indicated requirements, including fire and wind resistance (ANSI/SPRI/FM 4435/ES-1) requirements. Work not specifically addressed and any deviation from specified requirements must be in general accordance with recommendations of the NRCA Roofing and Waterproofing Manual, membrane manufacturer published recommendations and details, and compatible with surrounding components and construction. Submit any deviation from specified or indicated requirements to the Contracting Officer for approval prior to installation.

1.11 ELIMINATION, PREVENTION OF FALL HAZARDS

****

NOTE: Any part or component of the building, facility, structure, or equipment requiring future maintenance work must incorporate in the design fall prevention methods or techniques to eliminate fall hazards, in accordance with ANSI/ASSE A1264.1. Fall prevention methods may include identifying, designing, and installing anchorages (hard points) for safe use of fall arrest equipment and systems. Select materials for metal compatibility in order to minimize corrosion, type 316 stainless steel is recommended.

****

1.11.1 Fall Protection

[_____]

PART 2 PRODUCTS

****

NOTE: Edit the materials specification requirements as necessary for the system(s) specified in PART 1 - DESCRIPTION OF ROOF MEMBRANE SYSTEM.

See the Note in PART 1 - DESCRIPTION OF ROOF MEMBRANE SYSTEM for useful information in editing the membrane materials requirements.

Include bracketed requirements only as applicable to the system being specified (e.g., torch applied systems are prohibited on combustible roof decks or when combustible materials are used in the roofing installation; torch applied systems may not require asphalt in the installation; granule surfaced cap sheets do not require gravel or coating surfacing).

****

2.1 MATERIALS

Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Protect materials provided from defects and make suitable for the service and climatic conditions of the installation.

2.1.1 Energy [and Cool Roof] Performance

****

NOTE: Standards such as UFC 1-200-02 promote the use of cool roofing, and increased energy conservation through additional insulation. Design cool roofs following the requirements in UFC 3-110-03 "Roofing" Chapter 1, Cool Roofs. Consider that when cool roofing is used with insulation R values greater than 24, the 'cool roof' surface has little if no influence on the energy performance of the building. Additionally, designers should be aware of the possible negative impacts of using cool roofing that may result in unintended consequences. Design mechanically-fastened single-ply roof systems in accordance with the requirements in UFC 3-110-03 Roofing, Chapter 2. Condensation on the underside of mechanically-fastened systems can result in ice build-up in winter, mold growth on the facers, moisture dripping into the interior, and replacement of the roofs with less than four years of service. See Appendix B of UFC 3-110-03 for more information. Inadequate design of cool roofs in ASHRAE climate zones 4 and higher have resulted in the unintended consequence of condensation below the membrane-a result of the material's inability to warm and drive moisture downward. Roofs that experience this condensation have had to be replaced. Other unintended consequences include the overheating of masonry walls, interior spaces, roof top piping and mechanical equipment as a result of

the reflected UV rays.

NOTE: Designer to specify the roof performance by R-Value on the drawings or stated in other specification sections.

****

****

NOTE: Facilities with dominant cooling loads or in mild or warm climate zones are required to meet "cool roofing" requirements of FEMP. Design cool roofs following the requirements in UFC 3-110-03 Roofing, Appendix B and ASHRAE 90.1 Chapter 5, for the insulation and energy performance of the building.

NOTE: If a cool roof is not selected in ASHRAE zones 1 thru 3, design must meet one of the exception requirements listed in ASHRAE 90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Coordinate these requirements with insulation design and specifications.

Retain the next to last bracketed note for project with cool roof requirement. Retain the last bracketed sentence for project with sustainable third party certification credit requirement for reduced heat island effect.

****

Install a roof system that meets an overall performance as specified on the drawings or by insulation specified in other sections.[The roofing system will need to include a top surface finish that meets the criteria for Cool Roof Products.[Provide emittance and reflectance percentages, solar reflectance index values, [and] slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]]

2.2 MODIFIED BITUMEN SHEETS AND FIBERGLASS FELT MATERIALS

Furnish a combination of specified materials that comprise the modified bitumen manufacturer's standard system of the number and type of plies specified. Provide materials suitable for the service and climatic conditions of the installation. Modified bitumen sheets must be watertight and visually free of pinholes, particles of foreign matter, non-dispersed raw material, factory splices, or other conditions that might affect serviceability. Polymer modifier must comply with ARMA PMBRG98 and be uniformly dispersed throughout the sheet. Edges of sheet must be straight and flat.

****

NOTE: Select the base sheet option required and delete other base sheet options. Specify base sheets under insulation in the insulation specification section.

Specify modified bitumen base sheet for two-ply membrane systems and incorporate in three-ply membrane systems.

Perforated venting base sheet option should only be specified for application directly on concrete deck. Base sheets with perforations are rolled into place and then top mopped with hot asphalt. Base sheets without perforations are mechanically attached to nailable substrates.

****

[a. Venting Base Sheet: ASTM D4897/D4897M, Type II, [without][with] perforations and as approved by the modified bitumen roof membrane manufacturer.

][b. Fiberglass Felt Base Sheet: ASTM D4601/D4601M,ASTM D1668/D1668M Type II, [without][with] perforations and as approved by the modified bitumen roof membrane manufacturer.

]

****

NOTE: When specifying a two-ply membrane system or application over a fiberglass felt base sheet, delete any reference to Interply sheet. Use modified bitumen base sheet and cap sheet.

Specify polyester-reinforced membrane for high traffic roofs and where enhanced puncture resistance and overall durability are required. Where polyester reinforced sheet is required, delete any reference to ASTM D6163/D6163M.

Do not specify fiberglass membrane layer over a polyester-reinforced membrane layer.

Specify Type II modified bitumen materials for all two-ply membrane installations, heavy-duty or high traffic service conditions and for all instances where fiberglass reinforced modified bitumen cap sheets are permitted.

****

[c. SBS Base Sheet: [ASTM D6162/D6162M] [or] [ASTM D6164/D6164M] [or] [ASTM D6163/D6163M], Type [I or] II, Grade S, minimum 2.0 mm 80 mils thick.

][d. SBS Interply Sheet: [ASTM D6162/D6162M] [or] [ASTM D6164/D6164M] [or] [ASTM D6163/D6163M], Type [I or] II, Grade S, minimum 2.0 mm 80 mils thick.
]

****

NOTE: Specify Grade S cap sheet only with the approval of the Government and when gravel surfacing or field applied coating is required in lieu of factory-applied mineral granule surfacing.

Specify 3.7 mm 145 mils minimum thickness for SBS cap sheet unless directed otherwise by the Government.

****

[e. SBS Cap Sheet: [ASTM D6162/D6162M] [or] [ASTM D6164/D6164M] [or] [ASTM D6163/D6163M]; Type II, Grade [G][S], minimum [3.7 mm 145 mils] [_____] thick, and as required to provide specified fire safety rating.

]
[f. APP Base Sheet: ASTM D6222/D6222M, Type I or II; or ASTM D6223/D6223M; Grade [G][S], minimum 3.5 mm 140 mils thick.

]
****

NOTE: Specify Grade S cap sheet only with the approval of the Government and when gravel surfacing or field applied coating is required in lieu of factory-applied mineral granule surfacing.

Specify minimum 4 mm 160 mil APP cap sheet thickness unless directed otherwise by the Government.

****

[g. APP Cap Sheet: ASTM D6222/D6222M, Type II; or ASTM D6223/D6223M; Grade [G][S], minimum 4.0 mm 160 mils thick.

]2.3 BASE FLASHING MEMBRANE

****

NOTE: Include metal clad flashing membrane option only where the foil surfacing will not create an aesthetic issue and reflectance of no concern. Do not specify foil surfaced materials for facilities along flight line or adjacent to telemetry or tracking equipment.

Metal clad membrane flashing should not be considered effective grease protection for the flashing or roof membrane in areas where the roof may be exposed to cooking grease release. Lap areas remain susceptible to degradation from exposure to grease and solvents.

****

Membrane manufacturer's standard, minimum two-ply modified bitumen membrane flashing system compatible with the roof membrane specified and as recommended in membrane manufacturer's published literature. Provide flashing membranes that meet or exceed the properties of the material standards specified for the modified bitumen [base][, interply] and cap sheet, except that flashing membrane thickness must be as recommended by the membrane manufacturer.[Provide metal clad flashing membrane that complies with ASTM D6298].

[2.4 ASPHALT

****

NOTE: Include paragraph or bracketed requirement when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

****

ASTM D312/D312M, Type III or IV, in accordance with modified bitumen membrane manufacturer requirements and compatible with the slope conditions of the installation.

][2.5 COLD-APPLIED MEMBRANE ADHESIVE

****

NOTE: Materials standards and application requirements vary for cold applied membrane adhesives. Ensure product data and application instructions are included under "Submittals" when cold-process membrane applications are specified. This information will be referenced by the field personnel in monitoring the application process.

Consider low VOC adhesives for cold-process applications on occupied buildings and when otherwise necessary.

****

Membrane manufacturer's recommended [low volatile organic compound (VOC)] cold process adhesive for application of the membrane plies.

][2.6 MEMBRANE SURFACING

****

NOTE: Coordinate surfacing requirements with the type of system specified in paragraph DESCRIPTION OF ROOF MEMBRANE SYSTEM. Specify factory-applied granule surfaced membrane except under non-typical conditions where aggregate or coating applications may be considered. Factory-applied granules or aggregate surfacing should be used where possible. Specify required finished membrane surfacing. Delete other options.

****

Provide modified bitumen roof membrane cap sheet with factory-applied granule surfacing of [light][_____] color [as selected from membrane manufacturer's standard colors].[Provide modified bitumen membrane manufacturer's recommended field-applied protective coating of [white][light gray][_____] color.[Provide aluminized coating that complies with ASTM D2824/D2824M, Type I or III, as recommended by the modified bitumen roof membrane manufacturer].][Light colored, opaque water-worn gravel aggregate surfacing material conforming to ASTM D1863/D1863M, or other aggregate as recommended by the membrane manufacturer and approved by the Contracting Officer[, and applied in flood coat of hot asphalt].]

]2.7 PRIMER

ASTM D41/D41M, or other primer compatible with the application and as approved in writing by the modified bitumen membrane manufacturer.

2.8 MODIFIED BITUMEN ROOF CEMENT

ASTM D4586/D4586M, Type II for vertical surfaces, Type I for horizontal surfaces, compatible with the modified bitumen roof membrane and as recommended by the modified bitumen membrane manufacturer.

2.9 CANT AND TAPERED EDGE STRIPS

****

NOTE: Use wood cant in non-supported flashing and wood blocking details (i.e., expansion joints, area dividers, and wall/roof intersections where roof deck is not supported by a wall).

If wood cants and/or tapered edge strips are used in the installation of the roof, torch application of the system is prohibited.

****

Provide standard cants and tapered edge strips of [perlite conforming to ASTM C728][the same material as the roof insulation][or when roof insulation material is not available, provide pressure preservative treated wood, wood fiberboard, or rigid perlite board cants and edge strips as recommended by the manufacturer.] [or wood fiber conforming to ASTM C208] treated with bituminous impregnation, sizing, or waxing and fabricated to provide maximum 45 degree change in direction of membrane. Cant strips must be minimum [38.1 mm 1-1/2 inch thick and provide for minimum 127 mm 5 inch face and 88.9 mm 3-1/2 inch vertical height when installed at 45 degree face angle][101.6 mm 4 inch vertical height with 45 degree cant angle], except where clearance restricts height to lesser dimension. Taper edge strips at a rate of 25.4 mm to 38.1 mm per 304.8 mm one to 1-1/2 inch per foot to a minimum of 3.175 mm 1/8 inch of thickness. Provide kiln-dried preservative-treated wood cants, in compliance with requirements of Section 06 10 00 ROUGH CARPENTRY at base of wood nailers set on edge and wood curbing and where otherwise indicated.

2.10 FASTENERS AND PLATES

****

NOTE: If fastening of membrane or felts to wood materials is required, torch application of the roofing system is prohibited.

****

Provide coated, corrosion-resistant fasteners as recommended by the modified bitumen sheet manufacturer's printed instructions and meeting the requirements of FM 4470 and FM APP GUIDE for Class I roof deck construction and the wind uplift resistance specified. For fastening of membrane or felts to wood materials, provide fasteners driven through 25.4 mm 1 inch diameter metal discs, or one piece composite fasteners with heads not less than 25.4 mm 1 inch in diameter or 25.4 mm 1 inch square with rounded or 45 degree tapered corners.

2.10.1 Masonry or Concrete Walls and Vertical Surfaces

Use hardened steel nails or screws with flat heads, diamond shaped points, and mechanically deformed shanks not less than 25.4 mm 1 inch long for securing felts, modified bitumen sheets, metal items, and accessories to masonry or concrete walls and vertical surfaces. Use power-driven fasteners only when approved in writing by the Contracting Officer.

2.10.2 Metal Plates

Provide flat corrosion-resistant round stress plates as recommended by the modified bitumen sheet manufacturer's printed instructions and meeting the requirements of FM 4470; not less than 50.8 mm 2 inch in diameter. Form discs to prevent dishing or cupping.

[2.11 PRE-MANUFACTURED ACCESSORIES

****

NOTE: Edit, delete, and insert accessory materials requirements as required for the specific project and components to be installed.

****

Pre-manufactured accessories must be manufacturer's standard for intended purpose,[comply with applicable specification section,] compatible with the membrane roof system and approved for use by the modified bitumen membrane manufacturer.

[2.11.1 Pre-fabricated Curbs

Provide [_____] gauge [G90 galvanized][AZ55 galvalume][_____] curbs with minimum 101.6 mm 4 inch flange for attachment to roof nailers. Curbs must be minimum height of 254 mm 10 inch above the finished roof membrane surface.

][2.11.2 Elevated Metal [Walkways] [and] [Platforms]

As specified in Section[05 50 13 MISCELLANEOUS METAL FABRICATIONS][05 51 33 METAL LADDERS][05 52 00 METAL RAILINGS][05 51 00 METAL STAIRS].

]][2.12 WALKPADS

****

NOTE: Use walkpads as walkways and at roof access points and where the roof or areas of the roof are intended to bear foot traffic for maintenance or other purposes once a month or more frequently.

****

Provide roof walkpads that are polyester reinforced, granule-surfaced modified bitumen membrane material, minimum [_____] [5 mm] [_____][197] mils thick, compatible with the modified bitumen sheet roofing and as recommended by the modified bitumen sheet roofing manufacturer. Panels must not exceed 1.219 meters 4 foot in length. Other walkpad materials require approval of the Contracting Officer prior to installation.

][2.13 PAVER BLOCKS

****

NOTE: Use concrete pavers as walkways on aggregate surface roofs where the roof or areas of the roof are intended to bear foot traffic for maintenance or other purposes once a month or more frequently. Use paver blocks under heavy bearing components, irregular base bearings and for support and attachment of lightweight pipe, conduit, and drainage lines routed along roof surface.

****

Precast concrete, minimum 38.1 mm 1-1/2 inch thick, minimum 457 mm 18 inch square for walkways and minimum 152.4 mm by 304.8 mm 6 inch by 12 inch for use in supporting surface bearing components but extending not less than 50.8 mm 2 inch beyond all sides of surface bearing bases. Install walkpad material under all paver blocks.

][2.14 ROOF INSULATION BELOW MODIFIED BITUMEN MEMBRANE SYSTEM

****

NOTE: If the roofing system contains insulation, coordinate with the appropriate insulation specification section. The insulation specification should include materials and installation up to the substrate on which the roof membrane base sheet and or membrane layers are to be installed. Coordinate base sheet attachment (mechanically fastened or mopped) with FM or UL fire and wind uplift requirements.

****

Provide insulation compatible with the roof membrane, approved by the membrane manufacturer and meeting all the requirements of [ASTM C552][ASTM C578][ASTM C726] as specified in Section 07 22 00 ROOF AND DECK INSULATION.

]2.15 MEMBRANE LINER

Provide self-adhering modified bitumen underlayment conforming to ASTM D1970/D1970M, EPDM membrane liner conforming to ASTM D4637/D4637M, or other waterproof membrane liner material as approved by the Contracting Officer.

[2.16 TOP COATING

****

NOTE: Top coatings can provide Energy Star classification when applied as final surface. Typical colors are white, tan, and other light colors. In review of the overall performance of the roof, color and materials specified earlier in this specification, the designer has the option to include Energy Star rating by including the paragraph below.

****

Provide a top coating product that is Energy Star labeled and is produced and compatible with the roof material of this specification. Provide data identifying Energy Star label for top coating product. Install to the manufacturer's written installation methods. Provide written confirmation that installation of a top coat will not modify or void the required roof warranty.

]2.17 PHOTOVOLTAIC (PV) SYSTEMS - RACK MOUNTED SYSTEMS

****

NOTE: The installation of a PV roof system over existing roof systems should be undertaken with extreme caution. Do not install PV systems on roofs with a shorter expected service life than the new PV system. Prior to the design of such systems the following must be undertaken:

a. Determine if the existing roof structure can handle the anticipated roof load increase.

b. Inspect and determine that the existing roof system has at least 10 years of service life remaining. If not, remove the existing roof and provide a new replacement roof system design in tandem with the photovoltaic system.

c. If 10 years remaining service life remains, ensure the design of the intersecting details, required roof protection, re-inspections, and warranty requirements for maintaining the roof system has been coordinated with the installation and manufacturers' warranties.

d. Design the roof related details for anticipated roof replacement work. Coordinate with the PV system designer to anticipate and plan for future roof replacement.

e. PV equipment on a rooftop creates additional roof protection requirements during initial installation and throughout the PV life-cycle. Ensure a roof protection program is specified during the PV system installation.

f. Permanently affix PV supports to stanchions which are anchored to the building structure.

****

Adhere to the following guidelines:

a. Building Owners Guide to Roof-mounted PV Systems, published by NRCA.

b. Guidelines for Roof-Mounted PV Systems, published by NRCA.

PART 3 EXECUTION

3.1 EXAMINATION

Ensure that the following conditions exist prior to application of the roofing materials:

a. Do not install items that show visual evidence of biological growth.

b. [Drains,] [curbs,] [cants,] [control joints,] [expansion joints,] [perimeter walls,] [roof penetrating components,] [and] [equipment supports] are in place.

c. Surfaces are rigid, clean, dry, smooth, and free from cracks, holes, and sharp changes in elevation. Joints in the substrate are sealed to prevent dripping of bitumen into building or down exterior walls.

d. The plane of the substrate does not vary more than 6.35 mm 1/4 inch within an area 3.048 by 3.048 meters 10 by 10 foot when checked with a 3.048 meter 10 foot straight edge placed anywhere on the substrate.

e. Substrate is sloped as indicated to provide positive drainage.

f. Walls and vertical surfaces are constructed to receive counter flashing, and will permit mechanical fastening of the base flashing materials.

g. Treated wood nailers are in place on non-nailable surfaces, to permit nailing of base flashing at minimum height of 203.2 mm 8 inch above finished roofing surface.

h. Protect all combustible materials and surfaces which may contain concealed combustible or flammable materials. All fire extinguishing equipment has been placed as specified.

i. Verify all Fire Watch personnel assignments.

****

NOTE: Coordinate with Section 06 10 00 ROUGH CARPENTRY to ensure that waterborne preservative treatment is specified for wood which will be in contact with roofing components.

****

j. Treated wood nailers are fastened in place at eaves, gable ends, openings, and intersections with vertical surfaces for securing of membrane, edging strips, attachment flanges of sheet metal, and roof fixtures.[Embedded nailers are flush with deck surfaces.][Surface-applied nailers are the same thickness as the roof insulation.]

****

NOTE: Wood cants should also be used where there are non-wall supported flashing at wood blocking forming area dividers and expansion joints, and at wall and roof intersections where roof deck is not supported on wall.

****

k. Cants are securely fastened in place in the angles formed by walls and other vertical surfaces. The angle of the cant is 45 degrees and the height of the vertical leg is not less than 88.9 mm 3-1/2 inch.

****

NOTE: Include venting provision for wet fill substrate materials like lightweight cellular concrete.

****

[l. Venting is provided in accordance with the following:

[(1) Edge Venting: Perimeter nailers are kerfed across the width of the nailers to permit escape of gaseous pressure at roof edges.

][(2) Underside Venting: Vent openings are provided in steel form decking for cast-in-place concrete substrate.

]]m. Exposed nail heads in wood substrates are properly set. Warped and split [boards] [sheets] have been replaced. There are no cracks or end joints 6.35 mm 1/4 inch in width or greater. Knot holes are covered with sheet metal and nailed in place. [Wood][Plywood] decks are covered with rosin paper or unsaturated felt prior to base sheet or roof membrane application.[Joints in plywood substrates are taped or otherwise sealed to prevent air leakage from the underside.]

[n. Insulation boards are installed smoothly and evenly, and are not broken, cracked, or curled. There are no gaps in insulation board joints exceeding 6.35 mm 1/4 inch in width. Insulation is being roofed over on the same day the insulation is installed.

][o. Cast-in-place substrates have been allowed to cure and the surface dryness requirements specified under paragraph FIELD QUALITY CONTROL have been met.

][p. Joints between precast concrete deck units are grouted, leveled, and stripped in with felt or bituminous stripping membrane set in bituminous cement prior to applying other roofing materials over the area.

] q. Roof deck and framing are sloped as indicated to provide positive drainage.

3.2 PREPARATION

3.2.1 Protection of Property

3.2.1.1 Protective Coverings

****

NOTE: Include bracketed requirement when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

****

Install protective coverings at paving and building walls adjacent to hoists[, tankers][, and kettles] prior to starting the work. Lap protective coverings not less than 15.24 cm 6 inch, secure against wind, and vent to prevent collection of moisture on covered surfaces. Keep protective coverings in place for the duration of the roofing work.

[3.2.1.2 Bitumen Stops

****

NOTE: Include paragraph when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

****

Provide felt bitumen stops or other means to prevent bitumen drippage at roof edges, openings, and vertical projections before hot mopped application of the roofing membrane.

][3.2.2 Equipment

****

NOTE: Select equipment references as applicable to the project. Delete paragraphs that are not applicable.

****

[3.2.2.1 Mechanical Application Devices

Mount mechanical application devices on pneumatic-tired wheels. Use devices designed and maintained to operate without damaging the insulation, roofing membrane, or structural components.

][3.2.2.2 Flame-Heated Equipment

Do not place flame-heated equipment on roof. Provide and maintain a fire extinguisher adjacent to flame-heated equipment and on the roof.

][3.2.2.3 Open Flame Application Equipment

****

NOTE: Include this requirement when torch-applied modified bitumen sheet roofing is specified or when torch application of base flashing is permitted.

Remove this requirement when the roof deck or materials associated with the installation of the roofing system are combustible and have the potential to ignite in torch applications.

****

Utilize torches and other open flame equipment specifically designated for use in application of modified bitumen materials and approved by the modified bitumen sheet manufacturer. Open flame equipment must not be ignited (burning) when left unattended. Provide and maintain a fire extinguisher adjacent to open flame equipment on the roof. Specific requirements for fire watches and burn permits exist. These requirements will be reviewed at the preroofing conference.

]3.2.2.4 Electric-Heated Equipment

Provide adequate electrical service as required by manufacturer of electrical equipment to ensure against damage to equipment and property and to ensure proper application of roofing materials.

][3.2.3 Heating of Asphalt

****

NOTE: Include paragraph when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

****

Break up solid asphalt on a surface free of dirt and debris. Heat asphalt in kettle designed to prevent contact of flame with surfaces in contact with the asphalt. Utilize kettles with visible working thermometer and thermostatic controls set to the temperature limits specified herein. Keep controls in working order and calibrated. Use immersion thermometer, accurate within a tolerance of plus or minus one degree C 1.8 degrees F, to check temperatures of the asphalt frequently. When temperatures exceed maximums specified, remove asphalt from the site. Do no permit cutting back, adulterating, or fluxing of asphalt.

[3.2.3.1 Temperature Limitations for Asphalt

****

NOTE: Include paragraph when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

****

Heat and apply asphalt at the temperatures specified below unless specified otherwise by manufacturer's printed application instructions. Use thermometer to check temperature during heating and application. Have kettle attended constantly during heating process to ensure specified temperatures are maintained. Do not heat asphalt above its finished blowing temperature (FBT). Do not heat asphalt between 260 and 274 degrees C 500 and 525 degrees F for longer than four consecutive hours. Do not heat asphalt to the flash point (FP). Apply asphalt and embed membrane sheets when temperature of asphalt is within plus or minus 14 degrees C 25 degrees F of the equiviscous temperature (EVT) but not less than 204 degrees C 400 degrees F. Before heating and application of asphalt refer to the asphalt manufacturer's label or bill of lading for FP, FBT, and EVT of the asphalt used.

]]3.2.4 Priming of Surfaces

Prime all surfaces to be in contact with adhered membrane materials. Apply primer at the rate of 3 liters per 10 sq. meters 0.75 gallon per 100 sq. ft. or as recommended by modified bitumen sheet manufacturer's printed instructions to promote adhesion of membrane materials. Allow primer to dry prior to application of membrane materials to primed surface. Avoid flammable primer material conditions in torch applied membrane applications.

3.2.4.1 Priming of Concrete and Masonry Surfaces

****

NOTE: Include this paragraph when roofing and flashing are applied directly to concrete or masonry surfaces.

****

After surface dryness requirements have been met, coat concrete and masonry surfaces which are to receive membrane materials uniformly with primer.

3.2.4.2 Priming of Metal Surfaces

Prime flanges of metal components to be embedded into the roof system prior to setting in bituminous materials or stripping into roofing system.

3.2.5 Membrane Preparation

Unroll modified bitumen membrane materials and allow to relax a minimum of 30 minutes prior to installation. In cold weather, adhere to membrane manufacturer's additional recommendations for pre-installation membrane handling and preparation. Inspect for damage, pinholes, particles of foreign matter, non-dispersed raw material, factory splices, or other conditions that might affect serviceability. Edges of seams must be straight and flat so that they may be seamed to one another without forming fish mouths or wrinkles. Discard damaged or defective materials.

3.2.6 Substrate Preparation

Apply membrane to clean, dry surfaces only. Do not apply membrane to surfaces that have been wet by rain or frozen precipitation within the previous 12 hours. Provide cleaning and artificial drying with heated blowers or torches as necessary to ensure clean, dry surface prior to membrane application. Torches may not be used to ensure clean, dry surfaces prior to membrane applications if the roof deck or materials used in the installation of the roofing system are combustible.

3.3 APPLICATION

Apply roofing materials as specified herein unless approved otherwise by the Contracting Officer. Keep roofing materials dry before and during application. Complete application of roofing in a continuous operation. Begin and apply only as much roofing in one day as can be completed that same day. Maintain specified temperatures for asphalt. [Provide temporary roofing and flashing as specified herein prior to application of permanent roofing system.]

3.3.1 Phased Membrane Construction

Phased application of membrane plies is prohibited unless otherwise approved by the Contracting Officer and supported by the membrane manufacturer's written application instructions. If cap sheet installation is delayed, thoroughly clean the applied membrane material surface and dry immediately prior to cap sheet installation. Priming of the applied membrane surface may be required at the discretion of the Contracting Officer prior to cap sheet installation.

3.3.2 Temporary Roofing and Flashing

****

NOTE: Include requirements for temporary roofing and flashing when construction will require considerable work on roof, such as, installing cooling towers, antennas, pipes, ducts, solar collectors, or other equipment, and temporary roofing is considered necessary to ensure that permanent roofing is not damaged during construction.

****

Provide watertight temporary roofing and flashing where considerable work by other trades, such as installing [cooling towers,] [antennas,] [pipes,] [ducts,] [_____,] is to be performed on the roof or where construction scheduling or weather conditions require protection of the building's interior before permanent roofing system can be installed. Do not install temporary roofing over permanently installed insulation. Provide rigid pads for traffic over temporary roofing.

[3.3.2.1 Removal

Completely remove temporary roofing and flashing before continuing with application of the permanent roofing system.

]3.3.3 Application Method

****

NOTE: Specify the applicable application method(s)

and distinguish any varying requirements or options related to membrane and base flashing (e.g., in general manufacturer may allow base flashing membrane to be torched provided that the roof deck and materials used in the installation of the roofing system are non-combustible, or set in cold adhesive on hot mopped roof membrane installations; however, this may or may not be desirable for a specific project installation.).
****

[3.3.3.1 Hot Asphalt Application of Modified Bitumen Membrane

****
NOTE: Include paragraph when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.
****

Apply membrane immediately following application of hot asphalt. Apply hot asphalt within 1.829 m 6 foot of roll. Do not work ahead with asphalt. Asphalt must be completely fluid, with mop temperatures within the asphalt's EVT range, but not less than 204.4 degrees C 400 degrees F, at the instant membrane comes into contact with asphalt. Apply bitumen between layers to provide full, continuous, uniform coverage and complete contact of hot asphalt with the sheet above and below. Embed sheets in asphalt. As sheets are being rolled into hot asphalt, immediately and thoroughly apply uniform positive pressure by squeegee, roll, or broom to ensure full adhesion and lap seal, eliminate trapped air and to provide tight, smooth laminations. Avoid excessive extrusion of asphalt at lap areas. Control asphalt bleed out to approximately 25.4 mm 1 inch maximum.

]3.3.3.2 Torch Applied [Heat Welded] Modified Bitumen Membrane [Flashing]

****
NOTE: Include the first bracketed sentence if base flashing may be torch-applied on hot mopped membrane work. Include requirement to roll lap areas with weighted roller when heat welding technique is specified.

Delete the first bracketed sentence and the bracketed references to "either" and "torch" when the roof deck or materials used in the installation of the roofing system are combustible.

Where heat welding is specified, coordinate with language in "Description of Roof Membrane System" and other parts of this specification.
****

[Base flashing membrane may be torch applied.] Ensure substrate membrane surfaces are warmed[either] naturally[or by torch] during the installation. Apply heat evenly to underside of roll membrane being installed and exposed side lap area of previously installed sheet. Provide for slight, uniform flow of bitumen in front of roll and full width of roll as the material is being rolled or set into place. Apply uniform positive pressure to ensure membrane is fully adhered and all laps are sealed. Prior to forming lap over granulated surfaces, embed granules of the receiving sheet by heating and troweling-in the granules to form a uniform black compound surface. [Roll all lap areas with a weighted roller immediately after forming lap. Provide for visual bleed out of compound in lap areas.][Avoid overheating the membrane or burning through to membrane reinforcement. Inspect and ensure all lap areas are fully sealed.

][3.3.3.3 Cold Adhesive Applied Modified Bitumen Membrane

Apply cold adhesive with airless sprayer or 6.35 mm 1/4 inch saw-toothed rubber squeegee to prepared surfaces in accordance with membrane manufacturer's application instructions. Fully cover substrate with adhesive. Roll or lay membrane in adhesive in accordance with manufacturer's recommendations and within the time limitations of adhesive application. Broom the membrane to ensure full contact with adhesive. Seal laps with adhesive or by heat fusing with hot air welder as required by membrane manufacturer. Minimize traffic on installed membrane during the adhesive cure and set time.

][3.3.4 Ventilating Base Sheets

****

NOTE: Include this paragraph when ventilating base sheets are specified in the paragraph DESCRIPTION OF ROOF MEMBRANE SYSTEM and in the absence of rigid board roof insulation. Include mechanical attachment or top mop requirements as applicable. Where rigid board roof insulation is a component of the roof system, ventilating base sheets should be specified in the roof insulation section 07 22 00 ROOF AND DECK INSULATION.

****

Apply ventilating base sheets with 76.2 mm 3 inch side laps and 152.4 mm 6 inch end laps in accordance with manufacturer's printed application instructions for substrate [and wind uplift conditions]specified. [Provide mechanical attachments as required for wind resistance specified and to include increased frequency of attachment at corner and perimeter areas. Drive fasteners flush with no dishing or cupping of fastener plate.][Top mop perforated sheet with a full, continuous mopping of hot asphalt.]

]3.3.5 [Fiberglass Felt][Modified Bitumen] Base Sheet

****

NOTE: Select the applicable application method. Delete other options. Delete requirements for adhered base sheets where the sheet is to be mechanically fastened through to nailable deck. Apply base sheets at right angles to roof slope, except on insulated roofs where nailers (insulation stops) have been applied at right angles to slope and on decks sloped one inch per foot or more, apply felts parallel to roof slope. Include requirements for applying felts to barrel-type roofs only when applicable.

****

[Fully adhere [spot adhere] base sheets in accordance with membrane manufacturer's printed instructions.] [Spot adhere base sheets with hot asphalt applied in 304.8 mm 12 inch diameter spots installed in two staggered rows, centered 304.8 mm 12 inch in from edge of the base sheet.][Apply cold adhesive with airless sprayer or a 6.35 mm 1/4 inch saw-toothed rubber squeegee and at application rate recommended by the membrane manufacturer. Fully cover substrate with cold adhesive. Ensure laps areas of base sheet are fully sealed.] Roll and broom in the base sheet to ensure full contact with the [hot asphalt][adhesive] application.[On nailable substrates, mechanically fasten base sheet in conformance with specified wind resistance requirements and membrane manufacturer's printed instructions, and to include increased fastening frequency in corner and perimeter areas. Drive fasteners flush with no dishing or cupping of fastener plate. Where applicable, mechanically fasten base sheet in conjunction with insulation to the substrate, in accordance with membrane manufacturers printed instructions.] Apply sheets in a continuous operation. Apply sheets with side laps at a minimum of 50.8 mm 2 inch unless greater side lap is recommended by the manufacturer's standard written application instructions. Provide end laps of not less than 152.4 mm 6 inch and staggered a minimum of 914.4 mm 36 inch. Apply sheets [at right angles to the roof slope so that the direction of water flow is over and not against the laps] [parallel to the roof slope] [so that plies of sheets extend from eave line on one side of the barrel-type roof and 457.2 mm 18 inch over the center line of the crown of the roof. Apply sheets on the other side in the same manner, resulting in twice the normal amount of roofing sheets and asphalt at the crown]. Extend base sheets approximately 50.8 mm 2 inch above the top of cant strips at vertical surfaces and to the top of cant strips elsewhere. Trim base sheet to a neat fit around vent pipes, roof drains, and other projections through the roof. Application must be free of ridges, wrinkles, and buckles.

3.3.6 Modified Bitumen Membrane Application

****

NOTE: On slopes up to 1:6 (2 inches per foot), specify membrane application perpendicular to slope of roof. On slopes greater than or equal to 1:6 (2 inches per foot), specify membrane application parallel to roof slope.

****

Ensure proper sheet alignment prior to installation. [Apply membrane layers perpendicular to slope of roof in shingle fashion to shed water, including application on areas of tapered insulation that change slope direction.][Apply membrane layers parallel to slope of roof.] Bucking or backwater laps are prohibited. Fully adhere membrane sheets to underlying substrate materials. Provide minimum 76.2 mm 3 inch side laps and minimum 152.4 mm 6 inch end laps and as otherwise required by membrane manufacturer. Stagger end laps minimum 914.4 mm 36 inch. Offset side laps between membrane layers a minimum of 304.8 mm 12 inch. Offset end laps between membrane layers a minimum of 914.4 mm 36 inch. Install all membrane layers the same workday, unless supported otherwise by roof membrane manufacturer application instructions and approved by the Contracting Officer. Provide tight smooth laminations of each membrane layer without wrinkles, ridges, buckles, kinks, fishmouths, or voids. Ensure full membrane adhesion and full lap seals. Rework to seal any open laps prior to application of subsequent membrane layers. The completed membrane application must be free of surface abrasions, air pockets, blisters, ridges, wrinkles, buckles, kinks, fishmouths, voids, or open seams.

3.3.6.1 Cap Sheet Installation

****
NOTE: Include the option of hot asphalt or torch application of cap sheet where permissible. Torch applied cap sheet can be applied over hot mopped membrane plies provided that the roof deck and materials used in the installation of the roofing system are non-combustible. Torch application of cap sheet may reduce instances of cap sheet blistering.

Where finished appearance of the roof is of consequence, include the bracketed requirement for granule application in areas of bitumen bleed out.
****

Underlying applied membrane must be inspected and repaired free of damage, holes, puncture, gouges, abrasions, and any other defects, and free of moisture, loose materials, debris, sediments, dust, and any other conditions required by the membrane manufacturer prior to cap sheet installation. Do not apply cap sheet if rain or frozen precipitation has occurred within the previous 24 hours. Align cap membrane and apply by the specified method with the proper side and end lap widths. [Set cap sheet in hot asphalt or torch apply as recommended by the modified bitumen membrane manufacturer when the roof deck and materials used in the installation of the roofing system are non-combustible.] Cut at a 45 degree angle across selvage edge of cap membrane to be overlapped in end lap areas prior to applying overlapping cap membrane. [Apply matching granules in any areas of [bitumen][adhesive] bleed out while the [asphalt is still hot][adhesive is still tacky].] Minimize traffic on newly installed cap sheet membrane.

[3.3.6.2 Backnailing of Cap Sheet

****
NOTE: Include this paragraph for roof slopes greater than or equal to 1:6 (2 inches per foot). Coordinate with insulation Section 07 22 00 ROOF AND DECK INSULATION and nailer requirements Section 06 10 00 ROUGH CARPENTRY to allow for backnailing of the membrane.
****

Unless otherwise recommended by the modified bitumen membrane manufacturer and approved by the Contracting Officer, provide minimum 88.9 mm 3-1/2 inch wide nailing strips matching insulation thickness and applied perpendicular to roof slope for backnailing of roof membrane. Space nailing strips as recommended by the membrane manufacturer, but not exceeding 4.88 m 16 foot on center unless approved otherwise by the Contracting Officer. Coordinate the nailer installation with insulation requirements. Install the modified bitumen cap sheet to provide for end laps at nailer locations. Nail the modified bitumen cap sheet at the end lap area across the width of the sheet. Nail within 25.4 mm 1 inch of each edge of the sheet and at 203.2 mm to 215.9 mm 8 inch to 8-1/2 inch on center across the width of the sheet in a staggered fashion. Nails must have 25.4 mm 1 inch diameter metal cap or be nailed through 25.4 mm 1 inch diameter caps. Cover nails by overlapping adjacent upslope sheet at the end lap area.

]3.3.7 Membrane Flashing

Apply two-ply modified bitumen strip flashing and sheet flashing in the angles formed where the roof deck abuts walls, curbs, ventilators, pipes, and other vertical surfaces, and where necessary to make the work watertight. Apply membrane flashing in accordance with the roof membrane manufacturers printed instructions and as specified. Cut at a 45 degree angle across terminating end lap area of cap membrane prior to applying adjacent overlapping cap membrane. Press flashing into place to ensure full adhesion and avoid bridging. Ensure full lap seal in all lap areas. Mechanically fasten top edge of modified bituminous base flashing 150 mm (6 inches) on center through minimum 25.4 mm 1 inch diameter tin caps with fasteners of sufficient length to embed minimum one inch into attachment substrate.[Apply matching granules in any areas of [asphalt][adhesive] bleed out while the [asphalt is still hot][adhesive is still tacky].] Apply membrane liner over top of exposed nailers and blocking and to overlap top edge of base flashing installation at curbs, parapet walls, expansion joints and as otherwise indicated to serve as waterproof lining under sheet metal flashing components. Metal flashing per SMACNA 1793 guidelines and standards is specified under Section 07 60 00 FLASHING AND SHEET METAL. Do not set metal flashing in hot asphalt.

3.3.7.1 Membrane Strip Flashing

Set primed flanges of metal flashing in full bed of modified bituminous cement material and securely fasten through to attachment substrate. Strip-in with membrane flashing so that strip extends not less than 101.6 mm 4 inch beyond outer edge of flange. Where multiple membrane stripping plies are installed, extend each additional stripping ply minimum 101.6 mm 4 inch beyond edge of previous ply.

[3.3.7.2 Membrane Flashing at Roof Drain

****

NOTE: Include this paragraph when roof drains are indicated.

****

Roof drains are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Flashing for roof drains, is specified in Section 07 60 00 FLASHING AND SHEET METAL. Extend membrane sheets to edge of drain bowl opening at the roof drain deck flange in accordance with membrane manufacturer's printed application instructions. Securely clamp membrane sheets and metal roof drain flashing and strip flashing in the flashing clamping ring. Secure clamps so that sheets and metal flashing are free from wrinkles and folds. Trim stripping must be flush with inside of clamping ring.

][3.3.7.3 Pre-fabricated Curbs

Securely anchor prefabricated curbs to nailer or other base substrate and flash with modified bitumen membrane.

]3.3.7.4 Set-On Accessories

Where pipe or conduit blocking, supports and similar roof accessories are set on the membrane, adhere walkpad material to bottom of accessories prior to setting on roofing membrane. Install set-on accessories to permit normal movement due to expansion, contraction, vibration, and similar occurrences without damaging roofing membrane. Do not mechanically secure set-on accessories through roofing membrane into roof deck substrate.

3.3.7.5 Lightning Protection

Flash and attach lightning protection system components to the roof membrane in a manner acceptable to the roof membrane manufacturer.

3.3.8 Roof Walkpads

Install walkpads at roof access points and where otherwise indicated for traffic areas and for access to mechanical equipment, in accordance with the modified bitumen sheet roofing manufacturer's printed instructions. Provide minimum 152.4 mm 6 inch separation between adjacent walkpads to accommodate drainage. Provide walkpad [or an additional layer of cap sheet] under precast concrete paver blocks to protect the roofing.

[3.3.9 Elevated Metal [Walkways] [and] [Platforms]

Install over completed roof system in accordance with [Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS]. Provide for protection of roof membrane by placing walkpad material, or other material approved by the Contracting Officer, at all surface bearing support locations.

]3.3.10 Paver Blocks

Install paver blocks where indicated and as necessary to support surface bearing items traversing the roof area. Set paver block on a layer of walkpad [or cap sheet] applied over the completed roof membrane.

[3.3.11 Field Applied Surfacing

****

NOTE: Delete FIELD APPLIED SURFACING and associated paragraphs if factory-applied granule surfaced membrane is specified. Otherwise, include only the applicable surfacing, delete all others.

****

After completion of roof membrane and flashing installation, and correction of tears, gouges, and other deficiencies in the installed work, apply specified surfacing.

[3.3.11.1 Aggregate

Uniformly flood coat the surface with hot asphalt at a rate of approximate 27.2 kg 60 pounds per square. While asphalt is still hot, apply gravel aggregate surfacing material at a rate of 181.4 kg 400 pounds per square or 136.1 kg 300 pounds per square for slag or other approved aggregate surfacing. Provide for full and uniform coverage of the roof surface. Solidly adhere approximately 50 percent of the aggregate in the asphalt.

][3.3.11.2 Coating Application

Apply surface coating materials to membrane and flashing in accordance with coating material manufacturer's recommendations.

]]3.3.12 Correction of Deficiencies

Where any form of deficiency is found, take additional measures as deemed necessary by the Contracting Officer to determine the extent of the deficiency and perform corrective actions as directed by the Contracting Officer.

3.3.13 Clean Up

Remove debris, scraps, containers and other rubbish and trash resulting from installation of the roofing system from job site each day.

3.4 CORRECTION OF DEFICIENCIES

Where any form of deficiency is found, take additional measures as deemed necessary by the Contracting Officer to determine the extent of the deficiency and perform corrective actions as directed by the Contracting Officer.

3.5 PROTECTION OF APPLIED ROOFING

At the end of the day's work and when precipitation is imminent, protect applied modified bitumen roofing system from water intrusion.

[3.5.1 Water Cutoffs

****

NOTE: Include this paragraph when roof insulation is a substrate for the modified bitumen sheet roofing.

****

Straighten insulation line using loose-laid cut insulation sheets and seal the terminated edge of modified bitumen roofing system in an effective manner. [Seal off flutes in metal decking along the cutoff edge.] Remove the water cut-offs to expose the insulation when resuming work, and remove the insulation sheets used for fill-in.

]3.5.2 Temporary Flashing for Permanent Roofing

Provide temporary flashing at drains, curbs, walls and other penetrations and terminations of roofing sheets until permanent flashing can be applied. Remove temporary flashing before applying permanent flashing.

3.5.3 Temporary Walkways, Runways, and Platforms

Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards, mats or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to live load limits of roof construction. Use rubber-tired equipment for roofing work.

3.6 FIELD QUALITY CONTROL

Perform field tests in the presence of the Contracting Officer. Notify the Contracting Officer one day before performing tests.

[3.6.1 Test for Surface Dryness

****

NOTE: Include paragraph or bracketed requirement when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

****

Before application of membrane sheets and starting work on the area to be roofed, perform test for surface dryness in accordance with the following:

a. Foaming: When poured on the surface to which membrane materials are to be applied, one pint of asphalt when heated in the range of 176 to 204 degrees C 350 to 400 degrees F, must not foam upon contact.

b. Strippability: On cementitious substrate surfaces, after asphalt used in the foaming test application has cooled to ambient temperatures, test coating for adherence. Should a portion of the sample be readily stripped clean from the surface, do not consider the surface to be dry and do not start application. Should rain occur during application, stop work and do not resume until surface has been tested by the method above and found dry.

c. Prior to installing any roof system on a concrete deck, conduct a test per ASTM D4263. The deck is acceptable for roof system application when there is no visible moisture on underside of plastic sheet after 24 hours.

]3.6.2 Construction Monitoring

During progress of the roof work, make visual inspections as necessary to ensure compliance with specified parameters. Additionally, verify the following:

a. Materials comply with the specified requirements.

b. Materials are not installed in adverse weather conditions.

    (1) All materials are properly stored, handled and protected from moisture or other damages.

c. Equipment is in working order. Metering devices are accurate.

d. Substrates are in acceptable condition, in compliance with specification, prior to application of subsequent materials.

    (1) Nailers and blocking are provided where and as needed.

    Insulation substrate is smooth, properly secured to its substrate, and without excessive gaps prior to membrane application.

    (2) The proper number, type, and spacing of fasteners are installed.

    (3) Membrane heating, hot mopping, or adhesive application is provided uniformly and as necessary to ensure full adhesion of roll materials. Asphalt is heated and applied within the specified temperature range.

    (4) The proper number and types of plies are installed, with the

specified overlaps.

(5) Applied membrane surface is inspected, cleaned, dry, and repaired as necessary prior to cap sheet installation.

(6) Lap areas of all plies are completely sealed.

(7) Membrane is fully adhered without ridges, wrinkles, kinks, fishmouths, or other voids or delaminations.

(8) Installer adheres to specified and detailed application parameters.

(9) Associated flashing and sheet metal are installed in a timely manner in accord with the specified requirements.

(10) Temporary protection measures are in place at the end of each work shift.

[3.6.2.1 Manufacturer's Inspection

****

NOTE: Include this paragraph when manufacturer's inspection of work is required. Select desired frequency of manufacturer inspection and coordinate with text of optional second and third bracketed sentences.

****

Manufacturer's technical representative must visit the site a minimum of three [_____] times [once per week] during the installation for purposes of reviewing materials installation practices and adequacy of work in place. [Inspections must occur during the first 20 squares of membrane installation, at mid-point of the installation, and at substantial completion, at a minimum. Additional inspections must not exceed one for each 100 squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer.] After each inspection, submit a report, signed by the manufacturer's technical representative to the Contracting Officer within 3 working days. Note in the report overall quality of work, deficiencies and any other concerns, and recommended corrective action.

]3.6.3 Samples of Roofing

****

NOTE: This requirement is included for optional enforcement at the discretion of the Contracting Officer. It is not the intent to require cut samples on all roof projects.

****

Take samples per ASTM D5147/D5147M, sized 101.6 mm by 1016 mm 4-inch by 40-inch cut across width of modified bitumen sheets as directed by the Contracting Officer. Cut samples will be examined by the Contracting Officer for specified number of plies, proper lap width, complete lap seal, full uniform adhesive compound application and adhesion, full bond between plies, harmful foreign materials, presence of moisture, and wet insulation. Where cuts are not retained by the Contracting Officer or disposed, set cut strip back in cut area in bed of modified bitumen cement. Repair area of cut with new minimum two-ply modified bitumen membrane patch.

3.6.4 Roof Drain Test

****
NOTE: Include this paragraph when roof drains are required. Consult with structural engineer to verify loading capability of roof structural system.
****

After completing roofing, but prior to Government acceptance, perform the following test for watertight integrity. Plug roof drains and fill with water to edge of drain sump for 8 hours. Do not plug secondary overflow drains at the same time as adjacent primary drain. To ensure some drainage from roof, do not test all drains at same time. Measure water at beginning and end of the test period. When precipitation occurs during test period, repeat test. When water level falls, remove water, thoroughly dry, and inspect installation; repair or replace roofing at drain to provide for a properly installed watertight flashing seal. Repeat test until there is no water leakage.

[3.7 INFRARED INSPECTION

****
NOTE: This optional requirement should be included only under special circumstances and on roof systems conducive to effective infrared scanning, or as otherwise instructed. This section may be necessary at project locations where infrared inspections cannot be performed during construction due to climate or other adverse conditions.
****

[Eight][_____] months after completion of the roofing system, the Contractor must inspect the roof surface using infrared (IR) scanning as specified in ASTM C1153. Where the IR inspection indicates moisture intrusion, replace wet insulation and damaged or deficient materials or construction in a manner to provide watertight construction and maintain the specified roof system warranties.[Coordinate infrared inspections with building envelope commissioning activities.]

]3.8 INSTRUCTIONS TO [GOVERNMENT][CONTRACTOR] PERSONNEL

Furnish written and verbal instructions on proper maintenance procedures to designated Government personnel. Furnish instructions by a competent representative of the modified bitumen membrane manufacturer and include a minimum of 4 hours on maintenance and emergency repair of the membrane. Include a demonstration of membrane repair, and give sources of required special tools. Furnish information on safety requirements during maintenance and emergency repair operations.

3.9 INFORMATION CARD

For each roof, furnish a typewritten information card for facility Records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved 1 mm 0.039 inch thick aluminum card for exterior display. Card must be 215 mm by 275 mm 8 1/2 by 11 inch minimum, identifying facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, membrane, number of plies, method of application, manufacturer, insulation and cover board system and thickness; presence of tapered insulation for primary drainage, presence of vapor retarder; date of completion; installing contractor identification and contact information; membrane manufacturer warranty expiration, warranty reference number, and contact information. Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 53 23 (May 2012)**
Change 2 - 08/18
Preparing Activity: NAVFAC **Superseding**
UFGS-07 53 23 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 07 53 23

ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING

05/12, CHG 2: 08/18

PART 3 EXECUTION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-07 53 23 (May 2012)**
Change 2 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-07 53 23 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 07 53 23

ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING

05/12, CHG 2: 08/18

****

NOTE: This guide specification covers the requirements for ethylene propylene diene terpolymer (EPDM) elastomeric sheet roofing, with associated elastomeric sheet flashing, for installations with the insulation below the membrane on both existing and new roof systems with slopes from 6 mm to 76 mm 1/4 inch to 3 inches per foot.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Standard application methods include loose-laid ballasted, fully adhered, and mechanically fastened systems. Also included is a special combined fully adhered and mechanically fastened system for excessive wind loading conditions. This guide specification does not include the structural roof deck, insulation, sheet metal fascias, gravel stops, flashings, nor use of elastomeric sheets for roofing located adjacent to kitchen or food service exhaust system discharge ducts. Grease and oil attack EPDM. Exhaust fumes must be directed away from the roofing system.

Coordinate this section with other roof system components specifications such as rough carpentry, insulation and sheet metal flashing. Also coordinate this section with the criteria contained in UFC 3-110-03, "Roofing" as it relates to the specific project and Service Exceptions indicated therein.

Specify membrane attachments that are compatible with the insulation specified. Do not adhere membrane directly to polystyrene, perlite or standard wood fiber, insulation. Ensure facer on polyisocyanurate insulations is compatible with the adhesive of a fully adhered membrane application. Glass mat, moisture resistant gypsum roof board can be used as an underlayment over insulation for adhesive application of roof membrane with approval of the membrane manufacturer. Utilize wood fiberboard, perlite, or glass mat, moisture resistant gypsum roof board as top insulation layer under ballasted roofing systems.

****

PART 1   GENERAL

1.1   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM D448	(2012; R 2017) Standard Classification for Sizes of Aggregate for Road and Bridge Construction
ASTM D4637/D4637M	(2015) EPDM Sheet Used in Single-Ply Roof Membrane
ASTM D4811/D4811M	(2016) Standard Specification for Nonvulcanized (Uncured) Rubber Sheet Used as Roof Flashing
ASTM D6369	(1999; R 2006) Design of Standard Flashing Details for EPDM Roof Membranes
ASTM E108	(2024) Standard Test Methods for Fire Tests of Roof Coverings

FM GLOBAL (FM)

FM 4470	(2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA RoofMan	(2020) The NRCA Roofing Manual

SINGLE PLY ROOFING INDUSTRY (SPRI)

ANSI/SPRI RD-1	(2019) Performance Standard for Retrofit Drains

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 790	(2022) UL Standard for Safety Test Methods for Fire Tests of Roof Coverings
UL RMSD	(2012) Roofing Materials and Systems Directory

1.2 DESCRIPTION OF ROOF MEMBRANE SYSTEM[S]

****

NOTE: Coordinate with Part 2 materials specification.

Select the application method required. Delete

other options.

Where EPDM systems are utilized, fully adhered systems applied over minimum two layers of rigid board roof insulation is the preferred norm.

Do not specify stone ballasted systems along flight lines, in wind zones exceeding 160 km/h 100 mph, within 8 km 5 miles of coastline, within 457 m 1500 feet of open body of water, and on or adjacent to critical facilities such as hospitals. Where ballasted systems are required, utilize interlocking pavers designed to resist the required wind loads. Ballasted systems on air permeable decks (e.g., metal decks, precast concrete panels or planks) must incorporate an air barrier in the assembly.

Also incorporate an air barrier in the roof assembly for mechanically fastened systems. Use reinforced membrane in wind zones exceeding 160 km/h 100 mph, within 8 km 5 miles of coastline or within 457 m 1500 feet of open body of water.

Specify combination attachment only for isolated geographic locations that experience extreme and extended wind conditions such as portions of Alaska and Iceland, or as otherwise required by the Government.

Where one membrane system is required for all roof areas, use the first paragraph. Where different systems are required, use the second paragraph successively and replace the open brackets with a description of the substrate(s) or area of the building or project where each system is to be applied.

****

[Fully adhered][Mechanically fastened][Ballasted][Combination fully adhered and mechanically fastened] EPDM roof membrane system applied over [insulation][recovery board][concrete roof deck] substrate.

[_____]: [Fully adhered][Mechanically fastened][Ballasted][Combination fully adhered and mechanically fastened] EPDM roof membrane system applied over [insulation][recovery board][concrete roof deck] substrate.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roof Plan Drawing

Wind Load Calculations

Boundaries of Enhanced Perimeter

Corner Attachments of Roof System Components

Location of Perimeter Half-Sheets

Spacing of Perimeter, Corner, and Infield Fasteners

Slopes and Drain Locations

SD-03 Product Data

Cement

EPDM Sheet; G, [_____]

[Heat Island Reduction; S

][Energy Star Label for Top Coating; S

] Seam Tape

Bonding Adhesive

Lap Splice Adhesive

Water Cutoff Mastic/Water Block

Lap Cleaner, Lap Sealant, and Edge Treatment

Flashings

Flashing Accessories

Flashing Tape

Fasteners and Plates

[Ballast

] Roof Insulation

[Protection Mat

][Pre-Manufactured Accessories

] Sample Warranty Certificate; G, [_____]

Submit all data required together with requirements of this section. Include a written acceptance by the roof membrane manufacturer of the insulation and other products and accessories to be provided. List products in the applicable wind uplift and fire rating classification listings, unless approved otherwise by the Contracting Officer.

SD-05 Design Data

****

NOTE: Incorporate this paragraph for ballasted systems and anytime non-FM rated systems are permissible. Coordinate with requirements of "Wind Uplift" paragraph.

****

Wind Uplift Calculations; G, [_____]

[Engineering calculations validating the wind resistance of roof system.

] SD-07 Certificates

Qualification of Manufacturer

Certify that the manufacturer of the roof membrane meets requirements specified under paragraph entitled "Qualification of Manufacturer."

Qualification of Applicator

Certify that the applicator meets requirements specified under paragraph entitled "Qualification of Applicator."

Wind Uplift Resistance classification, as applicable; G, [_____]

Fire Resistance classification; G, [_____]

Submit the roof system assembly [wind uplift and] fire rating classification listings.

SD-08 Manufacturer's Instructions

****

NOTE: Edit the manufacturers instructions submission requirements as necessary for the system specified. Include bracketed requirements only as applicable to the system being specified.

****

Application; G, [_____]

Application Method; G, [_____], including pattern and frequency of mechanical attachments required in the field of roof, corners, and perimeters to provide for the specified wind resistance

Membrane Flashing; G, [_____]

Seam Tape

Tape Seams / Lap Splices

Adhesive Seams / Lap Splices

Perimeter Attachment

Primer

Fasteners

[Pavers

][Protection Mat

][Pre-Manufactured Accessories

] Cold Weather Installation; G, [_____]

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications. Explicitly identify in writing, differences between manufacturer's printed instructions and the specified requirements.

SD-11 Closeout Submittals

Warranty

Information Card

Instructions To Government Personnel

Include copies of Safety Data Sheets (SDS) for maintenance/repair materials.

1.3.1 Shop Drawings

Roof plan drawing depicting wind load calculations and boundaries of enhanced perimeter and corner attachments of roof system components, [location of perimeter half-sheets][, spacing of perimeter, corner, and infield fasteners,] as applicable. Include the project roof plan of each roof level and conditions indicated. Provide all slopes and drain locations.

1.4 QUALITY ASSURANCE

****

NOTE: All projects with more than 15,000 square feet 1400 square meters of roof area or that is defined as critical use or mission critical in the project DD Form 1391 must have a Registered Roof Consultant (RRC) or a registered professional engineer (PE) or registered architect (RA) that derives his or her principal income from roofing design on the quality control staff of the design team.

****

1.4.1 Qualification of Manufacturer

****

NOTE: Specify 5 years manufacturer experience unless directed otherwise by the Government

****

EPDM sheet roofing membrane manufacturer must have at least [5][_____] years experience in manufacturing EPDM roofing products.

1.4.2 Qualification of Applicator

****

NOTE: Specify 3 years as an approved Contractor unless directed otherwise by the Government

****

Roofing system applicator must be approved, authorized, or licensed in writing by the roof membrane manufacturer and must have a minimum of [3][_____] years experience as an approved, authorized, or licensed applicator with that manufacturer and be approved at a level capable of providing the specified warranty. The applicator must supply the names, locations and client contact information of 5 projects of similar size and scope that the applicator has constructed using the manufacturer's roofing products submitted for this project within the previous three years.

1.4.3 Qualifications of Photovoltaics (PV) Rooftop Applicator

The PV rooftop applicator must be approved, authorized, or certified by a Roof Integrated Solar Energy (RISE) Certified Solar Roofing Professional (CSRP), and comply with applicable codes, standards, and regulatory requirements to maintain the weatherproofing abilities of both the integrated roof system and photovoltaic system.

1.4.4 Fire Resistance

Complete roof covering assembly must:

a. Be Class A rated in accordance with ASTM E108, FM 4470, or UL 790; and

b. Be listed as part of Fire-Classified roof deck construction in the UL RMSD or Class I roof deck construction in the FM APP GUIDE.

FM or UL approved components of the roof covering assembly must bear the appropriate FM or UL label.

1.4.5 Wind Uplift Resistance

****

NOTE: Determine the required wind uplift resistance based on ASCE 7-16 wind loading calculations or applicable building code requirements.

The specified FM approval rating incorporates a safety factor of 2 over the maximum calculated uplift pressure in inch-pound units. Therefore, a FM approval rating of 1-90 correlates to a maximum uplift calculation of 2.2 kPa 45 psf. When specifying an FM rated system, ensure the designed roof system is capable of providing the specified FM approval rating. Where non-rated systems may be permissible, include the bracketed portion of the second sentence and the third sentence.

Design ballast for loose-laid ballasted application in accordance with ANSI/RMA/SPRI RP-4. Where ballasted systems are specified include the bracketed option at the end of the paragraph.

Delineate calculated values in the roof specification or drawings. Utilize independently tested and rated roof systems, such as Factory Mutual (FM), Underwriters Laboratories (UL), and Single Ply Roofing Industry (SPRI).

****

Provide a complete roof system assembly that is rated and installed to resist wind loads [indicated][calculated in accordance with ASCE 7-16] and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Do not install non-rated systems except as approved by the Contracting Officer. Submit licensed engineer's wind uplift calculations and substantiating data to validate any non-rated roof system. Base wind uplift measurements based on a design wind speed of [_____] km/h [_____] mph in accordance with ASCE 7-16 and other applicable building code requirements

1.4.6 Preroofing Conference

After approval of submittals and before performing roofing [and insulation] system installation work, hold a preroofing conference to review the following:

a. Drawings, specifications and submittals related to the roof work;

b. Roof system components installation;

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representative;

d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing; and

e. Quality control plan for the roof system installation;

f. Safety requirements.

Coordinate preroofing conference scheduling with the Contracting Officer. The conference must be attended by the Contractor, the Contracting Officer's designated personnel, personnel directly responsible for the installation of roofing[and insulation], flashing and sheet metal work, [[mechanical] [and] [electrical] work], other trades interfacing with the roof work, and representative of the roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver materials in their original, unopened containers or wrappings with labels intact and legible. Where materials are covered by a referenced specification number, the labels must bear the specification number, type, class, and shelf life expiration date where applicable. Deliver materials in sufficient quantity to allow continuity of work.

1.5.2 Storage

Store and protect materials from damage and weather in accordance with manufacturer's printed instructions, except as specified otherwise. Keep materials clean and dry. Store and maintain adhesives, sealants, primers and other liquid materials above 15 degrees C 60 degrees F. Utilize insulated hot boxes or other enclosed warming devices in cold weather. Mark and remove damaged materials from the site. Use pallets to support and canvas tarpaulins to completely cover material materials stored outdoors. Do not use polyethylene as a covering. Locate materials temporarily stored on the roof in approved areas, and distribute the load to stay within the live load limits of the roof construction. Remove unused materials from the roof at the end of each days work.

1.5.3 Handling

Prevent damage to edges and ends of roll materials. Do not install damaged materials in the work. Select and operate material handling equipment so as not to damage materials or applied roofing. Do not use materials contaminated by exposure or moisture. Remove contaminated materials from the site. When hazardous materials are involved, adhere to the special precautions of the manufacturer. Adhesives may contain petroleum distillates and may be extremely flammable; prevent personnel from breathing vapors, and do not use near sparks or open flame.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not install EPDM sheet roofing during high winds or inclement weather, or when there is ice, frost, moisture, or visible dampness on the substrate surface, or when condensation develops on surfaces during application. Unless recommended otherwise by the EPDM sheet manufacturer and approved by the Contracting Officer, do not install EPDM sheet when air temperature is below 4 degrees C 40 degrees F or within 3 degrees C 5 degrees F of the dewpoint. Follow manufacturer's printed instructions for installation during cold weather conditions.

1.7 SEQUENCING

Coordinate the work with other trades to ensure that components which are to be secured to or stripped into the roofing system are available and that permanent flashing and counterflashing are installed as the work progresses. Ensure temporary protection measures are in place to preclude moisture intrusion or damage to installed materials.[Apply roofing immediately following application of insulation as a continuous operation. Coordinate roofing operations with insulation work so that all roof insulation applied each day is covered with roof membrane installation the same day.]

1.8 WARRANTY

Provide roof system material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard membrane manufacturer warranty as required to comply with the specified requirements. Provide a manufacturer's warranty that has no dollar limit, covers full system water-tightness and has a minimum duration of 20 years.

1.8.1 Roof Membrane Manufacturer Warranty

****

NOTE: Insulated and routinely occupied facilities or facilities containing sensitive equipment or operations require a warranty of not less than 15 years. Designer may specify 5 or 10 year manufacturer warranty on facilities of small roof area and of minor importance where interiors and contents are not severely impacted by potential water intrusion. Environmentally controlled interiors require minimum 10 year warranty regardless of small size.

****

Furnish the roof membrane manufacturer's 20 year no dollar limit roof system materials and installation workmanship warranty, including flashing, insulation, and accessories necessary for a watertight roof system construction. Write the warranty directly to the Government and commence at time of Government's acceptance of the roof work. The warranty must state that:

a. If within the warranty period the roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, splits, tears, cracks, delaminates, separates at the seams, shrinks to the point of bridging or tenting membrane at transitions, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the roof system assembly and correction of defective workmanship is the responsibility of the roof membrane manufacturer. The roof membrane manufacturer is responsible for all costs associated with the repair or replacement work.

b. When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others does not void the warranty.

1.8.2 Roofing System Installer Warranty

The roof system installer must warrant for a period of two years that the roof system, as installed, is free from defects in installation workmanship, to include the roof membrane, flashing, insulation, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Write the warranty directly to the Government. The roof system installer is responsible for correction of defective workmanship and replacement of damaged or affected materials. The roof system installer is responsible for all costs associated with the repair or replacement work.

1.8.3 Continuance of Warranty

Approve repair or replacement work that becomes necessary within the warranty period and accomplish in a manner so as to restore the integrity of the roof system assembly and validity of the roof membrane manufacturer warranty for the remainder of the manufacturer warranty period.

1.9 CONFORMANCE AND COMPATIBILITY

Provide the entire roofing and flashing system in accordance with specified and indicated requirements, including fire and wind resistance requirements. Work not specifically addressed and any deviation from specified requirements must be in general accordance with recommendations of the NRCA RoofMan, membrane manufacturer published recommendations and details, ASTM D6369, and compatible with surrounding components and construction. Submit any deviation from specified or indicated requirements to the Contracting Officer for approval prior to installation.

1.10 ELIMINATION, PREVENTION OF FALL HAZARDS

****

NOTE: Any part or component of the building, facility, structure, or equipment requiring future maintenance work must incorporate in the design fall prevention methods or techniques to eliminate fall hazards, in accordance with ANSI/ASSE A1264.1. Fall prevention methods may include identifying, designing, and installing anchorages (hard points) for safe use of fall arrest equipment and systems. Select materials for metal compatibility in order to minimize corrosion, type 316 stainless steel is recommended.

****

1.10.1 Fall Protection

[_____]

PART 2 PRODUCTS

2.1 MATERIALS

Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Protect materials provided from defects and make suitable for the service and climatic conditions of the installation.

2.1.1 EPDM Sheet

****

NOTE: Refer to Designer Note in PART 1 - DESCRIPTION OF ROOF MEMBRANE SYSTEM for guidance regarding membrane attachment method and in editing the membrane materials requirements.

Specify minimum 2.3 mm 0.090 inch membrane for all application. Reinforced membrane for mechanically fastened applications in wind zones exceeding 160 km/h 100 mph, within 8 km 5 miles of coastline or within 457 m 1500 feet of open body of water.

Typically specify 2.3 mm 0.090 inch non-reinforced membrane for fully adhered or ballasted application. When Type III membrane is required the adhesive is typically a spray applied compound, spray foam adhesive, or hot asphalt. Modify related portions of this specification for proper adhesive and application parameters when Type III membrane is specified.

****

Ethylene Propylene Diene Terpolymer (EPDM), ASTM D4637/D4637M, [Type I, non-reinforced][Type II, scrim or fabric reinforced][Type III, fabric or fleece backed], 2.3 mm 0.090 inch nominal thickness for [mechanically fastened] [fully adhered] [loose-laid ballasted] [combined fully adhered and mechanically fastened] application. Provide membrane with minimum thickness not less than minus 10 percent of the specified thickness value. EPDM membrane thickness specified is exclusive of backing material on the EPDM membrane. Principal polymer used in manufacture of the membrane sheet must be greater than 95 percent EPDM. Width and length of sheet must be [as recommended by the manufacturer.][maximum width attainable as recommended by the manufacturer to minimize field formed seams in the field of the roof.]

2.1.2 Energy [and Cool Roof] Performance

****

NOTE: Standards such as UFC 1-200-02 promote the use of cool roofing, and increased energy conservation through additional insulation. Design cool roofs following the requirements in UFC 3-110-03 "Roofing" Chapter 1, Cool Roofs. Consider that when cool roofing is used with insulation R values greater than 24, the 'cool roof' surface has little if no influence on the energy performance of

the building. Additionally, designers should be aware of the possible negative impacts of using cool roofing that may result in unintended consequences. Design mechanically-fastened single-ply roof systems in accordance with UFC 3-110-03 Roofing, Chapter 2. Condensation on the underside of mechanically-fastened systems can result in ice build-up in winter, mold growth on the facers, moisture dripping into the interior, and replacement of the roofs with less than four years of service. See Appendix B of UFC 3-110-03 for more information. Inadequate design of cool roofs in ASHRAE climate zones 4 and higher have resulted in the unintended consequence of condensation below the membrane-a result of the material's inability to warm and drive moisture downward. Roofs that experience this condensation have had to be replaced. Other unintended consequences include the overheating of masonry walls, interior spaces, roof top piping and mechanical equipment as a result of the reflected UV rays.

NOTE: Designer to specify the roof performance by R-Value on the drawings or stated in other specification sections.

****

****

NOTE: Facilities with dominant cooling loads or in mild or warm climate zones are required to meet "cool roofing" requirements of FEMP. Design cool roofs following the requirements in UFC 3-110-03 Roofing, Appendix B and ASHRAE 90.1 Chapter 5, for the design of insulation and energy performance of the building.

NOTE: If a cool roof is not selected in ASHRAE zones 1 thru 3, design must meet one of the exception requirements listed in ASHRAE 90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Coordinate these requirements with insulation design and specifications.

Retain the next to last bracketed note for project with cool roof requirement. Retain the last bracketed sentence for project with sustainable third party certification credit requirement for reduced heat island effect

****

Install a roof system that meets an overall performance as specified on the drawings or by insulation specified in other sections.[The roofing system will need to include a top surface finish that meets the criteria for Cool Roof Products.[Provide emittance and reflectance percentages, solar reflectance index values, [and] slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]]

2.1.3 Seam Tape

****

NOTE: Seam tapes have proven most effective in maintaining long term seal of field seams of roof membrane. Seam tapes can be difficult to apply to membrane flashing situations. As such, lap splice adhesive or self-adhering flashing membrane are used as alternatives in difficult membrane flashing areas.

Seam tapes must be minimum 75 mm 3 inch wide. Some specific situations may require wider seam tapes as recommended by the membrane manufacturer.

****

Double-sided synthetic rubber tape, minimum 0.76 mm 0.03 inch thick, minimum 75 mm 3 inch wide. Utilize seam tape as recommended by the manufacturer's printed data for forming watertight bond of EPDM sheet materials to each other for the application specified and conditions encountered. 150 mm 6 inch wide tape is required for seam seals along lines of mechanical attachment of membrane.

2.1.4 Lap Splice Adhesive

****

NOTE: Lap splice adhesive is used for some membrane to membrane bond applications.

Include bracketed options as applicable.

Low VOC materials may be required in some geographic locations and on occupied buildings to minimize potential irritation to occupants.

Include second and third brackets options at end of paragraph when lap splice adhesive is prohibited for field seams of roof membrane.

****

[Low volatile organic compound (VOC)] synthetic rubber adhesive as supplied by roof membrane manufacturer and recommended by the manufacturer's printed data for forming watertight bond of EPDM sheet membrane materials to each other [in areas of membrane flashing]. [Do not use splice adhesive to form membrane seams in field of roof or at standard base flashing conditions.]

2.1.5 Bonding Adhesive

****

NOTE: Bonding adhesive is used for adhering EPDM membrane to materials other than EPDM.

Low VOC materials may be required in some geographic locations and on occupied buildings to minimize potential irritation to occupants.

When Type III (fleece-backed) membrane is specified, include the first bracketed option as applicable, delete the second bracketed option, and write in a description of the adhesive required as the third

bracketed option. When hot asphalt is the specified adhesive, in Part 3, include parameters for heating of asphalt and application similar to those found in Section 07 51 13 BUILT-UP ASPHALT ROOFING.

****

[Low volatile organic compound (VOC)] [synthetic rubber][_____] adhesive as supplied by roof membrane manufacturer and recommended by the manufacturer's printed data for bonding EPDM membrane materials to insulation, wood, metal, concrete or other substrate materials. Do not use bonding adhesive to bond membrane materials to each other.

2.1.6 Lap Cleaner, Lap Sealant, and Edge Treatment

As supplied by the roof membrane manufacturer and recommended by the manufacturer's printed data.

2.1.7 Water Cutoff Mastic/Water Block

As supplied by the roof membrane manufacturer and recommended by the manufacturer's printed data.

2.1.8 Membrane Flashings and Flashing Accessories

Provide membrane flashing, including self-adhering membrane flashing, perimeter flashing, flashing around roof penetrations, and prefabricated pipe seals, that is minimum 1.1 mm 0.045 inch cured EPDM, as recommended by the roof membrane manufacturer or minimum 1.4 mm 0.055 inch thick uncured EPDM sheet in compliance with ASTM D4811/D4811M, Type I. Use cured EPDM membrane to the maximum extent recommended by the roof membrane manufacturer. Limit uncured flashing material to reinforcing inside and outside corners and angle changes in plane of membrane, and to flash scuppers, pourable sealer pockets, and other formed penetrations or unusually shaped conditions as recommended by the roof membrane manufacturer where the use of cured material is impractical.

2.1.8.1 Flashing Tape

EPDM-backed synthetic rubber tape, minimum 150 mm 6 inch wide as supplied by the roof membrane manufacturer and recommended by the manufacturer's printed data.

2.1.9 Membrane Fasteners and Plates

Coated, corrosion-resistant fasteners as recommended by the roof membrane manufacturer and meeting the requirements of FM 4470 and FM APP GUIDE for Class I roof deck construction and the wind uplift resistance specified. As supplied and warranted for the substrate type(s) by EPDM sheet manufacturer and recommended by EPDM sheet manufacturer's printed data.

2.1.9.1 Stress Plates for Fasteners

Flat corrosion-resistant round stress plates as recommended by the roof membrane manufacturer's printed instructions and meeting the requirements of FM 4470; not less than 50 mm 2 inch in diameter. Provide pre-formed discs to prevent dishing or cupping.

2.1.9.2 Auxiliary Fasteners

Corrosion resistant screws, nails, or anchors suitable for intended attachment purpose and as recommended by the roof membrane manufacturer.

2.1.9.3 Powder-Driven Fasteners

Powder-driven fasteners may be used only when approved in writing.

2.1.9.4 Metal Disks

Provide flat metal disks of minimum 25 mm 1 inch in diameter, made of nonferrous material compatible with the nails or fasteners.

[2.1.10 Ballast

****

NOTE: Delete these paragraphs unless loose-laid ballasted system is specified. Normally specify stone ballast for a ballasted system. Specify paver ballast when:

a. There is danger of aggregate being drawn into air intakes of jet aircraft.

b. There is danger of wind-blown aggregate jeopardizing property and life safety.

c. In wind zones exceeding 160 km/h 100 mph, within 8 km 5 miles of coastline, within 457 m 1500 feet of open body of water, and on or adjacent to critical facilities such as hospitals.

d. Heavy foot traffic over large areas of roof is expected.

****

[2.1.10.1 Stone Ballast

Smooth, rounded, river-washed stone graded in accordance with ASTM D448, sizes 1, 2, 24, 3, and 4, nominal 19 mm to 38 mm 3/4 inch to 1-1/2 diameter, except as recommended otherwise by the roof membrane manufacturer and approved by the Contracting Officer.

][2.1.10.2 Ballast Pavers

****

NOTE: Specify paver weight based on calculated wind load conditions and ANSI/RMA/SPRI RP-4.

Lightweight interlocking paver ballast may be used in lieu of heavier weight non-interlocking pavers in wind zones in excess of 160 km/h 100 mph, within 8 km 5 miles of coastline or within 457 m 1500 feet of open body of water. Non-interlocking pavers should weigh not less than 88 kg per square meter 18 pounds per square foot.

Elevated paver systems and pavers intended to

support pedestrian traffic, such as plaza decks or observation decks, should be minimum 50 mm 2 inch thick, 600 mm 24 inch square, and minimum 51,700 kPa 7500 psi compressive strength.

Specify paver pedestals for pavers without drainage channels. Specify adjustable pedestals for systems required to be elevated to a level plane such as a plaza or observation deck.
****

Provide weather resistant, precast [interlocking] concrete roof pavers [with drainage channels on the underside], and as recommended by the roof membrane manufacturer. Provide pavers of minimum 20,680 kPa 3000 psi 51,700 kPa 7500 psi compressive strength, weigh not less than 58 kg per square meter 12 pounds per square foot 88 kg per square meter 18 pounds per square foot [_____], not less than 30 mm 1-1/4 inch 50 mm 2 inch thick and nominal 600 mm 24 inch [_____] in length and width and without sharp edges and projections. [Elevate pavers above the roof membrane surface with paver manufacturer's recommended [adjustable] pedestal system [to provide for level walking surface] as required by the roof membrane manufacturer.]

]][2.1.11 Protection Mat / Slip Sheet

****
NOTE: Specify protection mat for application between roof membrane and ballast when ballasted systems are specified.
****

Minimum 154 gram per square meter 4.5 ounce per square yard 200 gram per square meter 6 ounce per square yard ultraviolet resistant polypropylene, non-woven, needle punched fabric for use as protection mat under ballast system and as recommended by the roof membrane manufacturer.

][2.1.12 Pre-Manufactured Accessories

****
NOTE: Edit, delete, and insert accessory materials requirements as required for the specific project and components to be installed.
****

Pre-manufactured accessories must be manufacturer's standard for intended purpose,[comply with applicable specification section,] compatible with the membrane roof system and approved for use by the roof membrane manufacturer.

[2.1.12.1 Pre-fabricated Curbs

Provide [_____] gauge [G90 galvanized][AZ55 galvalume][_____] curbs with minimum 100 mm 4 inch flange for attachment to roof nailers. Provide minimum height of 250 mm 10 inch above the finished roof membrane surface.

]][2.1.13 [Rubber Walkboards] [and] [Precast Concrete Paver Block Walkways]

****
NOTE: Use pavers or rubber walkboards as walkways where the roof or areas of the roof are intended to

bear foot traffic for maintenance or other purposes once per month or more frequently.

****

Provide [either of] the following:

[2.1.13.1 Rubber Walkboards

Preformed reprocessed rubber, compatible with the EPDM sheet, 6 mm 1/4 inch minimum thickness, and weighing not less than .68 kg per square meter 1-1/2 pounds per square foot.

][2.1.13.2 Precast Concrete Paver Block

Precast concrete blocks, 450 mm by 450 mm 18 inch by 18 inch 600 mm by 600 mm 24 inch by 24 inch, without sharp edges and projections, and weighing no more than 20 kg 45 pounds 36 kg 80 pounds each.

]]2.1.14 Roof Insulation Below EPDM Sheet

****

NOTE: If the roofing system contains insulation, coordinate with the appropriate insulation specification section. The insulation specification should include materials and installation up to the substrate on which the roof membrane is applied.

Do not fully adhere single ply membrane to perlite, polystyrene, or standard wood fiber insulation board. High density wood fiber board is acceptable if approved by the roof membrane manufacturer for the wind resistance condition specified.

Coordinate insulation system attachment with the wind resistance requirements. In many instances, insulation system must be adhered or mechanically fastened to deck in corner and perimeter areas, if not throughout the field of the roof, when specifying a ballasted roof system.

****

Ensure insulation system and facer material is compatible with membrane application specified and as approved by the roof membrane manufacturer.

[2.1.15 Top Coating

****

NOTE: Top coatings can provide Energy Star classification when applied as final surface. Typical colors are white, tan, and other light colors. In review of the overall performance of the roof, color and materials specified earlier in this specification, the designer has the option to include Energy Star rating by including the paragraph below.

****

Provide a top coating product that is Energy Star labeled and is produced and compatible with the roof material of this specification. Provide data identifying Energy Star label for top coating product. Install to the manufacturer's written installation methods. Provide written confirmation that installation of a top coat will not modify or void the required roof warranty.

]2.1.16 Photovoltaic (PV) Systems - Rack Mounted Systems

****

NOTE: The installation of a PV roof system over existing roof systems should be undertaken with extreme caution. Do not install PV systems on roofs with a shorter expected service life than the new PV system. Prior to the design of such systems the following must be undertaken:

a. Determine if the existing roof structure can handle the anticipated roof load increase.

b. Inspect and determine that the existing Page 20 roof system has at least 10 years of service life remaining. If not, remove the existing roof and design a new replacement roof system in tandem with the photovoltaic system.

c. If 10 years remaining service life remains, ensure the design of the intersecting details, required roof protection, re-inspections, and warranty requirements for maintaining the roof system has been coordinated with the installation and manufacturers' warranties.

d. Design the roof related details for anticipated roof replacement work. Coordinate with the PV system designer to anticipate and plan for future roof replacement.

e. PV equipment on a rooftop creates additional roof protection requirements during initial installation and throughout the PV life-cycle. Ensure a roof protection program is specified during the PV system installation.

f. Permanently affix PV supports to stanchions which are anchored to the building structure.

****

Adhere to the following guidelines:

a. Building Owners Guide to Roof-mounted PV Systems, published by NRCA.

b. Guidelines for Roof-Mounted PV Systems, published by NRCA.

2.1.17 Wood Products

****

NOTE: Coordinate with Section 06 10 00 ROUGH CARPENTRY. Some fire retardant treatment (FRT) chemicals may affect EPDM materials. Submit SDS listing active ingredients for the FRT wood to EPDM

manufacturer prior to applying EPDM materials in contact with FRT wood.
****

Do not allow fire retardant treated materials be in contact with EPDM membrane or EPDM accessory products, unless approved by the membrane manufacturer and the Contracting Officer.

2.1.18 Membrane Liner

[Self-adhering]EPDM membrane liner conforming to ASTM D4637/D4637M, or other waterproof membrane liner material as approved by the roof membrane manufacturer and the Contracting Officer.

2.2 FLASHING CEMENT

Provide a self-vulcanizing butyl compound flashing cement for splicing laps and for flashings workable at minus 7 degrees C 20 degrees F. Obtain a recommendation for such flashing cement from the roofing membrane manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

Ensure that the following conditions exist prior to application of the roofing materials:

a. Do not install items that show visual evidence of biological growth.

b. [Drins,a] [curbs,] [control joints,] [expansion joints,] [perimeter walls,] [roof penetrating components,] [and] [equipment supports] are in place.

c. Surfaces are rigid, clean, dry, smooth, and free from cracks, holes, and sharp changes in elevation.

d. The plane of the substrate does not vary more than 6 mm 1/4 inch within an area 3 by 3 meters 10 by 10 feet when checked with a 3 meter 10 foot straight edge placed anywhere on the substrate.

e. Substrate is sloped to provide positive drainage.

f. Walls and vertical surfaces are constructed to receive counterflashing, and will permit mechanical fastening of the base flashing materials.

g. Treated wood nailers are in place on non-nailable surfaces, to permit nailing of base flashing at minimum height of 200 mm 8 inch above finished roofing surface.

****
NOTE: Coordinate with Section 06 10 00 ROUGH CARPENTRY to ensure that preservative treatment is specified for wood which will be in contact with roofing components.
****

h. Pressure-preservative treated wood nailers are fastened in place at eaves, gable ends, openings, and intersections with vertical surfaces for securing of membrane, edging strips, attachment flanges of sheet metal, and roof fixtures. [Embedded nailers are flush with deck surfaces.] [Surface-applied nailers are the same thickness as the roof insulation.]

i. Avoid contact of EPDM materials with fire retardant treated wood, except as approved by the roof membrane manufacturer and Contracting Officer.

****

NOTE: Wood cants should also be used where there are non-wall supported flashings at wood blocking forming area dividers and expansion joints, and at wall and roof intersections where roof deck is not supported on wall.

****

j. Cants are securely fastened in place in the angles formed by walls and other vertical surfaces. The angle of the cant is 45 degrees and the height of the vertical leg is not less than 89 mm 3-1/2 inch.

****

NOTE: Include venting provision for wet fill substrate materials like lightweight cellular concrete.

****

[k. Venting is provided in accordance with the following:

[(1) Edge Venting: Perimeter nailers are kerfed across the width of the nailers to permit escape of gaseous pressure at roof edges.

][(2) Underside Venting: Vent openings are provided in steel form decking for cast-in-place concrete substrate.

][(3) Vapor pressure relief vents: Holes equal to the outside diameter of vents are provided through the insulation where vents are required. Space vents in accordance with membrane manufacturer's recommendations.

]]l. Exposed nail heads in wood substrates are properly set. Warped and split [boards] [sheets] have been replaced. There are no cracks or end joints 6 mm 1/4 inch in width or greater.[Joints in plywood substrates are taped or otherwise sealed to prevent air leakage from the underside.]

][m. Insulation boards are installed smoothly and evenly, and are not broken, cracked, or curled. There are no gaps in insulation board joints exceeding 6 mm 1/4 inch in width. Insulation is being roofed over on the same day the insulation is installed.

]3.2 APPLICATION

****

NOTE: Coordinate application method with paragraphs "Description of Roof Membrane System" and appropriate subparagraph under "EPDM Sheet Roofing".

****

Apply entire EPDM sheet utilizing [fully adhered] [loose-laid ballasted] [mechanically fastened] [combined fully adhered and mechanically fastened] application method[s]. Apply roofing materials as specified herein unless approved otherwise by the Contracting Officer.

3.2.1 Special Precautions

a. Do not dilute coatings or sealants unless specifically recommended by the materials manufacturer's printed application instructions. Do not thin liquid materials with cleaners used for cleaning EPDM sheet.

b. Keep liquids in airtight containers, and keep containers closed except when removing materials.

c. Use liquid components, including adhesives, within their shelf life period. Store adhesives at 15 to 27 degrees C 60 to 80 degrees F prior to use. Avoid excessive adhesive application and adhesive spills, as they can be destructive to some elastomeric sheets and insulations; follow adhesive manufacturer's printed application instructions. Mix and use liquid components in accordance with label directions and manufacturer's printed instructions.

d. Provide clean, dry cloths or pads for applying membrane cleaners and cleaning of membrane

e. Do not use heat guns or open flame to expedite drying of adhesives or primers.

f. Require workmen and others who walk on the membrane to wear clean, soft-soled shoes to avoid damage to roofing materials.

g. Do not use equipment with sharp edges which could puncture the EPDM sheet.

h. Shut down air intakes and any related mechanical systems and seal open vents and air intakes when applying solvent-based materials in the area of the opening or intake. Coordinate shutdowns with the Contracting Officer.

3.2.2 EPDM Sheet Roofing

Provide a watertight roof membrane sheet free of contaminants and defects that might affect serviceability. Provide a uniform, straight, and flat edge. Unroll EPDM sheet roofing in position without stretching membrane. Inspect for holes. Remove sections of EPDM sheet roofing that are damaged. Allow sheets to relax minimum 30 minutes before seaming. Lap sheets as specified, to shed water, and as recommended by the roof membrane manufacturer's published installation instructions for the application required but not less than 75 mm 3 inch in any case.

3.2.3 Application Method

[3.2.3.1 Combined Fully Adhered and Mechanically Fastened Application

****

NOTE: Delete this paragraph unless a combined fully adhered and mechanically fastened application is specified. Where this paragraph is included, include and edit the fully adhered and mechanically

fastened membrane application paragraphs to remove redundancy of requirements.
****

Install combined fully adhered and mechanically fastened roof membrane system in the manner specified and including seaming, perimeter and infield fastening and half sheets.

][3.2.3.2 Fully Adhered Membrane Application

****
NOTE: Delete this paragraph unless a fully adhered or combined fully adhered and mechanically fastened application is specified.

Delete the bracketed option in the fourth sentence and delete the fifth sentence when non-standard adhesives are specified such as sprayed foam or hot asphalt used with fleece-backed membrane.
****

Layout membrane and side lap adjoining sheets in accordance with membrane manufacturer's printed installation instructions. Allow for sufficient membrane to form proper membrane terminations. Remove dusting agents and dirt from membrane and substrate areas where bonding adhesives are to be applied. Apply specified adhesive evenly and continuously to substrate [and underside of sheets] at rates recommended by the roof membrane manufacturer's printed application instructions. When adhesive is spray applied, roll with a paint roller to ensure proper contact and coverage. Do not apply bonding adhesive to surfaces of membrane in seam or lap areas. Allow adhesive to flash off or dry to consistency prescribed by manufacturer before adhering sheets to the substrate. Roll each sheet into adhesive slowly and evenly to avoid wrinkles; broom or roll the membrane to remove air pockets and fishmouths and to ensure full, continuous bonding of sheet to substrate. Form field lap splices or seams as specified. Check all seams and ensure full lap seal. Apply lap sealant to all adhesive formed seams and all cut edges of reinforced membrane materials.

][3.2.3.3 Mechanically Fastened Membrane Application

****
NOTE: Delete this paragraph unless a mechanically fastened or combined fully adhered and mechanically fastened application is specified.

Membrane side lap depends on method of mechanical attachment, wind resistance testing of the specific system provided, and requirements of the membrane manufacturer. Generally, position attachments such that minimum 75 mm 3 inch seam width remains beyond the outer edge of the attachment plate or batten strip. Fastener and plate attachment typically requires 175 mm to 200 mm 7 to 8 inch membrane overlap. Batten attachment typically requires 100 mm to 150 mm 4 to 6 inch membrane overlap.
****

Layout membrane and lap adjoining sheets in accordance with membrane manufacturer's printed instructions such that a minimum 75 mm 3 inch

[_____] seam width is maintained and seam width is as required by tested assembly meeting specified wind resistance requirements. Account for additional overlap required for placement of fasteners and plates or battens beyond the closed seam. Allow for sufficient membrane to form proper membrane terminations. Ensure membrane is free of wrinkles and ridges in the installation. Mechanically secure the membrane sheet with specified fasteners in the lap area. Space fasteners as required to provide the wind uplift resistance specified and in accordance with submitted fastener patterns for the field, corner, and perimeter roof areas. Set fasteners firm to plate or batten. Form field lap splices or seams as specified. Check all seams and ensure full lap seal. Apply lap sealant to all adhesive formed seams and all cut edges of reinforced membrane materials.

][3.2.3.4 Ballasted Membrane Application

****

NOTE: Delete this paragraph unless a loose-laid ballasted application is specified.

****

Layout membrane and side lap adjoining sheets minimum 100 mm 4 inch and according to membrane manufacturer's printed instructions. Allow for sufficient membrane to form proper membrane terminations. Ensure membrane is free of wrinkles and ridges in the installation. Form field lap splices or seams as specified and of width required by the membrane manufacturer's installation instructions. Check seams to ensure continuous seal before proceeding with further work. Apply continuous lap sealant to all adhesive formed seams and all cut edges of reinforced membrane materials.

]3.2.4 Tape Seams / Lap Splices

****

NOTE: Seam tape must be the primary seaming, or lap splice, technique. Only specify adhesive seaming in the field of the roof with Government approval. Adhesive seaming of flashing in limited areas may be required where tapes are difficult to apply.

****

Field form seams, or lap splices, with seam tape in accordance with membrane manufacturer's printed instructions and as specified. Clean and prime mating surfaces in the seam area. After primer has dried or set in accordance with membrane manufacturer's instructions, apply seam tape to bottom membrane and roll with a 75 mm to 100 mm 3 inch to 4 inch wide smooth silicone or steel hand roller, or other manufacturer approved rolling device, to ensure full contact and adhesion of tape to bottom membrane. Tape end laps must be minimum 25 mm 1 inch. Roll top membrane into position to check for proper overlap and alignment. Remove release paper from top of seam tape and form seam splice. Ensure top membrane contact with seam tape as release paper is removed. Roll the closed seam with a smooth silicone or steel hand roller, rolling first across the width of the seam then along the entire length, being careful not to damage the membrane. Apply minimum 225 mm 9 inch long strip of membrane-backed flashing tape over T-intersections of roof membrane. Roll tape to ensure full adhesion and seal over T-joint.

[3.2.5 Adhesive Seams / Lap Splices

****

NOTE: Include the bracketed option in the first sentence as the norm. Government approval required for adhesive formed seams in the field of the roof.

****

Use only field-applied adhesive formed seams [in flashing areas] where approved by the membrane manufacturer and the Contracting Officer. Do not use adhesive formed seams for field of roof membrane seaming[, except as approved by the membrane manufacturer and the Contracting Officer]. Thoroughly and completely clean mating surfaces of materials throughout the lap area. Remove all dirt, dust, and contaminants and allow to dry.

Apply primer as recommended by the membrane manufacturer. Apply splice adhesive with a 75 mm to 100 mm 3 inch to 4 inch wide, 13 mm 1/2 inch thick, solvent-resistant brush in a smooth, even coat with long brush strokes. Bleed out brush marks. Do not apply adhesive in a circular motion. Simultaneously apply adhesive to both mating surfaces in an approximate 0.63 mm to 0.75 mm 0.025 to 0.030 inch wet film thickness, or other thickness as recommended by the roof membrane manufacturer's printed instructions.

Allow the splice adhesive to set-up in accordance with membrane manufacturer's printed instructions. Perform manufacturer recommended field check to test for adhesive readiness prior to closing seam. Apply a 3 mm to 6 mm 1/8 inch to 1/4 inch bead of in-seam sealant approximately 13 mm 1/2 inch from the inside edge of the lower membrane sheet prior to closing the seam. Ensure the in-seam sealant does not extend onto the splice adhesive. Maintain the full adhered seam width required. Roll the top membrane onto the mating surface. Roll the seam area with a 50 mm to 75 mm 2 inch to 3 inch wide, smooth silicone or steel hand roller. A minimum of 2 hours after joining sheets and when the lap edge is dry, clean the lap edge with membrane manufacturer's recommended cleaner and apply a 6mm to 9 mm 1/4 inch to 3/8 inch bead of lap sealant centered on the seam edge. With a feathering tool, immediately feather the lap sealant to completely cover the splice edge, leaving a mound of sealant over the seam edge. Apply lap sealant to all adhesive formed seams.

]3.2.6 Perimeter Attachment

****

NOTE: All application methods of EPDM membranes require mechanical fastening of the membrane to wood nailers at the roof perimeters, at angular penetrations, or at circular penetrations, except roof drains greater than 457 mm 18 inch in diameter.

****

Adhesive bond or mechanically secure roof membrane sheet at roof perimeter in a manner to comply with wind resistance requirements and in accordance with membrane manufacturer's printed application instructions. When adhesively bonding a mechanically fastened system in perimeter areas, the perimeter boundary of the adhesive bond must be the same as the boundary required for additional perimeter mechanical fastening to meet wind resistance requirements.

3.2.7 Securement at Base Tie-In Conditions

Mechanically fasten the roof membrane at penetrations, at base of curbs and walls, and at all locations where the membrane turns and angle greater than 4 degrees (1:12). Space fasteners a maximum of 300 mm 12 inch on center, except where more frequent attachment is required to meet specified wind resistance or where recommended by the roof membrane manufacturer. Flash over fasteners with a fully adhered layer of material as recommended by the roof membrane manufacturer's printed data.

3.3 FLASHINGS

3.3.1 General

Provide flashings in the angles formed at walls and other vertical surfaces and where required to make the work watertight, except where metal flashings are indicated.

Provide a one-ply flashing membrane, as specified for the system used, and install immediately after the roofing membrane is placed and prior to finish coating where a finish coating is required. Flashings must be stepped where vertical surfaces abut sloped roof surfaces. Provide sheet metal reglet in which sheet metal cap flashings are installed of not more than 400 mm 16 inch nor less than 200 mm 8 inch above the roofing surfaces. Exposed joints and end laps of flashing membrane must be made and sealed in the manner required for roofing membrane.

3.3.2 Membrane Flashing

****

NOTE: Coordinate flashing requirements with Section 07 60 00 FLASHING AND SHEET METAL and details. Ensure Section 07 60 00 FLASHING AND SHEET METAL is properly edited for application to EPDM roofing systems and for inclusion of flashing conditions of the project.

****

Install flashing and flashing accessories as the roof membrane is installed. Apply flashing to cleaned surfaces and as recommended by the roof membrane manufacturer and as specified. Utilize cured EPDM membrane flashing and prefabricated accessory flashings to the maximum extent recommended by the roof membrane manufacturer. Limit uncured flashing material to reinforcing inside and outside corners and angle changes in plane of membrane, and to flashing scuppers, pourable sealer pockets, and other formed penetrations or unusually shaped conditions as recommended by the roof membrane manufacturer where the use of cured material is impractical. Extend base flashing not less than 200 mm 8 inch above roofing surface and as necessary to provide for seaming overlap on roof membrane as recommended by the roof membrane manufacturer.

Seal flashing membrane for a minimum of 75 mm 3 inch on each side of fastening device used to anchor roof membrane to nailers. Completely adhere flashing sheets in place. Seam flashing membrane in the same manner as roof membrane, except as otherwise recommended by the membrane manufacturer's printed instructions and approved by the Contracting Officer. Reinforce all corners and angle transitions by applying uncured membrane to the area in accordance with roof membrane manufacturer recommendations. Mechanically fasten top edge of base flashing with manufacturer recommended termination bar fastened at maximum 300 mm 12 inch on center. Install sheet metal flashing over the termination bar in the completed work. Mechanically fasten top edge of base flashing for all other terminations in a manner recommended by the roof membrane manufacturer. Apply membrane liner over top of exposed nailers and blocking and to overlap top edge of base flashing installation at curbs, parapet walls, expansion joints and as otherwise indicated to serve as waterproof lining under sheet metal flashing components.

[3.3.3 Flashing at Roof Drain

****

NOTE: Include this paragraph when roof drains are indicated.

****

Provide a tapered insulation sump into the drain bowl area. Do not exceed tapered slope of (4:12) 18 degrees for unreinforced membrane and (1:12) 5 degrees for reinforced membrane. Provide tapered insulation with surface suitable for adhering membrane in the drain sump area. Avoid field seams running through or within 600 mm 24 inch of roof drain, or as otherwise recommended by the roof membrane manufacturer. Adhere the membrane to the tapered in the drain sump area. Apply water block mastic and extend membrane sheets over edge of drain bowl opening at the roof drain deck flange in accordance with membrane manufacturer's printed application instructions. Ensure membrane is free of wrinkles and folds in the drain area. Securely clamp membrane in the flashing clamping ring. Ensure membrane is cut to within 20 mm 3/4 inch of inside rim of clamping ring to maintain drainage capacity. Do not cut back to bolt holes. Retrofit roof drains must conform to ANSI/SPRI RD-1.

]3.3.4 PRE-FABRICATED CURBS

Securely anchor prefabricated curbs to nailer or other base substrate and flashed with EPDM membrane flashing materials.

3.3.5 Set-On Accessories

Where pipe or conduit blocking, supports and similar roof accessories, or isolated paver block, are set on the membrane, adhere reinforced membrane or walkpad material, as recommended by the roof membrane manufacturer, to bottom of accessories prior to setting on roofing membrane. Install set-on accessories to permit normal movement due to expansion, contraction, vibration, and similar occurrences without damaging roofing membrane. Do not mechanically secure set-on accessories through roofing membrane into roof deck substrate.

3.3.6 Lightning Protection

Flash lightning protection system components or attach to the roof membrane in a manner acceptable to the roof membrane manufacturer.

[3.4 ROOF WALKPADS

Install walkpads at roof access points and where otherwise indicated for traffic areas and for access to mechanical equipment, in accordance with the roof membrane manufacturer's printed instructions. Provide minimum 150 mm 6 inch separation between adjacent walkpads to accommodate drainage.

3.4.1 Elevated Metal [Walkways] [and] [Platforms]

Provide for protection of roof membrane by placing reinforced membrane or walkpad material, or other material approved by the Contracting Officer, at all surface bearing support locations.

3.4.2 Isolated Paver Blocks

Install paver blocks where indicated and as necessary to support surface bearing items traversing the roof area. Set paver block on a layer of reinforced membrane or walkpad applied over the completed roof membrane.

3.4.3 [Stone][Paver] Ballast [Paver System]

****

NOTE: Indicate the appropriate ballast type. Indicate ballast weight required based on wind loading conditions. In some instances paver ballast may be used in perimeter and corner areas in combination with stone ballast in the field of the roof. If so, include the [Paver] option in item "a". Where elevated paver system is required, refer to as "Paver System" in the paragraph title. Delete bracketed options related to protection mat installation, stone ballast, and coverage rates. The paver type and weight must be as specified in Part 2.

****

Complete all membrane and membrane flashing work, including inspection and repair of all membrane and seams in the area of [ballast][paver] application prior to applying [ballast][paver] system. [Install protection mat over roof membrane in accordance with roof membrane manufacturer's recommendations. Provide minimum 75 mm 3 inch side laps and 150 mm 6 inch end laps. Turn mat up vertical surfaces to extend 50 mm 2 inch above ballast. Immediately after placement of protection mat,][Install and level pedestal system in accordance with manufacturer's requirements and] apply [stone][and][paver] [ballast][system.] [at the following coverage rates:

a. [Pavers:] [_____] kg per square meter pounds per square foot for perimeter and corner areas of roof.

b. [_____] kg per square meter pounds per square foot for field of roof.

In no case apply ballast at a coverage rate less than 49 kg per square meter 10 pounds per square foot or more than [_____] kg per square meter pounds per square foot.]

]3.5 CORRECTION OF DEFICIENCIES

Where any form of deficiency is found, take additional measures as deemed necessary by the Contracting Officer to determine the extent of the deficiency and perform corrective actions as directed by the Contracting Officer.

3.6 CLEAN UP

Remove debris, scraps, containers and other rubbish and trash resulting from installation of the roofing system from job site each day.

3.7 PROTECTION OF APPLIED ROOFING

At the end of the day's work and when precipitation is imminent, protect applied membrane roofing system from water intrusion.

[3.7.1 Water Cutoffs

****

NOTE: Include this paragraph when roof insulation is a substrate for the EPDM sheet roofing.

****

Straighten insulation line using loose-laid cut insulation sheets and seal the terminated edge of the roof membrane system in an effective manner. [Seal off flutes in metal decking along the cutoff edge.] Remove the water cut-offs to expose the insulation when resuming work, and remove the insulation sheets used for fill-in.

]3.7.2 Temporary Flashing for Permanent Roofing

Provide temporary flashing at drains, curbs, walls and other penetrations and terminations of roofing sheets until permanent flashings can be applied. Remove temporary flashing before applying permanent flashing.

3.7.3 Temporary Walkways, Runways, and Platforms

Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards, mats or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to live load limits of roof construction. Use rubber-tired equipment for roofing work.

3.8 FIELD QUALITY CONTROL

3.8.1 Construction Monitoring

During progress of the roof work, Contractor must make visual inspections as necessary to ensure compliance with specified parameters. Additionally, verify the following:

a. Equipment is in working order. Metering devices are accurate.

b. Materials are not installed in adverse weather conditions.

c. Substrates are in acceptable condition, in compliance with specification, prior to application of subsequent materials.

    (1) Nailers and blocking are provided where and as needed.

    (2) Insulation substrate is smooth, properly secured to its substrate, and without excessive gaps prior to membrane application.

    (3) The proper number, type, and spacing of fasteners are installed.

    Materials comply with the specified requirements.

    (4) All materials are properly stored, handled and protected from

moisture or other damages. Liquid components are properly mixed prior to application.

(5) Membrane is allowed to relax prior to seaming. Adhesives are applied uniformly to both mating surfaces and checked for proper set prior to bonding mating materials. Mechanical attachments are spaced as required[, including additional fastening of membrane in corner and perimeter areas as required.]

(6) Membrane is properly overlapped.

(7) Membrane seaming is as specified and seams are hand rolled to ensure full adhesion and bond width. [In-seam sealant is applied when adhesive seams are used in the field of the roof.] All seams are checked at the end of each work day.

(8) Applied membrane is inspected and repaired as necessary prior to ballast installation.

[(9) Membrane is fully adhered without ridges, wrinkles, kinks, fishmouths.

] (10) Installer adheres to specified and detailed application parameters.

(11) Associated flashings and sheet metal are installed in a timely manner in accord with the specified requirements.

(12) Ballast is within the specified weight range.

(13) Temporary protection measures are in place at the end of each work shift.

[3.8.2 Manufacturer's Inspection

****

NOTE: Include this paragraph when manufacturer's inspection of work is required. Select desired frequency of manufacturer inspection and coordinate with text of optional 2nd and 3rd bracketed sentences.

****

Manufacturer's technical representative must visit the site a minimum of three [_____] times [once per week] during the installation for purposes of reviewing materials installation practices and adequacy of work in place. [Inspections must occur during the first 20 squares of membrane installation, at mid-point of the installation, and at substantial completion, at a minimum. Do not exceed additional inspections one for each 100 squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer.] After each inspection, submit a report signed by the manufacturer's technical representative to the Contracting Officer within 3 working days. Note overall quality of work, deficiencies and any other concerns, and recommended corrective action.

][3.8.3 Roof Drain Test

****

NOTE: Include this paragraph when roof drains are required. Consult with structural engineer to verify loading capability of roof structural system.
****

After completing roofing but prior to Government acceptance, perform the following test for watertightness. Plug roof drains and fill with water to edge of drain sump for 8 hours. Retrofit roof drains must conform to ANSI/SPRI RD-1. Do not plug secondary overflow drains at the same time as adjacent primary drain. To ensure some drainage from roof, do not test all drains at same time. Measure water at beginning and end of the test period. When precipitation occurs during test period, repeat test. When water level falls, remove water, thoroughly dry, and inspect installation; repair or replace roofing at drain to provide for a properly installed watertight flashing seal. Repeat test until there is no water leakage.

]3.9 INSTRUCTIONS TO GOVERNMENT PERSONNEL

Furnish written and verbal instructions on proper maintenance procedures to designated Government personnel. Furnish instructions by a competent representative of the roof membrane manufacturer and include a minimum of 4 hours on maintenance and emergency repair of the membrane. Include a demonstration of membrane repair, and give sources of required special tools. Furnish information on safety requirements during maintenance and emergency repair operations.

3.10 INFORMATION CARD

For each roof, furnish a typewritten information card for facility records anda photoengraved 1 mm 0.032 inch thick aluminum card for exterior display. Card must be 215 mm by 275 mm 8-1/2 by 11 inch minimum, identifying facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, membrane, number of plies, method of application, manufacturer, insulation and cover board system and thickness; presence of tapered insulation for primary drainage, presence of vapor retarder; date of completion; installing contractor identification and contact information; membrane manufacturer warranty expiration, warranty reference number, and contact information. Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 54 19 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-07 54 19 (February 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-07 54 19 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-07 54 19 (February 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 54 19

POLYVINYL-CHLORIDE ROOFING
08/23

****

NOTE: This guide specification covers the requirements for reinforced polyvinyl chloride roofing membrane on both existing and new roof systems with slopes from 6 mm to 76 mm 1/4 inch to 3 inches per foot.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification is intended for both new construction and reroofing installations. This guide specification is also applicable for use with a supplemental, chemical/grease-resistant PVC membrane for roof areas in need of additional roof protection such as adjacent to kitchen or food service exhaust system discharge ducts; consult PVC membrane roof system manufacturer for this application. Supplemental grease, chemical and oil-resistant PVC roofing membranes are available.

Coordinate this section with other roof system components specifications such as rough carpentry, insulation and sheet metal flashing. Also coordinate this section with the criteria contained in UFC 3-110-03 Roofing, as it relates to the specific project and Service Exceptions indicated therein.

PVC membrane roofing should not be adhered directly to polystyrene, perlite or standard wood fiber insulation. The compatibility of the system must be verified by the membrane manufacturer. Glass mat and moisture resistant gypsum roof board can be used as an overlayment above and in conjunction with the roof system insulation to impart improved wind, impact, and hail resistance.

Do not use reinforced PVC membrane roofing in direct physical contact with asphalt, coal tar pitches, nor petroleum-based products. For additional guidance on PVC roofing membrane and material compatibility, consult with the PVC roofing membrane manufacturer.

NOTE: PVC roofing materials in high humidity locations are susceptible to fungal and biological growth. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Consider other roofing materials where the avoidance of fungal and biological growth is critical.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.24	(2022) Roofing - Safety Requirements for Low-Sloped Roofs

ASTM INTERNATIONAL (ASTM)

ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4434/D4434M	(2015) Standard Specification for Poly(Vinyl Chloride) Sheet Roofing
ASTM D6754/D6754M	(2010) Standard Specification for Ketone Ethylene Ester Based Sheet Roofing
ASTM E108	(2024) Standard Test Methods for Fire Tests of Roof Coverings
ASTM E1980	(2011; R 2019) Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces

COOL ROOF RATING COUNCIL (CRRC)

ANSI/CRRC S100	(2016) Standard Test Methods for Determining Radiative Properties of Materials

FM GLOBAL (FM)

FM 4470	(2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 3621	(2017) Quality Control and Quality-assurance Guidelines for the Application of Membrane Roof Systems
NRCA 3740	(2005) The NRCA Waterproofing Manual

NRCA 3906	(2018) NRCA Guidelines for Rooftop-mounted Photovoltaic Systems

SINGLE PLY ROOFING INDUSTRY (SPRI)

ANSI/SPRI RD-1	(2019) Performance Standard for Retrofit Drains
ANSI/SPRI/FM 4435/ES-1	(2017) Test Standard for Edge Systems Used with Low Slope Roofing Systems

UL SOLUTIONS (UL)

UL 790	(2022) UL Standard for Safety Test Methods for Fire Tests of Roof Coverings

1.2 SUMMARY

****

NOTE: Coordinate with PART 2, select the application method required and delete other options.

Where PVC membrane roofing is utilized, in either adhered, mechanically fastened, combination adhered/protected membrane and paver ballasted system configurations, the preferred norm is to attach the PVC membrane roof over a minimum, two layer assembly of rigid board roof insulation (this norm does not apply to IRMA or garden-style roofs). Additionally, adhered and mechanically fastened PVC membrane roofing systems must utilize reinforced membrane, always. Exception to use of reinforced PVC membrane is given only for specialized, pre-fabricated PVC roof system detail flashings (not deck sheet) that are supplied, warranted and recommended in the printed instructions published by the specified PVC membrane roof system manufacturer.

Do not use stone or gravel ballast on any PVC membrane roofing system.

Adhered and mechanically fastened systems are preferred along flight lines, in wind zones exceeding 160 km/h 100 mph, within 8 km 5 miles of coastline, within 457 m 1500 feet of an open body of water, and on or adjacent to critical facilities such as hospitals; but a combination adhered/protected membrane system utilizing paver ballast can be specified using interlocking pavers designed to both protect the underlying PVC membrane from airborne projectiles and to help provide the required wind load resistance established by local building code and designer preference.

Only specify combination adhered/protected roof membrane attachment for isolated geographic locations that experience extreme and extended wind conditions such as portions of Alaska, Iceland, Florida and the Gulf coast, or as otherwise required

by the Government. Other mechanically fastened or adhered PVC membrane roof system installation configurations are also accommodative to such excessive wind loading conditions.

Where an air barrier is required, apply at the deck level or within the insulation sandwich. Air barriers are specified in Section 07 22 00 ROOF AND DECK INSULATION.

Where one membrane system configuration is required for all roof areas, use the first paragraph. Where different system configurations are required, use the second paragraph successively and replace the open brackets with a description of the substrate(s) or area of the building or project where each system is to be applied.

****

[Adhered] [Mechanically fastened] [Combination adhered] polyvinyl-chloride (PVC) roof membrane system applied over [insulation] [recovery board] [concrete roof deck] [PVC membrane roofing manufacturer-accepted] substrate. [Incorporate air barrier in the roof assembly as specified in Section 07 22 00 ROOF AND DECK INSULATION.]

1.3 ASSEMBLY REQUIREMENTS

****

NOTE: For guidance on flashings and drainage details, the designer should consult the SMACNA "Architectural Sheet Metal Manual."

****

Provide roofing membrane sheet widths consistent with membrane attachment methods and wind uplift requirements, and as large as practical. In order to minimize joints and 3-way overlaps, prefabricated sheets are not accepted. Provide membrane which is free of defects and foreign material. Coordinate flashing work to permit continuous roof-surfacing operations. Install insulation and weatherproofed planned sections on the same day.

1.3.1 Fire Resistance

Complete roof system assembly:

****

NOTE: Specify Class B option only when Class A may not be attainable such as membrane system application directly to wood deck. Provide justification/rationale for Class B option with design submission

****

a. Class A [or B] rated in accordance with ASTM E108, FM 4470, or UL 790; and

b. Be listed as Class I roof deck construction in FM APP GUIDE.

FM or UL approved components of the roof covering assembly must bear the appropriate FM or UL label.

1.3.2 Wind Uplift Resistance

****

NOTE: Determine the required wind uplift resistance based on ASCE 7-22 wind loading calculations or applicable building code requirements.

The specified FM rating incorporates a safety factor of 2 over the maximum calculated uplift pressure. Therefore, a FM rating of 1-90 correlates to a maximum uplift calculation of 2.2 kPa 45 psf. When a rated system is specified, ensure the specified roof system is capable of meeting the wind uplift resistance specified. Where non-rated systems may be permissible, include the bracketed option.

Delineate calculated values in the roof specification or drawings. Utilize independently tested and rated roof systems, such as Factory Mutual (FM), Underwriters Laboratory (UL), and Single Ply Roofing Industry (SPRI).

****

Provide a complete roof system assembly that is rated and installed to resist wind loads [indicated][calculated in accordance with ASCE 7-22] and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Do not install non-rated systems, except as approved by the Contracting Officer. Submit Engineering calculations, signed, sealed, and dated by a Registered Engineer validating the wind resistance in accordance with ASCE 7-22, and ANSI/SPRI/FM 4435/ES-1 of non-rated roof system. Base wind uplift measurements on a design wind speed of [_____] km/h mph in accordance with ASCE 7-22 and other applicable building code requirements.

1.3.3 Solar Reflectance Index (SRI)

****

NOTE: Compliance with ASHRAE 90.1 is required on all projects. For ASHRAE 90.1 compliance, include the first bracketed sentences for projects in ASHRAE climate zones 0 thru 3. See ASHRAE 90.1 Chapter 5, section titled "Roof Solar Reflectance and Thermal Emittance", for exceptions when roof design conditions eliminate these requirements and this section can be deleted. When a designer desires IgCC compliance with cool roof requirements, include the second set of bracketed sentences for projects in ASHRAE climate zones 0 thru 3. See IgCC Chapter 5 for exceptions when design conditions eliminate these requirements.

****

SRI measures the roof's ability to reject solar heat, defined such that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. [Provide roof finishes for more than 75 percent of the roof surface having a minimum 3-year aged solar reflectance of 0.55, and a minimum 3-year aged thermal emittance of 0.75 when tested in accordance with ANSI/CRRC S100, or, a minimum 3-year aged

Solar Reflectance Index of 64 when determined in accordance with the Solar Reflectance Index method in ASTM E1980 using a convection coefficient of 6.62 W per m^2 2.1 BTU per h ft^2.] [Use roofing materials having minimum 3-year aged SRI for more than 75 percent of roof surface (less than or equal to 2:12 slope, SRI greater than 64; greater than 2:12 slope, SRI greater than 25).] SRI values are based on a minimum three-year aged solar reflectance and thermal emittance, as measured in accordance with ANSI/CRRC S100.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Roof Plan; G, [_____]

SD-03 Product Data

PVC Roofing Membrane; G, [_____]

[Heat Island Reduction; S]

Bonding Adhesive

Flashing

Membrane Fasteners and Plates

Roof Insulation

Protection Mat

Pre-Manufactured Accessories

Water Cutoffs

Information Card

SD-05 Design Data

****
NOTE: Coordinate with requirements of Wind Uplift Resistance paragraph. Include bracketed requirement where non-rated systems may be permissible.
****

Wind Uplift Resistance; G, [_____]

SD-07 Certificates

Qualification of Manufacturer

Qualifications of Applicator

Fire Resistance classification

Minimum Polymer Thickness

Sample Warranty; G, [_____]

SD-08 Manufacturer's Instructions

Application Method; G, [_____]

Membrane Flashing; G, [_____]

Perimeter and High Wind Attachment

Auxiliary Fasteners

Pre-Manufactured Accessories

Cold Weather; G, [_____]

SD-11 Closeout Submittals

Warranty; G, [_____]

Information Card; G, [_____]

Instructions to Government Personnel; G, [_____]

1.5 QUALITY ASSURANCE

****

NOTE: All projects with more than 1400 square meters 15,000 square feet of roof area or that is defined as critical use or mission critical in the project DD Form 1391 must have a Registered Roof Consultant (RRC) or a registered professional engineer (PE) or registered architect (RA) that derives his or her principal income from roofing design on the quality control staff of the design team.

****

1.5.1 Qualification of Manufacturer

****

NOTE: Specify minimum five years manufacturer experience unless directed otherwise.

****

Polyvinyl-Chloride sheet roofing system manufacturer must have a minimum of [5] [10] [___] years experience in manufacturing PVC roofing products.

1.5.2 Qualifications of Applicator

****

NOTE: Specify minimum five years as an approved Contractor unless directed otherwise

****

Roofing system applicator must be approved, authorized, or licensed in writing by the PVC sheet roofing system manufacturer and have a minimum of [five][_____] years experience as an approved, authorized, or licensed applicator with that manufacturer and be approved at a level capable of providing the specified warranty. Supply the names, locations and client contact information of five projects, within the previous three years, of similar size and scope that the applicator has constructed using the manufacturer's roofing products submitted for this project.

1.5.3 Conformance and Compatibility

Provide an entire roofing and flashing system that is in accordance with specified and indicated requirements, including fire and wind resistance.

1.5.4 Preroofing Conference

After approval of submittals and before performing roofing [and insulation] system installation work, hold a preroofing conference to review the following:

****

NOTE: Delete the following bracketed statement if

the roof work is for a new structure.
****

a. Drawings, including roof plan, specifications and submittals related to the roof work. [Field inspection and verification of existing conditions, including fire safety issues, existing structure, and existing materials, including concealed combustibles, which may require additional protection during installation.]

b. Roof system components installation;

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, and roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representative to roof manufacturer;

d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing; and

e. Quality control(NRCA 3621) plan for the roof system installation;

f. Safety requirements.

Coordinate preroofing conference scheduling with the Contracting Officer. The conference must be attended by the Contractor, the Contracting Officer's designated personnel, personnel directly responsible for the installation of roofing[and insulation], flashing and sheet metal work, [[mechanical] [and] [electrical] work], other trades interfacing with the roof work, designated safety personnel trained to enforce and copy with ASSP A10.24,[Fire Marshall,] and a representative of the roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.6 DETAIL DRAWINGS

Submit roof plan depicting wind loads and boundaries of enhanced perimeter and corner attachments of roof system components, [location of perimeter half-sheets] [, spacing of perimeter, corner, and infield fasteners,] as applicable. Provide drawings that reflect the project roof plan of each roof level and conditions indicated. Submit bids with approved detail drawings and specifications approved and furnished by the PVC membrane manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Delivery

Deliver materials in the manufacturer's original, unopened containers and rolls with labels intact and legible. Mark and remove wet or damaged materials from the site. Where materials are covered by a referenced specification number, the container must bear the specification number, type, class, and shelf life expiration date where applicable. Deliver materials in sufficient quantity to allow work to proceed without interruption.

1.7.2 Storage

Protect materials against moisture absorption and contamination or other damage. Avoid crushing or crinkling of roll materials. Store roll materials on end on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer. Do not store roll materials in buildings under construction until concrete, mortar, and plaster work is finished and dry. Maintain roll materials at temperatures above 10 degrees C 50 degrees F for 24 hours immediately before application. Do not store materials outdoors unless approved by the Contracting Officer. Completely cover felts stored outdoors, on and off roof, with waterproof canvas protective covering. Do not use polyethylene sheet as a covering. Tie covering securely to pallets to make completely weatherproof. Provide sufficient ventilation to prevent condensation. Do not store more materials on roof than can be installed the same day and remove unused materials at end of each days work. Distribute materials temporarily stored on roof to stay within live load limits of the roof construction.

a. Maintain a minimum distance of 10.67 meters 35 foot for stored flammable materials, including materials covered with shrink wraps, craft paper or tarps from torch/welding applications.

b. Immediately remove wet, contaminated or otherwise damaged or unsuitable materials from the site. Damaged materials may be marked by the Contracting Officer.

1.7.3 Handling

Prevent damage to edges and ends of roll materials. Do not install damaged materials in the work. Select and operate material handling equipment to prevent damage to materials or applied roofing.

1.8 ENVIRONMENTAL REQUIREMENTS

Do not install roofing system when air temperature is below 4.5 degrees C 40 degrees F, during any form of precipitation, including fog, or when there is ice, frost, moisture, or any other visible dampness on the roof deck. Follow manufacturer's printed instructions for Cold Weather Installation.

1.9 SEQUENCING

Coordinate the work with other trades to ensure that components which are to be secured to or stripped into the roofing system are available and that permanent flashing and counterflashing in accordance with NRCA 3740, are installed as the work progresses. Ensure temporary protection measures are in place to preclude moisture intrusion or damage to installed materials. [Apply roofing immediately following application of insulation as a continuous operation. Coordinate roofing operations with insulation work so that roof insulation applied each day is covered with roof membrane installation the same day.]

1.10 WARRANTY

Provide roof system material and workmanship warranties. Provide revision or amendment to standard membrane manufacturer warranty as required to comply with the specified requirements. Provide a manufacturer's warranty that has no dollar limit, covers full system water-tightness, and has a minimum duration of 20 years. Submit sample certificate.

1.10.1 Roof Membrane Manufacturer Warranty

****

NOTE: Insulated and routinely occupied facilities or facilities containing sensitive equipment or operations require a warranty of not less than 15 years. Designer may specify a 5 or 10 year manufacturer warranty on facilities of small roof area and of minor importance where interiors and contents are not severely impacted by potential water intrusion. Require minimum 10 year warranty on environmentally controlled interiors regardless of small size.

****

Furnish the roof membrane manufacturer's 20-year, no dollar limit roof system materials and installation workmanship warranty, including flashing, insulation, and accessories included in Section 07 60 00 FLASHING AND SHEET METAL. Provide warranty directly to the Government commencing at the time of Government's acceptance of the building. The warranty must state that:

a. If within the warranty period the roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, splits, tears, cracks, delaminates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the roof system assembly and correction of defective workmanship are the responsibility of the roof membrane manufacturer. All costs associated with the repair or replacement work are the responsibility of the roof membrane manufacturer.

b. When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others does not void the warranty.

1.10.2 Roofing System Installer Warranty

The roof system installer must warrant for a minimum period of two years that the roof system, as installed, is free from defects in installation workmanship, to include the roof membrane, flashing, insulation, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Write the warranty directly to the Government. The roof system installer is responsible for correction of defective workmanship and replacement of damaged or affected materials. The roof system installer is responsible for all costs associated with the repair or replacement work.

1.10.3 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty period must be approved, as required, and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the manufacturer warranty for the remainder of the manufacturer warranty period.

PART 2 PRODUCTS

2.1 MATERIALS

Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Protect materials provided from defects and make suitable for the service and climatic conditions of the installation.

****

NOTE: Edit the product data submission requirements as necessary for the PVC membrane roof system specified. Include bracketed requirements as applicable to the system being specified.

****

2.1.1 PVC Roof Membrane

Provide a minimum polymer thickness 2.03 mm 0.08 inch reinforced PVC as specified herein. Provide PVC system capable of obtaining 20 year warranties and as listed in the applicable wind uplift and fire rating classification listings.

Submit Data as required by Section 07 22 00 ROOF AND DECK INSULATION together with requirements of this section. Provide data that includes written acceptance by the roof membrane manufacturer of the insulation and other products and accessories to be provided by and warranted under the full system guarantee of the roof membrane manufacturer.

a. Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Provide materials free of defects and suitable for the service and climatic conditions of the installation. Provide warranted roof system in which all components are sourced from the PVC roof membrane manufacturer, including but not limited to all insulation, coverboards, accessories, adhesives and edge metal.

b. For each roof, furnish a typewritten information card for facility records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved 1 mm 0.032 inch thick aluminum card for exterior display. Provide card that is 215 by 275 mm 8 1/2 by 11 inches minimum. On the information card identify facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, membrane, number of plies, method of application, manufacturer, insulation and cover board system and thickness; presence of tapered insulation for primary drainage, presence of vapor retarder; date of completion; installing Contractor identification and contact information; membrane manufacturer warranty expiration, warranty reference number, and contact information. Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

2.1.2 Energy [and Cool Roof] Performance

****

NOTE: Standards such as UFC 1-200-02 promote the use of cool roofing, and increased energy conservation through additional insulation. Design

cool roofs following the requirements in UFC 3-110-03 "Roofing" Chapter 1, Cool Roofs. Design insulation for cool roofs to meet at a minimum the ASHRAE 90.1 Chapter 5 zone requirements. Consider that when cool roofing is used with insulation R values greater than 24, the 'cool roof' surface has little if no influence on the energy performance of the building. Additionally, designers should be aware of the possible negative impacts of using cool roofing that may result in unintended consequences. Design mechanically-fastened single-ply roof systems following the requirements in UFC 3-110-03 Roofing, Chapter 2. Condensation on the underside of mechanically-fastened systems can result in ice build-up in winter, mold growth on the facers, moisture dripping into the interior, and replacement of the roofs with less than four years of service. See Appendix B of UFC 3-110-03 for more information. Poor design of cool roofs in ASHRAE climate zones 4 and higher have resulted in the unintended consequence of condensation below the membrane-a result of the material's inability to warm and drive moisture downward. Roofs that experience this condensation have had to be replaced. Other unintended consequences include the overheating of masonry walls, interior spaces, roof top piping and mechanical equipment as a result of the reflected UV rays.

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NOTE: If a cool roof is selected, meet the ASHRAE 90.1 Chapter 5 values for roof insulation, roof solar reflectance and thermal emittance. If a cool roof is not selected in zones 1-3, meet one of the exception requirements listed in ASHRAE 90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Retain the last bracketed sentence for project with sustainable third party certification credit requirement for reduced heat island effect.

****

Install a roof system that meets an overall performance as specified on the drawings or by insulation specified in other sections. [The roofing system must meet the criteria for Cool Roof Products. [Provide emittance and reflectance percentages, solar reflectance index values, [and] slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]]

2.1.3 Bonding Adhesive

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NOTE: Bonding adhesive is used for adhering PVC membrane to materials other than PVC.

Coordinate work restrictions when working on occupied buildings. For these instances, write in a

description of the adhesive required. Consider peel and stick adhesion of PVC membranes in these instances.

****

Provide PVC membrane manufacturer's recommended adhesive, as supplied by roof membrane manufacturer, and recommended by the manufacturer's printed data for bonding of PVC membrane materials to acceptable insulation, wood, metal, concrete or other acceptable substrate materials. Do not use bonding adhesive to bond membrane materials to each other.

2.1.4 Water Cutoff Mastic/Water Block

As supplied by the roof membrane manufacturer and recommended by the manufacturer's printed data.

2.1.5 Membrane Flashing

Provide membrane flashing, including self-adhering membrane flashing, perimeter flashing, flashing around roof penetrations and prefabricated pipe seals, of a minimum polymer thickness 1.8 mm 0.072 inch reinforced PVC for 20 year warranties, and utilized as recommended and supplied by the roof membrane manufacturer or minimum 1.8 mm 0.072 inch thick reinforced PVC roof membrane and flashings for 20 year warranties. Submit certification from PVC membrane manufacturer that the proposed PVC membrane roofing product meets the minimum polymer thickness specified.

2.1.6 Membrane Fasteners and Plates

Coated, corrosion-resistant fasteners as recommended and supplied by the PVC roof membrane manufacturer and meeting the requirements of FM 4470 and FM RoofNav (www. roofnav.com) or FM APP GUIDE for Class I roof deck construction and the wind uplift resistance specified. Fasteners and plates to be supplied and warranted for the substrate type(s) by PVC membrane manufacturer and recommended by PVC membrane manufacturer's printed data.

2.1.6.1 Stress Plates, Bar or Rail for Fasteners

Utilize corrosion-resistant stress plates as recommended by the roof membrane manufacturer's printed instructions and meeting the requirements of FM 4470. Stress plates to be supplied by PVC roof membrane manufacturer. Form stress plates to prevent dishing or cupping. Manufacturer-supplied anchoring bar or rails may be utilized for high wind conditions.

2.1.6.2 Auxiliary Fasteners

Provide corrosion resistant screws, nails, or anchors suitable for intended attachment purpose and be recommended and supplied for use by the PVC roof membrane manufacturer.

[2.1.7 Protection Mat

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NOTE: Specify protection mat for application between roof membrane and paver ballast when combination adhered/protected membrane and loose-laid PVC membrane roofing systems are

specified without pedestals and for application between roof membrane and insulation or other growth medium and system components for IRMA and garden-style PVC membrane roofing systems.

****

Minimum [154] [200] gram/square m [4.5] [6] ounce/square yard ultraviolet resistant polypropylene, non-woven, needle punched fabric for use as protection mat under ballast system or as recommended and supplied by the roof membrane manufacturer.

][2.1.8 Pre-manufactured Accessories

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NOTE: Edit, delete, and insert accessory materials requirements as required for the specific project and components to be installed.

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NOTE: Specify aluminum or stainless steel in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. AZ55 galvalume and G90 galvanized are allowed in ESC C1 and C2 project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Provide pre-manufactured accessories that are manufacturer's standard for intended purpose, comply with the applicable specification section, are compatible with the membrane roof system and approved for use and supplied by the PVC roof membrane manufacturer. Provide pre-fabricated curbs of [_____] gauge [G90 galvanized] [AZ55 galvalume] [_____] with minimum 100 mm 4 inch flange for attachment to roof nailers. Provide curbs of minimum height of 250 mm 10 inches above the finished roof membrane surface.

][2.1.9 PVC Walk Tread

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NOTE: Use PVC Walk Tread as pedestrian walkways where the roof, or areas of the roof, are intended to bear foot traffic for maintenance or other purposes once per month or more frequently.

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Scrim reinforced 2.4 mm 0.096 inch thickness PVC membrane with a textured surface, compatible with and supplied by manufacturer of the PVC roof membrane.

][2.1.10 Elevated Metal [Walkways] [and] [Platforms]

As specified in Section 08 31 00 ACCESS DOORS AND PANELS, and as approved by the roof membrane manufacturer.

]2.1.11 Roof Insulation

****

NOTE: If the roofing system contains insulation, coordinate with the appropriate insulation specification section. The insulation specification should include materials and installation up to the substrate on which the roof membrane is applied and must be supplied by the PVC membrane manufacturer and guaranteed under the PVC membrane roof manufacturer's full system warranty.

Do not adhere single ply PVC roof membrane to perlite, polystyrene, or standard wood fiber insulation board.

Coordinate insulation system attachment with the wind resistance requirements. In many instances, insulation system must be adhered or mechanically fastened to deck with increased frequency in corner and perimeter areas, if not throughout the field of the roof.

****

Provide insulation system and facer material compatible with membrane application specified and be approved and supplied by the PVC membrane roof manufacturer[and as specified in Section 07 22 00 ROOF AND DECK INSULATION].

2.1.12 Wood Products

****

NOTE: Coordinate with Section 06 10 00 ROUGH CARPENTRY. Some fire retardant treatment (FRT) chemicals may affect PVC materials. SDS listing active ingredients for the FRT wood must be submitted to PVC manufacturer prior to applying PVC materials in contact with FRT wood.

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As specified in Section 06 10 00 ROUGH CARPENTRY, except that fire retardant treated materials must not be in contact with PVC membrane or PVC accessory products, unless approved by the membrane manufacturer and the Contracting Officer.

2.2 REINFORCED, PVC MEMBRANE

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NOTE: Refer to Designer Note in PART 1 for guidance regarding membrane attachment method and in editing the membrane materials' requirements.

Specify minimum 2.03 mm 0.08 inch thickness PVC membrane for all applications.

Specify adhered membrane systems only to acceptable substrates (consult PVC membrane manufacturer) or mechanically fastened PVC membrane roof systems (in all wind zones). For adhered roof membrane application (typically, not located in extreme wind zones), specify reinforced roofing membrane that is particularly suitable, due to the reinforcement's

dimensional stability characteristics, for adhered PVC roof membrane system application. Similar adhered membranes that utilize a peel and stick release paper are also acceptable.

Specify a minimum 2.03 mm 0.08 inch membrane thickness that complies with either ASTM D4434/D4434M Type II, Grade I, or TYPE III or Type IV, or ASTM D6754 reinforced PVC membrane roofing specifications. A reinforced membrane is required on vegetative roofs, as well as in cold climate locations.

Minimum 2.03 mm 0.08 inch thickness ASTM D4434/D4434M Type II, Grade I membrane with fleece-backing may be used in certain adhered applications where the adhesive is typically an applied compound, spray foam adhesive, or when PVC fleecebacked membrane roofing is to be adhered to lightweight cellular insulating concrete. Modify this specification for proper adhesive and application parameters in accordance with PVC roof membrane manufacturer's requirements and recommendations when adhered fleeceback PVC membrane is specified.

Minimum membrane thickness is not inclusive of fleece.

2.4 mm 0.096 inch PVC membrane is also available. Specify 2.4 mm 0.096 inch membrane for applications that experience regular heavy traffic conditions or regular extreme wind conditions that can experience airborne debris. 2.4 mm 0.096 inch membrane may be adhered or mechanically fastened. Alternately, a combination adhered/protected membrane system can be utilized for high wind locations that can experience airborne debris.

****

Provide reinforced polyvinyl chloride (PVC) membrane containing fibers or scrim, and complying with ASTM D4434/D4434M, [Type II, Grade I] [Type III] [Type IV] [Type II, Grade I or Type III or Type IV, fleece backed], or ASTM D6754/D6754M, and in all cases provide 2.03 mm 0.08 inch minimum thickness for [adhered] [mechanically fastened] [combination adhered/protected membrane] application. Not withstanding the ASTM standards referenced, provide reinforced PVC roof membranes having the minimum, labeled thickness specified. PVC membrane thickness specified herein is exclusive of backing material on the bottom of fleece-backed membrane. Provide principal polymer used in manufacture of the membrane sheet as PVC, with width and length of PVC membrane roofing sheet consistent with membrane attachment methods and wind uplift requirements, and sheet size as large as practical. In order to minimize joints and 3-way overlaps, prefabricated sheets are not accepted. Maximum reinforced PVC membrane roofing sheet dimensions to be the maximum width obtainable from PVC membrane roof manufacturer in order to minimize seams in the field of the roof.

2.3 PHOTOVOLTAIC (PV) SYSTEMS - RACK MOUNTED SYSTEMS

****

NOTE: The installation of a PV roof system over existing roof systems should be undertaken with extreme caution. Do not install PV systems on roofs with a shorter expected service life than the new PV system. Prior to the design of such systems the following must be undertaken:

a. Determine if the existing roof structure can handle the anticipated roof load increase.

b. Inspect and determine that the existing roof system has at least 10 years of service life remaining. If not, remove the existing roof and provide a new replacement roof system design in tandem with the photovoltaic system.

c. If 10 years remaining service life remains, ensure the design of the intersecting details, required roof protection, re-inspections, and warranty requirements for maintaining the roof system has been coordinated with the installation and manufacturers' warranties.

d. Design the roof related details for anticipated roof replacement work. Coordinate with the PV system designer to anticipate and plan for future roof replacement.

e. PV equipment on a rooftop creates additional roof protection requirements during initial installation and throughout the PV life-cycle. Ensure a roof protection program is specified during the PV system installation.

f. Permanently affix PV supports to stanchions which are anchored to the building structure.

****

Adhere to NRCA 3906.

PART 3 EXECUTION

[3.1 CONCRETE SURFACE DRYNESS

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NOTE: Delete this Article unless roofing system is being installed on a concrete deck.

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Prior to installing roof system on a concrete deck, including application of insulation or membrane materials, conduct a test for surface dryness in accordance with ASTM D4263. The deck is acceptable for roof system application when there is no visible moisture on underside of plastic sheet after 24 hours.

]3.2 EXAMINATION

Ensure that the following conditions exist prior to application of the roofing materials:

a. Do not install items that show visual evidence of biological growth.

b. [Drains,] [curbs,] [control joints,] [expansion joints,] [perimeter walls,] [roof penetrating components,] [and] [equipment supports] are in place.

c. Surfaces are rigid, clean, dry, smooth, and free from cracks, holes, and sharp changes in elevation.

d. Substrate is sloped to provide positive drainage.

e. Walls and vertical surfaces are constructed to receive counterflashing, and will permit mechanical fastening of the base flashing materials.

f. Treated wood nailers are in place on non-nailable surfaces, to permit nailing of base flashing at minimum height of 200 mm 8 inches above finished roofing surface.

****

NOTE: Coordinate with Section 06 10 00 ROUGH CARPENTRY to ensure that preservative treatment is specified for wood which will be in contact with roofing components.

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g. Pressure-preservative treated wood nailers are fastened in place at eaves, gable ends, openings, and intersections with vertical surfaces for securing of membrane, edging strips, attachment flanges of sheet metal, and roof fixtures. [Embedded nailers are flush with deck surfaces.] [Surface-applied nailers are the same thickness as the roof insulation.]

h. PVC materials are not in contact with fire retardant treated wood, except as approved by the PVC membrane roof manufacturer and Contracting Officer.

****

NOTE: Include venting provision for wet fill substrate materials like lightweight cellular concrete where required by cellular lightweight concrete manufacturer.

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[i. If required or recommended by the cellular lightweight concrete manufacturer's requirements and recommendations, provide venting.]

[j. Exposed nail heads in wood substrates are properly set. Warped and split [boards] [sheets] have been replaced. There are no cracks or end joints 6 mm 1/4 inch in width or greater. [Joints in plywood substrates are taped or otherwise sealed to prevent air leakage from the underside.]]

[k. Insulation boards are installed smoothly and evenly, and are not broken, cracked, or curled. There are no gaps in insulation board joints exceeding 6 mm 1/4 inch in width. Insulation is attached as specified in Section 07 22 00 ROOF AND DECK INSULATION. Insulation is being roofed over on the same day the insulation is installed.]

3.3 APPLICATION METHOD

****

NOTE: Coordinate application method with paragraphs "Description of Roof Membrane System" and appropriate subparagraph under "PVC Membrane Roofing".

Edit the manufacturers instructive submission requirements as necessary for the system specified. Include bracketed requirements only as applicable to the system being specified.

Mechanically fastening methods can have limitations on the roof warranty and require additional securement measures across the field of the installation.

As per UFC 3-110-01 section titled "Mechanically Fastened Weldable Thermoplastic Systems", Cool roofs in ASHRAE Climate Zones 4-8 must be fully adhered and not mechanically fastened.

****

Apply entire PVC membrane roofing utilizing [adhered] [mechanically fastened] [combination adhered/protected membrane] application method[s]. Apply roofing materials as specified herein unless approved otherwise by the Contracting Officer. Submit instructions including pattern and frequency of mechanical attachments required in the field for roof, corners, and perimeters to provide for the specified wind resistance

3.3.1 Special Precautions

a. Do not dilute coatings or sealants unless specifically recommended by the material manufacturer's printed application instructions. Do not thin liquid materials or cleaners used for cleaning PVC sheet.

b. Keep liquids in airtight containers, and keep containers closed except when removing materials.

c. Use liquid components, including adhesives, within their shelf life period. Store adhesives at 15 to 27 degrees C 60 to 80 degrees F prior to use. Avoid excessive adhesive application and adhesive spills, as they can be destructive to some thermoplastic sheets and insulations; follow adhesive manufacturer's printed application instructions. Mix and use liquid components in accordance with label directions and manufacturer's printed instructions.

d. Provide clean, dry cloths or pads for applying membrane cleaners and cleaning of membrane.

e. Do not use heat guns or open flame to expedite drying of adhesives or primers.

f. Require workmen and others who walk on the membrane to wear clean, soft-soled shoes to avoid damage to roofing materials.

g. Do not use equipment with sharp edges which could puncture the PVC membrane roofing sheet.

h. Shut down air intakes and related mechanical systems and seal open vents and air intakes when applying solvent-based materials in the area of the opening or intake. Coordinate shutdowns with the Contracting Officer.

i. Identify any combustible materials at or near heat seaming devices. Remove the combustible material and use particular caution around those combustible materials throughout the installation.

j. At no time will torch equipment be used for seams, repairs, or welding installations. Install all welded components and seams using heat guns within the strict written instructions of the membrane manufacturer.

k. All heat welding must be performed by an individual that has and maintains a NFPA 101 Hot Work Safety Certificate.

l. Upon completion of the heat seaming, establish a fire watch with the use of a thermal heat imager during the watch.

3.3.2 PVC Roofing Membrane

Provide a watertight roof membrane sheet free of contaminants and defects that might affect serviceability. Provide a uniform, straight, and flat edge. Provide and install only felt-backed membrane directly on concrete deck or other hard surface which may otherwise damage the membrane, absent the felt backing. Do not place non-felt-backed PVC membrane roofing sheet directly on concrete deck or other hard surface which may damage the membrane. Provide membrane overlap of a minimum of 75 mm 3 inches at sides for adhered applications and 140-180 mm 5.5-7 inches for mechanically fastened applications and minimum 100 mm 4 inches at ends. Direction of laps must allow water to flow over and not against the lap. Install membrane joints that are free of wrinkles and fishmouths. During the day of installation, probe the entire length of hot-air-welded seams and correct deficiencies. Reweld defective areas. Cut out fishmouths, or damaged areas and cover the area with membrane using a continuous hot-air-welded seam on all sides. Probe test repairs for continuity. Hot-air-welded seams are to be accomplished in accordance with the PVC membrane roofing manufacturer's published requirements.

3.3.2.1 Nailing

Fasten membrane to nailers in accordance with the membrane manufacturer's approved instructions. Unless otherwise specified, stagger nails on 100 mm 4 inch centers maximum; stagger screws for sheet metal on 200 mm 8 inch centers maximum; and install rows of fasteners at least 13 mm 1/2 inch from edges of sheet metal.

3.3.2.2 Flashing

Flash all roof edges, projections through the roof and changes in roof planes. Seal the seam a minimum of 75 mm 3 inches beyond the fasteners which attach the membrane to nailers. Secure the installed flashing at the top of the flashing a maximum of 300 mm 12 inches on centers under the counterflashing or cap. Where possible, install prefabricated components for pipe seals and flashing accessories.

3.3.2.3 Expansion Joints

Cover expansion joints using Prefabricated covers or elastomeric flashing in accordance with the recommendations of the manufacturer.

3.3.2.4 Cutoffs

If work is terminated prior to weatherproofing the entire roof, seal the membrane to the roof deck. Also, seal flutes in metal decking along the cutoff edge. Pull the membrane free or cut to expose the insulation when resuming work and remove the cut insulation sheets used for fill-in. Do not use asphalt or coal-tar products for sealing.

3.3.2.5 Walkways

Install walkways on a loose-laid pad of the membrane material extending at least 25 mm 1 inch beyond the walkway material, and as specified by the manufacturer. Do not place stone ballast below or above walkways.

[3.3.3 Adhered Membrane Application

****

NOTE: Delete this paragraph unless an adhered or combination adhered and mechanically fastened application is specified.

Delete the bracketed option in the fourth sentence and delete the fifth sentence when non-standard adhesives are specified such as sprayed foam or hot asphalt used with fleece-backed membrane.

****

Layout membrane and side lap adjoining sheets in accordance with membrane manufacturer's printed installation instructions. Allow for sufficient membrane to form proper membrane terminations. Remove dusting agents and dirt from membrane and substrate areas where bonding adhesives are to be applied. Apply specified adhesive evenly and continuously to substrate [and underside of sheets] at rates recommended by the roof membrane manufacturer's printed application instructions. When adhesive is spray applied, roll with a paint roller to ensure proper contact and coverage. Do not apply bonding adhesive to surfaces of membrane in seam or lap areas. Allow adhesive to flash off or dry to consistency prescribed by manufacturer before adhering sheets to the substrate. When adhesive is peel and stick release paper-activated, follow manufacturer's printed instructions. Roll each sheet into adhesive slowly and evenly to avoid wrinkles; broom or roll the membrane to remove air pockets and fishmouths and to ensure adequately uniform bonding of sheet to substrate. Form field hot-air-welded laps or seams as specified and ensure that hot-air welded dimension is at width required by the membrane manufacturer's installation instructions. Check all seams and continuous hot-air-weld of all seams and lap seals.

][3.3.4 Mechanically Fastened Membrane Application

****

NOTE: Delete this paragraph unless a mechanically fastened application is specified.

As per UFC 3-110-01 section titled "Mechanically

Fastened Weldable Thermoplastic Systems", Cool roofs in ASHRAE Climate Zones 4-8 must be fully adhered and not mechanically fastened.

Membrane side lap depends on method of mechanical attachment, wind resistance testing of the specific system provided, and requirements of the membrane manufacturer. Generally, position attachments such that minimum 75 mm 3 inch seam width remains beyond the outer edge of the attachment plate or batten strip. Fastener and plate attachment typically requires 140 mm to 180 mm 5.5 to 7 inch membrane overlap. Batten attachment typically requires 100 mm to 150 mm 4 to 6 inch membrane overlap.

****

Layout membrane and lap adjoining sheets in accordance with membrane manufacturer's printed instructions such that the minimum recommended seam width is maintained and to ensure that seam width is as required by tested assembly meeting specified wind resistance requirements. Account for additional overlap required for placement of fasteners and plates or battens beyond the closed seam. Allow for sufficient membrane to form proper membrane terminations. Ensure membrane is free of wrinkles and ridges in the installation. Mechanically secure the membrane sheet with specified fasteners in the lap area. Space fasteners as required to provide the wind uplift resistance specified and in accordance with submitted fastener patterns for the field, corner, and perimeter roof areas. Set fasteners firm to plate or batten. Form field hot-air-welded seams, laps and coverstrips, as specified. Check all seams and ensure full/continuous lap seal.

][3.3.5 Perimeter and High Wind Attachment

****

NOTE: All application methods of PVC membranes require mechanical fastening of the membrane to wood nailers at the roof perimeters, at angular penetrations, at circular penetrations, or other roof features/components, except roof drains greater than 456 mm 18 inches in diameter.

****

Adhesive bond and mechanically secure roof membrane sheet at roof perimeter and other areas in a manner to comply with wind resistance requirements and in accordance with membrane manufacturer's printed application instructions. When adhesively bonding a mechanically fastened system in perimeter areas, the perimeter boundary of the adhesive bond must be the same as the boundary required for additional perimeter mechanical fastening to meet wind resistance requirements.

][3.3.6 Securement at Base Tie-In Conditions

Mechanically fasten the roof membrane at penetrations, at base of curbs and walls, and at all locations where the membrane turns and angles greater than 4 degrees (1:12). Space fasteners a maximum of 300 mm 12 inches on center, except where more frequent attachment is required to meet specified wind resistance or where recommended by the roof membrane manufacturer. Cover over all exposed fasteners with a layer of roof manufacturer's flashing material. Hot-air-weld all seams of flashing material as recommended by the roof membrane manufacturer's printed data.

][3.3.7 Pre-fabricated Curbs

Securely anchor prefabricated curbs to nailer or other base substrate and flashed with PVC membrane flashing materials.

3.3.7.1 Set-On Accessories

Where pipe or conduit blocking, supports and similar roof accessories, or isolated paver block, are set on the membrane, adhere reinforced membrane or walkpad material, as recommended by the roof membrane manufacturer, to bottom of accessories prior to setting on roofing membrane. Specific method of installing set-on accessories must permit normal movement due to expansion, contraction, vibration, and similar occurrences without damaging roofing membrane. Do not mechanically secure set-on accessories through roofing membrane into roof deck substrate.

][3.3.8 Roof Walkways

Install walkways at roof access points and where otherwise indicated for traffic areas and for access to mechanical equipment, in accordance with the PVC membrane roof manufacturer's printed instructions. Provide minimum 150 mm 6 inch separation between adjacent walkways to accommodate drainage.

][3.3.9 Elevated Metal [Walkways] [and] [Platforms]

Install over completed roof system in accordance with Section 08 31 00 ACCESS DOORS AND PANELS. Provide for protection of roof membrane by placing reinforced membrane or walkpad material, or other material approved by the PVC membrane roof manufacturer and Contracting Officer, at all surface bearing support locations.

][3.3.10 Isolated Paver Blocks

Install paver blocks where indicated and as necessary to support surface bearing items traversing the roof area. Set paver block on a layer of reinforced PVC membrane or walkway applied over the completed PVC roof membrane.

]3.4 FLASHINGS

Provide flashings in the angles formed at walls and other vertical surfaces and where required to make the work watertight, except where metal flashings are indicated.

3.4.1 General

Provide a one-ply flashing membrane, as specified for the system used, and install immediately after the roofing membrane is placed and prior to finish coating where a finish coating is required. Flashings must be stepped where vertical surfaces abut sloped roof surfaces. Provide sheet metal reglet in which sheet metal cap flashings are installed of not more than 400 mm 16 inch nor less than 200 mm 8 inch above the roofing surfaces. Exposed joints and end laps of flashing membrane must be made and sealed in the manner required for roofing membrane.

3.4.2 Membrane Flashing

****
NOTE: Coordinate flashing requirements with Section 07 60 00 FLASHING AND SHEET METAL and details. Ensure Section 07 60 00 FLASHING AND SHEET METAL is properly edited for application to PVC roofing systems and for inclusion of flashing conditions of the project.
****

3.4.2.1 Installation

Install flashing and flashing accessories as the roof membrane is installed. Apply flashing to cleaned surfaces and as recommended by the roof membrane manufacturer and as specified. Utilize cured PVC membrane flashing and prefabricated accessory flashings to the maximum extent recommended by the roof membrane manufacturer. Limit uncured flashing material to reinforcing inside and outside corners and angle changes in plane of membrane, and to flashing scuppers, pourable sealer pockets, and other formed penetrations or unusually shaped conditions as recommended by the roof membrane manufacturer where the use of cured material is impractical. Extend base flashing not less than 200 mm 8 inch above roofing surface and as necessary to provide for seaming overlap on roof membrane as recommended by the roof membrane manufacturer.

3.4.2.2 Sealing

Seal flashing membrane for a minimum of 75 mm 3 inch on each side of fastening device used to anchor roof membrane to nailers. Completely adhere flashing sheets in place. Seam flashing membrane in the same manner as roof membrane, except as otherwise recommended by the membrane manufacturer's printed instructions and approved by the Contracting Officer. Reinforce all corners and angle transitions by applying uncured membrane to the area in accordance with roof membrane manufacturer recommendations. Mechanically fasten top edge of base flashing with manufacturer recommended termination bar fastened at maximum 300 mm 12 inch on center. Install sheet metal flashing over the termination bar in the completed work. Mechanically fasten top edge of base flashing for all other terminations in a manner recommended by the roof membrane manufacturer. Apply membrane liner over top of exposed nailers and blocking and to overlap top edge of base flashing installation at curbs, parapet walls, expansion joints and as otherwise indicated to serve as waterproof lining under sheet metal flashing components.

3.4.3 Flashing at Roof Drain

****
NOTE: Include this paragraph when roof drains are indicated.
****

Provide a tapered insulation sump into the drain bowl area. Do not exceed tapered slope of (4:12) 18 degrees for unreinforced membrane and (1:12) 5 degrees for reinforced membrane. Provide tapered insulation with surface suitable for adhering membrane in the drain sump area. Avoid field seams running through or within 600 mm 24 inch of roof drain, or as otherwise recommended by the roof membrane manufacturer. Adhere the membrane to the tapered in the drain sump area. Apply water block mastic and extend membrane sheets over edge of drain bowl opening at the roof drain deck flange in accordance with membrane manufacturer's printed application instructions. Ensure membrane is free of wrinkles and folds in the drain area. Securely clamp membrane in the flashing clamping ring. Ensure membrane is cut to within 20 mm 3/4 inch of inside rim of clamping ring to maintain drainage capacity. Do not cut back to bolt holes. Retrofit roof drains must conform to ANSI/SPRI RD-1.

3.5 ROOF WALKPADS

Install walkpads at roof access points and where otherwise indicated for traffic areas and for access to mechanical equipment, in accordance with the roof membrane manufacturer's printed instructions. Provide minimum 150 mm 6 inch separation between adjacent walkpads to accommodate drainage.

3.5.1 Elevated Metal [Walkways][and][Platforms]

Provide for protection of roof membrane by placing reinforced membrane or walkpad material, or other material approved by the Contracting Officer, at all surface bearing support locations.

3.6 CORRECTION OF DEFICIENCES

Where any form of deficiency is found, take additional measures as deemed necessary by the Contracting Officer to determine the extent of the deficiency and provide corrective action recommendations. Perform corrective action as directed by the Contracting Officer.

3.7 PROTECTION OF APPLIED ROOFING

At the end of the day's work and when precipitation is imminent, protect applied membrane roofing system from water intrusion.

[3.7.1 Water Cutoffs

****

NOTE: Include this paragraph when roof insulation is a substrate for the reinforced PVC membrane roofing.

****

Straighten insulation line using loose-laid cut insulation sheets and seal the terminated edge of the roof membrane system in an effective manner. [Seal off flutes in metal decking along the cutoff edge.] Remove the water cut-offs to expose the insulation when resuming work, and remove the insulation sheets used for fill-in.

]3.7.2 Temporary Flashing for Permanent Roofing

Provide temporary flashing at drains, curbs, walls and other penetrations and terminations of roofing sheets until permanent flashings can be applied. Remove temporary flashing before applying permanent flashing.

3.7.3 Temporary Walkways, Runways, and Platforms

Do not permit storing, walking, wheeling, and trucking directly on applied roofing system. Provide temporary walkways, runways, and platforms of smooth clean boards, mats or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to live load limits of roof construction. Use rubber-tired equipment for roofing work.

3.8 FIELD QUALITY CONTROL

3.8.1 Construction Monitoring

During progress of the roof work, make visual inspections as necessary to ensure compliance with specified parameters. Additionally, verify the following:

a. Equipment is in working order. Metering devices are accurate.

b. Materials are not installed in adverse weather conditions.

c. Substrates are in acceptable condition, in compliance with specification, prior to application of subsequent materials.

  (1) Nailers and blocking are provided where and as needed.

  (2) Insulation substrate is smooth, properly secured to its substrate, and without excessive gaps prior to membrane application.

  (3) The proper number, type, and spacing of fasteners are installed.

  (4) Materials comply with the specified requirements.

  (5) All materials are properly stored, handled and protected from moisture or other damages. Liquid components are properly mixed prior to application.

  (6) Adhesives are applied uniformly to both mating surfaces and checked for proper set prior to bonding mating materials. Mechanical attachments are spaced as required[, including additional fastening of membrane in corner and perimeter areas as required.]

  (7) Membrane is properly overlapped.

  (8) Membrane seaming is as specified by PVC membrane manufacturer. All seams are checked at the end of each work day.

  (9) Applied membrane is inspected and repaired as necessary prior to paver installation.

[(10) Membrane is adhered without ridges, wrinkles, kinks, fishmouths.]

  (11) Installer adheres to specified and detailed application parameters.

  (12) Associated flashing's and sheet metal are installed in a timely manner in accord with the specified requirements.

  (13) Paver ballast is within the specified weight range.

  (14) Temporary protection measures are in place at the end of each work shift.

[3.8.2 Manufacturer's Inspection

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NOTE: Include this paragraph when manufacturer's guarantee is required. Select desired frequency of manufacturer inspection and coordinate with text of optional 2nd and 3rd bracketed sentences.
****

Manufacturer's technical representative must [be present full time when Single Source Contract Liability Warranty is desired] [visit the site a minimum of [[3] [_____] times] [once per week] during the installation for purposes of reviewing materials installation practices and adequacy of work in place].[Inspections must occur during the first 20 squares of membrane installation, at mid-point of the installation, and at substantial completion, at a minimum. Additional inspections need not exceed one for each 100 squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer.] After each inspection, a report, signed by the manufacturer's technical representative to the roofing Contractor and then to the Contracting Officer within 3 working days. Within the report state the overall quality of work, deficiencies and any other concerns, and recommended corrective action.

]3.9 CLEAN UP

Remove debris, scraps, containers and other rubbish and trash resulting from installation of the roofing system from job site each day.

3.10 INSTRUCTIONS TO GOVERNMENT PERSONNEL

Furnish written and verbal instructions on proper maintenance procedures to designated Government personnel. Verbal instructions must be provided by a competent representative of the roof membrane manufacturer and include a minimum of 4 hours on maintenance and emergency repair of the membrane. Include a demonstration of membrane repair, and give sources of required special tools. Furnish information on safety requirements during maintenance and emergency repair operations. Include copies of Safety Data Sheets for maintenance/repair materials.

[3.11 ROOF DRAIN TEST

****
NOTE: Include this paragraph when roof drains are required. Consult with structural engineer to verify loading capability of roof structural system.
****

After completing roofing but prior to Government acceptance, perform the following test for watertightness. Plug roof drains and fill with water to edge of drain sump for 8 hours. Do not plug secondary overflow drains at the same time as adjacent primary drain. To ensure some drainage from roof, do not test all drains at same time. Measure water at beginning and end of the test period. When precipitation occurs during test period, repeat test. When water level falls, remove water, thoroughly dry, and inspect installation; repair or replace roofing at drain to provide for a properly installed watertight flashing seal. Repeat test until there is no water leakage.

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-07 55 00 (August 2009)**
Change 1 - 05/14

Preparing Activity: USACE **Superseding**
UFGS-07 55 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 55 00

PROTECTED MEMBRANE ROOFING

08/09, CHG 1: 05/14

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-07 55 00 (August 2009)**
Change 1 - 05/14

Preparing Activity: USACE **Superseding**
UFGS-07 55 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 55 00

PROTECTED MEMBRANE ROOFING

08/09, CHG 1: 05/14

****

NOTE: This guide specification covers the requirements for protected membrane roof system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This specification covers a roofing system in which the membrane is protected by an overlay of extruded polystyrene insulation, a filter fabric, and a layer of ballast on top. The surface of overhangs must be sealed to prevent leakage of air and, therefore, uplift. For additional guidance on PMR, the designer should consult the National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual.

Roof must be constructed with a minimum slope of 1 to 48, and a maximum slope of 1 to 6. Drainage is critical as the insulation will float if submerged and not adequately ballasted. Where internal drains are not used, ice dams may occur at eaves and

scuppers. For guidance on flashings and drainage details, the designers should consult the SMACNA "Architectural Sheet Metal Manual."

Undersides of the deck, including overhangs, should be sealed when using loose-laid protected membrane to prevent wind from pressurizing the underside of the membrane.

Bituminous membranes should be flood-coated and not surfaced with aggregate. Polystyrene should not be placed in contact with asphalt.

Except where exposed drain baskets pose a safety hazard, there must be an opening in the insulation, filter fabric, and ballast above each drain basket. Pavers above hidden drains will be marked so that the drains can be inspected periodically.

Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C578	(2023) Standard Specification for Rigid,

	Cellular Polystyrene Thermal Insulation
ASTM C726	(2024) Standard Specification for Mineral Wool Roof Insulation Board
ASTM C1177/C1177M	(2024) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C1396/C1396M	(2024) Standard Specification for Gypsum Board
ASTM D448	(2012; R 2017) Standard Classification for Sizes of Aggregate for Road and Bridge Construction
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM D4751	(2020) Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D5034	(2009; R 2017) Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/
FM P9513	(2002) Specialist Data Book Set for Roofing Contractors; contains 1-22 (2001), 1-28 (2002), 1-29 (2002), 1-28R/1-29R (1998), 1-30 (2000), 1-31 (2000), 1-32 (2000), 1-33 (2000), 1-34 (2001), 1-49 (2000), 1-52 (2000), 1-54 (2001)

SINGLE PLY ROOFING INDUSTRY (SPRI)

SPRI RP-4	(2013) Wind Design Standard for Ballasted Single-Ply Roofing Systems

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

PL 109-58	Energy Policy Act of 2005 (EPAct05)

UL SOLUTIONS (UL)

UL 580	(2006; Reprint Apr 2024) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies
UL 790	(2022) UL Standard for Safety Test Methods

for Fire Tests of Roof Coverings

1.2 SYSTEM DESCRIPTION

1.2.1 Wind Uplift Resistance

****

NOTE: Design should be in accordance with SPRI RP-4. Fully adhered protected membranes have performed well in hurricane areas when ballasted as specified in SPRI RP-4. Roof deck must be adequate to support weight of ballast as dead load.

****

Wind uplift resistance of the complete roof assembly must be rated Class I-[60] [90] in accordance with UL 580. Wind resistance of loose-laid ballasted system must be in accordance with [FM P9513] [SPRI RP-4]. Submit drawings required for the membrane, modified to include the complete PMR assembly.

1.2.2 Pre-Roofing Conference

After approval of submittals and before performing roofing [and insulation] installation work, hold a pre-roofing conference to review the following:

a. Drawings, specifications and submittals related to the roof work

b. Roof system components installation

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representatives to roof manufacturer

d. Plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing

e. Quality control plan for the roof system installation

f. Safety requirements

Coordinate pre-roofing conference scheduling with the Contracting Officer. The conference must be attended by the Contractor, the Contracting Officer's designated personnel, and personnel directly responsible for the installation of roofing [and insulation], flashing and sheet metal work, [[mechanical][and][electrical] work], other trades interfacing with roof work , [Fire Marshall,] and representative of the roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roof Assembly

SD-07 Certificates

Material and Equipment

Energy Efficiency

Qualifications

1.4 QUALITY ASSURANCE

1.4.1 Material and Equipment

Submit material supplier's or equipment manufacturer's statement that the supplied insulation, filter fabric and membrane materials meet specified requirements. Each certificate must be signed by an official authorized to certify on behalf of material supplier or product manufacturer and must identify quantity and date or dates of shipment or delivery to which the certificates apply. Submit certificates of compliance for material and equipment, as specified.

1.4.2 Energy Efficiency

Provide products that meet or exceed the specified energy efficiency requirements of FEMP designated or Energy Star qualified products. Submit documentation certifying that product conforms to PL 109-58 by meeting or exceeding Energy Star or FEMP efficiency requirements as defined at "Energy-Efficient Products" at http://www1.eere.energy.gov/femp/procurement. Indicate Energy Efficiency Rating.

1.4.3 Qualifications

Submit documentation verifying a minimum of 2 years experience with PMR systems and certification by the PMR manufacturer as an approved Installer for the specified PMR system.

1.4.4 Fire Resistance

The completed roof system must be rated Class A as determined by UL 790 or Class I as determined by FM APP GUIDE. Indicate compliance of each component of the roofing system by the label or written certification from the manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

Store insulation away from areas where welding is being performed or where contact with open flames is possible. Shield insulation from extended exposure to sunlight. Remove materials damaged by moisture from the site. Do notstore ballast on the roof.

PART 2 PRODUCTS

****

NOTE: Insulation to be placed beneath the membrane is described in Section 07 22 00 ROOF AND DECK INSULATION.

****

2.1 UNDERLAYMENT

****

NOTE: Loose-laid membrane will not be placed directly on concrete or other hard, potentially rough deck.

****

Underlayment may be [concrete] [any insulation which is suitable for the particular membrane] [mineral fiberboard in accordance with ASTM C726][or][gypsum board in accordance with ASTM C1396/C1396M, 16 mm 5/8 inch thick or glass mat gypsum roof board in accordance with ASTM C1177/C1177M, [6.35 mm 1/4 inch] [12.7 mm 1/2 inch] [15.87 mm 5/8 inch]].

2.2 ROOF MEMBRANE

****

NOTE: Specify built-up roof, EPDM, modified bitumen roofing, or PVC roof membrane, or allow Contractor to choose from these options. Delete each inapplicable roof membrane. When editing these

paragraphs, delete aggregate surfacing, walkways, and types of insulation not used. Specify Section 07 51 13 ASPHALT BUILT-UP ROOFING when membrane is applied directly to concrete deck, and require two final bitumen flood coats, each coat providing 1.5 kg of bitumen per square meter 30 pounds per square.

****

Provide roof membrane in accordance with Section [07 51 13 ASPHALT BUILT-UP ROOFING] [07 53 23 ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING] [07 54 19 POLYVINYL CHLORIDE ROOFING] [or] [07 52 00 MODIFIED BITUMINOUS MEMBRANE ROOFING].

2.3 INSULATION ABOVE THE MEMBRANE

****

NOTE: Determine the required R-value and show the R-value at the appropriate detail on the drawings. The required R-value will never be less than that used in the Energy Budget Analysis.

Specify a vapor retarder only when required by calculations made as specified in ASTM Manual 18 "Moisture Control in Buildings" or in the CRREL-EC report "Vapor Retarders for Membrane Roofing Systems."

****

Insulation placed above the membrane must be extruded polystyrene, or extruded polystyrene with a mortar face. Provide manufacturer's standard insulation factory marked with the manufacturer's name or trade mark, the material specification number, the R-value at 24 degrees C 75 degrees F, and the thickness. Mark boards individually. The thermal resistance of the insulation less than the R-value shown on the drawings is not permitted. Insulation must conform to ASTM C578, Type V, VI or VII and must be intended by the manufacturer for use above a protected roof membrane. Bottom layer of insulation must provide drainage paths, mostly parallel to the slope, between insulation and membrane. Top surface of mortar-faced insulation must be 10 mm 3/8 inch thick portland cement latex mortar having minimum properties as follows: specific gravity: 2.0, compressive strength: 20.7 MPa 3000 psi and bond strength to insulation: 69 kPa 10 psi. Top layer of insulation may have ribbed top surfaces when flat-bottom pavers are used as ballast. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.4 FILTER FABRIC

Provide filter fabric that is either woven or non-woven pervious sheet of long chain polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamide, or polyvinylidene-chloride, formed into a pattern with distinct and measurable openings. The filter fabric must provide an ASTM D4751 Apparent Opening Size (AOS) no finer than the 0.125 mm No. 120 sieve and no coarser than the 0.212 mm No. 70 sieve. Selvage or finish edges of fabric to prevent raveling. Provide fabric with a minimum weight of 102 gms/sq. m 3 oz/sq. yard and conforming to the following table:

Property	Test Procedure	Result
Tensile strength	ASTM D5034 Grab test method using 25 mm 1 inch square jaws and a travel rate of 55 mm per sec 12 inches per minute	29 kg/25 mm65 lbs/inch minimum in any principal direciton
Puncture strength	ASTM D751 - Tension testing machine with ring clamp; steel ball replaced with a 8 mm 5/16 inch diameter solid steel cylinder with a hemispherical tip centered within the ring clamp	18 kg40 lbs minimum load

2.5 BALLAST

****

NOTE: Pavers are preferred over aggregate ballast, and a combination of pavers and ballast is preferred over aggregate only.

Determine ballast and/or paver size and quantity using SPRI RP-4 and modify paragraph BALLAST INSTALLATION accordingly. SPRI RP-4 allows crushed stone over protected membrane. Use light-colored aggregate when locally available. Small aggregate will not be used in vicinity of aircraft operations; however, rock or paver ballast may be used in such areas. Where ambient temperatures drop below freezing, avoid use of ballast or pavers that will break during freeze-thaw cycles.

Installations where this roofing system is used should be monitored; any problems or noteworthy benefits encountered in the use of this system should be brought to the attention of HQUSACE (CEMP-ET) WASH DC 20314-1000 for information and possible dissemination.

****

Provide ballast that is screened gravel, screened crushed stone, precast concrete pavers, or extruded polystyrene insulation with integral mortar topping. Indicate size and placement. Selected ballast exposed to sunlight must have an initial solar reflectance greater or equal to 0.65 and a solar reflectance greater or equal to 0.50 three years after installation under normal conditions.

2.5.1 Pavers

Furnish air-entrained concrete, minimum 38 mm 1-1/2 inches thick pavers having a 21 MPa 3000 psi minimum compressive strength. Use pavers that are ribbed on the bottom over smooth topped insulation and flat on the bottom over insulation with ribbed top.

2.5.2   Aggregate Ballast

Provide gravel and crushed stone conforming to ASTM D448, Size 4 and 2, with less than 2 percent that passes through a 10 mm 3/8 inch screen. Ballast must have minimum unit mass of 960 kg/cubic meter 60 pcf as determined by ASTM C29/C29M.

PART 3   EXECUTION

3.1   INSTALLATION

Install roof membrane and flashing in accordance with Sections [07 51 13 ASPHALT BUILT-UP ROOFING] [07 53 23 ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING] [07 54 19 POLYVINYL CHLORIDE ROOFING] [or] [07 52 00 MODIFIED BITUMINOUS MEMBRANE ROOFING].

3.2   FLOOD TEST

After the membrane and its flashings are installed, and before the insulation is placed above the membrane, plug the drains and flood the roof with water for 24 hours. Repair leaks before insulation is installed.

3.3   INSULATION

****

NOTE: Specify or indicate a 0.13 mm 4 mil polyethylene sheet below the insulation when surface is flood coat bitumen.

****

Loosely lay insulation on the membrane after the membrane is completed and flood coat (if any) is cool. When required by the manufacturer of the insulation, install a slip sheet over the membrane. Provide drainage paths between the lower surface of the insulation and the membrane. Make most of the drainage paths parallel to the slope of the roof. Unless otherwise specified by the manufacturer, stagger end joints. Joints between boards exceeding 6 mm 1/4 inch are not permitted. Install insulation within 19 mm 3/4 inch of projections and cant strips.

3.4   FILTER FABRIC INSTALLATION

Loosely lay filter fabric over insulation, smooth and free of tension and stress. Lap edges and ends a minimum of 300 mm 1 foot and extend above the ballast 50 to 75 mm 2 to 3 inches at the perimeter and penetrations. Joints parallel to perimeter will not be permitted within 1.8 meters 6 feet of the perimeter.

3.5   BALLAST INSTALLATION

Place ballast to provide a weight of 479 Pa 10 psf on the roof area, except that the weight must be 957 Pa 20 psf within 1.2 meters 4 feet of the roof perimeter. At approved intervals, weigh the placed ballast and correct to be within plus or minus 10 percent of specified weight. Install pavers where indicated. Mark pavers above hidden drains so that drains may be inspected. Surround interior roof drains with gravel or stone graded between 25 and 38 mm 1 and 1-1/2 inches to the level of ballast over insulation or to mid-height of drain bonnet, whichever is lower. During placement of aggregate ballast, cover drains and other openings to prevent inadvertent entry of ballast. Ballast buggy wheels are not allowed on the membrane.

3.6 INSPECTION

****

NOTE: Where justified by the amount or criticality of the insulation and roofing involved, and similar requirements are not established for the Contractor Quality Control Organization specified elsewhere, the following INSULATION TECHNICIAN and inspection requirements may be added:

"INSULATION TECHNICIAN

A roof insulation technician responsible directly to the Contractor and experienced in the installation of roof insulation and related work must perform the inspection functions and must be on the site whenever roof insulation operations are in progress."

****

Establish and maintain an inspection procedure to ensure compliance of the installed roof with the contract requirements. Promptly remove work that is not in compliance with the contract and replace or correct in an approved manner. Inspection includes, but is not limited to, the following:

a. Observation of environmental conditions; number and skill level of roofing workers; start and end time of various tasks; condition of substrate.

b. Verification of compliance of materials before, during, and after installation, proper storage and handling of insulation.

c. Inspection of mechanical fasteners; type, number, length, and spacing.

d. Coordination with other materials, cants, nailers, flashings, and penetrations.

e. Inspection of proper placement of insulation, joint orientation and laps between layers, joint widths and bearing of edges of underlayment on deck.

f. Inspection of proper placement of pavers and amount and leveling of ballast.

Submit procedures for approval, prior to start of roofing work including a checklist of points to be observed. Document the actual inspections and furnish a copy of the documentation to the Contracting Officer at the end of each day.

-- End of Section --

****

USACE / NAVFAC / AFCEC	**UFGS-07 57 13 (May 2011)**
	Change 4 - 02/23

Preparing Activity: NAVFAC	**Superseding**
	UFGS-07 57 13 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 57 13

SPRAYED POLYURETHANE FOAM (SPF) ROOFING

05/11, CHG 4: 02/23

PART 1   GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-07 57 13 (May 2011)**

Change 4 - 02/23

Preparing Activity: NAVFAC **Superseding**

UFGS-07 57 13 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 57 13
SPRAYED POLYURETHANE FOAM (SPF) ROOFING

05/11, CHG 4: 02/23

****

NOTE: This guide specification covers the requirements for spray applied urethane foam roofing systems with a fluid applied elastomeric protection coating.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Slope roof to drain, with minimum slope after deflection of 20 mm per meter 1/4 inch per foot. Roof slope will be obtained by sloping the structural deck and not by varying the thickness of the sprayed insulation. Do not apply the roofing system when deck is of lightweight concrete or when other than light foot traffic is anticipated on the roof. Broomed finish should be specified for concrete decks.

The designer will determine the minimum required R-value and calculate the insulation thickness based on the aged R-value of 5.6. Specify or indicate insulation thickness on drawings with minimum thickness not less than 38 mm 1-1/2 inches.

Coordinate this section with other system components specifications such as decking and sheet metal flashing. Also coordinate this section with the criteria of UFC 3-110-03, "Roofing" as it relates to the specific project and Service Exceptions indicated therein.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)

AIHA Z88.6	(2006) Respiratory Protection - Respirator Use-Physical Qualifications for Personnel

ASTM INTERNATIONAL (ASTM)

ASTM C177	(2019; E 2023) Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C273/C273M	(2020) Standard Test Method for Shear Properties of Sandwich Core Materials
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM D56	(2016a) Standard Test Method for Flash

	Point by Tag Closed Cup Tester
ASTM D93	(2019) Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D579/D579M	(2015) Standard Specification for Greige Woven Glass Fabrics
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622/D1622M	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D1623	(2017) Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
ASTM D2126	(2020) Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2697	(2003; R 2014) Volume Nonvolatile Matter in Clear or Pigmented Coatings
ASTM D2842	(2019) Water Absorption of Rigid Cellular Plastics
ASTM D5469/D5469M	(2012) Application of New Spray Applied Polyurethane Foam and Coated Roofing Systems
ASTM D6226	(2021) Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2024) Standard Test Methods for

	Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM G154	(2023) Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials
ASTM G155	(2021) Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA RoofMan	(2020) The NRCA Roofing Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

SPRAY POLYURETHANE FOAM ALLIANCE (SPFA)

SPFA AY-104	(1994; R 2008) Spray Polyurethane Foam Systems for New and Remedial Roofing

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 790	(2022) UL Standard for Safety Test Methods for Fire Tests of Roof Coverings
UL 1256	(2023) Fire Test of Roof Deck Constructions
UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 DESCRIPTION OF ROOF SYSTEM

****

NOTE: Granules will be used only where appearance of roof is important and for walkways.

****

Provide a roofing system consisting of sprayed in-place polyurethane foam roof insulation covered with a waterproof elastomeric protective coating[and surfaced with ceramic granules[in areas indicated]].

1.2.1 Design Requirements

1.2.1.1 Fire and Wind Uplift

****

NOTE: Specify roofing over a metal deck with either a UL 1256 classification or an FM Class I listing in addition to UL 790. Specify UL 790 Class A fire rating for all applications of less than 1:4 slope. Slope greater than 1:4 may require Class B rating based on flame spread on steeper slope.

Factory Mutual (FM) 1-90 wind uplift is the minimum recommendation for all spray foam roofing applied directly to deck substrates. The wind rating of sprayed foam applied to an existing roof system is typically the same as the rating of the existing roof system.

****

[Provide a complete roof system having a[UL 1256,] UL 790, Class A[or B] fire rating, be listed as "fire classified" in UL Bld Mat Dir, and bearing the UL label or be listed as a Class 1 Roof Deck in FM APP GUIDE.][Provide roof system over steel deck rated as Class 1-[90][_____] in accordance with FM APP GUIDE.] Ratings from other independent laboratories may be substituted provided that the tests, requirements and ratings are documented to be equivalent, to the satisfaction of the Contracting Officer.

1.2.2 Performance Requirements

Provide an installed roof system that is watertight; free of defects including foam and coating delamination, blistering, or voids; suitable for the climatic and service conditions of the installation; and providing positive drainage of the roof area.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Spray Urethane Foam; G, [_____]

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

Protective Coating; G, [_____]

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

Primer

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

Sealants

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

[Mineral Granules]

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

[Heat Island Reduction; S

][Energy Star Label for Top Coating; S

] Blowing Agent

SD-04 Samples

Sprayed Polyurethane Foam Roof System Mock-Up; G, [_____]

Sample Warranty; G, [_____]

SD-06 Test Reports

Core Sample Tests; G, [_____]

Provide [_____] copies of test reports.

SD-07 Certificates

Qualification of Manufacturer; G, [_____]

Qualification of Applicator; G, [_____]

SD-08 Manufacturer's Instructions

Spray Urethane Foam

Protective Coating

Polyurethane foam; G, [_____]

Submit manufacturer's complete application instructions and details, and to include storage, handling, and warnings or precautions on flammability and toxicity. Include manufacturer's written recommendations for primers and for surface preparation of metals, concrete, roofing, and other materials and surface substrates over which sprayed polyurethane foam and coating system will be applied.

Roof coating; G, [_____]

Submit manufacturer's complete application instructions and details, and to include storage, handling, and warnings or precautions on flammability and toxicity. Include manufacturer's written recommendations for primers and for surface preparation of metals, concrete, roofing, and other materials and surface substrates over which sprayed polyurethane foam and coating system will be applied.

Primers; G, [_____]

Submit manufacturer's complete application instructions and details, and to include storage, handling, and warnings or precautions on flammability and toxicity. Include manufacturer's written recommendations for primers and for surface preparation of metals, concrete, roofing, and other materials and surface substrates over which sprayed polyurethane foam and coating system will be applied.

Surface preparation; G, [_____]

Submit manufacturer's complete application instructions and details, and to include storage, handling, and warnings or precautions on flammability and toxicity. Include manufacturer's written recommendations for primers and for surface preparation of metals, concrete, roofing, and other materials and surface substrates over which sprayed polyurethane foam and coating system will be applied.

SD-09 Manufacturer's Field Reports

Daily Log; G, [_____]

Submit at completion of each day's work, including a record of each day's wet bulb and dry bulb temperature readings, substrate temperature readings, humidity readings, wind speed, and time of readings, wet film thickness measurements and their location, and quality control inspection observations. Include slit and core sample information as a part of the daily log. Mark area foamed and locate slit and core samples on roof plan and submit with daily log.

SD-11 Closeout Submittals

Warranty; G, [_____]

Information Card; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Manufacturer

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NOTE: Specify 10 years manufacturer experience unless directed otherwise by the Government.

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Sprayed polyurethane foam and elastomeric coating products manufacturer must have a minimum of [10][_____] years experience in the manufacture of polyurethane foam and elastomeric coating products.

[1.4.1.1 Manufacturer's Technical Representative

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NOTE: Include this paragraph where manufacturer inspection is required.

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Manufacturer's technical representative must have a minimum of 10 years experience with sprayed polyurethane roof systems products and installations and be thoroughly familiar with the products to be installed, installation requirements and practices, quality control of the installation, and with any special considerations in the geographical area and climate where construction will take place. The representative must be available to perform field inspections and attend meetings as specified.

]1.4.2 Qualification of Applicator

****

NOTE: Specify 5 years as an approved contractor unless directed otherwise by the Government.

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The roof system applicator must have prior manufacturer training in the application of sprayed polyurethane foam and coating materials. Applicator must be certified and approved by the foam and coating manufacturer to apply the specified materials and provide the specified manufacturer warranty. Applicator must have a minimum of [5][_____] years experience in application of the specified materials and minimum of [10][_____] years experience in the application of sprayed polyurethane foam roof systems. Mechanics applying the foam and coating materials must have minimum 3 years prior experience in handling and spraying the type of materials specified and spray equipment must be operated by or under the direct full-time supervision of manufacturer-trained personnel. The applicator must supply the names, locations and client contact information of 5 projects of similar size and scope that the applicator has constructed using the manufacturer's roofing products submitted for this project within the previous three years.

1.4.3 Preroofing Conference

After approval of submittals and before performing roofing system installation work, hold a preroofing conference to review the following:

a. Drawings and specifications and submittals related to the roof work;

b. Roof system components installation;

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representative;

d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components impacting the roof;

e. Quality control plan for the roof system installation;

f. Property protection measures.

g. Safety requirements.

Coordinate and schedule a preroofing conference coordinated with the Contracting Officer and attended by the Contractor, the Contracting Officer's designated personnel, personnel directly responsible for the installation of roof system, related sheet metal work, [[mechanical][and][electrical] work], other trades interfacing with the roof work, and a representative of the sprayed polyurethane foam roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.4.4 Foam Roof System Mock-Up

Apply the spray foam roofing system, including the specified elastomeric protective coating, in a designated test area of not less than 4 square meters 50 square feet. Notify the Contracting Officer a minimum of 48 hours prior to the test application. Include a drain and wall and perimeter flashing into the test area. Include in the test area the applicable roofing details, the requirements of surface texture, foam adhesion, and adhesion of the roof coating to the foam. Use the same equipment in the construction that is used in the application of the test roof system.

1.4.5 Sample Warranty

Submit sample warranty for the complete roof system meeting the specified warranty requirements. Sample warranty must be submitted and approved by the Contracting Officer prior to commencement of roof work.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver and store materials in sufficient quantity to allow for uninterrupted flow of work. Deliver materials to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand name, description of contents, and shelf life of containerized materials.

1.5.2 Storage

Store materials in clean, dry areas, away from excessive heat, sparks, and open flame. Ventilate the storage area to prevent build-up of flammable gases. Maintain temperatures in the storage area below the materials' flash point and within limits recommended by the manufacturer's printed instructions.

1.5.3 Handling

Handle materials and containers during application work safely and in accordance with manufacturer recommendations. Store liquids in airtight containers and keep containers closed except when removing materials. Do not use equipment or containers containing remains of dissimilar materials. Do not expose foam component containers to direct sunlight for periods of time sufficient to cause contents to exceed 26 degrees C 80 degrees F. Mark and remove from job site materials which have been exposed to moisture or that exceed shelf life limits. Not more than half the shelf life must have expired when materials are applied.

1.6 ENVIRONMENTAL CONDITIONS

Do not apply roof system materials during inclement weather or when ice, frost, surface moisture, or visible dampness is present on the surface to be covered, or when precipitation is imminent. Use moisture-measuring methods and equipment as required to verify that the moisture conditions of substrate surfaces are in accordance with roof system materials manufacturer requirements prior to application of foam and coating materials. Verify substrate temperatures are within limits recommended by the manufacturer's printed instructions, unless specified otherwise. Use wind screen protection for all spray applications when wind speeds exceed 10 miles per hour.

1.6.1 Primer

Follow manufacturer's printed application and curing instructions, except that no primer can be applied when ambient temperature is below 4 degrees C 40 degrees F or when ambient temperature is expected to fall below 2 degrees C 35 degrees F during drying or curing period. Select primer material and color to promote proper substrate temperature for sprayed polyurethane foam application.

1.6.2 Sprayed Polyurethane Foam

Suspend foam spraying when wind speeds exceed 40.23 kilometers per hour 25 miles per hour. Do not apply sprayed polyurethane foam if the roof surface temperature is less than 10 degrees C 50 degrees F, higher than 54 degrees C 130 degrees F, or is less than 3 degrees C 5 degrees F above the dewpoint. Verify relative humidity is within limits recommended by the sprayed polyurethane foam manufacturer's printed instructions. Determine the dewpoint at the jobsite prior to and upon completion of each work day unless variable weather conditions require more frequent monitoring. Verify the wet bulb and dry bulb temperatures during application of sprayed polyurethane foam are within the ranges recommended by the sprayed polyurethane foam manufacturer. Take wet bulb and dry bulb temperatures at the beginning of foaming, end of foaming, and at 2 hour intervals during foaming. Record each wet bulb and dry bulb temperature reading, substrate temperature, wind speed, humidity, time of reading, and date, and area foamed on a copy of the roof plan and submit with daily log to the Contracting Officer.

1.6.3 Elastomeric Coating

Prior to applying coating, check polyurethane foam with a moisture resistance meter to ensure that foam is dry. Apply roof coating between the temperature ranges of 10 and 43 degrees C 50 and 110 degrees F, ambient.

1.7 COORDINATION

Coordinate roofing operations with work of other trades to ensure that components are installed as required to permit continuous self-flashing of the sprayed polyurethane foam and protective coating system. Protect the installed roofing system from damage. Repair any damaged areas.

[1.7.1 Flashing

Metal flashing guidelines and standards are specified under Section 07 60 00 FLASHING AND SHEET METAL. Provide flashing shop drawing submittal requirements of Section 07 60 00 FLASHING AND SHEET METAL as a part of the submittal requirements of this section.

]1.8 WORK SEQUENCE

Schedule the work in order to prevent using newly constructed roofing for storage, walking surface, or material or equipment movement. If access is necessary, protect new roofing surfaces, flashings, and mechanical equipment. Repair damage which does occur and notify the Contracting Officer within 24 hours of the repairs.

1.9 FOAM SPRAY EQUIPMENT

1.9.1 Applicator

Use an airless foam spray gun of the mechanical, self-cleaning type, that does not require a flushing solvent during the spray operation.

1.9.2 Equipment Calibration

Fully calibrate the foam metering equipment to monitor each liquid component to within 2 percent of the foam material manufacturer's required metering ratio. Calibrate spray equipment each day at start of operations, after each restart if spraying operations have been terminated for more than one hour, whenever there is a change in fan pattern or pressure, whenever slow curing areas are noticed, whenever a change is made in hose length or working height, and after changeover between materials. Verify and demonstrate the calibration of equipment is adjusted to deliver components in proper mix and proportion. Complete calibration on cardboard or plywood on the roof adjacent to the area to be sprayed.

1.9.3 Metering Equipment Requirements

Use foam metering equipment capable of developing and maintaining the foam manufacturer's required liquid component pressures and temperatures. Foam metering equipment must have gages for visual monitoring. Verify the equipment is within the temperature control of foam components and within the temperature ranges recommended by the foam manufacturer's printed instructions.

1.9.4 Moisture Protection

Protect the surfaces of component supply containers or tanks used to feed the foam metering equipment from moisture.

1.9.5 Compressed Air

Supply compressed air in contact with foam components during mixing or atomization through moisture traps that are continuously bled.

1.9.6 Dispense Excess Materials

Do not deposit materials used for cleaning of equipment or materials dispensed for calibration purposes and establishment of spray gun pattern on the roof surfaces to be sprayed. Dispense such materials into scrap containers or onto plastic film, or cardboard, and dispose of in compliance with safety requirements and jobsite regulations.

1.10 SPECIAL SAFETY PROVISIONS

During application, use the following instructions or equipment unless these are in conflict with the manufacturer's recommendations or requirements of a recognized legal authority, in which case, the manufacturer's recommendations or the legal authority's requirements take precedence:

1.10.1 Special Equipment

1.10.1.1 Air Masks

Wear fresh air supply masks when applying foam or when handling hazardous liquid materials. Use respiratory protective devices as recommended by AIHA Z88.6. Instruct personnel required to use respiratory protective devices in the use of the devices. Maintain such equipment and inspect regularly.

1.10.1.2 Eye and Face Masks

Use eye and face protection during materials application. Use eye and face protective equipment meeting the requirements of ANSI/ISEA Z87.1.

1.10.1.3 Clothing and Gloves

Wear protective clothing and gloves during materials application. Where skin areas are not covered by clothing, protect those areas by using protective creams.

1.10.2 Handling Precautions

1.10.2.1 Venting of Material Containers

Partially unscrew material container and drum caps to gradually vent the containers prior to opening. Do not inhale vapors. Decontaminate empty component containers by filling with water and allowing to stand for 48 hours with bung caps removed. Under no circumstances seal, stop, or close the containers which have been emptied of the foam component.

1.11 WARRANTY

Provide roof system material and workmanship warranties meeting specified requirements. Where project specific requirements require revision or amendment to the standard manufacturer warranty, provide written revisions and amendments to the Contracting Officer.

1.11.1 Roof System Manufacturer Warranty

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NOTE: Specify 10 year warranty unless directed otherwise by the Government.

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Furnish a single-source roof system manufacturer's [_____][10]-year no dollar limit materials and installation workmanship warranty, for a watertight roof system construction. Provide warranty directly to the Government and commence warranty date at time of Government's acceptance of the roof work. The warranty must state that:

a. If within the warranty period the roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion into the roof system, blisters, cracks, ruptures, splits, delaminates, disbonds, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged foam and coating materials of the roof system and correction of defective workmanship is the responsibility of the spray foam and coating manufacturer. All costs associated with the repair or replacement work are the responsibility of the manufacturer.

b. When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others does not void the warranty.

1.11.2 Roofing System Installer Warranty

The roof system installer must warrant for a period of not less than two years that the roof system, as installed, is free from defects in installation workmanship, to include the foam and coating applications, flashing, accessories, attachments, and sheet metal installation. Write the warranty directly to the Government. Correction of defective workmanship and replacement of damaged or affected materials is the responsibility of the roof system installer. All costs associated with the repair or replacement work are the responsibility of the installer.

1.11.3 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty period must be approved, as required, and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the manufacturer warranty for the remainder of the manufacturer warranty period.

1.12 CONFORMANCE AND COMPATIBILITY

The entire roofing and flashing system must be in accordance with specified and indicated requirements, including fire and wind resistance requirements. Work not specifically addressed and any deviation from specified requirements must be in general accordance with applicable recommendations of the NRCA Roofing and Waterproofing Manual, reference standards, membrane manufacturer published recommendations and details, and compatible with surrounding components and construction. Submit any deviation from specified or indicated requirements to the Contracting Officer for approval prior to installation.

PART 2 PRODUCTS

2.1 MATERIALS

Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Protect materials provided from defects and make suitable for the service and climatic conditions of the installation.

2.2 SPRAY URETHANE FOAM

Provide urethane foam as the standard product of the manufacturer, and in containers that are factory marked with the manufacturer's name or trademark. Provide foam material that is a formulation suitable for the environmental and climatic conditions in which foam is applied. Provide urethane foam meeting the following requirements:

Blowing Agent Products that contain hydrochlorofluorocarbons (HCFCs), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), or other blowing agent with Ozone Depletion Potential (ODP) greater than 0.015 or Global Warming Potential (GWP) above 17 are prohibited. For a list of foam blowing agents with ODP and GWP values see https://www.epa.gov/snap/substitutes-rigid-polyurethane-spray.

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Density (Sprayed in Place)	ASTM D1622/D1622M	48 (minimum)	kg/m3

Properties in Metric Units			
K-Factor (aged)	ASTM C177 ASTM C518	1800 (maximum)	J per square meter/hr; degrees C per 25 mm
Compressive Strength Parallel to Foam Rise	ASTM D1621	290 (minimum)	kPa
Shear Strength	ASTM C273/C273M	275 (minimum)	kPa
Tensile Strength Parallel to Foam Rise	ASTM D1623	414 (minimum)	kPa
Dimensional Stability (Humid Aging)7 days volume change 71 degrees C, 100 relative humidity	ASTM D2126	6 (maximum)	percent net
Water Vapor Permeability	ASTM E96/E96M	4.35 by 10-9 (maximum)	G/Pa m2
Closed Cell Content	ASTM D6226	90 (minimum)	percent by volume
Water Absorption	ASTM D2842	0.49 (maximum)	kg/m2
Flammability	ASTM E84	Flame spread of 75 or less	---

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Density (Sprayed in Place)	ASTM D1622/D1622M	3.0 (minimum)	lb./ft3
K-Factor (aged)	ASTM C177 ASTM C518	0.15 (maximum)	BTU per SF/hr; degrees F per inch
Compressive Strength Parallel to Foam Rise	ASTM D1621	42 (minimum)	lb/in2

Properties in Inch-Pound Units			
Shear Strength	ASTM C273/C273M	40 (minimum)	lb/in2
Tensile Strength Parallel to Foam Rise	ASTM D1623	60 (minimum)	lb/in2
Dimensional Stability (Humid Aging)7 days volume change 160 degrees F, 100 relative humidity	ASTM D2126	6 (maximum)	percent net
Water Vapor Permeability	ASTM E96/E96M	3.0 (maximum)	per inch
Closed Cell Content	ASTM D6226	90 (minimum)	percent by volume
Water Absorption	ASTM D2842	0.10 (maximum)	lb./ft2
Flammability	ASTM E84	Flame spread of 75 or less	---

2.3 PROTECTIVE COATING

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NOTE: Refer to Society of Plastics Industry publication AY 102, "A Guide for Selection of Elastomeric Protective Coatings Over Sprayed Polyurethane Foam" for information regarding coatings selection. Include only the required coating type(s). Delete other options.

In general roof coatings designated as Types A and B are equally acceptable and should be included as Contractor options where roof slopes are 1/2:12 or greater. Coating Type CB may be used as the total coating system (base, intermediate, and finish) or may be used as base and intermediate with Type CF as finish coat. Coating Type CF should only be used as finish coat. Systems using type CB as total or a combination of Types CB and CF may be used for any slope.

SELECTION GUIDANCE TABLE		
COATING DESCRIPTION	**PERFORMANCE FEATURES**	**RECOMMENDED APPLICATIONS**
Type A(Silicone) One component system. High permeability (breathable). Good weatherability. Withstands temperature extremes well. Use on slopes 1:24 (1/2:12) and greater. Typical 4-8 hour cure time. Use dark base coat. Available in off white, tan, shades of gray.		

<table>
<tr><th colspan="3">SELECTION GUIDANCE TABLE</th></tr>
<tr><th>COATING DESCRIPTION</th><th>PERFORMANCE FEATURES</th><th>RECOMMENDED APPLICATIONS</th></tr>
<tr><td colspan="3">Type B(Silicone) Two component system. High permeability (breathable). Use on slopes 1:24 (1/2:12) and greater. Use fast cure base coat to promote adhesion to foam. Use standard cure type for finish coat where granules are added, otherwise use fast cure for finish coat. Typical fast cure in 10-20 minutes. Standard cure in 2-8 hours. Available in light and medium grays.</td></tr>
<tr><td colspan="3">Type CB (Urethane aromatic) Available as one or two component. Generally low permeability but some are considered permeable. Good abrasion resistance, tensile strength, elongation, impact resistance, and low temperature flexibility. High solids content. Darkens and chalks on exposure. Will withstand moderate ponding water. Use as base, intermediate and finish coat system, or as base and intermediate with Type CF finish coat. Standard dry time of 4-6 hours with cure time of 10-24 hours. Fast dry time of 1-20 minutes with cure time of 10-24 hours. Type CF(Urethane aliphatic) Available as one or two component. Generally low permeability but some are considered permeable. Excellent abrasion resistance, tensile strength, elasticity, impact resistance, and low temperature flexibility. Moderate solids content. Good color and gloss retention. Will withstand moderate ponding water. Use only as finish coat over Type CB base and intermediate coats. Recommended where highly weather resistant or aesthetic finish coat required.</td></tr>
</table>

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<table>
<tr><th colspan="3">SELECTION GUIDANCE TABLE</th></tr>
<tr><td>COATING DESCRIPTION</td><td>PERFORMANCE FEATURES</td><td>RECOMMENDED APPLICATIONS</td></tr>
<tr><td>Type A (silicone)</td><td>One component system. High permeability (breathable). Good weatherability. Withstands temperature extremes well.</td><td>Use on slopes 1:24 (1/2:12)and greater. Typical 4-8 hour cure time. Use dark base coat. Available in off white, tan shades of gray.</td></tr>
</table>

SELECTION GUIDANCE TABLE		
COATING DESCRIPTION	PERFORMANCE FEATURES	RECOMMENDED APPLICATIONS
Type B (silicone)	Two component system. High permeability (breathable).	Use on slopes 1:24 (1/2:12) and greater. Use fast cure base coat to promote adhesion to foam. Use standard cure type for finish coat where granules are added, otherwise use fast cure for finish coat. Typical fast cure in 10-20 minutes. Standard cure in 2-8 hours. Available in light and medium grays.
Type CB (Urethane aromatic)	Available as one or two component. Generally low permeability but some are considered permeable. Good abrasion resistance, tensile strength, elongation, impact resistance, and low temperature flexibility. High solids content. Darkens and chalks on exposure.	Will withstand moderate ponding water. Use as base, intermediate and finish coat system, or as base and intermediate with Type CF finish coat. Standard dry time of 4-6 hours with cure time of 10-24 hours. Fast dry time of 1-20 minutes with cure time of 10-24 hours.
Type CF (Urethane aliphatic)	Available as one or two component. Generally low permeability but some are considered permeable. Excellent abrasion resistance, tensile strength, elasticity impact resistance, and low temperature flexibility. Moderate solids content. Good color and gloss retention.	Will withstand moderate ponding water. Use only as finish coat over type CB base and intermediate coats. Recommended where highly weather resistant or aesthetic finish coat required.

Provide protective coating as approved by the foam manufacturer for use as the coating component of a sprayed polyurethane foam roof system. Provide coating consisting of separately applied base, intermediate and finish coat of[one-component silicone (Type A),][two-component silicone (Type B),][two-component urethane-aromatic (Type CB),][or][combination system of two-component urethane-aromatic with two-component urethane-aliphatic finish coat (Type CB and Type CF)]. Coating must bond to urethane foam and have the following minimum properties:

[2.3.1 Type A Coating

Silicone rubber, single component. Provide uncured silicone rubber having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	60, minimum	percent by volume
Solids Content	ASTM D2697	70, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	38, minimum	degrees C

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	60, minimum	percent by volume
Solids Content	ASTM D2697	70, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	100, minimum	degrees F

Provide cured silicone rubber having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 24 degrees C, 50 percent relative humidity	150, minimum	percentage
Tensile Strength	ASTM D412, die C, 24 degrees C, 50 percent relative humidity	2900, minimum	kPa

Properties in Metric Units			
Properties	ASTM Test	Value	Units
UV Exposure	ASTM D822, 6000 hours in atlas carbon arc, Type E weatherometer	No cracking checking, or significant discoloration	---
Hardness, Shore A	ASTM D2240	45, minimum	points
Permeability	ASTM E96/E96M Procedure E 0.50 mm thickness	2.3, maximum	perms

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 75 degrees F, 50 percent relative humidity	150, minimum	percentage
Tensile Strength	ASTM D412, die C, 75 degrees F, 50 percent relative humidity	450, minimum	psi
UV Exposure	ASTM D822, 6000 hours in atlas carbon arc, Type E weatherometer	No cracking checking, or significant discoloration	---
Hardness, Shore A	ASTM D2240	45, minimum	points

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Permeability	ASTM E96/E96M Procedure E 20 mil thickness	2.3, maximum	perms

][2.3.2 Type B Coating

Silicone rubber, two component, with [standard][fast] curing time for [all coats][base coat] [and][standard][fast] cure for intermediate and finish coat. Provide uncured silicone rubber having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	65, minimum	percent by volume
Solids Content	ASTM D2697	75, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	38, minimum	degrees C
Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	65, minimum	percent by volue
Solids Content	ASTM D2697	75, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	100, minimum	degrees F

Provide cured silicone rubber having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 24 degrees C, 50 degrees relative humidity	100, minimum	percentage

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Tensile Strength	ASTM D412, die C, 24 degrees C, 50 degrees relative humidity	3447, minimum	kPa
Permanent Set	ASTM D412	1.0, minimum	percentage
Change in Elongation, Tensile Strength, Permanent Set after Heat Aging 26 weeks at 65 degrees C	ASTM D412	1.0 within tolerance of test	percentage
UV Exposure	ASTM D822, 6000 hours in atlas xenon or carbon arc weatherometer	No cracking, checking or significant discoloration	---
Water Absorption, 168 hours, 24 degrees C	ASTM D570	0.5, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	45, minimum	points
Permeability	ASTM E96/E96M Procedure E 0.50 mm thickness	2.3, maximum	perms

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 75 degrees F, 50 degrees relative humidity	100, minimum	percentage
Tensile Strength	ASTM D412, die C, 75 degrees F, 50 degrees relative humidity	500, minimum	psi
Permanent Set	ASTM D412	1.0, minimum	percentage

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Change in Elongation, Tensile Strength, Permanent Set after Heat Aging 26 weeks at 150 degrees F	ASTM D412	1.0 within tolerance of test	percentage
UV Exposure	ASTM D822,6000 hours in atlas carbon arc, Type E weatherometer	No cracking, checking or significant discoloration	---
Water Absorption, 168 hours, 75 degrees F	ASTM D570	0.5, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	45, minimum	points
Permeability	ASTM E96/E96M Procedure E 20 mil thickness	2.3, maximum	perms

][2.3.3 Type CB Coating

Aromatic urethane elastomer, [one][two] component. Provide uncured urethane having the following values when tested for specified properties in accordance with specified test method:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	73, minimum	percent by volume
Solids Content	ASTM D2697	81, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	28, minimum	degrees C
Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	73, minimum	percent by volue
Solids Content	ASTM D2697	81, minimum	percent by weight

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Flash Point	ASTM D56 or ASTM D93	82, minimum	degrees F

Provide cured aromatic urethane elastomer having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 24 degrees C, 50 degrees relative humidity	400, minimum	percentage
Tensile Strength	ASTM D412, die C, 24 degrees C, 50 degrees relative humidity	6895, minimum	kPa
Permanent Set at break	ASTM D412	25	percentage
Change in Elongation, Tensile Strength, Permanent Set after Heat Aging 26 weeks at 65 degrees C	ASTM D412	1.0 within tolerance of test	percentage
Tear Resistance	ASTM D624, Die C	26.25 minimum	KN per meter
UV Exposure	ASTM D822, ASTM G155, ASTM G154, 6000 hours in atlas xenon or carbon arc weatherometer, or QUV	No cracking, checking, loss of flexibility or significant discoloration	---
Water Absorption, 168 hours, 24 degrees C	ASTM D570	2.0, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	60, minimum	points

Properties in Metric Units

Properties	ASTM Test	Value	Units
Permeability	ASTM E96/E96M Procedure E 0.50 mm thickness	1.0, maximum	perms

Properties in Inch-Pound Units

Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 75 degrees F, 50 degrees relative humidity	400, minimum	percentage
Tensile Strength	ASTM D412, die C, 75 degrees F, 50 degrees relative humidity	1000, minimum	psi
Permanent Set at break	ASTM D412	25, minimum	percentage
Change in Elongation, Tensile Strength, Permanent Set after Heat Aging 26 weeks at 65 degrees C	ASTM D412	1.0 within tolerance of test	percentage
Tear Resistance	ASTM D624, Die C	150, minimum	Pounds per linear inch
UV Exposure	ASTM D822, ASTM G155, ASTM G154, 6000 hours in atlas xenon or carbon arc weatherometer, or QUV	No cracking, checking, loss of flexibility or significant discoloration	---
Water Absorption, 168 hours, 75 degrees F	ASTM D570	2.0, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	60, minimum	points
Permeability	ASTM E96/E96M Procedure E 20 mils thickness	1.0, maximum	perms

][2.3.4 Type CF Coating

Provide aliphatic urethane elastomer, [one][two] component, cured elastomer having no urethane groups bonded directly to aromatic rings. Provide uncured urethane having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	55, minimum	percent by volume
Solids Content	ASTM D2697	69, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	22, minimum	degrees C

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	55, minimum	percent by volue
Solids Content	ASTM D2697	69, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	71, minimum	degrees F

Provide cured aliphatic urethane elastomer having the following values when tested for specified properties in accordance with specified test method:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 24 degrees C, 50 degrees relative humidity	150, minimum	percentage
Tensile Strength	ASTM D412, die C, 24 degrees C, 50 degrees relative humidity	11030, minimum	kPa
Permanent Set at break	ASTM D412	15	percentage
Tear Resistance	ASTM D624, Die C	34.13 minimum	KN per meter

Properties in Metric Units

Properties	ASTM Test	Value	Units
UV Exposure	ASTM D822, ASTM G155, ASTM G154, 6000 hours in atlas xenon or carbon arc weatherometer, or QUV	No cracking, checking, loss of flexibility or significant discoloration	---
Water Absorption, 168 hours, 24 degrees C	ASTM D570	2.0, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	60, minimum	points
Permeability	ASTM E96/E96M Procedure E 0.50 mm thickness	1.0, maximum	perms

Properties in Metric Units

Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 75 degrees F, 50 degrees relative humidity	400, minimum	percentage
Tensile Strength	ASTM D412, die C, 75 degrees F, 50 degrees relative humidity	1000, minimum	psi
Permanent Set at break	ASTM D412	25, minimum	percentage
Tear Resistance	ASTM D624, Die C	150, minimum	Pounds per linear inch
UV Exposure	ASTM D822, ASTM G155, ASTM G154, 6000 hours in atlas xenon or carbon arc weatherometer, or QUV	No cracking, checking, loss of flexibility or significant discoloration	---
Water Absorption, 168 hours, 75 degrees F	ASTM D570	2.0, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	60, minimum	points

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Permeability	ASTM E96/E96M Procedure E 20 mil thickness	1.0, maximum	perms

]2.3.5 Energy [and Cool] Roof Performance

****

NOTE: Standards such as UFC 1-200-02 promote the use of cool roofing, and increased energy conservation through additional insulation. Design cool roofs following the requirements in UFC 3-110-03 "Roofing" Chapter 1, Cool Roofs. Consider that when cool roofing is used with insulation R values greater than 24, the 'cool roof' surface has little if no influence on the energy performance of the building. Additionally, designers should be aware of the possible negative impacts of using cool roofing that may result in unintended consequences. Poor design of cool roofs in ASHRAE climate zones 4 and higher have resulted in the unintended consequence of condensation below the membrane-a result of the material's inability to warm and drive moisture downward. Roofs that experience this condensation have had to be replaced. Other unintended consequences include the overheating of masonry walls, interior spaces, roof top piping and mechanical equipment as a result of the reflected UV rays.

****

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NOTE: Design cool roofs following the requirements in UFC 3-110-03 Roofing, Appendix B, and ASHRAE 90.1 Chapter 5, for the design of insulation and energy performance of the building. Design insulation for cool roofs in accordance with the minimum requirements of ASHRAE 90.1 Chapter 5 zone requirements. Inadequate design of cool roofs in ASHRAE climate zones 4 and higher have resulted in unintended consequences of condensation below the membrane, overheating of masonry walls, interior spaces, roof top piping and mechanical equipment as a result of the reflected UV rays.

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NOTE: If a cool roof is selected, meet the ASHRAE 90.1 Chapter 5 values for cool roofing. The roofing system will need to include a top surface layer (e.g. protective coating or surface) that meets Energy Star criteria for Cool Roof Products; see http://energy.gov/eere/femp/covered-product-category-cool-roof-products. **If a cool roof is not selected in zones 1-3, meet one of the exception requirements listed in ASHRAE**

90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Retain the last bracketed sentence for project with sustainable third party certification credit requirement for reduced heat island effect.
****

Install a roof system that meets an overall performance as specified on the drawings or by insulation specified in other sections.[The roofing system will need to include a top surface finish that meets the criteria for Cool Roof Products.[Provide emittance and reflectance percentages, solar reflectance index values, [and] slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]]

[2.3.6 Energy Star

****
NOTE: Top protective coatings or additional coatings can also provide Energy Star classification as a final surface. Typical colors are white, tan, and other light colors. In review of the overall performance of the roof, color and materials specified earlier in this specification, the designer has the option to include Energy Star rating by including the paragraph below.
****

Provide a protective or top coating product that is also Energy Star labeled and is produced and compatible with the roof material of this specification. Provide data identifying Energy Star label for top coating product. Install to the manufacturer's written installation methods. Provide written confirmation that installation of a protective or additional top coat will not modify or void the required roof warranty.

]2.3.7 Coating Color

****
NOTE: Select or insert required color for finish coat. Delete remaining options.
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Provide coating layers of distinguishably different color such that dry film thickness of each layer of the completed application can be determined. Provide finish coat as [white][off-white][light gray][gray][_____].

2.4 PRIMER

Provide primers as required and recommended by the coating and spray foam materials manufacturer for the substrate to be covered. Provide rust-inhibiting primer on ferrous metal surfaces. Cut-back asphalt primers are prohibited.

[2.5 CERAMIC GRANULES

****
NOTE: Mineral granules may be embedded in wet finish coat of silicone coatings. Mineral granule surfacing is generally not required with urethane

coating but can be used if desired. Granules are used to:

1. Improve impact resistance to foot traffic, dropped tools, bird pecking, and other impacts;

2. Improve fire resistance;

3. Improve appearance.

****

Provide aggregate surfacing of siliceous mineral granules, 98 percent passing the No. 10 sieve and 98 percent retained on the No. 35 sieve. Provide granules that are free of fines and dust. Provide one-color granule surfacing with the granule color compatible with the color of the topcoat. The color of granules will be selected by the Contracting Officer from the manufacturer's samples and descriptive literature.

]2.6 SEALANTS

Provide sealants as recommended by the coating manufacturer.

[2.7 WALKPADS

Breathable material as recommended by the roof system manufacturer, minimum 1.0 m by 1.2 m 3 ft by 4 ft.

]2.8 TRAFFIC AREA FABRIC

Provide traffic fabric that complies with ASTM D579/D579M, style 1620[, or non-woven polyester as approved by the roof material manufacturer].

2.9 INSPECTION TOOLS

Maintain the following inspection tools on site for use in evaluating conditions and quality:

a. Moisture meter - to measure degree of moisture within or on the substrate surface.

b. Sling Psychrometer and psychrometric chart, or electronic psychrometer or hygrometer - to measure ambient temperature, humidity and dew point.

c. Surface thermometer - to read temperature of a surface.

d. Optical comparator - to read dry film thickness.

e. Magnifying glass, minimum 75 mm 3 inch - to inspect surface conditions.

f. Wet film thickness gauge - read wet film thickness.

g. Probe wire (0.025 inches diameter, maximum) - to inspect foam depth.

PART 3 EXECUTION

3.1 PROTECTION OF PROPERTY

Protect the building structure, equipment, and other surfaces adjacent to the work from overspray from foam and coating materials. Provide protective coverings secured and vented to prevent collection of moisture on covered surfaces. Use protective shields or barriers when spraying along open roof edges and walls to prevent uncontrolled overspray. Restore or replace any surfaces damaged by roof system products to the satisfaction of the Government at no additional expense to the Government.

3.1.1 Masking

Provide masking protection to protect surfaces immediately adjacent to foam and coating terminations at time of application. Adjust or provide new masking protection at roof perimeter to protect surfaces immediately adjacent to coating terminations and to provide for clean smooth coating termination lines.

[3.1.2 Warning Signs

Post warning signs at ground level in the adjacent to the work area and a minimum of 45.72 meters 150 feet from the application area stating the area is off limits to unauthorized persons and warning of potential overspray hazard. Place clearly visible and legible warning sign at entrance to primary road leading to the project facility warning of presence of flammable materials, irritating fumes, and potential of overspray damage.

]3.2 SPECIAL PRECAUTIONS AND INSTRUCTIONS

3.2.1 Safe Working Load Limits

Do not place materials or equipment on the roof deck exceeding the indicated live load limits of the roof construction.

3.2.2 Primers

Do not dilute primers or other materials unless required and recommended by the manufacturer. Do not use cleaning solvents for thinning primers or other materials.

3.2.3 Material Handling

Handle materials and containers during application work safely and in accordance with recommendations of the manufacturer. Store liquids in airtight containers and keep containers closed except when removing materials. Do not use equipment or containers containing remains of dissimilar materials or products. Do not install items that show visual evidence of biological growth.

3.2.4 Shoes

Wear clean, soft-soled shoes without heels while walking on roofing surfaces during installation.

3.2.5 Fire and Explosion Hazards

Prohibit open flames, sparks, welding, and smoking in the application area. Provide and maintain a fire extinguisher of appropriate type and size in the application area.

3.3 ROOF AREA PREPARATION

3.3.1 Preapplication Inspection

****

NOTE: Provide expansion joints in the roofing at each expansion joint in the structure, where substrate material changes, and at each intersection where an L- or T-shaped roof deck changes direction. Locate expansion joints at high points, where practicable, and place on curbs above the water line.

NOTE: Clamping rings on in-roof drain receivers are not required and should not be used with spray foam roofing systems.

NOTE: Equipment should be mounted on curbs integrally sealed with the roof system. Curbs should be minimum of one foot high. If possible, complete foam and elastomeric weather coating prior to mounting equipment. Equipment mounted over roof should have not less than 24 inches of clearance between bottom of equipment and roof surface.

****

Ensure that [curbs,] [roof penetrations,] [drains,] [equipment supports,] [cants,] [control joints,] [expansion joints,] [perimeter walls,] and perimeter foam stops are in place prior to the application of the [primer and] spray polyurethane foam.

3.3.1.1 Surface Examination

Examine surfaces and correct defects that may adversely affect the roofing system application or performance.

3.3.2 Close Intake Vents

****

NOTE: Specify whether ventilation shutdown will be required during the roof system application. Reroofing projects require closer attention to this issue. Delete "shutdown" if job is new construction and the ventilation system is not being used. Shutdown of the ventilation equipment is necessary to avoid drawing fumes into interior spaces. Where loss of air conditioned rooms is critical, specify portable ventilation and air conditioning units.

****

Seal off [and shutdown] air intake vents during foam and coating application. Coordinate with the Contracting Officer. [Give the Contracting Officer 7 days notice before shutting down ventilation equipment.] [Provide portable ventilation and air conditioning during shutdown [as required by the Contracting Officer][to Room [_____].]]

3.4 GENERAL APPLICATION

Install applications as specified and in general accord with requirements and recommendations of ASTM D5469/D5469M and NRCA RoofMan "Quality Control

Guidelines in the Application of Spray Polyurethane Foam Roofing".

3.5 SURFACE PREPARATION FOR FOAM APPLICATION

Verify surfaces that are to be primed or receive spray foam application are dry; completely cured; free of grease, oils, dirt and other foreign matter or contaminants which will interfere with total adhesion of primer and polyurethane foam. Prior to foam application, fill or otherwise seal openings where foam spray may damage or contaminate interior items or surfaces.

[3.5.1 Ferrous Metal

Sandblast iron and steel surfaces which are not primed, shop painted, or otherwise protected in accordance with SSPC SP 6/NACE No.3. Remove loose rust and unsound primer from shop-primed iron and steel surfaces by scraping or wire brushing.

][3.5.2 Concrete Decks

Remove spalling and loose material from the concrete deck and prime, if required, in accordance with recommendations of the manufacturer of the spray polyurethane foam materials.

][3.5.3 Wood Decks and Other Wood Surfaces

****

NOTE: Spray foam may be applied to wood decks when the following minimum requirements are met: Wood decks are designed and constructed for maximum deflection of L/240 under all loading conditions, including dead and live loads and loads from construction or maintenance; all laminated woods have waterproof adhesives; all plywood is at least equal to PS-1, Exterior grade B-C, 13 mm 1/2 inch thick, with edge joints supported by framing. Foam used on wood roofs should not be placed over plank-type or tongue-and-groove wood decks unless decks are first overlaid with 6mm 1/4 inch Exterior grade B-C plywood and nailed on 12 inch centers with 4d, annular-groove nails.

****

Prime untreated and unpainted surfaces. If painted, inspect surfaces for adhesion problems.

][3.5.4 Existing Roof Covering Surfaces

****

NOTE: This specification is written for new construction; adaptation of this system to reroofing jobs requires preparation of the existing roof in accordance with the spray foam roof manufacturer's recommendations. Requirements vary based on existing roof type. Where gravel, aggregate or ballasted roof is present, surfacing must be removed prior to spray foam application.

****

Prepare existing roof covering systems to receive spray polyurethane foam in accordance with recommendations of manufacturer of the spray polyurethane foam materials.

]3.6 SPRAY FOAM APPLICATION

3.6.1 Spray Foam

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NOTE: Specify minimum thickness. This thickness is that required to attain the U-factor for the complete roof construction including insulation requirements for the design of heating and air-conditioning systems, except that not less than 38 mm 1-1/2 inch thickness must be specified.

****

Apply foam to provide a minimum finished thickness of[38 mm 1-1/2 inches][_____] inches in at least two spray passes. Apply each spray pass at right angles to the previous pass to the extent practicable. Each pass, except for filleting or tapering as required at terminations, must be between 13 mm 1/2 inch and 25 mm 1 inch in thickness. Check foam thickness during application by probing depth with probe wire. Adjust application procedures as necessary to develop required foam thickness.

3.6.2 Terminations

Unless otherwise indicated, conform with manufacturer's standard details, for foam thickness around drains, penetrations, curbs, and other terminations. Install transitions between horizontal and vertical surfaces as smooth and sprayed at a nominal angle of 45 degrees. Terminate foam uniformly a minimum of 100 mm 4 inches above the roof line at all curb, stack, pipe and other vertical penetrations and boundary terminations in the roof, unless otherwise indicated or required by the roof system manufacturer and approved by the Contracting Officer. At metal eave and rake terminations provide V-cut 13 mm 1/2 inch deep into the foam and fill with sealant compatible with the coating system prior to application of the coating.

3.6.3 Surface Uniformity

Do not exceed the minimum thickness of the foam by more than 13 mm 1/2 inch, except as necessary at transitions and penetrations, or as otherwise approved by the Contracting Officer. Apply the foam of a sufficient overall surface uniformity to prevent water ponding. Using the finished spray foam surface, provide free drainage of the roof area.

3.6.4 Finish Appearance and Texture

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NOTE: Surface Texture: Spray foam tends to telegraph surface over which it is applied. Therefore, some broadcasting of deck joints, lines, offsets, and other irregularities may appear in finished foam surface unless specified otherwise. Where a smooth, even plane is required, specify as such and insert requirements for filling of with a base layer of foam or leveling of base layer of foam by shaving or scarfing prior to primary foam layers

application.
****

Provide the finished surface of applied foam as[a smooth, even plane] free of ridges, bumps, pinholes, depressions, crevices, voids, or oxidation. Provide a surface that is "course orange peel" or smoother in conformance with photographic standards of ASTM D5469/D5469M or SPFA AY-104. Remove and replace any spongy, delaminating, brittle, or otherwise non-complying areas of foam.

3.6.5 Foam Finish Correction

If the sprayed foam skin is removed to correct surface texture or to remove excess foam thickness, respray the cut surface with foam formation at least 13 mm 1/2 inch thick to provide a protective foam skin prior to application of the protective coating.

3.6.6 Finish Removal

Remove foam that is not bonded, of poor cell structure, wet, or otherwise does not meet the material quality specifications.

3.6.7 Application Time Limits

Do not start foam application on an area larger than can be brought to the specified full foam thickness, cured, and coated with the base coat of the coating system on the same day. Allow no applied foam, except for leading edges, to stand uncoated overnight. Inspect the leading edge of foam before resuming work the next day. Remove and replace damaged or wet foam material.

3.6.8 Curing Time

Cure the applied foam for a minimum of 2 hours and as otherwise recommended by the foam manufacturer prior to application of the protective coating.

3.6.9 Spray Foam Clean Up

Remove overspray masking materials and coverings upon completion of the spray foam application and prior to the application of the protective coating. Do not remove the masking over air intake vents until two hours after application of the foam. Remove foam overspray found on adjacent surfaces not scheduled to application of the protective coating.

3.7 SURFACE PREPARATION FOR PROTECTIVE COATING APPLICATION

Apply roof coating on surfaces free of water, grease, oils, dirt, debris, and other foreign materials, and cured completely.

3.7.1 [Metal] [Concrete] [and] [Masonry] Surfaces

[Clean rust and scale from metal surfaces which are to receive roof coatings by abrasive cleaning or wire brushing. Wipe with an industrial solvent such as naphtha or mineral spirits.] [Wire brush [concrete] [and] [masonry] surfaces which are to receive roof coatings, and remove resulting dust.]

3.7.2 Primer

Apply as recommended by the coating manufacturer.

3.7.3 Sealant

Apply as recommended by the coating manufacturer to include application in V-groove at eave and rake terminations.

3.8 PROTECTIVE COATING APPLICATION

Apply protective coating on foam insulation not less than 2 hours after but on the same day as installation of the foam insulation. Do not leave foam uncoated overnight. Apply coating on insulation, and continue up walls and roof penetrations to a point indicated, but not less than 50 mm 2 inches beyond foam termination where conditions will allow. Provide terminal edges of the foam at roof penetrations, terminations, and roof edges with an extra base coat back 100 mm 4 inches from the edge of the foam and onto adjacent substrate surface. Check roof coating wet film thickness during application to ensure that the wet mil thickness required for each coat is provided. For each coat, provide a dry film thickness not less than specified in paragraph entitled "Minimum Dry Film Thickness (DFT) in Mils." Provide smooth coatings free of runs, dry spray, or overspray, and provide a uniform film over the foam. Consider that coating applications can result in possible coverage loss due to overspray, waste, foam texture, wind, and other factors that affect coverage rate. Adjust methods and quantities to provide the minimum DFT for each coating layer free of blowholes, pinholes, voids, blisters, and other conditions detrimental to coating performance.

3.8.1 Base Coat Application

Apply Type [A] [B] [CB] coating as the base coat. Apply in accordance with manufacturer's printed installation instructions in a manner and rate to provide full coverage at the specified DFT. Apply coating uniformly and in one direction. Inspect the completed surface for blowholes, pinholes, cracks, breaks, voids, blisters, and other defects and repair with base coat material. Allow base coat to cure as recommended by the coating manufacturer prior to application of intermediate coat, but in no case allow the base coat cure time to be less than 2 hours. Check cured base coat to determine dry film thickness before applying the next coat. Clean areas of base coat which become dirty with a clean wet cloth prior to application of intermediate coat.

3.8.2 Intermediate Coat Application

Apply Type [A] [B] [CB] coating in same manner as base coat except apply in a direction perpendicular to the direction in which base coat was applied. Apply intermediate coat within 48 hours of base coat application. Apply in accordance with manufacturer's printed installation instructions in a manner and rate to provide full coverage at the specified DFT. Allow intermediate coat to cure as recommended by the coating manufacturer prior to application of finish coat, but in no case allow the base coat cure time to be less than 2 hours. Check cured intermediate coat to determine dry film thickness and inspect surface for blowholes, pinholes, cracks, breaks, voids, blisters, and other defects. Repair with intermediate coat material before applying finish coat. If base or intermediate coat thickness is deficient, apply additional intermediate coat prior to applying finish coat to bring total dry film thickness up to that required.

3.8.3 Finish Coat Application

Apply Type [A] [B] [CB] [CF] coating as finish coat in accordance with manufacturer's printed installation instructions in a manner and rate to provide full coverage at the specified DFT, exclusive of granules. Apply in a direction perpendicular to the direction in which intermediate coat was applied. Provide finish coat free of blowholes, pinholes, cracks, breaks, voids, blisters, and other defects that may affect performance, durability, and longevity of the coating.

3.8.4 Minimum Dry Film Thickness (DFT)

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NOTE: When Type CB and CF coating is used in hot and humid climates, specify a total minimum DFT of 1 mm 40 mils with a minimum base and finish coat thickness of 38 mm 15 mils each.

****

Type	Base Coat	Intermediate Coat	Finish Coat	Total System
[A-Silicone]	[0.25 mm]	[0.13 mm]	[0.25 mm]	[0.64 mm]
[B-Silicone]	[0.25 mm]	[0.13 mm]	[0.25 mm]	[0.64 mm]
[CB-Urethane]	[0.25 mm]	[0.13 mm]	[0.25 mm]	[0.75 mm]
[CF-Urethane]			[0.25][0.38] mm	[[0.75][0.88] mm]

Type	Base Coat	Intermediate Coat	Finish Coat	Total System
[A-Silicone]	[10 mils]	[5 mils]	[10 mils]	[25 mils]
[B-Silicone]	[10 mils]	[5 mils]	[10 mils]	[25 mils]
[CB-Urethane]	[10 mils]	[10 mils]	[10 mils]	[30 mils]
[CF-Urethane]			[10][15] mils	[[30][35] mils]

3.8.5 Granule Surfacing

****

NOTE: Mineral granules may be embedded in wet finish coat of silicone coatings. Mineral granule surfacing is generally not required with urethane coating but can be used if desired. Granules are used to:

1. Improve impact resistance to foot traffic,

dropped tools, bird pecking, and other impacts;

2. Improve fire resistance;

3. Improve appearance.
****

Spray-apply mineral granules to finish coat, coating within 2 to 5 minutes after application of finish coating, depending on temperature and humidity, as required by roof coating manufacturer's printed installation instructions. Apply using a sand blaster with output pressure reduced to 69 to 138 kPa 10 to 20 psi. Apply granules to surface evenly at a rate of 25 kg per 10 square meters 50 pounds per 100 square feet.[Provide granules in full coverage of the roof surface.][Cover bare spots by applying additional finish coat and granules.] Do not allow traffic on finished areas for minimum 24 hours after granule application is completed.

3.8.6 Penetrations

Apply an additional 0.25 mm 10 mil finish coat for one meter 3 feet all around roof access locations and 0.75 meters 2 feet around all penetrations. Double the specified coating system thickness at all drain sumps, applied in maximum 0.38 mm 15 mil thickness per coat.

3.8.7 Walkways

****
NOTE: Walkways should be specified whenever heavy foot traffic on the roof is expected.
****

Provide reinforced[walkways][walkpads] where indicated. Provide traffic paths consisting of[additional application of finish coat and granules over first layer of granules and finish coat][a layer of reinforcing fabric laid smooth into and fully overcoated with an additional finish coat to extend minimum 150 mm 6 inches beyond edges of fabric.].

3.8.8 Coating Application Clean-Up

Clean surfaces that receive roof coating materials which are not designated to receive such materials. Remove overspray masking materials and coverings upon completion of the coating work.

3.9 FIELD QUALITY CONTROL

3.9.1 Construction Monitoring

During progress of the roof work, make visual inspections as necessary to ensure compliance with specified parameters. Additionally, verify the following:

a. Protection measures are in place.

b. Equipment is in working order. Metering devices are accurate.

c. Materials are not installed in adverse weather.

d. Surfaces are cleaned and primed and substrates are in acceptable condition prior to application of materials.

e. Materials comply with specified requirements.

f. All materials are properly stored, handled and protected from moisture or other damages.

g. Foam material is applied in minimum of two passes, or lifts, applied perpendicular to the subsequent pass and in thickness from 13 mm 1/2 inch to 38 mm 1-1/2 inches per lift.

h. Foam is free of blistering in its formation and the surface texture is as specified.

i. Foam is applied to provide for positive drainage of the roof area.

j. Foam is cured minimum of 2 hours and in accordance with manufacturer requirements prior to coating application.

k. Base coat is applied to fully cover the applied foam at the end of each work day.

l. Coating is applied in a minimum of three coats as specified. Each coat is applied perpendicular in direction to the preceeding coat.

m. Wind screens are utilized as necessary.

n. Foot traffic is prohibited on foamed and coated surfaces until completely cured.

o. Granules, where utilized, are embedded as specified.

3.9.2 Coating Wet Film Thickness Monitoring

Prior to application of base coat, place one 100 mm 4 inch square flat metal test plate on surface of foam insulation for every 10 square meters 100 square feet to measure wet film thickness of coating during application. During application of intermediate and finish coats, place plates on surface of previously applied coat in same manner.

3.9.3 Slit samples

Inspect top-coated foam by cutting a minimum of one V-shaped 50 mm 2 inch long by 6 mm 1/4 inch deep sample for every 100 square meters 1000 square feet of roof area as selected at random by the Contracting Officer. Provide one edge of the V-shaped sample at a 90 degree angle to the coated surface. Examine and measure coating thickness of each sample with an optical comparator. Inspect samples at peaks of surface texture of foam, not at valleys. Do not average measurements of DFT of coating. Report slit sample observations in the daily log and provide slit samples to the Government as a part of the daily log. Bag slit samples and identify by sequentially numbering, dating, and locating on roof plan. Completely seal cut areas by filling them with and lapping over adjacent undisturbed coating with caulking material recommended by the coating manufacturer. Recoat areas where representative samples indicate inadequate thickness and sample again until specified DFT is achieved.

3.9.4 Core samples

Remove minimum of one, 50 mm 2 inch diameter or 50 mm 2 inch square core sample from each day's foam application as directed by the Contracting Officer. Visually examine core samples for proper foam thickness, lift thickness, cell formation and adhesion. Verify foam is free of blisters, voids, and delaminations, and displays full cell formation without spongy nature or brittleness. Identify core samples by sequentially numbering, dating, and locating on roof plan. Report core sample observations on daily log. Maintain core samples at the job site throughout the work for observation by Government personnel. Provide core samples to the Government at completion of the work. Provide additional core samples as directed by the Contracting Officer for laboratory testing to verify conditions and material properties, including compressive strength, density, and cell structure by test methods outlined in ASTM D5469/D5469M. Provide only one core for each day's application unless deficiencies are found that require further testing to determine extent of such deficiency. Provide independent laboratory testing from an independent laboratory approved by the Contracting Officer and at no additional cost to the Government. The Government maintains the right to conduct laboratory testing of core samples for confirmation of conditions. Repair all core locations to a watertight condition with spray applied foam or foam plug set in compatible sealant. Apply protective coating in the specified manner to the repaired area.

[3.9.5 Manufacturer's Field Inspection

Manufacturer's technical representative must visit the site as necessary during the installation process to ensure roof system materials are being applied in a satisfactory manner. As a minimum, manufacturer's technical representative must be present at work start-up and perform field inspection of the first day's completed application and at substantial completion, prior to demobilization of roofing contractor. Conduct inspection in the presence of Government representatives. After each inspection, submit an inspection report signed by the manufacturer's technical representative to the Contracting Officer within 2 working days. Within the inspection report state overall quality of work, deficiencies and any other concerns, and recommended corrective actions in detail. Notify the Contracting Officer a minimum of 2 working days prior to site visit by manufacturer's technical representative.

]3.9.6 Visual Inspection and Moisture Scanning

The Government may conduct a detailed visual inspection and nondestructive moisture scan of the completed installation prior to expiration of the Contractor warranty. The Contractor must repair any roof system deficiencies or remove moisture found in the roof system installation.

3.10 CORRECTION OF DEFICIENCIES

Correct any deficiencies as directed by the Contracting Officer at no additional cost to the Government.

3.11 CLEAN-UP AND DISPOSAL

Clean and remove all waste material, material containers, and debris daily and placed in appropriate trash containers. At completion of the work, remove all waste material, debris, and containers from the job site and disposed of as required by local regulations.

3.12 INFORMATION CARD

For each roof, furnish a typewritten information card for facility records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved 1 mm 0.032 inch thick aluminum card for exterior display. Provide cards that are 215 mm by 275 mm 8-1/2 by 11 inches minimum. On the information card identify facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, identification of foam substrate, foam thickness, type coating, foam and coating manufacturer, date of completion; installing contractor identification and contact information; manufacturer warranty expiration, warranty reference number, and contact information. Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-07 60 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 60 00 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 07 60 00

FLASHING AND SHEET METAL

08/23

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****

USACE / NAVFAC / AFCEC **UFGS-07 60 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 60 00 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 07 60 00

FLASHING AND SHEET METAL
08/23

****

NOTE: This guide specification covers the requirements for flashing and sheet metal work including gutters and downspouts, scuppers, splash pans, and sheet metal roofing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The specified sheet metal roofing is the type commonly used for on-site fabrication which does not include factory fabricated or preformed metal roofing. Preformed metal roofing is covered in other Division 7 sections. Gravity roof ventilators, roof scuttles, louvers, and similar items are not included in this section. This guide specification requires extensive editing when used with single ply roof systems in order to assure compatibility.

****

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NOTE: This Section covers counterflashing associated with roofing systems; however, through

wall flashing is included in the applicable wall system Sections. Edit and include wall system Sections as required by projects.

****

****

NOTE: Show details of sheet metalwork on project drawings in accordance with the appropriate details in the Architectural Sheet Metal Manual of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) 1793.

Coordinate specifications with the drawings so that drawing details and SMACNA 1793 requirements do not conflict or repeat. Delete references to SMACNA 1793 when requirements are detailed on the drawings.

****

****

NOTE: On the drawings, show:

1. Sheet metal roofing assembly, profile, extent, and slope. Specifying metal roofing for roofs with slope 3:12 or less is discouraged due to a propensity of metal roofs to leak at lower pitches. Consider other roof assemblies for 3:12 and lower slopes.

2. Roof drain, base, counter open valley, and eave flashings

3. fascia, drip edges, miscellaneous trim.

4. Gutters and downspouts.

5. Expansion joint details - (interior and exterior) at walls, ceilings, floors, roof, and parapets. Provide isometric details for expansion joint intersections.

****

PART 1 GENERAL

****

NOTE: Sheet metal color must be durable and long lasting and resist fading and chalking. Specify products such as coated steel, anodized aluminum, or baked enamel. Painting in the field, other than touch-ups are prohibited. This does not preclude the use of natural materials such as copper or aluminum, however avoid the use of copper where drainage from copper will pass over exposed masonry, stonework, or other metal surfaces.

Galvanized steel is not permitted as an option to other metals specified. Galvanized steel may be specified for temporary structures or where it may be satisfactory due to climatic conditions. Where galvanized steel is specified, make changes to the

text as follows:

Paragraph REFERENCES:

ASTM A653/A653M

(Galvanized) by the Hot-Dip Process,

Commercial Quality

Paragraph MATERIALS Add: Galvanized Steel: ASTM A653/A653M, Coating G90.

Paragraph PROTECTION FROM CONTACT WITH DISSIMILAR METALS: Require galvanized steel to be treated the same as aluminum, i.e., separated from copper or protected.

Paragraph INSTALLATION: Require galvanized steel to be soldered.

Paragraph EXPANSION JOINTS: Expansion joints to be spaced at 12.0 m 40 foot intervals for galvanized steel.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A308/A308M	(2010) Standard Specification for Steel Sheet, Terne (Lead-Tin Alloy) Coated by the Hot Dip Process
ASTM A480/A480M	(2024a) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B69	(2021) Standard Specification for Rolled Zinc
ASTM B101	(2022) Standard Specification for Lead-Coated Copper Sheet and Strip for Building Construction
ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM E1980	(2011; R 2019) Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces
ASTM E2112	(2023) Standard Practice for Installation of Exterior Windows, Doors and Skylights

COOL ROOF RATING COUNCIL (CRRC)

ANSI/CRRC S100	(2016) Standard Test Methods for Determining Radiative Properties of Materials

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0429	(2022) The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control and Reroofing

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SINGLE PLY ROOFING INDUSTRY (SPRI)

ANSI/SPRI RD-1	(2019) Performance Standard for Retrofit Drains
ANSI/SPRI/FM 4435/ES-1	(2017) Test Standard for Edge Systems Used with Low Slope Roofing Systems

1.2 GENERAL REQUIREMENTS

Finished sheet metal assemblies must form a weathertight enclosure without waves, warps, buckles, fastening stresses or distortion, while allowing for expansion and contraction without damage to the system. The sheet metal installer is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal modifications required to accommodate the work of other trades. Coordinate installation of sheet metal items used in conjunction with roofing with roofing work to permit continuous, uninterrupted roofing operations.

1.2.1 General Material Requirements

All materials specified in this Section installed in conjunction with the roofing system must be provided by the roofing system manufacturer, or by a manufacturer approved by the roofing system manufacturer for use in the roofing system, and must form a part of the Warranty as required by the applicable roofing system Section.

[1.2.2 Additional Wind Uplift Requirements

****

NOTE: When specific roofing requirements in other Sections (such as low slope roofs) include wind uplift requirements to comply with ES-1, include the following paragraph.

****

All flashing and edge materials specified in this Section must be installed in conjunction with the requirements of the roofing system to meet the requirements of ES-1 wind uplift. Details must include but not limited to ANSI/SPRI/FM 4435/ES-1 (ES-1), "Wind Test Design Standard for Edge Systems" used with Low Slope Roofing Systems, Test Methods: RE-1, RE-2 and RE-3 using uplift roofing details of the NRCA 0429.

]1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL

PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Exposed Sheet Metal Coverings; G, [_____]

Gutters; G, [_____]

Downspouts; G, [_____]

Expansion Joints; G, [_____]

Gravel Stops and fascia; G, [_____]

Splash Pans; G, [_____]

Flashing for Roof Drains; G, [_____]

Base Flashing; G, [_____]

Counterflashing; G, [_____]

Flashing at Roof Penetrations and Equipment Supports; G, [_____]

Reglets; G, [_____]

Scuppers; G, [_____]

Copings; G, [_____]

Drip Edges; G, [_____]

Conductor Heads; G, [_____]

Open Valley Flashing; G, [_____]

Eave Flashing; G, [_____]

Recycled Content; S

SD-03 Product Data

Cool Roof Data; G, [_____]

SD-04 Samples

Finish Samples; G, [_____]

SD-07 Certificates

Warranty on Finishes; G, [_____]

SD-08 Manufacturer's Instructions

Instructions for Installation; G, [_____]

[Quality Control Plan; G, [_____]

] SD-10 Operation and Maintenance Data

Cleaning and Maintenance; G, [_____]

1.4 MISCELLANEOUS REQUIREMENTS

1.4.1 Product Data

Indicate thicknesses, dimensions, fastenings, anchoring methods, expansion joints, and other provisions necessary for thermal expansion and contraction. Scaled manufacturer's catalog data may be submitted for factory fabricated items.

1.4.2 Finish Samples

Submit two color charts and two finish sample chips from manufacturer's standard color and finish options for each type of finish indicated.

1.4.3 Operation and Maintenance Data

Submit detailed instructions for installation and quality control during installation, cleaning and maintenance, for each type of assembly indicated.

1.5 DELIVERY, HANDLING, AND STORAGE

Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the job site. Remove from the site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until installation.

PART 2 PRODUCTS

2.1 RECYCLED CONTENT

Provide products with recycled content. Provide data for each product with recycled content, identifying percentage of recycled content.

2.2 MATERIALS

****

NOTE: Permit use of optional materials to extent that project design, relative costs, local environmental conditions, and commercial availability permit. Relative costs for materials listed in Table I range from 100 as index for stainless steel followed by terne-coated steel, zinc-coated steel, and copper in that order down to approximately 50 for aluminum, based on weights, gages and thicknesses indicated. Specify exposed

sheet metal in materials indicated except where additions to buildings require matching of existing and if the appearance of the building would be detrimentally affected by use of a different material. Use aluminum to match existing exposed zinc-alloy or galvanized metal, except in highly corrosive environments such as project locations with Environmental Severity Classification C3 thru C5, high humidity locations in and around industrial buildings, and areas that experience high winds or sand abrasion. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Where Contractor's choice is limited because of above conditions, revise accordingly. Delete items that do not apply. Weights and thicknesses listed are minimum for items described. If greater weights and thicknesses are justified by unusual local conditions, modify accordingly.

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NOTE: If material is not specified, Contractor will have a choice of aluminum, copper or stainless steel, as listed in NRCA Roofing Manual or SMACNA 1793 and not prohibited herein. If the material is specified, delete all other sheet metal specifications listed in this section. Lead or lead-coated sheet can be used for plumbing vents and other pipe penetrations through the roof, and may be used to match construction on historical preservation projects.

The minimum thicknesses specified in NRCA Roofing Manual or SMACNA 1793 may be increased and other materials may be used if justified by local conditions.

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NOTE: In humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, in an atmosphere laden with salt spray, stainless steel is recommended. Where salt spray is not severe, flashings, gutters, and downspouts may be of stainless steel, aluminum alloy (3003-N14), or copper. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Use any metal listed by NRCA 0429 or SMACNA 1793 for a particular item, unless otherwise indicated. Provide materials and configurations in accordance with NRCA 0429 or SMACNA 1793 for each material, while also meeting the minimum thickness requirements specified in this Section. Different items need not be of the same metal, except that[if copper is selected for any exposed item, all exposed items must be copper, and that] contact between dissimilar metals must be avoided.

Provide sheet metal items in 2400 to 3000 mm 8 to 10 foot lengths. Single pieces less than 2400 mm 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 300 mm 12 inch legs. Provide accessories and other items essential to complete the sheet metal installation. Provide accessories made of the same or compatible materials as the items to which they are applied. Fabricate sheet metal items of the materials specified below and to the gage, thickness, or weight shown in Table I at the end of this section. Provide sheet metal items with mill finish unless specified otherwise. Where more than one material is listed for a particular item in Table I, each is acceptable and may be used, except as follows:

2.2.1 Exposed Sheet Metal Items

Provide exposed sheet metal items of the same material. Consider the following as exposed sheet metal: gutters, including hangers; downspouts; gravel stops and fascia; cap, valley, steeped, base, and eave flashings and related accessories.

2.2.2 Drainage

Do not use copper for an exposed item if drainage from that item will pass over exposed masonry, stonework or other metal surfaces. In addition to the metals listed in Table I, lead-coated copper may be used for such items.

2.2.3 Copper, Sheet and Strip

Provide in accordance with ASTM B370, cold-rolled temper, H 00 (standard).

2.2.4 Lead-Coated Copper Sheet

****

NOTE: Factory-applied color coating on sheet aluminum and galvanized steel may be used on building additions where necessary to match existing galvanized or other exposed painted metal work. This coating may also be used on sheet aluminum and galvanized steel surfaces of new buildings where a long-life exterior color finish is desired.

****

Provide in accordance with ASTM B101.

2.2.5 Lead Sheet

****

NOTE: In humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, lead sheet is recommended for plumbing vents and other pipe penetrations through the roof. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Provide in a minimum weight of 19.6 kilograms per square meter 4 pounds per square foot.

2.2.6 Steel Sheet, Zinc-Coated (Galvanized)

****

NOTE: Factory-applied color coating on sheet aluminum and galvanized steel may be used on building additions where necessary to match existing galvanized or other exposed painted metal work. This coating may also be used on sheet aluminum and galvanized steel surfaces of new buildings where a long-life exterior color finish is desired.

****

Provide in accordance with ASTM A653/A653M, a minimum of 0.70 mm 24 gauge, and a minimum zinc coat weighting of 275 grams per square meter 90 ounces per square feet.

2.2.7 Zinc Sheet and Strip

Provide in accordance with ASTM B69, Type I, a minimum of 0.61 mm 0.024 inch thick.

2.2.8 Steel Sheet, Aluminum Zinc-Coated

****

NOTE: Factory-applied color coating on sheet aluminum and galvanized steel may be used on building additions where necessary to match existing galvanized or other exposed painted metal work. This coating may also be used on sheet aluminum and galvanized steel surfaces of new buildings where a long-life exterior color finish is desired.

****

Provide in accordance with ASTM A792/A792M, a minimum of 0.70 mm 24 gauge.

2.2.9 Stainless Steel

****

NOTE: Factory-applied color coating on sheet aluminum and galvanized steel may be used on building additions where necessary to match existing galvanized or other exposed painted metal work. This coating may also be used on sheet aluminum and galvanized steel surfaces of new buildings where a long-life exterior color finish is desired. Finishes are described in SMACNA Architectural Sheet Metal Manual. See ASTM A48/A48M for other than standard mill finishes.

****

Provide in accordance with ASTM A480/A480M, Type 302 or 304, 2D Finish, fully annealed, dead-soft temper, a minimum of 0.64 mm 24 gauge.

2.2.10 Terne-Coated Steel

Provide in accordance with ASTM A308/A308M, a minimum of 350 by 500 mm 14 by 20 inch with minimum of 18 kilogram 40 pound coating per double base box. ASTM A308/A308M.

2.2.11 Aluminum Alloy Sheet and Plate

****

NOTE: Factory-applied color coating on sheet aluminum and galvanized steel may be used on building additions where necessary to match existing galvanized or other exposed painted metal work. This coating may also be used on sheet aluminum and galvanized steel surfaces of new buildings where a long-life exterior color finish is desired.

****

****

NOTE: Do not use less than 0.813 mm 0.032-inch thick material in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. In hurricane and typhoon areas, ensure aluminum thickness is not less than 1.651 mm 0.065 inches where exposed to the direct wind. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Provide in accordance with ASTM B209/B209M[anodized [clear][color [_____][_____]]] form alloy, and temper appropriate for use. Provide material not less than [0.813 mm] [1.651 mm] [0.032-in] [0.065-in] in thickness.

[2.2.11.1 Alclad

When fabricated of aluminum, fabricate the following items with Alclad 3003, Alclad 3004, or Alclad 3005, clad on [one side][both sides] unless otherwise indicated.

a. Gutters, downspouts, and hangers

b. Gravel stops and fascia

c. Flashing

]2.2.12 Finishes

****

NOTE: If a cool roof is required, there are a number of methods by which to specify requirements; three are indicated below, as Contractor options.

Pitches of 3:12 or less metal roofs are not recommended, however, if specified, cool roof criteria is provided herein.

Cool roof colors are not necessarily light colors anymore. This has to do with the arrangement of ions in the finish coating which result in high

reflectance and emissivity values. High values indicate finishes best suited to save cooling energy and to reduce heat island effect. Such coatings are readily available from most manufacturers for nominal upcharges; look for 'cool' series colors and product data.

ASHRAE 90.1 Compliance:
UFC 3-110-03 Roofing requires that cool roofs meet ASHRAE 90.1 (2019 version) Chapter 5 values for cool roofing. The requirements of this standard are included herein, however, this method does not appear to differentiate roof angle to the sun (slope) and uses only aged values.

Third-Party Certification Compliance:
When pursuing a specific TPC, review the requirements for cool roof finishes and replace the "Cool Roof Finishes" section below with those requirements.
****

Provide exposed exterior sheet metal and aluminum with a baked on, factory applied coil fluoropolymer color coating or approved equal siliconized polyester coating. Dry film thickness of coatings must be 0.020 to 0.033 mm 0.8 to 1.3 mils. Color to be selected from[manufacturer's full range of "cool roof" color choices][manufacturer's standard range of color choices][manufacturer's full range of color choices][as indicated on the Drawings]. Field applications of color coatings are prohibited and will be rejected.

2.2.12.1 Warranty on Finishes

****
NOTE: Generally, a 20-year warranty is available for fluoropolymer finishes and a 10-year warranty is available for siliconized polyester finishes.
****

Provide a manufacturer's warranty to repair, or replace, sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within [20][10] years from date of project substantial completion. Deterioration includes the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.

b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.

c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2.2.13 Cool Roof Finishes

****
NOTE: Compliance with ASHRAE 90.1 is required on all projects. For ASHRAE 90.1 compliance, include this section as written for projects in ASHRAE

climate zones 0 thru 3. See ASHRAE 90.1 Chapter 5, section titled "Roof Solar Reflectance and Thermal Emittance", for exceptions when roof design conditions eliminate these requirements and this section can be deleted.

When a specific Third-party Certification is being pursued, cool roof finishes may be different than the requirements in this section; review the TPC requirements and edit this section accordingly.
****

Provide roof finishes having a minimum 3-year aged solar reflectance of 0.55, and a minimum 3-year aged thermal emittance of 0.75 when tested in accordance with ANSI/CRRC S100, or, a minimum 3-year aged Solar Reflectance Index of 64 when determined in accordance with the Solar Reflectance Index method in ASTM E1980 using a convection coefficient of 6.62 W per m2 2.1 BTU per h ft2, to comply with ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

2.2.14 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B221MASTM B221.

2.2.15 Solder

Provide in accordance with ASTM B32, 95-5 tin-antimony.

2.2.16 Reglets

2.2.16.1 Polyvinyl Chloride Reglets

Provide in accordance with ASTM D1784, Type II, Grade 1, Class 14333-D, 1.9 mm 0.075 inch minimum thickness.

2.2.16.2 Metal Reglets

Provide factory fabricated caulked type or friction type reglets with a minimum opening of 6 mm 1/4 inch and a depth of 30 mm 1-1/4 inch, as approved.

2.2.16.2.1 Caulked Reglets

Provide with rounded edges, temporary reinforcing cores, and accessories as required for securing to adjacent construction. Provide built-up mitered corner pieces for inside and outside corners.

2.2.16.2.2 Friction Reglets

Provide with flashing receiving slots not less than 16 mm 5/8 inch deep, 25 mm one inch jointing tongues, and upper and lower anchoring flanges installed at 600 mm 24 inch maximum snap-lock type receiver.

2.2.17 Scuppers

Line interiors of scupper openings with sheet metal. Provide a drip edge at bottom edges with returns of not less than 25 mm one inch against the face of the outside wall at the top and sides. Provide the perimeter of the lining approximately 13 mm 1/2 inch less than the perimeter of the scupper.

2.2.18 Conductor Heads

Provide conductor heads and screens in the same material as downspouts. Provide outlet tubes not less than 100 mm 4 inches long.

2.2.19 Splash Pans

Provide splash pans where downspouts discharge onto roof surfaces and at locations indicated. Unless otherwise indicated, provide pans not less than 600 mm long by 450 mm wide 24 inches long by 18 inches wide with metal ribs across bottoms of pans. Provide sides of pans with vertical baffles not less than 25 mm one inch high in the front, and 100 mm 4 inches high in the back.

2.2.20 Copings

Unless otherwise indicated, provide copings in copper sheets, 2400 or 3000 mm 8 or 10 feet long, joined by a 20 mm 3/4 inch locked and soldered seam.

2.2.21 Bituminous Plastic Cement

Provide in accordance with ASTM D4586/D4586M, Type I.

2.2.22 Roofing Felt

****

NOTE: The two types of asphalt-saturated felts are: type I which is commonly called No. 15 asphalt felt, and type II which is commonly called No. 30. These numbers no longer refer to product weights; see ASTM D2526 for more information. Edit paragraph as necessary to fit project requirements.

****

Provide in accordance with ASTM D226/D226M [Type I][Type II].

2.2.23 Asphalt Primer

Provide in accordance with ASTM D41/D41M.

2.2.24 Fasteners

****

NOTE: In humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, use stainless steel nails, bolts and fasteners. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Use the same metal as, or a metal compatible with the item fastened.[Use stainless steel fasteners to fasten.] Confirm compatibility of fasteners and items to be fastened to avoid galvanic corrosion due to dissimilar materials.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: On-site fabricated flat copper, zinc, or terne-coated steel metal roofing is not included in text of this guide specification because it is infrequently used. These materials do not require field painting. (However, if terne plate is used, field painting must be specified: one coat of iron oxide paint on underside before application, and on exposed surfaces after application. Exposed surfaces also require finish coat of compatible exterior oil paint over iron oxide paint). If design requires this type of metal roofing, edit subsections below as necessary.

****

3.1.1 Metal Roofing

[3.1.1.1 [Flat Copper,] [Zinc,] [Terne-coated Steel] Roofing

Before applying roofing, cover deck with rosin-sized roofing felt. Lap 50 mm 2 inch at joints and secure in place with roofing nails. Using solder of equal parts tin and lead, solder slowly with well-heated irons to thoroughly heat sheet and completely sweat solder through full width of seam.[Tin edges of copper to be soldered at least 20 mm 3/4 inch before sheets are locked.][Use stainless nails in terne-coated steel];[in copper, use solid copper or bronze roofing nails][in zinc, use zinc-coated roofing nails]. Where roof decks abut vertical surfaces, turn metal roofing up vertical surfaces about 200 mm 8 inch where practicable; where vertical surfaces are covered with applied materials, turn up roofing behind applied materials. Use standing-seam method for roofs having rise of more than one in four 3 inch per foot, and use flat-seam method when rise is one in four 3 inch per foot or less. Walking not permitted directly on metal roofs; provide approved walkways.

][3.1.1.2 Standing-seam Method

Make standing seams parallel with slope of roof. Fabricate sheets into long lengths at shop by locking short dimensions together and thoroughly soldering joints thus formed. In applying metal, turn up one edge of course at each side seam at right angles 40 mm 1.5 inch. Then install 50 by 75 mm 2 by 3 inch cleats spaced 300 mm 12 inches apart by fastening one end of each cleat to roof with two 25 mm one inch long nails and folding roof end back over nail heads. Turn end adjoining turned-up side seam up over upstanding edge of course. Turn up adjoining edge of next course 45 mm 1.75 inches and abutting upstanding edges locked, turned over, and flattened against one side of standing seam. Make standing seams straight, rounded neatly at the top edges, and stand about 25 mm one inch above roof deck. All sheets must be same length, except as required to complete run or maintain pattern. Locate transverse joints of each panel half way between joints in adjacent sheets. Align joints of alternate sheets horizontally to produce uniform pattern, as shown in SMACNA 1793.

][3.1.1.3 Flat-seam Method

Lay metal so short dimension is parallel to gutter or eave lines and so water will flow over and not into seams. Make seams by turning edges of sheet 20 mm 3/4 inch and lock and solder together. If sheets are laid one at a time, secure to roof deck with cleats, using three cleats to each sheet, two on long side and one on short side. Use cleats 50 mm 2 inches wide, hooked over 20 mm 3/4 inch upturned edges of sheets, and nail to roof deck with two 25 mm one inch long nails. Turn back roof end of cleat over nail heads before next sheet is applied. If desired, sheets may be made into long lengths at shop by locking short dimensions together and soldering seams thus formed. Turn long lengths 20 mm 3/4 inch, and secure each length to roof deck by cleats spaced 300 mm 12 inches apart. Mallet and solder seams after pans are in place. All sheets to be same length, except as required to complete run or maintain pattern. Locate transverse joints of each panel half way between joints in adjacent sheets. Align joints of alternate sheets horizontally to produce uniform pattern, as shown in SMACNA 1793.

]3.1.2 Workmanship

Make lines and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 13 mm 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793, Architectural Sheet Metal Manual. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.3 Nailing

****

NOTE: In humid locations or project locations with Environmental Severity Classifications (ESC) of C4 and C5, include the last sentence in the paragraph below for wind-resistant installations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Confine nailing of sheet metal generally to sheet metal having a maximum width of 450 mm 18 inches. Confine nailing of flashing to one edge only. Space nails evenly not over 75 mm 3 inch on center and approximately 13 mm 1/2 inch from edge unless otherwise specified or indicated. Face nailing is not permitted. Where sheet metal is applied to other than wood surfaces, include in shop drawings, the locations for sleepers and nailing strips required to secure the work.[Secure flashing at one-half the normal interval to ensure a wind-resistant installation.]

3.1.4 Cleats

Provide cleats for sheet metal 450 mm 18 inches and over in width. Space cleats evenly not over 300 mm 12 inches on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 50 mm wide by 75 mm long 2 inches wide by 3 inches long and of the same material and thickness as the sheet metal being installed. Secure one end of the cleat with two nails and the cleat folded back over the nailheads. Lock the other end into the seam. [Where the fastening is to be made to concrete or masonry, use screws and drive in expansion shields set in concrete or masonry.]Pre-tin cleats for soldered seams.

3.1.5 Bolts, Rivets, and Screws

Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection. Provide mechanically formed joints in aluminum sheets 1.0 mm 0.040 inches or less in thickness.

3.1.6 Seams

Straight and uniform in width and height with no solder showing on the face.

3.1.6.1 Flat-lock Seams

Finish not less than 20 mm 3/4 inch wide.

3.1.6.2 Lap Seams

Finish soldered seams not less than 25 mm one inch wide. Overlap seams not soldered, not less than 75 mm 3 inches.

3.1.6.3 Loose-Lock Expansion Seams

Not less than 75 mm 3 inches wide; provide minimum 25 mm one inch movement within the joint. Completely fill the joints with the specified sealant, applied at not less than 3 mm 1/8 inch thick bed.

3.1.6.4 Standing Seams

Not less than 25 mm one inch high, double locked without solder.

3.1.6.5 Flat Seams

Make seams in the direction of the flow.

3.1.7 Soldering

Where soldering is specified, apply to copper, terne-coated stainless steel, zinc-coated steel, and stainless steel items. Pre-tin edges of sheet metal before soldering is begun. Seal the joints in aluminum sheets of 1.0 mm 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

3.1.7.1 Edges

Scrape or wire-brush the edges of lead-coated material to be soldered to produce a bright surface. Flux brush the seams in before soldering. Treat with soldering acid flux the edges of stainless steel to be pre-tinned. Seal the joints in aluminum sheets of 1.0 mm 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

3.1.8 Welding and Mechanical Fastening

Use welding for aluminum of thickness greater than 1.0 mm 0.040 inch. Aluminum 1.0 mm 0.040 inch or less in thickness must be butted and the space backed with formed flashing plate; or lock joined, mechanically fastened, and filled with sealant as recommended by the aluminum manufacturer.

3.1.8.1 Welding of Aluminum

Use welding of the inert gas, shield-arc type. For procedures, appearance and quality of welds, and the methods used in correcting welding work, conform to AWS D1.2/D1.2M.

3.1.8.2 Mechanical Fastening of Aluminum

Use No. 12, aluminum alloy, sheet metal screws or other suitable aluminum alloy or stainless steel fasteners. Drive fasteners in holes made with a No. 26 drill in securing side laps, end laps, and flashings. Space fasteners 300 mm 12 inches maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 50 mm 2 inches from the end of the overlapping sheet.

3.1.9 Protection from Contact with Dissimilar Materials

3.1.9.1 Copper or Copper-bearing Alloys

Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moistureproof building felts.

3.1.9.2 Aluminum

****

NOTE: In humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, insert the last sentence. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Do not allow aluminum surfaces in direct contact with other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, paint the dissimilar metal with a primer followed by two coats of aluminum paint. Where drainage from a dissimilar metal passes over aluminum, paint the dissimilar metal with a non-lead pigmented paint.[Aluminum may be used over concrete construction, provided that required reglets are of stainless steel and aluminum surface in contact with concrete or masonry is coated with bituminous paint or zinc chromate primer.]

3.1.9.3 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.9.4 Wood or Other Absorptive Materials

Paint surfaces that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

3.1.10 Expansion and Contraction

Provide expansion and contraction joints at not more than 9750 mm 32 foot intervals for aluminum and at not more than 12 meter 40 foot intervals for other metals. Provide an additional joint where the distance between the last expansion joint and the end of the continuous run is more than half the required interval. Space joints evenly. Join extruded aluminum gravel stops and fascia by expansion and contraction joints spaced not more than 3600 mm 12 feet apart.

3.1.11 Base Flashing

****

NOTE: Bracketed first sentence applies only to shingled roofs. Do not include for built-up roofing. Normally, only bituminous base flashing should be specified with built-up roofing. Limit use of metal base flashing to locations where flashing is subject to damage by foot traffic and to runs of 6000 mm 20 feet or less when used with built-up roofing. Flashing for heating, plumbing, and electrical equipment should be specified in the appropriate sections.

****

[Lay the base flashings with each course of the roof covering, shingle fashion, where practicable, where sloped roofs abut chimneys, curbs, walls, or other vertical surfaces.]Extend up vertical surfaces of the flashing not less than 200 mm 8 inches and not less than 100 mm 4 inches under the roof covering. Where finish wall coverings form a counterflashing, extend the vertical leg of the flashing up behind the applied wall covering not less than 150 mm 6 inches. Overlap the flashing strips[or shingles] with the previously laid flashing not less than 75 mm 3 inches. Fasten the strips[or shingles] at their upper edge to the deck. Horizontal flashing at vertical surfaces must extend vertically above the roof surface and fastened at their upper edge to the deck a minimum of 150 mm 6 inches on center with[large headed aluminum roofing nails][hex headed, galvanized shielded screws] a minimum of 150 mm 2 inch lap of any surface. Solder end laps and provide for expansion and contraction. Extend the metal flashing over crickets at the up-slope side of [chimneys,][curbs,][and similar]vertical surfaces extending through sloping roofs, the metal flashings. Extend the metal flashings onto the roof covering not less than 115 mm 4.5 inches at the lower side of [dormer walls,][chimneys,][and similar]vertical surfaces extending through the roof decks. Install and fit the flashings so as to be completely weathertight. Provide factory-fabricated base flashing for interior and exterior corners. Do not use metal base flashing on built-up roofing.

3.1.12 Counterflashing

****

NOTE: Include the last bracketed sentence for use of two-piece counterflashing components in masonry or other exterior wall veneers where counterflashing

and reglets could be damaged during future reroofing activities.

****

Except where indicated or specified otherwise, insert counterflashing in reglets located from 230 to 250 mm 9 to 10 inches above roof decks, extend down vertical surfaces over upturned vertical leg of base flashings not less than 75 mm 3 inches. Fold the exposed edges of counterflashings 13 mm 1/2 inch. Where stepped counterflashings are required, they may be installed in short lengths a minimum [200 mm by 200 mm] [200 mm by 250 mm] 8 inches by 8 inches or may be of the preformed single piece type. Provide end laps in counterflashings not less than 75 mm 3 inches and make it weathertight with plastic cement. Do not make lengths of metal counterflashings exceed 3000 mm 10 feet. Form flashings to the required shapes before installation. Factory form corners not less than 300 mm 12 inches from the angle. Secure the flashings in the reglets with lead wedges and space not more than 450 mm 18 inches apart; on[chimneys and][stair/elevator towers] short runs, place wedges closer together. Fill caulked-type reglets or raked joints which receive counterflashing with caulking compound. Turn up the concealed edge of counterflashings built into masonry or concrete walls not less than 6 mm 1/4 inch and extend not less than 50 mm 2 inches into the walls. Install counterflashing to provide a spring action against base flashing.[Where bituminous base flashings are provided, extend down the counter flashing as close as practicable to the top of the cant strip. Factory form counter flashing to provide spring action against the base flashing.][Utilize two piece counterflashing components to minimize damage of counterflashing and reglets during future reroofing activities.]

3.1.13 Metal Reglets

Keep temporary cores in place during installation. Ensure factory fabricated caulked type or friction type, reglets have a minimum opening of 6 mm 1/4 inch and a minimum depth of 30 mm 1-1/4 inch, when installed.

3.1.13.1 Caulked Reglets

Wedge flashing in reglets with lead wedges every 450 mm 18 inches, caulked full and solid with an approved compound.

3.1.13.2 Friction Reglets

Install flashing snap lock receivers at 600 mm by 600 mm 24 inches on center maximum. When flashing has been inserted the full depth of the slot, caulk the slot, lock[with wedges], and fill with sealant.

3.1.14 Polyvinyl Chloride Reglets for Temporary Construction

Rigid polyvinyl chloride reglets may be provided in lieu of metal reglets for temporary construction.

3.1.15 Gravel Stops and fascia

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NOTE: On projects having smooth surfaced roofs, the upstanding leg of the gravel stop may be omitted. Specify in the appropriate roofing section. Coordinate installation requirements for sheet metal gravel stops and fascia with the referenced roofing

section.
****

Prefabricate in the shapes and sizes indicated and in lengths not less than 2400 mm 8 feet. Extend flange at least 100 mm 4 inches onto roofing. Provide prefabricated, mitered corners internal and external corners. Install gravel stops and fascia after all plies of the roofing membrane have been applied, but before the flood coat of bitumen is applied. Prime roof flange of gravel stops and fascia on both sides with an asphalt primer. After primer has dried, set flange on roofing membrane and strip-in. Nail flange securely to wood nailer with large-head, barbed-shank roofing nails 38 mm 1.5 inch long spaced not more than 75 mm 3 inches on center, in two staggered rows.

3.1.15.1 Edge Strip

Hook the lower edge of fascia at least 20 mm 3/4 inch over a continuous strip of the same material bent outward at an angle not more than 45 degrees to form a drip. Nail hook strip to a wood nailer at 150 mm 6 inches maximum on center. Where fastening is made to concrete or masonry, use screws spaced 300 mm 12 inches on center driven in expansion shields set in the concrete or masonry. Where horizontal wood nailers are slotted to provide for insulation venting, install strips to prevent obstruction of vent slots. Where necessary, install strips over 2 mm 1/16 inch thick compatible spacer or washers.

3.1.15.2 Joints

Leave open the section ends of gravel stops and fascia 6 mm 1/4 inch and backed with a formed flashing plate, mechanically fastened in place and lapping each section end a minimum of 100 mm 4 inches set laps in plastic cement. Face nailing is not permitted. Install prefabricated aluminum gravel stops and fascia in accordance with the manufacturer's printed instructions and details.

3.1.16 Metal Drip Edges

Provide a metal drip edge, designed to allow water run-off to drip free of underlying construction, at eaves and rakes prior to the application of roofing shingles. Apply directly on the wood deck at the eaves and over the underlay along the rakes. Extend back from the edge of the deck not more than 75 mm 3 inches and secure with compatible nails spaced not more than 250 mm 10 inches on center along upper edge.

3.1.17 Gutters

****
NOTE: Where it is local practice to omit gutters because of glaciation and ice damage, provide eave flashing in accordance with paragraph EAVE FLASHING.
****

The hung type of shape indicated and supported on underside by brackets that permit free thermal movement of the gutter. Provide gutters in sizes indicated complete with mitered corners, end caps, outlets, brackets, and other accessories necessary for installation. Bead with hemmed edge or reinforce the outer edge of gutter with a stiffening bar not less than 20 by 5 mm 3/4 by 3/16 inch of material compatible with gutter. Fabricate gutters in sections not less than 2400 mm 8 feet. Lap the sections a minimum of 25 mm one inch in the direction of flow or provide with concealed splice plate 150 mm 6 inches minimum. Join the gutters, other than aluminum, by riveted and soldered joints. Join aluminum gutters with riveted sealed joints. Provide expansion-type slip joints midway between outlets. Install gutters below slope line of the roof so that snow and ice can slide clear. Support gutters on[adjustable hangers spaced not more than 750 mm 30 inches on center][as indicated][by continuous cleats][and][or][by cleats spaced not less than 900 mm 36 inches apart]. Adjust gutters to slope uniformly to outlets, with high points occurring midway between outlets. Fabricate hangers and fastenings from compatible metals.

3.1.18 Downspouts

****

NOTE: For additions to existing buildings, downspouts may be specified to match the design of the existing portion of the building.

****

Space supports for downspouts according to the manufacturer's recommendation for the[wood][masonry] or[steel] substrate. Types, shapes and sizes are indicated. Provide complete including elbows and offsets. Provide downspouts in approximately 3000 mm 10 foot lengths. Provide end joints to telescope not less than 13 mm 1/2 inch and lock longitudinal joints. Provide gutter outlets with wire ball strainers for each outlet. Provide strainers to fit tightly into outlets and be of the same material used for gutters. Keep downspouts not less than 25 mm one inch away from walls. Fasten to the walls at top, bottom, and at an intermediate point not to exceed 1500 mm 5 feet on center with leader straps or concealed rack-and-pin type fasteners. Form straps and fasteners of metal compatible with the downspouts.

3.1.18.1 Terminations

Neatly fit into the drainage connection the downspouts terminating in drainage lines and fill the joints with a portland cement mortar cap sloped away from the downspout. Provide downspouts terminating in splash blocks with elbow-type fittings. Provide splash pans as specified.

3.1.19 Flashing for Roof Drains

Provide a 750 mm 30 inches square sheet indicated. Taper insulation to drain from 600 mm 24 inches out. Set flashing on finished felts in a full bed of asphalt roof cement, ASTM D4586/D4586M. Heavily coat the drain flashing ring with asphalt roof cement. Clamp the roof membrane, flashing sheet, and stripping felt in the drain clamping ring. Secure clamps so that felts and drain flashing are free of wrinkles and folds. Retrofit roof drains must conform to ANSI/SPRI RD-1.

3.1.20 Scuppers

Extend the scupper liner through and project outside of, the wall it penetrates to form a bottom drip edge against the face of the wall. Fold outside edges under 13 mm 1/2 inch on all sides. Join the top and sides of the lining on the roof deck side to a closure flange by a locked and soldered joint. Join the bottom edge by a locked and soldered joint to the closure flange, where required, form with a ridge to act as a gravel stop around the scupper inlet. Provide surfaces to receive the scupper lining and coat with bituminous plastic cement.

3.1.21 Conductor Heads

Set the depth of the top opening equal to two-thirds of the width or the conductor head. Flat-lock solder seams. Where conductor heads are used in conjunction with scuppers, set the conductor a minimum of 50 mm 2 inches wider than the scupper. Attach conductor heads to the wall with masonry fasteners. Securely fasten screens to heads.

3.1.22 Splash Pans

Install splash pans lapped with horizontal roof flanges not less than 100 mm 4 inches wide to form a continuous surface. Bend the rear flange of the pan to contour of can't strip and extend up 150 mm 6 inches under the side wall covering or to height of base flashing under counterflashing. Bed the pans and roof flanges in plastic bituminous cement and strip-flash as specified.

3.1.23 Open Valley Flashing

Provide valley flashing free of longitudinal seams, of width sufficient to extend not less than 150 mm 6 inches under the roof covering on each side. Provide a 13 mm 1/2 inch fold on each side of the valley flashing. Lap the sheets not less than 150 mm 6 inches in the direction of flow and secure to roofing construction with cleats attached to the fold on each side. Nail the tops of sheets to roof sheathing. Space the cleats not more than 300 mm 12 inches on center. Provide exposed flashing not less than 100 mm 4 inches in width at the top and increase 25 mm one inch in width for each additional 2400 mm 8 feet in length. Where the slope of the valley is one in 2.67 or less 4.5 inches or less per foot, or the intersecting roofs are on different slopes, provide an inverted V-joint, 25 mm one inch high, along the centerline of the valley; and extend the edge of the valley sheets 200 mm 8 inches under the roof covering on each side.

Valley flashing for asphalt shingle roofs is specified in Section 07 31 13 ASPHALT SHINGLES.

3.1.24 Eave Flashing

One piece in width, applied in 2400 to 3000 mm 8 to 10 foot lengths with expansion joints spaced as specified in paragraph EXPANSION AND CONTRACTION. Provide a 20 mm 3/4 inch continuous fold in the upper edge of the sheet to engage cleats spaced not more than 250 mm 10 inches on center. Locate the upper edge of flashing not less than 450 mm 18 inches from the outside face of the building, measured along the roof slope. Fold lower edge of the flashing over and loose-lock into a continuous edge strip on the fascia. Where eave flashing intersects metal valley flashing, secure with 25 mm one inch flat locked joints with cleats that are 250 mm 10 inches on center.

3.1.25 Flashing at Wall Openings

Install pan flashing in the rough opening sill at all penetrations in the exterior wall assemblies, such as windows, louvers, storefronts and curtain walls. Pan sill flashing must have end dams at both jambs a minimum of 50 mm 2 in high and a rear dam of 50 mm 2 in high. Flashing must comply with ASTM E2112 and SMACNA 1793.

3.1.26 Sheet Metal Covering on Flat, Sloped, or Curved Surfaces

Except as specified or indicated otherwise, cover and flash all minor flat, sloped, or curved surfaces such as crickets, bulkheads, dormers and small decks with metal sheets of the material used for flashing; maximum size of sheets, 375 by 455 mm 16 by 18 inches. Fasten sheets to sheathing with metal cleats. Lock seams and solder. Lock aluminum seams as recommended by aluminum manufacturer. Provide an underlayment of roofing felt for all sheet metal covering.

3.1.27 Expansion Joints

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NOTE: The Contract drawings should contain details of building expansion joints at walls, ceiling, floors, roof, and parapets. Include exterior and interior details. Provide isometric detailing for expansion joints intersections.

****

Provide expansion joints for roofs, walls, and floors as [specified][indicated]. Provide[expansion joints in continuous sheet metal at[12 meter 40 foot intervals for copper and stainless steel][and at 9750 mm 32 foot intervals for aluminum,][aluminum gravel stops and fascia which must have expansion joints at not more than 3600 mm 12 foot spacing]. Provide evenly spaced joints. Provide an additional joint where the distance between the last expansion joint and the end of the continuous run is more than half the required interval spacing]. Conform to the requirements of Table I.

3.1.27.1 Roof Expansion Joints

Consist of curb with wood nailing members on each side of joint, bituminous base flashing, metal counterflashing, and metal joint cover. Bituminous base flashing is specified in Roofing Section. Provide counterflashing as specified in paragraph COUNTERFLASHING, except as follows: Provide counterflashing with vertical leg of suitable depth to enable forming into a horizontal continuous cleat. Secure the inner edge to the nailing member. Make the outer edge projection not less than 25 mm one inch for flashing on one side of the expansion joint and be less than the width of the expansion joint plus 25 mm one inch for flashing on the other side of the joint. Hook the expansion joint cover over the projecting outer edges of counterflashing. Provide roof joint with a joint cover of the width indicated. Hook and lock one edge of the joint cover over the shorter projecting flange of the continuous cleat, and the other edge hooked over and loose locked with the longer projecting flange. Joints are specified in Table II.

3.1.27.2 Floor and Wall Expansion Joints

Provide U-shape with extended flanges for expansion joints in concrete and masonry walls and in floor slabs.

3.1.28 Flashing at Roof Penetrations and Equipment Supports

****

NOTE: Insert appropriate Section number and title in the blank below using format in accordance with UFC 1-300-02, Unified Facilities Guide

Specifications (UFGS) Format Standard.
****

Provide metal flashing for all pipes, ducts, and conduits projecting through the roof surface and for equipment supports, guy wire anchors, and similar items supported by or attached to the roof deck. Goose-necks, rain hoods, power roof ventilators, and [_____] are specified in [_____].

3.1.29 Single Pipe Vents

See Table I, footnote (d). Set flange of sleeve in bituminous plastic cement and nail 75 mm 3 inches on center. Bend the top of sleeve over and extend down into the vent pipe a minimum of 50 mm 2 inches. For long runs or long rises above the deck, where it is impractical to cover the vent pipe with lead, use a two-piece formed metal housing. Set metal housing with a metal sleeve having a 100 mm 4 inches roof flange in bituminous plastic cement and nailed 75 mm 3 inches on center. Extend sleeve a minimum of 200 mm 8 inches above the roof deck and lapped a minimum of 75 mm 3 inches by a metal hood secured to the vent pipe by a draw band. Seal the area of hood in contact with vent pipe with an approved sealant.

3.1.30 Stepped Flashing

Provide stepped flashing where sloping roofs surfaced with shingles abut vertical surfaces. Place separate pieces of base flashing in alternate shingle courses.

3.1.31 Copings

Provide coping with locked and soldered seam. Terminate outer edges in edge strips. Install with sealed [lap joints][cover plate joints][standing seam joints] as indicated.

3.1.32 Through Wall Flashing

Provide through wall flashing as required in the applicable wall system Sections.

3.2 PAINTING

Touch ups in the field may be applied only after metal substrates have been cleaned and pretreated in accordance with manufacturer's written instructions and products.

Field-paint dissimilar sheet metals in contact to separate and deter galvanic interactions.

[3.2.1 Aluminum Surfaces

Clean with solvent and apply one coat of zinc-molybdate primer and one coat of aluminum paint.

]3.3 CLEANING

Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub-clean. Free the exposed metal surfaces of dents, creases, waves, scratch marks, and solder or weld marks.

3.4 REPAIRS TO FINISH

Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items which cannot be repaired.

[3.5 FIELD QUALITY CONTROL

****

NOTE: When justified, and similar requirements are not established for Contractor Quality Control specified in other sections, add the following requirement at the end of paragraph FIELD QUALITY CONTROL:

"A roofing technician responsible directly to the Contractor and experienced in construction of the specified type of roofing system and related work must perform quality control functions and be present on site during roofing installations."

****

Establish and maintain a Quality Control Plan for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the Contract requirements. Remove work that is not in compliance with the Contract and replace or correct. Include quality control, but not be limited to, the following:

a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.

b. Verification that specified material is provided and installed.

c. Inspection of sheet metalwork, for proper size(s) and thickness(es), fastening and joining, and proper installation.

3.5.1 Procedure

Submit for approval prior to start of roofing work. Include a checklist of points to be observed. Document the actual quality control observations and inspections. Provide a copy of the documentation to the Contracting Officer at the end of each day.

****

NOTE: Metal gauges listed in the following tables are applicable to light commercial and residential types and uses. Compare metal thickness stated herein with the requirements of the NRCA Manual (Architectural Metal Flashing and Condensation and Air Leakage Control), SMACNA 1793 and edit these tables using the more stringent requirement of these. Gauges of metal gutters in the following tables are only applicable to gutters less than 150 mm by 150 mm 6 inches by 6 inches. Use SMACNA 1793 for commercial gutters of larger sizes.

****

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES					
Sheet Metal Items	[Copper kilograms per square meter]	[Aluminum mm]	[Stainless Steel, mm]	[Terne-Coated Stainless Steel, mm]	[Zinc-Coated Steel, mm]
[Building Expansion Joints]					
[Cover]	4.9	1.60	0.635	0.635	0.6
[Waterstop-bellow or flanged, U-type.]	4.9	-	0.635	0.635	-
[Covering on minor flat, pitched or curved surfaces]	6.125	1.60	0.635	0.635	-
[Downspouts and leaders]	4.9	1.60	0.635	0.635	0.6
[Downspout clips and anchors]	-	1.02 clip 3.175 anchor	-	-	-
[Downspout straps, 50 mm]	14.7 (a)	1.52	1.27	-	-
[Conductor heads]	4.9	1.60	0.635	0.635	-
[Scupper lining]	6.125	1.60	0.635	0.635	-
[Strainers, wire diameter or gage]	4.0 gage	3.66 diameter	2.77 diameter	-	
[Flashings:]					
[Base]	6.125	1.60	0.635	0.635	0.6
[Cap (Counter-flashin	4.9	1.60	0.635	0.635	0.5
[Eave]	4.9	-	0.635	0.635	0.6
[Spandrel beam]	3.1	-	0.635	0.635	-
[Bond barrier]	4.9	-	0.635	0.635	-
[Stepped]	4.9	1.60	0.635	0.635	-
[Valley]	4.9	1.60	0.635	0.635	-
[Roof drain]	4.9 (b)				

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES					
Sheet Metal Items	[Copper kilograms per square meter]	[Aluminum mm]	[Stainless Steel, mm]	[Terne-Coated Stainless Steel, mm]	[Zinc-Coated Steel, mm]
[Pipe vent sleeve (d)]					
[Coping]	4.9	-	-	-	-
[Gravel stops and fascia:]					
[Extrusions]	-	1.91	-	-	-
[Sheets, corrugated]	4.9	1.60	0.635	0.635	-
[Sheets, smooth]	6.125	1.60	0.635	0.635	0.6
[Edge strip]	7.35	1.60	0.635	-	-
[Gutters:]					
[Gutter section]	4.9	0.81	0.38	0.38	0.6
[Continuous cleat]	4.9	0.81	0.38	0.38	0.6
[Hangers, dimensions]	25 mm by 3 mm (a)	25 mm by 2 mm (c)	25 mm by 1 mm	-	-
[Joint Cover plates (See Table II)]	4.9	1.60	0.635	0.635	0.6
[Reglets (c)]	3.1	-	0.635	0.635	-
[Splash pans]	4.9	1.60	0.635	0.635	-
(a) Brass.					
(b) May be lead weighing 19.6 kilograms per square meter.					
(c) May be polyvinyl chloride.					
(d) 12.25 kilogram minimum lead sleeve with 100 mm flange. Where lead sleeve is impractical, refer to paragraph SINGLE PIPE VENTS for optional material.					

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES

Sheet Metal Items	[Copper kilograms per square foot]	[Aluminum, inch]	[Stainless Steel, inch]	[Terne-Coated Stainless Steel, inch]	[Zinc-Coated Steel, U.S. Std. Gage]
[Building Expansion Joints]					
[Cover]	16	.032	.015	.015	24
[Waterstop-bellow or flanged, U-type.]	16	-	.015	.015	-
[Covering on minor flat, pitched or curved surfaces]	20	.040	.018	.018	-
[Downspouts and leaders]	16	.032	.015	.015	24
[Downspout clips and anchors]	-	.040 clip .125 anchor	-	-	-
[Downspout straps, 2-inch]	48 (a)	.060	.050	-	-
[Conductor heads]	16	.032	.015	.015	-
[Scupper lining]	20	.032	.015	.015	-
[Strainers, wire diameter or gage]	No. 9 gage	.144 diameter	.109 diameter	-	
[Flashings:]					
[Base]	20	.040	.018	.018	24
[Cap (Counter-flashin	16	.032	.015	.015	26
[Eave]	16	-	.015	.015	24
[Spandrel beam]	10	-	.010	.010	-
[Bond barrier]	16	-	.015	.015	-
[Stepped]	16	.032	.015	.015	-
[Valley]	16	.032	.015	.015	-
[Roof drain]	16 (b)				

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES

Sheet Metal Items	[Copper kilograms per square foot]	[Aluminum, inch]	[Stainless Steel, inch]	[Terne-Coated Stainless Steel, inch]	[Zinc-Coated Steel, U.S. Std. Gage]
[Pipe vent sleave (d)]					
[Coping]	16	-	-	-	-
[Gravel stops and fascia:]					
[Extrusions]	-	.075	-	-	-
[Sheets, corrugated]	16	.032	.015	.015	-
[Sheets, smooth]	20	.050	.018	.018	24
[Edge strip]	24	.050	.025	-	-
[Gutters:]					
[Gutter section]	16	.032	.015	.015	24
[Continuous cleat]	16	.032	.015	.015	24
[Hangers, dimensions]	1 inch by 1/8 inch (a)	1 inch by .080 inch (c)	1 inch by inch	-	-
[Joint Cover plates (See Table II)]	16	.032	.015	.015	24
[Reglets (c)]	10	-	.010	.010	-
[Splash pans]	16	.040	.018	.018	-
(a) Brass.					
(b) May be lead weighing 4 pounds per square foot.					
(c) May be polyvinyl chloride.					
(d) 2.5 pound minimum lead sleeve with 4 inch flange. Where lead sleeve is impractical, refer to paragraph SINGLE PIPE VENTS for optional material.					

TABLE II. SHEET METAL JOINTS			
TYPE OF JOINT			
Item Designation	Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel	Aluminum	Remarks
Joint cap for building expansion seam, cleated joint at roof	30 mm single lock, standing seam, cleated	30 mm single lock, standing	--
Flashings			
Base	25 mm 75 mm lap for expansion joint	25 mm flat locked, soldered; sealed; 75 mm lap for expansion joint	Aluminum manufacturer's recommended hard setting sealant for locked aluminum joints. Fill each metal expansion joint with a joint sealing compound.
Cap-in reglet	75 mm lap	75 mm lap	Seal groove with joint sealing compound.
Reglets	Butt joint	--	Seal reglet groove with joint sealing compound.
Eave	25 mm flat locked, cleated. 25 mm loose locked, sealed expansion joint, cleated.	25 mm flat locked, locked, cleated 25 mm loose locked, sealed expansion joints, cleated	Same as base flashing.
Stepped	75 mm lap	75 mm lap	--
Valley	150 mm lap cleated	150 mm lap cleated	--
Edge strip	Butt	Butt	--
Gravel stops:			

TABLE II. SHEET METAL JOINTS			
TYPE OF JOINT			
Item Designation	Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel	Aluminum	Remarks
Extrusions	--	Butt with 13 mm space	Use sheet flashing beneath and a cover plate
Sheet, smooth	Butt with 6 mm space	Butt with 6 mm space	Use sheet flashing backup plate.
Sheet, corrugated	Butt with 6 mm space	Butt with 6 mm space	Use sheet flashing beneath and a cover plate or a combination unit
Gutters	40 mm lap, riveted and soldered	25 mm flat locked riveted and sealed	Aluminum producers recommended hard setting sealant for locked aluminum joints.
(a) Provide a 75 mm lap elastomeric flashing with manufacturer's recommended sealant.			
(b) Seal Polyvinyl chloride reglet with manufacturer's recommended sealant.			

TABLE II. SHEET METAL JOINTS			
TYPE OF JOINT			
Item Designation	Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel	Aluminum	Remarks
Joint cap for building expansion seam, cleated joint at roof	1.25 inch single lock, standing seam, cleated	1.25 inch single lock, standing	--
Flashings			

TABLE II. SHEET METAL JOINTS			
TYPE OF JOINT			
Item Designation	Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel	Aluminum	Remarks
Base	One inch 3 inch lap for expansion joint	One inch flat locked, soldered; sealed; 3 inch lap for expansion joint	Aluminum manufacturer's recommended hard setting sealant for locked aluminum joints. Fill each metal expansion joint with a joint sealing compound.
Cap-in reglet	3 inch lap	3 inch lap	Seal groove with joint sealing compound.
Reglets	Butt joint	--	Seal reglet groove with joint sealing compound.
Eave	One inch flat locked, cleated. One inch loose locked, sealed expansion joint, cleated.	One inch flat locked, locked, cleated one inch loose locked, sealed expansion joints, cleated	Same as base flashing.
Stepped	3 inch lap	3 inch lap	--
Valley	6 inch lap cleated	6 inch lap cleated	--
Edge strip	Butt	Butt	--
Gravel stops:			
Extrusions	--	Butt with 1/2 inch space	Use sheet flashing beneath and a cover plate
Sheet, smooth	Butt with 1/4 inch space	Butt with 1/4 inch space	Use sheet flashing backup plate.

TABLE II. SHEET METAL JOINTS

TYPE OF JOINT			
Item Designation	Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel	Aluminum	Remarks
Sheet, corrugated	Butt with 1/4 inch space	Butt with 1/4 inch space	Use sheet flashing beneath and a cover plate or a combination unit
Gutters	1.5 inch lap, riveted and soldered	One inch flat locked riveted and sealed	Aluminum producers recommended hard setting sealant for locked aluminum joints.

(a) Provide a 3 inch lap elastomeric flashing with manufacturer's recommended sealant.

(b) Seal Polyvinyl chloride reglet with manufacturer's recommended sealant.

]   -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 61 14.00 20 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-07 61 14.00 20 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-07 61 14.00 20 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-07 61 14.00 20 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 07 61 14.00 20

STEEL STANDING SEAM ROOFING

08/16, CHG 1: 08/18

****
NOTE: This guide specification covers the requirements for steel standing seam roofing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: This guide specification is primarily for Structural Standing Seam Metal Roofing Systems (SSMRS), i.e. Self-Supporting Systems designed to span from purlin to purlin at slopes as low as 1 in 24 1/2 inch per foot versus architectural cladding systems that require continuous support, secondary moisture protection and slopes no less than 1 in 4 3 inches per foot. Structural systems may be used for architectural applications whereas architectural systems cannot be used for structural applications. If an SSMRS system is desired primarily for architectural purposes use Section 07 41 13 METAL ROOF PANELS; otherwise use this section.
****

****
NOTE: Design exterior envelope to meet the

requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including moisture control and thermal performance.

****

****

NOTE: On the drawings, show:

1. Roof slope

2. Supporting structural framework.

3. Intermediate support and attachment details, when applicable.

4. Attachment clip spacing.

5. Flashing support and fastening spacing.

6. Roof venting. (Pay particular attention to preventing infiltration of wind-driven rain.)

7. Sealant and closure locations.

8. Locations for dissimilar metal protection.

9. Details of accessories such as ladders, walkways, antenna mounts, guy wire fastening, ventilation equipment, and lightning rods.

10. Details of flashing at all roof penetrations. On roof plan add note to offset penetrations so center of penetrations coincide with mid-point of panel seams.

11. Design loads including stress diagram.

12. Location and attachment of permanent fall protection devices.

****

****

NOTE: When designing standing seam roofs, consider:

1. Consult with manufacturers early in design stage to obtain current manuals, specific guidance, and structural information regarding roof attachment. Early contact will reduce need for corrections and changes during review process and construction phase. Ensure that system detailed and specified can be provided by three separate manufacturers.

2. Calculate wind uplift forces in accordance with UFC 1-200-01, "General Building Requirements".

Submit calculations and stress diagram with design review package.

3. Minimum guidelines are 1 in 24 1/2 inch per foot for roof slopes. Provide greater slope if possible. In renovation of existing buildings, adequate slope must often be obtained by imaginative solutions. Prefabricated steel systems, sleepers, and stub walls have been used successfully, but attachment and structural stability of these must be assured. In some existing structures it will be difficult to design strong connections to structural system unless modifications are made to resist wind forces adequately.

4. Flashing presents a particular design problem in preventing wind and water infiltration. High winds and thermal movement create stresses in flashing which must be resisted by careful detailing of attachment.

While standing seam roofing presents continuous, sealed surface to the elements, flashing transitions are often the cause of serious problems. Overhangs are especially susceptible to high wind forces, and attachment at the edges should be carefully designed. Copious use of sealants and closure pieces molded to conform to the roof panels is imperative.

5. Building may require equipment such as antennae, ladders or lightning rods installed on roof. Access to roof-mounted mechanical equipment is often required. Provide walking surfaces and attachment accessories which do not compromise integrity of roof system. These accessories should provide support without penetrating roofing panels. Usually this is done with clamps attached to standing seam, or specially designed clips. Provide curbs or structural supports for mechanical equipment. Where condensate or other piping will be attached to or come in contact with roofing panels, ensure that the piping and anchorage materials are compatible with roof panel base metal to avoid corrosion from galvanic action. Ensure that condensate or other discharge of liquid onto roof panels will not stain or corrode panel finish and/or base metal.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings

ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

1.2 DEFINITIONS

1.2.1 Field-Formed Seam

Seams of panels so configured that when adjacent sheets are installed the seam is sealed utilizing mechanical or hand seamers. Crimped (45 degree bend), roll formed (180 degree bend), double roll formed (2 - 180 degree bends), and roll and lock systems are types of field-formed seam systems.

1.2.2 Snap Together Seam

Panels so configured that the male and female portions of the seam interlock through the application of foot pressure or tamping with a mallet. Snap-on cap configurations are a type of snap together system.

1.2.3 Pre-Formed

Formed to the final, less field-formed seam, profile and configuration in the factory.

1.2.4 Field-Formed

Formed to the final, less field-formed seam, profile and configuration at the site of work prior to installation.

1.2.5 Roofing System

The roofing system is defined as the assembly of roofing components, including roofing panels, flashing, fasteners, and accessories which, when assembled properly result in a watertight installation.

1.2.6 SSMRS

Standing Seam Metal Roof System (SSMRS) is abbreviation of the entire roof system specified herein with all components and parts coming from a single manufacturer's system.

1.3 SYSTEM DESCRIPTION

1.3.1 Design Requirements

a. Panels must be continuous lengths up to manufacturer's standard longest lengths, with no joints or seams, except where indicated or specified. Ribs of adjoining sheets must be in continuous contact from eave to ridge. Individual panels of snap together type systems must be removable for replacement of damaged material.

b. There must be no exposed or penetrating fasteners except where shown on approved shop drawings. Fasteners into steel must be stainless steel, zinc cast head, or cadmium plated steel screws inserted into predrilled holes. There must be a minimum of two fasteners per clip. Single fasteners will be allowed when supporting structural members are prepunched or predrilled.

c. Snap together type systems must have a capillary break and a positive side lap locking device. Field-formed seam type systems must be mechanically locked closed by the manufacturer's locking tool. The seam must include a continuous factory applied sealant when required by the manufacturer to withstand the wind loads specified.

d. Roof panel anchor clips must be concealed and designed to allow for longitudinal thermal movement of the panels, except where specific fixed points are indicated. Provide for lateral thermal movement in panel configuration or with clips designed for lateral and longitudinal movement.

1.3.2 Design Conditions

Design the system to resist positive and negative loads specified herein in accordance with the AISI SG03-3. Panels must support walking loads without permanent distortion or telegraphing of the structural supports.

1.3.2.1 Wind Uplift

****

NOTE: Determine appropriate pressures that apply to various portions of roof using UFC 3-301-01 "Structural Engineering" for structural design and wind load information. Use criteria of local building code when their provisions exceed NAVFAC/AF criteria. Insert calculated pressures in table; regardless of calculated value, use 2.25 kPa 45 psf minimum for Class 90 systems.

****

Compute and apply the design uplift pressures for the roof system using a basic wind speed of [_____] kilometers per hour (km/h) miles per hour (mph). Roof system and attachments must resist the following wind loads, in kilopascals (kPa) pounds per square foot (psf):

	Negative
a. At eaves	[_____]
b. At rakes	[_____]
c. At ridge	[_____]
d. At building corners	[_____]
e. At central areas	[_____]

The design uplift force for each connection assembly must be that pressure given for the area under consideration, multiplied by the tributary load area of the connection assembly, and multiplied by the appropriate factor of safety, as follows:

a. Single fastener in a connection: 3.0

b. Two or more fasteners in each connection: 2.25

1.3.2.2 Roof Live Loads

****

NOTE: Refer to UFC 3-301-01 "Structural Engineering" for additional requirements.

****

Loads must be applied on the horizontal projection of the roof structure. The minimum roof design live load must be 1 kPa 20 psf.

1.3.2.3 Thermal Movement

****

NOTE: Insert design low temperature for the project location as obtained from UFC 3-400-02 "Design: Engineering Weather Data." Select first bracketed option for unpainted finish and light colors, select second bracketed option for dark colors.

****

System must be capable of withstanding thermal movement based on a temperature range of 5 degrees C 10 degrees F below [_____] degrees C F and[60 degrees C140 degrees F.] [80 degrees C180 degrees F.]

1.3.2.4 Deflection

Panels must be capable of supporting design loads between unsupported spans with deflection of not greater than L/180 of the span.

1.3.3 Structural Performance

****

NOTE: Full scale testing is required to certify the adequacy of the SSMRS. Once a SSMRS is certified for a specific loading condition, that certification may be used for future projects.

****

The structural performance test methods and requirements of the Standing Seam Roofing Systems (SSRS) must be in accordance with ASTM E1592.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roofing; G, [_____]

SD-03 Product Data

Roofing Panels; G, [_____]

Energy Star Label for Steel Roofing Product; S

Recycled Content for Steel Roofing Product; S

[Heat Island Reduction; S

] Attachment Clips

Closures

Accessories

Fasteners

Sealants

[Insulation, including Joint Sealing Measures for Vapor Barrier Facing

] Sample Warranty Certificate; G, [_____]

Submit for materials to be provided. Submit data sufficient to indicate conformance to specified requirements.

SD-04 Samples

Roofing Panel

Submit a 300 mm 12 inch long by full width section of typical panel.

[For color selection, submit 50 by 100 mm 2 by 4 inch metal samples in color, finish and texture [specified] [selected]. [When colors are not indicated, submit samples of not less than six different manufacturer's standard colors for selection.]

] Accessories

Submit each type of accessory item used in the project including, but not limited to each type of anchor clip, closure, fastener, and leg clamp.

Sealants

Intermediate Support Section

Submit full size samples of each intermediate support section, 300 mm 12 inches long.

SD-05 Design Data

Design Calculations

SD-06 Test Reports

Field Inspection; G

Submit manufacturer's technical representative's field inspection reports as specified in paragraph MANUFACTURER'S FIELD INSPECTION.

****

NOTE: This paragraph requires certified test reports for structural and finish tests. If there is reason to require a factory test report for other tests, modify this paragraph accordingly.

****

Structural Performance Tests

Finish Tests

SD-07 Certificates

Manufacturer's Technical Representative's Qualifications

Statement of Installer's Qualifications

Submit documentation from roofing manufacturer proving the manufacturer's technical representative meets below specified requirements. Include name, address, telephone number, and experience record.

Submit documentation proving the installer is factory-trained, has the specified experience, and authorized by the manufacturer to install the products specified.

[Coil Stock Compatibility; G, [_____]

Provide certification of coil compatibility with roll forming machinery to be used for forming panels without warping, waviness, and rippling not part of panel profile; to be done without damage, abrasion or marking of finish coating.

] SD-08 Manufacturer's Instructions

Installation Manual; G, [_____]

Submit manufacturers printed installation manual, instructions, and standard details.

SD-11 Closeout Submittals

Information Card

For each roofing installation, submit a typewritten card or photoengraved aluminum card containing the information listed on Form 1 located at the end of this section.

Warranty

1.5 DESIGN CALCULATIONS

****

NOTE: Ensure that appropriate design loads are specified in paragraph WIND UPLIFT.

****

Provide design calculations prepared by a professional engineer specializing in structural engineering verifying that system supplied and any additional framing meets design load criteria indicated. Coordinate calculations with manufacturer's test results. Include calculations for:

a. Wind load uplift design pressure at roof locations specified in paragraph WIND UPLIFT.

b. Clip spacing and allowable load per clip.

c. Fastening of clips to structure or intermediate supports.

d. Intermediate support spacing and framing and fastening to structure when required.

e. Allowable panel span at anchorage spacing indicated.

f. Safety factor used in design loading.

g. Governing code requirements or criteria.

h. Edge and termination details.

1.6 QUALITY ASSURANCE

1.6.1 Preroofing Conference

****

NOTE: Consult with the Contracting Officer responsible for construction of the project to determine who should conduct the conference. For NAVFAC SE administered projects, delete the option

of Contractor conducting the conference and delete the last sentence.
****

After submittals are received and approved but before roofing [and insulation] work, including associated work, is preformed, the [Contracting Officer will] [Contractor must] hold a preroofing conference to review the following:

a. The drawings and specifications

b. Procedure for on site inspection and acceptance of the roofing substrate and pertinent structural details relating to the roofing system

c. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing

d. Safety requirements

The preroofing conference must be attended by the Contractor and personnel directly responsible for the roofing [and insulation] installation, [[mechanical] [and] [electrical] work], and the roofing manufacturer's technical representative. Conflicts among those attending the preroofing conference must be resolved and confirmed in writing before roofing work, including associated work, is begun. [Prepare written minutes of the preroofing conference and submit to the Contracting Officer.]

1.6.2 Manufacturer

The SSMRS must be the product of a metal roofing industry - recognized manufacturer who has been in the practice of manufacturing SSMRS for a period of not less than 5 years and who has been involved in at least 5 projects similar in size and complexity to this project.

1.6.3 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products and with installations in the geographical area where construction will take place. The manufacturer's representative must be an employee of the manufacturer with at least 5 years experience in installing the roof system. The representative must be available to perform field inspections and attend meetings as required herein, and as requested by the Contracting Officer.

1.6.4 Installer's Qualifications

The roofing system installer must be factory-trained, approved by the steel roofing system manufacturer to install the system, and must have a minimum of three years experience as an approved applicator with that manufacturer. The applicator must have applied five installations of similar size and scope as this project within the previous 3 years.

1.6.5 Single Source

Roofing panels, clips, closures, and other accessories must be standard products of the same manufacturer; must be the latest design by the manufacturer; and must have been designed by the manufacturer to operate as a complete system for the intended use.

1.6.6 Laboratory Tests For Panel Finish

The term "appearance of base metal" refers to the metal coating on steel. Panels must meet the following test requirements:

a. Formability Test: When subjected to a 180 degree bend over a 3 mm 1/8 inch diameter mandrel in accordance with ASTM D522/D522M, exterior coating film may show only slight microchecking and no loss of adhesion.

b. Accelerated Weathering Test: Withstand a weathering test for a minimum of 2000 hours in accordance with ASTM G152 and ASTM G153, Method 1 without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with a penknife blade or similar instrument will be considered to indicate loss of adhesion.

c. Chalking Resistance: After the 2000-hour weatherometer test, exterior coating may not chalk greater than No. 8 rating when measured in accordance with ASTM D4214 test procedures.

d. Color Change Test:

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NOTE: In general, only colors such as white, beige, and tan will not exceed the 2 NBS units requirement. To allow for heavier pigmented colors, specify color change not to exceed 5 NBS units for a 3000-hour weatherometer test.

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e. After the [2000] [_____]-hour weatherometer test, exterior coating color change must not exceed [2] [_____] NBS units when measured in accordance with ASTM D2244 test procedure.

****

NOTE: For projects located in high temperature and humidity or corrosive atmospheres or where premium finish would be justified, use:

Salt spray test: Rating of 10, no blisters in field
Rating of 7, 2 mm 1/16 inch edge creep

Abrasion Resistance Test: 100 liters

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f. Salt Spray Test: Withstand a salt spray test for a minimum of 1000 hours in accordance with ASTM B117, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating must receive a rating of [8, few blisters] [10, no blisters] in field as determined by ASTM D714; and an average rating of [6, 3 mm] [7, 2 mm] [6, 1/8 inch] [7, 1/16 inch] failure at scribe, as determined by ASTM D1654. Rating Schedule No. 1.

g. Abrasion Resistance Test for Color Coating: When subjected to the falling sand test in accordance with ASTM D968, coating system must withstand a minimum of [50][100][_____] liters of sand per mil thickness before appearance of base metal.

h. Humidity Test: When subjected to a humidity cabinet test in accordance with ASTM D2247 for 1000 hours, a scored panel must show no signs of blistering, cracking, creepage, or corrosion.

i. Gloss Test: The gloss of the finish must be 30 plus or minus 5 at an angle of 60 degrees, when measured in accordance with ASTM D523.

[j. Glare Resistance Test:

****

NOTE: The requirements for glare resistance should be included only when specifically required by the facility for critical glare areas such as control towers or other structures where glare can be an operational hazard. Refer to UFC 4-211-01N, "Aircraft Maintenance Hangars" for assistance in determining critical glare areas. Delete gloss test above if this paragraph is included.

****

k. Surfaces of panels that will be exposed to the exterior must have a specular reflectance of not more than 10 when measured in accordance with ASTM D523 at an angle of 85 degrees. Specular reflectance may be obtained with striations or embossing. Requirements specified under FORMABILITY TEST will be waived if necessary to conform to this requirement.

]1.6.7 Shop Drawing Requirements

Submit roofing drawings to supplement the instructions and diagrams. Include design and erection drawings containing an isometric view of the roof showing the design uplift pressures and dimensions of edge, ridge and corner zones; and show typical and special conditions including flashings, materials and thickness, dimensions, fixing lines, anchoring methods, sealant locations, sealant tape locations, fastener layout, sizes, and spacing, terminations, penetrations, attachments, and provisions for thermal movement. Details of installation must be in accordance with the manufacturer's Standard Instructions and details or the SMACNA 1793. Prior to submitting shop drawings, have drawings reviewed and approved by the manufacturer's technical engineering department.

1.7 WARRANTY

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NOTE: This warranty paragraph may be used with this guide specification without special authorization.

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Furnish manufacturer's no-dollar-limit materials and workmanship warranty for the roofing system. The warranty period must be not less than 20 years from the date of Government acceptance of the work. The warranty must be issued directly to the Government. The warranty must provide that if within the warranty period the metal roofing system becomes non-watertight or shows evidence of corrosion, perforation, rupture or excess weathering due to deterioration of the roofing system resulting from defective materials or installed workmanship the repair or replacement of the defective materials and correction of the defective workmanship must be the responsibility of the roofing system manufacturer. Repairs that become necessary because of defective materials and workmanship while roofing is under warranty must be performed within 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time will constitute grounds for having the repairs performed by others and the cost billed to the manufacturer. In addition, provide a 2 year contractor installation warranty.

1.8   DELIVERY, STORAGE AND HANDLING

Deliver, store, and handle preformed panels, bulk roofing products and other manufactured items in a manner to prevent damage or deformation.

1.8.1   Delivery

Provide adequate packaging to protect materials during shipment. Crated materials must not be uncrated until ready for use, except for inspection. Immediately upon arrival of materials at the jobsite, inspect materials for damage, dampness, and staining. Replace damaged or permanently stained materials that cannot be restored to like-new condition with satisfactory material. If materials are wet, remove the moisture and re-stack and protect the panels until used.

1.8.2   Storage

Stack materials on platforms or pallets and cover with tarpaulins or other suitable weathertight covering which prevents water trapping or condensation. Store materials so that water which might have accumulated during transit or storage will drain off. Do not store the panels in contact with materials that might cause staining, such as mud, lime, cement, fresh concrete or chemicals. Protect stored panels from wind damage.

1.8.3   Handling

Handle material carefully to avoid damage to surfaces, edges and ends.

PART 2   PRODUCTS

2.1   ROOFING PANELS

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NOTE: Certain roofing products are required to conform to public law (PL) 109-58 - Energy Policy Act of 2005 (EPAct05) by meeting or exceeding Energy Star or FEMP efficiency requirements at "energy-efficient products" at http://energy.gov/eere/femp/energy-and-water-efficient-products.

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NOTE: Facilities with dominant cooling loads and/or in mild or warm climate zones are required to meet "cool roofing" requirements of FEMP. Cool roof design must follow the requirements in UFC 3-110-03 Roofing, Appendix B and ASHRAE 90.1 Chapter 5, for the design of insulation and energy performance of the building. The roofing system will need to include a top surface layer that meets the Energy

Star criteria for Cool Roof Products see http://www.energystar.gov/products/certified-products/detail/roof-products.

NOTE: If a cool roof is not selected in ASHRAE zones 1 thru 3, design must meet one of the exception requirements listed in ASHRAE 90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Coordinate these requirements with insulation design and specifications.

Retain the next to last bracketed sentence for project with cool roof requirement. Retain the last bracketed sentence for project with sustainable third party certification credit requirement for reduced heat island effect.

****

Provide panels with interlocking ribs for securing adjacent sheets and with concealed clip fastening system for securing the roof covering to structural framing members. Fasteners must not penetrate the panels except at the ridge, eave, rakes, penetrations, and end laps. Backing plates and ends of panels at end laps must be predrilled or prepunched. Factory prepare ends of panels to be lapped by trimming part of seam, die-setting, or swaging ends of panels. Individual sheets must be sufficiently long to cover the entire length of any unbroken roof slope when such slope is 9 meters 30 feet or less. Provide panels that extend over two or more spans when length of run exceeds 9 meters 30 feet. Obtain Contracting Officer (KO) approval for sheets longer than 9 meters 30 feet before submitting shop drawings. Sheets must provide not less than 300 mm 12 inches of coverage (width) in place. Provide panels with a minimum corrugation height of [45] [57] [76] mm [1.75] [2.25] [3.0] inches (nominal). Make provisions for expansion and contraction at either ridge or eave, consistent with the type of system to be used. Form panels from coil stock without warping, waviness or ripples not part of the panel profile, and free of damage to the finish coating system.

Provide steel roofing product that is Energy Star labeled. Provide data identifying Energy Star label for steel roofing product.[Provide solar reflectance product with an initial solar reflectance greater than or equal to 0.25 and a solar reflectance greater than or equal to 0.15 three years after installation under normal conditions.][Provide emittance and reflectance percentages, solar reflectance index values, [and] slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]

2.1.1 Material

****

NOTE: Research shows the product is available from US national manufacturers above the minimum recycled content stated. Some manufacturers and regions have higher percentages.

****

Zinc-coated steel conforming to ASTM A653/A653M, Z275 G90 coating designation or aluminum-zinc alloy coated steel conforming to ASTM A792/A792M, AZ 165 AZ 55 coating. Provide material with a minimum thickness of 0.6 mm 0.023 inch thick (24 gage) minimum except when mid field of roof is subject to design wind uplift pressures of 3 kPa 60 psf or greater, entire roof system must have a minimum thickness of 0.8 mm 0.030 inch (22 gage). Steel roofing materials must contain a minimum of 30 percent total recycled content. Provide data identifying percentage of recycled content for steel roofing product.[Prior to shipment, treat mill finish panels with a passivating chemical and oil to inhibit the formation of oxide corrosion products. Dry, retreat, and re-oil panels that have become wet during shipment or storage but have not started to oxidize.]

2.1.2 Texture

****

NOTE: Stucco embossing is a mechanical process that imparts some structural strength to the steel and reduces the visual effect of oil-canning. Embossed texture is slightly more expensive than smooth texture but should be considered for use on high visibility projects.

****

[Stucco embossed.][Smooth.][Smooth with raised intermediate ribs for added stiffness.]

2.1.3 Finish

****

NOTE: Choose finish appropriate for the project. In general, hangars, warehouses, and other utilitarian structures may use unpainted finish to reduce cost. ASTM A792/A792M (Galvalume) should be specified only for corrosive environments when unpainted finish is required. Delete paragraph LABORATORY TESTS FOR PANEL FINISH and reference to finishes when unpainted finish is specified. Some paint colors are substantially more costly than others, due to scarcity of pigments.

****

[Unpainted][Factory color finish].

[2.1.3.1 Factory Color Finish

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NOTE: Provide clear edge coating on all metal panels for projects within the salt spray area of the ocean (within 300 feet of the water).

****

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NOTE: Check with the facility regarding color selection. Use only manufacturer's standard colors. Delete this subparagraph if unpainted finish has been selected. Specify 0.050 mm 0.2 mil prime coat if undersides of panels are to be field painted, the same coating as exterior if undersides of panels are to be exposed and a premium coating is desired, otherwise use 0.0125 mm 0.5 mil wash coat.

****

Provide factory applied, thermally cured coating to exterior and interior of metal roof and wall panels and metal accessories. Provide exterior finish top coat of [70 percent resin polyvinylidene fluoride][_____] with not less than [0.005 mm][0.020 mm][_____] [0.2 mil][0.8 mil][_____] dry film thickness. Provide exterior primer [standard with panel manufacturer][_____] with not less than [0.005 mm][0.020 mm] [0.2 mil][0.8 mil] dry film thickness. Interior finish must consist of [[0.005 mm][0.2 mil]dry film thickness prime coat][[0.0125 mm][0.5 mil] dry film thickness backer coat][the same coating and dry film thickness as the exterior coating][_____]. Provide exterior [and interior]coating meeting test requirements specified below. Tests must have been performed on the same factory finish and thickness provided.[Provide clear factory edge coating on all factory cut or unfinished edges.]

]2.2 INTERMEDIATE SUPPORTS

Fabricate panel subgirts, subpurlins, T-bars, Z-bars and tracks from galvanized steel conforming to ASTM A653/A653M, Z275 G90, Grade D (1.6 mm thick 16 gage and heavier), Grade A (1.3 mm thick 18 gage and lighter); or steel conforming to ASTM A36/A36M, ASTM A1011/A1011M , or ASTM A1008/A1008M prime painted with zinc-rich primer. Size, shape, thickness and capacity as required to meet the load[, insulation thickness] and deflection criteria specified.

2.3 ATTACHMENT CLIPS

Fabricate clips from ASTM A1011/A1011M, or ASTM A1008/A1008M steel hot-dip galvanized in accordance with ASTM A653/A653M, Z275 G 90, or Series 300 stainless steel. Size, shape, thickness and capacity as required to meet the load, insulation thickness and deflection criteria specified.

2.4 ACCESSORIES

Sheet metal flashings, [gutters,] [downspouts,] trim, moldings, closure strips, pre-formed crickets, caps, equipment curbs, and other similar sheet metal accessories used in conjunction with preformed metal panels must be of the same material as used for the panels. Provide metal accessories with a factory color finish to match the roofing panels, except that such items which will be concealed after installation may be provided without the finish if they are stainless steel. Metal must be of a thickness not less than that used for the panels. Thermal spacer blocks and other thermal barriers at concealed clip fasteners must be as recommended by the manufacturer except that wood spacer blocks are not allowed.

2.4.1 Closures

2.4.1.1 Rib Closures

Corrosion resisting steel, closed-cell or solid-cell synthetic rubber, neoprene or polyvinyl chloride pre-molded to match configuration of rib opening. Material for closures must not absorb water.

2.4.1.2 Ridge Closures

Metal-clad foam or metal closure with foam secondary closure matching panel configuration for installation on surface of roof panel between panel ribs at ridge and headwall roof panel flashing conditions and terminations. Foam material must not absorb water.

2.4.2 Fasteners

Zinc-coated steel, corrosion resisting steel, zinc cast head, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Design the fastening system to withstand the design loads specified. Exposed fasteners must be gasketed or have gasketed washers on the exterior side of the covering to waterproof the penetration. Washer material must be compatible with the covering; have a minimum diameter of 10 mm 3/8 inch for structural connections; and gasketed portion of fasteners or washers must be neoprene or other equally durable elastomeric material approximately 3 mm 1/8 inch thick.

2.4.2.1 Screws

Not smaller than 4.75 mm No. 14 diameter if self-tapping type and not smaller than 4 mm No. 12 diameter if self-drilling and self-tapping.

2.4.2.2 Bolts

Not smaller than 6 mm 1/4 inch diameter, shouldered or plain shank as required, with proper nuts.

2.4.2.3 Automatic End-Welded Studs

Automatic end-welded studs must be shouldered type with a shank diameter of not smaller than 5 mm 3/16 inch and cap or nut for holding covering against the shoulder.

2.4.2.4 Explosive Driven Fasteners

Fasteners for use with explosive actuated tools must have a shank diameter of not smaller than 4 mm 0.145 inch with a shank length of not smaller than 13 mm 1/2 inch for fastening to steel and not smaller than 25 mm 1 inch for fastening to concrete.

2.4.2.5 Rivets

Blind rivets must be stainless steel with 3 mm 1/8 inch nominal diameter shank. Rivets must be threaded stem type if used for other than the fastening of trim. Rivets with hollow stems must have closed ends.

2.4.3 Sealants

Elastomeric type containing no oil or asphalt. Exposed sealant must cure to a rubberlike consistency. Concealed sealant must be the non-hardening type. Seam sealant must be factory-applied, non-skinning, non-drying, and must conform to the roofing manufacturer's recommendations. Silicone-based sealants must not be used in contact with finished metal panels and components unless approved otherwise by the Contracting Officer.

2.4.4 GASKETS AND INSULATING COMPOUNDS

Nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds must be nonrunning after drying.

[2.5 THERMAL INSULATION

****

NOTE: Insulation should be included in appropriate

section. Most manufacturers recommend batts with minimum thickness of 38 mm 1 1/2 inches for standing seam systems to minimize condensation on underside of roofing sheets and for sound attenuation. Spacer blocks should be required with insulation. 100 mm 4 inches (R 25) is the recommended maximum thickness.
****

Flexible blanket, rigid, or semi-rigid faced with a flexible vapor retarder. Insulation and facing must have a flame-spread rating of 50 or less in accordance with ASTM E84. Vapor retarder facing must have a permeance rating of 0.05 perm or less. Provide a thermal resistance "R" value of [_____] or more. [Exposed insulation must have a white nondusting and nonshedding finish.] Facings [and finishes] must be factory-applied.

][2.6 UNDERLAYMENT FOR WOOD SUBSTRATES

****
NOTE: Include this article where roof coverings are applied to wood decks.
****

ASTM D226/D226M, Type I perforated, covered by water-resistant rosin sized building paper.

]2.7 LINER PANELS

Fabricate liner panels of the same material as roof panels, and formed or patterned to prevent waviness and distortion. Liner panels must have a factory applied, one mil thick minimum painted coating on the inside face and a prime coat on the liner side.

PART 3 EXECUTION

Do not install building construction materials that show visible evidence of biological growth.

3.1 EXAMINATION

Examine surfaces to receive standing seam metal roofing and flashing. Ensure that surfaces are plumb and true, clean, even, smooth, as dry and free from defects and projections which might affect the installation.

3.2 PROTECTION FROM CONTACT WITH DISSIMILAR MATERIALS

3.2.1 Cementitious Materials

Paint metal surfaces which will be in contact with mortar, concrete, or other masonry materials with one coat of alkali-resistant coating such as heavy-bodied bituminous paint.

3.2.2 Contact with Wood

Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.3 INSTALLATION

****

NOTE: Include bracketed sentences where roof coverings are applied directly to wood decks.

****

Install in accordance with the approved manufacturer's erection instructions, shop drawings, and diagrams. Panels must be in full and firm contact with attachment clips. Where prefinished panels are cut in the field, or where any of the factory applied coverings or coatings are abraded or damaged in handling or installation, they must, after necessary repairs have been made with material of the same color as the weather coating, be approved before being installed. Seal completely openings through panels. Correct defects or errors in the materials. Replace materials which cannot be corrected in an approved manner with nondefective materials. Provide molded closure strips where indicated and where necessary to provide weathertight construction. Use shims as required to ensure attachment clip line is true. Use a spacing gage at each row of panels to ensure that panel width is not stretched or shortened.[Provide one layer of asphalt-saturated felt placed perpendicular to roof slope, covered by one layer of rosin-sized building paper placed parallel to roof slope with side laps down slope and attached with roofing nails. Overlap side and end laps 75 mm 3 inches, offset seams in building paper with seams in felt.]

3.3.1 Roof Panels

Apply roofing panels with the standing seams parallel to the slope of the roof. Provide roofing panels in longest practical lengths from ridge to eaves (top to eaves on shed roofs), with no transverse joints except at the junction of ventilators, curbs, skylights, chimneys, and similar openings. Install flashing to assure positive water drainage away from roof penetrations. Locate panel end laps such that fasteners do not engage supports or otherwise restrain the longitudinal thermal movement of panels. Form field-formed seam type system seams in the field with an automatic mechanical seamer approved by the manufacturer. Attach panels to the structure with concealed clips incorporated into panel seams. Clip attachment must allow roof to move independently of the structure, except at fixed points as indicated.

[3.3.2 Insulation Installation

****

NOTE: For applications where permeability is a critical consideration, sealing of the insulation joints or other methods of providing continuity of the vapor retarder must be specified. Overall roof construction should be reviewed to assure permeability is consistent with requirements specified for the vapor retarder.

****

Install between covering and supporting members to present a neat appearance. Fold and staple [and tape] seams unless approved otherwise by the Contracting Officer.

3.3.2.1 Rigid or Semi-Rigid Insulation

Install in areas where insulation is exposed to view. Fasten securely without loose joints or unsightly sags.

3.3.2.2 Blanket Insulation

May be used in concealed locations. Lap facing at joints and fasten in a manner that will provide tight joints.

]3.3.3 Flashings

****

NOTE: In high winds, metal will vibrate and fatigue at fasteners on "normal" spacings. For this reason, cleated (blind fastened) flashings are not acceptable, and attachment at 150 to 200 mm 6 to 8 inches on center is customary. Flashing should not extend any significant distance more than one inch beyond a support or fastener.

****

Provide flashing, related closures and accessories as indicated and as necessary to provide a weathertight installation. Install flashing to ensure positive water drainage away from roof penetrations. Flash and seal the roof at the ridge, eaves and rakes, and projections through the roof. Place closure strips, flashing, and sealing material in an approved manner that will assure complete weathertightness. Details of installation which are not indicated must be in accordance with the SMACNA 1793, panel manufacturer's approved printed instructions and details, or the approved shop drawings. Allow for expansion and contraction of flashing.

3.3.4 Flashing Fasteners

Fastener spacings must be in accordance with the panel manufacturer's recommendations and as necessary to withstand the design loads indicated. Install fasteners in roof valleys as recommended by the manufacturer of the panels. Install fasteners in straight lines within a tolerance of 13 mm 1/2 inch in the length of a bay. Drive exposed penetrating type fasteners normal to the surface and to a uniform depth to seat gasketed washers properly and drive so as not to damage factory applied coating. Exercise extreme care in drilling pilot holes for fastenings to keep drills perpendicular and centered. Do not drill through sealant tape. After drilling, remove metal filings and burrs from holes prior to installing fasteners and washers. Torque used in applying fasteners must not exceed that recommended by the manufacturer. Remove panels deformed or otherwise damaged by over-torqued fastenings, and provide new panels.

3.3.5 Rib and Ridge Closure/Closure Strips

Set closure/closure strips in joint sealant material and apply sealant to mating surfaces prior to adding panel.

3.4 PROTECTION OF APPLIED ROOFING

Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to indicated live load limits of roof construction.

3.5 CLEANING

Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces must be free of dents, creases, waves, scratch marks, solder or weld marks and damage to the finish coating.

3.6 MANUFACTURER'S FIELD INSPECTION

Manufacturer's technical representative must visit the site as necessary during the installation process to assure panels, flashings, and other components are being installed in a satisfactory manner. Manufacturer's technical representative must perform a field inspection during the first [20] [_____] squares of roof panel installation and at substantial completion prior to issuance of warranty, as a minimum, and as otherwise requested by the Contracting Officer. Additional inspections must not exceed one for [100] [_____] squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer. Each inspection visit must include a review of the entire installation to date. After each inspection, submit a report, signed by the manufacturer's technical representative, to the Contracting Officer noting the overall quality of work, deficiencies and any other concerns, and recommended corrective actions in detail. Notify Contracting Officer a minimum of 2 working days prior to site visit by manufacturer's technical representative.

3.7 COMPLETED WORK

Completed work must be plumb and true without oil canning, dents, ripples, abrasion, rust, staining, or other damage detrimental to the performance or aesthetics of the completed roof assembly.

3.8 INFORMATION CARD

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NOTE: Include only the applicable EFD.

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For each roof, provide a typewritten card, laminated in plastic and framed for interior display or a photoengraved 0.8 mm thick 0.032 inch thick aluminum card for exterior display. Card to be 220 by 280 mm 8 1/2 by 11 inches minimum and contain the information listed on Form 1 at end of this section. Install card near point of access to roof, or where indicated. Send a photostatic paper copy to [NAVFAC Washington, Building 2, Washington Navy Yard, Washington, DC 20374-2121] [LANTNAVFACENGCOM, Code 1613, 1510 Gilbert Street, Norfolk, VA 23511-2699] [NORTHNAVFACENGCOM, Code 103A, 10 Industrial Highway, Mail Stop #82, Lester, PA 19113-2090] [PACNAVFACENGCOM, Code 102, Pearl Harbor, HI 96860-7300] [SOUTHNAVFACENGCOM, Code 0535, P.O. Box 190010, North Charleston, SC 29419-9010] [SOUTHWESTNAVFACENGCOM, Code 133SB, 1220 Pacific Highway, San Diego, CA 92132-5190].

3.9 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of English unit measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

PRODUCTS	ENGLISH UNITS	METRIC UNITS
a. Steel sheets	0.023 inch	0.6 mm
	0.030 inch	0.8 mm
b. Gasket washers	3/8 inch	10 mm
	1/8 inch	3 mm
c. Screws	No. 14	4.75 mm
	No. 12	4 mm
d. Bolts	1/4 inch	6 mm
e. Studs	3/16 inch	5 mm
f. Fasteners	0.145 inch by 1/2 inch	4 mm by 13 mm
	One inch	25 mm
g. Rivets	1/8 inch	3 mm

3.10 FORM ONE

FORM 1 - PREFORMED STEEL STANDING SEAM ROOFING SYSTEM COMPONENTS

1. Contract Number:

2. Building Number & Location:

3. NAVFAC Specification Number:

4. Deck/Substrate Type:

5. Slopes of Deck/Roof Structure:

6. Insulation Type & Thickness:

7. Insulation Manufacturer:

8. Vapor Retarder: ( )Yes ( )No

9. Vapor Retarder Type:

10. Preformed Steel Standing Seam Roofing Description:

a. Manufacturer (Name, Address, & Phone No.):
b. Product Name: c. Width: d. Gage:
e. Base Metal: f. Method of Attachment:

11. Repair of Color Coating:

a. Coating Manufacturer (Name, Address & Phone No.):
b. Product Name:
c. Surface Preparation:
d. Recoating Formula:
e. Application Method:

12. Statement of Compliance or Exception:________________________________
____
____

13. Date Roof Completed:

14. Warranty Period: From_______________ To_______________

15. Roofing Contractor (Name & Address):

16. Prime Contractor (Name & Address):

Contractor's Signature _________________________ Date:

Inspector's Signature _________________________ Date:

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 61 15.00 20 (August 2016)**
Change 2 - 11/18

Preparing Activity: NAVFAC **Superseding**
UFGS-07 61 15.00 20 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 61 15.00 20

ALUMINUM STANDING SEAM ROOFING

08/16, CHG 2: 11/18

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 61 15.00 20 (August 2016)**
Change 2 - 11/18

Preparing Activity: NAVFAC **Superseding**
UFGS-07 61 15.00 20 (May 2011)

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****

SECTION 07 61 15.00 20

ALUMINUM STANDING SEAM ROOFING

08/16, CHG 2: 11/18

****

NOTE: This guide specification covers the requirements for aluminum standing seam roofing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Design exterior envelope to meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including moisture control and thermal performance.

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NOTE: On the drawings, show:

1. Design loads.

2. Roof slope (minimum 1e in 24 1/2 inch per foot).

3. Line(s) of fixity.

4. Supporting structural framework.

5. Track spacing and attachment details, when applicable.

6. Attachment clip spacing (list capacity of each type in spec).

7. Flashing support and fastening spacing.

8. Roof venting. (Pay particular attention to preventing infiltration of wind-driven rain).

9. Sealant and closure locations.

10. Locations for dissimilar metal protection.

11. Details of accessories such as ladders, walkways, antenna mounts, guy wire fastening, ventilation equipment and lighting.

12. Details of flashing at all roof penetrations.

13. Location and attachment of permanent fall protection devices.

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NOTE: When designing standing seam roofs, consider:

1. Consult with manufacturers early in design stage to obtain current design manuals and structural information regarding roof attachments. Early contact will reduce need for corrections and changes during review process and construction phase.

2. Calculate wind uplift forces in accordance with UFC 1-200-01, "General Building Requirements".

3. Minimum guidelines are 1 in 24 1/2 inch per foot for roof slopes. Provide greater slope if possible. In renovation of existing buildings, adequate slope must often be obtained by imaginative solutions. Sleepers and stub walls have been successfully used, but attachment and structural stability of these must be assured. In some existing structures it will be difficult to design strong connections to structural system, or modifications to existing structural shimming system will be necessary to resist wind forces adequately.

4. It will be necessary to diagram a number of attachment clips for varying roof conditions. Each type should be individually designated on the drawings with spacing shown. Spacing will be a function of allowable panel span and holding

capability assumed for the clip(s). Minimum holding force for each type should be specified as subparagraphs under paragraph ATTACHMENT CLIPS. Assure that fasteners used to attach clips to structure develop full capacity of clip. Check existing structures to assure that the forces can be resisted by existing structural system. Make provisions for thermal expansion of roof structure.

5. Flashing presents a particular design problem in preventing wind and water infiltration. High winds create stresses in flashing which must be resisted by careful detailing of attachment.

While standing seam roofing presents continuous, sealed surface to the elements, flashing transitions are often the cause of serious problems. Overhangs, especially, are susceptible to high wind forces and attachment should be at much closer spacing than usual. Copious use of sealants and closure pieces molded to conform to roof panels is imperative.

6. Building may require equipment such as antennae, ladders, or lighting installed on roof. Access to roof-mounted mechanical equipment is often required. Provide walking surfaces and attachment accessories which do not compromise integrity of roof system. These accessories should provide support without penetrating roofing panels. Usually this is done with clamps attached to standing seam, or other specially designed clips. Provide curbs for mechanical equipment.

7. Specify insulation in appropriate Division 07 section.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile

references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual
AA ASM-35	(2000) Specifications for Aluminum Sheet Metal Work in Building Construction, Construction Manual Series Section 5

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN WOOD COUNCIL (AWC)

AWC NDS	(2018) National Design Specification (NDS) for Wood Construction

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D2247	(2015; R 2020) Standard Practice for

	Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D2565	(2016) Standard Practice for Xenon Arc Exposure of Plastics Intended for Outdoor Applications
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA CONDET	(2014) Construction Details Manual

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

1.2 DEFINITIONS

1.2.1 Field-Formed Seam

Seams of panels so configured that when adjacent sheets are installed the seam is sealed utilizing mechanical or hand seamers. Crimped (45 degree bend), roll formed (180 degree bend), double roll formed (2 - 180 degree bend), and roll and lock systems are types of field-formed seam systems.

1.2.2 Snap Together Seam

Panels so configured that the male and female portions of the seam interlock through the application of foot pressure or tamping with a mallet. Snap-on cap configurations are a type of snap together system.

1.2.3 Pre-Formed

Formed to the final, less field-formed seam, profile and configuration in the factory.

1.2.4 Field-Formed

Formed to the final, less field-formed seam, profile and configuration at the site of work prior to installation.

1.2.5 Roofing System

The roofing system is defined as the assembly of roofing components, including roofing panels, flashing, fasteners, and accessories which, when assembled properly result in a watertight installation.

1.2.6 SSMRS

Standing Seam Metal Roof System (SSMRS) is abbreviation of the entire roof system specified herein with all components and parts coming from a single manufacturer's system.

1.3 SYSTEM DESCRIPTION

1.3.1 Design Requirements

a. Provide continuous length panels with no joints or seams, except where indicated. Individual panels must be removable for replacement of damaged material.

b. There must be no exposed or penetrating fasteners except where shown on the approved shop drawings. Fasteners into wood must be stainless steel sheet metal screws with full length threads. Fasteners into steel must be stainless steel or cadmium plated stainless steel screws inserted into predrilled holes. Length and diameter of screws must be sufficient to meet the design loads with a suitable factor of safety for the material to which the roofing components are attached. Calculate fastener capacity in accordance with AISI SG03-3, AA ADM or AWC NDS as applicable.

c. Roof panel standing seam must include a capillary break and be mechanically locked closed by the manufacturer's locking tool. The seam must include a continuous sealant when required by the manufacturer to withstand the rainfall and wind specified in paragraph MANUFACTURER'S REQUIREMENTS.

d. Roof panel anchor clips must be concealed and designed to allow for thermal movement of the panels, except where specific fixed points are indicated.

e. The system must resist the positive and negative loads specified herein in accordance with "Sheet Building Sheathing Design Guide" of the AA ADM.

Determine capacity in accordance with principles of ASTM E330/E330M modified as follows:

(1) Test panels must be production material of the type proposed for use. Use either full length or partial length panels with attachment representative of the main part of the roof.

(2) Test specimens must be five panels wide, span one or more supports, and must have no end or edge attachment or seals that will restrict crosswise movement of the panels under load. Do not bridge longitudinal seams with tape or film that can restrict separation.

(3) Test panels to failure. Report load at failure.

f. Panels must support walking loads without excessive distortion or telegraphing of the structural supports. Panels must support a 115 kilogram 250 pound load concentrated on a 2500 square millimeter (mm) 4 square inch area at the center of the panel without buckling or permanent distortion.

1.3.2 Performance Requirements

1.3.2.1 Wind Loads

****

NOTE: Determine the appropriate pressures, positive and negative, that apply to the various portions of the roof using current engineering technology that takes into account the height, shape, and location of the structure. See UFC 3-301-01, "Structural Engineering," for structural design and wind load information.

****

Resistance to wind uplift generated by winds of [200] [_____] km/h [124] [_____] mph. The roof system and attachments must resist the following wind loads (kPapsf) with a factor of safety appropriate for the material holding the anchor:

	Positive	Negative
At eaves	[_____]	[_____]
At rakes	[_____]	[_____]
At ridge	[_____]	[_____]
At building corners	[_____]	[_____]
At central areas	[_____]	[_____]

1.3.2.2 Resistance to Water Infiltration

Roofing system must show no infiltration at seams, edges, flashings, counterflashings and penetrations when subjected to a rainfall of [125] [_____] mm [5] [_____] inches per hour with [200] [_____] km/h [124] [_____] mph wind.

1.3.2.3 Thermal Movement

****

NOTE: Select the temperature range appropriate for the finish and color specified.

****

The system must be capable of withstanding thermal movement based on a temperature range of 5 degrees C 10 degrees F below design low air temperature and [60 degrees C140 degrees F for mill finish and light colors.][82 degrees C180 degrees F for dark colors.]

1.3.2.4 Deflection

Panel deflection must not exceed L/140.

1.3.2.5 Structural Performance

The structural performance test methods and requirements must be in accordance with ASTM E1592.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roofing Panels; G, [_____]

Submit drawings as necessary to supplement the instructions and diagrams. Include design and erection drawings containing an isometric view of the roof showing the design uplift pressures and dimensions of edge, ridge and corner zones. Show typical and special conditions including flashings, accessory installation, materials and thicknesses, all dimensions, anchoring methods, sealant locations, sealant tape locations, fastener layout, sizes, spacing, provisions for thermal movement, terminations, penetrations, and attachments. Details of installation must be in accordance with the manufacturer's Standard Instructions and details or the SMACNA 1793. The manufacturer's technical engineering department must approve the drawings before they are submitted.

SD-03 Product Data

Roofing Panels; G, [_____]

Energy Star Label for Aluminum Roofing Product; S

Recycled Content of Aluminum Roofing Products; S

[Heat Island Reduction; S

] Attachment Clips

Closures

Accessories

Underlayment

Sample Warranty Certificate; G, [_____]

Submit for all materials to be provided. Submit data sufficient to indicate conformance to specified requirements.

SD-04 Samples

Roofing Panels

Submit a 300 mm 12 inch long section of typical panel [in color specified] [in color selected].

When colors are not indicated, submit samples of not less than six different manufacturer's standard colors for selection.

Accessories

Submit each type of accessory item used in the project including, but not limited to: each type of anchor clip, closures, fasteners and leg clamps.

SD-05 Design Data

Load Calculations; G, [_____]

SD-06 Test Reports

Structural Performance; G, [_____]

Panel Finish; G, [_____]

Submit reports of the tests required by this section.

Manufacturer's Field Inspection; G, [_____]

Submit manufacturer's technical representative's inspection reports as required in paragraph MANUFACTURER'S FIELD INSPECTION.

SD-07 Certificates

Technical Representative

Qualification of Installer

Submit documentation proving the installer is factory-trained, has the specified experience and is authorized by the manufacturer to install the products specified.

Coil Stock Compatibility; G, [_____]

Provide certification of coil compatibility with roll forming machinery to be used for forming panels without warping, waviness, and rippling not part of panel profile; to be done without damage, abrasion or marking of finish coating.

SD-08 Manufacturer's Instructions

Sealant

Submit manufacturer's sealant requirements for roofing.

Installation Manual; G, [_____]

Submit manufacturer's printed installation manual/instructions and standard details.

SD-11 Closeout Submittals

Information Card

For each roofing installation, submit a typewritten card or photoengraved aluminum card containing the information listed on Form 1 located at the end of this section.

Warranty

1.5 LOAD CALCULATIONS

****
NOTE: Ensure that appropriate design loads are specified in paragraph WIND LOADS.
****

****
NOTE: Use 200 km/h 124 mph at Adak, Alaska.
****

Submit load calculations for the following by a structural engineer registered as a Professional Engineer in any jurisdiction verifying that the system supplied meets the design loads indicated. Coordinate calculations with manufacturer's test results.

a. Wind load uplift design pressure at roof locations specified in paragraph WIND LOADS.

b. Clip spacing and allowable load per clip calculations.

c. The fastening of clips to structure or intermediate support spacing.

d. Intermediate support spacing and fastening to structure when required.

e. Allowable panel span at anchorage spacing indicated.

f. Safety factor used in determining loading.

1.6 QUALITY ASSURANCE

1.6.1 Preroofing Conference

****
NOTE: Consult with the Contracting Officer responsible for construction of the project to determine who should conduct the conference. For NAVFAC SE administered projects, delete the option of Contractor conducting the conference and delete the last sentence.
****

After submittals are received and approved but before roofing [and insulation] work, including associated work, is preformed, the [Contracting Officer will] [Contractor must] hold a preroofing conference to review the following:

a. The drawings and specifications

b. Procedure for on site inspection and acceptance of the roofing substrate and pertinent structural details relating to the roofing system

c. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing

d. Safety requirements.

The preroofing conference must be attended by the Contractor and personnel directly responsible for the roofing [and insulation] installation, [mechanical] [and] [electrical work], and the roofing manufacturer's technical representative. Conflicts among those attending the preroofing conference must be resolved and confirmed in writing before roofing work, including associated work, is begun.[Prepare written minutes of the preroofing conference and submit to the Contracting Officer.]

1.6.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products and with installations in the geographical area where construction will take place. The manufacturer's representative must be an employee of the manufacturer with at least 5 years experience in installing the roof system. The representative must be available to perform field inspections and attend meetings as required herein, and as requested by the Contracting Officer.

1.6.3 Qualification of Installer

The roofing system installer must be factory-trained, approved by the aluminum roofing system manufacturer to install the system, and must have a minimum of three years experience as an approved applicator with that manufacturer. The applicator must have applied five installations of similar size and scope to this project within the previous 3 years.

1.6.4 Single Source

Provide roofing panels, clips, closures and other accessories from a single manufacturer.

1.6.5 Manufacturer

The SSMRS must be the product of an aluminum roofing industry recognized SSMRS manufacturer who has been in the practice of manufacturing SSMRS for a period of not less than 5 years and who has been involved in at least 5 projects similar in size and complexity to this project.

1.6.6 Laboratory Tests For Panel Finish

Previously manufactured panels of the same type and finish as proposed for the project must have been tested by an approved testing laboratory to ensure conformance to specifications. The term "appearance of base metal" refers to the aluminum base metal. Panels must meet the following test requirements.

1.6.6.1 Salt Spray Test

****

NOTE: Use 2000-hour test for products to be installed in marine environments.

****

Panels must withstand a salt spray test for a minimum of [1000][2000] hours in accordance with ASTM B117, including the scribe requirement in the test. Immediately upon removal of the panel from the test, coating must receive a rating of 10, no blistering, as determined by ASTM D714; and a rating of 7, 2 mm 1/16 inch failure at scribe, as determined by ASTM D1654, Rating Schedule No. 1.

1.6.6.2 Formability Test

For formability test, when subjected to a 180 degree bend over a 3 mm 1/8 inch diameter mandrel in accordance with ASTM D522/D522M, exterior coating film must show only microchecking of the exterior film and there must be no loss of adhesion.

1.6.6.3 Accelerated Weathering Test

Panels must withstand an accelerated weathering test for a minimum of 2000 hours in accordance with ASTM G152, ASTM G153 or ASTM D2565 without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with a penknife blade or similar instrument will be considered to indicate loss of adhesion.

1.6.6.4 Chalking Resistance

After the 2000-hour weatherometer test, exterior coating may not chalk greater than No. 8 rating when measured in accordance with ASTM D4214 test procedures.

1.6.6.5 Abrasion Resistance Test for Color Coating

When subjected to the falling sand test in accordance with ASTM D968, coating system must withstand a minimum of 100 liters of sand per 0.025 mm (mil) of coating thickness before appearance of base metal.

1.6.6.6 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D2247 for 1000 hours, a scored panel must show no signs of blistering, cracking, creepage, or corrosion.

1.6.6.7 Fire Hazard

****

NOTE: Delete this paragraph if mill finish has been selected. If roofing is exposed in exit areas, use a flame spread of 25; if exposed in non-exit areas, use flame spread of 75; otherwise delete the paragraph.

****

The finish on factory-fabricated panels must have a flame spread rating of not more than [25][75] when tested in accordance with ASTM E84.

1.6.6.8 Gloss

The gloss of the finish must be 30 plus or minus 5 at an angle of 60 degrees, when measured in accordance with ASTM D523.

1.6.6.9 Glare Resistance

****

NOTE: The requirements for glare resistance should be included only when specifically required by the facility for critical glare areas such as control

towers or other structures where glare can be an operational hazard.

****

Surfaces of panels that will be exposed to the exterior must have a specular reflectance of not more than 10 when measured in accordance with ASTM D523 at an angle of 85 degrees. Requirements specified under FORMABILITY TEST will be waived if necessary to conform to this requirement.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle preformed panels, bulk roofing products and other manufactured items in a manner to prevent damage or deformation.

1.7.1 Delivery

Provide adequate packaging to protect materials during shipment. Do not uncrate materials until ready for use except for inspection. Immediately upon arrival of materials at jobsite, inspect materials for damage, dampness, and staining. Replace damaged or permanently stained materials that cannot be restored to like-new condition with new material. If materials are wet, remove moisture, restack and protect panels until used.

1.7.2 Handling

Handle material carefully to avoid damage to surfaces, edges and ends.

1.7.3 Storage

Stack materials stored on the site on platforms or pallets and cover with tarpaulins or other suitable weathertight coverings which prevent water trapping or condensation. Store panels so that water which might have accumulated during transit or storage will drain off. Do not store the panels in contact with materials that might cause staining, such as mud, lime, cement, fresh concrete or chemicals. Protect stored panels from wind damage.

1.8 WARRANTY

Furnish manufacturer's no dollar limit materials and workmanship warranty for the roofing system. The warranty period must be not less than 20 years from the date of Government acceptance of the work. Issue the warranty directly to the Government. The warranty must provide that if within the warranty period the aluminum roofing system becomes non-watertight or shows evidence of corrosion, perforation, peeling paint, rupture or excess weathering due to deterioration of the roofing system resulting from defective materials or workmanship the repair or replacement of the defective materials and correction of the defective workmanship must be the responsibility of the roofing system manufacturer. Repairs that become necessary because of defective materials and workmanship while roofing is under warranty must be performed within 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time will constitute grounds for having the repairs performed by others and the cost billed to the manufacturer. In addition, provide a 2 year contractor installation warranty.

PART 2 PRODUCTS

2.1 ROOFING PANELS

****

NOTE: Certain roofing products are required to conform to public law (PL) 109-58 - Energy Policy Act of 2005 (EPAct05) by meeting or exceeding Energy Star or FEMP efficiency requirements at "energy-efficient products" at http://energy.gov/eere/femp/energy-and-water-efficient-products.

Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows the product is available from US national manufacturers above the minimum recycled content stated. Some manufacturers and regions have higher percentages.

****

2.1.1 Material

3004 aluminum, ASTM B209M ASTM B209. Aluminum roofing materials must contain a minimum of 30 percent total recycled content. Provide data identifying percentage of recycled content of aluminum roofing products.

****

NOTE: Facilities with dominant cooling loads and/or in mild or warm climate zones are required to meet "cool roofing" requirements of FEMP. Cool roof design must follow the requirements in UFC 3-110-03 Roofing, Appendix B and ASHRAE 90.1 Chapter 5, for the design of insulation and energy performance of the building. The roofing system will need to include a top surface layer that meets the Energy Star criteria for Cool Roof Products see http://www.energystar.gov/products/certified-products/detail/roof-products.

NOTE: If a cool roof is not selected in ASHRAE zones 1 thru 3, design must meet one of the exception requirements listed in ASHRAE 90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Coordinate these requirements with insulation design and specifications.

Retain the next to last bracketed sentence for project with cool roof requirement. Retain the last bracketed sentence for project with sustainable

third party certification credit requirement for reduced heat island effect.

****

Provide aluminum roofing product that is Energy Star labeled. Provide data identifying Energy Star label for aluminum roofing product.[Provide solar reflectance product with an initial solar reflectance greater than or equal to 0.25 and a solar reflectance greater than or equal to 0.15 three years after installation under normal conditions.][Provide emittance and reflectance percentages, solar reflectance index values, [and] slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]

2.1.1.1   Thickness

1.0 mm0.040 inch minimum.

2.1.1.2   Finish

****

NOTE: Choose the finish appropriate for the project. In general, hangars, warehouses, and other utilitarian structures may use mill finish to reduce cost. Mill finish Alclad is more economical than fluorocarbon painted finish. Some colors in the painted finish are substantially more costly than others, due to the scarcity of certain pigments.

****

****

NOTE: Use coated alclad in locations with an Environmental Severity Classification (ESC) of C3 through C5. Unpainted aluminum, mill finish, may be used in locations with an ESC of C1 or C2 unless there are factors which may lead to a locally corrosive microenvironment (e.g., local source of industrial pollution). See UFC 1-200-01 for determination of ESC for project locations.

****

[Alclad mill finish, unpainted] [Alclad fluorocarbon baked enamel exterior and neutral washcoat interior].

2.1.1.3   Texture

[Stucco embossed.][Smooth.][Smooth with raised intermediate ribs for added stiffness].

2.1.1.4   Color

****

NOTE: Check with the facility regarding color selection. Use only manufacturer's standard colors. Delete this paragraph if mill finish has been selected.

****

[Blue][Red][[_____], No. [_____]] exterior as selected from the manufacturer's standard colors.

2.1.1.5 Configuration

****

NOTE: The height of vertical legs should not be less than 50 mm 2 inches on roofs having a slope less than 2 in 12. The occurrence of ice dams or other water flow obstructions should be considered when determining the vertical leg height.

****

Provide panels of continuous lengths from ridge to eaves or from top to eaves on shed roof designs. Panels must be [300] [_____] mm [12] [_____] inches wide with a minimum [50] [_____] mm [2.0] [_____] inch high vertical legs and two [9.4 mm0.37 inch] [_____] stiffening ribs at 100 mm 4 inches on center between the legs to minimize oil-canning and telegraphing of structural members. Leading vertical leg must have a continuous groove in the rib top for anti-siphon protection when hook-rib top of next panel is locked over leading vertical leg to form the standing seam. Panels from coil stock must be formed without warping, waviness or ripples not a part of the panel profile, and must be free of damage to the finish coating system.

[2.1.1.6 Prefinished Coating System

****

NOTE: Delete this paragraph if mill finish has been selected.

****

Fluorocarbon baked enamel, factory-applied, minimum total dry film nominal thickness of [0.0175] [0.050] [_____] mm [0.7] [2.0] [_____] mils, and conforming to test requirements specified herein. Provide prefinished coating system on [both faces.] [the exterior face.] Interior face must receive same coating system, or, at the manufacturer's option, receive a coat of acrylic wash coat applied to a minimum total dry film nominal thickness of 0.005 mm 0.20 mil.

]2.2 ATTACHMENT CLIPS

****

NOTE: Add the appropriate choice(s) for the attachment clip(s) used in the design. Insert design value for minimum load capacity.

****

Series 300 non-magnetic stainless steel.

a. Type 1: [_____] clip, minimum capacity [_____] kgs lbs.

b. Type 2: [_____] clip, minimum capacity [_____] kgs lbs.

c. Type 3: [_____] clip, minimum capacity [_____] kgs lbs.

2.3 ACCESSORIES

Sheet metal flashings, trim, moldings, closure strips, caps, preformed crickets, equipment curbs, [gutters,] [down spouts,] and other similar sheet aluminum accessories provided in conjunction with preformed aluminum panels must be of the same material and finish as panels, except that such items which will be concealed after installation may be provided without the finish if they are aluminum or stainless steel. Provide ridge and rib closures, as specified. Aluminum must be of thickness not less than that of panels. Molded closure strips must be closed-cell synthetic rubber, neoprene, or polyvinyl chloride premolded to match configurations of preformed aluminum panels. Thermal spacer blocks and other thermal barriers at concealed fasteners must be as recommended by the roofing panel manufacturer.

2.3.1 Closures

2.3.1.1 Ridge Closure

Aluminum-clad foam or aluminum closure with foam secondary closure matching panel configuration for installation on surface of roof panel between panel ribs at ridge and headwall roof panel flashing conditions and terminations. Foam material must not absorb water.

2.3.1.2 Rib Closure

Aluminum, closed-cell or solid-cell synthetic rubber, neoprene or polyvinyl chloride pre-molded to match configuration of rib opening. Material for closures must not absorb water.

2.3.2 Fasteners

****

NOTE: In the high winds, metal will vibrate and fatigue at fasteners on "normal" spacings. For this reason, cleated (blind fastened) flashings are not acceptable, and attachment at 50 to 200 mm 6 to 8 inches on center is customary. Flashing should not extend a significant distance more than 25 mm 1 inch beyond a support or fastener.

****

Series 300 stainless steel with composite metal and neoprene composition washers. Fasteners for attachment to structural supports and fasteners for attachment of panels must be as approved and in accordance with manufacturer's recommendation. Unless specified otherwise herein, fasteners must be either self-tapping screws, bolts and nuts, or self-locking bolts. Design fastening system to withstand design loads indicated. Fasteners must not be over-torqued and must develop full capacity of attachment clips.

2.3.2.1 Screws

Provide not less than 0.242 mm No. 14 diameter for self-tapping type and not less than 0.216 mm No. 12 diameter for self-drilling and self-tapping.

2.3.2.2 Bolts

Provide not less than 6 mm 1/4 inch diameter, shouldered or plain shank as required, with proper nuts.

2.3.2.3 Automatic End-Welded Studs

Provide shouldered type with a shank diameter of not less than 5 mm 3/16 inch and cap or nut for holding covering against the shoulder.

2.3.2.4 Explosive Driven Fasteners

Provide fasteners to be driven with explosive actuated tools and with a shank diameter of not less than 13 mm 1/2 inch for fastening to steel and not less than 25 mm 1 inch for fastening to concrete.

2.3.2.5 Rivets

Blind rivets must be aluminum with 5 mm 3/16 inch nominal diameter shank or stainless steel with 3 mm 1/8 inch nominal diameter shank. Rivets must be threaded stem type if used for other than fastening trim. Rivets with hollow stems must have closed ends.

2.3.3 Sealant

Elastomeric type containing no oil or asphalt. Exposed sealant must cure to a rubberlike consistency. Concealed sealant must be the non-hardening type. Seam sealant must be factory-applied, non-skinning, non-drying, and must conform to the roofing manufacturer's recommendations. Do not use silicone-based sealants in contact with finished metal panels and components unless approved otherwise by the Contracting Officer.

2.3.4 Sealant Tape

Polyvinyl chloride closed cell foam tape or composed of 99 percent solids in a base of butyl polyisobutylene rubber with the following properties and characteristics:

a. Webbing and Elongation: 100 percent minimum at 25 degrees C 77 degrees F

b. Adhesion: Excellent to surfaces used

c. U-V light exposure: No effect

d. Ozone: No effect

e. Weathering: 1000 hours in QUV Test Apparatus - Excellent, no cracking, bleeding, or significant changes.

f. Moisture Transmission: 0.05 to 0.15 grams per 62500 square mm 100 square inches in 24 hours.

g. Service Temperature Tests: Bending over 13 mm 1/2 inchmandrel at minus 50 degrees C minus 60 degrees F with no cracking. Expose sealed typical metal lap joint to plus 176 degrees C plus 350 degrees F for 24 hours with no significant loss of original properties.

h. Reaction to Metals: Non-corrosive to aluminum

2.4 UNDERLAYMENT FOR WOOD SUBSTRATES

****

NOTE: Include the following paragraph where standing seam aluminum roof is applied directly to a wood deck.

****

Provide underlayment ASTM D226/D226M, Type I perforated, covered by water-resistant rosin sized building paper.

2.5 LINER PANELS

Fabricate liner panels of the same material as roof panels, and formed or patterned to prevent waviness and distortion. Liner panels must have a factory applied, 0.025 mm one mil thick minimum painted coating on the inside face, and a prime coat on the liner side.

PART 3 EXECUTION

3.1 EXAMINATION

Do not use building construction materials that show visible evidence of biological growth.

Examine surfaces to receive standing seam aluminum roofing and flashing. Provide plumb and true surfaces, clean, even, smooth and as dry as possible. Ensure that surfaces are free from defects and projections which might affect the installation. Report unsuitable conditions to Contracting Officer.

3.2 PROTECTION OF DISSIMILAR METALS

****

NOTE: Galvanized steel will deteriorate in humid conditions, coastal areas and should be considered a dissimilar metal unless it is known that the contact surface will remain dry and free from condensation. Wood which has been pressure treated will also react with aluminum. Provide protection if aluminum could contact treated wood.

****

Where an aluminum component is in contact with, fastened to, or contacted by drainage from dissimilar metals other than stainless steel, give such dissimilar metals one of the following treatments:

a. A heavy brush coat of primer followed by two coats of aluminum metal and masonry paint.

b. A heavy coat of alkali-resistant bituminous paint.

c. Separate contact surfaces with non-absorptive tape or gasket.

3.2.1 Contact with Masonry

Where aluminum is in contact with masonry, concrete, or plaster, apply a heavy coat of alkali-resistant bituminous paint.

3.2.2 Contact with Wood

Where aluminum is in contact with wood or other absorptive material subject to wetting, or with wood treated with a preservative not compatible with aluminum, seal joints with sealing compound and apply one heavy brush coat of aluminum pigmented bituminous paint.

3.3 INSTALLATION

Install in accordance with approved manufacturer's erection instructions shop drawings, and diagrams, except as specified otherwise herein. Provide panels in full and firm contact with clips. Obtain approval prior to installation on prefinished panels cut in the field, and factory applied coverings or coatings that were repaired after being abraded or damaged during handling or installation. Make repairs with material of same color as weather coating. Completely seal openings through panels. Correct defects or errors in materials in an approved manner. Replace materials which cannot be corrected in an approved manner with new materials. Provide molded closure strips where indicated and where necessary for weathertight construction. [Use shims as required to ensure clip line is true.] Use a spacing gage at each row of panels to ensure that panel width is not stretched or shortened. [Provide one layer of asphalt-saturated felt placed perpendicular to roof slope covered by one layer of rosin-sized building paper placed parallel to roof slope with side laps down slope and attached with roofing nails. Overlap side end laps 75 mm 3 inches, offset seams in building paper with seams in felt.]

3.3.1 Roof Panels

Apply roofing panels with standing seams parallel to slope of roof. Provide roofing panels in full lengths from ridge to eaves (top to eaves on shed roofs), with no transverse joints except at the junction of ventilators, curbs, skylights, chimneys, and similar openings. Form interlocking rib type panel seams in the field with an automatic mechanical seamer approved by the manufacturer. Attach panels to structure with concealed clips which are incorporated into the panel seams. Clip attachment must allow roof to move freely and independently of the structure, except at fixed points as indicated.

3.3.2 Flashings

****

NOTE: In the high winds metal will vibrate and fatigue at fasteners on "normal" spacings. For this reason, cleated (blind fastened) flashings are not acceptable, and attachment at 100 to 150 mm 4 to 6 inches on center is customary. Flashing should not extend a significant distance more than 25 mm one inch beyond a support or fastener.

****

Provide flashing and related closures and accessories in connection with preformed metal panels [as indicated] and as necessary to provide a weathertight installation. Install flashing to ensure positive water drainage away from roof penetrations. Flash and seal roof at ridge, eaves and rakes, at projections through roof, and elsewhere as necessary. Accomplish placement of closure strips, flashing, and sealing material in an approved manner that will ensure complete weathertightness. Details of installation which are not indicated must be in accordance with the NRCA CONDET, SMACNA 1793, AA ASM-35, panel manufacturer's printed instructions and details of the approved shop drawings. Installation must allow for expansion and contraction of flashing.

3.3.3 Flashing Fasteners

****

NOTE: In the high winds, metal will vibrate and fatigue at fasteners on "normal" spacings. For this reason, cleated (blind fastened) flashings are not acceptable, and attachment at 100 to 150 mm 4 to 6 inches on center is customary. Flashing should not extend any significant distance more than 25 mm one inch beyond a support or fastener.

****

Fastener spacings must be in accordance with the panel manufacturer's recommendations and as necessary to withstand the indicated design loads. Install fasteners in roof valleys as recommended by the manufacturer of the panels. Install fasteners in straight lines within a tolerance of 13 mm 1/2 inch in the length of a bay. Drive exposed penetrating type fasteners normal to the surface and to a uniform depth to seat gasketed washers properly and drive so as not to damage factory applied coating. Exercise extreme care in drilling pilot holes for fastenings to keep drills perpendicular and centered. Do not drill through sealant tapes. After drilling, remove metal filings and burrs from holes prior to installing fasteners and washers. Torque used in applying fasteners must not exceed that recommended by the manufacturer. Remove panels deformed or otherwise damaged by over-torqued fastenings, and provide new panels.

3.3.4 Closure/Closure Strips

Set closure/closure strips in joint sealant material.

3.4 CLEANING

Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs on completion to prevent discoloration and harm to the panels and flashing. Remove grease and oil films, excess sealants handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces must be free of dents, creases, waves, scratch marks, and solder or weld marks.

3.5 MANUFACTURER'S FIELD INSPECTION

Manufacturer's technical representative must visit the site as necessary during the installation process to assure panels, flashings, and other components are being installed in a satisfactory manner. Manufacturer's technical representative must perform a field inspection during the first [20] [_____] squares of roof panel installation and at substantial completion prior to issuance of warranty, as a minimum, and as otherwise requested by the Contracting Officer. Additional inspections must not exceed one for each [100] [_____] squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer. Each inspection visit must include a review of the entire installation to date. After each inspection, submit a report, signed by the manufacturer's technical representative, to the Contracting Officer noting the overall quality of work, deficiencies and any other concerns, and recommended corrective actions in detail. Notify Contracting Officer a minimum of 2 working days prior to site visit by manufacturer's technical representative.

3.6 COMPLETED WORK

Completed work must be plumb and true without oil canning, dents, ripples, abrasion, rust, staining, or other damage detrimental to the performance or aesthetics of the completed roof assembly.

3.7 INFORMATION CARD

****
NOTE: Include only the applicable EFD.
****

For each roof, provide a typewritten card, laminated in plastic and framed for interior display or a photoengraved 0.8 mm thick 0.032 inch thick aluminum card for exterior display. Card to be 220 by 280 mm 8 1/2 by 11 inches minimum and contain the information listed on Form 1 at end of this section. Install card near point of access to roof, or where indicated. Send a photostatic paper copy to [NAVFAC Washington, Building 2, Washington Navy Yard, Washington, DC 20374-2121][LANTNAVFACENGCOM, Code 1613, 1510 Gilbert Street, Norfolk, VA 23511-2699] [NORTHNAVFACENGCOM, Code 103A, 10 Industrial Highway, Mail Stop #82, Lester, PA 19113-2090] [PACNAVFACENGCOM, Code 102, Pearl Harbor, HI 96860-7300] [SOUTHNAVFACENGCOM, Code 0535, P.O. Box 190010, North Charleston, SC 29419-9010] [SOUTHWESTNAVFACENGCOM, Code 133SB, 1220 Pacific Highway, San Diego, CA 92132-5190][_____].

3.8 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of English unit measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

PRODUCTS	ENGLISH UNITS	METRIC UNITS
a. Sheet Aluminum	0.040 inch	1.0 mm
b. Panels	12 inches	300 mm
- vertical legs	2 inches	50 mm
- stiffening ribs	4 inches	100 mm
c. Screws	No. 14	0.242 mm
	No. 12	0.216 mm
d. Bolts	1/4 inch	6 mm
e. Studs	3/16 inch	5 mm
f. Fasteners	1/2 inch	13 mm
	One inch	25 mm

g. Rivets	1/16 inch	5 mm
	1/8 inch	3 mm

3.9 FORM ONE

FORM 1 - PREFORMED STEEL STANDING SEAM ROOFING SYSTEM COMPONENTS

1. Contract Number:

2. Building Number & Location:

3. NAVFAC Specification Number:

4. Deck/Substrate Type:

5. Slopes of Deck/Roof Structure:

6. Insulation Type & Thickness:

7. Insulation Manufacturer:

8. Vapor Retarder: ( )Yes ( )No

9. Vapor Retarder Type:

10. Preformed Steel Standing Seam Roofing Description:

a. Manufacturer (Name, Address, & Phone No.):
b. Product Name: c. Width: d. Gage:
e. Base Metal: f. Method of Attachment:

11. Repair of Color Coating:

a. Coating Manufacturer (Name, Address & Phone No.):
b. Product Name:
c. Surface Preparation:
d. Recoating Formula:
e. Application Method:

12. Statement of Compliance or Exception:____________________________________
____
____

13. Date Roof Completed:

14. Warranty Period: From_______________ To_______________

15. Roofing Contractor (Name & Address):

16. Prime Contractor (Name & Address):

Contractor's Signature __________________________ Date:

Inspector's Signature __________________________ Date:

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 62 13 (August 2009)**

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 62 13

COPPER SHEET METAL FLASHING AND TRIM

08/09

PART 1 GENERAL

PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 62 13 (August 2009)**

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****

SECTION 07 62 13

COPPER SHEET METAL FLASHING AND TRIM
08/09

****

NOTE: This guide specification covers the requirements for copper sheet metal used as flashing, including gutters and downspouts and for historic structures which require roof repairs.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Details of sheet metalwork will be shown on project drawings in accordance with the appropriate details in the Architectural Sheet Metal Manual of the Sheet Metal and Air Conditioning Contractors National Association, except that the first ply of roofing will not be extended into gutters.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C1136	(2023) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM F547	(2017) Standard Terminology of Nails for Use with Wood and Wood-Base Materials

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-51145	(Rev D; Notice 1; Notice 2; Notice 3; Notice 4) Flux, Soldering, Non-Electronic, Paste and Liquid

1.2 SYSTEM DESCRIPTION

a. Perform sheet metalwork to accomplish weathertight construction. Install the work without waves, warps, buckles, fastening stresses or distortion, allowing for expansion and contraction. Perform cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades by sheet metal mechanics. Hem exposed edges. Angle bottom edges of exposed vertical surfaces to form drips. Form flashing into a 3-dimensional configuration, at the end of a run. to direct water to the outside of the system. Weights and thicknesses of copper flashing are as specified in TABLE 1. Install joints as specified in TABLE 2. Provide accessories and other items, essential to complete the sheet metal installation, though not specifically indicated or specified.

b. Coordinate installation of sheet metal items used in conjunction with roofing with roofing work to permit continuous roofing operations. Pack factory-fabricated components in cartons marked with the manufacturer's name or trademark printed or embossed at frequent intervals to permit easy identification. Sheet metalwork pertaining to heating, ventilating, and air conditioning is specified in other sections.

****

NOTE: Galvanic action between dissimilar metals must be avoided in order to prevent corrosion. In replacing flashing, gutters and other copper sheet metal items on historic structures, it is often necessary to reuse existing non-copper support or connecting items. Proper insulation between unlike materials will provide protection against galvanic action and subsequent deterioration.

****

c. Use proper insulation to avoid galvanic action between copper and iron or steel. Insulate the copper covering the steel member with insulation; placing strips of sheet lead between the two metals; or by heavily tinning the iron.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Sheet Metal

SD-03 Product Data

Contractor Quality Control

SD-04 Samples

Materials

1.4 DELIVERY, STORAGE, AND HANDLING

Adequately package and protect materials during shipment and inspect for damage, dampness, and wet-storage stains upon delivery to the jobsite. Clearly label materialsas to type and manufacturer. Handle sheet metal items carefully to avoid damage. Store materials in dry, weathertight, ventilated areas until installation.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials conforming to the requirements specified below, and those given in TABLE 1. Materials exposed to weather must be copper. Recyclable materials (building paper, etc.) must conform to EPA requirements in conformance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Submit samples of materials proposed for use, upon request.

2.1.1 Asphalt Roof Cement

ASTM D4586/D4586M, Type I.

2.1.2 Fasteners

Provide fasteners conforming to TABLE 1. Provide nails conforming to ASTM F547 or as approved. Provide copper nails and rivets. Provide bronze screws and bolts. Fasteners must be the best type for the application.

2.1.3 Felt

ASTM D226/D226M, Type II.

2.1.4 Flux

CID A-A-51145, Type I.

2.1.5 Slip Sheet

Building paper meeting the requirements of ASTM C1136, Type IV, style optional.

2.1.6 Sheet Metal

Furnish sheet metal conforming to ASTM B152/B152M, ASTM B370, Light cold-rolled temper (H00) copper. Submit drawings showing weights, gauges, or thickness of sheet metal; type of material; joining, expansion-joint spacing, and fabrication details; and installation procedures. Do not deliver materials to the site until after the approved detail drawings have been returned to the Contractor.

2.1.7 Solder

ASTM B32 Sn50.

2.2 SEALANTS AND SEALING COMPOUNDS

Sealants and sealing compounds are specified in Section 07 92 00 JOINT SEALANTS.

PART 3 EXECUTION

3.1 EXISTING COPPER SHEET METAL

Salvage existing, original, historic copper sheet metal elements that are intact and serviceable and reuse whenever possible. This may include, but is not limited to, gutters, hangers, downspouts, connectors, leader heads, leader straps, basket strainers, splash pans, and other architectural sheet metal elements such as finials, and decorative panels. When work involves repair and replacement of copper sheet metal elements, match new elements to existing original elements as closely as possible.

3.2 SOLDERING AND SEAMING

3.2.1 Soldering

Pretin edges of sheet metals, except lead coated materialbefore soldering is begun. Solder slowly with well heated soldering irons to thoroughly heat the seams and completely sweat the solder through the full width of the seam. Scrape or wire-brush edges of lead coated material to be soldered to produce a bright surface, and brush a liberal amount of flux in seams before soldering is begun. Solder immediately after applying flux.

Upon completion of soldering, thoroghly clean the acid flux residue from the sheet metal with a solution of washing soda in water and rinse with clean water.

3.2.2 Seams

Finish flat-lock and soldered-lap seams no less than 25 mm 1 inch wide. Do not lap unsoldered plain-lap seams less than 75 mm 3 inches unless otherwise specified. Make flat seams in the direction of the flow.

3.3 COVERING ON MINOR FLAT, PITCHED, OR CURVED SURFACES

Unless otherwise indicated, cover or flash minor flat, pitched, or curved surfaces, such as crickets, bulkheads, dormers, and small decks with 450 x 600 mm 18 x 24 inch metal sheets and secure with cleats. Apply one ply of felt covered with 1 ply of slip sheet as underlayment on wood surfaces. Place 2 cleats on the long side and place 1 cleat on the short side. Lock and solder seams.

3.4 CLEATS

Provide a continuous cleat where indicated or specified to secure loose edges of the sheet metalwork. Space butt joints approximately 3 mm 1/8 inch apart. Fasten the cleat to the supporting construction with nails evenly spaced not over 300 mm 12 inches on centers. Where the fastening is to be made to concrete or masonry, use screws driven in expansion shields set in concrete or masonry. Install the cleat for fascia anchorage to extend below the supporting construction to form a drip and to allow the flashing to be hooked over the lower edge at least 19 mm 3/4 inch. The cleat must be wide enough to provide adequate bearing area to ensure a rigid installation. Where horizontal nailer is vented for insulation and the cleat is placed over masonry or concrete, install the cleat over 1.6 mm 1/16 inch thick metal washers placed at screws. Use metal washers that are electrolytically compatible with the continuous cleat.

3.5 EXPANSION JOINTS

Provide expansion joints at 12.0 meter 40 foot intervals, except that where the distance between the last expansion joint and the end of the continuous run is more than half the required interval spacing, provide an additional joint. Space joints evenly.

3.6 FLASHINGS

3.6.1 General

Install flashings at intersections of roof with vertical surfaces and at projections through roof, except that flashing for heating and plumbing, including piping, roof, and floor drains, and for electrical conduit projections through roof or walls is covered in appropriate sections for such work. Turn cap flashings around exterior corners of masonry or concrete walls at least 50 mm 2 inches, secure into masonry joints and into concrete with expansion anchors and seal with No. 2 or 4 sealing compound. Use corner units that have mitered joints, install with 75 mm 3 inch lap joint over flashings on each side. Unless otherwise indicated, terminate through-wall flashing 13 mm 1/2 inch inside each exposed face of the wall. Provide cap flashings over base flashings. Cover up perforations in flashings made by masonry anchors by applying bituminous plastic cement at the perforation. For exposed and unfastened flashings, turn the edge of the strip under 13 mm 1/2 inch. Install flashing on top of joint reinforcement.

3.6.2 Base Flashings

a. Extend base flashings under the uppermost row of tile the full depth of the tile or at least 100 mm 4 inches over the tile immediately below the metal.

b. Turn up the vertical leg of the metal not less than 100 mm 4 inches and preferably 200 mm 8 inches on the abutting surface. Where a vertical surface butts against the roof slope, build the base flashing into each course of tile as it is laid, turning the metal out 100 mm 4 inches on the tile and at least 200 mm 8 inches above the roof.

c. Where the roof stops against a stuccoed wall, secure a wood 2 x 4 with a beveled top edge to the wall. Then turn out base flashing over the tile at least 100 mm 4 inches and bend up vertically at least 75 mm 3 inches on the board.

d. Turn out the base flashing 100 mm 4 inches on the roof surface and from 150 to 200 mm 6 to 8 inches on the vertical surface for either sloping or flat slate roofs.

e. Use base flashings where posts, flagpoles, or scuttles project through the roof. Vent pipes must have base flashings in the form of special sleeves and/or EPDM boots.

3.6.3 Cap Flashings (Counterflashings)

Where the base flashing is not covered by vertical tile or siding, build a cap flashing into the masonry joints lapping not less than 50 mm 2 inches vertically, extending down over the base flashing 100 mm 4 inches, and the edge bent back and up 13 mm 1/2 inch.

3.6.4 Stepped Flashing

Install stepped flashing where sloping roofs surfaced with tiles abut vertical surfaces. Place separate pieces of base flashing in alternate tile courses. Extend each piece of base flashing out onto the roof at least 100 mm 4 inches and nail to the deck. Extend the stepped base flashing up along the wall not less than 100 mm 4 inches and stop beneath the cap flashing or anchor beneath wood siding in frame construction. Set cap flashings in a reglet into masonry and concrete construction, and lap cap flashing over the flashing below not less than 75 mm 3 inches. Lap the stepped base flashing at vertical joints between the sections not less than 75 mm 3 inches.

3.6.5 Valley Flashing

Valley flashing must be free from longitudinal seams and wide enough to extend not less than 150 mm 6 inches under the roof covering on each side. Lap the sheets not less than 200 mm 8 inches in the direction of flow and secure to roofing construction with cleats on each side. Space cleats not more than 600 mm 24 inches on centers. Do not puncture the copper sheet with nails at any place.

3.6.5.1 Open Valley Flashings

a. Open valleys must be not less than 100 mm 4 inches wide. Determine the proper width by the following rule: Starting at the top with a width of 100 mm 4 inches, increase the width 25 mm 1 inch for every 2.4 meters 8 feet of length of the valley. Flashing pieces must be full length sheets and of sufficient width to cover the open portion of the valley and extend up under the roofing not less than 150 mm 6 inch on each side.

b. Where two valleys of unequal size come together; where the areas drained by the valley are unequal; where the slope of the valley is 26 degrees or less (500 mm per meter or less 6 inches or less per foot;) or where the intersecting roofs are of different slopes, provide an inverted V-joint 25 mm 1 inch high along the centerline of the valley, and extend the edge of the valley sheets 200 mm 8 inches under the roof covering on each side.

3.6.5.2 Closed Valleys

a. Flashing pieces for closed valleys must be long enough to extend 50 mm 2 inches above the top of the roofing piece and lap the flashing piece below 75 mm 3 inches, and of sufficient width to extend up the sides of the valley far enough to make the valley 200 mm 8 inches deep.

b. Place flashing with the roofing so that all pieces are separated by a course of tile. Set pieces so as to lap at least 75 mm 3 inches and to be entirely concealed by the tiles. Fasten flashing by nails at the top edge only.

3.6.6 Through-Wall Flashing

Through-wall flashing includes sill, lintel, and spandrel flashing. Lay the flashing with a layer of mortar above and below the flashing so that the total thickness of the two layers of the mortar and flashing are the same thickness as the regular mortar joints. Flashing must be one piece for lintels and sills.

3.6.6.1 Lintel Flashing

Extend lintel flashing the full length of lintel. Extend it through the wall one masonry course above the lintels and bend down over the top of masonry and precast concrete lintels. Underlay bedjoints of lintels at control joints with sheet metal bond breaker.

3.6.6.2 Sill Flashing

Extend sill flashing the full width of the sill and not less than 100 mm 4 inches beyond ends of sill except at a control joint where the flashing is terminated at the end of the sill.

3.6.7 Eave and Rake Flashings

Place eave and rake flashings in accordance with SMACNA 1793.

3.7 REGLETS

Reglets must be a factory fabricated product, complete with fittings and special shapes as may be required. Provide open-type reglets filled with fiberboard or other suitable separator to prevent crushing of the slot during installation. Locate reglets no less than 200 mm 8 inches nor more than 400 mm 16 inches above roofing not having cant strips or locate no less than 125 mm 5 inches nor more than 325 mm 13 inches above cant strip. Do not space reglet plugs over 300 mm 12 inches on centers and fill reglet grooves with sealant. Friction or slot-type reglets must have metal flashings inserted the full depth of slot and must be lightly punched every 300 mm 12 inches to crimp the reglet and cap flashing together.

3.8 GRAVEL STOPS AND FASCIA

Fabricate sheets without longitudinal joints except where 2-piece fasciae are used when fascia depth exceeds 175 mm 7 inches. Provide provision for expansion at joints. Provide factory fabricated internal and external corner units with mitered joints. Extend roof flange and splice plate of the gravel stop and fascia out on the roof no less than 100 mm 4 inches, and set in bituminous cement over the roofing felt. Secure roof flange with nails spaced no greater than 75 mm 3 inches on centers located within 25 mm 1 inch of the outer edge of the flange. Do not face nail the fascia section except as specified for 2-piece fascia. The upper piece of two-piece fascia must be the same as specified above except that the fascia depth must be at least 90 mm 3-1/2 inches, and must overlap the lower fascia not less than 50 mm 2 inches. Hook the lower piece 13 mm 1/2 inch over edge strip and splice plate and face nail on 300 mm 12 inch centers 25 mm 1 inch below top of sheet. Hem the upper fascia 13 mm 1/2 inch at lower edge and form to fit tight against lower fascia.

3.9 DOWNSPOUTS

Set downspouts plumb and no less than 25 mm 1 inch from the wall. Provide leaders to connect gutters on overhanging eaves to downspouts. Set leaders with a slope no less than 0.3 degrees, 5 mm per m 1/16 inch per foot or more than 30 degrees below a horizontal line. Fit leaders over the outlet tube in gutter bottom. Fit into and rivet to the downspout. Rivet spacing more than 50 mm 2 inches is not permitted. Loosely set strainers in the eave tube opening in gutter. Make joints between lengths of downspouts by telescoping the end of the upper lengths at least 19 mm 3/4 inch into the lower length. Neatly fit downspouts terminating in drainage lines into downspout boots and fill the joint with a portland cement mortar cap sloped away from downspout. Provide downspouts terminating at splash blocks or splash pans with stock elbow-type fittings. Provide downspout hangers adjacent to the joint at the top of each section of downspout, except that the bottom section must have an additional strap adjacent to the bottom joint when splash blocks or splash pans are required. Hangers must be 1.5 x 25 mm 1/16 x 1 inch flat stock of the same material as the downspout.

3.10 GUTTERS

Terminate gutters at least 13 mm 1/2 inch away from vertical surfaces. [Anchor supporting cleats to the structure at spacings not exceeding 400 mm 16 inches.] [Fasten gutter brackets and spacersto roof nailer by screws or deformed shank-type nails and interlock with or fasten to the leading edge of gutter. Gutter spacers must be 1.5 x 25 mm 1/16 x 1 inch flat-stock of the same material as the gutter. Alternate brackets and spacers at not more than 900 mm 36 inches on centers.] hang gutters with high points at ends or equidistant from downspouts and [level] [slope not less than 0.3 degrees 5 mm per m 1/16 inch per foot].

3.11 SCUPPER LININGS

Line the interior of scupper openings with sheet metal. Form the lining to return not less than 25 mm 1 inch against both faces of the wall or parapet with the outside edges folded under 13 mm 1/2 inch less on the top and sides. The perimeter of the lining must be approximately 13 mm 1/2 inch less than the perimeter of the scupper. Join the top and sides of scuppers on the roof-deck side to base flashing by a locked and soldered joint. Join the bottom edge by a locked and soldered joint to the base flashing and where required, form with a ridge to act as a gravel stop around the scupper inlet. Coat surfaces to receive the lining with bituminous cement.

3.12 SPLASH PANS

Install splash pans where downspouts discharge on roof surfaces and at other locations as indicated. Pans must be of size indicated. Bed pans and roof flanges in plastic bituminous cement and strip flashed.

3.13 CONTRACTOR QUALITY CONTROL

****

NOTE: When justified by the amount or criticality of the roofing involved, and similar requirements are not established for the Contractor Quality Control organization specified elsewhere, the following requirement will be added at the end of the paragraph:

A roofing technician responsible directly to the Contractor and experienced in the construction of the specified roofing system and related work must perform the quality control functions and be on the site whenever roofing operations are in progress.

****

Establish and maintain a quality control procedure for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Promptly remove and replace or correct any work found not to be in compliance with the contract in an approved manner. Submit a Quality Assurance Plan, including a checklist of points to be observed, prior to start of roofing work. Quality control includes, but is not limited to, the following:

a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.

b. Verification of compliance of materials before, during, and after installation.

c. Inspection of sheet metalwork, for proper size and thickness, fastening and joining, and proper installation.

Document the actual quality control observations and inspections and furnish a copy of the documentation to the Contracting Officer at the end of each day.

TABLE 1 - COPPER SHEET METAL WEIGHTS AND THICKNESSES	
Item Description	Copper (kg/square moz/square foot)
Building expansion joints: Cap	4.9 16
Building expansion joints: Waterstop - bellows or flanged-U-type	4.9 16
Cleats (Continuous)	7.3 24
Covering on minor flat, pitched or curved surfaces	6.1 20
Downspouts, heads and leaders	4.9 16
Flashings: Base	6.1 20
Flashings: Cap, stepped or valley	4.9 16
Gravel stops and fasciae: Sheets,	4.9 16
Gutters (girth): Up to 380 mm15 inches	4.9 16
Gutters (girth): 380 to 510 mm15 to 20 inches	4.9 16
Gutters (girth): 510 to 635 mm20 to 25 inches	6.1 20
Gutters (girth): 635 to 760 mm25 to 30 inches	7.3 24
Gutter brackets (girth): Up to 380 mm15 inches	3 x 25 mm 1/8 x 1 inch
Gutter bracket s (girth): 380 to 510 mm15 to 20 inches	6 x 25 mm 1/4 x 1 inch
Gutter brackets (girth): 510 to 610 mm20 to 24 inches	6 x 38 mm 1/4 x 1 1/2 inch
Gutter cleats and cover plates	4.9 16
Scupper lining	6.1 20
Strainers (wire gauge)	No. 9
Reglets (1)	3.1 10
Splash pans	4.9 16
Copings	4.9 16
Pitch pockets	4.9 16
Through-wall, flashings above roof line	4.9 16
Through-wall, below roof line, except as otherwise specified in paragraph MATERIALS	3.1 10

TABLE 2 - COPPER SHEET METAL JOINTS	
Item Designation	Type of Joint
Building expansion joint at roof	32 mm1-1/4 inch single lock standing seam, cleated
Cleats (Continuous)	Butt
Flashings: Base	25 mm1 inch flat locked, soldered 75 mm3 inch lap for expansion joint
Cap - in reglet	75 mm3 inch lap
Cap - two - piece	Receiver 75 mm 3 inch lap Cap piece 75 mm 3 inch lap
Stepped	75 mm3 inch lap
Through-wall spandrel flashing (metal	38 mm1-1/2 inch mechanical interlock
Valley	150 mm6 inch lap, cleated
Sheet, corrugated	Butt with 6 mm 1/4 inch
Sheet, smooth	Butt with 6 mm 1/4 inch space
Gutters	38 mm1-1/2 inch lap, riveted and soldered
Pitch pockets	25 mm1 inch soldered lap
Reglets	Butt joint

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 72 20 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-07 72 20 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 72 20

GRAVITY-TYPE ROOF VENTILATORS

08/23

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-07 72 20 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-07 72 20 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 07 72 20

GRAVITY-TYPE ROOF VENTILATORS
08/23

****
NOTE: This guide specification covers the requirements for gravity-type roof ventilators including stationary, turbine, and ridge types.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

1.2 DESIGN REQUIREMENTS

****

NOTE: Use the latest ventilator manufacturer's recommendations, including latest ASHRAE Handbook "Fundamentals" published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, to determine the ventilator size and performance requirements.

****

Design ventilators for use with the specific type of project roofing system, and to provide uniform and continuous air flow. Ventilator design must provide protection against rain and snow, and be provided with a continuous weep along the bottom of both sides of wind band. Units must be self-cleaning by the action of the elements, and have provisions for carrying water and normal wind-transported soil matter to the outside. Design units for windspeeds of not less than [36] [_____] m/second [80] [_____] mph in accordance with ASCE 7-22. Ventilators must be free of internal obstructions or moving parts which require maintenance, and be complete with type of mounting indicated on drawings.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roof Ventilators; G, [_____]

1.4 QUALITY ASSURANCE

Manufacturer must specialize in design and manufacture of the type of roof ventilators specified in this section, and have a minimum of [_____] years of documented successful experience. Provide a ventilator installer experienced in the installation of ventilator types specified.

1.5 DELIVERY, STORAGE, AND HANDLING

Roof ventilators must be cartoned or crated prior to shipment. Protect ventilators from moisture and damage. Remove damaged items from the site.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Specify ventilators fabricated of aluminum in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Galvanized steel is acceptable for project locations with ESC of C1 or C2. See UFC 1-200-01 for determination of ESC for project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1).

****

2.1.1 Aluminum Extrusions

Aluminum extrusions must be alloy 6063, temper T5 in compliance with ASTM B221M ASTM B221.

2.1.2 Aluminum Sheets

Aluminum sheets must be alloy 5005, temper H15 or alloy 3003, temper H14 in compliance with ASTM B209/B209M.

2.1.3 Galvanized Steel Sheets

Steel sheets must be commercial quality, zinc-coated steel (hot-dip galvanized) in compliance with ASTM A653/A653M, minimum G90 coating thickness.

2.2 RIDGE VENTILATORS

****

NOTE: Review building code requirements to determine if no damper or manually-operated dampers are acceptable. If dampers must meet fire code requirements, carefully review code and ventilator manufacturer's data before editing this spec.

****

Provide roof ridge ventilators fabricated of [galvanized steel] [aluminum], and assembled to any desired length. Connect continuous-run ridge ventilators with splice plates of type which will telescope together and not require fasteners, soldering or welding. Provide ventilators with [manually-operated single-leaf dampers complete with accessories to meet design and performance requirements.] [UL labeled fire-actuated damper system complete with accessories to meet building code requirements.] Provide dampers and airshafts complete with urethane gasketing for extra-tight enclosures. Provide metal closure strips, which match the panel roof rib contours, to close out weather and provide a secure seat for ventilators. Provide [Insect] [Bird] screens.

2.3 STATIONARY VENTILATORS

Provide stationary roof ventilators fabricated of [galvanized steel] [aluminum] with seamless spun conical-shaped weathercap, and having straight-through drainage for eliminating the possibility of air-borne debris collecting in the ventilator openings. Provide [Insect] [Bird] screens.

2.4 TURBINE VENTILATORS

Provide turbine ventilators fabricated of [galvanized steel] [aluminum] [corrugated] [flat] sheets, complete with sensitive ball-bearing action to enable the slightest motion of air to move the rotor head where suction is maintained at low wind velocities. Ventilators must have 360 degree operating surface to assure access of wind currents regardless of wind velocities. Anchor rotor head to prevent head from lifting or jumping off the rotor in high winds. Rotor crown plate must be seamless. Provide [Bird] [Insect] screens.

2.4.1 Dampers

****

NOTE: Select desired option for operation of the ventilator dampers.

****

Provide turbine ventilators with [dampers manually-operated with direct pull-chain or rack and pinion] [push-button control electric gear motor-operated dampers] [thermostat control electric gear motor-operated dampers].

2.4.2 Rotor Shaft

Rotor shaft bearings must be entirely shielded in corrosion-resistant aluminum casing. Bearings must be pre-lubricated and have life-time warranty. Bearings must be at top and bottom to assure accurate alignment. Shaft and bearings must be easily replaceable as a unit. Rotor collar must be rolled and welded.

2.5 FABRICATION

Ventilators must be fabricated in accordance with approved shop drawings. Welds, soldered seams, rivets and fasteners must be clean, secure, watertight, and smooth. Edges must be wired or beaded, where necessary, to ensure rigidity. Joints between sections must be watertight and allow for expansion and contraction. Galvanic action between different metals in direct contact must be prevented by nonconductive separators.

2.6 CURB BASES

****

NOTE: Delete this paragraph if flange-mounting is used.

****

Ventilator bases for curb-mounted installations must be of size indicated on drawings, and be designed specifically for the type of ventilator and roofing system approved for this project. Curb bases must be factory-formed and flashed for a watertight installation. Curb bases must be fabricated of material and finish to match the ventilator.

2.7 SCREENS

****

NOTE: Select screen types required above within each ventilator type section. Insect screens are typically required for ventilators in hospitals, mess halls, bakeries and similar buildings. Insect screens should not be used when exhausting noxious gases because insect screens will clog up. Include bird screens where insect screens are not required in order to meet requirements of ASHRAE 62.1. If both bird screening and insect screening are required, indicate location of each on drawings and edit as required.

****

Screens must be furnished by ventilator manufacturer as part of ventilator assembly. Screen (with frames) must be manufactured of material to match ventilators, and must be designed to be easily removed for cleaning purposes.

2.8 FINISH

****

NOTE: Use high performance coating systems for special situations where appearance is important, project locations with Environmental Severity Classifications (ESC) of C3 thru C5, or high humidity locations. In ESC C1 and C2 project locations, other finish options are acceptable. See UFC 1-200-01 for determination of ESC for project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1).

****

2.8.1 Galvanized Steel Finish

Galvanized steel roof ventilators must be factory-coated with rust-resistant primer and [baked-on finish coats of acrylic] [finish coats to match metal roof panels] [two-coat high-performance coating system] [field-painted in accordance with Section 09 90 00 PAINTS AND COATINGS] [_____].

2.8.2 Aluminum Finish

Aluminum roof ventilators must be factory-finished [to match metal roof finish and color] [with two-coat fluoropolymer high-performance coating system] [_____].

2.8.3 Color

Color must be in accordance with [Section 09 06 00 SCHEDULES FOR FINISHES] [_____].

PART 3 EXECUTION

3.1 PREPARATION

Prepare rough openings and other roof conditions in accordance with approved shop drawings and manufacturer's recommendations. Rough openings must be field-measured and recorded on shop drawings prior to fabrication of roof ventilators. Before starting the ventilator work, protect surrounding roof surfaces from damage. Coordinate fabrication with construction schedule. Submit dimensioned drawings indicating location of each type of ventilator including details of construction, gauges of metal, and methods of operation of dampers and controls.

3.2 INSTALLATION

Coordinate roof ventilator installation with roofing work, and in accordance with approved shop drawings, manufacturer's published instructions, and chapter 8 of SMACNA 1793. The ventilator installation must be watertight and free of vibration noise. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals. Aluminum surfaces in contact with sealant must not be coated with a protective material. Do not use aluminum with copper or with water which flows over copper surfaces. Clean roof ventilators in accordance with ventilator manufacturer's recommendations.

3.3 PROTECTION

Protect exposed ventilator finish surfaces against the accumulation of paint, grime, mastic, disfigurement, discoloration and damage for duration of construction activities.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-07 81 00 (February 2011)**

Preparing Activity: USACE **Superseding**
UFGS-07 81 00 (November 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 81 00

SPRAY-APPLIED FIREPROOFING

02/11

PART 1 GENERAL

PART 2 PRODUCTS

PART 3   EXECUTION

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-07 81 00 (February 2011)**

Preparing Activity: USACE **Superseding**
UFGS-07 81 00 (November 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 07 81 00

SPRAY-APPLIED FIREPROOFING
02/11

****
NOTE: This guide specification covers the requirements for spray-applied fire protection.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

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PART 1 GENERAL

1.1 REFERENCES

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATION OF THE WALL AND CEILING INDUSTRY (AWCI)

AWCI TM 12-A	(1997; 3rd Ed) Standard Practice for the Testing and Inspection of Field Applied Sprayed Fire-Resistive Materials; An Annotated Guide

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E605/E605M	(2019; R 2023) Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM E736	(2000; R 2011) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E759/E759M	(1992; R 2023) Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E760/E760M	(1992; R 2023) Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E761/E761M	(1992; R 2023) Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E859/E859M	(2023) Standard Test Method for Air Erosion of Sprayed Fire-Resistive Materials (SFRMs) Applied to Structural Members
ASTM E937/E937M	(1992; R 2023) Standard Test Method for Corrosion of Steel by Sprayed

	Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM E1042	(2022) Standard Classification for Acoustically Absorptive Materials Applied by Trowel or Spray
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC23	(2012; R 2016) Acceptance Criteria for Sprayed Fire-resistant Materials (SFRMs), Intumescent Fire-resistant Coatings and Mastic Fire-resistant Coatings Used to Protect Structural Steel Members

UL SOLUTIONS (UL)

UL 263	(2011; Reprint Aug 2021) UL Standard for Safety Fire Tests of Building Construction and Materials
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SYSTEM DESCRIPTION

****

NOTE: Specify, or indicate on the drawings, each structural member, and floor and deck underside to be fireproofed. Indicate structural members that do not require fireproofing, such as exterior structural peripheral members.

The following information will be shown on the project drawings or detailed in this section:

1. The extent and location of sprayed fire protection.

2. Fire resistance rating of each structural component to receive fireproofing, and whether the component is restrained or unrestrained as specified in UL Fire Resistance.

3. Fire protection other than that specified in this section for equivalent masonry, concrete or plaster fire protection on outside surfaces of exterior structural peripheral members.

4. Bearing members which do not require fire protection including structural steel and underside of steel decks in elevator machine rooms, and steel bearing members in elevator hoistways.

****

1.2.1 General Requirements

****

NOTE: New floor/ceiling and roof/ceiling assemblies requiring the underside of the roof or floor deck to have spray-applied fireproofing are prohibited. Include the bracketed statement only for projects replacing or repairing existing spray applied fireproofing.

****

Protect all structural steel[, undersides of steel floors (if required) and steel roof decks (if required)] with spray-applied fireproofing to a fire resistance hour-rating as indicated below, unless otherwise indicated.

1.2.2 Fire Resistance Rating

****

NOTE: Fire ratings will be determined in accordance with the nationally-recognized building code used for the project, i.e. Uniform Building Code, published by the International Conference of Building Officials, or the International Building Code published by the International Code Council.

Thickness and rating must be specified for each fireproofing application not covered by a specified UL Design Number. However, the UL Design number is for a specific product; therefore, is indirectly being proprietary and would require justification for sole source.

The roof deck designs should utilize systems that do not require the underside of the decking to receive spray-applied fireproofing. This may require specifying a thicker deck or a different system. Due to flexing of the deck, spray-applied fireproofing will eventually become loose and be of no value.

****

Fire resistance ratings must be in accordance with the fire rated assemblies listed in UL Fire Resistance. Proposed materials not listed in UL Fire Resistance must have fire resistance ratings at least equal to the UL Fire Resistance ratings as determined by an approved independent testing laboratory, based on tests specified in UL 263 or ASTM E119. Submit reports and test records, attesting that the fireproofing material conforms to the specified requirements. Each test report must conform to the report requirements specified by the test method. For the underside of the decking use metal lath installed prior to the fireproofing material or Rigid Board Fireproofing Material as outlined in the UL Fire Resistance Directory Volume 1. Apply fireproofing to structural steel members, with the following hourly fire resistance rating and in accordance with the following UL design or approved equivalent. Use unrestrained fire resistance ratings, unless the architect/engineer has specified that the degree of thermal restraint of the construction meets or exceeds the degree of thermal restraint of the tested assembly. Performance tests must be in accordance with ASTM E119.

Fire Rating Schedule		
Element	Hourly Rating	UL Design Reference
Columns supporting one floor	[_____]	[_____]
Columns supporting more than one floor	[_____]	[_____]
Columns supporting roof	[_____]	[_____]
Floor decks	[_____]	[_____]
Floor supports	[_____]	[_____]
Roof decks	[_____]	[_____]
Roof supports	[_____]	[_____]

1.2.3 Evaluation Reports - ICC-ES Reports

Evaluate materials in accordance with ICC-ES AC23. Include ICC-ES Reports as part of the Submittals below. The reports will identify the product as code compliant and having met the physical performance requirements outlined in paragraphs "Dry Density and Cohesion/Adhesion" through "Air Erosion".

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification
and as described in Section 01 33 00 SUBMITTAL
PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fireproofing Material[; G][; G, [NVFAC]]

SD-04 Samples

Spray-Applied Fireproofing[; G][; G, [NVFAC]]

SD-06 Test Reports

Fire Resistance Rating[; G][; G, [NVFAC]]

Field Tests; G, [_____]

Evaluation Reports; G, [_____]

SD-07 Certificates

Installer Qualifications; G, [_____]

Surface Preparation Report[; G][; G, [NVFAC]]

Manufacturer's Inspection Report[; G][; G, [NVFAC]]

1.4 QUALITY ASSURANCE

1.4.1 Installer Qualifications

Engage an experienced installer that is certified, licensed, or otherwise qualified by the spray-on fireproofing manufacturer as having the necessary experience, staff, and training to install the manufacturer's products in accordance with specified requirements. Submit manufacturer's certification that each listed installer is qualified and trained to install the specified fireproofing. Show evidence that each fireproofing installer has had a minimum of 3 years experience in installing the specified type of fireproofing. Each installer of fireproofing material must be trained, have a minimum of 3 years experience and a minimum of three installations using fireproofing of the type specified. A manufacturer's willingness to sell its products to the Contractor or installer does not infer qualification of the buyer.

1.4.2 Pre-Installation Meeting

Hold a meeting with the installer, field testing agency, the manufacturer, subcontractors (whose employees come into contact with the fireproofing), and the Contracting Officer prior to the installation of any fireproofing material to review the substrates for acceptability, method of application, applied thickness, patching, repair, inspection and testing procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver packaged material in the original unopened containers, marked to show the brand name, the manufacturer, and the UL markings. Keep fireproofing material dry until ready to be used, and store off the ground, under cover and away from damp surfaces. Damaged or opened containers will be rejected. Apply material with shelf-life prior to expiration of the shelf-life.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Temperature

Maintain substrate and ambient air temperatures above 4 degrees C 40 degrees F during application and for 24 hours before and after application. Maintain relative humidity within the limits recommended by the fireproofing manufacturer.

1.6.2 Ventilation

Provide adequate ventilation to properly dry the fireproofing after application. In enclosed areas, provide a minimum of 4 air exchanges per hour by forced air circulation.

PART 2 PRODUCTS

****

NOTE: Select the SPRAY-APPLIED FIREPROOFING tailoring option to implement spray-applied fireproofing conforming to ASTM E1042. Select the SPRAY-APPLIED INTUMESCENT EPOXY COATING tailoring option to implement an intumescent epoxy coating system. Include a requirement for a topcoat over the fire protective layer for exterior surfaces exposed to the weather.

****

2.1 SPRAY-APPLIED FIREPROOFING

Provide spray-applied fireproofing material, including sealer, conforming to ASTM E1042, Class (a), Category A, either Type I or Type II, except that the dust removed must not exceed 0.027 gram per square meter 0.0025 gram per square foot of fireproofing material applied as specified in the project. Only products that have been evaluated at UL and bear and "investigated for exterior use" approval are allowed in waterfront areas where the fireproofing may be directly exposed to a natural body of water. Material must be asbestos free, and must resist fungus for a period of 28 days when tested in accordance with ASTM G21. Material must have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84. Submit one sample panel, 450 mm 18 inches square, for each specified type of fireproofing. Also, prepare a designated sample area of not less than 9 square m 100 square feet. Sample area must be representative of typical installation of fireproofing including metal decks, beams, columns and attachments. Equipment, materials and procedures used in the sample area must be the same as, or representative of, that to be used in the work. The sample area must be approved prior to proceeding with fireproofing work in any other area. Use thw approved sample area as a reference standard for applied fireproofing material. Keep sample area in place and open to observation until all spray-applied fireproofing is completed and accepted, at which time it may become part of the work.

2.1.1 Dry Density and Cohesion/Adhesion

****

NOTE: For Navy projects use the table in NAVFAC's guide specification, since the numbers in the table were provided by the manufacturer's when the spec was developed. Otherwise, include the same numbers into these paragraphs. The wording in the definitions contained in NAVFAC's guide specification should be included in these paragraphs, to avoid misinterpretations.

****

Fireproofing must have a minimum ASTM E605/E605M dry density and ASTM E736 cohesion/adhesion properties as follows:

2.1.1.1 Concealed Structural Components

Fireproofing for structural components concealed above the ceiling, or within a wall, chase, or furred space, must have a [minimum] [average] applied dry density of 240 kg per cubic meter 15 pounds per cubic foot and a cohesion/adhesion strength of 9.57 kPa 200 psf.

2.1.1.2 Exposed Structural Components

Fireproofing for exposed structural components, except where otherwise specified or indicated, must have a minimum applied dry density of 350 kg per cubic meter 22 pounds per cubic foot and a cohesion/adhesion strength of 20.83 kPa 434 psf.

2.1.1.3 Mechanical Rooms and Storage Areas

Fireproofing for structural components located in mechanical rooms and storage areas must have a minimum applied dry density of 640 kg per cubic meter 40 pcf and a cohesion/adhesion strength of [350] [_____] kPa [1,000] [_____] psf.

2.1.2 Deflection

Spray-applied fireproofing must not crack, spall, or delaminate when backing to which it is applied is subject to downward deflection 1/120 of 3 m 10 foot clear span, when tested in accordance with ASTM E759/E759M.

2.1.3 Bond-Impact

Spray-applied fireproofing material must not crack, spall or delaminate when tested in accordance with ASTM E760/E760M.

2.1.4 Compressive Strength

****

NOTE: For Navy projects use the table in NAVFAC's guide specification, since the numbers in the table

were provided by the manufacturer's when the spec was developed. Otherwise, include the same numbers into these paragraphs. The wording in the definitions contained in NAVFAC's guide specification should be included in these paragraphs, to avoid misinterpretations.
****

Provide minimum compressive strength of 48 kPa 1000 psf when tested in accordance with ASTM E761/E761M.

2.1.5 Corrosion

Spray-applied fireproofing material must not contribute to corrosion of test panels when tested as specified in ASTM E937/E937M.

2.1.6 Air Erosion

Dust removal exceeding 0.25 gram per square meter 0.025 gram per square foot when tested in accordance with ASTM E859/E859M is not acceptable.

2.2 SEALER

****
NOTE: Specify color contrasting with the fireproofing to facilitate inspection.
****

Provide sealer approved by the manufacturer of the fireproofing material, that is fungus resistant, has a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84, and has a [white] [_____] [or] [green] color.

2.3 WATER

Use potable water for material mixing and surface preparation .

2.4 SPRAY-APPLIED INTUMESCENT EPOXY COATING SYSTEM

Provide a two-component epoxy based intumescent fire protective coating that meets the following requirements.

a. On curing it forms a flexible and tough epoxy barrier which transforms into a ceramic-like, insulating char to provide thermal protection of the substrate in the event of a fire.

b. The coating system includes the manufacturer's required surface preparation, primer, and fire protective layer, and topcoat.

c. The coating system protects the substrate from corrosion and retain its fire protection properties under aggressive chemical environments.

d. Resistant to solvents, acids, alkalis, salts and abrasion while retaining its fire protective properties.

Provide a system that exhibits the following properties:

2.4.1 Percent Solids by Weight

100 percent

2.4.2 In Service Temperature Restrictions

Up to 65 degrees C 150 degrees F

2.4.3 Application Method

Air spray or specialized plural component airless equipment approved by the manufacture. Troweling can be used for small areas or touch-up work.

2.4.4 Drying Time

Approximately 24 hours to achieve a Shore D hardness of 25.

2.4.5 Shelf Life

Minimum shelf life under proper storage condition is 1 Year from date of manufacture.

2.4.6 Pot Life

Approximately 40 minutes at 25 degrees C 77 degrees F and 50 percent relative humidity. Pot life is not a factor when using specialized plural component airless spray equipment.

2.4.7 Flash Point

Greater than 100 degrees C 212 degrees F Pensky-Martens for each component.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

****

NOTE: Surfaces to receive sprayed fire protection may be primed only as permitted by UL Fire Resistance. Surfaces to be galvanized and/or left unpainted must be coordinated with other sections. Metal deck to receive fireproofing will be galvanized and not primed or painted; coordinate with Section 05 30 00 STEEL DECKS.

Most applications of spray-applied fireproofing are for unprimed and unpainted surfaces. Structural members to receive fireproofing will not be painted because the paint may weaken the cohesion or adhesion of the fireproofing.

Ducts, piping, and conduit will not be installed until fire protection materials have been applied to all ceiling areas to be treated (avoiding underside of the floor and roof decks) and application has been approved; coordinate with mechanical and electrical requirements.

If it is determined that surfaces to receive fire

proofing should not be painted, omission of painting should be coordinated with Section 09 90 00 PAINTS AND COATINGS.

****

Thoroughly clean surfaces to be fireproofed of dirt, grease, oil, paint, primers, loose rust, rolling lubricant, mill scale or other contaminants that will interfere with the proper bonding of the sprayed fireproofing to the substrate. Test painted/primed steel substrates in accordance with ASTM E736, with specified sprayed fireproofing material, to provide the required fire-resistance rating; painted or primed steel surfaces may require a fireproofing bond test to determine if the paint formulation will impair proper adhesion. Certify the acceptability of surfaces to receive sprayed-applied fireproofing by inspection and submit a Surface Preparation Report accordingly. List the structural members and the areas that have been inspected and certified. Clear overhead areas to be fireproofed of all obstructions interfering with the uniform application of the spray-applied fireproofing. Install hardware such as support sleeves, inserts, clips, hanger attachment devices and the like prior to the application of the fireproofing. Condition of the surfaces must be acceptable to the manufacturer prior to application of spray-applied fireproofing. Applications listed for use on primed surfaces must be in accordance with the manufacturer's recommendations and standards, and detailed in submittal item SD-03 Product Data.

3.2 PROTECTION

Cover surfaces not to receive spray-applied fireproofing to prevent contamination by splatter, rebound and overspray. Cover exterior openings in areas to receive spray-applied fireproofing prior to and during application of fireproofing with tarpaulins or other approved material. Clean surfaces not to receive fireproofing of fireproofing and sealer.

3.3 FIREPROOFING MATERIAL

Mix fireproofing material in accordance with the manufacturer's recommendations. Submit data identifying performance characteristics of fireproofing material. Data includes recommended application requirements and indicate thickness of fireproofing to be applied to achieve each required fire rating.

3.4 APPLICATION

****

NOTE: For renovation projects, spray-applied fireproofing must be compatible with encapsulant of remaining residual asbestos.

****

3.4.1 Sequence

****

NOTE: Spray applied Fireproofing is prohibited for new constriction. Include the bracketed statement only for projects replacing or repairing existing spray applied fireproofing.

****

Prior to application of fireproofing on each floor, inspect and approve application equipment, water supply and pressure, and the application procedures.[If fireproofing is required to be applied to underside of steel roof deck and steel floor assemblies, apply it only after respective roof or floor construction is complete. Do not allow roof or floor traffic during application.] Apply fireproofing material prior to the installation of ductwork, piping and conduits which would interfere with uniform application of the fireproofing.

3.4.2 Application Technique

Maintain water pressure and volume to manufacturer's recommendations throughout the fireproofing application. Apply fireproofing material to the thickness and density established for the specified fire resistance rating, in accordance with the procedure recommended by the manufacturer, and to a uniform density and texture. Do not tamp fireproofing material to achieve the desired density.

3.4.3 Sealer Application

If sealer is required by the product used, apply it after field testing has been conducted and after corrective measures and repairs, if required, have been completed.

3.4.4 Applied Thickness

The minimum average thickness must be no less than 9.525 mm 0.375 inches. Thicknesses must not be less than required to achieve designated fire resistance ratings. If the specified thickness is greater than or equal to 25 mm 1 inch, any individual measurement must not be less than the specified thickness minus 6 mm 0.25 inches. If the specified thickness is less than 25 mm 1 inch, any individual measurement must not be less than the specified thickness minus 25 percent.

3.4.5 Application of Spray-Applied Intumescent Epoxy Coating System

Prepare surfaces and apply the spray-applied Intumescent epoxy coating system in accordance with the manufacturer's written recommendations.

3.5 MANUFACTURER'S SERVICES

****

NOTE: The requirement to have a manufacturer's representative onsite, for small jobs and in remote locations, must be based on an economical analysis.and the importance of the project.

For Navy projects, consult with EFD/A Fire Protection Engineer to determine if the manufacturer's representative is required for the project.

****

3.5.1 General

The manufacturer, or its representative, must be onsite prior to, periodically during, and at completion of the application, to provide the specified inspections and certifications; and to ensure that preparations are adequate and that the material is applied according to manufacturer's recommendations and the contract requirements.

3.5.2 Manufacturer's Insertion

****
NOTE: Delete requirement for manufacturer's inspection for small jobs and remote sites where such support is not economical.
****

Inspect the fireproofing work after the work is completed on each floor or area, including testing, repair and clean-up, and certify that the work complies with the manufacturer's criteria and recommendations. Before the sprayed material is covered, and after all of the fireproofing work is completed, including repair, testing, and clean-up; and after mechanical, electrical and other work in contact with fireproofing material has been completed, re-inspect the work and certify that the entire project complies with the manufacturer's criteria and recommendations. Obtain and submit the Manufacturer's Inspection Report and certifications of approval stating that the spray-applied fireproofing in the entire project complies with the manufacturer's criteria and recommendations.

3.6 FIELD TESTS

****
NOTE: This paragraph applies to the spray-applied fireproofing meeting the requirements of ASTM E1042. Delete the paragraph in its entirety if the spray-applied intumescent epoxy coating system is being implemented
****

Test the applied fireproofing by an approved independent testing laboratory to be selected by the A/E and paid for by the Contractor. Submit test reports documenting results of tests on the applied material in the project. Include defects identified, repair procedures, and results of the retests when required. Perform the tests in approved locations: for density in accordance with ASTM E736, cohesion/adhesion in accordance with ASTM E736, and for thickness in accordance with ASTM E605/E605M. Determine densities in accordance with ASTM E605/E605M or Appendix A, "Alternate Method for Density Determination" of AWCI TM 12-A. Take density determinations at the flat portion of deck, beam bottom flange, beam web, column, and an equivalent area from the top of the lower beam flange. Areas showing a density less than specified will be rejected. Locate a test sample every 920 square meters 10,000 square feet of floor area or two for each floor, whichever produces the greatest number of test areas. Correct any area showing less than minimum requirements. Proposed corrective measures, in writing, must be approved before starting the corrective action. Retest corrected work.

3.6.1 Structural Components

Test each structural component type at floor and roof decks, beams, columns, joists, and trusses. Minimum average thickness must be as [indicated] [or] [required by UL Fire Resistance]. Density and cohesion/adhesion must be as specified.

3.6.2 Repair

Additional fireproofing material may be added to provide proper thickness.

Correct rejected areas of fireproofing to meet specified requirements by adding fireproofing material to provide the proper thickness, or by removing defects and respraying with new fireproofing material. Use same type of fireproofing material for repairs as originally applied or use patching materials recommended by the manufacturer. Retest and reinspect repaired areas. Apply fireproofing material to voids or damaged areas by hand-trowel, or by respraying.

3.6.3   Visual Inspections

Inspections must be made by the certified independent laboratory prior to closure of concealed areas. These inspections may be phased, but must not occur less than 5 working days prior to the enclosure of the fireproofing. Sprayed areas must receive a final inspection. Inspect fireproofed surfaces after mechanical, electrical, and other work in contact with fireproofing material has been completed and before sprayed material is covered. Patch any locations missing fireproofing in accordance with the manufacturer's requirements.

3.6.4   Patching

Patch and repair damaged fireproofing. The patching material must be the same as that specified for that area.

3.7   CLEANUP

Thoroughly clean surfaces not indicated to receive fireproofing of sprayed material within a 24 hour period after application.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-07 84 00 (May 2010)**
Change 1 - 08/13

Preparing Activity: USACE **Superseding**
UFGS-07 84 00 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 84 00

FIRESTOPPING

05/10, CHG 1: 08/13

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-07 84 00 (May 2010)**
Change 1 - 08/13

Preparing Activity: USACE **Superseding**
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****

SECTION 07 84 00

FIRESTOPPING

05/10, CHG 1: 08/13

****

NOTE: This guide specification covers the requirements for firestopping using tested and listed firestop systems to form an effective barrier against the spread of fire, smoke and gases, and to maintain the integrity of fire resistance rated construction.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 SUMMARY

Furnish and install tested and listed firestopping systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps.

a. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents.

b. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; do not allow firestopping material to interfere with the required movement of the joint.

c. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof or floor deck above and at the intersection of shaft assemblies and adjoining fire resistance rated assemblies.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E699	(2009) Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components
ASTM E814	(2024) Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM E1399/E1399M	(1997; R 2022) Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
ASTM E1966	(2015; R 2019) Standard Test Method for

	Fire-Resistive Joint Systems
ASTM E2174	(2020a) Standard Practice for On-Site Inspection of Installed Firestop Systems
ASTM E2307	(2023b) Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus
ASTM E2393	(2020a) Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers

FM GLOBAL (FM)

FM 4991	(2013) Approval of Firestop Contractors
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 1479	(2015; Reprint Apr 2024) Fire Tests of Through-Penetration Firestops
UL 2079	(2015; Reprint Jun 2024) Tests for Fire Resistance of Building Joint Systems
UL Fire Resistance	(2014) Fire Resistance Directory

1.3 SEQUENCING

****

NOTE: Edit this paragraph depending on whether existing insulation is to remain or be removed.

****

Coordinate the specified work with other trades. Apply firestopping materials, at penetrations of pipes and ducts, prior to insulating, unless insulation meets requirements specified for firestopping. Apply firestopping materials. at building joints and construction gaps, prior to completion of enclosing walls or assemblies. Locate cast-in-place firestop devices and install in place before concrete placement. Install pipe, conduit or cable bundles through cast-in-place device after concrete placement but before area is concealed or made inaccessible. Firestop material must be inspected and approved prior to final completion and enclosing of any assemblies that may conceal installed firestop.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping System; G, [_____]

SD-03 Product Data

Firestopping Materials; G, [_____]

SD-06 Test Reports

Inspection; G, [_____]

SD-07 Certificates

Inspector Qualifications

Firestopping Materials

Installer Qualifications; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Installer

Engage an experienced Installer who is:

a. FM Research approved in accordance with FM 4991, operating as a UL Certified Firestop Contractor, or

b. Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products in accordance with specified requirements. Submit documentation of this experience. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer installer qualifications on the buyer. The Installer must be a trained representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures. Obtain and submit installer's written certification of training, and retain proof of certification for duration of firestop installation.

1.5.2 Inspector Qualifications

****

NOTE: For Army Projects this paragraph should be deleted when a 3rd party inspector is not required by ICC IBC or desired by the project fire protection engineer. The ICC IBC requires a 3rd party inspector for through-penetrations and fire-resistant joint systems for high-rise buildings or buildings assigned to seismic risk category III or IV. The fire protection designer may also consider requiring 3rd party inspection for other projects in which the firestop systems are particularly important (e.g. laboratories, high hazard occupancies, multi-family housing buildings, etc.)

****

The inspector must[meet the criteria contained in ASTM E699 for agencies involved in quality assurance and must] have a minimum of two years experience in construction field inspections of firestopping systems, products, and assemblies. The inspector must be completely independent of, and divested from, the installer, the manufacturer, and the supplier of any material or item being inspected. The inspector must not be a competitor of the installer, the contractor, the manufacturer, or supplier of any material or item being inspected. Include in the qualifications submittal a notarized statement assuring compliance with the requirements stated herein.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the original unopened packages or containers showing name of the manufacturer and the brand name. Store materials off the ground, protected from damage and exposure to elements and temperatures in accordance with manufacturer requirements. Remove damaged or deteriorated materials from the site. Use materials within their indicated shelf life.

PART 2 PRODUCTS

2.1 FIRESTOPPING SYSTEM

****

NOTE: Projects designed to be LEED registered must include submittal for low-emitting materials; LEED credit EQ 4.1 VOC content of product, providing a maximum allowable VOC content of <250 g/l as calculated by EPA method 24. Projects not registering for LEED certification but are designed to LEED standards must still include VOC content requirements.

****

Submit detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resistance or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, submit a manufacturer's engineering judgment, derived from similar UL system designs or other tests for review and approval prior to installation. Submittal must indicate the firestopping material to be provided for each type of application. When more than a total of 5 penetrations and/or construction joints are to receive firestopping, provide drawings that indicate location, "F" "T" and "L" ratings, and type of application.

Also, submit a written report indicating locations of and types of penetrations and types of firestopping used at each location; record type by UL list printed numbers.

2.2 FIRESTOPPING MATERIALS

****

NOTE: Insert sentence if project is registering for LEED certification or designed to LEED standards. VOC content of firestop materials installed on project is limited to [< 250 g/l] as calculated by EPA method 24.

****

Provide firestopping materials, supplied from a single domestic manufacturer, consisting of commercially manufactured, asbestos-free, nontoxic products FM APP GUIDE approved, or UL listed, for use with applicable construction and penetrating items, complying with the following minimum requirements:

2.2.1 Fire Hazard Classification

Provide material that has a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E84 or UL 723. Provide an approved firestopping material as listed in UL Fire Resistance or by a nationally recognized testing laboratory.

2.2.2 Toxicity

Provide material that is nontoxic and carcinogen free to humans at all stages of application or during fire conditions and does not contain hazardous chemicals or require harmful chemicals to clean material or equipment.

2.2.3 Fire Resistance Rating

Firestop systems must be UL Fire Resistance listed or FM APP GUIDE approved with "F" rating at least equal to fire-rating of fire wall or floor in which penetrated openings are to be protected. Where required, firestop systems must also have "T" rating at least equal to the fire-rated floor in which the openings are to be protected.

2.2.3.1 Through-Penetrations

****

Note: Insert the appropriate time period required in accordance with Chapter 7 of the International Building Code (IBC). Indicate locations of fire resistance rated walls, partitions, floors, ceiling-floor assemblies and other locations requiring firestopping.

When second option in item a. is selected, rating of walls and partitions being penetrated must be shown on the drawings.

If smoke barrier walls are required in the project, show them on the drawings.

****

Firestopping materials for through-penetrations, as described in paragraph SUMMARY, must provide "F", "T" and "L" fire resistance ratings in accordance with ASTM E814 or UL 1479. Provide fire resistance ratings as follows:

2.2.3.1.1 Penetrations of Fire Resistance Rated Walls and Partitions

F Rating = [[_____] hour] [Rating of wall or partition being penetrated].

2.2.3.1.2 Penetrations of Fire Resistance Rated Floors, Floor-Ceiling Assemblies and the Ceiling Membrane of Roof-Ceiling Assemblies

F Rating = [_____] hour, T Rating = [_____] hour. Where the penetrating item is outside of a wall cavity the F rating must be equal to the fire resistance rating of the floor penetrated, and the T rating must be in accordance with the requirements of ICC IBC.

2.2.3.1.3 Penetrations of Fire and Smoke Resistance Rated Walls, Floors, Floor-Ceiling Assemblies, and the ceiling membrane of Roof-Ceiling Assemblies

F Rating = [_____] hour, T Rating = [_____] hour and L Rating = [[<10] cfm/sf] [Where L rating is required].

2.2.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph

SUMMARY, and gaps such as those between floor slabs and curtain walls must be [the same as the construction in which they occur.] [as follows: construction joints in walls, [_____] hour; construction joints in floors, [_____] hour; gaps between floor slabs and curtain walls, [_____] hour; gaps between top of the walls and the bottom of roof and floor decks, [_____] hour, and provide L rating of <5 cfm/lf where required.] Provide construction joints and gaps with firestopping materials and systems that have been tested in accordance with ASTM E119, ASTM E1966 or UL 2079 to meet the required fire resistance rating. Provide curtain wall joints with firestopping materials and systems that have been tested in accordance with ASTM E2307 to meet the required fire resistance rating. Systems installed at construction joints must meet the cycling requirements of ASTM E1399/E1399M or UL 2079. Provide a minimum class II movement capability for all joints at the intersection of the top of a fire resistance rated wall and the underside of a fire-rated floor, floor ceiling, or roof ceiling assembly.

2.2.4 Material Certification

Submit certificates attesting that firestopping material complies with the specified requirements. Provide certification of compliance with UL 1479 for all intumescent firestop materials used in through penetration systems.

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping must be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement must be sound and capable of supporting device. Prepare surfaces as recommended by the manufacturer.

3.2 INSTALLATION

****

NOTE: Drawings must indicate location and fire ratings of all fire-rated walls, partitions, floors and ceilings; and details of firestopping for each type of construction.

****

Completely fill void spaces with firestopping material regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 100 mm 4 inches or more in any direction must be capable of supporting the same load as the floor is designed to support or be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Install firestopping in accordance with manufacturer's written instructions. Provide tested and listed firestop systems in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.

b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.

c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.

e. Construction joints in floors and fire rated walls and partitions.

f. Other locations where required to maintain fire resistance rating of the construction.

3.2.1 Insulated Pipes and Ducts

****

NOTE: Coordinate insulation requirements with appropriate Sections.

****

Cut and remove thermal insulation where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Replace thermal insulation with a material having equal thermal insulating and firestopping characteristics.

3.2.2 Fire Dampers

****

NOTE: When including this paragraph, ensure that the appropriate information is contained in Section 23 30 00 HVAC AIR DISTRIBUTION.

****

Install and firestop fire dampers in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION. Firestop installed with fire damper must be tested and approved for use in fire damper system. Firestop installed with fire damper must be tested and approved for use in fire damper system.

3.2.3 Data and Communication Cabling

****

NOTE: The designer should determine whether to specify re-enterable devices or products (e.g. blocks, plugs, pillows, composite sheets, etc.). Consideration should be given to the fact that products such as blocks, plugs, and pillows can easily be removed and not properly replaced after construction, which would compromise the integrity of the penetration. The designer must also consider whether an L rating (i.e. an air leakage rating) is desirable for a given penetration; if so, a re-enterable system is recommended. If the designer wishes to specify that some or all of their penetrations should use devices and not products, annotate the penetrations on the plans accordingly; using a note that reads "Penetration(s) of fire-rated partion(s), wall(s), or floor(s) by data and/or communication wiring must be through a modular, re-enterable firestopping device(s) containing self-sealing intumescent inserts.

****

Seal cabling for data and communication applications with re-enterable firestopping [products] [devices] [products and devices as indicated].

3.2.3.1 Re-Enterable Devices

Provide firestopping devices that are pre-manufactured modular devices, containing built-in self-sealing intumescent inserts. Allow for cable moves, additions or changes without the need to remove or replace any firestop materials. Devices must be capable of maintaining the fire resistance rating of the penetrated membrane at 0 percent to 100 percent visual fill of penetrants; while maintaining "L" rating of <10 cfm/sf [measured at ambient temperature and 205 degrees C 400 degrees F] at 0 percent to 100 percent visual fill.

3.2.3.2 Re-Sealable Products

Provide firestopping pre-manufactured modular products, containing self-sealing intumescent inserts. Allow for cable moves, additions or changes. Provide devices capable of maintaining the fire resistance rating of the penetrated membrane at 0 percent to 100 percent visual fill of penetrants.

3.3 INSPECTION

****

NOTE: For Navy projects use all bracketed statements.

****

[For Navy projects, install one of each type of penetration and have it inspected and accepted by the [_____] Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer prior to the installation of the remainder of the penetrations. At this inspection, the manufacturer's technical representative of the firestopping material must be present.] For all projects, do not cover or enclose[the remainder of][the firestopped areas] until inspection is complete and approved by the Contracting Officer. [The inspector must inspect] [Inspect] the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements. Submit written reports indicating locations of and types of penetrations and types of firestopping used at each location; record type by UL listed printed numbers.

3.3.1 Inspection Standards

****

NOTE: For Army Projects, delete this paragraph when a 3rd party inspector will not be required (see the note in paragraph INSPECTOR QUALIFICATIONS).

****

Inspect all firestopping in accordance with ASTM E2393 and ASTM E2174 for firestop inspection, and document inspection results to be submitted.

3.3.2 Inspection Reports

Submit inspection report stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-07 92 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 92 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

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SECTION 07 92 00

JOINT SEALANTS

08/23

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USACE / NAVFAC / AFCEC **UFGS-07 92 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-07 92 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 07 92 00

JOINT SEALANTS

08/23

****
NOTE: This guide specification covers the requirements for sealants for normal building construction.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: This guide specification must be carefully modified if resealing or sealing of an addition to an existing building is required or if conditions require use of special sealing materials and designs such as high-rise curtain wall systems.
****

****
NOTE: On the drawings, show:

1. Joints in which each type of sealant will be used.

2. Typical scale or full-size details of sealant joints, indicating joint symbol or designation.
****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C509	(2006; R 2021) Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C734	(2015; R 2024) Standard Test Method for Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C834	(2017; R 2023) Standard Specification for Latex Sealants
ASTM C919	(2024) Standard Practice for Use of Sealants in Acoustical Applications
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1193	(2016) Standard Guide for Use of Joint Sealants
ASTM C1311	(2022) Standard Specification for Solvent Release Sealants
ASTM C1521	(2019; R 2020) Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints

ASTM D217	(2021a) Standard Test Methods for Cone Penetration of Lubricating Grease
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2452	(2015; R 2019) Standard Test Method for Extrudability of Oil- and Resin-Base Caulking Compounds
ASTM D2453	(2015; R 2020; E 2020) Standard Test Method for Shrinkage and Tenacity of Oil- and Resin-Base Caulking Compounds
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants; G, [_____]

Primers; G, [_____]

Bond Breakers; G, [_____]

Backstops; G, [_____]

Caulking; G, [_____]

Cleaning Solvents; G, [_____]

SD-06 Test Reports

Field Adhesion; G, [_____]

SD-07 Certificates

Indoor Air Quality For Interior Sealants; S

Indoor Air Quality For Interior Floor Joint Sealants; S

Indoor Air Quality For Interior Acoustical Sealants; S

Indoor Air Quality For Interior Caulking; S

1.3 PRODUCT DATA

Include storage requirements, shelf life, curing time, instructions for mixing and application, and accessories. Provide manufacturer's Safety Data Sheets (SDS) for each solvent, primer and sealant material proposed.

[1.4 CERTIFICATIONS

****

NOTE: Include the following section where these products are used on the interior of the building (defined as inside of the weatherproofing system).

****

1.4.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

1.4.1.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

]1.5 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 4 and 32 degrees C 40 and 90 degrees F.

1.6 DELIVERY AND STORAGE

Deliver materials to the jobsite in unopened manufacturers' sealed shipping containers, with brand name, date of manufacture,[color,] and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Handle and store materials in accordance with manufacturer's printed instructions. Prevent exposure to foreign materials or subjection to sustained temperatures exceeding 32 degrees C 90 degrees F or lower than 4 degrees C 0 degrees F. Keep materials and containers closed and separated from absorptive materials such as wood and insulation.

1.7 QUALITY ASSURANCE

1.7.1 Compatibility with Substrate

Verify that each sealant is compatible for use with each joint substrate in accordance with sealant manufacturer's printed recommendations for each application.

1.7.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.7.3 Mock-Up

Provide a mock-up of each type of sealant using materials, colors, and techniques approved for use on the project. Approved mock-ups may be incorporated into the Work.

1.7.4 Adhesion

Provide in accordance with ASTM C1193 or ASTM C1521.

PART 2 PRODUCTS

2.1 SEALANTS

****

NOTE: Use Latex Sealant (ASTM C834) for temporary, low budget construction but verify toxicity of products prior to specifying; interior sealing of joints in wood or masonry, or in short joints between masonry, wood, or metal surfaces where maximum movement is anticipated not to exceed 15 percent of joint width.

Use elastomeric Sealants (ASTM C920) for interior and exterior applications where maximum joint movement is anticipated to be between 25 and 50 percent of joint width.

Chemically curing sealants should not be used adjacent to or above membrane surfaces of asphaltic or bituminous materials; a sealant based on asphalt or bituminous materials similar to those in the membrane should be used.

Since all sealants meeting this specification are not suitable for all applications and substrates, specify applicable type, grade, class, and use(s) for each intended purpose:

Type S: Single component

Type M: Multi-component

Grade P: Pourable or self-leveling sealant for horizontal applications

Grade NS: Nonsag for vertical applications

Class 25: Withstands increase and decrease of at least 25 percent of joint width

Class 12.5: Withstands increase and decrease of at least 12.5 percent of joint width

Use T: Pedestrian and vehicular traffic areas such as walkways, plazas, decks, and parking garages

Use NT: Non-traffic areas, horizontal and vertical surfaces

Use M: Meets this specification when tested on mortar

Use G: Meets this specification when tested on glass

Use A: Meets this specification when tested on aluminum

Use O: Meets this specification when tested on substrates other than above. Specify substrate types in project specification.

****

****

NOTE: In project locations with ambient temperatures that exceed 43.33 degrees C 110 degrees F; insert bracketed paragraph below.

****

Provide sealant products that have been tested, found suitable, and documented as such by the manufacturer for the particular substrates to which they will be applied.

[In areas with ambient temperatures that exceed 43.33 degrees C 110 degrees F, do not use polybutene, bituminous, acrylic-latex, polyvinyl acetate latex sealants, polychloroprene (neoprene), polyvinyl chloride (PVC), and polyurethane foams, and neoprene, PVC, and styrene butadiene rubber extruded seals and closure strips due to these materials having maximum recommended surface temperature ranges from 54.44 degrees C to 82.22 degrees C 130 to 180 degrees F.

]2.1.1 Interior Sealants

Provide[ASTM C834][ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT]. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior sealants. Location(s) and color(s) of sealant for the following (Note, color "as selected" refers to manufacturer's full range of color options):

LOCATION	COLOR
a. Small voids between walls or partitions and adjacent lockers, casework, shelving, door frames, built-in or surface mounted equipment and fixtures, and similar items.	[As selected] [Gray] [White] [______]
b. Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces.	[______]
c. Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed.	[______]
d. Joints between edge members for acoustical tile and adjoining vertical surfaces.	[______]

LOCATION	COLOR
e. Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted.	[_____]
f. Joints between bathtubs and ceramic tile; joints between shower receptors and ceramic tile; joints formed where non-planar tile surfaces meet.	[_____]
g. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.	[_____]
h. Behind escutcheon plates at valve pipe penetrations and showerheads in showers.	[_____]
i. [_____]	[_____]

2.1.2 Exterior Sealants

****

NOTE: Include bracketed hybrid sealant option when thermal movement may be an issue (such as tropical environments), for joints connecting dissimilar substrates, and for applications that require both paintability and adhesion to non-porous substrates.

****

For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T.[Hybrid sealant meeting ASTM C920, Type S, Grade NS, Class 50, use NT, M, A, G, or O.] Provide location(s) and color(s) of sealant as follows (Note, color "as selected" refers to manufacturer's full range of color options):

LOCATION	COLOR
a. Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations.	[Match adjacent surface color] [As selected] [Gray] [White] [_____]
b. Joints between new and existing exterior masonry walls.	[_____]
c. Masonry joints where shelf angles occur.	[_____]
d. Joints in wash surfaces of stonework.	[_____]
e. Expansion and control joints.	[_____]

LOCATION	COLOR
f. Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required.	[_____]
g. Voids where items pass through exterior walls.	[_____]
h. Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.	[_____]
i. Metal-to-metal joints where sealant is indicated or specified.	[_____]
j. Joints between ends of gravel stops, fascia, copings, and adjacent walls.	[_____]
k. [_____]	[_____]

2.1.3 Floor Joint Sealants

ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior floor joint sealants. Provide location(s) and color(s) of sealant as follows (Note, color "as selected" refers to manufacturer's full range of color options):

LOCATION	COLOR
a. Seats of metal thresholds for exterior doors.	[As selected] [Gray] [White] [_____]
b. Control and expansion joints in floors, slabs, ceramic tile, and walkways.	[_____]

2.1.4 Acoustical Sealants

****

NOTE: See ASTM C919 for use of acoustical sealant. The acoustical sealant described here is to be used only in non-moving joints protected from abuse. Other specified sealants may be used in acoustical applications when appropriate.

****

[_____] Rubber or polymer based acoustical sealant in accordance with

ASTM C919 to have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84. Provide non-staining acoustical sealant with a consistency of 250 to 310 when tested in accordance with ASTM D217. Acoustical sealant must remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C734. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior acoustical sealants.

2.1.5 Preformed Sealants

Provide preformed sealants of polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealants capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 34 to plus 71 degrees C 30 to plus 160 degrees F, sealants must be non-bleeding and have no loss of adhesion.

2.1.5.1 Tape

[_____] Tape sealant: Provide cross section dimensions of [_____].

2.1.5.2 Bead

[_____] Bead sealant: Provide cross section dimensions of [_____].

2.1.5.3 Foam Strip

****

NOTE: Untreated polyurethane foam can be used where exposed to view or where staining of adjacent surfaces is not acceptable.

****

Provide [_____] foam strip of polyurethane foam with cross section dimensions of [_____]. Provide foam strip capable of sealing out moisture, air, and dust when installed and compressed in accordance with manufacturer's printed instructions. Service temperature must be minus 40 to plus 135 degrees C minus 40 to plus 275 degrees F. Install untreated strips with adhesive to hold them in place. Do not allow adhesive to stain or bleed onto adjacent finishes. Saturate treated strips with butylene waterproofing or impregnate with asphalt.

2.2 PRIMERS

Non-staining, quick drying type and consistency as recommended by the sealant manufacturer for the particular application. Provide primers for interior applications that meet the indoor air quality requirements of the paragraph INTERIOR SEALANTS above.

2.3 BOND BREAKERS

Type and consistency as recommended by the sealant manufacturer to prevent adhesion of the sealant to the backing or to the bottom of the joint. Provide bond breakers for interior applications that meet the indoor air quality requirements of the paragraph INTERIOR SEALANTS above.

2.4 BACKSTOPS

Provide glass fiber roving, neoprene, butyl, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Provide backstop material that is compatible with sealant. Do not use oakum[, [_____]] or other types of absorptive materials as backstops.

2.4.1 Rubber

****

NOTE: Class A is adequate for most applications. Select Class B for petroleum oil or fuel resistance. Select Class D for temperatures of minus 75 to 175 degrees C minus 103 to 347 degrees F with no oil exposure.

Specify Type 2 closed cell when moisture may migrate to the backing.

****

Provide in accordance with ASTM D1056,[Type 1, open cell,][or][Type 2, closed cell,] Class [A][B][D], Grade [_____],[round] [_____] cross section for [_____] cellular rubber sponge backing.

2.4.2 PVC

****

NOTE: Do not use open cell vinyl foam in moist areas, below grade, or humid environments. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1).

****

Provide in accordance with ASTM D1667, Grade [VO 12][_____], open-cell foam, [round][_____] cross section for [_____] polyvinyl chloride (PVC) backing.

2.4.3 Synthetic Rubber

****

NOTE: Use Option I and Type I for most applications. Select Option II only if flame resistance is NOT required. Type II provides the highest ozone resistance.

****

Provide in accordance with ASTM C509, Option [I][II], Type [I][II] preformed[rods][or][tubes] for [_____] synthetic rubber backing.

2.4.4 Neoprene

Provide in accordance with ASTM D1056,[closed cell expanded neoprene cord Type 2, Class C, Grade [2C2][_____]][open cell neoprene sponge Type 1, Class C, Grade [1C3][_____]] for [_____] neoprene backing.

2.4.5 Butyl Rubber Based

Provide in accordance with ASTM C1311, from a single component, with solvent release. color[as selected from manufacturer's full range of color choices] [_____].

2.4.6 Silicone Rubber Base

Provide in accordance with ASTM C920, from a single component, with solvent release, Non-sag, Type [_____], Grade [_____], Class [25][_____]. Color[as selected from manufacturer's full range of color choices] [_____].

2.5 CAULKING

****

NOTE: The term "caulking" is limited herein to oil- and resin-based caulking which should be used only indoors and where there is little or no anticipated joint movement. Use a sealant where joints may move.

****

For interior use and only where there is little or no anticipated joint movement. Provide in accordance with ASTM D2452 and ASTM D2453, Type [_____], for [_____] oil and resin-based caulking. Provide products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior caulking.

2.6 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer and in accordance with environmental requirements herein.[Protect adjacent aluminum and bronze surfaces from solvents]. Provide solvents for interior applications that meet the indoor air quality requirements of the paragraph INTERIOR SEALANTS above.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

Perform a field adhesion test in accordance with manufacturer's instructions and ASTM C1193, Method A or ASTM C1521, Method A, Tail Procedure. Remove sealants that fail adhesion testing; clean substrates, reapply sealants, and re-test. Test sealants adjacent to failed sealants. Submit field adhesion test report indicating tests, locations, dates, results, and remedial actions taken.

3.2 SURFACE PREPARATION

Prepare surfaces according to manufacturer's printed installation instructions. Clean surfaces from dirt, frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would destroy or impair adhesion. Remove oil and grease with solvent; thoroughly remove solvents prior to sealant installation. Wipe surfaces dry with clean cloths. When resealing an existing joint, remove existing caulk or sealant prior to applying new sealant. For surface types not listed below, provide in accordance with sealant manufacturer's printed instructions for each specific surface.

3.2.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finished work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue free solvent. Remove resulting debris and solvent residue prior to sealant installation.

3.2.2 Aluminum or Bronze Surfaces

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and residual adhesive prior to sealant application. For removing protective coatings and final cleaning, use non-staining solvents recommended by the manufacturer of the item(s) containing aluminum or bronze surfaces.

3.2.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Remove laitance, efflorescence and loose mortar from the joint cavity. Remove resulting debris prior to sealant installation.

3.2.4 Wood Surfaces

Ensure wood surfaces that will be in contact with sealants are free of splinters, sawdust and other loose particles.

[3.2.5 Removing Existing Hazardous Sealants

For sealants applied prior to 1979, or that have been tested and found to contain polychlorinated biphenyls (PCBs), remove and dispose of these sealants in accordance with Section 02 84 33 REMOVAL AND DISPOSAL OF POLYCHLORINATED BIPHENYLS (PCBs).

]3.3 SEALANT PREPARATION

Do not add liquids, solvents, or powders to sealants. Mix multicomponent elastomeric sealants in accordance with manufacturer's printed instructions.

3.4 APPLICATION

3.4.1 Joint Width-To-Depth Ratios

Acceptable Ratios:

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
For metal, glass, or other nonporous surfaces:		
6 mm (minimum)	6 mm	6 mm

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
over 6 mm	1/2 of width	Equal to width
For wood, concrete, masonry, stone, or [_____]:		
6 mm (minimum)	6 mm	6 mm
over 6 mm to 13 mm	6 mm	Equal to width
over 13 mm to 25 mm	50 mm	16 mm
Over 25 mm	prohibited	

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
For metal, glass, or other nonporous surfaces:		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch	1/2 of width	Equal to width
For wood, concrete, masonry, stone, or [_____]:		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
over 1/2 inch to 1 inch	1/2 inch	5/8 inch
Over 1 inch	prohibited	

Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is prohibited at metal surfaces.

3.4.2 Unacceptable Sealant Use

Do not install sealants in lieu of other required building enclosure weatherproofing components such as flashing, drainage components, and joint closure accessories, or to close gaps between walls, floors, roofs, windows, and doors, that exceed acceptable installation tolerances. Remove sealants that have been used in an unacceptable manner and correct building enclosure deficiencies to comply with contract documents requirements.

3.4.3 Masking Tape

Place masking tape on the finished surface on one or both sides of joint cavities to protect adjacent finished surfaces from primer or sealant smears. Remove masking tape within 10 minutes of joint filling and tooling.

3.4.4 Backstops

Provide backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide joints in specified depths. Provide backstops where indicated and where backstops are not indicated but joint cavities exceed the acceptable maximum depths specified in JOINT WIDTH-TO-DEPTH RATIOS Table.

3.4.5 Primer

Clean out loose particles from joints immediately prior to application of. Apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's printed instructions. Do not apply primer to exposed finished surfaces.

3.4.6 Bond Breaker

Provide bond breakers to surfaces not intended to bond in accordance with, sealant manufacturer's printed instructions for each type of surface and sealant combination specified.

3.4.7 Sealants

Provide sealants compatible with the material(s) to which they are applied. Do not use a sealant that has exceeded its shelf life or has jelled and cannot be discharged in a continuous flow from the sealant gun. Apply sealants in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Work sealant into joints so as to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Apply sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled joints, apply additional sealant, and tool smooth as specified. Apply sealer over sealants in accordance with the sealant manufacturer's printed instructions.

3.5 PROTECTION AND CLEANING

3.5.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled and no residual tape marks remain.

3.5.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

a. Masonry and Other Porous Surfaces: Immediately remove fresh sealant that has been smeared on adjacent masonry, rub clean with a solvent, and remove solvent residue, in accordance with sealant manufacturer's printed instructions. Allow excess sealant to cure for 24 hours then remove by wire brushing or sanding. Remove resulting debris.

b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent moistened cloth. Remove solvent residue in accordance with solvent manufacturer's printed instructions.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 01 52 (August 2009)**

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 08 01 52

OPERATION AND MAINTENANCE OF WOOD WINDOWS

08/09

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PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 01 52 (August 2009)**

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 08 01 52

OPERATION AND MAINTENANCE OF WOOD WINDOWS

08/09

****

NOTE: This guide specification covers the requirements for repair and rehabilitation of wood windows in historic buildings.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1184	(2023) Standard Specification for Structural Silicone Sealants

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED BD+C	(2009; R 2010) Leadership in Energy and Environmental Design(tm) Building Design and Construction (LEED-NC)

1.2 SYSTEM DESCRIPTION

Repair wood windows as indicated, and return them to proper operation and sound condition.

1.3 SUSTAINABILITY REPORTING

****
NOTE: The bracketed items are representative of LEED material documentation and requirements that may apply to this project. These items should be edited to reflect the project requirements.
****

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for project LEED BD+C [local/regional materials,] [low-emitting materials,] [recycled content,] [____] [and][rapidly renewable materials] and LEED documentation requirements.

1.4 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G, [_____]

SD-03 Product Data

Hardware

Weatherstripping

Qualifications

SD-04 Samples

Hardware

Moldings

Weatherstripping

SD-11 Closeout Submittals

LEED Documentation

1.5 QUALITY ASSURANCE

a. Provide qualified workers trained and experienced in repairing, restoring, replicating, and replacing windows in historic buildings; submit documentation of their Qualifications during 5 consecutive years of work of this type; and a list of installations made identifying when, where and for whom the installations were made.

b. Submit Shop Drawings indicating elevations of units, full-size sections, fastenings, methods of installation and anchorage, method of glazing, locations of operating hardware, mullion details, method and material for weatherstripping, insect screen, details, connections with other work and window schedules showing location of each window unit.

1.6 DELIVERY, STORAGE, AND HANDLING

Store materials out of contact with the ground and under weathertight covering.

PART 2 PRODUCTS

****

NOTE: Deteriorated historic windows should be repaired rather than replaced wherever possible. In the event replacement is necessary, the new windows should match the historic ones in design, color, size, configuration, reflective qualities, shadow lines, detail, and material. Only when it is not feasible to match the historic fabric should substitute window material be considered.

****

2.1 MATERIALS

Reuse existing materials whenever possible in the repair and rehabilitation of historic wood windows. This includes all wood elements, hardware and glazing that are determined to be of historic significance. Replace window elements with new material only when originals are so deteriorated as to prohibit their useful function.

2.2 WOOD

Use wood of the same species and grade as the original to replace deteriorated window members, unless otherwise noted. Finger-jointed stock may be used for interior casing and trim only where scheduled to be painted.

2.3 GLASS AND GLAZING

Reuse existing intact original glass. Reuse removed lights in their original frames and positions. New glass and glazing materials must conform to Section 08 81 00 GLAZING.

2.4 HARDWARE

Reuse existing original hardware, when it is salvageable. Replacement hardware must match original in design, material, and finish. Submit Manufacturer's installation instructions for each type of hardware and weatherstripping; see paragraph WEATHERSTRIPPING in PART 3. Submit representative sample of each type of hardware with identifying tags.

2.5 FASTENERS

Provide stainless steel, galvanized, or non-ferrous metal fasteners.

2.6 GLAZING COMPOUND

Provide glazing compound for single pane glass which is oil-based, non-staining and non-bleeding. Reglaze existing insulated glass units with silicone sealant complying with ASTM C1184 and compatible with the unit seal on the glass unit.

2.7 GLAZING POINTS

Provide stainless steel or galvanized steel glazing points.

2.8 EPOXY CONSOLIDANTS

2.8.1 Liquid Consolidant

Provide liquid wood consolidant consisting of a two-part, low-viscosity liquid epoxy that meets the criteria of Table A.

2.8.2 Epoxy Paste

Provide epoxy paste consisting of a two-part, thixotropic paste that meets the criteria of Table A.

TABLE A

	LIQUID CONSOLIDANT	EPOXY PASTE
Properties	Low-Viscosity Liquid	No-Slump, Thixotropic Paste
Toxicity	Low	Very Low
Toxicity Cured	Non-Toxic	Non-Toxic
Ratios	1:1 by Volume	1:1 by Volume
Pot Life @ Room Temp.	30 minutes minimum	50 minutes minimum
Hardening @ Room Temp.	1 hr. or longer	1 hr. or longer
Hardening @ 60 deg. C 140 deg. F	16 min. or less	18 min. or less
Viscosity Poises @ 22 deg C72 deg F	4.7 max.	Thixotropic paste
Solids	95% minimum	98% minimum
Tensile Strength	26 MPa 4000 psi	16.2 MPa 2500 psi
Elongation (percent)	50	4

PART 3 EXECUTION

3.1 EVALUATION

Perform a complete evaluation survey of the existing conditions of each wood window to determine the extent of repairs necessary. The evaluation survey may be in the form of a schedule and must note at a minimum:

a. Window location.

b. Condition of the paint.

c. Condition of the frame and sill.

d. Condition of the interior and exterior trim.

e. Condition of the sash (including rails, stiles, and muntins).

f. Glazing problems.

g. Window hardware and operating system.

h. The overall condition of the window.

3.2 REPAIRS

3.2.1 Example Window

Prepare an existing window of each type to serve as an example of the quality of repairs to be provided for inspection and approval by the Contracting Officer.

3.2.2 Sash Removal

Remove the interior stops first, in a method so as to not scar the wood. Detach connecting hardware and operating mechanisms and remove the sash from the frame. Identify removed sashes and frames as to location to assure reinstallation in their original positions. For windows with counter-weight systems, detach the sash cords from the sides of the sash and pin their ends with a nail or tie in a knot to prevent them from falling into the weight pocket; the lower sash can then be removed. Remove the parting bead so as to not scar the wood. Install plastic covering or plywood to cover the window opening during repairs.

3.2.3 Paint Removal

****

NOTE: When testing determines that paint on windows contains lead, the following sentence will be added to the beginning of the paragraph: "Paint removal must comply with the procedures described in Section 02 83 00 LEAD REMEDIATION."

****

Remove paint from areas on frame, sill, sash and muntins where paint or varnish has peeled, alligatored, blistered or crazed, to bare wood or first sound paint layer, using non-destructive means such as a chemical stripper or heat gun. If chemical strippers are used, neutralize wood after stripping to a litmus pH of 5 to 8.5. Allow wood to dry to a moisture content of 8 to 12 percent before repainting. If heat methods are used for paint removal, protect glass from sudden temperature change to avoid breakage.

3.2.4 Wood Repair

Remove badly decayed areas (with more than 30 percent wood decayed) from wood sash, sill, frame, and trim assemblies. Patch moderately decayed areas (less than 30 percent decayed), weathered, or gouged wood with approved patching compounds, and sand smooth. Repair intact sash rails and stiles that are loose with new dowels to make joints tight.

3.2.5 Epoxy Wood Repair

Apply epoxy wood repair materials in accordance with manufacturer's written instructions. Follow health and safety instructions in accordance with the manufacturer's instructions. Identify the source or cause of wood decay and correct prior to application of patching materials. Dry wet wood to a moisture content of 8 to 12 percent to its full depth before patching. Clean dust, grease, and loose paint from wood that is to be patched. Use clean mixing equipment to avoid contamination. Provide mix and proportions as directed by the manufacturer. Provide batches large enough to complete the specific job intended. Cure patching materials before painting or reinstalling patched pieces.

3.2.5.1 Epoxy Liquid Wood Consolidant

Use epoxy liquid wood consolidant to penetrate and impregnate deteriorated wood sections to reinforce wood fibers that have become softened or absorbent.

3.2.5.2 Epoxy Paste

Use epoxy paste to fill areas where portions of wood are missing such as holes, cracks, gaps, gouges, and other voids. Prime areas to receive epoxy paste patching material with compatible epoxy liquid wood consolidant or a primer recommended by the manufacturer.

3.2.6 Wood Replacement

Replace pieces decayed beyond repair with new pieces that match originals in all respects. Match joinery to existing. Provide muntins consisting of coped mortise and tenon joints. Provide molded members that have mitered or coped joints.

3.2.7 Hardware

Reuse existing hardware, which is in good condition, unless otherwise noted. Strip reused existing hardware of paint down to bare metal. Install new hardware where original is missing, damaged, or unsuitable for new operation, in accordance with manufacturer's directions to provide a secure and smoothly operating window assembly.

3.2.8 Glazing

Reinstall lights to be reused in their original frames and positions. Brush rabbeted integral glazing recesses with boiled linseed oil prior to the application of bed glazing compound. Replace broken glass as specified in Section 08 81 00 GLAZING.

3.2.9 Operating System

Repair windows with counter-weight systems to original operating function. Reuse original sash weights (and sash chains, if applicable) wherever possible. Replace missing weights and sash cords or chains. Replace missing or deteriorated sash cords with new cotton-polypropylene cord rated for sash weight. When new weights are required, match the originals in weight. Provide cast iron or square milled steel bar stock replacement weights.

3.2.10 Weatherstripping and Moldings

Install Weatherstripping on all operable windows. Provide weatherstripping consisting of brass, compression or interlocking weather strips designed for permanent sealing under bumper or wiper action. Provide weatherstripping at the perimeter of each sash including meeting rails and install in accordance with manufacturer's instructions. Submit a 300 mm 12 inch long sample of each type of weatherstripping required with fasteners. Weatherstripping must be completely concealed when sash is closed. Install moldings in accordance with manufacturer's instructions. Submit a 300 mm 12 inch long piece of each molding type required for each window and casing with specified finish.

3.3 PAINTING PREPARATION

Scrape, sand, and feather edges in areas where paint was removed or where existing paint shows crazing, wrinkling, and intercoat peeling. Remove paint to bare wood or first sound paint layer. Clean all parts by brush using bleach and/or trisodium phosphate (TSP) solution, and let dry. Degloss existing finish. Fill open joints and cracks with epoxy repair materials. Caulk perimeter of fixed sash.

3.4 PAINTING

Prime and paint wood elements in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.5 REASSEMBLY

After repairs are completed, reassemble the window with all parts tight, true and functioning properly. Wood surfaces must be free of blemishes.

3.6 ADJUSTMENTS

Make final adjustment, for proper operation of ventilating unit, after reassembly. Make adjustments to operating sash or ventilators to assure smooth operation and weathertight performance when locked closed.

3.7 CLEANING

Clean windows on both exterior and interior sides.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 11 13 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 11 13 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 11 13

STEEL DOORS AND FRAMES

08/20

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-08 11 13 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 11 13 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 08 11 13

STEEL DOORS AND FRAMES

08/20

****

NOTE: This guide specification covers steel doors and frames. Some paragraphs may need to be supplemented to meet project requirements.

Include Section 08 34 73 SOUND CONTROL DOOR ASSEMBLIES when project includes flush steel sound retardant doors with Sound Transmission Classification (STC) ranging from 25 to 45.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: On the drawings, show:

1. Sizes of door openings, thicknesses of doors, swings, and travels of doors, and design of doors, whether flush panel, full flush, paneled, glazed, or louvered. It is recommended that standard door-type nomenclature, SDI 106, be used to indicate designs (e.g., F, L, G, GL in lieu of A, B, C).

2. Details of nonstructural mullions, mullion covers, and removable mullions.

3. Type and thickness of glazing required; whether or not insulating glass units are required.

4. Method, type, and spacing required for anchoring door frames to adjoining construction.

5. Lintels and reinforcement required to support walls or partitions above doors.

6. Type of shop finish on steel surfaces.

7. Free area for louvers in doors.

8. Complete door schedule. Schedule should assign a separate number for each opening and should indicate door type and style, material, design, size, thickness, glazed or unglazed, class fire rating for fire doors, hardware set number, threshold material, if any, and material for frames, mullions, and transom bars.

****

PART 1 GENERAL

1.1 REFERENCES

****

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A879/A879M	(2012; R 2017) Standard Specification for Steel Sheet, zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM D2863	(2019) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM F2247	(2018) Standard Test Method for Metal Doors Used in Blast Resistant Applications (Equivalent Static Load Method)
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass
ASTM F2927	(2012) Standard Test Method for Door Systems Subject to Airblast Loadings

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.115	(2016) Hardware Preparation in Steel Doors and Steel Frames

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMMA 810	(2009) Hollow Metal Doors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 105	(2025) Standard for Smoke Door Assemblies and Other Opening Protectives
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR 111	(2009) Recommended Details for Standard Steel Doors, Frames, and Accessories and Related Components
SDI/DOOR 113	(2023) Standard Practice for Determining the Steady-State Thermal Transmittance of Steel Door and Frame Assemblies
SDI/DOOR A250.3	(2019) Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames
SDI/DOOR A250.4	(2022) Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors
SDI/DOOR A250.6	(2020) Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
SDI/DOOR A250.8	(2023) Specifications for Standard Steel Doors and Frames
SDI/DOOR A250.11	(2022) Recommended Erection Instructions for Steel Frames

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

UL SOLUTIONS (UL)

UL 10C	(2016; Reprint May 2021) UL Standard for Safety Positive Pressure Fire Tests of Door Assemblies

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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SD-02 Shop Drawings

Doors; G, [_____]

Frames; G, [_____]

Accessories

Schedule of Doors; G, [_____]

Schedule of Frames; G, [_____]

SD-03 Product Data

Doors; G, [_____]

Recycled Content for Steel Door Product; S

Frames; G, [_____]

Recycled Content for Steel Frame Product; S

Accessories

[SD-04 Samples

Factory-applied Enamel Finish; G, [_____]

]1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging.[Strap knock-down frames in bundles.][Provide temporary steel spreaders securely fastened to the bottom of each welded frame.] Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 6 mm 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

PART 2 PRODUCTS

2.1 STANDARD STEEL DOORS

****

NOTE: Standard steel doors are the most common and competitively priced which apply to most metal door openings in most projects. Different classifications and performance requirements are available as explained in the editor's notes in paragraph CLASSIFICATION - LEVEL, PERFORMANCE, MODEL.

****

****

NOTE: For forced entry, include the bracketed option below regarding exterior glazing when personnel density is greater than one person per 40 square meters 430 square feet and the minimum AT/FP standoff distances are met. This does not include guard type facilities or single and duplex detached family housing. These requirements are specified in UFC 4-010-01 "DoD Minimum Antiterrorism Standards for Buildings". Include last bracketed sentence if exterior doors must meet antiterrorism requirements of UFC 4-010-01.

****

SDI/DOOR A250.8, except as specified otherwise. Prepare doors to receive door hardware as specified in Section 08 71 00 DOOR HARDWARE. Undercut where indicated. Provide exterior doors with top edge closed flush and sealed to prevent water intrusion. Provide doors at 44.5 mm 1-3/4 inch thick, unless otherwise indicated. Provide door material that uses a minimum of 25 percent recycled content. Provide data indicating percentage of recycled content for steel door product.[Provide exterior glazing in accordance with ASTM F2248 and ASTM E1300.][Exterior doors must be tested in accordance with ASTM F2247 or ASTM F2927 to meet requirements of UFC 4-010-01.]

2.1.1 Classification - Level, Performance, Model

****

NOTE: When a door level is not required, delete the entire paragraph for that level. Door levels for various locations should be determined in accordance with SDI 108 Table 2 and the following list.

Closet doors (without locks)	**Level 1**
Individual offices, storage rooms, classrooms, patients' rooms, bathrooms, and bedrooms (except BEQ bedrooms)	**Level 2**
BEQ sleeping room entrance doors and interior egress doors	**Level 3**
Exterior Main entrance and circulation doors and other locations	**Level 4**

Model designations are as follows:

Model 1 Full Flush Design
Model 2 Seamless Design
Model 3 Stile and Rail

Where appearance is important and edge seams are objectionable, use Model 2.

Core constructions must be at the manufacturer's discretion and are as follows:

a. Kraft/Paper Honeycomb
b. Polyurethane Modified Polyisocyanurate
c. Polystyrene
d. Mineral Board
e. Vertical Steel Stiffeners

****

2.1.1.1 Standard Duty Doors

SDI/DOOR A250.8, Level 1, physical performance Level C, Model [1] [2], of size(s) and design(s) indicated and core construction as required by the manufacturer. Provide [where shown][for doors No. [_____]].

2.1.1.2 Heavy Duty Doors

SDI/DOOR A250.8, Level 2, physical performance Level B, Model [1][2], with core construction as required by the manufacturer [for interior doors][and][for exterior doors], of size(s) and design(s) indicated.[Where vertical stiffener cores are required, the space between the stiffeners must be filled with board insulation.][Provide Level 2 [where indicated][for doors No. [_____]].]

2.1.1.3 Extra Heavy Duty Doors

SDI/DOOR A250.8, Level 3, physical performance Level A, Model [1][2][3] with core construction as required by the manufacturer [for interior doors][and][for indicated exterior doors], of size(s) and design(s) indicated.[Where vertical stiffener cores are required, the space between the stiffeners must be filled with board insulation.][Provide Level 3 [where indicated] [for doors No. [_____]].]

2.1.1.4 Maximum Duty Doors

SDI/DOOR A250.8, Level 4, physical performance Level A, Model [1][2] with core construction as required by the manufacturer [for interior doors][and][for indicated exterior doors], of size(s) and design(s) indicated.[Where vertical stiffener cores are required, the space between the stiffeners must be filled with board insulation.][Provide Level 4 [where indicated] [for doors No. [_____]].]

[2.2 CUSTOM HOLLOW METAL DOORS

****

NOTE: Custom steel doors are typically scheduled in locations that (1) require unique dimensions that are oversized, non-standard, or located in special use buildings or retrofits, (2)require enhanced performance from weather, sound reduction, forced entry, bullet resistant, or blast doors, or (3) require specific aesthetics that require embossments, attractive panels or other customization possibly for historic or other installations. Where only standard steel doors are used in a project, delete this paragraph.

****

****

NOTE: For forced entry, include the bracketed option below regarding exterior glazing when personnel density is greater than one person per 40 square meters 430 square feet and the minimum AT/FP standoff distances are met. This does not include guard type facilities or single and duplex detached family housing. These requirements are specified in UFC 4-010-01 "DoD Minimum Antiterrorism Standards for Buildings". Include last bracketed sentence if exterior doors must meet antiterrorism requirements of UFC 4-010-01.

****

Provide custom hollow metal doors where nonstandard steel doors are indicated. Provide custom steel doors in the door size(s), design(s), materials, construction, gages, and finish as specified for custom steel doors and complying with the requirements of NAAMM HMMA 810. Fill all spaces in exterior doors with insulation. Close top and bottom edges with steel channels not lighter than 1.5 mm thick 16 gage.[Close tops of exterior doors flush with an additional channel and seal to prevent water intrusion.] Prepare doors to receive hardware specified in Section 08 71 00 DOOR HARDWARE.[Undercut doors where indicated.] Provide doors at 44.5 mm 1-3/4 inch thick, unless otherwise indicated.[Provide exterior glazing in accordance with ASTM F2248 and ASTM E1300.][Exterior doors much be tested in accordance with ASTM F2247 and ASTM F2927 to meet the requirements of UFC 4-010-01.]

][2.3 INSULATED STEEL DOOR SYSTEMS

****

NOTE: Insulated steel doors and frames are recommended for entrances to dwelling units in UEPH's and barracks. Edit or delete the paragraph to suit the project.

****

Provide insulated steel doors and frames in accordance with SDI/DOOR 113 at entrances to dwelling units and where indicated. Meet energy requirements including Solar Heat Gain Coefficient (SHGC) and U-factor. Provide insulated steel doors with a core of polyurethane foam; face sheets, edges, and frames of galvanized steel not lighter than 0.7 mm thick 23 gage, 1.5 mm thick 16 gage, and 1.5 mm 16 gage respectively; magnetic weatherstripping; nonremovable-pin hinges; thermal-break aluminum threshold; and vinyl door bottom. Provide to doors and frames a phosphate treatment, rust-inhibitive primer, and baked acrylic enamel finish. Test doors in accordance with SDI/DOOR A250.4 and meet the requirements for Level C. Prepare doors to receive specified hardware. Provide doors 44.5 mm 1-3/4 inch thick.

]2.4 ACCESSORIES

2.4.1 Shelves for Dutch Doors

SDI/DOOR 111. Fabricate shelves of steel not lighter than 1.5 mm thick 16 gage, [[_____] mm inches wide][of the size indicated]. Provide brackets of stock type fabricated of the same metal used to fabricate shelves.

2.4.2 Louvers

****

NOTE: Interior and exterior louvers are applied to steel doors differently. Interior door louvers are removable on side by molding flange and exterior door louver frames are permanently welded to the door and provided with removable bird screen or insect screen.

****

****

NOTE: Avoid louvers on exterior doors in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5 as they are very susceptible to weather deterioration. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Consider other means of providing the venting function.

Ensure that louvers in doors are drainable, weatherproof and factory primed. Doors with factory-installed louvers are also recommended.

****

2.4.2.1 Interior Louvers

****

NOTE: Lightproof louvers are used when light transmission must be avoided. However, these provide a minimal free air flow.

****

SDI/DOOR 111. Where indicated, provide louvers of stationary [sightproof][and][lightproof] type[where scheduled].[Louvers for lightproof must not transmit light.] Detachable moldings on room or non security side of door; on security side of door, moldings to be integral part of louver. Form louver frames of 0.9 mm thick 20 gage steel and louver blades of a minimum 0.6 mm 24 gage.[Louvers for lightproof doors must have minimum of 20 percent net-free opening.][Sightproof louvers to be inverted ["V" blade design with minimum 55][and][inverted ["Y"] blade design with minimum 40] percent net-free opening.]

2.4.2.2 Exterior Louvers

****

NOTE: Use aluminum screens in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Provide louvers of the inverted ["Y"]["V"]["Z"] type with minimum of [30][55][35] percent net-free opening. Weld or tenon louver blades to continuous channel frame and weld assembly to door to form watertight assembly. Form louvers of hot-dip galvanized steel of same gage as door facings. At louvers provide steel-framed [insect][bird] screens secured to room side and readily removable. Provide [aluminum wire cloth, 7 by 7 per 10 mm or 7 by 6 per 10 mm 18 by 18 or 18 by 16 inch mesh, for insect screens][galvanized steel, 13 by 13 mm 1/2 by 1/2 inch mesh hardware cloth, for bird screens]. Net-free louver area to be before screening.

2.4.3 Astragals

For pairs of exterior steel doors which will not have aluminum astragals or removable mullions, as specified in Section 08 71 00 DOOR HARDWARE provide overlapping steel astragals with the doors.

2.4.4 Moldings

Provide moldings around glass of interior and exterior doors and louvers of interior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings.

2.5 INSULATION CORES

****

NOTE: Door manufacturers use various insulation materials as their standard. Unless the designer has a specific reason to eliminate an insulation material, it is advised to maintain all listed types of insulation materials.

If additional interior or specialty doors require thermal insulation include the bracketed option and indicate these requirements on the door schedule in the drawings.

****

Provide insulating cores at all exterior doors[and other specific doors noted in the door schedule], and provide an apparent U-factor of .48 in accordance with SDI/DOOR 113 and conforming to:

a. Rigid Cellular Polyisocyanurate Foam: ASTM C591, Type I or II, foamed-in-place or in board form, with oxygen index of not less than 22 percent when tested in accordance with ASTM D2863; or

b. Rigid Polystyrene Foam Board: ASTM C578, Type I or II; or

c. Mineral board: ASTM C612, Type I.

2.6 STANDARD STEEL FRAMES

****

NOTE: Designate whether frames are to be welded or knock-down field-assembled type. In general, utilize welded frames unless knock-down frames are required due to a renovation project or the temporary nature of the partitions being constructed. Welded frames must be built in as CMU walls are constructed or before drywall is installed on studs. Slip-on drywall frames must be knock-down type to be inserted after drywall is installed. When both types are required for the project, modify paragraph to specify both types and locations where required.

****

SDI/DOOR A250.8, Level [1][2][3][4], except as otherwise specified. Form frames to sizes and shapes indicated, with [welded corners][or][knock-down field-assembled corners]. Provide steel frames for doors, [transoms,] [sidelights,] [mullions,] [cased openings,][and][interior glazed panels,] unless otherwise indicated. Provide frame product that uses a minimum of 25 percent recycled content. Provide data indicating percentage of recycled content for steel frame product.

2.6.1 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded.

[2.6.2 Knock-Down Frames

****

NOTE: Remove this section unless knock-down frames are required due to a renovation project or the temporary nature of the partitions being constructed.

****

Design corners for simple field assembly by concealed tenons, splice plates, or interlocking joints that produce square, rigid corners and a tight fit and maintain the alignment of adjoining members. Provide locknuts for bolted connections.

]2.6.3 Mullions and Transom Bars

Provide mullions and transom bars of closed or tubular construction with heads and jambs butt-welded together[or knock-down for field assembly].

Bottom of door mullions must have adjustable floor anchors and spreader connections.

2.6.4 Stops and Beads

Provide form and loose stops and beads from 0.9 mm thick 20 gage steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 300 to 400 mm 12 to 16 inch on center. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

2.6.5 Terminated Stops

****

NOTE: Specify or indicate when stops (rabbet strips) are required to be terminated above the floor; generally, terminated stops are used in hospitals and similar buildings to eliminate projections on which wheels of beds and carts are caught and to eliminate small, dirt-catching corners.

****

Where indicated, terminate interior door frame stops 150 mm 6 inch above floor.[Do not terminate stops of frames for [lightproof,] [soundproof,] [or lead-lined] doors.]

2.6.6 Cased Openings

Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

2.6.7 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated not lighter than 1.2 mm thick 18 gage.

2.6.7.1 Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 2285 mm 7.5 feet in height, provide one additional anchor for each jamb for each additional 760 mm 2.5 feet or fraction thereof.

a. Masonry: Provide anchors of corrugated or perforated steel straps or 5 mm 3/16 inch diameter steel wire, adjustable or T-shaped;

b. Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened [to wood studs with nails,] [to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding];

c. Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111; and

d. Solid plaster partitions: Secure anchors solidly to back of frames and tie into the lath. Provide adjustable top strut anchors on each side of frame for fastening to structural members or ceiling construction above. Provide size and type of strut anchors as recommended by the frame manufacturer.

2.6.7.2 Floor Anchors

****

NOTE: In masonry construction, extension clips at bottom of frames are usually required in locations where additional floor fill occurs on top of structural slabs, and the metal frames and partitions are installed before the fill is placed. In such cases, the drawings or specifications should indicate the distance required between the rough slab and finished floor.

****

Provide floor anchors drilled for 10 mm 3/8 inch anchor bolts at bottom of each jamb member.[Where floor fill occurs, terminate bottom of frames at the indicated finished floor levels and support by adjustable extension clips resting on and anchored to the structural slabs.]

2.7 FIRE [AND] [SMOKE] DOORS AND FRAMES

****

NOTE: For each opening requiring labeled doors, specify or indicate the hourly rating of fire doors, as established by the National Fire Protection Association. When labeled doors are necessary on both sides of a fire wall, provide adequate details. Labels cannot be obtained for double-acting doors or for steel angle frames. Metal frames to receive labeled wood fire doors must also be labeled.

If the facility includes sprinklers and other fire protection measures, doors may or may not require insulation for temperature rise. In projects that require temperature rise criteria on fire doors, include the bracketed last sentence in the paragraph below and indicate this requirement in the door schedule.

****

Provide fire[and smoke] doors and frames in accordance with NFPA 80[and][NFPA 105] and this specification.[Include insulated core materials in fire doors where indicated in the door schedule.]

2.7.1 Labels

Provide fire doors and frames bearing the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing must be in accordance with NFPA 252 or UL 10C. Provide labels that are metal with raised letters, bearing the name or file number of the door and frame manufacturer. Labels must be permanently affixed at the factory to frames and to the hinge edge of the door. Do not paint door and labels.

2.7.2 Oversized Doors

For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

2.7.3 Astragal on Fire [and Smoke] Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements.[On smoke control doors, conform to NFPA 105.]

2.8 EXTERIOR FRAMES

****

NOTE: In lieu of grouting exterior frames which is no longer recommended by SDI/Door, the minimum thickness of exterior door frames required herein provides security without grouting the frame.

****

Provide thermal insulation in all exterior frames. Provide frames of a minimum Level 4, with frames of a minimum thickness of 1.7 mm 0.067 inch, 14 gage.

2.9 HARDWARE PREPARATION

Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to ANSI/BHMA A156.115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Punch door frames[, with the exception of frames that will have weatherstripping [or] [lightproof] [or] [soundproof] gasketing,] to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.10 FINISHES

****

NOTE: Specify the type finish required for the type of steel used for fabrication of doors and frames. Specify hot-dip zinc-coated steel for exterior hollow metal doors and frames in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Also specify hot-dip zinc-coated steel for interior hollow metal doors and frames in high humidity building spaces and interior doors at project locations with ESC classifications of C4 and C5. Hugh humidity building spaces include bathrooms, locker rooms, shower areas, laundry rooms, pools, and trainers. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Galvannealed steel is suitable for interior doors and frames in most buildings in ESC locations of C1 and C2. Unless factory finish coating is required, specify finish coating will be applied by field painting in Section 09 90 00 PAINTS AND COATINGS.

****

[2.10.1 Factory-Primed Finish

Thoroughly clean all surfaces of doors and frames then chemically treat and factory prime with a rust inhibiting coating as specified in SDI/DOOR A250.8 [.][, or paintable A25 galvannealed steel without primer. Where coating is removed by welding, apply touchup of factory primer.]

][2.10.2 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate [exterior][interior][scheduled] doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A924/A924M and ASTM A653/A653M. The coating weight must meet or exceed the minimum requirements for coatings having 122 grams per square meter 0.4 ounces per square foot, total both sides, i.e., ZF120 A40. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in SDI/DOOR A250.8.[Provide for [exterior doors][and][interior doors][door openings No. [_____]]].

]2.10.3 Electrolytic Zinc-Coated Anchors and Accessories

Provide electrolytically deposited zinc-coated steel in accordance with ASTM A879/A879M, Commercial Quality, Coating Class A. Phosphate treat and factory prime zinc-coated surfaces as specified in SDI/DOOR A250.8.

[2.10.4 Factory-Applied Enamel Finish

****

NOTE: Use this paragraph if field coatings as specified in Section 09 90 00 PAINTS AND COATINGS are not required or provided. One coat of factory-applied enamel finish is readily available in standard colors. Two coats and special colors add to cost and to delivery time.

****

Provide coatings that meet test procedures and acceptance criteria in accordance with SDI/DOOR A250.3. After factory priming, apply [one coat][two coats] of [low-gloss][medium-gloss] enamel to exposed surfaces. Separately bake or oven dry each coat. Drying time and temperature requirements must be in accordance with the coating manufacturer's recommendations. Provide finish coat color(s) [as indicated][_____] to match approved color sample(s).

]2.11 FABRICATION AND WORKMANSHIP

Provide finished doors and frames that are strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Provide molded members that are clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints must be well formed and in true alignment. Conceal fastenings where practicable.[Frames for use in solid plaster partitions must be welded construction.][On wraparound frames for masonry partitions, provide a throat opening 3 mm 1/8 inch larger than the actual masonry thickness.][Design[other] frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive caulking compound.]

2.12 PROVISIONS FOR GLAZING

Materials are specified in Section 08 81 00, GLAZING.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Frames

Set frames in accordance with SDI/DOOR A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction.[Where frames require ceiling struts or overhead bracing, anchor frames to the struts or bracing.]

3.1.2 Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

3.1.3 Fire [and Smoke] Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80.[Install[fire rated] smoke doors and frames in accordance with [NFPA 80][and][NFPA 105].]

3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 11 16 (May 2017)**
Change 2 - 11/18

Preparing Activity: NAVFAC **Superseding**
UFGS-08 11 16 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 11 16

ALUMINUM DOORS AND FRAMES

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USACE / NAVFAC / AFCEC **UFGS-08 11 16 (May 2017)**
Change 2 - 11/18

Preparing Activity: NAVFAC **Superseding**
UFGS-08 11 16 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 08 11 16

ALUMINUM DOORS AND FRAMES
05/17, CHG 2: 11/18

****

NOTE: This guide specification covers aluminum doors and frames intended for use primarily as main entrance and vestibule doors, and for prominent interior doors from lobbies and similar spaces in buildings of public access where appearance is important.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Coordinate with or incorporate into this guide specification Aluminum-Framed Entrances and Storefronts, Curtain Wall and Glazed Assemblies (frames), Steel/Aluminum Doors and Frames and Glazing. Insert the appropriate assembly in the blanks as applicable. Choose apprpriate damage level/level of protection for building occupancy as defined in UFC 4-010-01 (Table 2-1).

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: On the drawings, show:

1. Size and types of door openings; thicknesses, swings and travel of doors; whether flush, paneled,

glazed, or louvered; width of stiles and rails, and power transfer components as applicable.

2. Elevations of each door and frame type, at 1:50 1/4 inch scale

3. Details of head, jamb, sill, mullions, and transom sections; key sections to door frame plans and elevations. Indicate type and spacing of anchors.

4. Indicate thickness of glazing required and cross reference to Section 08 81 00 GLAZING.

5. Details of weatherstripping for exterior doors.

6. Amount of free area for louvers.

7. A unique number for each door opening on door schedule.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2603	(2020) Voluntary Specification,

	Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
AAMA 2604	(2017a) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1886	(2019) Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
ASTM E1996	(2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F1643	(2012) Standard Test Methods for Detention Sliding Door Locking Device Assembly
ASTM F2247	(2018) Standard Test Method for Metal Doors Used in Blast Resistant Applications (Equivalent Static Load Method)
ASTM F2927	(2012) Standard Test Method for Door Systems Subject to Airblast Loadings

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

1.2 PERFORMANCE REQUIREMENTS

1.2.1 Structural Calculations

****

NOTE: Dynamic analysis is preferred because it typically yields a more appropriate and economical/efficient design. UFC 4-010-01 also indicates that for vestibules, foyers, or similar entry configurations into inhabited areas where there are inner and outer doors the vestibules, foyers, or similar entries are considered not to be routinely occupied spaces. Specify inner doors and glazing capable of mitigating any hazards resulting from the enclosed vestibule or foyer outer doors and glazing failure in response to the design blast event. This is to account for the fact that at levels of protection required in these standards the outer doors and glazing may fail, which would subject the inner doors and glazing to significant blast loads. To provide that debris resistance, the inner doors, sidelights, and transoms must meet the windborne debris resistance requirements of ASTM E1996 (missiles A and D in Table 2). For door assemblies into vestibules, foyers, and similar entry configurations into inhabited areas use the bracketed item "Wind-Borne Debris" below.

****

1.2.1.1 Minimum Antiterrorism Performance

Provide doors meeting the minimum antiterrorism performance as specified in the paragraphs below.

[a. Dynamic Design Analysis Method

****
NOTE: Use the following bracketed paragraph if designing the door assembly using dynamic analysis.
****

b. As an alternative to the static equivalent load design approach described above, glazed opening framing members, anchors, and glazing may be designed using a dynamic analysis to prove the glazed opening system will provide performance equivalent to or better than a very low hazard rating in accordance with ASTM F1642/F1642M associated with the applicable low level of protection for the project.

][c. Standard Airblast Test Method

****
NOTE: Use the following bracketed paragraph if testing the door assembly in accordance with ASTM F2927 Standard Test Method for Door Systems Subject to Airblast Loadings.
****

d. Testing in accordance with ASTM F2927 may be by shock tube or arena test. Perform the test on the entire proposed door assembly, which must include, but not be limited to, the glazing, its framing/support system, operating devices, and all anchorage devices. Install door system anchorage that replicates the method of installation to be used for the project. Utilize the fasteners and anchorage methods used to attach the tested door assembly that are representative of the actual door installation. Demonstrate by calculation any deviations in actual installation of the connections or the connected elements from those tested to provide the damage level as indicated below.

e. The minimum airblast loading parameters for the test must be as follows: peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square inch (psi); and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec).

f. The acceptance criteria for the proposed door systems, as determined by the damage level/door response damage criteria of [ASTM F2247][ASTM F2927], will provide a performance equivalent to or better than a category [IV]; [III]; [_____] door damage level rating.[Door glazing performance must be equivalent to or better than [H3- Very Low][H4-Low] hazard rating in accordance with ASTM F1642/F1642M.]

][1.2.2   Wind Borne Debris

****
NOTE: In projects located in windborne debris regions, design performance requirements may exceed blast mitigation requirements. Select the most stringent requirement based on geographic region and AT standoff.
****

a. Provide impact resistant door [_____] assemblies meeting the Windborne-Debris-Impact Resistant Performance requirements of ASTM E1996 and ASTM E1886 as follows:

(1) Pass missile-impact tests when tested according to ASTM E1886 and meeting performance requirements according to ASTM E1996 for missiles A and D in Table 2.

]1.2.3 Air Infiltration

When tested in accordance with ASTM E283, air infiltration per door leaf cannot exceed 2.83 by 10-4 cms per square meter 0.6 cubic feet per minute per square foot of fixed area at a test pressure of 0.30 kPa 6.24 pounds per square foot.

1.2.4 Water Penetration

When tested in accordance with ASTM E331, there can be no water penetration at a pressure of 0.14 kPa 2.86 pounds per square foot of fixed area.

1.2.5 Thermal Transmittance, Solar Heat Gain, Visible Light Transmittance

****

NOTE: Coordinate compliance with ASHRAE 90.1 for "whole-window" (or overall assembly) thermal transmittance value (U-factor), Solar Heat Gain Coefficient (SHGC) and visible light transmittance (VT) for field assembled fenestration. Enter required values in brackets. Certification of system is by means of NFRC validated Project Label Certificates for all field assembled fenestration.

****

Provide products bearing NFRC Project Label Certificates for Fenestration verifying compliance with requirements for each assembly indicated. An NFRC Bid Report, or approved equal, for field assembled exterior doors may be submitted in lieu of Project Label Certificates for Fenestration if such reports are created in accordance with NFRC CAMP procedures and are provided by the manufacturer. Such alternate reports may be submitted with shop drawings, however, NFRC validated Project Label Certificates for Fenestration are required as a Closeout Submittal. Contact NFRC for information on NFRC 100 and NFRC 200 Compliance and Monitoring Program (CAMP) rating requirements: http://www.nfrc.org/industry/certification/compliance-and-monitoring-program-camp/

1.2.5.1 U-Factor

Provide exterior glazed assemblies, including aluminum entrances doors with greater than 50 percent glazed area, certified by the NFRC as having a whole window U-factor of [_____] or less as determined in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP and as verified in accordance with NFRC 100.

1.2.5.2 Solar Heat Gain Coefficient (SHGC)

Provide exterior glazed assemblies, including aluminum entrances doors with greater than 50 percent glazed area, certified by the National Fenestration Rating Council with a whole window SHGC of [_____] or less as determined in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP and as verified in accordance with NFRC 200.

1.2.5.3 Visible Light Transmittance (VLT)

Provide exterior glazed assemblies, including aluminum entrances doors with greater than 50 percent glazed area, certified by the NFRC with a whole window VLT of [_____] or greater as determined in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP and as verified in accordance with NFRC 200.

[1.2.5.4 Doors with Less than 50 Percent Glazed Area

For exterior aluminum entrances doors with less than 50 percent glazed area, the glazed area is considered the fenestration area and must be certified by the National Fenestration Rating Council with a whole window U-Factor, SHGC and VLT as required above.

]1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

For Each Type of Door and Frame Assembly; G, [_____]

SD-03 Product Data

For Each Type of Door and Frame Assembly; G, [_____]

Recycled Content of Aluminum Material; S

SD-04 Samples

Finish Samples; G, [_____]

SD-05 Design Data

[Design Analysis; G, [_____]

] Structural Calculations for Deflection and Antiterrorism; G, [_____]

SD-06 Test Reports

Air Infiltration; G, [_____]

Water Penetration; G, [_____]

[Standard Airblast; G, [_____]

] SD-07 Certificates

NFRC Project Label Certificates for Fenestration; G, [_____]

SD-08 Manufacturer's Instructions

Installation of Each Type of Door and Frame Assembly; G, [_____]

SD-10 Operation and Maintenance Data

Adjustments, Cleaning, and Maintenance; G, [_____]

SD-11 Closeout Submittals

NFRC Project Label Certificates for Fenestration; G, [_____]

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage. Unload and store with minimum handling. Provide storage space in dry location with adequate ventilation, free from dust or water, and easily accessible for inspection and handling. Stack materials on non-absorptive strips or wood platforms. Do not cover doors and frames with tarps, polyethylene film, or similar coverings. Protect finished surfaces during shipping and handling using manufacturer's standard method. Do not apply coatings or lacquers to surfaces to which caulking and glazing compounds must adhere.

1.5 QUALITY CONTROL

1.5.1 Shop Drawing

Indicate elevations and sections for each type of door and frame assembly. Show sizes and details of each assembly, frame construction,[subframe attachment,] thickness and gages of metal, details of door and frame construction, proposed method(s) of anchorage, glazing details, provisions for an location of hardware, [mullion details,] method and materials for flashing and weatherstripping, miscellaneous trim, installation details, and other related items necessary for a complete representation of all components. A qualified blast engineer must perform testing or calculations for door system design resistance to specified blast loads.

1.5.2 Finish Samples

Submit two color charts and two finish sample chips from manufacturer's standard color and finish options for each type of finish indicated.

[1.5.3 Design Analysis

Submit design analysis with calculations showing that the design of each different size and type of door unit [_____]and its anchorage to the structure meets the minimum antiterrorism standards required by paragraph MINIMUM ANTITERRORISM PERFORMANCE[, unless conformance is demonstrated by standard blast test results]. Calculations verifying the performance of each door [_____] proposed for use, under the given loads, must be prepared and signed by a registered Professional Engineer. The door [_____] components and anchorage devices to the structure, as determined by the design analysis, must be reflected in the shop drawings.

]1.5.4 Test Reports

Test door assembly [including glazing]for evaluation of hazards generated from airblast loading in accordance with [ASTM F2247][ASTM F2927] by an independent testing agency regularly engaged in blast testing. This test method and the resulting data are valid for the door size tested and smaller doors of identical construction.

****

NOTE: Use the following bracketed paragraph if designing the door assembly using dynamic analysis.

****

[Design Door assembly (including glazing) using a dynamic analysis to prove the performance equivalent to or better than a category [IV];[III];[_____] door damage level in accordance with ASTM F2927 for the peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square inch (psi); and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). Use a triangular blast load using the applicable pressure and impulse identified above.

****

NOTE: Use the following bracketed paragraph if testing the door assembly in accordance with ASTM F2927 Standard Test Method for Door Systems Subject to Airblast Loadings.

****

][For minimum Antiterrorism doors [_____], in lieu of a Design Analysis, submit results of standard blast testing, included in a test report, providing information in accordance with [ASTM F2247][ASTM F2927], as prepared by the independent testing agency performing the test. The test results must demonstrate the ability of each door [_____] proposed for use to withstand the blast loading parameters and achieve the damage [hazard] level rating specified in paragraph TESTING.

][Testing in accordance with ASTM F2927 may be by shock tube or arena test. Perform the test on the entire proposed door assembly, which must include, but not be limited to, the glazing, its framing/support system, operating devices, and all anchorage devices. Install door system anchorage that replicates the method of installation to be used for the project. Utilize the fasteners and anchorage methods used to attach the tested door assembly that are representative of the actual door installation. Demonstrate by calculation any deviations in actual installation of the connections or the connected elements from those tested to provide the damage level as indicated below.

The minimum airblast loading parameters for the test must be as follows: peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square inch (psi); and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec).

] The acceptance criteria for the proposed door systems, as determined by the damage level/door response damage criterial of [ASTM F2247][ASTM F2927], will provide a performance equivalent to or better than a category [IV]; [III]; [_____] door damage level rating.[Door glazing performance must be equivalent to or better than [H3 - Very low][H4 - Low] hazard rating in accordance with ASTM F1643.]

1.5.5 Operation and Maintenance Data

Submit detailed instructions for installation, adjustments, cleaning, and maintenance of each type of assembly indicated.

1.6 QUALITY ASSURANCE

1.6.1 Engineer Qualifications for Blast Design

All blast design calculations must be performed by or under the direct supervision of a registered engineer with a minimum of 5 years' experience performing blast design. The engineering firm performing the blast design must be able to demonstrate experience on similar size projects using similar design methods to meet the requirements outlined in this specification.

PART 2 PRODUCTS

2.1 DOORS AND FRAMES

Provide swing-type aluminum doors and frames of size, design, and location indicated. Provide doors complete with frames, framing members[, subframes][, transoms][, adjoining side lites] , trim, and accessories.[Coordinate side lites, window walls, adjacent curtainwall with Section 08 41 13 ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS][and Section 08 44 00 CURTAIN WALL AND GLAZED ASSEMBLIES.]

2.2 MATERIALS

2.2.1 Anchors

Stainless steel [or steel with hot-dipped galvanized finish].

2.2.2 Weatherstripping

Continuous wool pile, silicone treated, or type recommended by door manufacturer.

2.2.3 Aluminum Alloy for Doors and Frames

ASTM B221M, ASTM B221, Alloy 6063-T5 for extrusions. ASTM B209M, ASTM B209, alloy and temper best suited for aluminum sheets and strips. Provide aluminum materials that include a minimum of 30 percent recycled content. Provide data indicating percentage of recycled content of aluminum material.

2.2.4 Fasteners

Hard aluminum or stainless steel.

2.2.5 Structural Steel

ASTM A36/A36M.

2.2.6 Aluminum Paint

Aluminum door manufacturer's standard aluminum paint.

2.3 FABRICATION

2.3.1 Aluminum Frames

Extruded aluminum shapes with contours approximately as indicated. Provide removable glass stops and glazing beads for frames accommodating fixed glass. Use countersunk stainless steel Phillips screws for exposed fastenings, and space not more than 300 mm 12 inches on center. Mill joints in frame members to a hairline fit, reinforce, and secure mechanically.

2.3.2 Aluminum Doors

Of type, size, and design indicated and minimum 45 mm 1-3/4 inch thick. minimum wall thickness, 3 mm 0.125 inch, except beads and trim, 1.25 mm 0.050 inch. Door sizes shown are nominal; include standard clearances as follows: 2.5 mm 0.093 inch at hinge and lock stiles, 3 mm 0.125 inch between meeting stiles, 3 mm 0.125 inch at top rails, 5 mm 0.187 inch between bottom and threshold, and 17 mm 0.687 inch between bottom and floor.[Provide bevel single-acting doors 2 or 3 mm 0.063 or 0.125 inch at lock, hinge, and meeting stile edges.][Provide double-acting doors rounded edges at hinge stile, lock stile, and meeting stile edges.]

2.3.2.1 Full Glazed Stile and Rail Doors

Provide doors with [narrow][medium][wide] stiles and rails as indicated. Fabricate from extruded aluminum hollow seamless tubes or from a combination of open-shaped members interlocked or welded together. Fasten top and bottom rail together by means of welding or by 10 or 13 mm 3/8 or

1/2 inch diameter cadmium-plated tensioned steel tie rods. Provide an adjustable mechanism of jack screws or other methods in the top rail to allow for minor clearance adjustments after installation.

2.3.2.2 Flush Doors

****

NOTE: The optional types of door construction may not be suitable for use in all facilities. Delete any option listed not considered desirable for a particular usage or for use in a particular facility.

****

Use facing sheets with[a vertical ribbed][an embossed][or][a plain smooth] surface. Use one of the following constructions:

a. A phenolic resin-impregnated kraft paper honeycomb core, surrounded at edges and around glass and louvered areas with extruded aluminum shapes. Provide cores with a minimum impregnation of 18 percent resin content. Provide sheet aluminum door facings minimum 0.8 mm 0.032 inch thick laminated to a 2.5 mm 0.10 inch thick tempered hardboard backing, with the backing bonded to the honeycomb core. Bond facing sheets to cores under heat and pressure with thermosetting adhesive and mechanically lock to extruded edge members.

b. A phenolic resin-impregnated kraft paper honeycomb core. Use aluminum facing sheets minimum 1.25 mm 0.050 inch thick and form into two pans to eliminate seams on faces. Bond honeycomb core to face sheets using epoxy resin or contact cement-type adhesive.

c. A solid fibrous core, surrounded at edges and around glass and louvered areas and cross braced at intermediate points with extruded aluminum shapes. Use aluminum facing sheets of minimum 1.25 mm 0.050 inch thickness. Bond facing sheets to core under heat and pressure with a thermosetting adhesive, and mechanically lock to the extruded edge members.

d. Form from extruded tubular stiles and rails mitered at corners, reinforce, and continuously weld at miters. Provide facing sheets of minimum 0.8 mm 0.032 inch thick sheet aluminum internally reinforced with aluminum channels or Z-bars placed horizontally not more than 400 mm 16 inch apart and extending the full width of panels. Fit spaces between reinforcing with sound-deadening insulation. Weld facing sheets to reinforcing bars or channels and to stiles and rails. Finish facing sheets flush with faces of stiles and rails.

e. Form from an internal grid composed of extruded aluminum tubular sections. Provide tubular sections at all sides and perimeter of louver and glass openings. Provide three extruded aluminum tubular sections at top and bottom of each door. Provide wall thickness of tubular sections minimum 2.25 mm 0.09 inch except at lock rails which must be minimum 3 mm0.125 inch thick, hinge lock rails which must be minimum 3 mm 0.125 inch thick, and hinge rail edges which must be minimum 5 mm 0.19 inch thick. Fill spaces in door with mineral insulation. Provide facing sheets of aluminum minimum 2.25 mm 0.09 inch thick.

f. Form from extruded aluminum members at top and bottom, both sides, and at perimeters of louver and glass openings. Provide wall sections of extruded aluminum members minimum 2.25 mm 0.09 inch thick and reinforce for application of hardware. Cover framing members on both sides with aluminum facing sheets minimum 2 mm 0.064 inch thick. Fill door panels with [172 kPa25 pounds per square inch density polystyrene] [40 kg per cubic meter2.5 pound per cubic foot density, chlorofluorocarbon (CFC) free, foamed urethane] with a flame spread rating of no more than 25.

2.3.3 Welding and Fastening

Where possible, locate welds on unexposed surfaces. Dress welds on exposed surfaces smoothly. Select welding rods, filler wire, and flux to produce a uniform texture and color in finished work. Remove flux and spatter from surfaces immediately after welding. Exposed screws or bolts will be permitted only in inconspicuous locations, and must have countersunk heads. Weld concealed reinforcements for hardware in place.

2.3.4 Weatherstripping

****

NOTE: Maximum air leakage rates are 2.19 by 10-5 cms per sq. m 0.5 cfm per sq. ft. of door area for residential swinging doors and 5.48 by 10-5 cms per sq. m 1.25 cfm per sq. ft. of door area for non-residential doors. Both of the air leakage rates assume the use of threshold and sweep strip. Coordinate with Section 08 71 00 DOOR HARDWARE.

****

Provide on stiles and rails of exterior doors. Fit into slots which are integral with doors or frames. Weatherstripping must be replaceable without special tools, and adjustable at meeting rails of pairs of doors. During installation, verify doors swing freely and close positively. Refer to paragraph AIR INFILTRATION for air leakage requirements and testing.

2.3.5 Anchors

On the backs of subframes, provide anchors of the sizes and shapes indicated for securing subframes to adjacent construction. Anchor transom bars at ends and mullions at head and sill.[Where indicated, reinforce vertical mullions with structural steel members of sufficient length to extend up to the overhead structural slab or framing and secure thereto.][Reinforce and anchor freestanding door frames to floor construction as indicated on approved shop drawings and in accordance with manufacturer's recommendation.] Place anchors [as indicated][near top and bottom of each jamb and at intermediate points not more than 635 mm 25 inch apart].

2.3.6 Provisions for Hardware

****

NOTE: This guide specification requires that hardware and glazing for aluminum doors be specified in their respective sections of the project specification.

****

****

NOTE: Where items of hardware such as operating mechanism for balanced doors, integral push bars, concealed closing devices, and special panic bolts

for exceptionally narrow stile doors are designed as an integral part of door or frame construction, it may be necessary to revise specification so these items are furnished as part of door and frame unit. When accessories, such as finger guards, electric strikes, automatic power operators, and special thresholds are required, add as necessary.

****

Coordinate with Section 08 71 00 DOOR HARDWARE. Deliver hardware templates and hardware (except field-applied hardware) to the door manufacturer for use in fabrication of aluminum doors and frames. Cut, reinforce, drill, and tap doors and frames at the factory to receive template hardware. Provide doors to receive surface-applied hardware, except push plates, kick plates, and mop plates, with reinforcing only; drill and tap in the field. Provide hardware reinforcements of stainless steel or steel with hot-dipped galvanized finish, and secure with stainless steel screws.[Provide reinforcement in core of flush doors as required to receive locks, door closers, and other hardware.]

2.3.7 Provisions for Glazing

****

NOTE: This guide specification requires that hardware and glazing for aluminum doors be specified in their respective sections of the project specification.

****

[Provide extruded aluminum snap-in glazing beads on interior side of doors.][Provide extruded aluminum, theft-proof, snap-in glazing beads or fixed glazing beads on exterior or security side of doors.][Provide glazing beads with vinyl insert glazing gaskets.][Design glazing beads to receive thickness indicated for each glazed assembly.] Coordinate requirements with Section 08 81 00 GLAZING.

2.3.8 Finishes

****

NOTE: Specify finish designation AA-M10-C22-A31, Architectural Class II clear (natural) anodized finish or AA-M10-C22-A32, Architectural Class II color-anodized finish, when doors will not be subject to excessive wear or abrasion and will be regularly cleaned and maintained. Specify finish designation AA-M10-C22-A41, Architectural Class I clear (natural) anodized finish or AA-M10-C22-A42, Architectural Class I color-anodized finish, when doors will be subject to excessive wear and will not be regularly cleaned and maintained. Also specify these designations (Class I) are used in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.. Color-anodized finish is available in medium bronze, dark bronze, and black. Where revolving aluminum doors and frames are shown

in connection with aluminum swing doors, exercise care to obtain matching color and finish of the two door types.

****

Provide exposed aluminum surfaces with [mill finish] [factory finish of anodic coating or organic coating].

2.3.8.1 Anodic Coating

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45. Provide [clear (natural), designation AA-M10-C22-A31, Architectural Class II 0.01 to 0.0175 mm 0.4 mil to 0.7 mil][clear (natural), designation AA-M10-C22-A41, Architectural Class I 0.0175 mm 0.7 mil or thicker)][integral color-anodized, designation AA-M10-C22-A32, Architectural Class II 0.01 to 0.0175 0.4 mil to 0.7 mil][integral color-anodized, designation AA-M10-C22-A42, Architectural Class I 0.0175 mm 0.7 mil or thicker][electrolytically deposited color-anodized, designation AA-M10-C22-A34, Architectural Class II 0.01 to 0.0175 mm 0.4 mil to 0.7 mil][electrolytically deposited color-anodized, designation AA-M10-C22-A44, Architectural Class I 0.0175 mm 0.7 mil or thicker] finish.[Provide material(s) in color(s) [_____][as indicated][as selected from manufacturer's [standard][complete] range of color options]].

2.3.8.2 Organic Coating

****

NOTE: Specify baked enamel finish as an option to Class II anodized. Specify high-performance finish as an option to Class I anodized.

****

Clean and prime exposed aluminum surfaces. Provide [a baked enamel finish in accordance with AAMA 2603 with total dry film thickness minimum 0.02 mm 0.8 mil][a high-performance finish in accordance with AAMA 2604 with total dry film thickness of minimum 0.03 mm 1.2 mils]. Finish color to be [_____] [as indicated] [as selected from manufacturer's [standard][complete] range of color options].

PART 3 EXECUTION

3.1 INSTALLATION

Plumb, square, level, and align frames and framing members to receive doors[, transoms][, adjoining side lites][, and][, adjoining window walls]. Anchor frames to adjacent construction as indicated and in accordance with manufacturer's printed instructions and the approved shop drawings. Install anchorage that complies with applicable structural requirements. Anchor bottom of each frame to rough floor construction with 2.4 mm 3/32 inch thick minimum stainless steel angle clips secured to back of each jamb and to floor construction; use stainless steel bolts and expansion rivets for fastening clip anchors. Hang doors to produce clearances specified in paragraph ALUMINUM DOORS. After erection and glazing, adjust doors and hardware to operate properly.

3.2 PROTECTION FROM DISSIMILAR MATERIALS

3.2.1 Dissimilar Metals

Where aluminum surfaces come in contact with metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact to dissimilar metals.

3.2.1.1 Protection

Provide one of the following systems to protect surfaces in contact with dissimilar metals:

a. Paint the dissimilar metal with one coat of heavy-bodied bituminous paint.

b. Apply elastomeric sealant between aluminum and dissimilar metals in accordance with Section 07 92 00 JOINT SEALANTS.

c. Paint dissimilar metals with one coat of primer and one coat of aluminum paint.

d. Use a non-absorptive tape or gasket in permanently dry locations.

3.2.2 Drainage from Dissimilar Metals

In locations where drainage from dissimilar metals has direct contact with aluminum, provide protective paint to prevent aluminum discoloration.

3.2.3 Masonry and Concrete

Provide aluminum surfaces in contact with mortar, concrete, or other masonry materials with one coat of heavy-bodied bituminous paint.

3.2.4 Wood or Other Absorptive Materials

Provide aluminum surfaces in contact with absorptive materials subject to frequent moisture, and aluminum surfaces in contact with treated wood, with two coats of aluminum paint or one coat of heavy-bodied bituminous paint. In lieu of painting aluminum, paint the wood or other absorptive surface with two coats of aluminum paint and seal joints with elastomeric sealant.

3.3 SEALING AROUND ASSEMBLIES

Seal all penetrations of the air barrier by sealing around door openings as necessary to achieve compliance with air leakage requirements indicated in [the air barrier sections of the specifications][, the requirements of Section 07 27 10 BUILDING AIR BARRIER SYSTEM][, and Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING]. Flash all doors with corrosion resistant flashing to prevent water intrusion.

3.4 CLEANING

Upon completion of installation, clean door and frame surfaces in accordance with door manufacturer's written recommended procedure. Do not use abrasive, caustic, or acid cleaning agents.

3.5 PROTECTION

Protect doors and frames from damage and from contamination by other materials such as cement mortar. Prior to completion and acceptance of the work, restore damaged doors and frames to original condition, or replace with new ones.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 11 73 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 11 73 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 11 73

SLIDING FIRE DOORS

08/20

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 11 73 (August 2020)**

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****

SECTION 08 11 73

SLIDING FIRE DOORS
08/20

****
NOTE: This guide specification covers the requirements for horizontal and vertical sliding steel-covered composite, hollow-metal, corrugated sheet metal, and tin-clad fire doors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Fire rated doors of the swinging hollow metal, wood, coiling, and overhead types are not covered in this guide specification and should be covered in the respective section covering the particular type door.
****

****
NOTE: On the drawings, show:

1. Rough opening for each door.

2. Required headroom for level or inclined track.

3. Fire rating classification for each door.

4. Type of door operation, i.e. level track, inclined track, single-sliding, center-parting pair.

5. Type of power operators if used, service characteristics and connection points.

6. Location and type of controls if power operators are used.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C1036	(2021) Standard Specification for Flat Glass

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives

UL SOLUTIONS (UL)

UL 9	(2009; Reprint Oct 2024) Standard for Fire Tests of Window Assemblies
UL 10A	(2009; Reprint Mar 2022) UL Standard for Safety Tin-Clad Fire Doors
UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies
UL 14B	(2008; Reprint Sep 2021) UL Standard for Safety Sliding Hardware for Standard, Horizontally Mounted Tin-Clad Fire Doors
UL 33	(2010; Reprint Apr 2020) Heat Responsive Links for Fire-Protection Service
UL 228	(2006; Reprint Mar 2022) UL Standard for Safety Door Closers-Holders, With or Without Integral Smoke Detectors
UL 325	(2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Sliding Fire Doors; G, [_____]

SD-03 Product Data

Sliding Fire Doors; G, [_____]

Electrical Work; G, [_____]

SD-08 Manufacturer's Instructions

Sliding Fire Doors

SD-10 Operation and Maintenance Data

Sliding Fire Doors, Data Package 2; ; G, [_____]

1.2.1 Shop Drawing Information

Submit drawings for all sliding fire doors. Show types, sizes, location, metal gages, hardware, installation details, and other details of construction.[For motor-operated doors, include supporting brackets for motors, location, type, ratings of motors, and safety devices. Submit wiring diagrams for motors and controls.]

1.3 DELIVERY AND STORAGE

Deliver fire doors to the job site wrapped in a protective covering bearing manufacturer's name and brand. Store doors in dry locations with adequate ventilation, free from dust or water, and in such a manner to permit access for inspection and handling. Handle doors carefully to prevent damage. Remove damaged items that cannot be restored to like-new condition and provide new items.

PART 2 PRODUCTS

2.1 SLIDING FIRE DOORS

Conform to NFPA 80, UL 10B, and the requirements specified herein, and must be listed (labeled). Provide doors complete with operating devices, hardware, and accessories.

2.2 FABRICATION

****

NOTE: Types of doors should be specified optionally unless appearance is a factor or if certain doors are unobtainable in ratings required. Manufacturer's catalogs should be consulted before a selection is made.

****

Provide one of the following types:

2.2.1 Steel-Covered Composite

Flush panel consisting of a manufactured core material, such as calcium-silicate block insulation, covered on both faces with a bonded steel sheet not lighter than 0.9 mm thick 20 gage and on edges with a steel perimeter channel not lighter than 1.2 mm thick 18 gage. Door panel edges must be encased in a steel channel not lighter than 1.8 mm thick 14 gage. All joints in face sheets must be backed by an interior steel "H" column and covered with a steel, surface-applied faceplate or adequately reinforced panels at connecting joints to provide a solid one piece unit when installed.

2.2.2 Hollow-Metal

Flush panel consisting of a resin-impregnated, kraft honeycomb core covered on both faces with a bonded steel sheet not lighter than [0.9 mm thick 20 gage for door openings up to and including 3000 mm 10 feetin height][and][1.2 mm thick 18 gage for door openings over 3000 mm 10 feet in height] and on edges with a steel perimeter channel not lighter than 1.2 mm thick 18 gage. Door panel edges must be encased in a steel channel not lighter than 1.8 mm thick 14 gage. All joints in face sheets must be backed by an interior steel "H" column and covered with a steel, surface-applied faceplate or adequately reinforced panels at connecting joints to provide a solid one piece unit when installed.

2.2.3 Corrugated Sheet Metal

Approximately 65 mm 2 1/2 inches thick consisting of two galvanized corrugated steel sheets not lighter than 0.8 mm thick 22 gage each sheet. The corrugations must be approximately 65 mm 2 1/2 incheson centers and must run vertically on one side of the door and horizontally on the other. A 2 mm 1/16 inch thick layer of noncombustible insulation material must be provided between the sheets. Provide steel frame composed of structural steel shapes at all edges of door leafs. Secure frame to corrugated sheets by through bolting or by welding.

2.2.4 Tin-Clad

Conform to UL 10A. Door must have a core made up of layers of boards nailed to each other and encased in terne- or zinc-coated plates that are jointed together at their edges with nails driven through the joints into the core.

2.3 OPERATION

****

NOTE: Modify paragraph to agree with type of operation indicated on drawings. Power operators should be specified for sliding fire doors subject to heavy usage and required to remain closed. Power operated doors should also be used between heated production areas and unheated storage areas where there is frequent traffic between the two areas. Use last sentence to cover doors in hazardous locations such as ammunition loading areas. Refer to NFPA 70, National Electrical Code, for proper classes, groups, and divisions.

****

****

NOTE: If operator controls occur in hazardous locations, utilize the proper portion. Refer to NFPA 70 for requirements. NEMA Type 7 enclosures are suitable for indoor use in Class 1, Groups A, B, C, or D. NEMA Type 8 enclosures are suitable for indoor or outdoor use in Class 1, Groups A, B, C, or D. NEMA Type 9 enclosures are suitable for indoor use in Class II, Groups E, F, or G.

****

[Single-slide][Center-parting]on [level] [inclined] tracks normally [closed] [open with automatic closing system of UL labeled [reel type][or][weight type with weight box of sheet steel not lighter than 1.5 mm thick 16 gage. Provide continuous length weight box for the entire travel of the weights.][Provide fusible links as required by NFPA 80 to activate at 71 degrees C 160 degrees F.][Provide manually operated doors capable of being operated with a force of 20 kilograms 45 pounds.][Provide [pneumatic] [electric] operators conforming to NFPA 80 and the requirements specified herein and a UL or (FM APP GUIDE) listed releasing device to permit automatic closing in case of power failure.] Provide safety edges to reverse direction of doors when an obstruction is encountered and limit switches to stop the doors in the fully open or fully closed position. Operators, holders, and release devices must conform to UL 228 and UL 325 and be listed (labeled).][Operating devices for use on door No. [_____] must conform to Article 500 - of NFPA 70, Class [_____], Group [_____], Division [_____].]

[2.3.1 Pneumatic Operators

****

NOTE: Select the applicable paragraph(s) from the following:

****

****

NOTE: Modify the paragraph to suit the type of controls required. Insert air pressure that will be available for door operation.

****

****

NOTE: If operator controls occur in hazardous locations utilize the proper portion. Refer to NFPA 70 for requirements. NEMA Type 7 enclosures are suitable for indoor use in Class 1, Groups A, B, C, or D. NEMA Type 8 enclosures are suitable for indoor or outdoor use in Class 1, Groups A, B, C, or D. NEMA Type 9 enclosures are suitable for indoor use in Class II, Groups E, F, or G.

****

Heavy-duty type designed to operate door at 0.3 meters one foot per second with air pressure of [_____] kPa psi. Operator must open, close, start, and stop the door smoothly. Control equipment must be [electrical conforming to NEMA ICS 1 and NEMA ICS 2; enclosures must be NEMA ICS 6, Type 12,] [pneumatic] [pushbutton wall switches] [ceiling pull switches] [roll-over floor treadle] [as indicated] [except that for enclosures for use in the hazardous space indicated as [_____] must conform to Article 500 of NFPA 70].[Provide full-guarded type pushbuttons to prevent accidental operation.]

][2.3.2 Electric Operators

****

NOTE: Modify the paragraph to suit the type of controls required. Insert the electrical characteristics that will be available for the door operation. Motors provided for operation on 480-volt circuits should have a voltage rating of 460 volts. Motors provided for operation on 208-volt circuits should have a voltage rating of 200 volts.

****

****

NOTE: If operator controls occur in hazardous locations, utilize the proper portion. Refer to NFPA 70 for requirements. NEMA Type 7 enclosures are suitable for indoor use in Class 1, Groups A, B, C, or D. NEMA Type 8 enclosures are suitable for indoor or outdoor use in Class 1, Groups A, B, C, or D. NEMA Type 9 enclosures are suitable for indoor use in Class II, Groups E, F, or G.

****

Heavy-duty type designed to operate door at not less than 0.2 two-thirds or more than 0.3 meters one foot per second. Provide electrical control equipment conforming to NEMA ICS 1 and NEMA ICS 2; enclosures must be NEMA ICS 6, Type 12, [pushbutton wall switches] [ceiling pull switches] [roll-over floor treadle] [as indicated] [except that for enclosures for use in the hazardous space indicated as [_____] must conform to Article 500 of NFPA 70].[Provide full-guarded type pushbuttons to prevent accidental operation.] Provide electric power operators of the type recommended by the door manufacturer and provide complete assembly with motor, controls, limit switches, magnetized reversing contactor, and other necessary accessories. Design the operator so that the motor may be removed without disturbing the limit-switch timing and without affecting the emergency operators. Provide the operator with slipping clutch coupling to prevent stalling the motor. Where control voltages differ from motor voltage, provide a control voltage transformer in and as part of the starter. Motors must conform to NEMA MG 1; be high-starting torque, reversible type; be of sufficient kilowatt horsepower and torque output to move the door in either direction from any position; and produce a door travel speed of not less than 0.2 two-thirds or more than 0.3 meters one foot per second without exceeding the rated capacity. Provide motors rated [_____] volts, [_____] hertz, [_____]-phase current and suitable for across-the-line magnetic starting. Design all motors to operate at full capacity with a voltage variation of plus or minus 10 percent of the motor voltage rating. Provide door motors with an enclosed, across-the-line type, magnetic reversing contactor having thermal overload protection.

]2.3.3 Electrical Work

****

NOTE: This paragraph applies to both pneumatic and electric operated doors.

****

Conform to NFPA 70. Provide all control devices and all conduit and wiring from the motor to controls necessary for the proper operation of the doors. Electrical wiring for power from the power source to the operators or controls is specified in Division 26. Provide electrical wiring from controls to operators under this section.

2.4 HARDWARE

Conform to NFPA 80, UL 14B, and the requirements specified herein, and must be listed (labeled). Design tracks, roller assemblies, and installation hardware to support a dead load to 1-1/2 times the door and attached hardware without deformation which would interfere with the operation of the door. Provide tracks formed of sheet steel not lighter than 1.8 mm thick 14 gage. Provide ball or roller bearing wheels or rollers with case-hardened races on all devices incorporating wheels or rollers. Provide recessed steel pulls on both sides of all door leaves [except for corrugated sheet metal doors which may be surface mounted]. Fusible links must conform to UL 33 and must be listed (labeled).

2.5 ACCESSORIES

2.5.1 Track Hood

****

NOTE: Delete paragraph if exterior doors mounted on the exterior of the wall are not used.

****

Form of zinc-coated steel not lighter than 1.2 mm thick 18 gage.

2.5.2 Glass Lights

****

NOTE: Delete paragraph if glass lights are not used.

****

UL 9 listed (labeled) and ASTM C1036, Type II, Class I, Form 1, M1 or M2, 6 mm 1/4 inch thick of size indicated, except that in no case must the size be larger than permitted with the required fire rating.

2.5.3 Weather Stripping

****

NOTE: Modify paragraph to indicate where weather stripping is required. If weather stripping is not required, delete paragraph.

****

Provide on head, jamb, and sills of [exterior doors] [interior doors [_____]].[Form of 1.5 mm 1/16 inch thick fabric-reinforced neoprene. Install using steel continuous retainers.][Provide nylon filament brush type in extruded aluminum retainers.]

2.5.4 Locking Device

****

NOTE: Delete paragraph if locking devices are not required. Do not include locking devices on doors of required exitways unless approval is obtained from the Fire Protection Engineer.

****

[Provide heavy-duty hasp and staple on doors [_____]. Locate on [_____] side.] [Provide heavy-duty mortise sliding door locks with [double] [single] pin-tumbler cylinders.]

2.6 FINISH

2.6.1 Exterior Door[s] [and Interior Door[s]] With Hardware

Steel Surfaces of Exterior Door[s] [and Interior Door[s]] Including Hardware: Provide galvanized finish on all concealed surfaces. Provide a shop-primed galvanized finish on all exposed surfaces. Galvanizing must conform to ASTM A653/A653M, coating designation Z275 G90 for steel sheets and ASTM A123/A123M for assembled steel products. Clean and coat all galvanized surfaces damaged during fabrication with galvanized repair paint. Prior to receiving primer, thoroughly clean all surfaces and phosphate treat to assure maximum paint adherence. Provide a metallic oxide or synthetic resin primer of the manufacturer's standard type and shall be applied by dipping or spraying.

2.6.2 Steel Surfaces of Interior Door[s] Including Hardware

****

NOTE: Delete paragraph if interior doors are to receive same finish as exterior doors.

****

Provide a shop-primed finish or a galvanized finish on all exposed surfaces. Galvanizing must conform to ASTM A653/A653M, coating designation Z275 G90 for steel sheets and ASTM A123/A123M for assembled steel products. Provide a metallic oxide or synthetic resin primer of the manufacturer's standard type applied by dipping or spraying. Prior to receiving primer, thoroughly clean all surfaces and phosphate treat to assure maximum paint adherence.

2.7 LABELS

Provide fire doors bearing labels of the UL or FM APP GUIDE as evidence of the door[s] conforming to the rating[s] indicated. The construction details necessary to obtain the labels must take precedence over details indicated or specified herein. Labels must be a minimum of 20 by 50 mm 3/4 by 2 inch brass plate with 13 mm 1/2 inch high raised letters. Label must be permanently attached to the door and must not be painted.

2.7.1 Contractor's Option

In lieu of UL or FM APP GUIDE labels, the fire doors may bear the label of a nationally recognized testing agency. The testing agency must be adequately equipped and competent to perform services equivalent to the UL inspection and certification program. Copies of the test reports indicating compliance with required ratings must accompany the certificates of compliance.

2.7.2 Oversized Doors

Where fire doors and frames exceed the size for which testing and labeling service is offered, furnish certificates of inspection from the testing laboratory. The certificate must state that the doors, frames, and hardware to be provided are identical in design, materials, and construction to a door that has been tested and rated.

PART 3 EXECUTION

3.1 INSTALLATION

Install fire doors in accordance with NFPA 80 and the manufacturer's approved instructions and shop drawings. Doors must be free from warp, twist, or distortion and must be lubricated and properly adjusted to operate freely.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 13 73 (February 2011)**

Preparing Activity: USACE **Superseding**
UFGS-08 13 73 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 08 13 73

SLIDING METAL DOORS

02/11

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 13 73 (February 2011)**

Preparing Activity: USACE **Superseding**
UFGS-08 13 73 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 13 73

SLIDING METAL DOORS

02/11

****

NOTE: This guide specification covers the requirements for horizontal sliding steel doors used primarily for fire rated application and electrically operated horizontal and biparting sliding doors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification is intended to cover horizontal sliding steel doors used primarily for fire rated applications. Use a center parting door at locations where an overhead monorail passes through the opening or where there is limited side room due to the lack of unobstructed wall space adjacent to the opening.

The following information should be indicated on the project drawings:

a. Size of door openings.

b. Fire rating classification for each door.

c. Type of door operation.

d. Type of power operators and service characteristics, and emergency/safety controls.

e. Location and type of power operator controls.

f. Type of closing system required.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or

	Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B136	(2023) Standard Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum
ASTM B137	(1995; R 2021) Standard Test Method for Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminum
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 28	(1991; E 2004) Water-Borne Epoxy Primer for Steel Surfaces
SSPC Paint 36	(2006) Two-Component Weatherable Aliphatic Polyurethane Topcoat, Performance-Based

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-8625	(1993; Rev F; Am 1 2003) Anodic Coatings, for Aluminum and Aluminum Alloys

UL SOLUTIONS (UL)

UL 10A	(2009; Reprint Mar 2022) UL Standard for Safety Tin-Clad Fire Doors
UL 14B	(2008; Reprint Sep 2021) UL Standard for Safety Sliding Hardware for Standard, Horizontally Mounted Tin-Clad Fire Doors
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers

1.2 SYSTEM DESCRIPTION

****

NOTE: For exterior doors, use wind load values selected from the tables below; the first table is metric units, the second table shows I-P units. The applicable basic wind speed and importance factor will be selected in accordance with ASCE 7-16, Minimum Design Loads For Buildings and Other Structures. Design wind loads may be reduced by 10 percent when the roof slope is equal to or less than 10 degrees. Delete this paragraph if exterior doors are not specified.

Design Wind Load +/- Pa psf					
Basic Wind	**Importance Factor**				
Speed m/s mph	**0.95**	**1.00**	**1.05**	**1.07**	**1.11**
31 70	**720 15**	**765 16**	**860 18**	**910 19**	**960 20**
36 80	**910 19**	**1005 21**	**1100 23**	**1150 24**	**1245 26**
40 90	**1150 24**	**1295 27**	**1435 30**	**1485 31**	**1580 33**
45 100	**1435 30**	**1580 33**	**1770 37**	**1820 38**	**1965 41**
49 110	**1725 36**	**1915 40**	**2105 44**	**2200 46**	**2395 50**
54 120	**2060 43**	**2300 48**	**2540 53**	**2635 55**	**2825 59**

****

Provide fire doors conforming to NFPA 80 and the requirements specified herein. Provide fire doors bearing the Underwriters Laboratories, Warnock Hersey, Factory Mutual, or other nationally recognized testing laboratory label for the required fire rating class and temperature rise classification if applicable. Provide each door with a permanent label showing the manufacturer's name and address and the model number of the door. Doors in excess of the labeled size will be deemed oversize and provided with a certificate signed by an official of the company, certifying that the door and operator have been designed to meet the specified requirements. Provide each door complete with operating devices, hardware, and accessories. Minimum design wind load is [_____] Pa psf.

Construct doors to sustain a superimposed load, both inward and outward, equal to 1.5 times the minimum design wind load and not to deflect more than 1/120 of the door width and height. When tested in accordance with the static air pressure test procedure of ASTM E330/E330M, the door must support the superimposed loads for a minimum period of 10 seconds without evidence of serious damage and be operable after conclusion of the tests. As an option, conduct the tests using an equivalent uniform static load. Support the uniform static load test specimen using rollers and track as required for project installation. Recovery must be at least three-fourths of the maximum deflection within 24 hours after the test load is removed.

1.2.1 Performance Requirements

Design Analysis and Calculations, equipment and performance data for Sliding Door Assemblies, and Hardware and Accessories must meet design specifications as required by referenced standards within this section.

1.2.1.1 Door Performance

Provide [[an electrically operated door with manual override mechanism] [a manually operated door], industrial type constructed of ASTM A36/A36M [structural steel sections] [formed plates] sized for loads specified.] [doors of the [one-way sliding] [and] [biparting double-leaf] type as indicated [supported on recessed rails set in floor with top guides]]. Furnish doors complete with hardware, tracks, guides, and accessories.

1.2.1.2 Biparting Doors

Provide doors requiring operating personnel to walk with leaf as it moves. Each door leaf must have separate drive units, [driving one or more wheels]. Each leaf must have [motor-mounted, spring-set,] [_____] [solenoid-released] motor brake. Each leaf must move independently from other leaves. Design leaves of biparting doors as follows:

a. Exterior windload of [2400] [_____] pascal [50] [_____] psf

b. Windload deflection not to exceed [_____] [the door height in mm inches divided by 120] [_____].

c. Interior horizontal sliding doors to withstand an internal pressure of [500] [_____] pascal [10] [_____] psf, both directions.

d. Door operating speed greater than [0.15] [_____] meter per second [30] [_____] feet per minute (fpm) and less than [0.08] [_____] meter per second [15] [_____] fpm is not permitted.

1.2.2 Seal Performance

When pressure is applied to the OPEN button, seals must automatically deflate before doors open. Upon deflation of pressure in each seal, provide switches [connected in series] that energize door-open controller. Every seal must deflate properly before permitting doors to move. Coordinate controls with this operating sequence for seals and door movement. Pressure must keep doors closed and hold center seals tight. When power fails, a braking device will hold each door shut and maintain seals. [Interlock personnel door to prevent movement of the leaf, or group in which it is located, when the personnel door is open.]

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Sliding Metal Doors

SD-07 Certificates

Fire Doors

Fabrication Drawings

Installation Drawings

Design Analysis and Calculations

Sliding Door Assemblies

Hardware and Accessories

Doors

Flush Doors

Rails

Paint

1.4 QUALITY ASSURANCE

Submit Fabrication Drawings with framing member details, welding details, and finish and painting details for sliding door assemblies. Include in the drawings elevations of each door type, details of anchorage, details of construction, location and installation of hardware, shape and thickness of materials, details of joints and connections, and details of tracks, rollers, power operators, controls, and fittings. Include a schedule showing the location of each door with the drawings, and the manufacturer's catalog data. Provide Installation Drawings with type and location of hardware, framing details, and rough opening dimensions and details for horizontal door and biparting door systems.

a. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to work specified in this section.

b. Conform to the requirements of Underwriters Laboratories, Inc., for motors, wiring and controls.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the jobsite wrapped in a protective covering, with the brands and names clearly marked thereon. Store doors in an adequately ventilated, dry location that is free from dust, water, or other contaminants and in a manner that permits access for inspection and handling. Handle doors carefully to prevent damage to the faces, edges, and ends. Replace damaged items that cannot be restored to like-new condition.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

1.7 MAINTENANCE

Provide manufacturer's installation, operation, and maintenance instructions for sliding metal doors.

PART 2 PRODUCTS

2.1 DOORS

Provide leaf sections consisting of welded construction. Provide joints to develop 100 percent of the strength of the framing members. Members may be prefabricated for field assembly. When using bolts, conform to ASTM A325M ASTM A325 for fastening main members. Bolts conforming to ASTM A307 are permitted for fastening secondary members.

a. Make vertical members continuous throughout the height of the door. Make members adjoining each other at splices to facilitate field assembly. Provide framing members that are true to dimensions and square in all directions. Leaf out of line in vertical or horizontal plane of the door opening greater than[3 mm in 6100 mm 1/8 inch in 20 feet] [_____] is not permitted.

b. Provide [full-depth members] [gusset plates at the one-third points] for lateral support to all main vertical members. Provide diagonal bracing to support the leaf assembly to withstand shipping, assembly, and operational loads. Provide ground smooth welds.

c. Fabricate cover sheets from [1.2] mm [0.050] inch [_____] thick (minimum) [aluminum] [_____] facing, [Alloy 3003] [_____], meeting ASTM B209M ASTM B209 requirements. Provide [ribbed] [fluted] finish. Provide joints of the [butt] [_____] type showing a minimum crack. Reinforce to ensure rigid construction and prevent warping and sagging.

d. Seal cover sheets with an approved caulking compound. Fasten to frame with corrosion-resistant [steel] [_____] fasteners [230] mm [9] inch [_____] on center. Where flat sheets are attached as either covering or linear sheets, do not exceed [2.3] square meter [25] square feet [_____] for unsupported areas.

2.2 PERSONNEL DOORS

****

NOTE: Delete this paragraph when personnel doors are not required.

****

Provide manufacturer's standard flush doors of [aluminum type,] [_____] size as indicated, complete with hardware and airtight seals.

2.3 SLIDING DOORS

****

NOTE: Types of doors should be specified optionally where a fire rating is required unless appearance is a factor. Manufacturer's catalogs should be consulted before a selection is made. If doors are not fire rated, the hollow metal and flush tubular frame doors should be specified for interior use, and the insulated door should be specified for exterior use.

Composite doors are available in 3 or 4 hour models and may be specified with or without a temperature rise rating. Hollow metal doors are available up to a 4 hour rating; however, they are not available with a temperature rise rating. The maximum size available with a UL listing and a FM approval is 3.6 m by 3.6 m 12 foot by 12 foot for the composite and hollow metal doors. Tin-clad doors are available as 2-ply and 3-ply types. The 2-ply door is available with 3/4 and 1-1/2 hour rating. The 3-ply door is available with a 3/4, 1-1/2, and 3 hour rating. Tin-clad doors with a 1-1/2 or 3 hour rating have a maximum temperature rise limitation.

In highly corrosive environments, recommend using FRP doors and frames for improved corrosion resistance. Refer to UFGS 08 22 20 for standard specifications.

Edit the following paragraphs to meet project requirements.
****

Provide sliding doors of the following types:

[2.3.1 Steel-Covered Composite

Provide composite fire doors that are [[3 hour] [4 hour] [_____] rated] [as shown on drawings]. Provide flush panel doors consisting of a manufactured core material, such as calcium silicate block or mineral fiberboard insulation, covered on both faces with a bonded steel sheet not lighter than 1.0 mm 20 gauge and covered on edges with a steel perimeter channel not lighter than 1.3 mm 18 gauge. Doors may be fabricated using several panels, with panel edges encased in a steel channel not lighter than 1.9 mm 14 gauge. Join or back joints in panels by an interior steel H column and cover with a steel-surface applied face plate. Provide fire-rated doors that have a [maximum temperature rise rating of 121 degrees C 250 degrees F at 30 minutes] [non-temperature rise rating].

][2.3.2 Hollow Metal

Provide[[non] [3 hour] [4 hour] [_____] rated] doors [as shown on drawings]. Provide flush panel doors consisting of a resin impregnated Kraft honeycomb core covered on both faces with a bonded steel sheet not lighter than 1.0 mm 20 gauge and covered on edges with a steel perimeter channel not lighter than 1.3 mm 18 gauge. Doors may be fabricated using several panels, with panel edges encased in a steel channel not lighter than 1.9 mm 14 gauge. Back joints in face sheets by an interior steel H column and covered with a steel surface applied face plate.

][2.3.3 Flush Steel Tubular Frame

Provide flush steel tubular frame doors that are [[non] [3 hour] [4 hour] [_____] rated] [as shown]. Provide flush panel doors consisting of a 1.6 mm (16 gauge) 16 gauge steel tubing frame with 1.3 mm (18 gauge) 18 gauge face sheets with fiberglass core. Provide intermediate stiffeners at 600 mm 24 inches on center maximum. Spot weld the face sheets to the frame and stiffeners. Door may be fabricated using several panels, with 3.1 mm (11 gauge) 11 gauge steel splice plates full height on both sides. Provide fire rated doors that have a [maximum temperature rise rating of 121 degrees C 250 degrees F at 30 minutes] [non-temperature rise rating].

][2.3.4 Tin-Clad

Provide tin-clad doors that are [[2-ply [3/4] [1-1/2]] [3-ply [3/4] [1-1/2] [3]] hour rated] [as shown], conforming to UL 10A. Provide hardware conforming to UL 14B. Provide doors having a core made up of layers of 19 mm 3/4 inch thick wooden boards nailed to each other and encased in tern or zinc plates that are jointed together at their edges with nails through the joints into the core. Doors with 1-1/2 hour and 3 hour rating must have a maximum temperature rise rating of 121 degrees C 250 degrees F at 30 minutes.

][2.3.5 Insulated

****
NOTE: Doors with a thermal conductance (U-value) of 0.85 W/square meter times K 0.15 btu/hr times sq f times f are readily available. Specify and indicate on the drawings all doors with a lower thermal conductance (U-value) where indicated by the energy budget analysis. Review manufacturer's literature to verify the availability of doors with lower thermal conductance (U-values).
****

[Provide flush panel non-labeled insulated doors consisting of a urethane, polystyrene, or fiberglass insulation core covered on both faces with a bonded steel sheet not lighter than 1.3 mm (18 gauge) 18 gauge and covered on the edges with a steel perimeter channel not lighter than 1.3 mm (18 gauge)18 gauge.] [Provide flush panel labeled [3/4] [1-1/2] [3] [4] hour rated doors consisting of fiberglass insulation core covered on both faces with a bonded steel sheet not lighter than 1.3 mm (18 gauge) 18 gauge and covered on the edges with a steel perimeter channel not lighter than 1.3 mm (18 gauge) 18 gauge. Fire rated doors must have a [maximum temperature rise rating of 121 degrees C 250 degrees F at 30 minutes] [non-temperature rise rating] [rating as shown]]. Perform door construction to provide a thermal conductance (U-value) of [0.85 W/square meter times K 0.15 btu/hr times sq f times f] [_____]. Doors may be fabricated using several panels. Encase panel edges in a steel channel not lighter than 1.9 mm (14 gauge)14 gauge. Back joints in face sheets by an interior steel H column and covered with a steel surface-applied face plate. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

]2.4 OPERATION

****
NOTE: Edit this paragraph to agree with type of operation indicated on the drawings. Tin-clad doors are available with inclined tops.
****

Provide doors that are [single-slide] [center-parting] on [level] [inclined] tracks and designed to normally remain in the [open position and close automatically in case of fire] [or] [closed position but permit normal operation for passage]. Doors must be [manually] [power] operated. Automatic closing system must be a [labeled automatic reel type closer] [or] [weight type closer with a weight box fabricated of steel not lighter than 1.6 mm (16 gauge) 16 gauge]. Provide fusible links as required by NFPA 80 and activate at 71 degrees C 160 degrees F.

2.4.1 Power Operators

****
NOTE: Power operators should be specified for sliding doors which are subject to heavy usage and are required to remain closed. Also use power operated sliding doors between heated production areas and unheated storage areas where there is a frequent traffic flow between the two areas. This

paragraph applies to both pneumatic and electric operated doors.
****

Provide [pneumatic] [electric] type operator specified herein. Provide both the door and the power actuating device with a UL or FM listed releasing mechanism that will permit the required self-closing feature to function and close the door automatically in case of fire irrespective of power failure or manual operation. Provide readily adjustable limit switches to automatically stop the door in its full open or closed position. Provide operating devices suitable for the Class, Division, and Group shown and as defined in NFPA 70.

[2.4.2 Pneumatic Operators

****
NOTE: Edit this paragraph to suit the type of controls required. Insert the air pressure that will be available for the door operation.
****

Provide heavy duty industrial type operator, designed to operate the door at [0.3] [0.6] [0.9] [1.2] m [1] [2] [3] [4] ft per second with air pressure of [_____] kPapsi. The operator must open, close, start, and stop the door smoothly. Control must be [[electrical, conforming to NEMA ICS 2, Part 8 and NEMA ICS 6. Provide enclosures which are Type 12 (industrial use), Type 7 or 9 in hazardous locations,] [pneumatic,] with [push button wall switches.] [ceiling pull switches.] [roll-over floor treadle.]] [as indicated on the drawings.]

]2.4.3 Electric Operators

****
NOTE: Edit this paragraph to suit the type of controls required. Insert the electrical characteristics that will be available for the door operation.
****

Provide heavy-duty industrial type operator, designed to operate the door at not less than [0.3] [0.6] [0.9] [1.2] m [1] [2] [3] [4] ft per second. Provide [push button wall switches] [ceiling-pull switches] [roll-over floor treadle] electrical controls as indicated. Provide all electrical power operators complete with electric motor, brackets, controls, limit switches, magnetic reversing starter, and all other accessories necessary. Design the operator so that the motor may be removed without disturbing the limit-switch timing and without affecting the emergency closing system. Provide the power operator with a slipping clutch coupling or torque limiter, as required to prevent stalling of the motor. Provide operators with provisions for immediate emergency manual operation of the door in case of electrical failure. Where control voltages differ from motor voltage, provide an integrated control voltage transformer as part of the starter. Provide electric control conforming to NEMA ICS 2, Part 8 and NEMA ICS 6 with voltage of 120 volts or less. Provide enclosures of the Type 12 (industrial use), Type 7 or 9 in hazardous locations, [with [push button wall switches.] [ceiling pull switches.] [roll-over floor treadle.]] [as indicated on the drawings.]

2.4.3.1 Motors

Provide drive motors conforming to NEMA MG 1, have high-starting torque, reversible type, and with sufficient power and torque output to move the door in either direction from any position at the required speed without exceeding the rated capacity. Provide motors suitable for operation on [_____] volts, [60] [_____] hertz, [single] [three] phase, and suitable for across-the-line starting. Design motors to operate at full capacity over a supply voltage variation of plus or minus 10 percent of the motor voltage rating.

2.4.3.2 Controls

Provide each door motor with thermal overload protection, limit switches, and remote-control switches with control equipment conforming to NEMA ICS 2. Provide NEMA ICS 6 Type 12 (industrial use) enclosures, Type 7 or 9 enclosures in hazardous locations, or as otherwise indicated. Each wall control station must be the three-button type, with the controls marked "OPEN," "CLOSE," and "STOP." When the door is in motion and the "STOP" control is pressed, the door must stop instantly and remain in the stop position; from the stop position. Provide doors operable in either direction by the "OPEN" or "CLOSE" controls. Provide full-guarded ontrols to prevent accidental operation.

2.4.4 Electrical Work

Provide conduit and wiring necessary for proper operation in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Make flexible connections between doors and fixed supports with extra flexible type SO cable, except in hazardous locations where wiring conforms to NFPA 70. The cable must have spring-loaded automatic take-up reel coil cord or an equivalent and approved device.

2.4.5 Transformer

Conform to UL 506 for control transformers.

2.5 HARDWARE

****

NOTE: Door design should eliminate corrosive contaminants collection location. Proper design should include effective drain-to-drain-through requirements. If materials are expected to be exposed to corrosive contaminants, select design geometries, materials, manufacturing processes, and coatings that prevent or control corrosion.

Selected design disciplines should enable designers to evaluate the following general approaches to design: selecting the right materials and manufacturing processes, applying protective coatings as necessary, using proper corrosion preventative and control designs, and modifying the environment.

Avoid materials that are dissimilar and can cause galvanic corrosion. Consider compatibility when using multiple materials. If dissimilar materials

cannot be avoided, isolate those materials from each other through the use of sealants, protective coatings, barrier materials, etc.

****

Provide hardware conforming to NFPA 80, UL 14B and the requirements specified herein. Design tracks, roller assemblies, and installation hardware to support a dead load equal to 1.5 times the weight of the door and attached hardware without deformation that would interfere with the operation of the door. Form tracks of galvanized G90 steel not lighter than 1.9 mm (14 gauge) 14 gauge. Provide ball or roller bearing wheels or rollers with case hardened races on all devices incorporating wheels or rollers. Attach hardware using zinc plated through bolts, nut plates, or similar devices to ensure adequate fastener strength. Provide recessed steel pulls on both sides of all door leaves. Provide closing system for [sliding doors] [and] [sliding fire doors] that is [counterweight closing with weight boxes] [cable reel closer] [controlled speed cable reels].

[2.6 RAILS

Provide [steel] [_____] rails for horizontal sliding doors of [18 kg 40 pound] [as indicated].

]2.7 SAFETY DEVICE

The leading edge of doors must have a safety device that will immediately reverse the door movement upon contact with an obstruction and cause the door to return to its full open position. The safety device cannot substitute for a limit switch. Provide exterior doors with a combination weather seal and safety device.

2.8 ACCESSORIES

2.8.1 Track Hood

Provide zinc-coated steel no lighter than 1.3 mm (18 gauge) 18 gauge track hood for exterior doors mounted on the exterior face of the wall.

2.8.2 Glass Lights

Provide glass lights of the size indicated, except that in no case can the size be larger than that permitted by the required fire rating. Provide glass in accordance with Section 08 81 00 GLAZING.

2.8.3 Weatherstripping

Provide weatherstripping on head, jamb, and sills of exterior doors. Provide 1.6 mm 1/16 inch thick fabric-reinforced neoprene or nylon-brush type weatherstripping and consisting of continuous metal retainers and UL listed.

[2.8.4 Locking Device

****

NOTE: Do not provide locking devices on doors of required exitways unless approval is first obtained from the Fire Protection Engineer. Delete this paragraph if locking devices are not required.

****

Provide [heavy-duty hasp and staple] [electric solenoid lock] on doors [_____], locate on [_____] side.

][2.8.5 Pass Door

Provide a pass door of nominal size [_____] [as shown on the drawings] complete with an integral frame. Factory install and fit the pass door. The pass door must be complete with three full mortise spring hinges and a mortise latch set with flush cup and lever handle with US32D finish.

]2.8.6 Top Guide Rollers

Provide top guide rollers of the [horizontal] [_____] type [with single wheel] [as indicated]. Provide rollers of [steel] [malleable iron] [cast iron] and sized for load conditions. Provide rollers that have [permanently lubricated] [_____] anti-friction bearings. Construct assemblies allowing removal. Construct top roller assemblies to transmit the load from the door to the building structure.

2.8.7 Bottom Rollers

Provide bottom rollers of [double-flanged cast steel] [welded pressed steel] [_____] having minimum tread diameter of [455] mm [18] inch [_____]. When the door leaf height-to-width exceeds 3, provide adjustable rollers. Construct rollers for removal without removing the door leaf from rail.

a. Provide treads with bearing seats. Horizontal clearance between the wheel and the rail must be [3] mm [1/8] inch [_____] maximum at the bottom and [6] mm [1/4] inch [_____] maximum at edge of flanges.

b. Provide bearing seats meeting the bearing manufacturer's requirements. Have bearings of [ball] [roller] type arranged to ensure that vertical loads and horizontal wind loads will be transmitted from leaves to wheels. Bearings with seals must retain grease and prevent the entrance of dirt. Equip bearings with high-pressure grease fittings.

2.8.8 Track Cleaners

Provide door leaves with sweeps to clear debris from the rail head and wheel flange grooves as the leaf is moved.

2.8.9 Toe Guards

Attach an adjustable full-length flexible toe guard reaching to the floor to the exterior bottom edge of each leaf of bi-parting doors.

2.8.10 Warning Device

Provide alarms with each leaf which signals door movements and are [electronically] [electrically] [mechanically] activated.

2.8.11 Track Bumpers

When limit switch fails, provide bumpers to limit door travel and automatically stop the door.

2.8.12 Drive Clutch

When power is not applied, the clutch must disengage from the door drives.

2.8.13 Manual Operators

Provide a manual [removable crank] [hand wheel] device that open doors. [Door leaf must have readily accessible brackets for crank storage.]

2.9 FINISH

2.9.1 Steel Surfaces of Exterior Doors

****

NOTE: When increased corrosion protection and coating system durability is needed, a coating system of SSPC Paint 28 primer with a SSPC Paint 36 topcoat applied by spray application can be used. This option is suggested for areas of high corrosion and heavy use.

****

Provide galvanized coating conforming to ASTM A653/A653M or ASTM A924/A924M, coating designation G90, for steel sheets on all steel surfaces of exterior doors, after first applying a shop-primed finish. Prior to receiving primer, clean and phosphate-treat all surfaces for maximum paint adherence. Provide metallic oxide or synthetic resin primer of the manufacturer's standard type and apply by dipping or spraying. [For increased corrosion protection and coating system durability apply a coating system of SSPC Paint 28 primer with a SSPC Paint 36 topcoat by spray application.]

2.9.2 Exposed Steel Surfaces of Interior Doors

****

NOTE: When increased corrosion protection and coating system durability is needed, a coating system of SSPC Paint 28 primer with a SSPC Paint 36 topcoat applied by spray application can be used. This option is suggested for areas of high corrosion and heavy use.

****

Provide exposed steel surfaces of interior doors with a [shop-primed finish] [and] [galvanized coating]. Galvanizing must conform to ASTM A653/A653M or ASTM A924/A924M, coating designation G90, for steel sheets. Provide primer which is a metallic oxide or synthetic resin primer of the manufacturer's standard type and applied by dipping or spraying. Prior to receiving primer, clean and phosphate treat all surfaces for maximum paint adherence. [For increased corrosion protection and coating system durability apply a coating system of SSPC Paint 28 primer with a SSPC Paint 36 topcoat by spray application.]

[2.10 SPECIAL FINISHES

Provide surfaces of [aluminum] [_____] doors with [an anodic] [_____] coating conforming to [MIL-A-8625, Type II] [_____]; seal coating. Determine weight and effectiveness of sealing and coating(s) in accordance with [ASTM B137 and ASTM B136] [_____]. Apply [_____] coat(s) of [a clear [methacrylate lacquer] [_____]] to [_____] surfaces prior to shipment.

][2.11 SHOP PAINTING

a. Paint [steel] [_____] portions of doors with [_____] coats of manufacturer's standard [rust-inhibitive] Paint.

b. Paint [aluminum] [_____] surfaces which contact dissimilar metals with bituminous paint.

c. Coat both dissimilar metal surfaces to prevent galvanic corrosion.

d. Submit certificates of inspection from an independent testing laboratory, for oversize fire doors, stating that the doors and hardware are identical in design, materials, and construction to a door that has been tested and meets the requirements for the class indicated.

]PART 3 EXECUTION

3.1 INSTALLATION

Install doors in accordance with NFPA 80, approved detail drawings and manufacturer's instructions. Accurately locate anchors and inserts for guides, brackets, [motors,] [switches,] hardware, and accessories. Upon completion, doors must be free from warp, twist, or distortion. Provide weather tight exterior doors. Lubricate and properly adjust doors, and demonstrate doors operate freely.

[3.2 FIELD FINISHING

Finish doors to receive field finish in accordance with Section 09 90 00 PAINTING, GENERAL. Color must be [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____]. For field coatings applied to the exterior and interior of steel doors use coatings described in Paragraphs STEEL SURFACES OF EXTERIOR DOORS and EXPOSED STEEL SURFACES OF INTERIOR DOORS

]3.3 TESTING

Test doors in the presence of a representative of the door manufacturer and the Contracting Officer. Perform test consisting of [10] complete opening and closing cycles for each individual door, each pair of doors, and [three] complete manual cycles. On the fifth and tenth cycles, check, the inflatable seals for wear and leakage. Switches must function properly, and operation of doors must be smooth. Show an airtight condition when a successful soap-bubble test is made with the doors closed.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 14 00 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-08 14 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 14 00

WOOD DOORS

08/16, CHG 1: 08/18

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-08 14 00 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-08 14 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 08 14 00

WOOD DOORS
08/16, CHG 1: 08/18

****

NOTE: This guide specification covers requirements for wood doors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: On the drawings, show:

1. Locations

2. Sizes, types, thicknesses, glazing, and louvers

3. Designs

4. Fire rating requirements

5. Color

6. Door swing

7. Sound transmission class.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

ASTM INTERNATIONAL (ASTM)

ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E2226	(2024) Standard Practice for Application of Hose Stream

CALIFORNIA AIR RESOURCES BOARD (CARB)

CARB 93120	(2007) Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 105	(2025) Standard for Smoke Door Assemblies and Other Opening Protectives
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 770	Formaldehyde Standards for Composite Wood Products

UL SOLUTIONS (UL)

UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

ANSI/WDMA I.S.1A	(2013) Interior Architectural Wood Flush Doors
ANSI/WDMA I.S.6A	(2013) Interior Architectural Stile and Rail Doors

WOODWORK INSTITUTE (WI)

NAAWS 4.0	(2021 Errata Edition) North American Architectural Woodwork Standards

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G, [_____]

Submit drawings or catalog data showing each type of door unit [; include descriptive data of head and jamb weatherstripping with installation instructions]. Indicate within drawings and data the door types and construction, sizes, thickness, [methods of assembly,] [door louvers,] and [glazing,].

SD-03 Product Data

Doors; G, [_____]

[Recycled Content for Door Cores; S

] Accessories

Water-resistant Sealer

Sample Warranty

[Sound Transmission Class Rating; G, [_____]

][Fire Resistance Rating; G, [_____]

] SD-04 Samples

****

NOTE: Require door samples only for relatively larger quantities of doors and only when justified and desired.

****

Doors

Prior to the delivery of wood doors, submit a sample section of each type of door which shows the stile, rail, veneer, finish, and core construction.

Door Finish Colors; G, [_____]

Submit a minimum of three color selection samples [, minimum 76 by 127 mm 3 by 5 inches in size representing wood stain] [for selection by the Contracting Officer].

SD-06 Test Reports

****

NOTE: Require tests and test reports when fire rated wood doors are included in the project. Doors designated to have "C" label have a 3/4 hour rating, doors designated to have "B" label have a one or 1 1/2 hour rating.

****

Cycle-Slam

Hinge Loading Resistance

Submit cycle-slam test report for doors tested in accordance with ANSI/WDMA I.S.1A, and hinge loading resistance test report for doors tested in accordance with ANSI/WDMA I.S.6A.

SD-07 Certificates

Certificates of Grade

[Certified Sustainably Harvested Stile and Rail Wood Doors; S

][Certified Sustainably Harvested Flush Wood Doors; S

][Indoor Air Quality for Particleboard and Agrifiber Door Cores: S

] SD-11 Closeout Submittals

Warranty

1.3 CERTIFICATIONS

1.3.1 Certified Wood Grades

Provide certificates of grade from the grading agency on [x-ray resistant doors], [acoustical doors], and [fire doors].

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

****

[1.3.2 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

][1.3.3 Indoor Air Quality Certification

****

NOTE: Include the following section where interior doors with particleboard and agrifiber cores are included in the project.

****

[1.3.3.1 Composite Wood, Wood Structural Panel and Agrifiber Products

For purposes of this specification, composite wood and agrifiber products include particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, and door cores. Provide products certified to meet requirements of both 40 CFR 770 and CARB 93120. Provide current product certification documentation from certification body.

]]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 100 mm 4 inch thick, located at each end and at the midpoint of the door. Store doors in a well-ventilated building so that they will not be exposed to excessive moisture, heat, dryness, direct sunlight, or extreme changes of temperature and humidity.[Do not store in a building under construction until concrete, masonry work, and plaster are dry.] Replace defective or damaged doors with new ones.

1.5 WARRANTY

****

NOTE: The warranty clause in this guide specification has been approved by NAVFACENGCOMHQ in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS).
NFAS can be found at the following link:
https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_forbusinesses_
The paragraph in this guide specification may be used without any other HQ approval or request for waiver.

****

Warrant doors free of defects as set forth in the door manufacturer's standard door warranty.

PART 2 PRODUCTS

2.1 DOORS

****

NOTE: It is preferred that door sizes, designs and thicknesses be indicated on the drawings; if not indicated, schedule appropriate criteria in specifications. Refer to ANSI/WDMA I.S.1A and ANSI/WDMA I.S.6A for stock sizes and designs; the use of stock doors is recommended.

****

****

NOTE: Include requirements for wood frames, except for prehung interior wood door units, in Section 06 20 00 FINISH CARPENTRY. Include requirements for metal frames for wood doors in Section 08 11 13 STEEL DOORS AND FRAMES. Include requirements for hardware, other than for sliding and bi-fold doors, in Section 08 71 00 DOOR HARDWARE.

****

****

NOTE: Premium or select grade is intended for natural or stain finish, standard grade is intended for opaque (paint) finish.

****

Provide doors of the types, sizes, and designs [indicated] [specified] free of urea-formaldehyde resins.

2.1.1 Stile and Rail Doors

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

[Premium][Standard] grade Ponderosa Pine doors or [premium or select][standard] stile and rail doors conforming to ANSI/WDMA I.S.6A. Furnish laminate panels in not less than three ply thickness. Provide flat panels with a minimum finished panel thickness of 13 mm 1/2 inch and 20 mm 3/4 inch thickness for raised panels.[Provide certified sustainably harvested stile and rail wood doors.]

2.1.2 Flush Doors

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Conform to ANSI/WDMA I.S.1A for flush doors. Provide hollow core doors with lock blocks and 25 mm 1 inch minimum thickness hinge stile. Hardwood stile edge bands of doors receives a natural finish, compatible with face veneer. Provide mill option for stile edge of doors scheduled to be painted. No visible finger joints will be accepted in stile edge bands. When used, locate finger-joints under hardware.[Provide certified sustainably harvested flush wood doors.]

[2.1.2.1 Exterior Flush Doors

****

NOTE: Use of wood doors on exterior of buildings is not recommended for permanent structures unless the doors are well protected from the weather.

****

Solid wood core, Type I conforming to ANSI/WDMA I.S.1A. Provide doors with [tempered hardboard] [medium density overlayed hardwood veneer] faces. Provide wood edge bands. Install in exterior flush doors with [aluminum] [bronze] [copper] flashings at the bottom of the openings.

]2.1.2.2 Interior Flush Doors

****

NOTE: Hollow core doors should be used for light duty residential only. Face veneers of doors for painted finish should be either hardboard or sound grade rotary cut hardwood. Face veneers of doors for natural finish should be premium or good grade

rotary cut hardwood. Premium grade, book matched, wood veneer should only be specified for medical facilities and other high quality installations such as chapels, hospitals, and where the additional cost is justified. Select grade and species desired for hardwood veneer faced doors. Specify other veneers if desired (such as poplar or cherry); refer to ANSI/WDMA I.S.1A. Luan is not acceptable.

****

****

NOTE: Consider the use of agrifiber board in place of particle board with wood fibers. Types of agrifiber include, but are not limited to, wheat, sunflower, grass straw, cereal straw, rice straw, soybean, bagasse (fibrous by-product of crushing sugarcane or sorghum to extract their juice) and stover (leaves and stalks of corn, sorghum or soybean plants left in the field after harvest). Agrifiber board is dimensionally stable and highly resistant to moisture, while also being lighter in weight than rational wood composites.

****

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available from US national manufacturers above the minimum recycled content percentages stated. Some manufacturers and regions have higher percentages.

NOTE: For doors that include either particleboard or agrifiber cores, include the last bracketed sentences requiring products with indoor air quality certifications as defined in Part 1 of this specification.

****

Provide [staved lumber] [particleboard] [agrifiber] [hollow] core, Type II flush doors conforming to ANSI/WDMA I.S.1A with faces of [sound grade hardwood or hardboard for painted finish] [[premium] [good] grade natural birch] [select [premium white] [red] birch] [[premium] [good] grade [red] [white] oak] [[premium] [good] grade walnut] [plastic laminate]. [Hardwood veneers must be [[rotary cut] [plain sliced] [quarter sliced]] [[random] [slip] [book] matched]]. [Finish plastic laminate faced doors on both vertical edges with [wood] [laminated plastic] of color matching faces.] [Door cores must have a minimum recycled content of 45 percent. Provide data identifying percentage of recycled content for door cores.] [Products must contain no added urea-formaldehyde resins. Provide certification of indoor air quality for particleboard and agrifiber door cores.]

2.1.3 Bi-Fold Closet Doors

Provide [hardboard grade flush doors conforming to ANSI/WDMA I.S.1A.]

[paneled] [louvered] doors [premium or select] [standard] grade, conforming to ANSI/WDMA I.S.6A with [28.5] [35] mm [1-1/8] [1-3/8] inch thickness. Equip doors with the manufacturer's standard hardware, including tracks, hinges, guides, and pulls.

2.1.4 Sliding Closet Doors

Provide flush wood doors to conform to ANSI/WDMA I.S.1A. Provide [paneled] [and] [louvered] doors to conform to ANSI/WDMA I.S.6A [premium or select] [standard] grade with 35 mm 1-3/8 inch thickness. Equip doors with the manufacturer's standard hardware.

2.1.5 X-Ray Resistant Doors

****

NOTE: Specify minimum door thickness as follows: 44.5 mm 1-3/4 inch for lead sheet 5 mm 3/16 inch thick and less; 50 mm 2 inch for lead sheet over 5 to 6 mm 3/16 to 1/4 inch thick; 57 mm 2-1/4 inches for lead sheet over 6 to 10 mm 1/4 to 3/8 inch thick; 64 mm 2-1/2 inch for sheet lead over 10 to 13 mm 3/8 to 1/2 inch thick. Coordinate with Section 13 49 10 X-RAY SHIELDING.

****

ANSI/WDMA I.S.1A solid core flush doors, hardwood veneered, minimum [44.5] [50] [57] [64] mm [13/4] [2] [2 1/4] [2 1/2] inch thick, of sizes and construction indicated. Provide lead sheets with 99.9 percent pure lead, [_____] mm inch thickness, free from dross, oxide, inclusions, laminations, scale, blisters, and cracks. Locate lead sheets in accordance with manufacturer's standard, to extend fully from edge to edge, from top to bottom, and to be an integral part of the door. Provide wood edge strips compatible with face veneers.

2.1.6 Acoustical Doors

****

NOTE: Ensure that STC rating is coordinated with the STC ratings of walls detailed on drawings. Doors should be provided with STC rating equal to the walls and ceilings. Except where walls and ceilings are designed for an STC of 40 or more, specify STC of 35. Doors requiring STC ratings greater than 35 may have to be thicker than otherwise specified. Check manufacturer's literature.

****

ANSI/WDMA I.S.1A, solid core, constructed to provide Sound Transmission Class rating of [35] [_____] when tested in accordance with ASTM E90.

2.1.7 [Composite-Type] Fire Doors

****

NOTE: Composite-Type fire doors are not recommended for use in areas where security is desired or high abuse is expected. A hollow-metal type fire door will provide a higher degree of security and withstand more abuse.

****

Provide doors specified or indicated to have a fire resistance rating conforming to the requirements of UL 10B, ASTM E2226, or NFPA 252 for the class of door indicated. Affix a permanent metal label with raised or incised markings indicating testing agency's name and approved hourly fire rating to hinge edge of each door.

2.1.8 Prehung Doors

****

NOTE: Use of wood frames in new construction is not recommended except for family housing.

****

Frames for prehung interior doors to be for [painted] [clear] finish, with [3 piece adjustable jamb units] [3 piece adjustable jamb units with pins]. Provide doors complete with frame, hinges, and prepared to receive finish hardware.

2.2 ACCESSORIES

2.2.1 Door Louvers

****

NOTE: The use of wood louvers in exterior wood doors is not recommended. Louvers are not permitted in fire-rated doors with glass lights or exit devices. Louvers may be no larger than 600 by 600 mm 24 by 24 inch and must be an approved fusible link type. Delete the sentence referring to blocking if hollow core doors are not included in the project.

****

Fabricate from wood and of sizes indicated. Provide louvers with a minimum of 35 percent free air. Equip louvers with [slat] [sightproof inverted vee slat] type. [Block hollow core doors to provide solid anchorage for the louvers.] Mount louvers in the door with [flush wood moldings.] [wood lip moldings.]

2.2.2 Door Light Openings

Provide glazed openings with the manufacturer's standard wood moldings. [Provide moldings for doors to receive natural finish of the same wood species and color as the wood face veneers.] Provide moldings on the exterior doors with sloped surfaces. [Lip type moldings for flush doors.]

2.2.3 Weatherstripping

****

NOTE: Include weatherstripping when Section 08 71 00 DOOR HARDWARE is NOT included in project specification; otherwise, add to Section 08 71 00 DOOR HARDWARE Complete weatherstripping should be specified for exterior doors of heated and air-conditioned spaces. Thresholds with extended lip will require door weatherstripping shaped to engage the extended lip on the threshold. Thresholds with raised stops to receive latch bolts of panic-type hardware will require vinyl or

neoprene inserts in face of stop. Specify overlapping astragal only when one leaf of double doors is inactive and is equipped with head and foot bolts. Avoid installations which will require door "coordinators."

****

****

NOTE: Maximum air leakage rates are 0.0025 cubic meter per second per sq. m 0.5 cfm per sq. ft. of door area for residential swinging doors and 0.0031 per cubic meter per second per sq. m 1.25 cfm per sq. ft. of door area for non-residential swinging doors.

****

Provide weatherstripping that is a standard cataloged product of a manufacturer regularly engaged in the manufacture of this specialized item. Provide weatherstripping [tempered spring bronze] [or] [looped neoprene or vinyl held in an extruded non-ferrous metal housing]. Install [bronze weatherstripping with a minimum thickness of 0.23 mm 0.0089 inch for sills, and a minimum thickness of 0.16 mm 0.0063 inch elsewhere.] Air leakage of weatherstripped doors not to exceed [0.0025] [0.0031] cubic meter per second of air per square meter [0.5] [1.25] cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283.

2.2.4 Additional Hardware Reinforcement

****

NOTE: Size and shape of core blocking can add considerably to the price of doors. Check manufacturer's catalogs prior to specifying the larger five inch blocking.

****

Provide the minimum lock blocks to secure the specified hardware. The measurement of top, bottom, and intermediate rail blocks are a minimum 125 mm 5 inch by full core width. Comply with the manufacturer's labeling requirements for reinforcement blocking, but not mineral material similar to the core.

2.3 FABRICATION

2.3.1 Marking

****

NOTE: Marking may not be required for smaller jobs, or for doors not required to be fire-rated. Delete this paragraph and coordinate with paragraph SUBMITTALS when appropriate.

****

Stamp each door with a brand, stamp, or other identifying mark indicating quality and construction of the door.

2.3.2 Quality and Construction

Identify the standard on which the construction of the door was based [, identify the standard under which preservative treatment was made,] and identify doors having a Type I glue bond.

2.3.3 Preservative Treatment

Treat doors scheduled for restrooms, janitor closets and other possible wet locations including exterior doors with a water-repellent preservative treatment and so marketed at the manufacturer's plant.

2.3.4 Adhesives and Bonds

ANSI/WDMA I.S.1A. Use Type I bond for exterior doors and Type II bond for interior doors. Provide a nonstaining adhesive on doors with a natural finish.

2.3.5 Prefitting

Provide factory [prefinished] [finished] [and] factory prefitted doors for the specified hardware, door frame and door-swing indicated. Machine and size doors at the factory by the door manufacturer in accordance with the standards under which the doors are produced and manufactured. The work includes sizing, beveling edges, mortising, and drilling for hardware and providing necessary beaded openings for glass and louvers. Provide the door manufacturer with the necessary hardware samples, and frame and hardware schedules to coordinate the work.

2.3.6 Finishes

2.3.6.1 Field Painting

****

NOTE: Finishes for exterior wood surfaces must be specified in Exterior Division 6 Wood paint Table in Section 09 90 00 PAINTS AND COATINGS. When new interior doors are to be provided, select the desired coating system in the Interior Division 6 Wood paint Table in Section 09 90 00 PAINTS AND COATINGS.

****

Factory prime or seal doors, and field paint.

2.3.6.2 Factory Finish

****

NOTE: Factory finish, other than plastic laminate and natural finishes, may not be available nor cost effective for relatively small quantities of doors (less than 200 doors of the same finish). Contact door manufacturers for availability and cost.

****

****

NOTE: Select finish system NAAWS 4.0 System No. 4 or No.5 for traditionally produced finishes OR select WDMA system TR-8, TR-2 and TR-4 for finishing systems devoted to low VOC requirements for sustainability.

****

****

NOTE: Select open grain effect where the more expensive closed grain effect is not required. Closed grain effect provides a near furniture-like finish and adds considerably to the cost of a door while it may not necessarily add to the durability.

****

Provide doors finished at the factory by the door manufacturer as follows: [NAAWS 4.0 Section 1500, specification for System No. 4 Conversion varnish alkyd urea or System No. 5 Vinyl catalyzed.][WDMA System TR-8 (UV cured acrylated polyester/urethane) or TR-2 (catalyzed lacquer) or TR-4 (conversion varnish) factory finish systems that utilize water-based stains and finishes with ultraviolet UV protection.] The coating is NAAWS 4.0 premium, medium rubbed sheen, [open] [closed] grain effect. Use stain when required to produce the finish specified for color. Seal edges, cutouts, trim, and wood accessories, and apply two coats of finish compatible with the door face finish. Touch-up finishes that are scratched or marred, or where exposed fastener holes are filled, in accordance with the door manufacturer's instructions. Match color and sheen of factory finish using materials compatible for field application.

2.3.6.3 Plastic Laminate Finish

Factory applied, ANSI/NEMA LD 3, General or Specific purpose type, 1.25 mm 0.050 inch minimum thickness. Glue laminated plastic for hollow core doors to wood veneer, plywood, or hardboard backing to form door panel. Provide a combined thickness of laminate sheet and backing of 2.5 mm 0.10 inch minimum.

2.3.6.4 Color

Provide door finish colors in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.

2.3.7 Water-Resistant Sealer

Provide manufacturer's standard water-resistant sealer compatible with the specified finish[es].

2.4 SOURCE QUALITY CONTROL

****

NOTE: Require tests and test reports when fire rated wood doors are included in the project. Doors designated to have "C" label have a 3/4 hour rating, doors designated to have "B" label have a one or 11/2 hour rating.

****

Meet or exceed the following minimum performance criteria of stiles of "B" and "C" label fire doors utilizing standard mortise leaf hinges:

a. Cycle-slam: [Standard Duty Doors: 250,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of ANSI/WDMA I.S.1A] [Heavy Duty Doors: 500,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of ANSI/WDMA I.S.1A] [Extra Heavy Duty Doors: 1,000,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of ANSI/WDMA I.S.1A].

b. Hinge loading resistance: Averages of ten test samples not less than [Standard Duty doors: 1780 Newton 400 pounds force] [Heavy Duty doors: 2110 Newton 475 pounds force] [Extra Heavy Duty doors: 2440 Newton 550 pounds force] when tested for direct screw withdrawal in accordance with ANSI/WDMA I.S.6A using a No. 12, 30 mm 1-1/4 inch long, steel, fully threaded wood screw. Drill 4 mm 5/32 inch pilot hole, use 40 mm 1-1/2 inch opening around screw for bearing surface, and engage screw full, except for last 3 mm 1/8 inch. Do not use a steel plate to reinforce screw area.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: If area rugs or carpeting is used in spaces which door openings serve, such as residential occupancies, specify adequate clearance at bottom of doors.

****

Do not install building construction materials that show visual evidence of biological growth.

Before installation, seal top and bottom edges of doors with the approved water-resistant sealer. Seal cuts made on the job immediately after cutting using approved water-resistant sealer. Fit, trim, and hang doors with a 2 mm 1/16 inch minimum, 3 mm 1/8 inch maximum clearance at sides and top, and a 5 mm 3/16 inch minimum, 6 mm 1/4 inch maximum clearance over thresholds. Provide 10 mm 3/8 inch minimum, 11 mm 7/16 inch maximum clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 3 mm in 50 mm 1/8 inch in 2 inch. Door warp must not exceed 6 mm 1/4 inch when measured in accordance with ANSI/WDMA I.S.1A.

3.1.1 Fire[and Smoke] Doors

****

NOTE: Fire doors must be installed in fire rated frames and with fire rated hardware. Frames and hardware must be specified in their respective sections of the specifications.

****

Install fire doors in accordance with NFPA 80. [Install smoke doors in accordance with NFPA 105.]Do not paint over labels.

3.1.2 Prehung Doors

Install doors in accordance with the manufacturer's instructions and details. Provide fasteners for [stops] [and] [casing trim] within 75 mm 3 inch of each end and spaced 279 mm 11 inch on center maximum. Provide side and head jambs joined together with a dado or notch of 5 mm 3/16 inch minimum depth.

[3.1.3 Weatherstripping

****

NOTE: Use of wood doors on exterior of buildings is not recommended for permanent structures unless they are well protected from the weather.

****

Install doors in strict accordance with the door manufacturer's printed installation instructions and details. Weatherstrip exterior swing-type doors at sills, heads and jambs to provide weathertight installation. Apply weatherstripping at sills to bottom rails of doors and hold in place with a brass or bronze plate. Apply weatherstripping to door frames at jambs and head. Shape weatherstripping at sills to suit the threshold. [Meeting stiles of exterior double-doors must be made weathertight by means of [a looped vinyl or neoprene strip in an extruded nonferrous metal housing applied to the edge of one door leaf] [a neoprene, vinyl or spring-bronze weatherstripped astragal secured to the inactive door leaf].]

]3.2 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
Closet doors	1-1/8 inch	28.5 mm
	1-3/8 inch	35 mm
X-Ray resistant doors	1-3/4 inch	44.5 mm
	2 inches	50 mm
	2-1/4 inch	57 mm
	2-1/2 inch	64 mm
Weatherstripping	0.0089 inch	0.23 mm
	0.0063 inch	0.16 mm

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 22 20 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-08 22 20 (May 2015)

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 22 20

FIBERGLASS REINFORCED PLASTIC (FRP) DOORS AND FRAMES

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PART 3   EXECUTION

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-08 22 20 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-08 22 20 (May 2015)

References are in agreement with UMRL dated January 2025
****

SECTION 08 22 20

FIBERGLASS REINFORCED PLASTIC (FRP) DOORS AND FRAMES
11/19

****
NOTE: This guide specification covers fiberglass reinforced plastic (FRP) doors and frames. Some paragraphs may need to be supplemented to meet project requirements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: On the drawings, show:

1. Sizes of door openings, thicknesses of doors and frames, swings, and travels of doors, and design of doors, whether flush panel, full flush, paneled, glazed, or louvered.

2. Details of structural or non-structural frame; head, jamb, and removable astragal.

2. Details of fire rated or non-fire rated frame; head, jamb, and removable astragal.

3. Type and thickness of glazing required; whether or not insulating glass units are required.

4. Method, type, and spacing required for anchoring

door frames to adjoining construction.

5. Lintels and reinforcement required to support walls or partitions above doors.

6. Type of shop finish surfaces.

7. Free area for louvers in doors.

8. Complete door schedule. Schedule should assign a separate number for each opening and should indicate door type and style, material, design, size, thickness, glazed or unglazed, class fire rating for fire doors, hardware set number, threshold material, if any, and material for frames; head, jamb, and astragal.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D695	(2010) Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D790	(2017) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2344/D2344M	(2016) Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E2074	(2000e1) Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies
ASTM E2112	(2023) Standard Practice for Installation of Exterior Windows, Doors and Skylights
ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.115	(2016) Hardware Preparation in Steel Doors and Steel Frames

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 101	(2024) Life Safety Code
NFPA 105	(2025) Standard for Smoke Door Assemblies and Other Opening Protectives
NFPA 241	(2022) Standard for Safeguarding Construction, Alteration, and Demolition Operations
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction

UL SOLUTIONS (UL)

UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Meeting

Within [30] [_____] days of Contract Award, the Contracting Officer will schedule a Pre-Installation meeting. For that meeting, submit the following Shop Drawings for review and approval:

a. Doors

b. Frames

[c. Door Hardware Components and Accessories

][d. Weather-stripping

][e. Smoke Seals

] Include fabrication, installation details, schedule and location for doors, frames, hardware components and accessories, showing plans, elevations, sections, details, method of glazing within the door, construction and installation attachments to other work.

Submit manufacturer's catalog data, including material descriptions for doors, frames, and accessories, dimensions of individual components and profiles, and finishes for each type of door, frame, hardware components and accessories of size, design, and location indicated.

Submit documentation substantiating that the items provided within this section are from a manufacturer having a minimum of [5] [10] [_____] years experience in the design and manufacture of similar products and systems.

Submit a Sample Warranty.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

```
**************************************************************************
          NOTE:  When door hardware components and
          accessories, weatherstripping, and smoke seals are
          specified in Section 08 71 00 DOOR HARDWARE delete
          the bracketed item "Door Hardware Components and
          Accessories""Weatherstripping" and "Smoke Seals".
**************************************************************************
```

SD-02 Shop Drawings

Doors[; G, [_____]]

Frames[; G, [_____]]

[Door Hardware Components and Accessories[; G, [_____]]

][Weather-stripping[; G, [_____]]

][Smoke Seals[; G, [_____]]
]

```
**************************************************************************
          NOTE:  When door hardware components and
          accessories, weatherstripping, and smoke seals are
          specified in Section 08 71 00 DOOR HARDWARE delete
          the bracketed items "Door Hardware Components"
          "Weatherstripping" and "Smoke Seals".
**************************************************************************
```

SD-03 Product Data

Doors[; G, [_____]]

Calculations[; G, [_____]]

Frames[; G, [_____]]

[Door Hardware Components and Accessories[; G, [_____]]

][Weather-stripping[; G, [_____]]

][Smoke Seals[; G, [_____]]

][Thresholds[; G, [_____]]]

Fire Resistance Rating for Doors and Frames[; G, [_____]]

SD-04 Samples

Product Samples[; G, [_____]]

SD-07 Certificates

Sample Warranty[; G, [_____]]

Warranty[; G, [_____]]

1.4 QUALITY CONTROL

1.4.1 Product Samples

Submit two sets of color chips representing specified colors and finishes.

Submit samples of each type, consisting of FRP door corner construction, minimum 152.4 mm by 152.4 mm 6 inch by 6 inch legs.

Where color or texture variations are anticipated, such as anodized finishes, include two or more units in each set of samples indicating extreme limits of variations.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver FRP doors, frames, components and accessories in manufacturer's original unopened packaging. Mark and remove damaged materials from the project site. Where materials are covered by a referenced specification, label the package with the specification number, type, and class, as applicable. Deliver materials in sufficient quantity to allow work to proceed without interruption.

1.5.2 Storage

Protect materials against moisture absorption and contamination or other damage.

Store all materials on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer.

Do not store materials in buildings under construction until concrete, mortar, and plaster work is finished and dry.

Do not store materials outdoors unless approved by the Contracting Officer. Completely cover materials stored outdoors, with waterproof canvas protective covering. Tie covering securely to pallets to ensure complete weatherproofing is met. Provide sufficient ventilation to prevent condensation. Do not use polyethylene sheet as a covering.

Do not store materials in contact with other materials that might cause staining, denting, or other surface damage.

1.5.3 Handling

Prevent damage to corners, edges and ends of materials. Do not install damaged materials in the work. Select and operate material handling equipment to prevent damage to materials.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Existing Conditions

Take Field measurements prior to the preparation of drawings and fabrication.

1.7 WARRANTY

Submit sample material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard manufacturer warranty as required to comply with the specified requirements.

Furnish the manufacturer's [5] [10] [_____] year no dollar limit for materials and installation, workmanship, and deterioration of factory-applied finishes within specified warranty period. Provide warranty directly to the Government and commence warranty effective date at time of Government's acceptance of the work.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide door and frame components including, but not limited to, astragals, cores, faces, stiles, rails, heads, jambs, and internal reinforcement, which are FRP structural shapes manufactured by the pultrusion process. Ensure all structural shapes are composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements in accordance with ASCE 7-16, [ICC IBC] and dimensions specified.

Ensure fiberglass reinforcements are a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.

Verify resins are of isophthalic polyester with chemical formulation necessary for corrosion resistance, strength and other physical properties as required.

2.1.1 Design Requirements

2.1.1.1 Finish Surfaces

Ensure all finished surfaces of FRP items and fabrications are smooth, resin-rich, free of voids and without dry spots, cracks, and un-reinforced areas. Completely cover all glass fibers with resin to protect against their exposure due to wear or weathering. All stiles, rails, heads, jambs, and internal reinforcement are to be integrally pigmented [yellow] [_____].

2.1.1.2 Ultraviolet Protection

Provide documentation that all pultruded structural shapes are further protected from ultraviolet (UV) attack with:

a. Integral UV inhibitors within the resin

b. Synthetic surfacing veil to help produce a resin rich surface

c. UV resistant coating for outdoor exposures.

2.1.1.3 Flame Spread Rating

All FRP products to have a flame spread rating of 25 or less as per ASTM E84 Tunnel Test.

2.1.1.4 Structural Properties

Meet minimum longitudinal structural properties with structural shapes in the door and frame system as follows:

Tensile Strength	ASTM D638	30,000 psi
Compressive Strength	ASTM D695	30,000 psi
Flexural Strength	ASTM D790	30,000 psi
Flexural Modulus	ASTM D790	1,600,000 psi
Short Beam Shear	ASTM D2344/D2344M	4,500 psi
Impact, Notched	ASTM D256	25 ft-lb/in
Thermal Expansion	ASTM D696	.000008 in/in/F
Fire Resistance	ASTM E84	Class I

2.1.1.5 Fire Resistance Rating for Doors and Frames

Provide complete [swing-type] [sliding-type] FRP doors with frames of the size, design and location indicated, including but not limited to, framing members, subframes,[transom,] [door light,] [adjoining side light,] [trim,] [molding,] [panel and plant,] and accessories.

[Provide complete door hardware schedule, design and location as specified in specification Section [08 71 00 DOOR HARDWARE] [08 71 63 DETENTION HARDWARE] [08 71 63.10 ELECTRICAL LOCKING CONTROL FOR BRIGS].

][Provide complete door [glazing] [louver] schedule, design and location as specified in specification Section [08 81 00 GLAZING] [08 88 53 DETENTION AND SECURITY GLAZING][08 91 00 METAL [WALL] [AND] [DOOR] LOUVERS].

] a. FRP Door

Provide and install a seamless press-molded constructed FRP door. Laminate FRP face sheets to be applied while wet and uncured to an internal door stile and rail subframe/core assembly which is pressure molded under heat. Integrally fuse the composite door panel over the entire surface area, do not adhesive-bond at the perimeter stile and rail.

Provide door stiles and rails which are high-modulus pultruded FRP square or rectangular tube subframe. Miter and join tubes internally at the corners with solid polymer blocks to yield a one piece unit. Provide a mid-rail tube across the width of the door at lockset height and additional horizontal rails where specified. Chemically weld all connections. No mechanical fastening at the tube joints is permitted.

Provide a triangular shaped .375 cm 3/8 inch phenolic resin impregnated kraft paper honeycomb cell core for maximum rigidity and compressive strength. Use of polyurethane foam or balsa wood cores are not permitted.

Provide internal reinforcement composed of high-modulus pultruded tubular FRP or high-density polymer compression blocks at all hardware and corner locations. No aluminum, steel, or wood blocking for reinforcement is permitted. A minimum pull-out force strength of 900 pounds per screw is required for all hinge locations.

Door faces are to utilize a chemical resistant thermosetting polyester resin with fiberglass reinforcing layers. Provide structural reinforcement which is knitted multi-layer material with layers of unidirectional fiberglass orientated in both vertical and horizontal directions for high stiffness, impact and warp resistance. Furnish door faces as indicated by the door elevation drawings.

Ensure the exposed finish of the FRP door faces are to be an ultra-violet light stabilized marine grade Neopentyl Glychol (NPG)-isophthalic polyester gelcoat integrally molded to a 25/30 mil wet thickness.

[Provide an integral heavy pultruded FRP astragal on the stile edge of the inactive leaf for double doors of the same materials as specified for door stiles and rails.

][Cutouts for door lights and louvers are to be manufactured and not field fabricated. Cutouts are to be totally enclosed by internal pultruded FRP stiles and rails as specified and incorporated into the door subframe with the opening completely fused to both door faces.

][Provide raised panel door as indicated by the door elevation drawings and schedule. Plants to be applied by the manufacturer as an integral part of the door face and not field applied. All molding and plants are to be a rein material and installed by the manufacturer to resemble a raised panel door.

] b. FRP Frame

Provide FRP Door Frame utilizing a high-modulus pultruded structural FRP shape. Fabricate pultruded frame with a wall thickness of not less than 5 mm 3/16 inch. Frames are to be one piece factory constructed with molded stop. Jambs and header to utilize miter corner connections chemically welded with FRP material ground for a visibly smooth frame face. Post and beam or mechanical fastened corners and joints are not acceptable. Provide sizes and shapes as detailed on the approved drawings.

Provide hardware reinforcement connections utilizing a chemical weld with FRP material at required locations. A minimum pull-out force strength of 1,100 lbs per screw is required for all hardware locations.

Frame finish is to be identical to door color and finish.[Integrally mold a [15] [20] [25] wet mil resin rich gel coat into the frame during manufacturing.]

[2.1.1.6 Fire-Rated Labeled FRP Door

Provide a Fire-Rated Door Assembly with a [20] [45] [60] [90] minute rating complying with NFPA 80 and UL Fire Resistance that are listed and labeled by [a qualified testing agency][Underwriters Laboratories (UL)] [Factory Mutual Engineering and Research (FM)] [Warnock Hersey International (WHI)], for the fire-protection ratings indicated in the door and frame schedule. Base the door testing [at positive pressure] [as close to neutral pressure as possible] according to [ASTM E2074] [NFPA 252] [and] [UL 10B]. Provide certification for Oversized Fire-Rated Door Assembly units exceeding the size of tested assemblies, by a qualified testing agency, that the door complies with standard construction requirements for tested and labeled fire-rated door assemblies except for the size. Ensure door labels are permanently affixed at the factory to the hinge edge of the door and do not paint.

Provide and install a seamless press-molded constructed FRP door. Laminate FRP face sheets to be applied while wet and uncured to an internal door stile and rail subframe/core assembly which is pressure molded under heat. Integrally fuse the composite door panel over the entire surface area; do not adhesive-bond at the perimeter stile and rail.

Ensure door is provided with a fire resistant mineral core for maximum rigidity and compressive strength. Molding pressure and resin gel time are to be sufficient to allow for full penetration of resin into the cellular structure of the core to maximize shear and peel strengths at the door faces and core to reduce the possibility of delamination. Verify that the mineral core has been completely enclosed with an intumescent and FRP laminated edge perimeter, with the intumescent molded into the FRP door structure with a minimum 3.1 mm 1/8 inch thick perimeter FRP edge banding prior to machining. Only Category A type door construction is permitted. Category B type construction with exposed edge intumescent components or products is prohibited.

Hardware reinforcement to be high-modulus pultruded tubular FRP or high-density polymer compressions blocks at all hardware and corner locations. No aluminum, steel, or wood blocking for reinforcement is permitted. A minimum pull-out force strength of 1,100 lbs per screw is required for all hinge locations.

Door faces are to utilize a chemical resistant thermosetting polyester resin formulated for the specified environment with a maximum flame spread of 25 in accordance with ASTM E84, and self-extinguishing in accordance with ASTM D635 with fiberglass reinforcing layers. Provide structural reinforcement of knitted multi-layer material with layers of unidirectional fiberglass orientated in both vertical and horizontal directions for high stiffness, impact and warp resistance. Furnish door faces as indicated by the door elevation drawings.

Ensure the exposed finish of the FRP door faces with an ultra-violet light stabilized marine grade Neopentyl Glychol (NPG)-isophthalic polyester gelcoat integrally molded to a 25/30 mil wet thickness.

[Provide an integral heavy pultruded FRP astragal on the stile edge of the inactive leaf for double doors of the same materials as specified for door stiles and rails.

][Provide raised panel door as indicated by the door elevation drawings and schedule. Plants are to be applied by the manufacturer as an integral part of the door face and not field applied. All molding and plants are to be a rein material and installed by the manufacturer to resemble a raised panel door.

]][2.1.1.7 Fire Rated Labeled FRP Frame

Provide a Fire-Rated Door Frame with a [20] [45] [60] [90] minute rating complying with NFPA 80 that are listed and labeled by [a qualified testing agency][Underwriters Laboratories (UL)] [Factory Mutual Engineering and Research (FM)] [Warnock Hersey International (WHI)], for the fire-protection ratings indicated in the door and frame schedule.

Permanently affix frame labels, at the factory, to the hinge side of the door jamb. Do not paint.

Provide a Fire-Rated Door Frame utilizing a high-modulus pultruded structural FRP shape. Fabricate pultruded frame with a wall thickness of not less than 5 mm 3/16 inch. Provide one piece factory constructed frames with molded stop. Utilize miter corner door jambs and header connections chemically welded with FRP material ground for a visibly smooth frame face. Post and beam or mechanical fastened corners and joints are not acceptable. Provide sizes and shapes to be as detailed on the approved drawings.

Provide a minimum density of 0.4 kg per liter 25 pounds per cubic foot fire resistant composite formulated core for the specified environment with a maximum flame spread of 25 in accordance with ASTM E84, and self-extinguishing as per ASTM D635.

Frame finish is to be identical to door color and finish. Ensure a [15] [20] [25] wet mil resin rich gel coat is integrally molded into door frame during manufacturing.

]2.1.1.8 Frame Anchors

Provide anchorage devices and fasteners where necessary for fastening fabricated FRP door frame to the adjacent construction-in-place as recommended by the FRP frame manufacturer.

2.1.1.9 Jamb Anchors

[Provide anchors of the material, type, number, and spacing as required by the FRP frame manufacturer.

][Provide Masonry Anchors of [corrosive-resistant] [hot-dip galvanized] steel [corrugated or perforated straps not less 50 mm 2 inches wide by 250 mm 10 inches long] [wire a minimum of 5 mm 3/16 inch diameter] [adjustable loop] [T-shaped] minimum of 1.3 mm 18 gauge thick.

][Provide hot-dip galvanized steel Stud-Wall Type anchors designed to engage the [wood] [cold-formed steel] wall framing; not less than 1.3 mm 18 gauge thick.

][Provide Expansion Type Anchor for [concrete] [masonry] of [corrosive-resistant] [hot-dip galvanized] steel a minimum 9.5 mm 3/8 inch diameter bolt with expansion shield or insert.

][Provide a Powder-Actuated Anchorage System suitable for the application in [concrete] [steel] fabricated from [corrosive-resistant] [hot-dip galvanized] steel with clips or other accessory devices for attaching FRP frames.

]2.1.1.10 Hardware Preparation

Provide hardware reinforcing as specified. Prepare doors and frames for hardware in accordance with the applicable requirements of the FRP door and frame manufacturer. For additional requirements refer to ANSI/BHMA A156.115.

[Provide [door hardware components and accessories] as indicated on the drawings[.][, including [weather-stripping] [smoke seals] [thresholds] [_____].]

]2.1.2 Performance Requirements

2.1.2.1 Structural

****

NOTE: Include the bracketed statement for static load, frame deformation, minimum glazing frame bite,and frame connection requirements when personnel density is greater than one person per 40 square meters 430 square feet and minimum AT/FP standoff distances are met. This provision is not required for guard type facilities, single and duplex detached family housing. The requirements are specified in UFC 4-010-01, "Department of Defense Minimum Antiterrorism Standards for Buildings"**.**

****

[Design exterior doors, frames and hardware to resist equivalent static design loads in accordance with ASTM F1642/F1642M, with frame deflections not to exceed L/160 of the unsupported member lengths. Use equivalent static design loads for connections of the door frame to the surrounding walls or hardware and associated connections, in accordance with ASTM F2248 and ASTM E1300. Design supporting elements and their connections based on their ultimate capacities. Provide calculations prepared by a Professional Engineer that substantiates compliance with these requirements, including insulation materials. Use frames that provide an equivalent level of performance.]Provide framing members with shape and thickness sufficient to withstand [a design wind load of not less than [1.4] [_____] kPa [30] [_____] pounds per square foot of supported area] [the design wind load indicated] with a deflection of not more than 1/175 times the length of the member and a safety factor of not less than 1.65. Provide glazing beads, moldings, and trim of not less than 1.25 mm 0.050 inch nominal thickness.

[Design doors and frames to withstand the specified design wind load acting normal to the plane of the entrance wall either inward or outward, in accordance with ASCE 7-16[and ICC IBC].

]2.1.2.2 Air Infiltration

When tested in accordance with ASTM E283, air infiltration cannot to exceed 2.63 by 10-5 cms per square meter 0.06 cubic feet per minute per square foot of fixed area at a test pressure of 0.30 kPa 6.24 pounds per square foot 80 kilometers 50 mile per hour wind.

2.1.2.3 Water Penetration

When tested in accordance with ASTM E331, no water penetration is allowed, at a pressure of 0.38 kPa 8 pounds per square foot of fixed area.

2.1.2.4 Provisions for Thermal Movement

Design doors and frames to provide for expansion and contraction of the component parts caused by an ambient temperature range of minus 17.8 to 37.8 degrees C 0 to 100 degrees Fcausing buckling, opening of joints, overstressing of fasteners, or other harmful effects.

PART 3 EXECUTION

3.1 INSTALLATION

Conform all work to the requirements of 29 CFR 1910, 29 CFR 1926,and NFPA 241.

3.1.1 FRP Frame

Set FRP door frame plumb and true, aligned, and secured with the adjacent construction-in-place, in conformance with ASTM E2112. Anchor frame as specified and in accordance with the FRP door manufacturer's requirements.

Installation Tolerances

a. Squareness: Plus or minus 1.6 mm 1/16 inch, measure at the door rabbet on a line 90 degrees from the jamb perpendicular to the frame head.

b. Alignment: Plus or minus 1.6 mm 1/16 inch, measure at the jamb on a horizontal line parallel to the wall plane.

c. Twist: Plus or minus 1.6 mm 1/16 inch, measure at the opposite face corners of the jambs on parallel lines, and perpendicular to the wall plane.

d. Plumb and True: Plus or minus 1.6 mm 1/16 inch, measure at the jambs to the floor.

3.1.2 FRP Door

Fit and hang door in accordance with clearances specified below:

Clearance Tolerances

a. Jambs and Head: Plus 3 mm 1/8 inch or minus 1.6 mm 1/16 inch.

b. Pairs of Doors: Plus 3 mm 1/8 inch or minus 1.6 mm 1/16 inch.

c. Bottom of Door and Top of Threshold: Maximum 9.5 mm 3/8 inch.

d. Bottom of Door and Top of finish floor (No Threshold: Maximum 19 mm 3/4 inch.

[3.1.3 Labeled Door and Frame

Install fire-rated door and frame, including hardware, in accordance with NFPA 101 [NFPA 80] [and] [NFPA 105].

]3.2 ADJUSTING AND CLEANING

Check and re-adjust all operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including all FRP that is warped, bowed, or otherwise unacceptable to the Contracting Officer.

3.3 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to final completion and acceptance of the project or replace with new, as directed by the Contracting Officer. Thoroughly clean all surfaces of the door and frame prior to final completion and acceptance of the project.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Warranty

Submit the approved Warranty made out to the Government, to the Contracting Officer no later than [10] [_____] days prior to final inspection.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 31 00 (May 2017)**
Change 1 - 08/18

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 08 - OPENINGS

SECTION 08 31 00

ACCESS DOORS AND PANELS

05/17, CHG 1: 08/18

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PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 31 00 (May 2017)**

Change 1 - 08/18

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 31 00

ACCESS DOORS AND PANELS

05/17, CHG 1: 08/18

****

NOTE: This guide specification covers requirements for access doors and panels.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Show the following on the drawings:

1. Locations and assemblies of each type of access door and panel.

2. Sizes and dimensions of doors and panels.

3. Materials, finishes, and types of doors and panel surfaces, for example, flush, recessed, louvered, decorative, security, type of surface finish to be matched.

4. Location of hinges and direction of swing. Indicate whether hatch must be detachable.

5. Required fire-ratings, acoustical ratings, level of security.

6. Required hardware including locking mechanisms. Indicate electrified hardware, if necessary.

7. Connection details, other than manufacturer's standard.

8. Provide a unique door number for each access door or panel. Coordinate with project door schedule.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar

ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E1332	(2016) Standard Classification for Rating Outdoor-Indoor Sound Attenuation

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for Metal

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies
NFPA 288	(2017) Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance-Rated Assemblies

UL SOLUTIONS (UL)

UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies
UL 263	(2011; Reprint Aug 2021) UL Standard for Safety Fire Tests of Building Construction and Materials

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Access Doors And Panels; G, [_____]

SD-03 Product Data

Access Doors And Panels; G, [_____]

Hardware Including Locks and Keys; G, [_____]

Accessories; G, [_____]

[Power Transfer Components; G, [_____]

] Recycled Content; S

SD-04 Samples

Finishes; G, [_____]

[SD-06 Test Reports

Fire-rating(s) of Assemblies; G, [_____]

Acoustical Ratings of Assemblies; G, [_____]

]1.3 MISCELLANEOUS REQUIREMENTS

For access doors and panels provide the following:

1.3.1 Shop Drawings

For field assembled access doors and panels, provide plans, elevations, sections, and details for each type of access door and panel assembly. Indicate frame, surface and edge construction, materials, and accessories. Indicate types of finished surfaces and details for panel edge conditions. Provide a door schedule with a unique number for each access door and panel, specific location in the project, location of hinges and hardware for each door.[Indicate [acoustical ratings of assemblies as sound transmission class (STC) ratings][,][and][fire-rating(s) of assemblies][and][locations and power transfer components for electrified locks and alarms].]

1.3.2 Product Data

For shop assembled access doors and panels, provide literature indicating sizes, types, frame and edge construction, finishes, hardware, accessories such as gaskets, seals and weatherstripping, and location of each door and panel in the project. Indicate[acoustical ratings of assemblies,][fire-ratings of assemblies,][and][locations and power transfer components for electrified locks and alarms.]. Provide details of adjoining work for each condition indicated.

1.3.3 Finish Samples

Submit two color charts from manufacturer's standard color and finish options for each type of frame and panel assembly finish indicated.

[1.3.4 Test Reports

[Provide test reports for acoustical assemblies when tested in accordance with ASTM E90 and classified in accordance with ASTM E413 and ASTM E1332.][Provide test reports for fire-rated assemblies when tested in accordance with NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically and NFPA 288 for fire-rated access door assemblies installed horizontally.]

]1.4 PERFORMANCE REQUIREMENTS

****

NOTE: Select access panels that will maintain the integrity of the surface in which they occur, for example, specify acoustical panels at acoustical wall and ceiling assemblies (if access cannot be eliminated); specify fire-rated panels at fire-rated wall and ceiling assemblies (and verify ratings in accordance with IBC 2015); specify security access panels at locations requiring forced entry resistance, access control, or intrusion detection.

NOTE: Access control and alarms require power to the access door; coordinate to avoid surface mounting of power transfer devices that are unsightly and easy to defeat.

NOTE: Coordinate locations of access doors and panels with mechanical drawings and specifications.
****

1.4.1 Structural Requirements

Provide floor access assemblies to support live loads indicated for floors. Deflection must not exceed 1/180 of span.

[1.4.2 Acoustical Requirements

Provide access panels with a minimum sound transmission class (STC) of [_____][as indicated on the Drawings]. Provide gasketing in accordance with manufacturer's written recommendations.

][1.4.3 Fire-Rating Requirements

Provide access panels with a minimum fire-rating of [[_____]-Hour][as indicated on the Drawings].

][1.4.4 Insulated Access Panels

Provide panels in a thickness as necessary to achieve a minimum R-value of [_____][as indicated on the Drawings]. Provide gasketing as necessary for an airtight installation.

][1.4.5 Access Panels for Wet Areas

Provide panel assemblies that will be located in wet areas with corrosion resistant finishes and hardware and water resistant gasketing.

]1.5 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

****
NOTE: Select access panels for each type of surface in which panels occur. Consider the appearance of panels in relation to their locations. If the prominence of an access panel will not be aesthetically acceptable at gypsum wallboard locations, wood clad ceilings and walls, tile surfaces, specify recessed panels intended to receive and support such matching finishes. If the appearance of access panels is acceptable, provide cost effective flush steel panels, either factory painted or factory primed and field painted, and coordinate metal finishes or specify to match the surfaces in which they occur. Specify decorative access panels or louvered panels only when there is a compelling design reason to do so.
****

2.1 RECYCLED CONTENT

Provide products with recycled content. Provide data for each product with recycled content, identifying percentage of recycled content.

2.2 MATERIALS

2.2.1 Steel Plates, Shapes, and Bars

Provide in accordance with ASTM A36/A36M.

2.2.2 Sheet Steel

Provide cold rolled steel sheet substrate in accordance with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

2.2.3 Stainless Steel

Provide in accordance with ASTM A666, type 302 or 304.

2.2.4 Metallic Coated Steel Sheet

Provide in accordance with ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.2.5 Hardware

Provide automatic closing devices. Provide latch releases operable from insides of doors.[Provide anchors in accordance with applicable fire test parameters.]

2.2.6 Hinges

Provide concealed spring hinges, 175 degrees of opening, with [non-]removable hinge pins[to allow removal of door panel from frame]. Provide hinges of same steel as door and frame or in accordance with manufacturer's written recommendations. If providing non-continuous hinges, provide in numbers required to maintain alignment of door panel with frame. Provide coatings as necessary to permanently protect dissimilar metals from contact with one another; see Part 3 herein for more information.

2.2.7 Locks

Unless otherwise indicated, provide flush [screwdriver operated cam lock. Provide plastic sleeve or stainless steel bushings to protect holes in surface finishes for screwdriver to access lock.][keyed lock][tamper proof screws (spanner head locks) for access panels in locations requiring such security.][Lock cylinders are specified in Section 08 71 00 DOOR HARDWARE.]

2.2.8 Accessories

Provide anchors in size, number and location on four sides to secure access door to substrate. Provide anchors in types as recommended by manufacturer's written installation instructions for each substrate indicated. Provide shims, bushings, clips, gaskets, and other devices as necessary for a complete installation.

2.3 FABRICATION

2.3.1 Thickness, Size, Edges

Fabricate frames for access doors of steel not lighter than 16 gage with welded joints and anchorage for securing to adjacent construction. Provide doors a minimum of 600 by 600 mm 24 by 24 inches and of not lighter than 16 gage steel, with stiffened edges and welded attachments. Provide with eased (lightly rounded) edges, without burrs, snags or sharpness and exposed welds ground smooth.

2.3.2 Welding

Provide in accordance with AWS D1.1/D1.1M.

2.4 ACCESS ASSEMBLY TYPES

Unless indicated otherwise, provide flush-face steel access doors and panels with steel frames and flanges.

[2.4.1 Recessed Doors

Provide recessed access doors[with gypsum wallboard bead flanges]. Depth of door panel recess must accommodate the installed thickness of the finish material of the wall assembly for a flush finished condition of the wall and the access panel face. Reinforce panel and frame to prevent sagging.

][2.4.2 Fire-rated Doors

2.4.2.1 Door Construction

Provide ceiling access door construction in accordance with ASTM E119 or UL 263. Provide wall access doors in accordance with NFPA 252 or UL 10B.

2.4.2.2 Labels

Provide class B opening according to UL 10B or test by another nationally recognized laboratory, approved by the Contracting Officer. Provide fire-rating as indicated herein, with a maximum temperature rise of 120 degrees C 216 degrees F.

2.4.2.3 Door Panel and Frame

[Steel][Stainless steel] sheet, with mineral fiber insulation core, insulated sandwich type construction.

][2.4.3 Acoustical Doors

Manufacturer's standard assembly rated in accordance with STC requirements indicated herein. Acoustical insulating materials must have a flame spread rating of no more than 25.

][2.4.4 Insulated Doors

Provide access door panels with [172 kPa25 pounds per square inch density polystyrene][80 kg per cubic meter5 pound per cubic foot density, chlorofluorocarbon (CFC) free, foamed urethane] with a flame spread rating of no more than 25.

****
NOTE: For BEQ projects which have terminal air blenders, add the bracketed item.
****

[Provide ceiling access panels for terminal air blenders as indicated. Provide pin-tumbler cylinder locks with appropriate cams in lieu of screwdriver-operated latches.]

]2.5 FINISHES

[Provide steel frames and panel surfaces with a [baked enamel][powder coated finish.]Provide manufacturer's standard two coat finish system consisting of one coat primer and one thermoset topcoat. Provide dry film thickness in 0.05 mm 2 mils minimum.][Provide steel frame and panel surfaces with a shop applied prime coat. [Field paint frames and panels to match wall and ceiling surfaces in which they occur.]][Provide stainless steel frames and panels.][Provide brushed aluminum frames and panels.] Provide exposed fastenings that approximately match the color and finish of the each material to which fastenings are applied.

PART 3 EXECUTION

3.1 PREPARATION

Field verify all measurements prior to fabrication. Verify access door locations and sizes provide required maintenance access to installed building services components. Protect existing construction and completed work from damage during installation.

3.2 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, in accordance with manufacturer's written instructions. Include materials and parts as necessary for a complete installation of each item. Conceal fastenings where practicable. Poor matching of holes to fasteners is cause for rejection of the work.

3.3 ACCESS LOCATIONS

Install removable access panels directly below each valve, flow indicator, damper, air splitter or other utility requiring access that is located above ceilings, other than at acoustical panel ceilings, and that would otherwise not be accessible. Install access doors and panels permitting access to service valves, traps, dampers, cleanouts, and other mechanical, electrical and conveyor control items concealed in walls and partitions.

3.4 ACCESS LOCATIONS IN WET AREAS

When possible, avoid locating access panels in wet areas. When such locations cannot be avoided, provide moisture resistant assemblies as indicated in Part I herein.

[3.5 RECESSED ACCESS DOORS

Install fire-rated access doors in fire-rated partitions and ceilings in accordance with NFPA 80.

]3.6 FIELD PAINTING

Field painting primed access doors in accordance with the requirements of Section 09 90 00 PAINTS AND COATINGS.

3.7 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, protect surfaces with a coating in accordance with MPI 79 to prevent galvanic or corrosive action.

3.8 ADJUSTMENT

Adjust hardware so that door panel opens freely. Adjust door when closed center door panel in frame.

3.9 ENVIRONMENTAL CONDITIONS

Do not paint surfaces when damp or exposed to weather, when surface temperature is below 7 degrees C or over 35 degrees C 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 32 13 (August 2020)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-08 32 13 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 08 - OPENINGS

SECTION 08 32 13

ALUMINUM SLIDING GLASS DOORS

08/20, CHG 1: 02/22

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-08 32 13 (August 2020)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-08 32 13 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 08 32 13

ALUMINUM SLIDING GLASS DOORS

08/20, CHG 1: 02/22

****

NOTE: This guide specification covers the requirements for aluminum sliding glass doors for commercial, residential, and monumental type buildings.

Adher to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Aluminum sliding glass doors are intended for use as an entrance to a patio, terraced area, or balcony, where only primary conventional door exits are available for use from the same interior area. Sliding glass doors shall not be the only exit from public use areas.

****

****

NOTE: On the drawings show opening sizes and schedule, arrangement of fixed and sliding panels, and methods of anchoring frames.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 800	(2016) Voluntary Specifications and Test Methods for Sealants
AAMA 1503	(2009) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

ASTM INTERNATIONAL (ASTM)

ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM D3656/D3656M	(2013) Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM E2016	(2022) Standard Specification for Industrial Woven Wire Cloth

ASTM F842	(2017; R 2023) Standard Test Methods for Measuring the Forced Entry Resistance of Sliding Door Assemblies, Excluding Glazing Impact

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

****

NOTE: Select this paragraph or the paragraph MANUFACTURER'S CATALOG DATA based on which is

appropriate for the project. Both paragraphs may be used if necessary.
****

Aluminum Sliding Glass Doors

SD-03 Product Data

****
NOTE: Select this paragraph or the paragraph DRAWINGS based on which is appropriate for the project. Both may be used if necessary.
****

Aluminum Sliding Glass Doors

Hardware

Glazing

Weatherstripping

Screens

Finish

SD-04 Samples

Finish

SD-10 Operation and Maintenance Data

Aluminum Sliding Glass Doors, Data Package 1; ; G, [_____]

1.2.1 Shop Drawing Information

Submit drawings for aluminum sliding glass doors[, screens,] and accessories that indicate elevations of each door type, full size sections, thickness, nominal gages of metal, fastenings, proposed method of installation and anchoring, the size and spacing and method of glazing, details of operating hardware, method and material for weatherstripping, type of finish, and screen details.

1.2.2 Samples Information

Submit color chart of factory color coatings when factory-finished color coating is to be provided.

1.3 TEMPORARY PROTECTIVE COVERING

****
NOTE: The protection specified in this paragraph is a temporary protection for doors to be installed during construction of new buildings. The paragraph may be deleted when specifying doors for existing building construction.
****

Prior to shipment from the factory, finished surfaces of aluminum sliding glass doors must receive a protective covering of waterproof tape, strippable plastic, or cardboard to protect against discoloration and surface damage that may occur during transportation, storage, and construction activities. Also, do not apply coatings or lacquers to surfaces to which caulking and glazing compounds must adhere. Covering must be readily removable after installation.

1.4 DELIVERY AND STORAGE

Inspect aluminum sliding glass doors,[including screens,] hardware and accessories, for damage and unload and store doors upright on platforms in accessible spaces with a minimum of handling. The storage spaces must be dry, adequately ventilated, free from heavy dust and not subject to combustion products, sources of water or other conditions that could damage the door. Storage spaces must have easy access for inspection and handling of doors.

[1.5 EXTRA STOCK

Deliver an extra stock of markings for glass panels to the Government for use in future replacement of original markings. The extra stock shall be of the same designs, colors, and materials as the markings installed on this project. Furnish markings in original containers or packages in a quantity not less than [_____] percent of the amount of markings to be installed.

]PART 2 PRODUCTS

2.1 ALUMINUM SLIDING GLASS DOORS

****

NOTE: Aluminum sliding glass doors (SDG) designation and type in AAMA/WDMA/CSA 101/I.S.2/A440 establishes a minimum Performance Class for each door Grade: 15 for residential (R) 20 for commercial (C); and 40 for heavy commercial (HC). Units installed in high wind zones should be specified in accordance with the recommendation in AAMA/WDMA/CSA 101/I.S.2/A440.

****

****

NOTE: For minimum cost, use stock designs in standard sizes where possible. Require only minimum changes to standard design, and use minimum number of different sizes. Vinyl safety markings should be used where appropriate to make personnel aware of glass. If specific designs and colors are required for markings, indicate on the drawings; in monumental installation, a horizontal muntin may be specified or indicated.

****

Provide aluminum sliding glass doors with sliding panels and fixed panels in the sizes and arrangements indicated and conforming to AAMA/WDMA/CSA 101/I.S.2/A440 for Type [SGD-R15] [SGD-C20] [SGD-HC40], [SGD-_____] except frame must be equipped with thermal barrier.[Mark panels identically and permanently to visibly interrupt the span of glass. Use markings [of the design and color indicated] [approximately 2500 square millimeters 4 square inches] of opaque, pressure-sensitive vinyl film with precoated adhesive.] Sliding door glazing must be set in aluminum frames and roller assemblies of sufficient strength to withstand lateral live stresses and static load or weight requirements.

2.1.1 Hardware

****

NOTE: Key-operated cylinders may be incorporated into a master keying system provided they are: (1) manufactured by the same manufacturer as the manufacturer of the locks for the other doors, and (2) the number of pin tumblers in the cylinder for the sliding glass door locks is the same as the number of pin tumblers provided in the cylinders of the locks for the other doors.

****

Sliding door panel must have a manually operated adjustable latch [operable by latch handle or slide bar from inside only] [operable by a five-pin tumbler cylinder lock on outside and thumb-turn on the inside] [operable by a five-pin tumbler cylinder lock from either side]. Fit sliding screen door panel with a self-latching hook or rotary-type latch operable from [inside only] [both sides].[Provide pulls for both inside and outside of sliding panel and the sliding screen panel].[Provide a pull on the inside of the sliding door panel and the sliding screen panel only].[Provide auxiliary pin lock [bottom] [top and bottom] on inner side of sliding glass door panel opposite manually operated adjustable latch.] Exposed hardware is to be aluminum or stainless steel, color finished to match door color finish.

2.1.2 Glazing

****

NOTE: Select the thickness of glass using the Glass Table provided in AAMA/WDMA/CSA 101/I.S.2/A440. Glass thickness must be not less than 6 mm 1/4 inch. The Condensation Resistance Factor should be specified in accordance with the recommendation in AAMA 1503.

****

Factory glazed sliding glass doors, including fixed panel, with double-glazed glass conforming to ASTM C1048, Kind FT, Condition A, Type [I] [II], Class 1, not less than [6] [_____] mm [1/4] [_____] inch thick.[Double glazing must have a minimum condensation resistance factor of [_____] in accordance with AAMA 1503.] Glazing material must be certified as meeting CPSC 16 CFR 1201, Category II. Set glazing unit in polyvinyl-chloride or synthetic rubber glazing channels. Channels must be reusable when replacing glass and have mitered or continuous corners. Channels exposed to view must blend in color with the aluminum frame finish.

2.1.3 Weatherstripping

Provide four sides of each sliding panel and interlocking stiles and jambs with weatherstripping. Weatherstripping must conform to AAMA/WDMA/CSA 101/I.S.2/A440 and must provide maximum protection against the elements and be designed for ease of replacement.

2.1.4 Screens

****

NOTE: Delete paragraph and other references to screens in this specification, if screens are not indicated on the project drawings.

****

Provide horizontal sliding aluminum screens in combination with aluminum sliding glass doors. Provide screen frames consisting of aluminum shapes of size and design standard with the door manufacturer. Frames must have removable splines of aluminum or vinyl and must permit screening fabric replacement. Screening shall be [18 by 16 mesh aluminum conforming to ASTM E2016,] [plastic-coated fibrous glass conforming to ASTM D3656/D3656M, Class 2, 18 by 14 mesh, [_____ color] [selected color to match doors]]. Install screening with weave parallel with frames and sufficiently tight to present a smooth appearance. Conceal edges of screening in the spline channel. Screens must be complete with rollers, hardware, and accessories and must slide on or within tracks provided in the door frame members. Design and assemble doors so that aluminum-to-aluminum contact of moving members will not occur. Provide insect-proofing, formed of wool pile or other suitable material, at interlocking stiles and jambs. Finish on screen frames must be as specified for doors.

2.1.5 Finish

****

NOTE: Specify AA-M-10-C22-A31 clear (natural) anodized finish or AA-M-10-C22-A32 color anodized finish, when doors will not be subjected to excessive wear or abrasion and will be regularly cleaned and maintained. Also, specify these finishes in project locations with Environmental Severity Classifications (ESC) of C1 or C2. See UFC 1-200-01 for determination of ESC for project locations.

Specify AA-M-10-C22-A41 clear (natural) anodized finish or AA-M-10-C22-A42 color anodized finish, when doors will be subject to excessive wear and will not be regularly cleaned and maintained, or in highly corrosive industrial atmospheres with dust, gases, salts, or other disruptive elements that attack metal. Also, specify these finishes in project locations with Environmental Severity Classifications (ESC) of C3 thru C5. See UFC 1-200-01 for determination of ESC for project locations.

Color anodized finishes available include medium bronze, dark bronze, and black. Insert color desired in blank space provided. Of the choices indicated, black is generally most expensive.

In project locations with Environmental Severity Classifications (ESC) of C4 or C5, specify the anodized finish as 0.0175 mm 0.7 mil thickness or greater. See UFC 1-200-01 for determination of ESC for project locations.

****

Before fabrication, clean sliding glass door units and give a [AA-M-10-C22-A31 clear (natural) anodized finish] [AA-M-10-C22-A41 clear (natural) anodized finish] [AA-M-10-C22-A32 [_____] (color) anodized finish] [AA-M-10-C22-A42 [_____] (color) anodized finish] in accordance with the requirements of the AA DAF45. The finish thickness must be [A41, 0.01 mm 0.4 mil or greater] [A42, 0.0175 mm 0.7 mil or greater].

2.2 CAULKING AND SEALING

As specified under Section 07 92 00 JOINT SEALANTS.

2.3 FORCED ENTRY RESISTANT DOORS

In addition to meeting AAMA/WDMA/CSA 101/I.S.2/A440, doors designated forced entry resistant must conform to ASTM F842.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Doors, Frames, and Accessories

Install doors, frames, framing members, hardware, and accessories in accordance with approved shop drawings and the requirements specified herein. Set frames securely anchored in place to straight, plumb, square, level condition without distortion and in alignment. Install door panels to retain proper weathering contact with frames. Caulk metal-to-metal joints between frame members and remove excess material. Caulking around perimeter of door frame and wall openings to provide weathertight installation must be accomplished in accordance with AAMA 800 and manufacturer's recommendations. Finished work must be rigid, neat in appearance, and free from defects. Upon completion, adjust sliding doors to operate properly. Thoroughly clean aluminum frames and glass in accordance with manufacturer's recommendation. Doors damaged prior to completion and acceptance must be restored to original manufactured condition or replaced with new doors as directed.

3.1.2 Protection of Aluminum from Dissimilar Materials

3.1.2.1 Aluminum to Dissimilar Metals

Prevent aluminum surfaces from contacting dissimilar metals other than stainless steel, zinc, or white bronze by one or a combination of the following:

a. Paint dissimilar metal with one coat of heavy-bodied bituminous paint.

b. Apply caulking between aluminum and dissimilar metal.

c. Paint dissimilar metal with primer, followed by one coat of aluminum paint or other suitable lead-free coating.

d. Use nonabsorptive tape or gasket in permanently dry locations.

3.1.2.2 Drainage from Dissimilar Metals

Paint dissimilar metals located in areas where their drainage washes over aluminum to prevent the staining of aluminum.

3.1.2.3 Aluminum to Masonry and Concrete

Prevent aluminum surfaces from coming into contact with mortar, concrete, or other masonry materials by applying one coat of heavy-bodied bituminous paint to the aluminum surfaces.

3.1.2.4 Aluminum to Wood

Prevent aluminum surfaces from coming into contact with wood, treated wood, or similarly absorptive materials by one or a combination of the following methods:

a. Paint aluminum surfaces with two coats of aluminum paint or one coat of heavy-bodied bituminous paint.

b. Paint the wood, treated wood, or other absorptive surfaces with two coats of aluminum paint and seal contiguous joints with caulking compound.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 33 13 (May 2009)**
Change 2 - 11/12

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 08 - OPENINGS

SECTION 08 33 13

COILING COUNTER DOORS

05/09, CHG 2: 11/12

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PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-08 33 13 (May 2009)**
Change 2 - 11/12

Preparing Activity: USACE | **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 08 33 13

COILING COUNTER DOORS

05/09, CHG 2: 11/12

****

NOTE: This guide specification covers the requirements for metal rolling counter doors.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

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SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Warranty
Rolling Counter Doors
Installation
Cleaning

SD-06 Test Reports

Drop-test

SD-10 Operation and Maintenance Data

SD-11 Closeout Submittals

Rolling Counter Door (Non-Rated)
Fire-Rated Rolling Counter Door

1.3 QUALITY ASSURANCE

Submit Detail Drawings showing elevations of each door type, details of anchorage, details of construction, location and description of hardware, shape and thickness of materials, details of joints and connections, and details of guides and fittings. Include a schedule showing the location of each counter door with the drawings.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver rolling counter doors to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Store rolling counter doors in accordance with the manufacturer's instructions in a dry location that is adequately ventilated and free from dust, water, or other contaminants, and in a manner that permits easy access for inspecting and handling. Handle doors carefully to prevent damage. Replace damaged items that cannot be restored to like-new condition.

1.5 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period. Submit no later than 30 days prior to final inspection.

PART 2 PRODUCTS

****

NOTE: These paragraphs will be edited to retain only the materials and finishes for the type of rolling counter door required for the project. If finishes other than those specified are required, the specification will be revised accordingly. Generally G40 minimum galvanized coating with prime coat is sufficient for interior applications on most projects. Aluminum or stainless steel should be selected for esthetics. Aluminum should not be chosen for high use applications. Fire rated doors should be constructed only of steel or stainless steel.

Fire-rated doors are not normally available in sizes as large as non-rated doors. Coordinate with manufacturers on available heights and widths.

Add requirements for weatherstripping and weather-tight installation for rolling counter doors located on exterior walls.

****

2.1 SYSTEM DESCRIPTION

Furnish rolling counter doors of the type, size, and design indicated on the drawings. Provide the standard product of a manufacturer regularly engaged in the production of rolling counter doors. Provide each door with a permanent label showing the manufacturer's name and address and the model number of the door. Submit Manufacturer's descriptive data and catalog cuts.

2.2 BASIC COMPONENTS

2.2.1 Curtain

****

NOTE: Standard non-rated rolling counter doors may be constructed of aluminum, steel or stainless steel. Fire rated counter doors must be constructed of steel or stainless steel. Edit the specification for the type or types of rolling doors required for the project.

****

Fabricate the curtain of [extruded aluminum slats conforming to ASTM B221M ASTM B221, Alloy 6063] [0.759 mm 22 gauge stainless steel slats conforming to ASTM A240/A240M, Type 304 or Type 430] [or] [0.853 mm 22 gauge galvanized steel slats conforming to ASTM A653/A653M, Coating Designation [G60] [G90]]. Provide thickness of slat material as required by width of opening [or as required by specified fire-rating.] Use slats approximately 32 to 38 mm 1-1/4 to 1-1/2 inch wide with a depth of crown of 13 mm 1/2 inch. Fit alternate slats with endlocks to maintain curtain alignment. Provide bottom of curtain with angle or tubular bar reinforcement matching the curtain, and fitted with a resilient bottom seal.

2.2.2 Jamb Guides

Furnish guides of [3 mm 1/8 inch minimum thickness extruded aluminum conforming to ASTM B221M ASTM B221, Alloy 6063, and fitted with neoprene silencers or replaceable heavy nap striping to eliminate noise and dust infiltration.] [2.372 mm 13 gauge minimum thickness stainless steel conforming to ASTM A240/A240M, Type 304 or Type 430.] [2.278 mm 13 gauge minimum thickness galvanized steel angles conforming to ASTM A653/A653M, Coating Designation minimum G40.]

2.2.3 Counterbalance Shaft Assembly

Furnish the curtain coiled around a steel tube of sufficient thickness and diameter to prevent deflection exceeding 2.5 mm per meter 0.03 inch per foot. Provide a barrel containing oil tempered helical steel torsion springs capable of sufficient torque to counterbalance the weight of the curtain. Calculate the springs to provide a minimum of [7,500] [_____] operating cycles (one complete cycle of door operation will begin with the door in the closed position, move to the full open position and return to the closed position).

2.2.4 Brackets

Furnish brackets of a minimum 2.657 mm 12 gauge thickness steel if flat plate, or 1.519 mm 16 gauge thickness if there are a minimum of 3 returns of 19 mm 3/4 inch width.

2.2.5 Hood

Provide a hood of [1.02 mm 0.040 inch minimum thickness aluminum sheet conforming to ASTM B209M ASTM B209, Alloy 5005.] [0.607 mm 24 gauge stainless steel conforming to ASTM A240/A240M, Type 304 or Type 430.] [0.701 mm 24 gauge galvanized steel conforming to ASTM A653/A653M, Coating Designation minimum G40.]

2.2.6 Locks

Lock the curtain at [each side of the bottom bar by an integral slide bolt] [both sides of bottom bar by a chrome-plated cylinder lock keyed into the building keying system]. Locate lock on the [_____] room side of the counter door. [Provide keying [conforming to Section 08 71 00 DOOR HARDWARE] [as indicated].]

2.3 ROLLING COUNTER DOOR (NON-RATED)

****

NOTE: Standard non-rated rolling counter doors may

be constructed of aluminum, steel or stainless steel. Operation may be manual push-up, manual crank with removable handle, or motor operation. Edit the specification for the type or types of rolling doors required for the project.
****

Construct rolling counter doors, curtains, guides and hood components of [aluminum] [stainless steel] [galvanized steel] conforming to the requirements specified herein. Submit [Six] [_____] complete copies of Data Package 2 for Rolling Counter Doors (Non-Rated) and Fire-Rated Rolling Counter Doors (next paragraph) in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Provide a list of the parts recommended by the manufacturer to be replaced after [1 year] [and] [3 years] of service.

2.4 FIRE-RATED ROLLING COUNTER DOOR

****
NOTE: Fire-rated rolling counter doors are available with Class A (3 hr), Class B (1-1/2 hr), C (3/4 hr), or Class D (1-1/2 hr) label. If only one class of rolling counter door is required for the project, the label requirement may be specified. If the project requires more than one class of rolling counter door, the label requirements should be shown on the drawings. If fire-rated rolling counter doors are not required, all references to fire-rating and label requirements will be deleted.
****

Furnish fire-rated rolling counter doors, [[Class A (3 hr.)] [Class B (1-1/2 hr.)] [Class C (3/4 hr.)] [Class D (1-1/2 hr.)] rated] [as shown] and conforming to the requirements specified and to NFPA 80 for the class indicated. Provide labels of a recognized testing agency for the doors, indicating the applicable fire resistance rating. The construction details necessary for labeled rolling counter doors will take precedence over details indicated or specified herein. Furnish door curtains, guides and hood of [stainless steel] [galvanized steel]. Provide fire-rated rolling counter doors complete with hardware, accessories, and automatic closing device. Provide rolling counter doors, in exit corridor walls, with perimeter smoke and draft control gasketing.

2.5 INTEGRAL FRAME ROLLING COUNTER DOOR (RATED OR NON-RATED)

****
NOTE: Requirements for counter and frame construction will be shown on the drawings. Integral frame units may be used where appropriate; however, the specification must be edited to incorporate the additional requirements for frame and counter. Fire rated integral frame units are available in galvanized steel, stainless steel, and with Class A (3 hr), Class B (1-1/2 hr), or Class C (3/4 hr), or Class D (1-1/2 hr) label. Integral frame doors are not available as split frame.
****

Furnish integral frame rolling counter door of [[aluminum] [stainless steel] [galvanized steel].] [[[Class A (3 hr.)] [Class B (1-1/2 hr.)]

[Class C (3/4 hr.)] [Class D (1-1/2 hr.)]] [as shown], [stainless steel] [galvanized steel].] Conform fire-rated doors to the requirements of NFPA 80 for the Class indicated and bearing the labels of a recognized testing agency indicating the applicable fire resistance rating. Form jambs to create guides for the curtain. Provide head and jambs of 1.519 mm 16 gauge thickness. Provide counter of 1.897 mm 14 gauge thickness. Provide rolling counter doors, in exit corridor walls, with perimeter smoke and draft control gasketing.

2.6 AUTOMATIC CLOSING DEVICE

****

NOTE: Activation of the automatic closing device on fire rated counter doors will be by the building's fire alarm system or smoke/heat detector system when counter doors are located in smoke barriers and fire barriers, or where life safety would be endangered by fire and smoke if the doors were left open. Fusible link devices will only be used in those areas where protection of property from fire is the only consideration.

****

Equip fire-rated counter doors with an automatic closing device which operates upon [the fusing of a 74 degrees C 165 degree F fusible link] [activation of the building's [fire alarm system] [smoke alarm system] [heat detector system]. Furnish fire and smoke doors that easily reset by the facility user after they have been released by the detection system. Resetting the door must not require the use of special tools.]

2.7 FINISH

Exposed parts of the counter door, including the curtain, bottom rail, guides, and hood must be of uniform finish and appearance. Furnish [aluminum with a clear anodized finish.] [stainless steel with a No. 4 finish.] [steel galvanized coating with a [prime coat] [and] [a baked-on or powder-coated Factory top coat finish].] Give all other steel parts a shop coat of primer paint standard with the manufacturer. Provide a factory coated color [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____].

PART 3 EXECUTION

3.1 INSTALLATION

Install doors in accordance with approved detail drawings and manufacturer's instructions. Accurately locate anchors and inserts for guides, brackets, hardware, and other accessories. Upon completion, warped, twisted, or distorted doors are not acceptable. Lubricate, properly adjust, and demonstrate doors to operate freely. Conform fire-door installation with NFPA 80 for the class indicated and the manufacturer's instructions.

3.2 OPERATION

****

NOTE: Rolling counter doors over 3050 mm 10 feet wide, or where the interior counter is over 380 mm 15 inches deep, may use manual crank operation or

electric operation.
****

3.2.1 Manual Operation

Provide curtain operated by means of [manual push-up with lift handles or continuous full width lift bar] [manual crank with removable handle].

3.2.2 Power Operation

Furnish a high-starting torque, reversible type motor of sufficient power and torque output to move the door in either direction from any position at the required speed. Provide power operator with an emergency push-up operation, limit switch, three-button type control marked "OPEN", "CLOSE", and "STOP". Provide control voltage of [24 vac] [120 vac]. Provide conduit and wiring necessary for proper operation in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.3 TESTS

Drop-test the fire doors in accordance with NFPA 80 to show proper operation and full automatic closure and reset in accordance with the manufacturer's instructions. Provide a written record of initial test to the Contracting Officer.

3.4 FIELD FINISHING

Factory prime doors to receive field finishing as required, and then finish in accordance with Section 09 90 00 PAINTS AND COATINGS. Provide color [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____].

3.5 CLEANING

Clean aluminum and stainless steel doors in accordance with manufacturer's approved instructions. Submit Manufacturer's preprinted installation and cleaning instructions.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 33 23 (August 2020)**
Change 1 - 02/22

Preparing Activity: USACE **Superseding**
UFGS-08 33 23 (November 2019)
UFGS-08 34 19.10 20 (February 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 08 - OPENINGS

SECTION 08 33 23

OVERHEAD COILING DOORS

08/20, CHG 1: 02/22

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 33 23 (August 2020)**
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****

SECTION 08 33 23

OVERHEAD COILING DOORS

08/20, CHG 1: 02/22

****

NOTE: This guide specification covers the requirements for manually-operated, power-operated overhead coiling doors, and overhead coiling counter doors.

Verify drawings indicate door location, opening dimensions, wall thickness, side room and headroom clearances, structural framing above the door track, jamb conditions, location and type of electrical service, and remote-control stations, power characteristics, elevations, sections, details, materials, finishes, conditions for anchorage and support of each door. For fire-rated pass doors, comply with NFPA 80, Section 5.2.3.1.

Coordinate the weight of the door with the structural engineer if additional framing is required.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B29.400	(2001; (R 2008) (R 2013) (R 2018) (R 2023)) Combination, "H" Type Mill Chains, and Sprockets

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe,

	Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM F568M	(2007) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

DOOR AND ACCESS SYSTEM MANUFACTURERS ASSOCIATION (DASMA)

ANSI/DASMA 108	(2017) Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA ST 1	(1988; R 1994; R 1997) Specialty Transformers (Except General Purpose Type)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives

UL SOLUTIONS (UL)

UL 325	(2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems
UL 674	(2022) UL Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Coiling Doors[; G, [_____]]

Counterbalancing Mechanism[; G, [_____]]

Manual Door Operators[; G, [_____]]

Electric Door Operators[; G, [_____]]

Bottom Bars[; G, [_____]]

Guides[; G, [_____]]

Mounting Brackets[; G, [_____]]

Hood[; G, [_____]]

Installation Drawings[; G, [_____]]

SD-03 Product Data

Overhead Coiling Doors[; G, [_____]]

Hardware[; G, [_____]]

Counterbalancing Mechanism[; G, [_____]]

Manual Door Operators[; G, [_____]]

Electric Door Operators[; G, [_____]]

Fire-Rated Door Assembly[; G, [_____]]

Recycled content for steel curtain slats; S

Recycled content for stainless steel curtain slats; S

SD-05 Design Data

Overhead Coiling Doors[; G, [_____]]

Hardware[; G, [_____]]

Counterbalancing Mechanism[; G, [_____]]

Manual Door Operators[; G, [_____]]

Electric Door Operators[; G, [_____]]

Fire-Rated Door[; G, [_____]]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 2[; G, [_____]]

SD-11 Closeout Submittals

Warranty[; G, [_____]]

1.3 QUALITY CONTROL

****

NOTE: Select the appropriate design and fire rating classification. Depending on the size of the fire door, labeling and oversize certificates or labels vary with the individual manufacturers. Generic installation of a rolling fire door, as shown in NFPA 80 is applicable to masonry type fire walls and the manufacturer's listed procedures, or the authority having jurisdiction. Other wall construction listings such as non-masonry (drywall) are accomplished per the individual manufacturer's listed procedures or as approved by the authority having jurisdiction. Manufacturer's catalogs should be consulted for required headroom and side room.

Class A is typically 3 hours; Class B is typically 1 1/2 hours.

****

Provide fire-rated door assemblies bearing the Underwriters Laboratories, Warnock Hersey, Factory Mutual or other nationally recognized testing laboratory label for [Class [_____] rating.] [the rating listed on the drawings.] Provide a permanent label for each door showing the manufacturer's name and address, and the model/serial number of the door.

Provide oversized fire-rated door assemblies with a listing agency oversize label, or a certificate signed by an official of the manufacturing company certifying that the door and operator are designed to meet the specified

requirements.

1.3.1 Warranty

Furnish a written guarantee that the helical spring and counterbalance mechanism are free from defects in material and workmanship for not less than [two] [_____] years after completion and acceptance of the project.

Warrant that upon notification by the Government, any defects in material, workmanship, and door operation are immediately correct within the same time period covered by the guarantee, at no cost to the Government.

1.3.2 Operation And Maintenance Submittals

Submit [6] [_____] copies of the operation and maintenance manuals 30 calendar days prior to testing the Overhead Coiling Door Assemblies. Update and resubmit data for final approval no later than 30 calendar days prior to cContract completion.

Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies, including the following items:

[Manual Door Operators

] Electric Door Operators

[Hood

] Counterbalancing Mechanism

Painting

Provide operation and maintenance manuals which are consistent with manufacturer's standard brochures, schematics, printed instructions, operating procedures, and safety precautions.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Store doors in an adequately ventilated dry location that is free from dirt and dust, water, or other contaminants. Store in a manner that permits easy access for inspection and handling. Handle doors carefully to prevent damage. Remove damaged items that cannot be restored to like-new condition and provide new items.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: To provide maximum protection from the weather, exterior doors normally are installed on the interior face of the wall. Weather protection features should be considered for doors installed on the exterior face of the wall. In the following paragraph, edit as appropriate to identify if door(s) are for exterior or interior openings, and also to either require exterior doors to be mounted on interior face of walls or as indicated on

drawings. Additionally, select the desired means of operating the door(s), either by lifting handles, hand chain, hand crank, or electric power with auxiliary hand chain - designer needs to coordinate with building tenant for desired door operation.

Indicate the following information on the project drawings:

a. Size of door openings.

b. Type and details of door frames or jambs plus side room, jamb loads and door curtain deflection under pressure load.

c. All wire and conduit from source of power to the operators and controls for electric power operated doors.
****

Provide overhead coiling doors with interlocking slats, complete with anchoring and door hardware, guides, hood, and operating mechanisms, and designed for use on openings as indicated. Doors must be spring counterbalanced, rolling type, and designed for use on [exterior] [or] [interior] openings, as indicated. Doors must be operated [by means of lifting handles] [by hand chain with gear or sprocket reduction] [by hand crank with gear or sprocket reduction] [by electric-power with auxiliary hand chain operation]. Doors to be surface-mounted type with guides at jambs set back a sufficient distance to provide a clear opening when door is in open position. [Mount exterior doors [as indicated] [on interior face of walls].] [Where doors are indicated to be chain- or crank-operated, the door design and construction must allow for future installation of electric-power operation.]

2.1.1 Design Requirements

2.1.1.1 Door Detail Shop Drawings

Provide installation drawings for door assemblies which show: elevations of each door type, shape and thickness of materials, finishes, details of joints and connections, details of guides and fittings, rough opening dimensions, location and description of hardware, anchorage locations, and counterbalancing mechanism and door operator details. Show locations of replaceable fusible links on wiring diagrams for power, signal and controls. [For motor-operated doors include supporting brackets for motors, location, type, and ratings of motors, and safety devices.] Include a schedule showing the location of each door with the drawings.

2.1.2 Performance Requirements

****
NOTE: The IBC establishes criteria for wind loadings for buildings in hurricane-prone locations.
****

2.1.2.1 Wind Loading

Design and fabricate door assembly to withstand the wind loading pressure of at least [_____] kilopascal pounds per square foot in accordace with

ANSI/DASMA 108. Provide test data showing compliance with ASTM E330/E330M. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested. Ensure that the complete assembly meets or exceeds the requirements of ASCE 7-16.

2.1.2.2 Fire-Rated Doors, Frames, and Hardware

Provide fire-rated doors, frames, and hardware that are tested, rated, and labeled in accordance with Underwriters Laboratories, Factory Mutual or Warnock Hersey. Fire doors must be complete with hardware, accessories, and automatic closing device as required by NFPA 80. Indicate on the labels the rating in hours, per NFPA 80, of fire exposure duration. Additionally, ensure a letter follows the hourly rating to designate the location for which the assembly is designed and the temperature rise on the unexposed door face at the end of 30 minutes of fire exposure is required. The construction details necessary for labeled doors take precedence over details indicated or specified for non-labeled doors.

Provide and attach metal UL labels to the bottom bar.

2.1.2.3 Oversized Coiling Fire-rated Door Assemblies

Where fire-rated doors and frames exceed the size for which testing and labeling services are offered, furnish certificates of inspection from either UL, Factory Mutual or Warnock Hersey. State within certificates that except for size; doors, frames, and hardware are identical in design, materials, and construction to a door that has been tested and rated.

2.1.2.4 Operational Cycle Life

****

NOTE: The particular needs of the project are those that will be used to determine frequency of usage. The normal operating frequency for overhead coiling doors is 10 cycles per day. Typical rolling doors are designed for 15,000-20,000 spring cycles. If doors are expected to operate at a significantly higher frequency, the number of cycles per day or hour should be specified.

****

Design all portions of the door, hardware and operating mechanism that are subject to movement, wear, or stress fatigue to operate through a minimum number of [10] [_____] cycles per [day] [hour]. One complete cycle of door operation is defined as when the door is in the closed position, moves to the fully open position, and returns to the closed position.

2.2 COMPONENTS

2.2.1 Overhead Coiling Doors

2.2.1.1 Curtain Materials and Construction

****

NOTE: Unless required for security reasons or impact resistance, such as an industrial storage warehouse, for corrosion protection reasons select stainless steel or aluminum curtain materials for project locations with Environmental Severity

Classifications (ESC) of C3 thru C5. See UFC 1-200-01 for determination of ESC for a project location.

NOTE: For security applications, steel slats as heavy as 1.2 mm thick 18 gage may be specified.

****

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Where minimums are stated, research shows the product is available among US manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets and delete the first set of brackets.

****

[Provide curtain slats fabricated from Grade A steel sheets conforming to ASTM A653/A653M, with the additional requirement of a minimum yield point of 228 Megapascal 33,000 psi. Provide [22][20][18] gauge sheets, Grade 40 steel with galvanized steel zinc coating in conformance with ASTM A653/A653M and ASTM A924/A924M. Provide steel curtain slats containing a minimum of [20][_____] percent recycled content. Submit data identifying percentage of recycled content for steel curtain slats.

][Provide curtain slats fabricated from Type 304 stainless steel sheets conforming to ASTM A666; sheet thickness as required by the size of the door to meet the required windload. Provide stainless steel curtain slats containing a minimum of [60][_____] percent recycled content. Submit data identifying percentage of recycled content for stainless steel curtain slats.

][Provide curtain slats fabricated from aluminum sheets conforming to ASTM B209M ASTM B209, or ASTM B221M ASTM B221 extrusions, alloy and tempering standard from the manufacturer for type of use and finish indicated; with a thickness as required by the size of the door to meet the required windload.

] Fabricate doors from interlocking cold-rolled slats, with section profiles as specified, designed to withstand the specified wind loading. Ensure the provided slats are continuous without splices for the width of the door.

Provide slats filled with manufacturer's standard thermal insulation, complying with the maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84. Enclose the insulation completely within the slat faces on the interior surface of the slats.

2.2.1.2 Non-Insulated Curtains

****

NOTE: Where physical abuse of the doors may be a problem, the minimum decimal thickness of material (bare metal) should be specified for the various door widths. If physical abuse is not a factor, the decimal thickness of material may be determined by wind pressure alone and delete the references to door width. The referenced bare metal thicknesses do not include galvanization or paint coating thicknesses.

****

Form curtains from the manufacturer's standard shapes of interlocking slats.

2.2.1.3 Insulated Curtains

****

NOTE: Several manufacturers can provide insulated slats that comply with all specified requirements. Check manufacturers' literature for information on R-value. For severe climates, 38 mm 1 1/2 inch thick insulated slats with a "U" factor of 0.11 (R of 9) are available from some manufacturers. At least one manufacturer makes an oversize slat that provides increased insulation.

Do not specify insulated slats for fire doors.

****

Form curtains from manufacturer's standard shapes of interlocking slats. Supply a slat system with a minimum R-value of [4] [_____] when calculated in accordance with ASHRAE FUN IP. Slats to consist of a [urethane] [polystyrene] core not less than 17 mm 11/16 inch thick, completely enclosed within metal facings. Slat steel thickness as required by the size of the door to meet specified performance requirements. The insulated slat assembly requires a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E84.

2.2.1.4 Curtain Bottom Bar

Install curtain bottom bars as pairs of angles or using extrusions from the manufacturer's standard steel, stainless and aluminum extrusions not less than 50 by 50 millimeter by 4.8 millimeter 2.0 by 2.0 inches by 0.188 inch. Do not use aluminum on doors more than 1877 mm 16 feet wide. Ensure steel extrusions conform to ASTM A36/A36M. Stainless steel extrusions conforming to ASTM A666, Type 304. Aluminum extrusions conforming to ASTM B221M ASTM B221. Galvanize angles and fasteners in accordance with ASTM A653/A653M and ASTM A924/A924M. Coat welds and abrasions with paint conforming to ASTM A780/A780M.

[Provide two minimum 50 mm by 50 mm by 3.2 mm 2 inch by 2 inch by 1/8 inch structural steel angles.

][2.2.1.5 Vision Lites

****

NOTE: Indicate on drawings the size and location of vision panels.

****

Provide complete manufacturer's standard vision panels assembly consisting of clear acrylic glazing panels or fire-rated glass as required for the type door.

]2.2.1.6 Endlocks (and Windlocks)

Provide endlocks of Grade B cast steel conforming to ASTM A47/A47M, galvanized in accordance with ASTM A153/A153M. Secure locks at every other curtain slat. [In addition to endlocks, exterior doors which are more than 4877 mm 16 feet wide or which have a design wind load of more than 0.96 kilopascal 20 pounds per square foot, must have windlocks of manufacturer's standard design. Windlocks must prevent curtain from leaving guide because of deflection from wind pressure or other forces.]

2.2.1.7 Weather Stripping

Provide a hood baffle inside the hood that is a minimum 1.6 millimeter 1/16 inch thick sheet of vinyl, neoprene rubber or equivalent. Provide guide weather stripping that is a minimum 1.6 millimeter 1/16 inch thick sheet of vinyl, neoprene rubber, or equivalent.

Provide bottom bar weather-stripping that is a minimum 1.6 millimeter 1/16 inch thick sheet of vinyl, neoprene rubber, or equivalent.

2.2.1.8 Locking Devices

Ensure that the slide bolt engages through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

Provide a locking device assembly which includes cylinder lock, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

[Provide a chain lock keeper suitable for a standard padlock.

]2.2.1.9 Safety Interlock

Equip power-operated doors with a safety interlock switch to disengage power supply when the door is locked, or provide an operator with an internal lock sensing device to prevent the door opening when the door is locked.

2.2.2 Hardware

Ensure that all hardware conforms to ASTM A153/A153M, ASTM A307, and ASTM F568M.

2.2.2.1 Guides

****

NOTE: Indicate on drawings jamb-guide anchorage details.

****

Fabricate curtain jamb guides from the manufacturer's standard angles or channels of same material and finish as curtain slats unless otherwise indicated. Provide guides with sufficient depth or incorporate a steel locking bar to retain the curtain in place under the wind pressure specified. Ensure curtain operates smoothly. Slot bolt holes for track adjustment. Securely attach guides to adjoining construction with not less than 10 mm 3/8 inch diameter bolts, spaced near each end and not over 762 mm 30 inches apart.

[Ensure guides are roll-formed steel channel bolted to angle or structural grade, three angle assembly of [steel][stainless steel][aluminum] to form a slot of sufficient depth to retain curtains in guides to achieve 13.8 kilopascal 20 psf windload standard. Guides may be provided with integral windlock bars and removable bottom bar stops.

][Fabricate with [structural steel][stainless steel][aluminum] angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Flare the top of inner and outer guide angles outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.

]2.2.2.2 Hood

Provide a hood with a minimum[24-gauge][aluminum 18-gauge B&S][galvanized][stainless steel] sheet metal, flanged at top for attachment to header and flanged at bottom to provide longitudinal stiffness. The hood encloses the curtain coil and counterbalance mechanism.

[Hoods for openings more than 3658 mm 12 feet in width must have intermediate support brackets to prevent excessive sag.] [Provide a weather baffle at the lintel or inside the hood of each exterior door.

]2.2.3 Counterbalancing Mechanism

Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted, around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members.

2.2.3.1 Brackets

Provide the manufacturer's standard mounting brackets with one located at each end of the counterbalance barrel conforming to ASTM A36/A36M. Provide brackets of hot-rolled steel.

[Brackets will be of[5 mm 3/16 inch][6.35 mm 1/4 inch] minimum thick steel plates, with permanently sealed ball bearings. Designed to enclose ends of coil and provide support of counterbalance pipe at each end.

]2.2.3.2 Counterbalance Barrels

Curtain must roll up on a barrel supported at head of opening on brackets and be balanced by a torsion spring system in the barrel. Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, conforming to ASTM A53/A53M or equivalent. Ensure the barrel is of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats. Limit barrel deflection to not more than 2.5 mm per meter 0.03 inch per foot of span under full load.

a. Barrel

Provide steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot 2.5 mm per meter of width.

b. Spring Balance

Provide an oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door. Ensure that effort to operate manually operated units does not exceed 110 N 25 lbs. At least 80 percent of the door weight must be counterbalanced at any position. Provide wheel for applying and adjusting spring torque.

2.2.3.3 Spring Balance

****

NOTE: Delete the paragraph heading and the following paragraphs if Metal Rolling Counter Doors are not being used.

****

Install one or more oil-tempered, heat-treated steel helical torsion springs within the barrel, capable of producing sufficient torque to assure easy operation of the door curtain. Provide and size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

2.2.3.4 Torsion Rod for Counter Balance

Fabricate rod from the manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

[2.2.3.5 Counterbalance Shaft Assembly

[a. Barrel

Provide steel pipe capable of supporting the curtain load with maximum deflection of 2.5 mm per meter 0.03 inches per foot of width.

][b. Spring Balance

Provide an oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door. Ensure that maximum effort to operate does not exceed 110 Newton 25 pounds. Provide wheel for applying and adjusting spring torque.

]]2.2.4 Manual Door Operators

****

NOTE: Select desired method of manual operation paragraph from the following three paragraphs and delete the remaining two paragraphs.

****

[2.2.4.1 Manual Push-Up Door Operators

Provide lifting handles on both sides of door and counterbalance in a manner to provide easy operation while raising or lowering the curtain by hand. Adjust counterbalance mechanisms so that the required lift or pull for operation does not exceed 11 kilogram 25 pounds unless another type of door operator is indicated. Provide pull-down straps or pole hooks on bottom rail of doors over 2134 mm 7 feet high.

][2.2.4.2 Manual Chain-Hoist Door Operators

Provide door operators which consist of an endless steel hand chain, chain-pocket wheel, guard, and a geared reduction unit [of at least a 3 to 1 ratio] [with a maximum lifting force of[111 N 25 lbf][133 N 30 lbf]]. Required pull for operation cannot exceed 16 kilogram 35 pounds. Chain must extend to within 914 mm 3 feet of floor.

Provide chain hoists with a mechanism allowing the curtain to be stopped at any point in its upward or downward travel and to remain in that position until moved to the fully open or closed position. Provide hand chains of galvanized steel. Ensure that the yield point of the chain is at least three times the required hand-chain pull.

Provide chain sprocket wheels of cast iron conforming to ASTM A48/A48M.

][2.2.4.3 Manual Crank-Hoist Door Operators

Provide door operators which consist of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit with a maximum[111 N 25 lbf][133 N 30 lbf] force to turn crank. Fabricate gearbox to be oil tight and to completely enclose operating mechanism. Gears must be high-grade gray iron, cast from machine-cut patterns.

]2.2.5 Electric Door Operators

****

NOTE: Delete the paragraph heading and the following paragraphs if electric door operation is not required.

Refer to DIVISION 26 ELECTRICAL, for electrical requirements and equipment with a fire-protection system.

Delete bracketed paragraph relating to hazardous locations where it does not apply. Doors to which it is applicable should be identified in the specifications.

****

Provide electrical wiring and door operating controls conforming to the applicable requirements of NFPA 70 and UL 325. The door manufacturer must furnish automatic control and safety devices, including extra flexible type SO cable and spring-loaded automatic takeup reel or equivalent device, as required for proper operation of the doors. Conduit, wiring, and mounting of controls are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

[Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70, must be specifically approved by Underwriters Laboratories or an independent testing agency using equivalent standards, for the particular chemical group and the class and division of hazardous location involved.

] Electric door-operator assemblies need to be the sizes and capacities recommended and provided by the door manufacturer for specified doors.

Furnish complete assemblies with electric motors and factory-prewired motor controls, starter, gear reduction units, solenoid-operated brakes, clutch, remote-control stations, manual or automatic control devices, and accessories as required for proper operation of the doors.

Design the operators so that motors may be removed without disturbing the limit-switch adjustment and affecting the emergency auxiliary operators.

Provide a manual operator of crank-gear or chain-gear mechanisms with a release clutch to permit manual operation of doors in case of power failure. Arrange the emergency manual operator so that it may be put into and out of operation from floor level, and its use does not affect the adjustment of the limit switches. Provide an electrical or mechanical device that automatically disconnects the motor from the operating mechanism when the emergency manual operating mechanism is engaged.

2.2.5.1 Door-Operator Types

[Provide an operator mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.]

[Provide an operator mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.]

[Provide an operator mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.]

[Provide a bench mounted operator mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.]

[Provide a through-wall operator which is mounted on other side of wall from coil side of door.]

2.2.5.2 Electric Motors

Provide motors which are the high-starting-torque, reversible, constant-duty electrical type with overload protection of sufficient torque and wattage horsepower to move the door in either direction from any position. Ensure they produce a door-travel speed of not less than 0.2 nor more than 0.3 meter 8 nor more than 12 inches per second without exceeding the wattage horsepower rating.

Provide motors which conform to NEMA MG 1 designation, temperature rating, service factor, enclosure type, and efficiency to the requirements specified. Motors must be suitable for operation on current of the characteristics indicated.[Single-phase motors must not have commutation or more than one starting contact.][Motor enclosures must be the drip-proof type or NEMA TEFC and TENV type.] Install motors in approved locations.

[Certify and label explosion-proof motors to indicate conformance to the

following:

[UL 674, Class I, Groups C and D]

[UL 674, Class II, Groups F and G]]

2.2.5.3 Motor Bearings

Select bearings with bronze-sleeve or heavy-duty ball or roller antifriction type with full provisions for the type of thrust imposed by the specific duty load.

Pre-lubricate and factory seal bearings in motors less than 375 watts 1/2 horsepower.

Equip motors coupled to worm-gear reduction units with either ball or roller bearings.

Equip bearings in motors 375 watts 1/2 horsepower or larger with lubrication service fittings. Fit lubrication fittings with color-coded plastic or metal dust caps.

In any motor, bearings that are lubricated at the factory for extended duty periods do not need to be lubricated for a given number of operating hours. Display this information on an appropriate tag or label on the motor with instructions for lubrication cycle maintenance.

2.2.5.4 Motor Starters, Controls, and Enclosures

Provide each door motor with: a factory-wired, unfused, disconnect switch; a reversing, across-the-line magnetic starter with thermal overload protection; 24-volt operating coils with a control transformer limit switch; and a safety interlock assembled in a NEMA ICS 6 type enclosure as specified herein. Ensure control equipment conforms to NEMA ICS 1 and NEMA ICS 2.

Provide adjustable switches, electrically interlocked with the motor controls and set to stop the door automatically at the fully open and fully closed position.

2.2.5.5 Control Enclosures

Provide control enclosures that conform to NEMA ICS 6 for [NEMA Type 4][NEMA Type 4X][general purpose NEMA Type 1]. [oil-tight and dust-tight NEMA Type 12.] [explosion-proof, NEMA Type 7, group as indicated.] [explosion-proof NEMA Type 9, group as indicated.]

2.2.5.6 Transformer

Provide starters with 230/460 to 115 volt control transformers with one secondary fuse when required to reduce the voltage on control circuits to 24volts or less. Provide a transformer conforming to NEMA ST 1.

2.2.5.7 Sensing-Edge Device

****

NOTE: Coordinate location of devices on drawing elevations.

****

Provide each door with a pneumatic or electric sensing device that meets UL 325, extends the full width of the door, and is located within a U-section neoprene or rubber astragal, mounted on the bottom rail of the bottom door section. Device needs to immediately stop and reverse the door upon contact with an obstruction in the door opening or upon failure of the device or any component of the control system and cause the door to return to its user-defined open position. Any momentary door-closing circuit must be automatically locked out and the door must be operable manually or with constant pressure controls until the failure or damage has been corrected. A sensing device is not a substitute for a limit switch.

Connect sensing device to the control circuit through a retracting cord and reel.

2.2.5.8 Remote-Control Stations

[Remote control stations must be at least 1500 mm 5 feet above the floor line, and all switches must be located so that the operator will have complete visibility of the door at all times. Provide interior remote control stations that are full-guarded, momentary-contact three-button, heavy-duty, surface-mounted NEMA ICS 6 type enclosures as specified. Mark buttons "OPEN," "CLOSE," and "STOP." The "OPEN" and "STOP" buttons must be of the type requiring only momentary pressure to operate. The "CLOSE" button must be of the type either requiring constant pressure to maintain the closing motion of the door or momentary pressure when installed with a monitored entrapment detection device which, upon failure of the device or any component of the control system, cause the door to return to its full open position. When the door is in motion and the "STOP" button is pressed, ensure the door stops instantly and remains in the stopped position. From the stopped position, the door may then be operated in either direction by the "OPEN" or "CLOSE" buttons. When the door is in motion, and the "CLOSE" button of the constant pressure type is released, the door must stop and remain in the stop position or reverse to the user set up position; from the stop position, the door may then be operated in either direction by the "OPEN" or "CLOSE" buttons. Controls must be adjustable to automatically stop the doors at their fully open and closed positions. Open and closed positions must be readily adjustable.]

[Provide exterior control stations that are full-guarded, momentary-contact three-button standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosures, key-operated, with the same operating functions as specified herein for interior remote-control stations.]

2.2.5.9 Speed-Reduction Units

Provide speed-reduction units consisting of hardened-steel worm and bronze worm gear assemblies or planetary gear reducers running in oil or grease and inside a sealed casing, coupled to the motor through a flexible coupling. Drive shafts need to rotate on ball- or roller-bearing assemblies that are integral with the unit.

Provide minimum ratings of speed reduction units in accordance with AGMA provisions for class of service.

Ground worm gears to provide accurate thread form; machine teeth for all other types of gearing. Surface harden all gears.

Provide antifriction type bearings equipped with oil seals.

2.2.5.10 Chain Drives

Provide roller chains that are a power-transmission series steel roller type conforming to ASME B29.400, with a minimum safety factor of 10 times the design load.

Heat-treat or otherwise harden roller-chain side bars, rollers, pins, and bushings.

Provide high-carbon steel chain sprockets with machine-cut hardened teeth, finished bore and keyseat, and hollow-head setscrews.

2.2.5.11 Brakes

Provide 360-degree shoe brakes or shoe and drum brakes. Ensure the brakes are solenoid-operated and electrically interlocked to the control circuit to set automatically when power is interrupted.

2.2.5.12 Clutches

Ensure clutches are friction type or adjustable centrifugal type.

2.2.5.13 Weather/Smoke Seal Sensing Edge

Provide automatic stop control by an automatic sensing switch within neoprene astragal extending the full width of door bottom bar.

Provide an electric sensing edge device. Ensure the door immediately stops downward travel when contact occurs before door fully closes. Provide a self-monitoring sensing edge connection to the motor operator.

2.2.6 Fire-Rated Door Assembly

Provide fire-rated door assemblies with the dimensions, fire rating, and operating type indicated with electric operators and assemblies that do not interfere with manufacturer's standard interconnecting fusible links. Equip fire doors with an automatic closing mechanism. Doors must be forced into a closed position at a rate of descent of not more than 0.61 meters 2 feet per second and not less than 0.15 meters 6 inches per second without impact. The curtain must be held against the sill until the release mechanism has been reset. The automatic closing mechanism must not interfere with normal operation of the door.

[Provide the door manufacturer's standard interconnecting fusible links for door assemblies on both sides of the wall opening.

]2.2.6.1 Fire Ratings

Provide fire-rated door assemblies complying with NFPA 80 Standard for Fire Doors and Other Opening Protectives. Fire doors must be complete with hardware, accessories, and automatic closing device as required by NFPA 80.

2.2.7 Surface Finishing

Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Noticeable variations in the same metal component are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

2.2.7.1 Galvanized and Shop-Primed Finish

****

NOTE: Include the bracketed item below for projects in locations with Environmental Severity Classifications of ESC C1 or C2 (noncorrosive locations) or where the internal space is conditioned and the coiling door will be maintained in a closed position. Refer to UFC 1-200-01 for determination of ESC for project locations.

****

Surfaces specified must have a zinc coating, a phosphate treatment, and a shop prime coat of rust-inhibitive paint. The galvanized coating must conform to ASTM A653/A653M, coating designation Z275 (G90), for steel sheets[, except that hoods located on interior of the building may be Z180 (G60)], and ASTM A123/A123M for iron and steel products. The weight of coatings for products must be as designated in Table I of ASTM A123/A123M for the thickness of base metal to be coated. The prime coat must be a type especially developed for materials treated by phosphates and adapted to application by dipping or spraying. Repair damaged zinc-coated surfaces by the materials and methods conforming to ASTM A780/A780M and spot prime. At the option of the Contractor, a two-part system including bonderizing, baked-on epoxy primer, and baked-on enamel top coat may be applied to slats and hoods before forming, in lieu of prime coat specified.

2.2.7.2 Baked-Enamel or Powder-Coat Finish

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NOTE: Baked-Enamel is less expensive than a Powder-Coat Finish. The benefits of powder coatings are a smoother, more durable finish and availability in a variety of colors.

****

Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with the coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 EXECUTION

3.1 INSTALLATION

Install overhead coiling door assembly, anchors and inserts for guides, brackets, motors, switches, hardware, and other accessories in accordance with approved detail drawings and manufacturer's written instructions. Upon completion of installation, ensure doors are free from all distortion.

Install overhead coiling doors, motors, hoods, and operators at the mounting locations as indicated for each door in the Contract Documents and as required by the manufacturer.

Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility and as required by the manufacturer.

3.1.1 Field Painted Finish

Ensure field painted steel doors and frames are in accordance with Section 09 90 00 PAINTS AND COATINGS and the manufacturer's written instructions. Protect the weather stripping from paint. Ensure that the finishes are free of scratches or other blemishes.

3.2 ADJUSTING AND CLEANING

3.2.1 Acceptance Provisions

After installation, adjust the hardware and moving parts. Lubricate bearings and sliding parts as recommended by manufacturer to provide smooth operating functions for ease movement, free of warping, twisting, or distortion of the door assembly.

Adjust seals to provide a weather-tight fit around entire perimeter.

Engage a factory-authorized service representative to perform startup service and checks according to the manufacturer's written instructions.

Test the door opening and closing operation when activated by controls[or alarm-connected fire-release] system. Adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Reset the door-closing mechanism after a successful test.

Test and make final adjustment of new doors at no additional cost to the Government.

3.2.1.1 Maintenance and Adjustment

Not more than 90 calendar days after completion and acceptance of the project, examine, lubricate, test, and re-adjust doors as required for proper operation.

3.2.1.2 Cleaning

Clean doors in accordance with manufacturer's approved instructions.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 34 01 (August 2009)**

Preparing Activity: USACE **Superseding**
UFGS-08 34 01 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 08 - OPENINGS

SECTION 08 34 01

FORCED ENTRY RESISTANT COMPONENTS

08/09

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-08 34 01 (August 2009)**

Preparing Activity: USACE **Superseding**
UFGS-08 34 01 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 34 01

FORCED ENTRY RESISTANT COMPONENTS
08/09

****

NOTE: This guide specification covers requirements for forced entry resistant door assemblies, window assemblies, louvers, pass-through drawers, and prefabricated guardhouses.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: The manuals listed below contain information on the forced entry tactic.

UFC 4-020-1 Security Engineering - Project Development

UFC 4-020-2FA Security Engineering - Concept Design

UFC 4-020-3FA Security Engineering - Final Design

These manuals are marked "For Official Use Only", and they may be ordered by Department of the Army agencies from the U.S. Army Publications

Distribution Center, 2800 Eastern Blvd., Baltimore, MD 21220-2896.

UFC 4-020-1 defines threats to military assets including the forced entry tactic in terms of weapons, tools, and explosives. The threat to an asset may be developed using the threat analysis procedure described in UFC 4-020-1. UFC 4-020-2FA and UFC 4-020-3FA contain guidance on design and protective measures to resist forced entry and other tactics. To be effective, a forced entry resistant component must be part of a forced entry resistant construction envelope that protects and asset. Refer to appendix C of UFC 4-020-2FA for a table of components and construction elements that are rated against various threat severity levels of the forced entry tactic. If a designer chooses to design components for shop fabrication, the materials should be specified in appropriate sections including Section 08 31 00 ACCESS DOORS AND PANELS.

At the time of preparation of this specification, manufacturers had not tested vehicle doors to the forced entry test standards covered herein. The designer may specify oversized swinging doors or specify a door for vehicle entry to meet a forced entry test standard as an alternate bid item, or under a separate bid request doors to be tested in accordance with the required test standard. If the latter is chosen, allow long lead time for the manufacturer to design, test, and receive approval of the door.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the

basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASM INTERNATIONAL (ASM)

ASM STFA	(2001; 6th Ed) The Surface Treatment and Finishing of Aluminum and Its Alloys (2 Vol.)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C1036	(2021) Standard Specification for Flat Glass
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM C1172	(2024) Standard Specification for Laminated Architectural Flat Glass
ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D542	(2014) Index of Refraction of Transparent Organic Plastics
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D638	(2014) Standard Test Method for Tensile

	Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D905	(2008; E 2009) Strength Properties of Adhesive Bonds in Shear by Compression Loading
ASTM D1003	(2013) Haze and Luminous Transmittance of Transparent Plastics
ASTM D1044	(2019) Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion by the Taber Abraser
ASTM D1922	(2015; R 2020) Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method
ASTM D3595	(2014) Polychlorotrifluoroethylene (PCTFE) Extruded Plastic Sheet and Film
ASTM D3951	(2018) Commercial Packaging
ASTM D4093	(1995; R 2014) Photoelastic Measurements of Birefringence and Residual Strains in Transparent or Translucent Plastic Materials
ASTM D4802	(2016) Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet
ASTM D5420	(2016) Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Strike Impacted by a Falling Weight (Gardner Impact)
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E169	(2016; R 2022) Standard Practices for General Techniques of Ultraviolet-Visible Quantitative Analysis
ASTM E831	(2024) Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis

ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM F428	(2019; R 2024) Intensity of Scratches on Aerospace Glass Enclosures
ASTM F520	(2021) Standard Test Method for Environmental Resistance of Aerospace Transparencies to Artificially Induced Exposures
ASTM F521	(2022) Standard Test Methods for Bond Integrity of Transparent Laminates
ASTM F548	(2019; R 2024) Standard Test Method for Intensity of Scratches on Aerospace Transparent Plastics
ASTM F735	(2022; E 2022) Standard Test Method for Abrasion Resistance of Transparent Plastics and Coatings Using the Oscillating Sand Method
ASTM F791	(1996; R 2013) Stress Crazing of Transparent Plastics
ASTM F1233	(2021) Standard Test Method for Security Glazing Materials and Systems
ASTM G155	(2021) Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.1	(2021) Butts and Hinges
ANSI/BHMA A156.4	(2024) Door Controls - Closers
ANSI/BHMA A156.5	(2020) Cylinder and Input Devices for Locks
ANSI/BHMA A156.8	(2021) Door Controls - Overhead Stops and Holders
ANSI/BHMA A156.13	(2022) Mortise Locks & Latches Series 1000
ANSI/BHMA A156.16	(2023) Auxiliary Hardware
ANSI/BHMA A156.18	(2020) Materials and Finishes
ANSI/BHMA A156.115	(2016) Hardware Preparation in Steel Doors and Steel Frames

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2008) Glazing Manual

H.P. WHITE LABORATORY (HPW)

HPW TP-0500.03	(2003) Transparent Materials for use in Forced Entry or Containment Barriers

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMMA 801	(2012; R 2018) Glossary of Terms for Hollow Metal Doors and Frames
NAAMM HMMA 802	(2007) Manufacturing of Hollow Metal Doors and Frames
NAAMM HMMA 810	(2009) Hollow Metal Doors
NAAMM HMMA 820	(2008) Hollow Metal Frames
NAAMM HMMA 830	(2002) Hardware Selection for Hollow Metal Doors and Frames

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 80A	(2022) Recommended Practice for Protection of Buildings from Exterior Fire Exposures

U.S. DEPARTMENT OF STATE (SD)

SD Std-01.01	(1993 Rev G Amended; Inx Certified Prod/Mfg) Certification Standard Forced Entry and Ballistic Resistance of Structural Systems

UL SOLUTIONS (UL)

UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, [_____]

SD-03 Product Data

Forced Entry Resistant Components

Installation

Components

SD-07 Certificates

Forced Entry Resistant Components; G, [_____]

1.3 QUALITY ASSURANCE

****

NOTE: The project forced entry threat must be identified before selection of test standard. The designer will then select the forced entry testing standard that most represents the threat, using Table I. The designer will then indicate the applicable test standard in paragraph COMPONENT TEST REQUIREMENTS or on the drawings in door, window, or other component schedule.

If project criteria includes more than one forced entry threat, each component will be correlated with the appropriate test standard it is required to meet.

Test standards should be selected based on the forced entry threat as defined in UFC 4-020-1 for a given asset. The forced entry tactic has associated

with it five threat severity levels consisting of very low, low, medium, high, and very high.

There is no single uniform standard for forced entry resistance. Each testing agency has its own parameters. Variables include the tools used, the attack time, the attack team size, and the failure criteria. Some standards apply only to specific components. Verify that the test standard is applicable to components being specified.

Bullet and forced entry resistant window design. Refer to Section 08 34 02, BULLET-RESISTANT COMPONENTS, when specifying ballistic threats only. Where both forced entry and ballistic resistance are required, the designer must substantially alter and combine the pertinent parts of this UFGS and UFGS Section 08 34 02. Combined forced entry and ballistic testing procedures are included in SD Std-01.01 and ASTM F1233.

TABLE I - EQUIVALENT FORCED ENTRY STANDARDS						
Forced Entry Standard						
Threat Severity Levels	Number of Attackers (where applicable)	Attack Times (minutes) (where applicable)	Very Low	Low	Medium	High
ASTM F1233						
Class IV	---	Variable	X			
Class V	---	Variable		X		
HPW TP-0500.03						
Level II	---	Variable	X			
Level III	---	Variable	X			
Level IV	---	Variable		X		
Level V	---	Variable		X		
SD Std-01.01						
5 Minute Protection Level	2	5		X		
15 Minute Protection Level	2	15		X		

TABLE I - EQUIVALENT FORCED ENTRY STANDARDS						
Forced Entry Standard						
Threat Severity Levels	**Number of Attackers (where applicable)**	**Attack Times (minutes) (where applicable)**	**Very Low**	**Low**	**Medium**	**High**
60 Minute Protection Level	**2**	**60**		**X**		

ABBREVIATIONS:

ASTM	**- American Society for Testing and Materials**
HPW	**- H. P. White Laboratories**
UL	**- Underwriters Laboratories, Inc.**
SD	**- U. S. Department of State**

The forced entry test standards described below include both those developed and used by independent testing laboratories and those developed for specific application by other Government agencies. These standards differ in attack tools employed, the number of persons (if any) used in the attack force, the attack duration, and the failure criteria. Before specifying construction components to meet a standard, obtain the standard and become familiar with it. A brief description follows each standard and, when possible, the standard is equated to forced entry severity levels from UFC 4-020-1.

1. American Society for Testing and Materials (ASTM).

a. "Standard Test Method for Security Glazing Materials and Systems," ASTM F1233. Acceptance of component is determined by one of the following: ballistics attack only; physical attack only to include blunt tool impacts, sharp tool impacts, thermal stress, and chemical deterioration; or ballistics attack followed by and in combination with physical attack. The physical attack tools used in the Class V testing sequence are similar to the "low forced entry severity level." The physical attack tools used in the Class IV testing sequence are similar to the "very low forced entry severity level." The use of power tools or devices requiring more than two persons to transport or operate is specifically exempted from testing. This test method defines two factors (the tools employed and the techniques and methods used by the attackers) and allows a third factor (duration) to vary in order to establish severity levels of forced entry.

b. "Test Methods for Resistance of Window

Assemblies to Forced Entry, Excluding Glazing", ASTM F588. This specification applies to window assemblies of various materials and types of construction. Five window types are classified. The tests are intended to establish a measure of resistance to attack by unskilled or opportunistic burglars. Tests include hand manipulation, tool manipulation, static load, and locking device strength resistance. This testing is at a level comparatively below the "very low forced entry severity level."

2. H. P. White Laboratories: "Transparent Materials and Assemblies for Use in Forced Entry or Containment Barriers," HPW TP-0500.03. This standard was developed by H. P. White Laboratories for commercial, governmental, or military application and generally is used in testing prison (forced exit resistant) components. This test method defines two of three factors (tools and techniques) and varies the third factor (time) to establish five levels of forced entry resistance. Levels I, II, III, IV, and V specify attack tools and sequences of attacks with the specified tools. Attack weapons and tools include hand tools, propane and acetylene torch, chemical solvents, and five levels of ballistic assault. The ballistic threats are considered integral to the forced entry rating in this standard and differ from those in other H. P. White standards. Tests are conducted on either a 915 x 1220 mm 3 x 4 foot specimen of transparent material or on a complete assembly.

3. International Code Council, "Tests for Window Assemblies," UBC 41.2. Describes the following tests which are related to security windows: hand manipulation, tool manipulation, static load, and locking device tests. This testing is at a level comparatively below the "very low forced entry severity level."

4. National Institute of Justice (NIJ). "Physical Security of Window Units," NIJ 0316.00-80. Use of the NIJ standard for Army application is limited because it describes construction types which have been demonstrated to have minimal penetration times against the more sophisticated threats. This specification describes four classes of physical security by describing the window types indicated below. This testing is at a level comparatively below the "very low forced entry severity level."

a. Class I (Grade 10)--minimum level: Regular glazing in commercial sash; double locks; wood frame acceptable.

b. Class II (Grade 20)--moderate level: Heavy-duty sash with laminated or polycarbonate glazing; wood sash must be reinforced or heavy.

c. Class III (Grade 30)--medium level: Heavy-duty sash with laminated glass over 6 mm 1/4 inch thick or polycarbonate glazingr 6 mm 1/4 inch thick; locks should include two heavy-duty deadlocking bolts.

d. Class IV (Grade 40)--high level: Very heavy fixed frames with laminated glass overr 6 mm 1/4 inch thick or security screen, bars, or shutters with special locking devices.

e. Window performance requirements include lock tests for stability (cycles of unlocking motion) and strength (loads ranging from 218 N 49 lb. force to 3350 N 753 lb. force; sash strength (218 N(49 lb. force) primary and secondary loads to 445 N 100 lb. force primary load, 3350 N 753 lb. force secondary load) and impact resistance (not applicable to Class I, Grade 10; other classes range from one impact at 50 J 37 ft-lb force to 10 at 100 J 74 ft-lb force); and glazing impact test (same as for sash impact).

5. Underwriters Laboratories Inc. (UL), "Standard for Burglary Resisting Glazing Material," UL 972, evaluates a glazing material's ability to withstand multiple impacts over a wide temperature range. Impact testing is standardized rather than subjecting the specimen to actual physical attack simulations by persons who can analyze and exploit the weaknesses of specimens. A steel ball is dropped a number of times from different heights. The intent of this standard is to replicate hit-and-run burglary attacks on commercial establishments. This testing is at a level below the "very low forced entry severity level."

6. U. S. Department of State (SD).

"SD Std-01.01. This standard was developed for determining the forced entry resistance of building components to be used in State Department facilities. The protection level is 5, 15, or 60 minutes. The tools are similar to the low forced entry severity level. This standard is for the testing of louvers, fixed windows and panels, and doors. Testing is performed by a two-member team for the 5-minute protection level and by a six-member team for the 15- and 60-minute protection levels. Penetration time is considered to be when an opening has been created which allows passage of either a solid, incompressible object 300 x 300 x 200 mm 12 x 12 x 8 inches or a solid, incompressible right cylinder 300 x 300 mm 12 x 12 inches. Both a forced entry and a ballistic rating can be obtained on the same component if the component passes the ballistic and forced entry tests contained in the test standard.

Add more rows of information when necessary.

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Qualify welding procedures, welders, and welding operators in accordance with AWS D1.1/D1.1M. Forced entry resistant components must be certified as resistant to the forced entry test standards indicated herein. Test forced entry resistant components as specified below. The test results and certification thereof must be approved by the Contracting Officer before delivery of the component to the job site.

Component	Test Standard	Level Within Test Standard (If	Minimum Attack Time (Minutes)
[_____]	ASTM F1233	Class IV	Variable
[_____]	ASTM F1233	Class V	Variable
[_____]	HPW TP-0500.03	Prolonged	180
[_____]	HPW TP-0500.03	Level II	Variable
[_____]	HPW TP-0500.03	Level III	Variable
[_____]	HPW TP-0500.03	Level IV	Variable
[_____]	HPW TP-0500.03	Level V	Variable
[_____]	SD Std-01.01	5 Minute	5
[_____]	SD Std-01.01	15 Minute	15
[_____]	SD Std-01.01	60 Minute	60

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver Components to the job site with the manufacturer's name, and model number clearly marked thereon. Deliver, store, and handle components so as not to be damaged or deformed and in accordance with ASTM D3951. Carefully handle components to prevent damage to the faces, edges, corners, ends, and glazing where applicable. Clean, repair, or replace immediately abraded, scarred, or rusty areas upon detection of the damage. Replace damaged components that cannot be restored. Store components and equipment in a dry location on platforms or pallets that are ventilated adequately, free of dust, water, and other contaminants, and stored in a manner which permits easy access for inspection and handling. Submit lists including schedule of components to be incorporated in the work with manufacturer's model or catalog numbers, specification and drawing reference numbers, warranty information, threat level designated, [fire ratings,] [sound transmission coefficient ratings,] [insulation "U" value,] and number of items provided. Listing of similar products that have been satisfactorily in use for two years or more, including name of purchasers, locations of installations, dates of installations, and service organizations.

1.5 SEQUENCING AND SCHEDULING

When testing of a previously untested component is specified, allow sufficient lead time so that testing will not delay construction. The test results and component must be approved by the Contracting Officer before delivery of the component to the job site.

1.6 WARRANTY

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NOTE: A warranty for all glazings should be specified. The designer will determine availability of warranty.

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Furnish manufacturer's warranty for [_____] [5] years for glazing materials. Warranty must provide for replacement and installation of glazing if delamination, discoloration, or cracking or crazing occurs.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

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NOTE: This specification is to be used for components identified as forced entry resistant. The designer will clearly distinguish on the drawings, such as on door, window, and louver schedules, which components are to be forced entry resistant.

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2.1.1 General Requirements

Components covered in this specification are designed to resist forced entry attacks with increasing severity levels of hand, power, and thermal tools and weapons and explosives. The components include forced entry resistant [personnel door/frame assemblies] [louvers] [windows] [glazing for doors] [pass-through drawers] [prefabricated guardhouses]. Each type of forced entry resistant component must be a complete assembly produced by a single manufacturer. Provide movable and operable components that operate smoothly and freely. Design items for exterior installation to resist water and vapor penetration or entrapment. Submit manufacturer's descriptive data, installation instructions, and certificate and test report showing compliance with the specified forced entry test standard as specified in paragraph COMPONENT TEST REQUIREMENTS for all components. [Following approval of manufacturer's descriptive data, submit a schedule listing the items and components to be furnished.] Submit manufacturer's certificate indicating that compliance with the installation instructions [and drawings] will provide the specified degree of forced entry resistance.

2.1.2 Other Submittal Requirements

Submit the following:

a. Manufacturer's descriptive data and finish samples.

b. The forced entry resistant door lock functions, for selection by the Contracting Officer.

c. Airflow calculations for louvers.

d. Manufacturer's certificates attesting that components conform to the requirements on drawings and in specifications.

e. Testing reports from independent testing laboratories indicating conformance to regulatory requirements.

f. Certificate, in lieu of a label, for fire rated doors.

g. Certificate indicating compliance with the requirements for doors of the type and fire rating class.

h. Manufacturer certification that compliance with the installation instructions and/or drawings will provide the specified degree of forced entry resistance.

2.2 COMPONENTS

For each type of forced entry resistant component, provide the standard product of a manufacturer regularly engaged in the manufacture of such products and duplicate items that have been tested and approved in accordance with the forced entry test standard specified in paragraph COMPONENT TEST REQUIREMENTS.

2.3 FORCED ENTRY RESISTANT PERSONNEL DOOR AND FRAME ASSEMBLIES

Provide doors and frames that are factory fabricated assemblies of indicated sizes. Provide doors consisting of steel, hardened steel, or reinforced internally with steel shapes and clad with aluminum. Provide interior composition and reinforcement determined by the manufacturer. Install rubber silencers on door frames. Close top edges of exterior doors flush and seal against water penetration, insulate, and provide with weatherstripping and thresholds. Provide locks and hinges that are the same or equal in performance and number as the hardware used on the tested door. Provide manufacturer's lock and hardware as a complete assembly. Furnish frames from the door fabricator, with anchorage to wall construction completely specified as to number of anchors, anchor size, material, and length.

2.3.1 Fire Rated Doors

Provide fire rated doors at locations indicated. Provide door assemblies complying with the forced entry test standard specified and bearing the listing identification label of the Underwriters' Laboratories, Inc. or a nationally recognized testing laboratory that is qualified to perform tests of fire door assemblies in accordance with UL 10B, and that has a listing service for the tested assemblies. Door assemblies include door, hardware, frame, closers, and glazing. A certificate indicating that the units were inspected in accordance with NFPA 80 and NFPA 80Amay be furnished in lieu of label. For oversized doors, a certificate from Underwriters' Laboratories, Inc. or a nationally recognized testing laboratory may be furnished in lieu of label. State that oversized doors are manufactured in compliance with the requirements for doors of the type and fire rating class. Submit manufacturer's descriptive data.

2.3.2 Sound Rated Doors

Provide sound rated doors at locations indicated. Provide door assemblies complying with the forced entry test standard specified and consisting of door, hardware, frame, threshold, and adjustable gaskets. The assembly must have a laboratory Sound Transmission Class (STC) rating [of [_____]] [as indicated] when tested in accordance with ASTM E90. Submit manufacturer's descriptive data, test report, and certification of the test report showing compliance with the specified requirements.

2.3.3 Door and Frame Fabrication

The subsurfaces must be flat, parallel, and plumb after fabrication. Provide doors that are reinforced [and fully insulated] in accordance with manufacturer's design. Anchor door frames as specified by the door manufacturer. Coordinate the door manufacturer's requirements for welding to wall reinforcement or casting frame embedments into wall before wall is placed. Miter or cope steel door frames and weld at the corners with welds ground smooth. Where structural channel frames are used, specify the size, weight, stops, welding, and anchorage into surrounding construction and test along with the door as an assembly. Make any necessary reinforcements in the door and the frame in the factory. Drill and tap door and frame as required for the specified hardware. Miter or cope frame channels and weld at corners with full penetration groove welds. Dress smoth exposed welds. Manufacture hollow metal doors and frames in accordance with NAAMM HMMA 801, NAAMM HMMA 802, NAAMM HMMA 810, and NAAMM HMMA 820 as a standard of quality, and meet the specified forced entry testing standard.

2.3.4 Sidelight Frames and Door Glazing

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NOTE: Designers should avoid sidelights because they make the door assembly more susceptible to prying and jamb spreading. When they are used, reinforce side jambs with heavy structural steel anchored at the top and bottom.

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Construct sidelight frames using forced entry resistant door frame sections. For glazing in door or sidelight, provide stop height and rabbet depth as required to accommodate the glazing material that is resistant to the forced entry test standard specified. Test the assembly with the specified glazing and stops installed. Exterior (attack side) glazing stops must be welded or integral to the frame. Provide removable interior (protected side) glazing stops attached with high-strength alloy steel machine screws with tamper-resistant heads or as required by the manufacturer. Glazing is specified in paragraph Forced Entry Resistant Glazing Materials.

2.3.5 Preparation for Hardware

Prepare doors and frames for hardware in accordance with [NAAMM HMMA 830] [manufacturer's instructions]. Drill and tap surface applied hardware in the field.

2.3.6 Hardware

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NOTE: Panic hardware on a forced entry rated door renders the door more susceptible to compromise. If panic hardware is required, use a push pad type which has a flush-mounted bar. Locks and hinges are an integral part of the forced entry resistance of a door assembly.

The following hardware guidance refers to single and pairs of swinging personnel doors, up to 1.22 x 2.44

m 4 x 8 feet per leaf. The locks and hinges listed below provide minimum levels of protection only. The locks and hinges for forced entry resistant door assemblies should be a tested part of a door manufacturer's assembly. For other door hardware, extra-heavy-duty standard commercial hardware is suitable.

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Provide hardware for forced entry resistant door assemblies by the door assembly manufacturer to ensure a complete forced entry resistant assembly. Where test standard requires hardware to be tested with the door assembly, include locks and hinges in the labeling and/or test certification. Provide locks and hinges that are the same or equal in performance, quality, grade, and quantity as used on the successfully tested door assembly in accordance with the specified forced entry testing standard. Provide certification that the locks, latches, and hinges provide the same degree of forced entry resistance as required by the specified forced entry testing standard. Provide keying as specified in Section 08 71 00 DOOR HARDWARE.

2.3.6.1 Locks and Latchsets

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NOTE: Most forced entry resistant door assemblies require two or more specialty locks severely limiting lock functions. Coordinate with codes for fire exiting and safety. Hardware for doors located in a means of egress must comply to the requirements of NFPA 101, Life Safety Code. Add specialized requirements for locking, keying, and opening to this paragraph.

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Submit available lock functions for selection of function by the Contracting Officer. Provide mortise lock and latchsets, as a minimum, series 1000, operational Grade 1, Security Grade 1 or 1A, and conforming to ANSI/BHMA A156.13. Provide strikes for mortise locks and latches (including deadbolt locks), as a minimum, conforming to ANSI/BHMA A156.115 except strikes must be rectangular (without curved lip). Provide mortise-type locks and latches for doors 45 mm 1-3/4 inches thick and over that have adjustable bevel fronts or otherwise conform to the shape of the door. Mortise locks must have armored fronts. Mortise locks and latches must have full escutcheon, through-bolted, extruded stainless steel trim. Provide lock finish [630] [639] [652] in accordance with ANSI/BHMA A156.18.

2.3.6.2 Hinges

Provide steel doors and frames required to resist the "very low" or "low" threat severity level that are up to and including 2.13 m 7 feet 0 inches high must, as a minimum, equipped with three Grade 1 hinges in accordance with ANSI/BHMA A156.1, minimum size 125 mm 5 inches high, heavy, double, or triple weight as required for weight of door. For each additional 300 mm 12 inches of door height beyond 2.13 m 7 feet 0 inches, provide a minimum of one more hinge. Provide hinges that are full mortise, half mortise, full surface, or half surface design as recommended by the manufacturer for frame and door design and tamperproof unless mounted on the protected side of the door. Hinges must have [pins as recommended by the manufacturer] [nonremovable pins] [security pins] [and be equipped with a safety stud].

Spot welding of hinge pin will not be acceptable. Provide hinge manufacturer's certification that the hinge supplied meets applicable test requirements for ANSI/BHMA A156.1 type number of hinge specified and that the hinge is suitable for the size and weight of the door assembly on which it will be utilized. Continuous extra heavy-duty piano-type hinge sized to carry the weight of the door without sagging is permitted. If continuous piano-type hinges are provided with the door, furnish independent laboratory reports covering both the door weight capacity and a 2,500,000 cycle testing to match the ANSI/BHMA A156.1 Grade 1 requirements. Furnish prime coated steel interior door hinges . Furnish nonferrous metal or stainless steel exterior door hinges.

2.3.6.3 Electric Strikes

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NOTE: Use of an electric strike makes the door assembly more susceptible to compromise, especially on doors swinging into a protected area.

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Where required, provide electric strikes conforming to ANSI/BHMA A156.5 Grade 1. Furnish strike boxes with deadbolt and latch strikes for Grade 1. Provide [fail secure] [fail safe] strikes.

2.3.6.4 Door Closers

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NOTE: Excessively heavy doors require coordination with manufacturers to ensure selection of proper sizes and types of closers.

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Provide manufacturer's recommended Grade 1, extra heavy duty closers conforming to ANSI/BHMA A156.4. Provide [600] [689] [690] [691] [692] door closer finish in accordance with ANSI/BHMA A156.18.

2.3.6.5 Door Stops and Holders

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NOTE: Excessively heavy doors require coordination with manufacturers to ensure selection of proper sizes and types of stops and holders.

****

Provide extra heavy duty door stops [and holders] conforming to [ANSI/BHMA A156.8, Type C08511 overhead surface mounted type] [ANSI/BHMA A156.16, Type L11251 for floor mounted installation] [ANSI/BHMA A156.16, Type L11271 for wall mounted installation] [_____].

2.3.7 Frame Anchors

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NOTE: Some manufacturers require frame anchors to be built or cast into the surrounding construction.

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Provide jamb and head anchors with door/frame assembly as specified by the manufacturer and forced entry resistant to the same degree as the component. Coordinate concrete work with component manufacturers when the manufacturer specifies frame anchors to be embedded into a concrete or concrete masonry unit surface during construction.

2.3.8 Weatherstripping

Provide head and jambs of exterior doors with compression-type neoprene bulb or closed-cell neoprene adjustable type weatherstripping. Door stops must be weatherstripped with a surface-mounted sponge neoprene strip in bronze housing not less than 1.78 mm 0.070 inch thick installed to make contact with the door. Install weatherstripping in conformance with the manufacturer's directions after completion of finish painting.

2.3.9 Louvers for Doors

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NOTE: Due to louver thickness and heavy weight, designers should avoid louvers in doors. If used, place louvers in inactive leaf of door pair where possible.

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Where indicated, provide doors with full louvers or louver section. Insert sightproof louvers into the door. Do not use pierced louvers. Inserted louvers must be stationary and nonremovable from the attack side of forced entry resistant doors. [Insect screens must be removable type with 18 by 16 mesh aluminum or bronze cloth.] The free area of the total square meters square feet of the louver must be [17 percent for channel style louvers] [39 percent for chevron style louvers (inverted angles at 25 mm 1 inch on center)] [[_____] percent]. Provide louvers in accordance with AMCA 500-D airflow test; minimum airflow must be [[_____] percent for channel style] [[_____] percent for chevron style] [[_____] percent]. Submit airflow calculations and test data showing compliance.

2.4 FORCED ENTRY RESISTANT LOUVERS

Fabricate louvers and frames from steel shapes to the opening dimensions indicated. The free area of the total square meters square feet of the louver must be [17 percent for channel style louvers] [39 percent for chevron style louvers (inverted angles at 25 mm 1 inch on center)] [[_____] percent]. Test louver in accordance with AMCA 500-D airflow test; minimum airflow must be [[_____] percent for channel style] [[_____] percent for chevron style] [[_____] percent]. Submit airflow calculations and test data showing compliance.

2.5 FORCED ENTRY RESISTANT WINDOW ASSEMBLIES

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NOTE: Forced entry resistant glazing materials may be glass, plastic, or composites. Specify glazing only at the "very low" or "low" threat severity levels. Do not specify glazing thickness.

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Construct forced entry resistant window assemblies using forced entry resistant frame sections. Provide welded frame unitssized and shaped with minimum frame face dimensions of 50 mm 2 inches. Provide frame anchorage as specified by the manufacturer and forced entry resistant to the same degree as the component. Provide top height and rabbet depth as required to accommodate the glazing material resistant to the forced entry test standard specified. Exterior (attack side) glazing stops must be welded to or integral to the frame. Interior (protected side) glazing stops must be removable stops attached with high-strength alloy steel machine screws with tamper-resistant heads, or as required by the manufacturer.

2.5.1 Deal Trays

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NOTE: Install in windows only; do not use in doors.

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Provide nominal 325 mm 12-3/4 inch wide by 40 mm 1-5/8 inch high opening in sill of window frame[and include a 165 mm 6-1/2 inch steel writing ledge on exterior side of window][and provide with a weatherproof closure]. Provide deal tray of the same materials and finish, that is a welded subassembly of the window assembly, and conforming to specified forced entry requirements for the entire window assembly.

2.5.2 Speaking Apertures

Fabricate speaking apertures to allow passage of voice at normal speaking volume without distortion, and to resist the referenced forced entry resistant standard for [outdoor] [indoor] use. Speaking aperture must be a welded subassembly of the window assembly conforming to the specified requirements for the entire window assembly.

2.5.3 Forced Entry Resistant Glazing Material

Provide [glass,] [plastic,][or][composite] glazing material conforming to applicable requirements ASTM C1036, ASTM E1300, and ASTM C1048. Test glazing materials in accordance with the applicable sections of the following test procedures: ASTM D905, ASTM D1003, ASTM F428, ASTM F548, ASTM D4093, and ASTM F520. Plastic glazing must be acrylic plastic sheets, polycarbonate plastic sheets, or approved equal. Plastic glazing must be smooth and clear on both sides. [Provide factory installed glazing material.] Cover factory-glazed components to protect them from damage during adjacent finish work.

2.5.3.1 Laminated Glass

Provide laminated glass conforming to applicable sections of ASTM C1172. Provide adhesive interlayer material for bonding glass to glass that is chemically compatible with surfaces which are to be bonded. Test materials selected for lamination purposes in accordance with the following testing procedures: ASTM D905, ASTM D1044, ASTM F735, ASTM D4093, ASTM F521, ASTM F520, and ASTM D1003. Glass plies used in the lamination must be [annealed float glass conforming to Type I, quality q3, Class 1, ASTM C1036] [or] [heat-strengthened or fully heat-tempered float glass, Condition A, Type I, quality q3, Class 1, ASTM C1048].

2.5.3.2 Acrylic Plastic Sheets

Use acrylic plastic glazing sheets "as cast" and in stretching operations with improved moisture absorption resistance conforming to ASTM D4802. Test acrylic materials in accordance with the applicable sections of the following testing procedures: ASTM D256, ASTM D5420, ASTM D542, ASTM D570, ASTM D635, ASTM D638, ASTM D696, ASTM D792, ASTM D1003, ASTM E831, ASTM F791, and ASTM G155.

2.5.3.3 Polycarbonate Plastic Sheets

Provide laminated or solid, ultraviolet stabilized [flame resistant] [high abrasion resistant] polycarbonate plasticsheets conforming to ASTM D3595. Test polycarbonate materials in accordance with the applicable sections of the following testing procedures: ASTM D256, ASTM D5420, ASTM D792, ASTM F735, ASTM D1003, ASTM D635, ASTM D638, ASTM D1044, ASTM D882, ASTM D1922, ASTM D570, ASTM F520, ASTM E169, ASTM G155, and ASTM F791. Do not use polyvinyl butyral in contact with polycarbonate because its placticizer may craze polycarbonate.

2.5.3.4 Glass/Plastic Laminate Glazing

Provide glass/plastic laminated glazing materials consisting of glass/plastic laminated construction or glass-clad plastic "sandwich" construction conforming to applicable sections of ASTM C1172.

2.5.3.5 Glass/Plastic Air-Gap Glazing

Provide forced entry resistant glass/plastic air-gap glazing consisting of an assembly in which glass forms the exterior [and interior (protected side)] layer, separated by an air space from the laminated plastic plies. Glass plies must be [annealed float glass conforming to Type I, quality q3, Class 1, ASTM C1036] [or] [heat-strengthened or fully heat-tempered float glass, Condition A, Type I, quality q3, Class 1, ASTM C1048]. Provide plastic plies consisting of laminated ultraviolet stabilized polycarbonate sheets, conforming to paragraph Polycarbonate Plastic Sheets and/or acrylic sheets for use "as cast" and in stretching operations with improved moisture absorption resistance conforming to paragraph Acrylic Plastic Sheets.

2.5.4 Adhesive Interlayer Materials

Provide adhesive interlayer material for bonding laminates (glass-glass, glass-plastic, or plastic-plastic bonds) that is chemically compatible with the surfaces bonded. Interlayer materials may be polyvinyl butyral, cast-in-place urethane, proprietary materials, sheet from urethane and other materials. Do not use polyvinyl butyral to bond polycarbonate. Provide adhesives conforming to ASTM D905 and the manufacturer's recommendations.

2.5.5 Sealants

Provide sealants for glazings that are chemically compatible with the glazing materials they are in contact with and have no deleterious effects to the glazing materials or to the adhesives used in glazing laminates. Sealants must conform to the glazing manufacturer's recommendations and the requirements of GANA Glazing Manual.

2.6 FORCED ENTRY RESISTANT PASS-THROUGH DRAWER

Fabricate pass-through drawer of steel and of the size indicated. Assembly must provide a weather resistant opening. Attachment to wall assembly must be in accordance with the manufacturer's recommendations. Finish must be [primed for painting] [satin stainless steel] [_____].

2.7 FORCED ENTRY RESISTANT PREFABRICATED GUARDHOUSES

Provide guardhouse consisting of prefabricated, forced entry resistant, modular wall [and] [ceiling] [and floor] panels insulated to R-value of [_____] with [doors] [windows] [louvers] [gunports] and necessary connecting posts, hardware, and accessories. Submit complete enclosure. Components must be factory painted with rust inhibitive primer unless indicated otherwise. Dress smooth exposed welds. Workmanship must be rigid, neat in appearance, and free from defects. Guardhouse must be [of rain and weatherproof design.] [designed to be relocatable by [crane] [forklift].] Perform electrical work in accordance with local codes.

2.8 ACCESSORIES

Provide accessories for the installation of components into the surrounding structure. Anchorage must be forced entry resistant to the same degree as the component. Install in accordance with the manufacturer's recommended instructions. Materials, parts, bolts, anchors, supports, braces, fasteners, and connections necessary for completion of the work.

2.9 LABELING

Plainly and permanently label forced entry resistant components as to the applicable forced entry test standard and level within the test standard under which the component was tested and approved. Label must be visible only from the protected side after component installation and include the following information: (1) manufacturer's name or identifying symbol; (2) model number, control number, or equivalent; (3) date of manufacture with the week, month or quarter, and year (this may be abbreviated or be in a traceable code such as the lot number); (4) correct mounting position (by removable label); and (5) forced entry resistant rating by indicating the test standard, level within the test standard (if any), and minutes of attack time withstood (if variable in the standard).

2.10 SHOP/FACTORY FINISHING

Unless otherwise specified, shop finish all factory or manufactured components as indicated below.

2.10.1 Ferrous Metal

Clean surfaces of ferrous metal, except galvanized and stainless steel surfaces, and factory prime for painting. Provide finish painting in accordance with Section 09 90 00 PAINTS AND COATINGS. Prior to shop painting, clean surfaces with solvents to remove grease and oil and with power wire-brushing or sandblasting to remove loose rust, loose mill scale, and other foreign substances. Do not shop paint surfaces of items to be embedded in concrete.

2.10.2 Galvanizing

Items specified to be galvanized must be hot-dip processed after fabrication. Galvanize in accordance with ASTM A123/A123M or ASTM A653/A653M.

2.10.3 Aluminum

Unless otherwise specified, aluminum items must be standard mill finish. When anodic coatings are specified, coatings must conform to ASM STFA, with treatment to a coating thickness not less than that specified for protective and decorative type finish in AA DAF45. Items to be anodized must receive a polished satin finish pretreatment and a clear lacquer overcoat conforming to the above-referenced standard.

PART 3 EXECUTION

3.1 EXAMINATION

Field verify dimensions of rough openings for components and that surfaces of openings are level, plumb, and provide required clearances. Examine components for racking, twisting, and other malformation and corrected prior to installation. Replace damaged components that cannot be corrected. Protect surrounding work prior to installation of forced entry resistant components. Repair surrounding work, which is damaged as a result of the installation of forced entry resistant components, in an approved manner prior to acceptance. Protect glazed units from damage during adjacent work.

3.2 FABRICATION

Construct, assemble, weld, and equip components with all hardware and accessories required to complete the assembly in the shop of a competent fabricator.

3.3 FASTENERS

Fasteners exposed to view must match in color and finish and harmonize with the material to which fasteners are applied. Drill or neatly punch holes for bolts and screws. Reject work with poor matching holes . Conceal fasteners where practicable. Unless otherwise specified, provide fasteners conforming to Section 08 31 00 ACCESS DOORS AND PANELS.

3.4 CORROSION PROTECTION - DISSIMILAR MATERIALS

Give a protective coating to contact surfaces between dissimilar metals and aluminum surfaces in contact with concrete, masonry, pressure-treated wood, or absorptive materials subject to wetting in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.5 INSTALLATION

The finished work must be free from defects. Install components plumb and level and secure rigidly in place. Install components in accordance with approved manufacturer's recommended instructions. Test operable parts of components for smooth operation in the presence of the Contracting Officer. Coordinate frame embedments into the construction where required by the component manufacturer. Replace or repair materials which incur damage as a result of adjacent finish work as specified above. Install glazing for window assemblies, which are not specified as factory glazed, in accordance with GANA Glazing Manual and the manufacturer's recommended instructions. Field glazing must occur only after concrete, masonry, ceiling, electrical, mechanical, plumbing and adjacent finish work has been completed. Properly install forced entry resistant door assemblies so that operating clearances and bearing surfaces conform to the manufacturer's instructions. Secure the bottom of door frames to the floor slab in accordance with the manufacturer's recommendations. Install weatherstripping and thresholds at exterior door openings to provide a weathertight installation. Submit Drawings showing (1) anchorage of components and appurtenances into the actual surrounding construction, (2) clearances for operation, and (3) hardware location and installation details. Submit complete drawings for forced entry resistant prefabricated guardhouses. Submit a copy of installation instructions and recommended cleaning and maintenance instructions.

3.6   MANUFACTURER'S FIELD SERVICES

****

NOTE: Designer will only use this paragraph when justified.

****

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the component specified. At the request of the Contracting Officer, the representative must supervise the installation, adjustment, and operation (if operable) of the component. The representative must be onsite [1] [2] [_____] working days.

3.7   ADJUSTING/CLEANING

Make adjustments to assure smooth operation. Provide units that are weathertight when closed and locked. Clean components in accordance with manufacturer's instructions. Use only cleanser recommended by the manufacturer to clean polycarbonate, plastic, and applied hardcoats.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 34 02 (August 2009)**

Preparing Activity: USACE **Superseding**
UFGS-08 34 02 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-08 34 02 (August 2009)**

Preparing Activity: USACE **Superseding**
UFGS-08 34 02 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 34 02

BULLET-RESISTANT COMPONENTS

08/09

****

NOTE: This section covers requirements for bullet resistant components including doors, windows, louvers, gunports, pass drawers, deal trays, and speaking apertures.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C1036	(2021) Standard Specification for Flat Glass
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM C1172	(2024) Standard Specification for Laminated Architectural Flat Glass
ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D542	(2014) Index of Refraction of Transparent Organic Plastics
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics

ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D905	(2008; E 2009) Strength Properties of Adhesive Bonds in Shear by Compression Loading
ASTM D1003	(2013) Haze and Luminous Transmittance of Transparent Plastics
ASTM D1044	(2019) Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion by the Taber Abraser
ASTM D1922	(2015; R 2020) Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method
ASTM D3595	(2014) Polychlorotrifluoroethylene (PCTFE) Extruded Plastic Sheet and Film
ASTM D3951	(2018) Commercial Packaging
ASTM D4093	(1995; R 2014) Photoelastic Measurements of Birefringence and Residual Strains in Transparent or Translucent Plastic Materials
ASTM D4802	(2016) Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet
ASTM D5420	(2016) Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Strike Impacted by a Falling Weight (Gardner Impact)
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E169	(2016; R 2022) Standard Practices for

	General Techniques of Ultraviolet-Visible Quantitative Analysis
ASTM E204	(1998; R 2007) Identification of Material by Infrared Absorption Spectroscopy, Using the ASTM Coded Band and Chemical Classification Index
ASTM E831	(2024) Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis
ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM F428	(2019; R 2024) Intensity of Scratches on Aerospace Glass Enclosures
ASTM F520	(2021) Standard Test Method for Environmental Resistance of Aerospace Transparencies to Artificially Induced Exposures
ASTM F521	(2022) Standard Test Methods for Bond Integrity of Transparent Laminates
ASTM F548	(2019; R 2024) Standard Test Method for Intensity of Scratches on Aerospace Transparent Plastics
ASTM F735	(2022; E 2022) Standard Test Method for Abrasion Resistance of Transparent Plastics and Coatings Using the Oscillating Sand Method
ASTM F791	(1996; R 2013) Stress Crazing of Transparent Plastics
ASTM F1233	(2021) Standard Test Method for Security Glazing Materials and Systems
ASTM G155	(2021) Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.1	(2021) Butts and Hinges
ANSI/BHMA A156.4	(2024) Door Controls - Closers
ANSI/BHMA A156.5	(2020) Cylinder and Input Devices for Locks
ANSI/BHMA A156.8	(2021) Door Controls - Overhead Stops and Holders
ANSI/BHMA A156.13	(2022) Mortise Locks & Latches Series 1000
ANSI/BHMA A156.16	(2023) Auxiliary Hardware

ANSI/BHMA A156.18	(2020) Materials and Finishes
ANSI/BHMA A156.115	(2016) Hardware Preparation in Steel Doors and Steel Frames

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2008) Glazing Manual

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMMA 810	(2009) Hollow Metal Doors
NAAMM HMMA 820	(2008) Hollow Metal Frames
NAAMM HMMA 830	(2002) Hardware Selection for Hollow Metal Doors and Frames
NAAMM HMMA 840	(2017) Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames
NAAMM HMMA 850	(20140) Fire Rated Hollow Metal Doors and Frames
NAAMM HMMA 862	(2021) Guide Specifications for Commercial Security Hollow Metal Doors and Frames

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives

NATIONAL INSTITUTE OF JUSTICE (NIJ)

NIJ Std 0108.01	(1985) Ballistic Resistant Protective Materials

NAVAL FACILITIES ENGINEERING AND EXPEDITIONARY WARFARE CENTER (NAVFAC EXWC)

NAVFAC EXWC CR 80.025	(1980) Testing and Evaluation of Attack Resistance and Hardening Retrofits of Marine Barrack Construction Types to Small Arms Multiple Impact Threat

U.S. DEPARTMENT OF STATE (SD)

SD Std-01.01	(1993 Rev G Amended; Inx Certified Prod/Mfg) Certification Standard Forced Entry and Ballistic Resistance of Structural Systems

UL SOLUTIONS (UL)

UL 752	(2023) UL Standard for Safety Bullet-Resisting Equipment

1.2 SYSTEM DESCRIPTION

****

NOTE: In the event that the designer chooses to design and detail the component for shop fabrication, the materials and construction should be specified in Section 08 31 00 ACCESS DOORS AND PANELS.

Determine bullet-resisting ratings of metals by ballistics tests in accordance with the threat specified in paragraph COMPONENT TEST REQUIREMENTS.

****

1.2.1 Design Requirements

Provide bullet resistant components conforming to the requirements specified for the particular items and, as much as possible, complete assemblies by a single manufacturer.

1.2.2 Performance Requirements

Specify all bullet resistant items to the threat specified. Operate movableand operable components smoothly and freely. When a reference for performance is listed, conform to referenced requirements.

1.2.3 Submittal Requirement Details

Submit the followin:

a. Manufacturer's descriptive data and installation instructions. Include cleaning instructions as recommended by the plastic sheet manufacturer.

b. Spare parts data for each bifold door, after approval of the related submittals, and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and supply source.

c. Air flow calculations for louvers and louvers in doors.

d. Lists including schedule of all components to be incorporated in the work with manufacturer's model or catalog numbers, specification and drawing reference numbers, warranty information, threat level certified, [fire ratings,] [sound transmission coefficient ratings,] [insulation "U" value,] and number of items provided.

e. Evidence that standard products essentially duplicate items that have been satisfactorily in use for two years or more, including name of purchasers, locations of installations, dates of installations, and service organizations.

f. Manufacturer's certificates attesting that all components conform to the requirements on drawings and in specifications. Include testing reports from independent testing laboratories indicating conformance to regulatory requirements.

g. [Six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the bifold doors furnished. The manuals must be approved prior to beneficial occupancy.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Submittals SD-03 and SD-10, are to be used

only when bifold doors are part of the work. Edit out those paragraphs if no bifold doors are required in the work.

****

SD-02 Shop Drawings

Installation; G, [_____]

SD-03 Product Data

Bullet Resistant Components

Bifold Doors

SD-07 Certificates

Bullet Resistant Components

SD-10 Operation and Maintenance Data

Bullet Resistant Components; G, [_____]

1.4 QUALITY ASSURANCE

****

NOTE: The threat must be identified before selection of the applicable test standard from Table I. If project criteria includes more than one threat, each component will be correlated with the appropriate regulation or standard it is required to meet. Coordinate with the drawings.

The design threat must be determined based on the importance of the assets in the facility, facility location, history, a likelihood of attacks at the location, and many other factors. The process used to determine design criteria for applicable threat and design guidance to resist the threat is provided in the manuals listed below:

UFC 4-020-01 Security Engineering - Project Development

UFC 4-020-2FA Security Engineering - Concept Design

UFC 4-020-3FA Security Engineering - Final Design

These manuals are marked "For Official Use Only". and they may be ordered by Department of the Army agencies from the U.S. Army Publications Distribution Center, 2800 Eastern Blvd., Baltimore, MD 21220-2896.

The identified threat criteria should be recorded in the Design Analysis for the project. The designer will indicate the applicable threats, selected from Table I below, under paragraph COMPONENT TEST REQUIREMENTS or in door, window, or other component

schedules as appropriate.

There is no single, uniform standard for bullet resistance. Each testing agency has its own parameters. Variables include firing distance to the test component; number of shots fired and proximity to each other; and failure criteria, such as penetration, amount of spall or further operability of the item. Most ballistic threats are based on complete penetration by projectiles or fragments of projectiles through a construction material, or on spall of the material to the degree that injury would be caused to a person standing behind the material. Some standards require only material specimen testing rather than testing of complete assemblies. This enables a designer to specify materials as bullet resistant, but does not ensure that fasteners, anchors, frames, etc., are bullet resistant. Designer should:

(1) Verify criteria requirements, define threats using standards which test complete assemblies and specify threat accordingly, or

(2) Specify that all materials and connections be certified to resist the specified threat.

Some standards also include different temperature requirements depending upon whether the component is for indoor or outdoor installation. Verify testing requirements with specification of components.

Designer will also note adverse environmental conditions which require galvanized coatings on carbon steel, stainless steel, or criteria such as temperature, weather, humidity, ventilation, and illumination required for proper installation or application. If necessary, designer will explain existing conditions through statements or by references to documents where information such as existing structures or geophysical reports can be found.

Most bullet-resistant components are custom fabricated from manufacturer's standard designs. Coordinate installation details with adjacent construction.

TABLE I - TABLE OF RELATIVE BALLISTIC STANDARDS

STANDARD THREAT LEVEL	**CALIBER**	**WEAPON**	**BULLET WEIGHT & TYPE**	**VELOCITY (FT/SEC)/ NO. SHOTS RESISTED**
NIJ- TYPE I	**.22**	**Handgun 6-6.5 in. Barrel**	**40 gr. LRHV Lead**	**1010-1090/ 5 Shots**

TABLE I - TABLE OF RELATIVE BALLISTIC STANDARDS

STANDARD THREAT LEVEL	CALIBER	WEAPON	BULLET WEIGHT & TYPE	VELOCITY (FT/SEC)/ NO. SHOTS RESISTED
	and .38 Special	Handgun 6-6.5 in. Barrel	158 gr. LRN	800-900/ 5 Shots
UL-MPSA	.38 Super	Pistol Automatic 5 in. Barrel	130 gr. FMJ	1152-1344/ 3 Shots
ASTM- Submachine Gun	9 mm. Parabellum		124 gr.	1350-1450/ 3 Shots
	and 12 gauge 3 in. Magnum (adjunct)		No. 00 Buckshot	1265-1465/ Variable
(UFC 4-020-01 Low Severity Level, Ballistics Tactic):				
HPW Minimum Standards or SD Submachine Gun (S)	9 mm.	Submachine Gun	115 gr. FMJ (Steel)	1350-1450/ 3 Minimum and 1 each @ Specified Locations
	and 12 gauge (Optional)	Shotgun	No. 4 Buckshot	1275-1375/ 3 Minimum and 1 each @ Specified Locations
NIJ- TYPE IIA	.357 Magnum	Handgun 4-4.75 in.	158 gr.	1200-1300/ 5 Shots
	and 9 mm.	Handgun 4-4.75 in. Barrel	124 gr.	1050-1130/ 5 Shots
ASTM-	.44 Magnum		240 gr.	1400-1500/

TABLE I - TABLE OF RELATIVE BALLISTIC STANDARDS

STANDARD THREAT LEVEL	CALIBER	WEAPON	BULLET WEIGHT & TYPE	VELOCITY (FT/SEC)/ NO. SHOTS RESISTED
Handgun (.44 Magnum)			Soft Point	3 Shots
	and 12 gauge 3 in. Magnum (adjunct)		No. 00 Buckshot	1265-1465/ Variable
ASTM- Handgun (.38 Super)	.38 Super		130 gr. FMJ	1230-1330/ 3 Shots
	and 12 gauge 3 in. Magnum (adjunct)		No. 00 Buckshot	1265-1465/ Variable
NIJ- TYPE II	.357 Magnum	Handgun 6-6.5 in. Barrel	158 gr. JSP	1345-1445/ 5 Shots
	and 9 mm.	Handgun 4-4.75 in. Barrel	124 gr. FMJ	1135-1215/ 5 Shots
UL-HPSA	.357 Magnum	Handgun 8.35 in. Barrel	158 gr. Lead	1305-1523/ 3 Shots
NIJ- TYPE IIIA	.44 Magnum	Handgun 5.5- 6.25 in. Barrel	240 gr. Lead SWC Gas Checked	1350-1450/ 5 Shots
	and 9 mm.	Submachine Gun 9.5- 10.25 in. Barrel	124 gr. FMJ	1350-1450/ 5 Shots
(UFC 4-020-01 Medium Severity Level, Ballistics Tactic):				
UL-SPSA	.44 Magnum	Handgun 6.5 in. Barrel	240 gr. Lead	1323-1544/ 3 Shots
UL-HPR	.30-'06 Springfield	Rifle Bolt Action 24 in.	220 gr. Soft Point	2169-2531/ 1 Shot

TABLE I - TABLE OF RELATIVE BALLISTIC STANDARDS

STANDARD THREAT LEVEL	CALIBER	WEAPON	BULLET WEIGHT & TYPE	VELOCITY (FT/SEC)/ NO. SHOTS RESISTED
		Barrel		
ASTM-Rifle (.44 Magnum)	7.62x51 mm. (.308 Winchester) and		M-80 Ball	2750-2850/ 3 Shots
	12 gauge 3 in. Magnum (adjunct)		No. 00 Buckshot	1265-1465/ Variable
NIJ-TYPE III	7.62x51 mm. NATO	Rifle	147 gr. M-80 Ball	2700-2800/ 5 Shots
(SEM High Severity Level, Ballistics Tactic):				
HPW Rifle Standard	5.56x45 mm. NATO	Rifle	55 gr. M-193 Ball	3135-3235/ 1 @ Specified Locations
	and 7.62x51 mm. NATO	Rifle	147 gr. M-80 Ball	2700-2800/ 2 @ Specified Locations
	and 12 gauge	Shotgun	No. 4 Buckshot	1275-1375/ 3-6 @ Specified Locations
SD Military Rifle (R)	5.56 mm. NATO	Rifle	55 gr. M-193 Ball	3135-3235/ 2 Minimum and 1 each @ Specified Locations

TABLE I - TABLE OF RELATIVE BALLISTIC STANDARDS

STANDARD THREAT LEVEL	CALIBER	WEAPON	BULLET WEIGHT & TYPE	VELOCITY (FT/SEC)/ NO. SHOTS RESISTED
	5.56 mm. (Optional)	Rifle	63 gr. M-855 Ball	2950-3050 1 each @
Specified Locations				
	and 7.62 mm. NATO	Rifle	147 gr. M-80	2700-2800/ 1
Minimum and 1 each @ Specified Locations				
	12 gauge 2-3/4 in. (Optional)	Shotgun	No. 4 shot (00 Buckshot)	1275-1375/ 1 each @
Specified Locations				
NFESC SAMIT	7.62x51 mm. NATO	Machine gun Light 25-1/2 in. Barrel M60E3 (US)	147 gr. M-80 Ball	2750-2850/ 25 Shots
ASTM- Rifle AP	.30-'06		M2AP	2725-2825/ 3 Shots
	and 12 gauge 3 in. Magnum (adjunct)		No. 00 Buckshot	1265-1465/ Variable

(SEM Very High Severity Level, Ballistics Tactic):

HPW Rifle AP Standard	7.62x51 mm.	Rifle	150 gr. M61 AP	2700-2800/ 3-6 @
Specified Locations				
	or			

TABLE I - TABLE OF RELATIVE BALLISTIC STANDARDS

STANDARD THREAT LEVEL	CALIBER	WEAPON	BULLET WEIGHT & TYPE	VELOCITY (FT/SEC)/ NO. SHOTS RESISTED
	.30-'06	Rifle	165 gr. M2 AP	2800-2900/ 3.6 @
Specified Locations				
	and 12 gauge	Shotgun	No. 4 Buckshot	1275-1375/ 3.6 @
Specified Locations				
SD Rifle (AP)	.30-'06 (Optional)	Rifle	165 gr. M2 AP	2750-2850/ 1 each @
Specified Locations				
	12 gauge 2-3/4 in. (Optional)	Shotgun	No. 4 shot (00 Buckshot)	1275-1375/ 1 each @ Specified
Locations				
NFESC SAMIT (AP)	7.62x51 mm. NATO	Machine gun Light 25-1/2 in. Barrel M60E3 (US)	150 gr. M61 AP	2800/ 25 Shots
NIJ- TYPE IV	.30-'06	Rifle 22 in. Barrel	166 gr.	2750-2850/ 1 Shot

ABBREVIATIONS:

AP - Armor Piercing
LRN - Lead Round Nose Bullet
FMJ - Full Metal Jacketed
MPSA - Medium Power Small Arms
HPR - High Power Rifle
HPSA - High Power Small Arms
SPSA - Super Power Small Arms
JSP - Jacketed Soft Point

US - United States
LRHV - Long Rifle High Velocity

BALLISTIC TESTING STANDARDS:

ASTM - American Society for Testing and Materials; ASTM F1233, "Security Glazing Materials and Systems," 1989.

NFESC-SAMIT - Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC), Department of the Navy; NAVFAC EXWC CR 80.025 "Testing and Evaluation of Attack Resistance and Hardening Retrofits of Marine Barrack Construction Types to Small Arms Multiple Impact Threat (SAMIT) 1980.

NIJ - National Institute of Justice; NIJ Standard 0108.01, "Ballistic Resistant Protective Materials," 1985.

SD - Department of State; SD Std-01.01 Rev F, "Certification Standard Forced Entry and Ballistic Resistance of Structural Systems Test Procedures," 1992.

UL - American National Standards Institute/Underwriters Laboratories, Inc.; ANSI/UL 752, "Standard for Bullet-Resisting Equipment," 1995.
****

Provide Bullet-resistant components at locations shown on the drawings. Bullet-resistant components [where indicated] [_____] must be in accordance with [[NIJ Type I] [NIJ Type IIA] [NIJ Type II] [NIJ Type IIIA] of NIJ Std 0108.01.] [[UL MPSA] [UL HPSA] [UL SPSA] [UL HPR] of UL 752.] [[ASTM Submachine Gun] [ASTM Handgun (.44 Magnum)] [ASTM Handgun (.38 Super)] [ASTM Rifle (.44 Magnum)] [ASTM Rifle (AP)] of ASTM F1233.] [[HPW Minimum Standard] [HPW Rifle Standard] [HPW Rifle AP Standard].] [[SD Submachine Gun (S)] [SD Military Rifle (R)] [SD Rifle (AP)] of SD Std-01.01.] [the test requirement of [NFESC SAMIT] [NFESC SAMIT (AP)] of NAVFAC EXWC CR 80.025.]

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver components to the job site with the brand, name, and model number clearly marked thereon. Deliver, store and handle all components so as not to be damaged or deformed, and in accordance with ASTM D3951. Handle doors, windows, and louvers carefully to prevent damage to the faces, edges, corners, ends, and glazing. Clean, repair, or replace abraded, scarred, or rusty areas immediately upon detection. Replace damaged components that cannot be restored to like-new condition. Store components and equipment in a dry location on platforms or pallets that are ventilated adequately, free of dust, water, and other contaminants, and stored in a manner which permits easy access for inspection and handling.

1.6 SCHEDULING

Glaze bullet-resistant windows, except factory-glazed units, after all concrete, masonry, ceiling, electrical, mechanical, plumbing and adjacent finish work iscomplete to avoid damage to the glazing material. Cover factory-glazed windows to protect them from damage during adjacent finish work.

1.7 WARRANTY

Furnish manufacturer's warranty for [_____] [5] years for glazing materials. Provide for replacement and installation of glazing if delamination, discoloration, or cracking, or crazing occurs.

PART 2 PRODUCTS

2.1 MATERIALS AND COMPONENTS

Provide materials and components which are the standard products of a manufacturer regularly engaged in the manufacture of such products, unless otherwise indicated and detailed on the drawings, and that essentially duplicate items that have been in satisfactory use for at least two years prior to bid opening. Provide components supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site, or by the manufacturer. Where components are detailed on the drawings and do not conform to a manufacturer's standard product, provide components that are constructed of manufacturer's standard materials which conform to the specified ballistic standard or test. Provide bullet-resistant component assemblies of size and type indicated and provide at locations shown. Design all items included for exterior installation to resist water penetration or entrapment.

2.2 ELECTRICAL WIRING

Provide electrical wiring and conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.3 BULLET-RESISTANT STEEL PERSONNEL DOORS

Provide factory fabricated door/frame assemblies, designed to be bullet resistant to the specified threat level, and conforming to applicable requirements of NAAMM HMMA 810, NAAMM HMMA 820, NAAMM HMMA 862, this section, and requirements indicated on drawings. Provide frames furnished by the door fabricator. Provide door silencers to cushion the impact of the door on the frame so that steel to steel contact is not made during closing. Completely weatherstrip, weatherproof, and fully insulate exterior doors. Exterior doors must close at flush top and bottom edges. Seal tops of doors against water penetration.

2.3.1 Fire Rated Doors

Provide fire rated doors at locations shown on the drawings. Furnish door assemblies bearing the identifying label of the Underwriters Laboratories, or a nationally recognized testing agency qualified to perform certificate programs, indicating that the units conform to the requirements for Special Purpose Type Fire Doors in accordance with NFPA 80. Construct fire rated doors in accordance with NAAMM HMMA 850. Certificate may be furnished in lieu of label. For oversized fire doors, state that doors are manufactured in compliance with the requirements for doors of this type and class, and have been tested and meet the requirements for the class indicated.

2.3.2 Sound Rated Doors

Provide sound rated doors at locations shown on the drawings. Furnish door assemblies consisting of door, hardware, frame, threshold, and adjustable gaskets. The assembly must have a Sound Transmission Class (STC) rating [of] [_____] [as shown on the drawings] when tested in accordance with ASTM E90. [Submit manufacturer's descriptive data, and certificate or test report showing compliance with the specified requirements.] [Perform a field test on the door assembly to determine if the STC is within 2 points of the equivalent laboratory tested product. If the test reveals a less than acceptable STC, replace the door assembly and test the new assembly to provide an acceptable rating.]

2.3.3 Door and Frame Fabrication

Exercise special care during welding to prevent warping. Design stiffeners and attach interior armor plates such that heat-affected areas, which result from welding, do not allow a potential ballistic leak in product construction. Make subsurfaces flat, parallel, and plumb after fabrication. Construct doors and frames of [bullet-resistant steel] [or] [hollow metal with internal armoring] such that the completed assembly meets the specified regulatory requirements. Reinforce [and fully insulate] doors in accordance with manufacturer's design. Miter or cope steel door frames and weld at the corners with all welds ground smooth. Design corner assemblies to eliminate ballistic penetrable seams. Where structural channel frames are used, make stops of 38 mm 1-1/2 inch by 16 mm 5/8 inch bars welded or top screwed to the frame at not more than [150] [300] mm [6] [12] inch centers. Furnish countersunk screws. Place stops so that full contact with the frame will be assured. Make necessary reinforcements and drill and tap the frames as required for the hardware. Miter or cope frame channels and weld at corners with full penetration groove welds. Dress smooth exposed welds.

2.3.4 Sidelight Frames

Construct sidelight frames using door frame sections as shown on the drawings. Provide stop height and rabbet depth as required to accommodate the bullet-resistant glazing material specified. Weld exterior (attack side) glazing stops or make integral to the frame. Provide removable interior (protected side) glazing stops attached with high-strength alloy steel machine screws with tamper-resistant heads.

2.3.5 Preparation for Hardware

Prepare doors and frames for hardware in conformance with Section 08 71 00 DOOR HARDWARE, and NAAMM HMMA 830. Drill and tap frames for surface applied hardware in the field.

2.3.6 Hardware

****

NOTE: The hardware options listed below apply only to those bullet resistant door assemblies for which extra-heavy-duty standard commercial hardware is suitable. This includes the following types of doors:

(1) Single and pairs of swinging personnel doors, up to 1.2 m 4 feet - 0 inches by 2.44 m 8 feet - 0

inches per leaf.

(2) Bullet-resistant threat levels up to maximum listed in paragraph COMPONENT TEST REQUIREMENTS.

(3) Bullet-resistant only or combined bullet and fire resistive, manual or powered opening.

For the following assemblies, custom or specially designed hardware should be specified (with manufacturer's guidance):

(1) Oversized single and pairs of swinging doors, such as those for vehicle entry.

(2) Sliding doors of all types.

(3) Folding doors of all types.

(4) Upward moving doors of all types.

(5) Bullet-resistant threat levels above the maximum listed in paragraph COMPONENT TEST REQUIREMENTS.

(6) Bullet-resistant doors of any type with additional forced entry blast, missile or pressure resistive requirements.

For sound rated doors rated for STC 52 or more with cypher lock requirements, designers should specify electronic cypher locks rather than mechanical locks.

Where balanced magnetic switches (BMS) are required on door/frames, specify shop drilled hardware preparation and installation of magnets.

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Furnish hardware for bullet-resistant door assembly provided by the door assembly manufacturer to ensure a complete bullet resistant assembly. Where test standard requires hardware to be tested with the door assembly, include hardware in the labeling and/or test certification. Key as specified in Section 08 71 00 DOOR HARDWARE.

2.3.6.1 Mortise Locks and Latchsets

Furnish mortise lock and latchsets that are series 1000, operational Grade 1, Security Grade 1 or 1A, functions as indicated in the Hardware Schedule, and conforming to ANSI/BHMA A156.13. Furnish strikes for all mortise locks and latches, including deadlocks, conforming to ANSI/BHMA A156.115 except provide rectangular strikes without lip for security doors. Provide mortise-type locks and latches for doors 44 mm 1-3/4 inches thick and over that have adjustable bevel fronts or otherwise conforming to the shape of the door. Mortise locks must have armored fronts. Mortise locks and latches must have full escutcheon, thru-bolted, extruded stainless steel trim.

2.3.6.2 Hinges

Equip all 2.1 m 7 feet - 0 inch high doors with a minimum of three Grade 1 hinges in accordance with ANSI/BHMA A156.1, minimum size 125 mm 5 inches high, heavy, double or triple weight as required for weight of door, or a single, continuous extra-heavy-duty piano-type hinge sized to carry the weight of the door without sagging. For each additional 300 mm 12 inches of door height beyond 2.1 m 7 feet - 0 inch, provide minimum of one more hinge. Equip doors greater than 2.1 m 7 feet - 0 inches with a minimum of four hinges. Provide hinges that are full mortise, half mortise, full surface or half surface design as recommended by manufacturer for frame and door design, and tamperproof or mount on the inside face of the door. Provide hinge manufacturer's certification that the hinge supplied meets all applicable test requirements of ANSI/BHMA A156.1, type, number of hinges specified, and that the hinge is suitable for the size and weight of the door assembly on which it will be utilized. If continuous piano-type hinges are provided with door, furnish independent laboratory reports covering both the door weight capacity and a 2,500,000-cycle testing to match ANSI/BHMA A156.1 Grade 1 requirements. Provide steel, prime coated interior door hinges. Provide nonferrous metal or stainless steel exterior door hinges.

2.3.6.3 Electric Strikes

Provide electric strikes conforming to ANSI/BHMA A156.5, Grade 1. Furnish strike boxes with dead bolt and latch strikes for Grade 1.

2.3.6.4 Door Closers

****

NOTE: Due to the excessive weight of bullet-resistant doors, they will present a safety hazard if allowed to close unchecked. Coordinate with manufacturers to ensure selection of proper size and types of closers.

****

Provide extra heavy duty closers of size and type recommended by manufacturer, and Grade 1 in accordance with ANSI/BHMA A156.4. Provide door closer finish that is [600] [689] [690] [691] [692] in accordance with ANSI/BHMA A156.18.

2.3.6.5 Door Stops and Holders

****

NOTE: Due to the excessive weight of bullet-resistant doors, they will present a safety hazard if allowed to have an uncontrolled opening cycle, particularly exterior out-swinging doors subject to wind pressure. Coordinate with manufacturers to ensure selection of proper size and type of stops and holders. If hold-open feature is not required or permitted (fire doors) specify equal grade stop without hold-open feature.

****

Provide extra heavy duty door stops [and holders] [Type C08511 in accordance with ANSI/BHMA A156.8] [[Type L11251] [and] [Type L11271] in accordance with ANSI/BHMA A156.16] [_____].

2.3.7 Frame Anchors

Provide jamb anchors with door/frame assembly conforming to manufacturer's recommendations to ensure complete bullet-resistant assemblies. Make provisions to stiffen the top member of all spans over 900 mm 3 feet. Extend the bottom of the frames below the finish floorline and secure to the floor slab by means of angle clips and expansion bolts. Floor clips are not required for installation in pre-built or existing openings.

2.3.8 Weatherstripping

Provide head and jambs with compression-type neoprene bulb or closed-cell neoprene adjustable-type weatherstripping. Weatherstrip door stops with a surface-mounted sponge neoprene strip in bronze housing no less than 1.78 mm 0.070 inch thick installed to make contact with the door. Install weatherstripping in conformance with the manufacturer's directions after completion of finish painting.

2.3.9 Louvers for Doors

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NOTE: Due to louver thickness and heavy weight, designers should avoid louvers in doors. If used, place louvers in inactive leaf of door pair where possible.

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Where indicated, provide doors with full louvers or louver section. Louvers must be certified resistant to the same ballistic threat level as the rest of the door assembly. Insert sightproof louvers into the door. Do not use pierced louvers. Furnish inserted louvers that are stationary and nonremovable from the outside of exterior doors or the threat side of interior doors. [Provide removable insect screens with 18 by 16 mesh aluminum or bronze cloth.] [Where required by test standard, provide louvers with a spall-resistant screen of fine stainless steel mesh.] The free area of the total square meters feet of the louver must be [17 percent for channel style louvers] [39 percent for chevron style louvers (inverted angles at 25 mm 1 inch on center)] [[_____] percent]. Submit louver that has been tested in accordance with AMCA 500-Dairflow test, with a minimum airflow of [[_____] percent for channel style] [[_____] percent for chevron style] [[_____] percent]. Submit airflow calculations and test data showing compliance.

2.4 BULLET-RESISTANT LOUVERS

Fabricate louvers and frames from steel shapes to the opening dimensions indicated. Provide factory fabricated louver units designed to be bullet-resistant to the specified test standard in paragraph COMPONENT TEST REQUIREMENTS. Submit manufacturer's descriptive data, certificate, and test report showing compliance with the specified forced entry standard. The free area of the total square meters feet of the louver must be [17 percent for channel style louvers] [39 percent for chevron style louvers (inverted angles at 25 mm 1 inch on center)] [[_____] percent]. Submit louver that has been tested in accordance with AMCA 500-D airflow test. Provide a minimum airflow of [[_____] percent for channel style] [[_____] percent for chevron style] [[_____] percent]. Submit airflow calculations and test data showing compliance.

2.5 BULLET-RESISTANT STEEL BIFOLD DOORS, FRAMES, AND HARDWARE

Provide bifold doors consisting of two leaves per door, four per opening, as indicated on the drawings. Hardware must allow easy manual movement of doors. Provide doors and hardware that are either entirely jamb-supported or jamb-supported with floor rollers to reduce bearing load on hinges. Provide steel hinges of ample length to prevent sagging, and are through-bolted in accordance with manufacturer's instructions. Furnish operators and all installation hardware that is the product of a manufacturer which specifically designs and produces hardware for heavy-duty industrial-type doors. Factory prime door surfaces for painting and reinforced and prepared for hardware installation. [Bifold doors must be manually securable from the protected side through actuation of surface-mounted cane bolt or similar device as recommended by manufacturer.] Maximum clearance at bottom of doors must be 25 mm 1 inch. Provide exterior doors with weather seals at jambs, head, and sill.

2.5.1 Testing

Subject bullet-resistant bifold door to testing by manufacturer to demonstrate appropriate design, strength, and application and operation of all hardware, both manual and electric. Perform door tests to replicate actual installation to the maximum extent possible. Coordinate arrangements with Contracting Officer as to time and location of tests. Tests must be witnessed and results subjected to approval by representatives of the Contracting Officer prior to delivery of the doors to the job site.

2.5.2 Bifold Doors

Furnish bullet-resistant bifold doors complete with [pneumatic operators] [electric operators] [and other] accessories specified. Design the operator so that the motor may be removed without affecting emergency auxiliary operators. [Provide a manual operator of crank-gear or chain-gear mechanism to allow manual operation in case of power failure. Provide a device for locking the chain or crank.] Submit a copy of the instructions proposed to be framed and posted.

2.5.3 Power Operators

Provide [pneumatic] [electric] type conforming to NFPA 80 and the requirements specified herein. Provide readily adjustable limit switches to automatically stop the door in its full open or closed position. [All operating devices must be suitable for the hazardous Class, Division, and Group shown, as defined in NFPA 70.]

2.5.3.1 Pneumatic Operators

****

NOTE: Designer will coordinate with the drawings to ensure compressed air is available at door locations.

****

Provide pneumatic operators, heavy-duty industrial type designed to operate the door at not less than 0.2 nor more than 0.3 m/second 8 inches nor more than one foot/second with air pressure of [_____] kPa psi. Provide pressure regulator if operator is not compatible with previously specified air pressure. Provide dryer, filter, filter alarm, pneumatic piping up to connection with building compressed air, but not more than 6 m 20 feet from door jambs. Operators must have provision for immediate emergency manual operation of the door in case of failure. The operator must open, close, start, and stop the door smoothly. Control must be [electric, conforming to NEMA ICS 2 and NEMA ICS 6; enclosures must be Type 12 (industrial use), Type 7 or 9 in hazardous locations, or as otherwise indicated] [pneumatic] with [push button wall switches] [ceiling pull switches] [rollover floor treadle] as indicated.

2.5.3.2 Electric Operators

Provide electric operators, heavy-duty industrial type designed to operate the door at not less than 0.2 nor more than 0.3 m/second 8 inches nor more than 1 foot/second. Provide electrical controls that are [push button wall switches] [ceiling pull switches] [rollover floor treadle] as indicated. Provide electric power operators complete with electric motor, brackets, controls, limit switches, magnetic reversing starter, and all other accessories necessary. Design the operator so that the motor may be removed without disturbing the limit-switch timing and without affecting the emergency operator. Provide the power operator with a slipping clutch coupling to prevent stalling of the motor. Operators must have provisions for immediate emergency manual operation of the door in case of electrical failure. Where control voltages differ from motor voltage, provide a control voltage transformer in and as part of the starter. Provide control voltage of 120 volts or less.

a. Motors: Provide drive motors conforming to NEMA MG 1, with high-starting torque, reversible type, and of sufficient horsepower and torque output to move the door in either direction from any position at the required speed without exceeding the rated capacity. Provide motors suitable for operation on [_____] volts, [60] [_____] hertz, [single] [three] phase, and suitable for across-the-line starting. Design all motors to operate at full capacity over a supply voltage variation of plus or minus 10 percent of the motor voltage rating.

b. Controls: Provide an enclosed reversing across-the-line type magnetic starter having thermal overload protection, limit switches, remote control switches and conforming to NEMA ICS 2 for each door motor; provide enclosures that are NEMA ICS 6, Type 12 (industrial use), Type 7 or 9 in hazardous locations, or as otherwise indicated. Each wall control station must be of the three-button type, with the controls marked and color coded: OPEN - white; CLOSE - green; and STOP - red. When the door is in motion and the "STOP" control is pressed, the door must stop instantly and remain in the stop position; from the stop position, the door must be operable in either direction by the "OPEN" or "CLOSE" controls. Provide full-guarded controls to prevent accidental operation.

2.5.4 Safety Device

Provide a safety device that will immediately reverse the door movement upon contact with an obstruction and cause the door to return to its full open position. Do not substitute the safety device for a limit switch. Provide exterior doors with a combination weather seal and safety device on the leading edge.

2.6 BULLET-RESISTANT STEEL WINDOWS

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NOTE: Bullet-resisting glazing materials may be

glass, plastic, or composite of the two. Edit out all inappropriate items. Do not specify thickness of glazing. Selection of no-spall criteria generally requires use of plastic or composite glazing materials. Therefore, if these options are edited out, use low-spall criteria. Verify that glass glazing, where required, is available to meet low-spall criteria for threat specified.
****

Fabricate window assemblies from [bullet-resistant steel shapes] [or] [hollow metal with internal armoring] and bullet-resistant glazing materials specified herein; the entire assembly must meet or exceed the specified regulatory requirements. Provide welded frame units of sizes and shapes indicated on the drawings with minimum frame face dimensions of 50 mm 2 inches. Furnish glazing material with window assembly for onsite installation, or furnish factory glazed window units. Entire assembly must be furnished by same manufacturer. Weld exterior (attack side) glazing stops or integral to frame. Provide removable interior (protected side) glazing stops attached with high-strength alloy steel machine screws with tamper-resistant heads.

2.6.1 Glazing Materials

Provide factory fabricated units designed to be bullet-resistant to the specified test standard in paragraph COMPONENT TEST REQUIREMENTS. Glazing material must be [glass,] [plastic,] [or] [composite] with a [no-spall] [low-spall] protected (interior) face. [Low-spall interior face must meet or exceed requirements for spall resistance defined in UL 752.] Provide glazing material conforming to applicable requirements contained in ASTM C1036, ASTM C1048, and ASTM E1300. Test glazing materials in accordance with the applicable sections of the following testing procedures: ASTM D905, ASTM D1003, ASTM F428, ASTM F548, ASTM D4093, and ASTM F520. Apply a hardcoat to all plastic glazing exposed to the interior or exterior environment.

2.6.1.1 Laminated Glass

Provide bullet-resistant laminated glass consisting of all glass laminated construction conforming to applicable sections of ASTM C1172. The adhesive interlayer material for bonding glass to glass must be chemically compatible with the surfaces which are to be bonded. Test materials selected for lamination purposes in accordance with the following testing procedures: ASTM D905, ASTM D1044, ASTM F735, ASTM D4093, ASTM F521, ASTM F520, and ASTM D1003. Use glass plies in the lamination that are [annealed float glass conforming to Type I, quality q3 Class 1, in accordance with ASTM C1036] [or] [heat-strengthened or fully heat tempered, float glass, Condition A, Type I, q3 Class 1, in accordance with ASTM C1048].

2.6.1.2 Acrylic Plastic Sheets

Use bullet-resistant acrylic plastic glazing sheets "as cast" and in stretching operations with improved moisture absorption resistance conforming to ASTM D4802. Test acrylic materials in accordance with the applicable sections of the following testing procedures: ASTM D256, ASTM D5420, ASTM D542, ASTM D570, ASTM D635, ASTM D638, ASTM D696, ASTM D792, ASTM D1003, ASTM E831, ASTM F791, and ASTM G155. Provide plastic glazing sheets that are clear and smooth on both sides.

2.6.1.3 Polycarbonate Plastic Sheets

Provide bullet-resistant laminated polycarbonate sheets, ultraviolet stabilized, [flame resistant] [high abrasion resistant] sheets conforming to ASTM D3595. Test polycarbonate materials in accordance with the applicable sections of the following testing procedures: ASTM D256, ASTM D5420, ASTM D792, ASTM F735, ASTM D1003, ASTM D635, ASTM D638, ASTM D1044, ASTM D882, ASTM D1922, ASTM D570, ASTM F520, ASTM E169, ASTM E204, ASTM G155, and ASTM F791. Do not use polyvinyl butyral in contact with polycarbonate because its plasticizer may craze polycarbonate.

2.6.1.4 Glass/Plastic Laminate Glazing

Furnish bullet-resistant glass/plastic laminated glazing materials consisting of glass/plastic laminated construction or glass-clad plastic "sandwich" construction conforming to applicable sections of ASTM C1172. Polycarbonate must be ultraviolet stabilized.

2.6.1.5 Glass/Plastic Air-Gap Glazing

Furnish bullet-resistant glass/plastic air-gap glazing consisting of an assembly in which glass forms the exterior [and interior (protected side)] layer, separated by an air space from the laminated plastic plies. Provide exterior glass plies that are [annealed float glass conforming to Type I, quality q3 Class 1, in accordance with ASTM C1036] [or] [heat-strengthened or fully heat tempered, float glass, Condition A, Type I, q3 Class 1, in accordance with ASTM C1036] [or] [heat-strengthened or fully heat tempered, float glass, Condition A, Type I, q3 class 1, in accordance with ASTM C1048]. [Provide interior (protected side) glass plies that are [annealed float glass conforming to Type I, quality q3 Class 1, in accordance with ASTM C1036] [or] [heat-strengthened or fully heat tempered, float glass, Condition A, Type I, q3 Class 1, in accordance with ASTM C1048].] [Where annealed glass is used on the protected side of the window, apply a sheet of 0.102 mm 4 mil thick clear mylar fragment retention film to the interior surface in accordance with film manufacturer's instructions. Apply film that wraps around the edges of the glass prior to glazing the window.] Furnish plastic plies consisting of laminated ultraviolet stabilized polycarbonate sheets, conforming to paragraph Polycarbonate Plastic Sheets and/or acrylic sheets for use "as cast" and in stretching operations with improved moisture absorption resistance conforming to applicable requirements of paragraph Polycarbonate Plastic Sheets.

2.6.2 Adhesive Interlayer Materials

Provide adhesive interlayer materials for bonding laminates (glass-glass, glass-plastic, or plastic-plastic bonds) that are chemically compatible with the surfaces being bonded. Interlayer materials may be polyvinyl butyral, cast-in-place urethane, proprietary materials, sheet form urethane and other materials. Do not use polyvinyl butyral to bond polycarbonate. Provide adhesives in accordance with ASTM D905 and manufacturer's recommendations.

2.6.3 Sealants

Furnish sealants for glazings that are chemically compatible with the glazing materials they contact with no deleterious effects to the glazing materials or to the adhesives used in laminates. Sealants must be in accordance with glazing manufacturer's recommendations and

GANA Glazing Manual.

2.6.4 Deal Trays

Provide nominal 325 mm 12-3/4 inch wide by 40 mm 1-5/8 inch high opening in sill of window frame [and include a 165 mm 6-1/2 inch steel writing ledge on exterior side of window]. Provide deal tray welded subassembly of window assembly conforming to specified requirements for entire window assembly. Provide opening configuration of deal tray that prevents ballistic penetration or spall from the threat weapon, and resists lead spray from a shotgun blast. Provide tray opening that prevents insertion of the muzzle of a firearm.

2.7 BULLET-RESISTANT SPEAKING APERTURES

Fabricate speaking apertures to allow passage of voice at normal speaking volume without distortion, to resist the specified threat level for [outdoor] [indoor] use, and designed to prevent direct aim by the insertion of the muzzle of any firearm. Finish must match [window] [door] construction in which aperture is installed.

2.8 BULLET-RESISTANT GUNPORTS

Operate only from the protected side of the barrier, with a protected side shutter that closes automatically and is lockable from the protected side. Fabricate gunport from bullet resistant steel shapes and the entire assembly must meet or exceed the specified regulatory requirements. Size gunport for operation using submachine guns and rifles. [Provide assembly with a weather resistant opening.] Provide hinged or pivoted shutterand do not obstruct operation when in open position. Attach to wall assembly in accordance with manufacturer's recommendations. Include all aspects of gunport assembly, including hardware and method of anchorage to wall, in labeling or test certification. Provide [primed for painting] [satin stainless steel] finish. Gunport must not be operable from exposed side.

2.9 BULLET-RESISTANT PASS-THROUGH DRAWER

Fabricate pass-through drawer from bullet-resistant steel shapes; the entire assembly must meet or exceed the specified regulatory requirements. Provide pass-through drawer of size indicated on the drawings and designed to prohibit forcible entry or direct aim by the insertion of the muzzle of a firearm from exterior side when drawer is in the open position. [Provide a weather resistant opening.] Attach to wall assembly in accordance with manufacturer's recommendations. Include all aspects of the assembly, including hardware and method of anchorage to wall, in the labeling or test certification. Provide [primed for painting] [satin stainless steel] finish.

2.10 BULLET-RESISTANT PREFABRICATED MODULAR ENCLOSURE

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NOTE: Prefabricated enclosures, as specified herein, are intended for use primarily as hardlines on the interior of a facility, i.e., bullet-resistant partitions. Develop separate specifications if bullet resistant guards houses, control towers, etc., are required. Coordinate this specification with other disciplines where electrical work, plumbing, or HVAC are required.

****

Provide enclosure consisting of prefabricated, bullet-resistant, modular [insulated] wall [and] [ceiling] [and floor] panels with [doors,] [windows,] [louvers,] [gunports,] [and] all necessary connecting posts, hardware and accessories. Complete enclosure must be of minimum dimensions shown on the drawings. Provide [doors,] [windows,] [louvers,] [and] [gunports] in accordance with the requirements specified in those respective paragraphs. Components must be factory-welded assemblies. Factory paint all metal components with rust inhibitive primer unless indicated otherwise. Dress smooth all exposed welds. Workmanship must be rigid, neat in appearance, and free from defects. [Design enclosure to be relocatable by [crane] [forklift].]

2.11 ACCESSORIES

Provide all accessories for the installation or erection of above components into the surrounding structure. Anchorage must be as strong and bullet-resistant as the components. Install/erect in accordance with manufacturer's recommended instructions.

2.12 LABELING

****

NOTE: Model numbers and rating labels advertise the level of threat which the component is capable of resisting. Require removable labels where possible. Where this information cannot be removable, specify that it must be on the protected side or concealed from view by casual observers.

****

Plainly [and permanently] label bullet-resistant equipment in accordance with regulatory requirements. Provide label that is compatible with plastic or coating, visible only on protected side, after installation, including the following information:

a. Manufacturer's name or identifying symbol

b. [Model Number, Control Number, or equivalent]

c. Date of manufacture by week, month or quarter and year. This may be abbreviated or be in a traceable code such as the lot number.

d. Correct mounting position including threat side and secure side (by removable label on glazing material).

e. Code indicating bullet-resistant rating and test standard used (by removable label on glazing material).

2.13 SHOP/FACTORY FINISHING

Furnish all ferrous metal components, except stainless steel, primed for painting unless indicated otherwise. Perform finish painting in accordance with Section 09 90 00 PAINTS AND COATINGS, unless otherwise indicated. When anodic coatings are specified, the coatings must conform to AAMA 611, with coating thickness not less than that specified for protective and decorative type finish in AA DAF45. Apply a polished satin finish pretreatment and a clear lacquer overcoat to anodized items. Shop finish all factory or manufactured components as indicated.

2.13.1 Ferrous Metal

Clean surfaces of ferrous metal, except galvanized and stainless steel surfaces, and shop coat with the manufacturer's standard protective coating other than a bituminous protective coating, compatible with finish coats. Prior to shop painting, clean surfaces with solvents to remove grease and oil, and with power wire-brushing or sandblasting to remove loose rust, loose mill scale and other foreign substances. Do not shop paint surfaces of items to be embedded in concrete.

2.13.2 Galvanizing

Items specified to be galvanized must be hot-dip processed after fabrication. Galvanize in accordance with ASTM A123/A123M or ASTM A653/A653M as applicable.

2.13.3 Aluminum

Unless otherwise specified, aluminum items must be standard mill finish. For anodic coatings see paragraph SHOP/FACTORY FINISHING above.

PART 3 EXECUTION

3.1 EXAMINATION

Field verify dimensions of rough openings for components, and that surfaces of openings are plumb, true, and provide required clearances. Protect surrounding work prior to installation of bullet-resistant components. Restore surrounding work which is damaged as a result of the installation of bullet-resistant components to like-new condition prior to acceptance of the work described herein. Examine existing work to ensure that it is ready for installation or erection of the components. Check and correct components for racking, twisting, and other malformation prior to installation. Set frames true, plumb and aligned for proper installation. Examine all surfaces and connections for damage prior to installation.

3.2 FRAMED INSTRUCTIONS

Post framed instructions, under glass or in plastic with all edges laminated, including wiring and control diagrams showing the complete layout of each bifold door unit, where directed. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking for normal safe operation, and procedures for safely starting and stopping in typed form, frame as specified above and post beside the diagrams. Post the framed instructions before acceptance testing.

3.3 INSTALLATION

Provide finished work that is rigid, neat in appearance and free from defects. Install equipment plumb, level, and secured rigidly in place. Install doors and frames conforming to NAAMM HMMA 840. Install doors, frames, and hardware in strict compliance with approved printed instructions and detail drawings provided by the manufacturer. The Contractor is responsible for proper installing of the door assembly so that operating clearances and bearing surfaces conform to manufacturer's instructions. Install weatherstripping and thresholds at exterior door openings to provide a weathertight installation. Install all other components in accordance with approved manufacturer's recommended instructions. Test all operable parts of components for smooth, trouble-free operation, in the presence of the Contracting Officer. Submit Drawings containing complete wiring and schematic diagrams, where appropriate, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of components and appurtenances, and relationship to other parts of work including clearances for operation and maintenance. Show conformance to all requirements, including fabrication details, sizes, thickness of materials, anchorage, finishes, hardware location and installation.

3.4 FASTENERS

Fasteners exposed to view must match in color and finish and must harmonize with the material to which fasteners are applied. Provide fasteners in accordance with Section 08 31 00 ACCESS DOORS AND PANELS.

3.5 CORROSION PROTECTION - DISSIMILAR MATERIALS

Give contact surfaces between dissimilar metals and aluminum surfaces in contact with concrete, masonry, pressure-treated wood or absorptive materials subject to wetting, a protective coating in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.6 ELECTRICAL WORK

Perform all electrical work in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Make flexible connections between doors and fixed supports with extra flexible type SO cable, except in hazardous locations where wiring conforms to NFPA 70. Provide cable consisting of a spring-loaded automatic take up reel, or an equivalent and approved device.

3.7 ADJUSTING/CLEANING

Make adjustments to doors and pass-thru drawers to assure smooth operation. Units must be weathertight when closed and locked. Clean all components in accordance with manufacturer's instructions.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 34 16 (May 2017)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 34 16 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-08 34 16 (May 2017)**

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SECTION 08 34 16

CORROSION CONTROL HANGAR DOORS
05/17

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NOTE: This guide specification covers the requirements for fabrication and manufacture of hangar doors used in corrosion control hangars.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: These doors are unique because they also serve as the air supply plenum.

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NOTE: Painting of hangar doors must be specifically mentioned in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES, along with a reference to this Section and with instructions not to paint operating parts, mechanisms, limit switches, or trolley ducts.

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NOTE: On the design drawings, show:
1. Size and arrangement of doors. Electrical and

structural provisions for motor operators.
2. Location and type of weather stripping, exterior covering, interior lining and flashing.
3. Location, spacing, size and type of top guides and rails. Center-to-center dimension of leaves including interior and exterior coverings.
4. Location and type of personnel doors. Do not locate personnel doors between wheels and edge of hangar door leaf.
5. Location of bumpers and pulls.
6. That wheels will be required. Type, size, and number should not be shown since size and weight of doors will determine these.
7. Appropriate design wind pressures based on the design wind velocity. See section on "Wind Loads" for more detailed requirements.
8. Details of expansion joints in rails and top guides where building expansion joints occur.
9. Electrical service for motor operators, preferably 460 volts, 3-phase, 60-hertz, and location of power supply disconnect.
10. Access for installation, maintenance, and replacement of top rollers if hangar requires floating top rollers.
11. Dimensions and details of tail doors, if required.
12. Bottom rail drains for full length of bottom rails. This may be done with cross drains normal to the rails spaced about 6 M 20 feet on center. In cold areas it may be necessary to provide de-icing equipment below the rails.
13. End of travel bumpers and bumper supports at end of door travel. Dimension and location should be in accordance with door manufacturer's approved drawings.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile

references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN LADDER INSTITUTE (ALI)

ALI A14.3	(2008; R 2018) Ladders - Fixed - Safety Requirements

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A29/A29M	(2023) Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A519/A519M	(2024) Standard Specification for Seamless Carbon and Alloy Steel Mechanical Tubing
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural,

	High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM A1018/A1018M	(2023a) Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B103/B103M	(2023) Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D740	(2011) Methyl Ethyl Ketone
ASTM D4614	(2011) Standard Specification for Ethyl Acetate (All Grades)
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 519	(2022) Standard for Harmonic Control in Electrical Power Systems

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2017) Metal Bar Grating Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 220	(2024) Standard on Types of Building Construction
NFPA 409	(2022) Standard on Aircraft Hangars

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-C-22542	(2012; Rev A; Stabilized (S) 2012) Cleaning Compound, High Pressure Cleaner, Liquid
SAE J514	(2012) Hydraulic Tube Fittings
SAE J1405	(2012) Optional Test Procedures for Hydraulic Hose Assemblies

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-D-16791	(1990; Rev G, Am 1 1993; Notice 1 2020) Detergents, General Purpose (Liquid, Non-Ionic)
MIL-DTL-5541	(2006; Rev F; Notice 2 2024) Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-DTL-15021	(2014; Rev B) Hook, Snap Bolt, Swivel-Eye, and Rings
MIL-R-24243	(1994; Rev C, Notice 1 2020) Rivets, Blind, Nonstructural, Retained Mandrel, Open End, Domed Head, Aluminum Alloy, Carbon Steel, Corrosion Resistant Steel
MIL-T-81772	(2019; Rev C) Thinner, Aircraft Coating
UFC 1-200-01	(2022; with Change 4, 2024) DoD Building Code
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-857	(Rev B, Notice 3) Thinner, Dope and Lacquer (Cellulose Nitrate)
FS RR-C-271	(Rev H; Am 1) Chains and Attachments, Carbon And Alloy Steel

UL SOLUTIONS (UL)

UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, 03 30 00 CAST-IN-PLACE CONCRETE, 05 12 00 STRUCTURAL STEEL, 08 11 13 STEEL DOORS AND FRAMES, 08 71 00 DOOR HARDWARE, 43 15 00.00 20 LOW PRESSURE COMPRESSED AIR PIPING (NON-BREATHING AIR TYPE), 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES and 09 90 00 PAINTS AND COATINGS apply to this section with additions and modifications specified herein.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

SD-02 Shop Drawings

Door Materials; G, [_____]

SD-05 Design Data

Door Structure; G, [_____]

SD-10 Operation and Maintenance Data

Lubrication; G, [_____]

Air System; G, [_____]

Electrical Equipment; G, [_____]

1.3.1 Door Materials

Submit design drawings covering door structure, all operating devices, mechanical systems and "U" value

Show all details for construction, installation and operation; size, shapes and thickness of materials, joints and connections; reinforcing; hardware; mechanical devices; electrical devices; and all design and detail data for work of other trades affected by hangar doors.

Submit the door manufacturer's complete schematic compressed air and wiring diagrams, field piping and wiring diagrams, and a complete physical location drawing showing the location of all pressure regulators, gages, metering valves, lubricators, filter-dryers, interlocking valves and controls with the runs of pipe and conduit, pipe size and conduit size, wire number and wire size in each conduit, junction box location and full control mounting details

1.3.2 Door Structure

Submit design calculations covering door structure, all operating devices, mechanical systems and "U" value. A Registered Professional Engineer shall prepare and sign structural calculations.

1.3.2.1 Adjustable Frequency Motor Drive

IEEE 519.

1.3.3 Operation and Maintenance Manuals

Drawings and instructions showing all lubrication points, proper lubricants, lubrication frequency schedule and complete operating instructions. Complete compressed air system schematic and electrical equipment wiring diagrams.

Furnish the above in duplicate to the Contracting Officer.

1.4 QUALITY ASSURANCE

1.4.1 Manufacturer's Qualifications

Use a corrosion control hangar door product from a manufacturer who is regularly engaged in the design, fabrication, erection, and service of corrosion control hangar doors of type and size required for this project. The manufacturer shall have at least 5 years of similar corrosion control hangar door design experience. Similar doors must have comparable function and design including size, configuration, type of use, retractable or moving elements, safety features, controls, and other key engineering elements as the door being specified. It is acceptable to show that a series of similar doors collectively meet all comparable elements to the door being specified, although not necessarily individually. Manufacturer must submit written evidence on similar past door designs and installations listing the name, location, contact information of owners, installation dates, overall sizes, features, and other relevant information for experience and qualifications evaluation. Only manufacturers who can submit this evidence of actual installations where the products have proven practical, durable, and require a minimum of maintenance, will be qualified under this specification.

1.4.2 Installer's Qualifications

Installation of the door(s) shall be supervised by a manufacturer's representative and shall be in accordance with approved shop drawings. Installers shall be skilled and experienced in the erection of corrosion control hangar doors of the type specified herein. Installers must submit written evidence of similar past door installations listing the name, locations, contacts information of owners, installation dates, overall sizes, features, and other relevant information for experience and qualifications evaluation.

1.4.3 Warranty

The door manufacturer shall provide a three-year warranty for all mechanical and electrical components against defects in material and workmanship beginning on the date of Project Acceptance.

1.5 DELIVERY AND STORAGE

Deliver materials which are not shop-installed in the doors in original packages, containers, boxes or crates bearing the manufacturer's name, brand and model number. Store all materials and equipment in dry locations with adequate ventilation, free from dust or water, and to permit access for inspection and handling. Handle doors carefully to prevent damage. Remove damaged items that cannot be restored to like-new condition and provide new items.

1.6 DESIGN REQUIREMENTS

1.6.1 Door Design and Components

The corrosion control hangar doors and components indicated in the construction documents are representative of a commercially-available door. Design and fabricate the door to fit within the space allocated and in accordance with the criteria specified herein. Design doors to operate properly without binding, interference, or damage to weather stripping or the adjacent structure. Door must be of limited combustible construction in accordance with NFPA 220 and NFPA 409.

Submit Calculations sealed by the door manufacturer's registered professional engineer for review.

1.6.1.1 Steel Door Components

Design all supporting, steel bracing and framing steel members in accordance with the specified loads and the requirements of AISC 325 and AISC 360. Design all cold formed steel in accordance with AISI SG03-3. Weld steel in accordance with the AWS D1.1/D1.1M Standards.

1.6.2 Loads

Design the door for the loads in accordance with UFC 1-200-01, UFC 3-301-01 and all other applicable criteria.

1.6.2.1 Wind Loads

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NOTE: In accordance with UFC 1-200-01 and UFC 3-301-01, the Engineer of Record must show the appropriate design wind pressure for the design of the door on the drawings. The simplified procedure/method must not be used to calculate the design wind pressures for the door, only an analytical procedure is allowed. The building volume accessed by the corrosion control hangar door must be considered "Partially Enclosed". The design pressure must be based on the specific project design criteria and on the design wind velocity for cladding and components with the appropriate tributary area. An example table of required design wind pressures is shown below.

Zone	Effective Area (SF)	Max Positive Pressure (PSF)	Max Negative Pressure (PSF)
?	10	?	?
?	100	?	?
?	200	?	?
?	500	?	?
?	700	?	?

Components and Cladding elements with Effective Areas greater than 65.032 square meters 700 square feet must be permitted to be designed using the provisions for MWFRSs.

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In the closed position, design doors and all components to withstand the wind pressures indicated by the Engineer of Record. Design all door components to withstand both the highest positive and negative pressures based on actual tributary area from the wind load indicated.

In addition, design doors and all components to be operational during wind events which cause a positive or negative service load pressure of 0.718 kPa 15 psf on the surface of the door.

1.6.3 Deflections

For any door member, the deflection due to design wind load shall not exceed the member's length divided by 120. Design the differential deflection at the door seals to be less than 51 mm 2 inches.

Design Doors as a system to withstand the upward and downward deflections of the door header structure.

1.6.4 Drive Mechanism

Design the drive mechanism to operate the door against a wind pressure of 5 pounds per square foot perpendicular to the leaf. Design the drive so that when stopped at any point, the door automatically locks in place against a 185 km/h 115 mph wind. Provide sufficient wheel traction to lock hangar doors when the track is wet. Design for the effect door sway and vibration will have on wheel traction in a 185 km/h 115 mph wind.

1.6.5 Door Seals

Use sealing system between door leaf and building, between door leaf and foundation, and between leaf, designed to provide an air tight closure with the building and the ventilation supply air plenum. Coordinate the design of the door seal system with the building architectural and structural details, and the mechanical ventilation systems. Use fully adjustable door seal system to permit initial setting during installation of the doors, and to permit future adjustments. Use door sealing system designed for ease of replacement and that incorporates commercially available components.

1.6.6 Pneumatic Locking Mechanism

Provide manual and pneumatic control devices, piping, tubing and hose for the locking mechanisms. Include the flexible connection to the building air system. Use air system designed to accommodate the non-lubricated building air supply available. Use system designed to maintain air loading of the cylinders at all times except when the lock pins are to be retracted. Locate compressed air accessories, including the filter / regulator assembly, and control valves where they will be readily accessible for maintenance. Secure all tubing runs in the door plenum to the door frame using cushion clamp assemblies spaced to prevent sag in runs. Arrange all tubing runs to prevent accumulated moisture from reaching the air cylinders. Locate air system accessories to be readily accessible for inspection and servicing. Provide manual release of the automatic door in the event of power failure. Accomplish disengagement of the air cylinder by venting the air supply to the cylinder, removing the air loading on the piston. Provide manual retraction of the locking pins by means of a hand pull attachment through a corrosion resistant wire rope cable system.

1.6.7 Electrical Requirements

Use electrical wiring and equipment approved for Class 1, Division 1 locations as described in Article 501 of NFPA 70. Use electric motor (460 V, 3-phase) as prime mover.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Structural Steel

ASTM A36/A36M.

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Note to the designer:

Include the following paragraphs in Section 05 12 00 STRUCTURAL STEEL.

".1 Top Guides and Bottom Rails for Hangar Doors:

.1.1 Top Guides: Maintain nominal elevation within plus or minus 6 mm 1/4 inch and nominal center-to-center dimension within plus or minus 3 mm 1/8 inch, with variation from nominal no greater than one mm in 2 meters 1/8 inch in 20 feet. Joints of head guides are not required to be welded, but shim and grind so adjoining guide surfaces are not out of line more than 2 mm 1/16 inch. Top guide tolerances shall be met after dead load is imposed on building frame.[Top guide surfaces which will be in contact with rollers during door operation shall be stainless steel framing or structural members.]

.1.2 Hanging Head Flashing: Galvanized steel, not thinner than 1.2 mm thick 18 gage, reinforced as required. Coordinate with hangar door manufacturer. Show exact location and configuration on top guide shop drawings. Top guide and head flashing system shall be shop assembled to verify accuracy of fit and fastener location, and disassembled for shipping. Install head flashing after doors are in place.

.1.3 Bottom Rails: Standard A.S.C.E. or A.R.E.A. weighing not less than [_____] kilograms per meter pounds per yard. Do not install rails until top guide system has been installed. Continuously support rails and anchor as indicated. Set rails to elevation within plus or minus 6 mm 1/4 inch, with variations from elevation no greater rate than one mm in 2 meters 1/8 inch in 20 feet. Nominal design relationship between top guides and bottom rails to be maintained without exception. Center-to-center dimensions of bottom rails to be maintained within plus or minus 3 mm 1/8 inch with variation from nominal no greater than one mm in 2 meters 1/8 inch in 20 feet. Weld rail joints and grind smooth or provide with splice plate in accordance with ASCE standards."

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2.1.2 Formed Steel

AISI SG03-3.

2.1.3 Galvanized Steel

Hot dipped galvanized frames in accordance with ASTM A123/A123M.

2.1.4 Sheet Steel

ASTM A1011/A1011M, hot-rolled sheet steel, commercial quality, or ASTM A1008/A1008M, cold-rolled steel sheet, commercial quality.

2.1.5 Galvanized Sheet Steel

ASTM A653/A653M, coating designation G90 galvanized steel sheet, commercial quality.

2.1.6 Exterior Covering

Preform the hanger door/plenums' exterior wall from siding panels over rigid insulation boards, assembled in accordance with the siding manufacturer's standard detail. Provide panels with factory finish equal to Kynar 500 PVDF fluoropolymer

2.1.6.1 Exterior Roof Panels

Coated steel sheets conforming to the requirements of Section 07 41 13 METAL ROOF PANELS, with ribbed exterior face, 38 mm 1-1/2 inch panel, depth and thickness to meet design loads and purlin spacing, but not less than 22 MFG STD gage, with factory finish equal to Kynar 500 PVDF fluoropolymer.

2.1.6.2 Liner Panels

Coated steel sheets conforming to the requirements of Section 07 41 13 METAL ROOF PANELS, or galvanized steel sheets conforming to ASTM A653/A653M, coating designation G90, with flush interior face, 47.6 mm 1-7/8 inch panel depth and thickness to meet design loads and purlin spacing, but not less than 22 MFG STD gage, with factory finish.

2.1.6.3 Insulation

Permanently secure insulation materials in place between the face and line panels. Design the doors to have an air-to-air "U" value not more than 0.05, a flame spread rating of 75 or less and a smoke-developed rating of 100 or less when tested in accordance with ASTM E84. Do not use cellular plastics.

2.1.6.4 Accessories

Sheet metal flashings, trim molding, closure strips, caps, subgirts and other similar sheet metal accessories used in conjunction with the preformed panels shall be of the same material and finish as the panels. Metal shall be of a thickness not less than that used for the panels.

2.1.7 Hardware

Provide hardware suitable for use on hangar doors and designed to accommodate actual dead loads plus wind loads specified herein.

2.1.7.1 Pivots

Provide pivots with heavy duty thrust bearings sealed against dust and water, and with drip-type lubrication fittings requiring infrequent attention. They shall be of sufficient strength to resist all loads specified herein, with a factor of safety of 2. Provide for expansion and contraction over a temperature range of 27 degrees C 80 degrees F. Design the top pivot to provide movement in the plane of the door to accommodate a differential settlement of 101.6 mm 4 inches within the length of the track and between the track and the building. Design the top pivot to provide movement in the plane of the door in the closed position to accommodate a horizontal displacement of the building of vertical door alignment adjustments at the top and bottom pivot points. The bottom pivot point shall be self-aligning and installed in a cement case with removable weather tight cover, and shall be designed to resist axial and radial thrust loads.

2.1.8 Weatherstripping

Rubber bulb seals shall be resistant to incidental contact with the following chemicals and solvents used in the facility:

MATERIAL	MILITARY OR FEDERAL SPECIFICATION
MEK	ASTM D740
Dope and Lacquer Thinner	CID A-A-857
Aircraft Coating Thinner	MIL-T-81772
High Pressure Cleaning Compound	SAE AMS-C-22542
Ethyl Acetate	ASTM D4614
Non-Ionic Detergent	MIL-D-16791
Conversion Coating	MIL-DTL-5541

2.1.9 Fasteners

Hot dipped galvanized.

2.1.10 Sealant

Single-component or multi-component elastomeric type conforming to ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT. Provide a sealant that has been tested on the type(s) of substrate to which it will be applied.

2.1.11 Light Fixtures

The door manufacturer shall provide all light fixtures indicated in or on the door. Conform to the electrical drawings and the requirements specified in 26 20 00 INTERIOR WIRING SYSTEMS.

2.1.12 Personnel Emergency Pass Doors and Plenum Access Doors

Provide doors in each hangar door leaf for personnel access to the building, and for access to the air plenum for maintenance of the drive mechanism and lock pin mechanisms. Doors shall be exterior, hollow metal, flush type, insulated, with gasketed frame to provide an airtight seal. Doors shall conform to 08 11 13 STEEL DOORS AND FRAMES. Provide hardware conforming to 08 71 00 FINISH HARDWARE, as follows:

a. Personnel Pass Doors:

1-1/2 Pairs, Hinges	A5111 (Temp.) 5 by 4-1/2
1 Each Exit	Type 2, Function 01
1 Each Door Closer	C02061, Size IV
1 Each Kickplate	J102
1 Set Airtight Seals	As specified

b. Personnel Pass Doors:

1 Pair, Hinges	A5111 (Temp.) 5 by 4-1/2
1 Each Lockset	Series 1000, Grade 1, Function F04
1 Each Door Closer	C02011, Size 111
1 Set Airtight Seals	As specified

2.1.13 Concrete and Non-Shrink Grout

Pour in place normal concrete having a strength of 3000 psi. Concrete and non-shrink grout shall conform to the requirements of 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.14 Filter Assembly

The filter system for the hangar doors shall consist of a replaceable media filter system in a permanent frame filter bank mounted in the door frame as indicated. The filter frame bank shall consist of universal modular frames, nominal 0.6 m by 0.6 m 24 inch by 24 inch, fastened to each other to form an assembly. Fabricate frames from 16 gage galvanized steel and include filter holding clips to permit easy removal of the filters without removal of the clips. Fasten frames to each other and to the supporting door frame by means of stainless steel break mandrel rivets (pop rivets) conforming to MIL-R-24243. Use replaceable filters of the extended surface type, nominal 0.6m by 0.6 m by 51mm 24 inch by 24 inch by 2 inch deep, with a 30 percent efficiency when rated by ASHRAE 52.2. Filters shall meet the fire-resistant requirements of UL 900, Class 1. Use pleated type filters with a welded wire media support grid and nonflammable enclosing frame bonded to the filter media. Provide one complete set of replacement filters for each door leaf.

2.1.15 Differential Pressure Switches

Provide each door leaf with a differential pressure switch to annunciate when the filters are dirty and require replacement. Provide 101.6 mm 4 inch diaphragm operated differential pressure switches to activate a single pole double throw snap switch. Restrain motion of the diaphragm by a calibrated stainless steel spring adjustable through the full range. Transmit spring range the snap switch by means of a direct mechanical linkage. Switch shall be rated for a temperature range of minus minus 1 degree C 30 degrees F to 82.2 degrees C 180 degrees F, and a pressure of 10 psig. The operating range shall be 1/2 to 2 inch water column with a maximum dead bank of 0.12 inches water column, and repetitive accuracy of 2 percent of range. Use U.L. listed switch mounted in an explosion-proof housing suitable for use in a Class 1, Division 1, Group D hazardous area. Use 3.2 mm 1/8 inch NPT pressure sensing connection. Use 12.7 mm 1/2 inch NPT electrical connection. Use switch rated 15 amps, 120 volt A.C., resistive load.

2.1.16 Door Drive Mechanism

Each door leaf shall be driven by a single drive wheel operating on an embedded standard crane rail. The drive wheel shall be driven by an electric worm gear motor through a double reduction chain and sprocket. The drive mechanism shall be capable of operating the door under the design loads specified herein.[For areas classified as Class 1, Division 1, Group D hazardous areas, all moving parts exposed within the door plenum and the aircraft by shall be non-sparking, except where protected by drive system sealed enclosure. Limit the acceleration of the door to reduce the potential hazard of the drive wheel sparking the rail.] Incorporate machinery in the drive mechanism to permit the door leaf to be operated manually by means of a tractor in the event of a power failure or motor drive failure. The drive mechanism shall be of the design indicated, or shall be of a comparable, previously-proven design for a similar type door which shall be approved by the CQC Representative.

2.1.16.1 Worm Gear Motor

The gear motor shall consist of a multiple reduction helical worm gear reducer with an integrally mated A.C. motor and electric brake.

2.1.16.2 Gear Reducer

The gear reducer shall be A.G.M.A. rated for the design torque with a service factor of 1.0. Use gear reducer housing of high strength cast aluminum or cast steel. The worm shall be machined of high strength leaded alloy steel carburized and hardened to 60-62 Rockwell C, tempered, honed and ground after hardening. The worm gear shall be cast bronze. The output shaft shall be high strength alloy steel. Bearings shall be either tapered or ball rollers on the work shaft and tapered rollers on the output shaft. Use dual lip spring-loaded seals to protect against leakage and foreign matter. Use gear reducer with a large oil reservoir for adequate splash lubrication for cool operation and an easily accessible oil fill, level and drain holes for maintaining proper oil level. The gear reducer shall have an adaptable base, machined for direct mounting to the support structure.

2.1.16.3 Motor

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NOTE: Provide a Totally Enclosed Wash-Down (TEWD) motor enclosure in harsh salt air marine environments. Hangar doors have a history of early motor failure where facilities are adjacent to the ocean.

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Use integrally mated motor suitable for variable speed operation with input power from an adjustable frequency drive unit,[explosion-proof for areas designated as Class 1, Division 1, Group D hazardous areas,][totally-enclosed, wash-down (TEWD)] constant torque, NEMA Design D, 3 phase, 60 hertz, 460 volt service, with Class B insulation, time and temperature rating 30 minutes 75 degrees C 167 degrees F temperature rise over 40 degrees C 104 degrees F ambient, 1.2 service factor and with sealed bearings. Include in motor an integrally mounted disc brake in an explosion-proof enclosure. Brake shall have a manual release with automatic reset. Extend shaft through brake for manual operation. Select motor for starting torque and not stall torque. Motor shall conform to NEMA MG 1 standard.

2.1.16.4 Chain and Sprocket Drive

Accomplish double reduction chain and sprocket drive through a sprocket mounted on the output shaft of the gear motor, a sprocket mounted on the drive wheel shaft and an intermediate jack shaft with sprockets. Use single or double strand type sprockets to match the ANSI pitch chain with hardened steel teeth. Use sprockets designed to have a minimum of 40 percent tooth contact. Use jack shaft designed with a clutch mechanism to permit disengaging the gear motor drive from the drive wheel to permit manual operation of the door. Use jackshaft fabricated from high strength alloy steel and supported by two pillow blocks or flanged bearings. Use bearings designed for an L10 life of 20,000 hours, with self-aligning double row spherical bearings in a cast iron housing, a spring locking collar, spring loaded lip seals and grease fittings. Use manual clutch mechanism with a handle of sufficient length to facilitate manual operation and a latching device to assure positive engagement under normal operation when not mechanically retracted for manual operation. Fit the chain and sprocket drive system with an automatic oil lubricator readily accessible for inspection. Use roller chain of single or double strand conforming to ANSI standards for dimensions. Use roller chain of heavy series type rated for occasional shock loading. Use press fit riveted type pins. Use press fit cotter pin type connecting pin.

2.1.16.5 Drive Wheel Truck Assembly

Mount each drive wheel on a removable truck assembly, as indicated, to permit removal and servicing without dismantling the door.

2.1.16.6 Drive Wheel

Use wheel fabricated from heat treated chromium-molybdenum alloy, AISI strength. Use wheels designed to operate on a standard crane rail as specified herein. Use wheels conforming to the following dimensions after machining:

a. Diameter of tread	533.4mm to 0.13 mm21.0 inch to 0.005 inch

b. Width of tread	82.6 mm3 1/4 inch
c. Bore	As required

After machining, flame harden wheels to 325 to 375 brinell hardness.

2.1.16.7 Shafting

Fit and weld wheels to a high strength steel tube shaft. Machine tube shaft from hot finished seamless carbon steel mechanical round tubing conforming to ASTM A519/A519M, and steel conforming to ASTM A1018/A1018M with a wall thickness as required by design. Machine tubing shaft to receive bearings so that the combination with the wheel shall be concentric with the bearings and support shaft within a tolerance of 0.5mm 0.002 inches. Run tube shaft on tapered roller bearings press fit into the ends of the tube. Ends of tube are supported by a high strength machined inner shaft mounted directly to the wheel truck. Machine inner shaft from medium carbon, high manganese, free machining, cold finished, Stress proof steel shafting, drawn, ground and polished with a tensile strength of 125,000 psi and a yield strength of 100,000 psi. Drill and tap inner shaft to accommodate lubrication tubing and to permit distribution of grease to both bearings.

2.1.16.8 Tapered Roller Bearings

Use self-aligning, cylindrical bore, spherical roller type bearings, sized for the static and dynamic forces with an LB-10 minimum life rating of 20,000 hours. Use manufacturer's standard precision machined self-locking bearing nut for retaining the bearings on the shaft. Machine bearing sleeve for preloading the tapered roller bearings from Stress proof steel shafting used to support the wheels.

2.1.16.9 Fabricated Truck

Use plate conforming to ASTM A36/A36M except as indicated and specified herein.

2.1.16.10 Seals and Seal Housing

Fabricate seal housing as indicated for clearance fit to shaft and sleeve. Use double lip, spring loaded seal to retain bearing lubricating grease and protect the bearings from dirt.

2.1.16.11 Bearing Lubrication Components

Use copper tubing the size indicated conforming to ASTM B88, Type L, for use with compression type fittings. Use brass fittings conforming to SAE J514 to connect tubing to shaft and to truck. Use male connector fitting for connection to shaft, male pipe end and flare tube end to receive tubing. Use "Triple-Lok" fittings as manufactured by Parker Hannafin, or approved equal. Provide alemite grease fitting to mate with bulkhead female pipe fitting.

2.1.16.12 Door Drive Mechanism Enclosure

Design and fabricate drive mechanism enclosure to be readily removable to facilitate inspection and maintenance of the mechanical drive components. Fabricate enclosure to airtight to maintain the integrity of the pressurized air plenum.

2.1.17 Lock Pins

Equip leading edge of doors with top and bottom automatic lock pins designed to restrain the door in the full open or full closed positions, under the design operating wind forces. Assure that doors are properly aligned in the fully closed position with seals compressed. Use non-sparking lock pin mechanisms designed to accommodate thermal expansion and contraction of the doors, with sufficient range of action horizontally to seat under full wind load deflections (inward or outward). Seat bottom lock pins in special receptacles set in the concrete slab designed to accommodate the full travel of the pin, and designed to prevent dirt and water from accumulating inside. Use air operated lock pins designed for normal operating conditions with mechanism to manually release the pins in the event of a failure of the control system. Use lock pin mechanism of the design indicated, or of a comparable, previously proven design for a similar type door approved by the CQC Representative.

2.1.17.1 Operating Mechanism

Use direct action double acting air cylinder operating mechanism for opening and closing the lock pins. Use cylinders sized to operate the lock pins when binding in the receivers under full wind loads or other combination of loads including thermal expansion and contraction of the doors, and settlement deflection of the doors with available 80 psig air. Use cylinder of corrosion-resistant construction suitable for industrial application and rated for 200 psig non-lubricated air service. Machine cylinder barrel head from high strength steel tubing, honed to a 10-15 micron-inch finish and hard chrome plated inside and outside. Fit head with easily externally removable precision machined high strength fine grained iron, bronze or aluminum rod bearing, incorporating seals and rod wiper to prevent dirt form entering cylinder. Use cylinders cushioned at both ends with built-in adjustable needle valves to allow adjustment of the cushion effect. Fit piston with double seals for minimum friction under varying dynamic pressures. Machine cylinder rod from high strength steel, 90,000 to 100,000 psi minimum yield, hard chrome plated, and sized for operating the pin with a factory safety of five based on yield strength. Pre-lubricate cylinder with a permanent type dry lubricant. LR2 Permanently Lubricated Air Cylinders or Universal "A-2" Series Heavy Duty Pre-Lubricated Pneumatic Cylinders as manufactured by Schrader Bellows of Akron, Ohio conform to this specification.

2.1.17.2 Top Pin

Machine top pin cold drawn ASTM A29/A29M, Grade 1018 steel bar stock. Hard chrome plate top pin after machining. Machine pin bottom to mate with the clevis fitting on the air cylinder. Use two sets of bronze guide rollers to guide pin for the full stroke. Use bronze rollers designed to accommodate the maximum forces under the design loadings plus: forces due to temperature expansion and contraction of the door,; forces due to settlement of the door; and other binding forces on the top pin when engaged in its receiver. Use top pin latching receiver assembly designed to accommodate the maximum pin loading and to mate with the 12.7 mm 1/2 inch building truss plate provided for the lock mechanism. Use receiver assembly provided with a phosphor bronze liner sheet conforming to ASTM B103/B103M with a hard temper, minimum tensile strength of 80,000 psi and Rockwell Hardness Number B86.

2.1.17.3 Bottom Pin

Machine bottom pin from cold drawn ASTM A29/A29M, Grade 1018 steel cold finished round stock. Machine pin to thread to the cylinder rod. Guide pins at the bottom of door with UHMW supported in a fabricated steel bracket. Engage pin in sockets embedded on the floor. Use sockets with UHMW sleeves.

2.1.17.4 Air System

Use air system for operating the lock pins consisting of shop compressed air available near each door at 12.7 mm 1/2 inch valved connection on the aircraft by wall as indicated. The compressed air is classified as industrial plant grade air at a pressure of 100 to 125 psig. The door manufacturer shall provide appropriate air accessories such as valves, regulators, filters, dryers and gages for the operating and control equipment, to ensure trouble-free service.

a. Air Filter: Each door leaf control air system shall be served by a primary filter separator provided immediately ahead of the pressure regulator. Use filter separator sized for the maximum air flow. Use filter separator capable of separating free water from other liquids, and particulates larger than 5 microns that may cause damage to the pneumatic equipment. Use filter separator with a transparent bowl guard, non-corrosive filter element. Include an automatic drain and replaceable filter elements for filter separator. Provide two spare filter elements for each filter.

b. Pressure Regulator: Serve each door leaf control air system by a pressure regulator to reduce the 100 to 125 psig plant supply air to 90 psig to provide the regulate air supply for the cylinders. Use relieving regulators with T-bar stem locking handle. Include a pressure gage with a range of 5 to 125 psig.

c. Air Exhaust Mufflers: Pipe venting and exhaust of control air systems through a muffler to reduce noise level. Use expansion chamber muffler with a built-in resonator and air disseminator. Use muffler constructed entirely of corrosion-resistant metal.

d. Directional Control Valves: Control operated cylinders by means of a solenoid pilot operated directional control valve suitable for operation in a hazardous location classified as Class 1, Division 1, Group D, approved for rain tightness. Use 2-position, 4-way, single solenoid, pilot actuated, spring return type for solenoid control valve. Use valves rated by manufacturer as suitable for the non-lubricated air service provided. Use internally supplied pilot. Use continuous duty rated solenoid suitable for 115-120 volt A.C. service with Class "A" (105 degrees C221 degrees F) insulation.

e. Piping System: Use Type K, fully annealed seamless copper tube conforming to ASTM B88 for lock pin pneumatic control piping, including field piping and prefabricated shop assembled components. All fittings employed in the piping system, conforming to SAE J514, except the fitting material shall be brass and bronze compatible with the copper tubing. All factory assembled components shall employ cushion type tubing supports for supporting the tubing runs. UseSAE J1405 air hose rated for 250 psig for flexible hose connection between the building supply and the door. Use hose constructed of a synthetic rubber inner tube, a single partial stainless steel wire braid reinforcement covered by a protective synthetic rubber layer and an outer synthetic rubber impregnated textile cover. Fit hose with brass swivel type reusable fittings.

2.1.18 Top Lock Pin Maintenance Platform

Provide a platform, as required, for maintenance of the top lock pin mechanism.

2.1.18.1 Metal Grating

Platform metal grating shall conform to NAAMM MBG 531.

2.1.18.2 Handrails

Fabricate handrails from standard-weight steel pipe, nominal inside diameter 38.1 mm 1-1/2 inches. Use hot-dipped zinc-coated finished railing assemblies conforming to ASTM A123/A123M. Complete railing with standards, brackets, caps, plugs, toe guards and all other accessories and fastenings for complete job. Fabricate railings in one length for each run and securely anchor to the supporting structure. Conform railing to the requirements of Occupational Safety Health Act Article 1926.500.

2.1.18.3 Jointing

Perform jointing of posts, rail and corners by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints and grinding smooth. Butt railing slices and reinforce with tight fitting interior sleeve not less than 152.4 mm 6 inches in length. Railings may be bent at corners in lieu of jointing, provided bends are made in suitable jigs and that the pipe is not crushed. Weld posts welded directly to the steel platform structure.

2.1.18.4 Ladders

Fabricate vertical ladders conforming to ALI A14.3 of 63.5 mm by 9.5 mm 2-1/2 inches by 3/8 inches steel flats for strings and 19 mm 3/4 inch diameter steel rods for rungs. Space rungs a maximum one foot apart, and plug weld or shoulder and head into strings. Hot dip galvanized ladder assemblies after fabrication in conformance to ASTM A123/A123M. Install ladder so that rungs are not less than 177.8 mm 7 inches from the finished wall surface or other structural element. Secure ladder to adjacent construction with heavy clip angles welded to the string and secured to structure as indicated. Install intermediate clip angles not over 1.2 m 48 inches on centers. Install brackets as required for securing to ladders. Provide safety cage and spreaders as required.

2.1.18.5 Safety Chains

Construct safety chains of 3/16 inch, zinc-coated, steel welded chain conforming to FS RR-C-271, Type 1, Group C, Class 4 with snap bolt hook with ring on both ends and eye bolt on both ends. Use swivel eye snap bolt hooks conforming to MIL-DTL-15021. Use galvanized eye bolts with 9.5 mm 3/8 inch bolt and 19 mm 3/4 inch eye diameter for attachment of chains. Supply two chains, 101.6 mm 4 inches longer than the anchorage spacing, for each guarded area. Mount top chain 09 m by 1.8 m 3 feet to 6 feet above the platform floor. Mount lower chain 0.6 m to zero m 2 feet to zero inches above the platform floor.

2.1.18.6 Structural Framing

Provide additional structural framing welded to the tubular structure to accommodate the platform load.

2.1.19 Electrical Equipment

Provide electric motors, wire and equipment specified under this section conforming to 26 20 00 INTERIOR DISTRIBUTION SYSTEM, NFPA 70 and NEMA ICS 1, NEMA ICS 2 and NEMA ICS 6. All electrical wiring entrances and equipment within the door and mounted on the door within the aircraft bay shall be constructed to NEMA ICS 6 standards [NEMA 250 Type 4/7 for hazardous locations]. Use watertight, NEMA ICS 6, Type 4 enclosures for all electrical wiring and equipment on the exterior of the door.

2.1.19.1 Plenum Lights

Provide fluorescent or LED lights within the door plenum to provide lighting for servicing the drive mechanism and the lock pin mechanisms. Light levels at each maintenance spaces shall be 5 footcandles. Use a switch mounted in the personnel access vestibule adjacent to the plenum access door for light control. Use[combination explosion-proof and] weatherproof switch for plenum lights. Use 120 volts A.C. obtained from the door drive control transformer as indicated for circuit lighting.

2.1.19.2 Controls

Use two joysticks as part of the controls for each door. Require that operator maintain constant contact with joystick for door drive motor to be engaged or energized. Locate a pushbutton on each side of the door at the "seeing" end with control configuration such that either of the two joysticks can maintain door movement. Locate joysticks such that the operator can "walk" the door to either the open or closed position and have view of the direction of travel while maintaining the hand activation of the joystick. Design door to automatically stop if the operator's hand is removed from the joystick. Include an audible and visual alarm to be activated when the door is in motion. Alarms shall have a distinct warning sound and visual display that is different than all other warning systems in the hangar bay.

Include proximity sensors[and][or]switches to detect "near end of travel" and "end of travel" in door and door apron. Include adjustable acceleration and deceleration ramping from zero to maximum speed and from maximum to zero speed in door motor drive. Include an automatic "soft start" with gradual acceleration to a pre-set maximum speed. Include capability to adjust maximum speed. Include automatic deceleration and a gradual stop when a "near end of travel" point is reached. Include automatic disengagement or de-energization when door "end of travel" is reached. Include capability of door motor drive reversing, such that the door can be powered open and powered close.

2.1.19.3 Control Cabinet

House all applicable control components for the door in each control cabinet. Use factory installed and wired control cabinet components for each door. Locate control cabinet on the exterior face of door and size for the electrical control equipment indicated and specified herein. Surface mount cabinet: NEMA ICS 6 Type 4 classification. Fabricate cabinet of 14 gauge steel minimum with all seams continuously welded. Use a 12-gage back panel, for mounting equipment and devices, mounted on collar studs welded to the back face of the enclosure. Use heavy duty continuous hinged door constructed with rolled edge. Attach a neoprene gasket to doors with oil resistant adhesive and steel retaining strips. Provide stainless steel door clamps to hold the door securely closed. Punch holes in door to accept control switches and indicator lights as indicated. Include an exterior flange mounted NEMA ICS 6 Type 4 disconnect switch. Interlock the padlockable operating switch handle with the cabinet door so that the door can only be opened when the disconnect switch is open. Size the switch based on the voltage and electrical load in accordance with NFPA 70. Cabinets shall contain the following equipment.

a. A microprocessor-based adjustable frequency motor drive unit (for each door) such that the door drive motor (460 volt, 3 phase) shall have variable speed capability. Make drive until capable of reversing. Motor protection in compliance with NFPA 70, Article 430. Make drive until capable of producing a controlled adjustable frequency/voltage output at suitable power levels to successfully operate the door drive mechanism.

b. Use UL listed adjustable frequency drive unit in compliance with IEEE 519. Use additional supplemental equipment as necessary to comply with IEEE 519. Submit a mathematical analysis by the drive until vendor verifying compliance.

c. The adjustable frequency drive units shall have as a minimum the following features:

    (1) Ambient operating temperature range:
        (a) 0 to 40 degrees C 32 to 104 degrees F.
        (b) Humidity 5-95", non-condensing.

    (2) Electrical:
        (a) Input Voltage: 460 VAC < plus 10 percent, minus 5 percent. 3-phase.
        (b) Input Frequency: 58-62 Hz.
        (c) Output Voltage: 0-460 VAC, 3-phase.
        (d) Output Frequency: 3 -60 Hz. The output shall be as a result of a sine coded pulse width modulated (PEM) output from the inverter section. Frequency regulation shall be plus 0.5 percent of maximum.
        (e) Current ratings: continuous for 100 percent of drive rating, 120 percent for one minute.
        (f) Electronic circuitry protection.
        (g) Minimum .94 power factor.

    (3) Programmable functions:
        (a) Acceleration rate.
        (b) Deceleration rate.
        (c) Voltage boost.
        (d) Maximum frequency.
        (e) Output current limit.
        (f) Motor overload.
        (g) Reduced volts per Hertz.

    (4) LED or digital display of the following:
        (a) Overvoltage.
        (b) Undervoltage.
        (c) Ground fault..

(d) Instantaneous current
(e) Overtemperature.

d. Use control transformers rated 2 KVA 480-120 volts, 60 Hz.

e. Use door mounted indicator lights, NEMA ICS 6, Type 4 transformer style, push-to-test type for operation up to 120 volts AC/DC. Use colored lens as indicated. Square D Type SK control units conform to this specification.

f. Door mount push-button switches, NEMA ICS 6, Type 4, 4X momentary contact type for operation on 120 volts AC. Use black buttons, except use red for "off" and "open" buttons. Include extended guards for pushbuttons to protect against accidental operation.

g. Use control relays rated at not less than 250 V, 60 Hz, 10 A contacts, 120 V, 60 Hz coils. Use plug in type, suitable for mounting to the back panel of the control cabinet with clamp type terminals. Furnish a minimum of one spare contact per relay. Use break coil relays rated for 600 V.

h. Use programmable logic controller (PLC) to perform all control and timing of door operation. I/O no greater than 1200 AC or DC. Use relay suitable for mounting to the back panel.

[i. Use Factory Mutual approved intrinsically safe barrier relays for hazard classification Class 1, Division 1, Group D. Suitable for use with a "close" pushbutton. Capable of switching a 120 V, 60 Hz, 5A load and withstanding 20 A inrush in one second. Use encapsulated, irreparable, and vibration resistant relay.

] j. Use solid-state pulsating type piezoelectric horns suitable for use at 120 V, 60 Hz. Produce a one-half second intermittent 3900 Hz tone of approximately 50 percent duty cycle. Minimum sound level 85 dB at 0.6 m 2 feet on axis. Suitable for door mounting with screw type terminals.

k. Use barrier type terminal blocks made of thermosetting phenolic or nylon rated for 600 V, 20A with a maximum operating temperature of 121 degrees C 250 degrees F. Use tabular screw blocks with pressure plate terminals. Locate marking strips on the top of the terminal block and center between the binding screws to permit full access to the binding screws with the marking strip in place.

l. Use 120 V fuses, 31.8 mm 1-1/4 inch, quick blow cartridge type in suitable fuse block for back panel mounting. Capable of handling 20 A continuous with screw or clamp type terminals.

m. Fabricate nameplates from plastic laminate 3-ply engraving stock, minimum thickness 0.79 mm 1/32 inch, dark blue with white core. Characters a minimum of 3.12 mm 1/8 inch high, all capitals, gothic, unless noted otherwise. Engrave information; locate as indicated. Unless noted otherwise, determine nameplate length and height to fit legend and to present a neat and pleasing appearance. Engrave legend plates at pushbuttons and indicator lights engraved as indicated.

n. Provide cooling fans if necessary for proper cooling of cabinet components.

2.1.19.4 Joysticks

On the control cabinet door and the interior face of the door, use bidirectional spring-return-to-center type joysticks with normally open contacts as indicated. Handle 95.3 mm 3-3/4 inches long, threaded to accept a spherical phenolic knob. Comply with NEMA ICS 4, suitable for 120 volts 60 hertz operation. Install joystick on the interior face of the door in a NEMA ICS 6 Type 4 enclosure. As of publication, Cutler Hammer File E20 two position joysticks conform to this specification.

2.1.19.5 Limit Switches

Use heavy duty type limit switches, mechanically actuated,[in a NEMA ICS 6 Type 4, 7 explosion proof weathertight enclosure][in a NEMA ICS 6 Type 4 weathertight enclosure]. Use contacts rated 10 amperes, 600 volts, DPDT. Use limit operable in ambient temperatures from minus 23.3 to 85 degrees C minus 10 to 185 degrees F. Microswitch Type LCS and HDLS limit switches conform to this specification.

2.1.19.6 Klaxon Horns

Use weatherproof, A.C. vibration type horns for annunciation of door movement suitable for operation on 120 volts 60 hertz. Use horns with adjustable volume, range of 78 to 128 db SPL measured on axis at 3.04 m 10 feet.

2.1.19.7 Explosion Proof Control Devices

On the door interior face use weathertight and explosion proof indicator lights and pushbutton (Class 1, Division 1, Group D, hazardous area), suitable for use in 120 volt 60 hertz control circuit. Use NEMA ICS 6, Type 4, 7 enclosures as indicated.

2.1.19.8 Interconnecting Cable

Between each door and building interface junction box, use cable Type SO, UL listed, neoprene jacketed, 600 volt rated, of the number of conduits and gage indicated. Use cable consisting of multiple stranded bare copper conductors, with a flexible heavy duty black neoprene jacket overall suitable for exterior installation to resist ozone, sunlight, moisture, oil and abrasion. Supply cable of sufficient length to accommodate the door swing.

2.1.19.9 Conduit, Wire and Fittings

a. Conduit: rigid hot dipped galvanized steel with thread connections.

b. Within the control cabinet, use stranded copper wire type SIS. Minimum size power wiring: No.12 AWG. Minimum size control wiring: No.14 AWG. In conduit, use stranded copper wire Type THWN No.14 for control and No.12 for Power.

[c. Within the door and on the interior wall use explosion proof and weathertight boxes and fittings, NEMA ICS 6 Type 4, 7.

d. Use conduit seals suitable for Class 1, Division 1, Group D hazardous area.

] e. Use watertight fittings for Type SO cable.

[f. In hazardous areas use flexible conduit suitable for installation in a Class 1, Division 1, Group D hazardous area.

]2.1.19.10 Rotating Beacons

Use rotating beacons rated 60 hertz 120 volts or 360 degree rotation, weatherproof, red dome, gasketed aluminum shock mount housing, suitable for 25.4 mm 1 inch stanchion mounting.

2.2 FABRICATION

2.2.1 Doors

Use door leaves fabricated from hot rolled sections or structural tubing in accordance with AISC 325 and AWS D1.1/D1.1M. Welded joints except where impractical. All joints shall develop 100 percent of the strength of the framing members.[Prepare splices accurately to facilitate field assembly in accordance with standard practice.] Use frames and framing members true to dimensions and square in all directions; no leaf shall be bowed, warped or out of line in the vertical or horizontal plane of the door opening by more than 3.2 mm in 6.1 m 1/8 inch in 20 feet. Provide bracing so that the completed leaf assembly will be adequately braced to withstand shipping, assembly and operational loads. Ground smooth exposed welds and welds which interfere with the installation of parts such as wall panels and cove sheets. Seal flat cover sheets with sealant and fasten to frame either by edge welding, plug welding or threaded fasteners on 304.8 mm 12 inch centers. Prepare, prime, and coat structural framing and miscellaneous steel as specified in paragraph FINISHES. Seal joints in assembled door/plenum to provide an airtight plenum.

2.2.2 Latches

Provide automatic latching devices at top and bottom of doors to take over positioning of the doors during closing, compress the seals, and anchor the door against full wind and seismic loads. Use devices with sufficient throw to allow for thermal expansion and contraction of the doors, and sufficient range of action horizontally to set under full wind deflection, inward or outward. Provide an automatic foot bolt to anchor the door in fully open position. seat bottom bolts in dust-proof strikes set in concrete pavement. Interlock latching devices with motors to prevent door operation unless the bolts are fully retracted.

2.2.3 Tractor Pulls

Provide tractor pulls so that leaves can be towed by a tractor or similar equipment. The tractor pull shall be designed for a drive force to tow door of 22240 N 5000 pounds whichever is greater. Minimum thickness steel plate shall 10 mm 3/8 inch.

2.2.4 Exterior Covering

Install exterior covering on the assembled door structure in accordance with the siding manufacturer's recommendation and approved shop drawings. Form and seal joints so that both sides of the covering are weathertight and the plenum is airtight.

2.2.5 Interior Covering

Fabricate interior wall of hangar door/plenums of aluminum sheet, perforated in a regular pattern with holes 12.7 mm 1/2 inch diameter providing the total free area per door leaf indicated. Use sheet sufficiently thick to meet design loads and purlin spacing. Install sheets with the smooth side of punched holes on the exterior face of the door. Fasten sheets in place to vertical and horizontal framing members at 304.8 mm 12 inches on center maximum with No. 14 or larger, self-tapping screws. Seal joints to provide an airtight plenum.

2.2.6 Weatherstripping

Install resilient bulb seals as[shown][required], to provide a weathertight seal around the perimeter of the door leaves and an airtight seal at the perimeter of the plenum opening mating surfaces with the supply ducts at the door head. Provide seals with molded or vulcanized corners. Reinforce bottom seals with woven fabric. Install seals designed to allow for horizontal displacement of the building at the head of the door plus or minus 76.2 mm 3 inches in the plane of the door in the closed position under seismic loading.

2.2.7 Support Rail

Use support rail as indicated per civil drawings to support wheel loads. Furnish complete with anchor bolts and leveling plates as indicated, installed by the door manufacturer. Set the rails to the indicated radius, plus or minus 3.2 mm 1/8 inch and leveled to within plus or minus 2.5 mm to 3.0 m 0.1 inch to 10 feet. From side to side, the top of the rail shall not vary more than 2 degrees from true level.

2.2.8 Services

The door manufacturer shall provide all piping, wiring and devices in the door.

2.2.9 Perforated Aluminum

Attach the aluminum perforated sheets to the door frame with plated fasteners with neoprene washers at not more than 304.8 mm 12 inches on centers. Protect dissimilar metals with bituminous paint. The thickness of the sheet .10 5052 alloy H32 hardness. Holes shall be [_____] mm inch at 25.4 mm 1 inch on centers. 8 percent open.

2.2.10 Electrical

All manual and automatic control devices, control cabinets, light fixtures, door mounted interface junction boxes with cable and all conduit and wiring mounted on the doors and specified herein shall be provided under this section. Raceways and interconnect wiring within the aircraft bays will be provided under 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Use color coded wiring, clearly labeled with identification numbers in accordance with approved shop drawings. Make individual wire identification at all terminations with wire numbers stamped on durable plastic heat-shrinkable sleeving, 19.1 mm 3/4 inch minimum length. Neatly train and lace wiring within the cabinet or run in plastic wiring ducts. Make cable connections to boxes watertight cable clamps. Make conduit connections to motor and limit switches with flexible conduit[explosion proof in Class 1, Division 1, Group D hazardous areas] or liquid tight flexible conduit to permit servicing of equipment and of sufficient length to permit field adjustment. Secure conduit to the door structure.[Provide conduits entering hazardous areas and areas with arcing devices with conduit seals in accordance with NFPA 70.] Install conduit runs to permit easy access to junction boxes and not to interfere with the operation of the door or with servicing of components. Electrical installation shall conform to the requirements of 26 20 00 INTERIOR WIRING SYSTEMS, and NEMA ICS 1.

2.3 FINISHES

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NOTE: The coating system specified in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES is very robust and should always be allowed. It includes the following:

Abrasive blast prep per SSPC SP 10/NACE No. 2

Zinc-Rich Epoxy Primer Coat; 3-5 mil

Epoxy Intermediate Coat; 3-5 mil

Polyurethane Topcoat; 2-3 mil.

Insert the following into Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES, Surfaces To Be Coated:

Section 08 34 16 CORROSION CONTROL HANGAR DOORS references Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES and requires shop application of these coatings.

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2.3.1 Ferrous Metal

Clean, prepare, and coat all exposed and non-exposed ferrous metal surfaces as part of the Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES work, including all requirements, submittals, certifications, testing, and inspections required by Section 09 97 13.27. Do not coat finished bearing surfaces. Alternate coating systems or products will not be considered. Prepare surface and apply coatings in the shop, following all temperature, humidity, and testing requirements listed in the Section 09 97 13.27. After installation of the door, prep and touch up surfaces damaged during assembly and installation of the door. Prep and coat unfinished ferrous metal accessories such as bolts and brackets.

2.3.2 Factory-Finished Panels

All factory-finished ferrous metal panels to be exposed to the interior or exterior shall be galvanized G90 per ASTM A653/A653M and coated with a PVDF fluoropolymer equal to Kynar 500.

2.4 SINAGE

Provide a placard sign immediately adjacent to the controls explaining how to operate the door and indicating the following:

a. Notice

(1) Doors must be closed and not operated when wind speeds above 96.6 km/hr 60 mph are expected.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

The installation of the assemblies shall be performed by workmen skilled in this type of work in accordance with the approved shop erection drawings and procedures. Use erecting equipment suitable for the work and in fully operable condition. Report immediately to the CQC Representative if parts cannot be assembled or fitted properly as a result of errors in fabrication or of deformation due to handling or transportation. Obtain approval of the method of correction from the CQC Representative, and make correction in his presence. Use approved methods to straighten plates, angles or other structural shapes.

3.2 ERECTION

Assemble doors and accessories in accordance with approved shop drawings. Do not erect doors until the work of other trades in preparing the opening has been completed and the hangar roof is completed and under full dead load.

3.2.1 Erection Procedure

Include in the erection procedure complete description of the material handling equipment and accessories and the methods which will be used to assure that individual assemblies will not twist, buckle, deform or otherwise be damaged during the handling and erection. Describe the method of alignment and leveling of the rails including equipment to be used. Describe the method of alignment of the door structure with respect to the pivots, locks and seals of the building.

3.2.1.1 Templates

Furnish steel templates and installation instructions, including placing drawings, for setting the anchor bolts for the door rail and embedded lock pin receptacles. The manufacture of the door shall ascertain that these items are properly set prior to the installation of the rails and the erection of the doors.

3.2.1.2 Door Rails

Anchor door rails to the concrete support base as indicated using the double nut method on anchor bolts for adjusting and setting elevation. Weld all rail joints and grind smooth. Set rails to indicated radius within a tolerance of plus or minus 0.79 mm 1/32 inch. Place non-shrink grout to provide continuous positive contact with the underside of the rails. After the non-shrink grout has cured, and after the rail grounds provided under 26 20 00 INTERIOR WIRING SYSTEMS are installed, and after door and drive assemblies have been checked for alignment and fit, fill the remainder of rail recess in the concrete base with concrete. Conform to 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.1.3 Door Bottom Lock Pin Receivers

Locate lock pin receiver assemblies accurately and set to elevation indicated plus or minus 0.79 mm 1/32 inch using the double nut method on the anchor bolts. Protect spring assembly during placement of concrete to prevent damage or entry of foreign matter.

3.2.1.4 Door Leafs

Field erect door leafs in accordance with approved shop erection drawings after: the rails have been installed and checked for alignment and grade; the bottom pivot base assembly has been installed and checked for alignment and grade; and the lock pin receiver assemblies have been installed and checked for location and grade. First install lower assembly of each door leaf on the bottom pivot with the drive wheel on the rail. After checking for fit, erect and mate the upper assemblies to the lower assembly and the top pivot. Before installing the siding, concrete base fill, filter bank and seals, manually operate each door leaf through the total of 90 degrees of travel to check for final alignment, fit and freedom of movement of the pivots with no binding. After confirmation of the proper movement of each door leaf, permanently locate all limit switches and secure. Place concrete fill, followed by the siding, flashing and seals. Make all electrical and compressed air connections with the building services. Commission and test the drive mechanism and lock pin mechanisms. Perform installation to assure that the equipment will function properly for its intended purpose in conformance with the requirements of the drawings and specifications. After installation has been completed, the Contractor shall perform such final adjustments, operational testing, and cleaning to assure conformance with the requirements specified herein.

3.2.1.5 Compressed Air Tubing

Run tubing in maximum lengths possible without breaks or fittings. Install tubing runs and bends free of kinks, ripples or flattened surfaces. Align tubing with connectors before connections are made. Male appropriate union fittings for tubing connections to accessories and devices to permit removal of the item without removal of the tubing. Before final connection to the air system accessories and cylinders, clean and pressure test entire air piping system leaks in accordance with section 43 15 00.00 20 LOW PRESSURE COMPRESSED AIR PIPING (NON-BREATHING AIR TYPE).

3.2.1.6 Electrical

Install and wire electrical power and control systems, including the motion annunciators (horn and light), and limit switches. Adjust location of each limit switch and set in proper position.[The electrical installation within the doors and on the interior faces of the doors for Class 1, Division 1, Group D hazardous areas shall conform to NFPA 70 requirements.] Make watertight installation of electrical on the outside of doors. Make the SO power and control cables between the building interface junction boxes and the door of sufficient length to permit full travel of the doors without tangling or binding. Wire exit light as indicated. All wiring within the building including the interface junction boxes on the building will be performed under 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2.1.7 Touch-Up Coating

After installation of the door, the same installer that performed the initial coating prior to assembly and erection shall prep and touch up surfaces damaged during assembly and installation of the door as well as unfinished ferrous metal accessories per the requirements listed in Section

09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES and per this Section.

3.3 FIELD INSPECTION AND TESTS

The Contractor Quality Control Representative shall perform all field inspections and tests specified herein at the Contractor's expense.

3.3.1 Inspection General

Inspection shall continue during receipt and off-loading of door components and during erection. Make an inspection of the fabricated components prior to installation to determine conformance with the specifications and approved shop drawings. Correct or replace all rejected material to the satisfaction of the CQC Representative.

3.3.2 Manufacturer's Field Engineer

The manufacturer of the hangar doors shall provide a qualified field engineer to supervise the installation and perform the inspection services specified hereinafter. The field engineer shall furnish duplicate copies of his report to the Contractor Quality Control Representative within 24 hours following each inspection. The Contractor shall furnish a copy of the field inspection engineer's report to the CQC Representative within 48 hours and shall perform the following:

a. Inspect doors during job site unloading, sub-assembly and prior to erection.

b. Inspect installation of rails and other embedded items before pouring of fill concrete to ensure that the elevation and alignment indicated have been complied with and that rails are level to the specified tolerance.

c. Recheck rails and other embedded items to verify the accuracy of dimensions.

d. Provide recommendations for any necessary corrective action.

e. Inspect final erection and assembly of door leafs for alignment and fit, and clearance between doors and building, and between door and leafs.

f. Inspect setting of all seals in the closed position to assure an airtight installation.

g. Inspect the positioning and fit of pivot assemblies.

h. Inspect the mating of lock pins with receptacles.

i. Inspect all fasteners to assure that all screws and bolts are properly secured to prevent loosening.

j. Inspect all field welds in accordance with AWS D1.1/D1.1M.

k. Check all drive assemblies and lock pins for smooth operation and that all lubrication has been accomplished.

l. Check that final sealing provides an airtight plenum.

m. Verify that all gear boxes and bearings have been lubricated.

n. Supervise the testing, including the balancing of the air flow specified herein.

3.3.3 Operation

Install doors for smooth operation, providing indicated clearance and seal with the building. Door shall not bind or damage sealing mechanism while being opened or closed. Door shall be free of twists.

3.3.4 Tests

Upon completion of the installation, subject doors to operational tests. When all necessary corrections have been accomplished, advise the CQC Representative. CQC Representative will schedule a final inspection and test. Furnish all instruments, labor and materials required for test. The Manufacturer's field engineer shall be present to conduct the test. Test each door leaf for the full extent of its travel in both directions and check to assure that there is no conflict when both leafs are operated simultaneously. Power operate each door leaf through twenty cycles to measure travel time. Test doors to demonstrate manual opening and closing, and unlocking without electric power. Demonstrate the distribution of the ventilation supply air through the diffuse and filter assemblies for uniformity of velocity.

3.3.5 Corrections

Adjust doors failing to operate properly.

3.4 PERSONNEL EQUIPMENT SYSTEMS ORIENTATION

Provide orientation and instruction of Government plant personnel in the operation and maintenance of the doors, mechanical drive system, locking systems and pivot system. Provide a factory trained representative to conduct formal classes at the facility for one eight-hour period during the final check-out and acceptance stages for the entire door system, after the receipt by the Government of approved operation and maintenance manuals.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 34 16.10 (November 2021)**
Change 1 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-08 34 16.10 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 08 - OPENINGS

SECTION 08 34 16.10

HORIZONTAL ROLLING STEEL DOORS

11/21, CHG 1: 08/24

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 34 16.10 (November 2021)**
Change 1 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-08 34 16.10 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 34 16.10

HORIZONTAL ROLLING STEEL DOORS

11/21, CHG 1: 08/24

****

NOTE: This guide specification covers the requirements for horizontal rolling steel door systems including their operators and controls.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Painting of hangar doors must be specifically mentioned in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES, along with a reference to this Section and with instructions not to paint operating parts, mechanisms, limit switches, or trolley ducts.

****

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NOTE: Steel rails, top guides, head flashing, painting, and electrical work for these door systems are specified in other sections.

****

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NOTE: On the design drawings, show:

1. Size and arrangement of doors including, if applicable, clearances in accordance with UFC 4-211-01 Paragraph 2.3 MINIMUM AIRCRAFT MAINTENANCE BAY CLEARANCES. Electrical and structural provisions for motor operators.

2. Location and type of weather stripping, exterior covering, interior lining, and flashing.

3. Location, spacing, size, and type of top guides and rails. Center-to-center dimension of leaves not less than 350 mm 14 inches, and not less than 115 mm 4 1/2 inches greater than total thickness of each leaf, including interior and exterior coverings. Where electrical trolley duct is required between leaves, provide additional 150 mm 6 inches of clearance. Where cable system is required between leaves, provide additional 25 mm 1 inch of clearance.

4. Location and type of personnel doors. Do not locate personnel doors between wheels and edge of door leaf. Exact location to be determined by structural design of door leaf.

5. Location of bumpers and pulls.

6. That wheels will be required. Size and weight of the doors will determine wheel type, size, and number and thus should not be shown on the drawings.

7. Appropriate design wind pressures based on the design wind velocity. See paragraph WIND LOADS for more detailed requirements. Appropriate seismic, blast or other loads must be considered in the design and construction of these door systems. Include positive and negative deflection of top guides due to all applicable loads other than dead load.

8. Details of expansion joints in rails and top guides where building expansion joints occur.

9. Electrical service for motor operators, preferably 460 volts, 3-phase, 60-hertz, and location of power supply disconnect.

10. Festooned or draped cables, cable reels or trolley duct.

11. Access for installation, maintenance, and replacement of top rollers if door system requires floating top rollers.

12. Door pockets: Minimum clearance of 450 mm 18 inches for doors up to 300 mm 12 inches thick, 800 mm 32 inches for doors more than 300 mm 12 inches thick, should be allowed from center line of power leaf rail to farthest projection of interior wall of

door pocket to accommodate operators and provide access. Consider clearance in the door pocket such that a person cannot be injured or trapped by closing doors.

13. Dimensions and details of tail doors or aperture doors, if required.

14. Minimum clearance of 100 mm 4 inches between extreme faces of adjacent leaves in vicinity of interconnecting cables to allow sufficient space for cable sheaves and cable pickup.

15. Minimum clearance of 100 mm 4 inches between extreme faces of adjacent leaves in vicinity of pick up brackets to allow sufficient space for brackets to engage.

16. Clearance of 100 mm 4 inches between metal parts on vertical edges of leaves and between leaves and jambs which are weather-stripped.

17. Pocket depth, equal to width of widest door leaf, plus 1 meter 3 feet net clearance for cable sheave brackets extending beyond trailing edge of leaves.

18. Rail drains for full length of bottom rails. This may be done with cross drains perpendicular to the rails spaced at a maximum of 3 meters 10 feet on center, emptying into continuous parallel floor drain. In cold areas it may be necessary to provide a means to prevent accumulation of ice at the rails to maintain door operation.

19. End of travel bumpers and bumper supports at end of door travel. Dimensions and locations should be in accordance with door manufacturer's approved drawings.

20. When this specification is used for a fuel cell maintenance hangar, paint hangar, or corrosion control hangar the hazardous classification may impact electrical components of the Horizontal Rolling Steel Door system - such as the electrical drive, limit switches, control panels, etc. All electrical devices within the hazardous classification areas must be specified to be rated for the hazardous location where electrical equipment is installed. Clearly indicate electrical classification.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.8/D1.8M	(2016) Structural Welding Code—Seismic Supplement

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 220	(2024) Standard on Types of Building Construction

NFPA 409	(2022) Standard on Aircraft Hangars

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-R-5001	(1992, Rev B) Rubber Cellular Sheet, Molded And Hand-Built Shapes; Latex Foam
MIL-STD-889	(2021; Rev D) Galvanic Compatibility of Electrically Conductive Materials
UFC 1-200-01	(2022; with Change 4, 2024) DoD Building Code
UFC 3-101-01	(2020; with Change 4, 2024) Architecture
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

UL SOLUTIONS (UL)

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

SD-02 Shop Drawings sealed by the Door Manufacturer's Registered Professional Engineer

Horizontal Rolling Steel Doors; G, [_____]

SD-05 Design Data sealed by the Door Manufacturer's Registered Professional Engineer

Horizontal Rolling Steel Doors; G, [_____]

Door Compliance Matrix; G, [_____]

SD-10 Operation and Maintenance Data

Horizontal Rolling Steel Doors, Data Package 2; G, [_____]

1.3 DESIGN REQUIREMENTS

1.3.1 Door Design and Components

The Horizontal Rolling Steel Door system described in the construction documents are representative of a commercially available door. Design and provide the door[, including tail doors,][, including aperture doors,] to fit within the space allocated and in accordance with the criteria specified herein. Design doors to operate properly without binding, interference, or damage to weather stripping or the adjacent structure. Door must be of limited combustible construction in accordance with NFPA 220 and NFPA 409.

Submit Calculations sealed by the door manufacturer's registered professional engineer for review.

Submit drawings showing details of construction, installation, and operation; size, shapes, and thickness of materials; joints and connections; reinforcing; hardware; mechanical devices; electrical devices; and design and detail data for work of other trades affected by these door system(s).

Submit a Door Compliance Matrix which references each specification requirement and the corresponding document and page number where compliance may be verified by the reviewer.

1.3.1.1 Steel Door Components

Design all supporting, steel bracing and framing steel members in accordance with the specified loads and the requirements of AISC 325 and AISC 360. Design all cold formed steel in accordance with AISI SG03-3. Weld steel in accordance with the AWS D1.1/D1.1M Standards.

1.3.2 Loads

Design the door for the loads in accordance with UFC 1-200-01, UFC 3-301-01 and all other applicable criteria.

1.3.2.1 Wind Loads

****

NOTE: In accordance with UFC 1-200-01 and, if applicable, UFC 3-301-01, the Engineer of Record must indicate the appropriate design wind pressure for the design of the door system on the drawings. Where conflicts exist between UFC and UFGS, the UFGS takes precedence.The simplified procedure/method may not be utilized to calculate these design wind pressures for these doorsystems, only the analytical procedure is allowed. The building volume accessed by these steel doors must be designed as a "Partially Enclosed" building in accordance with UFC 3-301-01 paragraph 2-4.6. The door system design pressure must be based on the specific project design criteria and on the design wind velocity for components and cladding based upon each structural element's associated tributary area. An example table of required design wind pressures is shown below and must be included in the drawings.

Zone	**Effective Area (SF)**	**Max Positive Pressure (PSF)**	**Max Negative Pressure (PSF)**
?	10	?	?
?	100	?	?
?	200	?	?
?	500	?	?
?	700	?	?

Components and Cladding elements with Effective Areas greater than 65.032 square meters 700 square feet must be permitted to be designed using the provisions for MWFRSs.

****

In the closed position, design the entire door system to withstand the component and cladding wind pressures as indicated by the Engineer of Record for a Partially Enclosed building, based upon the indicated design wind velocity, geometry and other factors. Design all elements of the door's components and cladding to withstand both the highest positive and negative pressures based upon the actual tributary area from the wind, as indicated.

In addition, design the entire door system to be both fully open and fully operational for wind velocities up to 125 km/h 78 mph. Calculate the applicable component and cladding wind pressures, including importance factor, and utilize the controlling wind pressures or utilize a positive and negative wind pressure of 0.718 kPa 15 psf on the surface of the door, whichever is greater.

Submit complete Calculations sealed by the door manufacturer's registered professional engineer for review.

1.3.3 Deflections

****

NOTE: Temperature effects have been noted to be an design issue on multiple cantilever truss structures. The structural engineer of record is responsible for providing a design, including appropriate camber, to accommodate anticipated deadloads and proper door operation.

****

For any door member, the deflection due to design wind load shall not exceed the member's length divided by 120.

Design Doors as a system to withstand a minimum of 150 percent of both the upward and downward deflections of the door header structure, or as recommended by the door manufacturer. The total anticipated service level maximum vertical deflections which may be experienced during the life of the door and building are [_____] [76 mm] [3 inches] upwards and [_____] [152 mm] [6 inches] downwards.

[For cantilevered truss structures, the camber to accommodate anticipated deadload is [_____] [152 mm] [6 inches] downward.

] Submit design drawings and structural including detail drawings to accommodate deflections described.

1.3.4 Door Structure and Connections

Design connections at top and bottom guide rails to withstand both the positive and negative design wind pressures[and seismic loads][and blast loads] as required by the construction documents. Utilize the governing design loads in accordance with ASCE 7-16 load combinations.

1.3.5 Primary and Secondary Door Members and Connections

Design primary door members and their connections with hot-rolled steel members only. Design complete vertical and lateral load paths, including interconnection system load path from pickup bracket or cable system through the door bracing, to both the top and bottom door leaf members.

[Pick Up Brackets for group doors: Connection of the bracket to the door will not use the torsion resistance of the frame to resist loading.

]1.3.6 Wind Girt Members and Connections

Cold-formed members are not permitted for use in primary or secondary (main) framing of the door leaf and bracing. In addition, face skin finish materials cannot be utilized as part of the lateral force resisting system, including diaphragm action.

Door manufacturer may utilize cold-formed steel infill members as wind girts to support the cladding. If utilized, cold-formed members may be not be thinner than 2 mm 14 GA in material thickness.

1.3.7 Cybersecurity

Design all control systems (including systems separate from a utility monitoring and control system) in accordance with UFC 4-010-06 and as required by Section 25 05 11 CYBERSECURITY OF FACILITY-RELATED CONTROL SYSTEMS [_____]. Implement cybersecurity requirements to mitigate vulnerabilities to all facility-related control systems.

1.4 QUALITY ASSURANCE

1.4.1 Manufacturer's Qualifications

Use a horizontal rolling steel door product from a manufacturer who is regularly engaged in the design, fabrication, erection, and service of horizontal rolling steel doors of type, complexity, and size required for this project. The manufacturer must have at least 5 years of similar horizontal rolling steel door design experience. Similar doors must have comparable function and design including size, configuration, type of use, retractable or moving elements, safety features, controls, and other key engineering elements as the door being specified. It is acceptable to show that a series of similar doors collectively meet all comparable elements to the door being specified, although not necessarily individually. Manufacturer must submit written evidence on similar past door designs and installations listing the name, location, contact information of owners, installation dates, overall sizes, features, and other relevant information for experience and qualifications evaluation. Only manufacturers who can submit this evidence of actual installations where the products have proven practical, durable, and require a minimum of maintenance, will be qualified under this specification.

1.4.2 Installer's Qualifications

A manufacturer's representative, skilled and experienced in the erection of horizontal rolling steel steel doors of the type specified herein, is required to supervise installation of the door system(s) in accordance with approved shop drawings. For each installer submit written evidence of similar past door installations listing the name, locations, contact information of owners, installation dates, overall sizes, features, and other relevant information for experience and qualifications evaluation.

1.4.3 Warranty

Provide a three-year warranty for all mechanical and electrical components against defects in material and workmanship beginning on the date of Project Acceptance.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials which are not shop installed on the doors in original rolls, packages, containers, boxes, or crates bearing the manufacturer's name, brand, and model number. Store materials and equipment in dry locations with adequate ventilation, free from dust and water, and so as to permit access for inspection and handling. Handle doors carefully to prevent damage. Remove damaged items that cannot be restored to like-new condition and provide new items.

PART 2 PRODUCTS

2.1 HORIZONTAL ROLLING STEEL DOORS

2.1.1 Structural Steel

****

NOTE: Specify stainless steel only if the project site is located in Environmental Severity Classification (ESC) C4 or greater or local experience indicates that steel guides will rust and interfere with door operation.

Include the following paragraphs in Section 05 12 00 STRUCTURAL STEEL.

".1 Top Guides and Bottom Rails for Horizontal Rolling Steel Doors:

.1.1 Top Guides: Maintain nominal elevation within plus or minus 6 mm 1/4 inch and nominal center-to-center dimension within plus or minus 3 mm 1/8 inch, with variation from nominal no greater than one mm in 2 meters 1/8 inch in 20 feet. Coordinate Guide Spacing with door manufacturer's design. Joints of head guides are not required to be welded, but shim and grind so adjoining guide surfaces are not out of line more than 2 mm 1/16 inch. Top guide tolerances must be met after dead load is imposed on building frame. [Provide stainless steel framing or structural members for top guide surfaces which will be in contact with rollers during door operation.]

.1.2 Head Flashing: Galvanized steel or galvalume, not thinner than 1.2 mm thick 18 gage, reinforced as required. Coordinate with door manufacturer. Show exact location and configuration on top guide shop drawings. Install head flashing after doors are in place.

.1.3 Bottom Rails: Standard A.S.C.E. or A.R.E.A. weighing not less than [_____] kilograms per meter pounds per yard. Coordinate rail spacing with door manufacturer's design and do not install rails until top guide system has been installed. Continuously support rails and anchor as indicated. Set rails to elevation within plus or minus 6 mm 1/4 inch, with variations from elevation no greater rate than one

mm in 2 meters 1/8 inch in 20 feet. Nominal design relationship between top guides and bottom rails to be maintained without exception. Center-to-center dimensions of bottom rails to be maintained within plus or minus 3 mm 1/8 inch with variation from nominal no greater than one mm in 2 meters 1/8 inch in 20 feet. Weld rail joints and grind smooth or provide with splice plate in accordance with ASCE standards."

****

AISC 360 and ASTM A36/A36M.

2.1.2 Formed Steel

AISI SG03-3.

2.1.3 Galvanized Steel

Hot dipped galvanized frames in accordance with ASTM A123/A123M.

2.1.4 Sheet Steel

ASTM A1011/A1011M hot-rolled steel sheet, commercial quality, ASTM A1008/A1008M cold-rolled steel sheet, commercial quality.

2.1.5 Galvanized Sheet Steel

ASTM A653/A653M, coating designation G 90 galvanized steel sheet, commercial quality.

2.1.6 Exterior Covering

****

NOTE: Choose one of the following options.

****

****

NOTE: Designer's options.

Use the first paragraph if the doors are a part of a new or renovated building which will have the same exterior cladding as the rest of the facility (i.e., insulated metal wall panels, translucent wall panels, etc.). Include in the project specifications the appropriate referenced specification section and edit to include the exterior cladding for this door system.

Use the second paragraph if the door's cladding will not be provided by another specification. Examples of this condition may include a historical door replacement or a door in an existing facility which is being reskinned or replaced and must be thinner due to existing door clearances. In this example the door manufacturer will design the door to be a part of the exterior enclosure and will provide the entire door assembly, including cladding, insulation and air barrier.

****

[Insulated Metal Wall Panels as specified in Section [07 42 63 FABRICATED WALL PANEL ASSEMBLIES][_____].

][Flat [sheet steel] [galvanized steel sheet], not thinner than 2.15 mm thick 13 gage[_____].

]2.1.7 Interior Covering

****
NOTE: Choose one of the following options.
****

****
NOTE: Designer's Options.

Use the first paragraph if the doors are a part of a new or renovated building which will have an interior metal liner panel. Include in the project specifications the appropriate referenced specification section and edit to include the liner panel for this door system.

Use the second paragraph if the door's interior liner panel will not be provided by another specification. Examples of this condition may include a historical door replacement or a door in an existing facility which is being reskinned or replaced and must be thinner due to existing door clearances. In this example the door manufacturer will design the door to be a part of the building's exterior enclosure and thus they will provide the entire door assembly, including cladding, insulation and air barrier.

Use the third paragraph if no interior liner panel is required.
****

[Preformed metal liner panel is specified in Section 07 42 13 METAL WALL PANELS with factory finish equal to Kynar 500 PVDF fluoropolymer. Provide interior panel[full height of door][for the bottom [_____] meters feet of door][as shown in the drawings].

][Flat [sheet steel] [galvanized steel] liner sheets, not thinner than 1.5 mm thick 16 gage. Provide interior panel[full height of door][for the bottom [_____] meters feet of door][as shown in the drawings].

][No interior liner panel required.

]2.1.8 Exterior Envelope

2.1.8.1 Insulation

****
NOTE: Choose one of the following options.
****

****

NOTE: Designer's Options.

Use the first paragraph if the doors are a part of a new or renovated building which will have insulated metal wall panels provided as a part of the rest of the facility (i.e., insulated metal wall panel assemblies, translucent wall panels, etc.). Include in the project specifications the appropriate referenced specification section and edit to include the insulated exterior cladding for this door system.

Use the second paragraph if the door's cladding will not be provided by another specification and insulation must be provided within the door. Examples of this condition may include a historical door replacement or a door in an existing facility which is being reskinned or replaced and must be thinner due to existing door clearances and thus not permit an insulated metal wall panel on the exterior. In this example the door manufacturer will design the door to be a part of the exterior enclosure and will provide the entire door assembly, including cladding, insulation and air barrier.

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NOTE: Specify same U value as required for the walls of the building. Specify STC rating when required to limit sound transmission. Clearly list STC requirements in the Contract Documents while considering desired method and reason to achieve STC ratings. Particular attention should be paid to the perimeters of door panels. STC rating cannot be calculated empirically and are developed after field test of each installation including door flashing and weather stripping. If the STC rating is required for security, consider alternatives such as restricting how close people may be to the doors, based upon testing of the fully installed system. Coordinate STC rating and detailing with door manufacturers during design.

****

[Do not provide insulation if insulated metal panels are used.

][Provide insulation that:

a. Contains no asbestos;

b. Is permanently secured in place behind the exterior covering; and

c. Has a flame spread rating of 75 or less and a smoke-developed rating of 100 or less when tested in accordance with ASTM E84.

Do not use cellular plastics as exposed finish material. Design the doors to have an air-to-air U value of not more than [_____] and a sound transmission class (STC) of not less than [_____].

][Batt or blanket insulation as specified in Section 07 21 16 MINERAL FIBER BLANKET INSULATION.

] Submit design drawings and U value calculations.

2.1.8.1.1 Air Barrier

****

NOTE: UFC 3-101-01 Architecture imposes air tightness requirements in accordance with ASHRAE 90.1 for all buildings and requires full design and inspection of the Air Barrier. In accordance with Section 3-6.3, testing of the air barrier is not required in hangar bays, maintenance bays, or similar areas. Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING also notes this exception in the editor's notes in paragraph BUILDING ENVELOPE AIR TIGHTNESS REQUIREMENT. This acknowledges the inherent challenge in pressurizing a space of this volume, and the way these door systems seal, which inherently relieve this internal pressure. Indicate the delegated design responsibility to either the door manufacturer or the insulated metal panel provider, depending upon who is responsible for the envelope (Insulation and Air Barrier) design.

****

The [door manufacturer] [insulated metal panel provider] is responsible for the delegated requirement to design, provide and inspect the door cladding portion of the Air Barrier in accordance with UFC 3-101-01.

a. When the door system is fully open, all door system components will be outside of the required clearance area for the door opening.

b. When the door system is fully closed the door system will seal and form a portion of the building's exterior envelope.

The door manufacturer is responsible for the delegated requirement to design, provide and inspect the door flashings and weather stripping for their ability to seal to form a portion of the Air Barrier in accordance with UFC 3-101-01.

2.1.9 Hardware

Provide door hardware to accommodate all design loads specified. Provide top guide rollers, bottom wheels, interleaf bumpers, tractor pulls, track cleaners, and top bumpers as required for a complete and operational installation.

2.1.9.1 Wheel Assemblies

Provide steel plate bottom wheels having a minimum tread diameter as required for the actual wheel loading. Construct wheel assemblies to permit removal of the wheel without removing the door leaf from its position on the rail.

a. Treads: Machine wheel treads concentric with bearing seats. The clear distance between flanges not exceeding the width of the rail by more than 3 mm 1/8 inch at the tread nor more than 6 mm 1/4 inch at the edge of the flange. Machine internal bearing seats accurately for a press fit. Heat treat wheels 450 mm 18 inches or greater in diameter to obtain a rim hardness of 320 Brinnel.

b. Wheel bearings: Provide tapered roller or spherical bearings, either internal or cartridge type, arranged so that both horizontal and vertical loads are transferred to the rail only through the bearing. Provide bearings tightly sealed and equipped with high-pressure grease fittings.

2.1.9.2 Top Guide Rollers

****

NOTE: Select one type of top guide roller and delete other types. In Environmental Severity Classification (ESC) C4 or greater or, in circumstances as indicated by the DoD, specify stainless steel rollers only if local experience indicates that steel rollers will rust and interfere with door operation. Consider both cost and softness of stainless steel rollers and thus shorter lifespan versus benefits.

****

Provide top guide rollers of suitable size and capacity for satisfactory performance under the design load conditions. In addition, provide the top guide roller type matching the top guide system to be used.

2.1.9.2.1 Fixed Pancake Top Guide Rollers

Horizontal type; to be used between two vertical steel surfaces formed by the top guide system. Provide adequate clearance for vertical deflection of top guide system. Provide rollers not allowing more than 6 mm 1/4 inch of side to side movement of the door. Provide guide heads each with single or double steel rollers of a suitable diameter and thickness for satisfactory performance under the designated load conditions and top guide system used. Provide permanently lubricated bearings. Design doors to use no less than two top guide heads. Use fixed type head flashing when providing fixed pancake top guide rollers.[Provide stainless steel rollers.]

2.1.9.2.2 Vertical Floating Head Top Guide Rollers

Provide top-roller assemblies to:

a. Move up and down within the specified positive and negative deflection of the roof in the vicinity of the door opening;

b. Allow easy removal through the top of the guide system; and

c. Include both horizontal and vertical [stainless steel] rollers built into a frame which is connected in such a manner as to transmit the specified wind loads from the door to the building structure and to prevent disengagement of the door from the top guide; and

[d. Provide vertical floating head top guide rollers that use floating type head.

]2.1.10 Personnel Doors

****

NOTE: Emergency Exit/Egress doors are no longer permitted to be located in hangar doors in accordance with UFC 4-211-01. Personnel doors for convenient access to the flightline are permitted if provided in accordance with the second paragraph.

****

[Personnel doors are not required within these Hangar doors.

][Provide personnel doors in door leaves as indicated in the drawings. Provide insulated steel or aluminum personnel doors as specified in Section [08 11 13 STEEL DOORS AND FRAMES][08 11 16 ALUMINUM DOORS AND FRAMES]. Provide complete personnel door with all hardware including, hinges, lockset, stop, weatherstripping, and interlock.

] **

NOTE: Personnel doors, their frames, and hardware are specified in the respective sections of the project specification. Provide self-closing door hardware. Personnel doors in hangar doors are often part of the flight line security perimeter locking behind someone exiting through the hangar door and may, or may not, have exterior door hardware pulls. Specifier must address getting back into the hangar from the flight line when the hangar doors are all closed.

****

The door manufacturer is responsible for providing structural frames and electrical interlock for personnel doors.

2.1.10.1 Doors and Frames

Specified in Section 08 11 13 STEEL DOORS AND FRAMES.

2.1.10.2 Hardware for Personnel Doors

Specified in Section 08 71 00 DOOR HARDWARE.

2.1.10.3 Electrical Interlock

Provide each personnel door with an electrical interlock switch to prevent motor operation of the leaf or group in which it is located when the personnel door is open. Provide an identified indicator light at each door leaf control station indicating when the personnel door is in the open position. The intent of this requirement is to prevent any other door leaf from bypassing the door leaf with an open personnel door.

2.1.11 Weather Stripping

Provide adjustable and readily replaceable material. Provide [as indicated] [on vertical edges, sills, and heads] to afford a weathertight installation. Weather stripping is [flap] [bulb] type.

****

NOTE: Designers Option. Select either single or

double edge flashing between door leaf panels. It is recommended that double edge flashing be provided when door panels are 300 mm 12 inches wide or greater.

****

Provide minimum [single] [double] edge weather stripping between door leaf panels.

****

NOTE: Clearly list STC requirements in the Construction Drawings while carefully considering desired method and reason to achieve STC ratings. Particular attention should be paid to the perimeters of door panels (flashing and weather stripping). If the STC rating is required for security, consider alternatives such as restricting how close people may be to the doors, based upon testing of the fully installed system. Coordinate STC rating and detailing with door manufacturers during design.

****

[Design and provide the door's weather stripping and flashing to meet or exceed a sound transmission class (STC) of not less than [_____].

]2.1.11.1 Rubber

Provide flexible weather stripping on vertical edges and sills. Provide clearance between metal parts on vertical edges of leaves and between leaves and jambs which are to be weather-stripped as indicated, or a minimum of 50 mm 2 inches whichever is greater. Use either flap-type, two-ply, EPDM or double flap, single or dual opposed solid neoprene material.

For flap-type weather stripping, provide a two-ply cloth-inserted EPDM material with a minimum thickness of 3 mm 1/8 inch and retained continuously for its full length and secured with rust-resistant fasteners spaced no more than 300 mm 12 inches on center.

For double flap weather stripping, provide extruded neoprene with heavy center section attached at 300 mm 12 inches on center.

2.1.11.2 Metallic

Form head weather stripping material between each leaf and the top guide system of not thinner than 1.2 mm thick 18 gage galvanized sheet steel or flap-type, cloth-inserted neoprene, as indicated.

2.1.11.3 Head Flashing

****

NOTE: Select one of the following options for different head flashing designs. Coordinate with the top guide structure and top guide head design. Hanging head flashing must be designed and fabricated to accommodate total positive and negative deflection of roof in vicinity of door opening. Design stiffened hanging head flashing to

fasten to top guides; Provide 2.15 mm 13 gage galvanized or galvannealed steel material stiffened by supporting frames to adequately withstand specified wind loads without permanent deformation. Material must be furnished and installed by same trade that furnishes top guide system, so preparation for fasteners can be done at fabrication shop. However, to minimize possibility of damage to the material, installation must be done after doors are in final position on rails.

****

Provide with the top guide system specified in Section 05 12 00 STRUCTURAL STEEL. Provide cloth-inserted neoprene weathering fastened to top of door leaves to engage the head flashing when doors are closed. Head flashing type is dictated by top guide system and top guide head type.

2.1.11.3.1 Hanging Head Flashing

Provide head flashing secured to top guide structure so as not to obstruct path of door movement.

2.1.11.3.2 Floating Head Flashing

Provide head flashing secured to top guide heads and travel with the guide heads as the guide system deflects under live load. Provide adequate clearance such that when the floating flashing moves, it does not crash into the door structure.

2.1.11.3.3 Fixed Head Flashing

Provide head flashing secured to the door structure and extending vertically upward until it creates an overlapping seal with the top guide structure. Select dimensions such that the top guide roller will contact the guide structure before the head flashing so that it does not drag during operation.

2.1.12 Fasteners

Fasteners are selected by the hangar door manufacturer in order to develop the full strength of the connection required. Bolted structural connections require ASTM A325 or ASTM A449 bolts. Bolt finish is [zinc plated][black oxide][Hot dipped galvanized].

2.1.13 Sealant

Single-component or multicomponent elastomeric type conforming to ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT. Provide a sealant that has been tested on the types of substrate to which it will be applied.

2.1.14 Primer

Zinc-Rich Epoxy Primer in accordance with Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES.

2.1.15 Variable Frequency Drives

Provide a variable frequency drive (VFD) in NEMA ICS 1, Type [4][12] enclosures equipped with access door-controlled, UL 489 Molded Case Circuit

Breaker (MCCB) with a through-the-door disconnect switch. The control system includes but is not limited to a VFD equipped with overload and undervoltage protection, relays and timing devices as required, control circuit transformers, and a numbered terminal strip. Provide a control circuit transformer capable of reducing the voltage in the control circuits to 120 volts or less, and conforms to UL 506.

2.1.16 Electrical

Provide conduit, wire, flexible cables, boxes, devices, and accessories[, and install trolley duct,] under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. If permanent electrical power is not available when door installation is complete, provide temporary power in accordance with distribution system requirements in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, for testing and adjusting the doors.

Submit the door manufacturer's complete schematic wiring diagram, field wiring diagram, and a complete physical location drawing showing the location of controls with the runs of conduit, size of conduit, number and size of wires in each conduit, location of junction boxes, and full details of control mountings.

2.1.16.1 Electrical Classification

****

NOTE: A Class 1 Division 2 rating is required to 450 mm 18 inches above the floor as a minimum per UFC 4-211-01. Specify a Class 1 Division 1 rating to the required height for corrosion control or fuel cell hangars.

****

This building and these doors are required to adhere to a [Class 1 Division 1] [Class 1 Division 2] [_____] electrical classification[to a height of [_____] meters feet as shown in the Contract Drawings].

2.2 FABRICATION

2.2.1 Doors

2.2.1.1 Frames and Framing

Provide welded or bolted construction in door leaves. Design joints to develop 100 percent of the strength of the framing members. Provide continuous vertical members throughout the height of the door. When required, prepare splices to facilitate field assembly in accordance with standard practice. Provide frames and framing members true to dimensions and square in all directions; no bowed leaves, warped, or out of line in the vertical or horizontal plane of the door opening by more than 1 mm in 2 meters 1/8 inch in 20 feet. Provide diagonal bracing so that the completed leaf assembly will be braced to withstand shipping, assembly, and operational loads. Grind smooth any exposed welds and welds which interfere with the installation of various parts such as cover sheets. Prepare, prime, and coat structural framing and miscellaneous steel as specified in the paragraph FINISHES.

2.2.1.2 Exterior Covering and Interior Liner Sheets

****

NOTE: Delete the paragraph below if flat sheet liner is not specified for either exterior or exterior covering.
****

Fasten flat sheets to the frame either by edge welding, plug welding, or threaded fasteners at no greater than 300 mm 12 inches on center. The maximum area where flat sheets are attached as either exterior covering or interior liner sheets cannot exceed 2.5 square meters 25 square feet. Make edges of exterior sheets weathertight with sealant.

2.2.2 Locking Devices

Do not provide locking devices on motor-operated doors.

2.2.3 Tractor Pulls

Provide tractor pulls so that leaves can be towed by a tractor or similar equipment in the event of power failure. Design the tractor pull for drive force to tow door or 22240 N 5000 pounds whichever is greater. Provide a minimum 10 mm 3/8 inch thickness steel plate.

2.2.4 Track Cleaners

Provide a device to clear debris from the rail head and wheel flange grooves as the leaf is moved.

2.2.5 Insulation

Secure insulation to doors with clips, studs, or adhesive. Protect insulation within 2400 mm 8 feet of floor with steel liner sheets secured to framing 300 mm 12 inches on center at edges with hot dipped galvanized, self-tapping screws.

2.2.6 Interconnection of Door Leaves

****
NOTE: Designer's option. Select either Cable System or Pick Up Bracket interconnection design. Delete the paragraph for the option not selected.

Pick up brackets may be preferred when there is limited space behind or between the doors, when the doors are short (under 9 meters 30 feet), and when cost is critical. Do not specify pick up brackets on a floating group door system.

Cable Systems are preferred to reduce impact and potential fatigue issues especially in large, heavy doors that are 9 meters 30 feet tall and greater. Cable systems require more spacing between the door leaves to accommodate the sheave brackets and wire rope.
****

[Individually operated doors are not interconnected.

][2.2.6.1 Cable System for Group Doors

The minimum size for the cable which interconnects the leaves is 10 mm 3/8 inch; provide cables containing either improved plow steel with lubricated hemp centers or wire rope cores. Sheaves over which the cables operate have a diameter of at least 18 cable diameters and either sealed ball- or roller-type bearings or graphite bronze bearings of a sufficient capacity for the operating loads. Grease fittings are provided for the sheave bearings unless permanently lubricated bearings are used. Operate cable sheave systems such that the lead door travels at 20 meters 60 feet per minute.

][2.2.6.2 Pick Up Brackets for Group Doors

Pick Up Brackets are designed to accept operational loads imparted by the lead leaf. Operate pick up bracket systems such that the lead door travels at 15 meters 45 feet per minute. Provide door spacing sufficient to allow overlap of pick up brackets not less than 13 mm 1/2 inch to prevent brackets from inadvertently passing each other. Pick up brackets not to encroach on adjacent door or its components closer than 13 mm 1/2 inch. Provide cushion on brackets to reduce noise and impact load on doors.

]2.3 OPERATION

****

NOTE: Door type, operation and control will depend upon use and configuration of the facility. Choose one of the three types of door operation in the paragraphs below compatible with the design requirements. Delete configurations not used.

NOTE: If applicable, please refer to UFC 4-211-01 Aircraft Maintenance Hangars for limitations on types, operation and control of Horizontal Rolling Steel Doors allowed for aircraft maintenance hangars.

****

2.3.1 Door Types

Provide [unidirectional] [biparting] [individually operated] [as indicated] door type. Provide [Floating Group] [Anchored Group] doors.[Floating Group doors are interconnected by cable sheaves.][Anchored Group doors are interconnected by [cable sheaves] [pick up brackets].]

[2.3.1.1 Individually Operated Doors

For each door leaf, provide a separate, traction-drive operating unit driving one or more of the bottom wheels. For each leaf, provide a motor-mounted, spring-set, solenoid-released motor brake. Provide the ability for each leaf shall move independently of the other leaves. Provide doors that require operating personnel to walk with the leaf as it moves. Do not interconnect door leaves for individually operated doors.

2.3.1.1.1 Push Buttons for Individually Operated Doors

Provide push buttons mounted on the exterior face for the leaves mounted on the outer rails; provide push buttons mounted on the interior face for the leaves on the inner rails; and provide push buttons mounted on both the exterior and interior faces for the leaves on the middle rails. Provide the button at each edge of a leaf allowing the leaf to travel with that edge as the leading edge only. The controls are not be reversible. Provide each control button at the location indicated.

2.3.1.1.2 Plunger-Type Limit Switches

Provide at each edge of each leaf of individually operated doors. Provide limit switches actuated by 20 mm 3/4 inch diameter stainless steel rods of adjustable length, guided at both ends with nonmetallic bearings and with tape-type constant force springs to return the rods to their normal position after actuation. Provide actuating rods with sufficient over-travel so that the leaves cannot bump one another or any portion of the building or be damaged when being towed. Provide adjustability for each rod 150 mm 6 inches plus or minus from its normal position.

2.3.1.1.3 Safety Edges

Provide fail-safe safety edges on each edge of each leaf of individually operated doors.

2.3.1.1.4 Warning Device

Provide a clearly audible signal[and clearly visible LED flashing light] on each individually operated leaf group of leaves.

][2.3.1.2 Floating Group Doors

****

NOTE: Consider visual appearance when using the anchored or wraparound cable system. The cables used to move the door leaves are sometimes exposed to view.

****

Provide each group of three or more leaves with a separate, traction-drive operating unit located in each end leaf of the floating group doors, which drives one or more wheels of the end leaf, and a wraparound cable system on the intermediate leaves coupled to each end leaf. Design the door system so that movement of either end leaf allows stacking and unstacking of the other end and allows intermediate leaves to move in concert. The group of leaves traveling abreast may then be positioned as desired in the opening. Provide necessary cables, fittings, cable sheaves, housings, guards, anchors, and miscellaneous hardware. Provide doors that require operating personnel to walk with the leaf as it moves. See operator requirements for cable sheave doors. Do not use pick up brackets for floating group doors.

2.3.1.2.1 Push Buttons for Floating Group Doors

Design each group to be controlled by push button stations mounted at each end of each group of leaves. Stations contain one button for stacking the leaves and one button for unstacking the leaves. The stack push buttons are used to move the doors as a group once the doors are fully stacked. The group move function begins after the doors have grouped together and after a five second delay has expired. Provide push buttons mounted on the exterior face of the leaves mounted on the outer rail. Provide push buttons mounted on the interior face of the leaves mounted on the inner rail. Show the location of each control station on manufacturer's drawings.

2.3.1.2.2 Plunger-Type Limit Switches

Provide at each end of each group of floating group doors. Provide limit switches actuated by 20 mm 3/4 inch diameter stainless steel rods of adjustable length, guided at both ends with nonmetallic bearings and with tape-type constant force springs to return the rods to their normal position after actuation. Provide actuating rods with sufficient overtravel so that the leaves cannot bump one another or any portion of the building or be damaged when being towed. Provide adjustability for each rod 150 mm 6 inches plus or minus from its normal position.

2.3.1.2.3 Safety Edges

Provide fail-safe safety edges on each leading and trailing edge of drive leaves for floating group doors.

2.3.1.2.4 Warning Device

Provide a clearly audible signal[and clearly visible LED flashing light] on each group of leaves.

][2.3.1.3 Anchored Group Doors

Provide a traction-drive operating unit located in the lead leaf of the group and driving one or more wheels of the lead leaf.[If connected by cable sheaves, design the leaves in each group to start to moving at the same time and arrive at their fully open or fully closed positions simultaneously.] Provide necessary[cables, fittings, sheaves, housings,] guards,[pickup, brackets,] anchors, and miscellaneous hardware. Provide doors that require operating personnel to walk with the leaf as it moves. See operator requirements for [cable sheave] [pick up bracket] doors.

2.3.1.3.1 Push Buttons for Anchored Group Doors

****

NOTE: Specify interior or exterior push buttons depending on the arrangement of the doors. Interior push buttons may become obstructed when the leading leaf is on the outermost rail.

****

Each group is controlled by a two-button push button station marked "OPEN" and "CLOSE" mounted near the [inside] [outside] leading edge of the lead leaf.

2.3.1.3.2 Lever Arm Type Limit Switches

Provide for anchored group doors to stop the travel of each group in the fully open and fully closed positions. Provide limit switches with:

a. Positive acting, snap action, lever arm type with actuating cams designed with sufficient overtravel to permit the group to come to a complete stop without over traveling the limit switches.

b. Mounted on the leaves, and the actuating cams mounted either on the top guides or on adjacent door leaves.

2.3.1.3.3 Safety Edges

Provide fail-safe safety edges on the leading edge of the drive leaf of anchored group doors.

2.3.1.3.4 Warning Device

Provide a clearly audible signal [and clearly visible LED flashing light] on each group of leaves.

]2.3.2 Operating Units

****

NOTE: Delete "lead" for individually operated doors. Leave in for group doors. Pick up bracket doors operate at 15 meters 45 feet per minute. Cable sheave doors operate at 20 meters 60 feet per minute.

Provide a Totally Enclosed Wash-Down (TEWD) motor enclosure in harsh salt air marine environments. Doors have a history of early motor failure where facilities are adjacent to the oceanor exist in corrosive environments.

****

Design each operating unit to move its [lead] leaf at a speed of approximately [20 meters] [15 meters] [60 feet] [45 feet] per minute at zero wind load conditions. Design the operating units to consist of either a separate motor and gear reducer or a gearhead motor, high-speed shaft brake, and necessary roller chains and sprockets. Provide the systems with overload protection for the drive units and a means for emergency tractor towing operation.

a. Provide NEMA MG 1, high-starting torque, reversible type motors with sufficient horsepower and torque output to operate the leaves in either direction from any position under zero wind load conditions at not more than 75 percent of their rated capacity. Motors shall operate on current voltage of the characteristics indicated at not more that 3600 [1800] rpm. Provide drip-proof type motor enclosures or NEMA totally-enclosed, fan-cooled (TEFC) [totally-enclosed, wash-down (TEWD)] type. Design motors using a minimum service factor of 1.2.

b. Provide gear reduction units that allow a reversal of effort through the gears without damage to the units.

c. Provide operating mechanisms covered on the interior of the leaf by a hinged 1.5 mm thick 16 gage flat steel cover.

2.3.3 Braking Systems

Design braking systems to ensure stoppage of the leaves under normal, dry rail conditions within the safety edge overtravel limit. Provide either a magnetic, spring-set, solenoid-released brake or hydraulic type braking systems. Provide a hand release to release the brake when it becomes necessary to move the leaf with an outside force. Provide an automatic reset type hand release so that the brake will be operable during subsequent electrical operation of the door.

2.3.4 Controls

Provide doors controlled by constant pressure push buttons mounted on the door leaves. Removing pressure from the button shall stop the movement of the leaves. Provide control equipment conforming to NEMA ICS 1 and NEMA ICS 2. Provide [mushroom] [guarded] head type interior push buttons, mounted in heavy-duty, oil-tight enclosures conforming to NEMA ICS 6, Type 4, except that enclosure for the VFD with disconnect switch requires [Type 12 for interior application] [Type 4 for exterior application].[Provide watertight enclosures for exterior push buttons conforming to NEMA ICS 6, Type 4.]

2.3.5 Limit Switches

Provide limit switches to prevent overtravel and bumping. Safety edges are not to be used as limit switches.

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include wiring and control diagrams.

2.3.6 Safety Edges

****

NOTE: Edit to suit type of door operation required. Select pneumatic or electric type safety edge with consideration of the significant cost increase when specifying electric safety edge. Allow manufacturer to select based on their preference unless otherwise specified by A/E if a Project/Base/User preference is stated during design.

****

Provide fail-safe safety edges on door leaves from 25 mm one inch above the floor to the top of the door leaf. For leaves 300 mm 12 inches thick (including siding) or less, provide a single run of safety edge the full width of door. For leaves over 300 mm 12 inches thick (including siding,) provide a double run of safety edge spaced to provide the maximum degree of safety in stopping the leaves. For leaves over 300 mm 12 inches thick (including siding) provide a double run of safety edges on the outer edge of each side of door leaf covering no less than 80 percent of leaf.

a. Design: Provide safety edges to provide a minimum of 90 mm 3-1/2 inches of overtravel after actuation until solid resistance is met and door motion comes to a complete stop. If door requires more than 90 mm 3-1/2 inches to come to a complete stop, provide additional overtravel built into safety edge the distance required for door motion to come to a complete stop. Use [pneumatic] [electric] [pneumatic or electric] safety edges.

b. Specs: Use sensing edges of reinforced [EPDM] [polyvinyl chloride] cover or other Government-approved material with chemical resistance to diesel and JP-4 fuel, hydraulic fluids, SAE-30 oil and salt water. Use cover that provides hermetic seal for weather and moisture resistant protection of internal foam and contact elements. Internal foam may be polyurethane and/or latex foam in accordance with military specification MIL-R-5001, medium density. Use [natural gum rubber hose, plugged on one end] [two contact elements separated by perforated foam] or other Government -approved materials and design to perform the switching function when the sensing edge encounters an obstruction along any portion of its active length.

c. Operation: Verify that actuation of the safety edge on leading edge of a group of leaves stops movement of the group. Actuation of a safety edge locks out the motor control in the direction of travel until reset, but shall permit the door to be reversed away from the obstruction which tripped the safety edge. Design safety edges to reset by moving doors away from the obstruction. Design the lower portion of the safety edges to a height of approximately 1500 mm 5 feet to be independently removable for convenience in servicing or repair. The remainder of the edge may be in one piece up to a maximum of 6000 mm 20 feet.

****

NOTE: Specify either Bumper(s) or Tow Bar. Tow bars will protect safety edges better than a bumper system and allow the door panels to be either pushed or pulled.

****

d. Door Edge Protection

[(1) Bumper(s): Protect each door leaf edge provided with a safety edge with a spring type bumper(s). Design bumper to absorb 150 percent of the door drive force when door is pushed in an emergency. For continuous safety edges, extend bumpers to the sides. For sectional safety edges, the bumper can interrupt the safety edge for a distance not greater than 305 mm 12 inches.

][(2) Tow Bar(s): Provide rigid tow bar for each door leaf edge provided with a safety edge. Design rigid tow bar assembly for 150 percent of the door drive force when door is pushed or pulled in an emergency. Provide swivel connection at door end and hook pintle hitch at opposite end.

] e. Keyed bypass: Provide a keyed bypass to the door controls to render the safety edges in a temporary "repair" mode, if necessary. The door drive shall be restored from its "fail safe" mode by activation of the keyed bypass.

2.3.6.1 Electrical Safety Edges

Connect the safety edge in series with the necessary relays and resistors to make the system complete. The service shall be not more than 24 volts and the circuit shall be normally energized so that the malfunction of any of the component parts will make the door inoperative. Wire sensing edges to provide for control reliable 4-wire operation of door so that any power loss to the sensing edges is experienced, then the door becomes inoperable until power is restored and a reset operation is initiated. Install sensing edges to operate through a normally energized relay so that when the sensing edge is compressed the relay contacts open. Install relay contacts to also open if any component in the sensing edge control circuit is broken so as to break continuity. Use 24 volts electrical service to the control circuit. Ensure service to the sensing edge does not exceed a nominal 24 volts. Install a large red indicator light and/or a loud siren, to be simultaneously activated with the actuation of any sensing edge, to indicate the presence of an obstruction.

2.3.6.2 Pneumatic Safety Edges

Pneumatic safety edges operate by means of displaced air actuating air switches. Provide a minimum of one air switch for each 6 meters 20 feet of vertical edge. Provide a pneumatic sensing hose utilizing a natural gum rubber with a 20 mm 3/4 inch inside diameter. Provide electrical service to the air switch no more than 120V. Locate all air switches, associated wire, and conduit above 450 mm 18 inches minimum above the floor.

2.3.7 Warning Device

Provide warning device that complies to the following:

a. Operate when the push button is actuated for movement of the door in either direction;

b. Sound 5 seconds before the door moves, and while the door is moving; and

c. Be distinctly different than the fire alarm and be a minimum of 100 dB within 1 meter 30 feet.

2.3.8 Emergency Operation

Provide doors[, including tail doors,][, including aperture doors,] constructed and equipped so that they can be operated-manually or by tractors from the ground level in case of power failure. Design the manual operation of doors to avoid damage to safety edges.

2.3.9 Electrical Work

****

NOTE: Insert the following into Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

"HORIZONTAL ROLLING STEEL DOORS: Provide field wiring[and trolley duct installation] for doors under this section in accordance with door manufacturer's written instructions, drawings and diagrams, and NFPA 70 and NEMA ICS 1. Provide conduit, wiring, boxes, cables, devices, and accessories under this section. If permanent electrical power is not available when door installation is complete, provide temporary power for testing and adjusting doors for proper operation.[Trolley ducts will be furnished by door manufacturer and installed under this section in accordance with door manufacturer's approved drawings.][Provide draped or festooned cables or cable reels under this section. Provide extra-flexible Type SD cable, and have a spring-loaded, automatic take-up reel, coil-cord, draped cable, or equivalent device.] [as indicated.]"

****

It is the door manufacturer's responsibility to provide the proper electrical equipment and controls built in accordance with the latest NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 standards. Provide equipment, control circuits, and safety edge circuits that conform to NFPA 70. Where located 450 mm 18 inches or less above the floor, meet the requirements to be explosion-proof as defined in NFPA 70, Article 513. Provide mannual or automatic control devices necessary for motor operation of the doors, including push button stations, limit switches, variable frequency drive with UL 489 MCCB motor circuit protection, control circuit transformers, relays, timing devices, warning devices, and [trolley ducts with collectors or trolleys] [required festoon system].

2.3.9.1 Trolley Ducts

****

NOTE: Individually motor-operated doors and floating group doors should always be provided with a trolley duct system to bring power to door leaves. Anchored group doors may be equipped with draped or festooned cables, cable reels or trolley duct. Trolley duct systems should be specified to be furnished by door manufacturer but installed under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM in accordance with door manufacturer's drawings. Only door manufacturer is properly qualified to know where to place trolley duct so there is adequate clearance and noninterference. This specification defines whether trolley duct or SO cable electrification is to be used. Even when a trolley duct system is used, if group doors have a personnel door interlock in a leaf other than the lead leaf, SO cable must be used to communicate the interlock back to the control panel.

****

Provide one or more runs of trolley duct as required for the door system provided. Provide ducts with solid copper conductors in a protective steel [or polyvinyl chloride] housing. Locate ducts as shown on door manufacturer's drawings. Provide adequate clearances in the top guide system for the ducts.

a. Provide each run with the required number of sections of straight track, a section of dropout track, feed boxes, end caps, couplings, hangers, and other accessories to make the system complete and workable. If required, provide expansion tracks in each run where the system crosses a building expansion joint in the roof construction and in the top guides.

b. Furnish one track-supported tandem trolley or self-supporting collector for each [individually motor-operated door] [group of doors], complete with spring-loaded brush contacts. Provide trolley pulling brackets and corrosion-protected chains attached from each side of the pulling bracket to each side of the tandem trolley or support bracket for self-supporting collectors.

2.3.9.2 Electrical Cables

****

NOTE: Draped or festooned cables and cable reels should be specified to be furnished and installed under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

****

Provide festoon flexible cables with support system or cable reels with

Type SO cable with strain relief connections and support system in accordance with the door manufacturer's approved drawings and wiring diagrams.

2.3.9.3 Door Pocket Safety Device

****

NOTE: If applicable, provide an illuminated push/pull emergency stop button for bi-parting and unidirectional doors at the pockets where the doors stack together. If the user is conducting work inside the door pockets, they can press the illuminated pull/push emergency stop to prevent the door from moving.

****

Provide illuminated push/pull emergency stop button for bi-parting and unidirectional doors at the pockets where the doors stack together.

2.4 FINISHES

****

NOTE: The coating system specified in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES is very robust and should always be allowed. It includes the following:

Abrasive blast prep in accordance with SSPC SP 10/NACE No. 2

Zinc-Rich Epoxy Primer Coat; 3-5 mil

Epoxy Intermediate Coat; 3-5 mil

Polyurethane Topcoat; 2-3 mil

Insert the following into Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES, paragraph, SURFACES TO BE COATED:

Section 08 34 16.10 HORIZONTAL ROLLING STEEL DOORS references Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES and requires shop application of these coatings.

****

2.4.1 Ferrous Metal

Clean, prepare, and coat all exposed and non-exposed ferrous metal surfaces as part of the Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES work, including all requirements, submittals, certifications, testing, and inspections required by Section 09 97 13.27. Do not coat finished bearing surfaces. Alternate coating systems or products will not be considered. Prepare surface and apply coatings in the shop, following all temperature, humidity, and testing requirements listed in the Section 09 97 13.27. After installation of the door, prep and touch up surfaces damaged during assembly and installation of the door. Prep and coat unfinished ferrous metal accessories such as bolts and brackets.

2.4.2 Factory-Finished Panels

Provide [[galvanized G90] [galvannealed A90] per ASTM A653/A653M] [coated with a PVDF fluoropolymer equal to Kynar 500] on all factory-finished ferrous metal panels to be exposed to the interior or exterior.

2.5 SIGNAGE

Provide a placard sign immediately adjacent to all control panels explaining how to operate the door and indicating the below notices. The Notice posts the service level wind speed which corresponds to the ultimate wind speed used in design of the open/operational door in paragraph WIND LOADS.

a. Notice:

    (1) Horizontal Rolling Steel Doors must be closed and not operated when wind speeds above [96.6 km/hr] [60 mph] [_____] are expected.

PART 3 EXECUTION

3.1 ERECTION

Provide all work associated with these door systems under the direct supervision and control of the fabricator for safety, control of product liability, and Engineer of Record responsibilities. Coordinate the erection of the doors with the work of other trades. Coordinate the design, fabrication and erection of the door systems and adjust for actual camber, fabrication, and erection tolerances of the surrounding framing. Verify the door system as installed within the erected superstructure accommodates the required upward and downward deflections of the top guide system including required factor of safety. Ensure that all steel support, bracing and framing members are furnished and accurately installed. Coordinate electrical work, including locations of all panels, equipment, motors and other components for required clearances, access and routing of power.

3.1.1 Assembly

Assemble and install the doors and accessories in accordance with the manufacturer's recommendations and installation manual. Provide additional supports as necessary for attachment of guides, brackets, doors, and operation mechanisms. After erection is complete and before touch-up field painting is applied, thoroughly clean all abraded surfaces, field welds, and field bolts; coat in accordance with the paragraph FINISHES.

3.1.2 Cleaning

Clean both the interior and exterior of doors after the completion of erection.

3.1.3 Control Panel Installation

Locate all door control panel indoors, adjacent to the door opening, and with an unobstructed line of sight for the entire door opening. Provide all conduit entries into the bottom of the control panel. Mount control panels and provide three phase power to each control panel.

3.2 PROTECTIVE COATINGS

3.2.1 Cleaning

After fabrication, clean all metal surfaces thoroughly of all mill scale, rust, oil, grease and other foreign substances. Apply rust-preventive primer to all steel parts immediately after cleaning.

3.2.2 Shop Painting

After cleaning, coat with primer all steel surfaces other than machine-finished parts. Keep paint off finished bearing surfaces. Before assembly, prime surfaces that will be inaccessible after assembly. Handle painted materials with care to avoid scraping and breaking the protective film. Ferrous metal surfaces that will be exposed after fabrication will be shop coated and touch-up painted in the field in accordance with the paragraph FINISHES.

3.2.3 Metal Protection

Provide in accordance with Chapter 4 of UFC 1-200-01 when door system is in a corrosion prone location or where door system components use dissimilar metals. If dissimilar metals are used, also provide in accordance with MIL-STD-889. Provide added corrosion protection to the design such as, but not limited to, the following. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact masonry or concrete, protect against corrosion by painting contact surfaces with bituminous coating.

3.3 WELDS

3.3.1 Visual Inspection

Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections in accordance with AWS D1.1/D1.1M. Perform visual inspections on 100 percent of all welds with a Certified Welding Inspector. Document this inspection in the weld inspection report.

Inspect proper preparation, size, gaging location, and acceptability of all welds; identification marking; operation and current characteristics of welding sets in use.

3.3.2 Nondestructive Testing

Perform nondestructive testing in accordance with AWS D1.1/D1.1M[and AWS D1.8/D1.8M]. Perform ultrasonic testing in accordance with Table [6.2] [or 6.3] of AWS D1.1/D1.1M. Test 50 percent of all welds, with sampling representative of all weld types and locations for the entire door system and for the duration of the fabrication schedule. All personnel performing NDT are required to be certified in accordance with ANSI/ASNT CP-189 in the method of testing being performed. Submit certificates showing compliance with ANSI/ASNT CP-189 for all NDT technicians. If more than 10 percent of welds made by a welder contain defects identified by testing, then all groove welds made by that welder are required to be tested by ultrasonic testing, and all fillet welds made by that welder are required to be inspected by magnetic particle testing (MT) or dye penetrant testing (PT). When groove welds made by an individual welder are required to be tested, magnetic particle or dye penetrant testing may be used only in areas inaccessible to ultrasonic testing. Retest all repaired areas. Submit weld inspection report.

3.4 ELECTRICAL WORK

NFPA 70. Provide all conduit, wiring, and mounting of controls in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Door manufacturer to coordinate with the qualified, licensed electrical contractor who will provide and install all [208 3-phase] [480 3-phase] supply power to all components (such as Main, auxiliary, controllers, panels, motors, etc.) which require this low voltage supply power. The qualified, licensed electrical contractor will provide and install all conduit for the control level power under the review and approval of the door manufacturer. Either the qualified, licensed electrical contractor or a factory authorized technician may provide and install all wiring for control level power under the review and approval of the door manufacturer in accordance with the approved construction submittals.

3.5 ACCEPTANCE TESTING PROCEDURE AND REPORT

Submit an Acceptance Testing Procedure for approval, which includes coordination with Section 01 91 00.15 BUILDING COMMISSIONING for such items as door position switches which interact with HVAC controls. After Government approval, perform the testing and submit a report of the results. Provide acceptance testing for the entire door system, including every component, performed by the door manufacturer and suppliers. The following subparagraphs are included in the acceptance testing.

3.5.1 General

Upon completion of installation, including work by other trades, lubricate, adjust, and test doors to verify operation on accordance with manufacturer's product data. Final adjustments will be made by the manufacturer's authorized representative. Adjust and re-test the doors until the entire installation is fully operational and acceptable. Acceptance testing consists of operating each door open and closed (one cycle) ten times successfully and consecutively within a nine-hour time interval in accordance with manufacturer's recommended time interval between open/close cycles. Provide the Contracting Officer's Representative a copy of the final acceptance testing report with completed tests.

3.6 PERSONNEL TRAINING

Provide a 4-hour on-site training session for the Government's door operating personnel and maintenance. Attendees may include base personnel such as facility users, fire department and others. In the training, outline door safety, normal operation, emergency operation, troubleshooting, maintenance, and repair guidelines.[Record this on-site training and provide a video presented in an organized and coherent fashion such that the Government may use the video as the sole training program for future user operators. In multiple locations throughout the video, specifically mention the door system must be completely closed and secured prior to experiencing [96.6 km/hr] [60 mph] [_____] wind speeds. It is acceptable to utilize stock training video content in this video provided the door operation, safety and controls are identical to the door system provided.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 34 16.20 (August 2021)**
Change 2 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-08 34 16.20 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 34 16.20

VERTICAL LIFT FABRIC DOORS

08/21, CHG 2: 08/24

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 34 16.20 (August 2021)**
Change 2 - 08/24

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SECTION 08 34 16.20

VERTICAL LIFT FABRIC DOORS
08/21, CHG 2: 08/24

****

NOTE: This guide specification covers the requirements for vertical lift fabric doors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present. For example, if providing a single door (leaf) remove requirements for mullions, mullion pits,and other applicable door elements.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: These doors are an alternative to traditional horizontal steel sliding doors. Contact the NAVFAC Engineering Innovation and Criteria Office for more information.

The door system design needs to provide for alternate means of operating doors in the event of loss of power.

As of this writing, the fabric utilized in these doors does not comply with impact-resistance requirements on facilities in DoD "wind-borne debris regions" and do not meet the testing criteria of ASTM E1996/ASTM E1886 (Refer to UFC 3-310-01 Paragraph 2-4.6 for additional information).

Testing is underway by some manufacturers to find and develop vertical lift fabric door systems which meet these requirements.

When this specification is used for a fuel cell maintenance hangar, paint hangar, or corrosion control hangar the hazardous classification may impact electrical components of the vertical lift fabric door system - such as the electrical drive, limit switches, control panels, and other electrical devices. All electrical devices within the hazardous classification areas must be specified to be rated for the hazardous location where electrical equipment is installed.

To properly coordinate with this specification, the drawings must, at a minimum, indicate the following information:

1. **Size and arrangement of doors including, if applicable, clearances in accordance with UFC 4-211-01 Paragraph 2.3 MINIMUM AIRCRAFT MAINTENANCE BAY CLEARANCES.**
2. **Preferred location of mullions, mullion pits and mullion swing, as applicable.**
3. **Electrical and structural provisions and preferred locations for hoists, motors and control center.**
4. **Location and type of any required personnel doors and extent of any non-fabric flat panel door area(s).**
5. **Design wind velocity and appropriate design wind pressures based on the design wind velocity. See paragraph below entitled, WIND LOADS for more detailed requirements.**
6. **Anticipated, service level maximum vertical deflections (up and down) of the building structure from which the door system will be supported. Deflections should not include dead load - but should be indicative of the anticipated deflections that may be experienced during the life the door and building. Additionally, the structural engineer of record shall coordinate with manufacturers on supporting structure serviceability limitations and provide camber to anticipate deadloads including the weight of the door.**

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in

this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual
AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN WELDING SOCIETY (AWS)

AWS A5.10/A5.10M	(2023) Welding Consumables - Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys - Classification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum
AWS D1.8/D1.8M	(2016) Structural Welding Code—Seismic Supplement

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM D2136	(2002; R 2012) Coated Fabrics - Low-Temperature Bend Test
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60034-1	(2022) Rotating Electrical Machines – Part 1: Rating and Performance
IEC 60034-5	(2020; Corr 1 2024) Rotating Electrical Machines – Part 5: Degrees of Protection Provided by the Integral Design of Rotating Electrical Machines (IP Code) – Classification
IEC 60034-6	(1991) Rotating Electrical Machines Part 6: Methods of Cooling (IC Code)

IEC 60034-14	(2007) Rotating Electrical Machines – Part 14: Mechanical Vibration of Certain Machines with Shaft Heights 56 mm and Higher – Measurement, Evaluation and Limits of Vibration Severity
IEC 60204-1	(2021) Safety of Machinery – Part 1: General Requirements
IEC 60269-1	(2024) Low-Voltage Fuses – Part 1: General Requirements
IEC 60269-2	(2024) Low-Voltage Fuses – Part 2: Supplementary Requirements for Fuses for Use by Authorized Persons (Fuses Mainly for Industrial Application) – Examples of Standardized Systems of Fuses A to K
IEC 60364-1	(2005) Low-voltage Electrical Installations in Buildings - Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions
IEC 60364-5	(2009) Low-Voltage Electrical Installations - Part 5-52: Selection and Erection of Electrical Equipment - Wiring Systems
IEC 60947-1	(2020; Corr 1 2024) Low-Voltage Switchgear and Controlgear – Part 1: General Rules
IEC 60947-2	(2024) Low-Voltage Switchgear and Controlgear – Part 2: Circuit-Breakers
IEC 60947-3	(2020; Corr 1 2021) Low-Voltage Switchgear and Controlgear – Part 3: Switches, Disconnectors, Switch-Disconnectors and Fuse-Combination Units
IEC 60947-4-1	(2023) Low-voltage Switchgear and Controlgear, Part 4-1: Contactors and Motor Starters - Electromechanical Contactor and Motor Starters

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and

	Overload Relays Rated 600 V
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 79	(2015) Electrical Standard for Industrial Machinery
NFPA 220	(2024) Standard on Types of Building Construction
NFPA 409	(2022) Standard on Aircraft Hangars

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-889	(2021; Rev D) Galvanic Compatibility of Electrically Conductive Materials
UFC 1-200-01	(2022; with Change 4, 2024) DoD Building Code
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

UL SOLUTIONS (UL)

UL 98	(2016; Reprint Jan 2022) UL Standard for Safety Enclosed and Dead-Front Switches
UL 248-1	(2011) Low Voltage Fuses - Part 1: General Requirements
UL 248-12	(2011; Reprint Aug 2020) Low Voltage Fuses - Part 12: Class R Fuses
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment

UL 698A	(2018; Rev 2019) UL Standard for Safety Industrial Control Panels Relating to Hazardous (Classified) Locations
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

SD-02 Shop Drawings specific to this project, sealed by the Door Manufacturer's Registered Professional Engineer.

Door Design; G, [_____]

SD-03 Product Data

Diagrams, performance curves and characteristic curves of equipment and systems.

Electric Operator; G, [_____]

Motors; G, [_____]

Doors; G, [_____]

Controls; G, [_____]

Door Fabric; G, [_____]

Surge Protection Device (SPD); G, [_____]

SD-05 Design Data

Calculations; G, [_____]

Door Load Diagrams; G, [_____]

Door Compliance Matrix; G, [_____]

SD-06 Test Reports

Safety Arrester Operation Test; G, [_____]

Door Fabric: ASTM D2136; G, [_____]

Door Fabric: ASTM E84; G, [_____]

Door Fabric Connection; G, [_____]

Weld Inspection Report; G, [_____]

SD-07 Certificates

Manufacturer's Qualifications; G, [_____]

Installers Qualifications; G, [_____]

Welding Procedures and Qualifications; G, [_____]

SD-09 Manufacturer's Field Reports

Acceptance Testing Procedure and Report; G, [_____]

SD-10 Operation and Maintenance Data

Door Operation, Data Package 2; G, [_____]

Emergency and Routine Preventative Maintenance Plan; G, [_____]

SD-11 Closeout Submittals

Acceptance Testing Procedure and Report; G, [_____]

Manufacturer's Warranty; G, [_____]

1.3 DESIGN REQUIREMENTS

1.3.1 Door Design and Components

The vertical lift fabric doors and components indicated in the construction documents are representative of a commercially-available door. Design and fabricate the door to fit within the space allocated and in accordance with the criteria specified herein and without binding, interfering, or damaging the adjacent structure or itself. Provide a door with a minimum maintenance free operation for 3 years or 1,500 cycles, whichever occurs first, as counted by the door close limit switch. Construct the door with limited combustible construction materials in accordance with NFPA 220 and NFPA 409.

Include a Door Compliance Matrix along with your submittal which references each specification requirement and the corresponding document and page number where compliance may be verified by the reviewer.

Shop drawings of motors, all electrical control devices, and all electrical control panels, including schematic diagrams, dimensional drawings of control panels, details of control panel installations, internal wiring diagrams of control panels, and wiring diagrams indicating all external connections between control panels and from control panels to remote control devices. Furnish list of materials for all control devices, both inside and remote from control panels including manufacturer's model number, electrical ratings, location, and quantity of each item furnished.

Show all vertical lift fabric doors and components, including types, sizes, locations, fabric, supporting, bracing and framing steel and aluminum members, metal gages, fasteners, speed, hardware provisions, signage, installation details, and other details of construction. Include supporting brackets for motors, location of motors, and safety devices. Include personnel door, mullion pit and cover or retractable pin and strike if utilized. Provide details for the closure between bulkhead and doors. Include details for supporting and bracing the door assembly from the structure. Demonstrate through detailing that the indicated superstructure's non-dead load, service level deflections are accommodated in both the downward and upward directions. Indicate finishes to be used.

1.3.1.1 Steel Door Components

The door manufacturer's registered professional engineer is responsible for designing all supporting, bracing and framing steel members associated with the door system for the specified loads in accordance with the requirements of AISC 325 and AISC 360. Comply with the AWS D1.1/D1.1M Standards for all steel welding. Refer to Section 05 12 00 STRUCTURAL STEEL for other requirements, including bolted connections.

1.3.1.2 Aluminum Door Components

The door manufacturer's registered professional engineer is responsible for designing all supporting, bracing and framing aluminum members associated with the door system for the specified loads in accordance with the requirements of the Aluminum Association (AA ADM). Comply with the AWS D1.2/D1.2M Standards for all aluminum welding.

1.3.1.3 Door Operational Performance

Provide a door which does not bind, catch or become adversely out of level during door operation. Door operation includes (1) fully opening then closing, (2) partially opening then closing, and (3) partially opening, then fully opening, and then closing. Partially opened doors may occur at any intermediate point and smooth operation of the door is required with smooth operation without binding.

1.3.2 Loads

Use the governing design loads for the design of the door system in accordance with UFC 1-200-01, UFC 3-301-01 and all other applicable criteria.

1.3.2.1 Wind Loads

****

NOTE: In accordance with UFC 1-200-01, UFC 3-301-01 and, if applicable, UFC 4-211-01, the Engineer of Record must indicate the appropriate design wind pressures for the design of the door system on the drawings. The simplified procedure/method must not be used to calculate the design wind pressures for the door system, only the analytical procedure is permitted. The structure of the building volume accessed by the vertical lift fabric door must be designed as a Partially Enclosed building in accordance with UFC 3-301-01 paragraph 2-4.6. The door system design pressure must be based on the specific project design criteria and on the design wind velocity for components and cladding based upon each structural element's associated tributary area. An example table of required design wind pressures is shown below and must be included in the drawings.

Zone	**Effective Area (SF)**	**Max Positive Pressure (PSF)**	**Max Negative Pressure (PSF)**
?	**10**	**?**	**?**
?	**100**	**?**	**?**
?	**200**	**?**	**?**
?	**500**	**?**	**?**
?	**700**	**?**	**?**

Components and Cladding elements with Effective Areas greater than 65.032 square meters 700 square feet must be permitted to be designed using the provisions for MWFRSs.

****

In the closed position, design the entire door system to withstand the component and cladding wind pressures as indicated by the Engineer of Record for a Partially Enclosed building, based upon the indicated design wind velocity, geometry and other factors. Design all elements of the door's components and cladding to withstand both the highest positive and negative pressures based upon the actual tributary area from the wind, as indicated.

In addition, design the entire door system to be both fully open and fully operational for wind velocities up to 125 km/h 78 mph. Calculate the applicable component and cladding wind pressures, including importance factor, and utilize the controlling wind pressures or a positive and negative wind pressure of 0.718 kPa 15 psf on the surface of the door, whichever is greater. Design door mullions and jambs for the unbalanced positive or negative pressure on the surface of a closed adjacent door with the other adjacent door being open.

Submit complete calculations for all components sealed by the door manufacturer's registered professional engineer for review. Include calculations with analysis of the intermediate and bottom beams using the above applied wind conditions and door positions. Do not design intermediate or bottom beams to rely upon stabilization or bracing from the fabric when the door is not in the closed position. In both the open and closed position, design all intermediate beams for the maximum potential rotation permitted by manufacturer detailing such that applied wind loads are not assumed to act in only the strong axis.

1.3.2.2 Other Loads

Provide door mullions and jambs of adequate strength to transmit the forces from design wind loads, in addition to the other loads resulting from door operations or the door's action as a tributary element, with no detrimental effect on the operation of the door. Submit the vertical and horizontal loads imposed upon the building structure by the vertical lift fabric door system.

1.3.3 Door Speed

Provide for each door leaf to open fully with a minimum speed of 152 mm 6 inches per second under all design conditions. Provide door mullion(s), when required by the contract documents, to rotate with a minimum wire rope retraction speed of 152 mm 6 inches per second.

1.3.4 Door Weight

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NOTE: Careful coordination with the structural engineer of record is required to ensure proper support of the vertical lift door system.

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Submit door load diagrams of the door in the closed and governing open position(s). Provide details showing clearance and attachment requirements for coordination with the structural steel, miscellaneous steel, slab/foundation, and demonstration that superstructure's unfactored deflections are accommodated by the design of the mullions, pits and door leaves.

1.3.5 Cybersecurity

Design all control systems (including systems separate from a utility monitoring and control system) in accordance with UFC 4-010-06 and as required by Section 25 05 11 [_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS [_____]. Implement cybersecurity requirements to mitigate vulnerabilities to all facility-related control systems.

1.4 QUALITY ASSURANCE

1.4.1 Manufacturer's Qualifications

Use a vertical lift fabric door product from a manufacturer who is regularly engaged in the design, fabrication, erection, and service of vertical lift fabric doors of type and size required for this project. The manufacturer must have at least 5 years of similar vertical lift fabric door design experience. Similar doors must have comparable function and design including size, configuration, type of use, retractable or moving elements, safety features, controls, and other key engineering elements as the door being specified. It is acceptable to show that a series of similar doors collectively meet all comparable elements to the door being specified, although not necessarily individually. Submit written manufacturer evidence on similar past door designs and installations listing the name, location, contact information of owners, installation dates, overall sizes, features, and other relevant information for experience and qualifications evaluation. Only manufacturers who can submit this evidence of actual installations where the products have proven practical, durable, and require a minimum of maintenance, will be qualified under this specification.

1.4.2 Installer's Qualifications

A manufacturer's representative, skilled and experienced in the erection of vertical lift fabric doors of the type specified herein, is required to supervise installation of the door system(s) in accordance with approved shop drawings. For each Installer, submit written evidence of similar past door installations listing the name, locations, contacts information of owners, installation dates, overall sizes, features, and other relevant information for experience and qualifications evaluation.

1.4.3 Warranty

Provide a three-year warranty for all mechanical and electrical components against defects in material and workmanship beginning on the date of Project Acceptance. Manufacturer is responsible for items requiring adjustment, repair or replacement for the three-year maintenance-free warranty period, or 1500 door cycles, whichever occurs first. Provide a ten year warranty for defects in the fabric material.

1.4.3.1 Maintenance and Repair Action Plan

Provide an Emergency and Routine Preventative Maintenance Plan. In Data Package SD-10 "Operation and Maintenance Data", include a list of phone numbers and personnel contactsand provide a list of suggested spare parts materials and tools to be purchased by the Contracting Officer. Include a list of annual visual safety inspections to be performed or contracted by the government and provide a door design which accommodates each of the visual inspection items with removable panels or viewing ports where inspection items are not directly viewable. A Preventative Maintenance

Plan which requires adjustment or maintenance intervals less than 3 years or 1,500 cycles is not permitted.

Submit vertical lift fabric door manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4.4 Delivery, Storage and Handling

Provide shipment of all materials required for door installation in protective packaging. Protect door and accessories from damage during delivery, storage, and handling. Mark all packaging clearly with manufacturer's brand name, door model and job site location. Store in dry location with adequate ventilation, and free from dust and water. Storage must permit easy access for inspection and handling. Remove damaged items that cannot be restored to like new condition or provide new items.

1.5 WELDING PROCEDURES AND QUALIFICATIONS

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welder or welding operator is more than 6 months old, the welding operator's qualification certificate must be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

Comply with applicable provisions of AWS D1.1/D1.1M for Steel.

Comply with applicable provisions of AWS D1.2/D1.2M for Aluminum.

PART 2 PRODUCTS

2.1 MATERIALS

Select materials based on durability, low maintenance, weather resistance and strength (permanent deformation from loading is not permitted). Comply with ASTM E84 for limited combustible construction for all door system materials.

2.1.1 Steel Plate and Bars

ASTM A36/A36M

2.1.2 Steel Sheet

ASTM A653/A653M

2.1.3 Steel Shapes

ASTM A992/A992M

2.1.4 Aluminum Extrusions

ASTM B221, Alloy 6063-T6, Alloy 6005-T5 or 6000 Series Aluminum

2.1.5 Aluminum Sheets and Strips

ASTM B209, alloy and temper best suited for the purpose.

2.1.6 Aluminum Welding Rods and Bare Electrodes

AWS A5.10/A5.10M.

2.1.7 Door Fabric

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NOTE: Translucent fabric is not recommended in all geographies (i.e. extremely high UV index areas, such as the Middle East). Additionally, very high fabric tension forces may require heavier fabric (i.e. 800plus gram/square meter) which limits its intended purpose. Prior to including any of the below options for translucent panels, consult with a manufacturer.

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Provide fabric material that is a heavy-duty, rip stop, vinyl coated polyester fabric weighing not less than 644 grams/square meter 19 oz/square yard, capable of carrying 4.46 kg/mm 250 lb/in per panel. Provide fabric that is impervious and resistant to solvents, fuel, lubricants, and other similar fluids commonly found in aircraft maintenance hangars. Provide fabric that is ultraviolet (UV) stabilized, self-extinguishing (0-75 flame spread), and suitable to withstand temperatures between plus 70 to minus 35 degrees C plus 158 to minus 31 degrees F in compliance with ASTM D2136.[Use a translucent fabric material [in approximately the top 3 m 10 feet of the door] [as shown in the drawings] to allow daylighting of the hangar aircraft servicing area. Provide translucent fabric material that meets the same requirements and loadings as the standard door fabric.] Fabric color will be selected by the Government from the manufacturer's standard colors. Construct door system such that fabric is tight between the intermediate beams when the door is closed and the wind locks engaged. Test the fabric to meet the criteria of ASTM E84 (flame spread - Class A interior wall and ceiling finish), ASTM D2136 (cold cracking, brittleness and temperature), and ASTM D751 (tensile and tear strength). Provide a minimum 4:1 factor of safety on the fabric design while accounting for degradation due to UV and temperature effects.

Submit door fabric panel samples for weight, strength, and color approval.

2.1.8 Wire Rope

ASTM A1023/A1023M.

2.2 DOORS

Door system consists of individual hoist-up fabric door leaves with intermediate aluminum beams or trusses. Maximum wind load deflection of steel structural door members is not to exceed the member length divided by 120. Maximum wind load deflection of extruded aluminum door members is not to exceed the member length divided by 30. Design and install the door system to accommodate the anticipated downward deflection due to self weight of the door system after all the building dead load has been applied. Then provide a door system which accommodates the stated unfactored downward and upward deflections of the superstructure to which it is being attached.

2.2.1 Fabric Door Leaves

When one-piece fabric construction is utilized, loop fabric over the uppermost beam and attach the fabric to both flanges of the intermediate beams, top beam, and bottom beam with self-tapping screws through corrosion resistant anodized or coated aluminum batten strip. Provide independent, third party laboratory testing to demonstrate door fabric connection has a minimum 2:1 factor of safety above the required connection forces while accounting for fabric degradation due to UV and temperature effects.

Alternatively, when fabric panel construction is utilized, attach the fabric at all beams using a keder type connection. Provide independent, third party laboratory testing to demonstrate connections are stronger than the fabric.

2.2.2 Intermediate Door Beams

Provide corrosion resistant, extruded aluminum intermediate beams of a suitable depth dependent on the door width and the wind load requirements with a spacing not to exceed 1800 mm 6 feet. Provide, at each end of the beams, a guide block of self-lubricating material or rollers that run along the guides. Built-up members meeting these requirements are acceptable. Design the intermediate door beams and guide block or rollers to carry the full design wind load without failure and without being pulled from the door guides. Guide block or roller design cannot put the intermediate beam into tension under design wind load which would cause pulling forces on door jambs. Provide guide block material of nylon, polyoxymethylene (POM), or Ultra High Molecular Weight (UHMW) polyethylene. Provide rollers that are galvanized steel with maintenance free, lifetime sealed ball-bearings in case-hardened steel races. Midspan splices are prohibited in intermediate beams.

2.2.3 Door Guides

The vertical door guides are an integral part of the door, made of extruded aluminum with a suitable depth and width dependent on the size of the intermediate beams and wind load requirements. Provide guide rails with a T-shaped center guide designed to prevent guide blocks from escaping the guides and designed to prevent placing the intermediate beam in tension under design winds loads (catenary effect). Design the guides to provide weather sealing on the inside and outside faces. Provide adequate space inside the guides, or within the door, for all required components such as the nylon belt, polyester belt, or wire rope of the drive unit, windlocks and safety arresters. Provide removable door guides with anchorage to the mullion and jambs, as applicable, of the size and type required to carry the full design wind load without failure and without permanent deformation. Removable door guides will be mechanically fastened to permit the guide rail to be readily removed with standard tools. Provide guide blocks or roller, inside the guides, sufficient to prevent scraping or damage to the guide rail during normal door operation.

2.3 ELECTRIC OPERATORS

2.3.1 Drive Units

Provide each door leaf with a motor drive system with horsepower sized as appropriate for the weight of the door leaf plus door friction to account for operational wind speeds and corresponding pressures. Equip the gear motor with a drum on which the nylon belt, polyester belt, or wire ropes are wound, including required safety wraps and connections. For dead ends on wire ropes, provide a minimum of two unclamped dead wraps on the wire rope drum with the dead end anchored on the drum barrel by clamps or by inserting end fitting into reinforced pockets. For hoists using synthetic belts, provide a minimum of five dead wraps and belt anchorage to the drum.

If a single motor drive is used, wind the belts and wire ropes on the same drum. When using wire ropes, provide a grooved drum. Attach the belts and wire ropes to the bottom beam via the safety arresters. Provide a hand crank device or other manual means on the motor for manual operation of the door in the event of a power failure. Provide a gear motor that is removable without disturbing limit switch adjustment. Coordinate the drive units with the location of aircraft such that the drive units are accessible while aircraft are in the hangar.

Submit drive unit system horsepower, belt type, and locations. Safety arrestor type, test reports, and brake system details.

2.3.2 Belt/Wire Rope System

Properly select and utilize belts and/or wire ropes to transmit motive force to each door leaf. Install belts/wire ropes free of any kinks and design the system and sheave diameter to prevent the occurrence of any kinks, and abnormal stress in the operating belts/wire ropes. Where belts/wire ropes pass through openings of the building structure, construct the openings to prevent abrasion, wear, or damage to the belts/wire ropes. Design belts, wire ropes, and their connections to have a minimum 6:1 factor of safety, including impact loads.

Do not use belt systems where individual lifted door weight exceeds 2800 Kg 6,200 Lbs. Include edge wear indicators on belts and properly terminate at all connections. Provide fully stitched flat eye belt terminations which are permanent and do not require routine adjustment or maintenance.

Properly swage wire rope ends and include thimble loops to prevent wire rope abrasion at end connections. Provide wire rope end connections which are permanent and do not require routine adjustment or maintenance.

Minimize the quantity of motors, sheaves and drums used to guide the belts or wire ropes to reduce maintenance requirements. Provide sheave units in accessible locations that allow inspection and preventive maintenance. Do not locate motors, sheaves, and drums in enclosed locations, which are not readily accessible for visual inspection and maintenance.

2.3.3 Door Drop Prevention

2.3.3.1 Door Leaf Safety Arresters

Supply each door leaf with safety arresters at each jamb door guide that automatically activate and support the door in case the door lifting system fails similar to a belt or wire rope breaking. Attach safety arresters to each end of the bottom beam which travel in the vertical guide tracks and cannot escape from, or pull off of, the door's guide rails. Provide safety arresters that immediately engage to stop the downward movement of the door in case of belt/wire rope failure in accordance with the below test requirements.

Perform a "Safety Arrestor Operation Test" on each set of safety arresters by a nationally recognized independent testing source to withstand at least

110 percent of the maximum door leaf weight.

The "Safety Arrestor Operation Test" will be deemed successful when it contains at least the following minimum criteria:

a. Test door weight to at least 110 percent of the specific project's door weight.

b. Test by simulating the door lifting system abruptly disengaging, similar to a belt or wire rope breaking.

c. Verify the Safety Arresters automatically engage.

d. Verify door leaf is brought to rest after an initial downward movement (or drop) of not more than 300 mm 12 inches and that the door leaf is held firmly in this position.

e. Verify that damage from activation of the Safety Arrestors is limited to localized replaceable components, such as the guide rails or safety arrestors, and not a system failure which would require repair or replacement of any other portion of the door system or its structural support.

Submit independent testing source documentation of successful "Safety Arrester Operation Test".

2.3.3.2 Door Leaf Safety Arrester Alternative

Door leaf safety arresters may be omitted, if each door leaf is provided with four or more lifting belts/wire ropes and if is it demonstrated through analysis of the entire door system that the door leaf remains stable, without falling, with the loss of either end belt/wire rope, or any two intermediate belts/wire ropes. Additionally demonstrate, that other failure mechanisms inherent in the door system will not result in a falling door leaf.

[2.3.3.3 Swing-Up Door Mullion Safety Arrester

Provide swing-up door mullions with a lifting motor that includes a backup arresting system or secondary brake system to prevent the mullion from falling in case of motor, wire rope, or primary brake failure.

]2.3.4 Slack Belt/Wire Rope Breaker

Use a safety device on all belts and wire ropes that will send a slack belt/wire rope condition to the appropriate drive unit(s) and prevent unsafe operation or any other unsafe condition.

2.3.5 Motors

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NOTE: Select the standard to which the motor will be rated. If IEC motors are utilized, the door electrical motors must comply with IEC standard IEC 60034-1, IEC 60034-5, IEC 60034-6 and IEC 60034-14. If NEMA motors are utilized, the door electrical motors must comply with NEMA MG-1. Coordinate with the local authority and regulations and standards at the location of the construction to determine which

standard is applicable for the project.
****

[NEMA MG 1][or][IEC 60034-1, IEC 60034-5, IEC 60034-6, IEC 60034-14], high-starting torque, reversible type with sufficient horsepower and torque output to move the door in either direction from any position. Provide a motor to produce a door travel speed of not less than 150 mm 6 inches per second without exceeding the rated capacity. Provide motors that operate on the indicated voltage. Provide motor enclosures that are drip-proof type or NEMA totally enclosed. Supply a hand crank which fits the motor for manual operation of the door in the event of a power failure. Install motors in approved locations. Provide motors that have a minimum service factor of 1.2 at continuous duty under maximum full load. Provide motors in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and requirements listed above.

When two or more motors are used, provide mechanical linkage, electronic position monitoring and/or logic to eliminate the possibility that the door may bind, catch or become adversely out of level during door operation.

Submit motor characteristics including horsepower, service factor, safety factor, and standards compliance.

2.3.6 Controls

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NOTE: Select the standard to which controller will be rated. If IEC controls are utilized, the door electrical controls must comply with IEC standards IEC 60204-1, IEC 60269-1, IEC 60269-2, IEC 60364-1, IEC 60364-5, IEC 60947-1, IEC 60947-2, IEC 60947-3, and IEC 60947-4-1. If NEMA controls are utilized, the door electrical controls must comply with NEMA AB-1, NEMA ICS-2, NEMA ICS-5, and NEMA KS-1. The door electrical controls must comply with NEMA ICS-1, NEMA ICS-6, NFPA-70, NFPA-79, UL 98, UL 248-1, UL 248-12, UL 489, UL 508, UL 1449 and UL 698A. Coordinate with the local authority and regulations and standards at the location of the construction to determine which stands is applicable for the project.

When presented with the choice of NEMA 4 or NEMA 4X in the below paragraphs, select NEMA 4X in corrosive environments and NEMA 4 in non-corrosive environments.
****

Provide control equipment in accordance with [NEMA ICS 2][or][IEC]. Provide control enclosures in accordance with NEMA ICS 6, Type 12 or Type 4X.[Provide door electrical controls in accordance with IEC standards IEC 60204-1, IEC 60269-1, IEC 60269-2, IEC 60364-1, IEC 60364-5, IEC 60947-1, IEC 60947-2, IEC 60947-3, and IEC 60947-4-1.][Provide door electrical controls in accordance with NEMA AB 1, NEMA ICS 2, NEMA ICS 5, and NEMA KS 1. Provide door electrical controls in accordance with NEMA ICS 1, NEMA ICS 6, NFPA 70, NFPA 79, UL 98, UL 248-1, UL 248-12, UL 489, UL 508, UL 1449, and UL 698A.] Provide UL listed door control components. Provide each Door Module with the following operators:

a. Main Control Panel (Station) [NEMA Type 4][NEMA Type 4X] enclosure.

b. Remote (Auxiliary) Control Panel (Station) at the opposite end of hangar door [NEMA Type 4][NEMA Type 4X] enclosure to match Main Control Panel.

[c. Provide emergency Stop Buttons located outside at the end of each hangar bay in a NEMA Type 4X enclosure.

] d. Provide "Open" operator on the exterior of each bay of doors, keyed for use by Fire Department personnel to allow entry in the event of an emergency, in a NEMA Type 4X enclosure.

Provide conduit and control wiring between Main, Auxiliary, emergency stop controls, proximity switches, limit switches, and each door motor drive unit. Provide power and controls wiring and conduit in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Submit controls characteristics including all electrical components and devices used in the control system, enclosures, safety devices, transformer size and voltage, and emergency power connection.

2.3.6.1 Control Panel Enclosures

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NOTE: Relay logic must be the default style of control for single leaf doors. A Programmable logic controller is required to be used and paired with the User Interface with diagnostics by default for multi-leaf doors and is optional for single leaf doors.

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Provide NEMA ICS 6, Type 12 or Type 4X control panel enclosures. Provide an integral main power disconnect switch that is mechanically interlocked with the control panel door at each control panel. Provide factory wired field wiring terminal strip in each control panel and instantaneous three-phase thermal overload relays. Provide each control panel enclosure including an internal motor starter or VFD with adequate integral ventilation (air conditioning if required) for operation in a 49 degree C 120 degree F ambient environment. Provide [NEMA][or][IEC] rated control relays. Provide main control panel with programmable logic controller.

Provide a three phase UL 1449 listed surge protection device (SPD) for the incoming power to each door control panel. Provide a UL 1449 listed surge suppression device (SPD) for each control circuit (limit switch, proximity switch, motor, brake, solenoid, indicating light, and pushbutton) that is routed external from each door main control panel.

Submit data for each incoming [and][or] outgoing power feeder and each control circuit.

Provide devices to control the logic and sequence of door and mullion operation to ensure safe, smooth and dependable operation at each control panel. Provide interlocks to preclude personnel injury, including an interlock between the power supply system and use of the hand crank for manual operation of the door. Provide constant-pressure type, fully guarded, illuminated push buttons on the control panel for both up and down operations. Provide mushroom type emergency stop button on each control panel. Utilize individual user password protected touch screen interface to select desired door or mullion motion. Door motion will be initiated via fully guarded push buttons.

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NOTE: If a permanent generator is provided for the door, acquire approval from the applicable government agency. The addition of a generator may impact existing air pollution permits. Coordinate with the local authority to add a generator to the project. Coordinate the type of connection with other electrical specifications. Provide the details of the connection in the appropriate electrical section.

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Provide back-up power hook up at the control panel to connect to [a building backup power generator with automatic transfer switch] [a portable generator provided by the Base via a pin and sleeve female receptacle (coordinate with Base) and manual transfer switch provided on the main control panel].

2.3.7 Limit Switches

Provide limit switches or proximity switches to automatically stop doors [and mullions] at the fully open and fully closed positions. Provide limit switches or proximity switch positions that are readily adjustable. Provide limit switches or proximity switches for the wind lock with visual indication on the control panel for each door leaf. Provide visual indication to notify the door operator that the wind locks are engaged for all door leaves.

****

NOTE: Include paragraph below when the Government decides to include retractable mullion pins and floor strikes. Recommend discussing with potential manufacturers. Advantages include a significantly smaller mullion pit and covers. Disadvantages include additional cost, maintenance and potential operating issues/errors associated with each motor and limit switch along with design/construction complexities associated with the Class I Division 2 challenges. Refer also to paragraph MULLION PIT AND COVER WHERE INDICATED.

****

[Provide each retractable mullion pin with a limit switch or proximity switch interlock that proves that the electric mullion pin is fully extended and locked before the door can be moved. If the limit switch or proximity switch is located below 0.46 meters 18 inches above the hangar floor, either provide rated Class I Division 2 explosion-proof device or provide an intrinsically safe circuit rated for a Class I Division 2 hazardous location.

] Demonstrate the operability of all limit switches prior to Government occupancy.

2.3.8 Door Control Alarms

Provide an audible alarm device on each door main control panel (minimum 100 dbA) that sounds 5 seconds before the door moves and continues to sound when the door is moving. Coordinate this audible signal such that it is clearly different from all of the other audible signals utilized in the hangar bay.

Provide a visual alarm device above each door main control panel (LED beacon with 1600 lumens) that operates 5 seconds before the door moves and continues to operate when the door is moving. Coordinate the color of this visual signal such that it is clearly a different color than all of the other visual signals utilized in the hangar bay.

2.3.9 Safety Device

Provide an intrinsically safe (suitable for a Class I Division 2 hazardous location) electric safety edge on the bottom of the edge of each door, continuous over the full length of the door. Provide a safety edge located inside of a rubber cushioned bottom weather sealing edge (or boot) with sufficient vertical height (factoring in the time and distance that it takes to stop a closing door) to prevent collision damage along the bottom edge of the door. Activate the safety edge when the door is closing and do not allow the safety edge to prevent the door from completely closing and properly sealing along its entire length.

2.3.10 Control Transformers

Provide fused transformers inside of each Main Control Panel as necessary to reduce the voltage on the control circuits to 120 volts or less.

2.3.11 Electrical Components

NFPA 70. Provide automatic control and safety devices, including failsafe battery powered wireless limit switches or hard-wired limit switches electrified components[including personnel door interlocks]. Wire rope reel type take-up devices are not allowed. Provide control wiring in accordance with NFPA 70. Provide conduit, wiring, and mounting of controls in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

[2.3.12 User Interface with Diagnostics

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NOTE: Include paragraph below only when a programmable logic controller is specified as an optional controls interface. The user interface with diagnostics is an additional option and does not replace the other controls options. Include Human Machine Interface paragraph below when specifying a multi-part (multi-leaf) door system. Do not include for single leaf door systems without confirming with the government and manufacturers as the cost typically outweighs the benefits (exceptions may include alert hangars).

****

Supply a human machine interface (HMI) on the face of the Main Control Panel and all Auxiliary Control Panels. The function of the diagnostic panel is to provide information on the status of electrical components in the door system. Provide a large (250 mm 10 inch minimum diagonal measure) HMI touch screen to include a graphical representation of the entire door system to facilitate ease of use. Provide the HMI with current door status including windlocks. Include a self-diagnostic system to provide detailed status information of a malfunction and provide guided trouble shooting and diagnostic features. Provide a log for malfunctions and system alarms on the HMI as well as detailed service monitoring and service history. Control operation and configuration of the system is by unique, multi-level password access to limit access to the system to qualified and authorized users. Provide HMI with automatic screen lock after 60 seconds of inactivity. Include functionality on the HMI for remote access to the system, by the manufacturer via both Internet and cellular modem, to review malfunction logs, update programming/settings, or assist in troubleshooting, should the user choose to permit such access as permitted by cybersecurity restrictions.

]2.4 HEADER BOX

Construct the header boxes of carbon steel and finished in accordance with the paragraph FINISHES.

2.5 BOTTOM BEAM

Construct the bottom beam of carbon steel and finished in accordance with the paragraph FINISHES. Provide a bottom beam of a suitable width and depth to carry the load of the intermediate beams when the door is not closed, and to ensure full closing and a tight floor seal under full design wind speeds spanning between windlocks located at each jamb. Provide a heavy-duty bottom rubber seal to form a tight seal with the floor under all design conditions. Provide a bottom edge safety device that is integral with the bottom seal.

Design bottom beams to span between safety arrestors at the jambs and support the weight of the door, including intermediate beams, while remaining stable and within the door guides. If the door leaf safety arrestor alternative is utilized per paragraph DOOR LEAF SAFETY ARRESTERS, design the bottom beam to support the weight of the door, including intermediate beams with either end belt/wire rope, or any two intermediate belts/wire ropes, removed while remaining stable and within the door guides. Midspan splices are prohibited in the bottom beam.

2.6 WIND LOCK

At each door leaf provide wind locks at each jamb, which automatically activate and lock the bottom beam into place when the door reaches its closed position to maintain a tight floor seal and intermediate beam stability with tight fabric under design wind conditions. Provide a limit switch, or a proximity switch, with indicator to notify the door operator that all wind locks are engaged properly. Provide switches located below 45.7 cm 18 inches above finish floor that are compliant with NFPA 70, Class I, Division 2 hazardous environment.

[2.7 SWING-UP MULLION WHERE INDICATED

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NOTE: The mullion pick up point of 3 meters 10 feet above finished floor is appropriate for mullions taller than 7.6 meters 25 feet. For mullions shorter than 7.6 meters 25 feet the pickup point can

reasonably be lowered to 2.4 meters 8 feet above finished floor. The height of the pickup point affects the winch size required to pick it up and the stability of the mullion during movement. The lower pick up point creates a hazard for the user when the VLFD is open and the mullion is down.
****

The swing-up mullions will be designed to swing up under the door leaf in the raised position. They will be constructed of carbon steel and finished in accordance with the paragraph FINISHES. The mullion hinge pivot will be of a maintenance-free bearing design. Provide sufficient length of door guide, between fall arrestors and mullion hinge pivot, to permit door's safety arrestors to fully engage and stop the door from falling in the case of a belt/wire rope break or other failure condition when the door is in the fully open position.

The swing-up mullion must be raised and lowered by a wire rope hoist with a secondary back-up wire rope arresting system. If the secondary back-up wire rope arresting system is fully integrated into the hoist unit, it will be produced by one manufacturer. Wire rope hoist and secondary system will connect to mullion a minimum of 3.05 m 10 feet above finish floor. Attach using a double shear connection through the mullion. Demonstrate through calculations that the lifting apparatus and its connection to the mullion is designed for all loads. Refer to the paragraph ELECTRICAL OPERATION for controls and interlocks of mullion and door panels.

Swing-up mullion assembly, including lifting arm and wire rope, is not permitted to encroach on required aircraft clear space required by the contract documents.

2.7.1 Mullion Pit and Cover where Indicated

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NOTE: Wheel loads shown are minimums. Designer to coordinate wheel loads with the project criteria.
****

Provide a mullion pit frame, guide plate, and cover(s), manufactured of aluminum or steel, for each mullion. Hinged cover plates will be attached to the mullion pit frame. Mullion pit covers will be designed to support a 156 kN 35,000 pounds force single wheel load with a tire pressure of 1379 kPa 200 psi and contact area 0.1 square meters 175 square inches.

[2.7.2 Retractable Mullion Pin and Floor Strike

****
NOTE: Include paragraph below when the Government decides to include retractable mullion pins and floor strikes. Recommend discussing with potential manufacturers. Advantages include a significantly smaller mullion pit and covers. Disadvantages include additional cost, maintenance and potential operating issues/errors associated with each motor and limit switch along with design/construction complexities associated with the Class I Division 2 challenges.
****

Provide retractable mullion pin with a heavy duty, reversing electric linear actuator. Design mullion pin and strike to resist all mullion design loads and accommodate all vertical movement of the mullion. Provide a hinged cover at each floor strike, funnel shaped at the top, manufactured of aluminum or steel, accommodate mullion pin size and pin throw, and be designed to support a 155.7 kN 35,000 pound force single wheel load with a tire pressure of 1379 kPa 200 psi and contact area 0.1 square meters 175 square inches. Refer to paragraph LIMIT SWITCHES for information on mullion pin and floor strike limit switches.

]]2.8 PERSONNEL DOOR

[Personnel doors are not required in Hangar doors.

] **

NOTE: Emergency Exit/Egress doors are no longer permitted to be located in hangar doors in accordance with UFC 4-211-01. Personnel doors for convenient access to the flightline are permitted if provided in accordance with the below paragraph.

****

[Provide personnel doors in door leaves as indicated in the drawings. Provide insulated steel or aluminum personnel doors as specified in Section [08 11 13 STEEL DOORS AND FRAMES] [08 11 16 ALUMINUM DOORS AND FRAMES]. Provide complete personnel door with all hardware including, hinges, lockset, stop, weather stripping, and interlock.

]2.9 OPERATION

2.9.1 Door Operation

Provide a vertical lift fabric door which guides up and down in weather sealed vertical guides attached to the structure[and mullions]. Provide a door system which operates by lifting the bottom beam upwards in each door leaf, thereby stacking the intermediate beams one on top of the other, with the fabric material folding in pleats. Door operational safety is of paramount importance.

When the door system is fully open, all door system components will be outside of the required clearance area for the door opening.

When the door system is fully closed the door system will seal the opening and form a portion of the building's air barrier. The intermediate beams hang between the two fabric faces thus pulling the fabric material tight and sealing along the guides at each jamb. The tension created in the fabric panels is permitted to stabilize the intermediate beams, if proven capable by the manufacturer, and the bottom beam seal will fit tightly along the entire length of the door threshold.

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Including wiring diagrams and the complete manufacturer's instructions for operation and maintenance of the doors, door mullions where indicated, and accessories, including emergency operation, in the event of general building power failure to the doors.

2.9.2 Electrical Operation

Provide the main control panel with control logic such that when the [integral female pin and sleeve emergency power receptacle is inserted and the integral manual transfer switch associated with the pin and sleeve receptacle is engaged][remote building automatic transfer switch "dry" auxiliary contact with the stationary emergency generator is closed in the "emergency" position] the control panel will automatically limit only one door lift motor or one mullion lift motor to operate at a time.

The door will be stopped by a primary limit switch when the door is opened completely. In case of over travel, the door will be stopped by a secondary limit switch to prevent damage. Slack belt/wire rope breakers will stop the drive unit when the door is closed. In case of belt/wire rope break/rupture or if an obstruction should prevent the door from being closed the slack belt/wire rope breakers will also stop the drive unit. Weight or springs activate the slack breakers.

A touch screen (HMI) control panel station is required at the main and at all auxiliary stations.

Control door operation by three buttons marked "OPEN", "CLOSE", and "STOP". The "OPEN" and "STOP" buttons require only momentary pressure to operate. The "CLOSE" button requires constant pressure to maintain the closing motion of the door. The door will immediately stop, and remain in that position, when the door is in motion and the "STOP" button is pressed or the "CLOSE" button is released. From that stop position, the door operation is then continued in either direction by the "OPEN" or "CLOSE" buttons. Removing the pressure from the "CLOSE" button results in stopping the motor drive and setting the brake.

[Two buttons marked "Horizontal Position and Vertical Position" control the mullion operation. Both buttons are controlled by constant pressure to open and to close. Removing the pressure from either button stops the motor drive and sets the brake. The electrical control panel provides an interlock function to coordinate door leaf and mullion operation.

] Buttons are illuminated on the HMI (control panel) and utilize simple flashing/solid illumination schemes to inform the operator of door status (fully open, closed, in motion, etc.). The large touch screen display graphically illustrates the door system to permit the user to select desired operation and inform the user of current door status. Door operation on the HMI (Control Panel) are password protected, by individual user, to prevent accidental or unauthorized operation.

****

NOTE: Include paragraph below only when a programmable logic controller is specified as an optional controls interface. The user interface with diagnostics is an additional option and does not replace the other controls options.

****

[[Multipart doors][Alert Hangar] will utilize a human machine interface display (HMI) for door leaf/mullion operation. Upon selection, door operation will be controlled by three buttons marked UP, DOWN, and STOP. The UP and STOP buttons will operate as indicated in the door operation controls section above.

When operating a mullion, controls will operate as described in the mullion operation controls above.

The main control panel will be equipped with backup method of controlling the door system should an HMI failure occur.

][2.9.3 Backup Door Operation

****

NOTE: At the time of this writing, only one manufacturer is believed to have a system capable of meeting this requirement. Prior to including this paragraph, designer will investigate and confirm if there are adequate door system manufacturers currently available that are able to provide this option and confirm if this option is justified/required for the facility. Coordinate and incorporate space, clearance, utility, infrastructure and other facility requirements with the contract documents.

****

Separate from the connection to a backup power source or emergency generator, provide a door system backup power source and system capable of opening and closing the entire door system at least one time, with complete loss of power to the entire facility. For the purposes of this requirement, the minimum door leaf and mullion speeds indicated in this specification are not applicable.

]2.10 FINISHES

****

NOTE: If compliance with UFC 4-211-01 is required, the coating system specified in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES is required. This specification is very robust and the coating system includes the following:

Prep in accordance with SSPC SP 10/NACE No. 2. Apply Zinc-Rich Epoxy Primer Coat (3-5 mil), Epoxy Intermediate Coat (3-5 mil), and a Polyurethane Topcoat (2-3 mil).

Where possible also allow hot-dip galvanizing so the manufacturer may choose the best/most cost effective coating option. Hot-dip galvanizing may not always be appropriate as the process can warp long structural components or assemblies and galvanizers for large sections are increasingly difficult to locate.

Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES is a complicated spec with significant content based on coating exterior tanks, and recoating of old steel. Since coatings related to vertical lift fabric doors will be shop coating of new steel, the only anticipated field painting would be touching up damage to the coating occurring during shipping and installation and coating of accessories such as bolts and brackets.

****

2.10.1 Ferrous Metal

Provide cleaned, prepared and shop-finished ferrous metal surfaces in accordance with Section [09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES] [09 90 00 PAINTS AND COATINGS] [or hot-dip galvanized in accordance with ASTM A653/A653M, coating designation Z275, for steel sheets, and ASTM A123/A123M for assembled steel products]. Follow coating system manufacturer's written instructions. Shop finishing of all ferrous metal coatings is required with field coatings limited to touch-up painting and coating of only unfinished accessories such as bolts and brackets.[The following submittals if required by Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES are not required for shop-finished vertical lift fabric doors: Work Plans, Coating Inspection Reports, Test Reports, and Qualifications for Certified Industrial Hygienists, Protective Coating Specialists, Blasters, Painters and Inspectors.]

2.10.2 Aluminum

****

NOTE: Specify AAMA 2605 powder coating, or AA-M12-C22-A41 clear (natural) anodized finish, as aluminum door fabric retention components will be subject to excessive wear, abrasion and will not likely be regularly cleaned or maintained. This finish is also appropriate in highly corrosive industrial atmospheres with dust, gases, salts, or other disruptive elements that attack metal.

In the second paragraph below, select the first bracketed choice if aluminum fabric retention components exposed to view are required to match the color of the fabric, otherwise select the second bracketed choice for a clear anodized aluminum finish for fabric retention components.

****

Before fabrication, clean the units and provide the coating system specified below in accordance with the requirements of the Aluminum Association Designation System, AA DAF45.

[Provide an Organic Coating (superior performance exterior coating) complying with the requirements of AAMA 2605. Clean surfaces and pretreat them with a conversion coating before applying 0.0076mm 0.3 mil dry-film thickness of epoxy or acrylic primer according to the recommendations of the finish coat manufacturer. Apply a finish coat of [70 percent] [_____] minimum fluoropolymer resin fused to primed surfaces at the temperature recommended by the manufacturer at a minimum dry film thickness of 0.25mm 1.0 mil. Use a minimum 3-coat or 4-coat system as required for the color selected.][Clear Anodized: Conforming to AA-M12-C22-A41 in accordance with NAAMM AMP 500 and complying with AAMA 611. The minimum finish thickness is 0.0175mm 0.7 mil or greater.]

2.11 SIGNAGE

Provide a placard sign immediately adjacent to all control panels indicating the below Notice. Include the service level wind speed which corresponds to the ultimate wind speed used in design of the open/operational door in paragraph WIND LOADS in the Notice post..

Notice:

Vertical lift fabric doors will be closed and not operated when wind speeds above[96.6 km/hr 60 mph][_____] are expected.

Vertical lift fabric doors will be transferred to back-up power for operation when commercial power is not available.

PART 3 EXECUTION

3.1 PROTECTIVE COATINGS

3.1.1 Cleaning

After fabrication, clean all metal surfaces thoroughly of all mill scale, rust, oil, grease and other foreign substances. Apply rust-preventive primer to all steel parts immediately after cleaning.

3.1.2 Shop Painting

After cleaning, coat with primer all steel surfaces other than machine-finished parts. Keep paint off finished bearing surfaces. Before assembly, prime surfaces that will be inaccessible after assembly. Handle painted materials with care to avoid scraping and breaking the protective film. Ferrous metal surfaces that will be exposed after fabrication will be shop coated and touch-up painted in the field in accordance with the paragraph FINISHES.

3.1.3 Metal Protection

Provide in accordance with Chapter 4 of UFC 1-200-01 when door system is in a corrosion prone location or where door system components use dissimilar metals. If dissimilar metals are used, also provide in accordance with MIL-STD-889. Provide added corrosion protection to the design such as, but not limited to, the following. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact masonry or concrete, protect against corrosion by painting contact surfaces with bituminous coating.

3.2 WELDS

3.2.1 Visual Inspection

Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections in accordance with AWS D1.1/D1.1M. Perform visual inspections on 100 percent of all welds with a Certified Welding Inspector. Document this inspection with the Nondestructive Testing.

Inspect proper preparation, size, gaging location, and acceptability of all welds; identification marking; operation and current characteristics of welding sets in use.

3.2.2 Nondestructive Testing

Perform nondestructive testing in accordance with AWS D1.1/D1.1M[and AWS D1.8/D1.8M]. Perform ultrasonic testing in accordance with Table [6.2] [or 6.3] of AWS D1.1/D1.1M. Test 50 percent of all welds, with sampling representative of all weld types and locations for the entire door system and for the duration of the fabrication schedule. All personnel performing NDT are required to be certified in accordance with ANSI/ASNT CP-189 in the method of testing being performed. Submit certificates showing compliance with ANSI/ASNT CP-189 for all NDT technicians. If more than 10 percent of welds made by a welder contain defects identified by testing, then all groove welds made by that welder are required to be tested by ultrasonic testing, and all fillet welds made by that welder are required to be inspected by magnetic particle testing (MT) or dye penetrant testing (PT). When groove welds made by an individual welder are required to be tested, magnetic particle or dye penetrant testing may be used only in areas inaccessible to ultrasonic testing. Retest all repaired areas. Submit weld inspection report.

3.3 ERECTION

Provide all work associated with these door systems under the direct supervision and control of the fabricator for safety, control of product liability, and Engineer of Record responsibilities. Coordinate the erection of the doors with the work of other trades. Coordinate the design, fabrication and erection of the door systems and adjust for actual camber, fabrication, and erection tolerances of the supporting structure including simulated door weight load testing and survey to ensure proper fit-up of the final door system. Coordinate mullion pit locations (including their drains), alignment and orientation. Ensure that all steel support, bracing and framing members are furnished and accurately installed. Coordinate electrical work, including locations of all panels, equipment, motors and other components for required clearances, access and routing of power.

3.3.1 Assembly

Assemble and install the doors and accessories in accordance with the manufacturer's recommendations and installation manual. Secure guides to the walls plum, level, and in-line. Anchor guides at spacing indicated on the manufacturer's installation drawings. Provide additional supports as necessary for attachment of guides, brackets, doors, and operation mechanisms. After erection is complete and before touch-up field painting is applied, thoroughly clean all abraded surfaces, field welds, and field bolts; coat in accordance with paragraph FINISHES.

3.3.2 Cleaning

Clean both the interior and exterior of doors after the completion of erection.

3.3.3 Control Panel Installation

Locate all door control panels indoors, adjacent to the door opening, and with an unobstructed line of sight for the entire door opening. Provide all conduit entries into the bottom of the control panel. Mount control panels and provide three phase power to each control panel.

3.4 ELECTRICAL WORK

NFPA 70. Provide all conduit, wiring, and mounting of controls in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Door manufacturer to coordinate with the qualified, licensed electrical contractor who will provide and install all [208 3-phase][480 3-phase] supply power to all components (such as Main, auxiliary, controllers, panels, motors, and other electrical devices) which require this low voltage supply power. The qualified, licensed electrical contractor will provide and install all conduit for the control level power under the review and approval of the door manufacturer. Either the qualified, licensed electrical contractor or a factory authorized technician may provide and install all wiring for control level power under the review and approval of the door manufacturer in accordance with the approved construction submittals.

3.5 ACCEPTANCE TESTING PROCEDURE AND REPORT

Submit an Acceptance Testing Procedure for approval, which includes coordination with Section 01 91 00.15 BUILDING COMMISSIONING for such items as hangar door position switches which interact with HVAC controls. After Government approval, perform the testing and submit a report of the results. Provide acceptance testing for the entire door system, including every component, performed by the door manufacturer and suppliers. The following subparagraphs are included in the acceptance testing.

3.5.1 General

Upon completion of installation, including work by other trades, lubricate, adjust, and test doors to verify operation in accordance with manufacturer's product data. Final adjustments will be made by the Manufacturer's authorized representative. Adjust and re-test the doors until the entire installation is fully operational and acceptable. Acceptance testing must consist of operating each door[and mullion] open and closed (one cycle) ten times successfully and consecutively within a nine-hour time interval in accordance with manufacturer's recommended time interval between open/close cycles. Provide Contracting Officer's Representative a copy of the final acceptance testing report with completed tests.

3.5.2 Door Drop Prevention Demonstration

Perform a non-destructive demonstration of the safety arrester function by slowly engaging the installed safety arresters on the guiderails at a height of 1 m 3 feet above closed position in a controlled manner so as to not fall and not damage any door system components or adjacent structure. Perform demonstration on all door leaves and components in the presence of the Contracting Officer's Representative.

If the door leaf safety arrestor alternative is utilized per paragraph DOOR LEAF ARRESTER ALTERNATIVE, perform a non-destructive demonstration showing the bottom beam is able to support the door with the loss of either end belt/wire rope, or any two intermediate belts/wire ropes, in a safe and controlled manner so as to not fall and not damage any door components or adjacent structure. Perform demonstration on all door leaves and components in the presence of the Contracting Officer's Representative.

3.6 PERSONNEL TRAINING

Provide an 8-hour on-site training session for the door operating personnel and maintenance department. In the training, outline door safety, operation, troubleshooting and repair guidelines.[Record this on-site training and provide a video presented in a coherent fashion such that the Government may use the video as the sole training program for future user operators. In multiple locations throughout the video, specifically mention the door system must be completely closed prior to experiencing 96.6 km/hr 60 mph [_____] wind speeds. It is acceptable to utilize stock training video content in this video provided the door operation, safety and controls are identical to the door system provided.]

3.7 EXTRA MATERIALS

Supply a door fabric patch kit with approximately 4.2 square meters 45 square feet of fabric for each hangar door and all other materials required for door panel repair. Provide all unique tools required to maintain the door system. Provide a patch kit with color matched fabric and associated repair materials and tools.

3.8 INSPECTION AND ADJUSTMENT

Within the 12 month warranty period, following the initial period of use and changes in seasonal temperature, the manufacturer's authorized representative will return to inspect and adjust doors to confirm the door system is fully operational and acceptable. Provide the Contracting Officer's Representative an inspection report outlining observations, door condition, operation, and all items requiring adjustment or requiring repair/replacement under the door system warranty. Include a report with recommended annual inspection and maintenance items. As needed, schedule a follow-up visit to complete items requiring adjustment, repair or replacement. Manufacturer is responsible for items requiring adjustment, repair or replacement for the 3 year maintenance-free warranty period or 1500 cycles, whichever occurs first, beginning after the first 12 month contractor's warranty period.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 34 49.00 20 (November 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 34 49.00 20 (November 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-08 34 49.00 20 (November 2022)**

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****

SECTION 08 34 49.00 20

HEMP SHIELDED DOOR
11/22

****
NOTE: This guide specification covers the requirements for furnishing and installing high-altitude electromagnetic pulse (HEMP) shielded door.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Show the following information on the project drawings:

a. Location of HEMP shielded door.

b. Location of alarm panel.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D9.1/D9.1M	(2018) Sheet Metal Welding Code

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B194	(2022) Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 299	(2006; R 2012) Standard Method for

	Measuring the Effectiveness of Electromagnetic Shielding Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 80A	(2022) Recommended Practice for Protection of Buildings from Exterior Fire Exposures
NFPA 101	(2024) Life Safety Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-188-125-1	(1998; Rev A; Notice 1 2021) High-Altitude Electromagnetic Pulse (HEMP) Protection for Ground-Based Facilities Performing Critical, Time-Urgent Missions, Part I Fixed Facilities

1.2 DEFINITIONS

1.2.1 Regularly Engaged

As it applies to the testing company is defined to mean that the testing company has successfully performed electromagnetic shielding attenuation (SA) test and shielded enclosure leak detection system (SELDS) tests at least [six] [_____] times in the last [two] [_____] years.

1.2.2 Independent

As it applies to the testing company is defined to mean that the company has no financial interest and not directly or indirectly part of the shielding Contractor, subcontractor, or general contractor QC organization.

1.2.3 Shielding Attenuation

As it applies to this section is defined as the shielding effectiveness. Shielding effectiveness at a test area for the purpose of this procedure is the ratio expressed in decibels (dB), of the received signal when the receiving antenna is illuminated by electromagnetic radiation in the test calibration configuration (no shield present) to the received signal through the electromagnetic barrier in the test measurement configuration. Assuming that antenna voltage is detected.

$$SE = 20 \log(Vc/Vm)$$

Where Vm is the measured signal at the test area and Vc is the calibration signal at the same frequency and transmitting antenna polarization. Shielding effectiveness values are test-method dependent and different values may be obtained when time-domain or other frequency-domain measurement techniques are used.

1.2.4 Corrections and Repair

Replacing existing defective part(s) with identical parts which are shown in approved shop drawings, parts list, catalog, and maintenance manual. This includes cleaning, adjustment, and tightening.

1.2.5 Modification

Adding new part(s) like pieces or extra row(s) of finger-stocks, gasket (all shapes and sizes), bronze wool, microwave absorber which are not shown in drawings, parts list, catalog, and maintenance manual.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

****

NOTE: Base typical installation of frames and HEMP shielded door(s) in accordance with manufacturer's installation drawings.

****

HEMP Shielded Door Installation; G, [_____]

Electric Connectivity; G, [_____]

Installation Details; G, [_____]

SD-03 Product Data

Shielded Door and Frame; G, [_____]

Hardware and Accessories; G, [_____]

Hinges; G, [_____]

Panic Hardware; G, [_____]

SD-06 Test Reports

Swinging Door Static Load Test; G, [_____]

Swinging Door Sag Test; G, [_____]

Door Closure Test; G, [_____]

Handle Pull Test; G, [_____]

Electromagnetic SA Test; G, [_____]

Electromagnet (EM) Shielded Door Tests; G, [_____]

Submit test reports for specified tests under paragraph SOURCE QUALITY CONTROL. Include as minimum, list of equipment used with calibration data, test point location, date, project title and location, location of signal source, dynamic range, noise floor, SA (required and actual), any repair performed, person performing the test and witness signature.

SD-07 Certificates

Certification of Welders; G, [_____]

Test compliance of HEMP shielded door; G, [_____]

SD-08 Manufacturer's Instructions

Test Plan; G, [_____]

Welding Procedure; G, [_____]

SD-10 Operation and Maintenance Data

****

NOTE: Designer should consult with the Engineering Service Center, Code 065, on DNA-TR-91-87 HM/HS Manual.

****

Hardness Maintenance and Hardness Surveillance (HM/HS) Manual, Data Package 3; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Final Acceptance Test

EM Shielded Door Tests

****

NOTE: Check with using agency, if test report needs to be classified [secret] [top secret].

****

Submit test reports for specified tests under paragraph FIELD QUALITY CONTROL. containing as a minimum, list of equipment used with calibration data, test point location, date, project title and location, location of signal source, dynamic range, noise floor, SA (required and actual), any repair performed, person performing the test and witness signature.[Test report is classified [secret] [top secret] [_____], therefore, the independent tester must have the necessary security clearance]. Log the test data for each test point on the form as the test progresses. Have the witness sign the data form at the end of each day.

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 HEMP Shielded Door Manufacturer

Provide supervision and installation of work required under this section by the HEMP shielded door manufacturer who will have successfully manufactured and completed at least [3] [_____] similar HEMP shielded door projects of comparable size in the last [1] [_____] year.

1.4.2 Regulatory Requirements

Fire rated HEMP shielded door and assemblies must meet NFPA 80 and NFPA 80A requirements and bear the identifying label of a nationally recognized testing agency qualified to perform certification programs.

1.4.3 Certification of Welders

Before assigning welders to work covered by this section, submit the names of the welders to be employed, together with certification that each welder has passed the qualification tests in the process specified in AWS D1.1/D1.1M and AWS D9.1/D9.1M. Require welders to retake the tests when, in the opinion of the Contracting Officer, the work of the welder creates a reasonable doubt as to the proficiency of the welder. Make recertification of the welder to the Contracting Officer only after welder has taken and passed the required tests. The Contracting Officer may require specimens to be cut from any location in any joint for testing. Sections of welds found defective must be chipped, ground, or cut out to base metal, and properly rewelded before proceeding with the work. Should [2] [_____] specimens cut from the work of welder show test strengths less than that of the base metal, it will be considered as evidence of negligence or incompetence and such welder must be permanently removed from this project.

1.4.4 Welding Procedure

Submit welding procedure statement showing the details of MIG welding procedure, materials used, current and voltage settings, gas mixture, and welding rate.

1.4.5 Installation Details

Provide shop drawings in accordance with manufacturer's installation drawings to include the following:

a. Overall dimensions

b. Controls

c. Typical front view

d. Typical cross sectional view

e. Typical side view

f. Typical assembly

g. Material

h. Connection of door frame to shield

i. Clearances

1.4.6 HEMP Shielded Door

Submit certification indicating HEMP shielded door being provided has been tested for compliance with MIL-STD-188-125-1. Submit test data supporting these certifications.

1.5 DELIVERY, STORAGE, AND HANDLING

Package HEMP shielded door for shipment. Ship HEMP shielded door assembled with the door frame to hold the door and frame in alignment. Include physical, temperature, and moisture protection, so that door is delivered to jobsite in an undamaged condition. HEMP shielded door will not be accepted at the jobsite with visible damage. Provide special physical, temperature, and moisture protection upon door arrival at jobsite; before, during, and after door installation through completion of building construction. Provide protection instructions from HEMP shielded door specialist (manufacturer) when special protection is required after installation but before building completion. Provide adequate protection prior to beneficial occupancy. Do not allow materials to be exposed to extreme temperature and humidity. Ship the door assembled with the door frame. Exercise great care when packing, shipping, unpacking and installing the HEMP shielded door and frame assembly.

1.6 COORDINATION

Avoid unauthorized penetrations. Repair work damaged as a result of unauthorized penetrations, discontinuities or other adverse changes to SA of the system.

1.7 WARRANTY

****

NOTE: The warranty clause in this guide specification may require Level I Contracting Officer approval. Designer should consult the appropriate Engineering Field Division/Activity for guidance.

****

Warrant HEMP shielded door to provide the required SA, for a period of [15] [_____] years. Warrant parts and labor for operating mechanisms, including the interlocking components, for at least [3] [_____] years following the date of beneficial use. Any part of these mechanisms or component(s) causing operating or attenuation degradation of 5 dB or more during the warranty period must be repaired or replaced, including the required reinstallation and testing by the Contractor. HEMP shielded door assemblies must be suitable for repetitious use. Adequate structural strength and permanent sealing is required to meet the total specification, usage, and [15] [_____] year service life requirements. Assemblies including doors, hardware, shielding devices, sealing operating mechanisms, and other components must function properly through [10,000] [_____] cycles of use.

1.8 MAINTENANCE

1.8.1 Hardness Maintenance and Hardness Surveillance (HM/HS) Manual

Submit HEMP HM/HS manual. HM/HS are the combined routine and preventive maintenance, inspection, test, and repair activities performed on HEMP door to ensure that HEMP hardness is retained throughout system life cycle of HEMP shielded door installed under this contract. HEMP shielded door is a hardness critical item which must survive day to day use. Consult with Engineering Service Center, Code 065 before preparation of the HM/HS manual.

1.8.2 Spare Parts

Furnish one set of finger-stock and HEMP shielding gaskets (if door provided uses finger-stocks and gaskets) for each type, style, and size hinged HEMP shielded door provided under this contract. Furnish one set of manufacturer recommended and Contracting Officer approved spare parts for each HEMP shielded door of each style installed under this contract.

PART 2 PRODUCTS

2.1 HEMP SHIELDED DOOR AND FRAME

Steel conforming to ASTM A36/A36M or ASTM A1008/A1008M or ASTM A568/A568M or ASTM A1011/A1011M, and be stretcher leveled, and installed free of mill scale. Provide metals thicker where indicated or required. Provide metal thresholds of the type for proper shielding at the floor, rising not more than 6.35 mm 1/4 inch above finished flooring. Supply assemblies complete with a rigid structural frame, hinges, latches, and all parts necessary for operation. Products supplied must duplicate assemblies that have been in satisfactory use for not less than [1] [_____] year. Provide door frame made of steel and suitable for welding to surrounding structure and shield. HEMP shielded door must be non-sagging, and non-warping. Provide HEMP shielded door with a minimum SA of 20 dB greater than minimum requirements per MIL-STD-188-125-1 when tested in the factory. Provide door with a clear opening of [915] [_____] mm wide and [2134] [_____] high [36] [_____] inches wide and [84] [_____] inches high. When the shielded door has knife edge and when it is exposed to moist air containing salt (near the sea coast), uncontrolled environment or corrosive environment; make knife edge out of stainless steel 430 (magnetic type) series. For security reason, locate controls and locking mechanism inside HEMP space so that unauthorized personnel cannot tamper.

2.1.1 Pneumatic Type Door

Form at door and door periphery a continuous conductive continuity seal by direct metal to metal contact. Implement continuity seal by exertion of force from the pneumatic pressure system that maintains adequate sealing pressure on entire face of the independently hung door panel, sealing each panel to the mating surfaces on the door frame. Construct door compartment in a manner such that each door panel forms an independent shield. Provide factory prepared mating surfaces of the door and frame to offer a corrosion-resistant, conductive, long-life finish. Finished area must form adequate peripheral margin on door panel and frame. Provide stand-alone, redundant compressed air system to support the HEMP shielded door. Provide emergency power to compressed air system. Design the system for fail-safe mode of operation.

2.1.1.1 Sealing System

Actuate pneumatic sealing system by a single, air control valve, operable from inside or outside. Include with outside control panel a pressure regulator and filter. Normal operation of the air control valve will unseal and allow manual operation of door within [15] [_____] seconds. Provide each door with a separate control-valve system.

2.1.2 Sliding Type Door

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NOTE: Ensure door openings and operating direction are shown on the drawings.

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Provide sliding HEMP shielded door of the size and operating direction indicated. Clear openings indicated must not require dismantling of any part of the door. Provide door manually operable from either side, inside or outside, with a maximum pull (force) of [156] [_____] Newton [35] [_____] pounds to set HEMP shielded door in motion. Construct HEMP shielded door face panels and frames from reinforced steel suitable for achieving the specified SA. Construct frame from steel welded together to form a true rectangular opening. In the sealed position, shielded door must provide minimum attenuation specified without any derating. Design door for long life and reliability and do not use RF gaskets, RF finger-stocks, or other sealing devices other than specified direct metal to metal contact. Provide label attached to sliding door warning against painting of the mating surfaces.

2.1.3 Electromagnetic Type Door (Swinging or Sliding)

Form HEMP seal by a solid metal to metal contact around the periphery of the door frame. Materials at the contact area must be compatible and corrosion resistant. Only electromagnets (permanent magnet unacceptable) may provide contact force. Provide minimum of two electromagnets. When the electromagnets are energized, door leaf will be magnetically attracted to ensure a solid and continuous contact with the door frame. When electromagnets are deenergized, the door leaf will be free to [swing] [slide]. The electromagnetic type HEMP shielded door must use exclusively electromagnets. Provide emergency power to the system. Design for fail-safe operation. The door manufacturer must provide HEMP filter(s) with surge arrestors, card access system, control panel, alarm panel, cipher or combination lock, any other hardwares if required and electrical penetration. Provide door with a minimum of three hinges.

2.1.4 Latching Type

Provide latching type HEMP shielded door with a three point minimum latching mechanism to provide proper compressive force for the radio frequency(RF) finger-stock. Operating handle must not mechanically interfere with the door frame when the HEMP shielded door is opened or closed. Force necessary to operate the lever (handle) to latch and release (unlatch) the HEMP shielded door must not exceed [98] [_____] Newton [22] [_____] pounds. Design HEMP shielded door handles fitted with lever openings so that a force of [1112.5] [_____] Newton [250] [_____] pounds may be applied at the free end in any direction without permanently deforming or damaging operating mechanism or degrading SA by 5 [_____] dB or more. Provide door latches and hinges rated for a minimum of [10,000] [_____] cycles without loss of SA and without adjustments.

2.1.4.1 Finger-Stock (Contact Finger)

Provide contacts of copper beryllium, phosphor bronze, or stainless steel finger-stock (contact finger) conforming to ASTM B194. Secure finger stock to the HEMP shielded door or frame without using special tools or adhesives and with a minimum of [50] [_____] mm [2] [_____] inches of overlap. Door RF seals must, after [10,000] [_____] cycles of opening and closing, continue to provide SA specified in MIL-STD-188-125-1 and sealing components will not need to be replaced.

2.1.5 Door and Frame Assembly

Provide each type of HEMP shielded door as an assembly with a frame welded into place in the primary shield. Accurately position door in frame.

2.2 HINGES

Provide each type of HEMP shielded door except the sliding type with a minimum of three well balanced, adjustable sealed ball bearing or adjustable radial, thrust-bearing hinges suitable for equal weight distribution of the HEMP shielded door. Hinges must allow adjustment in two directions. Comply with NFPA 101 for force necessary to set the HEMP shielded door in motion. Provide lubricating fitting at each hinge unless not required by the design of the hinge or the bearing.

2.3 HARDWARE AND ACCESSORIES

The door manufacturer must provide all hardware and accessories including electrical filters if required.

2.3.1 Power Assist

Should HEMP shielded door mechanism preclude the manual operation of the HEMP shielded door with a specified maximum pull (force) of [156] [_____]

Newton [35] [_____] pounds to set the HEMP shielded door in motion, provide a power assist system to meet the [156] [_____] Newton [35] [_____] pound requirement. Install power assist system in such a manner that the clear opening of the door is not obstructed. Provide redundant compressed air system. Provide emergency power to the control and redundant compressed air system.

Include the following:

a. Pressure regulator and air control valve to control the speed and direction of the door.

b. Provide pneumatic mechanism to power assist.

c. Air control valve operable from inside or outside.

d. Allowance for manual operation within [15] [_____] seconds should loss of air pressure occur.

2.3.2 Threshold Protectors

Provide threshold protectors for each of the HEMP shielded door consisting of portable ramps that protect the threshold when equipment carts or other wheeled vehicles are used to move articles across threshold. Ramps may be asymmetrical to account for different floor elevations on each side, but slope of ramp must not exceed 4:1 on either side. Design ramps to support a [227] [_____] kg [500] [_____] pound force applied to a 75 mm by 12.7 mm 3 inch by 1/2 inch footprint for cargo loading. Footprint contact area may be anywhere on the threshold seal area covered by threshold protector. Provide mounting brackets, convenient to the entry, to store ramp when not in use.

2.3.3 Locks and Interlocks

2.3.3.1 Cipher Locks

When specified by system design, provide cipher locks furnished by the door manufacturer to ensure compatibility of the electric bolt/strike and the controller. Provide cipher locks with the following features:

a. Exterior push button panel with a minimum of 10 numbered buttons (a combination of [4] [_____] of these buttons in proper sequence will activate the door opener).

b. Adjustable time penalty to block efforts to activate the door opener when incorrect or out-of-sequence button is pushed.

c. Adjustable door-open time control.

d. Ease in changing the combination.

e. Local alarm contact with manual reset to activate a bell if an incorrect or out-of-sequence button is pushed.

f. Latch bolt to be electrically operated on low voltage directly from the door control unit.

g. Adjustable volume bell to operate from the door control alarm unit.

h. Adjustable volume buzzer to be activated by a separate push button and a low voltage AC power source (with associated transformer and connection).

i. Provide emergency power or battery backup power to comply with Life Safety Code NFPA 101.

2.3.3.2 Interlocks

Provide interlocks for vestibule HEMP shielded door pairs. Design interlocks so that both doors cannot be opened at the same time during normal operation. Provide a manual override to allow emergency egress. Provide audible alarm, which continues to sound as long as both doors are open. Provide a low-voltage alarm in a tamper proof enclosure and with a sound intensity of [85] [_____] dB minimum at [3050] [_____] mm [10] [_____] feet. Provide lights on inside of HEMP space and on outside of exterior door to indicate that the other door is open. Integrate interlock system into the cipher lock system. Interlock system must be in a fail-safe unlocked condition in the event of power failure. Ensure activation of fire alarm overrides the interlock system. Provide emergency power to interlock control.

2.3.4 Threshold Alarm

Provide press-it-any-point ribbon switches for use with threshold to enunciate alarm when pressure is applied to the threshold of HEMP shielded door.

2.3.5 Hold Open Device

Provide each HEMP shielded door leaf with a hold open device permanently attached to the door leaf.

2.3.6 Counting Device

Provide electric or electronic device for counting open, close cycles of HEMP shielded door.

2.3.7 Door Stop

Provide door stop to prevent HEMP shielded door from hitting the wall.

2.4 EMERGENCY EXIT HEMP SHIELDED DOOR

Equip emergency exit HEMP shielded door with panic hardware. The force required to latch and unlatch the emergency exit HEMP shielded door must meet Life Safety Code NFPA 101. Alterations or modifications in the field to panic hardware are prohibited.

2.5 PAINTING

Paint HEMP shielded door in accordance with Section 09 90 00 PAINTS AND COATINGS with an environmentally acceptable, OSHA approved rust inhibiting primer that will provide corrosion resistance. HEMP shielded door may be factory finish painted; provided damaged paint is touched-up. Do not paint stainless steel surfaces and grounding contacts.

2.6 TOOLS

Furnish one full set of special tools that are required to maintain each type of door provided under this contract and that are not typically available from tool vendors. Furnish environmentally safe lubricants, cleaning solvents or coatings which meet OSHA regulations in sufficient quantities to last for [3] [_____] years.

2.7 ELECTRIC CONNECTIVITY

Install sensors, alarms, interlocks and filters in accordance with HEMP shielded door manufacturer's instructions.

2.8 MAINTENANCE SUPPLIES AND PROCEDURES

Deliver for each door maintenance supplies sufficient for a [3] [_____] year period or [50,000] [_____] cycles, whichever is greater. Include the activity and entry location for certifying that the maintenance was undertaken. Provide a counting device to show the number of door open close cycles. Prominently display maintenance instructions required to maintain the door through the cycle count. Maintenance procedures must be such that the HEMP SA meets the requirements of MIL-STD-188-125-1.

2.9 SOURCE QUALITY CONTROL

Test of HEMP shielded door at factory will require shielded room. Factory test of HEMP shielded door must comply with requirements of this specification and MIL-STD-188-125-1. Government reserves the right to witness all factory tests. Provide [30] [_____] days notice for test performed in Continental United States and [45] [_____] days for overseas locations. Conduct the swinging door static load test, swinging door sag test, door closure test, and handle pull test on each door of each size and each type provided including electromagnetic type. Use the HEMP filter(s) with surge arrestors, card access system, control panel, alarm panel, cipher or combination lock(s), and any other hardwares to ensure the entire system meets the specification requirements. Submit a Test Plan for the test specified herein.

2.9.1 Swinging Door Static Load Test

Mount and latch swinging HEMP shielded door to its frame and then set down in a horizontal position so that the door opens downward and only the frame is rigidly and continuously supported from the bottom. With door closed, apply a load of [195] [_____] kg/m2 [40] [_____] pound per square foot uniformly over the entire surface of the door for at least [30] [_____] minute. Door will not be acceptable when this test causes breakage, failure, or permanent deformation that results in the clearance between door leaf and stops to vary more than 1.58 mm 1/16 inch, or reduction of SA by 5 dB. Perform this test on all door types, including electromagnet type. Subject the same door leaf to the door closure, handle pull and door sag tests.

2.9.2 Swinging Door Sag Test

Install HEMP shielded door and its frame normally and open 90 degrees. Suspend two [45.4] [_____] kg [100] [_____] pounds weights from door, one on each side of door, within [125] [_____] mm [5] [_____] inches of the outer edge for at least [30] [_____] minutes. Door will not be acceptable when this test causes any breakage, failure, or permanent deformation that results in the clearance between door leaf and door frame to vary more than 1.58 mm 1/16 inch from its original dimension, or reduction of SA by 5 dB. Perform this test on all door types, including electromagnet type.

2.9.3 Door Closure Test

Operate HEMP shielded door of each size, type, design [10,000] [_____] complete open-close cycles. HEMP shielded door will not be acceptable when this test causes any breakage, failure, or permanent damage or deformation that results in clearance between door and frame to vary more than 1.58 mm 1/16 inch from its original dimension, or reduction of SA by 5 dB. Perform this test on all door types, including electromagnet type.

2.9.4 Handle Pull Test

Mount and latch HEMP shielded door to its original frame. Apply a force of [1112.5] [_____] Newton [250] [_____] pound perpendicular (outward) to handle within [50] [_____] mm [2] [_____] inch of the end for at least [30] [_____] minutes. Door will not be acceptable when this test causes any breakage, failure, or permanent damage or deformation exceeding 3.17 mm 1/8 inch from its original dimension, or reduction of SA by 5 dB. Perform this test on all door types, including electromagnet type.

2.9.5 Electromagnetic SA Test

Perform this test on each size, and type shielded door after performing the following test: swinging door static load, swinging door sag, door closure and handle pull tests. Door will not be acceptable when this test causes in the reduction of SA by 5 dB. Test HEMP shielded door for SA in the factory or independent lab prior to shipping to jobsite. HEMP shielded door must comply with minimum requirements of MIL-STD-188-125-1. Make measurements for SA at [6] [_____] number of test points required by MIL-STD-188-125-1 for HEMP single leaf personnel shielded door, [9] [_____] test points for HEMP double leaf shielded door, and all penetrations of door. Scale up number of test points proportionately for larger doors. Locate test points around periphery of door and at center of astragal. Perform testing in accordance with MIL-STD-188-125-1 and modified (orient magnetic loop antenna co-axial or co-planar or cross which ever gives least SA or maximum signal pick-up) IEEE 299. Required SA will be 20 dB above minimum of MIL-STD-188-125-1 at each test frequency for each test point. Repair is allowed, however, modification is prohibited.

2.9.5.1 Test Frequencies (Factory Test)

Make magnetic field, electric field, and plane wave measurements at the following seven test frequencies.

a. Magnetic field (low impedance): One frequency at 14 KHz, one frequency at 100 KHz, one frequency at 1 MHz, and one frequency at 10 MHz.

b. Electric field (high impedance): One frequency at 30 MHz.

c. Plane wave (377 ohm): One frequency at 100 MHz, one frequency at 400 MHz, one frequency at 750 MHz, and one frequency at 1 GHz.

2.9.5.2 Test Methodology

Regardless of test methodology or procedure used, orient antenna for maximum signal pickup or least SA. Orient magnetic loop antennas for co-axial, co-planar, or cross for maximum signal pick up or least SA. Orient horn antenna vertically or horizontally for maximum signal pick up or least SA.

2.9.5.3 Test Instruments and Equipment

a. Use instruments and equipment with current, non-expired calibration tags. Traceable to the National Institute of Standards and Technology (NIST).

b. Use spectrum analyzer of direct reading, digital type. Use slow sweep, and sweep at least three times prior to taking measurements.

c. Use signal generator frequency synthesized.

d. Provide a dynamic range a minimum of 10 dB above the SA requirement.

2.9.5.4 Calibration and Recalibration

Calibrate test set up and signal each time power is turned off or set up is moved. During test, Government representative or Government witness reserves the right to verify the test signal. Calibrate prior to each test, and at the end of each test. Use only the equipments, cables, antennas, amplifiers, attenuators used for calibration of transmitters and receivers respectively for testing. At the end of each day, recalibrate if the dynamic range varies more than 3 dB compared to the beginning of the calibration of each day. Retest all test points.

2.9.5.5 Inspection

In-plant quality control procedures will be required to ensure that HEMP shielded door provides required SA. Include:

a. Measurement of all dimensions and spacings. Hold dimensions on approved shop drawings to within allowable tolerances.

b. Inspection of material, construction methods, and finishes.

2.9.5.6 Independent Tester

Furnish testing by an independent tester who is regularly engaged in performing SA tests conforming to the procedures contained in IEEE 299 and MIL-STD-188-125-1. Independent tester must not offer advice or suggestions to correct problem. Only HEMP shielded door manufacturer may offer suggestions or advice to correct problems. General Contractor will hire the independent tester.

2.9.6 ELECTROMAGNET (EM) SHIELDED DOOR TESTS

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NOTE: The following tests are required for EM shielded door only.

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2.9.6.1 EM R.F. Seal Breaking Force

Mount the shielded door in a horizontal position with the door capable of opening downward and support the door frame rigidly. Energize the EM coils. Load one corner of the shielded door, apply weights sin an area not to exceed 0.2075 square meter 324 square inches, opposite to hinged corner (not supported by hinges) by weights. With the EM coils energized, the force required to break EM R.F. seal must be not less than 2003 N 450 pounds. Subject the same door leaf of each size to SA due to residual magnetism, and SA due to inner and outer coil tests.

2.9.6.2 SA Due to Residual Magnetism (RM)

Perform in-factory tests for all test points to determine the SA due to residual RM by disconnecting the power by unplugging/deenergizing the power source, vice activating "Open Door Switch." Activating "Open Door Switch" will reverse the polarity of EM resulting in reduced RM, hence, reduces the force required to open the shielded door. Perform this test in the factory in the installed position. The SA for each test point and for each frequency, must not be less than 50 percent to minimum required.

2.9.6.3 SA Due to Inner or Outer or Both EM Coils

Perform this in-factory test by energizing one at a time inner, outer, and both EM coils to determine the SA provided by inner, outer , and both EM coils. Perform this test in the factory for each test point and for each frequency. The SA for each test point due to inner or outer coil must not be less than 80 percent of minimum required.

PART 3 EXECUTION

HEMP shielded door manufacturer must furnish supervision and installation of work performed under this section.

3.1 HEMP SHIELDED DOOR FRAME AND ASSEMBLIES

Weld door frame to HEMP shield using Metal Inert Gas (MIG) method. Install HEMP shielded door under direct supervision of HEMP shielded door specialist and per manufacturer's recommendations. Adopt skip welding technique to minimize warpage.

3.2 HEMP DOOR FRAME ACCESSIBILITY

Entire periphery including threshold of HEMP shielded door frame where attached to HEMP shield must be accessible from inside and outside of shield for access and future removal with minimum demolition.

3.3 HEMP SHIELDED DOOR INSTALLATION

HEMP shielded door manufacturer must install the frame and shielded door(s). Install HEMP shielded door assemblies as complete assemblies in pre-existing prepared openings. Install in accordance with the approved shop drawings, and peripherally MIG weld HEMP shielded door to HEMP shield. Exercise care during installation to prevent damage, especially to finger-stock (contact fingers) and or RF gaskets. Furnish doors, frames, thresholds, and associated hardware as preassembled matched units. Install each unit in its respective door openings in accordance with the approved shop drawings. Maintain alignment within tolerances as shown in the approved shop drawings during installation and tack welding and final welding of the HEMP shielded door assembly to preclude warpage.

3.4 POST INSTALLATION PROTECTION

During construction phase, keep opening and closing of HEMP shielded door to a minimum, in order to limit wear on door components, particularly contact surfaces. Plan operations to keep HEMP shielded door in a permanently open position, with protection over the sensitive components, during construction activities. Secure temporary covers of not less than 15.87 mm 5/8 inch thick plywood to protect exposed RF contacts from physical damage. Apply easily removable masking or strippable coatings over contact surfaces to eliminate soiling and corrosion. Remove coatings, clean contact surfaces with an appropriate environmentally safe and OSHA approved solvent prior to final acceptance testing. Place threshold protective ramps over threshold when doors are blocked open. Replace components that have been damaged during construction phase.

3.5 FIELD QUALITY CONTROL

3.5.1 Tests

Shielded door manufacturer will supervise and install HEMP shielded door to ensure that HEMP shielded door and frame is installed without misalignment or warpage that would degrade the performance of the HEMP shielded door. The HEMP shielded door specialist must be present to witness field tests including retests to correct problems. Perform the following tests on-site after HEMP shielded door is installed in completed HEMP shield. Prior to performing repair, Contracting Officer will approve corrective, recommended, or adopted measures.

3.5.1.1 Final Acceptance Test

Government reserves the right to witness and field testing. Provide [30] [_____] days advance notice for field testing within Continental United States. A [45] [_____] day notice is required for testing conducted outside Continental United States. Engineering Service Center, Code 065, will witness all tests and repair on the shielded door. Make acceptance testing of HEMP shielded door at construction site as part of acceptance test of HEMP protection system. HEMP shielded door manufacturer can perform corrections and repairs necessary to bring HEMP shielded door into compliance with MIL-STD-188-125-1, however, modification is prohibited.

a. EM SA test: HEMP shielded door must comply with the minimum requirements of MIL-STD-188-125-1. Make measurements for SA at [6] [_____] test points required by MIL-STD-188-125-1 for single leaf personnel HEMP shielded door, [9] [_____] test points for double leaf HEMP shielded door, and all penetrations of shielded door. Scale up number of test points proportionately for larger HEMP shielded door. Locate test points around periphery of HEMP shielded door and at center of astragal. Perform testing in accordance with MIL-STD-188-125-1 and modified (orient magnetic loop antenna co-axial or co-planar or cross whichever gives least SA or maximum signal pick-up) IEEE 299.

b. Test frequencies: Make magnetic field, electric field, and plane wave measurements at the following seven test frequencies.

    (1) Magnetic field (low impedance): One frequency at 14 KHz, one frequency at 100 KHz, one frequency at 1 MHz, and one frequency at 20 MHz.

    (2) Electric field (high impedance): One frequency at 30 MHz.

    (3) Plane wave (377 Ohm): One frequency at 100 KHz, one frequency at 400 MHz, one frequency at 750 MHz, and one frequency at 1 GHz.

Sweep each test point 610 mm 2 feet around test point.

c. Test methodology: Regardless of test methodology or procedure used, orient antennas for maximum signal pickup or least SA. Orient magnetic loop antennas for co-axial, co-planar, or cross for maximum signal pick up or least SA. Orient horn antenna vertically or horizontally for maximum signal pick up or least SA.

d. Test instruments and equipment:

   (1) Instruments and equipment: Current, non-expired calibration tags traceable to NIST.

   (2) Spectrum analyzer: Direct reading and digital. Use slow sweep, and sweep at least three times prior to taking measurements.

   (3) Signal generator: Frequency synthesized.

   (4) Dynamic range: Minimum of 10 dB above SA requirement of MIL-STD-188-125-1.

e. Independent tester: SA tests will be performed by an independent tester regularly engaged in SA testing and tests must conform to the procedures contained in modified(orient magnetic loop antenna co-axial or co-planar or cross whichever gives least SA or maximum signal pick-up) IEEE 299 and MIL-STD-188-125-1. Independent tester must not offer advice or suggestions to correct problem. General Contractor will hire the independent tester.

f. Calibration: Calibrate test set up and signal each time power is turned off or set up is moved. During test, Government representative or Government witness reserves the right to verify the test signal. Calibrate prior to each test, and at the end of each test. Use only the equipments, cables, antennas, amplifiers, attenuators used for calibration of transmitters and receivers respectively for testing.

g. Interlock alarm configuration tests (field): Test electrical and functional operation of interlock alarm system[, including cipher locks (when included),] to verify performance of interlock system.

h. Force tests (field): Perform test for force required to latch and release (unlatch) each HEMP shielded door in installed position (field) in the presence of the Contracting Officer or the Contracting Officer's representative. Perform test by using a calibrated force measuring device, recording and retaining maximum force required to latch and release (unlatch) until reset. Modifications or alterations to panic hardware of emergency exit HEMP shielded door to meet NFPA 101 force requirements for latching and releasing (unlatching) are prohibited.

i. Recalibration: At the end of each day, recalibrate if the dynamic range varies more than 3 dB compared to the beginning of the calibration of each day. Retest all test points.

3.5.2 EM Shielded Door Tests

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NOTE: The following test are required for EM shielded door only.

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3.5.2.1 SA Due to RM

Perform tests for all test points to determine the SA due to residual RM by disconnecting the power by unplugging/deenergizing the power source, vice activating "Open Door Switch." Activating "Open Door Switch" will reverse the polarity of EM resulting in reduced RM, hence, reduces the force required to open the shielded door. Perform this test in the field in the installed position. The SA must be not less than 50 percent of minimum required.

3.5.2.2 SA Due to Inner or Outer or Both EM Coils

Perform this test by energizing one at a time inner, outer, and both EM coils to determine the SA provided by inner, outer, and both EM coils. Perform this test in the field in the installed position. The SA for each test point, due to inner or outer coil, must be not less than 80 percent of minimum required.

3.6 TRAINING

Provide a minimum of [8] [_____] hours of hands on maintenance training to each person designated by the Contracting Officer. Training must include but not be limited to routine, preventive and corrective maintenance, cleaning of knife edge, finger-stock, alignment of doors, adjustment of latching mechanism, replacement of gaskets and finger-stocks, lubrication, interlock, locking (latching) mechanism, and adjustment of hinges. Provide [6] [_____] [VHS] [_____] video cassette tapes showing details and procedures of hardness critical item HEMP shielded door in accordance with HM/HS manual.

3.7 SITE SPECIFIC REPAIRS AND TEMPORARY FIXES

Corrections and repairs are allowed, however, modification is prohibited. Use of bronze wool, conductive tape, conductive caulking, pieces of RF gaskets all shapes and sizes, rope gasket, and microwave absorber, which are normal troubleshooting aids are prohibited as permanent solution (fix) to correct design or manufacturing deficiencies of HEMP shielded door. Only the use of materials such as RF gasket, finger-stock shown in approved shop drawings, catalog, HM/HS manual, and list of material will be acceptable. Each HEMP shielded door of similar design must contain identical RF gasket material.

3.8 RETESTS

Retest each repair, adjustment, corrective action including cleaning or HEMP shielded door at each frequency for each test point. If retest is scheduled for a later date, provide [30] [_____] days notice for Continental United States and [45] [_____] days notice for overseas locations for Government to witness the retests. Recalibrate if the dynamic range varies more than 3 dB compared to the beginning of the calibration of each day. Retest each test points. Recalibrate if any hardware is changed.

3.9 EMERGENCY EXIT PANIC HARDWARE FIELD MODIFICATION

Equip emergency exit with panic hardware. Force required to release (unlatch) emergency exit HEMP shielded door must meet NFPA 101.

Modifications or alterations to panic hardware and latching mechanism in the field is prohibited in order to meet NFPA 101.

3.10 WELDING

AWS D1.1/D1.1M, certified welders. When specimens are removed from part of an assembly, repair cut members at no additional cost to Government, with joints of proper type to maintain SA and to develop full strength of members and joints cut, with peelings as necessary or directed to relieve residual stress. Provide welder identification next to weld.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 34 58 (August 2008)**

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 34 58 (August 2008)**

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SECTION 08 34 58

FILE ROOM DOORS AND FRAMES
08/08

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NOTE: This guide specification covers the requirements for non-security type fire-insulated record-vault doors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

UL SOLUTIONS (UL)

UL 140	(2006; Reprint May 2023) Relocking Devices for Safes and Vaults
UL 155	(2000; Reprint Feb 2024) UL Standard for Safety Tests for Fire Resistance of Vault and File Room Doors
UL 768	(2006; Reprint Aug 2023) Standard for Combination Locks

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

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SD-02 Shop Drawings

Vault Door Unit

Doors

Day Gate

Frames and Sills

Hardware

SD-03 Product Data

Vault Door Unit

Doors

Day Gate

Frames and Sills

SD-07 Certificates

Vault Door Unit

Frames and Sills

Hardware

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver, store and handle doors and frames in a manner that prevents damage.

PART 2 PRODUCTS

2.1 VAULT DOOR UNIT

Provide an insulated, steel, flat-sill, record-vault-type door with frame that is a standard product of a manufacturer specializing in this type of construction.

2.2 DOORS

****

NOTE: When the required clear opening for the door is in excess of 1000 mm 40 inches in width, a pair of doors must be used.

****

Design and construction of doors must be manufacturer's standard with a

UL 155 fire-resistant classification for a [6-hour] [4-hour] [2-hour] exposure rating, bearing the UL label on the door and frame for the exposure rating required. Provide doors of the size indicated. The finish for door, frame, and hardware must be the manufacturer's standard for the type door indicated. Provide each door equipped with a relocking device conforming to UL 140 and with an inner escape device that permits the bolt work to be released from inside the vault. [Escape mechanism to be panic bar type or other approved type requiring no tools or special instructions for operation.] [Provide printed instructions for operating the escape device inside the vault near the escape device release.] Provide Hardware meeting the following specifications:

a. Provide [not less than 5 bolts for the door] [five bolts for each side of the door]. Each bolt must be greater than 17 mm 11/16 inch in diameter and permanently lubricated. When the bolts are not located on both jamb sides of the door, the jamb side not provided with bolts must interlock with the frame walls of that side. Exposed bolt work must be corrosion resistant or nickel plated steel.

b. Provide each door with not less than three heavy, offset roller or ball bearing steel hinges, unless noted otherwise on the drawings.

c. Provide a combination lock that complies with UL 768, Group 1R, for each door. Provide locking mechanism operated by means of a lever handle. Provide locks that are combination 3 or 4 tumbler, key or hand-changing type with metal cases protected by drill-resistive steel plates and operated by lever handles. The front-plate of the doors must be not lighter than 1.5 mm 0.060 inch steel plate either riveted or welded to the edge plates. Edge plates and back plates of doors must be not lighter than 0.81 mm 0.032 inch steel. Lock must be [highly resistant to expert manipulation conforming to UL 768, Group I, combination locks.][reasonably resistant to unauthorized opening conforming to Group II of UL 768 combination locks.]

d. Submit installation drawings which include details of construction, method of anchorage and type and location of the following: Vault Door Units, Hardware, Frames and Sills, and Day Gate

e. The label or listing of the Underwriters Laboratories, for fire-resistance classification and safety-relocking devices is acceptable as sufficient evidence that the vault-door unit conforms to these requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency adequately equipped and competent to perform such services, stating that the vault-door unit has been tested and that this unit conforms to the requirements listed herein, including methods of testing of the Underwriters Laboratories, Inc.

f. Submit certificates attesting that the vault-door unit, frames, sills, and hardware furnished under this specification conform with the referenced standards contained in this section and to the requirements of the Underwriters Laboratories.

2.3 Frames and Sills

Provide frames of the tongue-and-groove interlocking type, constructed of not lighter than 1.2 mm 0.0478 inch cold-formed steel, formed from a single length for each jamb and a single length for the head. Continuously weld head and jambs along the entire intersection. Sills must be flat and not less in width than the jambs. Provide frame, jambs and heads insulated with the same material as the door. Design the frame for the thickness of vault wall indicated. Submit Manufacturer's descriptive data and catalog cuts and preprinted installation instructions.

2.4 Day Gate

****

NOTE: If no day gate is required, omit this paragraph in its entirety.

****

The vault door unit must include a day gate of the manufacturer's standard make, and the door frame designed to accommodate this day gate. The gate must be of the swing-in, hinged type, with not less than 15 mm 5/8 inch diameter rods, and the gate frame of not less than 10 mm 3/8 inch by 31 mm 1-1/4 inch aluminum or steel members. Provide the day gate equipped with a locking device arranged to permit locking and unlocking of the gate[from the inside only]. Finish of the day gate must be the manufacturer's standard. The day gate must not interfere with the operation of the inner escape device.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: If carpet is to be installed in front of the door, increase the height of the wall opening by the combined thickness of the carpet and pad.

****

Install the vault door unit in strict compliance with the approved installation instructions and drawings provided by the manufacturer. [Install the day gate in a manner that does not interfere with operation of the release handle on the inside of the vault door.] After installation, adjust the door, the locking mechanism, and the inner escape for proper operation.

-- End of Section --

USACE / NAVFAC / AFCEC **UFGS-08 34 59 (August 2008)**
Change 1 - 11/12

Preparing Activity: USACE **Superseding**
UFGS-08 34 59 (April 2006)
UFGS-08 34 53.00 40 (June 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 34 59

VAULT DOORS AND DAY GATES

08/08, CHG 1: 11/12

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-08 34 59 (August 2008)**
Change 1 - 11/12

Preparing Activity: USACE **Superseding**
UFGS-08 34 59 (April 2006)
UFGS-08 34 53.00 40 (June 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 34 59

VAULT DOORS AND DAY GATES

08/08, CHG 1: 11/12

****

NOTE: This guide specification covers the requirements for vault door units meeting the protective storage criteria for classified materials.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS AA-D-600	(Rev D, Am 1; Am 4) Door, Vault, Security

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED BD+C	(2009; R 2010) Leadership in Energy and Environmental Design(tm) Building Design and Construction (LEED-NC)

1.2 SUSTAINABILITY REPORTING

****
NOTE: The bracketed items are representative of LEED material documentation and requirements that may apply to this project. These items should be edited to reflect the project requirements.
****

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for project LEED BD+C [local/ regional materials][and][recycled content] and LEED documentation requirements.

1.3 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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SD-02 Shop Drawings

Vault Door Unit; G, [_____]
Day Gate; G, [_____]

SD-03 Product Data

Vault Door and Frame

SD-07 Certificates

Vault Door and Frame

SD-08 Manufacturer's Instructions

Installation

SD-11 Closeout Submittals

LEED Documentation

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver door and frame assemblies to the jobsite in a protective covering with the brand and name clearly marked thereon. Inspect materials delivered to the jobsite for damage, and unload them with a minimum of handling. Store in a dry location with adequate ventilation, free from dust, water, and other contaminants, and allowing easy access for inspection and handling. Store door assemblies off the floor on nonabsorptive strips or wood platforms. Prevent damage to doors and frames during handling. Replace damaged items that cannot be restored to like-new condition.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide vault door unit consisting of a steel security-vault type door with frame, [day gate], and ramp type threshold, which is a standard product of a manufacturer specializing in this type of fabrication. Submit drawings showing head, jamb, and sill sections, and elevations of the doors [and gate].

2.2 VAULT DOOR AND FRAME

****

NOTE: Select the appropriate Type and Style designation for the door, and delete inapplicable portions. FS AA-D-600 covers the following classes of security vault doors: Class 5-V: Vault door resistant to 20 man-hours surreptitious entry, 30 man-minutes covert entry, and 10 man-minutes forced entry.

Electro-mechanical lock. Primarily used for storage of classified information.
Class 5-A: Armory door resistant to 30 man-minutes covert entry and 10-man minutes forced entry.
Mechanical lock. Primarily used for storage of arms.
Class 5-B: Ballistic door resistant to 20 man-hours surreptitious entry, 30 man-minutes covert entry, and 10 man-minutes forced entry.
Electro-mechanical lock. Similar to class 5-V but is ballistic resistant.

Type: Select the appropriate door type or types, and delete those not applicable. "Right opening swing" means hinges to the right when viewed from outside the vault. Specify the optical device only when requested by the Using Agency.

Style: Specify Style K unless Style H is requested by the Using Agency.

Design: Design S - single lock. Design B - No exterior hardware. Design S, the default value, is more available. If B is a customer requirement, check availability with manufacturers on the QPL.

APPROVAL OF AN EXCEPTION TO APPLICABLE SECURITY REQUIREMENTS MUST BE OBTAINED BY THE USING ACTIVITY THROUGH THEIR OPERATIONAL CHAIN OF COMMAND FOR PROVISION AND INSTALLATION OF ANY AND ALL SECURITY VAULT DOORS WITHOUT A GSA-APPROVED LABEL. The GSA labeled vault door is a single-leaf door, and provides a clear opening of 1015 mm 40 inches wide and 1980 mm 78 inches high. A double-leaf vault door is available with a clear opening of 2080 mm 82 inches wide and 1980 mm 78 inches high. Obtain both single-leaf and double-leaf vault doors to satisfy special size requirements. The double-leaf and special size units are built to Class 5 standards, but are not tested and labeled by GSA. When custom size doors are required, verify availability with door manufacturers, and verify the acceptability of unlabeled doors with the Using Agency.

****

Design and construct the door and frame assembly in conformance with FS AA-D-600. Provide a door which is Class [5-V] [5-A] [5-B], Type [IR – right opening swing with optical device] [IL – left opening swing with optical device] [IIR – right opening swing without optical device] [IIL – left opening swing without optical device] [IIIR – double leaf, active right opening swing] [IIIL – double leaf, active left opening swing], Style [H – hand change combination lock] [K – key change combination lock], Design [S – single lock] [B – no exterior hardware]. [The optical device must permit observation from the [inside to the outside] [outside to the inside] of the vault.] Submit manufacturer’s catalog data including catalog cuts and brochures showing that the proposed vault door unit conforms with the requirements in FS AA-D-600, and has been tested and approved by the General Services Administration (GSA). Submit certification stating that the vault-door units that do not bear the GSA label are constructed to Class [5-V] [5-A] [5-B] standards.

2.3 DAY GATE

****

NOTE: The day gate is not covered by FS AA-D-600. Specify the day gate only when specifically requested by the Using Agency.

****

Provide a day gate which is the manufacturer's [standard] [custom] product designed for use with the vault door furnished, and that provides access control [and visual security] [and [material] [equipment] [weapons] issue]. The gate must be hinged on the same side as the vault door, swing into the vault, and have a locking device operable from outside by key and from inside by knob or handle. [Include an issue port hatch [and [2.5] [_____] mm [12] [_____] gage thick steel shelf]. The issue port must be a framed 200 by 300 mm 8 by 12 inch opening with a minimum [0.8] [_____] mm [22] [_____] gage thick steel protective door (hatch cover) which is hinged and lockable from the interior side. Weld the issue port frame to the day gate. [The shelf must be [300] [_____] mm [12] [_____] inches deep by width to match the port hatch.]] Provide the manufacturer's standard finish. The day gate must not interfere with the operation of vault door inner escape device.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: The door frame is a nongrout type and is adaptable to walls of 150, 200, 250, or 300 mm 6, 8, 10, or 12 inch thickness with a 13 mm 1/2 inch tolerance. Where required, the availability of frames to accommodate thicker walls must be verified with manufacturers. Construction and wall opening size requirements vary between manufacturers. There is no need to detail the door or frame; however, the walls must be detailed as necessary to show reinforcing. Show wall opening sizes as "approximate," with the final size to be as determined by the vault door manufacturer.

****

Install the vault door assembly in strict compliance with the printed instructions and drawings provided by the manufacturer. Install the day gate in a manner that does not interfere with operation of the release handle on the inside of the vault door. After installation, adjust the door, the locking mechanism, and the inner escape device for proper operation. Submit printed instructions and drawings provided by the manufacturer.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 34 63 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 34 63 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 34 63

DETENTION HOLLOW METAL FRAMES, DOORS, AND DOOR FRAMES

08/24

PART 1 GENERAL

PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-08 34 63 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 34 63 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 08 34 63

DETENTION HOLLOW METAL FRAMES, DOORS, AND DOOR FRAMES
08/24

****
NOTE: This guide specification covers the requirements for detention hollow frames, metal doors, and door frames for use in brigs and detention facilities in locations where prisoners may have access.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Show the following information on the project drawings:

1. Sizes of door or view window, speaking port, louver, view port and food pass, if any, openings, thicknesses of doors, swings, and travels of doors.

2. Indicate detention hollow metal doors as "Sec. Holl. Mtl." or "SHM" and show that the term means "Detention Hollow Metal Doors and Frames," in a schedule of abbreviations.

3. The size of wall or partition where door is to be located.

4. Type and thickness of glazing required.

5. Method, type, and spacing required for anchoring frames to adjoining construction.

6. Include a complete door schedule. The door schedule should assign a separate number for each opening and should indicate the door type and style, material, design, size, thickness, hardware set number, threshold material, if any.

****

PART 1 GENERAL

1.1 REFERENCES

****

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****

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ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved

	Formability, and Ultra-High Strength
ASTM G60	(2001; R 2018) Standard Practice for Conducting Cyclic Humidity Exposures

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMMA 863	(2014) Guide Specifications for Detention Security Hollow Metal Doors and Frames

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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SD-02 Shop Drawings

Detention Hollow Metal Doors and Frames

SD-03 Product Data

Detention Hollow Metal Doors and Frames

SD-06 Test Reports

Door Fabrication

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver hollow metal work with packaging to provide protection during transit and job storage as recommended by the manufacturer. Provide door frames with steel spreader angles, temporarily attached to the bottom of both jambs, one on each side of the opening to serve as a brace during shipping and handling. Inspect hollow metal work upon delivery for damage. Store hollow metal units on raised platforms in vertical positions with blocking between units to allow air circulation. Keep stored material covered and protected from damage and rust. Do not cover with plastic or unvented canvas.

1.4 HARDWARE COORDINATION CONFERENCE

****

NOTE: The conference is to ensure that the coordination takes place.

****

Conduct a conference for hardware and hollow metal work prior to submittals for the purpose of coordinating the interface of materials that are furnished or installed by the participants listed. Require that a representative of the entity responsible for each of the following functions attend the conference. Notify the following participants a minimum of 5 working days before the conference:

a. Contractor

b. Hollow metal supplier and installer

c. Detention hollow metal supplier and installer

d. Hardware supplier

e. Hardware installer

f. Detention hardware supplier

g. Detention hardware installer

h. Remote control operator and locking device supplier and installer

i. Electrical contractor.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Hot-Rolled Carbon Steel

ASTM A1011/A1011M, commercial quality, 14 gauge and thicker.

2.1.2 Cold-Rolled Carbon Steel

ASTM A1008/A1008M, commercial quality, stretcher level sheets, 12 gauge.

2.1.3 Galvanized Steel

ASTM A653/A653M, CQ, mill phosphatized tested by ASTM G60.

2.2 DETENTION HOLLOW METAL DOORS AND FRAMES

2.2.1 Door Fabrication

****

NOTE: Refer to architectural door schedule on drawing for all pertinent information about doors, door frames, and security hardware set numbers.

****

a. Provide doors fabricated of cold rolled, pickled and oiled stretcher leveled steel sheets with clean smooth surfaces. Provide gauges indicated for each type of door. Form molded members straight with joints coped or mitered, and in true alignment. Welded joints on exposed surfaces must be dressed smooth to be invisible. Provide doors that are custom made full flush design, internally reinforced, sound deadened and insulated, 50 mm 2 inches thick to receive detention locks, of the elevations, types and sizes shown on the approved shop drawings and schedules.

b. Provide face sheets that are mild steel fully welded on edges with continuous inner-reinforcements full height and width. Provide internally 10 gauge steel channel banding around complete door perimeter, spot welded to face sheet 75 mm 3 inches on center. Inner reinforcements must be truss design with triangular form, or interlocking channels with "Z" bar stiffeners, the shape of which cannot be altered without changing the length of the sides. Flat apexes must be resistance spot welded on 70 mm 2-3/4 inches centers horizontally and 75 mm 3 inchescenters vertically. Insulate each flute of reinforcement with 96 kg/cubic meter 6 pound density rock wool.

c. Bevel vertical door edges 3 mm in 50 mm 1/8 inch in 2 inches and internally reinforced full length with 3 mm 1/8 inch thick steel channels spot welded not over 75 mm 3 inches on center inside both door faces. Close top and bottom door edges with continuous recessed 10 gauge channels extending the full width of the door and welded 75 mm 3 inches on center maximum to both faces and continuously welded to the vertical door edge channels to form a single perimeter frame inside the door. Finish flush the top and bottom edges of doors, except for provisions for weatherproofing. Mortise, reinforce, drill and tap door edges to receive templated specified hardware in accordance with the approved hardware schedule and the hardware manufacturer's recommendations for the proper installation of hardware and detention equipment.

d. Coordinate clearances with frame and in accordance with NAAMM HMMA 863, Part 2, Section 2.02.

e. Doors must be free from warpage, wind or buckle. Bends must be of minimum radius for the gauge of metal used.

f. The removable glass stop must consist of 10 gauge angle securely fastened to the frame using machine screws (6 mm 1/4 inch pound 20UNRC: 25 mm at 150 mm 1 inch at 6 inches on center and no more than 100 mm 4 inches from corners). Exposed screw heads must be button head type and torx and pin fitting tamperproof. The finished glass stop must be tight fitting and mitered at the corner joints. Provide a minimum glass engagement of 25 mm 1 inch.

2.2.2 Door and View Window Frame Fabrication

a. Custom-made, fully assembled, factory-welded units of the size and shapes shown on the approved shop drawings. "Knock-down" frames will not be accepted. Coordinate frame dimension to thickness of door or glass.

b. Strong, rigid, neat in appearance, and free from defects. Provide frame members that are clean cut, straight, and of uniform profile.

c. Form frames to provide mitered trim and butted stops. Join head and jamb members by continuous welds occupying the full depth and width of the frame. Grind exposed welds smooth and flush.

d. When frames are for door light or food pass, fabricate members as closed tubular shapes having no visible seams or joints on exposed surfaces. Grind exposed welds smooth and flush.

e. Provide a channel stiffener not less than 12 gauge welded into the head at the factory frames over 1200 mm 4 feet wide installed in masonry partitions.

f. Protect cutouts and reinforcements with pressed steel mortar guards on the inside of the frame.

g. Floor anchors formed of not less than 12 gauge steel must be securely welded to the bottom of each jamb.[Where scheduled, provide adjustable floor anchors extending not less than 50 mm 2 inches below the finish floor line.]

h. Provide frames for installation in masonry walls with non-removable adjustable jamb anchors constructed of not less than 14 gauge material. Provide jamb anchors at 400 mm 16 inches on center.

i. Welded frames that are to be installed in previously prepared masonry openings must be 12 mm 1/2 inch smaller in width and 6 mm 1/4 inch smaller in height than the masonry opening to provide 6 mm 1/4 inch clearance on all sides.

j. Provide removable glass stop for view window frame consisting of 10 gauge angle securely fastened to the frame using machine screws of 6 by 32 mm 1/4 by 1-1/4 inch spaced at 200 mm 8 inches on center maximum. Provide removable screw heads that are round, pan, or oval type, and are torx and pin drive, tamperproof. The finished glass stop must be tight fitting and mitered at the corner joints. Provide a minimum of 25 mm 1 inch glass engagement. Install plaster guards covering the glass stop screws on masonry grouted frames.

k. When shipping limitations dictate, fabricate frames for large openings in sections designed for field welded splicing. Welds must be ground smooth and primed for painting. Sections must be assembled at the factory to ensure proper fit and be clearly marked for field reassembly.

2.2.3 Door Reinforcement for Hardware

a. Mortise, reinforce, drill, and tap doors at the factory for mortised hardware in accordance with the approved hardware schedule and templates. Doors to receive surface-mounted hardware must have inner reinforcing plates for drilling and tapping to be performed in the field.

b. For each mortised hinge, provide a reinforcing plate measuring 5 by 38 by 250 mm 3/16 by 1-1/2 by 10 inches that is continuously welded inside the edge channel. The top hinge preparation must be additionally braced by a channel, welded to the back of the hinge reinforcing plate and inside the edge reinforcing channel.

c. Where detention locks are scheduled, provide reinforced pocket to receive locks. Finish the secure side of the door flush with a 5 mm 3/16 inch backup plate to protect lock. Form the pocket perimeter of 12 gauge channels on three sides with the door edge channel completing the perimeter frame. Do not cut the door edge channel except for passage of the lock bolt. Provide a 5 mm 3/16 inch thick steel mounting and protection plate to cover the lock pocket and extend at least 20 mm 3/4 inch on three sides beyond the cutout. Secure the lock to the protection plate in accordance with the lock manufacturer's instructions. Secure the cover plate to the door by at least six 6 mm 1/4 inch security-type machine screws. Make provisions so that removal of the lock is impossible when the lock bolt is extended.

d. For door pulls, provide reinforcements that are 5 mm 3/16 inch steel welded inside door. Reinforcement size must be 38 by 250 mm 1-1/2 by 10 inches for loop type pull and 150 by 175 mm 6 by 7 inches for flush type pull. For all other surface hardware items, weld minimum 12 gauge reinforcing inside door.

2.2.4 Frame Reinforcement for Hardware

a. Mortise, reinforce, drill, and tap frames at the factory for templated mortised hardware, in accordance with the approved hardware schedules and templates. Where surface-mounted hardware is to be applied, frames must have reinforcing plates completely drilled and tapped for installation in the field.

b. For each mortised hinge, provide a 7 gauge, off-set reinforcing plate that is factory drilled and tapped and measures 38 by 250 mm 1-1/2 by 10 inches. Top hinge reinforcement must be additionally braced by a 7 gauge backup angle welded to the reinforcement and to the inside of the frame trim.

c. Where electrical frame-mounted locks are used, provide a special housing with a 7 gauge backup for attachment of the lock and a lock cover plate of the same thickness. Provide a junction box or enclosure behind each item of electrical hardware on the frame. Factory install conduit between interconnecting electrical items within each frame.

d. For all other mortised and surface-mounted hardware reinforcements, provide not less than 12 gauge thickness.

2.2.5 Factory Finishing

a. After fabrication, dress, fill, and sand tool marks and surface imperfections to make faces and vertical edges smooth, level, and free of irregularities.

b. Chemically treat surfaces and cleanse of rust, oil, and impurities. Provide a phosphate treatment to ensure paint adhesion.

c. Paint exposed surfaces of doors, and both inside and outside of frames with a minimum of one-mil thickness of rust inhibitive primer which must be dried and completely cured to develop hardness before shipment.

2.3 ACCESS PANELS

Provide steel access panels of sizes and locations as indicated and where required for access to utilities, equipment, and controls.

a. Provide doors that are 10 gauge steel, flanged 32 mm 1-1/4 inches on four sides, with welded corners.

b. Provide frames composed of steel angles measuring 5 by 50 by 50 mm 3/16 by 2 by 2 inches. Weld and grind joints smooth.

c. Provide detention type hinges with nonremovable pin, three per frame. Weld to door and frames.

d. Weld steel stop angles measuring 3 by 25 by 25 mm 1/8 by 1 by 1 inch to frame on all four sides.

e. Factory weld masonry anchors 3 by 25 by 150 mm 1/8 by 1 inch by 6 inches, minimum four per panel.[Provide expansion shields at concrete openings, factory countersunk for 10 mm 3/8 inch flathead machine screw, minimum two per jamb.]

f. Factory finish with prime coat of rust-inhibitive, baked-on enamel.

g. Provide locks at panels within the security perimeter [and points of egress from ducts and tunnels terminating outside the security perimeter]. Lock case and cover are to be malleable iron and steel. Bolt must be high strength bronze and project 20 mm 3/4 inch from case when retracted and have a throw of not less than 16 mm 5/8 inch. Locks must have five tumblers, each actuated by phosphor bronze springs. Locks must operate from one side only. Attach to panel with detention type screws. Locks must be keyed alike. Enter coded keys into keying system as specified in Section 08 71 63 DETENTION HARDWARE.

2.4 OPENING PROVISION

[Speaking ports][Louvers][View ports][Food passes]must be manufactured as indicated.

2.5 SOURCE QUALITY CONTROL

Prior to fabrication, perform the following minimum performance test on a 12 gauge reinforced flush door of the type to be provided on this project:

a. Test "A" - Static Load: Under centrally applied load of 62 kN (32 kPa) 14,000 pounds (660 pounds per square foot) at quarter points, the maximum permitted deflection must be 15 mm 0.58 inch with a rebound of 0.4 mm 0.015 inch after release of load.

b. Test "B" - Rack Test: Under a concentrated load of 33 kN 7,500 pounds on one unsupported corner of door, deflection must not exceed 90 mm 3-1/2 inches, and failure must not incur.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Door Schedule

Refer to door schedule on drawings for location of doors, door frames, and door hardware.

3.1.2 Frames

Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After completing wall construction, remove temporary braces and spreaders. Do not use any part of the frame as lintels or load-carrying members. Anchor frame to masonry with flat head security type machine screws into expansion shields or attached to a pre-set rough buck anchored to the masonry in the same way. Install five anchors on each jamb for doors up to and including 2250 mm 7 feet 6 inches in height and six on each jamb for taller doors. Avoid punch and dimple attachments when possible, and grout all frames solid.

3.1.3 Doors

Fit hollow metal doors accurately in frames. Provide metal shims where necessary.

3.1.4 Access Panels

Prepare openings as required to receive frame. Use fasteners as specified and required by type of surrounding construction. Ensure that frames are properly seated into opening with steel shims and that doors are true, in alignment, and completely flush in appearance. Maintain 3 mm 1/8 inch maximum clearance between door and frame.

3.2 ADJUSTMENT AND CLEANING

Remove and replace defective work which is warped, bowed, or otherwise damaged. Adjust hollow metal work for smooth operation. Touch up scratches and bare edges in the field with a rust inhibiting primer prior to painting.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 34 73 (November 2019)**
Change 1 - 02/21

Preparing Activity: USACE **Superseding**
UFGS-08 34 73 (February 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-08 34 73 (November 2019)**
Change 1 - 02/21

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****

SECTION 08 34 73

SOUND CONTROL DOOR ASSEMBLIES

11/19, CHG 1: 02/21

****
NOTE: This guide specification covers the requirements for flush steel and wood sound retardant doors with Sound Transmission Classification (STC) ranging from 25 to 45. Doors are limited to standard height and width where noise control is required, relative to speech, music, office equipment, and general sounds.

Exterior hollow metal door frames will require infill.

Sound retardant doors for complex and special applications, where noise control related to machinery, industrial process sounds, automotive, and aircraft sounds, are not included. Revise specifications as required for the specific application.

Sound retardant door assemblies include the door, perimeter seals, and metal door frame. Some companies provide a complete guaranteed package consisting of door, frame, special threshold, seals, gasketing, and hardware. Typically, perimeter seals, hinges, and threshold are included in manufacturer's assembly.

Indicate on the drawings, door locations, required sound transmission classification (STC) ratings, required UL label, frame construction, required fire and smoke ratings, details of perimeter seals, and door bottom and vision panel requirements. Coordinate the balance of hardware with the hardware consultant.

Continuous hinges are not allowed at door and frame acoustic unit.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing**

this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A568/A568M	(2019a) Standard Specification for Steel,

	Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C476	(2023) Standard Specification for Grout for Masonry
ASTM C1036	(2021) Standard Specification for Flat Glass
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D4689	(2012) Standard Specification for Adhesive, Casein-Type
ASTM D6386	(2022) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E336	(2024) Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E1289	(2008; R 2022) Standard Specification for Reference Specimen for Sound Transmission Loss

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 101	(2024) Life Safety Code

NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

UL SOLUTIONS (UL)

UL 10C	(2016; Reprint May 2021) UL Standard for Safety Positive Pressure Fire Tests of Door Assemblies

WOODWORK INSTITUTE (WI)

NAAWS 4.0	(2021 Errata Edition) North American Architectural Woodwork Standards

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

SD-03 Product Data

Hollow Metal Sound Retardant Doors[; G, [_____]]

Wood Sound Retardant Doors[; G, [_____]]

Door Frames[; G, [_____]]

Door Hardware[; G, [_____]]

Door Frame Sound Infill[; G, [_____]]

[Vision Panels[; G, [_____]]

][Intumescent Seals and Gasketing[; G, [_____]]

] Thresholds[; G, [_____]]

[Astragals[; G, [_____]]

] SD-06 Test Reports

Wind Loading Tests[; G, [_____]]

Water Leakage Tests[; G, [_____]]

Acoustical Tests[; G, [_____]]

Air Infiltration Tests[; G, [_____]]

Positive Pressure Tests[; G, [_____]]

SD-07 Certificates

Hollow Metal Sound Retardant Doors[; G, [_____]]

Wood Sound Retardant Doors[; G, [_____]]

Door Frames[; G, [_____]]

Door Hardware[; G, [_____]]

[Vision Panels[; G, [_____]]

][Intumescent Seals,Gasketing [and Door Bottoms][; G, [_____]]

] Thresholds[; G, [_____]]

[Astragals[; G, [_____]]

] Assembly Test Reports

1.3 QUALITY CONTROL

Ensure work within this section is designed and furnished by one manufacturer, who has been engaged in the manufacture of Sound Retardant [Wood Swinging Door] [Hollow Metal Door] [_____] systems for at least five years prior to the start of this work.

Provide acoustic assemblies manufactured by a single source specializing in the production of this type work for a minimum of five years.

1.3.1 Compliance and Labeling

1.3.1.1 Compliance with Accessibility Requirements

Americans with Disabilities Act/Architectural Barriers Act (ADA/ABA) 36 CFR 1191

Accessibility Guidelines for Buildings and Facilities (ADAAG) 36 CFR 1191

[_____] (Insert appropriate accessibility standard)

1.3.1.2 Category A Positive Pressure Fire Door Construction

Where requirements for positive pressure are met, include for doors all requirements as part of the door construction per Category A guidelines as published by ITS/Warnock-Hersey. Intumescent is not allowed on the frame. Applying smoke gasketing around the perimeter of the frame to meet the "S" smoke rating is permissible in instances where smoke control is required.

1.3.1.3 Category B Positive Pressure Fire Door Construction

Conform all door openings to the applicable portions of NFPA 101 and NFPA 252. Incorporate field applied intumescent materials, applied by a licensed installer according to the manufacturers' instructions. Keep instructions on file. Additional gasketing may be required to meet the 'S' smoke rating. Submit Certificate for intumescent seals, gasketing[and door bottoms].

1.3.1.4 Labeling

Ensure all positive pressure door assemblies carry the fire label for the complete opening, clearly identifying the:

a. Manufacturer

b. Third party testing and certification agency

c. Fire door rating

d. Installation limitations

e. Compatible frame, hardware component ratings

f. Compatible lite or vision panel component ratings

g. Required building code information, including temperature and smoke rating

h. STC rating if required.

Indicate fire-ratings of applicable components. Provide documentation of ABA/ADA accessibility compliance of applicable components, as required by 36 CFR 1191 Appendix D - Technical.

1.4 DELIVERY, STORAGE, AND HANDLING

Ship all doors in the manufacturer's undamaged individual cartons, securely bundled and wrapped with moisture-resistant covers and stored in accordance with the manufacturer's printed instructions in a dry, clean, and ventilated area.

Deliver and store wood doors in the building following the installation of concrete, terrazzo, plaster, or other wet materials, and only after the building has dried out and has a roof.

Store all materials on planks in a dry location. Store doors and frames vertically with minimum [_____] airspace between. Store doors on the edge to eliminate any potential damage to the door bottom seal. Cover all material to protect from damage but in a manner to allow proper circulation.

Maintain relative humidity in the building between 30 and 65 percent. Maintain the ambient temperature at 16 degrees C 60 degrees F minimum at the time of installation of wood doors.

Perform final adjustment of seals when temperatures and humidity conditions replicate the interior conditions that will exist when the building is occupied.

1.5 WARRANTY

****

NOTE: Consult various US Armed Forces requirements.

The warranty clause in this guide specification has been approved by NAVFACENGCOMHQ in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS).
NFAS can be found at the following link:

https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_forbusinesses_
The paragraph in this guide specification may be used without any other HQ approval or request for waiver.

****

Manufacturer's warranty for [_____] [5] years from date of supply, covering material and workmanship. Failures include, but are not limited to, the following:

a. Failure to meet sound rating requirements

b. Faulty operation of sound seals

c. Deterioration of metals, metal finishes, and other materials beyond normal use or weathering.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide sound retardant door assemblies of the thickness, width, and height indicated, complete with perimeter seals, seal housings, gasketing, [automatic door bottoms,] thresholds, door frames, and astragals as required to conform to the specified STC per ASTM E90 and ASTM E1289.

Submit fabrication drawings for [Hollow Metal Sound Retardant Doors,][Wood Sound Retardant Doors,] Door Frames and Door Frame Sound Infill.

Submit certificates showing conformance with the referenced standards in this section, and manufacturer's catalog data including STC ratings and UL fire rating, where applicable, for the following items: Hollow metal sound retardant doors; wood sound retardant doors; door frames; door hardware; [vision panels]; [intumescent seals and gasketing]; thresholds;[and] [astragals].

Provide assemblies that are complete with metal frame, wood door(s), sealing system, and Cam-lift hinges (when required).[If vision lights are specified for doors, provide metal loose stops and field install glass and glazing when shipped separately.]

2.1.1 Design Requirements

2.1.1.1 Door Design

Provide sound Retardant Wood Swinging Doors that are a 4.445 centimeter 1-3/4-inch thickness construction with sizes as indicated on drawings. No visible seams are permitted on door faces. Provide face gauges, internal sound retardant core and perimeter door edge construction per manufacturer's standard for the specified STC rating. No lead or asbestos is permitted in door construction to achieve STC performance. Provide face veneer species cut and color as selected from manufacturer's full range of available colors and patterns. No lead or asbestos is permitted in door construction to achieve performance requirements.

2.1.1.2 Frame Design

Provide sound Retardant Metal Frames conforming to ASTM A1008/A1008M, not less than 1.90 millimeter 0.0747-inch thick, and free from pitting, scale, stretcher strains, fluting, and surface defects with integral trim and shipped with temporary spreader. Knockdown frames are not acceptable.

Provide frames with 50 millimeter 2 inch faces, profiles and dimensions as indicated, with mitered reinforced corners, welded the full depth of frame and trim, with exposed surfaces ground smooth and flush. Close contact edges to hairline joints.

2.1.2 Performance Requirements

2.1.2.1 STC (Sound Transmission Classification) Rating

Provide doors with an STC [of at least [25] [30] [35] [40] [45]][per the door schedule].

2.2 FABRICATION

Provide doors that are minimum 16 gauge, 4.445 centimeter 1 3/4 inch thick with welded, seamless construction. No visible joints are permitted on the exposed faces or edges. Join door skins at vertical edges by continuous welds, ground and dressed smooth to provide a flush finish. Reinforce top and bottom with 1.52 millimeter16 gauge continuous inverted steel channels spot welded to both faces. Finish both top and bottom to provide a smooth flush condition. Bevel both vertical edges .3175 centimeter in 5.08 centimeter 1/8 inch in 2 inches.

Clean and sand to smooth finish all doors to remove handling and storage marks, raised grain, minor surface marks and abrasions which are to receive a job site finish.

2.2.1 Hollow Metal Sound Retardant Doors

2.2.1.1 Construction

Conform to ASTM A1008/A1008M for door construction utilizing steel facing sheets. Conform stretcher level flatness to ASTM A568/A568M; not less than 1.52 millimeter 0.0598 inch thick; free from pitting, scale, and surface defects; separated by a core construction designed to meet the required STC; and tested and rated in accordance with ASTM E90.

Provide doors that have flush seamless face sheets and vertical edges, with continuous welded and smooth joints. Provide edges that are flush or rabbeted as required for perimeter seals.

Provide door surfaces that are visually flat and free from warp, waviness, and other surface irregularities and defects. Maximum allowable warp or twist-can not exceed 3 millimeter 1/8 inch when measured with a 2100 millimeter 7 foot straightedge along the diagonal and not exceed 1.5 millimeter 1/16 inch when measured with a 2100 millimeter 7 foot straightedge in the width or in any position along the length of the door.

Provide hardware reinforcement that is steel drilled, tapped to template requirements and welded in place. Provide minimum thicknesses as follows:

a. Butts, 4.7 millimeter 0.1494 inch

b. Lock strike, 3.04 millimeter 0.1196 inch

c. Surface applied hardware 1.90 millimeter 0.0747 inch

****

NOTE: Delete the following paragraphs if UL labeled sound retardant doors are not required. Select the UL label rating, if required.

On drawings indicate sound retardant UL doors.

****

Provide doors, including sound retardant type, to bear the UL [3-hour A] [1-1/2-hour B] [3/4-hour C] [1-1/2-hour D] label fire rating and the specified STC.

2.2.1.2 Coating

Thoroughly clean all mill scale, rust, oil, grease, dirt, and other foreign materials from surfaces before the application of the shop coat of paint.

****

NOTE: Select the following paragraph if painted galvanized surfaces are required for this project.

For exterior metal doors in coastal areas provide a minimum of G90 zinc galvanized coating.

****

After cleaning, provide galvanized surfaces free of paint in accordance with ASTM D6386, Method A, B, C, or D.

Apply to clean prepared dry surfaces one shop coat of rust inhibitive metallic oxide or synthetic resin primer by brush, dipping, or other approved method to provide a continuous minimum dry film thickness (dft) of 0.023 millimeter 0.9 mil.

Shop paint the exposed door surfaces, including surfaces that are galvanized.

Shop paint the concealed exterior door surfaces except galvanized surfaces.

2.2.2 Wood Sound Retardant Doors

****

NOTE: On drawings indicate door thickness, width and height, trim, and frame details.

****

Construct doors with wood veneer facings separated by a core construction designed to meet the required STC. Test, rate, and label in accordance with ASTM E90.

Comply with the NAAWS 4.0, "Guide Specifications and Quality Certification Program," for [premium] [custom] [economy] grade constructions and to the requirements specified.

Perform beveling, prefitting, machining, mortising, and routing for hardware, perimeter seals, and door bottom cutouts at the mill.

[Furnish [premium] [custom] [economy] grade door facings with standard thickness face veneers conforming to NAAWS 4.0, Type 1 for stain and transparent job site-applied finish.

][Apply medium density overlay door facings over a good grade of hardwood conforming to NAAWS 4.0, Type 3 for job site-applied paint finish.

][Furnish plastic laminate door facings, 1.5 millimeter 1/16 inch thick, in decorator color and patterns as selected, conforming to NAAWS 4.0, Type 4.

]

****

Verify if selected veneers are part of the endangered species (CITES).

****

2.2.2.1 Faces

Single-ply wood veneer not less than 0.508 mm 1/50 inch thick.

a. Species: [Anigre] [Select white ash] [Figured select white ash] [Select white birch] [Select red birch] [Cherry] [Select red gum] [Figured select red gum] [Select white maple] [Red oak] [White oak] [Persimmon] [Sapele] [Sycamore] [Walnut] [_____].

b. Cut: [Rotary cut] [Plain sliced (flat sliced)] [Quarter sliced] [Rift cut].

c. Match between Veneer Leaves: [Book] [Slip] [Random] match.

d. Assembly of Veneer Leaves on Door Faces: [Center-balance] [Balance] [Running] match.

e. Pair and Set Match: Provide for doors hung in same opening[or separated only by mullions].

f. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by [3 m10 feet] [6 m20 feet] [_____] or more.

g. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.

h. Transom Match: [Continuous match] [End match] [As indicated].

i. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling.

****

NOTE: Delete the following paragraph if plastic-laminate doors are selected.

****

2.2.3 Door Finishing

Conform factory finishing of Sound Retardant Wood Swinging Doors in accordance with AWI Quality Standards. Provide factory finish of a water-base stain and ultraviolet (UV) cured polyurethane sealer to comply with EPA Title 5 guidelines for Volatile Organic Compound (VOC) emissions limitations. Conform finish to meet or exceed performance standards of NAAWS 4.0 catalyzed polyurethane.

2.3 COMPONENTS

****

NOTE: Indicate frame profiles and dimensions on drawings.

Coordinate with door manufacturer when exit devices are required. Removable mullions are not recommended over STC45.

****

2.3.1 Frames

Construct frames for Sound Retardant Wood Swinging Doors from formed sheet steel or structural shapes and bars. Provide sheet steel that is commercial quality, level, cold rolled steel conforming to ASTM A1008/A1008M or hot rolled, pickled and oiled steel conforming to ASTM A1011/A1011M. Comply steel shapes with ASTM A36/A36M and steel bars with ASTM A108, Grade 1018.

2.3.2 Door Frame Sound Infill

[Grout: Comply with ASTM C476, with a slump of not more than 102 mm4 inches as measured according to ASTM C143/C143M.

][Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 0.381 millimeter15 mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

] Select the appropriate infill material [_____].

2.3.3 Hardware Reinforcements

Factory mortise, reinforce, drill and tap frames for all mortise hardware as required by hardware manufacturer's template. Provide necessary reinforcement plates as required for surface mounted hardware; installer to perform all field drilling and tapping. Provide dust cover boxes on all frame mortises. Provide minimum thicknesses as follows:

a. Butts, 4.7 millimeter 3/16 inch

b. Lock strike, 3.04 millimeter 0.1196 inch

c. Surface applied hardware 1.90 millimeter 0.0747 inch

2.3.4 Jamb Anchors

Provide number and spacing of anchors as follows:

2.3.4.1 Masonry Type

Locate anchors not more than 457 mm18 inches from top and bottom of frame. Space anchors not more than 813 mm32 inches o.c. and as follows:

a) Two anchors per jamb up to 1524 mm60 inches in height.

b) Three anchors per jamb from 1524 to 2286 mm60 to 90 inches in height.

c) Four anchors per jamb from 2286 to 2438 mm90 to 96 inches in height.

d) Four anchors per jamb plus one additional anchor per jamb for each 610 mm24 inches, or fraction thereof, more than 2438 mm96 inches in height.

2.3.4.2 Stud-Wall Type

Locate anchors not more than 457 mm18 inches from top and bottom of frame. Space anchors not more than 813 mm32 inches o.c. and as follows:

a) Three anchors per jamb up to 1524 mm60 inches in height.

b) Four anchors per jamb from 1524 to 2286 mm60 to 90 inches in height.

c) Five anchors per jamb from 2286 to 2438 mm90 to 96 inches in height.

d) Five anchors per jamb plus one additional anchor per jamb for each 610 mm24 inches, or fraction thereof, more than 2438 mm96 inches in height.

e) Two anchors per head for frames more than 1066 mm42 inches wide and mounted in metal-stud partitions.

2.3.4.3 Post-installed Expansion Type

Locate anchors not more than 152 mm6 inches from top and bottom of frame. Space anchors not more than 660 mm26 inches o.c.

2.3.5 Door Hardware

****

NOTE: If required to meet the specified STC rating, list the required hardware such as cam-lift hinges, perimeter seals, astragals, door bottoms, thresholds and hardware standoff brackets as part of this sections deliverables. List and coordinate all other hardware under Section 08 71 00 DOOR HARDWARE.

Coordinate type of door bottoms with drawings either surface mounted, semi mortised or fully mortised. Clean rooms recommend mortised door bottoms.

****

Provide the following STC related hardware with the door; [cam-lift hinges][, perimeter seals][, astragals][, door bottoms][, thresholds][, hardware standoff brackets] and [_____].

Include on Fabrication drawings a finish hardware schedule for each door and a hollow metal door frame schedule for each door indicating profile, dimensions, hardware reinforcement, and frame anchorage. Also indicate perimeter seals, door-bottom devices and other hardware items that are assembled in the shop.

Refer to Section 08 71 00 DOOR HARDWARE for remaining hardware requirements.

[2.3.6 Vision Panels

****

NOTE: Delete the paragraph heading and the following paragraphs if vision panels are not required. Edit the first paragraph as required for metal or wood doors.

Coordinate with Section 08 81 00 GLAZING.
Glazing Type: As scheduled on Drawings.
Glazing Type: Category II safety glass.
Glazing Type: One-way vision Category II safety glass.
Glazing Type: 6 mm1/4 inch fire rated ceramic safety glass.

****

Furnish doors with vision panels complete with glazing. Provide 1.90 millimeter 0.0747 inch steel or wood frames, moldings, and stop to match the door finish, with profile indicated. Assemble with mitered corners and flush joints, and secured with countersunk phillips-head screws.

Provide either a single thickness of acoustical plate glass laminated to an inner face of water-clear plastic or multiple thicknesses of 6 millimeter 1/4 inch plate glass, clear or patterned as indicated, and set in glazing gaskets and frames as required to meet the specified STC.

Provide glass to conform to ASTM C1036, Type I, Class 1. Provide acoustical plate glass that has been tested and rated in accordance with ASTM E90, with an STC of not less than 36 and a minimum thickness of 7.14 millimeter 9/32 inch.

][2.3.7 Head and Jamb Seals

[Provide a closed-cell, expanded cellular rubber Seal material conforming to ASTM D1056, Type S, Grade SBE-42 or SCE-42 for heads, jambs[, and door bottoms].

] Install seals in formed steel or extruded aluminum shapes designed to receive and hold seals and to provide concealed adjustable attachment to door frames. Provide concealed adjustment screws that are not more than 300 millimeter 12 inches on center and provide at least 10 millimeter 3/8 inch adjustment.

]2.3.8 Door Bottoms

****

NOTE: Include the following paragraph only if automatic door bottoms are required.

****

Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.

2.3.8.1 Automatic Door Bottoms

Neoprene or silicone gasket, held in place by metal housing, that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.

Mounting: [Mortised or semimortised into bottom of door] [or] [surface mounted on face of door] as required by testing to achieve STC rating indicated.

2.3.9 Thresholds

****

NOTE: Select the type of threshold. Delete the paragraph heading and both paragraphs if thresholds are not required.

The use of fluted threshold is not acceptable. Abrasive coated thresholds will cause premature wearing down of the door bottom neoprene and could cause the seal to pull out of its retainer and jam

up under the door.
****

Provide metal thresholds where indicated. Provide thresholds that are extruded aluminum, 6063-T5 alloy, mill finish, not less than 3 millimeter 1/8 inch thick, with integral seal grooves formed to the indicated section.

Provide flat, smooth, unfluted thresholds as recommended by manufacturer; fabricated from [aluminum][stainless steel][solid wood matching wood door faces].

a. Finish: [Clear][Color] anodic finish.

b. Color: [Light bronze][Medium bronze][Dark bronze][Black][Match Architect's sample][As selected by Architect from full range of industry colors and color densities].

Provide hardwood thresholds where indicated made of clear, all-heartwood, free of streaks, pin or worm holes, uniform in color, free of defects, finish sanded, and ready for job site, transparent or paint finish.

[2.3.10 Astragals

****
NOTE: Select the type of astragals. Delete the paragraph heading and both paragraphs if astragals are not required.
****

[Provide steel astragals for the inactive leaf of each pair of doors, as indicated. Surface mount to the door by welded connections or by countersunk, flat-head screws, within integral groove to receive perimeter seal material.

][Provide wood astragals for the inactive leaf of each pair of doors. Provide astragals that are solid hardwood. Match the veneer and finish of doors. Surface mount to doors by screw fasteners or with waterproof and mold-resistant adhesive conforming to ASTM D4689, Type II.

]]2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

****
NOTE: The three major U.S. testing organizations are (1) Intertek Testing Services (Warnock Hersey), (2) Factory Mutual Research, and (3) Underwriters Laboratories.

Determine if the doors qualify with the standard frame. If neither the frame nor the door is rated, a gasket system may be specified which will qualify the door/frame assembly. Failure to do so will result in the door assembly not qualifying for proper positive pressure labeling.

Verify with manufacturer of the infill material of the door frames.

Adhesive seals vs. compression seals.
****

2.4.1 Sound Transmission Classification

Provide test reports prepared by a nationally recognized, independent laboratory for Acoustical Tests, Air Infiltration Tests, Wind Loading Tests, and Water Leakage Tests indicating that the sound transmission classification (STC) of the proposed door, based on tests at 16 third-octave band frequencies from 125 to 4,000 hertz, is no less than the specified STC when tested in accordance with ASTM E90, and that the door tested is hung in substantially the type of wall and frame as indicated and is fully operable with hardware and perimeter seals installed.

2.4.2 Positive Pressure

Provide test reports, prepared by a nationally recognized, independent laboratory for Positive Pressure Tests, for all fire rated door assemblies, including Intumescent Seals,Gasketing[, and Door Bottoms].

2.4.3 Cam Lift Hinges

****

NOTE: Cam lift hinges are typically used on sound doors (STC). They lift the door up as it moves to the open position. Cam lift hinges can only be used with door closers that have a "Regular" style arm. Manual Closers: Maximum lift dimension is 3/4 inch. The following will not work with cam lift hinges: heavy duty parallel arm mount.

****

When required to achieve STC, manufacturer to furnish laboratory test data certifying hinges have been cycled a minimum of 1,000,000 while supporting a minimum door weight of 159 kg 350 pounds.

Full-mortise template type that raises the door 13 mm1/2 inch when door is fully open; with hardened pin; fabricated from stainless steel.

2.4.4 Guarantee

Provide written guarantee that each door delivered to the project is equal in construction, sound transmission classification (STC), and positive pressure test rating where applicable, with appropriate labeling and markings, to that of the sample door tested. Clearly state in written guarantee that each door assembly, when installed in accordance with the manufacturer's printed instructions, has an in-place STC within 3 decibels of the specimen tested. Submit the following test data and Certificates with the written Guarantee:

a. Wind Loading Tests

b. Water Leakage Tests

c. Acoustical Tests

d. Air Infiltration Tests

e. Positive Pressure Tests

PART 3 EXECUTION

3.1 PREPARATION

****

NOTE: Zinc-coated (galvanized) thickness of coating designations G60 or G90 are available, but not recommended, except for use in extreme exposure conditions due to potential paint adhesion issues. Refer to ASTM A653/653M for additional information.

****

Upon receipt of material, thoroughly inspect all frames, doors and accessories. Verify quantities and tag numbers according to the packing list provided. Report all discrepancies, deficiencies and/or damages immediately to Contracting Officer.

Prior to installation check all doors and frames for correct size and swing. Verify that frames are plumb, square and aligned without twist in accordance with tolerances published by NAAMM/HMMA and SDI.

3.1.1 Frame Painting and Cleaning

Clean thoroughly all surfaces of all mill scale, rust, oil, grease, dirt, and other foreign materials before the application of the shop coat of paint.

Apply one shop coat of rust inhibitive metallic oxide or synthetic resin primer applied to clean, dry, and prepared surfaces by brush, dipping, or other approved method to provide a continuous minimum dry film thickness of 0.023 millimeter 0.9 mil.

3.2 INSTALLATION

****

NOTE: The acoustic door manufacturer may have tested the infill of the hollow metal frames with acoustic liner instead of grout for non-fire-rated doors. Check manufacturers website for testing data.

Frames need to be backfilled with appropriate sound deadening material. Frames are not designed to act as forms for grout. It is recommended that the contractor be responsible for the grouting and for any required barrier coating.

****

3.2.1 Frame

Install frames plumb and true with not more than 0.8 millimeter 1/32 inch deviation in vertical alignment in 2440 millimeter 8 feet. Anchor to the wall in accordance with the manufacturer's instructions. Grout frames solid with mortar in masonry, concrete, and plaster wall construction. Spot grout frames in dry wall partitions with mortar at the jamb anchor clips; fill the space between metal frame and stud partition solidly with fiberglass or mineral wool insulation.

Field splices may be required after installation because of shipping limitations. Field weld splices by certified welders per manufacturer's instructions and in accordance with AWS D1.3/D1.3M.

3.2.2 Door

Install and adjust all doors, hardware, and seals in accordance with the approved drawings, hardware schedules, and the printed instructions of the door manufacturer.

****

NOTE: Delete bracketed sentence in the first paragraph and the second paragraph if automatic door bottom devices are not applicable to the project.

****

Install and adjust perimeter seals [and automatic door bottom seals] to provide positive compression contact with the entire sealing surface with no gaps, openings, or breaks. Hinges or hardware which distort or pinch the perimeter seal during operation of the door will be rejected.

Install door bottom devices to seal the space between the door bottoms and the finished floor and the space between the seal and seal housing.

Field apply perimeter seal housings with mitered corners and with flush, aligned hairline joints.

[Install wood doors and frames in accordance with [NFPA 80][UL 10C].

] Install components to manufacturer's written instructions. Coordinate with [masonry][gypsum board][concrete][_____] wall construction for anchor placement. Set frames plumb, square, level and at correct elevation. Adjust operable parts for correct clearances and function. Install and adjust perimeter and bottom acoustic seals.

[3.3 FIELD QUALITY CONTROL

Provide third party testing in accordance with ASTM E336. Verify in writing that installed product performs no less than five (5) ASTC or NIC rating points below the specified laboratory STC rating. Examine, adjust, and retest any installation not meeting that criteria until compliance is obtained.

3.3.1 Testing and Performance

Provide assemblies that are identical to those tested at an independent acoustical laboratory qualified under the National Voluntary Laboratory Accreditation Program (NVLAP) by the National Institute for Science and Technology (NIST) in accordance with ASTM E90 and ASTM E413. For the assembly test reports include the laboratory name, test report number and date of test.

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 36 13 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 36 13 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 36 13 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 36 13 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 36 13

SECTIONAL OVERHEAD DOORS

08/20

****

NOTE: This guide specification covers sectional overhead doors. Vertical lift metal doors of the overhead stacking type are now covered in Section 08 36 19 VERTICAL LIFT DOORS.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: On the drawings, show:

1. Location and size of door openings

2. Type and details of door frames

3. Wire and conduit from power source to operators and controls for electrically-operated doors

4. Type of lift required (consult manufacturer's catalogs for required headroom and backroom)

5. Design wind loads required for building

6. Profile of door panel if important. Do not use

proprietary profile.

7. Size and location of glazed panels

8. Location of motors and control stations.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A227/A227M	(2024) Standard Specification for Steel Wire, Cold-Drawn for Mechanical Springs
ASTM A229/A229M	(2024) Standard Specification for Steel Wire, Quenched and Tempered for Mechanical Springs
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or

	Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

DOOR AND ACCESS SYSTEM MANUFACTURERS ASSOCIATION (DASMA)

ANSI/DASMA 102	(2011) Specifications for Sectional Overhead-Type Doors
ANSI/DASMA 108	(2017) Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA ST 20	(2014) Dry-Type Transformers for General Applications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 325	(2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G, [_____]

SD-03 Product Data

Doors; G, [_____]

[Electric Operators; G, [_____]

] SD-08 Manufacturer's Instructions

Doors

SD-10 Operation and Maintenance Data

Doors, Data Package 2; G, [_____]

1.2.1 Shop Drawing Information

Show types, sizes, locations, metal gages including minimum metal decimal thickness, hardware provisions, installation details, and other details of construction.[For electrically-operated doors, include supporting brackets for motors, location, type, and ratings of motors, switches, and safety devices.]

[1.2.2 Electric Operators Product Data

For electrically motor-operated doors, submit manufacturer's wiring diagrams for motor and controls.

]1.3 DELIVERY, STORAGE, AND HANDLING

Protect doors and accessories from damage during delivery, storage, and handling. Clearly mark manufacturer's brand name. Store doors in dry locations with adequate ventilation, free from dust and water. Remove damaged items and provide new. Provide easy access for inspection and handling of overhead doors prior to installation.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Hard-Drawn Springwire

ASTM A227/A227M.

2.1.2 Oil-Tempered Springwire

ASTM A229/A229M.

2.1.3 Steel Sheet

ASTM A653/A653M.

2.1.4 Steel Shapes

ASTM A36/A36M.

2.1.5 Aluminum Extrusions

ASTM B221M ASTM B221, Alloy 6063-T5.

2.1.6 Aluminum Sheets and Strips

ASTM B209M ASTM B209, alloy and temper best suited for the purpose.

2.1.7 Glass

****
NOTE: In accordance with DASMA TDS-158, safety glazing may not be required in all applications. Refer to conditions listed within DASMA TDS-158.
****

[Fully tempered, clear float glass][Double strength, clear glass] [3] [_____] mm [1/8] [_____] inch thick.

2.2 DOORS

Doors must comply with ANSI/DASMA 102. Metal doors to have horizontal sections hinged together which operate in a system of tracks to completely close the door opening in the closed position and make the full width and height of the door opening available for use in the open position. Provide a permanent label on the door indicating the name and address of the manufacturer. Provide doors with [standard lift type designed to slide up and back into a horizontal overhead position and requiring a maximum of 400 mm 16 inch of headroom for 50 mm 2 inch tracks and 535 mm 21 inch of headroom for 75 mm 3 inch tracks] [low headroom type designed to slide up and back into a horizontal overhead position and requiring a maximum of 250 mm 10 inch of headroom for 50 mm 2 inch tracks and 300 mm 12 inch of headroom for 75 mm 3 inch tracks] [high lift type designed to slide up and back into a combination vertical and horizontal position] [vertical lift type designed to slide upward into a vertical position]. Doors operate [by lifting handles] [by hand chain with gear or sprocket reduction] [by hand crank with gear or sprocket reduction] [by electric power with auxiliary hand chain operation].

2.3 DESIGN REQUIREMENTS

****
NOTE: Determine design wind loads in accordance with ASCE 7-16. Insert design wind load for the building if not shown on the drawings Note that plus or minus 0.64 kilopascals plus or minus 13.3 PSF encompasses 185 KMH 115 MPH Exposure B per ASCE 7-16, which includes over 80 percent of the U.S. geographic area.
****

Design wind load must [conform to the design wind load for the building] [withstand a wind pressure of [plus or minus 0.64] [_____] kilopascals [a minimum of plus or minus 13.3] [_____] pounds per square foot] of door area without damage. Doors must be tested in accordance with either ASTM E330/E330M or ANSI/DASMA 108 and must meet the acceptance criteria of ANSI/DASMA 108.

2.4 FABRICATION

****
NOTE: Choose this paragraph and subparagraphs or the paragraph below ALUMINUM PANEL OVERHEAD DOORS.
****

2.4.1 Steel Overhead Doors

Form door sections of hot-dipped galvanized steel not lighter than [0.9 mm thick 20 gage with longitudinal integral reinforcing ribs][or][0.6 mm thick 24 gage with longitudinal integral reinforcing ribs and flat bottom V-grooves]. Install sections not less than 50 mm 2 inch in thickness. Meeting rails to have interlocking joints to ensure a weathertight closure and alignment for full width of the door. Provide sections of the height indicated or the manufacturer's standard. Do not exceed 600 mm thick 24 inch height for intermediate sections. Bottom sections may be varied to suit door height. Do not exceed 750 mm 30 inch height for bottom section.[Provide glass panels and install panels using manufacturer's standard for rubber gaskets.]

****

NOTE: Door assembly may be required to be rated for U-factor. Doors obtain U-factor in accordance with either ANSI/DASMA 105 or NFRC 100. Note that the U value of 0.27 is met in common insulation offerings such as 25.4 mm 1 inch polyurethane or 35 mm 1-3/8 inch EPS.

****

2.4.1.1 Insulated Sections

Insulate door sections with plastic foam or other material providing a "U" factor of 0.27 or less. Cover interior of door sections with steel sheets of not lighter than 0.4 mm thick 27 gage to completely enclose the insulating material.

[2.4.1.2 Aluminum Sections

At the Contractor's option, door sections may be constructed of aluminum in lieu of steel. Provide the same structural and thermal properties for aluminum sections as specified for steel sections.

][2.4.2 Aluminum Panel Overhead Doors

Provide door panel construction with extruded aluminum stiles and rails with aluminum[and glass] panels. Stiles and rails has a minimum wall thickness of 1.5 mm 0.060 inch. Meeting rails shall have interlocking joints to ensure a weathertight closure and alignment for full width of door. Provide sections to the height indicated or the manufacturer's standard, but the height of an intermediate section not to exceed 600 mm 24 inch. Bottom sections may be varied to suit door height, but to not exceed 750 mm 30 inch in height. Provide aluminum panels not less than 1.0 mm 0.040 inch in thickness. Install panel using a continuous vinyl gasket and snap-in type of aluminum or vinyl glazing bead.[Install glass panels as specified for aluminum panels.]

]2.4.3 Tracks

Provide galvanized steel tracks not lighter than 1.8 mm 14 gage thick for 50 mm 2 inch tracks and not lighter than 2.5 mm 12 gage thick for 75 mm 3 inch tracks. Provide galvanized steel vertical tracks with continuous galvanized steel angle not lighter than 2.1 mm thick 13 gage for installation to walls. Incline vertical track through use of adjustable brackets to obtain a weathertight closure at jambs. Reinforce horizontal track with galvanized steel angle; support from track ceiling construction with galvanized steel angle and cross bracing to provide a rigid installation.

2.4.4 Hardware

Provide hinges, brackets, rollers, locking devices, and other hardware required for complete installation. Install roller brackets and hinges with 14 gage galvanized steel. Provide rollers with ball bearings and case-hardened races. Provide reinforcing on doors where roller hinges are connected. Provide a positive locking device and cylinder lock with two keys on manually operated doors.

2.4.5 Counterbalancing

Counterbalance doors with an oil-tempered, helical-wound torsional spring mounted on a steel shaft. Provide adjustable spring tension, connect spring to doors with cable through cable drums. Provide cable safety factor of at least 5 to 1.

2.5 MANUAL OPERATORS

2.5.1 Pushup Operators

Provide lifting handles on both sides of door. Do not exceed the lesser of 10 percent of the door weight or 11.25 kilograms 25 pounds for the maximum lifting force of required to operate the door. Provide pulldown straps or ropes at bottom of doors over 2130 mm 7 feet high.

2.5.2 Chain Hoist Operators

Provide a galvanized, endless chain operating over a sprocket. Extend chain to within 1200 mm 4 feet of the floor and mount on inside of building. Obtain reduction by use of roller chain and sprocket drive or gearing. Provide chain cleat and pin for securing operator chain. Allow for future installation of power operators to chain hoist operator. Do not exceed the maximum lifting force of 15.75 kilograms 35 pounds required to operate the door.

2.6 ELECTRIC OPERATORS

****

NOTE: Indicate location of motors and control switches when electric operators are required. Specify three-phase motors whenever three-phase electric service is specified. Locate control stations at least 1500 mm 5 feet above floor line, so operator will have complete visibility of door at all times. Place one control station about 600 mm 2 feet from door jamb, guide, or track.

****

2.6.1 Operator Features

Operators must be labeled and listed to the requirements of UL 325. Provide operators of the drawbar type or side mount (jack shaft) type as recommended by the manufacturer. Include operators with electric motor, machine-cut reduction gears, steel chain and sprockets, magnetic brake, brackets, pushbutton controls, limit switches, magnetic reversing contactor, a manual chain hoist operator for emergency use, and other accessories necessary for operation. Design electric operator so motor may be removed without disturbing the limit switch timing and without affecting the manual operator. Provide the operator with slipping clutch coupling to prevent stalling the motor. Provide a clutch controlled emergency manual operator so that it may be engaged and disengaged from the floor; do not affect limit switch timing by operation. The manual operator is not required if door can be manual-pushup operated with a force not to exceed 11.25 kilograms 25 pounds. Provide an electrical or mechanical device that disconnects the motor from the operating mechanism when the manual operator is engaged.

2.6.2 Motors

NEMA MG 1, high-starting torque, reversible type with sufficient horsepower and torque output to move the door in either direction from any position. Provide a motor to produce a door travel speed of not less than 200 mm 8 inch or more than 300 mm one foot per second without exceeding the rated capacity. Motors must be operate on current of the characteristics indicated at not more than 377 rad/s 3600 rpm.[Single-phase motors must not have commutation or more than one starting contact.][Provide motor enclosures with drip-proof type or NEMA TENV type.]

2.6.3 Controls

Provide a motor for each door with an enclosed, across-the-line type, magnetic reversing contactor, thermal overload and undervoltage protection, solenoid-operated brake, limit switches, and control switches. Locate control switches at least 1500 mm 5 feet above the floor so the operator will have complete visibility of the door at all times. Provide control equipment to conform to NEMA ICS 1 and NEMA ICS 2. Provide control enclosures with NEMA ICS 6, Type 12 or Type 4, except that contactor enclosures may be Type 1. Provide a three-button type control switch stations with buttons marked "OPEN," "CLOSE," and "STOP." The "OPEN" and "STOP" buttons must require only momentary pressure to operate. The "CLOSE" button must require constant pressure to maintain the closing motion of the door. If the door is in motion and the "STOP" button is pressed or the "CLOSE" button released, the door must stop instantly and remain in the stop position; from the stop position, the door may be operated in either direction by the "OPEN" or "CLOSE" button. Provide full-guarded type pushbuttons to prevent accidental operation. Provide limit switches to automatically stop doors at the fully open and closed positions. Limit switch positions must be readily adjustable.

2.6.4 Entrapment Protection Devices

Provide entrapment protection devices for electrically-operated doors in accordance with UL 325. These devices must immediately stop and reverse the door in its closing travel upon sensing an obstruction in the door opening or upon failure of the device or any component of the control system. Any momentary door-closing circuit must be automatically locked out and the door must be operable manually or with constant pressure controls until the failure or damage has been corrected. No entrapment protection device must be used as a limit switch, unless its function is specifically intended to do so.

2.6.5 Control Transformers

NEMA ST 20. Provide transformers in power circuits as necessary to reduce the voltage on the control circuits to 120 volts or less.

2.6.6 Electrical Components

****

NOTE: Ensure that labor and materials for connecting motors and controls are specified in the electrical section, such as SECTIONAL OVERHEAD DOORS: Mount controls, including Type SO cable and takeup reels furnished by the door manufacturer, and provide necessary conduit, conductors, and devices in accordance with the door manufacturer's wiring diagrams.

****

NFPA 70. Provide manual or automatic control and safety devices, including extra flexible Type SO cable and spring-loaded automatic takeup reel or equivalent device, for operation of the doors. Conduit wiring and mounting of controls are specified in the corresponding electrical specification section.

[2.6.7 Hazardous Locations

****

NOTE: Delete this paragraph if not applicable. If applicable, identify doors.

****

Conform to NFPA 70. In addition to meeting other requirements specified, electrical materials, equipment, and devices for installation in hazardous locations must be specifically approved by Underwriters Laboratories or by an independent testing agency using equivalent standards, for the particular chemical group and the class and division of hazardous location involved.

]2.7 WEATHER SEALS [AND SENSING EDGES]

Provide exterior doors with weatherproof joints between sections by means of tongue-and-groove joints, rabbetted joints, shiplap joints, or wool pile, vinyl or rubber weatherstripping; a rubber, or vinyl adjustable weatherstrip at the top and jambs; and a compressible neoprene or rubber weather seal attached to the bottom of the door.[On exterior doors that are electrically operated, where a sensing edge is employed, the bottom seal must be combination compressible weather seal and sensing edge for stopping [and reversing] door movement.][On interior doors that are electrically operated, where a sensing edge is employed, the bottom seal must be a compressible type of sensing edge for stopping[and reversing] door movement.]

2.8 FINISHES

Hot-dip galvanize concealed metal surfaces and tracks in accordance with ASTM A123/A123M. Hot-dip galvanized and other ferrous metal surfaces, except rollers and lock components, which are galvanized or plated shop primed.

2.8.1 Galvanized and Shop Primed

Provide a zinc coating on specified surfaces, a phosphate treatment, and a shop prime coat of rust-inhibitive paint. Conform to ASTM A653/A653M for galvanized coating, coating designation Z180 G60, for steel sheets, and ASTM A123/A123M for assembled steel products. The weight of coatings for assembled products must be as designated in Table I of ASTM A123/A123M for the class of material to be coated. Provide a prime coat especially developed for materials treated by phosphates and adapted to application by dipping or spraying. Repair damaged zinc-coated surfaces with galvanizing repair paint and spot prime. At the Contractor's option, a two-part system including bonderizing, baked-on epoxy primer, and baked-on enamel topcoat may be applied in lieu of prime coat specified.

2.8.2 Aluminum

Provide a clear anodized finish to aluminum surfaces in accordance with AA-M10-C22-A41 contained in AA DAF45 and NAAMM AMP 500. Pretreat exposed surfaces and apply a [white] [_____] baked-on enamel finish in accordance with manufacturer's standard.

PART 3 EXECUTION

3.1 INSTALLATION

NFPA 70. Install doors in accordance with approved shop drawings and manufacturer's written installation instructions. Lubricate and adjust doors to operate freely.

Provide a weathertight installation and free from warp, twist, or distortion. Adjust and lubricate doors to operate freely.

Provide all items and accessories for a complete installation in every respect.

3.2 ELECTRICAL WORK

NFPA 70. Conduit, wiring, and mounting of controls.

3.3 TESTING

After installation is complete, operate doors to demonstrate installation and function of operators, safety features, and controls. Correct deficiencies.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 36 19 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 36 19 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 08 - OPENINGS

SECTION 08 36 19

VERTICAL LIFT DOORS

08/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 36 19 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 36 19 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 36 19

VERTICAL LIFT DOORS

08/20

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NOTE: This guide specification covers the requirements for vertical lift metal doors of the stacking type.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: On the drawings, show:

1. Location and size of door openings.

2. Type and details of door frames.

3. Design wind loads required for the building.

4. Wire and conduit from power source to operators and controls for electrically-operated doors.

5. Electrical power characteristics and location of motors and control station.

6. Counterweight tower location relative to door.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

DOOR AND ACCESS SYSTEM MANUFACTURERS ASSOCIATION (DASMA)

ANSI/DASMA 102	(2011) Specifications for Sectional Overhead-Type Doors

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 325	(2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G, [_____]

SD-03 Product Data

Doors; G, [_____]

[Motors; G, [_____]]

[Controls; G, [_____]]

SD-08 Manufacturer's Instructions

Doors

SD-10 Operation and Maintenance Data

Doors, Data Package 2; G, [_____]

1.2.1 Shop Drawing Information

Show types, sizes, locations, metal gages, hardware provisions, installation details, and other details of construction.[For electrically operated doors, include supporting brackets for motors, location, type, and ratings of motors, and safety devices. Include wiring diagrams for motors and controls.]

[1.2.2 Operation and Maintenance Data

For electrically operated doors, include wiring diagrams for motors and controls.

]1.3 DELIVERY, STORAGE, AND HANDLING

Protect doors and accessories from damage during delivery, storage, and handling. Clearly mark manufacturer's brand name. Store doors in dry locations with adequate ventilation, free from dust and water. Storage must permit easy access for inspection and handling. Remove damaged items that cannot be restored to like-new condition and provide new items.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Steel Sheet

ASTM A653/A653M.

2.1.2 Steel Shapes

ASTM A36/A36M.

2.1.3 Aluminum Extrusions

ASTM B221M ASTM B221, Alloy 6063-T5.

2.1.4 Aluminum Sheets and Strips

ASTM B209M ASTM B209, alloy and temper best suited for the purpose.

2.1.5 Glass

Fully tempered, clear float glass, [3] [_____] mm [1/8] [_____] inch thick.

2.2 DOORS

****

NOTE: Determine design wind loads in accordance with ASCE 7-16. The normal design wind load for vertical lift metal doors is one kPa 20 psf positive and negative. If conditions require greater design loads, use appropriate loads.

****

Doors must consist of multiple sections set one behind the other. Arrange door operation and travel so that sections arrive simultaneously at the full open position. Sections must stack vertically in a compact group above the head of the opening. Provide doors with counterweights. Design doors, components, and methods of installation in accordance with AISC 360 and ANSI/DASMA 102. Design wind loads must be [[one kPa] [___ kPa]] [[20 psf] [___ psf]] positive load and [[one kPa][___kPa]] [[20 psf][___psf]] negative load. Door wind load performance must be determined in accordance with ASTM E330/E330M. Maximum wind load deflection of the door must not exceed the door height in mm inches divided by 120 and the door width in mm inches divided by 120. Doors must be operable during design wind load.

2.3 MANUAL OPERATORS

Provide a galvanized, endless chain operating over a sprocket. Extend chain to within 900 mm 3 feet of the floor and mount on inside of building. Obtain reduction by use of roller chain and sprocket drive or gearing. Provide chain cleat and pin for securing operator chain. Hoist must allow for future installation of electric operators. The force required to operate the door must not exceed 15.75 kilograms 35 pounds.

2.4 ELECTRIC OPERATORS

****

NOTE: Specify three-phase motors wherever three-phase electrical service is or will be available. Locate control stations so operator will have complete visibility of the door at all times, within building at least 1500 mm 5 feet above floor line; one station should be placed about 600 mm 2 feet from jamb, guide, or track.

****

Provide operators of the type recommended by the door manufacturer. Operators must be labeled and listed to the requirements of UL 325. Operators must include electric motor, machine-cut reduction gears, steel chain and sprockets, magnetic brake, brackets, pushbutton controls, limit switches, magnetic reversing contactor, a manual operator as specified above for emergency use, and other accessories necessary for operation. The electric operator must be designed so that the motor may be removed without disturbing the limit switch timing and without affecting the manual operator. The manual operator must be clutch controlled so that it may be engaged and disengaged from the floor; operation must not affect limit switch timing. Provide an electrical or mechanical device that disconnects the motor from the operating mechanism when the manual operator is engaged.

2.4.1 Motors

NEMA MG 1, high-starting torque, reversible type with sufficient horsepower and torque output to move the door in either direction from any position. Motor must produce a door travel speed of not less than 200 mm two-thirds foot or more than 300 mm one foot per second without exceeding the rated capacity. Motors must operate on current of the characteristics indicated at not more than 377 rad/s 3600 rpm. [Single-phase motors must not have commutation or more than one starting contact.][Provide drip-proof type motor enclosures or NEMA totally enclosed non-ventilated (TENV) type.]Install motors in approved locations.

2.4.2 Controls

Each door motor must have an enclosed, across-the-line type, magnetic reversing contactor, thermal overload and undervoltage protection, solenoid-operated brake, limit switches, and control switches. Locate control switches at least 1500 mm 5 feet above the floor so the operator will have complete visibility of the door at all times. Control equipment must conform to NEMA ICS 1 and NEMA ICS 2. Control enclosures must be NEMA ICS 6, Type 12 or Type 4, except that contactor enclosures may be Type 1. Each control switch station must be of the three-button type; buttons must be marked "OPEN," "CLOSE," and "STOP." The "OPEN" and "STOP" buttons must require only momentary pressure to operate. The "CLOSE" button must require constant pressure to maintain the closing motion of the door. If the door is in motion and the "STOP" button is pressed or the "CLOSE" button released, the door must stop instantly and remain in the stop position; from the stop position, the door may be operated in either direction by the "OPEN" or "CLOSE" buttons. Pushbuttons must be full-guarded to prevent accidental operation. Provide limit switches to automatically stop doors at the fully open and closed positions. Limit switch positions must be readily adjustable.

2.4.3 Entrapment Protection Devices

Entrapment protection devices must be provided for electrically operated doors in accordance with UL 325. These devices must immediately stop and reverse the door in its closing travel upon sensing an obstruction in the door opening or upon failure of the device or any component of the control system. Any momentary door-closing circuit must be automatically locked out and the door must be operable manually or with constant pressure controls until the failure or damage has been corrected. No entrapment protection device can be used as a limit switch unless its function is specifically intended to do so.

2.4.4 Control Transformers

UL 325. Provide transformers in power circuits as necessary to reduce the voltage on the control circuits to 120 volts or less.

2.4.5 Electrical Components

****

NOTE: Ensure that labor and materials for connecting motors and controls are specified in the electrical section, such as "Vertical Lift Metal Doors." Mount controls, including Type SO cable and takeup reels furnished by the door manufacturer, and provide necessary conduit, conductors, and devices in accordance with door manufacturer's wiring diagrams.

****

NFPA 70. Provide manual or automatic control and safety devices, including extra flexible Type SO cable and spring-loaded automatic takeup reel or equivalent device, as required for operation of the doors. Conduit, wiring, and mounting of controls are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

[2.4.6 Hazardous Locations

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NOTE: Delete this paragraph if not applicable. If applicable, identify doors.

****

Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70, must be specifically approved by Underwriters Laboratories or by another independent testing agency using equivalent standards, for the particular chemical group and the class and division of hazardous location involved.

]2.5 WEATHER SEALS [AND SENSING EDGES]

Provide exterior doors with weatherproof joints between sections, a rubber or vinyl adjustable weatherstrip at the top, and a compressible neoprene or rubber weather seal attached to the bottom of the door.[On exterior doors that are electrically operated, where a sensing edge is employed, the bottom seal must be a combination compressible weather seal and sensing edge for stopping [and reversing] door movement.][On interior doors that are electrically operated, where a sensing edge is employed, the bottom seal must be a compressible type of sensing edge for stopping [and reversing] door movement.]

2.6 FINISHES

Concealed ferrous metal surfaces must be hot-dip galvanized. Exposed ferrous metal surfaces must be hot-dip galvanized and shop primed.

2.6.1 Galvanized and Shop Primed

Surfaces specified must have a zinc coating, a phosphate treatment, and a shop prime coat of rust-inhibitive paint. The galvanized coating must conform to ASTM A653/A653M, coating designation Z275 G90, for steel sheets, and ASTM A123/A123M for assembled steel products. The weight of coatings for assembled products must be as designated in Table I of ASTM A123/A123M for the class of material to be coated. The prime coat must be a type especially developed for materials treated by phosphates and adapted to application by dipping or spraying. Repair damaged zinc-coated surfaces by the application of galvanizing repair paint and spot prime. At the Contractor's option, a two-part system including bonderizing, baked-on epoxy primer, and baked-on enamel topcoat may be applied to slats before forming in lieu of prime coat specified.

2.6.2 Aluminum

[Surfaces must receive a clear anodized finish, AA-M10-C22-A41, in accordance with NAAMM AMP 500.] [Exposed surfaces must receive a pretreatment and a [white] [_____] baked-on enamel finish as standard with the manufacturer.]

PART 3 EXECUTION

3.1 FABRICATION

3.1.1 Door Sections

Provide vertical and horizontal door section members constructed of structural steel angle or channel shapes. Cover door section exteriors with sheet steel not lighter than 1.8 mm thick 14 gage, bolted, plug welded, or edge welded to frame at not more than 230 mm 9 inches on centers. Provide intermediate horizontal or vertical stiffeners so the maximum unsupported area of sheet is 1.8 square meters 20 square feet. Corners and intersections of frame members must be welded and ground smooth on exposed surfaces. Welds must develop the full strength of frame.

3.1.1.1 Insulated Sections

****

NOTE: Door assembly may be required to be rated for U-factor. Doors may obtain U-factor in accordance

with either ANSI/DASMA 105 or NFRC 100.
****

Insulated door sections must be insulated with material providing a "U" factor of 0.14 or less when tested in accordance with ASTM C136/C136M. Interior of door sections must be covered with steel sheets not lighter than 0.6 mm thick 24 gage to completely enclose the insulating material.

3.1.1.2 Aluminum Sections

At the Contractor's option, door sections may be constructed of aluminum in lieu of steel. Aluminum sections must, as a minimum, provide the same structural and thermal properties as steel sections.

3.1.2 Guides and Jamb Plates

Door sections must run in structural steel guides, securely fastened to the counterweight tower and to the idler tower, which must be attached to the building construction. The counterweight enclosure must extend approximately to the same height as the guides. Set back guides and tower faces on walls to provide clear door opening unobstructed by door guides, except when indicated otherwise.

3.1.3 Hardware

Door sections must be supported by chain or steel cable with a safety factor of five. The sheaves over which the chain or cable passes to the door must have permanently sealed precision bearings. Cast-iron counterweights must be stacked on a steel weight rod or in a special container. The counterweight tower must be enclosed with a removable steel cover not lighter than 1.8 mm thick 14 gage to a height of 2150 mm 7 feet above the floor. Provide doors with a positive locking device and cylinder lock with two keys.

3.1.4 Glazing

Provide glass panels where indicated. Install panels using rubber gaskets as standard with the door manufacturer.

3.2 INSTALLATION

NFPA 70. Install doors in accordance with approved detail drawings and manufacturer's instructions. Accurately locate anchors and inserts for guides, brackets, [motors,] [switches,] hardware, and other accessories. Upon completion, doors must be weathertight and free from warp, twist, or distortion. Doors must be lubricated and adjusted to operate freely.

3.3 ELECTRICAL WORK

NFPA 70. Conduit, wiring, and mounting of controls are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS.

3.4 TESTING

After installation is complete, operate doors to demonstrate installation and function of operators, safety features, and controls. Correct deficiencies.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 39 53 (February 2019)**
Change 1 - 05/20

Preparing Activity: USACE **Superseding**
UFGS-08 39 53 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 08 - OPENINGS

SECTION 08 39 53

BLAST RESISTANT DOORS (EARTH COVERED MAGAZINES)

02/19, CHG 1: 05/20

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 39 53 (February 2019)**
Change 1 - 05/20

Preparing Activity: USACE **Superseding**
UFGS-08 39 53 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 39 53

BLAST RESISTANT DOORS (EARTH COVERED MAGAZINES)

02/19, CHG 1: 05/20

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NOTE: This guide specification covers the requirements for blast resistant doors used in the construction or retrofit of earth covered magazines. It is highly recommended that installations and designers consult Department of Defense Explosives Safety Board Technical Paper 15 to determine if any ECM designs approved for new construction will fit the needs of the users. If a design is selected from Technical Paper 15 that is approved for new construction and the design of the door, door frame and its reinforced concrete structural elements which support the door under blast loading are unchanged from the approved design drawings, the specification should be used, but no additional blast design effort is needed. If a design is used that is not included in the list in Technical Paper 15 approved for new construction, or if a blast door is selected from an approved Technical Paper 15 design but the door frame or supporting reinforced concrete headwall deviates from this design, then this specification should be used.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: The following information must be shown on the project drawings:

1. The extent and location of structural steel;

2. Designations of steel members;

3. Yield strength of steel used in design;

4. Locations where galvanized steel will be used;

5. Types of connections (welded and bolted);

6. Locations where high-strength bolts and slip critical connections are required and the loads and stresses required if design is provided by Contractor.

7. Structural Designation of the ECM to be constructed (7 bar, 3 bar, or Undefined), as defined in DoD 6055.09-M.

8. Standard design from DDESB Technical Paper 15 being used, if applicable.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	(2020) Specifications for Structural Concrete
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 360	(2016) Specification for Structural Steel Buildings
ANSI/AISC 303	(2022) Code of Standard Practice for Structural Steel Buildings and Bridges

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A5.4/A5.4M	(2012; R 2022) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A514/A514M	(2022) Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A529/A529M	(2019) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A534	(2017; R 2022) Standard Specification for Carburizing Steels for Anti-Friction Bearings
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588/A588M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A618/A618M	(2021) Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars

	for Concrete Reinforcement
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM F436	(2011) Hardened Steel Washers
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD (DDESB)

DDESB Technical Paper 15	(2010) Approved Protective Construction

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 5100.76-M	(2012; Change 1-2018; Change 2-2020) Physical Security of Sensitive Conventional Arms, Ammunition, and Explosives
DOD 6055.09-M	(2010; Change 1-2012) DoD Ammunition and Explosives Safety Standards: General Explosives Safety Information and Requiements
MIL-DTL-29181	(2014; Rev C; Notice 3) Hasp, High Security, Shrouded for High and Medium Security Padlock
MIL-DTL-43607	(2015; Rev J; Notice 1) Padlock, Key Operated, High Security, Shrouded Shackle
UFC 3-340-02	(2008; with Change 2, 2014) Structures to Resist the Effects of Accidental Explosions

1.2 SYSTEM DESCRIPTION

****

NOTE: This specification applies solely to the main exterior doors of ECMs with the design intent of protecting AE stored therein from blast overpressures produced by an accidental detonation in an adjacent AE storage magazine sited in accordance with DOD 6055.09-M.

Unlike most other doors, a blast door must be designed in accordance with the provisions of UFC 3-340-02 and should be provided by one manufacturer as a complete assembly including the door, frame,

hardware, and accessories. This must be done because items such as the door, frame, latches, and hinges are of special manufacture and are interdependent parts of blast resistance. To facilitate the specification of individual door assemblies, the door type, blast effects, blast rating, deformation limits, operating forces, hardware, and accessories for each door are brought together under a products specification in Part 2 where assembly specification paragraphs for the various door types are provided. Before selecting a blast door's materials, a designer should verify the availability of these structural steels in the anticipated plate thicknesses and shapes. In addition, the design drawings should clearly disallow the substitution of other materials. The designer will become familiar with UFC 3-340-02 and with these assembly paragraphs prior to specification editing.

****

Provide a blast resistant door which fits a door description as follows: [Structural steel doors must be [flush mounted in frames] [or] [surface mounted] [as indicated].] [Doors must be the manually operated, [side hinged, swinging type] [or] [horizontal sliding type]]. Each door assembly must include the door, frame, anchors, hardware, and accessories and must be provided by a single manufacturer. Frames and anchors must be capable of transferring blast reactions to the adjacent supporting structure. Resistance to blast must be demonstrated either by design calculations or tests on prototype door assemblies.

Submit data on standard blast doors consisting of catalog cuts, brochures, circulars, specifications, calculations, and product data that show complete dimensions and completely describe overpressure ratings, rebound ratings, doors, frames, anchors, hardware, and accessories. Submit manufacturers' instructions for installation and field testing. Submit information, for door description, bound in manual form consisting of manufacturer's safety precautions, preventative maintenance and schedules, troubleshooting procedures, special tools, parts list, and spare parts data. All material must be cross referenced to the door designations shown on the drawings.

1.2.1 Design Requirements

The design must be in accordance with the explosives safety requirements of DOD 6055.09-M and the protective construction requirements of UFC 3-340-02.

1.2.1.1 Static Material Strength

Obtain the static values for minimum yield strength (or yield point) and (ultimate) tensile strength for steel from the applicable material specification. For tensile strength specified in terms of a tensile strength range, the lowest tensile strength specified must be selected for design. Structural steel having a minimum static yield strength (or yield point) of 50 ksi or less [and Grade 60 reinforcing bars] must be designed using an average yield strength computed as 1.1 times the minimum static yield strength or yield point. If the minimum static yield strength for structural steel exceeds 50 ksi, the expected yield strength used for design must be equal to the minimum specified static yield strength or yield point without increase. [The in-place compressive strength of concrete used for design must be the specified compressive strength.]

1.2.1.2 Dynamic Material Strength

Compute the dynamic material strength by applying a dynamic increase factor that accounts for the increase in material strength due to strain rate effects. Appropriate material-specific dynamic increase factors can be found in UFC 3-340-02 for use in design.

1.2.1.3 Structural Member Design

[Obtain structural steel section properties for rolled shapes from AISC 325, or steel manufacturers' catalogs.][Nominal reinforcing bar designations, weights, and dimensions must be obtained from ACI 318M, ACI 318, or the reinforcing bar specification.]Design structural members [,to include reinforced concrete members] in accordance with UFC 3-340-02 and satisfy all applicable response limits.

1.2.2 Blast Effects

****

NOTE: Blast loads required to be resisted by ECM doors are specified in DoDM 6055.09-M, V2.E5.5.2.4, including overpressure and impulse loads. There are three structural designations for ECM's: 7-bar, 3-bar, and Undefined. Required minimum separation distances between ECMs vary with the ECM's structural designation. The structural designation of the ECM is based, in part, upon the capabilities of its door to withstand the loads prescribed in this section. All ECM doors should, at a minimum, satisfy Protection Category 3 response limits for a shelter, as defined by UFC 3-340-02. In addition, the inward deflection of the door under blast loading may not result in its disengagement from its supports and passage between supports into an ECM. Specifying time dependent overpressure is required for ECM doors; this will reflect the applicable blast load defined in DOD 6055.09-M.

****

1.2.2.1 Overpressure

Overpressure to be resisted must be [_____] psi [with a [_____] millisecond duration] in the seating direction. The spatial distribution of overpressure must be uniform unless otherwise specified or indicated. [For overpressure specified or indicated with duration only, the waveform must be a triangle with a zero rise time.] [Special waveforms are indicated.]

1.2.2.2 Overpressure Direction

For overpressure identified as seating and for overpressure directions not otherwise specified or indicated, the positive phase overpressure must be in the direction that causes the door to seat toward the frame.

1.2.2.3   Fragment Resistance

****

NOTE: ECMs are typically constructed in distinct AE storage areas and are oriented so that all headwalls in an area face in the same direction. For other orientations, DOD 6055.09-M typically increases the required separation distance between magazines to mitigate debris hazards. As a result, primary fragment resistance is not a typical explosives safety design requirement for ECM doors. However, when special circumstances or physical security requirements necessitate such protection, design parameters will be determined in accordance with UFC 3-340-01, DDESB Technical Paper 16, or DOD 5100.76-M, as applicable. Exposing blast doors to primary fragments is not recommended because of the resulting severe damage to hardware, because molten fragments can weld the door to the frame preventing post-blast opening, and because it is difficult to prevent perforation at the door edges. Also, while latches and latch mechanisms can be protected, it is usually not practical to protect the hinges. Worst-case fragment perforation of the door can be prevented for structural steel and reinforced concrete doors by specifying fragment characteristics or a minimum plate or concrete thickness on the design drawings.

****

Per the physical security requirements of DOD 5100.76-M, the door must be designed for fragment and ballistic resistance. Accordingly, both the door and the door and frame interface must be designed to prevent fragment or ballistic perforation in accordance with DOD 5100.76-M.

1.2.3   Rebound

The explosives safety requirements of DOD 6055.09-M are based on a single explosives detonation in an adjacent ECM of its sited net explosives weight limit. DOD 6055.09-M does not require protection from multiple detonations or address physical security requirements that may apply after an accidental detonation. Accordingly, rebound resistance is not specifically required by DOD 6055.09-M. However, per DOD 5100.76-M, rebound resistance may be a physical security requirement and must be addressed accordingly.

1.2.4   Blast Door Operation

****

NOTE: NOTE: Specify swing forces of 135 and 90 N 30 and 20 pounds for structural steel doors, and 180 and 90 N 40 and 20 pounds for heavy structural steel doors. Use the lower values for structural doors when rolling bearing hinges are specified.

For latch engagement and release, specify 90 to 135 N 20 to 30 pounds for structural steel doors without gasket seals. Specifying 135 to 180 N 30 to 40 pounds for structural steel doors with gasket seals is recommended to accommodate the extra force

required to compress the gasket during latching. For means of egress, specify NFPA 101 operating forces. In this case, Type I (rolling bearing) hinges are recommended.
****

Measure the force required to set the door in motion from the 90-degree open position, and measure the force required to engage and release the latches at the latch handle with the door in the normal closed position.

Maximum operating forces must be [30] [40] [100] [_____] lbf to set the door in motion and[20] [50] [_____] lbf to [swing] [slide] the door. Maximum force to engage and release latches must be [20] [30] [_____] lbf. [Operating forces must conform to NFPA 101.]

1.3   SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project..

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Blast Resistant Door; G, [_____]

Trolley Track; G, [_____]

Trolleys; G, [_____]

Submit templates, erection and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-03 Product Data

Trolleys; G, [_____]

SD-05 Design Data

Manual Operator; G, [_____]

Submit calculations showing that manual operator has achieved by mechanical advantage, a required downward force to open the doors of not more than 18 pounds.

SD-10 Operation and Maintenance Data

Blast Resistant Door; G, [_____]

1.4 QUALITY ASSURANCES

****

NOTE: UFC 3-340-02 prohibits the welding of reinforcing bars.

****

Welders, welding operators, and weld inspectors must be qualified in accordance with AWS D1.1/D1.1M [except that] [welders performing arc welding of steel sheet and strip must be qualified in accordance with AWS D1.3/D1.3M].

1.5 DELIVERY, STORAGE, AND PROTECTION

Protection from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather, dust, and contaminants. Remove and replace damaged items with new items.

1.6 WARRANTY

Furnish manufacturer's written warranty covering the blast door assembly for 2 years after acceptance by the Government. Warranty must provide for repair and replacement of the blast door assembly and individual hardware and accessory items in the event of malfunction due to defects in design, materials, and workmanship except that the warranty need not cover finishes provided by others.

PART 2 PRODUCTS

2.1 MATERIALS

Only structural steel materials, for which tension properties have been obtained, may be used to resist blast. Select steel used in the door, door frame, and door frame anchors, and non stainless steel fasteners that resist blast, from the materials specified.

Submit structural analysis and design calculations demonstrating resistance to blast when blast resistance is not demonstrated by prototype tests. Design calculations must demonstrate adequacy under the blast effects specified or indicated. Include in the design calculations a sketch of the overpressure waveform; dimensioned sketches of blast resisting elements such as door members, frame members, latches, and hinges; section properties for blast resisting members including built-up sections; the standard under which steel is produced; static and dynamic material strength properties; the resistance, stiffness, mass, elastic natural period, and elastic deflection for flexural members; and the peak deflection, peak support rotation, and time to peak deflection for door members in flexure. Design calculations must cover initial response and all secondary items such as shear, welds, local buckling, web crippling, hinges, and latches.

2.1.1 Structural Steel

Structural steel bars, plates, and shapes must conform to ASTM A36/A36M, ASTM A242/A242M, ASTM A529/A529M, ASTM A572/A572M, ASTM A588/A588M, or ASTM A992/A992M. Quenched and tempered steel plate must conform to ASTM A514/A514M.

Submit steel mill reports covering the number, chemical composition, and tension properties for structural quality steels. When blast resistance is demonstrated by calculations, a certificate stating that the door assembly provided was manufactured using the same materials, dimensions, and tolerances shown in the calculations. When blast resistance is demonstrated by prototype testing, a certificate stating that door and frame provided was manufactured using the same materials, dimensions, and tolerances as the tested prototype and listing the hardware and frame anchors required to achieve blast resistance. Each certificate must be signed by an official authorized to certify in behalf of the manufacturer and must identify the door assembly and date of shipment or delivery to which the certificate applies.

2.1.2 Structural Tubing

****

NOTE: Retain this paragraph when structural steel doors are specified.

****

Structural tubing must conform to ASTM A500/A500M, ASTM A501/A501M, or ASTM A618/A618M.

2.1.3 Concrete and Concrete Reinforcement

****

NOTE: Retain this paragraph when doors infilled with concrete are specified.

****

Concrete is specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Concrete reinforcement must conform to ASTM A615/A615M or ASTM A706/A706M, Grade 60.

2.1.4 Bolts, Nuts, and Washers

2.1.4.1 Bolts

****

NOTE: Do not galvanize ASTM A490M ASTM A490 bolts. When galvanizing ASTM A325 bolts limit hardness of bolts to Rockwell C-32.

****

The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

a. Anchor Bolts: ASTM A307, Grade A.

b. High Strength Bolts: ASTM A325, Type 1 or 2.

c. High Strength Bolts: ASTM A490

2.1.4.2 Nuts

ASTM A563, Grade A, heavy hex style, except nuts under 1.5 inches may be provided in hex style.

2.1.4.3 Washers

ASTM F844 washers for ASTM A307 bolts, and ASTM F436 washers for ASTM A325 bolts.

2.1.5 Welding Electrodes and Rods

AWS D1.1/D1.1M.

2.2 HARDWARE

2.2.1 Trolleys

****

NOTE: Retain this paragraph when sliding-type doors are specified.

****

Must consist of cast steel or forged steel components and be designed to operate from the track beam section furnished under this contract. Trolley wheels must be made from high alloy forged steel. The wheel tread must be accurately machined to assure concentricity of axle and tread and hardened to 425-480 Brinell. Wheel treads must be unpainted. Wheel axles must be precision machined from high alloy, heat treated steel. Minimum Rated Load Capacity of the trolley must be 3,000 lbs, but not less than the load required for door operation.

2.2.1.1 Manual Operator

Provide a cast steel or forged steel, galvanized, pull door travel chain operating over a sprocket. Extend chain loop to within 3 feet of the floor. Provide chain cleat and pin for securing pull door travel chain. Provide mechanical advantage by means of roller chain and sprocket drive and/or gearing. The downward force required to operate the door must not exceed 18 pounds.

2.2.1.2 Trolley Track

Provide as indicated on drawings.

2.2.2 Hinges

****

NOTE: Retain this paragraph when structural steel swinging-type doors are specified.

Retain rolling bearing and operating cycle description under General Requirements when hinge Type 1 is specified.

Hinge Type 1 is intended for cases where high usage with smooth operation is the main requirement and is generally appropriate for facilities designed to resist the effects of improvised explosive devices.

Hinge Type 2 is intended for cases where in-structure shock could damage rollling thrust bearings and is recommended for facilities designed to resist the effects of conventional weapons.

Hinge Type 3 is recommended for low use applications such as infrequently used access doors.

****

2.2.2.1 General Requirements

Hinges must be specially manufactured to support the door and to resist blast induced loading. [The number and placement of hinges must be as shown on the structural drawings.] [The number of hinges must be determined by the blast door manufacturer.] Welds used in hinges must be continuous. Attach hinges to the door and frame using mechanical fasteners, except that full surface hinges for doors with locks must be attached to the door and frame by welding or approved tamper-resistant mechanical fasteners and hinges for doors with locks must have approved nonremovable pins. Load ratings and fatigue life for ball and roller bearings must be determined in accordance with ABMA 9 and ABMA 1111 as applicable and, unless otherwise approved, the bearing steel must conform ASTM A534. Hinges must be capable of operating for the minimum number of cycles specified without failure or excessive wear under the door service loads where one cycle consists of swinging the door back and forth between the normal closed position and the 90-degree open position, where failure or excessive wear means that the latches do not seat properly or the door does not swing smoothly due to hinge failure or wear, and where door service loads consist of the door weight plus any loads produced by hardware. Rolling bearings must be factory grease lubricated and either sealed or provided with easily accessible lubrication fittings.

2.2.2.2 Hinge Description

****
NOTE: Most hinges on DDESB-approved ECM doors in Technical Paper 15 are Type 2. Other hinge types have been included to allow for new designs to be utilized, but any new door design (including use of different components such as hinges) will need to be approved by DDESB to ensure that the ECM still qualifies for its intended blast rating.
****

[Hinge Type 1 must be capable of smooth operation for a minimum of 250,000 cycles. This type of hinge must be provided with structural quality steel [pins and leafs and either rolling bearings in both the thrust and radial directions or hardened steel washer (disc) thrust bearings and rolling radial bearings].] [Hinge Type 2 must be smooth operating and must be provided with structural quality steel pins and leafs, steel base washer (disc) thrust bearings, and metallic journal radial bearings or other approved non rolling type bearings.] [Hinge Type 3 must be provided with metallic bearings.] All hinges must conform to approved design drawings.

2.2.3 Locking System

2.2.3.1 Latching Points

The number and placement of latching points must be [as shown on the structural drawings] [determined by the door manufacturer].

[For multiple latching points, latching points can be provided at the head, sill, and jambs.] [For jamb latching points, latching points must be provided at the jambs only.]

2.2.3.2 Locking System Operation

****
NOTE: Retain the first sentence when hinge Type 1 is specified.
****

Locking systems must be capable of operating for the same number of cycles specified for the door hinges where one latch operating cycle consists of engaging and releasing using the handle. Latches must remain engaged until manually released and must not release under blast loads. [Manually operated latches must remain in the released position until manually engaged.] [Self-latching latches must provide self-activating engagement when the door is swung to the normal closed position.] Handles must release latches under a clockwise motion.

2.2.3.3 Latching Mechanism

[Latching mechanisms and latches for structural steel doors must be mounted on the seating face of the door.] [Unless otherwise approved, latch handle axles (spindles) for [structural steel doors] must extend through the blast load carrying portion of the door and must be provided with suitable metallic journal bearings.] Latch handle axles must be manufactured of hardened steel or stainless steel, and axles requiring lubrication must be provided with easily accessible lubrication fittings.

2.2.3.4 Safety Cover

****
NOTE: Safety covers apply to structural steel doors.
****

Safety covers must consist of steel housings that enclose the latching mechanism such that only the operating rods are exposed.

2.2.3.5 Cover Plate

Cover plates for structural steel doors must be manufactured of minimum 1/4 inch thick plate and must enclose the entire latching mechanism.

2.2.3.6 Latches

****
NOTE: Retain lever type latches for doors infilled with concrete.
****

Latches (latch bolts) must be manufactured of structural steel and the latch bolt throw must not be less than 3/4 inch. Latch bolts must be the sliding type in which the latch bolt slides into a matching strike in the door frame [or the lever type in which the latch bolt rotates into a groove in the frame as specified or indicated] [except that latches for doors with [mortise lock and latch sets] [and] [exit devices] must be the sliding type]. Manually operated latches must draw the door toward the frame during latching.

Submit shop and field operating test reports that include values for opening and closing forces and times, forces required to operate latches, and a description of all operating tests performed.

2.2.3.7 Handle

****
NOTE: Wheel or spoke handle options are recommended for structural steel doors when gasket seals are specified.
****

[Handles for doors with mortise lock and latch sets must be manufactured of [steel castings] [or] [stainless steel].] Latch handles must be firmly fastened to axles. Lever handles must be perpendicular to the door edge when latches are engaged. [Single lever handles must be located at the stile opposite the hinges.] [[Wheel] [and spoke lever] [Spoke lever] handles must be located approximately halfway between the stiles.]

2.2.4 Keying

[Keying must conform to Section 08 71 00 DOOR HARDWARE.] [Change keys for locks must be stamped with change number and the inscription "U.S. Property - Do Not Duplicate." Unless otherwise specified, two change keys must be provided for each lock.] [Locks must be furnished with the manufacturer's standard construction key system.]

2.2.5 Straight Steel Bar Door Pull

****

NOTE: This door pull is intended for structural steel and structural steel doors infilled with concrete. Type III normally applies.

****

Straight steel bar door pulls must be manufactured of round steel bar. The type furnished must be [Type I: 1/2 inch diameter, 5 inch grip and 2-1/2 inch projection with 1/2 inch inside bend radiuses] [;] [and] [Type II: 5/8 inch diameter, 12 inch grip and 4 inch projection with 15/16 inch inside bend radiuses] [; and] [Type III: 5/8 inch diameter, 8 inch grip and 4 inch projection with 15/16 inch inside bend radiuses]. Grip and projection dimensions are measured from the bar centerline. The pull must be attached to the door by fillet weld all around.

2.2.6 Shrouded Padlock

****

NOTE: Storage structures must be secured with either high-security padlocks and hasps or Internal Locking Devices (ILDs) as necessary to ensure protection is afforded according to level of threat. The use of the ILD should be considered for installation and use in new construction and major renovations of magazines storing SRC I and SRC II A&E as necessary to ensure protection is afforded according to the level of threat and SRC category. Contact the DoD Lock Program Technical Support Hotline at (800) 290-7606, DSN (312) 551-1212 or via the Internet at https://portal.navfac.mil/go/locks **for more information.**

****

High security padlocks with shrouded shackles must conform to MIL-DTL-43607.

2.2.7 High Security Hasp

****

NOTE: Storage structures must be secured with either high-security padlocks and hasps or Internal Locking Devices (ILDs) as necessary to ensure protection is afforded according to level of threat. The use of the ILD should be considered for installation and use in new construction and major renovations of magazines storing SRC I and SRC II A&E as necessary to ensure protection is afforded according to the level of threat and SRC category. Contact the DoD Lock Program Technical Support Hotline at (800) 290-7606, DSN (312) 551-1212 or via the Internet at https://portal.navfac.mil/go/locks **for more information..**

****

High security hasps must be [shrouded] [unshrouded] and must conform to MIL-DTL-29181.

2.2.8 Internal Locking Device

****

NOTE: Storage structures must be secured with either high-security padlocks and hasps or Internal Locking Devices (ILDs) as necessary to ensure protection is afforded according to level of threat. The use of the ILD should be considered for installation and use in new construction and major renovations of magazines storing SRC I and SRC II A&E as necessary to ensure protection is afforded according to the level of threat and SRC category. Contact the DoD Lock Program Technical Support Hotline at (800) 290-7606, DSN (312) 551-1212 or via the Internet at https://portal.navfac.mil/go/locks for more information..

****

For locking mechanism requirements, refer to DOD 5100.76-M. Internal Locking Devices must be provided by a competent manufacturer. Unique keys must be provided with each ILD. [ILD must be integrated with electronic monitoring and access control systems.] [_____]

2.2.9 Door Stop

Door stops must be designed to resist the impact of the door. The stop must not scratch or scar the door finish when the door is opened against the stop.

2.2.10 Overhead Door Holder

Overhead door holder must be surface mounted. The holder must have a spring or other device to cushion the door action and must limit the door swing at [85] [110] degrees. [The holder must have a built-in, hold-open capability at the swing limit specified.]

2.2.11 Gasket Seal

****

NOTE: Gasket seals are recommended for doors infilled with concrete. Gasket seals installed in manually operated doors are not recommended for reliable prevention of blast leakage. Seals are typically used to improve the weather seal and to provide a door silencer.

****

Sealed doors must have the full door perimeter and all door penetrations sealed. Perimeter seals must be the rubber gasket type. Gaskets must be removable, capable of sealing the mating surfaces, and resistant to the atmospheric environment. One spare set of gasket seals must be provided for each door assembly for which gasket seals are specified.

2.2.12 Door Silencer

****

NOTE: When gasket door seals are specified, the gasket seal will act as the silencer.

****

Rubber door silencers must cushion the impact of the door against the frame so that steel-to-steel contact is not made during closing.

2.2.13 Intrusion Detection System

****

NOTE: Refer to DOD 5100.76-M for specific Intrusion Detection System requirements.

****

Where required, as specified in DOD 5100.76-M, provide either an approved DOD Component standardized system, a DOD Component commercial equivalent, or an integrated system.

2.3 ACCESSORIES

2.3.1 Removable Threshold

The sill must be flush with the adjacent floor when the threshold is removed. The removable threshold must be attached using approved countersunk mechanical fasteners.

2.3.2 Ramp

The ramp must be structural steel, portable, and weigh not more than [200] [_____] pounds. The ramp must be of sufficient length to extend the full door opening width and must have the profile indicated. The ramp must be capable of supporting [a wheel load of [_____] lbf] [the wheel load indicated].

2.3.3 Weatherstripping

Weatherstripping seals must be 2 inch wide rubber impregnated canvas belting at head and jambs of doorway. The material must have a minimum thickness of 3/16 inch and must be attached to structure with a continuous 1/8 inch by 1-1/4 inch metal strip and 1/4 inch by 3/4 inch metal screws at 8 inches on center.

2.3.4 Locking Bars, Restraining Bracket, Chain Guide Holder and Handle

Provide as indicated on drawings.

2.3.5 Nameplate

Each door assembly must have a permanently affixed nameplate that displays the manufacturer's name, place and year of manufacture, and the applicable peak overpressure, impulse, and rebound rating.

2.4 FABRICATION

Fabricate doors in accordance with the applicable provisions of AISC 360. Workmanship must be equal to standard commercial practice in modern metal shops. Fabricate and assemble in the shop to the greatest extent possible.

Submit detailed fabrication and assembly drawings for doors not conforming to those included in DDESB Technical Paper 15 or for doors that are included but with appreciable modifications, indicating the location and showing dimensions, materials, fabrication methods, hardware, and accessories in sufficient detail to enable the Contracting Officer to check compliance with contract documents. These drawings need not be submitted for standard doors for which manufacturer's catalog data is submitted. Weld symbols used must conform to AWS A2.4.

Submit blast analyses and design calculations for any blast door frame or supporting reinforced concrete section that either is not listed as approved for new construction in Technical Paper 15 or does not conform to the approved Technical Paper 15 drawings for the door selected.

2.4.1 Shop Assembly

****

NOTE: For doors infilled with concrete, spall plates will be specified for all cases except in extreme cases where it is certain that spall damage is nonexistent or when faceplates are used.

****

Welding must be in accordance with AWS D1.1/D1.1M except that arc welding of steel sheet and strip must be in accordance with AWS D1.3/D1.3M. For the doors, welding might cause significant residual stresses; therefore, Contractor must submit for approval by the Contracting Officer a detailed sequence of the welding, augmenting the requirements given by the AWS specifications. [Stainless steel must be welded using electrodes conforming to AWS A5.4/A5.4M] Fabricated steel must be well-formed to shape and size, with sharp lines and angles. Intermediate and corner joints must be coped or mitered. Exposed welds must be dressed smooth. [The stiles [and top] of built-up structural steel doors must be closed using channel shapes or plates.] [When feasible, faceplates for structural steel doors must be one piece. When one-piece faceplates are not feasible, plates must be joined using full penetration groove weld butt joints or other approved welds.]

2.4.2 Shop Finishing

[Shop priming of steel surfaces must conform to Section 09 90 00 PAINTS AND COATINGS, except that surfaces that will be embedded in concrete need not be primed]. [Galvanizing of doors and frames must conform to ASTM A123/A123M or other approved methods. Surfaces that will be embedded in concrete need not be galvanized. Galvanizing of exposed portions of concrete anchors, non stainless steel fasteners, and hardware other than factory finished hardware must conform to ASTM A153/A153M or other approved methods.] All exposed surfaces must be primed and interior surfaces coated with an approved rust inhibitor.

2.4.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by the application of stick or thick paste material specifically designed for repair of galvanizing, as approved by the Contracting Officer. Clean areas to be repaired and remove the slag from the welds. Heat surfaces in which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread the molten material uniformly over surfaces to be coated and wipe the excess material off.

2.4.4 Painting

****
NOTE: Coordinate color of door and assembly with Contracting Officer.
****

The blast resistant door assembly must be shop painted in accordance with Section 09 90 00 PAINTS AND COATINGS.

2.4.5 Clearance

[Trolley, trolley track, and blast door] [Hinge, frame, and blast door] must be designed together as a system to operate properly within the vertical and horizontal space provided. [The clearance between the seated steel surfaces of structural steel doors and frames must not exceed 1/16 inch.] [The lateral clearance between flush mounted structural steel doors and frames must not exceed [1/4] [_____] inch at the head and jambs and the clearance between the meeting edges of pairs of doors must not exceed [1/2] [_____] inch.] The clearance between the door bottom and threshold must not exceed 3/4 inch.

2.4.6 Door Support System

Provide track clamps, threaded suspension rods, support brackets, hinge support plates, and door frame stiffeners as shown on the drawings such that the assembly is capable of supporting 150 percent of the design door loads.

PART 3 EXECUTION

3.1 ERECTION

3.1.1 Procedure

Erect in accordance with the manufacturer's written instuctions, AISC 360, and ACI 318. Use erecting equipment suitable for the work and in first class condition. Where parts cannot be assembled or fitted properly as a result of errors in fabrication or of deformation due to handling or transportation, report such condition immediately to the Contracting Officer and obtain approval of the method of correction; make the correction in his presence. The straightening of plates and angles or other shapes must be done by the methods approved by the Contracting Officer. If heating of metal is approved for straightening, it must not be to a higher temperature than that producing a dark "cherry red" color. After heating, the metal must be cooled as slowly as possible. Evidence of fracture on the surface of the metal after straightening is not allowed. Drain steelwork properly; fill pockets exposed to the weather with an approved waterproof material.

3.1.2 Connections

Provide anchor bolts and other connections between the steel and concrete and properly locate and build into connecting work. Design connections for which details are not indicated in accordance with AISC 360 and UFC 3-340-02.

3.1.3 High-Strength Bolting

Specification for structural joints using ASTM A325 bolts, approved by the

Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation must govern the furnishing and installation of high-strength bolting, with the following modifications. Alternate fasteners, specified in paragraph 2(d) will not be permitted.

3.1.4 Erection Tolerances

[Steel construction must be in accordance with ANSI/AISC 303.] [Concrete construction tolerances must be in accordance with ACI 301.]

3.1.5 Temporary Welds and Backing Strips

Temporary Welds and Backing Strips must be removed.

3.2 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit shop and field operating test reports that include values for opening and closing forces and times, forces required to operate latches, and a description of all operating tests performed.

3.2.1 Inspection

The manufacturer of the doors must provide a field inspection engineer to perform the following:

a. Check installation of embedded items before pouring of concrete (after forms or shoring are in place) to insure that the dimensional tolerances recommended by door manufacturer have been complied with.

b. Re-check embedded items to verify the accuracy of dimensions after shoring and forms are removed from concrete.

c. Supervise any necessary corrective action.

d. Supervise the job site assembly and installation of the doors and operators.

e. Inspect final assembly of doors and operators after corrections and adjustments have been made to doors.

f. Demonstrate to the Contracting Officer that operation of the door assembly is as specified.

3.2.2 Visual Inspection of Welding

Visually inspect welding while the operators are making the welds and again after the work is completed. After the welding is completed, hand or power wire brush welds and thoroughly clean them before the inspector makes the check inspection. Inspect welds with magnifiers under strong, adequate light for surface cracking, porosity, and slab inclusions; excessive roughness, unfilled craters, gas pockets, undercuts, overlaps, size and insufficient throat and concavity. Inspect the preparation of groove welds for adequate throat opening and for snug position of back-up-bars.

3.2.3 Nondestructive Testing

****

NOTE: The designer must indicate the location of test welds and types of testing desired. The

following information is presented as guidance. Dye penetrant testing detects small surface defects by enhancing the visibility of the flaw. Magnetic particle testing detects surface cracks and near-surface cracks; this test provides more information than the dye penetrant testing, and for approximately the same cost. Ultrasonic and radiographic testing detect surface and internal cracks, delaminations, lack of fusion, and density and thickness variations; these tests offer basically the same information, but their usage is limited by location and type of weld. Generally, fillet welds can only be dye penetrant or magnetic particle tested. Complete penetration welds at butt joints should be radiographically tested; all other complete penetration welds should be ultrasonically tested.

****

AWS D1.1/D1.1M. Test locations must be [as indicated] [selected by the Contracting Officer]. If more than [20] [_____] percent of welds made by a welder contain defects identified by testing, then all welds made by that welder must be tested by radiographic or ultrasonic testing, as approved by the Contracting Officer. When all welds made by an individual welder are required to be tested, magnetic particle testing must be used only in areas inaccessible to either radiographic or ultrasonic testing. Retest defective areas after repair.

Testing frequency: Provide the following types and number of tests:

Test Type	Number of Tests
Radiographic	[_____]
Ultrasonic	[_____]
Magnetic Particle	[_____]
Dye Penetrant	[_____]

Any weld repairs required must be in accordance with AWS D1.1/D1.1M.

3.2.4 Operational Tests

After installation is completed, field test each door for operation, clearance, fit, and seating by operating the door and hardware through at least 10 operating cycles. Test door and hardware operation using the forces specified. Provide personnel and equipment required to perform field testing. Unless waived, perform all field tests in the presence of the Contracting Officer. After testing is completed, prepare test reports and furnish [three] [_____] copies.

3.2.5 Prototype Static Test

****

NOTE: Retain this paragraph when dynamic design and/or blast testing is not used.

****

Static tests on prototype door assemblies must demonstrate that the door will resist the blast overpressure. Static tests will be accepted only if the door and frame proposed are manufactured using the same materials, dimensions, and tolerances as those in the prototype static test and the static overpressure used in the test is at least two times the blast overpressure. Static test reports must be supplemented with calculations that demonstrate rebound resistance when rebound resistance is required and is not tested.

3.2.6 Prototype Blast Test

Blast tests on the prototype door assembly must demonstrate that the door will resist the overpressure waveform. Blast tests will be accepted only if the door and frame proposed are manufactured using the same materials, dimensions, and tolerances as those in the prototype blast tests. The rise time of the test waveform must be zero or subject to approval. The overpressure waveform used in the test must exceed the overpressure waveform in both peak overpressure and impulse, and the blast test report must be supplemented with calculations that demonstrate the required rebound resistance is met. Submit certified test reports demonstrating blast resistance. Include in the test reports the name and location of the testing agency or laboratory, a description of the testing apparatus, the date of the tests, a description of the door specimen tested, descriptions of loadings, the value of measured peak door deflection and peak permanent set and analysis and interpretation of test results.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 39 54 (August 2009)**

Preparing Activity: USACE **Superseding**
UFGS-08 39 54 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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BLAST RESISTANT DOORS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 39 54 (August 2009)**

Preparing Activity: USACE **Superseding**
UFGS-08 39 54 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 08 39 54

BLAST RESISTANT DOORS
08/09

****
NOTE: This guide specification covers the requirements for manually operated swinging structural steel, reinforced concrete, and hollow metal blast resistant doors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2012) North American Specification for the Design of Cold-Formed Steel Structural Members

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A5.4/A5.4M	(2012; R 2022) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A354	(2017; E 2017; E 2018) Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A490M	(2014a) Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

ASTM A514/A514M	(2022) Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A529/A529M	(2019) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A534	(2017; R 2022) Standard Specification for Carburizing Steels for Anti-Friction Bearings
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A574	(2021) Standard Specification for Alloy Steel Socket-Head Cap Screws
ASTM A588/A588M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A606/A606M	(2023) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A618/A618M	(2021) Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by

	the Hot-Dip Process
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)
ASTM F835	(2023) Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws
ASTM F883	(2013; R 2022) Standard Performance Specification for Padlocks
ASTM F2155	(2001; R 2024) Standard Specification for Performance of Hasps and Other Attachment Devices for Padlocks of Seals

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.3	(2020) Exit Devices
ANSI/BHMA A156.4	(2024) Door Controls - Closers
ANSI/BHMA A156.8	(2021) Door Controls - Overhead Stops and Holders
ANSI/BHMA A156.13	(2022) Mortise Locks & Latches Series 1000
ANSI/BHMA A156.20	(2021) Strap and Tee Hinges, and Hasps

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 898-1	(2013) Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel — Part 1: Bolts, Screws and Studs with Specified Property Classes — Coarse Thread and Fine Pitch Thread

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 80A	(2022) Recommended Practice for Protection of Buildings from Exterior Fire Exposures
NFPA 101	(2024) Life Safety Code
NFPA 252	(2022) Standard Methods of Fire Tests of

Door Assemblies

U.S. DEFENSE LOGISTICS AGENCY (DLA)

DLA Lock	DOD Lock Program; http://www.dscp.dla.mil/gi/locks/

1.2 SYSTEM DESCRIPTION

****

NOTE: Unlike most other doors, a blast door is provided by one manufacturer as a complete assembly including the door, frame, hardware, and accessories. This must be done because items such as the door, frame, latches, and hinges are of special manufacture and are interdependent parts of blast resistance. To facilitate the specification of individual door assemblies, the door type, blast effects, rebound, deformation limits, operating forces, hardware, and accessories for each door are brought together under a blast door assembly specification in Part 2 where assembly specification paragraphs for the various door types are provided.

The designer will become familiar with these assembly paragraphs prior to specification editing. Coordinate with paragraph BLAST DOOR ASSEMBLIES.

****

Provide a blast resistant door which fits a Door Description as follows: [Structural steel doors that are [flush mounted in frames] [or] [surface mounted] [as indicated].] [Reinforced concrete doors that are surface mounted.] [Hollow metal doors that are flush mounted in frames.] Provide manually operated, side hinged, swinging type doors. Include the door, frame, anchors, hardware, and accessories for each door assembly, provided by a single manufacturer. Provide frames and anchors capable of transferring blast and rebound reactions to the adjacent supporting structure. Demonstrate resistance to blast either by design calculations or tests on prototype door assemblies.

1.2.1 Design Requirements

1.2.1.1 Static Material Strength

Obtain the static values for minimum yield strength (or yield point) and (ultimate) tensile strength for steel from the applicable material specification. For tensile strength specified in terms of a tensile strength range, select the lowest tensile strength specified for design. Design structural steel having a minimum static yield strength (or yield point) less than 345 MPa 50 ksi [and Grade 60 reinforcing bars] using an average yield strength computed as 1.1 times the minimum static yield strength or yield point. If the minimum static yield for structural steel exceeds 345 MPa 50 ksi, use an expected yield strength for design equal to the minimum specified static yield strength or yield point without increase. [Compute the in-place compressive strength of concrete used for design by multiplying the specified compressive strength by 1.1 to reach the expected compressed strength and then multiplying by not more than 1.15 to account for a one year age effect.] [Compute the expected yield stress for steel sheet and strip used in design as 1.21 times the specified static yield point.]

1.2.1.2 Dynamic Material Strength

Compute the dynamic material strength by applying a dynamic increase factor that accounts for the increase in material strength due to strain rate effects. Apply the dynamic increase factor for structural steel in flexure to the average yield strength and is [1.29] [_____], [1.19] [_____], and [1.09] [_____] for structural steel having a minimum yield strength (or yield point) of 248 MPa, 345 MPa, and 689 MPa 36, 50, and 100 ksi, respectively. Obtain the dynamic increase factor for structural steel having a minimum yield strength (or yield point) between these values by interpolation. Optionally, for structural steel in these yield ranges, determine the dynamic increase factor by a detailed analysis that accounts for the time to yield. The dynamic increase factor for structural steel having a minimum yield exceeding 689 MPa 100 ksi is 1.0. [The dynamic increase factor for Grade 60 flexural reinforcing bars is [1.17] [_____] applied to the average yield strength. The dynamic increase factor for concrete used in flexure is [1.19] [_____] applied to the in-place compressive strength. Optionally, determine the dynamic increase factor applied to flexural reinforcing bar yield and concrete compressive strength by a detailed analysis that accounts for the time to steel yield and time to ultimate concrete strength.] [The dynamic increase factor for steel sheet and strip used in flexure is 1.1 applied to the average yield stress.]

1.2.1.3 Structural Member Design

[Obtain structural steel section properties for rolled shapes from AISC 325, AISC 325, or steel manufacturers' catalogs. Compute the plastic moment capacity for single plate sections and sections built up from plates and shapes as the average of the elastic and plastic section modulus multiplied by the dynamic yield strength, unless otherwise approved. Design shear, welds, local buckling, and web crippling of structural steel in accordance with AISC 325, the plastic design provisions of AISC 360, or by other approved methods except that for blast design, the load factors and resistance factors are equal to 1.0 and substitute the dynamic yield strength for the static yield stress.] [Obtain nominal reinforcing bar designations, weights, and dimensions from ACI 318M ACI 318 or the reinforcing bar specification. The moment of inertia of the reinforced concrete cross section used to determine the elastic deflection is the average of the moment of inertia of the gross section and the moment of inertia of the cracked section. Compute the resistance of the reinforced concrete section in accordance with ACI 318M ACI 318 or other approved methods except that for blast design, the load and resistance factors are equal to 1.0 and substitute the dynamic reinforcing bar yield strength and dynamic ultimate concrete strength for the static strength values.] [Design hollow metal doors in accordance with AISI S100 except that for blast design, substitute the dynamic yield strength for the static yield point.]

1.2.1.4 Dynamic Analysis and Deformation

Design the door using an equivalent single degree of freedom or other approved dynamic analysis method. Select the manufacturer's maximum door deformation. Do not exceed the specified or indicated deformation limits for deformation in flexure. The deformation of structural steel members having a minimum yield strength or yield point greater than 448 MPa 65 ksi must not exceed the elastic deflection. [Increased resistance due to strain hardening of structural steel in flexure can be used when the ductility ratio exceeds 10 or when otherwise approved.] [Do not exceed a ductility ratio of 1.0 for flexural members in hollow metal doors.]

1.2.1.5 Rebound Resistance

****

NOTE: For structural steel and hollow metal doors, specify 100 percent rebound resistance in the extreme case when the blast overpressure duration is much shorter than the expected period of the door and when rebound resistance must be guaranteed. Specify less than 50 percent rebound resistance in the extreme case when the blast overpressure duration is much longer than the expected period of the door. Specify zero rebound in the extreme case in which the door need not remain in place after the blast. Otherwise, specify 50 percent rebound resistance as recommended in UFC 3-340-01. The most prevalent rebound resistance for reinforced concrete doors is 20 and 100 percent.

Rebound for each door will be specified in paragraph BLAST DOOR ASSEMBLIES.

****

Specify or indicate rebound resistance percentage of the door resistance at initial peak response.

1.2.2 Blast Effects

****

NOTE: Specifying doors in terms of overpressure without duration is recommended only when the overpressure is low and the overpressure duration is greater than about 10 times the expected period of the door. Overpressure without duration is often specified for hollow metal doors because they have low overpressure resistance. Hollow metal doors are available to resist overpressures in the range from 6 to 173 kPa 1 to 25 psi, but a structural steel door option should be considered when the overpressure exceeds 83 kPa 12 psi.

Specifying time dependent overpressure is required for other than low and long duration overpressures and is recommended for reinforced concrete doors. When the waveform is other than a zero rise time triangle, show the waveform on the drawings.

****

1.2.2.1 Overpressure

Provide uniform spatial distribution of overpressure unless otherwise specified or indicated. [For overpressure specified or indicated without duration, the overpressure waveform must have a zero rise time and infinite duration.] [For overpressure specified or indicated with duration only, the waveform must be a triangle with a zero rise time.] [Special waveforms are indicated.]

1.2.2.2 Overpressure Direction

[For overpressure identified as seating and for overpressure directions not otherwise specified or indicated, provide positive phase overpressure in the direction that causes the door to seat toward the frame.] [For overpressure identified as unseating, provide positive phase overpressure in the direction that causes the door to unseat away from the frame.]

1.2.2.3 Fragment Resistance

****

NOTE: Fragment design parameters will be determined in accordance with UFC 3-340-01, as applicable. Exposing blast doors to primary fragments is not recommended because of the resulting severe damage to hardware, because molten fragments can weld the door to the frame preventing post-blast opening, and because it is difficult to prevent perforation at the door edges. Also, while latches and latch mechanisms can be protected, it is usually not practical to protect the hinges.

Worst-case fragment perforation of the door can be prevented for structural steel and reinforced concrete doors by specifying fragment characteristics or a minimum plate or concrete thickness in the door assembly paragraph.

The 100 and 200 mm 4 and 8 inch reinforced concrete nominal thickness shown are typically available.

Hollow metal doors cannot prevent perforation by primary fragments and will not be used for this purpose.

Fragment parameters or door thickness will be specified in paragraph BLAST DOOR ASSEMBLIES.

****

For doors specified or indicated to resist fragments, design the door and the door and frame interface to prevent fragment perforation and shield the latches and latching mechanism from fragment damage. Locate the fragment impact point anywhere on the door and frame face exposed to overpressure.

1.2.3 Blast Door Operation

****

NOTE: Specify swing forces of 90 and 70 N 20 and 15 pounds for hollow metal doors, 135 and 90 N 30 and 20 pounds for structural steel doors, and 180 and 90 N 40 and 20 pounds for 200 mm 8 inch thick reinforced concrete doors and heavy structural steel doors. Use the lower values for structural and hollow metal doors when rolling bearing hinges are specified.

For latch engagement and release, specify 90 to 135 N 20 to 30 pounds for structural steel doors without gasket seals and for reinforced concrete doors.

Specify 135 to 180 N 30 to 40 pounds for structural steel doors with gasket seals is recommended to accommodate the extra force required to compress the gasket during latching.

For means of egress, specify NFPA 101 operating forces. In this case, Type I (rolling bearing) hinges are recommended.

Operating requirements will be specified in paragraph BLAST DOOR ASSEMBLIES.

****

Measure the force required to set the door in motion from the 90-degree open position, and measure the force required to engage and release the latches at the latch handle with the door in the normal closed position.

1.2.4 Other Submittals Requirements

Submit the following:

a. Detailed fabrication and assembly drawings for special doors or standard doors with appreciable modifications, indicating the door location and showing dimensions, materials, fabrication methods, hardware, and accessories in sufficient detail to enable the Contracting Officer to check compliance with contract documents. These drawings need not be submitted for standard doors for which manufacturer's catalog data is submitted. Use weld symbols conforming to AWS A2.4.

b. Data on standard blast doors consisting of catalog cuts, brochures, circulars, specifications, and product data that show complete dimensions and completely describe overpressure ratings, rebound ratings, doors, frames, anchors, hardware, and accessories. Manufacturer's instructions for installation and field testing.

c. Detailed structural analysis and design calculations demonstrating resistance to blast when blast resistance is not demonstrated by prototype tests. Demonstrate adequacy under the blast effects specified or indicated. Include in the design calculations a sketch of the overpressure waveform; dimensioned sketches of blast resisting elements such as door members, frame members, latches, and hinges; section properties for blast resisting members including built-up sections; the standard under which steel is produced; static and dynamic material strength properties; the resistance, stiffness, mass, elastic natural period, and elastic deflection for flexural members; and the peak deflection, peak support rotation, and time to peak deflection for door members in flexure. Cover initial response, rebound, and all secondary items such as shear, welds, local buckling, web crippling, hinges, and latches.

d. Steel mill reports covering the number, chemical composition, and tension properties for structural quality steels. When blast resistance is demonstrated by calculations, a certificate stating that the door assembly provided was manufactured using the same materials, dimensions, and tolerances shown in the calculations. When blast resistance is demonstrated by prototype testing, a certificate stating that door and frame provided was manufactured using the same materials, dimensions, and tolerances as the tested prototype and listing the hardware and frame anchors required to achieve blast resistance. Each certificate must be signed by an official authorized to certify in behalf of the manufacturer and must identify the door assembly and date of shipment or delivery to which the certificate applies.

e. Information, for DOOR DESCRIPTION, bound in manual form consisting of manufacturer's safety precautions, preventative maintenance and schedules, troubleshooting procedures, special tools, parts list, and spare parts data. Cross reference all material to the door designations shown on the drawings.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, [_____]

SD-03 Product Data

Door Description; G, [_____]

Design Requirements; G, [_____]

Manufacturer's Field Service

SD-06 Test Reports

Tests

Tests, Inspections, and Verifications

Fire Rating Test and Inspection

Prototype Static Test; G, [_____]

Prototype Blast Test; G, [_____]

SD-07 Certificates

Materials

Fire-Rated Door Assemblies

Thermal Insulation

Sound Rating Test

SD-10 Operation and Maintenance Data

Door Description; G, [_____]

1.4 QUALITY ASSURANCE

****

NOTE: Delete AWS D1.3/D1.3M requirement when hollow metal doors are not specified. Delete AWS D1.4/D1.4M requirement when reinforced concrete doors are not specified.

****

Welders, welding operators, and weld inspectors must be qualified in accordance with AWS D1.1/D1.1M [except that] [welders performing arc welding of steel sheet and strip must be qualified in accordance with AWS D1.3/D1.3M] [and] [welders and weld operators performing welding of reinforcing bars must be qualified in accordance with AWS D1.4/D1.4M].

1.5 DELIVERY, STORAGE,AND HANDLING

Store door assemblies, delivered and placed in storage, with protection from weather and dirt, dust, and contaminants.

1.6 WARRANTY

Furnish manufacturer's written warranty covering the blast door assembly for 2 years after acceptance by the Government. Provide for repair and replacement of the blast door assembly and individual hardware and accessory items in the event of malfunction due to defects in design, materials, and workmanship except that the warranty need not cover finishes provided by others.

PART 2 PRODUCTS

2.1 MATERIALS

Use only structural quality steel materials, for which tension properties have been obtained, to resist blast except that commercial quality steel sheet and permit strip for prototype tested hollow metal doors. Select steel used in the door, door frame, and door frame anchors, and non stainless steel fasteners that resist blast, from the materials specified.

2.1.1 Concrete and Concrete Reinforcement

****

NOTE: Retain this paragraph when reinforced concrete doors are specified.

****

Concrete is specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide concrete reinforcement conforming to ASTM A615/A615M or ASTM A706/A706M, Grade 60.

2.1.2 Structural Tubing

****

NOTE: Retain this paragraph when structural steel or hollow metal doors are specified.

****

Provide structural tubing conforming to ASTM A500/A500M, ASTM A501/A501M, or ASTM A618/A618M.

2.1.3 Structural Steel

****

NOTE: For reinforced concrete and hollow metal doors, specify only ASTM A36/A36M.

****

Provide structural steel bars, plates, and shapes conforming to ASTM A36/A36M, ASTM A242/A242M, ASTM A529/A529M, ASTM A572/A572M, or ASTM A588/A588M. Provide quenched and tempered steel plate conforming to ASTM A514/A514M.

2.1.4 Steel Sheet and Strip

****

NOTE: Retain this paragraph when hollow metal doors are specified.

****

Provide steel sheet and strip conforming to ASTM A653/A653M, Type A, B, and C; ASTM A653/A653M; ASTM A606/A606M; or ASTM A792/A792M, Grades 33, 37, 40, and 50.

2.1.5 Fasteners

Provide steel studs and bolts conforming to ASTM A307, ASTM A325M ASTM A325, ASTM A354, ASTM A449, or ASTM A490M ASTM A490 as applicable. Provide steel nuts that conform to ASTM A563M ASTM A563. Provide hardened circular, beveled, and clipped washers that conform to ASTM F436M ASTM F436. Provide steel hex cap screws conforming to ISO 898-1. Provide steel socket-headed cap screws conforming to ASTM A574. Provide steel button and flat-headed countersunk cap screws conforming to ASTM F835.

2.2 HARDWARE

2.2.1 Hinges

****

NOTE: Retain rolling bearing and operating cycle description under General Requirements when hinge Type 1 is specified.

Blast door hinges are normally full surface. Mortise hinges can be specified for hollow metal doors, but availability must be verified with door manufacturers.

Hinge Type 1 is intended for cases where high usage with smooth operation is the main requirement and is generally appropriate for facilities designed to resist the effects of improvised explosive devices.

Hinge Type 2 is intended for cases where in-structure shock could damage rolling thrust bearings and is recommended for facilities designed to resist the effects of conventional weapons.

Hinge Type 3 is recommended for low use applications such as infrequently used access doors.

****

2.2.1.1 General Requirements

Provide specially manufactured hinges to support the door and to resist blast induced loading. Determine the number of hinges by the blast door manufacturer. Use continuous welds in hinges. Attach hinges to the door and frame using mechanical fasteners, except attach full surface hinges for doors with locks to the door and frame by welding or approved tamper-resistant mechanical fasteners and hinges for doors with locks must have approved nonremovable pins. Determine load ratings and fatigue life for ball and roller bearings in accordance with ABMA 9 and ABMA 11 as applicable and, unless otherwise approved, the bearing steel must conform to ASTM A534. Provide hinges that are capable of operating for the minimum number of cycles specified without failure or excessive wear under the door service loads where one cycle consists of swinging the door back and forth between the normal closed position and the 90-degree open position, where failure or excessive wear means that the latches do not seat properly or the door does not swing smoothly due to hinge failure or wear, and where door service loads consist of the door weight plus any loads produced by hardware. Provide rolling bearings that are factory grease lubricated and either seal or provide with easily accessible lubrication fittings.

2.2.1.2 Hinge Description

[Hinge Type 1 must be capable of smooth operation for a minimum of 250,000 cycles. Provide this type of hinge with structural quality steel pins and leafs and either rolling bearings in both the thrust and radial directions or hardened steel washer (disc) thrust bearings and rolling radial bearings except permit rolling thrust bearings and metallic journal radial bearings for hollow metal doors when the specified overpressure is less than 21 kPa 3 psi]. [Hinge Type 2 must be smooth operating and provide with structural quality steel pins and leafs, steel base washer (disc) thrust bearings, and metallic journal radial bearings or other approved non rolling type bearings.] [Provide Hinge Type 3 with metallic bearings.]

2.2.2 Latching System

2.2.2.1 Latching Points

Determine the number of latching points by the door manufacturer. [For multiple latching points, latching points can be provided at the head, sill, and jambs.] [For jamb latching points, provide latching points at the jambs only.]

2.2.2.2 Latching System Operation

****

NOTE: Retain the first sentence when hinge Type 1 is specified.

****

Provide latching systems capable of operating for the same number of cycles specified for the door hinges where one latch operating cycle consists of engaging and releasing using the handle. Keep latches engaged until manually released and do not release under blast loads or rebound. [Keep manually operated latches in the released position until manually engaged.] [Provide self-latching latches that provide self-activating engagement when the door is swung to the normal closed position.] Provide handles that release latches under a clockwise motion.

2.2.2.3 Latching Mechanism

[Mount latching mechanisms and latches for structural steel doors on the seating face of the door.] [Mount latching mechanisms for hollow metal doors on the seating face of the door and safety covered.] [Unless otherwise approved, extend latch handle axles (spindles) for [structural steel doors] [and] [reinforced concrete doors] through the blast load carrying portion of the door and provide with suitable metallic journal bearings.] Provide latch handle axles manufactured of hardened steel or stainless steel, and provide axles requiring lubrication with easily accessible lubrication fittings.

2.2.2.4 Safety Cover

****

NOTE: Safety covers apply to structural steel and hollow metal doors.

****

Provide safety covers consisting of steel housings that enclose the latching mechanism such that only the operating rods are exposed.

2.2.2.5 Cover Plate

Provide cover plates for structural steel doors that are manufactured of minimum 6 mm 1/4 inch thick plate and that enclose the entire latching mechanism.

2.2.2.6 Latches

****

NOTE: Retain lever type latches for reinforced concrete doors.

****

Provide latches (latch bolts) that are manufactured of structural quality steel with latch bolt throw no less than 19 mm 3/4 inch. Provide sliding type latch bolts in which the latch bolt slides into a matching strike in the door frame [or the lever type in which the latch bolt rotates into a groove in the frame as specified or indicated] [except that latches for doors with [mortise lock and latch sets] [and] [exit devices] must be the sliding type]. Provide manually operated latches to draw the door toward the frame during latching.

2.2.2.7 Handle

****

NOTE: Wheel or spoke handle options are recommended for structural steel doors when gasket seals are specified.

****

[Provide handles for doors without locks that are manufactured of steel castings, forgings, pipe, round tubing, bar, or plate and are one piece or have welded joints except that wheel handles can be manufactured of aluminum castings.] [Provide handles for doors with mortise lock and latch sets that are manufactured of [steel castings] [or] [stainless steel].] Fasten latch handles firmly to axles. Lever handles must be perpendicular to the door edge when latches are engaged. [Locate single lever handles at the stile opposite the hinges.] [Locate [wheel] [and spoke lever] [spoke lever] handles approximately halfway between the stiles.]

2.2.3 Mortise Lock and Latch Set

****

NOTE: Mortise lock and latch sets are practical only for hollow metal doors. These lock and latch sets are special built and are not normally cycle tested as specified in ANSI/BHMA A156.13. Mortise lock and latch sets are usually specified only when a deadbolt function is required.

****

Release latches using a torque not exceeding 3 N-meters 27 lb-inch. Locate latches (latch bolts) at the stiles and operate from a single lever handle. Provide only one deadbolt . Provide deadbolt manufactured of structural quality steel with a deadbolt throw no less than 25 mm 1 inch. Provide mortise locks with armored fronts. Provide function numbers for mortise locks as defined in ANSI/BHMA A156.13.

2.2.4 Keying

[Conform to Section 08 71 00 DOOR HARDWARE.] [Stamp change keys for locks with change number and the inscription "U.S. Property - Do Not Duplicate." Unless otherwise specified, provide two change keys for each lock.] [Furnish locks with the manufacturer's standard construction key system.]

2.2.5 Exit Device

****

NOTE: Exit devices are practical only for hollow metal doors and light structural steel doors.

****

Release latches (latch bolts) by depressing the actuation bar using a force of no more than 67 N 15 lbf applied perpendicular to the door in the swing direction. Provide exit device that [conforms to the finish test values specified in ANSI/BHMA A156.3 and] is of [stainless steel construction] [and] plain design with straight, beveled, or smoothly rounded sides, corners, and edges. A touch bar may be provided in lieu of a conventional actuation bar (cross bar). Provide function numbers for exit devices as defined in ANSI/BHMA A156.3.

2.2.6 Straight Steel Bar Door Pull

****

NOTE: This door pull is intended for structural steel and reinforced concrete doors. Type III normally applies.

****

Provide straight steel bar door pulls manufactured of round steel bar. Furnish [Type I: 13 mm 1/2 inch diameter, 125 mm 5 inch grip and 65 mm 2-1/2 inch projection with 13 mm 1/2 inch inside bend radiuses] [;] [and] [Type II: 16 mm 5/8 inch diameter, 300 mm 12 inch grip and 100 mm 4 inch projection with 24 mm 15/16 inch inside bend radiuses] [; and] [Type III: 16 mm 5/8 inch diameter, 200 mm 8 inch grip and 100 mm 4 inch projection with 24 mm 15/16 inch inside bend radiuses]. Grip and projection dimensions are measured from the bar centerline. Attach the pull to the door by fillet welding all around.

2.2.7 Padlock

****

NOTE: For ASTM F883 padlock, specify Type P01 (key operated) or P02 (combination operated) and Grade 1 (lowest) to 6 (highest) performance. Available ASTM F883 options are "A" (key is captive in cylinder when padlock is unlocked), "B" (removable cylinder), "C" (changeable combination), "D" (combination operated with key control), "E" (corrosion resistant), and "F" (provided with nonferrous shackles).

****

Provide low security padlocks conforming to ASTM F883, Type [PO1][PO2], Option [_____] [and] [_____], Grade [_____].

2.2.8 Shrouded Padlock

****
NOTE: Use a shrouded padlock in conjunction with a high security shrouded hasp.
****

Provide high security padlocks with shrouded shackles conforming to DLA Lock, 5340-01-217-5068.

2.2.9 Hasp

Provide low security hasps conforming to ANSI/BHMA A156.20, Grade [1] [2] [3], steel, [safety] [or] [open hinge] type with [adjustable] [,] [or] [swivel] [,] [or] [fixed] staple, [paint finished] [or] [galvanized] [as specified] and screw fastened to the door and frame.

2.2.10 High Security Hasp

****
NOTE: This high security hasp is a non-shrouded mortise type. Styles 1 through 9 are available. Consult referenced military specification.
****

Provide high security hasps conforming to ASTM F2155, Style [_____] [carbon] [corrosion resistant] steel, attached by [fasteners] [welding].

2.2.11 Shrouded Hasp

****
NOTE: Style 1 applies to right-hand doors and Style 2 to left-hand doors.
****

Provide high security shrouded hasps conforming to ASTM F2155.

2.2.12 Door Stop

Design door stops to resist the impact of the door. The stop must not scratch or scar the door finish when the door is opened against the stop.

2.2.13 Surface Door Closer

****
NOTE: Door closers are practical only for hollow metal doors and light structural steel doors.
****

Provide surface door closer conforming to ANSI/BHMA A156.4. Provide size and grade selected by the door manufacturer.

2.2.14 Overhead Door Holder

Provide surface mounted overhead door holder. Provide a spring or other device to cushion the door action and limit the door swing at [85] [110] degrees. [Provide a built-in, hold-open capability at the swing limit specified.] [Provide overhead door holders for hollow metal doors weighing less than 90 kg 200 pounds conforming to ANSI/BHMA A156.8.]

2.2.15 Gasket Seal

****

NOTE: Gasket seals are recommended for reinforced concrete doors.

Gasket seals installed in manually operated doors are not recommended for reliable prevention of blast leakage. Seals are typically used for reinforced concrete doors to improve the weather seal and provide a door silencer.

****

Provide sealed doors that have the full door perimeter and all door penetrations sealed. Provide rubber gasket perimeter seals. Provide gaskets that are removable, capable of sealing the mating surfaces, and resistant to the atmospheric environment. Provide one spare set of gasket seals for each door assembly for which gasket seals are specified.

2.2.16 Door Silencer

****

NOTE: When gasket door seals are specified, the gasket seal will act as the silencer.

****

Provide rubber door silencers to cushion the impact of the door against the frame so that steel-to-steel contact is not made during closing.

2.2.17 Optical Device

Provide wide angle optical device (spy hole) and do not breech or dislodge by the specified or indicated blast overpressure. Permit observation from the seating face of the door and locate approximately 1.5 m 5 feet above the seating side floor and approximately centered between the stiles.

2.3 ACCESSORIES

2.3.1 Subframe

At the Contractor's option, a subframe can be provided and built into the structure prior to installation of the frame. Provide subframe and subframe anchors that are capable of transferring blast and rebound reactions to the adjacent structure, and a frame capable of transferring these reactions to the subframe. Fabricate the subframe in the same manner specified for the frame.

2.3.2 Nameplate

Provide a permanently affixed nameplate that displays the manufacturer's name, place and year of manufacture, and the applicable peak overpressure, impulse, and rebound rating for each door assembly.

2.3.3 Removable Threshold

The sill must be flush with the adjacent floor when the threshold is removed. Attach the removable threshold using approved countersunk mechanical fasteners.

2.3.4 Ramp

Provide structural steel, portable ramp that weighs no more than [90] [_____] kg [200] [_____] pounds. Provide ramp of sufficient length to extend the full door opening width and with the profile indicated. The ramp must be capable of supporting [a wheel load of [_____] N lbf] [the wheel load indicated].

2.3.5 Self-Rescue Kit

****

NOTE: Self-rescue kits are usually specified only when post-blast operation is desired and debris could prevent the door from opening.

****

Contain illustrated instructions, nonadjustable wrenches, screwdrivers, jacks, and all other tools required to open the blast door from the seating face to a width of at least 300 mm 12 inches. A jack capacity less than [334] [_____] kN [75,000] [_____] lbf is not permitted. Mount tools securely in a steel frame using wing nuts or other approved fasteners. Fabricate the self-rescue kit frame in the same manner specified for the door frame and anchor securely to the wall at the location indicated or as directed.

2.4 FABRICATION

2.4.1 Shop Assembly

****

NOTE: Delete welding of stainless steel when only reinforced concrete doors are specified.

For reinforced concrete doors, spall plates will be specified for all cases except in extreme cases where it is certain that spall damage is nonexistent or when faceplates are used.

Specify faceplates for exterior doors in conventional weapons resistant facilities in cases where construction is to parallel NATO criteria.

Composite faceplated reinforced concrete doors with studs welded to both faceplates are also available. When these doors are required, specify the following in the fabrication paragraph: "Provide composite faceplated reinforced concrete doors with studs shop welded to faceplates at both ends of the stud. Studs must be of sufficient diameter and spacing to effectively transfer shear forces." Specify the following under door assembly paragraph Door Type: "Composite faceplated reinforced concrete door."

****

Perform welding in accordance with AWS D1.1/D1.1M except that arc welding of steel sheet and strip must be in accordance with AWS D1.3/D1.3M and welding of concrete reinforcing bars must be in accordance with AWS D1.4/D1.4M. [Weld stainless steel using electrodes conforming to

AWS A5.4/A5.4M.] [Structural steel doors must be of welded construction.] Provide fabricated steel that is well-formed to shape and size, with sharp lines and angles. Cope or miter intermediate and corner joints. Smooth dress exposed welds. [Close the stiles [and top] of built-up structural steel doors using channel shapes or plates.] [When feasible, provide one-piece faceplates for structural steel doors. When one-piece faceplates are not feasible, join plates using full penetration groove weld butt joints or other approved welds.] [Close reinforced concrete doors at the edges with structural steel channels or plates and mortise latch housings. Do not use lap splices for flexural reinforcing bars.] [Provide one-piece spall plates, covering the entire concrete surface on the seating face of the door, and weld securely to the door edges. Spall plates less than 6 mm 1/4 inch thick are not permitted.] [Provide faceplated reinforced concrete doors with one-piece faceplates on both door faces. Provide faceplates that cover the entire concrete surface and weld securely at the door edges. Faceplates less than 9 mm 3/8 inch thick are not permitted.] [Provide hollow metal door frames consisting of pressed steel or structural steel with welded joints. Provide steel frames or subframes installed in masonry walls with adjustable anchors. Provide hollow metal doors consisting of unitized grid construction with welded grid junctions that have flat, one-piece face sheets spot welded to each face of the grid system. Close the edges of hollow metal doors with seams continuously welded. Provide hollow metal doors that are neat in appearance, free from warpage and buckle, and provide suitable reinforcing for hardware.]

2.4.2 Mullion

Fabricate mullions for double doors in the same manner specified for frames. [Weld fixed mullions to the frame.] [Attach removable mullions to the frame with mechanical fasteners that are accessible for mullion removal or, in lieu of the removable mullion, provide an astragal at the seating face of the inactive door leaf.] Doors must seat directly against the mullion, and the mullion or astragal must be capable of transferring the door reactions to the frame.

2.4.3 Thermal Insulation

****

NOTE: Thermal insulation is practical only for hollow metal doors.

****

Completely fill the interior cells between the unitized grid with thermal insulation material. The U value through the door (panel) must not exceed [1.36] [_____] W per square meter per degree K [0.24] [_____] Btu per square foot per hour per degree F. Submit certification or test report for [thermal insulated] [sound rated] doors listing the type of hardware used to achieve the rating; see paragraph SOUND RATING TEST below.

2.4.4 Shop Finishing

[Shop prime steel surfaces in conformance to Section 09 90 00 PAINTS AND COATINGS, except that surfaces that will be embedded in concrete need not be primed and either dip hollow metal doors in primer after welding is completed, or prime exposed surfaces and coat interior surfaces with an approved rust inhibitor]. [Galvanize doors and frames conforming to ASTM A123/A123M or other approved methods. Surfaces that will be embedded in concrete need not be galvanized and the interior of hollow metal doors may be treated with an approved rust inhibitor in lieu of galvanizing.

Galvanize exposed portions of concrete anchors, non stainless steel fasteners, and hardware other than factory finished hardware conforming to ASTM A153/A153M or other approved methods.]

2.4.5 Clearance

[The clearance between the seated steel surfaces of structural steel doors and frames must not exceed 1.6 mm 1/16 inch.] [The lateral clearance between flush mounted structural steel doors and frames must not exceed [6] [_____] mm [1/4] [_____] inch at the head and jambs and the clearance between the meeting edges of pairs of doors must not exceed [13] [_____] mm [1/2] [_____] inch.] [The lateral clearance between hollow metal doors and frames must not exceed 3 mm 1/8 inch at the head and jambs and the clearance between the meeting edges of pairs of doors must not exceed 6 mm 1/4 inch.] The clearance between the door bottom and threshold must not exceed 19 mm 3/4 inch.

2.5 BLAST DOOR ASSEMBLIES

****

NOTE: The assembly paragraphs provided for structural steel, reinforced concrete, and hollow metal doors will be repeated and edited as many times as required to specify all door assemblies. The door designations will then be referenced in the door schedule on the drawings. Items shown on the drawings will not be duplicated in the door assembly paragraphs. The door assembly paragraphs are pre-edited to show normal use and hardware availability; e.g., thermal insulation, sound rating, and mortise locks are omitted for structural steel and reinforced concrete doors, Type 2 hinges are normally used for reinforced concrete doors and thus are shown without brackets, etc.

****

2.5.1 Door [_____]; Steel

****

NOTE: Coordinate with paragraphs DESCRIPTION and BLAST DOOR ASSEMBLIES.

****

2.5.1.1 Type

Type must be [structural steel] [double structural steel door with [fixed] [or] [removable] mullion] [,] [galvanized] [,] [and] [fire-rated].

2.5.1.2 Overpressure

Provide overpressure of [_____] kPa psi [with a [_____] millisecond duration] in the [seating] [unseating] direction [and [_____] kPa psi [with a [_____] millisecond duration] in the unseating direction]. Indicate the [shock and gas overpressure] [overpressure] waveform.

2.5.1.3 Fragment

****

NOTE: Coordinate with paragraph Fragment

Resistance, under paragraph DESCRIPTION.
****

[The fragment must be [_____] g ounces with a velocity of [_____] m/s fps and impact [normal to] [at an angle of [_____] degrees measured from] the door face.] [Provide protection from fragments by steel plate no less than [_____] mm inches in thickness.]

2.5.1.4 Rebound

****
NOTE: Coordinate with paragraph Rebound Resistance, under paragraph DESCRIPTION.
****

Provide rebound resistance of [50] [100] [_____] percent.

2.5.1.5 Deformation Limits

****
NOTE: For structural steel doors, the deformation limit criteria for accidental explosion applications is given below.

Prot. Cat. No.	**Support Rotation (Deg.)**	**Ductility Ratio**
1	**2**	**10**
2	**12**	**20**

A 2-degree support rotation and ductility ratio of 10 is recommended when post-blast opening is required. This deformation limit is recommended for conventional weapon and improvised weapon exterior door applications in order to avoid entrapment of personnel.
****

Do not exceed [10 and do not exceed 2 degrees for support rotation] [20 and do not exceed 12 degrees for support rotation] for ductility ratio.

2.5.1.6 Hardware

****
NOTE: Coordinate with paragraph Hinges, under paragraph HARDWARE. A door pull is recommended.
****

Provide Type [1] [2] [3] full surface hinges. Provide [multiple] [jamb] latching points and [multiple lever handles] [,] [or] [a single lever handle] [,] [or] [a wheel handle] [,] [or] [a spoke lever handle] operated from [the seating face] [and] [opposite the seating face] with [manual] [self-latching] latch engagement and [either] sliding [or lever] latch bolts. Provide [safety] [or] [cover] plated latching mechanism. Provide a [Type [I] [II] [III] straight steel bar door pull] [,] [and] [padlock] [shrouded padlock] [,] [and] [hasp] [high security hasp] [shrouded hasp] [,] [and] [door stop] [,] [and] [surface door closer] [overhead door holder] [,] [and] [gasket seals] [door silencer] [,] [and] [optical device].

2.5.1.7   Operating Forces

****
NOTE: Coordinate with paragraph Blast Door Operation, under paragraph DESCRIPTION.
****

[Provide maximum operating forces of [135] [180] [_____] N [30] [40] [_____] lbf to set the door in motion and [90] [_____] N [20] [_____] lbf to swing the door. Provide maximum force to engage and release latches of [90] [135] [180] [_____] N [20] [30] [40] [_____] lbf.] [Operating forces must conform to NFPA 101.]

2.5.1.8   Accessories

Provide a [removable threshold] [or] [ramp] [and] [self-rescue kit].

2.5.2   Door [_____]; Concrete

****
NOTE: Coordinate with paragraph DESCRIPTION and paragraph BLAST DOOR ASSEMBLIES.
****

2.5.2.1   Type

Type must be [reinforced concrete] [double reinforced concrete] door with [fixed] [or] [removable] [mullion] [and] [with] [spall plate] [faceplates].

2.5.2.2   Overpressure

Provide overpressure of [_____] kPa psi [with a [_____] millisecond duration] in the [seating] [unseating] direction [and [_____] kPa psi with a [_____] millisecond duration in the unseating direction]. Indicate the [shock and gas overpressure] [overpressure] waveform.

2.5.2.3   Fragment

****
NOTE: Coordinate with paragraph Fragment Resistance, under paragraph DESCRIPTION.
****

[The fragment must be [_____] g ounces with a velocity of [_____] m/s fps and impact [normal to] [at an angle of [_____] degrees measured from] the door face.] [Provide nominal door thickness no less than [100] [200] [_____] mm [4] [8] [_____] inches].

2.5.2.4   Rebound

****
NOTE: Coordinate with paragraph Rebound Resistance, under paragraph DESCRIPTION.
****

Provide rebound resistance of [20] [100] [_____] percent.

2.5.2.5 Deformation Limits

****

NOTE: For reinforced concrete doors, the deformation limit criteria for accidental explosion applications is given below.

Door Type	**Prot. Cat. No.**	**Support Rotation (Deg.)**
One-way	**1**	**1**
acting without stirrups	**2**	**2**
One-way	**1**	**2**
acting with stirrups	**2**	**4**
Two-way	**1**	**2**
acting	**2**	**8**

A support rotation of not more than 2 degrees is recommended when post-blast opening is required. This deformation limit is recommended for conventional weapon and improvised weapon exterior door applications in order to avoid entrapment of personnel.

****

[Do not exceed [1 degree] [2 degrees] door support rotation for one-way acting doors without stirrups, [2] [4] degrees for one-way acting doors with stirrups, and [2] [8] degrees for two-way acting doors.] [Do not exceed 2 degrees support rotation except do not exceed 1 degree support rotation for one-way acting doors without stirrups.]

2.5.2.6 Hardware

Provide Type 2 hinges. Provide [multiple] [jamb] latching points and multiple lever handles operated from [the seating face] [and] [opposite the seating face] with manual latch engagement and lever latch bolts. Provide Type [I] [II] [III] straight steel bar door pull [,] [and] [padlock] [shrouded padlock] [,] [and] [hasp] [high security hasp] [shrouded hasp] [,] [and] [door stop] [,] gasket seals [, and optical device].

2.5.2.7 Operating Forces

****

NOTE: Coordinate with paragraph Blast Door Operation, under paragraph DESCRIPTION.

****

Provide maximum operating forces of [180] [_____] N [40] [_____] lbf to set the door in motion and [90] [_____] N [20] [_____] lbf to swing the door. Provide maximum force to engage and release latches of [135] [_____] N [30] [_____] lbf.

2.5.2.8 Accessories

Provide a [removable threshold] [ramp] [and] [self-rescue kit].

2.5.3 Door [_____]; Metal

****

NOTE: Coordinate with paragraph DESCRIPTION and with paragraph BLAST DOOR ASSEMBLIES.

The STC value bracketed is close to the highest obtainable for blast doors.

****

2.5.3.1 Type

Type must be [hollow metal] [double hollow metal door with a [fixed] [or] [removable] mullion] [,] [galvanized] [;] [and] [thermal insulation] [sound-rated to STC [40] [_____]] [, and] [fire-rated].

2.5.3.2 Overpressure

Provide overpressure of [_____] kPa psi in the [seating] [unseating] direction [and [_____] kPa psi in the unseating direction].

2.5.3.3 Rebound

****

NOTE: Coordinate with subparagraph Rebound Resistance, under paragraph DESCRIPTION.

****

Provide rebound resistance of [50] [100] [_____] percent.

2.5.3.4 Hardware

****

NOTE: Coordinate with subparagraph Hinges, under paragraph HARDWARE.

Delete the latch sentence when a mortise lock and latch set or exit device is specified.

****

Provide Type [1] [2] [3] [full surface] [mortise] hinges. [Provide [multiple] [jamb] latch points and [multiple lever handles] [or] [a single lever handle] operated from the [seating face] [and] [opposite the seating face] with [manual] [self-latching] latch engagement and [either] sliding [or lever] latch bolts.] [Provide exit device with [multiple latch points] [jamb latch points] [and with function [_____]].] [Provide mortise lock and latch set [with function [_____]].] [Provide a [padlock] [and] [hasp] [,] [and] [door stop] [,] [and] [surface door closer] [overhead door holder] [,] [and] [gasket seals] [door silencer] [,] [and] [optical device].]

2.5.3.5 Operating Forces

****

NOTE: Delete the latch operating force sentence when a mortise lock and latch set or exit device is

specified.

Coordinate with paragraph Blast Door Operation, under paragraph DESCRIPTION.

****

[Provide maximum operating forces of [90] [_____] N [20] [_____] lbf to set the door in motion and [70] [_____] N [15] [_____] lbf to swing the door.] [Provide operating forces conforming to NFPA 101.] Provide maximum force of [90] [_____] N [20] [_____] lbf to engage and release latches.

2.5.3.6 Accessories

Provide a [removable threshold] [or] [ramp].

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit shop and field operating test reports that include values for opening and closing forces and times, forces required to operate latches, and a description of all operating tests performed.

2.6.1 Prototype Static Test

****

NOTE: Retain this paragraph when overpressure is specified without duration.

****

Perform static tests on prototype door assemblies to demonstrate that the door will resist the blast overpressure. Static tests will be accepted only if the door and frame proposed are manufactured using the same materials, dimensions, and tolerances as those in the prototype static test and the static overpressure used in the test is at least two times the blast overpressure. Supplement static test reports with calculations that demonstrate rebound resistance when rebound is not tested.

2.6.2 Prototype Blast Test

Perform blast tests on the prototype door assembly to demonstrate that the door will resist the overpressure waveform. Blast tests will be accepted only if the door and frame proposed are manufactured using the same materials, dimensions, and tolerances as those in the prototype blast tests. The rise time of the test waveform must be zero or subject to approval. [For an overpressure with infinite duration, use the overpressure in the test that is no less than that specified or indicated for a duration equal to at least five times the natural period of the door and supplement the test report with calculations that demonstrate the specified or indicated rebound resistance.] [For overpressure with finite duration, use the overpressure waveform in the test that exceeds the overpressure waveform in both peak overpressure and impulse and supplement the blast test report with calculations that demonstrate the specified or indicated rebound resistance when the positive phase waveform duration in the test exceeds the positive phase duration specified or indicated.] Submit certified test reports demonstrating blast resistance. Include in the test reports the name and location of the testing agency or laboratory, a description of the testing apparatus, the date of the tests, a description of the door specimen tested, descriptions of loadings, the value of measured peak door deflection and peak permanent set and analysis and interpretation of test results.

2.6.3 Shop Operating Test

Prior to shipment, fully erect each door assembly in a supporting structure and test for proper operation. Such testing includes opening, closing, and operating all moving parts to ensure smooth operation and proper clearance, fit, and seating. Determine the operating forces and opening and closing times. Notify the Contracting Officer at least [7] [_____] calendar days prior to the start of testing and test [all doors] [door [_____] [,] [_____] [,] [and] [_____]] in the presence of the Contracting Officer. Prepare a test report and furnish [three] [_____] copies within [7] [_____] calendar days after testing.

2.6.4 Air Leakage Test

****

NOTE: Retain and edit this paragraph when door seals or thermal insulation are specified.

****

Factory test each door assembly for which [door seals] [or] [thermal insulation] [are] [is] specified for air leakage rate in accordance with ASTM E283. The rate of air leakage per unit length of crack must not exceed [0.90] [_____] L/s [0.20] [_____] cfm using a pressure difference of [76.7] [_____] Pa [1.57] [_____] psf. Prototype tests can be substituted for door assembly tests when the prototype door, frame, and hardware tested are equivalent to that provided or when otherwise approved.

2.6.5 Sound Rating Test

****

NOTE: Retain this paragraph when sound-rated hollow metal doors are specified.

****

Determine the sound transmission class (STC) rating in accordance with ASTM E90.

2.6.6 Fire Rating Test and Inspection

****

NOTE: Retain this paragraph when fire rating is required. The door schedule on the drawings will indicate where fire-rated doors are to be used and their rating requirements.

****

Provide fire-rated door assemblies bearing the listing identification label of the UL, or other nationally recognized testing laboratory qualified to perform tests of fire door assemblies in accordance with NFPA 252 and having a listing for the tested assemblies. Inspect doors exceeding the size for which listing label service is offered in accordance with NFPA 80, NFPA 80A, and NFPA 101. A letter may be submitted by the testing laboratory (in lieu of a UL listing for fire door assemblies) which identifies the submitted product by manufacturer and type or model and certifies that it has tested a sample assembly and issued a current listing. Submit certificate of inspection conforming to NFPA 80, NFPA 80A, and NFPA 101 for fire doors exceeding the size for which label service is available.

PART 3 EXECUTION

3.1 INSTALLATION

Install doors and frames in accordance with the manufacturer's written instructions. [Place concrete in reinforced concrete doors using the door manufacturer's standard forms.] [Fully grout pressed steel frames for hollow metal doors.] Finish paint exposed surfaces in accordance with Section 09 90 00 PAINTS AND COATINGS. Repair galvanized surfaces damaged prior to final acceptance in accordance with ASTM A780/A780M to the same thickness as the original galvanizing.

3.2 TESTS

After installation is completed, field test each door for operation, clearance, fit, and seating by operating the door and hardware through at least 10 operating cycles. Test door and hardware operation using the forces specified. Provide personnel and equipment required to perform field testing. Unless waived, perform all field tests in the presence of the Contracting Officer. After testing is completed, prepare test reports and furnish [three] [_____] copies.

3.3 MANUFACTURER'S FIELD SERVICE

Perform installation and testing of door assemblies under the supervision of the door manufacturer's erection engineer. Upon completion of the work, and at a time designated by the Contracting Officer, provide the services of one engineer and other technical personnel, as required, for a period of not less than [4] [_____] hours to instruct Government personnel in the operation and maintenance of the blast doors and all other items furnished under this specification. Include in the instructions videotapes and use of the operation and maintenance manual. Submit an instruction outline and procedure for approval prior to scheduling the instruction and information describing training to be provided, training aids to be used, and background data on the personnel conducting the training.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 39 55.00 20 (November 2024)**

Preparing Activity: NAVFAC **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 08 - OPENINGS

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NAVY STANDARD EARTH-COVERED MAGAZINE DOORS

11/24

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USACE / NAVFAC / AFCEC **UFGS-08 39 55.00 20 (November 2024)**

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SECTION 08 39 55.00 20

NAVY STANDARD EARTH-COVERED MAGAZINE DOORS

11/24

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NOTE: This guide specification covers the requirements for Earth Covered Navy Magazine Doors, security, operators, and controls. The intent of this specification is to augment standardized doors or custom designed doors for all magazines such that components, controls, and systems are interchangeable between doors. There are Navy standard magazine doors which have been completely designed and detailed in standard drawings, and this specification augments and supports those completed designs. The door construction, headwall, and locking system must be in accordance with the design drawings and may not be altered in any way. As such, this specification is not a performance specification; it is an affirmation of the door design, and includes all peripherals required for a complete door system, including execution and testing.

Adhere to UFC 1-300-02 Unified Facilities Guide **Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Painting of magazine doors must be

specifically mentioned in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES, along with a reference to the drawings and this Section.

In order for this specification to be properly coordinated, the following information must be included in the Navy Standard Magazine Door Design Drawings or in other completed door designs:

1. Size and arrangement of doors, including all details at head, sill, and jambs.

2. All material requirements for all components of the magazine door.

3. Location and type of seals, weather stripping, flashing, operators, and end of travel bumpers with limit switches.

4. Location, spacing, size, type of top guides and bottom rails, and trench covers, including drainage and plow-type trench cover lifting system (plow system).

5. Design wind, seismic, blast, and other loads utilized for the design of the doors.

6. Electrical (power, low voltage, security) and grounding requirements, including device ratings.

7. Access for installation, maintenance, and re-placement of door components such as motors, drive.

8. Special Inspections List.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile

references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	(2020) Specifications for Structural Concrete
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings
ANSI/AISC 303	(2022) Code of Standard Practice for Structural Steel Buildings and Bridges

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN WELDING SOCIETY (AWS)

AWS A5.4/A5.4M	(2012; R 2022) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel
AWS D1.6/D1.6M	(2017) Structural Welding Code – Stainless Steel
AWS D1.8/D1.8M	(2016) Structural Welding Code–Seismic Supplement

ASTM INTERNATIONAL (ASTM)

ASTM A1	(2000; R 2018) Standard Specification for Carbon Steel Tee Rails
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A500/A500M	(2023) Standard Specification for

	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-101-01	(2020; with Change 4, 2024) Architecture
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems
UFC 4-420-01	(2015; with Change 1, 2015) Ammunition and Explosives Storage Magazines

UL SOLUTIONS (UL)

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case

	Switches and Circuit-Breaker Enclosures
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

Acceptance Testing Procedure; G, [_____]

Field Testing Instructions; G, [_____]

Coating Submittal Package; G, [_____]

Sequence of Welding; G, [_____]

Manufacturer's Installation Instructions; G, [_____]

Installation Plan; G, [_____]

Quality Control Plan; G, [_____]

SD-02 Shop Drawings

Shop Drawings; G, [_____]

Electrical Package; G, [_____]

Trench Package; G, [_____]

Boltworks Locking System; G, [_____]

SD-03 Product Data

Product Data; G, [_____]

SD-05 Design Data

Design Data; G, [_____]

SD-07 Certificates

Welding Procedures and Welder's Qualifications; G, [_____]

NDT Certificates; G, [_____]

SD-10 Operation and Maintenance Data

Training Video; G, [_____]

Door Description Information; G, [_____]

Draft Operations and Maintenance Manual, Data Package 2; G, [_____]

Final Operations and Maintenance Manual, Data Package 2; G, [_____]

SD-11 Closeout Submittals

Weld Inspection Report; G, [_____]

Report of Special Inspections; G, [_____]

Shop and Field Operating Test Reports; G, [_____]

Acceptance Testing Report; G, [_____]

Manufacturer's Warranty; G, [_____]

1.3 DOORS

Doors constructed in accordance with this specification are used in magazine standard drawings approved by the Department of Defense Explosive

Safety Board (DDESB) as a[7-bar][3-bar] earth covered magazine and may be sited as an exposed site magazine from other potential explosion sites storing up to [227,000 kg] [500,000 pounds] [_____] hazard division 1.1 explosives. The design and detailing of the magazine for blast loading is the sole responsibility of the government. The government is the engineer of record for the blast door. Any deviation from these standard drawings, except for foundation modifications, without the written approval from the Department of Defense Explosive Safety Board (DDESB) is not permitted as it may require the magazine to be considered an undefined magazine and may severely restrict the allowable storage capacity.

1.3.1 Door Systems

The general contractor must select a single manufacturer to provide a complete blast door system, including but not limited to the blast door and all associated components, hardware, rail, trench, trench cover assembly, plow-type trench cover lifting system (plow system), and embedded plates, including controls, motors, and installation. Provide blast-resistant magazine door system in accordance with the non-deviational standard drawings for door type[CLWS single bay][CLWS double bay][Box Type G][Box Type H][MSM v2] [_____] and UFC 4-420-01. This door system is designed to resist all wind, seismic, and blast effects, including fragment, ballistic, and forced entry resistance. Door system includes flashing, seals, weather stripping, controls, operators, electrical power, low voltage, security, and grounding as well as access for installation, maintenance, and replacement of all door components including, but not limited to, operators, motors, and drive. The door system size and arrangement of doors, top guides, bottom rails with drainage, and plow system, including details at head, sill, jambs, and door/frame and door/sill interfaces are specifically indicated based upon the performance standards required by the Government. The single manufacturer is responsible for providing all door components and completing the design of items not fully designed in the standard drawings. The entire door system described in the standard drawings must be manufactured and installed by a single manufacturer or the single manufacturer's representative, sanctioned by the manufacturer.

For the Door System: Submit Shop Drawings sealed by the door manufacturer's Registered Professional Engineer, Product Data, and Design Data consisting of catalog cuts, brochures, circulars, specifications, calculations, and product data that show the complete door system including all components. Submit Manufacturer's Installation Instructions and Field Testing Instructions. Submit Door Description Information, bound in manual form consisting of manufacturer's safety precautions, preventive maintenance, and schedules, troubleshooting procedures, special tools, parts list, and spare parts data. All material shown on the shop drawings must be cross referenced to the door designations shown on the standard drawings.

1.3.2 Door System Components

The door design is structurally complete and is non-deviational, including the headwall and locking system. Materials, dimensions, strengths, and connections included in the standard drawings must be strictly adhered to. Stronger material grades will not be permitted as they may result in increased reactions and altered performance under blast loading.

Door seals are critical to door system performance. All seals and weather-stripping must be positively contacted when the door is closed, and all seals and weatherstripping must be inspectable and replaceable with the door in place.

1.3.3 Cybersecurity

Design all control systems (including systems separate from a utility monitoring and control system) in accordance with UFC 4-010-06 and as required by Section 25 05 11[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS WITH C-I-A DETERMINATION [_____]. Implement cybersecurity requirements to mitigate vulnerabilities to all facility-related control and security systems.

1.4 QUALITY CONTROL

The blast door manufacturer is solely responsible for manufacturing, shipping, installing, and erecting the blast door system and must submit a Quality Control Plan which details quality control procedures to be undertaken at each phase of this work. The Quality Control Plan will be an item of discussion at the preconstruction meeting.

1.4.1 Welding

Welders, welding operators, and weld inspectors must be qualified in accordance with AWS D1.1/D1.1M except that welders performing arc welding of steel sheet and strip must be qualified in accordance with AWS D1.3/D1.3M.

1.4.2 Quality Control Plan

Develop and submit for approval a blast door system fabrication and installation quality control plan as specified herein. The plan must include the following:

a. Indicate the contractor's understanding and explanation of the QC process.

b. Include Special inspector qualifications and responsibilities.

c. Include shop QC manager (or in-house inspector) qualifications and responsibilities.

d. A list of challenging issues (available material challenges, shipping challenges, and schedule challenges).

e. Special procedures and processes.

f. Include a discussion of SI record keeping and required bi-weekly submittals and any other submittals to the contractor's QC manager.

g. Show coordination between SI inspector, in-house inspector, Shop QC manager, KTR QC manager.

h. Provide quality control reports to the Contracting Officer and Quality Manager.

i. Inspection and approval of all embedded items prior to placement of concrete.

Upon completion of the Quality Plan and a minimum of 2 weeks prior to beginning fabrication or construction activities, a preconstruction meeting must be held to review the Magazine Door Quality Plan. The meeting must include the DOR, Contractor's Quality Manager, Special Inspector, Fabrication Shop Quality Manager, in-house inspector, Contractor Superintendent, the Government Construction Manager, and a government representative familiar with Blast Doors, or their designated representative(s).

1.4.3 Manufacturer's Qualifications

The manufacturer providing the complete door system, must be regularly engaged in the fabrication, erection, and service of large, horizontal rolling, blast resistant, steel doors of the type, complexity, and size required for this project. The manufacturer must have at least 10 years of demonstrated experience fabricating, erecting, and servicing similar horizontal rolling, blast resistant steel doors weighing a minimum of 13,600 kg 30,000 pounds. Similar doors must have comparable function and design including size, configuration, type of use, elements, safety features, controls, and other key engineering elements as the door being specified. It is acceptable to show that a series of similar doors collectively meet all comparable elements to the door being specified, although not necessarily individually. The manufacturer must submit written evidence on a minimum of five examples of similar past doors listing the name, location, contact information of owners, installation dates, overall sizes, features, and other relevant information for experience and qualifications evaluation for approval by the Contracting Officer. Only manufacturers who can submit this evidence of actual installations where the products have proven practical and durable, and require a minimal amount of maintenance, will be qualified under this specification.

1.4.4 Installer's Qualifications

The manufacturer is responsible for the installation of the entire blast door system, including all components, and achieve final approval and acceptance by the Navy. A manufacturer's representative, skilled and experienced in the erection of horizontal rolling, blast resistant, steel doors of the type specified may be utilized if supervised by the manufacturer of the door system in accordance with approved shop drawings. For each installer, submit written evidence of similar past door installations listing the name, locations, contact information of owners, installation dates, overall sizes, features, and other relevant information for experience and qualifications evaluation.

1.4.5 Welding Procedures and Welder's Qualifications

Welders, welding operators, and weld inspectors must be qualified in accordance with AWS D1.1/D1.1M and AWS D1.6/D1.6M except that welders performing arc welding of steel sheet and strip must be qualified in accordance with AWS D1.3/D1.3M. Provide copies of all Welder's Certifications for welders both in the shop and in the field.

[Welding procedures which are considered pre-qualified as specified in AWS D1.1/D1.1M and AWS D1.6/D1.6M as applicable will be accepted without further qualification. Submit for approval a listing or an annotated drawing to indicate the joints not pre-qualified. Procedure qualification is mandatory for these joints.] [No pre-qualified welding procedures are allowed. Qualify the welding procedures and welders by tests prescribed in the applicable code or specification not withstanding the fact the code or specification may allow pre-qualified procedures.]

1.4.6 Manufacturer's Warranty

Furnish manufacturer's written warranty covering the blast door assembly for 5 years after acceptance by the Government. Warranty must provide for repair and replacement of the blast door assembly, individual hardware, mechanical, electrical, and accessory items in the event of malfunction due to defects in design, materials, and workmanship.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials which are not shop installed on the doors in original rolls, packages, containers, boxes, or crates bearing the manufacturer's name, brand, and model number. Store materials and equipment in dry locations with adequate ventilation, free from soil, water, dust, and contaminants, and to permit access for inspection and handling. Handle doors carefully to prevent damage. Remove damaged items that cannot be restored to like-new condition and provide new items.

PART 2 PRODUCTS

2.1 DOORS

2.1.1 Structural Steel

Construct all structural steel in accordance with AISC 360. Structural steel bars, plates, and shapes must conform to ASTM A572/A572M, ASTM A992/A992M as indicated in the standard drawings, including steel grades. Hollow Structural Steel Sections must conform to ASTM A500/A500M Grade C, as indicated in the standard drawings. Provide stainless steel in accordance with ASTM A240/A240M Type 304 and design in accordance with AWS D1.6/D1.6M for trench covers, trench weldments, and embedments.

2.1.1.1 Bolted Connections

Provide bolted connections as shown in the standard drawings. Provide bolt heads of the supplied fasteners marked with the manufacturer's identification mark, the strength grade, and type specified by ASTM specifications. Provide the following:

Anchor Bolts: ASTM F1554, Grade as specified

High Strength Bolts: ASTM F3125/F3125M, Grade as specified

Provide compatible nuts and washers corresponding to the bolt grades and strengths above.

2.1.1.2 Welded Connections

Provide welds as shown in the standard drawings.

Provide Welding Electrodes and Rods in accordance with AWS D1.1/D1.1M and AWS D1.6/D1.6M.

2.1.2 Concrete

Concrete properties are specified in the standard drawings and must also comply with[Section 03 30 00 CAST-IN-PLACE CONCRETE][03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [_____]. For concrete reinforcement, provide stainless steel expanded metal reinforcement of the type, size and gage as specified in the standard drawings. Refer to the standard drawings for the required concrete weight, mix design, admixtures, placement, and curing.

2.1.3 Wood

Refer to the standard drawings for species, size, and arrangement of wood to be utilized in the door. Provide wood that is kiln dried.

2.1.4 Components

2.1.4.1 Top Door Guide Assembly

Provide the Top Door Guide Assembly to resist the minimum lateral load capacity as shown on the standard drawings and permit magazine and door construction tolerances and temperature changes without binding or disengaging the door from the top door guide. Door roller guide will be welded to the door per manufacturer's calculations and recommendations and include horizontal stainless-steel rollers with sealed bearings which can be removed and replaced with the door remaining in place. Size and weld retention angles and plates per manufacturer's calculations and recommendations to resist forces and to permit construction tolerances and smooth door operation.

2.1.4.2 Door Stop

Provide door stops to resist the impact of the door at each extent of travel. The stop must not scratch or scar the door finish when the door engages the stop. Door silencers must also be provided to cushion the impact of the door so that steel-to-steel contact is not made during closing.

2.1.4.3 Door Seals

Door seals are critical to door system performance. Doors must have the full door perimeter and all door penetrations sealed. Provide as indicated[between door leaves and] on vertical edges, sills, and heads to afford a weathertight installation and form a portion of the Air Barrier in accordance with UFC 3-101-01. All seals must be positively contacted when the door is closed. Seals must be capable of sealing the mating surfaces, resistant to the atmospheric environment, and be inspectable, adjustable, and replaceable with the door in place. One spare set of gasket seals must be provided for each door assembly for which seals are specified.

Provide flexible door seals in all specified locations including on vertical edges, sills, and heads. Seals must be the dimension shown, but not less than 51 mm 2 inch wide, and be a minimum of two-ply cloth-inserted EPDM material with a minimum thickness of 3 mm 1/8 inch and retained continuously for its full length with flat head socket cap and secured with rust-resistant fasteners spaced no more than 152 mm 6 inches on center. Provide weather stripping at bottom of the door to match the lowest height of the jamb weather stripping.

2.1.4.4 Wheel and Motor Drive System

Machine wheels from a single piece of material. Provide steel plate bottom wheels having a minimum tread diameter as required for the actual wheel loading, but not less than 457 mm 18 inches. Construct wheel assemblies to permit removal of the wheel without requiring removal of the door.

Concrete filled doors require wheels offset nominally toward the interior side of the door to be located at the door's center of gravity. Door manufacturer must calculate and verify center of gravity, prior to final fabrication.

2.1.4.4.1 Treads

Machine wheel treads are to be concentric with bearing seats. The maximum clear distance between flanges cannot exceed the width of the rail by more than 3 mm 1/8 inch at the tread nor more than 6 mm 1/4 inch at the edge of the flange. Machine internal bearing seats accurately for a press fit. Heat treat wheels to obtain a rim hardness of 320 Brinell.

2.1.4.4.2 Wheel Bearings

Provide tapered roller or spherical bearings, either internal or cartridge type, arranged so that both horizontal and vertical loads are transferred to the rail only through the bearing. Provide bearings tightly sealed and equipped with high-pressure grease fittings.

2.1.4.4.3 Traction Drive

Provide a traction drive door system where the leading edge (door closing) wheel box contains both a wheel and a chain drive power system. The trailing edge wheel is not powered and only contains an idler wheel.

Provide a door system with a manual system override including motor brake disengagement and 13 mm 0.5 inch standard female socket that is capable of both opening and closing the door system.

2.1.4.4.4 Motor Drive

Design motor drive to move its door at a speed of approximately 4.5 meters 15 feet per minute. Design the operating units to consist of a separate motor and gear reducer, high-speed shaft brake, and necessary roller chains and sprockets. Provide the systems with overload protection for the drive units. Provide NEMA MG 1, high-starting torque, reversible type motor with sufficient horsepower and torque output to operate its door in both directions from any position at not more than 75 percent of its rated capacity. Select motor to operate on current voltage of the characteristics indicated at not more than 3600 rpm. Provide NEMA totally-enclosed, fan-cooled (TEFC) and design using a minimum service factor of 1.2. Provide calculations and product data.

Provide braking systems to ensure stoppage of the doors under normal, dry rail conditions. Provide either a magnetic, spring-set, solenoid-released brake or hydraulic type braking systems. Provide a hand release to release the brake when it becomes necessary to move the door manually. Provide an automatic reset type hand release so that the brake will be operable during subsequent electrical operation of the door.

2.1.4.5 Rail and Trench System

Provide rail(s) as indicated in the standard drawings per ASTM A1. Provide the plow trench cover system and complete the notionally detailed design shown in the standard drawings. Provide all rail and trench system including all components in the Trench Package.

2.1.4.5.1 Rail Tolerance

In accordance with the design, the blast door and components must meet the following tolerances for trueness and levelness:

All trenches and door guide rail must have a 6 mm 1/4 inch maximum differential tolerance per every 11 meters 37 feet.

2.1.4.6 Plow-type Trench Cover Lifting System (Plow System)

The plow trench cover assembly is notionally detailed in the standard drawings. The system to be provided by the manufacturer may vary based upon the door manufacturer's approved design. Dimensions noted with an asterisk (*) must be coordinated with the door manufacturer designing and providing the plow system to provide a door trench cover roller with a smooth transition between closed and open positions.

All plates are to be 6 mm 1/4 inch thick plate minimum unless noted otherwise and weld all joints with a minimum 5 mm 3/16 inch fillet unless noted otherwise in the details.

2.2 FABRICATION

Fabricate doors in accordance with the applicable provisions of AISC 360. Workmanship must be equal to standard commercial practice in modern metal shops. Fabricate and assemble in the shop to the greatest extent possible.

2.2.1 Frames and Framing

Provide welded or bolted construction of doors as shown in the standard drawings. Provide continuous vertical members throughout the height of the door, unless noted otherwise in the standard drawings. Provide frames and framing members true to dimensions and square in all directions; no bowed leaves, warped, or out of line in the vertical or horizontal plane of the door opening by more than 1 mm in 2 meters 1/8 inch in 20 feet. Do not deviate from the standard drawings for any reason, including to resist operational loads and packaging to withstand shipping loads. Grind smooth any exposed welds and prepare, prime, and coat steel as specified in paragraph FINISHES.

2.2.2 Weldments, Embedments, and Trench Covers

Provide ASTM A240/A240M, Type 304 Stainless Steel for door systems including door jamb, door head and locking pilaster.

2.2.3 Shop Assembly

Welding is a critical component in the success of constructing these doors, including meeting door construction tolerances. Welding must be in accordance with AWS D1.1/D1.1M except that arc welding of steel sheet and strip must be in accordance with AWS D1.3/D1.3M. For the doors, welding might cause significant residual stresses; therefore, the contractor must submit for approval by the Contracting Officer a detailed Sequence of Welding, augmenting the requirements given by the AWS specifications.[Stainless steel must be welded using electrodes conforming to AWS A5.4/A5.4M.] Fabricated steel must be well-formed to shape and size, with sharp lines and angles. Intermediate and corner joints must be coped or mitered. Exposed welds must be dressed smooth.[The stiles[and top] of built-up structural steel doors must be closed using channel shapes or plates as shown in the standard drawings.] Weld all steel in accordance with the standard drawings.

2.2.4 Door Tolerance

In accordance with the design, the blast door and components must meet the following tolerances for trueness and levelness:

Blast door cannot exceed a total maximum flatness tolerance of 7 mm 1/4 inch either vertically or horizontally.

2.2.5 Quality Assurance Demonstration

The door manufacturer must commence a shop demonstration of each door in the presence of the Contracting Officer or their designee, consisting of a successful cycle of opening and closing the door by controls, opening and closing of trench plates by door plows, locking and unlocking door, and alignment of door in security pilaster. The demonstration must be a minimum of half the length of the door travel. Demonstration must also include manual operation of the blast door in both directions.

2.3 OPERATION

Each door is individually operated. For each door provide a separate, traction-drive operating unit driving one of the bottom wheels. On each door provide a motor-mounted, springset, solenoid-released motor brake. Provide doors that are operated from pilaster mounted controls with visibility of the door's leading edge.

2.3.1 Controls

Provide control equipment conforming to NEMA ICS 1 and NEMA ICS 2. Provide[mushroom][guarded] head type push buttons, mounted in heavy-duty, oiltight enclosures conforming to NEMA ICS 6, Type 4, except that enclosure for the VFD with disconnect switch requires Type[12 for interior application][4 for exterior application].[Provide watertight enclosures for exterior push buttons conforming to NEMA ICS 6, Type 4.]

When the Internal Locking Device (ILD) Boltworks Locking System is locked, the Variable Frequency Drive (VFD) is not powered. When unlocked, the VFD is powered. Provide constant pressure push buttons for each individually operated door. Door movement will be stopped upon removal of pressure from the button. Provide push buttons mounted on the exterior face of locking pilaster next to the ILD locking boltworks. Provide the open control button on top of the color green and provide a closer button below the open button of the color red.

2.3.1.1 Safety Interlocks

****

NOTE: When mechanical rooms are included in the design, include the below section for safety interlocks to prevent the adjacent blast door from interfering with mechanical room access [and][or] door.

****

When mechanical rooms are included in the design, door controller must be provided for the blast door adjacent to the associated mechanical room with safety interlock feature when sensing mechanical room is open. Door control feature must include a door contact/relay interlocking with blast door control system and mechanical room door so that once the mechanical room door is in 'open mode' or 'unlocked', the control system of the adjacent blast door will be disabled from moving the blast door.

2.3.2 Variable Frequency Drive(s)

For each door, provide a Variable Frequency Drive (VFD) in NEMA ICS 1, Type[4][12] enclosures equipped with access door-controlled, UL 489 Molded Case Circuit Breaker (MCCB) with a through-the-door disconnect switch. The control system includes but is not limited to a VFD equipped with overload and undervoltage protection, relays and timing devices as required, control circuit transformers, and a numbered terminal strip. Provide a control circuit transformer capable of reducing the voltage in the control circuits to 120 volts or less and conforms to UL 506. Provide each VFD to move its door at a speed of approximately 4.5 meters 15 feet per minute. The VFD in each door must automatically transition to crawl speed at each confirmed limit of door movement (full open and full close).

Provide each operating unit with a separate motor and gear reduction unit, highspeed shaft brake, and necessary roller chains and sprockets. Provide the systems with overload protection for the drive units and a means for emergency tractor towing operation.

2.3.2.1 Gear Reduction Unit(s)

Provide gear reduction units that allow a reversal of effort through the gears without damage to the units.

2.3.3 Operations and Maintenance Manual

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include wiring and control diagrams. Door manufacturer must submit a complete Draft Operations and Maintenance Manual, Data Package 2 to the Contracting Officer for approval and must also submit a Final Operations and Maintenance Manual, Data Package 2 for record.

2.4 LIGHTNING PROTECTION SYSTEM

The Lightning Protection System (LPS) consists of a complete grounding system which electrically bonds all steel doors, frames, and components to the magazine's reinforcing cage in order to maintain equipotential. Provide a grounding reel at top of the door with a grounding path in the door to all components. Provide local bonding with a dedicated path tied to the facility grounding systems to maintain equipotential. All structural and miscellaneous items embedded in the concrete must be electrically bonded to the reinforcing cage by wire ties.

2.5 ELECTRICAL

Provide conduit, wire, flexible cables, boxes, devices, and accessories[, and install trolley duct,] under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. If permanent electrical power is not available when door installation is complete, provide temporary power in accordance with distribution system requirements in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, for testing and adjusting the doors.

Submit the door manufacturer's Electrical Package including complete schematic wiring diagram, field wiring diagram, and a complete physical location drawing showing the location of controls with the runs of conduit, size of conduit, number and size of wires in each conduit, location of junction boxes, and full details of control mountings.

2.5.1 Electrical Work

****

NOTE: Insert the following into Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.
"EARTH COVERED MAGAZINE DOORS: Provide field wiring for doors under this section in accordance with door manufacturer's written instructions, drawings and diagrams, and NFPA 70 and NEMA ICS 1. Provide conduit, wiring, boxes, cables, devices, and accessories under this section. If permanent electrical power is not available when door installation is complete, provide temporary power for testing and adjusting doors for proper operation. Provide draped or festooned cable system under this section with extra-flexible Type SD cable."

****

It is the door manufacturer's responsibility to provide the proper electrical equipment and controls built in accordance with the latest NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 standards. Provide all equipment and controls, and circuits that conform to NFPA 70. Provide automatic control devices necessary for motor operation of the door, including push button stations, limit switches, variable frequency drive with UL 489 MCCB motor circuit protection, control circuit transformers, relays, timing devices, warning devices, and draped or festooned cable system with extra flexible Type SD cable.

2.5.2 Intrusion Detection System (IDS)

Coordinate with the Contracting Officer for the size and locations of balanced magnetic switches and motion sensors, and routing of all IDS conduit. Balanced magnetic switches, motion sensors, and conductors will be installed and connected to the Intrusion Detection System (IDS) by the Government. Pathway, conduit, and junction boxes will be provided by the contractor.

Coordinate with the Contracting Officer for the locations, routing of conduit, and connection of the Internal Locking Device (ILD) Boltworks Locking System which must be installed and connected to the Intrusion Detection System (IDS) by the Government. Pathway, conduit, and junction boxes will be provided by the contractor.

2.6 FINISHES

****

NOTE: The coating system specified in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES is very robust and should always be followed.

The Navy Standard Magazine Door drawings require the

following:

All coating and installation of coatings must comply with Section 09 97 13.27.

Shop Coatings:
SSPC (THE SOCIETY OF PROTECTIVE COATINGS) QP3
Field Coatings: SSPC QP1 + QS1
Color: Light Gray

Surface Preparation:
Remove slag from all welding surfaces prior to cleaning in accordance with NACE SP0178. Solvent clean surface to be coated prior to abrasive blasting in accordance with SSPC SP1. Prior to fully assembling or fabricating door, clean and primer surfaces that will become inaccessible after the door is assembled. The door must not be galvanized. Dry abrasive blast to near white finish in accordance with SSPC SP10/NACE No. 2. Blast profile must be 1-3 mils tooth height.

Paint Systems:
Total coating dry film thickness (DFT): 12 mils

Zinc Rich Primer Coat:
Abrasion resistant inorganic zinc silicate primer (3-5 mils). SSPC Paint 20, Type IC, Level 1 with at least 85 percent zinc in dry film.

Intermediate Coat:
High solids epoxy coating (3-5 mils). MPI No. 108.

Top Coat:
High solids polyurethane coating (3-5 mils). MPI No. 72.

Insert the following into Section 09 97 13.27 paragraph, SURFACES TO BE COATED:

Section 08 39 55.00 20 NAVY STANDARD EARTH-COVERED MAGAZINE DOORS references Section 09 97 13.27 and requires shop application of these coatings.
****

Clean, prepare, and coat all exposed and non-exposed ferrous metal surfaces as part of the Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES work, including all requirements, submittals, certifications, testing, and inspections required by Section 09 97 13.27. Do not coat finished bearing surfaces. Alternative coating systems or products will not be considered. Prepare surface and apply coatings in the shop, following all temperature, humidity, and testing requirements listed in Section 09 97 13.27. After installation of the door, prep and touch up surfaces damaged during assembly and installation of the door. Prep and coat unfinished ferrous metal accessories such as bolts and brackets. Provide details and document compliance path in the Coating Submittal Package.

2.7 SPECIAL INSPECTIONS

Special inspection requirements are included in the standard drawings, UFC 3-301-01, and UFC 4-420-01 which must be adhered to, and the successful final results of all Special Inspections will be submitted in the Report of Special Inspections. Systems requiring special inspections include, but are not limited to:

Fabricator Certification and Quality Control Procedures

Fabrication Inspection

Shop Demonstration

ECM Grounding

Grounding System

Individual Bonds

LPS Components

LPS Testing

Door Laps

Embedded and Attached Items (Doors, Frames, and Trenches)

2.8 ACCESSORIES

2.8.1 Hardware

Coordinate with the Contracting Officer for procurement and installation of the Internal Locking Device (ILD) Boltworks Locking System and the distribution of key sets for each magazine door. The ILD Boltworks Locking System must be procured with two unique keys for operation.

Contact the DoD Lock Program for directions on how to procure the ILD Boltworks Locking System and the qualifications for procuring a qualified Boltworks Manufacturer.

DoD Lock Program: https://navfac.navy.mil/go/locks

Email: ILD_Field_Support@navy.mil

ILD Support Hotline: 805-982-5625

DoD Lock Program Technical Support: 800-290-7607 or 805-982-1212

2.8.2 Nameplate

Each door assembly must have a permanently affixed nameplate that displays the manufacturer's name, place, year of manufacture, and applicable peak overpressure, and impulse. Mount nameplate on a nearby interior wall.

PART 3 EXECUTION

3.1 ERECTION

Assemble and install the doors and accessories in accordance with the manufacturer's recommendations and installation manual. Provide all work associated with these door systems under the direct supervision and control of the manufacturer for safety, quality control, and control of product performance and liability. Coordinate the erection of the doors with the work of other trades. Coordinate electrical work, including locations of all panels, equipment, motors, and other components for required clearances for maintenance, access, and routing of power.

3.1.1 Procedure

Erect and install in accordance with the manufacturer's written instructions, AISC 360, and ACI 318 and submit an Installation Plan which is covered in the preconstruction meeting. Use erecting equipment suitable for the work and in proper working condition. Where parts cannot be assembled or fitted properly as a result of errors in fabrication or of deformation due to handling or transportation, report such condition immediately to the Contracting Officer, obtain approval of the method of correction, and make the correction in their presence. The straightening of plates and angles or other shapes must be done by the methods approved by the Contracting Officer. If heating of metal is approved for straightening, it must not be to a higher temperature than that producing a dark "cherry red" color. After heating, the metal must be cooled as slowly as possible. Evidence of fracture on the surface of the metal after straightening is not allowed. Drain steelwork properly; fill pockets exposed to the weather with an approved waterproof material.

3.1.2 Erection Tolerances

Steel construction must be in accordance with the tolerances in ANSI/AISC 303, unless noted otherwise. Concrete construction must be in accordance with the tolerances in ACI 301, unless noted otherwise.

3.1.3 Temporary Welds and Backing Strips

Temporary Welds and Backing Strips must be removed.

3.2 ELECTRICAL WORK

Provide all conduit, wiring, and mounting of controls in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and NFPA 70. Provide and install all[208v 3-phase][480v 3-phase] [_____] supply power to all components such as main, auxiliary, controllers, panels, motors, and other devices which require low voltage supply power. Provide and install all conduit for the control level power. Provide and install all wiring for control level power in accordance with the approved submittals.

3.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit Shop and Field Operating Test Reports that include values for opening and closing forces and times, forces required to operate latches, and a description of all operating tests performed.

3.3.1 Inspection

The manufacturer of the doors must provide a field inspection engineer to perform the following:

a. Check installation of embedded items before placing of concrete (after forms or shoring are in place) to ensure that the dimensional tolerances recommended by the door manufacturer have been complied with.

b. Recheck embedded items to verify the accuracy of dimensions after shoring and forms are removed from concrete.

c. Supervise any necessary corrective action.

d. Supervise the job site assembly and installation of the doors and operators.

e. Inspect final assembly of doors and operators after corrections and adjustments have been made to doors.

f. Demonstrate to the Contracting Officer that operation of the door assembly is as specified.

3.3.2 Visual Inspection of Welding

Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections in accordance with AWS D1.1/D1.1M and AWS D1.6/D1.6M. Perform visual inspections on 100 percent of all shop and field welds with a Certified Welding Inspector. Document this inspection in the Weld Inspection Report.

Inspect for proper preparation, size, gaging location, identification marking, and operation and current characteristics of welding sets in use and acceptability of all welds.

3.3.3 Nondestructive Testing

Perform nondestructive testing (NDT) in accordance with AWS D1.1/D1.1M[and AWS D1.6/D1.6M][and AWS D1.8/D1.8M]. Perform ultrasonic testing in accordance with Table[6.2][6.3] of AWS D1.1/D1.1M[and Table 8.2 of AWS D1.6/D1.6M]. Test 50 percent of all welds, with sampling representative of all weld types and locations for the entire door system, for the duration of the fabrication schedule and both shop and field welds. All personnel performing NDT are required to be certified in accordance with ANSI/ASNT CP-189 in the method of testing being performed. Submit NDT Certificates showing compliance with ANSI/ASNT CP-189 for all NDT technicians. If more than 10 percent of welds made by a welder contain defects identified by testing, then all groove welds made by that welder are required to be tested by ultrasonic testing, and all fillet welds made by that welder are required to be inspected by magnetic particle testing (MT) or dye penetrant testing (PT). When groove welds made by an individual welder are required to be tested, MT or PT may be used only in areas inaccessible to ultrasonic testing. Retest all repaired areas. Submit Weld Inspection Report.

Any weld repairs required must be in accordance with AWS D1.1/D1.1M.

3.4 FINAL CLEANUP, PROTECTION, LUBRICATION, AND ADJUSTMENT

3.4.1 Cleanup

After erection is complete, and before repair of protective coatings, thoroughly clean both the interior and exterior of the door and all abraded surfaces, field welds, and field bolts.

3.4.2 Protective Coatings

Complete all protective coating systems in accordance with the paragraph FINISHES including repair of all damage to the protective coating system in accordance with the requirements of Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. Prepare surface and apply coatings following all temperature, humidity, and testing requirements listed in Section 09 97 13.27.

3.4.3 Lubrication and Adjustment

Upon completion of installation, including work by other trades, lubricate, adjust, and perform preliminary door tests to verify operation in accordance with manufacturer's product data. Final adjustments will be made by the manufacturer. Adjust and retest the doors until the entire installation is fully operational and acceptable.

3.5 ACCEPTANCE TESTING PROCEDURE AND REPORT

Submit an Acceptance Testing Procedure for approval. After Government approval, and after installation is complete, field test each door for operation, clearance, fit, seating, and sealing by operating the door and hardware through a minimum of 10 operating cycles (unlock, full open, full close, and lock is one cycle) within the manufacturer's written time interval between cycles. Test the entire door system including every component and door hardware, and confirm maximum operational forces specified are not exceeded. Provide personnel and equipment required to perform field testing. Perform all field tests in the presence of the Contracting Officer. After testing is successfully completed, prepare the Acceptance Testing Report and submit to the Contracting Officer.

3.6 PERSONNEL TRAINING

Provide a 2-hour on-site training session for the Government's door operating personnel and maintenance. Attendees may include base personnel such as facility users, fire department, and others. In the training, outline door safety, normal operation, emergency operation, troubleshooting, maintenance, and repair guidelines.[Record this on-site training and provide a Training Video presented in an organized and coherent fashion such that the Government may use the video as the sole training program for future user operators. It is acceptable to utilize stock training video content in this video provided the door operation, safety, and controls are identical to the door system provided.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 41 13 (November 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-08 41 13 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025
****

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ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

08/18, CHG 1: 08/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 41 13 (November 2016)**
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SECTION 08 41 13

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

08/18, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for Aluminum Entrances, glass and glazing, door hardware and components.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501	(2015) Methods of Test for Exterior Walls
AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum
AAMA 800	(2016) Voluntary Specifications and Test Methods for Sealants
AAMA 1503	(2009) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330/E330M	(2014; R 2021) Standard Test Method for

	Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E783	(2002; R 2018) Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
ASTM E1105	(2015; R 2023) Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference
ASTM E1424	(2022) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure and Temperature Differences Across the Specimen
ASTM E1886	(2019) Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
ASTM E1996	(2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.4	(2024) Door Controls - Closers
ANSI/BHMA A156.10	(2024) Power Operated Pedestrian Doors

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-645	(Rev C; Notice 1) Primer, Paint, Zinc-Molybdate, Alkyd Type

UL SOLUTIONS (UL)

UL 325	(2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Meetings

Conduct a meeting before installation begins to verify the project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

Within [30] [_____] days of the Contract Award, submit the following for review and approval by the Contracting Officer:

a. List of product installations

b. Sample warranty

c. Finish and color samples

d. Manufacturer's catalog data

Concurrently submit certified test reports showing compliance with specified performance characteristics and UL 325 for the following:

a. Wind Load (Resistance) in accordance with AAMA 501

b. Deflection in accordance with ASTM F1642/F1642M

c. Condensation Resistance and Thermal Transmittance Performance Requirements in accordance with AAMA 1503

d. Water Infiltration in accordance with ASTM E331

e. Structural Requirements in accordance with ASTM F1642/F1642M

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sample Warranty; G, [_____]

List of Product Installations; G, [_____]

SD-02 Shop Drawings

Installation Drawings; G, [_____]

[Fabrication Drawings; G, [_____]
]

SD-03 Product Data

Manufacturer's Catalog Data; G, [_____]

Finish; G, [_____]

Recycled Content of Aluminum Material; S

SD-04 Samples

Finish and Color Samples; G, [_____]

SD-06 Test Reports

Certified Test Reports; G, [_____]

Deflection

Air Infiltration

Condensation Resistance and Thermal Transmittance

Water Infiltration

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-11 Closeout Submittals

Manufacturer's Product Warranty

1.4 QUALITY CONTROL

1.4.1 Qualifications

1.4.1.1 Installer Qualifications

Provide documentation of the installer's experience [as determined by the Contractor] in performing the work specified in this section.

Ensure that the installers are specialized in work similar to that required for this project, and that they are acceptable to product manufacturer.

1.4.1.2 Manufacturer Qualifications

Ensure that manufacturers meet the requirements specified in this section and project drawings.

Ensure that the manufacturer is capable of providing field service representation during construction, approving acceptable installers and approving application methods.

1.4.2 Single-Source Responsibility

When aluminum entrances are part of a building enclosure system, that includes storefront framing, windows, a curtain wall system, and related products, provide building enclosure system products from a single-source manufacturer.

Use a single source manufacturer with sole responsibility for providing design, structural engineering, and custom fabrication for door portal systems and for supplying components, materials, and products. Do not use products provided from numerous sources for assembly at the site. Ensure that the following work items and components are fabricated or supplied by a single source are:

****

NOTE: Edit the following list to reflect components required for glass wall and door portal assembly. Verify that sole source responsibility requirement is included in other sections.

****

a. Door assemblies to be installed in door portals as specified in [Section 08 11 16 ALUMINUM DOORS AND FRAMES][_____].

b. Glazed walls to be constructed around door portals as specified in [this Section][_____].

c. Door operating hardware to be installed on or within door portals as specified in Section 08 71 00 DOOR HARDWARE.

d. Glass as specified in [Section 08 81 00 GLAZING][_____].

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Ordering

To avoid construction delays, comply with the manufacturer's lead-time requirements and instructions for ordering.

1.5.2 Packing, Shipping, Handling and Unloading

Deliver materials in the manufacturer's original, unopened, undamaged containers with identification labels intact.

1.5.3 Storage and Protection

Store materials in a way that protects them from exposure to harmful weather conditions. Avoid damaging the storefront material and components during handling. Protect storefront material against damage from elements, construction activities, and other hazards before, during, and after storefront installation.

Do not use adhesive papers or sprayed coatings that become firmly bonded when exposed to sunlight. Do not leave coating residue on surfaces.

1.6 PROJECT / SITE CONDITIONS

1.6.1 Field Measurements

Verify actual measurements or openings by taking field measurements before fabrication; record these measurements on shop drawings. To avoid construction delays, coordinate field measurements, and fabrication schedule with construction progress.

1.7 WARRANTY

Provide a written manufacturer's warranty, executed by a company official, warranting against defects in materials and products for [_____] [2] years from the date of shipment. Warrant that the door corner construction is for the life of the project.[Provide a written installer's warranty, warranting work to be watertight and free from defective materials, defective workmanship, and glass breakage as a result of defective design, and agreeing to replace components that fail within [_____] [2] years.]

The warranty states the following:

a. Watertight and airtight system installation is completed within specified tolerances.

b. The completed installation remains free of rattles, wind whistles and noise caused by thermal movement and wind pressure.

c. System is structurally sound and free from distortion.

d. Glass and glazing gaskets will not break or "pop" from frames as a result of design, wind load pressure, movement caused by expansion or contraction, or structural loading.

e. Glazing sealants and gaskets remain free of abnormal deterioration or dislocation as a result of sunlight, weather, or oxidation.

****

NOTE: Delete paragraph below if high performance exterior finish is not used.

****

[Provide written warranty stating that the organic coating finish will not fade more than 10 percent or show chalking, yellowing, peeling, cracking, pitting, corroding or variations in color, or gloss deterioration beyond the manufacturer's descriptive standards for [_____] years from the shipment date and agreeing to promptly correct defects.

] **

NOTE: Delete paragraph below if thermal barrier framing system is not used.

****

[Provide a written thermal integrity warranty for [_____] years from ship date against thermal barrier system failure resulting from the following:

a. Longitudinal and transverse thermal barrier shrinkage.

b. Thermal barrier cracking.

c. Structural failure of the thermal barrier material.

d. Loss of adhesion or loss of prescribed edge pressure on glazing material, resulting in excessive air and water infiltration.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide aluminum entrances, with glass and glazing, door hardware, and components.

Aluminum entrances include impact resistance entrances; [medium stile, 88.9 mm 3 1/2 inch] [_____] vertical face dimension, [44.45 mm 1-3/4 inch] [_____] depth, for interior structural silicone glaze, for high-traffic/impact-resistant applications.

2.1.1 Design Requirements for Aluminum (Entrances and Components)

Provide a door portal system designed to withstand the following loads without breakage, loss, failure of seals, product deterioration, or other defects.

a. Dead and Live Loads: Determined by ASCE 7-16 and calculated in accordance with applicable codes.

b. Seismic Loads: Design and install the system to comply with the seismic requirements for the project location in accordance with Section 1613 of the International Building Code, ICC IBC.

c. Wind Loads: Design and install the system so that the effects of wind load acting inward and outward normal to the plane of the wall are in accordance with ASTM E330/E330M.

d. Thermal Loads And Movement:

(1) Ambient Temperature Range: [67][_____] degrees C [120][_____] degrees F

(2) Material Surfaces Range: [100][_____] degrees C [180][_____] degrees F

e. Water and Air Resistance: Provide weatherstripping, exterior gaskets, sealants, and other accessories to resist water and air penetration.

f. Impact-Protective Systems Provide an impact-protective system in accordance with [ASTM E1886][ASTM E1996].

2.1.1.1 Material Standard

ASTM B221MASTM B221; 6063-T5 alloy and tempered.

Provide door stile and rail face dimensions of the entrance doors as follows:

Vertical Stile	Top Rail	Bottom Rail
8.89 cm	8.89 cm	16.51 cm

Vertical Stile	Top Rail	Bottom Rail
3-1/2 inches	3-1/2 inches	6-1/2 inches

Provide major portions of the door members at 0.3175 cm 0.125 inches nominal in thickness and glazing molding at 0.127 cm 0.050 inches thick.

2.1.1.2 Recycled Content

Provide aluminum framed entrances and storefronts that have a minimum of 20 percent recycled content based upon the aluminum billet used in the original material. Provide data indicating percentage of recycled content of aluminum material.

2.1.1.3 Sealants

Provide either ethylene propylene diene monomer (EPDM) elastomeric extrusions or thermoplastic elastomer glazing gaskets. Structural silicone sealant is required.

Internal Sealants: Provide sealants that according to the manufacturer will remain permanently elastic, tacky, non-drying, non-migrating, and weather tight.

2.1.1.4 Thermal Barrier

Use a rigid, structural thermal barrier to separate all exterior aluminum from interior aluminum. For purposes of this specification, a structural thermal barrier is defined as a system that transfers shear during bending and, therefore, promotes composite action between the exterior and interior extrusions. Do not use a nonstructural thermal barrier. Ensure that the thermal barrier provides a structural connection between the two sides of the door.

2.2 FABRICATION

Provide the following information when submitting fabrication drawings for custom fabrications:

a. Indicate elevations, detailed design, dimensions, member profiles, joint locations, arrangement of units, and member connections.

b. Show the following items:

  (1) Details of special shapes.

  (2) Reinforcing.

  (3) Anchorage system.

  (4) Interfacing with building construction.

  (5) Provisions for expansion and contraction.

[(6) Thermal breaks.
]

c. Indicate typical glazing details[, locations of various types and thickness of glass][, emergency breakout locations,] and internal sealant requirements as recommended by the sealant manufacturer.

d. Clearly indicate locations of exposed fasteners and joints.

e. Clearly show where and how the manufacturer's system deviates from Contract drawings and these specifications.

2.2.1 Entrance System Fabrication

Provide door corner construction consisting of mechanical clip fastening, SIGMA deep penetration plug welds and 2.8575 cm 1-1/8 inch long fillet welds inside and outside all four corners. Provide a hook-in type exterior glazing stop with EPDM glazing gaskets reinforced with non-stretchable cord. Provide an interior glazing stop that is mechanically fastened to the door member and that incorporates a silicone-compatible spacer used with silicone sealant.

Accurately fit and secure joints and corners. Make joints hairline in appearance. Remove burrs and smooth edges. Prepare components with internal reinforcement for door hardware. Arrange fasteners and attachments so that they are concealed from view.

Separate dissimilar metals with protective coating or pre-formed separators to prevent contact and corrosion.

2.2.2 Shop Assembly

Fabricate and assemble units with joints only at the intersection of aluminum members with hairline joints; rigidly secure these units, and seal them in accordance with the manufacturer's recommendations.

2.2.2.1 Welding

Conceal welds on aluminum members in accordance with AWS recommendations or methods recommended by the manufacturer. Members showing welding bloom or discoloration on finish or material distortion will be rejected by the Contacting Officer.

2.2.3 Finish

****

NOTE: Specify AA-M-10-C22-A31 clear (natural) anodized finish or AA-M-10-C22-A32 color anodized finish, when doors will not be subjected to excessive wear or abrasion and will be regularly cleaned and maintained.

Specify AA-M-10-C22-A41 clear (natural) anodized finish or AA-M-10-C22-A42 color anodized finish, when doors will be subject to excessive wear and will not be regularly cleaned and maintained, or in highly corrosive industrial atmospheres with dust, gases, salts, or other disruptive elements that attack metal.

Color anodized finishes available include medium bronze, dark bronze, and black. Insert color desired in blank space provided. Of the choices indicated, black is generally most expensive.

In a tropical environment or in areas where corrosion is severe, specify the anodized finish as 0.0175 mm 0.7 mil thickness or greater.

****

Before fabrication, clean the units and give them a [AA-M-10-C22-A31 clear (natural) anodized finish] [AA-M-10-C22-A41 clear (natural) anodized finish] [AA-M-10-C22-A32 [_____] (color) anodized finish] [AA-M-10-C22-A42 [_____] (color) anodized finish] in accordance with the requirements of the AA DAF45. The finish thickness is [A41, 0.01 mm 0.4 mil or greater.] [A42, 0.0175 mm 0.7 mil or greater.]

****

NOTE: Select and edit following items for appropriate finish; delete inapplicable types.

****

a. Organic Coating (high-performance exterior coating):

    (1) Comply with requirements of AAMA 2605.

    (2) Clean surfaces and pretreat them with a conversion coating before applying 0.0076 0.3 mil dry-film thickness of epoxy or acrylic primer according to the recommendations of the finish coat manufacturer.

    (3) Apply a finish coat of [70 percent][_____] minimum fluoropolymer resin fused to primed surfaces at the temperature recommended by the manufacturer and at a minimum dry film thickness of 0.25 mm 1.0 mil.

(4) Use a 2-, 3-, or 4-coat system as required for the color selected.

[b. Clear Anodized; Conforming to [AA-M12C22A31][_____] and AAMA 611.

Select and edit the following items for the appropriate finish; delete types that do not apply.

(1) Architectural Class II [_____]

(2) Etched, medium matte [_____]

(3) Clear anodic coating, 0.10 mm 0.4 minimum thickness [_____]

]

****

NOTE: AA class 44 is a type I coating and is 0.018 mm 0.7 mil thick. AA Class 34 is a type II coating and is 0.010 mm 0.4 mil thick.

****

[c. Color Anodized: Conforming to [AA-M12C22A [34] [44]] [_____] and AAMA 611

Select and edit the following items for appropriate finish; delete types that do not apply.

(1) Architectural Class [II] [I]

(2) Etched, medium matte

(3) [Black] [dark bronze][medium bronze] [light bronze] anodic coating,[0.010 mm 0.4 mil][0.018 mm 0.7 mil] minimum thickness

]2.2.4 Fabrication Tolerance

Fabricate and assemble units with joints only at intersection of aluminum members with hairline joints; rigidly secure these units, and seal them in accordance with the manufacturer's recommendations.

Fabricate aluminum entrances in accordance with the entrance manufacturer's prescribed tolerances.

2.2.4.1 Material Cuts

Square to 0.8 mm 1/32 inch off square, over largest dimension; proportionate amount of 0.8 mm 1/32 inch on the two dimensions.

[2.2.4.2 Maximum Offset at Consecutive Members

0.4 mm 1/64 inch in alignment between two consecutive members in line, end to end.

][2.2.4.3 Maximum Offset at Glazing Pocket Corners

0.4 mm 1/64 inch between framing members at glazing pocket corners.

]2.2.4.4 Joints

Between adjacent members in same assembly: Joints are hairline and square to the adjacent member.

2.2.4.5 Variation

In squaring diagonals for doors and fabricated assemblies: 1.6 mm 1/16 inch.

2.2.4.6 Flatness

For doors and fabricated assemblies: 1.6 mm plus/minus 1/16 inch of neutral plane.

2.3 MATERIALS

2.3.1 Sealants

[Refer to Section 07 92 00 JOINT SEALANTS.]Ensure that all sealants conform to AAMA 800.

2.3.2 Glass

Refer to Section 08 81 00 GLAZING.

2.4 ACCESSORIES

2.4.1 Fasteners

Provide stainless steel fasteners in areas where the fasteners are exposed.

Use non-corrosive and compatible fasteners with components being fastened. Do not use exposed fasteners, except where unavoidable for application of hardware.

In areas where fasteners are not exposed, use aluminum, non-magnetic stainless steel, or other materials warranted by the manufacturer.

For exposed locations, provide countersunk Phillips head screws when items with a matching finish are fastened. For concealed locations, provide the manufacturer's standard fasteners.

Provide nuts or washers that have been designed with a means to prevent disengagement; do not deform fastener threads.

2.4.2 Perimeter Anchors

When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

2.4.2.1 Inserts and Anchorage Devices

Provide manufacturer's standard formed or fabricated assemblies, steel or aluminum, of shapes, plates, bars, or tubes. Shop-coat steel assemblies after fabrication with an alkyd zinc chromate primer complying with FS TT-P-645.

2.4.3 Standard Entrance Hardware

2.4.3.1 Weatherstripping

Equip meeting stiles on pairs of doors with an adjustable astragal using wool pile with a polymeric fin.

Provide door weatherstripping on a single-acting offset pivot or butt-hung door and frame (single or pairs) consisting of a thermoplastic elastomer weatherstripping on a tubular shape with a semi-rigid polymeric backing.

Provide sill-sweep strips: Provide an EPDM blade gasket sweep strip in an aluminum extrusion applied to the interior exposed surface of the bottom rail with concealed fasteners. (Provide as necessary to meet specified performance tests.)

2.4.3.2 Threshold

Provide an extruded aluminum threshold, one piece per door opening, with ribbed surface.

2.4.3.3 Offset Pivots

Provide the manufacturer's standard top and bottom pivots with one intermediate offset pivot.

2.4.3.4 Panic Device

Provide the manufacturer's recommended standard panic hardware.

2.4.3.5 Closer

Provide a surface closer in accordance with ANSI/BHMA A156.4.

2.4.3.6 Security Lock or Dead Lock

Provide [A/R MS 1850A lock with two A/R 1871 cylinder operated flush bolts] [_____].

2.4.3.7 Cylinder(s)/Thumb-turn

Provide the manufacturer's recommended standard.

2.4.3.8 Cylinder Guard

Provide the manufacturer's recommended standard.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Site Verification of Conditions

Verify that the condition of substrate previously installed under other sections is acceptable for product installation in accordance with the manufacturer's instructions.

Verify that openings are sized to receive the storefront system and that the sill plate is level in accordance with the manufacturer's acceptable tolerances.

3.2 PREPARATION

Field-verify dimensions before fabricating components for the door portal assembly.

Coordinate requirements for locations of blockouts for anchorage of door portal columns and other embedded components with Section 03 30 00 CAST-IN-PLACE CONCRETE.

Coordinate the erection of door portal with installation of surrounding glass wall and door assemblies. Ensure that the door portals can provide support and anchorage for assembly components.

****

NOTE: Edit the following list to reflect components required for glass wall and door portal assembly. Verify that sole source responsibility requirement is included in other sections.

****

Coordinate electrical requirements for [automatic door assemblies] [electrified door hardware] to ensure proper power source, conduit, wiring, and boxes.

3.2.1 Adjacent Surfaces Protection

Protect adjacent work areas and finish surfaces from damage during product installation.

3.2.2 Aluminum Surface Protection

Protect aluminum surfaces from contact with lime, mortar, cement, acids, and other harmful contaminants.

3.3 INSTALLATION

Submit installation drawings for review and approval.

Install the entrance system in accordance with the manufacturer's instructions and the AAMA storefront and entrance guide specifications manual. Attach the entrance system to the structure, allowing it to be adjusted to accommodate construction tolerances and other irregularities. Provide alignment attachments and shims to permanently fasten the system to the building structure. Align the assembly so that it is plumb and level, and free of warp and twist. Maintain assembly dimensional tolerances aligning with adjacent work.

Set thresholds in a bed of mastic and secure the thresholds. Protect aluminum members in contact with masonry, steel, concrete, or dissimilar materials using nylon pads or a bituminous coating. Shim and brace the aluminum system before anchoring the system to the structure. Verify that weep holes are open, and the metal joints are sealed in accordance with the manufacturer's installation instructions. Seal metal-to-metal joints using a sealant recommended by the system manufacturer.

3.3.1 Tolerances

Ensure that tolerances for wall thickness and other cross-sectional dimensions of entrance members are nominal and in compliance with Aluminum Standards and Data, published by the Aluminum Association.

3.3.2 Adjusting

Adjust operating hardware for smooth operation, and as recommended by the manufacturer.

3.3.3 Related Products Installation Requirements

3.3.3.1 Sealants (Perimeter)

Refer to Section 07 92 00 JOINT SEALANTS.

3.3.3.2 Glass

Refer to Section 08 81 00 GLAZING.

3.4 FIELD QUALITY CONTROL

3.4.1 Air Infiltration

Test air infiltration in accordance with ASTM E783

Submit certified test reports showing compliance with specified performance characteristics as follows:

a. For single-acting offset pivot, butt hung, or continuous geared hinge entrances in the closed and locked position, test the specimen in accordance with ANSI/BHMA A156.10, and ASTM E283 at a pressure differential of 7.7.67 kilogram/square meter 1.57 psf for pairs of doors; ensure that maximum infiltration for a pair of 2.13 meter by 2.44 meter 7 foot by 8 foot entrance doors and frame is 0.034 cubic meters per minute/square meter 1.2 cfm/square foot.

b. Ensure the maximum allowable infiltration for a completed storefront system does not exceed 0.0017 cubic meters/square meter 0.06 cfm/square foot when tested in accordance with ASTM E1424 at a differential static pressure of 299 Pa 6.24 psf.

3.4.2 Wind Loads

Provide a completed storefront system capable of withstanding wind pressure loads, normal to the wall plane indicated, as follows:

a. Exterior Walls

  (1) Positive Pressure: [_____] kilogram/square meter [_____] psf

  (2) Negative Pressure: [_____] kilogram/square meter [_____] psf

b. Interior Walls: (pressure acting in either direction) [_____] kilogram/square meter [_____] psf

3.4.3 Deflection

Submit certified test reports showing that the maximum allowable deflection in a member when tested in accordance with ASTM E330/E330M with allowable stress is L/175 or 19.1 mm 3/4 inches maximum.

3.4.4 Condensation Resistance and Thermal Transmittance

Submit certified test reports showing compliance with specified performance characteristics as follows:

a. U-Value Requirements:

  (1) Perform test in accordance with the AAMA 1503 procedure and on the configuration specified therein.

  (2) Thermal Transmittance ("U" Value) maximum [_____] [3.69 W/sqm/deg C] at [_____] [24.14] kmph [_____] [0.65 (6250) BTU/hr/sf/deg F] at [15] [_____] mph exterior wind.

b. CRF Class Requirements:

  (1) Perform a test in accordance with AAMA 1503.

  (2) Condensation Resistance Factor Requirements (CRF) minimum [_____].

3.4.5 Water Infiltration

Submit certified test reports showing that the system is designed to provide no uncontrolled water when tested in accordance with ASTM E1105 at a static pressure of 956 Pa 8 psf.

3.5 ADJUSTING AND CLEANING

3.5.1 Protection

Protect the installed product's finish surfaces from damage during construction. Protect the aluminum storefront system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.

3.5.2 Cleaning

Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions before acceptance remove excess mastic, mastic smears, and other foreign materials. Remove construction debris from the project site and legally dispose of this debris.

3.6 WARRANTY

Submit [three] [_____] signed copies of the manufacturer's product warranty for the entrance system as follows:

a. Warranty Period: [Five] [_____] years from Date of Substantial Completion of the project, provided that the Limited Warranty begins no later than [6] [_____] months from the date of shipment by the manufacturer. In addition, support welded door corner construction with a limited lifetime warranty for the life of the door under normal use.

Ensure that the Warranty's language is identical to the "As Approved" version of the sample warranty submitted to and returned from the Contracting Officer.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 44 00 (May 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 44 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-08 44 00 (May 2019)**

Preparing Activity: NAVFAC **Superseding**
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SECTION 08 44 00

CURTAIN WALL AND GLAZED ASSEMBLIES

05/19

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NOTE: This guide specification covers the requirements for complete glazed curtain wall system exclusive of doors, entrances, and store fronts, commercial aluminum curtain walls designed to accommodate fixed-glass lights, window sashes, panels, louvers, and other curtain-wall accessories.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

Curtain-wall systems may be classified by visual characteristics as follows:

1. Mullion type has dominant vertical lines. Vertical mullions are usually 45 millimeter 1-3/4 inches or more wide and usually extend 100 millimeter 4 inches or more beyond the exterior face of the curtain wall. Mullions are usually not more than 1525 millimeter 5 feet on center.

2. Grid type has equally dominant vertical and horizontal lines. Vertical and horizontal mullions are usually 45 millimeter 1-3/4 inches or more wide and usually extend 100 millimeter 4 inches or more

beyond the exterior face of the curtain wall. The area enclosed by the mullions is usually not more than 3 square meter 32 square feet.

3. Spandrel type has dominant horizontal lines, and the supports are not a primary element of expression. The sheathed type has a nonlinear pattern, and the supports are not a primary element of expression.

Related work specified in this section as required by the project includes:

1. Field-applied thermal insulation, glass and glazing, and field-applied joint sealing and expansion joints.

2. Methods of securing framing to structure and details of fastenings, anchors, and auxiliary shapes,

3. Openings to be glazed with double-glazing units.

Include a complete schedule of system types and sizes and all window units for the work to be performed and indicate the following::

1. Arrangement of curtain-wall framing showing all dimensions, shapes, and sizes of the members, floor elevations, connections, and the relation of the curtain-wall framing to other building components

2. Windows showing types, sizes, ventilators, dimensions, shapes, and sizes of members, and the relationship of each window sash to the curtain-wall system

3. Insect screens showing locations, dimensions, shapes, and sizes of members; shade screens and baffles showing locations, dimensions, shapes, and sizes of members; location of window cleaners' bolts

4. Panels showing all dimensions, edge detail, and the relationship of panels to the curtain-wall system, openings to be glazed with double-glazing units

5. Doors and frames showing the door size, thickness, and hand. Arrangement of frames including dimensions, shapes, and sizes of members and connections; and the relationship of doors and frames to the curtain-wall system

6. Metal accessories, such as aluminum sills at the bottom of curtain walls, aluminum coping at the top of curtain walls, and exterior architectural louvers showing all dimensions, shapes, and sizes of members, connections, and the relationship of each metal accessory item to the curtain-wall system

7. Field-applied thermal-insulation systems showing the location, method of attachment, nominal thickness, and name of insulation

8 Joints to be sealed with field-applied sealing compound showing the kind of materials that will be in contact with the sealing compound; locations, dimensions of joints, name of backup material, and name of sealing compound, for each type of sealing compound

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual
AA ASD1	(2024) Aluminum Standards and Data
AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501.1	(2017) Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
AAMA 501.2	(2015) Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems

AAMA 501.4	(2018) Recommended Static Test Method for Evaluating Window Wall, Curtain Wall and Storefront Systems Subjected to Seismic and Wind-Induced Inter-Story Drift
AAMA 501.5	(2007) Test Method for Thermal Cycling of Exterior Walls
AAMA 501.6	(2018) Recommended Dynamic Test Method for Determining the Seismic Drift Causing Glass Fallout from Window Wall, Curtain Wall and Storefront Systems
AAMA 501.7	(2017) Recommended Static Test Method for Evaluating Windows, Window Wall, Curtain Wall and Storefront Systems Subjected to Vertical Inter-Story Movements
AAMA 609 & 610	(2015) Cleaning and Maintenance Guide for Architecturally Finished Aluminum
AAMA 800	(2016) Voluntary Specifications and Test Methods for Sealants
AAMA 2603	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
AAMA 2604	(2017a) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA CW-10	(2015) Care and Handling of Architectural Aluminum from Shop to Site
AAMA MCWM-1	(1989) Metal Curtain Wall Manual
AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121	(2007) Standard Definitions for Use in the Design of Steel Structures
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS A5.10/A5.10M	(2023) Welding Consumables - Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys - Classification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A424/A424M	(2009a; R 2016) Standard Specification for Steel Sheet for Porcelain Enameling
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A572/A572M	(2021; E 2021) Standard Specification for

	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588/A588M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A606/A606M	(2023) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B85/B85M	(2018) Standard Specification for Aluminum-Alloy Die Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B136	(2023) Standard Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum
ASTM B137	(1995; R 2021) Standard Test Method for Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminum
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B211/B211M	(2023) Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished

	Bar, Rod, and Wire
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B244	(2009; R 2021) Standard Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments
ASTM B308/B308M	(2010; R 2020) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B316/B316M	(2020) Standard Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods
ASTM B429/B429M	(2010; E 2012) Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM C220	(1991; R 2015) Standard Specification for Flat Asbestos-Cement Sheets
ASTM C481	(1999; R 2011) Standard Test Method Laboratory Aging of Sandwich Constructions
ASTM C542	(2005; R 2024) Standard Specification for Lock-Strip Gaskets
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C592	(2024) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)

ASTM C610	(2017; R 2023) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C665	(2024) Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C864	(2005; R 2015) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM C1087	(2016) Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems
ASTM C1135	(2015) Standard Test Method for Determining Tensile Adhesion Properties of Structural Sealants
ASTM C1184	(2023) Standard Specification for Structural Silicone Sealants
ASTM C1363	(2024) Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
ASTM C1401	(2014) Standard Guide for Structural Sealant Glazing
ASTM D1037	(2012; R 2020) Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D1730	(2009; R 2020) Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D3656/D3656M	(2013) Standard Specification for Insect Screening and Louver Cloth Woven from

	Vinyl-Coated Glass Yarns
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E546	(2014; R 2020) Standard Test Method for Frost Point of Sealed Insulating Glass Units
ASTM E576	(2014; R 2020) Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position
ASTM E783	(2002; R 2018) Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
ASTM E1105	(2015; R 2023) Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference
ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings

ASTM E1332	(2016) Standard Classification for Rating Outdoor-Indoor Sound Attenuation
ASTM E1886	(2019) Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
ASTM E1996	(2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
ASTM E3061	(2017) Standard Test Method for Analysis of Aluminum and Aluminum Alloys by Inductively Coupled Plasma Atomic Emission Spectrometry (Performance-Based Method)
ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass
ASTM F2912	(2017) Standard Specification for Glazing and Glazing Systems Subject to Airblast Loadings

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A135.4	(2012; R2020) Basic Hardboard

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence
NFRC 500	(2010) Procedure for Determining Fenestration Product Condensation Resistance Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 285	(2023) Standard Fire Test Method for

	Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

PORCELAIN ENAMEL INSTITUTE (PEI)

PEI 1001	(1996) Specification for Architectural Porcelain Enamel (ALS-100)
PEI CG-3	(2005) Color Guide for Architectural Porcelain Enamel

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 3	(2024) Power Tool Cleaning
SSPC SP 12/NACE No.5	(2002) Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating

STEEL WINDOW INSTITUTE (SWI)

SWI AGSW	(2002) Architect's Guide to Steel Windows

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy

and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Glazed Curtain Wall System; G, [_____]

Installation Drawings

Shop-Painting Aluminum; G, [_____]

Shop-Painting Steel; G, [_____]

SD-03 Product Data

Glazed Curtain Wall System; G, [_____]

Metals For Fabrication; G, [_____]

Nonskinning Sealing Compound; G, [_____]

Metal Accessories; G, [_____]

Curtain-Wall Framing Members; G, [_____]

Aluminum Doors and Frames; G, [_____]

Laminated Panels; G, [_____]

Thermal Insulation Materials; G, [_____]

Masonry Anchorage Devices; G, [_____]

[Recycled Content of Aluminum Doors and Frames; S

][Recycled Content of Aluminum Curtain-Wall Framing Members; S

][Recycled Content of Aluminum Windows; S

] Sample Warranties; G, [_____]

SD-05 Design Data

[Anodic Finish; G, [_____]

][Pigmented Organic Coating; G, [_____]

] Exposed-to-View Aluminum Finish; G, [_____]

Seismic Calculations; G, [_____]

Structural Calculations for Deflection; G, [_____]

****

NOTE: Provide Design Analysis when blast design is required by UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Building

****

[Design Analysis; G, [_____]

] SD-06 Test Reports

****

NOTE: Provide Standard Airblast Test Reports when required by UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Building.

****

[NFPA 285 Factory Test Results; G, [_____]

][Standard Airblast Test; G, [_____]

] Field Water Spray Test Results; G, [_____]

Air Infiltration Test Results; G, [_____]

Water Penetration Test Results; G, [_____]

SD-07 Certificates

Energy Performance Certificates; G, [_____]

****

NOTE: Require Engineer Qualifications when blast design is required by UFC 4-010-01, DoD Minimum Antiterrorism requirements for buildings.

****

[Engineer Qualifications; G, [_____]

] Qualifications for the Curtain-Wall Installer; G, [_____]

SD-08 Manufacturer's Instructions

Glazed Curtain Wall System; G, [_____]

Insulating Glass; G, [_____]

Preventive Maintenance and Inspection; G, [_____]

SD-11 Closeout Submittals

Warranty; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Engineer Qualifications for Blast Design

All blast design calculations must be performed by or under the direct supervision of a registered engineer with a minimum of 5 years experience performing blast design. The [engineer] performing the blast design must be able to demonstrate experience on similar size projects using similar design methods to meet the requirements outlined in this specification.

1.3.2 Qualification of Welders

Welding must be performed by certified welders qualified in accordance with AWS D1.1/D1.1M using procedures, materials, and equipment of the type required for the work.

1.3.3 Qualifications for the Curtain-Wall Installer

Submit a written description of the proposed curtain-wall system installer giving the name of the curtain-wall manufacturer, qualifications of personnel, years of concurrent contracting experience, lists of projects similar in scope to the specified work. Installer must be approved by the Manufacturer as a Certified Installer and have a minimum of 5 years experience installing curtain wall systems, and have completed projects similar in size to this project.

1.3.4 Testing Requirements

****

NOTE: Revise this paragraph as necessary to cover project requirements.

****

The components listed below must be tested in accordance with the requirements below, and meet performance requirements specified.

a. Joint and Glazing Sealants: Perform tests as required by applicable publications referenced.

b. Preformed Compression Gaskets and Seals: ASTM C864.

c. Preformed Lock-strip Gaskets: ASTM C542, modified as follows: Heat age specimens seven days at 70 degrees C 158 degrees F, in zipped or locked position under full design compression. Unzip, cool for one hour, re-zip, and test lip seal pressure, which must be minimum 0.045 kilograms per linear millimeter 2.5 pounds per linear inch on any extruded or corner specimen.

d. Spandrel Glass: Fallout resistance test, ASTM C1048.

e. Porcelain Enamel: Acid resistance, color retention, and spall resistance tests, PEI 1001.

f. Anodized Finishes: Stain resistance, coating weight, and coating thickness tests, ASTM B136, ASTM B137, and ASTM B244, respectively.

g. Insulating Glass: ASTM E546 or ASTM E576 at [minus 29 degrees C 20 degrees F] [_____], no frost or dew point.

[1.3.5 Mockup

****

NOTE: Size of project and system specified will determine whether mock-ups are necessary. Complete information should be given concerning extent, details, and purpose of mock-ups. Where mock-ups have been previously tested for another project or for commercial production, they may serve the purpose. When testing of a mock-up is required, the unit should be erected at a testing laboratory or other location where adequate testing equipment is available.

****

1.3.5.1 Construction

Construct at [job site] [manufacturer's plant] [approved testing laboratory] full size typical wall unit which incorporates horizontal and vertical joints, framing, window units, panels, glazing, and other accessories as detailed and specified. Mock-up wall unit size and design must be as indicated.

1.3.5.2 Performance Test

Conduct tests after approval of visual aspects has been obtained. Finished work must match approved mock-up.

1.3.5.3 Approved Mock-Up

After completion and approval of test results [[transport mock-up to job site and] install, where directed, for reference during construction.] [Approved mock-up must remain property of the Contractor.]

]1.3.6 Factory Tests

****

NOTE: The overall performance requirements and tests will vary with the design and geographical location of the building as well as with the type of construction and components specified. Only those tests which are necessary to establish compliance with specifications should be included in the project specification. Refer to AAMA Curtain Wall Manual for detailed testing methods and the recommended minimum performance requirements and safety factors.

****

Perform the following tests except that where a curtain wall system or component of similar type, size, and design as specified for this project has been previously tested, under the conditions specified herein, the resulting test reports may be submitted in lieu of testing the components listed below:

a. [NFPA 285 Factory Test Results]

b. [_____]

c. [_____]

1.3.6.1 Deflection and Structural Tests

Curtain wall framing members must not deflect, in a direction normal to the plane of the wall, more than 1/175 of its clear span or 20 mm 3/4 inch, whichever is less, when tested in accordance with ASTM E330/E330M, except that when a plastered surface will be affected the deflection must not exceed 1/360 of the span. Framing members must not have a permanent deformation in excess of 0.2 percent of its clear span when tested in accordance with ASTM E330/E330M for a minimum test period of 10 seconds at 1.5 times the design wind pressures specified. Provide Structural Calculations for Deflection.

1.3.6.2 Water Penetration Test

****

NOTE: The test method of ASTM E331 is that of determining resistance of the curtain wall to water penetration under uniform static air pressure difference. When testing under dynamic conditions is required, AAMA Specification 501.1 should be referenced.

****

Water penetration must not occur when the wall is tested in accordance with ASTM E331 at a differential static test pressure of 20 percent of the inward acting design wind pressure as specified, but not less than 575 Pa 12 psf. Make provision in the wall construction for adequate drainage to the outside of water leakage or condensation that occurs within the outer face of the wall. Leave drainage and weep openings in members and wall open during test.[Test curtain wall systems in areas subject to hurricanes and typhoons in accordance with AAMA 501.1 Dynamic Testing.]

1.3.6.3 Air Infiltration Test

Air infiltration through the wall, when tested in accordance with ASTM E283, must not exceed 0.005 cms per sq. m 0.06 cfm per square foot of fixed wall area, plus the permissible allowance specified for operable windows within the test area, at a static air pressure differential of 300 Pa 6.2 psf.

1.3.6.4 Delamination Test

Adhesively bonded metal-faced [[_____] faced] panels must show no evidence of delamination, warpage or other deterioration or damage when subjected to the six "Accelerated Aging Cycles" specified in ASTM D1037.

1.3.6.5 Sealant Adhesion and Compatibility Testing

ASTM C1401, submit to structural glazing sealant manufacturer, for testing indicated below. Samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that is in close proximity to or is touching the structural or nonstructural sealants of a structural glazed system.

a. Compatibility: Test materials or components using ASTM C1087.

b. Adhesion: Test for adhesion or lack of adhesion of a structural sealant to the surface of another material or component using ASTM C1135.

c. Submit no fewer than [8] [_____] pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.

d. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

e. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

f. Testing will not be required if data based on previous testing of current sealant products match those submitted.

1.3.6.6 Energy Performance Tests

Energy Performance Certificates for Glazed Aluminum Curtain Wall, Accessories, and Components from Manufacturer Confirming NFRC- Certified Energy Performance Values for Each Glazed Aluminum Curtain Wall.

The thermal transmittance of opaque panels must not exceed specified U-value, when tested in accordance with ASTM C1363. Certify and Label Energy Performance according to NFRC as follows:

****

NOTE: Thermal Transmittance (U-Factor) and SHGC are contingent upon the composition of the glazing for the project. Coordinate with glazing selections.

****

a. Thermal Transmittance (U-factor): Fixed glazing and framing areas as a system must have U-factor of not more than [0.29 Btu/sq. ft. x h x deg F] [0.36 Btu/sq. ft. x h x deg F] [0.38 Btu/sq. ft. x h x deg F] [0.41 Btu/sq. ft. x h x deg F] [0.46 Btu/sq. ft. x h x deg F] [0.50 Btu/sq. ft. x h x deg F] as determined according to NFRC 100.

b. SHGC: Fixed glazing and framing areas as a system must have a SHGC of no greater than [0.22] [0.25] [0.26] [0.29] [0.40] [0.45] as determined according to NFRC 200.

c. Condensation Resistance: Fixed glazing and framing areas as a system must have an NFRC-certified condensation resistance rating of no less than [45] [55] [65] [80] as determined according to NFRC 500.

1.3.6.7 Window Tests

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

Windows must meet the requirements specified in [_____] except where the requirements of this section differ, this section governs. Provide windows that meet the same requirements for deflection and structural adequacy as specified for framing members when tested in accordance with ASTM E330/E330M, except permanent deformation must not exceed 0.4 percent; there must be no glass breakage, and no permanent damage to fasteners, anchors, hardware, or operating devices. Provide windows that have no water penetration when tested in accordance with ASTM E331.

1.3.6.8 Fire Resistance Tests

****

NOTE: The exception to the smoke developed requirement as given in this paragraph does not apply to hospitals and confinement (correctional) facilities; insulation for these facilities must have a smoke developed rating not exceeding 150.

****

Insulation [provided in the curtain wall system] [field applied in conjunction with the curtain wall system] must have a flame spread rating not exceeding 75 and a smoke developed rating not exceeding 150 when tested in accordance with ASTM E84, except as specified otherwise herein.

a. Insulation: Insulation [contained entirely within panel assemblies which meets the flame spread and smoke developed ratings of 75 and 150 respectively] [isolated from the building interior by masonry walls, masonry cavity walls, or encased in masonry cores] is not required to comply with the flame spread and smoke developed ratings specified.

****

NOTE: Use bracketed option when required by Fire Code Analysis. Coordinate with other exterior wall component specifications.

****

b. Curtain Wall Systems: Material for firestopping the opening between the edge of the floor slab and back of the curtain wall system, must not have less than the flame spread and smoke developed ratings specified for insulation which is neither isolated from the building interior nor encased in masonry cores.[When required, entire curtain wall system must conform to NFPA 285.]

c. Curtain Wall Panels: Provide panels for fire resistive curtain walls that have a fire resistive rating of [_____] hours when tested in accordance with ASTM E119.

d. Firestopping Materials and Devices: Firestopping material and attachment devices must be an effective barrier against the spread of fire, smoke, and gases for a period of [_____] hours when exposed to the conditions of the standard ASTM E119time-temperature curve for a period equivalent to the fire rating of the floor system and must also be rated noncombustible when tested in accordance with ASTM E136.

1.3.6.9 Noise Reduction

Test according to ASTM E90, with ratings determined by ASTM E1332, as follows: Outdoor-Indoor Transmission Class: Minimum [26] [30] [34] [_____]. Sound Transmission Class: Minimum [31] [34] [37] [40] [_____].

1.4 FIELD TESTS

Testing must be performed by a testing agency regularly engaged in testing of architectural products, not affiliated with the curtain wall installer, and experienced with these test methods. Notify the Contracting Officer a minimum of seven calendar days prior to performing field tests.

1.4.1 Field Water Spray Tests

Engage a qualified testing agency to perform tests and inspection. Perform test on [one bay of at least 30 feet long by one story][a representative area of glazed curtain wall]. Perform water-spray test before interior finishes have begun, in accordance with AAMA 501.2. Test area must not show evidence of water penetration. Perform a minimum of [2] [3] [_____] tests. Submit Field Water Spray Test Results.

1.4.2 Air Infiltration

ASTM E783 at 1.5 times the rate specified for laboratory testing under factory test paragraph, but not more than 0.06 cfm/sq.ft at a static air pressure differential of 6.24 lbf/sq.ft. Perform a minimum of [2] [3] tests in representative areas. Submit Air Infiltration Test Results.

1.4.2.1 Water Penetration

ASTM E1105 at a minimum [uniform] [and] [cyclic] static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and must not evidence water penetration. Submit Water Penetration Test Results.

1.5 GLAZED CURTAIN WALL SYSTEM REQUIREMENTS

****

NOTE: This specification is intended for use with glazed curtain walls for low rise buildings and multi-story buildings. Since aluminum shapes are usually extruded and most other metal shapes are rolled-formed or brake-formed, the project drawings and details must show the materials and shapes desired. Requests to the Contractor for alternate bids is not allowed. The Contractor is not allowed to substitute one metal for another unless complete details are shown for each type of metal components permitted.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including moisture control, thermal performance, fenestrations and glazing.

For further guidance and information on the design of Curtain Walls for moisture control, thermal comfort, energy savings, and sustainability, see the "Whole Building Design Guide, Building Envelope Design Guide - Curtain Walls".

****

Provide system complete with framing, mullions, trim, [framed pre-assembled units,] panels, windows, glass, glazing, sealants, insulation, fasteners, anchors, accessories, concealed auxiliary members, and attachment devices for securing the wall to the structure as specified or indicated.

Submit installation drawings for curtain wall system, accessories[, and mock-up].[Tentative approval of drawings must be received before fabrication of mock-up. Final approval of drawings will be deferred pending approval of mock-up and accessories.] Drawings must indicate in detail all system parts including elevations, full-size sections, framing, jointing, panels, types and thickness of metal, flashing and coping details, field connections, weep and drainage system, finishes, sealing methods, glazing, glass sizes and details, firestopping insulation materials, and erection details.

1.5.1 Source

Furnish curtain wall system components by one manufacturer or fabricator; however, all components need not be products of the same manufacturer.

1.5.2 Design

****

NOTE: Refer to AAMA Curtain Wall Design Guide Manual "Testing, Types and Systems" for an explanation of the various curtain wall systems. The systems included in this guide specification are the standard architectural type as opposed to custom type. Generally the custom type of system is more expensive and should only be considered for special projects. When a system other than those listed is required this paragraph must be adjusted accordingly.

****

[Stick system] [Unit system] [Unit and mullion system] [[_____] system] with [mullions,] [horizontal rails,] [panels,] [window units,] [screens] [framed pre-assembled units with [integral] [nonintegral] spandrel panels [_____]]. Fully coordinate system accessories directly incorporated, and adjacent to contiguous related work and insure materials compatibility, deflection limitations, thermal movements, and clearances and tolerances as indicated or specified.

1.5.3 Tolerances

****

NOTE: The finished wall system requires the coordination and efforts of many different manufacturers, suppliers, and construction trades. Contractor submittal requirements must include sufficient detail to insure coordination between them.

****

Design and erect wall system to accommodate tolerances in building frame and other contiguous work as indicated or specified. Provide with the following tolerances:

a. Maximum variation from plane or location shown on approved shop drawings: one millimeter per 12 meters 1/8 inch per 12 feet of length up to not more than 13 mm 1/2 inch in any total length.

b. Maximum offset from true alignment between two identical members abutting end to end in line: 2 mm 1/16 inch.

1.5.4 Structural Requirements

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NOTE: When mullions are used to support window cleaning rigs, the loads on the mullion members created by the rigs must be considered in the mullion design and the appropriate figures listed in blank spaces.

****

Members may not deflect in a direction parallel to the plane of the wall, when carrying its full design load, more than an amount which will reduce the edge cover or glass bite below 75 percent of the design dimension. After deflection under full design load, members may not have a clearance between itself and the top of the panel, glass, sash, or other part immediately below it less than 3 mm 1/8 inch. The clearance between the member and an operable window or door must be minimum 2 mm 1/16 inch. [Design system members serving as guide rails for window cleaning equipment to carry mid-span concentrated load of [_____] kilograms pounds normal to plane of wall and [_____] kilograms pounds applied horizontally, parallel to wall plane without deflection which would affect adjacent surfaces.] Design entire system to withstand the indicated wind and concentrated loads, and the following wind loads acting normal to the plane of the wall:

a. On the first [_____] stories above grade [_____] kPa psf acting inward, and the same load acting outward.

b. On the next [_____] stories above grade [_____] kPa psf acting inward, and the same load acting outward.

c. On corner areas, extending [_____] meters feet from the building corners on the [_____] stories, on all facades, the outward-acting (negative) design load must be increased to [_____] kilopascals pounds per square foot.

[1.5.5 Seismic Calculations

When tested to AAMA 501.4 and AAMA 501.6, system must meet design displacement of 0.010 times the story height and ultimate displacement of 1.5 times the design displacement. Provide with the following tolerances:

a. Phase I: 3 stroke cycles using .005 times the story height - no damage or failure.

b. Phase II: 3 stroke cycles using .010 times the story height - no damage or failure.

]1.5.6 Thermal Cycling and Vertical Inter-Story Movement Calculations

a. Thermal Cycling: AAMA 501.5. Repeat the Air Infiltration Test, ASTM E283, and the Water Penetration Test Under Static Pressure, ASTM E331.

b. Inter-Story Drift: AAMA 501.4 and AAMA 501.7 at 100 percent of design displacement. Repeat the Air Infiltration Test, ASTM E283 and the

Water Penetrated Test Under Static Pressure, ASTM E331.

1.6 DELIVERY AND STORAGE

Inspect materials delivered to the site for damage; unload and store with a minimum of handling in accordance with recommendations contained in AAMA CW-10. Storage spaces must be dry locations with adequate ventilation, free from heavy dust, not subject to combustion products or sources of water, and must allow for easy access for inspection and handling. Deliver caulking and sealing compounds to the job site in sealed containers labeled to show the designated name, formula or specifications number; lot number; color; date of manufacturer; shelf life; and curing time when applicable.

1.6.1 Protective Covering

Prior to shipment from the factory, place knocked-down lineal members in cardboard containers and cover finished surfaces of [aluminum] [stainless steel] with protective covering of adhesive paper, waterproof tape, or strippable plastic. Covering must not chip, peel, or flake due to temperature or weather, must protect against discoloration and surface damage from transportation, and storage, and must be resistant to alkaline mortar and plaster. Do not cover [aluminum] [stainless steel] surfaces that will be in contact with sealants after installation.

1.6.2 Identification

Prior to delivery, mark wall components to correspond with shop and erection drawings placement location and erection.

1.7 WARRANTY

****

NOTE: The warranty clause in this guide specification has been approved by NAVFACENGCOMHQ in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS).
NFAS can be found at the following link:
https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_forbusinesses_pp/smallbusiness/contracting/navfac.
The paragraph in this guide specification may be used without any other HQ approval or request for waiver.

****

Guarantee insulating glass units not to develop material obstruction of vision as a result of dust or film formation on the inner glass surface caused by failure of the seal, other than through glass breakage, within a period of 5 years from date of acceptance of work by the Government. Replace units failing to comply with the terms of this guarantee with new units without additional cost to the Government. The Contractor must require the manufacturer to execute their warranties in writing directly to the Government.

1.7.1 Sample Warranties

Provide curtain wall and glazing assembly material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard membrane manufacturer warranty to comply with the specified

requirements.

a. Project Warranty: Refer to Section 01 11 00 SUMMARY OF WORK.

b. Manufacturer's Warranty: Submit, for acceptance, the Manufacturer's standard warranty document executed by authorized company official. The manufacturer's warranty is in addition to, and not a limitation of, other rights the Government may have under the Contract Documents.

c. Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of steel fire-rated glazed curtain-wall systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.

d. Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering. Deterioration includes, but is not limited to, color fading more than 5 Delta E units when tested according to ASTM D2244, chalking in excess of a No. 8 rating when tested according to ASTM D4214, cracking, peeling, or chipping.

e. Beneficiary: Issue warranty to the Government.

f. Warranty Period: [5] [10] [_____] years commencing on Date of Substantial Completion, covering complete curtain wall system for failure to meet specified requirements.

g. Warranty Acceptance: Owner is sole authority who will determine acceptability of manufacturer's warranty documents.

1.8 INTERPRETATION OF AWS CODE

****

NOTE: Coordinate the requirements of Section 05 05 23.16 STRUCTURAL WELDING. If Section 05 05 23.16 STRUCTURAL WELDING is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.

****

Section 05 05 23.16 STRUCTURAL WELDING applies to work specified in this section.

AWS code, when referred to herein, means AWS D1.1/D1.1M, "Structural Welding Code - Steel" with the following modification:

Revise AWS code Section 1, "General Provisions," Paragraph 1.1 as follows: References to the need for approval means "Approval by the Contracting Officer" and references to the "Building Commissioner" means the "Contracting Officer."

1.9 PERFORMANCE REQUIREMENTS

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NOTE: Structural performance, air infiltration and water penetration are standard performance requirements for all aluminum curtain wall types.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-00-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

"Antiterrorism Performance Requirements" and "Sound Attenuation" sections below are optional to designer, and must be omitted or revised as needed to meet project requirements.

Applicability of UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings

The antiterrorism (AT) standards contained in UFC 4-010-01 DO NOT establish the Design Basis Threat (DBT) or the Level of Protection (LOP) for DoD buildings. Installation Antiterrorism Plans may define a DBT for the installation. Use UFC 4-020-01 (Security Engineering: Facilities Planning Manual) to establish and/or validate the DBT and LOP for individual projects. The process outlined in UFC 4-020-01 will determine if the minimum AT standards are adequate or if additional protective measures are required. Where a specific DBT and LOP are identified, additional guidance is included in Appendix B (Best Practices) of UFC 04-010-01. For buildings that are outside an installation perimeter, use UFC 4-020-01 to establish the DBT and LOP. The DBT and LOP will result in a representative standoff distance for the appropriate construction - window systems (glazing, frame, connections) in this instance.

A Structural Analysis will need to be performed to determine if the most stringent loading on window assembly is from antiterrorism blast loads or windborne debris in high wind regions.
****

[1.9.1 Antiterrorism Performance Requirements

Curtain Wall assembly must meet the antiterrorism performance criteria specified in the paragraphs below and UFC 4-010-01. One of the following methods must validate conformance to the performance requirements.

1.9.1.1 Computational Design Analysis Method

Submit design analysis with calculations showing that the design of each different size and type of aluminum curtain wall and its anchorage to the structure meets the antiterrorism standards required by paragraph ANTITERRORISM PERFORMANCE REQUIREMENTS, unless conformance is demonstrated by Standard Airblast Test results. Calculations verifying the structural performance of each curtain wall proposed for use, under the given loads, must be prepared and signed by a registered Professional Engineer. The curtain wall components and anchorage devices to the structure, as determined by the design analysis, must be reflected in the shop drawings.

Design curtain wall assembly to the criteria listed herein. Computational design analysis must include calculations verifying the structural performance of each curtain wall assembly proposed for use, under the given static equivalent loads.

Design curtain wall frames, mullions, sashes, and glazing to the criteria listed herein. Computational design analysis must include calculations verifying the structural performance of each window system proposed for use, under the given static equivalent loads.

****

NOTE: The blanks in the following paragraph should be the value of the equivalent 3-second duration design loading obtained from Figure 1 of ASTM F2248 for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. This section must be completed by an engineer experienced in blast-resistant design.

****

Glazing resistance must be greater than equivalent 3-second duration loading of [_____] Pascal pounds per square foot (psf) for type [_____] window [per Window Schedule indicated on the drawings] [and [_____] Pascal psf for the remaining window types]. The glazing frame bite for the window frames must be in accordance with ASTM F2248.

Aluminum/Steel window framing members must restrict deflections of the edges of glazing they support to L/60 under two times (2X) the glazing resistance per the requirements of ASTM F2248 and ASTM E1300.

****

NOTE: Connection Design: For mullion and framing members designed using dynamic analysis or shown to work through airblast testing, all connections between mullions and/or framing members and all connections of storefront systems to the supporting structure must be designed for the full dynamic capacity of the attached member or the maximum calculated dynamic reaction with a load factor equal to 1.0. Use ultimate capacity of fasteners as recommended by the fastener manufacturer with a capacity reduction factor of 0.75. Use Load and Resistance Factor Design (LRFD) with appropriate reduction (phi) factors per material specific code for design of connections components into supporting structure. All dynamic and static material strength increase factors for the connection components must be equal to 1.0. All connection designs must be performed checking all conventional failure mechanisms. See Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: https://pdc.usace.army.mil/library/tr/10-02 **) for**

additional information. Calculations/Design Analysis for the connection design as stated above must be completed by an engineer experienced in blast-resistant design.

****

****

NOTE: Use the first bracketed requirement below if the maximum air blast pressure is greater than one half the magnitude of the load resistance of the blast resistant glazing.

Use the second bracketed requirement below if the maximum air blast pressure is less than one half the magnitude of the load resistance of the blast resistant glazing.

****

[Anchor curtain wall frames to the supporting structure with anchors designed to resist [two times (2X)] [one time (1x)] the glazing resistance in accordance with ASTM F2248 and ASTM E1300.

]1.9.1.2 Dynamic Design Analysis Method

****

NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01 (Table B-1). Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering/billeting building occupancy as defined in UFC 4-010-01 (Table B-1). Dynamic analysis is preferred because it typically yields a more appropriate and economical / efficient design. The values for input into the blanks in the following paragraph related to 'ductility ratio' and 'maximum support rotation' (for the appropriate level of protection – very low, low) for steel and aluminum framing/mullions can be found in Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: https://pdc.usace.army.mil/library/tr/10-02). This section must be completed by an engineer experienced in blast-resistant design.

****

Design curtain wall assembly using a dynamic analysis to prove the system will provide performance equivalent to or better than a [low];[very low]; [_____] hazard rating in accordance with ASTM F2912 for the peak positive pressure of [_____] kilopascals (kPa) pounds per square inch (psi); and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) pounds per square inch - millisecond (psi-msec). Use a triangular blast load using the applicable pressure and impulse indicated above. The allowable response limits of [aluminum]; [steel] frame elements are as follows: Maximum ductility ratio of [_____] and maximum support rotation of [_____] degrees.

1.9.1.3 Standard Airblast Test Method

For Antiterrorism curtain wall, in lieu of a Design Analysis, include in a test report results of airblast testing, whether by arena test or shock tube providing information in accordance with ASTM F1642/F1642M, as prepared by the independent testing agency performing the test. Demonstrate in the test results the ability of each curtain wall proposed for use to withstand the airblast loading parameters and achieve the hazard level rating specified in paragraph STANDARD AIRBLAST TEST METHOD. Demonstrate in the test results the ability of each curtain wall proposed for use to withstand the airblast loading parameters and achieve [low]; [very low] hazard level rating or better when rated per the requirements of ASTM F2912.

****

NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01. Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering building occupancy as defined in UFC 4-010-01. This section must be completed by an engineer experienced in blast-resistant design.

****

As an alternative to the 'Computational Design Analysis Method' and 'Dynamic Design Analysis Method' indicated above, curtain wall assembly may be tested for evaluation of hazards generated from airblast loading in accordance with ASTM F1642/F1642M by an independent testing agency regularly engaged in blast testing. For proposed window systems that are of the same type as the tested system but of different size, the test results may be accepted provided the proposed window size is within the range from 25 percent smaller to 10 percent larger in area and aspect ratio of the original qualified tested glazing systems in accordance with ASTM F2912. Proposed window system/assembly of a size outside this range requires testing to evaluate their hazard rating or are certified by the 'Dynamic Design Analysis Method' indicated above. Testing may be by shock tube or arena test. Perform the test on the entire proposed window system/assembly, which must include, but not be limited to, the glazing, its framing/support system, operating devices, and all anchorage devices. Anchorage of the window support system must replicate the method of installation to be used for the project. The minimum airblast loading parameters for the test must be as follows: peak positive pressure of [_____] kilopascals (kPa) pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) pounds per square inch - millisecond (psi-msec). The hazard rating for the proposed window systems, as determined by the rating criteria of ASTM F2912, to provide performance equivalent to or better than a [low]; [very low]; [_____] hazard rating (i.e. the "No Break", "No Hazard", "Minimal Hazard", "Very Low Hazard" and "Low Hazard" ratings are acceptable. "High Hazard" ratings are unacceptable. Results of window systems previously tested by test protocols other than ASTM F1642/F1642M may be accepted provided the required loading, hazard level rating, and size limitations stated herein are met.

[1.9.1.4 Wind-Borne Debris /Hurricane Performance Requirements

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NOTE: See UFC 3-301-01 Structural Engineering for Wind Load design criteria and applicability of wind-borne debris requirements.

****

Provide impact resistant or protected curtain wall systems in buildings with an impact-resistant covering meeting the Windborne-Debris-Impact-Resistant Performance requirements of ASTM E1996 for project wind zone when tested in accordance with ASTM E1886, based upon testing of specimens not less than the size required for project and utilizing installation method identical to that specified for project as follows:

a. Project Wind Zone: [Wind Zone 1] [Wind Zone 2] [Wind Zone 3] [Wind Zone 4].

b. Large-Missile Test: For glazing located within 9.1 m 30 feet of grade.

c. Small-Missile Test: For glazing located more than 9.1 m 30 feet above grade.

]]1.9.2 Allowable Design Stresses

Aluminum-alloy framing member allowable design stresses must be in accordance with the requirements of AA ADM pertaining to building type structures made of the specified aluminum alloy.

Hot-rolled structural-steel member allowable design stresses and design rules must be in accordance with the requirements of AISC/AISI 121 pertaining to the specified structural steel.

Cold-formed light-gage steel structural member allowable design stresses and design rules must be in accordance with the requirements of AISI SG03-3 SG570 pertaining to structural members formed from the specified structural-steel sheet or strip.

1.9.3 Design Wind Load

****

NOTE: First bracketed valve in the following paragraph specifies the design windload recommended in the American Insurance Association AIA CO-1 "National Building Code," Appendix K, for areas subject to severe winds and for height zones of 9140 to 14900 millimeters 30 to 49 feet.

The second bracketed valve specifies the design windload recommended in ANSI A58.1, "Minimum Design Loads for Buildings and Other Structures," for 160 kilometer per hour 100 miles per hour wind velocity,

for unprotected locations in flat, open country or near shorelines of large bodies of water and fully exposed to a long fetch of wind, and for a height zone of 12200 millimeters 40 feet.

The third bracketed valve specifies the design windload recommended in ANSI A58.1, "Minimum Design Loads for Buildings and Other Structures," for 160 kilometer per hour 100 miles per hour wind velocity, and for a height zone of 9100 millimeters 30 feet and under.

The fourth bracketed valve specifies the design windload recommended in the American Insurance Association's AIA CO-1 "National Building Code," Appendix K, for areas subject to severe winds and for a height zone of less than 9100 millimeters 30 feet.

The fifth bracketed valve specifies the design windload recommended in ANSI A58.1, "Minimum Design Loads for Buildings and Other Structures," for the Langley field area, and for a height zone of less than 9100 millimeters 30 feet.

The sixth bracketed valve specifies the minimum design load recommended in ANSI A58.1. Langley Research Center policy does not permit use of this paragraph.

****

Design windload must be [2155] [1963] [1819] [1676] [1436] [718] pascal [45] [41] [38] [35] [30] [15] pounds per square foot. Design windload must be in accordance with ASCE 7-16.

1.9.4 Structural Capacity

Design curtain-wall system, including framing members, windows, doors and frames, metal accessories, panels, and glazing to withstand the specified design windload acting normal to the plane of the curtain wall and acting either inward or outward.

Deflection of any metal framing member in a direction normal to the plane of the curtain wall, when subjected to the test of structural performance, using the specified windload in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, must not exceed 1/175 of the clear span of the member or 20 millimeter 3/4 inch, whichever value is less.

Deflection of any metal member in a direction parallel to the plane of the curtain wall, when the metal member is carrying its full design load, must not exceed 75 percent of the design clearance dimension between that member and the glass, sash, panels, or other part immediately below it.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aluminum

Must be free from defects impairing strength or durability of surface finish. Provide standard alloys conforming to standards and designations of AA ASD1. Special alloys, not covered by the following ASTM specifications, must conform to standards and designations recommended by the manufacturer for the purpose intended.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

****

[Provide Aluminum [Doors][Frames][Curtain-wall Framing Members][Window Frames] with a minimum recycled content of 20 percent. Provide data identifying percentage of [recycled content of aluminum doors and frames][recycled content of aluminum curtain-wall framing members][recycled content of aluminum windows].

]2.1.1.1 Wrought Aluminum Alloys

Must be those which include aluminum alloying elements not exceeding the following maximum limits when tested and additional in accordance with ASTM E3061. These limits apply to both bare products and the core of clad products. The cladding of clad products must be within the same limits except that the maximum zinc limit may be 2.5 percent in order to assure that the cladding is anodic to the core. Special wrought alloys with a silicon content not more than 7.0 percent will be acceptable for limited structural uses where special appearance is required:

ALLOY	MAXIMUM PERCENT
Silicon	1.5
Magnesium, Manganese, and Chromium combined	6.0
Iron	1.0
Copper	0.4
Zinc	1.0

Within the chemical composition limits set forth above, wrought aluminum alloys must conform to the following:

a. Extruded bars, rods, shapes and tubes: ASTM B221M ASTM B221 and ASTM B308/B308M and ASTM B429/B429M.

b. Sheet and Plate: ASTM B209M ASTM B209.

2.1.1.2 Cast Aluminum Alloys

Provide those in which the alloying elements are silicon, magnesium, manganese, or a combination of these. Other elements must not exceed the following limits:

ALLOY	MAXIMUM PERCENT
Iron	1.2
Copper	0.4
Nickel	0.4
Titanium	0.2
Others (total)	0.5

Within the chemical composition limits set forth above, cast aluminum alloys must conform to the following:

a. Sand castings: ASTM B26/B26M.

b. Die casting: ASTM B85/B85M.

c. Permanent mold castings: ASTM B108/B108M.

2.1.1.3 Welding Rods and Electrodes

Provide welding rods and bare electrodes conforming to AWS A5.10/A5.10M as recommended by the manufacturer of the aluminum base metal alloy being used.

2.1.1.4 Strength

Aluminum extrusions for framing members used in curtain walls and main frame and sash or ventilator members in windows must have a minimum ultimate tensile strength of 152 MPa 22,000 psi and a minimum yield strength of 110 MPa 16,000 psi.

2.1.2 Bronze

Bronze sheets, tubes, and drawn shapes must be commercial bronze, alloy No. 220. Extruded shapes must be architectural bronze, alloy No. 385. Rolled or drawn rods must be [commercial bronze, alloy No. 220] [or] [architectural bronze, alloy No. 385]. Bronze used for [_____] must have a [_____] finish.

2.1.3 Copper

Conform to ASTM B152/B152M, hot or cold-rolled of the temper suitable for the respective forming operations.

2.1.4 Carbon Steel

Conform to the following specifications:

a. Rolled shapes, plates, and bars: ASTM A36/A36M.

b. Galvanized sheets: ASTM A653/A653M.

c. Sheets for porcelain enameling: ASTM A424/A424M.

d. Other sheets: ASTM A1011/A1011M or ASTM A1008/A1008M.

2.1.5 Stainless Steel

****

NOTE: Type 316 stainless steel offers additional corrosion resistance through the addition of molybdenum. It is often recommended for use in salty or highly corrosive atmospheres. Since its cost is greater than Types 302 or 304, Type 316 should be specified only when the project requirements justify the additional cost.

****

Conform to ASTM A240/A240M. Conform to Type 302 or 304, and finish in accordance with the NAAMM AMP 500. Conform to Metal Finishes Manual as follows:

a. Concealed flashings: Dead soft fully annealed, [2 D finish] [[_____] finish].

b. Exposed work: [No. 4 finish] [[_____] finish] to match approved sample.

2.1.6 Weathering High-Strength Low-Alloy Steel

****

NOTE: Water draining or dripping from weathering steel surface for the first two or three years while the oxide coating is developing, will contain oxide particles which may stain or streak adjacent materials. Permanent provisions must be made through design, detailing, and the selection of materials and colors to accommodate or divert this run-off water. Refer to weathering steel manufacturer's recommendations for suggested methods to prevent staining.

****

Weathering steel must be a high-strength, low-alloy steel conforming to ASTM A242/A242M, ASTM A588/A588M, ASTM A606/A606M, and ASTM A1011/A1011M as applicable to the shapes and thicknesses required. In addition, the steel must be capable of developing a tightly adhered protective oxide coating when left unpainted and subjected to atmospheric exposure. Provide steel that conforms to the manufacturer's published mechanical properties and chemical composition.[Protect weathering steel used for [_____] on the unexposed side with a shop coat of paint.] Perform cleaning, surface preparation, handling, bolting, riveting, and welding of weathering steel in strict accordance with the specification and recommendations of the steel manufacturer.

2.1.7 High-Strength, Low-Alloy Steel

Conform to ASTM A572/A572M for structural shapes, plates, and bars.

2.1.8 Metal Fasteners

Provide fasteners as specified in paragraph entitled "Fastener Metals for Joining Various Metal Combinations" in "Part 2 - Products" of the AAMA MCWM-1.[Fastener metals used in connection with weathering steel must be of type recommended by the weathering steel manufacturer.] Metals for fasteners must be chemically and galvanically compatible with contiguous materials.

2.1.9 Porcelain Enamel

Apply to all areas of each unit over base metal surfaces of [metal facing panels,] [adhesively bonded panels, metal-faced,] in compliance with PEI 1001. Apply colored enamel to exposed faces as follows:

a. Color: [_____].

b. Texture: [_____].

c. Gloss: [_____].

d. Thickness of coating: [_____].

2.1.10 Joint Sealants and Accessories

****

NOTE: This specification permits the three listed compounds to be used at the Contractor's option. Each is acceptable for intended purpose. Do not use silicone type sealants in horizontal surfaces where water occurs over the joint. For projects where it is desirable to limit sealant types, revise text accordingly.

****

Provide manufacturer's standard colors to closely match adjacent surfaces. For interior application of joint sealants comply with applicable regulations regarding reduced VOC's as specified in Sections 07 92 00 JOINT SEALANTS and 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.1.10.1 Elastomeric, Single or Multiple Component

ASTM C920, [Type S, single component] [Type M, multiple component]. Use Grade NS, nonsag type in joints on vertical surfaces and use Grade P, self-leveling or flow type, in joints on horizontal surfaces.

2.1.10.2 Single Component Silicone Rubber Base

ASTM C920, Type S, Grade NS (Silicone).

2.1.10.3 Solvents and Primers

Provide material which is quick drying, colorless, nonstaining, compatible with compound used, as recommended by sealant manufacturer. Where primer is specified or recommended by sealant manufacturer, manufacturer's data related to that material must include primer.

2.1.10.4 Structural Sealant

ASTM C1184 and ASTM C1401. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant must occur before adhesive failure. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.1.10.5 Backing Material

Provide material which is nonstaining, nonabsorbent, and compatible with sealing compound. Closed cell resilient urethane, polyvinylchloride or polyethylene foam; closed-cell sponge of vinyl or rubber; closed cell neoprene or butyl rod; or polychloroprene tubes or beads.

2.1.10.6 Bond Preventive Materials

Provide polyethylene tape with pressure-sensitive adhesive; aluminum foil or waxed paper.

2.1.10.7 Preformed Sealing Compound

Provide nonskinning type conforming to AAMA 800. Tapes, beads, ribbons or other shapes as required.

2.1.11 Glass and Glazing

Materials are specified under Section 08 81 00 GLAZING.

2.1.12 Firestopping Material

****

NOTE: Refer to AAMA TIR-A3-1975, "Fire Resistive Design Guidelines for Curtain Wall Assemblies," for other recommended materials and methods used for firestopping the opening between the curtain wall and floor edges.

****

[Portland cement concrete of same design and strength as floor slab] [As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE] [Mineral fiber manufactured from asbestos-free materials, and conforming to ASTM C612 or ASTM C665, meeting fire resistance requirements specified].

2.1.13 Screens

ASTM D3656/D3656M, Class 2, 18 by 14 mesh, color [charcoal] [gray] [_____].

2.1.14 Paint and Finishes

****

NOTE: Coordinate the requirements of Section 09 90 00 PAINTS AND COATINGS. If Section 09 90 00 PAINTS AND COATINGS is not included in project specification, applicable requirements therefrom

should be inserted and the following text deleted.
****

See Section 09 90 00 PAINTS AND COATINGS, for field applied coatings.

2.1.15 Panels

****
NOTE: Double glazing and thermal breaks in wall and window framing systems will result in considerable reduction of heat transmission through wall system. Refer to ASHRAE Handbook of Fundamentals, and AAMA Curtain Wall Manual, "Design for Energy Conservation in Aluminum Curtain Walls" for additional information on heat transmission losses and condensation on interior surfaces.
****

****
NOTE: When other types of panels are required the text must be modified accordingly. When nonmetallic panels such as stone, precast concrete, tile or other materials are required, they must be included in the project specification. All panels which are a part of the wall system, regardless of the material or type, must be included as a part of the curtain wall specification.
****

Maximum U-value [_____]. Where, in order to meet the requirements specified, the proposed panel assembly is thicker than indicated, make corresponding adjustments in accessories and other work such as door, window and louver frames, flashing, coping, and trim products at no extra cost to the Government. Unless otherwise indicated, design for installation from outside the building. Provide vapor barrier on interior face of insulation. Seal edges of panels with cores of absorptive material to prevent entrance of water and allow venting of the core space to outside air. Panels must comply with ASTM E84 surface burning characteristics, with a flame spread index of [25] [_____] or less and a smoke developed index of [50] [450] [_____] or less tested by a Qualified Testing Agency. Identify products with appropriate markings of Applicable Testing Agency. Tempered Hardboard must conform to ANSI/CPA A135.4, Class 1, [_____] mm inch thick.

2.1.15.1 Metal Facing Panels, Single Thickness

Metal facing panels must be single thickness. Panel facing must be [flat sheet] [textured] [impressed-relief] [_____] type, made of [porcelain enamel] [aluminum] [bronze] [stainless steel] and, with [backside stiffeners] [or] [edge flanges] spaced as required to meet flatness specified. Where indicated, backup panels with [_____].

2.1.15.2 Laminated Panels

****
NOTE: Delete the paragraph heading and the following paragraphs when panels are not required. Only metal-faced laminated panels are specified. If another panel type is used, revise the

specifications to suit the project. Indicate locations and dimensions of panels on the drawings.
****

Panels must be metal-faced laminated both sides, consisting of exterior metal facing, facing backing, insulating core, facing backing, and interior metal facing. Facing-panel dimensions must be as indicated.

2.1.15.2.1 Exterior Metal Facing

Facing must be Porcelain-Enamel on steel. Base metal must be steel sheets for porcelain enameling, 0.25 to 0.38 millimeter 0.010 to 0.015 inch thick, of the quality and type best suited for the work, stretcher level standard of flatness, conforming to ASTM A424/A424M, and properly precleaned and treated for adherence of the porcelain enamel.

Porcelain-enamel processing, corrosion protection, weather resistance, color retention of red, yellow, and orange porcelain enamels, continuity of coating, and surface appearance must meet or exceed the requirements specified in PEI 1001.

****
NOTE: PEI designates color of porcelain enamel by the munsell color system (hue, value/chroma). 47 standard colors are shown in PEI CG-3, "Color Guide for Architectural Porcelain Enamel." The following paragraph illustrates the method of specifying the color of porcelain enamel and must be revised as required to suit the project.
****

Color of porcelain-enamel exposed-to-view surfaces must be PEI CG-3 [______]. Ivory (Munsell number by 8.7/3.4) and match the color of the approved samples.

****
NOTE: Select one of the following paragraphs.
****

Gloss of exposed-to-view surfaces must be [high] [medium] [low] reflectivity.

2.1.15.2.2 Facing Backing

Nominal 3 millimeter 1/8-inch thick, flat non-asbestos-cement sheets, flexible smooth-one-side surface finish, conforming to ASTM C220, Type F.

2.1.15.2.3 Core Insulation

[Core must be expanded perlite conforming to ASTM C610.

][Core must be rigid urethane conforming to ASTM C591, Type 2.

][Core must be preformed block polystyrene conforming to ASTM C578, Type II.

][Core must be cellular glass conforming to ASTM C552.

][Core must be mineral fiberboard conforming to [ASTM C612][ASTM C553][ASTM C592][ASTM C547].

]2.1.15.2.4 Interior Metal Facing

[Facing must be 0.7 millimeter 24-gage galvanized-steel sheets conforming to ASTM A653/A653M, coating Z275. G90.

][Facing must be as specified for exterior metal facing.

]2.1.15.2.5 Panel Fabrication

Securely bond panel materials together to form a stable and durable composite unit. Panels with core insulation of absorptive material must have edges sealed and provide venting to the outside air. Provide panels that conform to the following:

Flatness: Provide exterior surfaces of such flatness that, when measured at room temperature, the maximum slope of the surface at any point, measured from the nominal plane of the surface, that do not exceed the following:

1.0 percent for surfaces having a finish of high reflectivity

1.25 percent for surfaces having a finish of medium reflectivity

1.5 percent for surfaces having a finish of low reflectivity

Structural requirements: Panels of the maximum size required by the work, when supported in the manner intended, must withstand the windload specified without permanent deformation or damage.

Accelerated aging: Panels must show no evidence of delamination, warpage, or other deterioration or damage after completion of six accelerated aging cycles in accordance with ASTM C481, Cycle A.

Thermal transmittance: U-factor of a panel, when a panel not less than 1 square meter 10 square feet in area and of identical construction is tested in accordance with ASTM C1363, must be as follows:

****

NOTE: Before selecting the U-factor, the panel thickness and insulation-core material must be determined.

****

Not more than [0.57] [0.85] [1.14] [1.42] [1.70] [2.27] [2.56] watt/square meter-degrees C [0.10] [0.15] [0.20] [0.25] [0.30] [0.40] [0.45] Btu/hr-square foot-degree F.

2.1.15.3 Nonmetallic Panels

a. Provide panels that are glass-faced on the side that will be exposed to view. Glass must be spandrel glass with ceramic coating on its nonweathering surface and [smooth] [_____] finish on the exposed surface [; backing must be adhesively bonded to nonweathering surface]. Backing must be [_____] and include [galvanized steel] [_____] on surface nearest the building. Color of glass when viewed from the surface that will be exposed after installation must be [_____]. Where indicated, back up glass panels with [_____].

b. Adhesively bonded insulated panels must be nonmetallic faced, sandwich type, [_____] [tempered hardboard] on exposed face and on nonexposed face. Apply coating of [epoxy] [polyester] [_____] followed by application of [inert aggregate] [_____] to exposed face in the [factory] [field]. [Inert aggregate] [_____] must be [natural stone chips] [crushed marble] [_____] [with minimum and maximum sizes of [_____] and [_____]]. Color of [_____] must be [_____].

c. Nonmetallic panels, [_____] surfaced: [_____] [tempered hardboard] [_____] board base with applied [factory] [or] [field] finish of [[_____] resins and decorative natural stone chips] [_____]. Apply [epoxy] [polyester] coating of [_____] followed by application of [inert aggregate] [_____] to exposed face in the [factory] [field]. [Inert aggregate] [_____] must be [natural stone chips] [crushed marble] [_____] [with minimum and maximum sizes of [_____] and [_____]]. Color of [_____] must be [_____].

2.1.16 Metal Windows

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

[Fixed] [Operating] [Fixed and operating]. Comply with requirements of [_____], [Steel] [Aluminum] Windows [_____] [AAMA/WDMA/CSA 101/I.S.2/A440] [SWI AGSW] as modified herein. Provide inside glazing with removable metal glazing beads [except for windows having structural gaskets]. Comply with glass clearance dimensions and sealant dimensions recommended by glass manufacturer.

2.1.16.1 Frames

Frames for fixed glazed panels and window units must be [aluminum] [bronze] [stainless steel] [steel].

2.1.16.2 Operating Windows

Operating windows must be [double-hung] [projected] [horizontally pivoted] [vertically pivoted] [top-hinged inswinging] [horizontal sliding] [casement] [_____] type. [Operating windows must be complete with hardware, weatherstripping, and accessories.] Hardware must comply with [AAMA/WDMA/CSA 101/I.S.2/A440] [SWI AGSW] modified as follows:

a. Metal and finish for hardware must be [_____].

b. [_____].

2.1.16.3 Window Construction

Weld or mechanically join and seal corners of frames and ventilators for water-tight construction. Remove excess metal from welded joints and dress smooth on exposed and contact surfaces so that no objectionable discoloration or roughness will be visible after finishing. Apply sealing compound in interior surfaces of corners and frame intersections.

[2.1.17 Insect Screens

****

NOTE: Where metal accessories mentioned herein occur in connection with metal curtain walls, the kind and gage of metal must be shown or specified.

****

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

Provide insect screens for ventilators of [_____] windows [_____] in accordance with [_____], [Steel] [Aluminum] Windows [_____] [AAMA/WDMA/CSA 101/I.S.2/A440] [SWI AGSW]. Screens for double-hung windows must be [full length, top-hung type] [double vertical sliding type] [half-length fixed type]. Screens for [projected] [casement] [_____] windows must be [_____] type. Mount screens on [inside] [outside] of windows. Screens must be rewirable, easily removable from inside the building, and interchangeable for same size ventilators of similar type windows. Provide hardware, guides, stops, clips, bolts, and screws as necessary for a secure and tight attachment to window.[Where sliding or hinged wickets are required in screens to permit operation of window hardware, the frame around the wicket opening must be of similar material and strengths as the screen frames.]

a. Frames: Construct screen frames of similar material and finish as specified for the windows to which attached. Screen frame construction must consist of closed tubular shapes standard with the manufacturer, either extruded or roll formed. Frames must be mitered, electrically flash welded, then dressed smooth; or have internal reinforcing or blocks at corners and mechanically connected corners. Screen frames must have removable splines of aluminum, stainless steel, or vinyl.

b. Screening: Weave of screening must be parallel with frames and sufficiently tight to present a smooth appearance. Conceal edges of screening in spline channel of frames.

c. Hardware: Screen hardware must be manufacturer's standard type and finish, unless otherwise indicated.

]2.1.18 Metal Accessories

[Gravel stops and fascias,] [Flashings,] [Metal sills,] [Metal stools,] [Louvers,] [Venetian blind pockets,] [Closures,] [and soffits] [_____]. Fabricate accessories of sizes and shapes indicated from similar materials and finish as specified for wall system.

2.2 METALS FOR FABRICATION

2.2.1 Aluminum-Alloy Extrusions

Extrusions must conform to ASTM B221M ASTM B221.

****

NOTE: Delete the following paragraph when integral-color anodic coating is not required.

****

Extrusions to receive an integral-color anodic coating must be the alloy and temper recommended by the aluminum producer for the specified finish with integral-color anodic coating and have mechanical properties equal to or exceeding those of ASTM B221M ASTM B221 6063-T5.

2.2.2 Aluminum-Alloy Sheets and Plates

Unless otherwise specified, sheets and plates must conform to ASTM B209M ASTM B209, Alloy 3003-H16.

Sheets and plates to receive a clear anodic coating must conform to ASTM B209M ASTM B209, Alloy 5005-H16.

****

NOTE: Delete the following paragraph when integral-color anodic coating is not required.

****

Sheets and plates to receive an integral-color anodic coating must be the alloy and temper recommended by the aluminum producer for the specified coating and have mechanical properties equal to or exceeding those of 5005-H16.

2.2.3 Structural Steel

Hot-rolled shapes, plates, and bars must conform to ASTM A36/A36M.

Hot-formed tubing must conform to ASTM A501/A501M.

Sheet and strip for cold-formed, light-gage, structural members must conform to ASTM A1011/A1011M.

2.2.4 Metals for Fasteners

Provide aluminum-alloy bolts and screws made from rod conforming to ASTM B211/B211M, Alloy 2024-T351.

Provide aluminum-alloy nuts made from rod conforming to ASTM B211/B211M, Alloy 6061-T6.

Provide aluminum-alloy washers made from sheet conforming to ASTM B209M, ASTM B209, ASTM B211/B211M, Alloy 2024-T4.

Provide aluminum-alloy rivets made from rod or wire conforming to ASTM B316/B316M, Alloy 6053-T61.

Provide steel fasteners made from corrosion-resistant chromium-nickel Type 302, 303, 304, 305, or 316 with the form and condition best suited for the work.

2.3 NONSKINNING SEALING COMPOUND

Sealing compound must be nonskinning, gun-grade type conforming to AAMA 800.

2.4 FABRICATION

2.4.1 Workmanship

Metal Accessories must be accurately formed; joints, except those designed to accommodate movement, accurately fitted and rigidly assembled.

Insofar as practical, fitting and assembly of the work must be done in the manufacturer's plant. Mark work that cannot be permanently factory-assembled before shipment to ensure proper assembly at the site.

2.4.2 Shop-Painting Aluminum

Shop prime aluminum surfaces that will come in contact with dissimilar metals, masonry, concrete, or wood.

Prepare aluminum surfaces for painting in accordance with ASTM D1730, Type B, Method 2 or 3.

Give aluminum surfaces one shop coat of paint applied to dry, clean, surfaces to provide a continuous minimum dry-film thickness of 0.038 millimeter 1.5 mils.

2.4.3 Shop-Painting Steel

Shop prime surfaces of concealed steel.

Remove scale, rust, and other deleterious materials. Remove heavy rust and loose mill scale in accordance with SSPC SP 3 or SSPC 7/NACE No.4. Remove oil, grease, and similar contaminants in accordance with SSPC SP 1.

Give steel surfaces two coats of paint; the second coat must have a color different from the first coat. Apply paint to dry, clean, surfaces to provide a continuous minimum dry-film thickness of 0.038 millimeter 1.5 mils for the first coat and 0.025 millimeter 1 mil for the second coat.

2.4.4 Depth of Glazing Rabbets

Depth of glazing rabbets for openings to receive glass materials or panels must be as follows:

****

NOTE: Select as required to suit the glass materials and panels used. Delete inapplicable items.

****

MATERIAL	NOMINAL THICKNESS	MAXIMUM SIZE	MINIMUM RABBET DEPTH
Single-glass lights	Double strength	Up to 0.46 square meter	10 millimeter
	Double strength	Over 0.46 square meter	15 millimeter
	3 millimeter	Up to 0.46 square meter	10 millimeter
	3 millimeter	0.46 to 2.32 square meter	15 millimeter
	3 millimeter	2.32 to 6.5 square meter	16 millimeter
	4.5 millimeter	Up to 2.32 square meter	15 millimeter
	4.5 millimeter	Over 2.32 square meter	16 millimeter
	5.5 millimeter	All sizes	16 millimeter
	6 millimeter	Up to 9.3 square meter	16 millimeter
	6 millimeter	Over 9.3 square meter	20 millimeter
	8 millimeter	All sizes	20 millimeter
	10 millimeter	All sizes	22 millimeter
	15 millimeter	All sizes	22 millimeter
	20 millimeter	All sizes	22 millimeter
Double-glazing units	All thicknesses	Up to 2.23 square meter	16 millimeter
	All thicknesses	2.23 to 6.5 square meter	20 millimeter
Panels	Up to 25 mm	All sizes	16 millimeter
	25 to 40 mm	All sizes	20 millimeter

MATERIAL	NOMINAL THICKNESS	MAXIMUM SIZE	MINIMUM RABBET DEPTH
Single-glass lights	Double strength	Up to 5 square feet	3/8 inch
	Double strength	Over 5 square feet	1/2 inch
	1/8 inch	Up to 5 square feet	3/8 inch
	1/8 inch	5 to 25 square feet	1/2 inch
	1/8 inch	25 to 70 square feet	5/8 inch
	3/16 inch	Up to 25 square feet	1/2 inch
	3/16 inch	Over 25 square feet	5/8 inch
	7/32 inch	All sizes	5/8 inch
	1/4 inch	Up to 100 square feet	5/8 inch
	1/4 inch	Over 100 square feet	3/4 inch
	5/16 inch	All sizes	3/4 inch
	3/8 inch	All sizes	7/8 inch
	1/2 inch	All sizes	7/8 inch
	3/4 inch	All sizes	7/8 inch
Double-glazing units	All thicknesses	Up to 25 square feet	5/8 inch
	All thicknesses	25 to 70 square feet	3/4 inch
Panels	Up to 1 inch	All sizes	5/8 inch
	1 to 1-1/2 inches	All sizes	3/4 inch

[2.4.5 Anodic Finish

The following designation of finishes refer to standard finishes as defined in the NAAMM AMP 500. Exposed-to-View Aluminum Finish of surfaces must be:

****

NOTE: Delete the following finishes that are not required. Where more than one is required, the location of each must be indicated on the drawing.

****

[Frosted finish with Class II clear anodic coating: Medium-matte chemical etch and Architectural Class II (0.01 to 0.018 millimeter thickness) anodic coating producing a natural aluminum color. Finish must be AA C22-A31 in accordance with AA DAF45.

][Frosted finish with Class I clear anodic coating: Medium-matte chemical etch and Architectural Class I (0.018 millimeter and greater thickness) anodic coating producing a natural aluminum color. Finish must be AA C22-A41 in accordance with AA DAF45.

][Polished frosted finish with Class II clear anodic coating: Smooth specular-buffed mechanical, followed by a medium-matte chemical etch and Architectural Class II (0.01 to 0.018 millimeter thickness) anodic coating producing a natural aluminum color. Finish must be AA M21-C22-A31 in accordance with AA DAF45.

][Frosted finish with Class II clear anodic coating: Medium-matte chemical etch and Architectural Class II (0.4- to 0.7-mil thickness) anodic coating producing a natural aluminum color. Finish must be AA C22-A31 in accordance with AA DAF45.

][Frosted finish with Class I clear anodic coating: Medium-matte chemical etch and Architectural Class I (0.7-mil and greater thickness) anodic coating producing a natural aluminum color. Finish must be AA C22-A41 in accordance with AA DAF45.

][Polished frosted finish with Class II clear anodic coating: Smooth specular-buffed mechanical, followed by a medium-matte chemical etch and Architectural Class II (0.4- to 0.7-mil thickness) anodic coating producing a natural aluminum color. Finish must be AA M21-C22-A31 in accordance with AA DAF45.
]

****

NOTE: It is recommended that a sample of the required color be on display where it may be seen by bidders during the bidding period.

****

Polished frosted finish with integral-color anodic coating: Smooth specular buffed mechanical, followed by nonetching inhibitive alkaline cleaning, medium-matte chemical etch, and Architectural Class I (0.018 millimeter 0.7-mil and greater thickness) anodic coating producing an integral-color finish. Color must be:

[Light bronze] [Medium bronze] [Dark bronze] [Black]

****

NOTE: The following paragraph must be included.

****

Match aluminum-finish color and appearance to that of the sample approved for use in the project within the aluminum producer's standard color range.

****

NOTE: Delete the following paragraphs when an anodic coating is not required.

****

Test the anodic coating on aluminum for thickness in accordance with ASTM B244.

Test anodically coated aluminum for the weight of the coating in accordance with ASTM B137.

Test the resistance of anodically coated aluminum to staining by dyes in accordance with ASTM B136.

][2.4.6 Pigmented Organic Coating

Curtain wall framing exposed to view to be[a pigmented organic coating complying with AAMA 2603][a high-performance organic coating complying with AAMA 2604][a superior performing organic coating complying with AAMA 2605] Color: [_____].

]2.5 CURTAIN-WALL FRAMING MEMBERS

****

NOTE: Size and arrangement of all framing members must be indicated on the drawings. Curtain-wall system manufacturer's stock sizes and shapes should be used. Frame depth must be coordinated with the window sash, panels, single-glass lights, double-glazing units, and louvers and other metal accessories that are to be incorporated into the curtain-wall system.

****

2.5.1 General

Framing members must be thermally broken and be the section dimensions and arrangement indicated and designed to accommodate windows, panels, and other materials to be incorporated into the curtain-wall system.

[Curtain-wall framing must be the vertical mullion type with the vertical mullions extending the indicated distance beyond the exterior face of the curtain wall.

][Curtain-wall framing must be the grid type with both the vertical and horizontal mullions extending the indicated distance beyond the exterior face of the curtain wall.

]2.5.2 Construction

Framing members must be aluminum-alloy extrusions with a wall thickness not less than 3.1 millimeter 0.125 inch. Glazing rabbet legs must be an integral part of the frame with the leg depth not less than the minimum depth specified for the thickness and size of the glass material or panel to be installed in the curtain-wall frame. Design and construct frames to receive window sash and louvers of the type specified when required.

Prepare vertical mullions for anchorage to the building construction at the bottom, at each intermediate floor elevation, and at the top.

[Corners of frames must be mortise-and-tenon construction except that the corners of the vertical and horizontal mullions in grid frames must be coped-and-welded construction. Welds must be on the unexposed surfaces. Corner joints must be accurately fitted and flush, with watertight hairline joints not exceeding 0.4 millimeter 1/64 inch in width. Apply nonskinning sealing compound to the unexposed surfaces of all mortise-and-tenon joints.

][Corners of frames must be coped and welded construction. Welds must be on the unexposed surfaces. Corner joints must be accurately fitted and flush, with watertight hairline joints not exceeding 0.4 millimeter 1/64 inch in width.

]2.6 ALUMINUM DOORS AND FRAMES

****

NOTE: Delete the paragraph heading and the following paragraph when aluminum doors and frames are not a part of the curtain-wall system.

****

Aluminum doors and frames are specified in Section 08 11 16 ALUMINUM DOORS AND FRAMES.

2.7 METAL ACCESSORIES

2.7.1 Sills

****

NOTE: Delete the paragraph heading and the following paragraphs if sills are not required. Sills must be detailed on the drawings.

****

Sills must be the shapes and dimensions indicated and fabricated of aluminum-alloy extrusions having a wall thickness not less than 3 millimeter 0.125 inch.

Sills must run continuously under the curtain wall and permit the lower curtain wall frame member to interlock without fastenings.

2.7.2 Coping

****

NOTE: Delete the paragraph heading and the following paragraphs if coping is not required. Coping must be detailed on the drawings.

****

Coping must be the shapes and dimensions indicated and welded mitered inside and outside corner sections, concealed cover plates, and other components as required for the installation.

Coping-system components must be aluminum-alloy extrusions with wall thicknesses of 1.2 millimeter 0.05 inch, minimum.

2.7.3 Exterior Architectural Louvers

****

NOTE: Delete the paragraph heading and the following paragraph when exterior architectural louvers are not required.

****

Exterior architectural louvers are specified in Section 05 72 00 DECORATIVE METAL SPECIALTIES.

[2.8 SUN CONTROL

Provide [sunshades][and][light shelves] in accordance with the following:

2.8.1 Sunshades

Assemblies consisting of manufacturer's standard outrigger brackets, louvers, and fascia, designed for attachment to curtain wall with mechanical fasteners.

a. Orientation: [Horizontal] [Vertical].

b. Projection from Wall: [As indicated on Drawings] [0.508] [0.635] [0.762] [0.889] [_____] meters [20] [25] [30] [35] [_____] inches.

c. Outriggers: [Straight with square edges] [Straight with rounded edge] [Curved] [Wedge] <Insert shape>.

d. Louvers:

    (1) Number: [Three] [Four] [Five] [_____] louvers per unit.

    (2) Shape: [Planar] [Arched] [Circular] [Airfoil] [Square].

    (3) Width: [0.1524] [0.2032] [0.254] [_____] millimeter [6] [8] [10] [_____] inches.

    (4) Mounting Angle: [0.635] [0.762] [0.889] [25] [30] [35] [_____] degrees.

e. Fasciae: [Rectangular] [Bullnose] [Angular] [Circular].

f. Finish: [Match adjacent glazed aluminum curtain wall] <Insert finish>.

g. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

h. Steel Reinforcement: As required by manufacturer.

2.8.2 Light Shelves

Light-reflecting assemblies consisting of manufacturer's standard support brackets or channels, and aluminum tray, designed for attachment to interior of curtain wall with mechanical fasteners.

a. Projection from Wall: [As indicated on Drawings] [0.508] [0.635] [0.762] [0.889] [_____] millimeter [20] [25] [30] [35][_____] inches.

b. Finish: [Match adjacent glazed aluminum curtain wall] [_____].

c. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

d. Steel Reinforcement: As required by manufacturer.

]2.9 THERMAL INSULATION MATERIALS

****

NOTE: Delete the paragraph heading and the following paragraph when thermal insulation materials are not required. Location of the curtain-wall system to be insulated, type of thermal insulation material to be used, and the nominal

thickness of the insulation material must be indicated. Select the appropriate insulation system(s) Section Reference and delete those which are not applicable.
****

Thermal insulation materials are specified in [Section 07 21 16 MINERAL FIBER BLANKET INSULATION][Section 07 21 13 BOARD AND BLOCK INSULATION][Section 07 21 23 LOOSE FILL THERMAL INSULATION][Section 07 24 00 EXTERIOR INSULATION AND FINISH SYSTEMS][_____].

2.10 SEALANTS AND CAULKINGS

****
NOTE: Delete the paragraph heading and the following paragraph when sealants and caulkings are not required for installation of curtain wall.
****

Sealants and caulkings are specified in Section 07 92 00 JOINT SEALANTS.

2.11 CURTAIN-WALL INSTALLATION MATERIALS

****
NOTE: Delete the following installation materials that are not applicable.

Concrete inserts should be used for fastening the specified work to cast-in-place concrete construction when the anchorage device will be subjected to direct pullout loadings. Indicate concrete inserts on the drawings.
****

2.11.1 Threaded Concrete Inserts

Galvanized ferrous castings with enlarged bases with not less than two nailing lugs, length as indicated, internally threaded 20 millimeter 3/4-inch diameter machine bolt must conform to ASTM A47/A47M, Grade [32510] [35018] [Grade 22010] or ASTM A27/A27M, Grade U-60-30, and hot-dip galvanized in accordance with ASTM A153/A153M.

2.11.2 Wedge Concrete Inserts

Galvanized, box-type, ferrous castings with an integral loop at the back of the box and designed for 20 millimeter 3/4-inch diameter bolts with wedge-shaped heads must conform to ASTM A47/A47M, Grade [32510] [35018] or ASTM A27/A27M, Grade U-60-30, and hot-dip galvanized in accordance with ASTM A153/A153M.

Carbon steel bolts with wedge-shaped heads, nuts, washers, and shims must be hot-dip galvanized in accordance with ASTM A153/A153M.

2.11.3 Slotted Concrete Inserts

Galvanized pressed-steel plate, welded construction, box type with a slot designed for 20 millimeter 3/4-inch diameter square-head bolts to provide lateral adjustment must be 3 millimeter 1/8-inch minimum thickness, conforming to ASTM A283/A283M, Grade C, hot-dip galvanized in accordance with ASTM A123/A123M. Length of the insert body less anchorage lugs must be 155 millimeter 6 inches minimum and provided with a knockout cover.

2.11.4 Masonry Anchorage Devices

****

NOTE: Masonry anchorage devices should be used only for fastening materials to solid masonry and concrete-in-place construction when the anchorage device will not be subjected to direct pullout nor to vibration. Masonry anchorage devices should be used only for nonvibratory shear loads such as for fastening sash-pole hangers, door frames, and door thresholds.

****

2.11.5 Toggle Bolts

Toggle bolts must be the tumble-wing type.

2.11.6 Steel Bolts, Nuts, and Washers

Bolts must be regular hexagon head, low-carbon steel.

Nuts must be hexagon, regular style, carbon steel.

Plain washers must be round, general-assembly purpose, carbon steel.

Lockwashers must be helical spring, carbon steel.

2.11.7 Machine Screws

Provide screws for concealed work that are corrosion-resistant steel, slotted or cross-recessed type, roundhead.

Provide screws for exposed-to-view work that are corrosion-resistant steel, cross-recessed, flathead.

2.11.8 Electrodes for Welding Steel

Electrodes for welding steel by the manual shielded metal arc welding process must meet the requirements of AWS D1.1/D1.1M and be covered mild-steel electrodes conforming to AWS A5.1/A5.1M, E60 series.

PART 3 EXECUTION

3.1 GENERAL

Install curtain walls and accessories in accordance with the approved drawings and as specified.

3.2 FABRICATION

Provide curtain wall components of the materials and thickness indicated or specified. The details indicated are representative of the required design and profiles. Acceptable designs may differ from that shown if the proposed system components conform to the limiting dimensions indicated and the requirements specified herein. Unless specifically indicated or specified otherwise, the methods of fabrication and assembly must be at the discretion of the curtain wall manufacturer. Perform fitting and assembling of components in the shop to the maximum extent practicable. Provide anchorage devices with adjustment capability in three directions. Exposed fastenings used on finished surfaces must be truss head, flat head, or oval head screws or bolts.

3.2.1 Joints

Provide welded or mechanical fasteners as indicated or specified. Match joints in exposed work to produce continuity of line and design. Bed-joints or rabbets receiving caulking or sealing material must be minimum 20 mm 3/4 inch deep and 10 mm 3/8 inch wide at mid ambient temperature range.

3.2.2 Welding

Conform to AWS D1.1/D1.1M. Use methods and electrodes recommended by manufacturers of base metal alloys. Provide welding rods of an alloy that matches the color of the metal being welded. Protect glass and other finish from exposure to welding spatter. Ground and finish weld beads on exposed metal surfaces to minimize mismatch and to blend with finish on adjacent parent metal. If flux is used in welding aluminum, completely remove it immediately upon completion of welding operations. Do not use exposed welds on aluminum surfaces.

3.2.3 Soldering and Brazing

Provide as recommended by suppliers. Solder only for filling or sealing joints.

3.2.4 Ventilation and Drainage

Provide internal ventilation and drainage system of weeps based on principles of pressure equalization to ventilate the wall internally and to discharge condensation and water leakage to exterior as inconspicuously as possible. Flashings and other materials used internally must be nonstaining, noncorrosive, and nonbleeding.

3.2.5 Protection and Treatment of Metals

3.2.5.1 General

Remove from metal surfaces lubricants used in fabrication and clean off other extraneous material before leaving the shop.

3.2.5.2 Galvanic Action

Provide protection against galvanic action wherever dissimilar metals are in contact, except in the case of aluminum in permanent contact with galvanized steel, zinc, stainless steel, or relatively small areas of white bronze. Paint contact surfaces with one coat bituminous paint or apply appropriate caulking material or nonabsorptive, noncorrosive, and nonstaining tape or gasket between contact surfaces.

3.2.5.3 Protection for Aluminum

Protect aluminum which is placed in contact with, built into, or which will receive drainage from masonry, lime mortar, concrete, or plaster with one coat of alkali-resistant bituminous paint. Where aluminum is contacted by absorptive materials subject to repeated wetting or treated with preservative noncompatible with aluminum, apply two coats of aluminum paint, to such materials and seal joints with approved caulking compound.

3.3 INSTALLATION

Installation and erection of glazed wall system and all components must be performed under direct supervision of and in accordance with approved recommendations and instructions of wall system manufacturer or fabricator.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.3.1 Bench Marks and Reference Points

Establish and permanently mark bench marks for elevations and building line offsets for alignment at convenient points on each floor level. Should any error or discrepancy be discovered in location of the marks, stop erection work in that area until discrepancies have been corrected.

3.3.2 Verifying Conditions and Adjacent Surfaces

After establishment of lines and grades and prior to system installation examine supporting structural elements. Verify governing dimensions, including floor elevations, floor to floor heights, minimum clearances between curtain wall and structural frames, and other permissible dimensional tolerances in the building frame.

3.3.3 Materials Embedded In Other Construction

Install materials to be embedded in cast-in-place concrete and masonry prior to the installation of the curtain wall. Provide setting drawings, templates, and instructions for installation.

3.3.4 Fastening To Construction-In-Place

Provide anchorage devices and fasteners for fastening work to construction-in-place. Provide fasteners as specified.

3.3.5 Setting Masonry Anchorage Devices

****

NOTE: Delete the paragraph heading and the following paragraph when masonry anchorage devices are not required (such as for securing sash-pole hangers, door frames, and door thresholds).

****

Set devices in masonry or concrete-in-place construction in accordance with the manufacturer's printed instructions. Leave drilled holes rough and free of drill dust.

3.3.6 Field-Welding Steel And Touchup Painting

****

NOTE: Delete the paragraph heading and the following paragraphs when field-welding of steel is not required.

****

Procedures of manual shielded metal arc welding, the appearance and quality of the welds made, and the methods used in correcting welding work must conform to AWS D1.1/D1.1M.

After completion of welding, clean and paint field welds and scarred surfaces on steel work and on adjacent ferrous-metal surfaces. Paint must be the same as that used for shop painting.

3.3.7 Installation Tolerances

Install curtain walls within the following tolerances:

Deviation in location from that indicated on the drawings	Plus or minus 6 millimeter
Deviation from the plumb or horizontal	
In 3660 millimeter of length	Not more than 3 millimeter
In any total length	Not more than 15 millimeter
Offset from true alignment at joints between abutting members in line	Not more than 1 millimeter

Deviation in location from that indicated on the drawings	Plus or minus 1/4 inch
Deviation from the plumb or horizontal	
In 12 feet of length	Not more than 1/8 inch
In any total length	Not more than 1/2 inch
Offset from true alignment at joints between abutting members in line	Not more than 1/16 inch

3.3.8 Placing Curtain-Wall Framing Members

Install members plumb, level, and within the limits of the installation tolerances specified.

Connect members to building framing. Provide supporting brackets adjustments for the accurate location of curtain-wall components. Adjustable connections must be rigidly fixed after members have been positioned.

3.3.9 Panel Installation

****

NOTE: Delete the paragraph heading and the following paragraph when panels are not required.

****

Panels must be set with a glazing-tape back bed, two-component elastomeric sealing-compound heel bead, glazing-tape bedding of the stop, and two-component elastomeric sealing-compound topping bead on both sides of the panel. Face and edge clearances must not be less than 3 millimeters 1/8 inch. Remove excess sealing compound on both sides of the curtain wall opening with a glazing knife at a slight angle over the rabbet leg or applied stop. Install applied stops on the exterior side of the curtain wall and secured with screws.

3.3.10 Panels

Install panels [in framing member openings] [into framed pre-assembled units] [_____] using [sealants] [gaskets] [gaskets and sealants] [_____] as indicated or specified.

3.3.11 Windows

Install windows in accordance with details indicated and approved detail drawings.

3.3.11.1 Sealing

Seal exterior metal to metal joints between members of windows, frames, mullions, and mullion covers. Remove excess sealant.

3.3.11.2 Ventilators and Hardware

After installing and glazing windows, adjust ventilators and hardware to operate smoothly and to be weathertight when ventilators are closed and locked. Lubricate hardware and moving parts.

3.3.11.3 Weatherstripping

Install to make weathertight contact with frames when ventilators are closed and locked. Do not cause binding of sash or prevent closing and locking of ventilator.

Provide for ventilating sections of all windows to insure a weather-tight seal meeting the infiltration tests specified. Use easily replaceable factory-applied weatherstripping of manufacturer's stock type. Use molded vinyl, molded or molded-expanded neoprene for weatherstripping for compression contact surfaces. For sliding surfaces, use treated woven pile or wool, polypropylene or nylon pile with nylon fabric and metal or plastic backing strip weatherstripping. Do not use neoprene or polyvinyl chloride weatherstripping where they will be exposed to direct sun light.

3.3.12 Joint Sealants

3.3.12.1 Surface Preparation

Surfaces to be primed and sealed must be clean, dry to the touch, free from frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter. Enclose joints on three sides. Clean out grooves to proper depth. Joint dimensions must conform to approved detail drawings with a tolerance of plus 3 mm 1/8 inch. Do not apply compound unless ambient temperature is between 4 and 32 degrees C 40 and 90 degrees F. Clean out loose particles and mortar just before sealing. Remove protective coatings or coverings from surfaces in contact with sealants before applying sealants or tapes. Solvents used to remove coatings must be of type that leave no residue on metals.

3.3.12.2 Applications

Match approved sample. Force compound into grooves with sufficient pressure to fill grooves solidly. Sealing compound must be uniformly smooth and free of wrinkles and, unless indicated otherwise, tooled and left sufficiently convex to result in a flush joint when dry. Do not trim edges of sealing material after joints are tooled. Mix only amount of multi-component sealant which can be installed within four hours, not to exceed 19 liters 5 gallons at any given time.

3.3.12.3 Primer

Apply to masonry, concrete, wood, and other surfaces as recommended by sealant manufacturer. Do not apply primer to surfaces which will be exposed after caulking is completed.

3.3.12.4 Backing

Tightly pack in bottom of joints which are over 13 mm 1/2 inch in depth with specified backing material to depth indicated or specified. Roll backing material of hose or rod stock into joints to prevent lengthwise stretching.

3.3.12.5 Bond Prevention

Install bond preventive material at back or bottom of joint cavities in which no backstop material is required, covering full width and length of joint cavities.

3.3.12.6 Protection and Cleaning

Remove compound smears from surfaces of materials adjacent to sealed joints as the work progresses. Use masking tape on each side of joint where texture of adjacent material will be difficult to clean. Remove masking tape immediately after filling joint. Scrape off fresh compound from adjacent surfaces immediately and rub clean with approved solvent. Upon completion of caulking and sealing, remove remaining smears, stains, and other soiling, and leave the work in clean neat condition.

3.3.13 Glass

Install in accordance with insulating glass manufacturer's recommendations as modified herein.[Install insulating glass units made with heat absorbing glass with heat absorbing pane on exterior side.]

3.3.13.1 Inspection of Sash and Frames

Before installing glass, inspect sash and frames to receive glass for defects such as dimensional variations, glass clearances, open joints, or other conditions that will prevent satisfactory glass installation. Do not proceed with installation until defects have been corrected.

3.3.13.2 Preparation of Glass and Rabbets

Clean sealing surfaces at perimeter of glass and sealing surfaces of rabbets and stop beads before applying glazing compound, sealing compound, glazing tape, or gaskets. Use only approved solvents and cleaning agents recommended by compound or gasket manufacturer.

3.3.13.3 Positioning Glass

Set glass from inside the building unless otherwise indicated or specified. Maintain specified edge clearances and glass bite at perimeter. Maintain position of glass in rabbet and provide required sealant thickness on both sides of glass. For glass dimensions larger than 1270 united millimeters 50 united inches, provide setting blocks at sill and spacer shims on all four sides; locate setting blocks one quarter way in from each jamb edge of glass. Where setting blocks and spacer shims are set into glazing compound or sealant, butter with compound or sealant, place in position, and allow to firmly set prior to installation of glass.

3.3.13.4 Setting Methods

****

NOTE: Select methods applicable to the project conditions and details. Delete non-applicable methods. Methods listed are typical for many glass and sealant manufacturers; other suitable methods may also be included.

****

Apply glazing compound, glazing sealant, glazing tape, and gaskets uniformly with accurately formed corners and bevels. Remove excess compound from glass and sash. Use only recommended thinners, cleaners, and solvents. Strip surplus compound from both sides of glass and tool at slight angle to shed water and provide clean sight lines. Secure stop beads in place with suitable fastenings. Do not apply compound or sealant at temperatures lower than 4 degrees C 40 degrees F, or on damp, dirty, or dusty surfaces. After glazing, fix ventilators in sash so they cannot be operated until compound or sealant has set.

a. Use sealant glazing to completely fill channel on edges and on both sides of glass for [_____].

b. Use sealant and tape glazing, with glazing sealant for cap bead above glazing tape against fixed exterior stops and glazing tape full height against removable interior stops for [_____].

c. Use sealant and tape glazing, with glazing sealant full height against removable exterior stops with heel bead or glazing sealant and glazing tape full height against fixed interior stops for [_____].

d. Use sealant and tape glazing, with glazing sealant cap beads above glazing tape against both exterior and interior stops for [_____]. Removable stops may be on either exterior or interior side of glass.

e. Use tape, sealant, and compound glazing, with glazing tape full height against fixed exterior stops, glazing compound as a cap bead above heel bead sealant and against removable interior stops for [_____].

f. Use tape, sealant, and gasket glazing, with glazing tape full height against fixed exterior stops, glazing sealant as a heel bead at edge of glass, and preformed vision strip gasket against removable interior snap-on stops for [_____].

g. Use compression gasket glazing, with compression gaskets both sides of glass and adjustable or snap-on interior stops for [_____].

h. Use lock-strip gasket glazing, with lock-strip glazing gaskets for [_____]. Install gaskets in accordance with manufacturer's instructions using special tools and lubricants. When lock-strip type gaskets are used for glazing insulating glass units, follow glass manufacturer's recommendations regarding horizontal wall supports between vertical units, setting blocks, weep holes, and the use of supplementary wet sealants.

3.3.13.5 Void Space

Heat absorbing, insulating, spandrel, and tempered glass, and glass of other types that exceed 2540 united millimeters 100 united inches in size: Provide void space at head and jamb to allow glass to expand or move without exuding the sealant.

3.3.13.6 Insulating Glass

Provide adequate means to weep incidental water and condensation away from the sealed edges of insulated glass units and out of the wall system. The weeping of lock-strip gaskets must be in accordance with the recommendation of the glass manufacturer.

3.3.13.7 Insulating Glass With Edge Bands

Insulating glass with flared metal edge bands set in lock-strip type gaskets: Follow glass manufacturer's recommendations and add supplementary wet seal as required; when used with glazing tape, use tapered tape.

3.3.14 Firestopping

Provide firestopping [, where indicated,] in openings between wall system and floor at each story to prevent passage of flame and hot gases from floor to floor under extended fire exposure. Installed fire stopping must remain in place under extended fire exposure despite distortions that may occur in wall system components. Securely attach anchoring or containment devices to building structure and not to wall system. Place [concrete] [mineral fiber] [_____] on [steel plates attached to bottom of floor slab] [impaling chips embedded in edge of floor slab] [_____].

3.3.15 Field Applied Insulation

****

NOTE: Where project specifications do not include a separate section for field applied insulation, add here and delete cross-reference to other section. Where field applied insulation is specified in another section, keep cross-reference and coordinate fire rating and U-value with the other section. See paragraph entitled "Fire Resistance Tests" for fire rating requirements of insulation.

****

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

Provide insulation with minimum R-value of [_____], on clean, dry, properly prepared surfaces of [masonry] [concrete] [_____] back-up wall in accordance with [_____] INSULATION using approved accessories and methods as recommended by insulation manufacturer unless indicated or specified otherwise. Cover and protect each day's application until protection is provided by completed work.

3.4 FINISHES

3.4.1 Galvanizing

Conform to ASTM A123/A123M, ASTM A153/A153M, and ASTM A653/A653M, as applicable.

3.4.1.1 Repair of Zinc-Coated Surfaces

Repair zinc coated surfaces damaged by welding or other means with galvanizing repair paint or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved.

3.4.2 Shop Cleaning and Painting

3.4.2.1 Cleaning

Clean steel and iron work by power wire brushing or other approved manual or mechanical means, for removal of rust, loose paint, scale, and deleterious substances. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other foreign matter, with solvents until thoroughly clean in accordance with SSPC SP 12/NACE No.5. Cleaning steel embedded in concrete is not required.

3.4.2.2 Painting Steel or Iron Surfaces

[Apply one coat of primer.] [Apply primer to a minimum dry film thickness of 0.025 mm 1.0 mil.] Apply additional shop coat of specified paint, to which a small amount of tinting material has been added, on surfaces that will be concealed in the finished construction or that will not be accessible for finish painting. Accomplish painting in dry weather or under cover, and on steel or iron surfaces that are free from moisture and frost. Do not paint surfaces of items to be embedded in concrete. Recoat damaged surfaces upon completion of work. Prime coat steel immediately after cleaning. Do not apply bituminous protective coatings to items to be finish painted.

3.4.2.3 Painting Weathering Steel

Clean and paint surfaces which will not be exposed to the weather with one shop or field coat of specified primer, or other approved rust-inhibitive primer. Clean and strip-paint weathering steel contact surface to be covered by structural or compression gaskets or sealants with one coat to insure positive seal.

3.5 FIELD TESTS

Notify the Contracting Officer a minimum of seven calendar days prior to performing field tests. Conduct field check test for water leakage on designated wall areas after erection. Conduct test on [two] [_____] wall areas, two bays wide by two stories high where directed. Conduct test and take necessary remedial action as described in AAMA 501.1.

3.6 CLEANING AND PROTECTION

3.6.1 General

At the completion of the installation, clean the work to remove mastic smears and other foreign materials.

3.6.2 Manufacturer's Information

Preventive Maintenance and Inspection must consist of the aluminum manufacturer's recommended cleaning materials and application methods, including detrimental effects to the aluminum finish when improperly applied.

3.6.3 Glass

Upon completion of wall system installation, thoroughly wash glass surfaces on both sides and remove labels, paint spots, putty, compounds, and other defacements. Replace cracked, broken, and defective glass with new glass at no additional cost to the Government.

3.6.4 Aluminum Surfaces

Protection methods, cleaning, and maintenance must be in accordance with AAMA 609 & 610.

3.6.5 Other Metal Surfaces

After installation, protect windows, panels, and other exposed surfaces from disfiguration, contamination, contact with harmful materials, and from other construction hazards that will interfere with their operation, or damage their appearance or finish. Protection methods must be in accordance with recommendations of product manufacturers or of the respective trade association. Remove paper or tape factory applied protection immediately after installation. Clean surfaces of mortar, plaster, paint, smears of sealants, and other foreign matter to present neat appearance and prevent fouling of operation. In addition, wash with a stiff fiber brush, soap and water, and thoroughly rinse. Where surfaces become stained or discolored, clean or restore finish in accordance with recommendations of product manufacturer or the respective trade association.

3.6.6 Porcelain-Enamel Surfaces

****

NOTE: Delete the paragraph heading and the following paragraph when porcelain-enamel faced panels are not required.

****

Wash surfaces with clean water and soap and rinsed with clean water. Do not use acid solutions, steel wool, or other harsh abrasives.

3.7 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
Glass	1/4 inch	6 mm

3.8 INSPECTION AND ACCEPTANCE PROVISIONS

3.8.1 Finished Curtain-Wall System Requirements

Curtain-wall work which contains any of the following deficiencies, is unacceptable, and will be rejected:

****

NOTE: Delete any of the following paragraphs that are not applicable.

****

Finish of exposed-to-view aluminum having color and appearance that are outside the color and appearance range of the approved samples.

Installed curtain-wall components having stained, discolored, abraded, or otherwise damaged exposed-to-view surfaces that cannot be cleaned or repaired.

Aluminum surfaces in contact with dissimilar materials that are not protected as specified.

3.8.2 Repair of Defective Work

Remove and replace defective work with curtain-wall materials that meet the specifications at no expense to the Government.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 51 13 (May 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 51 13 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 51 13

ALUMINUM WINDOWS

05/19

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-08 51 13 (May 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 51 13 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 08 51 13

ALUMINUM WINDOWS
05/19

****

NOTE: This guide specification covers the requirements for R, LC, CW and AW performance class aluminum windows.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Use aluminum windows (fixed or operable) in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Aluminum will oxidize and the specified finish should be anodic (clear or colored). Use stainless steel hardware for operable parts.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

1. Windows requiring UL fire rating must be steel, and may occur in conjunction with aluminum windows which cannot be approved for this use. When steel windows are used in conjunction with aluminum, specify finish matching aluminum windows. Steel

windows should be specified in Section 08 51 23 STEEL WINDOWS.

2. Aluminum windows are not acceptable for use as security windows which should be steel, specified in Section 08 51 23 STEEL WINDOWS. Security steel windows are designed and constructed to give protection against unauthorized entrance and removal of materials from warehouses and other storage type areas; they are not designed for detention use. Guard windows for detention use are not included in this guide; where such windows are desired, consult Steel Window Institute Recommended Specifications and manufacturers' data, and specify in Section 08 51 23 STEEL WINDOWS.

3. Specify the following items of related work under other sections of the specifications:

a. Glass and glazing and the furnishing of glazing clips and gaskets.

b. Caulking and sealants.

c. Structural building supports at window mullions.

d. Wood subframes for windows in frame walls.

e. Drilling and tapping for attachment of window shades, drapery rods, and venetian blinds. The drilling and tapping of window frames to receive brackets for shades, venetian blinds, and curtain rods has been omitted from this specification. It is contemplated that this work will be done after erection of windows by the trade for the item to be installed. On projects where factory drilling for these items is required, revise this specification accordingly.

f. Brackets and supports for window shades, drapery rods, and venetian blinds.

g. Electrical requirements for motor driven operators.

****

****

NOTE: On the drawings, show:

1. Sizes and types of windows; metal and wood subframes, casings, or stools; and hardware.

2. Sizes, location, and swing of ventilators; direction of slide for sliding ventilators; location and details of fixed sash.

3. Typical window sections and details. Show glass thickness. Show special glazing.

4. Method of anchoring windows to adjoining construction; size and types of clips, anchors, screws, or other fasteners.

5. Details of nonstructural mullions and mullion covers; details of anchoring and reinforcing nonstructural mullions at windows to receive window cleaner anchors.

6. Number and locations of window cleaner anchors.

7. Locations of windows requiring special operators. Show method of operation and concealment of operators, cables and rods. Show wiring diagram for motor driven operators.

8. Locations of windows designated as forced entry resistant.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum

AAMA 701/702	(2011) Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals
AAMA 901	(2016) Voluntary Specification for Rotary & Linear Operators in Window Applications
AAMA 902	(2016) Voluntary Specification for Sash Balances
AAMA 907	(2015) Voluntary Specification for Corrosion Resistant Coatings on Carbon Steel Components Used in Windows, Doors and Skylights
AAMA 1503	(2009) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
AAMA 2603	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
AAMA 2604	(2017a) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA WSG.1	(1995) Window Selection Guide
AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 169	(2021) Climate Data for Building Design Standards

ASTM INTERNATIONAL (ASTM)

ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM D3656/D3656M	(2013) Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E1332	(2016) Standard Classification for Rating Outdoor-Indoor Sound Attenuation
ASTM E1886	(2019) Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
ASTM E1996	(2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
ASTM F588	(2017) Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact
ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass
ASTM F2912	(2017) Standard Specification for Glazing and Glazing Systems Subject to Airblast Loadings

INTERNATIONAL WINDOW CLEANING ASSOCIATION (IWCA)

IWCA I-14.1	(2001) Window Cleaning Safety Standard

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

PASSIVE HOUSE INSTITUTE - US (PHIUS)

PHIUS Certified	Certified Data Program for Window

Performance

PASSIVE HOUSE INSTITUTE INTERNATIONAL (PHI)

Passivhaus Certified	(2012) Certification of Passive House Suitable Components
Passivhaus Criteria	(2012) Certification Criteria for Certified Passive House Glazings and Transparent Components

SCREEN MANUFACTURERS ASSOCIATION (SMA)

SMA 1004	(1987; R 1998) Aluminum Tubular Frame Screens for Windows
SMA 1201	(R 2013) Specifications for Insect Screens for Windows, Sliding Doors and Swinging Doors

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows; G, [_____]

Fabrication Drawings

SD-03 Product Data

Windows; G, [_____]

[Recycled Content of Aluminum Windows; S

] Hardware; G, [_____]

Fasteners; G, [_____]

Window Performance; G, [_____]

Thermal-Barrier Windows; G, [_____]

Mullions; G, [_____]

Window Cleaners' Bolts; G, [_____]

Screens; G, [_____]

Weatherstripping; G, [_____]

Accessories; G, [_____]

Adhesives

Thermal Performance; G, [_____]

Energy Star Label For Residential Aluminum Window Products; S

SD-04 Samples

Finish Sample

Window Sample

[Window Mock-Ups; G, [_____]

] SD-05 Design Data

Structural Calculations for Deflection; G, [_____]

Design Analysis; G, [_____]

SD-06 Test Reports

Minimum Condensation Resistance Factor

[Resistance to Forced Entry

][Standard Airblast Test; G, [_____]

][Windborne-Debris-Impact Performance

] SD-07 Certificates

****

NOTE: Provide engineer's qualifications when required to show conformance to UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.

****

[Engineer's Qualifications

] SD-10 Operation and Maintenance Data

Windows, Data Package 1; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Plastic Identification

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Manufacturer

Window manufacturer must specialize in designing and manufacturing the type of aluminum windows specified in this section, and have a minimum of [_____] years of documented successful experience. Manufacturer must have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.3.2 Shop Drawing Requirements

Take field measurements prior to preparation of drawings and fabrications. Provide drawings that indicate elevations of windows, full-size sections, thickness and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, [mullion details,] [method and materials for weatherstripping,] [method of attaching screens,] [material and method of attaching subframes,] [stools,] [casings,] [sills,] [trim,] [window cleaner anchors,] installation details, and other related items.

[1.3.3 Engineer's Qualifications for Blast Design

****

NOTE: Provide engineer's qualifications when

required to show conformance to UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.
****

All blast design calculations must be performed by or under the direct supervision of a registered engineer with a minimum of 5 years experience performing blast design. The engineer performing the blast design must be able to demonstrate experience on similar size projects using similar design methods to meet the requirements outlined in this specification.

]1.3.4 Sample Requirements

1.3.4.1 Finish Sample Requirements

Submit color chart of standard factory color coatings when factory-finish color coating is to be provided.

1.3.4.2 Window Sample Requirements

****
NOTE: Choose one of the following options. Include the first choice for projects requiring a large number of windows. Include the second choice for projects requiring a limited number of windows.
****

[Submit one full-size window of each type proposed for use, complete with AAMA Label, glazing, hardware, anchors, and other accessories. Where screens or weatherstripping is required, fit sample windows with such items that are to be used. After approval, install each sample in work, clearly identified, and record its location.

][Submit one full-size corner of each window type proposed for use. Where screens or weatherstripping is required, fit sample with such items that are to be used.

][1.3.4.3 Mock-Ups

****
NOTE: Requesting mock-up samples of aluminum windows is not required for most projects. Size of project and scope of quality control should be carefully evaluated before requiring Contractor to provide a costly mock-up. Delete paragraph if mock-ups are not required.
****

Before fabrication, full-size mock-up of [each type of aluminum window] [one window unit] [_____] complete with glass and AAMA certification label for structural purposes and NFRC Temporary and Permanent Label for certification of thermal performance rating will be required for review of window construction and quality of hardware operation.

]1.3.5 Design Data Requirements

Submit calculations to substantiate compliance with deflection requirements[and Antiterrorism Performance Requirements]. A registered Professional Engineer must provide calculations.

Submit design analysis with calculations showing that the design of each different size and type of aluminum window unit and its anchorage to the structure[.] [meets the requirements of paragraph ANTITERRORISM PERFORMANCE REQUIREMENTS.] Calculations verifying the structural performance of each window proposed for use, under the given loads, must be prepared and signed by a registered professional engineer. Reflect the window components and anchorage devices to the structure, as determined by the design analysis, in the shop drawings.

1.3.6 Test Report Requirements

****

NOTE: Include bracketed wording when windows are required to resist blast loads all required by UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.

****

Submit test reports for each type of window attesting that identical windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 including test size, [and] minimum condensation resistance factor (CRF)[, and resistance to forced entry][, and, for Antiterrorism windows, in lieu of a Design Analysis, results of a Standard Airblast Test].[For Antiterrorism windows, in lieu of a Design Analysis, results of airblast testing, whether by arena test or shock tube, must be included in a test report, providing information in accordance with ASTM F1642/F1642M, as prepared by the independent testing agency performing the test. The test results must demonstrate the ability of each window proposed for use to withstand the airblast loading parameters and achieve the hazard level rating specified in paragraph STANDARD AIRBLAST TEST METHOD.]

1.3.7 Certification

****

NOTE: Energy Star Certification is required for residential windows. FEMP Designation, Passivhaus, and PHIUS Certifications are methods to ensure compliance with thermal performance.

****

Ensure that construction is performed with products that meet or exceed [Energy Star criteria,] [FEMP Designated criteria,] [and Passivhaus Criteria] [Passivhaus Certified] [and be current in their certification].[Provide PHIUS Certified window performance.]

Each prime window unit must bear the AAMA Label warranting that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440. Certified test reports attesting that the prime window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, including test size, will be acceptable in lieu of product labeling.

1.4 DELIVERY AND STORAGE

Deliver windows to project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the jobsite. Store windows and components out of contact with the ground, under a weathertight covering, so as to prevent bending, warping, or otherwise damaging the windows. Repair damaged windows to an "as new" condition as approved. If windows can not be repaired, provide a new unit.

1.5 PLASTIC IDENTIFICATION

****

NOTE: The marking system indicated below is intended to provide assistance in identification of products for making subsequent decisions as to handling, recycling, or disposal.

****

Label plastic products provided to indicate their polymeric composition according to the following list. Where products are not labeled, provide product data indicating polymeric information in Operation and Maintenance Manual.

a. Type 1: Polyethylene Terephthalate (PET, PETE).

b. Type 2: High Density Polyethylene (HDPE).

c. Type 3: Vinyl (Polyvinyl Chloride or PVC).

d. Type 4: Low Density Polyethylene (LDPE).

e. Type 5: Polypropylene (PP).

f. Type 6: Polystyrene (PS).

g. Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

1.6 PERFORMANCE REQUIREMENTS

1.6.1 Wind Loading Design Pressure

Design window components, including mullions, hardware, and anchors, to withstand a wind-loading design pressure of at least [_____] pascal pounds per square foot (psf).

[1.6.2 Tests

Test windows proposed for use in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for the particular type and quality window specified.

Perform tests by a nationally recognized independent testing laboratory equipped and capable of performing the required tests. Submit the results of the tests as certified laboratory reports required herein.

Minimum design load for a uniform-load structural test must be 2400 pascal 50 psf.

[Test projected windows in accordance with the applicable portions of the AAMA WSG.1 for air infiltration, water resistance, uniform-load deflection, and uniform-load structural test.

][Test double-hung windows in accordance with the applicable portions of the AAMA WSG.1 for air infiltration, water resistance, uniform-load deflection, and uniform-load structural test.

]]1.7 DRAWINGS

Submit the Fabrication Drawings for aluminum window units showing complete window assembly including hardware, weatherstripping, and subframe assembly details.

1.8 WINDOW PERFORMANCE

****

NOTE: Structural performance, air infiltration and water penetration are standard performance requirements for all aluminum window types.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-00-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

ANTITERRORISM PERFORMANCE REQUIREMENTS and SOUND ATTENUATION sections below are optional to designer, and must be omitted or revised as needed to meet project requirements.

Applicability of UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings

The antiterrorism (AT) standards contained in UFC 4-010-01 DO NOT establish the Design Basis Threat (DBT) or the Level of Protection (LOP) for DoD buildings. Installation Antiterrorism Plans may define a DBT for the installation. Use UFC 4-020-01 (Security Engineering: Facilities Planning Manual) to establish and/or validate the DBT and LOP for individual projects. The process outlined in UFC 4-020-01 will determine if the minimum AT standards are adequate or if additional protective measures are required. Where a specific DBT and LOP are identified, additional guidance is included in Appendix B (Best Practices) of UFC 04-010-01. For buildings that are outside an installation perimeter, use UFC 4-020-01 to establish the DBT and LOP. The DBT and LOP will result in a representative standoff distance for the appropriate construction - window systems (glazing, frame, connections) in this instance.

A structural analysis will need to be performed to determine if the most stringent loading on window assembly is from antiterrorism blast loads or windborne debris in high wind regions.

****

Aluminum windows must meet the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

1.8.1 Structural Performance

Structural test pressures on window units must be for positive load (inward) and negative load (outward). After testing, there will be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There must be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA/WDMA/CSA 101/I.S.2/A440 for the window types and classification specified in this section.

[1.8.2 Antiterrorism Performance Requirements

Windows must meet the antiterrorism performance criteria as specified in the paragraphs below in accordance with UFC 4-010-01. Conformance to the performance requirements must be validated by one of the following methods.

1.8.2.1 Computational Design Analysis Method

Design window assembly to the criteria listed herein. Include computational design analysis calculations verifying the structural performance of each window assembly proposed for use, under the given static equivalent loads.

Design window frames, mullions, sashes, and glazing to the criteria listed herein. Include computational design analysis calculations verifying the structural performance of each window system proposed for use, under the given static equivalent loads.

****

NOTE: The blanks in the following paragraph should be the value of the equivalent 3-second duration design loading obtained from Figure 1 of ASTM F2248 for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. This section must be completed by an engineer experienced in blast-resistant design.

****

Glazing resistance must be greater than equivalent 3-second duration loading of [_____] Pascal pounds per square foot (psf) for type [_____] window[and [_____] Pascal psf for the remaining window types]. The glazing frame bite for the window frames must be in accordance with ASTM F2248.

Design Aluminum/Steel window framing members to restrict deflections of the edges of glazing they support to L/60 under two times (2X) the glazing resistance per the requirements of ASTM F2248 and ASTM E1300.

****

NOTE: Connection Design: For mullion and framing members designed using dynamic analysis or shown to work through airblast testing, all connections between mullions and/or framing members and all connections of storefront systems to the supporting structure must be designed for the full dynamic

capacity of the attached member or the maximum calculated dynamic reaction with a load factor equal to 1.0. Use ultimate capacity of fasteners as recommended by the fastener manufacturer with a capacity reduction factor of 0.75. Use Load and Resistance Factor Design (LRFD) with appropriate reduction (phi) factors per material specific code for design of connections components into supporting structure. All dynamic and static material strength increase factors for the connection components must be equal to 1.0. All connection designs must be performed checking all conventional failure mechanisms. See Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: https://pdc.usace.army.mil/library/tr/10-02**) for additional information. Calculations/Design Analysis for the connection design as stated above must be completed by an engineer experienced in blast-resistant design.**

****

****

NOTE: Use the first bracketed requirement below if the maximum air blast pressure is greater than one-half the magnitude of the load resistance of the blast resistant glazing.

Use the second bracketed requirement below if the maximum air blast pressure is less than one-half the magnitude of the load resistance of the blast resistant glazing.

****

[Anchor window frames to the supporting structure with anchors designed to resist [two times (2X)][one time (1X)] the glazing resistance in accordance with ASTM F2248 and ASTM E1300.

]1.8.2.2 Dynamic Design Analysis Method

****

NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01 (Table B-1). Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering/billeting building occupancy as defined in UFC 4-010-01 (Table B-1). Dynamic analysis is preferred because it typically yields a more appropriate and economical / efficient design. The values for input into the blanks in the following paragraph related to ‘ductility ratio’ and

‘maximum support rotation’ (for the appropriate level of protection – very low, low) for steel and aluminum framing/mullions can be found in Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: https://pdc.usace.army.mil/library/tr/10-02**). This section must be completed by an engineer experienced in blast-resistant design.**

****

Design window assembly using a dynamic analysis to prove the system will provide performance equivalent to or better than a [low];[very low]; [_____] hazard rating in accordance with ASTM F2912 for the peak positive pressure of [_____] kilopascals (kPa) [_____]pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). Use a triangular blast load using the applicable pressure and impulse indicated above. The allowable response limits of [aluminum] [steel] frame elements are as follows: Maximum ductility ratio of [_____] and maximum support rotation of [_____] degrees.

1.8.2.3 Standard Airblast Test Method

****

NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01. Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering building occupancy as defined in UFC 4-010-01. This section must be completed by an engineer experienced in blast-resistant design.

****

As an alternative to the 'Computational Design Analysis Method' and 'Dynamic Design Analysis Method' indicated above, window [_____] assembly may be tested for evaluation of hazards generated from airblast loading in accordance with ASTM F1642/F1642M by an independent testing agency regularly engaged in blast testing. For proposed window systems that are of the same type as the tested system but of different size, the test results may be accepted provided the proposed window size is within the range from 25 percent smaller to 10 percent larger in area and aspect ratio of the original qualified tested glazing systems in accordance with ASTM F2912. Proposed window system/assembly of a size outside this range will require testing to evaluate their hazard rating or are certified by the 'Dynamic Design Analysis Method' indicated above. Testing may be by shock tube or arena test. Perform the test on the entire proposed window system/assembly, including, the glazing, its framing/support system, operating devices, and all anchorage devices. Window support system replicate anchorage of the window support system with the method of installation to be used for the project. The minimum airblast loading parameters for the test will be as follows: peak positive pressure of

[_____] kilopascals (kPa) [_____] pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). The hazard rating for the proposed window systems, as determined by the rating criteria of ASTM F2912, to provide performance equivalent to or better than a [low];[very low]; [_____] hazard rating (i.e. the "No Break", "No Hazard", "Minimal Hazard", "Very Low Hazard" and “Low Hazard” ratings are acceptable. "High Hazard" ratings are unacceptable. Results of window systems previously tested by test protocols other than ASTM F1642/F1642M may be accepted provided the required loading, hazard level rating, and size limitations stated herein are met.

]1.8.3 Air Infiltration

Air infiltration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

1.8.4 Water Penetration

Water penetration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

1.8.5 Thermal Performance

****

NOTE: Window properties are critical to energy performance and comfort. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain.

Energy Star labeling is applicable to residential units only.

For nonresidential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy efficiency and meeting minimum building envelope requirements of UFC 3-101-01 including fenestrations and glazing.

Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting bracketed energy performance requirements before specifying and edit as needed.

****

Windows (including frames and glass) will be independently tested and certified with a Solar Heat Gain Coefficient (SHGC) determined according to NFRC 200 procedures and a whole window U-factor determined in accordance with NFRC 100 within the ranges as indicated below according to the ASHRAE 169 Climate Zone of the project location.[Windows used solely within the interior of a conditioned envelope are exempted from meeting U-Factor and SHGC requirements, unless otherwise noted.] Provide visual Transmittance (VT) of 0.5 or greater. Submit documentation supporting compliance with Energy Star, FEMP designated, and Passive House qualifications as applicable. Provide proof of Energy Star label for residential aluminum window products.

[1.8.5.1 Southern Climate

Windows installed in Climate Zone [1] [2] will have a U-Factor of [1.3] [1.25] [_____] W/m^{2}·degrees C [0.40][_____] BTU/h·ft^{2}·degrees F or less and a SHGC of [0.25] [_____] or less.

][1.8.5.2 South-Central Climate

Windows installed within Climate Zone 3 will have a U-Factor of [0.85] [1.25] [_____] W/m^{2}·degrees C [0.30][_____] BTU/h·ft^{2}·degrees F or less and a SHGC of [0.25] [_____] or less.

][1.8.5.3 North-Central Climate

Windows installed within Climate Zone 4 will have a U-Factor of [0.85] [1.25] [_____] W/m^{2}·degrees C [0.30] [_____] BTU/h·ft^{2}·degrees F or less and a SHGC of [0.36] [_____] or less.

][1.8.5.4 Northern Climate

Windows installed within Climate Zone [5] [6] [7] will have a U-Factor of [0.65] [1.25][_____] W/m^{2}·degrees C [0.27] [_____] BTU/h·ft^{2}·degrees F or less and a SHGC of [0.36] [0.41] [_____] or less.

][1.8.5.5 Subarctic Climate

Windows installed within Climate Zone 8 will have a U-Factor of [0.45] [1.25] [_____] W/m^{2}·degrees C [0.08] [0.22] [_____] BTU/h·ft^{2}·degrees F or less. There is no SHGC limit for this climate zone.

][1.8.6 Life Safety Criteria

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NOTE: Designer must indicate on the drawings which windows serve as rescue and/or secondary means of escape.

****

Provide windows that conform to NFPA 101 Life Safety Code when rescue and/or second means of escape are indicated.

][1.8.7 Sound Attenuation

****

NOTE: Aluminum environmental control windows have a "built-in" sound attenuation. This paragraph will be used only when sound attenuation is a design parameter. Use outside-indoor transmission class (OITC) when exterior source noise is a concern.

****

When tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 or the following below, provide a minimum Sound Transmission Class (STC) of 35 in accordance with ASTM E90 and as determined by ASTM E413 or Outside-Indoor Transmission Class (OITC) of 25 in accordance with ASTM E1332 and as determined by ASTM E413 with the window glazed with 13 mm 1/2 inch air space between two pieces of 6 mm 1/4 inch.

][1.8.8 Windborne-Debris-Impact Performance

****

NOTE: Retain WINDBORNE-DEBRIS-IMPACT RESISTANCE Paragraph if required by Project. The UFC 1-200-01 DoD Building Code cited IBC defines windborne debris regions. Enhanced protection applies to essential facilities. Verify site specific requirements with the AHJ. Delete items not required.

****

Exterior window system including glazing must comply with indicated basis or enhanced protection testing requirements in ASTM E1996 for [Wind Zone 1] [Wind Zone 2] [Wind Zone 3] [Wind Zone 4] when tested according to ASTM E1886. Test specimens must be no smaller in width and length than glazing indicated for use on Project and must be installed in same manner as glazing indicated for use on Project.

a. Refer to drawings for classification of window requiring basic or enhanced protection.

[b. Large-Missile Test: For glazing located within 9.1 m 30 feet of grade.

][c. Small-Missile Test: For glazing located more than 9.1 m 30 feet above grade.

]]1.9 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 WINDOWS

****

NOTE: AAMA/WDMA/CSA 101/I.S.2/A440 includes a designation system with a four part code, which includes Product Type, Performance Class, Performance Grade (design pressure) and maximum size tested to achieve desired rating (example Double Hung or H, CW30 760 by 1520 (30 by 60)). Product Type is an abbreviation for window type (AP for awning, hopper, projected window, C for casement, H for hung, etc.). Performance classes represent the level of performance (R, LC, CW and AW). Performance Grade represents the design pressure to which the window is constructed.

AAMA/WDMA/CSA 101/I.S.2/A440 establishes minimum Performance Grade for each Performance Class: 15 for R (corresponding to a design pressure of 720 Pa 15 psf); 25 for LC (corresponding to a design pressure of 1200 Pa 25 psf); 30 for CW (corresponding to a design pressure of 1440 Pa 30 psf); and 40 for AW (corresponding to a design pressure of 1920 Pa 40 psf).

AAMA/WDMA/CSA 101/I.S.2/A440 also includes criteria

for specifying windows required to meet higher design pressures if minimum pressure is inadequate. These windows are designated as Optional Performance Grade and should be specified in increments of 240 Pa 5 psf above the minimum Performance Grade.
****

****
NOTE: Consult AAMA 1503 "Voluntary Test Method for Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections" and select the minimum Condensation Resistance Factor (CRF) required for the particular project conditions.
****

****
NOTE: Consult AAMA/WDMA/CSA 101/I.S.2/A440 to calculate design pressure(s) applicable to the project. Adjust "design factors" because naval facilities are typically less than 100 miles from hurricane ocean line.
****

****
NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.
****

Provide prime windows that comply with AAMA/WDMA/CSA 101/I.S.2/A440 and the requirements specified herein. In addition to compliance with AAMA/WDMA/CSA 101/I.S.2/A440, window framing members for each individual light of glass must not deflect to the extent that deflection perpendicular to the glass light exceeds L/175 of the glass edge length when subjected to uniform loads at specified design pressures. Provide Structural calculations for deflection to substantiate compliance with deflection requirements. Provide windows of types, performance classes, performance grades, combinations, and sizes indicated or specified.[Provide aluminum window frames with a minimum recycled content of 20 percent. Provide data identifying percentage of recycled content of aluminum windows.] Design windows to accommodate hardware, glass, weatherstripping, screens, and accessories to be furnished. Each window must be a complete factory assembled unit with or without glass installed. Dimensions shown are minimum. Provide windows with insulating glass and thermal break necessary to achieve a minimum Condensation Resistance Factor (CRF) of [_____] when tested in accordance with AAMA 1503. Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

****
NOTE: Performance Grades represent design pressure values for which products have been tested. Specify an Optional Performance Grade where a higher than minimum Performance Grade is desired due to severe weather conditions and wind loadings. Optional

Performance Grade windows must be tested in compliance with AAMA/WDMA/CSA 101/I.S.2/A440. Testing must substantiate requirements for uniform loading (structural), water resistance, and air infiltration.
****

2.1.1 Awning Windows (AP)

Type AP-[R15] [LC25] [CW30] [AW40] [[R] [LC] [CW] [AW]- [_____] (Optional Performance Grade)]. Conceal operating mechanism within the frame members or enclose within a metal casing not less than 1.59 mm 0.0625 inch thick sheet aluminum.

2.1.2 Casement Windows (C)

Type C-[R15] [LC25] [CW30] [AW40] [[R] [LC] [CW] [AW]- [_____] (Optional Performance Grade)]. Ventilators must be[rotary crank][handle] operated. Provide ventilators over 1650 millimeters 65 inches high with two separate locking devices or a two-point locking device operated by rods from a single lever handle. Conceal rods where possible.[Provide casement windows in combination with [fixed][projected] windows specified below.]

2.1.3 Hung Windows (H)

****
NOTE: Tilt-in windows most likely will not meet ATFP pressure requirements and should not be specified if force protection is required.
****

[Double][_____] Hung, Type H-[R15] [LC25] [CW30][AW40] [[R] [LC] [CW] [AW]- [_____] (Optional Performance Grade)]. Test and rate sash balance to conform with AAMA 902.

Design windows, mullions, hardware, and anchors to withstand the wind loading specified.

2.1.4 Horizontal Sliding Windows (HS)

Type HS-[R15] [LC25] [CW30] [AW40] [[R] [LC] [CW] [AW]- [_____] (Optional Performance Grade)].

2.1.5 Projected Windows (AP)

Type AP-[R15] [LC25] [CW30] [AW40] [[R] [LC] [CW] [AW]- [_____] (Optional Performance Grade)]. Provide projected windows with concealed four bar friction hinges only. Gear-type rotary hardware to comply with AAMA 901. Provide operators that function without requiring the removal of interior screens.

2.1.6 Top-Hinged Windows (TH)

Type TH-[CW30] [AW40] [[CW] [AW]- [_____] (Optional Performance Grade)]. Top-hinged windows must be [inswinging][outswinging].

2.1.7 Vertically Pivoted Windows (VP)

****

NOTE: Pivoting windows most likely will not meet ATFP pressure requirements and should not be specified if force protection is required.

****

Type VP-[R15] [LC25] [CW30] [AW40] [[R] [LC] [CW] [AW]-[_____] (Optional Performance Grade)].[Provide window with remotely operated venetian blind mounted between an access sash and the main sash.]

2.1.8 Fixed Windows (F)

Type F-[R15] [LC25] [CW30] [AW40] [[R] [LC] [CW] [AW]- [_____] (Optional Performance Grade)].

2.1.9 Forced Entry Resistant Windows

****

NOTE: Conventional aluminum windows offer nominal resistance to forced entry by unskilled or opportunistic intruders. While there is no way to make a window absolutely "burglar proof," windows complying with AAMA 1302 can provide reasonable assurance that entry, or attempted entry, will leave ample evidence of "forced entry." It establishes only a pass/fail condition when specific concentrated loads are applied to sash or ventilator in attempt to open or remove sash or ventilator from window frame and specifies no measured time delay. It provides moderate degree of security against unskilled or opportunistic intruder at little or no additional cost. When forced entry resistant windows are specified, coordinate glazing requirements and specify impact resistant glass and glazing materials in Section 08 81 00 GLAZING.

For projects requiring security windows, specify steel security windows in Section 08 51 23 STEEL WINDOWS. Protection in high crime areas against skilled professional intruders requires a more sophisticated approach to physical security. Consult Design Manual 13.1 "Physical Security" for recommendations.

****

In addition to meeting the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, windows designated for resistance to forced entry must conform to the requirements of ASTM F588.

2.1.10 Glass and Glazing

Materials are specified in Section 08 81 00 GLAZING.

2.1.11 Caulking and Sealing

Are specified in Section 07 92 00 JOINT SEALANTS.

2.1.12 Weatherstripping

AAMA/WDMA/CSA 101/I.S.2/A440. Provide for all ventilating (operable) sash for all windows. Provide woven wool pile weatherstripping 5.3 millimeter 0.210 inch thick, conforming to AAMA 701/702, or polypropylene multifilament fiber weatherstripping installed in an integral weatherstripping groove in the sash or frame, and flexible polyvinylchloride weatherstripping installed in the sill member.

2.1.13 Sash Poles

Seamless aluminum tube, 1.59 mm 0.0625 inch minimum wall thickness, 25 mm one inch diameter, [_____] m feet long, with cast aluminum hook and protective cover or tip on the lower end. Finish must match windows.

2.2 FABRICATION

Fabrication of window units must comply with AAMA/WDMA/CSA 101/I.S.2/A440.

2.2.1 Provisions for Glazing

****

NOTE: Specify glass thickness and vinyl gaskets in Section 08 81 00 GLAZING. Inside glazing is preferred, especially for windows above first floor and other locations where access is difficult. Windows designed for inside glazing may not be available in double-hung type; check manufacturers' literature. Where project requires insulating glass, show sash members, glazing beads, and hardware of sufficient size and weight to receive and support glass of thickness specified. Allow 3 mm 1/8 inch minimum between each side of insulating glass and metal frame and between edges of glass and frame for glazing compound and expansion. Drawings must clearly indicate method for securing insulating glass in place.

****

****

NOTE: Include the bracket option for minimum glazing frame bite requirements when personnel density is greater than one person per 40 square meters 430 square feet and minimum ATFP standoff distances are met. This does not include guard type facilities, single and duplex detached family housing. These requirements are specified in Department of Defense Antiterrorism Standards for Buildings.

****

Design windows and rabbets suitable for glass thickness shown [or specified].[For minimum antiterrorism windows, attach glazing to its supporting frame using structural silicone sealant or adhesive glazing tape in accordance with ASTM F2248.] Design sash for[inside][outside][single][double] glazing and for securing glass with[metal beads,][glazing clips,][glazing channels,] or glazing compound.

2.2.2 Fasteners

Use window manufacturer's standard for windows, trim, and accessories. Self-tapping sheet-metal screws are not acceptable for material more than 2 mm 1/16 inch thick.

2.2.3 Adhesives

Provide joint sealants as specified in Section 07 92 00 JOINT SEALANTS. For interior application of joint sealants, comply with applicable regulations regarding reduced VOC's, and as specified in Section 07 92 00 JOINT SEALANTS.

2.2.4 Drips and Weep Holes

Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, drips must be continuous across tops of fixed windows. Provide drips and weep holes as required to return water to the outside.

2.2.5 Combination Windows

Windows used in combination must be factory assembled of the same class and grade. Where factory assembly of individual windows into larger units is limited by transportation considerations, prefabricate, match mark, transport, and field assemble.

2.2.6 Mullions and Transom Bars

****

NOTE: Specify the design pressure used to specify the Performance Grade or the Optional Performance Grade for the adjoining windows.

****

****

NOTE: Include the bracketed paragraph included under the "WINDOWS" heading for static loads when minimum measures of antiterrorism/force protection (ATFP) are required and delete the first bracketed sentence in the following paragraph.

****

[Provide mullions between multiple window units to resist two times (2X) glazing resistance in accordance with ASTM F2248 and ASTM E1300.]Provide mullions with a thermal break. Secure mullions and transom bars to adjoining construction and window units in such a manner as to permit expansion and contraction and to form a weathertight joint.[Where window cleaner anchors are required, reinforce mullions and anchor to adjoining construction so as to provide safe and adequate support.] Provide mullion covers on the interior and exterior to completely close exposed joints and recesses between window units and to present a neat appearance.[Provide special covers over structural support at mullions as indicated.]

2.2.7 Accessories

Provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation and proper operation.[Furnish extruded aluminum subframe receptors[and subsill] with each window unit.]

2.2.7.1 Hardware

****

NOTE: Use stainless steel hardware in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

AAMA/WDMA/CSA 101/I.S.2/A440. The item, type, and functional characteristics must be the manufacturer's standard for the particular window type. Provide [stainless steel]hardware of suitable design and of sufficient strength to perform the function for which it is used. Equip all operating ventilators with a lock or latching device which can be secured from the inside.

2.2.7.2 Fasteners

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Anchors and fasteners must be compatible with the window and the adjoining construction. Provide a minimum of three anchors for each jamb located approximately 150 mm 6 inches from each end and at midpoint.

2.2.7.3 Window-Cleaner Anchors

****

NOTE: Window-cleaner anchors should be shown and specified for windows having sills more than 1800 mm 6 feet above grade, adjoining balconies, or adjoining roofs, unless window cleaning methods at activity make use of anchors unnecessary. Coordinate window cleaning procedures and requirements with using activity. When requested by using activity, removable or tilting-type sash may be provided instead of anchors. Removable or tilting-type sash may be specified as Contractor option when these units are desired by using activity and are economically competitive with double-hung sash equipped with anchors. When appropriate, add the following at end of paragraph WINDOW-CLEANER ANCHORS:

"Removable or tilting-type sash may be provided in lieu of double-hung windows equipped with window cleaner anchors. Design sash so that both sides of glass can be readily cleaned from interior without dismantling any part of window or screens. Provide removable and tilting-type sash with tamper-proof hardware to prevent sash removal by unauthorized personnel."

****

Provide double head anchors for windows[indicated][specified]. Anchors must be stainless steel of size and design required for the window type and application, conforming to ASTM A276/A276M. Provide two anchors for each single window[and each adjacent fixed glass window unit]. Fasten anchors 1120 mm 44 inches above the window sill utilizing appropriate methods for the window type and application in accordance with industry safety standards.

2.2.7.4 Window Anchors

Anchoring devices for installing windows must be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA/WDMA/CSA 101/I.S.2/A440.

2.2.8 Finishes

****

NOTE: Specify anodic and organic coatings as Contractor's option when these finishes are determined to be economically competitive in the project area, unless the project requires use of one or the other to match an existing condition.

****

Comply with NAAMM's "Metal Finishes Manual" for applying and designating finishes. Exposed aluminum surfaces must be factory finished with an[anodic coating][or][organic coating].[Color must be [_____][as indicated].] All windows[for each building] must have the same finish.

2.2.8.1 Anodic Coating

****

NOTE: Specify Architectural Class I in locations with an Environmental Severity Classification (ESC) of C3 through C5, locations where microenvironments may create a locally corrosive environment regardless of ESC (e.g., prevailing winds, ventilation, waterfront environments, and penetrations of the building envelope), high humidity interior areas (bathrooms, locker rooms, pools, trainers), areas open to the exterior (mechanical rooms and hangars), and spaces that are not conditioned by design or may not be conditioned during prolonged periods due to deployment or non-occupancy. See UFC 1-200-01 for determination of ESC for project locations. Specify Architectural Class II for all atmospheric conditions not requiring Class I.

****

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish must be:

[a. Architectural Class II (0.01 to 0.0175 mm 0.4 mil to 0.7 mil), designation AA-M10-C22-[A31, clear (natural)] [A32, integral color] [A34, electrolytically deposited color] anodized.

][b. Architectural Class I (0.0175 mm 0.7 mil or thicker), designation AA-M10-C22-[A41, clear (natural)] [A42, integral color] [A44, electrolytically deposited color] anodized.

]2.2.8.2   Organic Coating

****

NOTE: When anodic and organic coatings are determined to be economically competitive in the project area, specify baked enamel finish (AAMA 2603) as an option to Architectural Class II, anodic coating or high-performance finish (AAMA 2604 or AAMA 2605) as an option to Architectural Class I, anodic coating.

****

Clean and prime exposed aluminum surfaces. Provide a[baked enamel finish in accordance with AAMA 2603 with total dry film thickness not less than 0.02 mm 0.8 mil][high-performance finish in accordance with [AAMA 2604][AAMA 2605] with total dry film thickness of not less than 0.03 mm 1.2 mils].

2.2.9   Screens

AAMA/WDMA/CSA 101/I.S.2/A440. Provide one insect screen for each operable exterior sash or ventilator. Design screens to be rewirable, easily removable from inside the building, and to permit easy access to operating hardware. Manufacturers standard aluminum frame complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusion, concealed fasteners and removable PVC spline/anchors concealing edge of frame.

2.2.9.1   Insect Screen

Insect screen mesh to be[Glass-fiber mesh, 18x16 of PVC-coated glass-fiber threads; woven and fused to form a fabric mesh in accordance with ASTM D3656/D3656M][Aluminum wire fabric, 18x16 mesh of 0.2794 mm 0.011 inch diameter coated aluminum wire].

2.3   SPECIAL OPERATORS

****

NOTE: Remote and group operated windows will require special operators. Identify these windows on the drawings and show method of operation.

****

For windows having operating hardware or locking or latching devices located more than 1800 mm 6 feet above the floor, provide suitably designed operators or locking or latching devices necessary for convenient and proper window operation.

2.3.1   Pole Operators

Poles must be of proper length to permit window operation from 1500 mm 5 feet above the floor. Provide one pole operator for each room, and one pole hanger for each pole. Locate hangers where directed.

2.3.2   Extension Crank Operators

Provide removable handles for crank-operated rotary-type operators located more than 1800 mm 6 feet above the floor. Provide one removable handle for each room.

2.3.3 Mechanical Operators

****

NOTE: When motor driven operators are specified, specify electrical characteristics in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM.

****

Provide [manual] [electric motor driven] operators for group operation of continuous rows of windows [located [_____] mm feet above the floor]. Operators must be capable of opening and closing windows without appreciable deflection, vibration or rattle. Provide means of adjustment for transmission lines. Provide operators to control window units in groups [as recommended by the window manufacturer] [or] [as indicated].

2.4 THERMAL-BARRIER WINDOWS

Provide thermal-barrier windows, complete with accessories and fittings, where indicated.

Specify material and construction except as follows:

a. Aluminum alloy must be 6063-T6.

b. Frame construction, including operable sash, must be factory-assembled and factory-sealed inner and outer aluminum completely separated from metal-to-metal contact. Join assembly by a continuous, concealed, low conductance divider housed in an interlocking extrusion of the inner frame. Metal fasteners, straps, or anchors must not bridge the connection between the inner and outer frame.

c. Operating hardware for each sash must consist of spring-loaded nylon cushion blocks and pin locks designed to lock in predetermined locations.

d. Sash must be completely separated from metal-to-metal contact by means of woven-pile weatherstripping, plastic, or elastomeric separation members.

e. Operating and storm sash must be factory-glazed with the type of glass indicated and of the quality specified in Section 08 81 00 GLAZING.

2.5 MULLIONS

****

NOTE: Drawings must indicate the profile and dimensions of mullions, anchorage and reinforcing members as required for wind loading, and the type, profile, and fastening system for the mullion cover (screw-fastened or snap-on).

****

Provide mullions between multiple-window units where indicated.

Provide profiles for mullions and mullion covers, reinforced as required for the specified wind loading, and securely anchored to the adjoining construction. Mullion extrusion will include serrations or pockets to receive weatherstripping, sealant, or tape at the point of contact with each window flange.

Mullion assembly must include aluminum window clamps or brackets screwed or bolted to the mullion and the mullion cover.

Mullion cover must be screw-fastened to the mullion unless otherwise indicated.

Mullion reinforcing members must be fabricated of the materials specified in AAMA/WDMA/CSA 101/I.S.2/A440 and meet the specified design loading.

2.6 WINDOW CLEANERS' BOLTS

Provide window cleaners' bolts for all windows 2100 millimeter 7 feet or higher above finished grade, except for windows that can be removed and cleaned from the ground or from a lower roof level without the use of an extension ladder. Provide two bolts for each single window unit and each fixed glass unit. Locate bolts 1120 millimeter 44 inches above the window sill.

Window cleaners' bolts must be double-head type, AISI Series 300 corrosion-resistant steel, size and design complying with IWCA I-14.1. Contact side of the bolts must be ground to fit flat against window jambs. Bolts must be factory- or field-attached before windows are set. Reinforce backs of frames to receive bolts with 6 by 150 millimeter 1/4 by 6-inch corrosion-resistant steel or aluminum plates bolted or welded to the frames at the factory. Special wall anchors must be provided on frames at the point of bolt attachment.

PART 3 EXECUTION

3.1 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
Metal Casing	0.0625 inch	1.59 mm
Aluminum Tube (Diameter)	0.0625 inch	1.59 mm
	1 inch	25 mm

3.2 INSTALLATION

3.2.1 Method of Installation

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as the work progresses or install without forcing into prepared window openings. Set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Protect ventilators and operating parts against accumulation of dirt and building materials by keeping ventilators tightly closed and locked to frame. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install and caulk windows in a manner that will prevent entrance of water and wind. Fasten insect screens securely in place.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.2.2 Dissimilar Materials

Where aluminum surfaces are in contact with, or fastened to masonry, concrete, wood, or dissimilar metals, except stainless steel or zinc, protect the aluminum surface from dissimilar materials as recommended in the Appendix to AAMA/WDMA/CSA 101/I.S.2/A440. Do not coat surfaces in contact with sealants after installation with any type of protective material. Do not apply coatings or lacquers to surfaces to which caulking and glazing components must adhere.

3.2.3 Anchors and Fastenings

Make provision for securing units to each other, to masonry, and to other adjoining construction. Windows installed in masonry walls must have head and jamb members designed to recess into masonry wall not less than 11 mm 7/16 inch.

3.2.4 Adjustments After Installation

After installation of windows and completion of glazing and field painting, adjust all ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts as necessary.[Adjust double hung windows to operate with maximum applied force of 25 pounds in either direction, not including breakaway friction force.] Verify that products are properly installed, connected, and adjusted.

3.3 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weather-stripping, and to prevent interference with the operation of hardware. Replace all stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 51 23 (August 2020)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-08 51 23 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 08 - OPENINGS

SECTION 08 51 23

STEEL WINDOWS

08/20, CHG 1: 02/22

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 51 23 (August 2020)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
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SECTION 08 51 23

STEEL WINDOWS

08/20, CHG 1: 02/22

****

NOTE: This guide specification covers the requirements for standard steel windows.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Do not use steel windows in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. When security analysis identifies an explosive threat, antiterrorism upgrades for blast resistance in accordance with Appendix B-3 of UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings, may still apply. If the windows are not required to meet these criteria, then requirements for blast rating, blast testing, forced entry, and

antiterrorism criteria should be removed.

****

****

NOTE: On the drawings, show:

1. Sizes and types of windows; metal sub-frames, casings, or stools, if any; and hardware.

2. Sizes, location and swing of ventilators; location and details of fixed sash.

3. Method of anchoring windows to adjoining construction; size and types of clips, anchors, screws, or other fasteners.

4. Details of non-structural mullions and mullion covers

5. Locations of special glass such as tempered, insulating, heat-absorbing, light-reducing, bullet-resisting, wire, figured, plate, and spandrel glass.

6. Locations of insect screens and storm windows, if any.

7. Locations of fire-rated windows, if required.

8. Number and location of extension crank operators.

9. If motorized operators are required, show on electrical drawings and specify in Division 26.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM D3656/D3656M	(2013) Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E1886	(2019) Standard Test Method for Performance of Exterior Windows, Curtain

	Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
ASTM E1996	(2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass
ASTM F2912	(2017) Standard Specification for Glazing and Glazing Systems Subject to Airblast Loadings

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 101	(2024) Life Safety Code

STEEL WINDOW INSTITUTE (SWI)

SWI SWS	(2017; R 2018) Steel Window Specifications

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows

SD-03 Product Data

Steel Framing Materials

Recycled Content for Steel Framing Materials; S

Mullions

Hardware

Hardware Materials

Fasteners

Accessories

Operators

Screens

SD-04 Samples

Color Coating; G, [_____]

Windows

SD-05 Design Data

Structural Calculations for Deflection; G, [_____]

Design Analysis; G, [_____]

SD-06 Test Reports

Air Infiltration

Water Infiltration

Mullion and Transom Bar Wind Load

Minimum Condensation Resistance Factor

[Resistance to Forced Entry

][Standard Airblast Test; G, [_____]

][Windborne-Debris-Impact Performance

] SD-07 Certificates

[Engineer's Qualifications

] SD-10 Operation and Maintenance Data

Windows, Data Package 1; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Shop Drawing Information

Indicate elevations of windows, full-size sections, thicknesses and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, [mullion details,] [method and materials for weatherstripping,] [method of attachment of screens,] [metal subframes,] [stools,] [casings,] [sills,] [trim,] other related items, and installation details.

1.3.2 Color Coating Samples Information

Submit chart of manufacturer's color coatings if factory finish is to be provided in lieu of field painting.

1.3.3 Windows Samples Information

Submit one complete, full size glazed window of each type proposed for use, complete with hardware, anchors, and other accessories.[Where screens or weatherstripping are required, fit sample windows with such items that are to be used.] After approval, install each sample in the work, clearly identified, with location recorded.

[1.3.4 Engineer's Qualifications for Blast Design

****

NOTE: In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. Include engineer's qualifications and design data requirements subsections below when security analysis identifies an explosive threat and antiterrorism upgrades are required to provide blast resistance in conformance with UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.

****

All blast design calculations must be performed by or under the direct supervision of a registered engineer with a minimum of 5 years experience performing blast design. The engineer performing the blast design must be able to demonstrate experience on similar size projects using similar design methods to meet the requirements outlined in this specification.

][1.3.5 Design Data Requirements

Submit structural calculations for deflection to substantiate compliance requirements[and Antiterrorism Performance Requirements]. A registered Professional Engineer must provide calculations. Submit design analysis with calculations showing that the design of each different size and type of steel window unit and its anchorage to the structure[.][meets the requirements of paragraph ANTITERRORISM PERFORMANCE REQUIREMENTS.] Calculations verifying the structural performance of each window proposed for use, under the given loads, must be prepared and signed by a registered professional engineer. Reflect the window components and anchorage devices to the structure, as determined by the design analysis, in the shop drawings.

]1.4 TEST REPORT REQUIREMENTS

1.4.1 Air and Water Infiltration

ASTM E283 and ASTM E331. Do not exceed maximum air infiltration of 0.05 cubic meter per minute per meter one-half cubic foot per minute per foot of crack length when subjected to a static pressure of 75 Pa 1.56 pounds per square foot (equivalent to a wind velocity of 40 kilometers per hour (kph) 25 miles per hour (mph)). Water infiltration must be "zero."

1.4.2 Mullion and Transom Bar Wind Load Tests

****

NOTE: Specify wind loading requirements in areas subject to wind velocities above 113 kph 70 mph; otherwise delete. The wind loading of 958 Pa 20 psf is based on a 145 kph 90 mph wind velocity at 61 meters 200 feet above grade.

****

****

NOTE: Delete when not applicable.

****

ASTM E330/E330M. Members must withstand a uniform wind load of 958 Pa 20 pounds per square foot of window area without deflecting more than 1/175 of the span.

1.4.3 Blast Testing

****

NOTE: In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. Include the following section when security analysis identifies an explosive threat and windows are required to resist blast loads required by Appendix B-3 of UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.

****

Submit test reports for each type of window attesting that identical windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 including test size, [and] minimum condensation resistance factor (CRF)[, and resistance to forced entry][, and, for Antiterrorism windows, in lieu of a Design Analysis, results of a Standard Airblast Test].[For Antiterrorism windows, in lieu of a Design Analysis, results of airblast testing, whether by arena test or shock tube, must be included in a test report, providing information in accordance with ASTM F1642/F1642M, as prepared by the independent testing agency performing the test. The test results must demonstrate the ability of each window proposed for use to withstand the airblast loading parameters and achieve the hazard level rating specified in paragraph STANDARD AIRBLAST TEST METHOD.]

1.5 WINDOW PERFORMANCE

Steel windows must meet the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

1.5.1 Structural Performance

Structural test pressures on window units must be for positive load (inward) and negative load (outward). After testing, there will be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There must be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA/WDMA/CSA 101/I.S.2/A440 for the window types and classification specified in this section.

1.5.2 Thermal Performance

****

NOTE: Window properties are critical to energy performance and comfort. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain.

For nonresidential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy efficiency and meeting minimum building envelope requirements of UFC 3-101-01 including fenestrations and glazing.

Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting bracketed energy performance requirements before specifying and edit as needed.
****

Non-residential glazed systems (including frames and glass) must be certified by the National Fenestration Rating Council with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [_____] determined according to NFRC 200 procedures and a U-factor maximum of [_____] W per square m by K Btu per square foot by hr by degree F in accordance with NFRC 100.

[1.5.3 Windborne-Debris-Impact Performance

****
NOTE: Retain WINDBORNE-DEBRIS-IMPACT RESISTANCE paragraph if required by Project. The UFC 1-200-01 DoD Building Code cited IBC defines windborne debris regions. Enhanced protection applies to essential facilities. Verify site specific requirements with the AHJ. Delete items not required.
****

Exterior window system including glazing must comply with indicated basis or enhanced protection testing requirements in ASTM E1996 for [Wind Zone 1] [Wind Zone 2] [Wind Zone 3] [Wind Zone 4] when tested according to ASTM E1886. Test specimens must be no smaller in width and length than glazing indicated for use on Project and must be installed in same manner as glazing indicated for use on Project.

a. Refer to drawings for classification of window requiring basic or enhanced protection.

[b. Large-Missile Test: For glazing located within 9.1 m 30 feet of grade.

][c. Small-Missile Test: For glazing located more than 9.1 m 30 feet above grade.

]][1.5.4 Antiterrorism Performance Requirements

****
NOTE: ANTITERRORISM PERFORMANCE REQUIREMENTS section below is optional to designer, and must be omitted or revised as needed to meet project requirements.

Applicability of UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings:

In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. When security analysis identifies an explosive threat, antiterrorism upgrades for blast resistance in accordance with Appendix B-3 of UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings, may still apply. If the windows are not required to meet these criteria, then this section and subsections for design analyses and airblast testing should be removed.

A structural analysis will need to be performed to determine if the most stringent loading on window assembly is from antiterrorism blast loads or windborne debris in high wind regions.

****

Windows must meet the antiterrorism performance criteria as specified in the paragraphs below in accordance with UFC 4-010-01. Conformance to the performance requirements must be validated by one of the following methods.

1.5.4.1 Computational Design Analysis Method

Design window assembly to the criteria listed herein. Include computational design analysis calculations verifying the structural performance of each window assembly proposed for use, under the given static equivalent loads.

Design window frames, mullions, sashes, and glazing to the criteria listed herein. Include computational design analysis calculations verifying the structural performance of each window system proposed for use, under the given static equivalent loads.

****

NOTE: The blanks in the following paragraph should be the value of the equivalent 3-second duration design loading obtained from Figure 1 of ASTM F2248 for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. This section must be completed by an engineer experienced in blast-resistant design.

****

Glazing resistance must be greater than equivalent 3-second duration loading of [_____] Pascal pounds per square foot (psf) for type [_____] window[and [_____] Pascal psf for the remaining window types]. The glazing frame bite for the window frames must be in accordance with ASTM F2248.

Design Steel window framing members to restrict deflections of the edges of glazing they support to L/60 under two times (2X) the glazing resistance per the requirements of ASTM F2248 and ASTM E1300.

****

NOTE: Connection Design: For mullion and framing members designed using dynamic analysis or shown to work through airblast testing, all connections between mullions and/or framing members and all connections of storefront systems to the supporting structure must be designed for the full dynamic capacity of the attached member or the maximum calculated dynamic reaction with a load factor equal to 1.0. Use ultimate capacity of fasteners as recommended by the fastener manufacturer with a capacity reduction factor of 0.75. Use Load and Resistance Factor Design (LRFD) with appropriate reduction (phi) factors per material specific code for design of connections components into supporting

structure. All dynamic and static material strength increase factors for the connection components must be equal to 1.0. All connection designs must be performed checking all conventional failure mechanisms. See Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: pdc.usace.army.mil/library/tr/10-02) for additional information. Calculations/Design Analysis for the connection design as stated above must be completed by an engineer experienced in blast-resistant design.

****

****

NOTE: Use the first bracketed requirement below if the maximum air blast pressure is greater than one-half the magnitude of the load resistance of the blast resistant glazing.

Use the second bracketed requirement below if the maximum air blast pressure is less than one-half the magnitude of the load resistance of the blast resistant glazing.

****

[Anchor window frames to the supporting structure with anchors designed to resist [two times (2X)][one time (1X)] the glazing resistance in accordance with ASTM F2248 and ASTM E1300.

]1.5.4.2 Dynamic Design Analysis Method

****

NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01 (Table B-1). Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering/billeting building occupancy as defined in UFC 4-010-01 (Table B-1). Dynamic analysis is preferred because it typically yields a more appropriate and economical / efficient design. The values for input into the blanks in the following paragraph related to 'ductility ratio' and 'maximum support rotation' (for the appropriate level of protection - very low, low) for framing/mullions can be found in Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: pdc.usace.army.mil/library/tr/10-02). This section must be completed by an engineer experienced in

blast-resistant design.
****

Design window assembly using a dynamic analysis to prove the system will provide performance equivalent to or better than a [low;] [very low;] [_____] hazard rating in accordance with ASTM F2912 for the peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). Use a triangular blast load using the applicable pressure and impulse indicated above. The allowable response limits of [aluminum] [steel] frame elements are as follows: Maximum ductility ratio of [_____] and maximum support rotation of [_____] degrees.

1.5.4.3 Standard Airblast Test Method

****
NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01. Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering building occupancy as defined in UFC 4-010-01. This section must be completed by an engineer experienced in blast-resistant design.
****

As an alternative to the 'Computational Design Analysis Method' and 'Dynamic Design Analysis Method' indicated above, window [_____] assembly may be tested for evaluation of hazards generated from airblast loading in accordance with ASTM F1642/F1642M by an independent testing agency regularly engaged in blast testing. For proposed window systems that are of the same type as the tested system but of different size, the test results may be accepted provided the proposed window size is within the range from 25 percent smaller to 10 percent larger in area and aspect ratio of the original qualified tested glazing systems in accordance with ASTM F2912. Proposed window system/assembly of a size outside this range will require testing to evaluate their hazard rating or are certified by the 'Dynamic Design Analysis Method' indicated above. Testing may be by shock tube or arena test. Perform the test on the entire proposed window system/assembly, including, the glazing, its framing/support system, operating devices, and all anchorage devices. Window support system replicate anchorage of the window support system with the method of installation to be used for the project. The minimum airblast loading parameters for the test will be as follows: peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). The hazard rating for the proposed window systems, as determined by the rating criteria of ASTM F2912, to provide performance equivalent to or better than a [low;] [very low;] [_____] hazard rating (i.e. the "No Break", "No Hazard", "Minimal Hazard", "Very Low Hazard" and "Low Hazard" ratings are acceptable. "High Hazard" ratings are unacceptable. Results of window systems previously tested by test protocols other than ASTM F1642/F1642M may be accepted provided the required loading, hazard level rating, and size limitations stated herein are met.

]1.6 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

1.7 DELIVERY AND STORAGE

Deliver to project site in undamaged condition. Store windows and components on edge, out of contact with the ground, under weathertight covering, and arranged to avoid bending, warping, or other damage.

PART 2 PRODUCTS

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Steel window framing typically contains up to 100 percent recycled material coming from recycled steel billets.

****

****

NOTE: Window properties are critical to energy performance and visual satisfaction. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting bracketed energy performance requirements before specifying and edit as needed.

****

2.1 MATERIALS

2.1.1 General System Requirements

Steel framing materials must contain a minimum of 40 percent total recycled content. Provide data identifying percentage of recycled content for steel framing materials.

2.1.2 Steel Bars

SWI SWS.

2.1.3 Sheet Steel

ASTM A1011/A1011M.

2.1.4 Zinc-Coated Sheet Steel

ASTM A653/A653M.

2.1.5 Zinc Coating

ASTM A123/A123M.

2.1.6 Screws and Bolts

ASME B18.6.3 as applicable.

2.2 FABRICATION OF WINDOWS

Form permanent joints by welding or mechanically fastening as specified for each type window. Use joints of strength to maintain structural value of members connected. Weld joints solid, remove excess metal, and dress smooth on exposed and contact surfaces. Closely fit joints formed with mechanical fastenings and make permanently watertight. Assemble frames and sash, including ventilators and thermal breaks, at the plant and ship as a unit with hardware unattached. Provide the following construction:

a. Where fixed window sections adjoin ventilator sections, provide fixed sash, fabricated from similar frame members, and of manufacturer's standard type suitable for the purpose.

b. Roll weathering surfaces integrally to provide two-point parallel-surface contact with overlap at both inside and outside points of closure.

c. Provide drips and weep holes as required to return water to outside.

d. Design glazed windows and rabbets suitable for glass thickness shown on drawings [or specified].

e. Use flathead, cross recessed type, exposed head screws and bolts with standard threads on windows, trim and accessories. Screw heads must finish flush with adjoining surfaces. Self tapping sheet-metal screws are not acceptable.

f. For hot-dipped galvanized windows, use stainless steel or hot-spun galvanized steel fasteners. For windows with painted finish use electro-galvanized fasteners. Finish exposed heads to match finish of windows.

2.3 FIRE RATED WINDOWS

****

NOTE: Windows requiring an Underwriters Laboratories fire rating must be steel. Aluminum windows cannot be approved for this use.

****

Provide sash and frame with necessary hardware to conform to the requirements of Underwriters Laboratories Inc. (UL), for class of window indicated. Submit proof of conformance. UL label will be accepted as proof. Labeled window details take precedence over details indicated or specified for nonlabeled windows, except when sections required for nonlabeled windows are heavier than those required by UL. In lieu of UL label, written certification by approved nationally recognized testing agency may be submitted. Certification must state that complete window unit of type provided has been tested and conforms to published standards, including methods of tests, of UL.

2.4 PROVISIONS FOR GLAZING

****

NOTE: Exterior frames, mullions, and window hardware must be designed to resist equivalent static design loads in accordance with ASTM F1642/F1642M. Frame and mullion deflection must not exceed L/160 of the unsupported member lengths. The Contractor must demonstrate by calculations or dynamic tests in accordance with ASTM F1642/F1642M that the window complies with the loading requirement. Equivalent static design loads for connections of window to the surrounding walls or hardware and associated connections, and glazing stop connections must be in accordance with ASTM F2248 and ASTM E1300.

****

****

NOTE: Inside glazing is preferred, especially for windows above first floor and other locations where access is difficult. Windows designed for inside glazing may not be available in double-hung type. Check manufacturers' literature. Where project requires insulated glass, specify sash members, glazing beads, and hardware of sufficient size and weight to receive and support glass of thickness shown. Allow 3 mm 1/8 inch minimum between each side of insulating glass and metal frame for glazing compound and expansion. Also allow 3 mm 1/8 inch between edges of glass and frame. Drawings should indicate method for securing insulating glass.

****

****

NOTE: Include the last bracketed sentence where the antiterrorism requirements of UFC 4-010-01 apply based on the facility's occupancy classification and occupancy load.

****

Design sash for [inside] [outside] glazing and for securing glass with [metal beads] [glazing clips] and glazing compound.[Where insulating glass is indicated, use rabbets of adequate weight and depth to receive and properly support glass and glazing accessories.][For windows required to comply with antiterrorism provisions, design in accordance with Standard 10 of UFC 4-010-01.]

2.5 MULLIONS AND TRANSOM BARS

Provide mullions between multiple window units designed to withstand specified wind load requirements.[Provide mullions with a thermal break.] Secure mullions and transom bars to adjoining construction and window units in such a manner as to permit expansion and contraction and to form weathertight joint. Provide mullion covers of manufacturer's stock design on the interior and exterior to completely cover exposed joints and recesses between window units and for neat appearance.[Provide special covers over structural supports at mullions as indicated.]

2.6 METAL-TO-METAL JOINTS

Set in mastic, using type recommended by window manufacturer to provide weathertight joints. Remove excess mastic before it hardens.

2.7 ACCESSORIES

Provide windows with hardware, clips, fins, anchors, glazing beads, and fastenings, necessary for complete installation and operation of ventilators.

2.7.1 Anchors

Use hot-dip galvanized steel anchors. Secure anchors and fastenings to heads, jambs, and sills of openings, and fasten securely to windows or frames. Use anchors recommended by window manufacturer for specific type of construction and conceal. Anchor each frame at jambs with minimum of three adjustable steel anchors.[Provide perforated anchor stems for mortar keying with anchor flanges of sufficient width to provide sliding friction fit inside frames. Extend perforated stems not less than 100 mm 4 inches into masonry.][For anchorage at concrete walls and prepared openings, equip frames with manufacturer's standard bent-clips located approximately 150 mm 6 inches from each end and at midpoint.]

2.7.2 Weatherstripping

Provide on all operable windows so that, when tested before leaving factory, in accordance with ASTM E283, do not exceed a maximum air infiltration of 0.05 cubic meter per minute per meter one half cubic foot per minute per foot of crack length when subjected to static pressure of 75 Pa 1.56 pounds per square foot equivalent to wind velocity of 40 kmh 25 mph.

2.7.3 Hardware

Equip all operable sash with latching device which can be secured from inside. The item, type, and function of hardware required are specified under individual window type. Attach hardware securely to windows with corrosion resisting bolts or machine screws; do not use sheet metal screws. At fixed screens, adapt hardware to permit operation of ventilators. Fit and test hardware for each window at factory to ensure satisfactory operation and security.

2.7.3.1 Hardware Materials and Finish

****

NOTE: Select finish desired and delete others; or

allow options listed. Other finishes available include chromium, nickel, and zinc-coated malleable iron and steel. Hardware for shops, boiler rooms, and similar industrial applications may be malleable iron or hot-dip, zinc-coated steel.
****

Provide[non-magnetic type stainless steel exposed hardware with satin finish][white bronze with satin finish hardware][yellow bronze with dull (oxidized) finish hardware]. Use galvanizedsteel or malleable iron hinges, with nonferrous pins, or with steel pins and non-ferrous bushings or washers.

2.7.4 Fasteners

Stainless steel or aluminum materials[; zinc-coated steel elsewhere as shown on Drawing Sheet No. [_____.]] Prime exposed heads of coated or plated fasteners and finish to match adjacent material.

2.7.5 Metal Sub-frames and Stools

Manufacturer's standard type designed to suit the particular window. Match exposed surfaces to windows.

2.8 GLASS AND GLAZING

Provide materials in accordance with Section 08 81 00 GLAZING.

2.9 WINDOW FINISH

****
NOTE: An upgraded hot-dip galvanized, phosphate treated, and prime coat finish is specified here on a shop primed finish product for long-term performance on DoD projects. Optional factory applied color coat is acceptable for all locations. Include field coats under Section 09 90 00 PAINTS AND COATINGS.
****

2.9.1 Shop Primed Finish

After fabrication, clean all surfaces of windows, fins, mullions, cover plates, and screen frames and provide a hot-dip galvanized, phosphate-treated and shop primed finish. Conform to SWI SWS for the methods of cleaning, chemical treatment, galvanizing, and painting.

2.9.2 Factory Finish

In lieu of shop primed finish, factory finish may be provided using the following method, in which case finish field painting will not be required:

a. Chemically clean and bonderize windows. Apply dip coat of epoxy primer baked on for not less than 15 minutes at not less than 149 degrees C 300 degrees F, followed by finish coat of alkyd-amine enamel of not less than 0.025 mm one mil thickness, baked on for 15 minutes at not less than 149 degrees C 300 degrees F.

b. Finish color coating to be selected from manufacturer's standard color chart.

c. Touch up abraded surfaces with enamel as specified for factory finish.

2.10 WINDOW TYPES

****

NOTE: For the paragraphs in this Article representing window types, only include the window types used on the project and delete those that do not apply.

****

Conform to SWI SWS. Provide combinations, types and sizes indicated. Each window must consist of a unit including [subframe,] [frame,] sash, hardware, [mullions,] trim, [casing,] [insect screen,] [storm units,] and anchors. Design windows indicated to have screen [or storm units] to accommodate items to be furnished.

2.10.1 Awning Windows

Provide compression-type weatherstripping. Heavy Intermediate materials in group of top-hinged or projected out-swinging ventilators:

2.10.1.1 Operators

****

NOTE: Select applicable paragraph(s) from the following:

****

****

NOTE: Specify push-bar operators in lieu of rotary hand crank operation wherever feasible. Experience indicates that rotary hand cranks require excessive maintenance and, in most cases, will not withstand continued hard usage. In the event push-bar operation is not feasible, specify removable crankhandles. Remote and group operation of windows may require rotary crankhandle operation. See paragraph SPECIAL OPERATORS.

****

[Control must be simultaneous by means of cam-type lever handle fastener for hand push-pull operation. For windows with screens, provide with underscreen push bar operators. For operators more than 2 meters 6 feet above floor, provide with hardware designed for pole operation.

][Provide simultaneous control by means of a rotary mechanical power unit manually operated by bronze [removable] crankhandle, providing positive adjustment and holding of vents in any position from fully open to fully closed. Operator must securely close ventilators on both sides of window without additional locking devices. Heavy-duty worm-gear rotary operator with machine-cut case-hardened steel gears in steel housing with smooth lacquer finish.

]2.10.1.2 Ventilators

Support on two hinges and two arms, or on two steel slide arms pivoted to vent and to principal frame member. Provide bronze-brushed pivots and hinges with bronze pins. Design ventilators to close and weather on each other, or on independent meeting rails assembled as part of window frame. Provide for positive adjustment of individual vents to ensure positive contact between sash and frame when closed.

2.10.2 Casement Windows

[Standard Intermediate] [Heavy Intermediate] [Heavy Custom]. Provide continuous drip molds immediately above ventilators. Where fixed sections adjoin ventilators, provide drips continuous across top of fixed sections. Provide each side hinged ventilator with one pair of non-friction extension hinges, one sash operator, and one locking handle. Provide sash over 1680 mm 66 inches high with three hinges. Provide hinges with strength necessary to permanently support glazed ventilator without twist or sag. Provide compression-type weatherstripping.

2.10.2.1 Sash Operators

Use [sliding underscreen] [crank-operated rotary] sash operators. Design operators to hold ventilators firmly in position at any angle up to 90 degrees.[Use friction or thumb-screw sliding operators.] Use heavy-duty worm-gear rotary operators, with machine-cut, case hardened steel gears. Provide pivoted lever type locking handles, engaging beveled strike plate or keeper. For ventilators exceeding 1680 mm 66 inches in height, provide two-point locking device, operated by rods from single lever handle. Conceal rods where design of sash section will permit.

2.10.2.2 Hopper or Sill Type Ventilators

For hopper or sill type ventilators occurring under casement or fixed sash, provide cam-acting locking handle. For hinged type, provide one pair of hinges and two concealed friction stay arms; for projected type, use two friction shoes with nonfriction stay arms to hold ventilator in any position, up to 45 degrees. For hopper vents over 1220 mm 48 inches wide, use two locking handles.

2.10.2.3 Transom Ventilators

When transom ventilators occur above casement or fixed sash, hang on two stay arms sliding in friction shoes. Provide ventilators with hardware designed for pole operation.

2.10.3 Continuous Windows

****

NOTE: Select desired operation and describe in detail under paragraph SPECIAL OPERATORS. Specify motorized operators under Division 26 and include uniform wind load (in areas subject to high wind velocity) against which motorized equipment must operate ventilators noiselessly without chattering.

****

Continuous type with [manual] [motorized] mechanical operation.

2.10.4 Fixed Windows

[Standard Intermediate] [Heavy Intermediate] [Heavy Custom] windows.

2.10.5 Horizontally Pivoted Windows

[Standard Intermediate] [Heavy Intermediate] [Heavy Custom]. Make pivots integral with jamb weathering bars to ensure permanent alignment. Hold ventilator in place at pivots with solid bronze, replaceable shouldered pivots, washer and nuts.

2.10.5.1 Operators

Equip ventilators with chain roller guide, chain and chain stay located at convenient distance from floor. Attach chain to spring-latch at ventilator head, looping down and back up through roller-guide in spring-catch. Secure end to keeper on frame. Unscreened ventilators readily accessible from floor may have steel stay adjusters.

2.10.6 Projected Windows

[Standard Intermediate] [Heavy Intermediate] [Heavy Custom].

2.10.6.1 Operators

Equip ventilators under 1220 mm 48 inches wide with one cam-type lever handle fastener; equip ventilators 1220 mm 48 inches wide and over, and not pole operated, with two fasteners. Where fixed screens occur at projected-out ventilators, provide underscreen push bar operators. Provide ventilators with locking rails more than 2 meters 6 feet above the floor with hardware designed for pole operation.

2.10.7 Security Windows

****

NOTE: Use steel for security windows; aluminum windows are not acceptable. Steel security windows may occur in conjunction with aluminum windows, in which case, a finish matching that of the aluminum windows should be specified. Security steel windows are designed and constructed to give protection against unauthorized entrance and removal of materials from warehouses and other storage type areas; they are not designed for detention use. The stock ventilators are bottom hung to project-in with the grill frame on outside of ventilator. Guard windows for detention use are not included in this guide; where such windows are desired, consult SWI SWS, and modify this guide section accordingly.

****

SWI SWS. Provide ventilators with manufacturer's standard hardware of iron, steel or zinc. Equip ventilators having locking rails more than 2 meters 6 feet above floor with hardware designed for pole operation.

2.11 SCREENS

Provide one insect screen for each operable exterior sash or ventilator. Locate screen units either inside or outside, depending upon window type and method of operation. Provide [full-length top-hung] [double vertical sliding] [half-length sliding] [half-length fixed] type screens. Design screens to fit closely around entire perimeter of ventilator or opening, to be rewirable, easily removable from inside building, and interchangeable for same size ventilators of similar type windows, with minimum of exposed fasteners and latches. Provide all guides, stops, clips, bolts, and screws, as necessary, for a secure and insect-tight attachment to window. Where wickets are necessary, use sliding or hinged type, with friction catches, framed and trimmed for durability and tight fit. Provide wicket opening frames of similar material and cross-section as screen frames. Provide continuous framing bar between the two sides of screen frames.

2.11.1 Construction

Provide screen frames of steel with finish matching that of windows. Equip frames with removable splines of steel or vinyl. Form groove in frame for holding screen cloth in place with noncylindrical splines. Make spline and groove assembly so that cloth cannot be removed from groove by pressure on cloth. Make splines of such size and shape that rotation of spline in groove will be prevented and spline will tightly hold cloth in place.

2.11.2 Insect Screening

ASTM D3656/D3656M, Class 2, 18 by 14 mesh, color [charcoal] [gray] [_____]. Install with weave parallel to frames. Stretch tight for smooth appearance. Conceal edges in spline channels.

2.12 SPECIAL OPERATORS

2.12.1 Pole Operators

Provide for windows having operating hardware or locking rails more than 2 meters 6 feet above floor. Provide window manufacturer's standard pole design of length to provide operation from 1.67 meters 5 feet above floor, and with push-pull hooks of proper shape and length. Provide one pole operator for each room, and one pole hanger for each pole in location as directed.

[2.12.2 Extension Crank Operators

****

NOTE: Delete when not applicable.

****

Provide removable handles for crank operated rotary operators located more than 2 meters 6 feet above floor. Provide one removable handle for each room.

]2.12.3 Mechanical Operators

****

NOTE: Delete when not applicable.

****

Provide [manual] [motorized] operators for group operation of continuous rows of windows, and for windows located at unusual heights, where other types of remote operation are not feasible. Provide operators that open and close windows without appreciable deflection, vibration or rattle. Provide transmission lines equipped with means of adjustment. Control window units in groups with operators as recommended by window manufacturer for the particular window arrangement shown, unless specifically indicated otherwise. Use mechanical operators of one of the following types:

a. On-Sill Operators: Centrally located, manually controlled mechanisms for adjusting ventilators, assembled of bronze telescoping shafts with machine cut threads. Conceal, except for linkage members, by appropriate covers. Provide one operator, secured to sill, for each window. Finish operators exposed to view to match hardware finish. Finish covers to match window casings.

b. Geared Lever-Arm Operator: Provide power unit with machine-cut gears and machined thrust bearings housed in dustproof oil-tight case, with provision for lubrication. Provide torsion shaft of standard black iron pipe not less than 25 mm one inchinside diameter. Rigidly clamp steel or malleable iron operating arms to shaft and connect to ventilator by push bar and hinge bracket. Support operating mechanism on brackets securely attached to building structure or mullions. No single line is allowed to extend more than 9 meters 30 feet from either or both sides of power unit.

c. Geared Rack-and-Pinion Operator: Provide power unit with machine-cut gears and machined thrust bearings housed in dustproof oil-tight case, with provision for lubrication. Provide torsion shaft of standard black iron pipe not less than 25 mm one inchinside diameter. Cut steel rack to a pitch that will mesh accurately with the cut teeth on a steel or cast iron pinion. Fasten pinion securely to torsion shaft. Provide steel rack with a hinged bracket for attaching to ventilator. Hold rack in mesh with pinion by steel yoke with bearing rollers of solid brass. Support operating mechanism on steel brackets securely attached to building structure or mullions. No single line is allowed to extend more than 15 meters 50 feet from either or both sides of power unit.

[2.12.3.1 Operating Arms and Racks

****

NOTE: Delete when not applicable.

****

Provide each ventilator not more than 900 mm 36 inches wide with single operating arm or rack attached at center of rail. Provide each ventilator more than 900 mm 36 inches wide with two operating arms or racks attached to side rails or near ends of horizontal rail of ventilator.

][2.12.3.2 Chain Control

****

NOTE: Delete when not applicable.

****

Provide power unit with hand chain, operating over chain wheel with chain guard. Drill and secure wheel to worm shaft by key. Terminate chain approximately 600 mm 2 feet above floor. Where building construction makes it impracticable to hang chain vertically from power unit, furnish single or double chain idlers to convey chain to point shown or directed.

][2.12.3.3 Steel Shaft Control

****

NOTE: Delete when not applicable.

****

Provide power unit with vertical standard black iron pipe of not less than 19 mm 0.75 inch inside diameter or solid steel shaft with malleable iron or steel coupling. Support vertical shaft with brackets spaced not over 2 meters 6 feet apart. Where hand operating wheel is indicated 1.5 meters 4 feet 6 inches above floor, place wheel in vertical position. Where hand operating wheel is indicated 2 meters 6 feet 6 inches above floor, place wheel in horizontal position. Secure wheel in place permanently. Furnish universal joints or beveled gears to locate control at point shown or as directed on nearest wall or column. Where practicable, mount vertical shafts on walls instead of pilasters.

]PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with window manufacturer's printed instructions and details. Coordinate installation with commissioning as specified in Section [_____].[Install fire rated windows in accordance with NFPA 80 and NFPA 101.] Build in windows as work progresses or install without forcing into prepared window openings. Set at proper elevation, location, and reveal; plumb, square, level, and in alignment. Brace and stay to prevent distortion and misalignment. Protect ventilators and operating parts against dirt and building materials by keeping closed and locked to frame. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant recommended by window manufacturer. Install and seal windows in a manner that will prevent entrance of water and wind.[Fasten insect screens securely in place.]

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.2 ANCHORS AND FASTENINGS

Make provision for securing units to each other and to adjoining construction. Design head and jamb members to enter into masonry not less than 11 mm 7/16 inch where windows are installed in direct contact with masonry. Where windows are set in prepared masonry openings, build in anchors and fastenings to jambs of openings and fasten securely to windows or frames and to adjoining construction. Space anchors not more than 450 mm 18 inches apart on jambs and sills, and install a minimum of three anchors on each side of each opening. Anchors and fastenings must have sufficient strength to hold member firmly in position. Where type, size, or spacing of anchors is not shown or specified, use expansion or toggle bolts or screws as best suited to construction material. Provide expansion shield and bolt assemblies of type designed to give holding power beyond tensile and shearing strength of bolt. Minimum fastener penetration must be not less than that recommended by manufacturer for type fastener and wall material involved.

3.3 OPERATORS

Install operators before glazing. Plumb and level shaft risers and runs. Adjust ventilators for free opening and tight closing. Secure housings and adjustable supports to wall. Anchor operator parts to steel window mullions with 13 mm 1/2 inch bolts. Couple individual lengths of shafting with steel rivets or bolts. Leave mechanical equipment and ventilators in proper operating condition.

3.4 WEATHERSTRIPPING

Use bronze, spring-brass, or stainless steel and secure with non-ferrous screws. Secure weatherstripping or rubbing-blocks to parting-strip and each end of meeting-rails. For solid bar stock windows, use manufacturer's standard weatherstripping inserted into groove.

3.5 ADJUSTMENTS AFTER INSTALLATION

After installation of windows and completion of glazing and field painting, adjust all ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts. Adjust weatherstripping to assure weathertight contact with frames when ventilators are closed and locked. Weatherstripping must not cause binding of sash, or prevent closing and locking of ventilator. Verify products are properly installed, connected, and adjusted.

3.6 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance and to prevent fouling of weathering surfaces and weatherstripping, or interference with operation of hardware. Clean and touch up abraded surfaces. Replace with new windows any stained, discolored, or abraded windows that cannot be restored to original condition.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 51 69.10 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 51 69.10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 51 69.10

ALUMINUM STORM WINDOWS

08/20

****
USACE / NAVFAC / AFCEC **UFGS-08 51 69.10 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 51 69.10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 08 51 69.10

ALUMINUM STORM WINDOWS
08/20

****
NOTE: This guide specification covers the requirements for storm windows for internal or external application on existing buildings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: On the drawings, show location, size, and type of storm window and details of installation; show existing conditions where applicable.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum
AAMA 1002	(2011) Voluntary Specification for Secondary Storm Products for Windows and Sliding Glass Doors
AAMA 2603	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants

1.2   SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Storm Windows

SD-03 Product Data

Storm Windows

SD-10 Operation and Maintenance Data

Storm Windows, Data Package 1; ; G, [_____]

1.2.1 Shop Drawing Information

Submit drawings showing elevations of units, full-sized section, thicknesses and gages of material, fastenings, methods of anchorage, size and spacing of anchors, and locations of operating hardware. Indicate method of glazing, method of attaching and operating both screen and glass insert panels, and method and materials for weatherstripping. Include mullion details, details of installation, and connections with other work, including details of existing windows and adjacent construction. Storm window schedule must show location of each unit.

1.2.2 Product Data Submittal Requirements

Submit complete descriptive literature for each type of storm window and accessory. Clearly mark data to indicate which type, size, model, or item is to be provided. Data must include instructions for adjustments, cleaning, and maintenance.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver products to the project site in undamaged condition. Store products out of contact with the ground under weathertight covering, and protect against damage. Do not install damaged units.

1.4 FIELD MEASUREMENT

Dimensions shown are nominal. Field measure openings to obtain exact dimensions needed for fabrication. Meeting rails or stiles of storm windows must align with the meeting rails or stiles of the prime windows.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aluminum

AAMA 1002.

2.1.2 Storm Windows

****

NOTE: See referenced publications for requirements not included in this section. The designations listed are:

FWE - Fixed-Removable Insulating Storm Windows for External Application

HWE - Horizontally Operating Insulating Storm Windows for External Application

VWE - Vertically Operating Insulating Storm Windows for External Application

FWI - Fixed-Removable Insulating Storm Windows for Internal Application

HWI - Horizontally Operating Insulating Storm Windows for Internal Application

VWI - Vertically Operating Insulating Storm Windows for Internal Application

****

AAMA 1002, Specification [FWE,] [HWE,] [VWE,] [FWI,] [HWI,] [VWI,] except as otherwise specified herein. Provide windows with a Performance Class of [20] [30] [40] [_____]. Extrusions must have a nominal wall thickness of not less than 1.14 mm 0.045 inch.

2.1.3 Sealant

****

NOTE: Where Section 07 92 00 JOINT SEALANTS is included in the specifications select the first bracketed option; if this section not included, select second option.

****

[See Section 07 92 00 JOINT SEALANTS for sealant requirements.] [ASTM C920, Type S or M, Grade NS, Class 12.5, use NT, Color [_____]. Sealant must have been tested for use with the materials on which it will be used in this project.]

2.2 FABRICATION

AAMA 1002.

2.2.1 Connections

Rigidly connect frames at corners so as to prevent racking during normal handling and installation.

2.2.2 Locks or Latches

On vertically operating inserts, locks must engage round holes or deep notches in the main frame. On horizontally operating inserts, latches must automatically engage a groove or ridge on the main frame or sash.

2.2.3 Access for Cleaning

Inserts, both operating and non-operating, must be removable for cleaning.[Where fixed sashes are indicated, the inserts must be normally fixed but removable for cleaning.] Where prime windows have only one operating sash, the operating sash of the storm window must be in the same position as the prime window.

2.3 FINISHES

****

NOTE: For most applications, the finish should be clear anodized, Architectural Class II, or baked enamel organic, at the option of the Contractor. Specify other finish or color only if specific conditions justify the additional cost or if required to match finish on prime windows. While an upgraded anodic Class I product or organic finish conforming to AAMA 2604 or 2605 is desired in areas with high humidity and corrosive environments, research shows that availability is limited for products with these upgraded finishes. Project locations with Environmental Severity Classifications (ESC) of C3 thru C5 are corrosive environments. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Designer must confirm availability of product through multiple suppliers prior to selecting the desired finish. Mill finish is not recommended.

****

Exposed aluminum surfaces must be factory finished with anodic coating or organic coating. New storm windows must have the same finish.

2.3.1 Anodic Coating

Exposed surfaces of aluminum extrusions and sheet must be cleaned and given an anodized finish conforming to AA DAF45. Finish must be [clear (natural), designation AA-M10-C22-A31, Architectural Class II, AAMA 611] [integral color anodized, designation AA-M10-C22-A32, Architectural Class II, AAMA 611, or electrolytically deposited color anodized, designation AA-M10-C22-A34, Architectural Class II, AAMA 611. Color must be [as indicated] [_____]].

2.3.2 Organic Coating

Exposed surfaces of aluminum extrusions and sheet must be cleaned, primed, and given a baked enamel finish in accordance with AAMA 2603, with total dry film thickness not less than 0.02 mm 0.8 mil. The finish color must be [white] [as indicated] [_____].

PART 3 EXECUTION

3.1 PREPARATION

****

NOTE: Insert additional subparagraphs on repairing, freeing stuck sash, weatherstripping, recaulking, reputtying, sanding, and painting to suit the project. If other surfaces are to be painted, the reputtying, sanding, and painting should be specified in Section 09 90 00 PAINTS AND COATINGS.

****

Clean, repair, and paint existing prime windows which are to receive storm windows before storm windows are installed.[Examination and repair of weatherstripping and sealant of the prime window is not required.] Clean glass[, wood,] and metal surfaces which will be between the storm and prime windows with appropriate detergents or cleaning agents. Leave free of dirt, streaks, fingerprints, and other soil.

3.2 INSTALLATION

Install square, in true plane, level, plumb, in alignment with adjacent construction, and in accordance with manufacturer's printed instructions to ensure proper fit, sealing, and operation.

3.2.1 Sealants

Make perimeter of storm windows weathertight, except at weep holes. Provide gaskets to separate new metal from existing metal.

3.2.2 Fastening

Holes in the main frame must be oversized to allow for expansion and contraction. Attach units with panhead screws of adequate dimensions for the particular installation.

3.2.3 Drainage

At the storm window sill, between main frame and sill, provide weep holes of ample size to drain rainwater collecting between a closed prime window and an open (summer position) storm window.

3.3 CLEANING

After installation, clean exposed surfaces to remove foreign matter and surface blemishes. Remove units which cannot be cleaned satisfactorily, and units which are damaged, and provide new units.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 52 00 (August 2020)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-08 52 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 08 52 00

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08/20, CHG 1: 02/22

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-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-08 52 00 (August 2020)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-08 52 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 08 52 00

WOOD WINDOWS

08/20, CHG 1: 02/22

****

NOTE: This guide specification covers the requirements for wood windows of the following types: single-hung, double-hung, awning, casement, horizontal sliding, and non-operative (stationary window unit). If designer desires vinyl-clad or aluminum-clad windows, this specification must be edited accordingly.

In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. When security analysis identifies an explosive threat and antiterrorism upgrades for blast resistance are required in accordance with Appendix B-3 of UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings, do not use wood windows as defined in this guide specification.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Do not use wood windows in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for

this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum
AAMA 2603	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 169	(2021) Climate Data for Building Design Standards

ASTM INTERNATIONAL (ASTM)

ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D3656/D3656M	(2013) Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM D6330	(1998; R 2014) Standard Practice for Determination of Volatile Organic Compounds (Excluding Formaldehyde) Emissions from Wood-Based Panels Using Small Environmental Chambers Under Defined Test Conditions
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E1332	(2016) Standard Classification for Rating Outdoor-Indoor Sound Attenuation
ASTM E1886	(2019) Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
ASTM E1996	(2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

SCREEN MANUFACTURERS ASSOCIATION (SMA)

SMA 1004	(1987; R 1998) Aluminum Tubular Frame

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

WDMA I.S.4	(2019) Preservative Treatment for Millwork

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wood Windows; G, [_____]

SD-03 Product Data

Wood Windows; G, [_____]

[Energy Star Label for Residential Windows; S

] Engineered Wood Products

Fasteners

Adhesives; G, [_____]

SD-08 Manufacturer's Instructions

Wood Windows

SD-10 Operation and Maintenance Data

Wood Windows, Data Package 1; G, [_____]

Plastic Identification

1.2.1 Shop Drawing Information

Indicate elevations of units, full-size sections, fastenings, methods of installation and anchorage, method of glazing, locations of operating hardware, mullion details, method and material for weatherstripping, [bar and muntin layouts,]method of attaching[insect screens], details of installation, and connections with other work.

1.2.2 Wood Windows Manufacturer's Instructions

Submit manufacturer's written instructions for installation.

1.2.3 Engineered Wood Products

Submit documentation verifying that no urea-formaldehyde resins were used.

1.2.4 Plastic Identification O & M Data

When not labeled, identify types in Operation and Maintenance Manual per paragraph MATERIAL IDENTIFICATION REQUIREMENTS.

1.3 DELIVERY AND STORAGE

Deliver windows to site in sealed undamaged cartons or in palletized multiple units. Protect from damage, dampness and extreme temperature or humidity changes. Store under cover in well-ventilated enclosed space. Do not store in a building under construction until concrete, masonry, and plaster are dry. Replace defective or damaged windows.

1.4 MATERIAL IDENTIFICATION REQUIREMENTS

1.4.1 Plastic Identification

****

NOTE: The marking system indicated below is intended to provide assistance in identification of products for making subsequent decisions as to handling, recycling, or disposal.

****

Label plastic products provided to indicate their polymeric composition according to the following list. Where products are not labeled, provide product data indicating polymeric information in Operation and Maintenance Manual.

Type 1: Polyethylene Terephthalate (PET, PETE).

Type 2: High Density Polyethylene (HDPE).

Type 3: Vinyl (Polyvinyl Chloride or PVC).

Type 4: Low Density Polyethylene (LDPE).

Type 5: Polypropylene (PP).

Type 6: Polystyrene (PS).

Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

1.5 WINDOW PERFORMANCE

Provide wood windows meeting the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

1.5.1 Thermal Performance

****

NOTE: Window properties are critical to energy performance and comfort. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain.

Energy Star labeling is applicable to residential units only.

For nonresidential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy efficiency and meeting minimum building envelope requirements of UFC 3-101-01 including fenestrations and glazing.

Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting bracketed energy performance

requirements before specifying and edit as needed.
****

Windows (including frames and glass) will be independently tested and certified with a Solar Heat Gain Coefficient (SHGC) determined according to NFRC 200 procedures and a whole window U-factor determined in accordance with NFRC 100 within the ranges as indicated below according to the ASHRAE 169 Climate Zone of the project location.[Windows used solely within the interior of a conditioned envelope are exempted from meeting U-Factor and SHGC requirements, unless otherwise noted.] Provide visual Transmittance (VT) of 0.5 or greater.[Residential glazed systems (including frames and glass) must be Energy Star label for residential windows labeled products for the [Northern] [North-Central] [South-Central] [Southern] climate zone. Provide proof of Energy Star label for residential windows.]

[1.5.1.1 Southern Climate

Windows installed in Climate Zone [1] [2] will have a U-Factor of [1.3] [1.25] [_____] W/m^2·degrees C [0.40] [_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.25] [_____] or less.

][1.5.1.2 South-Central Climate

Windows installed within Climate Zone 3 will have a U-Factor of [0.85] [1.25] [_____] W/m^2·degrees C [0.30][_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.25] [_____] or less.

][1.5.1.3 North-Central Climate

Windows installed within Climate Zone 4 will have a U-Factor of [0.85] [1.25] [_____] W/m^2·degrees C [0.30] [_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.40] [_____] or less.

][1.5.1.4 Northern Climate

Windows installed within Climate Zone [5] [6] [7] will have a U-Factor of [0.65] [1.25][_____] W/m^2·degrees C [0.27] [_____] BTU/h·ft^2·degrees F or less. There is no SHGC limit for this climate zone.

][1.5.1.5 Non-residential Windows

Non-residential glazed systems (including frames and glass) must be certified by the National Fenestration Rating Council with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [_____] determined according to NFRC 200 procedures and a U-factor maximum of [_____] W per square m by K Btu per square foot by ht by degree F in accordance with NFRC 100.

][1.5.2 Sound Attenuation

****
NOTE: Include this paragraph when sound attenuation is a design parameter. Use outside-indoor transmission class (OITC) when exterior source noise is a concern.
****

When tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 or the following below, provide a minimum Sound Transmission Class (STC) of 35 in accordance with ASTM E90 and as determined by ASTM E413 or Outside-Indoor Transmission Class (OITC) of 25 in accordance with ASTM E1332 and as determined by ASTM E413 with the window glazed with 13 mm 1/2 inch air space between two pieces of 6 mm 1/4 inch.

][1.5.3 Windborne-Debris-Impact Performance

****

NOTE: Retain WINDBORNE-DEBRIS-IMPACT RESISTANCE paragraph if required by Project. The UFC 1-200-01 DoD Building Code cited IBC defines windborne debris regions. Enhanced protection applies to essential facilities. Verify site specific requirements with the AHJ. Delete items not required.

****

Exterior window system including glazing must comply with indicated basis or enhanced protection testing requirements in ASTM E1996 for [Wind Zone 1] [Wind Zone 2] [Wind Zone 3] [Wind Zone 4] when tested according to ASTM E1886. Test specimens must be no smaller in width and length than glazing indicated for use on Project and must be installed in same manner as glazing indicated for use on Project.

a. Refer to drawings for classification of window requiring basic or enhanced protection.

[b. Large-Missile Test: For glazing located within 9.1 m 30 feet of grade.

][c. Small-Missile Test: For glazing located more than 9.1 m 30 feet above grade.

]]PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Wood is a renewable resource. Non-sustainable harvesting of wood can produce soil erosion, pollutant runoff, increased levels of atmospheric carbon dioxide, global warming, and habitat loss. Supplies of clear grades and large-dimension timbers are limited. Specify lower grades and engineered wood products for large-dimension timbers when appropriate.

****

2.1.1 Virgin Lumber

****

NOTE: The following paragraph is tailored for inclusion in Navy projects only.

****

****

NOTE: Old growth timber comes from trees over 200 years old. In industry, it is high quality lumber in "upper" or "architectural" grades. Lumber suppliers should know which timber is old growth and

which is not, but sources are not always tracked.
****

Lumber fabricated from old growth timber is not permitted. Avoid companies who buy, sell, or use old growth timber in their operations, when possible.

2.1.2 Engineered Wood Products

****
NOTE: Engineered wood products include plywood, OSB, composite wood panels, fiberboard, particleboard, glue-laminated beams, structural composite lumber, including laminated veneer lumber and parallel strand lumber, as well as I-joists and metal plate connected wood trusses. The use of engineered wood products can result in higher resource efficiencies than conventional lumber/timber construction. Waste is minimized due to uniformity of product. Spans and spacing may be increased for engineered joists over spans for same depth dimensional lumber. However, adhesive binders used in engineered wood products are any of several synthetic resins that pose varying degrees of human health risks. Engineered wood products might be more difficult to recycle than standard, solid sawn lumber due to the binders used in manufacturing.
****

****
NOTE: Based on the type of engineered wood product selected for the project (such as composite wood, glue-laminated wood, or laminated veneer lumber), designer must identify the appropriate maximum VOC level based on the products that are available and their characteristics. VOC levels of some composite wood products are restricted by the requirements of 40 CFR 770; for example, this EPA rule limits VOC emissions for hardwood plywood to 0.05 ppm.
****

Products cannot contain added urea-formaldehyde. Determine Volatile Organic Compounds (VOCs), excluding formaldehyde, emitted from manufactured wood-based panels in accordance with ASTM D6330. Products must not be used if VOC emissions exceed [_____].

2.2 WOOD WINDOWS

****
NOTE: The following Article includes tailoring for Navy projects; on Navy projects, include the sentence stating requirements for "good sash insulation performance" with recycled wood fiber and recycled HDPE requirements.
****

****
NOTE: Where operating hardware is located 1980 mm 6 feet 6 inches or more above floor, specify poles and pole-operated handles to operate windows.

****

****
NOTE: Where storm windows are included in project, include Section 08 51 69.10 ALUMINUM STORM WINDOWS. Show locations where storm units are to be installed. Do not provide storm units for windows in equipment rooms, laundry rooms and similar spaces. Storm windows are not required over double-glazed insulating type windows.

Specify window screens in medical facilities, food preparation areas, dining areas, sleeping areas, and similar locations. Show screen locations on drawings.
****

****
NOTE: Include the last bracketed sentence where the antiterrorism requirements of UFC 4-010-01 apply based on the facility's occupancy classification and occupancy load.
****

Wood windows must consist of complete units including sash, glass, frame, weatherstripping, [insect screen,] and hardware. Window units must meet the Grade 40 requirements of AAMA/WDMA/CSA 101/I.S.2/A440, except maximum air infiltration must not exceed 0.00016 cu m per second 0.34 CFM per linear foot of sash crack when tested under uniform static air pressure difference of 75 pascals 1.57 psf. In addition to general hardware requirements of AAMA/WDMA/CSA 101/I.S.2/A440, provide hardware for various window types as indicated below. Glass and glazing materials must conform to Section 08 81 00 GLAZING. For good sash insulation performance, preference must be given to engineered wood core clad in wood veneer or PVC-wood composite (uninsulated), using post-industrial wood fiber and 100 percent post-consumer HDPE plastic. [Wood members which will receive transparent finish must be in one piece, not finger-jointed.][For windows required to comply with antiterrorism provisions, design in accordance with Standard 10 of UFC 4-010-01.]

2.2.1 Single-Hung and Double-Hung Windows

****
NOTE: For the remaining paragraphs in this Article representing window types, only include the window types used on the project and delete those that do not apply.
****

****
NOTE: Provide double-hung or single-hung windows for living quarters, where storm sash are to be provided or window air-conditioners used. Single-hung have less air leakage and should be considered over double-hung where feasible.
****

Provide with one sash fastener and two sash lifts, except provide one sash lift when window is fitted with a balance that counterbalances weight of sash.

2.2.2 Awning Windows (Top Hinged)

Awning window ventilators in same bay must operate [separately] [in unison]. Provide two or more hinges, pivots, or sash-supporting arms for each operative sash to allow easy operation, substantial support and cleaning of both sides of sash from inside. Provide latches for securing each sash if operating devices do not include locking features. Provide operating devices for controlling position of sash, including full open, tight close, and intermediate firm hold. Provide operating devices with rotary operators of worm-gear type with wear-resistant and impact-resistant gears or lever operators of lever handle, off-set arm type. Provide venting sash with corrosion resistant steel hinges connected to top and bottom rails of sash. When lever operators are used, operating arms must be adjustable so that even sash edge contact can be maintained. Provide compression-type weatherstripping.

2.2.3 Casement Windows

Provide two or more hinges, pivots, or sash-supporting arms for each operative sash to allow easy operation, substantial support and cleaning of both sides of sash from inside. Provide latches for securing each sash if operating devices do not include locking features. Provide operating devices for controlling the position of the operative sash, including full open, tight close, and intermediate firm hold. Operating devices must include rotary gears and adjustable operating arms so that even sash contact can be maintained. Provide compression-type weatherstripping.

2.2.4 Horizontal-Sliding Windows

Provide latches, pulls, and corrosion resistant steel slides necessary to control and secure window. Provide for cleaning of both sides of sash from inside.

2.2.5 Stationary Windows

Provide fixed sash and basic frame in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.

2.3 ACCESSORIES

2.3.1 Adhesives

Provide sealants as specified in Section 07 92 00 JOINT SEALANTS.

2.3.2 Fasteners

Fasteners and anchors exposed to the environment to be corrosion resistant coated steel, aluminum, or stainless steel compatible with the window material and adjoining construction, and of a type and size recommended by the manufacturer to meet the performance requirements.

2.4 FINISHES

****

NOTE: Factory-applied finishes are typically more durable and release fewer solvents to the environment than field-applied finishes.

****

[2.4.1 Paint

Provide windows with factory-primed surfaces which will be exempt from first paint coat application required in Section 09 90 00 PAINTS AND COATINGS.

][2.4.2 Vinyl (PVC) Cladding

****
NOTE: Select the applicable paragraphs(s) from the following:
****

Preservative treat all basic wood frame and sash members in accordance with WDMA I.S.4 and Section 06 10 00 ROUGH CARPENTRY, except do not use pentachlorophenol. Clad all exterior surfaces with rigid polyvinyl sheathing, complying with ASTM D1784, class 14344-C, not less than 0.9 mm 35 mil average thickness.

][2.4.3 Aluminum Cladding

Preservative treat all basic wood frame and sash members in accordance with WDMA I.S.4, except do not use pentachlorophenol. Clad all exterior surfaces with extruded aluminum with joints sealed during assembly. Aluminum clad frames and sash must meet performance requirements of AAMA/WDMA/CSA 101/I.S.2/A440.

2.4.3.1 Aluminum Finish

****
NOTE: The selection of anodic or organic coating is based primarily on the desired appearance: anodized finishes provide a metallic appearance and organic finishes provide a painted or metal-like finish (organic finishes are available in a variety of colors). Only allow both types as a Contractor option when the Designer confirms that the desired appearance is available in both types of finishes.

Based on research, there are a limited number of manufacturers supplying an aluminum cladded product with an anodic finish. If the Designer desires an anodic finish it is prudent to confirm availability by multiple suppliers prior to specifying.
****

Factory finish with [anodic coating] [or] [organic coating].

[2.4.3.2 Anodic Coating

****
NOTE: For anodic coatings, specify Architectural Class I for harsh atmospheres where dust, gases, salts, and other destructive elements will attack metal finish. Also specify Class I for humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid

locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Specify Architectural Class II for all atmospheric conditions not requiring Class I.
****

Conform to AA DAF45 and AAMA 611. Finish must be [clear (natural), designation AA-M10-C22-A31, Architectural Class II 0.010 to 0.0175 mm 0.4 mil to 0.7 mil] [clear (natural), designation AA-M10-C22-A41, Architectural Class I 0.0175 mm 0.7 mil or thicker] [integral color-anodized, designation AA-M10-C22-A32, Architectural Class II 0.010 to 0.0175 mm 0.4 mil to 0.7 mil] [integral color-anodized, designation AA-M10-C22-A42, Architectural Class I 0.0175 mm 0.7 mil or thicker] [electrolytically deposited color-anodized designation AA-M10-C22-A34, Architectural Class II 0.010 to 0.0175 mm 0.4 mil to 0.7 mil] [electrolytically deposited color-anodized, designation AA-M10-C22-A44, Architectural Class I 0.0175 mm 0.7 mil or thicker].[Finish Color: [_____] [as indicated].]

]2.4.3.3 Organic Coating

****
NOTE: For organic coatings, to provide enhanced resistant to corrosion, weathering, ozone, and UV radiation, utilize superior performance powder coat finishes conforming to AAMA 2605 in humid locations and project locations with an ESC of C3 thru C5; baked enamel finishes conforming to AAMA 2603 may be utilized for non-humid locations and ESC C1 or C2 project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Refer to UFC 1-200-01 for determination of ESC for a specific project location.
****

Clean and prime exposed aluminum surfaces. Provide [baked enamel finish in accordance with AAMA 2603 with total dry film thickness not less than 0.020 mm 0.8 mil] [superior performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 0.030 mm 1.2 mils]. Finish color [_____] [as indicated].

][2.5 INSECT SCREENS

ASTM D3656/D3656M, Class 2, 18 by 14 mesh, color [charcoal] [gray] [_____]. Aluminum frames to meet SMA 1004.

]PART 3 EXECUTION

3.1 INSTALLATION

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.1.1 Wood Windows

Install in accordance with the approved installation instructions. Securely anchor windows in place. Install and seal windows in a manner that will prevent entrance of water and wind.

[3.1.2 Insect Screen

Install screen panels in accordance with manufacturer's instructions. Install aluminum framed screens in accordance with SMA 1004.

]3.2 ADJUSTMENTS

Make final adjustment for proper operation of ventilating unit after glazing. Make adjustments to operating sash or ventilators to assure smooth operation. Units must be weathertight when locked closed. Verify products are properly installed, connected, and adjusted.

3.3 CLEANING

Clean windows on both exterior and interior in accordance with manufacturer's recommendations.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 53 00 (August 2020)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-08 53 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 08 - OPENINGS

SECTION 08 53 00

PLASTIC WINDOWS

08/20, CHG 1: 02/22

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-08 53 00 (August 2020)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 08 53 00

PLASTIC WINDOWS

08/20, CHG 1: 02/22

****

NOTE: This guide specification covers the requirements for prime and replacement PVC windows.

In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. When security analysis identifies an explosive threat and antiterrorism upgrades for blast resistance are required in accordance with Appendix B-3 of UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings, do not use plastic windows as defined in this guide specification.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Do not use plastic windows in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Specify the following items of related work under other sections of the specifications:

1. Glass and glazing and the furnishing of glazing clips and gaskets.

2. Caulking and sealants.

3. Structural building supports at window mullions.

4. Wood or metal subframes for windows in frame walls.

5. Drilling and tapping for attachment of window shades, drapery rods, and venetian blinds. The drilling and tapping of window frames to receive brackets for shades, venetian blinds, and curtain rods has been omitted from this specification. It is contemplated that this work will be done after erection of windows by the trade for the item to be installed. On projects where factory drilling for these items is required, revise this specification accordingly.

6. Brackets and supports for window shades, drapery rods, and venetian blinds.

****

****

NOTE: On the drawings, show:

1. Sizes and types of windows; subframes, casings, stools, and hardware.

2. Sizes, location, and swing of ventilators; direction of slide for sliding ventilators; location and details of fixed sash.

3. Typical window sections and details. Show glass thickness and air spaces of insulating glass. Show special glazing, if any.

4. Method of anchoring windows to adjoining construction; size and types of clips, anchors, screws, and other fasteners.

5. Details of nonstructural mullions and mullion covers. Details of transom bars.

6. Types and details of accessories to be furnished, such as, trim, screens, grills, and integral venetian blinds.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 1503	(2009) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 169	(2021) Climate Data for Building Design Standards

ASTM INTERNATIONAL (ASTM)

ASTM D3656/D3656M	(2013) Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum

Antiterrorism Standards for Buildings

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows; G, [_____]

Schedule of Windows; G, [_____]

SD-03 Product Data

Windows; G, [_____]

[Energy Star Label for Residential Windows; S

] Fasteners

Hardware

Screens

Weatherstripping

Accessories

[Adhesives

] SD-04 Samples

Windows; G, [_____]

SD-06 Test Reports

Windows; G, [_____]

SD-10 Operation and Maintenance Data

Windows, Data Package 1; G, [_____]

Plastic Identification

1.2.1 Shop Drawing Information

Indicate elevations of windows, full-size sections, thicknesses of PVC, reinforcing members, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, [mullion details,] [method and materials for weatherstripping,] [method of attaching screens,] [material and method of attaching subframes,] [fins,] [stools,] [casings,] [sills,] [trim,] accessories, installation details, window flashings and other related items.

Submit schedule of windows with drawings indicating location of each window unit.

1.2.2 Window Samples Information

Submit one full-size window of each type, complete with certification label indicating conformance to AAMA/WDMA/CSA 101/I.S.2/A440, glazing, hardware, [fins,] anchors, and other accessories.[Where screens or weatherstripping are required, fit sample windows with such items that are to be provided.] After approval, install each sample in the work, clearly identified, and record its location.

1.2.3 Window Test Report Data

Submit for each window type attesting that identical or larger windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 and the specified minimum Condensation Resistance Factor (CRF).

1.2.4 Plastic Identification O & M Data

****
NOTE: This paragraph is tailored for inclusion in Navy projects only.
****

When not labeled, identify types in Operation and Maintenance Manual per paragraph MATERIAL IDENTIFICATION.

1.3 QUALITY ASSURANCE

1.3.1 Labels

Each window unit must bear a certification label from an independent, nationally recognized testing organization validating that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440 for the type, grade, and performance class specified.

1.3.2 Certification

Certified test reports attesting that the window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440 as specified will be acceptable in lieu of product labeling or marking.

1.4 DELIVERY, STORAGE, AND HANDLING

****
NOTE: Include bracketed sentence for cold climate installations of PVC windows.
****

Deliver windows to the project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the job site. Store windows and components out of contact with the ground, under a weathertight covering, to prevent bending, warping, or otherwise damaging the windows.[Store windows and components so they will not have to be handled at minus 28 degrees C 20 degrees F or colder.] Repair damaged windows to an "as new" condition as approved. Provide new units if windows cannot be repaired.

1.5 PROTECTION

Protect finished surfaces during shipping and handling using the manufacturer's standard method, except do not apply coatings or lacquers on surfaces to receive caulking and glazing compounds.

1.6 MATERIAL IDENTIFICATION

****
NOTE: This Article is tailored for inclusion in Navy projects only.
****

1.6.1 Plastic Identification

****
NOTE: The system indicated below is intended to provide assistance in identification of products for

making subsequent decisions as to handling, recycling, or disposal.
****

Plastic products to be incorporated into the project provide product data indicating polymeric information in Operation and Maintenance Manual.

Type 1: Polyethylene Terephthalate (PET, PETE).

Type 2: High Density Polyethylene (HDPE).

Type 3: Vinyl (Polyvinyl Chloride or PVC).

Type 4: Low Density Polyethylene (LDPE).

Type 5: Polypropylene (PP).

Type 6: Polystyrene (PS).

Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

1.7 WINDOW PERFORMANCE

Provide vinyl windows meeting the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

1.7.1 Thermal Performance

****
NOTE: Window properties are critical to energy performance and comfort. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain.

Energy Star labeling is applicable to residential units only.

For nonresidential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy efficiency and meeting minimum building envelope requirements of UFC 3-101-01 including fenestrations and glazing.

Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting bracketed energy performance requirements before specifying and edit as needed.
****

Windows (including frames and glass) will be independently tested and certified with a Solar Heat Gain Coefficient (SHGC) determined according to NFRC 200 procedures and a whole window U-factor determined in accordance with NFRC 100 within the ranges as indicated below according to the ASHRAE 169 Climate Zone of the project location.[Windows used solely within the interior of a conditioned envelope are exempted from meeting U-Factor and SHGC requirements, unless otherwise noted.] Provide visual

Transmittance (VT) of 0.5 or greater.

[Residential glazed systems (including frames and glass) must be Energy Star label for residential windows labeled products for the [Northern] [North-Central] [South-Central] [Southern] climate zone. Provide proof of Energy Star label for residential windows.

][1.7.1.1 Southern Climate

Windows installed in Climate Zone [1] [2] will have a U-Factor of [1.3] [1.25] [_____] W/m^2·degrees C [0.40][_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.25] [_____] or less.

][1.7.1.2 South-Central Climate

Windows installed within Climate Zone 3 will have a U-Factor of [0.85] [1.25] [_____] W/m^2·degrees C [0.30][_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.25] [_____] or less.

][1.7.1.3 North-Central Climate

Windows installed within Climate Zone 4 will have a U-Factor of [0.85] [1.25] [_____] W/m^2·degrees C [0.30] [_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.40] [_____] or less.

][1.7.1.4 Northern Climate

Windows installed within Climate Zone [5] [6] [7] will have a U-Factor of [0.65] [1.25][_____] W/m^2·degrees C [0.27] [_____]BTU/h·ft^2·degrees F or less. There is no SHGC limit for this climate zone.

][1.7.1.5 Non-residential Windows

Non-residential glazed systems (including frames and glass) must be certified by the National Fenestration Rating Council with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [_____] determined according to NFRC 200 procedures and a U-factor maximum of [_____] W per square m by K Btu per square foot by ht by degree F in accordance with NFRC 100.

]PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR WINDOWS

****

NOTE: Edit to indicate materials and items required. Consult AAMA 1503, "Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections" and select the minimum Condensation Resistance Factory (CRF) required for the particular project conditions.

****

Provide windows conforming to AAMA/WDMA/CSA 101/I.S.2/A440 and to requirements specified herein. Provide windows of materials, types, grades, performance classes, combinations and sizes indicated or specified. Provide each window as a unit consisting of [subframe,] frame, sash, glass, hardware, [mullions,] [fins,] [trim,] [casing,] [screen,] [weatherstripping,] anchors and accessories complete. Design windows to accommodate glass, hardware, [screens,] [weatherstripping,] and accessories to be furnished. Provide factory or field installed glass. Provide windows with a minimum CRF of [_____] when tested in accordance with AAMA 1503.

2.2 MATERIALS

2.2.1 Windows

Provide PVC, reinforcing members, fasteners, hardware, weatherstripping, and anchors conforming to AAMA/WDMA/CSA 101/I.S.2/A440 and as specified herein.

2.2.2 Glass and Glazing

As specified in Section 08 81 00 GLAZING.

2.2.3 Caulking and Sealing

As specified in Section 07 92 00 JOINT SEALANTS.

2.2.4 Adhesives

Provide sealants as specified in Section 07 92 00 JOINT SEALANTS.

2.2.5 Insect Screening

ASTM D3656/D3656M, Class 2, 18 by 14 mesh, color [charcoal] [gray] [_____].

2.2.6 Accessories

As standard with the manufacturer and as specified herein.

2.3 WINDOW TYPES

****

NOTE: Edit for window types to be included in the project and delete window types not used. Consult the AAMA "Window Selection Guide" or the Certified Products Directory for definitions of each type and design consideration. The most commonly used window types have been listed in this specification; windows are available in other types and can be made in various combinations and custom fabrications. Select window types on basis of functional requirements and economic considerations. Functional requirements include operation of window, weather environment, conditions of usage and aesthetic factors. Economic considerations include initial cost as well as maintenance costs over life of the facility.

****

****

NOTE: Consult AAMA/WDMA/CSA 101/I.S.2/A440 to calculate design pressure(s) applicable to the project. Adjust "design factors" because naval facilities are typically less than 100 miles from

hurricane oceanline.
****

****
NOTE: Performance Grades represent design pressure values for which products have been tested. Specify an Optional Performance Grade where a higher than minimum Performance Grade is desired due to severe weather conditions and wind loadings. Optional Performance Grade windows must be tested in compliance with AAMA/WDMA/CSA 101/I.S.2/A440. Testing must substantiate requirements for uniform loading (structural), water resistance, and air infiltration.
****

Provide windows of the following types, as indicated.

2.3.1 Awning Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type A- [R 15] [C 20] [[_____] (Optional Performance Class)]. Provide compression-type weatherstripping.

2.3.2 Casement Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type C- [R 15] [C 20] [HC 40] [[_____] (Optional Performance Class)]. Provide [rotary crank] [handle] operated ventilators. Provide ventilators over 1675 mm 66 inches high with two separate locking devices or a two-point locking device operated by rods from a single lever handle. Conceal rods where possible. Provide compression-type weatherstripping.[Provide casement windows in combination with [fixed] [projected] windows specified below.]

2.3.3 Hung Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type H- [R 15] [(Optional Performance Class)].

2.3.4 Horizontal Sliding Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type HS- [R 15] [(Optional Performance Class)].

2.3.5 Projected Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type P- [R 15] [(Optional Performance Class)]. Provide projected windows with concealed four bar friction hinges only.

2.3.6 Fixed Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type F- [R 15] [(Optional Performance Class)].

2.3.7 Dual Action (Tilt/Turn) Windows

Provide dual action windows with a ventilator which swings into the room from the top for ventilation and swings in from the side for cleaning of the outside surface. When swung from the side, the ventilator must swing in sufficiently to allow safe access to the outside surface.

2.3.7.1 Construction

Provide ventilators with one or more stabilizing arms attached to the frame when ventilator is opened from top. When ventilator is in the tilt-open position, stabilizing arms must provide positive positioning of the ventilator.

2.3.7.2 Hardware

Equip each ventilator with one handle to provide both tilt and swing operation. The tilt or swing operation must be individually selected and rendered operable starting only from the closed sash position. Provide a secondary locking device for each ventilator to prevent accidental swing operation.

2.3.7.3 Performance Requirements

Provide dual action windows to meet the primary performance requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440 for Grade and Performance Class [R 15] [(Optional Performance Class)].

2.4 FABRICATION

Conform to AAMA/WDMA/CSA 101/I.S.2/A440 and to the requirements specified herein.

2.4.1 Subframes, Mullions and Transom Bars

****

NOTE: Edit and include this paragraph when PVC subframes, mullions and transom bars are included, otherwise delete. Specify the design pressure used to specify the Performance Class or the Optional Performance Class for the adjoining windows. Avoid mullion covers in cold climate installations.

****

Provide subframes, transom bars and mullions between multiple window units which meet the design pressure of [72] [96] [192] [_____] kilograms per square meter (kg/sq m) [15] [20] [40] [_____] pounds per square foot (psf). Fabricate mullions and transom bars in such a manner as to permit expansion and contraction between adjoining construction and window units and to form a weathertight joint.[Provide mullion covers on the interior and exterior to completely close exposed joints and recesses between window units and to present a neat appearance.][Provide special covers over structural support at mullions as indicated.]

2.4.2 Combination Windows

Provide factory assembled combination windows of the same grade and performance class. Where factory assembly of individual windows into larger units is limited by transportation considerations, prefabricate, match mark, transport, and field assemble.

2.4.3 Frames and Sash

2.4.3.1 Corners and Reinforcement

****

NOTE: Specify mechanically fixed and sealed or welded corners for most applications. Specify only welded corners for cold climate applications.

****

Provide [mechanically fixed and sealed or welded] [welded] corners on PVC frames and sashes. Reinforce frames and sash as necessary to meet the requirements for the performance classes or grades specified herein.

2.4.3.2 Adjustability

Ventilating sash must be adjustable vertically and horizontally to ensure smooth operation.

2.4.3.3 Drips and Weep Holes

****

NOTE: Include the first two sentences when operable windows are included in the project, otherwise delete.

****

[Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, provide continuous drips across tops of fixed windows.]Provide drips and weep holes as required to return water to the outside.

2.4.3.4 Provisions for Glazing

****

NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

Specify glass thickness in Section 08 81 00 GLAZING. Inside glazing is preferred, especially for windows above first floor and other locations where access is difficult. Windows designed for inside glazing may not be available in double-hung type. Check manufacturer's literature. Where project requires insulating glass, show sash members, glazing beads, and hardware of sufficient size and weight to receive and support glass of specified thickness. Allow sufficient space between each side of insulating glass and frame for glazing compound or glazing gaskets and expansion as well as sufficient space between edges of glass and frame. Drawings must clearly indicate method for securing insulating glass in place. Specify windows which will require glazing beads if they are indicated as such; specify vinyl, EPDM or silicone rubber gaskets in Section 08 81 00 GLAZING. Do not use glazing compound, vinyl glazing gaskets or exterior glazing beads in cold climates; dry glaze with EPDM or

silicone rubber gaskets.

NOTE: Include the last bracketed sentence where the antiterrorism requirements of UFC 4-010-01 apply based on the facility's occupancy classification and occupancy load.

****

Design windows and rabbets suitable for glass thickness shown [or specified]. Design sash for [inside] [outside] [single] [double] [triple] glazing and for securing glass with [glazing beads,] [glazing clips,] [glazing channels,] [glazing gaskets,] [or glazing compound].[For windows required to comply with antiterrorism provisions, design in accordance with Standard 10 of UFC 4-010-01.]

2.4.4 Hardware

The item, type, and functional characteristics must be the manufacturer's standard for the particular window type. Provide hardware of suitable design and of sufficient strength to perform the function for which it is used. Equip operating ventilators with a lock or latching device which can be secured from the inside.

2.4.5 Weatherstripping

Provide for ventilating sections of windows to ensure a weathertight seal meeting the infiltration requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440. Provide easily replaceable factory-applied weatherstripping.

2.4.6 Screens

Provide one insect screen for each operable exterior sash or ventilator. Design screens to be rewirable, easily removable from inside the building, and to permit easy access to operating hardware.

2.4.7 Color

****

NOTE: Standard PVC window color is white and should be specified for most projects. A number of other colors are available, particularly tan (ivory, beige, almond), gray and dark brown (architectural bronze), at additional cost. Colors co-extruded to the exterior of the window are especially designed to prevent heat build-up. Specify premium colors only after verification of availability, cost and aesthetic need.

****

Provide [white] [_____] window PVC color. Color must be integral or co-extruded to the PVC to prevent heat build-up.

2.4.8 Fasteners

Provide fastener types as standard with the window manufacturer for windows, trim, and accessories. Fasteners exposed to the environment to be corrosion resistant coated steel, aluminum, or stainless steel compatible with the window material and adjoining construction, and of a type and size recommended by the manufacturer to meet the performance requirements.

2.4.9 Accessories

****

NOTE: Edit for accessories to be included. Check availability of integral venetian blinds before specifying. Indicate windows to receive grills or integral venetian blinds on the drawings. If venetian blinds are to be separate from the windows, delete the paragraph INTEGRAL VENETIAN BLINDS and specify venetian blinds in Section 12 21 00 WINDOW BLINDS.

****

Provide windows complete with clips, fins, anchors, [grills,] [venetian blinds,] and other appurtenances necessary for complete installation and proper operation.

2.4.9.1 Anchors

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Provide corrosion resistant anchors and fasteners compatible with the window and the adjoining construction. For each jamb 900 mm 36 inches or longer, provide a minimum of three anchors located approximately 150 mm 6 inches from each end and at midpoint. For jambs less than 900 mm 36 inches long, provide two anchors.

2.4.9.2 Grills

Provide the manufacturer's standard grills for the windows indicated. Grills must be removable type or sealed within insulating glass units. Provide manufacturer's standard grill pattern design or as approved, unless otherwise indicated.

[2.4.9.3 Integral Venetian Blinds

Provide the manufacturer's standard venetian blinds mounted within the window frame for the windows indicated. Venetian blinds must be fully adjustable allowing full angle tilting and stops at any position. Provide [white]blinds[to match color of the PVC].

]PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as work progresses or install without forcing into prepared window openings. Set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install and seal windows in a manner that will prevent entrance of water and wind.[Fasten insect screens securely in place.] Fasten hardware to windows.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.1.1 Anchors and Fastenings

Secure units to each other, to masonry, and to other adjoining construction with clips, fins, screws, or other devices recommended by the window manufacturer.

3.2 ADJUSTING

After installation of windows and completion of glazing and field painting, adjust ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts as necessary. Verify products are properly installed, connected, and adjusted.

3.3 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weatherstripping, and to prevent interference with operation of hardware. Replace stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

3.4 PROTECTION

Protect ventilators and operating parts against accumulation of dirt and building materials by keeping ventilators tightly closed and locked to frame.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 56 46.10 20 (August 2011)**
Change 1 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-08 56 46.10 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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RADIO FREQUENCY SHIELDED ENCLOSURES, DEMOUNTABLE TYPE

08/11, CHG 1: 02/22

PART 3 EXECUTION

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USACE / NAVFAC / AFCEC | **UFGS-08 56 46.10 20 (August 2011)**
Change 1 - 02/22

Preparing Activity: NAVFAC | **Superseding**
UFGS-08 56 46.10 20 (April 2006)

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References are in agreement with UMRL dated January 2025

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SECTION 08 56 46.10 20

RADIO FREQUENCY SHIELDED ENCLOSURES, DEMOUNTABLE TYPE

08/11, CHG 1: 02/22

****

NOTE: This guide specification covers the requirements for radio frequency shielded enclosures, demountable Type.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: This guide specification covers the requirements for radio frequency shielded enclosures, demountable Type, in sizes under 50 square meter 500 square feet. For larger enclosures and for High Altitude Electromagnetic Pulse (HEMP) protected enclosures, contact NAVFAC Engineering Innovation and Criteria Office (Code EICO) before beginning design. Do not design HEMP enclosures utilizing demountable shield construction. The electrical designer should refer to MIL-HDBK-419 Volumes I and II for special grounding and bonding requirements for EMI enclosures and to NACSIM 5203 for TEMPEST enclosures. All metallic electrical conduits which penetrate a TEMPEST shield must be isolated within 50 mm 2 inches of the exterior of the shield by a nonmetallic conduit section at least

150 mm 6 inches long to prevent conduction of information from the shielded enclosure. Although not addressed in this specification, it is recognized that fiber optic cable has gained acceptance as an effective method of transmitting data across the boundary of shielded enclosures without filtering. If fiber optic cable is used, describe the penetration of the shield in detail. For a discussion of the advantages and disadvantages of fiber optic systems see NAVFAC DM-12.02. Designer should consult these documents and other appropriate sources before applying this guide specification to large scale EMI enclosures to HEMP and to TEMPEST Projects. The potential requirement for thermal expansion joints inherent to large scale enclosures is not addressed in this guide specification. The extent and location of the work to be accomplished and wiring, equipment, and accessories necessary for a complete installation should be indicated on the project drawings.

****

****

NOTE: The following information shall be shown on the project drawings:

1. Assembly details;

2. Penetration details;

3. Location and method of mounting shielded enclosure within building;

4. Location of mechanical and electrical equipment within shielded enclosure;

5. Interior wall finish;

6. Suspended ceiling; and

7. Raised computer floor.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B194	(2022) Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM F1066	(2023) Standard Specification for Vinyl Composition Floor Tile

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 299	(2006; R 2012) Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF COMMERCE (DOC)

DOC/NIST PS51	(1971) Hardwood and Decorative Plywood
DOC/NIST PS58	(1973) Basic Hardboard (ANSI A135.4)

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-15733	(2010; Rev J, Supp 1 2010; Notice 1 2015; Notice 2 2020) Filters and Capacitors, Radio Frequency Interference, General Specification for
MIL-STD-220	(2009; Rev C; Notice 2 2024) Method of Insertion Loss Measurement
MIL-STD-461	(2015; Rev G) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

1.2 GENERAL REQUIREMENTS

****

NOTE: Insert additional details describing the specific project for which this specification is being used. Projects involving military communications equipment must be designed to incorporate the applicable requirements of MIL-STD-188-124, "Grounding, Bonding and Shielding for Common Long Haul/Tactical Communication Systems." Be aware that standard manufactured shielded doors are not designed for exposure to weather.

****

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, applies to this section, with the additions and modifications specified herein. The enclosure[s] shall be capable of being erected, disassembled, and reerected entirely from its interior without special tools [, except where RF enclosure ceiling is specified as being supported by the structural ceiling above]. Provide enclosure[s] complete with [power line filters,] [telephone/signal line filters,] [RF air vents,] [penetrations for compressed air lines, water lines and [_____],] [coaxial cables,] [lighting fixtures,] [workbenches with convenience outlets,] and door assembly. Provide each item with fittings and hardware necessary for a complete and operable RF shielded enclosure. Where two or more units of the same type, class, and size of equipment are required, these units shall be products of a single manufacturer. Provide means of completely isolating the structure electrically from the building in which it is to be installed.

1.2.1 Mechanical Work

****

NOTE: Modify or delete these paragraphs as required for each project. Additional items such as raised computer floors may be specified in the same manner.

****

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02, "Unified Facilities Guide Specifications (UFGS) Format Standard".

****

Provide complete shielded enclosure[s] including work specified in [_____] [and [_____]].

1.2.2 Electrical Work

****

NOTE: Modify or delete these paragraphs as required for each project. Additional items such as raised computer floors may be specified in the same manner.

****

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

Conform to the requirements of the NFPA 70, National Electrical Code. Provide a complete shielded enclosure[s] including work specified in [_____] [and [_____]].

1.2.3 Acoustical Ceiling System

****

NOTE: Modify or delete these paragraphs as required for each project. Additional items such as raised computer floors may be specified in the same manner.

****

Provide as specified in Section 09 51 00 ACOUSTICAL CEILINGS.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Radio frequency shielded enclosure

Include penetration details.

SD-03 Product Data

Telephone and signal line filters

Shielded air vents

Lighting fixtures

Exhaust fan

Door assemblies

SD-06 Test Reports

****

NOTE: When specifying nonlatching doors, delete door static load and sag tests and cycle test for door latches. Retain cycle test for door hinges.

****

Door static load test

Door sag test

Swinging door closure test

EMI tests for line filters

Submit final report to Resident Officer in Charge of Construction within 30 days following completion.

Attenuation testing

Seam leak detection testing

The results of EMI testing shall be submitted to the Contracting Officer on a daily basis and test results incorporated into a EMI Shielding Test Final Report. Submit final reports within 30 days following completion of tests. List location of the permanent

SELDS test leads.

SD-07 Certificates

Performance test plan

Qualifications of installation supervision personnel

Qualifications of testing agency

Certification of test equipment

Components of shielded enclosure individually and as a system, meet specified attenuation requirements.

SD-10 Operation and Maintenance Data

Shielded enclosure, Data Package 3; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 RELIABILITY

Reliability to maintain high shielding effectiveness for long term usage with minimum maintenance shall be stressed throughout the design, construction, and erection of the specified shielded enclosure. Particular attention shall be paid to the total project so that corrosion and the installation of electrical service, power line filters, ventilation, and connector panels do not derate the required shielding effectiveness. The enclosures will be subject to varying moveable live floor loads and continuous use of the ventilation system and ac power line filters.

1.5 DELIVERY AND STORAGE

Deliver materials to the job site in undamaged condition. Store material to ensure proper alignment, and protect material against dampness and accumulated moisture before and after delivery. Store materials under cover in a well-ventilated enclosure, and do not allow materials to be exposed to extreme changes in temperature and humidity. Do not store materials in the building until concrete and masonry are dry.

1.6 QUALITY ASSURANCE

1.6.1 Certificates

1.6.1.1 Performance Test Plan

Submit a performance test plan for SELDS and IEEE 299 testing of the facility. The test plan shall include tester qualifications, equipment listings (including calibration dates and antenna factors), and proposed test report format. The plan shall also address specific dates and durations that testing will be conducted during the overall construction period so that the expert Government witness may be scheduled to observe the testing and so that repairs may be made to the shield and retests conducted before the building finish materials are installed. Finally, the test plan shall indicate the proposed dates and duration of the lowest and the highest frequency tests following installation of the building finish materials [so that an expert Government witness may be available for these final acceptance tests].

1.6.1.2 Qualifications of Testing Agency

Submit the experience and qualifications of an independent testing agency for review and approval. The testing agency shall have recent experience in Shielded Enclosure Leak Detection System (SELDS) and IEEE 299 shielded enclosure testing and shall list where and when the experience was obtained. Submit with the performance test plan.

1.6.1.3 Certification of Test Equipment

Certify that test equipment for the attenuation testing has been calibrated within last 12 months.

1.7 MAINTENANCE

1.7.1 Contents

In addition, the manual shall contain the following information:

a. A complete set of assembly and disassembly drawings;

b. A schedule of recommended maintenance and adjustment procedures to ensure continuous shielding effectiveness;

c. Allowable loads on top of room and on shelves mounted on walls, including permissible weights of equipment that can be mounted on walls; and

d. Prescribed method of handling panels, cleaning of seams and contact fingers, bonding jumpers, installing metallic items penetrating the shielding material without decreasing the attenuation characteristics.

PART 2 PRODUCTS

2.1 SHIELDED ENCLOSURE CHARACTERISTICS

2.1.1 Radio Frequency Interference Attenuation

The attenuation and shielding effectiveness requirements apply to the finished shielded enclosure[s] and enclosure's components when all power line filters are installed and carrying current, ventilation systems are operating, [the coaxial connector panels capped,] and shielded door[s] are in normal operation position. The specified shielded effectiveness shall be achieved without using conductive tapes, gaskets, or cement materials. Provide enclosure[s] having the following minimum magnetic, electric, and plane wave attenuation:

Magnetic - [60] [_____] dB at 14kHz increasing linearly to [100] [_____] dB at 200 kHz

Electric - [100] [_____] dB from 1.0 kHz to 50 MHz

Plane Wave - [100] [_____] dB between 50 MHz and 10 GHz

2.1.2 Sound Transmission Class (STC)

****

NOTE: STC 30 provides only minimum sound transmission loss. For greater sound control, more detailed acoustical design requirements must be incorporated into the specification.
****

Provide enclosure[s] having an STC of [30] [_____] dB minimum when tested according to ASTM E90 [not including sound transmission loss of surrounding building construction].

2.2 PANELS CONSTRUCTION

Flat steel sheet laminated to each side of a 20 mm 3/4 inch structural core of either plywood or hardboard. [Panels shall have a flame spread rating of less than 25 when tested according to ASTM E84.]

2.2.1 Flat Steel Sheet

ASTM A653/A653M with Z180 G-60 coating, minimum 24 gage, phosphatized.

2.2.2 Plywood

DOC/NIST PS51 for exterior, sound grade hardwood, Type I.

2.2.3 Hardboard

DOC/NIST PS58 for standard type hardboard.

2.2.4 Adhesive for Laminating Steel Sheets to Structural Core

Waterproof type which maintains a permanent bond for the lifetime of the enclosure.

2.2.5 Floor Finish

****
NOTE: Indicate or specify whether other flooring is to be provided or higher floor loads are required. This is most critical when raised floors are required. Allowances must be made for elevated door thresholds. Vinyl composition 1 is asbestos-free and should be specified for all projects.
****

Vinyl-composition tile, ASTM F1066, Type IV, composition 1, 300 by 300 mm, 3 mm 12 by 12 inches, 1/8 inch, thick.

2.3 FRAMING-JOINING SYSTEM

The panels shall be joined and supported by specially designed members that clamp the edges of the panels and provide continuous, uniform, and constant pressure contact against the shielding elements of the panels. The walls shall be self-supporting from floor to ceiling with no bracing. Deflection of walls under a static load of 35 kg 75 pounds applied normal to the wall surface at any point along the framing members shall not exceed 1/250 of the span between supports. [Ceilings shall be self-supporting from wall to wall.] [Ceilings shall be supported by adjustable, nonconducting, isolated hangers from the structural ceiling above.] Ceilings shall be designed to have a deflection under total weight, including ceiling finish, of not more than 1/270 of the span. At corner intersections of walls, floor, or ceiling, provide a one-piece factory prewelded corner section or trihedral corner framed with brass machined cast corner cap assemblies consisting of inner and outer parts. The modular enclosure shall be designed for ease of erection, disassembly, and re-assembly.

2.3.1 Channels

The framing-joining system members shall consist of 3 mm 1/8 inch zinc-plated steel channels having minimum 16 mm 5/8 inch overlap along each side of the contacting surface. Screw fasteners shall be spaced at 75 or 100 mm 3 or 4 inch intervals.

2.3.2 Screw Fasteners

Screw fasteners shall be either zinc-plated or cadmium-plated steel, minimum size 6 mm 1/4 inch - 20 with pan or flat Phillips heads. Fasteners shall be heat treated and hardened with minimum tensile strength of 930 MPa 135,000 psi.

2.4 DOOR ASSEMBLIES

****

NOTE: Do not accept doors that deviate from this specification without consulting NAVFAC 15C. Probable deviations include: magnetic and electromagnetic doors, other non-finger stock type doors, adhesive mounted finger stock, and requests to approve doors tested to less than 10,000 open close cycles, among others.

****

The enclosure door shall be nonsagging and nonwarping and shall afford shielded effectiveness equal to the rest of the enclosure when the door is closed. The shielded door shall be provided with [multiple rows] [at least one row] of RF finger stock around the door or its frame. The fingers that form a contact between the door and its frame shall be protected from damage due to physical contact and shall be concealed within the door and frame assemblies. The door shall have a clear opening of [900 mm] [36 inches] [_____] wide and [2100 mm] [84 inch] [_____] high. Door assembly shall be the same manufacture as the enclosure. Doors shall be reinforced steel or laminated type. Laminated type shall be the same construction as enclosure panels, except the steel faces shall be electrically and mechanically joined by channels or overlapping seams, both of which shall be continuously seam welded along all joined surfaces.

2.4.1 Finger Stock

Contacts for doors shall be copper beryllium conforming to ASTM B194, Condition HT. The finger stock shall be secured to the door or frame without using special tools or soldering or adhesives and shall have a minimum overlap of 50 mm 2 inches.

2.4.2 [Latching Type

****

NOTE: Select the applicable paragraph(s) from the following:

****

****
NOTE: Specially designed door for electrical or pneumatic operation may be specified; however, these special doors are not compatible with all demountable enclosures.
****

The door shall be lever controlled with roller cam action requiring not more than 90 N 20 pounds of operating force on the handle for both opening and closing. The door shall be equipped with a two or three-point latching mechanism that provides proper compressive force for the RF seal. The mechanism shall be operable from both sides of the door and shall have permanently-lubricated ball bearings at points of pivot and rotation. The door latches and hinges shall be rated for a minimum of 10,000 cycles without loss of attenuation and without adjustments.]

[Nonlatching Type

****
NOTE: Nonlatching doors may be used for enclosures having many daily open-close operations; however, they may not retain as high an attenuation over the long term compared with doors having three-point latching mechanisms.
****

The door shall be equipped with three heavy-duty ball bearing hinges and a door pull. Door shall open and close with a force not to exceed 20 N 5 pounds.]

2.5 LINE FILTERS

2.5.1 Power Line Filters

Shall have current and voltage ratings as [indicated] [specified].

2.5.2 Telephone and Signal Line Filters

MIL-PRF-15733. Filters shall have an insertion loss of 100 decibels in the frequency range of 14 kHz to 10 GHz measured according to MIL-STD-220, full load condition. Filters shall have a pass band of [_____] kHz to [_____] kHz with a characteristic impedance of [_____] ohms.

2.6 WAVEGUIDE-TYPE AIR VENTS

Honeycomb-type air vents shall have cores fabricated of brass or steel, and each guide shall be electrically and mechanically bonded to all adjacent guides. Air vents shall be a permanent part of the shielded enclosure and shall have a shielding effectiveness equal to that of the total enclosure. Static pressure drop through the vents shall not exceed 5 Pa 0.02 inch water gage at an air velocity of 3 m/s 600 feet per minute.

2.7 GROUNDING STUD

Enclosure shall have a permanently installed, solid brass or bronze grounding stud complete with hardware and jamb nuts located in the entrance plate [unless otherwise specified or indicated]. The stud shall be 13 mm 1/2 inch diameter double-threaded bolt which allows a full 50 mm 2 inch running thread inside and outside of the shielded enclosure.

2.8 SERVICE ENTRANCE PLATES (SET-UP PANELS)

Shall be minimum 3 mm 1/8 inch thick steel, sized [300 by 300 mm] [12 by 12 inches] [_____] and shall have a 6 mm 1/4 inch extruded brass frame for mounting to shielded enclosure wall panel.

2.9 NAMEPLATES

Major components of equipment shall have manufacturer's name, address, catalog number, model, style, and type on a plate securely and conspicuously attached to each item of equipment. Nameplates for electrical apparatus shall conform to NEMA Standards.

2.10 LIGHTING

****

NOTE: In shielded enclosures where electronic equipment is very sensitive to EMI, specify a dual lighting system so that fluorescent lighting can be turned off and incandescent lighting left on during sensitive tests or operations.

****

Provide lighting fixtures as indicated [and as specified in Section 26 51 00 INTERIOR LIGHTING]. Fluorescent lighting fixtures shall meet the requirements of MIL-STD-461, Class C3, Group I for both conducted and radiated interference.

2.11 EXHAUST FAN

****

NOTE: This paragraph cites only minimum requirements. Design calculations are necessary to size HVAC to suit room size and equipment/personnel contained within. Exhaust fan motors located inside shielded enclosure must meet MIL-STD-461, Class C3, Group I.

****

Propeller fans shall be [direct drive] [belt drive] for [wall or window] [roof or ceiling] mounting, except that fans shall be centrifugal type with aluminum housing and wheel. Additionally exhaust fans shall be electromagnetically compatible. Motors shall be completely shielded from the air stream. Provide exhaust opening and gravity closing type automatic louvers. Provide exhaust which can supply 15 room air changes per hour. Capacity of fans shall be certified in accordance with AMCA 210, and shall be not greater than 110 percent of the indicated capacity at indicated pressure drop.

2.12 COAXIAL CABLE PENETRATIONS

For each coaxial cable entering the shielded enclosure, provide RF waveguide threaded insert with cap and chain on shielded room side of enclosure.

2.13 SOURCE QUALITY CONTROL

****

NOTE: When specifying nonlatching doors, delete door static load and sag tests and cycle test for door latches. Retain cycle test for door hinges.

****

2.13.1 Door Static Load Test

The door shall be mounted and latched to its frame, then set down in a horizontal position such that the door will open downward and only the frame is rigidly and continuously supported from the bottom. A load of 2kPa 40 psf shall be applied uniformly over the entire surface of the door for at least 10 minutes. The door will not be considered acceptable if this load causes breakage, failure, or permanent deformation which varies the clearance between door leaf and stops to vary more than 2 mm 1/16 inch from the original dimension.

2.13.2 Door Sag Test

The door and its frame shall be installed normally and opened 90 degrees. Two 23 kg 50 pound weights, one on each side of the door, shall be suspended from the door within 125 mm 5 inches of the outer edge for at least 10 minutes. The door will not be considered acceptable if this test causes breakage, failure, or permanent deformation which varies the clearance between the door leaf and floor frame more than 2 mm 1/16 inch from its original dimension.

2.13.3 Swinging Door Closure Test

Door shall be operated 5000 complete open-close cycles. The door will not be acceptable if the closure test causes any breakage, failure, or permanent deformation that causes the clearance between door and frame to vary more than 2 mm 1/16 inch from the original dimension.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Installation Supervision

Furnish the services of a qualified installation engineer or technician regularly employed by the shielding manufacturer/fabricator for a minimum of three 8 hours working days to instruct Contractor personnel in the installation of the RFI shield. A qualified installation technician is acceptable in lieu of a qualified installation engineer. After the shielded enclosure has been completely installed including RF filters, vents, and exhaust fans, furnish the services of the engineer or technician described herein to inspect the installation for compliance with the specifications. The inspection shall be made before any finishes or the concrete topping coat are installed.

3.1.2 Panel Installation

Lay panels in a straight line with true, level, and even surfaces and with the joints in alignment; install them in accordance with the shielding manufacturer's recommendations. Exercise care while handling and installing metal shielding panels to ensure that panels are not damaged.

Clean exposed surfaces of all dirt, finger marks, and foreign matter resulting from manufacturing processes, handling, or installation. Inside the enclosure, mount items including boxes, conduits, fixtures, and switches directly to the RF panels with 16 mm 5/8 inch long, zinc-plated, self-tapping screws. Keep electrical conduits as close to RF shielding as possible. Do not use framing-joining system bolts to mount material and equipment. If material and equipment penetrate shielded enclosure, seam weld or solder materials and equipment to both shielding surfaces.

3.1.3 Surface Preparation

Clean and buff surfaces to ensure good electrical contact with shielding surface. Remove paint or other coverings on mating surfaces of special boxes such as for fire alarm systems, buzzers, and signal lights, including areas between box and cover, box and wall, and box and conduit. Remove insulating material to maintain a low-resistance ground system and to ensure firm mating of metal surfaces.

3.1.4 Floor Panel Setting

Place a polyethylene film of 6-mil thickness over the structural floor of the parent room before any other work is set thereon. Provide a 3 mm 1/8 inch thick layer of hardboard over this film with joints loosely butted. Over this layer provide an additional layer of similar filler material of equal thickness as the projection of the framing-joining member from the bottom surface of the floor panel leaving no more than 6 mm 1/4 inch space between the hardboard and the framing-joining member.

3.2 FRAMING-JOINING SYSTEM

Tighten screws with a calibrated adjustable torque wrench so that equal torque can be set on each screw. (Proper torque values will be approximately 9 Nm 80 inch pounds, but may vary somewhat depending on the manufacturer).

3.3 DOOR ASSEMBLIES

Mount so that the clearance between the door edges and frame shall not vary more than 2 mm 1/16 inch and the innerface of the door periphery does not vary more than 2 mm 1/16 inch from the plane of the face of the stop. Through-bolt hinges to the door and the frame.

3.4 LINE FILTERS

Provide filters for incoming electrical power lines [, including neutrals,] and for incoming telephone and signal lines. Support filters independently of the shielding.

3.5 WAVEGUIDE-TYPE AIR VENTS

[Provide each inlet and return air duct with the number and size of waveguide-type air vents at each location where the ducts enter the shielded enclosure.] [As a minimum, provide each enclosure with one 300 mm 12 inch square and one 300 mm 12 inch square return waveguide-type air vent.]

3.6 EXHAUST FAN

Mount on [wall] [or] [ceiling] over the exhaust vent on the exterior surface of shielded enclosure. Provide power from electrical source exterior to the shielded enclosure.

3.7 CONDUCTOR INSTALLATION

Provide filtered conductors in conduit, except for coaxial cables, from filter to shielding and penetrate the enclosure through threaded rigid steel conduits. [Twist conductors leading from the filters and conductors inside the shielded enclosure approximately 10 turns per foot in the conduit.]

3.8 GROUNDING

****

NOTE: If not specified in Division 26, "Electrical," the following sentence shall be added: "Wires inside the enclosure and for a distance of at least 15 meters 50 feet outside of the enclosure shall be enclosed in a grounded, threaded rigid steel conduit system."

****

Extend the grounding stud through and [bolt] [weld] it to the electrical power panel with a minimum No. 4 AWG insulated stranded copper conductor to effectively serve as a single grounding point for the completely assembled shielded enclosure, both internally and externally.

3.9 SERVICE ENTRANCE PLATE

Install RF connectors for coaxial cable and other RF shielded cable on entrance plate. Soft solder connectors to the plate. If location of plate is not indicated, mount plate in wall panel adjacent to power line filters.

3.10 FIELD TESTS

3.10.1 Seam Leak Detection Testing

****

NOTE: SELDS testing the seams in the floor shielding is usually very difficult because you cannot "sniff" on both sides (assuming the shield is on the ground level). To circumvent this problem SELDS loops may be positioned beneath the floor shield for SELDS testing.

****

Continuously test seams during fabrication using the SELDS, commonly known as a "sniffer." Upon completion of the basic shielded enclosure, before applying any metal primer or installing any accessories, test the entire shielded enclosure with the SELDS. Install terminal points on the shielding exterior and permanently attach test leads on two sets of diagonally opposing corners during construction for use with the SELDS. Continuously probe seams with the test receiver set to detect abrupt change of shielding level greater than 10 dB on the "shielding unit" scale. Clearly mark points having change greater than 10 dB and repair the seam to meet the specified requirement. Retest each repaired point until there are no points on seams which fail test.

3.10.2 Attenuation Testing

[Furnish the services of an independent testing laboratory, approved by the Contracting Officer, to test the shielded enclosure. Certify that laboratory is equipped and staffed to perform field tests of RF shielded enclosures and performs the tests as a normal service.] [Final acceptance testing will be by the Government.] Conduct the final shielding acceptance test after penetrations have been completed, specifically including electrical and other utility penetrations. In addition, the Contractor may schedule a complete or abbreviated test to verify that the shielding assembly is adequate prior to conducting final shielding acceptance test.

3.10.2.1 Test Method

****

NOTE: Expert Government witness should be present for all final acceptance testing. Note that IEEE 299 requires one magnetic field test (150 kHz), three electric field tests (200 kHz, 1 MHz, 18 MHz), and one plane wave test (400 MHz). Also, note that IEEE 299 and NSA 65-6 differ on positioning of source and receiver. IEEE 299 requires source outside and receiver inside the shield, while NSA 65-6 requires source inside and receiver outside (to simulate TEMPEST conditions). For TEMPEST shielding effectiveness testing, continuous sweeping of seams at one or more plane wave frequencies should also be specified, in addition to testing around all door panels, filters, air duct penetrations and all other penetrations of the shielding at all test frequencies. If enclosure is designed specifically for attenuating microwave frequencies, specify additional test frequencies above 1 GHz. Such testing is expensive and should only be used when a firm requirement exists (e.g., NSA-65-6).

****

The test procedure, frequencies, and equipment shall be as specified in IEEE 299 [plus the additional frequencies specified in the contract]. Perform the test as soon as possible after completion of the shielded enclosure, including installation of services, power/telephone/signal lines, RF filters, and waveguide vents. Conduct tests with doors closed and the filters under normal load conditions.

3.10.2.2 Additional Test Points

****

NOTE: Use this paragraph if design includes strict tolerances, high attenuation requirements, and many penetrations.

****

Measure additional test points beyond those specified in IEEE 299. Test points include the periphery of doors and covers, handles, latches, power filter penetrations, air vent filters, telephone and control line filter penetrations, and points of penetration by pipes, tubes, and bolts.

3.10.3 Final In Service Testing

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that equipment and devices are in operating condition and performing the intended function. Give the Contracting Officer five working days advance notice of the dates and times for checks and tests.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 56 46.20 20 (August 2011)**
Change 2 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-08 56 46.20 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC	**UFGS-08 56 46.20 20 (August 2011)** **Change 2 - 02/22**

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****

SECTION 08 56 46.20 20

RADIO FREQUENCY SHIELDED ENCLOSURES, WELDED TYPE

08/11, CHG 2: 02/22

****

NOTE: This guide specification covers the requirements for radio frequency shielded enclosures, welded type in sizes under 50 square meters 500 square feet.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: For larger enclosures and for High Altitude Electromagnetic Pulse (HEMP) protected enclosures, contact NAVFAC Engineering Innovation and Criteria Office (Code EICO) before beginning design. The electrical designer should refer to MIL-HDBK-419 Volumes I and II for special grounding and bonding requirements for EMC enclosures and to NACSIM 5203 for TEMPEST enclosures. All metallic electrical conduits which penetrate a TEMPEST shield must be isolated within 50 mm 2 inches of the exterior of the shield by a nonmetallic conduit section at least 150 mm six inches long to prevent conduction of information from the shielded enclosure. Although not addressed in this specification, it is recognized that fiber optic cable has gained

acceptance as an effective method of transmitting data across the boundary of shielded enclosures without filtering. If fiber optic cable is used, describe the penetration of the shield in detail. For a discussion of the advantages and disadvantages of fiber optic systems see NAVFAC DM-12.02. Designer should consult these documents and other appropriate sources before applying this guide specification to large scale EMI enclosures to HEMP and to TEMPEST Projects. The potential requirement for thermal expansion joints inherent to large scale enclosures is not addressed in this guide specification. The extent and location of the work to be accomplished and wiring, equipment, and accessories necessary for a complete installation should be indicated on the project drawings.

****

****

NOTE: The following information shall be shown on the project drawings:

1. Assembly details;

2. Penetration details;

3. Location and method of mounting shielded enclosure within building;

4. Location of mechanical and electrical equipment within shielded enclosure;

5. Interior wall finish;

6. Suspended ceiling; and

7. Raised computer floor.

****

PART 1   GENERAL

1.1   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B194	(2022) Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM F1066	(2023) Standard Specification for Vinyl Composition Floor Tile

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 299	(2006; R 2012) Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-15733	(2010; Rev J, Supp 1 2010; Notice 1 2015; Notice 2 2020) Filters and Capacitors, Radio Frequency Interference, General Specification for
MIL-STD-220	(2009; Rev C; Notice 2 2024) Method of Insertion Loss Measurement
MIL-STD-461	(2015; Rev G) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

1.2 GENERAL REQUIREMENTS

****

NOTE: Insert additional details describing the specific project for which this specification is being used. Projects involving military communications equipment must be designed to incorporate the applicable requirements of MIL-STD-188-124, "Grounding, Bonding, and Shielding for Common Long Haul/Tactical Communication Systems." A/An 2400 by 2400 by 2400 mm 8 by 8 by 8 feet test module has proven beneficial on complex, extra large, or extra critical construction projects. The module simulates the Contractor's welding techniques, penetration techniques, and testing techniques prior to trying them out in the actual building shield. The test module fabrication and testing plan should also detail the SELDS and NSA 65-6/IEEE 299 test to be performed including test dates so that an expert government witness may be present for the tests. The results of all module testing must be included in a final test module reports. Be aware that standard manufactured shielded doors are not designed for exposure to weather.

****

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section, with the additions and modifications specified herein.[Design and fabricate the enclosure[s] as free-standing structures.][The enclosure[s] must be [mounted on rollers] [fitted with forklift channels in the base] [fitted with lifting eyes on the roof].] Provide enclosure complete with [power line filters,] [telephone/signal line filters,] [RF air vents,] [penetrations for compressed air lines, water lines, and [_____],] [[_____],] [coaxial-cables] [lighting fixtures,] [workbenches with convenience outlets,] and door assembly. Provide each item with fittings and hardware necessary for a complete and operable RF shielded enclosure. Where two or more units of the same type, class, and size of equipment are required, units shall be products of a single manufacturer. Completely isolate the enclosure electrically from the building in which the enclosure is to be installed.

1.2.1 Mechanical Work

****

NOTE: Modify or delete these paragraphs as required for each project. Additional items such as raised computer floors may be specified in the same manner.

****

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02, "Unified Facilities Guide Specifications (UFGS) Format Standard".

****

Provide complete shielded enclosure[s] including work specified in [_____][and [_____]].

1.2.2 Electrical Work

****

NOTE: Modify or delete these paragraphs as required for each project. Additional items such as raised computer floors may be specified in the same manner.

****

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

Conform to the requirements of the NFPA 70, National Electrical Code. Provide complete shielded enclosure[s] including work specified in [_____][and [_____]].

1.2.3 Acoustical Ceiling System

****

NOTE: Modify or delete these paragraphs as required for each project. Additional items such as raised computer floors may be specified in the same manner.

****

Provide as specified in Section 09 51 00 ACOUSTICAL CEILINGS.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Radio frequency shielded enclosure

Include penetration details. The shop drawings for the shielded enclosures shall be prepared by a shielding manufacturer/ fabricator experienced in the installation of metal welded [Electromagnetic Pulse (EMP) and] EMI shielded enclosures and who has supervised the installation of two such enclosures which have operated satisfactorily. Prior to commencing work, and as a condition of continuing work, forward to the Contacting Officer information demonstrating such experience. [Drawings shall be approved by and bear the seal of a registered, professional structural engineer.]

SD-03 Product Data

Telephone and signal line filters

Shielded air vents

Lighting fixtures

Exhaust fans

Door assemblies

SD-06 Test Reports

****
NOTE: When specifying nonlatching doors, delete door static load and sag tests and cycle test for door latches. Retain cycle test for door hinges.

****

Door static load test

Door sag test

Swinging door closure test

EMI factory tests for line filters

Attenuation testing

SELDS seam tests

For SELDS seam testing, include location of the permanent test leads.

SD-07 Certificates

Performance test plan

Qualifications of shielding enclosure testing agency

Qualifications of installation supervision personnel

Components of shielded enclosure individually and as a system, meet specified attenuation requirements.

SD-08 Manufacturer's Instructions

Radio frequency shielded enclosure

SD-10 Operation and Maintenance Data

Radio frequency shielded enclosure, Data Package 2; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Indicate allowable loads on top of room and on shelves mounted on walls, including permissible weights of equipment that can be mounted on walls. Include prescribed method of welding panels, cleaning of seams and contact fingers, bonding jumpers, installing metallic items penetrating the shielding material without decreasing the attenuation characteristics.

SD-11 Closeout Submittals

Radio frequency shielded enclosure record drawings

Submit a complete set of assembly drawings.

1.4 RELIABILITY

Reliability to maintain high shielding effectiveness for long term usage with minimum maintenance shall be stressed throughout the design, construction, and erection of the specified shielded enclosure. Particular attention shall be paid to the total project so that corrosion and the installation of electrical service, power line filters, ventilation and connector panels do not derate the required shielding effectiveness. The enclosures will be subject to varying moveable live floor loads and continuous use of the ventilation system and ac power line filters.

1.5 DELIVERY AND STORAGE

Deliver materials to the job site in undamaged condition. Store material to ensure proper alignment, and protect material against dampness and accumulated moisture before and after delivery. Store materials under cover in a well-ventilated enclosure, and do not allow materials to be exposed to extreme changes in temperature and humidity. Do not store materials in the building until concrete and masonry are dry.

1.6 QUALITY ASSURANCE

1.6.1 Certifications

1.6.1.1 Performance Test Plan

Submit a performance test plan for SELDS and IEEE 299 testing of the facility. The test plan shall include tester qualifications, equipment listings (including calibration dates and antenna factors), and proposed test report format. The plan shall also address specific dates and durations that testing will be conducted during the overall construction period so that the expert Government witness may be scheduled to observe the testing and so that repairs may be made to the shield and retests conducted before the building finish materials are installed. Finally the test plan shall indicate the proposed dates and duration of the lowest and highest frequency tests following installation of the building finish materials [so that an expert Government witness may be available for these final acceptance tests]. The results of EMI testing shall be submitted to the Contracting Officer on a daily basis and test results incorporated into an EMI Shielding Test Final Report.

1.6.1.2 Qualifications of the Shielding Enclosure Testing Agency

Submit the experience and qualifications of an independent testing agency for review and approval. The testing agency shall have recent experience in Shielded Enclosure Leak Detection System (SELDS) and IEEE 299shielded enclosure testing and shall list where and when the experience was obtained. Certify that laboratory is equipped and staffed to perform field tests of RF shielded enclosures and performs the tests as a normal service. Certify that test equipment has been calibrated within the last 12 months.

1.6.1.3 Door Static Load Test

The door shall be mounted and latched to its frame, then set down in a horizontal position such that the door will open downward and only the frame is rigidly and continuously supported from the bottom. A load of 2 kPa 40 psf shall be applied uniformly over the entire surface of the door for at least 10 minutes. The door will not be considered acceptable if this load causes breakage, failure, or permanent deformation which varies the clearance between door leaf and stops to vary more than 2 mm 1/16 inch from the original dimension.

1.6.1.4 Door Sag Test

The door and its frame shall be installed normally and opened 90 degrees. Two 23 kg 50 pound weights, one on each side of the door, shall be suspended from the door within 125 mm 5 inches of the outer edge for at least 10 minutes. The door will not be considered acceptable if this test causes breakage, failure, or permanent deformation which varies the clearance between the door leaf and floor frame more than 2 mm 1/16 inch from its original dimension.

1.6.1.5 Swinging Door Closure Test

Door shall be operated 5000 complete open-close cycles. The door will not be acceptable if closure test causes any breakage, failure, or permanent deformation that causes the clearance between door and door frame to vary more than 2 mm 1/16 inch from the original dimension.

PART 2 PRODUCTS

2.1 SHIELDED ENCLOSURE CHARACTERISTICS

2.1.1 Radio Frequency Interference Attenuation

The attenuation and shielding effectiveness requirements apply to the finished shielded enclosure[s] and enclosure's components when all power line filters are installed and carrying current, ventilation systems are operating, [the coaxial connector panels capped,] and shielded door[s] are in normal operating position. The specified shielding effectiveness shall be achieved without using conductive tapes, gaskets, or cement materials. Provide enclosure[s] having the following minimum magnetic, electric, and plane wave attenuation:

Magnetic - [60] [_____] dB at 14 KHz increasing linearly to [100] [_____] dB at 200 KHz

Electric - [100] [_____] dB from one KHz to 50 MHz

Plane Wave - [100] [_____] dB between 50 MHz and 10 GHz

2.1.2 Sound Transmission Class (STC)

****

NOTE: STC 30 provides only minimum sound transmission loss. For greater sound control, more detailed acoustical design requirements must be incorporated into the specification.

****

Provide enclosure[s] having an STC of [30] [_____] dB minimum when tested according to ASTM E90 [not including sound transmission loss of surrounding building construction].

2.2 STEEL AND WELDING MATERIALS

AISC 325.

2.2.1 Shielding Steel

****

NOTE: Be aware that shielding steel thickness should not be based solely on the minimum thickness required for RFI/EMI attenuation. Thicker steel may be necessary because of structural factors and heat deformation or burn-through from seam welding.

****

ASTM A1008/A1008M or ASTM A568/A568M, minimum [_____] [_____] gage.

2.2.2 Welding Electrodes

AWS D1.1/D1.1M for Metal Electrode, Inert Gas (MIG) welding method.

2.2.3 Floor

****

NOTE: Indicate or specify whether other flooring is to be provided or higher floor loads are required. This is most critical when raised floors are specified. Allowances must be made for elevated door thresholds. Specify special requirements for laboratory loads or seismic loading in this paragraph. If concrete floors are specified, they should be thick enough to hold anchor bolts for equipment, supports, and interior partitions. Vinyl tile composition 1 is asbestos-free and should be specified for all projects.

****

Provide welded steel floor that is flat and free from warping and buckling to support the intended floor finish without damage under design traffic and loads. The floor shall be capable of [1950 kg/sq m] [400 psf][_____] minimum loading [and shall not buckle or distort when lifted by a forklift].

2.2.3.1 Floor Finish

Vinyl composition tile, ASTM F1066, Type IV composition 1, 300 by 300 mm, 3 mm 12 by 12 inches, 1/8 inch thick.

2.2.3.2 [Subfloor

19 mm 3/4 inch exterior grade Douglas Fir plywood.

]2.2.3.3 [Heavy Duty Floor

Heavy Duty Floor shall be a minimum of [100 mm] [4 inches] [_____] of steel reinforced concrete rated at 20 MPa 3000 psi, compressive strength applied directly on top of the steel floor of the enclosure.

]2.3 DOOR ASSEMBLIES

****

NOTE: Do not accept doors that deviate from this specification without consulting NAVFAC 15C. Probable deviations include: magnetic and electromagnetic doors, other non-finger stock type doors, adhesive mounted finger stock, and requests to approve doors tested to less than 10,000 open close cycles, among others.

****

The enclosure door[s] shall be nonsagging and nonwarping and shall afford shielded effectiveness equal to the rest of the enclosure when the door is closed. Provide [multiple rows] [at least one row] of RF finger stock around the shielded door or door frame. The fingers that form a contact between the door and door frame shall be protected from damage due to physical contact and shall be concealed within the door and frame assemblies. The door shall have a clear opening of [900 mm] [36 inches] [_____] wide and [2100 mm] [84 inches] [_____] high. Door assemblies shall be factory made. Doors shall be reinforced steel or laminated type. Laminated type shall have the steel faces electrically and mechanically joined by channels or overlapping seams, both of which shall be continuously seam welded along joined surfaces.

2.3.1 [Finger Stock

ASTM B194, Condition HT. The finger stock shall be secured to the door or frame without using special tools or soldering or adhesives and shall have a minimum overlap of 50 mm 2 inches.

]2.3.2 Latching Type

Provide lever controller door with roller cam action requiring not more than 90 N 20 pounds of operating force on the handle for both opening and closing. The door shall be equipped with a three-point latching mechanism that provides proper compressive force for the RF seal. The mechanism shall be operable from both sides of the door and shall have permanently-lubricated ball bearings at points of pivot and rotation. The door latches and hinges shall be rated for a minimum of 10,000 cycles without loss of attenuation and without adjustments.

2.3.3 Nonlatching Type

****

NOTE: Nonlatching doors may be used for enclosures having many daily open-close operations; however, nonlatching doors may not retain as high as attenuation over the long term compared to doors having three-point latching mechanisms.

****

Provide door equipped with three heavy-duty ball bearing hinges and a door pull. Door shall open and close with a force not to exceed 20 N 5 pounds.

2.3.4 Special Door Assemblies

2.3.4.1 Hydraulic or Pneumatic Sealing Mechanism

Shall accomplish the electromagnetic sealing of the opening by use of pressure to force the door panels against the frame surfaces. The contact areas of door and frame shall be a peripheral strip not less than 75 mm 3 inches wide, completely around the door, of tinned or highly conductive noncorrosive surface. After the door is in sealing position, the sealing mechanism shall accomplish the exertion of pressure in not more than 10 seconds. Actuation shall be possible from both inside and outside of enclosure. Release mechanism shall actuate in not more than 5 seconds and shall be provided with a manual override. The mating and sealing of the door to frame shall be further enhanced by two peripheral rows of beryllium copper 6 by 25 mm 1/4 by one inch mesh gasket or beryllium copper finger stock. Removal and replacement of finger stock or gasketing shall be possible in less than 8 hours without the use of soldering or special tools. When the door is sealed, the attenuation around the edges shall meet the requirements of this specification. Provide a threshold of zinc-plated steel, not less than 10 mm 3/8 inch thick, at each swinging door. The steel shall be the same alloy as the shielding steel.

2.3.4.2 Sliding Doors

Shall be manually operated from either inside or outside of the shielded enclosure with a maximum break-away pull of [160 N] [35 pounds][_____] in the unsealed condition. The door shall center inside of the steel RF sealing frame designed for the forces involved. The door shall form an RF seal by the operation of an air valve so that the door shielding, on both sides, expands to a minimum mating surface 90 mm 3.5 inches wide around the periphery of the door. Mating surfaces of the door's expandable shields and the door frame shall be a conductive material. Provide the door with an air system that maintains a nominal sealing pressure of [240 kPa] [35 psi] [_____]. In the RF sealed position, the shielded door shall provide the same minimum attenuation as the class of shielding specified without derating.

a. Design: The door shall be designed for long life and reliability without the use of RF gaskets, RF finger stock, or other sealing devices other than the direct metal-to-metal contact as specified above. The RF sealing device shall be fail-safe upon loss of air pressure and shall readily allow manual opening of the door. For either normal operation or fail-safe operation, the maximum time to reach the open condition shall be no more than 7 seconds. The enclosure design shall include provision for removing the door for routine maintenance without disturbing the door alignment and RF sealing properties.

b. Control Panel: The inside and outside of the shielded enclosure shall contain a control panel to include the necessary opening and closing air valves. The outside control panel shall also have a pressure regulator and filter. Provide for quick opening of door air supply from inside the enclosure to allow escape when opening-air valves fail or malfunction.

2.4 LINE FILTERS

2.4.1 Power Line Filters

Shall have current and voltage ratings as [indicated] [specified].

2.4.2 Telephone and Signal Line Filters

MIL-PRF-15733. Filters shall have an insertion loss of 100 dB in the frequency range of 14 KHz to 10 GHz measured according to MIL-STD-220, full load condition. Filters shall have a pass band of [_____] KHz to [_____] KHz with a characteristic impedance of [_____] ohms.

2.5 WAVEGUIDE-TYPE AIR VENTS

Provide honeycomb type with cores fabricated of brass or steel. Each waveguide shall be electrically and mechanically bonded to adjacent waveguides. Air vents shall be a permanent part of the shielded enclosure and shall have a shielding effectiveness equal to that of the total enclosure. Static pressure drop through the vents shall not exceed 5 Pa 0.02 inch water gage at an air velocity of 3 m/s 600 feet per minute.

2.6 GROUNDING STUD

Enclosure shall have a permanently installed, solid brass or bronze grounding stud complete with hardware and jamb nuts located in the entrance plate [unless otherwise specified or indicated]. The stud shall be 12 mm 1/2 inch diameter double-threaded bolt which allows a full 50 mm 2 inch running thread inside and outside of the shielded enclosure.

2.7 SERVICE ENTRANCE PLATES (SET-UP PANELS)

Shall be minimum 3 mm 1/8 inch thick steel, sized [300 by 300 mm] [12 by 12 inches] [_____] and shall have a 6 mm 1/4 inchextruded brass frame for mounting to shielded enclosure wall panel.

2.8 NAMEPLATES

Major components of equipment shall have manufacturer's name, address, catalog number, model, style, and type on a plate securely and conspicuously attached to each item of equipment. Nameplates for electrical apparatus shall conform to NEMA standards.

2.9 LIGHTING

****

NOTE: In shielded enclosures where electronic equipment is very sensitive to EMI, specify a dual lighting system so that fluorescent lighting can be turned off and incandescent lighting turned on during sensitive tests or operations.

****

Provide lighting fixtures as indicated [and as specified in Section 26 51 00 INTERIOR LIGHTING.] Fluorescent lighting fixtures shall meet the requirements of MIL-STD-461, Class C3, Group I for both conducted and radiated interference.

2.10 EXHAUST FANS

****

NOTE: This paragraph cites only minimum requirements. Design calculations are necessary to size HVAC to suit room size and equipment/personnel contained within. Exhaust fan motors located inside shielded enclosure must meet MIL-STD-461, Class C3, Group 1.

****

Propeller fans shall be [direct drive] [belt drive] for [wall or window] [roof or ceiling] mounting, except that fans shall be centrifugal type with aluminum housing and wheel. Additionally, exhaust fans shall be electromagnetically compatible. Motors shall be completely shielded from the airstream. Provide exhaust opening and gravity closing type automatic louvers. Provide exhaust which can supply 15 room air changes per hour. Capacity of fans shall be certified in accordance with AMCA 210, and shall be not greater than 110 percent of the indicated capacity at indicated pressure drop.

2.11 COAXIAL CABLE PENETRATIONS

For each coaxial cable entering the shielded enclosures, provide RF waveguide threaded insert with cap and chain on shielded room side of enclosure.

PART 3 EXECUTION

3.1 SHIELDING STEEL INSTALLATION

Install in strict accordance with the shielding manufacturer's/fabricator's recommendations. Exercise care while handling and installing shielding steel to ensure against damage. Clean exposed surfaces of dirt, finger marks, and foreign matter resulting from manufacturing processes, handling, or installation. Inside the enclosure, mount items including boxes, conduits, fixtures, and switches directly to the structural steel members. Do not allow mounting bolts and screws to penetrate shielding steel. Locate electrical conduits as close to RF shielding as possible. If materials and equipment penetrate the shielded enclosure, seam weld or solder materials and equipment to both surfaces or shielding steel. Where the steel sheet is much thinner than the penetrating member, provide a welded collar of intermediate thickness for transition to accomplish the welding.

3.1.1 Surface Preparation

Clean and buff surfaces to ensure firm contact with shielding steel. Remove paint or other coverings on mating surfaces of special boxes such as for fire alarm systems, buzzers, and signal lights, including areas between box and cover, box and wall, and box and conduit. Remove insulating material to maintain a low-resistance ground system and to ensure firm mating of metal surfaces.

3.1.2 Installation Supervision

Furnish the services of a qualified installation engineer or technician regularly employed by the shielding manufacturer/fabricator for a minimum of three 8 hour working days to instruct Contractor personnel in the installation of the RFI shield. A qualified installation technician is acceptable in lieu of a qualified installation engineer. After the shielded enclosure has been completely installed including RF filters, vents, and exhaust fans, furnish the services of the engineer or technician described herein to inspect the installation for compliance with the specifications. The inspection shall be made before any finishes or the concrete topping coat are installed.

3.1.3 Floor Panel Setting

Place a polyethylene dielectric film of 0.15 mm 6 mil thickness over the structural floor of the parent enclosure before any other work is set thereon. Provide a 3 mm 1/8 inch thick layer of hardboard over the film, with joints loosely butted. Over hardboard layer, provide an additional layer of similar filler material of equal thickness as the projection of the structural member from the bottom surface of the floor panel, leaving no more than 6 mm 1/4 inch space between the hardboard and the structural member. Along panel seams and at support channels, provide a refractory glass cloth strip to protect subfloor and dielectric film from welding heat.

3.1.4 Welding

Provide the electromagnetic shielding work in accordance with performance criteria specified. Structurally weld the shielding steel to the steel frame in accordance with AWS D1.1/D1.1M, and seal electrical seams RF tight by the MIG method, using electrodes structurally and electrically compatible with the adjacent steel sheets. Plug weld or tack weld steel sheet to framework at 300 mm 12 inches on center to support steel sheets, then use continuous seam welding to seal RF seams in the enclosure. Do not allow slag inclusions, gas pockets, voids, or incomplete fusion anywhere along continuous welded seams. Be aware that welds which seem highly satisfactory upon visual inspection may fail the electromagnetic test. Correct weld failures by grinding out such welds and replacing with new welds. Perform welding, both structural and RF sealing, by employing a welder certified competent for MIG welding in all positions in accordance with the Standard Qualification Procedure of AWS D1.1/D1.1M.

3.2 DOOR ASSEMBLIES

Mount so that the clearance between the door edges and frame shall not vary more than 2 mm 1/16 inch and the innerface of the door periphery does not vary more than 2 mm 1/16 inch from the plane of the door stop's face. Through-bolt hinges to the door and the frame.

3.3 LINE FILTERS

Provide filters for incoming electrical power lines [, including neutrals,] and for incoming telephone and signal lines. Support filters independently of the shielding.

3.4 WAVEGUIDE-TYPE AIR VENTS

[Provide each inlet and return air duct with the number and size of waveguide-type air vents at each location where the ducts enter the shielded enclosure.] [As a minimum, provide each enclosure with one 300 mm 12 inch square inlet and one 300 mm 12 inch square return waveguide-type air vent.]

3.5 EXHAUST FAN

Mount on [wall] [or] [ceiling] over the exhaust vent on the exterior surface of shielded enclosure. Provide power from electrical source exterior to the shielded enclosure.

3.6 CONDUCTOR INSTALLATION

Provide filtered conductors in conduit, except for coaxial cable, from filter to shielding and penetrate the enclosure through threaded rigid steel conduits. [Twist conductors leading from the filters and conductors inside the shielded enclosure approximately 30 turns per meter 10 turns per foot in the conduit.]

3.7 GROUNDING

****

NOTE: If not specified in Division 26, "Electrical," the following sentence shall be added: "Wires inside the enclosure and for a distance of at least 15 meters 50 feet outside of the enclosure

shall be enclosed in a grounded, threaded rigid steel conduit system."

****

Extend the grounding stud through and [bolt] [weld] stud to the electrical power panel with a minimum No. 4 AWG insulated stranded copper conductor to effectively serve as a single grounding point for the completely assembled shielded enclosure, both internally and externally.

3.8 SERVICE ENTRANCE PLATE

Install RF connectors from coaxial cable and other RF shielded cable on entrance plate. Soft solder connectors to the plate. If location of plate is not indicated, mount plate in wall panel adjacent to power line filters.

3.9 FIELD TESTS

3.9.1 Weld Testing

****

NOTE: If the installation is critical, further welding tests may be specified such as ultrasonic, radiographic, or magnetic particle tests.

****

Visually inspect welding during the welding operation and after the welding is completed. Inspect completed welds after the welds have been thoroughly cleaned by hand or power wire-brush. Inspect welds with magnifiers under bright light for surface cracking, porosity, slag inclusion, excessive roughness, unfilled craters, gas pockets, undercuts, overlaps, size, and insufficient throat and concavity. Grind out defective welds and replace with sound welds.

3.9.2 Seam Leak Detection Testing

****

NOTE: SELDS testing the welds in the floor shielding is usually very difficult because you cannot "sniff" on both sides (assuming the shield is on the ground level). To circumvent this problem SELDS loops may be positioned beneath the floor shield for SELDS testing. Dye penetrant has also been used to test the welds and if the dye is used properly this test can be as critical of a test as SELDS.

****

Continuously test welds during fabrication using the SELDS, commonly known as a "sniffer." Upon completion of the basic shielded enclosure, before applying any metal primer or installing any accessories, test the entire shielded enclosure with the SELDS. Install terminal points on the shielding exterior and permanently attach test leads on two sets of diagonally opposing corners during construction for use with SELDS. Continuously probe seams with the test receiver set to detect abrupt changes of shielding level greater than 10 dB on the "shielding unit" scale. Clearly mark points having change greater than 10 dB and repair the weld to meet the specified requirement. Retest each repaired point until there are no points on seams which fail test.

3.9.3 Attenuation Testing

[Furnish the services of an independent testing laboratory, approved by the Contracting Officer, to test the shielded enclosure.] [Final acceptance testing will be by the Government.] Conduct the final shielding acceptance test after penetrations have been completed, specifically including electrical and other utility penetrations. In addition, the Contractor may schedule a complete or abbreviated test to verify that the shielding assembly is adequate prior to conducting final shielding acceptance test.

3.9.3.1 Test Procedure, Frequencies, and Equipment

****

NOTE: Expert Government witness should be present for all final acceptance testing. Note that IEEE 299 requires one magnetic field test (150 KHz), three electric field tests (200 KHz, one MHz, 18 MHz), and one plane wave test (400 MHz). Also, note that IEEE 299 and NSA 65-6 differ on positioning of source and receiver. IEEE 299 requires source outside and receiver inside the shield while NSA 65-6 requires source inside and receiver outside (to simulate TEMPEST conditions). For TEMPEST shielding effectiveness testing, continuous sweeping of seams at one or more plane wave frequencies should also be specified, in addition to testing around all door panels, filters, air duct penetrations and all other penetrations of the shielding at all test frequencies. When finish materials are in place (floor topping slabs, gypsumboard wall finishes, roof insulation and coverings, etc.) it is recommended that limited testing be repeated. One plane wave frequency sweep, baked up by magnetic field probing of any new leakage areas discovered, with repair and retest as necessary to bring the enclosure back into proper SE performance, is recommended. If enclosure is designed specifically for attenuating microwave frequencies, specify additional test frequencies above 1 GHz. Such testing is expensive and should only be used when a firm requirement exists (e.g., NSA-65-6).

****

The test procedure, frequencies, and equipment shall be as specified in IEEE 299 [plus the additional frequencies specified in the contract]. Perform the test as soon as possible after completion of the shielded enclosure, including installation of services, power/telephone/signal lines, RF filters, and waveguide vents. Conduct test with doors closed and the filters under normal load conditions.

3.9.3.2 Additional Test Points

****

NOTE: Use this paragraph if design includes strict tolerances, high attenuation requirements, and many penetrations. If all of the welded seams are to be tested using IEEE 299 procedure and frequencies, the specification must clearly state this to avoid change orders.

****

Measure additional test points beyond those specified in IEEE 299. Test points include the periphery of doors and covers, handles, latches, power filter penetrations, air vent filters, telephone and control line filter penetrations, and points of penetration by pipes, tubes, and bolts.

3.9.3.3 Final In Service Testing

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that equipment and devices are in operating condition and performing the intended function. Give the Contracting Officer five working days advance notice of the dates and times for checks and tests.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 56 53 (August 2020)**
Change 1 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-08 56 53 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 08 - OPENINGS

SECTION 08 56 53

BLAST RESISTANT TEMPERED GLASS WINDOWS

08/20, CHG 1: 08/24

PART 1 GENERAL

PART 2   PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 56 53 (August 2020)**
Change 1 - 08/24

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****

SECTION 08 56 53

BLAST RESISTANT TEMPERED GLASS WINDOWS

08/20, CHG 1: 08/24

****

NOTE: This guide specification covers the requirements for blast resistant tempered glass windows that require upgrades based on the blast, antiterrorism, and setback requirements set forth in UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Specific details are expanded upon in MIL-HBK-1013/1A, Design Guidelines for Physical Security of Facilities.

****

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NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

****

NOTE: On the drawings, show:

1. Locations of each type of glass, using same terminology as in the specification.

2. Frame and rabbet details, indicating method of glazing.

3. Sizes and types of windows; metal and wood subframes, casings, or stools, if any; and hardware.

4. Sizes, location, and swing of ventilators; direction of slide for sliding ventilators; location and details of fixed sash.

5. Typical window sections and details. Show glass thickness. Show special glazing, if any.

6. Method of anchoring windows; size and types of clips, anchors, screws, or other fasteners.

7. Details of nonstructural mullions and mullion covers; detail of anchoring and reinforcing nonstructural mullions at windows to receive window cleaner anchors.

8. Number of window cleaner anchors required and locations.

9. Locations of windows designated as forced entry resistant, if any.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the

basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum
AAMA 2603	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA WSG.1	(1995) Window Selection Guide
AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 169	(2021) Climate Data for Building Design Standards

ASTM INTERNATIONAL (ASTM)

ASTM C509	(2006; R 2021) Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E1886	(2019) Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective

	Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
ASTM E1996	(2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass
ASTM F2912	(2017) Standard Specification for Glazing and Glazing Systems Subject to Airblast Loadings

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2008) Glazing Manual

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

PASSIVE HOUSE INSTITUTE - US (PHIUS)

PHIUS Certified	Certified Data Program for Window Performance

PASSIVE HOUSE INSTITUTE INTERNATIONAL (PHI)

Passivhaus Certified	(2012) Certification of Passive House Suitable Components
Passivhaus Criteria	(2012) Certification Criteria for Certified Passive House Glazings and Transparent Components

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows; G, [_____]

Fabrication Drawings

SD-03 Product Data

Window Units; G, [_____]

Hardware

Setting Materials

Weatherstripping

SD-04 Samples

Finish Sample

Window Sample

[Window Mock-Ups; G, [_____]

] SD-05 Design Data

Structural Calculations for Deflection; G, [_____]

Design Analysis; G, [_____]

SD-06 Test Reports

Minimum Condensation Resistance Factor

[Resistance to Forced Entry

][Standard Airblast Test; G, [_____]

][Windborne-Debris-Impact Performance

] SD-07 Certificates

****

NOTE: Provide engineer's qualifications when required to show conformance to UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.

****

[Engineer's Qualifications

] SD-08 Manufacturer's Instructions

Glass

SD-10 Operation and Maintenance Data

Window Units, Data Package 1; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Manufacturer

Window manufacturer must specialize in designing and manufacturing the type of aluminum windows specified in this section, and have a minimum of [_____] years of documented successful experience. Manufacturer must have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.3.2 Shop Drawing Requirements

Take field measurements prior to preparation of drawings and fabrications. Provide drawings that indicate elevations of windows, full-size sections, thickness and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware,[mullion details,][method and materials for weatherstripping,][method of attaching screens,][material and method of attaching subframes,][stools,][casings,][sills,][trim,][window cleaner anchors,] installation details, and other related items.

[1.3.3 Engineer's Qualifications for Blast Design

****

NOTE: Provide engineer's qualifications when required to show conformance to UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.

****

Perform blast design calculations by or under the direct supervision of a registered engineer with a minimum of 5 years experience performing blast design. The engineer performing the blast design must be able to demonstrate experience on similar size projects using similar design methods to meet the requirements outlined in this specification.

]1.3.4 Sample Requirements

1.3.4.1 Finish Sample Requirements

Submit color chart of standard factory color coatings when factory-finish color coating is to be provided.

1.3.4.2 Window Sample Requirements

****

NOTE: Choose one of the following options. Include the first choice for projects requiring a large number of windows. Include the second choice for projects requiring a limited number of windows.

****

[Submit one full-size window of each type proposed for use, complete with AAMA Label, glazing, hardware, anchors, and other accessories. Where screens or weatherstripping is required, fit sample windows with such items that are to be used. After approval, install each sample in work, clearly identified, and record its location.

][Submit one full-size corner of each window type proposed for use. Where screens or weatherstripping is required, fit sample with such items that are to be used.

][1.3.4.3 Window Mock-Ups

****

NOTE: Requesting mock-up samples of aluminum windows is not required for most projects. Size of project and scope of quality control should be carefully evaluated before requiring Contractor to provide a costly mock-up. Delete paragraph if mock-ups are not required.

****

Before fabrication, full-size mock-up of[each type of aluminum window][one window unit] [_____] complete with glass and AAMA certification label for structural purposes and NFRC Temporary and Permanent Label for certification of thermal performance rating will be required for review of window construction and quality of hardware operation.

]1.3.5 Design Data Requirements

Submit structural calculations for deflection to substantiate compliance with requirements[and Antiterrorism Performance Requirements]. A registered Professional Engineer must provide calculations. Submit design analysis with calculations showing that the design of each different size and type of aluminum window unit and its anchorage to the structure[.][meets the requirements of paragraph ANTITERRORISM PERFORMANCE REQUIREMENTS.] Calculations verifying the structural performance of each window proposed for use, under the given loads, must be prepared and signed by a registered professional engineer. Reflect the window components and anchorage devices to the structure, as determined by the design analysis, in the shop drawings.

1.3.6 Test Report Requirements

****

NOTE: Include bracketed wording when windows are required to resist blast loads all required by UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.

****

Submit test reports for each type of window attesting that identical windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 including test size,[and] minimum condensation resistance factor (CRF)[, and resistance to forced entry][, and, for Antiterrorism windows, in lieu of a Design Analysis, results of a Standard Airblast Test].[For Antiterrorism windows, in lieu of a Design Analysis, results of airblast testing, whether by arena test or shock tube, must be included in a test report, providing information in accordance with ASTM F1642/F1642M, as prepared by the independent testing agency performing the test. The test results must demonstrate the ability of each window proposed for use to withstand the airblast loading parameters and achieve the hazard level rating specified in paragraph STANDARD AIRBLAST TEST METHOD.]

1.3.7 Certification

****

NOTE: Energy Star Certification is required for residential windows. FEMP Designation, Passivhaus, and PHIUS Certifications are methods to ensure compliance with thermal performance.

****

Ensure that construction is performed with products that meet or exceed[Energy Star criteria,][FEMP Designated criteria,][and Passivhaus Criteria][Passivhaus Certified][and be current in their certification].[Provide PHIUS Certified window performance.] Each prime window unit must bear the AAMA Label warranting that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440. Certified test reports attesting that the prime window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, including test size, will be acceptable in lieu of product labeling.

1.3.8 Label

Each prime window unit must bear the AAMA Label warranting that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440. Certificates of Compliance attesting that the prime window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440 will be acceptable in lieu of product labeling.

1.3.9 Glass and Glazing

Provide materials that are certified to meet ANSI Z97.1 by an independent testing laboratory.

1.4 DELIVERY, STORAGE, AND HANDLING

a. Deliver products to the site in unopened containers, labeled plainly with manufacturers' name and brands. Deliver window assemblies in an undamaged condition. Exercise care in handling and hoisting windows during transportation and at the job site. Store windows and components out of contact with the ground, under a weathertight covering, so as to prevent bending, warping, or otherwise damaging the windows.

b. Protect finished surfaces during shipping and handling using the manufacturer's standard method, except that no coatings or lacquers may be applied to surfaces to which sealants, caulking, or glazing compounds must adhere.

1.5 ENVIRONMENTAL CONDITIONS

Do not start glazing work until the outdoor temperature is above 4 degrees C 40 degrees F and rising unless approved provisions are made to warm the glass and rabbet surfaces. Provide sufficient ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work if moisture collects on window assemblies or during rainy weather.

1.6 PERFORMANCE REQUIREMENTS

1.6.1 Wind Loading Design Pressure

Design window components, including mullions, hardware, and anchors, to withstand a wind-loading design pressure of at least [_____] pascal pounds per square foot (psf).

[1.6.2 Tests

Test windows proposed for use in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for the particular type and quality window specified.

Perform tests by a nationally recognized independent testing laboratory equipped and capable of performing the required tests. Submit the results of the tests as certified laboratory reports required herein.

Minimum design load for a uniform-load structural test must be 2400 pascal 50 psf.

[Test projected windows in accordance with the applicable portions of the AAMA WSG.1 for air infiltration, water resistance, uniform-load deflection, and uniform-load structural test.

][Test double-hung windows in accordance with the applicable portions of the AAMA WSG.1 for air infiltration, water resistance, uniform-load deflection, and uniform-load structural test.

]]1.7 DRAWINGS

Submit the fabrication drawings for aluminum window units showing complete window assembly including hardware, weatherstripping, and subframe assembly details.

1.8 WINDOW PERFORMANCE

****

NOTE: Structural performance, air infiltration and water penetration are standard performance requirements for all aluminum window types.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

ANTITERRORISM PERFORMANCE REQUIREMENTS section below is optional to designer, and must be omitted or revised as needed to meet project requirements.

Applicability of UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings.

The antiterrorism (AT) standards contained in UFC 4-010-01 DO NOT establish the Design Basis Threat (DBT) or the Level of Protection (LOP) for DoD buildings. Installation Antiterrorism Plans may define a DBT for the installation. Use UFC 4-020-01 (DoD Security Engineering Facilities Planning Manual) to establish and/or validate the DBT and LOP for individual projects. The process outlined in UFC 4-020-01 will determine if the minimum AT standards are adequate or if additional protective measures are required. Where a specific DBT and LOP are identified, additional guidance is included in Appendix B (Best Practices) of UFC 04-010-01. For buildings that are outside an installation perimeter, use UFC 4-020-01 to establish the DBT and LOP. The DBT and LOP will result in a representative standoff distance for the appropriate construction - window systems (glazing, frame, connections) in this instance.

A structural analysis will need to be performed to determine if the most stringent loading on window assembly is from antiterrorism blast loads or windborne debris in high wind regions.

****

Aluminum windows must meet the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

1.8.1 Structural Performance

Structural test pressures on window units must be for positive load (inward) and negative load (outward). After testing, there will be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There must be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA/WDMA/CSA 101/I.S.2/A440 for the window types and classification specified in this section.

[1.8.2 Antiterrorism Performance Requirements

Meet antiterrorism performance criteria as specified in the paragraphs below in accordance with UFC 4-010-01. Validate conformance to the performance by one of the following methods.

1.8.2.1 Computational Design Analysis Method

Design window assembly to the criteria listed herein. Include computational design analysis calculations verifying the structural performance of each window assembly proposed for use, under the given static equivalent loads.

Design window frames, mullions, sashes, and glazing to the criteria listed herein. Include computational design analysis calculations verifying the structural performance of each window system proposed for use, under the given static equivalent loads.

****

NOTE: The blanks in the following paragraph should be the value of the equivalent 3-second duration design loading obtained from Figure 1 of ASTM F2248 for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. This section must be completed by an engineer experienced in blast-resistant design.

****

Glazing resistance must be greater than equivalent 3-second duration loading of [_____] Pascal pounds per square foot (psf) for type [_____] window[and [_____] Pascal psf for the remaining window types]. The glazing frame bite for the window frames must be in accordance with ASTM F2248.

Design Aluminum/Steel window framing members to restrict deflections of the edges of glazing they support to L/60 under two times (2X) the glazing resistance per the requirements of ASTM F2248 and ASTM E1300.

****

NOTE: Connection Design: For mullion and framing members designed using dynamic analysis or shown to work through airblast testing, all connections

between mullions and/or framing members and all connections of storefront systems to the supporting structure must be designed for the full dynamic capacity of the attached member or the maximum calculated dynamic reaction with a load factor equal to 1.0. Use ultimate capacity of fasteners as recommended by the fastener manufacturer with a capacity reduction factor of 0.75. Use Load and Resistance Factor Design (LRFD) with appropriate reduction (phi) factors per material specific code for design of connections components into supporting structure. All dynamic and static material strength increase factors for the connection components must be equal to 1.0. All connection designs must be performed checking all conventional failure mechanisms. See Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: pdc.usace.army.mil/library/tr/10-02) for additional information. Calculations/Design Analysis for the connection design as stated above must be completed by an engineer experienced in blast-resistant design.

****

****

NOTE: Use the first bracketed requirement below if the maximum air blast pressure is greater than one-half the magnitude of the load resistance of the blast resistant glazing.

Use the second bracketed requirement below if the maximum air blast pressure is less than one-half the magnitude of the load resistance of the blast resistant glazing.

****

[Anchor window frames to the supporting structure with anchors designed to resist[two times (2X)][one time (1X)] the glazing resistance in accordance with ASTM F2248 and ASTM E1300.

]1.8.2.2 Dynamic Design Analysis Method

****

NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01 (Table B-1). Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering/billeting building occupancy as defined in UFC 4-010-01 (Table B-1). Dynamic analysis is preferred because it typically yields a more appropriate and economical / efficient

design. The values for input into the blanks in the following paragraph related to 'ductility ratio' and 'maximum support rotation' (for the appropriate level of protection - very low, low) for steel and aluminum framing/mullions can be found in Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: pdc.usace.army.mil/library/tr/10-02). This section must be completed by an engineer experienced in blast-resistant design.

****

Design window assembly using a dynamic analysis to prove the system will provide performance equivalent to or better than a[low;][very low;] [_____] hazard rating in accordance with ASTM F2912 for the peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). Use a triangular blast load using the applicable pressure and impulse indicated above. The allowable response limits of[aluminum][steel] frame elements are as follows: Maximum ductility ratio of [_____] and maximum support rotation of [_____] degrees.

1.8.2.3 Standard Airblast Test Method

****

NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01. Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering building occupancy as defined in UFC 4-010-01. This section must be completed by an engineer experienced in blast-resistant design.

****

As an alternative to the 'Computational Design Analysis Method' and 'Dynamic Design Analysis Method' indicated above, window [_____] assembly may be tested for evaluation of hazards generated from airblast loading in accordance with ASTM F1642/F1642M by an independent testing agency regularly engaged in blast testing. For proposed window systems that are of the same type as the tested system but of different size, the test results may be accepted provided the proposed window size is within the range from 25 percent smaller to 10 percent larger in area and aspect ratio of the original qualified tested glazing systems in accordance with ASTM F2912. Proposed window system/assembly of a size outside this range will require testing to evaluate their hazard rating or are certified by the 'Dynamic Design Analysis Method' indicated above. Testing may be by shock tube or arena test. Perform the test on the entire proposed window system/assembly, including, the glazing, its framing/support system, operating devices, and all anchorage devices. Window support system replicate anchorage of the window support system with the method of installation to be used for the project. The minimum airblast loading parameters for the test will be as follows: peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). The hazard rating for the proposed window systems, as determined by the rating criteria of ASTM F2912, to provide performance equivalent to or better than a[low;][very low;] [_____] hazard rating (i.e. the "No Break", "No Hazard", "Minimal Hazard", "Very Low Hazard" and "Low Hazard" ratings are acceptable. "High Hazard" ratings are unacceptable. Results of window systems previously tested by test protocols other than ASTM F1642/F1642M may be accepted provided the required loading, hazard level rating, and size limitations stated herein are met.

]1.8.3 Air Infiltration

Do not exceed air infiltration values established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

1.8.4 Water Penetration

Do not exceed water penetration established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

1.8.5 Thermal Performance

****

NOTE: Window properties are critical to energy performance and comfort. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain.

Energy Star labeling is applicable to residential units only.

For nonresidential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy efficiency and meeting minimum building envelope requirements of UFC 3-101-01 including fenestrations and glazing.

Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting bracketed energy performance requirements before specifying and edit as needed.

****

Windows (including frames and glass) will be independently tested and certified with a Solar Heat Gain Coefficient (SHGC) determined according to NFRC 200 procedures and a whole window U-factor determined in accordance with NFRC 100 within the ranges as indicated below according to the ASHRAE 169 Climate Zone of the project location.[Windows used solely within the interior of a conditioned envelope are exempted from meeting U-Factor and SHGC requirements, unless otherwise noted.] Provide visual Transmittance (VT) of 0.5 or greater. Submit documentation supporting compliance with Energy Star, FEMP designated, and Passive House qualifications as applicable. Provide proof of Energy Star label for residential aluminum window products.

[1.8.5.1 Southern Climate

Windows installed in Climate Zone[1][2] will have a U-Factor of [1.3] [1.25] [_____] W/m^2·degrees C [0.40] [_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.25] [_____] or less.

][1.8.5.2 South-Central Climate

Windows installed within Climate Zone 3 will have a U-Factor of [0.85] [1.25] [_____] W/m^2·degrees C [0.30] [_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.25] [_____] or less.

][1.8.5.3 North-Central Climate

Windows installed within Climate Zone 4 will have a U-Factor of [0.85] [1.25] [_____] W/m^2·degrees C [0.30] [_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.36] [_____] or less.

][1.8.5.4 Northern Climate

Windows installed within Climate Zone [5] [6] [7] will have a U-Factor of [0.65] [1.25] [_____] W/m^2·degrees C [0.27] [_____] BTU/h·ft^2·degrees F or less and a SHGC of [0.36] [0.41] [_____] or less.

][1.8.5.5 Subarctic Climate

Windows installed within Climate Zone 8 will have a U-Factor of [0.45] [1.25] [_____] W/m^2·degrees C [0.08] [0.22] [_____] BTU/h·ft^2·degrees F or less. There is no SHGC limit for this climate zone.

]1.8.6 Windborne-Debris-Impact Performance

****

NOTE: Retain WINDBORNE-DEBRIS-IMPACT RESISTANCE paragraph if required by Project. The UFC 1-200-01 DoD Building Code cited IBC defines windborne debris regions. Enhanced protection applies to essential facilities. Verify site specific requirements with the AHJ. Delete items not required.

****

Exterior window system including glazing must comply with indicated basis or enhanced protection testing requirements in ASTM E1996 for[Wind Zone 1][Wind Zone 2][Wind Zone 3][Wind Zone 4] when tested according to ASTM E1886. Test specimens must be no smaller in width and length than glazing indicated for use on Project and must be installed in same manner as glazing indicated for use on Project.

a. Refer to drawings for classification of window requiring basic or enhanced protection.

[b. Large-Missile Test: For glazing located within 9.1 m 30 feet of grade.

][c. Small-Missile Test: For glazing located more than 9.1 m 30 feet above grade.

]1.9 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 WINDOW UNITS

Primed window frames must conform to AAMA/WDMA/CSA 101/I.S.2/A440 and the requirements specified herein. Provide windows of types, grades, performance classes, combinations, and sizes indicated or specified. Provide windows to accommodate hardware, glass, weatherstripping and accessories. Each window must be a complete factory-assembled unit with glass factory or field installed.

2.2 WEATHERSTRIPPING

Conform to AAMA/WDMA/CSA 101/I.S.2/A440.

2.3 GLASS

Use ASTM C1048 and ANSI Z97.1 Grade B (tempered), Style I (uncoated), Type 2, Class[1 (transparent)][2 (heat absorbing)].

2.4 SETTING MATERIALS

Provide types required for the applicable setting method specified in the GANA Glazing Manual, unless specified otherwise herein. Do not use metal sash putty, non-skinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted must be[gray,][black] or neutral color.

2.4.1 Elastomeric Sealant

****

NOTE: Where Section 07 92 00 JOINT SEALANTS is included in the specifications select the first bracketed option; if this section not included, select second option.

****

[See Section 07 92 00 JOINT SEALANTS for sealant requirements.][ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT. Use for channel or stop glazing[and][metal] sash. Provide sealant chemically compatible with setting blocks, edge blocks, and sealing tapes. Color of sealant is[as selected][gray][black][white] [_____].]

2.4.2 Sealing Tapes, Beads or Gaskets

Gaskets or beads must be at least 9.5 mm 3/8 inch wide with a Shore "A" durometer hardness of 50 and conform to ASTM C509.

2.4.3 Setting Blocks and Edge Blocks

Use neoprene of 70 to 90 Shore "A" durometer hardness, chemically compatible with sealants used, and of sizes recommended by the glass manufacturer.

2.4.4 Accessories

Use accessories as required to provide a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

2.5 WINDOW ASSEMBLIES

Conform to AAMA/WDMA/CSA 101/I.S.2/A440.

2.5.1 Provisions for Glazing

****

NOTE: Edge clearances, face clearances, and bites must be maintained as shown below:

Minimum Clearance and Bite Requirements			
Glass Thickness (mm)	"A" Minimum Edge Clearance (mm)	"B" Nominal Bite (mm)	"C" Minimum Face Clearance (mm)
6.0	6.0	13.0	3.00
8.0	8.0	13.0	4.75
10.0	8.0	13.0	4.75
12.0	9.5	13.0	6.00
16.0	9.5	13.0	6.00
19.0	9.5	13.0	8.00
22.0	13.0	16.0	8.00
25.0	13.0	19.0	9.50

Minimum Clearance and Bite Requirements			
Glass Thickness (in)	"A" Minimum Edge Clearance (in)	"B" Nominal Bite (in)	"C" Minimum Face Clearance (in)
1/4	1/4	1/2	1/8
5/15	5/16	1/2	3/16
3/8	5/16	1/2	3/16
1/2	3/8	1/2	1/4

Minimum Clearance and Bite Requirements			
Glass Thickness (in)	**"A" Minimum Edge Clearance (in)**	**"B" Nominal Bite (in)**	**"C" Minimum Face Clearance (in)**
5/8	**3/8**	**1/2**	**1/4**
3/4	**3/8**	**1/2**	**5/16**
7/8	**1/2**	**5/8**	**5/16**
1	**1/2**	**3/4**	**3/8**

****

Provide windows and rabbets suitable for specified glass thickness.[Minimum edge clearance must be [_____]. Nominal bite must be [_____]. Minimum face clearance must be [_____].] Provide sash for glazing and for securing glass with[metal beads][glazing clips][glazing channels] and glazing compound.

2.5.2 Sealant, Gaskets, and Beads

Continuous around the perimeter of the glass.

2.5.3 Weatherstripping

Provide for ventilating sections of windows to ensure a weathertight seal meeting the infiltration requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440. Provide factory-applied weatherstripping that can be replaced by field repair mechanics. Use molded vinyl, molded or molded-expanded neoprene for weatherstripping for compression contact surfaces. Do not use neoprene or polyvinyl chloride weatherstripping where it will be exposed to direct sunlight.

2.5.4 Fasteners

Provide flathead, cross-recessed type, exposed head screws and bolts with standard threads for use on windows, trim, and accessories. Screw heads must finish flush with adjoining surfaces. Screws and bolts exposed to the environment to be corrosion resistant coated steel, aluminum, or stainless steel compatible with the window material and adjoining construction, and of a type and size recommended by the manufacturer to meet the performance requirements. Self-tapping sheet-metal screws are not acceptable for material more than 1.59 mm 1/16 inch thick.

2.5.5 Drips and Weep Holes

Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, drips must be continuous across tops of fixed windows. Provide drips and weep holes as required to return water to the outside.

2.5.6 Combination Windows

Windows used in combination must be the same grade and performance class and must be factory assembled. Where factory assembly of individual windows into larger units is limited by transportation considerations, prefabricate, match mark, transport, and field assemble.

2.5.7 Accessories

Provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation and proper operation.

2.5.8 Hardware

The item, type, and functional characteristics must be the manufacturer's standard for the particular window type and must conform to AAMA/WDMA/CSA 101/I.S.2/A440. Provide hardware that functions after the window assembly has withstood the application of the design blast pressure causing the development of a static design resistance, ru, uniformly applied over both glazing and frame as defined in paragraph CERTIFICATES OF COMPLIANCE of this section. Equip operating ventilators with a lock or latching device which can be secured from the inside.

2.5.9 Anchors

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Provide corrosion resistant anchors and fasteners compatible with the window and the adjoining construction. Provide a minimum of three anchors for each jamb located approximately 150 mm 6 inches from each end and at midpoint.

2.5.10 Window Cleaner Anchors

****

NOTE: Windows having sills more than 13.7 meters 45 feet above grade, adjoining balconies, or adjoining roofs should be shown and specified as requiring window cleaner anchors, unless window cleaning methods at the activity make use of these anchors on lower windows. Coordinate window cleaning procedures and requirements with the using activity in making the decision as to the need for window cleaner anchors. No removable or tilting-type sash may be provided instead of the anchors.

****

Provide double-head anchors for windows[indicated][specified]. Anchors must be stainless steel of size and design required for the window type and application. Provide two anchors for each single window[and each adjacent glass window unit]. Fasten anchors 1120 mm 44 inches above the window sill utilizing appropriate methods for the window type and application in accordance with industry safety standards.

2.5.11 Finishes

****

NOTE: Specify anodic and organic coatings meeting the selection requirements in the Notes below as Contractor's option when these finishes are determined to be available in the desired colors and economically competitive in the project area, unless

the project requires use of one or the other to match an existing condition. The selection of anodic or organic coating is based primarily on the desired appearance: anodized finishes provide a metallic appearance and organic finishes provide a painted or metal-like finish (organic finishes are available in a variety of colors). Only allow both types as a Contractor option when the Designer confirms that the desired appearance is available in both types of finishes.

****

Exposed aluminum surfaces must be factory finished with an[anodic coating][or][organic coating].[Color must be [_____][as indicated].] Windows[for each building] must have the same finish.

2.5.11.1 Anodic Coating

****

NOTE: Specify Architectural Class I for harsh atmospheres where dust, gases, salts, and other destructive elements will attack metal finish. Also specify Class I for humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Specify Architectural Class II for all atmospheric conditions not requiring Class I. See UFC 1-200-01 for determination of ESC for project locations.

****

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish must be:

[a. Architectural Class II (0.01 to 0.0175 mm) (0.4 mil to 0.7 mil), designation AA-M10-C22-[A31, clear (natural)][A32, integral color][A34, electrolytically deposited color]anodized.

][b. Architectural Class I (0.0175 mm (0.7 mil or thicker), designation AA-M10-C22-[A41, clear (natural)][A42, integral color][A44, electrolytically deposited color]anodized.

]2.5.11.2 Organic Coating

****

NOTE: For organic coatings, to provide enhanced resistant to corrosion, weathering, ozone, and UV radiation utilize superior performance powder coat finishes conforming to AAMA 2605 in humid locations and project locations with an ESC of C3 thru C5; baked enamel finishes conforming to AAMA 2603 may be utilized for non-humid locations and ESC C1 or C2 project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Refer to UFC 1-200-01 for determination of ESC for a specific project location.

****

Clean and prime exposed aluminum surfaces. Provide a[baked enamel finish in accordance with AAMA 2603 with total dry film thickness not less than 0.02 mm 0.8 mil][superior performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 0.03 mm 1.2 mils].

2.6 SOURCE QUALITY CONTROL

2.6.1 Window Assembly Structural Test

2.6.1.1 Test Sample Number

Test at least two sample window assemblies for each type of window provided under an increasing uniform static load. Number of samples, beyond two, is left up to the vendor. However, it is noted that the acceptance criteria encourages a larger number of test samples.

2.6.1.2 Test Procedure

****

NOTE: To assure receiving the desired blast resistance protection, window assemblies provided by Contractor must be exactly as specified. If deviations from the specified requirements are sought by the Contractor, the Contractor must perform acceptance testing for the provided blast resistant window assemblies.

****

Test windows (glass panes and support frame) must be identical in type, size, sealant, gasket or bead and construction to those furnished by the window manufacturer. Secure the frame assembly in the test setup by boundary conditions that simulate the adjoining walls of the structure for intended installation. The simulation securing boundary conditions must be verified and attested by an attending Professional Engineer. Using either a vacuum or a liquid-filled bladder, apply an increasing uniform load to the entire window assembly (glass and frame) until failure occurs in either the glass or frame. Failure is defined as either breaking of glass or loss of frame resistance. The failure load, rf, must be recorded to three significant figures. The load should be applied at a rate of 0.5 ru per minute where ru is the static design resistance:

Glass Size	Static Design Resistance
[_____] by [_____] mm [_____] by [_____] inch	[_____] kPa [_____] psi

2.6.1.3 Acceptance Criteria

The static load capacity (rs) of a glass pane for the specified acceptance test procedure is:

$$rs = 0.876\ ru \qquad (1)$$

The window assembly (frame and glass) is considered acceptable when the arithmetic mean of all the samples tested, r- such that:

r- => rs plus sA (2)

where: rs = static load capacity of the glass pane for certification testing
s = sample standard deviation
A = acceptance coefficient (Table 1)

a. Arithmetic mean/standard deviation: For n test samples, r- is defined as:

(1) r- = sum from i = 1 thru n for rfi divided by n (3)

where rfi is the recorded failure load of the ith test sample.

The sample standard deviation, s, is defined as:

(2) s = the square root of the quantity of the sum from i = 1 thru n for (rfi - r-2) divided by (n - 1) (4)

The minimum value of the sample standard deviation, s, permitted to be employed in Equation (2) is:

(3) s = 0.145 rs (5)

This assures a sample standard deviation no better than observed for the general population of tempered glass.

b. Additional sampled determination: The following equation can be used by tester to determine if additional test samples are justified. If:

(1) r- =< rs plus sB (6)

then with 90 percent confidence, the design will not prove to be adequate with additional tests. Obtain rejection coefficient, B, from Table 1.

Table 1. Statistical Acceptance and Rejection Coefficients

Number of Window Assemblies, n	Acceptance Coefficient A	Rejection Coefficient, B
2	4.14	.546
3	3.05	.871
4	2.78	1.14
5	2.65	1.27
6	2.56	1.36
7	2.50	1.42
8	2.46	1.48
9	2.42	1.49

Table 1. Statistical Acceptance and Rejection Coefficients

Number of Window Assemblies, n	Acceptance Coefficient A	Rejection Coefficient, B
10	2.39	1.52
11	2.37	1.54
12	2.35	1.57
13	2.33	1.58
14	2.32	1.60
15	2.31	1.61
16	2.30	1.62
17	2.38	1.64
18	2.27	1.65
19	2.27	1.65
20	2.26	1.66
21	2.25	1.67
22	2.24	1.68
23	2.24	1.68
24	2.23	1.69
25	2.22	1.70
30	2.19	1.72
40	2.17	1.75
50	2.14	1.77

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Method of Installation

Install in accordance with the window manufacturer's printed instructions and details. Set windows at proper elevation, location, and reveal. Brace properly to prevent distortion and misalignment. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install windows in a manner that will prevent entrance of water. Fasten hardware to windows.

3.1.2 Glass Setting

Items to be glazed must be either shop or field glazed using glass of the quality and thickness specified or indicated. Preparation and glazing, unless otherwise approved, must conform to applicable recommendations in the GANA Glazing Manual. Windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops furnished with items to be glazed, to secure glass in place.

3.1.3 Dissimilar Materials

Where aluminum surfaces are in contact with, or fastened to, masonry, wood, or dissimilar metals, except stainless steel or zinc, protect the aluminum surface from dissimilar materials as recommended in the Appendix to AAMA/WDMA/CSA 101/I.S.2/A440. Do not coat surfaces on which sealants are to adhere.

3.1.4 Anchors and Fastenings

Make provision for securing units to each other and to adjoining construction.

3.1.5 Adjustments After Installation

After installation of windows and completion of glazing and field painting, adjust ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts as recommended by the manufacturer.

3.2 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weatherstripping, and to prevent interference with the operation of hardware. Remove stained, discolored, or abraded windows that cannot be restored to their original condition, and replace with new windows.

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of English unit measurements, and not on metric measurements commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

Products	English Units	Metric Units
Gaskets	3/8 inch	9.5 mm
Glass	1/4 inch	6.0 mm
	5/16 inch	8.0 mm
	3/8 inch	10.0 mm
	1/2 inch	12.0 mm
	5/8 inch	16.0 mm
	3/4 inch	19.0 mm
	7/8 inch	22.0 mm
	1 inch	25.0 mm

-- End of Section --

UFGS

****
USACE / NAVFAC / AFCEC **UFGS-08 56 63 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-11191 (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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DIVISION 08 - OPENINGS

SECTION 08 56 63

DETENTION AND SECURITY WINDOWS

04/06

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 56 63 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-11191 (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 56 63

DETENTION AND SECURITY WINDOWS

04/06

****

NOTE: This guide specification covers the requirements for detention steel cell windows.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The following information shall be shown on the project drawings:

1. Jamb, head and sill sections.

2. Method of anchoring and spacing; type of anchor.

3. Window elevations and dimensions.

4. Type of glazing.

5. Elevations above finished floor.

6. Details of non-structural mullions and mullion covers.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A90/A90M	(2021) Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A239	(2021) Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles
ASTM A627	(2003; R 2011) Standard Specification for Tool-Resisting Steel Bars, Flats, and

	Shapes for Detention and Correctional Facilities
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

STEEL WINDOW INSTITUTE (SWI)

SWI AGSW	(2002) Architect's Guide to Steel Windows

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Window Units

Indicate the elevations of windows, half-size sections, thicknesses and gages of metal, fastenings, proposed method of anchoring, the size and spacing of anchors, details of construction, method of glazing, mullion details, casings, sills, trim, other related items, and installation details.

SD-03 Product Data

Window Units

Fasteners

Accessories

Include finishes.

SD-06 Test Reports

Air Infiltration

Water infiltration

Mullion and Transom Bar Wind Load

1.3 QUALITY ASSURANCE

The requirements specified in this section govern where there is a difference between this section and the referenced industry specifications.

1.3.1 Test Reports

1.3.1.1 Air and Water Infiltration Tests

ASTM E283 and ASTM E331. Air infiltration shall not exceed 0.8 L/s per meter one-half cubic foot per minute per foot of crack length when subjected to a static pressure of 75 Pa 1.56 pounds per square foot (equivalent to a wind velocity of 40 km/hr 25 miles per hour). The amount of water infiltration shall be "zero" when tested in accordance with ASTM E331.

1.3.1.2 Mullion and Transom Bar Wind Load Tests

****

NOTE: Specify wind loading requirements in areas subject to high wind velocities in excess of 110 km/hr 70 MPH; otherwise delete. The wind loading of 960 Pa 20 psf is based on a 145 km/hr 90 mph wind velocity at 61 m 200 feet above grade.

****

****

NOTE: Delete when not applicable.

****

ASTM E330/E330M. Members shall withstand a uniform wind load of 960 Pa 20 pounds per square foot of window area without deflecting more than 1/175 of the span.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver windows to project site in an undamaged condition. Store windows and components at the site on edge, out of contact with the ground, and under a weathertight covering.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Steel Bars

SWI AGSW.

2.1.2 Sheet Steel

ASTM A1011/A1011M.

2.1.3 Zinc-Coated Sheet Steel

ASTM A653/A653M.

2.1.4 Zinc-Coated Steel

ASTM A90/A90M, ASTM A123/A123M or ASTM A153/A153M.

2.1.5 Corrosion Resisting Sheet Steel

ASTM A167.

2.1.6 Screws and Bolts

ASTM B766 or ASME B18.6.3, as applicable.

2.2 WINDOW UNITS

Units shall conform to the SWI AGSW, except as modified herein.

2.3 FABRICATION

Form permanent joints by welding or by mechanically fastening as specified [for each type window]. Use joints of strength required to maintain the structural value of members connected. Weld joints solid, remove excess metal, and dress smooth on exposed and contact surfaces. Closely fit joints formed with mechanical fastenings and make permanently watertight. Assemble frames at the plant, and ship as a unit with hardware unattached.

2.3.1 Window Sections

Where fixed window sections adjoin, provide a fixed sash, fabricated from similar frame members and of the manufacturer's standard type suitable for the purpose. [Roll weathering surfaces integrally to provide two-point, parallel-surface contact with an overlap at both inside and outside points of closure.]

2.3.2 Drainage Holes

Provide drips and weep holes, as required, to return water to outside, minimum of two per window.

2.3.3 Fasteners

Use flat or oval head spanner, twist-off or safety head screws and bolts with standard threads on windows, trim and accessories. Self tapping sheet-metal screws are not acceptable.

2.3.4 Fastener Finish

Fabricate windows with hot-dipped galvanized finish, using stainless steel or hot-spun galvanized steel fasteners. Use heavily cadmium plated steel fasteners for windows with painted finish or electrogalvanized in accordance with ASTM A239. Finish exposed heads of fasteners to match finish of windows.

2.3.5 Frames

Form frames from low carbon steel not less than 12 U.S. gage. Frames shall be one piece, channel shaped sections, at each jamb and between jamb at head and sill. Cope or miter and weld frame members at corners full depth of the frame for maximum strength and weathertightness; dress exposed welds smooth. Provide frame members with dimensions and profiles indicated. Provide 20 by 57 mm 3/8 by 2 1/4 inch, tool resistant steel flats conforming to ASTM A627, penetrated by 22 mm 7/8 inch tool-resistant steel rounds conforming to ASTM A627 in frame members.

2.4 PROVISIONS FOR GLAZING

Design for outside single glazing and for securing glass with metal beads and glazing compound. Glazing specified in Section 08 88 53 DETENTION AND

SECURITY GLAZING.

2.5 SCREENS

Provide manufacturer's standard screens for window units with movable sash, galvanized frame.

2.6 ACCESSORIES

Provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation of windows.

2.7 ANCHORS

Use hot-dip, zinc-coated steel anchors of the type indicated or specified. Use cadmium or zinc-coated nuts, bolts, and other fasteners for ferrous material.

2.8 SHOP PRIMED FINISH

After fabrication, clean surfaces of windows, fins, mullions, cover plates [and screen frames], provide a hot-dip galvanized, phosphate-treated and shop primed finish. The methods of cleaning, chemical treating, galvanizing, and painting shall conform to SWI AGSW. Windows shall receive finish paint coats as specified in Section 09 90 00 PAINTS AND COATINGS.

PART 3 EXECUTION

3.1 INSTALLATION

Install windows in accordance with the manufacturer's printed instructions and details, except as specified otherwise in this section. Build in windows as the work progresses. Set windows at indicated elevation, location, and reveal. Set plumb, square, level, and in alignment. Brace, strut, and stay to prevent distortion and misalignment.

3.2 ANCHORS AND FASTENINGS

Place anchorage as wall construction progresses. Build in anchors or bolt anchors and fastenings to the jambs of openings and weld securely to the windows or frames and to the adjoining construction. Space anchors not more than 400 mm 16 inches apart on jambs, and install a minimum of four anchors on each side of each opening. Anchors and fastenings shall have sufficient strength to hold the member firmly in position.

3.3 SEALANTS

Section 07 92 00 JOINT SEALANTS.

3.4 CLEANING

Clean metal surfaces of windows, inside and outside, of mortar, plaster, paint, and other foreign matter to present a neat appearance and to prevent fouling of weathering surfaces. Clean and touch-up abraded surfaces of steel windows. Replace stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 60 45 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-08 60 45 (February 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-08 60 45 (August 2020)**

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SECTION 08 60 45

[SKYLIGHTS][AND][TRANSLUCENT PANELS]

08/20

****

NOTE: This guide specification covers the requirements for skylights and translucent panels manufactured from glass-fiber or thermoplastic polycarbonate.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 SUMMARY

Provide commercially available [roof windows] [unit skylights [flat glass] [domed] [pyramidal] [vaulted]] [metal or wood framed skylights] which satisfy all requirements contained in this section and have been verified by load testing and independent design analyses (if required) to meet specified design requirements. Provide UV-stabilized, shatterproof and energy efficient skylight systems. Provide light transmitting plastics in the manufacturing of skylights for daylighting applications. Systems must meet requirements of UFC 4-010-01.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum
AAMA 2603	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

ASTM INTERNATIONAL (ASTM)

ASTM C297/C297M	(2016; R 2024) Flatwise Tensile Strength of Sandwich Constructions
ASTM D572	(2004; R 2019) Rubber Deterioration by Heat and Oxygen
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

ASTM D1002	(2010; R 2019) Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
ASTM D1003	(2013) Haze and Luminous Transmittance of Transparent Plastics
ASTM D1037	(2012; R 2020) Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D1929	(2020) Standard Test Method for Determining Ignition Temperature of Plastics
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2843	(2019) Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics
ASTM D3841	(2016) Standard Specification for Glass Fiber-Reinforced Polyester Plastic Panels
ASTM E72	(2022) Conducting Strength Tests of Panels for Building Construction
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E108	(2024) Standard Test Methods for Fire Tests of Roof Coverings
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E661	(2022) Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated

	Static and Impact Loads
ASTM E695	(2022) Standard Test Method of Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC04	(2012; R 2015) Acceptance Criteria for Sandwich Panels

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23	(Nov 2016) Ladders

UL SOLUTIONS (UL)

UL 972	(2006; Reprint Nov 2020) UL Standard for Safety Burglary Resisting Glazing Material Type

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G, [_____]

SD-03 Product Data

[Skylights][and][Translucent Panels]; G, [_____]

Recycled Content for Aluminum Framing Materials; S

Energy Star Label for Residential Skylights; S

Warranty

SD-06 Test Reports

Test Reports

SD-07 Certificates

Systems

Qualifications

1.4 QUALITY ASSURANCE

a. Provide documentation of Qualifications for the following: The manufacturer is a company specializing in the manufacture of the specified products with a minimum of [5] [10] years documented experience. The installer has documented experience of [5] [_____] years minimum performing the work specified.

b. Before fabrication, provide a full service mock-up of [each type of skylight] [one skylight unit] [_____] complete with glass and AAMA certification label for structural purposes and NFRC temporary and

Permanent Label for certification of thermal performance rating for review of skylight construction and quality of hardware operation. Glass and glaze in conformance with the applicable requirements of Section 08 81 00 GLAZING.

1.5 DELIVERY, STORAGE, AND HANDLING

Provide factory assembled system modules to the greatest extent possible. Ship panels to the jobsite in rugged shipping units, ready for erection. Affix conspicuous decals on all skylights warning individuals against sitting or stepping on the units. Store skylight panels on the long edge, several mm inches above the ground, blocked and under cover to prevent warping. Deliver unit skylights in manufacturer's original containers, dry, undamaged, with seals and labels intact. Deliver, store and protect all products in accordance with manufacturer's recommendations.

1.6 WARRANTY

Provide the manufacturer's complete warranty for materials, workmanship, and installation. The warranty is for [5] [_____] years from the time of project completion and with no proration. The warranty must guarantee, but not be limited to, the following:

a. [No change in light transmission and color of the panels after exposure to heat of 149 degrees C 300 degrees F for 25 minutes.][In accordance with ASTM D2244, panels do not darken more than 3.0 Delta E units after 5 years of outdoor weathering in South Florida at 45 degrees facing south. Document compliance with this requirement in submitted Test Reports.]

b. There is no delamination of the panel affecting appearance, performance, weatherability or structural integrity of the panels or the completed system.

c. There is no fiberbloom on the panel face.

d. Change in light transmission of no more than 6 percent in accordance with ASTM D1003, and in color (yellowing index) no more than 10 points in comparison to the original specified value over a 10 year period.

e. Provide a single source warranty for the glazing panels and the framing system. Third party warranty for the glazing panels will not be accepted.

PART 2 PRODUCTS

2.1 [SKYLIGHTS][AND][TRANSLUCENT PANELS]

****

NOTE: A polyvinyl fluoride film coating may be specified for the exterior surface of skylight panels when longer wearability is considered necessary. For fire rated construction, panels with fire ratings consistent with the overall construction of the building should be specified. Retain appropriate bracketed statements and corresponding paragraphs below and delete the others.

The designer must consider the differences and

performance characteristics of the two materials: glass-fiber reinforced polyester and extruded cellular thermoplastic polycarbonate before making the selection to meet specific project requirements.

When editing this section and developing details for skylight systems, Designer must ensure systems meet requirements of UFC 4-010-01.
****

Fabricate skylight panels of [glass-fiber reinforced polyester] [or] [extruded cellular thermoplastic polycarbonate] panels conforming to the specified requirements and other appropriate lab test specified criteria, weighing not less than 2.4 kg/square meter 8 ounces/square foot. Submit certified Test Reports from independent testing laboratory for each type and class of panel system. Reports must verify that the material meets specified performance requirements. Previously completed test reports will be acceptable if they are current and indicative of products used on this project. Where a Class A, B or C roof is part of the project, provide a listing certificate for roof covering systems category certifying that the product complies with the safety standards of ASTM E108 and ICC IBC. Size and color of skylight panels as indicated.

2.2 GLASS-FIBER PANELS

Provide glass-fiber reinforced polyester panels conforming to ASTM D3841, Class [_____] and to the requirements of AAMA/WDMA/CSA 101/I.S.2/A440.

2.2.1 Weatherability

Provide the exposed faces of fiberglass sandwich type panels with a permanent glass veil erosion barrier embedded integrally to provide maximum long term resistance to reinforcing fiber exposure. The exterior face sheet must be uniform in strength and resistant to penetration by pencil point.

2.2.2 Non Combustible Grid Core

Use 6063-T6 aluminum I-beams with provisions for mechanical interlocking of muntin-mullion and perimeter to prevent high and low intersections which do not allow full bonding surface to contact with face material. I-beam width no less than 11 mm 7/16 inch. Machine I-beam grid to tolerances of not greater than plus or minus 0.05 mm 0.002 inch for flat panels. Panels must withstand 650 degrees C 1200 degrees F fire for a minimum of one hour without collapse or exterior flaming.

2.2.3 Adhesive

Use heat and pressure resin-type laminate adhesive engineered for structural sandwich panel use; which passes testing requirements specified by the International Conference of Building Officials' "Acceptance Criteria for Sandwich Panel Adhesive". Provide with the following minimum strength:

a. Tensile Strength of 5.2 MPa 750 psi in accordance with ASTM C297/C297M after two exposures to six cycles each of the aging conditions prescribed in ASTM D1037.

b. Shear Strength, after exposure to five separate aging conditions in accordance with ASTM D1002:

(1) 3.7 MPa 540 psi at 50 percent relative humidity and 23 degrees C 73 degrees F.

(2) 5.5 MPa 800 psi under accelerated aging in accordance with ASTM D1037 at room temperature.

(3) 1.7 MPa 250 psi under accelerated aging in accordance with ASTM D1037 at 83 degrees C 182 degrees F.

(4) 9.7 MPa 1400 psi after 500 hour Oxygen Bomb in accordance with ASTM D572.

(5) 690 kPa 100 psi at 83 degrees C 182 degrees F.

2.2.4 Panel Construction

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. Where it is confirmed panels are readily available with aluminum containing recycled content, include the last bracketed sentences.

****

Provide panels consisting of fiberglass faces laminated to an aluminum I-beam grid core and deflecting no more than 48 mm 1.9 inches at 147 kg per square meter in 3 m 30 psf in 10 feet in accordance with ASTM E72, without a supporting frame. Include manufacturing facilities, sandwich panel components and production sandwich panels in the quality control inspections and required testing, conducted at least once each year, for conformance with ICC-ES AC04 or equivalent. [Provide aluminum framing materials with a minimum recycled content of 20 percent. Provide data identifying percentage of recycled content for aluminum framing materials.]

2.3 THERMOPLASTIC POLYCARBONATE PANELS

Manufacture systems from translucent polycarbonate panels designed for architectural applications. Provide panels consisting of a polycarbonate resin with a permanent, co-extruded, ultra-violet protective layer; co-extruded by the manufacturer during the original extrusion of the panel a permanent part of the exterior and interior layers. Pot-applied coatings or films of dissimilar materials are unacceptable. Provide panel width not to exceed 600 mm 2 feet to ensure best performance for wind uplift, vibration, oil canning and visual appearance. Meet the following manufacturing requirements:

a. Extruded in one single formable length. Transverse sections are unacceptable. Manufacture the panels with upstands which are integral to the unit, and with the upstands 90 degrees to the panel face (standing seam dry glazed concept). Welding or gluing of upstands or standing seam is unacceptable.

b. Provide dry glazed profiles mullions, using no sealant, welding, adhesives or gaskets; thermally break mullions continuous for panel length.

c. For structural performance, the use of adhesives, plastic or sonic welding or sealant is not allowed.

d. For longevity, the minimum ratio of panel weight to thickness must be [2.44 kg/m^2 for 10 mm 0.5 psf for 0.4 inch] [3.3 kg/$m^2$for 16 mm 0.68 psf for 0.63 inch] [4.4 kg/m^2 for 55, 75,and 100 mm double glazed 0.91 psf for 2.2, 3, and 4 inch double glazed] thick panel.

e. Extruded panel includes integral extruded multi-cells, and truss-like structural core for resistance to buckling. Interconnect the panel's exterior skins and space apart by supporting ribs, perpendicular to the skins, at a spacing not to exceed 4 mm 0.16 inches (truss-like construction). In addition, divide the space between the two exterior skins in a cross section by multiple parallel intermediate surfaces, at a spacing not to exceed 4 mm 0.16 inches.

f. Interior flame spread classification is Class [I] [II] in accordance with ASTM E84.

g. Smoke density no greater than 70 in accordance with ASTM D2843.

h. The exterior and interior faces must be an approved light transmitting panel with a CC1 fire rating classification in accordance with ASTM D635.

i. Self-ignition greater than 570 degrees C 1058 degrees F in accordance with ASTM D1929.

j. Fire rated roof assembly translucent panels must be successfully evaluated for fire from exterior exposure in accordance with [ASTM E108] [_____] to meet Class [A] [B] [C] rating. Provide panel listed by an independent recognized listing laboratory.

2.4 COMMON PANEL REQUIREMENTS

2.4.1 Appearance

Provide face sheets uniform in color to prevent splotchy appearance and completely free of ridges and wrinkles which prevent proper surface contact. Clusters of air bubbles/pinholes which collect moisture and dirt are not acceptable.

2.4.2 Panel Fabrication

Panel construction must meet the following requirements:

a. Light transmission [_____] percent; color [_____].

b. Assembled panel thickness [_____] mm inches.

c. Grid size [_____][as indicated].

2.4.3 Thermal Performance

****

NOTE: Skylight properties are critical to energy performance and comfort. Specify low U value (rate of heat transfer) to reduce winter heat loss and low solar heat gain coefficient to reduce summer solar

heat gain.

Energy Star labeling is applicable to residential units only. For nonresidential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy efficiency and meet minimum building envelope requirements of UFC 3-101-01 including fenestrations and glazing.

Select the performance requirements for non-residential skylights and the residential skylights.
****

Provide non-residential skylights (including frames and glass) certified by the National Fenestration Rating Council with a whole-unit Solar Heat Gain Coefficient (SHGC) maximum of [_____] determined according to NFRC 200 procedures and a U-factor maximum of [_____] W/m2-KBtu/hr-ft2-F in accordance with NFRC 100.

Provide residential skylights (including frames and glass) that are Energy Star labeled products for the [Northern] [North-Central] [South-Central] [Southern] climate zone, or have the following performance characteristics: [Southern climate zone, thermal properties of windows must not exceed a U-factor of 0.60 determined according to NFRC 100, and a solar heat gain coefficient (SHGC) not exceeding 0.28 determined according to NFRC 200.][South-Central climate zone, thermal properties of windows must not exceed a U-factor of 0.53 determined according to NFRC 100, and a solar heat gain coefficient (SHGC) not exceeding 0.28 determined according to NFRC 200.][North-Central climate zone, thermal properties of windows must not exceed a U-factor of 0.53 determined according to NFRC 100, and a solar heat gain coefficient (SHGC) not exceeding 0.35 determined according to NFRC 200.][Northern climate zone, thermal properties of windows must not exceed a U-factor of 0.50 determined according to NFRC 100.][Provide proof of Energy Star label for residential skylights.]

2.4.4 Condensation Index Rating

****
NOTE: Determination of the resistance of the skylight unit to the formation of condensation in any form, referred to as the Condensation Index, should be accomplished using the NFRC approved software tool THERM. Refer to paragraph Condensation Index Rating in Section 08 52 00 WOOD WINDOWS for examples and guidance. In addition, the design must meet the requirements of UFC 1-200-02, High Performance and Sustainable Building Requirements, "Moisture Control" and meet minimum building envelope requirements of UFC 3-101-01 "Architecture" including fenestrations and glazing.
****

The condensation index rating must be [_____] as determined using National Fenestration Rating Council approved software THERM.

2.5 [SKYLIGHT][AND][TRANSLUCENT PANEL] SYSTEMS

****

NOTE: A wide variety of skylight configurations, features, fastening systems, and accessories is commercially available. Unique details of the roof system, which could affect the skylight installation, will be shown on the Contract drawings. It is not possible to indicate all possible combinations and selections which may be utilized in adapting this guide specification to a particular project; therefore, careful editing is necessary to assure that the project is properly and adequately specified.

Since the skylight becomes an integral element of the roofing system after installation, it must meet or exceed the roof requirements for fire protection, insulation value, energy efficiency rating, thermal performance, air infiltration, and water penetration. Design must meet the requirements of UFC 1-200-02, High Performance And Sustainable Building Requirements and meet minimum building envelope requirements of UFC 3-101-01 "Architecture" including fenestrations and glazing.

****

Submit manufacturer's certificate that the systems meet or exceed specified requirements. Provide systems evaluated and listed (the whole [skylight][and][translucent panel] as a unit, not just a glazing material in the unit) by the recognized building code authorities: ICC and SBCCI-Public Safety Testing and Evaluation Services Inc. Product ratings determined using NFRC 100 and NFRC 200 must be authorized for certification and properly labeled by the manufacturer. Provide [skylight][and][translucent panel] systems meeting the following requirements:

a. Integral perimeter framing system assembly by the manufacturer.

b. Exterior panel faces [crystal] [clear matte] [white] [_____] in color. Interior panel faces [crystal] [clear matte] [white] [_____] in color.

c. Air infiltration at 75 Pa 1.57 psf less than [0.2] [_____] L/s/m^2 [0.04] [_____] cfm/ft^2 and at 300 Pa 6.24 psf less than [0.36][0.5] [_____] L/s/m^2 [0.07][0.1] [_____] cfm/ft^2 in accordance with ASTM E283.

d. Water penetration at test pressure of 718 Pa 15 psf equals zero in accordance with ASTM E331.

e. Manufacturer is responsible for maximum system deflection, in accordance with the applicable building code, and without damage to system performance. Calculate deflection in accordance with engineering principles.

f. Incorporate weepage elements within the perimeter framework of the glazing system for drainage of any condensation or water penetration.

g. System must accommodate movement within the system; movement between the system and perimeter framing components; dynamic loading and release of loads; and deflection of supporting members. Achieve this without damage to system or components, deterioration of weather seals and fenestration properties specified.

h. The exterior panel face must repel an impact of[68 N-m 50 foot-pounds without fracture or tear when impacted by a 83 mm diameter, 2.3 kg 3.25 inch diameter, 5 pound free falling ball dropped from a vertical distance of 3 m 10 feet][271 N-m 200 foot-pounds without fracture or tear when impacted by a 83 mm diameter, 2.3 kg 3.25 inch diameter, 5 pound free falling ball dropped from a vertical distance of 12 m 40 feet] when tested in accordance with UL 972.

i. Provide system meeting the fall through requirements of 29 CFR 1910.23 as demonstrated by testing in accordance with ASTM E661 or ASTM E695, thereby not requiring supplemental screens or railings.

****

NOTE: The selection of anodic or organic coating is based primarily on the desired appearance: anodized finishes provide a metallic appearance and organic finishes provide a painted or metal-like finish (organic finishes are available in a variety of colors). Only allow both types as a Contractor option when the Designer confirms that the desired appearance is available in both types of finishes.

For organic coatings, to provide enhanced resistant to corrosion, weathering, ozone, and UV radiation utilize superior performance powder coat finishes conforming to AAMA 2605 in humid locations and project locations with an ESC of C3 thru C5; baked enamel finishes conforming to AAMA 2603 may be utilized for non-humid locations and ESC C1 or C2 project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Refer to UFC 1-200-01 for determination of ESC for a specific project location.

For anodic coatings, specify Architectural Class I for harsh atmospheres where dust, gases, salts, and other destructive elements will attack metal finish. Also specify Class I for humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Specify Architectural Class II for all atmospheric conditions not requiring Class I.

****

j. Exposed aluminum color must be [a [_____] shade] selected from the manufacturer's standard range. Provide corrosion resistant [baked-on enamel coating in accordance with AAMA 2603 with a total dry film thickness not less than 20 µm 0.8 mil] [superior-performance organic finish in accordance with AAMA 2605] [with total dry film thickness of not less than 30 µm 1.2 mils][anodized finish complying with AA DAF45 and AAMA 611 must be [Architectural Class II (10 µm to 18 µm0.4 mil to 0.7 mil), designation AA-M10-C22-[A31, clear (natural)] [A32, integral color] [A34, electrolytically deposited color]][Architectural Class I (

18 µm0.7 mil or thicker), designation AA-M10-C22-[A41, clear (natural)] [A42, integral color] [A44, electrolytically deposited color] anodized.]].

k. Provide a system requiring no scheduled recoating to maintain its performance or for UV resistance.

l. Design criteria:

  (1) Wind Load [_____]; snow load [_____].

  (2) Frame Blast Loads: Design framing to resist 2.4 kPa 50 pounds per square foot blast load at L/160 deflection.

  (3) Anchor Blast Loads: Design anchors to resist 4.8 kPa 100 pounds per square foot blast load.

m. Use 6063-T6 and 6063-T5 extruded aluminum; all fasteners of stainless steel or plated steel.

2.5.1 Glass Glazed Skylights and Roof Windows

Provide roof windows to withstand dead and live loads caused by pressure and uplift of wind acting normal to the plane of roof and tested by an ICC listed, independent testing and quality control inspection agency to an allowable downward pressure of [0.57-8.71] [_____] MPa [12-182] [_____] psf and an uplift pressure of [1.05-5.03] [_____] MPa [22-105] [_____] psf measured in accordance with ASTM E330/E330M, as recommended by the manufacturer for the type of window tested.

2.5.1.1 Fixed Skylight

Fixed skylight featuring a select wood frame, mortise and tenon joints, gaskets to drain any condensation to the outside, a choice of tempered clear, laminated, insulated daylight area. Provide [aluminum] [copper] protective exterior cladding for protection and low profile appearance. The skylight must have a [ventilation flap that opens to allow air circulation and contains a filter within the flap to keep dust and insects out] [ventilating panel and insect screen with an operator hook that allows easy opening and closing, with control rods, for out-of-reach installations or smooth-turning handle for within-reach installation].

2.5.1.2 Emergency Escape and Rescue Roof Window

Emergency escape and rescue roof window which opens [45] [_____] degrees to satisfy egress requirements for emergency escape. When the unit is closed, a ventilation flap can be opened to allow in fresh air. For easy cleaning from inside the room, the sash rotates completely inward. Insect screen and sunscreen accessories are available.

2.5.1.3 Balcony Roof Window Featuring Dual-Sash Operation

The top sash opens for maximum ventilation and also pivots completely inward for easy cleaning from inside the room; the bottom sash opens outward to create a roof balcony. When the window is closed, a ventilation flap allows fresh air circulation. Insect screen and sunscreen accessories are available.

2.5.2 [Plastic Glazed Unit Skylight][and][Translucent Panels]

2.5.2.1 Dome

Provide factory assembled dome skylight units each consisting of [a single dome or sealed double domes with a 1.5 mm 0.06 inch extruded aluminum frame and 1.5 mm 0.06 inch] [sealed double or triple domes with 1.5 mm 0.06 inch extruded aluminum frame with a polyurethane thermal break to prevent condensation on the interior portion of the frame and 1.75 mm 0.07 inch] extruded aluminum retainer cap. Submit Manufacturer's descriptive data, catalog cuts and certificate stating that products meet or exceed specified requirements. Provide the skylight with an integral condensation gutter with weep hole slots to provide sufficient drainage to the outside; and [clear] [white] [bronze] [_____] dome. Use the manufacturer's standard for self-flashing domes, the curbs, treated wood nailer, and insulation. Uniform design load capacity of composite dome and frame must meet or exceed [1.9] [1.4] [_____] MPa [40] [30] [_____] psf snow load. Insulated curbs with PVC thermal barriers connecting the top and bottom of the inner and outer walls are available.

2.5.2.2 Pyramid

Pyramid skylights are, for all practical purposes, just a configuration alternative to the dome skylights; the requirements specified above for the domes also apply to the pyramids. Pyramid skylight units are available from 1.2 to 6 m 4 to 20 foot square and can be used for both self-flashing or curb mount installations; 22 and 40 degrees are standard. The maximum horizontal thrust load on the pyramid curb is [0.4 to 1.5 kN 90 to 330 lbs (1 panel per side)] [1.8 to 3.2 kN 410 to 730 lbs (2 panels per side)] [3.8 to 5.8 kN 850 to 1300 lbs (4 panels per side)] depending on size. Pyramids are available in grid and tandem models.

2.5.2.3 Vault

Provide [single] [double] glazed vault skylights; barrel vault height, for low rise vaults, at 10 percent of the vault width, and 50 percent of the vault width for half round vaults; provide outside curbs in accordance with the manufacturer's details. Vaults must support a 1.4 or 1.9 MPa 30 or 40 psf roof snow or live load, and a negative 1.2 MPa 25 psf wind load plus dead load; rafter spacing is determined by load requirements but must not exceed 900 mm 36 inches on center for 1.9 MPa 40 psf and 1200 mm 48 inches on center for 1.4 MPa 30 psf. Provide sill members that are factory slotted at anchors for thermal movement, and weep water infiltration and condensation. Use EPDM gaskets. Ship all units over 2.2 m 87 inches unassembled for access to anchors from roof level.

2.5.3 [Framed Skylights][and][Translucent Panels]

Framed skylights must [be designed to [_____] size] [span up to [3.4] [_____] m [12] [_____] feet in a single pitch and up to [6] [_____] m [20] [_____] feet in a double pitch configuration]; determine rafter and purlin spacing by loading requirements. Skylights manufactured in prefabricated sections easy to install are available in a wide range of standardized pitches. Provide [tubular] [I-beam] framing members; deflection of rafters not to exceed [L/175] [L/180] [_____] of the rafter span. A registered professional engineer must size all framing members and design all structural connections; submit a copy of the calculations. Framing includes a primary gutter system with secondary gutters to control water infiltration and condensation runoff from the underside of the glazing material and channel it to the exterior. Design skylight structural members for a live load of [_____] MPa psf and wind load of [_____] MPa psf; do not induce objectionable distortion or stress in fastenings and joinery due to expansion and contraction when subjected to a 55 degree C 100 degree F temperature change.

2.6 FLEXIBLE SEALING TAPE

Provide manufacturer's standard pre-applied sealing tape to closure system at the factory under controlled conditions.

PART 3 EXECUTION

3.1 EXAMINATION

Field verify all submitted opening sizes, dimensions and tolerances; preparation of openings includes isolating dissimilar materials from aluminum system to avoid damage by electrolysis. The installer must examine area of installation to verify readiness of site conditions and to notify the Contractor about any defects requiring correction. Verify when structural support is ready to receive all specified work and to convene a pre-installation conference, if approved by the Contracting Officer, including the Contractor, skylight installer and all parties directly affecting and affected by the specified work. Do not install any materials that show visual evidence of biological growth due to the presence of moisture. Do not commence work until conditions are satisfactory.

3.2 ERECTION

Erect translucent skylight system in accordance with the approved shop drawings supplied by the manufacturer. Submit drawings showing fabrication details, materials, dimensions, installation methods, anchors, and relationship to adjacent construction. Fasten and seal in accordance with the manufacturer's shop drawings. Remove all panel, after other trades have completed work on adjacent materials. Carefully inspect and adjust panel installation as necessary to ensure proper installation and weather-tight conditions. provide all staging, lifts and hoists required for the complete installation and field measuring. Install system clean of dirt, debris or staining and thoroughly examined for removal of all protective material prior to final inspection of the designated work area. Do not use snow rakes on roof windows or skylights.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 71 00 (February 2016)**
Change 4 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-08 71 00 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 08 - OPENINGS

SECTION 08 71 00

DOOR HARDWARE

02/16, CHG 4: 02/22

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 71 00 (February 2016)**
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SECTION 08 71 00

DOOR HARDWARE

02/16, CHG 4: 02/22

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NOTE: This guide specification covers the requirements for finish hardware for permanent structures. All items of finish hardware necessary for completion of the project and not specified in other sections should be included in this section.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: On the drawings, show:

1. Location, class, and hourly rating of fire doors;

2. Location and installation details for blocking behind door stops (wall bumpers) mounted on wallboard partitions; and

3. Either hardware set numbers (e.g. HW-2) in the door schedule, or list doors by number in each hardware set.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM F883	(2013; R 2022) Standard Performance Specification for Padlocks

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.1	(2021) Butts and Hinges
ANSI/BHMA A156.2	(2022) Bored and Preassembled Locks and Latches
ANSI/BHMA A156.3	(2020) Exit Devices
ANSI/BHMA A156.4	(2024) Door Controls - Closers
ANSI/BHMA A156.5	(2020) Cylinder and Input Devices for Locks
ANSI/BHMA A156.6	(2021) Architectural Door Trim
ANSI/BHMA A156.7	(2016) Template Hinge Dimensions
ANSI/BHMA A156.8	(2021) Door Controls - Overhead Stops and Holders

ANSI/BHMA A156.10	(2024) Power Operated Pedestrian Doors
ANSI/BHMA A156.12	(2022) Interconnected Locks & Latches
ANSI/BHMA A156.13	(2022) Mortise Locks & Latches Series 1000
ANSI/BHMA A156.14	(2013) Sliding and Folding Door Hardware
ANSI/BHMA A156.15	(2021) Release Devices Closer Holder, Electromagnetic and Electromechanical
ANSI/BHMA A156.16	(2023) Auxiliary Hardware
ANSI/BHMA A156.17	(2019) Self Closing Hinges & Pivots
ANSI/BHMA A156.18	(2020) Materials and Finishes
ANSI/BHMA A156.19	(2013) Power Assist & Low Energy Power Operated Doors
ANSI/BHMA A156.21	(2019) Thresholds
ANSI/BHMA A156.22	(2021) Gasketing
ANSI/BHMA A156.23	(2010) Electromagnetic Locks
ANSI/BHMA A156.24	(2012) Delayed Egress Locking Systems
ANSI/BHMA A156.25	(2013) Electrified Locking Devices
ANSI/BHMA A156.26	(2012) Continuous Hinges
ANSI/BHMA A156.27	(2011) Power and Manual Operated Revolving Pedestrian Doors
ANSI/BHMA A156.29	(2012) Exit Locks, Exit Alarms, Alarms for Exit Devices
ANSI/BHMA A156.30	(2014) High Security Cylinders
ANSI/BHMA A156.31	(2013) Electric Strikes and Frame Mounted Actuators
ANSI/BHMA A156.36	(2010) Auxiliary Locks

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 101	(2024) Life Safety Code

NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8	(2023) Specifications for Standard Steel Doors and Frames

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

UL SOLUTIONS (UL)

UL 14C	(2006; Reprint Oct 2021) UL Standard for Safety Swinging Hardware for Standard Tin-Clad Fire Doors Mounted Singly and in Pairs
UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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NOTE: If sustainable door hardware is available, choose bracketed option.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Manufacturer's Detail Drawings; G, [_____]

Verification of Existing Conditions; G, [_____]

Hardware Schedule; G, [_____]

Keying System; G, [_____]

SD-03 Product Data

Hardware Items; G, [_____]

****
NOTE: For special hardware items requiring shop drawings, add submittal requirement for SD-04, Drawings. Do not require shop drawings for standard commercial hardware.
****

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance Data

Hardware Schedule Items, Data Package 1; G, [_____]

SD-11 Closeout Submittals

Key Bitting

1.3 SHOP DRAWINGS

Submit manufacturer's detail drawings indicating all hardware assembly components and interface with adjacent construction.[Indicate power components and wiring coordination for electrified hardware.] Base shop drawings on verified field measurements and include verification of existing conditions.

1.4 PRODUCT DATA

Indicate fire-ratings at applicable components. Provide documentation of ABA/ADA accessibility compliance of applicable components, as required by

36 CFR 1191 Appendix D - Technical.

1.5 HARDWARE SCHEDULE

Provide Hardware Item List and Hardware Schedule containing the following information, and additional information as needed to identify the complete make up of each hardware set and its application to each opening:

1.5.1 Hardware Item List:

a. Hardware Type

b. Item Number

c. Quantity

d. Size(s)

e. Reference Publication / Type Number

f. Manufacturer's Name / Catalog Number

g. Key Control Symbols

h. UL Mark (If fire rated and listed)

i. BHMA Finish(es)

j. Remarks

1.5.2 Hardware Schedule

a. Hardware Set Number

b. Opening Number(s)

c. Opening Description (single/double leaf, hand, size, door/frame material)

d. Fire Rating

e. Sound Rating

f. Hardware Items

g. Quantity

h. Size

i. BHMA Finish

j. Remarks

In addition, submit hardware schedule data package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6 KEY BITTING CHART REQUIREMENTS

1.6.1 Requirements

Submit key bitting charts to the Contracting Officer prior to completion of the work. Include:

a. Complete listing of all keys (e.g. AA1 and AA2).

b. Complete listing of all key cuts (AA1-123456, AA2-123458).

c. Tabulation showing which key fits which door.

d. Copy of floor plan showing doors and door numbers.

e. Listing of 20 percent more key cuts than are presently required in each master system.

1.7 QUALITY ASSURANCE

1.7.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges,[pivots,] and closers of one lock, hinge,[pivot,] or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

1.7.2 Key Shop Drawings Coordination Meeting

Prior to the submission of the key shop drawing, the Contracting Officer, Contractor, Door Hardware Subcontractor, using Activity and Base Locksmith must meet to discuss and coordinate key requirements for the facility.

1.8 DELIVERY, STORAGE, AND HANDLING

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NOTE: Whenever construction master keying is required, permanent keys (and removable cores) should be sent directly to the Contracting Officer.

****

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown on hardware schedule.[Deliver permanent keys[and removable cores] to the Contracting Officer, either directly or by certified mail. Deliver construction master keys with the locks.]

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

Hardware applied to metal [or to prefinished]doors must be manufactured using a template. Provide templates to door and frame manufacturers in accordance with ANSI/BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 72 for door alarms, NFPA 80 for fire doors, NFPA 101 for exit doors, NFPA 252 for fire tests of door assemblies, ABA/ADA accessibility requirements, and all other requirements indicated, even if such hardware is not specifically mentioned in paragraph HARDWARE SCHEDULE.[Provide swinging hardware for tin-clad fire doors in accordance with UL 14C.] Provide Underwriters Laboratories, Inc. labels for such hardware in accordance with UL Bld Mat Dir or equivalent labels in accordance with another testing laboratory approved in writing by the Contracting Officer.

2.3 HARDWARE ITEMS

****

NOTE: It is essential for the specifier to have current editions of the ANSI/BHMA A156 series standards, available online at http://www.buildershardware.com from Builders Hardware Manufacturers Association, 355 Lexington Avenue, 15th Floor, New York, New York, 10017. For Department of Defense (DoD) employees, these standards are available through the Whole Building Design Guide (WBDG) / IHS. The specifier should also have publications of the ANSI/BHMA A156 series Standards, for guidance in selecting and scheduling finish hardware.

Levels of quality are standardized for particular hardware items in the ANSI/BHMA A156 Standards. These product grades (grade 1, 2, or 3 - with grade 1 being the highest) are defined by progressive levels of performance benchmarks in each applicable ANSI/BHMA standard. The grade of any particular architectural hardware item can also be ascertained by looking at its BHMA product number. This standardized BHMA numbering system also delineates other important classification information, such as the predominant material used, product category, and function of a specific hardware item.

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NOTE: For projects at Camp Lejeune and New River:

1. Specify Series 4000, Grade 1, locks and latches with 70 mm 2-3/4 inch backset.

2. Specify interchangeable cores with seven pin tumblers.

3. Specify "All locks must have interchangeable cores of Grade 1 products from one manufacturer. Verify manufacturer compliance with existing Base hardware systems."

4. For offices, entrances, classrooms, and maintenance shops, specify lock function F81, unless F82 or F84 is more appropriate.

5. For mechanical rooms and pipe chases, specify lock function F86 (storeroom lock, outside knob

always rigid).

6. For sleeping room doors, specify one deadbolt, E2151, with concealed mounting screws, and one latch set, F75.

7. For Bachelor Enlisted Quarters (BEQs), require a separate master keying system for each floor of each building.

****

Clearly and permanently mark with the manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts and closers where the identifying mark is visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover. Coordinate electrified door hardware components with corresponding components specified in Division 28 ELECTRONIC SECURITY SYSTEMS (ESS).

2.3.1 Hinges

Provide in accordance with ANSI/BHMA A156.1. Provide hinges that are 114 by 114 mm 4-1/2 by 4-1/2 inch unless otherwise indicated. Construct loose pin hinges for interior doors and reverse-bevel exterior doors so that pins are non-removable when door is closed. Other anti-friction bearing hinges may be provided in lieu of ball bearing hinges.

****

NOTE: Use full-mortise (butt) hinges except where special types are required. Use swing-clear hinges where necessary to keep door opening completely clear when door is opened 90 to 95 degrees. Use wide-throw hinges where necessary to keep door leaf clear of wall, casings, jambs, or reveals. Use antifriction-bearing hinges on high-frequency or extra-heavy doors, and on doors equipped with closers. Use plain-bearing hinges on low-frequency doors up to 900 mm 3 feet wide and without closers. Use hospital tips in neuropsychiatric areas of medical facilities. In general, full-mortise hinges for interior doors should be steel with BHMA 600 finish (primed for painting). Hinges on natural wood or plastic surfaced interior doors should be steel with BHMA 652 finish (satin chromium plated) or BHMA 639 finish (satin bronze plated) to match finish of other door hardware. Hinges for exterior doors should be stainless steel with BHMA 630 finish or solid brass or bronze with BHMA 626 finish. Use stainless steel with BHMA 630 finish on all exterior hinges in humid conditions or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Provide interior hinges at project locations with ESC classifications of C3 thru C5 of cast or forged bronze or stainless steel, Type 302 or 304. Fire rated doors must have base metal of steel or stainless steel. Plated steel hinges may rust if

used on exterior doors. Use two hinges for doors 1500 mm 60 inch or less in height and one additional hinge for each additional 750 mm 30 inches (or fraction thereof) of door height.

1. Select and size hinges for lead lined, unusually heavy, and high-frequency doors on an individual basis.

2. The 114 by 114 mm 4-1/2 by 4-1/2 inch listed is for 44 mm 1-3/4 inch doors up to 915 mm 3 feet wide and with up to 20 mm 3/4 inch trim projection, and covers the majority of openings. For other doors, determine hinge width in accordance with:

Twice the door thickness plus trim projection, minus 13 mm 1/2 inch, or 2(t plus p) minus 1/2. If answer falls between regular hinge sizes, use nearest larger size. Formula is for hinges set back 6 mm 1/4 inch from edge of door.

Hinge Sizes Chart

Thickness of Doors in mm	Width of Doors in mm	Height of Hinges (Length of Joint) in mm
22 to 29 screen	To 915	76
35	To 815	89
35	Over 815 to 940	102
44	To 915	114
44	Over 915 to 1220	127 Heavy Weight
44	Over 1220	152 Heavy Weight
51, 57, and 64	To 1065	127 Heavy Weight
51, 57, and 64	Over 1065	152 Heavy Weight

Hinge Sizes Chart

Thickness of Doors in inches	Width of Doors in inches	Height of Hinges (Length of Joint) in inches
7/8 to 1-1/8 screen	To 36	3
1-3/8	To 32	3-1/2
1-3/8	Over 32 to 37	4

Hinge Sizes Chart		
Thickness of Doors in inches	**Width of Doors in inches**	**Height of Hinges (Length of Joint) in inches**
1-3/4	**To 36**	**4-1/2**
1-3/4	**Over 36 to 48**	**5 Heavy Weight**
1-3/4	**Over 48**	**6 Heavy Weight**
2, 2-1/4 and 2-1/2	**To 42**	**5 Heavy Weight**
2, 2-1/4 and 2-1/2	**Over 42**	**6 Heavy Weight**

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[2.3.1.1 Protection Devices

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NOTE: In accordance with UFC 4-740-14 Design: Child Development Centers provide finger guards to protect children's fingers from being crushed or injured in the hinge space of a door or gate.

****

Provide full height hand and finger protection device at the hinge-side area opening of doors and gates. Provide hinge-side protection devices on both sides of doors and gates, covering hinges and space between door and frame when doors are in the open position. The installed device must push hand and fingers out of the opening and away from a crushing hazard.

]2.3.2 Continuous Hinges

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NOTE: For heavy duty doors, where required. See ANSI/BHMA A156.26 and manufacturers' literature for types available. Coordinate with security door specifications.

****

Where continuous hinges are required, provide in accordance with ANSI/BHMA A156.26.

2.3.3 Pivots

****

NOTE: For extra heavy doors, pivots are sometimes preferable to hinges, particularly on entrance doors and lead-lined doors. See ANSI/BHMA A156.4 and manufacturers' literature for types available.

****

Provide in accordance with ANSI/BHMA A156.17.

2.3.4 Spring Hinges

****

NOTE: Use spring hinges only where closers are not practicable and for gates at counters. Ensure that specified spring hinges are large enough and strong enough to serve their purpose adequately. See ANSI/BHMA A156.17 for types available. See manufacturers catalogs for recommendations on sizes, quantities, and styles of spring hinges.

****

Provide in accordance with ANSI/BHMA A156.17.

2.3.5 Locks and Latches

****

NOTE: Specify Series 1000, in paragraph MORTISE LOCKS AND LATCHES, for hollow metal doors where security is a major factor. See ANSI/BHMA A156.13, Appendix A, Users' Guide, for guidance on Security Grades.

For Unaccompanied Housing UH/BEQ sleeping room doors, specify electronic key card locks used in current industry standards. For Navy and Marine Corps UH spec writer should also confirm this locking requirement with FC 4-721-10N to ensure the sleeping room locking requirement has not changed. Check with activity housing managers to determine preference.

For doors between sleeping room and shared bath, use a privacy lock, F76, Grade 1, and a deadlock, E0151 (key by thumb turn) keyed like the sleeping room entrance door and with the key on the bathroom side.

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NOTE: Choose the applicable paragraph(s) from the following.

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NOTE: Insert this paragraph into all locks and locksets in humid conditions or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

[a. At exterior locations provide locksets of full stainless steel type 302 or 304 construction including fronts, strike, escutcheons, knobs, bolts and all interior working parts. Marine Grade I, fully non-ferrous.

b. In non-air-conditioned interior environments or humid interior environments, provide interior locksets on the same Marine Grade I, fully non-ferrous as exterior locksets.

]2.3.5.1 Mortise Locks and Latches

Provide in accordance with ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2.[Provide factory installed lead lining in locks for lead shielded doors.][Provide mortise locks with escutcheons not less than 178 by 57 mm 7 by 2-1/4 inch with a bushing at least 6 mm 1/4 inch long. Cut escutcheons to fit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges.] Provide knobs and roses of mortise locks with screwless shanks and no exposed screws.

2.3.5.2 Bored Locks and Latches

Provide in accordance with ANSI/BHMA A156.2, Series 4000, Grade 1.[Provide factory installed lead lining in locks for lead -shielded doors.]

2.3.5.3 Residential Bored Locks and Latches

****

NOTE: For temporary buildings and family housing only. Delete if not applicable. See ANSI/BHMA A156.2 for types available.

****

Provide in accordance with ANSI/BHMA A156.2, Series 4000, Grade 2. Install locks for exterior doors with threaded roses or concealed machine screws.

[2.3.5.4 Interconnected Locks and Latches

****

NOTE: For exterior doors in family housing units only. See BHMA A156.12 and manufacturers' literature for types available.

****

Provide in accordance with ANSI/BHMA A156.12. Provide F96 or F97, unless otherwise specified.

]2.3.5.5 Hospital Latches

Push-pull latch set similar and equal to Glynn-Johnson HL6, 13 mm 1/2 inch throw, [70 mm2-3/4 inch] [127 mm5 inch] backset, to fit 161 cutout. Cover approximately 64 by 140 mm 2-1/2 by 5-1/2 inch, handle approximately 38 by 114 mm 1-1/2 by 4-1/2 inch, projection approximately 64 mm 2-1/2 inch, covers and handles of stainless steel, BHMA 630 finish, engraved "PUSH" and "PULL" on handles, push handle pointing up, pull handle pointing down.

2.3.5.6 Auxiliary Locks

****

NOTE: Delete if not applicable. See ANSI/BHMA A156.36 for types available.

****

Provide in accordance with ANSI/BHMA A156.36, Grade 1.

2.3.5.7 Combination Locks

****
NOTE: For medical projects only, include the first bracketed option.
****

[Key pharmacy door locks separately from building master key system.]Heavy-duty, mechanical combination lockset with five push buttons, standard sized knobs, 20 mm 3/4 inch deadlocking latch, 70 mm 2-3/4 inch backset. Locks to operate by pressing two or more of the buttons in unison or individually in the proper sequence. Inside knob operates the latch. Provide a keyed cylinder on the interior to permit setting the combination.[Provide a keyed [removable core]cylinder on the exterior to permit bypassing the combination.][Provide a thumb turn on the interior to activate passage set function so that outside knob operates latch without using the combination.]

2.3.6 Exit Devices

****
NOTE: Due to the difficulty in securing exit devices against unauthorized use, they should only be specified where required by NFPA 101. Use single exit doors with locksets in preference to pairs of doors. When pairs are required, specify removable mullions and rim type devices. Vertical rod devices require use of an overlapping astragal and door coordinator for security and fire protection. They should be used only where mullions are not feasible.
****

****
NOTE: Insert the last bracketed paragraph for all exit devices in humid conditions or project locations with Environmnental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.
****

Provide in accordance with ANSI/BHMA A156.3, Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Provide open back strikes for pairs of doors with mortise and vertical rod devices. Provide [touch bars in lieu of conventional crossbars and arms.][Provide escutcheons not less than 178 by 57 mm 7 by 2-1/4 inch.]

[Use stainless steel or bronze base metal with plated finishes. Also include stainless steel fasteners and screws.

]2.3.7 Exit Locks With Alarm

Provide in accordance with ANSI/BHMA A156.3 and ANSI/BHMA A156.29, Type E0431 (with full width horizontal actuating bar) for single doors; Type E0431 (with actuating bar) or E0471 (with actuating bar and top and bottom bolts, both leaves active) for pairs of doors, unless otherwise specified.[Provide terminals for connection to remote indicating panel.][Provide outside control key.] Provide door alarms integrated with the fire alarm system in accordance with NFPA 72.

2.3.8 Cylinders and Cores

****

NOTE: When an extension of an existing system is required, the manufacturer's name and type of locks should be indicated. Confirm existing hardware requirements with Contracting Officer's Representative (COR). Requirements may include but are not limited to interchangeable cores, product level of quality, compatibility, if any, with other manufacturers' hardware components.

Specify the system which will best meet the activity's needs without restricting competition.

For projects at Lajes Field, Azores, delete first paragraph; use second paragraph.

****

[Provide cylinders and cores for new locks, including locks provided under other sections of this specification.]Provide cylinders and cores with [six] [seven] pin tumblers. Provide cylinders from the products of one manufacturer, and provide cores from the products of one manufacturer.[Rim cylinders, mortise cylinders, and knobs of bored locksets have interchangeable cores which are removable by special control keys. Stamp each interchangeable core with a key control symbol in a concealed place on the core.]

[Provide cylinders for new locks, including locks provided under other sections of this specification. Provide fully compatible cylinders of Grade 1 products from products of one manufacturer with interchangeable cores that are removable by a special control key. Factory set the cores with [six] [seven] pin tumblers using the A4 system and F keyway. Submit a core code sheet with the cores. Provide master keyed cores in one system for this project. Provide construction interchangeable cores.

][For medical projects, key pharmacy door locks separately from building master key system.

]2.3.8.1 High Security Cylinders

Provide in accordance with ANSI/BHMA A156.30, security level [A][B][C] for all high security cylinder components.

2.3.9 Push Button Mechanisms

Provide in accordance with ANSI/BHMA A156.5, Grade 1.

2.3.10 Electrified Hardware

****

NOTE: Coordinate electrified hardware operation and specific backup power requirements with site safety personnel, site fire authority, and applicable life safety codes. Determine whether signal switches are required for the particular site application.

****

Comply with the requirements of NFPA 70 for wiring of electrified hardware.

2.3.10.1 Electric Strikes and Frame Mounted Actuators

****

NOTE: Specify electric strikes and lock functionality when power fails. Choose one of three bracketed choices (release automatically, remain secure or remain maintained).

****

Provide in accordance with ANSI/BHMA A156.31, Grade 1. Provide electric strikes and actuators as required to meet operational requirements. Provide electric strikes that [release automatically] [remain secure] [remain maintained] during power failure.[Provide a separate power supply for electric strikes, other locking devices and ancillary parts.][Provide battery backup for continued operation during power failure.] Provide strikes and actuators with a minimum opening force of 101 kilonewtons (kN) 2300 pounds.

Provide facility interface devices that use direct current (dc) power to energize the solenoids. Provide electric strikes and actuators that incorporate end-of-line resistors to facilitate line supervision by the system. If not incorporated into the electric strike or local controller, provide metal oxide resistors (MOVs) to protect the controller from reverse current surges.

2.3.10.1.1 Solenoid

Provide actuating solenoid for strikes and actuators that are rated for continuous duty, cannot dissipate more than 12 Watts and must operate on 12 or 24 Volts dc. Inrush current cannot exceed 1 ampere and the holding current cannot be greater than 500 milliamperes. Actuating solenoid must move from fully secure to fully open positions in less than 500 milliseconds.

2.3.10.1.2 Signal Switches

Provide strikes and actuators with signal switches to indicate to the system when the bolt is not engaged or the strike mechanism is unlocked. Signal switches must report a forced entry to the system.

2.3.10.1.3 Tamper Resistance

[Provide strike guards that prevent tampering with the latch bolt of the locking hardware or the latch bolt keeper of the electric strike. Strike guards to bolt through the door using tamper resistant screws. Provide strike guards made of 3 mm 1/8 inch thick brass and that are 286 mm 11-1/14 inch high by 41 mm 1-5/8 inch wide, with a minimum 4 mm 5/32 inch wide offset.

]2.3.10.1.4 Coordination

Provide electric strikes and actuators of a size, weight and profile compatible with each specified door frame. Field verify installation clearances prior to procurement.

2.3.10.1.5 Mounting Method

Provide electric strikes and actuators suitable for use with single and double doors, with mortise or rim type hardware specified, and for right or left hand mounting as specified. In double door installations, locate the lock in the active leaf and monitor the fixed leaf.

2.3.10.2 Electrified Mortise Locks

****

NOTE: Electrified mortise locks provide an excellent solution for stairwell doors that require positive latching when unlocked. A power transfer hinge or raceway is required to get power and signal wire from the door to the doorframe for a secure and fully enclosed connection to the access control system. Specify power transfer hinges for doors with electrified hardware.

****

Provide in accordance with ANSI/BHMA A156.25, Grade 1. Provide electrified mortise locks that [release automatically] [remain secure] [remain maintained] during power failure. Provide facility interface devices that use dc power to energize solenoids. Provide solenoids, resisters, and signal switches in accordance with paragraph ELECTRIC STRIKES AND FRAME MOUNTED ACTUATORS.

2.3.10.2.1 Power Transfer Hinges

Provide power transfer hinges with each electrified lock that route power and monitoring signals from the lockset to the door frame. Coordinate power transfer hinges with door frames.

2.3.10.3 Card Readers and Keypad Access Control Hardware

****

NOTE: Verify card readers are compatible with card type. Coordinate this section with Division 28 ELECTRONIC SECURITY SYSTEMS (ESS) requirements.

****

Provide in accordance with ANSI/BHMA A156.5 and ANSI/BHMA A156.25, Grade 1 components. Provide devices that are tamper alarmed, tamper and vandal resistant, solid state, and do not contain electronics which could compromise the access control subsystem should the subsystem be attacked. Provide surface, semi-flush, pedestal, or weatherproof mountable devices as specified for each individual location.[Each device to contain a visual display, either mounted on the face, or on an integral part of the device, to indicate access or exit request processing, request approval, and request denial.] Provide [proximity] [insertion] [swipe through] type card readers capable of reading [magnetic stripe] [high coercivity magnetic stripe] [Wiegand] [Hollerith] [proximity] [Transmissive Infrared] [Keypad] [[_____]/Keypad] [Smart Card] [Biometric] [_____] type access control cards. Provide keypads that contain an integral 12-digit tactile keyboard with digits [arranged in numerical order]. Provide keypads that are [a standalone device] [or] [integrated into the card reader]. Coordinate access control hardware with corresponding devices and systems specified in Division 28 ELECTRONIC SECURITY SYSTEMS (ESS).

2.3.10.4 Power Operated Pedestrian Door Hardware

Provide in accordance with ANSI/BHMA A156.10, Grade 1.

2.3.10.5 Release Devices

In accordance with ANSI/BHMA A156.15, Grade 1.

2.3.10.5.1 Closer Holders

Provide [floor] [door] [header] mounted closer holder devices connected by [separate releasing] [integral releasing] to [fire] [smoke] detecting devices.

2.3.10.5.2 Release Devices

Provide [wall] [floor] [door] mounted [Electromagnetic] [electromechanical] [free swinging] release devices connected to [fire] [smoke] detecting devices.

2.3.10.6 Power Assist and Low Energy Power Operated Doors

Provide in accordance with ANSI/BHMA A156.19, Grade 1.

2.3.10.7 Electromagnetic Locks

Provide in accordance with ANSI/BHMA A156.23, Grade 1. Provide electromagnetic locks that do not contain any moving parts and depend solely upon electromagnetism to secure a portal by generating at least 5.3 kN 1200 pounds of holding force. The lock must interface with the local processors without external, internal or functional alteration of the local processor. The electromagnetic lock must incorporate an end of line resistor to facilitate line supervision by the system. Provide metal-oxide resistors (MOVs) to protect controllers from reverse current surges, if not incorporated into the electromagnetic lock or local controller.

2.3.10.7.1 Armature

Provide electromagnetic locks with internal circuitry to eliminate residual magnetism and inductive kickback. Provide atuating armature that operates on 12 or 24 Volts dc and cannot dissipate more than 12 Watts. Holding current must be less than 500 milliamperes. Actuating armature must take less than 300 milliseconds to change the status of the lock from fully secure to fully open or fully open to fully secure.

2.3.10.7.2 Tamper Resistance

Provide lock mechanism encased in hardened guard barriers to deter forced entry.

2.3.10.7.3 Mounting Method

Provide electromagnetic lock suitable for use with single and double door with mortise or rim type hardware and compatible with right or left hand mounting.

2.3.10.8 Delayed Egress Locking System

Provide in accordance with ANSI/BHMA A156.24, Grade 1.

2.3.10.9 Power and Manual Operated Revolving Pedestrian Doors

Provide in accordance with ANSI/BHMA A156.27, Grade 1.

2.3.11 Keying System

****

NOTE: Do not require higher levels of master keying than necessary because each level decreases the security of the locks. Specify a construction system where necessary to ensure security after construction is complete.

****

Provide[a [great][grand] master keying system][an extension of the existing keying system. Existing locks were manufactured by [_____] and [do not] have interchangeable cores.][Provide[a construction master keying system][construction interchangeable cores].][Provide key cabinet as specified.]

****

NOTE: Add the following for Naval Submarine Base, Kings Bay, Georgia. Coordinate with the lead paragraph.

****

[The Government will provide permanent cylinders with cores and keys for mortise locksets, auxiliary locks, and exit devices.][Provide cylinders of Grade 1 products from one manufacturer. Notify the Contracting Officer 90 days prior to the required delivery of the cylinders. Provide temporary cores and keys for the Contractor's use during construction, and for testing of locksets.]

2.3.12 Lock Trim

****

NOTE: For facilities that have not been certified as accessible only to able-bodied personnel, specify lever handles for doors that will be accessible to disabled persons and knurled or abrasive coated knobs and lever handles for doors that are accessible to the visually impaired and that lead to dangerous areas. When only lever handles will be required, delete the paragraph KNOBS AND ROSES and the first bracket statement in the paragraph LEVER HANDLES.

****

Provide cast, forged, or heavy wrought construction and commercial plain design for lock trim.

2.3.12.1 Knobs and Roses

Provide in accordance with ANSI/BHMA A156.2 and ANSI/BHMA A156.13 for knobs, roses, and escutcheons. For unreinforced knobs, roses, and escutcheons, provide a 1.25 mm 0.050 inch thickness. For reinforced knobs, roses, and escutcheons, provide an outer shell thickness of 0.89 mm 0.035 inch and a combined total thickness of 1.78 mm 0.070 inch, except at knob shanks. Provide knob shanks 1.52 mm 0.060 inch thick.

2.3.12.2 Lever Handles

Provide lever handles [where indicated in the Hardware Schedule]. Provide in accordance with ANSI/BHMA A156.3 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when force in excess of that specified in ANSI/BHMA A156.13 is applied to the lever handle. Provide lever handles return to within 13 mm 1/2 inch of the door face.

2.3.13 Keys

****

NOTE: For projects at Lejes Field, Azores, delete first paragraph; use second paragraph.

****

[Furnish][Provide] one file key, one duplicate key, and one working key for each key change [and for each master [and grand master] keying system]. [Furnish][Provide] one additional working key for each lock of each keyed-alike group.[[Furnish][Provide] two additional keys for each sleeping room.][[Furnish][Provide] [[_____] great grand master keys,] [[_____] construction master keys,] [and [_____] control keys for removable cores].][[Furnish][Provide] a quantity of key blanks equal to 20 percent of the total number of file keys.] Stamp each key with appropriate key control symbol and "U.S. property - do not duplicate." Do not place room number on keys.

[[Furnish][Provide] seven change keys for each interchangeable core, [furnish][provide] two control keys, six maters keys, and six construction master keys.[[Furnish][Provide] a quantity of key blanks equal to 20 percent of the total number of change keys.] Stamp each key with appropriate key control symbol and "U.S. property - do not duplicate." Do not place room numbers on keys.

]2.3.14 Door Bolts

****

NOTE: Use chain and foot bolts for exceptionally high doors and where use of flush bolts is impracticable.

****

Provide in accordance with ANSI/BHMA A156.16. Provide dustproof strikes for bottom bolts, except at doors having metal thresholds. Provide automatic latching flush bolts in accordance with ANSI/BHMA A156.3, Type 25.

2.3.15 Closers

****

NOTE: Use closers Type C02011 with o.f. PT 4C for surface applications, except use parallel arm closers, C02021, on outswinging exterior doors. Specify holder arms, C02051 and C02061, where doors must be held open from 90 degrees to 135 degrees, or to 180 degrees where desired. Do not use holder arms for fire-rated doors. Use overhead concealed

closers on main entrance doors of monumental buildings, double-acting doors, and for other openings where concealment is necessary. Avoid overhead concealed closers with wood doors. Where they cannot be avoided, modify section on wood doors to require a 125 mm 5 inch head rail. Avoid use of floor-concealed closers, but where required, ascertain that floor slab design will not interfere with closer case.

****

****

NOTE: Insert the bracketed paragraph for all doors in humid conditions or project locations with Environmnental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Provide in accordance with ANSI/BHMA A156.4, Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, [full size covers, except at storefront mounting,] [pivots,] [cement cases,] and other features necessary for the particular application. Size closers in accordance with manufacturer's printed recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty.

[Use stainless steel inside bracketed or door mounted closers on exterior doors. Non-ferrous closers, such as aluminum or cast bronze, are permissible where door utilization is minimal. On interior doors use closers of 302 or 304 stainless steel or non-ferrous materials. On surface-mounted closers use or apply rust inhibiting finish on all ferrous parts. Also apply this finish on concealed closers.

]2.3.15.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation in locations that will be visible after installation.

2.3.16 Overhead Holders

****

NOTE: Use overhead holders for doors which will not swing 180 degrees and where there is no adjacent wall to accommodate wall type holder and stop. If holder must be on outside of doors, specify bronze (C12511) with satin chrome finish (626). Overhead holders can be specified as "Stop Only" where the hold open feature is not desirable.

****

Provide in accordance with ANSI/BHMA A156.8.

2.3.17 Door Protection Plates

****

NOTE: Use pulls attached to plates. Use 200 by 400 mm 8 by 16 inch push plates where door design permits. Use push bars or push and pull bars on all-glass doors. Use kick plates for push sides of doors equipped with closers. Use door plates in high traffic areas and where damage from rolling carts, shoe scuffs, and other potential damage to the bottom of doors is likely. Use door plates for hospital and clinic environments. Use armor plates on heavy-duty doors where hand trucks or other heavy objects regularly passing through the door could cause damage.

****

Provide in accordance with ANSI/BHMA A156.6.

2.3.17.1 Sizes of [Armor] [Mop] [and] Kick Plates

****

NOTE: NFPA 80 requires that door plates be not more than 400 mm 16 inch high. Where wheelchair traffic is anticipated, kick plates should be 400 mm 16 inch high.

****

50 mm2 inch less than door width for single doors; 25 mm 1 inch less than door width for pairs of doors. Provide [[200] [1200] mm [8] [10] inch kick plates for flush doors] [and] [125 mm1 inch less than height of bottom rail for panel doors]. Provide a minimum [900] [1200] [_____] mm [36] [48] [_____] inch armor plates for flush doors [and] completely cover lower panels of panel doors, except 400 mm 16 inch high armor plates on fire doors. Provide [100] [150] mm [4] [6] inch mop plates.

2.3.17.2 Edge Guards

****

NOTE: Edge guards should be detailed on drawings; stipulate items such as material, gauge, and dimensions. Use edge guards in addition to armor plates on heavy-duty doors where hand trucks or other heavy objects passing through could damage doors. They are not required at hinge stiles on doors equipped with "swing clear" hinges.

****

Stainless steel, of same height as armor plates. Apply to [hinge stile] [lock stile] [meeting stiles].

2.3.18 Door Stops and Silencers

****

NOTE: Specify wall bumpers Type L02251 wherever practical, except where they would be mounted on stud walls or partitions. Use floor stops only where necessary to prevent doors from hitting towel bars or similar items, as they create stumbling hazards and interfere with floor cleaning equipment.

****

Provide in accordance with ANSI/BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

2.3.19 Padlocks

****

NOTE: See referenced specification for types, grades and options available.

****

Provide in accordance with ASTM F883.

2.3.20 Thresholds

****

NOTE: Where vertical rod exit devices are used, and for other outswinging exterior doors, ANSI/BHMA A156.21, type J35100, is recommended.

****

Provide in accordance with ANSI/BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening out, unless specified otherwise.

2.3.21 Weatherstripping Gasketing

****

NOTE: Weatherstripping is also specified in Section 08 11 13 STEEL DOORS AND FRAMES Section 08 11 16 ALUMINUM DOORS AND FRAMES and Section 08 14 00 WOOD DOORS. Coordinate requirements to avoid conflict and duplication. Do not use interlocking type or spring tension type on metal doors and frames.

****

****

NOTE: Maximum air leakage rates are 2.19 by 10-5 cms per sq m 0.5 cfm per sq. ft. of door area for residential swinging doors and 5.48 by 10-5 cms per sq m 1.25 cfm per sq. ft. of door area for non-residential swinging doors.

****

Provide in accordance with ANSI/BHMA A156.22. Provide the type and function designation where specified in paragraph HARDWARE SCHEDULE. Provide a set to include head and jamb seals[, sweep strips,] [and, for pairs of doors, astragals]. Air leakage of weatherstripped doors not to exceed [2.19 by 10-5] [5.48 by 10-5] cms [0.5] [1.25] cubic feet per minute of air per square meter foot of door area when tested in accordance with ASTM E283. Provide weatherstripping with one of the following:

****

NOTE: At exterior doors, retainers at sills are necessary for air leakage and for weather and vermin protection.

****

2.3.21.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 1.25 mm 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide [clear (natural)] [bronze] anodized aluminum.

2.3.21.2 Interlocking Type

Zinc or bronze not less than 0.45 mm 0.018 inch thick.

2.3.21.3 Spring Tension Type

Spring bronze or stainless steel not less than 0.20 mm 0.008 inch thick.

2.3.22 [Lightproofing] [and] [Soundproofing] Gasketing

Provide in accordance with ANSI/BHMA A156.22. Provide adjustable doorstops at heads,jambs and automatic door bottoms in accordance with the hardware set, of extruded aluminum, [clear (natural)] [bronze] anodized, surface applied, with vinyl fin seals between plunger and housing. Provide doorstops with solid neoprene tube, silicone rubber, or closed cell sponge gasket. Provide door bottoms with adjustable operating rod and silicone rubber or closed cell sponge neoprene gasket. Provide doorstops that are mitered at corners. Provide type and function designation where specified in paragraph HARDWARE SETS.

****

NOTE: At exterior doors that are not protected by a horizontal projection such as an awning, roof, or eave, specify rain drips that overlap each side of each door at the head of such exposed doors by choosing the bracketed item below.

****

2.3.23 Rain Drips

Provide in accordance with ANSI/BHMA A156.22. Provide extruded aluminum rain drips, not less than 2.03 mm 0.08 inch thick, [clear anodized] [bronze anodized] [factory painted] [factory primed] finish. Provide the manufacturer's full range of color choices to the Contracting Officer for color selection.[Provide rain drips with a 102 mm 4 inch overlap on each side of each exterior door that is not protected by an awning, roof, eave or other horizontal projection.] Set drips in sealant and fasten with stainless steel screws.

2.3.23.1 Door Rain Drips

Approximately 38 mm high by 16 mm 1-1/2 inch high by 5/8 inch projection. Align bottom with bottom edge of door.

2.3.23.2 Overhead Rain Drips

Approximately 38 mm high by 64 mm 1-1/2 inch high by 2-1/2 inch projection. Align bottom with door frame rabbet.

2.3.24 Auxiliary Hardware (Other than locks)

Provide in accordance with ANSI/BHMA A156.16, Grade 1.

2.3.25 Sliding and Folding Door Hardware

Provide in accordance with ANSI/BHMA A156.14, Grade 1. Finishes to match other hardware specified herein.

2.3.26 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, as required to service and adjust hardware items.

2.4 FASTENERS

Provide fasteners of type, quality, size, and quantity appropriate to the specific application. Fastener finish to match hardware. Provide stainless steel or nonferrous metal fasteners in locations exposed to weather. Verify metals in contact with one another are compatible and will avoid galvanic corrosion when exposed to weather.

2.5 FINISHES

****

NOTE: Choose one of the following options. Choose the first option for new buildings. Choose the second option only where necessary to match the finish on existing hardware.

****

****

NOTE: Use stainless steel in bathroom and toilet locations and in project locations with Environmental Severity Classifications (ESC) of C3 through C5. See UFC 1-200-01 for determination of ESC for project locations.

****

[Provide in accordance with ANSI/BHMA A156.18. Provide hardware in BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except [aluminum paint] [prime coat] finish for surface door closers, and except [BHMA 652 finish (satin chromium plated)] [BHMA 600 finish (primed for painting)] for steel hinges. Provide hinges for exterior doors in stainless steel with BHMA 630 finish[or chromium plated brass or bronze with BHMA 626 finish]. Furnish exit devices in BHMA 626 finish in lieu of BHMA 630 finish [except where BHMA 630 is specified under paragraph HARDWARE SETS]. Match exposed parts of concealed closers to lock and door trim. Match hardware finish for aluminum doors to the doors.

][Provide in accordance with ANSI/BHMA A156.18. Provide hardware in BHMA 612 finish (satin bronze), unless specified otherwise. Finish surface door closers [bronze paint] [prime coat] finish. Provide steel hinges in [BHMA 639 finish (satin bronze plated)] [BHMA 600 finish (primed for painting)]. Provide exposed parts of concealed closers finish to match lock and door trim. Match hardware finish for aluminum doors to match the doors. Provide hardware showing on interior of [bathrooms] [shower rooms] [toilet rooms] [washrooms] [laundry rooms] [and kitchens] in BHMA 629 finish (bright stainless steel) or BHMA 625 finish (bright chromium plated).

]2.6   KEY CABINET AND CONTROL SYSTEM

****

NOTE: Key cabinets hold keys on panels. Systems include materials and devices for recording and cross-referencing data on use and location of locks and keys. See ANSI/BHMA A156.5 for description of cabinets and control systems.

****

Provide in accordance with ANSI/BHMA A156.5, [Type [E8331 (25 hooks)] [E8341 (125 hooks)] [E8351 (150 hooks)] [E8311 (600 hooks)] [E8321 (700 hooks)].] [Type required to yield a capacity (number of hooks) 50 percent greater than the number of key changes used for door locks.]

PART 3   EXECUTION

3.1   INSTALLATION

Provide hardware in accordance with manufacturers' printed installation instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

3.1.1   Weatherstripping Installation

Provide full contact, weathertight seals that allow operation of doors without binding the weatherstripping.

3.1.1.1   Stop Applied Weatherstripping

Fasten in place with color matched sheet metal screws not more than 225 mm 9 inch on center after doors and frames have been finish painted.

3.1.1.2   Interlocking Type Weatherstripping

Provide interlocking, self adjusting type on heads and jambs and flexible hook type at sills. Nail weatherstripping to door 25 mm 1 inch on center and to heads and jambs at 100 mm 4 inch on center.

3.1.1.3   Spring Tension Type Weatherstripping

Provide spring tension type on heads and jambs. Provide bronze nails with bronze. Provide stainless steel nails with stainless steel. Space nails not more than 38 mm 1-1/2 inch on center.

3.1.2   [Lightproofing] [and] [Soundproofing] Installation

Provide as specified for stop applied weatherstripping.

3.1.3   Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws[in expansion sleeves]. For aluminum thresholds placed on top of concrete surfaces, coat the underside surfaces that are in contact with the concrete with fluid applied waterproofing as a separation measure prior to placement.

3.2 FIRE DOORS AND EXIT DOORS

Provide hardware in accordance with NFPA 72 for door alarms, NFPA 80 for fire doors, NFPA 101 for exit doors, and NFPA 252 for fire tests of door assemblies. [Provide tin-clad fire doors in accordance with UL 14C].

3.3 HARDWARE LOCATIONS

Provide in accordance with SDI/DOOR A250.8, unless indicated or specified otherwise.

a. Kick and Armor Plates: Push side of single-acting doors. Both sides of double-acting doors.

b. Mop Plates: Bottom flush with bottom of door.

3.4 KEY CABINET AND CONTROL SYSTEM

Locate where [directed][indicated]. Tag one set of file keys and one set of duplicate keys. Place other keys in appropriately marked envelopes, or tag each key. Provide complete instructions for setup and use of key control system. On tags and envelopes, indicate door and room numbers or master or grand master key.

3.5 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, errors in cutting and fitting and damage to adjoining work.

3.6 HARDWARE SETS

****

NOTE: Coordinate this section with Section 08 11 16 ALUMINUM DOORS AND FRAMES.

Either list hardware set numbers on the drawings or list doors by number in each hardware set. List hardware sets in the following format:

SAMPLE LIST OF HARDWARE SETS	
HW-1 (Doors 1 and 2, each pair)	
3 Pair Hinges	**A2111 by 623 by NRP**
1 Three-Point Lock	**E8271**
2 Closers	**C02021**

SAMPLE LIST OF HARDWARE SETS	
2 Wall Bumpers	**L02251**
2 Pulls	**Extruded aluminum with decorative panels**
2 Push Bars	**Extruded aluminum with decorative panels**
1 Threshold	**Type 26**
HW-2 (Doors 3 and 4, each pair)	
3 Pair Hinges	**A2112 by 626 by NRP**
2 Exit Devices	**Type 1-05 by 630**
1 Removable Mullion	**Type 22**
2 Closers	**C02021**
2 Kick Plates	**J102 by 630**
2 Wall Bumpers	**L02251**
1 Threshold	**Type 26 by insert**
1 Set Weatherstripping	**R0D165**
HW-3 (Doors 5, 7, 9, each leaf)	
1-1/2 Pair Hinges	**A2112 by 626 by NRP**
1 Lockset	**F04 by 630**
1 Closer	**C02021**
1 Kick Plate	**J102 by 630**
1 Wall Bumper	**L02251**
1 Threshold	**Type 26 by insert**
1 Set Weatherstripping	**R0D165**
HW-101 (Doors 6, 8, 10, each leaf)	
1-1/2 Pair Hinges	**A8112 by 652**
1 Lockset	**F82**
1 Closer	**C02011**

SAMPLE LIST OF HARDWARE SETS	
1 Kick Plate	J102 by 630
1 Wall Bumper	L02251
HW-102 (Doors 11 and 12, each leaf)	
1-1/2 Pair Hinges	A8112 by 652
1 Pull Plate	J405 by 630
1 Push Plate	J301 by 630
1 Closer	C02011
1 Kick Plate	J102 by 630
1 Wall Bumper	L02101
HW-103 (Doors 13 and 14, each leaf)	
1-1/2 Pair Hinges	A8133 by 652
1 Latch set	F75
1 Wall Bumper	L02251

****

Provide [hardware for aluminum doors under this section. Deliver Hardware templates and hardware, except field applied hardware, to the aluminum door and frame manufacturer for use in fabricating doors and frames.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 71 63 (August 2024)**

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Preparing Activity: NAVFAC **Superseding**
UFGS-08 71 63 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-08 71 63 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 71 63 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 08 71 63

DETENTION HARDWARE
08/24

****
NOTE: This guide specification covers the requirements for detention hardware for use in brigs and detention facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.1	(2021) Butts and Hinges
ANSI/BHMA A156.4	(2024) Door Controls - Closers
ANSI/BHMA A156.5	(2020) Cylinder and Input Devices for Locks
ANSI/BHMA A156.6	(2021) Architectural Door Trim
ANSI/BHMA A156.7	(2016) Template Hinge Dimensions
ANSI/BHMA A156.8	(2021) Door Controls - Overhead Stops and Holders
ANSI/BHMA A156.16	(2023) Auxiliary Hardware
ANSI/BHMA A156.18	(2020) Materials and Finishes

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 101	(2024) Life Safety Code
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

UL SOLUTIONS (UL)

UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies
UL 14C	(2006; Reprint Oct 2021) UL Standard for Safety Swinging Hardware for Standard Tin-Clad Fire Doors Mounted Singly and in Pairs
UL 437	(2013; Reprint Jan 2022) UL Standard for Safety Key Locks

UL 634	(2007; Reprint Mar 2015) Connectors and Switches for Use with Burglar-Alarm Systems
UL 1034	(2011; Reprint Jun 2020) Burglary-Resistant Electric Locking Mechanisms

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Manufacturer's Detail Drawings; G, [_____]

Verification of Existing Conditions; G, [_____]

Detention Hardware Schedule; G, [_____]

Detention Keying System; G, [_____]

SD-03 Product Data

Hardware Items; G, [_____]

SD-08 Manufacturer's Instructions

Installation; G, [_____]

SD-10 Operation and Maintenance Data

Detention Locks, Data Package 5; G, [_____]

Door Closers, Data Package 5; G, [_____]

Door Position Switches, Data Package 5; G, [_____]

1.3 SHOP DRAWINGS

Submit manufacturer's detail drawings indicating all hardware assembly components and interface with adjacent construction.[Indicate power components and wiring coordination for electrified hardware.] Base shop drawings on verified field measurements and include verification of existing conditions.

1.4 DETENTION HARDWARE SCHEDULE

Provide Hardware Item List and Hardware Schedule containing the following information, and additional information as needed to identify the complete make up of each hardware set and its application to each opening:

1.4.1 Hardware Item List:

a. Hardware Type

b. Item Number

c. Quantity

d. Size(s)

e. Reference Publication / Type Number

f. Manufacturer's Name / Catalog Number

g. Key Control Symbols

h. UL Mark (If fire rated and listed)

i. BHMA Finish(es)

j. Remarks

1.4.2 Hardware Schedule

a. Hardware Set Number

b. Opening Number(s)

c. Opening Description (single/double leaf, hand, size, door/frame material)

d. Fire Rating

e. Sound Rating

f. Hardware Items

g. Quantity

h. Size

i. BHMA Finish

j. Remarks

In addition, submit hardware schedule data package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5 QUALITY CONTROL

1.5.1 Qualifications of Installer

Installation is to be completed by a detention equipment installer approved by the detention hardware manufacturer.

1.5.2 Regulatory Requirements

a. Electrically controlled, monitored, and operated detention hardware and related components are to meet requirements of NFPA 70.

b. Detention hardware for labeled fire doors are to meet requirements of UL 10B and be listed (labeled).

c. Detention hardware for doors that are considered "Means of Egress" are to meet requirements of NFPA 101.

d. Electrically operated detention locks are to meet requirements of UL 1034 and be listed (labeled).

1.5.3 Schedule Requirements

Submit detention hardware schedule at the same time hardware samples are submitted. Include quantities, manufacturer's catalog numbers, descriptive information, location, sizes, finish, key control symbols including keying systems for each piece in the detention hardware schedule.

1.5.4 Hardware Coordination Conference

Conduct a hardware coordination conference for hardware prior to submittals for the purpose of coordinating the interface of materials that are furnished by the participants listed. Require that a representative of the entity responsible for each of the following functions attend the conference. Notify participants a minimum of five working days before the conference.

a. Contractor

b. Detention hollow metal supplier and installer

c. Detention hardware supplier and installer

d. Locking control system supplier and installer

e. Electrical contractor

f. Contracting Officer

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Keys

Send to the Contracting Officer directly from the manufacturer via registered mail.

1.6.2 Detention Hardware

Deliver in a timely manner and store in accordance with the manufacturer's recommendations. Mark each individual container with item number as shown on detention hardware schedule. Deliver in manufacturer's original container and protect from damage by weather.

1.7 MAINTENANCE TOOLS

Furnish six tool holders and bits for each different size and type of screw and fastener.

1.8 TEMPLATES

Furnish templates for door and frame preparation.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

Make hardware to be applied to frames and doors to template.

2.2 HARDWARE ITEMS

2.2.1 Keys and Cylinders

ANSI/BHMA A156.5.

2.2.1.1 Mogul Keys

Provide keys for pin tumbler locks not less than 73 mm 2-7/8 inches in length, blade 14 mm 9/16 inch wide by 3.2 mm 1/8 inch thick. Provide handle that is 25 mm 1 inch in diameter. Stamp each key with number or letter per keyset.

2.2.1.2 Mogul Cylinder

Provide a special "Mogul" cylinder twice the diameter of a commercial mortise lock cylinder with internal parts proportionately larger. Special "Mogul" keys and restricted keying are required. The sale of cut keys and blanks are to be factory regulated to control usage and reproduction. The design is to be wear and pick resistant and include a minimum of five stainless steel 4 mm 5/32 inch diameter pin tumblers, stainless steel springs, and stainless steel ball bearings that intermesh with the key and pin tumblers. Cylinder to conform to UL 437.

2.2.1.3 Builders Cylinder

Type E09211A. Keys are for restricted use. Cylinder to conform to UL 437.

2.2.2 Detention Keying System

Keying system to consist of dissimilar combinations[for each building] with external doors keyed alike; internal corridor doors keyed alike; utility spaces,[wickets, and food passes] keyed alike; each group of cells[or dormitory group] keyed alike but different from other groups. Establish two separate detention key systems; one system for the security Mogul type hardware, and one for the paracentric key system.

2.2.3 Detention Hinges

Hinges to conform to ANSI/BHMA A156.1 and ANSI/BHMA A156.7. Type A8191 HT with stainless steel maximum security pin. Type A8192 HT with stainless steel maximum security pin. The 225 mm 9 inches denotes four wire continuous conduction. Screws are to be twist-off or spanner head. Sizing to conform to the standard. Drilled and counter-sunk hinges are to be provided for proper size machine screws. Use zinc coated hinges on exterior doors with a prime coat. Provide junction box and mortar shield. Electric hinges to conform to UL 634 and be labeled.

2.2.4 Detention Locks

Provide ligature resistant door trim on interior of all locks where door trim is specified below.

2.2.4.1 Type 1 Lock

Electro-mechanical solenoid operation lock; jamb mounted for use with security hollow metal doors with the following features:

a. Solenoid operated 115 V ac continuous duty.

b. Cylinder operated one or two sides using mogul or builders cylinders.

c. Lock case 10 gauge minimum galvanized cold-rolled steel.

d. Latch Bolt 20 mm 3/4 inch throw stainless steel.

e. Bronze or stainless steel face plate.

f. Signal switch for latch bolt and deadlocking bolt.

g. Strike and mounting screws.

h. Push button in frame if on a cell door.

2.2.4.2 Type 2 Lock

Mechanical deadlock; lever tumbler deadlock for use with security hollow metal doors with the following features:

a. Paracentric key operated one or two sides.

b. Six lever tumblers with spring temper brass/bronze springs.

c. Steel or stainless steel deadbolt with saw resistant insets.

d. Bolt 20 by 50 mm 3/4 by 2 inches with 20 mm 3/4 inch throw.

e. Lock case primed for paint or galvanized.

f. Lock mount plate including escutcheon, mounting screws, and strike.

2.2.4.3 Type 3 Lock

Electro-mechanical deadlocking latchlock to conform to UL 10B; jamb mounted in 50 mm 2 inch face security hollow metal frame with the following features:

a. Solenoid operated 24 V dc continuous duty.

b. Cylinder operated one or two side using builders cylinder.

c. Structural and working parts stainless steel.

d. Deadlatch 20 mm 3/4 inch throw stainless steel with saw resistant insets.

e. Stainless steel deadlocking bolt, base plate, and strike.

f. Signal switch for lock status.

g. Plug connectors for conductors.

2.2.4.4 Type 4 Lock

Mortise lock for security hollow metal swinging doors with the following features:

a. Mogul cylinder key operated one or two sides.

b. Cast brass, bronze, or stainless steel bolts. 25 mm One inch throw with saw resistant inserts. Knob operated deadbolt.

c. Armored front adjustable 3 in 50 mm 1/8 in 2 inches.

d. Strike and mounting screws.

e. Snap locks automatically when door is closed.

2.2.4.5 Type 5 Lock

Mechanical deadlocking latch lock for security hollow metal swinging doors with the following features:

a. Mogul key operated one or two sides.

b. Five lever tumbler with spring temper brass/bronze springs.

c. Steel or stainless steel latchbolt.

d. Lock case primed for paint or galvanized.

e. Lock mounting plate including escutcheon mounting screws and strike.

2.2.4.6 Type 6 Lock

Mechanical deadlock for use on security hollow metal doors with the following features.

a. Mogul key operated one or two sides.

b. Five lever tumblers with spring tempered brass/bronze screws.

c. Malleable iron case and cover.

d. Bronze deadbolt 20 by 38 by 16 mm 3/4 by 1-1/2 by 5/8 inch throw.

e. Lock case and cover primed for paint.

f. Lock mounting plate including escutcheon, mounting screws and strike.

2.2.4.7 Type 7 Lock

Mechanical spring lock for use on chase and access doors with the following features.

a. Mogul key operated one side only.

b. Five lever tumblers with spring temper brass/bronze springs.

c. Malleable iron case and cover.

d. Bolt retracted by key 25 by 12.7 mm with 11 mm 1 by 1/2 inch with 7/16 inch throw.

e. Lock case and cover primed for paint.

f. Mounting screws and strike.

2.2.5 Door Closers

2.2.5.1 Type 1 Door Closers

Surface mounted door closer to conform to test requirements of ANSI/BHMA A156.4, PT 1, Grade 1.

a. C02011: Regular Arm Type

b. C02021: Parallel Arm Type

2.2.5.2 Type 2 Door Closers

Concealed overhead closer to conform to ANSI/BHMA A156.4 PT6 Grade 2.

C05032:a. Concealed Arm and Track - Butt hinge hung

Closers to be installed in a 100 mm 4 inch head section.

2.2.6 Strikes

Mortised strikes are to be compatible with the lock the mortised strike serves. Provide dust box and switch to monitor lock bolt where indicated in set numbers.

2.2.7 Door Trim

Provide ligature resistant pulls on interior of all doors.

2.2.7.1 Loop Type Pulls

Manganese bronze or stainless steel 200 mm 8 inches center-to-center surface mounted with spanner type screws. Loop type pulls to conform to ANSI/BHMA A156.6 J401.

2.2.7.2 Flush Type Pulls

Manganese bronze or stainless steel set for one side or back to back mounting with spanner type screws. Flush type pulls to conform to ANSI/BHMA A156.6 J403.

2.2.7.3 Door Stops and Holders

2.2.7.3.1 Type PH1

Type PH1 to conform to ANSI/BHMA A156.8 C01511, hold-open overheard door holder and stop. Provide spanner heads for exposed screws.

2.2.7.3.2 Type PH2

Type PH2 to conform to ANSI/BHMA A156.8 C02511, overhead surface mounted slide type; attached with hex nut and bolt assemblies. Provide spanner heads for exposed screws.

2.2.7.3.3 Type OH3

Type OH3 to conform to ANSI/BHMA A156.8 C08511, overhead surface mounted rod type, attached with hex nut and bolt assemblies. Provide spanner heads for exposed screws.

2.2.7.3.4 Type FS1

Type FS1 to conform to ANSI/BHMA A156.16 L02131, cast door stop. Bronze.

2.2.7.3.5 Type FS2

Type FS2 to conform to ANSI/BHMA A156.16 L01371, offset door stop with hold open. Bronze.

2.2.7.3.6 Type FS3

Type FS3 to conform to ANSI/BHMA A156.16 L02141-L02161, dome door stop. Bronze. Exposed screw is to be spanner head.

2.2.8 Deadbolts (Head and Foot Bolt)

Surface mounted and 25 mm 1 inch diameter with 20 mm 3/4 inch throw. Bolt is operated by spanner key case, is malleable iron, or steel with cover. Provide attachment with spanner head screws.

2.2.9 Door Position Switches

2.2.9.1 Type 1 Door Position Switch

Mechanically mortised door position switch with the following features:

a. Components concealed when door is in closed position.

b. Switch mechanism housing mortises into door frame headers.

c. Galvanized steel actuator arm.

d. Actuator arm track mortises into the top rail of the door.

e. Allows door opening 180 degrees.

f. Switch monitors door position within 20 mm 3/4 inch from the leading edge of the door to the door stop.

g. Unit constructed of brass and plated steel. The exposed face plate galvanized steel.

h. Switch single pole, double throw type with a rating of 5 amps at 125/250 V ac.

i. Color coded wires with a pair of cable connectors.

2.2.9.2 Type 2 Door Position Switch

A magnetic door position switch for meeting requirements for UL 634 for mounting in head of door to indicate closed door position. Provide the following features:

a. Mortised into door frame header.

b. Potted components.

c. Life expectancy in accordance with manufacturer - over one million operations.

d. Maximum contact rating:

    (1) Current, resistive load - 1 amp.

    (2) Power, resistive load - 24 V ac.

e. Maximum current at 24 V ac, resistive load - 1 amp.

2.2.10 Security Door Accessories

2.2.10.1 Wall Bumpers

Wall bumpers to conform to ANSI/BHMA A156.16 Type L02101, wall mounted convex door stop.

2.2.10.2 Thresholds

Aluminum extrusion minimum thickness 4.4 by 125 mm 0.172 by 5 inches wide by 12 mm 1/2 inch rise with panic stop and vinyl or neoprene insert.

2.2.10.3 Drip Strip

Extruded galvanized steel strip 64 mm 2-1/2 inches wide with 16 mm 5/8 inch back strip. Attach to shower doors with a continuous weld.

2.2.10.4 Weatherstrip

Apply for head and jambs, pressure sensitive adhesive silicone rubber seal.

2.2.11 Screws and Fasteners

****

NOTE: There are several types of "tamper-resistant" fasteners and screws which provide different levels of security. Specify fasteners which will provide the level of security required. Consult detention hardware manufacturers.

****

Comply with detention manufacturer's standard fastening hardware and recommendations for size, type, and material.

2.2.11.1 Fabrication

Finish exposed fasteners to match hardware fastened. Fabricate fasteners of the same metal as hardware fastened, except use plated brass or stainless steel for fastening aluminum.

2.2.11.2 Location

Provide spanner head screws and fasteners for exposed hardware.

2.3 FINISHES

Finish surfaces, painted surfaces and painted items to conform to ANSI/BHMA A156.18 and as follows:

2.3.1 Painted Surfaces

BHMA 600 finish (primed for painting).

2.3.2 Finish Surfaces

BHMA 626 finish (satin chromium plated) or BHMA 630 finish (satin stainless steel).

2.3.3 Painted Items

BHMA 689 finish (aluminum painted).

PART 3 EXECUTION

3.1 EXAMINATION

Examine doors, frames, and hardware for damage, defects, and suitability for intended use. Inspect components and adjacent areas of construction for conditions that could be detrimental to the proper operation or performance of the detention hardware.

3.2 INSTALLATION

Provide hardware in accordance with manufacturers' printed installation instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

3.2.1 Weatherstripping Installation

Provide full contact, weathertight seals that allow operation of doors without binding the weatherstripping.

3.2.1.1 Stop Applied Weatherstripping

Fasten in place with color matched sheet metal screws not more than 225 mm 9 inches on center after doors and frames have been finish painted.

3.2.1.2 Interlocking Type Weatherstripping

Provide interlocking, self-adjusting type on heads and jambs and flexible hook type at sills. Nail weatherstripping to door 25 mm 1 inch on center and to heads and jambs at 100 mm 4 inches on center.

3.2.1.3 Spring Tension Type Weatherstripping

Provide spring tension type on heads and jambs. Provide bronze nails with bronze. Provide stainless steel nails with stainless steel. Space nails not more than 38 mm 1-1/2 inch on center.

3.2.2 [Lightproofing][and][Soundproofing] Installation

Provide as specified for stop applied weatherstripping.

3.2.3 Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws[in expansion sleeves]. For aluminum thresholds placed on top of concrete surfaces, coat the underside surfaces that are in contact with the concrete with fluid applied waterproofing as a separation measure prior to placement.

3.3 ADJUSTMENT AND CLEANING

Examine hardware for complete and proper installation. Lubricate bearing surfaces of moving parts. Adjust hinges, locks, and keepers to function properly. Test keys for smooth operation and for conformance to approved keying system. Ensure hardware operates freely without binding and is properly aligned. Protect hardware from paint, stains, weather, and other damage until acceptance of the work.

3.4 FIRE DOORS AND EXIT DOORS

Provide hardware that conforms to NFPA 72 for door alarms, NFPA 80 for fire doors, NFPA 101 for exit doors, and NFPA 252 for fire tests of door assemblies.[Provide tin-clad fire doors that conform to UL 14C.]

3.5 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, errors in cutting and fitting and damage to adjoining work.

3.6 TRAINING

Upon completion of the work and at a time designated by the Contracting Officer, a manufacturer's technical service representative or manufacturer's authorized representative for the locking control system, is to instruct Government personnel in the proper operation, troubleshooting, maintenance, safety, and emergency procedures of the system. The period of instruction is four, 8-hour sessions. Conduct training at the job site. The Government has the option to video tape training sessions. Notify the Contracting Officer at least two weeks in advance.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 71 63.10 (November 2022)**

Preparing Activity: NAVFAC

Superseding
UFGS-08 71 63.10 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 08 - OPENINGS

SECTION 08 71 63.10

ELECTRICAL LOCKING CONTROL FOR BRIGS

11/22

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USACE / NAVFAC / AFCEC   UFGS-08 71 63.10 (November 2022)

Preparing Activity: NAVFAC   Superseding
UFGS-08 71 63.10 (February 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 08 71 63.10

ELECTRICAL LOCKING CONTROL FOR BRIGS
11/22

****
NOTE: This guide specification covers the requirements for locking control systems which control all electrically controlled hardware and motorized gates and doors, including but not limited to solenoid locks.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: The system monitors and annunciates the status condition of electrically equipped hardware, doors, gates, control conditions, security conditions, call-in signals, and other functions as specified herein.
****

****
NOTE: Show the following information on the project drawings:

1. Location of locking control panels.

2. Electrified door hardware.

3. Homerun indications from electrified door hardware to appropriate locking control panel.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

1.2 SYSTEM DESCRIPTION

1.2.1 System Components

Configure the locking control systems from locking control panels, logic units, relay terminal equipment, and wiring.

a. Locking control panels: Provide mounting for various control switches, audible annunciators, and visual annunciators which provide control and annunciation interface between the staff and the locking control system.

b. Logic units: Provide logic transactions necessary to implement the functional operation of the locking control system.

c. Relay terminal equipment: Provide relay terminal equipment, with terminal facilities for field wiring and relay equipment for the conversion of low energy system control to high energy control signals, as necessary to control and operate devices as specified in this section.

1.2.2 General Control and Annunciation

The following paragraphs describe the operation for various devices controlled and annunciated at locking control panels.

1.2.2.1 Hardware

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NOTE: Coordinate with door schedule shown in the architectural drawing.

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Provide operational and annunciation provisions for each electrically controlled and monitored hardware set as specified herein. Refer to architectural door schedule for door hardware information. Provide hardware type in accordance with Section 08 71 63 DETENTION HARDWARE.

a. Annunciation: Annunciate each door and gate equipped to be monitored and controlled in the following manner. Single red indicator on the locking control panel illuminates on nonsecure condition at the door or gate. On swing doors and gates, the annunciation occurs on the first movement of the locking mechanism. Door and gate position switches causes the annunciation on nonsecured position. Monitor secured status of controlled doors and gates by either two or more position switches which include but are not limited to door on gate position, lockbar position, roller bolt position, latch-bolt position, and motor limit switches. Annunciate nonsecure condition by any one nonsecure switch on a given hardware set.

b. Cell and shower door solenoid: Where cell doors are equipped with solenoid locks, the following operation applies. Pressing the "unlock" switch of an "unlock - lock" pair of membrane switches on a locking control panel causes the hardware to unlock and remain unlocked until the "lock" switch is pressed. When the "lock" action is taken, the lock bolt extends, regardless of whether the door has been opened or not, except on deadbolt locks. Group unlock provisions must allow hardware to be held unlocked.

c. Corridor and miscellaneous solenoid: Where corridor and other doors are equipped with solenoid locks, and the specific door operation is not given elsewhere in this section, the following operation applies. Pressing the "unlock" switch of an "unlock/lock" pair of membrane switches on a locking control panel causes the hardware to unlock and remain unlocked until the "lock" switch is pressed. When the "lock" action is taken, the lock bolt extends, regardless of the door having been opened or not, except on deadbolt locks.

d. Key relock doors solenoid: Where fire egress doors are equipped with hardware which, when electrically unlocked, requires a key action at the door to relock, the following operation applies: Unlocking the door requires the simultaneous pressing of two unlock membrane switches. Releasing the switches on the locking control panel causes the operating power to return to the locked state.

e. Deadbolt solenoid locks: Where doors are equipped with electrically operated deadbolt locks, the operation is as specified for solenoid locks on noncell doors, except the bolt must not extend until the controls are in the "lock" condition and the door is closed.

f. Motorized overhead gates: Where motor operated gates are installed, the following operation applies. Pressing the "open" momentary action switch causes the gate to travel to the locked open position unless the "stop" momentary action switch is pressed, which will stop the travel of the gate. Pressing the "close" momentary action switch causes the gate to travel to the locked closed position unless the "stop" switch is pressed. Pressing the "open" or "close" switch while the gate is traveling in the opposite direction must have no effect.

1.2.2.2 Hardware Related Functions

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NOTE: Architectural door schedule should indicate those doors that require interlocking.

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NOTE: Specify night secure function for housing unit locking control panels that control prisoner cells and shower doors.

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a. Group control: For pretrial and female locking control panels requiring group operation of hardware, the following operation applies: Pressing the "open" or "unlock" membrane switch causes hardware in the associated group to unlock and cause the group control red LED to illuminate. Pressing the "off" switch causes the hardware to react to the condition required by the individual hardware controls, and the group annunciator extinguishes. On group unlock, solenoid locks unlocks in half second intervals.

b. Interlocks: Where two or more doors with electric hardware form a Sallyport or where interlocks between hardware sets occur, the operation of the individual hardware sets are as specified in this section with the following modifications. The controls must allow only one of the hardware sets to be in the nonsecured condition at any given time unless the interlock bypass function is activated. Upon simultaneously pressing the two interlock bypass switches, the red interlock bypass LED flashes on panels which control hardware in the same interlock scheme and allow the operator to control hardware with no interlock restrictions. By pressing the interlock bypass switch the second time, the interlock scheme reactivates. Provide locking control panels controlling interlocked doors with the interlock bypass switch and annunciator provisions. An amber "interlock active" LED illuminates on panels controlling hardware in a given interlock scheme when one or more of the interlocked doors are nonsecured. A separate annunciator for each interlock scheme on each controlling panel annunciates the "interlock active" condition. Once an interlock scheme has become active, activation of other unlock controls for hardware in the same scheme must have no effect and where the controls are specified as maintained contact devices and more than one has been placed in the unlock condition while the interlocks are active, upon resecuring of the original hardware one and only one of the additional doors will open in response to the multiple unlock switch position. Upon simultaneous operation of central devices in an interlock scheme, one and only one will cause a hardware set to become nonsecure.

c. Monitored doors and gates: Doors which are equipped with hardware which monitors the secure status and are not electrically operated, is monitored in the following manner: The door or gate red LED functions as specified for annunciation above, except as described in this paragraph. Control panels monitoring monitored-only doors and gates provides night secure provisions. The night secure provisions secures all doors and gates unless specific groups are required. Once the doors or gates are secured, this function alerts the control officer of unsecured conditions. Pressing the night secure switch on membrane switch panels causes the secure mode to become active and the secure green LED to illuminate. Upon activation, hardware in the nonsecure condition or hardware which becomes nonsecure causes an audible alarm to sound and the status LED for the nonsecure hardware to latch illuminated until reset. Pressing the silence switch silences the audible alarm. The secure function annunciates subsequent alarms audibly and visually in the manner specified above. Pressing the secure reset switch releases latched indicators, extinguish the secure green LED, and return the panel to normal operation.

d. Shower and cell call-in: For the shower and cell doors in the pretrial and female areas, the following operation applies: Pressing the momentary action pushbutton in the cell or shower causes an amber LED associated with the cell or shower on the locking control panel to flash and an audible signal sounds. Pressing the control panel momentary action silence switch on the control panel silences the audible signal and cause the LED to illuminate constantly. Pressing the control panel momentary action call-in reset switch extinguishes the LED. Once an individual cell or shower has been received at the control panel and has been silenced, additional activations of the same cell or shower call-in switch must have no effect. Silencing one call-in will not inhibit other calls from being received.

e. Control panel enable/disable keyswitch: Equip the locking control panel located at the reception counter with a keyswitch mounted on the front that enables and disables the locking panel control functions.

1.2.3   Battery Power

Provide batteries, complete with charging system as back-up power, in the event of a utility and emergency power failure. Provide adequate capacity to supply locking control system electrical load for a period of four hours. On restoration of utility or emergency power, the batteries must automatically be recharged. Battery backup provides power to support input status and LED annunciations, output controls, and memory retention. Battery backup power is not required for power source which actually operates the locking door or gate hardware.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Locking Control Systems

Security Equipment Cabinets

Graphic Locking Control Panels

Linear Locking Control Panels

SD-03 Product Data

Control Devices

Light Emitting Diodes

Audible Signal Devices

Control Power Transformer

Batteries

Auxiliary Relays

DC Power Supply

Wiring Materials

Submit specifications and data sheets.

SD-07 Certificates

Locking Control System Components

Submit manufacturer's certificates attesting that materials meet specified requirements.

SD-08 Manufacturer's Instructions

Graphic Locking Control Panels

Linear Locking Control Panels

Security Equipment Cabinets

Submit construction specifications.

SD-10 Operation and Maintenance Data

Locking Control Systems, Data Package 2; G, [_____]

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include as-built wiring diagrams complete with conductor color codes, conductor number, and termination identification. General system descriptions included in manufacturer's catalogs or advertising media will not be acceptable in meeting the operation and maintenance manual requirement.

1.4 QUALITY ASSURANCE

Programmable controller must be the product of a manufacturer engaged in the production of controllers for industrial applications.

1.4.1 Drawing Requirements

Submit installation drawings and wiring diagram for the overall system and for each of the following major components. Show how each item of equipment will function in the system and include an overall system schematic indicating relationship of components. Prior to preparation of drawings, review the electrical and operational characteristics of each electrically controlled and monitored hardware. Include a layout of devices to be installed in nongraphic locking control panel. Include cabinet dimensions, full dimensional drawings, and layout of equipment to be installed within security equipment cabinets. Include full dimensional drawings of graphic panels and nongraphic panels. Include layout of each display panel at a minimum of one-half full scale illustrating graphic layout orientation for area and position of devices required in console, as well as dimensional drawing of housing.

1.5 EXTRA PARTS

1.5.1 Programmable Controller

At final inspection, furnish one spare controller composed of one fully equipped processor, 1 percent space I/O interface boards (minimum of one), and 1 percent spare I/O modules (minimum of one of each type used).

1.5.2 Erasable Program Read-Only Memory (EPROM)

Provide one spare EPROM loaded with the proper software for each programmable controller and located with the controller in a protective enclosure. Mark the enclosure "SPARE EPROM" and physically identify the EPROM for use in the specific controller.

PART 2 PRODUCTS

2.1 LOCKING CONTROL PANEL COMPONENTS

2.1.1 Switches

Provide unembossed, nontactile, momentary contact membrane-type switches for control devices installed in the graphic and linear panels. Provide operating force of membrane-type switches of 2.22 N 8 ounces. Supply membrane switches with silver contacts and proper circuitry to perform functions as specified in this section. Supply membrane switches in modules with no more than four individual switches in each.

2.1.2 Light Emitting Diodes (LED)

Provide T 1 3/4 light emitting diodes (LED) visual indicators with resistors and protective diodes as required for operation at 24 volts dc. Provide indicators rated at a minimum of 4 million hours of operation at 20 milliamps dc and produce a minimum of 147 and 570 lumens/watt for red and yellow devices, respectively. Size resistors saccording to the manufacturer's instructions and adjusted to produce uniform brightness among LEDs. Mount resistors and protective diodes on standoff terminal blocks mounted adjacent to the LED served on the underside of the panel. Mounting hardware must not be visible from the face of the panel. Resistors and protective diodes may be an integral part of the LED. Include a red LED in the panels for each electrically controlled and monitored door.

2.1.3 Press to Test

Each locking control panel must contain a "press to test" pushbutton which tests visual and audible signal devices.

2.2 GRAPHIC LOCKING CONTROL PANELS

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NOTE: Provide graphic type locking control panels for housing unit control panels that control prisoner cell, shower, or for locking control panels

that control remote doors such as exterior doors.
Specify linear type for all others.

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2.2.1 Metal Control Cabinets

Provide graphic panel for locking system controls for installation in metal control cabinets as specified in this section. Custom build each graphic panel for the specific area to be controlled.

2.2.2 Construction

Construct graphic panel of 14 gage sheet steel with 38 mm 1 1/2 inch flange on all sides and cover for mounting devices hinged to frame at top. Provide continuous piano-type hinge. Secure panel to metal control cabinet with flathead, No. 8, 38 mm 1 1/2 inch flathead wood screw steel bolts on centers not exceeding 200 mm 8 inches. Overall general dimensions indicated are maximum dimensions. Coordinate mounting dimensions and support requirements with metal control cabinet installation.

2.2.3 Finish

Prime finish surfaces of the graphic panel, except that portion containing the graphic display, with rust inhibiting paint and two coats of hammertone finish gray enamel. Attach a reverse silkscreen polyester plastic film or lexan panel with nomenclature set forth in this specification to the graphic panel.

2.2.4 Graphic Display - Floor Plan Area

Provide graphic display of building floor plan area containing locking devices to be controlled. Display must graphically illustrate each electric-operated locking device to be controlled and also include legends of 5 mm 3/16 inch high letters in contrasting color. Provide graphic display in accordance with typical graphic display panel indicated, modified as required for the specific area and orientation of the building to be controlled. Scale of the graphic display may not be less than 3 mm per 300 mm 1/8 inch per foot. Make display with not more than eight colors.

2.2.5 Wiring

Group wiring on underside of graphic display and lace with nylon tie straps, support on intervals a maximum of 200 mm 8 inches and terminate on identified terminal blocks at top of panel adjacent to hinged side. Strand wiring spanning hinge on conductors. Terminate conductors with crimp-type lugs of both sets of terminal blocks. Leave 150 mm 6 inches of slack in conductors.

2.2.6 Graphic Display - Central Control Room

Provide a facility site plan graphic display of central control room main graphic locking panel. Control or monitor exterior doors from this panel.

2.3 LINEAR LOCKING CONTROL PANELS

2.3.1 Linear Panels

Provide linear panels as indicated and as specified to control groups of designated electric-operated locking devices. Manufacture and install linear locking control panels with same type materials and process as graphic locking control panels and identical except that graphic floor plan display is not required.

2.4 WIRING REQUIREMENTS

2.4.1 Power Wiring

Provide No. 14 THWN or XHHW conductors for solenoid-operated lock sets operating at 120 volts. Connect solenoid-operated lock sets operating at 24 V ac or dc with No. 16 MTW conductors.

2.4.2 Control Wiring

Provide class one signaling circuits as defined by Article 725 NFPA 70 for status indicator wiring. Install No. 16 MTW conductors in common conduit and equipment enclosures with other conductors for locking devices within limitations defined by Article 725-15 NFPA 70.

2.4.3 Wiring Materials

Use solid copper conductors for wiring systems. Stranded conductors will be acceptable only where all terminations can be made to screw type lug. Where stranded conductors are used, make all terminations with crimp type lug, size correctly for termination, and apply to conductor with crimping tool intended for use with lug used.

2.4.4 Color Coding

Color-code wiring systems, providing each conductor for individual lock sets and operating mechanisms with a distinctive color. Use white only for neutral conductors, and use green only for grounding conductors.

2.5 DISCRETE ELECTRONIC LOCKING CONTROL SYSTEM

2.5.1 Logic Units

Discrete electronic locking control system consisting of logic units in the form of printed circuit boards, relay terminal equipment, and associated hardware and wiring. Control system must accept input control information from and send output status information to graphic and linear type locking control panels.

2.5.2 Printed Circuit Boards

Logic units provided with circuitry necessary to perform the functions as specified. Mount circuit boards in a card cage frame, arranged to allow front and back access. Provide wiring connections to printed circuit boards capable of being connected to allow field replacement of printed circuit board with no disconnection or desoldering of wiring. Rack mount card cage frame in security equipment cabinets.

2.5.3 Relay Terminal Equipment

Consisting of electronic relays that switch the power wiring for locking and control devices. Control relays must be optically isolated, solid state type devices, rated for at least 50 percent more than connected load, capable of handling all connected load voltages, and provide a minimum of 2500 volts root mean square (RMS) isolation. Group and lace wiring with nylon tie straps, supported in intervals not to exceed 200 mm 8 inches and terminated on identified terminal blocks. Rack mount relay terminal equipment in security equipment cabinets.

2.6 PROGRAMMABLE CONTROLLERS

Programmable controllers may be provided in lieu of discrete electronic locking control for locking control, door monitoring, annunciation and other specified functions. Provide all necessary logic functions, timing functions, input points, output points, memory, communication capabilities and software for the operating features specified in this section. Individual input/output, (I/O), interface boards and I/O modules are considered part of the controller even if physically separated. Controller must be general purpose in nature, not custom designed and built for an isolated application, and not location specific in its construction. Controller may be made location specific and operationally customized by installing EPROM with applicable software and making the I/O interface boards system specific by setting the proper address via DIP switches or plug-in headers, and installing the proper I/O modules.

2.6.1 Logic Functions

Include, but do not limit to logical AND, OR, and INVERT functions implemented in sufficient levels to provide specified operating features. Arrange logic in such a manner as to prevent unsecure conditions from arising as a result of power failure to part or all of the control power system.

2.6.2 Timing Functions

Include, but do not limit to on-delay, off-delay, pulsing and stepping functions with programmable timing in sufficient variations and quantities to provide specified operating features.

2.6.3 Input/Output

Plug-in mounted on the I/O interface boards and held securely by screw type fasteners. Provide I/O modules as solid state devices providing a minimum of 2500 volts RMS (root means square) isolation. Provide output point modules rated for both voltage and load of device controlled including constant duty and inrush currents. In the event of power failure, output points controlling electrical locks and gates must fail in the secure condition, except shower points. Provide input point modules compatible with input device and voltage connected.

2.6.4 Software

Provide system and operating software and fixed data base contained in erasable program read only memory. Provide operating data base contained in random access memory backed up with a minimum of 48 hours of rechargeable batteries. Charge must be maintained by the controller. Develop operating software for each controller on an individual basis.

2.6.5 Processor

Controller processor communicates to and from the I/O interface boards via a multipair, bidirectional communication bus incorporating digital multiplexing techniques. Communications facilities must allow the processor to communicate with remotely located I/O interface boards at a distance of up to 305 meters 1000 feet. Where operational features require two or more controllers to interact, hard wire the interaction, point for point. Optionally, data communication may be provided for controller to controller interaction provided operational considerations remain unchanged.

2.6.6 Interface

Standard printed circuit boards containing the necessary coding/decoding solid state circuits for communicating with the processor, method of setting board address as required in this section, LED indicators which display the status of each point and plug-in input/output modules.

2.6.7 Voltage

Provide controller that operates on 105 to 130 V ac, 60 Hz and contains an integral circuit breaker for overload protection. Controller must operate properly in environmental conditions of zero to 60 degrees C in up to 95 percent humidity (noncondensing). Controller must conform to electrical noise standards of IEEE C37.90.1 and NEMA ICS 1.

2.6.8 Speed

Provide controller speed such that no delay is noticed between the initiation of a control function such as operating a switch or opening a monitored door, and the resulting control action.

2.7 CONTROL POWER TRANSFORMER

Provide control power transformers to supply low voltage, 24 V ac power for locking control or signaling devices. Provide transformer with secondary, 24 V ac output with circuit breaker type overload interruption. Provide transformer rated for not less than 20 percent of load imposed on transformer of most severe loading condition. Provide power source for control power transformer from building emergency power system.

2.8 DC POWER SUPPLY

2.8.1 Low Voltage Power Supply Units

Provide low voltage dc power supply units to provide 24-volt regulated, filtered dc power for locking controls, dc locks and signal devices. Provide 24 V dc output power with ampere rating not less than 150 percent of load imposed on power supply under most severe conditions of load. The dc output must be fused. Regulate output voltage within plus or minus 5 percent from no load to full load. Power supply unit must be U.L. listed. Provide power source for dc power supply unit from panelboards that are fed from emergency generator.

2.8.2 Multiple Power Supplies

Where low voltage dc requirements for control devices operated at maximum load exceed output of a single power supply, provide multiple power supplies and subdivide loads to prevent overloading the power supply unit.

2.9 SECURITY EQUIPMENT CABINETS

2.9.1 Location

Provide cabinets where indicated to house auxiliary control system components such as power supplies, control power transformers, auxiliary relays, and amplifiers.

2.9.2 Construction

Provide surface mounted cabinets, constructed of code-gage steel, and finished on all surfaces with rust inhibiting prime coat and two coats of flat medium gray enamel paint. Provide hinged door and flush mounted lock and latch.

2.10 METAL CONTROL CABINETS

Provide cabinet to house locking control equipment. Furnish multiple cabinets assembled to form a single unit with space to accommodate equipment required to be installed therein.

2.10.1 Construction

Provide louvered cabinet sides, 16 gage sheet steel attached to 14 gage, 12.7 mm 1/2 inches wide angle frames from the inside with bolts. Provide cabinet front with hinged, lockable louvered doors, keyed alike. Provide cabinet rear panel of solid sheet steel unless the cabinet is mounted against a solid wall, in which case, a back is not required. Prime and paint trim, braces, angles, and exterior sides. Visual parts outside the cabinet will be beige. Provide cabinet with 305 mm 12 inch writing surface the same width as the cabinet mounted approximately 760 mm 30 inches above the floor.

2.10.2 Sloped Turrets

Provide the top part of the cabinets with sloped fonts. The approximate slope of the turret off the horizontal axis should be 0.523 rad 30 degrees. Provide cabinets 635 mm 25 inches front to back unless indicated otherwise, and a maximum overall height of 1065 mm 42 inches.

2.10.3 Cooling Fan

Provide a cooling fan located on the interior of the panel side with a capacity of 9.63 cubic meter 340 cubic feet per minute equipped with a integral charcoal filter. Position the fan intake as low as possible in the cabinet. The fan must be fused, operate at 120 volts, and operate continuously.

2.10.4 Groupings

Group conductors by systems and tie with nylon tie straps. Shape wire bundles for support from top and sides of structure. Do not attach support devices to removable panels.

2.10.5 Protection

Where groups of conductors or single conductor pass through metal framing or panels, protect conductors with rubber or plastic grommets.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Locking Control Panels

Install graphic locking control panels and linear locking control panels in metal control cabinets as specified. Coordinate installation of locking control panels in metal control cabinets with respect to dimensions, mounting and accessibility.

3.1.2 Security Equipment Cabinets

Install security equipment cabinets for locking control systems in the security equipment or electrical room closest to the associated locking control panel.

3.1.3 Junction Boxes

Provide junction boxes required for locking systems wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Do not install junction boxes and pull boxes in areas accessible to prisoners.

3.1.4 Conduit Systems

Provide conduit systems required for locking systems wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.5 Wiring Systems

3.1.5.1 Wiring Specification

The work under this section includes the installation of wiring for the electrically operated locks, gates, and doors. The actual connections to individual locks, doors, and gates and the actual connections in the control panels and consoles is also included under this section. Coordinate this portion of the work with the detention hardware manufacturer.

3.1.5.2 Grouping

Group conductors within junction boxes, pull boxes, and equipment enclosures and lace with nylon tie straps with identification tabs, in individual sets servicing individual lock sets or operating mechanisms. Identify conductor groups on the strap with respect to room or operator served.

3.1.5.3 Continuous Runs

Do not splice locking system conductors. Conductors must be continuous between locksets and termination point for control panel.

3.1.5.4 Surge Protection

Protect communication and data equipment against surges induced on control, sensor, and data cables. Provide cables and conductors which serve as control, sensor or data conductors with surge protection circuits installed at each end that meets the IEEE C37.90.1 surge withstand capability test. Do not use fuses for surge protection.

3.1.5.5 Grounding

Provide grounding of wiring for locking control system in accordance with NFPA 70.

3.1.5.6 Wiring

Install wiring for locking control system in accordance with NFPA 70 and the approved locking control system wiring diagram.

3.2 PROTECTION OF EQUIPMENT

Due to the sensitivity of the locking control equipment to dust, dirt, condensing humidity, and other products normally found on construction sites, take precautions to ensure that the equipment is kept clean.

3.3 FIELD QUALITY CONTROL

Upon 7-days notice to the Contracting Officer, conduct the following tests in the presence of the Contracting Officer.

3.3.1 Locking Control System Test

Perform an operational system test to verify conformance of locking control system to this specification. Tests include the activation of all individual and group locking controls keep verification of operation, and verification of status annunciation of controlled devices.

3.3.2 Retesting

Rectify deficiencies indicated by test and completely retest work affected by such deficiencies.

3.4 TRAINING

Upon completion of the work and at a time designated by the Contracting Officer, furnish a competent technician regularly employed or authorized by the manufacturer of the locking control system to instruct Government personnel in the proper operation, troubleshooting, maintenance, safety, and emergency procedures of the locking control system. Provide a period of instruction of four eight-hour working days. Conduct the training at the job site. The Government has the option to record the training session.

3.5 EQUIPMENT SCHEDULES

The equipment schedules for locking control panels contained in this section of the specifications represent the type of control functions and status indication devices required in each locking control panel. Switches and LEDs must conform to the requirements for control devices and visual indicators as specified.

****

NOTE: Panel schedule is a sample to be used as a guide by the writer for developing locking panel. Information on the schedules should be as follows: the name of locking control panel, type (graphic or linear), mounting (metal control cabinet), and location. Also list the function (e.g., press to

test switch, silence switch, interlock bypass, interlock active, etc.) and quantity. These functions are individually described in this section. Under "REMARKS" include a brief description of the function. Finally, list the quantity and type of all security and builders hardware controlled or monitored by the locking control panel. Refer to architectural door schedule for type of door hardware.

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EQUIPMENT SCHEDULE		
Locking Control Panel:		Female Area
Type:		Graphic
Mounting:		Metal Cabinet
Location:		Female Control Area
		DEVICE REQUIREMENTS
Quantity	Remarks	Type or Function
1	Press to Test	Illuminates all LED's on panel.
1	Signal Silence	Silences all audible signals.
1	Interlock Bypass	Disables the interlock capability so that any number of doors may be open at one time.
5	Cell Call-in	
1	Shower Call-in	
3	Smoke Detector Indicators (Exhaust Duct Chase Mounted)	
1	Group Unlock	Unlocks all cell and shower doors
4	SH-7	Cell door hardware
1	SH-1	Cell door hardware
1	SH-16	Shower door hardware
1	SH-2	Sallyport dayroom door
1	SH-2	Sallyport door

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 81 00 (May 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 81 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 81 00

GLAZING

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 81 00 (May 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 81 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 81 00

GLAZING
05/19

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NOTE: This guide specification covers the requirements for normal glazing. For specifying pre-assembled window units used in residential buildings, utilize the following Sections: 08 51 13 ALUMINUM WINDOWS, 08 52 00 WOOD WINDOWS, or 08 53 00 PLASTIC WINDOWS.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: If special glazing such as leaded glass, laminated transparent mirrors, or plastic glazing for unprotected openings is required, add appropriate paragraphs.

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NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

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NOTE: On the drawings, show:

1. Locations of each type of glass, using same terminology as in specification.

2. Thickness of glass, unless glass of each type is same thickness.

3. Frame and rabbet details, indicating method of glazing.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 800	(2016) Voluntary Specifications and Test Methods for Sealants
AAMA GDSG-1	(1987) Glass Design for Sloped Glazing
AAMA TIR A7	(2011) Sloped Glazing Guidelines

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C509	(2006; R 2021) Standard Specification for Elastomeric Cellular Preformed Gasket and

	Sealing Material
ASTM C864	(2005; R 2015) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1021	(2008; R 2014) Standard Practice for Laboratories Engaged in Testing of Building Sealants
ASTM C1036	(2021) Standard Specification for Flat Glass
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM C1087	(2016) Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems
ASTM C1172	(2024) Standard Specification for Laminated Architectural Flat Glass
ASTM C1184	(2023) Standard Specification for Structural Silicone Sealants
ASTM C1281	(2016) Standard Specification for Preformed Tape Sealants for Glazing Applications
ASTM C1376	(2015) Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D2287	(2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D4802	(2016) Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E413	(2022) Classification for Rating Sound Insulation

ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E2190	(2010) Standard Specification for Insulating Glass Unit Performance and Evaluation
ASTM E2226	(2024) Standard Practice for Application of Hose Stream
ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F2912	(2017) Standard Specification for Glazing and Glazing Systems Subject to Airblast Loadings

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2008) Glazing Manual
GANA Sealant Manual	(2008) Sealant Manual
GANA Standards Manual	(2008) Engineering Standards Manual

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

IGMA TB-1200	(1983; R 2016) Guidelines for Insulating Glass Dimensional Tolerances
IGMA TB-3001	(2001) Guidelines for Sloped Glazing
IGMA TM-3000	(1990; R 2016) North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 251	(2006) Standard Methods of Tests of Fire Resistance of Building Construction and Materials
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

NFPA 257	(2022) Standard on Fire Test for Window and Glass Block Assemblies

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

UL SOLUTIONS (UL)

UL 752	(2023) UL Standard for Safety Bullet-Resisting Equipment
UL MEAPD	(2011) Mechanical Equipment and Associated Products Directory (online version is listed under Certifications at www.ul.com)

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Regarding the use of SD-03 Product Data and SD-07 Certificates, only use one of these on complicated and large products. It is preferred to use SD-03 Product Data. If control tower glazing data is only available by certificates, use SD-07 Certificates.

****

SD-03 Product Data

Insulating Glass

Plastic Glazing

Glazing Accessories

Sealants

Joint Backer

SD-04 Samples

Insulating Glass

Plastic Sheet

Glazing Compound

Glazing Tape

Sealing Tapes

[SD-07 Certificates

Insulating Glass

Plastic Glazing

] SD-08 Manufacturer's Instructions

Setting and Sealing Materials

Glass Setting

SD-11 Closeout Submittals

Warranty for Insulated Glass Units

[Warranty for Polycarbonate Sheet

][Warranty for Monolithic Reflective Glass

][Warranty for Monolithic Opacified Spandrel

] **

NOTE: The Energy Star designation below is for residential windows only.

****

[Energy Efficient Equipment for Residential Windows; S

][1.3 SYSTEM DESCRIPTION

Fabricate and install watertight and airtight glazing systems to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, or defects in the work. Glazed panels must comply with the safety standards, in accordance with ANSI Z97.1, and comply with indicated wind/snow loading in accordance with ASTM E1300.[Sloped glazing must comply with AAMA GDSG-1 and AAMA TIR A7, and IGMA TB-3001.]

[1.3.1 Glazing for Passive Solar and Dynamic Control Fenestration

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NOTE: Use the following paragraph if design is utilizing Passive Solar Heating Systems or Chromogenic Fenestration.

****

Identify glazing for Passive Solar and Dynamic Control Fenestration noted as part of a passive solar heating system and/or chromogenic fenestration and evaluate separately from other fenestration. Glazing for use in Passive Solar systems are exempt from SHGC requirements. Area-weighted averaging of chromogenic fenestration with other non-chromogenic fenestration is not permitted. For chromogenic fenestration systems, the lower-rated labeled SHGC must be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity.

]]1.4 QUALITY CONTROL

Submit two 203 by 254 mm 8 by 10 inch samples of each of the following: tinted glass, patterned glass, heat-absorbing glass, [_____] and insulating glass units.

Submit three samples of each other material. Samples of plastic sheets must be minimum 125 by 175 mm 5 by 7 inches.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not start glazing work until the outdoor temperature is above 4 degrees C

40 degrees F and rising, unless procedures recommended by the glass manufacturer and approved by the Contracting Officer are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

1.7 WARRANTY

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NOTE: The warranty clauses in this guide specification have been approved by a Level I Contracting Officer, and may be used without further approval or request for waiver.

****

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NOTE: Delete inapplicable paragraph[s].

****

1.7.1 Warranty for Insulated Glass Units

Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Government.

1.7.2 Warranty for Polycarbonate Sheet

For a 5-year period following acceptance of the work:

a. Warranty Type I, Class A (UV stabilized) sheets against breakage;

b. Warranty Type III (coated, mar-resistant) sheets against breakage and against coating delamination;

c. Warranty Type IV (coated sheet) against breakage and against yellowing;

d. Warranty extruded polycarbonate profile sheet against breakage.

For a 10-year period following acceptance of the work, warranty Type IV against yellowing and loss of light transmission.

[1.7.3 Monolithic Reflective Glass

Manufacturer must warrant the monolithic reflective glass to be free of peeling or deteriorating of coating for a period of 10 years after Date of Substantial Completion. Warranty must be signed by manufacturer.

][1.7.4 Monolithic Opacified Spandrel

Manufacturer must warrant the opacifier film on the spandrel to be free of peeling for a period of five years after Date of Substantial Completion. Warranty must be signed by manufacturer.

]PART 2 PRODUCTS

****

NOTE: Specifically identify any openings that are intended to facilitate solar heat gain for space heating using "passive solar" design strategies. Note that such fenestration is exempt from the Solar Heat Gain Coefficient (SHGC) requirements below. Likewise, passive solar and chromogenic fenestration must be specified and evaluated separately from other fenestration. Area-weighted averaging of chromogenic fenestration with other non-chromogenic fenestration is not permitted.

****

2.1 PRODUCT SUSTAINABILITY CRITERIA

[2.1.1 Energy Efficient Equipment for Residential Windows

Provide Energy Star residential windows in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTINGparagraph ENERGY EFFICIENT PRODUCTS.

]2.2 GLASS

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NOTE: Glazed openings subject to accidental human impact must be glazed with safety glazing material in accordance with Consumer Products Safety Commission (CPSC) Standard, 16 CFR Part 1201, Safety Standard for Architectural Glazing Materials. Consult applicable building codes for detail requirements.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

****

ASTM C1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

2.2.1 Clear Glass

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NOTE: Glass areas and thicknesses are based on 1.20 kilopascals 25 pounds per square foot (psf) design wind load and vertical glazing with annealed glass. For other glass and for wind loads greater than 1.20 kPa 25 psf, thickness will depend upon aspect ratio (length divided by width), area, and design wind load. The thickness and area limitations for each type of glass must be indicated or specified. Do not specify glass less than 3.0 mm 1/8 inch.

Method of Determination for Minimum Glass Thickness:

Refer to UFC 4-010-01 "DoD Minimum Antiterrorism Standards for Buildings", ASTM E1300, ASTM F1642/F1642M and ASTM F2248.

1. Determine peak gust wind speed and corresponding design wind loads, considering location, height, shape, and orientation, in accordance with ASCE 7-16 "Minimum Design Loads for Buildings and Other Structures", latest edition.

2. Determine aspect ratio, area, and type of glass for each opening to be glazed.

3. Select thickness required from glass manufacturer's chart for each type of glass.

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NOTE: Use the following data on Army projects

a. Category I Products: Doors and glazed panels that contain single piece of glazing material no greater than 0.84 m2 9 ft2 in area. The product must be capable of withstanding 203 Nm 150 foot pound impact load test.

b. Category II Products: Doors and glazed panels that contain any single piece of glazing material greater than 0.84 m2 9 ft2 in area. The product must be capable of withstanding a 542 Nm 400-foot-pound impact load test. Category II products may be used in both Category I and Category II situations.

c. Doors: 16 CFR 1201 applies to all types of interior doors and exterior doors, including storm doors and combination doors. FIRE/SAFETY RATED GLASS: Is not required for openings in doors through which a 76 mm 3 inch diameter sphere is unable to pass. Glazing for fire doors must be in accordance with NFPA 80, even though this may be at variance with requirements of 16 CFR 1201.

d. Glazed Panels: 16 CFR 1201 no longer applies to exterior and interior glazed panels. FIRE/SAFETY RATED GLASS: Glazed panels must conform to ANSI Z97.1, SAFETY PERFORMANCE SPECIFICATION AND METHODS OF TEST FOR SAFETY GLAZING MATERIALS USED IN BUILDINGS. Since glazed panels may be hazardous, safety glazing should be generally provided as described below:

FIRE/SAFETY RATED GLASS

(1) Glazed panels of any size located adjacent to a doorway, with the nearest vertical edge of panel within 1219 mm (48 inches) of doorway, and with bottom edge of panel below top of door. Safety glazing is not required for panels separated from

the doorway by an intervening interior permanent wall.

(2) Glazed panels with a surface area greater than 0.84 m2 9 ft2 where there is a walking surface on either side of panel, and the walking surface is within 914 mm 36 inches of the panel. Safety glazing is not required if the lowest edge of the glazing material is 457 mm 18 inches or more above both walking surfaces, or if the panels have a horizontal member, such as a mullion or permanent railing not less than 38 mm 1-1/2 inches in width, capable of withstanding a horizontal load of 75 kg/m (50 plf), on the accessible sides of the glazing and located between 609 mm and 914 mm 24 and 36 inches above the walking surface.

(3) Where insulating glass units are used in locations requiring safety glazing, both panes must be safety glass.

(4) For exterior applications, safety glazing must also meet the wind and snow load requirements in accordance with ASTM E1300.

(5) In general, any glazed area subject to human impact should be provided with safety glazing or other acceptable protective devices such as handrails or horizontal mullions.

ASTM C1036 covers the quality requirements for clear annealed glass, transparent tinted glass, patterned and wired glass with a series of classification designations such as Types, Classes, Qualities, Forms, Finishes, meshand pattern, as defined below:

1. Type designations are: Type I - Transparent Flat Glass; Class 1 - Clear, or Class 2 - Tinted; Type II - Patterned and Wired Flat Glass, Class 1 - Clear or Class 2 - Tinted..

2. Type I, Class 1 and 2 Quality and Uses: Quality: Q1, for the production of high quality mirrors; Q2, for the production of general use mirrors and other applications; Q3, production of architectural glass products, including coated, heat treated, laminated, and other select glass products; Q4, general glazing applications.

3. Type II, Class 1 and 2 Quality and Uses: Q5, applications in which design and aesthetic characteristics are major considerations; Q6, applications in which functional characteristics are a consideration and blemishes are not a major concern.

4. Form designations are: Form 1 - Wired polished both sides; Form 2 - Patterned and wired, Form 3 - Patterned.

5. Finish Designations are: F1, patterned one side; F2, patterned both sides.

6. Mesh Designations: M1, Diamond; M2, Square; M3, Parallel Strand; M4, Special.

7. Pattern Designation: P1, Linear; P2, Geometric; P3, Random; P4, Special.
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NOTE: It is critical that skylights be maintainable. Designer must include skylight access devices as a part of the design package where skylights are large or at great heights above floor.
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NOTE: Use the following bracketed statement for Army projects only.
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[For interior glazing (i.e., pass and observation windows), 6 mm 1/4 inch thick glass should be used.

] Type I, Class 1 (clear), Quality [q4 (A)] [q5 (B)]. Provide for glazing openings not indicated or specified otherwise. Use double-strength sheet glass or 3 mm 1/8 inch float glass for openings up to and including 1.39 square meters 15 square feet, 4.5 mm 3/16 inch for glazing openings over 1.39 square meters 15 square feet but not over 2.79 square meters 30 square feet, and 6 mm 1/4 inch for glazing openings over 2.79 square meters 30 square feet but not over 4.18 square meters 45 square feet.

2.2.2 Annealed Glass

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NOTE: Annealed glass is used for general glazing where clear or tinted glass is required. Glass thickness must be shown on drawings. Under some heavy thermal conditions, tinted glass may require heat strengthening for thermal endurance.
****

Annealed glass must be Type I transparent flat type, [Class 1 - clear,] Quality q3 - glazing select, [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C1036.

2.2.3 Heat-Absorbing Glass

****
NOTE: For Use On Army Projects Only: Heat-absorbing and light-absorbing glass may be used in accordance with TI 800-01, DESIGN CRITERIA. Tinted (light-reducing) glass may be used where glare is a problem and a reduction of visible light transmission is desired. Visible light transmittance will vary from 15 to 85 percent,

depending on color density and thickness. Color density is a function of thickness and increases as the thickness increases; visible light transmittance will decrease as thickness increases. ASTM C1036 separates Heat-Absorbing and Tinted (light-reducing) glasses into categories, Higher light transmittance, and Lower light transmittance, which is based on the maximum solar energy transmittance by glass thickness.

Refer to ASTM C1036 for evaluation quality requirements and glass manufacturer's data for color selection, light transmittance and shading coefficient. When specifying performance and color, the available ranges of performance and colors should be specified for glazing units to allow several manufacturers to bid. When matching existing glass, provide existing manufacturer's name, color and acceptable range for shading factor, light transmittance, indoor and outdoor reflectance.

Heat-absorbing and light-reducing glass is affected by thermal stresses which can result in breakage. Care should be taken to make sure that the glass units will not be thermally overburdened. Glass that will be thermally overburdened should be Heat-Strengthened or, if safety glazing is required, Fully Tempered to resist thermal breakage. Refer to ASTM C1048 for quality evaluation and refer to manufacturer's data for performance and color selection.

Factors which increase the risk of breakage include building orientation, unusual shapes of lites, large lites, indoor shading devices, heating registers, and outdoor shading by trees, structure or exterior shading devices.

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NOTE: For Navy Projects, consult manufacturer's literature for colors, thicknesses, and transmittance values available. Coordinate with safety glazing requirements and paragraph TEMPERED GLASS.

****

Type I, Class 2 (tinted), Quality [q3 (select)] [q4 (A)], [_____] mm inch thick, [blue][green] in color, [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C1036.

2.2.4 Reflective Coating Vision Glass

ASTM C1376

2.2.5 Wired Glass

****

NOTE: Wired glass is no longer produced in the

United States. On 17 March 1992 (effective for a five year period) OSD determined that the Buy America Act does not apply to the procurement of wired glass and added the product to the list of excepted materials under 48 CFR 25.108(d)(1) Excepted Articles, Materials, and Supplies. Accordingly, wired glass furnished in compliance with Section 08 81 00 GLAZING does not violate the Buy America Act.

Types of wired glass available are polished, patterned, and tinted/heat-absorbing wired glass. Wired glass cannot be tempered. Wired Glass does not meet the requirements of 16 CFR 1201 and cannot be used as safety glazing materials in situations governed by that regulation.

Typically 6 mm 1/4 inch thick wired glass is used for fire-rated windows and doors where required by building codes and other fire-protection criteria.

Only wired glass in Mesh 1 - Diamond and Mesh 2 - Square are acceptable for fire rated door and window openings. Mesh 3 - Parallel is not acceptable for fire rated openings.

Wired glass, because of the wire mesh and edge damage from cutting, is very susceptible to thermal breakage. Heat absorbing wired glass increases the tendency for breakage. Wired glass is also susceptible to edge breakage from water penetrating the capillary in which the wires reside. The glazing system should insure that the edges are kept dry by sealing the edges with silicone.

****

Provide UL listed glass for fire-rated windows rated for [45] [20] minutes when tested in accordance with ASTM E2226. Wired glass must be Type II flat type, Class [1 - translucent] [2 - tinted, heat-absorbing] [3 - tinted, light-reducing], Quality [q7 - decorative] [q8 - glazing], Form [1 - wired and polished both sides] [2 - patterned and wired], [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C1036. Wire mesh must be polished stainless steel Mesh [1 - diamond] [2 - square] [3 - parallel]. Wired glass for fire-rated windows must bear an identifying UL label or the label of a nationally recognized testing agency, and be rated for [20] [45] minutes when tested in accordance with NFPA 257. Wired glass for fire-rated doors must be tested as part of a door assembly in accordance with NFPA 252.

2.2.6 Patterned Glass

****

NOTE: Patterned glass is normally provided for windows of toilet rooms, vertical sliding sash in post offices borrowed light sash at entrances, etc. Patterned glass is available in various thicknesses, with a pattern embossed on one or both sides. This glass is frequently called "figured", "obscure", or "decorative" glass. The degree of diffusion

achieved is a function of the pattern and whether the pattern is on one or both sides. Some patterned glass cannot be heat-strengthened or tempered because of the pattern depth. Pattern glass does not offer complete obscurity and must be used with caution in very private areas such as toilets. The appropriate pattern designation should be selected from ASTM C1036. If a more specific pattern designation is desired, a manufacturer's name and pattern may be specified. When specific manufacturer's names and patterns are specified, the designer should add the following note to the spec: "Manufacturer's name and patterns indicated are for identification purposes only; the listing is not intended to limit selection of similar patterns from other manufacturers." Refer to GANA GLAZING MANUAL, and glass manufacturer's performance tables for proper evaluation of patterned glass thickness and size of opening to be glazed. Patterned glass 3 mm 1/8 inch thick should not be larger than 2.15 square meters 6 square feet.

****

Type II, Class 1 (translucent), Form 3 (patterned), Quality q5 or q6 (decorative), Finish [F1 (patterned one side)] [F2 (patterned two sides)], Pattern [P1 (linear)] [P2 (geometric)] [P3 (random)] [P4 (special)], [[_____] percent light transmittance, [_____] percent shading coefficient.] [3] [6] mm [1/8] [7/32] inch thick.[Provide [_____].]

2.2.7 Laminated Glass

****

NOTE: For Antiterrorism (AT) criteria, refer to UFC 4-010-01 "DoD Minimum Antiterrorism Standards for Buildings." Laminated annealed flat glass must be provided at exterior window and door glazing. When force protection minimum measures are required, use the first bracketed option below. Use the second bracketed option when greater than minimum measures are required. This section must be completed for an established DBT and LOP by an engineer experienced in Blast-Resistant Design.

****

[ASTM C1172, Laminated glass fabricated from two nominal [3] [_____] mm [1/8] [_____] inch pieces of Type I, Class 1, [Class _____], Quality Q3, flat annealed [ultraclear]; [clear] [_____] glass conforming to ASTM C1036.] [ASTM C1172, Laminated glass fabricated from two nominal [3] [_____] mm [1/8] [_____] inch pieces of Type I, Kind [HS] [FT], Condition [A] [B] [C], Class 1, Class [_____], Quality Q3, flat [heat strengthened] [fully tempered] [clear] [_____] glass conforming to ASTM C1048.] Flat glass to be laminated together with a minimum of 0.75 mm 0.030 inch [_____] mm inch thick, clear [polyvinyl butyral] [ionoplast] [cast-in-place liquid resin] laminate, conforming to requirements of 16 CFR 1201 and ASTM C1172. The total thickness of nominally 6 [_____] mm 1/4 [_____] inches. Color to be [clear] [gray] [bronze] [_____]. The total thickness of nominally [_____] mm inch.

[Design window glazing using a dynamic analysis[testing from airblast loading in accordance with ASTM F1642/F1642M by an independent testing agency regularly engaged in blast testing] to prove the glazing will provide performance equivalent to or better than a [low] [very low] [_____] hazard rating in accordance with ASTM F2912 for the peak positive pressure of [_____] kilopascals (kPa) [_____]pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) pounds per square inch - millisecond (psi-msec).

]2.2.8 Bullet-Resisting Glass

****

NOTE: Bullet-resisting glazing material is available in ten rating levels to resist shots from the following Arms:

UL 752 Level 1: Provides protection against three shots of a 124-grain 9mm full metal copper jacket with lead core at an fps between 1175 and 1293

UL 752 Level 2: Provides protection against three shots of a 158-grain .357 magnum jacketed lead soft point at an fps between 1250 and 1375

UL 752 Level 3: Provides protection against three shots of a 240-grain 44 Magnum Lead Semi-Wadcutter Gas Checked at an fps between 1350 and 1485

UL 752 Level 4: Provides protection against one shot of a 180-grain .30 caliber rifle lead core soft point at an fps between 2540 and 2794

UL 752 Level 5: Provides protection against one shot of a 150-grain 7.62mm rifle lead core full metal copper jacket military ball (.308 caliber) at an fps between 2750 and 3025

UL 752 Level 6: Provides protection against five shots of a 124-grain 9mm full metal copper jacket with lead core at an fps between 1400 and 1540

UL 752 Level 7: Provides protection against five shots of a 55-grain 5.56mm rifle full metal copper jacket with lead core (.223 caliber) at an fps between 3080 and 3383

UL 752 Level 8: Provides protection against five shots of a 150-grain 7.62mm rifle lead core full metal copper jacket military ball (.308 caliber) at an fps between 2750 and 3025

Shotgun: Provides protection against three shots of a 12-gauge rifled lead slug at an fps between 1585 and 1744 and three shots of a 12-gauge 00 buckshot (12 pellets) at an fps between 1200 and 1320

****

Fabricated from Type I, Class 1, Quality q3 glass with polyvinyl butyral plastic interlayers between the layers of glass and listed by UL MEAPD as bullet resisting, with a rating Level of [Level 1] [Level 2] [Level 3]

[Level 4] [Level 5] [_____] in accordance with UL 752. Provide [_____] [where indicated].

[2.2.9 Mirrors

****

NOTE: For Army projects only. Navy projects will specify mirrors in Division 10, Specialties. Select the frames (J-Mold channels) or clips to secure mirror to wall. Mastic is required with each type of installation. Mirror sizes will be shown on the drawings. Coordinate with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS, Section 05 51 00 METAL STAIRS or Section 05 51 33 METAL LADDERS and Section 10 28 13 TOILET ACCESSORIES to ensure that frames are specified for these mirrors.

One-way vision glass should be used for psychiatric and security observation windows. Where safety glazing is required, specify either laminated glass or tempered glass.

****

2.2.9.1 Glass Mirrors

Glass for mirrors must be Type I transparent flat type, Class 1-clear, Glazing Quality q1 6 mm 1/4 inch thick conforming to ASTM C1036. Glass must be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating must be highly adhesive pure silver coating of a thickness which must provide reflectivity of 83 percent or more of incident light when viewed through 6 mm 1/4 inch thick glass, and must be free of pinholes or other defects. Copper protective coating must be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and must be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint must consist of two coats of special scratch and abrasion-resistant paint , and must be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

]2.2.10 One-Way Vision Glass (Transparent Mirrors)

Type I, Class 1, Quality q1, 6 mm 1/4 inch thick, coated on one face with a hard, adherent film of chromium or other approved coating of equal durability. Glass must transmit not less than 5 percent or more than 11 percent of total incident visible light and must reflect from the front surface of the coating not less than 45 percent of the total incident visible light.[Provide [_____].]

2.2.11 Tempered Glass

****

NOTE: Tempered glass is the preferred material for areas requiring safety glazing materials. Laminated glass, organic-coated glass, wire glass, and plastic sheet are permitted if they conform to the requirements of the CPSC 16 CFR Part 1201.

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ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class

[1 (transparent)] [2 (tinted heat absorbing)], Quality q3, [_____] mm inch thick, [_____] percent light transmittance, [_____] percent shading coefficient conforming to ASTM C1048 and GANA Standards Manual. Color must be [[clear] [bronze] [gray] [_____]]. [Provide [_____]] [and wherever safety glazing material is indicated or specified].

2.2.12 Heat-Strengthened Glass

ASTM C1048, Kind HS (heat strengthened), Condition A (uncoated), Type I, Class [1 (clear)] [2 (tinted heat absorbing)], Quality q3, [_____] mm inch thick. [Provide [_____].]

2.2.13 Spandrel Glass

2.2.13.1 Ceramic-Opacified Spandrel Glass

Ceramic-opacified spandrel glass must be Kind HS heat-strengthened transparent flat type, Condition B, coated with a colored ceramic material on No. 2 surface, Quality q3 - glazing select, [_____] mm [_____] inch thick, conforming to ASTM C1048. Glass performance must be K-Value/Winter Nighttime [_____], R-Value/Winter Nighttime [_____], shading coefficient [_____]. Color must be [_____].

2.2.13.2 Film-Opacified Spandrel Glass

Film-opacified spandrel glass must be Kind HS heat-strengthened transparent flat type, Quality q3 - glazing select, Condition C glass with a polyester or polyethylene film 0.025 mm to 0.127 mm 2 mils to 5 mils thick attached to No. 2 surface of a sputtered solar-reflective film, conforming to ASTM C1048. Film opacification must be compatible to and specifically developed for application to solar reflective films. Glass performance must be K-Value/Winter Nighttime [_____], R-Value/Winter Nighttime [_____], shading coefficient [_____]. Color must be [_____].

2.2.13.3 Spandrel Glass With Adhered Backing

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NOTE: Spandrel glass with adhered backing is required wherever glass spandrels are located above sidewalks, pedestrian or vehicular ramps, paved plazas, entrances not covered by a protective canopy, and other locations where glass could fall onto an area used by the public.

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ASTM C1048, Kind HS or FT, Condition B (ceramic coated), Type I, Quality q5, [_____] mm inch thick and must pass the fallout resistance test specified in ASTM C1048. [Provide [_____].]

[2.2.14 Fire/Safety Rated Glass

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NOTE: Refer to NFPA 101 Life Safety Code for fire rated requirements of assemblies which have glazing components. Coordinate with adjacent framing and hardware assemblies to achieve required rating.

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[2.2.14.1 Fire Protection Rated Glass

Clear tempered and meet 16 CFR 1201 Category I (under 0.836 sqm) (under 9 square feet) or II (over 0.836 sqm) (over 9 square feet) impact safety standard. Glass to make [20] [45] minute rating when tested in accordance with NFPA 257 and NFPA 252. Glass to be permanently labeled with appropriate markings.

][2.2.14.2 Fire Resistive Rated Glazing

Fire resistive glass must be laminated, with intumescent interlayer, Type I transparent flat type, Class 1-clear and meet 16 CFR 1201 Category I (under 0.836 sqm) (under 9 square feet) or II (over 0.836 sqm) (over 9 square feet). Glass must have a [60] [90] [120] minute rating when tested in accordance with ASTM E119 and NFPA 251. Glass must be permanently labeled with appropriate markings.

]]2.3 INSULATING GLASS UNITS

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NOTE: Where safety glazing is required, both lights of insulating units must be safety glass, and each light must have a permanent label.

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NOTE: When antiterrorism/force protection requirements apply, specify laminated annealed flat glass for interior light. Use the bracketed option regarding ASTM C1172 in the paragraph below.

NOTE: Where safety glazing is required, both lights of insulating units must be safety glass, and each light must have a permanent label.

NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

NOTE: U value (rate of heat transfer) and SHGC (how much heat the building gains from the sun) are determined on a whole-opening basis (glazing and frame). Specify U value and SHGC in the appropriate exterior opening (window, door, curtain wall) sections and coordinate insulated glass description with energy performance requirements specified in those sections. Include bracketed U value and SHGC requirements here only if not specified elsewhere as a whole-opening rating for frame and glass. Determine appropriate values by consulting ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

Window properties are critical to energy performance and visual satisfaction. Low SHGC is achieved with

selective glass, tinted glass, or reflective coating. Specify selective glass for clear appearance or when high visible transmittance is required for daylighting goals. In the Northern Hemisphere, south side glass may be protected from summer sun by an overhang and have a high SHGC if winter heat is useful. Specify a low SHGC for south-side glass if the building is dominated by internal heat gain and solar heat is unwelcome even in winter. North side receives very little sun and requires no special treatment.

Consider glazing with aerogel insulation between two panels of glass, producing the highest visual transmittance with the highest insulation values currently available. Verify availability and cost before specifying aerogel.

Installing energy efficient windows contributes to achieving sustainability requirements as outlined in UFC 1-200-02.

For specifying pre-assembled window units used in residential buildings, utilize the following Sections: 08 51 13 ALUMINUM WINDOWS, 08 52 00 WOOD WINDOWS, or 08 53 00 PLASTIC WINDOWS.

Designer must verify availability and adequate competition for products energy performance requirements before specifying and edit as needed.

NOTE: STC levels higher than 35 may require costly design modifications and special glazing. STC addresses construction subject to interior sound frequencies and does not include all typical outdoor frequencies; Outside-Inside Transmission Class (OITC) was developed to evaluate an expanded sound-frequency range generally considered to be more reflective of exterior noise conditions imposed on the building envelope such as road, rail, and airplane traffic.

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[Two][Three] panes of glass separated by a dehydrated airspace[, filled with argon gas][, filled with krypton gas,][, filled with aerogel] and hermetically sealed, conforming to ASTM E2190. Submit performance and compliance documentation for each type of insulating glass.

[Insulated glass units must have a Solar Heat Gain Coefficient (SHGC) maximum of [_____] determined according to NFRC 200 and a U-factor maximum of [_____] W per square m by K Btu per square foot by hr by degree F in accordance with NFRC 100.

] [See section[s][_____] for energy performance requirements for glazed systems (glazing and frames).] [Glazed panels must be rated for not less than [26] [30] [35] [_____] Sound Transmission Class (STC) when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.]

Dimensional tolerances must be as specified in IGMA TB-1200. Spacer must be black, roll-formed, [thin-gauge, C-section steel] [steel-reinforced butyl rubber] [thermally broken aluminum] [polyurethane and silicon foams], with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal must be compressed polyisobutylene and the secondary seal must be a specially formulated silicone.

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NOTE: Delete intermediate light if triple glazing is not required.

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The inner light must be [ASTM C1172, clear annealed flat glass Type I, Class I, Quality q3] [ASTM C1036, Type I, Class 1, Quality q4, [_____] mm inch thick] [ASTM C1048, Grade B (fully tempered), Style I (uncoated), Type I, Class 1 (transparent), Quality q4, [_____] mm inch thick]. [The intermediate light must be [ASTM C1172, clear annealed flat glass Type I, Class I, Quality q3] [ASTM C1036, Type I, Class 1, Quality q4, [_____] mm inch thick] [ASTM C1048, Grade B (fully tempered), Style I (uncoated), Type I, Class 1 (transparent), Quality q4, [_____] mm inch thick].] The outer light must be [ASTM C1036, Type I, Class [1 (transparent)] [2 (tinted heat absorbing)], [2 (solar-reflective)], Quality q4, [_____] mm inch thick] [ASTM C1048, Grade B (fully tempered), Style I (uncoated), Type I, Class [1 (clear)] [2 (tinted heat absorbing)][solar-reflective], Quality q4, [_____] mm inch thick].

2.3.1 Low Emissivity Coatings

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NOTE: Low emissivity coating should be on the air space surface of the inner pane of glass (the number 3 surface) in heating-dominated buildings, and on the number 2 surface (inside surface of the exterior pane) in cooling-dominated buildings.

NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

****

Interior and exterior glass panes for Low-E insulating units must be Type I annealed flat glass, Class [1-clear] [2-tinted] with anti-reflective low-emissivity coating or heat-strengthened or fully tempered glass complying with ASTM C1048, Condition C on [No. 2 surface (inside surface of exterior pane)][No. 3 surface (inside surface of interior pane)], Quality q3 - glazing select, conforming to ASTM C1036. Glass performance must be U value maximum of [_____] [W/m2-K] [Btu/hr-ft2-F], Solar Heat Gain Coefficient (SHGC) maximum of [_____]. Color must be [green] [gray] [bronze] [blue] [_____] .

2.4 PLASTIC GLAZING

****

NOTE: Plastic glazing may be used in some areas where high resistance to breakage is required, but combustibility must be considered in the design. See manufacturers' literature for many types available. Do not specify plastic for glazing unprotected openings, for roof panels, or for skylights without consulting UFC 3-600-01, "Fire Protection Engineering for Facilities" and NAVFACENGCOM Code 04F.

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NOTE: Polycarbonate is more expensive than acrylic and should only be selected for locations which are highly vulnerable to vandalism or other types of abuse. Avoid polycarbonate if possible due to potentially hazardous constituent chemicals (including Bisphenol A). Where only one material is used in the project, the other one should be deleted.

Where translucent plastic sheets are required, locations will be shown on the contract drawings. The following will be added at the end of the paragraph:

"Translucent sheets, where shown, must be white having light transmission of [_____] percent for sheets [_____] mm inches thick, or clear with matte finish."

The light transmission required for a particular sheet thickness will be selected from plastic sheet manufacturer's catalogs.

Acrylic-plastic is a combustible material and must not be used in areas where exposure to fire would create a hazard condition.

Consider glazing with aerogel insulation between two panels of plastic, producing the highest visual transmittance with the highest insulation values currently available. Plastic glazing must have a U-factor maximum of the specified U-factor for insulating glass units. Verify availability and cost before specifying aerogel.

****

Plastic glazing must have a U-factor maximum of [_____] W per square m by K Btu per square foot by hr by degree F.[Plastic glazing must include a [16] [32] [_____] mm [0.63] [1.26] [_____] inch layer of aerogel between panels.]

Certificates stating that the plastic glazing meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

2.4.1 Acrylic Sheet

ASTM D4802, [Type I, regular] [Type II, heat resistant,] [clear and smooth on both sides] [translucent, textured on both sides,] [gray tint,] [bronze tint,] ultraviolet stabilized, [scratch resistant,] [_____] [6] [_____] mm [0.236] [_____] in. thick.

2.4.2 Polycarbonate Sheet

ANSI Z97.1, [Clear and smooth both sides] [Translucent, textured both sides] [Gray tint] [Bronze tint] [mar-resistant] [high abrasion resistant], ultraviolet stabilized, [_____] mm inch thick and listed in UL MEAPD as burglar resisting.

2.4.3 Extruded Polycarbonate Profiled Sheet

Provide [double] [triple] walled, surface treated for improved UV resistance, offering thermal efficiency and impact strength.

2.4.4 Bullet-Resistant Plastic Sheet

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NOTE: Bullet-resisting glazing material is available in four power ratings to resist scattered shots from (1) medium-power small arms (MSA); (2) high-power small arms (HSA); (3) super-power small arms (SSA); and (4) high-power rifles (HR). Bullet-resisting acrylic sheet is listed by UL for MSA rating only and is 25.4 mm one inch thick. Bullet-resisting polycarbonate sheet is listed for MSA 25.4 mm one inch and for HSA and SSA ratings 31.8 mm 1 1/4 inch. Consult manufacturers for exact thicknesses and availability.

****

Cast acrylic sheet or mar-resistant polycarbonate sheet laminated with a special interlayer, and listed in UL 752 as bullet resisting, Class [I] [II] [III], [clear] [_____] in color.[Provide [_____].]

2.5 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted must be gray or neutral color. Sealant testing must be performed by a testing agency qualified according to ASTM C1021.

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.[Include cleaning instructions for plastic sheets.]

2.5.1 Putty and Glazing Compound

Provide glazing compound as recommended by manufacturer for face-glazing metal sash. Putty must be linseed oil type. Do not use putty and glazing compounds with insulating glass or laminated glass.

2.5.2 Glazing Compound

Use for face glazing metal sash. Do not use with insulating glass units or laminated glass.

2.5.3 Sealants

Provide elastomeric [and structural] sealants.

2.5.3.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing [wood] [and] [metal] sash. Sealants must be chemically compatible with setting blocks, edge blocks, and sealing tapes[, with sealants used in manufacture of insulating glass units] [, and with plastic sheet]. Color of sealant must be white.

2.5.3.2 Structural Sealant

ASTM C1184, Type S.

2.5.4 Joint Backer

Joint backer must have a diameter size at least 25 percent larger than joint width; type and material as recommended in writing by glass and sealant manufacturer.

2.5.5 Glazing Tapes

2.5.5.1 Back-Bedding Mastic Glazing Tapes

Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

a. AAMA 804.3 tape, where indicated.

b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.

c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.5.5.2 Expanded Cellular Glazing Tapes

Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.

b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.5.6 Sealing Tapes

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D2287. Use only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes must be chemically compatible with the product being set.

2.5.7 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks must be dense extruded type conforming to ASTM C509 and ASTM D395, Method B, Shore A durometer between 70 and 90. Edge blocking must be Shore A durometer of 50 (plus or minus 5). Provide silicone setting blocks when blocks are in contact with silicone sealant. Profiles, lengths and locations must be as required and recommended in writing by glass manufacturer. Block color must be [black][_____].

2.5.8 Glazing Gaskets

Glazing gaskets must be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening must be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets must be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Provide glazing gasket profiles as recommended by the manufacturer for the intended application.

2.5.8.1 Fixed Glazing Gaskets

Fixed glazing gaskets must be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C509, Type 2, Option 1.

2.5.8.2 Wedge Glazing Gaskets

Wedge glazing gaskets must be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C864, Option 1, Shore A durometer between 65 and 75.

2.5.8.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing must be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.5.9 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers. Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to surface.

[2.6 MIRROR ACCESSORIES

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NOTE: Use for Army projects only. Navy projects will specify Mirrors and Accessories in Division 10, Specialties.

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2.6.1 Mastic

Mastic for setting mirrors must be a [polymer] [_____] type mirror mastic resistant to water, shock, cracking, vibration and thermal expansion. Provide mastic compatible with mirror backing paint, and as approved by mirror manufacturer.

2.6.2 Mirror Frames

Provide mirrors with mirror frames (J-mold channels) fabricated of one-piece roll-formed Type 304 stainless steel with No. 4 brushed satin finish and concealed fasteners which will keep mirrors snug to wall. Frames must be 32 by 6 by 6 mm 1-1/4 by 1/4 by 1/4 inch continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material must be provided with mirror frames.

2.6.3 Mirror Clips

Provide clips with concealed fasteners of type to suit wall construction material.

]PART 3 EXECUTION

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.1 PREPARATION

Preparation, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 GLASS SETTING

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Aluminum windows, wood doors, and wood windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

3.2.1 Sheet Glass

Cut and set with the visible lines or waves horizontal.

3.2.2 Patterned Glass

Set glass with one patterned surface with smooth surface on the weather side. When used for interior partitions, place the patterned surface in same direction in all openings.

3.2.3 Insulating Glass Units

Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation must conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

3.2.4 Installation of Wire Glass

Install glass for fire doors in accordance with installation requirements of NFPA 80.

3.2.5 Installation of Heat-Absorbing Glass

Provide glass with clean-cut, factory-fabricated edges. Field cutting will not be permitted.

3.2.6 Installation of Laminated Glass

Sashes which are to receive laminated glass must be weeped to the outside to allow water drainage into the channel.

3.2.7 Plastic Sheet

Conform to manufacturer's recommendations for edge clearance, type of sealant and tape, and method of installation.

3.3 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass must be clean at the time the work is accepted.[Clean plastic sheet in accordance with manufacturer's instructions.]

3.4 PROTECTION

Protect glass work immediately after installation. Identify glazed openings with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Protect reflective glass with a protective material to eliminate any contamination of the reflective coating. Place protective material far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Upon removal, separate protective materials for reuse or recycling. Remove and replace glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities with new units.

3.5 SCHEDULE

Some metric measurements in this section are based on mathematical

conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
Glass	1/8 inch	3 mm
	3/16 inch	4.5 mm
	7/32 inch	6 mm
	1/4 inch	6 mm
	3/8 inch	10 mm
Interlayer	0.015 inch	0.38 mm
Glazing Channels	1/4 inch	6 mm

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 87 23.13 (August 2009)**

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SAFETY FILMS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 87 23.13 (August 2009)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 08 87 23.13

SAFETY FILMS
08/09

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NOTE: This guide specification covers the requirements for transparent film at least 0.10 mm 0.004 inch thick (4 mil) applied to the interior side of glass to reduce spalling and fragment dispersal.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C1036	(2021) Standard Specification for Flat Glass
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D1044	(2019) Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion by the Taber Abraser
ASTM D3330/D3330M	(2004; R 2018) Standard Test Method for Peel Adhesion of Pressure-Sensitive Tape
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2008) Glazing Manual
GANA Sealant Manual	(2008) Sealant Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

1.2 SYSTEM DESCRIPTION

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NOTE: This specification should be used when glass may be subjected to the effects of explosives or

projectiles and when protection of personnel from the resulting glass spalling is required. The film is most effective when installed on the interior surface of the glass. Under low blast pressures or projectile loads, the film may not prevent the glass from breaking but it holds the glass fragments together and reduces the destructive capability of flying glass fragments. Note that testing has shown that fragment retention film will not necessarily hold glass fragments together when subjected to very high blast pressures, and the designer may therefore want to consider alternate methods for protection of personnel. The application of film to glass generally allows projectiles, fragments, or bullets to pass through; however, the film does reduce spalling of the glass associated with a projectile passing through the film.

The application of film to glass provides some resistance against impacts from hammers, rocks, clubs, or thrown objects. An impact on the film reinforced glass creates a hole approximately the size of the impacting object. Therefore, several impacts are needed to make a hole large enough for entry. The use of greater film thickness and/or factory laminated films provides more resistance against these impacts.

Tints and reflective films can improve the thermal energy performance of a building. However, darkly tinted and reflective films can cause internal heat buildup and internal stresses in the glass resulting in a weakened glazing system. If reflective films are used to reduce visibility into a facility, also provide curtains or shades for night use because films are not reflective when the light level on the exterior side of the film is less than that on the interior side.

****

1.2.1 General Requirements

Apply clean fragment retention film free of peeling, splitting, scratches, creases, wrinkles, discoloration, and foreign particles. The film application must be free of air bubbles after 30 days. Do not show signs of waviness and distortion at the time the work is accepted. Make this determination by the unaided eye (except for corrective prescription glasses), when the film is viewed from a distance of 3 m 10 feet from the interior room side at angles up to 45 degrees when looking at a clear or uniformly overcast sky. Remove unacceptable fragment retention film applications in accordance with manufacturer's instructions and new film applied.

1.2.2 Other Submittals Requirements

Submit the following for fragment retention film:

a. Manufacturer's data consisting of catalog cuts, brochures, circulars, and a list of glazing compounds and/or gaskets known to be incompatible with the fragment retention film.

b. Manufacturer's application and cleaning instructions for fragment retention film.

c. A statement that the fragment retention film supplied was manufactured using the same materials and process as the material tested. A statement that the adhesive contains ultraviolet inhibitors which limit ultraviolet transmission to not more than 8 percent of the radiation between 300 and 380 nanometers. A statement that the film manufacturer or manufacturer's representative trained the personnel who will apply the film.

d. A sample consisting of a minimum 200 by 275 mm 8 by 11 inch section of fragment retention film including the adhesive layer.

e. Certified test reports including analysis and interpretation of test results. Identify the manufacturer, the specific product name, the film thickness, the adhesive type and thickness, and the glass type and thickness. Identify the methods used and include the results recorded.

f. On applications where the film will contact the glazing beads or gaskets, a certificate from the Contractor stating that the glazing compounds and gaskets are compatible with the fragment retention film and adhesive.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL

PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fragment Retention Film

Cleaning

SD-04 Samples

Fragment Retention Film; G, [_____]

SD-06 Test Reports

Fragment Retention Film

SD-07 Certificates

Fragment Retention Film

1.4 QUALITY ASSURANCE

The personnel applying the fragment retention film must be trained by the film manufacturer or manufacturer's representative.

1.5 DELIVERY, STORAGE, AND HANDLING

The Contractor is responsible for delivery of the fragment retention film to the appropriate location for application. Deliver, store, and handle fragment retention film in accordance with the manufacturer's recommendations. Store glass, including glass in windows or doors with factory applied film, in a dry location free of dust, water, and other contaminants. Deliver, store, and handle glass with factory applied film so that the film is not damaged, scratched, or abraded and store in a manner which permits easy access for inspection and handling. Provide each roll of film with a tamperproof label containing full details of the roll, the batch number, and sufficient information to enable the Contracting Officer to ensure that the correct film is supplied.

1.6 WARRANTY

Furnish a 5 year warranty for fragment retention film material, providing for replacement of film if cracking, crazing, peeling, or inadequate adhesion occurs.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide fragment retention film which is the standard product of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.2 FRAGMENT RETENTION FILM

****

NOTE: Indicate windows and doors requiring film on the window and door schedules or window and door elevations of the drawings.

The film is available in 0.05 mm 0.002 in., 0.10 mm 0.004 in., 0.18 mm 0.007 in., 0.20 mm 0.008 in., 0.25 mm 0.010 in., and 0.30 mm 0.012 inch thicknesses. A minimum thickness of 0.10 mm 0.004 inch film is acceptable for fragment retention. The use of greater than 0.10 mm 0.004 inch film thickness and/or factory laminated films of 0.10 mm 0.004 inch or greater may provide more protection for occupants from flying fragments of glass but may not be warranted for low blast pressure. The designer must investigate window frames and building components adjacent to the glazed opening for transfer of the blast load when using 0.18 mm 0.007 inch and thicker films.

The properties of fragment retention film and/or the adhesive may change over time, effecting the film's capacity to retain fragments. Testing has shown the film retains fragments up to 7 years of use.

****

Provide fragment retention film consisting of polyester, polyethylene terephthalate, or a composite, optically clear and free of waves, distortions, impurities, and adhesive lines. The film may be a single layer or laminated. Laminate film at the factory of the fragment retention film manufacturer. Include an abrasion resistant coating on the surface that does not receive the film adhesive. Provide [clear] [tinted] [reflective] fragment retention film with a minimum thickness of [0.10] [0.18] [0.25] mm [0.004] [0.007] [0.010] inch. Supply with an optically clear weatherable pressure sensitive adhesive. The adhesive must contain ultraviolet inhibitors to protect the film for its required life and must limit ultraviolet transmission to not more than 8 percent of the radiation between 300 and 380 nanometers. The adhesive must not be water activated. A water soluble detackifier and/or release liner may be incorporated over the adhesive to facilitate film application. The adhesive must be 90 percent cured within 30 days of installation. Provide adhesives that are a minimum of 0.02 mm 0.0008 inch thick on film thicknesses of 0.25 mm 0.010 inch and greater. Perform the following tests to indicate compliance with specified requirements by an independent testing laboratory, and have a responsible official of the laboratory sign the laboratory reports.

2.2.1 Impact Performance

****

NOTE: Retain sentences about splices when the film will be applied to sheets of glass with a dimension exceeding 1475 mm 58 inches in both directions.

Paragraph 5.1.3 (2) of ANSI Z97.1 and paragraph 1204.4 (e) (1) (ii) of 16 CFR 1201 will not be an accepted form of testing glazing failure after the impact test because these paragraphs allow complete disintegration if fragment particles are small enough. Complete disintegration of the glazing is unacceptable under blast loading because the particles would be propelled into the building and could seriously injure or kill the occupants. Designers specifying fragment retention film for use in other countries may substitute impact test reports in accordance with British Standard (BS) BS 6206 Class B and German Standard DIN 5237, which use similar testing methods to the impact tests specified. The designer should accept but not specify films tested and receiving an A1 impact resistance under DIN 52290 or film which has tested positively in accordance with BS 5544. Do not specify the film to be tested in accordance with DIN 52290 or BS 5544 because relatively few films can pass these more stringent impact tests.
****

Test fragment retention film for impact in accordance with ANSI Z97.1 or 16 CFR 1201. Conduct tests on fragment retention film applied to 3.1 to 6.4 mm 1/8 to 1/4 inch-thick annealed flat glass which conforms to the requirements of ASTM C1036, Type I, Class 1, Quality q3. Apply the tested film to the glass with a splice located at the midpoint of the specimen. Include sketches showing location and configuration of splice in submitted certified test reports. After the impact portion of the test is conducted, determine satisfactory performance of the test specimens using ANSI Z97.1, paragraph 5.1.3 or 16 CFR 1201, paragraph 1201.4 (e)--INTERPRETATION OF RESULTS. To be qualified for use under this specification, provide a report that the fragment retention film satisfactorily performed in accordance with ANSI Z97.1, paragraph 5.1.3 (1), (3), or (4) or with 16 CFR 1201, paragraph 1204.4 (e) (1) (i), (iv), or (v). ANSI Z97.1, paragraph 5.1.3 (2) or 16 CFR 1201, paragraph 1204.4 (e) (1) (ii) does not constitute passing criteria.

2.2.2 Tensile Strength

The fragment retention film samples tested must exhibit a minimum tensile strength at break of 172.4 MPa 25,000 psi when tested in accordance with ASTM D882. Use Method A, Static Weighing, Constant Rate of Grip Separation Test, to conduct this test. Rate of grip separation exceeding 0.2 mm/s 1/2 inch per minute is not permitted.

2.2.3 Peel Strength

Conduct testing following 1,200 hours accelerated weathering exposure. The fragment retention film must exhibit a minimum peel strength of 930 N/m 5.3 pounds/inch for 0.10 mm 0.004 inch thick film and 790 N/m 4.5 pounds/inch for 0.18 mm 0.007 inch thick and thicker film when tested in accordance with ASTM D3330/D3330M. Use Method A to conduct the tests. Use a glass substrate and a maximum dwell time of 45 days is permitted.

2.2.4 Surface Abrasion

Exhibit a change in haze not to exceed 3.2 percent following 100 turns, using 500-gram weights on a CS 10F abrasive wheel when tested in accordance with ASTM D1044.

2.2.5 Flame Spread and Smoke Density

****

Note: The designer may delete the requirement for flame spread and smoke density index if not required by the project.

****

Exhibit a flame spread index not exceeding 25 and a smoke density index not exceeding 100 when tested in accordance with ASTM E84. For the test, mount the specimen to 6.4 mm 1/4 inch thick tempered glass which conforms to the requirements of ASTM C1048, Kind FT, Type I, Class 1, Quality q3.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Clean the glass surface, to which the fragment retention film is to be applied, of paint, foreign compounds, smears, and spatters. After the initial cleaning, further clean the surface to receive the film in accordance with the film manufacturer's instructions.

3.2 APPLICATION

****

NOTE: Greater protection for occupants from flying glass caused by blast loads is achieved by applying film such that it extends edge to edge of the sheet and into the bite of the frame. Some gaskets and compounds can dissolve the film surface, the adhesive, or the metallic coating interlayer of reflective or tinted films. For insulated glass units, apply film to the interior (room) side only. Other applications have not been tested. Tests show that film applications to insulated glass units offer more protection for occupants than applications on single sheets of glass. When more than one type of film application is used for a project, indicate the application to be used on the door and window schedules or elevations.

****

Provide fragment retention film on window and door glass where indicated. After surface preparation, apply the fragment retention film in accordance with the manufacturer's recommendations and instructions. Apply film to the interior (room) side of the glass for both single and double glazed sheets, unless otherwise indicated. Multiple applications of film to achieve specified thicknesses is not allowed. Do not apply film if there are visible dust particles in the air, if there is frost on the glazing, or if any room condition such as temperature and humidity do not meet the manufacturer's instructions. After film application, maintain room conditions as required by the manufacturer's instructions to allow for proper curing of the adhesive.

3.2.1 Application to New Glass Before Glazing

****
NOTE: Retain this paragraph when film will be applied to the glass before glazing. This may occur at the window or door manufacturer's shop or in the field. Designer will insert a coordinating note into Section 08 81 00 GLAZING, indicating that fragment retention film application is a requirement.
****

Apply fragment retention film so that it extends edge to edge of the glass sheet. Then set the film reinforced glass into the frame with glazing compounds or gaskets as specified in Section 08 81 00 GLAZING. Ensure compatibility when contact between the glazing compounds and/or gaskets and the film occurs. Coordinate fragment retention film application and curing with the glass supplier and window or door manufacturer prior to glazing installation.

3.2.2 Application to Existing Glass Involving Dismantlement

****
NOTE: Retain this paragraph when film is to be applied to existing glazing where the stops, compounds, and/or gaskets must be removed to apply the film edge to edge of the glass sheet. Dismantlement is recommended for glazed openings with removable stops and removable reusable gaskets. Removable gaskets include vinyl and rubber channels or beads and extruded aluminum beads. Dismantlement may be too expensive for openings glazed with compounds. This expense is due to the increased labor, increased risk of breakage, and increased cost of replacing compounds because most compounds are not reusable. Compounds include wet applied or semi-soft compounds such as sealant, putty, butyl, hypalon, silicone, acrylic, polyurethane, polysulfide, and preformed semi-solid tapes. Although existing gaskets are readily identifiable, determining the composition of existing compounds to check compatibility with the film is more difficult and could add expense to the project.
****

Remove the existing glazing compound, gaskets, and/or stops as required to expose the existing glass pane. If necessary, remove the glass so that the film can be applied extending edge to edge of the glass sheet. Install existing gaskets and/or stops and replace any removed glazing compounds with new glazing compounds. Scrap removed glazing compounds and do not reuse. Provide glazing compounds in accordance with GANA Sealant Manual. Perform glazing in accordance with GANA Glazing Manual. Ensure compatibility when contact between the glazing compounds and/or gaskets and the film occurs. Replace damaged or broken glazing and gaskets and reinstall in kind.

3.2.3 Application to Existing Glass Without Dismantlement

****

NOTE: Retain this paragraph for application where dismantlement is not possible or is too expensive. When exposed to the effects of explosives, films that stop close to the frame but do not extend into the bite tend to break along the weak edge and disengage completely from the frame. Because the disengaged film reinforced glass is held together as a unit, protection is provided for building occupants. This application is simplest and the least costly. Also, coordination and compatibility of the film with the compounds and gaskets is not necessary because they do not contact. If the edges of the existing glazing compounds are particularly irregular, the designer may specify the film application to be within a maximum of 5 mm 3/16 inch, although the 3 mm 1/8 inch maximum is recommended.

****

Apply fragment retention film so that it extends to within 1.6 mm 1/16 inch, with a maximum of [3] [5] mm [1/8] [3/16] inch, of the edge of the visible glass area.

3.2.4 Application to Existing Glass and Frame Without Dismantlement

****

NOTE: Retain this paragraph for application where dismantlement is not possible or is too expensive. Although this application has not been tested under blast loads, several manufacturers recommend it. In this application, the film is likely to contact the existing gaskets and compounds. Trim or a batten may be indicated on the drawings and/or added to this paragraph to hide the film edge.

****

Apply fragment retention film past the edge of the visible glass and extend onto the frame. Provide amount of film overlap, edge connection to the frame, and adhesive for adhering film to frame as recommended by the film manufacturer. Ensure compatibility when contact between the glazing compounds and/or gaskets and the film occurs.

3.2.5 Splicing

****

NOTE: Overlaps of 0.25 mm 0.010 inch thick and thicker film are highly visible and are not recommended. If no glazing has a dimension exceeding 1475 mm 58 inches in both directions, specify that the film may not be spliced.

****

[Splices or seams in fragment retention film are not permitted.] [Splices or seams in fragment retention film are permitted only when a sheet of glass has a dimension exceeding 1.475 m 58 inches in both directions. Apply all seams with a minimum overlap of 6 mm 1/4 inch unless submitted test reports indicate impact performance is not diminished when seam is applied with a different overlap or a gap.]

3.3 CLEANING

Clean the fragment retention film in accordance with the manufacturer's instructions.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-08 88 53 (May 2011)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 88 53 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 08 88 53

DETENTION AND SECURITY GLAZING

05/11

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****

USACE / NAVFAC / AFCEC **UFGS-08 88 53 (May 2011)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 88 53 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 08 88 53

DETENTION AND SECURITY GLAZING

05/11

****

NOTE: This guide specification covers the requirements for security glazing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA MCWM-1	(1989) Metal Curtain Wall Manual

ASTM INTERNATIONAL (ASTM)

ASTM C158	(2023) Standard Test Methods for Strength of Glass by Flexure (Determination of Modulus of Rupture)
ASTM C864	(2005; R 2015) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1036	(2021) Standard Specification for Flat Glass

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2008) Glazing Manual
GANA Sealant Manual	(2008) Sealant Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-59502	(Basic; Notice 1) Plastic Sheet, Polycarbonate

1.2 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Glazing materials

Include glass manufacturer's printed literature for setting and sealing materials and for cleaning of each type of glazing material specified.

SD-04 Samples

Glazing materials

Submit samples, 250 mm 10 inches square, factory labeled, for each type of glazing specified.

SD-08 Manufacturer's Instructions

Glass setting

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in their original unopened containers, plainly labeled with manufacturers' names and brands. Store all glass and setting materials in safe, dry locations and do not unpack until needed for installation. Handle and install materials in a manner that protects them from damage.

1.4 ENVIRONMENTAL CONDITIONS

Do not start glazing work until the outdoor temperature is above 4 degrees C 40 degrees F and rising unless approved provisions are made to warm the glass and rabbet surfaces. Provide sufficient ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during wet weather.

1.5 WARRANTY

****

NOTE: The warranty clause in this guide specification has been approved by NAVFACENGCOMHQ in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS).
NFAS can be found at the following link:
https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_forbusinesses_
The paragraph in this specification may be used without any HQ approval or request for waiver.

****

Warranty glass units against development of material obstruction to vision as a result of delamination, other than through glass breakage for at least a 5 year period from the date of acceptance of the work. Provide new units for units failing to comply with terms of this warranty no later than 45 working days following receipt of notice from the Government.

PART 2 PRODUCTS

2.1 DETENTION GLAZING ASSEMBLIES

2.1.1 Glass-Clad Polycarbonate

Two glass outer layers (plies), bonded to a core of one or more plastic layers (plies).

2.1.2 Plastic Laminated (Bonded) Construction

Two or more layers (plies) of plastic sheet bonded together with polyurethane.

2.1.3 Glass Laminated (Bonded) Construction

Two or more layers (plies) of chemically-strengthened float glass bonded together with polyvinyl butyral (PVB).

2.2 DETENTION GLAZING MATERIALS

2.2.1 Glass, Chemically Strengthened

ASTM C158, transparent prestressed.

2.2.2 Glass, Annealed, Wire

ASTM C1036, Type II, Class 1, form 1, Quality q8, 6 mm 1/4 inch thick, with diamond or square mesh.

2.2.3 Polycarbonate, Transparent, Rigid Sheet Plastic

****

NOTE: The type, class, and thickness of polycarbonate glazing material to be used in detention glazing assemblies is specified in paragraph entitled "Detention Glazing Types" by Type. Note that mar-resistant coating is to be provided in Glazing Types 3, 5, and 5W only.

****

CID A-A-59502, [Type I Grade A] [Type III Grade A] [clear] [transparent], thickness as specified.

2.3 DETENTION GLAZING TYPES

****

NOTE: Glazing types should be indicated on project drawings.

****

a. Type 1: Tempered Glass; Conform to Section 08 81 00 GLAZING.

b. Type 2: 11 mm 7/16 inch nominal glass-clad polycarbonate: 3 mm 1/8 inch clear chemically-strengthened glass, 1.3 mm 0.050 inch polyurethane interlayer, 3 mm 1/8 inch polycarbonate sheet, 1.3 mm 0.050 inch polyurethane interlayer, 3 mm 1/8 inch clear chemically-strengthened glass.

c. Type 3: 10 mm 3/8 inch nominal laminated plastic: 4.8 mm 3/16 inch mar-resistant (hard coat) polycarbonate (threat side), 0.9 mm 0.034 inch polyurethane interlayer, 4.8 mm 3/16 inch polycarbonate sheet.

d. Type 4: 11 mm 7/16 inch nominal laminated glass: 3 mm 1/8 inch clear chemically-strengthened glass, 2.3 mm 0.090 inch polyvinyl butyral interlayer, 3 mm 1/8 inchclear chemically-strengthened glass, 2.3 mm 0.090 inchpolyvinyl butyral interlayer, 3 mm 1/8 inch clear chemically-strengthened glass.

e. Type 4W: Add a separate (not laminated) 6 mm 1/4 inchannealed wire glass on staff side to Type 4.

f. Type 5: 14.3 mm 9/16 inch nominal glass-clad polycarbonate: 3 mm 1/8 inch clear chemically-strengthened glass (threat side), 1.3 mm 0.050 inch polyurethane interlayer, 6 mm 1/4 inch polycarbonate sheet, 1.3 mm 0.050 inch polyurethane interlayer, 3 mm 1/8 inch clear chemically-strengthened glass.

g. Type 5W: Add a separate (not laminated) 6 mm 1/4 inchannealed wire glass on staff side to Type 5.

h. Type 6: 8 mm 5/16 inch nominal laminated glass: 3 mm 1/8 inch clear chemically-strengthened glass, 2.3 mm 0.090 inch polyvinyl butyral interlayer, 3 mm 1/8 inchclear chemically-strengthened glass.

2.4 SETTING MATERIALS

Provide types required for the applicable setting method specified in GANA Glazing Manual and GANA Sealant Manual, except as modified in this section. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view shall be gray or neutral color.

2.4.1 Glazing Compound

Use for face glazing metal sash. Verify compatibility with materials in glazing assembly.

2.4.2 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, use NT. Use for channel or stop glazing metal sash. Sealant shall be chemically compatible with setting blocks, edge blocks, and sealing tapes [, and with plastic sheet]. Color of sealant shall be white.

2.4.3 Preformed Channels

Neoprene, AAMA MCWM-1, as recommended by the glass manufacturer for the particular condition. Channels shall be chemically compatible with plastic sheet.

2.4.4 Sealing Tapes

Preformed, semisolid, polymeric-based material of proper size and compressibility for the particular condition. Use only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. [Tapes shall be chemically compatible with plastic sheet.]

2.4.5 Setting Blocks and Edge Blocks

ASTM C864 neoprene of 70 to 90 Shore "A" durometer hardness, chemically compatible with sealants used, and of sizes recommended by the glass manufacturer.

2.4.6 Accessories

As required to provide a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

PART 3 EXECUTION

3.1 GLAZING TYPES

****

NOTE: Glazing types should be indicated on project drawings.

****

Locations and types of glass for use in glazed openings as indicated.

3.2 PREPARATION

Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Leave labels in place until the installation is approved. Securely attach movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.3 GLASS SETTING

Items to be glazed shall be either shop or field glazed using glass of the quality and thickness specified. Preparation and glazing shall conform to applicable recommendations in the GANA Glazing Manual and GANA Sealant Manual. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops furnished with items to be glazed to secure glass in place.

3.3.1 Wire Glass

Install glass for fire doors in accordance with installation requirements of NFPA 80.

3.3.2 Plastic Sheet

Conform to manufacturer's recommendations for edge clearance, type of sealant and tape, and method of installation.

3.4 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement. Glass shall be clean at the time the work is accepted. [Clean plastic sheet in accordance with manufacturer's instructions.]

3.5 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
Glass thickness	1 inch	25.4 mm

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-08 88 58 (May 2014)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 88 58

AIR TRAFFIC CONTROL TOWER CAB GLASS

05/14

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USACE / NAVFAC / AFCEC UFGS-08 88 58 (May 2014)

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 88 58

AIR TRAFFIC CONTROL TOWER CAB GLASS

05/14

****

NOTE: This guide specification covers the requirements for engineered outward sloping low-iron clear annealed tower cab glass for use in military air traffic control towers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The Designer of Record's (DOR) selection of tower cab glass performance and related systems must comply with the UFC including, at a minimum, UFC 1-200-01, General Building Requirements, UFC 3-301-01, , Structural Engineering and UFC 4-133-01N, Navy Air Traffic Control Facilities; if seismic design is required UFC 3-301-01, Structural Engineering; and if antiterrorism protection is required UFC 4-010-01, DoD Minimum Antiterrorism Standards for Buildings.

Coordinate tower cab glass with supporting glazing framing system and design performance requirements applicable to the location of the air traffic

control tower cab. Selection of framing system and glass units are integral to the performance as a whole and how glazing system is anchored to the structure. Coordinate with glass and framing systems manufacturer's anticipated design thicknesses and the connection between the glass the frame, the "bite", which is how far the glass is imbedded into the frame.

****

****

NOTE: On the drawings, show:
1. Locations of each type of tower cab glass unit, using the same terminology as in the specification.
2. Outward slope angle of tower cab glass.
3. Dimension and shape of tower cab glass units.
4. Frame and edge details indicating method of glazing, glass-edge bite requirements, and system anchorage.
5. Wind pressure on tower cab glass.
6. Whether tower cab glass is 'basic' or 'enhanced' per ASTM E1886 or ASTM E1996, as applicable.

In the specifications, show blast pressure and design method: standard air blast, dynamic, or computational, when antiterrorism protection is applicable.

****

PART 1 GENERAL

1.1 SUMMARY

This specification covers engineered tower cab glass for use in military air traffic control towers. Engineering of the tower cab glass is delegated to an approved Glass Engineer. The tower cab glass is used where air traffic is visually controlled and having tower cab glass free of optical distortions or other obstructions that can block or distort vision is critical to air traffic control operations.

1.2 DEFINITIONS

1.2.1 ATCT

Air Traffic Control Tower

1.2.2 Authority Having Jurisdiction (AHJ)

The party that regulates the design and construction process for the project on behalf of the Government.

[1.2.3 Deterioration of Coated Glass

Defects developed from normal use and weather conditions that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to fabricator's directions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

]1.2.4   Deterioration of Glass

Defects developed from normal use and weather conditions that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning glass contrary to fabricator's directions. Defects include glass found to be out of compliance with ASTM C1036.

[1.2.5   Deterioration of Insulating Glass

Failure includes, but is not limited to, failure of the hermetic seal under normal use and weather conditions due to causes other than glass breakage and improper practices for maintaining and cleaning insulating glass. Evidence of failure is the obstruction of vision by dust, moisture, film, or minerals on the surfaces of insulated glass facing the interspace or optical distortions (ghosting or double-images) not due to improper practices for maintaining and cleaning glass not in in compliance with the manufacturer's or fabricator's directions.

]1.2.6   Deterioration of Laminated Glass

Defects developed from normal use and weather conditions that are attributed to the manufacturing process and not to glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's or fabricator's directions. Defects include edge separation, delamination, materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated glass standard.

1.2.7   Designer of Record (DOR)

Architect or Engineer planning and designing the building and site and preparing the contract documents on behalf of the Government.

1.2.8   Fabricator

Where used in this Section to refer to a firm that fabricates glass units as defined in the referenced glazing standards.

1.2.9   Glass Thickness

Nominal glass thickness indicated by thickness designation per glass ply according to ASTM C1036.

[1.2.10   Interspace

Air- or inert gas-filled space between lites of an insulating-glass unit.

]1.2.11   Manufacturer

Where used in this Section to refer to a firm that produces primary glass or fabricated glass as defined in the referenced glazing standard.

1.2.12   Tower Cab Glass

Air traffic control tower cab glass as indicated on the Drawings.

1.3   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

****

NOTE: Ensure that the dates of the references are compatible with the version of the building code used for the design of this project.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C509	(2006; R 2021) Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1036	(2021) Standard Specification for Flat Glass
ASTM C1087	(2016) Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems
ASTM C1172	(2024) Standard Specification for Laminated Architectural Flat Glass
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set

ASTM D2287	(2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E1300	(2024) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E1886	(2019) Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
ASTM E1996	(2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
ASTM E2129	(2024) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM E2190	(2010) Standard Specification for Insulating Glass Unit Performance and Evaluation
ASTM E2461	(2012; R 2017) Standard Practice for Determining the Thickness of Glass in Airport Traffic Control Tower Cabs
ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass
ASTM F2912	(2017) Standard Specification for Glazing and Glazing Systems Subject to Airblast Loadings

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2008) Glazing Manual
GANA Laminate Manual	(2009) Laminated Glazing Reference Manual
GANA Sealant Manual	(2008) Sealant Manual

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

IGMA TB-3001	(2001) Guidelines for Sloped Glazing
IGMA TM-3000	(1990; R 2016) North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Tower Cab Glass; G, [_____]

Submittals which graphically show complete details of the proposed setting methods, mullion details, edge blocking, dimension of glass, dimension of openings, frame details and materials, and types of thickness of glass, coatings, coating position, laminates, and other aspects of the work.

SD-03 Product Data

****

NOTE: "Product Data for IEQ credit" Subparagraph below applies to LEED-NC and LEED-CS; coordinate with requirements for glazing sealants.

****

[Laminated Annealed Glass; G, [_____]

][Low-E Coated Laminated Annealed Glass; G, [_____]

][Insulated Laminated Annealed Glass Units; G, [_____]

][Low-E Coated Insulated Laminated Annealed Glass Units; G, [_____]

] Setting and Sealing Materials; G, [_____]

Glazing Accessories; G, [_____]

Submit manufacturer of the glass lites and the fabricator of the insulating units. Submit descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions from both the manufacturer of the glass lites and the fabricator of the insulating and laminated units.

[Product Data for IEQ credit: For field-applied glazing sealants - documentation including declaration of VOC content.

] SD-04 Samples

[Laminated Annealed Glass; G, [_____]

][Low-E Coated Laminated Annealed Glass; G, [_____]

][Insulated Laminated Annealed Glass Units; G, [_____]

][Low-E Coated Insulated Laminated Annealed Glass Units; G, [_____]

] Setting and Sealing Materials including color; G, [_____]

Glazing Accessories; G, [_____]

****

NOTE: Coordinate quantity of glass samples required with the Contracting Officer.

****

Provide [three][_____] 300 mm 12 inch by 300 mm 12 inch samples of tower cab glass units.

SD-05 Design Data

Cab Glazing Design Analysis; G, [_____]

Submit design analysis with glass engineering calculations showing that the design of each size and type of glass unit and its attachment to the glazing framing system and surrounding structure conform to project requirements. Indicate the structural performance of each glass unit proposed for use under the given loads as prepared and signed by an approved glass engineer. The size, composition of the glazing units, and details determined by the design analysis must be reflected in the shop drawings of all impacted trades and assemblies.

Glass Wind Load Calculations; G, [_____]

SD-06 Test Reports

Compatibility and Adhesion Test Reports

[Standard Airblast Test

] SD-07 Certificates

Glass Engineer Qualifications

Fabricator Qualifications

[Insulating Glass Certification

] Installer Qualifications

Product Certificates

[Local/Regional Materials

][Environmental Data

][Product Certificates for MR credit: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

] SD-10 Operation and Maintenance Data

Maintenance Manuals

[Warranty for Insulating Glass Products

][Warranty for Laminated Glass Products

][Warranty for Coated-Glass Products

]1.5 SYSTEM PERFORMANCE REQUIREMENTS

Provide glazing systems that are engineered, produced, fabricated, and installed to withstand normal thermal movement,[and] wind loading[, and impact loading] without failure including loss of glass or glass breakage attributable to the following: defective manufacture, fabrication, and installation, failure of sealants or gaskets to remain watertight and airtight, deterioration of glazing materials, visual distortion, blockage of vision, and other defects impacting use or performance.[Provide glazing systems that conform to antiterrorism protection blast pressure and design method or air blast test indicated.]

Normal thermal movement results from the following maximum change (range) in ambient and surface temperatures acting on glass-framing members and glazing components. Base engineering calculation on materials' actual surface temperatures due to both solar heat gain and nighttime sky heat loss expected for the service life of the tower.

****

NOTE: Verify temperature range at project site with range shown. Provide new data if site specific range is greater than default.

****

Temperature Change (Range): [67 degrees C 120 degrees F][_____], ambient; [100 degrees C 180 degrees F][_____], material surfaces.

Design, engineering, fabrication, and installation must comply with all applicable requirements.

1.6 QUALITY ASSURANCE

****

NOTE: Determine qualifications required for the Glass Engineer. In the U.S., a registered professional engineer is required; outside the U.S., consider specifying alternate licensing requirements (second set of brackets) where the services of a U.S. registered professional engineer may not be feasible. Alternate requirements must be coordinated with the Contracting Officer. Select requirements and delete items not required.

****

1.6.1 Glass Engineer Qualifications

Glass Engineer must be a registered professional engineer in [a U.S. state or territory][_____] experienced in the design of glass who has successfully completed a minimum of [five][_____] air traffic control tower cab glass projects and possesses no less than [5][_____] years of experience with similar projects in nature, size, and extent to this air traffic control tower; being familiar with special requirements indicated; and having complied with requirements of the AHJ.

1.6.2 Fabricator Qualifications

Provide qualifications for fabricators for glass units who have successfully completed a minimum of five air traffic control tower cab glass projects similar in nature, size, and extent to this air traffic control tower including successful in-service performance[and is a qualified insulating glass fabricator who is approved and certified by the [coated]glass manufacturer].

[1.6.3 Insulating Glass Certification Program

Provide insulating glass units permanently marked either on spacers or at least one component lite of units with appropriate certification label of inspecting and testing agency:

a. Insulating Glass Certification Council (IGCC).

b. Associated Laboratories, Inc. (ALI).

c. National Certified Testing Laboratories (NCTL).

]1.6.4 Installer Qualifications

Engage an experienced installer who has installed similar glazing assemblies in material, design, and extent to the indicated for this Project with a record of successful in-service performance. Installer must be certified under the National Glass Association's certified glass installer program as level Y2 (Senior Glaziers) or level Y3 (Master Glazier). Equivalent or better certification may be considered if acceptable to the Contracting Officer.

1.6.5 Single-Source Responsibility

Obtain all tower cab glass from one source. Obtain glazing accessories from one source for each product and installation method indicated.

1.6.6 Product Certificates

Signed by glazing materials manufacturers certifying that their products comply with specified requirements. Submit certificates to indicate that materials meet specified requirements. Permanent marking safety glass approval on glass lower corner exposed to view is required unless that requirement is waived by the AHJ.

1.6.7 Glazing Accessories

Submit certificates from the manufacturers attesting that the accessories meet the project requirements including requirements set by the glass engineer designing the glass and supports.

Provide compatibility and adhesion test reports from manufacturer of insulating glass edge sealant indicating that glass edge sealants were tested for compatibility with other glazing materials including sealants, glazing tape, gaskets, setting blocks, and edge blocks.

1.6.8 Setting and Sealing Materials

ASTM C1087. Submit data from the manufacturer attesting that the sealant used in glazing is compatible with the laminated glass interlayer or primary and secondary sealants in insulated units where applicable. Provide compatibility and adhesion test reports from sealant manufacturer; indicating that glazing materials were tested for compatibility and adhesion with glazing sealant. Include sealant manufacturer's test results relative to sealant performance and recommendations for primers and substrate preparation required for adhesion.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers labeled plainly with manufacturers' names and brands.

Tower cab glass must be boxed, crated, and shipped to the site in a vertical position or as directed by the fabricator. The tower cab glass must be stored in a vertical position against a sturdy support at an angle of approximately 7 degrees from vertical or as directed by the fabricator.

For insulating glass units that will be exposed to substantial altitude changes between location of fabrication and project site or in transit to project site, comply with insulating-glass manufacturer's written recommendations for preventing hermetic seal ruptures at any point or bowing inward or outward of glazing lites when installed due to pressure differentials between interspace air or gas pressure and ambient air pressure at project location.

Tower cab glass and setting materials must be stored in a safe, dry location with adequate ventilation free from heavy dust and must permit easy access for inspection and handling. Unpack glass at time of installation, or as directed by Contracting Officer.

Unpack glass from the front of the case or container and avoid sliding the glass against itself or any un-cushioned materials. Stack individual lites on edge using clean, cushioned pads placed at the quarter points of the bottom edge. Protect all edges from impact and use a clean dry separating materials.

1.8 ENVIRONMENTAL REQUIREMENTS

Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by the glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 5 degrees C 40 degrees F.

1.9 SUSTAINABLE DESIGN REQUIREMENTS

[1.9.1 Local/Regional Materials

****

NOTE: Include "Regional Materials" paragraph below for LEED-NC, or LEED-CS, MR credit; before retaining, verify availability of materials that comply. Coordinate with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Use second option if Contractor is choosing local products in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. First option must not be used for USACE projects. Army projects must include second option only if pursuing this LEED credit.

****

[Regional Materials: Materials must be manufactured within 800 kilometers 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as fabricated, within 800 kilometers 500 miles of Project site, if available from a minimum of [three][_____] sources.][See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total local material requirements. Glazing materials may be locally available.]

****

NOTE: Include following paragraph if required for LEED-NC or LEED-CS IEQ credit.

****

]1.9.2 Sealants VOC Content

Field-applied sealants must have a VOC content of not more than 250 g/L[or lower as required to meet LEED IAQ limits].

[1.9.3 Environmental Data

****

NOTE: ASTM E2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products.

****

Submit Table 1 of ASTM E2129 for sealants.

]1.10 WARRANTY

Provide 10-year manufacturer's or, where applicable, fabricator's warranty for tower cab glass.

****

NOTE: Include 10-year warranty for all projects. Select appropriate paragraphs for inclusion based on products specified.

****

[1.10.1 Warranty for Insulating-Glass Products

Provide warranty signed by the [manufacturer][or][fabricator] of insulating-glass units agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" article for Deterioration of Insulating Glass, FOB point of manufacture, freight allowed project site, within 10-years after date of Final Acceptance. Warranty covers only deterioration due to normal conditions of use as defined and not due to handling and installing.

][1.10.2 Warranty for Laminated-Glass Products

Provide warranty signed by glass the [manufacturer][or][fabricator] of laminated-glass agreeing to replace laminated-glass units that deteriorate as defined in "Definitions" article for Deterioration of Laminated Glass, FOB point of manufacture, freight allowed project site, within 10-years after date of Final Acceptance. Warranty covers only deterioration due to normal conditions of use as defined and not due to handling and installing.

][1.10.3 Warranty for Coated-Glass Products

****

NOTE: Verify whether glass manufacturer or glass fabricator applies coating to glass.

****

Provide warranty signed by coated-glass units the [manufacturer][or][fabricator] agreeing to replace coated-glass units that deteriorate as defined in definitions article for Deterioration of Coated Glass, FOB point of manufacture, freight allowed project site, within 10-years after date of Final Acceptance. Warranty covers only deterioration due to normal conditions of use as defined and not due to handling and installing.

]PART 2 PRODUCTS

2.1 SYSTEM DESIGN REQUIREMENTS

****

NOTE: The design of glass should be delegated to the contractor. The contractor is required to assume responsibility for glass engineering and final design and coordination.

****

2.1.1 Cab Glazing Design Analysis

Engage a qualified Glass Engineer to design glazing system as a delegated design. Installed glazing system must withstand normal thermal movement and wind[and][impact][and air blast] loads without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.[Delegated design must include antiterrorism protection requirements.]

2.1.2 Structural Performance

Submit signed and sealed glass wind load calculations by the Glass Engineer for all glass installations certifying compliance with wind load[and impact load] requirements below, and as indicated on the drawings[as well as antiterrorism protection blast loads and design methods specified]. The thickness of glass and support requirements must be determined using the most stringent requirements of both ASTM E1300 and ASTM E2461.

[For insulating glass units that will be exposed to substantial altitude changes after fabrication, engineer insulated glass unit lites to maintain parallel alignment to avoid optical distortions (ghosting /double images) when viewing through glass.
]

****

NOTE: The Designer of Record (DOR) is responsible for determining the design wind speed and the resulting design wind pressure on the tower cab glass. The glass manufacturer/fabricator is responsible for determining that glass engineering and fabrication meet the design wind pressure requirements.

The UFC cited International Building Code (IBC) requires that design wind speed and resulting pressure used for design of exterior components and cladding be determined by the DOR and be indicated on the construction drawings.

Verify the current standard for determining wind pressure and antiterrorism protection requirements with UFC 1-200-01. Wind (and impact, hurricane, and

tornado) design guidance is found in UFC 3-301-01. If anti-terrorism protection is a factor, coordinate with UFC 4-010-01 and referenced requirements.

The DOR is responsible for determining the antiterrorism protection requirements and for indicating loads, durations, and method of design in the specifications.

****

a. Design Wind Pressure: As indicated on the Drawings.

****

NOTE: Deflection requirements in "Maximum Lateral Deflection" Subparagraph below are examples only and apply only to glass supported on all four edges. The IBC does not contain any deflection limits for glass. ASTM E1300 requires that the deflection not result in loss of edge support. Revise to suit Project.

Modify maximum lateral deflection where insulated glass units are being shipped through, or installed at, substantially different altitudes than place of fabrication to keep inner and outer lite parallel to avoid optical distortions (ghosting/double images).

****

b. Maximum Lateral Deflection: Tower cab glass is supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than [1/50][_____] times the short-side length or 25 mm 1 inch, whichever is less.

2.1.3 Thermal Performance

Glazing must be designed in response to full calendar year project site climatic conditions and sun angles in coordination with tower cab mechanical systems assuring that maximum visibility is afforded while thermal effects that could overwhelm mechanical systems or cause condensation on interior or exterior surfaces of the glass are prevented.

[2.1.4 Antiterrorism Performance

****

NOTE: "Antiterrorism Performance" is optional to designer, and must be omitted or revised as needed to meet project requirements.

****

Minimum Antiterrorism Performance - Glazing must meet the minimum antiterrorism performance criteria specified in the paragraphs below. Conformance to the performance requirements must be validated by[one of] the following method[s].

****

NOTE: The blank in the following paragraph (Computational Design Analysis Method) should be the value of the equivalent 3-second duration design loading obtained from Figure 1 of ASTM F2248 for the

explosive weight and standoff distance combination that is being designed for in this project.

****

[a. Computational Design Analysis Method - Cab glazing must be designed to the criteria listed herein. Computational design analysis must include calculations verifying the structural performance of each glazing unit proposed for use, under the given static equivalent loads. Glazing resistance must be greater than equivalent 3-second duration loading of [_____] Pascal [_____] pounds per square foot (psf). The glazing frame bite for the cab frames must be in accordance with ASTM F2248.
]

****

NOTE: The blanks in the following paragraph (Dynamic Design Analysis Method) should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01. Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering building occupancy as defined in UFC 4-010-01. The values for input into the blanks in the following paragraph related to 'ductility ratio' and 'maximum support rotation' can be found in Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center: https://pdc.usace.army.mil/library/tr/10-02**)**

****

[b. Dynamic Design Analysis Method - Cab glazing must be designed using a dynamic analysis to prove the glazing will provide performance equivalent to or better than a [low][very low] hazard rating in accordance with ASTM F2912 associated with the applicable [very low] [low level] of protection for the peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square foot (psf) and positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). The allowable response limits of aluminum frame elements for low level of protection requirements are as follows: Maximum ductility ratio of [_____] and maximum support rotation of [_____] degrees.
]

****

NOTE: The blanks in the following paragraph (Standard Airblast Test Method) should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01. Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering building occupancy as defined in UFC 4-010-01.

****

[c. Standard Airblast Test Method - As an alternative to 'Dynamic Design Analysis Method' indicated above, glazing may be tested for evaluation of hazards generated from airblast loading in accordance with ASTM F1642/F1642Mby an independent testing agency regularly engaged in blast testing. For proposed glazing systems that are of the same type as the tested system but of different size, the test results may be accepted provided the proposed glazing size is within the range from 25 percent smaller to 10 percent larger in area and aspect ratio of the original qualified tested glazing systems. Proposed glazing of a size outside this range must require testing to evaluate their hazard rating or are certified by the 'Dynamic Design Analysis Method' indicated above. Testing may be by shock tube or arena test. The test must be performed on the entire proposed glazing system, which must include, but not be limited to, the glazing, its framing/support system, operating devices, and all anchorage devices. Anchorage of the glazing support system must replicate the method of installation to be used for the project. The minimum airblast loading parameters for the test must be as follows: peak positive pressure of [_____]kilopascal (kPa) [_____] pounds per square inch (psi) and positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). The hazard rating for the proposed glazing systems, as determined by the rating criteria of ASTM F1642/F1642M, to provide performance equivalent to or better than a [low][very low] hazard rating (i.e. the "No Break", "No Hazard", "Minimal Hazard" and "Very Low Hazard" ratings are acceptable. "Low Hazard" and "High Hazard" ratings are unacceptable) associated with the applicable [very low][low level] of protection. Results of glazing systems previously tested by test protocols other than ASTM F2912 may be accepted provided the required loading, hazard level rating, and size limitations stated herein are met.

]][2.1.5 Windborne-Debris-Impact Performance

****

NOTE: Retain "Windborne-Debris-Impact Resistance" Paragraph if required by Project. The UFC cited IBC defines windborne debris regions. Enhanced protection applies to essential facilities. Verify site specific requirements with the AHJ. Delete items not required.

****

Exterior glazing must comply with indicated basic or enhanced protection testing requirements in ASTM E1996 for [Wind Zone 1] [Wind Zone 2] [Wind Zone 3] [Wind Zone 4] when tested according to ASTM E1886. Test specimens must be no smaller in width and length than glazing indicated for use on Project and must be installed in same manner as glazing indicated for use on Project.

a. Refer to drawings for classification of tower cab requiring basic or enhanced protection.

[b. Large-Missile Test: For glazing located within 9.1 m 30 feet of grade.

][c. Small-Missile Test: For glazing located more than 9.1 m 30 feet above grade.

]]2.1.6 Tower Cab Glass Location and Sizes

Refer to Drawings for location, size intent, and geometry of tower cab glass units.

2.1.7 Tower Cab Glass Slope

Provide outward slope indicated on the drawings for tower cab glass.

2.2 GLASS MATERIALS

****

NOTE: Insulated glass systems should be used where required for thermal insulation or condensation control. Use air- or inert gas-filled interspace for insulated glass only.

****

Tower cab glass thicknesses shown on the Drawings or specified herein are minimums. Manufacturer must certify that glass can withstand all forces specified.

a. The thickness of the tower cab glass must be determined the Glass Engineer complying with ASTM E2461 for a probability of breakage of 1 lite per 1000.

****

NOTE: "Probability of Breakage for Sloped Glazing" subparagraph below is more conservative than ASTM E1300 and the IBC, which are based on a probability of breakage of 8 lite per 1000.

****

b. No on-site grinding or buffing of the glass is allowed. Glass edges must be clean cut, undamaged, and flat ground.

c. Probability of Breakage for Sloped Glazing: For glass surfaces sloped from vertical, the thickness of the tower cab glass must be determined by ASTM E2461 for a probability of breakage not greater than 1 lite per 1000 at the first occurrence of the design wind loading.

d. Glass subject to accidental human impact must be glazed with laminated safety glass in accordance with 16 CFR 1201 and ANSI Z97.1.

2.2.1 Annealed Glass

****

NOTE: Tower cab glazing recommended for air traffic control towers is low-iron clear float glass. Standard clear glass is not recommended because of lower visible light transmission compared to low-iron glass. However, where new glass is to match existing adjacent glass that is not low-iron the Contracting Officer may elect to approve standard glass. Tinted glass is not allowed for cab glazing.

Heat strengthened, tempered, and chemically strengthened glass is not allowed for cab glazing

because of optical distortions created by the strengthening process. Glass clad polycarbonate is also not allowed.

Coordinate with user and mechanical engineer if a Low-E coating is to be applied to glass to improve the glass unit's thermal properties. The Low-E coating has some affect on the visible light transmission, though this is considered an acceptable trade-off because of the increased comfort levels for the controllers in the tower cab.

Select one of the float glass products below as the tower cab glass. Retain or modify following sub-paragraphs as required.

****

Low-iron annealed float glass must be ASTM C1036, Type I, Class I (Clear), quality q3; and with visible light transmission of not less than 91 percent and solar heat gain coefficient of not less than 0.90 for 6 mm 1/4 inch thickness with the following quantities:

a. Allowable scratches: None.

****

NOTE: Select one of the following paragraphs below based on consultation with glass manufacturer on recommended glazing for tower cab. Wind design criteria developed by structural engineer, size of glass units, and cab glass framing system will dictate required assembly of cab glass.

****

[2.2.2 Insulated Glass

Insulating-glass components must be as required to factory-assemble glass units with hermetically sealed dehydrated interspace, qualified according to ASTM E2190.

****

NOTE: Base selection of sealing system of insulated glass units on compatibility with other glazing materials. For example, glazing systems installed with silicone glazing sealants generally require the same material for secondary sealing of insulating-glass units.

Insulating glass units inner and outer lites may not remain parallel if fabricated at one elevation level and transported or installed at higher elevations. Provide grade elevation of ATCT above sea level either on drawings or in specifications.

****

a. Sealing System: Units must be double sealed. Primary seal must be polyisobutylene; secondary seal must be silicone.

****

NOTE: Spacer must be stainless steel for the

following reasons, stronger and keeping hermetic seals intact during installation, and better thermal performance than other spacer materials.

****

b. Spacer: Stainless steel.

c. Desiccant: Molecular sieve or silica gel, or a blend of both.

****

NOTE: Breather tubes must not be allowed for insulated glass units. Coordinate with manufacturer the need for capillary tubes only if use is approved by the Contracting Officer and only if use does not limit warranty coverage.

Capillary Tube - Typically 0.25 to 0.50 mm 0.01 to 0.02 inch inside diameter stainless steel tubes, approximately 305 mm 12 inch long, and are left open after installation. Capillary tubes are used in low humidity mountainous areas of the country to equalize pressure. The 305 mm 12 inch long tube minimizes moisture entering unit, but in small glass units, this can still be significant amount of moisture.

Breather Tube - Typically 3 mm 1/8 inch inside diameter aluminum tubes, 75 to 150 mm 3 to 6 inches long that are sealed after installation. Breather tubes are used to allow for pressure differentials during shipping. Concern is will humidity enter dehydrated interspace during manufacturing and shipping. Some manufacturers will not honor warranty if glass unit has breather tube.

****

****

NOTE: Antiterrorism performance rated glass, windborne debris region rated glass, and safety glass are required to be laminated glass. One or all of these requirements may apply to the tower cab glass design.

****

][2.2.3 Laminated Glass Interlayers

Laminated glass must comply with the GANA Laminate Manual and interlayer must comply with ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

a. Interlayer Material: [Polyvinyl butyral (PVB) interlayer] [Ionomeric polymer interlayer][or][Cast-in-place and cured-transparent-resin interlayer] used in compliance with the interlayer manufacturer's written instructions.

b. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with engineered requirements.

c. Interlayer Color: Clear.

][2.2.4 Interspace

The inner and outer lites of insulated glass units must be separated by a 12.7 mm 1/2-inch minimum hermetically sealed interspace. The entrapped air or gas must be dehydrated by a drying agent. Tower cab glass must be fabricated for use at the installation’s elevation above mean sea level (AMSL). Units must be free of any optical distortion at the time of installation.

]2.3 TOWER CAB GLASS ASSEMBLIES

****

NOTE: Requirements for control tower cab glazing are for the sizes and details on the current standard control tower drawings. Any modification from standard will be made only with the approval of the Contracting Officer.

If spare units are required for a particular project an "Extra Materials" paragraph must be developed for PART 1 which identifies the items, states quantities, and indicates to whom, when and where to be delivered.

For overseas work the following subparagraph will also be added: When units from other than a United States manufacturer are proposed for use, the manufacturer must prove successful use of the insulating glazing units in aircraft control tower cabs to the Contracting Officer.

****

Tolerances and clearances for units must be designed to prevent the transfer of stress in metal frames to the glass under all design conditions. Resilient setting blocks, spacer strips, clips, bolts, washers, angles, glazing sealants, and resilient channels must be of the type recommended in the glass manufacturer's approved written instructions.

****

NOTE: For better thermal performance, a Low-Emissivity (Low-E) coating on glass is recommended for most locations. Low-E coating selection must have minimal impact on the visible light transmittance, as the importance of visible transmittance of light is critical to the cab operation. Coordinate with glass manufacturer, Contracting Officer, and mechanical engineer regarding selection of Low-E coating.

For insulated glass units, Low-E coating should be on one of the glass surfaces facing the interspace; on the interior-side surface in heating-dominated buildings and on the exterior-side surface (inside surface of the exterior pane) in cooling-dominated buildings. The number one surface of the glass is always the exterior face of the glass assembly; surfaces are counted on each ply of glass with the highest numbered surface facing the interior of the

building.

When selecting glass and a coating, verify with manufacturer/fabricator if Low-E coating is either pyrolytic or vacuum applied to glass. Be aware that currently applying Low-E coating to glass thicker than 6 mm 1/4 inch is problematic. If required on glass thicker than 6 mm 1/4 inch consider using laminated glass. Coordinate with glass manufacturer/fabricator.

Pyrolytic coatings (hard coat) are applied by glass manufacturer during the manufacturing process and are integral to the glass. Pyrolytic coatings are more durable than vacuum deposit. Easier to ship, handle, and install. This Low-E coating is used on single panes of glass where Low-E coating is exposed. (Verify if selecting laminated glass, if low-E is required to be pyrolitically applied.)

Vacuum deposit (Sputter) coatings (soft coat) can be applied by either manufacturer, or fabricator of glass. Vacuum deposit coatings require special handling and storage to protect the coating. Typically only used in insulated glass units, as coating requires protection. Vacuum deposit offers more coating options and improved solar, thermal, and light-to-solar gain options than the pyrolitic process.

Coordinate with glass manufacturer's and fabricator's thermal performance of glass assembly.

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NOTE: The use of Low-E coating on the glass is recommended for most climates, however caution should be used. It is problematic to apply to glass thicker than 6 mm 1/4 inch. If the glass layup is required to be thicker, then it is possible to use multiple layers of laminated glass (i.e., 6 mm 1/4 inch glass plus 1.52 mm 0.060 inch interlayer plus 12.7 mm 1/2 inch glass plus 1.52 mm 0.060-inch interlayer plus 12.7 mm 1/2 inch glass) with the Low-E on the 6 mm 1/4 inch lite when required.

Use greater interlayer thicknesses for improved impact and blast resistance as determined by the glass engineer. It is not recommended to use thickness less than 1.52 mm 0.060 inch.

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NOTE: The assembly of laminated glass can be done a number of different ways. It can be with or without a Low-E coating. It can be assembled in two, three, or more plies of varying glass ply thicknesses or the same thicknesses. Modify following paragraphs as necessary for selection of this cab glazing.

****

][2.3.1 Laminated Annealed Glass Units

Glass Type: Low-iron clear laminated glass with no less than two plies of low-iron annealed float glass.

****

NOTE: Provide overall unit thickness minimum based on concept design and including total glass thickness and interlayer thickness. These will be minimums as delegated glass engineering may increases unit thicknesses.

****

a. Overall Unit Thickness: [_____] mm [_____] inch minimum.

b. Minimum Thickness of Each Glass Ply: 3 mm 1/8 inch.

c. Interlayer Thickness: 1.52 mm 0.060 inch minimum each.

][2.3.2 Low-E Coated Laminated Annealed Glass Units

Glass Type: Low-iron clear Low-E laminated glass with [two] [_____] plies of low-iron annealed float glass.

a. Overall Unit Thickness: [_____] [_____] mm [_____] inch minimum.

b. Minimum Thickness of Each Glass Ply: 3 mm 1/8 inch.

c. Interlayer Thickness: 1.52 mm 0.060 inch minimum each.

****

NOTE: Where low-e coating is required at laminated uninsulated glass, provide pyrolitic hard coat at external surface when approved by the Contracting Officer or on surface approved or provide approved low-e film between two plies of interlayers.

****

d. Low-E Performance: [Pyrolytic hard coat on first surface (out of four surfaces total)] [Pyrolytic hard coat on fourth surface (out of four surfaces total)] [Low-E film between two plies of interlayer].

e. Winter Nighttime U-Factor: [_____] maximum.

f. Summer Daytime U-Factor: [_____] maximum.

g. Visible Light Transmittance: [_____] percent minimum.

h. Solar Heat Gain Coefficient: [_____] maximum.

][2.3.3 Insulated Laminated Annealed Glass Units

Glass Type: Insulating laminated low-iron clear annealed float glass.

a. Overall Unit Thickness: [_____] mm [_____] inch minimum.

b. Outdoor Lite: Low-iron clear laminated glass with two plies of low-iron annealed float glass.

(1) Minimum Thickness of Each Glass Ply: 3 mm 1/8 inch.

(2) Interlayer Thickness: 1.52 mm 0.060 inch minimum each.

c. Interspace Content: [Air][Argon].

d. Indoor Lite: Low-iron clear laminated glass with two plies of low-iron annealed float glass

(1) Minimum Thickness of Each Glass Ply: 3 mm 1/8 inch.

(2) Interlayer Thickness: 1.52 mm 0.060 inch minimum each.

e. Winter Nighttime U-Factor: [_____] maximum.

f. Summer Daytime U-Factor: [_____] maximum.

g. Visible Light Transmittance: [_____] percent minimum.

h. Solar Heat Gain Coefficient: [_____] maximum.

][2.3.4 Low-E Coated Insulated Laminated Annealed Glass Units

Glass Type: Insulating laminated Low-E coated low-iron clear annealed float glass.

a. Overall Unit Thickness: [_____] mm [_____] inch minimum.

b. Outdoor Lite: Low-iron clear laminated glass with two plies of low-iron annealed float glass.

(1) Minimum Thickness of Each Glass Ply: 3 mm 1/8 inch.

(2) Interlayer Thickness: 1.52 mm 0.060 inch minimum each.

c. Interspace Content: [Air][Argon].

d. Low-E Coating: [Pyrolytic on fourth] [Pyrolytic on fifth] [Sputtered on fourth] [Sputtered on fifth] surface (out of eight surfaces total).

e. Indoor Lite: Low-iron clear laminated glass with two plies of low-iron annealed float glass

(1) Minimum Thickness of Each Glass Ply: 3 mm 1/8 inch.

(2) Interlayer Thickness: 1.52 mm 0.060 inch minimum each.

f. Winter Nighttime U-Factor: [_____] maximum.

g. Summer Daytime U-Factor: [_____] maximum.

h. Visible Light Transmittance: [_____] percent minimum.

i. Solar Heat Gain Coefficient: [_____] maximum.

]2.4 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted must be a dark color to match mullions.

2.4.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing sash. Sealant must be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units. For laminated glass the sealant must be compatible with interlayer. Sealant color must be as selected from manufacturer's samples.

2.4.2 Preformed Channels

Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the project specific conditions.

2.4.3 Sealing Tapes

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D2287. Use sealing tape only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes must be chemically compatible with the product being set.

2.4.4 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks must be dense extruded type conforming to ASTM C509 and ASTM D395, Method B, Shore A durometer of 90. Profiles, lengths and locations must be as required and recommended in writing by glass manufacturer. Block color must be black.

2.4.5 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing must be permanent, elastic, non-shrinking, non-migrating, water tight, and weather tight.

2.4.6 Glazing Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide anticorrosion metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

2.5 FABRICATION

Provide glazing units required to fit glazing opening sizes and shapes and outward slope indicated on the construction documents and as verified in the field with edge and face clearances, edge and surface conditions, and bite complying with written instructions manufacturer, fabricator and referenced glazing publications, to comply with system performance requirements.

PART 3 EXECUTION

3.1 GLAZING, GENERAL

Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.

Install tower cab glass at outward slope indicated on the drawings.

Glazing channel dimensions as indicated on Drawings provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

Protect glass from edge damage during handling and installation as follows:

a. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass lites with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer's label.

b. Remove damaged glass from Project site and legally dispose of off site. Damaged glass is glass with edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.

Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

Install elastomeric setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

Provide spacers for glass as follows:

a. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with system performance requirements.

b. Provide manufacturer's recommended minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer. Prevent shifting of glass units within the mullion rabbets which could cause loss of required bite.

3.2 PREPARATION

Preparation, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

****

NOTE: Retain following paragraph if the speed of construction of the air traffic control tower is not of the essence. The cab glazing and structural framing system dimensions can sometimes be distorted by weight of cab roof assembly or temperature/ solar heat gain where radiant energy of the sun causes some opening sizes to vary during installation process.

****

[Where tower cab glass mullions also structurally support the tower cab roof and penthouse, the full dead load of the tower cab roof, not including the tower cab ceiling grid and panels, must be applied before taking final measurements of the tower cab glazing openings. The tower cab glass must then be fabricated to fit those actual dimensions.

] Inspect glazing units to locate exterior and interior surfaces. Temporarily label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not specified as permanently bonded to substrates.

Ensure that glazing framing weep system must not be obstructed during installation of glazing. Coordinate installation with glazing frame manufacturer's instructions, and requirements.

3.3 GLASS SETTING

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

3.3.1 Manufacturer's Instructions

Comply with the manufacturer's warranty and written instructions. Confirm that additional specified requirements are accepted by the manufacturer in writing. Secure glass in place with bolts and spring clips. The minimum clearance between bolts and edge of glass unit must be 5 mm 3/16 inch. The glass must be edged, top and bottom, with 5 mm 3/16 inch thick continuous neoprene, vinyl, or other approved material. Trim edging after installation. The channel shapes or strips must be firmly held against the glass by the spring action of the extruded metal moldings or metal bars. Resilient setting blocks, spacer strips, clips, bolts, washers, angles, applicable glazing compound, and resilient channels or cemented-on materials must be as recommended in the written instructions of the glass manufacturer which must be submitted and approved prior to shipping the tower cab glass.

3.3.2 Tolerances and Clearances of Units

Design to prevent the transfer of stress in the setting frames to the glass. Springing, twisting, or forcing of units during setting is not permitted.

[3.3.3 Insulating Glass Units

****

NOTE: Delete following paragraph if cab glass units are not insulated glass units.

****

Springing, forcing, or twisting of units during setting is not permitted. Handle units so as not to strike frames or other objects. Installation must conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

][3.3.4 Seismic Installation

****

NOTE: Delete following paragraph if cab glass units are not being installed in high seismic area.

****

Comply with the following requirements for seismic installation.

a. Glass Corner and Edge Cushioning: Padding consisting of 50-70 shore durometer hardness material should be placed in the glazing channel or on the glass edges/corners to avoid any glass to frame contact.

b. Gasket Performance: Gasket should have a positive lock-in method so that gasket will not disengage from metal framing system during up and down and side-to-side movement.

c. Setting Blocks and Supports: Permanently mount setting block and supports to frame using a compatible sealant. Use anti-walk blocks.

]3.3.5 Laminated Glass Units

****

NOTE: Delete following paragraph if cab glass units are not laminated glass.

****

Frames which are to receive laminated glass must be weeped to the outside to prevent water collection in channels or rabbets.

3.4 CLEANING

Follow recommendations of GANA Glazing Manual and the glass manufacturer. Clean glass and metal frequently during construction. Clean glass surfaces and remove labels, paint spots, and other defacement as required to prevent staining. Glass must be cleaned with a soft, clean, grit-free cloth, mild soap, detergent, or slightly acidic cleaning solution. Rinse immediately after cleaning with water and promptly remove excess rinse water with a clean squeegee. Razor blades or other sharp objects must not be used to clean glass surfaces. Glass must be clean at the time the Work is accepted.

3.4.1 Cleaning Prior to Final Inspection

Clean glass at least one day prior to final inspection. Final inspection will be performed during the day and at night. Inspection at night is required verifying that the glass does not have optical distortions that causes ghosting/double images. No additional work will be performed in tower cab by the contractor after final inspection without permission of contracting officer.

3.5 PROTECTION

Glass work must be protected immediately after installation. Glazed openings must be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Protective material must be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities must be removed and replaced with new units.

Follow recommendations of GANA Glazing Manual and the glass manufacturer. Protect the glass from weld splatter by using plywood or heavy tarpaulins. Do not place insulation over the glass for protection or keep shading material on the glass because excess thermal buildup could result in glass breakage. Do not allow materials to be stored or placed in contact with the glass.

3.6 WASTE MANAGEMENT

****

NOTE: Float glass cannot be recycled with beverage-container glass. Diverting waste from the landfill contributes to the required LEED MR credit. Coordinate with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL. Designer must verify that items are able to be disposed of as specified.

****

Disposal and recycling of waste materials, including corrugated cardboard recycling, must be in accordance with the Waste Management Plan. Close and seal tightly all partly used sealant containers and store protected in well-ventilated, fire-safe area at moderate temperature.

3.7 MAINTENANCE MANUALS

Provide product manufacturer's published and written instructions for both the maintenance and cleaning of the tower cab glass assemblies as installed in the format compliant with the project requirements and as approved by the Contracting Officer.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-08 91 00 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 91 00 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 91 00

METAL [WALL] [AND] [DOOR] LOUVERS

08/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-08 91 00 (August 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-08 91 00 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 08 91 00

METAL [WALL] [AND] [DOOR] LOUVERS

08/20

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NOTE: This guide specification covers the requirements for average metal wall louvers, metal louvers in wood doors, screens and frames, and accessories.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: For very large or special louvers and louvers subject to snow or seismic loads, insert additional paragraphs as required.

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NOTE: On the drawings, show:

1. Locations, sizes, and types of louvers.

2. Details of louver construction and installation, including subframes, sills, and flashing.

3. Locations and arrangement of mullions.

4. Colors of factory-finished louvers, unless color is specified.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-L	(2015) Laboratory Methods of Testing Louvers for Rating
AMCA 511	(2010; R 2016) Certified Ratings Program for Air Control Devices

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum
AAMA 2603	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic

	Coatings on Aluminum Extrusions and Panels

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wall Louvers

SD-03 Product Data

Metal Wall Louvers

Door Louvers

SD-04 Samples

Wall Louver Samples; G, [_____]

Door Louver Samples; G, [_____]

1.3 DELIVERY, STORAGE, AND PROTECTION

Deliver materials to the site in an undamaged condition. Carefully store materials off the ground to provide proper ventilation, drainage, and protection against dampness. Louvers must be free from nicks, scratches, and blemishes. Replace defective or damaged materials with new.

1.4 DETAIL DRAWINGS

Show all information necessary for fabrication and installation of wall louvers. Indicate materials, sizes, thicknesses, fastenings, and profiles.

1.5 COLOR SAMPLES

Colors of finishes for wall louver samples and door louver samples must closely approximate colors indicated. Where color is not indicated, submit the manufacturer's standard colors to the Contracting Officer for selection.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Sheet

ASTM A653/A653M, coating designation Z275 G90.

2.1.2 Aluminum Sheet

ASTM B209M ASTM B209, alloy 3003 or 5005 with temper as required for forming.

2.1.3 Extruded Aluminum

ASTM B221M ASTM B221, alloy 6063-T5 or -T52.

[2.1.4 Stainless Steel

Type 302 or 304, with 2B finish.

]2.1.5 Cold Rolled Steel Sheet

ASTM A1008/A1008M, Class 1, with matte finish. Use for interior louvers only.

2.2 METAL WALL LOUVERS

****

NOTE: Louver free areas vary from 25 to 65 percent, depending on blade design. When a certain free area is required, indicate blade type as well as louver size. CAUTION: Even "weather-resistant" louvers will allow water penetration. Quantity and velocity specified are for wall louvers in mechanical rooms and similar locations. Where water penetration would be a problem, specify acceptable quantity of water penetration at air velocity required, or provide operable louvers or operable dampers to exclude wind-driven rain.

****

[Weather][Wind driven rain] resistant type, with bird screens and made to withstand a wind load of not less than [1.44] [_____] kilopascals [30] [_____] pounds per square foot. Wall louvers must bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500-L and AMCA 511. The rating must show a water penetration of 0.06 kilograms or less per square meter 0.20 or less ounce per square foot of free area at a free velocity of 244 meters 800 feet per minute.

****

NOTE: Use only Aluminum or Stainless Steel louvers in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

2.2.1 Extruded Aluminum Louvers

Fabricated of extruded 6063-T5 or -T52 aluminum with a wall thickness of not less than 2 mm 0.081 inch.

2.2.2 Formed Metal Louvers

Formed of [zinc-coated] [stainless] steel sheet not thinner than 16 U.S. gage, or aluminum sheet not less than 2 mm 0.08 inch thick.

2.2.3 Mullions and Mullion Covers

****

NOTE: Large louvers may require bracing for given wind loads and with a maximum deflection of L/180.

****

Same material and finish as louvers. Provide mullions [where indicated] [for all louvers more than 1500 mm 5 feet in width at not more than 1500 mm 5 feet on centers]. Provide mullion covers on both faces of joints between louvers.

2.2.4 Screens and Frames

For aluminum louvers, provide 12.5 mm 1/2 inch square mesh, 1.8 or 1.5 mm 14 or 16 gage aluminum or 6 mm 1/4 inch square mesh, 1.5 mm 16 gage aluminum bird screening. For steel louvers, provide 12.5 mm 1/2 inch square mesh, 2.5 or 1.5 mm 12 or 16 gage zinc-coated steel; 12.5 mm 1/2 inch square mesh, 1.5 mm 16 gage copper; or 6 mm 1/4 inch square mesh, 1.5 mm thick 16 gage zinc-coated steel or copper bird screening. Mount screens in removable, rewirable frames of same material and finish as the louvers.

2.3 DOOR LOUVERS

****

NOTE: Avoid louvered doors on exterior locations in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5 as they are very susceptible to weather deterioration. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Consider other means of providing the venting functions.

Ensure that louvers in doors are drainable, weatherproof and factory primed. Doors with factory-installed louvers are also recommended.

NOTE: Avoid louvered doors on exterior locations in buildings subject to the antiterrorism requirements of UFC 4-010-01.

****

[Inverted "Y"][or][Inverted "V"] sightproof type not less than 25 mm one inch thick with matching metal trim. Louvers for exterior doors must be weather resistant type.

2.3.1   Extruded Aluminum Door Louvers

Fabricate of 6063-T5 or -T52 aluminum alloy with a wall thickness of not less than 1.25 mm 0.050 inch thick. Frames and trim must be clamp-in "L" type.

2.3.2   Formed Metal Door Louvers

Fabricate of [0.9 mm thick 20 U.S. gage steel sheet][or][sheet aluminum not less than 1.25 mm 0.050 inch thick]. Trim must be beveled "Z" molding both sides.

2.3.3   Screens and Frames

For exterior doors, provide aluminum insect screens, 18 by 16 or 18 by 14 mesh. Mount screens in removable, rewirable frames of same material and finish as the louvers.

2.4   FASTENERS AND ACCESSORIES

Provide stainless steel screws and fasteners for aluminum louvers and zinc-coated or stainless steel screws and fasteners for steel louvers. Provide other accessories as required for complete and proper installation.

2.5   FINISHES

****

NOTE: Specify anodic and organic coatings meeting the selection requirements in the Notes below as Contractor's option when these finishes are determined to be available in similar colors an economically competitive in the project area, unless the project requires use of one or the other to match an existing condition.

****

****

NOTE: The selection of anodic or organic coating is based primarily on the desired appearance: anodized finishes provide a metallic appearance and organic finishes provide a painted or metal-like finish (organic finishes are available in a variety of colors). Only allow both types as a Contractor option when the Designer confirms that the desired appearance is available in both types of finishes.

****

2.5.1   Aluminum

Exposed aluminum surfaces must be factory finished with an [anodic coating][or][organic coating].[Color must be [_____][as indicated].] Louvers [for each building] must have the same finish.

2.5.1.1   Anodic Coating

****

NOTE: Specify Architectural Class I for harsh

atmospheres where dust, gases, salts, and other destructive elements will attack metal finish. Also specify Class I for humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Specify Architectural Class II for all atmospheric conditions not requiring Class I. See UFC 1-200-01 for determination of ESC for project locations.
****

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish must be:

[a. Architectural Class II (0.01 to 0.0175 mm 0.4 mil to 0.7 mil), designation AA-M10-C22-[A31, clear (natural)] [A32, integral color] [A34, electrolytically deposited color] anodized.

][b. Architectural Class I (0.0175 mm 0.7 mil or thicker), designation AA-M10-C22-[A41, clear (natural)] [A42, integral color] [A44, electrolytically deposited color] anodized.

]2.5.1.2 Organic Coating

****
NOTE: For organic coatings, to provide enhanced resistant to corrosion, weathering, ozone, and UV radiation utilize superior performance powder coat finishes conforming to AAMA 2605 in humid locations and project locations with an ESC of C3 thru C5; baked enamel finishes conforming to AAMA 2603 may be utilized for non-humid locations and ESC C1 or C2 project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Refer to UFC 1-200-01 for determination of ESC for a specific project location.
****

Clean and prime exposed aluminum surfaces. Provide a [baked enamel finish conforming to AAMA 2603, with total dry film thickness not less than 0.02 mm 0.8 mil] [superior performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 0.03 mm 1.2 mil], color [_____].

2.5.2 Steel

****
NOTE: Include the bracketed item below for projects that include louvers on both the exterior and interior conditioned spaces of the building.
****

Surfaces specified must have a zinc coating, a phosphate treatment, and a shop prime coat of rust-inhibitive paint. The galvanized coating must conform to ASTM A653/A653M, coating designation Z275 (G90)[, except that louvers located in conditioned spaces on interior of the building may be Z180 (G60)]. The weight of zinc coatings must be as designated in Table I of ASTM A123/A123M for the thickness of base metal to be coated. The prime coat must be a type especially developed for materials treated by phosphates and adapted to application by dipping or spraying. Repair damaged zinc-coated surfaces by the materials and methods conforming to ASTM A780/A780M and spot prime. At the option of the Contractor, a two-part system including bonderizing, baked-on epoxy primer, and baked-on enamel top coat may be applied before forming, in lieu of prime coat specified.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Wall Louvers

Install using stops or moldings, flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with manufacturer's recommendations.

3.1.2 Door Louvers

Install louvers in wood doors by using metal "Z" or "L" moldings. Fasten moldings to door with screws.

3.1.3 Screens and Frames

Attach frames to louvers with screws or bolts.

3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

3.2.1 Copper or Copper-Bearing Alloys

Paint copper or copper-bearing alloys in contact with dissimilar metal with heavy-bodied bituminous paint or separate with inert membrane.

3.2.2 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

3.2.3 Metal

Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.2.4 Wood

Paint wood or other absorptive materials that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 01 90.50 (May 2009)**
Change 1 - 08/17

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 09 - FINISHES

SECTION 09 01 90.50

PREPARATION OF HISTORIC WOOD AND METAL SURFACES FOR PAINTING

05/09, CHG 1: 08/17

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-09 01 90.50 (May 2009)**

Change 1 - 08/17

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 09 01 90.50

PREPARATION OF HISTORIC WOOD AND METAL SURFACES FOR PAINTING

05/09, CHG 1: 08/17

****

NOTE: This guide specification covers the requirements for preparation for painting wood and metal surfaces in historic structures.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100	(2017; Suppl 2020) Documentation of the Threshold Limit Values and Biological Exposure Indices

ASTM INTERNATIONAL (ASTM)

ASTM D173/D173M	(2003; R 2011; E 2012) Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing
ASTM D3274	(2009; R 2017) Standard Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC PA Guide 5	(2023) Guide to Maintenance Coating of Steel Structures in Atmospheric Service
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 2	(2024) Hand Tool Cleaning
SSPC SP 3	(2024) Power Tool Cleaning
SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

1.2 SUMMARY

****

NOTE: The Federal Clean Air Act requires each state

to meet the National Ambient Air Quality Standards. In addition, each state or local government may impose more restrictive requirements. States with areas identified as exceeding EPA standards for ozone must adopt limits on the volatile organic compound (VOC) content of paint removers, wood preservatives, solvents and other chemical preparation materials. Therefore, the designer should determine the local restrictions and eliminate prohibited materials. It may be necessary to specify locally available commercial products which have been developed to meet local restrictions.

The requirements for Contractor test report responsibilities should be modified regarding exempt materials.

****

The procedures proposed for the accomplishment of the work must provide for safe conduct of the work, careful removal and disposition of materials specified to be salvaged, protection of property which is to remain undisturbed, and coordination with other work in progress. Submit the names, quantity represented, and intended use for proprietary brands of materials proposed to be substituted for the specified materials when the required quantity of a particular batch is 200 liters 50 gallons or less. Submit manufacturer's current printed product description, safety data sheets (SDS) and technical data sheets for each product. Provide detailed mixing, thinning and application instructions, minimum and maximum application temperature, and curing and drying times for each product submitted. Include in the work plan a Safety and Health plan describing procedures for handling monitoring, and disposition of VOCs and other hazardous and toxic materials. Submit [one copy] [[_____] copies] of the Work Plan and a certificate stating that products proposed for use meet the VOC regulations of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located. Include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations. Test the materials designated by the Contracting Officer.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Work Plan; G, [_____]

Materials

Qualifications

SD-07 Certificates

Work Plan

1.4 QUALITY ASSURANCE

Perform work in compliance with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in the CONTRACT CLAUSES. Include analyses of the potential impact of surface preparation operations on personnel and on others involved in and adjacent to the work zone in the Activity Hazard Analysis.

1.4.1 Worker Exposures

Do not expose workers to chemical substances exceeding limits as established by ACGIH 0100.

1.4.2 Training

Inform workers, having access to an affected work area, of the contents of the applicable SDS and of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is one which may receive dust, mists, and odors from the surface preparation operations. Workers involved in surface preparation and clean-up must be trained in the safe handling and application, and the exposure limit, for each material which the worker will use in the project. Instruct personnel having a need to use respirators and masks in the use and maintenance of such equipment.

1.4.3 Coordination

Coordinate work to minimize exposure of building occupants, other Contractor personnel, and visitors to mists and odors from surface preparation and cleaning operations.

1.4.4 Qualifications

Provide qualified workers trained and experienced in the preparation for painting of wood and metal surfaces in historic structures, submit documentation of 5 consecutive years of work of this type and a statement certified by the Contractor attesting that the experience and qualifications of the workers (journeymen) comply with the specifications.. Provide a list of similar jobs identifying when, where, and for whom the work was done and a current point-of-contact for identified references.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver paint removers, solvents, and other chemicals, used for surface preparation, in sealed containers that legibly show the designated name, formula or specification number, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Furnish such materials in containers not larger than 20 L 5 gallons; store them in accordance with the manufacturer's written directions; and, as a minimum, store them off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 4 and 35 degrees C 40 and 95 degrees F.

1.6 ENVIRONMENTAL REQUIREMENTS

Unless otherwise recommended by the product manufacturer, provide an ambient temperature between 7 and 35 degrees C 45 and 95 degrees F when applying paint removers, solvents, or other preparation materials.

PART 2 PRODUCTS

****

NOTE: When the required quantity of a particular material is 200 liters 50 gallons or less, the factors of time, value of material versus cost of testing, and the end use of material may justify acceptance on the basis of manufacturer's data.

****

2.1 PAINT REMOVERS

Provide chemical paint removers that are a commercial item specifically manufactured for the type of paint to be removed.

2.2 EPOXY CONSOLIDANTS

2.2.1 Liquid Consolidant

Provide liquid wood consolidant consisting of a 2-part, low-viscosity liquid epoxy that meets the criteria of Table 1.

2.2.2 Epoxy Paste

Provide epoxy paste consisting of a 2-part, thixotropic paste that meets the criteria of Table 1.

TABLE 1		
	LIQUID CONSOLIDANT	EPOXY PASTE
Properties	Low-Viscosity Liquid	No-Slump, Thixotropic Paste
Toxicity	Low	Very Low
Toxicity Cured	Non-Toxic	Non-Toxic
Ratios	1:1 by Volume	1:1 by Volume
Pot Life @ Room Temp.	30 minutes min.	50 minutes min
Hardening @ Room Temp.	1 hr. or longer	1 hr. or longer
Hardening @ 60 deg. C 140 deg. F	16 min. or less	18 min. or less
Viscosity Poises @ 22 deg. C 72 deg. F	4.7 max.	Thixotropic paste
Solids	95 percent min.	98 percent min.
Tensile Strength	27.6 MPa4000 psi	17.25 MPa2500 psi
Elongation	50 percent	4 percent
Compressive Strength		
Failure	131 MPA19,000 psi	---
Yield	24 MPa3500 psi	38 MPa5500 psi

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Use methods for preparation of historic wood and metal surfaces for painting which are the gentlest possible to achieve the desired results. Do not damage or marr substrate materials in the process of surface preparations. Collect and analyze samples of the existing paint finishes for the purpose of documentation or matching, if [so directed by the Contracting Officer] [required by the contract documents.] Material and application requirements for paints are covered in Section 09 90 00 PAINTS AND COATINGS.

3.2 VENTILATION

Ventilate interior work zones, having a volume of 280 cubic meters 10,000 cubic feet or less, at a minimum of 2 air exchanges per hour. Maintain ventilation in larger work zones by means of mechanical exhaust. Exhaust solvent vapors outdoors, away from air intakes and workers. Temporarily seal return air inlets in the work zone before start of work until the prepared surfaces have dried. Operators and personnel in the vicinity of paint removal processes involving chemicals or mechanical action (sanding or blasting) must wear respirators.

3.3 PROTECTION OF AREAS NOT TO BE PAINTED

Remove or protect items not to be painted, which are in contact with or adjacent to painted surfaces, prior to surface preparation and painting operations. Replace items removed prior to painting when painting is completed. Following completion of painting, reinstall removed items. Restore surfaces contaminated by preparation materials to original condition.

3.4 CLEANING OF SURFACES

Provide surfaces that are clean and free of grease, dirt, dust and other foreign matter before application of paint or surface treatments. After cleaning, exhibit a surface disfigurement rating of 7 or greater when evaluated in accordance with ASTM D3274. Clean dirt and surface contaminants by brush with solutions of water and detergent or trisodium phosphate, then rinsed clean with water and let dry. Clean surfaces on which mildew or other microbiological growth is present with a detergent solution containing household bleach. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Provide low toxicity cleaning solvents with a flashpoint in excess of 38 degrees C 100 degrees F. Program cleaning so that dust and other contaminants will not fall on newly prepared or newly painted surfaces.

3.5 EXISTING PAINT

Test existing paint for adhesion to substrate in accordance with ASTM D3359, Test Method A and obtain a rating of 4 or better in order to be considered sound. Existing paint meeting this requirement may be considered a satisfactory base for repainting.

3.6 PAINT REMOVAL

Remove flaking, cracking, blistering, peeling or otherwise deteriorated paint by scraping with hand scrapers. After scraping, remove large areas of paint or paint on architectural details using sanders, heat guns or heat plates, or chemical paint removers. Remove paint to bare substrate or first sound paint layer. Do not use open flame heat devices. Mechanical paint removal must not damage or mar the substrate material.

3.6.1 Chemical Paint Removers

Use chemical paint removers in accordance with manufacturer's recommendations. If chemical strippers are used, neutralizesubstrate to a pH of 5 to 8.5 after stripping.

3.6.2 Lead Paint

In preparation of lead-based painted surfaces for repainting, follow the procedures described in Section 02 83 00 LEAD REMEDIATION.

3.7 SURFACE PREPARATION

After cleaning and removal of deteriorated paint, feather and sand edges of remaining chipped paint. Repair damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls with suitable material to match adjacent undamaged areas. Roughen slick surfaces. Clean rusty metal surfaces in accordance with [SSPC SP 1] [SSPC SP 2] [SSPC SP 3] [SSPC SP 5/NACE No. 1] [SSPC SP 6/NACE No.3] [SSPC 7/NACE No.4] [SSPC SP 10/NACE No. 2]. Remove chalk so that when tested in accordance with ASTM D4214, the chalk resistance rating is no less than 8. Provide new, proposed coatings that are compatible with existing coatings. If existing surfaces are glossy, reduce the gloss.

3.8 WOOD SURFACES

Clean wood surfaces of foreign matter. Prime or touch up surfaces adjacent to surfaces to receive water-thinned paints before applying water-thinned paints. Scrape and clean small, dry seasoned knots, and give a thin coat of commercial knot sealer before application of the priming coat. Scrape off pitch on large, open, unseasoned knots and all other beads or streaks of pitch, or, if it is still soft, remove with mineral spirits or turpentine, and thinly coat the resinous area with knot sealer.

3.8.1 Interior Wood Surfaces

Sand interior wood surfaces to receive stain. Give oak and other open-grain wood to receive stain a coat of wood filler recommended by the finish manufacturer not less than 8 hours before the application of stain; remove excess filler and sand the surface smooth. Sanding of wood floors is specified in Section 09 64 29 WOOD STRIP AND PLANK FLOORING. Moisture content of the wood must not exceed 12 percent as measured by a moisture meter, unless otherwise authorized.

3.8.2 Wood Repair

Remove and repair badly decayed areas. Replace areas and pieces decayed beyond repair with new pieces that match originals in all respects. Patch moderately decayed areas, weathered, or gouged wood with approved patching compounds, and sand smooth. Identify and correct the source or cause of wood decay prior to application of patching materials. Completely dry wet wood to a moisture content not exceeding 12 percent, as measured by a moisture meter, to its full depth before patching, unless otherwise authorized. Wood that is to be patched must be clean of dust, grease, and loose paint.

3.8.2.1 Epoxy Wood Repair

Apply epoxy wood repair materials in accordance with manufacturer's written instructions. Follow health and safety instructions in accordance with the manufacturer's instructions. Use clean mixing equipment to avoid contamination. Provide mix and proportions as directed by the manufacturer. Provide batches large enough to complete the specific job intended. Completely cure batching materials before painting or reinstallation of patched pieces.

3.8.2.2 Epoxy Consolidant and Epoxy Paste

Use epoxy liquid wood consolidant: 1) to penetrate and impregnate deteriorated wood sections in order to reinforce wood fibers that have become softened or absorbent. 2) as a primer for areas that are to receive epoxy paste filler. Use epoxy paste to fill areas where portions of wood are missing such as holes, cracks, gaps, gouges, and other voids.

3.8.3 Exposed Ferrous Metals

Spot-prime exposed ferrous metals such as nail heads on or in contact with wood surfaces to be painted with water-thinned paints, with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.8.4 Finishing Nails

Set finishing nails, and prime all holes and surface imperfections. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler, colored to match the finish coat if natural finish is required, allowed to dry, and sanded smooth. Putty or wood filler must be compatible with subsequent coatings.

3.8.5 Wood Preservative

Treat areas of bare wood in exterior locations prone to excessive moisture or standing water with a commercial, fungicide, paintable water repellant/preservative. Do not use water repellant/preservatives on interior surfaces.

3.9 METAL SURFACES

Clean metal surfaces of foreign matter. Prepare metal in accordance with SSPC PA Guide 5. Remove grease, oil, and other soluble contaminants by solvent cleaning in accordance with SSPC SP 1. Surfaces must be free from soils and corrosion; e.g. grease, oil, solder flux, welding flux, weld spatter, sand, rust, scale, and other contaminants that might interfere with the application of the new finish. Gently clean to achieve the desired result. Do not abrasively clean metals which are soft, thin, or exhibit fine detail. Evidence of corrosion or contamination on a previously cleaned surface must be cause for recleaning prior to painting.

3.9.1 Ferrous Surfaces

Mechanically clean surfaces that contain loose rust, loose mill scale, and other foreign substances with hand tools according to SSPC SP 2, power tools according to SSPC SP 3 or by blast cleaning according to [SSPC SP 5/NACE No. 1], [SSPC SP 6/NACE No.3], [SSPC 7/NACE No.4], [SSPC SP 10/NACE No. 2]. Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.

3.9.2 Nonferrous Metallic Surfaces

Solvent-clean galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces in accordance with SSPC SP 1.

3.9.2.1 Aluminum

Treat aluminum surfaces in accordance with ASTM D173/D173M or ASTM D173/D173M. Do not use steel wool, steel brushes and uninhibited caustic etching solutions, such as sodium hydroxide, on aluminum.

3.9.2.2 Zinc

Clean zinc surfaces including zinc-coated substrates prior to painting as follows: degrease, soak in a mild and inhibited alkaline cleaner, rinse with clean overflowing water, clean anodically in an acid (e.g. 0.25 to 0.75 percent sulfuric acid), and rinse with clean overflowing water.

3.10 TIMING

Give surfaces that have been cleaned, pretreated, and otherwise prepared for painting a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Unless otherwise directed, applythe first coat primer within 48 hours of surface preparation.

3.11 SURFACES TO BE PREPARED FOR PAINTING

Prepare surfaces as specified and as shown in the painting schedule [in Section 09 90 00 PAINTS AND COATINGS] [on the drawings].

3.12 CLEANING

Place cloths, cotton waste and other debris, that might constitute a fire hazard, in closed metal containers for removal at the end of each day. Remove containers from the site or destroy in an approved manner. Remove preparation materials and other deposits on adjacent surfaces and leave the entire job clean and ready for painting.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 06 00 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-09 06 90 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 09 - FINISHES

SECTION 09 06 00

SCHEDULES FOR FINISHES

08/22

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 06 00 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-09 06 90 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 09 06 00

SCHEDULES FOR FINISHES
08/22

****
NOTE: This guide specification covers the requirements for color of exterior and interior materials and products.

Per 2017 NDAA-Section 888, the use of brand names or brand-name or equivalent descriptions, or proprietary specifications or standards is prohibited in Department of Defense solicitations unless a justification for such specification is provided and approved in accordance with section 2304(f) of title 10, United States Code.
Use this guide specification when providing a Justification and Approval (J&A), OR when using color reference systems such as Pantone, RAL, AMS-STD-595 (Federal Standard 595C)and NCS to define finish colors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 SUMMARY

This section covers only the color of exterior and interior materials and products that are exposed to view in the finished construction. The word "color", as used herein, includes surface color and pattern. Requirements for quality, product specifications, and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings if not identified in this specification. Items not designated for color in this section may be specified in other sections. When color is not designated for items, propose a color for approval.

1.2 SUBMITTALS

****

NOTE: Fill in the empty brackets following the "G" classification with a designation identifying the DOR (Designer of Record).

****

SD-04 Samples

Contractor Color Boards; G, [_____]

1.3 COLOR REFERENCE SYSTEMS

Colors for project finishes are identified in the Color Schedule and based on the [Pantone [Home & Interiors Color Guide][   ]][RAL [Design Color Guide] [   ]][AMS-STD-595 (Federal Standard 595C)][NCS [1950 Index][ ]][   ] color reference system.

PART 2 PRODUCTS

2.1 CONTRACTOR COLOR BOARDS

****

NOTE: If a Justification and Approval (J&A) is not obtained for a project, the following requirement can be included for the contractor to submit construction color boards.

****

Contractor to submit actual color boards to include all finish color samples specified on the project, prior to the submittal and approval of individual finish submittals. The DOR must review and approve the color boards to verify overall building finish coordination and aesthetic. Color boards must be prepared by professional interior designers or architects with significant interior design experience. Qualification of designers is based on education, experience and examination. Interior designers or architects must have completed a program accredited by the Council for Interior Design Accreditation (CIDA) or equal accreditation program of academic training in interior design. In addition, the interior designer or architect must also have attained National Council for Interior Design Qualification (NCIDQ) certification or state licensure, certification or registration and must not be affiliated with a furniture dealership, vendor or manufacturer.

2.2 COLOR SCHEDULE

****

NOTE: All interior and exterior finish colors are to be included in this specification or in the Finish Color Legend in the drawings. Add finishes not included in the specification per the project requirements, and delete finishes that are not required for the project. Include applicable mechanical, fire protection, structural, architectural, site and electrical items that have an impact on the aesthetics of a facility. Coordinate the color for these items with the appropriate design discipline.

When this specification is utilized, include reference in the applicable guide specifications "color will be as specified in Section 09 06 00 SCHEDULES FOR FINISHES." If this text is not currently included in the applicable guide specification, the designer should add it.

The Color Schedule may contain a reference to another specification section where the color is designated (example: Signage: See Section 10 14 00.10 EXTERIOR SIGNAGE for color).

When multiple colors of the same material are specified, add finish color codes and notes within the color listing to identify location of different material colors. For example, CPT-1 (Offices), CPT-2 (Conference Rooms) etc.

Coordinate finish terminology and finish color codes between the specifications and drawings, including drawing details such as floor and wall patterns, finish plans, and the Room Finish Schedule.

Do not duplicate information that is specified in the individual specifications or in the drawings.

EDITING TIPS:
1. An easy way to capture finish material text (example:

<SPT =2.2.1.1><TTL>2.2.1.1 Brick</TTL>

<ITM>[_____]</ITM>
</SPT =2.2.1.1>) is to place your cursor in the title, double click and continue to double click until it is highlighted from beginning tag (<SPT =2.2.1.1>) to end tag (/<SPT =2.2.1.1>). Once this has been done the highlighted portion can be deleted if not applicable or copied for further editing if text for a new finish material is required.

2. Add information inside ITEM tags (<ITM></ITM>) to prevent text wrapping problems (example:

2.3.1.2 Carpet Tile (CPT)

<ITM>CPT-1 - XYZ Co., Pattern ABC, Color #12354 Blue</ITM>
<ITM>CPT-2 - LPQ Co., Pattern JKL, Color #78911</ITM>).

****

The color information provided in the following paragraphs lists the colors, patterns and textures for exterior and interior finishes, including both factory applied and field applied colors. In the case of difference between the drawings and specifications, colors identified in this specification govern.

2.3 EXTERIOR FINISHES

****

NOTE: Exterior color information (exterior walls, exterior trim and exterior roof) can be included in this specification or on the exterior elevation drawings. If provided on the drawings include a color legend. When this information is added to the drawings delete the applicable paragraphs in this specification (paragraphs EXTERIOR WALLS, EXTERIOR TRIM and EXTERIOR ROOF).

****

[Reference drawings for color information.]

[2.3.1 Exterior Walls

Exterior wall colors apply to exterior wall surfaces including recesses at entrances and projecting vestibules. When applicable, paint conduit to closely match the adjacent surface color. Provide wall colors to match the colors listed below.

2.3.1.1 Brick

[_____]

2.3.1.2 Mortar

[_____]

2.3.1.3 Concrete Masonry Units ([Integrally Colored][Rock/Split-Faced][Ribbed][Burnished][_____])

[_____]

2.3.1.4 Metal Wall Panels, Hardware, and Associated Trim

[_____]

2.3.1.5 Insulation and Finish System

[_____]

2.3.1.6 Precast Concrete

[_____]

2.3.1.7 Precast Stone

[_____]

2.3.1.8 Glass and Glazing

[_____]

2.3.1.9 Paint

[_____]

2.3.1.10 Cement Board Siding and Trim

[_____]

2.3.1.11 Cultured Stone

[_____]

2.3.1.12 Screen Wall

[_____]

2.3.2 Exterior Trim

Provide exterior trim to match the colors listed below.

2.3.2.1 Steel Doors and Door Frames

[_____]

2.3.2.2 Steel Windows (mullion, muntin, sash, trim, and sill)

[_____]

2.3.2.3 Aluminum Doors and Door Frames

[_____]

2.3.2.4 Aluminum Windows (mullion, muntin, sash, trim, and sill)

[_____]

2.3.2.5 Wood Clad Windows (mullion, muntin, sash, trim, and sill)

[_____]

2.3.2.6 Window Screens

[_____]

2.3.2.7 Wood Stain

[_____]

2.3.2.8 Fascia

[_____]

2.3.2.9 Soffits and Ceilings

[_____]

2.3.2.10 Overhangs

[_____]

2.3.2.11 Downspouts and Gutters

[_____]

2.3.2.12 Scuppers

[_____]

2.3.2.13 Louvers

[Match adjacent material in color.][_____]

2.3.2.14 Flashings

[Match adjacent material in color.][_____]

2.3.2.15 Coping

[_____]

2.3.2.16 Precast Concrete [[Caps][,][_____][and][Sills]]

[_____]

2.3.2.17 Precast Stone [[Caps][,][_____][and][Sills]]

[_____]

2.3.2.18 Handrails

[_____]

2.3.2.19 Guardrails

[_____]

2.3.2.20 Caulking and Sealants

[Match adjacent material in color.][_____]

2.3.2.21 Stringers and Stair Framing

[_____]

2.3.2.22 Bollards

[_____]

2.3.2.23 Signage

[_____]

2.3.2.24 Sun Shades

[_____]

2.3.2.25 Control Joints

[Match adjacent material in color.][_____]

2.3.2.26 Expansion Joint and/or Covers

[Match adjacent material in color.][_____]

2.3.3 Exterior Roof

Apply roof color to exterior roof surfaces including sheet metal flashings and copings, snow guards, mechanical units, mechanical penthouses, roof trim, pipes, conduits, electrical appurtenances, and similar items. Provide roof color to match the colors listed below.

2.3.3.1 Metal

[_____]

2.3.3.2 Shingles

[_____]

2.3.3.3 EPDM

[_____]

2.3.3.4 TPO

[_____]

2.3.3.5 Penetrations

[Match roof in color.][_____]

]2.4 INTERIOR FINISHES

2.4.1 Interior Floor Finishes

Provide flooring materials to match the colors listed below.

2.4.1.1 Carpet (Broadloom)

[_____]

2.4.1.2 Carpet Tile

[_____]

2.4.1.3 Static-Control Carpet

[_____]

2.4.1.4 Vinyl Composition Tile

[_____]

2.4.1.5 Linoleum

[_____]

2.4.1.6 Luxury Vinyl Tile

[_____]

2.4.1.7 Cork

[_____]

2.4.1.8 Sheet Vinyl

[_____]

2.4.1.9 Rubber Tile

[_____]

2.4.1.10 Static-Control Resilient Flooring ([Conductive Vinyl Tile][Conductive Rubber Tile][Conductive Rubber SheetFlooring][Static-Dissipative Vinyl Tile][Static-Dissipative Rubber Tile])

[_____]

2.4.1.11 Stair Flooring

[_____]

2.4.1.12 Stair Landings

[_____]

2.4.1.13 Porcelain Tile

[_____]

2.4.1.14 Quarry Tile

[_____]

2.4.1.15 Ceramic Tile

[_____]

2.4.1.16 Grout

[_____]

2.4.1.17 [Aluminum][Marble][Solid Surface][_____] Transition

[_____]

2.4.1.18 Entrance Mat

[_____]

2.4.1.19 Plastic Laminate

[_____]

2.4.1.20 Wood

[_____]

2.4.1.21 Concrete ([Paint][Stain][Integrally Colored][_____])

[_____]

2.4.1.22 Industrial Floor Coating

[_____]

2.4.2 Interior Base Finishes

Provide base materials to match the colors listed below.

2.4.2.1 Resilient Base and Moldings

[_____]

2.4.2.2 Porcelain Tile

[_____]

2.4.2.3 Quarry Tile

[_____]

2.4.2.4 Ceramic Tile

[_____]

2.4.2.5 Grout

[_____]

2.4.2.6 Integral Cove Base

[_____]

2.4.2.7 Brick

[_____]

2.4.2.8 Mortar

[_____]

2.4.2.9 Paint

[_____]

2.4.2.10 Wood

[_____]

2.4.3 Interior Wall Finishes

Apply interior wall color to the entire wall surface, including reveals, vertical furred spaces and columns, grilles, diffusers, electrical and access panels, and piping and conduit adjacent to wall surfaces unless otherwise specified. Paint items not specified in other paragraphs to match adjacent wall surface. Provide wall materials to match the colors listed below.

2.4.3.1 Paint

[_____]

2.4.3.2 Vinyl Wall Covering

[_____]

2.4.3.3 Fabric Wall Covering

[_____]

2.4.3.4 Acoustical Wall Covering

[_____]

2.4.3.5 Porcelain Tile

[_____]

2.4.3.6 Ceramic Tile

[_____]

2.4.3.7 Grout

[_____]

2.4.3.8 Brick

[_____]

2.4.3.9 Mortar

[_____]

2.4.3.10 Metal Liner Panels

[_____]

2.4.3.11 Exposed Structural Columns

[_____]

2.4.4 Interior Ceiling Finishes

Apply ceiling colors to ceiling surfaces including soffits, furred down areas, grilles, diffusers, registers, and access panels. In addition, apply ceiling color to joists, underside of roof deck, and conduit and piping where joists and deck are exposed and required to be painted. Provide ceiling materials to match the colors listed below.

2.4.4.1 Acoustical Tile and Grid

[Manufacturers Standard Color][_____]

2.4.4.2 Paint (Ceilings)

[_____]

2.4.4.3 Paint (Soffits)

[_____]

2.4.4.4 Metal Deck

[_____]

2.4.4.5 Structural Framing

[_____]

2.4.5 Interior Trim

Provide interior trim to match the colors listed below.

2.4.5.1 Steel Doors

[_____]

2.4.5.2 Steel Door Frames

[_____]

2.4.5.3 Steel Windows (mullion, muntin, sash, trim, and stool)

[_____]

2.4.5.4 Aluminum Doors and Door Frames

[_____]

2.4.5.5 Aluminum Windows (mullion, muntin, sash, trim, and stool)

[_____]

2.4.5.6 Wood Doors

[_____]

2.4.5.7 Wood Stain

[_____]

2.4.5.8 Fire Extinguisher Cabinets

[_____]

2.4.5.9 Handrails

[_____]

2.4.5.10 Guardrails

[_____]

2.4.5.11 Ladders

[_____]

2.4.5.12 Metal Stairs[; includes [risers][and underside of stairs] only]

[_____]

2.4.5.13 Exposed Ductwork

[_____]

2.4.5.14 Bollards

[_____]

2.4.6 Interior Window Treatment

Provide window treatments to match the colors listed below.

2.4.6.1 Horizontal Blinds

[_____]

2.4.6.2 Vertical Blinds

[_____]

2.4.6.3 Window Shades

[_____]

2.4.6.4 Drapery Hardware

[_____]

2.4.7 Interior Miscellaneous

Provide miscellaneous items to match the colors listed below.

2.4.7.1 Toilet Partitions and Urinal Screens

[_____]

2.4.7.2 Casework

****

NOTE: Add project requirements for items such as cabinetry, countertops, backsplashes and toilet room access panels, etc. and list the finish materials for these items such as plastic laminate, wood finish, solid surface materials, engineered quartz, etc.

****

[_____]

2.4.7.3 Plastic Laminate

****

NOTE: Delete this paragraph if all applicable materials are listed under paragraph "Casework" above.

****

[_____]

2.4.7.4 Solid Surfacing Material

****

NOTE: Delete this paragraph if all applicable materials are listed under paragraph "Casework" above.

****

[_____]

2.4.7.5 Window Sills ([Solid Surface][Plastic Laminate][_____])

[_____]

2.4.7.6 Operable Partitions

[_____]

2.4.7.7 Accordion Partitions

[_____]

2.4.7.8 Acoustical Wall Panels

[_____]

2.4.7.9 Corner Guards

[_____]

2.4.7.10 Protective Wall Covering/Panel

[_____]

2.4.7.11 Chair Rail

[_____]

2.4.7.12 Signage Message Color

[_____]

2.4.7.13 Signage Background Color

[_____]

2.4.7.14 Building Directory

[_____]

2.4.7.15 Bulletin Board

[_____]

2.4.7.16 Markerboard

[_____]

2.4.7.17 Closet Shelving

[_____]

2.4.7.18 Lockers

[_____]

2.4.7.19 Benches

[_____]

2.4.7.20 Wall Switch Handles and Standard Receptacle Bodies

[_____]

2.4.7.21 Electrical Device Cover Plates

[_____]

2.4.7.22 Electrical Panels

[_____]

2.4.7.23 Fin Tubes

[_____]

2.4.7.24 Shower [Curtain][Doors]

[_____]

2.4.7.25 Shower Wall Kits, Trim and Shower Pan

[_____]

[2.5 PLACEMENT SCHEDULE

****

NOTE: Delete this paragraph if there is a Room Finish Schedule in the drawings.

If this schedule is required, use the same codes as in the above Color Schedule or create finish color codes to populate the columns.

****

Placement of color to be in accordance with the following schedule:

ROOM # AND NAME	FLOOR	BASE	NORTH WALL	SOUTH WALL	EAST WALL	WEST WALL	CEILING	REMARKS

]PART 3 EXECUTION

Not Used

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 22 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 22 00 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 22 00

SUPPORTS FOR PLASTER AND GYPSUM BOARD

08/24

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-09 22 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 22 00 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 09 22 00

SUPPORTS FOR PLASTER AND GYPSUM BOARD
08/24

****

NOTE: This guide specification covers the requirements for non-load bearing cold-formed metal framing, furring, and ceiling suspension systems for the attachment of lath, plaster, stucco, and wallboard. This Section should only be used when partition heights are less than or equal to 4.6 m 15 feet, when lateral partition loads are less than or equal to 24.41 kgf/m^2 5 psf, and when lateral support at the top of the wall has been specifically detailed in the drawings.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Load bearing cold-formed steel framing is included in Section 05 40 00 COLD-FORMED METAL FRAMING. Metal suspension systems for acoustical ceilings are included in Section 09 51 00 ACOUSTICAL CEILINGS.

****

****

NOTE: On the drawings, show:

1. Locations of each type of metal framing, furring, or suspension system.

2. Spacing and gauge of members if other than those required by referenced publication.

3. Seismic restraint for projects located in seismic zone 2, 3, or 4, in accordance with AISC 341 and UFC 3-301-01, "Structural Engineering".

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 341	(2016) Seismic Provisions for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S220	(2020) North American Standard for Cold-Formed Steel Nonstructural Framing

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C635/C635M	(2022) Standard Specification for

	Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C754	(2020) Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C841	(2023) Installation of Interior Lathing and Furring
ASTM C847	(2018; R 2024) Standard Specification for Metal Lath

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC98	(2021) Accreditation Criteria for Inspection Agencies

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

****
NOTE: Require drawings only for projects where complexity or quantity make it feasible.
****

Metal Support Systems; G, [_____]

SD-03 Product Data

Metal Support Systems

Recycled Content for Metal Support Systems; S

1.2.1 Sustainable Design Submittals

a. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

b. Environmental Product Declaration (EPD): For each product.

c. Construction and Demolition Waste Management: For each product.

d. Health Product Declaration (HPD): Provide documentation confirming product compliance with one of the following:

  (1) Option 1: Material Ingredient Reporting: Use at least 20 different permanently installed products from at least five different manufacturers that use one of the qualifying programs to demonstrate the chemical inventory of the product to at least 0.1 percent (1000 ppm).

  (2) Option 2: Material Ingredient Optimization: Use products that have a compliant material ingredient optimization report or action plan. Use at least five permanently installed products sourced from at least three different manufacturers.

SD-04 Evaluation Reports: Submit evaluation reports certified under an independent third-party inspection program administered by an agency accredited by IAS to ICC-ES AC98 accreditation criteria for inspection agencies.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the job site and store in ventilated dry locations permitting easy access for inspection and handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Remove damaged items and provide new items.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: The use of manufacturers standard EQ coating is acceptable. Provide G-90 galvanized coating, or equivalent, in high-humidity environments.

****

Provide steel materials for metal support systems with either a EQ (Equivalent Coating) coating or a galvanized coating AISI S220[G-40] G-60[G-90] or equivalent; aluminum coating T1-25; or a 55-percent aluminum-zinc coating AZ50.[Provide support systems and attachments in accordance with[AISC 341] [_____][UFC 3-301-01, "Structural Engineering"] in seismic zones.]

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

****

Provide metal support systems containing a minimum of 20 percent recycled content. Provide data identifying percentage of recycled content for metal support systems.

2.1.1 Materials for Attachment of Lath

2.1.1.1 Suspended and Furred Ceiling Systems and Wall Furring

ASTM C841 and ASTM C847.

2.1.1.2 Non-load Bearing Wall Framing

AISI S220.

2.1.2 Materials for Attachment of Gypsum Wallboard

2.1.2.1 Suspended and Furred Ceiling Systems

AISI S220.

2.1.2.2 Non-load Bearing Wall Framing and Furring

****

NOTE: Minimum thickness of 0.45 mm 0.0179 inch (25 gauge) is standard for interior non-load bearing studs without supporting attached loads. Choose the second option of 0.85 mm 0.0329 inch (20 gauge) thickness for medical, dental, or other building types requiring large quantities of wall supported

cabinet work and equipment throughout the facility.
****

a. Framing Members, General: Comply with AISI S220 for conditions indicated.

    (1) Steel Sheet Components: Comply with AISI S220 requirements for metal unless otherwise indicated.

    (2) Protective Coating: AISI S220, provide EQ (Equivalent Coating) coating, galvanized coating G-60 or equivalent. G40 or coating with equivalent corrosion resistance of G40 [_____]. Provide G-90 coating in high-humidity environments.

b. Studs and Runners: AISI S220. Use either steel studs and runners or embossed steel studs and runners.

c. AISI S220, but not thinner than[0.45 mm 0.0179 inch thickness, with 0.85 mm 0.0329 inch minimum thickness supporting wall hung items such as cabinetwork, equipment and fixtures][0.85 mm 0.0329 inch thickness].

d. Slip-Type Head Joints: Where indicated, provide one of the following:

    (1) Slotted Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

    (2) Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing[[40][50][60] mm [1-1/2][2][2-1/2] inch] [_____] minimum vertical movement.

    (3) Single Long-Leg Track System: Top track with 50 mm 2 inch deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging and spacer bar located within 300 mm 12 inches of the top of studs to provide lateral bracing.

e. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

f. Backing Plate: Fire-retardant-treated wood blocking used for fixture attachment.

g. Sound Isolation Clips: Used with 0457 mm 18 mil, (25 gauge), drywall furring channels to provide acoustical separation.

h. Framed Openings: Galvanized-steel, one-piece header and jamb studs in lieu of built-up members.

i. Partial Wall Framing Connection: Stud connector designed to support out-of-plane loading of cantilevered partial wall systems that are unsupported at the top track.

j. Drywall Penetration Barrier Mesh: Supply and install security mesh, as a penetration barrier behind gypsum wallboard walls and/or ceilings, where indicated on Drawings.

2.1.2.3 Furring Structural Steel Columns

AISI S220. Steel (furring) clips and support angles listed in UL Fire Resistance may be provided in lieu of steel studs for erection of gypsum wallboard around structural steel columns.

2.1.2.4 Z-Furring Channels with Wall Insulation

****

NOTE: The depth specified for Z-furring channels should be coordinated with the R-value specified for wall insulation thickness.

****

Not lighter than 0.45 mm thick 25 gauge galvanized steel, Z-shaped, with 30 mm and 20 mm 1-1/4 inch and 3/4 inch flanges and[[25][40][50][75] mm [1][1-1/2][2][3] inch furring depth][depth as required by the insulation thickness provided].

2.2 SUSPENSION SYSTEMS

2.2.1 Structural Classification

a. Main Beam/ Tee is to be Fire-Rated Heavy Duty classification in accordance with ASTM C635/C635M.

b. Classification can require wires to be closer together for additional loading when used to support double layer gypsum, verticals, slopes, circles, soffits, canopies, and step conditions which call for loading or unusual designs and shapes in drywall construction.

c. Deflection of fastening suspension system supporting light fixtures, ceiling grilles, access doors, verticals and horizontal loads are to have a maximum deflection of 1/360 of the span.

2.2.2 Components

a. Main Beam/ Tee: Is to be commercial quality, cold-rolled steel, double-web construction (minimum 0.45 mm 0.0179 inch prior to protective coating, AISI S220), hot dipped galvanized (per ASTM A653/A653M) and 40 mm 1-1/2 inch high minimum with knurled face.

b. Drywall Grid Cross Tees: Are to be commercial quality, cold-rolled steel, double-web steel construction (minimum 0.45 mm 0.0179 inch prior to protective coating, AISI S220), hot dipped galvanized (minimum G40 or G90 in accordance with ASTM A653/A653M) and 40 mm 1-1/2 inch high minimum with knurled face.

c. Wall Molding/ Channel:

(1) 50 mm by 50 mm 2 inch by 2 inch, knurled surface, pre-punched holes in top flange 100 mm 4 inch on center,[18 mil. (25 gauge)] 33 mil (20 gauge)

(2) Locking Angle Molding, 30 mm by 30 mm 1-1/4 inch by 1-1/4 inch

with pre-engineered locking tabs punched 202 mm 8 inches on center, knurled surface, screw stop hem, pre-punched holes in top flange, 101 mm 4 inch on center, 18 mil. (25 gauge)

(3) Knurled Angle molding, 30 mm by 30 mm 1-1/4 inch by 1-1/4 inch, knurled surface, screw stop hem, pre-punched holes in top flange, 100 mm 4 inch on center, 18 mil. (25 gauge)

(4) Knurled Angle molding, 40 mm by 40 mm 1-1/2 inch by 1-1/2 inch, knurled surface, screw stop hem, pre-punched holes in top flange 100 mm 4 inch on center, 18 mil. (25 gauge)

(5) Simple Curve Knurled Angle Molding, 40 mm by 40 mm 1-1/2 inch by 1-1/2 inch, knurled face radius 940 mm 37 inch, screw stop hem, pre-punched holes in top flange, 100 4 inch on center, 28 mil. (22 gauge)

d. Support Hanger:

(1) Strong Back Support Hanger

(2) Channel beam splice [150][200][250][300] mm [6][8][10][12] inch used to suspend main beams to 40 mm 1-1/2 inch black iron carrying channels.

(3) Hanger Wire 12 gauge, galvanized or as noted on drawings.

e. Accessories

(1) Radius Clip

(2) 90 Degree Drywall Angle/ Transition Clip

(3) 45 Degree Drywall Angle/ Transition Clip

(4) 30 Degree Drywall Angle/ Transition Clip

(5) Double Drywall Clip

(6) Wall Attachment Clip

(7) Splice Plate

(8) Dome Hub

(9) Close Mount Attachment clip

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Systems for Attachment of Lath

3.1.1.1 Suspended and Furred Ceiling Systems and Wall Furring

ASTM C841, except as indicated otherwise.

3.1.1.2 Non-load Bearing Wall Framing

ASTM C754, Installation Standard.

3.1.1.2.1 Firestop Track

Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

3.1.1.2.2 Sound-Rated Partitions

Install framing to comply with sound-rated assembly indicated.

3.1.2 Systems for Attachment of Gypsum Wallboard

3.1.2.1 Suspended and Furred Ceiling Systems

ASTM C754, except provide framing members 400 mm 16 inches on center unless indicated otherwise.

3.1.2.2 Non-load Bearing Wall Framing and Furring

ASTM C754, except as indicated otherwise. Provide a sealer gasket under bottom of track on concrete slab or foundation.

3.1.2.3 Furring Structural Steel Columns

Install studs or galvanized steel clips and support angles for erection of gypsum wallboard around structural steel columns in accordance with the UL Fire Resistance, design number(s)[indicated][of the fire resistance rating indicated].

3.1.2.4 Z-Furring Channels with Wall Insulation

Install Z-furring channels vertically spaced not more than 600 mm 24 inches on center. Locate Z-furring channels at interior and exterior corners in accordance with manufacturer's printed erection instructions. Fasten furring channels to[masonry][and][concrete] walls with powder-driven fasteners or hardened concrete steel nails through narrow flange of channel. Space fasteners not more than 600 mm 24 inches on center.

3.1.2.5 Firestop Tracks

In accordance with manufacturer's installation instructions, applicable building code and UL assembly.

3.1.2.6 Backing Plates

In accordance with manufacturer's installation instructions.

3.1.2.7 Framed Openings

In accordance with manufacturer's installation instructions and approved design.

3.1.2.8 Partial Wall Framing Connection

In accordance with manufacturer's installation instructions. Anchor to floor as designed by Engineer of Record. Provide a sealer gasket under bottom of track on concrete slab or foundation.

3.1.2.9 Drywall Penetration Barrier Mesh

Per manufacturer's instructions. Installation and layout of the panels to be approved by General Contractor prior to installation, with the intent to attached panels on vertical framing members. Panels may be installed in either direction. Attachment with approved clips and threaded fasteners.

3.1.2.10 Suspension Systems

a. Install suspension system and panels in accordance with the manufacturer's instructions, in compliance with ASTM C635/C635M installation standard, and with applicable codes as required by the authorities having jurisdiction.

b. Install according to approved Pre-construction drawings recommended for complex projects. Contact your local manufacturer representative for support.

c. Drywall Grid System can be installed in interior or exterior applications.

d. Install hanger wire as required with necessary on center spacing to support expected ceiling load requirements, following local practices, codes and regulations. Provide additional wires at light fixtures, grilles, and access doors where necessary. A pigtail knot is to be used with three tight wraps at top and bottom fastening locations.

e. Main tees/ beams are to be suspended from the overhead construction with hanger wire, spaced as required for expected ceiling loads, along the length of the main beams.

f. Install cross tees at on center spacing as specified by the drywall manufacturer. Typical drywall cross tee spacing:

  (1) 400 mm 16 inches on center with 15 mm or 13 mm 5/8 or 1/2 inch gypsum board.

  (2) 600 mm 24 inches on center with 15 mm 5/8 inch gypsum board.

g. Use channel molding or angle molding to interface with Drywall Grid System to provide perimeter attachment or to obtain drop soffits, verticals, slopes.

3.2 ERECTION TOLERANCES

Provide framing members which will be covered by finish materials such as wallboard, plaster, or ceramic tile set in a mortar setting bed, within the following limits:

a. Layout of walls and partitions: 6 mm 1/4 inch from intended position;

b. Plates and runners: 6 mm in 2.4 meters 1/4 inch in 8 feet from a straight line;

c. Studs: 6 mm in 2.4 meters 1/4 inch in 8 feet out of plumb, not cumulative; and

d. Face of framing members: 6 mm in 2.4 meters 1/4 inch in 8 feet from a true plane.

Provide framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive within the following limits:

a. Layout of walls and partitions: 6 mm 1/4 inch;

b. Plates and runners: 3 mm in 2.4 meters 1/8 inch in 8 feet from a straight line;

c. Studs: 3 mm in 2.4 meters 1/8 inch in 8 feet out of plumb, not cumulative and must not exceed minimum fastening requirements of sheathing or other finishing materials; and

d. Face of framing members: 3 mm in 2.4 meters 1/8 inch in 8 feet from a true plane.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 22 36 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 22 36 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-09 22 36 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 22 36 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 09 22 36

LATH
08/24

****
NOTE: This guide specification covers the requirements for lathing for gypsum and portland cement-based plaster work.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: Metal framing, furring and ceiling suspension systems for lathing are specified in Section 05 40 00 COLD-FORMED METAL FRAMING and Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD.

NOTE: If discoloration of exterior plaster work along the lines of the framing system used to support the lath (metal framing in particular and wood framing to a lesser extent) occurs or is anticipated, design the exterior wall with a thermal break between the metal lath and the framing members. One suggested solution is to install 12.7 mm 1/2 inch thick gypsum sheathing board, conforming to ASTM C1396, "Gypsum Sheathing Board" or to ASTM C1177, "Glass Mat Gypsum Substrate," on the framing

members before attaching the metal lath.

****

****

NOTE: On the drawings, show:

1. Location and extent of plastering

2. Type(s) and spacing of supports

3. Type(s) of plaster and location

4. Control joint locations

5. Fire resistance rating(s), where applicable

6. Sound transmission class (STC) rating(s), where applicable

7. Location and size of access panels and fabrication details for access panels larger than 600 by 900 mm 24 by 36 inches.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

ASTM A489	(2018; E 2018) Standard Specification for Carbon Steel Eyebolts
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM C841	(2023) Installation of Interior Lathing and Furring
ASTM C1063	(2024) Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster
ASTM C1764	(2020) Standard Test Methods for Non Metallic Plaster Bases (Lath) Used With Portland Cement Based Plaster in Vertical Wall Applications
ASTM C1787	(2020; R 2023) Standard Specification for Installation of Non Metallic Plaster Bases (Lath) Used with Portland Cement Based Plaster in Vertical Wall Applications
ASTM C1788	(2020) Standard Specification for Non Metallic Plaster Bases (Lath) Used With Portland Cement Based Plaster in Vertical Wall Applications

GYPSUM ASSOCIATION (GA)

GA 600	(2021) Fire Resistance and Sound Control

Design Manual

UL SOLUTIONS (UL)

UL Fire Resistance (2014) Fire Resistance Directory

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Lath

Recycled Content for Metal Lath; S

Accessories

Access Panels

1.3 DELIVERY AND STORAGE

Deliver materials in the manufacturer's original unbroken packages or containers that are labeled plainly with the manufacturer's names, brands, base metal gauge, and if a corrosion inhibiting coating is required, the description of the coating. Store materials in dry locations with adequate ventilation, free from water, and in such a manner to permit easy access for inspection and handling.[Stack gypsum lath flat to avoid sagging or damage to edges, ends, or surfaces, and protect from exposure to direct sunlight.]

PART 2 PRODUCTS

****

NOTE: This guide specification presents nonproprietary materials. When the guide specification is edited or supplemented to suit project requirements, ensure project specification section which contains no proprietary materials.

****

2.1 LATH

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

****

Provide metal lath containing a minimum of 20 percent recycled content. Provide data identifying percentage of recycled content for metal lath.

2.1.1 Metal Plastering Base (Lath)

Provide the type(s) and weight(s) required for the type and spacing of supports shown for the kind of plaster indicated and specified. Do not use rib lath for ceramic tile scratch coat. ASTM A924/A924M Galvanized, unless indicated otherwise.

****

NOTE: Consult Table 2 in ASTM C1063 and Table 1 in ASTM C841 to determine the type and weight of the metal lath based on the type and spacing of the support system shown on the project drawings.

****

2.1.1.1 For Portland Cement-Based Plaster (Stucco)

ASTM C1063,[diamond mesh][self-furring diamond mesh][flat rib][10 mm 3/8 inch rib][20 mm 3/4 inch rib][expanded metal][welded wire][woven wire] metal lath weighing not less than [_____] kilograms per square meter pounds per square yard.

2.1.1.2 For Gypsum Plaster

ASTM C841,[diamond mesh][self-furring diamond mesh][flat rib][10 mm 3/8 inch rib][20 mm 3/4 inch rib][expanded-metal][welded wire][woven wire] metal lath weighing not less than [_____] kilograms per square meter pounds per square yard.

2.1.1.3 Paper Backing (Waterproofed Kraft Building Paper)

****

NOTE: Specify "Moderate water-vapor Resistant" where moisture protection or use of vapor barrier is required. Specify "Water-vapor permeable" to maintain hollow partitions plaster free, to prevent plaster from bonding to substrate, to prevent over spray where plaster is sprayed on, to provide uniform plaster thickness and to improve bonding (keying). Specify paper backing at lath to help prevent plaster "push-through" or "blow-through" waste. Verify that paper backing is available for lath configurations retained below. Confirm that paper is Grade D or better black asphalt per Federal Specification UU-B-790a. Edit paragraph as required.

****

Provide metal plastering base with paper backing,["Moderate water-vapor Resistant" for room(s) [_____]]["Water-vapor permeable" for room(s) [_____]][and][for exterior plastering work].

2.1.1.4 Plastering Base

****

NOTE: Specify galvanized metal or stainless steel plastering base for all exterior plastering and for plastering interior areas subject to high moisture conditions such as natatoriums and shower and laundry rooms. Consider using stainless steel for all exterior locations such as surfaces exposed to water flow including walls, ledges, wall opening returns, and soffit edges that include drip reveals.

****

Provide[ASTM A924/A924M Galvanized Metal][ASTM A240/A240M Stainless Steel][for exterior plastering work][and][for plastering room(s) [_____]][in all locations].

2.1.2 Gypsum Lath

****

NOTE: Specify only for interior gypsum plastering work in relatively large, flat areas. Do not use for curved areas or areas subject to high moisture conditions.

****

ASTM C1063 ASTM C1764 ASTM C1787 ASTM C1788. Provide[plain][Type X (fire resistant)][foil-backed] gypsum lath [9.53][12.70][15.87] mm [3/8][1/2][5/8] inch thick.

2.1.3 Accessories

****

NOTE: Referenced ASTM standards permit accessories

fabricated from:

1. ASTM C1063:
- zinc coated (galvanized) steel
- zinc alloy
- rigid poly (vinyl chloride) (PVC) plastic

2. ASTM A240:
- stainless steel

3. ASTM C841:
- zinc coated (galvanized) steel
- paint coated steel
- rigid poly (vinyl chloride) (PVC) plastic
- clear plastic coated aluminum

If no exceptions are specified, these materials become Contractor options. Include the last sentence, appropriately edited, to exclude any undesirable options.

****

****

NOTE: Use PVC or plastic coated aluminum in lieu of galvanized metal for areas of high humidity or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid project locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

[ASTM C1063.][ASTM C841.][Provide only[galvanized steel][zinc alloy][stainless steel][rigid poly (vinyl chloride) (PVC) plastic][clear plastic coated aluminum] accessories.]

2.2 ACCESS PANELS

****

NOTE: Detail fabrication of access panels larger than 600 by 900 mm 24 by 36 inches on project drawings or any size where applied materials such as acoustic panels or wall panels will be supported by the access panels.

****

****

NOTE: Where access panels are located in ceilings and intended to swing down, specify panels that are greater than 2030 mm 6 foot 8 inches above finished floor when opened to their lowest point.

****

Prefabricated[galvanized][galvannealed][stainless] steel units, size(s)[as indicated][[_____] by [_____] mm inches]. Fabricate frame of preformed angle or channel with welded joints. Perforate wide leg or flange of frame section or extend frame section into expanded metal wings to provide a key for the plaster. Provide a hinged or snap-on type cover with turn-latch or spring catch.[Provide access panels[for room(s) [_____]] with a means for locking.] Fabricate access panels not larger than 600 by 900 mm 24 by 36 inches from 1.8 mm thick 14 gage steel with frames not lighter than 1.5 mm thick 16 gage. Fabricate access panels larger than 600 by 900 mm 24 by 36 inches as indicated. Factory-prime panels with rust-inhibitive paint[except at polished stainless steel access panels].

2.3 HANGERS

****

NOTE: Indicate and provide a detail drawing showing splayed and countersplayed suspension system hanger wires.

In high humidity areas or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, use corrosion resistant materials (stainless steel or copper-bearing alloys) for suspension components. Humid project locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Provide hangers and attachment capable of supporting a minimum 1330 N 300 pound ultimate vertical load without failure of supporting material or attachment.

2.3.1 Wires

****

NOTE: Select stainless steel or nickel copper alloy wire for facilities where high humidity can be expected such as large kitchens, dishwashing areas, and indoor swimming pools. Select zinc-coated steel wire for other locations.

When spacing of hanger wires exceeds 1200 mm 4 feet or when heavy loads are supported, specify 3.4 or 4.1 mm 8 or 10 gauge wire.

****

Conform wires to[ASTM A641/A641M, Class 1, [2.0] [_____] mm [0.08 inch (12 gauge)] [[_____] inch] in diameter.][ASTM A580/A580M, composition 302 or 304, condition annealed stainless steel, [2.0] [_____] mm [0.08 inch (12 gauge)] [[_____] inch] in diameter.]

****

NOTE: Normally wire hangers should be used, as specified above. If the project is in an area subject to violent storms, specify steel strap or rod hangers as included in the following sub-paragraphs.

****

[2.3.2 Straps

Provide straps of 25 by 5 mm 1 by 3/16 inch galvanized steel conforming to

ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

][2.3.3 Rods

Provide 5 mm 3/16 inch diameter threaded steel rods, zinc or cadmium coated.

]2.3.4 Eyebolts

Provide eyebolts of weldless, forged-carbon-steel, with a straight-shank in accordance with ASTM A489. Eyebolt size must be a minimum [_____] [7] mm [_____] [1/4] inch,[zinc coated][cadmium plated].

2.3.5 Masonry Anchorage Devices

Comply with [ASTM C636/C636M][_____] for anchorage devices for[eyebolts][machine screws][wood screws].

PART 3 EXECUTION

3.1 INSPECTION

Verify that framing, furring and accessories are securely attached and of proper sizes and spacing necessary to provide a suitable substrate to receive lath. Do not proceed with work until framing, furring and accessories are acceptable to the Contracting Officer for application of lath.

3.2 INSTALLATION

3.2.1 Lathing Materials and Accessories

Install in accordance with[ASTM C1063 for portland cement-based plaster work][and][ASTM C841 for gypsum plaster work], except where indicated or specified otherwise herein.

3.2.1.1 Metal Plastering Base

Install[where indicated][on wood or metal studding, furring, joists, rafters, and similar framing members for plastered walls, partitions, ceilings, and soffits][to receive scratch coat for ceramic tile or terrazzo work][on[concrete][and][masonry] surfaces to receive plaster].

3.2.1.2 Metal Plaster Base with Paper Backing

Where used, lap joints to provide backing on backing and metal-on-metal. Lap backing not less than 25 mm 1 inch. Lap backing so that water will flow to the exterior.

3.2.1.3 Gypsum Lath

Install[where indicated][on wood or metal studding, furring, joists, rafters and similar framing members for plastered walls, partitions, ceilings, and soffits].

3.2.1.4 Control (Expansion and Contraction) Joints

a. For portland cement-based plaster (ceilings and walls), install to create panels no larger than 9.3 square meters 100 square feet with no dimension exceeding 3.0 m 10 feet.

b. For unrestrained gypsum plaster ceilings install to create panels no larger than 232 square meters 2,500 square feet with no dimension exceeding 15.2 m 50 feet. For gypsum plaster walls, partitions and ceilings without perimeter relief install not more than 9.1 m 30 feet on centers in either direction.

c. Install[where indicated,] where expansion joints occur in the structural walls and ceilings and where ceiling framing or furring changes direction. Terminate lath at each side of joint and fasten joints securely to lath.

3.2.1.5 Unrestrained Ceilings

Ensure furred or suspended ceilings constructed with[gypsum plaster and larger than 232 square meters 2,500 square feet in area or with any dimension exceeding 15.2 m 50 feet][or][portland cement-based plaster] are unrestrained. Isolate ceiling lath and plaster from ceiling intersecting vertical surfaces with casing beads, control joints, or similar devices designed to keep the ceiling isolated from the adjacent vertical surfaces (walls, partitions, beams, and columns). Do not use corner reinforcement at the internal angle between the ceiling and the vertical surfaces.

3.2.1.6 Plastering Beads

Install edge trim (casing bead)[at the edges of plaster which abuts or adjoins an unplastered surface,][on each surface at the internal angle formed by load bearing and non-load bearing walls and partitions abutting structural walls, columns, or floor-ceiling slabs,][between concrete or terrazzo bases and the plaster above them,][on each side of the joint between walls or partitions constructed of dissimilar materials which require plastering,][and between plasters of a different composition]. Fill voids formed in corners with sealant. Install corner beads at all vertical external corners of plaster walls.

3.2.2 Fire-Resistant Assemblies

****

NOTE: Coordinate with the preparer of the project drawings to ensure that UL Design Number(s) or GA File Number(s) are indicated on the drawings for fire resistant construction.

****

Wherever fire-resistant construction is indicated, provide all materials and application methods, including types and spacing of fasteners, in accordance with the specifications contained in the[UL Fire Resistance for the Design Number(s) indicated][or][GA 600 for the File Number(s) indicated].

3.2.3 Access Panels

****

NOTE: Ensure project drawings include the exact number and location of access panels coordinate with mechanical and electrical work to ensure adequate access to mechanical and electrical systems. Do not

install access panels in fire rated walls or ceilings unless approved by the Government's Fire Protection Engineer.
****

****
NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02, "Unified Facilities Guide Specifications (UFGS) Format Standard".
****

Install in suspended ceilings and plastered walls at locations[indicated][and][specified in [_____]].

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
Access Panels	24 by 36 inches	600 by 900 mm
	14 gage	1.8 mm
	16 gage	1.5 mm

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 23 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 23 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 09 - FINISHES

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GYPSUM PLASTERING

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****
USACE / NAVFAC / AFCEC **UFGS-09 23 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 23 00 (August 2016)

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SECTION 09 23 00

GYPSUM PLASTERING
08/24

****
NOTE: This guide specification covers the requirements for interior and exterior plaster work.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Gypsum plaster refers to interior work. Stucco refers to cement plaster used on the building exterior. Indicate on the project drawings the extent and location of the work to be accomplished, and the type of plaster required.
****

****
NOTE: Specification requirements of a one-coat system are Portland cement plaster with a sand float finish applied to concrete masonry units and concrete surfaces.
****

****
NOTE: This specification is for unrestrained stucco and plaster systems. Design and detail the

cold-formed metal framing (Section 05 40 00 COLD-FORMED METAL FRAMING), lathing and accessories (Section 09 22 36 LATH and Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD) to provide an unrestrained system. Also design and detail sleeve and caulking for fire sprinkler, electrical, and mechanical penetrations to avoid transferring structural or vibrational loads from these systems to the plaster panels.

****

****

NOTE: For terminology on gypsum plaster, refer to latest edition of Portland Cement Plaster (Stucco) Manual by Portland Cement Association and ASTM C11 Standard Terminology Relating to Gypsum and Related Building Materials and Systems.

****

PART 1 GENERAL

1.1 REFERENCES

****

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C28/C28M	(2010) Gypsum Plasters
ASTM C35	(2001; R 2019) Inorganic Aggregates for Use in Gypsum Plaster
ASTM C59/C59M	(2000; R 2020) Standard Specification for Gypsum Casting Plaster and Gypsum Molding Plaster

ASTM C61/C61M	(2000; R 2011) Gypsum Keene's Cement
ASTM C206	(2014; R 2022) Standard Specification for Finishing Hydrated Lime
ASTM C472	(2020) Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete
ASTM C631	(2009; R 2020) Bonding Compounds for Interior Gypsum Plastering
ASTM C842	(2005; R 2021) Standard Specification for Application of Interior Gypsum Plaster
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E1042	(2022) Standard Classification for Acoustically Absorptive Materials Applied by Trowel or Spray

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

UL SOLUTIONS (UL)

UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Gypsum Base Coat Plaster

Gypsum Finish Coat Plaster

SD-04 Samples

[Sample Panel; G, [_____]

] Samples for Initial Selection; G, [_____]

Full-Size Samples; G, [_____]

SD-08 Manufacturer's Instructions

Ready-Mix Gypsum Plaster

Acoustical Plaster Finish

Mixing Instructions

[1.3 QUALITY ASSURANCE

****

NOTE: Retain this paragraph if a sample panel at the building site is required.

****

1.3.1 Sample Panels

Erect sample panel at the building site, or as otherwise directed. Finished gypsum plaster work must match the approved sample panel.

]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver manufactured materials in the manufacturers' original unbroken packages or containers which are labeled plainly with the manufacturers' names and brands. Keep cementitious materials dry and stored off the ground, under cover, and away from sweating walls and other damp surfaces until ready for use. Keep materials wrapped and separate from off-gassing materials, such as paints and adhesives. Do not use materials that have visible moisture or biological growth.

1.5 GYPSUM PLASTER SAMPLES

1.5.1 Samples for Initial Selection

Submit four 900 mm 36 inch square panels of varying texture for the Contracting Officer's approval.

1.5.2 Full-Size Samples

After selection of an acceptable texture, construct a sample[panel][wall] separate from the building, minimum size of [2400][_____] mm [8][_____] ft in height, by [2400][_____] mm [8][_____] ft in length, using 150 mm 6 inch metal studs, and gypsum board, metal lath and gypsum plaster. The sample wall must show all aspects of gypsum plaster work, including but not limited to, expansion joints, control joints, corner extrusions,[[electrical][mechanical][and][fire sprinkler] penetration[s]] and casing beads. A sample of a control joint and extrusion butt joint must also be incorporated into the sample wall. Finish work must match the approved sample panel.[Divide the panel into four equal quadrants with the expansion and control joints to show each phase of work, lath, scratch coat, brown coat, and finish coats.] Provide and protect the sample wall from damage during the length of the contract.

1.6 SCHEDULING AND ENVIRONMENTAL REQUIREMENTS

Commence application only after the area scheduled for gypsum plastering work is completely weathertight. The heating, ventilating, and air-conditioning systems must be complete and in operation prior to application of the plaster. If the mechanical system cannot be activated before veneer plastering is begun, the plastering may proceed in accordance with an approved plan to maintain the environmental requirements specified below. Apply plaster prior to the installation of finish flooring and acoustic ceiling.

1.6.1 Environmental Requirements

****

NOTE: Gypsum plaster is a very thin coating that will be adversely affected by extreme of non-uniform drying conditions and by rapid changes in temperature. It should not be used in spaces where adequate environmental control cannot be obtained.

****

Do not expose the gypsum base to excessive sunlight prior to plaster application, as bond failure of the plaster may result. Maintain a continuous uniform temperature of not less than 12.8 degrees C 55 degrees F and not more than 27 degrees C 80 degrees F for at least one week prior to the application of veneer plaster, while the plastering is being done, and for at least one week after the plaster is set. Shield air supply and distribution devices to prevent any uneven flow of air across the plastered surfaces. Provide ventilation to exhaust moist air to the outside during plaster application, set, and until plaster is dry. In glazed areas, keep windows open top and bottom or side to side 75 to 100 mm 3 to 4 inches. Openings can be reduced in cold weather. For enclosed areas lacking natural ventilation, provide temporary mechanical means for ventilation.

In unglazed areas subjected to hot, dry winds or temperature differentials from day to night of 10 degrees C 20 degrees F or more, screen openings with cheesecloth or similar materials. Avoid rapid drying. During periods of low indoor humidity, provide minimum air circulation following plastering and until plaster is dry.

[1.7 FIRE RESISTIVE COATINGS

****

NOTE: For fire-resistive assemblies, drawing details must follow the tested and approved designs as tested by a qualified testing agencies in accordance with ASTM E119. The addition of gypsum plaster to an approved gypsum wallboard design may improve the fire-resistive properties of partitions, though will require an engineering judgment, if not specifically described in approved designs. Tested and approved designs are published by gypsum wallboard manufacturers, Underwriters Laboratory, and Factory Mutual, and are included in the Gypsum Association Fire Resistance and Sound Control Design Manual.

****

Comply with specified fire-rated assemblies for design numbers indicated per UL Fire Resistance or FM APP GUIDE.

][1.8 SOUND TRANSMISSION

Where indicated, provide gypsum plaster assemblies matching assemblies tested by a qualified testing agency to meet required STC (sound transmission coefficient) ratings according to ASTM E90 and ASTM E413.

]PART 2 PRODUCTS

2.1 MATERIALS

Conform to the specifications, standards, and requirements specified herein. Provide asbestos-free materials.

2.2 GYPSUM BASE COAT PLASTER

****

NOTE: Retain paragraph(s) below if any of these materials are included in the project

****

[2.2.1 Gypsum Neat Plaster Base Coat

ASTM C28/C28M.

][2.2.2 Gypsum Ready-Mixed Plaster Base Coat

ASTM C28/C28M.

][2.2.3 Gypsum Wood-Fibered Plaster Base Coat

ASTM C28/C28M.

][2.2.4 High Strength Gypsum Plaster Base Coat

ASTM C28/C28M, gypsum neat plaster, except plaster must have a compressive strength of not less than [17.25][19.32] MPa [2,500][2,800] psi, when tested dry in accordance with ASTM C472.

]2.3 GYPSUM FINISH COAT PLASTER

****

NOTE: Retain paragraph(s) below if any of these materials are included in the project

****

[2.3.1 Gypsum Gauging Plaster Finish Coat

ASTM C28/C28M.

][2.3.2 High Strength Gypsum Gauging Plaster Finish Coat

****

NOTE: High strength gauging plaster, when blended with finish lime-putty, produces a finish plaster with controlled set, early hardness and strength, and resistance to shrinkage cracks.

****

ASTM C28/C28M, gypsum gauging plaster, except plaster must have a compressive strength of not less than [31][34.4] MPa [4,500][5,000] psi when tested dry in accordance with ASTM C472.

][2.3.3 Gypsum Molding Plaster for Ornamental Plaster

ASTM C59/C59M.

][2.3.4 Keene's Cement Finish Coat

ASTM C61/C61M.

][2.3.5 Acoustical Plaster Finish Coat

****

NOTE: Selected type and grade of plaster to provide the required acoustical characteristics. Acoustical plaster is not recommended for use in places where heavy abrasion and rough usage is expected.

A Portland cement - lime mix is corrosive to metal lath in high humidity/ salt intensive areas. For high humidity areas or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, to reduce plaster and stucco cracking, delete the lime and substitute a liquid plasticizing agent with a resin compound as the principal ingredient. The result produces a material with greater resistance to most climatic effects and minimizes structure related cracking. Humid project locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC

for project locations.

If surface is to be painted, do not use coral aggregate in the plaster system. If no option is available, use sodium silicate system for stabilization.

****

ASTM E1042 Type[I,][II,] Class A, noncombustible.

]2.4 HYDRATED LIME

ASTM C206, Type S.

2.5 AGGREGATES

2.5.1 Sand for Gypsum Base Coats

ASTM C35.

Sand Gradation: Percentage retained by weight (plus or minus 2 percent) on each sieve.

Sieve Size	Maximum	Minimum
No. 4 [4760 microns]	0	0
No. 8 [2380 microns]	5	0
No. 16 [1190 microns]	30	5
No. 30 [590 microns]	65	30
No. 50 [300 microns]	95	65
No. 100 [150 microns]	100	90

2.5.2 Sand for Gypsum Sand Float Finish

****

NOTE: Aggregates for finish-coat plaster should be less than No. 16 sieve size. Larger sizes may be added for finish appearance purposes. Select sieve number that will provide the desired texture. Float texture is governed by maximum sieve sizes of sand. Sieve sizes of 20 to 30 provide a fine float finish and 16 to 20 provide a coarse finish.

****

ASTM C842.

Sand Gradation: Percentage retained by weight (plus or minus 2 percent) on each sieve.

Sieve Size	Maximum	Minimum
No. 20 [850 microns]	0	
No. 30 [590 microns]	0.5	
No. 100 [150 microns]	100	40
No. 200 [75 microns]	100	70

2.5.3 Lightweight Aggregates, Perlite, or Vermiculite for Gypsum Base Coat

ASTM C35.

2.5.4 Silica Sand or Perlite Fines

For use in lime-putty gypsum-gauged finish, aggregated white coat, must have the following gradation: 10 percent maximum retained on a No. 30 sieve (590 microns), 4 percent minimum and 70 percent maximum retained on a No. 100 sieve (150 microns), and 70 percent minimum and 100 percent maximum retained on No. 200 sieve (75 microns). Provide sands and fines free from deleterious materials.

2.6 WATER

Use only potable water, free of mineral and organic substances that affect the hardening and durability of the plaster or stucco.

2.7 PROPORTIONING

Unless specified otherwise, materials are specified on a volume basis and must be measured in approved containers, to ensure that the specified proportions will be controlled and accurately maintained during the progress of the work. Measuring materials with shovels (shovel count) is not be permitted. Prepare ready-mix gypsum plaster for use by the addition of water only.

2.7.1 Gypsum Base Coat Plaster

****

NOTE: List all conditions where sand or lightweight aggregate should not be used.

****

Use of sand or lightweight aggregate is optional in gypsum plaster basecoats, except provide (1) sand for Keene's cement and high strength gypsum-gauged finish coats; (2) lightweight aggregate when necessary for a required fire resistance rating[; and (3) [_____]].

2.7.1.1 Sand and Gypsum Plaster Base Coat

Mix scratch coat in the proportion of 45 kg 100 lb of gypsum neat plaster to not more than 56 liter 2 cu ft of damp loose sand; mix brown coat in the proportion of 45 kg 100 lb of gypsum neat plaster to not more than 85 liter 3 cu ft of damp loose sand; or scratch and brown coats may both be mixed in the proportion of 45 kg 100 lb of gypsum neat plaster to not more than 70 liter 2-1/2 cubic feet of damp loose sand.[Mix the basecoats for double-up work in the proportion of 45 kg 100 lb of gypsum neat plaster to[not more than 70 liter 2-1/2 cu ft of damp loose sand on gypsum lath][

and][not more than 85 liter 3 cu ft of damp loose sand on masonry].]

2.7.1.2 Lightweight Aggregate and Gypsum Plaster Base Coat

Mix scratch coat in the proportion of 45 kg 100 lb of gypsum neat plaster to[not more than 70 liter 2-1/2 cu ft of lightweight aggregate on gypsum lath,][and][not more than 85 liter 3 cu ft of lightweight aggregate on masonry]. Mix brown coat in the proportion of 45 kg 100 lb of gypsum neat plaster to[not more than 70 liter 2-1/2 cu ft of lightweight aggregate on gypsum lath][and][not more than 85 liter 3 cu ft of light weight aggregate on masonry]. Where plaster thickness exceeds 25 mm 1 inch, the aggregate proportion may be increased to 85 liter 3 cu ft.[Mix the basecoats in two-coat double-up work in the proportion of 45 kg 100 lb of gypsum neat plaster to[not more than 70 liter 2-1/2 cu ft of lightweight aggregate on gypsum lath][and][not more than 85 liter 3 cu ft of lightweight aggregate on masonry]]. Gypsum ready-mixed plaster with perlite aggregate may be provided in lieu of field-mixed lightweight aggregate and gypsum plaster, provided the specified proportion of aggregate to plaster does not exceed the proportion specified for field-mixed plaster.

2.7.1.3 Sand and Wood Fibered Gypsum Plaster Base Coat

****

NOTE: Because of its higher cost, specify wood-fibered gypsum plaster only when needed; e.g., for fireproofing.

****

Mix basecoats in the proportion of 45 kg 100 lb of wood-fibered gypsum plaster to not more than 28 liter 1 cu ft of damp loose sand.

2.7.1.4 Sand and High-Strength Gypsum Plaster Base Coat

****

NOTE: Specify high strength gypsum plaster base coat only where needed to withstand heavy abuse; e.g., hospital corridors, handball courts, etc.

****

Mix scratch coat in the proportion of 45 kg 100 lb of high strength gypsum base coat plaster to not more than 56 liter 2 cu ft of damp loose sand. Mix brown coat in the proportion of 45 kg 100 lb of high strength gypsum basecoat plaster to not more than 85 liter 3 cu ft of damp loose sand.

2.7.2 Gypsum Plaster Finish Coat

****

NOTE: Do not use gypsum plaster in areas where the ceiling and walls will be subjected to frequent moisture or wetting.

****

2.7.2.1 Lime-Putty

Prepare lime-putty in accordance with the printed directions of the manufacturer. Use putty following preparation or following a soaking period as recommended by the manufacturer.

2.7.2.2 Lime-Putty Gypsum-Gauged (White Coat)

Use over[sand and gypsum plaster][sand and wood-fibered gypsum plaster]. Mix finish coat in the proportions of one part of gypsum gauging plaster to a volume of hydrated lime or lime putty.

This mix is approximately equivalent to one 45 kg 100 lb bag of gypsum gauging plaster to:

a. Not more than four 22.5 kg 50 lb bags of hydrated lime, or

b. Not more than 127 liter 4-1/2 cu ft of lime putty, or

c. Not more than 132 liter 35 gal of lime putty.

2.7.2.3 Aggregated Finish Coat

****

NOTE: Specify aggregated white coat where a smooth trowel finish is required over perlite or vermiculite base coats. Do not use smooth trowel finish over lightweight aggregate base coat or metal lath.

****

Finish coat must consist of the lime-putty, gypsum-gauged finish specified herein with the addition of fine pulverized silica sand or perlite fines in the following proportions:

a. 14 liter per 45 kg 1/2 cu ft per 100 lb bag of gypsum gauging plaster used in finish, or

b. 3.5 liter per 22.5 kg 1/8 cu ft per 50 lb bag of hydrated lime, or

c. 3.8 liter per 7.5 liter 1 gal per cu ft of lime-putty.

2.7.2.4 Gypsum Sand Float Finish[for [_____]]

****

NOTE: Do not use this type finish in bathrooms, kitchens, and other similar places requiring a constant cleaning cycle.

****

Mix finish in the proportion of one part neat unfibered gypsum plaster to not more than two parts of sand, by weight.

2.7.2.5 Keene's Cement Lime-Putty Finish[for [_____]]

****

NOTE: Do not use Keene's cement as finish coat over a portland cement plaster base coat, or on monolithic concrete, due to the probability of unsatisfactory bond between the materials. Not recommended over lightweight aggregate base coats.

****

Mix finish in the proportion of not more than 45 kg 100 lb of lime putty to 45 kg 100 lb of Keene's cement.

2.7.2.6 High Strength Gypsum-Gauged Plaster Finish[for [_____]]

****
NOTE: Specify high-strength gypsum-gauged finish plaster where surface hardness and resistance to abrasion are required. Not recommended over lightweight aggregate base coats.
****

Mix finish in the proportion of 90 kg 200 lb of high strength gauging to 45 kg 100 lb of hydrated lime.

2.7.2.7 Acoustical Plaster Finish[for [_____]]

Mix finish in accordance with manufacturer's printed instructions.

2.8 MIXING

2.8.1 Job-Mixed Materials

Mix materials in mechanical mixers except finish coats containing lime may be hand mixed. Mechanical mixers must be an approved type that accurately and uniformly controls the quantity of water. When mixing by hand, mix dry plaster aggregate to a uniform color in the mixing box, add water, and hoe the plaster immediately into the water and mix thoroughly to a proper consistency.

2.8.1.1 Water

Water used for rinsing and cleaning containers and tools must not be used in mixing the materials.

2.8.1.2 Sand

Sand proportions must be damp and in loose condition. A volume of damp loose sand must contain a minimum of 36 kg 80 lb of dry sand in 0.0283 cu m 1 cu ft.

2.8.1.3 Mixing (Do's)

Mix the material while the mixer is in continuous operation in the following sequence:

a. Add maximum close to 90 percent of estimated quantity of water.

b. Add approximately one-half of the sand. If vermiculite or perlite is used, add all the aggregate.

c. Add cement and approved admixtures.[Add lime prior to cement.]

d. Add remainder of sand.

e. Mix with remainder of water as required. Mix until the mixture is uniform in color and consistency.

2.8.1.4 Mixing (Don'ts)

Avoid excessive mixing and agitation. Discard gypsum plaster which has begun to set before it is used; do not permit retempering. Do not use frozen, caked, or lumped materials. Empty mixers and mixing boxes after each batch is mixed, and keep free of old plaster.

2.8.2 Ready-Mixed Packaged Materials

Mix ready-mixed packaged gypsum plaster in accordance with manufacturer's printed mixing instructions.

2.9 BONDING AGENT

****

NOTE: Bonding agents may be surface applied or integrally mixed with the plaster. Use Integral bonding agents only after review of the manufacturer's documentation of testing and past performance. Check compatibility of the bonding agent with the plaster mixtures. Bonding admixtures increase the potential for shrinkage of the plaster.

****

ASTM C631, interior application.

2.10 LATH AND ACCESSORIES

Coordinate work of this section with lath and accessories required in Section 09 22 36 LATH assuring that materials are fully integrated and thickness of plaster coats correspond to lath and accessory positions, depths, profiles, and manufacturers' installation instructions.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Clean surfaces before application of gypsum plaster of projections, dust, loose particles, grease, bond breakers, and foreign matter. Do not apply plaster directly to surfaces (1) of masonry or concrete that have been coated with bituminous compound or other waterproofing agents, or (2) that have been painted or previously plastered. Before plaster work is started, wet masonry and concrete surfaces thoroughly with a fine fog spray of clean water to produce a uniformly moist condition. Check metal grounds, corner beads, screeds, and other accessories carefully for alignment before starting work. Do not apply gypsum plaster to surfaces containing frost.

3.2 WORKMANSHIP

3.2.1 Slump Tests

Apply Plaster by hand or machine. When a plastering machine is used, control the fluidity of gypsum plaster to have a slump of not more than 75 mm 3 inch when tested using a 50 by 100 by 150 mm 2 by 4 by 6 inch high slump cone. Subsequent to determining water content to meet the specified slump, do not add additional water to the mix. Conduct the slump test according to the following procedure:

a. Place cone on level, dry, non-absorptive base plate.

b. While holding cone firmly against base plate, fill cone with plaster taken directly from the hose or nozzle of the plastering machine, tamping with metal rod during filling to release air bubbles.

c. Screed off plaster level with top of cone. Remove cone by lifting it straight up with a slow and smooth motion.

d. Place cone in a vertical position adjacent to freed plaster sample, using care not to shake or move base plate.

e. Lay a straightedge across top of cone, being careful not to shake or move cone. Measure slump in mm inch from the bottom edge of the straightedge to the top of the slumped plaster sample.

3.2.2 Application

Apply gypsum plaster in three coats, except as follows:

Gypsum plaster applied to[masonry][and][gypsum lath] using the two-coat double-up method.

Apply base coats with sufficient pressure and ensure plaster is sufficiently plastic to provide a strong bond to bases. Work base coats into screeds at intervals from 1500 to 2400 mm 5 to 8 ft. Plaster must not be continuous across expansion and control joints occurring in walls, partitions, and ceilings. Finish work level, plumb, square, and true, within a tolerance of 3 mm in 2400 mm 1/8 inch in 8 ft, without waves, cracks, blisters, pits, crazing, discoloration, projections, or other imperfections. Form plaster work carefully around angles and contours, and well-up to screeds. Take special care to prevent sagging and consequent dropping of applications. There must be no visible junction marks in finish coat where one day's work adjoins another.[Plastered surfaces to receive[rubber or vinyl base coves][wood base boards] must extend to wood ground indicated as backing for base.] Plaster not required behind built-in cabinets and equipment[, and [_____]] unless part of a fire-rated assembly.

3.2.3 Control And Expansion Joints

[Install control joints at locations indicated before applying gypsum plaster. Vertical joints must be continuous and butt horizontal joints against the vertical joints.]Check expansion, control joints and accessories to ensure unrestrained movement, metal lath not continuous behind the joints, and area between joints do not exceed 14 sq m 150 sq ft.

3.2.4 Curing

3.2.4.1 Gypsum Plaster

Before the plaster has set, provide environmental controls to prevent the plaster from drying too fast. After the plaster has set, provide for rapid drying to develop high strength.

3.3 GYPSUM PLASTER WORK

****

NOTE: Gypsum basecoat plaster may be by one of two methods for a three-coat or two-coat (double back) systems. The three-coat plaster system will require a basecoat of a scratch coat, cross raked, partial drying, and a brown coat. The two-coat plaster

system requires a scratch coat and a brown coat that is applied (double back) within a few minutes to the unset (moist) scratch coat. The cross raking of the scratch coat is omitted in the double back system.

****

****

NOTE: Consider requiring a slope to potentially level surfaces of plaster at bathrooms, kitchens, and other similar type places, which require a constant cleaning cycle.

****

ASTM C842.

3.3.1 Gypsum Plaster Thickness Requirements

Plaster thicknesses are from face of metal lath plaster base (scratch coat) or solid base surfaces.

a. Vertical Surfaces

Base Types	Base Coat	Finish Coat	Total Thickness
Metal Lath	13 mm 1/2 inch	3 mm 1/8 inch	16 mm 5/8 inch
Masonry	13 mm 1/2 inch	3 mm 1/8 inch	16 mm 5/8 inch
Concrete	13 mm 1/2 inch	3 mm 1/8 inch	16 mm 5/8 inch
Other Bases	10 mm 3/8 inch	3 mm 1/8 inch	13 mm 1/2 inch

b. Horizontal Surfaces. Total plaster thickness for metal lath plaster, masonry and concrete bases is 16 mm 5/8 inch. Total thickness of plaster for horizontal concrete surfaces is 3 to 10 mm 1/8 to 3/8 inch.

c. Where vertical and horizontal concrete surfaces require more than 16 mm 5/8 inch and 10 mm 3/8 inch, to produce required lines or surfaces,[attach metal plaster base for plaster application][as indicated].

3.3.2 Gypsum Plaster Basecoat Work

3.3.2.1 Gypsum Two-Coat System

Apply the first coat to cover the base with sufficient material and pressure to form a good bond on the wall or ceiling base. Before the first coat has set and without scratching or cracking the surface, apply a second coat (double back) of the same material proportion as the base coat to the screeds. Straighten to a true surface without application of water, and cross rake or scratch to receive the finish coat.

3.3.2.2 Gypsum Three-Coat System

Apply scratch coat 5 to 6 mm 3/16 to 1/4 inch thick to cover the base with sufficient material and pressure to form a good bond on the wall or ceiling base. Rake or scratch the surface and allow to set firm and hard. Apply the brown coat to bring the base coat out to the screeds, compact and straighten to a true surface without the application of water, and cross rake or scratch to receive the finish coat.

3.3.3 Gypsum Plaster Finish Coats

****

NOTE: Do not specify rough textured finishes bathrooms, kitchens, and other similar type places, which require a constant cleaning cycle.

****

****

NOTE: There are six gypsum finish coat plasters, each with a specific function:

Smooth Finishes: Gypsum-lime putty trowel finish; Keene's cement-lime putty trowel finish; Prepared gypsum trowel finish

Float Finishes: Keene's cement-lime sand float finish; Gypsum-sand float finish

Acoustical Plaster Finishes

****

Moderately moisten or fog spray base coat of plaster that has become dry before finish coat is applied. Accelerate plaster, if necessary, to provide a setting time of not more than 4 hours from the time the plaster is mixed.

3.3.3.1 Lime-Putty and Gypsum-Gauged Finish Coats

Apply lime-putty gypsum-gauged finish white coat or aggregated white coat[and high strength gypsum gauged finish] over the base coat, scratch in thoroughly, lay on well, double back, and fill out to a true, even surface. Allow the finish to dry a few minutes, then trowel well with water. Apply maximum pressure in order to compact the finish coat and provide a smooth finish free from blemishes and irregularities. Apply trowel finish coats of gypsum-gauged lime-putty over properly prepared base coats as thin as possible and 2 to 3 mm 1/16 to 1/8 inch thick for conventional plaster system, except as necessary in spots to level out hollows in base coat.

3.3.3.2 Keene's Cement Lime-Putty Finish Coat

****

NOTE: Do not use Keene's cement as finish coat over a portland cement plaster basecoat, or on monolithic concrete, due to the probability of unsatisfactory bond between gypsum and portland cement materials.

****

Apply finish over gypsum-sand base coat only, scratch in thoroughly, lay on well, double back, and fill out to a true, even surface. Allow the finish to dry a few minutes, then trowel it well with water. Apply maximum pressure in order to compact the finish coat and provide a smooth finish free of blemishes and irregularities. Continue troweling until the finish sets.

3.3.3.3 Gypsum Sand Float Finish Coat

****
NOTE: Specify type of float required to produce the texture desired.
****

Apply finish over the base coat, scratch in thoroughly, lay on with a trowel to an even surface, and then float with [_____] floats to a true, even surface, free of slick spots or other blemishes. Apply sand float finishes to a maximum thickness of 3 mm 1/8 inch except as necessary to level out hollow spots.

3.3.3.4 Acoustical Plaster Finish Coat

Apply finish in accordance with manufacturer's printed instructions and in the thickness necessary to provide the sound absorption coefficient specified, but not be less than 13 mm 1/2 inch thick.

3.4 ORNAMENTAL PLASTER WORK

Complete ornamental work before the finish coat of plaster is applied to adjoining areas. Plaster for ornamental work must consist of a mixture that will produce satisfactory results for the respective conditions, be reinforced properly with fiber or zinc-coated steel wire netting as necessary to provide permanent construction, and be rigidly secured in place. Run plain moldings in place to templates and guides, with true radial lines for curved work; where it is not practicable to run such moldings, cast or run them on a bench and then secure in place firmly. Cornices and moldings must be straight or curved, true to line, and corners neat.

3.5 PATCHING AND POINTING

Cut out and patch loose, cracked, damaged, or defective gypsum plaster. Patch must match existing work in texture, color and finish flush with previously applied gypsum plaster surfaces. Point work abutting or adjoining finish work in a neat manner. Remove droppings or spatterings from surfaces. Leave clean and in a condition to receive paint or other finish. Remove protective covering from floors and other surfaces, and rubbish and debris from[the interior and exterior of] the building.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 23 82 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-09 23 82 (May 2010)
UFGS-09 23 82.00 40 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 23 82

FIREPROOF GYPSUM PLASTERING

11/19

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 23 82 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-09 23 82 (May 2010)
UFGS-09 23 82.00 40 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 09 23 82

FIREPROOF GYPSUM PLASTERING
11/19

****
NOTE: This guide specification covers the requirements for fire protection applications of specified plaster bases.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: Associated work found in other sections includes metal framing, furring systems, and metal lath, and standard gypsum plastering applications. Show areas and location of application and installation details on drawings.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in

this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E605	(1993; R 2011) Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM E736	(2000; R 2011) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E761/E761M	(1992; R 2023) Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Meetings

Within [30] [_____] days of Contract Award, the Contracting Officer will schedule [a] Pre-Installation meeting[s]. Submit the following for review and approval at the Pre-Installation meeting:

a. Installation Drawings

b. Manufacturer's Catalog Data

c. Fireproofing Plaster Sample

d. Certificates of Conformance

[e. Special Provisions

]1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings[; G, [_____]]

SD-03 Product Data

Manufacturer's Catalog Data[; G, [_____]]

SD-04 Samples

Fireproofing Plaster Sample[; G, [_____]]

Mockups[; G, [_____]]

SD-07 Certificates

Certificates of Conformance[; G, [_____]]

SD-08 Manufacturer's Instructions

Manufacturer's Instructions[; G, [_____]]

Special Provisions[; G, [_____]]

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials in original unopened packages bearing the name of the product, manufacturer's name, and the Underwriters Laboratories, Inc. label.

Store materials off the ground, under cover, and away from damp surfaces and keep dry until ready to use. Discard all materials that have been exposed to water before use.

1.5 QUALITY CONTROL

1.5.1 Catalog Data

Submit manufacturer's catalog data for fireproof plaster showing applicable flame spread classification, fuel contribution, and smoke developed.

1.5.2 Plaster Sample

Submit no less than 0.2 kilogram 1/2 pound of Fireproofing Plaster Sample for review and approval.

1.5.3 Drawing Requirements

Submit installation drawings indicating the fireproof plaster, framing and furring as indicated and specified. Ensure components of the installation drawings meet the requirements of indicated and specified fireproofing.

****

NOTE: Coordinate with drawings for the appropriate hour rating assembly.

****

1.5.4 Four Hour Fire Rated Construction

Prior to the commencement of work, submit certificates of conformance for fireproof plaster showing conformance with the ICC IBC, "International Building Code", "Requirements for Four-Hour Construction". Submit manufacturer's instructions for Fireproof Plaster[including special provisions required to install equipment components and system packages]. Indicate all detail impedances, hazards and safety precautions on drawings.

[1.5.5 Mockups

Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

]PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Fireproof Plaster

Provide gypsum-vermiculite fireproof plaster mix, consisting of one part gypsum to two parts vermiculite, conforming to ICC IBC, "Requirements for 4-Hour Construction".

Ensure cohesion of the dry set material is such that the fireproofing coat will not crack or delaminate when the structural [steel]element is subjected to a downward deflection of 1/120 of the span, and the minimum compressive strength requirement in accordance with ASTM E761/E761M is not less than 485 kilopascal 70 pounds per square inch.

Provide set and dried material, which when tested in accordance with ASTM E84, yields the following characteristics:

a.	Flame spread	10
b.	Fuel contributed	5
c.	Smoke developed	0

2.1.2 Water

Use only potable water for mixing.

PART 3 EXECUTION

3.1 INSTALLATION

Apply fireproofing plaster as specified to those areas indicated on drawings. Install per details as indicated on drawings.

3.1.1 Application

Provide [pneumatic] [or] [and] [trowelled] application of fireproofing plaster in accordance with material manufacturer's written recommendations and ASTM E736. Provide thickness of application as indicated and in compliance with ASTM E605 and the applicable fire and local codes to provide rated fireproofing when tested in accordance with ASTM E119.

Provide framing and furring that meets the requirements of [09 22 00][09 22 36], and [as recommended by manufacturer for the installation of the fireproofing plaster thickness required][as indicated in the drawings].

3.2 ADJUSTING AND CLEANING

After completion of fireproofing work, remove all application equipment. Clean all areas of ceilings, walls, and floors, adjacent or exposed to the operations of application of the fireproofing material, and other surfaces and finishes that may have been soiled by fireproofing materials.

Remove any damaged or unacceptable portions of the fireproofing plaster and replace with new work at no additional cost to the Government.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-09 24 23 (August 2017)**
Change 2 - 11/18

Preparing Activity: USACE **Superseding**
UFGS-09 24 23 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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08/17, CHG 2: 11/18

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-09 24 23 (August 2017)**
Change 2 - 11/18

Preparing Activity: USACE | **Superseding**
UFGS-09 24 23 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 09 24 23

CEMENT STUCCO

08/17, CHG 2: 11/18

****

NOTE: This section covers requirements for stucco, including associated framing and lathing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A489	(2018; E 2018) Standard Specification for Carbon Steel Eyebolts
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C206	(2014; R 2022) Standard Specification for Finishing Hydrated Lime
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM C841	(2023) Installation of Interior Lathing and Furring
ASTM C847	(2018; R 2024) Standard Specification for Metal Lath
ASTM C897	(2015; R 2020) Aggregate for Job-Mixed

	Portland Cement-Based Plasters
ASTM C926	(2024) Standard Specification for Application of Portland Cement-Based Plaster
ASTM C933	(2014) Welded Wire Lath
ASTM C1032	(2014) Standard Specification for Woven Wire Plaster Base
ASTM C1063	(2024) Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lath

SD-03 Product Data

Proportions and Mixing

[Recycled percentage of fly ash in Portland cement; S]

[Recycled Content for steel framing; S]

[Recycled Content for metal lath; S]

SD-04 Samples

Colored Stucco Finish Coat

Sample Panel; G, [_____]

1.3 QUALITY ASSURANCE

Submit a SAMPLE PANEL as follows: [One 300 mm 12 inch square stucco panel showing finish texture and color and exposed reinforcement at the edges, one 300 mm 12 inch square of reinforcement, and a 300 mm 12 inch length of each accessory proposed, prior to proceeding with stucco work.] [A sample panel of stucco, constructed at the jobsite, and located as directed, to demonstrate installation procedures, texture and color, prior to proceeding with any stucco work; panel size must be a minimum of 1200 mm wide x 2400 mm 4 feet wide x 8 feet high; containing each type accessory proposed for use and constructed in the vertical position. Sample panel must have exposed reinforcement at the edges. Each phase of installation such as framing, scratch coat, brown coat, finish coat and curing procedures must be demonstrated in the construction of the panel. Submit one 300 mm 12 inch square of reinforcement and one 300 mm 12 inch length of each accessory proposed for use, prior to constructing the sample panel.]

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials to the site in the original packages and containers with labels intact and seals unbroken. Keep cementitious materials dry and stored off the ground, under cover and away from damp surfaces until ready to be used. Aggregate must be covered to prevent the absorption or loss of moisture.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not apply stucco when the ambient temperature is 4 degrees C 40 degrees F or lower, or when a drop in temperature below 4 degrees C 40 degrees F is expected within 48 hours after application.

PART 2 PRODUCTS

2.1 PORTLAND CEMENT

****

NOTE: Where colored or white stucco finish is required, the gray Portland cement will be omitted. Select type of cement to provide the required characteristics. Type I cement should normally be specified when stucco requires no special characteristics. Type II cement should be specified when stucco will be exposed to moderate sulphate (alkali) action. Type III cement should be specified when high early strength is needed.

Use materials with recycled content where appropriate for use. Verify sustainability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Consider specifying fly ash as recycled materials; however, where white stucco finish is required, the requirement for fly ash will be omitted. In no case should the installation contractor use more than 40% fly ash as strength will be compromised. Research shows fly ash is commonly available from recycling operations. The designer of record needs to confirm local/regional availability and cost effectiveness.

Research shows there are other recycled materials that may be considered in lieu of, or in addition to, fly ash. According to ASTM C 595, ground granulated blast furnace slag (GGBF slag) may replace up to 50 percent of the cementitious material on a dry weight basis. Cenospheres may replace up to 10 percent of the cementitious material by volume. And silica fume may replace up to 10 percent of the cementitious material on a dry weight basis.

A Portland cement-lime mix is corrosive to metal lath in high humidity/ salt intensive areas. For high humidity areas or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, to reduce plaster and stucco cracking, delete the lime base and substitute a liquid plasticizing agent with a resin compound as the principal ingredient. The result produces a material with greater resistance to most climatic effects and minimizes structure related cracking. Humid project locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

If surface is to be painted, do not use coral aggregate in the plaster system. If no option is

available, use sodium silicate system for stabilization.
****

Portland cement must conform to ASTM C150/C150M, [gray Portland cement Type [I] [II] [III].] [white Portland cement, Type [I] [II] [III].] [Provide system that has a minimum of 15% and maximum 40% fly ash. Provide data from installation contractor identifying recycled percentage of fly ash in Portland cement.]

2.2 COLORED STUCCO FINISH COAT

Colored stucco finish coat must be a mill mixed product using white Portland cement and requiring only the addition of and mixing with water for application. Color must be [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____]. Submit samples including both a fabricated portion of unit of work and color samples.

2.3 LIME

Lime must conform to ASTM C206, Type S.

2.4 SAND

Sand aggregate for job-mixed base coat and job-mixed finish coat stucco must conform to ASTM C897.

2.5 ACCESSORIES

****
NOTE: Custom aluminum radiuses, and custom miters and intersections with welded corners or taped backs are available. Aluminum shapes with clear anodized, color anodized, or baked enamel finishes may be used where required for aesthetic purposes. Aluminum shapes are more costly than standard steel or PVC shapes.

In areas of high humidity or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, use PVC or vinyl as galvanized metal will rust over time. Humid project locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.
****

Accessories must be [roll formed galvanized steel,][or] [rigid polyvinyl chloride (PVC)] [_____], except that cornerite and striplath must be formed from steel sheets with manufacturer's standard galvanized coating. Vinyl members must be in accordance with ASTM D1784. Welded wire corner reinforcements must be zinc coated, galvanized 1.4 mm 17 gauge steel wire conforming to ASTM A1064/A1064M. Furring must include hangers, bolts, inserts, clips, fastenings, and attachments of number, size, and design to develop the full strength of the members.

2.6 STEEL FRAMING

****

NOTE: Stud sizes and framing dimensions and details will be indicated on the drawings. Framing will be designed for a maximum deflection of L/240 studs only assembly or a maximum deflection of L/360 for completed assembly, based on wind load design requirements in UFC 3-301-01.

****

Steel framing must be as shown and must be manufacturer's standard products with shop applied protective coating. Refer to Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD.

Provide steel framing containing a minimum of 20 percent recycled content, as calculated by the sum of the percentage of post-consumer and ½ the percentage of pre-consumer recycled steel content. Provide data identifying percentage of recycled content for steel framing.

2.7 METAL LATH

Metal lath must conform to ASTM C847, types and weights in accordance with the various spacing shown in ASTM C841. Lath for vertical application on steel and wood framing supports must be expanded metal or welded or woven wire and must have paper backing with a minimum vapor permeance of 287.2 ng per Pa per second per square meter 5 perms. Woven wire lath must be a maximum 38 x 38 mm 1-1/2 x 1-1/2 inch mesh wire of not less than 1.37 mm 0.0540 inch nominal diameter and must conform to ASTM C1032. Welded wire lath must conform to ASTM C933, with openings not to exceed 50 x 50 mm 2 x 2 inches. Expanded metal or wire lath must be fabricated in a manner to provide not less than 6 mm 1/4 inch keying between wire and paper backing and keying must be obtained by a uniform series of slots in a perforated face paper woven between the wires.

Provide Metal Lath containing a minimum of 20 percent recycled content, as calculated by the sum of the percentage of post-consumer and ½ the percentage of pre-consumer recycled steel content. Provide data identifying percentage of recycled content for metal lath.

2.8 WATER

Provide clean, fresh, potable water, free from amounts of oils, acids, alkalis and organic matter that would be injurious to the stucco.

2.9 HANGERS

****

NOTE: Construction drawings should include a detail drawing showing splayed and countersplayed suspension system hanger wires.

In high humidity areas or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, use corrosion resistant materials (stainless steel or copper-bearing alloys) for suspension components. Humid project locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Provide hangers and attachment capable of supporting a minimum 1330 N 300 pound ultimate vertical load without failure of supporting material or attachment.

2.9.1 Wires

****

NOTE: Select stainless steel or nickel copper alloy wire for facilities where high humidity can be expected such as large kitchens, dishwashing areas, and indoor swimming pools. Select zinc-coated steel wire for other locations.

When spacing of hanger wires exceeds 1200 mm 4 feet or when heavy loads are supported, specify 3.4 or 4.1 mm 8 or 10 gage wire.

Use stainless steel wires in areas of high humidity.

****

Conform wires to [ASTM A641/A641M, Class 1, [2.0] [_____] mm [0.08 inch (12 gauge)] [[_____] inch] in diameter.][ASTM A580/A580M, composition 302 or 304, condition annealed stainless steel, [2.0] [_____] mm [0.08 inch (12 gauge)] [[_____] inch] in diameter.]

****

NOTE: Normally wire hangers should be used, as specified above. If the project is in an area subject to violent storms, specify steel strap or rod hangers as included in the following sub-paragraphs.

****

[2.9.2 Straps

Provide straps of 25 by 5 mm 1 by 3/16 inch galvanized steel conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

][2.9.3 Rods

Provide 5 mm 3/16 inch diameter threaded steel rods, zinc or cadmium coated.

]2.9.4 Eyebolts

Provide eyebolts of weldless, forged-carbon-steel, with a straight-shank in accordance with ASTM A489. Eyebolt size must be a minimum [_____] [7] mm [1/4] inch, [zinc coated][cadmium plated].

2.9.5 Masonry Anchorage Devices

Comply with[ASTM C636/C636M][_____] for anchorage devices for [eyebolts] [machine screws][wood screws].

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.2 FRAMING

Framing must be installed as indicated.

3.3 CONTROL JOINTS

****

NOTE: Control joints will be shown on the drawings, dividing the stucco into areas of not more than 13 square meters 144 square feet with no dimension between control joints greater than 5.4 meters 18 feet. The length to width ratio of the area bounded by the control joints will not exceed 25 to 65 mm 1 to 2-1/2 inches.

****

Locate control joints [as indicated on the drawings][so that unbroken areas of stucco do not exceed 13 square meters 144 square feet with no dimension between control joints greater than 5.4 m 18 ft.] Install prefabricated control joint members prior to the application of the stucco. Clear control joints of all stucco within the control area after stucco application and prior to final stucco set.

3.4 LATH

****

NOTE: Drawings will clearly indicate where metal lath is required. Metal lath will be used over metal supports and wood supports. Metal reinforcement with water-resistant paper is recommended in all steel frame construction and suspended ceilings. The use of metal reinforcement over concrete and masonry will be in accordance with local practice based upon satisfactory experience. Paper backed lath may be applied to interior concrete and masonry when adequate and uniform bond cannot be obtained otherwise, and when the lath will be protected from moisture.

****

Install lath in accordance with ASTM C841 or ASTM C1063 except as otherwise specified. Metal and wire lath must be applied straight, without buckles and with joints staggered. End laps of metal lath must be not less than 25 mm 1 inch. When paper-backed lath is used, the paper must be split from the lath at all lap areas to provide a paper to paper and lath to lath lap. Horizontal joints must be shiplapped. Lath must be interrupted at all control joints. Submit drawings showing details of construction for reinforcement, furring, and grounds; including manufacturer's installation instructions for stucco materials, and locations where each mix and coating thickness will be used.

3.4.1 Steel and Wood Supports

Apply metal lath over vertical open or solid wood and steel backing frame construction only after sheathing and air barrier has been applied to the area to receive the stucco. Fasten lath every 200 mm 8 inches vertically and every 400 mm 16 inches horizontally; and where sheets of lath are lapped. Drive fasteners to hold both lapped edges securely in place.

3.4.2 On Concrete and Masonry

Fasten lath every 200 mm 8 inches vertically and every 400 mm 16 inches horizontally. Where wood supports adjoin masonry or concrete in the same direction, provide casing bead, control joints, or reinforcement as indicated.

3.4.3 Over Metal Lintels and Flashings

Lath over metal lintels must be extended vertically over the angles to a height of not less than 150 mm 6 inches and horizontally across the underside of the lintels and must be secured in an approved manner. Lath over metal flashings must lap the flashings not less than 50 mm 2 inches and must be extended vertically for a height of not less than 150 mm 6 inches.

3.4.4 Special Shapes, Profiles, and Contours

Special shapes, profiles, and contours must be formed with wood, metal or aluminum furring and reinforcing.

3.5 FURRING

Furring must be installed to true lines and surfaces and must be rigidly supported and secured in place.

3.6 PREPARATION OF SURFACES

Preparation of surfaces for application of stucco to solid bases such as stone, masonry or concrete must conform to the applicable requirements of ASTM C926.

3.7 PROPORTIONS AND MIXING

Proportions and mixing for job-mixed base coat and finish coat must conform to the applicable requirements of ASTM C926. Mixing of mill-mixed finish coat must be in accordance with the manufacturer's directions. Submit detailed description of the proposed job-mix proportions for base and finish coats; including identification of thickness of coats.

3.8 STUCCO APPLICATION

Stucco must be applied in three coats to a thickness of not less than 25 mm 1 inch as measured from the back plane of metal reinforcement, exclusive of ribs or dimples or from the face of solid backing or support, with or without metal reinforcement, to the finished stucco surface, including moderate texture variations. Stucco application must conform to the applicable requirements of ASTM C926 and the following:

3.8.1 Workmanship

Items or features of the work in connection with or adjoining the stucco must be in place, plumb, straight, and true prior to beginning the stucco work. Metal and wire lath, where required, must be in place and positioned to provide a good key at back of lath. Where lath is applied over copper, the copper must be given a heavy coat of bituminous paint. Masonry surfaces to receive stucco must be evenly dampened immediately prior to application of stucco. Each stucco coat must be applied continuously in one general direction, without allowing mortar to dry at edges. Where it is impossible to work the full dimension of a wall surface in a continuous operation, jointing must be made at a break, opening, or other natural division of the surface. Edges to be joined must be dampened slightly to produce a smooth confluence. Exterior corners of stucco must be slightly rounded. Stucco on soffit surfaces must be pitched forward to form a drip.

3.8.2 Scratch Coat

Apply scratch coat not less than 10 mm 3/8 inch thick under sufficient pressure to form good keys and to completely embed the reinforcement. Before the scratch coat has set, it must be lightly scratched in one direction and vertical surfaces must be scratched in the horizontal direction only. The scratch coat must be fog cured for a minimum of 72 hours.

3.8.3 Brown Coat

Evenly dampen the scratch coat to obtain uniform suction before the brown coat is applied. There must be no visible water on the surface when the brown coat is applied. The brown coat must be applied to the scratch coat with sufficient pressure to force the stucco into the scratches and must be brought to a plumb, true, even plane with rod or straightedge. When set sufficiently, the brown coat must be uniformly floated with a dry float to promote densification of the coat and to provide a surface receptive to bonding of the finish coat. Brown coat must be fog cured for a minimum of 72 hours.

3.8.4 Finish Coat

Dampen surfaces of the brown coat not more than 1 hour before the finish coat is to be applied to a uniform wetness with no free-standing water on the surface. The finish coat must have a [smooth trowel] [float] [trowel-textured] [rough-textured] [spray-textured] [exposed aggregate] finish and must conform to the approved sample. Fog cure the finish coat for a minimum of 48 hours. Take care to prevent staining.

3.8.5 Surface Tolerance

When a 3 m 10 foot straightedge is placed at any location on the finished surface of the stucco, excluding rough-textured finish, the surface must not vary more than 3 mm 1/8 inch from the straightedge.

3.9 CURING AND PROTECTION

Perform fog curing by applying a fine mist of water to the stucco. Exercise care during fog curing to avoid erosion damage of the stucco surfaces. Do not use a solid stream of water. Fog not less than three times daily. Protect the stucco from the direct rays of the sun during severe drying conditions using canvas, cloth or other approved sheet material.

3.10 PATCHING AND POINTING

Replace or patch loose, cracked, damaged or defective work as directed. Patching must match existing work in texture and color and must be finished flush.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 26 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 26 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-09 26 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 26 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 09 26 00

VENEER PLASTER
08/24

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NOTE: This guide specification covers the requirements for veneer plaster systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Veneer plaster consists of a 2 to 3 mm 1/16 to 1/8 inch thick plaster coating applied in one or more coats to a special gypsum lath base over metal or wood framing. Veneer plaster provides a hard, dense finish for areas such as corridors and conference rooms of major facilities where walls are subjected to frequent impact and where appearance is important. It should not be used in shower rooms or excessively humid areas.

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****

NOTE: On the drawings, indicate location and extent of each type of veneer plaster and control joints.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C472	(2020) Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete
ASTM C475/C475M	(2017; R 2022) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C587	(2024) Gypsum Veneer Plaster
ASTM C631	(2009; R 2020) Bonding Compounds for Interior Gypsum Plastering
ASTM C645	(2024) Standard Specification for Nonstructural Steel Framing Members
ASTM C754	(2020) Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C843	(2023) Standard Specification for Application of Gypsum Veneer Plaster
ASTM C844	(2015; R 2021; E 2021) Standard Specification for Application of Gypsum

	Base to Receive Gypsum Veneer Plaster
ASTM C954	(2022) Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM C1002	(2022) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C1047	(2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C1396/C1396M	(2024) Standard Specification for Gypsum Board
ASTM C1629/C1629M	(2023) Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels
ASTM C1658/C1658M	(2019; E 2020) Standard Specification for Glass Mat Gypsum Panels
ASTM D3273	(2021) Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
ASTM D3678	(2019) Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Interior-Profile Extrusions
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

UL SOLUTIONS (UL)

UL Fire Resistance	(2014) Fire Resistance Directory

1.2 GENERAL REQUIREMENTS

****

NOTE: Select either the one- or two-coat system. The one-coat is slightly lower in cost, requires less installation time, and requires only one plastering material on the job. The two-coat system has greater crack resistance and is more resistant

to damage. The one-coat system should be used where appearance is the sole consideration. The two coat system should be used where physical abuse is a consideration.

****

Except where otherwise indicated or specified, conform to ASTM C754, ASTM C843, and ASTM C844. Apply the gypsum veneer plaster as a[one-coat][two-coat] system over a special gypsum base. The veneer plaster, gypsum base, and joint reinforcement must be products of the same manufacturer. The extent and location of veneer plaster must be as shown on the drawings. Metal framing is specified herein.[Wood framing specified in Section 06 10 00 ROUGH CARPENTRY may be used as an option to the steel framing.]

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Gypsum Base

Gypsum Veneer Plaster

[Recycled Content for Steel Framing or Furring; S

] SD-08 Manufacturer's Instructions

Installation Instructions

1.4 DELIVERY AND STORAGE

Deliver and store plaster materials in the manufacturer's original unopened containers. Store materials off the ground within a completely enclosed structure or enclosed within a weathertight covering. Store gypsum base and gypsum backing board flat to prevent warping and protect from excessive exposure to sunlight. Keep materials wrapped and separate from off-gassing materials, such as paint and adhesives. Do not use materials that have visible moisture or biological growth.

1.5 SCHEDULING

Commence application only after the area scheduled for veneer plaster work is completely weathertight. The heating, ventilating, and air-conditioning systems must be complete and in operation prior to application of the plaster. If the mechanical system cannot be activated before veneer plastering is begun, the plastering may proceed in accordance with an approved plan to maintain the environmental conditions specified below. Apply plaster prior to the installation of finish flooring and acoustic ceiling.

1.6 ENVIRONMENTAL REQUIREMENTS

****

NOTE: Veneer plaster is a very thin coating that will be adversely affected by extreme or non-uniform drying conditions and by rapid changes in temperature. It should not be used in spaces where adequate environmental control cannot be obtained.

****

Do not expose the gypsum base to excessive sunlight prior to plaster application, as bond failure of the plaster may result. Maintain a continuous uniform temperature of not less than 12.8 degrees C 55 degrees F and not more than 27 degrees C 80 degrees F for at least one week prior to the application of veneer plaster, while the plastering is being done, and for at least one week after the plaster is set. Shield air supply and distribution devices to prevent any uneven flow of air across the plastered surfaces. Provide ventilation to exhaust moist air to the outside during plaster application, set, and until plaster is dry. In glazed areas, keep windows open top and bottom or side to side 75 to 100 mm 3 to 4 inches. Openings can be reduced in cold weather. For enclosed areas lacking natural ventilation, provide temporary mechanical means for ventilation. In unglazed areas subjected to hot, dry winds or temperature differentials from day to night of 10 degrees C 20 degrees F or more, screen openings with cheesecloth or similar materials. Avoid rapid drying. During periods of low indoor humidity, provide minimum air circulation following plastering and until plaster is dry.

[1.7 FIRE RESISTIVE CONSTRUCTION

****

NOTE: For fire-resistive assemblies, drawing details must follow the tested and approved designs. The addition of veneer plaster to an approved gypsum wallboard design will improve the fire-resistive properties of the partitions. Tested and approved designs are published by gypsum wallboard manufacturers, Underwriters Laboratory, and Factory Mutual, and are included in the Gypsum Association Fire Resistance Design Manual.

****

Comply with specified fire-rated assemblies for design numbers indicated per UL Fire Resistance or FM APP GUIDE.

]PART 2 PRODUCTS

2.1 MATERIALS

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NOTE: The designer must assure that the drawings show the required thickness for gypsum base and gypsum backing board for all application.

****

****

NOTE: Venetian plaster finishing methods rely on multiple thin applications of plaster that are then burnished providing an artisanal appearance. This process requires special training and the results are often intended to match stone or existing finishes. If using venetian plaster, include requirements for mockups and certification and experience level of applicators. Include any necessary special controls such as environmental controls and protection of the completed work.

****

Conform to the requirements specified below. Miscellaneous items not otherwise specified must be as recommended by the veneer plaster system manufacturer and approved prior to use. Powder driven fasteners may be used only when approved in writing. Submit manufacturer's installation instructions for the materials listed below.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available from US national manufacturers above the minimum recycled content shown.

****

2.1.1 Steel Framing, Furring, and Related Items

ASTM C645.[Provide steel framing, furring, and related items that contain a minimum of 25 percent recycled content. Provide data identifying percentage of recycled content for steel framing or furring.]

2.1.2 Vapor Retarder

Foil-backed gypsum base or gypsum backing board, or 4-mil polyethylene.

2.1.3 Gypsum Backing Board

ASTM C1396/C1396M,[Regular [12.7][15.9] mm [1/2][5/8] inch][Foil-backed][Water-Resistant][Mold-Resistant score of 10 per ASTM D3273][Abuse-Resistant per ASTM C1629/C1629M][Glass-Mat per ASTM C1658/C1658M][Type X 15.9 mm 5/8 inch]. Provide boards with square edges as the first ply in two-ply application. Provide 1200 mm 48 inches wide boards, thickness as shown except that board used for liner panels and core plies of shaftwall construction must be the size and thickness recommended by the system manufacturer.

2.1.4 Gypsum Base

ASTM C1396/C1396M, non-combustible per ASTM E136,[Regular][Foil-backed][Type X], 1200 mm 48 inches wide, thickness as shown[, abuse-resistant per ASTM C1629/C1629M]. Provide square edges, rounded, or tapered as recommended by the veneer plaster manufacturer.

2.1.5 Gypsum Veneer Plaster

ASTM C587. Minimum compressive strength of finish coat plaster must be [17][20.4] MPa [2500][3000] psi as tested per ASTM C472.

2.1.6 Joint Reinforcement

ASTM C475/C475M, Mesh reinforcing strip or paper tape as recommended by the veneer plaster manufacturer.

2.1.7 Joint Compound

ASTM C475/C475M.

2.1.8 Screws

ASTM C1002 or ASTM C954, type appropriate to use.

2.1.9 Nails

ASTM C514, with corrosion-resistant treatment.

2.1.10 Corner Bead, Casing Bead, and Control Joints

ASTM C1047[or][ASTM D3678], Corrosion protective-coated steel[, vinyl or clear anodized aluminum] as recommended by the veneer plaster manufacturer. Provide flanges free of any material that would adversely affect bonding of the plaster.

PART 3 EXECUTION

3.1 STEEL FRAMING

****

NOTE: Since the veneer plaster is a thin, hard coating, it may be damaged by excessive deflection or racking of the partition. Partitions should be isolated from the structural building frame so that movement of the frame does not distort the partitions. Where heavy loads such as wall hung cabinets, counters or hospital TV sets are indicated, the partitions must be strengthened to support the applied loads.

****

ASTM C754. Space framing at 400 mm 16 inches on center maximum. Partitions must support applied loads such as cabinets and counters without exceeding the permitted deflection.

3.1.1 Partition Framing System

Metal non-load bearing framing and furring system must be capable of carrying a transverse load of 24 ksm 5 psf without exceeding either the allowable stress or a deflection of L/240. Provide studs of 0.45 mm 0.0179 inch minimum thickness for partitions having the same material and the same material thickness on both sides. For partitions using 0.45 mm 0.0l79 inch thick studs, the surfacing material must cover the full height of the partition on both sides, or the stud flange must be otherwise supported to insure rigidity. Provide studs of 0.84 mm 0.0329 inch minimum thickness for partitions having different materials or different material thickness on the two sides. At partition ends, corners, and intersections, and at jambs of openings, fasten studs to runners with screws.

3.1.2 Special Framing

Build framing for beams, columns, soffits, and other special items to the sizes, shapes, or forms indicated. Secure rigidly at each intersection with screws.

3.1.3 Shaftwall Framing System

Shaftwalls must be standard, tested designs. Metal framing must be in accordance with the shaftwall manufacturer's printed instructions.

3.1.4 Ceiling Openings

Provide support members at ceiling openings such as required for access panels, recessed light fixtures, and for air supply or exhaust. Locate support members of not less than 38 mm 1-1/2 inch main runner channels and suspension wires or straps to provide at least the minimum support specified herein for furring and wallboard attachment. Provide intermediate structural members for attachment or suspension of support members.

3.1.5 Wall Openings

At wall openings the framing system must provide for the installation and anchorage of the required subframes or finish frames. Attach steel frames securely through built-in anchors to the nearest stud on each side of the opening with wallboard screws. Provide 0.84 mm 0.329 inch minimum thickness double studs at both jambs of all doors openings. For doors over 1200 mm 4 feet wide, double doors, and for extra-heavy doors (such as x-ray doors), provide doubled studs [_____] millimeters inches minimum thickness. Spot grout door frames at the jamb anchor locations with joint compound applied just prior to application of gypsum base.

3.1.6 Blocking

Provide blocking when mounting equipment. Cut[metal][or][wood] blocking to fit in between the framing members. Rigidly anchor blocking to the framing members. Under no circumstances will accessories or other wall mounted equipment be anchored directly to the veneer plaster system.

3.2 APPLICATION OF GYPSUM BASE

Apply gypsum base and gypsum backing board to framing and furring members in accordance with ASTM C844 and the requirements specified herein. Gypsum wallboard may be used for the base ply in two-ply construction. Provide gypsum base and backing board of maximum practical length, using full length boards for vertical application. Install separate boards in moderate contact without forcing in place. Install boards tight against the framing so as to eliminate any offset in the face plane between adjoining boards. Stagger end joints of adjoining boards a minimum of 400 mm 16 inches. Fit abutting end and edge joints. Cut boards as required to make close joints around openings. Gypsum base may be adhered to gypsum backing board with an adhesive, except where prohibited by fire rating. In multi-layer construction, offset joints between layers. Offset joints on opposite faces of the partition.

3.2.1 Curved Surfaces

Use bending radii in accordance with ASTM C844, TABLE 5. Bend gypsum base into place without damaging the face paper. If the base is dampened to facilitate bending, dry thoroughly, and apply a bonding agent (ASTM C631) before plastering.

3.2.2 Cavity Shaftwall System

Install gypsum backing boards, core boards, and gypsum base in accordance with the shaftwall system manufacturer's printed recommendations to achieve the fire rating required.

3.2.3 Control Joints

****

NOTE: Control joint locations should be shown on the drawings. Control joint spacing in walls or wall furring must not exceed 9000 mm 30 feet. Control joint spacing must not exceed 9000 mm 30 feet in either direction in restrained ceilings, and 15000 mm 50 feet in either direction in ceilings with perimeter relief. Joints should be provided at the wings of L, U, and T shaped ceiling areas.

****

Control joints in ceilings and walls must be one piece manufactured products designed for use with a veneer plaster system.

3.2.4 Vapor Retarder

Install foil-backed gypsum base or gypsum backing board with the reflective surface against the framing members. Install polyethylene vapor retarder with joints over framing members, and with joints lapped the full width of the framing members.

3.3 JOINT REINFORCEMENT

Reinforce all interior angles and flat joints prior to application of the veneer plaster. Do not use self-adhering fiberglass mesh tape. Reinforcement must be a special mesh reinforcing strip embedded in veneer plaster, or paper gypsum wallboard tape embedded in joint compound.

3.3.1 Mesh Reinforcing

Embed the mesh reinforcing strip in veneer plaster so that embedment material is both under and covering the reinforcement. Allow areas of reinforcement to preset, and leave rough enough for proper bonding of the plaster coat. Reinforcement must be set, but not dry, before the application of veneer plaster.

3.3.2 Paper Tape Reinforcing

Press the paper tape into a bedding coat of setting type joint compound, and immediately cover with a skim coat of the same compound. After the bedding and skim coats are set, apply a fill coat of joint compound. Set the reinforcement and dry thoroughly before application of veneer plaster.

3.4 APPLICATION OF GYPSUM VENEER PLASTER

****

NOTE: Veneer plaster may be applied to masonry or concrete surfaces as well as to gypsum base. Special conditioning and treatment are required for masonry or concrete surfaces to receive veneer plaster. Review ASTM C843 and manufacturer's literature to determine requirements applicable to the project, and modify this section accordingly. Note that any cracking of the substrate will result in cracking of the plaster.

****

Apply gypsum veneer plaster in accordance with ASTM C843, and with the manufacturer's approved installation instructions where such instructions are additional to or more restrictive than the requirements of ASTM C843. Apply plaster as a[one-component][two-component] system. Minimum plaster thickness must be as recommended by the manufacturer, but must in no case be less than[1.6 mm 1/16 inch for one-component system.][1.6 mm 1/16 inch for base coat and 0.8 mm 1/32 inch for finish coat of a two-component system.]

3.4.1 Mixing

Clean mixer between batches to avoid accelerating the setting time. Do not add other plaster materials to modify the properties of the veneer plaster. When extreme conditions demand, small quantities of commercial retarder or accelerator may be added to the mixing water to adjust setting time. When used, the retarder or accelerator must conform to the veneer plaster manufacturer's recommendations.

3.4.2 Application

Trowel plaster on by hand. Apply with sufficient material and pressure to develop bond and to provide the specified component thickness.

3.4.2.1 Base Coat

****

NOTE: Delete base coat requirements when one-component system is desired.

****

Scratch in the base coat tightly, then immediately double back using material from the same batch. Fill all voids and imperfections and level the plaster to a true surface without the application of water. For good bond or adhesion, roughen the final surface for bond by brushing or cross-raking with a fine wire rake. For application of finish coat, set the base coat and partially dry. If the base coat is totally dry, dampen before finish coat application.

3.4.2.2 Finish Coat

****

NOTE: A smooth-troweled finish will normally be specified. If a textured finish is desired, it may be added to the specification. The texture pattern should be specified, i.e., swirl, skip trowel, etc. Some texture finishes may require a greater coating thickness.

****

Scratch in the finish coat tightly, then immediately double back using material from the same batch. After the plaster has been allowed to set up slightly, lightly trowel the surface without the addition of water, filling all voids and imperfections and eliminating surface irregularities. When the plaster has become firm and prior to set, smooth-trowel the surface using water sparingly. Avoid over troweling.

3.5 CLEANUP AND PATCHING

Remove plaster splashes from adjacent surfaces. Repair defects in the veneer plaster. Plaster surfaces must be smooth, clean, and in condition to receive the finishing materials that will be applied.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 29 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 29 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 29 00

GYPSUM BOARD

08/24

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 29 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 29 00 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 09 29 00

GYPSUM BOARD

08/24

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NOTE: This guide specification includes the requirements for gypsum board, cementitious backer units, and accessories intended for use in drywall construction.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

Reference Section 05 40 00 COLD-FORMED METAL FRAMING for load bearing studwork. Reference Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD for non-loadbearing studs, furring, and ceiling suspension systems.

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NOTE: On the drawings, show:

1. Locations of each type of gypsum board, backing board and cementitious backer units, using same terminology as in the specification.

2. Locations and UL or GA design numbers for fire rated gypsum board, and cementitious backer unit assemblies.

3. Locations of asphalt impregnated building felt if gypsum sheathing is used or if cementitious backer units are used in wet areas.

****

PART 1 GENERAL

1.1 REFERENCES

****

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AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108/A118/A136.1	(2024) American National Standard Specifications for the Installation of Ceramic Tile

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C475/C475M	(2017; R 2022) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board

ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C557	(2003; R 2017) Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing
ASTM C840	(2024) Standard Specification for Application and Finishing of Gypsum Board
ASTM C954	(2022) Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM C1002	(2022) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C1047	(2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C1063	(2024) Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster
ASTM C1177/C1177M	(2024) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C1178/C1178M	(2024) Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel
ASTM C1235	(2022) Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units
ASTM C1288	(2017) Standard Specification for Fiber-Cement Interior Substrate Sheets
ASTM C1396/C1396M	(2024) Standard Specification for Gypsum Board
ASTM C1629/C1629M	(2023) Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels
ASTM C1766	(2015; R2019) Standard Specification for Factory-Laminated Gypsum Panel Products
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D1037	(2012; R 2020) Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D1149	(2018) Standard Test Method for Rubber Deterioration - Cracking in an Ozone Controlled Environment
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2394	(2017) Standard Test Methods for Simulated Service Testing of Wood and Wood-Base Finish Flooring
ASTM D3273	(2021) Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
ASTM D5420	(2016) Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Strike Impacted by a Falling Weight (Gardner Impact)
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E336	(2024) Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
ASTM E695	(2022) Standard Test Method of Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

GYPSUM ASSOCIATION (GA)

GA 214	(2010) Recommended Levels of Gypsum Board Finish
GA 216	(2016) Application and Finishing of Gypsum Panel Products
GA 224	(2008) Installation of Predecorated Gypsum Board
GA 253	(2012) Application of Gypsum Sheathing
GA 600	(2021) Fire Resistance and Sound Control Design Manual

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

TILE COUNCIL OF NORTH AMERICA (TCNA)

TCNA Hdbk	(2017) Handbook for Ceramic, Glass, and Stone Tile Installation

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SUBMITTALS

****

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SD-02 Shop Drawings

Control Joint Shop Drawings

SD-03 Product Data

Gypsum Board

[Cementitious Backer Units

][Glass Mat Moisture-Resistant Gypsum Tile Backing Board

] Moisture- and Mold-Resistant Gypsum Backing Board

[Glass Mat Covered or Reinforced Gypsum Sheathing

][Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

][Abuse Resistant Gypsum Board

[Factory-Laminated Gypsum Board

][Exterior Gypsum Soffit Board

][Flexible Gypsum Panel

] Trim

] Accessories

[Recycled Content for Gypsum Board; S

][Recycled Content for Paper Facing and Gypsum Cores; S

] VOC Content of Joint Compound; S

SD-04 Samples

[Predecorated Gypsum Board; G, [_____]

] SD-06 Test Reports

[ASTM E90 Factory Test Report; G, [_____]

][ASTM E336 Field Test Report; G, [_____]

] SD-07 Certificates

Asbestos Free Materials; G, [_____]

Indoor Air Quality for Gypsum Board; S

Indoor Air Quality for Non-aerosol Adhesives; S

Indoor Air Quality for Aerosol Adhesives; S

****

NOTE: SD-08 and SD-10 are tailored for NAVY.

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SD-08 Manufacturer's Instructions

Safety Data Sheets

SD-10 Operation and Maintenance Data

Manufacturer Maintenance Instructions

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

****

NOTE: The Government's preference is for use of products that have been certified for indoor air quality by a third-party organization such as Greenguard or SCS Global Services. However, it must be verified there is a certified product available that is both cost effective and appropriate for the project. Retain the following section when the designer of record confirms local/regional availability of Greenguard or SCS products that does not impact cost effectiveness.

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[1.3.1.1 Ceiling and Wall Systems

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

]1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide adhesive products certified to meet ASTM C557. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

1.4.2 Storage

****

NOTE: Gypsum board provides a sink for adsorbing high short-term emissions of VOCs, formaldehyde, particulates, or other air-borne compounds. Materials with high short-term emissions include, but are not limited to: adhesives, sealants and glazing compounds (specifically those with petrochemical vehicles or carriers); paint, wood preservatives, and finishes; control and/or expansion joint fillers; hard finishes requiring adhesive installation; gypsum board (with associated finish processes and products); and composite or engineered wood products with formaldehyde binders.

****

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NOTE: The following paragraph contains NAVY tailoring.

****

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board, glass mat faced gypsum board, and cementitious backer units outside, store flat and off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions. Provide adequate ventilation to prevent condensation. Remove plastic wrapping that may inhibit ventilation. Store per manufacturer's recommendations for allowable temperature and humidity range. Do not store panels where temperatures may exceed 52 deg C 125 deg F. Do not store gypsum wallboard with materials which have high emissions of volatile organic compounds (VOCs) or other contaminants, including [_____]. Do not store panels near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives. Do not use materials that have visible moisture or biological growth. Do not stack panels higher than manufacturer's recommendations, and no higher than 5 m 17 feet.

1.4.3 Handling

Neatly stack gypsum board, glass mat faced gypsum board, and cementitious backer units flat to prevent sagging or damage to the edges, ends, and surfaces. Handle per manufacturer's recommendations.

1.5 QUALIFICATIONS

Furnish type of gypsum board work specialized by the installer with a minimum of[3] [_____] years of documented successful experience.

1.6 SCHEDULING

****

NOTE: This Article is tailored for NAVY.

Use one or both of the following procedures to minimize the exposure of gypsum wallboard to materials or finishes which have high short-term emissions of VOCs, formaldehyde, particulates, or other air-borne compounds.

****

[The gypsum wallboard must be taped, finished and primed before the installation of the highly-emitting materials, including [_____].] [The gypsum wallboard must be installed after the installation and ventilation period of the highly-emitting materials, including [_____].]

Commence application only after the area scheduled for gypsum board work is completely weathertight. The heating, ventilating, and air-conditioning systems must be complete and in operation prior to application of the gypsum board. If the mechanical system cannot be activated before gypsum board is begun, the gypsum board work may proceed in accordance with an approved plan to maintain the environmental conditions specified below. Apply gypsum board prior to the installation of finish flooring and acoustic ceiling.

1.7 ENVIRONMENTAL REQUIREMENTS

****

NOTE: Gypsum board is a thin sheathing that will be adversely affected by extreme or non-uniform drying conditions and by rapid changes in temperature. It should not be used in spaces where adequate environmental control cannot be obtained.

****

Do not expose the gypsum board to excessive sunlight prior to gypsum board application. Maintain a continuous uniform temperature of not less than 10 degrees C 50 degrees F and not more than 27 degrees C 80 degrees F for at least one week prior to the application of gypsum board work, while the gypsum board application is being done, and for at least one week after the gypsum board is set. Shield air supply and distribution devices to prevent any uneven flow of air across the plastered surfaces. Provide ventilation to exhaust moist air to the outside during gypsum board application, set, and until gypsum board jointing is dry. In glazed areas, keep windows open top and bottom or side to side 75 to 100 mm 3 to 4 inches. Reduce openings in cold weather to prevent freezing of joint compound when applied. For enclosed areas lacking natural ventilation, provide temporary mechanical means for ventilation. In unglazed areas subjected to hot, dry winds or temperature differentials from day to night of 10 degrees C 20 degrees F or more, screen openings with cheesecloth or similar materials. Avoid rapid drying. During periods of low indoor humidity, provide minimum air circulation following gypsum boarding and until gypsum board jointing complete and is dry.

[1.8 FIRE RESISTIVE CONSTRUCTION

****

NOTE: For fire-resistive assemblies, drawing details must follow the tested and approved designs. Tested and approved designs are published by gypsum wallboard manufacturers, Underwriters Laboratory, and Factory Mutual, and are included in the Gypsum Association Fire Resistance Design Manual.

****

Comply with specified fire-rated assemblies for design numbers indicated per UL Fire Resistance or FM APP GUIDE.

]PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Check ASTM C840, GA 216 and ANSI A108.11 for details of materials, fasteners, and application.

****

****

NOTE: Confirm combined characteristics of boards required for specific application on each project. For instance, impact resistance, fire rating, and moisture- and mold-resistance may be required for the same panel. Edit section as necessary.

****

****

NOTE: The following paragraph contains NAVY tailoring.

****

Conform to specifications, standards and requirements specified. Provide gypsum board types, gypsum backing board types, cementitious backing units, and joint treating materials manufactured from asbestos free materials only. Submit Safety Data Sheets and manufacturer maintenance instructions for gypsum materials including adhesives.

2.1.1 Gypsum Board

****

Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness, and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at https://www.epa.gov/. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Section allows establishing recycled content requirements based on either the gypsum board product in its entirety, or on the paper facing and gypsum core separately. Include the first bracketed sentence if specifying a recycled product in its entirety; include the second bracketed sentence if specifying a recycled product based on its separate components. Research shows the product is available from US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages (for components that have a threshold less than 100 percent). Based on research, insert desired minimum percentages into the empty set of brackets.

****

ASTM C1396/C1396M.[Gypsum board must contain a minimum of[5][10][_____] percent post-consumer recycled content, or a minimum of[20][40][_____] percent post-industrial recycled content. Provide data identifying percentage of recycled content for gypsum board.][Paper facings must contain a minimum of 100 percent recycled paper content. Gypsum cores must contain a minimum of[95] [_____] percent post-industrial recycled gypsum content. Provide data identifying percentage of recycled content for paper facing and gypsum cores.] Gypsum Board must not contain asbestos. Provide gypsum wall board and panels meeting the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for gypsum board.

2.1.1.1 Regular

****

NOTE: Use tapered and featured edge gypsum board with embedding and finishing compounds when a very flat surface is required, such as long walls with lighting at the end of the wall and down or up lighted walls.

****

1200 mm 48 inch wide, [12.7][15.9] mm [1/2][5/8] inch thick,[tapered][tapered and featured] edges.[Provide tapered and featured edge gypsum board[in Rooms [_____]][as indicated].]

[2.1.1.2 Foil-Backed

1200 mm 48 inch wide, [12.7][15.9] mm [1/2][5/8] inch thick,[tapered][tapered and featured] edges.

]2.1.1.3 Type X (Special Fire-Resistant)

****

NOTE: This subparagraph is tailored for FIRE-RATED CONSTRUCTION.

****

1200 mm 48 inch wide, 15.9 mm 5/8 inch thick,[tapered][tapered and featured] edges.

2.1.1.4 Type C (Special Fire-Resistant)

****

NOTE: This subparagraph is tailored for FIRE-RATED CONSTRUCTION.

****

1200 mm 48 inch wide, 15.9 mm 5/8 inch thick,[tapered][tapered and featured] edges.

[2.1.1.5 Mold Resistant / Anti-Microbial Gypsum

ASTM D3273. 1200 mm 48 inch wide, [12.7][15.9] mm [1/2][5/8] inch thick,[tapered][tapered and featured] edges.

][2.1.1.6 Exterior Gypsum Soffit Board

ASTM C1396/C1396M, anti-sag core additive, with mold resistant / anti-microbial facers. 1200 mm 48 inch wide,[regular [12.7][15.9] mm [1/2][5/8] inch thick][Type[X][C] 15.9 mm 5/8 inch thick], tapered edges.

][2.1.1.7 Flexible Gypsum Panel

****

NOTE: Use tapered and featured edge gypsum board with embedding and finishing compounds when a very flat surface is required, such as long walls with lighting at the end of the wall and down or up lighted walls.

****

1200 mm 48 inch wide, 6.4 mm 1/4 inch thick,[tapered][tapered and featured] edges.[Provide tapered and featured edge gypsum board[in Rooms [_____]][as indicated].]

]2.1.2 Regular Moisture- and Mold-Resistant Gypsum Backing Board

****

NOTE: For adhesive applied ceramic tile in wet areas (tubs, shower enclosures, saunas, steam rooms, gang shower rooms, etc.), use cementitious backer units (Tile Council of North America (TCNA) Handbook) as a substrate. Specify ASTM C1396/C1396M

or ASTM C1178/C1178M for all other tiled areas including areas where only ceramic or quarry tile base is to be installed, and for ceilings in humid areas. When using moisture-resistant gypsum backing board at tile applications, the metal studs should not be spaced more than 406 mm 16 inches on center. Specify moisture-resistant gypsum board ASTM C1396/C1396M for humid areas that are not exposed to direct moisture.

When using moisture-resistant board on ceilings, spacing of supports should be no more than 305 mm 12 inch on center.

****

****

NOTE: Additives used to produce moisture-resistant gypsum board ("green board") may include VOCs. Moisture-resistant types may be difficult to recycle.

****

ASTM C1396/C1396M

2.1.2.1 Regular

1200 mm 48 inch wide, [12.7][15.9] mm [1/2][5/8] inch thick, tapered edges.

2.1.2.2 Type X (Special Fire-Resistant)

****

NOTE: This subparagraph is tailored for FIRE-RATED CONSTRUCTION.

****

1200 mm 48 inch wide, 15.9 mm 5/8 inch thick, tapered edges.

2.1.2.3 Type C (Special Fire-Resistant)

****

NOTE: This subparagraph is tailored for FIRE-RATED CONSTRUCTION.

****

1200 mm 48 inch wide, 15.9 mm 5/8 inch thick,[tapered][tapered and featured] edges.

[2.1.3 Glass Mat Moisture-Resistant Gypsum Tile Backing Board

ASTM C1178/C1178M

2.1.3.1 Regular

1200 mm 48 inch wide, [12.7][15.9] mm [1/2][5/8] inch thick, square edges.

2.1.3.2 Type X (Special Fire-Resistant)

****

NOTE: This subparagraph is tailored for FIRE-RATED CONSTRUCTION.

****

1200 mm 48 inch wide, 15.9 mm 5/8 inch thick, square edges.

2.1.3.3 Type C (Special Fire-Resistant)

****

NOTE: This subparagraph is tailored for FIRE-RATED CONSTRUCTION.

****

1200 mm 48 inch wide, 15.9 mm 5/8 inch thick,[tapered][tapered and featured] edges.

][2.1.4 Glass Mat Covered or Reinforced Gypsum Sheathing

****

NOTE: This section should be used where exterior gypsum sheathing with water resistance is required (i.e., cavity sheathing over metal studs with brick veneer or as substrate for EIFS systems). Always use asphalt impregnated felt paper for sheathing protection. For additional protection or if recommended by the manufacturer, choose the paragraph for sheathing sealant.

****

****

NOTE: Glass-fiber reinforced types may be difficult to recycle.

****

Exceeds physical properties of ASTM C1396/C1396M and ASTM C1177/C1177M. Provide [12.7][15.9,] mm [1/2][5/8] inch, gypsum sheathing. Provide gypsum board of with a noncombustible moisture-resistant core, with glass mat surfaces embedded to the gypsum core or reinforcing embedded throughout the gypsum core. Warrant gypsum sheathing board for at least twelve months against delamination due to direct weather exposure. Provide continuous, asphalt impregnated, building felt to cover exterior face of sheathing.[Seal all joints, seams, and penetrations with compatible sealant.]

2.1.4.1 Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

Provide sealant compatible with glass mat covered or reinforced gypsum sheathing, rubber washers for masonry veneer anchors, and other associated cavity wall components such as anchors and through wall flashing. Provide sealants for glass mat covered or reinforced gypsum sheathing board edge seams and veneer anchor penetrations recommended by the glass mat covered or reinforced gypsum sheathing manufacturer and have the following performance requirements:

a. ASTM D412: Tensile Strength, 551 kilopascals 80 psi

b. ASTM D412: Ultimate Tensile Strength (maximum elongation), 1172 kilopascals 170 psi

c. ASTM D624: Tear Strength, Die B, 4.7 kN/m 27 ppi

d. ASTM D1149: Joint Movement Capability after 14 Days cure, plus or minus 50 percent.

][2.1.5 Abuse Resistant Gypsum Board

****

NOTE: Abuse Resistant Gypsum Board should be used when abuse or vandalism of walls is anticipated and gypsum board is the only wall material alternative feasible. Consult manufacturer for use restrictions of abuse resistant gypsum board on exterior walls. This product requires a minimum of 20 gauge metal framing as support, coordinate with Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD.

Some products rely on lexan backing for penetration resistance. The impervious layer will act as a vapor barrier which may not be desirable in certain wall systems and climates.

None of the paper faced gypsum products have high resistance to abrasion. Consider high strength veneer plaster on wall systems using abuse resistant gypsum wallboard, coordinate with Section 09 26 00 VENEER PLASTER.

****

1200 mm 48 inch wide, 15.9 mm 5/8 inch thick, tapered edges. Reinforced impact-resistant gypsum panel with imbedded fiber mesh or polycarbonate backing tested in accordance with the following tests. Hard body impact test must attain a Level 2 performance or greater in accordance with ASTM C1629/C1629M. Provide fasteners that meet manufacturer requirements and specifications stated within this section. Abuse resistant gypsum board, when tested in accordance with ASTM E84, have[a flame spread rating of 25 or less and a smoke developed rating of 50 or less for [_____]][and][a flame spread rating of 75 or less and a smoke developed rating of 100 or less for [_____]].

2.1.5.1 Soft Body Impact Test

ASTM E695 or ASTM D2394 for impact penetration and deformation. ASTM E695 using a 27.2 kg 60 lb leather bag filled with steel pellets, resisting no less than 407 N-m 300 ft. lb. cumulative impact energy before failure or ASTM D2394 using 139.7 mm 5.5 inch hemispherical projectile resisting no less than 357 N-m 264 ft. lb. before failure. Provide test specimen stud spacing a minimum 406 mm 16 inch on center.

2.1.5.2 Hard Body Impact Test

Comply with hard body impact test in accordance with ASTM C1629/C1629M Classification Level 2 or greater.

2.1.5.3 Surface Abrasion Test

Comply with test surface abrasion test in accordance with ASTM C1629/C1629M meeting[Level 1][Level 2][Level 3] abrasion resistance.

2.1.5.4 Indentation Test

ASTM D5420 or ASTM D1037 for indentation resistance and ASTM C1629/C1629M[

Level 1][Level 2][Level 3] requirements. ASTM D5420 using a .907 kg 32 oz weight with a 16 mm 5/8 inch hemispherical impacting head dropped once 915 mm 3 feet creating not more than 3.5 mm 0.137 inch indentation or ASTM D1037 using no less than 213 kg 470 lb weight applied to the 11.13 mm 0.438 inch diameter ball to create not more than a 0.5 mm 0.0197 inch indentation depth.

][2.1.6 Factory-Laminated Gypsum Board

****

NOTE: Specify Factory-laminated gypsum panels when using wall or ceiling assemblies to comply with high performance acoustical separation assemblies (laboratory tested assemblies STC 45 and above) noted in applicable DoD Unified Facilities Criteria (UFC). Such rooms and spaces can include conference rooms, partitions between living units, medical rooms and offices, rooms containing noise-generating equipment, such as mechanical rooms, and secure spaces that are required to meet IC Tech Spec - for ICD/ICS 705, Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities. Coordinate on drawings location(s), laboratory testing number, sound rating performance and composition of each sound rated assembly.

****

[ASTM C1766,[regular][Type X], 1200 mm 48 inch wide, [12.7][15.9][25] mm [1/2][5/8][1] inch thick, sound dampening gypsum panel products composed of[two[or more]] factory-laminated gypsum panels laminated into a composite panel with viscoelastic sound-absorbing polymer core[s].

][2.1.6.1 ASTM E90 Factory Test Report

****

NOTE: Include the following when using wall or ceiling assemblies intended to comply with acoustical separation assemblies noted in applicable DoD Unified Facilities Criteria (UFC) or perimeter of secure spaces that are required to meet IC Tech Spec - for ICD/ICS 705.

****

Submit Factory Test Report for proposed STC Rated wall assembly. Test reports must be prepared by an independent acoustical laboratory qualified under the National Voluntary Laboratory Accreditation Program (NVLAP) by the National Institute for Science and Technology (NIST). Test reports must indicate that the sound transmission classification (STC) of the proposed wall [and ceiling] assembly, based on tests at 16 third-octave band frequencies from 125 to 4,000 hertz, is no less than STC 50 for STC 45 assemblies and no less than STC 55 for STC 50 assemblies when tested in accordance with ASTM E90.

]][2.1.7 Predecorated Gypsum Board

****

NOTE: Predecorated gypsum board is available only in 1200 mm 48 inch wide panels. Interior finish

materials for exits, hospitals, individual rooms with capacity for five or more persons must have a flame spread rating of 25 or less and smoked developed rating of 50 or less. Interior finish materials for other locations must have flame spread rating of 75 or less and smoke developed rating of 100 or less. Flame spread rating greater than 75 and smoke developed rating greater than 100 are not permitted. Refer to UFC 3-600-01, "Fire Protection Engineering for Facilities," for further guidance on specifying flame spread and smoke developed ratings.

****

****

NOTE: If the optional phrase "as selected" is not used to designate a color (and pattern), insert a manufacturer's name and color (and pattern) designation in the blank and add the following to the end of this paragraph, "The manufacturer's name and catalog designation are provided in order to describe the color (and pattern) desired. Other manufacturer's products having a similar color (and pattern) will be acceptable."

****

****

NOTE: Insert designations of rooms or areas in which different flame spread and smoke developed ratings are required.

****

ASTM C1396/C1396M,[regular][Type X] gypsum board, 1200 mm 48 inch wide, [12.7][15.9] mm [1/2][5/8] inch thick, with a decorative wall covering (Class I)[or coating (Class II)] applied in-plant by the gypsum board manufacturer. The color[and pattern] of wall covering must be [_____][as selected]. Provide [_____] color[and pattern] wall covering selected.[Furnish gypsum board with square edges, and a slight bevel to produce a shallow vee joint. Wrap all coverings around edges.] Furnish a predecorated gypsum board with[a flame spread rating of 25 or less and a smoke developed rating of 50 or less for [_____]][and][a flame spread rating of 75 or less and a smoke developed rating of 100 or less for [_____]].

Submit for each color and pattern of predecorated gypsum board. Where colors are not indicated, submit color selection samples of not less than eight of the manufacturer's standard colors.

][2.1.8 Cementitious Backer Units

****

NOTE: For adhesive applied ceramic tile in wet areas (tubs, shower enclosures, saunas, steam rooms, gang shower rooms), specify only cementitious backer units.

****

Cementitious backer units must not contain asbestos. ASTM C1288 or ASTM C1235, ANSI A108/A118/A136.1 and in accordance with the Tile Council of North America (TCNA Hdbk).

]2.1.9 Joint Treatment Materials

ASTM C475/C475M. Product must be low emitting VOC types with VOC limits not exceeding 50 g/L. Joint materials must not contain asbestos. Provide data identifying VOC content of joint compound.[Use all purpose joint and texturing compound containing inert fillers and natural binders, including lime compound. Pre-mixed compounds must be free of antifreeze, vinyl adhesives, preservatives, biocides and other slow releasing compounds.]

2.1.9.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

2.1.9.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

2.1.9.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate, and fasteners.

2.1.9.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

2.1.9.5 Joint Tape

Use cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape recommended by the manufacturer.

2.1.10 Fasteners

2.1.10.1 Nails

ASTM C514.[For predecorated gypsum board provide special nails with factory coated heads of color to match wall covering materials as recommended by the predecorated gypsum board manufacturer.]

2.1.10.2 Screws

ASTM C1002, Type "G", Type "S", or Type "W" steel drill screws for fastening gypsum board to gypsum board, wood framing members, and steel framing members less than 0.84 mm 0.033 inch thick. ASTM C954 steel drill screws for fastening gypsum board to steel framing members 0.84 to 2.84 mm 0.033 to 0.112 inch thick. Provide cementitious backer unit screws with a polymer coating.

2.1.10.3 Staples

1.5 mm thick No. 16 USS gage flattened galvanized wire staples with 11.1 mm 7/16 inch wide crown outside measurement and divergent point for base ply of two-ply gypsum board application. Use as follows:

Length of Legs	Thickness of Gypsum Board
28.6 mm 1-1/8 inches	12.7 mm 1/2 inch
31.8 mm 1-1/4 inches	15.9 mm 5/8 inch

2.1.11 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building (inside of the weatherproofing system).

2.1.11.1 Adhesive for Fastening Gypsum Board to Metal Framing

****

NOTE: Use adhesive only where screw type fastener attachment to metal framing is not possible to avoid difficulty with future gypsum recycling.

****

[Not permitted.][Type recommended by gypsum board manufacturer.]

2.1.11.2 Adhesive for Fastening Gypsum Board to Wood Framing

****

NOTE: Use adhesive only where screw type fastener attachment to wood framing is not possible to avoid difficulty with future gypsum recycling.

****

[Not permitted.][ASTM C557.]

2.1.11.3 Adhesive for Laminating

****

NOTE: Use adhesive only where screw type fastener attachment is not possible to avoid difficulty with future gypsum recycling.

****

[Not permitted.][Adhesive attachment is not permitted for multi-layer gypsum boards. For laminating gypsum studs to face panels, provide adhesive recommended by gypsum board manufacturer.]

2.1.12 Gypsum Studs

Provide 25 mm 1 inch minimum thickness and 150 mm 6 inch minimum width. Studs may be of 25 mm 1 inch thick gypsum board or multilayers fastened to required thickness. Conform to ASTM C1396/C1396M for material and GA 216 for installation.

2.1.13 Shaftwall Liner Panel

****

NOTE: Shaftwall panels are typically used for elevators, stairwells, and mechanical chases that penetrate rated floor systems. When using shaftwall system, edit Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD to include shaftwall liner panel metal studs.

****

ASTM C1396/C1396M. Conform to the UL Fire Resistance for the Design Numbers(s) indicated for shaftwall liner panels. Manufacture liner panel for cavity shaftwall system, with moisture-resistant paper faces, bevel edges, single lengths to fit required conditions, [25.4 mm][19.05 mm] [1 inch][3/4 inch] thick, by 610 mm 24inch wide.

2.1.14 Accessories

****

NOTE: In areas of high humidity or project locations with Environmental Severity Classifications (ESC) of C3 thru C5, use PVC or plastic trim and accessories. Galvanized metal will rust over time. Humid project locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

ASTM C1047. Fabricate from[corrosion protected steel][primed aluminum][or][plastic] designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges must be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.[For predecorated gypsum board provide prefinished metal or plastic trim to match predecorated gypsum board.]

2.1.14.1 Trim

Provide trim for[plaster][and][stucco] including, as required:

a. Cornerbeads.

b. Bullnose Beads.

c. LC Beads.

d. L-Beads.

e. U-Beads.

f. Control Joints.

g. Curved-edge Cornerbeads.

h. Base-of-wall Trim.

i. Trim required to complete the work.

2.1.14.2 Materials

[Steel: ASTM A653/A653M Galvanized steel assemblies and fasteners.

][Aluminum: ASTM B221M ASTM B221 6063-T5 alloy aluminum extrusions with a factory applied[corrosion inhibiting primer][baked enamel finish] and stainless steel fasteners.

][Plastic: ASTM D1784 Extruded PVC with ASTM C1063 galvanized fasteners.

]2.1.15 Asphalt Impregnated Building Felt

Provide a 6.7 kg 15 lb asphalt moisture barrier over glass mat covered or reinforced gypsum sheathing. Conforming to ASTM D226/D226M Type 1 (No. 15) for asphalt impregnated building felt.

2.1.16 Water

Provide clean, fresh, and potable water.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board and cementitious backer units. Verify that all blocking, headers and supports are in place to support plumbing fixtures and to receive soap dishes, grab bars, towel racks, and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board and cementitious backer units.

3.1.2 [Gypsum Board][and][Framing]

Verify that surfaces of[gypsum board][and][framing] to be bonded with an adhesive are free of dust, dirt, grease, and any other foreign matter. Do not proceed with work until surfaces are acceptable for application of gypsum board with adhesive.

3.1.3 [Masonry][and][Concrete] Walls

Verify that surfaces of[masonry][and][concrete] walls to receive gypsum board applied with adhesive are dry, free of dust, oil, form release agents, protrusions and voids, and any other foreign matter. Do not proceed with work until surfaces are acceptable for application of gypsum board with adhesive.

3.1.4 Building Construction Materials

Do not install building construction materials that show visual evidence of biological growth.

3.2 APPLICATION OF GYPSUM BOARD

****

NOTE: Coordinate with the drawings to ensure that all types of gypsum board specified are indicated. Terminology on the drawings should be identical to that in the specifications.

****

****

NOTE: Allow adhesive bonding of gypsum board and substrate members only when required for proper installation.

****

****

NOTE: The following paragraph contains NAVY tailoring.

****

****

NOTE: Use of special clips designed to provide support at wall corners and wall-ceiling intersections in lieu of backup studs or blocking minimizes framing, and is approved except where not permitted in fire rated assemblies. Include gypsum or ceiling board over framing sentence when appropriate with design and meets industry guidance and requirements for fire rated assemblies. Ceilings insulated with heavy or compressed insulation (such as cellulose, mineral wool, or compressed fiberglass batts) may require 16 mm 5/8 inch gypsum board.

****

Apply gypsum board to framing and furring members in accordance with ASTM C840 or GA 216 and the requirements specified. Apply gypsum board with separate panels in moderate contact; do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length; select panel sizes to minimize waste. Cut out gypsum board to make neat, close, and tight joints around openings. In vertical application of gypsum board, provide panels in lengths required to reach full height of vertical surfaces in one continuous piece. Lay out panels to minimize waste; reuse cutoffs whenever feasible. Surfaces of gypsum board and substrate members may[not] be bonded together with an adhesive[, except where prohibited by fire rating(s)]. Treat edges of cutouts for plumbing pipes, screwheads, and joints with moisture-resistant compound as recommended by the gypsum board manufacturer. Minimize framing by floating corners with single studs and drywall clips.[Install[16 mm 5/8 inch] [_____] gypsum or[13 mm 1/2 inch] [_____] ceiling board over framing at[610 mm 24 inch] [_____] on center.] Provide type of gypsum board for use in each system specified herein as indicated.

3.2.1 Application of Single-Ply Gypsum Board to Wood Framing

Apply in accordance with ASTM C840, System I or GA 216.

3.2.2 Application of Two-Ply Gypsum Board to Wood Framing

Apply in accordance with ASTM C840, System II or GA 216.

3.2.3 Adhesive Nail-On Application to Wood Framing

Apply in accordance with ASTM C840, System III or GA 216. This method may be used in lieu of ASTM C840, System I at the option of the Contractor.

3.2.4 Semi-Solid Gypsum Board Partitions

Provide in accordance with ASTM C840, System IV or GA 216.

3.2.5 Solid Gypsum Board Partitions

Provide in accordance with ASTM C840, System V or GA 216.

3.2.6 Adhesive Application to Interior Masonry or Concrete Walls

Apply in accordance with ASTM C840, System VI or GA 216.

3.2.7 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C840, System VIII or GA 216.

3.2.8 Arches and Bending Radiuses

Apply gypsum board in accordance with ASTM C840, System IX or GA 216.

3.2.9 Gypsum Board for Wall Tile or Tile Base Applied with Adhesive

****

NOTE: For adhesive applied ceramic tile in wet areas (tubs, shower enclosures, saunas, steam rooms, gang shower rooms), specify cementitious backer board (in accordance with the Tile Council of North America Handbook) as the substrate; specify ASTM C1178/C1178M glass mat water-resistant backing board or ASTM C1396/C1396M moisture-resistant gypsum backing board for other tiled areas including areas where only ceramic or quarry tile base is to be installed.

****

In dry areas (areas other than tubs, shower enclosures, saunas, steam rooms, gang shower rooms), apply glass mat moisture-resistant gypsum tile backing board[or moisture-resistant gypsum backing board] in accordance with ASTM C840, System X or GA 216.

[3.2.10 Exterior Application

Apply exterior gypsum board, such as at soffits, in accordance with ASTM C840, System XI or GA 216. Do not install gypsum soffits in a manner that could allows liquid water to contact the gypsum soffits. Provide ventilated soffits where gypsum board is used at soffits.

][3.2.11 Glass Mat Covered or Fiber Reinforced Gypsum Sheathing

****

NOTE: Choose the bracketed option below if sealant will be applied to sheathing joints and penetrations in addition to the asphalt impregnated building felt.

****

Apply glass mat covered or fiber reinforced gypsum sheathing in accordance to gypsum association publications GA 253. Follow gypsum sheathing manufacturer's requirements of design details for joints and fasteners and be properly installed to protect the substrate from moisture intrusion. Do not leave exposed surfaces of the glass mat covered or fiber reinforced gypsum sheathing beyond the manufacturer's recommendation without a weather barrier cladding. Provide continuous asphalt impregnated building felt over sheathing surface in shingle fashion with edges and ends lapped a minimum of 150 mm 6 inch. Properly flash the openings.[Seal all joints, seams, and penetrations with a compatible silicone sealant.]

]3.2.12 Floating Interior Angles

****

NOTE: Use of special clips designed to provide support at wall corners and wall-ceiling intersections in lieu of backup studs or blocking minimizes framing, and is approved except where not permitted in fire rated assemblies. Include gypsum or ceiling board over framing sentence when appropriate for design and meets industry guidance and requirements for fire rated assemblies.

****

Minimize framing by floating corners with single studs and drywall clips. Locate the attachment fasteners adjacent to ceiling and wall intersections in accordance with ASTM C840, System XII or GA 216, for[single-ply][and][two-ply] applications of gypsum board to wood framing.

3.2.13 Control Joints

****

NOTE: The following paragraph contains tailoring for FIRE-RATED CONSTRUCTION.

****

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C840, System XIII or GA 216. Joints in fire-rated and sound-rated ceiling and walls to maintain the fire and sound rating. Fill control joints between studs in fire-rated construction with firestopping insulation to match the fire-rating of construction.

3.2.13.1 Control Joint Shop Drawings

a. Submit control joint shop drawings for approval.

b. Install control joints where a partition, wall, or ceiling traverses a construction joint in the base building structure.

c. Install control joints where a wall or partition runs in an uninterrupted straight plane exceeding 9.14 m 30 feet.

d. Install control joints in interior ceilings with a perimeter relief so that linear dimensions between control joints do not exceed 15.24 m 50 feet.

e. Install control joints in interior ceilings without perimeter relief so that linear dimensions between control joints do not exceed 9.14 m 30 feet.

f. Install control joints in exterior ceilings and soffits so that linear dimensions between control joints do not exceed 9.14 m 30 feet.

g. Install control joints or intermediate blocking where ceiling framing members change direction.

h. In addition to the above, install control joints where indicated on the drawings as a design accent or architectural feature.

i. Do not install control joints where building or structural expansion or seismic joints are located. Install suitable joint expansion or seismic joint assemblies as indicated on the drawings.

[3.2.14 Application of Foil-Backed Gypsum Board

Apply foil-backed gypsum board in accordance with ASTM C840, System XIV or GA 216.

][3.2.15 Application of Predecorated Gypsum Board

Apply predecorated gypsum board in accordance with GA 224. Attach predecorated gypsum board with adhesive and fasteners as recommended by the manufacturer. Conceal fasteners in the finished work.

][3.2.16 Application of Abuse Resistant Gypsum Board

Apply in accordance with applicable system of ASTM C840 as specified or GA 216. Follow manufacturers written instructions on how to cut, drill, and attach board.

][3.2.17 Application of Factory-Laminated Gypsum Board

Apply in accordance with manufacturer instructions for testing sound assembly. Face of laminated surface must not be on finished side of assembly.

][3.3 APPLICATION OF CEMENTITIOUS BACKER UNITS

3.3.1 Application

In wet areas (tubs, shower enclosures, saunas, steam rooms, gang shower rooms), apply cementitious backer units in accordance with ANSI A108/A118/A136.1. Place a 7.6 kg 15 lb asphalt impregnated, continuous felt paper membrane behind cementitious backer units, between backer units and studs or base layer of gypsum board. Place membrane with a minimum 150 mm 6 inch overlap of sheets laid shingle style.

3.3.2 Joint Treatment

ANSI A108/A118/A136.1.

]3.4 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C840, GA 214, and GA 216. Finish plenum areas above ceilings to Level 1 in accordance with GA 214.[Finish and paint walls required to be sound rated assembly field tested from true floor to true ceiling to Level 5 in accordance with GA 214.] Finish moisture-resistant gypsum backing board, ASTM C1396/C1396M, to receive ceramic tile to Level 2 in accordance with GA 214. Finish walls and ceilings to receive a heavy-grade wall covering or heave textured finish before painting to Level 3 in accordance with GA 214. Finish walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings to Level 4 in accordance with GA 214. Unless otherwise specified, finish all gypsum board walls, partitions, and ceilings to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Tool joints as smoothly as possible to minimize sanding and dust. Do not use self-adhering fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only. Provide treatment for moisture-resistant gypsum board as recommended by the gypsum board manufacturer. Protect workers, building occupants, and HVAC systems from gypsum dust.

3.4.1 Uniform Surface

Wherever gypsum board is to receive eggshell, semigloss, or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance to GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum board surface, after the two-coat joint and fastener treatment is complete and dry.

[3.4.2 Metal Trim for Predecorated Gypsum Board

Finish edges, ends, and joints of predecorated gypsum board, except prefinished vee joints and monolithic type joints, with metal or plastic trim selected to match the gypsum board finish.

]3.5 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board and cementitious backer units as specified in Section 07 92 00 JOINT SEALANTS. Apply material with exposed surface flush with gypsum board or cementitious backer units.

[3.5.1 Sealing for Glass Mat or Reinforced Gypsum Board Sheathing

Apply silicone sealant in a 9.5 mm 3/8 inch bead to all joints and trowel flat. Apply enough of the same sealant to all fasteners penetrating through the glass mat gypsum board surface to completely cover the penetration when troweled flat.[Do not place construction and materials behind sheathing until a visual inspection of sealed joints during daylight hours has been completed by Contracting Officer.]

]3.6 FIRE-RESISTANT ASSEMBLIES

****

NOTE: This Article is tailored for FIRE-RATED CONSTRUCTION.

****

****
NOTE: Coordinate with the drawings to ensure that UL or GA design numbers are indicated for fire-resistant assemblies. If review of building code requires pressurized enclosures, include the following:

Pressurized fire-rated gypsum board enclosures must allow the mechanical and electrical life-safety systems to operate in accordance with the design intent. Air pressure within elevator shaft must be 360 Pa 7.5 psf. Air pressure within stair shaft must be 240 Pa 5.0 psf. Maximum mid-span deflection must be L/360.
****

Wherever fire-rated construction is indicated, provide materials and application methods, including types and spacing of fasteners,[wall[and ceiling] framing] in accordance with the specifications contained in[UL Fire Resistance for the Design Number(s) indicated][or][GA 600 for the File Number(s) indicated]. Joints of fire-rated gypsum board enclosures must be closed and sealed in accordance with UL test requirements or GA requirements. Seal penetrations through rated partitions and ceilings tight in accordance with tested systems.

[3.7 SOUND RATED ASSEMBLIES

****
NOTE: Construction practices have an influence on final STC ratings of assemblies. Flanking sound patterns, the integrity of the assembly, and construction methods factor into the STC rating of the completed assembly. Include the following section when using wall or ceiling assemblies intended to meet the acoustical separation assembly requirements in applicable DoD Unified Facilities Criteria (UFC). Such rooms and spaces can include conference rooms, partitions between living units, medical patient rooms and offices, rooms containing noise-generating equipment, such as mechanical rooms, and secure spaces that are required to meet IC Tech Spec - for ICD/ICS 705, Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities. Coordinate on drawings location(s), laboratory testing number, sound rating performance and composition of each sound rated assembly.
****

When sound rated assemblies are required, provide materials and application methods, including panels, insulation, types and spacing of fasteners,[wall[and ceiling] framing] in accordance with the contract document and the description of the assembly in the ASTM E90 Factory Test Report. Seal partitions continuously with acoustical foam or sealant (both sides) and finished to match wall wherever it abuts another element such as the floor, ceiling, wall, column, mullion, or another system or assembly.

]3.8 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finishes.[Remove predecorated gypsum board which cannot be restored to like-new condition. Provide new predecorated gypsum board.]

3.9 SHAFTWALL FRAMING

Install the shaftwall system in accordance with the system manufacturer's published instructions. Coordinate bucks, anchors, blocking and other items placed in or behind shaftwall framing with electrical and mechanical work. Patch or replace fireproofing materials which are damaged or removed during shaftwall construction.

[3.10 SOUND RATED ASSEMBLY FIELD TESTING

****

NOTE: Include the following when field-testing is required for wall or ceiling assemblies intended to comply with acoustical separation assemblies noted in applicable DoD Unified Facilities Criteria (UFC) or perimeter of secure spaces that are required to meet IC Tech Spec - for ICD/ICS 705. For secure spaces that are to comply with IC Tech Spec - for ICD/ICS 705, this may be documented in the Construction Security Plan.

****

Provide third party testing of sound rated assemblies tested in accordance with ASTM E336. Provide the ASTM E336 Field Test Report verifying that the installed assemblies perform no less than five ASTC rating points below the ASTM E90 Factory Test Report. Examine, modify adjust, and retest any installation not meeting the STC Rating until compliance is obtained.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 30 10 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-09 30 10 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-09 30 10 (August 2020)**

Preparing Activity: USACE **Superseding**
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****

SECTION 09 30 10

CERAMIC, QUARRY, AND GLASS TILING
08/20

****
NOTE: This guide specification covers the requirements for a variety of types of ceramic tile for walls and floors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: Tile grouted with epoxy or furan resin is included in this specification, but quarry tile subject to severe chemical exposures is specified in Section 09 35 16 CHEMICAL-RESISTANT QUARRY TILING.

Ensure drawings indicate location, dimensions, elevations, schedules, content, details and such other information as required to indicate the extent of the work.

Base product selections on aesthetic values, function, type of facility, and cost as related to project needs.
****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108/A118/A136.1	(2024) American National Standard Specifications for the Installation of Ceramic Tile
ANSI A137.1	(2019) American National Standards Specifications for Ceramic Tile
ANSI A137.2	(2019) American National Standards Specifications for Glass Tile
ANSI A137.3/A108.19	(2017) American National Standard Specifications for Gauged Porcelain Tile and Gauged Porcelain Tile Panels/Slabs

ASTM INTERNATIONAL (ASTM)

ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C144	(2024) Standard Specification for Aggregate for Masonry Mortar
ASTM C150/C150M	(2024) Standard Specification for Portland Cement

ASTM C206	(2014; R 2022) Standard Specification for Finishing Hydrated Lime
ASTM C207	(2024) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C241/C241M	(2021) Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C373	(2018; R 2023)Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products
ASTM C648	(2020) Standard Test Method for Breaking Strength of Ceramic Tile
ASTM C847	(2018; R 2024) Standard Specification for Metal Lath
ASTM C1026	(2023) Standard Test Method for Measuring the Resistance of Ceramic and Glass Tile to Freeze-Thaw Cycling
ASTM C1027	(2009; R 2017) Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile
ASTM C1178/C1178M	(2024) Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel
ASTM F446	(2018; R 2023) Standard Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

MARBLE INSTITUTE OF AMERICA (MIA)

MIA Design Manual	(2016) Dimension Stone Design Manual

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

TILE COUNCIL OF NORTH AMERICA (TCNA)

TCNA Hdbk	(2017) Handbook for Ceramic, Glass, and Stone Tile Installation

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Porcelain Tile; G, [_____]

[Recycled Content for Porcelain Tile; S

] Gauged [Porcelain Tile][and][Porcelain Tile Panels/Slabs]; G, [_____]

Quarry Tile; G, [_____]

[Recycled Content for Quarry Tile; S

] Mosaic Tile; G, [_____]

[Recycled Content for Mosaic Tile; S

] Large Format Glass Tile; G, [_____]

[Recycled Content for Glass Tile; S

] Glazed Ceramic Wall Tile; G, [_____]

[Recycled Content for Glazed Ceramic Wall Tile; S

] Transition Strips; G, [_____]

Metal Strips; G, [_____]

Setting-Bed; G, [_____]

Mortar, Grout, and Adhesive; G, [_____]

Reinforcing Wire Fabric

[Cementitious Backer Units; G, [_____]

][Glass-Mat Gypsum Water-Resistant Backing Board; G, [_____]

] Waterproof Membrane; G, [_____]

Crack Isolation Membrane; G, [_____]

SD-04 Samples

Tile; G, [_____]

Accessories; G, [_____]

Transition Strips; G, [_____]

Metal Strips; G, [_____]

Grout; G, [_____]

SD-07 Certificates

[Indoor Air Quality for Adhesives; S

][Indoor Air Quality for Sealants; S

][Water Absorption Rates

] SD-08 Manufacturer's Instructions

Manufacturer's Approved Cleaning Instructions

SD-10 Operation and Maintenance Data

Gauged [Porcelain Tile][and][Porcelain Tile Panels/Slabs], Data Package 1; G, [_____]

Porcelain Tile, Data Package 1; G, [_____]

Quarry Tile, Data Package 1; G, [_____]

Mosaic Tile, Data Package 1; G, [_____]

Large Format Glass Tile, Data Package 1; G, [_____]

Glazed Ceramic Wall Tile, Data Package 1; G, [_____]

Transition Strips, Data Package 1; G, [_____]

Metal Strips, Data Package 1; G, [_____]

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body.When product does not have certification, provide validation that product meets the indoor air quality product requirements cited in this Section.

[1.3.2 Water Absorption Rates Certification

****

NOTE: The four water absorption (wa) classifications indicated below are from ANSI A137.1. Lower water absorption (wa) indicates a denser product.

1. Impervious tile has water absorption (wa) of less than 0.5 percent. Porcelain tile is typically

impervious tile.

2. Vitreous tile has water absorption (wa) of 0.5 to 3.0 percent. Mosaic tile and quarry tile can be vitreous tile.

3, Semi-Vitreous tile has water absorption (wa) of 3.0 to 7.0 percent. Quarry tile can be semi-vitreous tile, but with a maximum of 5 percent water absorption.

4. Non-Vitreous tile has water absorption (wa) of 7.0 percent or more. Ceramic wall tile, glazed and unglazed, is typically non-vitreous tile suitable for interior wall use.

The designer must select the water absorption (wa) rate for each type of tile needed on a project-specific basis, and must verify the tile manufacturers' actual water absorption (wa) rates for each tile product specified.

****

Provide certification for each tile type indicating compliance with the following water absorption (wa) rates per ANSI A137.1 criteria as tested per ASTM C373 requirements.

[a. [Porcelain][and][Mosaic] Tile (Impervious): Provide water absorption (wa) of 0.5 percent or less.

][b. [Mosaic][_____] Tile (Vitreous): Provide water absorption (wa) of more than 0.5 percent, but not more than 3.0 percent.

][c. [Mosaic][_____] Tile (Semi-Vitreous): Provide water absorption (wa) of more than 3.0 percent, but not more than 7.0 percent.

][d. [Ceramic Wall][_____] Tile (Non-Vitreous): Provide maximum water absorption (wa) of [7.0][___] percent.

]]1.4 QUALITY ASSURANCE

Provide installers having a minimum of two years of experience with a company specializing in performing the type of work described. Each type and color of tile to be provided from a single source. Each type and color of mortar, adhesive, and grout to be provided from the same source.

1.5 DELIVERY, STORAGE, AND HANDLING

Ship tiles in sealed packages and clearly marked with the grade, type of tile, producer identification, and country of origin. Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact. Protect materials from weather, and store them under cover in accordance with manufacturer's printed instructions. Store and handle tiles per manufacturer's instructions for gauged porcelain tile and gauged porcelain tile panels/slabs.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not perform ceramic tile work unless the substrate and ambient temperature is at least 10 degrees C 50 degrees F and rising. Maintain temperature above 10 degrees C 50 degrees F while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used, ventilate the area to the outside to avoid carbon dioxide damage to new tilework.

1.7 WARRANTY

Provide manufacturer's warranty to repair or replace defective tiling materials and workmanship[, including tile, mortar and grout products and installation as a system,] for a period of [one year][[_____][years]] from date of final acceptance of the work..

1.8 EXTRA MATERIALS

Supply an extra [2][_____] percent of each type tile used in clean and marked cartons.

PART 2 PRODUCTS

2.1 TILE

****

NOTE: Ceramic tile with low absorption rates are easier to maintain because they are more resistant to staining. They do not readily absorb grease, food or beverage spills, or other staining agents.

Not all tiles with a wet dynamic coefficient of friction (DCOF) equal to or greater than 0.42 are appropriate for all types of level interior spaces. Designer to consider application, use, and coordinate requirements with manufacturers to determine the recommended DCOF value. Tiles with a wet DCOF AcuTest of less than 0.42, should only be installed when the surface will be kept dry when walked upon and proper safety procedures will be followed when cleaning the tiles. For level interior spaces expected to be walked on when wet, the threshold minimum wet DCOF AcuTest value is 0.42.

Gauged porcelain tile and gauged porcelain tile panel/slabs are defined by the American National Standard Specification: "Gauged" means manufactured to a thickness that is specified and largely associated with installation and use. Tile panel/slabs are those that are on one square meter in facial area or larger.

Gauged porcelain tile and gauged porcelain tile panels/slabs are not suitable for some project types. Verify application with manufacturer of this tile type. Tiles with a 3 mm 1/8 inch thickness are suitable for wall application only. Tiles with a 6 mm 1/4 inch thickness are suitable for floors, walls and counter tops.

Per TCNA Hdbk breaking strength is measured in "lbf". This specification uses "pounds" since this

is how most manufacturers list the method of measurement.

Take into account expected foot traffic, building and site conditions and maintenance during selection of tile. In accordance with ANSI 137.1 the visible abrasion classifications for floors are as follows:

Class 0 - Generally used on walls. Not recommended for use on floors. This type of tile should not be exposed to wear, traffic or aggressive maintenance.

Class I - Light Residential. Tile may withstand soft-soled foot traffic as long as dirt and/or other abrasives are not present. Tile should not be used in areas with direct access to the outside or in areas with large amounts of foot traffic.

Class II - Residential. Tile may withstand soft-soled and some normal traffic with limited quantities of dirt and/or other abrasives. Tile is not recommended in areas with direct access to the outside or in areas with large amounts of foot traffic.

Class III - Heavy Residential or Light Commercial. Tile may withstand normal footwear and regular traffic with some dirt and/or other abrasives in limited quantities. Tile may be used in light commercial facilities with limited foot traffic and no direct access to the outside. Examples: residential kitchens and hallways with limited outside traffic.

Class IV - Commercial. Tile may withstand heavier amounts of traffic with more dirt and abrasives. Examples: commercial kitchens and spaces with regular outside traffic.

Class V - Heavy Commercial. Tiles may withstand constant foot traffic with larger amounts of dirt and/or other abrasives. Examples: airports, malls, and other commercial walkways subject to high volumes of foot traffic and constant traffic from the outside.

Manufacturers use the aesthetic classification to identify the variation of color, texture, and appearance within a particular line of tile. Delete this requirement if not necessary to express design intent.

The surface datum will be established for the top of the tile floors to indicate to other trades the required elevation for the top of subfloor.

Check availability of tile colors in the sizes specified before specifying color. Also, check availability of tile thickness before specifying.

Trim pieces are rarely made in the same factory as the tile and could be fabricated from other materials. Trim pieces are "coordinating trim pieces".

Per TCNA Hdbk Base/Cove Alternate installation details include square, flush and thin-lip. Provide direction for installation type.
****

Provide tiles that comply with ANSI A137.1 and are standard grade tiles[, the exception is glass tile. Furnish glass tiles that comply with ANSI A137.2][, the exception is gauged [porcelain tile][porcelain tile panels/slabs]. Furnish gauged [porcelain tile][porcelain tile panels/slabs] that comply with ANSI A137.3/A108.19]. Provide a minimum breaking strength of 57 kg 125 lbs. for wall tile and 113 kg 250 lbs. for floor tile in accordance with ASTM C648. Provide exterior building tile for cold climate projects that is approved by the manufacturer for exterior use when tested in accordance with ASTM C1026. Provide floor tiles with a minimum wet dynamic coefficient of friction (DCOF) value of [0.42][_____] when tested in accordance with ANSI A137.1 requirements. Provide glazed floor tile with a Class [III-Heavy Residential or Light Commercial][IV-Commercial][V-Heavy Commercial][_____] classification as rated by the manufacturer when tested in accordance with ASTM C1027 for visible abrasion resistance as related to foot traffic. For materials like tile, accessories, and transition strips submit samples of sufficient size to show color range, pattern, type and joints.

Submit manufacturers' descriptive product data for [each type of] ceramic, quarry and glass tiling indicated. Include manufacturers' literature, finishes, profiles and thicknesses of materials.

Submit manufacturers' operations and maintenance data for [each type of] ceramic, quarry and glass tiling indicated in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

2.1.1 Porcelain Tile

Provide [unglazed[through body (surface color and pattern go all the way through the tile body)]][or][glazed[color body (body of tile is stained to match the glaze color)]],[rectified] porcelain tile[and [cove][bullnose] base and trim pieces]. [Provide tile with a [V0][V1][V2][V3][V4] aesthetic classification. Blend tiles in factory and in a packages to have same color range and continuous blend for installation.] Provide nominal tile size(s) of [150 by 150][300 by 300][450 by 450][300 by 600] [_____] mm and [8][10][_____] mm [6 by 6][12 by 12][18 by 18][12 by 24][_____] inch and [3/8][5/16][_____] inch thick.

Provide porcelain tiling materials that contain a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for porcelain tile.

2.1.2 Gauged [Porcelain Tile][and][Porcelain Tile Panels/Slabs]

Provide [unglazed [through body (surface color and pattern go all the way through the tile body)]] [or] [glazed [color body (body of tile is stained to match the glaze color)]], [rectified] gauged [porcelain tile] [porcelain tile panels/slabs] [and [cove] [bullnose] base and trim pieces]. [Provide tile with a [V0][V1][V2][V3][V4] aesthetic classification.] Blend tiles in factory and in packages to have same color range and continuous blend for installation. Provide nominal tile size(s) of [750 by 375][750 by 750][1500 by 750][1500 by 1500][3000 by 1500][_____]mm [30 by 15][30 by 30][60 by 30][60 by 60][120 by 60] [_____] inch and [3][6][_____] mm [1/8][1/4][_____] inch thick.

Provide gauged [porcelain tile] and [porcelain tile panels/slabs] materials that contain a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for gauged [porcelain tile] and [porcelain tile panels/slabs].

[2.1.3 Quarry Tile

****

NOTE: Specify abrasive surface quarry tile for vestibules, kitchens, walk-in refrigerators, and work spaces behind serving lanes. Consider abrasive surface quarry tile for other areas which may become slippery due to grease or soapy water spillage or for other reasons. Red quarry tile is the most economical color. If other colors are desired, they should be limited to the darker shades.

****

Furnish an unglazed quarry tile, [cove][bullnose] base and trim pieces. Provide tile with [smooth][abrasive] surface. Provide nominal tile size(s) of [150 by 150][_____] mm and 13 mm [6 by 6][_____] inch and 1/2 inch thick.

Provide quarry tiling materials that contain a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for quarry tile.

]2.1.4 Mosaic Tile

****

NOTE: Glazed porcelain and ceramic mosaic tiles are recommended for walls only.

Typically glass, stone, and metal mosaic tiles are recommended for walls only, but can be installed on the floor. Verify application with manufacturer.

Verify that glass tiles specified are made in the USA. Many of these products are made in countries that do not comply with the Buy American Act.

****

Furnish [unglazed][glazed], mosaic tile[, [cove][bullnose] base] and trim composed of [ceramic][porcelain][glass][stone][metal]. [Provide tile with a [V0][V1][V2][V3][V4] aesthetic classification. Blend tiles in factory and in a packages to have same color range and continuous blend for installation.] Provide [nominal tile size(s) of [25 by 25][25 by 50][50 by 50][_____] mm [1 by 1][1 by 2][2 by 2][_____] inch][a mixture of standard sizes in a stock pattern].

Provide mosaic tiling materials that contain a minimum of 3 percent recycled content. Provide data identifying percentage of recycled content for mosaic tile.

2.1.5 Large Format Glass Tile

****

NOTE: Verify that glass tiles specified are made in the USA. Many of these products are made in countries that do not comply with the Buy American Act.

Typically glass tiles are recommended for walls only.

****

[Provide tile with a [V0][V1][V2][V3][V4] aesthetic classification.] Provide nominal tile size(s) of [75 by 75] [_____] mm [3 by 3] [_____] inches or greater.

****

NOTE: Research shows glass tile is available among US national manufacturers above the minimum recycled content shown.

****

Provide glass tiling materials that contain a minimum of [10][_____] percent recycled content. Provide data identifying percentage of recycled content for glass tile.

2.1.6 Glazed Ceramic Wall Tile

****

NOTE: Glazed wall tiles are recommended for walls only.

****

Provide glazed[, rectified] ceramic wall tile that has [cushioned edges][square edges] and trim with lead-free [bright][matte] finish. Provide nominal tile size(s) of [106 by 106][106 by 150][150 by 150] mm [4-1/4 by 4-1/4][4-1/4 by 6][6 by 6] inch.

Provide glazed ceramic wall tile materials that contain a minimum of 3 percent recycled content. Provide data identifying percentage of recycled content for glazed ceramic wall tile.

2.1.7 Accessories

****

NOTE: Where glazed accessories are required, add the color, style, and number to the accessories table in this paragraph, unless otherwise noted. For Navy projects add a sentence stating that color is as indicated since they provide color information in the drawings. Provide mounting heights for accessories in the drawings. Coordinate this paragraph with Section 10 28 13 TOILET ACCESSORIES.

****

Provide built-in type accessories of the same materials and finish as the wall tile. Provide accessories as follows:

	Quantity	Location
Recessed soap holders	[_____]	[_____]
Tumbler holders	[_____]	[_____]
Combination tumbler and toothbrush holders	[_____]	[_____]
Towel bars, [stainless steel][ceramic] [600] [750] mm [24] [30] inch long, two towel posts	[_____]	[_____]
Robe hooks	[_____]	[_____]
Roll paper holder	[_____]	[_____]
Recessed soap holder and hand hold combination: support static load in compliance with ASTM F446	[_____]	[_____]
Premade niche and shelf	[_____]	[_____]

2.2 SETTING-BED

Submit manufacturer's catalog data. Compose the setting-bed of the following materials:

2.2.1 Aggregate for Concrete Fill

Conform to ASTM C33/C33M for aggregate fill. Do not exceed one-half the thickness of concrete fill for maximum size of coarse aggregate.

2.2.2 Portland Cement

Conform to ASTM C150/C150M for cement, Type I, white for wall mortar and gray for other uses.

2.2.3 Sand

Conform to ASTM C144 for sand.

2.2.4 Hydrated Lime

Conform to ASTM C206 for hydrated lime, Type S or ASTM C207, Type S.

2.2.5 Metal Lath

Conform to ASTM C847 for flat expanded type metal lath, and weighing a minimum 1.4 kg/square meter 2.5 pound/square yard.

2.2.6 Reinforcing Wire Fabric

Conform to ASTM A1064/A1064M for wire fabric. Provide [50 by 50 mm2 by 2 inch mesh, 16/16 wire] [or] [38 by 50 mm1-1/2 by 2 inch mesh, 16/13 wire].

2.3 WATER

Provide potable water.

2.4 MORTAR, GROUT, AND ADHESIVE

****

NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the bracketed sentences below requiring products with indoor air quality certifications as defined in Part 1 of this specification.

Glass Tile Installation: Designer of record to verify with the glass manufacturer the thin-set mortar color best suited for glass tile installations.

Organic Adhesive: Not all tiles are suitable for the use of organic adhesive, verify with tile manufacturer.

****

[Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. For products located on the interior of the building (inside of the weatherproofing system, provide certification or validation of indoor air quality for adhesives.] Provide bond coat, mortar, and grout supplied from the same manufacturer.

2.4.1 Dry-Set Portland Cement Mortar

TCNA Hdbk.

2.4.2 Furan Mortar

TCNA Hdbk.

2.4.3 Latex-Portland Cement Mortar

TCNA Hdbk.

2.4.4 Ceramic Tile Grout

TCNA Hdbk; petroleum-free and plastic-free [sand-portland cement grout] [standard unsanded cement grout (dry-set grout)] [high-performance cement grout (latex-portland cement grout)] [standard cement commercial portland cement grout].

2.4.5 Organic Adhesive

TCNA Hdbk, Type I. Water-resistant. Comply with ANSI A108/A118/A136.1.

2.4.6 Epoxy Resin Grout

****

NOTE: Use resin grout where chemical resistance is required.

****

TCNA Hdbk. Water cleanable epoxy conforming to ANSI A108/A118/A136.1; provide manufacturer proportioned and packaged kit having hardener, resin and colored filler and horizontal and vertical grade products as applicable.

2.4.7 Furan Resin Grout

TCNA Hdbk; chemical resistant furan conforming to ANSI A108/A118/A136.1; and consist of an intimate mixture of furfuryl-alcohol resin with carbon filler and catalyst. Prohibited unless specifically indicated otherwise.

2.4.8 Urethane Grout

TCNA Hdbk; premixed, urethane, water-based grout with color consistency and antimicrobial protection; no color fading, streaking or shading, chemical and stain resistant; and UV stable.

2.4.9 Sealants

Comply with applicable regulations regarding toxic and hazardous materials and as specified. Provide sealant that does not change the color or alter the appearance of the grout. Refer to Section 07 92 00 JOINT SEALANTS.

****

NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the bracketed sentences below requiring products with indoor air quality certifications as defined in Part 1 of this specification.

****

[Provide sealants used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. For products located on the interior of the building (inside of the weatherproofing system), provide certification or validation of indoor air quality for sealants.]

2.5 SUBSTRATES

[Refer to Section 09 29 00 GYPSUM BOARD][for cementitious backer units][and][glass-mat water-resistant backing board].

****

NOTE: If substrates are specified in Section 09 29 00 GYPSUM BOARD, then delete paragraphs "Cementitious Backer Units" and "Glass-Mat Water-Resistant Backing Board".

****

[2.5.1 Cementitious Backer Units

Provide cementitious backer unit, for use as tile substrate as indicated, in accordance with TCNA Hdbk. Furnish [13][16] mm [1/2][5/8] inch thick cementitious backer units.

][2.5.2 Glass-Mat Gypsum Water-Resistant Backing Board

Provide glass-mat water-resistant backing board, for use as tile substrate as indicated, in accordance with ASTM C1178/C1178M. Provide [13][16] mm [1/2][5/8] inch thick glass-mat water-resistant backing board.

]2.6 MISCELLANEOUS TRIMS

****

NOTE: Provide transition strips where the top of tile floors will occur at a different elevation from the top of finished floors in adjoining spaces and to transition between different flooring materials.

Metal and vinyl cove-shaped trim profiles can be used for floor and wall transitions in lieu of cove tile base. Metal edge protection trims and other tile transition trim profiles are available to protect and conceal tile edges.

****

2.6.1 Transition Strips

Provide [[clear][_____] anodized aluminum transitions between tile and carpet or resilient flooring. Provide types as recommended by flooring manufacturer for both edges and transitions of flooring materials specified][marble transitions appropriate for conditions]. Categorize marble Group A as classified by MIA Design Manual. Provide a fine sand-rubbed finish marble, [white][pink][gray][beige] in color. Provide [minimum 12.0 marble abrasion when tested in accordance with ASTM C241/C241M.][solid surfacing material transitions appropriate for conditions. Refer to Section 06 61 16 SOLID SURFACING FABRICATIONS.] Provide transition strips that comply with 36 CFR 1191requirements.

2.6.2 Metal Strips

Provide [Cove][,][Angle][,][and][L-shape][,] [_____] trim shapes, height to match tile and setting thickness, designed specifically for flooring, and wall applications. [Provide [extruded, [clear] [_____] anodized aluminum][stainless steel][rigid-vinyl] cove strip where floor tile abuts wall tile for sanitary transition and elimination of cove tile base.] [Provide extruded [radiused][square][_____], [[clear][_____] anodized aluminum][stainless steel] edging at tile surfaces with exposed outside [and inside] corners.] [Provide profiles appropriate for finished floor and wall materials as indicated.]

2.7 WATERPROOF MEMBRANE

2.7.1 General

Manufacturer's standard product that complies with ANSI A108/A118/A136.1 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.7.2 Chlorinated-Polyethylene Shower Waterproof Membrane

Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; [1][_____] mm [0.040][_____] inch nominal thickness.

2.8 CRACK ISOLATION MEMBRANE

2.8.1 General

Manufacturer's standard product that complies with ANSI A108/A118/A136.1 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.8.2 Chlorinated-Polyethylene Crack Isolation Membrane

Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; [0.75][_____] mm [0.030][_____] inch nominal thickness.

2.9 COLOR, TEXTURE, AND PATTERN

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an Architect or Interior designer. Color should be selected from manufacturer's standard colors or identified in this specification only when the project has minimal finishes.

When the government directs that color be located in the drawings add a note that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

When more than one type, pattern or color is specified identify location and extent of work for each.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

NOTE: Drawings are required for projects with floor patterns.

****

Provide color, pattern and texture [as specified in Section 09 06 00 SCHEDULES FOR FINISHES.][as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.].

PART 3 EXECUTION

3.1 PREPARATORY WORK AND WORKMANSHIP

****

NOTE: When using the dry-set method to install tile on concrete or masonry surfaces, coordinate Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 04 20 00 UNIT MASONRY, as applicable, to require (1) steel trowel and fine broom-finished concrete floors free of curing compounds and waxes, (2) masonry surfaces that are level and plumb with struck joints and square openings.

****

Inspect surface to receive tile in conformance to the requirements of TCNA Hdbk for surface conditions for the type setting bed specified and for workmanship. Provide variations of tiled surfaces that fall within maximum values shown below:

TYPE	WALLS	FLOORS
Dry-Set Mortar	3 mm in 2.4 meter1/8 inch in 8 ft.	3.0 mm in 3 meter1/8 inch in 10 ft.
Organic Adhesives	3 mm in 2.4 meter1/8 inch in 8 ft.	1.5 mm in 1 meter1/16 inch in 3 ft.
Latex-Portland Cement Mortar	3 mm in 2.4 meter1/8 inch in 8 ft.	3.0 mm in 3 meter1/8 inch in 10 ft.
Epoxy	3 mm in 2.4 meter1/8 inch in 8 ft.	3.0 mm in 3 meter1/8 inch in 10 ft.

3.2 GENERAL INSTALLATION REQUIREMENTS

Do not start tile work until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing have been installed and tested. Close space, in which tile is being set, to traffic and other work. Keep closed until tile is firmly set. Do not start floor tile installation in spaces requiring wall tile until after wall tile has been installed. Apply tile in colors and patterns indicated in the area shown on the drawings. Install tile with the respective surfaces in true even planes to the elevations and grades shown. Provide special shapes as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Solidly back tile bases and coves with mortar. Do not walk or work on newly tiled floors without using kneeling boards or equivalent protection of the tiled surface. Keep traffic off horizontal portland cement mortar installations for at least 72 hours. Keep all traffic off epoxy installed floors for at least 40 hours after grouting, and heavy traffic off for at least 7 days, unless otherwise specifically authorized by manufacturer. Dimension and draw detail drawings at a minimum scale of1:50 1/4 inch = 1 foot. Include drawings of pattern at inside corners, outside corners, termination points and location of all equipment items such as thermostats, switch plates, mirrors and toilet accessories mounted on surface. Submit drawings showing ceramic tile pattern [elevations][and][floor plans]. Submit manufacturer's preprinted installation instructions.

Do not install building construction materials that show visual evidence of biological growth.

3.3 INSTALLATION OF SUBSTRATES

3.3.1 [Cementitious Backer Units] [and] [Glass-Mat Water-Resistant Backing Board]

Install [as specified in Section 09 29 00 GYPSUM BOARD.][in accordance with manufacturer's written instructions.]

3.4 INSTALLATION OF WALL TILE

****

NOTE: See current TCNA Hdbk for detailed guidance. Specify project-specific TCNA Hdbk numbers for each type of wall tile installation method. Edit text accordingly.

General guidance for wall tile installation methods as follows:

Specify TCNA Hdbk B-series methods for interior wet areas, including shower stalls, over wood or metal studs with glass-mat water-resistant backing board substrate or with cementitious backer unit substrate.

Specify TCNA Hdbk EJ-series methods for movement (i.e. construction, contraction, expansion, isolation or perimeter) joints.

Specify TCNA Hdbk W-series methods for interior and exterior walls, including masonry or concrete substrates, and wood or metal studs with glass-mat water-resistant backing board substrate.

Specify TCNA Hdbk TR-series methods for renovation applications over existing substrates.

****

Install wall tile in accordance with the TCNA Hdbk, method [_____] and with grout joints [[as recommended by the manufacturer for the type of tile][of [_____] mm][of [_____] inch]. [Install thinner wall tile flush with thicker wall tile applied on same wall and provide installation materials as recommended by the tile and setting materials manufacturer's to achieve flush installation.]]

3.4.1 Installation of Gauged [Porcelain Tile][Porcelain Tile Panels/Slabs]

Install gauged [porcelain tile][porcelain tile panels/slabs] in accordance with TCNA Hdbk method [_____] and ANSI A137.3/A108.19 for thin-bed method bonded with modified dry-set cement mortar over improved modified dry-set cement mortar.

3.4.2 Workable or Cured Mortar Bed

Install tile over workable mortar bed or a cured mortar bed at the option of the Contractor. Install a 0.102 mm 4 mil polyethylene membrane, metal lath, and scratch coat. Conform to TCNA Hdbk method [_____] for workable mortar bed, materials, and installation of tile. Conform to TCNA Hdbk method [_____] for cured mortar bed and materials.

3.4.3 Dry-Set Mortar and Latex-Portland Cement Mortar

Use [dry-set] [or] [latex-portland cement] to install tile in accordance with TCNA Hdbk method [_____]. Use latex-portland cement when installing porcelain ceramic tile.

3.4.4 Organic Adhesive

Comply with the requirements of TCNA Hdbk method [_____] for organic adhesive installation of ceramic tile.

3.4.5 Furan Mortar and Grout

Comply with the requirements of TCNA Hdbk method [_____] for furan mortar and grout installation.

3.4.6 Ceramic Tile Grout

Prepare and install ceramic tile grout in accordance with TCNA Hdbk method [_____]. [Provide and apply manufacturer's standard [_____] product for sealing grout joints in accordance with manufacturer's recommendations.]

3.4.7 Epoxy Resin Grout

Prepare and install epoxy resin grout in accordance with TCNA Hdbk method [_____].

3.4.8 Urethane Grout

Prepare and install urethane grout in accordance with TCNA Hdbk method [_____].

3.5 INSTALLATION OF FLOOR TILE

****

NOTE: See current TCNA Hdbk for detailed guidance. Specify project-specific TCNA Hdbk numbers for each type of floor tile installation method. Edit text accordingly.

General guidance for floor tile installation methods as follows:

Specify TCNA Hdbk B-series methods for interior shower receptors.

Specify TCNA Hdbk EJ-series methods for movement (i.e. construction, contraction, expansion, isolation or perimeter) joints.

Specify TCNA Hdbk F-series methods for interior and exterior floors, including concrete substrates (above-ground and on-ground), and interior floors over wood substrates.

Specify TCNA Hdbk TR-series methods for renovation applications over existing substrates.

****

Install floor tile in accordance with TCNA Hdbk method [specified herein] [_____] and with grout joints [as recommended by the manufacturer for the type of tile][of [_____] mm][of [_____] inch]. Install shower receptors in accordance with TCNA Hdbk method [B414] [B415] [_____].

3.5.1 Installation of Gauged [Porcelain Tile][Porcelain Tile Panels/Slabs]

Install gauged [porcelain tile][porcelain tile panels/slabs] in accordance with TCNA Hdbk method [_____] and ANSI A137.3/A108.19 for thin-bed method bonded with modified dry-set cement mortar over improved modified dry-set cement mortar.

3.5.2 Workable or Cured Mortar Bed

Install floor tile over a workable mortar bed or a cured mortar bed at the option of the Contractor. Conform to TCNA Hdbk method [_____] for workable mortar bed materials and installation. Conform to TCNA Hdbk method [_____] for cured mortar bed materials and installation. Provide minimum 6 mm 1/4 inch to maximum 10 mm 3/8 inch joints in uniformed width.

3.5.3 Dry-Set and Latex-Portland Cement

Use [dry-set] [or] [latex-portland cement] mortar to install tile directly over properly cured, plane, clean concrete slabs in accordance with TCNA Hdbk method [_____]. Use latex-portland cement when installing porcelain ceramic tile.

3.5.4 Resinous Grout

****

NOTE: Use resin grout where chemical resistance is required. For quarry tile subject to severe chemical exposure conditions, use Section 09 35 16 CHEMICAL-RESISTANT QUARRY TILING.

Ensure the areas to receive resin grout are clearly indicated on the drawings or defined in the specifications. Due to the higher cost of this grout, its use will generally be limited to areas such as:

a. Within the areas bounded by a line 610 mm 2 feet outside of the trough areas for ranges, kettles, and ovens.

b. Within the areas of pot washing and dish washing. In small kitchens where it may be impracticable to subdivide areas for grouting, resin grout method F114 or F133 may be used throughout.

For severe chemical exposure such as meat packing plants and photo labs, resin grout method F134 will be used throughout and a resin setting-bed will be required. Wherever resin setting-bed is used, the concrete slab will be steel-troweled finished to the final slope of the finished floor. Set tile in a 3 mm 1/8 inch thick layer of epoxy-or furan-resin

mortar. When using furan resins, the concrete slab will be neutralized or painted in accordance with the resin manufacturer's directions.
****

When resinous grout is indicated, grout quarry tile with either furan grout conforming to ANSI A108/A118/A136.1 or epoxy resin grout conforming to ANSI A108/A118/A136.1. Rake and clean joints to the full depth of the tile and neutralize when recommended by the resin manufacturer. Install epoxy resin grout in conformance with TCNA Hdbk method [_____]. Install resin grout in accordance with manufacturer's printed installation instructions. Provide a coating of wax applied from the manufacturer on all tile installed with furan resin. Follow manufacturer's printed installation instructions of installed resin grout for proportioning, mixing, installing, and curing. Maintain the recommended temperature in the area and on the surface to be grouted. Protect finished grout of grout stain.

3.5.5 Ceramic Tile Grout

Prepare and install ceramic tile grout in accordance with TCNA Hdbk method [_____]. Provide and apply manufacturer's standard [_____] product for sealing grout joints in accordance with manufacturer's recommendations.

3.5.6 Waterproof and Crack Isolation Membranes

Install as indicated in accordance with manufacturer's written instructions.

3.5.7 Concrete Fill

****
NOTE: Select the first sentence in areas to receive conductive ceramic tile.
****

Provide a 24.1 MPa 3500 psi concrete fill mix to dry as consistency as practicable. [Compose concrete fill by volume of 1 part Portland cement to 3 parts fine aggregate to 4 parts coarse aggregate, and mix with water to as dry a consistency as practicable.] Spread, tamp, and screed concrete fill to a true plane, and pitch to drains or levels as shown. Thoroughly damp concrete fill before applying setting-bed material. Reinforce concrete fill with one layer of reinforcement, with the uncut edges lapped the width of one mesh and the cut ends and edges lapped a minimum 51 mm 2 inch. Tie laps together with 1.02 mm 18 gauge wire every 254 mm 10 inch along the finished edges and every 152 mm 6 inch along the cut ends and edges. Provide reinforcement with support and secure in the centers of concrete fills. Provide a continuous mesh; except where expansion joints occur, cut mesh and discontinue across such joints. Provide reinforced concrete fill under the setting-bed where the distance between the under-floor surface and the finished tiles floor surface is a minimum of 51 mm 2 inches, and of the same thickness that the mortar setting-bed over the concrete fill with the thickness required in the specified TCNA Hdbk method [_____].

3.6 INSTALLATION OF MISCELLANEOUS TRIMS

****
NOTE: Where the top of tile floors will occur at a different elevation from the top of finished floors in adjoining spaces, provision for marble, or other

hard surface thresholds or saddles will be edited appropriately.

****

3.6.1 Transition Strips

Install transition strips where indicated, in a manner similar to that of the ceramic tile floor and as recommended by the manufacturer. Provide thresholds full width of the opening. Install head joints at ends not exceeding 6 mm 1/4 inch in width and grouted full.

3.6.2 Metal Trims

Install trim where indicated. Embed anchoring leg in setting mortar in accordance with manufacturer's instructions. During grouting of tile joints, immediately wipe grout from finish surface.

3.7 EXPANSION JOINTS

****

Note: Indicate expansion-joint details on the drawings. Location of expansion joints should, insofar as practical, be located outside the areas of tile finishes.

****

Form and seal joints as specified in Section 07 92 00 JOINT SEALANTS.

3.7.1 Walls

Provide expansion joints at control joints in backing material. Wherever backing material changes, install an expansion joint to separate the different materials.

3.7.2 Floors

Provide expansion joints over construction joints, control joints, and expansion joints in concrete slabs in accordance with TCNA Hdbk method [_____] EJ171 type to suit conditions. Provide expansion joints where tile abuts restraining surfaces such as perimeter walls, curbs and columns and at intervals of 6.1 to 7.6 m 20 to 25 feet each way in large interior floor areas[.][and 2.4 to 3.7 m 8 to 12 feet each way in large exterior areas or areas exposed to direct sunlight or moisture.] Extend expansion joints through setting-beds and fill.

3.8 CLEANING AND PROTECTING

Upon completion, thoroughly clean tile surfaces in accordance with manufacturer's approved cleaning instructions. Do not use acid for cleaning glazed tile. Clean floor tile with resinous grout or with factory mixed grout in accordance with printed instructions of the grout manufacturer. After the grout has set, provide a protective coat of a noncorrosive soap or other approved method of protection for tile wall surfaces. Cover tiled floor areas with building paper before foot traffic is permitted over the finished tile floors. Provide board walkways on tiled floors that are to be continuously used as passageways by workmen. Replace damaged or defective tiles.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-09 35 16 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 35 16 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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CHEMICAL-RESISTANT QUARRY TILING

08/16, CHG 1: 08/18

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 35 16 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 35 16 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 35 16

CHEMICAL-RESISTANT QUARRY TILING

08/16, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for quarry tile with chemical resistant grout and setting bed for use in medium to large dining facilities and other areas subject to spillage of acids or other chemicals.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: On the drawings, show:

1. Rooms, areas, or spaces to have chemical-resistant quarry tile floors including under ranges, kettles, and ovens and areas 600 mm 2 feet beyond such items, as well as 600 mm 2 feet outside trough areas; within dish-and pot-washing areas, food-preparation areas, serving areas, and garbage rooms. If quarry tile with conventional mortar and grout is also included in the project, areas for each type must be clearly indicated.

2. Depressed concrete slabs, 16 mm for 13 mm 5/8 inch for 1/2 inch tile and 22 mm for 19 mm 7/8 inch for 3/4 inch tile so that tile surfaces will align with adjacent finish materials. See detail F 131-15 or F 133-15 in Tile Council of America Inc. Handbook for Ceramic Tile Installation for recommended details.

3. Slope of floors to drain.

4. Treatment at expansion joints in tiled floors.

5. Thresholds at doorways.

6. Details at floor sinks, floor drains, intersections with walls, equipment bases, and trough areas.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C267	(2020) Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes
ASTM C395	(2001; R 2012) Chemical-Resistant Resin Mortars
ASTM C413	(2018; R 2023) Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and

	Polymer Concretes
ASTM C658	(1998; R 2012) Chemical-Resistant Resin Grouts for Brick or Tile

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

TILE COUNCIL OF NORTH AMERICA (TCNA)

TCNA Hdbk	(2017) Handbook for Ceramic, Glass, and Stone Tile Installation

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Quarry Tile; G, [_____]

Recycled Content for Chemical-Resistant Quarry Tile; S

Grout; G, [_____]

Indoor Air Quality for Mortar and Grout; S

SD-04 Samples

Quarry Tile; G, [_____]

Grout; G, [_____]

SD-06 Test Reports

Grout; G, [_____]

SD-08 Manufacturer's Instructions

Quarry Tile

Grout; G, [_____]

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site in manufacturers' original unbroken packages or containers plainly labeled with manufacturers' names and brands. Grade mark tile containers. Store materials in dry locations. Handle materials in a manner that will prevent inclusion of foreign materials and damage by water, dampness, or temperature extremes. Store materials in area in which they will be used at temperatures not lower than 16 degrees C 60 degrees F at least 24 hours before use.

1.4 ENVIRONMENTAL REQUIREMENTS

Do not start tile work unless ambient temperature of work area is at least 16 degrees C 60 degrees F and rising, and slab temperature is not less than 16 degrees C 60 degrees F. Maintain room and slab at these minimum temperatures without interruption while work is in progress and for at least 3 days after completion of work.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials conforming to the standards, specifications, and other requirements listed below:

2.1.1 Quarry Tile

****

NOTE: Check availability of tile colors in the sizes specified before specifying color. Also, check availability of tile thickness before specifying.

****

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available from US national manufacturers above the minimum recycled content percentages shown below. Some manufacturers and regions have higher percentages. Based on research, insert desired minimum percentages into the empty set of brackets.

****

TCNA Hdbk, standard grade, [_____] by [_____] [150 by 150 mm] [6 by 6 inches] by [minimum 13 mm 1/2 inch] [_____] thick, color [indicated] [selected by the Contracting Officer from the manufacturer's standard color samples.] [Minimum thickness in Garbage Room must be 30 by 200 by 200 mm 1-1/4 by 8 by 8 inches.] Quarry tile must have flat or serrated back. Chemical-Resistant Quarry Tiling Materials must contain a minimum of [3][10][_____] percent recycled content. Provide data identifying percentage of recycled content for chemical-resistant quarry tile.

2.1.1.1 Slip-Resistant Quarry Tile

****

NOTE: Slip-resistant quarry tile should be specified for areas where food and water spillage cause the floors to be slippery and hazardous (e.g., dishwashing areas, sculleries, food-preparation areas).

****

Provide quarry tile for floors [of [_____]] that contain an abrasive aggregate uniformly embedded into face surface of tile. Abrasive aggregate must be fused aluminum oxide or other rustproof aggregate of comparable hardness having a grain size smaller than 1.18 mm 16 mesh and larger than 150 micrometers 100 mesh (US Standard Sieve Sizes). Tile provided must contain grains in the surface between 50 percent and 150 percent, on the average by count, and as much aggregate as the approved samples.

2.1.1.2 Quarry Tile Trim Units

TCNA Hdbk standard grade. Provide cove base around perimeter of floors and at vertical projections through floors. Provide bullnose trim around depressions in floors. Provide rounded internal and external corners with 13 mm 1/2 inch minimum radius using appropriate matching corner units.

2.1.2 Chemical-Resistant Mortar and Grout

****

NOTE: Insert other items or areas subject to heat beyond 54 degrees C 130 degrees F.

If a project design includes use of mortar and grout products on the building interior (inside the weatherproofing system), include the bracketed paragraph requiring products with low emissions or VOC content properties.

****

Provide chemical-resistant grout for quarry tile floors [in [_____]]. Provide a compatible system of setting bed and joint material from a single source. In addition to the chemical resistance and physical properties specified, conform mortar and grout to the following:

[Provde mortar and grout products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for mortar and grout from certification body.]

2.1.2.1 Furan Mortar

ASTM C395. Either two-component or three-component is acceptable.

2.1.2.2 Furan Grout

ASTM C658.

2.1.2.3 Epoxy

ASTM C395 for setting tile grouted with furan.

2.1.2.4 Epoxy Mortar and Grout

TCNA Hdbk.

2.2 FACTORY TESTS

2.2.1 Chemical Resistance

****

NOTE: The chemicals and strengths are those considered necessary for use in food preparation and serving areas of medium to large dining facilities. For other types of projects modify the list of chemicals to reflect the exposure likely to be encountered.

****

Test mortar and grout in accordance with ASTM C267 except as modified herein. Immerse test specimens in the test solutions for 28 days, and maintain solutions continuously at 79 degrees C 175 degrees F for furan and 60 degrees C 140 degrees F for epoxy. The test specimens must not change in weight more than 5 percent after immersion, or exhibit a compressive strength of less than 90 percent of the compressive strength of specimens that have aged in air at 21 to 26 degrees C 70 to 80 degrees F during conditioning period. Test for chemical resistance to the following solutions:

a. Acetic acid, 5 percent

b. Citric acid, 5 percent

c. Lactic acid, 5 percent

d. Sodium hypochlorite, 5 percent

e. Trisodium phosphate, 5 percent

f. Household ammonia (test at room temperature)

g. Sugar, saturated solution

h. Vegetable oil

2.2.2 Physical Properties

After curing for 7 days at 21 to 26 degrees C 70 to 80 degrees F, the mortar must:

a. have a water absorption of not more than 0.5 percent when tested in accordance with ASTM C413;

b. have a hardness of not less than 90 percent of its initial hardness immediately before exposure, when tested after being exposed for 6 hours at 54 degrees C 130 degrees F for epoxy resin mortar and 93 degrees C 200 degrees F for furan resin mortar. Conduct hardness tests on 10 by 19 mm 3/8 by 3/4 inch samples with a Barcol Hardness Tester, within 30 seconds after the samples are removed from the oven.

PART 3 EXECUTION

3.1 PREPARATION

Do not start tile work until rough-in for plumbing, heating, ventilating, air conditioning, and electrical work has been completed and tested [and membrane waterproofing has been installed and tested]. Protect the work of other trades in area where tile work is to be done.

3.1.1 Preparation of Tile

****

NOTE: According to manufacturers, the prefinished wax surface is no longer available. Factory-coated units should be specified, if available, when experience indicates that application of wax in the field is unsatisfactory. Used as a protector for epoxy or furan grout - verify with the tile manufacturer if this is avaialble. Once grouting is complete, wax should be steamed off and removed.

When factory coated units are not selected, add language to require the application of a sealer and

grout release agent per manufacturer's recommendations.

****

[Factory coat] [Coat] with hot paraffin wax to produce a thin continuous film on the face surfaces only of quarry tile units to be installed and grouted with furan. Apply wax in such manner that it will not get on edges or backs of tile. Handle tile in a manner that will prevent waxed surfaces of units from touching the backs or edges of other units. Remove from the job tile with wax on edges or backs. Verify that wax used is acceptable to grout manufacturer. With flatback or serrated back tile use 6 mm 1/4 inch square notched trowel with notches on 13 mm 1/2 inch centers.

3.1.2 Preparation of Concrete Floors for Setting Beds

****

NOTE: Where tile is to be installed, concrete slabs should not have air entrainment or other additives in the mix, nor sealers or curing compounds applied without specific approval of mortar and grout manufacturer. Slabs should have steel trowel and fine broom finish and be free of laitance. In case of any question on condition of slab, it should be tested for bondability with a Dillon Dynamometer and show a tensile bond of not less than 2068 kPa 300 psi. These requirements should be incorporated in Section 03 30 00 CAST-IN-PLACE CONCRETE

****

Before tile is applied, test structural floor for levelness or uniformity of slope by water. Fill, level, and retest areas as required to meet tolerances specified in TCNA Hdbk and retest. When specified levelness or uniformity of slope is obtained, prepare floors for setting bed in accordance with TCNA Hdbk. Free floors of sealers, coatings, oil, dirt, and dust. Prepare floors before application of resin mortar in accordance with printed instructions and recommendations of the mortar manufacturer.

3.2 INSTALLATION

Except where specified otherwise herein, apply materials in accordance with manufacturer's printed instructions, including recommended safety requirements.

3.2.1 Setting Bed

Using a plain (not serrated) trowel, apply a continuous setting bed of chemical-resistant mortar, not less than 3 mm 1/8 inch thick. Apply only over a floor area that can be tiled during "open time" of mortar. Place tile into setting bed and tap lightly to a true plane. Level tile as it is placed. Maintain uniform tile joints of 6 mm 1/4 inch minimum and 10 mm 3/8 inch maximum width. Allow the setting bed to cure sufficiently to anchor tile in place, but not less than 24 hours, at a floor temperature of not less than 16 degrees C 60 degrees F. When furan setting bed is used, first install a glass reinforced asphalt membrane. With flatback or serrated back tile use trowel with 6 mm 1/4 inch square notches on 13 mm 1/2 inch centers.

3.2.2 Tile Joints

After the setting bed has cured, fill tile joints with chemical-resistant grout. Spread grout on surface of tile and work it into the open joints with a trowel. Fill joints flush with top surfaces of tile. Remove excess grout with one pass of a trowel or squeegee pulled diagonally across joints in order to prevent imperfect filling and low joints. Immediately fill voids, pinholes, and depressions with additional grout. Protect completed joints from dampness. Permit grout to harden for not less than 72 hours. Flush cure joints with tile edges; contour depression must not exceed 1.2 mm for 6 mm 3/64 inch for 1/4 inch wide joints or 2 mm for 10 mm 1/16 inch for 3/8 inch wide joints. Sealants for expansion joints provided by the grout manufacturer must be compatible with grout and setting mortars. Completely fill joints with no back up foam or rope. Install joints maximum 6000 mm 20 feet on center above slab around room peripheries and columns but not at drains.

3.2.3 Tile Installation

Install and grout tile with water cleanable tile setting and grouting epoxy in accordance with TCNA Hdbk.

3.3 CLEANING

After grout has hardened, scrub and wash tile surfaces with steam or hot water to melt wax coating and remove excess grout. Remove remnants of grout with wide-bladed paint scraper or other tool that will not damage tile. Rinse tile with clean warm water applied with a flat sponge. Remove excess water from floor, and leave floor dry when work is completed. Remove tile from which surface grout cannot be removed without damage to tile. Remove damaged tile and provide new tile.

3.4 PROTECTION

Cover finished tile floors with clean building paper before permitting foot traffic on them. Place board walkways on floors that are to be continuously used as passageways by workmen.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 51 00 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-09 51 00 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 51 00

ACOUSTICAL CEILINGS

08/20

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 51 00 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-09 51 00 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 09 51 00

ACOUSTICAL CEILINGS
08/20

****
NOTE: This guide specification covers the requirements for conventional and impact/abrasion resistant acoustical ceiling tile and panels, unit acoustical absorbers, hangers, and suspension system grid for installation in commercial-type work.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
Note: Plaster or gypsum wallboard ceilings, metal faced or ceramic-bonded mineral fiber acoustical ceilings should be used in lieu of mineral fiber, or fiberglass base acoustical ceiling systems, in wet areas such as showers and bathrooms or around grills, in kitchens, and similar facilities where greasy vapors are a problem. Be alert to this fact, however, gypsum board made in other countries may contain asbestos which, of course, is unacceptable.

Drawings should indicate the following:

a. Location of acoustical systems. Arrangement of acoustical units, panels, light fixtures, and diffusers, other penetrations and exposed suspension grids.

b. Location of systems required to have ceiling attenuation class (CAC).

c. Location of continuous or common acoustical ceilings that span or cover more than one room, so adequate detailing can be addressed on the drawings to coordinate requirements between CAC and STC ratings.

d. Location and details of system required to have a fire resistive rating.

e. Location and details and material of fire stops above suspended ceilings.

f. Location and details of access panels and maximum spacing of suspension members for concealed grid suspension systems.

g. Location of each different color and pattern when more than one type acoustical unit is specified for a project. Details of special or patterned panels if necessary to describe adequately. If more than one system is used, key to locations by using symbols.

h. Where acoustical ceilings are provided in conjunction with thermal insulation beneath vented attic spaces, careful attention should be given to furnishing the appropriate type ceiling tile, adequate details on the contract drawings, and to including appropriate sections in the specifications. Details on the drawings will cover such features as support of insulation at flush-mounted light fixtures, conduit, acoustical units, suspension system components, heating and air-conditioning units, and other utilities. Installation of insulation over the suspension systems, light fixtures, and other ceiling penetrations will be coordinated with Sections 06 10 00 ROUGH CARPENTRY and 07 21 13 BOARD AND BLOCK INSULATION, and manufacturer's literature.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A489	(2018; E 2018) Standard Specification for Carbon Steel Eyebolts
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C635/C635M	(2022) Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for

	Acoustical Tile and Lay-In Panels
ASTM C834	(2017; R 2023) Standard Specification for Latex Sealants
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E580/E580M	(2024) Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
ASTM E795	(2023) Standard Practices for Mounting Test Specimens During Sound Absorption Tests
ASTM E1111/E1111M	(2014; R 2022) Standard Test Method for Measuring the Interzone Attenuation of Open Office Components
ASTM E1264	(2023) Standard Classification for Acoustical Ceiling Products
ASTM E1414/E1414M	(2021a) Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
ASTM E1477	(1998; R 2022a) Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G, [_____]

SD-03 Product Data

Acoustical Ceiling Systems; G, [_____]

Fire Resistive Ceilings; G, [_____]

Recycled Content for Type III Ceiling Tiles; S

Recycled Content for Type IV Ceiling Tiles; S

Recycled Content for Type IX Ceiling Tiles; S

Recycled Content for Type XII Ceiling Tiles; S

Recycled Content for Suspension Systems; S

Acoustical Performance; G, [_____]

SD-04 Samples

Acoustical Units; G, [_____]

Acoustical Ceiling Tiles; G, [_____]

SD-06 Test Reports

Fire Resistive Ceilings; G, [_____]

SD-07 Certificates

Indoor Air Quality for Type III Ceiling Tiles; S

Indoor Air Quality for Type IV Ceiling Tiles; S

Indoor Air Quality for Type V Ceiling Tiles; S

Indoor Air Quality for Type VI Ceiling Tiles; S

Indoor Air Quality for Type VII Ceiling Tiles; S

Indoor Air Quality for Type IX Ceiling Tiles; S

Indoor Air Quality for Type X Ceiling Tiles; S

Indoor Air Quality for Type XI Ceiling Tiles; S

Indoor Air Quality for Type XII Ceiling Tiles; S

Indoor Air Quality for Impact/Abrasion Resistant Ceiling Tiles; S

Indoor Air Quality for Humidity Resistant Ceiling Tiles; S

Indoor Air Quality for Adhesives; S

Indoor Air Quality for Sealants; S

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

1.3.1.1 Ceiling Tiles

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this section. Provide current product certification documentation from certification body.

1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited in this Section.

1.4 DELIVERY, STORAGE. AND HANDLING

Deliver materials to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Carefully handle and store materials in dry, watertight enclosures. Immediately before installation, store acoustical units for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

1.5 ENVIRONMENTAL REQUIREMENTS

Maintain a uniform temperature of not less than 16 degrees C 60 degrees F nor more than 29 degrees C 85 degrees F and a relative humidity of not more than 70 percent for 24 hours before, during, and 24 hours after installation of acoustical units.

1.6 SCHEDULING

Complete and dry interior finish work such as plastering, concrete and terrazzo work before ceiling installation. Complete mechanical, electrical, and other work above the ceiling line; install and start operating heating, ventilating, and air conditioning systems in order to maintain temperature and humidity requirements.

1.7 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship including but not limited to, sagging and warping of panels and rusting and of grid systems, for a period of [ten years][_____][years] from date of final acceptance of the work.

[1.8 EXTRA MATERIALS

****

NOTE: In order to assure matching acoustical units that may become damaged and require spot replacement, a supply of extra ten percent of units

in the original pattern is recommended in order to prevent later replacement of the ceiling in an entire room because of mismatched units. However, the Government facility should be consulted to ensure that adequate warehousing and protection is available for these extra units.

****

Furnish spare tiles, from the same lot as those installed, of each color at the rate of [_____] [5] tiles for each 1000 tiles installed.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: When reflected ceiling plans showing ceiling penetrations are included in the project drawings, it may not be necessary for the Contractor to re-draw and submit as a shop drawing; in such cases, delete the requirement from SD-02. Details not applicable to the project should also be deleted. On simple projects where manufacturer's standard printed data are sufficient, omit this submittal category from SD-03.

Where many different ceiling systems are used, it may be more convenient to schedule acoustical performance ratings, fire ratings, panel and suspension types on the drawings, keyed to finish schedules, rather than to include this data in the specification.

****

Provide sound controlling units mechanically mounted on a ceiling suspension system for acoustical treatment. Provide the unit size, texture, finish, and color as specified.[The Contractor has the option to substitute inch-pound (I-P) Recessed Light Fixtures (RLF) for metric RLF. If the Contractor opts to provide I-P RLF, then provide I-P products for other ceiling elements like acoustical ceiling tiles, air diffusers, air registers and grills.] Coordinate the entire ceiling system with other details, like the location of access panels and ceiling penetrations, for instance, shown on the drawings. Submit drawings showing the the location, extent and details of acoustical treatment including suspension system, method of anchoring and fastening, and reflected ceiling plan.[Coordinate with paragraph RECLAMATION PROCEDURES for reclamation of mineral fiber acoustical ceiling panels to be removed from the job site.]

2.1.1 Fire Resistive Ceilings

****

NOTE: Certified laboratory test reports for fire resistance rating cannot be obtained for ceiling assemblies which are nonstandard with the manufacturer. Therefore, where a fire resistance rating is necessary, do not specify a nonstandard ceiling assembly. Refer to data in the UL Fire Resistance Directory for details.

For Navy projects, delete this paragraph when fire

separation is not required by UFC 3-600-01, Fire Protection Engineering for Facilities. Where required, rating applies to total floor-ceiling or roof-ceiling assembly, including mechanical-electrical elements, penetrations, structural system, and deck. If system is required to be fire-endurance rated, show details of recessed fixture enclosures and other penetrations on drawings.

****

Rate acoustical ceiling systems, indicated as fire resistant, for fire endurance as specified when tested in accordance with ASTM E119. Test suspended ceiling with a specimen [roof][floor] assembly representative of the indicated construction, including mechanical and electrical work within ceiling space openings for light fixtures, and air outlets, and access panels. Provide ceiling assembly rating for [[1][1-1/2][2][3][4] hour [concealed grid system][exposed grid system]][as shown on drawings]. Provide acoustical units with a flame spread of 25 or less and smoke development of 50 or less when tested in accordance with ASTM E84.

Submit manufacturer's catalog showing UL classification of fire-rated ceilings giving materials, construction details, types of floor and roof constructions to be protected, and UL design number and fire protection time rating for each required floor or roof construction and acoustic ceiling assembly.

Submit reports by an independent testing laboratory attesting that acoustical ceiling systems meet specified [fire endurance] [and] [sound transmission] requirements. Data attesting to conformance of the proposed system to Underwriters Laboratories requirements for the fire endurance rating listed in UL Fire Resistance may be submitted in lieu of test reports.

2.1.2 Acoustical Performance

2.1.2.1 Ceiling Sound Transmission

****

NOTE: In open spaces without partitions and areas where enclosed rooms have partitions that extend full height to the floor or roof above, Ceiling Attenuation Class (CAC) is not applicable and should not be specified unless required by an acoustician. Where enclosed rooms do not have full-height partitions, the sound transmission path through the plenum could prevent acoustical privacy between rooms. Ensure the CAC rating of the acoustical ceiling system, including all building services components, is equivalent to the STC rating of the partitions. It is ineffective for the acoustical ceiling to have a CAC rating that is lower or higher than the STC rating of the partition. Penetrations through the acoustical ceiling for light fixtures, air terminals, etc. can decrease the CAC rating of the ceiling system below that of the ceiling panel by 10 points. Verify that other specification sections and the drawings include appropriate noise

control measures such as light fixture covers, a ducted return air system, return air grille silencers, etc. so the penetrations do not degrade the CAC rating below the STC rating of the partition. Speech privacy between rooms typically requires partitions with STC ratings of 40-50. Limited acoustical ceiling panels can achieve CAC rating above 40 and these panels often do not comply with the specified sound absorption ratings. Lightweight, acoustic, plenum barriers oriented vertically over the partitions can increase the CAC rating of the acoustical ceiling system from CAC 20-35 to CAC 40-50 so that it matches the acoustical performance of the partition. Expected speech privacy levels with specific constructions: STC/CAC 40 minimal; STC/CAC 45 - acceptable; STC/CAC 50 - optimal. Speech privacy should not be expected for construction below STC/CAC 40. Some highly confidential rooms may require full height walls with STC ratings above 50.

****

Provide ceiling systems with the specified Ceiling Attenuation Class (CAC) ratings as determined in accordance with ASTM E1414/E1414M and ASTM E413. Provide sound attenuators over light fixtures, air terminals and other ceiling penetrations, provide acoustical blanket insulation on top of the ceiling or adjacent to partitions to provide lightweight acoustical plenum barriers above partitions as required to achieve the specified CAC ratings. Provide test ceiling continuous at the partition and assembled in the suspension system in the same manner that the ceiling will be installed on the project.

2.1.2.2 Ceiling Sound Absorption

****

NOTE: Ceiling panel sound absorption can be specified using Noise Reduction Coefficient (NRC) or Attenuation Class (AC). NRC is more common and used when the concern is general reverberation, loud occupant noise levels or speech intelligibility inside enclosed rooms. AC is sometimes used instead of NRC when the concern is speech privacy in mostly open areas, particularly open offices. The two metrics are highly correlated.

Ceilings in rooms and areas that are normally occupied by people should have a minimum NRC of 0.70. This level of absorption is appropriate for enclosed rooms with one person and no (or limited) noisy equipment. Ceilings in enclosed rooms with multiple people or with noisy equipment should have a minimum NRC of 0.80. Ceilings in open areas, especially those with high density occupancy should have a minimum NRC of 0.90 (or AC of 180).

****

Determine the Noise Reduction Coefficient (NRC) in accordance with ASTM C423. Determine Articulation Class (AC) in accordance with ASTM E1111/E1111M.

2.1.3 Light Reflectance

Determine light reflectance factor in accordance with ASTM E1477 test method.

2.2 ACOUSTICAL UNITS

****

NOTE: Color, class, pattern, NRC, LR coefficient, CAC, and type of acoustical ceiling units must be shown, as required, on the drawings when more than one type acoustical unit is specified for a project.

Color and pattern must be coordinated with the drawings, and this section when more than one type acoustical unit is specified for a project.

When a specific pattern, as shown in ASTM E1264 is required, specify the applicable one and delete other patterns; otherwise, specify all patterns as Contractor's options. Ascertain that a specific pattern required is commercially available in the type unit specified since some type units are available only in certain patterns. Specialized patterns must be described in detail within the bracketed blank space.

Acoustical units will be limited generally to Types III and IV and Type XX (stone wool, fiberglass). Metal-faced units (Types V, VI, VII, and VIII), and fabric faced overlay (Type XI), because of the higher cost factor, will not normally be considered.

Composition units with paint finish are lowest in cost and available in widest variety of patterns. Types III and IV are available in three forms: Form 1 (nodulated, cast, or molded) is appropriate for high quality areas such as conference rooms, and officers dining facilities. It is more costly than forms 2 (water-felted) and 3 (dry-felted). Type XX is available in a wide price range. All options have smooth, non-fissured surfaces.

Type I - Cellulose composition with standard washable painted finish (not listed as an option in this specification)

Type II - Cellulose composition with plastic membrane-faced overlay (not listed as an option in this specification)

Type III - Mineral composition with standard washable painted finish

Type IV - Mineral composition with plastic membrane-faced overlay

Type V - Steel facings with mineral composition absorbent backing

Type VI - Stainless steel with mineral composition absorbent backing

Type VII - Aluminum with mineral composition absorbent backing

Type VIII - Cellulose composition with scrubbable pigmented or clear finish (not listed as an option in this specification)

Type IX - Mineral composition with scrubbable pigmented or clear finish

Type X - Mineral composition with plastic/aluminum membrane

Type XX - Stone wool or fiberglass composition with membrane-faced overlay and painted finish.

Type XI - Mineral composition with fabric overlay

Type XII - Glass fiber composition with plastic/cloth overlay

Type III or IV units should be used except when any of the following conditions exist, one of the types listed below should be specified:

High Humidity - Aluminum or stainless steel pans with mineral wool pads. Humidity resistant mineral composition units.

Staining or Heavy Soiling - Composition units with plastic film face. Metal pan units. Metal faced composition units.

Impact Abrasion - Metal pan units. Impact resistant composition units. Metal faced composition units.

Metal pan units with pads cannot be used when space above the ceiling is used as an air plenum for heating, ventilating or air conditioning systems.

Pattern -

A. Perforated, regularly spaced large holes perforated
B. Perforated, randomly spaced large holes
C. Perforated, small holes
D. Fissured
E. Lightly textured
F. Heavily textured
G. Smooth
H. Printed
I. Embossed
J. Embossed-in-register
K. Surfaced Scored
L. Random Swirl

M. Other patterns (specify)

Mineral fiber Type III, IV, IX, and XI acoustical ceiling units offer a combination of rated fire resistance, flame spread classification, acoustical performance, and design versatility. Units are available in a variety of configurations ranging from flat panels with simple textured surfaces to panels with detailed edges or carved patterns and motifs. Cost generally increases with the complexity of design and increase of thickness and/or unit weight.

Fiberglass Type XII acoustical ceiling units are available cloth-faced and vinyl-faced. The fiberglass units have high acoustical performance, thermal insulation value, and moisture resistance ratings. The cloth faced units are good for open-office installations and areas such as libraries that require high acoustical absorption. The vinyl-faced fiberglass units, because of their washable vinyl face, are good for use in buildings with supply and return-air ducts in the ceiling.

Light Reflectance - A lower light reflectance may be specified when desired for special architectural or lighting effects. The available LR (light reflection factor) are LR-1 (0.75 minimum), LR-2 (0.70 minimum), LR-3 (0.65 minimum), LR-4 (0.60 minimum).

Edge Detail - Rabbeted edges may be specified to permit face of panels to project below surface of exposed grid system. Strong sidelighting at low angle of incidence in concealed suspension systems will greatly exaggerate surface irregularities; beveled edge tiles are suggested for such locations.

Review manufacturer's literature and edit the following paragraphs.
****

Submit samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color. Conform acoustical units to ASTM E1264, Class A, and the following requirements:

2.2.1 Units for Exposed-Grid System [A] [_____]

****
NOTE: In facilities where several different NRC values are specified, clearly indicate which room or areas should receive lay-in panels of a specific NRC value.
****

2.2.1.1 Type

****
NOTE: Use materials with recycled content where appropriate for use. Verify suitability,

availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Where minimums are stated, research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets.

****

[III (non-asbestos mineral fiber with painted finish).[Provide Type III Acoustical Ceiling Tiles containing a minimum of 30 percent recycled content. Provide data identifying percentage of recycled content for Type III ceiling tiles. Provide certification of indoor air quality for Type III Ceiling Tiles.]]

[IV (non-asbestos mineral fiber with membrane-faced overlay).[Provide Type IV Acoustical Ceiling Tiles containing a minimum of 60 percent recycled content. Provide data identifying percentage of recycled content for Type IV ceiling tiles. Provide certification of indoor air quality for Type IV Ceiling Tiles.]]

[IX (mineral fiber with scrubbable finish).[Provide Type IX Acoustical Ceiling Tiles containing a minimum [50][_____] percent recycled content. Provide data identifying percentage of recycled content for Type IX ceiling tiles. Provide certification of indoor air quality for Type IX Ceiling Tiles.]]

[X (mineral composition with plastic membrane).[Provide certification of indoor air quality for Type X Ceiling Tiles.]]

[XI (mineral fiber with fabric faced overlay).[Provide certification of indoor air quality for Type XI Ceiling Tiles.]]

[XII (fiberglass base with membrane-faced overlay).[Provide Type XII Acoustical Ceiling Tiles containing a minimum of [25][_____] percent recycled content. Provide data identifying percentage of recycled content for Type XII ceiling tiles. Provide certification of indoor air quality for Type XII Ceiling Tiles.]]

2.2.1.2 Flame Spread

Class A, 25 or less

2.2.1.3 Pattern

[A] [B] [C] [D] [E] [F] [G] [I] [J] [K] [_____]

2.2.1.4 Minimum NRC

[_____] when tested on mounting Type E-400 of ASTM E795.

2.2.1.5 Minimum Light Reflectance Coefficient

[LR-1, 0.75 or greater] [_____]

2.2.1.6 Nominal Size

[600 by 1200][600 by 600][_____] mm[24 by 48][24 by 24][_____] inch

2.2.1.7 Edge Detail

[Square] [Reveal] [Trimmed and butt] [Beveled] [Tegular] [_____]

2.2.1.8 Finish

Factory-applied standard finish. See paragraph COLORS AND STANDARDS.

2.2.1.9 Minimum CAC

[_____]

2.2.2 Units for Concealed-Grid System [A] [_____]

2.2.2.1 Type

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Where minimums are stated, research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets.

****

[III (non-asbestos mineral fiber with painted finish).[Provide Type III Acoustical Ceiling Tiles containing a minimum of 30 percent recycled content. Provide data identifying percentage of recycled content for Type III ceiling tiles. Provide certification of indoor air quality for Type III Ceiling Tiles.]]

[IV (non-asbestos mineral fiber with membrane-faced overlay).[Provide Type IV Acoustical Ceiling Tiles containing a minimum of 60 percent recycled content. Provide data identifying percentage of recycled content for Type IV ceiling tiles. Provide certification of indoor air quality for Type IV Ceiling Tiles.]]

[IX (mineral fiber with scrubbable finish).[Provide Type IX Acoustical Ceiling Tiles containing a minimum of [50][_____] percent recycled content. Provide data identifying percentage of recycled content for Type

IX ceiling tiles. Provide certification of indoor air quality for Type IX Ceiling Tiles.]]

[X (mineral composition with plastic membrane).[Provide certification of indoor air quality for Type X Ceiling Tiles.]]

[XI (mineral fiber with fabric faced overlay).[Provide certification of indoor air quality for Type XI Ceiling Tiles.]]

[XII (fiberglass base with membrane-faced overlay).[Provide Type XII Acoustical Ceiling Tiles containing a minimum of [25][_____] percent recycled content. Provide data identifying percentage of recycled content for Type XII ceiling tiles. Provide certification of indoor air quality for Type XII Ceiling Tiles.]]

2.2.2.2 Flame Spread

Class A, 25 or less

2.2.2.3 Pattern

[A] [B] [C] [D] [E] [F] [G] [I] [J] [K] [_____]

2.2.2.4 Minimum NRC

[_____] when tested on mounting Type B or Type E-400 of ASTM E795

2.2.2.5 Minimum Light Reflectance Coefficient

[LR-1, 0.75 or greater] [_____]

2.2.2.6 Nominal Size

[300 by 300][600 by 600][600 by 1200][_____] mm[12 by 12][24 by 24][24 by 48][_____] inch

2.2.2.7 Edge Detail

[Manufacturer's standard] [Beveled] [Square]

2.2.2.8 Joint Detail

[Kerfed and rabbeted] [Tongue and grooved] [Butted]

2.2.2.9 Finish

Factory-applied standard finish. See paragraph COLORS AND PATTERNS.

2.2.2.10 Minimum CAC

[_____]

2.2.3 Metal Pans [A] [_____]

2.2.3.1 Type

[V, steel.[Provide certification of indoor air quality for Type V Ceiling Tiles.]]

[VI, ASTM A167 stainless steel.[Provide certification of indoor air quality for Type VI Ceiling Tiles.]]

[VII, aluminum perforated pans with acoustical, non-asbestos, insulation backing.[Provide certification of indoor air quality for Type VII Ceiling Tiles.]]

2.2.3.2 Flame Spread

Class: A, 25 or less

2.2.3.3 Pattern

[A] [C] [I] [_____]

2.2.3.4 Minimum NRC

[0.75] [_____] in open office areas; [0.60] [_____] in conference rooms, executive offices, teleconferencing rooms, and other rooms as designated; [0.50] [_____] in all other rooms and areas when tested on mounting Type E-400 of ASTM E795.

2.2.3.5 Minimum Light Reflectance Coefficient

[LR-1, 0.75 or greater] [_____]

2.2.3.6 Nominal Size

[600 by 600][600 by 1200][_____] mm[24 by 24][24 by 48][_____] inch

2.2.3.7 Edge Detail

[Manufacturer's standard] [Square] [Reveal] [_____].

2.2.3.8 Joint Detail

[Beveled] [_____]

2.2.3.9 Finish

Factory-applied standard finish. See paragraph COLORS AND PATTERNS.

2.2.3.10 Pads

[Completely enclosed, of material and thickness required for acoustical and fire test ratings] [_____].

2.2.4 Impact/Abrasion Resistant Units

2.2.4.1 Type

Non-asbestos mineral composition with a hardened mineral surface and factory applied white paint finish. Provide a surface resistant to impact and abrasion.[Provide certification of indoor air quality for Impact/Abrasion Resistant Ceiling Tiles.]

2.2.4.2 Flame Spread

Class A, 25 or less

2.2.4.3 Pattern

[_____]

2.2.4.4 Minimum NRC

[_____] when tested on Mounting Type E-400 of ASTM E795.

2.2.4.5 Minimum Light Reflectance Coefficient

[LR-1, 0.75 or greater][_____]

2.2.4.6 Nominal Size

[600 by 600] [600 by 1200] [_____] mm[24 by 24] [24 by 48] [_____] inch

2.2.4.7 Edge Detail

[Manufacturer's standard] [Square] [Beveled]

2.2.4.8 Joint Detail

[Trimmed and butted] [Kerfed and rabbeted]

2.2.4.9 Finish

Factory-applied standard finish. See paragraph COLORS AND PATTERNS.

2.2.5 Humidity Resistant Composition Units

2.2.5.1 Type

Non-asbestos mineral or glass fibers bonded with ceramic, moisture resistant thermo-setting resin, or other moisture resistant material and having a factory applied white paint finish. Provide panels that do not sag or warp under conditions of heat, high humidity or chemical fumes.

[Provide certification of indoor air quality for Humidity Resistant Ceiling Tiles.]

2.2.5.2 Flame Spread

Class: A, 25 or less

2.2.5.3 Pattern

[_____]

2.2.5.4 Minimum NRC

[_____] when tested on Mounting Type E-400 of ASTM E795.

2.2.5.5 Minimum Light Reflectance Coefficient

LR-1, 0.75 or greater

2.2.5.6 Nominal Size

[600 by 600][600 by 1200][_____] mm[24 by 24][24 by 48][_____] inch

2.2.5.7 Edge Detail

Square

2.2.5.8 Finish

Factory-applied standard finish. See paragraph COLORS AND PATTERNS.

2.2.6 Metal Faced Composition Units

2.2.6.1 Type

[Type V (Steel facings with non-asbestos mineral composition absorbent backing).[Provide certification of indoor air quality for Type V Ceiling Tiles.]]

[Type VI (Stainless steel facings with non-asbestos mineral composition absorbent backing).[Provide certification of indoor air quality for Type VI Ceiling Tiles.]]

[Type VII (Aluminum facings with non-asbestos mineral composition absorbent backing) with [anodized] [baked enamel] [acrylic] finish color [white] [_____].[Provide certification of indoor air quality for Type VII Ceiling Tiles.]]

2.2.6.2 Flame Spread

Class: A, flame spread 25 or less

2.2.6.3 Pattern

[_____]

2.2.6.4 Minimum (NRC)

Base the tested NRC value on Mounting Type E-400 of ASTM E795.

2.2.6.5 Minimum Light Reflectance Coefficient

LR-1, 0.75 or greater

2.2.6.6 Nominal Size

[600 by 600][600 by 1200] mm[24 by 24][24 by 48] inch

2.2.6.7 Edge Detail

[Manufacturer's standard][Square][Beveled]

2.2.6.8 Joint Detail

Trimmed and butted

2.2.6.9 Finish

Factory-applied standard finish. See paragraph COLORS AND PATTERNS.

2.2.7 Unit Acoustical Absorbers

****

NOTE: Unit acoustical absorbers should be used in high noise areas such as bowling alleys, industrial areas or in other locations when recommended by an acoustical consultant. Quantity and spacing should be shown on the drawings.

****

Provide individually mounted sound absorbing plaques composed of glass fibers or non-asbestos mineral fibers and having a NRC range of not less than 0.60 - 0.70 when tested in accordance with ASTM C423 and reported as a 4 frequency average.

2.3 SUSPENSION SYSTEM

****

NOTE: If more than one type of acoustical unit is required, a separate paragraph for that type unit will be used. Each unit type will be designated with a letter or number symbol, such as A, B, etc. Use the same letters or numbers to key unit types to locations listed or shown on the drawings and in Section 09 06 00 SCHEDULES FOR FINISHES.

Each different type of suspension system must be shown on the drawings.

Generally, lay-in panels supported by exposed grid suspension system provide most economical installation and allow greatest access to space above ceiling. Where lay-in panels are subject to displacement by building occupants or where ceiling must be directly attached to underside of structural system, concealed framing system may be more appropriate. In lobbies, auditoriums, chapels or clubs where a monolithic appearance may be desired, greater expense of concealed suspension system may be justified. Downward access concealed systems should not be specified in areas of high seismic activity.

An intermediate-duty suspension system should be specified when the minimum load-carrying capacity of the main runner is 175 N per m 12 pounds per linear foot on a simple span of 1200 mm 4 feet without the mid-span deflection exceeding 1/360th of the span. Intermediate-duty systems are used primarily for ordinary commercial structures where some ceiling loads, due to light fixtures and air diffusers are anticipated.

A heavy-duty suspension system should be specified when the above described minimum load-carrying

capacity is 230 N per m 16 pounds per linear foot. Heavy-duty systems are used when ceiling loads are greater than ordinary commercial construction. See ASTM C635/C635M for load testing methods for metal suspension systems for acoustical tile and lay-in panel ceilings.

Select classification required to support ceiling load including acoustical units, lights and other items supported by suspension system. Light duty should be specified for residential construction only. Load carrying capacities based on 1200 mm (4 foot) hanger spacing:

Classification	**kg/meter lb/Linear Foot of Main Runner**		
	Direct Hung	**Indirect Hung**	**Furring Bar**
Light Duty	**7.44 5.0**	**2.98 2.0**	**6.7 4.5**
Intermediate Duty	**17.86 12.0**	**5.21 3.5**	**9.67 6.5**
Heavy Duty	**23.81 16.0**	**11.91 8.0**	**-**

Corner caps are not available in all types of wall moldings and are an extra cost item when available.

Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the second bracketed phrase, in the last sentence, if no seismic details are provided.

****

Provide [[standard] [fire-resistive] [snap-in metal pan]] [[exposed-grid] [indirect hung concealed H and T or Zee] [direct hung, concealed, downward access] [direct hung, concealed, upward access]] [[standard width flange] [narrow width flange] [narrow width slotted flange]] [as indicated] suspension system conforming to ASTM C635/C635M [for intermediate-duty systems] [for heavy-duty systems]. Provide surfaces exposed to view of [aluminum or steel with a factory-applied [white] [black] [color] baked-enamel finish] [aluminum with a clear anodized finish] [aluminum with colored factory-applied vinyl paint finish]. Provide wall molding having a flange of not less than [24 mm 15/16 inch] [_____]. Provide [inside and outside corner caps] [[standard] [overlapped] [mitered] corners]. Provide a suspension system with a maximum deflection of 1/360 of the span length capable of supporting the finished ceiling, light fixtures, air diffusers, and accessories, as shown.[Conform seismic details [to the guidance in UFC 3-301-01 and ASTM E580/E580M] [as indicated].]

[Provide Suspension System containing a minimum of 15 percent recycled content. Provide data identifying percentage of recycled content for suspension systems.]

2.4 HANGERS

****

NOTE: Construction drawings should include a detail drawing showing splayed and countersplayed suspension system hanger wires.
****

Provide hangers and attachment capable of supporting a minimum 1334 N 300 pound ultimate vertical load without failure of supporting material or attachment.

2.4.1 Wires

****
NOTE: Select stainless steel or nickel copper alloy wire for facilities where high humidity can be expected such as large kitchens, dishwashing areas, or indoor swimming pools. Select zinc-coated steel wire for other locations.

When spacing of hanger wires exceeds 1219 mm 4 feet or when heavy loads are supported, 3.25 or 2.59 mm 8 or 10 gauge wire should be specified.
****

Conform wires to [ASTM A641/A641M, Class 1, [2.0] [_____] mm [0.08 inch (12 gauge)] [[_____] inch] in diameter.] [ASTM A580/A580M, composition 302 or 304, condition annealed stainless steel, [2.0] [_____] mm [0.08 inch (12 gauge)] [[_____] inch] in diameter.]

2.4.2 Straps

****
NOTE: Normally wire hangers should be used. If the project is in an area subject to violent storms, steel straps or rod hangers should be specified.
****

Provide straps of 25 by 5 mm 1 by 3/16 inch galvanized steel conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

2.4.3 Rods

****
NOTE: Normally wire hangers should be used. If the project is in an area subject to violent storms, steel straps or rod hangers should be specified.
****

Provide 5 mm 3/16 inch diameter threaded steel rods, zinc or cadmium coated.

2.4.4 Eyebolts

Provide eyebolts of weldless, forged-carbon-steel, with a straight-shank in accordance with ASTM A489. Provide minimum [_____] [6] mm [1/4] inch, [zinc coated][cadmium plated] eyebolts.

2.4.5 Masonry Anchorage Devices

Comply with [ASTM C636/C636M] [_____] for anchorage devices for [eyebolts] [machine screws] [wood screws].

2.5 ACCESS PANELS

****

NOTE: Include this paragraph only when access panels are specified in paragraph titled SUSPENSION SYSTEM. Delete identification code numbers and systems not applicable to the particular project and add additional numerical codes and system descriptions if necessary. Code numbers and corresponding system descriptions must remain unchanged, i.e., if "sprinkler system" is omitted, the code number "6" will also be omitted from the listing.

****

Provide access panels that match adjacent acoustical units, designed and equipped with suitable framing and fastenings for removal and replacement without damage. Size panel to be not less than 300 by 300 mm 12 by 12 inch or more than 300 by 600 mm 12 by 24 inch.

a. Attach an identification plate of 0.8 mm 0.032 inch thick aluminum, 19 mm 3/4 inch in diameter, stamped with the letters "AP" and finished the same as the unit, near one corner on the face of each access panel.

b. Identify ceiling access panel by a number utilizing white identification plates or plastic buttons with contrasting numerals. Provide plates or buttons of minimum 25 mm 1 inch diameter and securely attached to one corner of each access unit. Provide a typewritten card framed under glass listing the code identification numbers and corresponding system descriptions listed above. Mount the framed card where directed and furnish a duplicate card to the Contracting Officer. Code identification system is as follows:

(1) Fire detection/alarm system

(2) Air conditioning controls

(3) Plumbing system

(4) Heating and steam systems

(5) Air conditioning duct system

(6) Sprinkler system

(7) Intercommunication system

[(8) Nurse's call system

][(9) Pneumatic tube system

][(10) Medical piping system

] (11) Program entertainment

(12) Telephone junction boxes

[(13) Detector X-ray

] (14) [_____]

2.6 ADHESIVE

****

NOTE: Tiles larger than 300 by 600 mm 12 by 24 inch should not be attached by adhesive method.

****

****

NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the bracketed sentences below requiring products with indoor air quality certifications as defined in Part 1 of this specification.

****

Use adhesive as recommended by tile manufacturer. [Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. For products located on the interior of the building (inside of the weatherproofing system), provide certification or validation of indoor air quality for adhesives.]

2.7 FINISHES

Use manufacturer's standard textures, patterns and finishes as specified for acoustical units and suspension system members. Treat ceiling suspension system components to inhibit corrosion.

2.8 COLORS AND PATTERNS

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an architect or interior designer. Color must be selected from manufacturers' standard colors or identified as a manufacturer's color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located in the drawings a note must be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.
****

Use colors and patterns for acoustical units and suspension system components [as specified in Section 09 06 00 SCHEDULES FOR FINISHES][as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers].

2.9 ACOUSTICAL SEALANT

****
NOTE: For projects where these products are located on the interior of the building (defined as inside of the weatherproofing system), include the bracketed sentences below requiring products with indoor air quality certifications as defined in Part 1 of this specification.
****

Conform acoustical sealant to ASTM C834, nonstaining. [Provide sealants used on the interior of the building (defined as inside of the weatherproofing system)][in accordance with requirements of Section 07 92 00 JOINT SEALANTS.][that meet either emissions requirements of CDPH SECTION 01350 (limit the requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. For products located on the interior of the building (inside of the weatherproofing system), provide certification of indoor air quality for Sealants.]

PART 3 EXECUTION

3.1 INSTALLATION

****
NOTE: Adhesive method of application should not be used for new construction. It may be used for application to existing ceiling surfaces in remodel work.
****

Do not install building construction materials that show visual evidence of biological growth.

Examine surfaces to receive directly attached acoustical units for unevenness, irregularities, and dampness that would affect quality and execution of the work. Rid areas, where acoustical units will be cemented, of oils, form residue, or other materials that reduce bonding capabilities of the adhesive. Complete and dry interior finish work such as plastering, concrete, and terrazzo work before installation. Complete and approve mechanical, electrical, and other work above the ceiling line prior to the start of acoustical ceiling installation. Provide acoustical work complete with necessary fastenings, clips, and other accessories required for a complete installation. Do not expose mechanical fastenings in the finished work. Lay out hangers for each individual room or space. Provide hangers to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Keep main runners and carrying channels clear of abutting walls and partitions. Provide at least two main runners for each ceiling span. Wherever required to bypass an object with the hanger wires, install a subsuspension system so that all hanger wires will be plumb.

3.1.1 Suspension System

Install suspension system in accordance with ASTM C636/C636M and as specified herein. Do not suspend hanger wires or other loads from underside of steel decking.

3.1.1.1 Plumb Hangers

Install hangers plumb and not pressing against insulation covering ducts and pipes. Where lighting fixtures are supported from the suspended ceiling system, provide hangers at a minimum of four hangers per fixture and located not more than 152 mm 6 inch from each corner of each fixture.

3.1.1.2 Splayed Hangers

****

NOTE: The designer will add a detail to the construction drawings detailing the proper method of splaying and countersplaying hangers when hangers must be splayed (sloped or slanted) around obstructions.

****

Splay (slope or slant) hangers around obstructions, offsetting the resulting horizontal force by bracing, countersplaying, or other acceptable means.

3.1.2 Wall Molding

Provide wall molding where ceilings abut vertical surfaces. Miter corners where wall moldings intersect or install corner caps. Secure wall molding not more than 76 mm 3 inch from ends of each length and not more than 406 mm 16 inch on centers between end fastenings. Provide wall molding springs at each acoustical unit in semi-exposed or concealed systems.

3.1.3 Acoustical Units

****

NOTE: In areas where the ceiling will be subject to impact or where lay-in ceiling units are subject to pressure differentials between the air plenum above the ceiling and the space below, units will be specified to be held in place with manufacturer's standard hold-down clips.

If the ceiling has a fire endurance rating or the panels weigh less than 4.9 kilograms per square meter 1.0 pound per square foot, hold down clips are

required. Hold down clips may also be specified where frequent cleaning is required to prevent displacement during cleaning.
****

Install acoustical units in accordance with the approved installation instructions of the manufacturer. Ensure that edges of acoustical units are in close contact with metal supports, with each other, and in true alignment. Arrange acoustical units so that units less than one-half width are minimized. Hold units in exposed-grid system in place with manufacturer's standard hold-down clips, if units weigh less than 4.9 kg/square meter 1 psf or if required for fire resistance rating.

3.1.4 Acoustical Sealant

****
NOTE: Specify acoustical sealant only when the space above the ceiling will be used as an air plenum, or when required to reduce sound transmission between rooms.
****

Seal all joints around pipes, ducts or electrical outlets penetrating the ceiling. Apply a continuous ribbon of acoustical sealant on vertical web of wall or edge moldings.

3.1.5 Adhesive Application

****
NOTE: Adhesive method of application should not be used for new construction. It may be used for application to existing ceiling surfaces in remodel work. Tiles larger than 300 by 600 mm 12 by 24 inch should not be attached by the adhesive method.
****

Wipe back of tile to remove accumulated dust. Daub acoustical units on back side with four equal daubs of adhesive. Apply daubs near corners of tiles. Ensure that contact area of each daub is at least 51 mm 2 inch diameter in final position. Press units into place, aligning joints and abutting units tight and uniform without differences in joint widths.

3.2 CEILING ACCESS PANELS

Locate ceiling access panels directly under the items which require access.

3.3 CLEANING

Following installation, clean dirty or discolored surfaces of acoustical units and leave them free from defects. Remove units that are damaged or improperly installed and provide new units as directed.

[3.4 RECLAMATION PROCEDURES

****
NOTE: If the job requires removal of acoustical ceiling systems, or acoustical units are left over from new construction, the decision to recycle must be weighed against the cost of packaging and

transportation, especially in remote areas. Most mineral fiber and fiberglass ceilings can be recycled. The following ceiling tiles cannot be recycled: 1) Faced materials (vinyl faced, mylar, metal faced). 2) Molded or cast ceiling products and glue up ceiling tiles (either 300 by 300 mm 12 by 12 inch or 300 by 600 mm 12 by 24 inch panels). 3) Fiberglass panels. 4) Ceramic based tiles. 5) Some proprietary products.

****

Neatly stack completely dry ceiling tile, designated for recycling by the Contracting Officer, on 1219 by 1219 mm 4 by 4 foot pallets not higher than 1219 mm 4 foot. Shrink wrap and symmetrically stack pallets on top of each other without falling over.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 62 38 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 62 38 (November 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-09 62 38 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
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****

SECTION 09 62 38

STATIC-CONTROL FLOORING

08/17, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for static-control resilient flooring over a concrete surface and static-control carpet over concrete or access flooring.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the

Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC 16	(2004; E 2008; E 2010) Colorfastness to Light
AATCC 107	(2013) Colorfastness to Water
AATCC 165	(2013) Colorfastness to Crocking: Textile Floor Coverings - Crockmeter Method

ASTM INTERNATIONAL (ASTM)

ASTM D5793	(2018) Standard Test Method for Binding Sites Per Unit Length or Width of Pile Yarn Floor Coverings
ASTM D5848	(2020) Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Coverings
ASTM D6859	(2011) Standard Test Method for Pile Thickness of Finished Level Pile Yarn Floor Coverings
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F150	(2006; R 2013) Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring
ASTM F1344	(2021a) Standard Specification for Rubber Floor Tile
ASTM F1700	(2024) Standard Specification for Solid Vinyl Floor Tile
ASTM F1859	(2021a) Standard Specification for Rubber Sheet Floor Covering Without Backing
ASTM F1861	(2021) Standard Specification for Resilient Wall Base
ASTM F1869	(2023) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

ASTM F2170	(2019a) Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CARPET AND RUG INSTITUTE (CRI)

CRI 104	(2015) Carpet Installation Standard for Commercial Carpet
CRI 105	(2015) Carpet Installation Standard for Residential Carpet
CRI Green Label Plus	(2017) Green Label Plus Quality Manual

ELECTROSTATIC DISCHARGE ASSOCIATION (ESD)

ESD S6.1	(2019) Standard for the Protection of Electrostatic Discharge Susceptible Items – Grounding

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2551	(2020) Textile Floor Coverings and Textile Floor Coverings in Tile Form-Determination of Dimensional Changes Due to the Effects of Varied Water and Heat Conditions and Distortion Out of Plane

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 99	(2024) Health Care Facilities Code

RESILIENT FLOOR COVERING INSTITUTE (RFCI)

FLOORSCORE	FLOORSCORE IAQ Certification

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program

For Chemical Emissions For Building
Materials, Finishes And Furnishings

1.2 SCHEDULING

Schedule static-control flooring work after any other work which would damage the finished surface of the flooring.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Static-Control Resilient Flooring; G, [_____]

Recycled content for Conductive Vinyl Tile; S

Recycled content for Conductive Rubber Tile; S

Recycled content for Conductive Rubber Sheet Flooring; S

Recycled content for Static-Dissipative Vinyl Tile; S

Recycled content for Static-Control Carpet; S

Accessories; G, [_____]

Adhesives; G, [_____]

Warranty

SD-04 Samples

Static-Control Resilient Flooring; G, [_____]

Static-Control Carpet; G, [_____]

Moldings; G, [_____]

Special Treatment Materials; G, [_____]

Accessories; G, [_____]

SD-06 Test Reports

Fire Resistance

Moisture, Alkalinity and Bond

Testing

SD-07 Certificates

Indoor Air Quality for Conductive Vinyl Tile; S

Indoor Air Quality for Conductive Rubber Tile; S

Indoor Air Quality for Conductive Rubber Sheet Flooring; S

Indoor Air Quality for Static-Dissipative Vinyl Tile; S

Indoor Air Quality for Static-Dissipative Rubber Tile; S

Indoor Air Quality for Static-Control Carpet; S

Indoor Air Quality for Adhesives; S

Qualifications of Applicator

SD-08 Manufacturer's Instructions

Static-Control Resilient Flooring; G, [_____]

Accessories; G, [_____]

SD-10 Operation and Maintenance Data

Static-Control Resilient Flooring; G, [_____]

Accessories; G, [_____]

1.3.1 Samples

1.3.1.1 Static-Control Resilient Flooring

Submit [three][_____] samples of each indicated color and type of flooring, base, moldings, and accessories sized a minimum 60 by 100 mm 2-1/2 by 4 inch.

1.3.1.2 Static-Control Carpet

Submit [three][_____] "Production Quality" samples 450 by 450 mm 18 by 18 inches of each carpet proposed for use, showing quality, pattern, and color specified.

1.3.1.3 Moldings

Submit [three][_____] pieces of each type at least 300 mm 12 inches long.

1.3.1.4 Special Treatment Materials

Submit [three][_____] samples showing system and installation method.

1.3.1.5 Operations and Maintenance Data

a. Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Submit [three][_____] copies of manufacturer's maintenance instructions for each type of flooring material describing recommended type of cleaning equipment and materials, spotting and cleaning methods, and cleaning cycles.

1.4 CERTIFICATIONS

1.4.1 Indoor Air Quality Certifications

1.4.1.1 Floor Covering Materials

Provide [Conductive Vinyl Tile][Conductive Rubber Tile][Conductive Rubber Sheet Flooring][Static-Dissipative Vinyl Tile][Static-Dissipative Rubber Tile] and wall base products certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide [Static-Control Carpet] certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold, CRI Green Label Plus or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body.

1.4.1.2 Adhesives

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body.

1.5 EXTRA MATERIALS

Provide extra material from same dye lot for future maintenance. Provide a minimum of [_____] percent of total square meters square yards of each flooring and base type, pattern, and color.

1.6 QUALITY ASSURANCE

The flooring manufacturer will approve the Qualifications of Applicator and certify that he/she has a minimum of 3 years of experience in the application of the materials to be used.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in original unopened containers bearing the manufacturer's name, style name, pattern color name and number, size, production run, project identification, handling instructions and related information. Observe ventilation and safety procedures specified in the Safety Data Sheets (SDS). Do not store flooring near materials that may off-gas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.7.1 Static-Control Resilient Flooring

Store materials in a clean, dry, secure, and well-ventilated area free from strong contaminant sources and residues with ambient air temperature range as recommended by the manufacturer but not less than 20 degrees C 68 degrees F or more than 30 degrees C 85 degrees F. Stack materials according to manufacturer's recommendations. Protect materials from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances.

1.7.2 Static-Control Carpet

Remove materials from packaging and store them in a clean, dry, well ventilated area protected from damage, soiling, and moisture, and maintain at a temperature range as recommended by the manufacturer but not less than 16 degrees C 60 degrees F or more than 32 degrees C 90 degrees F for 2 days prior to installation.

1.8 ENVIRONMENTAL CONDITIONS

Provide temporary ventilation during work of this section.

1.8.1 Static-Control Resilient Flooring

Maintain areas in which resilient flooring is to be installed at a temperature range as recommended by the manufacturer but not less than 20 degrees C 68 degrees F or more than 30 degrees C 85 degrees F for 3 days before application, during application and 2 days after application, unless otherwise directed by the flooring manufacturer for the flooring being installed. Maintain a minimum temperature range as recommended by the manufacturer but not less than 13 degrees C 55 degrees F thereafter for the duration of the contract. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

1.8.2 Static-Control Carpet

Maintain areas in which carpeting is to be installed at a temperature range as recommended by the manufacturer but not less than 16 degrees C 60 degrees F or more than 32 degrees C 90 degrees F for 2 days before installation, during installation, and for 2 days after installation. Maintain a minimum temperature range as recommended by the manufacturer but not less than 13 degrees C 55 degrees F thereafter for the duration of the contract. Do not permit traffic or movement of furniture or equipment in carpeted area for 24 hours after installation.

1.9 WARRANTY

1.9.1 Static-Control Resilient Flooring

Provide manufacturer's standard performance guarantees or warranties including a five year wear warranty and ten year conductivity warranty.

1.9.2 Static-Control Carpet

Provide manufacturer's standard performance guarantees or warranties including a minimum two years for material and workmanship and ten years for wear, static control, tuft bind and delamination.

PART 2 PRODUCTS

2.1 STATIC-CONTROL RESILIENT FLOORING

****

NOTE: Consider the function of the room, User requirements and consult with the project electrical engineer when determining the type of flooring that is appropriate.

Street shoes generate static electricity with all finish flooring types. Dependent on the function of the room and flooring material specified, special footwear may be required. The special footwear and flooring should be tested as a whole system. Verify with the user if and what type of special footwear will be used (such as ESD shoes or conductive heel straps). If the proper special footwear will not be worn on the static-control floor, a type of static-control flooring that provides very low static generation without special footwear should be specified. This type of flooring, such as static-control carpet, may be appropriate for mission critical areas such as 911 centers, call centers and air traffic control areas. Rooms requiring special handling considerations for electronic devices (for handling, repair, manufacturing and assembly) due to extreme device sensitivity (sometimes called Class 0) may require an alternative static-control flooring and footwear system that is also very low charging; additional research to determine appropriate flooring type is required. In this instance, extreme device sensitivity (or Class 0) is defined as having a HBM (Human Body Model) or CDM (Charged-Device Model)

threshold less than 250 volts.

This specification does not address testing of flooring and footwear together. This is testing which is not the responsibility of the Contractor. User is encouraged to test flooring and footwear together in method as referenced in ESD S20.20.

Heat welding adds cost to a project and is often reserved for clean rooms and wet lab type applications. Tile 305 mm x 305 mm 12 inches x 12 inches in size is not normally heat welded, 610 mm x 610 mm 24 inches x 24 inches tile is occasionally heat welded and 915 mm x 915 mm 36 inches x 36 inches tile is more typically used for heat weld applications.

This specification does not address applications requiring static-control during explosives handling. For this application, the designer is encouraged to research DOD 4145.26-M to determine the specific requirement of explosive handling versus static mitigation for electronic parts handling.

****

2.1.1 Conductive Resilient Flooring

2.1.1.1 Conductive Vinyl Tile

Conductive vinyl tile must be a homogeneous vinyl product and conform to ASTM F1700. Provide electrical resistance from surface to surface and surface to ground between 25,000 ohms (2.5 x 10 to the 4th) and 1,000,000 ohms (1.0 x 10 to the 6th) when tested in accordance with ASTM F150. Tile must be [300][600][900][_____] mm [12][24][36][_____] inches square and 3.2 mm1/8 inch thick.[Tile must be pre-grooved for heat welding of seams. As required, provide welding rods as recommended by the manufacturer.]

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content shown. Some manufacturers and regions have higher percentages.

****

[Provide Conductive Vinyl Tile containing a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for Conductive Vinyl Tile.]

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Conductive Vinyl Tile.]

2.1.1.2 Conductive Rubber Tile

****

NOTE: Some rubber flooring is not resistant to oil and grease and can perform poorly against certain reagents and stain spills. Determine project needs, research available product and add verbiage to paragraph if rubber flooring needs to be resistant to oil and grease and perform against certain reagents and stain spills.

Research available sizes and thicknesses since not all manufacturers offer all sizes and thicknesses. The following thicknesses of rubber flooring are recommended for the traffic type shown: 2.0 mm 0.080 inch thickness - low traffic; 2.5 mm 0.100 inch thickness - medium traffic; 3 mm 0.118 inch thickness or greater - heavy traffic.

Ingredients in rubber flooring may include either natural rubber or synthetic materials. Natural rubber is a renewable raw material that is extracted from the sap of the tropical rubber plant without harming the plant.

****

Provide conductive rubber tile conforming to ASTM F1344 Class 1 homogeneous, Type B (through mottled) with a [smooth][or][hammered] surface. Provide electrical resistance from surface to surface and surface to ground between 25,000 ohms (2.5 x 10 to the 4th) and 1,000,000 ohms (1.0 x 10 to the 6th) when tested in accordance with ASTM F150. Provide tile [300][_____] mm [24][_____] inches square and [2.0][_____]mm thick.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content shown. Some manufacturers and regions have higher percentages.

****

[Provide Conductive Rubber Tile containing a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for Conductive Rubber Tile.]

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Conductive Rubber Tile.]

2.1.1.3 Conductive Rubber Sheet Flooring

****

NOTE: Some rubber flooring is not resistant to oil and grease and can perform poorly against certain reagents and stain spills. Determine project needs, research available product and add verbiage to paragraph if rubber flooring needs to be resistant to oil and grease and perform against certain reagents and stain spills.

The following thicknesses of rubber flooring are recommended for the traffic type shown: 2.0 mm 0.080 inch thickness - low traffic; 2.5 mm 0.100 inch thickness - medium traffic; 3 mm 0.118 inch thickness or greater - heavy traffic.

Research available widths. Manufacturer's widths vary and not all manufacturers offer all sizes.

****

Provide conductive rubber sheet flooring conforming to ASTM F1859 (flooring without backing), Type I homogeneous. Provide electrical resistance from surface to surface and surface to ground between 25,000 ohms (2.5 x 10 to the 4th) and 1,000,000 ohms (1.0 x 10 to the 6th) when tested in accordance with ASTM F150. Provide tile [1200][_____] mm [4][_____] feet wide and [2.0][_____] mm thick.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content shown. Some manufacturers and regions have higher percentages.

****

[Provide Conductive Rubber Sheet Flooring containing a minimum of 5 percent recycled content. Provide data identifying percentage of recycled content for Conductive Rubber Sheet Flooring.]

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Conductive Rubber Sheet Flooring.]

2.1.2 Static-Dissipative Resilient Flooring

2.1.2.1 Static-Dissipative Vinyl Tile

Static-dissipative vinyl tile must be a homogeneous vinyl product and conform to ASTM F1700. Provide electrical resistance from surface to surface and surface to ground between 1,000,000 ohms (1.0 x 10 to the 6th) and 1,000,000,000 ohms (1.0 x 10 to the 9th) when tested in accordance with ASTM F150. Tile must be [300][600][900][_____] mm [12][24][36][_____] inches square and 3.2 mm 1/8 inch thick.[Tile must be pre-grooved for heat welding of seams. As required, provide welding rods as recommended by the manufacturer.]

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content shown. Some manufacturers and regions have higher percentages.

****

[Provide Static-Dissipative Vinyl Tile containing a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for Static-Dissipative Vinyl Tile.]

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Static-Dissipative Vinyl Tile.]

2.1.2.2 Static-Dissipative Rubber Tile

Static-dissipative rubber tile conforming to ASTM F1344 Class 1 homogeneous, [Type A (solid color)][Type B (through mottled)]. Provide a [smooth][hammered] surface. Provide electrical resistance from surface to surface and surface to ground between 1,000,000 ohms (1.0 x 10 to the 6th) and 1,000,000,000 ohms (1.0 x 10 to the 9th) when tested in accordance with ASTM F150. Provide tile [300][600][900][_____] mm [18][24][36][_____] inches square and [2.0][3.5][_____]mm thick.

[Provide certification of indoor air quality for Static-Dissipative Rubber Tile.]

2.2 STATIC-CONTROL CARPET

****

NOTE: Consider the function of the room, User requirements and consult with the project electrical engineer when determining the type of flooring that is appropriate.

Street shoes generate static electricity with all finish flooring types. Dependent on the function of the room and flooring material specified, special footwear may be required. The special footwear and flooring should be tested as a whole system. Verify with the user if and what type of special footwear will be used (such as ESD shoes or conductive heel straps). If the proper special footwear will not be worn on the static-control floor, a type of static-control flooring that provides very low static generation without special footwear should be specified. This type of flooring, such as static-control carpet, may be appropriate for mission critical areas such as 911 centers, call centers and air traffic control areas. Rooms requiring special handling considerations for electronic devices (for handling, repair, manufacturing and assembly) due to extreme device sensitivity (sometimes called Class 0) may require an alternative static-control flooring and footwear system that is also very low charging; additional research to determine appropriate flooring type is required. In this instance, extreme device sensitivity (or Class 0) is defined as having a HBM (Human Body Model) or CDM (Charged-Device Model) threshold less than 250 volts.

This specification does not address testing of flooring and footwear together. This is testing which is not the responsibility of the Contractor. User is encouraged to test flooring and footwear together in method as referenced in ESD S20.20.

If more than one carpet type is required for a project, a separate paragraph will be used for each carpet type. Each carpet type will be designated with a letter or number symbol. Use the same designations to key carpets to locations on the drawings and in Section 09 06 00 SCHEDULES FOR FINISHES.

ADA Requirements: Carpet must be securely attached; have a firm backing; and have a level loop, textured loop, level cut pile, or level cut/uncut pile texture. The maximum thickness should be 13 mm 1/2 inch. Fasten exposed edges of carpet to floor surfaces and have trim along the entire length of the exposed edge.

Nylon fiber is typically abrasion resistant and durable in all pile configurations using filament fiber, has good stain removal characteristics, and is recommended for commercial installations.
****

Provide first quality carpet; free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Provide carpet materials and treatments as reasonably non-allergenic and free of other recognized health hazards. Provide a static control construction on all grade carpets which gives adequate durability and performance.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content shown. Some manufacturers and regions have higher percentages.

****

[Provide Static Control Carpet containing a minimum of 40 percent recycled content. Provide data identifying percentage of recycled content for Static-Control Carpet.]

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Static-Control Carpet.]

2.2.1 Physical Characteristics

2.2.1.1 Carpet Construction

Tufted

2.2.1.2 Type

Modular tile [600 by 600][_____] mm square [24 by 24][_____] inch square with 0.15 percent growth/shrink rate in accordance with ISO 2551.

2.2.1.3 Pile Type

[Level-loop][Multilevel loop][_____]

2.2.1.4 Pile Fiber

Commercial 100 percent branded (federally registered trademark) nylon continuous filament

2.2.1.5 Conductive Fiber

Provide a continuous conductive fiber as recommended by the manufacturer in every tuft.

2.2.1.6 Gauge

Minimum [_____] mm inch in accordance with ASTM D5793.

2.2.1.7 Stitches

Minimum [_____] per square meter square inch

2.2.1.8 Surface Pile Weight

Minimum [_____] kg/square meter ounces per square yard. This does not include weight of backings. Determine weight in accordance with ASTM D5848.

2.2.1.9 Pile Thickness

Minimum [_____] mm inch in accordance with ASTM D6859.

2.2.1.10 Pile Density

****

NOTE: Pile Density = 36 x Pile Weight/Pile Thickness.

****

Minimum [_____]

2.2.1.11 Dye Method

[Solution dyed][_____]

2.2.1.12 Backing System

Provide conductive backing system of synthetic material as recommended by the carpet manufacturer.

2.2.2 Static-Control Carpet Performance Requirements

2.2.2.1 Electrical Resistance

****

NOTE: Coordinate acceptable measurement ranges for project with the project Electrical Engineer.

****

Provide electrical resistance from surface to surface and surface to ground between [25,000 ohms (2.5 x 10 to the 4th) and 100,000,000 ohms (1.0 x 10 to the 8th) ohms][_____] when tested in accordance with NFPA 99.

2.2.2.2 Tuft Bind

Provide tuft bind force required to pull a tuft or loop free from carpet backing with a minimum 40 N 10 pound average force for loop pile.

2.2.2.3 Colorfastness to Crocking

Comply dry and wet crocking with AATCC 165 and with a Class 4 minimum rating on the AATCC Color Transference Chart for all colors.

2.2.2.4 Colorfastness to Light

Comply colorfastness to light with AATCC 16, Test Option E "Water-Cooled Xenon-Arc Lamp, Continuous Light" and with a minimum 4 grey scale rating after 40 hours.

2.2.2.5 Colorfastness to Water

****

NOTE: Include the following test when specifying carpet constructed of yarn dyed fibers.

****

Comply colorfastness to water with AATCC 107 and with a minimum 4.0 gray scale rating and a minimum 4.0 transfer scale rating.

2.2.2.6 Delamination Strength

Provide delamination strength for tufted carpet with a secondary back of minimum 440 N/m 2.5 lbs/inch.

2.3 WALL BASE

2.3.1 Resilient Base

****

NOTE: Delete this paragraph if Section 09 65 00 RESILIENT FLOORING is used, it also specifies resilient base.

Job formed corners are recommended. The return on preformed corners is not always long enough to hold the piece in place and the corners can be knocked off during vacuuming and other cleaning operations.

Base is available in different lengths ranging from 1220 mm 4 feet pieces to 30,480 mm 100 feet or 36576 mm 120 feet rolls. Availability and roll lengths vary dependent on manufacturer. Identify required length if it impacts design intent. Some manufacturers of Type TS (vulcanized thermoset rubber) base offer only 1220 mm 4 feet lengths and not roll goods.

****

Resilient base must conform to ASTM F1861, [[Type TS (vulcanized thermoset rubber)][,][or][Type TP (thermoplastic rubber)]][, or][Type TV (thermoplastic vinyl)], [Style A (straight - installed with carpet)][,][and][Style B (coved - installed with resilient flooring)]. Provide [100][150] mm [4][6] inch high and a minimum 3 mm 1/8 inch thick wall base. Provide [preformed][job formed] corners in matching height, shape, and color.

2.3.2 Self-Coving

Self-coving must consist of static-control resilient flooring over a cove stick and must have [cove cap][and metal corner] as recommended by the manufacturer of the flooring. Self-coving base material must be same as floor material.

2.4 ADHESIVES

Provide conductive adhesive as recommended by the manufacturer of the static-control flooring [and self-coving base]. Provide conductive adhesive for carpet tile that is also releasable as recommended by the manufacturer. Provide adhesive for wall base as recommended by the wall base manufacturer.

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (use the office or classoom requirements, regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classoom requirements, regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

2.5 MOLDINGS

Provide heavy duty tapered moldings of [[vinyl][or][rubber]] [[_____]-colored anodized aluminum][clear anodized aluminum] and types as recommended by flooring manufacturer for both edges and transitions of flooring materials specified. Provide vertical lip on molding of maximum 6 mm 1/4 inch. Provide bevel change in level between 6 and 13 mm 1/4 and 1/2 inch with a slope no greater than 1:2. Provide [_____] color to match [resilient base][_____].

2.6 ACCESSORIES

Use accessories recommended by the manufacturer of the flooring.

2.7 ELECTRICAL GROUND CONNECTION

****

NOTE: The static-control resilient flooring is installed in a conductive adhesive. The floor system is grounded to an external ground by a short grounding strip, usually on a room-by-room basis. Designer must provide for connection to an external ground and should coordinate with static-control flooring manufacturers during design stage regarding connections to external ground. Designer will show ground connection to the external ground on the drawings.

****

Provide an electrical ground connection that meets the requirements of ESD S6.1. Connection between the static-control floor system and the external grounding system must be provided. Contact with the static-control floor system must be with conductive grounding strip and must have the greater of the following: a minimum contact area of 5800 square mm 9 square inch or the dimensions recommended by the manufacturer. Provide the grounding conductor recommended by the manufacturer of the flooring. Connect and install the grounding conductor as recommend by the flooring manufacturer.

2.8 MANUFACTURER'S COLOR, PATTERN AND TEXTURE

****

NOTE: Coordinate editing of color reference sentence(s) with the Government. Generally the Section 09 06 00 SCHEDULES FOR FINISHES or drawings

are used when the project is designed by an Architect or Interior designer. Select color from manufacturer's standard colors or identified in this specification only when the project has minimal finishes.

When the government directs that color be located in the drawings, a note will be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

When more than one type, pattern or color is specified identify location.

When a manufacturer's name, stock number, pattern, and color is specified for color, be certain that the product conforms to the specification, as edited.

****

Provide color, pattern and texture [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES][as indicated][_____]. Provide flooring in any one continuous area or replacement of damaged flooring in continuous area from same production run with same shade and pattern.

2.9 FIRE RESISTANCE TESTING REQUIREMENTS

****

NOTE: Choice of critical radiant flux level as it applies to building type and area of application will be made in accordance with the latest edition of UFC 3-600-01 and NFPA 101. Wherever the use of Class II (0.22) watts finish is required, Class I (0.45) watts will be permitted. Critical radiant flux will be a minimum average of 0.45 watts when used in corridors in bachelor enlisted quarters, bachelor officer quarters, hospital, child care centers, temporary lodging facilities, and new construction detention and correctional facilities. Generally the critical radiant flux will be a minimum of 0.22 for corridors of other type facilities. Where an approved automatic sprinkler system is installed, Class II interior floor finish may be used where Class I floor finish is required, and where Class II is required, no critical radiant flux rating is required.

****

Provide a minimum average critical radiant flux of [0.22][0.45] watts per square centimeter for flooring in corridors and exits when tested in accordance with ASTM E648.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

****

NOTE: Curing and sealing compounds should not be used on concrete surfaces to receive static-control resilient flooring. If a curing compound is required, it must be coordinated for compatibility with the flooring adhesive and approved by the flooring manufacturer.

****

Before any work under this section is begun, defects such as rough or scaling concrete, low spots, high spots, and uneven surfaces must be corrected, and damaged portions of concrete slabs must be repaired in accordance with flooring manufacturer's recommended instructions. Floor must be in a level plane with a maximum variation of 3 mm 1/8 inch every 3 m 10 feet, except where indicated as sloped. Repair cracks and irregularities and prepare the subfloor in accordance with flooring manufacturer's recommended instructions. Curing and sealing compounds should not be used on concrete surfaces to receive flooring unless they have been tested and approved by the flooring manufacturer. In addition, remove paint, varnish, oils, release agents, sealers, waxes, and adhesives, as required by the flooring product in accordance with manufacturer's printed installation instructions. If a curing compound is required, it must be coordinated for compatibility with the flooring adhesive.

3.2 MOISTURE, ALKALINITY AND BOND TESTS

Determine the suitability of the concrete subfloor for receiving the flooring with regard to moisture content and pH level by moisture and alkalinity tests. Conduct moisture testing in accordance with ASTM F1869 or ASTM F2170, unless otherwise recommended by the flooring manufacturer. Conduct alkalinity testing as recommended by the flooring manufacturer. Determine the compatibility of the flooring adhesives to the concrete floors by a bond test in accordance with the flooring manufacturer's recommendations.

3.3 GENERAL INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.4 INSTALLATION OF STATIC-CONTROL RESILIENT TILE FLOORING

Install static-control resilient flooring, ground connections[, heat welded joints,] and accessories in accordance with the approved manufacturer's installation instructions. Tile lines and joints must be kept square, symmetrical, tight, and even. Tile at the perimeter of the area to be finished may vary as necessary to maintain full-size tiles in the field, but no perimeter tile may be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Tile must be cut, fitted, and scribed to walls, partitions, and projections after field flooring has been applied. Install grounding strips in accordance with manufacturer's installation instructions. Protect edges of flooring material meeting hard surface flooring with molding and install in accordance with the molding manufacturer's printed instructions.

3.5 INSTALLATION OF STATIC-CONTROL RESILIENT SHEET FLOORING

Install static-control resilient sheet flooring, ground connections[, heat welded joints] and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Lay out sheets to minimize waste. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied. Finish joints flush, free from voids, recesses, and raised areas. Install grounding strips in accordance with manufacturer's installation instructions. Protect edges of flooring material meeting hard surface flooring with molding and install in accordance with the molding manufacturer's printed instructions.[Install flooring with an integral coved base.]

3.6 INSTALLATION OF STATIC-CONTROL CARPET

****

NOTE: When applicable to the project, coordinate method of installation of static-control carpet tile on raised access flooring with access flooring specification.

****

Install static-control carpet, ground connections and accessories in accordance with the approved manufacturer's installation instructions and CRI 104/CRI 105. Protect edges of carpet meeting hard surface flooring with molding and install in accordance with the molding manufacturer's printed instructions. Follow ventilation, personal protection, and other safety precautions recommended by the adhesive manufacturer. Continue ventilation during installation and for at least 72 hours following installation. Install modular tiles with [release][_____] adhesive and join together snugly. Lay tiles in [the same direction] [an alternating pattern] with accessibility to the subfloor where required. Install grounding strips in accordance with manufacturer's installation instructions.

3.7 INSTALLATION OF WALL BASE

3.7.1 Resilient Base

****

NOTE: Delete this paragraph if Section 09 65 00 RESILIENT FLOORING specifies resilient base.

****

Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Tighten base joints and make even with adjacent resilient flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

3.7.2 Self-Coving

The static-control resilient flooring must have a self-coving base and must be installed in accordance with the flooring manufacturer's printed installation instructions. Extend the self-cove up the walls, columns and pilasters [100][150] mm [4][6] inches. Terminate the coving with a cove cap. Place a cove stick at the floor-wall junction to support the coving at the bend. Provide self-cove [at room perimeter and at fixed vertical interruptions to the flooring][as indicated]. [Provide protective metal corners at outside and inside corners.]

3.8 CLEANING AND PROTECTION

The flooring must be cleaned in accordance with the manufacturer's recommendations. Flooring must be protected by a covering of heavy-duty building paper before foot traffic is permitted. Lap and secure edges of kraft paper protection to provide a continuous cover. Boardwalks must be placed over flooring in areas where subsequent building operations might damage the floor. Remove and replace flooring that becomes loose, broken, or curled prior to acceptance, or flooring that does not conform to resistance requirements of ASTM F150.

3.9 TESTING

Test the flooring in accordance with and conform to the requirements of ESD S6.1.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 64 00 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-09 64 00 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 64 00

PORTABLE (DEMOUNTABLE) WOOD FLOORING

08/16, CHG 1: 08/18

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-09 64 00 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
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****

SECTION 09 64 00

PORTABLE (DEMOUNTABLE) WOOD FLOORING
08/16, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for portable (demountable) wood flooring for use in enclosed multipurpose areas.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: On the drawings, show:

1. Elevation of top of concrete slab on which floor system is to be installed

2. Location of equipment around which flooring is to be installed

3. Locations of, and structural provisions for, anchor-plate assemblies for sports equipment

4. Plan of floor system showing overall dimension of portable panels, sizes and installation pattern of floor panels, and game line markings

5. Storage spaces for floor panels and flat bed,

four-wheel storage trucks.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C2	(2003) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

MAPLE FLOORING MANUFACTURERS ASSOCIATION (MFMA)

MFMA AFSFSCL	(2016) Athletic Floor Sealer and Finish Specifications and Conformance List #35
MFMA GRHM	(2000) Grading Rules for MFMA Northern Hardwood Maple

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Flooring System

Submit drawings indicating the overall layout, the panel numbers, and the complete details of the floor system. Include all assembly and disassembly instructions.

SD-03 Product Data

Finish Wood Flooring

Floor Finish Material

Coating for Flooring Panels

Indoor Air Quality for Floor Finish Material; S

Indoor Air Quality for Game Line Marking Materials; S

Indoor Air Quality for Coating for Flooring Panels; S

SD-04 Samples

Wood Floor Unit; G, [_____]

Accessories

Submit one wood floor unit, consisting of two completely finished, interlocked partial panels measuring 915 by 915 mm 36 by 36 inches.

SD-07 Certificates

[Certified Sustainably Harvested Wood Flooring; S

] SD-08 Manufacturer's Instructions

Wood Flooring Unit Assembly

Wood Flooring Unit Storage

Finishing

SD-10 Operation and Maintenance Data

Finish Maintenance, Data Package 1; G, [_____]

1.3 CERTIFICATIONS

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

****

[1.3.1 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

]1.4 DELIVERY AND STORAGE

Deliver floor materials to the building site in original containers, properly assembled and thoroughly protected by providing flat-strapped wire, fiberboard protectors, blocking, and bulkheading, as necessary. Before the initial assembly and erection, store the floor materials under cover in a well-ventilated, enclosed area so that the floor materials are not exposed to extreme changes in temperature and humidity. Do not store the floor materials in an enclosed area under construction until the concrete, masonry, ceramic tile work, terrazzo, and plaster are dry.

1.5 STANDARD PRODUCT

Provide portable (demountable) wood flooring system product of a manufacturer regularly engaged in the production of such wood flooring systems. Provide all accessories required for a finished installation.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Wood Framing Members

****

NOTE: Modify the pressure-preservative treatment specified herein in accordance with the recommendations made by the special assistant for entomology and wood preservation assigned by NAVFAC directives.

****

Use kiln-dried, 50 by 75 mm 2 by 3 inch (nominal size), S4S, No. 1 common and better Douglas fir or No. 2 dimension southern pine lumber. The moisture content of the lumber must not exceed 15 percent. Provide pressure-preservative treatment of the lumber in accordance with AWPA C1 and AWPA C2.

2.1.2 Finish Wood Flooring

****

NOTE: Select the appropriate flooring as follows: First Grade--where fine appearance is desired, e.g., churches, offices, hospitals; Second and Better Grade--stores, schools, factories, and other similar locations; Third and Better Grade--recreation rooms, factories, warehouses, grain storage bins, farm buildings, and other similar locations.

****

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Provide flooring of hard maple (acer saccharum), graded in accordance with the MFMA GRHM "Grading Rules for Hard Maple." Provide flooring of [26.2 mm 33/32 inch] [19.8 mm25/32 inch] thickness with a 57 mm 2 1/4 inch face, kiln dried, continuous tongue-and groove, and end-matched. Clearly stamp the flooring: [First Grade] [Second and Better Grade] [Third and Better Grade]. Provide wood products with no added urea-formaldehyde resins. The moisture content of the flooring must not exceed 8 percent at the time of arrival and must not be greater than [8 to 10] [8 to 9] percent when installed.[Provide certified sustainably harvested wood flooring.]

2.1.3 Portable Flooring Subfloor

Provide subfloor of 12.7 mm 1/2 inch thick fir or pine plywood, C-D grade with exterior grade glue, Exposure 1.

2.1.4 Floor Finish Material

The floor finish material must be selected by the flooring manufacturer from the latest MFMA AFSFSCL "Floor Finish List." The finish material must be suitable for the service requirements imposed on the type of portable flooring specified herein. Provide products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for floor finish material.

2.1.5 Kiln Drying

Only flooring which has been kiln dried will be considered to be standard grade.

2.1.6 Edge Grain Flooring

Use edge grain hardwood flooring consisting of pieces with annual rings that range from 30 degrees horizontal to 90 degrees vertical.

[2.1.7 Game Line Marking Materials

Use game line marking materials recommended by the wood floor finish manufacturer. Provide products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for game line marking materials.

]2.1.8 Nails

Use coated casing nails, screw nails, staples, or nailing cleats recommended by the flooring manufacturer.

[2.1.9 Storage Trucks

****

NOTE: If trucks are to be used for storage of floor panels, one truck will be required for each row of floor panels. An 18 by 34 meter A 60 by 112 foot floor will have 15 rows of floor panels, will require 15 storage trucks and 48 square meters 480 square feet of floor space for storage with each row approximately 1065 mm 42 inches high.

****

Use manufacturer-recommended flatbed, four-wheel roller-bearing trucks of approximately 1200 by 2400 mm 4 by 8 feet on which to stack the panels.

]2.1.10 Coating for Flooring Panels

****

NOTE: Use Group II finish for multipurpose, high-wear areas; use Group III for floors to be utilized solely for sports.

****

The coating must conform to MFMA AFSFSCL "Heavy-Duty and Gymnasium Finishes for Maple, Beech, and Birch Floors"; Group [II] [III] finish. Provide products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for coating for flooring panels.

2.1.11 Moisture, Insect, and Fungi Protection

Structural wood members must be treated for moisture and termite protection.

Prior to shipment, apply to the underside portion of the floor system, including subflooring, a heavy coating of pigmented, moisture-repellent resin paint with additives to control moisture absorption and to prevent attack by termites and fungi.

2.2 FLOORING SYSTEM

2.2.1 Design

****

NOTE: The overall dimensions specified cover the optimum floor size for an official basketball court as required by the National Collegiate Athletic Association (NCAA).

****

****

NOTE: The section of the project specification pertaining to the subfloor should include the requirement that the subfloor must not vary more than 6 mm 1/4 inch within an area 3 by 3 meters 10 by 10 feet. If the intent is to install the portable floor over an existing floor, specify the 6 mm 1/4 inch tolerance in paragraph INSPECTION OF THE SUBFLOORS.

****

Design and construct the system for use over [a concrete floor slab as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.] [a wood subfloor as specified in Section 06 10 00 ROUGH CARPENTRY.] [an ice rink surface.] [a synthetic floor surface.] Provide flooring system consisting primarily of 1200 by 2400 mm and 1200 by 1200 mm 4 by 8 foot and 4 by 4 foot self-aligning and interlocking panels. Each panel must consist of hardwood strip flooring nailed to subflooring which is nailed to rigid lumber frames.

2.2.2 Assembly and Construction

Provide an assembled floor that is properly aligned, smooth, level and with the overall appearance of being a permanent floor. Bolts, screws or other fastening or locking devices must not be visible on the floor surface. Design and construct the flooring panels in a manner affording simple and recurrent assembling, interlocking, disassembling, and storing without the use of special tools or equipment. Ensure that all like panels are interchangeable and replaceable. The method of panel assembling and locking must preclude inadvertent disassembling under all types of playing conditions. Where they are used, the projecting tongues interlocking the flooring sections must be wood, metal, metal-clad, or another material approved by the Contracting Officer.

2.3 SHOP FABRICATION AND PREASSEMBLY

2.3.1 Framing

Use jigs for each fabrication operation to provide for maximum accuracy. Space the framing members at a maximum of 300 mm 12 inches on center. Fasten the framing members and blocking from the top. The bottom surfaces of the framing and blocking must be free of protrusions or sharp edges that could prevent proper seating of the finished panel or could prevent stacking of the panels for storage or shipment. Provide frames rigid, square, level, and true.

2.3.2 Finished Flooring

Lay the finished flooring over [the subflooring and] the framing members, running the flooring parallel with the long dimensions of the panels. Stagger the adjacent ends of the flooring strips so that there will be at least two strips of flooring between the joints.

2.3.2.1 Fastening the Finished Flooring

Fasten the finished flooring to [the subflooring and] the framing members with coated nails, screw nails, staples, or nailing cleats. Fasten each strip of flooring at each bearing. Provide for any normal expansion, contraction, or aeration in each panel.

2.3.3 Preassembly

Prior to shipment, preassemble the entire floor at the factory with all panels interlocked, and prepare for the sanding and finishing operations specified herein. Maintain proper temperatures and humidity conditions necessary to retain the quality of the flooring. During the preassembling of the flooring, note any inaccuracies, misalignments, or other defects, and make the necessary corrections before shipping the panels. Letter or number each panel on its the ends to indicate its position in the assembling of the floor.

2.4 [SHOP] [FIELD] SANDING, FINISHING, AND MARKING

****

NOTE: If it is preferred to have the sanding, finishing, and marking performed at the jobsite, the specification should be modified accordingly.

****

2.4.1 Sanding

Machine sand the surface of the wood floor and edging using coarse, medium, and fine grades of sandpaper, respectively, to provide for smooth and level surfaces. Following this perform a final disc sanding of the wood floor.

2.4.2 Finishing

Within 24 hours after the final sanding, sweep the floor clean using a tacky rag with a solvent recommended by the manufacturer of the floor finish material. Apply a liberal coat of sealer to the floor, and thoroughly dry and burnish the floor with No. 2 steel wool using an industrial-type power machine. Repeat this procedure with each coat, as specified in MFMA AFSFSCL specifications. [After the final burnishing but prior to the application of the final two finish coats, lay out and mark the game lines as specified herein. After the game lines are thoroughly dry, apply the final two finish coats.]

[2.4.3 Game Line Marking

[Striping and patterns must be completed in the manufacturing plant.]Lay out the game lines [,] [and the fields,][and the patterns,] as indicated, masking the edges to provide for sharp, clean edges. Provide straight edges and uniform widths. Apply the markings of colors as indicated, providing a minimum dry film thickness of one mil.

]PART 3 EXECUTION

3.1 INSPECTION OF THE SUBFLOORS

****

NOTE: The section of the project specification pertaining to the subfloor should include the requirement that the subfloor must not vary more than 6 mm 1/4 inch within an area 3 by 3 meters 10 by 10 feet. If the intent is to install the portable floor over an existing floor, specify the 6 mm 1/4 inch tolerance in paragraph INSPECTION OF THE SUBFLOORS.

****

Do not install portable floor systems on subfloors having defects that could prevent proper installation. Before the initial installation of the floor, correct all defects in the subfloor.

3.2 FIELD ASSEMBLY, INSTALLATION, DISASSEMBLY, AND STORAGE

Do not install the floor in an enclosed area under construction until the concrete, masonry, ceramic tile work, terrazzo, and plaster are dry. Do not install building construction materials that show visual evidence of biological growth.

3.2.1 Assembly and Installation

Assemble and install the entire floor system at the designated location. Unless directed otherwise, leave the floor system in place for a minimum of one week to permit inspection by the Contracting Officer.

3.2.2 Disassembly

After the floor system has been inspected and accepted, disassemble the floor system in the manner prescribed by the floor system manufacturer. Correct all deficiencies prior to the storage of the floor system.

3.2.3 Storage

Following the disassembling of the floor system, store the panels within the enclosed area at the location(s) [indicated] [designated by the Contracting Officer] and in accordance with the floor system manufacturer's printed instructions.

3.3 SCHEDULE

Metric measurements in this section are based on mathematical conversion of English unit measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

Products	English Units	Metric Units
Framing members	2 by 3 inches nominal	50 by 75 mm
Flooring	33/32 inch	26.2 mm
	25/32 inch	19.8 mm
	2-1/4 inches	57 mm
Plywood	1/2 inch	12.7 mm

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 64 23 (August 2016)**
Change 3 - 11/18

Preparing Activity: USACE **Superseding**
UFGS-09 64 23 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-09 64 23 (August 2016)**
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SECTION 09 64 23

WOOD PARQUET FLOORING
08/16, CHG 3: 11/18

****

NOTE: This guide specification covers the requirements for wood parquet flooring systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: On the drawings, show:

1. Location and extent of wood parquet flooring.

2. Where flooring is to be installed on concrete slab, indicate elevation of the top(s) of concrete slab.

3. Locations of equipment, columns, and other permanent obstructions adjoining flooring and around which flooring is to be laid.

4. Floor pattern that differs from conventional checkerboard pattern and is not defined by file sample.

5. Profile of shoe mold.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA E30	(2016) Engineered Wood Construction Guide

ASTM INTERNATIONAL (ASTM)

ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

HARDWOOD PLYWOOD AND VENEER ASSOCIATION (HPVA)

HPVA EF	(2020) American National Standard for Engineered Wood Flooring

NATIONAL WOOD FLOORING ASSOCIATION (NWFA) (formerly NOFMA)

NOFMA Grading Rules	(1999) Official Flooring Grading Rules

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

RESILIENT FLOOR COVERING INSTITUTE (RFCI)

FLOORSCORE	FLOORSCORE IAQ Certification

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings
SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Hardwood Parquet Flooring

SD-04 Samples

Hardwood Parquet Flooring

SD-07 Certificates

Certified Sustainably Harvested Hardwood Parquet Flooring; S

Indoor Air Quality for Hardwood Parquet Flooring; S

Indoor Air Quality for Primer; S

Indoor Air Quality for Adhesive; S

SD-08 Manufacturer's Instructions

Accessories and Supporting Materials

Adhesive

Finish

Premolded Cork Strips

Polyurethane Coating

Wax Finish

SD-10 Operation and Maintenance Data

Flooring Materials; G, [_____]

SD-11 Closeout Submittals

Warranty

1.3 CERTIFICATIONS

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

****

[1.3.1 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

]1.3.2 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

****

NOTE: Include this subpart requiring low VOC

content products when product will be located in offices or classrooms

****

[1.3.2.1 Floor Covering Materials

Provide hardwood parquet flooring product certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (GreenGuard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

]1.3.2.2 Paints and Coatings

Provide primer product certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.3.2.3 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in original, unopened packages, bundles, or containers. Protect materials against dampness during shipment and after delivery. Store materials under cover in a well ventilated building where materials will not be exposed to extreme changes of temperature and humidity. Do not store materials in buildings under construction until all wet-applied building materials are dry. Do not open packages, bundles, or containers until the flooring is to be installed. Remove rejected material from Government property. Keep materials wrapped and separated from off-gassing materials, such as paints and adhesives. Do not use materials that have visible moisture or biological growth.

1.5 ENVIRONMENTAL REQUIREMENTS

****

NOTE: Control of temperature and humidity prior to laying flooring is necessary to prevent buckling and cupping. Since climatic conditions vary due to geographical location and the trend is toward natural ventilation for energy conservation, it is imperative to check with flooring manufacturer and local installers to determine correct temperature

and humidity ranges for the project area.

****

Store the parquet flooring in the building or space where the parquet flooring is to be laid for a minimum of 3 days to allow absorbed moisture to evaporate. Separate the wood parquet so that all pieces are exposed to the air during this 3-day period to allow uniform acclimation. Maintain the temperature of the building or space between [21 and 10] [[_____] and [_____]] degrees C [70 and 50] [[_____] and [_____]] degrees F, and maintain the relative humidity between [30 and 65] [[_____] and [_____]] percent. Maintain the preceding temperatures and humidity conditions throughout the installation period.

1.6 SCHEDULING

Schedule parquet flooring work after completion of any other work which would raise the moisture content of the flooring or damage the finished surface of the flooring. See PART 3 for additional scheduling requirements.

1.7 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one-year period.

PART 2 PRODUCTS

2.1 FLOORING MATERIALS

****

NOTE: Select the type of flooring to be used on the appropriate project design requirements, availability, and relative cost. The method of specifying the pattern is optional, but the "file sample" is recommended for projects for which the design is sensitive.

Acrylic impregnated hardwood floors are recommended for commercial type facilities. Prefinished urethane and stain/wax prefinishes are normally for residential or light commercial usage.

Choice of critical radiant flux level as it applies to building type and area of application will be made in accordance with the latest edition of UFC 3-600-01 or NFPA 101. Wherever the use of Class II (0.22 watts) finish is required, Class I (0.45 watts) will be permitted.

Critical radiant flux will be a minimum average of 0.45 watts when used in corridors in bachelor enlisted quarters, bachelor officer quarters, hospital, child care centers, temporary lodging facilities, and new construction detention and correctional facilities. Generally the critical radiant flux will be a minimum of 0.22 for corridors of other type facilities. Where an approved automatic sprinkler system is installed, Class II interior floor finish may be used where Class I floor finish is required, and where Class II is

required, no critical radiant flux rating is required. Omit sentence if not applicable.

Use certified sustainably harvested wood where suitable for application and cost effective. Verify availability within the region, cost effectiveness, and adequate competition before specifying this certification.

Include last bracketed sentences requiring certification for indoor air quality when product will be located in offices or classrooms.

In termite-prone areas, wood should be termite treated. Verify with manufacturers on availability and effect on finishes.

****

Provide hardwood parquet flooring conforming to NOFMA Grading Rules. [The flooring must match the color and pattern of the sample on file at the office of the Contracting Officer.] [Pattern must be [_____] [as indicated].] Hardwood flooring in corridors and exits must have a minimum average critical radiant flux of [0.22] [0.45] watts per square centimeter when tested in accordance with ASTM E648. Provide wood products with no added urea-formaldehyde resins. Submit manufacturer's descriptive data, documentation stating physical characteristics and flame resistance, installation instructions and [two] [_____] samples of each type of parquet flooring. Provide samples, minimum 300 x 300 mm 12 x 12 inches. Submit statement from the manufacturer attesting that the materials meet the specified requirements. The statement must be dated after the award of the contract, stating the Contractor's name and address, showing the name of the project and location, and listing the specific requirements being certified. Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.[Provide a product treated for resistance to termite damage.] [Provide certified sustainably harvested hardwood parquet flooring.][

Product must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for hardwood parquet flooring.]

2.1.1 Laminated Block Flooring

****

NOTE: The species are listed in descending order of wear resistance and hardness. Limit the species, based on quality required and compatibility with color desired or selected for the file sample. Size of units will depend on pattern selected and should be stated.

****

HPVA EF, plain face, factory finished. Fabricate face veneer of each block from [hard maple,] [red oak,] [white oak,] [birch,] [ash,] [beech,] [walnut,] [or] [cherry]. Provide [_____] mm inches by [_____] mm inches flooring units.

2.1.2 Slat Block Flooring

****

NOTE: The species are listed in descending order of wear resistance and hardness. Limit the species, based on quality required and compatibility with color desired or selected for the file sample. Size of units will depend on pattern selected and should be stated.

****

APA E30, unfinished, Select and Better Grade, fabricated from [hard maple,] [teak,] [red oak,] [white oak,] [ash,] [walnut,] [or] [cherry]. Provide finishing at the site as specified herein. Provide [_____] mm inches by [_____] mminches flooring units.

2.1.3 Solid Block Flooring

2.1.3.1 Grading

****

NOTE: The species are listed in descending order of wear resistance and hardness. Limit the species, based on quality required and compatibility with color desired or selected for the file sample. Size of units will depend on pattern selected and should be stated.

****

[[Red oak] [or] [white oak] fabricated into [prime] [Standard and Better]] [or] [[hard maple,] [beech,] [or] [birch] fabricated into [First] [Second and Better]] Grade blocks, free from defects and discolorations. Grade blocks in accordance with the rules of the association governing the grading of the species used.

2.1.3.2 Construction

****

NOTE: Quarter-sawn oak and edge-grain maple wear better, but the plain-sawn and flat-grain cuts are adequate and should be allowed for most projects.

****

[Oak must be quarter-sawn [or plain-sawn].] [Maple must be edge-grain [or flat-grain].] Fasten the strips composing each block together tightly in a manner that will maintain the integrity of the block. Each block must have a standard flooring tongue or corresponding matching grooves on each of the four edges, so arranged that the blocks can be laid in the conventional checkerboard pattern with the strips of each block at right angles to the strips of the adjacent blocks. The back of each strip in the block may be flat or channeled. Face edges of blocks must not be beveled.

2.1.3.3 Dimensions

****

NOTE: When red or white oak is specified, specify tolerances of plus or minus 0.80 mm 1/32 inch in length and plus or minus 0.40 mm 1/64 inch in width. When other species are specified, use first

bracketed phrase.
****

Blocks must be 228.6 mm 9 inches square [plus or minus 0.40 mm 1/64 inch in length and width] [plus or minus0.80 mm 1/32 inch in length and plus or minus 0.40 mm 1/64 inch in width] and must be not less than 19 mm 3/4-inch thick. The length of the face diagonals of each block must be within 0.80 mm 1/32 inch to ensure squareness.

2.1.3.4 Moisture Content

Not less than 5 percent or more than 12 percent at time of shipment.

2.1.3.5 Finish

[Apply finish at the factory.] [Ship flooring to the site with a smooth surface without applied finish. Provide finish specified herein at the site.]

2.1.4 Premolded Cork Strips

Cork strips must be the same depth as the flooring and of width recommended by flooring manufacturer.

2.1.5 Accessories and Supporting Materials

Submit manufacturer's safety data sheets for adhesives, finishes, and other materials which may be considered hazardous because of toxicity, flammability, VOC's, or reactivity.

2.1.5.1 Wax Finish

As recommended by flooring manufacturer.

2.1.5.2 Asphalt Saturated Felt

ASTM D226/D226M.

2.1.5.3 Adhesive

Waterproof, suitable for use with [subflooring] [underlayment] used, and as recommended by flooring manufacturer. Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that are certified to meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for adhesive.

2.1.5.4 Primer

Provide primer recommended by flooring manufacturer. Provide primer product certified to meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide certificationor validation of Indoor Air Quality for Primer.

2.1.5.5 Shoe Molds

[Hard maple,] [red oak,] [white oak,] [ash,] [beech,] [birch,] [walnut,] [or] [cherry]. Shape and size as indicated. Prefinish shoe molds to match flooring.

2.2 FLOORING SYSTEMS

****

NOTE: Select flooring system to be used.

****

2.2.1 Flooring on Concrete Slabs

The system consists of the application of block flooring on concrete slabs by means of adhesive.

2.2.2 Flooring on [Subflooring] [Underlayment]

The system consists of the application of block flooring on [subflooring] [underlayment]. The provision of [subflooring] [underlayment] is specified in Section [_____]. The application of block flooring must be by means of [nails] [adhesive].

PART 3 EXECUTION

3.1 PREPARATION OF SURFACES

****

NOTE: If flooring is to be applied on slab-on-ground construction, site grading and drainage should be such that water will not collect under slab. A polyethylene vapor barrier of not less than 0.15 mm 6 mils thick and at least 150 mm 6 inches of porous fill consisting of clean, washed gravel graded from 19 to 38 mm 3/4 inch to 1-1/2 inch sizes should be specified in Division 3. A single-ply, asphalt-saturated felt or 0.15 mm 6 mil polyethylene film set in asphalt may be applied to top of slab if acceptable to flooring manufacturer. Add to this paragraph, if warranted.

****

3.1.1 Concrete Slabs

Do not install flooring on surfaces that are unsuitable for proper installation. Before work is begun, correct defects such as rough or scaling concrete, low spots and high spots, uneven surfaces, and all damaged portions of concrete slabs. If concrete curing compounds or surface sealers have been applied to the concrete slabs, remove the compounds and sealers from the slabs by an approved method. Concrete slabs must be level [within tolerance specified in the Section 03 30 00 CAST-IN-PLACE CONCRETE] [within a tolerance of 2 mm/meter 0.25 inch per 10 feet.]

3.1.2 [Underlayment] [Subflooring]

Repair damaged portions, and replace defective boards with sound boards; renail loose or warped boards, and drive protruding or loose nails flush.

3.1.3 Adhesive-Applied Wood Flooring on Concrete Slab

Clean concrete floor slabs that are to receive flooring. Remove spots of [paint,] [plaster,] [masonry droppings,] grease, dirt, and other foreign matter.

3.1.4 Nailed Wood Flooring on [Subflooring] [Underlayment]

Cover [subflooring] [underlayment] over which nailed wood flooring is to be laid with a layer of asphalt saturated felt. Lap all edges at least 50 mm 2 inches.

3.1.5 Adhesive-Applied Wood Flooring on [Subflooring] [Underlayment]

Prepare [subflooring] [underlayment] in accordance with the printed instructions of the flooring manufacturer.

3.2 INSTALLATION

Do not install flooring until other work that might cause damage to flooring has been completed, until all wet work is completed and has cured for [14] [_____] days, and until exterior openings are closed. Cure new concrete slabs to receive flooring a minimum of 60-days before application of flooring. Perform flooring installation, including sanding and finishing, in conformance with manufacturer's printed instructions. Provide mechanical ventilation of area receiving flooring as required to maintain concentrations of toxic gases and explosive vapors below permissible levels.

Do not install building construction materials that show visual evidence of biological growth.

3.2.1 Flooring on Concrete Slabs

Apply block flooring on concrete slabs in accordance with the flooring manufacturer's printed instructions.

3.2.2 Flooring on [Subflooring] [Underlayment]

****

NOTE: Wood or plywood subflooring or hardboard underlayment should be specified in Section 06 10 00 ROUGH CARPENTRY of the project specifications.

****

[In applying wood blocks with nails, lay blocks with close joints when nailing to [subflooring] [underlayment]. Drive blocks firmly together, and blind-nail each block.] [In applying block flooring with an adhesive, use the materials and follow the methods stipulated in the manufacturer's printed instructions.]

3.2.3 Expansion Spaces

Provide expansion spaces at walls and partitions. Size expansion spaces as recommended by flooring manufacturer. Install premolded cork strips in expansion spaces in accordance with flooring manufacturer's directions.

[3.2.4 Shoe Molds

Nail shoe molds to baseboards. [Baseboards are specified in Section [_____].]

]3.3 SANDING AND FINISHING [SLAT] [SOLID] BLOCK FLOORING

****

NOTE: Coordinate these requirements with Section 09 90 00 PAINTS AND COATINGS of the project specifications.

If prefinished flooring is used, delete this paragraph.

****

3.3.1 Sanding

Sand and buff floors to smooth and level surface, free of sanding marks and in proper condition to receive the finish specified. After final sanding and buffing, vacuum or tack floors in accordance with finish manufacturer's recommendations. Wipe off foot marks.

3.3.2 Finishing

After final sanding and buffing have been completed, apply two coats of finish; use polyurethane coating recommended by flooring manufacturer for type and specie of wood flooring specified. When floors are dry, apply two coats of wax, unless otherwise recommended in writing by manufacturer of flooring. Spread at rate of 0.07 L/10 square meters one gallon per 1,500 square feet. Within 15 to 30 minutes after wax application, polish floors with weighted floor brush or electric polisher.

3.4 PROTECTION

After completion of laying [and the finishing and drying] of floors, cover flooring immediately with nonstaining kraft building paper. Lap and tape edges of paper. At project completion and acceptance, carefully take up and remove the protective paper.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 64 29 (August 2016)**
Change 2 - 11/18

Preparing Activity: USACE **Superseding**
UFGS-09 64 29 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 64 29

WOOD STRIP AND PLANK FLOORING

08/16, CHG 2: 11/18

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USACE / NAVFAC / AFCEC **UFGS-09 64 29 (August 2016)**

Change 2 - 11/18

Preparing Activity: USACE **Superseding**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 09 64 29

WOOD STRIP AND PLANK FLOORING

08/16, CHG 2: 11/18

****

NOTE: This guide specification covers the requirements for wood strip and plank flooring for gymnasiums, handball and squash courts, and other special purpose applications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 SUMMARY

****

NOTE: Wood strip flooring is very sensitive to ambient humidity conditions since all wood flooring will expand and contract as relative humidity varies. In order to keep the flooring manufacturer's warranty valid after installation, the areas in which the wood floors are installed must be adequately ventilated with natural or mechanical air circulation at all times during the life of the flooring.

If prior experience at the site indicates that relative humidity during sustained heating periods will fall below 35 percent, the office in charge of building maintenance should provide equipment to introduce moisture into the floored area when required; conversely, if relative humidity increases to 50 percent or higher at any time, measures should be taken to dry the floored area, including turning on the heat.

At sites with humidity problems, the maintenance of the flooring may require: 1) The design of a localized HVAC system to also react to and automatically control ambient humidity conditions through the life of the flooring; or 2) Continuous monitoring of relative humidity with on the spot corrective actions, as needed, without altering the HVAC system. These alternatives could be very expensive or impractical. The designer, in the absence of local experience, should coordinate with local manufacturers to specify compatible floorings which have performed well locally; that is, the designer should check gymnasiums in the area when building a gymnasium floor; the same for handball courts, etc. Of course, the designer has the option of purchasing commercially available floating or sleeper systems specifically designed to reduce the possibility of buckling and cupping brought on by moisture buildup or specifying other types of flooring when a cost analysis (including all HVAC variations) indicates that wood strip flooring is not economical.

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This specification is written to allow the Contractor to build wood strip floorings for gymnasiums, handball and squash courts, and other special purpose applications but does not preclude the installation of competitive, manufacturer standard, integrated systems.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

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references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

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ASTM INTERNATIONAL (ASTM)	
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)	
CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers
CSA GROUP (CSA)	
CSA Z809-16	(R2021) Sustainable Forest Management
FOREST STEWARDSHIP COUNCIL (FSC)	
FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship
MAPLE FLOORING MANUFACTURERS ASSOCIATION (MFMA)	
MFMA GS	(1999) Guide Specifications for Maple Flooring Systems
NATIONAL WOOD FLOORING ASSOCIATION (NWFA) (formerly NOFMA)	
NOFMA Grading Rules	(1999) Official Flooring Grading Rules
PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)	
PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements
RESILIENT FLOOR COVERING INSTITUTE (RFCI)	
FLOORSCORE	FLOORSCORE IAQ Certification
SCIENTIFIC CERTIFICATION SYSTEMS (SCS)	
SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings
SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Squash and Handball Court Walls; G, [_____]

Strip Flooring; G, [_____]

SD-03 Product Data

Strip Flooring

Recycled Content for Wood Strip and Plank Flooring; S

Bamboo

Indoor Air Quality for Asphalt Primer; S

Indoor Air Quality for Asphalt Mastic; S

Biobased Content for Bamboo Flooring; S

Installation

SD-04 Samples

Strip And Plank Flooring

SD-07 Certificates

Certified Sustainably Harvested Wood Strip and Plank Flooring; S

Indoor Air Quality for Wood Strip and Plank Flooring; S

Indoor Air Quality for Bamboo Flooring; S

Indoor Air Quality for Resilient Pads; S

1.4 CERTIFICATIONS

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood

certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

****

[1.4.1 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

]1.4.2 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

****

NOTE: Include this subparagraph requiring low VOC content products when product will be located in offices or classrooms.

****

[1.4.2.1 Floor Covering Materials

Provide wood strip and plank flooring, bamboo flooring, and resilient pad products certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (GreenGuard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

]1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site in original unopened packages, bundles or containers and with all labels intact. Store flooring in fully covered, well ventilated areas protected from extreme changes in temperature and humidity. Maintain flooring at an average moisture content of 6 to 9 percent. Temperature and humidity in the storage area must closely approximate the temperature and humidity of the rooms in which the flooring is to be installed.

1.6 ENVIRONMENTAL REQUIREMENTS

****

NOTE: The values stated in the guide specification for moisture content of the flooring and for the humidity and temperature of the space where the flooring will be installed are those which are generally suitable. When local experience has proven that values differing from those included in

the guide specification are necessary because of geographical location or seasonal weather conditions, appropriate values will be substituted for the values stated in the guide specification.
****

Provide permanent heating and air conditioning, installed and working, in rooms where wood flooring is to be installed or adequate arrangements for ventilation and temperature controls. Maintain the temperature at 14 to 27 degrees C 55 to 80 degrees F and maintain the humidity [at [40] [_____] percent] [as recommended by the manufacturer] starting not less than 3 days prior to beginning the installation of flooring and continuing throughout the remainder of the contract period.

1.7 SCHEDULING

Schedule strip and plank flooring work after any other work which would raise the moisture content of the flooring or damage the finished surface of the flooring.

PART 2 PRODUCTS

2.1 STRIP FLOORING

****
NOTE: Designer will select appropriate species and will permit maximum competition wherever possible; however, gymnasiums will be limited to hard maple. Flooring of 26 mm 33/32 inch) thickness should be considered when floors will be subjected to hard service and frequent sanding.
****

2.1.1 General Requirements

****
NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Designer must verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available from US national manufacturers above the minimum recycled content percentages shown below. Some manufacturers and regions have higher percentages. Based on research, insert desired minimum percentages into the empty set of brackets.

Include last bracketed sentences requiring certification or validation for indoor air quality

when product will be located in offices or classrooms.

In termite-prone areas, wood flooring should be termite treated. Verify with manufacturer for availability and effect on finishes.

****

Strip and plank flooring must be [19] [26] mm [3/4] [33/32] inch thick by 55 mm 2-1/4 inch face width, kiln dried, continuous tongue and groove and of standard lengths. [Provide certified sustainably harvested wood strip and plank flooring.] Beech and birch must be second grade in accordance with NOFMA Grading Rules. Hard maple must be second and better in accordance with MFMA GS. Red and white oak must be select grade in accordance with NOFMA Grading Rules. Provide wood products with no added urea-formaldehyde resins. Strip flooring must be marked with the trademark of the grading agency. Submit two samples of each type of strip and plank flooring. [Wood Strip Flooring must contain a minimum of [90][_____] percent reclaimed, salvaged, and recycled wood. Provide data identifying percentage of recycled content for wood strip and plank flooring.][Provide a product treated for resistance to termite damage.][

Provide flooring product meeting emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for wood strip and plank flooring.]

[2.1.2   Bamboo

****

NOTE: Use of materials, such as bamboo, with bio-based content is required where suitable for application and cost effective. Verify availability within the region, cost effectiveness and adequate competition before specifying product bio-based content requirements. A resource that can be used to identify products with bio-based content is the "Catalog" tab within the USDA's "Biopreferred" website at http://www.biopreferred.gov**. The bio-based content percentage listed is the required threshold within the USDA Biopreferred program. Use of other products which meet all requirements of this specification and contain bio-based content is also acceptable."**

Include last bracketed sentences requiring certification or validation for indoor air quality when product will be located in offices or classrooms.

In termite-prone areas, bamboo flooring should be termite treated. Verify with manufacturer for availability and effect on finishes.

****

Bamboo flooring must be laminated, tongue-and-groove plank flooring, [16 to 19 mm 5/8 to 3/4 inch thick, 2- or 3-ply, flat grain with horizontal laminations] [13 mm 1/2 inch thick with vertical laminations]. Provide bamboo products with minimum 91 percent bio-based content. Submit data identifying percentage of biobased content for bamboo flooring.[Provide a product treated for resistance to termite damage.][

Provide flooring product meeting emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for bamboo flooring.]

]2.2 NAILS

Provide nails in accordance with strip flooring manufacturer's recommendations.

2.3 RESILIENT PADS

****

NOTE: Include last bracketed sentences requiring certification or validation for indoor air quality when product will be located in offices or classrooms.

****

Resilient pads must be pneumatic rubber, PVC, or polyurethane resilient mounts to fit the selected floor system. [Provide product meeting emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for resilient pads.]

2.4 WALL BASE

Wall base must be wood molding or vented cove with premolded outside corners and mitered inside corners.

2.5 MOISTURE BARRIER

Moisture barrier must be 0.15 mm 6 mil minimum thickness polyethylene.

2.6 CLIPS, ANCHOR CHANNELS AND INSULATION

****

NOTE: Include this paragraph when channel anchorage system is specified. Channel anchorage system will be included as an option to wood nailers for gymnasium floors.

****

Galvanized steel clips for steel channel anchorage systems must be in accordance with steel channel anchorage system manufacturer's recommendations. Clips must be designed to provide holding at least equal to the nailing specified and must function without splitting the assembled boards or otherwise reducing the performance of the floor. Anchor channels must be as recommended by the flooring manufacturer. Anchor channels must be galvanized, complete with all pads, anchors and other components required for channel installation. Underfloor insulation must be asphalt impregnated fiberboard or closed-cell polyethylene foam.

2.7 ASPHALT PRIMER

ASTM D41/D41M. Provide asphalt primer product meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for asphalt primer.

2.8 ASPHALT MASTIC

As recommended by the flooring manufacturer. Provide asphalt mastic products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for asphalt mastic.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

Concrete slab must be level, steel troweled to a tolerance of 3 mm 1/8 inch plus or minus in a 3 m 10 foot radius. Slab surface must be clean, dry, and approved prior to start of installation. The slab must be depressed as required by the floor specified.

3.2 INSTALLATION

Install flooring in accordance with the approved installation instructions of the manufacturer. Submit manufacturer's descriptive data and installation instructions. Wood nailers are specified in Section 06 10 00 ROUGH CARPENTRY. Unless otherwise approved, flooring must be laid parallel to the length of the area to be floored. Strips must be laid [with close joints, snugly driven up but providing for absorption of a small amount of expansion] [to allow for intermediate expansion in accordance with humidity conditions expected during the life of the flooring]. End joints must be so alternated that there will be at least two boards between end joints in the same plane and at least 150 mm 6 inches between end joints in adjacent boards. Space for expansion must be left along perimeter walls and around fixed projections through the floor surface. Unless otherwise shown or permitted by the approved installation instructions, expansion space must be 5 mm per meter 1/16 inch per foot of distance between opposite walls, with one half the space provided at each wall and with a minimum space of 25 mm 1 inch at each wall.

Do not install building construction materials that show visual evidence of biological growth.

3.2.1 Gymnasium Floors

3.2.1.1 Wood Sleepers

For wood sleeper supported floors, the slab must be vapor-sealed with a two-ply membrane and hot-poured, steep-slope asphalt to a minimum depth of 6 mm 1/4 inch above bottom of sleepers. Anchored, treated wood sleepers must be spaced at 400 mm 16 inches on center with wood or plywood subfloor or, if required by design considerations, wood sleepers at 300 mm 12 inches on centers without subfloor and with 26 mm 33/32 inch thick flooring. Space between rows of wood sleepers must be left vacant. Expansion joints must be 50 mm 2 inches maximum.

3.2.1.2 Steel Channels

Galvanized steel channel system must be placed on manufacturer's standard grooved foam or grooved resilient insulation board. Expansion joints must be in accordance with manufacturer's recommendations.

3.2.2 Handball Court Floor and Walls

Strip flooring used for floors and walls in handball courts must be laid out to provide an overall light appearance; contrast from one board to the next must be gradual in order to avoid dark streaks.

3.2.3 Squash and Handball Court Walls

Maximum space for expansion must be 50 mm 2 inches at each wall. Expansion joints over 25 mm 1 inch and expansion joints for steel channel-strip flooring application must be detailed and the drawings, showing the method of covering, submitted for approval.

3.2.3.1 Wood Supports

Anchored wood supports must be used to keep the treated wood sleepers shimmed away from the wall to provide ventilation. Wood sleepers must be spaced at 400 mm 16 inches on center. Exterior grade plywood 15 mm 5/8 inch thick, with two coats of aluminum enamel on the back side in accordance with Section 06 10 00 ROUGH CARPENTRY, must be used for vapor seal and sound deadener.

3.2.3.2 Steel Supports

Anchored, galvanized, steel channel supports must be used with steel channel system; steel channels must be spaced at 300 mm 12 inches on center. The space between the supporting wall and the back of the finished wall must be filled to within 300 mm 12 inches of the ceiling with an approved hot-poured, steep-slope asphalt as the construction of the wall progresses. As an option to the asphalt-backed wall construction when 26 mm 33/32 inch thick flooring is used, the wall must be vapor sealed with a 0.15 mm 6 mil thickness of polyethylene sheeting prior to application to steel channels and the space between the supporting wall and the back of the finished wall must be filled with insulation as used for the floor.

3.3 SANDING

Sand flooring to a smooth, even, uniform finish without burns. Make a minimum of three sanding cuts, each with a finer sandpaper. Use a heavy drum-type sander for floors, except a disc-type sander is permitted for the final cut on strip flooring. Either the first pass or the second pass of the drum-type sander must be at an angle of 45 degrees to the grain; other passes of the drum-type sander must be in the direction of the grain of strip flooring. Finish edges not reached by the sander with an edger or by hand methods. Perform the final sanding at a time and in a manner that will permit application of the first seal coat as specified in Section 09 90 00 PAINTS AND COATINGS to be completed within 8 hours after completion of sanding. Leave the flooring clean and ready to receive the finishing materials.

3.4 PROTECTION

Protect flooring from damage from the time of installation until final acceptance.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 64 66 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-09 64 66 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 09 - FINISHES

SECTION 09 64 66

WOOD ATHLETIC FLOORING

08/16, CHG 1: 08/18

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 64 66 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-09 64 66 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 09 64 66

WOOD ATHLETIC FLOORING

08/16, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for five gymnasium-type hardwood strip flooring systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: This specification is intended for use in gymnasiums and for other similar uses and purposes. Guidance for selection of a system can be made based on the recommended applications, local availability or costs as shown in Selection Guidance Table in paragraph entitled "Hardwood Strip Flooring Systems on Concrete Slab." Construction of squash and handball court walls is not within the scope of this specification.

****

****

NOTE: On the drawings, show:

1. Elevation of top of concrete slab on which the floor system will be installed.

2. Location of permanent or temporary seats

3. Location of equipment and other permanent obstructions around which flooring is to be laid

4. Structural provisions for anchor-plate assemblies for sport equipment

5. Edge detail, including kind and size of wall base

6. Location, width, and color of game lines.

****

PART 1 GENERAL

1.1 REFERENCES

****

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AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C2	(2003) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA M4	(2023) Standard for the Care of Preservative-Treated Wood Products

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM C208	(2022) Standard Specification for Cellulosic Fiber Insulating Board
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D449/D449M	(2003; R 2021) Standard Specification for Asphalt Used in Dampproofing and Waterproofing
ASTM D1622/D1622M	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D2103	(2015) Standard Specification for Polyethylene Film and Sheeting
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM F36	(2015; R 2021) Standard Test Method for Compressibility and Recovery of Gasket Materials

CALIFORNIA AIR RESOURCES BOARD (CARB)

CARB 93120	(2007) Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CARPET AND RUG INSTITUTE (CRI)

CRI GL CUSHION	Green Label Cushion Program

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

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MAPLE FLOORING MANUFACTURERS ASSOCIATION (MFMA)

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MFMA GRHM	(2000) Grading Rules for MFMA Northern Hardwood Maple
MFMA SSCLFMGF	(2016) Sanding, Sealing, Court Lining, Finishing and Resurfacing of Maple Gym Floors

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

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U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 770	Formaldehyde Standards for Composite Wood Products

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For Chemical Emissions For Building
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1.2 SUBMITTALS

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SD-02 Shop Drawings

Hardwood Strip Flooring System

Clearly delineate components of the system. Show layout of [sleepers] [steel channels] [steel spines]; location of anchor plate assemblies, floor outlets, and underfloor conduit or raceway location; flooring system details; and flooring abutting other construction. Accessories shall be approved by the flooring manufacturer.

SD-03 Product Data

Hardwood Strip Flooring Components

Indoor Air Quality for Asphalt Fill; S

Indoor Air Quality for Asphalt Primer; S

Indoor Air Quality for Asphalt Mastic; S

Indoor Air Quality for Seal Coat and Finish Coat Materials; S

Indoor Air Quality for Game Line Marking Materials; S

Indoor Air Quality for Adhesives; S

SD-04 Samples

****

NOTE: Delete materials not included in floor system selected. Samples shall be complemented with manufacturer's data and standard catalogs to describe the flooring system selected.

****

Strip Flooring; G, [_____]

Hardwood Base; G, [_____]

Molded-Rubber Base; G, [_____]

Steel Channels and Clips

[Fiberboard Underlayment

][Flexible Foam Underlayment

] Cushions and Pads

Corkboard or Corkroll

Sleepers and Nailers

SD-06 Test Reports

Preservative Treatment

SD-07 Certificates

Certified Sustainably Harvested Wood Strip Flooring; S

[Certified Sustainably Harvested Sleepers and Nailers; S

][Certified Sustainably Harvested Wood Board Subflooring; S

][Certified Sustainably Harvested Plywood Subflooring; S

][Indoor Air Quality for Wood Strip Flooring; S

] Indoor Air Quality for Molded-Rubber Base; S

[Indoor Air Quality for Fiberboard Underlayment; S

] Indoor Air Quality for Rubber Cushions and Pads; S

[Indoor Air Quality for Flexible Foam Underlayment; S

] SD-08 Manufacturer's Instructions

Flooring System

Adhesive for Membrane Installation

Submit flooring system manufacturer's installation instructions. Submit vaporproofing manufacturer's written recommendations for adhesives to be used in membrane installation.

SD-10 Operation and Maintenance Data

Hardwood Strip Flooring, Data Package 1; G, [_____]

1.3 CERTIFICATION

1.3.1 Certified Sustainably Harvested Wood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

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Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

1.3.2 Indoor Air Quality Certification

Submit required indoor air quality certifications in one submittal package.

1.3.2.1 Floor Covering Materials

Provide wood strip flooring and molded rubber base products certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide rubber cushions and pads, and flexible foam underlayment products certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (GreenGuard) Gold, SCS Global Services Indoor Advantage Gold, CRI GL CUSHION or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

****

NOTE: Include following section when fiberboard underlayment is included in project.

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[1.3.2.2 Composite Wood, Wood Structural Panel and Agrifiber Products

For purposes of this specification, composite wood and agrifiber products include particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, and door cores. Provide products certified to meet requirements of both 40 CFR 770 and CARB 93120. Provide current product certification documentation from certification body.

]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in original unopened packages, bundles, or containers. Protect materials against dampness during shipment and after delivery. Store material under cover in a well-ventilated building. Prevent exposure to extreme changes of temperature and humidity. Do not store materials in building under construction until wet-applied building materials are dry. Store flooring in accordance with MFMA GRHM, under adequate and controlled ventilation and under approved temperature and humidity conditions at the location where it is to be laid for at least seven days before installation. Handle and store preservative-treated materials in accordance with AWPA M4.

1.5 ENVIRONMENTAL CONDITIONS

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NOTE: Termite protection must be included. For new work, provide perimeter protection, using Section 31 31 16.13 CHEMICAL TERMITE CONTROL. For existing buildings without perimeter protection, add termite protection to the flooring using AWPA Standard C2 or other method recommended by the manufacturer.

****

For at least one week prior to and during installation, in the location to receive finish flooring and the location where flooring will be stored, maintain a temperature of between 18 and 27 degrees C 65 and 80 degrees F, and a relative humidity of between 40 and 60 percent. When the interior relative humidity exceeds 60 percent during or after installation of flooring, sanding and finishing of flooring shall be delayed for two to three weeks after completion of laying, unless directed otherwise. Provide adequate ventilation during the entire sealing and finishing process to ensure that no unhealthy or hazardous accumulation of vapors occurs. Ensure that environmental conditions are met.

PART 2 PRODUCTS

2.1 HARDWOOD STRIP FLOORING SYSTEMS ON CONCRETE SLAB

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NOTE: Select the system most suited to the project and as recommended in Selection Guidance Table below.

In areas where termite or other insect attack is likely to occur specify that flooring be treated with wood preservative as recommended by flooring manufacturer.

Designer must indicate on finish schedule, schedule at end of specification or on drawings the location of selected subfloor systems.

SELECTION GUIDANCE TABLE

DESCRIPTION OF FLOOR SYSTEM	PERFORMANCE FEATURES	RECOMMENDED APPLICATIONS	RELATIVE COST
1. Steel channel and clip-fastening system using special-milled random length hardwood strip flooring in hard maple and white pine. Low Profile System.	Greatest resistance to expansion and cupping. A tight, solid floor and a "fast" playing surface. High static load bearing. Expansion provisions at perimeter. A "quiet" floor.	Large gymnasiums, handball, squash and racket ball courts. Large stages.	100 percent
2. Rubber-cushione softwood sleepers placed over polyethylene covered slab and random-length standard hardwood strip flooring in hard maple nailed to sleepers. High Profile System.	Entire floor "floats" on slab. Excellent shock absorbing characteristic Low sound transmission. "Slower" floor.	Gymnasiums with lesser use and size potentials.	85 percent

SELECTION GUIDANCE TABLE

DESCRIPTION OF FLOOR SYSTEM	PERFORMANCE FEATURES	RECOMMENDED APPLICATIONS	RELATIVE COST
3. Wood subflooring nailed to rubber cushioned wood nailers, before installing finished surface. Pour hot asphalt fill under and between wood nailers. High Profile System.	Good shock absorption, good stability, improved uniformity of resilience and load bearing. Low sound transmission.	Gymnasiums, hardball courts.	90 percent
4. Cushioned double plywood subfloor, standard random length hardwood strip flooring in hard maple or other species as top surface. Flooring can be installed in special patterns. Low Profile System.	Combines best of shock absorbency with uniform resiliency and fast playing surface. Good load bearing characteristic Good stability. Low sound transmission. Quiet floor.	Gymnasiums, handball, squash, racquetball courts.	95 percent
5. Mastic-set uniform length hard maple flooring in continuous courses interlocked with steel splines.	Uniform resilience. "Quiet" surface. Easy replacement of damaged areas.	Gymnasiums, handball, squash, racquetball courts. Heavy industrial applications.	90 percent

****

[2.1.1 Clipped to Steel Channels on Underlayment

Provide flooring system consisting of hardwood strip flooring clipped to steel channels that rest in premilled grooves in [fiberboard] [flexible foam] underlayment. Anchor steel channels to concrete floor slab.

][2.1.2 Wood Sleepers with Rubber Cushions

Provide flooring system consisting of hardwood strip flooring nailed to wood sleepers that are seated on rubber cushions resting on the concrete floor slab.

][2.1.3 Wood Board Subflooring, Wood Nailers, and Asphalt Fill

Provide flooring system consisting of hardwood strip flooring nailed to wood board subflooring that is, in turn, nailed to shimmed wood nailers anchored to the concrete floor slab. Provide hot asphalt fill under and between the wood nailers.

][2.1.4 Plywood Subflooring with Rubber Pads

Provide flooring system consisting of hardwood strip flooring nailed to two-layer plywood subflooring that is seated on cushioned pads resting on the concrete floor slab.

][2.1.5 Steel-Splined, Continuous Unit, [on Cork Underlayment]

Provide flooring system consisting of uniform lengths of hardwood strip flooring interlocked with steel splines and laid in asphalt mastic [on cork underlayment which is laid in asphalt mastic over membrane of felt] on the concrete floor slab.

]2.2 MATERIALS

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NOTE: Delete materials not included in floor system selected. Samples shall be complemented with manufacturer's data and standard catalogs to describe the flooring system selected.

****

2.2.1 Strip Flooring

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NOTE: Flooring of 26.2 mm 33/32 inch thickness should be used for floors subjected to hard and frequent service and frequent sanding.

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NOTE: Maple flooring should be used for floors subjected to hard and frequent service or major athletics. Use beech and birch for less critical service.

Include last bracketed sentences requiring with indoor air quality certification or

validationproducts when product will be located in offices or classrooms.

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Second or better grade [hard maple] [beech or birch] graded in accordance with current MFMA GRHM. Flooring must be [19.8] [26.2] [_____] mm [25/32] [33/32] [_____] inch thick by [57] [38] mm [2 1/4] [1 1/2] inches or narrower on the face, kiln dried, continuous tongue-and-groove, and end-matched. Provide wood products with no added urea-formaldehyde resins. Each bundle of flooring must be clearly grade stamped. Moisture content of strip flooring must not exceed 8 percent at time of arrival on job site and must be allowed to acclimate in accordance with paragraph DELIVERY, STORAGE, AND HANDLING.[Flooring for steel-splined systems must be edge-grain 26.2 mm 33/32 inch thick by 33 mm 1 5/16 inch on the face, kiln-dried, continuous tongue-and-groove, and end grooved.] Provide certified sustainably harvested wood strip flooring.

[Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for wood strip flooring.

]2.2.2 Hardwood Base

Clear [hard maple] [beech or birch]. Provide shape and size of base as indicated or as recommended by the flooring manufacturer.

2.2.3 Molded-Rubber Base

100 mm4 inch vertical leg by 75 mm 3 inch, designed to allow ventilation under floor [with premolded outside corners and mitered inside corners], and as recommended by flooring manufacturer. Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for molded-rubber base.

2.2.4 Steel Angle Base

Provide 75 by 75 by 5 mm 3 by 3 by 3/16 inch continuous steel angle along perimeter walls, designed to allow ventilation under the floor. Base angle must conform to ASTM A36/A36M.

2.2.5 Steel Channels and Clips

Provide channels and clips not less than 1.5 mm thick 16 gagezinc-coated steel.

[2.2.6 Fiberboard Underlayment

ASTM C208, fiberboard insulation board, impregnated with asphalt or coated with asphalt on faces and edges, treated for termite and water resistance. Products must contain no added urea-formaldehyde resins. Provide certification of indoor air quality for fiberboard underlayment.

]2.2.7 Rubber Cushions and Pads

Rubber cushions and pads must have a durometer hardness of A50, plus or minus 5, when tested in accordance with ASTM D2240 and must have a minimum tensile strength of 10 MPa 1500 psi, when tested in accordance with ASTM D412. When subjected to an aging period of 70 hours and exposed to a temperature of 70 degrees C 158 degrees F, allowed to cool to room temperature over a period of 4 hours and retested, tested specimen must have a change in hardness of 10 points maximum, a change in tensile strength of minus 25 percent maximum and a change in ultimate elongation of minus 25 percent maximum in accordance with the applicable test methods referenced above. Test rubber cushions, under a load of 275 kPa 40 psi, in accordance with ASTM D395, Method A. Size of tested specimen must be 57 by 75 by 10 mm 2 1/4 by 3 by 3/8 inch. Length of testing time must be 22 hours; temperature of test must be 70 degrees C 158 degrees F. Test specimen must recover, without set or displacement. Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for rubber cushions and pads.

[2.2.8 Flexible Foam Underlayment

Multicellular, closed cell flexible polyethylene plastic foam having smooth skin; density 27 to 52 kg/cu m 1.7 to 3.3 pounds per cubic foot when tested by ASTM D1622/D1622M. Foam must be 13 mm 1/2 inch thick by 1200 mm 48 inches wide by manufacturer's standard length, premilled to receive steel channels at 300 mm 12 inch centers. Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for flexible foam underlayment.

]2.2.9 Polyethylene Vaporproofing Membrane

ASTM D2103 Type 21110. Minimum thickness shall be 0.15 mm 6 mils. Perm rating must not exceed 0.02 when tested in accordance with ASTM E96/E96M.

2.2.10 Asphalt Primer

ASTM D41/D41M. Provide asphalt primer products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for asphalt primer.

2.2.11 Asphalt Mastic

As recommended by the flooring manufacturer. Provide asphalt mastic products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for asphalt mastic.

2.2.12 Asphalt Fill

ASTM D449/D449M, Type I. Provide asphalt fill material products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for asphalt fill.

2.2.13 Felt

ASTM D226/D226M, type I, asphalt-saturated organic felt.

2.2.14 Building Paper

Water-vapor permeable, 290 grams per mm 20 lb per inch dry tensile strength.

2.2.15 Sleepers and Nailers

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NOTE: Preservative treatment specified herein shall be modified as necessary to suit local conditions. When referencing AWPA C1 and C2, water repellent requirements, if any, should be specified.

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NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Surfaced on four sides, 50 by 75 mm 2 by 3 inches nominal size, Standard or No. 2 grade douglas fir, northern or western and west coast hemlock, engleman-spruce or No. 2 dimension southern pine. Moisture content must not exceed 15 percent. Provide preservative treatment in accordance with [AWPA C1] [AWPA C2]. Identify treatment on each piece of material by the quality mark of an agency accredited by the Board of Review of the American Lumber Standard Committee. Brush coat exposed areas that are cut or drilled after treatment with the same preservative in accordance with AWPA M4.[Provide certified sustainably harvested sleepers and nailers.]

2.2.16 Wood Board Subflooring

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NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

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No. 2 common douglas fir, northern or western hemlock, englemann spruce, or southern pine No. 2 boards, northern red or Norway pine, surfaced on four sides. Nominal sizes must be 25 by 150 mm or 25 by 100 mm 1 by 6 inches or 1 by 4 inches. Moisture content must not exceed 15 percent.[Provide certified sustainably harvested wood board subflooring.]

2.2.17 Plywood Subflooring

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.

****

Douglas fir, southern pine, or western larch plywood; grade C-D, with exterior glue; 12.7 mm 1/2 inch thick by 4200 by 2400 mm 4 by 8 feet.[Provide certified sustainably harvested plywood subflooring.]

2.2.18 Sealing and Finishing for Hardwood Strip Flooring

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NOTE: Use Group II finish for aerobics, dance, and stage applications; use Group III for floors to be utilized for gymnasium and multipurpose applications.

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NOTE: Use Group II finish for multipurpose, high wear areas; use group III for floors to be utilized solely for sports. Group III finish generally requires two sealer coats and two finish coats. Group II finish requires one sealer coat and two finish coats. Regardless of which finish is selected, each coat except the final coat should be burnished with No. 2 steel wool and wiped with a tack rag before application of the next coat.

****

Conform to MFMA AFSFSCL, Group [II] [III] finish. Seal coat and finish coat materials must be compatible with each other. Provide seal coat and finish coat products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for seal coat and finish coat materials.

2.2.19 Game Line Marking Materials

As recommended by wood flooring finish manufacturer. Provide game line marking products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for game line marking materials.

2.2.20 Nails

Shape and size as recommended by flooring manufacturer.

2.2.21 Underlayment

Corkboard or corkroll, 13 mm 1/2 inch thick, conforming to ASTM F36.

2.2.22 Adhesives

Waterproof, suitable for use with molded rubber base, recommended by rubber base manufacturer. Provide adhesive products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for adhesives.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Condition of Subfloors

****

NOTE: The concrete slab on which the floor system is to be installed must be depressed according to the requirements of floor system being used. Ensure that the required depressions are shown on the drawings.

****

Do not install flooring on surfaces that are not suitable for proper installation. Before beginning work under this section, correct defects such as rough or scaling concrete, low spots, high spots, uneven surfaces, and repair damaged portions of concrete slabs. Concrete slabs must be given a leveling course of latex fill and the surface shall not vary more than 3 mm 1/8 inch when measured with a 3 meter 10 foot straightedge placed in any direction.

3.1.2 Preparation of Concrete Slab

Sweep concrete floor. Ensure that slab is dry and clean. Remove paint spots, plaster, masonry droppings, grease, dirt, and other foreign matter [including chemical curing agents which may affect the bond of adhesive-applied wood flooring systems]. Concrete must be fully cured and dry.

3.1.3 Anchor Plate Assemblies for Portable Sports Equipment

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NOTE: Anchor plate assemblies for portable sports equipment should be specified as a part of each individual piece of equipment in Division 11 of the project specifications; however, if no equipment is to be specified and anchor plates are desired for future equipment, they must be detailed in the drawings, and materials and installation must be specified in Part 2 of this section. Do not specify anchors to be supplied by floor manufacturer; they do not normally supply them.

****

Floor anchor plate assemblies for vertically adjustable portable sports equipment shall be installed where indicated. Flooring must be cut neatly around floor plates.

3.1.4 Work of Other Trades

Do not start work specified under this section until work of trades which could create moisture, has been completed.

3.1.5 Moisture Content

Check flooring, subflooring, sleepers and nailers with an approved meter verifying conformance with the requirements specified hereinbefore.

3.2 INSTALLATION

****

NOTE: Provisions for expansion and contraction will be governed by local weather conditions and by temperatures and humidities to be maintained within building. Modify specifications accordingly. The

floor systems included in this specification are intended for installation on or above grade. If installation is below grade, provisions for waterproofing must be made and the requirements specified in Division 7. Select type of flooring to be used and delete other.

In conjunction with vapor-proofing, at least 150 mm 6 inches of porous fill, capillary water barrier, consisting of clean, washed gravel graded from 19 to 38 mm 3/4 to 1 1/2 inch sizes should be provided under slab and specified in Division 2. No sand or crushed coral should be used between top of gravel and bottom of slab. If surrounding drainage conditions indicate probable development of hydrostatic pressure under slab, three-ply membrane waterproofing should be provided under slab. Specify in Division 7.

****

Do not install building construction materials that show visual evidence of biological growth.

3.2.1 Vaporproofing For Slabs on Grade

Cover slab with the polyethylene membrane. Lap joints at least 150 mm 6 inches. Seal joints with a full coverage of the adhesive recommended by the membrane manufacturer.

3.2.2 Flooring Clipped to Steel Channels

3.2.2.1 Channel Placing

Install each channel in premilled grooves spaced 300 mm 12 inches on center in [fiberboard] [flexible foam] parallel to the short side of the room, with butted end-to-end joints staggered at least 600 mm 24 inches. Anchor channels to the slab at 350 mm 14 inches on center with 10 mm 3/8 inch diameter, flat headed anchors that penetrate the slab by at least 32 mm 1-1/4 inches. Set channels level.

3.2.2.2 Laying of Finished Flooring

Lay finished flooring at right angles to the steel channels. Begin installation with double-tongue strips of flooring in center of room. Clip each board down tightly at each channel intersection with zinc-coated flooring clips. Each clip must firmly engage the side edges of the flooring and the steel channels. Ensure that each clip is placed properly. Stagger adjacent end joints of flooring so that there will be at least two boards between joints. Where floor plates occur, install steel channels along edges of flooring board; provide clips for flooring. Drive each flooring strip up sideways and endways as tightly as practicable using steel driving tools that prevent marring of exposed flooring. Scribe boards to permanent obstructions and be securely blocked at wall lines.

3.2.3 Flooring on Wood Sleepers with Rubber Cushions

3.2.3.1 Installation of Wood Sleepers With Rubber Cushions

Install rubber-cushioned wood sleepers, [300 mm12 inches on center for 26.2

mm 33/32 inch] [225 mm9 inches on center for 19.8 mm 25/32 inch] thick flooring, parallel to short side of the room, with butted end-to-end joints, 6 mm 1/4 inch apart at the joints, staggered at least 600 mm 24 inches. Sleepers must have the rubber cushions attached at 300 mm 12 inch centers. Provide a 50 mm 2 inch air space between ends and sides of sleepers at walls and other permanent obstructions. Sleepers must be seated level and firm with rubber cushions bearing completely on the subfloor.[In areas where fixed or temporary seats are indicated, provide 40 by 48 mm 1-5/8 by 1-7/8 inch wood screeds midway between the cushioned wood sleepers.]

3.2.3.2 Laying of Finished Flooring

Begin installation of flooring in center of space with double-tongue strips of flooring. Lay flooring at right angles to the wood sleepers. Blind nail each strip of flooring to each wood sleeper with 63 by 3 mm 8 penny spiral screw nails. Leave a continuous air space, 50 mm 2 inches wide, between the finished flooring and perimeter walls and other permanent obstructions. Stagger end joints of adjacent strips of flooring so that there will be at least two boards between each joint.

3.2.4 Flooring on Board Subflooring, Wood Nailers, and Asphalt Fill

3.2.4.1 Priming of Concrete Slab

Prime slab with asphalt primer using minimum of 1.6 liter per 10 square meters one gallon per 250 square feet. Allow primer to dry.

3.2.4.2 Wood Nailers

Install continuous 50 by 75 mm 2 by 3 inch nominal size wood nailers 300 mm 12 inches on center, parallel to short side of room, with butted end-to-end staggered joints, 6 mm 1/4 inch apart at the joints. Elevate bottoms of nailers about 5 mm 3/16 inch above concrete slab with fiber shims. Fasten nailers to slab with 6 by 88 mm 1/4 by 3 1/2 inch power driven anchors spaced 750 mm 30 inches on center and staggered in adjacent rows. Provide an additional anchor not more than 150 mm 6 inches from the end of each nailer. Provide a 50 mm 2 inch air space between ends and sides of sleepers at walls and other permanent obstructions. Nailers must be set level and in alignment. Check level of tops of nailers with a surveyor's instrument.

3.2.4.3 Asphalt Fill

****

NOTE: Because of asphalt cushion and fill specified, no additional vapor barrier is recommended.

****

When the wood nailers have been set and leveled, pour the hot asphalt over the entire concrete slab surface; fill the spaces under the wood nailers completely and cover the concrete slab surface between the nailers to a depth of approximately 10 to 13 mm 3/8 to 1/2 inch. Pour asphalt up 6 mm 1/4 inch on the sides of the nailers.

3.2.4.4 Wood Board Subflooring

Apply wood subflooring diagonally over the wood nailers. Cut ends parallel to and over center lines of wood nailers. Nail subflooring securely to each wood nailer with 57 by 3 mm 7 penny steel spiral screw nails; use two nails for 100 and 150 mm 4 and 6 inch wide boards. Space boards approximately 3 mm 1/8 inch apart. Top of subflooring shall have a true, even plane. Provide 50 mm 2 inches of clearance between subflooring and perimeter walls and other permanent obstructions.

3.2.4.5   Felt

Cover wood subflooring with a layer of the felt. Butt edges tightly. Do not extend felt over air space between ends and sides of finished floor and perimeter walls or other permanent obstructions.

3.2.4.6   Laying of Finished Flooring

Begin installation of flooring in center of space with double-tongue strips of flooring. Lay flooring at right angles to the wood nailers and parallel with the long dimension of the room. Blind nail each strip of flooring through the subflooring and into the sleeper with 63 by 3 mm 8 penny screw type nails, spaced not over 300 mm 12 inches apart over the sleepers. Leave a continuous air space 50 mm 2 inches wide between the finished flooring and perimeter walls and other permanent obstructions. Stagger end joints of adjacent strips of flooring so that there will be at least two boards between each joint.

3.2.5   Flooring on Plywood Subflooring With Rubber Pads

3.2.5.1   Installation of Plywood Subflooring With Rubber Pads

Provide two layers of 12.7 mm 1/2 inch thick plywood sheets, of 1200 by 2400 mm 4 by 8 feet. Each 1200 by 2400 mm 4 by 8 foot sheet in the bottom layer bearing on slab must have 32 rubber pads, 57 by 75 by 10 mm 2-1/4 by 3 by 3/8 inch thick, approximately 300 mm 12 inches on center in each direction, stapled to underside of sheet. Partial sheets must have rubber pads 300 mm 12 inches on center and at perimeters. Lay first layer of plywood on concrete floor slab, parallel to short side of room. Lay second layer at a 45 degree angle to first layer and fasten it to first layer by machine nailing or stapling on 600 mm 24 inch centers using 25 mm one inch nails or staples. Leave a continuous air space 50 mm 2 inches wide between the subflooring and perimeter walls and other permanent obstructions and 6 mm 1/4 inch between panels at sides and ends. Lap panels so that no joint will fall over any joint of the first layer.[In areas where fixed or temporary seats are indicated, provide fixed hardboard shims, 3 mm 1/8 inch thick, between the cushioned pads.]

3.2.5.2   Laying of Finished Flooring

Begin installation of flooring in center of space with double-tongue strips of flooring. Lay flooring parallel with the long dimension of the room. Flooring must be blind nailed on 250 mm 10 inch centers with 45 mm 1-3/4 inch spiral screw nails. Leave a continuous air space, 50 mm 2 inches wide, between the finished flooring and perimeter walls and other permanent obstructions. Stagger end joints of adjacent strips of flooring so that there will be at least two boards between each joint.[Roller skating rink flooring shall be 26.2 mm 33/32 inch thick or 19.8 mm 25/32 inch and laid in special octagonal pattern as indicated. Diagonal intersections of flooring shall be joined with barbed steel splines.]

3.2.6 Flooring, Continuous Steel-Splined, [on Cork Underlayment]

3.2.6.1 Vaporproofing for Slabs on Grade

Prime concrete slab with asphalt primer using a minimum of 1.6 liter per 10 square meters one gallon per 250 square feet. Following application and drying of the primer apply a membrane of two layers of felt. Lay each layer of felt in a coating of trowelled asphalt mastic, applied at the rate of at least 11.5 liters per 10 square meters one gallon per 35 square feet. Felts shall be butted at joints. Turn up felt 40 mm 1-1/2 inches at perimeter walls and other permanent obstructions. Roll felt thoroughly, eliminating air pockets and blisters, to provide an overall smooth and level surface. Cover top layer of felt with a coating of trowelled asphalt mastic applied at the rate of at least 11.5 liters per 10 square meters one gallon per 35 square feet.

[3.2.6.2 Cork Underlayment

Install underlayment in asphalt mastic. Provide a 2 mm 1/16 inch space at joints of corkboard. After underlayment has been installed, roll entire area with a 68 kilogram 150 pound roller to attain maximum bond and a uniformly even surface. Leave a 40 mm 1-1/2 inch air space between underlayment and perimeter walls and other permanent obstructions.

]3.2.6.3 Finished Flooring

Lay 300 mm 12 inch long strips of finished flooring firmly in full bed of asphalt mastic in end-to-end courses, interlocking with saw-tooth steel splines into the slotted ends. Break joints of continuous strip units in succeeding courses. Lay continuous strip units parallel with the width of the room. Lay flooring level and in correct alignment. Leave a continuous air space, 40 mm 1-1/2 inches wide, between the finished flooring and perimeter walls and other permanent obstructions. Lay flooring with hairline joints. Do not drive flooring up tightly.

3.2.7 Hardwood Base Installation

****

NOTE: Select type of base desired and delete the inapplicable types. Bases specified are not a standard product of any manufacturer, and must be detailed on the drawings.

****

Install molded and perforated continuous hardwood base of the type indicated, along perimeter walls. Base shall have 10 mm 3/8 inch diameter vent holes spaced 125 mm 5 inches on center in a straight row. Nail or bolt base to wall. Do not fasten base to flooring.

3.2.8 Molded-Rubber Base Installation

****

NOTE: Select type of base desired and delete the inapplicable types. Bases specified are not a standard product of any manufacturer, and must be detailed on the drawings.

****

Install molded-rubber base firmly on perimeter walls in continuous adhesive as recommended by the base manufacturer. Provide vertical, circular or semicircular vent holes in base spaced 125 mm 5 inches on center in a straight row. Do not fasten base to flooring.

3.2.9 Steel Angle Base Installation

****

NOTE: Select type of base desired and delete the inapplicable types. Bases specified are not a standard product of any manufacturer, and must be detailed on the drawings.

****

Install 75 by 75 by 5 mm 3 by 3 by 3/16 inch continuous steel angle along perimeter walls. Bottom leg of angle shall have 10 mm 3/8 inch diameter vent holes spaced 125 mm 5 inches on center in a straight row. Fasten angle to wall at intervals of 400 mm 16 inches with countersunk head [expansion] [toggle] bolts. Do not fasten angle to flooring.

3.3 SANDING, FINISHING, AND MARKING

3.3.1 Sanding

Sand wood floor surfaces with a machine using coarse, medium, and fine grades of sandpaper; the edges must be sanded to a smooth edge; the finished surface must be smooth and level, free from scratches. A final disc sanding shall be provided. After final sanding or buffing, vacuum floors until clean. Do not walk on floors thereafter until finish has been applied and is dry.

3.3.2 Finishing

****

NOTE: Use first bracketed sentence if finish is to be specified elsewhere in Division 9 of the project specifications; use second bracketed sentence if finish is specified under this section. Select Group II or Group III finish in the next-to-last sentence of this section.

****

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

[Finishing must be provided as specified in [_____].] [Within one day after the final sanding, buffing, and sweeping have been completed, use a tacky rag to clean flooring with a low VOC solvent recommended by the manufacturer of the floor finish material. Follow cleaning with a coating of sealer; when thoroughly dry, burnish with No. 2 steel wool, using a power machine. After final burnishing and prior to application of final finish coat(s), layout and mark game lines as specified herein; after game lines are thoroughly dry, apply final finish coat.] Floors must be wiped with a tacky rag each burnishing.[Finish floors in accordance with MFMA SSCLFMGF. Four Coat Specification: Group II finish must consist of one sealer coat and three finish coats. Group III finish must consist of two sealer coats and two finish coats. Allow 5 days for proper curing.]

3.3.3 Marking

Lay out game lines and fields [and patterns] where indicated, masking edges to provide sharp, clean edges. Edge must be straight and width shall be uniform. Apply marking of colors indicated, providing a minimum dry film thickness of one mil.

3.4 PROTECTION

After completion of laying, finishing, and marking of the flooring, do not use the floor for at least 72 hours. Avoid heavy traffic on the floor for at least one week. Upon floor drying, use nonstaining, porous building paper of the type and grade recommended by manufacturer, taped along edges. Remove kraft paper covering after work in this area is completed.

3.5 SCHEDULE

Metric measurements in this section are based on mathematical conversion of English unit measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

Products	English Units	Metric Units
Flooring	25/32 inch	19.8 mm
	33/32 inch	26.2 mm
	2 1/4 inches	57 mm
	1 1/2 inches	38 mm
	1 5/16 inches	33 mm
Rubber Base	4 by 3 inches	100 by 75 mm
Steel Channels	16 gage	1.5 mm
Sleepers	2 by 3 inches	50 by 75 mm
Plywood	1/2 inch	12.7 mm

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 65 00 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-09 65 00 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 09 - FINISHES

SECTION 09 65 00

RESILIENT FLOORING

11/24

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-09 65 00 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-09 65 00 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 09 65 00

RESILIENT FLOORING
11/24

****

NOTE: This guide specification covers the requirements for resilient floor coverings, base materials, and accessory items.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Resilient flooring may be used over wood subfloor provided that the subfloor underside is well ventilated and the installation conforms to the manufacturer's recommendations. Note that not all products are recommended for installation over panel type underlayment.

Flooring such as nonslip tile is not included in this specification; add appropriate wording when it is required.

Show location of resilient flooring, including types, on the drawings.

Vinyl Composition Tile (VCT) is not a preferred flooring type for new work except where necessary to match existing VCT flooring partially cut and patched or repaired.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

ASTM INTERNATIONAL (ASTM)

ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D4078	(2002; R 2015) Water Emulsion Floor Polish
ASTM D5603	(2001; R 2008) Rubber Compounding Materials - Recycled Vulcanizate Particulate Rubber
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F710	(2022) Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
ASTM F1066	(2023) Standard Specification for Vinyl Composition Floor Tile

ASTM F1303	(2004; R 2021) Standard Specification for Sheet Vinyl Floor Covering with Backing
ASTM F1344	(2021a) Standard Specification for Rubber Floor Tile
ASTM F1482	(2021) Standard Practice for Installation and Preparation of Panel Type Underlayments to Receive Resilient Flooring
ASTM F1516	(2023) Standard Practice for Sealing Seams of Resilient Flooring Products by the Heat Weld Method (when Recommended)
ASTM F1700	(2024) Standard Specification for Solid Vinyl Floor Tile
ASTM F1859	(2021a) Standard Specification for Rubber Sheet Floor Covering Without Backing
ASTM F1860	(2021) Standard Specification for Rubber Sheet Floor Covering With Backing
ASTM F1861	(2021) Standard Specification for Resilient Wall Base
ASTM F1869	(2023) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F1913	(2004; R 2014) Vinyl Sheet Floor Covering Without Backing
ASTM F2034	(2008; R 2013) Sheet Linoleum Floor Covering
ASTM F2169	(2015; R 2020; E 2020) Standard Specification for Resilient Stair Treads
ASTM F2170	(2019a) Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
ASTM F2195	(2018; R 2023) Linoleum Floor Tile
ASTM F3008	(2013; R 2020) Standard Specification for Cork Floor Tile
ASTM F3261	(2020) Standard Specification for Resilient Flooring in Modular Format with Rigid Polymeric Core

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 253	(2011) Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Guide 21	(2015) Guide to Evaluation of Slip and Fall Resistance of Flooring Surfaces

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

TILE COUNCIL OF NORTH AMERICA (TCNA)

TCNA A326.3	(2022) American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Resilient Flooring and Accessories; G, [_____]

SD-03 Product Data

Resilient Flooring and Accessories; G, [_____]

Adhesives

Vinyl Composition Tile

Recycled content for Vinyl Composition Tile; S

Sheet Vinyl Flooring

Recycled content for Sheet Vinyl Flooring; S

Luxury Vinyl Tile

Recycled content for Luxury Vinyl Tile; S

Rubber Tile

Rubber Sheet Flooring

Solid Vinyl Tile

Wall Base

Stair Treads, Risers, and Stringers

Mouldings

Sheet Linoleum

Recycled content for Sheet Linoleum; S

Bio-based content for Sheet Linoleum; S

Linoleum Tile

Recycled content for Linoleum Tile; S

Bio-based content for Linoleum Tile; S

Cork Flooring

Recycled content for Cork Flooring; S

Bio-based content for Cork Flooring; S

SD-04 Samples

Resilient Flooring and Accessories; G, [_____]

SD-06 Test Reports

Moisture, Alkalinity, and Bond Tests; G, [_____]

SD-07 Certificates

Indoor Air Quality for Vinyl Composition Tile; S

Indoor Air Quality for Sheet Vinyl Flooring; S

Indoor Air Quality for Rubber Tile; S

Indoor Air Quality for Rubber Sheet Flooring; S

Indoor Air Quality for Luxury Vinyl Tile; S

Indoor Air Quality for Solid Vinyl Tile; S

Indoor Air Quality for Sheet Linoleum; S

Indoor Air Quality for Linoleum Tile; S

Indoor Air Quality for Cork Flooring; S

Indoor Air Quality for Wall Base; S

Indoor Air Quality for Adhesives; S

Certified Sustainably Harvested Cork Flooring; S

SD-08 Manufacturer's Instructions

Surface Preparation; G, [_____]

Installation; G, [_____]

SD-10 Operation and Maintenance Data

Resilient Flooring and Accessories; G, [_____]

1.3 CERTIFICATES

1.3.1 Indoor Air Quality

Submit required indoor air quality certifications and validations in one submittal package.

1.3.1.1 Floor Covering Materials

Provide [Vinyl Composition Tile][Sheet Vinyl Flooring][Rubber Tile][Rubber Sheet Flooring][Luxury Vinyl Tile][Solid Vinyl Tile][Sheet Linoleum][Linoleum Tile][Cork Flooring], and wall base products certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification documentation from certification body.

1.3.1.2 Adhesives, Caulking, and Sealants

Provide asbestos-free products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

****

NOTE: Include the following section when specifying cork flooring. Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forest Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest regeneration (such as, replanting and reforestation); 2) Third-party certification audits performed by

accredited certification bodies; 3) publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certification other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

****

1.3.2 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001, ATFS STANDARDS, CSA Z809-16, SFI 22 Standards and Rules, or other third party program certified by PEFC ST 2002:2013. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

1.4 DELIVERY, STORAGE, AND HANDLING

****

NOTE: Materials which are woven, fibrous, or porous in nature have a high capacity to adsorb VOC emissions; for instance, acoustical ceilings, carpet, textiles, and unprimed gypsum wall board. If specifying porous materials include bracketed text and indicate materials to be protected.

****

Deliver materials to the building site in original unopened containers bearing the manufacturer's name, style name, pattern color name and number, production run, project identification, and handling instructions. Store materials in a clean, dry, secure, and well-ventilated area free from strong contaminant sources and residues with ambient air temperature maintained above 20 degrees C 68 degrees F and below 30 degrees C 85 degrees F, stacked according to manufacturer's recommendations. Remove resilient flooring products from packaging to allow ventilation prior to installation. Protect materials from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances. Observe ventilation and safety procedures specified in the MSDS. Do not store rubber surface products with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions, including [_____]. Do not store exposed rubber surface materials in occupied spaces. Do not store [_____] near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.5 ENVIRONMENTAL REQUIREMENTS

Maintain areas to receive resilient flooring at a temperature above 21 degrees C 70 degrees F and below 30 degrees C 85 degrees F for 3 days before application, during application and 2 days after application, unless otherwise directed by the flooring manufacturer for the flooring being installed. Maintain a minimum temperature of 13 degrees C 55 degrees F thereafter. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

1.6 SCHEDULING

Schedule resilient flooring application after the completion of other work which would damage the finished surface of the flooring.

1.7 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

1.8 EXTRA MATERIALS

****

NOTE: To ensure matching flooring that may become damaged and require spot replacement, a supply of extra flooring of same types, colors and dye lot is recommended. Coordinate requirement for extra stock with customer; warehousing may not be available.

****

Provide extra flooring material of each color and pattern at the rate of [[_____] [5] tiles for each 1000 tiles] [and] [[_____] [0.5] square m [5] square feet for each 92 square m 1000 square feet of sheet flooring] installed. Provide extra wall base material composed of 6 m 20 linear feet of each type, color and pattern. Package all extra materials in original properly marked containers bearing the manufacturer's name, brand name, pattern color name and number, production run, and handling instructions. Provide extra materials from the same lot as those installed. Leave extra stock at the site in location assigned by Contracting Officer.

PART 2 PRODUCTS

****

NOTE: Appropriate flooring material should be determined by:
- **Amount and type (such as, foot, cart, wheelchair) of traffic**
- **Abrasiveness of local soil conditions**
- **Exposure to water, chemicals, grease, and burns**
- **Exposure to in-use damage (cuts, tears, gouges)**
- **Exposure to direct sunlight (fading potential)**
- **Anticipated type of and frequency of maintenance**
- **Cost of maintenance**
- **Appearance expectations**

Verify proposed use of flooring with manufacturer's recommendations.

Sheet flooring should be considered for areas such as healthcare facilities due to the reduced amount of seams. Seam welded sheet flooring without backing provides a monolithic floor impervious to moisture penetration.

Specify special adhesive for resilient flooring installed on floors with radiant heating, wet areas and areas with heavy rolling loads.

If more than one type of resilient flooring is required, a separate paragraph for each type will be used. Each type will be designated with a letter or number symbol. Use the same symbols to key flooring to locations on the drawings and in Section 09 06 00 SCHEDULES FOR FINISHES. Delete reference to type symbol if not used.

Terms such a "plank" or "tile" are subject to available product formats from the manufacturers. Sizes suggested in Part 2 are not exhaustive or intended to exclude other sizes.

The term "antimicrobial" refers to products that provide antibacterial and antifungal properties. These properties may be derived from inorganic or organic materials and may be proprietary. Consider verified effectiveness and limitations and whether products may be proprietary if considering their use.

****

2.1 VINYL COMPOSITION TILE [TYPE [_____]]

****

NOTE: Vinyl Composition Tile (VCT) is not a preferred flooring type for new work except where necessary to match existing VCT flooring partially cut and patched or repaired.

NOTE: When vinyl composition tile is used, 3.2 mm 1/8 inch thick should be utilized in high traffic commercial type installations.

Solid color tiles are tiles with uniform color throughout. These are recommended for use as an accent only in small quantities and not as the floor field color. These tiles do not hide soiling well and show scratches easily.

Through pattern tiles are tiles with patterning distributed through the entire thickness.

****

Conform to ASTM F1066 [Class 1, (solid color tile),] [Class 2, (through pattern tile),] Composition 1, asbestos-free, [300] [_____] mm [12] [_____] inch square and [2.4] [3.2] mm [3/32] [1/8] inch thick. Provide color and pattern uniformly distributed throughout the thickness of the tile.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available from some US

national manufacturers above the minimum recycled content shown. Some manufacturers do not offer recycled content.

****

[Provide Vinyl Composition Tile containing a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for Vinyl Composition Tile.]

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Vinyl Composition Tile.]

2.2 SHEET VINYL FLOORING [TYPE [_____]]

****

NOTE: Not all sheet vinyl flooring is available with chemically bonded or heat welded seams. Research available products.

****

Conform to [ASTM F1303, Type I, Grade 1, [Class A-non-asbestos formulated fibrous backing] [or] [Class B-nonfoamed plastic backing] (minimum wear layer thickness 0.5 mm 0.020 inch and minimum overall thickness 2 mm 0.080 inch) and a minimum [1800 mm 6 feet] [3660 mm 12 feet] wide.] [ASTM F1303, Type II, Grade 1, without backing (minimum wear layer thickness 2 mm 0.080 inch and minimum overall thickness 2 mm 0.080 inch), and a minimum 1800 mm 6 feet wide. Extend color and pattern through the total thickness of the material.] [ASTM F1303, Type II, Grade 1, [Class A non-asbestos formulated fibrous backing] [or] [Class B nonfoamed plastic backing] (minimum wear layer thickness 1.27 mm 0.050 inch and minimum overall thickness 2 mm 0.080 inch) and a minimum 1800 mm 6 feet wide. Extend color and pattern throughout the thickness of the wear layer.] [ASTM F1913, (minimum wear layer thickness 1.9 mm 0.075 inch and minimum overall thickness 1.9 mm 0.075 inch) and a minimum 1800 mm 6 feet wide. Extend color and pattern through the total thickness of the material.] As required, provide welding rods as recommended by the manufacturer for heat welding of joints.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available from some US national manufacturers above the minimum recycled content shown. Some manufacturers do not offer recycled content.

****

[Provide Sheet Vinyl Flooring containing a minimum of 25 percent recycled content. Provide data identifying percentage of recycled content for Sheet Vinyl Flooring.]

****

NOTE: Include the last bracketed sentence requiring

products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Sheet Vinyl Flooring.]

2.3 RUBBER TILE [TYPE [_____]]

****

NOTE: Rubber flooring provides slip resistance not usually found with other type floor tiles. Consider for areas such as stairwell landings and ramps. Rubber flooring has a cushioning quality that reduces leg weariness and fatigue.

Some rubber flooring is not resistant to oil and grease and can perform poorly against certain reagents and stain spills. Determine project needs, research available product and add verbiage to paragraph if rubber flooring needs to be resistant to oil and grease and perform against certain reagents and stain spills.

Research available sizes. Manufacturer's sizes vary and not all manufacturers offer all sizes.

Ingredients in rubber flooring may include either natural rubber or synthetic materials. Natural rubber is a renewable raw material that is extracted from the sap of the tropical rubber plant without harming the plant. Typically, no waxes are required to maintain rubber floors.

****

Conform to ASTM F1344 [Class 1 homogeneous] [Class 2 layered], [Type A (solid color)] [Type B (through mottled)], [300] [450] [600] [900] [_____] mm [12] [18] [24] [36] [_____] inch square. Provide [smooth] [_____] [raised [round] [square] [diamond] surface studs with chamfered edges. Provide [high] [low]] stud profile. Provide [3.2] [_____] mm [0.125] [_____] inch overall thickness. [ASTM D2240 Type A durometer hardness [Grade 1, minimum of 85][Grade 2, minimum of 70] and not less than required by ASTM F1859.][With Vulcanizate Particulate Rubber, use recycled tire treads in accordance with ASTM D5603, fine mesh size particulate, [Grade 1, 2, or 3] [Grade 4] [Grade 5] [Grade 6]].

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Rubber Tile.]

2.4 RUBBER SHEET FLOORING [TYPE [_____]]

****

NOTE: Rubber sheet flooring provides slip resistance not usually found with other type floor tiles. Consider for areas such as stairwell

landings and ramps. Rubber flooring has a cushioning quality that reduces leg weariness and fatigue.

Some rubber flooring is not resistant to oil and grease and can perform poorly against certain reagents and stain spills. Determine project needs, research available product and add verbiage to paragraph if rubber flooring needs to be resistant to oil and grease and perform against certain reagents and stain spills.

The following thicknesses of rubber flooring are recommended for the traffic type shown: 2.0 mm 0.080 inch thickness - low traffic; 2.5 mm 0.100 inch thickness - medium traffic; 3 mm 0.118 inch thickness or greater - heavy traffic.

Research available widths. Manufacturer's widths vary and not all manufacturers offer all sizes.
****

Conform to [ASTM F1859 (flooring without backing), [Type I homogeneous] [Type II layered]] [or] [ASTM F1860 (flooring with backing), [Type I homogeneous] [Type II layered]], [minimum] [1 m 36 inch] [_____] wide. Provide [smooth] [embossed] [_____] surface. Provide [2] [2.5] [3] [_____] mm [0.080] [0.100] [0.118] [_____] inch overall thickness. [ASTM D2240 Type A durometer hardness [Grade 1, minimum of 85][Grade 2, minimum of 70] and not less than required by ASTM F1860.][With Vulcanizate Particulate Rubber, use recycled tire treads in accordance with ASTM D5603, fine mesh size particulate, [Grade 1, 2, or 3] [Grade 4] [Grade 5] [Grade 6].]
****
NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.
****

[Provide certification of indoor air quality for Rubber Sheet Flooring.]

2.5 LUXURY VINYL TILE [TYPE [_____]]

Conform to ASTM F1700 Class III printed film with a minimum wear layer thickness [0.50 mm 0.020 inch (20 mil)][0.70 mm 0.030 inch (30 mil)][_____] and minimum overall thickness [[2.5 mm 0.098 inch] [or] [3 mm 0.118 inch]] [5 mm 0.197 inch[with non slip/skid backing]][8 mm 0.375 inch[with non slip/skid backing]][[_____] mm[_____] inch[with non slip/skid backing]], Type [A (smooth)] [B (embossed)]. Provide[[300 by 600] [_____] mm [12 by 24] [_____] inch][[300] [400] [450] [600] [900] [_____] mm [12] [16] [18] [24] [36] [_____] inch square][_____] tile.[Provide tile with concealed water-blocking interlocking joints.][Provide tile with a factory protective finish that enhances cleanability and durability.]
****
NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available from some US national manufacturers above the minimum recycled content shown. Some manufacturers do not offer recycled content.

Some manufacturers provide proprietary interlocking connections between some thicker available planks, for instance in 8 mm 3/8 inch versions. These interlocking means are typically concealed from view once installed and may provide some water-blocking function to help prevent cleaning methods or spills from easily passing through flooring installation to substrates below.

Term "waterproof" is used in some manufacturer's sales literature. When specifying flooring, clarify if material is water-resistive and/or interlocking seams are water-blocking. Refrain from using term "waterproof" for any flooring that is not a seamless and watertight membrane to prevent misunderstandings of flooring performance.

Tile formats may be referred to as "plank" by manufacturers when units are longer than they are wide such that they visually suggest planks. These can still be categorized as tile.

****

[Provide Luxury Vinyl Tile containing a minimum of 35 percent recycled content. Provide data identifying percentage of recycled content for Luxury Vinyl Tile.]

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Luxury Vinyl Tile.]

[Provide ASTM F3261 solid core[tile][and][plank]flooring with rigid polymeric core[and concealed interlocking edges] and minimum overall thickness[4 mm 0.187 inch][[_____] mm [_____] inch].]

2.6 SOLID VINYL TILE [TYPE [_____]]

Conform to ASTM F1700 Class I monolithic (minimum wear layer thickness 3 mm 0.125 inch and minimum overall thickness 3 mm 0.125 inch, Type [A (smooth)] [B (embossed)]. Provide [300] [400] [450] [600] [900] [_____] mm [12] [16] [18] [24] [36] [_____] inch square tile.

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Solid Vinyl Tile.]

2.7 SHEET LINOLEUM [TYPE [_____]]

Conform to ASTM F2034 and consist of a homogeneous layer of a mixture of linoleum cement (binder in linoleum consisting of a mixture of linseed oil, pine rosin, fossil, or other resins or rosins, or an equivalent oxidized oleoresinous binder), cork and/or wood flour, mineral fillers, and pigments bonded to a jute backing. Provide a minimum 1800 mm 6 feet wide and overall thickness not less than [2.0 mm 0.080 inch] [2.5 mm 0.100 inch] [3.2 mm 0.125 inch] for linoleum. As required, provide welding rods as recommended by the manufacturer for heat welding of joints.

Provide Sheet Linoleum containing a minimum of 30 percent recycled content. Provide data identifying percentage of recycled content for Sheet Linoleum.

Provide Sheet Linoleum products with minimum 95 percent bio-based content. Submit data identifying percentage of bio-based content for Sheet Linoleum.

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Sheet Linoleum.]

2.8 LINOLEUM TILE [TYPE [_____]]

Conform to ASTM F2195 and consist of a homogeneous layer of a mixture of linoleum cement (binder in linoleum consisting of a mixture of linseed oil, pine rosin, fossil, or other resins or rosins, or an equivalent oxidized oleoresinous binder), cork or wood flour, mineral fillers, and pigments bonded to a [polyester] [_____] backing. Provide square tiles a minimum [450 mm 18 inch] [_____] square and overall thickness [2.0 mm 0.08 inch] [_____] minimum for linoleum tile.

Provide Linoleum Tile containing a minimum of 30 percent recycled content. Provide data identifying percentage of recycled content for Linoleum Tile.

Provide Linoleum Tile with minimum 90 percent bio-based content. Submit data identifying percentage of bio-based content for Linoleum Tile.

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms.

****

[Provide certification of indoor air quality for Linoleum Tile.]

2.9 CORK FLOORING [TYPE [_____]]

****

NOTE: Cork granules used for cork flooring and linoleum are by-products from bottle-cork manufacturing. Some cork floors use synthetic binders in the manufacturing process and synthetic finishes to provide more durable walking surfaces. Typically available only in tile form, cork usually provides better sound absorption characteristics than most vinyl flooring but is less durable than

commercial vinyl and rubber flooring.
****

Conform to ASTM F3008, and be [300] [_____] mm [12] [_____] inches square and [0.05] [_____] m [3/16][_____] inches to [0.08] [_____] m [5/16] [_____] inches thick. [Provide cork-faced MDF tongue-and-groove planks with cork facing.] Do not use products made with urea-formaldehyde binder.

****
NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available from some US national manufacturers above the minimum recycled content shown. Some manufacturers do not offer recycled content.
****

[Provide Cork Flooring containing a minimum of 95 percent recycled content. Provide data identifying percentage of recycled content for Cork Flooring.]

Provide Cork Flooring with minimum 100 percent bio-based content. Submit data identifying percentage of bio-based content for Cork Flooring.
****
NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms. Research shows that the product is available from some US national manufacturers with the following certification.
****

[Provide certification of indoor air quality for Cork Flooring.]
****
NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify availability within the region, cost effectiveness, and adequate competition before specifying these certifications.
****

[Provide certified sustainably harvested Cork Flooring.]

2.10 WALL BASE

****
NOTE: Job formed corners are recommended. The return on preformed corners is not always long enough to hold the piece in place and the corners can be knocked off during vacuuming and other cleaning operations.

Base is available in different lengths ranging from 1.22 m 4 feet pieces to 30.48 m 100 feet or 36.58 m 120 feet rolls. Availability and roll lengths vary dependent on manufacturer. Identify required length

if it impacts design intent. Some manufacturers of Type TS (vulcanized thermoset rubber) base offer only 1.22 m 4 feet lengths and not roll goods.

****

Conform to ASTM F1861, [[Type TS (vulcanized thermoset rubber)] [or] [Type TP (thermoplastic rubber)]] [, or] [Type TV (thermoplastic vinyl)], [Style A (straight - installed with carpet)] [,] [and] [Style B (coved - installed with resilient flooring)] [,] [and] [Style C (butt toe cove installed with 3 mm 1/8 inch thick flooring)]. Provide [100] [150] mm [4] [6] inch high and a minimum 3.175 mm 1/8 inch thick wall base. Provide [preformed] [job formed] corners in matching height, shape, and color. [With Vulcanizate Particulate Rubber, use recycled tire treads in accordance with ASTM D5603, fine mesh size particulate, [Grade 1, 2, or 3] [Grade 4] [Grade 5] [Grade 6].]

****

NOTE: Include the last bracketed sentence requiring products with indoor air quality certifications when product will be located in offices or classrooms. Research shows that the product is available from some US national manufacturers with the following certification.

****

[Provide certification of indoor air quality for Wall Base.]

2.11 INTEGRAL COVE BASE

****

NOTE: Integral coves can be used in many situations in which sheet vinyl and linoleum flooring are used to enhance the sanitary capacity inherent in seamless construction.

Consider specifying corner protectors in high traffic areas and areas that may receive some abuse.

Corner protectors are preferred in naval installations.

****

Extend integral coved base for [[sheet vinyl] [and] [sheet linoleum] flooring up the wall [100] [150] mm [4] [6] inch]. Provide a [vinyl] [or] [rubber] [clear anodized aluminum], [square] [round] cap strip and vinyl, rubber, or wood fillet strip with a minimum radius of 19 mm 3/4 inch for integral coved bases [at perimeter and fixed vertical interruptions to flooring] [as shown]. Provide integral cove of the same material as flooring. [Provide inside and outside corner protectors of [[_____]-colored anodized aluminum] [clear anodized aluminum] [or] [plastic] approved by flooring manufacturer.]

2.12 STAIR TREADS, RISERS, AND STRINGERS

Conform to ASTM F2169, [[Type TS (vulcanized thermoset rubber)] [or] [Type TP (thermoplastic rubber)]] [or] [Type TV (thermoplastic vinyl)]. Conform to ASTM F2169 for surface of treads [Class 1 smooth] [[Class 2 raised [round] [square] [diamond] stud] [ribbed] pattern] [and have [Group 1 abrasive non-slip strip] [Group 2 strip for visually impaired of contrasting [_____] color of [same] [abrasive] material]]. Provide [square] [or] [round] nosing. Provide either a one piece nosing/tread/riser or a two piece nosing/tread design with a matching coved riser.[With Vulcanizate Particulate Rubber, use recycled tire treads in accordance with ASTM D5603, fine mesh size particulate, [Grade 1, 2, or 3] [Grade 4] [Grade 5] [Grade 6].]

2.13 MOULDINGS

Provide tapered mouldings of [[vinyl] [or] [rubber]] [[_____]-colored anodized aluminum] [clear anodized aluminum] and types as recommended by flooring manufacturer for both edges and transitions of flooring materials specified. Provide vertical lip on moulding of maximum 6 mm 1/4 inch. Provide bevel change in level between 6 and 13 mm 1/4 and 1/2 inch with a slope no greater than 1:2.

2.14 ADHESIVES

****

NOTE:
Adhesives may be a source of VOCs. Some styles of plastic flooring are available in loose-laid design (puzzle pieces that are tapped together with a rubber mallet) that can be installed without adhesive.

****

Provide asbestos-free adhesives for flooring, base and accessories as recommended by the manufacturer and comply with local indoor air quality standards. Submit manufacturer's descriptive data, documentation stating physical characteristics, and mildew and germicidal characteristics.

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

2.15 SURFACE PREPARATION MATERIALS

****

NOTE: Panel type underlayments, such as plywood and hardboard, are specified in Section 06 10 00 ROUGH CARPENTRY. Coordinate underlayments requirements with the ROUGH CARPENTRY specifications.

****

Provide asbestos-free surface preparation materials, such as panel type underlayment, lining felt, leveling compounds, and floor crack fillers as recommended by the flooring manufacturer for the subfloor conditions. Comply with ASTM D5603 and ASTM F1482 for panel type underlayment products. Use one of the following substrates:

[a. Particleboard: As specified in Section 06 10 00 ROUGH CARPENTRY.]

[b. Fiberboard: As specified in Section 06 10 00 ROUGH CARPENTRY.]

[c. Cork Joint Filler: As specified in Section 06 10 00 ROUGH CARPENTRY.]

[d. Cement-fiber board: As specified in Section 09 29 00 GYPSUM BOARD.]

[e. Plywood: As specified in Section 06 10 00 ROUGH CARPENTRY.]

[f. Concrete: As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.]

2.16 POLISH/FINISH

Provide polish finish as recommended by the manufacturer and conform to ASTM D4078 for polish. Confirm that polish finishes meet dry and wet coefficient of friction per TCNA A326.3,SSPC Guide 21, as applicable.

2.17 CAULKING AND SEALANTS

Provide asbestos-free caulking and sealants in accordance with Section 07 92 00 JOINT SEALANTS.

2.18 ACCESSORIES

Provide accessories necessary to complete transitions, coves, terminations, caps, accent bands, and trim as recommended by the resilient flooring and accessories manufacturers in writing.

2.19 MANUFACTURER'S COLOR, PATTERN, AND TEXTURE

****

NOTE: Coordinate color reference sentence(s) with the Government. Generally the Section 09 06 00 SCHEDULES FOR FINISHES or drawings are used when the project is designed by an Architect or Interior designer. Select color from manufacturer's standard colors or identify in this specification.

When the government directs that color be located in the drawings, add a note that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

When more than one type, pattern or color is specified identify location.

When a manufacturer's name, stock number, pattern, and color is specified for color, be certain that the product conforms to the specification, as edited.

Drawings are required for projects with floor patterns.

****

Provide color, pattern and texture for resilient flooring and accessories [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [as indicated on the drawings] [selected from manufacturer's standard colors] [[_____]. Color listed is not intended to limit the selection of equal colors from other manufacturers].[Provide floor patterns as specified on the [drawings Sheet No. [_____]] [_____].] Provide flooring in any one continuous area or replacement of damaged flooring in continuous area from same production run with same shade and pattern. Submit scaled drawings indicating patterns (including location of patterns and colors) and dimensions. Submit manufacturer's descriptive data and [three] [_____] samples of each indicated color and type of flooring, base, mouldings, [heat welding bead], and accessories sized a minimum 150 by 230 mm 6 by 9 inch. [Submit welded-seam samples of seamless-installation with resilient flooring and accessories samples for each seamless resilient sheet type, color, and pattern; place seam at center of 150 by 230 mm 6 by 9 inch sample run lengthwise with sample applied over a board prepared by the flooring installer.] Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

2.20 FIRE RESISTANCE TESTING REQUIREMENTS

****

NOTE: Choice of critical radiant flux level as it applies to building type and area of application will be made in accordance with the latest edition of UFC 3-600-01 and NFPA 101. Wherever the use of Class II (0.22) watts finish is required, Class I (0.45) watts will be permitted. Critical radiant flux will be a minimum average of 0.45 watts when used in corridors in bachelor enlisted quarters, bachelor officer quarters, hospital, child care centers, temporary lodging facilities, and new construction of detention and correctional facilities. Generally the critical radiant flux will be a minimum of 0.22 for corridors of other type facilities. Where an approved automatic sprinkler system is installed, Class II interior floor finish may be used where Class I floor finish is required, and where Class II is required, no critical radiant flux rating is required.

****

Provide a minimum average critical radiant flux of [0.22][0.45] watts per square centimeter for flooring in corridors and exits when tested in accordance with ASTM E648 or NFPA 253.

PART 3 EXECUTION

3.1 EXAMINATION

Examine and verify that site conditions are in agreement with the design package. Report all conditions that will prevent a proper installation. Do not take any corrective action without written permission from the Government. Work will proceed only when conditions have been corrected and accepted by the installer. Submit manufacturer's printed installation instructions for all flooring materials and accessories, including preparation of substrate, seaming techniques, and recommended adhesives.

3.2 SURFACE PREPARATION

Provide a smooth, true, level plane for surface preparation of the flooring, except where indicated as sloped. Floor to be flat to within 4.75 in 3048 mm 3/16 inch in 10 feet. Prepare subfloor in accordance with flooring manufacturer's printed instructions. Prepare the surfaces of lightweight concrete slabs (as defined by the flooring manufacturer) as recommended by the flooring manufacturer. Comply with ASTM F710 for concrete subfloor preparation. Floor fills or toppings may be required as recommended by the flooring manufacturer. Install underlayments, when required by the flooring manufacturer, in accordance with manufacturer's printed installation instructions. Comply with ASTM F1482 for panel type underlayments. Before any work under this section is begun, correct all defects such as rough or scaling concrete, chalk and dust, cracks, low spots, high spots, and uneven surfaces. Repair all damaged portions of concrete slabs as recommended by the flooring manufacturer. Remove concrete curing and sealer compounds from the slabs, other than the type that does not adversely affect adhesion. Remove paint, varnish, oils, release agents, sealers, waxes, and adhesives, as required by the flooring product in accordance with manufacturer's printed installation instructions.

3.3 MOISTURE, ALKALINITY, AND BOND TESTS

Determine the suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content and pH level by moisture and alkalinity tests. Conduct moisture testing in accordance with ASTM F1869 or ASTM F2170, unless otherwise recommended by the flooring manufacturer. Conduct alkalinity testing as recommended by the flooring manufacturer. Determine the compatibility of the resilient flooring adhesives to the concrete floors by a bond test in accordance with the flooring manufacturer's printed installation instructions. Submit copy of test reports for moisture and alkalinity content of concrete slab, and bond test stating date of test, person conducting the test, and the area tested.

3.4 GENERAL INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Comply with manufacturer's written instructions for installing resilient sheet flooring and for unrolling and stabilizing flooring materials prior to installation.[Minimize the number of seams in sheet flooring, especially in high traffic or conspicuous locations. Avoid cross seams.]

3.5 PLACING VINYL COMPOSITION, LINOLEUM, AND SOLID VINYL TILES

Install tile flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions. Keep tile lines and joints square, symmetrical, tight, and even. Keep each floor in true, level plane, except where slope is indicated. Vary edge width as necessary to maintain full-size tiles in the field, no edge tile to be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe edge tile to walls and partitions after field flooring has been applied.

3.6 PLACING LUXURY VINYL TILES

****

NOTE: Most LVT flooring is installed using

conventional glue down installation. LVT flooring that is 5 mm 0.197 inch thick can be installed loose lay or adhesive dependent on the project requirements. Glue down installation is typically required in areas with high traffic and rolling loads. Coordinate recommended installation methods with flooring manufacturers.
****

[Install luxury vinyl tile flooring using [glue down] [loose lay (room perimeter adhesive only)] installation.]Install flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions for installation method specified. Keep tile lines and joints square, symmetrical, tight, and even. Keep each floor in true, level plane, except where slope is indicated. Vary edge width as necessary to maintain full-size tiles in the field, no edge tile to be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe edge tile to walls and partitions after field flooring has been applied.

3.7 PLACING SHEET VINYL FLOORING

****
NOTE: Determine if welded seams are necessary to meet project requirements.
****

Install sheet vinyl flooring and accessories in accordance with manufacturer's printed installation instructions and ASTM F1516. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Lay out sheets to minimize waste. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied.[Provide [chemically bonded] [or] [heat welded] seams and edges [in rooms [______]] [shown on the drawings] in accordance with the manufacturer's printed installation instructions. Finish joints flush, free from voids, recesses, and raised areas.] [Install flooring with an integral coved base.]

3.8 PLACING SHEET LINOLEUM FLOORING

****
NOTE: Determine if welded seams are necessary to meet project requirements.
****

Install sheet linoleum flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Lay out sheets to minimize waste. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied. Cut seams by overlapping or underscribing as recommended by the manufacturer. [Provide heat welded seams [in rooms [_____]] [as shown on the drawings] in accordance with the manufacturer's written installation instructions.] Finish joints flush, free from voids, recesses, and raised areas. [Install flooring with an integral coved base.]

3.9 PLACING RUBBER TILE

Install rubber tile and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Vary width of edge tiles as necessary to maintain full-size tiles, except where irregular-shaped rooms makes it impossible. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied.

3.10 PLACING RUBBER SHEET FLOORING

Install rubber sheet flooring and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Cut seams by overlapping or underscribing as recommended by the manufacturer. Lay out sheets to minimize waste. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied.

3.11 PLACING CORK FLOORING

Install cork [tile] [plank flooring] and accessories in accordance with manufacturer's installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions. Provide square, symmetrical, tight, and even flooring lines and joints except where slope is indicated. Keep each floor in true, level plane, except where slope is indicated. [Vary width of edge tiles as necessary to maintain full-size tiles in field, while keeping edge tiles larger than one-half full size, except where irregular-shaped rooms make it impossible.] Cut and fit flooring around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit and scribe flooring to walls and partitions after field flooring has been applied.

3.12 PLACING FEATURE STRIPS

Install feature strips in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions.

3.13 PLACING MOULDINGS

Provide mouldings where flooring termination is higher than the adjacent finished flooring and at transitions between different flooring materials. When required, locate mouldings under door centerline. Mouldings are not required at doorways where thresholds are provided. [Secure mouldings with adhesive as recommended by the manufacturer. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions.]

[Anchor aluminum mouldings to floor surfaces as recommended by the manufacturer.]

3.14 PLACING WALL BASE

Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions. Tighten base joints and make even with adjacent resilient flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

3.15 PLACING STAIR TREADS, RISERS, AND STRINGERS

****

NOTE: Installation of stringers can be labor intensive. Dependent on the project requirements consider other stringer finish alternatives, an example would be a painted stringer.

****

Secure and install stair treads, risers, and stringers in accordance with manufacturer's printed installation instructions. Cover the surface of treads and risers[the full width of the stairs][within 150 mm 6 inch to the stair edges]. Provide equal length pieces butted together to cover the treads and risers for stairs wider than manufacturer's standard lengths. [Provide stringer angles on both the wall and banister sides of the stairs, and landing trim.]

3.16 PLACING INTEGRAL COVED BASE

Install integral cove base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed installation instructions. Shape integral coved base by extending the flooring material [100] [150] [_____] mm [4] [6] [_____] inch onto the wall surface. Support cove by a filler. Provide a cap strip at the top of the base. Fill voids along the top edge of base at masonry walls with caulk.

3.17 CLEANING

****

NOTE: Some activities prefer no-wax maintenance; others prefer waxing. Pre-waxed flooring and flooring that does not require wax need not be waxed after installation if properly protected. Coordinate any requirements for application of polish/floor finish with the end using agency. Modify paragraph accordingly.

****

Immediately upon completion of installation of flooring in a room or an area, dry and clean the flooring and adjacent surfaces to remove all surplus adhesive. Clean flooring as recommended in accordance with manufacturer's printed maintenance instructions and within the recommended time frame. As required by the manufacturer, apply the recommended number of coats and type of polish and finish in accordance with manufacturer's printed instructions.

3.18 PROTECTION

From the time of installation until acceptance, protect flooring from damage as recommended by the flooring manufacturer. Remove and replace flooring which becomes damaged, loose, broken, or curled and wall base which is not tight to wall or securely adhered.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 65 66 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 65 66 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-09 65 66 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 65 66 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 65 66

RESILIENT ATHLETIC FLOORING

08/16, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for resilient athletic flooring.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Systems specified in this guide specification are recommended for indoor athletic rooms e.g., weight rooms, running tracks, recreational areas, aerobic centers, multi-purpose gym floors, etc. Hardwood flooring is preferable for basketball courts, handball, and racquetball courts. Rubber-base floorings can be used in outdoor installations like wet bars, running tracks, tennis courts, and swimming pool walks.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D1054	(2002; R 2007) Rubber Property - Resilience Using a Rebound Pendulum
ASTM D1894	(2014) Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2632	(2015; R 2019) Standard Test Method for Rubber Property-Resilience by Vertical Rebound
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F1303	(2004; R 2021) Standard Specification for Sheet Vinyl Floor Covering with Backing

ASTM F1869	(2023) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F2170	(2019a) Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
ASTM F2772	(2011) Standard Specification for Athletic Performance Properties of Indoor Sports Floor Systems
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CARPET AND RUG INSTITUTE (CRI)

CRI GL CUSHION	Green Label Cushion Program
CRI GLP QM	(2017) Green Label Plus Quality Manual

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems- Requirements
ISO 14001	(2015) Environmental Management Systems — Requirements with Guidance for Use

RESILIENT FLOOR COVERING INSTITUTE (RFCI)

FLOORSCORE	FLOORSCORE IAQ Certification

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings
SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G, [_____]

SD-03 Product Data

Installation

Indoor Air Quality for Rubber Poured-In-Place Flooring; S

Indoor Air Quality for Urethane Poured-In-Place Flooring; S

Indoor Air Quality for Adhesives; S

Indoor Air Quality for Primer; S

Indoor Air Quality for Game Line Marking Materials; S

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Indoor Air Quality for Indoor-Outdoor Carpeting; S

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Indoor Air Quality for Sheet Rubber Composition Flooring; S

Indoor Air Quality for Sheet Vinyl Composition Flooring; S

Indoor Air Quality for Resilient Mat Underlay; S

Indoor Air Quality for Wall Base; S

SD-11 Closeout Submittals

Warranty

1.3 QUALITY ASSURANCE

1.3.1 Shop Drawings

Provide approved detail drawings showing, as a minimum, installation details and locations of borders, patterns, and locations of floor seams.

1.3.2 Manufacturer Qualifications

Manufacturer must have at least ten years active experience in the manufacturing and marketing of indoor resilient athletic flooring, and be a certified manufacturer in accordance with ISO 9001 and ISO 14001. Manufacturer must also have an authorized installer training program.

1.3.3 Installer Qualifications

Installer must have at least five years of experience in the installation of resilient athletic flooring, and have experience on at least five projects of similar size, type and complexity as this Project. Installer must also utilize workers for this Project who are competent in techniques required by manufacturer of resilient athletic flooring installation indicated.

1.3.4 Laboratory Test Results

1.3.4.1 Performance Properties

Provide certification documents indicating testing per ASTM F2772 has been performed and the product being supplied complies with the ASTM category/classification specified for this project. Information from product catalogs or sales literature is not sufficient.

1.3.4.2 Shock Absorption

Shock absorption (force reduction) test results certified by an independent testing laboratory certified to perform such testing.

a. ASTM test must be from certified North American laboratories.

b. EN and DIN test must be from certified European laboratories.

1.3.4.3 Fire Performance

Provide fire performance test results.

1.3.5 Fire Test Characteristics

As determined by testing identical products according to ASTM E648, Class 1, by a qualified testing agency acceptable to authorities having jurisdiction.

1.3.6 Athletic Performance Properties

Comply with ASTM F2772 Performance Level C2 for force reduction and ball rebound.

1.3.7 Adhesive Application

Adhesive applied and poured-in-place flooring must be installed by an experienced floor applicator approved by the manufacturer.

1.3.8 Flooring Material Samples

Submit three samples minimum 225 x 275 mm 9 x 11 inches of each color of flooring material required and manufacturer's certificates stating that the resilient athletic flooring materials conform to the specified requirements. Labels or markings affixed to manufacturer's products attesting that products meet requirements specified herein will be accepted in lieu of certificates.

1.4 CERTIFICATIONS

1.4.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

1.4.1.1 Floor Covering Materials

Provide rubber composition tile, sheet rubber composition flooring, sheet vinyl composition flooring, and wall base products certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide resilient mat underlay products certified to meet indoor air quality requirements by FLOORSCORE, UL 2818 (GreenGuard) Gold, SCS Global Services Indoor Advantage Gold, CRI GL CUSHION or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide indoor-outdoor carpeting products certified to meet indoor air quality requirements by UL 2818 (GreenGuard) Gold, SCS Global Services Indoor Advantage Gold, CRI GLP QM or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver Materials in manufacturer's original unopened containers with labels intact. Do not deliver materials to the installation area or installed before all work that may damage the materials or the finished floor, such as overhead work, is completed. Store materials in a clean, dry area. Maintain materials in storage at temperatures recommended by the manufacturer. Store protection boards flat and off the ground.

a. Store flooring and installation materials in protected dry spaces, with ambient temperatures maintained within range recommended by manufacturer, but less than 13 degrees C 55 degrees F nor more than 29 degrees C 85 degrees F.

b. Store the indoor resilient athletic surfacing rolls in an upright position on a smooth flat surface immediately upon delivery to Project.

1.6 WARRANTY

1.6.1 Manufacturer's Warranty

Manufacturer's standard form in which manufacturer agrees to repair or replace sports flooring that fails within specified warranty period. Material warranty must be direct from the product manufacturer. Material warranties from separate or third party insurance providers are not valid. Material warranties from private label distributors are not valid.

Failures include, but are not limited to, the following:

a. Material manufacturing defects.

b. Surface wear and deterioration to the point of wear-through.

c. Failure due to substrate moisture exposure not exceeding 80 percent relative humidity when tested according to ASTM F2170 or 5 pounds moisture vapor emission rate when tested according to ASTM F1869.

1.6.1.1 Warranty Period

For materials: Minimum of 2 years from date of Substantial Completion. For surface wear: minimum of 15 years from date of Substantial Completion.

1.6.2 Installer's Warranty

Installer's standard form in which installer agrees to repair or replace sports flooring that fails due to poor workmanship or faulty installation within the specified warranty period.

1.7 COORDINATION

Coordinate layout and installation of flooring with other gymnasium equipment.

1.8 EXTRA MATERIALS

1.8.1 Floor Tiles

Furnish spare tiles of each color at the rate of [_____] [5] tiles for each 1000 tiles installed. Tiles must be from the same lot as those installed.

1.8.2 Carpeting

Extra material from same dye lot consisting of full width continuous broadloom must be provided for maintenance. A minimum of [_____] percent of total square meters square yards of each carpet type, pattern, and color must be provided.

PART 2 PRODUCTS

****

NOTE: If more than one type of resilient flooring is required, a separate paragraph for that type floor will be used. Each flooring type will be designated with a letter or number symbol. Use the same symbols to key flooring types to locations listed or shown on the drawings.

Floor types will be specified for a specific use such as, carpet for pool areas, multi-use areas, and pro shops, or rubber tile flooring for weight rooms, etc. Edit specification as required to meet project needs and omit text not applicable.

****

2.1 FLOORING MATERIALS

****

NOTE: If more than one type of resilient flooring is required, a separate paragraph for that type floor will be used. Each flooring type will be designated with a letter or number symbol. Use the same symbols to key flooring types to locations listed or shown on the drawings.

Floor types will be specified for a specific use such as, carpet for pool areas, multi-use areas, and pro shops, or rubber tile flooring for weight rooms, etc. Edit specification as required to meet project needs and omit text not applicable.

****

2.1.1 Indoor-Outdoor Carpeting Type [A] [_____]

****

NOTE: Carpeting must be specially designed for indoor or indoor-outdoor environments as required, e.g., weight rooms, outdoor playground areas, indoor/outdoor pool areas, and pro shops. Edit as required to meet project requirements.

****

Carpet-type flooring that is spike proof [[ribbed] [berber] pattern consisting of a top layer of rugged [polypropylene] [or] [nylon] fibers combined with an inorganic cut-resistant [non-skid] [_____]] [wet areas artificial turf pattern consisting of a top layer of rugged polypropylene fibers combined with an inorganic cut-resistant [porous rubber knob][foam] [_____]] backing. Minimum total thickness must be [10] [_____] mm [0.375] [_____] inches. Finished surface pile yarn weight (face weight) must be minimum [_____] kg/square meter ounces/square yard. Test results for resistance to soil bacteria or fungi must show no sustained growth or discoloration after 21 days when tested in accordance with ASTM G21. Product must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for Indoor-Outdoor Carpeting.

2.1.2 Rubber Composition Tile Type [A] [_____]

Provide [interlocked] [_____] [600 x 600] [_____] mm [24 x 24] [_____] inches square, of solid first quality rubber, uniformly resilient material rubber tiles, designed to be applied [with] [without] adhesive. Provide tiles that are approximately [13] [_____] mm [1/2] [_____] inch thick, [smooth] [traction] [_____] texture, and [reversible] [non-reversible]. Flooring must be able to withstand [75 percent compression for 22 hours at 70 degrees C 158 degrees F] [_____] without residual deformation when tested in accordance with ASTM D395. Provide flooring with a durometer hardness Shore-A of 50-60 when tested in accordance with ASTM D2240. Product must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for Rubber Composition Tile.

2.1.3 Rubber Poured-In-Place Flooring Type [A] [_____]

Provide resilient poured-in-place rubber surface composed of chloroprene rubber, chloroprene rubber sponge, aggregate, setting powders, and a top finish composed of acrylic resins. Flooring must be able to withstand 50 percent compression for 72 hours at 22 degrees C 72 degrees F with a residual deformation of less than 10 percent when tested in accordance with ASTM D395. Flooring must have a minimum compression modulus at 10 percent of 690 kPa 100 psi, a minimum elongation of 250 percent and a minimum tensile strength of 3800 kPa 550 psi plus or minus 34 kPa 5 psi when tested in accordance with ASTM D412. Provide flooring with a durometer hardness Shore-A of 55-60 when tested in accordance with ASTM D2240 and a minimum tear resistance of 10.5 kN/m 60 lbf/inch when tested in accordance with ASTM D624. For interior applications (defined as inside of the weatherproofing system) of rubber poured-in-place flooring, provide products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for Rubber Poured-In-Place Flooring.

2.1.4 Sheet Rubber Composition Flooring Type [A] [_____]

Provide prefabricated, homogeneous, natural and synthetic rubbers sheet rubber flooring, minimum [5] [_____] mm [3/16] [_____] inch thick, and [smooth gymnasium] [textured all-purpose] finish. provide roll type flooring not less than 1500 [_____] mm 60 [_____] inches wide. Flooring must have a minimum tensile stress at 100 percent elongation of 1500 kPa 220 psi and a minimum ultimate elongation of 250 percent when tested in accordance with ASTM D412. Flooring must be able to withstand 50 percent compression for 72 hours at 22 degrees C 72 degrees F with a residual deformation of less than 10 percent when tested in accordance with ASTM D395.

Flooring must provide a 55 plus or minus 5 percent rebound when tested in accordance with ASTM D1054. Product must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for Sheet Rubber Composition Flooring.

2.1.5 Sheet Vinyl Composition Flooring Type [A] [_____]

Provide sheet vinyl flooring consisting of a solid polyvinyl chloride material that conforms to the chemical resistance requirements of ASTM F1303. Provide flooring not less than 1200 mm 48 inches wide and a minimum thickness of [3] [_____] mm [1/8] [_____] inch. Provide [smooth] [stipple] [track embossed] texture floor surface. Flooring must have a minimum coefficient of friction of 0.75 when tested in accordance with ASTM D1894. Provide flooring with an average thickness loss of 0.2 mm 8.0 mils plus or minus 0.025 mm 1 mil. Rebound resilience of flooring must be greater than 12 percent and less than 30 percent when tested in accordance with ASTM D2632. Product must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for Sheet Vinyl Composition Flooring. [Provide an optional compatible top coating recommended by the sheet vinyl flooring manufacturer.]

2.1.6 Urethane Poured-In-Place Flooring Type [A] [_____]

****

NOTE: Urethane resilient flooring may be installed on a variety of substrates and in a variety of thicknesses from 3 to 25 mm 1/8 to 1 inch. Coordinate with manufacturer's literature. Edit specification as required.

****

The resilient poured-in-place urethane surface is composed of a seamless pigmented monolithic material. Provide minimum [3] [_____] mm [1/8] [_____] inch thick and [smooth gymnasium] [textured all-purpose] [textured track] finish flooring. Flooring must have a durometer hardness Shore-A of 55-60 when tested in accordance with ASTM D2240. Flooring must have a minimum ultimate elongation of 250 percent when tested in accordance with ASTM D412 and must have a density of 1.25.

For interior applications (defined as inside of the weatherproofing system) of urethane poured-in-place flooring, provide products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for Urethane Poured-in-Place Flooring.

2.2 RESILIENT MAT UNDERLAY

****

NOTE: Resilient mat underlay may be used under a two-component polyurethane wear coat system, sheet rubber surfacing system, or a vinyl sheet surfacing system. Deletion or specification and thickness of mat underlay will be determined by the athletic flooring requirements. Coordinate with manufacturer's literature.

****

Provide prefabricated resilient mat underlay consisting of granulated indoor/outdoor rubber mat bound with polyurethane for shock absorption. Mat thickness must be [_____] mm inches. Product must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for Resilient Mat Underlay.

2.3 ADHESIVES

Adhesive must be as recommended by the flooring manufacturer and correspond to the specified flooring product and to the substrate. Adhesive products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for adhesives.

2.4 CRACK FILLER/LEVELER FOR CONCRETE SURFACES

Provide crack filler/leveler for concrete floor surfaces as recommended by flooring manufacturer.

2.5 EDGING STRIPS

Provide strips of the same material and design as recommended by flooring manufacturer.

2.6 PRIMER

Concrete primer must be as recommended by flooring manufacturer and correspond to the specified flooring product and to the substrate. For interior applications (defined as inside of the weatherproofing system) of primer, provide products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for primer.

2.7 GAME LINE MATERIAL

Game line material must be as recommended by the flooring manufacturer and correspond to the specified flooring product. For interior applications (defined as inside of the weatherproofing system) of game line marking materials, provide products meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for game line marking materials.

2.8 WALL BASE

****

NOTE: Include last bracketed sentences requiring products with indoor air quality certifications or validations when product will be located in offices or classrooms.

****

Base must be [rubber] [vinyl], Type [straight] [coved] style. Base must be 100 mm 4 inches high and minimum 2 mm 0.080 inch thick.[

Product must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for wall base.]

2.9 SEALANTS

provide sealants in accordance with Section 07 92 00 JOINT SEALANTS.

2.10 MANUFACTURERS COLOR

Color must be [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____].

PART 3 EXECUTION

****

NOTE: Expansion joints under resilient athletic flooring should be avoided to the maximum extent possible by placing the joints at the perimeter of the floor area. For large areas such as gymnasiums, shrinkage compensating concrete may be advisable.

****

3.1 PREPARATION

Concrete surfaces must be completely cured and dry. Do not use curing agents, sealers, or hardeners to aid in the curing of the concrete slab. Surfaces must be free of paint spots, and other foreign materials. Surfaces must be ground down or leveled with an approved leveling compound to a tolerance of plus or minus 3 mm 1/8 inch within a 3 meters 10 foot radius. Cracks, construction joints, or damaged portions of floor must be filled with crack filler for concrete surfaces. Expansion joints must be filled and sealed in accordance with the approved installation instructions of the manufacturer. All sealants must be in accordance with ASTM C920. Expansion joints must not be filled with a material that will make them inoperable.

3.2 MOISTURE TEST

Confirm that the moisture content of concrete subfloors is in the range recommended by the flooring manufacturer before floor installation.

3.3 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.3.1 General Requirements

Installation must be in accordance with the approved installation instructions. Tile or sheet flooring must be rolled with a medium-sized roller in both directions to release entrapped air. Submit manufacturer's descriptive data and catalog cuts indicating materials of construction and physical characteristics. Installation, cleaning and maintenance instructions must be included.

3.3.2 Molded Rubber Base

Install base in accordance with the approved installation instructions of the manufacturer of the base.

3.3.3 Indoor-Outdoor Carpeting

Apply flooring as recommended by the manufacturer.

3.3.4 Sheet Vinyl Composition Flooring

Prime the concrete slab in accordance with approved installation instructions. Install flooring as recommended by the manufacturer.

3.3.4.1 Seams

Cut and place end seams as recommended by the manufacturer. Weight seams weighted as required.

3.3.4.2 Hot-Welded Seams

Groove butted sheets to a depth of approximately two thirds of their total thickness using an electrical or hand grooving tool. Thermoweld grooved seams using a hot air welding tool and a PVC welding thread. After seam has cooled to room temperature, trim the excess off to provide a flush joint.

3.3.5 Sheet Rubber Composition Flooring

Sheet flooring must be dry cut and layed out flat a minimum of 24 hours prior to adhering to the substrate. Single cut end seams. Cut edge seams through overlapping sheets, then snap into place to ensure tight seams. Weight seams as required.

3.3.6 Rubber Composition Tile Flooring

****

NOTE: Tile flooring can be installed with adhesive or without adhesive using a mechanical locking technique. Edit to comply with the type flooring specified.

****

3.3.6.1 Application With Adhesive

Lay tiles on adhesive surface in pattern according to approved detail drawings. Joints of tiles must be even and tight. Cut tiles to fit tightly against the wall. Submit drawings showing game lines, location of anchor plate assemblies, floor outlets, and under-floor conduit or raceways.

3.3.6.2 Application Without Adhesive

Join tiles together using interlocking ears or other mechanical locking techniques. Interlock the ears into the adjoining tile 40 mm 1-1/2 inches and provide at least five interlocks for each 600 mm 24 inch edge. Where required, supply a beveled transfer border to interlock with the flooring tiles. The borders must be 150 mm 6 inches wide and 600 mm 24 inches long and the same thickness as the matching tiles.

3.3.7 Rubber Poured-in-Place Flooring

Prime the concrete slab with primer recommended by manufacturer in a thin film covering approximately 10 square meters/L 400 square feet per gallon. Pour chloroprene rubber onto subfloor and trowel to a smooth and uniform layer of the required thickness. Apply a grout chloroprene rubber coat to fill possible voids in surface. After the chloroprene rubber is completely dry, apply a pigmented finish with a spray and roller.

3.3.8 Urethane Poured-in-Place Flooring

Prime the concrete slab with primer recommended by the manufacturer. Rate of application must be in accordance with approved installation instructions and be allowed to dry odor free. Cover concrete construction joints with 50 mm 2 inch wide PVC duct tape. Apply resin in a minimum of 2 lifts. Apply pigmented and textured coatings in accordance with manufacturer's recommendations.

3.3.9 Resilient Mat Underlay

Unroll the resilient mat underlay and allow to relax prior to cutting or fitting. Install the mat in accordance with manufacturers instructions.

3.3.10 Line Marking and Finishing

After installation is complete, clean the floor surface in accordance with installation instructions. Lay out, mask, and paint line marking according to approved detail drawings and approved installation instructions. Finish in accordance with the manufacturer's recommendations.

3.4 PROTECTION

Protect the installed flooring from soiling and damage with heavy reinforced, nonstaining kraft paper, plywood, or hardboard sheets as required. Lap and secure edges of kraft paper protection to provide a continuous cover. Remove protective covering when directed by the Contracting Officer.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 66 13 (August 2016)**
Change 2 - 11/18

Preparing Activity: USACE **Superseding**
UFGS-09 66 13 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 09 66 13

PORTLAND CEMENT TERRAZZO FLOORING

08/16, CHG 2: 11/18

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PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 66 13 (August 2016)**
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****

SECTION 09 66 13

PORTLAND CEMENT TERRAZZO FLOORING

08/16, CHG 2: 11/18

****

NOTE: This guide specification covers the requirements for standard terrazzo bonded to concrete subfloor.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Bonded terrazzo is normally 45 mm 1-3/4 inch total thickness, consisting of 13 mm 1/2 inch thick terrazzo topping over a 32 mm 1-1/4 inch thick underbed.

Where structural movement which may injure the terrazzo is anticipated, installations should be by the sand cushion (floating) method. Where requirement exists for sand-cushion or other-type installation method, bases, precast work, or specialized work such as structural, abrasive, rustic, or venetian terrazzo, or terrazzo over permanent metal forms, the specification should be revised or a separate section should be prepared as

appropriate.

Areas to receive terrazzo will be shown on the drawings. Color should be indicated by showing a selected plate number from the NTMA publication, "Terrazzo Design/Technical Data"

Example: NTMA Terrazzo Color Palette, plate No. S-301-4. Colors selected may be any combination of standard marble granules of domestic origin available in the local market.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C241/C241M	(2021) Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL TERRAZZO AND MOSAIC ASSOCIATION (NTMA)

NTMA Info Guide	(2017) Terrazzo Reference Guide

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, [_____]

SD-03 Product Data

Flooring System Materials

Recycled Content for Portland Cement Terrazzo Flooring System; S

Indoor Air Quality for Curing Material; S

Indoor Air Quality for Sealer; S

SD-04 Samples

Terrazzo Flooring

Divider Strips

Control Joint Strips

Colorants

SD-10 Operation and Maintenance Data

Cleaning and Sealing

SD-11 Closeout Submittals

Warranty

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the manufacturer's unopened containers marked with the brand name. Deliver, handle, and store materials in accordance with manufacturers instructions in a manner that prevents deterioration and contamination.

1.4 ENVIRONMENTAL REQUIREMENTS

Maintain areas to receive terrazzo at a temperature above 10 degrees C 50 degrees F 24 hours prior to the time mixtures are placed and until completely cured.

1.5 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one-year period.

PART 2 PRODUCTS

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled

content requirements.

Research shows the product is commonly available with the minimum recycled content percentages shown below. Include section below when system with recycled content is desired, and select material option based on research of availability and price effectiveness.

****

[2.1 PORTLAND CEMENT TERRAZZO FLOORING SYSTEM MATERIALS

Provide system that has a minimum of [40 percent fly ash] [100 percent recycled aggregate] [____]. Provide data identifying percentage of recycled content for portland cement terrazzo flooring system. Do not use coral, dolomite, or limestone aggregates in setting bed.

]2.2 PORTLAND CEMENT

Provide portland cement conforming to ASTM C150/C150M, Type I, of colors required to match NTMA Info Guide color plate indicated [in Section 09 06 00 SCHEDULES FOR FINISHES].

2.3 SAND

Provide sand conforming to ASTM C33/C33M for fine aggregate.

2.4 MARBLE CHIPS

Provide marble chips of domestic origin of sizes and colors required to match NTMA Info Guide color plate indicated [in Section 09 06 00 SCHEDULES FOR FINISHES]. Marble chips must have an abrasive hardness of not less than 10 when tested in accordance with ASTM C241/C241M; contain no deleterious or foreign matter; and less than one percent by weight dust content.

2.5 DIVIDER STRIPS

****

NOTE: Manufacturer's literature should be reviewed when making selections for divider strips. When material and thickness of divider strips and color of plastic strips vary, depending on location in the project, material thickness and color should be shown on the drawings and specified.

****

Provide divider strips in accordance with NTMA Info Guide and 30 mm 1-1/4 inch deep, [_____] mm gauge thick and of [brass] [zinc] [plastic in color as indicated [in Section 09 06 00 SCHEDULES FOR FINISHES]]. Standard type one-piece divider strips must [be not lighter than 1.5 mm No. 16 Brown & Sharpe gage thick] [be of thickness indicated]. Heavy-top strips may be either one- or two-piece strips with a solid top section, [not less than 6 mm 1/4 inch nor more than 10 mm 3/8 inch in depth and not less than [3] [6] mm [1/8] [1/4] inch thick] [of thickness shown]. Submit two 150 mm 6 inch lengths of each type divider.

2.6 CONTROL JOINT STRIPS

****

NOTE: Manufacturer's literature should be reviewed when making selections for control joint strips.
****

Provide control joint strips in accordance with NTMA Info Guide and [_____] mm inches deep, [_____] mm gauge thick of [brass] [zinc]. Use neoprene filler [_____] mm inches thick in color as indicated [in Section 09 06 00 SCHEDULES FOR FINISHES]. Submit two 150 mm 6 inch lengths of each type control joint strip.

2.7 COLORANTS

Provide alkali-resistant and nonfading colorants. Pigments must be of colors required to match NTMA Info Guide color plate indicated [in Section 09 06 00 SCHEDULES FOR FINISHES].

2.8 CURING MATERIAL

Curing material must be either liquid membrane-forming compound, wet sand, polyethylene sheeting, or water. Liquid membrane-forming compound must conform to ASTM C309, Type I. Floor curing material products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for curing material. Polyethylene sheeting must conform to ASTM C171.

2.9 TERRAZZO CLEANER

Use biodegradable, phosphate free terrazzo cleaner with a pH factor between 7 and 10 and of a type specially prepared for use on terrazzo. Submit maintenance instructions for bonded terrazzo.

2.10 SEALER

****
NOTE: Include bracketed pH factor for NAVFAC SW projects only.
****

Sealer must [have a pH factor between 7 and 10 and] be a penetrating type specially prepared for use on terrazzo. The sealer must not discolor or amber the terrazzo and must produce a slip resistant surface. Flash point of sealer must be in accordance with NTMA Info Guide. Sealer products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for sealer.

2.11 SHEET MATERIALS

Sheet materials used for curing the terrazzo must conform to ASTM C171.

PART 3 EXECUTION

3.1 TERRAZZO PROPORTIONS

3.1.1 Underbed

Use underbed composed of one part portland cement to [4] [4.5] parts sand. Add water to provide workability at as low a slump as possible. Spread to a level 13 mm 1/2 inch below the finished floor, to a thickness of approximately 30 mm 1-1/4 inches.

3.1.2 Terrazzo Topping

Topping must be composed of one 43 kg 94 pound bag of portland cement per 91 kg 200 pounds of marble chips and approximately 20 L 5 gallons of water. Add color pigment as needed, but not to exceed 1 kg 2 pounds per bag of cement. Add water in sufficient quantity to provide workability at as low a slump as possible.

3.2 INSTALLATION

Submit drawings indicating the type, size, and layout of divider strips and control joint strips and color of floor areas.

3.2.1 Underbed Placement

Clean and saturate concrete surfaces with water in accordance with NTMA Info Guide. Do not treat concrete substrate to receive bonded terrazzo with curing agent or additives which would preclude bonding. Remove excess water from the subfloor before slushing and brooming with neat cement paste. Place the underbed on the concrete subfloor and screed to an elevation 13 mm 1/2 inch below the finished floor. Install divider strips in the semiplastic underbed. Firmly trowel the underbed along the edges to insure positive anchorage of the divider strips. Install control joint strips over subfloor expansion joints and extend the full depth of the underbed.

3.2.2 Setting Divider Strips

Set in accordance with layout indicated while underbed is still plastic. Set strips to straight lines and to the proper level to ensure that tops of strips will show uniformly after completing grinding and finishing operations. Fit joints and intersections tight. Where divisions in field work are not shown, divide field work into squares or rectangles of uniform size and not more than 1800 mm 6 feet on a side. Divide borders by strips to coincide with the layout of division strips in the field of floors. Place edging strips at doorways between terrazzo and other types of flooring and along the edges of terrazzo borders adjoining other types of floor finishes or floor coverings. Place expansion strips over control joints, construction joints, and expansion joints.

3.2.3 Placing Terrazzo Topping

Slush and broom the underbed in accordance with NTMA Info Guide with neat cement paste of the same color as required for the topping. Place the topping in panels formed by divider strips and trowel level with the top of the strips. Seed the troweled surface with chips in the same color proportions as contained in the terrazzo mix, trowel and roll with heavy rollers until excess water has been extracted. Trowel the terrazzo to a uniform surface disclosing the lines of the divider strips.

3.2.4 Curing

Cure the terrazzo until the topping develops sufficient strength to prevent lifting or pulling of terrazzo chips during grinding. Keep the completed terrazzo continuously moist and free of traffic during the curing period. Cure by covering with a liquid membrane-forming compound, sheet materials, wet sand, or sprinkling with water.

3.2.5 Finishing

[Finish in accordance with NTMA Info Guide.] [After curing the grout coat for a minimum of 72 hours, grind the floor using a No. 80 or finer grit stone. In the latter stages of grinding, use grit stones or other abrasive in the grinding machine of a grain or fineness that will give the surface a honed finish. Grind and rub by hand small areas, inaccessible portions, and corners that cannot be reached by the grinding machine. The honed surface of finished terrazzo must show not less than 70 percent of the area as exposed aggregate evenly distributed, and conform in appearance to the approved samples. Finished thickness of terrazzo topping must be a minimum of 13 mm 1/2 inch.]

3.2.5.1 Rough Grinding

After topping has cured, machine gring the terrazzo using the wet method, to a true even surface using No. 24 or finer grit followed by No. 80 grit or finer grit stone. Finish floor surface must not vary by more than 2 mm/meter 1/4 inch in 10 feet.

3.2.5.2 Grouting

After rough grinding, cleanse and rinse the floor with clean water. After removing excess rinse water, grout the floor using identical portland cement, color and pigments as used in the topping taking care to fill voids. After the grout has attained its initial set, cure the surface for a minimum of 72 hours.

3.2.5.3 Fine Grinding

After grout has cured, gring the surface with fine grit stones until all grout is removed from the surface. Upon completion of grinding, the terrazzo flooring must show a minimum of 70 percent of marble chips. Submit two 150 x 150 mm 6 x 6 inch (minimum) samples of each color of terrazzo

3.3 CLEANING AND SEALING

Wash the terrazzo with a neutral cleaner and, where required, clean with a fine abrasive to remove stains or cement smears. Rinse the cleaned surface. When dry, apply a terrazzo sealer in accordance with the manufacturer's directions.

3.4 PROTECTION

cover and protect the terrazzo work from damage until completion of the work of all other trades.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 66 16 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 66 16 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 66 16

TERRAZZO FLOOR TILE

08/16, CHG 1: 08/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-09 66 16 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE | **Superseding**
UFGS-09 66 16 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 09 66 16

TERRAZZO FLOOR TILE
08/16, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for cast marble or granite terrazzo tile of various sizes and thicknesses).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C97/C97M	(2015) Absorption and Bulk Specific Gravity of Dimension Stone
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C501	(2021) Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser
ASTM D2047	(2017) Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Terrazzo Tile; G, [_____]

SD-03 Product Data

Terrazzo Tile

Recycled Content for Terrazzo Tile; S

Adhesive

Indoor Air Quality for Adhesive; S

Installation

SD-04 Samples

Terrazzo Tile

Terrazzo Base

Metal Edge Strips

SD-10 Operation and Maintenance Data

Manufacturer's Maintenance Instructions; G, [_____]

SD-11 Closeout Submittals

Warranty

1.3 QUALITY ASSURANCE

Installer must possess, to the satisfaction of the Contracting Officer, the technical qualifications, experience, trained personnel, and facilities to properly install the specified items.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the jobsite in the manufacturer's original unopened containers marked with the manufacturer's brand name, color, and pattern. Store materials delivered and placed in storage protected from damage, weather, humidity and temperature variation, dirt and dust, or other contaminants. Temperature of storage area must not be lower than 10 degrees C 50 degrees F or higher than 32 degrees C 90 degrees F.

1.5 SITE CONDITIONS

Do not install tiles until other work that could cause damage to the finished flooring has been completed. Maintain a temperature of not less than 21 degrees C 70 degrees F in all areas where tile is to be installed for a period of not less than [48] [_____] hours before, during and after laying of tiles. Bring tiles into installation areas and allow to condition at not less than 21 degrees C 70 degrees F for a period of [48] [_____] hours prior to installation. After installation of tiles, maintain a minimum temperature of 13 degrees C 55 degrees F.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials which are the standard products of a manufacturer regularly engaged in the manufacture of the material and that essentially duplicate products that have been in satisfactory use at least 2 years prior to bid opening.

2.2 TERRAZZO TILE

****

NOTE: Designer will select the chip requirements and also determine whether flexible or rigid resin is required, or give the Contractor the options. The source of the aggregate will directly impact the look of the tile.

Coordinate with manufacturer's data of terrazzo tile when determining the patterns, styles, sizes and thicknesses of tiles.

****

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is commonly available with the minimum recycled content percentages shown below. Based on research, insert desired minimum percentages into the empty set of brackets.

****

Provide terrazzo tile of the indicated colors and consisting of [marble] [or] [granite] chips embedded in a [flexible] [or] [rigid] thermoset resin matrix. Submit drawings indicating pattern, size, style, and color of tiles and two 150 by 150 mm 6 by 6 inch minimum samples of each color and pattern of terrazzo tile to be used. Tiles must be [5] [_____] mm [3/16] [_____] inch thick and nominal [300 by 300] [_____] mm [12 by 12] [_____] inches. Provide tiles with a [polished] [polished and [honed] [textured]] [honed] [textured] finish with uniform color distribution of chips. [Grade marble chips to [16] [6] mm [5/8] [1/4] inch maximum size.] [Granite chips must be manufacturer's standard gradation.] Provide tile with the following properties:

TERRAZZO TILE PROPERTIES		
PROPERTY	TEST METHOD	VALUE
Compressive Strength	ASTM C109/C109M	20 MPa 3000 psi minimum
Water Absorption	ASTM C97/C97M	0.7 percent maximum
Abrasive Wear	ASTM C501	Index 28
Coefficient of Friction	ASTM D2047	0.5 wet
Flame Spread	ASTM E84	Class A
Critical Radiant Flux	ASTM E648	Class I

[

Provide Terrazzo Tile with [50][100][_____] percent recycled aggregate. Provide data identifying percentage of recycled content for terrazzo tile.]

2.3 ADHESIVE

Adhesive must be flooring manufacturer's standard product or a product recommended by the manufacturer. Submit documentation from manufacturer indicating that the materials conform to the specified requirements and flooring manufacturer's approval of underlayment, adhesive, and cleaners. Adhesive products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of

CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for adhesive.

2.4 TERRAZZO BASE

Provide terrazzo base of colors as indicated, meeting the requirements of paragraph TERRAZZO TILE and being a manufacturer's standard product. Base/strips must be [10] [19] mm thick by [_____] mm wide by [_____] mm long [3/8] [3/4] inch thick by [_____] inch wide by [_____] inch long. Provide base/strips that have [polished] [honed] [textured] finish. Submit two 100 mm 4 inch long samples of each type and color of trim pieces.

2.5 TERRAZZO STRIPS

Provide terrazzo strips of colors as indicated, meeting the requirements of paragraph TERRAZZO TILE and being a manufacturer's standard product. Strips must be [_____] mm high by [_____] mm wide by [_____] mm long [3/8] [3/4] inch high by [_____] inch wide by [_____] inch long. Strips must have [polished] [honed] [textured] finish. Submit two 100 mm 4 inch long samples of each type and color of trim pieces.

2.6 METAL EDGE STRIPS

Metal edge strips must be extruded aluminum, butt type, approximately 40 mm 1-1/2 inches wide with thickness to set top surface flush with top of tile and with bevel at exposed edge. Edge strips must have countersunk holes near each end and spaced not more than 200 mm 8 inches on center for securement. Submit one 150 mm 6 inch long sample of metal edge strip

2.7 COLOR

Color must be [as indicated] [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____].

PART 3 EXECUTION

3.1 GENERAL

Install flooring and base on floor surfaces and walls where indicated. Except as required for installation of new tile, keep traffic new tile for at least [24] [_____] hours after installation.

3.2 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.3 SUBSTRATE PREPARATION

Fill holes and cracks with mortar. Floors must be free of curing compounds, grease, dirt, loose particles and other foreign matter that would prevent adhesion. Chip and grind smooth projecting irregularities. Fill depressions and level uneven surfaces. Rinse subfloors and allow to dry prior to applying adhesive.

3.4 MOISTURE TEST

After concrete floor surfaces have been cleaned, spread small patches of adhesive in several locations in each room or area to receive tile and allowed to dry overnight. If the adhesive can be peeled easily from the floor surfaces, the surface is not sufficiently dry. Repeat the steps until the adhesive adheres properly. Do not apply tiles until adhesive adheres tightly to the floor.

3.5 INSTALLATION

Submit the manufacturer's printed installation instructions for the conditions indicated.

3.5.1 Tile

Install tile in accordance with the manufacturer's approved installation instructions, except as specified herein. Lay tile symmetrical about center lines of rooms or areas. Joints must be tight, inconspicuous as possible, and in alignment. Cut tile to fit snugly at pipes and other vertical surfaces. Seal joints at pipes with adhesive. Remove spots or smears of adhesive immediately. Entire surface of finished tile floor must be smooth, straight, and free from bleeding adhesive, buckles, waves, or projecting tile edges upon completion. Bleeding of adhesive on finished floors is cause for rejection by the Contracting Officer. Remove and replace damaged or rejected tiles.

3.5.2 Metal Edge Strips

Secure edge strips with No. 10 aluminum alloy, counter-sunk, flathead machine screws with expansion sleeves. Provide exposed edges of tile with one-piece metal edge strips.

3.5.3 Terrazzo Base/Strips

Terrazzo base/strips must be continuous and adhesively applied. Joints must be tight and inconspicuous in same manner as floor tile.

3.6 CLEANING

Upon completion of the installation and after adhesive has cured, thoroughly clean flooring in accordance with the manufacturer's recommendations.

3.7 PROTECTION

Cover and protect the terrazzo tile work from damage until completion of the work of all other trades. Remove and replace defects which develop, such as loose, broken, or curled tiles. Submit [six] [_____] copies of the Manufacturer's Maintenance Instructions.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 66 23 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 66 23 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 66 23

RESINOUS MATRIX TERRAZZO FLOORING

08/16, CHG 1: 08/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 66 23 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 66 23 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 09 66 23

RESINOUS MATRIX TERRAZZO FLOORING

08/16, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for resinous terrazzo flooring and conductive resinous terrazzo flooring.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: The resinous terrazzo floor systems covered by this guide specification may be used in lieu of portland cement terrazzo where the light weight of the thin set system would be advantageous.

The conductive resinous terrazzo flooring is primarily intended for use in areas where volatile materials are handled, clean-rooms, parachute assembly areas, etc. These systems, which have a wear factor four times better than cementitious terrazzo and five to six times better than vinyl may be used, when economically justified, in hard wear areas where there is a need for a high degree of cleanliness, a decorative effect, and some chemical resistance. These systems will not be used over

lightweight concrete and will not be used in lieu of quarry tile in kitchens.

The selection of a floor system for a location where resistance to specific conditions is important should be based upon the ability of the system to withstand required exposure conditions. For example, polyesters are suitable where resistance to detergents is required but should not be used in laboratory or other areas where spillage of sodium hydroxide or similar strong alkaline solution occurs; epoxies should not be used where resistance to oxidizing acids is required or where resistance to temperatures in excess of 54 degrees C 130 degrees F is required; latex mastic and resin emulsions should not be used where resistance to strong acids or alkalis is required. Each job should be evaluated on its own merits considering exposure conditions, costs, and local experience with the various systems.

Areas to receive terrazzo will be shown on the drawings. Color should be shown by specifying a selected plate number from the NTMA publication, "Terrazzo Information Guide." Example: NTMA terrazzo catalog, plate No. S-301-4. Colors selected may be any combination of standard marble granules of domestic origin available in the local market, but it is highly desirable that color combinations be designated by NTMA color plates.

****

1.1 SUMMARY

****

NOTE: Conductive floors will be used at operations where explosives having an electrostatic sensitivity of 0.1 joule or less such as primer, detonator, igniter, and incendiary mixtures are exposed. Conductive floors are also required where the following are performed:

a. Loose unpacked ammo with electric primers.
b. Exposed electro-explosive devices.
c. Electrically initiated items with exposed electric circuitry.
d. Hazardous materials that could be ignited by static discharge from humans.

****

Apply resinous terrazzo flooring, in the colors indicated, in the areas shown on the detail drawings. Submit two 150 x 150 mm 6 x 6 inches, (minimum) samples of each color of resinous terrazzo and two 150 mm 6 inches lengths, of each type of strip. Flooring must be [[an epoxy terrazzo system that conforms to the requirements specified in paragraphs 2.01A and B of NTMA Info Guide][or][a polyester terrazzo flooring system that conforms to the requirements specified in paragraphs 2.01A and B of NTMA Info Guide.]] [a conductive [epoxy terrazzo system that conforms to the requirements specified in paragraphs 2.01A, B, and H of NTMA Info Guide.]

[or] [polyester terrazzo flooring system that conforms to the requirements specified in paragraphs 2.10A, B, and J of NTMA Info Guide].]

1.2 REFERENCES

****

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D56	(2016a) Standard Test Method for Flash Point by Tag Closed Cup Tester

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 99	(2024) Health Care Facilities Code

NATIONAL TERRAZZO AND MOSAIC ASSOCIATION (NTMA)

NTMA Info Guide	(2017) Terrazzo Reference Guide

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings
SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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SD-02 Shop Drawings

Detail Drawings; G, [_____]

Strips; G, [_____]

Control Joint Strips; G, [_____]

SD-03 Product Data

Resin

Recycled Content for Marble Chips; S

Indoor Air Quality for Primer; S

Indoor Air Quality for Resin; S

Indoor Air Quality for Grout; S

Indoor Air Quality for Sealer; S

Mixing, Proportioning, and Installation

Cleaning and Sealing

SD-04 Samples

Resinous Terrazzo Flooring

SD-06 Test Reports

Certified Test Reports; G, [_____]

SD-07 Certificates

Qualifications of Installer; G, [_____]

1.4 QUALITY ASSURANCE

Applicator must be approved by the resin manufacturer and must have a minimum of 3 years experience in the application of the materials to be used and must have completed 8 successful installations within the past 2 years. Furnish a written statement from the manufacturer detailing the Qualifications of Installer.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in manufacturer's original unopened containers. Keep materials in a clean, dry, area with temperatures controlled between 10 and 33 degrees C 50 and 90 degrees F.

1.6 ENVIRONMENTAL REQUIREMENTS

Maintain areas to receive terrazzo at a temperature above 10 degrees C 50 degrees F for 2 days prior to installation and for 7 days following installation.

PART 2 PRODUCTS

2.1 PRIMER

Primer must be a material recommended by the resin manufacturer which will penetrate the pores of the substrate and bond with the topping to form a permanent monolithic bond between the substrate and the topping. Primer products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for primer.

2.2 RESIN

Resin for the specified terrazzo flooring must conform to the requirements shown in NTMA Info Guide. Submit resin manufacturer's descriptive data, plus mixing, proportioning, and installation instructions. Resin products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of

CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for resin.

2.3 FILLERS

Fillers, if required, must be inert mineral or cellulosic material as recommended by the manufacturer and best suited for the resin binder used. Fillers must be furnished in the quantity necessary to impart the required color and physical characteristics.

2.4 MARBLE CHIPS

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Consider specifying marble chips as recycled materials. Research shows marble chips are commonly available from recycling operations. The designer of record needs to confirm local/regional availability that does not impact cost effectiveness.

****

Marble chips must be of domestic origin of sizes and colors to match NTMA Info Guide color plate indicated [on the drawings] [in Section 09 06 00 SCHEDULES FOR FINISHES]. Chips must be a range of sizes up to and including the NTMA Standard No. 0 and Standard No. 1 for 6 mm 1/4 inch thick floors and Standard No. 0 through Standard No. 2 for 10 mm 3/8 inch thick floors.[

Provide Marble Chips with 100 percent recycled content. Provide data identifying percentage of recycled content for marble chips.]

2.5 STRIPS

Submit drawings indicating the type, size, and layout of divider strips and control joint strips.

2.5.1 Divider Strips

****

NOTE: Location of strips will be shown on the drawings. Strips should be used at logical stops and expansion joints. Manufacturer's literature should be reviewed when making selections for strips.

Plastic divider strips and control joint strips should be used with conductive type terrazzo.

****

Divider strips must be as deep as required, [_____] mm gauge and of [brass] [zinc] [plastic in color as indicated [in Section 09 06 00 SCHEDULES FOR FINISHES]].

2.5.2 Control Joint Strips

Control joint strips must be as deep as required, [_____] mm gauge and of [brass] [zinc] [plastic in color as indicated [on the drawings] [in Section 09 06 00 SCHEDULES FOR FINISHES]]. Provide neoprene filler [_____] mm inches thick in color as indicated [in Section 09 06 00 SCHEDULES FOR FINISHES].

2.6 GROUT

Grout must be as recommended by the manufacturer of the resin. Grout products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide validation of indoor air quality for grout.

2.7 SEALER

Sealer must have a pH factor between 7 and 10 and must be a penetrating type specially prepared for use on terrazzo. The sealer must not discolor or amber the terrazzo and must produce a slip resistant surface. Flash point of sealer must be a minimum of 27 degrees C 80 degrees F when tested in accordance with ASTM D56. Sealer products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for sealer.

PART 3 EXECUTION

3.1 PREPARATION OF CONCRETE SUBFLOOR

Do not commence installation of the floor topping until the concrete substrate has cured for at least 28 calendar days. Prepare the concrete surfaces in accordance with the instructions of the resin manufacturer.

3.2 MIXING, PROPORTIONING, AND INSTALLATION

****

NOTE: Terrazzo topping thickness will be determined by the marble chip size indicated in the selected NTMA-01 color plate referenced in paragraph MARBLE CHIPS. If the cross-section is less than 10 mm 3/8 inch the use of No. 1 and No. 0 size chips will be required. Delete last sentence if resinous terrazzo bases are not required.

****

Mixing, proportioning, and installing must be in accordance with the approved instructions of the manufacturer. Install strips in locations indicated. Appply the topping to give a finish thickness of [6] [10] mm [1/4] [3/8] inch. Provide cove type bases cast-in-place with 25 mm 1 inch radius cove and [100] [150] mm [4] [6] inch high.

3.3 TESTING

Between 30 and 45 days after flooring installation is completed, and prior to its use, test the conductive resinous terrazzo flooring in accordance with paragraph 12-4.1.3.8(b)(7) of NFPA 99. The resistance of the conductive floor at any one location must be more than 5,000 ohms in areas with 110 volts service, more than 10,000 ohms in areas with 220 volt service, and average less than 1,000,000 ohms and more than 25,000 ohms in all areas. Submit certificates indicating conformance with specified requirements. Accompany certificates with certified test reports showing that the conductive resinous terrazzo floor has been tested and meets the requirements specified.

3.4 CLEANING AND SEALING

Wash the terrazzo with a neutral cleaner and where required, clean with a fine abrasive to remove any stains or cement smears. Rinse the cleaned surfaces. When dry, apply a terrazzo sealer in accordance with the manufacturer's directions. Submit maintenance literature for terrazzo cleaning and sealing.

3.5 PROTECTION

cover and protect the terrazzo work from damage until completion of the work of all other trades.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 67 23.13 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-09 67 23.13 (November 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-09 67 23.13 (November 2019)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 09 67 23.13

STANDARD RESINOUS FLOORING
11/19

****
NOTE: This guide specification covers the requirements for thin-set, troweled, heavy-duty, epoxy floor toppings.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A990/A990M	(2023) Standard Specification for Castings, Iron-Nickel-Chromium and Nickel Alloys, Specially Controlled for Pressure-Retaining Parts for Corrosive Service
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM D445	(2019a) Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D1475	(2013) Standard Test Method for Density of Liquid Coatings, Inks, and Related Products
ASTM D1544	(2004; R 2010) Standard Test Method for Color of Transparent Liquids (Gardner Color Scale)
ASTM D1652	(2011; E 2012) Standard Test Method for Epoxy Content of Epoxy Resins
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2471	(1999) Standard Test Method for Gel Time and Peak Exothermic Temperature of

	Reacting Thermosetting Resins
ASTM D4259	(2018) Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application
ASTM F1869	(2023) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F2170	(2019a) Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Meetings

Pre-installation Conference: Conduct conference at Project site.

1.2.2 Product Data

Within [30] [_____] days of contract award, submit manufacturer's catalog data for the following items:

a. Epoxy-Resin Binder/Matrix

b. Cured Epoxy Binder

[c. Aggregate

] d. Surface Sealing Coat

1.2.3 Design Mix Data

Within [30] [_____] days of contract award, submit design mix data for the following items, including a complete list of ingredients and admixtures:

a. Epoxy-Resin Binder/Matrix

b. Cured Epoxy Binder

c. Surface Sealing Coat

Ensure applicable test reports verify the mix has been successfully tested and meets design requirements.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings[; G, [_____]]

[Fabrication Drawings[; G, [_____]]
]

SD-03 Product Data

Manufacturer's Catalog Data[; G, [_____]]

SD-04 Samples

Hardboard Mounted Epoxy Flooring[; G, [_____]]

Floor Topping[; G, [_____]]

Mockups[; G, [_____]]

SD-05 Design Data

Design Mix Data[; G, [_____]]

SD-07 Certificates

Listing of Product Installations

Referenced Standards Certificates

SD-11 Closeout Submittals

Warranty[; G, [_____]]

1.4 DELIVERY, STORAGE, AND HANDLING

Protect materials from weather, soil, and damage during delivery, storage, and construction. Deliver materials in original packages, containers, or bundles bearing brand name and name of material.

Maintain materials used in the installation of floor topping at a temperature between 18 and 30 degrees C 65 and 85 degrees F.

1.5 QUALITY CONTROL

Prior to commencement of work, submit referenced standards certificates for the following, showing conformance with the referenced standards contained in this section:

a. Epoxy-Resin Binder/Matrix

b. Cured Epoxy Binder

c. Aggregate

d. Surface Sealing Coat

1.5.1 Mockups

Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Apply full-thickness mockups on 2.44 meters96 inch square floor area selected by Contracting Officer. Simulate finished lighting conditions for the review of mockups.

1.5.2 Qualifications

Submit a listing of product installations for heavy duty epoxy flooring including identification of at least [5][_____] units, similar to those proposed for use, that have been in successful service for a minimum period of [5][_____] years. Identify purchaser, address of installation, service organization, and date of installation.

Ensure floor system applicators are experienced in the application of troweled [walnut-shell][_____] aggregate thin-set floor topping.

1.5.3 Sampling

Submit hardboard mounted epoxy flooring samples not less than 300 millimeter 12 inch square for each required color.

Provide panels showing nominal thickness of finished toppings, color, and texture of finished surfaces. Finished floor toppings and the approved samples are to match in color and texture.

1.6 WARRANTY

Submit a [2] [_____] year written warranty for all materials and installation work.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Thin-set, heavy-duty, troweled floor topping is a mixture of a two-component epoxy-resin binder and a blend of several sizes of pregraded aggregate. Clearly designate on drawings areas of application.

****

****

NOTE: Coordinate with plumbing drawings for floor drains, slopes and details.

****

****

NOTE: Delete the second paragraph for projects which are cast completely on site. Include the second paragraph for projects requiring factory assembly prior to site delivery.

****

Submit installation drawings for heavy duty epoxy flooring systems clearly designating the areas of application and the installation plan. Include in the installation plan, methods to control sand and dust if sand blasting is required.

[Submit fabrication drawings for heavy duty epoxy flooring Systems consisting of fabrication and assembly details to be performed in the factory.

]2.2 MATERIALS

2.2.1 Mixes

2.2.1.1 Epoxy-Resin Binder/Matrix

Provide a clear two-component compatible system epoxy resin binder consisting of: (1) a liquid blend of a biphenyl-based epoxy resin and an aliphatic polyglyceride ether, and (2) a liquid blend of two modified amine curing agents, which individually cures the epoxy resin at room temperature to a glossy smooth film. Ensure the two components and the cured epoxy binder have the following physical properties:

PROPERTY	TEST METHOD	REQUIREMENT
	COMPONENT A (EPOXY RESIN)	

PROPERTY	TEST METHOD	REQUIREMENT
Viscosity (kinematic), at 25 degrees C, millipascal-second	ASTM D445	3000 to 5000
Weight per epoxide, grams	ASTM D1652	205 to 225
Color (Gardner Color Scale), maximum	ASTM D1544	5
Weight per milliliter, grams	ASTM D1475	1.13 - 1.15
	COMPONENT B (CURING AGENT)	
Viscosity (kinematic), at 25 degrees C, square milliliter per second	ASTM D445	75 to 125
Weight per milliliter, grams	ASTM D1475	0.90 to 0.91
Color (Gardner Color Scale), maximum	ASTM D1544	8

PROPERTY	TEST METHOD	REQUIREMENT
	COMPONENT A (EPOXY RESIN)	
Viscosity (kinematic), at 77 degrees F, centipoises	ASTM D445	3000 to 5000
Weight per epoxide, grams	ASTM D1652	205 to 225
Color (Gardner Color Scale), maximum	ASTM D1544	5
Weight per gallon, pounds	ASTM D1475	9.46 - 9.56
	COMPONENT B (CURING AGENT)	
Viscosity (kinematic), at 77 degrees F, centistokes	ASTM D445	75 to 125
Weight per gallon, pounds	ASTM D1475	7.50 to 7.60
Color (Gardner Color Scale), maximum	ASTM D1544	8

2.2.1.2 Cured Epoxy Binder

Provide a cured epoxy binder with the following properties.

PROPERTY	TEST METHOD	REQUIREMENT
Water absorption, percent 24 hours at 25 degrees C, maximum	ASTM D570	0.40
Hardness, Shore D	ASTM D2240	74 to 82
Linear shrinkage, millimeter/millimeter, maximum	ASTM C881/C881M	0.15
Shrinkage, glass bow, milli-meter divergence, maximum	ASTM A990/A990M	0.40
Coefficient of linear thermal expansion, mm/mm/degrees C, maximum	ASTM D696 0 degrees C to 40 degrees C	200 X 10-6
Gel time/peak exotherm at 25 degrees C, 100 gm mass in 120 millimeter metal container	ASTM D2471	20 to 40 minutes at 150 degrees C, maximum
*3 millimeter thick castings		
**3 by 25 by 80 millimeter castings, aged in forced draft oven		

PROPERTY	TEST METHOD	REQUIREMENT
Tensile strength, psi* at test temperature: 77 degrees F	ASTM D638	4500 to 6500
Tensile elongation, percent* at test temperature: 77 degrees F	ASTM D638	20 to 40
Water absorption, percent 24 hours at 77 degrees F, maximum	ASTM D570	0.40
Hardness, Shore D	ASTM D2240	74 to 82
Linear shrinkage, inch/inch maximum	ASTM C881/C881M	0.006
Shrinkage, glass bow, inch divergence, maximum	ASTM A990/A990M	0.016

PROPERTY	TEST METHOD	REQUIREMENT
Coefficient of linear thermal expansion, inch/inch/degree C, maximum	ASTM D696 0 degrees C to 40 degrees C	200 X 10-6
Gel time/peak exotherm at 77 degrees F, 100 gm mass in 4 ounce metal container	ASTM D2471	20 to 40 minutes at 300 degrees F, maximum
*1/8 inch thick castings		
**1/8 by 1 by 3 inch castings, aged in forced draft oven		

[2.2.1.3 Aggregate

Provide aggregate recommended by the resinous flooring manufacturer and approved by the Contracting Officer. Deliver aggregate to the site in three separate package gradations for blending. Gradations are:

	PERCENT	
SIEVE SIZE	MAXIMUM	MINIMUM
GRADATION NO. 1		
Retained on 3.35 millimeter	0.0	-
Passing 3.35 millimeter, retained on 2.36 millimeter	5.0	0.0
Passing 2.36 millimeter, retained on 1.7 millimeter	100.0	74.0
Passing 850 micrometer	1.0	-
GRADATION NO. 2		
Retained on 1.18 millimeter	0.0	-
Passing 1.18 millimeter, retained on 1.0 millimeter	5.0	0.0
Passing 1.0 millimeter, retained on 425 micrometer	100.0	85.0
Passing 425 micrometer, retained on 250 micrometer	9.0	0.0
Passing 250 micrometer	1.0	-
GRADATION NO. 3		
Retained on 850 micrometer	0.0	-
Passing 850 micrometer, retained on 500 micrometer	5.0	0.0

	PERCENT	
SIEVE SIZE	MAXIMUM	MINIMUM
Passing 500 micrometer, retained on 250 micrometer	100.0	80.0
Passing 250 micrometer, retained on 150 micrometer	13.0	0.0
Passing 150 micrometer	2.0	-

	PERCENT	
SIEVE SIZE	MAXIMUM	MINIMUM
GRADATION NO. 1		
Retained on No. 6	0.0	-
Passing No. 6, retained on No. 8	5.0	0.0
Passing No. 8, retained on No. 12	100.0	74.0
Passing No. 20	1.0	-
GRADATION NO. 2		
Retained on No. 16	0.0	-
Passing No. 16, retained on No. 18	5.0	0.0
Passing No. 18, retained on No. 40	100.0	85.0
Passing No. 40, retained on No. 60	9.0	0.0
Passing No. 60	1.0	-
GRADATION NO. 3		
Retained on No. 20	0.0	-
Passing No. 20, retained on No. 35	5.0	0.0
Passing No. 35, retained on No. 60	100.0	80.0
Passing No. 60, retained on No. 100	13.0	0.0
Passing No. 100	2.0	-

]2.2.1.4 Surface Sealing Coat

****

NOTE: Glossy final finishes may cause a slip hazard

under room conditions when exposed to water or oily lubricants, particularly in various labs or maintenance areas. Specify the type of final finish desired and the material required (grit) to be added to prevent slip hazards.

The slip resistance of floor surfaces is an important consideration for resinous flooring. Static coefficient-of-friction (COF) requirements for walking surfaces are not stipulated in the ADA standards. Previous accessibility guidance for floor surfaces recommended COF values of not less than 0.6 for level surfaces and 0.8 for ramped surfaces, but did not indicate the test required to make the measurement.

****

Provide nonambering aliphatic or aromatic moisture-curing polyurethane surface sealer into which has been incorporated a flatting agent. Add flatting agent not more than 24 hours prior to actual application of the coating. Ensure cured coating with flatting agent yields 60-degree specular gloss of 10 to 20 when tested in accordance with ASTM D523.

PART 3 EXECUTION

3.1 PREPARATION

****

NOTE: Select test per manufacturer's written instructions.

****

Prior to applying resinous flooring material, inspect substrate and immediately report any unsatisfactory conditions that exist and repair.

Verify that the concrete substrates are dry and the moisture-vapor emissions are within acceptable levels according to the manufacturer's written instructions.

[Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with application of resinous flooring only after substrates have a maximum moisture-vapor-emission rate of [1.36 kg of water/92.9 sq. meters3 lb of water/1000 sq. ft.][2.04 kg of water/92.9 sq. meters4.5 lb of water/1000 sq ft.][Insert emission rate] of slab area in 24 hours.

][Relative Humidity Test: Use in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [75] [Insert number] percent relative humidity level measurement.

][Alkalinity and Adhesion Testing: Verify that concrete substrates have a pH within an acceptable range. Perform tests recommended by the manufacturer. Proceed with the application only after the substrates pass testing.]

3.1.1 Safety Precautions

Prior to application in confined spaces of toppings and coatings containing flammable or toxic properties, institute safety precautions recommended by the manufacturer of the product.

Erect "NO SMOKING" signs, and prohibit smoking or use of spark- or flame-producing devices within 15 meter 50 feet of any mixing or placing operation involving flammable materials.

Provide the personnel required to handle, mix, or apply toppings containing toxic or flammable properties with such items of personal protective equipment and apparel for eye, skin, and respiratory protection as are recommended by the manufacturer of the product. Ensure all personnel are trained in the appropriate use and wearing of personal protection equipment.

3.1.2 Protection of Adjacent Surfaces

In addition to the protection of adjacent surfaces during installation, provide areas used to store and mix materials with a protective covering under the materials. After application of the sealer coats, protect finished flooring during the remainder of the construction period. In areas of expected minimum or moderate traffic, cover floors with[12300 newton per meter 70 pound kraft paper][a 30-30-30 waterproof kraft paper][_____], with strips taped together and edges secured to prevent roll-up. Place vegetable fiberboard, plywood, or other suitable material that does not mar the flooring over the paper to protect areas used as passages by workmen and areas subject to floor damage because of subsequent building operations. Upon completion of construction, remove the protection, clean flooring and, where necessary, repair, reseal, or both, at no additional cost to the Government.

3.1.3 Concrete Subfloor

[3.1.3.1 New Concrete Floors

Do not commence installation of the floor topping until the concrete has cured a minimum of 28 calendar days. Verify that the concrete floor is straight, properly sloped, and has [rough] [broom] [wooden float] type finish. Ensure that the concrete is moist cured with burlap or polyethylene. Before applying the prime coat, clean the concrete surface by an approved method.

][3.1.3.2 Existing Concrete Floors

Clean existing concrete floors, with hard troweled or contaminated areas in conformance with ASTM D4259. Ensure the concrete is free of all paint, sealers, curing agents, oil, grease, moisture, dirt or any other contaminants. Remove any loose or corroded segments of existing concrete. Patch with a grouting compound as recommended by the resinous flooring manufacturer. Fill all cracks with an elastomeric jointing compound compatible with the resinous flooring system used.

][3.1.4 Steel Subfloor

Clean surfaces of grease, rust, and mill scale by dry sand blasting in accordance with SSPC SP 6/NACE No.3. Prime all surfaces with a primer as recommended by the resinous flooring manufacturer, the same day or before there are any visible signs of oxidation, which ever is sooner. Using other means of surface preparation is optional, as approved by the Contracting Officer, provided the degree of cleanliness and the profile obtained by sand blasting is equivalent. Power brushing is not permitted.

]3.1.5 Mixing Of Materials

****
NOTE: Mixtures providing satisfactory density, trowelability, and surface texture are affected by variations in particle shapes, sizes, and size distribution.
****

Select the job mix proportions on the trial batch proportions used to prepare the floor topping samples as submitted and approved.

Use mechanical equipment for mixing of materials in accordance with the manufacturer's instructions.

Use rotating paddle-type masonry mortar mixers for preblending the three sizes and color pigment, if any, of the walnut shell aggregate and addition of the mixed epoxy resin binder. Ensure mixing times are as recommended by the materials supplier(s), provided mixing times result in homogeneous mixtures. Limit quantity of material mixed at one time to that which can be applied and finished within the working life of the mixtures. Verify that the temperature of materials at the time of mixing are between 18 and 30 degrees C 65 and 85 degrees F.

3.2 APPLICATION

3.2.1 Areas of Application

Anchor plates set with the top surface at or above the finished epoxy floor level do not require coverage with this flooring material. Extend flooring under equipment, except when the equipment base is indicated to be flush against the structural floor. Cover and/or mask surfaces not to receive the epoxy floor topping, such as equipment or cabinets installed prior to surface-preparation efforts and adjacent to the flooring installation.

3.2.2 Application of Prime Coat and Troweling

Combine the epoxy binder components A and B in the proportions specified by the manufacturer to form a clear compatible system immediately on mixing. Cure combined components to a clear film possessing a glossy, non-greasy surface at relative humidities less than 80 percent, having the following properties after curing 24 hours at 25 degrees C 77 degrees F, followed by 24 hours at 52 degrees C 125 degrees F:

Ensure that the prepared subfloor surface is dry and at a temperature of not less than 16 degrees C 60 degrees F when application of the floor topping is initiated. Immediately before application of the prime/scratch coat on the prepared surface, remove dust or other loose particles by blowing with compressed air or vacuum cleaned. Use only an air compressor equipped with an efficient oil-water trap to prevent oil contamination or wetting of surface.

Apply a thin roller coat of the epoxy binder specified to the prepared subfloor as a prime coat. As an aid to placing, compacting, and finishing the floor topping, form a scratch coat by sprinkling a minimum quantity of the walnut shell aggregate on the prime coat surface immediately following the prime coat application. Prior to application of the prime/scratch coat, fill cracks in the concrete per manufacturer's instructions, and make provisions to keep control or expansion joints open.

Place the floor topping prior to final gelling of the prime/scratch coat. Immediately after the materials are mixed as specified, dump the mixture in the placement area and spread to prolong troweling life. Screed or rough trowel placed materials to the specified thickness and then compact by the use of a smooth roller prior to finish troweling to a nominal thickness of 4.76 millimeter plus or minus 1.59 millimeter 3/16 inch plus or minus 1/16 inch. Ensure all finished surfaces are free of ridges, hollows (bird-baths), trowel marks, and smoothness varies no more than 3.18 millimeter 1/8 inch when tested with an 2500 millimeter 8 foot straightedge. Make provisions to maintain the work areas in a relatively dust-free environment during curing of the topping.

3.2.3 Sealer Coat

After the floor topping has set firmly (approximately 6 to 16 hours depending on subfloor temperature) in a relatively dust-free environment, apply two thin coats of the sealer coat, by means of brush, roller, squeegee, or notched trowel to provide a pore-free, easy-to-clean surface. At the time of sealer application, ensure that the surface is dust-free. Depending on relative humidity, allow the applied sealer to cure to a tack-free condition in 2 to 4 hours. Do not apply second coat until after the initial coat has cured to a tack-free, hard film. Maintain topping areas in a relatively dust-free environment during curing of the sealer coats.

[3.2.4 Integral Cove Base

****

NOTE: Use the following paragraph if project requires an integral cove base.

****

Provide a [10.16] [_____] cm [4] [_____] inch high cove base to all wall surfaces as indicated on the drawings. Install so as to provide a [1.27] [_____] cm [1/2] [_____] inch radius at the juncture of the floor and the wall.

]3.3 FIELD QUALITY CONTROL

3.3.1 Repairing

Remove and replace damaged or unacceptable portions of completed work with new work to match adjacent surfaces at no additional cost to the Government.

3.4 ADJUSTING AND CLEANING

Clean surfaces of the new work, and adjacent surfaces soiled as a result of the work. Remove all equipment, surplus materials, and rubbish associated with the work from the site.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 67 23.14 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 67 23.14 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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CHEMICAL RESISTANT RESINOUS FLOORING

08/16, CHG 1: 08/18

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USACE / NAVFAC / AFCEC **UFGS-09 67 23.14 (August 2016)**
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****

SECTION 09 67 23.14

CHEMICAL RESISTANT RESINOUS FLOORING

08/16, CHG 1: 08/18

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NOTE: This specification covers the requirements for trowelled-on industrial resinous flooring, conductive resinous flooring, and decorative resinous flooring except resinous terrazzo.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The floor systems covered by this guide specification are primarily intended for use in biological laboratories, in similar areas which are subject to hard wear or spillage of chemicals and require a high degree of cleanliness, and for explosive and ammunition facilities.

These systems are for use over normal weight concrete and will not be used over lightweight concrete. The selection of a floor system for a location where resistance to specific chemical conditions is important should be based upon the ability of the system to withstand required exposure

conditions. For example, polyesters are suitable for use where resistance to detergents is required but should not be used in laboratory or other areas where spillage of sodium hydroxide or similar strong alkaline solution occurs; epoxies should not be used where resistance to oxidizing acids is required or where resistance to temperatures in excess of 54 degrees C 130 degrees F is required. Each job should be evaluated on its own merits considering exposure conditions, costs, flammability of materials, and local experience with the various systems. All provisions relating to the systems not selected will be deleted.

Check other sections of the specifications to ensure:

1. No vermiculite or perlite aggregates in concrete substrates.

2. No curing compounds or sealers on concrete substrates.

3. New concrete receives single trowelled finish; and no burnished finishes.

4. Vapor barrier is provided under all concrete slabs-on-grade.

5. Only exterior grade plywood on new plywood substrates. No interior grade or interior grade with exterior glue. Plywood is nailed with annular ring or spiral nails only.

6. No dimension lumber substrate in new construction; when existing lumber substrates are to be covered, overlay with 50 by 50 mm (2 by 2 inch) mesh hardware cloth.

On the drawings, show:

1. Location of resinous flooring. If more than one type is to be used, key each to location on the drawings.

2. Details of special items such as coved bases, expansion joints, control joints, stairs, and floor drains.

3. Details for grounding of conductive floors.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C307	(2023) Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C413	(2018; R 2023) Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes
ASTM C531	(2018; R 2023) Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings, and Polymer Concretes
ASTM C579	(2023) Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C580	(2018; R 2023) Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C722	(2018; R 2023) Standard Specification for Chemical-Resistant Resin Monolithic Floor Surfacings
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D4060	(2019) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4263	(1983; R 2018) Standard Test Method for

	Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM E162	(2024) Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 99	(2024) Health Care Facilities Code

NATIONAL TERRAZZO AND MOSAIC ASSOCIATION (NTMA)

NTMA Info Guide	(2017) Terrazzo Reference Guide

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Flooring Systems; G, [_____]

SD-03 Product Data

Sealer and Resin; G, [_____]

Floor Surfacing; G, [_____]

Conductive Sparkproof Flooring; G, [_____]

Indoor Air Quality for Primer; S

Indoor Air Quality for Top Coating; S

Indoor Air Quality for Sealer And Resin; S

Mixing; G, [_____]

SD-04 Samples

Flooring Systems; G, [_____]

SD-06 Test Reports

Testing; G, [_____]

SD-07 Certificates

Qualifications of Installer; G, [_____]

SD-08 Manufacturer's Instructions

Application; G, [_____]

SD-10 Operation and Maintenance Data

Flooring Systems; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Qualifications of Installer

Perform installation by an applicator approved by the manufacturer of the floor surfacing materials. Furnish a written statement from the manufacturer detailing the Qualifications of Installer.

1.3.2 Shop Drawings

Submit drawings indicating the type and layout of the flooring system for approval.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver the materials to the project site in unopened bags and containers clearly labeled with the name of the manufacturer, type of material, batch number, and date of manufacture. Store materials, other than aggregates, away from fire, sparks, or smoking areas. Maintain the storage area between 10 and 32 degrees C 50 and 90 degrees F.

1.5 ENVIRONMENTAL REQUIREMENTS

Maintain the ambient room and floor temperatures at 18 degrees C 65 degrees F, or above, for a period extending from 48 hours before installation until one week after installation. Cure concrete for at least 28 days and keep it free of water for at least 7 days prior to receiving surfacing in accordance with ASTM D4263. Measure and insure moisture content of wood substrates between 8 and 10 percent prior to application.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials (except aggregate) used in the flooring from a single manufacturer. Furnish and install [trowel applied type epoxy finish of 6 mm 1/4 inch thickness with properties and chemical resistance conforming to the requirements specified in NTMA Info Guide.] [trowel or spray applied [1.6 mm 1/6 inch] [3.17 mm 1/8 inch] [6.35 mm 1/4 inch] thick, epoxy, polyester, or other resinous material conforming to ASTM C722 with [Type A surfacings (chemical resistance and moderate to heavy traffic resistance)] [Type B surfacings (mild chemical resistance and severe thermal shock stability)]] resin-based flooring. Meet the following material requirements:

2.1.1 Primer

Type recommended by the manufacturer to penetrate into the pores of the substrate and bond with the floor surfacing matrix to form a permanent monolithic bond between substrate and surfacing matrix. Primer products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for primer.

2.1.2 Aggregate

****

NOTE: Select the desired colors for colored quartz from the following and specify the percentage of each color in the mixture; white, grey, brown, buff, green, and red.

Use first bracketed sentence when industrial resinous and conductive industrial resinous flooring are required (biological laboratories, industrial facilities, clean rooms, laundries, and other areas subject to hard wear or spillage). Use second bracketed sentence when decorative floor is desired and floor is subject to spillage or requires high degree of cleanliness (gang showers, clean rooms, laundries, laboratories, and small kitchens where quarry tile is not economically feasible).
****

Provide [silica sand, quartz, granite, or other suitable chemical resistant material having a Mohr's hardness of not less than 6.0] [angular, translucent quartz covered with a colored inorganic coating as [indicated] [selected from manufacturer's standard aggregates]] aggregate.

2.1.3 Binder

****
NOTE: Delete unsuitable matrix or matrices in accordance with the following:

Do not use latex or resin emulsion matrices where maximum resistance to solvents, strong acid or alkaline solutions is required; where high stain resistance is required; where maximum resistance to compressive loads and indentation are required; or where colored quartz decorative aggregate is specified.

Do not use epoxy matrix where resistance to strong oxidizing acid solutions is required; where maximum fire resistance is required; where subject to prolonged temperatures in excess of 54 degrees C 130 degrees F; where frequently exposed to steam or boiling liquids; where white or light colored quartz decorative aggregates are specified or where substrate cannot be thoroughly dried.

Do not use polyester matrix where resistance to strong alkaline solutions is required; where maximum fire resistance is required; where maximum slip resistance is required; where building will be occupied during installation; or where food stuffs will be stored within building during installation.
****

Provide [synthetic rubber latex or resin emulsion] [thermo-setting epoxy] [or] [medium reactive nonthixotropic modified polyester] binder.

2.1.4 Fillers

If required, provide inert silica, quartz or other hard aggregate material fillers as recommended by the flooring manufacturer. Furnish fillers in the quantity necessary to impart the required color and physical characteristics. Provide a filler containing sufficient fines to obtain an even-textured, nonslip type of surface on the finished topping.

2.1.5 Top Coating

****

NOTE: Specify clear top coat for decorative aggregate flooring. Top coatings are available in light grey, dark grey, red, blue, tan, brown, dark green, and light green for industrial resinous floors. Conductive resinous floorings are dark grey to black and should be specified with conductive clear top coats only.

****

Furnish [clear] [[_____] color] coating of type recommended by the manufacturer. Floor top coating products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for top coating.

2.2 FLOORING SYSTEMS

Submit cured samples of each floor finish or color combination and Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. The complete systems, after curing, must have the following properties when tested in accordance with the test methods listed for each property.

2.2.1 Latex or Resinous Emulsion Matrix Floor Surfacing

****

NOTE: Resistance to reagents specified in item j. is required to withstand cleaning agents and spillage associated with normal use. Where resistance to specific chemicals associated with laboratories, plating shops, etc., is required, these chemical solutions and concentrations should be added to the lists. Manufacturer's literature should be checked to assure that the matrix is capable of resistance to these chemicals.

****

2.2.1.1 Compressive Strength

ASTM C579, 31 MPa 4500 psi minimum at 7 days.

2.2.1.2 Tensile Strength

ASTM C307, 4.2 MPa 600 psi minimum at 7 days.

2.2.1.3 Flexural Strength

ASTM C580, 5.6 MPa 800 psi minimum at 7 days.

2.2.1.4 Thermal Coefficient of Expansion

ASTM C531; 5.5 x 10-4 mm per 100 mm 0.01 mil per inch per degree C F maximum.

2.2.1.5 Bond Strength

1.4 MPa 200 psi minimum with 100 percent concrete failure.

2.2.1.6 Flame Spread Index

ASTM E162, 4.0 maximum.

2.2.1.7 Smoke Developed

ASTM E162, 0.4 gm maximum.

2.2.1.8 Abrasion Resistance

ASTM D4060; 30 mg weight loss.

2.2.1.9 Moisture Absorption

ASTM C413; 3.5 percent maximum.

Chemical Resistance

ASTM D1308; no effect when exposed to the following reagents for 7 days:

Acetic Acid: 5 percent solution
Ammonium Hydroxide: 10 percent solution
Citric Acid: 5 percent solution
Coffee
Cola Syrup
Isopropyl Alcohol
Mineral Oil
Sodium Hydroxide: 5 percent solution
Tri-Sodium Phosphate: 5 percent solution
Urea: 6.6 percent solution

2.2.2 Epoxy Matrix Floor Surfacing

****

NOTE: The first set of figures in brackets for items b. and c. represents epoxy and polyester matrix containing more fillers and extenders and are suitable for most installations. The second set of figures in brackets represents high resin content epoxy and polyester matrices and should be specified only when higher strengths or increased chemical resistance is required.

Resistance to reagents specified in item k. is required to withstand cleaning agents and spillage associated with normal use. Where resistance to specific chemicals associated with laboratories, plating shops, etc., is required, these chemical solutions and concentrations should be added to the lists. Manufacturer's literature should be checked to assure that the matrix is capable of resistance to these chemicals.

****

2.2.2.1 Compressive Strength

ASTM C579; 64 MPa 10,000 psi minimum at 7 days.

2.2.2.2 Tensile Strength

ASTM C307; [4.2] [10.3] MPa [600] [1500] psi minimum at 7 days.

2.2.2.3 Flexural Modulus of Elasticity

ASTM C580; [1610] [3215] MPa [250,000] [500,000] psi minimum at 7 days.

2.2.2.4 Thermal Coefficient of Expansion

ASTM C531; 22 by 10-4 mm per 100 mm 0.00004 inches per inch per degree C F maximum.

2.2.2.5 Shrinkage

ASTM C531; 0.5 percent maximum.

2.2.2.6 Bond Strength

1.9 MPa 300 psi minimum with 100 percent concrete failure (16 MPa 2500 psi Compressive Strength Concrete).

2.2.2.7 Flame Spread Index

ASTM E162; 25 maximum.

2.2.2.8 Smoke Deposited

ASTM E162; 4 mg maximum.

2.2.2.9 Abrasion Resistance

ASTM D4060; 15 mg maximum weight loss.

2.2.2.10 Moisture Absorption

ASTM C413; 1.0 percent maximum.

2.2.2.11 Chemical Resistance

ASTM D1308; no effect when exposed to the following reagents for 7 days:

Acetic acid: 5 percent solution
Ammonium Hydroxide: 10 percent solution
Citric Acid: 5 percent solution
Coffee
Cola Syrup
Isopropyl Alcohol
Mineral Oil
Sodium Hydroxide: 5 percent solution
Tri-Sodium Phosphate: 5 percent solution
Urea: 6.6 percent solution

2.2.3 Polyester Matrix Floor Surfacing

****

NOTE: The first set of figures in brackets for items a., b., c., and e. represents epoxy and polyester matrix containing more fillers and extenders and are suitable for most installations. The second set of figures in brackets represents high resin content epoxy and polyester matrices and should be specified only when higher strengths or increased chemical resistance is required.

Resistance to reagents specified in item q. is required to withstand cleaning agents and spillage associated with normal use. Where resistance to specific chemicals associated with laboratories, plating shops, etc., is required, these chemical solutions and concentrations should be added to the lists. Manufacturer's literature should be checked to assure that the matrix is capable of resistance to these chemicals.

****

2.2.3.1 Compressive Strength

ASTM C579; [51] [64] MPa [8000] [10,000] psi minimum at 7 days.

2.2.3.2 Tensile Strength

ASTM C307; [3.8] [10.3] MPa [600] [1500] psi minimum at 7 days.

2.2.3.3 Flexural Modulus of Elasticity

ASTM C580; [3215] [6430] MPa [500,000] [1,000,000] psi minimum at 7 days.

2.2.3.4 Thermal Coefficient of Expansion

ASTM C531; 22 by 10-4 mm per 100 mm 0.00004 inches per inch per degree C F maximum.

2.2.3.5 Shrinkage

ASTM C531; [0.6] [1.0] percent maximum.

2.2.3.6 Bond Strength

1.9 MPa 300 psi minimum with 100 percent concrete failure.

2.2.3.7 Flame Spread Index

ASTM E162; 25 maximum.

2.2.3.8 Smoke Deposited

ASTM E162; 4 gm maximum.

2.2.3.9 Abrasion Resistance

ASTM D4060; no more than 0.025 mm 1.0 mil loss of thickness.

2.2.3.10 Porosity

ASTM D4060; no more than 8 percent gain in weight and no evidence of cracking, peeling, blistering, or loss of adhesion.

2.2.3.11 Impact Resistance

ASTM D4060; no evidence of cracking, spalling, or loss of adhesion.

2.2.3.12 Fungistatic and Bacteriostatic Resistance

ASTM D4060; no support for growth of fungus or bacteria.

2.2.3.13 Ultraviolet Light Resistance

ASTM D4060; no evidence of chalking, cracking, peeling, blistering, or loss of adhesion.

2.2.3.14 Thermal Shock Resistance

ASTM D4060; no evidence of cracking, peeling, blistering, spalling, or loss of adhesion.

2.2.3.15 Stain Resistance

ASTM D4060; no permanent staining.

2.2.3.16 Adhesion

ASTM D4060; 90 percent failure of concrete substrate.

2.2.3.17 Chemical Resistance

ASTM D1308; no effect when exposed to the following reagents for 7 days.

Acetic Acid: 5 percent solution
Ammonium Hydroxide: 10 percent solution
Citric Acid: 5 percent solution
Coffee
Cola Syrup
Isopropyl Alcohol
Mineral Oil
Sodium Hydroxide: 5 percent solution
Tri-Sodium Phosphate: 5 percent solution
Urea: 6.6 percent solution

2.3 CONDUCTIVE SPARKPROOF FLOORING

****

NOTE: Conductive floors will be used at operations where explosives having an electrostatic sensitivity of 0.1 joule or less such as primer, detonator, igniter, and incendiary mixtures are exposed. Conductive floors are also required where the following are performed:

a. Loose unpacked ammo with electric primers.
b. Exposed electro-explosive devices.

c. Electrically initiated items with exposed electric circuitry.
d. Hazardous materials that could be ignited by static discharge from humans.

****

Trowel or spray apply conductive sparkproof industrial resin-based flooring [1.6 mm 1/16 inch] [3 mm 1/8 inch] [6 mm 1/4 inch] thick, epoxy, polyester, or other resinous material conforming to ASTM C722with [Type A surfacings (chemical resistance and moderate to heavy traffic resistance)] [Type B surfacings (mild chemical resistance and severe thermal shock stability)]. Ground conductive flooring and conform to the requirements for conductive flooring of NFPA 99.

2.4 SEALER AND RESIN

Provide a sealer product recommended by the industrial resin-based flooring manufacturer; when applied to the resin topping and dried, it must be nonslip and resistant to staining and suitable for the type application indicated. Floor resin and sealer products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation for Indoor Air Quality for Sealer and Resin.

2.5 ANTIMICROBIAL

****

NOTE: Include the requirement for this item only on projects where this additional feature is needed.

****

Treat industrial resin-based flooring to be resistant to fungi and bacteria.

2.6 COLOR

Provide color [as indicated] [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____].

PART 3 EXECUTION

3.1 SURFACE PREPARATION

****

NOTE: Resinous floor systems should not be installed over existing resilient tile or sheet flooring. If existing concrete substrates are badly cracked, crumbling, punky, or deeply contaminated with oil or fat, a new concrete topping of proper thickness and strength should be shown and specified. Wood floors that are poorly supported, badly worn, splinter, grease or oil soaked should be renovated prior to application of resinous flooring.

****

[Completely remove existing resilient flooring and adhesive by scraping.] [Remove all dirt, dust, debris, and other loose particles by sweeping or vacuum cleaning.] Protect adjacent surfaces not scheduled to receive the flooring by masking, or by other means, to maintain these surfaces free of the flooring material.

[3.1.1 Concrete Surfaces

****

NOTE: Proper preparation of substrate is essential for satisfactory performance of resinous floor systems. Existing concrete floors should be carefully inspected to determine condition. Based on inspection, select most suitable surface treatment:

Surface Condition	**Surface Preparation Required**
New Concrete	**Acid etching and air drying**
Old Concrete	
Acid contaminated	**Neutralize with hot alkaline cleaner, acid etching, and air drying**
Oil, fat or wax contaminated	**Mechanical cleaning or steam cleaning**
Alkali contaminated	**Acid etching and air drying**
Painted	**Mechanical cleaning or paint stripping**
Adhesive and asphalt contaminated	**Mechanical cleaning**
Dust and dirt contaminated	**Mechanical cleaning**
Form oil, sealer or curing compound contaminated	**Mechanical cleaning**

NOTE: Select the applicable paragraph(s) from the following:

****

[3.1.1.1 Mechanical Cleaning

Completely remove dirt, wax, paint, laitance, and [_____] by grinding with a terrazzo machine, sanding with coarse open grid sandpaper, sand blasting, chipping, bush hammering, or wire brushing.

][3.1.1.2 Steam Cleaning

Completely remove all animal fats, grease, oil, wax, and [_____] using a high pressure steam cleaner equipped with a soap injection system. Scrape the surface to remove any build-up of debris. Then thoroughly saturate the surface with hot caustic solution. Allow the solution to remain on the floor for 15 to 20 minutes. Apply steam, with caustic, over the presoaked area until all contamination is removed. Leach the caustic residue from the surface using one or more applications of steam without caustic. Flush the floor with warm water.

][3.1.1.3 Paint Stripping

Brush or spray on a paint stripping material that has been demonstrated to effectively remove the paint. Leave the stripping material on the surface until the paint has softened or blistered. Remove paint by scraping, brushing, or wiping. Rinse the surface in accordance with the stripping material manufacturer's recommendations. Avoid strippers containing toxic methylene chloride.

][3.1.1.4 Acid Etching

Apply a 10 percent solution of muriatic acid at a rate of one L/square meter one quart/each 10 square feet of concrete surface. Allow the solution to stand until it stops bubbling but not less than 5 minutes. Remove the acid and wash the surfaces several times, as required, to remove all traces of the acid. Always dilute acid by pouring into water. Use face shield rubber gloves, and other safety equipment when using acids, alkalis, or solvents.

][3.1.1.5 Air Drying

After cleaning, allow concrete surface to air dry thoroughly prior to application of surfacing. Blowers or oil free compressed air may be used. Do not use flame-drying methods. Prior to application of surfacing, test concrete surface for excessive moisture in at least two locations. Place rubber mats at each location with smooth side against concrete and place weight on top of mat to hold in position and ensure contact with concrete. Polyethylene with all edges taped may be used in lieu of mats. After 8 hours remove mat or sheeting and examine floor surface for moisture accumulation. If tests indicate accumulation of moisture at either location, perform additional air drying until additional tests show no moisture accumulation.

]]3.1.2 Plywood

For new plywood substrates, provide exterior grade plywood with exterior grade glue nailed with annular ring or spiral nails. Sand the plywood to remove all latent contaminants. Sweep or vacuum surfaces to remove all sanding debris. Tape joints with 100 mm 4 inch wide glass fiber reinforced tape.

3.1.3 Ceramic Tile

Remove all fats, oils, grease, or soap scum using a caustic solution of one kg one pound of caustic soda to 8.3 L one gallon of water. Allow the solution to stand on the surface for at least one hour then scrub with steel brushes or steel wool. Mop up the caustic solution, neutralize it with a 10 percent muriatic acid solution, and thoroughly rinse the residue from the surface. Test glazed tile a deglazing agent as recommended by the flooring manufacturer and sanded or acid etched to roughen the surface sufficiently to obtain a good bond. Sweep or vacuum surfaces to remove all sanding debris. Use face shield, rubber gloves, and other safety equipment when using acids, alkalis, or solvents.

3.1.4 Substrate Cracks, Spalls, Joints, and Depressions

Fill all cracks, joints, spalls, and other depressions in the substrate with a latex underlayment, as recommended by the manufacturer compatible with the floor surfacing material.

3.2 MIXING

Proportion and mix the floor surfacing components in accordance with the manufacturer's instructions. Submit flooring manufacturer's descriptive data, mixing, proportioning, and installation instructions. Include maintenance literature for resinous flooring.

3.3 APPLICATION

Submit complete instructions for application of flooring system including any precautions or special handling instructions required to comply with OSHA 29 CFR 1910-Subpart Z. Apply primer, floor surfacing, and seal coat in accordance with the manufacturer's recommendations and the following requirements.

3.3.1 Primer

Apply primer uniformly over the entire area to receive floor surfacing using clean rubber squeegees or clean steel trowels. Do not allow primer to collect in depressions. Allow primer to dry thoroughly before the next coat is applied. Reprime porous areas or areas where primer has dried.

3.3.2 Floor Surfacing

****

NOTE: Specify desired thickness of resinous flooring. Latex and resinous emulsion matrix flooring should be installed 6, 10 and 13 mm 1/4, 3/8, and 1/2 inch thick for light, medium, and heavy duty traffic. Epoxy and polyester matrix flooring should be installed 3, 5 and 6 mm 1/8, 3/16, and 1/4 inch thick for light, medium, and heavy duty traffic.

Use first bracketed option requiring continuous floor installation only if structural floor control joints have been located out of floor area.

****

Apply mixed surfacing material to provide a finish floor surfacing not less than [_____] mm inch thick. The entire surfacing in any one room or area must be [placed in one continuous operation without use of cold joints or divider strips] [one continuous operation except for placement of divider strips at structural floor control joints or as indicated]. All surfaces must be flush, true to plane and line, and level within 2 mm in one meter 1/4 inch in 10 feet.

3.3.3 Seal Coat

Apply seal coat uniformly covering all surfaces after floor surfacing has cured and as recommended by the supplier.

3.4 TESTING

****

NOTE: For explosive and ammunition facilities and other facilities requiring conductive sparkproof industrial resinous flooring, edit the following paragraphs. Omit when not required.

****

Submit reports of tests for conductive sparkproof flooring, including analysis and interpretation of test results. Properly identify each report. Identify and record the test methods used.

3.4.1 Electrical Resistance

Test the flooring between 30 and 45 days after flooring installation is completed, and prior to its use, in accordance with paragraph 12-4.1.3.8(b)(7) of NFPA 99. The resistance of the floor at any one location must be more than 5,000 ohms in areas with 110 volts service, more than 10,000 ohms in areas with 220 volt service, and average less than 1,000,000 ohms and more than 25,000 ohms in all areas. Perform tests using a technician experienced in such work.

3.4.2 Spark Resistance

Test the floor for spark resistance by stroking the floor vigorously with a 300 mm 12 inch hardened steel file in a 914.4 mm 3 foot arc. Perform the test for each 7.43 square meters 80 square feet of floor area. Perform the tests in a darkened space and only when the relative humidity of the atmosphere within the space does not exceed 50 percent. The floor must not produce a spark when tested under these conditions.

3.5 PROTECTION

Allow surfacing to set for a minimum period of 48 hours before traffic is allowed on the floor. Protect finished flooring from traffic by covering with 13.5 kg 30 pound building paper or other equally effective means until final acceptance of the project.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-09 67 23.15 (February 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 67 23.15 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 67 23.15

FUEL RESISTIVE RESINOUS FLOORING, 3-COAT SYSTEM

02/21

PART 1 GENERAL

PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC UFGS-09 67 23.15 (February 2021)

Preparing Activity: NAVFAC Superseding
UFGS-09 67 23.15 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 67 23.15

FUEL RESISTIVE RESINOUS FLOORING, 3-COAT SYSTEM

02/21

****

NOTE: This guide specification covers the requirements for a three-coat, liquid flooring system with reflective urethane topcoats, slip resistance, and joint work.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This guide specification contains tailoring options for Army and Navy projects. Where an Editor's Note states a paragraph is tailored for a Service or project type, the content of the paragraph, or a portion of the paragraph, is suited specifically to be included only for that Service or project type.

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NOTE: The designer must not alter the products or processes specified herein without thorough knowledge of the need for the changes and the implications of those changes. Use of alternate coating systems must be justified by evaluating

lifecycle costs using 50 year life as a baseline.
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NOTE: The thin film flooring system is appropriate for use in: aircraft maintenance hangars, equipment maintenance shops, and all other industrial floors where resistance to abrasion and fuel is required. Installation costs: $2.00 to $4.50 per 0.1 square meters square foot. Nominal thickness: 0.375 mm 15.0 mils. Can be rejuvenated by replacing urethane topcoats, and non-skid, only. Approximate service life: Urethane top coating with non-skid grit at three or more years. The flooring system is neither conductive nor Electro-Static Dissipative (ESD), however, either formulation is easily designed upon request. This specification is not for use in overcoating existing sound floor coatings.
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NOTE: Prior to the flooring systems installation, a concrete condition assessment in accordance with the Naval Facilities Engineering Service Center's (NFESC) Users Guide (UG)-2036-SHR is highly recommended. The condition assessment is designed to identify problem floors and eliminate premature flooring failures produced by: 1) coating concrete with low surface strength, 2) coating concrete with high levels of surface contamination (such as oils, fuels, fats, and waxes), and 3) coating concrete with a high rate of Moisture Vapor Emission (MVE). The thin film flooring system is suitable for application to: A) "smooth" concrete surface texture (no greater than ICRI 310.2R CSP 5), B) concrete with a rate of MVE no more than 169.0 micrograms moisture per second, square meter 3.0 pounds moisture per 24 hours, 1000 square feet (ASTM F1869), C) concrete with surface strength greater than 1.34 MPa 200 psi (ASTM D4541), and D) concrete with fuel/oil contamination to a depth no more than 6.25 mm 1/4 inch.
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NOTE: If a concrete floor has a rate of Moisture Vapor Emission (MVE) more than 197.0 micrograms moisture per second, square meter 3.5 pounds moisture per 24 hours, 1000 square feet (ASTM F1869), apply a layered Moisture Reducing System (MRS) prior to the application of the thin film flooring system. The MRS must be compatible with the submitted flooring system and approved / warranted by the manufacturer of the thin film flooring system. Apply the MRS to shot blasted concrete and reduce the rate of MVE to less than 169.0 micrograms moisture per second, square meter 3.0 pounds moisture per 24 hours, 1000 square feet. MRSs can employ combinations of concrete sealers,

specific epoxies, and moisture insensitive grouts, with or without mesh.
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NOTE: Include Section 03 01 00 REHABILITATION OF CONCRETE for repair of minor spalls and surface deterioration to depths less than 75 mm 3 inches. Specify epoxy mortar for repairs to depths no more than 50 mm 2 inches. Specify epoxy concrete for repairs to depths from 25 mm 1 inch to 75 mm 3 inches. Contain repairs to depths greater than 25 mm 1 inch in a rectangular geometry with saw cut edges. Finish repairs to resemble surrounding concrete using a stainless steel trowel.

Include Section 32 01 29.61 PARTIAL DEPTH PATCHING OF RIGID PAVING for repair of large spalls and severe deterioration to depths from 75 mm 3 inches to 150 mm 6 inches. Specify Portland Cement Concrete (PCC) with less than 0.45 water-cement ratio, light steel trowel finish, and cure using plastic coated burlap. Provide rectangular geometry for repairs with saw cut edges to a nominal repair depth of 150 mm 6 inches. Cure PCC repair for approximately 30 days prior to the application of the flooring system. Do not cure repairs using liquid membrane-forming compounds.

For repairs to spalls and severely distressed concrete to depths greater than 150 mm 6 inches, seek material guidance from Section 03 30 00 CAST-IN-PLACE CONCRETE and procedural guidance from the American Concrete Pavement Association (ACPA) Guideline TB-002.02P "Concrete Paving Technology - Guidelines for Full Depth Repair." Contain within repair base a minimum of 50 mm 2 inchesof clean, non-reactive concrete sand over a suitable vapor retarder (0.25 mm 10 mils polyethylene sheeting). Finish repairs by light steel trowel and cured using plastic coated burlap. Cure repairs for approximately 30 days, or more, prior to the application of the flooring system. Do not cure repairs using liquid membrane-forming compounds.

Scarify to level any curled or settled slab ends with joint surfaces displaying more than 3.2 mm 1/8 inch difference in vertical height. Contain within resulting surfaces a height difference no more than 1.5 mm 1/16 inch and a surface texture equal ICRI 310.2R CSP 4.
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NOTE: Include Section 03 30 00 CAST-IN-PLACE CONCRETE for new concrete slab construction. Employ measures to control the rate of base, subbase, and subgrade Moisture Vapor Emission (MVE) to total no more than 169.0 micrograms moisture per second,

square meter 3.0 pounds moisture per 24 hours, 1000 square feet when measured on the slab's surface (ASTM F1869). Improper MVE controls have produced numerous premature coating failures. In addition to appropriate subbase drainage, specify a minimum of 25 mm 2 inches of clean, non-reactive concrete sand over no less than 0.25 mm 10 mils of polyethylene sheeting (ASTM F4397) with sealed lap joints. Specify concrete mix to be free of both accelerators containing calcium chloride and other sources of chloride ion contamination. Specify two passes of a light power troweled finish and cure using plastic coated burlap or equal method. Do not cure concrete using liquid membrane-forming compounds. Do not specify surface hardeners or dry shake finish (Section 09 97 23 METALLIC TYPE CONDUCTIVE/SPARK RESISTANT CONCRETE FLOOR FINISH). Approximately 60 days following the concrete pour and prior to the installation of the flooring system, test concrete for the rate of MVE and confirm rate is no more than 169.0 micrograms moisture per second, square meter 3.0 pounds moisture per 24 hours, 1000 square feet (ASTM D1869). Consult ACI 224.3R "Joints in Concrete Construction," ACI 302.1R "Guide for Concrete Floor and Slab Construction," ACI 360R "Design of Slabs on Grade," and other appropriate construction guidance.

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NOTE: Where tile is to be removed prior to the application of flooring system, test both tile and mastic for the presence of asbestos. If asbestos is detected, include Section 02 82 00 ASBESTOS REMEDIATION for removal and disposal.

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NOTE: If flooring system is to be applied to warehouse floors with heavy forklift traffic, a semi-flexible joint sealant is required in lieu of the specified flexible sealant. Use a semi-flexible epoxy sealant with approximately 90 percent elongation. Do not use semi-flexible sealants in areas exposed to exterior temperatures.

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NOTE: Include Section 01 45 00 QUALITY CONTROL, as applicable.

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NOTE: Include Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. This section defines fugitive dust, generated waste, hazardous materials, hazardous substance, hazardous waste, solid waste, construction and demolition (CD) debris, and liquid waste, and contains documentation for dangerous

waste profile, waste information sheet, waste identification document, waste generation record, landfill disposal form, and hazardous material reporting.
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PART 1   GENERAL

1.1   REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C679	(2015; R 2022) Standard Test Method for Tack-Free Time of Elastomeric Sealants
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable

	Adhesion Testers
ASTM D6237	(2019) Standard Guide for Painting Inspectors (Concrete and Masonry Substrates)
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI 310.2R	(2013) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems-Requirements

MASTER PAINTERS INSTITUTE (MPI)

MPI 211	(2018) Floor Coating, Primer, Thin Film, for Aircraft Maintenance Facilities
MPI 212	(2018) Floor Coating, Thin Film, for Aircraft Maintenance Facilities

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC QP 5	(2022) Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies
SSPC QP 8	(2015) Standard Procedure for Evaluating the Qualifications of Contracting Firms that Install Polymer Coatings, Surfacings, Linings or FRP Composites on Concrete and Other Cementitious Substrates
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC-TU 2/NACE 6G197	(1997) Design, Installation, and Maintenance of Coating Systems for Concrete Used in Secondary Containment

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1000	Air Contaminants
29 CFR 1926.59	Hazard Communication

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Joint Sealant; G, [_____]

Thin Film Flooring System; G, [_____]

White Aluminum Oxide Non-Skid Grit; G, [_____]

SD-05, Design Data

Environmental Control System

SD-06 Test Reports

Joint Sealant Test Report; G, [_____]

Primer Coat; G, [_____]

Urethane Topcoat; G, [_____]

White Aluminum Oxide Non-Skid Grit; G, [_____]

Patch Test Demonstration; G, [_____]

Daily Inspection Report; G, [_____]

Adhesion Testing; G, [_____]

SD-07 Certificates

Coating Work Plan; G, [_____]

Joint Sealant Certificates; G, [_____]

Thin Film Flooring System Certificates; G, [_____]

Qualifications of Certified Industrial Hygienist (CIH)

Qualifications of Certified Protective Coatings Specialist (PCS)

Qualifications of Coating Inspection Company

Qualifications of QC Specialist Coating Inspector

Qualifications of Coating Contractors; G, [_____]

Warranty; G, [_____]

SD-08 Manufacturer's Instructions

Joint Sealant Manufacturer's Instructions; G, [_____]

Thin Film Flooring System Manufacturer's Instructions; G, [_____]

Water-Based Alkaline Degreaser; G, [_____]

SD-11 Closeout Submittals

Inspection Logbook; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Qualifications of Certified Protective Coatings Specialist (PCS)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party PCS. Submit documentation that the specialist is certified by SSPC: The Society for Protective Coatings (SSPC) as a PCS, including certification number and date of certification/recertification. If the PCS is employed by the same coating inspection company to which the coating inspector is employed, this does not violate the independent third-party requirements. The PCS must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. The PCS must not be the designated coating inspector.

1.3.2 Coating Work Plan

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NOTE: For maintenance painting, add requirement for pre-work determination of the existing surface condition. If paint removal is specified in another Section include this evaluation such that the paint removal operation does not create excessive profile.
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a. Include Coating Work Plan in Quality Control Plan.

b. Provide procedures for reviewing Contract Documents immediately after award to identify errors, omissions, and discrepancies so that any such issues can be resolved prior to project planning and development of detailed procedures.

c. Provide procedures for verification of key processes during Initial Phase to ensure that Contract requirements can be met. Key processes must include surface preparation, coating application and curing, inspection, and documentation, and any other process that might adversely impact orderly progression of work.

d. Provide procedures for all phases of coating operations, including planned work, rework, repair, inspection, and documentation. Address mobilization and setup, surface preparation, coating application, coating initial cure, tracking and correction of non-compliant work, and demobilization. Coordinate work processes with health and safety plans and confined space entry plans. For each process, provide procedures that include appropriate work instructions, material and equipment requirements, personnel qualifications, controls, and process verification procedures. Provide procedures for inspecting work to verify and document compliance with Contract requirements, including inspection forms and checklists, and acceptance and rejection criteria.

e. [Provide procedures for determining the existing surface profile under paint, and procedures for ensuring that the profile is not increased beyond the maximum profile specified herein.][_____]

f. Provide procedures for correcting non-compliant work. Detailed procedures are required in advance to avoid delays in meeting overcoat windows as well as to avoid delays in production. Provide procedures for repairing defects in the coating film, such as runs, drips, sags, holidays, overspray, as well as how to correct coating thickness non-compliance, any other areas of repair or rework that might be adversely affected by delays in preparing and approving new procedures.

g. If a procedure is based on a proposed or approved request for deviation, the deviation must be referenced. Changes to procedures must be noted by submittal number and date approved, clearly delineating old requirements and new requirements, so that the records provide a continuous log of requirements and procedures.

1.3.3 Design Data

1.3.3.1 Environmental Control System

Submit design details of the proposed environmental control system to include ventilation, humidity control, and temperature regulation. Provide calculations for humidity control during separate surface preparation and coating application procedures, ventilation requirements during coating application, and maximum allowable coating application rates to coincide with ventilation. Include basis of design data on local conditions. Provide equipment layout sketches and procedures showing function of each piece of equipment and fail-safe measures. A Certified Industrial Hygienist must approve calculations, work procedures and personal protective equipment.

1.3.4 Test Reports

1.3.4.1 Joint Sealant Test Report

Submit test results that confirm sealant complies with the requirements of Table Ia. Samples must have been tested within the last three years.

1.3.4.2 Daily Inspection Report

Submit one copy of the daily inspection report to the Contracting Officer within 24 hours of the date recorded.

1.3.5 Certificates

1.3.5.1 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party CIH. Submit documentation that hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. Provide evidence of experience with hazards involved in industrial coating application work.

1.3.5.2 Qualifications of Coating Inspection Company

Submit documentation that the coating inspection company performing all coating inspection functions is certified by SSPC to the requirements of SSPC QP 5 prior to Contract award. The coating inspection company submitted and approved must remain and not changed through completion of the Contract. The coating inspection company must remain so certified for the duration of the project. If a coating inspection company's certification expires, the firm will not be allowed to perform any inspection functions, and all surface preparation and coating application work must stop, until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered. Notify the Contracting Officer of any change in coating inspection company certification status. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from SSPC and furnish a copy of all inspection reports.

1.3.5.3 Qualifications of QC Specialist Coating Inspector

Submit documentation that each coating inspector is employed, and qualified to SSPC QP 5, Level II, by the selected coating inspection company. Each inspector must remain employed by the coating inspection company while performing any coating inspection functions. In addition to the handwritten records, the inspector must employ an electronic reporting program with functionality as outlined in Table II. The Administrator must be the designated Government Representative for the project.

1.3.5.4 Qualifications of Coating Contractors

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NOTE: Solicitations requiring certification for prequalification should point out the existence and location of the certification requirement on the PROJECT INFORMATION FORM. This requirement must be pointed out in the solicitation documents for the "prior to Contract award" requirement to be enforceable. Certification is a special responsibility requirement pursuant to FAR 9.104-2 Special Standards. This is analogous to requiring bidders to have a specified level of experience or expertise and GAO has sustained these types of special requirements.

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All Contractors that perform surface preparation or coating application must be certified to SSPC QP 8 and should also be SSPC QS 1 certified prior to Contract award and must remain certified while accomplishing any surface preparation or coating application. The painting Contractors must remain so certified for the duration of the project. If a Contractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site audits from SSPC and furnish a copy of all audit reports.

[For OCONUS, non-US territories where documentation is provided that certified SSPC QP 8 with or without SSPC QS 1 Contractors did not bid and are not available, all Contractors that perform surface preparation or coating application must be certified to ISO 9001 prior to Contract award, and must remain certified while accomplishing any surface preparation or coating application. If a Contractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from the ISO certifying organization and furnish a copy of all inspection reports.

][Minimum requirements for the installation Contractor are as follows: Completed three or more jobs within the past two years applying the specified materials to concrete surfaces in which the total area exceeds 18,587 square meters 200,000 square feet. Submit documentation listing location of work, point of contact at job site, total square footage of applied materials, listing of both materials and equipment used, and validation from coating manufacturer documenting quality of materials purchased per job for work totaling 18,587 square meters 200,000 square feet within the past two years. In addition to the above requirements, be certified by the material manufacturer(s) to install the submitted coatings and sealant. Submit copy of certificates.

]1.3.5.5 Joint Sealant Certificates

Submit literature documenting the past performance of the sealant's use in automotive or aircraft maintenance shops. Minimum requirements are two or more maintenance shops with joint work totaling 3,048 linear meters 10,000 linear feet where the sealant has performed for two years with less than 1 percent combined sealant failures and defects. List location of shops, total linear feet of sealant applied per shop, shop point of contact, date sealant was applied, and the name of the installed sealant material.

1.3.5.6 Thin Film Flooring System Certificates

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NOTE: Use bracketed option when MPI certified products cannot be obtained.

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Provide manufacturer's certification of conformance to Contract requirements.

[Submit literature documenting the past performance of the coating system's use in aircraft maintenance shops and over floors with high rates of Moisture Vapor Emission (MVE). Minimum requirements are two or more aircraft maintenance shops totaling 3,160 square meters 34,000 square feet where the coating system has performed for two years with less than 0.05 percent combined premature coating failures, material defects and surface discoloration; no more than 0.03 percent discoloration from aviation chemicals, tire plasticizers, and UV exposure. Provide a minimum of two additional case histories where successful installation occurred on floor slabs with no less than 197.0 micrograms moisture per second, square meter 3.5 pounds moisture per 24 hours, 1000 square feet. List location of shops, total coated area per shop, shop point of contact, date coating system was applied, successful installation to concrete with high MVE, and the names of the installed coating materials.

]1.3.6 Product Data

1.3.6.1 Joint Sealant Manufacturer's Instructions

Submit manufacturer's printed instructions to include detailed application procedures, minimum and maximum application temperatures, and curing procedures. In accordance with 29 CFR 1926.59, include Safety Data Sheets (SDS) for the sealant to be used at the job site.

1.3.6.2 Thin Film Flooring System Manufacturer's Instructions

Submit manufacturer's printed instructions to include detailed mixing, minimum and maximum application temperatures, acceptable atmospheric and interior climatic conditions, application procedures, curing procedures, and procedures for maintenance cleaning of flooring system. Provide explicit instructions detailing surface preparation, recoat windows and remedial actions in case recoat windows are missed, and, if applicable, solvent-wiping between coats with acceptable types and grades of solvents. In accordance with 29 CFR 1926.59, include SDSs for the coatings to be used at the job site.

1.3.6.3 Water-Based Alkaline Degreaser

Submit manufacturer's printed instructions to include detailed mixing, rate of dilution, application procedures, and rinsing procedures. In accordance with 29 CFR 1926.59, include SDSs for the water-based alkaline degreaser to be used at this job site.

1.4 DELIVERY, STORAGE, AND HANDLING

Store coatings and sealant in spaces with temperatures from 5 degrees C 40 degrees F to 24 degrees C 75 degrees F. Inspect materials on site for damage prior to use. Return to manufacturer packaged materials in dented, rusty, or leaking containers. Conduct testing by manufacture of returned materials with an expired shelf life and if compliant, reissue a shelf life extension.

1.5 COATING HAZARDS

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NOTE: Include either Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS or prepare instructions detailing each element of safety for use with this section.

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Ensure that employees are trained in all aspects of the safety plan. Follow the coating manufacturer's written safety precautions throughout mixing, application, and curing of coatings. Comply with respiratory protection requirements in 29 CFR 1910.134 and safe levels of airborne contaminants in 29 CFR 1910.1000.

1.6 JOB SITE REFERENCES

Make available to the Contracting Officer at least one copy each of ASTM D4541, ASTM D6237, SSPC-TU 2/NACE 6G197, and ICRI 310.2R, including replica standards ICRI 310.2R CSP 1 through CSP 9, at the job site.

1.7 PATCH TEST DEMONSTRATION

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NOTE: Patch test demonstration is a very important part of the submittal process. While it is unusual to require a test patch prior to the submitted coating system's approval, this flooring system is unusual in that it is required to provide extended, uninterrupted performance. A demonstration of Contractor claims, especially under conditions to be encountered in the specific project, is considered necessary.

If customer is not satisfied with the level of non-skid grit, adjustments to the specification can be made. Grit coarser than No. 60 aluminum oxide is not recommended. On architectural floors, non-skid grit broadcast rates can range from none to approximately half the specified level.

****

Prior to the submitted flooring system's approval, apply the complete coating system to a 3 meter by 3 meter 10 foot by 10 foot square section of concrete as prepared in accordance with PART 3 EXECUTION. Within this area, perform three adhesion tests as described in the paragraph ADHESION TESTING. If adhesion testing produces cohesive failures within the concrete, no less than 1 mm 40 mils concrete removed over 95 percent of each pull-off coupon, or adhesion more than 2.75 MPa 400 psi, patch test adhesion is acceptable. If concrete surface preparation was insufficient, apply an additional coating system patch to properly prepared concrete followed by the above adhesion testing. If adhesion results are unacceptable for both the topcoats and the primer, submit a new coating system manufactured by a different coating vendor. Apply a patch of the new coating system and subject patch to the above requirements for adhesion prior to approval. If customer is not satisfied with the non-skid grit application, adjustments to the specifications can be made. Grit coarser than No. 60 aluminum oxide is not recommended.

1.8 WARRANTY

Warranty materials and workmanship for a minimum period of one year following coating and sealant application. The following terms and conditions form a part of the warranty: If the applied coating system develops either blisters (chemical), checks, softening, or lifting within one year following application, rework each area at Contractor's expense. The following conditions are excluded from the warranty: A) concrete cracking, flooring system mirrors cracks in concrete; B) cosmetic imperfections due to scratching and gouging; C) application to metallic concrete finishes; and D) application to concrete with a rate of Moisture Vapor Emission (MVE) greater than 197.0 micrograms moisture per second, square meter 3.5 pounds moisture per 24 hours, 1000 square feet. If the coating system's adhesion is in question, perform one adhesion test per 9.3 square meters 100 square feet as described in the paragraph ADHESION TESTING. To satisfy the warranty, each adhesion test must produce cohesive failures, concrete removal over 95 percent of each pull-off coupon, or adhesion no less than 2.8 MPa 400 psi. Require two additional adhesion tests to confirm results for each area failing to meet adhesion requirements. Within the warranty period, remove to sound material and rework all areas unable to meet adhesion requirements. There must be zero percent sealant failures within one year. Within the warranty period, remove and rework all sealant material with chemically attacked surfaces or lifting from joint walls. Topcoat cracking over sealant is excluded from warranty.

PART 2 PRODUCTS

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NOTE: The specified materials are not appropriate for use in primary chemical containment, secondary chemical containment, or on floors subjected to spills from concentrated acids, bases, and organic solvents. Consult with the Naval Facilities Engineering and Expeditionary Warfare Center's (NAVFAC EXWC) Paints and Coatings Center of Expertise for alternative coating systems to suit specific Navy needs.

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2.1 JOINT SEALANT

Formulate the joint sealant to exhibit the properties as listed in Table Ia.

2.2 THIN FILM FLOORING SYSTEM

A three-coat industrial flooring system consisting of primer and two urethane topcoats. Apply the coating system at a Dry Film Thickness (DFT) ranging from 325 to 500 microns 13 to 20 mils and contain a broadcast of aluminum oxide non-skid grit.

2.2.1 Primer Coat

In addition to the requirements of the thin film flooring system, use MPI 211 primer coat.

2.2.2 Urethane Topcoat

In addition to the requirements of the thin film flooring system, use MPI 212 top coat.

2.3 WHITE ALUMINUM OXIDE NON-SKID GRIT

Size No. 60, dust free (washed and dry), minimum 99 percent pure, having the following sieve analysis when tested using a 1000 gram 2.2 pound sample (ASTM E11):

Sieve No. 40	100 percent passing
Sieve No. 50	15-30 percent retained
Sieve No. 60	70-85 percent retained
Sieve No. 70	0-15 percent retained

PART 3 EXECUTION

3.1 COATING SAMPLE COLLECTION

The Contracting Officer and QC Manager must witness all material sampling. Notify the Contracting Officer a minimum of three days in advance of sampling. Obtain liquid samples of each component of primer and topcoat by random selection from sealed containers and in accordance with ASTM D3925. Samples may be either individual cans of liquid material or 1.0 liter 1.0 quart quantities of properly mixed, extracted, and sealed liquid material. Identify samples by designated name, specification number, batch number, project Contract number, sample date, intended use, and quantity involved. When the applied coating system has met the requirements defined in the paragraph ADHESION TESTING, return coating to the installation Contractor for proper disposal.

[3.2 TILE AND TILE ADHESIVE REMOVAL

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NOTE: Delete this Article if concrete is not tiled.

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Remove 100 percent of tile employing one or more of the following techniques: chipping, scraping, sanding, scarification, high-pressure water, and various hand tools. Remove 100 percent of the tile adhesive using solvents and power scrubbing. Remove residual contamination using hot potable water under a minimum of 27.6 MPa 4,000 psi. Resulting surfaces must appear clean and display the gray color of concrete.

]3.3 JOINT MATERIAL REMOVAL, RE-SAW CUTTING, CRACK CHASING

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NOTE: Hairline cracks having no more than 3.2 mm 1/8 inch width are typically not repaired. However,

cracks greater than 3.2 mm 1/8 inch width can be chased to a minimum depth of 12.5 mm 1/2 inch and sealed using the procedures and materials specified for joints. Cracks more than 18.75 mm 3/4 inch width can be repaired using either epoxy mortar or epoxy concrete. Sealed cracks will assist in protecting the subbase against chemical migration.

****

Remove 100 percent of the existing material in all joints including material bonded to joint walls and base. Rigid material may require saw cutting equipment to remove. Joints may be widened up to 3.2 mm 1/8 inch when re-saw cutting. Chase concrete cracks identified for repair and open to a minimum depth of 12.5 mm 1/2 inch below crack surface resulting in crack(s) with smooth vertical walls. Cracks greater than 18.75 mm 3/4 inch width can be repaired using either epoxy mortar or epoxy concrete.

3.4 DEGREASING

On both coated and uncoated concrete, degrease entire floor by scrubbing using a solution of hot potable water, 49 degrees C 120 degrees F to 77 degrees C 170 degrees F, and a concentrated water-based alkaline degreaser. Perform two complete degreasing cycles on the entire floor surface. Allow solution to soak into surfaces prior to scrubbing and remove using hot potable water under a minimum of 27.6 MPa 4,000 psi. Rinsing is complete when the rinse water appears clear. If the industrial detergent is not biodegradable, collect all rinse water and dispose as hazardous waste. Squeegees and shop vacuums may be used to collect pooling rinse water. Fans may be used to aid drying of floor surfaces.

[3.5 COATING SYSTEM REMOVAL

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NOTE: Delete this Article if concrete is uncoated.

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Remove 100 percent of the existing coating system employing one or more of the following techniques: shot blasting, chipping, scraping, sanding, scarification, high pressure water blasting, and various hand tools. Impact tools, such as scabblers, may be used to remove unsound epoxy mortar flooring systems. In general, a coating system cannot be completely removed by shot blasting and, to attain 100 percent coating removal, requires a combination of the above techniques.

]3.6 SURFACE PREPARATION

Shot blast entire floor to produce a level of coarseness equal to ICRI 310.2R CSP 3. Overlap each pass of shot blasting by 6.25 mm 1/4 inches to 12.5 mm 1/2 inches. Add new shot to shot blasting equipment prior to blasting. Prepare surfaces inaccessible to shot blasting, base of perimeter walls and under secured equipment, using diamond disk grinding or light scarification to produce a level of coarseness equal to ICRI 310.2R CSP 2 or ICRI 310.2R CSP 4, respectively. Resulting surfaces must appear clean and contain the appropriate level of surface coarseness. If the resulting level of cleanliness cannot be determined, place numerous drops of water on surfaces that appear contaminated. If the water drops soak into concrete, the surfaces are free of hydrocarbon contamination (oils, grease, skydrol). If the water drops bead up and do not flatten out, surfaces require additional degreasing as detailed in the Article

DEGREASING. Shot blasting coarse concrete or broom finished concrete can produce a level of coarseness equal to ICRI 310.2R CSP 5: employ a best-effort attempt to minimize over-shot-blasting of coarse concrete. If coarse concrete is encountered, shot blasting to a level of coarseness equal to ICRI 310.2R CSP 5 is acceptable: however, extremely coarse concrete can require resurfacing prior to the flooring system's installation. Sweep, vacuum, and run a high powered magnet over all surfaces to be coated, including joints.

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NOTE: At this point in the installation sequence, minor spalls and surface deterioration to depths less than 75 mm 3 inches can be repaired. Use epoxy mortar for repairs to depths no more than 50 mm 2 inches. Use epoxy concrete for repairs to depths from 25 mm to 75 mm 1 inch to 3 inches. Finish repairs to depths greater than 25 mm 1 inch with a rectangular geometry with saw cut edges. Repairs must be finished to resemble surrounding concrete using a stainless steel trowel. Include Section 03 01 00 REHABILITATION OF CONCRETE if concrete repairs of this nature are required.

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3.7 JOINT TREATMENT

Use the "Conventional Sealed Joint" as detailed in Figure 1 of SSPC-TU 2/NACE 6G197 to seal joints. Employ measures to reduce contamination from equipment and foot traffic. Limit floor access to essential Contractor personnel. Confirm joint surfaces are sufficiently clean.

3.7.1 Install Backer Rod

Install a continuous length of round, closed-cell polyethylene backer rod into each joint using a backer rod tool. For 12.5 mm 1/2 inch, 9.4 mm 3/8 inch, and 6.25 mm 1/4 inch wide joints, place backer rod to a depth of 9.4 mm 3/8 inch (depth equals the distance from the concrete's surface to the highest point on the backer rod). For joints greater than or equal to 18.75 mm 3/4 inch width, place backer to a depth of 15.6 mm 5/8 inch below the concrete's surface. Fit backer rod tight between joint walls (30 percent compression). Remove and reinstall all backer rod that is installed using either the incorrect size (loose fit) or at the incorrect depth. Following backer rod installation, apply painter's tape to surfaces adjacent joints to protect from sealant.

3.7.2 Joint Sealant Application

Apply sealant directly into joints using a bulk-caulking gun. At room temperature, the resulting sealant application must exhibit a concave recess between 3.2 mm 1/8 inch to 1.6 mm 1/16 inch below the concrete's surface. Remove and reapply cured sealant remaining either flush or greater. Following sealant application, remove painter's tape and sealant drips on concrete surfaces. Cure sealant a minimum of 24 hours, prior to the application of coatings.

3.8 PRE-APPLICATION TESTING FOR CONTAMINATION

Spot check surfaces for oil/grease contamination using the water break test. At a rate of 5 tests per 95 square meters 1000 square feet, place one to two drops of water onto surfaces and observe for beading. Test all other surfaces that show visible signs of potential contamination. Apply additional degreasing techniques to surfaces displaying water beading in accordance with the Article DEGREASING.

3.9 COATING APPLICATION

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NOTE: Use epoxy primer the same color, either white or ultra-light gray, as the selected topcoats. Ultra-light gray is preferred to white.

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Vacuum flooring space one additional time prior to coating application.

3.9.1 Primer Application

Apply MPI 211 epoxy primer to flooring space at 175 microns 7.0 mils to 375 microns 15.0 mils Dry Film Thickness (DFT). If the prepared concrete resembles an ICRI 310.2R CSP 3 surface, apply the primer at a minimum of 175 microns 7.0 mils DFT. If the prepared concrete resembles an ICRI 310.2R CSP 5 surface, apply the primer at a maximum of 375 microns 15.0 mils DFT. The previously applied sealant may be lightly coated.

3.9.2 Non-Skid Grit Broadcast

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NOTE: Aircraft hangars servicing light aircraft with weight less that 18,140 kg 40,000 pounds may require a higher loading of non-skid grit. The additional grit will assist in towing aircraft under wet conditions; however, the additional grit will decrease coating aesthetics. Up to 450 grams 1 pound per 93 square meters 100 square feet of additional non-skid grit can be required.

On either warehouse or architectural floors, considerably less non-skid grit may be appropriate. Broadcast rates can range from none to less than 450 grams 1.0 pound per 93 square meters 1000 square feet.

****

Broadcast non-skid grit at a rate of 680 grams 1.5 pounds per 9.3 square meters 100 square feet into the second urethane top coat and backroll. Map floor into 55.8 square meter 600 square foot sections where 4080 grams 9.0 pounds of non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 55.8 square meter 600 square foot section.

3.9.3 Application of Topcoats

Apply two coats of MPI 211 epoxy urethane topcoat to the epoxy primer and broadcast white aluminum oxide non-skid grit directly into the second urethane topcoat.

3.9.3.1 First Topcoat

Apply a full coat of the urethane topcoat at a spreading rate from 62.5 to 80 microns 2.5 to 3.2 mils Dry Film Thickness (DFT). Stripe coat perimeter edges and around equipment footings. Monitor and record a minimum of one Wet Film Thickness (WFT) reading per 55.8 square meter 600 square feet of floor surface. Sealant is to be lightly coated.

3.9.3.2 Second Topcoat

Apply a second coat of the urethane topcoat at a spreading rate of 62.5 to 80 microns 2.5 to 3.2 mils DFT. Stripe coat perimeter edges and around equipment footings. Monitor and record a minimum of one WFT reading per 55.8 square meters 600 square feet of floor surface prior to broadcasting non-skid grit. When the correct WFT has been applied per 55.8 square meters 600 square feet of area, immediately and evenly broadcast non-skid grit directly into the second topcoat of urethane and backroll in two directions. Test the adhesion of the thin film flooring system in accordance with the paragraph ADHESION TESTING.

3.9.3.3 Walkway Stripe and Grounding Rod Markings

Place the walkway stripe and grounding rod markings according to Government drawings, if applicable. When the second topcoat is within its recoat window, apply a walkway stripe of the red/orange urethane topcoat at 75 microns 3.0 mils DFT, completely hiding the top coat, in one coat. If insufficient hiding occurs, apply one additional coat of the walkway stripe. Lightly broadcast non-skid grit into the wet walkway stripe. Use solvent-resistant tape to protect the floor coating against stripe coat bleed. A thin clear coat of either epoxy or urethane may be required to prevent stripe coat bleed prior to the full application of the colored stripe coat. Apply grounding rod markings using similar procedures, urethane top coat, and colors and size according to Government drawings.

3.10 CURING

Cure installed materials to display performance equal to manufacturer's product literature. Remove and reapply improperly cured material.

3.11 FIELD QUALITY CONTROL

3.11.1 Coating Inspector

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NOTE: Insert directly into Section 01 45 00 QUALITY CONTROL, as applicable, requirement for SSPC QP5 Level II Coating Inspector.

A) Modify Section 01 45 00 QUALITY CONTROL to include SSPC QP5 Level II Coating Inspector as follows:

1. In the Submittals Article, add submittal requirement "SD-07 Certificates," add "SSPC QP5 Level II Coating Inspector; G" and add the following paragraph below the addition of "SSPC QP5 Level II Coating Inspector; G."

2. Add the following to the table in the paragraph "QC Specialists Duties and Qualification:" under the heading "Qualification/Experience in Area of Responsibility, add "SSPC QP5 Level II Coating Inspector;" under the heading "Area of

Responsibility," add "Surface preparation, flooring system installation, field tests, and field inspection;" and under the heading "Frequency" add "Full-time during surface preparation, flooring system installation, field tests, and field inspection."

3. Use SSPC QP5 Level II Coating Inspector on all flooring projects or, as a minimum, on flooring projects with greater than 232.25 square meters 2,500 square feet.

B) Modify Section 01 45 00 QUALITY CONTROL to include SSPC QP5 Level II Coating Inspector as follows:

Add SSPC QP5 Level II Coating Inspector to paragraph CQC PERSONNEL and its associated Experience Matrix. The SSPC QP5 Level II Coating Inspector must be directly employed by the prime Contractor. Use the following for the Qualifications column:

The SSPC QP5 Level II Coating Inspector will act as QC Specialist.

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Consider the Coating Inspector as a QC Specialist, who works for the QC Manager, and qualified in accordance with Section 01 45 00 QUALITY CONTROL. The Coating Inspector must be present during all field tests, surface preparation, flooring application, initial cure of the flooring system, and during all flooring repair work. The Coating Inspector must provide all tools/equipment necessary to perform field tests and inspection. The Coating Inspector is responsible for field tests and specified level of inspection.

3.11.2 Inspection

Document weather conditions, job site occurrences, and report conditions and occurrences potentially detrimental to the flooring system. The listed inspection requirements are in addition to the QC inspection and reporting requirements defined in Section 01 45 00 QUALITY CONTROL. The Coating Inspector must prepare a project reference sheet outlining all requirements, tests, test methods, and evaluation criteria, and hold regular meetings with Contractor personnel, including shot blasting operators and applicators, to review requirements/evaluation criteria for upcoming work prior to execution. At the start of coating operations and every hour following until daily work is complete, record air temperature, substrate temperature, and relative humidity. Following the application of each coat, inspect surfaces for improperly cured material, blisters, inadequate or excessive coating thickness, and other defects. Document each inspection, test, non-compliant area, and location of each non-compliant area. List method of evaluation, evaluation criteria, areas requiring rework, and all other pertinent observations.

3.11.2.1 Daily Inspection Report

Submit to the Contracting Officer one copy of the daily inspection report completed each day when performing work under this Section. Use Appendix X1 "Inspection Checklist" of ASTM D6237 to monitor daily activity and to assist in preparing the daily inspection report. Note each non-compliant issue and each issue identified for rework in accordance with the QC documentation procedures of Section 01 45 00 QUALITY CONTROL. Use of forms containing entry blocks for all required data is encouraged. The data must be legible and presented in a professional format. Submit report within 24 hours of the report date.

3.11.2.2 Inspection Logbook

Maintain a continuous record of all activity related to this Section on a daily basis. A computer / software package as outlined in Table II is preferred to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information including photo documentation where appropriate. The designated Government Representative for the project is assigned the highest level Administrator privileges and only the Administrator must be able to modify reports. In areas where photography is not allowed, the computer must come with verification that the camera / photo capability has been removed.

Alternatively, a continuous record of all activity related to this Section must be maintained in an Inspection Logbook on a daily basis. The logbook must be hard or spiral bound with consecutively numbered pages, and must be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information. Submit the original Inspection Logbook to the Contracting Officer upon completion of the project and prior to final payment.

3.11.2.3 Inspection Equipment

Use equipment in good condition, operational within its design range, and calibrated as required by the specified standard for use with each device.

3.11.3 Adhesion Testing

Perform a minimum of three adhesion tests in accordance with ASTM D4541 to the thin film flooring system. Select three random flooring locations spaced a minimum of 6 meters 20 feet between each location. Prior to attaching pull-off coupons, lightly sand flooring surface and attach pull-off coupons containing a grit-blasted anchor profile. Adhere directly to the center of each sanded surface a 18.75 mm 3/4 inch diameter pull-off coupon. When pull-off coupon adhesive has sufficiently cured, score circumference of each pull-off coupon to concrete substrate. Test adhesion and evaluate results. If testing produces cohesive failures within the concrete, no less than 1 mm 40 mils concrete removed over 95 percent of each pull-off coupon, or adhesion more than 2.75 MPa 400 psi coating system's adhesion is acceptable. If the above requirements are not satisfied, then perform one adhesion test per 9.3 square meters 100 square feet using the above procedures. Perform two additional tests per non-compliant area to confirm results. Remove to sound material and rework all areas unable to meet adhesion requirements. Repair each adhesion test using a combination of primer, sand-filled epoxy mortar (for deep cohesive failures, if applicable), and two urethane topcoats. Make repairs flush with adjacent coatings and display an equivalent appearance.

3.12 FINAL CLEANUP

Following completion of the work, remove debris, equipment, and materials from the site. Remove temporary connections to Government or Contractor furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

TABLE I - MATERIALS REQUIREMENTS	
TABLE Ia	
Test	Minimum Requirement (maximum where indicated)
Sealant System (two-pack: self-leveling)	Polysulfide (Manganese Cure; MnO2) or Urethane
Percent Volume Solids	100 percent
Chemical Resistance to JP-8 plus 100 Fuel at 21 degrees C (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Chemical Resistance to Motor Oils at 21 degrees C (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Chemical Resistance to Skydrols at 21 degrees C (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Hardness (ASTM D2240:Shore A)	20
Tensile Strength (ASTM D412) (or ASTM D638)	1.0 MPa
Percent Elongation (ASTM D412) (or ASTM D638)	500 percent
Tack Free at 18.3 degrees C (ASTM C679)	12 hours maximum
Adhesion to Concrete	0.96 MPa
Adhesion to Urethane Topcoats (paintable sealant)	0.96 MPa
NOTES: (1) Immerse and test a minimum of three 50 mm by 12.5 mm by 12.5 mm sections of cured sealant.	

TABLE I - MATERIALS REQUIREMENTS

TABLE Ia

Test	Minimum Requirement (maximum where indicated)
Sealant System (two-pack: self-leveling)	Polysulfide (Manganese Cure; MnO2) or Urethane
Percent Volume Solids	100 percent
Chemical Resistance to JP-8 plus 100 Fuel at 70 degrees F (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Chemical Resistance to Motor Oils at 70 degrees F (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Chemical Resistance to Skydrols at 70 degrees F (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Hardness (ASTM D2240: Shore A)	20
Tensile Strength (ASTM D412) (or ASTM D638)	150 psi
Percent Elongation (ASTM D412) (or ASTM D638)	500 percent
Tack Free at 65 degrees F (ASTM C679)	12 hours maximum
Adhesion to Concrete	140 psi
Adhesion to Urethane Topcoats (paintable sealant)	140 psi

NOTES: (1) Immerse and test a minimum of three 2 inch by 1/2 inch by 1/2 inch section of cured sealant.

TABLE II
Reporting Program Requirements QA/QC
Administrative Controls:
Administrators must be able to turn on and off unique access to specific jobs and Contracts.
Administrators must be able to remotely enable and disable access for users.
All enabled users must view the same active report in real time. There must be no opportunity for multiple versions of the same report to exist.
Administrators must be able to setup unique approval processes for each project and promote or remove unique people from this process at any time.
Administrators must be able to associate Contract specific documents and specification limits quickly and easily.
Administrators must be able to associate PDS, SDS, blueprints, scope of work and Contracts uniquely to each job.
Objectivity Controls:
Data Entry fields must be by multi-selectable choices, numeric keypads, pickers and skip logic to ensure repeatable data entry in a way that makes running analytics and metrics easy and objective.
The program / hardware package must be able to communicate with inspection devices that provide (batch) data export capability such as Elcometer and Defelsko gages.
The program / hardware package must automatically time, date and GPS stamp all reports without input or interference from the inspector.
Real Time Syncing:
Forms must be available for approved associates to view at all times.
Retrievable storage must be provided for all job related reports and documents for a minimum time of 5 years from completion of the job or project. Archiving of the documents after 5 years will be the responsibility of the Government.
Document Library:
All reports must be in searchable and annotatable PDF format.
The Administrator must be able to upload and annotate job specific reports in real time. Examples include but not limited to Safety Data Sheets, Product Data Sheets and Blueprints.

TABLE II
Annotations and modifications must be locked and associated with the document. Only the Administrator has rights to modify or delete annotations or allow modifications to the document library especially all related inspection reports.
Customization:
The program must be capable of being customized to specific jobs, Contracts or specifications.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 67 23.16 (February 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 67 23.16 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 67 23.16

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02/21

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PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-09 67 23.16 (February 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 67 23.16 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 67 23.16

FUEL RESISTIVE RESINOUS FLOORING, 5-COAT SYSTEM

02/21

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NOTE: This guide specification covers the requirements for a five-coat, epoxy mortar flooring system with reflective urethane topcoats, slip resistance, and joint work.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: This guide specification contains tailoring options for Army and Navy projects. Where an Editor's Note states a paragraph is tailored for a Service or project type, the content of the paragraph, or a portion of the paragraph, is suited specifically to be included only for that Service or project type.

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NOTE: The designer must not alter the products or processes specified herein without thorough knowledge of the need for the changes and the implications of those changes. Use of alternate coating systems must be justified by evaluating

lifecycle costs using 50 year life as a baseline.
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NOTE: The epoxy mortar flooring system is appropriate for use in: aircraft maintenance hangars, equipment maintenance shops, jet engine test cells, and all other industrial floors where resistance to impact, abrasion, and fuel is required. Benefits: Tolerates high Moisture Vapor Emission (MVE) rates, produces a level surface over coarse concrete, high impact resistance, good chemical resistance, and may provide a suitable topcoat base for more than 10 years service. Can be rejuvenated by replacing urethane topcoats, and non-skid, only. Approximate service life: Urethane topcoating with non-skid grit at three or more years. The flooring system is neither conductive nor Electro-Static Dissipative (ESD), however, either formulation is easily designed upon request. This specification is not for use in overcoating existing sound coating systems.
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NOTE: Prior to the flooring systems installation, a concrete condition assessment in accordance with the Naval Facilities Engineering Service Center's (NFESC) Users Guide (UG)-2036-SHR is highly recommended. The condition assessment is designed to identify problem floors and eliminate premature flooring failures produced by: 1) Coating concrete with low surface strength, 2) coating concrete with high surface contamination levels (such as oils, fuels, fats, and waxes), and 3) coating concrete with a high Moisture Vapor Emission (MVE) rate. The thin film flooring system is suitable for application to: A) "Smooth" or "Coarse" concrete surface textures, B) concrete with a MVE rate no more than 254 micrograms moisture per second, square meter 4.5 pounds moisture per 24 hours, 1000 square feet (ASTM F1869), C) concrete with surface strength greater than 1.34 MPa 200 psi (ASTM D4541), and D) concrete with fuel/oil contamination to a depth no more than 6.25 mm 1/4 inch.
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NOTE: If a concrete floor has a Moisture Vapor Emission (MVE) rate more than 254 micrograms moisture per second, square meter 4.5 pounds moisture per 24 hours, 1000 square feet (ASTM F1869), apply a layered Moisture Reducing System (MRS) prior to the epoxy mortar flooring system application. Use MRS compatible with the submitted flooring system and approved / warranted by the epoxy mortar flooring system manufacturer. Apply the MRS to shot blasted concrete and reduce the MVE rate to less than 254 micrograms moisture per

second, square meter 4.5 pounds moisture per 24 hours, 1000 square feet. MRSs can employ combinations of concrete sealers, specific epoxies, and moisture insensitive grouts, with or without mesh.

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NOTE: Include Section 03 01 00 REHABILITATION OF CONCRETE for minor spalls and surface deterioration repair to depths less than three inches. Specify epoxy mortar for repairs to depths no more than 50 mm 2 inches. Specify epoxy concrete for repairs to depths from 25 to 75 mm 1 to 3 inches. Saw cut repairs to depths greater than 25 mm 1 inch to a rectangular geometry. Finish repairs to resemble surrounding concrete using a stainless steel trowel.

Include Section 32 01 29.61 PARTIAL DEPTH PATCHING of RIGID PAVING for repair of large spalls and severe deterioration to depths from 75 to 150 mm 3 to 6 inches. Specify Portland Cement Concrete (PCC) with less than 0.45 water-cement ratio, light steel trowel finish, and cure using plastic coated burlap. Use rectangular geometry for repairs with saw cut edges to a nominal repair depth of 150 mm 6 inches. Cure PCC repair for approximately 30 days prior to the application of the flooring system. Do not cure repairs using liquid membrane-forming compounds.

For repairs to spalls and severely distressed concrete to depths greater than 150 mm 6 inches, seek material guidance from Section 03 30 00 CAST-IN-PLACE CONCRETE and procedural guidance from the American Concrete and Pavement Association (ACPA) Guideline TB-002.02P "Concrete Paving Technology - Guidelines for Full Depth Repair." Fill repair base with a minimum of 50 mm 2 inches of clean, non-reactive concrete sand over a suitable vapor retarder (0.25 mm 10 mils polyethylene sheeting). Finish repairs by light steel trowel and cured using plastic coated burlap. Cure repairs for approximately 30 days, or more, prior to the the flooring system application. Do not cure repairs using liquid membrane-forming compounds.

Scarify level any curled or settled slab ends with joint surfaces displaying more than 3.2 mm 1/8 inch difference in vertical height. Resulting surfaces must contain a height difference no more than 1.5 mm 1/16 inch and a surface texture equal to ICRI-310.2R CSP 4.

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NOTE: Include Section 03 30 00 CAST-IN-PLACE CONCRETE for new concrete slab construction. Employ measures to control the base, subbase, and subgrade

moisture Moisture Vapor Emission (MVE) rates to total no more than 169.0 micrograms moisture per second, square meter 3.0 pounds moisture per 24 hours, 1000 square feet when measured on the slab's surface (ASTM F1869). Improper MVE controls have produced numerous premature coating failures. In addition to appropriate subbase drainage, specify a minimum of 50 mm 2 inches of clean, non-reactive concrete sand over no less than 0.25 mm 10 mils of polyethylene sheeting (ASTM D4397) with sealed lap joints. Specify concrete mix to be free of accelerators containing calcium chloride and other sources of chloride ion contamination. Specify two passes of a light power troweled finish and cure using plastic coated burlap or equal method. Do not cure concrete using liquid membrane-forming compounds. Do not specify surface hardeners or dry shake finish (Section 09 97 23 METALLIC TYPE CONDUCTIVE/SPARK RESISTANT CONCRETE FLOOR FINISH). Approximately 60 days following the concrete pour and prior to the flooring system installation, test concrete for the MVE rate and confirm rate is no more than 254 micrograms moisture per second, square meter 4.5 pounds moisture per 24 hours, 1000 square feet (ASTM F1869). Consult ACI 224.3R "Joints in Concrete Construction," ACI 302.1R "Guide for Concrete Floor and Slab Construction," ACI 360R "Design of Slabs on Grade," and other appropriate construction guidance.

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NOTE: Where tile is to be removed prior to the flooring system application, test both tile and mastic for the presence of asbestos. If asbestos is detected, include Section 02 82 00 ASBESTOS REMEDIATION for removal and disposal.

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NOTE: If flooring system is to be applied to warehouse floors with heavy forklift traffic, a semi-flexible joint sealant is required in lieu of the specified flexible sealant. Use a semi-flexible epoxy sealant with approximately 90 percent elongation. Do not use semi-flexible sealants in areas exposed to exterior temperatures.

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NOTE: Include Section 01 45 00 QUALITY CONTROL, as applicable.

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NOTE: Include Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. This section defines fugitive dust, generated waste, hazardous materials, hazardous substance, hazardous waste, solid waste,

construction and demolition (CD) debris, and liquid waste, and contains documentation for dangerous waste profile, waste information sheet, waste identification document, waste generation record, landfill disposal form, and hazardous material reporting.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C679	(2015; R 2022) Standard Test Method for Tack-Free Time of Elastomeric Sealants
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings

ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D6237	(2019) Standard Guide for Painting Inspectors (Concrete and Masonry Substrates)
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI 310.2R	(2013) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems-Requirements

MASTER PAINTERS INSTITUTE (MPI)

MPI 208	(2020) Floor Coating, Thick Film, Primer, for Aircraft Maintenance Facilities
MPI 209	(2020) Floor Coating, Thick Film, Epoxy Mortar, For Aircraft Maintenance Facilities
MPI 210	(2020) Floor Coating, Thick Film, Grout Coat, For Aircraft Maintenance Facilities
MPI 212	(2018) Floor Coating, Thin Film, for Aircraft Maintenance Facilities

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC QP 5	(2022) Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies
SSPC QP 8	(2015) Standard Procedure for Evaluating the Qualifications of Contracting Firms that Install Polymer Coatings, Surfacings, Linings or FRP Composites on Concrete and Other Cementitious Substrates
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC-TU 2/NACE 6G197	(1997) Design, Installation, and Maintenance of Coating Systems for Concrete Used in Secondary Containment

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection

29 CFR 1910.1000	Air Contaminants
29 CFR 1926.59	Hazard Communication

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Joint Sealant; G, [_____]

Epoxy Mortar Flooring System; G, [_____]

White Aluminum Oxide Non-Skid Grit; G, [_____]

SD-05, Design Data

Environmental Control System

SD-06 Test Reports

Joint Sealant Test Report; G, [_____]

Primer Coat; G, [_____]

Epoxy Mortar Coat; G, [_____]

Grout Coat; G, [_____]

Urethane Topcoat; G, [_____]

White Aluminum Oxide Non-Skid Grit; G, [_____]

Patch Test Demonstration; G, [_____]

Daily Inspection Report; G, [_____]

Adhesion Testing; G, [_____]

SD-07 Certificates

Coating Work Plan; G, [_____]

Qualifications of Coating Contractors; G, [_____]

Joint Sealant Certificates; G, [_____]

Epoxy Mortar Flooring System Certificates; G, [_____]

Qualifications of Certified Industrial Hygienist (CIH)

Qualifications of Certified Protective Coatings Specialist (PCS)

Qualifications of Coating Inspection Company

Qualifications of QC Specialist Coating Inspector

Warranty; G, [_____]

SD-08 Manufacturer's Instructions

Joint Sealant Manufacturer's Instructions; G, [_____]

Epoxy Mortar Flooring System Manufacturer's Instructions; G, [_____]

Water-Based Alkaline Degreaser; G, [_____]

SD-11 Closeout Submittals

Inspection Logbook; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Qualifications of Certified Protective Coatings Specialist (PCS)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third-party PCS. Submit documentation that the specialist is certified by SSPC: The Society for Protective Coatings (SSPC) as a PCS, including certification number and date of certification/recertification. If the PCS is employed by the same coating inspection company to which the coating inspector is employed, this does not violate the independent third-party requirements. The PCS must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. The PCS must not be the designated coating inspector.

1.3.2 Coating Work Plan

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NOTE: For maintenance painting, add requirement for pre-work determination of the existing surface condition. If paint removal is specified in another Section include this evaluation such that the paint removal operation does not create excessive profile.

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a. Include coating Work Plan in Quality Control Plan.

b. Provide procedures for reviewing Contract Documents immediately after award to identify errors, omissions, and discrepancies so that any such issues can be resolved prior to project planning and development of detailed procedures.

c. Provide procedures for verification of key processes during Initial Phase to ensure that Contract requirements can be met. Key processes must include surface preparation, coating application and curing, inspection, and documentation, and any other process that might adversely impact orderly progression of work.

d. Provide procedures for all phases of coating operations, including planned work, rework, repair, inspection, and documentation. Address mobilization and setup, surface preparation, coating application, coating initial cure, tracking and correction of non-compliant work, and demobilization. Coordinate work processes with health and safety plans and confined space entry plans. For each process, provide procedures that include appropriate work instructions, material and equipment requirements, personnel qualifications, controls, and process verification procedures. Provide procedures for inspecting work to verify and document compliance with Contract requirements, including inspection forms and checklists, and acceptance and rejection criteria.

e. [Provide procedures for determining the existing surface profile under paint, and procedures for ensuring that the profile is not increased beyond the maximum profile specified herein.][_____]

f. Provide procedures for correcting non-compliant work. Detailed procedures are required in advance to avoid delays in meeting overcoat windows as well as to avoid delays in production. Provide procedures for repairing defects in the coating film, such as runs, drips, sags, holidays, overspray, as well as how to correct coating thickness non-compliance, any other areas of repair or rework that might be adversely affected by delays in preparing and approving new procedures.

g. If a procedure is based on a proposed or approved request for deviation, the deviation must be referenced. Changes to procedures must be noted by submittal number and date approved, clearly delineating old requirements and new requirements, so that the records provide a continuous log of requirements and procedures.

1.3.3 Design Data

1.3.3.1 Environmental Control System

Submit design details of the proposed environmental control system to include ventilation, humidity control, and temperature regulation. Provide calculations for humidity control during separate surface preparation and coating application procedures, ventilation requirements during coating application, and maximum allowable coating application rates to coincide with ventilation. Include basis of design data on local conditions. Provide equipment layout sketches and procedures showing function of each piece of equipment and fail-safe measures. A Certified Industrial Hygienist must approve calculations, work procedures and personal protective equipment.

1.3.4 Test Reports

1.3.4.1 Joint Sealant Test Report

Submit test results that confirm sealant complies with Table Ia requirements. Samples must have been tested within the last three years.

1.3.4.2 Daily Inspection Report

Submit one copy of the daily inspection report to the Contracting Officer within 24 hours of the date recorded.

1.3.5 Certificates

1.3.5.1 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party CIH. Submit documentation that hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. Provide evidence of experience with hazards involved in industrial coating application work.

1.3.5.2 Qualifications of Certified Protective Coatings Specialist (PCS)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third-party PCS. Submit documentation that specialist is certified by SSPC: The Society for Protective Coatings (SSPC) as a PCS, including certification number and date of certification/recertification. If the PCS is employed by the same coating inspection company to which the coating inspector is employed, this does not violate the independent third-party requirements. The PCS must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. The PCS must not be the designated coating inspector.

1.3.5.3 Qualifications of Coating Inspection Company

Submit documentation that the coating inspection company performing all coating inspection functions is certified by SSPC to the requirements of

SSPC QP 5 prior to Contract award. The approved coating inspection company must remain and not be changed through completion of the Contract. The coating inspection company must remain so certified for the duration of the project. If a coating inspection company's certification expires, the firm will not be allowed to perform any inspection functions, and all surface preparation and coating application work must stop, until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered. Notify the Contracting Officer of any change in coating inspection company certification status. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from SSPC and furnish a copy of all inspection reports.

1.3.5.4 Qualifications of QC Specialist Coating Inspector

Submit documentation that each coating inspector is employed, and qualified to SSPC QP 5, Level II, by the selected coating inspection company. Each inspector must remain employed by the coating inspection company while performing any coating inspection functions. In addition to the handwritten records, the inspector must employ an electronic reporting program with functionality as outlined in Table II. The Administrator must be the designated Government Representative for the project.

1.3.5.5 Qualifications of Coating Contractors

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NOTE: Solicitations requiring certification for prequalification should point out the existence and location of the certification requirement on the PROJECT INFORMATION FORM. This requirement must be included in the solicitation documents for the "prior to Contract award" requirement to be enforceable. Certification is a special responsibility requirement pursuant to FAR 9.104-2 Special Standards. This is analogous to requiring bidders to have a specified level of experience or expertise and GAO has sustained these types of special requirements.

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All Contractors that perform surface preparation or coating application must be certified to SSPC QP 8 and should also be SSPC QS 1 certified prior to Contract award and must remain certified while accomplishing any surface preparation or coating application. The painting Contractors must remain so certified for the duration of the project. If a Contractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site audits from SSPC and furnish a copy of all audit reports.

[For OCONUS, non-US territories where documentation is provided that certified SSPC QP 8 with or without SSPC QS 1 Contractors did not bid and are not available, all Contractors that perform surface preparation or coating application must be certified to ISO 9001 prior to Contract award, and must remain certified while accomplishing any surface preparation or coating application. If a Contractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from the ISO certifying organization and furnish a copy of all inspection reports.

][Minimum requirements for the installation Contractor are as follows: Completed three or more jobs within the past two years applying the specified materials to concrete surfaces in which the total area exceeds 18 587 square meters 200,000 square feet. Submit documentation listing location of work, point of contact at job site, total square footage of applied materials, listing of both materials and equipment used, and validation from coating manufacturer documenting quality of materials purchased per job for work totaling 18,587 square meters 200,000 square feet within the past two years. In addition to the above requirements, installation Contractor must be certified by the material manufacturer(s) to install the submitted coatings and sealant. Submit copy of certificates.

]1.3.5.6 Joint Sealant Certificates

Submit literature documenting the sealant's past performance in automotive or aircraft maintenance shops. Minimum requirements are two or more maintenance shops with joint work totaling 3048 linear meters 10,000 linear feet whereby the sealant has performed for two years with less than one percent combined sealant failures and defects. Include from sealant manufacturer a list of shop locations, total linear feet of sealant applied per shop, shop point of contact, date sealant was applied, and the name of the installed sealant material.

1.3.5.7 Epoxy Mortar Flooring System Certificates

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NOTE: Use bracketed option when MPI certified products cannot be obtained.

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Provide manufacturer's certification of conformance to Contract requirements.

[Submit literature documenting the coating system's past performance in aircraft maintenance shops and over floors with high Moisture Vapor Emission (MVE) rates. Minimum requirements are two or more aircraft maintenance shops totaling 3160 square meters 34,000 square feet where the coating system has performed for two years with less than 0.05 percent combined premature coating failures, material defects and surface discoloration; no more than 0.03 percent discoloration from aviation chemicals, tire plasticizers, and UV exposure. Provide a minimum of two additional case histories where successful installation occurred on floor slabs with no less than 254 micrograms moisture per second, square meter 4.5 pounds moisture per 24 hours, 1000 square feet. Include from flooring manufacturer a list of shop locations, total coated area per shop, shop point of contact, date coating system was applied, successful installation to concrete with high MVE, and the names of the installed coating materials.

]1.3.6 Product Data

1.3.6.1 Joint Sealant Manufacturer's Instructions

Submit manufacturer's printed instructions to include detailed application procedures, minimum and maximum application temperatures, and curing procedures. In accordance with 29 CFR 1926.59, include Safety Data Sheets (SDS) for the sealant to be used at the job site.

1.3.6.2 Epoxy Mortar Flooring System Manufacturer's Instructions

Submit manufacturer's printed instructions to include detailed mixing, minimum and maximum application temperatures, acceptable atmospheric and interior climatic conditions, application procedures, curing procedures, and procedures for flooring system maintenance cleaning. Provide explicit instructions detailing surface preparation, recoat windows and remedial actions in case recoat windows are missed, and, if applicable, solvent-wiping between coats with acceptable types and grades of solvents. In accordance with 29 CFR 1926.59, include SDSs for the coatings to be used at the job site.

1.3.6.3 Water-Based Alkaline Degreaser

Submit manufacturer's printed instructions to include detailed mixing, dilution rate, application procedures, and rinsing procedures. In accordance with 29 CFR 1926.59, include SDSs for the water-based alkaline degreaser to be used at the job site.

1.4 DELIVERY, STORAGE, AND HANDLING

Store coatings and sealant in spaces with temperatures from 5 to 24 degrees C 40 to 75 degrees F. Inspect materials on site for damage prior to use. Return to manufacturer any packaged materials in dented, rusty, or leaking containers. Return to manufacturer materials with an expired shelf life for testing, and if compliant, reissuing of shelf life extension.

1.5 COATING HAZARDS

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NOTE: Include either Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS or prepare instructions detailing each safety element for use with this section.

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Ensure that employees are trained in all safety plan aspects. Follow the coating manufacturer's written safety precautions throughout mixing, application, and curing of coatings. Comply with respiratory protection requirements in 29 CFR 1910.134 and safe levels of airborne contaminants in 29 CFR 1910.1000.

1.6 JOB SITE REFERENCES

Make available to the Contracting Officer at least one copy each of ASTM D4541, ASTM D6237, SSPC-TU 2/NACE 6G197, and ICRI 310.2R, including replica standards ICRI 310.2R-CSP 1 through CSP 9, at the job site.

1.7 PATCH TEST DEMONSTRATION

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NOTE: Patch test demonstration is a very important part of the submittal process. While it is unusual to require a test patch prior to the submitted materials' approval, this flooring system is unusual in that it is required to perform significant tasks for a long time. Proof of Contractor claims, especially under conditions to be encountered in the specific project, is considered necessary.

If customer is not satisfied with the non-skid grit level, adjustments to the specification can be made. Grit coarser than No. 60 aluminum oxide is not recommended. On architectural floors, non-skid grit broadcast rates can range from none to approximately half the specified level. To confirm grit broadcast is acceptable, walk on cured patch test under both dry and wet conditions. Water can be used to simulate the wet condition.

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Prior to the submitted flooring system's approval, apply the complete flooring system to a 3 meter by 3 meter10 foot by 10 foot square concrete section as prepared in accordance with PART 3 EXECUTION. Within this area, perform three adhesion tests using procedures as detailed in the paragraph ADHESION TESTING. If adhesion testing produces cohesive failures within the concrete, no less than 1 mm 40 mils concrete removed over 95 percent of each pull-off coupon,or adhesion more than 2.75 MPa 400 psi, patch test adhesion is acceptable. If concrete surface preparation was insufficient, apply an additional coating system patch to properly prepared concrete followed by the above adhesion testing. If adhesion results are unacceptable for both the topcoat and the coatings below the grout coat, submit a new coating system manufactured by a different coating vendor. Apply new coating system to a patch and subject this patch to the above requirements for adhesion prior to approval. If customer is not satisfied with the non-skid grit application, adjustments to the specifications can be made. Grit coarser than No. 60 aluminum oxide is not recommended. Immediately following "passing" adhesion results, remove urethane topcoats and grout coat by sanding, repair patch test holes using epoxy mortar, and place a "Key-In Termination" adjacent to patch test perimeter. Perform coarse scarification or pneumatic scabbling as required to remove patch tests failing to meet adhesion requirements.

1.8 WARRANTY

Warranty materials and workmanship for a minimum of one year following completion of flooring and sealant application. The following terms and conditions form a part of the warranty: If the applied coating system develops blisters (chemical), checks, softening, or lifting within one year following application, rework each area at Contractor's expense. The following conditions are excluded from the warranty: A) Concrete cracking, flooring system mirrors cracks in concrete, B) cosmetic imperfections due to scratching and gouging, C) application to metallic concrete finishes (Section 09 97 23 METALLIC TYPE CONDUCTIVE/SPARK RESISTANT CONCRETE FLOOR FINISH), and D) application to concrete with a MVE rate greater than 282 micrograms moisture per second, square meter 5.0 pounds moisture per 24 hours, 1000 square feet. If the coating system's adhesion is in question, perform one adhesion test per 9.3 square meters 100 square feet as described in the paragraph ADHESION TESTING. To satisfy the warranty, adhesion testing must produce cohesive failures within the concrete, concrete removal over 95 percent of each pull-off coupon, or adhesion no less than 2.8 MPa 400 psi. Each area failing to meet adhesion requirements requires two additional adhesion tests to confirm results. Within the warranty period, remove to sound material and rework all areas unable to meet adhesion requirements. There must be zero percent sealant failures within one year. Within the warranty period, remove and rework all sealant material that has chemically attacked surfaces or lifting from joint walls. Topcoat cracking over sealant is excluded from warranty.

PART 2 PRODUCTS

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NOTE: The specified materials are not appropriate for use in primary chemical containment, secondary chemical containment, or on floors subjected to spills from concentrated acids, bases, and organic solvents. Consult with the Naval Facilities Engineering and Expeditionary Wareface Center's (NAVFAC EXWC) Paints and Coatings Center of Expertise for alternative coating systems to suit specific Navy needs. The system must be provided by a single manufacturer or have proven compatibility.

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NOTE: Tables Ia and II are presented at the end of PART 3 EXECUTION.

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2.1 JOINT SEALANT

Formulate the joint sealant to exhibit the properties as listed in Table Ia.

2.2 EPOXY MORTAR FLOORING SYSTEM

A five-coat flooring system consisting of primer, epoxy mortar, grout coat, and two urethane topcoats. Apply the system at a nominal thickness of 6.25 mm 1/4 inch and contain an aluminum oxide non-skid grit broadcast. Additional requirements for primer coat, epoxy mortar, grout coat, and urethane top coat are contained in the following sub-paragraphs.

2.2.1 Primer Coat

In addition to the epoxy mortar flooring system requirements, use MPI 208 primer coat.

2.2.2 Epoxy Mortar Coat

In addition to the epoxy mortar flooring system requirements, use MPI 209 epoxy mortar coat compatible with MPI 208, MPI 210, and MPI 212.

2.2.3 Grout Coat

In addition to the epoxy mortar flooring system requirements, use MPI 210 grout coat compatible with MPI 208, MPI 209, and MPI 212.

2.2.4 Urethane Topcoat

In addition to the epoxy mortar flooring system requirements, use MPI 212 topcoat compatible with MPI 208, MPI 209, and MPI 210.

2.3 WHITE ALUMINUM OXIDE NON-SKID GRIT

Size No. 60, dust-free (washed and dry), minimum 99 percent pure, having the following sieve analysis when tested using a 1000 gram 2.2 pound sample (ASTM E11):

Sieve No. 40	100 percent passing
Sieve No. 50	15-30 percent retained
Sieve No. 60	70-85 percent retained
Sieve No. 70	0-15 percent retained

PART 3 EXECUTION

3.1 COATING SAMPLE COLLECTION

The Contracting Officer and QC Manager must witness all material sampling. Notify the Contracting Officer a minimum of three days in advance of sampling. Obtain liquid samples of each component (e.g., primer, intermediate, grout coat, topcoat) by random selection from sealed containers and in accordance with ASTM D3925. Samples may be either individual cans of liquid material or 1.0 liter 1.0 quart quantities of properly mixed, extracted, and sealed liquid material. Label samples by designated name, specification number, batch number, project Contract number, sample date, intended use, and quantity involved. When the applied epoxy mortar system has met the requirements defined in the paragraph ADHESION TESTING, return coating samples to the installation contractor for proper disposal.

[3.2 TILE AND TILE ADHESIVE REMOVAL

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NOTE: Delete this Article if concrete is not tiled.

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Remove 100 percent of tile employing one or more of the following techniques: chipping, scraping, sanding, scarification, high-pressure water, and various hand tools. Remove 100 percent of the tile adhesive using solvents and power scrubbing. Remove residual contamination using hot potable water under a minimum of 27.6 MPa 4,000 psi. Resulting surfaces must appear clean and display the gray color of concrete.

]3.3 JOINT MATERIAL REMOVAL, RE-SAW CUTTING, CRACK CHASING

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NOTE: Hairline cracks having no more than 3.2 mm 1/8 inch width are typically not repaired. However, cracks greater than 3.2 mm 1/8 inch width can be chased to a minimum depth of 12.5 mm 1/2 inch and sealed using the procedures and materials specified for joints. Cracks more than 18.75 mm 3/4 inch

width can be repaired using either epoxy mortar or epoxy concrete. Sealed cracks will assist in protecting the subbase against chemical migration.
****

Remove 100 percent of the existing material in all joints including material bonded to joint walls and base. Rigid material may require saw cutting equipment to remove. Joints may be widened up to 3.2 mm 1/8 inch when re-saw cutting. Hairline cracks having no more than 3.2 mm 1/8 inch width are typically not repaired. Cracks greater than 3.2 mm 1/8 inch width can be chased to a minimum depth of 12.5 mm 1/2 inch and sealed using the procedures and materials specified for joints. Cracks more than 18.75 mm 3/4 inch width can be repaired using either epoxy mortar or epoxy concrete. Chase concrete cracks identified for repair and open to a minimum depth of 12.5 mm 1/2 inch below crack surface resulting in crack(s) with smooth vertical walls.

3.4 DEGREASING

On both previously coated and uncoated concrete, degrease entire floor by scrubbing using a hot potable water solution, 49 to 77 degrees C 120 to 170 degrees F, and a concentrated water-based alkaline degreaser. Perform two complete degreasing cycles on the entire floor surface. Allow solution to soak into surfaces prior to scrubbing and remove using hot potable water under a minimum of 27.6 MPa 4,000 psi. Rinsing must be complete when the rinse water appears clear. If the industrial detergent is not biodegradable, collect all rinse water and dispose of as hazardous waste. Squeegees and shop vacuums may be used to collect pooling rinse water. Fans may be used to aid drying of floor surfaces.

[3.5 COATING SYSTEM REMOVAL

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NOTE: Delete this Article if concrete is uncoated.
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Remove 100 percent of the existing coating system employing one or more of the following techniques: shot blasting, chipping, scraping, sanding, scarification, high pressure water blasting, and various hand tools. Impact tools such as scabblers may be used to remove unsound epoxy mortar flooring systems. In general, a coating system cannot be completely removed by shot blasting and, to attain 100 percent coating removal, requires a combination of the above techniques.

]3.6 SURFACE PREPARATION

Shot blast entire floor to produce a level of coarseness equal to ICRI 310.2R CSP 3. Overlap each shot blasting pass by 6.25 to 12.5 mm 1/4 to 1/2 inch. Add new shot to shot blasting equipment prior to blasting. Prepare concrete surfaces inaccessible to shot blasting, perimeter wall bases and under secured equipment, using a diamond disk grinding or light scarification to produce a level of coarseness equal to ICRI 310.2R CSP 2, ICRI 310.2R CSP 4, respectively. Resulting surfaces must appear clean and contain the appropriate surface coarseness level. If the resulting cleanliness level cannot be determined, place numerous drops of water on surfaces that appear contaminated. If the water drops soak into concrete, the surfaces are hydrocarbon contamination free (oils, grease, skydrol). If the water drops bead up and do not flatten out, surfaces require additional degreasing as detailed in the Article DEGREASING. Shot blasting coarse concrete or broom finished concrete can produce a coarseness level equal to ICRI 310.2R CSP 5: employ a best-effort attempt to minimize over-shot-blasting of coarse concrete. If coarse concrete is encountered, shot blasting to a level of coarseness equal to ICRI 310.2R CSP 5 is acceptable: however, extremely coarse concrete can require resurfacing prior to the flooring system's installation. Sweep, vacuum, and run a high powered magnet over all surfaces to be coated, including joints.

3.6.1 Concrete Masonry Units (CMU) Surface Preparation

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NOTE: Delete paragraph if epoxy mortar is not to be applied to the CMU wall bases.

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Remove 100 percent of coatings 100 mm 4 inches up the base of CMU walls adjacent the flooring space, and prepare surface by power grinding to a resulting level of coarseness equal to ICRI 310.2R CSP 2. If oils/grease are present, degrease in accordance with the Article DEGREASING.

3.7 COVE STRIP INSTALLATION

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NOTE: Delete paragraph if epoxy mortar is not to be applied to the CMU wall bases.

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Install a continuous cove strip at a nominal height of 100 mm 4 inches up each CMU perimeter wall base. Install a solvent-resistant cove strip using a solvent-resistant adhesive.

3.8 KEY-IN TERMINATIONS

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NOTE: If the epoxy mortar flooring system is to be applied up the CMU wall bases, a Key-In termination is not required adjacent these walls.

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Place the "Key-In" termination as detailed in SSPC-TU 2/NACE 6G197 Figure 8 at transition surfaces, directly below doorways, and adjacent walls, floor drains, drain grates (interior side), and all other obstructions embedded into the floor slab. The Key-In termination must contain one vertical wall at a depth from 9.4 to 15.6 mm 3/8 to 5/8 inch and, leading down to the resulting vertical depth, a sloped surface from 37.5 to 50 mm 1-1/2 to 2 inches. A hand held concrete saw can be used to cut the correct vertical depth followed by power tool grinding to create a sloped surface. Remove concrete dust by vacuuming.

3.9 CRACK REPAIRS

Use the "Elastomeric Underlayer Crack-Bridging Design" as detailed in SSPC-TU 2/NACE 6G197 Figure 7 over the surface of epoxy mortar filled cracks.

3.9.1 Install Bondbreaker

Install bondbreaker, either solvent-resistant bondbreaker tape or a 3.2 to 6.25 mm 1/8 to 1/4 inch No. 20-No. 40 mesh silica sand layer, to the base of previously chased cracks identified for repair. For cracks without a rigid base, install suitably sized fiberboard to a depth of 12.5 mm 1/2 inch below floor level and with bondbreaker over exposed fiberboard. Install bondbreaker to cover the crack's horizontal base and continuously span the entire crack length. Bondbreaker application prevents epoxy mortar from penetrating deep into cracks. Use bondbreaker tape no more than 150 microns 6 mils thick. In this application, the use of backer rod is prohibited.

3.9.2 Repair Cracks

Using the specified materials, prime interior crack walls and apply epoxy mortar directly into wet primer. Finish epoxy mortar level with floor and without feathered edges. When cured, remove mortar imperfections by sanding flush with adjacent concrete. Apply solvent-resistant tape parallel to each side of the mortar filled crack(s) at a minimum inner width of 100 mm 4 inches between tape. A 100 mm 4 inch inner tape width is generally suitable for cracks less than 12.5 mm 1/2 inch wide whereas cracks more than 12.5 mm 1/2 inch wide can require an inner tape width of 150 mm 6 inches. Apply 1 mm 1/24 inch of the specified sealant, in one coat, directly over filled crack(s) and spread flush with inner tape edges: a stiff bristled paintbrush can be used to spread the sealant. Use a Wet Film Thickness (WFT) gage to confirm sealant application is between 875 to 1125 microns 35 to 40 mils wet. Remove tape and allow sealant to cure a minimum of 24 hours prior to the epoxy mortar flooring system application. Sealant application above 1250 microns 50 mils dry will require removal and reapplication.

3.10 PRE-APPLICATION TESTING FOR CONTAMINATION

Spot check surfaces for oil/grease contamination using the water break test. At a rate of 5 tests per 95 square meters 1000 square feet place one to two water drops onto surfaces and observe for beading. Test all other surfaces that show visible signs of potential contamination. Perform additional degreasing to surfaces displaying water beading in accordance with Article DEGREASING.

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NOTE: At this point in the installation sequence, minor spalls and surface deterioration to depths less than 75 mm 3 inches can be repaired. Use epoxy mortar for repairs to depths no more than 50 mm 2 inches. Use epoxy concrete for repairs to depths from 25 to 75 mm 1 to 3 inches. Contain repairs to depths greater than 25 mm 1 inch in a rectangular geometry with saw cut edges. Finish repairs to resemble surrounding concrete using a stainless steel trowel. Include Section 03 01 00 REHABILITATION OF CONCRETE if concrete repairs if this nature are required.

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3.11 COATING APPLICATION

Prior to the flooring system application, vacuum flooring space and mark all joints.

3.11.1 Isolation (Expansion) and Construction Joint Treatment

Install into each isolation (expansion) and construction joint, a continuous length of round polyethylene backer rod flush with the floor's surface and under 30 percent compression.

3.11.2 Contraction Joint Treatment

Apply primer and epoxy mortar directly into all contraction joints. This quantity is in addition to the specified 6.25 mm 1/4 inch epoxy mortar thickness. This step may be performed either prior to, or during, the full epoxy mortar application.

3.11.3 Primer Application

Apply MPI 208 epoxy primer to flooring space at a minimum of 250 microns 10.0 mils wet. Do not prime previously installed patch test.

3.11.4 Epoxy Mortar Application

Apply MPI 209 epoxy mortar at 6.25 mm 1/4 inch directly into wet primer using a screed box or equal equipment. Finish open areas using a power trowel with stainless steel blades. Perimeter edges and adjacent equipment footings may require finishing by stainless steel hand trowel. Directly above areas with Key-In terminations and at a distance from 25 to 37.5 mm 1 to 1-1/2 inches away from the mortar's outer edge, slope the mortar down and flush with the concrete's surface. Terminate the resulting angle flush with the Key-In termination vertical cut. Apply epoxy mortar flush with previously installed patch test. Do not apply epoxy mortar onto patch test surface. When sufficiently cured, sand entire mortar surface. Resulting surface must appear level, contain uniform thickness, and be free of surface imperfections including trowel marks.

3.11.5 Primer Application to CMU Walls

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NOTE: Delete paragraph if epoxy mortar is not to be applied to CMU wall bases.

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When the epoxy mortar has sufficiently cured, prime approximately 100 mm 4 inches up base of CMU walls to cove strip and 50 mm 2 inches adjacent the wall's base using the specified primer.

3.11.6 Epoxy Mortar Application to CMU Walls

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NOTE: Delete paragraph if epoxy mortar is not to be applied to CMU wall bases.

****

Apply MPI 209 epoxy mortar directly into wet primer at 4.5 mm to 6.25 mm 3/16 to 1/4 inch. Use a cove trowel to create a rounded transition between floor surfaces and perimeter wall bases. When sufficiently cured, sand the base and 100 mm 4 inches up perimeter walls. Resulting finish must contain a rounded transition of uniform thickness between flooring surfaces and CMU walls. When sufficiently cured, sand mortar surfaces. Resulting surface must be free of surface imperfections including trowel marks.

3.11.7 Grout Coat Application

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NOTE: Select a grout coat color identical to the selected topcoat color, either white or ultra-light gray. Ultra-light gray is preferred to white.
****

Sweep and vacuum up residual dust from epoxy mortar sanding. Apply MPI 210 grout coat to epoxy mortar at a minimum of 250 microns 10 mils wet. Apply grout coat to previously install patch test. Where wall bases are used, extend coating up CMU wall. If the cured grout coat feels oily/greasy, an amine blush has occurred which requires removal. Consult the coating manufacturer to recommend an appropriate blush removal procedure. Epoxy amines can blush during cool temperatures with high humidity.

3.11.8 Grout Coat Sanding

Sand grout coat using 100 grit or finer sandpaper to a dull appearance with visible scratches. Resulting surface must appear 100 percent absent of gloss with zero shiny spots. Lightly sand perimeter edges and around equipment footings.

3.11.9 Saw Cutting and Sealing Joints

Use the "Conventional Sealed Joint" as detailed in Figure 1 of SSPC-TU 2/NACE 6G197 to seal each contraction and expansion joint. Take care to reduce contamination from saw cutting equipment and foot traffic. Limit floor access to essential Contractor personnel. When performing joint work, including saw cutting, suggest placing clean rolled cardboard adjacent joint surfaces to reduce coating system contamination.

3.11.9.1 Saw Cut Contraction Joints

Place saw cuts directly in the middle of each contraction joint 6.25 mm 1/4 inch wide, placed to a minimum depth of 31.2 mm 1-1/4 inches, and span the joint's entire length.

3.11.9.2 Saw Cut Isolation (Expansion) and Construction Joints

Place saw cuts to the isolation (expansion) and construction joint's original width and to a minimum depth of 31.2 mm 1-1/4 inches. Completely remove the epoxy mortar across the joint's width and further remove the previously installed backer rod.

3.11.9.3 Install Backer Rod

Install a continuous length of round, closed-cell polyethylene backer rod into each saw cut. For 12.5, 9.4 and 6.25 mm 1/2, 3/8 and 1/4 inch wide saw cuts, place backer rod to a depth of 9.4 mm 3/8 inch below the grout coat's surface the highest point on the backer rod. For expansion joint saw cuts greater than or equal to 18.8 mm 3/4 inch wide, place backer rod to a depth of 15.6 mm 5/8 inch below the grout coat's surface. Fit backer rod tight between joint walls under 30 percent compression and place using a backer rod tool. Remove and reinstall all backer rod that is the incorrect size or at the incorrect depth. Following backer rod installation, apply painter's tape to surfaces adjacent joints to protect from sealant.

3.11.9.4 Joint Sealant Application

Apply sealant directly into joints using a bulk-caulking gun. At room temperature, the resulting sealant application must exhibit a concave recess between 3.2 to 1.0 mm 1/8 to 1/24 inch below the grout coat's surface. Remove and reapply cured sealant remaining either flush or greater. Following sealant application, remove painter's tape and sealant drips on grout coat. Prior to topcoating, cure sealant a minimum of 24 hours.

3.11.10 Application of Topcoats

Apply two coats of MPI 212 urethane topcoat. Broadcast No. 60, white, aluminum oxide non-skid grit into the second urethane topcoat.

3.11.10.1 Non-Skid Grit Broadcast

****

NOTE: Aircraft hangars servicing light aircraft with weight less than 18,140 kg 40,000 pounds may require a higher non-skid grit loading. The additional grit will assist in towing aircraft under wet conditions; however, the additional grit will decrease coating aesthetics. Up to 450 grams 1.0 pounds per 9.3 square meters 100 square feet of additional non-skid grit can be required.

On either warehouse or architectural floors, considerably less non-skid grit may be appropriate. Broadcast rates can range from none to less than 450 grams 1.0 pound per 93 square meters 1000 square feet.

****

Broadcast non-skid grit at a rate of 680 grams 1.0 pound per 9.3 square meters 100 square feet into the second urethane topcoat and backroll. Map floor into 55.8 square meters 600 square foot sections where 4080 grams 9.0 pounds of non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 55.8 square meter 600 square foot section.

3.11.10.2 Grout Coat Cleaning

Inspect floor for shiny grease spots and, if detected, spot degrease using manufacturer approved solvent(s) with clean, lint-free rags. Sweep and vacuum up all residual dirt and dust. Solvent wipe all surfaces using solvent(s) and procedures as recommended by manufacturer of epoxy mortar flooring system.

3.11.10.3 First Topcoat

Apply a full coat of urethane topcoat at a spreading rate from 62.5 to 80 microns 2.5 to 3.2 mils Dry Film Thickness (DFT). Stripe coat perimeter edges and around equipment footings. Monitor and record a minimum of one Wet Film Thickness (WFT) reading per 55.8 square meters 600 square foot section of floor surface. Sealant is to be lightly coated.

3.11.10.4 Second Topcoat

Apply a second coat of urethane topcoat at a spreading rate from 62.5 to 80 microns 2.5 to 3.2 mils DFT. Stripe coat perimeter edges and around equipment footings. Monitor and record a minimum of one WFT reading per 55.8 square meters 600 square foot section of floor surface prior to broadcasting non-skid grit. When the correct WFT has been applied per 55.8

square meters 600 square feet of area, immediately and evenly broadcast non-skid grit into the second urethane topcoat and backroll in two directions. Test the adhesion of the epoxy mortar flooring system in accordance with the paragraph ADHESION TESTING.

3.11.10.5 Walkway Stripes and Grounding Rod Markings

Place the walkway stripe and grounding rod marker, if applicable, according to Government drawings. When the second topcoat is within its recoat window, apply a walkway stripe of the red/orange urethane topcoat at 75 microns 3.0 mils DFT. Lightly broadcast non-skid grit into the wet walkway stripe. Use solvent-resistant tape to protect the floor coating against stripe coat bleed. A thin clear coat of either epoxy or urethane may be required to prevent stripe coat bleed prior to the full application of the colored stripe coat. Completely hide the topcoat color with the red/orange stripe, in one coat. If insufficient hiding occurs, apply one additional walkway stripe coat. Apply grounding rod markings using similar procedures, urethane topcoat, and colors and size according to Government drawings.

3.12 CURING

Installed materials must cure and display performance equal to manufacturer's product literature. Remove and reapply improperly cured material.

3.13 FIELD QUALITY CONTROL

3.13.1 Coating Inspector

****

NOTE: Insert directly into Section 01 45 00 QUALITY CONTROL, as applicable, requirement for SSPC QP5 Level II Coating Inspector.

A) Modify Section 01 45 00 QUALITY CONTROL to include SSPC QP5 Level II Coating Inspector as follows:

1. In the Submittals Article, add submittal requirement "SD-07 Certificates," add "SSPC QP5 Level II Coating Inspector; G" and add the following paragraph below the addition of "SSPC QP5 Level II Coating Inspector; G."

2. Add the following to the table in the paragraph "QC Specialists Duties and Qualification:" under the heading "Qualification/Experience in Area of Responsibility," add "SSPC QP5 Level II Coating Inspector;" under the heading "Area of Responsibility," add "Surface preparation, flooring system installation, field tests, and field inspection;" and under the heading "Frequency" add "Full-time during surface preparation, flooring system installation, field tests, and field inspection."

3. Use SSPC QP5 Level II Coating Inspector on all flooring projects or, as a minimum, on flooring

projects with greater than 232.25 square meters 2,500 square feet.

B) Modify Section 01 45 00 QUALITY CONTROL to include SSPC QP5 Level II Coating Inspector as follows:

Add SSPC QP5 Level II Coating Inspector to paragraph CQC PERSONNEL and its associated Experience Matrix. The SSPC QP5 Level II Coating Inspector must be directly employed by the prime Contractor. Use the following for the Qualifications column:

The SSPC QP5 Level II Coating Inspector will act as QC Specialist.

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Consider the Coating Inspector a QC Specialist, working for the QC Manager, and be qualified in accordance with Section 01 45 00 QUALITY CONTROL. The Coating Inspector must be present during all field tests, surface preparation, flooring application, initial cure of the flooring system, and during all flooring repair work. The Coating Inspector must provide all tools/equipment necessary to perform field tests and inspection. The Coating Inspector is responsible for field tests and specified level of inspection.

3.13.2 Inspection

Document weather conditions, job site occurrences, and report conditions and occurrences potentially detrimental to the flooring system. The listed inspection requirements are in addition to the QC inspection and reporting requirements defined in Section 01 45 00 QUALITY CONTROL. The Coating Inspector must prepare a project reference sheet outlining all requirements, tests, test methods, and evaluation criteria, and hold regular meetings with Contractor personnel, including shot blasting operators and applicators, to review requirements/evaluation criteria for upcoming work prior to execution. At the start of coating operations and every hour following until daily work is complete, record air temperature, substrate temperature, and relative humidity. Following each coat application, inspect surfaces for improperly cured material, blisters, inadequate or excessive coating thickness, and other defects. Document each inspection, test, non-compliant area, and location of each non-compliant area. List evaluation method, evaluation criteria, areas requiring rework, and all other pertinent observations.

3.13.2.1 Daily Inspection Report

Submit to the Contracting Officer one copy of the daily inspection report completed each day when performing work under this Section. Use Appendix X1 "Inspection Checklist" of ASTM D6237 to monitor daily activity and to assist in preparing the daily inspection report. Note each non-compliant issue and each issue identified for rework in accordance with the QC documentation procedures in Section 01 45 00 QUALITY CONTROL. Use of forms containing entry blocks for all required data is encouraged. The data must be legible and presented in a professional format. Submit report within 24 hours of the report date.

3.13.2.2 Inspection Logbook

Maintain a continuous record of all activity related to this Section on a daily basis. A computer / software package as outlined in Table II is preferred to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information including photo documentation where appropriate. The designated Government Representative for the project is assigned the highest level Administrator privileges and only the Administrator must be able to modify reports. In areas where photography is not allowed the computer must come with verification that the camera / photo capability has been removed.

Alternatively, a continuous record of all activity related to this Section must be maintained in an Inspection Logbook on a daily basis. The logbook must be hard or spiral bound with consecutively numbered pages, and must be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information. Submit the original Inspection Logbook to the Contracting Officer upon completion of the of the project and prior to final payment.

3.13.2.3 Inspection Equipment

Use equipment in good condition, operational within its design range, and calibrated as required by the specified standard for each device.

3.13.3 Adhesion Testing

Perform a minimum of three modified adhesion tests (ASTM D4541) on the topcoat no less than forty-eight hours following application. Select three random flooring locations spaced a minimum of 6 meters 20 feet between each location. Vertically core completely through the epoxy mortar flooring system and a minimum of 9.4 mm 3/8 inch into concrete using a suitable drill fitted with a 25 mm 1 inch diameter core bit. Throughout coring, employ a best effort attempt to avoid fracturing and overheating both the mortar system and concrete: improper coring can affect adhesion results. Adhere directly to each cored surface's center a 18.75 mm 3/4 inch diameter pull-off coupon. Lightly sand test area flooring surface prior to attaching pull-off coupons containing a grit-blasted anchor profile. When pull-off coupon adhesive has sufficiently cured, test adhesion and evaluate results. If testing produces cohesive failures within the concrete, no less than 1 mm 40 mils concrete removed over 95 percent of each pull-off coupon, or adhesion more than 2.75 MPa 400 psi mortar system's adhesion is acceptable. If the above requirements are not satisfied, then perform one adhesion test per 9.3 square meters 100 square feet using the above procedures. Two additional tests will confirm results for each non-compliant area. Remove and rework all areas unable to meet adhesion requirements to sound material. Fill core holes using primer, sand-filled epoxy mortar, grout coat, and urethane topcoats. Finish resulting repairs flush with adjacent coatings, displaying an equivalent appearance.

3.14 FINAL CLEANUP

Following work completion, remove debris, equipment, and materials from site. Remove temporary connections to Government or Contractor furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

TABLE I

MATERIAL REQUIREMENTS

Table Ia - Sealant

Test	Minimum Requirement (maximum where indicated)
Sealant System (two-pack: self-leveling)	Polysulfide (Manganese Cure; MnO2) or Urethane
Percent Volume Solids	100 percent
Chemical Resistance to JP-8 plus 100 Fuel at 21 degrees C (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Chemical Resistance to Motor Oils at 21 degrees C (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Chemical Resistance to Skydrols at 21 degrees C (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Hardness (ASTM D2240: Shore A)	20
Tensile Strength (ASTM D412) (or ASTM D638)	1.0 MPa
Percent Elongation (ASTM D412) (or ASTM D638)	500 percent
Tack Free at 18.3 degrees C (ASTM C679)	12 hours maximum
Adhesion to Sand Filled Epoxy Polyamine	0.96 MPa
Adhesion to Urethane Topcoats (paintable sealant)	0.96 MPa

NOTES: (1) Immerse and test a minimum of three - 50 by 12.5 by 12.5 mm section of cured sealant.

TABLE I	
MATERIAL REQUIREMENTS	
Table Ia - Sealant	
Test	Minimum Requirement (maximum where indicated)
Sealant System (two-pack: self-leveling)	Polysulfide (Manganese Cure; MnO2) or Urethane
Percent Volume Solids	100 percent
Chemical Resistance to JP-8 plus 100 Fuel at 70 degrees F (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Chemical Resistance to Motor Oils at 70 degrees F (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Chemical Resistance to Skydrols at 70 degrees F (ASTM D1308) (see note 1)	48 hours immersion: 2.0 percent (max) weight increase, 5.0 percent (max) volume increase, 2.0 percent (max) weight loss
Hardness (ASTM D2240: Shore A)	20
Tensile Strength (ASTM D412) (or ASTM D638)	150 psi
Percent Elongation (ASTM D412) (or ASTM D638)	500 percent
Tack Free at 65 degrees F (ASTM C679)	12 hours maximum
Adhesion to Sand Filled Epoxy Polyamine	140 psi
Adhesion to Urethane Topcoats (paintable sealant)	140 psi
NOTES: (1) Immerse and test a minimum three - 2 by 1/2 by 1/2 inch section of cured sealant.	

TABLE II
Reporting Program Requirements QA/QC
Administrative Controls:
Administrators must be able to turn on and off unique access to specific jobs and Contracts.
Administrators must be able to remotely enable and disable access for users.
All enabled users must view the same active report in real time. There must be no opportunity for multiple versions of the same report to exist.
Administrators must be able to setup unique approval processes for each project and promote or remove unique people from this process at any time.
Administrators must be able to associate Contract specific documents and specification limits quickly and easily.
Administrators must be able to associate PDS, SDS, blueprints, scope of work and Contracts uniquely to each job.
Objectivity Controls:
Data Entry fields must be by multi-selectable choices, numeric keypads, pickers and skip logic to ensure repeatable data entry in a way that makes running analytics and metrics easy and objective.
The program / hardware package must be able to communicate with inspection devices that provide (batch) data export capability such as Elcometer and Defelsko gages.
The program / hardware package must automatically time, date and GPS stamp all reports without input or interference from the inspector.
Real Time Syncing:
Forms must be available for approved associates to view at all times.
Retrievable storage must be provided for all job related reports and documents for a minimum time of 5 years from completion of the job or project. Archiving of the documents after 5 years will be the responsibility of the Government.
Document Library:
All reports must be in searchable and annotatable PDF format.
The Administrator must be able to upload and annotate job specific reports in real time. Examples include but not limited to Safety Data Sheets, Product Data Sheets and Blueprints.

TABLE II
Annotations and modifications must be locked and associated with the document. Only the Administrator has rights to modify or delete annotations or allow modifications to the document library especially all related inspection reports.
Customization:
The program must be capable of being customized to specific jobs, Contracts or specifications.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 68 00 (November 2024)**

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Preparing Activity: USACE **Superseding**
UFGS-09 68 00 (November 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 68 00

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USACE / NAVFAC / AFCEC **UFGS-09 68 00 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-09 68 00 (November 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 09 68 00

CARPETING
11/24

****
NOTE: This guide specification covers the requirements for broadloom carpet, modular tile carpet, and entrance carpet.

This section is intended for floor coverings only, and should not be used to specify carpeting installed on wall or ceiling surfaces. Where carpeting is to be used on surfaces other than floors, refer to Section 09 72 00 WALLCOVERINGS.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC 16.1	(2023) Test Method for Colorfastness to Light: Outdoor
AATCC 107	(2013) Colorfastness to Water
AATCC 134	(2016) Electrostatic Propensity of Carpets
AATCC 165	(2013) Colorfastness to Crocking: Textile Floor Coverings - Crockmeter Method
AATCC 174	(2016) Antimicrobial Activity Assessment of New Carpets

ASTM INTERNATIONAL (ASTM)

ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM D297	(2015; R 2019) Rubber Products - Chemical Analysis
ASTM D1335	(2017; E 2018) Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2646	(2024) Standard Guide for Backing Fabric Characteristics of Pile Yarn Floor Coverings
ASTM D2859	(2016) Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
ASTM D3278	(2021) Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup

	Apparatus
ASTM D3574	(2017) Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams
ASTM D3676	(2013) Rubber Cellular Cushion Used for Carpet or Rug Underlay
ASTM D3936	(2021) Standard Test Method for Resistance to Delamination of the Secondary Backing of Pile Yarn Floor Covering
ASTM D5793	(2018) Standard Test Method for Binding Sites Per Unit Length or Width of Pile Yarn Floor Coverings
ASTM D5848	(2020) Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Coverings
ASTM D6859	(2011) Standard Test Method for Pile Thickness of Finished Level Pile Yarn Floor Coverings
ASTM D7330	(2015) Standard Test Method for Assessment of Surface Appearance Change in Pile Floor Coverings Using Standard Reference Scales
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F1869	(2023) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F2170	(2019a) Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CARPET AND RUG INSTITUTE (CRI)

CRI 104	(2015) Carpet Installation Standard for Commercial Carpet
CRI 105	(2015) Carpet Installation Standard for Residential Carpet
CRI GLP QM	(2017) Green Label Plus Quality Manual
CRI Test Method 103	(2015) Standard Test Method for the Evaluation of Texture Appearance Retention

of Carpet Standards Program

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2551	(2020) Textile Floor Coverings and Textile Floor Coverings in Tile Form-Determination of Dimensional Changes Due to the Effects of Varied Water and Heat Conditions and Distortion Out of Plane

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 253	(2011) Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source

NSF INTERNATIONAL (NSF)

NSF/ANSI 140	(2019) Sustainability Assessment for Carpet

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings
SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1630	Standard for the Surface Flammability of Carpets and Rugs (FF 1-70)

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

Carpet; G, [_____]

Textile Composite Carpet; G, [_____]

Carpet Cushion; G, [_____]

Recycled Content for Carpeting; S

Recycled Content for Fiber Cushion; S

Recycled Content for Rubber Cushion; S

Recycled Content for Polyurethane-Foam Cushion; S

Recycled Content for Textile Composite Carpet; S

Moldings; G, [_____]

Indoor Air Quality for Aerosol Adhesives; S

Indoor Air Quality for Non-Aerosol Adhesives; S

Indoor Air Quality for Concrete Primer; S

[Modular Carpet Tile Connectors; G, [_____]

] SD-04 Samples

Carpet; G, [_____]

Textile Composite Carpet; G, [_____]

Carpet Cushion; G, [_____]

Moldings; G, [_____]

Sustainable Product Certifications; S

SD-06 Test Reports

Moisture and Alkalinity Tests; G, [_____]

SD-07 Certificates

Indoor Air Quality for Carpet; S

Indoor Air Quality for Textile Composite Carpet; S

Indoor Air Quality for Fiber Cushion; S

Indoor Air Quality for Rubber Cushion; S

Indoor Air Quality for Polyurethane-Foam Cushion; S

SD-08 Manufacturer's Instructions

Surface Preparation

SD-10 Operation and Maintenance Data

Cleaning and Protection

Maintenance Service

SD-11 Closeout Submittals

Warranty

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

1.3.1.1 Floor Covering Materials

Provide carpet[,][and]cushion[, and textile composite carpet] products certified to meet indoor air quality requirements by UL 2818 (GreenGuard) Gold, SCS Global Services Indoor Advantage Gold, CRI GLP QM or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site in the manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size, dye lot number, and related information. Remove materials from packaging and store them in a clean, dry, well ventilated area (100 percent outside air supply, minimum of 1.5 air changes per hour, and no recirculation), protected from damage, soiling, and moisture, and strong contaminant sources and residues, and maintain at a temperature above 16 degrees C 60 degrees F for 2 days prior to installation. Do not store carpet or modular carpet tiles with materials which have high emissions of volatile organic compounds (VOCs) or other contaminants, including paints and adhesives. Do not store carpet near materials that may off gas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.5 AMBIENT CONDITIONS

Maintain areas in which carpeting is to be installed at a temperature above 16 degrees C 60 degrees F and below 32 degrees C 90 degrees F for 2 days before installation, during installation, and for 2 days after installation. Provide temporary ventilation during work of this section. Maintain a minimum temperature of 13 degrees C 55 degrees F thereafter for the duration of the contract.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties including minimum ten year wear warranty, two year material and workmanship and ten year tuft bind and delamination.

PART 2 PRODUCTS

2.1 CARPET

****

NOTE: If more than one carpet type is required for a project, use a separate paragraph for each carpet type. Designate each carpet type with a letter or number symbol. Use the same designations to key carpets to locations on the drawings and in Section 09 06 00 SCHEDULES FOR FINISHES.

ADA Requirements: Carpet must be securely attached; have a firm cushion, or backing, or no cushion; and have a level loop, textured loop, level cut pile, or level cut/uncut pile texture. The maximum thickness should be 13 mm 1/2 inch. Fasten exposed edges of carpet to floor surfaces and have trim along the entire length of the exposed edge.

Nylon fiber is typically abrasion resistant and durable in all pile configurations using filament fiber, has good stain removal characteristics, and is recommended for commercial installations.

Triexta (PTT) fiber is recommended for residential installations. Some PTT fiber made outside the US can be used in commercial applications, but specification of these products must comply with the

Buy America Act when applicable. Triexta is marketed as offering excellent durability, resiliency and crush resistance. Permanent stain resistance, bleach resistance and colorfastness built into the fiber helps to make triexta carpets easy to clean and can extend the life of the carpet. It is important to note that long term performance of triexta fiber has not yet been tested.

Polyethylene terephthalate (PET) recycled polyester fiber has permanent fade resistance, is permanently colorfast, has a permanent stain resistance which is higher than other type fibers, is impervious to harsh chemicals, and has the lowest static buildup. PET type polyester carpet, once crushed under continued high pressure, is less likely than nylon carpet to rebound. PET carpet is not recommended for severe and moderate wear level areas and should be limited to light wear areas.

Wool is a natural fiber, which is inherently flame resistant, forming a char that will neither melt nor drip. Wool is also rapidly renewable and resilient, and due to the scaly character of its fiber it scatters optical light, thus reducing soiling visibility. Wool is highly recommended for shipboard use due to it being inherently flame resistant.

Wool, cotton, jute, hemp and sisal carpets may not meet accepted performance requirements of commercial carpet. Verify suitability, availability and adequate competition before specifying these products.

Flexible and modular components, like carpet tile, reduce the labor and materials costs related to operations and maintenance, churn, and future renovations.

Continuous dye process uses two to three times less water than batch dyeing during manufacture.

****

Furnish first quality carpet that is free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Provide carpet materials and treatments as reasonably nonallergenic and free of other recognized health hazards. Provide a static control construction on all grade carpets which gives adequate durability and performance. Submit manufacturer's catalog data and printed documentation stating physical characteristics, durability, resistance to fading, and flame resistance characteristics for each type of carpet material and installation accessory. Submit manufacturer's Product Data for a.) Carpet, b.) Moldings, c.) Carpet Cushion, and d.) Textile Composite Carpet. Also, submit Samples of the following:

a. Carpet: [Two] [_____] "Production Quality" samples 450 by 450 mm 18 by

18 inches of each carpet proposed for use, showing quality, pattern, and color specified

b. Moldings: [Two] [_____] samples of each type minimum 300 mm 12 inches long

c. Carpet Cushion: [Two] [_____] samples minimum 150 by 150 mm 6 by 6 inches

[d. Textile Composite Carpet: [Two] [_____] samples minimum 450 by 450 mm 18 by 18 inches

]2.1.1 Recycled Content

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows the product is available from US national manufacturers above the minimum recycled content percentages shown below. Some manufacturers and regions have higher percentages. Based on research, insert desired minimum percentages into the empty set of brackets.

****

Carpeting must contain a minimum of [20][40][_____] percent recycled content. Provide data identifying percentage of recycled content for carpeting[and recycled content for textile composite carpet].

2.1.2 PFOS/PFOA Requirements

Provide materials free from perfluorooctanesulfonic acid (PFOS) or perfluorooctanoic acid (PFOA).

2.1.3 Indoor Air Quality Requirements

Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for carpet[indoor air quality for textile composite carpet].

[2.1.4 Sustainable Product Certifications

Submit sustainable product certifications per NSF/ANSI 140.

]2.1.5 Physical Characteristics for [Broadloom][Modular Tile][Entrance][Textile Composite] Carpet

****

NOTE: Copy this paragraph including subparagraphs if more than one carpet is specified. Designate each carpet type with a letter or number symbol. Use the same designations to key carpets to locations on the drawings or in Section 09 06 00 SCHEDULES FOR FINISHES.

Terms such as "sheet carpet" may be used in the industry for "broadloom carpet" and "textile composite flooring" may be used in the industry for "textile composite carpet." Confirm differing terminologies when editing and selecting carpeting products.

Terms such a "plank" or "tile" are subject to available product formats from the manufacturers. Sizes suggested in Part 2 are not exhaustive or intended to exclude other sizes.

****

2.1.5.1 Carpet Construction

[Tufted] [Woven] [Bonded] [Needlebond] [Needle Felt] [Composite] [_____]

2.1.5.2 Type

[Broadloom carpet [3.6] [1.8] m [12] [6] feet minimum usable carpet width [with exception of corridors] [and] [stairs] [_____].][Modular carpet tile [450 by 450] [500 by 500] [600 by 600] [914 by 305] [1219 by 305] [_____] mm square [18 by 18] [20 by 20] [24 by 24] [36 by 12] [48 by 12] [_____] inch square with 0.15 percent growth/shrink rate in accordance with ISO 2551.] [Entrance [450 by 450] [_____] mm [18 by 18] [_____] inch square [3.6] [1.8] m [12] [6] feet width [_____] mat size.] [Modular tile textile composite carpet of [knitted][molded] fabric on backer [305 by 1219] [450 by 450] [610 by 610] [_____] mm[12 by 48] [18 by 36] [24 by 24] [_____] inch] [Backed broadloom matching [modular carpet tile][modular tile textile composite carpet] for use on[stairs][and][ramps].][See Section [09 69 13 RIGID GRID ACCESS FLOORING][and][09 69 19 STRINGERLESS ACCESS FLOORING] for size required for a one to one alignment with raised access floor panels.]

2.1.5.3 Pile Type[s]

[Level-loop] [Multilevel loop] [Cut and loop] [Frieze] [Cut pile] [Random sheared] [Level tip shear] [Knitted fabric]

2.1.5.4 Pile Fiber

Commercial 100 percent branded (federally registered trademark) [nylon continuous filament] [nylon staple] [wool with Woolmark certification] [wool blend with Wool Bureau certification] [_____].

2.1.5.5 Gauge or Pitch

Minimum [_____] mm inch in accordance with ASTM D5793

2.1.5.6 Stitches or Rows/Wires

Minimum [_____] per square meter square inch

2.1.5.7 Surface Pile Weight

Minimum [_____] kg/square meter ounces per square yard. This does not include weight of backings. Determine weight in accordance with ASTM D5848.

2.1.5.8 Pile Thickness

Minimum [_____] mm inch in accordance with ASTM D6859

2.1.5.9 Pile Density

****

NOTE: Pile Density = 36 x Pile Weight/Pile Thickness.

****

Minimum [_____]

2.1.5.10 Dye Method

[Solution dyed] [Stock dyed] [Yarn (or Skein) dyed] [Piece dyed] [Space dyed] [Continuous dyed]

2.1.5.11 Backing Materials

Provide primary backing materials like [those customarily used and accepted by the trade for each type of carpet] [polypropylene] [synthetic material] [rubber] [jute] [cotton] [_____]. Provide secondary backing to suit project requirements of those customarily used and accepted by the trade for each type of carpet.

2.1.5.12 Attached Cushion

Provide an attached cushion [chemically frothed polyurethane with minimum weight of 0.610 kg/sq. m 18 oz/sq. yard, minimum density of 176 kg/cubic m 11 lb/cubic foot] [mechanically frothed polyurethane with minimum weight of 0.745 kg/sq. m 22 oz/sq. yard, minimum density of 224 kg/cubic m 14 lb/cubic foot, minimum thickness of 2.5 mm 0.100 inch, and maximum compression resistance of 34.5 kPa 5 psi, and compression set of 15 percent in accordance with ASTM D3676]. Do not exceed the maximum ash content of 50 percent when tested in accordance with ASTM D297. Pass the accelerated aging test in accordance with [ASTM D3676] [ASTM D1667] for the cushion.

2.2 PERFORMANCE REQUIREMENTS

2.2.1 Texture Appearance Retention Rating (TARR)

****

NOTE: Use the chart below to identify the recommended minimum use TARR traffic level classification that corresponds to the end-use application. These classifications are based on typical usage. Use a higher classification if traffic exposure is expected to be greater than

usual. Provide a TARR traffic level classification for each carpet used on a project.

END-USE CLASSIFICATION CHART

End-Use Application	***Minimum Use Classification***
BANKS/CREDIT UNIONS	
Entrances and customer banking space	**Severe**
Open office space, private offices	**Heavy**
BOWLING ALLEYS	
Concourses (excluding food service, working and storage areas)	**Severe**
CHAPELS AND OTHER RELIGIOUS FACILITIES	
Educational wing, worship areas	**Heavy**
CHILD CARE CENTERS	
All areas	**Severe**
CLUBS	
All areas	**Severe**
HOUSING	
Single Family	
Family rooms, living rooms, dining rooms	**Heavy**
Sleeping rooms	**Heavy**
Combination living/sleeping rooms	**Heavy**
Multi-Family	
Common areas (lobbies, lounges)	**Severe**
Corridors	**Severe**
Family rooms, living rooms, dining rooms	**Heavy**
Multi-purpose areas	**Severe**
Sleeping rooms	**Heavy**
Combination living/sleeping rooms	**Heavy**
LABORATORY/RESEARCH FACILITIES	
Computer work areas	**Severe**
Closed private office	**Heavy**
Open work areas, dry labs	**Severe**
LIBRARIES	
Conference rooms, corridors	**Severe**
LODGING FACILITIES/DORMITORIES	
Conference rooms	**Severe**
Combination living/sleeping rooms	**Severe**
Dining facilities	**Severe**
Offices	**Heavy**
Public areas(lobbies, lounges, TV rooms, day rooms)	**Severe**
Sleeping rooms	**Heavy**
MEDICAL FACILITIES (excluding patient treatment areas)	
Assisted living areas, classrooms	**Heavy**
Chapels, consultation rooms	**Heavy**
Clinical waiting areas (outpatient,	

pharmacy, ancillary zone only)	Severe
Corridors, dining areas, elevators	Severe
Entrance areas (entry mats should be used)	Severe
Libraries	Heavy
Lobbies	Severe
Lounges	Heavy
Offices (private, semi-private)	Severe
Patient rooms	Heavy
Playrooms (OB/GYN, Pediatric clinics)	Severe
Staff sleeping and watch areas	Heavy
MILITARY HOUSING	
Family Housing	
Flag	Heavy
Single unit	Heavy
Multi-unit (corridors, sleeping/living rooms)	Heavy
Multi-unit (public areas, lobbies, lounges)	Severe
Bachelor Officer Quarters	
Sleeping/living rooms	Heavy
Public areas (lobbies, lounges)	Severe
Dining Facilities	Severe
Offices	Heavy
Bachelor Enlisted Quarters	
Sleeping/living rooms	Severe
Public areas (lobbies, lounges)	Severe
Dining Facilities	Severe
Offices	Heavy
MUSIC OR DRAMA CENTERS	
All areas	Severe
OFFICES (including administrative areas)	
Closed private offices	Heavy
Corridors	Severe
Conference rooms	Heavy
Open plan office (circulation areas)	Severe
Open plan office (work areas)	Heavy
RESTAURANTS (excluding work spaces)	
Dining areas	Severe
Cafeteria-type dining areas, enlisted canteens	Severe
Office areas	Heavy
RETAIL STORES	
Offices	Heavy
Restaurant and cafeteria dining areas	Severe
Sales areas	Severe
THEATERS	
All areas	Severe
TRAINING BUILDINGS/EDUCATIONAL FACILITIES (including dependents' schools)	
Classrooms, corridors	Severe

Staff/administration offices	**Heavy**
YOUTH CENTERS	
All areas	**Severe**

****

Provide carpet with a greater than or equal to [3.0 (Heavy)] [3.5 (Severe)] TARR traffic level classification in accordance with ASTM D7330 or CRI Test Method 103.

2.2.2 Static Control

****

NOTE: Specify static control to meet project requirements. Installations for critical areas such as computer rooms will use the 2.0 kV requirements. Static protected carpets for most commercial installations are normally rated at 3.5 kV.

****

Provide static control to permanently regulate static buildup to less than [3.5] [2.0] [_____] kV when tested at 20 percent relative humidity and 21 degrees C 70 degrees F in accordance with AATCC 134.

2.2.3 Flammability and Critical Radiant Flux Requirements

****

NOTE: Choice of critical radiant flux level as it applies to building type and area of application will be made in accordance with the latest edition of NFPA 101. Wherever the use of Class II (0.22) watts finish is required, Class I (0.45) watts will be permitted.

****

Comply with 16 CFR 1630 or ASTM D2859. Provide carpet in corridors and exits with a minimum average critical radiant flux of [0.22] [0.45] watts per square centimeter when tested in accordance with ASTM E648 or NFPA 253.

2.2.4 Tuft Bind

Comply with ASTM D1335 for tuft bind force required to pull a tuft or loop free from carpet backing with a minimum [40 N 10 pound average force for loop pile broadloom] [18 N 3 pound average force for cut pile broadloom] [36 N 8 pound average force for modular carpet tile].

2.2.5 Colorfastness to Crocking

Comply dry and wet crocking with AATCC 165 and with a Class 4 minimum rating on the AATCC Color Transference Chart for all colors.

2.2.6 Colorfastness to Light

Comply colorfastness to light with AATCC 16.1, Test Option E "Water-Cooled Xenon-Arc Lamp, Continuous Light" and with a minimum 4 gray scale rating after 40 hours.

2.2.7 Colorfastness to Water

****
NOTE: Include this test when specifying carpet constructed of yarn dyed fibers.
****

Comply colorfastness to water with AATCC 107 and with a minimum 4.0 gray scale rating and a minimum 4.0 transfer scale rating.

2.2.8 Breaking Strength

ASTM D2646 dry breaking strength, not less than 445 N100 lbf.

2.2.9 Delamination Strength

Provide delamination ASTM D3936 strength for tufted carpet with a secondary back of minimum 615 N/m 3.5 lbs/inch.

[2.2.10 Noise Reduction Coefficient

Provide noise reduction coefficient (NRC) of [_____] per ASTM C423.

]2.2.11 Antimicrobial

****
NOTE: Include when required for a specific use such as child care, dining facilities or hospitals.
****

Nontoxic antimicrobial treatment in accordance with AATCC 174 Part I (qualitative), guaranteed by the carpet manufacturer to last the life of the carpet.

2.3 CARPET CUSHION

****
NOTE: Select the appropriate carpet cushion.

Carpet such as modular tile carpet, modular tile textile composite carpet, and broadloom versions of modular carpet types are manufactured with integral cushion backing. Confirm types when editing to prevent unintentionally omitting padding or duplicating padding under backed carpet.
****

[2.3.1 Fiber Cushion

[Rubberized hair, mothproofed and sterilized] [Rubberized jute [with minimum 40 percent recycled content], mothproofed and sterilized] [Synthetic with minimum [___] percent recycled content] [Resinated, recycled textile]. [Provide data identifying percentage of recycled content for fiber cushion.

Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for fiber cushion.]

2.3.1.1 Weight

[_____] g/sq.m[_____] oz./sq. yd.

2.3.1.2 Thickness

[_____] mm[_____] inches plus 5 percent maximum

2.3.1.3 Density

[_____] kg/cu.m[_____] lb/cu.ft.

][2.3.2 Rubber Cushion

[Flat][Rippled waffle][Textured flat][Reinforced][, with minimum 60 percent recycled content. Provide data identifying percentage of recycled content for rubber cushion.

Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for rubber cushion.]

2.3.2.1 Weight

[_____] g/sq.m[_____] oz./sq. yd.

2.3.2.2 Thickness

[_____] mm[_____] inches plus 5 percent maximum

2.3.2.3 Compression Resistance

[_____] kg/sq. mm[_____] lb/sq. in. at [25][65] percent in accordance with ASTM D3574.

2.3.2.4 Density

[_____] kg/cu.m[_____] lb/cu.ft.

][2.3.3 Polyurethane-Foam Cushion

[Grafted prime] [Densified] [Bonded] [Mechanically frothed] [, with minimum 15 percent recycled content. Provide data identifying percentage of recycled content for polyurethane-foam cushion.

Products must meet emissions requirements of CDPH SECTION 01350. Provide certification or validation of indoor air quality for polyurethane-foam cushion.]

2.3.3.1 Compression Force Deflection at 65 Percent

[_____] mm[_____] lb/sq.in. of polymer density in accordance with ASTM D3574

2.3.3.2 Thickness

[_____] mm[_____] inches plus 5 percent maximum

2.3.3.3 Density

[_____] kg/cu.m[_____] lb/cu.ft.

]2.3.4 Performance Requirements - Critical Radiant Flux

Provide carpet cushion in corridors and exits with a minimum average critical radiant flux of [0.22][0.45] watts per square centimeter when tested in accordance with ASTM E648.

2.4 ADHESIVES AND CONCRETE PRIMER

Comply with applicable regulations regarding toxic and hazardous materials. Provide water resistant, mildew resistant, nonflammable, and nonstaining adhesives and concrete primers for carpet installation as required by the carpet manufacturer. Provide release adhesive for modular tile carpet as recommended by the carpet manufacturer. Provide adhesives flashpoint of minimum 60 degrees C 140 degrees F in accordance with ASTM D3278. Non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide validation of indoor air quality for aerosol adhesives. Provide validation of indoor air quality for non-aerosol adhesives. Concrete primer products used on the interior of the building (defined as inside of the weatherproofing system) must meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for concrete primer.

[2.5 MODULAR CARPET TILE CONNECTORS

Provide carpet manufacturer's concealed modular carpet tile connectors (adhesive tabs) to restrain modular carpet tiles in place in lieu of adhesive between modular carpet tile and substrate.[Where intended for use over access flooring panels, confirm source of connectors by either flooring panel or carpet tile manufacturer. Provide coordinated layout drawings of connectors, modular carpet tile joints, flooring panel joints, and penetrating items through carpet tiles and flooring panels.]

][2.6 ADHESIVE BACKING

Provide adhesive backed modular tile with release paper for removal at installation.

]2.7 MOLDINGS

Provide carpet moldings where floor covering material changes or carpet edge does not abut a vertical surface. Provide [a heavy-duty [vinyl] [rubber] molding designed for the type of carpet being installed. Provide floor flange of a minimum [38 mm] [1 1/2 inches] wide. Provide [_____] color to match [resilient base] [_____].] [an aluminum molding, pinless clamp-down type, designed for the type of carpet being installed. Provide [natural color anodized] [prefinished color [_____] finish. Provide a floor flange of a minimum 38 mm 1-1/2 inch wide and face a minimum 16 mm 5/8 inch wide.]]

2.8 TAPE

Provide tape for seams as recommended by the carpet manufacturer for the type of seam used in broadloom installation. Seam sealant must have a maximum VOC content of no more than 50 grams/liter. Do not use sealants that contain 1,1,1-trichloroethane or toluene.

2.9 COLOR, TEXTURE, AND PATTERN

****

NOTE: Coordinate editing of color reference sentence(s) with the Government. Generally the Section 09 06 00 SCHEDULES FOR FINISHES or drawings are used when the project is designed by an Architect or Interior designer. Select color from manufacturer's standard colors or identified in this specification only when the project has minimal finishes.

When the government directs that color be located in the drawings, add a note that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

When more than one type, pattern or color is specified identify location.

When a manufacturer's name, stock number, pattern, and color is specified for color, be certain that the product conforms to the specification, as edited.

****

Provide color, texture, and pattern in accordance with [Section 09 06 00 SCHEDULES FOR FINISHES] [the drawings] [_____].

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Do not install carpet on surfaces that are unsuitable and will prevent a proper installation. Prepare subfloor in accordance with flooring manufacturer's recommended instructions. Repair holes, cracks, depressions, or rough areas using material recommended by the carpet or adhesive manufacturer. Free floor of any foreign materials and sweep clean. Before beginning work, test subfloor with glue and carpet to determine "open time" and bond. Submit [three] [_____] copies of the manufacturer's printed Installation instructions for the carpet, including Surface Preparation, seaming techniques, and recommended adhesives and tapes.

3.2 MOISTURE AND ALKALINITY TESTS

Test concrete slab for excessive moisture content and excessive alkalinity in accordance with CRI 104/CRI 105, ASTM F1869, and ASTM F2170. Submit [three] [_____] copies of reports of Moisture and Alkalinity Tests including content of concrete slab stating date of test, person conducting the test, and the area tested. Perform tests for each [18.6 sq. m200 sq. ft.][304.8 sq. m1000 sq. ft.]. Perform a minimum of three evenly spaced tests of each installation area. For anhydrous calcium chloride test, confirm substrates have a moisture-vapor-emission rate less than [1.36 kg of water/92.9 sq. m3 lb of water/1000 sq. ft.][_____]. For relative humidity tests confirm substrate relative humidity levels are less than [75][_____] percent.

3.3 PREPARATION OF CONCRETE SUBFLOOR

****

NOTE: Coordinate need for sealing of concrete slab with project requirements such as wet conditions which might occur in hospital care.

****

Do not commence installation of the carpeting until concrete substrate is at least 90 days old. Prepare the concrete surfaces in accordance with the carpet manufacturer's instructions. Match carpet, when required, and adhesives to prevent off-gassing to a type of curing compounds, leveling agents, and concrete sealer.

3.4 INSTALLATION

Isolate area of installation from rest of building. Perform all work by manufacturer's approved installers. Conduct installation in accordance with the manufacturer's printed instructions and CRI 104/CRI 105. Protect edges of carpet meeting hard surface flooring with molding and install in accordance with the molding manufacturer's printed instructions. Use autofoam mothproofing system for wool carpets. Follow ventilation, personal protection, and other safety precautions recommended by the adhesive manufacturer. Continue ventilation during installation and for at least 72 hours following installation. Do not permit traffic or movement of furniture or equipment in carpeted area for 24 hours after installation. Complete other work which would damage the carpet prior to installation of carpet. Submit [three] [_____] copies of Installation Drawings for 1) Carpet, 2) Carpet Cushion, and 3) Moldings indicating areas receiving carpet, carpet types, patterns, direction of pile, location of seams, and locations of edge molding.

Do not install building construction materials that show visual evidence of biological growth.

3.4.1 Broadloom Installation

Install broadloom carpet [direct glue down] [pre-applied adhesive glue down] smooth, uniform, and secure, with a minimum of seams. Apply regular, unnoticeable, and treated seams with a seam adhesive. Run side seams toward the light, where practical, and where such layout does not increase the number of seams. Install breadths parallel, with carpet pile in the same direction. Match patterns accurately. Neatly cut and fit cutouts, at door jambs, columns and ducts securely. Locate seams at doorways parallel to and centered directly under doors. Do not make seams perpendicular to doors or at pivot points. Provide seams at changes in directions of corridors to follow the wall line parallel to the carpet direction. Lay the carpet lengthwise down the corridors with widths less than 1.8 m 6 feet.

3.4.2 Modular Tile Installation

Install modular tiles with [releasable] [manufacturer's adhesive tab system] [permanent vinyl-compatible] [self-adhering] [_____] adhesive and snug joints. Use [monolithic] [1/4 turn] [ashlar] [brick] [herringbone] [random] [_____] installation method. Comply with manufacturer installation instructions for required drying time of releasable adhesive so it sets up properly. Provide accessibility to the subfloor where required. Modular carpet tile on stairs and sloped surfaces must be installed with a more permanent installation method in accordance with the manufacturer's instructions and with manufacturer recommended adhesives for this application. Install broadloom version of modular tile when available from the same manufacturer for use on stairs and sloped surfaces. [See Section [09 69 13 RIGID GRID ACCESS FLOORING][and][09 69 19 STRINGERLESS ACCESS FLOORING] for installation method of modular carpet tile on access flooring.]

3.4.3 Entrance Carpet Installation

[Install tiles with [permanent vinyl-compatible] [releasable] adhesive and snug joints. Use [monolithic] [1/4 turn] [ashlar] [brick] [random] installation method.] [Install roll goods [direct glue down] [pre-applied adhesive glue down] and smooth, uniform, and secure, with a minimum of seams. Prepare regular, unnoticeable, and treated seams with a seam adhesive. Install breadths parallel, with carpet pile in the same direction. Match patterns accurately. Neatly cut and fit, securely, cutouts at door jambs, columns, and ducts. Locate seams at doorways parallel to and centered directly under doors. Do not make seams perpendicular to doors or at pivot points.] [Cut mats to specified size and finish them with a tapered vinyl edge that is glued and sewn on.]

[3.4.4 Stretch-in Installation

****

NOTE: Installation with tack strips (stretch in method) over cushion can avoid potential adhesive interaction with carpet backing. It is appropriate for residential and hospitality settings, in which rooms are relatively small and separate cushion is used; but not feasible in large, open spaces.

****

Provide carpet tack strips wherever carpeting abuts vertical surfaces. Install tackless carpet stripping by nailing. Place carpet cushion face-up, as recommended by cushion manufacturer, over entire floor area to be carpeted with joints butted. Do not use adhesives to attach carpet, cushion, or substrate. Comply with carpet manufacturer's instructions for installation. Attach rubber or metal edge strip to substrate with adhesive for transition when carpet meets other flooring materials or to finish carpet edge when required.

]3.5 CLEANING AND PROTECTION

Submit [three] [_____] copies of carpet manufacturer's maintenance instructions describing recommended type of cleaning equipment and material, spotting and cleaning methods, and cleaning cycles.

3.5.1 Cleaning

As specified in Section 01 78 00 CLOSEOUT SUBMITTALS. After installation of the carpet, remove debris, scraps, and other foreign matter. Remove soiled spots and adhesive from the face of the carpet with appropriate spot remover. Cut off and remove protruding face yarn. Vacuum carpet clean with a high-efficiency particulate air (HEPA) filtration vacuum.

3.5.2 Protection

Protect the installed carpet from soiling and damage with heavy, reinforced, nonstaining kraft paper, plywood, or hardboard sheets. Lap and secure edges of kraft paper protection to provide a continuous cover. Restrict traffic for at least 48 hours. Remove protective covering when directed by the Contracting Officer.

3.6 REMNANTS

Manage waste as specified in the Waste Management Plan. [Provide remnants remaining from the installation, consisting of scrap pieces more than 600 mm 2 feet in dimension with more than 0.6 square meters 6 square feet total [to the Government] [to local non-profit such as Habitat for Humanity as directed by the Government]]. [Set aside and return non-retained scraps to manufacturer for recycling into new product] [Remove non-retained scraps from site and recycle appropriately].

3.7 MAINTENANCE

3.7.1 Extra Materials

Provide extra material from same dye lot consisting of [full width continuous broadloom][,][and][uncut modular carpet tiles][,][and][textile composite carpet] for future maintenance. Provide a minimum of [three] [_____] percent of total square meters square yards of each carpet type, pattern, and color. [Furnish [three] [____] percent extra of total adhesive tabs.]

3.7.2 Maintenance Service

****

NOTE: Maintenance agreements are standard practice in the building industry. Under a green lease, when the customer no longer requires the use of the particular product or requires an updated model, the manufacturer is obligated to reclaim it and refurbish it or disassemble it for recycling as appropriate.

****

Collect information from the manufacturer about [maintenance agreement] [green lease] options, and submit to Contracting Officer. Service must reclaim materials for recycling and/or reuse. Service must not landfill or burn reclaimed materials. When such a service is not available, seek local recyclers to reclaim the materials. Submit documentation of manufacturer's [maintenance agreement] [take-back program] [green lease] for carpet. Include contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and reuse.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 69 13 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-09 69 13 (November 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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RIGID GRID ACCESS FLOORING

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PART 1 GENERAL

PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-09 69 13 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-09 69 13 (November 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 09 69 13

RIGID GRID ACCESS FLOORING

11/24

****
UFGS Manager NOTE: (This note does not apply to the designer.) When making a change to this UFGS also make it to UFGS 09 69 19 STRINGERLESS ACCESS FLOORING where applicable since the two specifications are so similar.
****

****
NOTE: This Guide Specification covers the requirements for rigid grid access flooring.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: This specification does not include the floor upon which the elevated floor is superimposed, except to define the nature and condition of the supporting floor.

Access flooring systems include floor panels, pedestals and items such as stringers, steps, ramps,

closures and trim. Access flooring systems must be designed to accommodate static, rolling and impact loadings.

None of the mechanical and electrical services essential to the operation of equipment are included. Coordinate with mechanical and electrical to provide ventilation and cable openings which will be required.

The designer is responsible for identifying and defining requirements for the floors. Drawings must indicate location and limits of the flooring systems, finish floor elevation, panel size, type, finish and anti-static provisions, colors, pedestal mounting and subfloor connection system details.

STRINGERLESS ACCESS FLOORING is covered in SECTION 09 69 19.

Stair and/or ramp information, such as tread width and riser height for stairs and width, slope and length of ramps, including railings, are included in this section.

Ancillary components such as floor diffusers and grills, fascias and floor opening trims are also included.

Seismic loadings and any other information required to indicate the extent of work must be considered in designing access flooring systems.

There are three fundamental conditions relative to the design of access flooring installations:

Condition I - Floors are completely surrounded by building walls. These are the most resistant to seismic loadings.

Condition II - Floors have part of the edge exposed and not restrained by other structural elements. Condition II floors are less resistive to seismic loadings along the axis of the unconstrained side. Seismic loadings can be resisted by securing the perimeter panels of all floors to the supporting structural framing and fitting the panels tightly together, or by cross bracing the structural frame to resist overturning. The designer must select fascia type and finish for exposed edges.

Condition III - Floors are free standing without lateral contact with other structural elements. Type III floors are primarily strengthened with cross bracing to resist lateral loads.

Buildings not excluded by UFC 3-301-01 or TI 800-01 Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities

Act (ADA-ABA) Accessibility Guidelines for Buildings and Facilities and Architectural Barriers Act (ABA) Accessibility Guidelines.

On the drawings, show:

1. Extent and shape of access flooring area. Include details of panel-to-panel and panel-to-wall intersections, edge treatment at openings, expansion joints, elevation(s) above structural floor, and other special features of the elevated floor system.

2. Location and design of ramps, steps, and doors to access floor area; railing heights and design.

3. Location and sizes of registers, grilles, perforated panels, and cable openings through access floor panels.

4. Design and type of plenum fire extinguishing systems, if space under access floor is to be used as air plenum.

5. Layout of plenum dividers.

6. Pattern of access floor panels.

7. Location of building electrode. Coordinate structural grounding connections with appropriate building and electrical systems.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A1264.1	(2017) Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrail/Handrail Systems

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA E30	(2016) Engineered Wood Construction Guide
APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood

ASTM INTERNATIONAL (ASTM)

ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B85/B85M	(2018) Standard Specification for Aluminum-Alloy Die Castings
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F150	(2006; R 2013) Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F1700	(2024) Standard Specification for Solid Vinyl Floor Tile
ASTM F1861	(2021) Standard Specification for Resilient Wall Base

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CEILINGS AND INTERIOR SYSTEMS CONSTRUCTION ASSOCIATION (CISCA)

CISCA Access Floors	(2007) Recommended Test Procedures for Access Floors

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A208.1	(2022) Particleboard
CPA A208.2	(2016) Medium Density Fiberboard (MDF) for Interior Applications

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC300	(2014) Acceptance Criteria for Access Floors

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

MASTER PAINTERS INSTITUTE (MPI)

MPI 58	(2012) Stain for Concrete Floors
MPI 99	(2012) Sealer, Water Based, for Concrete Floors
MPI 104	(2012) Sealer, Solvent Based, for Concrete Floors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 75	(2024) Standard for the Protection of Information Technology Equipment
NFPA 99	(2024) Health Care Facilities Code
NFPA 253	(2011) Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings
SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-C-490	(Rev H; 2024) Chemical Conversion Coatings and Pretreatments for Metallic Substrates (Base for Organic Coatings)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Installation Drawings; G, [_____]

Fabrication Drawings; G, [_____]

SD-03 Product Data

Access Flooring System; G, [_____]

Recycled Content of Access Flooring System; S

Indoor Air Quality For Pedestal Adhesive; S

Indoor Air Quality For Concrete Sealer; S

Indoor Air Quality For Adhesives; S

SD-04 Samples

Floor Panels

Floor Covering; G, [_____]

Panel Support System

Accessories; G, [_____]

Fascia; G, [_____]

Exposed Step and Ramp Structure; G, [_____]

Railings; G, [_____]

Perforated Directional Air Supply Panels; G, [_____]

Cut Outs; G, [_____]

SD-05 Design Data

Seismic Calculations

SD-06 Test Reports

Factory Tests

Concentrated Load

Uniform Live Load

Rolling Load

Impact Load

Ultimate Load

Stringer Load

Pedestal Axial Load

Bonding Strength of Pedestal Adhesive

Electrical Resistance

Field Tests

SD-07 Certificates

Compliance with ICC-ES AC300

Compliance with ICC IBC

Certificate of Compliance

Qualification of Manufacturer

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

SD-11 Closeout Submittals

Lifting Device

Warranty; G, [_____]

1.3 SPARE PARTS

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NOTE: To assure matching floor panel, which may become damaged and require replacement, supply of extra stock is recommended. Set amount based on conditions of specific project. Do not specify extra stock unless Using Agency concurs; warehousing may not be available.

****

[Furnish spare floor panels for each finish including bare panels for carpet tile, complete pedestal assemblies, and stringers at the rate of one for each 100 or fraction thereof required.][Provide [four] [_____] floor panels complete with specified floor covering for future use.][Provide four spare panels with identical floor covering pedestals and stringers for each 100 square meters 1,000 square feet of access flooring and total of 3 linear meters 10 linear feet of cut-out trim. Store extra stock in same manner and location as project materials.][Provide extra carpet tile from same dye lot consisting of uncut tiles for future maintenance. Provide a minimum of [three][_____] percent of total square meters square yards of each carpet type, pattern, and color. [Furnish [[five][____] percent extra of total adhesive tabs][[one][____] percent extra of total components] required for installing carpet tile.]]

1.4 QUALITY CONTROL

1.4.1 Qualification of Manufacturer

****

NOTE: Specify 5 years manufacturer experience unless directed otherwise by the Government

****

Access flooring manufacturer must have at least 5 years experience in manufacturing access flooring systems. Certify that the manufacturer of the access flooring system meets requirements specified under paragraph entitled QUALIFICATION OF MANUFACTURER.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver materials to site in undamaged condition, in original containers or packages, complete with accessories and instructions. Label packages with manufacturer's name and brand designations. Package materials covered by specific references bearing specification number, type and class as applicable.

1.5.2 Storage

Store all materials in original protective packaging in a safe, dry, and clean location. Store panels at temperatures between 4 and 32 degrees C 40 and 90 degrees F, and between 20 and 70 percent humidity. Replace defective or damaged materials.

1.5.3 Handling

Handle and protect materials in a manner to prevent damage during the entire construction period.

1.6 WARRANTY

****

NOTE: Manufacturers standard warranty is for one year. For government projects, at an additional cost, manufacturers will provide an extended warranty of 5 or more years.

****

Minimum manufacturer warranty must have no dollar limit, cover full system, and must have a minimum duration of [1] [5] [_____] years. Include an agreement to repair or replace floor panels, pedestals or stringers that fail within the warranty period in the standard performance guarantee or warranty. Failures include, but are not limited to, sagging and warping of panels; rusting; and manufacturing defects of panels or support system.[For [high pressure laminate][conductive high pressure laminate][solid vinyl tile][luxury vinyl tile] provide manufacturer's standard performance guarantees or warranties that extend beyond a one-year period for finish materials.][For [conductive][static-dissipative] vinyl tile provide manufacturer's standard performance guarantees or warranties that extend beyond one year, standard warranty must not be less than a five year wear warranty and ten year conductivity warranty.][For carpet tile provide manufacturer's standard performance guarantees or warranties including a minimum two years for material and workmanship and ten years for wear, static control, tuft bind and delamination.]

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Access flooring support systems are available as either a stringer or stringerless system. Refer to Section 09 69 19 STRINGERLESS ACCESS FLOORING for stringerless applications.

A stringer is a horizontal framing member that connects the pedestal head, supports the panel edges and adds lateral stability to the floor system. Stringers should be used on all systems with a height that exceeds 300 mm 12 inches.

Specify the stringer system in seismic zones or when the total area is over 278 square meters 3,000 square feet unless the system provides bolted connection between the panel and pedestal. Coordinate with applicable codes and Structural Engineer.

For Air Force facilities, use stringer type floor systems for data processing facilities.

Consideration should be given to loads which will be imposed during operation. Some equipment, such as high speed printers require large quantities of paper to be delivered by carts. When in motion, these heavy loads may exceed capacity of floor system. Check with Using Agency and floor system manufacturer when heavy rolling loads are expected. Ensure that project specific floor loading requirements are fully coordinated with Structural Engineer and applicable codes.

Zinc whiskers can occur on the underside of raised floor systems which are treated with a zinc electroplated anti-corrosion coating. Zinc whiskers are small enough (2 microns in diameter up to several millimeters in length) to render normal dust filters on computer equipment ineffective. The result is possible electrical shorts and damage to circuitry and equipment. Zinc electroplated anti-corrosion coated components must be prohibited in office areas and data centers when the access flooring system is utilized as an air plenum.

****

a. Provide for self-alignment of floor panels, adjustable pedestals and readily removable floor panels covered as specified.

b. Lateral stability of floor support system must be independent of panels. Provide a finished assembly that is rigid and free of vibration, noises, and rocking panels.[Provide bolted stringer system with equipotential plane grounding.]

c. Submit certificate of compliance attesting that the installed access floor system meets specification requirements, including all special equipment loads and specific electrical and or cable requirements for the complete access flooring system including, but not limited to the following:

(1) Compliance with ICC-ES AC300 and Compliance with ICC IBC Acceptance Criteria for Access Floors.

(2) Load-bearing capabilities of pedestals, floor panels, and pedestal adhesive resisting force.

(3) Supporting independent laboratory test reports. For panel, stringer and pedestal load test results include concentrated loads at center of panel, panel edge midpoint, ultimate loads and uniform loads.

(4) Floor electrical characteristics.

(5) Material requirements.

(6) An elevated floor system free of defects in materials, fabrication, finish, and installation, that will remain so for a period of not less than [_____] [1] years after completion.

d. Submit manufacturer's product data for access flooring system consisting of descriptive data, catalog cuts, and installation instructions. Include in the data information about any design and production techniques, total system including all accessories and finish coatings of under-floor components, procedures and policies used to conserve energy, reduce material, improve waste management or incorporate green building/recycled products into the manufacture of their components or products. Include cleaning and maintenance instructions. Systems which contain zinc electroplated anti-corrosion coatings are prohibited.

2.1.1 Design Requirements

****

NOTE: Insert heavier load as required by facility use conditions. The deflection and permanent deformation limits are for panels 610 by 610 mm 24 by 24 inches, and smaller.

Check manufacturer's literature for maximum loadings available. Generally, by ICC IBC, computer rooms are based on live load of 4.8 kPa 100 psf and point load of 900 kg 2000 lbs. Server rooms may require greater floor loading. Coordinate design loads for access floor with project specific floor loading requirements, structural engineer and design of structural slab.

Project design loads will be in accordance with the International Building Code and UFC 1-200-01.

For most office spaces, underfloor systems rated at 6.9 to 8.6 MPa 1000 to 1250 PSI concentrated load are adequate. For heavier traffic loads at loading docks, elevator entrances, and corridors underfloor systems rated at 10.3 MPa 1500 PSI are appropriate. Underfloor systems rated at 17.2 MPa 2500 PSI are available for heavy equipment.

When editing below paragraphs a., b., c., d. and f. ensure that each paragraph is matched up with it's matching option. Options in each paragraph are in matching sequential order.

****

Conduct floor panel testing in accordance with CISCA Access Floors. When tested as specified, make all deflection and deformation measurements at the point of load application on the top surface of the panel. Floor panels must be capable of supporting the following loads:

a. Concentrated load of [4450] [5560] [6670] [8900] [11120] [_____] N [1000] [1250] [1500] [2000] [2500] [_____] pounds on 645 square mm one square inch, at any point on panel, without a top-surface deflection more than 2.54 mm 0.10 inch, and a permanent set not to exceed 0.25 mm 0.01 inch in any of the specified tests. Testing must be in accordance with CISCA Access Floors, Section 1 Concentrated Loads with test panels being supported by understructure to be used with installed system instead of steel support blocks.

b. Uniform live load of [11.97] [14.36] [16.76] [19.15] [23.94] [_____] kPa [250] [300] [350] [400] [500] [_____] psf, without a top-surface deflection more than 1.0 mm 0.04 inch, and a permanent set not to exceed 0.25 mm 0.01 inch in any of the specified tests, when tested in accordance with CISCA Access Floors, Section 7 Uniform Load Test with test panels being supported by understructure to be used with installed system instead of steel support blocks.

c. A rolling load of [2670] [3560] [4450] [5340] [7110] [_____] N [600] [800] [1000] [1200] [1600] [_____] pounds applied through hard rubber surfaced wheel 152 mm 6 inch diameter by 51 mm 2 inch wide for 10,000 cycles over the same path. Permanent set at conclusion of test must not exceed 1.0 mm 0.040 inch when tested in accordance with CISCA Access Floors, Section 3 Rolling Loads.

d. A rolling load of [3560] [4450] [5560] [6670] [8890] [_____] N [800] [1000] [1250] [1500] [2000] [_____] pounds applied through a 75 mm 3 inch diameter by 30 mm 1-13/16 inch wide caster for 10 cycles over the same path, without developing a local overall surface deformation greater than 1 mm 0.04 inch. In accordance with CISCA Access Floors, Section 3 Rolling Loads, the permanent deformation limit under rolling load must be satisfied in all of the specified tests.

e. An impact load of [670] N [150] pounds anywhere on the panel dropped from a height of 914 mm 36 inches onto a 645 square mm 1 square inch area without failure of the system, according to CISCA Access Floors, Section 8 Drop Impact Load Test.

f. Ultimate Load. Panels must meet manufactures published Ultimate Load rating of [6230] [8010] [11120] [12450] [13790] [_____] N [1400] [1800] [2500] [2800] [3100] [_____] pounds when tested in accordance with

CISCA Access Floors, Section 2 Ultimate Loading.

g. Safety Factor. Panels must provide a minimum Safety Factor of 5 times the uniform load specified above in accordance with ICC-ES AC300.

h. Recycled Content. Provide Access Flooring System (panels, stringers and pedestals) containing a minimum of [20] [_____] percent recycled content. Provide data identifying percentage of recycled content of access flooring system.

2.1.2 Allowable Tolerances

2.1.2.1 Floor Panel Flatness

Plus or minus 0.89 mm 0.035 inches on diagonal on top of panel or underneath edge.

2.1.2.2 Floor Panel Length

Plus or minus 0.4 mm 0.015 inch.

2.1.2.3 Floor Panel Squareness

Plus or minus 0.5 mm 0.02 inch in panel length.

2.1.3 Stringers

Provide stringers capable of supporting a [_____] N [_____] pound[1110 N 250 pound][90 kg 200 pounds] [1550 N 350 pound] [2000 N 450 pound] concentrated load at midspan without permanent deformation in excess of 0.25 mm 0.010 inch, when tested in accordance with CISCA Access Floors, Section 4 Stringer Load Testing.

2.1.4 Pedestals

****

NOTE: Pedestals consist of a base plate, post and an adjustable head, and are available in heights from 150 mm 6 inches to 2400 mm 96 inches. Pedestals 610 mm 24 inches high or higher must be securely anchored to the structural floor in addition to being held in place by adhesive.

Pedestals are normally held in place with an adhesive and must be in full contact with the subfloor surface. Pedestal 610 mm 24 inches high or higher will be securely anchored to the structural floor in addition to the adhesive.

For Air Force projects, the minimum pedestal height is 300 mm 12 inches.

****

Pedestals must be capable of supporting a [22.24 kN 5000 pound][26.69 kN 6000 pound] axial load without permanent deformation, when tested in accordance with CISCA Access Floors, Section 5 Pedestal Axial Load Test.

2.1.5 Bonding Strength of Pedestal Adhesive

****
NOTE: Use 113 Nm 1,000 lbf-in for raised floors with a maximum height of 610 mm 24 inches and 226 Nm 2,000 lbf-in for raised floor heights greater than 610 mm 24 inches up to 1219 mm 48 inches maximum. Raised floor heights greater than 1219 mm 48 inches require specific structurally designed bracing.
****

Adhesive for anchoring pedestal bases must have a bonding strength capable of resisting an overturning moment of[113 Nm 1,000 lbf-in][226 Nm 2,000 lbf-in] [_____] when a force is applied to the top of the pedestal in any direction, when tested in accordance with CISCA Access Floors, Section 6 Pedestal Overturning Moment Test. Pedestal adhesive must meet emissions requirement of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type). Provide validation of indoor air quality for pedestal adhesive.

2.1.6 Bond Strength of Factory Installed Covering

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NOTE: Coordinate test load weights with those specified for floor panel testing in General System Requirements.
****

Bond strength of floor covering must be sufficient to permit handling of the panels by use of the panel lifting device, and to withstand moving caster loads up to [3560] [4450] [5560] [6670] [8890] [_____] N [800] [1000] [1250] [1500] [2000] [_____] pounds, without separation of the covering from the panel.

2.1.7 Seismic Calculations

2.1.7.1 Navy Project Specific Requirements

****
NOTE: For Navy projects, provide lateral bracing calculations on all installations. Level 1 Contracting Officer's approval was granted for calculations by a registered professional engineer. Occupancy importance factor (I) and seismic zone factor (z) should be deleted in accordance with UFC 1-200-01.

Provide seismic requirements, if a Government designer (Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the second bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT must be included in the contract documents.
****

Submit seismic calculations for lateral bracing, sealed by a Professional Engineer. Document that access flooring system complies with seismic requirements of ICC IBC and ASCE 7-22 for Occupancy Importance Factor (Ip) of [1.0] [1.5], and seismic horizontal force (Fp) determined in accordance with UFC 3-301-01 and Section 1615 of the ICC IBC and ASCE 7-22, Minimum Design Loads for buildings and other structures.

2.1.7.2 Army Project Specific Requirements

****

NOTE: Provide seismic requirements, if a Government designer (Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the second bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT must be included in the contract documents.

****

Submit seismic calculations for special bracing to resist the effects of seismic or other forces [in accordance with UFC 3-301-01, ICC IBC and ASCE 7-22] [as shown on the approved detailed installation drawings]. Submit design calculations which demonstrate that the proposed floor system meets requirements for seismic loading. Certified copies of test reports may be submitted in lieu of calculations.

2.2 FLOOR PANELS

2.2.1 Floor System Drawings And Planer Quality

a. Submit Fabrication Drawings for elevated floor systems consisting of fabrication and assembly details to be performed in the factory.

b. Indicate on Location Drawings exact location of pedestals, ventilation openings, cable cutouts, and the panel installation pattern.

c. Provide Detail Drawings showing details of the pedestals, pedestal-floor interlocks, floor panels, panel edging, floor openings, floor opening edging, floor registers, floor grilles, cable cutout treatment, perimeter base, expansion, and peripheral support facilities.

d. Design and workmanship of the floor, as installed, must be completely planar within plus or minus 1.5 mm in 3050 mm 0.060 inch in 10 feet, 2.5 mm 0.100 inch for the entire floor, and 0.7 mm 0.030 inch across panel joints.

e. Floor-panel joint-width tolerances must not exceed 0.43 mm 0.017 inch as measured with a feeler gage at any point in any joint when the panels are installed and as long as the air leakage requirements specified in this section are met.

f. Submit [three][_____] complete samples of floor panels.

2.2.2 Detailed Installation Drawings

Submit Detailed Installation Drawings that as a minimum indicate the following:

a. Location of panels

b. Layout of supports, panels, and cutout locations

c. Stair, handrail, and ramp framing

d. Sizes and details of components

e. Details at floor perimeter and height above structural floor

f. Method of anchorage to structural subfloor

g. Lateral bracing

h. Typical cutout details

i. Gasketing, return air grilles, supply air registers, and perforated panels. Include air transfer capacity of grilles, registers and panels

j. Description of [shop] [factory] coating

k. Floor finishes

l. Location of connection to building grounding electrode

2.2.3 Panel Construction

****

NOTE: There are five basic floor panel types: aluminum, hollow formed steel, cementitious-filled formed steel, metal-clad wood core, and concrete. The most commonly used floor panel is the Cementitious-Filled Formed Steel (Composite Panels). Nonferrous materials should be used in areas where there is potential for damage by rust oxides or paint flakes.

Editing of a Non-Proprietary Specification: Note that there are two primary Buy America FAR compliant access flooring system suppliers to the North American market who respectively manufacture the Cementitious-Filled Formed Steel and Lightweight Concrete Filled Panels. Both panel types should be selected to ensure non-proprietary specifications.

The standard panel size of 600 by 600 mm 24 by 24 inch will normally be used. Check with Using Agency and verify product availability before specifying nonstandard panels of 450, 750 and 900 mm 18, 30, and 36 inch where required to match existing floor systems or to satisfy special requirements.

Use 150 mm 6 inches as minimum practical height for access floor installation and 300 mm 12 inches minimum when there is a plenum. Include the five panel types as options except that wood core panels should not be specified for Air Force projects, SPAWARS projects, or other projects where data processing involves highly strategic data having direct bearing on National Defense effort. Check with Using Agency activity before specifying wood core panels. SPAWARS may be involved in Air Force and Army projects, verify with the Using Agency.

****

a. Base access floor system on a 600 by 600 mm 24 by 24 inch square module providing minimum of [150][300][_____] mm [6][12][_____] inch clearance between structural floor and underside of panel and stringer. Fabricate so accurate job cutting and fitting may be done using standard sizes for perimeters and around columns.

b. Do not expose metal on finished top surface of panels. Provide cutouts and cutout closures to accommodate utility systems and equipment intercabling. Reinforce cutouts to meet design load requirements. Provide extra support pedestals at each corner of cutout for cutout panels that do not meet specified design load requirements.

c. Panel design must provide for convenient panel removal for underfloor servicing and for openings for new equipment. Use panels of uniform dimensions within specified tolerances. Permanently mark panels to indicate load rating and model number.

d. Machine square floor panels to within plus or minus 0.38 mm 0.015 inch with edge straightness plus or minus 0.064 mm 0.0025 inch. If plastic edging is applied to the panel, the tolerances apply to the panel before the plastic edging is applied.

****

NOTE: For security or additional structural stability of the access flooring system, panels can be bolted to pedestals. However this will cause additional maintenance concerns and will need to be coordinated with the desired floor covering.

****

[e. Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk corrosion resistant screws with heads that are flush with top of panel.]

[2.2.3.1 Aluminum

****

NOTE: Die-cast aluminum panels are lightweight, have very little variation in dimension from panel to panel, and are acceptable in environments where nonferrous materials are required (e.g., Magnetic Resonance Imagery rooms), but they tend to be more expensive than other types of panels.

Die-cast aluminum panels are normally used as a stringerless system. Stringers, when required, are fastened to the top of the pedestal shaft.

****

Provide aluminum panels of die-cast or extruded construction conforming to ASTM B85/B85M.

][2.2.3.2 Hollow Formed Steel

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NOTE: Die-formed hollow steel panels perform best under static loads and should not be used under

dynamic (rolling) loads. These panels are more economical than other types of panels and can be provided by most flooring system manufacturers.

****

Steel panels must be of die-formed construction, consisting of a flat steel top sheet welded to one or more formed steel stiffener sheets or components. Panels must be chemically cleaned, bonderized, and painted with the manufacturer's standard finish.

][2.2.3.3 Cementitious-Filled Formed Steel (Composite Panels)

****

NOTE: Cementitious core filled panels are enclosed in steel sheeting and are designed to provide improved resistance to rolling and impact loads. Specific strength and load requirements should be specified wherever it is a critical concern. These panels are quiet due to their mass.

There is some concern that the fill material may deteriorate when subjected to repeated loading cycles, and the cut edges could introduce dust into the underfloor space. Where the underfloor space will be a plenum, or where dust-sensitive computer equipment is to be installed, verify that the composite panel is acceptable to the Using Agency.

Current Air Force criteria does not permit the use of composite panel.

****

a. Provide composite panels of die-formed steel construction totally enclosing the panel, including the top surface. The void spaces between the top sheet and the formed steel bottom sheet must be completely filled with an incombustible cementitious or concrete material. Seal cut edges in accordance with manufacturer's recommendations. Gravity held panels with bolted stringer understructure: Fasten end of each stringer and mid-point of each 1212 mm 4 foot stringer positively to pedestal heads, using manufacturer's standard screws. Provide screws that are removable from top.

b. Grid supported panels must be further tested by supporting them at two opposite edges and applying a 2225 newton 500-pound load at the center of a panel selected; the panel must be similarly tested while supported at the other two edges. Weld failure at any point under this loading is not acceptable. This additional test must be applied to one panel per 46.45 square meter 500 square feet of floor in the system, but in no case less than two panels. When any weld fails, the number of panels designated by the Contracting Officer must be similarly tested; replace those panels that have a weld failure at no cost to the Government.

][2.2.3.4 Metal-Clad Wood Core

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NOTE: Wood core panels consist of a core of particleboard with an overlapping skin of galvanized steel. The wood core is a good sound deadener and

insulator and increases resistance to rolling loads. Wood core panels are the most economical option.

Although the core material is combustible, the composite panel with bonded steel for face sheets when tested in accordance with the NFPA 225, revealed the composite panel to be noncombustible with a flame spread index of 0, a smoke developed index of 10, and to have a Class A fire rating. Confirm applicable test data for each manufacturer considered. Confirm fire rating and smoke developed per ASTM E84.

Wood core panels can be easily cut and trimmed; however, doing so causes loss of fire retardancy and UL rating. The edges of wood core panels must be protected from moisture in order to prevent warping.

****

Provide wood core panels with cores of wood particleboard conforming to ANSI/CPA A208.1, Grade 1-M-3, or of plywood conforming to CPA A208.2, APA E30, and APA L870, EXT-DFPA-C-C. The core must be not less than 25 mm 1 inch thick, and be faced on all sides with structurally bonded zinc-coated steel sheets not lighter than 0.70 mm 24 gauge. All edges and corners must be sealed with zinc-coated steel or extruded aluminum. The completed panels must have a flame spread rating of 25 or less and smoke-developed index of 50 or less when tested in accordance with ASTM E84. Provide zinc-coated steel, extruded aluminum, fire resistant vinyl, or other fire resistant edging to protect shop and field edge cuts and cutouts through the face of panels in a manner to meet specified flame spread, smoke developed and Class A fire rating requirements.

][2.2.3.5 Lightweight Concrete Filled Panels (Exposed Concrete)

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NOTE: Lightweight concrete filled panels are either solid or metal clad. They perform well under dynamic loadings with little deformation and their weight is approximately 195 kg/m^2 10 psf. They are primarily used in office flooring and are similar in cost to cementitious fill panels.

****

Provide lightweight concrete of lightweight structural concrete with either structural reinforcing or a die-formed, hot dipped galvanized steel bottom pan. All concrete surfaces, including those resulting from field cuts, must be sealed with the manufacturer's standard sealer before covering the surfaces with other materials. Concrete sealer must meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for concrete sealer.

]2.2.4 Floor Covering

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NOTE: Verify with Using Agency and manufacturers which finishes are recommended for what type of

functional space, type of panel and understructure. Delete finish paragraphs that are not applicable to the project.

Clearly indicate in contract documents where different floor covering types are located if more than one type is specified for a project.

Verify that finishes being considered are approved for use by the access flooring manufacturer. Some finishes may be considered standard by some manufacturers and non-standard by others which could add cost to the project. The finishes need to be of a size that is appropriate for a one-to-one installation to the floor panel with no seams, size needs to be slightly smaller than a standard 610 by 610 mm 24 inch by 24 inch. Coordinate size with access flooring manufacturer. Note that not all manufacturer floor tile products are available in the required size and may require additional cuts, this may add cost to the project and add product waste.

Consider the desired aesthetics, appearance and use of a facility and the following edge detail information to determine the type of floor covering edge detail preferred for a project:

a. Cementitious Filled Formed Steel (Composite) and Lightweight Concrete Filled (Exposed Concrete) Panels with factory applied high pressure laminate or resilient flooring material - The integral finish edge detail is available from more manufacturers than the applied trim piece edge detail. If the applied trim piece detail is acceptable for a project, recommend that both types remain in the specification to open it up to more manufacturers so the specification does not become proprietary with only the applied trim piece. The integral finish detail is more durable than the applied trim piece which can become damaged.

b. Metal-Clad Wood Core Panels with factory applied high pressure laminate material- Edge detail is available both integral to the finish material and as an applied trim piece dependent upon the manufacturer. Recommend that both types remain in the specification to open it up to more manufacturers so the specification does not become proprietary.

c. Metal-Clad Wood Core Panels with factory applied resilient flooring material- Edge detail with applied trim piece is more typical.

d. Steel and Aluminum Panels - Edge detail is available both integral to the finish material and as an applied trim piece dependant upon the manufacturer. Recommend that both types remain in the specification to open it up to more manufacturers so the specification does not become proprietary.

Verify that finish being considered is appropriate for the system specified when raised access floor panels are required to be screwed into place. Panels that are screwed into place and have a factory finish that is bonded into place will have an exposed screwhead in each corner. The screwhead for resilient floor materials will be flush with panel face and not finish face and may require additional maintenance to clean out screwhead locations. If it is determined that a panel with factory applied finish will be screwed into place verify with Using Agency if a requirement for finish plugs be added to the specification to provide a more finished appearance and coordinate availability with the manufacturer. These plugs would be the same material as the panel finish and would be installed to cover the exposed screwhead. Plugs are not permanent, can come out and become lost. Plug should be installed per manufacturer recommendations for easy removal and replacement for Using Agency to access underfloor area.

Choice of critical radiant flux level as it applies to building type and area of application will be made in accordance with UFC 3-600-01, UFC 1-200-01 and NFPA 101. Wherever the use of Class II (0.22) watts finish is required, Class I (0.45) watts will be permitted.

Aluminum panels often do not receive an applied finish. If it is determined a finish is required, add edge detail requirement to applicable finish paragraph inside empty brackets.

Verify with manufacturer if embossed texture being specified is acceptable for use with the lifting device.

****

Surface floor panels with [factory applied finish materials firmly bonded in place with waterproof adhesive][carpet tile installed in the field]. Provide finish flooring materials in corridors and exits with a critical radiant flux of not less than [0.45 watts per square centimeter (Class 1)][0.22 watts per square centimeter (Class 2)] when tested in accordance with ASTM E648 or NFPA 253. The electrical resistance must remain stable over the life expectancy of the floor covering. Any anti-static agent used in the manufacturing process must be an integral part of the material, not surface applied. Bolt heads or similar attachments must not rise above the traffic surface. Submit [three] [_____] separate samples of each specified floor covering finish and color.

[2.2.4.1 High Pressure Laminate

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NOTE: HDM, 2 mm 1/16 inch thick high pressure laminate is typically used. HDH, 3.2 mm 1/8 inch thickness is also available, but is more expensive than the HDM.

****

Provide factory applied high pressure laminate surfacing conforming to ANSI/NEMA LD 3, High-Wear type, Grade [HDM, 2 mm 1/16 inch thickness][_____]. Finish material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]]. The total system electrical resistance from the wearing surface of the floor to the ground connection must be between 1,000,000 (1.0 x 10^6) ohms and 20,000,000,000 ohms (2.0 x 10^{10}).

][2.2.4.2 Conductive High Pressure Laminate

****

NOTE: HDM, 2 mm 1/16 inch thick high pressure laminate is typically used. HDH, 3.2 mm 1/8 inch thickness is also available, but is more expensive than the HDM.

****

Provide factory applied high pressure laminate surfacing conforming to ANSI/NEMA LD 3, High-Wear type, Grade [HDM, 2 mm 1/16 inch thickness][_____]. Finish material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]]. The total system electrical resistance from the wearing surface of the floor to the ground connection must be between 25,000 ohms (2.5 x 10^4) and 1,000,000 ohms (1.0 x 10^6).

][2.2.4.3 Solid Vinyl Tile

Provide factory applied conductive vinyl tile that is a homogeneous vinyl product and conforms to ASTM F1700, Class I monolithic (minimum wear layer thickness 3 mm 0.125 inch and minimum overall thickness 3 mm 0.125 inch), Type A smooth surface. Finish material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]].

][2.2.4.4 Luxury Vinyl Tile

Provide factory applied luxury vinyl tile conforming to Class III printed film minimum wear layer thickness of 0.50 mm 0.020 inch and minimum overall thickness 3 mm 0.125 inch, Type [A (smooth)] [B (embossed)]. Finish material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]].

][2.2.4.5 Conductive Vinyl Tile

Provide factory applied conductive vinyl tile that is a homogeneous vinyl product and conforms to ASTM F1700, Class I monolithic, Type A smooth surface. Provide electrical resistance from surface to surface and surface to ground between 25,000 ohms (2.5 x 10^4) and 1,000,000 ohms (1.0 x 10^6) when tested in accordance with ASTM F150. Material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]].

][2.2.4.6 Static-Dissipative Vinyl Tile

Provide factory applied static-dissipative vinyl tile that is a homogeneous vinyl product and conforms to ASTM F1700, Class I monolithic, Type A smooth surface. Provide electrical resistance from surface to surface and surface to ground between 1,000,000 ohms (1.0 x 10^6) and 1,000,000,000 ohms (1.0 x 10^9) when tested in accordance with ASTM F150. Material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]].

][2.2.4.7 Carpet Tile

****

NOTE: Consider the function of the room, Using Agency requirements and consult with the project electrical engineer when determining the type of carpet that is appropriate, 09 68 00 CARPETING or 09 62 38 STATIC-CONTROL FLOORING (for static-control carpet tile).

Be aware that full spread releasable if not installed in accordance with manufacturer required drying time can become overly tacky making it difficult to remove from screwheads and between panels and to lift carpet tile from panel.

Coordinate carpet tile selection for one to one alignment with floor panels with the access flooring manufacturers. Due to the size required (slightly smaller than 610 by 610 mm 24 inch by 24 inch) the access flooring manufacturers have a variety of standard carpets available from different carpet manufacturers.

Recommend listing at least two manufacturers for one to one alignment so specification does not become proprietary.

Installation method for one to one alignment with floor panels is limited to monolithic and quarter turn installation patterns.

Do not use the odor-free adhesive tab system or full spread releasable adhesive to achieve a one to one alignment with floor panels. This is not recommended by manufacturers.

Over ramps and steps to be covered with carpet tile, consider backed sheet carpet by the same manufacturer as the carpet tile fully adhered in place and protected and restrained at edges to avoid fall or slip risks that could arise with

delaminating or slipping carpet tiles.
****

Reference Section [09 68 00 CARPETING][and][09 62 38 STATIC-CONTROL FLOORING (static-control carpet tile)] for carpet tile specification requirements including recycled content, volatile organic compound (VOC) limits, and additional flammability testing requirements for carpet tile. Carpet tile must be field installed and comply with the following:

a. Installation method on level surfaces must allow carpet tile to be easily removed and replaced in the field and must be installed in accordance with manufacturer's recommended installation instructions.

b. Install carpet tile in a [monolithic][1/4 turn][ashlar][brick][random][_____] pattern.

[c. Install carpet tile on secure and level surfaces offset from the access floor grid with a [manufacturer approved odor-free adhesive tab system][or][with full spread releasable adhesive using manufacturer recommended adhesives. Comply with manufacturer installation instructions for required drying time so the adhesive sets up properly].

][d. Install carpet tile on secure and level surfaces with the access flooring manufacturer's recommended mechanical installation method and components for a one to one alignment with floor panels (one carpet tile to one floor panel); confirm source of mechanical connectors by either flooring panel or carpet tile manufacturer. This installation method requires the removal of only one carpet tile to access one raised access panel. Provide coordinated layout drawings of connectors, modular carpet tile joints, flooring panel joints, and penetrating items through carpet tiles and flooring panels. Carpet tile size for a one-to-one installation must be slightly smaller than a standard 610 by 610 mm 24 inch by 24 inch tile, coordinate required size with the raised access flooring manufacturer. Factory applied carpet tile with perimeter edge strip and field applied one to one carpet tile installation over raised access floor panels with permanent or releasable adhesive are not acceptable installation methods.

][e. Carpet tile on access flooring stairs and sloped surfaces must be installed with a more permanent installation method in accordance with manufacturer's instructions and with manufacturer recommended adhesives for these types of locations to prevent delamination or slippage of carpet tiles.

]][2.2.4.8 Lightweight Concrete Filled (Exposed Concrete)

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NOTE: Bare panels may be specified to achieve a desired visual aesthetic. Finish panels with sealer to prevent dusting and to minimize water absorption. Using Agency should be made aware that sealer will need to be reapplied over time.
****

Provide lightweight concrete filled panel with a [MPI 58 concrete stain][and][[MPI 104 concrete floor sealer][or][MPI 99 water based concrete floor sealer]]. Apply coatings in accordance with manufacturer's instructions.

]2.2.5 Accessories

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NOTE: Perforated panels are preferred for use in areas with hard surfaces such as high pressure laminates, and grilles or registers are preferred in areas with carpet

****

Provide the manufacturer's standard registers, grilles, perforated panels, and plenum dividers type where indicated. Provide registers, grilles, and perforated panels designed to support the same static loads as floor panels without structural failure, and capable of delivering the air volumes indicated. Registers and perforated panels must be 25 percent open area and equipped with adjustable dampers. Submit [three][_____] samples and colors of each accessory. Provide[round][slotted] perforations.

2.2.6 Resilient Base

Conform to ASTM F1861, [[Type TS (vulcanized thermoset rubber)] [or] [Type TP (thermoplastic rubber)]] [, or] [Type TV (thermoplastic vinyl)], [Style A (straight - installed with carpet)] [and] [Style B (coved - installed with resilient flooring)]. Provide [100] [150] mm [4] [6] inch high and a minimum 3.175 mm 1/8 inch thick wall base. Provide [preformed] [job formed] corners in matching height, shape, and color.

2.2.7 Adhesives

Provide adhesives as recommended by the manufacturer. Provide non-aerosol adhesive products that meet either emissions requirements of CDPH SECTION 01350 (use the requirements for either office or classroom, regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives that meet either emissions requirements of CDPH SECTION 01350 (use the requirements for office or classroom, regardless of space type) or VOC content requirements of GS-36. Provide validation of indoor air quality for adhesives.[Provide conductive adhesive as recommended by the manufacturer of the static-control flooring.][Provide conductive releasable adhesive as recommended by the manufacturer for static-control carpet tile.]

2.2.8 Lifting Device

At turn over provide one floor panel lifting device standard with the floor manufacturer, for each individual floor area (room or corridor). Furnish a minimum of two devices. For AIR FORCE projects, at turnover, provide a total of two suction-type floor panel lifting devices for each floor area (room or corridor).

2.3 PANEL SUPPORT SYSTEM

Design support system to allow for 360 degree clearance in laying out cable and cutouts for service to machines and so that panel and stringer together take up maximum of 50 mm 2 inches. Submit one sample of suspension system proposed for use.

2.3.1 Pedestals

Provide pedestals made of steel or aluminum or a combination thereof. Ferrous materials must have a factory-applied corrosion-resistant finish.

Provide pedestal base plates with a minimum of 10,300 square mm 16 square inches of bearing surface and a minimum of 3 mm 1/8 inch thickness. Pedestal shafts must be threaded to permit height adjustment within a range of approximately 50 mm 2 inches, to permit overall floor adjustment within plus or minus 2.5 mm 0.10 inch of the required elevation, and to permit leveling of the finished floor surface within 1.56 mm 0.062 inch in 3000 mm 10 feet in all directions. Provide locking devices to positively lock the final pedestal vertical adjustments in place. Pedestal caps must interlock with [panels] [stringers] to preclude tilting or rocking of the panels.

2.3.2 Stringers

****

NOTE: Specify bolted stringer and bolted panel systems. Specify bolted stringer type system and high pressure laminate finish for computer room access flooring in Air Force and Naval Warfare Systems Command (SPAWARS) facilities, except where die-cast interlocking panel to pedestal aluminum system is designated. SPAWARS may be involved in Air Force and Army projects, verify and coordinate requirements with Using Agency.

Consideration must be given to equipment planned for installation including type and amount of grounding required. If such equipment has extendable drawers or chassis which require equipment to be firmly anchored to prevent overturning, a rigid grid stringer system of suitable strength and rigidity may be used as anchoring point in lieu of fabricating special subfloor foundations for such equipment, which would restrict 360 degree freedom. The specification may require modification to provide sufficiently rigid grid system to accommodate this condition.

****

Provide stringers of rolled steel or extruded aluminum, to interlock with the pedestal heads to prevent lateral movement. Provide stringers that can be added or removed after floor is in place.[

Provide positive fastener connections between floor panels and supporting stringers in lieu of reliance on gravity alone.]

2.3.3 Gaskets

Provide continuous gasketing at contact surfaces between panel and stringers to deaden sound and seal off the underfloor cavity from above for air tightness, and to maintain panel alignment.

2.4 FASCIA

Provide aluminum or steel fascia plates at open ends of floor, at sides of ramps and steps, and elsewhere as required to enclose the free area under the raised floor. Steel plates must have a factory applied baked enamel finish. Finish on aluminum plates must be standard with the floor system manufacturer. Fascia plates must be reinforced on the back, and supported using the manufacturer's standard lateral bracing at maximum 1200 mm 4 feet on center. Provide trim, angles, and fasteners as required. Submit [three][_____] color samples for fascia.

2.5 STEPS AND RAMPS

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NOTE: Coordinate step and ramp finish with finishes specified in FLOOR COVERINGS and insert selected finish. Resilient flooring is recommended if there will be a lot of cart traffic. Carpet tile should be installed with a permanent adhesive.

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Securely fasten steps and ramps to the access flooring system and to the structural floor. Include in the construction standard floor system components and custom components as required, and all supports, fasteners, and trim necessary for a finished installation. Step nosings, threshold strips, and floor bevel strips must be cast or extruded aluminum with non-slip traffic surfaces. Submit [three][_____] color samples for exposed step and ramp structure.

2.5.1 Steps

Height of risers must comply with applicable codes. Design steps to support a uniform load of 7.18 kPa 150 psf. Surface treads with the manufacturer's standard non-slip floor finish. Floor covering must be [____].

2.5.2 Ramps

Slope of ramps must comply with applicable codes and 36 CFR 1191 Americans with Disabilities Act (ADA). In no case will ramps be steeper than 1:12 (rise:run). Design ramps to support the same loads as specified for floor panels. Surface ramps with the [manufacturer's standard fixed non-slip floor finish approved for ramp traffic][____].

2.6 RAILINGS

****

NOTE: Where open sides of floors are 1200 mm (4 feet or more above adjacent ground or floor level, install "standard railing" in accordance with CFR 1910.23(e). Run post through raised floor and bolt to concrete floor for stability.

****

Provide railings compliant with applicable codes and 36 CFR 1191 Americans with Disabilities Act (ADA). As a minimum railings must be of the double rail and post type, fabricated of at least [25 mm 1 inch] [_____] [round] [square] seamless [aluminum tubing] [_____] with a [satin natural anodized] [_____] finish. At steps and ramps, make the top rail a minimum of 900 mm 36 inches high and parallel to the incline. Make the top rail 1050 mm 42 inches high at open ends of the floor. Guardrails must have intermediate rails or an ornamental pattern such that a sphere 100 m 4 inches in diameter cannot pass through. Space posts maximum of [1200] [1500] [1800] mm [4] [5] [6] feet oc. Provide railings complete with anchorages, floor plates, and end caps.[Electronically ground hand rails to raised floor system to prevent static build-up.] Submit [three][_____] color samples for railings.

2.7 FACTORY TESTS

Factory test access flooring, using an independent laboratory, at the same position and maximum design elevation and in the same arrangement as shown on the drawings for installation so as to duplicate service conditions as much as possible.

2.7.1 Load Tests

Conduct floor panel, stringer, and pedestal testing in accordance with CISCA Access Floors to determine deformation and permanent set of panels and systems due to concentrated, Uniform, rolling, impact and ultimate loading when panels are supported by actual understructure.

2.7.2 Bond Strength of Covering

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NOTE: Coordinate test load weights with those specified for floor panel testing in General System Requirements.

Delete this test when field applied carpet tile is specified.

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Conduct test for bond strength of covering in accordance with CISCA Access Floors for rolling loads, except as specified. Panels must be tested with specified hard surface flooring and on the pedestals and stringers as specified for the installed floor. Brace the supports as necessary to prevent sideways movement during the test. Impose a test load of [3560] [4450] [5560] [6670] [8890] [_____] N [800] [1000] [1250] [1500] [2000] [_____] pounds on the test assembly through a 75 mm 3 inches in diameter and 25 mm 1 inch wide hard plastic caster. Roll the caster completely across the center of the panel. The panel must withstand 20 passes of the caster with no delamination or separation of the covering.

[2.8 REGISTERS AND GRILLES

****

NOTE: Size of registers should be stated if applicable. Coordinate with Mechanical Engineer.

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Registers and grilles must be [_____] mm inches by [_____] mm inches long with a minimum free area of [_____] square mm inches, made from extruded [aluminum] [_____], in [mill] [_____] finish, to sustain point loads of 2669 newton 600 pounds per vane without failure or permanent deformation. No part of a grille may project more than 3 mm 1/8 inch above the floor. Registers and grills are not permitted in a laminate floor tile system.

][2.9 PERFORATED AIR SUPPLY PANELS

Provide air supply floor panels that meet the design criteria specified for standard panels, to sustain point loads of 4448 newton 1000 pounds without failure or permanent deformation, are fabricated of 2 mm 14-gage perforated steel sheet welded to minimum 1.6 mm 16-gage side channels, are covered with high pressure laminate to match standard panels, and have a uniform perforated pattern to allow even air distribution.

][2.10 PERFORATED DIRECTIONAL AIR SUPPLY PANELS

Provide directional air supply floor panels that meet or exceed the design criteria specified for standard panels, are fabricated of [light weight die cast aluminum with powder coat finish] [welded steel vanes with powder coat finish] [perforated steel sheet welded to a formed steel pan with powder coat finish]. Submit [three][_____] color samples for perforated directional air supply panels.

][2.11 CUT OUTS

Provide cable cutouts finished with rigid polyvinylchloride or molded polypropylene edging to conform to the appearance level of the floor surface and to cover raw edges of the cutout panel. Extrusion must be of a configuration to permit its effective and convenient use when new cable openings are required. Provide at least 7300 mm 24 feet of additional extrusion for future use. Submit [three][_____] color samples for cut outs.

a. Provide non-metallic adapter for openings less than 100 mm 4 inches wide. Secure adapter adhesively in cutout to preclude removal from panel. Provide at least two adapters per 10 square meter 1000 square feet for future use.

b. Openings larger than 100 mm 4 inches wide must use rigid polyvinylchloride or molded polypropylene edging. Perform cutting of panels, including cutouts, outside of the building.

c. When size of cutout reduces the performance requirement of panel, provide intermediate stringers adjacent to cutouts.

][2.12 EDGE CLOSURE

Provide 1.5 mm 1/16 inch aluminum closure plate and extruded aluminum nosing, or manufacturer's standard method for supporting panel edges, at exposed edge of floor. Back up the closure plates with aluminum or steel framing braced diagonally, or anchor at bottom to continuous angle. Provide a transition between access flooring and adjoining floors at same level.

]2.13 PEDESTAL BASE FASTENERS

Provide [two][four] fasteners at each pedestal support base sized per ASTM E488/E488M to support loads without failure up to 1.5 times loads due to pedestal overturning moment.

Provide [ASTM B633 zinc plated steel][ASTM F593] post-installed fasteners for securing pedestal bases to supporting concrete floor slabs.

2.14 COLOR

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally UFGS 09 06 00 SCHEDULES FOR FINISHES or as indicated is used when the project is designed by an Architect or Interior designer. Color should be selected from manufacturer's standard colors or identified as a manufacturer's color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located as indicated, a note must be added to the drawings that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note that there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is referenced, be certain that the product conforms to this specification, as edited.

****

Color must be [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES][as indicated][______]. Color listed is not intended to limit the selection of equal colors from other manufacturers.

PART 3 EXECUTION

3.1 INSTALLATION

Install access flooring at the location and elevation and in the arrangement shown on the approved detailed installation drawings. The floor system must be of the rigid grid stringer type, complete with all supplemental items, and be the standard product of a manufacturer specializing in access flooring systems.

Install the floor system in accordance with the manufacturer's instructions. Open ends of the floor, where the floor system does not abut wall or other construction, must have positive anchorage and rigid support. Maintain areas to receive access flooring between [16] [4] and 32 degrees C [60] [40] and 90 degrees F, and between 20 and 70 percent humidity for 24 hours prior to and during installation.

3.1.1 Preparation for Installation

****

NOTE: Section 03 30 00 CAST-IN-PLACE CONCRETE should require that concrete floors used as air plenum surfaces beneath raised floors be sealed with approved liquid sealer compound. Sealer should be compatible with pedestal adhesive, if pedestals are anchored with adhesive. If a non-compatible sealer is applied before pedestals are anchored, specify removal of sealer at pedestal locations before adhesive is applied. If an existing subfloor has been painted or otherwise sealed with non-compatible sealer or paint, specify removal of coating before applying adhesive.

****

Clear out all debris in the area in which the floor system is to be installed. Thoroughly clean structural floor surfaces and remove all dust. Install floor coatings, required for dust or vapor control, prior to installation of pedestals, only if the pedestal adhesive will not damage the coating. If the coating and adhesive are not compatible, apply the coating after the pedestals have been installed and the adhesive has cured.

3.1.2 Pedestals

****

NOTE: Seismic calculations must be made by the designer to determine if adhesives or anchors are to be used; pedestal adhesives must be capable of securing pedestals in place with sufficient bonding strength to resist an overturning force of 113 N-m 1000 inch-pounds. If the calculations indicate the overturning force is greater than 113 N-m 1000 inch-pounds steel expansion anchors will be used.

****

Pedestals must be accurately spaced, and set plumb and in true alignment. Set base plates in full and firm contact with the structural floor, and secured to the structural floor with adhesive or steel expansion anchors in accordance with manufacturer's instructions, and as required by seismic design.

3.1.3 Stringers

Interlock stringers with the pedestal caps to preclude lateral movement, spaced uniformly in parallel lines at the indicated elevation.

3.1.4 Auxiliary Framing

Provide auxiliary framing or pedestals around columns and other permanent construction, at sides of ramps, at open ends of the floor, and beneath panels that are substantially cut to accommodate utility systems. Use special framing for additional lateral support as shown on the approved detailed installation drawings. Provide additional pedestals and stringers designed to specific heights and lengths to meet structural irregularities and design loads. Connect auxiliary framing to main framing.

3.1.5 Panels

Interlock panels with supports in a manner that will preclude lateral movement. Fasten perimeter panels, cutout panels, and panels adjoining columns, stairs, and ramps to the supporting components to form a rigid boundary for the interior panels. Level floors within the specified tolerances. Cut edges of [steel and wood-core panels must be [painted] [finished] [_____] as recommended by the panel manufacturer.][Exposed edges of composite panels must be coated with a silicone rubber sealant or with an adhesive recommended by the panel manufacturer.] Secure extruded vinyl edging in place at all cut edges of all panel cut-outs to prevent abrasion of cables.[Where the space below the floor is a plenum, close cutouts for conduit and similar penetrations using self-extinguishing sponge rubber or air sealing grommets.]

3.1.6 Carpet Tile

Reference carpet tile paragraph in FLOOR COVERING for carpet tile installation requirements.

3.1.7 Resilient Base

Provide base at vertical wall intersections as indicated in the [drawings][_____]. Apply the base after the floor system has been completely installed. Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Tighten base joints and make even with adjacent flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

3.1.8 Fascia Plates

Cover exposed floor ends and exposed openings of ramps and stairs with [aluminum] [steel closures] [finish material as indicated on the drawings].

3.1.9 Repair of Zinc Coating

Repair zinc coating that has been damaged, and cut edges of zinc-coated components and accessories, by the application of a galvanizing repair paint conforming to ASTM A780/A780M. Areas to be repaired must be thoroughly cleaned prior to application of the paint.

3.2 FIELD TESTS

Submit certified copies of test reports from an approved testing laboratory, attesting that the proposed floor system components meet the performance requirements specified.

3.2.1 Acceptance Tests

Conduct acceptance tests after installation of floor system. Make at least one test for each [40] [100] [_____] square meters [400] [1000] [_____] square feet of floor area. Conduct tests in presence of Contracting Officer and representatives of manufacturer and installer. Submit certified copies of test reports from an approved testing laboratory, attesting that the proposed floor system components meet the performance requirements specified.

3.2.2 Air Leakage

****

NOTE: Delete the requirements for air leakage when the space under the finished floor is not used as an air plenum. Concrete floors to be used as air plenums must be sealed and coated. Coordinate with Mechanical Engineer for anticipated positive pressure in the plenum.

****

When the space below the finished floor is an air plenum, air leakage through the joints between panels and around the perimeter of the floor system must not exceed 0.15 L/s of air per linear meter 0.1 cubic foot of air per minute per linear foot of joint subjected to 2.5 mm [.05 inches h2o (Pa)][0.1 inches h2o (Pa)], water gauge, positive pressure in the plenum, when tested in accordance with CISCA Access Floors, Section 10 Air Leakage Test. Measure the leakage rate on the finished raised floor system, which may include carpet.

3.2.3 Grounding

****

NOTE: Access flooring system must be grounded for safety hazard and static control. The three most common static control requirements are:

1. Computer rooms, electronic offices, data centers and control rooms. The access floor system should provide resistance from floor wearing surface to building grounding electrode within range of 0.5 to 20,000 megohms.

2. Clean rooms, laboratories, and other environments which are more sensitive to static discharge. The access floor system should provide resistance within range of 0.2 to 2.0 megohms.

3. Hospitals and other facilities described by NFPA 99 and referenced to UL 779. The access floor system should provide resistance within range of 0.025 to 1.0 megohms.

These limits may be changed if other values are required by the Using Agency. Design the grounded floor system to provide positive contact between all metal components. Grounding details must be shown on the project drawings; the option of using manufacturer's alternate methods of grounding may be included in the project specification.

****

Ground the access flooring system for safety hazard and static suppression. Provide positive contact between components for safe, continuous electrical grounding of entire floor system. Total system resistance from wearing surface of floor to building grounding electrode must be within range of [0.5 to 20,000 megohms] [0.2 to 2.0 megohms] [0.025 to 1.0 megohms].

3.2.3.1 Metal Grilles

Exposed metal is not allowed at wearing surface of access floor system, except at metal grilles and registers. When grilles and metal registers are provided, insulate as required to provide same grounding resistance as wearing surface.

3.2.3.2 Joint Resistance

****

NOTE: Coordinate with electrical drawings and specifications to assure that connection to building grounding electrode is shown. Do not use sound deadening materials which prevent grounding of

system. Select a total system resistance to comply with Using Agency requirements.
****

Electrical joint resistance between individual stringer and pedestal junctions must be less than 10 ohms. Electrical resistance between stringers and floor panels, as mounted in normal use, must be less than 10 ohms when tested in accordance with ASTM F150.

3.2.4 Electrical Resistance

Conduct testing of electrical resistance, in the completed installation, in the presence of the Contracting Officer in accordance with NFPA 99, modified by placing one electrode on the center of the panel surface and connecting the other electrode to the metal flooring support. Take measurements at five or more locations. Each measurement must be the average of five readings of 15 seconds duration at each location. During the tests, relative humidity must be 45 to 55 percent and temperature set at 21 to 24 degrees C 69 to 75 degrees F. Select panels used in the testing at random and include two panels most distant from the ground connection. Measure electrical resistance with instruments that are accurate within 2 percent and that have been calibrated within 60 days prior to the performance of the resistance tests. The metal-to-metal resistance from panel to supporting pedestal must not exceed 10 ohms. The resistance between the wearing surface of the floor covering and the ground connection, as measured on the completed installation, must be in accordance with paragraph FLOOR COVERING.

[3.2.5 SEISMIC SPECIAL INSPECTION AND TESTING

****
NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by Appendix 11A of ASCE 7-16.

This paragraph will be applicable to both new buildings designed according to UFC 3-301-01 SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs.

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with UFC 3-301-01 and Appendix 11A of ASCE 7-16. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.
****

Perform special inspections and testing for seismic-resisting systems and components in accordance with UFC 3-301-01 and Section 01 45 35 SPECIAL INSPECTIONS.

]3.3 CLEANING AND PROTECTION

3.3.1 Cleaning

Keep the space below the completed floor free of all debris. Before any traffic or other work on the completed raised floor is started, clean the completed floor in accordance with the floor covering manufacturer's instructions.[Do not permit seepage of cleaner between individual panels.][Cleaning of ferrous surfaces must conform to FS TT-C-490.]

3.3.2 Protection

Protect traffic areas of raised floor systems with a covering of building paper, fiberboard, or other suitable material to prevent damage to the surface. Cover cutouts with material of sufficient strength to support the loads to be encountered. Place plywood or similar material on the floor to serve as runways for installation of heavy equipment not in excess of design load capacity. Maintain protection until the raised floor system is accepted.

3.3.3 Surplus Material Removal

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work. Remove all installation equipment, surplus materials, and rubbish from the work site.

[3.4 FIRE SAFETY

Install an automatic detection system below the raised floor meeting the requirements of NFPA 75 paragraph 5-2.1 to sound an audible and visual alarm. Air space below the raised floor must be subdivided into areas not exceeding 929 square meters 10,000 square feet by tight, noncombustible bulkheads. Seal all penetrations for piping and cables to maintain bulkhead properties.

]3.5 OPERATION AND MAINTENANCE MANUALS

Submit maintenance instructions for proper care of the floor panel surface. When conductive flooring is specified, also submit maintenance instructions to identify special cleaning and maintenance requirements to maintain "conductivity" properties of the panel finish. Include requirements for maintenance of required dry and wet flooring slip resistance for level and ramped surfaces complying with ASSP A1264.1.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-09 69 19 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-09 69 19 (November 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-09 69 19 (November 2024)**

Preparing Activity: USACE **Superseding**
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SECTION 09 69 19

STRINGERLESS ACCESS FLOORING

11/24

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UFGS Manager NOTE: (This note does not apply to the designer.) When making a change to this UFGS also make it to UFGS 09 69 13 RIGID GRID ACCESS FLOORING where applicable since the two specifications are so similar.

****

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NOTE: This Guide Specification covers the requirements for stringerless access flooring.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in the respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)

****

PART 1 GENERAL

****

NOTE: This specification does not include the floor upon which the elevated floor is superimposed, except to define the nature and condition of the supporting floor.

Access flooring systems include floor panels, pedestals and items such as steps, ramps, closures

and trim. Access flooring systems must be designed to accommodate static, rolling and impact loading.

None of the mechanical and electrical services essential to the operation of equipment are included. Coordinate with mechanical and electrical to provide ventilation and cable openings which will be required.

The designer is responsible for identifying and defining requirements for the floors. Drawings must indicate location and limits of the flooring systems, finish floor elevation, panel size, type, finish and anti-static provisions, colors, pedestal mounting and subfloor connection system details.

RIGID GRID ACCESS FLOORING is covered in SECTION 09 69 13.

Stair and/or ramp information, such as tread width and riser height for stairs and width, slope and length of ramps, including railings, are included in this section.

Ancillary components such as floor diffusers and grills, fascias and floor opening trims are also included.

Seismic loadings and any other information required to indicate the extent of work must be considered in designing access flooring systems.

There are three fundamental conditions relative to the design of access flooring installations:

Condition I - Floors are completely surrounded by building walls. These are the most resistant to seismic loadings.

Condition II - Floors have part of the edge exposed and not restrained by other structural elements. Condition II floors are less resistive to seismic loadings along the axis of the unconstrained side. Seismic loadings can be resisted by securing the perimeter panels of all floors to the supporting structural framing and fitting the panels tightly together, or by cross bracing the structural frame to resist overturning. The designer must select fascia type and finish for exposed edges.

Condition III - Floors are free standing without lateral contact with other structural elements. Type III floors are primarily strengthened with cross bracing to resist lateral loads.

Buildings not excluded by UFC 3-301-01 or TI 800-01 Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA-ABA) Accessibility Guidelines for Buildings

and Facilities and Architectural Barriers Act (ABA) Accessibility Guidelines.

On the drawings, show:

1. Extent and shape of access flooring area. Include details of panel-to-panel and panel-to-wall intersections, edge treatment at openings, expansion joints, elevation(s) above structural floor, and other special features of the elevated floor system.

2. Location and design of ramps, steps, and doors to access floor area; railing heights and design.

3. Location and sizes of registers, grilles, perforated panels, and cable openings through access floor panels.

4. Design and type of plenum fire extinguishing systems, if space under access floor is to be used as air plenum.

5. Layout of plenum dividers.

6. Pattern of access floor panels.

7. Location of building electrode. Coordinate structural grounding connections with appropriate building and electrical systems.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A1264.1	(2017) Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrail/Handrail Systems

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA E30	(2016) Engineered Wood Construction Guide
APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood

ASTM INTERNATIONAL (ASTM)

ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B85/B85M	(2018) Standard Specification for Aluminum-Alloy Die Castings
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F150	(2006; R 2013) Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F1700	(2024) Standard Specification for Solid Vinyl Floor Tile
ASTM F1861	(2021) Standard Specification for Resilient Wall Base

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CEILINGS AND INTERIOR SYSTEMS CONSTRUCTION ASSOCIATION (CISCA)

CISCA Access Floors	(2007) Recommended Test Procedures for Access Floors

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A208.1	(2022) Particleboard
CPA A208.2	(2016) Medium Density Fiberboard (MDF) for Interior Applications

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC300	(2014) Acceptance Criteria for Access Floors

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

MASTER PAINTERS INSTITUTE (MPI)

MPI 58	(2012) Stain for Concrete Floors
MPI 99	(2012) Sealer, Water Based, for Concrete Floors
MPI 104	(2012) Sealer, Solvent Based, for Concrete Floors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 75	(2024) Standard for the Protection of Information Technology Equipment
NFPA 99	(2024) Health Care Facilities Code
NFPA 253	(2011) Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1113	(2016) Architectural Coatings
SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-C-490	(Rev H; 2024) Chemical Conversion Coatings and Pretreatments for Metallic Substrates (Base for Organic Coatings)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Installation Drawings; G, [_____]

Fabrication Drawings; G, [_____]

SD-03 Product Data

Access Flooring System; G, [_____]

Recycled Content For Access Flooring System; S

Indoor Air Quality For Pedestal Adhesive; S

Indoor Air Quality For Concrete Sealer; S

Indoor Air Quality For Adhesives; S

SD-04 Samples

Floor Panels

Floor Covering; G, [_____]

Panel Support System

Accessories; G, [_____]

Fascia; G, [_____]

Exposed Step and Ramp Structure; G, [_____]

Railings; G, [_____]

Perforated Directional Air Supply Panels; G, [_____]

Cut Outs; G, [_____]

SD-05 Design Data

Seismic Calculations

SD-06 Test Reports

Factory Tests

Concentrated Load

Uniform Live Load

Rolling Load

Impact Load

Ultimate Load

Pedestal Axial Load

Bonding Strength of Pedestal Adhesive

Electrical Resistance

Field Tests

SD-07 Certificates

Compliance with ICC-ES AC300

Compliance with ICC IBC

Certificate of Compliance

Qualification of Manufacturer

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

SD-11 Closeout Submittals

Lifting Device

Warranty; G, [_____]

1.3 SPARE PARTS

****

NOTE: To assure matching floor panel, which may become damaged and require replacement, supply of extra stock is recommended. Set amount based on conditions of specific project. Do not specify extra stock unless Using Agency concurs; warehousing may not be available.

****

Furnish spare floor panels for each finish including bare panels for carpet tile, complete pedestal assemblies at the rate of one for each 100 or fraction thereof required.Provide [four] [_____] floor panels complete with specified floor covering for future use.Provide four spare panels with identical floor covering and pedestals for each 100 square meters 1,000 square feet of access flooring and total of 3 linear meters 10 linear feet of cut-out trim. Store extra stock in same manner and location as project materials.[Provide extra carpet tile from same dye lot consisting of uncut tiles for future maintenance. Provide a minimum of [three][_____] percent of total square meters square yards of each carpet type, pattern, and color. Furnish [[five][____] percent extra of total adhesive tabs][[one][____] percent extra of total components] required for installing carpet tile.]

1.4 QUALITY CONTROL

1.4.1 Qualification of Manufacturer

****

NOTE: Specify 5 years manufacturer experience unless directed otherwise by the Government

****

Access flooring manufacturer must have at least 5 years experience in manufacturing access flooring systems. Certify that the manufacturer of the access flooring system meets requirements specified under paragraph entitled QUALIFICATION OF MANUFACTURER.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver materials to site in undamaged condition, in original containers or packages, complete with accessories and instructions. Label packages with manufacturer's name and brand designations. Package materials covered by specific references bearing specification number, type and class as applicable.

1.5.2 Storage

Store all materials in original protective packaging in a safe, dry, and clean location. Store panels at temperatures between 4 and 32 degrees C 40 and 90 degrees F, and between 20 and 70 percent humidity. Replace defective or damaged materials.

1.5.3 Handling

Handle and protect materials in a manner to prevent damage during the entire construction period.

1.6 WARRANTY

****

NOTE: Manufacturers standard warranty is for one year. For government projects, at an additional cost, manufacturers will provide an extended warranty of 5 or more years.

****

Minimum manufacturer warranty must have no dollar limit, cover full system, and must have a minimum duration of [1] [5] [_____] years. Include an agreement to repair or replace floor panels or pedestals that fail within the warranty period in the standard performance guarantee or warranty. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of panels or support system.[For [high pressure laminate][conductive high pressure laminate][solid vinyl tile][luxury vinyl tile] provide manufacturer's standard performance guarantees or warranties that extend beyond a one-year period for finish materials.][For [conductive][static-dissipative] vinyl tile provide manufacturer's standard performance guarantees or warranties that extend beyond one year, standard warranty must not be less than a five year wear warranty and ten year conductivity warranty.][For carpet tile provide manufacturer's standard performance guarantees or warranties including a minimum two years for material and workmanship and ten years for wear, static control, tuft bind and delamination.]

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Access flooring support systems are available as either a stringer or stringerless system. Refer to Section 09 69 13 RIGID GRID ACCESS FLOORING for applications using stringers.

A stringer is a horizontal framing member that connects the pedestal head, supports the panel edges and adds lateral stability to the floor system. Stringers should be used on all systems with a height that exceeds 300 mm 12 inches.

Specify the stringer system in seismic zones or when the total area is over 278 square meters 3000 square feet unless the system provides bolted connection between the panel and pedestal. Coordinate with applicable codes and Structural Engineer.

For Air Force facilities, use stringer type floor systems for data processing facilities.

Consideration should be given to loads which will be imposed during operation. Some equipment, such as high speed printers require large quantities of paper to be delivered by carts. When in motion, these heavy loads may exceed capacity of floor system. Check with Using Agency and floor system manufacturer when heavy rolling loads are expected. Ensure that project specific floor loading requirements are fully coordinated with Structural Engineer and applicable codes.

Zinc whiskers can occur on the underside of raised floor systems which are treated with a zinc electroplated anti-corrosion coating. Zinc whiskers are small enough (2 microns in diameter up to several millimeters in length) to render normal dust filters on computer equipment ineffective. The result is possible electrical shorts and damage to circuitry and equipment. Zinc electroplated anti-corrosion coated components must be prohibited in office areas and data centers when the access flooring system is utilized as an air plenum.

****

a. Provide for self-alignment of floor panels, adjustable pedestals and readily removable floor panels covered as specified.

b. Make lateral stability of floor support system integral with panels. Finished assembly must be stable and free of vibration, noises, and rocking panels.[Provide stringerless system with equipotential plane grounding.]

c. Submit certificate of compliance attesting that the installed access floor system meets specification requirements, including all special equipment loads and specific electrical and or cable requirements for the complete access flooring system including, but not limited to the following:

   (1) Compliance with ICC-ES AC300 and Compliance with ICC IBC Acceptance Criteria for Access Floors.

   (2) Load-bearing capabilities of pedestals, floor panels, and pedestal adhesive resisting force.

   (3) Supporting independent laboratory test reports. For panel, stringer and pedestal load test results include concentrated loads at center of panel, panel edge midpoint, ultimate loads and uniform loads.

   (4) Floor electrical characteristics.

   (5) Material requirements.

   (6) An elevated floor system free of defects in materials, fabrication, finish, and installation, that will remain so for a period of not less than [_____] [1] years after completion.

d. Submit manufacturer's product data for access flooring system consisting of descriptive data, catalog cuts, and installation instructions. Include in the data information about any design and production techniques, total system including all accessories and finish coatings of under-floor components, procedures and policies used to conserve energy, reduce material, improve waste management or incorporate green building/recycled products into the manufacture of their components or products. Include cleaning and maintenance instructions. Systems which contain zinc electroplated anti-corrosion coatings are prohibited.

2.1.1 Design Requirements

****

NOTE: Insert heavier load as required by facility use conditions. The deflection and permanent deformation limits are for panels 610 by 610 mm (24 by 24 inches, and smaller.

Check manufacturer's literature for maximum loadings available. Generally, by ICC IBC, computer rooms are based on live load of12 kPa 100 psf and point load of 900 kg 2000 lbs. Server rooms may require greater floor loading. Coordinate design loads for access floor with project specific floor loading requirements, structural engineer and design of structural slab.

Project design loads will be in accordance with the International Building Code and UFC 1-200-01.

For most office spaces, underfloor systems rated at 6.9 to 8.6 MPa 1000 to 1250 PSI concentrated load

are adequate. For heavier traffic loads at loading docks, elevator entrances, and corridors underfloor systems rated at 10.3 MPa 1500 PSI are appropriate. Underfloor systems rated at 17.2 MPa 2500 PSI are available for heavy equipment.

When editing below paragraphs a., b., c., d. and f. ensure that each paragraph is matched up with it's matching option. Options in each paragraph are in matching sequential order.

****

Conduct floor panel testing in accordance with CISCA Access Floors. When tested as specified, make all deflection and deformation measurements at the point of load application on the top surface of the panel. Floor panels must be capable of supporting the following loads:

a. Concentrated load of [4450] [5560] [6670] [8900] [11120] [_____] N [1000] [1250] [1500] [2000] [2500] [_____] pounds on 645 square mm one square inch, at any point on panel, without a top-surface deflection more than 2.54 mm 0.10 inch, and a permanent set not to exceed 0.25 mm 0.01 inch in any of the specified tests. Testing must be in accordance with CISCA Access Floors, Section 1 Concentrated Loads with test panels being supported by understructure to be used with installed system instead of steel support blocks.

b. Uniform live load of [11.97] [14.36] [16.76] [19.15] [23.94] [_____] kPa/square meter [250] [300] [350] [400] [500] [_____] psf, without a top-surface deflection more than 1.0 mm 0.04 inch, and a permanent set not to exceed 0.25 mm 0.01 inch in any of the specified tests, when tested in accordance with CISCA Access Floors, Section 7 Uniform Load Test with test panels being supported by understructure to be used with installed system instead of steel support blocks.

c. A rolling load of [2670] [3560] [4450] [5340] [7110] [_____] N [600] [800] [1000] [1200] [1600] [_____] pounds applied through hard rubber surfaced wheel 152 mm 6 inch diameter by 51 mm 2 inch wide for 10,000 cycles over the same path. Permanent set at conclusion of test must not exceed 1.0 mm 0.040 inch when tested in accordance with CISCA Access Floors, Section 3 Rolling Loads.

d. A rolling load of [3560] [4450] [5560] [6670] [8890] [_____] N [800] [1000] [1250] [1500] [2000] [_____] pounds applied through a 75 mm 3 inch diameter by 30 mm 1-13/16 inch wide caster for 10 cycles over the same path, without developing a local overall surface deformation greater than 1 mm 0.04 inch. In accordance with CISCA Access Floors, Section 3 Rolling Loads, the permanent deformation limit under rolling load must be satisfied in all of the specified tests.

e. An impact load of [670] N [150] pounds anywhere on the panel dropped from a height of 914 mm 36 inches onto a 645 square mm 1 square inch area without failure of the system, according to CISCA Access Floors, Section 8 Drop Impact Load Test.

f. Ultimate Load. Panels must meet manufactures published Ultimate Load rating of [6230] [8010] [11120] [12450] [13790] [_____] N [1400] [1800] [2500] [2800] [3100] [_____] pounds when tested in accordance with CISCA Access Floors, Section 2 Ultimate Loading.

g. Safety Factor. Panels must provide a minimum Safety Factor of 5 times the uniform load specified above in accordance with ICC-ES AC300.

h. Recycled Content. Provide Access Flooring System (panels, stringers and pedestals) containing a minimum of [20] [_____] percent recycled content. Provide data identifying percentage of recycled content for access flooring system.

2.1.2 Allowable Tolerances

2.1.2.1 Floor Panel Flatness

Plus or minus 0.89 mm 0.035 inches on diagonal on top of panel or underneath edge.

2.1.2.2 Floor Panel Length

Plus or minus 0.4 mm 0.015 inch.

2.1.2.3 Floor Panel Squareness

Plus or minus 0.5 mm 0.02 inch in panel length.

2.1.3 Pedestals

****

NOTE: Pedestals consist of a base plate, post and an adjustable head, and are available in heights from 150 mm 6 inches to 2400 mm 96 inches. Pedestals 610 mm 24 inches high or higher must be securely anchored to the structural floor in addition to being held in place by adhesive.

Pedestals are normally held in place with an adhesive and must be in full contact with the subfloor surface. Pedestal 610 mm 24 inches high or higher will be securely anchored to the structural floor in addition to the adhesive.

For Air Force projects, the minimum pedestal height is 300 mm 12 inches.

****

Pedestals must be capable of supporting a [22.24 kN 5000 pound][26.69 kN 6000 pound] axial load without permanent deformation, when tested in accordance with CISCA Access Floors, Section 5 Pedestal Axial Load Test.

2.1.4 Bonding Strength of Pedestal Adhesive

****

NOTE: Use 113 Nm 1,000 lbf-in for raised floors with a maximum height of 610 mm 24 inches and 226 Nm 2,000 lbf-in for raised floor heights greater than 610 mm 24 inches up to 1219 mm 48 inches maximum. Raised floor heights greater than 1219 mm 48 inches require specific structurally designed bracing.

****

Adhesive for anchoring pedestal bases must have a bonding strength capable of resisting an overturning moment of[113 Nm 1,000 lbf-in][226 Nm 2,000 lbf-in] [_____] when a force is applied to the top of the pedestal in any direction, when tested in accordance with CISCA Access Floors, Section 6 Pedestal Overturning Moment Test. Pedestal adhesive must meet emissions requirement of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type). Provide validation of indoor air quality for pedestal adhesive.

2.1.5 Bond Strength of Factory Installed Covering

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NOTE: Coordinate test load weights with those specified for floor panel testing in General System Requirements.

****

Bond strength of floor covering must be sufficient to permit handling of the panels by use of the panel lifting device, and to withstand moving caster loads up to [3560] [4450] [5560] [6670] [8890] [_____] N [800] [1000] [1250] [1500] [2000] [_____] pounds, without separation of the covering from the panel.

2.1.6 Seismic Calculations

2.1.6.1 Navy Project Specific Requirements

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NOTE: For Navy projects, provide lateral bracing calculations on all installations. Level 1 Contracting Officer's approval was granted for calculations by a registered professional engineer. Occupancy importance factor (I) and seismic zone factor (z) should be deleted in accordance with UFC 1-200-01.

Provide seismic requirements, if a Government designer (Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the second bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT must be included in the contract documents.

****

Submit seismic calculations for lateral bracing, sealed by a Professional Engineer. Document that access flooring system complies with seismic requirements of ICC IBC and ASCE 7-22 for Occupancy Importance Factor (Ip) of [1.0] [1.5], and seismic horizontal force (Fp) determined in accordance with UFC 3-301-01 and Section 1615 of the ICC IBC and ASCE 7-22, Minimum Design Loads for buildings and other structures.

2.1.6.2 Army Project Specific Requirements

****

NOTE: Provide seismic requirements, if a Government designer (Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the second bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and

Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT must be included in the contract documents.
****

Submit seismic calculations for special bracing to resist the effects of seismic or other forces [in accordance with UFC 3-301-01, ICC IBC and ASCE 7-22] [as shown on the approved detailed installation drawings]. Submit design calculations which demonstrate that the proposed floor system meets requirements for seismic loading. Certified copies of test reports may be submitted in lieu of calculations.

2.2 FLOOR PANELS

2.2.1 Floor System Drawings And Planer Quality

a. Submit Fabrication Drawings for elevated floor systems consisting of fabrication and assembly details to be performed in the factory.

b. Indicate on Location Drawings exact location of pedestals, ventilation openings, cable cutouts, and the panel installation pattern.

c. Provide Detail Drawings showing details of the pedestals, pedestal-floor interlocks, floor panels, panel edging, floor openings, floor opening edging, floor registers, floor grilles, cable cutout treatment, perimeter base, expansion, and peripheral support facilities.

d. Design and workmanship of the floor, as installed, must be completely planar within plus or minus 1.5 mm in 3050 mm 0.060 inch in 10 feet, 2.5 mm 0.100 inch for the entire floor, and 0.7 mm 0.030 inch across panel joints.

e. Floor-panel joint-width tolerances must not exceed 0.43 mm 0.017 inch as measured with a feeler gage at any point in any joint when the panels are installed and as long as the air leakage requirements specified in this section are met.

f. Submit [three][_____] complete samples of floor panels.

2.2.2 Detailed Installation Drawings

Submit Detailed Installation Drawings that as a minimum indicate the following:

a. Location of panels

b. Layout of supports, panels, and cutout locations

c. Stair, handrail, and ramp framing

d. Sizes and details of components

e. Details at floor perimeter and height above structural floor

f. Method of anchorage to structural subfloor

g. Lateral bracing

h. Typical cutout details

i. Gasketing, return air grilles, supply air registers, and perforated panels. Include air transfer capacity of grilles, registers and panels

j. Description of [shop] [factory] coating

k. Floor finishes

l. Location of connection to building grounding electrode

2.2.3 Panel Construction

****

NOTE: There are five basic floor panel types: aluminum, hollow formed steel, cementitious-filled formed steel, metal-clad wood core, and concrete. The most commonly used floor panel is the Cementitious-Filled Formed Steel (Composite Panels). Nonferrous materials should be used in areas where there is potential for damage by rust oxides or paint flakes.

Editing of a Non-Proprietary Specification: Note that there are two primary Buy America FAR compliant access flooring system suppliers to the North American market who respectively manufacture the Cementitious-Filled Formed Steel and Lightweight Concrete Filled Panels. Both panel types should be selected to ensure non-proprietary specifications.

The standard panel size of 600 by 600 mm 24 by 24 inch will normally be used. Check with Using Agency and verify product availability before specifying nonstandard panels of 450, 750 and 900 mm 18, 30, and 36 inch where required to match existing floor systems or to satisfy special requirements.

Use 150 mm 6 inches as minimum practical height for access floor installation and 300 mm 12 inches minimum when there is a plenum. Include the five panel types as options except that wood core panels should not be specified for Air Force projects, SPAWARS projects, or other projects where data processing involves highly strategic data having direct bearing on National Defense effort. Check with Using Agency before specifying wood core panels. SPAWARS may be involved in Air Force and Army projects, verify and coordinate requirements with Using Agency.

****

a. Base access floor system on a 600 by 600 mm 24 by 24 inch square module providing minimum of [150] [300] [_____] mm [6] [12] [_____] inch clearance between structural floor and underside of panel. Fabricate so accurate job cutting and fitting may be done using standard sizes for perimeters and around columns.

b. Do not expose metal on finished top surface of panels. Provide cutouts and cutout closures to accommodate utility systems and equipment intercabling. Reinforce cutouts to meet design load requirements.

Provide extra support pedestals at each corner of cutout for cutout panels that do not meet specified design load requirements.

c. Panel design must provide for convenient panel removal for underfloor servicing and for openings for new equipment. Use panels of uniform dimensions within specified tolerances. Permanently mark panels to indicate load rating and model number.

d. Machine square floor panels to within plus or minus 0.38 mm 0.015 inch with edge straightness plus or minus 0.064 mm 0.0025 inch. If plastic edging is applied to the panel, the tolerances apply to the panel before the plastic edging is applied.

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NOTE: For security or additional structural stability of the access flooring system, panels can be bolted to pedestals. However this will cause additional maintenance concerns and will need to be coordinated with the desired floor covering.

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[e. Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk corrosion resistant screws with heads that are flush with top of panel.]

[2.2.3.1 Aluminum

****

NOTE: Die-cast aluminum panels are lightweight, have very little variation in dimension from panel to panel, and are acceptable in environments where nonferrous materials are required (e.g., Magnetic Resonance Imagery rooms), but they tend to be more expensive than other types of panels.

Die-cast aluminum panels are normally used as a stringerless system.

****

Provide aluminum panels of die-cast or extruded construction conforming to ASTM B85/B85M.

][2.2.3.2 Hollow Formed Steel

****

NOTE: Die-formed hollow steel panels perform best under static loads and should not be used under dynamic (rolling) loads. These panels are more economical than other types of panels and can be provided by most flooring system manufacturers.

****

Steel panels must be of die-formed construction, consisting of a flat steel top sheet welded to one or more formed steel stiffener sheets or components. Panels must be chemically cleaned, bonderized, and painted with the manufacturer's standard finish.

][2.2.3.3 Cementitious-Filled Formed Steel (Composite Panels)

****

NOTE: Cementitious core filled panels are enclosed in steel sheeting and are designed to provide improved resistance to rolling and impact loads. Specific strength and load requirements should be specified wherever it is a critical concern. These panels are quiet due to their mass.

There is some concern that the fill material may deteriorate when subjected to repeated loading cycles, and the cut edges could introduce dust into the underfloor space. Where the underfloor space will be a plenum, or where dust-sensitive computer equipment is to be installed, verify that the composite panel is acceptable to the Using Agency.

Current Air Force criteria does not permit the use of composite panel.

****

Provide composite panels of die-formed steel construction totally enclosing the panel, including the top surface. The void spaces between the top sheet and the formed steel bottom sheet must be completely filled with an incombustible cementitious or concrete material. Seal cut edges in accordance with manufacturer's recommendations.

][2.2.3.4 Metal-Clad Wood Core

****

NOTE: Wood core panels consist of a core of particleboard with an overlapping skin of galvanized steel. The wood core is a good sound deadener and insulator and increases resistance to rolling loads. Wood core panels are the most economical option.

Although the core material is combustible, the composite panel with bonded steel for face sheets when tested in accordance with the NFPA 225, revealed the composite panel to be noncombustible with a flame spread index of 0, a smoke developed index of 10, and to have a Class A fire rating. Confirm applicable test data for each manufacturer considered. Confirm fire rating and smoke developed per ASTM E84.

Wood core panels can be easily cut and trimmed; however, doing so causes loss of fire retardancy and UL rating. The edges of wood core panels must be protected from moisture in order to prevent warping.

****

Provide wood core panels with cores of wood particleboard conforming to ANSI/CPA A208.1, Grade 1-M-3, or of plywood conforming to CPA A208.2, APA E30, and APA L870, EXT-DFPA-C-C. The core must be not less than 25 mm 1 inch thick, and be faced on all sides with structurally bonded zinc-coated steel sheets not lighter than 0.70 mm 24 gauge. All edges and corners must be sealed with zinc-coated steel or extruded aluminum. The completed panels must have a flame spread rating of 25 or less when tested in accordance with ASTM E84. Provide zinc-coated steel, extruded aluminum, fire resistant vinyl, or other fire resistant edging to protect shop and field edge cuts and cutouts through the face of panels in a manner to meet specified flame spread, smoke developed and Class A fire rating requirements.

][2.2.3.5 Lightweight Concrete Filled Panels (Exposed Concrete)

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NOTE: Lightweight concrete filled panels are either solid or metal clad. They perform well under dynamic loadings with little deformation and their weight is approximately 195 kg/m^2 10 psf. They are primarily used in office flooring and are similar in cost to cementitious fill panels.

****

Provide lightweight concrete of lightweight structural concrete with either structural reinforcing or a die-formed, hot dipped galvanized steel bottom pan. All concrete surfaces, including those resulting from field cuts, must be sealed with the manufacturer's standard sealer before covering the surfaces with other materials. Concrete sealer must meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of SCAQMD Rule 1113. Provide validation of indoor air quality for concrete sealer.

]2.2.4 Floor Covering

****

NOTE: Verify with Using Agency and manufacturers which finishes are recommended for what type of functional space, type of panel and understructure. Delete finish paragraphs that are not applicable to the project.

Clearly indicate in contract documents where different floor covering types are located if more than one type is specified for a project.

Verify that finishes being considered are approved for use by the access flooring manufacturer. Some finishes may be considered standard by some manufacturers and non-standard by others which could add cost to the project. The finishes need to be of a size that is appropriate for a one-to-one installation to the floor panel with no seams, size needs to be slightly smaller than a standard 610 by 610 mm 24 inch by 24 inch. Coordinate size with access flooring manufacturer. Note that not all manufacturer floor tile products are available in the required size and may require additional cuts, this may add cost to the project and add product waste.

Consider the desired aesthetics, appearance and use of a facility and the following edge detail

information to determine the type of floor covering edge detail preferred for a project:

a. Cementitious Filled Formed Steel (Composite) and Lightweight Concrete Filled (Exposed Concrete) Panels with factory applied high pressure laminate or resilient flooring material - The integral finish edge detail is available from more manufacturers than the applied trim piece edge detail. If the applied trim piece detail is acceptable for a project, recommend that both types remain in the specification to open it up to more manufacturers so the specification does not become proprietary with only the applied trim piece. The integral finish detail is more durable than the applied trim piece which can become damaged.

b. Metal-Clad Wood Core Panels with factory applied high pressure laminate material- Edge detail is available both integral to the finish material and as an applied trim piece dependent upon the manufacturer. Recommend that both types remain in the specification to open it up to more manufacturers so the specification does not become proprietary.

c. Metal-Clad Wood Core Panels with factory applied resilient flooring material- Edge detail with applied trim piece is more typical.

d. Steel and Aluminum Panels - Edge detail is available both integral to the finish material and as an applied trim piece dependant upon the manufacturer. Recommend that both types remain in the specification to open it up to more manufacturers so the specification does not become proprietary.

Verify that finish being considered is appropriate for the system specified when raised access floor panels are required to be screwed into place. Panels that are screwed into place and have a factory finish that is bonded into place will have an exposed screwhead in each corner. The screwhead for resilient floor materials will be flush with panel face and not finish face and may require additional maintenance to clean out screwhead locations. If it is determined that a panel with factory applied finish will be screwed into place verify with Using Agency if a requirement for finish plugs be added to the specification to provide a more finished appearance and coordinate availability with the manufacturer. These plugs would be the same material as the panel finish and would be installed to cover the exposed screwhead. Plugs are not permanent, can come out and become lost. Plug should be installed per manufacturer recommendations for easy removal and replacement for Using Agency to access underfloor area.

Choice of critical radiant flux level as it applies to building type and area of application will be made in accordance with UFC 3-600-01, UFC 1-200-01

and NFPA 101. Wherever the use of Class II (0.22) watts finish is required, Class I (0.45) watts will be permitted.

Aluminum panels often do not receive an applied finish. If it is determined a finish is required, add edge detail requirement to applicable finish paragraph inside empty brackets.

Verify with manufacturer if embossed texture being specified is acceptable for use with the lifting device.

****

Surface floor panels with [factory applied finish materials firmly bonded in place with waterproof adhesive][carpet tile installed in the field]. Provide finish flooring materials in corridors and exits with a critical radiant flux of not less than [0.45 watts per square centimeter (Class 1)][0.22 watts per square centimeter (Class 2)] when tested in accordance with ASTM E648 or NFPA 253. The electrical resistance must remain stable over the life expectancy of the floor covering. Any anti-static agent used in the manufacturing process must be an integral part of the material, not surface applied. Bolt heads or similar attachments must not rise above the traffic surface. Submit [three] [_____] separate samples of each specified floor covering finish and color.

[2.2.4.1 High Pressure Laminate

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NOTE: HDM, 2 mm 1/16 inch thick high pressure laminate is typically used. HDH, 3.2 mm 1/8 inch thickness is also available, but is more expensive than the HDM.

****

Provide factory applied high pressure laminate surfacing conforming to ANSI/NEMA LD 3, High-Wear type, Grade [HDM, 2 mm 1/16 inch thickness][_____].Finish material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]]. The total system electrical resistance from the wearing surface of the floor to the ground connection must be between 1,000,000 (1.0×10^6) ohms and 20,000,000,000 ohms (2.0×10^{10}).

][2.2.4.2 Conductive High Pressure Laminate

****

NOTE: HDM, 2 mm 1/16 inch thick conductive high pressure laminate is typically used. HDH, 3.2 mm 1/8 inch thickness is also available, but is more expensive than the HDM.

****

Provide factory applied high pressure laminate surfacing conforming to ANSI/NEMA LD 3, High-Wear type, Grade [HDM, 2 mm 1/16 inch thickness][_____]. Finish material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]].The total system electrical resistance from the wearing surface of the floor to the ground connection must be between 25,000 ohms (2.5×10^4) and 1,000,000 ohms (1.0×10^6).

][2.2.4.3 Solid Vinyl Tile

Provide factory applied conductive vinyl tile that is a homogeneous vinyl product and conforms to ASTM F1700, Class I monolithic (minimum wear layer thickness 3 mm 0.125 inch and minimum overall thickness 3 mm 0.125 inch), Type A smooth surface. Finish material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]].

][2.2.4.4 Luxury Vinyl Tile

Provide factory applied luxury vinyl tile conforming to Class III printed film minimum wear layer thickness of 0.50 mm 0.020 inch and minimum overall thickness 3 mm 0.125 inch, Type [A (smooth)] [B (embossed)]. Finish material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]].

][2.2.4.5 Conductive Vinyl Tile

Provide factory applied conductive vinyl tile that is a homogeneous vinyl product and conforms to ASTM F1700, Class I monolithic, Type A smooth surface. Provide electrical resistance from surface to surface and surface to ground between 25,000 ohms (2.5×10^4) and 1,000,000 ohms (1.0×10^6) when tested in accordance with ASTM F150. Material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]].

][2.2.4.6 Static-Dissipative Vinyl Tile

Provide factory applied static-dissipative vinyl tile that is a homogeneous vinyl product and conforms to ASTM F1700, Class I monolithic, Type A smooth surface. Provide electrical resistance from surface to surface and surface to ground between 1,000,000 ohms (1.0×10^6) and 1,000,000,000 ohms (1.0×10^9) when tested in accordance with ASTM F150. Material must consist of one piece to cover the face of the panel. Provide edge detail that is [integral to the finish material][or][is an applied trim piece that finishes the edges of the panel, is flush with floor finish, and is [PVC][or][ABS][_____]].

][2.2.4.7 Carpet Tile

****

NOTE: Consider the function of the room, Using Agency requirements and consult with the project electrical engineer when determining the type of carpet that is appropriate, 09 68 00 CARPETING or 09 62 38 STATIC-CONTROL FLOORING (for static-control

carpet tile).

Be aware that full spread releasable if not installed in accordance with manufacturer required drying time can become overly tacky making it difficult to remove from screwheads and between panels and to lift carpet tile from panel.

Coordinate carpet tile selection for one to one alignment with floor panels with the access flooring manufacturers. Due to the size required (slightly smaller than 610 by 610 mm 24 inch by 24 inch) the access flooring manufacturers have a variety of standard carpets available from different carpet manufacturers.

Recommend listing at least two manufacturers for one to one alignment so specification does not become proprietary.

Installation method for one to one alignment with floor panels is limited to monolithic and quarter turn installation patterns.

Do not use the odor-free adhesive tab system or full spread releasable adhesive to achieve a one to one alignment with floor panels. This is not recommended by manufacturers.

Over ramps and steps to be covered with carpet tile, consider backed sheet carpet by the same manufacturer as the carpet tile fully adhered in place and protected and restrained at edges to avoid fall or slip risks that could arise with delaminating or slipping carpet tiles.

****

Reference Section [09 68 00 CARPETING][and][09 62 38 STATIC-CONTROL FLOORING (static-control carpet tile)] for carpet tile specification requirements including recycled content, volatile organic compound (VOC) limits and additional flammability testing requirements for carpet tile. Carpet tile must be field installed and comply with the following:

a. Installation method on level surfaces must allow carpet tile to be easily removed and replaced in the field and must be installed in accordance with manufacturer's recommended installation instructions.

b. Install carpet tile in a [monolithic][1/4 turn][ashlar][brick][random][____] pattern.

[c. Install carpet tile on secure and level surfaces offset from the access floor grid with a [manufacturer approved odor-free adhesive tab system][or][with full spread releasable adhesive using manufacturer recommended adhesives. Comply with manufacturer installation instructions for required drying time so the adhesive sets up properly].
]

[d. Install carpet tile on secure and level surfaces with the access flooring manufacturer's recommended mechanical installation method and components for a one to one alignment with floor panels (one carpet tile to one floor panel); confirm source of mechanical connectors by either flooring panel or carpet tile manufacturer. This installation method requires the removal of only one carpet tile to access one raised access panel. Provide coordinated layout drawings of connectors, modular carpet tile joints, flooring panel joints, and penetrating items through carpet tiles and flooring panels. Carpet tile size for a one-to-one installation must be slightly smaller than a standard 610 by 610 mm 24 inch by 24 inch tile, coordinate required size with the raised access flooring manufacturer. Factory applied carpet tile with perimeter edge strip and field applied one to one carpet tile installation over raised access floor panels with permanent or releasable adhesive are not acceptable installation methods.]

[e. Carpet tile on access flooring stairs and sloped surfaces must be installed with a more permanent installation method in accordance with manufacturer's instructions and with manufacturer recommended adhesives for these types of locations to prevent delamination or slippage of carpet tiles.]

][2.2.4.8 Lightweight Concrete Filled (Exposed Concrete)

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NOTE: Bare panels may be specified to achieve a desired visual aesthetic. Finish panels with sealer to prevent dusting and to minimize water absorption. Using Agency should be made aware that sealer will need to be reapplied over time.

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Provide lightweight concrete filled panel with a [MPI 58 concrete stain][and][[MPI 104 concrete floor sealer][or][MPI 99 water based concrete floor sealer]]. Apply coatings in accordance with manufacturer's instructions.

]2.2.5 Accessories

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NOTE: Perforated panels are preferred for use in areas with hard surfaces such as high pressure laminates, and grilles or registers are preferred in areas with carpet

****

Provide the manufacturer's standard registers, grilles, perforated panels, and plenum dividers type where indicated. Provide registers, grilles, and perforated panels designed to support the same static loads as floor panels without structural failure, and capable of delivering the air volumes indicated. Registers and perforated panels must be 25 percent open area and equipped with adjustable dampers. Submit [three][_____] samples and colors of each accessory. Provide[round][slotted] perforations.

2.2.6 Resilient Base

Conform to ASTM F1861, [[Type TS (vulcanized thermoset rubber)] [or] [Type TP (thermoplastic rubber)]] [, or] [Type TV (thermoplastic vinyl)], [Style A (straight - installed with carpet)] [and] [Style B (coved - installed with resilient flooring)]. Provide [100] [150] mm [4] [6] inch high and a minimum 3.175 mm 1/8 inch thick wall base. Provide [preformed] [job formed] corners in matching height, shape, and color.

2.2.7 Adhesives

Provide adhesives as recommended by the manufacturer. Provide non-aerosol adhesive products that meet either emissions requirements of CDPH SECTION 01350 (use the requirements for either office or classroom, regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives that meet either emissions requirements of CDPH SECTION 01350 (use the requirements for office or classroom, regardless of space type) or VOC content requirements of GS-36. Provide validation of indoor air quality for adhesives.[Provide conductive adhesive as recommended by the manufacturer of the static-control flooring.][Provide conductive releasable adhesive as recommended by the manufacturer for static-control carpet tile.]

2.2.8 Lifting Device

At turnover provide one floor panel lifting device standard with the floor manufacturer, for each individual floor area (room or corridor). Furnish a minimum of two devices.[For AIR FORCE projects, at turnover, provide a total of two suction-type floor panel lifting devices for each floor area (room or corridor).]

2.3 PANEL SUPPORT SYSTEM

Design panel and pedestal support system to allow for 360 degree clearance in laying out cable and cutouts for service to machines. Submit one sample of suspension system proposed for use.

2.3.1 Pedestals

Provide pedestals made of steel or aluminum or a combination thereof. Ferrous materials must have a factory-applied corrosion-resistant finish. Provide pedestal base plates with a minimum of 10,300 square mm 16 square inches of bearing surface and a minimum of 3 mm 1/8 inch thickness. Pedestal shafts must be threaded to permit height adjustment within a range of approximately 50 mm 2 inches, to permit overall floor adjustment within plus or minus 2.5 mm 0.10 inch of the required elevation, and to permit leveling of the finished floor surface within 1.56 mm 0.062 inch in 3000 mm 10 feet in all directions. Provide locking devices to positively lock the final pedestal vertical adjustments in place. Pedestal caps must interlock with panels to preclude tilting or rocking of the panels.

[2.3.2 Gaskets

****

NOTE: For stringerless systems, gasketing is not available for all panel types. Verify availability of gaskets for the panel types specified.

****

Provide continuous gasketing at contact surfaces between panel to deaden sound and seal off the underfloor cavity from above for air tightness, and to maintain panel alignment.

]2.4 FASCIA

Provide aluminum or steel fascia plates at open ends of floor, at sides of ramps and steps, and elsewhere as required to enclose the free area under the raised floor. Steel plates must have a factory applied baked enamel finish. Finish on aluminum plates must be standard with the floor system manufacturer. Fascia plates must be reinforced on the back, and supported using the manufacturer's standard lateral bracing at maximum 1200 mm 4 feet on center. Provide trim, angles, and fasteners as required. Submit [three][_____] color samples for fascia.

2.5 STEPS AND RAMPS

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NOTE: Coordinate step and ramp finish with finishes specified in FLOOR COVERINGS and insert selected finish. Resilient flooring is recommended if there will be a lot of cart traffic. Carpet tile should be installed with a permanent adhesive.

****

Securely fasten steps and ramps to the access flooring system and to the structural floor. Include in the construction standard floor system components and custom components as required, and all supports, fasteners, and trim necessary for a finished installation. Step nosings, threshold strips, and floor bevel strips must be cast or extruded aluminum with non-slip traffic surfaces. Submit [three][_____] color samples for exposed step and ramp structure.

2.5.1 Steps

Height of risers must comply with applicable codes. Design steps to support a uniform load of 7.18 kPa 150 psf. Surface treads with the manufacturer's standard non-slip floor finish. Floor covering must be [____].

2.5.2 Ramps

Slope of ramps must comply with applicable codes and 36 CFR 1191 Americans with Disabilities Act (ADA). In no case will ramps be steeper than 1:12 (rise:run). Design ramps to support the same loads as specified for floor panels. Surface ramps with the [manufacturer's standard fixed non-slip floor finish approved for ramp traffic][____].

2.6 RAILINGS

****

NOTE: Where open sides of floors are 1200 mm 4 feet or more above adjacent ground or floor level, install "standard railing" in accordance with CFR 1910.23(e). Run post through raised floor and bolt to concrete floor for stability.

****

Provide railings compliant with applicable codes and 36 CFR 1191 Americans with Disabilities Act (ADA). As a minimum railings must be of the double rail and post type, fabricated of at least[25 mm 1 inch] [_____] [round] [square] seamless [aluminum tubing] [_____] with a [satin natural anodized] [_____] finish. At steps and ramps, make the top rail a minimum of 900 mm 36 inches high and parallel to the incline. Make the top rail 1050 mm 42 inches high at open ends of the floor. Guardrails must have intermediate rails or an ornamental pattern such that a sphere 100 m 4 inches in diameter cannot pass through. Space posts maximum of [1200] [1500] [1800] mm [4] [5] [6] feet oc. Provide railings complete with anchorages, floor plates, and end caps.[Electronically ground hand rails to raised floor system to prevent static build-up.] Submit [three][_____] color samples for railings.

2.7 FACTORY TESTS

Factory test access flooring, using an independent laboratory, at the same position and maximum design elevation and in the same arrangement as shown on the drawings for installation so as to duplicate service conditions as much as possible.

2.7.1 Load Tests

Conduct floor panel and pedestal testing in accordance with CISCA Access Floors to determine deformation and permanent set of panels and system due to concentrated, Uniform, rolling, impact and ultimate loading when panels are supported by actual understructure.

2.7.2 Bond Strength of Covering

****

NOTE: Coordinate test load weights with those specified for floor panel testing in General System Requirements.

Delete this test when field applied carpet tile is specified.

****

Conduct test for bond strength of covering in accordance with CISCA Access Floors for rolling loads, except as specified. Panels must be tested with specified hard surface flooring and on the pedestals and stringers as specified for the installed floor. Brace the supports as necessary to prevent sideways movement during the test. Impose a test load of [3560] [4450] [5560] [6670] [8890] [_____] N [800] [1000] [1250] [1500] [2000] [_____] pounds on the test assembly through a 75 mm 3 inches in diameter and 25 mm 1 inch wide hard plastic caster. Roll the caster completely across the center of the panel. The panel must withstand 20 passes of the caster with no delamination or separation of the covering.

[2.8 REGISTERS AND GRILLES

****

NOTE: Size of registers should be stated if applicable. Coordinate with Mechanical Engineer.

****

Registers and grilles must be [_____] mm inches by [_____] mm inches long with a minimum free area of [_____] square mm inches, made from extruded [aluminum] [_____], in [mill] [_____] finish, to sustain point loads of 2669 newton 600 pounds per vane without failure or permanent deformation. No part of a grille may project more than 3 mm 1/8 inch above the floor. Registers and grills are not permitted in a laminate floor tile system.

][2.9 PERFORATED AIR SUPPLY PANELS

Provide air supply floor panels that meet the design criteria specified for standard panels, to sustain point loads of 4448 newton 1000 pounds without failure or permanent deformation, are fabricated of 2 mm 14-gage perforated steel sheet welded to minimum 1.6 mm 16-gage side channels, are covered with high pressure laminate to match standard panels, and have a uniform perforated pattern to allow even air distribution.

][2.10 PERFORATED DIRECTIONAL AIR SUPPLY PANELS

Provide directional air supply floor panels that meet or exceed the design criteria specified for standard panels, are fabricated of [light weight die cast aluminum with powder coat finish] [welded steel vanes with powder coat finish] [perforated steel sheet welded to a formed steel pan with powder coat finish]. Submit [three][_____] color samples for perforated directional air supply panels

][2.11 CUT OUTS

Provide cable cutouts finished with rigid polyvinylchloride or molded polypropylene edging to conform to the appearance level of the floor surface and to cover raw edges of the cutout panel. Extrusion must be of a configuration to permit its effective and convenient use when new cable openings are required. Provide at least 7300 mm 24 feet of additional extrusion for future use. Submit [three][_____] color samples for cut outs.

a. Provide non-metallic adapter for openings less than 100 mm 4 inches wide. Secure adapter adhesively in cutout to preclude removal from panel. Provide at least two adapters per 10 square meter 1000 square feet for future use.

b. Openings larger than 100 mm 4 inches wide must use rigid polyvinylchloride or molded polypropylene edging. Perform cutting of panels, including cutouts, outside of the building.

c. When size of cutout reduces the performance requirement of panel, provide intermediate pedestals adjacent to cutouts.

][2.12 EDGE CLOSURE

Provide 1.5 mm 1/16 inch aluminum closure plate and extruded aluminum nosing, or manufacturer's standard method for supporting panel edges, at exposed edge of floor. Back up the closure plates with aluminum or steel framing braced diagonally, or anchor at bottom to continuous angle. Provide a transition between access flooring and adjoining floors at same level.

]2.13 PEDESTAL BASE FASTENERS

Provide [two][four] fasteners at each pedestal support base sized per ASTM E488/E488M to support loads without failure up to 1.5 times loads due to pedestal overturning moment.

Provide [ASTM B633 zinc plated steel][ASTM F593] post-installed fasteners for securing pedestal bases to supporting concrete floor slabs.

2.14 COLOR

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally UFGS 09 06 00 SCHEDULES FOR FINISHES or as indicated is used when the project is designed by an Architect or

Interior designer. Color should be selected from manufacturer's standard colors or identified as a manufacturer's color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located as indicated, a note must be added to the drawings that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note that there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is referenced, be certain that the product conforms to this specification, as edited.

****

Color must be [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [as indicated] [_______]. Color listed is not intended to limit the selection of equal colors from other manufacturers.

PART 3 EXECUTION

3.1 INSTALLATION

Install access flooring at the location and elevation and in the arrangement shown on the approved detailed installation drawings. The floor system must be of the stringerless type, complete with all supplemental items, and be the standard product of a manufacturer specializing in access flooring systems.

Install the floor system in accordance with the manufacturer's instructions. Open ends of the floor, where the floor system does not abut wall or other construction, must have positive anchorage and rigid support. Maintain areas to receive access flooring between [16] [4] and 32 degrees C [60] [40] and 90 degrees F, and between 20 and 70 percent humidity for 24 hours prior to and during installation.

3.1.1 Preparation for Installation

****

NOTE: Section 03 30 00 CAST-IN-PLACE CONCRETE should require that concrete floors used as air plenum surfaces beneath raised floors be sealed with approved liquid sealer compound. Sealer should be compatible with pedestal adhesive, if pedestals are anchored with adhesive. If a non-compatible sealer is applied before pedestals are anchored, specify removal of sealer at pedestal locations before adhesive is applied. If an existing subfloor has

been painted or otherwise sealed with non-compatible sealer or paint, specify removal of coating before applying adhesive.
****

Clear out all debris in the area in which the floor system is to be installed. Thoroughly clean structural floor surfaces and remove all dust. Install floor coatings, required for dust or vapor control, prior to installation of pedestals, only if the pedestal adhesive will not damage the coating. If the coating and adhesive are not compatible, apply the coating after the pedestals have been installed and the adhesive has cured.

3.1.2 Pedestals

****
NOTE: Seismic calculations must be made by the designer to determine if adhesives or anchors are to be used; pedestal adhesives must be capable of securing pedestals in place with sufficient bonding strength to resist an overturning force of 113 N-m 1000 inch-pounds. If the calculations indicate the overturning force is greater than 113 N-m 1000 inch-pounds steel expansion anchors will be used.
****

Pedestals must be accurately spaced, and set plumb and in true alignment. Set base plates in full and firm contact with the structural floor, and secured to the structural floor with adhesive or steel expansion anchors in accordance with manufacturer's instructions, and as required by seismic design.

3.1.3 Auxiliary Framing

Provide auxiliary framing or pedestals around columns and other permanent construction, at sides of ramps, at open ends of the floor, and beneath panels that are substantially cut to accommodate utility systems. Use special framing for additional lateral support as shown on the approved detailed installation drawings. Provide additional pedestals designed to specific heights and lengths to meet structural irregularities and design loads. Connect auxiliary framing to main framing.

3.1.4 Panels

Interlock panels with supports in a manner that will preclude lateral movement. Fasten perimeter panels, cutout panels, and panels adjoining columns, stairs, and ramps to the supporting components to form a rigid boundary for the interior panels. Level floors within the specified tolerances. Cut edges of [steel and wood-core panels must be [painted] [finished] [_____] as recommended by the panel manufacturer.] [Exposed edges of composite panels must be coated with a silicone rubber sealant or with an adhesive recommended by the panel manufacturer.] Secure extruded vinyl edging in place at all cut edges of all panel cut-outs to prevent abrasion of cables.[Where the space below the floor is a plenum, close cutouts for conduit and similar penetrations using self-extinguishing sponge rubber or air sealing grommets.]

3.1.5 Carpet Tile

Reference carpet tile paragraph in FLOOR COVERING for carpet tile installation requirements.

3.1.6 Resilient Base

Provide base at vertical wall intersections as indicated in the [drawings][_____]. Apply the base after the floor system has been completely installed. Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Tighten base joints and make even with adjacent flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

3.1.7 Fascia Plates

Cover exposed floor ends and exposed openings of ramps and stairs with [aluminum] [steel closures] [finish material as indicated].

3.1.8 Repair of Zinc Coating

Repair zinc coating that has been damaged, and cut edges of zinc-coated components and accessories, by the application of a galvanizing repair paint conforming to ASTM A780/A780M. Areas to be repaired must be thoroughly cleaned prior to application of the paint.

3.2 FIELD TESTS

Submit certified copies of test reports from an approved testing laboratory, attesting that the proposed floor system components meet the performance requirements specified.

3.2.1 Acceptance Tests

Conduct acceptance tests after installation of floor system. Make at least one test for each [40] [100] [_____] square meters [400] [1000] [_____] square feet of floor area. Conduct tests in presence of Contracting Officer and representatives of manufacturer and installer. Submit certified copies of test reports from an approved testing laboratory, attesting that the proposed floor system components meet the performance requirements specified.

3.2.2 Air Leakage

****

NOTE: Delete the requirements for air leakage when the space under the finished floor is not used as an air plenum. Concrete floors to be used as air plenums must be sealed and coated. Coordinate with Mechanical Engineer for anticipated positive pressure in the plenum.

****

When the space below the finished floor is an air plenum, air leakage through the joints between panels and around the perimeter of the floor system must not exceed 0.15 L/s of air per linear meter 0.1 cubic foot of air per minute per linear foot of joint subjected to 2.5 mm [.05 inches h2o (Pa)][0.1 inches h2o (Pa)], water gauge, positive pressure in the plenum, when tested in accordance with CISCA Access Floors, Section 10 Air Leakage

Test. Measure the leakage rate on the finished raised floor system, which may include carpet.

3.2.3 Grounding

****

NOTE: Access flooring system must be grounded for safety hazard and static control. The three most common static control requirements are:

1. Computer rooms, electronic offices, data centers and control rooms. The access floor system should provide resistance from floor wearing surface to building grounding electrode within range of 0.5 to 20,000 megohms.

2. Clean rooms, laboratories, and other environments which are more sensitive to static discharge. The access floor system should provide resistance within range of 0.2 to 2.0 megohms.

3. Hospitals and other facilities described by NFPA 99 and referenced to UL 779. The access floor system should provide resistance within range of 0.025 to 1.0 megohms.

These limits may be changed if other values are required by the Using Agency. Design the grounded floor system to provide positive contact between all metal components. Grounding details must be shown on the project drawings; the option of using manufacturer's alternate methods of grounding may be included in the project specification.

****

Ground the access flooring system for safety hazard and static suppression. Provide positive contact between components for safe, continuous electrical grounding of entire floor system. Total system resistance from wearing surface of floor to building grounding electrode must be within range of [0.5 to 20,000 megohms] [0.2 to 2.0 megohms] [0.025 to 1.0 megohms].

3.2.3.1 Metal Grilles

Exposed metal is not allowed at wearing surface of access floor system, except at metal grilles and registers. When grilles and metal registers are provided, insulate as required to provide same grounding resistance as wearing surface.

3.2.3.2 Joint Resistance

****

NOTE: Coordinate with electrical drawings and specifications to assure that connection to building grounding electrode is shown. Do not use sound deadening materials which prevent grounding of system. Select a total system resistance to comply with Using Agency requirements.

****

Electrical joint resistance between individual stringer and pedestal junctions must be less than 10 ohms. Electrical resistance between stringers and floor panels, as mounted in normal use, must be less than 10 ohms when tested in accordance with ASTM F150.

3.2.4   Electrical Resistance

Conduct testing of electrical resistance, in the completed installation, in the presence of the Contracting Officer in accordance with NFPA 99, modified by placing one electrode on the center of the panel surface and connecting the other electrode to the metal flooring support. Take measurements at five or more locations. Each measurement must be the average of five readings of 15 seconds duration at each location. During the tests, relative humidity must be 45 to 55 percent and temperature set at 21 to 24 degrees C 69 to 75 degrees F. Select panels used in the testing at random and include two panels most distant from the ground connection. Measure electrical resistance with instruments that are accurate within 2 percent and that have been calibrated within 60 days prior to the performance of the resistance tests. The metal-to-metal resistance from panel to supporting pedestal must not exceed 10 ohms. The resistance between the wearing surface of the floor covering and the ground connection, as measured on the completed installation, must be in accordance with paragraph FLOOR COVERING.

[3.2.5   SEISMIC SPECIAL INSPECTION AND TESTING

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by Appendix 11A of ASCE 7-16.

This paragraph will be applicable to both new buildings designed according to UFC 3-301-01 SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs.

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with UFC 3-301-01 and Appendix 11A of ASCE 7-16. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with UFC 3-301-01 and Section 01 45 35 SPECIAL INSPECTIONS.

]3.3   CLEANING AND PROTECTION

3.3.1   Cleaning

Keep the space below the completed floor free of all debris. Before any traffic or other work on the completed raised floor is started, clean the completed floor in accordance with the floor covering manufacturer's instructions.[Do not permit seepage of cleaner between individual panels.] [Cleaning of ferrous surfaces must conform to FS TT-C-490.]

3.3.2 Protection

Protect traffic areas of raised floor systems with a covering of building paper, fiberboard, or other suitable material to prevent damage to the surface. Cover cutouts with material of sufficient strength to support the loads to be encountered. Place plywood or similar material on the floor to serve as runways for installation of heavy equipment not in excess of design load capacity. Maintain protection until the raised floor system is accepted.

3.3.3 Surplus Material Removal

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work. Remove all installation equipment, surplus materials, and rubbish from the work site.

[3.4 FIRE SAFETY

Install an automatic detection system below the raised floor meeting the requirements of NFPA 75 paragraph 5-2.1 to sound an audible and visual alarm. Air space below the raised floor must be subdivided into areas not exceeding 929 square meters 10,000 square feet by tight, noncombustible bulkheads. Seal all penetrations for piping and cables to maintain bulkhead properties.

]3.5 OPERATION AND MAINTENANCE MANUALS

Submit maintenance instructions for proper care of the floor panel surface. When conductive flooring is specified, also submit maintenance instructions to identify special cleaning and maintenance requirements to maintain "conductivity" properties of the panel finish. Include requirements for maintenance of required dry and wet flooring slip resistance for level and ramped surfaces complying with ASSP A1264.1.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 72 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 72 00 (November 2012)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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08/17, CHG 1: 08/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 72 00 (August 2017)**
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SECTION 09 72 00

WALLCOVERINGS

08/17, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for wallcoverings over gypsum wallboard, plaster, concrete, or masonry.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: On the drawings, show:

1. Location and extent of work including dimensions of surfaces to receive wallcovering.

2. Profile of wainscot cap, when required.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

GYPSUM ASSOCIATION (GA)

GA 214	(2010) Recommended Levels of Gypsum Board Finish

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 265	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls

NFPA 286	(2024) Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS CCC-W-408	(Rev D; Notices 1, 2, 3) Wallcovering, Vinyl Coated

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00

SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wallcoverings and Accessories; G, [_____]

Primer and Adhesive

[Recycled Content for vinyl wallcovering; S]

[Recycled Content for textile wallcovering; S]

[Recycled Content for acoustical wallcovering; S]

[Recycled Content for wallcovering border; S]

SD-04 Samples

Wallcoverings and Accessories; G, [_____]

SD-07 Certificates

Indoor Air Quality; S

SD-08 Manufacturer's Instructions

Wallcoverings and Accessories

SD-10 Operation and Maintenance Data

Wallcoverings and Accessories; G, [_____]

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications and validations in one submittal package.

1.3.1.1 Fabrics and Wallcoverings

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body.

1.3.1.2 Primers and Adhesives

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver the material to the site in manufacturer's original wrappings and packages and clearly label with the manufacturer's name, brand name, pattern and color name and number, dye lot number, size, and other related information. Store in a safe, dry, clean, and well-ventilated area at temperatures not less than 10 degrees C 50 degrees F and within a relative humidity range of 30 to 60 percent. Store wallcovering material in a flat position and protected from damage, soiling, and moisture. Do not open containers until needed for installation, unless verification inspection is required.

1.5 ENVIRONMENTAL REQUIREMENTS

Comply with wallcovering manufacturer's printed installation instructions for minimum temperature of area to receive requirements for conditioning adhesive and wallcovering. Provide a minimum 10 degrees C 50 degrees F area temperature, 72 hours prior to installation, during installation, and until the adhesive dries. Observe ventilation and safety procedures.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one-year period.

1.7 EXTRA MATERIALS

****

NOTE: Extra stock of wallcovering may be required. If not, delete this paragraph. Extra stock should be based on anticipated usage. In the absence of experience data, a minimum of one linear meter for each 100 lineal meters one linear foot for each 100 linear feet installed is suggested.

****

Provide one linear meter foot of full-width wallcovering of each pattern and color for each [100] [_____] linear meters [100] [_____] linear feet of wallcovering installed[, excluding presentation dry erase wallcovering]. Provide the same manufacturer, type, pattern, color, and lot number of extra stock as the installed wallcovering. Provide full rolls, packed for storage and marked with content, manufacturer's name, pattern and color name and number and dye lot number. Leave extra stock at the site at a location as directed by the Contracting Officer.

PART 2 PRODUCTS

2.1 WALLCOVERINGS AND ACCESSORIES

****

NOTE: If more than one wallcovering type is required and specifications vary, a separate paragraph vinyl wallcovering Type, textile wallcovering Type, and/or wall covering Border Type will be used for each wallcovering type. Each wallcovering type will be designated with a letter or number symbol. Use the same symbols to key wallcovering types to locations on the drawings and Section 09 06 00 SCHEDULES FOR FINISHES. Delete reference to type symbol if not used.

Comply with NFPA 101 requirements.

****

Provide wall coverings and accessories material designed specifically for the specified use. Provide vinyl wallcovering and borders with a mercury, cadmium, lead, and chromium free base. Protect wallcoverings with bactericides and mildew inhibitors against microbiological and mildew growth.

2.1.1 Product Data

a. Wallcovering: Submit manufacturer's descriptive data, documenting physical characteristics, flame resistance, mildew and germicidal characteristics for wallcovering.

b. Accessories: Submit manufacturer's descriptive data for corner guard and wainscot cap.

c. Primer and Adhesive: Submit manufacturer's descriptive data, documenting physical characteristics, mildew and germicidal characteristics.

2.1.2 Samples

2.1.2.1 Wallcovering

Submit [three][_____] samples of each indicated type, pattern, and color of wallcovering. Provide minimum 125 by 175 mm 5 by 7 inch samples of wallcovering to show pattern repeat of sufficient size.

2.1.2.2 Accessories

Submit [three][_____] samples of each indicated type corner guard and wainscot cap; provide samples a minimum of 75 mm 3 inchlong. Submit [three][_____] samples of each indicated type of frame for presentation dry erase wallcovering; provide samples a minimum of 75 mm 3 inch long.

[2.1.2.3 Wallcovering

Provide three samples, 3 meter yards long by the width specified, of each type to be installed in the work, as required to illustrate material weight, color, shade, decorative design, and embossing when required.

][2.1.2.4 Wallcovering Mockup Panels

After samples are approved, and prior to starting installation, provide a minimum 2430 by 2430 mm 8 by 8 foot wallcovering mock-up for each color and type of [vinyl][,][fabric][, and][presentation dry erase] wallcovering, using the proposed primers and adhesives and actual substrate materials. Once approved, use the mock-up samples as a standard of workmanship for installation within the facility. Written notification to the Contracting Officer at least 48 hours prior to mock-up installation.

]2.1.3 Certificates

Submit manufacturer's statement attesting that the product furnished meets or exceeds specification requirements. Date the statement after the award of the contract, state Contractor's name and address, name the project and location, and list the requirements being certified. Include these certificates:

(1) Certified laboratory test reports of the physical properties for vinyl wallcovering, as specified.

(2) Certificates of Compliance for UL fire hazard classification listing, as specified.

(3) Certificates of Compliance for contact adhesive.

2.1.4 Manufacturer's Instructions

Submit preprinted installation instructions for wallcovering and accessories, adhesives and primers. Include substrate preparation and material application in the instructions.

2.1.5 Operations and Maintenance Data

a. Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Submit [three][_____] copies of manufacturer's maintenance instructions for each type of vinyl wallcovering and accessory describing recommended type of cleaning equipment and materials, spotting and cleaning methods, and cleaning cycles. Instructions to also include preventative maintenance, recommended cleaning materials and precautions in the use of cleaning materials that may be detrimental to the wallcovering surface and accessories when improperly applied.

2.2 VINYL WALLCOVERING [TYPE [A] [_____]]

****

NOTE: Select the appropriate vinyl Type designation for each wallcovering specified and delete inapplicable Types. Type selection should be based on abuse conditions and the following recommendations:

Type I (Light Duty) is satisfactory for use on ceilings and light duty walls not subjected to scuffing and abrasion. This type is rarely used.

Type II (Medium Duty) is satisfactory for areas

subject to average traffic wear and scuffing (varies based on facility type and use); can include areas such as vestibules, corridors, lounges, offices. It may be used full height on walls or as a wainscot. Type II should be used for most vinyl wallcovering installations.

Type III (Heavy Duty) is slightly more resistant to scuffing than Type II but is difficult to install and clean, and is not available from most manufacturers. Type III wallcovering is expensive and should be used only where specifically requested; may include areas that are exposed to damage by moving equipment.

Some manufacturer's Type I, Type II and/or Type III wallcovering will overlap or vary slightly from the weights shown in the following paragraphs.

Conversion Table:

	Type I	Type II	Type III
ozs/sq yd	7 (10)	13	22
ozs/linear yd (54 inch wide)	10.5 (15)	20	33
g/sq meter	237 (339)	441	
g/linear meter	325 (465)	620	

The Wallcovering Association WA-101 and Chemical Fabrics and Film Association CFFA-W-101-D minimum weight requirements are listed in the ozs/sq yd row in the above table, with the exception of the number shown in parenthesis. The measurements in parenthesis reflect what is currently used in the industry for Type I. The heavier weight provides a more durable product. Note that CFFA-W-101-D has now been replaced by the WA-101, but it is still being used by industry.

The following formulas can be used for English to metric conversions:

a. Ounces per square yard to ounces per linear yard-
Multiply # ounces per square yard by 1872 for 52 inches wide or 1908 for 53 inches wide or 1944 for 54 inches wide. Divide the total by 1296 to obtain per linear yard.

b. Ounces per square yard to grams per square meter-
Divide the # ounces per square yard by 144. Multiply total by 4882 to obtain grams per square

meter measurement.

c. Ounces per linear yard to grams per linear meter- Multiply # ounces per linear yard by 28.35. Multiply total by 1.0936 to obtain grams per linear meter measurement.

Polyvinyl-fluoride (PVF) film is an extra cost. The film is designed to provide additional resistance to staining and soiling from exposure to staining reagents or chemicals, and resistance from abuse. Generally the PVF coated vinyl wallcoverings have a slightly different appearance from the standard noncoated vinyl wallcovering. The film is available in 3 thicknesses with the thin gauge material being much less expensive. Various thicknesses represent moderate (thinnest), heavy, and extreme wear (thicker) in the installation area. Consider PVF film top coating for heavy-use areas and other areas exposed to chemical reagents and staining agents such as dormitories, dining halls, cafeterias, medical facilities, and clubs.

Delete PVF film when not required.

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NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets.

****

Provide a vinyl coated woven or nonwoven wallcovering fabric. Conform to FS CCC-W-408 for vinyl wallcovering, [Type I (Light Duty) with a minimum total weight of [237] [339] grams/square meter [7] [10] ounces/square yard and [325][465] grams/linear meter [10.5][15] ounces/linear yard][Type II (Medium Duty) with a minimum total weight of 441 grams/square meter 13 ounces/square yard and 620 grams/linear meter 20 ounces/linear yard][Type III (Heavy Duty) with a minimum total weight of 746 grams/square meter 22 ounces/square yard and 1023 grams/linear meter 33 ounces/linear yard]. Provide width of[1320/1371 mm 52/54 inch] [_____]. Test vinyl wallcovering in accordance with NFPA 286 or meet the requirements of Class A when tested in accordance with ASTM E84 or UL 723. [Apply a polyvinyl fluoride (PVF) film,[0.00889 mm 0.00035 inch] [0.0127 mm 0.0005 inch] [0.0254 mm 0.0010 inch] thick over the face of the wallcovering. Provide a transparent (clear) film, medium gloss.]

[Provide Vinyl Wallcovering containing a minimum of [10][_____] percent recycled content. Provide data identifying percentage of recycled content for vinyl wallcovering.]

Provide certification of indoor air quality for vinyl wallcovering.

2.3 TEXTILE WALLCOVERING [TYPE [A] [_____]]

****

NOTE: These notes apply to both textile and acoustical wallcoverings.

In accordance with NFPA 101, the use of textile materials on walls and ceilings will comply with one of the following conditions:

a. Textile materials meeting the requirements of Class A when tested in accordance with ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials, or UL 723, Standard for Test for Surface Burning Characteristics of Building Materials, using the mounting method of ASTM E2404, Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Vinyl Wall or Ceiling Coverings to Assess Surface Burning Characteristics, ARE PERMITTED ON THE WALLS OR CEILINGS OF ROOMS OR AREAS PROTECTED BY AN APPROVED AUTOMATIC SPRINKLER SYSTEM.

b. Textile materials meeting the requirements of Class A when tested in accordance with ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials, or UL 723, Standard for Test for Surface Burning Characteristics of Building Materials, using the mounting method of ASTM E2404, Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Vinyl Wall or Ceiling Coverings to Assess Surface Burning Characteristics, are permitted on partitions that do not exceed 3/4 of the floor-to-ceiling height or do not exceed 2440 mm 8 feet in height whichever is less.

c. Textile materials meeting the requirements of Class A when tested in accordance with ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials, or UL 723, Standard for Test for Surface Burning Characteristics of Building Materials, using the mounting method of ASTM E2404, Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Vinyl Wall or Ceiling Coverings to Assess Surface Burning Characteristics, are permitted to extend not more than 1200 mm 48 inches above the finished floor on ceiling-height walls and ceiling-height partitions.

d. Textile materials are permitted on walls and partitions where tested in accordance with NFPA 265. (ICC IBC is equivalent to NFPA 265.)

e. Textile materials are permitted on walls, partitions, and ceilings where tested in accordance with NFPA 286.

Add information on natural fibers as applicable to the project.

****

Provide colorfast, stain, and soil resistant textile wallcovering fabricated of woven fabric with paper or acrylic backing. [Test in accordance with NFPA 265 or NFPA 286.][Meet the requirements of Class A when tested in accordance with ASTM E84 or UL 723.] Comply with or exceed the following for textile wallcovering:

Face fiber content	[_____]
Weave	[Plain] [_____]
Total Weight	[_____] g/square meter ounces/square yard
Width	[_____] mm inch

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets.

****

[Provide Textile Wallcovering containing a minimum of [5][_____] percent recycled content. Provide data identifying percentage of recycled content for textile wallcovering.]

Provide certification of indoor air quality for textile wallcovering.

2.4 ACOUSTICAL WALLCOVERING [TYPE [A] [_____]]

****

NOTE: See textile wallcovering notes; these notes also apply to acoustical wallcovering.

****

Provide acoustical wallcovering fabricated of [synthetic material] [vinyl coated fabric with porous surface with fused back] [_____]. [Test in accordance with NFPA 265 or NFPA 286.] [Meet the requirements of Class A when tested in accordance with ASTM E84 or UL 723.] Comply with or exceed the following for textile wallcovering:

Total Weight	[_____] g/square meter ounces/square yard
Width	[_____] mm inch
NRC rating in accordance with ASTM C423	[_____] mm inch

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content shown.

****

Provide Acoustical Wallcovering containing a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for acoustical wallcovering.

Provide certification of indoor air quality for acoustical wallcovering.

2.5 WALLCOVERING BORDER [TYPE [A] [_____]]

Provide wallcovering border of nonwoven vinyl cellulose/polyester blend or vinyl coated strippable paper back. Comply with or exceed the following for wallcovering border:

Total Weight	[_____] g/linear meter ounces/linear yard
Width	[_____] mm inch

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets.

****

[Provide Wallcovering Border containing a minimum of [10][_____] percent recycled content. Provide data identifying percentage of recycled content for wallcovering border.]

Provide certification of indoor air quality for wallcovering border.

2.6 PRESENTATION DRY ERASE WALLCOVERING

****

NOTE: Some products must be installed on glass reinforced cement board to achieve Class A rating.

Research product to determine available features. Note that surfaces designed to be used as a projection screen are not available with 50 by 50 mm 2 by 2 inch grid pattern.

****

Provide presentation dry erase wallcovering that accepts dry erase markings [and is designed to be used as a projection screen] [and has a 50 by 50 mm 2 by 2 inch grid pattern]. Provide wallcovering with a minimum total weight of [678] [_____] g/square meter [20] [_____] ounces/square yard, a width of[1524 mm 60 inch][_____] and backing of a woven or nonwoven polyester. Test wallcovering in accordance with NFPA 286 or have a Class A flame spread rating of 0-25 and smoke development rating of 0-450 when tested in accordance with ASTM E84 or UL 723. Provide wallcovering color [selected from manufacturer's standard colors] [white] [_____]. When frame is required provide [aluminum] [oak] [_____] and have a full length tray of the same material. Markings must be removable with a felt eraser or cloth without ghosting. Provide each unit complete with an eraser, four different color compatible dry erase markers, and a 240 mlan 8 ounce bottle of liquid surface cleaner recommended by the manufacturer.

Provide certification of indoor air quality for presentation dry erase wallcovering.

2.7 WALL LINER

****

NOTE: Wall lining should be specified where wallcovering will be installed over masonry walls.

****

Provide a non-woven polyester cellulose blend wall liner having a minimum weight of 125 g/square meter 3.7 ounces/square yard and a total minimum thickness of 0.33 mm 0.013 inch. Test wall liner in accordance with NFPA 286 or have a Class A flame spread rating of 0-25 and smoke development rating of 0-450 when tested in accordance with ASTM E84 or UL 723.

Provide certification of indoor air quality for wall liner.

2.8 CORNER GUARDS

****

NOTE: Delete references to corner guards in this specification if they are to be of the type specified in Section 10 26 00 WALL AND DOOR PROTECTION. Some projects may require both types. Coordinate locations when this occurs.

****

Provide[1 mm 0.040 inch thick corner guards and cover 20 mm 3/4 inch] [2 mm 0.075 inch thick corner guards and cover 28 mm 1 1/8 inch] [2.2 mm 0.085 inch thick and cover 63 mm 2 1/2 inch] [_____] each side of corner at right angles. Provide [clear] [_____] [polycarbonate] [vinyl] [rubber] corner guards from the same color lot.

Provide certification of indoor air quality for corner guards.

2.9 WAINSCOT CAP

****

NOTE: A metal, vinyl, or wood wainscot cap molding will normally be required for all wainscot installations. The specification should include whether metal, vinyl, or wood molding is required. If metal or vinyl cap moldings are shown on the drawings, provisions in this paragraph should be modified accordingly. Delete inapplicable text if wainscot doesn't apply.

****

Provide [[satin-finished extruded aluminum] [_____] wainscot cap [19][_____] mm [3/4][_____] inch high, feathered at bottom edge, with 5 mm 3/16 inch exposed face on top edge, and grooved to receive the covering][_____].

2.10 PRIMER AND ADHESIVE

****

NOTE: When mold is a problem in the area consider specifying mold proof primers and adhesives.

****

Provide a type primer and adhesive recommended by the wallcovering manufacturer, containing a non-mercury based mildewcide, and complying with local indoor air quality standards. Primer must permit removal of the wallcovering and protect the wall surface during removal. Do not damage gypsum wallboard facing paper during removal of wallcovering. Provide a strippable type adhesive. When substrate color variations show through vinyl wallcovering, provide a white pigmented primer as recommended by the wallcovering manufacturer used to conceal the variations. Provide a recommended type adhesive to install corner guards and wainscot cap by the manufacturer of the corner guards and wainscot cap.

Provide primers and non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for primer; also, provide certification or validation of indoor air quality for adhesives.

2.11 COLOR, TEXTURE, AND PATTERN

****

NOTE: Avoid selection of a deeply embossed pattern where frequent cleaning of wallcovering is required.

Editing of color reference sentence(s) must be coordinated with the Government. Generally Section 09 06 00 Color Schedule or drawing is used when the project is designed by an Architect or Interior designer. Color should be selected from manufacturer's standard colors or identified in this specification only when the project has minimal finishes.

When the government directs that color be located in the drawings add a note that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

When more than one type, pattern or color is specified identify location and extent of work for each.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

Prior to specifying a custom color finish, research to determine if additional cost is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

****

Provide color, texture and pattern in accordance with [Section 09 06 00 SCHEDULES FOR FINISHES] [the drawings] [selected from manufacturers standard colors][[_______]. Color listed is not intended to limit the selection of equal colors from other manufacturers].

PART 3 EXECUTION

3.1 EXAMINATION

Inspect all areas and conditions under which wallcoverings are to be installed. Notify the Contracting Officer, in writing, of any conditions detrimental to the proper and timely completion of the installation. Work will proceed only when conditions have been corrected and accepted by the installer.

3.2 SURFACE PREPARATION

****

NOTE: When applying wallcovering over concrete or masonry surfaces, Section 03 30 00 CAST-IN-PLACE CONCRETE, will be coordinated to require, as applicable: (1) smooth concrete finish (2) masonry surfaces that are level and plumb with flush joints

and square openings and (3) no variations in the surfaces exceeding 1 mm in 1000 mm 1/8 inch in 10 feet with no abrupt irregularities.

Coordinate level of gypsum wallboard finish required for presentation dry erase wallcovering with Section 09 29 00 Gypsum Board. Some manufacturers require a Level 4 finish and others Level 5.

When mold is a problem in an existing building that is being renovated, add verbiage to specification to cover removal of mold and appropriate surface preparation necessary to install new wallcovering. In addition, the source of the moisture needs to be located and fixed prior to installation of the wallcovering.
****

Do not apply wallcovering to surfaces that are rough, that contain stains which will bleed through the wallcovering, or that are otherwise unsuitable for proper installation. Fill cracks and holes; sand rough spots smooth. Finish walls to receive presentation dry erase wallcovering to a Level 4 gypsum wallboard finish in accordance with GA 214 unless Level 5 is recommended by the wallcovering manufacturer. Thoroughly dry surfaces at least 30 days prior to installation of vinyl wallcovering. Provide interior surfaces of new and existing gypsum wallboard with a wallcovering primer in accordance with the manufacturer's printed instructions. As required, use white primer when substrate color variations are visible through thin or light color wallcovering. Seal interior surfaces of exterior masonry walls to prevent moisture penetration, then prime with a wallcovering primer in accordance with the manufacturer's printed instructions. Provide masonry walls with flush joints. Test moisture content of plaster, concrete, and masonry with an electric moisture meter of a maximum five percent reading. Apply a thin coat of joint compound or cement plaster, as recommended by the wallcovering manufacturer, to the concrete and masonry walls as a substrate preparation. To promote adequate adhesion of wall lining over masonry walls, prime the walls as recommended by the wall lining manufacturer. Prime the surfaces of walls as required by the manufacturer's printed instructions to permit ultimate removal of wallcovering from the wall surfaces. Allow primer to completely dry before adhesive application.

3.3 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.3.1 Wallcovering

Install wallcovering in accordance with the manufacturer's printed installation instructions. Remove glue and adhesive spillage from wallcovering face and seams with a remover recommended by the manufacturer.

3.3.1.1 Textile Wallcovering

When textile wallcoverings are specified to comply with NFPA 265, NFPA 286, or ICC IBC (Section 803.5 Textile wall coverings) testing, install the wallcovering in accordance with the manufacturer's printed installation instructions for compliance with the testing using the same product mounting system, including adhesive. After the installation is complete, vacuum the fabric with a ceiling to floor motion.

3.3.1.2 Acoustical Wallcovering

When acoustical wallcoverings are specified to comply with NFPA 265, NFPA 286, or ICC IBC (Section 803.5 Textile wall coverings) testing, install the wallcovering in accordance with the manufacturer's printed installation instructions for compliance with the testing using the same product mounting system, including adhesive. After the installation is complete, vacuum the fabric with a ceiling to floor motion.

3.3.1.3 Presentation Dry Erase Wallcovering Placement

****

NOTE: Delete frame size column in schedule when wall-to-wall and floor-to-ceiling wallcovering is specified.

Location of wallcovering and mounting height of framed wallcovering must be specified.

Size and type of wallcovering should be specified only once in the contract documents. If more than one type is specified, clearly identify locations.

Installing horizontally eliminates seams at writing height when installed at the proper height.

****

Install presentation dry erase wallcovering [wall-to-wall and floor-to-ceiling] [_____] and horizontally on the wall. Make the first seam at[610 mm 24 inch above finished floor for rooms with 2440 mm 8 foot ceilings][and][760 mm 30 inch above finished floor for rooms with 2740 mm 9 foot ceilings] [_____]. Do not make seams at writing height to provide a continual, seamless writing surface.[Provide wallcovering with an [aluminum] [oak] [_____] frame. When frame and tray are required for presentation dry erase wallcovering, install them in accordance with manufacturer's installation instructions. Upon completion of presentation dry erase wallcovering installation, clean the wallcovering surface as recommended by the manufacturer prior to first use. Provide a mounting height of framed wallcovering [as shown on the drawings] [[_____] above finished floor to top of the frame.]] Wallcovering locations are [as indicated on drawings.] [as scheduled below:

Room Name and Number	Wall Location	Frame Size
[_____]	[_____]	[_____]

]

3.3.2 Wall Liner

****

NOTE: Provide reinforcing at partitions to support presentation dry erase wallcovering frames.

****

Install wall liner over masonry walls that are to receive wallcovering.

Install liner in accordance with the manufacturer's printed installation instructions. Install liner perpendicular to wallcovering to prevent overlapping of seams between liner and wallcovering.

3.3.3 Corner Guards and Wainscot Cap

Install corner guards and wainscot cap [as indicated on sheet [_____]] [on all exposed corners with [wallcovering] [_____]] and in accordance with the manufacturer's printed instructions. Run corner guards from top of base to [wainscot cap] [ceiling] [_____] in a continuous length.

3.4 CLEAN-UP

Upon completion of the work, clean wallcovering free of dirt, soiling, stain, or residual film. Remove and clean surplus materials, rubbish, and debris resulting from the wallcovering installation.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 84 20 (August 2016)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-09 83 13 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-09 84 20 (August 2016)**

Change 1 - 08/18

Preparing Activity: USACE **Superseding**

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****

SECTION 09 84 20

ACOUSTICAL WALL PANELS

08/16, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for fabric covered acoustical wall panel systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC 16	(2004; E 2008; E 2010) Colorfastness to Light

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

ASTM INTERNATIONAL (ASTM)

ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM D5034	(2009; R 2017) Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

CALIFORNIA AIR RESOURCES BOARD (CARB)

CARB 93120	(2007) Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G, [_____]

SD-03 Product Data

Installation

Acoustical Wall Panels; G, [_____]

Recycled Content for Wood Panels; S

Recycled Content for Fabric Panels; S

Indoor Air Quality for Composite Wood and Agrifiber Products; S

SD-04 Samples

Acoustical Wall Panels; G, [_____]

SD-07 Certificates

Acoustical Wall Panels

Certified Sustainably Harvested Wood; S

SD-11 Closeout Submittals

Warranty

[1.3 CERTIFICATIONS

1.3.1 Certified Sustainably Harvested Wood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

****

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22s, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

]1.4 DELIVERY, STORAGE, AND HANDLING

Protect materials delivered and placed in storage from the weather, humidity and temperature variations, dirt, dust, or other contaminants.

1.5 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design

Provide [wood][fabric wrapped mineral / glass-fiber core] acoustical wall panel materials in the manufacturer's standard sizes and finishes of the type, design and configuration indicated.

[2.1.1.1 Wood Recycled Content

****

NOTE: Use materials with recycled content, calculated on the basis of post-industrial and post-consumer percentage content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows wood panels are available from US national manufacturers above the minimum recycled content percentages shown below. Some manufacturers and regions have higher percentages. Based on research, insert desired minimum percentages into the empty set of brackets.

****

Wood Panels must contain a minimum of [50][_____] percent recycled content. Provide data identifying percentage of recycled content for wood panels.

][2.1.1.2 Sustainably Harvested Wood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.
****

Wood Panels must contain a minimum of [50][_____] percent certified sustainably harvested wood. Provide documentation that certified sustainably harvested wood is used and identify percentage.

][2.1.1.3 Fabric Recycled Content

****
NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Based on research, recycled content percentages of fabric panels varies among national manufacturers. Designer must research acceptable products and insert minimum percentage in the empty bracket below.
****

Fabric Panels must contain a minimum of [_____] percent recycled conten. Provide data identifying percentage of recycled content for fabric panels.

Composite wood and agrifiber products must contain no added urea-formaldehyde resins. Products containing composite wood and agrifiber components must meet emissions requirements of either CARB 93120 or CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide validation of indoor air quality for composite wood and agrifiber products.

]2.2 FABRIC COVERED ACOUSTICAL WALL PANELS

****
NOTE: Drawings must show locations and dimensions of acoustical panels, details of joints, base, head, and mounting details.

The same or similar acoustical benefits can possibly be obtained by other means such as wall covering, etc.

Omit the following items that do not meet project requirements.
****

Provide acoustical wall panels consisting of prefinished, factory assembled, seamless fabric covered, fiber glass or mineral fiber core system as described below manufactured to the dimensions and configurations shown on the approved detail drawings; submit drawings showing plan locations, elevations and details of method of anchorage, location of doors and other openings, base detail and shape and thickness of materials.

Perimeter edges must be [non-reinforced.] [reinforced by either an aluminum frame or a formulated resin edge hardener.] Acoustical wall panels must comply with the interior finish requirements of NFPA 101. Submit manufacturer's descriptive data and catalog cuts; fabric and vinyl swatches, minimum 450 mm 18 inches wide by 600 mm 24 inches long [3] [_____] samples of each color range specified; and certificates of compliance from an independent laboratory accredited by the National Laboratory Accreditation Program of the National Institute of Standards. A label or listing from the testing laboratory will be acceptable evidence of compliance. Wall panels must conform to the following:

2.2.1 Panel Width

[Widths must be [600] [750] [1200] [1500] mm [24] [30] [48] [60] inches] [End panels may vary in width as necessary to cover wall] [Panel width must be as detailed.]

2.2.2 Panel Height

[Heights must be [2400] [2700] [3000] mm [96] [108] [120] inches.] [[Field measures panels for custom fit to ceiling.] [Tolerance at floor as detailed].] [Panel height must be as detailed.]

2.2.3 Thickness

[Panel thickness as required to meet the indicated NRC range] [_____].

2.2.4 Fabric Covering

Seamless [non-woven, embossed texture, needle punched 100 percent polyester, minimum 0.034 kg/linear meter 11 ounces/linear yard. Tear strength a minimum 110 N 25 pounds machine direction and minimum 178 N 40 pounds cross-machine direction. Tensile strength a minimum 220 N 50 pounds machine direction and minimum 330 N 75 pounds cross-machine direction in accordance with ASTM D5034.] [plain woven 2-ply 100 percent polyester, minimum 0.47 kg/linear meter 15 ounces/linear yard. Tear strength a minimum 129 N 29 pounds. Tensile strength 667 N 150 pounds minimum in accordance with ASTM D5034.] [perforated vinyl covering with fabric backing, minimum 0.62 kg/linear meter 20 ounces/linear yard total weight.] Stretch fabric covering free of wrinkles and then bond to the edges and back or bond directly to the panel face, edges, and back of panel a minimum distance standard with the manufacturer. Light fastness (fadeometer) approximately 40 hours in accordance with AATCC 16.

2.2.5 Fire Rating for the Complete Composite System

Class A, 200 or less smoke density and flame spread less than 25, when tested in accordance with ASTM E84.

2.2.6 Substrate

Fiber glass or mineral fiber

2.2.7 Noise Reduction Coefficient (NRC) Range

[0.50-0.60] [0.80-0.90] [_____] ASTM C423

2.2.8 Edge Detail

[Half bevel] [Bevel] [Radius] [Square] [Mitered] [_____] edge with fabric wrapped on all four sides.

2.2.9 Core Type

[Standard acoustical] [High impact acoustical] [Acoustical/tackable] [_____] core

2.2.10 Mounting Acoustical Panels

Mount acoustical panels by manufacturer's standard [concealed spline] [mechanical fasteners] [magnetic fasteners] [hook and loop] [adhesive mounting] [_____].

2.3 COLOR

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an Architect or Interior designer. Select color from manufacturers standard colors or identified as a manufacturers color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located in the drawings add a note that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

****

[In accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [As indicated] [Selected from manufacturers standard colors] [[_____]. Color listed is not intended to limit the selection of equal colors from other manufacturers.]

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

Must be clean, smooth, oil free and prepared in accordance with panel manufacturer's instructions. Do not begin installation until all wet work, such as, plastering, painting, and concrete are completely dry.

3.2 INSTALLATION

Panel installation must be by personnel familiar with and normally engaged in installation of acoustical wall panels. Apply panels in accordance with the manufacturer's installation instructions. Submit manufacturer's installation instructions and recommended cleaning instructions.

3.3 CLEANING

Following installation, clean dirty or stained panel surfaces in accordance with manufacturer's instructions and leave free from defects. Remove and replace panels that are damaged, discolored, or improperly installed.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-09 90 00 (February 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 90 00 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 90 00

PAINTS AND COATINGS

02/21

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-09 90 00 (February 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 90 00 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 09 90 00

PAINTS AND COATINGS

02/21

****

NOTE: This guide specification covers the requirements for painting of new and existing, interior and exterior substrates, including masonry, concrete, metal, wood, and other miscellaneous materials.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification includes tailoring for ARMY and NAVY projects, and for INTERIOR and EXTERIOR painting. Where an Editor's Note states a paragraph is tailored for a Service or painting type, the content of the paragraph, or a portion of the paragraph, is suited specifically to be included only for that Service or painting type.

****

****

NOTE: This Guide Specification is used in the preparation of project specifications for Department of Defense facilities:
1. Buildings;

2. Related mechanical, electrical, and miscellaneous items; and
3. Shore-to-ship utility connections.

This guide specification has been prepared to address the requirements of routine maintenance painting when modified to include or utilize maintenance options.

This guide specification DOES NOT address high-performance or specialty coating requirements, or protective coating of industrial structures or facilities, including but not limited to:
1. Towers;
2. Pilings;
3. Pavement markings;
4. Items requiring specialized treatment due to peculiar usage;
5. Petroleum storage facilities;
6. Water storage facilities;
7. Waterfront facilities, except shore-to-ship utility connections; and
8. Hangars

If such items are in the project include in a separate section or modify this section accordingly. The following guide specifications are examples of those available for specific service conditions noted, and may be modified to provide for related service conditions:

1. Section 09 97 23 METALLIC TYPE CONDUCTIVE/SPARK RESISTANT CONCRETE FLOOR FINISH. This specification covers the requirements for metallic type conductive/spark resistant concrete floor finish for ordnance and other similar structures.

2. Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES. This specification covers the painting of hydraulic structures located in fresh water such as locks and dams.

3. Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. This specification is usable for any steel structure exposed to weather, and is usable for other purposes as well, such as hangar structures, enclosed swimming pool structures, and most situations requiring high-performance protective coating systems.

4. Section 09 97 13.16 INTERIOR COATING OF WELDED STEEL WATER TANKS. This guide specification covers the requirements for polyamide epoxy coating system for interior of newly constructed Navy and Air Force water tanks, potable and non-potable, where shop applied coatings are not being considered.

This guide specification generally contains only two types of coating systems, solvent based and water

based. If different systems are required regionally, or for special needs, modify the guide accordingly.

****

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

****

NOTE: Indicate type and extent of work on drawings. Specific quantities should not be cited in the specification. Indicate on the drawings the linear amount of existing putty, glazing compound, sealant or caulking to be replaced with new material and quantify the area of existing coating to be removed by methods specified for each substrate material.

****

1.1.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.

b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.

c. Existing coated surfaces that are damaged during performance of the work.

1.1.1.1 Exterior Painting

****

NOTE: The following subparagraph is tailored for inclusion in projects with exterior painting.

Choose bracketed items according to scope of project.

****

Includes new surfaces[, existing coated surfaces,][and][existing uncoated surfaces,] of the building[s] and appurtenances. Also included are existing coated surfaces made bare by cleaning operations.

1.1.1.2 Interior Painting

****

NOTE: The following subparagraph is tailored for inclusion in projects with interior painting.

Choose bracketed items according to scope of project.

****

Includes new surfaces[, existing uncoated surfaces,][and][existing coated surfaces] of the building[s] and appurtenances as indicated and existing coated surfaces made bare by cleaning operations. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

a. Exposed columns, girders, beams, joists, and metal deck; and

b. Other contiguous surfaces.

1.1.2 Painting Excluded

Do not paint the following unless indicated otherwise.

a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.

b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, crawl spaces, elevator shafts and chases.

c. Steel to be embedded in concrete.

d. Copper, stainless steel, aluminum, anodized aluminum, brass, and lead except existing coated surfaces.

e. Hardware, fittings, and other factory finished items.

[f. Do not paint surfaces in the following areas: [_____].

]1.1.3 Mechanical and Electrical Painting

****

NOTE: Choose bracketed items in paragraph below according to scope of project.

****

Includes field coating of [interior][and][exterior] new[and existing] surfaces.

a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.

    (1) Exposed piping, conduit, and ductwork;

    (2) Supports, hangers, air grilles, and registers;

    (3) Miscellaneous metalwork and insulation coverings.

[b. Do not paint the following, unless indicated otherwise:

[(1) New zinc-coated, aluminum, and copper surfaces under insulation

][(2) New aluminum jacket on piping

][(3) New interior ferrous piping under insulation.

]][1.1.3.1 Fire Extinguishing Sprinkler Systems

Clean, pretreat, prime, and paint new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories. Apply coatings to clean, dry surfaces, using clean brushes.

][1.1.4 Exterior Painting of Site Work Items

****

NOTE: The following paragraph is tailored for inclusion in projects with exterior painting.

Insert list of Site Work Items to be painted in table below, such as hand rails, fire extinguishing systems, doors.

****

Field coat the following items:

	New Surfaces	Existing Surfaces
a.		
b.		
c.		

]1.1.5 Miscellaneous Painting

1.1.5.1 Lettering [Building][Room Number(s)]

Provide lettering [as scheduled on the drawings][block][Gothic] type, [black enamel][water-type decalcomania, finished with a protective coating of spar varnish]. Samples must be approved before application.

[1.1.5.2 Obstructions To Aviation

****

NOTE: Specify by name structures such as smokestacks, poles, and buildings which have been identified as obstruction to aviation. Verify that the structures so identified are not specified to be painted in the sections specifying the structures so that painting will not be specified twice. Coordinate with FAA for alternate colors and patterns.

****

Paint the following obstructions to aviation in the pattern and color prescribed by FAA AC 70/7460-1: [smokestacks][poles][buildings][_____]

]1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100	(2017; Suppl 2020) Documentation of the Threshold Limit Values and Biological Exposure Indices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D235	(2022) Standard Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D2824/D2824M	(2018) Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Non-Fibered, and Fibered without Asbestos
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4444	(2013; R 2018) Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters
ASTM D6386	(2022) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces

	for Painting
ASTM F1869	(2023) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

Intelligence Bulletin 65	(2013) Occupational Exposure to Carbon Nanotubes and Nanofibers

MASTER PAINTERS INSTITUTE (MPI)

MPI 1	(2012) Aluminum Paint
MPI 2	(2012) Aluminum Heat Resistant Enamel (up to 427 C and 800 F
MPI 3	(2016) Primer, Alkali Resistant, Water Based
MPI 4	(2016) Interior/Exterior Latex Block Filler
MPI 5	(2015) Primer, Exterior Alkyd Wood
MPI 6	(2015) Primer, Exterior Latex Wood
MPI 8	(2016) Alkyd, Exterior Flat (MPI Gloss Level I)
MPI 9	(2016) Alkyd, Exterior Gloss (MPI Gloss Level 6)
MPI 10	(2016) Latex, Exterior Flat (MPI Gloss Level 1)
MPI 11	(2016) Latex, Exterior Semi-Gloss, MPI Gloss Level 5
MPI 13	(2016) Stain, Exterior Solvent-Based, Semi-Transparent
MPI 16	(2016) Stain, Exterior, Water Based, Solid Hide
MPI 17	(2016) Primer, Bonding, Water Based
MPI 19	(2012) Primer, Zinc Rich, Inorganic
MPI 21	(2012) Heat Resistant Coating, (Up to 205°C/402°F), MPI Gloss Level 6
MPI 22	(2012) Aluminum Paint, High Heat (up to 590° C/1100° F)
MPI 23	(2015) Primer, Metal, Surface Tolerant
MPI 27	(2016) Floor Enamel, Alkyd, Gloss (MPI Gloss Level 6)

MPI 31	(2012) Varnish, Polyurethane, Moisture Cured, Gloss (MPI Gloss Level 6)
MPI 38	(2016) Elastomeric Coating, Exterior, Water Based, Non-Flat
MPI 39	(2018) Primer, Latex, for Interior Wood
MPI 42	(2012) Textured Coating, Latex, Flat
MPI 44	(2016) Latex, Interior, (MPI Gloss Level 2)
MPI 45	(2016) Primer Sealer, Interior Alkyd
MPI 46	(2016) Undercoat, Enamel, Interior
MPI 47	(2016) Alkyd, Interior, Semi-Gloss (MPI Gloss Level 5)
MPI 48	(2016) Alkyd, Interior, Gloss (MPI Gloss Level 6-7)
MPI 49	(2015) Alkyd, Interior, Flat (MPI Gloss Level 1)
MPI 50	(2015) Primer Sealer, Latex, Interior
MPI 51	(2016) Alkyd, Interior, (MPI Gloss Level 3)2
MPI 52	(2016) Latex, Interior, (MPI Gloss Level 3)
MPI 54	(2016) Latex, Interior, Semi-Gloss (MPI Gloss Level 5)
MPI 56	(2012) Varnish, Interior, Polyurethane, Oil Modified, Gloss
MPI 57	(2012) Varnish, Interior, Polyurethane, Oil Modified, Satin
MPI 59	(2016) Floor Paint, Alkyd, Low Gloss
MPI 60	(2016) Floor Paint, Latex, Low Gloss
MPI 68	(2016) Floor Paint, Latex, Gloss
MPI 71	(2012) Varnish, Polyurethane, Moisture Cured, Flat (MPI Gloss Level 1)
MPI 72	(2016) Polyurethane, Two-Component, Pigmented, Gloss (MPI Gloss Level 6-7)
MPI 76	(2016) Primer, Alkyd, Quick Dry, for Metal
MPI 77	(2015) Epoxy, Gloss
MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for

	Metal
MPI 90	(2012) Stain, Semi-Transparent, for Interior Wood
MPI 94	(2016) Alkyd, Exterior, Semi-Gloss (MPI Gloss Level 5)
MPI 95	(2015) Primer, Quick Dry, for Aluminum
MPI 101	(2016) Primer, Epoxy, Anti-Corrosive, for Metal
MPI 107	(2016) Primer, Rust-Inhibitive, Water Based
MPI 108	(2015) Epoxy, High Build, Low Gloss
MPI 113	(2018) Elastomeric, Pigmented, Exterior, Water Based, Flat
MPI 116	(2012) Block Filler, Epoxy
MPI 119	(2016) Latex, Exterior, Gloss (MPI Gloss Level 6)
MPI 120	(2020) Epoxy, High Build, Self Priming, Low Gloss
MPI 134	(2015) Primer, Galvanized, Water Based
MPI 138	(2016) Latex, Interior, High Performance Architectural, (MPI Gloss Level 2)
MPI 139	(2016) Latex, Interior, High Performance Architectural, (MPI Gloss Level 3)
MPI 140	(2016) Latex, Interior, High Performance Architectural, (MPI Gloss Level 4)
MPI 141	(2016) Latex, Interior, High Performance Architectural, Semi-Gloss (MPI Gloss Level 5)
MPI 144	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 2)
MPI 145	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 3)
MPI 146	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 4)
MPI 147	(May 2016) Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (MPI Gloss Level 5)
MPI 149	(2016) Primer Sealer, Interior, Institutional Low Odor/VOC

MPI 151	(2016) Light Industrial Coating, Interior, Water Based (MPI Gloss Level 3)
MPI 153	(2016) Light Industrial Coating, Interior, Water Based, Semi-Gloss (MPI Gloss Level 5)
MPI 154	(2016) Light Industrial Coating, Interior, Water Based, Gloss (MPI Gloss Level 6)
MPI 161	(2016) Light Industrial Coating, Exterior, Water Based (MPI Gloss Level 3)
MPI 163	(2016) Light Industrial Coating, Exterior, Water Based, Semi-Gloss (MPI Gloss Level 5)
MPI 164	(2016) Light Industrial Coating, Exterior, Water Based, Gloss (MPI Gloss Level 6)
MPI 177	(2020) Epoxy, Semi-Gloss (MPI Gloss Level 5)
MPI 214	(2016) Latex, Exterior (MPI Gloss Level 2)
MPI ASM	(2019) Architectural Painting Specification Manual
MPI GPS-1-14	(2014) Green Performance Standard GPS-1-14
MPI GPS-2-14	(2014) Green Performance Standard GPS-2-14
MPI MRM	(2015) Maintenance Repainting Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC Glossary	(2011) SSPC Protective Coatings Glossary
SSPC Guide 6	(2021) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
SSPC Guide 7	(2015) Guide to the Disposal of Lead-Contaminated Surface Preparation Debris
SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 2	(2024) Hand Tool Cleaning

SSPC SP 3	(2024) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC VIS 3	(2004) Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning
SSPC VIS 4/NACE VIS 7	(1998; E 2000; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Waterjetting
SSPC-SP WJ-1/NACE WJ-1	(2012) Clean to Bare Substrate, Waterjet Cleaning of Metals
SSPC-SP WJ-2/NACE WJ-2	(2012) Very Thorough Cleaning, Waterjet Cleaning of Metals
SSPC-SP WJ-3/NACE WJ-3	(2012) Thorough Cleaning, Waterjet Cleaning of Metals
SSPC-SP WJ-4/NACE WJ-4	(2012) Light Cleaning, Waterjet Cleaning of Metals

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-680	(2010; Rev C; Notice 1 2015) Degreasing Solvent
MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA Method 24	(2000) Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(2016; Rev L; Change 2) Obstruction Marking and Lighting

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-313	(2018) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
29 CFR 1910.1001	Asbestos
29 CFR 1910.1025	Lead
29 CFR 1926.62	Lead

1.3 DEFINITIONS

1.3.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third-party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.3.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing must be accomplished by an MPI testing lab.

1.3.3 Coating

SSPC Glossary; (1) A liquid, liquefiable, or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer; (2) Generic term for paint, lacquer, enamel.

1.3.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.3.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five levels are generically defined under the Assessment sections in the MPI MRM, MPI Maintenance Repainting Manual.

1.3.6 EXT

****

NOTE: The following paragraph is tailored for inclusion in projects with exterior painting.

****

MPI short term designation for an exterior coating system.

1.3.7 INT

****
NOTE: The following paragraph is tailored for inclusion in projects with interior painting.
****

MPI short term designation for an interior coating system.

1.3.8 Loose Paint

Paint or coating that can be removed with a dull putty knife.

1.3.9 micron / microns

The metric measurement for 0.001 mm or one one-thousandth of a millimeter.

1.3.10 mil / mils

The English measurement for 0.001 in or one one-thousandth of an inch.

1.3.11 mm

The metric measurement for millimeter, 0.001 meter or one one-thousandth of a meter.

1.3.12 MPI Gloss Levels

MPI system of defining gloss. Seven gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units at 60 degree angle	Units at 80 degree angle
G1	Matte or Flat	0 to 5	10 max
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	
G7	High Gloss		

Gloss is tested in accordance with ASTM D523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.3.13 MPI System Number

The MPI coating system number in each MPI Division found in either the MPI

Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN).

1.3.14 Paint

SSPC Glossary; (1) Any pigmented liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer that is converted to an opaque solid film after application. Used for protection, decoration, identification, or to serve some other functional purposes; (2) Application of a coating material.

1.3.15 REX

****

NOTE: The following paragraph is tailored for inclusion in projects with exterior painting.

****

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.3.16 RIN

****

NOTE: The following paragraph is tailored for inclusion in projects with interior painting.

****

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

1.4 SCHEDULING

****

NOTE: This Article is tailored for inclusion in NAVY projects only.

Materials that adsorb VOCs include carpets, textiles, unprimed gypsum wallboard, and acoustical ceiling panels. Add any of these materials that are included in the project and other adsorbing materials into the empty bracket.

****

Allow paint, polyurethane, varnish, and wood stain installations to cure prior to the installation of materials that adsorb VOCs, including[carpets,][textiles,][unprimed gypsum wallboard,][acoustical ceiling panels,][_____].

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Samples of specified materials may be taken and tested for compliance with specification requirements.

SD-02 Shop Drawings

Piping Identification

SD-03 Product Data

Coating; G, [_____]

Product Data Sheets

Sealant

SD-04 Samples

Color; G, [_____]

Textured Wall Coating System; G, [_____]

[Sample Textured Wall Coating System Mock-Up; G, [_____]

] SD-07 Certificates

Qualification Testing laboratory for coatings; G, [_____]

Indoor Air Quality for Paints and Primers

[Indoor Air Quality for Consolidated Latex Paints

] SD-08 Manufacturer's Instructions

Application Instructions

Mixing

Manufacturer's Safety Data Sheets

SD-10 Operation and Maintenance Data

Coatings, Data Package 1; G, [_____]

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

1.6.1.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to conform.

1.6.1.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.6.1.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.6.1.4 Asbestos Content

Provide asbestos-free materials.

1.6.1.5 Mercury Content

Provide materials free of mercury or mercury compounds.

1.6.1.6 Silica

Provide abrasive blast media containing no free crystalline silica.

1.6.1.7 Human Carcinogens

Provide materials that do not contain ACGIH 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.6.1.8 Carbon Based Fibers / Tubes

Materials must not contain carbon based fibers such as carbon nanotubes or carbon nanofibers. Intelligence Bulletin 65 ranks toxicity of carbon nanotubes on a par with asbestos.

****

NOTE: Select only one of the following two bracketed paragraphs.

****

[1.6.2 Coating Contractor's Qualification

****

NOTE: When using the Contractor qualification clause rather than the SSPC Certification requirements, edit to require appropriate experience.

****

****

NOTE: Insert structure type comparable to those being painted in brackets.

****

Submit the name, address, telephone number, and e-mail address of the Contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on [_____] on a minimum of three similar projects within the past three years. List information by individual and include the following:

a. Name of individual and proposed position for this work.

b. Information about each previous assignment including:

Position or responsibility

Employer (if other than the Contractor)

Name of facility owner

Mailing address and telephone number of facility owner

Name of individual in facility owner's organization who can be contacted as a reference

Location, size and description of structure

Dates work was carried out

Description of work carried out on structure

][1.6.3 SSPC QP 1 Certification

****

NOTE: For projects in continental U.S., Hawaii, Alaska, and Puerto Rico, require SSPC Certification. Use in other locations where qualified U.S. Contractor is desired. If project involves removal of paint containing hazardous materials, add requirement for SSPC QP 2 certification in section of specification where the hazardous paint removal is specified, generally Section 02 83 00 LEAD REMEDIATION.

****

****

NOTE: **WARNINGWARNING**WARNING**WARNING** Solicitations requiring SSPC Certification must point out the existence and location of the certification requirement, in the Project Information Form. To be enforceable, include the requirement in the solicitation documents. SSPC Certification is a special responsibility requirement pursuant to FAR 9.104-2 Special Standards. This is analogous to requiring bidders to have a specified level of experience or expertise and GAO has sustained these types of special requirements.**

****

****

NOTE: Use bracket option below concerning SSPC QP 1 only when industrial coatings are required. Painting qualifications for projects such as BEQ's, training facilities and general administration buildings do not require QP 1 certification.

****

Contractors that perform surface preparation or coating application on steel substrates must be certified by the Society for Protective Coatings (formerly Steel Structures Painting Council) (SSPC) to the requirements of SSPC QP 1 prior to Contract award, and must remain certified while accomplishing any surface preparation or coating application. If a Contractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site audits from SSPC and furnish a copy of all audit reports.

]1.6.4 Approved Products List

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of Contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire Contract and each coating system is to be from a single manufacturer. Provide all coats on a particular substrate from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

1.6.5 Paints and Coatings Indoor Air Quality Certifications

****

NOTE: The Governments's preference is for use of products that have been certified for indoor air quality by a third-party organization such as MPI's MPI GPS-1-14 and MPI GPS-2-14 Green Performance Standards. Research has shown that all paints except consolidated latex paints are available among three national manufacturers. Verify there is a

certified product available when specifying consolidated latex paint that is both cost effective and appropriate for the project. Confirm local/regional availability of certified products when specifying consolidated latex paint that does not impact cost effectiveness.
****

Provide paint and coating products certified to meet indoor air quality requirements by MPI GPS-1-14, MPI GPS-2-14 or provide certification by other third-party programs. Provide current product certification documentation from certification body.

Provide certification of Indoor Air Quality for Paints and Primers. [Provide certification of Indoor Air Quality for Consolidated Latex Paints.]Submit required indoor air quality certifications in one submittal package.

1.6.6 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph SAMPLING PROCEDURE. Test each chosen product as specified in the paragraph TESTING PROCEDURE. Remove products from the job site which do not conform, and replace with new products that conform to the referenced specification. Test replacement products that failed initial testing as specified in the paragraph TESTING PROCEDURE at no cost to the Government.

****

NOTE: The following paragraph is tailored for inclusion in ARMY projects only.

Only require the testing for large quantities of epoxy/polyurethane coatings or a single coating system that is used in large quantities on the project. A large quantity of epoxy/polyurethane coatings is considered to be 189 Liters 50 gallons or more, a large quantity of other coating systems is considered to be 757 Liters 200 gallons or more. List all coatings for testing by MPI or SSPC paint number in the following paragraph.
****

[Another required testing is Batch Quality Conformance Testing to prove conformance of the manufacturer's paint to the specified MPI standard. This testing is accomplished before the materials are delivered to the job site. Provide testing for [_____] paint products. Test paint products as specified in the paragraph TESTING PROCEDURE.
]

1.6.6.1 Sampling Procedure

Select paint at random from the products that have been delivered to the job site for sample testing. The Contractor must provide one liter one quart samples of the selected paint materials. Take samples in the presence of the Contracting Officer, and label, and identify each sample. Provide labels in accordance with the paragraph PACKAGING, LABELING, AND STORAGE.

1.6.6.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph QUALIFICATION TESTING laboratory for coatings. Include the backup data and summary of the test results within the qualification testing lab report. Provide a summary listing of all the reference specification requirements and the result of each test. Clearly indicate in the summary whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If MPI is chosen to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

1.6.7 Textured Wall Coating System

Three complete samples of each indicated type, pattern, and color of textured wall coating system applied to a panel of the same material as that on which the coating system will be applied in the work. Provide samples of wall coating systems minimum 125 by 175 mm 5 by 7 inches and of sufficient size to show pattern repeat and texture.

[1.6.8 Sample Textured Wall Coating System Mock-Up

****

NOTE: Include the following Mock-Up section when a textured wall coating system is included in the project.

****

After coating samples are approved and prior to starting installation, provide a minimum 2.43 m by 2.43 m 8 foot by 8 foot mock-up for each substrate and for each color and type of textured wall coating using the actual substrate materials. Use the approved mock-up samples as a standard of workmanship for installation within the facility. Submit at least 48 hour advance written notice to the Contracting Officer's Representative prior to mock-up installation.

]1.7 PACKAGING, LABELING, AND STORAGE

****

NOTE: The following paragraph includes tailoring for inclusion in Navy projects. Include the last two sentences for Navy projects only.

Materials with a high capacity to absorb VOC emissions include materials which are woven, fibrous or porous in nature, such as acoustical ceilings, carpet, and textiles. Include such materials being

installed in brackets.
****

Provide paints in sealed containers that legibly show the Contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Furnish pigmented paints in containers not larger than 20 liters 5 gallons. Store paints and thinners in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 4 to 35 degrees C 40 to 95 degrees F. Do not store paint, polyurethane, varnish, or wood stain products with materials that have a high capacity to absorb VOC emissions[, including [_____]]. Do not store paint, polyurethane, varnish, or wood stain products in occupied spaces.

1.8 SAFETY AND HEALTH

Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and in Appendix A of EM 385-1-1. Include in the Activity Hazard Analysis the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.8.1 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

a. The applicable manufacturer's Safety Data Sheets (SDS) or local regulation.

b. 29 CFR 1910.1000.

c. ACGIH 0100, threshold limit values.

****
NOTE: Delete following paragraph if no lead is contained in existing coating systems.
****

[d. The appropriate OSHA standard in 29 CFR 1910.1025 and 29 CFR 1926.62 for surface preparation on painted surfaces containing lead. Removal and disposal of coatings which contain lead is specified in Section 02 83 00 LEAD REMEDIATION. Additional guidance is given in SSPC Guide 6 and SSPC Guide 7. Refer to drawings for list of hazardous materials located on this project. Coordinate paint preparation activities with this specification section.
]
****
NOTE: Delete following paragraph if no asbestos is contained in existing coating systems.
****

[e. The appropriate OSHA standards in 29 CFR 1910.1001 for surface preparation of painted surfaces containing asbestos. Removal and disposal of coatings which contain asbestos materials is specified in Section 02 82 00 ASBESTOS REMEDIATION. Refer to drawings for list of hazardous materials located on this project. Coordinate paint preparation activities with this specification section.

] Submit manufacturer's Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

1.9 ENVIRONMENTAL REQUIREMENTS

****

NOTE: Choose bracketed option in the following paragraph if high emission paints or coatings, such as epoxies or alkyds, will be used.

****

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation.[Isolate area of application from rest of building when applying high-emission paints or coatings.]

1.9.1 Coatings

Do not apply coating when air or substrate conditions are:

a. Less than 3 degrees C 5 degrees F above dew point;

b. Below 10 degrees C 50 degrees F or over 35 degrees C 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Do not, under any circumstances, violate the manufacturer's application recommendations.

1.9.2 Post-Application

****

NOTE: The following paragraphs are tailored for inclusion in NAVY projects only.

Choose the most appropriate option(s) for ventilation. For instance, high-humidity regions may generate too much condensate when using 100 percent outside air.

****

Vacate space for as long as possible after application. Wait a minimum of 48 hours before occupying freshly painted rooms. Maintain one of the following ventilation conditions during the curing period, or for 72 hours after application:

a. Supply 100 percent outside air 24 hours a day.

b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 13 degrees C 55 degrees F and 29 degrees C 85 degrees F and humidity is between 30 percent and 60 percent.

c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Reprocessed and consolidated latex paints are EPA designated products. Verify the availability of certified products within the region when specifying consolidated latex paint.

****

Conform to the coating specifications and standards referenced in PART 3. Submit Product Data Sheets for specified coatings and solvents. Provide preprinted cleaning and maintenance instructions for all coating systems. Submit Manufacturer's Instructions on Mixing: Detailed mixing instructions, minimum and maximum application temperature and humidity, pot life, and curing and drying times between coats.

[2.2 COLOR CODING FOR SHORE-TO SHIP UTILITY CONNECTIONS

****

NOTE: Include the following bracketed paragraph and Table if the project includes painting of Shore-To-Ship Utility connections

****

Color Coding For Shore-To-Ship Utility Connections: Paint hose connection fittings and shut-off valves the designated color. In addition to color coding provide 50 mm 2 inch high stenciled letters using black stencil paint, clearly designating service for each connection.

Color Coding for Shore-to-Ship Utility Connections		
Service	Color	SAE AMS-STD-595A No.
Potable Water*	Blue	15044
Water Provided for Fire Protection**	Red	11105
Chilled Water	Striped Blue/White	15044 / 17886
Oily Waste Water	Striped Yellow/Black	13528 / 17038
Sewer	Gold	17043
Steam	White	17886
High Pressure Air	Gray	16081
Low Pressure Air	Tan	10324
Fuels	Yellow	13655
* This includes connections serving domestic functions.		

Color Coding for Shore-to-Ship
** This includes non-potable salt water or, at some locations, fresh water connections provided for fire protection (may also include flushing and cooling requirements). Note: This does not include waterfront fire hydrants.

]2.3 COLOR SELECTION OF FINISH COATS

Provide colors of finish coats as indicated or specified. Allow Contracting Officer to select colors not indicated or specified. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors are approximately the colors indicated and the product conforms to specified requirements.

****

NOTE: On Navy projects, do not use Section 09 06 00 SCHEDULES FOR FINISHES. Provide color selection on the Contract drawings.

****

Provide color, texture, and pattern of wall coating systems [as indicated][in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____]. Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated. Submit color stencil codes. Tint each coat progressively darker to enable confirmation of the number of coats.

PART 3 EXECUTION

****

NOTE: Exercise caution when deviating from paint systems listed in tables of PART 3 EXECUTION. Verify compatibility and suitability of paint systems substituted by reviewing the Evaluation of Systems sections of the MPI Manuals.

****

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, reinstall removed items by workmen skilled in the trades. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

[3.2 REPUTTYING AND REGLAZING

****

NOTE: Include this paragraph only for projects involving painting of existing windows but not including a glazing section. Reputtying work should be covered in glazing section if such a section is used in the project specifications. This is

normally used in historical preservation. Avoid using linseed oil putty at building interior.
****

Remove cracked, loose, and defective putty or glazing compound on glazed sash and provide new putty or glazing compound. Where defective putty or glazing compound constitutes 30 percent or more of the putty at any one light, remove the glass and putty or glazing compound and reset the glass. Remove putty or glazing compound without damaging sash or glass. Clean rabbets to bare wood or metal and prime prior to reglazing. Provide linseed oil putty for wood sash. Patch surfaces to provide smooth transition between existing and new surfaces. Finish putty or glazing compound to a neat and true bead. Allow glazing compound time to cure, in accordance with manufacturer's recommendation, prior to coating application. Allow putty to set one week prior to coating application.

][3.3 RESEALING OF EXISTING EXTERIOR JOINTS

****
NOTE: The following Article is tailored for inclusion in projects with exterior painting.
****

3.3.1 Surface Condition

****
NOTE: Include this paragraph only for projects involving resealing of existing exterior joints but not including a sealant Section 07 92 00 JOINT SEALANTS. Such work should be covered in sealant section if such a section is used in the project specifications.
****

Begin with surfaces that are clean, dry to the touch, and free from frost and moisture; remove grease, oil, wax, lacquer, paint, defective backstop, or other foreign matter that would prevent or impair adhesion. Where adequate grooves have not been provided, clean out to a depth of 13 mm 1/2 inch and grind to a minimum width of 6 mm 1/4 inch without damage to adjoining work. Grinding is not required on metal surfaces.

3.3.2 Backstops

In joints more than 13 mm 1/2 inch deep, install glass fiber roving or neoprene, butyl, polyurethane, or polyethylene foams free of oil or other staining elements as recommended by sealant manufacturer. Provide backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

3.3.3 Primer and Bond Breaker

Install the type recommended by the sealant manufacturer.

3.3.4 Ambient Temperature

Between 4 degrees C 38 degrees F and 35 degrees C 95 degrees F when applying sealant.

3.3.5 Exterior Sealant

For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T. Color(s) will be selected by the Contracting Officer. Apply the sealant in accordance with the manufacturer's printed instructions. Force sealant into joints with sufficient pressure to fill the joints solidly. Apply sealant uniformly smooth and free of wrinkles.

3.3.6 Cleaning

Immediately remove fresh sealant from adjacent areas using a solvent recommended by the sealant manufacturer. Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean condition. Allow sealant time to cure, in accordance with manufacturer's recommendations, prior to coating.

]3.4 SURFACE PREPARATION

****

NOTE: Define existing coating systems compositionally before recoating.

1. Hazardous Materials: Follow regulatory restrictions when planning either partial or full removal of existing coatings. Records establishing the composition of materials in the coating systems, if available, may assist in a preliminary review of planned surface preparation and disposal. Generally an overall assessment of applicable regulations for personnel and environmental protection will be required, with appropriate sampling and testing, followed by use of proper material control procedures.

2. Determine compatibility of the existing coating system with a planned repair or overcoating system by procedures such as the following:

a. Identification of the existing topcoat and any undercoats that will be exposed, by consulting local records.

b. If binder extraction is possible, ASTM D2621, "Infrared Identification of Vehicle Solids from Solvent-Reducible Paints," can be used for vehicle identification.

c. General compatibility considerations and chart listings of expected relationships between binder types are given in MPI Evaluation of systems, "Transition Coat and Architectural Paint Compatibility Chart". Consult coating specialist codes regarding questionable compatibilities indicated in the chart.

d. For some maintenance operations, use of ASTM D5064, "Standard Practice for Conducting a Patch

Test to Assess Coating Compatibility," may be warranted. Interpretation of the results of patch testing is not always straight-forward, therefore, consult appropriate coating specialists when considering patch testing.

****

****

NOTE: Specify nonhazardous cleaning agents when possible.

****

Remove dirt, splinters, loose particles, grease, oil,[disintegrated coatings,] and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Schedule cleaning so that dust and other contaminants will not fall on wet, newly painted surfaces. Spot-prime exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas. Refer to MPI ASM and MPI MRM for additional more specific substrate preparation requirements.

[3.4.1 Additional Requirements for Preparation of Surfaces With Existing Coatings

****

NOTE: Delete inapplicable phrases or entire paragraph if no previously painted surfaces will be encountered.

****

Before application of coatings, perform the following on surfaces covered by soundly-adhered coatings, defined as those which cannot be removed with a putty knife:

a. Test existing finishes for lead before sanding, scraping, or removing. If lead is present, refer to paragraph Toxic Materials.

b. Wipe previously painted surfaces to receive solvent-based coatings, except stucco and similarly rough surfaces clean with a clean, dry cloth saturated with mineral spirits, ASTM D235 or as specified in MPI MRM. Wipe the surfaces dry with a clean, dry, lint free cloth. Wipe immediately preceding the application of the first coat of any coating, unless specified otherwise.

c. Sand existing glossy surfaces to be painted to reduce gloss. Brush, and wipe clean with a damp cloth to remove dust.

d. The requirements specified are minimum. Comply also with the application instructions of the paint manufacturer and specific surface preparation requirements as outlined in MPI MRM Exterior Surface Preparation and Interior Surface Preparation.

e. Thoroughly clean previously painted surfaces[specified to be repainted][damaged during construction] of all grease, dirt, dust or other foreign matter.

f. Remove blistering, cracking, flaking and peeling or otherwise deteriorated coatings.

g. Remove chalk so that when tested in accordance with ASTM D4214, the chalk resistance rating is no less than 8.

h. Roughen slick surfaces. Repair damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls with suitable material to match adjacent undamaged areas.

i. Feather and sand smooth edges of chipped paint.

j. Clean rusty metal surfaces in accordance with SSPC requirements. Use solvent, mechanical, or chemical cleaning methods to provide surfaces suitable for painting.

k. Provide new, proposed coatings that are compatible with existing coatings.

][3.4.2 Existing Coated Surfaces with Minor Defects

****

NOTE: Delete inapplicable phrases or entire paragraph if no previously painted surfaces will be encountered.

****

[Sand, spackle, and treat minor defects to render them smooth. Minor defects are defined as scratches, nicks, cracks, gouges, spalls, alligatoring, chalking, and irregularities due to partial peeling of previous coatings.][Remove chalking by sanding[or blasting] so that when tested in accordance with ASTM D4214, the chalk rating is not less than 8.]

][3.4.3 Removal of Existing Coatings

****

NOTE: Delete this paragraph if project does not include removal of existing coatings.

****

Remove existing coatings from the following surfaces:

a. Surfaces containing large areas of minor defects;

b. Surfaces containing more than 20 percent peeling area; and

c. Surfaces designated by the Contracting Officer, such as surfaces where rust shows through existing coatings.

]3.4.4 Substrate Repair

a. Repair substrate surface damaged during coating removal;

b. Sand edges of adjacent soundly-adhered existing coatings so they are tapered as smooth as practical to areas involved with coating removal; and

c. Clean and prime the substrate as specified.

3.5 PREPARATION OF METAL SURFACES

3.5.1 Existing and New Ferrous Surfaces

****

NOTE: Surface preparation procedures must be compliant with any local or base restrictions. Specify use of nonhazardous cleaning agents when possible. For cleaning or blasting ferrous surfaces, select applicable options from the table below.

The considerations suggested here for painting over existing paint are covered in a Coating Condition Survey (CCS). Consult UFC 3-190-06 "Protective Coatings and Paints" for details. The intent of performing a CCS is to be able to design a maintenance coating project that carries minimum risk of coating failure.

Use the following table to help select a primer type and surface preparation to specify for steel surfaces. The table provides minimum requirements for mild or severe exposure. Mild exposure includes climate-controlled environments, project locations with Environmental Severity Classifications (ESC) C1 or C2, and low humidity locations. Severe exposure includes high humidity locations or project locations with ESC of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Severe exposure also includes marine, chemical, or immersion service, as well as application of heat resistant or nonslip floor coatings. A high-performing system may be a better choice for longer performance, even in mild exposure.

Ferrous Surface Preparation			
SSPC Blasting/Cleaning Levels[a] - Primer Types/Exposures			
Exposure			
	Mild		**Severe[b]**
Primer Type	**alkyd/oil latex oleoresinous phenolic**		**epoxy silicone inorganic zinc-rich**
Surface Condition			
Uncoated			

Ferrous Surface Preparation			
Oil, Grease, Dirt	SP 1		SP 10; (SSPC-SP WJ-2/NACE WJ-2) or SP 5; (SSPC-SP WJ-1/NACE WJ-1)
Localized corrosion - mill scale, rust	SP 2, SP 3, or SP 7; SP 11; (SSPC-SP WJ-4/NACE WJ-4)		SP 10; (SSPC-SP WJ-2/NACE WJ-2) or SP 5; (SSPC-SP WJ-1/NACE WJ-1)
Extensive deterioration	SP 6[c];(SSPC-SP WJ-3/NACE WJ-3)		SP 10; (SSPC-SP WJ-2/NACE WJ-2) or SP 5; (SSPC-SP WJ-1/NACE WJ-1)
Shop coated			
Oil, Grease, Dirt	[d]		SP 10; (SSPC-SP WJ-2/NACE WJ-2) or SP 5; (SSPC-SP WJ-1/NACE WJ-1)
Localized damage to be spot repaired	SP 2, SP 3, or SP 7; SP 11; (SSPC-SP WJ-4/NACE WJ-4)		SP 10; (SSPC-SP WJ-2/NACE WJ-2) or SP 5; (SSPC-SP WJ-1/NACE WJ-1)
Extensive deterioration	SP 6[c];(SSPC-SP WJ-3/NACE WJ-3)		SP 10; (SSPC-SP WJ-2/NACE WJ-2) or SP 5; (SSPC-SP WJ-1/NACE WJ-1)
Existing coating			
Oil, Grease	[d]	[d]	SP 1
Chalking, foreign matter other than oil or grease, localized	[e]		[f]
Extensive deterioration	SP 6[c];(SSPC-SP WJ-3/NACE WJ-3)		SP 10; (SSPC-SP WJ-2/NACE WJ-2) or SP 5; (SSPC-SP WJ-1/NACE WJ-1)

Ferrous Surface Preparation

[a] If it is not possible to abrasive blast or use waterjetting, SP 11 is recommended. It is considered equivalent to SP 6. SP 11 is also preferred wherever SP 2 or SP 3 are shown in the Table.

[b] For marine, chemical, or immersion service, or application of heat resistant or nonslip floor coatings. SP 10 is preferred for zinc-rich primers, and for extremely severe environments where long-term performance is desired.

[c] Use water jetting to SSPC-SP WJ-3/NACE WJ-3, as alternate to SSPC SP 6 degree of cleanliness where abrasive blasting cannot be used.

[d] Use only the steam clean, or non-alkaline detergent solutions of SP 1.

[e] First, remove chalk and dirt with a non-alkaline detergent solution, and follow with power wash to SSPC-SP WJ-4/NACE WJ-4. Second, spot clean, in order of preference by SSPC SP 6, SSPC SP 11, SSPC SP 7, SSPC SP 3, or SSPC SP 2.

[f] First, remove chalk and dirt with a non-alkaline detergent solution, and follow with power wash to SSPC-SP WJ-4/NACE WJ-4. Second, spot clean, in order of preference, by SSPC SP 10, SSPC SP 6

****

a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: [Solvent clean][or][detergent wash] in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to [SSPC SP 2,][SSPC SP 3,][SSPC SP 6/NACE No.3,] or [SSPC SP 10/NACE No. 2].[Brush-off blast remaining surface in accordance with SSPC 7/NACE No.4]; [Water jetting to SSPC-SP WJ-4/NACE WJ-4 may be used to remove loose coating and other loose materials. Use inhibitor as recommended by coating manufacturer to prevent premature rusting.] Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.

b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with [SSPC SP 6/NACE No.3 / SSPC-SP WJ-3/NACE WJ-3][SSPC SP 10/NACE No. 2 / SSPC-SP WJ-2/NACE WJ-2].

****

NOTE: For rusted surfaces, modify surface preparation requirements to include near white blast cleaning in accordance with SSPC SP 10 or waterjetting equivalent of WJ-2 prior to coating application.

****

[c. Metal Floor Surfaces to Receive Nonslip Coating: Clean in accordance with [SSPC SP 10/NACE No. 2][SSPC-SP WJ-2/NACE WJ-2].

]3.5.2 Final Ferrous Surface Condition:

****

NOTE: Verify there are no local or base restrictions on use of abrasive blasting. Specify cleaning options as follows:

Type Coating	**Level of Cleaning, SSPC SP**
a. Latex or Alkyd	**2,3,6 or SP 12 WJ-2.(7 and 10, SSPC-SP WJ-2/NACE WJ-2 or SSPC-SP WJ-1/NACE WJ-1 may be left in as Contractor options)**
b. High Performance (i.e. Epoxy, Urethane, others)	**6,10**

****

3.5.2.1 Tool Cleaned Surfaces

Comply with SSPC SP 2 and SSPC SP 3. Use as a visual reference, photographs in SSPC VIS 3 for the appearance of cleaned surfaces.

3.5.2.2 Abrasive Blast Cleaned Surfaces

Comply with SSPC 7/NACE No.4, SSPC SP 6/NACE No.3, and SSPC SP 10/NACE No. 2. Use as a visual reference, photographs in SSPC VIS 1 for the appearance of cleaned surfaces.

3.5.2.3 Waterjet Cleaned Surfaces

Comply with SSPC-SP WJ-1/NACE WJ-1, SSPC-SP WJ-2/NACE WJ-2, SSPC-SP WJ-3/NACE WJ-3 or SSPC-SP WJ-4/NACE WJ-4. Use as a visual reference, photographs in SSPC VIS 4/NACE VIS 7 for the appearance of cleaned surfaces.

3.5.3 Galvanized Surfaces

****

NOTE: Choose bracketed items in paragraph below according to scope of project. Local restrictions may apply or limits imposed by project location.

****

a. New or Existing Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with [solvent,][steam,][or][non-alkaline detergent solution]in accordance with SSPC SP 1. Completely remove coating by brush-off abrasive blast if the galvanized metal has been passivated or stabilized. Do not "passivate" or "stabilize" new galvanized steel to be coated. If the absence of hexavalent stain inhibitors is not documented, test as described in ASTM D6386, Appendix X2, and remove by one of the methods described therein.

****

NOTE: Delete the text below if there are no existing surfaces to receive coatings. Verify there are no local or base restrictions on the use of

abrasive blasting.
****

b. Galvanized with Slight Coating Deterioration or with Little or No Rusting: Water jetting to SSPC-SP WJ-3/NACE WJ-3 to remove loose coating from surfaces with less than 20 percent coating deterioration and no blistering, peeling, or cracking. Use inhibitor as recommended by the coating manufacturer to prevent rusting.

****
NOTE: Delete the text below if there are no existing surfaces to receive coatings. Verify there are no local or base restrictions on the use of abrasive blasting.
****

c. Galvanized With Severe Deteriorated Coating or Severe Rusting: [Water jet to SSPC-SP WJ-3/NACE WJ-3 degree of cleanliness.][Spot abrasive blast rusted areas as described for steel in SSPC SP 6/NACE No.3, and waterjet to SSPC-SP WJ-3/NACE WJ-3 to remove existing coating.]

3.5.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

3.5.5 Terne-Coated Metal Surfaces

Solvent clean surfaces with mineral spirits, ASTM D235. Wipe dry with clean, dry cloths.

3.5.6 Existing Surfaces with a Bituminous or Mastic-Type Coating

Remove chalk, mildew, and other loose material by washing with a solution of 0.20 liter 1/2 cup trisodium phosphate, 0.1 liter 1/4 cup household detergent, 1.6 liters one quart 5 percent sodium hypochlorite solution and 4.8 liters 3 quarts of warm water.

3.6 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE

3.6.1 Concrete and Masonry

a. Curing: Allow concrete, stucco and masonry surfaces to cure at least 30 days before painting, and concrete slab on grade to cure at least 90 days before painting.

b. Surface Cleaning: Remove the following deleterious substances.

****
NOTE: Choose bracketed items in subparagraphs below according to scope of project that should be based on a coating condition survey.
****

(1) Dirt,[Chalking,] Grease, and Oil: Wash new[and existing uncoated] surfaces with a solution composed of 0.2 liter 1/2 cup

trisodium phosphate, 0.1 liter 1/4 cup household detergent, and 6.4 liters 4 quarts of warm water. Then rinse thoroughly with fresh water.[Wash existing coated surfaces with a suitable detergent and rinse thoroughly.] For large areas, water blasting may be used.

(2) Fungus and Mold: Wash [new][, existing coated,] [and existing uncoated] surfaces with a solution composed of 0.2 liter 1/2 cup trisodium phosphate, 0.1 liter 1/4 cup household detergent, 1.6 liters one quart 5 percent sodium hypochlorite solution and 4.8 liters 3 quarts of warm water. Rinse thoroughly with fresh water.

(3) Paint and Loose Particles: Remove by wire brushing.

(4) Efflorescence: Remove by scraping or wire brushing followed by washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 0.4 square meter 4 square feet of surface, per workman, at one time.

[(5) Removal of Existing Coatings: For surfaces to receive textured coating MPI 42, remove existing coatings including soundly adhered coatings if recommended by textured coating manufacturer.

] c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.

d. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water. Do not apply epoxies to damp vertical surfaces as determined by ASTM D4263 or horizontal surfaces that exceed 169.0 micrograms moisture per second, square meter 3 lbs of moisture per 1000 square feet in 24 hours as determined by ASTM F1869. In all cases follow manufacturer's recommendations. Allow surfaces to cure a minimum of 30 days before painting.

3.6.2 Gypsum Board, Plaster, and Stucco

3.6.2.1 Surface Cleaning

Verify that plaster and stucco surfaces are free from loose matter and that gypsum board is dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of the first coat material. A damp cloth or sponge may be used if paint is water-based.

3.6.2.2 Repair of Minor Defects

Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.

3.6.2.3 Allowable Moisture Content

Latex coatings may be applied to damp surfaces, but not surfaces with droplets of water. Do not apply epoxies to damp surfaces as determined by ASTM D4263. Verify that new plaster to be coated has a maximum moisture content of 8 percent, when measured in accordance with ASTM D4444, Method A, unless otherwise authorized. In addition to moisture content requirements, allow new plaster to age a minimum of 30 days before preparation for painting.

[3.6.3 Existing Asbestos Cement Surfaces

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NOTE: Delete entire paragraph if no asbestos cement surfaces will be encountered.

****

Remove oily stains by solvent cleaning with mineral spirits in accordance with MIL-PRF-680 or ASTM D235. Remove loose dirt, dust, and other deleterious substances by brushing with a soft brush or rubbing with a dry cloth prior to application of the first coat material. Do not wire brush or clean using other abrasive methods. Verify surfaces are dry and clean prior to application of the coating.

][3.7 PREPARATION OF WOOD AND PLYWOOD SURFACES

****

NOTE: Choose bracketed items in this Article according to scope of project.

Delete inapplicable phrases or entire Article if no wood surfaces will be encountered.

****

3.7.1 New[, Existing Uncoated,][and][Existing Coated] Plywood and Wood Surfaces, Except Floors:

a. Surface Cleaning: Clean wood surfaces of foreign matter. Verify that surfaces are free from dust and other deleterious substances and in a condition approved by the Contracting Officer prior to receiving paint or other finish. Do not use water to clean uncoated wood.[Scrape to remove loose coatings. Lightly sand to roughen the entire area of previously enamel-coated wood surfaces.]

[b. Removal of Fungus and Mold: Wash existing coated surfaces with a solution composed of 0.2 liter 3 ounces (2/3 cup) trisodium phosphate, 0.1 liter one ounce (1/3 cup) household detergent, 1.6 liters one quart 5 percent sodium hypochlorite solution and 4.8 liters 3 quarts of warm water. Rinse thoroughly with fresh water.

] c. Do not exceed 12 percent moisture content of the wood as measured by a moisture meter in accordance with ASTM D4444, Method A, unless otherwise authorized.

d. Prime or touch up wood surfaces adjacent to surfaces to receive water-thinned paints before applying water-thinned paints.

e. Cracks and Nailheads: Set and putty stop nailheads and putty cracks after the prime coat has dried.

f. Cosmetic Repair of Minor Defects:

(1) Knots and Resinous Wood[and Fire, Smoke, Water, and Color Marker Stained Existing Coated Surface]: Prior to application of

coating, cover knots and stains with two or more coats of 1.3-kg-cut 3-pound-cut shellac varnish, plasticized with 0.14 liters 5 ounces of castor oil per liter gallon. Scrape away existing coatings from knotty areas, and sand before treating. Prime before applying any putty over shellacked area.

(2) Open Joints and Other Openings: Fill with whiting putty, linseed oil putty. Sand smooth after putty has dried.

(3) Checking: Where checking of the wood is present, sand the surface, wipe and apply a coat of pigmented orange shellac. Allow to dry before paint is applied.

g. Prime Coat For New Exterior Surfaces: Prime coat [wood doors,][windows,][frames,][and][trim] before wood becomes dirty, warped[or weathered].

3.7.2 Wood Floor Surfaces, Natural Finish

a. Initial Surface Cleaning: As specified in Article SURFACE PREPARATION.

[b. Existing Loose Boards and Shoe Molding: Before sanding, renail loose boards. Countersink nails and fill with an approved wood filler. Remove shoe molding before sanding and reinstall after completing other work. At Contractor's option, new shoe molding may be provided in lieu of reinstalling old. Provide new wood molding of the same size, wood species, and finish as the existing.

] c. Sanding and Scraping: Sanding of wood floors is specified in Section [09 64 29 WOOD STRIP AND PLANK FLOORING] [09 64 23 WOOD PARQUET FLOORING] [09 64 66 WOOD ATHLETIC FLOORING] [09 64 00 PORTABLE (DEMOUNTABLE) WOOD FLOORING]. Fill floors of oak or similar open-grain wood with wood filler recommended by the finish manufacturer and the excess filler removed.

d. Final Cleaning: After sanding, sweep and vacuum floors clean. Do not walk on floors thereafter until specified sealer has been applied and is dry.

3.7.3 Interior Wood Surfaces, Stain Finish

****

NOTE: The following paragraph is tailored for inclusion in projects with interior painting.

****

Sand interior wood surfaces to receive stain. Fill oak and other open-grain wood to receive stain with a coat of wood filler not less than 8 hours before the application of stain; remove excess filler and sand the surface smooth.

3.7.4 Water Blasting of Existing Coated Wood Surfaces:

****

NOTE: Require water blasting for existing wood surfaces only for architectural restoration work where the cost is justified.

Add surfaces to be water blasted, such as wood

siding, in brackets.
****

Provide water blasting for the following surfaces: [_____].

a. Sample Panel: Prior to the initial surface cleaning, water blast a representative surface designated by the Contracting Officer. Provide surface cleaning of the remaining work to match the sample panel approved by the Contracting Officer.

b. Initial Surface Cleaning: Water blast surfaces to receive paint with a high pressure spray, to remove loose paint, dirt, and other foreign or deleterious materials. Provide working pressure less than 17 MPa 2500 pounds per square inch gage (psig). Do not flood vents or damage windows and floors. If the pressure specified will cause damage to existing wood, advise the Contracting Officer and obtain permission to vary the pressure. Direct the wash nozzle at the surface at an angle of approximately 75 degrees with the surface and at a distance not greater than 1500 mm 5 feet to apply water pressure required to remove loose paint, dirt, chalking, and other foreign matter.

c. Final Surface Cleaning: After allowing the surfaces to dry for a minimum of 24 hours, remove remaining dirt, splinters, loose particles, disintegrated and loose paint, grease, oil, and other foreign matter from the surface.

]3.8 APPLICATION

3.8.1 Coating Application

****
NOTE: Use the second bracket option when fire protection sprinkler systems including valve, piping, conduit, hangers and other miscellaneous items are to be painted.
****

a. Comply with applicable federal, state and local laws enacted to ensure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

b. At the time of application, paint must show no signs of deterioration. Maintain uniform suspension of pigments during application.

c. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Use rollers for applying paints and enamels of a type designed for the coating to be applied and the surface to be coated. Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.

d. Only apply paints, except water-thinned types, to surfaces that are completely free of moisture as determined by sight or touch.

e. Thoroughly work coating materials into joints, crevices, and open spaces. Pay special attention to ensure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

f. Apply each coat of paint so that dry film is of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Completely hide all blemishes.

****

NOTE: USe broom cleaning when other means are not available.

****

g. Touch up damaged coatings before applying subsequent coats.[Broom clean and clear dust from interior areas before and during the application of coating material.]

****

NOTE: Delete inapplicable phrases or entire subparagraphs if no fire extinguishing sprinkler system surfaces will be encountered.

****

[h. Apply paint to new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metal work, and accessories. Shield sprinkler heads with protective coverings while painting is in progress. Remove sprinkler heads which have been painted and replace with new sprinkler heads. Unfinished spaces include attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and space where walls or ceiling are not painted or not constructed of a prefinished material. Upon completion of painting, remove protective covering from sprinkler heads.

i. Piping in Unfinished Areas: Provide primed surfaces with one coat of red alkyd gloss enamel (MPI 9) applied to a minimum dry film thickness of 0.025 mm 1.0 mil in attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and spaces where walls or ceiling are not painted or not constructed of a prefinished material.

j. Piping in Finished Areas: Provide primed surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel (MPI 9) applied to a minimum dry film thickness of 0.025 mm 1.0 mil or two component gloss polyurethane (MPI 72) in exterior applications.

k. Provide labeling on the surfaces of all feed and cross mains to show the pipe function such as "Sprinkler System", "Fire Department Connection", "Standpipe". For pipe sizes 100 mm 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 50 mm 2 in in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 100 mm 4-inch, provide white painted stenciled letters and arrows, a minimum of 18 mm 0.75 in in height and visible from the floor.

l. All fire suppression system valves must be marked with permanent tags indicating normally open or normally closed.

] m. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.

n. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Cover each preceding coat or surface completely by ensuring visually perceptible difference in shades of successive coats.

o. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

p. Thermosetting Paints: Apply topcoats over thermosetting paints (epoxies and urethanes) within the overcoat window recommended by the manufacturer.

****

NOTE: Choose bracketed items in the subparagraph below according to scope of project.

Delete inapplicable phrases or entire subparagraph if nonslip surfacing to floors or ramps will not be encountered.

****

q. Floors: [For nonslip surfacing on level floors, as the intermediate coat is applied, cover wet surface completely with almandite garnet, Grit No. 36, with maximum passing U.S. Standard Sieve No. 40 less than 0.5 percent. When the coating is dry, use a soft bristle broom to sweep up excess grit, which may be reused, and vacuum up remaining residue before application of the topcoat.][For nonslip surfacing on ramps, provide MPI 77 with non-skid additive, applied by roller in accordance with manufacturer's instructions.]

3.8.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. Verify that the written permission includes quantities and types of thinners to use.

When thinning is allowed, thin paints immediately prior to application with not more than 0.125 L one pint of suitable thinner per liter gallon. The use of thinner does not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning cannot cause the paint to exceed limits on volatile organic compounds. Do not mix paints of different manufacturers.

3.8.3 Two-Component Systems

Mix two-component systems in accordance with manufacturer's instructions. Follow recommendation by the manufacturer for any thinning of the first coat to ensure proper penetration and sealing for each type of substrate.

3.8.4 Coating Systems

****

NOTE: Delete MPI Divisions from the Table listing below that are not required for the project.

****

a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

****

NOTE: The following Table is tailored for inclusion in projects with exterior painting.

****

Table for Exterior Applications	
MPI Division	Substrate Application
MPI Division 3	Exterior Concrete Paint Table
MPI Division 4	Exterior Concrete Masonry Units Paint Table
MPI Division 5	Exterior Metal, Ferrous and Non-Ferrous Paint Table
MPI Division 6	Exterior Wood; Dressed Lumber, Paneling, Decking, Shingles Paint Table
MPI Division 9	Exterior Stucco Paint Table
MPI Division 10	Exterior Cloth Coverings and Bituminous Coated Surfaces Paint Table

****

NOTE: The following Table is tailored for inclusion in projects with interior painting.

****

Table for Interior Applications	
MPI Division	Substrate Application
MPI Division 3	Interior Concrete Paint Table
MPI Division 4	Interior Concrete Masonry Units Paint Table
MPI Division 5	Interior Metal, Ferrous and Non-Ferrous Paint Table
MPI Division 6	Interior Wood Paint Table
MPI Division 9	Interior Plaster, Gypsum Board, Textured Surfaces Paint Table

b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 0.038 mm 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness, where specified, refers to the minimum dry film thickness.

c. Coatings for Surfaces Not Specified Otherwise: Coat unspecified surfaces the same as surfaces having similar conditions of exposure.

d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:

(1) One coat of primer.

(2) One coat of undercoat or intermediate coat.

(3) One topcoat to match adjacent surfaces.

e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.

3.9 COATING SYSTEMS FOR METAL

Apply coatings of Tables in MPI Division 5 for Exterior and Interior.

a. Apply specified ferrous metal primer to steel surfaces on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.

b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.

c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.

d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 0.038 mm 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.

e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat. Overcoat these items with the specified ferrous-metal primer prior to application of finish coats.

f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

3.10 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in MPI Division 3, 4 and 9 for Exterior and Interior.

3.11 COATING SYSTEMS FOR WOOD AND PLYWOOD

a. Apply coatings of Tables in MPI Division 6 for Exterior and Interior.

b. Prior to erection, apply two coats of specified primer to treat and prime wood[and plywood] surfaces which will be inaccessible after erection.

c. Apply stains in accordance with manufacturer's printed instructions.

[d. Wood Floors to Receive Natural Finish: Thin first coat 2 to 1 using thinner recommended by coating manufacturer. Apply all coatings at rate of 30 square meters per 4 liters 300 to 350 square feet per gallon. Apply second coat not less than 2 hours and not over 24 hours after first coat has been applied. Apply with lamb's wool applicators or roller as recommended by coating manufacturer. Buff or lightly sand between intermediate coats as recommended by coating manufacturer's printed instructions.

]3.12 PIPING IDENTIFICATION

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NOTE: If pipe marking is to be covered in the mechanical section, delete this paragraph. Use the Activity preferred bracketed reference.

****

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with [MIL-STD-101][ASME A13.1]. Place stenciling in clearly visible locations. On piping not covered by [MIL-STD-101][ASME A13.1], stencil approved names or code letters, in letters a minimum of 13 mm 1/2 inch high for piping and a minimum of 50 mm 2 inches high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

3.13 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

3.14 WASTE MANAGEMENT

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NOTE: Take-back programs refer to programs in which the product manufacturer "takes-back" scrap material or packaging associated with its product. Coordinate with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

****

As specified in the Waste Management Plan and as follows. Do not use kerosene or any such organic solvents to clean up water based paints. Properly dispose of paints or solvents in designated containers. Close and seal partially used containers of paint to maintain quality as necessary for reuse. Store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste in designated containers.[Coordinate with manufacturer for take-back program. Set aside scrap to be returned to manufacturer for recycling into new product. When such a service is not available, contact local recyclers to reclaim the materials.][Set aside extra paint for future color matches or reuse by the Government.][Where local options exist for leftover paint recycling, collect all waste paint by type and provide for delivery to recycling or collection facility for reuse by local organizations.]

3.15 PAINT TABLES

****

NOTE: Choose coatings that meet the MPI Green Performance^{TM} Standard (GPS-1-12), unless no such products are available for the specified application. An E3 rating is more stringent than an E2 rating, which is more stringent than an E1 rating. Where indoor air quality (odor) is an issue, use only MPI listed materials having a minimum E2 rating. Edit Interior Paint Tables to include only products that are listed in the MPI Green Approved Products List, available at https://www.mpi.net/APL/index to maximize sustainability in all projects.

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NOTE: MPI Division Numbers are in accordance with MPI designated divisions and also follow the CSI MasterFormat. MPI number designations are from MPI Product List.

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NOTE: These paint tables largely include MPI designated coating systems and materials. The specifier may find the the Master Painters Institute (MPI) Architectural Painting Specification resources helpful when specifying paint systems for the multiple architectural substrates (both interior and exterior). Note that not all coatings and systems available in MPI are included in this specification. In the event of conflicts between MPI resources and these tables, use the paint materials specified in this table.

When using the MPI resources, such as the MPI Decision Tree, MPI designates systems for "Normal" or Aggressive" service and identifies the coating performance level which the specifier may find helpful when selecting from coating system options. When using the MPI resources, select "Normal" for locations defined as noncorrosive and select "Aggressive" for corrosive locations.

****

****

NOTE: Where available, select more durable coatings for projects located in corrosive environments and humid locations. Some of the coating systems for substrates listed in this table are explicitly for aggressive environments. Corrosive locations are defined in UFC 1-200-01, section titled "Corrosion Prone Locations". For exterior painting of metallic surfaces, corrosive locations include project

locations with Environmental Severity Classifications (ESC) of C3 thru C5, or humid locations. For exterior painting of nonmetallic surfaces, corrosive locations are project locations with ESC of C4 and C5, or humid locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Corrosive locations also includes marine, chemical, or immersion service as well as application of heat resistant or nonslip floor coatings. Interior high humidity areas such as bathrooms, locker rooms, laundry rooms, pools, and trainers are also considered as corrosive locations and require more durable coatings.
****

All DFT's are minimum values.[Use only materials with a MPI GPS-1-14 green check mark having a minimum MPI "Environmentally Friendly" [E1] [E2] [E3] rating based on VOC (EPA Method 24) content levels.] Acceptable products are listed in the MPI Green Approved Products List, available at https://www.mpi.net/APL/index.asp.

****
NOTE: Eliminate paint systems and gloss levels from the paint tables below that are not to be used for this project.
****

****
NOTE: As guidance in selection of coating systems in the Paint Tables, VOC compliant materials may be selected, based on:

1. Regional air quality regulations for the site location,

2. The applicable rule, and

3. Any specialty or exemption category.

Environmentally acceptable coatings may be further ensured by avoiding hazardous materials and including, as a minimum, requirements in purchase order or bill of materials to prohibit coatings containing materials listed in paragraph entitled "Environmental Protection." ACGIH A1 confirmed human carcinogens include asbestos, benzene, chromates, and coal tar. ACGIH A2 suspected human carcinogens include cadmium and certain chromates. Specify new galvanized steel, in appropriate section, to be without hexavalent chromium stain inhibitors.

Where only topcoating for cosmetic purposes is required, select a compatible topcoat that hides substrate. There are proposed rules limiting VOC content in states other than California. These rules are for architectural and industrial maintenance paints and coatings. Check local and

State regulations concerning allowable VOC limits. The most stringent govern.

Water-based paints and acrylic latex paints are lower in VOCs than solvent-based paints. Water-based paints are generally safer to handle and can be cleaned up with water, reducing health risks to workers and minimizing or avoiding hazardous waste.

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NOTE: Gloss levels are defined by MPI as follows:

Gloss Level	**Description**	**Units at 60 degrees**	**Units at 80 degrees**
G1	**Matte or Flat**	**0 to 5**	**10 max**
G2	**Velvet**	**0 to 10**	**10 to 35**
G3	**Eggshell**	**10 to 25**	**10 to 35**
G4	**Satin**	**20 to 35**	**35 min**
G5	**Semi-Gloss**	**35 to 70**	
G6	**Gloss**	**70 to 85**	
G7	**High Gloss**		

****

****

NOTE: The following paragraphs / Tables are tailored for inclusion in projects with exterior painting.

****

3.15.1 Exterior Paint Tables

****

NOTE: MPI paints No. 10 and No. 11 are mildew resistant paints. Specify these paints in the Tables for MPI Divisions 3, 4, 5, 6, 9, and 10 in high humidity locations or project locations with Environmental Severity Classifications (ESC) of C4 and C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 4C and 5C (as identified in ASHRAE 90.1).

****

****

NOTE: Edit following tables as needed based on the scope of the project. Use lower gloss levels in

non-contact areas such as ceilings. Use higher gloss levels where ease of cleanliness or impact and abrasion resistance are critical such as barrack walls and floors.

****

3.15.1.1 MPI Division 3: Exterior Concrete Paint Table

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NOTE: MPI DIVISION 3: Exterior Concrete Paint Table. For applications of high-build glaze finishes over concrete masonry units requiring block filler that meets resistance to wind-driven rain or resistance to hydrostatic pressure, specify filler materials and applications of Section 09 96 59 HIGH-BUILD GLAZE COATINGS.

Color: The main reason for painting concrete and stucco is to obtain desired color. Before specifying paint systems, coordinate with other specification sections to confirm that concrete does not have special waterproof finish or applied, colored cementitious finish and that stucco does not have color pigment integral with mix.

****

A. Concrete; Vertical Surfaces, Undersides of Balconies and Soffits

(1) [New and uncoated existing][and][Existing, previously painted] concrete; vertical surfaces, including undersides of balconies and soffits but excluding tops of slabs

Latex					
New and uncoated existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI EXT 3.1A-G1 (Flat)	MPI REX 3.1A-G1 (Flat)	MPI 3	MPI 10	MPI 10	88 microns 3.5 mils
MPI EXT 3.1A-G2 (Velvet)	MPI REX 3.1A-G2 (Velvet)	MPI 3	MPI 214	MPI 214	88 microns 3.5 mils
MPI EXT 3.1A-G5 (Semigloss)	MPI REX 3.1A-G5 (Semigloss)	MPI 3	MPI 11	MPI 11	88 microns 3.5 mils
MPI EXT 3.1A-G6 (Gloss)	MPI REX 3.1A-G6 (Gloss)	MPI 3	MPI 119	MPI 119	88 microns 3.5 mils
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces.					

(2) [New and uncoated existing][and][Existing, previously painted] concrete, textured system; vertical surfaces, including undersides of balconies and soffits but excluding tops of slabs

****

NOTE: Use MPI 10, MPI 11, or MPI 119 on new cast-in-place concrete walls. Use MPI 42, for accent panels, special effect, or ceilings.

****

Latex Aggregate					
New and uncoated existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI EXT 3.1B-G2 (Flat)	MPI REX 3.1A-G1 (Flat)	MPI 42	MPI 10	MPI 10	N/A
MPI EXT 3.1B-G5 (Semigloss)	MPI REX 3.1A-G5 (Semigloss)	MPI 42	MPI 11	MPI 11	N/A
MPI EXT 3.1B-G6 (Gloss)	MPI REX 3.1A-G6 (Gloss)	MPI 42	MPI 119	MPI 119	N/A
Texture - [Fine] [Medium] [Coarse]. Surface preparation and number of coats in accordance with manufacturer's instructions. Topcoat: Coating to match adjacent surfaces.					

(3) [New and uncoated existing][and][Existing, previously painted] concrete, elastomeric system; vertical surfaces, including undersides of balconies and soffits but excluding tops of slabs

****

NOTE: Use MPI 10, MPI 11, or MPI 119 on new cast-in-place concrete walls. Use MPI 42, for accent panels, special effect, or ceilings.

****

Elastomeric Coating					
New and uncoated existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI EXT 3.1F-G1 (Flat)	MPI REX 3.1F-G1 (Flat)	Per Manufacturer	MPI 113	MPI 113	400 microns 16 mils
MPI EXT 3.1F-G2/3 (Velvet)	MPI REX 3.1F-G2/3 (Velvet)	Per Manufacturer	MPI 38	MPI 38	400 microns 16 mils
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces. Surface preparation and number of coats in accordance with manufacturer's instructions. NOTE: Apply sufficient coats to achieve a minimum dry film thickness of 400 microns 16 mils.					

B. Concrete; Swimming Pools

****

NOTE: If a project includes swimming pools, consult with a knowledgeable expert to select an appropriate

coating. Identify the coating type, surface preparation, and thickness in this paint schedule. Chlorinated rubber coatings are common choices but due to their high VOC content may not be locally available.

****

(1) [New and uncoated existing][and][Existing, previously painted] concrete: Walls and bottom of swimming pools

Swimming Pool Paint					
New and uncoated existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
Per Manufacturer	Per Manufacturer	Per Manufacturer	Per Manufacturer	Per Manufacturer	Per Manufacturer
Primer as recommended by manufacturer. Surface preparation and number of coats in accordance with manufacturer's instructions.					

C. Cementitious Composition Board

(1) [New][and][Existing] Cementitious composition board (including Asbestos cement board)

Latex					
New and uncoated existing	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 3.3A-G1 (Flat)	MPI REX 3.3A-G1 (Flat)	MPI 10	MPI 10	MPI 10	N/A
MPI EXT 3.3A-G5 (Semigloss)	MPI REX 3.3A-G5 (Semigloss)	MPI 11	MPI 11	MPI 11	N/A
MPI EXT 3.3A -G6 (Gloss)	MPI REX 3.3A-G6 (Gloss)	MPI 119	MPI 119	MPI 119	N/A
Topcoat: Coating to match adjacent surfaces.					

3.15.1.2 MPI Division 4: Exterior Concrete Masonry Units Paint Table

****

NOTE: MPI Division 4: Exterior Concrete Masonry Units Paint Table. For applications of high-build glaze finishes over concrete masonry units requiring block filler that meets resistance to wind-driven rain or resistance to hydrostatic pressure, specify filler materials and applications of Section 09 96 59 HIGH-BUILD GLAZE COATINGS.

Color: The main reason for painting concrete masonry is to obtain desired color. Before specifying paint systems, coordinate with other specification sections to confirm that concrete masonry does not have special waterproof finish or applied, colored cementitious finish and that it does not have color pigment integral with mix.

****

A. [New][and][Existing] concrete masonry on uncoated surface

Latex						
New	Existing	Block Filler	Primer	ntermediat	Topcoat	System DFT
MPI EXT 4.2A-G1 (Flat)	MPI REX 4.2A-G1 (Flat)	MPI 4	N/A	MPI 10	MPI 10	275 microns 11 mils
MPI EXT 4.2A-G5 (Semigloss)	MPI REX 4.2A-G5 (Semigloss)	MPI 4	N/A	MPI 11	MPI 11	275 microns 11 mils
MPI EXT 4.2A-G6 (Gloss)	MPI REX 4.2A-G6 (Gloss)	MPI 4	N/A	MPI 119	MPI 119	275 microns 11 mils
Topcoat: Coating to match adjacent surfaces.						

B. [New][and][Existing] concrete masonry, textured system; on uncoated surface

Latex Aggregate					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 4.2B-G1 (Flat)	MPI REX 3.1A-G1 (Flat)	MPI 42	MPI 42	MPI 10	N/A
MPI EXT 4.2B-G5 (Semigloss)	MPI REX 3.1A-G5 (Semigloss)	MPI 42	MPI 42	MPI 11	N/A
MPI EXT 4.2B-G6 (Gloss)	MPI REX 3.1A-G6 (Gloss)	MPI 42	MPI 42	MPI 119	N/A
Texture - [Fine] [Medium] [Coarse]. Surface preparation and number of coats in accordance with manufacturer's instructions. Topcoat: Coating to match adjacent surfaces.					

C. [New][and][Existing] concrete masonry, elastomeric system; on uncoated surfaces

Elastomeric Coating					
New and uncoated existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI EXT 3.1F-G1 (Flat)	MPI REX 3.1F-G1 (Flat)	Per Manufactur	MPI 113	MPI 113	400 microns 16 mils
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces. Surface preparation and number of coats in accordance with manufacturer's instructions. NOTE: Apply sufficient coats of MPI 113 to achieve a minimum dry film thickness of 400 microns 16 mils.					

3.15.1.3 MPI Division 5: Exterior Metal, Ferrous and Non-Ferrous Paint Table

A. Steel / Ferrous Surfaces

(1) New Steel that has been hand or power tool cleaned to SSPC SP 2 or SSPC SP 3

Alkyd					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1Q-G5 (Semigloss	MPI REX 5.1D-G5 (Semigloss)	MPI 23	MPI 94	MPI 94	131 microns 5.25 mils
MPI EXT 5.1Q-G6 (Gloss)	MPI REX 5.1D-G6 (Gloss)	MPI 23	MPI 9	MPI 9	131 microns 5.25 mils
Topcoat: Coating to match adjacent surfaces.					

(2) New Steel that has been blast-cleaned to SSPC SP 6/NACE No.3

Alkyd					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1D-G5 (Semigloss)	MPI REX 5.1D-G5 (Semigloss)	MPI 79	MPI 94	MPI 94	131 microns 5.25 mils
MPI EXT 5.1D-G6 (Gloss)	MPI REX 5.1D-G6 (Gloss)	MPI 79	MPI 9	MPI 9	131 microns 5.25 mils
Topcoat: Coating to match adjacent surfaces.					

(3) Existing steel that has been spot-blasted to SSPC SP 6/NACE No.3

****

NOTE: Use MPI 72 in severe environments for a

durable, glossy appearance. Use latex systems where MPI 20, MPI 101, or MPI 108 is not allowed. MPI 72, urethane is allowed in California. For selection of top coats, use the first bracketed option for geographic areas that do not have harsh environmental conditions. Use the second bracketed option for areas that have harsh corrosive environments.
****

(a) Surface previously coated with alkyd or latex

Waterborne Light Industrial Coating				
Existing, previously coated with alkyd or latex	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.1C-G5 (Semigloss)	MPI 79	MPI 163	MPI 163	125 microns 5 mils
MPI REX 5.1C-G6 (Gloss)	MPI 79	MPI 164	MPI 164	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

(b) Surfaces previously coated with epoxy

Waterborne Light Industrial Coating				
Existing, previously coated with epoxy	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.1L-G5 (Semigloss)	MPI 101	MPI 163	MPI 163	125 microns5 mils
MPI REX 5.1L-G6 (Gloss)	MPI 101	MPI 164	MPI 164	125 microns5 mils
Topcoat: Coating to match adjacent surfaces.				

Pigmented Polyurethane				
Existing, previously coated with epoxy	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.1H-G6 (Gloss)	MPI 101	MPI 108	MPI 72	212 microns 8.5 mils
Topcoat: Coating to match adjacent surfaces.				

(4) New [and existing] steel blast cleaned to SSPC SP 10/NACE No. 2

Waterborne Light Industrial					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1R-G5 (Semigloss)	MPI EXT 5.1R-G5 (Semigloss)	MPI 101	MPI 108	MPI 163	212 microns 8.5 mils
MPI EXT 5.1R-G6 (Gloss)	MPI EXT 5.1R-G6 (Gloss)	MPI 101	MPI 108	MPI 164	212 microns 8.5 mils
Topcoat: Coating to match adjacent surfaces.					

Pigmented Polyurethane					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1J-G6 (Gloss)	MPI EXT 5.1J-G6 (Gloss)	MPI 101	MPI 108	MPI 72	212 microns 8.5 mils
Topcoat: Coating to match adjacent surfaces.					

(5) Metal floors (non-shop-primed surfaces or non-slip deck surfaces) with non-skid additive (NSA), load at manufacturer's recommendations

Epoxy					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1S-G5 (Semi Gloss)	MPI EXT 5.1S-G5 (Semi Gloss)	MPI 120	MPI 177	MPI 177	131 microns 5.25 mils
MPI EXT 5.1S-G6 (Gloss)	MPI EXT 5.1S-G6 (Gloss)	MPI 120	MPI 77	MPI 77	131 microns 5.25 mils
Topcoat: Coating to match adjacent surfaces. Load Non-Skid Additive at manufacturer's recommendations.					

B. Exterior Galvanized Surfaces

(1) New Galvanized surfaces

****

NOTE:For overcoating existing alkyd, latex or epoxy systems refer to Evaluation Section of MPI Repaint Manual.

In the first option, select appropriate top coat. Use first top coat option for geographic areas that do not have harsh environmental conditions. Use the

second top coat option for areas that have harsh, corrosive environments.
****

Waterborne Primer / Latex				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.3H-G1 (Flat)	MPI 134	MPI 10	MPI 10	112 microns 4.5 mils
EXT 5.3H-G5 (Semigloss)	MPI 134	MPI 11	MPI 11	112 microns 4.5 mils
MPI EXT 5.3H-G6 (Gloss)	MPI 134	MPI 119	MPI 119	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Waterborne Primer / Waterborne Light Industrial Coating				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.3J-G5 (Semigloss)	MPI 134	MPI 163	MPI 163	112 microns 4.5 mils
MPI EXT 5.3J-G6 (Gloss)	MPI 134	MPI 164	MPI 164	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Epoxy Primer / Waterborne Light Industrial Coating				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.3K-G5 (Semigloss)	MPI 101	MPI 163	MPI 163	125 microns 5 mils
MPI EXT 5.3K-G6 (Gloss)	MPI 101	MPI 164	MPI 164	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

Pigmented Polyurethane				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT

MPI EXT 5.3L-G6 (Gloss)	MPI 101	N/A	MPI 72	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

(2) Galvanized surfaces with slight coating deterioration; little or no rusting

****

NOTE: For overcoating existing alkyd, latex or epoxy systems refer to Evaluation Section of MPI Repaint Manual.

****

Waterborne Light Industrial Coating				
Galvanized Surfaces with slight coating deterioration	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3J-G5 (Semigloss)	MPI 134	N/A	MPI 163	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Pigmented Polyurethane				
Galvanized Surfaces with slight coating deterioration	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3D-G6 (Gloss)	MPI 101	N/A	MPI 72	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

(3) Galvanized surfaces with severely deteriorated coating or rusting

Waterborne Light Industrial Coating				
Galvanized surfaces with severely deteriorated coating or rusting	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3L-G5(Semigloss)	MPI 101	MPI 108	MPI 163	212 microns 8.5 mils

MPI REX 5.3L-G6(Gloss)	MPI 101	MPI 108	MPI 164	212 microns 8.5 mils
Topcoat: Coating to match adjacent surfaces.				

Pigmented Polyurethane				
Galvanized surfaces with severely deteriorated coating or rusting	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3D-G6(Gloss)	MPI 101	MPI 72	MPI 72	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

C. Exterior Surfaces, Other Metals (Non-Ferrous)

(1) Aluminum, aluminum alloy and other miscellaneous non-ferrous metal items not otherwise specified except hot metal surfaces, roof surfaces, and new prefinished equipment

Alkyd				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.4F-G1 (Flat	MPI 95	MPI 8	MPI 8	125 microns 5 mils
MPI EXT 5.4F-G5 (Semigloss)	MPI 95	MPI 94	MPI 94	125 microns 5 mils
MPI EXT 5.4F-G6 (Gloss)	MPI 95	MPI 9	MPI 9	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

Waterborne Light Industrial Coating				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.4F-G1 (Flat	MPI 95	MPI 161	MPI 161	125 microns 5 mils

MPI EXT 5.4F-G5 (Semigloss)	MPI 95	MPI 163	MPI 163	125 microns 5 mils
MPI EXT 5.4F-G6 (Gloss)	MPI 95	MPI 164	MPI 164	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

(2) Existing roof surfaces previously coated

Aluminum Pigmented Asphalt Roof Coating				
Existing roof surfaces previously coated	N/A	Intermediate	Topcoat	System DFT
Non-MPI System	ASTM D2824/D28	N/A	N/A	200 microns 8 mils
Sufficient coats to provide not less than 200 microns 8 mils of finished coating system (without asbestos fibers).				

Aluminum Paint				
Existing roof surfaces previously coated	Primer	Intermediate	Topcoat	System DFT
MPI REX 10.2D	MPI 107	MPI 1	MPI 1	88 microns 3.5 mils
Topcoat: Coating to match adjacent surfaces.				

(3) Surfaces adjacent to painted surfaces; [Mechanical,] [Electrical,] [Fire extinguishing sprinkler systems including valves, conduit, hangers, supports,][exposed copper piping,] [and miscellaneous metal items] not otherwise specified except floors, hot metal surfaces, and new prefinished equipment

Alkyd				
New	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1D-G1 (Flat)	MPI 79	MPI 8	MPI 8	131 microns 5.25 mils
MPI EXT 5.1D-G5 (Semigloss)	MPI 79	MPI 94	MPI 94	131 microns 5.25 mils

MPI EXT 5.1D-G6 (Gloss)	MPI 79	MPI 9	MPI 9	131 microns 5.25 mils
Topcoat: Coating to match adjacent surfaces.				

Waterborne Light Industrial Coating				
New	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1C-G3(Eggshell)	MPI 79	MPI 161	MPI 161	125 microns5 mils
MPI EXT 5.1C-G5(Semigloss)	MPI 79	MPI 163	MPI 163	125 microns5 mils
MPI EXT 5.1C-G6(Gloss)	MPI 79	MPI 164	MPI 164	125 microns5 mils
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces.				

D. Exterior Hot Surfaces

(1) Hot metal surfaces [including smokestacks] subject to temperatures up to 205 degrees C 400 degrees F

****

NOTE: Heat Resistant Paints may require a high heat cure cycle to achieve proper cure. Determine curing requirements before specifying so that the supplier will be aware of requirements.

Consider hot dip galvanizing, aluminum metallizing, and zinc metallizing alternatives to the specified coating systems.

****

Heat Resistant Enamel				
New	N/A	Intermediate	Topcoat	System DFT
MPI EXT 5.2A	MPI 21	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

(2) Ferrous metal subject to high temperature, up to 400 degrees C 750 degrees F

****

NOTE: Heat Resistant Paints may require a high heat cure cycle to achieve proper cure. Determine curing requirements before specifying so that the supplier

will be aware of requirements.

Consider hot dip galvanizing, aluminum metallizing, and zinc metallizing alternatives to the specified coating systems.

****

Inorganic Zinc Rich Coating				
New	N/A	Intermediate	Topcoat	System DFT
MPI EXT 5.2C	MPI 19	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

Heat Resistant Aluminum Enamel				
New	N/A	Intermediate	Topcoat	System DFT
MPI EXT 5.2B	MPI 2	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

(3) [New surfaces][and][Existing surfaces] made bare subject to temperatures up to 593 degrees C 1100 degrees F

****

NOTE: Heat Resistant Paints may require a high heat cure cycle to achieve proper cure. Determine curing requirements before specifying so that the supplier will be aware of requirements.

Consider aluminum metallizing alternative to the specified coating system.

****

(1) [New surfaces][and][Existing surfaces] made bare cleaning to SSPC SP 10/NACE No. 2 subject to temperatures up to 593 degrees C 1100 degrees F

Heat Resistant Coating					
New	Existing	N/A	Intermediate	Topcoat	System DFT
MPI EXT 5.2D	MPI REX 5.2D	MPI 22	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.					

3.15.1.4 MPI Division 6: Exterior Wood; Dressed Lumber, Paneling, Decking, Shingles Paint Table

A. New [and Existing, uncoated] Dressed lumber, Wood and plywood, trim, [including top, bottom and edges of doors] not otherwise specified

Alkyd					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.3B-G5 (Semigloss)	MPI EXT 6.3B-G5 (Semigloss)	MPI 5	MPI 94	MPI 94	125 microns5 mils
MPI EXT 6.3B-G6 (Gloss)	MPI EXT 6.3B-G6 (Gloss)	MPI 5	MPI 9	MPI 9	125 microns5 mils
Topcoat: Coating to match adjacent surfaces.					

Latex					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.3A-G1 (Flat)	MPI EXT 6.3A-G1 (Flat)	MPI 5	MPI 10	MPI 10	125 microns 5 mils
MPI EXT 6.3A-G5 (Semigloss)	MPI EXT 6.3B-G5 (Semigloss)	MPI 5	MPI 11	MPI 11	125 microns 5 mils
MPI EXT 6.3A-G6 (Gloss)	MPI EXT 6.3B-G6 (Gloss)	MPI 5	MPI 119	MPI 119	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.					

Waterborne Solid Color Stain					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.3K	MPI EXT 6.3K	MPI 5	MPI 16	MPI 16	106 microns 4.25 mils
Topcoat: Coating to match adjacent surfaces.					

B. Existing, dressed lumber, Wood and plywood, trim, [including top, bottom and edges of doors] previously coated with an alkyd / oil based finish coat not otherwise specified

Alkyd				
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT
MPI REX 6.3B-G5 (Semigloss)	MPI 5	MPI 94	MPI 94	125 microns5 mils

MPI REX 6.3B-G6 (Gloss)	MPI 5	MPI 9	MPI 9	125 microns5 mils

Latex				
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT
MPI REX 6.3A-G1 (Flat)	MPI 5	MPI 10	MPI 10	125 microns5 mils
MPI REX 6.3B-G5 (Semigloss)	MPI 5	MPI 11	MPI 11	125 microns5 mils
MPI REX 6.3B-G6 (Gloss)	MPI 5	MPI 119	MPI 119	125 microns5 mils

C. Existing, dressed lumber, Wood and plywood, trim, [including top, bottom and edges of doors] previously coated with a latex / waterborne finish coat not otherwise specified

Latex				
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT
MPI REX 6.3L-G1 (Flat)	MPI 6	MPI 10	MPI 10	112 microns 4.5 mils
MPI REX 6.3L-G5 (Semigloss)	MPI 6	MPI 11	MPI 11	112 microns 4.5 mils
MPI REX 6.3L-G6 (Gloss)	MPI 6	MPI 119	MPI 119	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Waterborne Solid Color Stain				
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.3K	MPI 6	MPI 16	MPI 16	100 microns 4 mils
Topcoat: Coating to match adjacent surfaces.				

D. Wood Siding

(1) New, Uncoated wood siding

Semi-Transparent Stain				
New	Primer	Intermediate	Topcoat	System DFT

MPI EXT 6.3D	N/A	MPI 13	MPI 13	N/A
Topcoat: Coating to match adjacent surfaces.				

(2) Existing, previously stained wood siding

Latex				
Existing, previously stained	Primer	Intermediate	Topcoat	System DFT
MPI REX 6.2K-G1 (Flat)	MPI 5	MPI 10	MPI 10	112 microns 4.5 mils
MPI REX 6.2K-G5 (Semigloss)	MPI 5	MPI 11	MPI 11	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

(3) Existing Uncoated or previously semitransparent stained wood siding

Semi-Transparent Stain				
Existing	Primer	Intermediate	Topcoat	System DFT
MPI REX 6.3D	N/A	MPI 13	MPI 13	Per Manufacturer
Topcoat: Coating to match adjacent surfaces.				

E. Wood: [Steps,] [platforms,] [floors of open porches,] and [_____] [with non-skid additive (NSA), load at manufacturer's recommendations.]

Latex Floor Paint				
New	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.5A-G2 (Flat)	MPI 5	MPI 60 [plus NSA]	MPI 60 [plus NSA]	112 microns 4.5 mils
MPI EXT 6.5A-G6 (Gloss)	MPI 5	MPI 68 [plus NSA]	MPI 68 [plus NSA]	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces. Load non-skid additive (NSA) at manufacturer's recommendations.				

Alkyd Floor Paint				
New	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.5B-G2 (Flat)	MPI 59	MPI 59 [plus NSA]	MPI 59 [plus NSA]	125 microns5 mils

MPI EXT 6.5B-G6 (Gloss)	MPI 27	MPI 27 [plus NSA]	MPI 27 [plus NSA]	125 microns5 mils
Topcoat: Coating to match adjacent surfaces. Load non-skid additive (NSA) at manufacturer's recommendations.				

3.15.1.5 MPI Division 9: Exterior Stucco Paint Table

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NOTE: (MPI DIVISION 9: EXTERIOR STUCCO PAINT TABLE)

Color: The main reason for painting stucco is to obtain desired color. Before specifying paint systems, coordinate with other specification sections to confirm that stucco does not have special waterproof finish or applied, colored cementitious finish and that stucco does not have color pigment integral with mix.

****

A. [New][and Existing] stucco

Latex					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 9.1A-G1 (Flat)	MPI REX 9.1A-G2 (Flat	MPI 10	MPI 10	MPI 10	112 microns 4.5 mils
MPI EXT 9.1A-G5 (Semigloss)	MPI REX 9.1A-G5 (Semigloss)	MPI 11	MPI 11	MPI 11	112 microns 4.5 mils
MPI EXT 9.1A-G6 (Gloss)	MPI REX 9.1A-G6 (Gloss)	MPI 119	MPI 119	MPI 119	112 microns 4.5 mils
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces. On existing stucco, apply primer based on surface condition.					

B. [New][and][Existing] stucco, elastomeric system

Elastomeric Coating					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 9.1C-G1 (Flat)	MPI REX 9.1C-G1 (Flat)	N/A	MPI 113	MPI 113	400 microns 16 mils
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces. Surface preparation and number of coats in accordance with manufacturer's instructions Apply sufficient coats of MPI 113 to achieve a minimum dry film thickness of 400 microns 16 mils.					

3.15.1.6 MPI Division 10: Exterior Cloth Coverings and Bituminous Coated Surfaces Paint Table

A. Insulation and surfaces of insulation coverings (canvas, cloth, paper): (Interior and Exterior Applications)

Latex				
New	Primer	Intermediate	Topcoat	System DFT
MPI EXT 10.1A-G1 (Flat)	N/A	MPI 10	MPI 10	80 microns3.2 mils
MPI EXT 10.1A-G5 (Semigloss)	N/A	MPI 11	MPI 11	80 microns3.2 mils
MPI EXT 10.1A-G6 (Gloss)	N/A	MPI 119	MPI 119	80 microns3.2 mils
Topcoat: Coating to match adjacent surfaces.				

3.15.2 Interior Paint Tables

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NOTE: The following Tables / paragraphs are tailored for inclusion in projects with interior painting.

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NOTE: Consider latex paint options for occupied buildings and where strong odors would be objectionable. Where allowable, consider eggshell or semigloss enamel in lieu of flat paint for areas subject to soiling where gloss is not desired.

For existing surfaces with alkyd enamel coating, do not specify latex paint which does not bond well to enamel.

****

****

NOTE: MPI paint No. 54 is mildew resistant paint. Specify this paint in the Tables for MPI Division 3 and 5 in high humidity locations or project locations with Environmental Severity Classifications (ESC) of C4 and C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 4C and 5C (as identified in ASHRAE 90.1).

****

3.15.2.1 MPI Division 3: Interior Concrete Paint Table

A. [New and uncoated existing][and Existing, previously painted] Concrete, vertical surfaces, not specified otherwise

Latex					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1A-G2 (Flat)	MPI RIN 3.1A-G2 (Flat)	MPI 3	MPI 44	MPI 44	100 microns 4 mils
MPI INT 3.1A-G3 (Eggshell)	MPI RIN 3.1A-G3 (Eggshell)	MPI 3	MPI 52	MPI 52	100 microns 4 mils
MPI INT 3.1A-G5	MPI RIN 3.1A-G5 (Semigloss)	MPI 3	MPI 54	MPI 54	100 microns 4 mils
Topcoat: Coating to match adjacent surfaces.					

High Performance Architectural Latex					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1C-G2 (Flat)	MPI RIN 3.1J-G2 (Flat)	MPI 3	MPI 138	MPI 138	100 microns 4 mils
MPI INT 3.1C-G3 (Eggshell)	MPI RIN 3.1J-G3 (Eggshell)	MPI 3	MPI 139	MPI 139	100 microns 4 mils
MPI INT 3.1C-G4 (satin)	MPI RIN 3.1J-G4	MPI 3	MPI 140	MPI 140	100 microns 4 mils
MPI INT 3.1C-G5 (Semigloss)	MPI RIN 3.1J-G5 (Semigloss)	MPI 3	MPI 141	MPI 141	100 microns 4 mils
Topcoat: Coating to match adjacent surfaces.					

Institutional Low Odor / Low VOC Latex					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1M-G2 (Flat)	MPI RIN 3.1L-G2 (Flat)	MPI 149	MPI 144	MPI 144	100 microns 4 mils
MPI INT 3.1M-G3 (Eggshell)	MPI RIN 3.1L-G3 (Eggshell)	MPI 149	MPI 145	MPI 145	100 microns 4 mils
MPI INT 3.1M-G4 (satin)	MPI RIN 3.1L-G4	MPI 149	MPI 146	MPI 146	100 microns 4 mils

MPI INT 3.1M-G5 (Semigloss)	MPI RIN 3.1L-G5 (Semigloss)	MPI 149	MPI 147	MPI 147	100 microns 4 mils
Topcoat: Coating to match adjacent surfaces.					

B. Concrete Ceilings, Uncoated

****

NOTE: For hiding imperfections in new concrete ceilings. Do not specify in wet or humid areas or for previously painted surfaces.

****

Latex Aggregate				
New, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1N-G1 (Flat)	N/A	N/A	MPI 42	Per Manufacturer
Texture - [Fine] [Medium] [Coarse]. Surface preparation, number of coats, and primer in accordance with manufacturer's instructions. Topcoat: Coating to match adjacent surfaces.				

C. [New and uncoated existing][and][Existing, previously painted] Concrete in [toilets,] [food-preparation,] [food-serving,] [restrooms,] [laundry areas,] [shower areas,] [areas requiring a high degree of sanitation,] [______] [and other high-humidity areas] not otherwise specified except floors

****

NOTE: List other high humidity areas requiring enamel finishes. For tile-like finishes, filler materials, and applications, refer to Section 09 96 59 HIGH-BUILD GLAZE COATINGS. These high performance coatings are normally used to meet exposure-resistant requirements and can be applied to wood, metal, and concrete substrates.

****

Waterborne Light Industrial Coating					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1L-G3(Eggshell	MPI RIN 3.1C-G3(Eggshell	MPI 3	MPI 151	MPI 151	120 microns 4.8 mils
MPI INT 3.1L-G5(Semiglos	MPI RIN 3.1C-G5(Semiglos	MPI 3	MPI 153	MPI 153	120 microns 4.8 mils
MPI INT 3.1L-G6(Gloss)	MPI RIN 3.1C-G6(Gloss)	MPI 3	MPI 154	MPI 154	120 microns 4.8 mils

Topcoat: Coating to match adjacent surfaces.

Alkyd					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1D-G3 (Eggshell)	MPI RIN 3.1D-G3 (Eggshell)	MPI 3	MPI 51	MPI 51	112 microns 4.5 mils
MPI INT 3.1D-G5 (Semigloss)	MPI RIN 3.1D-G5 (Semigloss)	MPI 3	MPI 47	MPI 47	112 microns 4.5 mils
MPI INT 3.1D-G6 (Gloss)	MPI RIN 3.1D-G6 (Gloss)	MPI 3	MPI 48	MPI 48	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.					

Epoxy					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1F-G6 (Gloss)	MPI RIN 3.1E-G6 (Gloss)	MPI 77	MPI 77	MPI 77	100 microns 4 mils
Note: Primer may be reduced for penetration per manufacturer's					

D. [New and uncoated existing][and Existing, previously painted] concrete walls and bottom of swimming pools

****

NOTE: If a project includes swimming pools, consult with a knowledgeable expert to select an appropriate coating. Identify the coating type, surface preparation, and thickness in this paint schedule. Chlorinated rubber coatings are common choices but due to their high VOC content may not be locally available.

****

Chlorinated Rubber					
New and uncoated existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
Chlorinated Rubber	Per Manufacturer	Per Manufacturer	Per Manufacturer	Per Manufacturer	Per Manufacturer

Note: Primer may be reduced for penetration per manufacturer's instructions.

Epoxy					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1F	MPI RIN 3.1E	MPI 77	MPI 77	MPI 77	100 microns 4 mils
Note: Primer may be reduced for penetration per manufacturer's instructions.					

E. [New and uncoated existing][and Existing, previously painted] concrete floors in following areas [_____]

Latex Floor Paint					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT	MPI RIN	MPI 60	MPI 60	MPI 60	125 microns

Alkyd Floor Paint					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.2B-G2 (Flat)	MPI RIN 3.2B-G2 (Flat)	MPI 59	MPI 59	MPI 59	125 microns 5 mils
Note: Primer may be reduced for penetration per manufacturer's instructions.					

Epoxy					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.2C-G6 (Gloss)	MPI RIN 3.2C-G6 (Gloss)	MPI 77	MPI 77	MPI 77	125 microns 5 mils
Note: Primer may be reduced for penetration per manufacturer's instructions.					

3.15.2.2 MPI Division 4: Interior Concrete Masonry Units Paint Table

****

NOTE: Use MPI 4 or MPI 116 block filler if smooth surface is required on CMU surfaces.

****

A. New[and uncoated Existing] Concrete Masonry

High Performance Architectural Latex					
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT
MPI INT 4.2D-G2 (Flat)	MPI 4	N/A	MPI 139	MPI 138	275 microns 11 mils
MPI INT 4.2D-G3 (Eggshell)	MPI 4	N/A	MPI 139	MPI 139	275 microns 11 mils
MPI INT 4.2D-G4 (Satin)	MPI 4	N/A	MPI 140	MPI 140	275 microns 11 mils
MPI INT 4.2D-G5 (Semigloss)	MPI 4	N/A	MPI 141	MPI 141	275 microns 11 mils
Fill all holes in masonry surface					

Institutional Low Odor / Low VOC Latex					
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT
MPI INT 4.2E-G2 (Flat)	MPI 4	N/A	MPI 144	MPI 144	100 microns 4 mils
MPI INT 4.2E-G3 (Eggshell)	MPI 4	N/A	MPI 145	MPI 145	100 microns 4 mils
MPI INT 4.2E-G4 (Satin)	MPI 4	N/A	MPI 146	MPI 146	100 microns 4 mils
MPI INT 4.2E-G5 (Semigloss)	MPI 4	N/A	MPI 147	MPI 147	100 microns 4 mils
Fill all holes in masonry surface					

B. Existing, Previously Painted Concrete Masonry

High Performance Architectural Latex					
Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT
MPI RIN 4.2K-G2 (Flat)	N/A	MPI 138	MPI 138	MPI 138	112 microns 4.5 mils
MPI RIN 4.2K-G3 (Eggshell)	N/A	MPI 139	MPI 139	MPI 139	112 microns 4.5 mils
MPI RIN 4.2K-G4	N/A	MPI 140	MPI 140	MPI 140	112 microns 4.5 mils

MPI RIN 4.2K-G5 (Semigloss)	N/A	MPI 141	MPI 141	MPI 141	112 microns 4.5 mils

Institutional Low Odor / Low VOC Latex					
Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT
MPI RIN 4.2L-G2 (Flat)	N/A	MPI 144	MPI 144	MPI 144	100 microns 4 mils
MPI RIN 4.2L-G3 (Eggshell)	N/A	MPI 145	MPI 145	MPI 145	100 microns 4 mils
MPI RIN 4.2L-G4 (Satin)	N/A	MPI 146	MPI 146	MPI 146	100 microns 4 mils
MPI RIN 4.2L-G5 (Semigloss)	N/A	MPI 147	MPI 147	MPI 147	100 microns 4 mils

C. New[and uncoated Existing] Concrete masonry units in [toilets,] [food-preparation,] [food-serving,] [restrooms,] [laundry areas,] [shower areas,] [areas requiring a high degree of sanitation,] [_____,] [and other high humidity areas] unless otherwise specified

****

NOTE: List other high humidity areas requiring enamel finishes. For tile-like finishes, filler materials, and applications, refer to Section 09 96 59 HIGH-BUILD GLAZE COATINGS. These high performance coatings are normally used to meet exposure-resistant requirements and can be applied to wood, metal, and concrete substrates.

****

Waterborne Light Industrial Coating					
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT
MPI INT 4.2K-G3(Eggshell)	MPI 4	N/A	MPI 151	MPI 151	275 microns11 mils
MPI INT 4.2K-G5(Semigloss	MPI 4	N/A	MPI 153	MPI 153	275 microns11 mils
MPI INT 4.2K-G6(Gloss)	MPI 4	N/A	MPI 154	MPI 154	275 microns11 mils
Fill all holes in masonry surface					

Alkyd

New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT
MPI INT 4.2K-G3(Eggshell)	MPI 4	MPI 50	MPI 51	MPI 51	300 microns12 mils
MPI INT 4.2K-G5(Semigloss	MPI 4	MPI 50	MPI 47	MPI 47	300 microns12 mils
MPI INT 4.2K-G6(Gloss)	MPI 4	MPI 50	MPI 48	MPI 48	300 microns12 mils
Fill all holes in masonry surface					

Epoxy					
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT
MPI INT 4.2G-G6 (Gloss)	MPI 116	N/A	MPI 77	MPI 77	250 microns10 mils
Fill all holes in masonry surface					

D. Existing, previously painted, concrete masonry units in [toilets,] [food-preparation,] [food-serving,] [restrooms,] [laundry areas,] [shower areas,] [areas requiring a high degree of sanitation,] [_____,] [and other high humidity areas] unless otherwise specified

Waterborne Light Industrial Coating					
Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT
MPI RIN 4.2G-G3(Eggshell)	N/A	MPI 151	MPI 151	MPI 151	112 microns 4.5 mils
MPI RIN 4.2G-G5(Semigloss)	N/A	MPI 153	MPI 153	MPI 153	112 microns 4.5 mils
MPI RIN 4.2G-G6(Gloss)	N/A	MPI 154	MPI 154	MPI 154	112 microns 4.5 mils

Alkyd					
Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT
MPI RIN 4.2C-G3 (Eggshell)	N/A	MPI 17	MPI 51	MPI 51	112 microns 4.5 mils

MPI RIN 4.2C-G5 (Semigloss)	N/A	MPI 17	MPI 47	MPI 47	112 microns 4.5 mils
MPI RIN 4.2C-G6 (Gloss)	N/A	MPI 17	MPI 48	MPI 48	112 microns 4.5 mils

Epoxy					
Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT
MPI RIN 4.2D-G6	N/A	MPI 77	MPI 77	MPI 77	125

3.15.2.3   MPI Division 5: Interior Metal, Ferrous and Non-Ferrous Paint Table

A. Interior Steel / Ferrous Surfaces

(1) Metal,[Mechanical,][Electrical,][Fire extinguishing sprinkler systems including valves, conduit, hangers, supports,][Surfaces adjacent to painted surfaces (Match surrounding finish),][exposed copper piping,][and miscellaneous metal items] not otherwise specified except floors, hot metal surfaces, and new prefinished equipment

High Performance Architectural Latex				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1R-G2 (Flat)	MPI 76	MPI 138	MPI 138	125 microns 5 mils
MPI INT 5.1R-G3 (Eggshell)	MPI 76	MPI 139	MPI 139	125 microns 5 mils
MPI INT 5.1R-G5 (Semigloss)	MPI 76	MPI 141	MPI 141	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

Alkyd				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1E-G2 (Flat)	MPI 76	MPI 49	MPI 49	131 microns 5.25 mils
MPI INT 5.1E-G3 (Eggshell)	MPI 76	MPI 51	MPI 51	131 microns 5.25 mils
MPI INT 5.1E-G5 (Semigloss)	MPI 76	MPI 47	MPI 47	131 microns 5.25 mils

MPI INT 5.1E-G6 (Gloss)	MPI 76	MPI 48	MPI 48	131 microns 5.25 mils
Topcoat: Coating to match adjacent surfaces.				

(2) Metal floors (non-shop-primed surfaces or non-slip deck surfaces) with non-skid additive (NSA), load at manufacturer's recommendations

Alkyd (over q.d. Alkyd Primer)				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1E-G5 (Semi-Gloss)	MPI 76	MPI 47	MPI 47	131 microns 5.25 mils
Topcoat: Coating to match adjacent surfaces.				

Epoxy				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1L-G6 (Gloss)	MPI 101	MPI 101	MPI 101	131 microns 5.25 mils
Topcoat: Coating to match adjacent surfaces.				

(3) Metal in[toilets,][food-preparation,][food-serving,][restrooms,][laundry areas,][shower areas,][areas requiring a high degree of sanitation,][_____,][and other high-humidity areas] not otherwise specified except floors, hot metal surfaces, and new prefinished equipment

****

NOTE: List other high humidity areas requiring enamel finishes. For tile-like finishes, filler materials, and applications, refer to Section 09 96 59 HIGH-BUILD GLAZE COATINGS. These high performance coatings are normally used to meet exposure-resistant requirements and can be applied to wood, metal, and concrete substrates.

****

Alkyd				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1E-G3 (Eggshell)	MPI 76	MPI 51	MPI 51	131 microns 5.25 mils
MPI INT 5.1E-G5 (Semigloss)	MPI 76	MPI 47	MPI 47	131 microns 5.25 mils

MPI INT 5.1E-G6 (Gloss)	MPI 76	MPI 48	MPI 48	131 microns 5.25 mils
Topcoat: Coating to match adjacent surfaces.				

Alkyd; For Hand Tool Cleaning				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1T-G3 (Eggshell)	MPI 23	MPI 51	MPI 51	131 microns 5.25 mils
MPI INT 5.1T-G5 (Semigloss)	MPI 23	MPI 47	MPI 47	131 microns 5.25 mils
MPI INT 5.1T-G6 (Gloss)	MPI 23	MPI 48	MPI 48	131 microns 5.25 mils
Topcoat: Coating to match adjacent surfaces.				

(4) Ferrous metal in concealed damp spaces or in exposed areas having unpainted adjacent surfaces as follows: [_____]

Aluminum Paint				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1M	MPI 76	MPI 1	MPI 1	106 microns 4.25 mils
Topcoat: Coating to match adjacent surfaces.				

(5) Miscellaneous non-ferrous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish

High Performance Architectural Latex				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.4F-G2 (Flat)	MPI 95	MPI 138	MPI 138	125 microns 5 mils
MPI INT 5.4F-G3 (Eggshell)	MPI 95	MPI 139	MPI 139	125 microns 5 mils
MPI INT 5.4F-G4 (Satin)	MPI 95	MPI 140	MPI 140	125 microns 5 mils

MPI INT 5.4F-G5 (Semigloss)	MPI 95	MPI 141	MPI 141	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

Alkyd				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.4J-G2 (Flat)	MPI 95	MPI 49	MPI 49	125 microns 5 mils
MPI INT 5.4J-G3 (Eggshell)	MPI 95	MPI 51	MPI 51	125 microns 5 mils
MPI INT 5.4J-G5 (Semigloss)	MPI 95	MPI 47	MPI 47	125 microns 5 mils
MPI INT 5.4J-G6 (Gloss)	MPI 95	MPI 48	MPI 48	125 microns 5 mils
Topcoat: Coating to match adjacent surfaces.				

B. Hot Surfaces

(1) Hot metal surfaces [including smokestacks] subject to temperatures up to 205 degrees C 400 degrees F

****

NOTE: Heat Resistant Paints may require a high heat cure cycle to achieve proper cure. Determine curing requirements before specifying so that the supplier will be aware of requirements.

Consider hot dip galvanizing, aluminum metallizing, and zinc metallizing alternatives to the specified coating systems.

****

Heat Resistant Enamel				
New	N/A	Intermediate	Topcoat	System DFT
MPI INT 5.2A	MPI 21	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

(2) Ferrous metal subject to high temperature, up to 400 degrees C 750 degrees F

****

NOTE: Heat Resistant Paints may require a high heat cure cycle to achieve proper cure. Determine curing

requirements before specifying so that the supplier will be aware of requirements.

Consider hot dip galvanizing, aluminum metallizing, and zinc metallizing alternatives to the specified coating systems.

****

Inorganic Zinc Rich Coating				
New	N/A	Intermediate	Topcoat	System DFT
MPI INT 5.2C	MPI 19	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

Heat Resistant Aluminum Enamel				
New	N/A	Intermediate	Topcoat	System DFT
MPI INT 5.2B (Aluminum Finish)	MPI 2	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

(3) New and Existing Surfaces made bare subject to temperatures up to 593 degrees C 1100 degrees F

****

NOTE: Heat Resistant Paints may require a high heat cure cycle to achieve proper cure. Determine curing requirements before specifying so that the supplier will be aware of requirements.

Consider aluminum metallizing alternative to the specified coating system.

****

(1) [New surfaces][and][Existing surfaces] made bare cleaning to SSPC SP 10/NACE No. 2 subject to temperatures up to 593 degrees C 1100 degrees F:

Heat Resistant Coating					
New	Existing	N/A	Intermediate	Topcoat	System DFT
MPI INT 5.2D	MPI RIN 5.2D	MPI 22	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.					

3.15.2.4 MPI Division 6: Interior Wood Paint Table

A. Interior Wood and Plywood

(1) New[and Existing, uncoated] Wood and plywood not otherwise specified

High Performance Architectural Latex				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.4S-G3 (Eggshell)	MPI 39	MPI 139	MPI 139	112 microns 4.5 mils
MPI INT 6.4S-G4 (Satin)	MPI 39	MPI 140	MPI 140	112 microns 4.5 mils
MPI INT 6.4S-G5 (Semigloss)	MPI 39	MPI 141	MPI 141	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Alkyd				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.4B-G3 (Eggshell)	MPI 45	MPI 51	MPI 51	112 microns 4.5 mils
MPI INT 6.4B-G5 (Semigloss)	MPI 45	MPI 47	MPI 47	112 microns 4.5 mils
MPI INT 6.4B-G6 (Gloss)	MPI 45	MPI 48	MPI 48	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Institutional Low Odor / Low VOC Latex				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.3V-G2 (Flat)	MPI 39	MPI 144	MPI 144	100 microns4 mils
MPI INT 6.3V-G3 (Eggshell)	MPI 39	MPI 145	MPI 145	100 microns4 mils
MPI INT 6.3V-G4 (Satin)	MPI 39	MPI 146	MPI 146	100 microns4 mils
MPI INT 6.3V-G5 (Semigloss)	MPI 39	MPI 147	MPI 147	100 microns4 mils

(2) Existing, previously painted Wood and plywood not otherwise specified

High Performance Architectural Latex				
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 6.4B-G3 (Eggshell)	MPI 39	MPI 139	MPI 139	112 microns 4.5 mils
MPI RIN 6.4B-G4 (Satin)	MPI 39	MPI 140	MPI 140	112 microns 4.5 mils
MPI RIN 6.4B-G5 (Semigloss)	MPI 39	MPI 141	MPI 141	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Alkyd				
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 6.4C-G3 (Eggshell)	MPI 46	MPI 51	MPI 51	112 microns 4.5 mils
MPI RIN 6.4C-G5 (Semigloss)	MPI 46	MPI 47	MPI 47	112 microns 4.5 mils
MPI RIN 6.4C-G6 (Gloss)	MPI 46	MPI 48	MPI 48	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Institutional Low Odor / Low VOC Latex				
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 6.4D-G2 (Flat)	MPI 39	MPI 144	MPI 144	100 microns4 mils
MPI RIN 6.4D-G3 (Eggshell)	MPI 39	MPI 145	MPI 145	100 microns4 mils
MPI RIN 6.4D-G4 (Satin)	MPI 39	MPI 146	MPI 146	100 microns4 mils
MPI RIN 6.4D-G5 (Semigloss)	MPI 39	MPI 147	MPI 147	100 microns4 mils

B. Interior New [and Existing, previously finished or stained] Wood and Plywood, except floors; natural finish or stained

Natural finish, oil-modified polyurethane					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.4J-G4	MPI RIN 6.4L-G4	MPI 57	MPI 57	MPI 57	100 microns 4 mils
MPI INT 6.4J-G6 (Gloss)	MPI RIN 6.4L-G6 (Gloss)	MPI 56	MPI 56	MPI 56	100 microns 4 mils

Stained, oil-modified polyurethane						
New	Existing	Stain	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.4E-G4	MPI RIN 6.4G-G4	MPI 90	MPI 57	MPI 57	MPI 57	100 microns4 mils
MPI INT 6.4E-G6 (Gloss)	MPI RIN 6.4G-G6 (Gloss)	MPI 90	MPI 56	MPI 56	MPI 56	100 microns4 mils

Stained, Moisture Cured Urethane						
New	Existing	Stain	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.4V-G2 (Flat)	MPI RIN 6.4V-G2 (Flat)	MPI 90	MPI 71	MPI 71	MPI 71	100 microns 4 mils
MPI INT 6.4V-G6 (Gloss)	MPI RIN 6.4V-G6 (Gloss)	MPI 90	MPI 31	MPI 31	MPI 31	100 microns 4 mils

C. Interior New[and Existing, previously finished or stained] Wood Floors; Natural finish or stained

Natural finish, oil-modified polyurethane					
New	Existing, previously finished or stained	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.5C-G6 (Gloss)	MPI RIN 6.5C-G6 (Gloss)	MPI 56	MPI 56	MPI 56	100 microns 4 mils

Natural finish, Moisture Cured Polyurethane					
New	Existing, previously finished or stained	Primer	Intermediate	Topcoat	System DFT

MPI INT 6.5K-G6 (Gloss)	MPI RIN 6.5D-G6 (Gloss)	MPI 31	MPI 31	MPI 31	100 microns 4 mils

Stained, oil-modified polyurethane						
New	Existing, previously finished or stained	Stain	Primer	ntermediat	Topcoat	System DFT
MPI INT 6.5B-G6 (Gloss)	MPI RIN 6.5B-G6 (Gloss)	MPI 90	MPI 56	MPI 56	MPI 56	100 microns4 mils

Stained, Moisture Cured Urethane						
New	Existing, previously finished or stained	Stain	Primer	ntermediat	Topcoat	System DFT
MPI INT 6.4V-G6 (Gloss)	MPI RIN 6.4V-G6 (Gloss)	MPI 90	MPI 31	MPI 31	MPI 31	100 microns4 mils

D. New [and Existing, previously coated] Wood floors; pigmented finish

Latex Floor Paint					
New	Existing, previously finished	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.5G-G2 (Flat)	MPI RIN 6.5J-G2 (Flat)	MPI 45	MPI 60	MPI 60	112 microns 4.5 mils
MPI INT 6.5G-G6 (Gloss)	MPI RIN 6.5J-G6 (Gloss)	MPI 45	MPI 68	MPI 68	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.					

Alkyd Floor Paint					
New	Existing, previously finished	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.5A-G2 (Flat)	MPI RIN 6.5A-G2 (Flat)	MPI 59	MPI 59	MPI 59	112 microns 4.5 mils

MPI INT 6.5A-G6 (Gloss)	MPI RIN 6.5A-G6 (Gloss)	MPI 27	MPI 27	MPI 27	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.					

E. Interior New[and Existing, uncoated] wood surfaces in[toilets,][food-preparation,][food-serving,][restrooms,][laundry areas,][shower areas,][areas requiring a high degree of sanitation,][_____][and other high humidity areas] not otherwise specified

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NOTE: List other high humidity areas requiring enamel finishes. For tile-like finishes, filler materials, and applications, refer to Section 09 96 59 HIGH-BUILD GLAZE COATINGS. These high performance coatings are used for exposure-resistant requirements and can be applied to wood, metal, and concrete substrates.

****

High-Build Glaze Coatings
As specified in Section 09 96 59 HIGH-BUILD GLAZE COATINGS.

Waterborne Light Industrial				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.3P-G5 (Semigloss)	MPI 45	MPI 153	MPI 153	112 microns 4.5 mils
MPI INT 6.3P-G6 (Gloss)	MPI 45	MPI 154	MPI 154	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Alkyd				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.3B-G5 (Semigloss)	MPI 45	MPI 47	MPI 47	112 microns 4.5 mils
MPI INT 6.3B-G6 (Gloss)	MPI 45	MPI 48	MPI 48	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

F. Existing, previously painted wood surfaces in[toilets,][food-preparation,][food-serving,][restrooms,][laundry areas,][shower areas,][areas requiring a high degree of sanitation,][_____][and other high humidity areas] not otherwise specified

****

NOTE: List other high humidity areas requiring enamel finishes. For tile-like finishes, filler materials, and applications, refer to Section 09 96 59 HIGH-BUILD GLAZE COATINGS. These high performance coatings are used for exposure-resistant requirements and can be applied to wood, metal, and concrete substrates.

****

High-Build Glaze Coatings
As specified in Section 09 96 59 HIGH-BUILD GLAZE COATINGS.

Waterborne Light Industrial				
Existing, previously finished	Primer	Intermediate	Topcoat	System DFT
MPI RIN 6.3P-G5 (Semigloss)	MPI 39	MPI 153	MPI 153	112 microns 4.5 mils
MPI RIN 6.3P-G6 (Gloss)	MPI 39	MPI 154	MPI 154	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Alkyd				
Existing, previously finished	Primer	Intermediate	Topcoat	System DFT
MPI RIN 6.3B-G5 (Semigloss)	MPI 46	MPI 47	MPI 47	112 microns 4.5 mils
MPI RIN 6.3B-G6 (Gloss)	MPI 46	MPI 48	MPI 48	112 microns 4.5 mils
Topcoat: Coating to match adjacent surfaces.				

G. Interior New [and Existing, previously finished or stained] Wood Doors; Natural Finish or Stained

Natural finish, oil-modified polyurethane					
New	Existing, previously finished or stained	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.3K-G4	MPI RIN 6.3K-G4	MPI 57	MPI 57	MPI 57	100 microns 4 mils
MPI INT 6.3K-G6 (Gloss)	MPI RIN 6.3K-G6 (Gloss)	MPI 56	MPI 56	MPI 56	100 microns 4 mils

Note: Sand between all coats per manufacturers recommendations.

Stained, oil-modified polyurethane						
New	Existing, previously finished or stained	Stain	Primer	ntermediat	Topcoat	System DFT
MPI INT 6.3E-G4	MPI RIN 6.3E-G4	MPI 90	MPI 57	MPI 57	MPI 57	100 microns4 mils
MPI INT 6.5B-G6 (Gloss)	MPI RIN 6.5B-G6 (Gloss)	MPI 90	MPI 56	MPI 56	MPI 56	100 microns4 mils
Note: Sand between all coats per manufacturers recommendations.						

Stained, Moisture Cured Urethane						
New	Existing, previously finished or stained	Stain	Primer	ntermediat	Topcoat	System DFT
MPI INT 6.4V-G2 (Flat)	MPI RIN 6.4V-G2 (Flat)	MPI 90	MPI 71	MPI 71	MPI 71	100 microns4 mils
MPI INT 6.4V-G6 (Gloss)	MPI RIN 6.4V-G6 (Gloss)	MPI 90	MPI 31	MPI 31	MPI 31	100 microns4 mils
Note: Sand between all coats per manufacturers recommendations.						

H. New [and Existing, uncoated] Wood Doors; Pigmented finish

Alkyd				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.3B-G5 (Semigloss)	MPI 45	MPI 47	MPI 47	112 microns 4.5 mils
MPI INT 6.3B-G6 (Gloss)	MPI 45	MPI 48	MPI 48	112 microns 4.5 mils
Note: Sand between all coats per manufacturers recommendations.				

Pigmented Polyurethane				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.1E-G6 (Gloss)	MPI 72	MPI 72	MPI 72	112 microns 4.5 mils

Note: Sand between all coats per manufacturers recommendations.

I. Existing, previously painted Wood Doors; Pigmented finish

Alkyd				
Existing, previously finished	Primer	Intermediate	Topcoat	System DFT
MPI RIN 6.3B-G5 (Semigloss)	MPI 46	MPI 47	MPI 47	112 microns 4.5 mils
MPI RIN 6.3B-G6 (Gloss)	MPI 46	MPI 48	MPI 48	112 microns 4.5 mils
Note: Sand between all coats per manufacturers recommendations.				

3.15.2.5 MPI Division 9: Interior Plaster, Gypsum Board, Textured Surfaces Paint Table

A. Interior New[and Existing, previously painted][Plaster][and][Wallboard] not otherwise specified

Latex					
New	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2A-G2 (Flat)	RIN 9.2A-G2 (Flat)	MPI 50	MPI 44	MPI 44	100 microns 4 mils
MPI INT 9.2A-G3 (Eggshell)	RIN 9.2A-G3 (Eggshell)	MPI 50	MPI 52	MPI 52	100 microns 4 mils
MPI INT 9.2A-G5 (Semigloss)	RIN 9.2A-G5 (Semigloss)	MPI 50	MPI 54	MPI 54	100 microns 4 mils
Topcoat: Coating to match adjacent surfaces.					

High Performance Architectural Latex - High Traffic Areas					
New	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2B-G2 (Flat)	MPI RIN 9.2B-G2 (Flat)	MPI 50	MPI 138	MPI 138	100 microns 4 mils
MPI INT 9.2B-G3 (Eggshell)	MPI RIN 9.2B-G3 (Eggshell)	MPI 50	MPI 139	MPI 139	100 microns 4 mils
MPI INT 9.2B-G5 (Semigloss)	MPI RIN 9.2B-G5 (Semigloss)	MPI 50	MPI 141	MPI 141	100 microns 4 mils

Topcoat: Coating to match adjacent surfaces.

Institutional Low Odor / Low VOC Latex, New

Institutional Low Odor / Low VOC Latex				
New	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2M-G2 (Flat)	MPI 149	MPI 144	MPI 144	100 microns4 mils
MPI INT 9.2M-G3 (Eggshell)	MPI 149	MPI 145	MPI 145	100 microns4 mils
MPI INT 9.2M-G4 (Satin)	MPI 149	MPI 146	MPI 146	100 microns4 mils
MPI INT 9.2M-G5 (Semigloss)	MPI 149	MPI 147	MPI 147	100 microns4 mils
Topcoat: Coating to match adjacent surfaces.				

Institutional Low Odor / Low VOC Latex, Existing, previously painted

Institutional Low Odor / Low VOC Latex				
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 9.2M-G2 (Flat)	MPI 144	MPI 144	MPI 144	100 microns4 mils
MPI RIN 9.2M-G3 (Eggshell)	MPI 144	MPI 145	MPI 145	100 microns4 mils
MPI RIN 9.2M-G4 (Satin)	MPI 144	MPI 146	MPI 146	100 microns4 mils
MPI RIN 9.2M-G5 (Semigloss)	MPI 144	MPI 147	MPI 147	100 microns4 mils
Topcoat: Coating to match adjacent surfaces.				

B. Interior New[and Existing, previously painted][Plaster][and][Wallboard] in[toilets,][food-preparation,][food-serving,][restrooms,][laundry areas,][shower areas,][areas requiring a high degree of sanitation,][_____][and other high humidity areas] not otherwise specified

****

NOTE: List other high humidity areas requiring enamel finishes. For tile-like finishes, filler materials, and applications, refer to Section 09 96 59 HIGH-BUILD GLAZE COATINGS. These high performance coatings are normally used to meet exposure-resistant requirements and can be applied

to wood, metal, and concrete substrates.
****

Waterborne Light Industrial Coating					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2L-G5(Semigloss	MPI RIN 9.2L-G5 (Semigloss)	MPI 50	MPI 153	MPI 153	100 microns4 mils
Topcoat: Coating to match adjacent surfaces.					

Alkyd					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2C-G5 (Semigloss)	MPI RIN 9.2C-G5 (Semigloss)	MPI 50	MPI 47	MPI 47	100 microns4 mils
Topcoat: Coating to match adjacent surfaces.					

Epoxy, New, uncoated Existing

Epoxy				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2E-G6 (Gloss)	MPI 50	MPI 77	MPI 77	100 microns4 mils
Topcoat: Coating to match adjacent surfaces.				

Epoxy, Existing, previously painted

Epoxy				
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 9.2D-G6 (Gloss)	MPI 17	MPI 77	MPI 77	100 microns4 mils
Topcoat: Coating to match adjacent surfaces.				

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 96 00 (November 2014)**

Preparing Activity: USACE **Superseding**
UFGS-09 96 00 (July 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 09 - FINISHES

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 96 00 (November 2014)**

Preparing Activity: USACE **Superseding**
UFGS-09 96 00 (July 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 96 00

HIGH-PERFORMANCE COATINGS
11/14

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NOTE: This guide specification covers the requirements for special coatings as required for harsh indoor locations or operations (any area subjected to chemical and/or abrasive action), and all outdoor installations.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM SI10	(2016) American National Standard for Use of the International System of Units (SI): The Modern Metric System

MASTER PAINTERS INSTITUTE (MPI)

MPI ASM	(2019) Architectural Painting Specification Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

QPL-TNT-AP-28	(2004) Paint, Aluminum, Heat Resisting (1200 Degrees F)

1.2 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Equipment List[; G, [_____]]

SD-03 Product Data

Heat-Resistant Coatings[; G, [_____]]

Epoxy Coatings[; G, [_____]]

Polyurethane Coatings[; G, [_____]]

Chlorinated-Rubber Coatings[; G, [_____]]

SD-04 Samples

Color Chips[; G, [_____]]

SD-07 Certificates

Heat-Resistant Coatings[; G, [_____]]

Epoxy Coatings[; G, [_____]]

Polyurethane Coatings[; G, [_____]]

Chlorinated-Rubber Coatings[; G, [_____]]

Manufacturer's Printed Instructions[; G, [_____]]

1.3 QUALITY CONTROL

Comply with Master Painters Institute (MPI) Standards indicated and listed in "MPI Approved Products List." Comply with the requirements in "MPI Architectural Painting Specification Manual" before any project is started.

Submit an equipment list consisting of a list of proposed equipment to be used in performance of construction work.

Submit three color chips 75 millimeter by 100 millimeter 3-inch by 4-inch or manufacture's pull-down of each finish color and gloss as scheduled.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver special coating materials to the project in their original containers bearing manufacturer's name, descriptive label, and coating formulations. Provide new and unopened containers.

Store special coating materials in tightly closed containers in a covered, well-ventilated area where they are not exposed to excessive heat, fumes, sparks, flame, or direct sunlight. Protect water-based coatings against freezing.

Store solvents, thinners, and equipment cleaners with the same care as the coating materials with ambient temperatures continuously maintained at a minimum 7 degrees C 45 degrees F.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

Submit manufacturer's catalog data including manufacturer's name and identification. Include detailed data analysis of each special coating material required for the project, with all the coating constituents measured as percentages of the total weight of the coating. Also provide manufacturer's data concerning application, thinning, and average coverage per liter gallon

2.1.1 Heat-Resistant Coatings

****

NOTE: Heat-resistant coatings are divided into four categories, with upper temperature limits of 204 degrees C, 316 degrees C, 427 degrees C and 649 degrees C. 400 degrees F, 600 degrees F, 800 degrees F and 1,200 degrees F

Coatings above 649 degrees C 1,200 degrees F are ceramic coatings. Generally, coatings applied to substrates where surface temperatures vary radically, do not have a long life span due to vehicle solid degradation and thermoshock of the metallic pigments. In areas such as this, consider flame deposition of sacrificial metal coatings.

****

2.1.1.1 Category 1, 10 to 204 Degrees C 50 to 400 Degrees F

****

NOTE: Use the following for ferrous surfaces where surface temperature does not exceed 204 degrees C 400 degrees F.

****

Provide alkyd resin-based material for surface temperature coatings not exceeding 204 degrees C 400 degrees F. Apply a minimum two coats of coating with a dry-film thickness of a minimum 0.1 millimeter 4 mils.

Apply an epoxy zinc primer as a first coat conforming to MPI ASM, No. 20 with the resin solids and zinc pigment not less than 80 percent of the total weight of the material.

White and color pigmented finish coats are an alkyd resin-based material with the resin solids and pigments not less than 85 percent of the total weight of the material. Ensure pigments are heat-stable materials, formulated to colors as scheduled.

Ensure black-pigmented finish coats are an alkyd resin, carbon-black pigmented material with resin solids and pigments not less than 50 percent of the total weight of the material.

Provide aluminum pigmented finish coats that are an alkyd resin-based material with resin solids and pigments not less than 50 percent of the total weight of the material.

2.1.1.2 Category 2, 149 to 316 Degrees C 300 to 600 Degrees F

****

NOTE: Use the following for ferrous surfaces where surface temperature does not exceed 316 degrees C 600 degrees F.

****

Coatings for surface temperatures not exceeding 316 degrees C 600 degrees F are based on modified silicone and silicone-based resins. Apply coatings in not less than two coats with a dry-film thickness of not less than 3 mils.

Provide a silicone-based resin zinc-pigmented material with the resin solids and zinc pigment for the first coat not less than 80 percent of the total weight of the material.

Apply color pigmented finish coats using silicone-based resin material with the resin solids and pigments not less than 80 percent of the material's total weight. Pigments are heat-stable materials, formulated to colors as scheduled.

Ensure black-pigmented finish coat is a silicone-based resin carbon-black pigmented material with resin solids and pigments not less than 50 percent of the total weight of the material.

Aluminum-pigmented finish coats are a modified, silicone-based-resin material with the resin solids and pigments not less than 50 percent of the total weight of the material.

2.1.1.3 Category 3, 316 to 427 Degrees C 600 to 800 Degrees F

****

NOTE: Use the following for ferrous surfaces where surface temperature does not exceed 427 degrees C 800 degrees F.

****

Provide a modified silicone or a silicone-based material of coating for surface temperatures not exceeding 427 degrees C 800 degrees F. Apply a minimum two coats with a dry-film thickness of a minimum 0.07 millimeter 3 mils 1 mils per manufacturer's recommendations.

Provide a silicone-based resin, zinc-pigmented material first coat with the resin solids and zinc pigment for the first coat not less than 80 percent of the total weight of the material.

Ensure black-pigmented finish coat is a silicone-based resin, carbon-black pigmented material with resin solids and pigments not less than 50 percent of the total weight of the material.

Aluminum-pigmented finish coat is a a modified, silicone-based-resin material with the resin solids and pigments not less than 50 percent of the total weight of the material.

2.1.1.4 Category 4, 427 to 649 Degrees C 800 to 1,200 Degrees F

****

NOTE: Use the following for ferrous surfaces where surface temperature does not exceed 649 degrees C 1,200 degrees F.

****

Provide an aluminum-pigmented, silicone-resin-based coating for surface temperatures not exceeding 649 degrees C 1,200 degrees F conforming to QPL-TNT-AP-28, as modified.

Apply a minimum two coats with a minimum 0.05 millimeter dry-film thickness of 2 mils.

Ensure the coating pigment contains a minimum 28 percent aluminum, based on the total weight of the material. Ensure coating contains a minimum of 22 percent silicone resin and a maximum of 49 percent of volatile thinners and driers based on the total weight of the material.

2.2 MATERIALS

2.2.1 Epoxy Coatings

Conform to MPI ASM, No. 116 for epoxy coatings and epoxy block filler, as modified.

Resins for finish coats are based on a polyamide-cured, epoxy-resin material. Apply finish coats with a dry-film thickness of not less than 0.1 millimeter 4 mils per coat. Finish color and gloss are as indicated.

****

NOTE: Use Epoxy resin coatings where surface coatings require high corrosion resistance, chemical resistance, bond strength, UV resistance, and toughness.

Amine-cured epoxy coatings have higher resistance to chemical attack and better color retention than polyamide-cured epoxy coatings. Polyamide-cured epoxy coatings have higher water resistance and bond strength than amine-cured coatings.

NOTE: Consider the Dry-film thickness given as a minimum and may be revised as required to suit conditions and surface use.

****

2.2.1.1 Concrete Surface Coatings

Apply a [epoxy coating system in conformance with MPI ASM, No. 77] [water-based epoxy coating system in conformance with MPI ASM, No. 115] for vertical concrete surfaces. Apply an epoxy slip-resistant deck coating system in conformance with MPI ASM, No. 82. Apply a prime coat to fill concrete surface pores with a total dry-film thickness of not less than 0.05 millimeter 2 mils.

2.2.1.2 Masonry Surfaces Coatings

Apply a[n] [Water-Based, Light-Industrial Coating System in conformance with MPI ASM, No. 110] [Epoxy Coating System in conformance with MPI ASM, No. 77] [Water-Based Epoxy Coating System in conformance with MPI ASM, No. 115] [Polyurethane, Pigmented, Over Epoxy Coating System in conformance with MPI ASM, No. 72]. Apply a block filler to fill surface pores with a total dry-film thickness of not less than 0.2 millimeter 7 mils.

2.2.1.3 Ferrous and Galvanized Metal Surface Coatings

Coatings on ferrous and galvanized metal surfaces consist of a prime coat and not less than two finish coats. Comply with MPI ASM, No. 101 for an epoxy zinc primer with a metallic-zinc pigment for the substrate to be coated and the end use of the coated surface. Ensure resin solids and zinc pigment are not less than 80 percent of the total weight of the coating material. Apply prime coat with a total dry-film thickness of not less than 0.1 millimeter 4 mils. Provide an epoxy-based finished coat as specified.

2.2.1.4 Aluminum Surface Coatings

Apply an Epoxy Coating System in conformance with MPI ASM, No. 80 and MPI ASM, No. 77. Apply a prime coat with a total dry-film thickness of not less than 0.1 millimeter 4 mils.

2.2.2 Polyurethane Coatings

****

NOTE: Polyurethane-based coatings are used where surfaces to be coated require high abrasion resistance, good flexibility and chemical resistance, UV resistance, and are a two-part, prepolymer, catalytic-cured resin material.

The two-part prepolymer, catalytic-cured, resin based materials are used for heavy-duty coatings where abrasion resistance and chemical resistance are required. Catalytic-cured resins are formulated as clear coatings and in a limited range of pigmented coatings.

****

Ensure polyurethane coatings use ASTM SI10 and conform to MPI ASM for each substrate indicated.

****

NOTE: Dry-film thickness given are considered minimum and may be revised as required.

****

Resins for finish coats are based on a two-part, prepolymer, catalytic-cured, polyurethane material. Apply catalytic-cured coatings with a total dry-film thickness of not less than 0.25 millimeter 10 mils per coat. Indicate finish color and gloss on the schedules.

2.2.2.1 Concrete Surface Coatings

****

NOTE: Policy is to avoid coating of exposed concrete unless it is considered aesthetically desirable.

****

Apply a [polyurethane, pigmented coating system in conformance with MPI ASM, No. 72 and MPI ASM, No. 80] [Polyurethane, Clear, Two-Component Coating System in conformance with MPI ASM, No. 78]. Ensure the prime coat fills surface pores with a total dry-film thickness of not less than 0.05 millimeter 2 mils. Finish coats are polyurethane-based material as specified.

2.2.2.2 Masonry Surface Coatings

Apply a polyurethane, clear, two-component coating system in conformance with MPI ASM, No. 78. Apply block filler to fill surface pores with a total dry-film thickness of not less than 0.2 millimeter 7 mils. Finish coats are polyurethane-based material as specified.

2.2.2.3 Ferrous and Galvanized Metal Surface Coatings

Apply a [polyurethane, pigmented coating system in conformance with MPI ASM, No. 72, MPI ASM, No. 77, and MPI ASM, No. 101] [high-performance architectural latex coating system in conformance with MPI ASM, No. 134, No. 138, and MPI ASM, No. 140]. Apply a prime coat with a dry-film thickness of not less than 0.05 millimeter 2 mils. Finish coats are polyurethane-based material as specified.

2.2.2.4 Aluminum Surface Coatings

Apply a water base, light industrial coating system in conformance with [MPI ASM, No. 95] [MPI ASM, No. 77 and MPI ASM, No. 80 for epoxy coating] [MPI ASM, No. 80 for polyurethane] coats on aluminum surfaces. Prime coat is a polyurethane-resin material as recommended by the coating manufacturer for the substrate to be coated. Apply prime coat with a dry-film thickness of not less than 0.05 millimeter 2 mils. Finish coats are polyurethane-based material as specified.

2.2.2.5 Wood Surface Coatings

Apply a [pigmented polyurethane coating in conformance with MPI ASM, No. 72][clear polyurethane two-component coating in conformance with MPI ASM, No. 13 and MPI ASM, No. 78]. Apply prime coat with a dry-film thickness of not less than 0.12 millimeter 5 mils. Finish coats are polyurethane-based material as specified.

2.2.3 Chlorinated-Rubber Coatings

****

NOTE: Chlorinated-rubber-based coatings are used

where the surface coating requires high resistance to water, salt spray, moist gases, and inorganic acids at 24 degrees C 75 degrees F.

Chlorinated rubber resins cannot be used in the unmodified state; they tend to deteriorate when exposed to heat and ultraviolet light. Chlorinated-rubber resins are generally modified with phenolic resins.

Chlorinated rubber coatings are based on modified, chlorinated-rubber, phenolic-resin materials. Coatings are formulated as gray and white coating with a wide range of tints for white base material.

****

****

NOTE: The dry-film thickness given is considered the minimum and may be revised to suit conditions and surface use.

****

Base resins for finish coats on a modified, chlorinated-rubber, phenolic-resin material. Ensure coating materials contain not less than 20 percent chlorinated rubber resin, based on the total weight of the material. Apply finish coats with a dry-film thickness of not less than 0.07 millimeter 3 mils per coat. Finish coating color is as indicated.

2.2.3.1 Concrete Surface Coatings

****

NOTE: Policy is to avoid coating of exposed concrete unless it is considered aesthetically desirable.

****

Apply a minimum three coats on concrete surfaces. Provide prime coats with a chlorinated-rubber resin material as recommended by the coating manufacturer for the substrate to be coated and the end use of the coated surfaces. Ensure the prime coat fills concrete surface pores with a total film thickness of not less than 0.05 millimeter 2 mils. Finish coats are chlorinated-rubber-based coatings as specified.

2.2.3.2 Masonry Surface Coatings

Apply a minimum of two finish coats of masonry block filler on masonry surfaces. Block fillers are based on an epoxy-ester resin material as recommended by the coating manufacturer for the substrate and end use of the coated surface. Fill surface pores with block filler at a total film thickness of not less than 0.2 millimeter 7 mils. Finish coats are chlorinated-rubber-based coatings as specified.

2.2.3.3 Ferrous and Galvanized Metal Surface Coatings

Apply a minimum two coats of high performance architectural latex coating in conformance with MPI ASM, No. 79 on ferrous and galvanized metal surfaces. Apply prime coat with a dry-film thickness of not less than 0.07 millimeter 3 mils. Finish coats are chlorinated rubber-based coatings as specified.

2.2.3.4 Aluminum Surface Coatings

Apply a minimum three coats of quick drying primer for aluminum surfaces. Ensure prime coats conform to MPI ASM, No. 80 for aluminum coating system.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Surface Preparation

Protect adjacent materials and equipment against damage from spillage, dripping, and spatter of coating materials. Leave clean building materials and equipment with all damaged surfaces corrected. Provide "WET PAINT" signs to indicate newly painted surfaces.

Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Contracting Officer, and leave in an undamaged condition. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

Provide forced ventilation for interior spaces during application and drying of coatings to prevent the buildup of toxic or explosive concentrations of solvent vapors.

Provide fire extinguishers of the required quantity and correct type to combat flammable liquid fires.

Dispose of rags that are used to wipe up coating materials, solvents, and thinners by drenching with water and placing them in a covered metal container

3.1.2 Cleaning

At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

Clean application equipment promptly and thoroughly with a suitable solvent after each use and stored in a clean, covered, well-ventilated container.

3.1.3 Concrete Surfaces

Conform to MPI ASM for substrates indicated. Remove plates, machined surfaces, and similar items already in place that are not to be coated. Provide surface-applied protection before surface preparation and coating where removal is impractical or impossible. After completing coating operations, reinstall items that were removed.

Clean dirt, oil, grease, and incompatible paints from substrates to ensure bonding. Coordination of shop-applied prime coats with high-performance coatings is critical. Remove incompatible primers. Reprime substrate with compatible primers as required to produce coating systems indicated.

3.1.3.1 Concrete Substrates

Remove release agents, curing compounds, efflorescence, and chalk. Maximum allowable moisture content of concrete is 12 percent. Measure moisture content with an electronic moisture meter.

Clean surfaces with pressurized water. Use pressure range of [10 350 to 27 580 kPa 1500 to 4000 psi at 150 mm to 300 mm 6 inch to 12 inch][27 580 to 68 950 kPa 4000 to 10,000 psi].

Comply with SSPC 7/NACE No.4 (NACE No. 4), "Brush-Off Blast Cleaning" for abrasive cleaning.

3.1.3.2 Clay Masonry Substrates

Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces exceeds that permitted in manufacturer's written instructions.

Clean surfaces with pressurized water. Use pressure range of [690 to 4140 kPa 100 to 600 psi] [10 350 to 27 580 kPa 1500 to 4000 psi] at 150 to 300 mm 6 inch to 12 inch.

****

NOTE: Delete paragraph below if primers are shop applied and are not removed in the field.

****

3.1.3.3 Steel Substrates

Remove rust and loose mill scale. Clean using methods recommended in writing by coating manufacturer. Conform to SSPC 7/NACE No.4 for blast cleaning.

****

NOTE: Galvanized-metal substrates should not be chromate passivated (commercially known as "bonderized"). If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.

****

3.1.3.4 Galvanized-Metal Substrates

Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

3.1.3.5 Aluminum Substrates

Remove surface oxidation.

3.1.3.6 Wood Substrates

Wood substrates that contain small surface knots are prepped by sanding surfaces smooth. Apply a thin coat of knot sealer before applying an interior latex-based wood primer. Prime edges, ends, faces, undersides, and back sides of wood. After priming, fill holes and crevices to the finished surface with putty or plastic wood filler. After finished surface is dry, smooth surface by sanding, for a finished product.

3.1.4 Coating Material Preparation

Mix and prepare coating materials in accordance with the coating manufacturer's printed instructions for applying the particular material and coat. Keep materials which are not in actual use in closed containers.

Coating materials that have been mixed with an automatic shaker are allowed to stand to let air bubbles escape, then given a final hand mixing before application. Stir materials so as to produce a mixture of uniform density. Stir at frequent intervals during application to prevent skinning. Do not stir film which may form on the surface of the material. Remove film and strain, if necessary.

3.1.4.1 Thinning

Thinning is done in accordance with coating manufacturer's printed directions for the particular material and coat.

3.1.4.2 Tinting

Ensure prime and intermediate coats of paint are slightly different tints from the finish coat to facilitate identification of each coat. Tinting is done by the coating manufacturer and clearly identified as to color and coat.

3.2 APPLICATION

Do not perform exterior painting in damp or rainy weather. Interior painting is not allowed until the building is enclosed and has thoroughly dried out. Painting is not allowed below 10 degrees C 50 degrees F or above 35 degrees C 95 degrees F. Apply paint in accordance with the coating manufacturer's recommendations, and as specified.

Ensure coating application is done by skilled applicators. Apply coatings to clean and properly prepared surfaces. Apply coatings with clean, high-quality application equipment. Allow sufficient time between coats to ensure complete drying and curing. Sand and dust surfaces between coatings, as required, to produce a surface free of visible defects. Lightly sand high gloss coatings and clear finishes between coats to ensure bond of following coats.

Apply coats to the surfaces in an even film. Cloudiness, spotting, holidays, laps, application marks, runs, sags, and other similar surface imperfections are not acceptable. Remove defective coating applications and re-coat as directed.

Ensure coating lines such as wainscots are sharp, true, and well-defined. Tape may be used to establish coating lines, providing tape is removed before ragging or sawtooth edges form.

Ensure surfaces, including edges, corners, crevices, welds, and other similar changes in surface plane, meet the dry-film thickness not less than specified.

3.2.1 Brush Application

Use clean, proper size brushes for high-quality application of the specified coating materials. Brush out slow-dry coatings. Brush out quick-dry coatings only enough to spread out evenly.

3.2.2   Roller Application

Use clean roller covers of the proper nap length, nap texture, and material for high-quality application of the specified coating materials.

Ensure roller application is equivalent in all respects to the same coats applied by high-quality brush application.

3.2.3   Spray Application

[Do not allow spray application of coatings.Spray application equipment is limited to airless-spray equipment and electrostatic-spray equipment. Ensure equipment is clean and operated by workmen skilled in high quality application of coating materials.

][Spray application of coatings is limited to finish coats on metal frame works, siding, decking, wire mesh, and other surfaces where hand work would be inferior. Apply spray coatings as equivalent in all respects to the same coats applied by high quality brush application. Permit each spray coat to cure before the succeeding coat is applied. Do not double back with application equipment, for the purpose of building up film thickness of two coats in one operation.

][Cover surfaces adjacent to sprayed areas to prevent damage from overspray, coating rebound, and spray drift.

]3.3   FIELD QUALITY CONTROL

3.3.1   Field Test

Government may take dry-film tests from time to time on finished surfaces. Apply additional coatings to surfaces where there is less than the minimum specified dry-film thickness.

3.3.2   Repairing

Remove damaged and unacceptable portions of completed work and replace with new work to match adjacent surfaces at no additional cost to the Government.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 96 59 (May 2011)**
Change 1 - 08/17

Preparing Activity: NAVFAC **Superseding**
UFGS-09 96 59 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 96 59

HIGH-BUILD GLAZE COATINGS

05/11, CHG 1: 08/17

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 96 59 (May 2011)**
Change 1 - 08/17

Preparing Activity: NAVFAC **Superseding**
UFGS-09 96 59 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 09 96 59

HIGH-BUILD GLAZE COATINGS
05/11, CHG 1: 08/17

****

NOTE: This guide specification covers the requirements for epoxy-polyamide, polyurethane, and epoxy polyester high performance, architectural wall coating systems for interior and exterior surfaces.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Except for moisture-curing polyurethane, they are two-component systems and contain fillers that help provide the high-build. They are intended for application to concrete, masonry, plaster or wallboard, and also may be used on wood, metal, or fiberglass. The coatings are available in gloss or semigloss and are sometimes called tile-like coatings or liquid glaze coatings. Some of the coatings are high in Volatile Organic Compounds (VOC). The specifier must ensure that selected products do not exceed allowable VOC requirements.

****

****

NOTE: On the drawings, show:

1. Locations for wall coating systems.

2. Finish schedule.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

MASTER PAINTERS INSTITUTE (MPI)

MPI 31	(2012) Varnish, Polyurethane, Moisture Cured, Gloss (MPI Gloss Level 6)
MPI 71	(2012) Varnish, Polyurethane, Moisture Cured, Flat (MPI Gloss Level 1)
MPI 72	(2016) Polyurethane, Two-Component, Pigmented, Gloss (MPI Gloss Level 6-7)

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

High-Build Glaze Coatings

Submit three copies of coating manufacturer's printed product data.

SD-04 Samples

High-Build Glaze Coatings; G, [_____]

Submit color chips of standard colors.

Coating System; G, [_____]

Submit rigid panels on which the complete coating system is applied. Submit panels of the same materials as the surfaces to which the coating system is to be applied.

SD-06 Test Reports

Filler Material

Primers

Top Coating

SD-07 Certificates

Qualifications of Installer

SD-08 Manufacturer's Instructions

Wall Coating System

Submit instructions covering application of the wall coating system, including surface preparation, detailed application procedures, number and types of coats required, maximum and minimum application temperatures, and induction, pot life, and intercoat cure times. Safety Data Sheets (SDS) shall address all components of the paint coating system, including solvents, primers, and other hazardous materials.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Acceptance at Site

Deliver materials to the project site in original, factory-sealed containers or packages labeled with identification of contents, manufacturer's name and address, manufacturer's tradename or trademark, date of manufacture, specification number, batch number, color, instructions for use, and recommendations for protective measures against toxicity.

1.3.2 Storage and Protection

Protect and store materials under cover in dry, well-ventilated areas. Keep in original tightly sealed containers or packages, and in such sequence that oldest stocks are used first. Store at temperatures between 4 and 49 degrees C 40 and 120 degrees F. Do not use material that is more than one year old from the date of manufacturing.

1.4 ENVIRONMENTAL REQUIREMENTS

1.4.1 Protection During Cleaning

Personnel engaged in solvent-cleaning of galvanized metal and aluminum, or cleaning concrete, masonry, or portland cement plaster with 5 to 10 percent solution of hydrochloric acid, shall wear the appropriate personal protective equipment to prevent skin and eye contact and fumes inhalation. Ventilate all work areas properly.

1.4.2 Personnel Protection During Coating Applications

Personnel painting with high-build glaze coating systems shall wear the appropriate personal protective equipment to prevent skin or eye contact or inhalation. Ensure employees use and maintain solvent-resistant, personal protective equipment for the whole body. Emergency eye wash and water supplies shall be available near the work area for emergency flushing of the eyes and body. Coating applications shall be performed only in areas with good ventilation. Smoking will not be permitted in the area where coating is being applied. Wall and room temperature at the time of coating application and curing shall be in accordance with the manufacturer's instructions.

1.4.3 Protection During Application of Polyurethane Paints

Mix and apply polyurethane paints only in specifically designated areas with local exhaust ventilation and other environmental control measures as recommended on the basis of an on-site industrial hygiene survey. Supply and use air respirators in closed areas where adequate ventilation cannot be obtained.

1.5 QUALIFICATIONS OF INSTALLER

Installation shall be by an applicator approved by the manufacturer of the surfacing materials. Furnish a written statement from the manufacturer indicating that the installer is acceptable.

PART 2 PRODUCTS

2.1 WALL COATING SYSTEM

2.1.1 Filler Material

As recommended by the coating system manufacturer.

2.1.2 Primers

As recommended by the coating system manufacturer.

2.1.3 Top Coating

****

NOTE: Select wall coatings compatible with the surfaces they are to cover and in accordance with:

1. High Performance Architectural Coatings (HIPAC). They are tough, durable, organic systems applied to a continuous (seamless) high-build film and cure to a hard glaze finish. They are resistant to continuous heat and humidity, abrasion, staining, chemicals, and biological growth. They are used in areas where high humidity, wear, or unusual chemical resistance requirements, particularly to soiling, are required, and where strong detergents are used to maintain sanitary conditions. Stall showers, public halls and stairways, lavatories, locker areas, animal pens, and biological laboratories are typical areas where these coatings are recommended. Other areas of use are in food processing, dairies,

restaurants, schools, and air terminals. HIPAC systems should be used only as complete systems, and as recommended by the manufacturer. Minimum dry film thickness is 0.075 mm 3 mils for each of two coats. Furnished in Gloss, and Semigloss.

These coatings are for interior use and are formulated with any one of the following resins: Epoxy-polyamide, epoxy polyester, or aliphatic or aromatic polyurethane resins:

a. Epoxy-polyamide - chemical- and corrosion-resistant, adhesive, alkali-resistant, water-tolerant.

b. Epoxy-polyester - chemical-resistant, abrasion-and impact-resistant, fire-resistant, low odor.

c. Aliphatic or aromatic polyurethane - flexible, abrasion- and impact-resistant.

2. Two component, epoxy-polyamide for interior use. For metal, wood, concrete, masonry surfaces, and painted surfaces where high gloss or glaze type finish, extreme workability and resistance to abrasion and stains is desired. Particularly useful for hallways, kitchens, bathrooms, laundries and hospitals where maintenance of sanitary conditions is important. Minimum dry film thickness is 0.075 mm 3 mils for each of two coats. Maximum volatile organic compounds (VOC) to be 340 grams/liter.

3. MPI 31 or MPI 71. Single component, moisture-curing urethane. For floors, walls, machinery, equipment and other surfaces where good abrasion resistance, color retention, gloss retention, graffiti resistance and good resistance to acids, alkalis, solvents, strong cleaners and sanitizers, fuel and chemicals are necessary. Can also be used on concrete floors, brick and masonry surfaces (properly conditioned), metals (properly primed), and wood (properly prepared and sealed.) Minimum dry film thickness is 0.075 mm 3 mils for each of 3 coats.

****

a. High Performance Architectural Coating, [Epoxy-Polyamide][Epoxy-Polyester][Polyurethane][, Gloss][, Semigloss]

b. Two component, epoxy-polyamide for interior use.

c. [c. MPI 31, Single Component, Moisture-curing Urethane, clear, gloss top coat.]

d. [d. MPI 71, Single Component, Moisture-curing Urethane, clear, flat top coat.]

e. [e. MPI 72, Two-Component, Pigmented, gloss level 6.]

2.1.4 High-Build Glaze Coatings Systems Requirements

Provide a complete coating system from a single manufacturer. The system shall have a flame spread index of not more than 25 and a smoke developed index of not more than [50] [_____], when tested in accordance with ASTM E84.

2.2 COLORS

****

NOTE: Indicate colors on the finish schedule. When colors are identified by a manufacturer's name and designation, include the optional sentence in brackets. If the "architectural finishes display board" is used, it must be on display in the office of the Contracting Officer. The architectural display board should be used only to supplement the information contained on the drawings.

****

Top coating colors shall be [as indicated] [and] [as shown on the architectural finishes display board]. [Colors indicated by reference to manufacturer's name and designations are for color identification only and are not intended to limit selection of other manufacturer's products with similar colors.]

2.3 SOURCE QUALITY CONTROL

2.3.1 Top Coat Testing

****

NOTE: Choose one of the following options.

****

[High Performance Architectural Coating: Abrasion resistance with 100 mg maximum loss, scrubability, resistance to heat and humidity, and impact resistance tests.]

[Epoxy-polyamide: abrasion resistance and steam resistance tests.]

[MPI 31 abrasion resistance and resistance to water tests [and, resistance to accelerated weathering test, for loss of gloss, and chalking, with continuous exposure to light and intermittent exposure to water spray].]

PART 3 EXECUTION

3.1 Examination

3.1.1 Verification of Surface Conditions

Before commencing work, inspect surfaces to receive coatings and report to the Contracting Officer, in writing, of unsatisfactory surfaces. Inspection shall include examining the nature and condition of surfaces before, during, and after painting application, and reporting the same on a systematic basis. Inspection shall include ensuring that manufacturer's recommended procedures are followed during each stage of surface preparation and paint application.

3.2 PREPARATION

3.2.1 Protection

Remove, mask, or otherwise protect hardware, fixtures, accessories, and parts in contact with coated surfaces, and other parts that are factory-finished such as motors, sensing devices, thermostats. Protect adjacent surfaces to confine coatings to designated areas. Correct defects caused by installed equipment prior to finishing. Reinstall removed work after completion of each area.

3.2.2 Moisture

****

NOTE: Select moisture percentage allowable in accordance with substrate materials: 15 percent maximum for concrete, masonry, and portland cement plaster surfaces and 8 percent maximum for gypsum plaster surfaces.

****

Surfaces shall be dry to receive finishes. Measure moisture content of substrate with probe-type moisture meter implanted into backing. Moisture content shall not exceed [8] [15] percent.

3.2.3 [Restoration

****

NOTE: Include this paragraph only for work on repair projects where painting of existing substrate surfaces is included.

****

Prior to application of coatings, touch up and restore all substrates where damaged or defaced.

]3.2.4 Surface Preparation

Prepare surfaces in accordance with the coating manufacturer's printed instructions. Remove contaminants including splinters, mortars, rust and other products of corrosion, disintegrated coatings, and other substances that could interfere with adhesion of the coating system to the substrate.

3.2.5 Additional Preparation for Specific Materials

3.2.5.1 Sealants and Caulkings

Remove loose, cracked, or otherwise defective sealant materials and replace with new sealant as specified in Section 07 92 00 JOINT SEALANTS. Sealant materials shall be compatible with wall coating system materials.

3.2.5.2 Foreign Substances

Remove foreign substances by water washing, steam cleaning, cleaning compounds or detergents, or other procedures.

3.2.5.3 [Previously Painted or Coated Surfaces

****

NOTE: The 25 percent area is visual only. Lesser area percentage may be removed fully at the recommendation of the user. Delete this paragraph if project does not include painting of existing surfaces.
****

Remove loose or scaling materials prior to application of wall coating. Repair, smooth, sand, spackle, or otherwise treat to render imperceptible in the finished work defects such as scratches, nicks, cracks, gouges, spalls, alligatoring, and irregularities due to partial peeling of previous paint coatings. Where impractical to satisfactorily eliminate defects by other means, remove existing coatings from the entire surface, repair surface as necessary, prime, and repaint. Completely remove coating in areas where more than 25 percent of the existing substrate material has failed.

]3.2.5.4 Ferrous Metals

Prepare ferrous metals in accordance with SSPC SP 5/NACE No. 1, SSPC SP 6/NACE No.3, or SSPC SP 10/NACE No. 2, as recommended by the manufacturer.

3.2.5.5 Galvanized Metal

Clean and dry, using solvent, galvanized metal surfaces of detrimental foreign matter such as oil, grease, and other contaminants. Prior to coating application, pretreat the surface material in accordance with manufacturer's printed instructions for pretreatment compound mixing and application.

3.2.5.6 Aluminum

Using solvent, clean surfaces of oils, grease, and other lubricants. Remove dirt, water-soluble chemicals, and similar surface contaminants by washing with water, or water and detergent. When detergents are used, rinse with clear water. Pretreat these surfaces prior to coating application in accordance with manufacturer's printed instructions.

3.2.5.7 Concrete, Masonry, and Portland Cement Plaster

Cure new concrete and masonry surfaces a minimum of 30 days prior to painting. Repair concrete surfaces before coating. Clean surfaces to be coated, removing dirt, fungus, grease, oil, asphalt, tar, and other foreign substances. Remove efflorescence, chalk, and similar substances from concrete, masonry, portland cement, and plaster surfaces in the following manner:

a. Wash with a 5 to 10 percent aqueous solution of hydrochloric acid and rinse the surface with clean water and allow to dry.

b. Free surfaces from mortar deposits and form release agents.

c. Remove laitance from surfaces by etching with hydrochloric acid solution.

d. Rinse the surface again with clean water and allow to dry.

e. Sand cracked surfaces smooth and fill with filler compatible with the substrate and coating materials.

f. Apply filler until surfaces are completely filled (pin-hole free) and smooth.

g. Sand lightly and wipe clean.

h. [h. Apply the filler in [one][two] coat[s], to a [wet] [dry] film thickness of [_____] millimeters mils [for each coat], measured with a Tooke gage or similar thickness measuring gage].

3.2.5.8 Gypsum Plaster

Thoroughly dry and clean gypsum plaster before application of coatings. Remove lime deposits by sanding lightly. Sand cracked surfaces smooth; and fill with joint treatment compound compatible with plaster and coating materials. Sand lightly and wipe clean. Surfaces of plaster shall age a minimum of 30 calendar days and pass the following test: Using an electric moisture meter, when more than 8 percent moisture is indicated, surfaces are not sufficiently cured to be coated.

3.2.5.9 Woodwork

****

NOTE: Select corresponding option or options applicable to the project. Delete this paragraph if project does not include woodwork areas.

****

Provide a surface which is dry, smooth, and free from raised grain or other imperfections. Fill nail holes, cracks, joints, crevices, and other blemishes with materials compatible with the coating materials, and sand smooth and flush with adjacent wood surfaces before application of coatings. Sand in the direction of the grain. Back-prime wood in contact with or built into concrete, masonry, or plaster as specified in Section 09 90 00 PAINTS AND COATINGS. Prime end cuts and edges. [Seal with a mixture of equal parts of shellac and alcohol or knot sealer.] [Treat as specified for defects such as knots, resins, gum, or extractives].

3.2.5.10 Gypsum Wallboard

Reinforce and conceal joints of gypsum wallboard panels as specified in Section 09 29 00 GYPSUM BOARD. Apply a skim coat of gypsum plaster over the gypsum wallboard. Sand smooth, fill with joint treatment compound, sand lightly, and wipe clean surfaces prior to application of glaze coating.

3.3 COATING APPLICATION

Apply coating system over specified filler where applicable.

3.3.1 Apply Coating

After preparing surface, apply coating system directly to metal, gypsum wallboard, gypsum plaster, and previously painted surfaces in accordance with the manufacturer's instructions. Provide alkali-resistant primers for concrete, masonry, and portland cement plaster surfaces.

3.3.2 Thickness Test

Measure dry film thickness of coating system, excluding filler coat, with a Tooke gage or similar thickness measuring gage. Any paint damaged during thickness measurement shall be repaired to match the original.

3.3.3 Interior Application

****

NOTE: Specify the dry film thickness of the coating required over the filler, in accordance with the type of substrate for specified coating.

****

Apply wall coating system in accordance with manufacturer's specifications with a spreading rate to produce a dry film thickness of [_____] mm mils for each of [two] [three] coats applied. Protect coated surfaces after application and during the curing periods.

3.3.4 Exterior Application

****

NOTE: Specify the dry film thickness of the coating required over the filler, in accordance with the type of substrate for specified coating.

****

Mix and apply wall coating system in accordance with manufacturer's specifications with a spreading rate to produce a dry film thickness of [_____] mm mils for each of [two][three] coats applied. Protect coated surfaces during curing periods.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 97 02 (February 2020)**
Change 1 - 11/21

Preparing Activity: USACE **Superseding**
UFGS-09 97 02 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 09 - FINISHES

SECTION 09 97 02

PAINTING: HYDRAULIC STRUCTURES

02/20, CHG 1: 11/21

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 97 02 (February 2020)**
Change 1 - 11/21

Preparing Activity: USACE **Superseding**
UFGS-09 97 02 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 09 97 02

PAINTING: HYDRAULIC STRUCTURES

02/20, CHG 1: 11/21

****

NOTE: This guide specification covers the requirements for the preparation of surfaces and the application of paints for hydraulic structures and appurtenant items. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 LUMP SUM PRICE

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (LUMP SUM PRICE) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

****

1.1.1 Painting: Hydraulic Structures

1.1.1.1 Payment

Payment will be made for costs associated with "Painting: Hydraulic Structures", which includes full compensation for furnishing all materials, equipment, and labor required to paint the hydraulic structures in accordance with this section.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D153	(1984; R 2014) Specific Gravity of Pigments
ASTM D235	(2022) Standard Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
ASTM D281	(2012; R 2016) Standard Test Method for Oil Absorption of Pigments by Spatula Rub-Out
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D561	(1982; R 2014) Carbon Black Pigment for Paint
ASTM D740	(2011) Methyl Ethyl Ketone

ASTM D841	(2019) Standard Specification for Nitration Grade Toluene
ASTM D962	(1981; R 2014) Aluminum Powder and Paste Pigments for Paints
ASTM D1045	(2019) Standard Test Methods for Sampling and Testing Plasticizers Used in Plastics
ASTM D1152	(2006; R 2012) Methanol (Methyl Alcohol)
ASTM D1153	(2012) Methyl Isobutyl Ketone
ASTM D1200	(2010; R 2014) Viscosity by Ford Viscosity Cup
ASTM D1210	(2005; R 2014) Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage
ASTM D2917	(2007; R 2013) Methyl Isoamyl Ketone
ASTM D3465	(2014) Standard Test Method for Purity of Monmeric Plasticizers by Gas Chromatography
ASTM D3721	(2005; R 2011) Synthetic Red Iron Oxide Pigment
ASTM D4228	(2005; R 2017) Standard Practice for Qualification of Coating Applicators for Application of Coatings to Steel Surfaces
ASTM D4417	(2021) Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D7091	(2021) Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nondestructive Coatings Applied to Non-Ferrous Metals
ASTM E1347	(2006; R 2020) Standard Test Method for Color and Color Difference Measurement by Tristimulus (Filter) Colorimetry

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices
ANSI/ISEA Z358.1	(2014; R 2020) American National Standard for Emergency Eyewash and Shower Equipment

MASTER PAINTERS INSTITUTE (MPI)

MPI 46	(2016) Undercoat, Enamel, Interior
MPI 47	(2016) Alkyd, Interior, Semi-Gloss (MPI

	Gloss Level 5)
MPI 48	(2016) Alkyd, Interior, Gloss (MPI Gloss Level 6-7)
MPI 49	(2015) Alkyd, Interior, Flat (MPI Gloss Level 1)
MPI 50	(2015) Primer Sealer, Latex, Interior
MPI 51	(2016) Alkyd, Interior, (MPI Gloss Level 3)2
MPI 52	(2016) Latex, Interior, (MPI Gloss Level 3)
MPI 53	(2012) Latex, Interior, Flat (MPI Gloss Level 1)
MPI 54	(2016) Latex, Interior, Semi-Gloss (MPI Gloss Level 5)
MPI 114	(2012) Latex, Interior, Gloss (MPI GLoss Level 6)
MPI 212	(2018) Floor Coating, Thin Film, for Aircraft Maintenance Facilities

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 2003-154	(2003; 4th Ed; Supple 3) NIOSH Manual of Analytical Methods

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC Guide 6	(2021) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
SSPC PA 2	(2015; E 2018) Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC PS 26.00	(2000; E 2004) Aluminum Pigmented Epoxy Coating System Materials Specification, Performance-Based (Type I for use over Blast Cleaned Steel and Type II for use over Hand Cleaned Steel)
SSPC Paint 16	(2023) Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint
SSPC Paint 20	(2019) Zinc-Rich Primers (Type I,

	Inorganic, and Type II, Organic)
SSPC Paint 33	(2023; R 2023; S 2023) Coal Tar Mastic, Cold-Applied
SSPC Paint 38	(2006) Single-Component Moisture-Cure Weatherable Aliphatic Polyurethane Topcoat, Performance-Based
SSPC Paint 40	(2019) Zinc-Rich Moisture-Cure Polyurethane Primer, Performance-Based
SSPC Paint 41	(2008) Moisture-Cured Polyurethane Primer or Intermediate Coat, Micaceous Iron Oxide Reinforced, Performance-Based
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC QP 2	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Removal of Hazardous Coatings from Structures)
SSPC QP 3	(2010) Standard Procedure for Evaluating Qualifications of Shop Painting Applicators
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 3	(2024) Power Tool Cleaning
SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 16	(2010) Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for
MIL-PRF-85285	(2022; Rev F) Topcoat, Aircraft and Support Equipment

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-3130	(Rev A) Paint (For Application to Wet Surfaces)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.20	Access to Employee Exposure and Medical Records
29 CFR 1910.94	Ventilation
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.146	Permit-required Confined Spaces
29 CFR 1926.62	Lead
40 CFR 50.6	National Primary and Secondary Ambient Air Quality Standards for PM10
40 CFR 50.12	National Primary and Secondary Ambient Air Quality Standards for Lead
40 CFR 58	Ambient Air Quality Surveillance
40 CFR 60	Standards of Performance for New Stationary Sources
40 CFR 117	Determination of Reportable Quantities for Hazardous Substances
40 CFR 122	EPA Administered Permit Programs: The National Pollutant Discharge Elimination System
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 262.22	Number of Copies
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
49 CFR 171	General Information, Regulations, and Definitions

1.3 SAFETY, HEALTH, AND ENVIRONMENTAL REQUIREMENTS

Perform work in accordance with all applicable health, safety, and environmental requirements as well as EM 385-1-1. Submit matters of interpretation of these requirements to the Contracting Officer for resolution before starting work. If no clarifications are sought, then the submittal is not necessary. Where the regulations conflict, the most stringent requirements apply. This paragraph supplements the health, safety, and environmental requirements of EM 385-1-1.

1.3.1 Safety

Submit an Accident Prevention Plan in accordance with the requirements of Section 01 of EM 385-1-1, including, but not limited to, each of the topic areas listed in Appendix A therein and the specified requirements. Develop each topic in a concise manner to include management and operational aspects. Submit a Ventilation Assessment Plan complying with all applicable safety standards.

1.3.1.1 Abrasive Blasting

For abrasive blasting comply with the requirements in Section 06.I of EM 385-1-1. In addition to the requirements in Section 20 of EM 385-1-1, use hoses and hose connections of a type to prevent shock from static electricity. Join hose lengths together by approved couplings of a material and type designed to prevent erosion and weakening of the couplings. The couplings and nozzle attachments must fit on the outside of the hose and be designed to prevent accidental disengagement.

1.3.1.2 Workers Other Than Blasters

Protect workers, other than blasting operators working in close proximity to abrasive blasting operations. Use MSHA/NIOSH-approved half-face or full-face air purifying respirators equipped with high-efficiency particulate air (HEPA) filters and eye protection meeting ANSI/ISEA Z87.1. Use hearing protectors (ear plugs and/or ear muffs) providing a noise reduction rating of at least 20 dBA or as needed to provide adequate protection. Provide personal protective equipment where required by 29 CFR 1910.146 and in accordance with 29 CFR 1910, Subpart I.

1.3.1.3 Cleaning Before and After Abrasive Blasting

Cleaning with compressed air must be in accordance with Section 20.B.5 of EM 385-1-1 and personnel protected as specified in 29 CFR 1910.134. When cleaning with solvents, provide ventilation where required by 29 CFR 1910.146 or where the concentration of solvent vapors exceeds 10 percent of the Lower Explosive Limit (LEL). Ventilation must be in accordance with 29 CFR 1910.94, paragraph (c)(5).

1.3.1.4 Pretreatment of Metals and Concrete with Acids

Personnel must be protected in accordance with 29 CFR 1910, Subpart I. In addition to the requirements of Section 05 of EM 385-1-1, provide an eyewash in accordance with ANSI/ISEA Z358.1, paragraph (6).

1.3.1.5 Paint Mixing

Provide local exhaust ventilation in the area where coatings are mixed. This ventilation system must be capable of providing at least 30.5 linear meters per minute 100 linear fpm of capture velocity in the mixing zone. Avoid exposure of skin and eyes by wearing appropriate chemically resistant gloves, safety goggles, and face shields meeting the requirements of ANSI/ISEA Z87.1. Provide a personal eyewash unit within close proximity to the mixing operation in accordance with ANSI/ISEA Z358.1, paragraph (9). All powered mixing equipment must be either pneumatic or double insulated (intrinsically safe), in order to guard against fire or explosion. Individuals who have a history of, or develop a sensitivity to epoxy or polyurethane resin systems, must not conduct work tasks or otherwise be exposed to such chemicals.

1.3.1.6 Confined Spaces

When using solvent-based paint in confined spaces, prepare a Confined Spaces Plan. Provide ventilation to exchange air in the space at a minimum rate of 140 cubic meters 5,000 cubic feet per minute per spray gun in operation. It may be necessary to install both a mechanical supply and exhaust ventilation system to effect adequate air changes within the confined space. Locate and affix all air-moving devices to an opening of the confined space in a manner assuring that the airflow is not restricted or short circuited and is supplied in the proper direction. A suitable means of egress must be maintained at all times. Continue ventilation after completion of painting and through the drying phase of the operation. If the ventilation system fails or the concentration of volatiles exceeds 10 percent of the LEL (except in the zone immediately adjacent to the spray nozzle), stop painting and evacuate spaces until adequate ventilation is provided. Provide an audible alarm that signals system failure as an integral part of the ventilation system. Check the effectiveness of the ventilation by using ventilation smoke tubes and making frequent oxygen and combustible gas readings during painting operations. Exhaust ducts must discharge clear of the working areas and away from possible sources of ignition. Submit detailed written standard operating procedures for confined spaces in accordance with 29 CFR 1910.146 and EM 385-1-1, Section 6H, Section 34. The procedures must include:

a. Certificates of calibration for all testing and monitoring equipment. The certificates of calibration must include: type of equipment, model number, date of calibration, firm conducting calibration, and signature of individual certifying calibration.

b. Methods of inspection of personal protective equipment prior to use.

c. Engineering controls and other work practices designed to reduce airborne hazardous chemical exposures to a minimum.

d. Specification of the design and installation of ventilation systems which provide adequate oxygen content and provide for the dilution of paint solvent vapor, lead, and other toxic particulates within the confined space. Procedures must also include plans to evaluate the adequacy of air flow patterns.

1.3.1.7 Paint Spraying

Submit a comprehensive written Respiratory Protection Plan in accordance with 29 CFR 1910.134, 29 CFR 1926.62, and EM 385-1-1, Section 05.G. During all spray painting operations, spray painters must use approved SCBA or SAR (air line) respirators, unless valid air sampling has demonstrated contaminant levels to be consistently within concentrations compatible with the Assigned Protection Factor (APF) of an air-purifying respirator.

Persons with facial hair that may interfere with the seal or valve function of a half or full facepiece style respirator may wear a hood or helmet respirator provided the APF is sufficient for the exposure. Air-purifying chemical cartridge/canister respirators that have a particulate prefilter and are suitable for the specific type(s) of gas/vapor and particulate contaminant(s) may be used for nonconfined space painting, mixing, and solvent cleaning. These respirators may be used provided the measured or anticipated concentration of the contaminant(s) in the breathing zone of the exposed worker does not exceed the APF for the respirator and the gas/vapor has good warning properties or the respirator assembly is equipped with a NIOSH-approved end of service life indicator for the gas(es)/vapor anticipated or encountered. Where paint contains toxic elements that may become airborne during painting in nonconfined spaces, air-purifying half- and full-facepiece respirators or powered air-purifying respirators equipped with appropriate gas vapor cartridges, in combination with a high-efficiency filter, or an appropriate canister incorporating a high-efficiency filter, must be used.

1.3.1.8 Explosion Proof Equipment

Electrical wiring, lights, and other equipment located in the paint spraying areas must be of the explosion proof type designed for operation in Class I, Division 1, Group D, hazardous locations as required by the NFPA 70. Electrical wiring, motors, and other equipment, outside of but within 6 m 20 feet of any spraying area, must not spark and must conform to the provisions for Class I, Division 2, Group D, hazardous locations. Electric motors used to drive exhaust fans must not be placed inside spraying areas or ducts. Fan blades and portable air ducts must be constructed of nonferrous materials. Properly maintain and ground motors and associated control equipment. Electrically bond and ground the metallic parts of all air-moving devices, spray guns, connecting tubing, and duct work.

1.3.1.9 Further Precautions

a. Workers must wear nonsparking safety shoes.

b. Solvent drums taken into the spraying area must be grounded. Maintain metallic bonding between containers and drums when materials are being transferred.

c. Inspect insulation on all power and lighting cables to ensure that the insulation is in excellent working condition and is free of all cracks and worn spots. Ensure that no connections are within 15 m 50 feet of the operation, that lines are not overloaded, and that they are suspended with sufficient slack to prevent undue stress or chafing.

1.3.1.10 Ignition Sources

Ignition sources, including lighted cigarettes, cigars, pipes, matches, or cigarette lighters, and electronic smoking devices are prohibited in areas of solvent cleaning, paint storage, paint mixing, or paint application.

1.3.2 Health

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NOTE: It is the responsibility of the designer to determine which structures are coated with a lead-based paint or other toxic material. Where

lead is present and the appropriate text from this guidance document is included in the contract, it is not necessary to include text from other UFGS documents that deal specifically with lead removal or disposal projects.
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Prepare and submit a Medical Surveillance Plan and a statement from the examining physician indicating the name of each employee evaluated and any limitations which will preclude the employee from performing the work required. The statement must include the date of the medical evaluation, the physician's name, signature, and telephone number.

1.3.2.1 Air Monitoring

Prepare and submit an Air Monitoring Test Plan. Perform air sampling and testing as needed to assure that workers are not exposed to contaminants above the permissible exposure limit. In addition, provide the Contracting Officer with a copy of the Air Monitoring Test Report from the laboratory within five working days of the sampling date, including records of air monitoring plans and tests performed. Submit reports as soon as information is available. Also provide results from direct-reading instrumentation on the same day the samples are collected. Prepare and submit an Airborne Sampling Plan detailing the NIOSH 2003-154, Factory Mutual, or Underwriters Laboratories approved equipment, equipment calibration procedures, sampling methods, sampling to be performed, and analytical procedures to be used based on the type of work to be performed and anticipated toxic contaminants to be generated. Include the name of the accredited laboratory, listed by the American Industrial Hygiene Association (AIHA), that will be used to conduct the analysis of any collected air samples.

1.3.2.2 Medical Status

Prior to the start of work, and annually thereafter, submit a Report of Medical Status Records. This report will certify that Medical Status Records, in accordance with the requirements below are maintained for all required employees. The Contractor-maintained Medical Status Reports will document the medical evaluation of all employees working with or around paint systems, thinners, blast media, those required to wear respiratory protective equipment, and those who will be exposed to high noise levels for the particular type of exposure they may encounter. The Contractor-maintained Records must include the employee's name, the tests performed and the name of the physician responsible for performing the tests, and a physician's statement that medical status would permit specific task performance. Maintain medical records as required by 29 CFR 1910.20. The evaluation must include:

a. Audiometric testing and evaluation of employees who will work in a noise environment with a time weighted average greater than or equal to 85 dBA.

b. Vision screening of employees who will require eye protection (employees who use full-facepiece respirators cannot wear contact lenses).

c. Medical evaluation of employees who will be required to wear respiratory protection must include, but is not limited to, the following:

(1) Medical history including, but not limited to, alcohol use, with emphasis on liver, kidney, and pulmonary systems, and sensitivity to chemicals to be used on the job.

(2) General physical examination with emphasis on liver, kidney, and pulmonary system.

(3) Determination of the employee's physical and psychological ability to wear respiratory protective equipment and to perform job-related tasks.

(4) Determination of baseline values of biological indices for later comparison to changes associated with exposure to paint systems and thinners or blast media, which include: liver function tests to include SGOT, SGPT, GGPT, alkaline phosphates, bilirubin, complete urinalysis, EKG (employees over age 40), blood urea nitrogen (bun), serum creatinine, pulmonary function test, FVC, and FEV, chest x-ray (if medically indicated), blood lead and ZPP (for individuals where it is known there will be an exposure to materials containing lead), other criteria that may be deemed necessary by the Contractor's physician.

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NOTE: 29 CFR 1926.62 Lead requires the development of a Worker Protection Plan for jobs involving removal of lead-containing coatings. It is the specifier's responsibility for determining when lead-containing paint will be removed and requiring the appropriate submittals including environmental compliance, worker protection, and waste management.

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(5) For lead-based paint removal, prepare and submit a Worker Protection Plan in accordance with the requirements of 29 CFR 1926.62, addressing all necessary aspects of worker protection. The plan must include medical screening, activities emitting lead, means to achieve compliance, alternative technologies considered, air monitoring program, implementation schedule, work practice program, administrative controls, multi-Contractor site arrangements, and jobsite inspections.

1.3.2.3 Change in Medical Status

Any employee whose medical status has changed negatively due to work related chemical and/or physical agent exposure while working with or around paint systems and thinners, blast media, or other chemicals must be evaluated by a physician, and obtain a physicians statement as described in paragraph MEDICAL STATUS prior to allowing the employee to return to those work tasks. Maintain Change in Medical Status Records detailing any negative changes in employee medical status and the results of the physicians reevaluation statement. Submit a Change in Medical Status Report detailing the negative changes in medical status and a summary of the physician's reevaluation without including personal information of the impacted employee.

1.3.3 Environmental Protection

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NOTE: An Environmental Compliance Plan for jobs involving removal of lead-containing coatings serves to demonstrate the Contractor's strategy for protecting the environment and the public from lead exposure. Elements of this plan may be redundant with other submittals listed herein including the Water Quality Plan, Soil Quality Plan, Ambient Air Monitoring Plan, and Visible Emissions Monitoring Plan. These submittals may be required for other jobs which do not involve the removal of lead-containing paint. The Environmental Compliance Plan integrates these plans as well as other lead-specific elements.

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In addition to the requirements of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, prepare an Environmental Protection Plan incorporating the submittals for Water Quality Plan, Containment Plan, Waste Disposal Plan, Soil Quality Plan, TSP Monitoring Plan, PM-10 Monitoring Plan, and Visible Emissions Monitoring Plan. The submitted plan must also address all aspects of establishing and demarcating regulated areas, ventilation/containment system performance verification, and reporting of accidental releases. Comply with the following environmental protection criteria.

1.3.3.1 Waste Classification, Handling, and Disposal

Prepare and submit a Waste Disposal Plan in accordance with the requirements of 40 CFR 261 and 40 CFR 262 including classification and handling. The Contractor is responsible for assuring the proper disposal of all hazardous and nonhazardous waste generated during the project. Regardless of the results of 40 CFR 261 App II, Mtd 1311, all waste generated from abrasive blasting, lead-containing paints with recyclable steel or iron abrasives must be either disposed of as a hazardous waste or be stabilized with proprietary pre-blast additives . Where stabilization is preferred, employ a proprietary blast additive, that has been blended with the blast media prior to use. Place hazardous waste in properly labeled, closed containers shielded adequately to prevent dispersion of the waste by wind or water. Any evidence of improper storage is cause for immediate shutdown of the project until corrective action is taken. Store nonhazardous waste in closed containers separate from hazardous waste storage areas. Transport all hazardous waste by a licensed transporter in accordance with 40 CFR 263 and 49 CFR 171, Subchapter C. Transport all nonhazardous waste in accordance with local regulations regarding waste transportation. In addition to the number of copies required by 40 CFR 262.22, supply one copy of each Waste Manifest to the Contracting Officer prior to transportation.

1.3.3.2 Containment

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NOTE: It is the responsibility of the specifier to determine whether containment is required and if so, to specify it.

Specify the containment requirements using SSPC Guide 6. Where lead or other hazardous materials are present and abrasive blasting will be performed, specify either Class 1A or Class 2A containment.

Where Class 1A containment is specified, instrument verification of negative pressure should be required. Class 1A provides the greatest level environmental protection and should be specified in areas where high levels of lead are present and the work is in the vicinity of critical receptors (parks, schools, residences, or sensitive water sources). Class 2A containment is the most commonly specified level of containment for civil works structures in non-critical areas. Class 3A containment may provide an adequate degree of environmental protection for some lead-containing paint removal jobs, however, an adequate degree of worker protection may not be achievable under some circumstances.

Where lead or other hazardous materials are not present but abrasive blasting will be performed, specify Class 2A or 3A containment. Where the Contractor proposes to use a low-dusting recyclable abrasive such as steel grit, then the Contracting Officer should allow one class lower of containment. Classes 3A and 4A containment provide minimal control over emissions. Minimal control of emissions would be used in situations where critical receptors are not near the work site. Containment of dust producing abrasive blasting operations is recommended because of NAAQS for PM-10.

Where lead or other hazardous materials are present and power tool cleaning will be performed, specify Class 1P containment. Where the Contractor proposes to use vacuum-shrouded power tools then the Contracting Officer should allow their use with ground covers and/or free hanging tarpaulins. Classes 2P or 3P can be specified where the paint contains low-levels of lead, less than 1 percent. As an option the Contractor should be allowed to use vacuum shrouded power tools without additional protection. Containment is not generally specified for power tool removal of nonhazardous paint materials.

A Containment Plan should also be required for nonlead jobs where containment is specified.
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Prepare a Containment Plan for containing debris generated during paint removal operations. Include drawings, load-bearing capacity calculations, and wind load calculations. When the design is such that the spent abrasive is allowed to accumulate in quantities greater than 453 kg 1,000 pounds, and/or impart a significant wind load on the structure, have the drawings approved by a registered structural engineer. The drawings and calculations must be stamped with the engineer's seal. Also identify the type and placement of water booms, methods for anchoring the booms, and the procedures for removing debris. Contain debris generated during paint removal operations in accordance with the requirements of SSPC Guide 6, Class [_____]. Where required, verify the containment air pressure [by instrument] [visually].

1.3.3.3 Visible Emissions Monitoring

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NOTE: It is the responsibility of the specifier to determine whether monitoring of visible emissions will be required and if so, to specify the requirements. The 40 seconds in 1-hour, 75 seconds in 2-hours, and 1 percent daily visible emissions criteria should be invoked for all lead and other hazardous paint removal jobs. The 200 seconds in 1-hour, 300 seconds in 2-hours, and 5 percent daily visible emissions criteria should be called for on jobs where abrasive blasting will be used to remove nonhazardous paints. Visible emissions monitoring should not be specified for power tool removal of nonhazardous paints. See NOTE for paragraph CONTAINMENT above.

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Prepare a Visible Emissions Monitoring Plan including the provisions for halting work and correcting the containment in the event unacceptable emissions are observed. General statements must not be used; specific methods, procedures, and details are required. Measure the time of emissions in accordance with 40 CFR 60, App A, Mtd 22. Monitor visible emissions for not less than 15 minutes of every hour. Calculate visible emissions for each hour by extrapolation. Visible emissions must not extend greater than 45 m 150 feet in any direction horizontal from the containment. Visible emissions must not be observed in the area of any sensitive receptor. If such emissions occur shut down the job immediately and take corrective action. Notify the foreman whenever visible emissions exceed [40] [200] seconds in a 1 hour period. Whenever visible emissions exceed [75] [300] seconds in a 2 hour period notify the foreman, shut down the job, and take corrective action. If the total observed visible emissions from the containment exceeds [1] [5] percent of the work day, shut down the job and take corrective action to prevent such an occurrence. Document each time that the work is halted due to a violation of the visible emissions criteria. Documentation must include the cause for shutdown and the corrective action taken to resolve the problem.

1.3.3.4 PM-10 Monitoring

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NOTE: It is the specifier's responsibility to contact the local authorities and state Bureaus of Air Pollution Control to determine if PM-10 (particulate matter less than 10 microns in size) monitoring is required. If so, include paragraph PM-10 MONITORING PLAN. The National Ambient Air Quality Standard (NAAQS) for lead does not apply to lead paint removal. However, if the (NAAQS) requirement for lead [total suspended particulate (TSP) lead] is invoked by a State or Local governing body on lead paint removal projects, include paragraph TSP MONITORING. In either case, air monitoring should be modified to address the specific state or local regulations. TSP lead monitoring is recommended for all lead paint removal jobs even where not required. TSP lead monitoring

data is useful in determining the efficacy of containment. PM-10 monitoring is not recommended for lead or other paint removal jobs where it is not required. It is a generally accepted fact that if there is no TSP-Pb exceedance predicted by TSP monitoring then there will also not be a PM-10 exceedance. For this reason SSPC recommends that just TSP monitoring be performed on lead jobs.
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Prepare and submit a PM-10 Monitoring Plan for monitoring emissions of particulate matter 10 microns or less in size (PM-10) in compliance with the requirements of EPA regulation 40 CFR 50.6 and this paragraph. The plan must also include provisions for halting work and correcting the containment in the event unacceptable emissions occur. Position the air monitoring equipment in accordance with 40 CFR 58, App E, Subpart (8). In addition, a minimum of two PM-10 monitors must be used at the project site, one downwind from the project and one in the area of greatest public access (e.g., playground, school yard, or homeowner's yard). When the project is in an area where there are critical receptors nearby, monitoring must be conducted throughout the entire period that abrasive blasting and cleanup operations are performed. Otherwise, perform monitoring 4 of the first 8 days and on a regular basis thereafter for a sum total of 25 percent of the time surface preparation and debris cleanup are performed. If air quality regulatory limits are not met, take corrective actions and immediately repeat air monitoring. Conduct the preproject PM-10 monitoring a minimum of 2 weeks prior to the beginning of the project and continue for a minimum of 3 days to establish background levels. Submit a PM-10 Test Report to the Contracting Officer within 48 hours, that includes:

a. Name and location of jobsite.

b. Date of monitoring.

c. Time of monitoring (i.e., time monitoring begins and ends each day).

d. Identification and serial number of monitoring units.

e. Drawing showing specific location of monitoring units.

f. Drawing showing specific location of paint removal operation and the method of removal or work activity being performed.

g. Wind direction and velocity.

h. A flow chart verifying the rate of air flow across the filter throughout the sampling period.

i. Name and address of laboratory.

j. Laboratory test procedure.

k. Laboratory test results.

l. Signatures of field and laboratory technicians conducting the work.

1.3.3.5 TSP Monitoring

Prepare a TSP Monitoring Plan for monitoring emissions of Total Suspended

Particulates (TSP) in compliance with the requirements of EPA regulation 40 CFR 50.12 and this paragraph. The plan must include provisions for halting work and correcting the containment in the event unacceptable emissions occur. Position the air monitoring equipment in accordance with 40 CFR 58, App E, Subpart (8). A minimum of two TSP monitors must be used at the project site, one downwind from the project and one in the area of greatest public access (e.g. playground, school yard, or homeowner's yard). When the project is in an area where there are critical receptors nearby, TSP-lead monitoring must be conducted throughout the entire period that abrasive blasting and cleanup operations are performed. Otherwise, perform monitoring 4 of the first 8 days and on a regular basis thereafter for a sum total of 25 percent of the time surface preparation and debris cleanup are performed. If air quality regulatory limits are not met, require air monitoring to be repeated immediately after corrective actions have been taken. Also conduct preproject TSP monitoring. Conduct the preproject TSP monitoring a minimum of 2 weeks prior to the beginning of the project and continue the monitoring for a minimum of 3 days to establish background levels. Submit a TSP Test Report to the Contracting Officer within 48 hours including:

a. Name and location of jobsite.

b. Date of monitoring.

c. Time of monitoring (i.e., time monitoring begins and ends each day).

d. Identification and serial number of monitoring units.

e. Drawing showing specific location of monitoring units.

f. Drawing showing specific location of paint removal operation and the method of removal or work activity being performed.

g. Wind direction and velocity.

h. A flow chart verifying the rate of air flow across the filter throughout the sampling period.

i. Name and address of laboratory.

j. Laboratory test procedure.

k. Laboratory test results.

l. Signatures of field and laboratory technicians conducting the work.

1.3.3.6 Water Quality

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NOTE: If the work is proximate to storm sewers, rivers, bays, streams, or other bodies of water, include paragraph WATER QUALITY to prohibit contamination of the water from the project activities; otherwise delete paragraph WATER QUALITY. Modify if necessary to comply with State or local EPA requirements.

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Prepare a Water Quality Plan for all job sites where lead-containing or other hazardous paint will be removed, including provisions for halting work if spills or emissions are observed entering into bodies of water or found in areas where storm water runoff could carry the debris into bodies of water or storm sewers. The plan must also address cleanup and reporting procedures. Conduct operations in such a manner that lead-containing and other hazardous paint debris do not contaminate the water and so that NPDES permits in accordance with EPA regulation 40 CFR 122 are not required for the project. Any release of lead paint debris into the waterways having a reportable quantity of hazardous substance pursuant to Section 311 of the Clean Water Act, must be reported to the EPA in accordance with 40 CFR 117 and 40 CFR 355. The plan must require the thorough documentation of any release or spill that carries into waterways or storm sewers. Include the time and location of the release, amount of material released, actions taken to clean up the debris, amount of debris recovered, and corrective action taken to avoid a reoccurrence. Also report releases to the Coast Guard and other state and local authorities as appropriate. If the release is equivalent to 4.5 kg 10 pounds or more of lead-containing material in a 24-hour period, it is considered to be a reportable quantity under CERCLA. Comply with 40 CFR 302.

1.3.3.7 Soil Quality

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NOTE: If the work is near exposed ground (e.g., soil, sand, clay, etc.), include the requirements of paragraph SOIL QUALITY to assure that the ground is not contaminated by project activities. Contact the State or local EPA to determine if a specific soil contamination criteria exists. If so, modify this section accordingly.

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Prepare a Soil Quality Plan for all job sites where lead-containing or other hazardous paint will be removed. The plan must include provisions for halting the work should soil contamination occur, correcting the deficiencies responsible for the contamination, and provide procedures for removing and replacing contaminated soil. Establish and implement practices and procedures for preventing contamination of the soil from the removal of lead-containing or other hazardous paints. Unless otherwise directed by the Contracting Officer, soil is considered to have been contaminated by the Contractor's operation if an increase in the total lead content of 100 PPM or greater over background levels occurs. For purposes of computing the increase compute the mean background levels and the mean post-removal levels. The 100 PPM criteria is met if the difference between the means is less than 100 PPM plus the 95 percent confidence limit. Conduct soil sampling and testing prior to the beginning of the project and after the project is completed. Interim testing may also be performed in the event the Contractor or Contracting Officer wants to confirm that the containment system and work practices continue to provide satisfactory protection of the soil. Unless otherwise directed by the Contracting Officer, the following minimum test locations must be selected for soil analysis. Select two locations beneath or immediately adjacent to the structure being prepared. Take additional samples within 30 m 100 feet in each direction of the project (i.e., N, S, E, W) in which soil is present. The number of soil sample locations must be sufficient to adequately characterize the soil contaminant levels within and around the project area. Collect five composite samples at each location. Each of the five samples must be comprised of five individual plugs of soil combined in a single bag. Use the following procedure to collect the composite samples:

a. Place a 0.093 square m 1-square foot template at each location.

b. Remove a sample of soil 19 mm 3/4 inch in diameter and 13 mm 1/2 inch in depth at the center of the template and at each of the four corners. Place the five soil plugs into a single bag. This represents one of the three samples to be removed at a given location.

c. Move the template 25 mm 1 inch in any direction and repeat the process to collect the second sample. Place all plugs in a separate bag. Move the template 5 mm 1 inch farther to collect the third sample.

d. Identify each sample bag with the date, specific location of the sample, name and signature of the sampling technician, and complete chain of custody records.

e. It is critical that the specific location of each sample be thoroughly measured and documented as the final project testing (and any interim testing) must be sampled in the precise locations.

Analyze three samples collected at each location. One of the remaining two samples is to be maintained by the Contractor for the duration of the project and the other by the Contracting Officer in the event reanalysis is required. Analyze lead-containing samples in accordance with EPA testing guidance as published in 40 CFR 261, App III, by a laboratory listed by the American Industrial Hygiene Association (AIHA) as being proficient in conducting the test. Note that if it is determined that contamination of the soil has occurred as a result of the paint removal operations, TCLP testing must be employed to determine if the soil must be handled and disposed of as a hazardous waste. The initial sampling of the soil for total lead content does not establish whether the soil will be considered hazardous by TCLP testing. As a result, at the Contractor's option, additional prework soil samples may be removed (minimum of 105 grams is required for a single test at each site) to conduct TCLP testing to establish whether the soil would be classified as hazardous prior to project startup. In the event that there is a release of lead paint debris onto the soil and if the release is 4.5 kg 10 pounds or more of lead-containing material in a 24-hour period, it is considered to be a reportable quantity under CERCLA. Comply with 40 CFR 302. Thoroughly document the occurrence of any spills of lead debris into the soil. The documentation must include the time and location of the release, amount of material released, actions taken to clean up the debris, amount of debris reclaimed, and corrective action taken to avoid a reoccurrence. Provide the documentation to the Contracting Officer including the Soil Quality Test Report with results of the prework and post work soil quality tests.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item,

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Safety, Health, and Environmental Requirements; G, [_____]

Accident Prevention Plan; G, [_____]

Confined Spaces Plan; G, [_____]

Respiratory Protection Plan; G, [_____]

Airborne Sampling Plan; G, [_____]

Ventilation Assessment Plan; G, [_____]

Medical Surveillance Plan; G, [_____]

Worker Protection Plan; G, [_____]

Environmental Protection Plan; G, [_____]

Waste Manifest

Waste Disposal Plan; G, [_____]

Containment Plan; G, [_____]

Visible Emissions Monitoring Plan; G, [_____]

PM-10 Monitoring Plan; G, [_____]

TSP Monitoring Plan; G, [_____]

Water Quality Plan; G, [_____]

Soil Quality Plan; G, [_____]

SD-03 Product Data

Manufacturer's Safety Data Sheet; G, [_____]

SD-04 Samples

Product Samples; G, [_____]

Special Paint Formulas; G, [_____]

Solvent and Thinners; G, [_____]

SD-06 Test Reports

PM-10 Test Report

TSP Test Report

Soil Quality Test Report

Inspection Reports

Medical Status Records

Change in Medical Status Report

Air Monitoring Test Plan; G, [_____]

Air Monitoring Test Report

SD-07 Certificates

Certified EHS Professional

Certified Lead Laboratory

SSPC [QP 1][QP-2][QP-3] Certificate; G, [_____]

Qualified Hazardous Paint Removal Contractor; G, [_____]

Coating Thickness Gage Qualification

Qualified Coating Applicator; G, [_____]

1.5 QUALIFICATIONS

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NOTE: USACE has identified an ongoing problem throughout the districts regarding poor paint performance due to unqualified contractors and/or unskilled painters. Districts can require Contractor certification by requiring industry

certification by SSPC: THE SOCIETY FOR PROTECTIVE COATINGS (SSPC-QP1, QP2, or QP3). While there are some industry certification programs for painters, none include the application of fast drying coatings such as the vinyl systems in this document.Guidance for attaining better and more economical paint jobs is provided in EM 1110-2-3400. Any consulting in reference to this guide specification or painting problems in general should be directed to the Paint Technology Center, U.S. Army Construction Engineering Research Laboratory, ATTN: CEERDC-CF-M, Champaign, IL; e-mail: paint@usace.army.mil; Phone: 217-373-7486.

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Qualifications and experience must comply with the following.

1.5.1 Certified Environmental, Health, and Safety (EHS) Professionals

Provide a certificate for each Certified EHS Professional; submit qualifications and experience of qualified and competent persons employed to provide preconstruction and onsite environmental, safety, and health services. Obtain acceptance of this submission prior to the submission of other required environmental, safety, and health submittal items. Utilize a qualified and competent person as defined in EM 385-1-1, Section 01 to develop the required safety and health submittal and to provide onsite safety and health services during the contract period. The person must be a Certified Industrial Hygienist (CIH), an Industrial Hygienist (IH), or a Certified Safety Professional (CSP) with a minimum of 3 years of demonstrated experience in similar related work. The CIH, IH, or CSP may utilize other qualified and competent persons, as defined in EM 385-1-1, to conduct on-site safety and health activities as long as these persons have a minimum of 2 years of demonstrated experience in similar related work and are under the direct supervision of the CIH, IH, or CSP. For lead containing jobsites, the competent and qualified person must have successfully completed an EPA or state accredited lead-based paint abatement Supervisor course specific to the work to be performed and possess current and valid state and/or local government certification, as required.

1.5.2 Certified Lead Laboratory

Provide documentation which includes the name, address, and telephone number of the laboratories to be providing services. In addition, the documentation must indicate that each laboratory is an EPA National Lead Laboratory Accreditation Program (NLLAP) accredited laboratory and that each is rated proficient in the NIOSH/EPA Environmental Lead Proficiency Analytical Testing Program (ELPAT) and will document the date of current accreditation. Certification must include accreditation for heavy metal analysis, list of experience relevant to analysis of lead in air, and a Quality Assurance and Quality Control Program. Submit a certificate for the Certified Lead Laboratory.

[1.5.3 Qualified Painting Contractor

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NOTE: The specifier should decide whether the work is of sufficient complexity or size that the use of a Qualified Painting Contractor is warranted. In

general, very large jobs of moderate complexity or small but very complex painting work should be performed by a Qualified Painting Contractor. Very complex work includes steel structures that will be painted and exposed in immersion. Large jobs are work where more than 9300 square m 100,000 square feet will be painted. SSPC utilizes an independent third party auditing firm to evaluate and certify painting Contractors for compliance with various types of work: QP-1 is for Field Application to Complex Structures; QP-2 requires QP-1 certification plus the ability to remove hazardous paint; QP-3 evaluates Shop Painting contractors. Lists of qualified Contractors are provided on the SSPC website at sspc.org. The designer may visit the site to determine the availability of qualified contractors in the project area.

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The Painting Contractor must be a certified SSPC QP 1 Painting Contractor. Submit a copy of the applicable SSPC [QP-1][QP-2][QP-3] Certificate. The contractor must have been certified prior to award of this contract and must remain certified for the duration of this contract. Certifications scheduled to expire during the contract performance period must be renewed and submitted to the Contracting Officer prior to expiration.

][1.5.4 Qualified Hazardous Paint Removal Contractor

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NOTE: The specifier should decide whether the work is of a nature such that the use of a Qualified Hazardous Paint Removal Contractor is warranted. A Qualified Hazardous Paint Removal Contractor is recommended for jobs involving more than the incidental removal of lead-containing paints. A qualified Contractor is not generally recommended for jobs where the lead paint contains low levels of lead, less than 1 percent. The risk of worker overexposure and environmental contamination is still significant for such jobs, but not to the extent necessary to warrant a certified hazardous paint removal Contractor. SSPC utilizes an independent third party auditing firm to evaluate and certify painting Contractors for compliance with Qualification Procedure SSPC QP 2, Standard Procedure for Evaluating The Qualifications of Painting Contractors To Remove Hazardous Paint. QP 2 provides two categories of qualification based on the level of containment. Category A qualifies the Contractor for work requiring a containment Class 1A or 2A - recommended classes for most Corps lead removal projects. Category B is for work in classes of containment with lesser requirements.

The specifier should select the necessary qualification category. The QP 2 certification is an extension of QP 1 certification. QP 2 certification should also be considered by the specifier for removal of other toxic paints such as

those that contain hexavalent chromium or cadmium. Lists of qualified Contractors are provided on the SSPC website at sspc.org. The designer may visit the site to determine the availability of qualified contractors in the project area.

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The Painting Contractor must be a certified SSPC QP 2 [Category A] [Category B] Painting Contractor for all surface preparation or coating application. Submit a copy of the applicable SSPC Certificate. The contractor must have been certified prior to award of this contract and must remain certified for the duration of this contract. Submit all renewals if they occur during the contract performance period. Renewals must be achieved prior expirations occurring.

][1.5.5 Qualified Shop Painting Contractor

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NOTE: The specifier should decide whether the work is of sufficient complexity or size that the use of a Qualified Shop Painting Contractor is warranted. In general, large jobs of moderate complexity or small but very complex painting work that may be performed in a shop should be performed by a Qualified Shop Painting Contractor. Shops having the certification are typically dedicated painting shops; typical fabricating shops are generally not certified. Lists of qualified Contractors are provided on the SSPC website at sspc.org. The designer may visit the site to determine the availability of qualified contractors in the project area.

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The Painting Contractor must be a certified SSPC QP 3 Painting Contractor for all off-site surface preparation or coating application. Submit a copy of the applicable SSPC Certificates. The contractor must have been certified prior to award of this contract and must remain certified for the duration of this contract. Submit all renewals if they occur during the contract performance period. Renewals must be achieved prior expirations occurring.

][1.5.6 Qualified Coating Applicator

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NOTE: The specifier should decide whether the work is of sufficient complexity or size that the use of Qualified Coating Applicators is warranted. In general, very large jobs of moderate complexity or small but very complex painting work should be performed by applicators who have shown they have the ability to apply the specified coating system. Very complex work includes steel structures that will be painted and exposed in immersion. Large jobs are work where more than 9300 square m 100,000 square feet will be painted. Application of vinyl coating systems using conventional spray equipment frequently justifies the qualification of applicators. Applicators typically have more

experience in the application of slower drying coatings such as epoxies and urethanes and use of airless spray equipment. This paragraph may also be modified replacing the panel described in ASTM D4228 with a selected area of the structure under contract.
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Submit records of qualification tests for each Qualified Coating Applicator. Prior to the initiation of any work all coating applicators must be tested and certified as meeting the requirements of ASTM D4228. Certification must be administered by an authorized government representative. Applicators failing the certification procedure will not be permitted to apply any paint on the project.

1.5.6.1 Certification Test Procedure

Conduct certification testing of coating applicators at the job site in coordination with the Contracting Officer. Supply the fabricated test plates to be used for the tests and provide crane service, rigging, and any other work necessary to provide accessibility for the certification testing and inspection. The test plate must be painted in a near vertical position. In preparation, clean and prepare the test plate in accordance with the requirements of the contracted work. Perform abrasive blasting with the blast media to be used in the contract. The paints to be applied are Contractor supplied materials and are those previously tested and approved for use on the contract. Paints must be applied as specified in this contract. The painter being tested must mix and thin the paints to be used in the test and set up and adjust the application equipment for use. Each painter must apply each of the types of paint comprising the specified system. The contractor's QC inspector must be present during the procedure to monitor the actions of the painter being tested.

1.5.6.2 Certification Criteria

Evaluate the paint applicator based on the conformance of the applied paint system to the requirements of this specification. Deficiencies in the coatings, improper mixing or improper application methods are basis for failure. The authorized Government Representative is the sole judge as to the acceptability of each coating applicator's performance.

]1.5.7 Coating Thickness Gage Qualification

Submit Coating Thickness Gage Qualification documentation of manufacturer's certification for all coating thickness gages. Use magnetic flux thickness gages as described in ASTM D7091 to make all coating thickness measurements on ferrous metal substrates. Use eddy current thickness gages as described in ASTM D7091 to measure coating thickness on all nonferrous metal substrates. Gages to be used on the job must have an accuracy of 3 percent or better and be certified by the manufacturer as meeting this requirement.

1.5.8 Certified Coating Inspector

Provide a certified coating inspector who is listed as either SSPC-PCI Level 2, or NACE CIP Level 2 for all surface preparation and painting activities. Submit a copy of the applicable SSPC or NACE Certificates. Submit all renewals if they occur during the contract performance period. Renewals must be achieved prior expirations occurring.

1.6 DELIVERY, STORAGE, AND HANDLING

Process and package paints to ensure that within a period of one year from date of manufacture, they will not gel, liver, or thicken deleteriously, or form gas in the closed container. Paints, unless otherwise specified or permitted, must be packaged in standard containers not larger than 20 L 5 gal, with removable friction or lug-type covers. Containers for vinyl-type paints must be lined with a coating resistant to solvents in the formulations and capable of effectively isolating the paint from contact with the metal container. Each container of paint or separately packaged component thereof must be labeled to indicate the purchaser's order number, date of manufacture, manufacturer's batch number, quantity, color, component identification and designated name, and formula or specification number of the paint together with special labeling instructions, when specified. Paint must be delivered to the job in unbroken containers. Paints that can be harmed by exposure to cold weather must be stored in ventilated, heated shelters. All paints must be stored under cover from the elements and in locations free from sparks and flames.

1.7 AMBIENT CONDITIONS

Paint must be applied in accordance with the manufacturers written instructions or to the special requirements contained herein. Surfaces that are less than 2.8 degrees C 5 degrees F above the dew point temperature must be monitored closely to assure that are completely free of moisture as determined by sight and touch. Paint must not be applied to surfaces upon which there is detectable frost or ice. Except as otherwise specified, paint must not be applied if the temperature of the surfaces to be painted and of air in contact therewith is less than 9 degrees C 45 degrees F during paint application nor if the surfaces can be expected to drop to 0 degrees C 32 degrees F or lower before the film has dried to a reasonably firm condition. During periods of inclement weather, painting may be continued by enclosing the surfaces and utilizing climate control equipment (e.g. dehumidification, heaters, etc.), provided the minimum temperatures and surface dryness requirements prescribed previously are maintained. Paint must not be applied to surfaces heated by direct sunlight or other sources to temperatures that will cause detrimental blistering, pinholing, or porosity of the film.

PART 2 PRODUCTS

2.1 PRODUCT SAMPLES

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NOTE: US Army Construction Engineering Research Laboratory provides paint testing services on a reimbursable basis. Allowing 30 days for testing of Special Formulation and Military Specification paints is sufficient. Complete testing commercial products submitted to meet SSPC requirements may take in excess of 6 months - the Contracting Officer may wish to discuss options with the Laboratory. Products listed on the MPI web site do not need further testing. Testing costs vary based on the type of paint. Specifier should contact ERDC-CERL for cost of testing. (E-mail:) Samples may be submitted to US Army ERDC-CERL, ATTN: Paint Laboratory, 2902 Newmark Drive, Champaign, IL 61822. Requiring the contractor to submit samples

directly to the laboratory saves time and avoids problems associated with shipment of hazardous materials.
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Submit product samples of each batch of thinner, solvent, and paint to the Government for testing. Submit manufacturer's Safety Data Sheet (SDS) for each type of paint used; for products that are specified to be applied in accordance with the manufacturer's recommendations, submit the paint manufacturer's product data sheet (PDS) or other written instructions for those products. Allow at least 30 days from time of delivery to the contracting officer for testing of samples of paints and thinners. Sampling may be at the jobsite or source of supply. Coordinate sampling and submission of all samples of paint and thinner with the Contracting Officer. Standard sample size for liquid paints and thinners is 1 L 1-quart; powders and other additives for multi component paints may be of appropriately smaller size. The sample must be labeled to indicate formula or specification number and nomenclature, batch number, batch quantity, color, date made, and applicable project contract number. Testing will be performed by the Government. Costs for retesting rejected material will be deducted from payments to the Contractor at the rate of [_____] dollars for each paint sample retested and [_____] dollars for each thinner retested.

2.2 SPECIAL PAINT FORMULAS

Special paints must have the composition as indicated in the formulas listed herein. Where so specified, package paint formulation components in separate containers for mixing on the job. If not specified or otherwise prescribed, the color must be that naturally obtained from the required pigmentation.

2.3 PAINT FORMULATIONS

Special paint formulas must comply with the following:

2.3.1 Formula V-102E

This formula is for Vinyl-Type Ready-Mixed Aluminum Impacted Immersion Coating, the ingredients are shown below.

INGREDIENTS	PERCENT BY MASS
Vinyl Resin, Type 3	18.2
Aluminum Powder	8.3
Plasticizer	3.1
Methyl Isobutyl Ketone (MIBK)	33.8
Toluene	36.6
Total	100.0

a. Furnish the paint with the aluminum pigment mixed into the vehicle.

b. The finished paint must show the proper proportions of specified materials when analyzed by chromatographic and/or spectrophotometric methods, and have a viscosity between 60 and 90 seconds using ASTM D1200 and a No. 4 Ford cup.

2.3.2 Formula V-103C

This formula is for Vinyl-Type Black-Finish Impacted Immersion Coating, the ingredients are shown below.

INGREDIENTS	PERCENT BY MASS
Vinyl Resin, Type 3	20.0
Carbon Black	1.5
Plasticizer	3.4
Methyl Isobutyl Ketone (MIBK)	36.0
Toluene	39.1
Total	100

a. Disperse the carbon black to a fineness of grind ASTM D1210 of not less than 7 on the Hegman scale. A paste composed of carbon black milled into a Type 3 vinyl resin dissolved in an appropriate solvent may be used provided the finished product has the specification composition and grind. Material must be free from seeding, gelling, and other deleterious effects. No grinding aids, antisettling agents, or any other materials except those shown in the formula will be permitted.

b. The finished paint must show the proper proportions of specified materials when analyzed by chromatographic and/or spectrophotometric methods, and have a viscosity between 60 and 90 seconds using ASTM D1200 and a No. 4 Ford cup.

2.3.3 Formula V-106D

This formula is for Vinyl-Type Red Oxide (Light or Dark Color) Impacted Immersion Coating, the ingredients are shown below.

INGREDIENTS	PERCENT BY MASS
Vinyl Resin, Type 3	5.50
Vinyl Resin, Type 4	11.20
Synthetic Iron Oxide (Red) (Light or Dark Color)	15.80
Plasticizer	2.90
Methyl Isobutyl Ketone	31.00
Toluene	33.54

INGREDIENTS	PERCENT BY MASS
Propylene Oxide	0.06
Total	100.00

a. Disperse the pigment by means of pebble mills or other approved methods to produce a fineness of grind (ASTM D1210) of not less than 7 on the Hegman scale. Grinding in steel-lined or steel-ball mills will not be permitted. No grinding aids, antisettling agents, or any other materials, other than those listed in the formula, will be permitted.

b. The finished paint must show the proper proportions of specified materials when analyzed by chromatographic and/or spectrophotometric methods, and have a viscosity between 60 and 90 seconds using ASTM D1200 and a No. 4 Ford cup.

c. Furnish the paint in two colors which are obtained by the alternative use of synthetic red iron oxide pigments of different shade. The dark paint must reasonably approximate color 10076 of SAE AMS-STD-595A, and light colored paint must be readily distinguishable in the field from the dark. Furnish the two shades in the volume ratio designated by the purchaser.

2.3.4 Formula VZ-108D

This formula is for Vinyl-Type Zinc-Rich Impacted Immersion Coating, the ingredients are shown below.

INGREDIENTS	PERCENT BY WEIGHT	KILOGRAMSPOUNDS	LITERSGALLONS
COMPONENT A			
Vinyl Resin, Type 3	16.6	49.5109.2	36.539.65
Methyl Isobutyl Ketone	80.6	239.9528.9	300.1879.30
Suspending Agent E	0.7	2.14.6	1.060.28
Suspending Agent F	0.4	1.22.7	0.720.19
Methanol	0.5	1.53.3	1.890.50
Synthetic Iron Oxide (Red)	1.2	3.67.9	0.720.19
Total	100.0	297.8656.6	341.1090.11
COMPONENT B			
Silane B	100.0	1.84.1	1.780.47
COMPONENT C			
Zinc Dust	100.0	249.5550.0	35.669.42

INGREDIENTS	PERCENT BY WEIGHT	KILOGRAMSPOUNDS	LITERSGALLONS
		Total Volume	378.54100.00 (mixed paint)

a. Disperse the iron oxide and suspending agents into the vehicle (Component A) to a fineness of grind of not less than 4 on the Hegman scale (ASTM D1210). Grinding in steel-lined containers or using steel-grinding media will not be permitted. The paint must show the proper proportions of specified materials when analyzed by chromatographic and/or spectrophotometric methods. The sole purpose of the iron oxide pigment is to produce a contrasting color. A red iron oxide-type 3 vinyl resin vehicle paste may be used in place of dry iron oxide provided compensating adjustments are made in the additions of Type 3 resin and methyl isobutyl ketone. The finished product with zinc dust added must produce a paint which has a red tone upon drying and a reflectance of not more than 16 (ASTM E1347).

b. Supply VZ-108D paint as a kit. Each kit must consist of 17 L 4.5 gal (15 kg 33.1 pounds) of Component A in a 20 L 5-gallon lug closure type pail, 12 kg 27.5 pounds of zinc dust (Component C) packaged in a 4 L 1-gal plastic pail, and 89 mL 3 fluid ounces of silane (Component B) packaged in a glass bottle of suitable size having a polyethylene lined cap. Place the bottle of silane on the zinc dust in the 4 L 1-gal pail. In addition to standard labeling requirements, identify each container of each component as to component type. Each container label of Component A must carry the following: MIXING AND APPLICATION INSTRUCTIONS: WARNING - THIS PAINT WILL NOT ADHERE TO STEEL SURFACES UNLESS COMPONENT B IS ADDED. Remove the 89 mL 3 ounces of bottled Component B (silane) from the Component C (zinc dust) container and add to the base paint Component A) with thorough stirring. Then sift the zinc dust into the base paint while it is being vigorously agitated with a power-driven stirrer and continue the stirring until the zinc dust has been dispersed. At some point strain the mixed paint through a 30-60 mesh screen to prevent zinc dust slugs from reaching the spray gun nozzle. Stir the paint continuously during application at a rate that will prevent settling. If spraying is interrupted for longer than 15 minutes, vigorously whip the entire length of the hose to redisperse the zinc. If the spraying is to be interrupted for more than 1 hour, empty the hose by blowing the paint back into the paint pot. Thinning will not normally be required when ambient temperatures are below about 26 degrees C 80 degrees F, but when the ambient and steel temperatures are higher, methyl isoamyl ketone (MIAK) or methyl isobutyl ketone (MIBK) should be used. If paint is kept covered at all times, its pot life will be about 8 days.

2.3.5 Formula V-766E

This formula is for Vinyl-Type White (or Gray) Impacted Immersion Coating, the ingredients are shown below.

INGREDIENTS	PERCENT BY MASS
Vinyl Resin, Type 3	5.6

INGREDIENTS	PERCENT BY MASS
Vinyl Resin, Type 4	11.6
Titanium Dioxide and (for Gray) Carbon Black	13.0
Plasticizer	2.9
Methyl Isobutyl Ketone	32.0
Toluene	34.7
Ortho-Phosphoric Acid	0.2
Total	100.0

a. Disperse the pigment by means of pebble mills or other approved methods to produce a fineness of grind (ASTM D1210) of not less than 7 on the Hegman scale. Grinding in steel-lined or steel-ball mills will not be permitted. No grinding aids, antisettling agents, or any other materials except those shown in the formula will be permitted. Measure the ortho-phosphoric acid accurately and dilute it with at least four parts of ketone to one part of acid. Add it slowly into the finished paint with constant and thorough agitation.

b. The finished paint must show the proper proportions of specified materials when analyzed by chromatographic and/or spectrophotometric methods, and have a viscosity between 60 and 90 seconds using ASTM D1200 and a No. 4 Ford cup.

c. Furnish the white and gray paints in the volume ratio designated by the purchaser. The gray paint must contain no pigments other than those specified. Include enough carbon black to produce a dry paint film having a reflectance of 20-24 (ASTM E1347). The resulting gray color must approximate color 26231 of SAE AMS-STD-595A.

2.3.6 Formula C-200A, Coal Tar-Epoxy (Black) Paint

The paint must conform to SSPC Paint 16 manufactured with Type 1 pitch. In addition to standard labeling, container labels must include the term, Corps of Engineers Formula C-200A.

2.4 INGREDIENTS FOR SPECIAL PAINT FORMULAS

The following ingredient materials and thinners apply only to those special paints whose formulas are shown above in detail.

2.4.1 Pigments and Suspending Agents

2.4.1.1 Aluminum Powder

For vinyl paint aluminum powder must conform to ASTM D962, Type 1, Class B.

2.4.1.2 Carbon Black

Carbon black must conform to ASTM D561, Type I or II.

2.4.1.3 Zinc Dust

Zinc dust pigment must conform to ASTM D520, Type II.

2.4.1.4 Iron Oxide

Iron oxide, (Dry) synthetic (red), must conform to ASTM D3721. In addition, the pigment must have a maximum oil absorption of 24 and a specific gravity of 4.90 to 5.20 when tested in accordance with ASTM D281 and ASTM D153, Method A, respectively. When the pigment is dispersed into specified vinyl paint formulation, the paint must have color approximating SAE AMS-STD-595A color 10076 (dark red paint), and show no evidence of incompatibility or reaction between pigment and other components after 6 months storage.

2.4.1.5 Titanium Dioxide

Titanium dioxide in vinyl paint Formula V-766E must be one of the following: Kronos 2160 or 2101, Kronos, Inc.; Ti-Pure R-960, E.I. Dupont DeNemours and Co., Inc.

2.4.1.6 Suspending Agent E

Suspending Agent E must be a light cream colored finely divided powder having a specific gravity of 2 to 2.3. It must be an organic derivative of magnesium aluminum silicate mineral capable of minimizing the tendency of zinc dust to settle hard without increasing the viscosity of the paint appreciably. M-P-A-14, produced by Elementis Specialties, has these properties.

2.4.1.7 Suspending Agent F

Suspending Agent F must be a light cream colored finely divided powder having a specific gravity of approximately 1.8. It must be an organic derivative of a special montmorillonite (trialkylaryl ammonium hectorite). Bentone 27, produced by Elementis Specialties, has these properties.

2.4.2 Resins, Plasticizer, and Catalyst

2.4.2.1 Plasticizer

The plasticizer must be either Di 2-propyl Heptyl Phthalate (DPHP) or Diisodecyl Phthalate (DIDP). DPHP must have an ester content of not less than 99.5 percent (ASTM D3465), must contain not more than 0.1 percent water, and must have an acid number (ASTM D1045) of not more than 0.07.DIDP must have a purity of not less than 99.0 percent, must contain not more than 0.1 percent water, and must have an acid number (ASTM D1045) of not more than 0.10.

2.4.2.2 Vinyl Resin, Type 3

Vinyl resin, Type 3, must be a vinyl chloride-acetate copolymer of medium average molecular weight produced by a solution polymerization process and must contain (by weight) 85 +/- 1.0 percent vinyl chloride and 15 +/- 1.0 percent vinyl acetate by weight. The resin must have film-forming properties and must, in specified formulations, produce results equal to Vinnol H 15/50, as manufactured by Wacker Chemie AG.

2.4.2.3 Vinyl Resin, Type 4

Vinyl resin, Type 4, must be a vinyl chloride-acetate type produced by a solution polymerization process, must contain 1 percent interpolymerized dicarbonic acid, 84 +/- 1.0 percent vinyl chloride, and 15 +/- 1.0 percent vinyl acetate. The resin must have film-forming properties and must, in the specified formulations, produce results equal to Vinnol H 15/45 M, as manufactured by Wacker Chemie AG.

2.4.2.4 Ortho-phosphoric Acid

Ortho-phosphoric acid must be a chemically pure 85-percent grade.

2.4.3 Solvent and Thinners

2.4.3.1 Methanol

Methanol (methyl alcohol) must conform to ASTM D1152.

2.4.3.2 Methyl Ethyl Ketone

Methyl ethyl ketone (MEK) must conform to ASTM D740.

2.4.3.3 Methyl Isobutyl Ketone

Methyl isobutyl ketone (MIBK) must conform to ASTM D1153.

2.4.3.4 Methyl Isoamyl Ketone

Methyl isoamyl ketone (MIAK) must conform to ASTM D2917.

2.4.3.5 Toluene

Toluene must conform to ASTM D841.

2.4.4 Silane B

Silane B for Formula VZ-108D must be N-beta-(aminoethyl)-gamma-aminopropyltrimethoxy silane. Silquest A-1120, produced by Momentive Performance Materials Inc., and Silane Z-6020, produced by Dow Corning Corporation, are products of this type.

2.4.5 Propylene Oxide

Propylene oxide must be a commercially pure product suitable for the intended use.

2.5 TESTING

2.5.1 Chromatographic Analysis

Solvents in vinyl paints and thinners are subject to analysis by programmed temperature gas chromatographic methods and/or spectrophotometric methods, employing the same techniques that give reproducible results on prepared control samples known to meet the specifications. If the solvent being analyzed is of the type consisting primarily of a single chemical compound or a mixture or two or more such solvents, interpretation of the test results must take cognizance of the degree of purity of the individual solvents as commercially produced for the paint industry.

2.5.2 Vinyl Paints

Vinyl paints are subject to the following adhesion test. When V-766 or V-106 formulations are tested, spray apply 125 to 175 microns 5 to 7 mils (dry) to mild steel panels. The steel panels must be essentially free of oil or other contaminants that may interfere with coating adhesion and be dry blast cleaned to a White Metal grade in compliance with SSPC SP 5/NACE No. 1. The surface must have an angular profile of 50 to 63 microns 2.0 to 2.5 mils as measured by ASTM D4417, Method C. When V-102 or V-103 formulations are tested, spray apply the product over 38 to 63 microns 1.5 to 2.5 mils (dry) of V-766 or V-106 known to pass this test. When VZ-108 is tested, the coating must be mixed in its proper proportions and then spray applied to a dry film thickness of 38 to 63 microns 1.5 to 2.5 mils above the blast profile. The VZ-108 must be top coated with a V-766 known to pass this test. In all cases, the complete system must have a total dry film thickness of 125 to 175 microns 5 to 7 mils above the blast profile. After being air dried for 2 hours at room temperature, dry the panel in a vertical position for 16 hours at 50 degrees C 120 degrees F. After cooling for 1 hour, immerse the panel in tap water at 30 to 32 degrees C 85 to 90 degrees F for 48 to 72 hours. Immediately upon removal, dry the panel with soft cloth and examine for adhesion as follows: With a pocket knife or other suitable instrument, make two parallel cuts at least 25 mm 1 inch long, 6 to 10 mm 1/4 to 3/8 inch apart through the paint film to the steel surface. Make a third cut perpendicular to and passing through the end of the first two. With the tip of the knife blade, loosen the film from the panel from the third cut between the parallel cuts for a distance of 3 to 6 mm 1/8 to 1/4 inch. With the panel being held horizontally, grasp the free end of the paint film between the thumb and forefinger and pulled vertically in an attempt to remove the film as a strip from between the first two cuts. Remove the strip of paint film at a rate of approximately 2 mm 1/10 inch per second and maintaining it in a vertical position during the process of removal. The adhesion is acceptable if the strip of paint breaks when pulled or if the strip elongates a minimum of 10 percent during its removal. Paints not intended to be self-priming must not exhibit any delamination from the primer.

PART 3 EXECUTION

3.1 CLEANING AND PREPARATION OF SURFACES TO BE PAINTED

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NOTE: Although this section is primarily intended for new construction, surface preparation for maintenance painting is closely related; therefore this guide specification may be used for maintenance painting. For further guidance, see EM 1110-2-3400.

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3.1.1 General Requirements

Clean surfaces to be painted before applying paint or surface treatments. Remove deposits of grease or oil in accordance with SSPC SP 1, prior to mechanical cleaning. Perform solvent cleaning with mineral spirits or other low toxicity solvents having a flash point above 38 degrees C 100 degrees F. Use clean cloths and clean fluids to avoid leaving a thin film of greasy residue on the surfaces being cleaned. Protect items not to be prepared or coated from damage by the surface preparation methods. Protect machinery and electrical components against entry of blast abrasive and dust into working parts. Program cleaning and painting such that dust or other contaminants from the cleaning process do not fall on wet, newly painted surfaces. Protect surfaces not intended to be painted from the effects of cleaning and painting operations. Conduct welding of, or in the vicinity of, previously painted surfaces in a manner to prevent weld spatter from striking the paint and to otherwise reduce coating damage to a minimum. Restore any paint damaged by welding operations to original condition. Surfaces to be painted that will be inaccessible after construction, erection, or installation operations are completed must be painted before they become inaccessible.

3.1.2 Ferrous Surfaces Subject to Atmospheric Exposures

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NOTE A: The option of power tool cleaning or brush-off blast cleaning is intended to be the Contractor's choice and should be retained in project specifications. It is the intention of this Note and the following paragraphs to distinguish between the type of surface preparation necessary for normal atmospheric exposure and for severe exposure conditions such as fresh and saltwater immersion, abrasion, etc.

Experience has shown that high-grade blast cleaning is generally unnecessary to obtain an adequate paint job on structural steel surfaces that will be subject only to ordinary atmospheric exposure, provided that primers are used that have the ability to effectively wet the surfaces and penetrate to base metal beneath the edges of semi-adherent mill scale as well as through the residual and tightly adherent rust that is always present to some extent when methods short of very thorough blast cleaning are employed. Shop cleaning and priming of steel that is not required to be thoroughly blast cleaned reduces unnecessary breakdown of the mill scale and attendant rusting of the surfaces.

Weathering steel may be painted if desired using the same surface preparation and coating systems as used for mild steel.

For jobs where existing coatings, including lead-based paints, will be completely removed the specifier should select Commercial Blast Cleaning (SP 6). This recommendation applies to Paint Systems No. 1 and 23 (series).

This paragraph requires rounding of sharp edges. Rounding is desirable because paint pulls thin on sharp edges resulting in early rusting. This requirement may result in significant cost when the structure is severely corroded or pitted.

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Clean ferrous surfaces that are to be continuously in exterior or interior atmospheric exposure and other surfaces as directed by means of [power tools or by dry blasting to the brush-off grade] [dry blasting to a commercial grade]. Perform cleaning and priming in the shop unless otherwise directed or permitted. [Conduct power tool cleaning in conformance with the requirements of SSPC SP 3.] [Conduct brush-off blast cleaning in conformance with the requirements of SSPC 7/NACE No.4.] [Conduct commercial blast cleaning in conformance with the requirements of SSPC SP 6/NACE No.3.] Clean welds and adjoining surfaces within a few inches (centimeters) of weld flux, spatter, and other harmful deposits by blasting, power impact tools, power wire brush, or such combination of these and other methods as may be necessary for complete removal of each type of deposit. The combination of cleaning methods need not include blasting when preparation of the overall surfaces is carried out by the power tool method; however, brush scrubbing and rinsing with clean water, after mechanical cleaning is completed is required unless the latter is carried out with thoroughness to remove all soluble alkaline deposits. Limit wetting of the surfaces during water-washing operations to the weld area required to be treated, and assure that wetted areas, including any crevices, are completely dry before painting. Welds and adjacent surfaces cleaned thoroughly by blasting alone will be considered adequately prepared provided that weld spatter not dislodged by the blast stream is removed with impact or grinding tools. Round all sharp edges including those caused by corrosion, to a minimum radius of 0.16 cm1/16 inch to ensure adequate paint coverage. Prime all surfaces as soon as practicable after cleaning and in all cases prior to contamination or deterioration of the prepared surfaces. To the greatest degree possible, clean (and prime)all steel surfaces prior to lengthy outdoor storage.

3.1.2.1 Coated Ferrous Surfaces Subject to Atmospheric Exposures

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NOTE B: Coated ferrous surfaces degrade with time. Touch up or spot painting mildly degraded coatings can extend the useful life of the coating system. Spot repair and overcoating can extend the useful life of moderately degraded coatings.

Coating System 23-D is well suited for maintaining degraded coatings. Overcoating does present a significant degree of risk, because of the possibility the overcoated system may either fail catastrophically or will not provide the desired period of protection. The applicability of overcoating is limited by the condition of the existing coating, the underlying substrate and the severity of the exposure environment. If the existing coating is too thick, brittle, or poorly adherent, then overcoating should not be performed. If the degree of substrate corrosion is significant, then the level of effort needed to prepare the substrate may indicate that overcoating is not economically viable. Overcoating is not recommended for severe exposure environments because an all new paint system will last significantly longer than overcoating and is more cost effective. For additional information on overcoating contact the Paint Technology Center.

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Power tool clean coated ferrous surfaces to be overcoated in accordance with SSPC SP 3. The entire surface to be overcoated does not have to be power tool cleaned provided that all surfaces are free of all loose rust, loose paint and visible surface contaminants. Following power tool cleaning, further clean surfaces by power washing using a rotating tip and pressures of 10.3 to 34.5 MPa1500 to 5000 PSI. Adjust water pressure such that all chalk is removed without significantly eroding the existing coating. After drying, spot prime all surfaces as soon as practicable and in all cases prior to contamination or deterioration of the prepared surfaces.

3.1.3 Ferrous Surfaces Subject to Severe Exposure

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NOTE C: Thorough removal of mill scale, corrosion products, and other surface contaminants from surfaces subject to immersion is specified because very clean, blast-roughened surfaces are necessary to obtain adequate adherence of the coating in the severe exposure conditions involved and because the organic coatings that have good durability in immersed exposure are particularly unsuited to any except thoroughly cleaned surfaces.

This paragraph requires rounding of sharp edges. Rounding is desirable because paint pulls thin on sharp edges resulting in early rusting. This requirement may result in significant cost when the structure is severely corroded or pitted.

Except to provide laminar flow, excessive pit depth, or other special considerations, the filling of pits with weld or epoxy based filler materials is typically not justified. When a filler is required, a compatible coating system must be selected. Weld must be ground smooth and abrasive blasted to provide required surface profile. Typically, a vinyl coating will not adhere to an epoxy based filler. Epoxy coatings typically provide good adhesion to epoxy fillers, but a specific recoat window or roughening of the filler material may be required by the coating manufacturer.

The parenthetical provisions relative to blasting in the shop should not be included in project specifications except after consideration of such factors as: surface area of components, probable adequacy of shop inspection, probable amount of damage to shop coating during shipment, field assembly, and cleaning, and painting capabilities of fabricators in the geographical area. Shop blast cleaning should be permitted only where the facilities and experience of the fabricator assure a satisfactory blasting and priming job. Field blasting and painting gives, in general, more satisfactory results and is better adapted to thorough inspection. In no case should shop blasting be made mandatory, since many fabricators

are not equipped for such work. Blasting, priming, and partial painting in the shop should not be considered in connection with epoxy systems because of the possibility of poor adhesion between shop and field coats.

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Dry blast-clean ferrous surfaces subject to extended periods of immersion or as otherwise required to white metal according to SSPC SP 5/NACE No. 1. The blast profile must be angular with a minimum profile height of 38 microns 1.5 mils. Select appropriate abrasive size and equipment operating parameters to limit maximum surface profile on new steel to 63 microns 2.5 mils and to prevent increasing existing profile height on previously blasted steel. Where an existing profile is encountered, remove representative spots of existing coating with a chemical stripper and measure and document the existing profile prior to initiating blasting operations. Measure all surface profiles in accordance with ASTM D4417, Method C. Steel shot or other abrasives that do not produce an angular profile must not be used. If recycled blast media is used, maintain an appropriate particle size distribution so that the specified profile is consistently obtained. Round all sharp edges including those caused by corrosion, to a nominal 0.16 cm 1/16 inch radius and reblast the areas prior to painting. Remove weld spatter not dislodged by blasting with impact or grinding tools and reblast the areas prior to painting. Surfaces must be dry at the time of blasting. Conduct blast cleaning to SSPC SP 5/NACE No. 1 in the field and, unless otherwise specifically authorized, after final erection. Within 8 hours after blast cleaning, and in any case prior to the deposition of any detectable moisture, contaminants, or corrosion, clean all ferrous surfaces of dust and abrasive particles by brush, vacuum cleaner, and/or blown down with clean, dry, compressed air, and apply the first coat of paint. Authorization to extend this 8 hour coating requirement for shop application, application within dehumidified containment, or other conditions will not be granted. Upon written request by the Contractor, the Contracting Officer may authorize mill or shop cleaning of assembled or partially assembled components specified to receive one of the vinyl-type paint systems or Systems 6-A-Z and 21-A-Z employing the epoxy zinc-rich primer or Systems 23-A-Z and 23-B-Z employing SSPC Paint 40 moisture cure urethane zinc-rich primer. Shop coat all shop blasted surfaces with the first and second coats of the specified paint system. At the time field painting is initiated, apply an additional single spray coat of the zinc rich primer to the epoxy zinc-rich and moisture cure urethane primed surfaces as specified in the paint system instructions. Maintain the shop coating in good condition by cleaning and touching up of areas damaged during the construction period. If pinpoint or general rusting appears, the defective areas must be reblasted and repainted at no added cost to the Government. Prior to the field application of subsequent coats, thoroughly clean soiled areas of the shop coating and all welds or other unpainted or damaged areas must be cleaned and coated in a manner to make them equivalent to adjacent, undamaged paint surfaces.

3.1.4 Damp and Wet Ferrous Metal Surfaces

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NOTE D: Painting of surfaces wet with condensation or standing and running water is not generally recommended. Dehumidification should be considered as a first choice for surfaces wet with condensation. However, in some cases it is not

possible to achieve a dry surface for painting. In such cases the procedures outlined here should be used. Thorough removal of mill scale, corrosion products, and other surface contaminants is specified because very clean, blast-roughened surfaces are necessary to obtain adequate adhesion of the coating in the severe application and exposure conditions involved.

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Blast-clean ferrous surfaces that are wet with condensation or standing or running water, to white metal according to SSPC SP 5/NACE No. 1. The blast profile must be angular with a minimum profile height of 38 microns 1.5 mils. Select appropriate abrasive size and equipment operating parameters to limit maximum surface profile on new steel to 63 microns 2.5 mils and to prevent increasing existing profile height on previously blasted steel. Where an existing profile is encountered, remove representative spots of existing coating with a chemical stripper and measure and document the existing profile prior to initiating blasting operations. Measure all surface profiles in accordance with ASTM D4417, Method C. Steel shot or other abrasives that do not produce an angular profile are not to be used. If recycled blast media is used, maintain an appropriate particle size distribution so that the specified profile is consistently obtained. Round all sharp edges including those caused by corrosion, to a nominal 0.16 cm 1/16 inch radius and reblast the areas prior to painting. Remove weld spatter not dislodged by blasting with impact or grinding tools and reblast the areas prior to painting. Immediately after cleaning and prior to the formation of extensive corrosion products, clean all ferrous surfaces of residual abrasive particles, and apply the first coat of paint in accordance with manufacturer's recommendations. A slightly visible rust bloom is permitted on surfaces to be painted.

3.1.5 Non-Ferrous Metal Surfaces

Abrasive blast all non-ferrous metal surfaces to be painted in accordance with SSPC SP 16 in order to roughen the surface and promote adhesion. Only non-metallic abrasives are permitted. All existing coatings must be removed and a minimum surface profile of 1.5 mils must be produced. Measure the surface profile in accordance with ASTM D4417 Method C. Prime all surfaces as soon as practicable after cleaning and in all cases prior to contamination or deterioration of the prepared surfaces.

3.2 PAINT APPLICATION

3.2.1 General

Unless otherwise specified, the finished coating must be free from holidays, pinholes, bubbles, runs, drops, ridges, waves, laps, excessive or unsightly brush marks, and variations in color, texture, and gloss. Do not initiate the application of initial or subsequent coatings until the Contracting Officer has verified that atmospheric conditions and the surfaces to be coated are satisfactory. Each paint coat must be applied in a manner that will produce an even, continuous film of uniform thickness. Provide special attention to edges, corners, crevices, seams, joints, welds, rivets, corrosion pits, and other surface irregularities to ensure that they receive an adequate thickness of paint. Spray equipment must be equipped with traps and separators and where appropriate, mechanical agitators, pressure gauges, pressure regulators, and screens or filters. Air caps, nozzles, and needles must be as recommended by the spray equipment manufacturer for the material being applied. Airless-type spray equipment may be used only on broad, flat, or otherwise simply configured surfaces, except that it may be employed for general painting if the spray gun is equipped with dual or adjustable tips of proper types and orifice sizes. The use of airless-type equipment is not allowed for the application of vinyl paints.

3.2.2 Mixing and Thinning of Coatings other than the Vinyl Formulations

Paints must be thoroughly mixed, strained where necessary, and kept at a uniform composition and consistency during application. Incorporate dry-powder pigments specified to be added at the time of use, into the vehicle or base paint with the aid of powered stirrers, in a manner that will produce a smooth, homogeneous mixture free of lumps and dry particles. Where necessary to suit conditions of the surface temperature, weather, and method of application, the paint may be thinned immediately prior to use. Thinning, induction time and pot life must comply with the manufacturers written instructions (PDS). Bring any paint that has been stored at a temperature below the manufacturer's application temperature range up to at least 21 degrees C 70 degrees F before being mixed and thinned. Its temperature in the spray tank or other working container must not fall below the manufacturer's specified application temperature range during the application. Any paint that has deteriorated in any manner to a degree that it cannot be restored to essentially its original condition by customary field-mixing methods must not be used and must be removed from the project site. In order to determine its suitability for application, resample and submit for testing any paint and thinner that is more than 1 year from the date of manufacture or last documented testing. Moisture cure urethane paint must be resampled and resubmitted for testing to determine its suitability for application whenever the paint is more than six months beyond the date of manufacture on the container or more than 6 months beyond the last documented laboratory testing.

3.2.3 Time between Surface Preparation and Painting

Surfaces that have been cleaned and/or otherwise prepared for painting must be primed as soon as practicable after such preparation has been completed but, in any event, prior to any deterioration of the prepared surface.

3.2.4 Method of Paint Application

Unless otherwise specified, paint must be applied by brush, roller, or spray to ferrous and nonferrous metal surfaces. Special attention must be directed toward ensuring adequate coverage of edges, corners, crevices, pits, rivets, bolts, welds, and similar surface irregularities. Other methods of application to metal surfaces are subject to the specific approval of the Contracting Officer. Paint on plaster, concrete, or other nonmetallic surfaces must be applied by brush, roller, and/or spray.

3.2.5 Coverage and Film Thickness

Film thickness or spreading rates must be as specified hereinafter. Where no spreading rate is specified, apply the paint at a rate consistent with the manufacturer's written instructions. In any event, the combined coats of a specified paint system must completely hide base surface and the finish coats must completely hide undercoats of dissimilar color.

3.2.6 Coating Thickness Measurement on Metal

Where dry film thickness requirements are specified for coatings on metal surfaces, make measurements with a gage qualified in accordance with paragraph Coating Thickness Gage Qualification and calibrated and used in accordance with ASTM D7091. Prior to each use, establish the Base Metal Reading (BMR) for the gage as specified in the test method. Verify the accuracy of the gage using plastic shims as specified by the test method both prior to and following each set of measurements. Perform dry film measurements on all areas of the structure being coated in accordance with SSPC PA 2 with Level 1 thickness restrictions. Perform a sufficient number of thickness measurements to ensure that every area on every member is in compliance with the requirements of this contract. Report all thickness measurements as the mean for each spot determination.

3.2.7 Progress of Painting Work

Where field painting on any type of surface has commenced, complete the entire painting operation on that portion of the work, including priming and finishing coats, as soon as practicable and without prolonged delays. Allow sufficient time between successive coats to permit them to dry properly for recoating, modifying this period as necessary to suit adverse weather conditions. Paint is considered dry for recoating when it feels firm, does not deform or feel sticky under moderate pressure of the finger, and the application of another coat of paint does not cause film irregularities such as lifting or loss of adhesion of the undercoat. All coats of all painted surfaces must be unscarred and completely integral at the time of application of succeeding coats. At the time of application of each successive coat, clean undercoats of dust, grease, overspray, or foreign matter by means of air blast, solvent cleaning, or other suitable means. Cement and mortar deposits on painted steel surfaces, not satisfactorily removed by ordinary cleaning methods, must be brush-off blast cleaned and completely repainted as required. If necessary for establishment of good adhesion, scuff sand high gloss undercoats, and, solvent wipe, or otherwise treat prior to application of a succeeding coat. Apply field coats on metal after erection except as otherwise specified and except for surfaces to be painted that will become inaccessible after erection.

3.2.8 Contacting Surfaces

When riveted or ordinary bolted contact is to exist between surfaces of ferrous or other metal parts of substantially similar chemical composition, such surfaces will not be required to be painted, but any resulting crevices must subsequently be filled or sealed with paint. Contacting metal surfaces formed by high-strength bolts in friction-type connections must not be painted. Where a nonmetal surface is to be in riveted or bolted contact with a metal surface, the contacting surfaces of the metal must be cleaned and given three coats of the specified primer. Unless otherwise specified, corrosion-resisting metal surfaces, including cladding therewith, must not be painted.

3.2.9 Drying Time Prior to Immersion

Minimum drying periods after final coat prior to immersion are: epoxy and moisture cure urethane systems at least 5 days, vinyl-type paint systems at least 3 days, and cold-applied coal tar systems at least 7 days. Increase minimum drying periods twofold if the drying temperature is below 18 degrees C 65 degrees F and/or if the immersion exposure involves considerable abrasion.

3.2.10 Protection of Painted Surfaces

Where shelter and/or heat are provided for painted surfaces during inclement weather, such protective measures must be maintained until the paint film has dried and discontinuance of the measures is authorized. Items that have been painted must not be handled, worked on, or otherwise disturbed until the paint coat is fully dry and hard. Store all metalwork coated in the shop or field prior to final erection out of contact with the ground in a manner and location that will minimize the formation of water-holding pockets; soiling, contamination, and deterioration of the paint film. Damaged areas of paint on such metalwork must be cleaned and touched up without delay. Apply the first field coat of paint within a reasonable period of time after the shop coat and in any event before weathering of the shop coat becomes extensive.

3.2.11 Vinyl Paints

3.2.11.1 General

Vinyl paints must be thoroughly mixed and kept at a uniform composition and consistency during application. Any paint that has deteriorated in any manner to a degree that it cannot be restored to essentially its original condition by customary field-mixing methods must not be used and must be removed from the project site. In order to determine its suitability for application, resample and submit for testing any paint and thinner that is more than 1 year from the previous documented testing. Each applied coat of vinyl paint must be free from any holidays, pinholes and bubbles. The finished coating must be free of excessive or unsightly brush marks, runs, drops, ridges, waves, laps and variations in color, and texture. Vinyl paints must be spray applied, except that areas inaccessible to spraying must be brushed. Vinyl Paints (Formulas V-102E, V-103C, V-106D, and V-766E) are ready-mixed paints designed to be spray applied over a wide range of ambient temperatures by field thinning with the proper type and amount of thinner. For spray application, they must be thinned as necessary up to approximately 25 percent (250 mL/L 1 quart/gallon of base paint) with the appropriate thinner; when ambient and steel temperatures are above normal, up to 40-percent thinning may be necessary for satisfactory application. The zinc-rich vinyl paint (Formula VZ-108D) will normally require thinning only under certain weather conditions. Thinners for vinyl paints must be as follows:

APPROXIMATE AMBIENT AIR TEMPERATURE (Degrees C) (Degrees F)	
Below 10 50	MEK
10 - 2150 - 70	MIBK
Above 21 70	MIAK

Vary the amount of thinner to provide a wet spray and avoid deposition of particles that are semidry when they strike the surface. Do not apply vinyl paints when the temperature of the ambient air and receiving surfaces is less than 2 degrees C 35 degrees F nor when the receiving surfaces are higher than 51 degrees C 125 degrees F. Each double spray coat of vinyl paint must consist of a preliminary stripe coat applied by spray, brush, or combination thereof on edges, corners, interior angles, pits, seams, crevices, junctions of joining members, rivets, weld lines, and similar surface irregularities followed by an overall double spray coat. A double spray coat of vinyl-type paint consists of applying paint to a working area of not less than several hundred square feet (meters) in a single, half-lapped pass, followed after drying to at least a near tack-free condition by another spray pass applied at the same coverage rate and where practicable at right angles to the first. Rivets, bolts, and similar surface projections must receive sprayed paint from every direction to ensure complete coverage of all faces. Pits, cracks, and crevices must be filled with paint insofar as practicable, but in any event, all pit surfaces must be thoroughly covered and all cracks and crevices must be sealed off against the entrance of moisture. Keep fluid and atomization pressures as low as practicable consistent with good spraying results. Application of more than 50 microns 2.0 mils, average dry film thickness, of vinyl paint per double spray coat typically indicates semidry application and must be avoided. Except where otherwise indicated, an undercoat of the vinyl-type paint may receive the next coat any time after the undercoat is tack-free and firm to the touch, provided that no speedup or delay in the recoating schedule results in film defects such as sags, runs, air bubbles, air craters, or poor intercoat adhesion. Do not walk on, or otherwise abrade the prime coat or any other coat until it has hardened sufficiently to resist mechanical damage.

3.2.11.2 Vinyl Zinc-Rich Primer

Primer must be field mixed combining components A, B, and C in accordance with label instructions. After mixing, keep the paint covered at all times to avoid contamination and apply the mixed paint within 8 days after mixing. When the ambient and/or steel temperature is below about 26 degrees C 80 degrees F, the paint will not normally require thinning; however, the paint must at all times contain sufficient volatiles (thinners) to permit it to be satisfactorily atomized and to provide a wet spray and to avoid deposition of particles that are semidry when they reach the surface. The paint must be stirred continuously during application at a rate that will prevent the zinc dust from settling. When spraying is resumed after any interruption of longer than 15 minutes, the entire length of the material hose must be whipped vigorously until any settled zinc is redispersed. Long periods of permitting the paint to remain stagnant in the hose must be avoided by emptying the hoses whenever the painting operation is to be suspended for more than 1 hour. Keep the material (paint) hoses as short as practicable, preferably not more than 15 m 50 feet in length. Equipment used for spraying this zinc primer must not be used for spraying other vinyl-type paints without first being thoroughly cleaned, since many of the other paints will not tolerate zinc contamination. Do not use any type of hot spray. An average dry film thickness of up to 63 microns 2.5 mils may be applied in one double-spray coat. Unless specifically authorized, any coat of VZ-108 must receive a succeeding coat within 8 days.

3.2.11.3 Repair of Vinyl Coating Defects

Coating defects should be repaired when they are first observed but must be repaired prior to coating acceptance. Runs and sags may be brushed out before becoming dry. Pinholes must be physically closed by scrubbing with a brush wet with ketone solvent before the succeeding coat is applied. Overspray that will not be melted smooth by the succeeding coat must be removed by scrubbing with a brush wet with ketone solvent. Minor overspray in the final coat that results only in a reduced gloss at the outer limits of the spray pattern is not considered a defect and requires no additional attention. Insufficient thickness or incomplete hiding must be corrected with additional paint before the succeeding coat is applied. If any defect extends to the substrate, it must be determined if the substrate is corroding. In the case of pinholes it may be necessary to use magnification to observe the substrate. If the substrate is showing any corrosion, the required surface preparation must be restored by spot blasting, and the entire coating system replaced at that location. Following the spot blasting the edges of the remaining coating must be scrubbed with ketone solvent to assure all remaining coating is tightly adhering before the new coating is applied. If VZ-108 does not receive the required succeeding coat within the required 8 days, it must be removed by abrasive blasting and replaced.

3.2.12 Coal Tar-Epoxy (Black) Paint (Formula C-200A)

3.2.12.1 Mixing

Add Component B to previously stirred Component A and thoroughly mix together with a heavy-duty mechanical stirrer just prior to use. The use of not more than 0.5 L 1 pint of xylene thinner per 4 L 1 gal of paint is permitted to improve application properties and extend pot life. The pot life of the mixed paint, extended by permissible thinning, may vary from 2 hours in very warm weather to 5 or more hours in cool weather. Pot life in warm weather may be extended by precooling the components prior to mixing; cooling the mixed material; and/or by slow, continuous stirring during the application period. Apply the mixed material before unreasonable increases in viscosity take place.

3.2.12.2 Application

High-pressure airless spray equipment must be equipped with spray tips of appropriate size for the structural members being coated. Brush application must be with a stiff-bristled brush heavily laden with material and wielded in a manner to spread the coating smoothly and quickly without excessive brushing. The coverage rate of the material is approximately 2.7 square meters/L 110 square feet/gal per coat to obtain 500 microns 20 mils (dry thickness) in a two coats of the C-200a. The paint must flow together and provide a coherent, pinhole-free film. The direction of the spray passes (or finish strokes if brushed) of the second coat must be at right angles to those of the first where practicable.

3.2.12.3 Subsequent Coats

Except at the high temperatures discussed later in this paragraph, the drying time between coal tar-epoxy coats must not be more than 72 hours, and application of a subsequent coat as soon as the undercoat is reasonably firm is strongly encouraged. Where the temperature for substrate or coating surfaces during application or curing exceeds or can be expected to exceed 52 degrees C 125 degrees F as the result of direct exposure to sunlight, the surfaces must be shaded by overhead cover or the interval between coats reduced as may be found necessary to avoid poor intercoat adhesion. Here, poor intercoat adhesion is defined as the inability of two or more dried coats of coal tar-epoxy paint to resist delamination when tested aggressively with a sharp knife. Under the most extreme conditions involving high ambient temperatures and sun-exposed surfaces, reduce the maximum drying time between coats to 10 hours, and the reduction of this interval to a few hours or less is strongly encouraged. Where the curing time of a coal tar-epoxy undercoat exceeds 72 hours at normal temperatures, 10 hours at extreme conditions, or where the undercoat develops a heavy blush, or when spot repair of damage is required, it must be given one of the following treatments before the subsequent coat is applied:

a. Etch the coating surface lightly by brush-off blasting, using fine abrasive, low air pressure, and a nozzle-to-surface distance of approximately 1 m 3 feet.

b. Remove the blush and/or soften the surface of the coating by wiping it with cloths dampened with 1-methyl-2-pyrrolidone. The solvent may be applied to the surface by fog spraying followed by wiping, but any puddles of solvent must be mopped up immediately after they form. Apply the subsequent coat in not less than 15 minutes or more than 3 hours after the solvent treatment.

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NOTE G: On structures having complex structure or numerous fasteners, the specifier may opt to include holiday testing employing a wet sponge tester (reference ASTM D5162). Holiday testing is not commonly required on large, simply configured structures such as sheet pile, conduits, tanks, and cannot be conducted on concrete structures.

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3.2.12.4 Repair of Coal Tar-Epoxy (Black) Paint (Formula C-200A) Defects

Coating defects should be repaired when they are first observed but must be repaired prior to coating acceptance. Runs, sags, pinholes and other visible application defects in any coat may be brushed out before the material cures. Excessive thickness as a result of runs, sags or heavy application of any coat that has been allowed to cure must be reduced to the specified thickness limitation. Any actions that damage the required surface profile must be followed by spot blasting to restore the profile prior to reapplication of the coating system in that area.

3.2.12.5 Ambient Temperature

Coal tar-epoxy paint must not be applied when the receiving surface or the ambient air is below 10 degrees C 50 degrees F nor if it can be reasonably anticipated that the average ambient temperature will be 10 degrees C 50 degrees F or higher for the 5-day period subsequent to the application of any coat.

3.2.12.6 Safety

In addition to the safety provisions in paragraph SAFETY, HEALTH, AND ENVIRONMENT, other workers as well as painters must avoid inhaling atomized particles of coal tar-epoxy paint and contact of the paint with the skin.

3.3 PAINT SYSTEMS APPLICATION

The required paint systems and the surfaces to which they are to be applied are shown in this paragraph, and/or in the drawings. Supplementary information follows.

3.3.1 Fabricated and Assembled Items

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NOTE H: Thought should be given beforehand as to which items are considered suitable for receiving

the manufacturer's standard coating and which are not. In some cases, it may be advisable to include a listing of the items for which the manufacturer's coating is considered adequate. In general, it is believed that a manufacturer's standard coating will be at least reasonably adequate on most items that are to be in normal interior or exterior atmospheric exposure, free from difficult environmental factors, e.g., frequent condensation, water mists and spray, marine atmospheres, etc. Information relative to the type paint to be applied as a field topcoat should be included in each paragraph of the project specification containing a requirement for shop priming.

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Items that have been fabricated and/or assembled into essentially their final form and that are customarily cleaned and painted in accordance with the manufacturer's standard practice will be exempted from equivalent surface preparation and painting requirements described herein, provided that:

a. Surfaces primed (only) in accordance with such standard practices are compatible with specified field-applied finish coats.

b. Surfaces that have been primed and finish painted in accordance with the manufacturer's standard practice are of acceptable color and are capable of being satisfactorily touched up in the field.

c. Items expressly designated herein to be cleaned and painted in a specified manner are not coated in accordance with the manufacturer's standard practice if different from that specified herein.

3.3.2 Surface Preparation

The method of surface preparation and pretreatment shown in the tabulation of paint systems is for identification purposes only. Cleaning and pretreatment of surfaces prior to painting must be accomplished in accordance with detailed requirements previously described.

3.3.3 System No. 1

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NOTE I: This NOTE applies to System No. 1, System No.16-A and System No.23 (series).

1. System No. 1, System No. 16-A and most of the System 23 (series) are all intended for ferrous surfaces subject to atmospheric exposure, e.g. Bridges, light standards, corner wall protection, gantries, exterior machinery and electric motors, adjacent piping and conduit, water tank exteriors, etc. (Exceptions are System No. 23-B-Z which is pigmented with coal tar and designed for immersion and System No. 23-E which does not have a durable topcoat and is designed for interior steel.) Systems No. 1, No. 16-A, and No. 23-D have the ability to adhere to poorly cleaned steel but have increased performance when applied over higher quality surface

preparation. The systems are not intended for coating steel subject to immersion in water. Surfaces to be immersed even once every few years for just a few weeks should be coated with a vinyl, moisture cure urethane or epoxy system designed for immersion. They may be used for interior or exterior atmospheric exposed surfaces of machinery, motors, etc., operating at a maximum temperature of 121 degrees C (250 degrees F). Where higher temperatures are involved, heat-resistant coatings as specified herein should be used. Systems No. 1 provides an aluminum finish; System No. 23-D provides a wide choice of colors including aluminum.

2. Systems No. 16-A and No. 23-D are easy to apply single component paints. System No. 16-A has a lower material cost and can be supplied tinted to custom colors. Color selection for System No. 23-D will be limited to the manufacturer's standard colors. Both may be used to touch-up and overcoat areas previously painted with FS TT-P-86, red lead primer. However, areas previously painted with FS TT-P-86 should be considered for total deleading prior to repainting and the primer upgraded to SSPC Paint 40 Type II. Non-galvanized iron and steel piping, conduit, hangers, etc., in interior unpainted spaces may also be coated with these systems or may be left bare where appearance is of no concern. System No. 23-D should be specified for miscellaneous adjacent galvanized and other nonferrous surfaces. System No. 16-A must not be applied directly to galvanized or zinc rich primed surfaces or to concrete or other masonry.

3. System No. 1 is an epoxy commercial product coating. Compatibility for use over existing oil-based coatings varies widely. Although not designed for immersion, System No. 1, when applied over a Commercial Blast, will withstand occasional immersion.

4. Systems No. 1 and 23-C-Z applied over a Commercial Blast are recommended where atmospheric conditions are more than normally severe. Applications include heavily industrialized locations, coastal structures over seawater or within a few hundred feet of the water's edge, exteriors of steel penstocks and similar surfaces exposed to long periods of condensation. System No. 21-A-Z with the optional urethane topcoat may also be specified in these applications for greater water resistance but less sunlight resistance. System No. 23-F-Z has the greatest sunlight resistance

5. Power tool cleaning and brush-off blast cleaning are intended to be Contractor's options and should be specified for minor touch up and repair of previously painted surfaces that are in generally good condition. Commercial blast cleaning is

included as a specifier's option and should generally be used to prepare previously painted surfaces that are in poor condition or steel that has never been painted. When deleading is desired, a minimum of Commercial Blast, SSPC SP 6/NACE No.3, should be specified.

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This epoxy paint system must have been tested and passed all the test requirements of SSPC PS 26.00. Application must be by spray, brush or roller in accordance with the manufacturer's written instructions. Application includes a preliminary stripe coat applied by brush to all edges, corners, welds, fasteners, and other surface irregularities. Allow the stripe coat to dry as recommended by the manufacturer, prior to the application of the first full coat. Dry film thickness per coat must be within plus or minus 20 percent of that recommended by the manufacturer. Application of the system in less than two coats will not be accepted. Mix and thin the epoxy coating in accordance with the manufacturers written directions. Mixed coating material that has exceeded the manufacturers pot life, that have been mixed for more than 8 hours or that have thickened appreciably must not be applied. The manufacturer's recommendations for minimum and maximum dry time between coats must be met.

3.3.4 System No. 3

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NOTE J: This Note applies to the next 6 paragraphs also.

1. Air quality regulations refer to solvents and thinners as "volatile organic compounds" or VOC. VOC regulations place a maximum on the amount of VOC that may be in each type of paint. (Properly thinned vinyls have a VOC of less than 780 g/L.) These regulations have been enacted at the local, state, and federal levels. Generally the regulation of the smaller body is more restrictive, and takes precedence over that of the larger body (i.e.; a city regulation could preclude the application of a vinyl paint even though it is allowed by state and federal regulations). Content of the regulations varies widely. The 1998 federal emission standards for architectural coatings has approximately 60 categories. Its maximum allowable VOC for Industrial Maintenance paints was 450 g/L and for Impacted Immersion Coatings was 780 g/L. Prior to specifying vinyl paint systems the specifier should access the regulations which may exist in the area where the painting will take place. In many localities "architectural" painting is not regulated while shop painting is regulated. This may mean that a new tainter valve cannot be painted with vinyl paint in the fabricating shop but could be painted after it is installed in the field structure. The new federal regulation class "Impacted Immersion Coatings" would allow the use of vinyl on the gates of a dam but not on the service bridge. Some state regulations adopt the federal classifications and restrict the actual

specification or use of the coating to the purpose for which it was marketed. Enforcement of this type of regulation usually allows the application of the coating to the entire item even if only a portion meets the purpose; (i.e., Atmospheric and condensation areas of tainter gates could be painted with vinyl even though these areas do not meet the "impacted immersion" requirements).

2. All of the vinyl systems are extremely durable in exterior atmospheric exposure; therefore, lock gates, crest gates, and similar structures with both immersed and weather-exposed areas may be painted overall with the same coating system. Vinyl systems should not be employed in direct immersion in seawater or other saline waters containing over 1,000 ppm chlorides or tideland splash zone area; see notes to System No. 6-A-Z, 21-A-Z and 23-B-Z with respect to the latter exposures.

3. The aluminum topcoats make Systems No. 3 and No. 3-A-Z very water and sunlight resistant but somewhat soft. They are the standard systems for surfaces subject to immersion intermittently or continuously in quiet or low-velocity fresh water or to prolonged condensation. They are considered suitable for interior surfaces or roller and double-skinplate tainter gates, control gates that normally hang in relatively quiet water, lock gates, stoplogs, and to the interior of water tanks except those subject to severe debris and ice action. The zinc primer increases the resistance to underfilm corrosion and to corrosion-undercutting at scratches and breaks in the coating and should be specified in more corrosive waters or where the complexity of the structure makes void free application difficult.

4. Systems No. 4, 5-D, 5-C-Z, and 5-E-Z provide finish colors other than aluminum. All of the systems are considerably more resistant to erosion, abrasion, and gouging than the aluminum Systems No. 3 or 3-A-Z and the black System 5-A-Z. All may be used for immersed surfaces subject to waters of moderate-to-high velocity and turbulence, particularly where floating debris and/or ice is of some significance. Under such circumstances, surface configuration assumes importance in as much as paint on sharp edges, rivet heads, and similar projections tends to be more damage-prone than on smooth surfaces. Systems No. 4, 5-D, 5-C-Z, and 5-E-Z are considered suitable for most freshwater structures subject to moderate-to-high abrasive, erosive, and gouging stresses stemming from moving water carrying floating debris and ice, e.g., navigation dam gates, tainter valves, sluice gates, trash racks, crest gates in some circumstances, and water tanks if exposed to ice action. The systems are most generally recommended for penstocks, spiral cases, and surge tanks. The use of the Systems No.

5-C-Z and 5-E-Z undercoated with zinc-rich paint are preferred because of superior adhesion, resistance to underfilm corrosion, and to undercutting by corrosion at breaks or holidays in the film.

5. Systems No. 4, 5-D, 5-C-Z, and 5-E-Z may not perform satisfactorily on freshwater immersed gate, valve, and pipe surfaces subject to very high velocities and turbulence, either alone or in combination with the action of suspended matter, floating debris, or ice. Where such conditions are anticipated, metallizing system No. 6-Z-A, described in Section 09 97 10.00 10 METALLIC COATINGS FOR HYDRAULIC STRUCTURES, should be considered. (It must be understood that in immersion the failure mechanism of metallized coatings is different than paint coatings. A metallized coating may be able to withstand a more severe abrasion environment but absent that severe abrasion, paint coatings may provide better long term protection.)

6. Generally, entire surface areas of items such as crest gates, miter gates, etc., should be treated as though subject to immersion (e.g., painted overall with a vinyl system) even though exposed only in part to the weather to avoid the problems and costs introduced by applying a different system on the atmospheric areas. Because of its great durability in atmospheric exposure, the additional cost of the vinyl system will eventually be recovered in lower maintenance expenses.

7. The vinyl systems, particularly those including the zinc-rich undercoat, are resistant to damage by supplementary cathodic protection if the applied current is carefully limited to the minimum required for protection of holidays in the film.

8. Aluminum and aluminum alloy surfaces subject to extended continuous immersion lose the protective oxide coating and allow pitting corrosion to progress rapidly. Surfaces may be protected by abrasive blasting and applying a vinyl paint system employing V-766E as the first and second coats. Third and subsequent coats may be of V-766, V-102, V-103, or V-106, depending on the desired durability or color. Systems No. 3 and 4 may be specified without alteration to provide aluminum or gray colors, respectively; black and red colors may be obtained by modifying System No. 5-A-Z and 5-D, respectively, so that the first and second coats are V-766. (When paint systems are altered in this manner, the existing system number should not be used).

****

Apply paint by spray to an average dry film thickness of a minimum of 150 microns 6.0 mils for the completed system with a minimum thickness at any spot of not less than 125 microns 5.0 mils. Build up approximately 75 microns 3.0 mils with no spot less than 64 microns 2.5 mils of the total dry film thickness with Formula V-766E paint. The specified film thickness must be attained in any event, and any additional coats needed to attain specified thickness must be applied at no additional cost to the Government. Attaining the specified film thickness in fewer than the prescribed number of coats or spray passes will be acceptable provided the heavier applications do not cause pinholes, bubbles, blisters, or voids in the dried film. The application of more than 50 microns 2.0 mils (dry film thickness) per double spray coat or more than 25 microns 1.0 mil per single spray pass typically indicates the paint is not being applied wet enough to properly flow out and must be avoided.

3.3.5   System No. 3-A-Z

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NOTE: See Note for System 3 above.

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Apply paint by spray to an average dry film thickness of a minimum of 165 microns 6.5 mils for the completed system, and a thickness at any spot of not be less than 138 microns 5.5 mils. The dry film thickness of the zinc-rich coat must be approximately 63 microns 2.5 mils with no spot less than 51 microns 2.0 mils. The thickness of the V-766E mid coat must be sufficient to completely hide the primer. Specified film thickness, including the prescribed total, must be attained in any event, and any extra coats needed to attain specified thickness must be applied at no additional cost to the Government. Attaining of the specified film thickness in fewer than the prescribed number of coats or spray passes will be acceptable provided heavier applications do not cause pinholes, bubbles, blisters, or voids in the dried film. The application of more than 50 microns 2.0 mils (dry film thickness) per double spray coat or more than 25 microns 1.0 mil per single spray pass of nonzinc paint typically indicates the paint is not being applied wet enough to properly flow out and must be avoided.

3.3.6   System No. 4

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NOTE: See Note for System 3 above.

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Apply paint by spray applied to an average dry film thickness of a minimum of 190 microns 7.5 mils for the completed system, with a thickness at any spot of not less than 150 microns 6.0 mils. The specified total film thickness must be attained in any event, and additional coats needed to attain the specified thickness must be applied at no additional cost to the Government. Attaining the specified film thickness in fewer than the prescribed number of coats or spray passes will be acceptable provided heavier applications do not cause pinholes, bubbles, blisters, or voids in the dried film. The application of more than 50 microns 2.0 mils (dry film thickness) per double spray coat or more than 25 microns 1.0 mil per single spray pass of nonzinc paint typically indicates the paint is not being applied wet enough to properly flow out and must be avoided.

3.3.7   System No. 5-A-Z

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NOTE: See Note for System 3 above.

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Apply paint by spray to an average dry film thickness of a minimum of 165 microns 6.5 mils for the completed system with the thickness at any spot not be less than 125 microns 5.0 mils. The approximate dry film thickness after application of the first and second double spray coats must be 63 and 100 microns 2.5 and 4.0 mils, respectively. The zinc primer must not be less than 51 microns 2.0 mils at any spot. The specified film thickness must be attained in any event, and any additional coats needed to attain specified thickness must be applied at no additional cost to the Government. Attaining the specified film thickness in fewer than the prescribed number of coats or spray passes will be acceptable provided heavier applications do not cause pinholes, bubbles, blisters, or voids in the dried film. The application of more than 50 microns 2.0 mils (dry film thickness) per double spray coat or more than 25 microns 1.0 mil per single spray pass of nonzinc paint typically indicates the paint is not being applied wet enough to properly flow out and must be avoided.

3.3.8 System No. 5-C-Z

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NOTE: See Note for System 3 above.

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Apply paint by spray to an average dry film thickness of a minimum of 175 microns 7.0 mils for the completed system, and the thickness at any spot of not less than 140 microns 5.5 mils. The dry film thickness of the zinc-rich coat must be approximately 63 microns 2.5 mils with the thickness at any spot not less than 51 microns 2.0 mils. Specified film thickness, including the prescribed total, must be attained in any event, and any extra coats needed to attain specified thickness must be applied at no additional cost to the Government. Attaining of the specified film thickness in fewer than the prescribed number of coats or spray passes will be acceptable provided heavier applications do not cause pinholes, bubbles, blisters, or voids in the dried film. The application of more than 50 microns 2.0 mils (dry film thickness) per double spray coat or more than 25 microns 1.0 mil per single spray pass of nonzinc paint typically indicates the paint is not being applied wet enough to properly flow out and must be avoided.

3.3.9 System No. 5-D

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NOTE: See Note for System 3 above.

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Apply paint by spray to an average dry film thickness of a minimum of 190 microns 7.5 mils for the completed system, with the thickness at any spot of not be less than 150 microns 6.0 mils. The specified total film thickness must be attained in any event, and any additional coats needed to attain specified thickness must be applied at no additional cost to the Government. Attaining the specified film thickness in fewer than the prescribed number of coats or spray passes will be acceptable provided heavier applications do not pinholes, bubbles, blisters, or voids in the dried film. The application of more than 50 microns 2.0 mils (dry film thickness) per double spray coat or more than 25 microns 1.0 mils per single spray pass of nonzinc paint typically indicates the paint is not being applied wet enough to properly flow out and must be avoided.

3.3.10 System No. 5-E-Z

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NOTE: See Note for System 3 above.

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Apply paint by spray to an average dry film thickness of a minimum of 175 microns 7.0 mils for the completed system, with the thickness at any spot of not be less than 140 microns 5.5 mils. The dry film thickness of the zinc-rich primer must be approximately 63 microns 2.5 mils with no spot less than 51 microns 2.0 mils. The specified film thickness must be attained in any event, and any extra coats needed to attain the specified thickness must be applied at no additional cost to the Government. Attaining the specified film thickness by applying fewer than the prescribed number of coats or spray passes will be acceptable provided heavier applications do not cause pinholes, bubbles, blisters, or voids in the dried film. The application of more than 50 microns 2.0 mils (dry film thickness) per double spray coat nor more than 25 microns 1.0 mil per single spray pass of nonzinc paint typically indicates the paint is not being applied wet enough to properly flow out and must be avoided.

3.3.11 System No. 6

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NOTE K: This NOTE also applies to the next paragraph.

1. Systems No. 6 and 6-A-Z are suitable for steel surfaces subject to immersion in fresh waters and, to a degree, their usefulness in this environment overlaps the vinyl systems. However, the vinyl systems are considered to be more suitable for components that are intermittently immersed or are partly immersed and partly in exterior atmospheric exposure. Also, the vinyl systems, except those with aluminum or black vinyl topcoats, are considered to be appreciably more resistant to gouging and abrasion than the No. 6 and 6-A-Z systems. The vinyls are adaptable to use under a wider range of application and drying temperatures than the coal tar-epoxy system. In addition, coal tar epoxy-coatings present more problems in application and inspection than vinyls. For interior surfaces of flooded compartments, spiral (turbine) cases, penstocks, and other large-diameter, low-to-moderate-velocity water conduits, and for exposed ferrous surfaces in dewatering and drainage sumps, the coal tar epoxy has excellent long-range performance capabilities and may be used (in place of vinyls) unless the specified application and curing temperature requirements would appear to unreasonably restrict construction progress. Also, while the vinyl systems perform very well in the great majority of fresh waters, Systems No. 6 and 6-A-Z may be better adapted to waters that have been made highly corrosive by intense industrial contamination, sewage, or mine waters. In general, system No. 6-A-Z is preferred to the No. 6 system by a margin

wide enough to outweigh its additional cost.

2. Systems No. 6 and 6-A-Z are also recommended for exterior steel surfaces of buried tanks and pipe. The systems should not be specified indiscriminately for pipe since, in small-to-moderately large diameters and particularly in large quantities, pipe coated in the shop at reasonable cost with hot-applied coal tar enamel (AWWA C203), fusion bond epoxy coating (AWWA C213), or extruded polyethylene is easily obtainable, while coal tar epoxy is not widely available as mill-applied pipe coating. Where large quantities of underground pipe are involved, see coating and pipe materials information in the various guide specifications for underground utility lines. Steel pipe, shop coated with extruded polyethylene, and field joints, double wrapped with hot-applied coal tar tape (AWWA C203) or pressure-sensitive plastic tape (AWWA C209), warrant consideration for hydraulic and other lines subject to underwater immersion.

3. System No. 6 or 6-A-Z should be used for coating (prior to driving) of underground, underwater, and incidental atmospheric exposed sections of inland steel piling where protection is considered necessary. Piling in undisturbed soils will not in general require protection; see National Bureau of Standards Journal of Research (Vol. 66C, No. 3, July-September 62) paper, Corrosion of Steel Pilings in Soils, and Lower Mississippi Valley Division Report (December 1969) concerning same subject distributed to all districts and divisions.

4. System No. 6-A-Z may be used for sector gates, steel piling etc., immersed in seawater and diluted seawater. It is suitable also for the tidal zone, splash zone, and incidental weather-exposed sections of such structures. The coal tar-epoxy coating becomes quite hard and is not significantly damaged by fouling organisms; therefore, anti-fouling coats are not considered necessary except possibly for operations reasons, e.g., prevention of weight increase and surface roughness due to fouling and reduction of repainting difficulties. There is presently no thoroughly proven anti-fouling paint for use over the coal tar-epoxy coating. Contact the Paint Technology Center, U.S. Army Construction Engineering Research Laboratory, ATTN: ERDC-CERL-EM, Champaign, IL.

5. The fact that C-200A paint adheres well to clean, sound concrete and also has good resistance to many chemicals indicates the use of a system similar to System No. 6 on concrete surfaces in contact with sewage and other materials tending to cause chemical damage. When used for concrete exposed to such environments, the surface preparation instructions for System No. 6 should be

changed to read blast clean to etch surfaces and remove contaminants. Obviously, the use of coatings to upgrade the chemical resistance of concrete has limitations and should not be relied on to solve an exposure situation in which uncoated concrete would be quickly damaged to a gross degree.

6. SSPC PS 26.00 may be employed as aluminum finish coats for C-200A when such a finish is desired. It adheres well to the C-200A in all except constant immersion applications.

7. System No. 6-A-Z and, to a lesser extent, System No. 6 are suitable for use in conjunction with cathodic protection provided the potential of the steel is kept at the minimum required for protection of holidays in the film.

****

Apply paint by spray or brush with a minimum of two coats to provide a minimum total thickness at any spot of 400 microns 16 mils. Any spot having an excess of coal tar paint, here defined as more than 500 microns 20 mils in a single coat or 875 microns 35 mils in multiple coats must be repaired by sanding, grinding or abrasive blasting the excess material from the surface and reapplying the coatings to the above specified requirements. The specified film thickness must be attained in any event, and any additional (beyond two) coats needed to attain specified thickness must be applied at no additional cost to the Government.

3.3.12 System No. 6-A-Z

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NOTE: See Note in above paragraph.

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Apply epoxy zinc-rich primer 19C in accordance with the manufacturer's directions in two single, half-lapped spray coats to an average dry film thickness of a minimum of 75 microns 3.0 mils. The thickness at any spot must not be less than 63 microns 2.5 mils or greater 200 microns 6 mils for the primer. After a minimum drying period of 6 hours and no more than 96 hours, apply at least two coats of coal tar epoxy paint to provide a minimum thickness at any spot of 400 microns 16 mils for the completed system. Any spot having an excess of coal tar paint, here defined as more than 500 microns 20 mils in a single coat or 875 microns 35 mils in multiple coats must be repaired by sanding, grinding or abrasive blasting the excess material from the surface and reapplying the coatings to the above specified requirements. If the epoxy zinc-rich paint has been applied in the shop or otherwise has been permitted to cure for longer than 96 hours, it must be abraded and recoated with an additional thin tack coat of the zinc-rich paint, which in turn must be overcoated within 96 hours with the first coat of coal tar-epoxy paint. The specified film thicknesses must be attained in any event, and any additional coats needed to attain specified thickness must be applied at no additional cost to the Government.

3.3.13 System No. 7

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NOTE L: 1. The system is included specifically for

use on local protection projects and is not to be used on other types of projects in place of vinyl or coal tar-epoxy systems. It may be used for coating the ferrous surfaces of equipment located below the operating floor of pump stations (in the station sump), in gate wells, in surge chambers, etc. It may be used on both inside and outside discharge pipes with diameters of 20 inches and greater. The items usually involved are storm water and sanitary pumps, slide gates, flap gates, etc. The coating, when applied to equipment and other manufactured items, should generally be permitted to be applied in the shop. Final touch-up painting should be done after installation is completed.

2. Pump discharge lines, except when located wholly within the station sump, should be protected as stipulated in Section 9 of EM 1110-2-3105. Discharge lines wholly within the station sump should be considered as part of the pump. Items of fabricated structural steel used in pump stations and on other features of local protection projects are usually of small size and are generally hot dipped galvanized after fabrication. Only those items fabricated of structural steel of such a large size that galvanizing would be impracticable or unduly expensive would be painted.

3. Cleaning of the metal surfaces can be accomplished by (1) SSPC SP 6/NACE No.3 Commercial Blast Cleaning or (2) by SSPC SP 3 Power Tool Cleaning or SSPC 7/NACE No.4 Brush-Off Blast Cleaning. Only one of the alternative methods should be specified. Although the Commercial blast cleaning assures better performance of the coating, it is considered that it should only be used where large pumping units are used. For the smaller pumping units, that is, size 900 mm 36 inch and below, power tool or brush-off blast cleaning is considered adequate since it will, in all probability, be more in keeping with the standard practice of the industry for equipment of the above-mentioned size. For the cleaning of sluice gates, flap gates, and other similar items, power tool or brush-off blast cleaning should be used. For touch-up paints, cleaning should be by the solvent and wire-brush method.

****

Apply a special primer under the coal tar-based paint only if/as recommended by the coating manufacturer. The materials must be heavily applied by brush or with heavy-duty spray equipment at a coverage rate that will give a minimum total dry film thickness of 500 microns 20 mils at any spot for the completed system. The paint must not be thinned unless recommended by the manufacturer. If brushed, the final strokes must be at right angles to those of the preceding coat. Comply with the manufacturer's recommendations regarding the application and drying time between coats.

3.3.14 System No. 8

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NOTE M: The Commercial Item Description describes commercially available coating systems for application to wet and damp surfaces. These are very unusual coatings and their use should be limited to only those locations where the surface cannot be made sufficiently dry for more typical coating systems.

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Mix and apply the coating in accordance with the manufacturer's written instructions. The coating must be applied in one or more coats to achieve an average dry film thickness of a minimum of 305 microns 12 mils. Minimum thickness at any spot must be not less than 228 microns 9 mils. Roller application is preferred. Application to vertical surfaces by airless spray may be performed provided all condensed water droplets are removed by wiping with a terry cloth towel immediately prior to spray application. Application to horizontal surfaces or surfaces otherwise covered by standing or running water must be by roller. Brush application must be limited to inside corners, bolt heads and other surface irregularities that are difficult to coat by roller. Apply subsequent coats in the shortest recommended recoat interval. Comply with all manufacturer's recommendations regarding ambient and surface temperatures during application and curing of the coating.

3.3.15 System No. 10

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NOTE N: 1. System No. 10 consists of 2 coats of inorganic zinc paint. SSPC Guide 12.00 discusses applications and limitations to the use of zinc-rich coatings. Use of this system within the Corps is anticipated to be limited to 2 basic applications: (a) For applications as a high temperature paint where exhaust stacks and other surfaces are to be protected from corrosion at dry heat temperatures up to 399 degrees C 750 degrees F; and, (b) To protect atmospheric steel exposed to high levels of condensation or salt air and where the appearance of an untopcoated zinc coating is acceptable.

2. Conventional good-quality alkyd enamels will withstand temperatures up to about 120 degrees C 250 degrees F. Heat resisting paints are available that provide many colors capable of withstanding 215 degrees C 400 degrees F. System No. 10 is resistant to temperatures up to 400 degrees C 750 degrees F maximum. It is not to be expected that any paint system will exhibit long life on surfaces operating for long periods at very high temperatures (in excess of about 400 degrees C 750 degrees F)), particularly when combined with exterior weathering. As an alternative to conventional high temperature coatings, thermal-sprayed metals such as System No. 8-A found in Section 09 97 10.00 10 METALLIC COATINGS FOR HYDRAULIC STRUCTURES may be used. System No. 8-A will withstand temperatures up

to 900 degrees C 1650 degrees F.

3. Surface preparation for inorganic zinc is critical; mill scale, rust or other coatings remaining on the surface will result in poor adhesion and ineffective protection. Application by spray is most common; application of excessive thickness per coat often results in mudcracking. Topcoating of inorganic zinc with non-zinc organic coatings is not recommended.

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Apply the paint in accordance with the manufacturer's recommendations to a minimum average dry film thickness of 125 microns 5 mils with a thickness at any spot of not less than 100 microns 4.0 mils. The specified film thickness may be obtained in a single coat provided this is allowed by manufacturer's recommendations and provided this does not result in improper cure or result in the development of mud cracking or other film defects.

3.3.16 System No. 12

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NOTE O: 1. The inclusion of galvanizing provisions in the painting section of project specification may or may not be desirable and is not mandatory. A principal purpose here is to draw attention to certain information concerning galvanizing versus paint for protection of steel surfaces.

2. Galvanizing of open-mesh-type floor grating (without paint overcoats) is more effective than painting.

3. There would appear to be a mistaken belief that galvanizing is a cure-all method of protection. While very suitable for steel in rural and mildly industrialized atmospheres, galvanizing does not have a greatly extended life in highly industrialized atmospheres, particularly where the air contains sulphur compounds. Galvanizing is not as effective as the best of paint coatings for steel exposed to cold, fresh water, and in warm and hot waters, galvanizing may result in pitting of the steel deeper than with no coating at all. The performance of galvanized pipe buried in the ground is not consistently good, and it cannot be considered to be equivalent to a high-quality organic pipe coating, particularly since the latter can be supplemented by cathodic protection.

4. The use of galvanizing appears to be economically justified in aboveground structures exposed to mildly corrosive atmospheres, constructed of lightweight structural steel members, and presenting difficult-to-paint and inaccessible surfaces, e.g., transmission towers. The

feasibility and economy of galvanizing on structures that are more massive and more easily painted is open to question, but its use on such surfaces is growing. To be considered also is the amount and nature of field erection work that results in destruction of the galvanizing, since satisfactory repair of such damage is difficult and expensive. It should be kept in mind that galvanizing generally has a poor record as a paint-receiving surface, requiring special measures for reliable and permanent adhesion.

5. Other hot-dipped coatings exist that contain various ratios of zinc and aluminum. Some of these coatings may perform better than galvanizing in some exposures. For example, aluminum hot-dipped coatings of pure aluminum are recommended for chloride environments. The specifier may also review ASTM A780 or SSPC Guide 14 for other repair procedures for hot dip galvanized surfaces.

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Wash galvanized surfaces to expose damaged areas. Clean mars and breaks in the galvanized coating by hand or power tool to remove all corroded substrate. Touch up the damaged areas with two coats of SSPC Paint 20, Type II.

3.3.17 System 16-A

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NOTE: See Note I.

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Brush or spray the first coat in the shop or field as indicated. Touch up the coating in the field as necessary to maintain its integrity at all times. Apply the second and third coats in the field. Procure all materials from the same coating manufacturer and apply each coat in accordance with the manufacturer's written instructions. The finish color must be as indicated. Do not apply paint to running surfaces of bearings and machinery. Remove pipe-threading and cutting compounds by solvent washing prior to application of paint to pipe surfaces.

3.3.18 System No. 17

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NOTE P: This Note applies to System 18 also.

1. Systems No. 17 and 18 are intended primarily for interior surfaces of wood, concrete, masonry, plaster, wallboard, and incidental surfaces within interior painted spaces. System No. 17 provides an all latex system; System No. 18 provides paint systems with oil based alkyd finish coats. The latex system typically has less odor during and immediately after application. Latexes are compatible with alkaline surfaces but may be less durable when subjected to frequent cleaning with abrasive cleansers. Repainting of aged latex paints presents fewer intercoat adhesion problems than when

repainting aged semigloss and gloss oil based paints. Additional systems intended for similar surfaces are shown in guide specification Section 09 90 00 PAINTS AND COATINGS.

2. System 17 provides options for the specifier to select finish coats which are MPI 114 (high gloss), MPI 54 (semigloss), MPI 52 (egg shell), or MPI 53 (flat). See paragraph 4 below for guidance in selection of the proper finish coat. When multiple gloss levels are to be used in a contract the specifier should develop alternate systems using an additional letter (System No. 17A, vs. System No. 17B) and clearly identify the items to be coated with each system.

3. System 18 requires the specifier to select both the appropriate primer and the appropriate finish coats. MPI 46 primer is an alkyd. Products meeting this specification typically have superior adhesion to wood and existing oil based enamel coatings. They may be applied directly to clean ferrous surfaces but should not be applied directly onto sheet rock, masonry, galvanized metal, or other alkaline surfaces. MPI 50 primer is latex. Products meeting this specification are commonly applied to a wide range of sheet rock, masonry, and wood surfaces; however, they should not be applied directly to unprimed ferrous or aluminum surfaces. All finish coats are compatible with either primer. The options for finish coats include MPI 49 (Flat), MPI 47 (Semigloss), MPI 51 (Eggshell) and MPI 48 (Gloss). See paragraph 4 below for guidance in selection of the proper gloss. When multiple gloss levels are to be used on a contract the specifier should develop alternate systems using an additional letter (System No. 18A vs. System No. 18B) and clearly identify the items to be coated with each system.

4. Flat finishes tend to hide surface irregularities but are often more difficult to clean. They should be used for walls and ceilings constructed of concrete, block, plaster, or wallboard where no unusual soiling problems exist. Egg shell finishes are sometimes specified where flat finishes are desired but a higher level of cleanability is required. Semigloss finishes are specified on smooth plaster, wood, or other high quality surfaces when appearance requirements are above average. Semigloss and high gloss finishes should generally be used on wainscot areas, stairwells, washrooms, workrooms, etc., subject to moisture, soiling, or staining problems. Avoidance of very light colors on wainscots and other areas subject to high degree of soiling is suggested. Semigloss and high gloss finishes are frequently applied over an alkyd primer on interior wood and steel doors, windows, frames, etc.

5. The use of the systems for finishing complex spaces (such as in powerhouses) involving numerous ceiling, wall, wainscot, door, and trim colors and varying degrees of gloss in numerous rooms is more easily specified by preparing a separate room and door finish schedule.

6. Attention is directed to the absence of any requirements in this guide for rubbing, sacking, fin removal, etc., to improve the paintability or appearance of painted concrete surfaces; such requirements, if needed, should be included in the concrete section. Also, if coated interior concrete block surfaces are intended to be substantially free of surface voids, they should be first treated with MPI 4 Interior/Exterior Latex Block Filler.

7. System No. 18 with MPI 46 primer and semigloss or gloss finish coats is adequate for battery rooms in some divisions. However, System No. 21 conforms to the requirements of EM 1110-2-3001.
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Except as otherwise required, apply the same finish paint to all metal ductwork, conduit, pipe, radiators, grilles, louvers, pull boxes, and exposed surfaces of miscellaneous embedded metalwork as is applied to adjacent ceilings or walls provided that:

a. The coat of MPI 50 may be omitted on metal surfaces primed with a shop or field coat of metal priming paint.

b. On bare ferrous surfaces and wood replace the coat of MPI 50 with a coat of MPI 46.

c. Solvent clean all galvanized and other nonferrous metal surfaces in accordance with SSPC SP 1 and prime with SSPC Paint 41 in place of the MPI 50 coat.

3.3.19 System No. 18

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NOTE: See NOTE for System 17 above.
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Thin oil based alkyd paints using only odorless mineral spirits (ASTM D235). Except as otherwise required, finish all metal ductwork, conduit, pipe, radiators, grilles, louvers, pull boxes, and exposed surfaces of miscellaneous embedded metalwork the same as adjacent ceilings or walls provided that:

a. The coat of MPI 46 or MPI 50 may be omitted on metal surfaces primed with a shop or field coat of metal priming paint.

b. Prime all bare ferrous surfaces with MPI 46.

c. Clean all galvanized and other nonferrous metal surfaces in accordance with SSPC SP 1 and prime with SSPC Paint 41 in place of MPI 46 or MPI 50.

3.3.20 System No. 21

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NOTE Q: This NOTE applies to the next paragraph also.

1. MIL-DTL-24441 consists of a general specification for a two-component epoxy-polyamide paint and detail specification sheets numbered MIL-DTL-24441/19C through MIL-DTL-24441/40B. Each specification sheet contains the formulation and requirements for a specific coating. Variations include high-build and regular build types for various primers and topcoat colors. Type IV high-build topcoats may be used over the 19C primer in System 21-A-Z; however, Type III products offer superior performance in immersion. Any of the type III or Type IV topcoats may be used directly on concrete or wood surfaces. Primer 29B should be specified for aluminum substrates or steel surfaces that are not primed with zinc-rich primer 19C. The designer must specify the specific coatings desired.

2. System No. 21 is suggested for concrete and other incidental surfaces of battery rooms and other rooms where resistance to chemical fumes is desired and/or which will be subjected to heavy soils necessitating frequent cleaning. It may be used on interior concrete floors; however, System No. 22 is specifically designed for this purpose.

3. Attention is directed to the absence in this guide of any requirements such as sacking, fin removal, etc., that would improve the paintability or appearance of painted concrete surfaces; such requirements should be included in the concrete section.

4. System No. 21-A-Z can be used on steel sector gates, steel piling, etc., immersed in seawater and diluted seawater. It is suitable also for the tidal zone, splash zone, and incidental weather exposed sections of such structures. The system is satisfactory in applications subject to low-to-moderate water velocities and abrasion. System No. 6-A-Z should be specified for applications where more severe abrasion is anticipated.

5. Systems No. 21 and 21-A-Z are suitable for steel surfaces subject to immersion in fresh waters and to a degree their usefulness in the environment overlaps vinyl Systems No. 3 through 5-E-Z and Epoxy Systems 6 and 6-A-Z. However, the vinyl Systems are more suitable for components that are intermittently immersed or are partly immersed and partly in exterior atmospheric exposure. Also, the vinyl Systems, except those topcoated with aluminum vinyl, are more resistant to gouging and abrasion than the

epoxy systems, with vinyl Systems No. 5-C-Z and 5-E-Z being the best in this respect. Finally, the vinyls are adaptable to use under a wider range of applications and drying temperatures than the epoxy systems. In general, System No. 21-A-Z is preferred to System No. 21 by a margin wide enough to outweigh its additional cost.

6. System No. 21-A-Z is suitable for use on exterior steel exposed to a marine (salt) atmosphere.

7. Systems No. 21 and 21-A-Z are suitable for use on hydraulic piping immersed in fresh water and may be considered equivalent to Systems No. 6 and 6-A-Z in this exposure.

8. Generally, entire surface areas of items such as miter gates, crest gates, etc., should receive the selected epoxy system even though only a portion will be subjected to atmospheric weathering. Epoxy coatings subject to atmospheric weathering may erode by as much as 25 µm 1 mil per year. In such cases where systems No. 21 and 21-A-Z will be exposed to normal atmospheric weathering, it is recommended that one or two coats of polyurethane meeting SSPC Paint 36, Level 3, or MIL-PRF 85285 be applied over the final coat of the epoxy system. The polyurethane should be applied only to the portion of the item generally exposed to atmospheric weathering and not to the entire item. It should be specified in a color similar to that of the immersed area. The polyurethane should be applied in the number of coats and at the dry film thickness recommended by the manufacturer. Products marketed by many manufacturers for compliance with SSPC Paint 36 are not suitable for immersion and Level 3 performance is not available in safety and designer colors. For greater water resistance and color retention MIL-PRF-85285, Type IV should be specified.

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Apply the paint in a minimum of two single coats to produce an average dry film thickness totaling 150 microns 6.0 mils with no less than 5.0 mils at any spot. No individual coat may be more than 150 microns 6.0 mils at any point. Apply MIL-DTL-24441 in compliance with the manufacturer's recommendations regarding type of thinner, amount of thinning, and required induction time. The drying time between coats must not be less than 8 hours nor more than 96 hours.

3.3.21 System No. 21-A-Z

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NOTE: See NOTE in preceding paragraph.

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Apply the epoxy zinc-rich paint 19C in two single half-lapped spray coats to an average dry film thickness of a minimum of 100 microns3.0 mils and a thickness at any spot of not less than 64 microns2.5 mils or greater than 200 microns6.0 mils. After a drying period of not less than 6 hours or more than 96 hours, apply at least two coats of epoxy polyamide paint to produce an average dry film thickness totaling 305 microns 12 mils and a thickness at any spot of not less than 254 microns 10 mils. If the epoxy zinc-rich paint has been applied in the shop or otherwise has been permitted to cure for longer than 96 hours, it must be abraded and recoated with an additional thin tack coat of the zinc-rich paint, which in turn must be overcoated within 96 hours with the first coat of the epoxy polyamide paint. Apply MIL-DTL-24441 in accordance with the manufacturer's recommendations regarding type of thinner, amount of thinning, and required induction time. The drying time between non-zinc coats must not be less than 12 hours nor more than 96 hours..

3.3.22 System No. 22

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NOTE R: MPI Paint 212 describes commercially available floor coating systems suitable for concrete floors of maintenance and other similar facilities. Specifier should consult manufacturers for guidance and availability in specifying color, hardness, level of reflectance, level of slip resistance. and warranty necessary for specific application.

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Apply the floor coating system MPI 212 in accordance with the manufacturer's written instructions. It must be a multi-coat system with the dry film thickness per coat as recommended by the manufacturer.

3.3.23 System No. 23-A-Z

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NOTE S:

1. Paint System No. 23-A-Z is comprised of three-coats of moisture cure urethane. The primer is a zinc-rich coating conforming to SSPC Paint 40, Type II. The primer may be packaged as a single component paint containing the zinc or a two component material where the zinc must be incorporated into the liquid paint. The intermediate coat is a single component aromatic moisture cure urethane conforming to SSPC Paint 41. The topcoat is a single component aliphatic moisture cure urethane conforming to SSPC Paint 38. The specifier must specify a color. Gray topcoat should have a reflectance of 20-24 (ASTM E1347). The resulting gray color should approximate color 26231 of SAE AMS-STD-595A. Red topcoat should approximate SAE AMS-STD-595A color 10076. White and black may also be specified.

2. The usefulness of System 23-A-Z overlaps to a certain extent with the vinyl systems. However, System 23-A-Z is not as durable as the vinyl systems because it is less abrasion and water resistant. In locations where it has been determined that vinyl paints do not meet air pollution requirements, System 23-A-Z is a suitable alternative to vinyls

for use on ferrous metal surfaces subject to fresh water immersion and adjoining atmospheric exposed surfaces.

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Apply the coating system in accordance with the manufacturer's written instructions. It must be a 3-coat system plus an additional stripe coat applied by brush to all edges, corners, welds, fasteners, and other surface irregularities. Allow the stripe coat to dry as recommended by the manufacturer, prior to the application of the first full coat. Application of the system in less than three coats will not be accepted. Procure all materials from the same coating manufacturer. The individual paints comprising the system must have been tested and passed all requirements of the applicable SSPC standards. SSPC Paint 38 topcoat must meet the requirements of Accelerated Weathering Level 3. Apply the coatings by spray in accordance with the manufacturer's written instructions. Limited use of brush and roller application is permitted provided the specified film thicknesses are achieved. Comply with the manufacturer's recommendations regarding mixing and thinning requirements, and pot life requirements, dry film thickness per coat and minimum and maximum dry time between coats. Do not use coating material that has thickened appreciably. Areas of bubbling noted upon curing of any individual coat must be removed by sanding or screening, the edges feathered, and the coat reapplied to the repaired areas before a subsequent coat is applied.

3.3.24 System No. 23-B-Z

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NOTE T:

1. Paint System No. 23-B-Z is comprised of three-coats of moisture cure urethane. The primer is a zinc-rich coating conforming to SSPC Paint 40, Type II. The primer may be packaged as a single component paint containing the zinc or a two component material where the zinc must be incorporated into the liquid paint. The second and third coats are a single component aromatic moisture cure urethane conforming to SSPC Paint 41 and containing coal tar pitch resin.

2. Coating System 23-B-Z is recommended for application on ferrous metal surfaces subject to fresh water and brackish water immersion, atmospheric, and buried environments. In fresh water immersion its usefulness overlaps with the vinyl systems. However, System 23-B-Z is not as durable as the vinyl systems because it is less abrasion resistant. In locations where it has been determined that vinyl paints do not meet air pollution requirements, System 23-B-Z is a suitable alternative to vinyls for use on ferrous metal surfaces subject to fresh water immersion and adjoining atmospheric exposed surfaces. In brackish or dilute salt water immersion and buried applications the system is comparable to System No. 6-A-Z. Its chief advantage over epoxy system 6-A-Z is that it can be applied at lower temperatures and higher humidity.

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Apply the coating system in accordance with the manufacturer's written instructions. It must be a 3-coat system plus an additional stripe coat applied by brush to all edges, corners, welds, fasteners, and other surface irregularities. Allow the stripe coat to dry as recommended by the manufacturer, prior to the application of the first full coat. Procure all materials from the same coating manufacturer. The individual paints comprising the system must have been tested and passed all requirements of the applicable SSPC standards. SSPC Paint 41 must be modified with coal tar pitch. Apply the coatings by spray in accordance with the manufacturer's written instructions. Limited use of brush and roller application is permitted provided the specified film thicknesses are achieved. Comply with the manufacturer's recommendations regarding mixing and thinning requirements, and pot life requirements, dry film thickness per coat and minimum and maximum dry time between coats. Do not use coating material that has thickened appreciably. Areas of bubbling noted upon curing of any individual coat must be removed by sanding or screening, the edges feathered, and the coat reapplied to the repaired areas before a subsequent coat is applied.

3.3.25 System No. 23-C-Z

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NOTE U: Paint System No. 23-C-Z is comprised of three-coats. The primer is a moisture cure zinc-rich urethane coating conforming to SSPC Paint 40, Type II. The primer may be packaged as a single component paint containing the zinc or a two component material where the zinc must be incorporated into the liquid paint. The zinc-rich primer provides excellent corrosion resistance in atmospheric exposures. Type II is an immersion grade primer and is recommended because surfaces coated with this system could be subject to intermittent immersion and the Type II primer offers an added degree of security. The second coat and third coats are a two-component aliphatic polyurethane conforming to MIL-PRF-85285 Type IV. This product provides the ultimate color and gloss retention but is only available in gray and white and is quite costly. Where custom colors are desired, SSPC Paint 36 may be substituted. In addition to the excellent corrosion resistance afforded by the primer the MIL-PRF-85285 Type IV topcoat will also provide a very high degree of resistance to UV-induced color change, dulling, and chalking, making an excellent choice for highly visible items such as handrails. The SSPC Paint 36 topcoat provides a wide range of colors including safety colors but will exhibit moderate chalking. The specifier must select a finish coat color..

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Apply the coating system in accordance with the manufacturer's written instructions. It must be a 3-coat system plus an additional stripe coat applied by brush to all edges, corners, welds, fasteners, and other surface irregularities. Allow the stripe coat to dry as recommended by the manufacturer, prior to the application of the first full coat. Procure all materials from the same coating manufacturer. The individual paints comprising the system must have been tested and passed all requirements of the applicable standards. Apply the coatings by spray in accordance with the manufacturer's written instructions. Limited use of brush and roller application is permitted provided the specified film thicknesses are achieved. Comply with the manufacturer's recommendations regarding mixing and thinning requirements, and pot life requirements, dry film thickness per coat and minimum and maximum dry time between coats. Do not use coating material that has thickened appreciably. Areas of bubbling noted upon curing of any individual coat must be removed by sanding or screening, the edges feathered, and the coat reapplied to the repaired areas before a subsequent coat is applied.

3.3.26 System No. 23-D

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NOTE V:

1. This system is comprised of three coats of moisture cure urethane paint conforming to SSPC Paint 41. The second and third coats may either be aluminum or a color such as grey. The choice of aluminum or color finish is the specifier' s option. Light colors may tend to yellow when exposed to sunlight. See Systems 23-A-Z and 23-C-Z for more light stable topcoat colors.

2. This system is used for three distinctly different applications. Surface preparation Alternate 1 in the painting schedule is to be used for overcoating existing coatings as a means of extending their economic life. This approach may be particularly cost effective if the existing coating contains lead or other hazardous constituents. Coating System 23-D is well suited for maintaining degraded coatings. Overcoating is performed with a significant degree of risk, which refers to the chance that the overcoated system may either fail catastrophically or will not provide the desired period of protection. The applicability of overcoating is limited by the condition of the existing coating and underlying substrate and the severity of the exposure environment. If the existing coating is too thick, brittle, or poorly adherent, then overcoating should not be performed. If the degree of substrate corrosion is significant, then the level of effort needed to prepare the substrate may indicate that overcoating is not economically viable. Overcoating is not recommended for severe exposure environments because an all new paint system would last significantly longer than overcoating and is more cost effective. For additional information on overcoating contact the Paint Technology Center.

3. System 23-D is specified for coating ferrous metal surfaces that are cleaned in accordance with surface preparation Alternate 2, SSPC SP 3 Power Tool Cleaning. SSPC Paint 41 is generally quite

tolerant of minimally prepared surfaces. When used on SP 3 cleaned surfaces System 23-D is generally adequate for mild atmospheric exposures. For more severe atmospheric exposures it generally is worth the added cost to specify System No. 23-B-Z which uses the more expensive zinc-rich primer and more expensive commercial blast cleaning. Where an aluminum finish is specified in conjunction with Alternate 2, System No. 23-D is roughly equivalent to System No. 1 which employs two coats of aluminum pigmented epoxy. The chief advantage of System No. 23-D over System No. 1 is that it can be applied at lower temperatures and higher humidity.

4. System 23-D is specified for coating non-ferrous metal surfaces using surface preparation Alternate 3 shown in the Painting Schedule. Surface preparation for Alternate 3 uses SSPC SP 16 surface preparation for non-ferrous surfaces. Galvanized surfaces and other hot-dip coated surfaces will not generally be painted. However, in exterior industrial and marine exposures or in below grade galleries and passageways subject to high humidity and condensation, painting to extend the protective life of galvanizing is sometimes advisable. Also galvanized ductwork, conduit, piping, etc., in finished spaces is generally painted for appearance purposes. System No. 23-D aluminum color is intended generally for galvanized handrail, pipe, conduit, etc., subject to exterior or interior exposure for the purpose of extending the life of the zinc coating and/or matching the appearance of adjacent painted structural steel. If preferred, System No. 23-D in gray or other suitable color may be used for this purpose. Aluminum and aluminum alloy surfaces will not generally be painted; however, System No. 23-D may be desirable for isolating aluminum in contact with mortar or concrete. System No. 23-D can be used for protection in salt (marine) atmospheres and for those situations where the aluminum surfaces may be in contact with damp wood, leaves, mud, etc., that tend to prevent free access of oxygen to the surfaces, thus causing possible loss of the metal's protective oxide film. Copper and brass surfaces will rarely be painted except for the purpose of appearance, e.g., gutters, exposed flashing, exposed piping in finished spaces, etc. Paint System No. 23-D can be used to paint copper and brass.

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Apply the coating system in accordance with the manufacturer's written instructions. It must be a 3-coat system plus an additional stripe coat applied by brush to all edges, corners, welds, fasteners, and other surface irregularities. Allow the stripe coat to dry as recommended by the manufacturer, prior to the application of the first full coat. The aluminum pigmented topcoat will not meet the SSPC Paint Procure all materials from the same coating manufacturer. The individual paints comprising the system must have been tested and passed all requirements of the applicable SSPC standards. [The first coat of the overcoat system must be applied by brush or roller to those areas where power tool cleaning exposed the steel substrate. The second coat of the overcoat system must also be applied by brush or roller to those areas that received a first coat of paint as well as any area where power tool cleaning or power washing removed the old topcoat. The final coat of the overcoat system must be applied to the entire surface by spray, brush, or roller.] [Application must be by spray. Limited use of brush and roller application is permitted provided the specified film thicknesses are achieved.] [Application must be by spray, brush, or roller.] Comply with the manufacturer's recommendations regarding mixing and thinning requirements, and pot life requirements, dry film thickness per coat and minimum and maximum dry time between coats. Do not use coating material that has thickened appreciably. Areas of bubbling noted upon curing of any individual coat must be removed by sanding or screening, the edges feathered, and the coat reapplied to the repaired areas before a subsequent coat is applied.

3.3.27 System No. 23-E

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NOTE W:

1. The system is intended for interior structural steel and other interior ferrous surfaces not otherwise specified with respect to painting. The category includes structural and miscellaneous steel exposed to view in unfinished spaces, concealed structural framework of buildings, and other ferrous surfaces that will be inaccessible for painting after construction, all of which are enclosed within a weather-tight structure. Care should be taken that requirements in this section are not in conflict with other painting requirements.

2. Where steelwork is permanently assured after erection of freedom from weathering, wind-driven rain, high humidity, condensation, etc., consideration should be given to limiting the painting (exclusive of decorative coats in finished areas) to the shop-applied first coat.

3. The specification provisions relative to substitution of finish paints for the second coat of primer in painted spaces is intended only to inform the Contractor that the second coat of primer is not always required. The details of the substitute finish painting should be taken care of elsewhere, e.g., in connection with painting of room walls and ceilings.

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Apply the coating system in accordance with the manufacturer's written instructions. It must be a 2-coat system. Application of the system in less than two coats will not be accepted. Procure all materials from the same coating manufacturer. The individual paints comprising the system must have been tested and passed all requirements of the applicable SSPC standards. Application must be by spray, brush, or roller in accordance with the manufacturer's written instructions. Comply with the manufacturer's recommendations regarding mixing and thinning requirements, and pot life requirements, dry film thickness per coat and minimum and maximum dry time between coats. Do not use coating material that has thickened appreciably. Areas of bubbling noted upon curing of any individual coat must be removed by sanding or screening, the edges feathered, and the coat reapplied to the repaired areas before a subsequent coat is applied.

3.3.28 System No. 23-F-Z

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NOTE X:

1. Paint System No. 23-F-Z is comprised of three-coats of moisture cure urethane. The primer is a zinc-rich coating conforming to SSPC Paint 40, Type II. The primer may be packaged as a single component paint containing the zinc or a two component material where the zinc must be incorporated into the liquid paint. The second and third coats are a single component aromatic moisture cure urethane conforming to SSPC Paint 41 and containing aluminum.

2. Coating System 23-F-Z is recommended for general use on atmospheric steel applications where an aluminum color is desired. Typical applications include service bridges, exterior of penstocks, lifting machinery, cranes, motors, and similar miscellaneous items located at civil works navigation, flood control or hydropower installations. If applied over a white metal blast cleaned surface, the system does withstand long term fresh water immersion where its usefulness overlaps with the vinyl systems. However, System 23-F-Z is not as durable as the vinyl systems because it is less abrasion resistant.

3. The usefulness of this system also overlaps with System No.1, a two-coat aluminum epoxy mastic system. However, System No. 23-F-Z is superior to System No. 1 when systems are applied to a commercial blast cleaned surfaces. System No. 23-F-Z is more expensive than System No. 1.

****

Apply the coating system in accordance with the manufacturer's written instructions. It must be a 3-coat system plus an additional stripe coat applied by brush to all edges, corners, welds, fasteners, and other surface irregularities. Allow the stripe coat to dry as recommended by the manufacturer, prior to the application of the first full coat. Procure all materials from the same coating manufacturer. The individual paints comprising the system must have been tested and pass all of the requirements of the applicable SSPC standards. Apply the coatings by spray in accordance with the manufacturer's written instructions. Limited use of brush and roller application is permitted provided the specified film thicknesses are achieved. Comply with the manufacturer's recommendations regarding mixing and thinning requirements, and pot life requirements, dry film thickness per coat and minimum and maximum dry time between coats. Do not use coating material that has thickened appreciably. Areas of bubbling noted upon curing of any individual coat must be removed by sanding or screening, the edges feathered, and the coat reapplied to the repaired areas before a subsequent coat is applied.

3.3.29 Protection of Nonpainted Items and Cleanup

Maintain walls, equipment, fixtures and all other items in the vicinity of the surfaces being painted free from damage by paint or painting activities. Promptly repair any paint spillage and painting activity damage.

3.4 INSPECTION

Surface preparation and painting inspections must be conducted by an inspector certified as meeting one of the following designations: SSPC-PCI Level 2, NACE-CIP Level 2. The inspector will inspect and document all work phases and operations on a daily basis and submit daily Inspection Reports. As a minimum the daily report must contain the following:

a. Inspections performed, including the area of the structure involved and the results of the inspection.

b. Surface preparation operations performed, including the area of the structure involved, the mode of preparation, the kinds of solvent, abrasive, or power tools employed, and whether contract requirements were met.

c. Thinning operations performed, including thinners used, batch numbers, and thinner/paint volume ratios.

d. Application operations performed, including the area of the structure involved, mode of application employed, ambient temperature, substrate temperature, dew point, relative humidity, type of paint with batch numbers, elapsed time between surface preparation and application, elapsed time for recoat, condition of underlying coat, number of coats applied, and if specified, measured dry film thickness or spreading rate of each new coating.

3.5 PAINTING SCHEDULES

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NOTE Y: In the case of formulations in which the type and amount of pigment are fixed, the manufacturer may be limited in the latitude of shades and colors that can be obtained. Colors should be selected in advance and designated in the project specifications or in the drawings. Insofar as practicable, colors must be designated by making use of SAE AMS-STD-595A color designations. When a proprietary or SSPC paint is specified, colors can be specified as approximating those not necessarily as matching the SAE AMS-STD-595A color designation.

1. The number assigned to each paint system should not be changed locally even though on specific projects some systems are omitted. If other systems are added locally, they should be assigned numbers other than those used in this guide. See also final

general note below for instructions relative to numbering other systems.

2. For maintenance of existing paint systems use System No. 23-D. For further guidance in maintenance painting, see EM 1110-2-3400.

3. For quick guidance to the first choice coating systems for steel surfaces from each of several exposure conditions frequently incurred on civil works projects, the following will be helpful:

a. Normal exterior atmospheric exposure - System No. 23 D or 23-F-Z.

b. Prolonged condensation, high humidity, coastal structures not subject to immersion, System No. 23-C-Z (colors) or 23-F-Z (aluminum).

c. Immersion in relatively quiet, minimally abrasive waters - System No. 3-A-Z.

d. Immersion in moderately-to-highly turbulent, abrasive waters - System No. 5-C-Z or 5-E-Z.

e. Immersion in very turbulent, ice- and debris-laden waters - System No. 6-Z-A of Section 09 97 10.00 10 METALLIC COATINGS FOR HYDRAULIC STRUCTURES.

f. Immersion in sea water or other extremely corrosive waters - System No. 6-A-Z (coal tar) or 21-A-Z (colors).

g. Immersion in fresh water where protection from zebra mussel fouling is deemed critical - System No. 6-Z-A of Section 09 97 10.00 10 METALLIC COATINGS FOR HYDRAULIC STRUCTURES.

4. For further information regarding system selection refer to the notes in the following general index.

GENERAL INDEX: (Substrate/Environment)	**Refer to Note No.**
Aluminum	**J8, P3, Q1, V4**
Battery Rooms	**P7, Q2**
Bridges	**I1, X**
Concrete	
Exposed to chemicals or sewage	**K5, Q2**
Interior	**P1, P4**

GENERAL INDEX: (Substrate/Environment)	Refer to Note No.
Floors	E, Q2, L, R
Copper	U4
Dewatering and drainage sumps	K1, L1, L2
Doors, wood or steel	P4, P5
Flooded compartments	K1
Floor grating	O2
Galvanized materials	I2, O2, V4
Galvanized Interior:	
High condensation	V4, O3
Nonexposed	I2, O3
Gantries	I1
Gates	J1, J2, J3, J4, J5, J6, K4, I1, M3, Q4, Q8
Gate wells	L1
Light standards	I1
Local protection projects	K1, L2
Painted Steel	B, I2, V2
Penstocks	I4, J4, K1, U
Piling, steel	K3, K4, Q4
Pipe and conduit	I1, I2, J4, J5, K1, K2, O3, Q7, V4
Pumps and machinery	I1, L1, L2, L3, U
Spiral (turbine) case	J4, K1
Stairwells	P4
Steel:	
Corrosive	J3, K1, O4
Damp or wet	M

GENERAL INDEX: (Substrate/Environment)	Refer to Note No.
Freshwater immersion:	
Low velocity	J3, K1, Q4
Med high velocity	J4
Intermittent immersion	J2, J3, K1, Q5, U
High condensation	D, H, I4, J1, J3, N1, V4, W
High temperature	I1, N1, N2
Normal exposure	A, H, Q8
Salt water immersion	A, T
Severe industrial	I4, K1, O3, V4
Tidal splash zones	J2, K4, Q4
Stop logs	J3
Structural framework	W1
Surge chambers	J4, L1
Tanks:	
Exterior	I1, K2
Interior	J3, J4
Trash rack	J4
Valves	J1, J4, J5
Walls (High-maintenance areas)	P4
Wall protection, corner	I1
Window frames	P4
Zebra mussel	Y4 (g)

****

SYSTEM NO. 1	
Items or surfaces to be coated:	[_____]
SURFACE PREPARATION	PAINT SYSTEM
Alternate 1: Power tool or brush-off blast cleaning	SSPC PS 26.00 Type II
Alternate 2: Commercial blast cleaning	SSPC PS 26.00 Type I

****

NOTE: The above alternatives are not intended to be a Contractor option. Type II coating should be specified for minor touch up and repair of previously painted surfaces that are in generally good condition. Type I coating should be used to prepare previously painted surfaces that are in poor condition or steel that has never been painted. See Note to Paragraph titled "System No. 1" above.

****

SYSTEM NO. 3				
Items or surfaces to be coated:		[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT	4th COAT
White metal blast cleaning	White Vinyl V-766E (double spray coat)	Gray Vinyl V-766E (double spray coat)	Aluminum Vinyl V-102E (double spray coat)	Aluminum Vinyl V-102E (double spray coat)

SYSTEM NO. 3-A-Z				
Items or surfaces to be coated:		[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT	4th COAT
White metal blast cleaning	Vinyl zinc-rich VZ-108D (double spray coat)	White Vinyl V-766E (double spray coat)	Aluminum Vinyl V-102E (double spray coat)	Aluminum Vinyl V-102E (double spray coat)

SYSTEM NO. 4					
Items or surfaces to be coated:			[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT	4th COAT	5th COAT
White metal blast cleaning	White Vinyl V-766E (double spray coat)	Gray Vinyl V-766E (double spray coat)	White Vinyl V-766E (double spray coat)	Gray Vinyl V-766E (double spray coat)	Gray Vinyl V-766E (double spray coat)

SYSTEM NO. 5-A-Z				
Items or surfaces to be coated:		[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT	4th COAT
White metal blast cleaning	Vinyl zinc-rich VZ-108D (double spray coat)	White Vinyl V-766E (double spray coat)	Black Vinyl V-103C (double spray coat)	Black Vinyl V-103C (double spray coat)

SYSTEM NO. 5-C-Z				
Items or surfaces to be coated:		[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT	4th COAT
White metal blast cleaning	Vinyl zinc-rich VZ-108D (double spray coat)	Dark Red Oxide Vinyl V-106D (double spray coat)	Light Red Oxide Vinyl V-106D (double spray coat)	Dark Red Oxide Vinyl V-106D (double spray coat)

SYSTEM NO. 5-D					
Items or surfaces to be coated:			[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT	4th COAT	5th COAT
White metal blast cleaning	Dark Red oxide Vinyl V-106D (double spray coat)	Light Red oxide Vinyl V-106D (double spray coat)	Dark Red oxide Vinyl V-106D (double spray coat)	Light Red oxide Vinyl V-106D (double spray coat)	Dark Red oxide Vinyl V-106D (double spray coat)

)

SYSTEM NO. 5-E-Z				
Items or surfaces to be coated:		[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT	4th COAT
White metal blast cleaning	Vinyl zinc-rich VZ-108D (double spray coat)	Gray Vinyl V-766E (double spray coat)	White Vinyl V-766E (double spray coat)	Gray Vinyl V-766E (double spray coat)

SYSTEM NO. 6			
Items or surfaces to be coated:		[_____]	
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
White metal blast cleaning	Coal tar epoxy C-200A (black)	Coal tar epoxy C-200A (black)	Coal tar epoxy C-200A (black) (if needed to attain required thickness)

SYSTEM NO. 6-A-Z			
Items or surfaces to be coated:		[_____]	
SURFACE PREPARATION	1st & 2nd COAT	3rd COAT	4th COAT
White metal blast cleaning	MIL-DTL-24441/19C	Coal tar epoxy C-200A (black)	Coal tar epoxy C-200A (black)

SYSTEM NO. 7			
Items or surfaces to be coated:	[______]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
Alternate 1: Power tool or brush-off blast cleaning	SSPC Paint 33	SSPC Paint 33	SSPC Paint 33
Alternate 2: Commercial blast cleaning	SSPC Paint 33	SSPC Paint 33	SSPC Paint 33

****

NOTE: ABOVE ALTERNATES ARE NOT INTENDED TO BE CONTRACTOR'S OPTIONS.

****

SYSTEM NO. 8		
Items or surfaces to be coated:	[______]	
SURFACE PREPARATION	1st COAT	2nd COAT
White metal blast cleaning	Paint (for wet surfaces) CID A-A-3130	Additional coats as recommended by the manufacturer

SYSTEM NO. 10		
Items or surfaces to be coated:	[______]	
SURFACE PREPARATION	1st COAT	2nd COAT
White metal blast cleaning	SSPC Paint 20 Type I-B or I-C	SSPC Paint 20 Type I-B or I-C

SYSTEM NO. 12		
Items or surfaces to be coated:	[______]	
SURFACE PREPARATION	1st COAT	2nd COAT
Refer to paragraph SYSTEM NO. 12	SSPC Paint 20 Type II	SSPC Paint 20 Type II

SYSTEM NO. 17			
Items or surfaces to be coated:		[______]	
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
As specified for each type of surface	MPI 50	[MPI 114][MPI 54][MPI 52][MPI 53]	[MPI 114][MPI 54][MPI 52][MPI 53]

SYSTEM NO. 18			
Items or surfaces to be coated:		[______]	
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
As specified for each type of surface	[MPI 46][MPI 50]	[MPI 48][MPI 47][MPI 51][MPI 49]	[MPI 48][MPI 47][MPI 51][MPI 49]

SYSTEM NO. 21		
Items or surfaces to be coated:	[______]	
SURFACE PREPARATION	1st & 2nd COAT	3rd COAT
As specified for each type of surface	MIL-DTL-24441, Sheet [______], Color No. [______]	as needed to obtain specified thickness

SYSTEM NO. 21-A-Z			
Items or surfaces to be coated:		[______]	
SURFACE PREPARATION	1st & 2nd COAT	3rd & 4th COAT	5th COAT
As specified for each type of surface	MIL-DTL-24441/19C	MIL-DTL-24441, Sheet [______], Color No. [______]	as needed to obtain specified thickness

SYSTEM NO. 22	
Items or surfaces to be coated:	[_____]
SURFACE PREPARATION	COATING SYSTEM
As specified by manufacturer	MPI 212

SYSTEM NO. 23-A-Z			
Items or surfaces to be coated:	[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
White metal blast cleaning	SSPC Paint 40 Type II	SSPC Paint 41	SSPC Paint 38 Finish color: [_____]

SYSTEM NO. 23-B-Z			
Items or surfaces to be coated:	[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
White metal blast cleaning	SSPC Paint 40 Type II	SSPC Paint 41 with coal tar pitch	SSPC Paint 41 with coal tar pitch

SYSTEM NO. 23-C-Z			
Items or surfaces to be coated:	[_____]		
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
Commercial blast cleaning	SSPC Paint 40 Type II	MIL-PRF-85285 Type IV Finish color: [_____]	MIL-PRF-85285 Type IV Finish color: [_____] as necessary for complete hiding

SYSTEM NO. 23-D Alternate 1			
Items or surfaces to be coated:		[_____]	
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
Power tool clean and power wash	SSPC Paint 41	SSPC Paint 41 Finish color: [_____]	SSPC Paint 41 Finish color: [_____]
SYSTEM NO. 23-D Alternate 2			
Items or surfaces to be coated:		[_____]	
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
Power tool clean	SSPC Paint 41	SSPC Paint 41 Finish color: [_____]	SSPC Paint 41 Finish color: [_____]

SYSTEM NO. 23-D Alternate 3			
Items or surfaces to be coated:		[_____]	
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
SSPC SP 16	SSPC Paint 41	SSPC Paint 41 Finish color: [_____]	SSPC Paint 41 Finish color: [_____]

SYSTEM NO. 23-E		
Items or surfaces to be coated:	[_____]	
SURFACE PREPARATION	1st COAT	2nd COAT
Alternate 1: Power tool clean	SSPC Paint 41	SSPC Paint 41 Finish color: [_____]
Alternate 2: Brush-off clean	SSPC Paint 41	SSPC Paint 41 Finish color: [_____]

SYSTEM NO. 23-F-Z			
Items or surfaces to be coated:		[_____]	
SURFACE PREPARATION	1st COAT	2nd COAT	3rd COAT
Commercial blast cleaning	SSPC Paint 40 Type II	SSPC Paint 41 with Aluminum	SSPC Paint 41 with Aluminum

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 97 10.00 10 (August 2021)**

Preparing Activity: USACE **Superseding**
UFGS-09 97 01.00 10 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-09 97 10.00 10 (August 2021)**

Preparing Activity: USACE **Superseding**
UFGS-09 97 01.00 10 (May 2009)

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SECTION 09 97 10.00 10

METALLIC COATINGS FOR HYDRAULIC STRUCTURES

08/21

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NOTE: This guide specification covers the requirements for preparation of surfaces and application of metallized coatings for hydraulic structures. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTES: The protective metallic coating systems listed have limited applicability at this time. Some states and municipalities have stringent regulations governing the use of architectural coatings containing volatile organic compounds (VOC). Many of the coating systems found in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES, do not meet VOC regulations in some regions of the country.

The coating systems contained herein are suitable substitutes for the paint systems in Section 09 97 02 and may be used should air pollution regulations so

dictate. It should be noted that some of the sealer and paint coats recommended in this guide may also not be VOC-compliant in some regions of the country.

The use of metallizing system 6-Z-A is advocated for use on steel immersed in very turbulent, ice- and debris-laden fresh waters. Exposures such as this may erode and cause total failure of the standard abrasion-resistant paint systems found in Section 09 97 02 in as little as 1 year. System 6-Z-A, with appropriate sealing and top coating, will provide superior protection for this type of severe service.

The use of metallizing system 8-A is endorsed for high temperature atmospheric exposures. Paint coatings do not generally perform as well as thermal spray coatings of aluminum for high temperature exposures such as stacks. The use of metallizing system 6-Z-A is recommended for use as a zebra mussel repellent coating where the use of such a coating is deemed necessary. System 6-Z-A is longer lived and has a lesser environmental impact than conventional copper-containing antifouling coatings. The use of this guide specification should be limited to work described in this note.

The metallizing systems described in this document are intended for corrosion protection of cold and hot rolled steel. Metallizing systems described herein are not intended for use on stainless steel, aluminum, bronze, copper, plastic, rubber, wood, masonry, and painted surfaces. Coating systems contained herein should not be specified for potable water tank interiors, moving parts or wear surfaces of machinery, or for surfaces subject to strong acids or bases.

For further technical assistance contact:

US Army Construction Engineering Research Laboratory
Attn: CECER-FL-M (Tel 217-373-7237)
P.O. Box 9005
Champaign, IL 61826-9005
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1.1 LUMP SUM PRICE

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NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (LUMP SUM PRICE) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
****

1.1.1 Payment

Payment will constitute full compensation for furnishing all plant, labor, materials and equipment and performing all operations necessary for metallizing hydraulic structures as specified.

1.1.2 Unit of Measure

Unit of measure: Lump Sum

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR QUALITY (ASQ)

ANSI/ASQ Z1.4	(2008; R 2013) Sampling Procedures and Tables for Inspection by Attributes

AMERICAN WELDING SOCIETY (AWS)

AWS A5.01M/A5.01	(2019; R 2024) Procurement Guidelines for Consumables - Welding and Allied Processes - Flux and Gas Shielded Electrical Welding Processes
AWS C2.25/C2.25M	(2012; R 2018) Specification for Thermal Spray Feedstock -- Solid and Composite Wire and Rods
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM D3951	(2018) Commercial Packaging
ASTM D4285	(1983; R 2018) Indicating Oil or Water in Compressed Air

ASTM D4417	(2021) Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D7091	(2021) Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nondestructive Coatings Applied to Non-Ferrous Metals
ASTM E337	(2015; R 2023) Measuring Humidity with a Psychrometer (The Measurement of Wet- and Dry-Bulb Temperatures)

COMPRESSED GAS ASSOCIATION (CGA)

CGA P-1	(2022) Standard for Safe Handling of Compressed Gases in Containers; 13th Edition

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices
ANSI/ISEA Z89.1	(2014; R 2019) American National Standard for Industrial Head Protection

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 2003-154	(2003; 4th Ed; Supple 3) NIOSH Manual of Analytical Methods

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC AB 1	(2015; E 2017) Mineral and Slag Abrasives
SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2023; R 2023) Ferrous Metallic Abrasive
SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.20	Access to Employee Exposure and Medical Records
29 CFR 1926	Safety and Health Regulations for Construction
42 CFR 84	Approval of Respiratory Protective Devices

1.3 DEFINITIONS

1.3.1 Metallizing

Refers to any of several application methods for depositing sprayed-metal coatings.

1.3.2 Wire Flame-Spray

A metallizing process in which metallic wire is melted in an oxygen and fuel gas flame and is dispersed with an airstream.

1.3.3 Arc-Spray

A metallizing process in which metallic wire is melted by an electric arc and is dispersed with an airstream.

1.4 SYSTEM DESCRIPTION

Prepare a thermal spray Job Reference Standard (JRS) at the jobsite prior to the onset of production work. The JRS is used at the initiation of the contract to qualify the surface preparation, thermal spray application, and sealing processes and also serves as a standard of quality in case of dispute. To prepare the JRS, solvent and abrasive blast clean a steel plate measuring 600 x 600 x 10 mm 2 feet x 2 feet x 3/8 inch of the same alloy as the surfaces to be metallized in accordance with the requirements of the contract. Use the same abrasive blast media and equipment that will be used on the job. Mask one-fourth of the JRS plate with sheet metal and apply thermal spray coating to the unmasked portion of the plate. Apply the thermal spray coating using the same equipment, approved wire, and spray parameters to be used on the job. Operate the gun in a manner substantially the same as will be used on the job. Measure and record the approximate traverse speed and standoff distance during spraying. Once the JRS is qualified, the operating parameters must not be altered, except as necessitated by the requirements of the job. Seal two-thirds of the thermal spray coated portion of the JRS in accordance with the requirements of the contract. Paint one-half of the sealed area in accordance with the contract if applicable. Apply the sealer and paint using the same paint spray equipment that will be used for production. Preserve and protect the prepared JRS in such a manner that it remains dry and free of contaminants for the duration of the contract. The Coating Inspector will verify and record surface cleanliness, blast profile shape and depth, thermal spray appearance, thickness, and adhesion, and sealer and paint thicknesses in accordance with the contract requirements.

1.4.1 General Requirements

Perform the work in accordance with the requirements of 29 CFR 1910, 29 CFR 1926, EM 385-1-1, and other references as listed herein. Submit matters of interpretation of the standards to the Contracting Officer for resolution before starting work. Where the regulations conflict, the most stringent requirements apply. This paragraph, with its subparagraphs, supplements the requirements of EM 385-1-1. In any conflict between Section 01 of EM 385-1-1 and this paragraph, the provisions herein govern. Submit a Safety Indoctrination Plan as specified in the Submittals paragraph.

1.4.2 Worker Hazard Communication Program

Submit the written program describing how the program is to be implemented, labels and other forms of warning, Safety Data Sheets(SDS), chemical inventory, employee information and training, methods the Contractor will use to inform employees of hazards associated with nonroutine tasks and unlabeled pipelines, and the methods the Contractor will use to inform Government employees and subcontractors of chemical hazards. The program must discuss the following items: 1) Treatment of airborne metal dusts, finely divided solids, or other particulate accumulations as explosive materials. 2) Maintaining proper ventilation, good housekeeping, and safe work practices to prevent the possibility of fire and explosion. 3) Danger of pointing thermal-spray equipment at a person or flammable material. 4) Avoiding thermal spraying in areas where paper, wood, oily rags, or cleaning solvents are present. 5) Use of conductive safety shoes in any work area where explosion is a concern. 6) Wearing of protective coveralls or aprons, hand protection, eye protection, hearing protection, and respiratory protection during metallizing operations, including the preparation and finishing processes. 7) Preparation and implementation of the Accident Prevention Plan as specified in the Submittals paragraph.

1.4.3 Surface Preparation Procedures

1.4.3.1 Abrasive Blasting

Ventilation and exhaust systems must comply with the requirements in Chapter 6-8.j of EM 385-1-1.

1.4.3.2 Hoses and Nozzles

In addition to the requirements in Chapter 20 of EM 385-1-1, use hoses and hose connections of a type to prevent shock from static electricity. Join hose lengths together by approved couplings of a material and type designed to prevent erosion and weakening of the couplings. The couplings and nozzle attachments must fit on the outside of the hose and be designed to prevent accidental disengagement.

1.4.3.3 Workers other than Blasters

Protect workers other than blasting operators, working in close proximity to abrasive blasting operations, by utilizing MSHA/NIOSH-approved half-face or full-face air purifying respirators equipped with high-efficiency particulate air (HEPA) filters, eye protection meeting or exceeding ANSI/ISEA Z87.1 and hearing protectors (ear plugs and/or ear muffs) providing at least 20 dBA reduction in noise level.

1.4.3.4 Personal Protective Equipment

Blasting operators must wear heavy canvas or leather gloves and apron or coveralls. Safety shoes must be worn to protect against foot injury. Hearing protection must be used during all blasting operations.

1.4.4 Metallizing Equipment

Submit for approval a tabulated list of equipment to be used on the job, including operating instructions.

1.4.4.1 Pressure Systems

Handle compressed gas cylinders in accordance with AWS Z49.1 and with CGA P-1. Use only special oxidation-resistant lubricants with oxygen equipment; do not use grease or oil. Install manifolding and pressure reducing regulators, flow meters, hoses, and hose connections in accordance with AWS Z49.1. Draw up tight, but do not over-tighten pressure connecting nuts. Replace any fitting if it cannot be sealed without excessive force. Use compressed air for thermal spraying or blasting operations only at pressures recommended by the equipment manufacturers. The air-line must be free of oil and moisture. Compressed air, oxygen, or fuel gas must not be used to clean clothing.

1.4.4.2 Flame-Spray Equipment

Maintain and operate flame-spray equipment according to the manufacturer's instructions. Metallizing operators must be fully trained in and familiar with specific equipment before starting an operation. Valves must be properly sealed and lubricated. Use friction lighters, pilot light, or arc ignition methods of lighting flame-spray guns. If a gun backfires, extinguish it as soon as possible. Do not attempt to reignite a gun that has backfired or blown out until the cause of the trouble has been determined. Do not hang flame-spray guns or hoses on regulators or cylinder valves. Release gas pressure from the hoses after equipment is shut down or when equipment will be left unattended. The pressure release sequence is as follows:

a. Close gun valves.

b. Close cylinder valve.

c. Open gun valves.

d. Turn regulator screw out until free.

e. Close gun valves.

f. Close tank valve or manifold valve ahead of regulator.

Do not allow oil to enter the gas mixing chambers when cleaning flame-spray guns. Use only special oxidation-resistant lubricants on valves or other parts of flame-spray guns that are in contact with oxygen or fuel gases.

1.4.4.3 Arc-Spray Equipment

Maintain and operate arc-spray equipment according to the manufacturer's instructions. Metallizing operators must be fully trained in and familiar with specific equipment before starting an operation.

1.4.5 Cleaning

1.4.5.1 Compressed Air

Perform cleaning with compressed air in accordance with Chapter 20-8.b of EM 385-1-1; protect personnel as specified in 29 CFR 1910, Part 139.

1.4.5.2 Solvents

Provide ventilation where required by 29 CFR 1910, Part 146 or where the concentration of solvent vapors exceeds 10 percent of the Lower Explosive Limit (LEL). Ventilation must be in accordance with 29 CFR 1910, Part 94, paragraph (c)(5). Sources of ignition are not permitted in the vicinity of solvent cleaning if there is any indication of combustible gas or vapor present. Take special precautions when metallizing materials that have been cleaned with hydrocarbon solvents. Make specific measurements to ensure that such solvent vapors are not present during metallizing operations, especially in confined spaces. Submit Confined Space Procedures as specified in the Submittals paragraph and including requirements for toxic materials and air sampling in confined spaces, as specified below. Collect representative air samples from the breathing zone of workers involved in the cleaning process to determine the specific solvent vapor concentrations. Provide personal protective equipment where required by 29 CFR 1910, Part 146 and in accordance with 29 CFR 1910, Subpart I.

1.4.6 Other Submittals Requirements

Submit the following:

a. SDS for all products required to have them as specified in 29 CFR 1910, Part 1200 plus documentation of the safety indoctrination plan as described in Chapter 6-2.q of EM 385-1-1.

b. An Accident Prevention Plan, in accordance with the requirements of Chapter 01 of EM 385-1-1, including, but not limited to, each of the topic areas listed in Appendix A therein and the specified requirements. Develop each topic in a concise manner to include management and operational aspects.

c. Detailed written standard operating procedures for confined spaces in accordance with 29 CFR 1910, Part 146 and Chapter 34. of EM 385-1-1. The procedures must include:

    (1) Certificates of calibration for all testing and monitoring equipment including: type of equipment, model number, date of calibration, firm conducting calibration, and signature of individual certifying calibration.

    (2) Methods of inspection of personal protective equipment prior to use.

    (3) Work practices and other engineering controls designed to reduce airborne hazardous chemical exposures to a minimum.

    (4) Specification of the design and installation of ventilation systems which must provide adequate oxygen content and provide for the dilution of paint solvent vapor, lead, and other toxic particulates within the confined space. Include plans to evaluate

the adequacy of air flow patterns.

d. A comprehensive written respiratory protection program in accordance with 29 CFR 1910, Part 134, 29 CFR 1926, Part 62, and Chapter 5-3.c of EM 385-1-1. Include an Airborne Sampling Plan detailing the NIOSH 2003-154, Factory Mutual, or Underwriters Laboratories requirements.

e. A written plan for ventilation assessments to be performed by a qualified person for all confined-space work, solvent cleaning, abrasive blasting, and metallizing operations.

f. A written Hazard Communication Program as required by 29 CFR 1910, Part 1200.

g. A tabulated list of metallizing equipment to be used on the job and a listing of the type, brand name, size gradation, and supplier of each type of abrasive blast media to be used on the job.

h. A written record of physical examinations provided to all employees who may be required to wear a respirator, who may be exposed to excessive noise levels, or who may be exposed to toxic contaminants, including statements signed by the examining physician for each employee stating that the exam included the minimum requirements and that the employee is medically fit to perform the work.

i. Documentation of the Contractor's qualifications and experience. Prior to submission of other required safety and health submittal items, a statement of qualifications and experience for the Competent Person. Documentation of coating inspector qualifications and experience.

j. A working standard of the metallized coating. A 1 kg 2.2 lb unused sample of each blast media to be used on the job. And one liter quart samples of each type and batch of sealer and paint to be used on the job.

k. A 300 mm 12 inch sample of each lot and type of wire to be used on the job. Store batches or lots of metallizing wire at the project site or segregate them at the source of supply sufficiently in advance of need to allow 30 days for sampling and testing. Notify the Contracting Officer when and where the metallizing wire is available for sampling. Perform all sampling in accordance with ANSI/ASQ Z1.4. Sampling of each lot will be witnessed by a representative of the Contracting Officer unless otherwise specified or directed. Samples of metallizing wire must be clearly labeled to indicate type of coating material, lot number, date, name of manufacturer, total weight represented by lots, and contract number.

l. A test report showing the results of the required tests performed on the metallized coating test plates for each applicator and a statement that the specified requirements are met. A test report showing the results of the tests required for the metallizing wire and the arc spraying equipment qualification. A test report showing the results of the required tests performed on the Job Reference Standard (JRS) and a statement that all of the contract requirements of surface preparation, metallized coating, sealing, and painting are represented by the JRS.

m. Certificates of qualifications for each Coating Inspector. And manufacturer's certificates of compliance.

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Safety Data Sheets

Accident Prevention Plan; G, [_____]

Confined Space Procedures; G, [_____]

Respiratory Protection Program; G, [_____]

Airborne Sampling Plan; G, [_____]

Ventilation Assessment Plan; G, [_____]

Worker Hazard Communication Program; G, [_____]

Metallizing Equipment; G, [_____]

Abrasive Media; G, [_____]

Contractor Qualifications and Experience

Competent Person Qualifications and Experience; G, [_____]

Safety Indoctrination Plan; G, [_____]

SD-04 Samples

Job Reference Standard (JRS)

Blast Media

Metallizing Wire

Sealer and Paint; G, [_____]

SD-06 Test Reports

Applicator Qualification Test

Metallizing Wire

Arc Spray Equipment Qualification

Job Reference Standard (JRS); G, [_____]

SD-07 Certificates

Coating Inspectors

Coating Thickness Gages

1.6 QUALITY ASSURANCE

1.6.1 Contractor Qualifications and Experience

The contractor must have a minimum of two years of documented experience in the field of thermal spray and have performed at least one similar project in the past.

1.6.2 Arc Spray Equipment Qualification

Each type and model of arc spray equipment to be used on the job must be qualified in accordance with the requirements of this subpart. Under conditions of continuous use, the equipment must be capable of keeping the actual current output, voltage, wire feed rate, atomization air pressure, and flow volume at set values and not deviate from them by more than 5 percent during a 15 minute period. The wire feed mechanism must be designed for automatic alignment. When operated continuously for 15 minutes the equipment and not sputter, pop, or stop operating. The equipment must be capable of continuous start and stop operation for a minimum of fifteen cycles consisting of 10 seconds on and 5 seconds off, without fusing, sputtering or deposition of nodules. The applied coating must be uniform and free of blisters, cracks, loosely adherent particles, nodules, or powdery deposits. The required measurements of operating performance must be conducted and documented by the qualified Coating Inspector.

1.6.3 Metallizing Applicator Qualification

Perform the Applicator Qualification Test in the presence of the Contracting Officer unless otherwise specified or directed. Qualify each worker to apply metallized coatings on the job in accordance with the requirements of this paragraph. Use test plates to qualify applicators at the start of a job that are 305 x 305 x 9.5 mm 12 x 12 x 0.375 inch flat steel and are of the same chemical composition as the work surfaces to be coated. The cleaning method and abrasives used to prepare the test plate are the same as that to be used on the work surfaces. Measure and record the blast profile in accordance with ASTM D4417, Method C. Apply the specified coating thickness in not less than two half lapped passes applied at right angles to each other. Test the adhesive strength in accordance with ASTM D4541 using a self-aligning Type IV adhesion tester. Measure and record the adhesion strength at five randomly selected locations. The average adhesion must not be less than [6.9 kPa 1000 psi for 85-15 zinc-aluminum alloy] [11 kPa 1600 psi for aluminum] [5.2 kPa 750 psi for zinc]. Any test plate with an average adhesion value below the requirements of this paragraph or any plate with a single adhesion measurement of less than 80-percent of the specified minimum average adhesion value will be rejected. If the test fails repeat the test using a new test plate. If the test fails on the second plate the applicator will be deemed unacceptable. The specified surface profile and adhesion tests must be conducted and documented by the qualified Coating Inspector.

1.6.4 Coating Inspector Qualifications and Experience

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NOTE: Specify NACE Basic for most projects, NACE Certified for large or complex projects. The specifier may add a requirement for the qualified coating inspectors to be employed by an independent 3rd party inspection firm.

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Submit documentation of certification for all coating inspectors. The minimum certification requirement is a [Basic] [Certified] Inspector under the National Association of Corrosion Engineers Coating Inspector Training and Certification Program. The documentation must include the NACE inspector identification numbers, date of qualification, and expiration date. In addition to certification all coating inspectors must as a minimum have performed coating inspection on at least one previous thermal spray job or have attended an SSPC tutorial on thermal spray coating application.

1.6.5 Metallized Coating Thickness Gage Qualification

Submit documentation of certification for all coating thickness gages. Use magnetic flux-type thickness gages, as described in ASTM D7091, Method B, to make all metallized coating thickness measurements. Thickness gages used on the job must be certified by the gage manufacturer as having an accuracy of 3 percent or better.

1.6.6 Competent Person Qualifications and Experience

Utilize a qualified and competent person, as defined in Chapter 1.3.a of EM 385-1-1, to develop the required safety and health submittal and to provide onsite safety and health services during the contract period. The person must be a Certified Industrial Hygienist (CIH), an Industrial Hygienist (IH), or a Certified Safety Professional (CSP) with a minimum of 3 years of demonstrated experience in similar related work. Certify that the Certified Industrial Hygienist (CIH) holds current and valid certification from the American Board of Industrial Hygiene (ABIH), that the IH is considered board eligible by written confirmation from the ABIH, or that the CSP holds current and valid certification from the American Board of Certified Safety Professionals. The CIH, IH, or CSP may utilize other qualified and competent persons, as defined in EM 385-1-1, to conduct onsite safety and health activities as long as these persons have a minimum of 3 years of demonstrated experience in similar related work and are under the direct supervision of the CIH, IH, or CSP.

1.6.7 Safety and Health Provisions

1.6.7.1 Electrical Shock Prevention

Control of electrical shock must include, but is not limited to, the following:

a. Properly maintain all cords and ground protection in good condition. Any damaged cords or grounding equipment must be immediately repaired or replaced. Cords must not be spliced.

b. Cords must be approved for wet or damp locations and be rated for hard usage or extra hard usage as specified in NFPA 70.

c. Use Ground Fault Circuit Interrupters (GFCI) in addition to appropriate overcurrent protection on all electrical outlets.

d. Switches and receptacles must have proper covers. Circuit breaker boxes must be closed.

e. Test all electrical circuit grounds and GFCI before beginning any actual work.

1.6.7.2 Respiratory Protection Program

Use appropriately certified respiratory equipment to protect the health of each employee who may be exposed to air contaminants. Select appropriate respirators from those currently approved and certified by NIOSH under the provisions of 42 CFR 84 and 29 CFR 1910, Part 134.

1.6.7.3 Eye Protection

Use helmets, handshields, faceshields, and goggles conforming to ANSI/ISEA Z87.1 and ANSI/ISEA Z89.1 to protect the eyes from infrared and ultraviolet radiation and flying particles during spraying or blasting operations. Provide helpers and adjacent operators with proper eye protection. Supplement faceshields with safety goggles.

1.6.7.4 Hearing Protection

Provide protection against the effects of noise exposure in accordance with

EM 385-1-1, Chapter 5, "Personal Protective and Lifesaving Equipment," Subchapter 5-3.b, "Hearing Protection," and 29 CFR 1910, Part 95.

1.6.7.5 Protective Clothing

Appropriate protective clothing is required for spray or blast operations.

1.6.7.6 Ventilation

Provide engineering controls, including local exhaust or general ventilation systems, to control toxic fumes and gases to the extent necessary. When toxic particulates are removed from a work area, use a dust collector to trap the dust and prevent contamination of the surrounding areas and the general environment. Submit a Ventilation Assessment Plan as specified in the Submittals paragraph.

1.6.7.7 Toxic Materials

Perform metallizing only with appropriate respiratory protection and adequate ventilation. When metallizing in a confined space provide either general or local ventilation. If ventilation cannot reduce exposures to safe levels, use respirators to reduce employee exposure to acceptable levels.

1.6.7.8 Air Sampling

Perform periodic air sampling as necessary to ensure that confined spaces are maintained within the limits of the acceptable entry conditions. Submit an Airborne Sampling Plan including a listing of approved equipment, equipment calibration procedures, sampling methods, sampling to be performed, and analytical procedures to be used based on the type of work to be performed and anticipated toxic contaminants to be generated. Include the name of the accredited laboratory, listed by the American Industrial Hygiene Association (AIHA), to be used to conduct the analysis of any collected air samples.

1.6.7.9 Medical Status

Prior to the start of work, and annually thereafter, submit a Medical Status Report. Medically evaluate all Contractor employees working with or around paint systems, thinners, blast media, flame- or arc-spray operations, those required to wear respiratory protective equipment, and those who will be exposed to high noise levels for the particular type of exposure they may encounter. The Report must include the employee's name, the tests performed, the name of the physician responsible for performing the tests, and a physician's statement that the employee's medical status would permit specific task performance. Maintain medical records as required by 29 CFR 1910.20. The evaluation must include:

a. Audiometric testing and evaluation of employees who will work in a noise environment with a time weighted average greater than or equal to 85 dBA.

b. Vision screening of employees who will require eye protection (employees who use full-facepiece respirators cannot wear contact lenses).

c. Medical evaluation of employees who will be required to wear respiratory protection must include, but is not limited to, the

following:

(1) Medical history including, but not limited to, alcohol use, with emphasis on liver, kidney, and pulmonary systems, and sensitivity to chemicals to be used on the job.

(2) General physical examination with emphasis on liver, kidney, and pulmonary system.

(3) Determination of the employee's physical and psychological ability to wear respiratory protective equipment and to perform job-related tasks.

(4) Determination of baseline values of biological indices for later comparison to changes associated with exposure to paint systems and thinners or blast media, which include: liver function tests to include SGOT, SGPT, GGPT, alkaline phosphates, bilirubin, complete urinalysis, EKG (employees over age 40), blood urea nitrogen (bun), serum creatinine, pulmonary function test, FVC, and FEV, chest x-ray (if medically indicated), blood lead and ZPP (for individuals where it is known there will be an exposure to materials containing lead), other criteria that may be deemed necessary by the Contractor's physician.

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NOTE: 29 CFR 1926.62 Lead requires the development of a Worker Protection Plan for jobs involving removal of lead-containing coatings. It is the specifier's responsibility for determining when lead-containing paint will be removed and requiring the appropriate submittals including environmental compliance, worker protection, and waste management.

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1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Metallizing Wire

Package, ship, and store metallizing wire in conformance with ASTM D3951. Commercial packaging used for distribution directly to a using customer or subsequent redistribution is required to protect items against physical and environmental damage during shipment, handling, and storage. Clearly and durably label individual spool containers and shipping containers to indicate contract numbers, specification number, material type, lot number, net weight, date of manufacture (month and year), wire diameter, and manufacturer's and distributor's name. Deliver metallizing wire to the job in unbroken containers. Store all metallizing wire under cover from the elements.

1.7.2 Sealers and Paints

Process and package sealers and paints to ensure that within a period of one year from date of manufacture, they will not gel, liver, or thicken deleteriously, or form gas in the closed container. Package sealers and paints, unless otherwise specified or permitted, in standard containers not larger than 20 L 5 gallons, with removable friction or lug-type covers. Label each container or separately packaged component thereof to indicate the purchaser's order number, date of manufacture, manufacturer's batch number, quantity, color, component identification and designated name, and formula or specification number of the paint together with special labeling instructions, when specified. Deliver materials to the job in unbroken containers. Store sealers and paints, that can be harmed by exposure to cold weather, in ventilated, heated shelters. Store all sealers and paints under cover from the elements and in locations free from sparks and flames.

1.8 ENVIRONMENTAL REQUIREMENTS

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NOTE: Minimum and maximum application temperatures should be specified for metallized coating-sealer duplexes. The established limits for sealer and paint topcoats should be specified for the entire system. Vinyl sealers and paints are generally limited to a minimum application temperature of 2 degrees C 35 degrees F. All other sealers and topcoats have a minimum application temperature of 10 degrees C 50 degrees F. If no sealer or paint is to be applied then the minimum application temperature is unlimited, however, a practical limit of 2 degrees C 35 degrees F is recommended.

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Apply metallic coatings only to surfaces that are a minimum of 3 degrees C 5 degrees F above the dew point and that are completely free of moisture as determined by sight and touch. Do not apply metallic coatings to surfaces upon which there is detectable frost or ice. Metallized coatings must not be applied when ambient and surface temperatures are below or are expected to drop below the minimum application temperature prior to completion of metallizing and curing of the sealer and paint. The minimum application temperature is equal to that specified by the manufacturer of the sealer or paint but not below 0 degrees C 32 degrees F. During periods of inclement weather characterized by extremes of humidity and temperature, metallizing may be continued by enclosing the work area and providing conditioned air, provided the proscribed ambient, surface, and dew point temperatures are maintained.

PART 2 PRODUCTS

2.1 METALLIZING WIRE

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NOTE: For quick guidance to the first choice metallizing system, for steel surfaces in each of several exposure conditions frequently incurred on projects, the following will be helpful:

Normal atmospheric exposures - Systems No. 1-Z and 4-Z-A.

Severe industrial atmospheric exposures - Systems No. 2-Z and 5-Z-A.

Prolonged condensation or immersion in relatively quiet, nonabrasive waters - System No. 5-Z-A.

Industrial atmosphere where longer service life is desired - Systems No. 3-Z and 6-Z-A.

Immersion in turbulent, ice- and debris-laden, abrasive waters - System No. 6-Z-A.

Zebra mussel control in fresh water immersion - System 6-Z-A.

Marine (salt) atmospheric exposures - System No. 7-A.

High temperature steel - System No. 8-A.

Immersion in sea water - System No. 8-A.

The following note paragraphs provide additional, useful information regarding the use of the different metallizing systems for specific applications.

For structural components that are only partially submerged, such as tainter gates, the designer should consider specifying a thicker system on the immersed surfaces and a thinner system on the atmospherically exposed surfaces. Systems using different metallizing materials should not be used for such applications. The use of multiple protective coating systems tailored to a specific structure may result in significant cost savings.

Systems No. 1-Z and 4-Z-A are considered equivalent and may be interchanged by the project specification writer. Systems No. 1-Z and 4-Z-A are intended for use on steel surfaces in normal atmospheric exposures.

Systems No. 2-Z and 5-Z-A are considered equivalent for atmospheric exposures only and may be interchanged by the project specification writer for this use. Systems No. 2-Z and 5-Z-A are intended for use on steel surfaces in normal and severe industrial atmospheres and for steel surfaces subject to prolonged periods of condensation. System 5-Z-A may also be used on steel surfaces in continuous or intermittent immersion in relatively quiet, nonabrasive fresh water.

For atmospheric exposures only, systems No. 3-Z and 6-Z-A are considered equivalent and may be interchanged by the project specification writer. Systems No. 3-Z and 6-Z-A may be used for steel surfaces exposed in normal and industrial atmospheres when a longer service life than would be provided by systems No. 2-Z or 5-Z-A is desired. System No. 6-Z-A is intended primarily for use on steel surfaces immersed in fresh waters.

System 6-Z-A is recommended for applications where a coating that prevents zebra mussel fouling is required.

System No. 7-A is recommended for use on steel surfaces in marine (salt) atmospheric exposures.

Metallizing system No. 8-A is recommended for use on high-temperature steel at temperatures up to 900 degrees C 1650 degrees F and for steel immersed in seawater. System No. 8-A may also be used for extended service on marine (salt) atmospheric steel.

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Have the wire tested by a commercial laboratory or by the manufacturer of the wire. Acceptance of metallizing wire is based on the testing requirements described in AWS A5.01M/A5.01 Schedule H (chemical analysis). The tested wire must conform to the compositional requirements specified in AWS C2.25/C2.25M for [99.99 Zinc] [1100 Aluminum] [85/15 Zinc-Aluminum] wire. Submit a report of the test results.

2.2 SEALER AND PAINT

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NOTE: See paragraph SPECIAL PAINTING INSTRUCTIONS for instructions not found in Section 09 97 02.

Metallizing systems will provide excellent atmospheric corrosion protection for extended periods without sealing or painting. However, painting is recommended to extend the life of the metallic coating, and in some cases, to achieve a desired appearance. Painting systems found in Section 09 97 02 may be used to seal and paint the metallized surface. It is often convenient to paint metallized surfaces with identical paint systems employed on adjacent or contacting surfaces that have not been metallized. Paint systems No. 3, 4, and 5-D are suitable for sealing atmospherically exposed portions of partially immersed items such as tainter gates. Systems 13, 14, and a modified version of system 21 where it is topcoated with SSPC Paint 34, are recommended for items only exposed to the atmosphere. Paint systems No. 14 and SSPC Paint 34 are available in safety colors. Paint system 13 provides an aluminum finish. Other coating systems found in Section 09 97 02 are not recommended.

When used for high temperature atmospheric applications system 8-A should not be sealed.

Sealing and painting of the metallized surfaces intended for immersion is generally recommended to extend the life of the metallic coating except that aluminum coatings to be immersed in salt water should not be painted. Paint systems No. 3, 4, 5-D, and 21 are recommended for immersion applications.

When used as a zebra mussel antifoulant, system 6-Z-A should not be sealed or painted.

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All sealer and paint materials must conform to the requirements of Section

09 97 02 PAINTING: HYDRAULIC STRUCTURES.

2.3 ABRASIVE MEDIA

Provide angular abrasive blast media capable of producing the specified surface profile listed in paragraph Abrasive Blasting. The blast media must be steel grit, garnet, iron oxide, coal slag, silicon carbide, or aluminum oxide. New steel grit must have a Rockwell C hardness of 51 or greater and conform to the requirements of SSPC AB 3 including paragraph 4.3.3.2 Steel Grit. Steel grit hardness must be Rockwell C of 51 or greater. Recycled steel grit must conform to the requirements of SSPC AB 2 and at no time contain greater than 15 per cent round or half-round particles when viewed under a 10X microscope or magnifying glass. Garnet abrasive must conform to the requirements of SSPC AB 1, Type 1, Class A. Iron oxide abrasive must be a commercial specular hematite material. Coal slag abrasive must conform to the requirements of SSPC AB 1, Type 2, Class A. Silicon carbide and aluminum oxide abrasives must be commercially pure.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Pit, Edge, and Weld Preparation

Grind visibly rough flame-cut steel and weld metal with a disk wheel grinder or other tool to produce a smooth contour prior to abrasive blasting. Perform grinding of flame-cut edges and welds to the extent necessary to etch heat-hardened metal. Grind pits with an aspect ratio of greater than unity (as deep as they are wide) with an abrasive disk or other tool prior to blasting. Pits with sharp edges, undercut pits, and pits with an irregular horizontal or vertical orientation must also be ground smoothto the extent necessary to allow the entire surface of the pit to be blasted and coated. Grind sharp edges prior to abrasive blasting to a uniform minimum diameter of 3 mm 1/8 inch.

3.1.2 Abrasive Blasting

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Note: Consideration should be given to high-pressure water washing when the substrate to be metallized has previously been exposed to a chloride environment. Chloride environments are marine exposures or bridges to which de-icing salts are applied. High-pressure washing should be performed before abrasive blasting.

A profile range is specified and is dependent on the type and thickness of metallizing to be applied. Specify a 0.05 to 0.07 mm 2.0 to 3.0 mil profile for systems 1-Z, 4-Z-A, and 7-A; 0.06 to 0.09 mm 2.5 to 3.5 mils for systems 2-Z, 5-Z-A, and 8-A; and 0.07 to 0.10 mm 3.0 to 4.0 mils for systems 3-Z and 6-Z-A.

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Solvent clean and blast all ferrous surfaces to be metallized to a white metal grade in accordance with SSPC SP 5/NACE No. 1. The surface profile, as measured in accordance with subparagraph Blast Profile, must be between [0.05 and 0.07] [0.06 and 0.09] [0.07 and 0.10] mm [2.0 and 3.0] [2.5 and 3.5] [3.0 and 4.0] mils. Take special care to achieve the specified blast profile on welds and flame-cut edges. In some cases, it may be necessary to either grind these surfaces with a disk wheel grinder or other tool prior to blasting or to use a harder abrasive blast media. If recycled abrasives are used, the particle size distribution of the working mix must be maintained such that a consistent blast profile is obtained. Remove weld spatter not dislodged by blasting with impact or grinding tools and reblast the area to bring the surface to the required profile. Acceptable surfaces must be free of all visible contaminants including moisture, grease, oil, soot, and dust prior to receiving the first or any succeeding coat of metallizing.

3.1.3 Protection

Program cleaning, metallizing, and painting so that dust, dry spray, or other contaminants from the cleaning and painting operations do not contaminate surfaces ready for metallization or painting. Protect surfaces not intended to be metallized from the effects of cleaning and metallizing operations. Protect machinery against entry of blast abrasive and dust into working parts.

3.2 METALLIZING APPLICATION

Set up and operate metallizing equipment in the same manner as used to prepare the JRS. Validate equipment set up and operation using a bend test. The bend test is acceptable if the coating shows no cracks or exhibits only minor cracking with no lifting of the coating from the substrate. If the coating cracks and lifts from the substrate, the results of the bend test are unacceptable. Provide clean and dry compressed air to atomize the metallized coating.

3.2.1 Metallizing Application Technique

Preheat surfaces to be flame sprayed to prevent condensation of the flame on the surface to be coated. Arc spray application does not require preheating of the substrate. Surfaces to be metallized must be free of all visible contaminants including grease, oil, soot, and dust prior to receiving the first and subsequent coats of metallizing. Apply all metallizing coats in such a manner as to produce an even, continuous film of uniform thickness. Give special attention to edges, corners, crevices, seams, joints, welds, rivets, and other surface irregularities to ensure that they receive an adequate thickness of metallic coating. Operate metallizing equipment using qualified applicators in accordance with the manufacturer's recommendations. Overlap each spray pass of the sprayed metal a minimum of 40 percent on each spray pass to ensure uniform coverage. Perform manual spraying in a block pattern not exceeding 600 by 600 mm 2 by 2 feet square. Build up the specified thickness of coating in multiple layers of no fewer than 2 spray coats (overlapping at right angles). Hold the application gun at such a distance from the work surface that the metal remains plastic until impact with the surface. Do not metallize closer than 19 mm 3/4 inch to surfaces that are to be welded.

3.2.2 Metallizing Appearance

The thermal-sprayed coating prior to sealing must have a uniform appearance and not contain any of the following: blisters, cracks, chips or loosely adhering particles, oils or other internal contaminants, pits exposing the substrate, or nodules.

3.2.3 Metallizing Thickness

Coat surfaces with the systems indicated in the metallizing schedule and/or as noted on the drawings in accordance with the following:

3.2.3.1 System No. 1-Z

Apply to a minimum average thickness of 0.15 mm 6.0 mils for the completed system and a thickness at any one spot of not less than 0.12 mm 5.0 mils.

3.2.3.2 System No. 2-Z

Apply to a minimum average thickness of 0.3 mm 12.0 mils for the completed system and a thickness at any one spot of notless than 0.25 mm 10.0 mils.

3.2.3.3 System No. 3-Z

Apply to a minimum average thickness of 0.4 mm 16.0 mils for the completed system and a thickness at any one spot of not less than 0.32 mm 13.0 mils.

3.2.3.4 System No. 4-Z-A

Apply to a minimum average thickness of 0.15 mm 6.0 mils for the completed system and a thickness at any one spot of not less than 0.12 mm 5.0 mils.

3.2.3.5 System No. 5-Z-A

Apply to a minimum average thickness of 0.3 mm 12.0 mils for the completed system and a thickness at any one spot of not less than 0.25 mm 10.0 mils.

3.2.3.6 System No. 6-Z-A

Apply to a minimum average thickness of 0.4 mm 16.0 mils for the completed system and a thickness at any one spot of not less than 0.32 mm 13.0 mils.

3.2.3.7 System No. 7-A

Apply to a minimum average thickness of 0.12 mm 5.0 mils for the completed system and a thickness at any one spot of not less than 0.10 mm 4.0 mils.

3.2.3.8 System No. 8-A

Apply to a minimum average thickness of 0.25 mm 10.0 mils and a thickness at any one spot of not less than 0.20 mm 8.0 mils.

3.2.4 Metallizing Adhesion

The minimum average adhesion of the metallized coating is [6.9 kPa 1000 psi for 85-15 zinc-aluminum alloy] [11.0 kPa 1600 psi for aluminum] [5.2 kPa 750 psi for zinc]. Any coating having an average adhesion value below the requirements of this paragraph or having any single adhesion measurement of less than 80-percent of the specified minimum average adhesion will be rejected.

3.2.5 Time Between Surface Preparation and Metallizing

Following surface preparation all surfaces approved for metallizing must receive the first coat of metallizing within 4 hours or prior to the appearance of flash rust, whichever is sooner.

3.2.6 Time Between Metallizing and Painting

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NOTE: Dry time prior to immersion, if applicable, should be in accordance with the painting schedule. There is no dry time associated with thermal-spray coatings. A brief cool-down period prior to painting is necessary and may be addressed in the painting schedule by specifying a maximum temperature for surfaces to be sealed.

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Within 8 hours or prior to the appearance of condensation on the receiving surfaces, whichever is sooner, seal approved sections of metallizing as metallized coatings must not be allowed to become contaminated prior to application of sealers. Apply subsequent paint coats in a timely manner consistent with the painting schedule.

3.2.7 Approved Methods of Metallizing

Metallizing methods, which employ metal wire feed stock with oxygen-fuel gas flame spray or electric-arc spray that produce coatings in conformance with requirements of this specification, are acceptable.

3.3 FIELD INSPECTION

3.3.1 Quality Control Inspection and Testing

The qualified Coating Inspector must be present during all work phases to perform and document all of the tests and inspections in paragraphs Ambient Conditions Inspection, Presurface Preparation Inspection, Surface Preparation Inspection, and Metallized Coating Inspection.

3.3.1.1 Ambient Conditions Inspection

Ambient air and surface conditions including humidity, dew point, and surface and ambient air temperature before and during all work phases. Determine humidity in accordance with ASTM E337. Conditions specified in paragraph Environmental Requirements must be met before work is initiated.

3.3.1.2 Presurface Preparation Inspection

Identify and mark all areas requiring preparation prior to abrasive blasting as specified in paragraph Pit, Edge, and Weld Preparation as well as areas requiring solvent-type cleaning. The entire work surface does not need to be inspected at one time, but rather the Coating Inspector may choose to mark up work areas with an indelible marker as the job progresses. Measure pit depth with any suitable pit depth gage. Identify irregular shaped pits visually.

3.3.1.3 Surface Preparation Inspection

Inspect all prepared surface for compliance with the specification. Blasted surfaces must meet the requirements of SSPC SP 5/NACE No. 1. Surfaces not meeting this requirement must be reblasted and reinspected.

3.3.1.3.1 Abrasive Blast Air Cleanliness

Evaluate the compressed air cleanliness on a daily basis at the beginning of the work shift in accordance with ASTM D4285. Allow the air compressor to warm up and discharge air under normal operating conditions to allow accumulated moisture to be purged. Hold an absorbent clean white cloth in the stream of compressed air not more than 600 mm 24 inch from the point of discharge for a minimum of one minute. Check the air as near as possible to the point of use and always after the position of the in-line oil and water separators. Inspect the cloth for moisture or staining. Do not use the compressed air source if there is any oil or water contamination present.

3.3.1.3.2 Recycled Blast Media Cleanliness and Shape

Evaluate the cleanliness of blast media on a daily basis at the beginning of the work shift. A clear glass container is half filled with new or recycled abrasive and distilled or deionized water is added to fill the container. The resulting slurry mixture is stirred or shaken and allowed to settle. The water is then examined for the presence of an oil sheen. If a sheen is present, the media must not be used and the source of contamination must be identified and corrected. Inspect recycled steel grit blast media at minimum once for every four hours of blasting for compliance with paragraph Abrasive Media requirements for number of round and half-round particles. Recycled steel grit working mixtures with greater than 15 percent round or half-round particles must be disposed or reconstituted by the addition of a suitable quantity of new steel grit abrasive to the working mixture. Retest the particle shape of the reconstituted steel grit prior to the commencement of blasting.

3.3.1.3.3 Blast Profile

Measure the surface profile depth in accordance with ASTM D4417, Method C. The mean value of three profile measurements taken within a 103 cm^2 16 in^2 area constitutes a spot measurement. Conduct a minimum number of 3 spot measurements at random per unit area per 45 m^2 500 ft^2. The average surface profile for each 45 m^2 500 ft^2 area must conform to the requirements of paragraph Abrasive Blasting. Perform spot measurements on weldments and flame-cut edges. Perform at least one spot measurement for each 15 m^2 50 ft^2 of weld and at least one spot measurement for each 3 m^2 10 ft^2 of flame-cut edge. Each spot measurement on welds or flame-cut edges must conform to the requirements of paragraph Abrasive Blasting. Surfaces not meeting the profile requirement must be reblasted and reinspected.

3.3.1.3.4 Contaminants on Prepared Surface

Visually inspect abrasive blasted surfaces that have been swept, blown down, or vacuum cleaned to remove residual debris and dust for grease, oil, and dust. Use any suitable test to enhance the visual inspection for grease and oil including water break, solvent evaporation, and heat tests. Inspect for grease and oil at least once per workday or every four hours of blasting. Inspect the cleaned surfaces for residual dust using the tape test. The tape test is performed by adhering a clear piece of tape to the surface. The removed tape is inspected for adherent particles. Perform the tape test once per 45 m^2 500 ft^2 of prepared surface.

3.3.1.4 Metallized Coating Inspection

3.3.1.4.1 Equipment Setup Validation Bend Test

Record and confirm that the operating parameters are the same as were used to prepare the JRS each day or every time the thermal spray equipment is to be used. The thermal spray applicator must then apply the coating to prepared test panels and conduct the bend test. The bend test is a qualitative test used to confirm that the equipment is in proper working condition. The test consists of bending coated steel panels around a cylindrical mandrel and examining the coating for cracking. Record the results of the bend test and label and save the test panels. The test panels consist of five cold rolled steel panels measuring 50 x 150 x 1.25 mm 2 x 6 x 0.050 inch. The panels are cleaned, blasted, and coated using the identical surface preparation procedures and spray parameters as used to prepare the working surface. The coating is applied in a cross-hatch pattern using the same number of overlapping spray passes as used to prepare the JRS. The coating thickness is measured to confirm that the coating thickness is within the specified range. Test panels are bent 180 degrees around a steel mandrel of a specified diameter. Thermal spray coating systems 1-Z, 2-Z, 4-Z-A, 5-Z-A, 7-A, and 8-A are tested using a 12.5 mm 0.5 inch diameter mandrel. Systems 3-Z and 6-Z-A are tested using a 15.6 mm 0.625 inch diameter mandrel. Use a pneumatic or manual mechanical bend test apparatus to bend the test panels. Visually examine the test panels without magnification. If the bend test fails, corrective action must be taken and the bend test repeated until acceptable results are achieved. Successful completion of the bend test is required before any metallizing is applied to the working surface.

3.3.1.4.2 Atomization Air Cleanliness

Test compressed air used for atomizing metallized coatings using the method described in paragraph Abrasive Blast Air Cleanliness.

3.3.1.4.3 Metallized Coating Appearance

Visually inspect the appearance of the applied metallized coating prior to sealing for compliance with the requirements of paragraph Metallized Coating Appearance. Report areas of defective coating to the Contracting Officer and document, and mark them for repair.

3.3.1.4.4 Metallized Coating Thickness

Evaluate the thickness of the thermal spray coating for compliance with paragraph Metallizing Thickness. Make measurements using an approved and calibrated magnetic film thickness gage. Calibrate the gage on metal substantially the same in composition and surface preparation to that being coated and having a similar thickness or a minimum thickness of 6 mm 1/4 inch. Use calibration thickness standards (shims) of a metallic composition and a thickness to that of the material being sprayed. Follow calibration instructions and obtain thickness standards from the manufacturer or supplier of the gage. Make thickness readings either in a straight line with individual readings taken at 25 mm 1 inch intervals or spaced randomly within a 25 cm^2 4 in^2 area as appropriate for the configuration of the surface being inspected.. The average of five readings comprises one spot measurement. Make a minimum of 5 randomly spaced spot measurements per 9 m^2 100 ft^2. For each 9 m^2 100 ft^2 area evaluated the minimum average and minimum spot thickness requirements must be met. Make areas of deficient coating thickness for correction before sealing begins. Document the results of the thickness measurements.

3.3.1.4.5 Metallized Coating Adhesion

Evaluate the adhesion of the thermal spray coating for compliance with paragraph Metallizing Adhesion in accordance with ASTM D4541 using a self-aligning type IV tester described in Annex A4 of the specification. Perform a total of three randomly spaced adhesion tests for each 45 m^2 500 ft^2 of work area. Where deficiencies are noted, additional testing may be performed to help delineate the extent of area with poor adhesion. Repair areas of deficient adhesion by removing and reapplying the metallized coating. Repair areas damaged by adhesion testing by abrasive blasting and reapplication of the metallic coating. As an alternative to testing to the failure point, the tests can be interrupted when the minimum specified adhesion value is achieved. This method precludes the need to repair coatings damaged by the test. The adherent pull stubs can then be removed by heating to soften the glue or by firmly striking the side of the stub. Use a strong (minimum 20.7 MPa 3000 psi) adhesive with a rapid cure (maximum 1-hour at 21 degrees C 70 degrees F) to adhere the pull stubs to the metallized coating. Some methyl methacrylate adhesives are known to achieve a 27.6 MPa 4000 psi bond strength in 1-hour.

3.3.2 Quality Assurance Hold Point Evaluations

The Coating Inspector must perform and document the Quality Assurance Hold Point evaluations and report the results to the Contracting Officer. The Contracting Officer will have sole authority to approve progression from one work phase to the next. Work phases are delineated by the Inspection Hold Points.

3.3.2.1 Surface Preparation Quality Assurance Hold Point Evaluation

At the completion of surface preparation on a given work area and prior to metallization, submit to the Contracting Officer the completed documentation resulting from the inspections performed in paragraphs Ambient Conditions Inspection, Presurface Preparation Inspection, Surface Preparation Inspection, Abrasive Blast Air Cleanliness Inspection, Blast Media Cleanliness and Shape, Blast Profile, and Contaminants on Prepared Surface.

3.3.2.2 Metallized Coating Quality Assurance Hold Point Evaluation

At the completion of metallized coating application on a given work area and prior to sealing, submit to the Contracting Officer the completed documentation resulting from the inspections performed in paragraphs Ambient Conditions Inspection, Atomization Air Cleanliness, Metallized Coating Appearance, Metallized Coating Thickness, and Metallized Coating Adhesion.

3.3.2.3 Sealed System Quality Assurance Hold Point Evaluation

At the completion of sealer and paint coat application on a given work area and prior to the placement of the coated item in service, submit to the Contracting Officer the completed documentation resulting from all inspections and tests including those specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.4 METALLIZING SYSTEMS TO BE APPLIED

Apply the required metallizing systems as shown on the drawings.

3.5 SPECIAL PAINTING INSTRUCTIONS

****

NOTE: Thinning instructions in the painting specification should be modified as follows: the first coat of systems No. 3, 4, 5-D, and 21 must be thinned with 25 percent by volume of the recommended thinner. Subsequent paint coats must be thinned in accordance with the standard instructions found in Section 09 97 02. The first coat of paint systems No. 13 and 14 should not receive extra thinning. It is not required.

In geographic regions where air pollution regulations prohibit the use of impacted immersion paint systems No. 3, 4, and 5-D, for architectural painting, paint system No. 21 should be substituted for immersion applications. If system 21 does not comply with air pollution regulation then no sealer should be used. Where systems 13 and 14 do not comply with VOC regulations then do not specify a sealer system for atmospheric service.

****

Perform sealing and painting in accordance with the painting schedule and with the requirements of Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES. The clean, dry metallized surface is the receiving surface for the specified paint systems.

3.6 METALLIZING SYSTEMS AND METALLIZING SCHEDULE

****

NOTE: By inserting specific item component names or surface description in the blank spaces provided in the tabulation, the metallizing to be done on a project can be shown in schedule form. Alternately, the metallizing system number can be shown on the applicable drawings.

The number assigned to each metallizing system in the listing should not be changed locally, even though on specific projects some systems are omitted. If other systems are added locally, they should be assigned numbers other than those used in this guide.

****

SYSTEM NO. 1-Z			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.05 - 0.072.0 - 3.0	Zinc	0.125	0.156

SYSTEM NO. 2-Z			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.06 - 0.092.5 - 3.5	Zinc	0.2510	0.3012

SYSTEM NO. 3-Z			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.08 - 0.103.0 - 4.0	Zinc	0.3514	0.4016

SYSTEM NO. 4-Z-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.05 - 0.072.0 - 3.0	85-15 Zinc-Aluminum	0.125	0.156

SYSTEM NO. 5-Z-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.06 - 0.092.5 - 3.5	85-15 Zinc-Aluminum	0.2510	0.3012

SYSTEM NO. 6-Z-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.08 - 0.103.0 - 4.0	85-15 Zinc-Aluminum	0.3514	0.4016

SYSTEM NO. 7-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.05 - 0.082.0 - 3.0	Aluminum	0.104	0.125

SYSTEM NO. 8-A			
Items or surfaces to be metallized:		[_____]	
Blast Profile (mm) (mils)	Metallizing Material	Coating Minimum (mm) (mils)	Thickness Average (mm) (mils)
0.06 - 0.092.5 - 3.5	Aluminum	0.208	0.2510

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 97 13.16 (May 2011)**
Change 2 - 08/19

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 13.16 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-09 97 13.16 (May 2011)**
Change 2 - 08/19

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 13.16 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 97 13.16

INTERIOR COATING OF WELDED STEEL WATER TANKS

05/11, CHG 2: 08/19

****

NOTE: This guide specification covers the requirements for polyamide epoxy coating system for interior of newly constructed Navy and Air force water tanks, potable and non-potable, where shop applied coatings are not being considered.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This guide specification should be used for all new welded steel water tanks. For maintenance coating design, see notes herein.

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NOTE: This specification should be edited by an SSPC certified Protective Coatings Specialist (PCS) that has five or more years of experience preparing coating specifications.

The designer should not alter the products and processes specified herein without thorough knowledge of the need for the changes and the

implications of those changes.
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****
NOTE: This guide specification should be used with Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES (Navy & AF) when complete interior and exterior coating systems are required.
****

****
NOTE: The metric standard for measuring coating thickness is microns (25.4 microns=1 mil - use nominal 25 microns=1 mil).
****

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NOTE: The specified system is a 3 Coat, thin film system, which is compliant with EPA VOC regulations as of June 2000.

- MIL-DTL-24441 Epoxy Coats 350 g/l 2.8 lbs/gal max. VOC

- NSF certified coatings should be monitored for compliance with required regulations.

The designer shall review state and local, regulations and determine whether the coating in this Section complies with restrictions on volatile organic components (VOC) and other chemical constituents.
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NOTE: Designs of tank linings for existing tanks should be based on recent inspections. Wherever possible, a coating inspection, or coating condition survey (CCS), as described in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES, should be accomplished prior to designing a coating project for water tank interiors. Without a competent inspection, there is no reliable way to determine the type or condition of the existing coating system. Without knowing the existing conditions, proper (effective and financially supportable) surface preparation or coating system selection cannot be made. It is not always cost effective to replace the entire coating system in a water tank, however, this is the tendency in preparing a design without inspection results.
****

****
NOTE: Previous versions of industrial coating guide specifications have included a requirement for surfaces to be abrasive blasted to SSPC 7/NACE No.4, inspected, and repaired, prior to coating. That requirement is not included in this specification,

and if required for a repair project, it should be included in the structural repair Section of the project specification. Tailor the requirement to the needs of cleaning that will be required in preparation for repairs, and note that the abrasive blasting for inspection should be accomplished in such a manner that it does not conflict with any surface condition requirements in this Section. For repair projects, specify appropriate portions of the steel surfacing requirements (according to NACE RP0178) from Section 33 16 15 WATER STORAGE STEEL TANKS.

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NOTE: Designers are encouraged to contact J. H. Brandon, NAVFAC LANT 1613G, 757-322-4645, brandonjh@efdlant.navfac.navy.mil prior to beginning a new Navy design.

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NOTE: Designers are encouraged to contact the Air Force Civil Engineering Corrosion Program Manager at AFCEC/COSM, 139 Barnes Drive, Suite 1, Tyndall AFB, FL 32403, Tel 850-283-6070, prior to beginning new Air Force design.

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D3276	(2015; E 2016) Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings
ASTM D4285	(1983; R 2018) Indicating Oil or Water in Compressed Air
ASTM D7127	(2017) Standard Test Method for Measurement of Surface Roughness of Abrasive Blast Cleaned Metal Surfaces using a Portable Stylus Instrument

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems-Requirements

NACE INTERNATIONAL (NACE)

NACE SP0188	(2024) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

NSF INTERNATIONAL (NSF)

NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2023; R 2023) Ferrous Metallic Abrasive
SSPC Guide 12	(2023) Guide for Illumination of Industrial Painting Projects
SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC PA 2	(2015; E 2018) Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC QP 5	(2022) Standard Procedure for Evaluating the Qualifications of Coating and Lining

	Inspection Companies
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning
SSPC SP COM	(2016; E 2017) Surface Preparation Commentary for Steel and Concrete Substrates
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-22262	(1993; Rev B; Am 1 1994; Am 2 1996; Notice 1 2021) Abrasive Blasting Media Ship Hull Blast Cleaning
MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for
MIL-DTL-24441/20	(2009; Rev B; Notice 1 2021) Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type III
MIL-DTL-24441/22	(2009; Rev B; Notice 1 2021) Paint, Epoxy-Polyamide, White Formula 152, Type III
MIL-DTL-24441/29	(2009; Rev B; Notice 1 2021) Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type IV
MIL-DTL-24441/31	(2009; Rev B; Notice 1 2021) Paint, Epoxy-Polyamide, White, Formula 152, Type IV

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART Z	Toxic and Hazardous Substances
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1000	Air Contaminants
29 CFR 1926.59	Hazard Communication

1.2 DEFINITIONS

Definitions are provided throughout this Section, generally in the paragraph where used, and denoted by capital letters. The following definitions are used throughout this Section:

a. CEILING - interior tank surfaces that extend from the horizontal plane at the designated maximum water line upward, including the upper portion of the tank shell (walls), columns, structural steel, the underside of the roof plates and other steel components in this area.

b. BOWL - interior tank surfaces that extend from the horizontal plane at the designated maximum water line downward, including the tank walls, columns, piping, pipe supports, bottom plates, and other steel components in this area.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project..

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-05, Design Data

Environmental Control System

SD-06 Test Reports

Metallic Abrasive Qualification Test Reports

Coating Sample Test Reports

Abrasive Sample Test Reports

Inspection Report Forms

Daily Inspection Reports

Recycled Metallic Abrasive Field Test Reports (Daily and Weekly)

SD-07 Certificates

Contract Errors, Omissions, and Other Discrepancies

Corrective Action Procedures

Coating Work Plan

Qualifications of Certified Industrial Hygienist (CIH)

Qualifications Of Individuals Performing Abrasive Blasting

Qualifications of Certified Protective Coatings Specialist (PCS)

Qualifications of Coating Inspection Company

Qualifications of QC Specialist Coating Inspector

Qualifications of Testing Laboratory for Coatings

Qualifications of Testing Laboratory for Abrasive

Qualifications of Coating Contractors

Roof Joint Sealant Materials

Roof Joint Sealant Compatibility

Epoxy Coating Materials

Non-metallic Abrasive

Metallic Abrasive

SD-08 Manufacturer's Instructions

Roof Joint Sealant Instructions

Coating System Instructions

SD-11 Closeout Submittals

Disposal of Used Abrasive; G, [_____]

Inspection Logbook; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Contract Errors, Omissions, and Other Discrepancies

Submit all errors, omissions, and other discrepancies in contract documents the Contracting Officer within 30 days of contract award for all work covered in this Section, other than the work that will not be uncovered until a later date. All such discrepancies shall be addressed and resolved, and the Coating Work Plan modified, prior to beginning the Initial and Follow-Up phases of work. Discrepancies that become apparent only after work is uncovered shall be identified at the earliest discoverable time and submitted for resolution. Schedule time (Float) should be built into the project schedule at those points where old work is to be uncovered or where access is not available during the first 30 days after award, to allow for resolution of contract discrepancies.

1.4.2 Corrective Action (CA)

CA shall be included in the Quality Control Plan.

1.4.2.1 Corrective Action Procedures

Develop procedures for determining the root cause of each non-compliance, developing a plan to eliminate the root cause so that the non-compliance does not recur, and following up to ensure that the root cause was eliminated. Develop Corrective Action Request (CAR) forms for initiating CA, and for tracking and documenting each step.

1.4.2.2 Implement Corrective Action

The Contractor shall take action to identify and eliminate the root cause of each non-compliance so as to prevent recurrence. These procedures shall apply to non-compliance in the work, and to non-compliance in the QC System. Corrective actions shall be appropriate to the effects of the non-compliance encountered. Each CAR shall be serialized, tracked in a Log to completion and acceptance by the Contracting Officer, and retained in project records. The Corrective Action Log, showing status of each CAR, shall be submitted to the Contracting Officer monthly. A CAR may be initiated by either the Contractor or the Contracting Officer. The Contracting Officer must approve each CAR at the root cause identification stage, the plan for elimination stage, and the close out stage after verification that the root cause has been eliminated.

1.4.3 Coating Work Plan

****

NOTE: For maintenance painting, add requirement for pre-work determination of the existing surface profile. If paint removal is specified in another Section, such as a blast cleaning prior to inspection or repair, or in the lead removal Section, include this evaluation of existing profile such that the paint removal operation does not create excessive profile.

****

This work plan shall be considered as part of the Quality Control Plan.

Provide procedures for reviewing contract documents immediately after award to identify errors, omissions, and discrepancies so that any such issues can be resolved prior to project planning and development of detailed procedures.

Provide procedures for verification of key processes during Initial Phase to ensure that contract requirements can be met. Key processes shall include surface preparation, coating application and curing, inspection, and documentation, and any other process that might adversely impact orderly progression of work.

Provide procedures for all phases of coating operations, including planned work, rework, repair, inspection, and documentation. Address mobilization and setup, surface preparation, coating application, coating initial cure, tracking and correction of non-compliant work, and demobilization. Coordinate work processes with health and safety plans and confined space entry plans. For each process, provide procedures that include appropriate work instructions, material and equipment requirements, personnel qualifications, controls, and process verification procedures. Provide procedures for inspecting work to verify and document compliance with contract requirements, including inspection forms and checklists, and acceptance and rejection criteria.

[Provide procedures for determining the existing surface profile under paint, and procedures for ensuring that the profile is not increased beyond the maximum profile specified herein.

] Provide procedures for correcting non-compliant work. Detailed procedures are required in advance to avoid delays in meeting overcoat windows as well as to avoid delays in production. Provide procedures for repairing defects in the coating film, such as runs, drips, sags, holidays, overspray, as well as how to correct coating thickness non-compliance, any other areas of repair or rework that might be adversely affected by delays in preparing and approving new procedures.

If a procedure is based on a proposed or approved request for deviation, the deviation shall be referenced. Changes to procedures shall be noted by submittal number and date approved, clearly delineating old requirements and new requirements, so that the records provide a continuous log of requirements and procedures.

1.4.4 Design Data

1.4.4.1 Environmental Control System

Submit design details of the proposed environmental control system to include ventilation, humidity control, and temperature regulation. Provide calculations for humidity control during separate surface preparation and coating application procedures, ventilation requirements during coating application, and maximum allowable coating application rates to coincide with ventilation. Include basis of design data on local conditions. Provide equipment layout sketches and procedures showing function of each piece of equipment and fail-safe measures. A Certified Industrial Hygienist shall approve calculations, work procedures and personal protective equipment.

1.4.5 Test Reports

1.4.5.1 Metallic Abrasive Qualification Test Reports

Submit results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 3. Submit test results from independent laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of prequalifying the abrasive.

1.4.5.2 Recycled Metallic Abrasive Field Test Reports (Daily and Weekly)

Submit test results from independent laboratory of daily and weekly Quality Control testing required by SSPC AB 2, as modified in paragraph ABRASIVE.

1.4.6 Qualifications

1.4.6.1 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party CIH. Submit documentation that hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. Provide evidence of experience with hazards involved in industrial coating application work.

1.4.6.2 Qualifications of Certified Protective Coatings Specialist (PCS)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party PCS. Submit documentation that specialist is certified by SSPC: The Society for Protective Coatings (SSPC) as a PCS, including certification number and date of certification/recertification. If the PCS is employed by the same coating inspection company to which the coating inspector is employed, this does not violate the independent third-party requirements. The PCS shall remain certified during the entire project, and the Contracting Officer shall be notified of any change in certification status within 10 days of the change. The PCS shall not be the designated coating inspector.

1.4.6.3 Qualifications of Coating Inspection Company

Submit documentation that the coating inspection company that will be performing all coating inspection functions is certified by SSPC to the requirements of SSPC QP 5 prior to contract award, and shall remain certified while accomplishing any coating inspection functions. The coating inspection company must remain so certified for the duration of the project. If a coating inspection company's certification expires, the firm will not be allowed to perform any inspection functions, and all surface preparation and coating application work must stop, until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in coating inspection company certification status.

1.4.6.4 Qualifications of QC Specialist Coating Inspector

Submit documentation that each coating inspector is employed, and qualified to SSPC QP 5, Level III, by the selected coating inspection company. Each inspector shall remain employed by the coating inspection company while performing any coating inspection functions.

1.4.6.5 Qualifications Of Individuals Performing Abrasive Blasting

Submit name, address, and telephone number of each person that will be performing abrasive blasting. Submit documentation that each blaster is qualified by SSPC to the SSPC C-7 Dry Abrasive Blaster Qualification Program. Each blaster shall remain qualified during the entire period of abrasive blasting, and the Contracting Officer shall be notified of any change in qualification status.

1.4.6.6 Qualifications of Testing Laboratory for Coatings

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified.

1.4.6.7 Qualifications of Testing Laboratory for Abrasive

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of abrasive for compliance with specification requirements. Submit documentation that laboratory has experience in testing samples of abrasive for conformance with specifications, and that employees performing testing are qualified.

1.4.6.8 Qualifications of Coating Contractors

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NOTE: If project involves removal of paint containing hazardous materials, add requirement for SSPC QP-2 certification in section of specification where the hazardous paint removal is specified, generally Section 02 83 00 LEAD REMEDIATION.

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NOTE: Solicitations requiring certification for prequalification should point out the existence and location of the certification requirement on the PROJECT INFORMATION FORM. This requirement must be pointed out in the solicitation documents for the "prior to contract award" requirement to be enforceable. Certification is a special responsibility requirement pursuant to FAR 9.104-2 Special Standards. This is analogous to requiring bidders to have a specified level of experience or expertise and GAO has sustained these types of special requirements.

****

All Contractors and Subcontractors that perform surface preparation or coating application shall be certified to either ISO 9001 or SSPC QP 1 and SSPC QS 1 prior to contract award, and shall remain certified while accomplishing any surface preparation or coating application. The painting

Contractors and painting Subcontractors must remain so certified for the duration of the project. If a Contractor's or Subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in Contractor certification status.

1.4.6.9 Roof Joint Sealant Materials

Provide manufacturer's certification of conformance to contract requirements[, and is certified in accordance with NSF/ANSI/CAN 61].

1.4.6.10 Roof Joint Sealant Compatibility

Provide manufacturer's certification that the selected joint sealant is compatible with the epoxy primer and is suitable for application directly to prepared steel surfaces.

1.4.6.11 Epoxy Coating Materials

Provide manufacturer's certification that the epoxy lining materials are [currently approved by the Naval Sea Systems Command and listed on the Qualified Products Lists (QPL) for the specified materials][certified in accordance with NSF/ANSI/CAN 61 for tanks of the size being coated].

1.4.6.12 Non-metallic Abrasive

Provide manufacturer's certification that the materials are currently approved by the Naval Sea Systems Command and listed on the Qualified Products Lists (QPL) for the specified materials.

1.4.6.13 Metallic Abrasive

Provide manufacturer's certification of conformance to contract requirements and provide copies of test results.

1.4.7 Protective Coating Specialist (PCS)

The PCS shall be considered a QC Specialist and shall report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The PCS shall approve all submittals prior to submission to the QC Manager for approval or submission to the government for approval.

1.4.8 Pre-Application Meeting

After approval of submittals but prior to the initiation of coating work, Contractor representatives, including at a minimum, project superintendent and QC manager, paint foreman, coating inspector, and PCS shall have a pre-application coating preparatory meeting. This meeting shall be in addition to the pre-construction conference. Specific items addressed shall include: corrective action requirements and procedures, coating work plan, safety plan, coordination with other Sections, inspection standards, inspection requirements and tools, test procedures, environmental control system, safety plan, and test logs. Notify Contracting Officer at least ten days prior to meeting.

1.5 PRODUCT DATA

1.5.1 Roof Joint Sealant Instructions

Submit manufacturer's printed instructions including detailed mixing and application procedures, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.5.2 Coating System Instructions

Submit manufacturer's printed instructions including detailed mixing and application procedures, number and types of coats required, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.6 DELIVERY AND STORAGE

Ship, store, and handle materials in accordance with SSPC PA 1, and as modified in this Section. Maintain temperature in storage spaces between 5 and 24 degrees C 40 and 75 degrees F, and air temperature more than 3 degrees C 5 degrees F above the dew-point at all times. Inspect materials for damage and return non-compliant materials to manufacturer. Remove materials with expired shelf life from government property immediately and notify the Contracting Officer. Expired materials may be returned to manufacturer, tested, and if compliant, issued a shelf life extension.

If materials are approaching shelf life expiration and an extension is desired, samples may be sent to the manufacturer, along with complete records of storage conditions, with a request for shelf life extension. If the manufacturer finds the samples and storage data suitable for shelf life extension, the manufacturer may issue an extension, referencing the product evaluation and the review of storage records. Products may not be extended longer than allowed in the product specification.

1.7 COATING HAZARDS

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NOTE: This specification Section should be used with 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS.

****

Ensure that employees are trained in all aspects of the safety plan. Specified coatings may have potential health hazards if ingested or improperly handled. The coating manufacturer's written safety precautions shall be followed throughout mixing, application, and curing of the coatings. During tank cleaning, cleanup, surface preparation, and paint application phases, ensure that employees are protected from toxic and hazardous chemical agents which exceed concentrations in 29 CFR 1910.1000. Comply with respiratory protection requirements in 29 CFR 1910.134. The CIH shall approve work procedures and personal protective equipment.

1.8 WORK SEQUENCE

Coat tank interior following leak testing.

1.9 JOB SITE REFERENCES

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NOTE: Include any other job site related references that might be added during design.

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Make available to the Contracting Officer at least one copy each of ASTM D3276, ASTM D3925, ASTM D4285, ASTM D7127, NACE SP0188, SSPC SP COM, SSPC SP 1, SSPC 7/NACE No.4, SSPC SP 10/NACE No. 2, SSPC PA 1, SSPC PA 2, SSPC Guide 12, SSPC VIS 1, , SSPC QP 1, SSPC QS 1, and an SSPC Certified Contractor Evaluation Form at the job site.

PART 2 PRODUCTS

2.1 ROOF JOINT SEALANT

Industrial grade, two component, minimum 95 percent solids by volume, polysulfide type caulking material that has a minimum history of 10 years acceptable service in water tanks. Sealant shall be compatible with the epoxy primer and suitable for direct application to prepared steel surfaces. Sealant shall contain no more than 0.06 percent by dry weight Lead, no more than 0.06 percent by dry weight Cadmium, and no more than 0.00 percent by dry weight Chromium.[Sealant shall be certified in accordance with NSF/ANSI/CAN 61.]

2.2 COATING SYSTEM

****

NOTE: Include bracketed text for new construction only.

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Alternate systems or products will not be considered. All primer, intermediate, and topcoat materials shall be manufactured by one manufacturer. [The entire coating system is intended to be applied in the field. Alternatively, surface preparation may be accomplished in the shop, following all temperature, humidity, and testing requirements listed herein, followed by an application of a hold-primer. Upon completion of field fabrication, all shop-applied coatings shall be removed, surfaces prepared to SSPC SP 10/NACE No. 2, and the specified coating system applied. Adjust all shop preparation to avoid conflicts with final surface preparation requirements.]

[2.2.1 NSF Certified Polyamide Epoxy Coating System

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NOTE: Choose the NSF Certified Polyamide Epoxy coating System where required. Remove Table I when NSF coating specified.

****

Select a commercially available, three coat polyamide epoxy coating system that is certified in accordance with NSF/ANSI/CAN 61 for contact with potable water in water storage tanks of the size being coated. The coating system shall be suitable for application in three even coats of 50-100 microns 3-5 mils dry film thickness (DFT), for a total minimum of 225 microns 9 mils DFT.

][2.2.2 MIL-DTL-24441 Epoxy System for Potable Water Tanks

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NOTE: Choose this system, MIL-DTL-24441 Type III (/20 and /22), for potable water where certification to NSF/ANSI/CAN 61 is not required. Edit Table I to match.

****

The epoxy coating materials shall be approved by the Naval Sea Systems Command and listed on their current Qualified Products List (QPL) for the specified materials.

2.2.2.1 Epoxy Primer Coat

Epoxy polyamide, MIL-DTL-24441/20 (Formula 150, Type III, Green).

2.2.2.2 Epoxy Intermediate Coat

Epoxy polyamide, MIL-DTL-24441/22 (Formula 152, Type III, White (Tinted)). Tint to approximately SAE AMS-STD-595A color number 27778 parchment using pigment dispersions prepared for epoxy paint tinting. Manufacturer shall tint material and appropriately label. All other requirements of this Military Specification apply.

2.2.2.3 Epoxy Topcoat

Epoxy polyamide, MIL-DTL-24441/22 (Formula 152, Type III, White).

][2.2.3 MIL-DTL-24441 Epoxy System for Non-potable Water Tanks

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NOTE: Choose this system, MIL-DTL-24441 Type IV (/29 and /31), for non-potable water. Type IV materials are not suitable for potable water due to Benzyl alcohol. Edit Table I to match.

****

The epoxy coating materials shall be approved by the Naval Sea Systems Command and listed on their current Qualified Products List (QPL) for the specified materials.

2.2.3.1 Epoxy Primer Coat

Epoxy polyamide, MIL-DTL-24441/29 (Formula 150, Type IV, Green).

2.2.3.2 Epoxy Intermediate Coat

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White (Tinted)). Tint to approximately SAE AMS-STD-595A color number 27778 parchment using pigment dispersions prepared for epoxy paint tinting. Manufacturer shall tint material and appropriately label. All other requirements of this Military Specification apply.

2.2.3.3 Epoxy Topcoat

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White). All other requirements of this Military Specification apply.

]2.3 COATING SAMPLE COLLECTION AND SHIPPING KIT

****

NOTE: Delete bracketed text, and remove "AND SHIPPING KIT" from the title of this Article, when NSF/ANSI/CAN 61 coating system is chosen.

****

Provide a kit that contains one liter quart can for the base of each coating material, an appropriately sized can for each activator, dipping cups for each component to be sampled[, a shipping box sized for the samples to to be shipped, and packing material]. Mark cans for the appropriate component.[Provide shipping documents, including either pre-paid shipping or a shipper number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.]

2.4 ABRASIVE SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit that contains one suitable plastic bag or container for each sample to be collected. Mark containers for the appropriate component. Provide shipping documents, including either pre-paid shipping or a shipper number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

2.5 TEST KITS

2.5.1 Test Kit for Measuring Chloride, Sulfate and Nitrate Ions on Steel and Coated Surfaces

Provide test kits called CHLOR*TEST CSN Salts, as manufactured by CHLOR*RID International Inc. of Chandler, Arizona (www.chlor-rid.com) or equal. An "equal" test kit shall meet the following requirements:

a. Kit contains all materials,supplies, tools and instructions for field testing and on-site quantitative evaluation of chloride, sulfate and nitrate ions;

b. Kit extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Kit components and solutions are mercury free and environmentally friendly;

d. Kit contains new materials and solutions for each test extraction;

e. Extraction test container (vessel, sleeve, cell. etc.) creates a sealed, encapsulated environment during salt ion extraction;

f. Test extract container is suitable for testing the following steel surfaces: horizontal (up/down configuration), vertical, flat, curved, smooth, pitted, and rough;

g. All salt ion concentrations are directly measured in micrograms per square centimeter.

2.5.2 Test Kit for Identifying Amine Blush on Epoxy Surfaces

After coating and/or primer has hardened and prior to applying the next coat, test for unreacted amines using the AMINE BLUSH CHECK, manufactured by Elcometer, Rochester Hills, Michigan, or equal. To be considered for approval as an "equal" test kit it shall meet the following requirements:

a. Be a completely self-contained field test kit with all materials, supplies, tools and instructions to perform tests and indicate the presence of unreacted amines;

b. Use an identifiable, consistent, uniform, pre-packaged, factory pre-measured indicating solution;

c. Kit contains no mercury or lead and is environmentally friendly;

d. Kit contains a solution of an unreacted amine for the purpose of "self checking" the indicator solution;

2.6 ABRASIVE

The referenced abrasive specifications have maximum limits for soluble salts contamination, however, this maximum level of contamination does not guarantee that contamination will not be transferred to the steel surface during abrasive blasting. Other factors such as on-site handling and recycling can allow contamination of abrasive. Contractors are cautioned to verify that the chosen abrasive, along with work and storage processes, allow the final surface cleanliness requirements to be achieved. Successful testing of chlorides in abrasive does not negate the final acceptance testing of steel surfaces.

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NOTE: The following paragraph is mandatory for all NAVFAC PAC projects. All other agencies may use it after checking applicability.

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[Interpret MIL-A-22262 to include the meaning that abrasive material contains a maximum one percent by weight of any toxic substance listed in either Table Z-1, Z-2, or Z-3 or 29 CFR 1910-SUBPART Z, with the exception of inert or nuisance dust materials, arsenic, beryllium, cadmium, cobalt, lead, mercury, rhodium, silver, tellurium, thallium, and uranium.
]

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NOTE: Reduce allowable gross gamma radioactivity to 5 picocuries per gram for all NAVFAC PAC projects. Reduce in other areas if states or localities require.

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2.6.1 Non-metallic Abrasive

Conform to MIL-A-22262, Type I (Inorganic materials)[except that the gross gamma radioactivity shall not exceed 5 picocuries per gram]. Abrasive shall be approved by the Naval Sea Systems Command and listed on the appropriate Qualified Products List (QPL) for the specified materials. Use sampling procedures and testing frequencies as prescribed in MIL-A-22262. Use abrasive that is specifically selected and graded to provide a sharp, angular profile to the specified depth. Do not use ungraded abrasive. Make adjustments to processes or abrasive gradation to achieve specified surface profile. Recycled non-metallic abrasive shall meet all requirements of the specification each time that it is placed in the blast pot.

2.6.2 Metallic Abrasive

2.6.2.1 New and Remanufactured Steel Grit

Conform to the chemical and physical properties of SSPC AB 3 Class 1 (Steel) only[, except that the gross gamma radioactivity shall not exceed 5 picocuries per gram]. Class 2 (Iron) abrasive shall not be used.

To develop a suitable work mix from new steel abrasive, a minimum of 200 - 400 recycles is required, therefore, it is advantageous for a Contractor to use remanufactured steel grit or grit reclaimed from a previous project. Such grit shall be considered to conform if it can be traced to new grit conforming to SSPC AB 3 Class 1 and it meets all cleanliness requirements of SSPC AB 3 Class 1 when brought to the current jobsite. Submit one representative sample of this work mix to the laboratory for testing, along with samples of new material. Acceptance and use of this work mix shall not be used to justify any deviation from surface preparation requirements.

2.6.2.2 Recycled Steel Grit

Conform to the chemical and physical properties of SSPC AB 2

PART 3 EXECUTION

Perform all work, rework, and repair in accordance with approved procedures in the Coating Work Plan.

[3.1 REMOVAL OF COATINGS CONTAINING HAZARDOUS MATERIALS

****

NOTE: Include Section 02 83 00 LEAD REMEDIATION in any project specification that requires removal or disturbance of coating containing hazardous materials in conjunction with a coating project. Include a contractor qualification requirement similar to the article entitled "Qualifications of Coating Contractors" in Part 1 of this Section, except that the contractor shall be qualified to SSPC QP-2. The removal of coatings containing hazardous materials and application of new coating system can be accomplished in a continuous operation if the contractor provides appropriate coordination of removal, cleaning, and coating application. It is specified as two separate operations to allow separate contractors to accomplish different phases of project. With the use of SSPC QP-1 and QP-2 requirements in contracts, the same contractor will generally be accomplishing both phases of work, and will probably want to perform both phases as a single operation to avoid preparing surfaces twice. To accomplish the coating removal and recoating in a continuous operation, the contractor's plan must be scrutinized for appropriate controls on the removal process, and on the surface preparation/coating application process. Delete this paragraph if no paint containing hazardous material is to be removed.

****

Coatings containing hazardous materials and identified for disturbance during surface preparation, including removal, shall be handled in accordance with Section 02 83 00 LEAD REMEDIATION. Coordinate surface preparation requirements from Section 02 83 00 LEAD REMEDIATION with this Section.

]3.2 COATING AND ABRASIVE SAMPLE COLLECTION AND TESTING

Sample and test materials delivered to the jobsite. Notify Contracting Officer three days in advance of sampling. The QC Manager, and either the PCS or coating inspector, shall witness all sampling.

3.2.1 Coating Sample Collection

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NOTE: Delete bracketed text when NSF/ANSI/CAN 61 coating system is chosen.

****

Provide a sample collection kit as required in paragraph COATING SAMPLE COLLECTION AND SHIPPING KIT. From each lot, obtain a one liter quart sample of each batch of each base material, and proportional samples of each activator based on mix ratio, by random selection from sealed containers in accordance with ASTM D3925. Prior to sampling, mix contents of each sealed container to ensure uniformity. As an alternative to collecting small samples from kits, entire kits may be randomly selected and shipped to laboratory, observing all requirements for witnessing and traceability. For purposes of quality conformance inspection, a lot is defined as that quantity of materials from a single, uniform batch produced and offered for delivery at one time. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Identify samples by designated name, specification number, batch number, project contract number, sample date, intended use, and quantity involved.[The QC Manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved laboratory for testing as required by the paragraph entitled "Coating Sample Test Reports."]

3.2.2 Abrasive Sample Collection

Provide suitably sized containers for each sample to be taken. Provide a sample collection kit as required in paragraph ABRASIVE SAMPLE COLLECTION AND SHIPPING KIT. For purposes of quality conformance inspection, a lot shall consist of all abrasive materials of the same type from a single, uniform batch produced and offered for delivery at one time. Obtain samples of each abrasive lot using the sampling techniques and schedule of MIL-A-22262. The addition of any substance to a batch shall constitute a new lot. Identify samples by designated name, specification number, lot number, project contract number, sample date, intended use, and quantity involved. The QC Manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved laboratory for testing as required by the paragraph ABRASIVE SAMPLE TEST REPORTS.

[3.2.3 Coating Sample Test Reports

****
NOTE: Delete this Article and modify SUBMITTALS in Part 1 when NSF/ANSI/CAN 61 coating system is chosen.
****

Submit test results for each lot of coating material delivered to the jobsite. Test samples of primer, intermediate, and topcoat materials for compliance with requirements of Table I. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

]3.2.4 Abrasive Sample Test Reports

Submit test results for each lot of abrasive delivered to the jobsite. Test samples of metallic abrasive to the requirements of paragraph REQUIREMENTS of SSPC AB 3, except paragraph 4.1.5 DURABILITY. Test samples of non-metallic abrasive as required in paragraph QUALITY CONFORMANCE INSPECTION of MIL-A-22262. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

[3.3 SLUDGE REMOVAL AND TANK CLEANING

Remove sludge and clean storage tanks in accordance with [_____].

]3.4 LIGHTING

Provide lighting for all work areas as prescribed in SSPC Guide 12.

3.5 ENVIRONMENTAL CONDITIONS

3.5.1 Control System Requirements

Provide and utilize dehumidification and ventilation equipment to control humidity, temperature, and vapor levels in tank from beginning of abrasive blasting through coating application and for four days after the last coating is applied. System shall maintain vapor concentrations at or below 10 percent of Lower Explosive Limit (LEL). System may incorporate any combination of solid desiccant and direct expansion refrigeration equipment. No liquid, granular, calcium chloride, or lithium chloride drying systems will be accepted. Use only electric, indirect fired combustion, indirect friction, or steam coil auxiliary heaters. System shall be compatible with removal of dust and solvent vapors, and shall have fail-safe measures to ensure reliability during operations.

3.5.2 Automated Monitoring Requirements

Provide continuous monitoring of DH equipment, and temperature, relative humidity, and dew point data at pertinent points on the structure, during surface preparation, coating application, and initial cure. Locate sensors to provide pertinent data for the surface preparation and coat application being performed. Make data available to the Contracting Officer through Internet access. Provide monitoring equipment to perform as follows:

a. Data is collected in the field unit in one minute increments, and available for download (on-site) in a standard format. Contractor shall collect this data and make available to the Contracting Officer;

b. Monitoring equipment shall have backup power such that data collection and transmission to web server will be uninterrupted during the entire period of the dehumidification requirement;

c. Monitoring equipment shall have capability to measure surface temperatures at a minimum of four locations anywhere on a 150 foot diameter by 50 foot high tank;

d. Monitoring equipment shall have capability to measure interior and exterior dry bulb temperature (DB), relative humidity (RH), and dewpoint temperature (DP);

e. Data shall be available continuously through secure internet connection, using widely available web browsers;

f. Internet accessible data shall be collected and stored in maximum 15 minute increments, and lag time between data collection and online availability shall be no greater than 70 minutes;

g. Internet accessible data shall be available for viewing online in tabular format, and graphical format using selected data;

h. Internet accessible data shall be available for download in user-defined segments, or entire project to date, in a standard format usable by Microsoft Excel and other spreadsheet programs.

i. Internet-based controls shall provide alerts to pre-designated parties through email messaging;

j. Internet-based controls shall monitor data uploads from field unit and issue alert if data not initiated within 60 minutes of last upload;

k. Internet-based controls shall monitor operation of DH equipment and issues alert when power remains off for more than 15 seconds, or if pre-determined temperature, RH, or DP conditions are exceeded;

The requirements listed here were developed around the Munters Exactaire Monitoring System, as this was the only monitoring system having Internet connectivity known to be commercially available. There is no requirement for connectivity of the monitoring system to control the DH equipment, therefore, any combination of equipment having the required functionality will be accepted.

3.5.3 Humidity Control for Surface Preparation and Primer Application

Provide and utilize dehumidification equipment to maintain relative humidity at appropriate level to prevent prepared steel surfaces from corroding at all times during abrasive blasting through primer application. Failure of humidity control system, or failure to maintain proper conditions, during surface preparation stage may allow surface rusting, which will be rejected and require rework. All surfaces to be coated must meet all requirements at time of primer application. Failure of humidity control system during primer application stage will be cause for removal and replacement of all materials applied and cured while conditions were not as prescribed above.

3.5.4 Humidity Control for Application of Intermediate and Topcoats and Initial Curing

Provide and utilize dehumidification equipment to maintain relative humidity at the coldest steel surface in tank below 55 percent at all times during coating application, and during the first four days of initial curing after application of topcoat. This measurement is not the same as measuring the relative humidity of ambient air in the tank, and will require either electronic equipment to monitor relative humidity at the steel surface, or complex calculations to convert relative humidity of air in tank to relative humidity at steel surface. An approved alternative method of monitoring dehumidification that requires less sophisticated equipment or calculations is to maintain a minimum dew point depression of 10 degrees C 18 degrees F below coldest steel surface temperature. This is in lieu of specific relative humidity and dew point requirements in this Section. Failure to maintain specified humidity control during this phase will be cause for extension of humidity controlled cure time to ensure four consecutive days at specified relative humidity at steel surfaces. Formation of condensation in coating application stage prior to the indicated dry-hard time will be cause for removal and replacement of all materials contacted by condensation.

3.6 EQUIPMENT USED IN TANK

Equipment used in the tank after surface preparation begins shall not leave any oily residue from exhaust or other sources. Internal combustion driven equipment, other than that powered by natural or bottled gas, shall not be used.

3.7 SURFACES TO BE COATED

Prepare and coat interior tank surfaces, including[CEILING][, BOWL][spot repair of [_____] spots of [_____] square meters square feet][_____].

3.8 SURFACE PREPARATION

3.8.1 Abrasive Blasting Equipment

Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 650 kPa 95 psig at nozzle. Confirm that air supply for abrasive blasting is free of oil and moisture when tested in accordance with ASTM D4285. Test air quality at each startup, but in no case less often than every five operating hours.

3.8.2 Operational Evaluation of Abrasive

Test abrasive for salt contamination and oil contamination as required by the appropriate abrasive specification daily at startup and every five operating hours thereafter.

3.8.3 Surface Standard

Inspect surfaces to be coated, and select plate with similar properties and surface characteristics for use as a surface standard. Blast clean one or more 300 mm 1 foot square steel panels as specified in paragraph SURFACE PREPARATION. Record blast nozzle type and size, air pressure at nozzle and compressor, distance of nozzle from panel, and angle of blast to establish procedures for blast cleaning. Measure surface profile in accordance with ASTM D7127. When the surface standard complies with all specified requirements, seal with a clearcoat protectant. Use the surface standard for comparison to abrasive blasted surfaces throughout the course of work.

3.8.4   Pre-Preparation Testing for Surface Contamination

Perform testing, abrasive blasting, and testing in the prescribed order.

3.8.4.1   Pre-Preparation Testing for Oil and Grease Contamination

****

NOTE: When specifying maintenance painting, use a water based pH neutral degreaser to avoid damaging existing coating.

****

Inspect all surfaces for oil and/or grease contamination using two or more of the following inspection techniques: 1) Visual inspection, 2) WATER BREAK TEST, 3) BLACK LIGHT TEST, and 4) CLOTH RUB TEST. Reject oil and/or grease contaminated surfaces, clean [using a water based pH neutral degreaser]in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.

WATER BREAK TEST - Spray atomized mist of distilled water onto surface, and observe for water beading. If water "wets" surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.

BLACK LIGHT TEST - Inspect surfaces for oil and grease contamination using the light specified in the paragraph BLACK LIGHT. Use light no more than 15 inches from surface unless testing indicates that the specific oil or grease found in tank fluoresce at a greater distance. Use light in tank that is completely sealed from light infiltration, under a hood, or at night. Any fluorescing on steel surfaces is indication of petroleum oil/grease contamination. Use either WATER BREAK TEST or CLOTH RUB TEST to confirm both contaminated and non-contaminated areas detected by BLACK LIGHT TEST. The BLACK LIGHT TEST may not be used during inspection of prepared surfaces for oil and grease contamination unless proven to fluoresce the oil and/or grease found in the specific tank and documented during testing prior to abrasive blasting. Generally, only petroleum oil/grease will fluoresce, however, some may not fluoresce sufficiently to be recognized and other methods, such as the WATER BREAK TEST or CLOTH RUB TEST, must be used to confirm findings of the BLACK LIGHT TEST.

CLOTH RUB TEST - Rub a clean, white, lint free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

3.8.4.2   Pre-Preparation Testing for Soluble Salts Contamination

Test surfaces for soluble salts, and wash as required, prior to abrasive blasting. Soluble salt testing is also required in paragraph PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION as a final acceptance test of prepared surfaces after abrasive blasting, and successful completion of this phase does not negate that requirement. This phase is recommended since pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Effective removal of soluble salts will require removal of any barrier to the steel surface, including rust. This procedure may necessitate combinations of wet abrasive blasting, high pressure water rinsing, and cleaning using a solution of water washing and soluble salts remover. The soluble salts remover shall be acidic, biodegradable, nontoxic, noncorrosive, and after application, will not interfere with primer adhesion. Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase are selected at the Contractor's discretion.

3.8.5 Abrasive Blasting

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NOTE: The issue of maximum profile on new structures is an important one. Once a profile is established, it is nearly impossible to reduce it, therefore, the initial profile will dictate the profile for the life of the structure.

The specified 2-3 mil surface profile is the preferred depth for preparing for the primer. On steel that was previously prepared to a deeper depth and coated, a depth of 4 mils can be tolerated with an additional mil of primer thickness.

To validate contractor claims of pre-existing profile greater than allowed, test an appropriate number of representative spots with abrasive that removes paint but does not affect profile, such as bicarbonate of soda, or other soft abrasive, or waterblasting, etc.

****

Abrasive blast steel surfaces to near-white metal in accordance with SSPC SP 10/NACE No. 2. Prepared surfaces shall conform to SSPC VIS 1 and shall match the prepared test-panels. Provide a 50 to 75 micron 2 to 3 mil surface profile. Reject profile greater than 75 microns 3 mils, discontinue abrasive blasting, and modify processes and materials to provide the specified profile. Measure surface profile in accordance with ASTM D7127, using Rmax as the measure of profile height. Record all measurements required in this standard. Measure profile at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 100 square meters 1000 square feet or part thereof. When surfaces are reblasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Do not attempt to wipe surface clean.

3.8.6 Disposal of Used Abrasive

Dispose of used abrasive off Government property in accordance with Federal, State and Local mandated regulations.

3.8.7 Pre-Application Testing For Surface Contamination

3.8.7.1 Pre-Application Testing for Oil and Grease Contamination

Ensure tank surfaces are free of contamination as described in paragraph PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION.

3.8.7.2 Pre-Application Testing for Soluble Salts Contamination

****

NOTE: In new tanks, require 30 percent of tests to be accomplished at welds. In tanks that have been in service, corroded areas should be tested for high chlorides.

****

Test surfaces for chloride contamination using the Test Kit described in paragraph TEST KIT FOR MEASURING CHLORIDE, SULFATE AND NITRATE IONS ON STEEL AND COATED SURFACES. Test all surfaces at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 200 square meters 2000 square feet or part thereof. [Concentrate testing of bare steel at areas of coating failure to bare steel and areas of corrosion pitting.][Perform 30 percent of tests on bare steel at welds, divided equally between horizontal and vertical welds.]One or more readings greater than nondetectable for chlorides, sulfates, or nitrates is evidence of soluble salt contamination. Reject contaminated surfaces, wash as discussed in paragraph PRE-PREPARATION TESTING FOR SOLUBLE SALTS CONTAMINATION, allow to dry, and re-test until all required tests show allowable results. Reblast tested areas using vacuum equipped blast equipment. Label all test tubes and retain for test verification.

3.8.7.3 Pre-Application Testing for Surface Cleanliness

Apply coatings to dust free surfaces. To test surfaces, apply strip of clear adhesive tape to surface and rub onto surface with finger. When removed, the tape should show little or no dust, blast abrasive, or other contaminant. Reject contaminated surfaces, clean by vacuum cleaning, and retest. Test surfaces at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 100 square meters 1000 square feet or part thereof. Provide two additional tests for each failed test or questionable test. Attach test tapes to Daily Inspection Reports.

3.9 MIXING AND APPLICATION OF SEALANT AND COATING SYSTEM

3.9.1 Preparation of Sealant and Coating Materials for Application

Each of the different products, sealant, primer, intermediate, and topcoat, is a two-component material supplied in separate containers.

3.9.1.1 Mixing

Mix in accordance with manufacturer's instructions, which may differ for each product. Do not mix partial kits, or alter mix ratios. Mix materials in same temperature and humidity conditions specified in paragraph DELIVERY AND STORAGE. Allow mixed material to stand for the required induction time based on its temperature.

3.9.1.2 Pot Life

Apply mixed products within stated pot life for each product. Stop applying when material becomes difficult to apply in a smooth, uniform wet film. Do not add solvent to extend pot life. Add all required solvent at time of mixing. Pot life is based on standard conditions at 21 degrees C 70 degrees F and 50 percent relative humidity. For every 10 degrees C 18 degrees F rise in temperature, pot life is reduced by approximately half, and for every 10 degrees C 18 degrees F drop, it is approximately doubled. Usable pot life depends on the temperature of the material at the time of mixing and the sustained temperature at the time of application. Other factors such as the shape of the container and volume of mixed material may also affect pot life. In hot climates, precooling or exterior icing of components for at least 24 hours to a minimum of 10 degrees C 50 degrees F will extend pot life. Following are approximate pot life times:

Sealant	As specified by manufacturer
Epoxy Primer and Intermediate Coat Materials	4 hours

3.9.1.3 Application Conditions and Recoat Windows

****

NOTE: These requirements are provided in an attempt to prevent the significant number of intercoat delamination failures that are frequently found on industrial structures. The very strict requirements on application conditions and recoat windows may require work during abnormal hours, including weekends. Contractor work hours should allow for such during coating application.

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NOTE: Cold-weather application is not covered by this specification. If a project is designed for coating in cold weather, then the enclosure and heating requirements may be significant. It is not intended that contractors be forced to apply coatings in cold weather, however, the underlying premise is that coatings must be applied within the specified temperature ranges. A cold-weather specification should not be used to simply save money, as the coating system will generally not have the same longevity as one applied within 60-100 degrees F.

****

The application condition requirements for the coating system are very time and temperature sensitive, and are intended to avoid the delamination problems frequently found on industrial structures. Plan coating application to ensure that specified temperature, humidity, and condensation conditions are met. If conditions do not allow for orderly application of sealant, primer, stripe coat, intermediate coat and topcoat, use appropriate means of controlling air and surface temperatures, as required. Partial or total enclosures, insulation, heating or cooling, or other appropriate measures may be required to control conditions to allow for orderly application of all required coats.

Maintain air and steel surface temperature between 16 and 38 degrees C 60 and 100 degrees F during application and the first four hours of cure for epoxy coats. Maintain steel surface temperature more than 3 degrees C 5 degrees F above the dew-point of the ambient air for the same period.

Use Table entitled "RECOAT WINDOWS" to determine appropriate recoat windows for each coat after the initial coat. Apply each coat during appropriate RECOAT WINDOW of preceding coat. If a RECOAT WINDOW is missed, the minimum and maximum primer and intermediate coat thickness may be adjusted to accommodate a FILL COAT, however, requirements for total epoxy coating thickness and total coating thickness will not be modified. Missing more than one RECOAT WINDOW may require complete removal of coating if maximum total coating thickness requirements cannot be achieved.

If coating is not applied during RECOAT WINDOW, or if surface temperature exceeds 49 degrees C 120 degrees F between applications, provide GLOSS REMOVAL, apply next coat within 24 hours. If next planned coat is topcoat, apply FILL COAT if required to fill sanding marks. Sanding marks from GLOSS REMOVAL of intermediate coat reflecting through topcoat will be considered as non-compliant. Apply FILL COAT within 24 hours of GLOSS REMOVAL, then apply topcoat within RECOAT WINDOW of FILL COAT.

RECOAT WINDOWS						
Temperature degrees C	16-21	22-27	28-32	33-38	39-43	44-49
RECOAT WINDOW (Hrs.)	24-72	18-60	16-48	12-36	8-18	8-18

RECOAT WINDOWS						
Temperature degrees F	60-70	71-80	81-90	91-100	101-110	111-120
RECOAT WINDOW (Hrs.)	24-72	18-60	16-48	12-36	8-18	8-18

The temperature ranges shown in the table above are for determining recoat windows. Choose recoat window based on the highest surface temperature that was sustained for one or more hours between coats. This applies to the entire time between coats. Measure and record air and surface temperatures on hourly basis to determine appropriate recoat windows. If surface temperature goes above 38 degrees C 100 degrees F, measure and record temperatures every half hour.

FILL COAT - Where indicated, apply coat of intermediate coat epoxy, at 50 to 75 microns 2 to 3 mils DFT, then apply next specified full coat within recoat window of FILL COAT. A FILL COAT may be used to adjust coating thickness to comply with requirements or to fill sanding marks in intermediate coat.

GLOSS REMOVAL - Where required, hand sand in a linear fashion to remove gloss using 120-200 grit wet/dry sandpaper, followed by solvent wiping with a clean rag soaked with denatured alcohol to remove all dust. GLOSS REMOVAL of primer coat is to scarify surface and shall consist of removal of approximately 25 microns 1 mil of coating. If steel is exposed during GLOSS REMOVAL, repair in accordance with paragraph PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING. GLOSS REMOVAL of intermediate coat may include removal of up to 3 mils of coating to avoid excess thickness, prior to application of FILL COAT.

3.9.2 Amine Blush Testing of Epoxy Coat Prior to Overcoating

Test epoxy surfaces prior to application of roof joint sealant, epoxy coat, or polyurethane topcoat for amine blush contamination using the Test Kit described in paragraph TEST KIT FOR IDENTIFYING AMINE BLUSH ON EPOXY SURFACES. Test all surfaces at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 200 square meters 2000 square feet or part thereof. If one or more tests show positive results for amine blush contamination, either treat all surfaces using the approved amine blush removal procedure or increase testing to ensure that all contamination is located, and then treat identified contamination using the approved procedure.

3.9.3 Application of Coating System and Roof Joint Sealant

Apply coatings in accordance with SSPC PA 1 and as specified herein. Apply sealant and coatings to surfaces that meet all stated surface preparation requirements.

After application of primer coat and prior to application of each subsequent coat, perform testing prescribed in paragraph PRE-APPLICATION TESTING FOR SURFACE CONTAMINATION, as necessary, to ensure minimal intercoat contamination. This testing may be reduced to one half of the prescribed rate for bare steel if the testing indicates no contamination when sampling is evenly distributed over surfaces being tested. If contamination is found between coats, revert to the specified testing rate. Generally, oil and grease contamination and soluble salts contamination are not encountered if subsequent coats are applied within specified recoat windows and the quality of air entering tank is controlled. Concern for intercoat contamination should be continually prevalent, and spot testing should be accomplished to verify satisfactory conditions. Where visual examination or spot testing indicates contamination, perform sufficient testing to verify non-contamination, or to define extent of contamination for appropriate treatment.

Apply each coat in a consistent wet film, at 90 degrees to previous coat. Ensure that primer and intermediate coat "cold joints" are no less than 150 mm six inches from welds. Apply stripe coat by brush. For convenience, stripe coat material may be delivered by spray if followed immediately with brush-out and approved procedures include appropriate controls on thickness. Apply all other coats by spray application. Use appropriate controls to prevent airborne coating fog from drifting beyond [[three][_____] meters [15][_____] feet from the tank perimeter] [the tank berm]. The cleanliness, temperature, recoat windows, and airborne paint containment requirements may necessitate the use of portable shelters or other appropriate controls.

****

NOTE: Maximum thickness measurements are to limit internal stresses in each coat and in total system. Internal stresses of epoxy and polyurethane coatings on steel can be significant, and unless limited through thickness, can cause premature failure as the coating ages. Such failures as shrinkage cracking and delamination, either from the substrate or between coats, are common. This system is not expected to receive a maintenance overcoat.

****

Apply coatings at the following specified thickness:

Coat	Minimum DFT (Microns)	Maximum DFT (Microns)
Primer	75	125
Intermediate	75	125

Coat	Minimum DFT (Microns)	Maximum DFT (Microns)
Top	75	125
Total system	225	375

Coat	Minimum DFT (Mils)	Maximum DFT (Mils)
Primer	3	5
Intermediate	3	5
Top	3	5
Total system	9	15

Measure coating thickness in accordance with SSPC PA 2 to confirm that coating application is within the specified range and within the tolerances of that standard. For non-compliant areas, increase number of test areas to identify all non-compliant application as required by SSPC PA 2. Add coating as required to correct underruns, and remove coating with excess thickness to bare steel and reapply as specified in paragraph PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING.

3.9.3.1 Application of Roof Joint Sealant

Apply sealant to the roof-to-shell joint, to all roof plate lap joints, and to roof-to-rafter joints up to 25 mm 1 inch gap to exclude moisture from these marginally prepared crevice areas. Allow sealant to cure according to manufacturer's instructions prior to application of the stripe coat.

3.9.3.2 Application of Stripe Coat

Apply stripe coat of epoxy primer material prior to application of general primer coat on CEILING. Apply stripe coat of epoxy intermediate coat material after application of general primer coat on BOWL. Where stripe coat is applied to areas of joint sealant, allow appropriate curing time for joint sealant. Apply stripe coat by brush, working the material into corners, crevices, pitted areas, and welds, and onto outside corners and angles. Where roof-to-rafter joints exceed 25 mm 1 inch gap and roof joint sealant was not applied, use appropriate application tools to provide "best effort" coating of all exposed steel surfaces in the gap. Mini-rollers or other tools may be required.

3.9.3.3 Application of Primer

Apply primer coat within RECOAT WINDOW of stripe coat.

3.9.3.4 Application of Intermediate Coat

Apply intermediate coat within RECOAT WINDOW of primer coat.

3.9.3.5 Application of Topcoat

Apply topcoat within RECOAT WINDOW of intermediate coat.

3.9.4 Holiday Testing

No sooner than 48 hours after application of the topcoat, perform holiday testing in accordance with the low voltage wet sponge method of NACE SP0188. Repair holidays per paragraph entitled "Procedure for Holiday and Spot Repairs of Newly Applied Coating."

3.9.5 Procedure for Holiday and Spot Repairs of Newly Applied Coating

Repair coating film defects at the earliest practicable time, preferably before application of the succeeding coat. Observe all requirements for soluble salts contamination, cleanliness between coats, and application conditions. Prepare defective area in accordance with SSPC SP 10/NACE No. 2, and feather coating as required to leave 100 mm 4 inches of each succeeding coat feathered and abraded. Do not abrade the polyurethane topcoat. Protect adjacent areas from damage and overspray. Remove dust and solvent wipe the prepared area plus an additional 100 mm 4 inches beyond the prepared area with clean denatured alcohol. Apply each coat within RECOAT WINDOW of preceeding coat. Within four hours of preparation, apply primer to prepared steel and feather onto prepared primer. Apply intermediate coat to primed area and feather to prepared intermediate area. Apply topcoat to intermediate coat and feather to prepared topcoat. Apply each repair coat to approximate thickness of surrounding coating system. If one percent or more of the total surface area, or more than one spot per 200 square meters 2000 square feet, of the BOWL area requires repair to any coat or coats, including feathered areas, the entire BOWL coating system shall be removed and reapplied. If 5 percent or more of the total surface area, or more than one spot per 100 square meters 1000 square feet, of the CEILING area requires repair to any coat or coats, including feathered areas, the entire CEILING coating system shall be removed and reapplied.

3.9.6 Tank Occupancy After Coating Application

Use clean canvas, or other approved, shoe covers when walking on coated surfaces, regardless of curing time allowed. For heavily trafficked areas, provide cushioned mats for additional protection.

3.9.7 Extended Cure of Coating System Prior to Immersion Service

Allow a cure time of at least 14 days after the final coating material has been applied before introducing water into tank.

3.10 PROJECT IDENTIFICATION

At the completion of the tank work, stencil coating information on the exterior of the tank adjacent to the main manway opening[, and adjacent to the access ladder on the lower portion of the leg for an elevated tank. Information should be easily accessible from the ground, and if there is not room on the leg to place the information, place it on the riser, facing the access ladder]. Stenciling shall be in 3/4 to one inch Helvetica style letters of contrasting color using acrylic stencil paint:

Date Interior coated:
Project Number:
Contractor:
Address:
Coating System
  Surface Prep: SSPC SP ____ Profile: ______

Primer: __________________ Thickness: ____
Intermediate: ____________ Thickness: ____
Topcoat: _________________ Thickness: ____
Total Thickness: _________

3.11 FIELD QUALITY CONTROL

Project documentation, including inspection and testing records, shall be used to determine the Contractor's compliance with contract requirements and approved procedures. The Contractor's certifications of completion, for both invoices and for project completion, shall be based on documented evidence of compliance with all requirements and approved Coating Work Plan procedures. Track inspections and tests in the Test Plan & Log.

3.11.1 Coating Inspector

The coating inspector shall be considered a QC Specialist and shall report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The Coating Inspector shall be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, during all coating repair work, and during completion activities as specified in Section 01 45 00 QUALITY CONTROL. The Coating Inspector shall provide complete documentation of conditions and occurrences on the job site, and be aware of conditions and occurrences that are potentially detrimental to the coating system. The requirements for inspection listed in this Section are in addition to the QC inspection and reporting requirements specified in Section 01 45 00 QUALITY CONTROL.

3.11.2 Field Inspection

3.11.2.1 Inspection Requirements

Perform field inspection in accordance with ASTM D3276 and the approved Coating Work Plan. Document Contractor's compliance with the approved Coating Work Plan.

Provide all tools and instruments required to perform the required testing, as well as any tools or instruments that the inspector considers necessary to perform the required inspections and tests. Document each inspection and test, including required hold points and other required inspections and tests, as well as those inspections and tests deemed prudent from on-site evaluation to document a particular process or condition, as follows:

a. Location or area;
b. Purpose (required or special);
c. Method;
d. Criteria for evaluation;
e. Results;
f. Determination of compliance;
g. List of required rework;
h. Observations.

Collect and record Environmental Conditions as described in ASTM D3276 on a 24 hour basis, as follows:

a. During surface preparation, every two hours or when changes occur;
b. During coating application and the first four days of initial cure, every hour, or when changes occur;
c. Note location, time, and temperature of the highest and lowest surface

temperatures each day;
d. Use a non-contact thermometer to locate temperature extremes, then verify with contact thermometers.

NOTE: Data collected on Environmental conditions in paragraph AUTOMATED MONITORING REQUIREMENTS may be used for overnight data, however, the data must be constantly verified as to location of sensors and validity of data with respect to the coating work being accomplished.

Document all equipment used in inspections and testing, including manufacturer, model number, serial number, last calibration date and future calibration date, and results of on-site calibration performed. Work documented using data from equipment found to be out of calibration shall be considered as non-compliant since last calibration or calibration check, as required.

3.11.2.2 Inspection Report Forms

Develop project-specific report forms as required to report measurement and test results and observations being complete and compliant with contract requirements. This includes all direct requirements of the contract documents and indirect requirements of referenced documents. Show acceptance criteria with each requirement and indication of compliance of each inspected item. Annotation of non-compliance shall be conspicuous so as to facilitate identification and transfer to the Rework Log. Report forms shall include requirements and acceptance and rejection criteria, and shall be legible and presented so that entered data can be quickly compared to the appropriate requirement.

3.11.2.3 Daily Inspection Reports

Submit one copy of daily inspection report completed each day when performing work under this Section, to the Contracting Officer. Note all non-compliance issues, and all issues that were reported for rework in accordance with QC procedures of Section 01 45 00 QUALITY CONTROL. Each report shall be signed by the coating inspector and the QC Manager. Submit report within 24 hours of date recorded on the report.

3.11.2.4 Inspection Logbook

A continuous record of all activity related to this Section shall be maintained in an Inspection Logbook on a daily basis. The logbook shall be hard or spiral bound with consecutively numbered pages, and shall be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information. The Coating Inspector's Logbook that is sold by NACE is satisfactory. Submit the original Inspection Logbook to the Contracting Officer upon completion of the project and prior to final payment.

3.11.3 Inspection Equipment

All equipment shall be in good condition, operational within its design range, and calibrated as required by the specified standard for use of each device.

3.11.3.1 Black Light

Use a black light having a 365 nanometer intensity of 4,000 microwatts per square centimeter minimum at 380 mm 15 inches. The Spectroline BIB-150P from Spectronics Corporation satisfies this requirement.

3.12 FINAL CLEANUP

Following completion of the work, remove debris, equipment, and materials from the site. Remove temporary connections to Government or Contractor furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

[

TABLE I						
COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS						
Table Ia. - Epoxy Primer Coat MIL-DTL-24441/20 Formula 150 Type III (Green)						
Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent	51.4	55.4	24.1	28.1	---	---
Volatiles, percent	25.1	29.1	22.6	26.6	---	---
Non-volatiles vehicle, percent	17.5	21.5	47.3	51.3	---	---
Course particles, percent	---	.03	---	.03	---	---
Consistency, grams	350	500	165	250	---	---
Weight						
Kilograms / liter	1.38	1.43	1.23	1.28	---	---
Pounds / gallon	11.5	11.9	10.3	10.7	---	---
Set to touch, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	2
Dry-hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	6
Fineness of grind, Hegman	---	---	2	---	---	---
Flashpoint						
Degrees C	35.6	---	37.8	---	---	---
Degrees F	96	---	100	---	---	---
Titanium Dioxide, percent of pigment	14	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	5	---
Sag resistance						

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ia. - Epoxy Primer Coat MIL-DTL-24441/20 Formula 150 Type III (Green)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Micrometers	---	---	---	---	225	---
Mils	---	---	---	---	9	---
Color of dry film to approximate color of SAE AMS-STD-595A color 24272	---	---	---	---	---	Conform
Contrast ratio at 75 micrometers, 3 mils DFT	---	---	---	---	0.98	---
VOC						
Grams / liter	---	---	---	---	---	340
Pounds / gallon	---	---	---	---	---	2.8

GENERAL NOTES:
Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441/20.

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ib. - Epoxy Intermediate Coat MIL-DTL-24441/22 Formula 152 Type III (White (Tinted))

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent	50.3	54.3	24.8	28.8	---	---
Volatiles, percent	25.9	29.9	19.6	23.6	---	---
Non-volatiles vehicle, percent	17.8	21.8	49.6	53.6	---	---
Course particles, percent	---	0.2	---	0.2	---	---
Consistency, grams	165	220	115	185	---	---
Weight						
Kilograms / liter	1.45	1.50	1.21	1.26	---	---
Pounds / gallon	12.1	12.5	10.1	10.5	---	---
Set to touch, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	2
Dry-hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	8
Fineness of grind, Hegman	4	---	4	---	---	---
Flashpoint						
Degrees C	35.5	---	37.8	---	---	---
Degrees F	96	---	100	---	---	---
Titanium Dioxide, percent of pigment	91	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	5	---
Sag resistance						
Micrometers	---	---	---	---	300	---

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ib. - Epoxy Intermediate Coat MIL-DTL-24441/22 Formula 152 Type III (White (Tinted))

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Mils	---	---	---	---	12	---
Color of dry film to approximate color of SAE AMS-STD-595A color 27778	---	---	---	---	---	Conform
Contrast ratio at 75 micrometers, 3 mils DFT	---	---	---	---	0.96	---
Gloss, 60 degree specular	---	---	---	---	35	---
VOC						
Grams / liter	---	---	---	---	---	340
Pounds / gallon	---	---	---	---	---	2.8

GENERAL NOTES:
Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441/22.

TABLE I						
COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS						
Table Ic. - Epoxy Topcoat MIL-DTL-24441/22 Formula 152 Type III (White)						
Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent	50.3	54.3	24.8	28.8	---	---
Volatiles, percent	25.9	29.9	19.6	23.6	---	---
Non-volatiles vehicle, percent	17.8	21.8	49.6	53.6	---	---
Course particles, percent	---	0.2	---	0.2	---	---
Consistency, grams	165	220	115	185	---	---
Weight						
Kilograms / liter	1.45	1.50	1.21	1.26	---	---
Pounds / gallon	12.1	12.5	10.1	10.5	---	---
Set to touch, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	2
Dry-hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	8
Fineness of grind, Hegman	4	---	4	---	---	---
Flashpoint						
Degrees C	35.5	---	37.8	---	---	---
Degrees F	96	---	100	---	---	---
Titanium Dioxide, percent of pigment	91	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	5	---
Sag resistance						
Micrometers	---	---	---	---	300	---

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ic. - Epoxy Topcoat MIL-DTL-24441/22 Formula 152 Type III (White)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Mils	---	---	---	---	12	---
Color of dry film to approximate color of SAE AMS-STD-595A color 27778	---	---	---	---	---	Conform
Contrast ratio at 75 micrometers, 3 mils DFT	---	---	---	---	0.96	---
Gloss, 60 degree specular	---	---	---	---	35	---
VOC						
Grams / liter	---	---	---	---	---	340
Pounds / gallon	---	---	---	---	---	2.8

GENERAL NOTES:
Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441/22.

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TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ia. - Epoxy Primer Coat MIL-DTL-24441/29 Formula 150 Type IV (Green)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent	45.0	50.0	35.0	40.0	---	---
Volatiles, percent	29.0	35.0	15.0	20.0	---	---
Non-volatiles vehicle, percent	17.5	23.5	43.0	48.0	---	---
Course particles, percent	---	.03	---	.03	---	---
Consistency, grams	300	410	470	600	---	---
Weight						
Kilograms / liter	1.33	1.39	1.33	1.39	---	---
Pounds / gallon	11.1	11.6	11.1	11.6	---	---
Set to touch, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	3
Dry-hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	6
Fineness of grind, Hegman	3	---	2	---	---	---
Flashpoint						
Degrees C	35.5	---	37.8	---	---	---
Degrees F	96	---	100	---	---	---
Titanium Dioxide, percent of pigment	18	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	4	---
Sag resistance						

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ia. - Epoxy Primer Coat MIL-DTL-24441/29 Formula 150 Type IV (Green)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Micrometers	---	---	---	---	300	---
Mils	---	---	---	---	12	---
Color of dry film to approximate color of SAE AMS-STD-595A color 24272	---	---	---	---	---	Conform
Contrast ratio at 75 micrometers, 3 mils DFT	---	---	---	---	0.98	---
VOC						
Grams / liter	---	---	---	---	---	340
Pounds / gallon	---	---	---	---	---	2.8

GENERAL NOTES:
Test methods as specified in MIL-DTL-24441.
Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441/29.

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ib. - Epoxy Intermediate Coat MIL-DTL-24441/31 Formula 152 Type IV (White (Tinted))

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent	44.0	49.0	33.0	38.0	---	---
Volatiles, percent	29.0	35.0	16.0	21.0	---	---
Non-volatiles vehicle, percent	17.5	23.5	44.0	49.0	---	---
Course particles, percent	---	0.3	---	0.3	---	---
Consistency, grams	180	320	300	470	---	---
Weight						
Kilograms / liter	1.39	1.45	1.29	1.35	---	---
Pounds / gallon	11.6	12.1	10.8	11.3	---	---
Set to touch, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	3
Dry-hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	8
Fineness of grind, Hegman	4	---	4	---	---	---
Flashpoint						
Degrees C	35.5	---	37.8	---	---	---
Degrees F	96	---	100	---	---	---
Titanium Dioxide, percent of pigment	91	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	4	---
Sag resistance						
Micrometers	---	---	---	---	300	---

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ib. - Epoxy Intermediate Coat MIL-DTL-24441/31 Formula 152 Type IV (White (Tinted))

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Mils	---	---	---	---	12	---
Color of dry film to approximate color of SAE AMS-STD-595A color 27778	---	---	---	---	---	Conform
Contrast ratio at 75 micrometers, 3 mils DFT	---	---	---	---	0.98	---
Gloss, 60 degree specular	---	---	---	---	35	---
VOC						
Grams / liter	---	---	---	---	---	340
Pounds / gallon	---	---	---	---	---	2.8

GENERAL NOTES:
Test methods as specified in MIL-DTL-24441.
Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441/31.

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ic. - Epoxy Intermediate Coat MIL-DTL-24441/31 Formula 152 Type IV (White)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent	44.0	49.0	33.0	38.0	---	---
Volatiles, percent	29.0	35.0	16.0	21.0	---	---
Non-volatiles vehicle, percent	17.5	23.5	44.0	49.0	---	---
Course particles, percent	---	0.3	---	0.3	---	---
Consistency, grams	180	320	300	470	---	---
Weight						
Kilograms / liter	1.39	1.45	1.29	1.35	---	---
Pounds / gallon	11.6	12.1	10.8	11.3	---	---
Set to touch, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	3
Dry-hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	8
Fineness of grind, Hegman	4	---	4	---	---	---
Flashpoint						
Degrees C	35.5	---	37.8	---	---	---
Degrees F	96	---	100	---	---	---
Titanium Dioxide, percent of pigment	91	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	4	---
Sag resistance						
Micrometers	---	---	---	---	300	---

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ic. - Epoxy Intermediate Coat MIL-DTL-24441/31 Formula 152 Type IV (White)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Mils	---	---	---	---	12	---
Color of dry film to approximate color of SAE AMS-STD-595A color 27778	---	---	---	---	---	Conform
Contrast ratio at 75 micrometers, 3 mils DFT	---	---	---	---	0.98	---
Gloss, 60 degree specular	---	---	---	---	35	---
VOC						
Grams / liter	---	---	---	---	---	340
Pounds / gallon	---	---	---	---	---	2.8

GENERAL NOTES:
Test methods as specified in MIL-DTL-24441.
Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441/31.

]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-09 97 13.17 (May 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 13.17 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 97 13.17

THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS

05/22

PART 1 GENERAL

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-09 97 13.17 (May 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 13.17 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 09 97 13.17

THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS

05/22

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NOTE: This guide specification covers the requirements for a three-coat epoxy system for interior coating of newly constructed, bulk fuel storage tanks. For maintenance coating design, see notes herein. Severe corrosion and corrosion pitting are not addressed in this specification.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
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NOTE: This specification should be edited by an AMPP (Association for Materials Protection and Performance) (previously SSPC) certified Protective Coatings Specialist (PCS) that has five or more years of experience preparing coating specifications.

The designer should not alter the products and processes specified herein without thorough knowledge of the need for the changes and the implications of those changes.
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NOTE: SSPC and NACE have merged to become AMPP. The merger was still in progress at the time this section was released.

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NOTE: The metric standard for measuring coating thickness is microns (25.4 microns=1 mil; use nominal 25 microns=1 mil).

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NOTE: This specification is for a three-coat, thin film system, which is compliant with Environmental Protective Agency (EPA) volatile organic compound (VOC) regulations as of June 2000.

- Epoxy Coats 350 grams per liter (g/l) 2.8 pounds per gallon (lbs/gal) maximum VOC

The designer must review state and local regulations and determine whether the coating in this Section complies with restrictions on VOC and other chemical constituents.

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NOTE: Tailor the SURFACE PREPARATION paragraph and subparagraphs to the needs of cleaning that will be required in preparation for repairs, and note that the abrasive blasting for inspection should be accomplished in such a manner that it does not conflict with any surface condition requirements in this Section, such as creating excessive surface profile that may require excessive primer thickness. For repair projects, specify appropriate portions of the steel surfacing requirements (according to NACE RPO178) from Section 33 56 21.17 SINGLE WALL ABOVE GROUND FIXED ROOF STEEL POL STORAGE TANK.

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NOTE: Designs for fuel tank linings should be based on recent inspections. Wherever possible, a coating inspection, or coating condition survey (CCS), as described in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES, should be accomplished prior to designing a coating project for fuel tank interiors. Without a competent inspection, there is no reliable way to determine the type or condition of the existing coating system. If existing conditions are not known, proper (effective and financially supportable) surface preparation or coating system selection cannot be made. It is not always cost effective to replace the entire coating system in a fuel tank; however, this is the tendency in preparing a design without inspection results.

Do not provide general overcoat to a fuel tank lining unless recommended in a CCS to add corrosion protection. Provide complete removal and replacement, or repairs to existing coating, as deemed appropriate. Overcoating the interior of a tank is generally a liability unless extraordinary measures are taken to ensure adhesion to the old coating, regardless of whether it is epoxy or urethane.

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NOTE: Designers are encouraged to contact Robert Jamond (robert.jamond@navy.mil) prior to beginning a new Navy design.

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NOTE: Designers are encouraged to contact the Air Force Civil Engineer Reachback Center (afcec.rbc@us.af.mil) prior to beginning a new Air Force design.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

API Std 653	(2014; Addendum 1 2018) Tank Inspection, Repair, Alteration, and Reconstruction

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D3276	(2015; E 2016) Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D3335	(1985a; R 2020) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D3718	(1985a; R 2015) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings
ASTM D4285	(1983; R 2018) Indicating Oil or Water in Compressed Air
ASTM D4417	(2021) Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4940	(2015) Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8502-3	(2017) Preparation of Steel Substrates Before Application of Paints and Related Products - Tests for the Assessment of Surface Cleanliness - Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)
ISO 9001	(2015) Quality Management Systems-Requirements

NACE INTERNATIONAL (NACE)

NACE SP0178	(2007) Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to be Lined for Immersion Service
NACE SP0188	(2024) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC AB 1	(2015; E 2017) Mineral and Slag Abrasives

SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2023; R 2023) Ferrous Metallic Abrasive
SSPC Guide 12	(2023) Guide for Illumination of Industrial Painting Projects
SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC PA 2	(2015; E 2018) Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC PA Guide 11	(2020) Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC QP 2	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Removal of Hazardous Coatings from Structures)
SSPC QP 5	(2022) Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning
SSPC SP 11	(2020) Surface Preparation Standard No. 11 - Power Tool Cleaning to Bare Metal
SSPC SP COM	(2016; E 2017) Surface Preparation Commentary for Steel and Concrete Substrates
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC-SP WJ-1/NACE WJ-1	(2012) Clean to Bare Substrate, Waterjet Cleaning of Metals
SSPC-SP WJ-2/NACE WJ-2	(2012) Very Thorough Cleaning, Waterjet Cleaning of Metals

SSPC-SP WJ-3/NACE WJ-3	(2012) Thorough Cleaning, Waterjet Cleaning of Metals
SSPC-SP WJ-4/NACE WJ-4	(2012) Light Cleaning, Waterjet Cleaning of Metals

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for
MIL-DTL-24441/29	(2009; Rev B; Notice 1 2021) Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type IV
MIL-DTL-24441/31	(2009; Rev B; Notice 1 2021) Paint, Epoxy-Polyamide, White, Formula 152, Type IV

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART Z	Toxic and Hazardous Substances
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1000	Air Contaminants
29 CFR 1926.59	Hazard Communication

1.2 DEFINITIONS

Definitions are generally provided throughout this Section in the paragraphs where used and denoted by capital letters. The following definitions are used throughout this Section:

a. ROOF - Interior tank surfaces that extend from the horizontal plane at the designated maximum fuel line upward, including the upper portion of the tank shell (walls), columns, structural steel, the underside of the roof plates, and other steel components in this area.

b. SHELL - Interior tank surfaces that extend along the vertical tank walls between the horizontal planes approximately 1 meter 40 inches above the shell-to-bottom joint upward to the horizontal plane at the designated fuel line, including columns, wall plates, and other steel components in this area.

c. BOTTOM - Interior tank surfaces below the horizontal plane approximately 1 meter 40 inches above the shell-to-bottom joint, including columns, wall plates, piping, pipe supports, bottom plates, and other steel components in this area.

d. INDEPENDENT THIRD-PARTY - Impartial third-party not a part or affiliated with Contractor or subcontractor principal or subsidiary businesses, and not a materials supplier.

e. STRIPE COAT - An additional corrosion protection measure on edges, outside corners, crevices, bolt heads, welds, and other irregular surfaces, including minor surface preparation on sharp edges.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contract Errors, Omissions, and Other Discrepancies

Corrective Action Procedures

Corrective Action Request (CAR) Form

Coatings Work Plan

Inspection Report Form

SD-05, Design Data

Environmental Control System

Use of Door Sheet Access Way; G, [_____]

SD-06 Test Reports

Coatings Qualification Test Reports

Joint Sealant Qualification Test Reports

Non-Metallic Abrasive Qualification Test Reports; G, [_____]

Ferrous Metallic Abrasive Qualification Test Reports

Coating Field Test Reports

Abrasive Field Test Reports

Recycled Ferrous Metallic Abrasive Field Test Reports (Daily and Weekly)

Daily Inspection Reports

SD-07 Certificates

Qualifications of Certified Industrial Hygienist (CIH)

Qualifications of Certified Protective Coatings Specialist (PCS)

Qualifications of Coatings Inspection Company

Qualifications of Quality Assurance Coatings Inspector

Qualifications of Coatings Contractors

Qualifications of Individuals Performing Abrasive Blasting

Qualifications of Individuals Applying Coatings

Qualifications of Testing Laboratory for Coatings

Qualifications of Testing Laboratory for Abrasive

Coating Materials Certificate of Conformance

Joint Sealant Materials Certificate of Conformance

Joint Sealant Compatibility

Non-Metallic Abrasive Certificate of Conformance

Ferrous Metallic Abrasive Certificate of Conformance

SD-08 Manufacturer's Instructions

Joint Sealant Instructions

Coating System Instructions

SD-11 Closeout Submittals

Disposal of Used Abrasive; G, [_____]

Inspection Logbook; G, [_____]

Corrective Action Log; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Contract Errors, Omissions, and Other Discrepancies

Submit all errors, omissions, and other discrepancies in contract documents the Contracting Officer within 30 days of contract award for all work covered in this Section, other than the work that will not be uncovered until a later date. All such discrepancies must be addressed and resolved, and the Coatings Work Plan modified, prior to beginning the Initial and Follow-Up phases of work. Discrepancies that become apparent only after work is uncovered must be identified at the earliest discoverable time and submitted for resolution. Schedule time (float) must be built into the project schedule at those points where old work is to be uncovered or where access is not available during the first 30 days after award, to allow for resolution of contract discrepancies.

1.4.2 Corrective Action (CA)

CA must be included in the Contractor Quality Control Plan as outlined in Section 01 45 00 QUALITY CONTROL.

1.4.2.1 Corrective Action Procedures

Develop procedures for determining the root cause of each non-compliance, developing a plan to eliminate the root cause so that the non-compliance does not recur, and following up to ensure that the root cause was eliminated.

1.4.2.2 Corrective Action Request (CAR) Form

Develop Corrective Action Request (CAR) forms for initiating CA and for tracking and documenting each step. The CAR should be included with the Corrective Action Procedures. A CAR must be initiated by either the Contractor or the Contracting Officer. The Protective Coatings Specialist (PCS) must approve each CAR at the root cause identification stage, the plan for elimination stage, and the close out stage after verification that the root cause has been eliminated.

1.4.2.3 Corrective Action Log

When a CAR is initiated, the Contractor must take action to identify and eliminate the root cause of each non-compliance so as to prevent recurrence. These actions must apply to non-compliance in the work, and to non-compliance in the Quality Control (QC) System. Corrective actions must be appropriate to the effects of the non-compliance encountered. The corrective action must be documented in a report that is serialized and tracked in the Corrective Action Log until project completion and acceptance by the Contracting Officer. All corrective action reports must be retained in project records. The Corrective Action Log, showing status of each CAR, must be submitted to the Contracting Officer monthly.

1.4.3 Coatings Work Plan

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NOTE: For maintenance painting, add requirement for pre-work determination of the existing surface profile. If paint removal is specified in another Section, such as a blast cleaning prior to inspection or repair, or in the lead removal Section, include this evaluation of existing profile such that the paint removal operation does not create excessive profile.

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NOTE: Choose the options pertaining to the floating pan that apply to the project. The pan must be removed for any significant coating work on the SHELL and ROOF, and for all but minor repairs on the BOTTOM.

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NOTE: If there is a possibility that generating non-detectable soluble salt levels per PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION could cause delays in surface preparation, the Coatings Work Plan must include a section that would provide guidance on the strategy to be pursued should greater-than-zero soluble salt levels be detected.

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NOTE: Ensure coordination between all parties, including the welder, weld inspector, coatings Contractor, Quality Assurance Coatings Inspector, and Coatings Contractor QC Coatings Inspector, on weld preparation and surface profile requirements.

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The Coatings Work Plan must be considered as part of the Contractor Quality Control Plan as outlined in Section 01 45 00 QUALITY CONTROL.

The Coatings Work Plan must be submitted and approved by the PCS prior to mobilization. The Coatings Work Plan must explain in detail all procedures including, but not limited to, all sequential processes, quality control for each process, quality assurance for each process, and safety considerations. Subsections must include at least the following:

a. Purpose;

b. Introduction[(including the scope of work (SOW) project program)];

c. Safety, fire, and health information;

d. Contractor and worker qualifications with certifications;

e. Project management organization and documents;

f. Timeline in a Gantt chart;

g. Project document references;

h. Reference to all applicable standards (e.g., AMPP, NACE, SSPC, ISO, and ASTM);

i. Coatings manufacturer's supporting documentation;

j. Descriptions and explanations of any exceptions from the coating manufacturer;

k. Coating and blasting equipment, model names, and, if applicable, calibration dates;

l. Containment design and details;

m. Environmental testing;

n. Material delivery, storage, and handling details;

o. Surface preparation[(include procedures for if the pre-existing anchor profile is greater than 100 microns 4 mils as specified in paragraph ABRASIVE BLASTING)];

p. Pre-application test panel validation for field-applied external coating as outlined in SURFACE STANDARD;

q. Coating materials, mixing, application, recoat windows, and coating curing times, if applicable;

r. Coating repairs and rework;

s. Non-conformance;

t. Spent material handling and effluent discharge containment and disposal;

u. Inspection test plan (as outlined in FIELD INSPECTION, and including inspection hold points, both Quality Assurance and Coating Contractor QC Coatings Inspector's responsibilities, and daily documentation and delivery);

v. Instruments and test kits;

w. Soluble salt testing (include procedures that must be used if greater-than-zero soluble salt levels are not able to be removed from the steel surface);

x. Warranty (in writing, signed by the Contractor and the coating manufacturer's representative);

y. Demobilization;

z. PCS and PM approval;

1.4.4 Design Data

1.4.4.1 Environmental Control System

Submit design details of the proposed environmental control system to include ventilation, humidity control, and temperature regulation. Provide calculations for humidity control during separate surface preparation and coating application procedures, ventilation requirements during coating application, and maximum allowable coating application rates to coincide with ventilation. Include basis of design data on local conditions. Provide equipment layout sketches and procedures showing function of each piece of equipment and fail-safe measures. A Certified Industrial Hygienist must approve calculations, work procedures, and personal protective equipment.

1.4.4.2 Use of Door Sheet Access Way

If use of a door sheet access way is desired, submit design drawings and calculations that address all aspects of the door sheet opening in accordance with API Std 653 and API Std 650, including cutting of door sheet, tank stabilization, door sheet replacement, weld testing, and final acceptance. A registered engineer must approve all calculations and procedures prior to submittal for government approval.

1.4.5 Test Reports

1.4.5.1 Coatings Qualification Test Reports

Submit qualification test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each coating material. U.S. Department of Defense laboratories are considered to be independent laboratories. Samples must have been tested within the last three years.

The purpose of qualification testing is to pre-qualify the coating materials to MIL-DTL-24441. Submit test results for materials in conformance to the requirements of MIL-DTL-24441. Note that this is the same testing that is required for listing on the Qualified Products List (QPL). The coating materials must remain on the QPL for the entire project.

1.4.5.2 Joint Sealant Qualification Test Reports

Submit qualification test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of joint sealant material that will be used on this project. Samples must have been tested within the last three years. Submit results of conformance to ASTM C920.

1.4.5.3 Ferrous Metallic Abrasive Qualification Test Reports

Submit results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 3. Submit test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of pre-qualifying the abrasive.

1.4.5.4 Non-Metallic Abrasive Qualification Test Reports

Submit results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 1. Submit test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each abrasive to be used on the jobsite.

Samples must have been tested within the last three years. Note that this testing is for the purpose of pre-qualifying the abrasive.

1.4.5.5 Recycled Ferrous Metallic Abrasive Field Test Reports (Daily and Weekly)

Submit test results from an INDEPENDENT THIRD-PARTY laboratory of daily and weekly Quality Control testing required by SSPC AB 2, as modified in paragraph ABRASIVE.

1.4.6 Qualifications

1.4.6.1 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY CIH. Submit documentation that the hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. The CIH must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. If a CIH's certification expires, the hygienist will not be allowed to perform any hygienist functions, and all hygienist work must stop, until the certification is reissued or another CIH is approved. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Provide evidence of experience with hazards involved in industrial coating application work.

1.4.6.2 Qualifications of Certified Protective Coatings Specialist (PCS)

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY PCS. Submit documentation that specialist is certified by the Association for Materials Protection and Performance (AMPP) (formerly SSPC: The Society for Protective Coatings (SSPC)) as a PCS, including certification number and date of certification/recertification. If the PCS is employed by the same coatings inspection company to which the Quality Assurance Coatings Inspector is employed, this does not violate the INDEPENDENT THIRD-PARTY requirements. The PCS must remain certified during the entire project, and the Contracting Officer shall be notified of any change in certification status within 10 days of the change. If a PCS's certification expires, the PCS will not be allowed to perform any PCS functions, and all coatings work must stop, until the certification is reissued or another PCS is approved. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. The PCS must not be the designated Quality Assurance Coatings Inspector. The PCS's responsibilities are outlined in PROTECTIVE COATINGS SPECIALIST (PCS).

1.4.6.3 Qualifications of Coatings Inspection Company

Submit documentation that the coatings inspection company that will be performing all quality assurance coatings inspection functions is certified by AMPP to the requirements of SSPC QP 5 prior to contract award. The coatings inspection company that is submitted and approved, must remain and cannot be changed through completion of the contract. The coatings inspection company must remain SSPC QP 5 certified for the duration of the coating work and the Contracting Officer must be notified of any change in certification status within 10 days of the change. If a coatings inspection company's certification expires, the firm will not be allowed to perform any inspection functions, and all surface preparation and coating application work must stop, until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports. The coatings inspection company must not engage in any activities that may conflict with their independence of judgment and integrity in relation to their inspection activities. In particular, they must not be engaged in the manufacture, supply, application, surface preparation, purchase, or maintenance of the applied coating in this project.

1.4.6.4 Qualifications of Quality Assurance Coatings Inspector

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NOTE: Although the Quality Assurance Coatings Inspector may be a certified NACE CIP Level III inspector, the Quality Assurance Coatings Inspector must be a certified QP 5 Level II inspector, with a minimum of a NACE CIP Level II certification, employed by the coatings inspection company.

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Submit documentation that each Quality Assurance Coatings Inspector is employed by the SSPC QP 5 company and is qualified to a minimum certification of NACE CIP Level II. Each inspector must remain employed by the coatings inspection company while performing any coatings inspection functions. The Quality Assurance Coatings Inspector's responsibilities are outlined in QUALITY ASSURANCE COATINGS INSPECTOR'S FIELD RESPONSIBILITIES. The roles of the Quality Assurance Coatings Inspector are in addition to, and distinct from, the role of the QC Coatings Inspector employed by the coatings Contractor.

1.4.6.5 Qualifications of Coatings Contractors

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NOTE: If project involves removal of paint containing hazardous materials, add requirement for SSPC QP 2 certification in section of specification where the hazardous paint removal is specified, generally Section 02 83 00 LEAD REMEDIATION.

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NOTE: Solicitations requiring certification for pre-qualification must point out the existence and location of the certification requirement on the PROJECT INFORMATION FORM. This requirement must be pointed out in the solicitation documents for the "prior to contract award" requirement to be enforceable. Certification is a special responsibility requirement pursuant to FAR 9.104-2 Special Standards. This is analogous to requiring bidders to have a specified level of experience or expertise and GAO has sustained these types of special requirements.

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All Contractors and Subcontractors that perform surface preparation or coating application must be certified to both SSPC QP 1 and SSPC QS 1 prior to contract award, and must remain certified while accomplishing any surface preparation or coating application. If a Contractor's or Subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports.

For projects located outside the United States, Guam, and Puerto Rico, the certifications for the coatings Contractor (SSPC QP 1 and SSPC QS 1) can be substituted if the coatings Contractor meets all of the below requirements:

a. ISO 9001 certified;

b. Eight years of experience with industrial coatings;

c. Evidence of recent work that has Contractor Performance Assessment Report System (CPARS) ratings, and other quality/performance ratings, that are equivalent to, or exceed, "Above Average";

d. Evidence of an INDEPENDENT THIRD-PARTY audit from AMPP demonstrating equivalency to SSPC QP 1 and SSPC QS 1 within the last two years.

[e. Evidence of an INDEPENDENT THIRD-PARTY audit from AMPP demonstrating equivalency to SSPC QP 2 within the last two years.

] The coatings Contractors and coatings Subcontractors must be certified to ISO 9001 prior to contract award and must remain so certified for the duration of the project. If a Contractor's or Subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from the ISO certifying organization and furnish a copy of all inspection reports.

1.4.6.6 Qualifications of Individuals Performing Abrasive Blasting

Submit name, address, and telephone number of each person that will be performing abrasive blasting. Submit documentation that each blaster is qualified by AMPP to the SSPC C7 Abrasive Blaster Qualification Program or CAS Coating Application Specialist Level 2 Certification Program (Interim Status). Each blaster must remain qualified during the entire period of abrasive blasting, and the Contracting Officer shall be notified of any change in qualification status within 10 days of the change. If a blaster's qualification expires, the blaster will not be allowed to perform any blasting functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply.

1.4.6.7 Qualifications of Individuals Applying Coatings

Submit name, address, and telephone number of each person that will be applying coatings. Submit documentation that each applicator is qualified by AMPP to the SSPC CAS Coating Application Specialist Level 2 Certification Program (Interim Status) or SSPC C12 Spray Application Certification. Each applicator must remain certified during the entire period of coating application, and the Contracting Officer must be notified of any change in qualification status within 10 days of the change. If an applicator's qualification expires, the applicator will not be allowed to perform any coatings application functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply.

1.4.6.8 Qualifications of Testing Laboratory for Coatings

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY laboratory or laboratories selected to perform testing of coating samples for qualification testing and for field sample testing for compliance with this Section. Submit documentation that the laboratory is regularly engaged in testing of paint samples for conformance with specifications and that the employees performing testing are qualified.

1.4.6.9 Qualifications of Testing Laboratory for Abrasive

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY laboratory or laboratories selected to perform testing of abrasive for compliance with this Section. Submit documentation that the laboratory has experience in testing samples of abrasive for conformance with specifications and that the employees performing testing are qualified.

1.4.6.10 Coating Materials Certificate of Conformance

Provide manufacturer's certification of conformance to MIL-DTL-24441.

1.4.6.11 Joint Sealant Materials Certificate of Conformance

Provide manufacturer's certification of conformance to ASTM C920 and as modified in this Section.

1.4.6.12 Joint Sealant Compatibility

Provide manufacturer's certification that the selected joint sealant is compatible with the epoxy topcoat.

1.4.6.13 Ferrous Metallic Abrasive Certificate of Conformance

Provide manufacturer's certification of conformance that the materials are currently in conformance with SSPC AB 3 and as modified in this Section, and have been tested within the last three years.

1.4.6.14 Non-Metallic Abrasive Certificate of Conformance

Provide manufacturer's certification of conformance that the materials are currently in conformance with SSPC AB 1 and as modified in this Section, and have been tested within the last three years.

1.4.7 QA and QC Personnel

1.4.7.1 QC Manager

The QC Manager is as defined in Section 01 45 00 QUALITY CONTROL.

1.4.7.2 Protective Coatings Specialist (PCS)

The PCS must be considered a QC Specialist and must report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The PCS must approve all submittals prior to submission to the QC Manager for approval or submission to the government for approval.

The PCS's responsibilities include, but are not limited to, the following:

a. Obtain, review, and understand all project documentation including, but not limited to, this Section, scope of work (SOW) project program, Coatings Work Plan, inspection and testing plan (ITP), and all submittals before the project starts, during the project, and all coatings related re-work;

b. Attend all pre-job coatings meetings (in-person, phone, or virtually);

c. Attend pre-final coatings walk-through (mandatory) and attend final coatings walk-through (as required).

1.4.7.3 Quality Assurance Coatings Inspector

The Quality Assurance Coatings Inspector must be considered a QC Specialist and must report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The Quality Assurance Coatings Inspector must be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, during all coating repair work, and during completion activities. The Quality Assurance Coatings Inspector must provide complete documentation of conditions and occurrences on the job site, and be aware of conditions and occurrences that are potentially detrimental to the coating system. The requirements for inspection listed in this Section are in addition to the QC inspection and reporting requirements specified in Section 01 45 00 QUALITY CONTROL. The responsibilities of the Quality Assurance Coatings Inspector are defined in QUALITY ASSURANCE COATING INSPECTOR'S FIELD RESPONSIBILITIES. These responsibilities are separate and distinct from the responsibilities of the Coatings Contractor QC Coatings Inspector.

1.4.7.4 Coatings Contractor QC Coatings Inspector

The Coatings Contractor QC Coatings Inspector must stop non-compliant work. The responsibilities of the Coatings Contractor QC Coatings Inspector are defined in COATINGS CONTRACTOR QC COATINGS INSPECTOR'S FIELD RESPONSIBILITIES. These responsibilities are separate and distinct from the responsibilities of the Quality Assurance Coatings Inspector.

1.4.8 Pre-Application Meeting

After approval of submittals, but prior to the initiation of coatings work, Contractor representatives, including at a minimum, project superintendent, QC manager, paint foreman, Quality Assurance Coatings Inspector, and PCS, must have a pre-application coating preparatory meeting. This meeting must be in addition to the pre-construction conference. Specific items addressed must include: corrective action requirements and procedures, coatings work plan, safety plan, coordination with other Sections, inspection standards, inspection requirements and tools, test procedures, environmental control system, and test logs. Notify Contracting Officer at least ten days prior to meeting.

1.5 PRODUCT DATA

1.5.1 Joint Sealant Instructions

Submit manufacturer's printed instructions including detailed mixing and application procedures, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.5.2 Coating System Instructions

Submit manufacturer's printed instructions including detailed mixing and application procedures, number and types of coats required, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.6 DELIVERY AND STORAGE

Ship, store, and handle materials in accordance with SSPC PA 1, and as modified in this Section. Maintain temperature in storage spaces between 5 and 24 degrees C 40 and 75 degrees F, and air temperature more than 3 degrees C 5 degrees F above the dew-point at all times. Inspect materials for damage prior to use and return non-compliant materials to manufacturer. Remove materials with expired shelf life from government property immediately and notify the Contracting Officer.

If materials are approaching shelf life expiration and an extension is desired, samples must be sent to the manufacturer, along with complete records of storage conditions, with a request for shelf life extension. If the manufacturer finds the samples and storage data suitable for shelf life extension, the manufacturer must issue an extension, referencing the product evaluation and the review of storage records. Products must not be extended longer than allowed in the product specification.

1.7 COATING HAZARDS

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NOTE: This specification Section must be used with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS.

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Ensure that employees are trained in all aspects of the safety plan. Specified coatings may have potential health hazards if ingested or improperly handled. The coating manufacturer's written safety precautions must be followed throughout mixing, application, and curing of the coatings. During tank cleaning, cleanup, surface preparation, and paint application phases, ensure that employees are protected from toxic and hazardous chemical agents which exceed concentrations in 29 CFR 1910.1000. Comply with respiratory protection requirements in 29 CFR 1910.134. The CIH must approve work procedures and personal protective equipment.

1.8 WORK SEQUENCE

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NOTE: Modify tank construction specification to indicate that floating pan will be installed over coated bottom and that the coating must be fully protected during pan installation with protective mats. Any required repairs must be done according to paragraph PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING.

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[Coat tank interior following tank tightness testing.] [Coat tank interior before installation of floating pan.]

1.9 JOB SITE REFERENCES

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NOTE: Include any other job-site-related references that might be added during design.

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Make available to the Contracting Officer at least one copy each of API Std 653, ASTM C920, ASTM D3276, ASTM D3925, ASTM D4285, ASTM D4417, ASTM D4940, NACE SP0178 and companion visual comparator, NACE SP0188, SSPC AB 1, SSPC AB 2, SSPC AB 3, SSPC SP COM, SSPC SP 1, SSPC SP 10/NACE No. 2, SSPC SP 11, SSPC PA 1, SSPC PA 2, SSPC Guide 12, SSPC VIS 1, SSPC QP 1, [SSPC QP 2,]SSPC QS 1, and an SSPC Certified Contractor Evaluation Form at the job site.

PART 2 PRODUCTS

2.1 COATING SYSTEM

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NOTE: Include bracketed text for new construction only.

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Coating systems must be as specified herein; alternate systems will not be considered. All primer, intermediate, and topcoat materials must be manufactured by one manufacturer and supplied by one supplier.[The entire coating system is intended to be applied in the field. Alternatively, surface preparation may be accomplished in the shop, following all temperature, humidity, and testing requirements listed herein, followed by an application of a hold-primer. Upon completion of field fabrication, all shop-applied coatings must be removed, surfaces prepared to SSPC SP 10/NACE No. 2, and the specified coating system applied. Adjust all shop preparation to avoid conflicts with final surface preparation requirements.]

2.1.1 Epoxy Primer, Intermediate, and Topcoats

The epoxy coating materials must be approved by the Naval Sea Systems Command and listed on their current Qualified Products List (QPL) for the specified materials.

2.1.1.1 Epoxy Primer Coat

Epoxy polyamide, MIL-DTL-24441/29 (Formula 150, Type IV, Green).

2.1.1.2 Epoxy Intermediate Coat

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White (Tinted)). Tint to approximately SAE AMS-STD-595A color number 27778 parchment using pigment dispersions prepared for epoxy paint tinting. Manufacturer shall tint material and appropriately label. All other requirements of this Military Specification apply.

2.1.1.3 Epoxy Topcoat

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White).

2.2 JOINT SEALANT

Industrial grade, two component, minimum 95 percent solids by volume, polysulfide type caulking material that has a minimum history of 10 years acceptable service in fuel tanks. Sealant must be compatible with the coating and suitable for direct application to prepared steel surfaces. Sealant must contain no more than 0.06 percent by dry weight lead, no more than 0.06 percent by dry weight cadmium, and no chromium. Joint sealant must be qualified to ASTM C920, Type M, Grade NS or P.

2.3 COATING FIELD COLLECTION KIT

Provide a kit for each sample to be collected. Each kit must contain: a one liter quart can for the base of the coating material; one appropriately sized can for the activator of the coating material; dipping cups for each component to be sampled; a shipping box sized for the samples to be shipped; and packing materials. Mark cans for the appropriate coating material and component (base or activator), including manufacturer's name, address, batch numbers, batch size shipped to the project site, and date of manufacture. Provide shipping documents, including either pre-paid shipping labels or a shipping number that can be used by the QC Manager to arrange pickup, addressed to the INDEPENDENT THIRD-PARTY coating testing laboratory.

2.4 ABRASIVE FIELD COLLECTION KIT

Provide a kit for each sample to be collected. Each kit must contain one suitable plastic bag or container for each sample to be collected. Mark containers with manufacturer's name, address, batch number, batch size, and date of manufacture. Provide shipping documents, including either pre-paid shipping labels or a shipping number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

2.5 INSPECTION TEST KITS

2.5.1 Test Kit for Measuring Chloride, Sulfate, and Nitrate Ions on Steel and Coated Surfaces

Provide test kits that meet all of the following requirements:

a. Contains all materials,supplies, tools, and instructions for field testing and on-site quantitative evaluation of chloride, sulfate, and nitrate ions;

b. Extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Components and solutions are mercury free and environmentally friendly;

d. Contains new materials and solutions for each test extraction;

e. Contains an extraction test container (vessel, sleeve, cell) creates a sealed, encapsulated environment during salt ion extraction;

f. Contains a test extract container is suitable for testing the following steel surfaces: horizontal (up/down configuration), vertical, flat, curved, smooth, pitted, and rough;

g. All salt ion concentrations are directly measured in micrograms per square centimeter.

2.5.2 Test Kit for Measuring Chlorides in Abrasives

Provide test kits that meet all of the following requirements:

a. Is a completely self-contained test kit with all materials, supplies, tools, and instructions to take tests and identify results;

b. Uses identifiable, consistent, factory pre-measured test extract solution;

c. Provides for testing equal volumes of abrasive and test solution;

d. Provides for taking direct measurements of the chloride ion in parts per million (PPM), without using conversion charts or tables;

e. Provides all new components for extraction and titration for each test;

f. Provides a factory sealed titration device for each test;

g. Uses the extract sampling container as the titration container.

2.5.3 Test Kit for Identifying Amine Blush on Epoxy Surfaces

Provide test kits that meet all of the following requirements:

a. Is a completely self-contained field test kit with all materials, supplies, tools, and instructions to perform tests and indicate the presence of unreacted amines;

b. Uses an identifiable, consistent, uniform, pre-packaged, factory pre-measured indicating solution;

c. Contains no mercury or lead and is environmentally friendly;

d. Contains a solution of an unreacted amine for the purpose of "self checking" the indicator solution;

2.6 ABRASIVE

Use abrasive that is specifically selected to provide a sharp, angular profile to the specified depth. Abrasive must meet all requirements of this Section each time that it is placed in the blast pot. A maximum limit for soluble salt contamination (chloride) is specified herein; however, this maximum level of contamination does not guarantee that contamination will not be transferred to the steel surface during abrasive blasting. Other factors, such as on-site handling and recycling, can allow contamination of abrasive that can be transferred to the steel surface. Contractors are cautioned to verify that the chosen abrasive, along with work and storage processes, allow the final surface cleanliness requirements to be achieved. Successful testing of contamination in abrasive does not negate the final acceptance testing of steel surfaces.

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NOTE: The following paragraph is mandatory for all NAVFAC PAC projects. All other agencies may use it after checking applicability.

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[Abrasive material used must contain a maximum of one percent by weight of any toxic substance listed in either Table Z-1, Z-2, or Z-3 of 29 CFR 1910-SUBPART Z, with the exception of inert or nuisance dust materials, arsenic, beryllium, cadmium, cobalt, lead, mercury, rhodium, silver, tellurium, thallium, and uranium.

] **

NOTE: Reduce allowable gross gamma radioactivity to 5 picocuries per gram for all NAVFAC PAC projects. Reduce in other areas if states or localities require.

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[Gross gamma radioactivity must not exceed 5 picocuries per gram.

]2.6.1 Ferrous Metallic Abrasive

2.6.1.1 New and Remanufactured Steel Grit

New and remanufactured steel grit abrasive must conform to the chemical and physical properties of SSPC AB 3 Class 1 (Steel) only; Class 2 (Iron) abrasive must not be used. Modify the requirements of SSPC AB 3 to substitute the requirement in paragraph 4.2.2 CONDUCTIVITY for one chloride test as measured using the test kit described in this Section (paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES). The maximum allowable chloride content is 25 parts per million (PPM).

To develop a suitable work mix from new steel abrasive, a minimum of 200 to 400 recycles is required; therefore, it may be advantageous for a Contractor to use remanufactured steel grit or grit reclaimed from a previous project. Such grit must be traced to new grit conforming to SSPC AB 3 Class 1 and it meets all cleanliness requirements of SSPC AB 3 Class 1 when brought to the current jobsite. Submit one representative sample of this work mix to the INDEPENDENT THIRD-PARTY laboratory for testing, along with samples of new material. Acceptance and use of this work mix must not be used to justify any deviation from surface preparation requirements.

2.6.1.2 Recycled Steel Grit

Recycled steel grit abrasive media must conform to the chemical and physical properties of SSPC AB 2 except that:

a. The maximum allowable chromium and cadmium content of the work mix must be 0.1 percent by weight when tested in accordance with ASTM D3718 for chromium and ASTM D3335 for cadmium. Modify the requirements of SSPC AB 2 to add requirement for one chromate test and one cadmium test for each "LEAD" test required.

b. The maximum allowable chloride content is 25 parts per million (PPM) as measured with the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES. Modify the requirements of SSPC AB 2 to substitute requirement for one chloride test for each "WATER SOLUBLE CONTAMINANTS" test.

2.6.2 Non-Metallic Abrasive

Non-metallic abrasive must be graded to the appropriate surface profile range and must conform to the chemical and physical properties of SSPC AB 1, Class A except that:

a. The maximum allowable chromium and cadmium content of the work mix must be less than 0.1 percent by weight when tested in accordance with ASTM D3718 for chromium and ASTM D3335 for cadmium.

b. Must contain less than 7 PPM chlorides when tested with the kit provided in paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES.

PART 3 EXECUTION

Perform all work, rework, and repair in accordance with approved procedures in the Coatings Work Plan. The Coatings Work Plan must be submitted and approved by the PCS prior to mobilization, in accordance with the paragraph COATINGS WORK PLAN.

[3.1 REMOVAL OF COATINGS CONTAINING HAZARDOUS MATERIALS

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NOTE: Include Section 02 83 00 LEAD REMEDIATION in any project specification that requires removal or disturbance of coating containing hazardous materials in conjunction with a coating project. Include a contractor qualification requirement similar to the article entitled "Qualifications of Coatings Contractors" in Part 1 of this Section, except that the contractor must be qualified to SSPC QP 2, Category A. Coatings containing hazardous materials can be removed and the new coating applied can be accomplished in a continuous operation if the contractor provides appropriate coordination of removal, cleaning, and coating application. It is specified as two separate operations to allow separate contractors to accomplish different phases of the project. With the use of SSPC QP 1 and QP 2 requirements in contracts, the same contractor will generally be accomplishing both phases of the work, and will probably want to perform both phases as a single operation to avoid preparing the surfaces twice. To accomplish the coating removal and recoating in a continuous operation, the contractor's plan must be scrutinized for

appropriate controls on the removal process, and on the surface preparation/coating application process. Delete this paragraph if no paint containing hazardous material is to be removed.
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Coatings containing hazardous materials and identified for disturbance during surface preparation, including removal, must be handled in accordance with Section 02 83 00 LEAD REMEDIATION. Coordinate surface preparation requirements from Section 02 83 00 LEAD REMEDIATION with this Section.

][3.2 DOOR SHEET ACCESS WAY

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NOTE: Tanks must be evaluated during inspection and design for appropriateness of cutting out a door sheet. If there is a reason not to allow a door sheet to be cut into a particular tank, delete this paragraph and the related paragraph in Part 1.
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A door sheet may be cut out of a tank to facilitate personnel and equipment access. The door sheet must be removed in accordance with API Std 653 and API Std 650, including all structural, welding, testing, and evaluation requirements. The door sheet must be installed, tested, and accepted prior to commencement of surface preparation. The door sheet and surrounding areas must be surfaced in accordance with Section 4 of NACE SP0178, and accompanying Visual Comparator, to the condition described and shown for NACE Weld Surface Preparation Designation "C" welds for interior surfaces and "D" Welds for exterior surfaces. The Contractor is responsible for cutting out the door sheet, stabilizing the tank or openings while the door sheet is out, replacing the door sheet, and testing the replaced door sheet using qualified engineering and testing services. Perform tank tightness testing before surface preparation where a door sheet access way was installed for this project. Hydrostatic testing must be performed prior to commencement of surface preparation.

]3.3 FIELD SAMPLE COLLECTION AND TESTING

Sample and test materials delivered to the jobsite as required in TEST REPORTS and subsequent subparagraphs. Notify the Contracting Officer three days in advance of sampling. The QC Manager, and either the PCS or Quality Assurance Coatings Inspector, shall witness all sampling.

3.3.1 Coating Field Sample Collection

Coatings that are on the MIL-DTL-24441 QPL require one sample to be collected. This sample must be collected and set aside for the duration of the project, and must be tested if unforeseen coatings issues arise or if testing is requested by the Contracting Officer. Coatings that are not on the MIL-DTL-24441 QPL require a random field sample from each lot of coating material used on-site in accordance with ASTM D3925. Each random sample must be tested.

For sampling, utilize sample collection kits as outlined in the paragraph COATING FIELD SAMPLE COLLECTION KIT. Each sample must consist of one liter quart sample of each batch of each base material, and a sample of the activator that is proportional to the mix ratio of the coating type. Prior to sampling, mix contents of each sealed container to ensure uniformity. As an alternative to collecting small samples from kits, entire kits may be randomly selected and shipped to the INDEPENDENT THIRD-PARTY laboratory, observing all requirements for witnessing and traceability. For purposes of quality conformance inspection, a lot is defined as that quantity of materials from a single, uniform batch produced and offered for delivery at one time. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Identify samples by designated name, specification number, batch number, project contract number, sample date, intended use, and quantity involved. If testing is required, the QC Manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and ship one complete sample of each material in question (including base and activator) with all batch information to the INDEPENDENT THIRD-PARTY laboratory for testing as required in paragraph COATING FIELD TESTING REPORTS.

3.3.2 Abrasive Field Sample Collection

Utilize the sample collection kits as required in paragraph ABRASIVE FIELD SAMPLE COLLECTION KIT to obtain samples from each lot of abrasive delivered to site using the sampling techniques and schedule of one sample per every 50 bags for ferrous metallic abrasive, paragraph 4 REQUIREMENTS FOR RECYCLED WORK MIX ABRASIVES of SSPC AB 2 for recycled ferrous metallic abrasives, or paragraph 5.3 SAMPLING FOR QUALITY CONTROL TESTS of SSPC AB 1 for non-metallic abrasives.

For purposes of quality conformance inspection, a lot must consist of all abrasive materials of the same type from a single, uniform batch produced and offered for delivery at one time. The addition of any substance to a batch must constitute a new lot. Identify samples by designated name, specification number, lot number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved laboratory for testing required in paragraph ABRASIVE FIELD SAMPLE TEST REPORTS.

3.3.3 Coating Field Test Reports

Submit test results for each sample that requires testing in paragraph COATING FIELD SAMPLE COLLECTION. Test samples of primer, intermediate, and topcoat materials for compliance with requirements of MIL-DTL-24441. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

3.3.4 Abrasive Field Test Reports

Submit test results for each lot of abrasive delivered to the jobsite. Test samples of ferrous metallic abrasive to the requirements of paragraph 5.2 TEST PARAMETERS of SSPC AB 3, excluding paragraph 5.2.4 DURABILITY. Test samples of recycled ferrous metallic abrasives to the requirements of paragraph 4 REQUIREMENTS FOR RECYCLED WORK MIX ABRASIVES of SSPC AB 2. Test samples of non-metallic abrasive to the requirements of paragraph 5.3 SAMPLING FOR QUALITY CONTROL TESTS of SSPC AB 1. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

[3.4 FUEL REMOVAL AND TANK CLEANING

Remove fuel and clean storage tanks in accordance with Section 33 01 50.55 CLEANING PETROLEUM STORAGE TANKS.

]3.5 LIGHTING

Provide lighting for all work areas as prescribed in SSPC Guide 12.

3.6 ENVIRONMENTAL CONDITIONS

3.6.1 Tank Containment

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NOTE: Delete this requirement where exterior containment is not required. Containment aids in maintaining environmental conditions by moderating extreme conditions.

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Maintain exterior tank containment in full working condition during interior surface preparation, coating application, and initial curing to aid in maintaining interior environmental conditions.

3.6.2 Control System Requirements

Provide and utilize dehumidification and ventilation equipment to control humidity, temperature, and vapor levels in tank from beginning of abrasive blasting through coating application and for four days after the last coating is applied. System must maintain vapor concentrations at or below 10 percent of Lower Explosive Limit (LEL). System may incorporate any combination of solid desiccant and direct expansion refrigeration equipment. No liquid, granular, calcium chloride, or lithium chloride drying systems will be accepted. Use only electric, indirect fired combustion, indirect friction, or steam coil auxiliary heaters. System must be compatible with removal of dust and solvent vapors, and must have fail-safe measures to ensure reliability during operations.

3.6.2.1 Automated Monitoring Requirements

Provide continuous monitoring of dehumidification equipment, temperature, relative humidity, and dew point data at pertinent points on the structure, during surface preparation, coating application, and initial cure. This data does not suffice for documentation of conformity to surface conditions during application and cure of coating. Locate sensors to provide pertinent data for the surface preparation and coat application being performed. Describe the location plan, including required moves, in the Coatings Work Plan. Provide monitoring equipment to perform as follows:

a. Data is collected in the field unit in 15-minute increments and available for download (on-site) in a standard database format. Contractor must collect these data and make available to the Contracting Officer, Quality Assurance Coatings Inspector, and QC Manager;

b. Monitoring equipment must have backup power such that data collection will be uninterrupted during the entire period of the dehumidification requirement;

c. Monitoring equipment must have capability to measure surface temperatures at a minimum of four locations anywhere on a structure, regardless of the size of the structure;

d. Monitoring equipment must have capability to measure interior and exterior dry bulb temperature (DB), relative humidity (RH), and dewpoint temperature (DP);

There is no requirement for connectivity of the monitoring system to control the dehumidification equipment; therefore, any combination of equipment having the required functionality will be accepted.

3.6.2.2 Humidity Control for Surface Preparation and Primer Application

Provide and utilize dehumidification equipment to maintain relative humidity at appropriate level to prevent prepared steel surfaces from corroding at all times during abrasive blasting through primer application. Failure of humidity control system, or failure to maintain proper conditions, during surface preparation stage may allow surface rusting, which will be rejected and require rework. All surfaces to be coated must meet all requirements at time of primer application. Failure of humidity control system during primer application stage will be cause for removal and replacement of all materials applied and cured while conditions were not as prescribed above.

3.6.2.3 Humidity Control for Application of Intermediate and Topcoats and Initial Curing

Provide and utilize dehumidification equipment to maintain relative humidity at the coldest steel surface in tank below 55 percent at all times during coating application, and during the first four days of initial curing after application of topcoat. This measurement is not the same as measuring the relative humidity of ambient air in the tank, and will require either electronic equipment to monitor relative humidity at the steel surface, or complex calculations to convert relative humidity of air in tank to relative humidity at steel surface. An approved alternative method of monitoring dehumidification that requires less sophisticated equipment or calculations is to maintain a minimum dew point depression of 10 degrees C 18 degrees F below coldest steel surface temperature. This is in lieu of specific relative humidity and dew point requirements in this Section. Failure to maintain specified humidity control during this phase will be cause for extension of humidity controlled cure time to ensure four consecutive days at specified relative humidity at steel surfaces. Formation of condensation in coating application stage prior to the indicated dry-hard time will be cause for removal and replacement of all materials contacted by condensation.

3.7 EQUIPMENT USED IN TANK

Equipment used in the tank after surface preparation begins must not leave any oily residue from exhaust or other sources. Internal combustion driven equipment, other than that powered by natural or bottled gas, must not be used.

3.8 SURFACES TO BE COATED

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NOTE: See UFC 3-460-01 for new coating systems and UFC 3-460-03 for coating system repairs for guidance

on which interior tank surfaces should be coated.
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NOTE: A "spot repair" is any repair requiring surface preparation to the bare metal surface.
****

Prepare and coat interior tank surfaces, including[BOTTOM][, SHELL][, ROOF][spot repair of [_____] spots of [_____] square meters square feet]. Remove interior piping to ensure complete coverage of the bottom and underside of pipe supports.[Do not coat aluminum floating pan.]

3.9 SURFACE PREPARATION

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NOTE: When editing this specification for maintenance coating work for which SSPC-SP WJ-1/NACE WJ-1, SSPC-SP WJ-2/NACE WJ-2, SSPC-SP WJ-3/NACE WJ-3, or SSPC-SP WJ-4/NACE WJ-4 preparation is to be allowed, include note for the contractor to use potable water, monitor the quality of the water, and adjust water quality to assure appropriate surface preparation and final surface requirements. There are many problems that might arise from both dissolved and suspended material. A common occurrence is water with high chlorides, even in potable water, which may leave unacceptable contamination on cleaned surfaces, and must not be suitable for waterjetting.
****

Prepare steel surfaces in accordance with SSPC PA 1 and as specified herein.

3.9.1 Abrasive Blasting Equipment

Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 650 kPa 95 psig at nozzle. Confirm that air supply for abrasive blasting is free of oil and moisture when tested in accordance with ASTM D4285. Test air quality at each startup, but in no case, less often than every five operating hours.

3.9.2 Operational Evaluation of Abrasive

Test abrasive for salt contamination and oil contamination as required in SSPC AB 1 for non-metallic abrasives, SSPC AB 2 for recycled ferrous abrasives, and SSPC AB 3 for ferrous abrasives. Modify the schedule of testing to be daily, at startup, and every five operating hours thereafter.

3.9.3 Surface Standard

Inspect surfaces to be coated, and select plate with similar properties and surface characteristics for use as a surface standard. Blast clean one or more 300 mm 1 foot square steel panels as specified in paragraph SURFACE PREPARATION. Record blast nozzle type and size, air pressure at nozzle and compressor, distance of nozzle from panel, and angle of blast to establish procedures for blast cleaning. Measure surface profile in accordance with ASTM D4417, Method C. When the surface standard complies with all specified requirements, seal with a clearcoat protectant. Use the surface standard for comparison to abrasive blasted surfaces throughout the course of work.

3.9.4 Pre-Preparation Testing for Surface Contamination

Perform testing, abrasive blasting, and testing in the prescribed order.

3.9.4.1 Pre-Preparation Testing for Oil and Grease Contamination

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NOTE: When specifying maintenance painting, use a water based, pH-neutral degreaser to avoid damaging existing coating.

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a. Inspect all surfaces for oil or grease contamination using two or more of the following inspection techniques: 1) Visual inspection, 2) WATER BREAK TEST, 3) BLACK LIGHT TEST, and 4) CLOTH RUB TEST. Reject oil- or grease-contaminated surfaces, clean [using a water based, pH-neutral degreaser]in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.

b. WATER BREAK TEST - Spray atomized mist of distilled water onto surface and observe for water beading. If water wets surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.

c. BLACK LIGHT TEST - Inspect surfaces for oil and grease contamination using the light specified in the paragraph BLACK LIGHT. Use light no more than 381 mm 15 inches from surface unless testing indicates that the specific oil or grease found in tank fluoresce at a greater distance. Use light in tank that is completely sealed from light infiltration, under a hood, or at night. Any fluorescing on steel surfaces is indication of petroleum oil/grease contamination. Use either WATER BREAK TEST or CLOTH RUB TEST to confirm both contaminated and non-contaminated areas detected by BLACK LIGHT TEST. The BLACK LIGHT TEST must not be used during inspection of prepared surfaces for oil and grease contamination unless proven to fluoresce the oil and grease found in the specific tank and documented during testing prior to abrasive blasting. Generally, only petroleum oil/grease will fluoresce; however, some may not fluoresce sufficiently to be recognized and other methods, such as the WATER BREAK TEST or CLOTH RUB TEST, must be used to confirm findings of the BLACK LIGHT TEST.

d. CLOTH RUB TEST - Rub a clean, white, lint-free, cotton cloth onto the surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent must be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

3.9.4.2 Pre-Preparation Testing for Soluble Salts Contamination

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NOTE: The testing for chlorides, sulfates, and nitrates (CSN) is especially important if there was evidence of corrosion production or if the bare surface has been contaminated prior to surface preparation.

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Test surfaces for soluble salts, and wash as required, prior to abrasive blasting. This phase is required since pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. The purpose of soluble salts testing prior to surface preparation is to establish a baseline reading. Test all surfaces at rate of three tests for the first 100 square meters 1000 square feet, plus one test for each additional 200 square meters 2000 square feet, or part thereof.[Concentrate testing of bare steel at areas of coating failure to bare steel and areas of corrosion pitting.][Perform 30 percent of tests on bare steel at welds, divided equally between horizontal and vertical welds.] One or more readings greater than non-detectable for chlorides, sulfates, or nitrates is evidence of soluble salt contamination. Reject contaminated surfaces, wash as described below, allow to dry, and re-test until all required tests show allowable results. Re-blast tested areas using vacuum equipped blast equipment. Label all test tubes and retain for test verification. Soluble salts testing is also required in paragraph PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION as a final acceptance test of prepared surfaces after abrasive blasting, and successful completion of this phase does not negate that requirement. Effective removal of soluble salts will require removal of any barrier to the steel surface, including rust. This procedure may necessitate combinations of wet abrasive blasting, high pressure water rinsing, and cleaning using a solution of water and soluble salts remover. The soluble salts remover shall be acidic, biodegradable, non-toxic, non-corrosive, and after application, will not interfere with primer adhesion. Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase are as stated in the Coatings Work Plan.

3.9.5 Abrasive Blasting

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NOTE: The issue of maximum profile on new structures is an important one. Once a profile is established, it is nearly impossible to reduce it; therefore, the initial profile will dictate the profile for the life of the structure.

The specified 2-4 mil surface profile is the preferred depth for preparing for the primer. On steel that was previously prepared to a deeper depth and coated, a depth of 4 mils can be tolerated with an additional mil of primer thickness.

It is the responsibility of the coatings Contractor to achieve the profile required by properly selecting the appropriate abrasive size. Harder, smaller abrasives can result in lower (shallower) profile depth.

If higher (deeper) pre-existing profile height is anticipated or encountered, both the PCS and the coating manufacturer must provide approval in writing to coat the higher surface profile. The government will not be responsible for the cost of

additional coating materials for higher than specified surface profiles. Procedures for coating higher pre-existing surface profiles and gathering specific approvals must be included in the Coatings Work Plan.

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Abrasive blast steel surfaces to near-white metal in accordance with SSPC SP 10/NACE No. 2. Prepared surfaces shall conform to SSPC VIS 1 and shall match the prepared test-panels as specified in paragraph SURFACE STANDARD. Provide a 50 to 100 micron 2 to 4 mil surface profile. Reject profile greater than 100 microns 4 mils, discontinue abrasive blasting, and modify processes and materials to provide the specified profile. Measure surface profile in accordance with ASTM D4417, Method A and Method C. The appearance of the surface after blasting must have the appearance of a Sand or Grit comparator. A rounded profile shape or peened surface is not acceptable. Record all measurements required in this standard. Measure profile at rate of three test areas for the first 100 square meters 1000 square feet plus one test area for each additional 100 square meters 1000 square feet or part thereof. When surfaces are re-blasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Dust and debris tend to collect at welds, plate overlaps, and surface irregularities. Do not attempt to wipe surface clean.

[On previously coated and prepared surfaces, determine and establish the average existing surface profile. If the pre-existing surface profile is greater than 100 microns 4 mils, or than what is allowable by the coating system instructions, the contractor must acquire written approval by the manufacturer to utilize a higher anchor profile. The manufacturer's supporting letter must state that the additional profile will not degrade coating performance in any way and will be warranted the same. Abrasive blast the steel surfaces to near-white metal in accordance with SSPC SP 10/NACE No. 2 using abrasive and technique which does not increase the existing profile. Provide a surface profile of at least 100 microns 4 mils but no additional profile than that existing. Reject profile greater than existing, discontinue abrasive blasting, and modify processes and materials to provide the specified agreed existing profile. Prepared surfaces must conform to SSPC VIS 1 and must match the prepared test-panels as specified in paragraph SURFACE STANDARD. Measure surface profile in accordance with ASTM D4417, Method A and Method C. The appearance of the surface after blasting must have the appearance of a Sand or Grit comparator. A rounded profile shape or peened surface is not acceptable. Record all measurements required in this standard. Measure profile at rate of three test areas for the first 100 square meters 1000 square feet plus one test area for each additional 100 square meters 1000 square feet or part thereof. Provide two additional measurements for each non-compliant measurement. When surfaces are re-blasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Dust and debris tend to collect at welds, plate overlaps, and surface irregularities. Do not attempt to wipe surface clean. On previously coated and prepared surfaces, profiles higher than 100 microns 4 mils should be anticipated and these procedures must be included in the Coatings Work Plan.

][For maintenance coating the use of SSPC-SP WJ-1/NACE WJ-1, SSPC-SP WJ-2/NACE WJ-2, SSPC-SP WJ-3/NACE WJ-3, or SSPC-SP WJ-4/NACE WJ-4 preparation is acceptable. Potable water must be used. The quality of the water must be monitored. The water quality must be adjusted to assure appropriate surface preparation and final surface requirements. Water must not contain dissolved or suspended material. High chlorides, even in potable water, can leave unacceptable contamination on cleaned surfaces, and must not be suitable for waterjetting.

]3.9.6 Disposal of Used Abrasive

Dispose of used abrasive off Government property in accordance with Federal, State, and Local mandated regulations.

3.9.7 Pre-Application Testing for Surface Contamination

3.9.7.1 Pre-Application Testing for Oil and Grease Contamination

Ensure tank surfaces are free of contamination as described in paragraph PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION.

3.9.7.2 Pre-Application Testing for Soluble Salts Contamination

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NOTE: In new tanks, require 30 percent of tests to be accomplished at welds. In tanks that have been in service, corroded areas must be tested for high chlorides.

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NOTE: The testing for chlorides, sulfates, and nitrates (CSN) is especially important if there was evidence of corrosion production or if the bare surface has been contaminated prior to surface preparation.

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Test surfaces for soluble salts contamination using the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDE, SULFATE, AND NITRATE IONS ON STEEL AND COATED SURFACES. Test all surfaces at rate of three tests for the first 100 square meters 1000 square feet; plus one test for each additional 200 square meters 2000 square feet; or part thereof.[Concentrate testing of bare steel where areas of coating failure to bare steel and areas of corrosion pitting were located.][Perform 30 percent of tests on bare steel at welds, divided equally between horizontal and vertical welds.] Label all test tubes and retain for test verification. One or more readings greater than non-detectable for chlorides, sulfates, or nitrates is evidence of soluble salt contamination. Reject contaminated surfaces, wash as required in paragraph PRE-PREPARATION TESTING FOR SOLUBLE SALTS CONTAMINATION, allow to dry, and re-test until all required tests show acceptable results. Re-blast tested areas using vacuum equipped blast equipment. An atmospheric event, such as a coastal storm blowing onshore, can bring chloride contamination. Following an atmospheric event, spot testing must be accomplished to verify satisfactory conditions and to avoid intercoat contamination. Where visual examination or spot testing indicates contamination, perform sufficient testing to verify non-contamination, or to define extent of contamination for appropriate treatment.

3.9.7.3 Pre-Application Testing for Surface Cleanliness

Apply coatings to dust free surfaces. To test surfaces, use ISO 8502-3. Use a kit that is compliant with ISO 8502-3. If the test does not result in a rating of 2 or better, then reject contaminated surfaces, clean by vacuum cleaning, and retest. Test surfaces at rate of three tests for the first 100 square meters 1000 square feet, plus one test for each additional 100 square meters 1000 square feet, or part thereof. Provide two additional tests for each failed test or questionable test. Document test results in the Daily Inspection Report and attach tape to the Daily Inspection Log.

Ferrous abrasives may become magnetized and difficult to remove from the steel substrate. If ferrous abrasives are used, additional visual inspection must be performed to ensure no surface contamination by the abrasive is present.

3.10 MIXING AND APPLICATION OF COATING SYSTEM AND SEALANT

3.10.1 Preparation of Sealant and Coating Materials for Application

Each of the different products, primer, intermediate, topcoat, and sealant, is a two-component material supplied in separate containers.

3.10.1.1 Mixing

Mix in accordance with coating system instructions, which may differ for each product. Do not mix partial kits unless standardized measuring cups are utilized. Do not alter mix ratios. All mixing processes must be witnessed by the Quality Assurance Coatings Inspector. Mix materials in same temperature and humidity conditions specified in paragraph DELIVERY AND STORAGE. Allow mixed material to stand for the required induction time based on its temperature.

3.10.1.2 Pot Life

Apply mixed products within stated pot life for each product. Stop applying when material becomes difficult to apply in a smooth, uniform wet film. Do not add solvent to extend pot life. All required solvent at time of mixing. Pot life is based on standard conditions at 21 degrees C 70 degrees F and 50 percent relative humidity. For every 10 degrees C 18 degrees F rise in temperature, pot life is reduced by approximately half, and for every 10 degrees C 18 degrees F drop, it is approximately doubled. Usable pot life depends on the temperature of the material at the time of mixing and the sustained temperature at the time of application. Other factors such as the shape of the container and volume of mixed material may also affect pot life. In hot climates, pre-cooling or exterior icing of components for at least 24 hours to a minimum of 10 degrees C 50 degrees F will extend pot life. The approximate pot life time for the epoxy primer and intermediate coat materials is four hours. The approximate pot life time for the sealant materials is as specified by the manufacturer.

3.10.1.3 Application Conditions and Recoat Windows

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NOTE: These requirements are provided in an attempt to prevent the significant number of intercoat delamination failures that are frequently found on industrial structures. The very strict requirements on application conditions and recoat windows may require work during abnormal hours, including weekends. Contractor work hours must allow for such during coating application.

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NOTE: Cold-weather application is not covered by this specification. If a project is designed for coating in cold weather, then the enclosure and heating requirements may be significant. It is not intended that contractors be forced to apply coatings in cold weather; however, the underlying premise is that coatings must be applied within the specified temperature ranges. A cold-weather specification must not be used to simply save money, as the coating system will generally not have the same longevity as one applied within 60-100 degrees F.

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The application condition requirements for the coating system are very time and temperature sensitive, and are intended to avoid the delamination problems frequently found on industrial structures.

a. Plan coating application to ensure that specified temperature, humidity, and condensation conditions are met. If conditions do not allow for orderly application of primer, STRIPE COAT, intermediate coat, topcoat, and sealant, use appropriate means of controlling air and surface temperatures, as required. Partial or total enclosures, insulation, heating or cooling, or other appropriate measures may be required to control conditions to allow for orderly application of all required coats.

b. Maintain air and steel surface temperature within the range allowable by the manufacturer's PDS during application and the first four hours of cure for each epoxy coat. Maintain steel surface temperature more than 3 degrees C 5 degrees F above the dew-point of the ambient air for the same period. These conditions may require environmental controls through containment.

c. If coating is not applied during recoat window specified by the coating manufacturer, or if surface temperature exceeds the temperature recommended in the manufacturer's PDS between applications, provide GLOSS REMOVAL. If next planned coat is topcoat, apply FILL COAT if required to fill sanding marks. Sanding marks from GLOSS REMOVAL of intermediate coat reflecting through topcoat will be considered as non-compliant. Apply FILL COAT within 24 hours of GLOSS REMOVAL, then apply topcoat within RECOAT WINDOW of FILL COAT. The topcoat must be free of defects and be of uniform appearance in accordance with SSPC PA 1. Lack of hiding by the finish coat must require additional applications to obtain uniform appearance.

d. FILL COAT - Where indicated, apply coat of intermediate coat epoxy, at 50 to 75 microns 2 to 3 mils DFT, then apply next specified full coat within recoat window of FILL COAT. A FILL COAT may be used to adjust coating thickness to comply with requirements or to fill sanding marks in intermediate coat.

e. GLOSS REMOVAL - Where required, hand sand in a circular fashion to remove gloss using 120-200 grit wet/dry sandpaper, followed by solvent wiping with a clean rag soaked with denatured alcohol to remove all dust. GLOSS REMOVAL of primer or intermediate coats is to scarify surface. If steel is exposed during GLOSS REMOVAL, repair in accordance with PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING. GLOSS REMOVAL of the topcoat may include removal of up to 75 microns 3 mils of coating to avoid excess thickness, prior to application of FILL COAT.

3.10.2 Amine Blush Testing of Epoxy Coat Prior to Overcoating

Test epoxy surfaces prior to application of each epoxy coat or sealant for amine blush contamination using the test kit described in paragraph TEST KIT FOR IDENTIFYING AMINE BLUSH ON EPOXY SURFACES. Test all surfaces at rate of three tests for the first 100 square meters 1000 square feet, plus one test for each additional 200 square meters 2000 square feet, or part thereof. If one or more tests show positive results for amine blush contamination, either treat all surfaces using the approved amine blush removal procedure or increase testing to ensure that all contamination is located, and then treat identified contamination using the approved procedure.

3.10.3 Application of Coating System and Joint Sealant

Apply coatings in accordance with SSPC PA 1, SSPC PA Guide 11 and as specified herein. Apply coatings and sealant to surfaces that meet all stated surface preparation requirements.

a. Apply each coat in a consistent wet film, at 90 degrees to previous coat. Ensure that primer and intermediate overlaps are no less than 150 mm 6 inches from welds. Apply STRIPE COAT by brush, working the material into corners, crevices, pitted areas, and welds, and onto outside corners and angles. For convenience, STRIPE COAT material may be delivered by spray if followed immediately with brush-out and approved procedures include appropriate controls on thickness. Apply all other coats by spray application. Use appropriate controls to prevent airborne coating fog from drifting beyond [[3][_____] meters [15][_____] feet from the tank perimeter] [the tank berm]. The cleanliness, temperature, recoat windows, and airborne paint containment requirements may necessitate the use of portable shelters or other appropriate controls.

b. After application of primer coat, and prior to application of each subsequent coat, perform testing prescribed in paragraph PRE-APPLICATION TESTING FOR SURFACE CONTAMINATION to ensure minimal intercoat contamination. If contamination is detected, wash per SSPC SP 1 and re-inspect. This testing may be reduced to one half of the prescribed rate for bare steel if the testing indicates no contamination when sampling is evenly distributed over surfaces being tested. If contamination is found between coats, revert to the specified testing rate. Generally, oil and grease contamination and soluble salts contamination are not encountered if subsequent coats are applied within specified recoat windows and the quality of air entering tank is controlled. Spot testing must be accomplished to verify satisfactory conditions and to avoid intercoat contamination. Where visual examination or spot testing indicates contamination, perform sufficient testing to verify non-contamination or to define extent of contamination for appropriate treatment.

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NOTE: Maximum thickness measurements are to limit internal stresses in each coat and in total system.

Internal stresses of epoxy coatings on steel can be significant, and unless limited through thickness, can cause premature failure as the coating ages. Such failures as shrinkage cracking and delamination, either from the substrate or between coats, are common. This system is not expected to receive a maintenance overcoat.
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Apply coatings at the following specified thickness and in the following order:

Coat	Minimum DFT (Microns)	Maximum DFT (Microns)
Primer	75	125
Intermediate	75	125
Top	75	125
Total system	225	375

Coat	Minimum DFT (Mils)	Maximum DFT (Mils)
Primer	3	5
Intermediate	3	5
Top	3	5
Total system	9	15

Measure coating thickness in accordance with SSPC PA 2 to confirm that coating application is within the specified range and within the tolerances of that standard. For non-compliant areas, increase number of test areas to identify all non-compliant application as required by SSPC PA 2. Add coating as required to correct low DFT areas, and remove coating with excess thickness to bare steel and reapply as specified in PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING.

3.10.3.1 Application of STRIPE COAT

Apply STRIPE COAT of epoxy primer material prior to application of general primer coat on ROOF and SHELL. Apply STRIPE COAT of epoxy intermediate coat material after application of general primer coat on BOTTOM. A STRIPE COAT must be applied to areas where joint sealant will be applied. This application must be consistent with APPLICATION OF COATING SYSTEM AND JOINT SEALANT. The STRIPE COAT must be in a contrasting color to the to preceding and subsequent coats and extend a width of no less than 38 mm 1.5 inches on each side of the feature being protected.

3.10.3.2 Application of Primer

Apply primer coat within recoat window of STRIPE COAT.

3.10.3.3 Application of Intermediate Coat

Apply intermediate coat within recoat window of primer coat.

3.10.3.4 Application of Topcoat

Make all required repairs to primer and intermediate coats as specified in PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING prior to applying topcoat. Apply topcoat within recoat window of intermediate coat. Consult manufacturer for application procedures for anticipated temperature and humidity conditions. Touch-up blemishes and defects within recoat window of epoxy topcoat.

3.10.3.5 Application of Joint Sealant

After a full coating system has been installed, holiday tested, and repaired as necessary, apply sealant to the roof-to-shell joint, to all roof plate lap joints, and to roof-to-rafter joints up to 25 mm 1 inch gap to exclude moisture from these marginally prepared crevice areas.

3.10.4 Holiday Testing

When the coating is dry to handle, but before the joint sealant is applied, perform holiday testing in accordance with the low voltage wet sponge method of NACE SP0188. Dry to handle is defined as curing to the degree that the surface will not be marred or damaged by normal foot traffic. Repair holidays per PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING.

3.10.5 Tank Occupancy After Coating Application

Verify the coating has reached a cured state that will allow foot traffic. Use clean canvas, or other approved, shoe covers when walking on coated surfaces, regardless of curing time allowed. Provide cushioned mats for all traffic areas.

3.10.6 Procedure for Holiday and Spot Repairs of Newly Applied Coating

Repair coating film defects at the earliest practicable time, and before application of the succeeding coat. Any holiday found must have a STRIPE COAT applied in the area prior to application of the finish coat. Observe all requirements for soluble salts contamination, cleanliness between coats, and application conditions. Prepare defective area in accordance with SSPC SP 10/NACE No. 2, and feather coating as required to leave 100 mm 4 inches of each succeeding coat feathered and abraded. If spot repair locations are less than 0.5 percent of the surface area and no greater than 150 mm 6 inches in diameter, prepare surface to SSPC SP 10/NACE No. 2 vacuum blasting or SSPC SP 11 using an impact tool to create an acceptable profile. Do not abrade the epoxy topcoat. Protect adjacent areas from damage and overspray. Remove dust and solvent wipe the prepared area plus an additional 100 mm 4 inches beyond the prepared area with clean denatured alcohol. Apply each coat within recoat window of preceding coat. Within four hours of preparation, apply primer to prepared steel and feather onto prepared primer. Apply intermediate coat to primed area and feather to prepared intermediate area. Apply topcoat to intermediate coat and feather to prepared topcoat. Apply each repair coat to approximate thickness of surrounding coating system. If one percent or more of the total surface area, or more than one spot per 200 square meters 2000 square feet, of the

BOTTOM area requires repair to any coat or coats, including feathered areas, the entire BOTTOM coating system must be removed and reapplied. The limit on BOTTOM repairs includes repairs made before and after floating pan installation. If 5 percent or more of the total surface area, or more than one spot per 100 square meters 1000 square feet, of the ROOF area requires repair to any coat or coats, including feathered areas, the entire ROOF coating system must be removed and reapplied. Repairs on the SHELL are not limited.

3.10.7 Extended Cure of Coating System Prior to Immersion Service

Allow a cure time of at least 14 days after the final coating material has been applied before introducing water or fuel into tank. [Allow a cure time of 12 days after the final coating material has been applied before beginning installation of the floating pan.]

3.11 PROJECT IDENTIFICATION

At the completion of the tank work, stencil the following information on the exterior of the tank adjacent to the main manway opening in 3/4- to one-inch Helvetica style letters of contrasting color using acrylic stencil paint:

Date Interior coated:
Project Number:
Contractor:
Address:
Coating System
  Surface Prep: SSPC SP ____ Profile: _______
  Primer: __________________ Thickness: ____
  Intermediate: ____________ Thickness: ____
  Topcoat: _________________ Thickness: ____
  Total Thickness: _________

3.12 FIELD QUALITY CONTROL

Project documentation, including inspection and testing records, must be used to determine the Contractor's compliance with contract requirements and approved procedures. The Contractor's certifications of completion, for both invoices and for project completion, shall be based on documented evidence of compliance with all requirements and approved Coatings Work Plan procedures. Track inspections and tests in the Test Plan & Log.

3.12.1 Field Inspection

3.12.1.1 Inspection and Documentation Requirements

a. Perform field inspection in accordance with ASTM D3276 and the approved Coatings Work Plan.

b. Provide all tools and instruments required to perform the required testing, as well as any tools or instruments that the inspector considers necessary to perform the required inspections and tests. Document each inspection and test, including required hold points and other required inspections and tests, as well as those inspections and tests deemed prudent from on-site evaluation to document a particular process or condition, as follows:

   (1) Location or area;

(2) Purpose (required or special);

(3) Method;

(4) Criteria for evaluation;

(5) Results;

(6) Determination of compliance;

(7) List of required rework;

(8) Observations.

c. Collect and record environmental conditions as described in ASTM D3276 on a 24 hour basis, as follows:

(1) During surface preparation, every hour, or when changes occur;

(2) During coating application and the first four days of initial cure, every hour, or when changes occur;

(3) Note location, time, and temperature of the highest and lowest surface temperatures each day;

(4) Use a non-contact thermometer to locate temperature extremes, then verify with contact thermometers.

d. Data collected on environmental conditions in AUTOMATED MONITORING REQUIREMENTS may be used for overnight data; however, the data must be constantly verified as to location of sensors and validity of data with respect to the coating work being accomplished.

e. Document all equipment used in inspections and testing, including manufacturer, model number, serial number, last calibration date and future calibration date, and results of on-site calibration performed. Work documented using data from equipment found to be out of calibration must be considered as non-compliant since last calibration or calibration check, as required.

f. Document Contractors compliance with the Coatings Work Plan.

3.12.1.2 Inspection Report Form

Develop project-specific report forms, as required, to report measurement and test results and observations being complete and compliant with contract requirements. This includes all direct requirements of the contract documents and indirect requirements of referenced documents. Show acceptance criteria with each requirement and indication of compliance of each inspected item. Annotation of non-compliance must be conspicuous so as to facilitate identification and transfer to the Rework Log. Report forms must include requirements and acceptance and rejection criteria, and must be legible and presented so that entered data can be quickly compared to the appropriate requirement. The data may be in any format, but must be legible and presented so that entered data can be quickly compared to the appropriate requirement.

3.12.1.3 Daily Inspection Reports

Submit one copy of daily inspection report completed each day when performing work under this Section, to the Contracting Officer. Note all non-compliance issues, and all issues that were reported for rework, in accordance with QC procedures of Section 01 45 00 QUALITY CONTROL. Each report must be signed by the Quality Assurance Coatings Inspector and the QC Manager. Submit report within 24 hours of date recorded on the report.

3.12.1.4 Inspection Logbook

A continuous record of all activity related to this Section must use an electronic reporting program as outlined in Table I and be maintained on a daily basis. The computer / software package must be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information including photo documentation where appropriate.

In areas where photography is not allowed, the computer must come with verification that the camera / photo capability has been removed. Alternatively, a continuous record of all activity related to this Section must be maintained in an Inspection Logbook on a daily basis. The logbook must be hard or spiral-bound book or digital program with consecutively numbered pages, and must be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information. Submit the original Inspection Logbook to the Contracting Officer upon completion of the of the project and prior to final payment.

3.12.1.5 Inspection Equipment

All equipment must be in good condition, operational within its design range, and calibrated as required by the specified standard for use of each device.

3.12.1.5.1 Black Light

Use a black light having a 365-nanometer intensity of 4,000 microwatts per square centimeter minimum at 380 mm 15 inches.

3.12.2 Coatings Contractor QC Coatings Inspector's Field Responsibilities

The Coatings Contractor QC Coatings Inspector responsibilities include complete documentation of all daily inspection and production activities for the entire coatings project as outlined in the Coatings Work Plan, scope of work (SOW) project program, and this Section. This includes, but is not limited to, the following:

a. Attending and documenting the pre-job meeting and acquiring the scope of work (SOW) project program, inspection and testing plan (ITP), schedule, and a list of who will receive the QC daily inspection reports;

b. Performing a project site walk-through with the Quality Assurance Evaluator (QAE) or asset owner, Coatings Contractor QC, QC Manager, and Quality Assurance Coatings Inspector, inspecting at least the following:

    (1) Asset(s) to be coated;

    (2) Equipment and placement of equipment;

(3) Materials delivery and storage;

(4) Facility operational requirements during the project.

c. Perform all daily and hold point inspections including, but not limited to, the following:

(1) Check equipment, including blotter test to verify compressed air cleanliness;

(2) Perform non-visible contaminants testing (in accordance with PRE-PREPARATION TESTING FOR SOLUBLE SALT CONTAMINATION and PRE-APPLICATION TESTING FOR SOLUBLE SALT CONTAMINATION);

(3) Perform visible contaminants testing (in accordance with PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION and PRE-APPLICATION TESTING FOR OIL AND GREASE CONTAMINATION);

(4) Obtain environmental readings;

(5) Perform abrasive field testing per SSPC AB 1, SSPC AB 2, or SSPC AB 3;

(6) Perform surface preparation monitoring and testing;

(7) Perform surface cleanliness testing;

(8) Perform dust quantity testing;

(9) Record materials storage documentation (record all coating and abrasive materials information, batch numbers, segregation, and storage temperature);

(10) Witness all coatings materials mixing and record mix materials temperatures, with verification of time of coatings pot life;

(11) Verify, witness, and record application method;

(12) Perform random wet film thickness (WFT) readings;

(13) Perform inspection of coatings application;

(14) Obtain dry film thickness (DFT) readings per SSPC PA 2;

(15) Perform holiday testing in accordance with HOLIDAY TESTING;

(16) Observe label asset identification (label stickers);

(17) Write Correction Action Reports (CAR), if needed;

(18) Write Non-Conformance Reports (NCR), if needed.

d. Writing a daily detailed summary of the work shift inspections, testing, and the day's events, including any meetings and prevalent conversations. The final daily report must include a project summary that must be part of the last daily coatings inspection report.

e. The Coatings Contractor QC Coatings Inspector must stop all non-compliant work.

3.12.3 Quality Assurance Coatings Inspector's Field Responsibilities

The Quality Assurance Coatings Inspector's field responsibilities include complete documentation of all on-site work associated with the coatings project. These responsibilities include, but are not limited to, the following:

a. Attending and documenting the pre-job meeting and acquiring the scope of work (SOW) project program, ITP, schedule, and a list of who will receive the QC daily inspection reports;

b. Performing a project site walk-through with the QAE or asset owner, prime Contractor, and coatings Contractor (QC Coatings Inspector and QC Manager), inspecting at least the following:

  (1) Asset(s) to be coated;

  (2) Equipment and placement of equipment;

  (3) Materials delivery and storage;

  (4) Facility operational requirements during the project.

c. Verifying all daily and hold point inspections performed by the Coatings Contractor QC Coatings Inspector or QC Manager by performing mirror inspections including, but not limited to, the following:

  (1) Verify equipment check, including blotter test to verify compressed air cleanliness;

  (2) Verify visible contaminants testing;

  (3) Take environmental readings;

  (4) Perform surface preparation monitoring and testing;

  (5) Perform surface cleanliness testing;

  (6) Perform dust quantity test;

  (7) Record materials storage documentation (record all coating and abrasive materials information, batch numbers, segregation, and storage temperature);

  (8) Witness all coatings materials mixing and record mix materials temperatures, with verification of time of coatings pot life;

  (9) Verify, witness, and record application method;

  (10) Inspect coatings application;

  (11) Perform dry film thickness (DFT) readings per SSPC PA 2;

  (12) Inspect asset identification (label stickers);

  (13) Write Correction Action Reports (CAR), if needed;

(14) Write Non-Conformance Reports (NCR), if needed.

d. The following testing is witnessed by the Quality Assurance Coatings Inspector and performed by the Coatings Contractor QC Coatings Inspector or QC Manager:

(1) Wet film thickness (WFT) readings by coatings applicator(s);

(2) Non-visible contaminants testing for chlorides, sulfates, and nitrates (CSN);

(3) Abrasive field testing per SSPC AB 1, SSPC AB 2, or SSPC AB 3;

(4) Holiday testing.

e. Writing a daily detailed summary of the work shift inspections, testing, and the day's events, including any meetings and prevalent conversations. The final daily report must include a project summary that will be part of the last daily coatings inspection report.

3.13 FINAL CLEANUP

Following completion of the work, remove debris, equipment, and materials from the site. Remove all foreign matter such as blast media, dust, dirt, debris, grease, and oils. Wipe all dry to handle coated surfaces with damp lint-free cloth. Remove temporary connections to Government- or Contractor- furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

Table I
QA/QC Reporting Program Requirements

Administrative Controls:

Administrators must be able to turn on and off unique access to specific jobs and contracts.

Administrators must be able to remotely enable and disable access for users.

Administrators must be able to associate contract specific documents and specification limits quickly and easily.

Administrators must be able to associate PDS, SDS, blueprints, scope of work, and contracts uniquely to each job.

Objectivity Controls:

Data entry fields must be by multi-selectable choices, numeric keypads, pickers and skip logic to ensure repeatable data entry in a way that makes running analytics and metrics easy and objective.

Retrievable storage must be provided for all job-related reports and documents for a minimum time of five years from completion of the job or project. Archiving of the documents after five years will be the responsibility of the Government.

Document Library:

All reports must be in searchable and annotatable Portable Document Format (PDF).

Annotations and modifications must be locked and associated with the document. Only the Administrator has rights to modify or delete annotations or allow modifications to the document library especially all related inspection reports.

Customization:

The program must be capable of being customized to specific jobs, contracts or specifications.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 97 13.25 (May 2011)**
Change 1 - 08/17

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 13.25 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 09 97 13.25

MAINTENANCE, REPAIR, AND COATING OF TALL ANTENNA TOWERS

05/11, CHG 1: 08/17

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 97 13.25 (May 2011)**
Change 1 - 08/17

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 13.25 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 97 13.25

MAINTENANCE, REPAIR, AND COATING OF TALL ANTENNA TOWERS

05/11, CHG 1: 08/17

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NOTE: This guide specification covers the requirements for coating of new, and repairs to existing, steel towers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: Due to the complexity of coating design for maintenance coating, this document is more of a compendium of "potential" requirements rather than a guide specification, and it should be edited for use only by personnel that are competent in coating design. For maintenance coating design, there is significant information that must be collected, tested, and evaluated to provide a satisfactory design. The scope of this information, particularly a coating condition survey (CCS), is discussed herein. Work covered by this specification includes replacement of structural members,coating/recoating of tower structure and minor electrical work.

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NOTE: New towers should be coated using one of the following systems in priority order:

First choice
Primer - Hot dip galvanizing
Intermediate - MIL-DTL-24441/29
Topcoat - MIL-PRF-85285 Type II

Second choice
Surface Preparation - SSPC SP-5
Primer - Spray metalizing (shop applied)
Sealer - MIL-DTL-24441/29 (thinned 50 percent)
Intermediate - MIL-DTL-24441/29
Topcoat - MIL-PRF-85285 Type II

Third choice
Surface Preparation - SSPC SP 5
Primer - DOD-PRF-24648 Type II, Class 1, Comp B
Inorganic zinc (shop applied)
Intermediate - MIL-DTL-24441/29
Topcoat - MIL-PRF-85285 Type II

New towers should be shop-coated in a shop that has SSPC QP 3 Certification, shipped to site, erected, and touched-up.

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NOTE: The fact that most high antenna towers were either galvanized or treated with a high-performance zinc primer requires considerable attention to the design to ensure that only the required work is scoped, and that the specified work does not damage sound zinc (galvanizing or other zinc primers) surfaces. While the coatings continue to age and degrade, the galvanized surfaces are generally found to be in good condition. A properly executed coating condition survey (CCS) will provide details of the condition of the entire coating system.

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NOTE: For purposes of this specification, the term "maintenance coating" refers to maintenance overcoating as opposed to complete removal of coatings and recoating. For maintenance coating designs, or to determine if maintenance overcoating is appropriate, a coating condition survey (CCS) should be accomplished. The CCS should be accomplished by personnel from a business that routinely performs coating evaluations, and the individual investigator should be Certified by SSPC as a Protective Coatings Specialist. The CCS should be sufficiently detailed to provide all technical information about the coatings, and structures to be coated, required to properly design the project. At a minimum, the CCS should provide a detailed report of:

1. Existing coating conditions, including condition of coating film, and the existence of potentially hazardous substances that may impact coating management (i.e. lead, cadmium, chromium);

2. Analysis of remaining coating life, suitability of overcoating, and technical requirements for overcoating;

3. Technical recommendations for the most cost effective management of existing coating systems, including any hazardous materials present in paint film; and

4. Any other information of interest to the coating system management that should be identifiable by an individual trained and experienced in the field of coating analysis, coating failure analysis, and coating design.

The scope of the CCS should be tailored to the specific project, and it should be recognized that while multiple coating failures or deficiencies may look similar to the untrained eye, the risks of generalizing to save evaluation costs are potentially very high. The cost of large-scale failure of the overcoating, and complete replacement of the coating system, is far more than the cost of a CCS for all but the smallest projects.

The risks of overcoating can usually be avoided by designing project to remove all existing coatings to bare metal, then providing appropriate surface preparation and coating application. However, the extra costs of the coating removal, especially if containing hazardous material, along with the cost of surface preparation to SSPC SP 10 Abrasive Blast to Near-White Metal, may be exorbitant compared to the costs of maintenance overcoating where the existing coating system is in fair-to-good condition.

Additionally, NAVFAC Design Policy Letter DPL-09B-0001, Lead-containing Paint on Non-residential Structures of 26 Mar 92 provides guidance for managing paints containing lead and other hazardous materials in place. The fact that lead was highly used as a primer is indicative of its value to the corrosion control industry. Premature removal of sound lead primer is not considered to be a good management practice.

Activities should consider an annual CCS to survey all structures to be authorized for design in the coming year. When accomplished for multiple projects, the per-structure cost will decrease. By accomplishing this survey prior to design, the basis for design is fully identified.

The CCS can also be a very useful tool when used to

screen structures for maintenance painting requirements. A CCS can be scoped to provide a general inspection of many structures to screen for near-term overcoating or recoating requirements, and subsequent investigation can be made to provide appropriate details for project planning and design.

It should be pointed out that the aesthetic features of a coating do not define the coating condition; they only describe how the coating looks. Many coating systems have been replaced when only the topcoat is in need of "refurbishment." Likewise, many structures such as water tanks and fuel tanks have had complete coating replacement when only the roof coating needed replacement. A CCS can identify the weak components as well as the satisfactory components, and propose solutions to make maximum use of existing resources.

The Society for Protective Coatings (formerly Steel Structures Painting Council) (SSPC), has published a Technology Update titled SSPC TU 3 Maintenance Overcoating. This document should be used as a guide for scoping the CCS, for accomplishing the CCS, and for designing the coating work.

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NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

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PART 1   GENERAL

1.1   REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 360	(2016) Specification for Structural Steel Buildings
ANSI/AISC 303	(2022) Code of Standard Practice for Structural Steel Buildings and Bridges

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B231/B231M	(2023) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B308/B308M	(2010; R 2020) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM D1200	(2010; R 2014) Viscosity by Ford Viscosity Cup
ASTM D1640/D1640M	(2014) Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings
ASTM D3335	(1985a; R 2020) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D3718	(1985a; R 2015) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings
ASTM D4285	(1983; R 2018) Indicating Oil or Water in Compressed Air
ASTM D4417	(2021) Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM F436	(2011) Hardened Steel Washers
ASTM F467	(2024) Standard Specification for Nonferrous Nuts for General Use
ASTM F468	(2023) Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	(2022) Standard Specification for Stainless Steel Nuts
ASTM F959/F959M	(2017a; R 2023) Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series
ASTM F1077	(2005) Selection of Committee F-16

Fastener Specifications

NACE INTERNATIONAL (NACE)

NACE SP0288	(2011) Inspection of Linings on Steel and Concrete Equipment

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2023; R 2023) Ferrous Metallic Abrasive
SSPC Guide 12	(2023) Guide for Illumination of Industrial Painting Projects
SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC PA 2	(2015; E 2018) Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC QP 3	(2010) Standard Procedure for Evaluating Qualifications of Shop Painting Applicators
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning
SSPC SP COM	(2016; E 2017) Surface Preparation Commentary for Steel and Concrete Substrates
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-22262	(1993; Rev B; Am 1 1994; Am 2 1996; Notice 1 2021) Abrasive Blasting Media Ship Hull Blast Cleaning
MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for
MIL-DTL-24441/19	(2009; Rev C; Notice 1 2023) Paint, Epoxy-Polyamide, Zinc Primer, Formula 159, Type III
MIL-DTL-24441/31	(2009; Rev B; Notice 1 2021) Paint, Epoxy-Polyamide, White, Formula 152, Type IV
MIL-PRF-85285	(2022; Rev F) Topcoat, Aircraft and Support Equipment

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 530/F-93/004	(1993; Rev 0; Updates I, II, IIA, IIB, and III) Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1000	Air Contaminants
29 CFR 1910.1018	Inorganic Arsenic
29 CFR 1926.59	Hazard Communication
29 CFR 1926.62	Lead
29 CFR 1926.1127	Cadmium
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions

1.2 MODIFICATIONS TO REFERENCES

In AISC 325, AISC 360, ANSI/AISC 303, and RCSC A348, except as modified in this section, shall be considered a part of AISC 325 and is referred to in this section as AISC 325.

1.3 DESCRIPTION OF WORK

[Provide a brief description of the work to be covered by this specification.

]1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Steel Fabrication; G, [_____]

][Stainless Steel Fabrication; G, [_____]

][Aluminum Fabrication; G, [_____]

] SD-03 Product Data

[Exothermic Weld Kits; G, [_____]

][Load Indicator Washers; G, [_____]

] SD-05 Design Data

[Containment System; G, [_____]

] SD-06 Test Reports

Non-metallic Abrasive Media; G, [_____]

Coatings; G, [_____]

Bolts, Nuts, and Washers; G, [_____]

Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

Metallic Abrasive Media; G, [_____]

Daily inspection checklist; G, [_____]

Coating Sample Testing; G, [_____]

Recycled Metallic Abrasive Media; G, [_____]

SD-07 Certificates

Coating System; G, [_____]

Abrasive Media; G, [_____]

Coating System Compatibility; G, [_____]

Galvanizing; G, [_____]

Bolts, Nuts, and Washers; G, [_____]

Work plan; G, [_____]

Qualifications of Certified Industrial Hygienist (CIH); G, [_____]

Qualifications of Testing Laboratory for Coatings; G, [_____]

Qualifications of Testing Laboratory for Abrasive Media; G, [_____]

Qualifications of Coating Contractors; G, [_____]

[Qualifications of Painting Shop; G, [_____]

] SD-08 Manufacturer's Instructions

Coating system; G, [_____]

SD-11 Closeout Submittals

Disposal of used abrasive; G, [_____]

1.5 SAFETY

The Contractor shall submit an Accident Prevention Plan as per Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Coating Materials

Ship, store and handle materials in accordance with SSPC PA 1. Maintain temperature in storage spaces between 5 and 24 degrees C 40 and 75 degrees F. Maintain ambient air temperature more than 3 degrees C 5 degrees F above the dew-point at all times. During mixing of polyurethane materials, maintain relative humidity below 90 percent.

1.6.2 Structural and Miscellaneous Materials

Handle, store, and protect materials in accordance with the manufacturer's recommendations. Replace damaged items with new items, or repair as approved by the Contracting Officer.

[1.7 EXISTING TOWER CONDITIONS

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NOTE: Include and reference Section 02 83 00 LEAD REMEDIATION if any of the existing lead paint system is to be removed. Include and reference Section 02 83 00 LEAD REMEDIATION if any structural elements are replaced which are painted with a lead based coating system.

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Include detailed information, from the CCS, on the condition of the tower including type of paint system, percentage of deterioration of the paint and structure, any hazardous contents of the paint such as Lead or Chromate, and any other pertinent information about exiting conditions.

]1.8 COATING HAZARDS

****

NOTE: This specification section is based on assumption that section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS will be included in project, otherwise, requirements for preparation and submittal of a safety plan, respiratory protection plan, etc. must be included in this specification section.

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NOTE: Include OSHA 29 CFR 1910.1018 for arsenic exposure and OSHA 29 CFR 1926.62 for lead exposure, and 29 CFR 1926.1127 for cadmium exposure.
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Ensure that employees are trained in all aspects of the safety plan. Specified coatings may have potential health hazards if ingested or improperly handled. The coatings manufacturer's written safety precautions shall be followed throughout the mixing, application, and curing of the coatings. During tank cleaning, cleanup, surface preparation, and paint application phases, ensure that employees are adequately protected from toxic and hazardous chemical agents which exceed the concentrations in OSHA 29 CFR 1910.1000[, OSHA 29 CFR 1910.1018, 29 CFR 1926.1127 and OSHA 29 CFR 1926.62]. Comply with respiratory protection requirements in OSHA 29 CFR 1910.134. Obtain the services of a certified industrial hygienist to review and approve the operations as to correctness of work procedures and personal protective equipment.

1.9 JOB SITE REFERENCES

Make available to the Contracting Officer at least one copy each of ASTM D3925, ASTM D4285, ASTM D4417, NACE SP0288, SSPC SP COM, SSPC SP 1[, SSPC 7/NACE No.4][, SSPC SP 10/NACE No. 2], SSPC PA 1, SSPC PA 2, SSPC Guide 12, [SSPC AB 2,] and SSPC VIS 1 at the job site.

1.10 PRE-APPLICATION MEETING

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As an alternative to a Pre-Application Meeting (PAM), a Pre-Application Test Period (PATP) may be specified. Either one will have some positive effect on the project by getting the appropriate people together. A PATP is a meeting, with the added benefit of some actual onsite evaluation of processes and procedures. This activity should be scheduled just prior to coating work beginning but after all submittals are approved. In either case, the work plan and safety plan should be fully discussed. The Coating Manufacturer's representative may be included for a large or complicated project.
****

Prior to any surface preparation or coating operations, Contractor representatives, including at a minimum, project superintendent and QC manager, paint foreman, Contracting Officer representatives, coating inspector[, and coating systems manufacturer's representative] shall have a pre-application tank coating preparatory meeting. This meeting shall be in addition to the pre-construction conference. Specific items to be addressed shall include: the work plan, the safety plan, inspection standards, inspector qualifications and tools, test procedures, environmental control system, safety plan, and test logs. Notify the Contracting Officer 10 days prior to meeting.

1.11 QUALITY ASSURANCE

1.11.1 Drawings: [Steel,] [Stainless Steel,] [Aluminum] Fabrication

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326 and AISC 325. Drawings shall not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS standard welding symbols.

1.11.2 Design Data: Coating System

Submit manufacturer's printed instructions including detailed mixing and application procedures, number and types of coats required, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.11.3 Certificates

1.11.3.1 Work Plan

A specific written plan describing in detail all phases of [structural repair,][electrical repair,][and]coating operations. For coating work, address work sequencing, surface preparation, coating application, recoat and cure time projections, as well as how each step will be controlled, tested, and evaluated. Address safety measures, work scheduling around weather, and record keeping.

1.11.3.2 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party CIH. Submit documentation that hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. Provide evidence of experience with hazards involved in industrial coating application work.

1.11.3.3 Qualifications of Testing Laboratory for Coatings

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of the coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that persons performing analyses are qualified.

1.11.3.4 Qualifications of Testing Laboratory for Abrasive Media

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform the testing of the abrasive media samples for compliance with specification requirements. Submit documentation that laboratory has experience in testing samples of abrasive media for conformance with specifications, and that persons performing analyses are qualified.

1.11.3.5 Qualifications of Coating Contractors

****

NOTE: For projects in continental US, Hawaii, Alaska, and Puerto Rico, require SSPC Certification. Use in other locations where qualified US contractor is desired. If project involves removal of paint containing hazardous materials, add requirement for SSPC QP-2 certification in appropriate section of specification, generally where the hazardous paint removal is specified .

****

****

NOTE: Solicitations requiring SSPC Certification should point out the existence and location of the certification requirement. SSPC Certification is a special responsibility requirement pursuant to FAR 9.104-2 Special Standards. This is analogous to requiring bidders to have a specified level of experience or expertise and GAO has sustained these types of special requirements.

****

[All contractors and subcontractors that perform surface preparation or coating application shall be certified by the Society for Protective Coatings (formerly Steel Structures Painting Council) (SSPC) to the requirements of SSPC QP 1 prior to contract award, and shall remain certified while accomplishing any surface preparation or coating application. The painting contractors and painting subcontractors must remain so certified for the duration of the project. If a contractor's or subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered, and liquidated damages will apply. Notify the Contracting Officer of any change in contractor certification status.
]

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NOTE: When using the contractor qualification clause rather than the SSPC Certification requirement, edit to require appropriate experience.

****

[Submit the name, address, telephone number, FAX number, and e-mail address of the agency that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on[industrial steel structures][_____] on a minimum of three separate projects within the past three years. List information by individual and include the following:

a. Name of individual and proposed position for this work.

b. Information about each previous assignment including:

(1) Position or responsibility
(2) Employer (if other than the Contractor)
(3) Name of facility owner

(4) Mailing address, telephone number, and telex number (if non-US) of facility owner
(5) Name of individual in facility owner's organization who can be contacted as a reference
(6) Location, size and description of structure
(7) Dates work was carried out
(8) Description of work carried out on structure

]1.11.3.6 Qualifications of Painting Shop

****

NOTE: For construction of new tower or where shop fabrication of significant components is feasible, consider requirement for SSPC QP3 Certification (enclosed shop) for shop performing coating preparation and application. Include appropriate NACE inspection of all coating work in shop.

****

[SSPC QP 3 (enclosed shop)

]1.11.3.7 Abrasive Media

Certify conformance to contract requirements and provide copies of test results required by MIL-A-22262 or SSPC AB 3 for material chosen.

1.11.3.8 Coating System Compatibility

Provide certification from each manufacturer of components of the coating system, epoxy primer, epoxy intermediate, and polyurethane topcoat, that the supplied coating material is suitable for use in the specified coating system. Each manufacturer shall identify the specific products, including manufacturer's name, which their product may be used with. The certification shall provide the name of the manufacturer that will provide technical support for the entire system. When all coating materials are manufactured by one manufacturer, this certification is not required.

1.11.4 Test Reports

1.11.4.1 Non-metallic Abrasive Media

Submit test results from independent laboratory of representative sample of abrasive media. Sample must have been tested within the last three years. Submit results as required in article entitled "QUALIFICATION INSPECTION" of MIL-A-22262, and as revised by article entitled "ABRASIVE MEDIA" herein. Note that requirement for "QUALIFICATION INSPECTION" is a pre-qualification requirement, and involves the same testing required for listing in the Qualified Products List of the respective material. See appropriate Military Specification for specific test requirements.

1.11.4.2 Coatings

Submit test results from independent laboratory of representative samples of each coating material. Samples must have been tested within the last three years. Submit results for epoxy materials as required in article entitled "QUALIFICATION INSPECTION" of MIL-DTL-24441, and as revised by article entitled "COATING SYSTEM" herein. Submit results for polyurethane materials as required in article entitled "QUALIFICATION INSPECTION" of MIL-PRF-85285, and as revised by article entitled "COATING SYSTEM" herein.

Note that requirement for "QUALIFICATION INSPECTION" is a pre-qualification requirement, and involves the same testing required for listing in the Qualified Products List of the respective material. See appropriate Military Specification for specific test requirements.

1.11.4.3 Metallic Abrasive Media

Submit test results from independent laboratory testing of sample of each batch delivered to job site.

1.11.4.4 Daily Inspection Checklist

Submit one copy of daily inspection checklist, completed each day when performing work under this section, to the Contracting Officer. Submit within 24 hours of date recorded on the checklist.

1.11.4.5 Recycled Metallic Abrasive Media

Submit test results from independent laboratory of daily and weekly Quality Control testing required by SSPC AB 2, as modified in article entitled "ABRASIVE MEDIA."

PART 2 PRODUCTS

2.1 STEEL

New steel shall be galvanized.

2.1.1 Structural and Miscellaneous Steel

ASTM A36/A36M, hot dip galvanized.

2.1.2 Steel Tubing and Pipe

ASTM A500/A500M, Grade B, hot dip galvanized.

2.2 STAINLESS STEEL

ASTM A666, Type 316, Stainless steel shall not be galvanized.

2.2.1 Band Clamps

ASTM A666, Type 316.

2.3 ALUMINUM

2.3.1 Plates and Shapes

ASTM B209, Type 6061-T6; ASTM B308/B308M

[2.3.2 Stranded Conductor

****

NOTE: Include this paragraph for leg riser cables for VLF and LF transmission towers.

****

ASTM B231/B231M, Class A, 19 wire, 5/8 inch diameter strand (leg riser cables).

]2.4 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.4.1 Structural Steel

2.4.1.1 Bolts

****

NOTE: Do not galvanize ASTM A490M ASTM A490 bolts.

****

ASTM A325, Type 1, hot dip galvanized. Bolts shall have a maximum Rockwell hardness of 32. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength, grade and type specified by ASTM specifications.

2.4.1.2 Nuts

[Provide galvanized ASTM A563 nuts, Grade and Style as specified in the applicable ASTM standard.][Provide ASTM A563, hot dip galvanized nuts with a locking pin set in the nut. The locking pin shall slide along the bolt threads, and by reversing the direction of the locking pin, the nut shall be removed without damaging the nut or bolt. Provide noncorrosive locking pins.]

2.4.1.3 Washers

ASTM F436, hot dip galvanized steel.

[2.4.1.4 Load Indicator Washers

****

NOTE: Include this paragraph when needed to ensure that AISC (American Institute of Steel Construction) required bolt pretension load.

****

ASTM F959/F959M, hot dip galvanized steel.

]2.4.2 Stainless Steel

2.4.2.1 Bolts

ASTM F593, type 304

2.4.2.2 Nuts

ASTM F594, type 304

2.4.2.3 Washers

ASTM A320/A320M, except provide type 304

2.4.3 Aluminum

2.4.3.1 Bolts

ASTM F468

2.4.3.2 Nuts

ASTM F467

2.4.3.3 Washers

ASTM F1077

2.5 GALVANIZING

ASTM A123/A123M or ASTM A153/A153M, as applicable, unless specified otherwise. GALVANIZED SURFACES SHALL NOT BE "PASSIVATED" OR "STABILIZED".

2.5.1 Galvanizing Repair Compound

ASTM A780/A780M, cold galvanizing repair compound.

2.6 WELDING

[AWS D1.1/D1.1M for steel][AWS D1.2/D1.2M for aluminum.]

2.6.1 Exothermic Weld Kits

Exothermic weld kits specifically designed by the manufacturer for welding the types of materials and shapes provided.

2.7 COATING SYSTEM

Alternate systems or products will not be considered.

[2.7.1 Sealer for Thermal Spray Metallizing

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White (thinned 50 percent using solvent recommended by manufacturer)). Modify requirements to include maximum allowable lead content of 0.06 percent by wt. as tested by ASTM D3335, maximum Cadmium content of 0.06 percent by wt. as tested by ASTM D3335, and maximum allowable Chromium content of 0.00 percent by wt. as tested by ASTM D3718. All other requirements of this Military Specification apply.

][2.7.2 Zinc Rich Epoxy Primer Coat

****

NOTE: Use this organic zinc-rich coating for repair to existing zinc primer, for repair of inorganic zinc primer, or for small projects where the tower is not to be galvanized or thermal spray metalized.

****

Epoxy polyamide, MIL-DTL-24441/19 (Formula 159, Type II). Modify requirements to include maximum allowable lead content of 0.06 percent by wt. as tested by ASTM D3335, maximum Cadmium content of 0.06 percent by wt. as tested by ASTM D3335, and maximum allowable Chromium content of 0.00

percent by wt. as tested by ASTM D3718. All other requirements of this Military Specification apply.

]2.7.3 Epoxy Intermediate Coat

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White (Tinted)). Tint to approximately SAE AMS-STD-595A color number 27778 parchment using pigment dispersions prepared for epoxy paint tinting. Manufacturer shall tint material and appropriately label. Modify requirements to include maximum allowable lead content of 0.06 percent by wt. as tested by ASTM D3335, maximum Cadmium content of 0.06 percent by wt. as tested by ASTM D3335, and maximum allowable Chromium content of 0.00 percent by wt. as tested by ASTM D3718. All other requirements of this Military Specification apply.

2.7.4 Polyurethane Topcoat

****

NOTE: Colors listed are as specified by FAA Advisory Circular AC 70/7460-1H, Obstruction Marking and Lighting. Always specify contrasting colors between coats.

****

Polyurethane coating topcoat of MIL-PRF-85285, Type II, White SAE AMS-STD-595A color number 17875, and Orange color number 12197.

Modify paragraph 3.6.4 of MIL-PRF-85285, Viscosity and Pot Life, as follows:

> The viscosity of the admixed coating, when tested in accordance with ASTM D1200 through a No. 4 Ford cup, shall be as follows:

Time from mix (minimum)	Maximum time through a No. 4 Ford cup
Initially	30 seconds
2 hours	60 seconds
4 hours	No gel

Modify paragraph 3.7.1 of MIL-PRF-85285, Drying Time, as follows:

> When applied by spray techniques and when tested in accordance with ASTM D1640/D1640M, the coating shall be set-to-touch within four hours and dry-hard within eight hours (see 4.6 and table I).

All other requirements of this Military Specification apply.

2.8 SOLUBLE SALTS TEST KITS

2.8.1 Test Kit for Measuring Chlorides on Steel Surfaces

Provide test kits called CHLOR*TEST, as manufactured by CHLOR*RID International Inc. of Chandler, Arizona (www.chlor-rid.com) or equal. To be considered for approval as an "equal" test kit, each proposed test kit shall:

a. Be a completely self-contained test kit with all materials, supplies, tools and instructions to take tests and identity results;

b. Use identifiable, consistent, factory pre-measured test extract solution;

c. Provide for testing of any steel surface, regardless of orientation;

d. Provide for testing flat, curved, smooth, pitted and rough surfaces;

e. Provide for taking direct measurements of the chloride ion in micrograms per square centimeter without using conversion charts or tables;

f. Be environmentally friendly and not contain any forms of mercury;

g. Provide all new components for extraction and titration for each test;

h. Provide an encapsulated environment while extracting chlorides;

i. Provide a factory sealed titration device for each test;

j. Use the extract sampling container as the titration container.

2.8.2 Test Kit for Measuring Chlorides in Abrasives

Provide test kits called CHLOR*TEST-A, as manufactured by CHLOR*RID International Inc. of Chandler, Arizona (www.chlor-rid.com), or equal. To be considered for approval as an "equal" test kit, each proposed test kit shall:

a. Be a completely self-contained test kit with all materials, supplies, tools and instructions to take tests and identify results;

b. Use identifiable, consistent, factory pre-measured test extract solution;

c. Provide for testing equal volumes of abrasive and test solution;

d. Provide for taking direct measurements of the chloride ion in parts per million (PPM), without using conversion charts or tables;

e. Provide all new components for extraction and titration for each test;

f. Provide a factory sealed titration device for each test;

g. Use the extract sampling container as the titration container.

2.9 ABRASIVE MEDIA

The referenced abrasives specifications have been modified to place additional requirements on testing for soluble salts contamination. Other factors such as on-site handling and recycling can allow contamination of abrasives. Successful testing of chlorides in abrasives does not negate the final acceptance testing of steel surfaces.

****

NOTE: Following paragraph is mandatory for all NAVFAC PAC projects. All other agencies may use it after checking applicability.

****

[Interpret MIL-A-22262 to include the meaning that abrasive material contains a maximum one percent by weight of any toxic substance listed in either Table Z-1, Z-2, or Z-3 or OSHA 29 CFR 1910-SUBPART Z, with the exception of inert or nuisance dust materials, arsenic, beryllium, cadmium, cobalt, lead, mercury, rhodium, silver, tellurium, thallium, and uranium.

]2.9.1 Non-metallic Abrasive Media

Abrasive media shall conform to MIL-A-22262, Type I (Inorganic materials) except that:

a. The maximum allowable chloride content is 7 parts per million (ppm) as measured with the test kit described in article entitled "Test Kit for Measuring Chlorides in Abrasives."

[b. The gross gamma radioactivity shall not exceed 5 picocuries per gram.

] Use sampling procedures and testing frequencies as prescribed in MIL-A-22262. Use abrasive media that is specifically selected and graded to provide a sharp, angular profile to the specified depth. Do not use ungraded media. Make adjustments to processes or media gradation to achieve specified surface profile. Do not use recycled non-metallic abrasive media.

2.9.2 Metallic Abrasive Media

Use abrasive media that is specifically selected and graded to provide a sharp, angular profile to the specified depth. Make adjustments to processes, media gradation, or media hardness to achieve specified surface profile.

2.9.2.1 New and Remanufactured Metallic Abrasive Media

Abrasive media shall conform to the chemical and physical properties of SSPC AB 3, except that:

a. The maximum allowable chloride content is 7 parts per million (ppm) as measured with the test kit described in article entitled "Test Kit for Measuring Chlorides in Abrasives." Modify the requirements of SSPC AB 3 to substitute requirement for one chloride test for each "WATER SOLUBLE CONTAMINANTS" test required.

b. Hardness of steel grit shall be chosen to match requirements of abrasive blasting work.

[c. The gross gamma radioactivity shall not exceed 5 picocuries per gram.

]2.9.2.2 Recycled Metallic Abrasive Media

Abrasive media shall conform to the chemical and physical properties of SSPC AB 2 except that:

a. The maximum allowable chloride content is 7 parts per million (ppm) as measured with the test kit described in article entitled "Test Kit for Measuring Chlorides in Abrasives." Modify the requirements of SSPC AB 2 to substitute requirement for one chloride test for each "WATER SOLUBLE CONTAMINANTS" test required.

b. The maximum allowable Chromium and Cadmium content of the work mix shall be 0.1 percent by wt. when tested in accordance with ASTM D3718 for Chromium and ASTM D3335 for Cadmium. Modify the requirements of SSPC AB 2 to add requirement for one Chromate test and one Cadmium test for each "LEAD" test required.

PART 3 EXECUTION

3.1 STRUCTURAL [REPAIRS][MODIFICATIONS]

3.1.1 Fabrication

By mechanics skilled in the trade and in accordance with the manufacturer's directions. Metalwork shall be well formed to shape and size, with sharp lines, angles, and true curves. Work shall be fabricated to allow for expansion and contraction of materials. Provide welding and bracing of adequate strength and durability, with tight, flush joints, dressed smooth and clean. Prior to erection, members shall be identified with a painted erection mark.

3.1.1.1 Measurements

****

NOTE: The designer shall indicate on the drawings all field measurements required to perform work.

****

Before fabrication, verify all measurements to ensure coordination of new members to existing tower structure.

3.1.1.2 Metal Surfaces

Shall be clean and free from mill scale, flake rust and rust pitting; well formed and finished to shape and size, with sharp lines, angles, and smooth surfaces. Shearing and punching shall leave clean true lines and surfaces. Weld permanent connections. Welds shall be used and finished flush and smooth on surfaces that will be exposed after installation.

3.1.1.3 Construction

Thickness of metal and details of assembly and supports shall be as indicated. Joints exposed to weather shall be formed to exclude water.

3.1.1.4 Fastening

Provide the necessary brackets so that the work can be assembled in a neat and substantial manner. Holes for bolts and screws shall be drilled. Joints exposed to the weather shall be formed to exclude water. Conceal fastenings where possible.

3.1.1.5 Shop Fabrication

Fabrication and assembly shall be done in the shop to the greatest extent possible.

3.1.2 Galvanizing

New metal, except stainless steel, shall be galvanized. Galvanize after fabrication. Repair galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied. Coat inside of holes drilled in existing steel structure with cold galvanizing repair compound within 1 hour of drilling.

3.1.3 Welding

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M for steel and AWS D1.2/D1.2M for aluminum. Existing tower steel shall be stripped to bare metal prior to welding. Weld in a manner to prevent permanent distortion of the connected parts. Weld continuously along the entire area of contact. Provide AWS qualified welders, welding operators and tackers.

[3.1.3.1 Exothermic Welding

****

NOTE: Include paragraph when grounding screens or ground wires are present.

****

Use exothermic weld kits for connections of #3/0 AWG bare copper grounding wire.

]3.1.4 Connections

****

NOTE: Use AISC 360 for designs using AISC 325 (allowable stress) and for designs using AISC M020L (load and resistance factor).

****

Except as modified in this section, connections not detailed shall be designed in accordance with AISC 360. Build connections into existing work. Punch, subpunch and ream, or drill bolt holes. Bolts, nuts, and washers shall be clean of dirt and rust, and lubricated immediately prior to installation.

[3.1.4.1 Bolts

****

NOTE: All structural connections shall be fully tensioned.

****

ASTM A325 bolts shall be fully tensioned to 70 percent of their minimum tensile strength. Provide load indicator washers in all high strength bolted connections. Direct tension indicator tightening, or installation of alternate design fasteners, shall be the only acceptable tightening methods. Bolts shall be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, bolts shall then be fully tensioned, progressing from the most rigid part of a connection to the free edges.

]3.1.4.2 Stainless Steel Fasteners

ASTM F593 bolts shall be tightened to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the

Contracting Officer for further instructions.

[3.1.4.3 Installation of Load Indicator Washers (LIW)

****
NOTE: Use with all structural connections.
****

ASTM F959/F959M. Where possible, the LIW shall be installed under the bolt head and the nut shall be tightened. If the LIW is installed adjacent to the turned element, provide a flat ASTM F436 washer between the LIW and nut when the nut is turned for tightening, and between the LIW and bolt head when the bolt head is turned for tightening.

]3.2 COATING SAMPLING AND FIELD TESTING

3.2.1 Coating Sample Collection

Notify Contracting Officer three days in advance of sampling. The Contracting Officer and either the QC Manager or NACE Coating Inspector shall witness all sampling. Obtain a one liter quart sample of each batch of each base material, and proportional samples of each activator based on mix ratio, by random selection from sealed containers in accordance with ASTM D3925. Prior to sampling, mix contents of sealed container to ensure uniformity. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Identify samples by designated name, specification number, batch number, project contract number, sample date, intended use, and quantity involved. Ship samples to an approved laboratory for testing as required by paragraph entitled "Testing of Coating Samples."

3.2.2 Coating Sample Testing

Test samples of all primer, intermediate, and topcoat materials for compliance with requirements of Table I. Reject samples that fail tests, reselect, and retest samples.

3.3 SURFACES TO BE COATED

****
NOTE: Where general corrosion and light pitting is found, an additional 50 to 100 microns 2 to 4 mil DFT coat of the intermediate epoxy material should be brush applied over the corroded areas. This will increase the total coating thickness in these areas by 75 microns 3 mils DFT. This will provide additional barrier protection to these areas that are especially prone to corrosion. An engineering evaluation must be made to determine the methods of repairing the corroded areas, such as welding and grinding.
****

Coat all exposed surfaces, including ladders, railings, [_____], and other exterior appurtenances.

3.3.1 Protection of Items not to be Painted

****

NOTE: List staging, grates, railings etc. that can be easily removed, given a better paint job in a shop and then reassembled.
****

Remove or protect all objects not to be abrasive blasted or painted. Items that are to be removed or protected are listed below:

a. [_____]

3.4 ACCEPTABLE INSTALLERS

Contractors qualified in accordance with this section shall perform all surface preparation and coating application.

3.5 LIGHTING

Provide lighting for all work areas as prescribed in SSPC Guide 12.

3.6 CONTAINMENT SYSTEM

****
NOTE: This paragraph (and subparagraphs) should not be used for blast containment. Such containment should be specified in Section 02 83 00 LEAD REMEDIATION. Coordinate this paragraph with limitations paragraph entitled APPLICATION OF COATING SYSTEM.
****

The contractor shall design and provide a containment system for the capture, containment, collection, storage and disposal of the waste materials generated by the work under this contract. Waste materials covered by this paragraph shall not include any material or residue from removal of coatings containing lead, chromium, cadmium, PCB, or any other hazardous material. Submit design drawings and calculations designed by a registered engineer, including an analysis of the load which will be added to the structure by the containment system and waste materials. The review and acceptance of the containment system shall in no way relieve the contractor of any responsibility for obtaining the degree of capture, containment, and collection. It is the contractors responsibility to insure the feasibility and workability of the containment system. The contractor shall perform his operations and work schedule in a manner as to minimize leakage of the containment system. The containment system shall be properly maintained and shall not deviate from the approved drawings, without the Contracting Officers approval. If at any time during the execution of the work, the containment system fails to function satisfactory in the opinion of the Contracting Officer, the contractor shall suspend all operations, except those required to minimize adverse impact on the environment or government property. Operations shall not resume until modifications have been made to correct the cause of the failure. Modifications shall be approved by the Contracting Officer.

3.6.1 Containment System Plans

Drawings shall be a minimum of 22 inch by 36 inch with proper lettering. General notes shall be placed in the space above the title box. Show the containment system in plan and elevation views, including details of hangers and clips. Permanent attachments or fasteners to the tower shall not be allowed. Identify all containment system components on the plan sheets. Drawings shall indicate the maximum permissible loads of blast materials, waste material, and wind speeds. Indicate all framework, work platforms, scaffolding, curtains, screens, tarps, method of securement, etc.

3.7 REMOVAL OF COATINGS CONTAINING HAZARDOUS MATERIALS

Coatings containing hazardous materials and identified for disturbance during surface preparation, including removal, shall be removed in accordance with Section 02 83 00 LEAD REMEDIATION. Dispose of waste products including contaminated blasting grit, water, and the like. Coatings specified may have potential health hazards if ingested or improperly handled. Follow manufacturer's written safety precautions throughout the mixing, application, and cure of the coatings.

3.8 SURFACE PREPARATION

3.8.1 Abrasive Blasting Equipment

Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 650 kPa 95 psig at nozzle. Filter air supply so that air is free of oil and moisture in accordance with ASTM D4285. Test compressed air quality at each startup, but in no case less often than every five operating hours.

3.8.2 Abrasives for Soluble Salts Contamination

Test abrasive media for chloride contamination using test kit as described in article entitled "Test Kit for Measuring Chlorides in Abrasives." The maximum allowable chloride concentration is 7 ppm. Collect composite samples using techniques described in MIL-A-22262 article entitled "QUALITY CONFORMANCE INSPECTION." Test abrasive media immediately prior to use, and in no case more than 24 hours prior to use.

3.8.2.1 Pre-Preparation Testing of Abrasive Media Shipped in Bulk Containers

For bulk containers containing 1350 kg 3000 pounds or less, test one composite sample from each container. Reject entire container for non-conforming test. For bulk containers over 1350 kg 3000 pounds, test one composite sample for each 1350 kg 3000 pounds, one sample from each compartment, as appropriate. Reject entire container or compartment for non-conforming test.

3.8.2.2 Abrasive Media Shipped in Bags (Nominal 50-110 lb.)

Maintain palletized grouping as provided from supplier. Test composite sample from one bag of each pallet, but no less than one sample each 1350 kg 3000 pounds of abrasive. Reject entire pallet for nonconforming test. If palletized grouping is not maintained, sample and test one bag for every 450 kg 1000 pounds of abrasive. Reject each 450 kg 1000 pounds represented by a nonconforming test. If bags are stamped with Lot number, test composite samples from each of two bags per lot. Reject entire lot for nonconforming test.

3.8.2.3 Operational Testing of Recycled Metallic Abrasive Media

For batch processing of abrasive, test composite sample of each batch. Reprocess entire batch for non-conforming test. For continuous processing, test composite sample once per cycle, but no less that one sample every four hours. For non-conforming test during continuous processing, discontinue processing, check equipment for correct operation, and check surfaces prepared with non-conforming abrasive media as prescribed in Article entitled "Pre-Application Testing For Surface Contamination." Make adjustments to equipment or to processing as required to correct problem, and resume blasting when testing indicates that equipment is operating properly.

3.8.3 Clean[and Repair]

****

NOTE: For maintenance projects, allow for inspection and repair of surfaces, as required. Brush-off blasting to remove both loose rust and pack rust facilitates chloride testing and removal as well as inspection of surface condition. Tailor this paragraph to the needs of cleaning that will be required in preparation for repairs.

****

Brush-off blast all surfaces in accordance with SSPC 7/NACE No.4 to remove all corrosion products, including surface rust and pack rust. After abrasive blasting, remove abrasive and dust from surfaces by brushing, blowing with dry compressed air, and remove all loose material from vicinity of areas to be painted.[Examine tank for defects. Repair defects found, such as cracks or splits, by welding. Grind off rough surfaces on weld seams, sharp edges, and corners to a radius of not less than three mm 1/8 inch. Weld sharp depressions or deep pits and grind-off smooth.]

3.8.4 Surface Standard

Inspect surfaces to be coated, and select plate with similar characteristics and surface characteristics for use as a surface standard. Blast clean one or more 300 mm 1 foot square steel panels. Surface preparation and profile shall be as specified in paragraph entitled "SURFACE PREPARATION." Record blast nozzle type and size, air pressure at nozzle and compressor, distance of nozzle from panel, and angle of blast to establish procedures for blast cleaning. Measure surface profile in accordance with ASTM D4417. Seal surface standard with a clearcoat protectant, or keep wrapped and sealed in vapor-tight material, for use as a standard of comparison for steel surfaces throughout the course of work.

3.8.5 Pre-Preparation Testing for Surface Contamination

Perform testing, abrasive blasting, and testing in the prescribed order.

3.8.5.1 Pre-Preparation Testing for Oil and Grease Contamination

Ensure surfaces are oil-free by visual examination. Check entire structure with water misted onto surface. Any beading of water is indication of oil or grease contamination. Clean contaminated surfaces in accordance with SSPC SP 1 and recheck for contamination until surfaces are grease and oil-free.

3.8.5.2 Pre-Preparation Testing for Soluble Salts Contamination

Test surfaces for soluble salts, and wash as required, prior to abrasive blasting. Soluble salt testing is also required as a final acceptance test of prepared surfaces after abrasive blasting, and successful completion of this phase does not negate that requirement. This phase is recommended since pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Effective removal of soluble salts will require removal of any barrier to the steel surface, including rust. This procedure may necessitate the use of wet abrasive blasting, high pressure water washing, or water washing with a soluble salt remover that is biodegradable, noncorrosive, nontoxic, and leaves no film. Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase are selected at the Contractor's discretion.

3.8.6 Abrasive Blasting

Abrasive blast steel surfaces to near-white metal in accordance with SSPC SP 10/NACE No. 2. Near-white metal surfaces shall conform to SSPC VIS 1 and shall match the prepared test-panels. Provide a 50 to 75 micron 2 to 3 mil surface profile. Surface profile greater than 75 microns 3 mils will not be accepted. Measure surface profile in accordance with ASTM D4417. Time interval between abrasive blasting and application of primer shall not exceed eight hours. After abrasive blasting, clean surfaces of dust and debris by brushing, blowing with oil-free and moisture-free compressed air, or vacuuming.

3.8.7 Disposal of Used Abrasive

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NOTE: For recoating of existing tower structures which contain or may contain any hazardous material in existing coating, add requirement for testing of used abrasive for hazardous waste.

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Dispose of used abrasive at a landfill off Government property in accordance with applicable regulations.[Test used abrasive in accordance with EPA test procedures manual EPA 530/F-93/004 and 40 CFR 261 to determine if it is a hazardous waste using TCLP for metals. Handle and dispose of abrasive determined to be hazardous waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, and 40 CFR 268. Dispose in accordance with Section 02 83 00 LEAD REMEDIATION. Payment for disposal of hazardous waste will not be made until a completed manifest from treatment or disposal facility is returned, and a copy furnished to the Government.]

3.8.8 Pre-Application Testing For Surface Contamination

3.8.8.1 Pre-Application Testing for Oil and Grease Contamination

Ensure surfaces are oil-free by visual examination. Check questionable areas and random areas for beading of water misted onto surface. Clean contaminated surfaces in accordance with SSPC SP 1 and recheck for contamination until surfaces are oil-free. Reblast tested and cleaned areas as required.

3.8.8.2 Pre-Application Testing for Soluble Salts Contamination

Test surfaces for chloride contamination using the Test Kit described in article entitled "Test Kit for Measuring Chlorides on Steel Surfaces." Test all surfaces at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 300 square meters 3000 square feet or part thereof.[Concentrate testing of bare steel at areas of coating failure to bare steel and areas of corrosion pitting.][Perform 30 percent of tests on bare steel at welds, divided equally between horizontal and vertical welds.] One or more readings greater than 5 micrograms per square centimeter of chlorides shall be cause for rejection of surface. Wash all surfaces as discussed in article entitled "Pre-Preparation Testing for Soluble Salts Contamination," allow to dry, and re-test until all required tests show allowable results. Reblast tested and cleaned areas as required. Label all test tubes and retain for test verification.

3.8.8.3 Pre-Application Testing for Surface Cleanliness

Apply coatings to dust free surfaces. To test surfaces, apply strip of clear adhesive tape to surface and rub onto surface with finger. When removed, the tape should show little or no dust, blast abrasive, or other contaminant. Clean contaminated surfaces and retest. Test surfaces at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 300 square meters 3000 square feet or part thereof.

3.9 MIXING AND APPLICATION OF COATING SYSTEM

3.9.1 Preparation of Coating Materials for Application

Each of the epoxy and polyurethane products, [sealer,][primer], intermediate, and topcoat, is a two-component coating supplied in separate containers.

3.9.1.1 Mixing [Sealer,][Primer,]Intermediate, and Topcoat Materials

Mix in accordance with manufacturer's instructions, which may differ for each product. Do not mix partial kits or alter mix ratios. Mix all coating materials in same temperature and humidity conditions specified in article entitled "DELIVERY AND STORAGE." Allow epoxy material to stand for required induction time based on its temperature. Keep coating material containers covered at all times after mixing and during application to prevent contamination. The polyurethane coating material is moisture sensitive and any introduction of moisture or water into the material during mixing or application will shorten usable pot life.

3.9.1.2 Pot Life

Apply mixed products within stated pot life for each product. Stop applying when material becomes difficult to apply in a smooth, uniform wet film. Do not add solvent to extend pot life. Add all required solvent at time of mixing. Pot life is based on standard conditions at 21 degrees C 70 degrees F and 50 percent relative humidity. For every 10 degrees C 18 degrees F rise in temperature, pot life is reduced by approximately half, and for every 10 degrees C 18 degrees F drop it is approximately doubled. Other factors such as the shape of the container and volume of mixed material may also affect pot life. Precooling or exterior icing of components for at least 24 hours to a minimum of 10 degrees C 50 degrees F in hot climates will extend pot life. High humidity at time of mixing and application shortens pot life of the Polyurethane topcoat material. Following are approximate pot life times at 21 degrees C 70 degrees F:

Epoxy materials	4 hours
Polyurethane materials	2 hours.

3.9.1.3 Application Conditions and Recoat Windows

The overcoating requirements for the coating system are very time and temperature sensitive. If ambient conditions do not allow for orderly application of primer, stripe coat, intermediate coat and topcoat, use appropriate means of controlling surface temperatures, as required. Partial or total enclosures may be required, as well as other measures, to control conditions to allow for orderly application of all required coats.

Apply coating only when ambient air and steel temperatures are between 16 and 38 degrees C 60 and 100 degrees F, and steel surface temperature is more than 3 degrees C 5 degrees F above the dew-point of the ambient air during application and the first four hours for epoxy and the first eight hours for polyurethane. Do not apply coatings above 38 degrees C 100 degrees F or below 16 degrees C 60 degrees F.

Use Table entitled "RECOAT WINDOWS" to determine appropriate recoat windows for each coat after the initial coat. Apply each coating during appropriate RECOAT WINDOW.

If coating is not applied during RECOAT WINDOW, apply during EXTENDED RECOAT WINDOW. Application of any epoxy coat within the EXTENDED RECOAT WINDOW requires application of a TACK COAT prior to applying any full coat. Perform cure test immediately prior to application of TACK COAT to determine condition of applied coating. If CURE TEST indicates that surface is fully cured, provide GLOSS REMOVAL prior to application of TACK COAT.

If coating is not applied during EXTENDED RECOAT WINDOW, wash surface with water and detergent, rinse clean with fresh water and allow surface to dry thoroughly, provide GLOSS REMOVAL, apply TACK COAT, where applicable, within 24 hours, and apply next full coat within TACK COAT RECOAT WINDOW.

RECOAT WINDOWS						
EPOXY OVER EPOXY						
Temperature degrees C	16-21	22-27	28-32	33-38	39-43	44-49
RECOAT WINDOW (Hrs.)	24-72	18-60	16-48	12-36	8-18	4-6
EXTENDED RECOAT (Hrs.)	72-168	60-140	48-120	36-96	18-36	6-12
TACK COAT RECOAT WINDOW (Hrs.)	6-72	4-60	4-48	3-36	2-18	1-6
POLYURETHANE OVER EPOXY						
Temperature degrees C	16-21	22-27	28-32	33-38	39-43	44-49
RECOAT WINDOW (Hrs.)	24-72	18-60	16-48	12-36	8-18	4-6
RECOAT WINDOW (Hrs.)	24-96	24-72	16-48	12-36	10-24	8-16
EXTENDED RECOAT (Hrs.)	96-168	72-144	48-120	36-96	24-48	16-24
TACK COAT RECOAT WINDOW (Hrs.)	24-96	24-72	16-48	12-36	10-24	8-16
POLYURETHANE OVER POLYURETHANE						
Temperature degrees C	16-21	22-27	28-32	33-38	39-43	44-49
RECOAT WINDOW (Hrs.)	8-48	6-48	4-36	3-24	2-12	1-2
EXTENDED RECOAT (Hrs.)	NONE					
TACK COAT RECOAT WINDOW (Hrs.)	NO TACK COAT USED					

RECOAT WINDOWS						
EPOXY OVER EPOXY						
Temperature degrees F	60-70	71-80	81-90	91-100	101-110	111-120
RECOAT WINDOW (Hrs.)	24-72	18-60	16-48	12-36	8-18	4-6
EXTENDED RECOAT (Hrs.)	72-168	60-140	48-120	36-96	18-36	6-12
TACK COAT RECOAT WINDOW (Hrs.)	6-72	4-60	4-48	3-36	2-18	1-6
POLYURETHANE OVER EPOXY						
Temperature degrees F	60-70	71-80	81-90	91-100	101-110	111-120
RECOAT WINDOW (Hrs.)	24-72	18-60	16-48	12-36	8-18	4-6
RECOAT WINDOW (Hrs.)	24-96	24-72	16-48	12-36	10-24	8-16
EXTENDED RECOAT (Hrs.)	96-168	72-144	48-120	36-96	24-48	16-24
TACK COAT RECOAT WINDOW (Hrs.)	24-96	24-72	16-48	12-36	10-24	8-16
POLYURETHANE OVER POLYURETHANE						
Temperature degrees F	60-70	71-80	81-90	91-100	101-110	111-120
RECOAT WINDOW (Hrs.)	8-48	6-48	4-36	3-24	2-12	1-2
EXTENDED RECOAT (Hrs.)	NONE					
TACK COAT RECOAT WINDOW (Hrs.)	NO TACK COAT USED					

The temperature ranges shown in the table above are for determining recoat windows. Choose recoat window based on the highest surface temperature that was sustained for one or more hours between coats. This applies to the entire time between coats. Measure and record air and surface temperatures on hourly basis to determine appropriate recoat windows. If surface temperature goes above 38 degrees C 100 degrees F, measure and record temperatures every half hour.

CURE TEST - Where indicated, test surface for cure using high-flash aromatic Naphtha only (cas #64742-95-6). Do not use aliphatic VMP Naphtha. Wipe surface with rag saturated with Naphtha, and check for surface tackiness, loss of gloss, or other indications that solvent has softened surface. If softening is found on 95 percent of test sites, this is indication that coating has not fully cured, and GLOSS REMOVAL is not required if TACK COAT is applied within three hours and full coat is applied within the TACK COAT RECOAT WINDOW. Test surfaces at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 300 square meters 3000 square feet or part thereof.

TACK COAT - Where indicated, apply coat of intermediate coat epoxy, at 25 to 50 microns 1 to 2 mils WFT, then apply next specified full coat within TACK COAT RECOAT WINDOW. Thin TACK COAT material approximately 25 percent by volume, using appropriate epoxy thinner.

GLOSS REMOVAL - Where indicated, remove all gloss by brush-off abrasive blasting in accordance with SSPC 7/NACE No.4 or by hand sanding with 150-200 grit wet/dry sandpaper, pressure wash or wipe down with a clean rag soaked with denatured alcohol to remove dust. If zinc primer coat is brush-off abrasive blasted, touch-up or overcoat as required to restore zinc coating to 100 percent coverage of steel surfaces, to the specified primer coat thickness.

3.9.2 Application of Coating System

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NOTE: For new tower construction where coating is applied in shop, the stripe coat should be applied by brush, and all other coats by spray. Although mitt application is an acceptable practice in the tower maintenance painting industry, the quality of the finished paint film by mitt application is questionable. Where painting is required due to severity of exposure, consideration should be given to excluding mitt application, particularly for primers.

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NOTE: Establish reasonable limits on particulate fallout area and airborne coating droplets. the specified coatings do not "dry" during a fall, therefore, anything in the path of windblown coating droplets will get coated.

****

Apply coatings in accordance with SSPC PA 1 and as specified herein. Apply coatings to surfaces that meet all stated surface preparation requirements.

After application of primer coat and prior to application of each subsequent coat, perform testing prescribed in article entitled "Pre-Application Testing For Surface Contamination," as necessary, to ensure minimal intercoat contamination. This testing may be reduced to one half of the prescribed rate for bare steel if the testing indicates no contamination when sampling is evenly distributed over surfaces being tested. If contamination is found between coats, revert to the specified testing rate. Generally, oil and grease contamination and soluble salts contamination are not encountered if subsequent coats are applied within specified recoat windows and unusual atmospheric events do not occur. Such atmospheric events as a coastal storm blowing onshore can bring unusual chloride contamination. Concern for intercoat contamination should be continually prevalent, and spot testing should be accomplished to verify satisfactory conditions. Where visual examination or spot testing indicates contamination, perform sufficient testing to verify non-contamination, or to define extent of contamination for appropriate treatment.

Apply each coat in a consistent wet film, at 90 degrees to previous coat. Ensure that primer and intermediate coat "cold joints" are no less than 150 mm six inches from welds. Apply stripe coat by brush. Apply all other coats by [spray][brush, roller, or mitt] application. Use appropriate controls to prevent airborne coating fog from drifting beyond[[three][_____] meters [15][_____] feet from the structure perimeter]. Cover or protect all surfaces that will not be coated. The cleanliness, temperature, recoat windows, and airborne paint containment requirements may necessitate the use of enclosures, portable shelters, or other appropriate controls.

[3.9.2.1 Sealer Coat for Spray Metalizing

Apply sealer coat at 25 to 50 microns 1 to 2 mils dry film thickness (DFT).

][3.9.2.2 Application of Primer

****

NOTE: This paragraph applies to application of organic zinc-rich primer (MIL-DTL-24441), either in the shop or when applied in field as spot primer. this paragraph also applies to application of Inorganic zinc-rich primer (DOD-P-24648.)

Delete primer and stripe coat if tower is hot dip galvanized or spray metallized.

****

Apply primer coat at 50 to 100 microns 2 to 4 mils dry film thickness (DFT). Maintain paint supply container height within 1 meter 3 feet of the paint nozzle when applying zinc primer. Maintain constant agitation of paint pot to ensure that zinc does not settle in container.

]3.9.2.3 Application of Stripe Coat

Apply a stripe coat of succeeding coat epoxy material within RECOAT WINDOW of primer coat. Apply by brush, working material into corners, crevices, angles, and welds, and onto outside corners and angles.

[3.9.2.4 Application of Intermediate Coat

Apply intermediate coat within RECOAT WINDOW of [sealer][primer] coat. Apply intermediate coat 75 to 125 microns 3 to 5 mils DFT. Check coating thickness prior to application of topcoat. If additional coating film is required, use intermediate coating material to provide desired thickness, then apply topcoat.

]3.9.2.5 Application of Topcoat

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NOTE: Adjust total system to compensate for galvanizing or spray metallizing, or for existing coating, as necessary.

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Make all required repairs to primer and intermediate coats as specified in paragraph entitled "Procedure for Making Spot Repairs" prior to applying topcoat. Apply topcoat within RECOAT WINDOW of intermediate coat. Apply polyurethane topcoat 40 to 60 microns 1-1/2 to 2-1/2 mils DFT. Total system of primer, intermediate, and topcoat shall not be less than 225 microns 9 mils DFT. Apply additional topcoat, if necessary, to obtain required minimum total system thickness.

3.9.2.6 Procedure for Making Spot Repairs

Use this procedure only with written approval from the Contracting Officer. Observe all requirements for soluble salts contamination and cleanliness between coats. Apply each coat within RECOAT WINDOW of preceeding coat. Prepare defective area in accordance with SSPC SP 10/NACE No. 2, and feather coating as required to leave 100 mm 4 inches of each succeeding coat feathered and abraded. Protect adjacent areas from damage and overspray. Remove dust and solvent wipe the prepared area plus an additional 75 mm 3 inches beyond the prepared area with clean denatured alcohol. Within four hours of preparation, apply zinc-rich primer to prepared steel and feather onto prepared primer. Apply intermediate coat to primed area and feather to prepared intermediate area. Apply topcoat by spray to intermediate coat and feather to prepared topcoat. Apply each repair coat to approximate thickness of surrounding coating system.

3.10 FIELD TESTS AND INSPECTION

3.10.1 NACE Coating Inspector

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NOTE: Include requirement for NACE Coating inspector in Section 01 45 00 QUALITY CONTROL, as a QC Specialist. Use NACE Certified inspector for most projects, NACE Basic inspector for small projects.

For Navy projects, make modifications to Section 01 45 00 QUALITY CONTROL as follows:

1. Requirements of the NACE Coating Inspector should be as follows:

"The NACE [Certified][Basic] Coating Inspector shall be an independent third party hired directly by the

prime construction contractor as an integral part of the prime construction contractor's Quality Control Organization. This inspector shall have no business relationships (owner, partner, operating officer, distributor, salesman, or technical representative, inspector) with any subcontractors involved with this project; or with any manufacturers, suppliers or installers for any material or equipment provided as part of this project."

2. The scope and duration of the NACE coating inspector should be as follows:

"The NACE Coating Inspector shall be present during all pre-preparation testing, surface preparation, coating application, initial cure of coating system, and during all repair work."

3. A submittal should be required as follows:

"Submit name, address, telephone number, FAX number, and e-mail address of the proposed coating inspector. Submit documentation that inspector is a [Certified][Basic] Coating Inspector under the National Association of Corrosion Engineers (NACE) Coating Inspector Training and Certification Program (NCITCP), including NACE inspector identification number, date of qualification, and expiration date."

For Army projects, make modifications to Section 01 45 00 QUALITY CONTROL as follows:

Add NACE Coating Inspector to paragraph CQC PERSONNEL and it's associated Experience Matrix. The NACE Coating Inspector should be directly employed by the prime contractor. Use the following for the Qualifications column:

"[Certified][Basic] Coating Inspector under the National Association of Corrosion Engineers (NACE) Coating Inspector Training and Certification Program (NCITCP)"

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The NACE Coating Inspector shall be present during all pre-preparation testing, surface preparation, coating application, initial cure of coating system, and during all repair work.

3.10.2 Field Inspection

The NACE Coating Inspector shall accomplish field inspection. Use the Daily Inspection Checklist forms attached to the end of this section, or a similar checklist with all pertinent data included. Record all surface preparation and coating application work accomplished, environmental conditions during this work, and results of regular inspections. Record all deviations from specifications. Accomplish testing in accordance with NACE SP0288 and as required herein.

3.10.2.1 Thickness Testing

Following application of each coat, inspect surfaces in presence of the Contracting Officer for pinholes, blisters, inadequate coating thickness, and other defects. Repair imperfections found. Measure dry film thickness in accordance with SSPC PA 2 Provide additional coating where required.

3.10.3 Hold Points for Quality Control Inspections

Provide appropriate QC inspections at the following hold-points:

Step	Action
Prior to preparation of surfaces for cleaning and repair	Safety inspection
After cleaning of structure and prior to surface preparation	Safety inspection, removal of dirt, trash, debris, and any hindrance to specified work.
After cleaning of structure and prior to abrasive blasting	Surface inspection for oil, grease, soluble salts, or other contaminants
Initiation of abrasive blasting, and at each work stoppage	1.) Confirm environmental conditions are suitable for abrasive blasting and for holding the blast.
	2.) Surface inspection to insure all aspects of surface preparation are properly addressed,as specified in article entitled "SURFACE PREPARATION", including visual cleanliness, surface profile, and soluble salt contamination.
	3.) Test compressor air for oil and water contamination.
After abrasive blasting	Surface inspection to insure all aspects of surface preparation are properly addressed,as specified in article entitled "SURFACE PREPARATION", including visual cleanliness, surface profile, and soluble salt contamination.

Step	Action
Immediately prior to coating application - provide for each coating application evolution	1.) Confirm environmental conditions are suitable for coating application per
	2.) Surface inspection to insure all aspects of surface preparation are properly addressed, as specified in article entitled "SURFACE PREPARATION", including visual cleanliness,surface profile, and soluble salt contamination.
	3.) Confirm that testing equipment for monitoring for hazardous conditions during coating application are working properly and are prepared for use as outlined in contractor's Safety Plan
During and after coating application.	Coating application inspection per paragraphs entitled "Application of Coating System" and "Field Tests and Inspection".
After final cleanup	Clean-up inspection specified in the paragraph entitled "Final Cleanup."

3.11 ELECTRICAL WORK

3.11.1 Terminating Aluminum Stranded Conductors

a. Use particular care in making up joints and terminations. Remove surface oxides by cleaning with a wire brush or emery cloth. Apply joint compound to conductors, and use UL-listed solid aluminum connectors for connecting aluminum to aluminum conductors.

b. Terminate aluminum conductors to existing steel tower structure using a circumferential compression type, aluminum bodied terminal lug UL listed for AL/CU and steel Belleville spring washers, flat washers, bolts, and nuts. Belleville spring washers shall be cadmium-plated hardened steel. Surface of existing steel where connection is to be made shall be stripped free of paint. Special care shall be taken to avoid destruction of underlying galvanized surface. Install the Belleville spring washers with the crown up toward the nut or bolt head, with the concave side of the Belleville bearing on a heavy-duty, wide series flat washer of larger diameter than the Belleville. Tighten nuts sufficient to flatten Belleville and leave in that position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.

c. Terminate aluminum conductors to aluminum bus by using all-aluminum nuts, bolts, washers, and lugs. Wire brush and apply joint compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection; if bus contact surface is unplated, scratch-brush and coat with joint compound (without grit).

3.12 FINAL CLEANUP

Following completion of the work, remove debris, equipment, and materials from the site. Remove temporary connections to Government or Contractor furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

[

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table I [_____]. - Zinc Rich Epoxy Primer Coat MIL-DTL-24441/19 Formula 159

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent (zinc dust)	---	---	81.5	85.5	---	---
Volatiles, percent	42.8	44.3	8.0	8.4	---	---
Non-volatiles vehicle, percent	53.7	57.7	8.3	8.7	---	---
Consistency, grams	---	---	250	500	---	---
Weight						
Kilograms / liter	0.87	1.01	3.30	3.40	---	---
Pounds / gallon	7.3	8.4	27.5	28.4	---	---
Set to touch, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	2
Dry-hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	8
Flashpoint						
Degrees C	35.6	---	37.8	---	---	---
Degrees F	96	---	100	---	---	---

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table I [_____]. - Zinc Rich Epoxy Primer Coat MIL-DTL-24441/19 Formula 159

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Titanium Dioxide, percent of pigment	18	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	4	---
Sag resistance						
Micrometers	---	---	---	---	300	---
Mils	---	---	---	---	12	---
VOC						
Grams / liter	---	---	---	---	---	304
Pounds / gallon	---	---	---	---	---	2.5
Lead, * percent, ASTM D3335						0.06
Cadmium, * percent, ASTM D3335						0.06
Chromium, * percent, ASTM D3718						0.00

GENERAL NOTES:
Test methods as specified in MIL-DTL-24441, except those marked with "*". Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441.

]

[

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table I [_____]. - Intermediate Epoxy Coat MIL-DTL-24441/31 Formula 152 Type IV (White)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent	44.0	49.0	33.0	38.0	---	---
Volatiles, percent	29.0	35.0	16.0	21.0	---	---
Non-volatiles vehicle, percent	17.5	23.5	44.0	49.0	---	---
Course particles, percent	---	0.3	---	0.3	---	---
Consistency, grams	180	320	300	470	---	---
Weight						
Kilograms / liter	1.39	1.45	1.29	1.35	---	---
Pounds / gallon	11.6	12.1	10.8	11.3	---	---
Set to touch, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	3
Dry-hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	8
Fineness of grind, Hegman	4	---	4	---	---	---
Flashpoint						
Degrees C	35.5	---	37.8	---	---	---
Degrees F	96	---	100	---	---	---
Titanium Dioxide, percent of pigment	91	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	4	---
Contrast ratio, 3 miles DFT	---	---	---	---	0.98	---

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table I [_____]. - Intermediate Epoxy Coat MIL-DTL-24441/31 Formula 152 Type IV (White)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Sag resistance						
Micrometers	---	---	---	---	300	---
Mils	---	---	---	---	12	---
Color of dry film to approximate color of standard color chip	---	---	---	---	---	340
VOC						
Grams / liter	---	---	---	---	---	340
Pounds / gallon	---	---	---	---	---	2.8
Lead, * percent, ASTM D3335	---	---	---	---	---	0.06
Cadmium, * percent, ASTM D3335	---	---	---	---	---	0.06
Chromium, * percent, ASTM D3718	---	---	---	---	---	0.00

GENERAL NOTES:
Test methods as specified in MIL-DTL-24441, except those marked with "*". Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441.

]

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table I [_____]. - Intermediate Epoxy Coat MIL-DTL-24441/31 Formula 152 Type IV (Tinted)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent	44.0	49.0	33.0	38.0	---	---
Volatiles, percent	29.0	35.0	16.0	21.0	---	---
Non-volatiles vehicle, percent	17.5	23.5	44.0	49.0	---	---
Course particles, percent	---	0.3	---	0.3	---	---
Consistency, grams	180	320	300	470	---	---
Weight						
Kilograms / liter	1.39	1.45	1.29	1.35	---	---
Pounds / gallon	11.6	12.1	10.8	11.3	---	---
Set to touch, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	3
Dry-hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	8
Fineness of grind, Hegman	4	---	4	---	---	---
Flashpoint						
Degrees C	35.5	---	37.8	---	---	---
Degrees F	96	---	100	---	---	---
Titanium Dioxide, percent of pigment	91	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	4	---
Contrast ratio, 3 miles DFT	---	---	---	---	0.98	---

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table I [_____]. - Intermediate Epoxy Coat MIL-DTL-24441/31 Formula 152 Type IV (Tinted)

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Sag resistance						
Micrometers	---	---	---	---	300	---
Mils	---	---	---	---	12	---
Color of dry film to approximate color of standard color chip	---	---	---	---	---	Conform
VOC						
Grams / liter	---	---	---	---	---	340
Pounds / gallon	---	---	---	---	---	2.8
Lead, * percent, ASTM D3335	---	---	---	---	---	0.06
Cadmium, * percent, ASTM D3335	---	---	---	---	---	0.06
Chromium, * percent, ASTM D3718	---	---	---	---	---	0.00

GENERAL NOTES:
Test methods as specified in MIL-DTL-24441, except those marked with "*". Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441.

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table I [_____]. - Polyurethane Topcoat MIL-PRF-85285 Type II

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Moisture content, percent	---	2	---	---	---	---
Course particles, percent	---	---	---	---	---	.5
Viscosity	---	---	---	---	---	See Note 1
Fineness of grind, Hegman	---	---	---	---	7	---
Drying to touch (See Note 2)	---	---	---	---	---	4
Dry-hard (See Note 2)	---	---	---	---	---	8
VOC, grams per liter	---	---	---	---	---	340
Color	---	---	---	---	delta E+-1.0	
Gloss 60 degree specular gloss						
Gloss	---	---	---	---	---	90
Semi-gloss	---	---	---	---	15	45
Opacity	---	---	---	---	0.95	---
Flexibility	---	---	---	---	---	Conform
Fluid resistance	---	---	---	---	---	Conform
Heat resistance (cure)	---	---	---	---	---	Conform
Solvent resistance (cure)	---	---	---	---	---	Conform
Condition in container	---	---	---	---	---	Conform

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table I [_____]. - Polyurethane Topcoat MIL-PRF-85285 Type II

Test	Componenent A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Odor	---	---	---	---	---	Conform
Lead percent	---	---	---	---	---	0.06
Cadmium percent	---	---	---	---	---	0.06
Chromium percent	---	---	---	---	---	0.00

NOTES:
(1) Modify paragraph 3.6.4 Viscosity and Pot Life, of MIL-PRF-85285 as follows:

The viscosity of the admixed coating, when tested in accordance with ASTM D1200 through a No. 4 Ford cup, shall be as follows:

Time from mix (minimum)	Maximum time through a No. 4 Ford Cup
Initially	30 seconds
2 hours	60 seconds
4 hours	No gel

(2) Modify paragraph 3.7.1 Drying Time, of MIL-PRF-85285. When applied by spray techniques and when tested in accordance with ASTM D1640/D1640M, the coating shall be set-to-touch within four hours and dry-hard within eight hours (see 4.6 and table I).

GENERAL NOTES:
Test methods as specified in MIL-PRF-85285, except those marked with "*". Where "Conform" is indicated, refer to specific requirements of MIL-PRF-85285.

DAILY INSPECTION CHECKLIST			
ITEM			REPORT #
SPECIFIC LOCATION	SAT	UNSAT	COMMENTS
I. PRE-SURFACE PREPARATION 1. Condition of Edges, Welds, etc.			
2. Grease / Oil			
3. Visible Moisture			
4. Protective Coverings			
5. Clean Dry Abrasive			
6. Recycled Abrasive Test			
7. Nozzle Air Pressure (Record)			
8. Compressed Air Cleanliness (Record)			
9. Ambient Conditions (Record)			Time of day:
II. SURFACE PREPARATION 10. Ambient Conditions (Record)			Wet Bulb: Humidity Dry Bulb: Dew Pt.: Amb. Air: Surf Temp:
11. Degree of Cleanliness (Record)			
12. Profile (Record)			
13. Type and Size Abrasive (Record)			
14. Dust and Abrasive Removal			
15. Time of Surface Acceptance			
III. MIXING 16. Product Name / Mfg / Batch Numbers (Records)			Product Name: Mfg: Batch Number:
17. Clean Equipment			
18. Material Temperature / Potlife (Record)			

DAILY INSPECTION CHECKLIST

ITEM			REPORT #
SPECIFIC LOCATION	SAT	UNSAT	COMMENTS
19. Thinner / Type and Amount (Record)			
20. Time of Mix (Record)			
IV. APPLICATION: 21. Ambient Conditions (Record) Time of Day:			Wet Bulb: Humidity Dry Bulb: Dew Pt.: Amb. Air: Surf Temp:
22. Applicator's Name (Record)			
23. Surface Prep. to Application (Record Time)			
24. Compressed Air Cleanliness			
25. Protective Coverings			
26. Time Application Began & Surf. Temp. (Record)			
27. Surrounding Air Cleanliness			
28. Recoat Times Observed			
29. Intercoat Cleanliness			
30. Proper Pot Agitation			
31. Type of Application Equip. & Tip Size (Record)			
32. Time Application Complete and Surf. Temp (Record)			
V. INSPECTION 33. Visual Appearance			
34. Dry Film Thickness (Record)			
35. Holiday Test			
36. Cure Test			

DAILY INSPECTION CHECKLIST			
ITEM			REPORT #
SPECIFIC LOCATION	SAT	UNSAT	COMMENTS
NOTES: (use additional sheets as necessary)			
NACE INSPECTOR	NACE NUMBER		DATE
QC MANAGER			DATE

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 97 13.27 (February 2021)**
Change 1 - 08/22

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 13.27 (October 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 09 - FINISHES

SECTION 09 97 13.27

HIGH PERFORMANCE COATING FOR STEEL STRUCTURES

02/21, CHG 1: 08/22

PART 1 GENERAL

PART 2   PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 97 13.27 (February 2021)**
Change 1 - 08/22

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 09 97 13.27

HIGH PERFORMANCE COATING FOR STEEL STRUCTURES
02/21, CHG 1: 08/22

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NOTE: This guide specification covers the requirements for zinc-rich epoxy/epoxy/polyurethane coating systems for the following:

1. New steel components in atmospheric service (non-immersion) which require the highest performance available to address severe environments, or where life-cycle costs are justified to avoid facility shutdowns for future re-coatings; or where finish application degradation, such as peeling, which jeopardizes assets within a facility. This includes, but is not limited to, aboveground fuel tanks, water tanks, and piping; components identified in UFC 4-211-01 Aircraft Maintenance Hangars, cranes, and towers.

2. New structures and coating of existing structures where all existing coating material is being removed to bare metal.

3. Repairing and coating of galvanized surfaces. Repair galvanizing with the zinc-rich primer, and apply general coats of intermediate and topcoat to all surfaces.

Coordinate surface preparation and coating systems with applicable Division 05 and Division 08 UFGS Sections.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in

respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: To determine the requirements for maintenance of an existing coating, a coating inspection, or coating condition survey (CCS), as described herein, should be accomplished prior to designing the coating project. Without a competent inspection, there is no reliable way to determine the type or condition of the existing coating system. Without knowing the existing conditions, proper (effective and financially supportable) surface preparation or coating system selection cannot be made.

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NOTE: This specification should be edited by an SSPC certified Protective Coatings Specialist (PCS) that has five or more years of experience preparing coating specifications.

The designer should not alter the products and processes specified herein without thorough knowledge of the need for the changes and the implications of those changes.

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NOTE: The metric standard for measuring coating thickness is microns (25.4 microns=1 mil - use nominal 25 microns=1 mil).

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NOTE: This specification is for an industry standard, 3 Coat, thin film, coating system that is compliant with EPA VOC regulations as of June 2000:

- Epoxy coats 350 g/l 2.8 lbs/gal max. VOC
- Polyurethane Topcoat 350 g/l 2.8 lbs/gal max. VOC

The designer shall review state and local, regulations and determine whether the coating in this Section complies with restrictions on volatile organic components (VOC) and other chemical constituents.

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NOTE: Previous versions of this specification have included a requirement for surfaces to be abrasive blasted to SSPC 7/NACE No.4, inspected, and repaired, prior to coating. That requirement has

been removed from this specification, and if required for a repair project, it should be included in the structural repair Section of the project specification. Tailor the paragraph to the needs of cleaning that will be required in preparation for repairs, and note that the abrasive blasting for inspection should be accomplished in such a manner that it does not conflict with any surface condition requirements in this Section, such as creating excessive surface profile that may require excessive primer thickness. For repair projects, specify appropriate portions of the steel surfacing requirements (according to NACE RPO178) from Section 33 56 21.17 SINGLE WALL ABOVE GROUND FIXED ROOF STEEL POL STORAGE TANK.

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NOTE: For purposes of this specification, the term "maintenance coating" refers to maintenance overcoating as opposed to complete removal of coatings and recoating. For maintenance coating designs, or to determine if maintenance overcoating is appropriate, a coating condition survey (CCS) should be accomplished. The CCS should be accomplished by personnel from a business that routinely performs coating evaluations, and the individual investigator should be Certified by SSPC as a Protective Coatings Specialist. The CCS should be sufficiently detailed to provide all technical information about the coatings, and structures to be coated, required to properly design the project. At a minimum, the CCS should provide a detailed report of:

1. Existing coating conditions, including condition of coating film, and the existence of potentially hazardous substances that may impact coating management (i.e. lead, cadmium, chromium);

2. Analysis of remaining coating life, suitability of overcoating, and technical requirements for overcoating;

3. Technical recommendations for the most cost effective management of existing coating systems, including any hazardous materials present in paint film; and

4. Any other information of interest to the coating system management that should be identifiable by an individual trained and experienced in the field of coating analysis, coating failure analysis, and coating design.

The scope of the CCS should be tailored to the specific project, and it should be recognized that while multiple coating failures or deficiencies may look similar to the untrained eye, the risks of

generalizing to save evaluation costs are potentially very high. The cost of large-scale failure of the overcoating, and complete replacement of the coating system, is far more than the cost of a CCS for all but the smallest projects.

The risks of overcoating can usually be avoided by designing project to remove all existing coatings to bare metal, then providing appropriate surface preparation and coating application. However, the extra costs of the coating removal, especially if containing hazardous material, along with the cost of surface preparation to SSPC SP 10 Abrasive Blast to Near-White Metal, may be exorbitant compared to the costs of maintenance overcoating where the existing coating system is in fair-to-good condition.

Additionally, NAVFAC Design Policy Letter DPL-09B-0001, Lead-containing Paint on Non-residential Structures of 26 Mar 92 provides guidance for managing paints containing lead and other hazardous materials in place. The fact that lead was highly used as a primer is indicative of its value to the corrosion control industry. Premature removal of sound lead primer is not considered to be a good management practice.

Activities should consider an annual CCS to survey all structures to be authorized for design in the coming year. When accomplished for multiple projects, the per-structure cost will decrease. By accomplishing this survey prior to design, the basis for design is fully identified.

The CCS can also be a very useful tool when used to screen structures for maintenance painting requirements. A CCS can be scoped to provide a general inspection of many structures to screen for near-term overcoating or recoating requirements, and subsequent investigation can be made to provide appropriate details for project planning and design.

It should be pointed out that the aesthetic features of a coating do not define the coating condition; they only describe how the coating looks. Many coating systems have been replaced when only the topcoat is in need of "refurbishment." Likewise, many structures such as water tanks and fuel tanks have had complete coating replacement when only the roof coating needed replacement. A CCS can identify the weak components as well as the satisfactory components, and propose solutions to make maximum use of existing resources.

SSPC: The Society for Protective Coatings (SSPC), has published a Technology Update titled SSPC TU 3 Maintenance Overcoating. This document should be used as a guide for scoping the CCS, for accomplishing the CCS, and for designing the coating

work.

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NOTE: Designers are encouraged to contact Robert Jamond (robert.jamond@navy.mil) prior to beginning a new Navy design.

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NOTE: Designers are encouraged to contact the Air Force Civil Engineer Reachback Center (afcec.rbc@us.af.mil) prior to beginning a new Air Force design.

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D1200	(2010; R 2014) Viscosity by Ford Viscosity Cup
ASTM D1640/D1640M	(2014) Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings
ASTM D3276	(2015; E 2016) Standard Guide for Painting

	Inspectors (Metal Substrates)
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings
ASTM D4285	(1983; R 2018) Indicating Oil or Water in Compressed Air
ASTM D7127	(2017) Standard Test Method for Measurement of Surface Roughness of Abrasive Blast Cleaned Metal Surfaces using a Portable Stylus Instrument
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems-Requirements

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2023; R 2023) Ferrous Metallic Abrasive
SSPC Guide 6	(2021) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
SSPC Guide 12	(2023) Guide for Illumination of Industrial Painting Projects
SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC PA 2	(2015; E 2018) Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC QP 5	(2022) Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC SP 1	(2015) Solvent Cleaning

SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning
SSPC SP COM	(2016; E 2017) Surface Preparation Commentary for Steel and Concrete Substrates
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-22262	(1993; Rev B; Am 1 1994; Am 2 1996; Notice 1 2021) Abrasive Blasting Media Ship Hull Blast Cleaning
MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for
MIL-DTL-24441/19	(2009; Rev C; Notice 1 2023) Paint, Epoxy-Polyamide, Zinc Primer, Formula 159, Type III
MIL-DTL-24441/31	(2009; Rev B; Notice 1 2021) Paint, Epoxy-Polyamide, White, Formula 152, Type IV
MIL-PRF-85285	(2022; Rev F) Topcoat, Aircraft and Support Equipment
MIL-STD-161	(2005; Rev G; Notice 1 2010) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART Z	Toxic and Hazardous Substances
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1000	Air Contaminants
29 CFR 1926.59	Hazard Communication

1.2 DEFINITIONS

Definitions are provided throughout this Section, generally in the paragraph where used, and denoted by capital letters.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-05, Design Data

Containment System

SD-06 Test Reports

Joint Sealant Qualification Test Reports

Coatings Qualification Test Reports

Metallic Abrasive Qualification Test Reports

Coating Sample Test Reports

Abrasive Sample Test Reports

Inspection Report Forms

Daily Inspection Reports

Recycled Metallic Abrasive Field Test Reports (Daily and Weekly)

SD-07 Certificates

Contract Errors, Omissions, and Other Discrepancies

Corrective Action Procedures

Coating Work Plan

Qualifications of Certified Industrial Hygienist (CIH)

Qualifications Of Individuals Performing Abrasive Blasting

Qualifications of Certified Protective Coatings Specialist (PCS)

Qualifications of Coating Inspection Company

Qualifications of QC Specialist Coating Inspector

Qualifications of Testing Laboratory for Coatings

Qualifications of Testing Laboratory for Abrasive

Qualifications of Coating Contractors

Joint Sealant Materials

Coating Materials

Coating System Component Compatibility

Non-metallic Abrasive

Metallic Abrasive

SD-08 Manufacturer's Instructions

Joint Sealant Instructions

Coating System Instructions

SD-11 Closeout Submittals

Disposal of Used Abrasive

Inspection Logbook; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Contract Errors, Omissions, and Other Discrepancies

Submit all errors, omissions, and other discrepancies in contract documents the Contracting Officer within 30 days of contract award for all work covered in this Section, other than the work that will not be uncovered until a later date. All such discrepancies shall be addressed and resolved, and the Coating Work Plan modified, prior to beginning the Initial and Follow-Up phases of work. Discrepancies that become apparent only after work is uncovered shall be identified at the earliest discoverable time and submitted for resolution. Schedule time (Float) should be built into the project schedule at those points where old work is to be uncovered or where access is not available during the first 30 days after award, to allow for resolution of contract discrepancies.

1.4.2 Corrective Action (CA)

CA shall be included in the Quality Control Plan.

1.4.2.1 Corrective Action Procedures

Develop procedures for determining the root cause of each non-compliance, developing a plan to eliminate the root cause so that the non-compliance does not recur, and following up to ensure that the root cause was eliminated. Develop Corrective Action Request (CAR) forms for initiating CA, and for tracking and documenting each step.

1.4.2.2 Implement Corrective Action

The Contractor shall take action to identify and eliminate the root cause of each non-compliance so as to prevent recurrence. These procedures shall apply to non-compliance in the work, and to non-compliance in the QC System. Corrective actions shall be appropriate to the effects of the non-compliance encountered. Each CAR shall be serialized, tracked in a Log to completion and acceptance by the Contracting Officer, and retained in project records. The Corrective Action Log, showing status of each CAR, shall be submitted to the Contracting Officer monthly. A CAR may be initiated by either the Contractor or the Contracting Officer. The Contracting Officer must approve each CAR at the root cause identification stage, the plan for elimination stage, and the close out stage after verification that the root cause has been eliminated.

1.4.3 Coating Work Plan

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NOTE: For maintenance painting, add requirement for pre-work determination of the existing surface profile. If paint removal is specified in another Section, such as a blast cleaning prior to inspection or repair, or in the lead removal Section, include this evaluation of existing profile such that the paint removal operation does not create excessive profile.

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This work plan shall be considered as part of the Quality Control Plan.

Provide procedures for reviewing contract documents immediately after award to identify errors, omissions, and discrepancies so that any such issues can be resolved prior to project planning and development of detailed procedures.

Provide procedures for verification of key processes during Initial Phase to ensure that contract requirements can be met. Key processes shall include surface preparation, coating application and curing, inspection, and documentation, and any other process that might adversely impact orderly progression of work.

Provide procedures for all phases of coating operations, including planned work, rework, repair, inspection, and documentation. Address mobilization and setup, surface preparation, coating application, coating initial cure, tracking and correction of noncompliant work, and demobilization. Coordinate work processes with health and safety plans and confined space entry plans. For each process, provide procedures that include appropriate work instructions, material and equipment requirements, personnel qualifications, controls, and process verification procedures. Provide procedures for inspecting work to verify and document compliance with contract requirements, including inspection forms and checklists, and acceptance and rejection criteria.

[Provide procedures for determining the existing surface profile under paint, and procedures for ensuring that the profile is not increased beyond the maximum profile specified herein.

] Provide procedures for correcting noncompliant work. Detailed procedures are required in advance to avoid delays in meeting overcoat windows as well as to avoid delays in production. Provide procedures for repairing defects in the coating film, such as runs, drips, sags, holidays, overspray, as well as how to handle correct coating thickness noncompliance, any other areas of repair or rework that might be adversely affected by delays in preparing and approving new procedures.

If a procedure is based on a proposed or approved request for deviation, the deviation shall be referenced. Changes to procedures shall be noted by submittal number and date approved, clearly delineating old requirements and new requirements, so that the records provide a continuous log of requirements and procedures.

1.4.4 Design Data

1.4.4.1 Containment System

Submit complete design drawings and calculations for the scaffolding and containment system, including an analysis of the loads which will be added to the structure by the containment system and waste materials. A registered engineer shall approve calculations and scaffold system design.

1.4.5 Test Reports

1.4.5.1 Joint Sealant Qualification Test Reports

Submit test results from independent laboratory of representative samples of joint sealant material. Samples must have been tested within the last three years. Submit results as required in paragraph QUALITY ASSURANCE PROVISIONS of ASTM C920. Note that testing in accordance with QUALITY ASSURANCE PROVISIONS is a pre-qualification requirement.

1.4.5.2 Coatings Qualification Test Reports

Submit test results from independent laboratory of representative samples of each coating material. U.S. Department of Defense laboratories are considered to be independent laboratories for purposes of compliance with "QUALIFICATION INSPECTION" requirements herein. Samples must have been tested within the last three years. Submit results for epoxy materials as required in paragraph QUALIFICATION INSPECTION of MIL-DTL-24441, and as revised by paragraph COATING SYSTEM herein. Submit results for polyurethane materials as required in paragraph QUALIFICATION INSPECTION of

MIL-PRF-85285, and as revised by paragraph COATING SYSTEM herein. Note that requirement for QUALIFICATION INSPECTION is a pre-qualification requirement, and involves the same testing required for listing in the Qualified Products List of the respective material. See appropriate Military Specification for specific test requirements.

1.4.5.3 Metallic Abrasive Qualification Test Reports

Submit results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 3. Submit test results from independent laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of prequalifying the abrasive.

1.4.5.4 Recycled Metallic Abrasive Field Test Reports (Daily and Weekly)

Submit test results from independent laboratory of daily and weekly Quality Control testing required by SSPC AB 2, as modified in paragraph ABRASIVE.

1.4.6 Qualifications

1.4.6.1 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party CIH. Submit documentation that hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. Provide evidence of experience with hazards involved in industrial coating application work.

1.4.6.2 Qualifications of Certified Protective Coatings Specialist (PCS)

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party PCS. Submit documentation that specialist is certified by SSPC: The Society for Protective Coatings (SSPC) as a PCS, including certification number and date of certification/recertification. If the PCS is employed by the same coating inspection company to which the coating inspector is employed, this does not violate the independent third-party requirements. The PCS shall remain certified during the entire project, and the Contracting Officer shall be notified of any change in certification status within 10 days of the change. The PCS shall not be the designated coating inspector.

1.4.6.3 Qualifications of Coating Inspection Company

Submit documentation that the coating inspection company that will be performing all coating inspection functions is certified by SSPC to the requirements of SSPC QP 5 prior to contract award, and shall remain certified while accomplishing any coating inspection functions. The coating inspection company must remain so certified for the duration of the project. If a coating inspection company's certification expires, the firm will not be allowed to perform any inspection functions, and all surface preparation and coating application work must stop, until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in coating inspection company certification status.

1.4.6.4 Qualifications of QC Specialist Coating Inspector

Submit documentation that each coating inspector is employed, and qualified to SSPC QP 5, Level III, by the selected coating inspection company. Each inspector shall remain employed by the coating inspection company while performing any coating inspection functions.

1.4.6.5 Qualifications Of Individuals Performing Abrasive Blasting

Submit name, address, and telephone number of each person that will be performing abrasive blasting. Submit documentation that each blaster is qualified by SSPC to the SSPC C-7 Dry Abrasive Blaster Qualification Program. Each blaster shall remain qualified during the entire period of abrasive blasting, and the Contracting Officer shall be notified of any change in qualification status.

1.4.6.6 Qualifications of Testing Laboratory for Coatings

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that persons performing analyses are qualified.

1.4.6.7 Qualifications of Testing Laboratory for Abrasive

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of abrasive for compliance with specification requirements. Submit documentation that laboratory has experience in testing samples of abrasive for conformance with specifications, and that persons performing analyses are qualified.

1.4.6.8 Qualifications of Coating Contractors

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NOTE: If project involves removal of paint containing hazardous materials, add requirement for SSPC QP-2 certification in section of specification where the hazardous paint removal is specified, generally Section 02 83 00 LEAD REMEDIATION.

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NOTE: Solicitations requiring certification for prequalification should point out the existence and location of the certification requirement on the PROJECT INFORMATION FORM. This requirement must be pointed out in the solicitation documents for the "prior to contract award" requirement to be enforceable. Certification is a special responsibility requirement pursuant to FAR 9.104-2 Special Standards. This is analogous to requiring bidders to have a specified level of experience or expertise and GAO has sustained these types of special requirements.

****

All Contractors and Subcontractors that perform surface preparation or coating application shall be certified to either ISO 9001 or SSPC QP 1 and SSPC QS 1 prior to contract award, and shall remain certified while accomplishing any surface preparation or coating application. The painting Contractors and painting Subcontractors must remain so certified for the duration of the project. If a Contractor's or Subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in Contractor certification status.

1.4.6.9 Joint Sealant Materials

Provide manufacturer's certification of conformance to contract requirements.

1.4.6.10 Coating Materials

Provide manufacturer's certification of conformance to contract requirements.

1.4.6.11 Coating System Component Compatibility

Provide certification from each manufacturer of components of the coating system, epoxy primer, epoxy intermediate, and polyurethane topcoat, that the supplied coating material is suitable for use in the specified coating system. Each manufacturer shall identify the specific products, including manufacturer's name, which their product may be used with. The certification shall provide the name of the manufacturer that will provide technical support for the entire system. When all coating materials are manufactured by one manufacturer, this certification is not required.

1.4.6.12 Non-metallic Abrasive

Provide manufacturer's certification that the materials are currently approved by the Naval Sea Systems Command and listed on the Qualified Products Lists (QPL) for the specified materials.

1.4.6.13 Metallic Abrasive

Provide manufacturer's certification of conformance to contract requirements and provide copies of test results.

1.4.7 Protective Coating Specialist (PCS)

The PCS shall be considered a QC Specialist and shall report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The PCS shall approve all submittals prior to submission to the QC Manager for approval or submission to the government for approval.

1.4.8 Pre-Application Meeting

After approval of submittals but prior to the initiation of coating work, Contractor representatives, including at a minimum, project superintendent and QC manager, paint foreman, coating inspector, and PCS shall have a pre-application coating preparatory meeting. This meeting shall be in addition to the pre-construction conference. Specific items addressed shall include: corrective action requirements and procedures, coating work plan, safety plan, coordination with other Sections, inspection standards, inspection requirements and tools, test procedures, environmental control system, safety plan, and test logs. Notify Contracting Officer at least ten days prior to meeting.

1.5 PRODUCT DATA

1.5.1 Joint Sealant Instructions

Submit manufacturer's printed instructions including detailed application procedures, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.5.2 Coating System Instructions

Submit manufacturer's printed instructions including detailed mixing and application procedures, number and types of coats required, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.6 DELIVERY AND STORAGE

Ship, store, and handle materials in accordance with SSPC PA 1, and as modified in this Section. Maintain temperature in storage spaces between 5 and 29 degrees C 40 and 85 degrees F, and air temperature more than 3 degrees C 5 degrees F above the dew-point at all times. Inspect materials for damage prior to use and return non-compliant materials to manufacturer. Remove materials with expired shelf life from government property immediately and notify the Contracting Officer.

If materials are approaching shelf life expiration and an extension is desired, samples may be sent to the manufacturer, along with complete records of storage conditions, with a request for shelf life extension. If the manufacturer finds the samples and storage data suitable for shelf life extension, the manufacturer may issue an extension, referencing the product evaluation and the review of storage records. Products may not be extended longer than allowed in the product specification.

1.7 COATING HAZARDS

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NOTE: This specification Section should be used with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS".

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Ensure that employees are trained in all aspects of the safety plan. Specified coatings may have potential health hazards if ingested or improperly handled. The coating manufacturer's written safety precautions shall be followed throughout mixing, application, and curing of the coatings. During all cleaning, cleanup, surface preparation, and paint application phases, ensure that employees are protected from toxic and hazardous chemical agents which exceed concentrations in 29 CFR 1910.1000. Comply with respiratory protection requirements in 29 CFR 1910.134. The CIH shall approve work procedures and personal protective equipment.

1.8 JOB SITE REFERENCES

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NOTE: Include any other jobsite related references that might be added during design.

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Make available to the Contracting Officer at least one copy each of ASTM D3276, ASTM D3925, ASTM D4285, ASTM D7127, SSPC SP COM, SSPC SP 1, SSPC 7/NACE No.4, SSPC SP 10/NACE No. 2, SSPC PA 1, SSPC PA 2, SSPC Guide 6, SSPC VIS 1, SSPC QP 1, SSPC QS 1, and an SSPC Certified Contractor Evaluation Form at the job site.

PART 2 PRODUCTS

2.1 JOINT SEALANT

TT-S-00230, Type II, Class B

2.2 COATING SYSTEM

****

NOTE: Use the first bracketed paragraph for entirely field applied systems.

Use the second bracketed paragraph option for applied coatings systems applied entirely in the shop, where required such as, but not limited to, exterior and interior ferrous metal components identified in UFC 4-211-01 Aircraft Maintenance Hangars.

Refer to Part 3 of this Section for surface preparation.

Coordinate with applicable Division 05 UFGS Sections and Division 08 UFGS Sections.

****

Alternate systems or products will not be considered. Provide a complete system (primer, intermediate coat, top coat) material from one supplier.

[Apply the entire coating system in the field. Remove all shop-applied primer prior to final field surface preparation and coating system application. Adjust all shop preparation to avoid conflicts with final surface preparation requirements.

][Prepare surface and apply the complete coating system in the shop. Follow all temperature, humidity, and testing requirements listed herein.

] The Military specification epoxy and polyurethane products specified in this Section do not require approval for listing on the QPL prior to contract award, as indicated in paragraph 3.2 of MIL-DTL-24441 and paragraph 3.1 of MIL-PRF-85285. Testing of products by an independent laboratory to the QUALIFICATION INSPECTION requirements of MIL-DTL-24441 and MIL-PRF-85285prior to contract award is required. See specific submittal requirements in paragraph QUALITY ASSURANCE.

2.2.1 Zinc-Rich Epoxy Primer Coat

Epoxy polyamide, MIL-DTL-24441/19 (Formula 159, Type III).

2.2.2 Epoxy Intermediate Coat

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White (Tinted)). Tint to approximately SAE AMS-STD-595A color number 27778 parchment using pigment dispersions prepared for epoxy paint tinting. Manufacturer shall tint material and appropriately label. All other requirements of this Military Specification apply.

2.2.3 Polyurethane Topcoat

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NOTE: Check with the activity to determine the desired topcoat color and finish. Generally, use white for Navy projects and beige for Air Force projects. Color number 17925 is white, and 27769 is beige. FAA Safety colors are White 17875 and Orange 12197. Always specify contrasting colors between coats. Finish schedule must reflect color selected below.

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Polyurethane coating topcoat of MIL-PRF-85285, Type II, [White SAE AMS-STD-595A color number 17925][Beige SAE AMS-STD-595A color number 27769 in gloss][White SAE AMS-STD-595A color number 17875, and Orange SAE AMS-STD-595A color number 12197].

Modify paragraph 3.6.4 of MIL-PRF-85285, Viscosity and Pot Life, as follows:

> The viscosity of the admixed coating, when tested in accordance with ASTM D1200 through a No. 4 Ford cup, shall be as follows:

Time from mix (minimum)	Maximum time through a No. 4 Ford cup
Initially	30 seconds
2 hours	60 seconds
4 hours	No gel

Modify paragraph 3.7.1 of MIL-PRF-85285, Drying Time, as follows:

> When applied by spray techniques and when tested in accordance with ASTM D1640/D1640M, the coating shall be set-to-touch within four hours and dry-hard within eight hours (see 4.6 and table I).

[2.3 COLOR IDENTIFICATION OF FUEL HANDLING AND STORAGE FACILITIES

Piping, conduit, and tank identification shall be in accordance with MIL-STD-161. Mark direction of fluids in accordance with MIL-STD-161. The NATO symbol for JP-8 is F-34.

]2.4 COATING SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit that contains one liter quart can for the base of each coating material, an appropriately sized can for each activator, dipping cups for each component to be sampled, a shipping box sized for the samples to to be shipped, and packing material. Mark cans for the appropriate component. Provide shipping documents, including either pre-paid shipping or a shipper number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

2.5 ABRASIVE SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit that contains one suitable plastic bag or container for each sample to be collected. Mark containers for the appropriate component. Provide shipping documents, including either pre-paid shipping or a shipper number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

2.6 TEST KITS

2.6.1 Test Kit for Measuring Chloride, Sulfate and Nitrate Ions on Steel and Coated Surfaces

Provide test kits that meet all of the following requirements:

a. Contains all materials,supplies, tools, and instructions for field testing and on-site quantitative evaluation of chloride, sulfate, and nitrate ions;

b. Extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Components and solutions are mercury free and environmentally friendly;

d. Contains new materials and solutions for each test extraction;

e. Contains an extraction test container (vessel, sleeve, cell) that creates a sealed, encapsulated environment during salt ion extraction;

f. Contains a test extract container suitable for testing the following steel surfaces: horizontal (up/down configuration), vertical, flat, curved, smooth, pitted, and rough;

g. All salt ion concentrations are directly measured in micrograms per square centimeter.

2.6.2 Test Kit for Identifying Amine Blush on Epoxy Surfaces

Provide test kits that meet all of the following requirements:

a. Is a completely self-contained field test kit with all materials, supplies, tools, and instructions to perform tests and indicate the presence of unreacted amines;

b. Uses an identifiable, consistent, uniform, pre-packaged, factory pre-measured indicating solution;

c. Contains no mercury or lead and is environmentally friendly;

d. Contains a solution of an unreacted amine for the purpose of "self checking" the indicator solution;

2.7 ABRASIVE

The referenced abrasive specifications have maximum limits for soluble salts contamination, however, this maximum level of contamination does not guarantee that contamination will not be transferred to the steel surface during abrasive blasting. Other factors such as on-site handling and recycling can allow contamination of abrasive. Contractors are cautioned to verify that the chosen abrasive, along with work and storage processes, allow the final surface cleanliness requirements to be achieved. Successful testing of chlorides in abrasive does not negate the final acceptance testing of steel surfaces.

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NOTE: The following paragraph is mandatory for all NAVFAC PAC projects. All other agencies may use it after checking applicability.

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[Interpret MIL-A-22262 to include the meaning that abrasive material contains a maximum one percent by weight of any toxic substance listed in either Table Z-1, Z-2, or Z-3 or 29 CFR 1910-SUBPART Z, with the exception of inert or nuisance dust materials, arsenic, beryllium, cadmium, cobalt, lead, mercury, rhodium, silver, tellurium, thallium, and uranium.
]

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NOTE: Reduce allowable gross gamma radioactivity to 5 picocuries per gram for all NAVFAC PAC projects. Reduce in other areas if states or localities require.

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2.7.1 Non-metallic Abrasive

Conform to MIL-A-22262, Type I (Inorganic materials)[except that the gross gamma radioactivity shall not exceed 5 picocuries per gram]. Abrasive shall be approved by the Naval Sea Systems Command and listed on the appropriate Qualified Products List (QPL) for the specified materials. Use sampling procedures and testing frequencies as prescribed in MIL-A-22262. Use abrasive that is specifically selected and graded to provide a sharp, angular profile to the specified depth. Do not use ungraded abrasive. Make adjustments to processes or abrasive gradation to achieve specified surface profile. Recycled non-metallic abrasive shall meet all requirements of the specification each time that it is placed in the blast pot.

2.7.2 Metallic Abrasive

2.7.2.1 New and Remanufactured Steel Grit

Conform to the chemical and physical properties of SSPC AB 3 Class 1 (Steel) only[, except that the gross gamma radioactivity shall not exceed 5 picocuries per gram]. Class 2 (Iron) abrasive shall not be used.

To develop a suitable work mix from new steel abrasive, a minimum of 200 - 400 recycles is required, therefore, it is advantageous for a Contractor to use remanufactured steel grit or grit reclaimed from a previous project.

Such grit shall be considered to conform if it can be traced to new grit conforming to SSPC AB 3 Class 1 and it meets all cleanliness requirements of SSPC AB 3 Class 1 when brought to the current jobsite. Submit one representative sample of this work mix to the laboratory for testing, along with samples of new material. Acceptance and use of this work mix shall not be used to justify any deviation from surface preparation requirements.

2.7.2.2 Recycled Steel Grit

Conform to the chemical and physical properties of SSPC AB 2

2.8 WHITE ALUMINUM OXIDE NON-SKID GRIT

Size #60, dust free (washed and dry), minimum 99 percent pure, having the following sieve analysis when tested in accordance with ASTM E11 using a 1000 gram 2.2 pound sample:

Sieve #	Percent Retained
40	0
50	15-40
60	60-85

PART 3 EXECUTION

Perform all work, rework, and repair in accordance with approved procedures in the Coating Work Plan.

[3.1 REMOVAL OF COATINGS CONTAINING HAZARDOUS MATERIALS

****

NOTE: Include Section 02 83 00 LEAD REMEDIATION in any project specification that requires removal or disturbance of coating containing hazardous materials. Include a contractor qualification requirement similar to the article entitled "Qualifications of Coating Contractors" in Part 1 of this Section, except that the contractor shall be qualified to SSPC QP-2, Category A. The removal of coatings containing hazardous materials and application of new coating system can be accomplished in a continuous operation if the contractor provides appropriate coordination of removal, cleaning, and coating application. It is specified as two separate operations to allow separate contractors to accomplish different phases of project. With the use of SSPC QP-1 and QP-2 requirements in contracts, the same contractor will generally be accomplishing both phases of work, and will probably want to perform both phases as a single operation so as not to have to prepare surface twice. To accomplish the coating removal and recoating in a continuous operation, the contractors plan must be scrutinized for appropriate controls on the removal process, and on the surface

preparation/coating application process. Delete this paragraph if no paint containing hazardous material is to be removed.
****

Coatings containing hazardous materials and identified for disturbance during surface preparation, including removal, shall be handled in accordance with Section 02 83 00 LEAD REMEDIATION. Coordinate surface preparation requirements from Section 02 83 00 LEAD REMEDIATION with this Section.

]3.2 COATING AND ABRASIVE SAMPLE COLLECTION AND TESTING

Sample and test materials delivered to the jobsite. Notify Contracting Officer three days in advance of sampling. The QC Manager and either the PCS or coating inspector shall witness all sampling.

3.2.1 Coating Sample Collection

Provide a sample collection kit as required in paragraph COATING SAMPLE COLLECTION AND SHIPPING KIT. From each lot, obtain a one liter quart sample of each base material, and proportional samples of each activator based on mix ratio, by random selection from sealed containers in accordance with ASTM D3925. Prior to sampling, mix contents of each sealed container to ensure uniformity. As an alternative to collecting small samples from kits, entire kits may be randomly selected and shipped to laboratory, observing all requirements for witnessing and traceability. For purposes of quality conformance inspection, a lot is defined as that quantity of materials from a single, uniform batch produced and offered for delivery at one time. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Identify samples by designated name, specification number, batch number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved laboratory for testing as required by the paragraph COATING SAMPLE TEST REPORTS.

3.2.2 Abrasive Sample Collection

Provide a sample collection kit as required in paragraph ABRASIVE SAMPLE COLLECTION AND SHIPPING KIT. For purposes of quality conformance inspection, a lot shall consist of all abrasive materials of the same type from a single, uniform batch produced and offered for delivery at one time. Obtain samples of each abrasive lot using the sampling techniques and schedule of MIL-A-22262. The addition of any substance to a batch shall constitute a new lot. Identify samples by designated name, specification number, lot number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved laboratory for testing as required by the paragraph ABRASIVE SAMPLE TEST REPORTS.

3.2.3 Coating Sample Test Reports

Submit test results for each lot of coating material delivered to the jobsite. Test samples of primer, intermediate, and topcoat materials for compliance with requirements of Table I. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

3.2.4 Abrasive Sample Test Reports

Submit test results for each lot of abrasive delivered to the jobsite. Test samples of metallic abrasive to the requirements of paragraph REQUIREMENTS of SSPC AB 3, except paragraph 4.1.5 DURABILITY. Test samples of non-metallic abrasive as required in paragraph QUALITY CONFORMANCE INSPECTION of MIL-A-22262. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

3.3 SURFACES TO BE COATED

Coat exterior surfaces of [tank][structure][_____][including steel roof, shell, legs, stair, railing, and other exterior appurtenances].

3.4 LIGHTING

Provide lighting for all work areas as prescribed in SSPC Guide 12.

3.5 ENVIRONMENTAL CONDITIONS

3.5.1 Containment

****

NOTE: Containment was a design option in previous versions where site congestion dictated control of dust and paint overspray. Experience has shown, however, that containment also provides cost-effective control of environmental conditions, and the better conditions result in a better coating product.

SSPC Guide 6, has four classes of containment, from Class 1 being the highest level of control. Generally Classes 1 and 2 are only required for removal of hazardous materials, while Class 3 is probably satisfactory for most coating operations. Class 4 requires minimal "knockdown" of airborne debris, and is not generally usable as an airborne particulate control measure.

****

Design and provide a containment system for the capture, containment, collection, storage and disposal of the waste materials generated by the work under this Section, to meet the requirements of SSPC Guide 6, Class [1][2][3]. Vapor concentrations shall be kept at or below 10 percent of Lower Explosive Limit (LEL) at all times. Containment may be designed as fixed containment for complete structure or portable containment for sections of structure, however, containment shall remain in any one place from beginning of abrasive blasting through initial cure of coating. Waste materials covered by this paragraph shall not include any material or residue from removal of coatings containing lead, chromium, cadmium, PCB, or any other hazardous material.

It is the Contractors responsibility to insure the feasibility and workability of the containment system. The Contractor shall perform his operations and work schedule in a manner as to minimize leakage of the containment system. The containment system shall be properly maintained and shall not deviate from the approved drawings. If the containment system fails to function satisfactorily, the Contractor shall suspend all operations, except those required to minimize adverse impact on the environment or government property. Operations shall not resume until modifications have been made to correct the cause of the failure.

3.5.2 Automated Monitoring Requirements

Provide continuous monitoring of temperature, relative humidity, and dew point data at pertinent points on the structure, during surface preparation, coating application, and initial cure. Locate sensors to provide pertinent data for the surface preparation and coat application being performed. Monitor any heating, cooling, or dehumidification equipment used. Make data available to the Contracting Officer through Internet access. Provide monitoring equipment to perform as follows:

a. Data is collected in the field unit in one minute increments, and available for download (on-site) in a standard format. Contractor shall collect this data and make available to the Contracting Officer;

b. Monitoring equipment shall have backup power such that data collection and transmission to web server will be uninterrupted during the entire period of the dehumidification requirement;

c. Monitoring equipment shall have capability to measure surface temperatures at a minimum of four locations anywhere on a 150 foot diameter by 50 foot high tank;

d. Monitoring equipment shall have capability to measure interior and exterior dry bulb temperature (DB), relative humidity (RH), and dewpoint temperature (DP);

e. Data shall be available continuously through secure Internet connection, using widely available web browsers;

f. Internet accessible data shall be collected and stored in maximum 15 minute increments, and lag time between data collection and online availability shall be no greater than 70 minutes;

g. Internet accessible data shall be available for viewing online in tabular format, and graphical format using selected data;

h. Internet accessible data shall be available for download in user-defined segments, or entire project to date, in a standard format usable by Microsoft Excel and other spreadsheet programs.

i. Internet-based controls shall provide alerts to pre-designated parties through email messaging;

j. Internet-based controls shall monitor data uploads from field unit and issue alert if data not initiated within 60 minutes of last upload;

k. Internet-based controls shall monitor operation of DH equipment and issues alert when power remains off for more than 15 seconds, or if pre-determined temperature, RH, or DP conditions are exceeded;

The requirements listed here were developed around the Munters Exactaire Monitoring System, as this was the only monitoring system having Internet connectivity known to be commercially available. There is no requirement for connectivity of the monitoring system to control the DH equipment, therefore, any combination of equipment having the required functionality will be accepted.

3.6 SURFACE PREPARATION

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NOTE: When editing this specification for maintenance coating work where Water jet cleaning is to be allowed, include note for the contractor to use potable water, monitor the quality of the water, and adjust water quality to assure appropriate surface preparation and final surface requirements. Refer to SSPC-SP WJ-1/NACE WJ-1 Waterjet Cleaning of Metals - Clean to Bare Substrate, SSPC-SP WJ-2/NACE WJ-2 Waterjet Cleaning of Metals - Very Thorough Cleaning, SSPC-SP WJ-3/NACE WJ-3 Waterjet Cleaning of Metals - Thorough Cleaning, and SSPC-SP WJ-4/NACE WJ-4 Waterjet Cleaning of Metals - Light Cleaning. There are many problems that might arise from both dissolved and suspended material. A common occurrence is water with high-chlorides, even in potable water, which may leave unacceptable contamination on cleaned surfaces, and may not be suitable for water jetting.

****

3.6.1 Abrasive Blasting Equipment

Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 650 kPa 95 psig at nozzle. Confirm that air supply for abrasive blasting is free of oil and moisture when tested in accordance with ASTM D4285. Test air quality at each startup, but in no case less often than every five operating hours.

3.6.2 Operational Evaluation of Abrasive

Test abrasive for salt contamination and oil contamination as required by the appropriate abrasive specification daily at startup and every five operating hours thereafter.

3.6.3 Surface Standard

Inspect surfaces to be coated, and select plate with similar properties and surface characteristics for use as a surface standard. Blast clean one or more 300 mm one foot square steel panels as specified in paragraph SURFACE PREPARATION. Record blast nozzle type and size, air pressure at nozzle and compressor, distance of nozzle from panel, and angle of blast to establish procedures for blast cleaning. Measure surface profile in accordance with ASTM D7127. When the surface standard complies with all specified requirements, seal with a clearcoat protectant. Use the surface standard for comparison to abrasive blasted surfaces throughout the course of work.

3.6.4 Pre-Preparation Testing for Surface Contamination

Perform testing, abrasive blasting, and testing in the prescribed order.

3.6.4.1 Pre-Preparation Testing for Oil and Grease Contamination

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NOTE: When specifying maintenance painting, use a water based pH neutral degreaser to avoid damaging existing coating.

****

Inspect all surfaces for oil and/or grease contamination using two or more of the following inspection techniques: 1) Visual inspection, 2) WATER BREAK TEST, 3) CLOTH RUB TEST. Reject oil and/or grease contaminated surfaces, clean [using a water based pH neutral degreaser]in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.

WATER BREAK TEST - Spray atomized mist of distilled water onto surface, and observe for water beading. If water "wets" surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.

CLOTH RUB TEST - Rub a clean, white, lint free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

3.6.4.2 Pre-Preparation Testing for Soluble Salts Contamination

Test surfaces for soluble salts, and wash as required, prior to abrasive blasting. Soluble salt testing is also required in paragraph PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION as a final acceptance test of prepared surfaces after abrasive blasting, and successful completion of this phase does not negate that requirement. This phase is recommended since pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Effective removal of soluble salts will require removal of any barrier to the steel surface, including rust. This procedure may necessitate combinations of wet abrasive blasting, high pressure water rinsing, and cleaning using a solution of water washing and soluble salts remover. The soluble salts remover shall be acidic, biodegradable, nontoxic, noncorrosive, and after application, will not interfere with primer adhesion. Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase are selected at the Contractor's discretion.

3.6.5 Abrasive Blasting

****

NOTE: The issue of maximum profile on new structures is an important one. Once a profile is established, it is nearly impossible to reduce it, therefore, the initial profile will dictate the profile for the life of the structure.

The specified 2-3 mil surface profile is the preferred depth for preparing for zinc primer. On steel that was previously prepared to a deeper depth

and coated, it is not feasible to reduce the deeper depth to the preferred depth. A depth of 4 mils can be tolerated with an additional mil of zinc primer thickness.

Designers must be aware that profile found to be in excess of 3 mils may require additional funding to add extra coating material.

To validate contractor claims of pre-existing profile greater than allowed, test an appropriate number of representative spots with abrasive that removes paint but does not affect profile, such as bicarbonate of soda, or other soft abrasive, or waterblasting, etc.

****

Abrasive blast steel surfaces to near-white metal in accordance with SSPC SP 10/NACE No. 2. Prepared surfaces shall conform to SSPC VIS 1 and shall match the prepared test-panels. Provide a 50 to 75 micron 2 to 3 mil surface profile. Reject profile greater than 75 microns 3 mils, discontinue abrasive blasting, and modify processes and materials to provide the specified profile. Measure surface profile in accordance with ASTM D7127, using Rmax as the measure of profile height. Record all measurements required in this standard. Measure profile at rate of three test areas for the first 100 square meters 1000 square feet plus one test area for each additional 100 square meters 1000 square feet or part thereof. When surfaces are reblasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Do not attempt to wipe surface clean.

3.6.6 Disposal of Used Abrasive

Dispose of used abrasive off Government property in accordance with Federal, State, and Local mandated regulations.

3.6.7 Pre-Application Testing For Surface Contamination

3.6.7.1 Pre-Application Testing for Oil and Grease Contamination

Ensure surfaces are free of contamination as described in paragraph PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION, except that only questionable areas need be checked for beading of water misted onto surface.

3.6.7.2 Pre-Application Testing for Soluble Salts Contamination

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NOTE: On new structures, require 30 percent of tests to be accomplished at welds. On structures that have been in service, corroded areas should also be tested for high chlorides.

****

Test surfaces for chloride contamination using the Test Kit described in TEST KIT FOR MEASURING CHLORIDE, SULFATE AND NITRATE IONS ON STEEL AND COATED SURFACES. Test all surfaces at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 200 square meters 2000 square feet or part thereof. [Concentrate testing of bare steel at areas of coating failure to bare steel and areas of corrosion pitting.][Perform 30 percent of tests on bare steel at welds, divided equally between horizontal and vertical welds.]One or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is evidence of soluble salt contamination. Reject contaminated surfaces, wash as discussed in paragraph PRE-PREPARATION TESTING FOR SOLUBLE SALTS CONTAMINATION, allow to dry, and re-test until all required tests show allowable results. Reblast tested and cleaned areas as required. Label all test tubes and retain for test verification.

3.6.7.3 Pre-Application Testing for Surface Cleanliness

Apply coatings to dust free surfaces. To test surfaces, apply strip of clear adhesive tape to surface and rub onto surface with finger. When removed, the tape should show little or no dust, blast abrasive, or other contaminant. Reject contaminated surfaces and retest. Test surfaces at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 100 square meters 1000 square feet or part thereof. Provide two additional tests for each failed test or questionable test. Attach test tapes to Daily Inspection Reports.

3.7 MIXING AND APPLICATION OF SEALANT AND COATING SYSTEM

3.7.1 Preparation of Sealant and Coating Materials for Application

Each of the sealant, primer, intermediate, and topcoat materials is a two-component material supplied in separate containers.

3.7.1.1 Mixing Sealant, Primer and Intermediate Coat Materials

Mix in accordance with manufacturer's instructions, which may differ for each product. Do not mix partial kits, or alter mix ratios. Mix materials in same temperature and humidity conditions specified in paragraph DELIVERY AND STORAGE. Allow mixed material to stand for the required induction time based on its temperature.

3.7.1.2 Mixing Topcoat Material

Do not mix partial kits, or alter mix ratios. Mix polyurethane coating materials in same temperature conditions specified in paragraph DELIVERY AND STORAGE. The polyurethane coating material is moisture sensitive and any introduction of moisture or water into the material during mixing or application will shorten usable pot life. Use a mixer that does not create a vortex. Do not add solvent without specific written recommendation from the manufacturer. No induction time is required, only thorough agitation of the mixed material.

3.7.1.3 Pot Life

Apply mixed products within stated pot life for each product. Stop applying when material becomes difficult to apply in a smooth, uniform wet film. Add all required solvent at time of mixing. Do not add solvent to extend pot life. Pot life is based on standard conditions at 21 degrees C 70 degrees F and 50 percent relative humidity. For every 10 degrees C 18 degrees F rise in temperature, pot life is reduced by approximately half, and for every 10 degrees C 18 degrees F drop it is approximately doubled. Usable pot life depends on the temperature of the material at the time of mixing and the sustained temperature at the time of application. Other factors such as the shape of the container and volume of mixed material may also affect pot life. Precooling or exterior icing of components for at least 24 hours to a minimum of 10 degrees C 50 degrees F in hot climates will extend pot life. High humidity at time of mixing and application shortens pot life of the Polyurethane topcoat material. Following are approximate pot life times:

Sealant	As specified by manufacturer
Epoxy primer and intermediate materials	4 hours
Polyurethane topcoat materials	2 hours.

3.7.1.4 Application Conditions and Recoat Windows

****

NOTE: These new requirements are provided in an attempt to prevent the significant number of intercoat delamination failures that are frequently found on industrial structures. The very strict requirements on application conditions and recoat windows may require work during abnormal hours, including weekends. Contractor work hours should allow for such during coating application.

****

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NOTE: Cold-weather application is not covered by this specification. If a project is designed for coating in cold weather, then the enclosure and heating requirements may be significant. It is not intended that contractors be forced to apply coatings in cold weather, however, the underlying premise is that coatings must be applied within the specified temperature ranges. A cold-weather specification should not be used to simply save money, as the coating system will generally not have the same longevity as one applied within 60-100 degrees F.

****

The application condition requirements for the coating system are very time and temperature sensitive, and are intended to avoid the delamination problems frequently found on industrial structures. Plan coating application to ensure that specified temperature, humidity, and condensation conditions are met. If conditions do not allow for orderly application of sealant, primer, stripe coat, intermediate coat and topcoat, use appropriate means of controlling air and surface temperatures, as required. Partial or total enclosures, insulation, heating or cooling, or other appropriate measures may be required to control conditions to allow for orderly application of all required coats.

Maintain air and steel surface temperature between 16 and 38 degrees C 60 and 100 degrees F during application and the first four hours of cure for epoxy coats and the first eight hours of cure for polyurethane coats. Maintain steel surface temperature more than 3 degrees C 5 degrees F above the dew-point of the ambient air for the same period.

Use Table entitled "RECOAT WINDOWS" to determine appropriate recoat windows for each coat after the initial coat. Apply each coat during appropriate RECOAT WINDOW of preceding coat. If a RECOAT WINDOW is missed, the minimum and maximum primer and intermediate coat thickness may be adjusted to accommodate a FILL COAT, however, requirements for total epoxy coating thickness and total coating thickness will not be modified. Missing more than one RECOAT WINDOW may require complete removal of coating if maximum total coating thickness requirements cannot be achieved.

If coating is not applied during RECOAT WINDOW, or if surface temperature exceeds 49 degrees C 120 degrees F between applications, provide GLOSS REMOVAL, apply next coat within 24 hours. If next planned coat is topcoat, apply FILL COAT if required to fill sanding marks. Sanding marks from GLOSS REMOVAL of intermediate coat reflecting through topcoat will be considered as noncompliant. Apply FILL COAT within 24 hours of GLOSS REMOVAL, then apply topcoat within RECOAT WINDOW of FILL COAT.

RECOAT WINDOWS						
EPOXY OVER EPOXY						
Temperature degrees C Temperature degrees F	16-21 60-70	22-27 71-80	28-32 12-36	33-38 91-100	39-43 101-110	44-49 111-120
RECOAT WINDOW (Hrs.)	24-72	18-60	16-48	12-36	8-18	4-6
POLYURETHANE OVER EPOXY						
Temperature degrees C Temperature degrees F	16-21 60-70	22-27 71-80	28-32 12-36	33-38 91-100	39-43 101-110	44-49 111-120
RECOAT WINDOW (Hrs.)	24-96	24-72	16-48	12-36	10-24	8-16
POLYURETHANE OVER POLYURETHANE						
Temperature degrees C Temperature degrees F	16-21 60-70	22-27 71-80	28-32 12-36	33-38 91-100	39-43 101-110	44-49 111-120

RECOAT WINDOWS						
RECOAT WINDOW (Hrs.)	8-48	6-48	4-36	3-24	2-12	1-2

The temperature ranges shown in the table above are for determining recoat windows. Choose recoat window based on the highest surface temperature that was sustained for one or more hours between coats. This applies to the entire time between coats. Measure and record air and surface temperatures on hourly basis to determine appropriate recoat windows. If surface temperature goes above 38 degrees C 100 degrees F, measure and record temperatures every half hour.

FILL COAT - Where indicated, apply coat of intermediate coat epoxy, at 50 to 75 microns 2 to 3 mils DFT, then apply next specified full coat within recoat window of FILL COAT. A FILL COAT may be used to adjust coating thickness to comply with requirements or to fill sanding marks in intermediate coat.

GLOSS REMOVAL - Where required, hand sand in a linear fashion to remove gloss using 120-200 grit wet/dry sandpaper, followed by solvent wiping with a clean rag soaked with denatured alcohol to remove all dust. GLOSS REMOVAL of primer coat is to scarify surface and shall consist of removal of approximately 25 microns 1 mil of coating. If steel is exposed during GLOSS REMOVAL, repair in accordance with paragraph PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING. GLOSS REMOVAL of intermediate coat may include removal of up to 75 microns 3 mils of coating to avoid excess thickness, prior to application of FILL COAT.

3.7.2 Amine Blush Testing of Epoxy Coat Prior to Overcoating

Test epoxy surfaces prior to application of roof joint sealant, epoxy coat, or polyurethane topcoat for amine blush contamination using the Test Kit described in paragraph TEST KIT FOR IDENTIFYING AMINE BLUSH ON EPOXY SURFACES. Test all surfaces at rate of three tests for the first 100 square meters 1000 square feet plus one test for each additional 200 square meters 2000 square feet or part thereof. Remove any identified contamination using an approved procedure.

3.7.3 Application of Coating System and Joint Sealant

Apply coatings in accordance with SSPC PA 1 and as specified herein. Apply coatings to surfaces that meet all stated surface preparation requirements.

After application of primer coat and prior to application of each subsequent coat, perform testing prescribed in paragraph PRE-APPLICATION TESTING FOR SURFACE CONTAMINATION, as necessary, to ensure minimal intercoat contamination. This testing may be reduced to one half of the prescribed rate for bare steel if the testing indicates no contamination when sampling is evenly distributed over surfaces being tested. If contamination is found between coats, revert to the specified testing rate. Generally, oil and grease contamination and soluble salts contamination are not encountered if subsequent coats are applied within specified recoat windows and unusual atmospheric events do not occur. Such atmospheric events as a coastal storm blowing onshore can bring unusual chloride contamination. Concern for intercoat contamination should be continually prevalent, and spot testing should be accomplished to verify satisfactory conditions. Where visual examination or spot testing indicates contamination, perform sufficient testing to verify non-contamination, or to define extent of contamination for appropriate treatment.

Apply each coat in a consistent wet film, at 90 degrees to previous coat. Ensure that primer and intermediate coat "cold joints" are no less than 150 mm six inches from welds. Apply stripe coat by brush. For convenience, stripe coat material may be delivered by spray if followed immediately with brush-out and approved procedures include appropriate controls on thickness. Apply all other coats by spray application. Use appropriate controls to prevent airborne coating fog from drifting beyond[[three][_____] meters [15][_____] feet from the structure perimeter] [the tank berm]. Cover or protect all surfaces that will not be coated. The cleanliness, temperature, recoat windows, and airborne paint containment requirements may necessitate the use of enclosures, portable shelters, or other appropriate controls.

****

NOTE: Maximum thickness measurements are to limit internal stresses in each coat and in total system. Internal stresses of epoxy and polyurethane coatings on steel can be significant, and unless limited through thickness, can cause premature failure as the coating ages. Such failures as shrinkage cracking and delamination, either from the substrate or between coats, are common. This system is limited to 12 mils to allow for maintenance overcoating without creating excessive film build.

****

Apply coatings at the following specified thickness:

Coat	Minimum DFT (Microns)	Maximum DFT (Microns)
Primer	75	125
Intermediate	75	125
Top	50	75
Total system	200	325

Coat	Minimum DFT (Mils)	Maximum DFT (Mils)
Primer	3	5
Intermediate	3	5
Top	2	3
Total system	8	13

3.7.3.1 Application of Primer

Apply primer coat, maintaining paint supply container height within 1 meter

3 feet of the paint nozzle for applying zinc primer. Maintain constant agitation of paint pot to ensure that zinc does not settle in container.

3.7.3.2 Application of Stripe Coat

Apply a stripe coat of intermediate coat epoxy material within RECOAT WINDOW of primer, allowing sufficient dry time to allow application of intermediate coat within RECOAT WINDOW of primer. Apply by brush, working material into corners, crevices, angles, and welds, and onto outside corners and angles.

3.7.3.3 Application of Intermediate Coat

Apply intermediate coat within RECOAT WINDOW of primer coat.

3.7.3.4 Non-skid for Stairs and Top

Where non-skid is required, apply a second intermediate coat, and immediately follow with application of non-skid grit, broadcast at the rate of 2 pounds per 100 square feet, and backroll. Apply topcoat as specified.

3.7.3.5 Application of Topcoat

Make all required repairs to primer and intermediate coats as specified in paragraph entitled "Procedure for Holiday and Spot Repairs of Newly Applied Coating" prior to applying topcoat. Apply topcoat within RECOAT WINDOW of intermediate coat. The polyurethane topcoat may require multiple passes to achieve desired aesthetics and required thickness. Consult manufacturer for thinning and application procedures for anticipated temperature, humidity, and wind conditions. Touch-up blemishes and defects within recoat window of polyurethane topcoat. Retain sample of polyurethane topcoat, from the same batch used to coat structure, to make touch-ups that might be required later.

3.7.3.6 Application of Joint Sealant

Apply joint sealant to back-to-back steel joints that are less that 3/8 inches wide and are not seal welded. Apply sealant to top and bottom, or each side, of narrow joints. Apply sealant within 48 hours of application of the topcoat, and touch-up with topcoat after appropriate cure of the sealant.

3.7.3.7 Procedure for Holiday and Spot Repairs of Newly Applied Coating

Repair coating film defects at the earliest practicable time, preferably before application of the succeeding coat. Observe all requirements for soluble salts contamination, cleanliness between coats, and application conditions. Prepare defective area in accordance with SSPC SP 10/NACE No. 2, and feather coating as required to leave 100 mm 4 inches of each succeeding coat feathered and abraded. Protect adjacent areas from damage and overspray. Remove dust and solvent wipe the prepared area plus an additional 100 mm 4 inches beyond the prepared area with clean denatured alcohol. Apply each coat within RECOAT WINDOW of preceeding coat. Within four hours of preparation, apply zinc-rich primer to prepared steel and feather onto prepared primer. Apply intermediate coat to primed area and feather to prepared intermediate area. Apply topcoat to intermediate coat and feather to prepared topcoat. Apply each repair coat to approximate thickness of surrounding coating system.

3.7.3.8 Structure Occupancy After Coating Application

Use clean canvas or other approved shoe covers when walking on coated surfaces, regardless of curing time allowed. For heavily trafficked areas, provide cushioned mats for additional protection.

3.8 PROJECT IDENTIFICATION

At the completion of the work, stencil the following information on the [structure][tank exterior adjacent to the main manway opening]in 3/4 to one inch Helvetica style letters of contrasting color using acrylic stencil paint:

Date exterior coated:
Project Number:
Contractor:
Address:
Coating System
  Surface Prep: SSPC SP ____ Profile: _______
  Primer: __________________ Thickness: ____
  Intermediate: ____________ Thickness: ____
  Topcoat: _________________ Thickness: ____
  Total Thickness: _________

3.9 FIELD QUALITY CONTROL

For marking of tank surfaces, use chalk for marking bare steel, and water based markers for marking coated surfaces, and remove marks prior to coating. Do not use any wax or grease based markers, or any other markers that leave a residue or stain.

3.9.1 Coating Inspector

The coating inspector shall be considered a QC Specialist and shall report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The Coating Inspector shall be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, during all coating repair work, and during completion activities as specified in Section 01 45 00 QUALITY CONTROL. The Coating Inspector shall provide complete documentation of conditions and occurrences on the job site, and be aware of conditions and occurrences that are potentially detrimental to the coating system. The requirements for inspection listed in this Section are in addition to the QC inspection and reporting requirements specified in Section 01 45 00 QUALITY CONTROL.

3.9.2 Field Inspection

3.9.2.1 Inspection Requirements

Perform field inspection in accordance with ASTM D3276 and the approved Coating Work Plan. Document Contractor's compliance with the approved Coating Work Plan.

Provide all tools and instruments required to perform the required testing, as well as any tools or instruments that the inspector considers necessary to perform the required inspections and tests. Document each inspection and test, including required hold points and other required inspections and tests, as well as those inspections and tests deemed prudent from on-site evaluation to document a particular process or condition, as follows:

a. Location or area;
b. Purpose (required or special);
c. Method;
d. Criteria for evaluation;
e. Results;
f. Determination of compliance;
g. List of required rework;
h. Observations.

Collect and record Environmental Conditions as described in ASTM D3276 on a 24 hour basis, as follows:

a. During surface preparation, every two hours or when changes occur;

b. During coating application and the first four days of initial cure, every hour, or when changes occur;

c. Note location, time, and temperature of the highest and lowest surface temperatures each day;

d. Use a non-contact thermometer to locate temperature extremes, then verify with contact thermometers.

Document all equipment used in inspections and testing, including manufacturer, model number, serial number, last calibration date and future calibration date, and results of on-site calibration performed.

Document Contractors compliance with the approved Coating Work Plan.

3.9.2.2 Inspection Report Forms

Develop project-specific report forms as required to report measurements, test results, and observations being complete and and conforming to contract requirements. This includes all direct requirements of the contract documents and indirect requirements of referenced documents. Show acceptance criteria with each requirement and indication of conformity of each inspected item. The data may be in any format, but must be legible and presented so that entered data can be quickly compared to the appropriate requirement.

3.9.2.3 Daily Inspection Reports

Submit one copy of daily inspection report completed each day when performing work under this Section, to the Contracting Officer. Note all non-compliance issues, and all issues that were reported for rework in accordance with QC procedures of Section 01 45 00 QUALITY CONTROL. Each report shall be signed by the coating inspector and the QC Manager. Submit report within 24 hours of date recorded on the report.

3.9.2.4 Inspection Logbook

A continuous record of all activity related to this Section shall be maintained in an Inspection Logbook on a daily basis. The logbook shall be hard or spiral bound with consecutively numbered pages, and shall be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information. The Coating Inspector's Logbook that is sold by NACE is satisfactory. Submit the original Inspection Logbook to the Contracting Officer upon completion of the project and prior to final payment.

3.9.2.5 Inspection Equipment

All equipment shall be in good condition, operational within its design range, and calibrated as required by the specified standard for use of each device.

3.10 FINAL CLEANUP

Following completion of the work, remove debris, equipment, and materials from the site. Remove temporary connections to Government or Contractor furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

TABLE 1

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ia - Zinc-rich Epoxy Primer Coat MIL-DTL-24441/19 Formula 159

Test	Component A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent (zinc dust)	---	---	81.5	85.5	---	---
Volatiles, percent	42.8	44.3	8.0	8.4	---	---
Non-volatile vehicle percent	53.7	57.7	8.3	8.7	---	---
Weight, Kilograms/liter	0.87	1.01	3.30	3.40	2.80	2.91
Weight, Pounds/gallon	7.3	8.4	27.5	28.4	23.4	24.4
Flashpoint, Degrees C	35.6	---	37.8	---	---	---
Flashpoint, Degrees F	96	---	100	---	---	---
Consistency, grams	---	---	250	500	150	300
Set to touch time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	2
Dry hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	8
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	4	---
Sag resistance, Micrometers	---	---	---	---	300	---
Sag resistance, Mils	---	---	---	---	12	---
VOC, Grams/liter	---	---	---	---	---	304
VOC, Pounds/gallon	---	---	---	---	---	2.5

NOTES: Test methods as specified in MIL-DTL-24441.

TABLE 1

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ib - Epoxy Intermediate Coat MIL-DTL-24441/31 Formula 152 Type IV (White (Tinted))

Test	Component A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Pigment content, percent	44.0	49.0	33.0	38.0	---	---
Volatiles, percent	29.0	35.0	16.0	21.0	---	---
Non-volatile vehicle percent	17.5	23.5	44.0	49.0	---	---
Coarse particles, percent	---	0.3	---	0.3	---	---
Consistency, grams	180	320	300	470	180	245
Weight, Kilograms/liter	1.39	1.45	1.29	1.35	1.34	1.4
Weight, Pounds/gallon	11.6	12.1	10.8	11.3	11.2	11.7
Set to touch time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	3
Dry hard time, hours at 23 degrees C, 73 degrees F	---	---	---	---	---	8
Fineness of grind, Hegman	4	---	4	---	---	---
Flashpoint, Degrees C	35.5	---	37.8	---	---	---
Flashpoint, Degrees F	96	---	100	---	---	---
Titanium dioxide, percent of pigment	91	---	---	---	---	---
Pot life, hours at 23 degrees C, 73 degrees F	---	---	---	---	4	---
Sag resistance, Micrometers	---	---	---	---	300	---
Sag resistance, Mils	---	---	---	---	12	---

TABLE 1

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ib - Epoxy Intermediate Coat MIL-DTL-24441/31 Formula 152 Type IV (White (Tinted))

Test	Component A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Color of dry film to approximate color of SAE AMS-STD-595A color 27778	---	---	---	---	---	Conform
Contrast ratio, at 75 micrometers, 3 mils DFT	---	---	---	---	.098	---
Gloss, 60 degree specular	---	---	---	---	35	---
VOC, Grams/liter	---	---	---	---	---	340
VOC, Pounds/gallon	---	---	---	---	---	2.8

GENERAL NOTES: Test methods as specified in MIL-DTL-24441.Where "Conform" is indicated, refer to specific requirements of MIL-DTL-24441/31.

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ic - Polyurethane Topcoat MIL-PRF-85285 Type II (White and Colors)

Test	Component A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Moisture content, percent	---	2	---	---	---	---
Course particles, percent	---	---	---	---	---	.5
Viscosity	---	---	---	---	---	See Note 1
Fineness of grind, Hegman	---	---	---	---	7	---
Drying to touch (See Note 2)	---	---	---	---	---	4
Dry-hard (See Note 2)	---	---	---	---	---	8
VOC, grams per liter	---	---	---	---	---	340
Color	---	---	---	---	delta E+-1.0	
Gloss 60 degree specular gloss						
Gloss	---	---	---	---	---	90
Semi-gloss	---	---	---	---	15	45
Opacity	---	---	---	---	0.95	---
Flexibility	---	---	---	---	---	Conform
Fluid resistance	---	---	---	---	---	Conform
Heat resistance (cure)	---	---	---	---	---	Conform
Solvent resistance (cure)	---	---	---	---	---	Conform
Condition in container	---	---	---	---	---	Conform
Odor	---	---	---	---	---	Conform
Lead percent	---	---	---	---	---	0.06
Cadmium percent	---	---	---	---	---	0.06

TABLE I

COATING QUALITY CONFORMANCE INSPECTION REQUIREMENTS

Table Ic - Polyurethane Topcoat MIL-PRF-85285 Type II (White and Colors)

Test	Component A		Component B		Mixed	
	Min.	Max.	Min.	Max.	Min.	Max.
Chromium percent	---	---	---	---	---	0.00

NOTES:
(1) Modify paragraph 3.6.4 Viscosity and Pot Life, of MIL-PRF-85285 as follows:

The viscosity of the admixed coating, when tested in accordance with ASTM D1200 through a No. 4 Ford cup, shall be as follows:

Time from mix (minimum)	Maximum time through a No. 4 Ford Cup
Initially	30 seconds
2 hours	60 seconds
4 hours	No gel

(2) Modify paragraph 3.7.1 Drying Time, of MIL-PRF-85285.
When applied by spray techniques and when tested in accordance with ASTM D1640/D1640M, the coating shall be set-to-touch within four hours and dry-hard within eight hours (see 4.6 and table I).

GENERAL NOTES:
Test methods as specified in MIL-PRF-85285, except those marked with "*".
Where "Conform" is indicated, refer to specific requirements of MIL-PRF-85285.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-09 97 13.28 (February 2010)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 13.28 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 09 - FINISHES

SECTION 09 97 13.28

PROTECTION OF BURIED STEEL PIPING AND STEEL BULKHEAD TIE RODS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 97 13.28 (February 2010)**

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SECTION 09 97 13.28

PROTECTION OF BURIED STEEL PIPING AND STEEL BULKHEAD TIE RODS
02/10

****

NOTE: This guide specification covers the requirements for exterior protection tape wrapping systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: This guide specification covers the requirements and application methods for tape wrapping systems that establish exterior protection of buried steel piping and steel bulkhead tie rods which rest above the reference level, 600 mm 2 feet below Mean Low Water (M.L.W) or Mean Lower Low Water (M.L.L.W.), and for tape coating of buried steel pipe covered with an adhesive thermoplastic resin coating system, a thermosetting epoxy coating system, or a polyethylene-butyl adhesive system. These protective systems are suitable for steel surfaces which have continuous operating temperatures not exceeding 60 degrees C 140 degrees F. An adhesive thermoplastic resin coating system is available in a high temperature system capable of service up to 88 degrees C 190 degrees F (see

paragraph entitled "Adhesive-Thermoplastic Resin Coating System").
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C209	(2019) Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fitting for Steel Water Pipelines
AWWA C213	(2022) Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
AWWA C214	(2024) Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C215	(2022) Extruded Polyolefin Coatings for Steel Water Pipe

NACE INTERNATIONAL (NACE)

NACE SP0274	(1974; R 2011) High Voltage Electrical Inspection of Pipeline Coatings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-I-631	(1961; Rev D; Am 6 1987; Notice 1 2021) Insulation, Electrical, Synthetic-Resin Composition, Nonrigid

1.2 DEFINITIONS

1.2.1 Coating

A continuous, uniformly thick layer formed on a surface by the mechanical application of a liquid, mastic, powdered, or extruded film material. Some types of application require elevated temperatures.

1.2.2 Coating System

One or more coatings applied to a properly prepared steel surface. If only one coating, that coating is applied directly to the steel surface; if more than one coating, each coating is applied in one operation over the previously applied and cured coating. For some applications, the first coating is a primer. Coatings of a particular system function together as a collective entity to protect the steel surface from corrosion. Coating system may be either liquid or tape applied.

1.2.3 Tape

Prefabricated laminate of plastic film backing with a homogeneous sealant layer or a pressure-sensitive adhesive layer produced in sheets, pads, or rolls wound on hollow cores. Tape applications do not require elevated temperatures.

1.2.4 Tape Coating System

One or more layers of tape applied cold over a properly prepared and primed steel surface. Tape on the primed surface protects the steel surface from corrosion.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Factory-applied Coating System

Field-applied Epoxy Coating system

Thermosetting Epoxy Coating System

Polyethylene-Butyl Adhesive Coating System

Adhesive Thermoplastic Resin Coating System

Tape Coating System

Electrical-flaw Detector

[Mastics

][Rock Shield]

[SD-06 Test Reports

Inspector's Certificate

Submit for each inspection and test.

Field-applied Epoxy Coating

] SD-08 Manufacturer's Instructions

Field-applied Epoxy Coating system

Thermosetting Epoxy Coating System

Electrical-flaw Detector

[Mastics

][Rock Shield

]PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Tape Coating System (TCS)

****

NOTE: Use of M.L.W. or M.L.L.W. should be based upon the usage by a particular Activity. Selection may be based on the datum for each Activity contained in Table 1-4, "Tide Data for Naval Activities"; of DM-26.1 "Harbor and Coastal Facilities." If the design does not include tie rods, delete those portions of the first sentences that refer to tie rods, M.L.W., and M.L.L.W.

****

****

NOTE: Factory-applied coating with field machine-applied coatings at joints and damaged areas is the preferred method. If the work is a small retrofit or repair, factory applied coatings may be too restrictive. Irregular surfaces such as tees, valve bodies, and flanges are done by hand.

****

****

NOTE: The thicknesses of inner and combined tape are designed for moderately, and severely corrosive soil environments. For lightly corrosive soil environment use thickness specified for moderately corrosive soil environment.

****

****

NOTE: Tape applied at a temperature below 10 degrees C 50 degrees F should be suitable for cold weather application down to minus 12 degrees C 10 degrees F. Delete if application is going to be above 10 degrees C 50 degrees F.

****

Prefabricated tape with adhesive primer [for bulkhead tie rods and turnbuckles][and][for use on [pipe,]couplings, damaged areas and fittings]. The tape wrapping system shall conform to AWWA C209 and to MIL-I-631, Class I for fungus resistance, except that the fungus rating shall lie between zero and one for all specimens. The overall thickness of the tape wrap protection shall be not less than [0.75] [1.12] [_____] mm [30] [45] [_____] mils.[The tape system shall be suitable to be applied at temperatures below 10 degrees C 50 degrees F and above minus 12 degrees C 10 degrees F.]

2.1.2 Adhesive Thermoplastic Resin Coating System (ATRCS)

Steel pipe factory-applied coating system conforming to AWWA C215 and coating manufacturer's instructions shall consist of a continuously extruded polyethylene coating[, capable of withstanding operating temperatures up to 88 degrees C 190 degrees F,] applied on an adhesive undercoat.

2.1.3 Thermosetting Epoxy Coating System (TECS)

****

NOTE: Use only epoxy coatings where petroleum fuels are expected.

****

Factory-applied steel pipe system conforming to AWWA C213. Provide field-applied epoxy coating in accordance with manufacturer's recommendations and AWWA C213.

2.1.4 Polyethylene-Butyl Adhesive Coating System (PBACS)

Factory-applied steel pipe system of extruded butyl adhesive compound, 0.18 mm 7 mils minimum thickness, covered with overlapping layers of extruded polyethylene wrapping, one mm 38 mils minimum thickness, in accordance with AWWA C214.

[2.1.5 Mastics

****

NOTE: Mastic coatings are brush applied. Mastics are used on irregular surfaces such as bolted flanges and valve bodies where the tape will not directly contact exposed surfaces. Show surfaces that will require mastic coatings on drawings. Delete if surfaces are smooth and round.

****

Apply a coating of manufacturer approved mastic protection to irregular surfaces. Mastic shall be compatible with coating system.[Apply the tape system over mastic.] Mastic layer thickness shall conform to coating manufacturer's recommendation.

][2.1.6 Rock Shield

****

NOTE: Rock shields are used where coarse rock backfill or rocky soil conditions may damage the tape coating.

****

Provide rock shield over completed coating system as recommended by coating manufacturer.

]PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 TCS

3.1.1.1 Surface Preparation

Surfaces shall be clean and dry. Wire brush weld beads, and remove weld spatters. Remove heavy rust or mill scale with wire brush.

3.1.1.2 Application

Remove paper from Kraft paper-protected material before placing in final position. Reinforce coating at sling points with roofing felt or other approved heavy shielding material, or handle with nylon or canvas slings. Apply polyvinylchloride-butyl rubber laminated tape or pressure-sensitive organic plastic tape and its adhesive primer by single machine operation.

a. Pipe: Spirally wrap straight runs in one layer, lapping the tape as applied. Overlap shall conform to recommendations of the tape manufacturer. When an outerwrap is used, overlap of outerwrap shall bridge joints of the tape. Apply at each end of straight runs a double wrap of one full width of tape at right angles to the axis in such a manner so as to seal ends of spiral wrapping.

b. Pipe Joints and Couplings and Damaged Areas of Coatings: Clean joint areas which are to be taped, of burrs and rust. Smooth down or cut away damaged coating when not firmly bonded to pipe. Spirally wrap with a two-layer wrapping system, overlapping coating surface at least 75 mm 3 inches. Initially stretch tape sufficiently to conform to the surface to which it is applied, using one layer half-lapped for tape 50 mm 2 inches or less in width or one layer lapped at least 25 mm one inch for tape more than 50 mm 2 inches wide. Apply a second layer, lapped as above, with tension as tape comes off roll, and press to conform to shape of component. For other irregular surfaces such as bolted flanges valve bodies where tape coating system containing mastics is to be provided, apply with brush.

c. Tie Rods and Tie Rod Fittings: Spirally wrap with a two-layer coating system. Apply tape to tie rods by lapping each layer of tape using a half-lap for tape 50 mm 2 inches or less in width or at least a 25 mm one inchlap for tape more than 50 mm 2 inches wide. For tie rod fittings, initially stretch tape sufficiently to conform to the surface to which it is applied, using one layer half-lapped for tape 50 mm 2 inches or less in width or one layer lapped at least 25 mm one inch for tape more than 50 mm 2 inches wide. Apply a second layer, lapped as before, with a tension as tape comes off the roll, and press to conform to the shape of component.

3.1.2 Joints, and Other Irregular Surfaces For ATRCS

Prepare surface as described in paragraph entitled "TCS." Wrap tape as specified in paragraph entitled "TCS"; except, apply the tape half-lapped, and prime extruded polyethylene coating and adhesive undercoat surfaces to be tape wrapped with a compatible primer as recommended by the tape manufacturer and approved by the extruded polyethylene coating applicator for use on the polyethylene coating.

3.1.2.1 Damaged Areas

Repair damaged areas of the extruded polyethylene coating by tape wrapping as specified under the paragraph, entitled "Tape Coating System" except press residual material from the extruded polyethylene coating into the break, or trim off. Prime areas to be taped prior to applying half-lapped tape.

3.1.3 TECS

****

NOTE: Use only epoxy coatings where petroleum products are expected.
****

Install in accordance with the manufacturer's instructions and AWWA C213.

3.1.3.1 Joints

Clean both sides of weld area by wire brushing, and remove dust, moisture, and other contaminants. Apply primer recommended by coating manufacturer after cleaning of joints.

3.1.3.2 Damaged Areas

Remove damaged coating by abrading, filing, or wire brushing. Clean area to be repaired free of dust, moisture, and other contaminants. Cover with a primer and a coating recommended by coating manufacturer. Apply coating over cleaned surface, and extend approximately 75 mm 3 inches beyond damaged area.

3.1.4 Joints and Other Irregular Surfaces For PBACS

Clean both sides of weld area by wire brushing, and remove dust, moisture, and other contaminants. Apply primer recommended by tape manufacturer and acceptable to coating manufacturer on cleaned area. Apply tape spirally with a 50-percent overlap in accordance with the tape manufacturer's instructions.

3.1.4.1 Damaged Areas

Remove rough or protruding polyethylene from damaged area by abrading, filing, or cutting the material. Clean area to be repaired free of dust, moisture, and other contaminants. Cover with tape recommended by coating manufacturer and primer recommended by tape manufacturer. Apply primer over cleaned surface, and extend approximately 75 mm 3 inches beyond damaged area. Apply tape over primer, and extend 25 mm one inch beyond damaged area. Apply additional primer over tape patch. Spirally wrap additional tape around pipe with a 50-percent overlap to cover tape patch, and extend a minimum of 50 mm 2 inches beyond the edge of the patch.

3.2 FIELD QUALITY CONTROL

****
NOTE: Require a certified inspector where the scope and cost of the project warrants. When editing Section 01 45 00 QUALITY CONTROL, ensure that the qualification of inspector required below is coordinated.
****

Conform to AWWA C214[and AWWA C213].[Inspection shall be performed by a National Association of Corrosion Engineers (NACE) certified inspector.]

3.2.1 Field Inspection

Examine material surface preparation and application proceduresperformed in the field.

3.2.2 Field Test

Test the protective system for holes, voids, cracks, and other visually undetectable damage that may occur during handling and installation in accordance with NACE Standard NACE SP0274. In critical applications no holidays will be permitted. In non critical applications up to 10 holidays per meter 3 holidays per linear feet of the pipe may be accepted. Test with an approved electrical-flaw detector in accordance with the detector manufacturer's printed instructions. Prepare inspector's certificate for each inspection and test. Repair areas where arcing occurs and retest.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-09 97 23 (August 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 23 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 09 - FINISHES

SECTION 09 97 23

METALLIC TYPE CONDUCTIVE/SPARK RESISTANT CONCRETE FLOOR FINISH

08/18

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 97 23 (August 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 23 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 09 97 23

METALLIC TYPE CONDUCTIVE/SPARK RESISTANT CONCRETE FLOOR FINISH

08/18

****
NOTE: This guide specification covers the requirements for metallic type conductive/spark resistant concrete floor finish for ordnance and other similar structures over a bonded floor topping with a thickness of 2 inches or greater or a monolithic base slab. For other installation procedures, edit specification accordingly.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Do not use the type of floor finish specified in this section in hospitals, laboratories, or other similar occupancies where sanitation is a primary consideration. This guide specification does not cover tile or fluid-applied conductive flooring. Such systems may be found in Section 09 65 00 RESILIENT FLOORING or Section 09 67 23.14 CHEMICAL RESISTANT RESINOUS FLOORING.
****

****
NOTE: This is a very specialized product and must

be well researched before this specification is used. Check with using activity to ensure that this type of floor finish is chemically compatible with explosives and solvents contemplated for use in proposed facility.

****

****

NOTE: On the drawings, show:

1. Extent of metallic type conductive and spark resistant concrete floor finish.

2. Required slopes, floor drains, and appropriate details.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 302.1R	(2015) Guide for Concrete Floor and Slab Construction

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates

ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM E1155	(2020) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM F150	(2006; R 2013) Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Graded Iron

Curing Compound

Water Reducing Admixture

High Range Water Reducing Admixture

SD-04 Samples

Conductive and Spark-Resistant Floor Finish

SD-05 Design Data

Mix Design

SD-06 Test Reports

Cement

Aggregate

Admixtures

Conductivity and Spark Resistance

Water

SD-08 Manufacturer's Instructions

Metallic Surfacing

Curing of Floor Finish

SD-10 Operation and Maintenance Data

Conductive Spark-Resistant Floor Finish, Data Package 1; G, [_____]

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Conductivity

****

NOTE: Include requirement for minimum resistance when electrical convenience outlets are provided around or above floor area. This usually occurs only in work and equipment assembly areas. Use 5000 ohms for 120 volt service, 10,000 ohms for 240 volt service, and 20,000 ohms for 440 volt service. If electrical service is greater than 440 volts, consult NAVSEA for guidance.

****

Floor finish must have a [minimum electrical resistance of [5,000] [10,000] [20,000] ohms and a] maximum average electrical resistance of 1,000,000 ohms. Measure electrical resistances on conditioned sample slab and on conditioned project slab using method of test specified herein.

1.3.2 Spark Resistance

Floor finish must produce no spark when tested using method of test specified herein.

1.4 ENVIRONMENTAL CONDITIONS

Do not start work unless environmental conditions conform to manufacturer's printed instructions. Maintain recommended environmental conditions without interruption during application and curing processes.

1.5 MANUFACTURER'S REPRESENTATIVE

****

NOTE: The requirements for the presence of a qualified technical representative of the metallic surfacing material manufacturer should be retained only for applications where strict compliance with installation procedures is considered to be critical.

****

Have manufacturer's technical representative present during start-up of each phase of work including inspection of grounding materials, preparation of base slab, mixing and placing concrete topping, application of dusted-on metallic surfacing, curing and testing.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver manufactured materials in manufacturer's original unbroken packages or containers plainly labeled with manufacturer's names, brands, lot numbers, and product expiration date. Use moisture-resistant containers. Store materials in dry, weathertight enclosures and handle in a manner that will prevent inclusion of foreign materials or damage by dampness.

1.7 CONDUCTIVE AND SPARK-RESISTANT FLOOR FINISH SAMPLE

****

NOTE: If the design thickness of the topping is less than 50 mm 2 inches, insert design thickness in the blank and remove the 50 mm 2 inch requirement.

****

Before work is started, prepare, test, and submit sample of conductive and spark-resistant floor finish, 1.22 meters 4 feet square and [50][_____] mm [2][_____] inches thick. Cast sample on 12 mm 1/2 inch thick plywood base covered with polyethylene film. Mix and apply topping in accordance with this specification, including troweling, curing, and protection.

Test floor finish sample for compliance with the conductivity and spark resistance requirements specified herein. Perform testing using an approved independent testing laboratory.

PART 2 PRODUCTS

2.1 FLOOR FINISH MATERIALS

2.1.1 Portland Cement

ASTM C150/C150M, Type I [or II]. Submit test report showing compliance with ASTM C150/C150M.

2.1.2 Aggregate

ASTM C33/C33M, except as specified below. Provide pea gravel, silica, traprock, or other approved materials of equivalent hardness. Conform to the following gradation:

Mesh	Percent Passing
9.5 mm 3/8 inch	100
4.75 mm No. 4	95-100
2.36 mm No. 8	65-80
1.18 mm No. 16	45-65
0.60 mm No. 30	25-45
0.30 mm No. 50	5-15
0.15 mm No. 100	0-5

Submit test report showing compliance with ASTM C33/C33M.

2.1.3 Admixtures

****

NOTE: Specify these admixtures where increased slump is beneficial with respect to ease of placement, consolidation, metallic hardener application, or where a delay of initial set is desirable due to high temperature and low humidity conditions.

****

ASTM C494/C494M. Water reducing, normal setting (Type A); water reducing admixture (Type D); or high range water reducing admixture (Type F). Admixtures must not contain more than 0.05 percent chloride ions. Submit product data for water reducing admixture and high range water reducing admixtures. Submit test report showing compliance with ASTM C494/C494M.

2.1.4 Water

Provide water complying with the requirements of ASTM C1602/C1602M. Provide [potable]water for mixing, free of injurious amounts of oil, acid, salt, or alkali. Submit test report showing water complies with ASTM C1602/C1602M.

2.2 GROUNDING MATERIALS

****

NOTE: Ground rods should be specified for slabs on grade. Grounding studs should be specified for suspended slabs. Division 3, "Concrete" sections of project specification should specify that ground rods or grounding studs be maintained in position to prevent misalignment before and during placement of structural concrete.

****

2.2.1 Ground Rods

****

NOTE: Specify hard copper or copper clad steel rods for normal conditions. Specify brass or stainless steel rods where electrolytic corrosion will be encountered.

****

[Hard copper][Copper-clad steel][Brass][Stainless steel] not less than 20 mm 0.75 inch in diameter, 3 meters 10 feet long. Die stamp each ground rod near top with name or trademark of manufacturer and length of rod in meters feet.

2.2.2 Grounding Studs

Hard copper, or brass, 12 mm 1/2 inch diameter and of such length as to project into structural concrete base slab not less than 75 mm 3 inches when installed.

2.2.3 Grounding Connector Disks

Approximately 50 to 100 mm 2 to 4 inch diameter or 50 to 100 mm 2 to 4 inch square pieces of copper or brass hardware cloth, 4 mesh, 1.2 mm 0.047 inch wire diameter.

2.3 METALLIC SURFACING MATERIAL

2.3.1 Graded Iron Mixture

A factory-prepared dry mixture of graded iron particles, cement, and chemicals; suitable for application by the dusted-on method; and free from nonferrous metal particles, oils, grease, soluble alkaline compounds, rust and materials intended to disguise rust, and any other contaminants. Submit product data for graded iron mixture.

Submit conductive spark-resistant floor finish, Data Package 1, in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

2.3.2 Water Content

Provide water absorbent metallic aggregate containing not more than 0.075 percent water soluble materials.

2.3.3 Cement Dispersing Agent

Combine a cement-dispersing agent, a pozzolanic material capable of combining with free lime to form a water insoluble compound, and an approved binder with metallic aggregate.

2.3.4 Purity

Do not add material to factory-prepared product at job site.

2.4 CURING COMPOUND

A product of the manufacturer of the metallic surfacing material or a type recommended by the manufacturer of the metallic surfacing material. Submit product data for curing compound.

PART 3 EXECUTION

3.1 INSTALLATION OF GROUNDING MATERIALS

Provide at least one ground [rod] [or] [stud] for each 37 square meters 400 square feet or less of floor area. Place grounding materials at least 50 mm 2 inches clear and free of pipes, conduits, sleeves, anchor bolts, floor drains, or other metal building material that projects through floor finish. Place tops of [rods] or [studs] at an elevation not more than 10 mm 3/8 inch below top surface of finish floor. Do not allow [rods] or [studs] to project above finish floor elevation. Center grounding connector disks on top of [rods] [or] [studs]. Braze disks to tops of [rods] [or] [studs]. Connect each ground [rod] [or] [stud] electrically to concrete slab reinforcement steel. Connect using a copper or brass braided strap. Braze to both reinforcing steel and ground [rod] [or] [stud].

3.1.1 Ground Rods

Drive ground rods vertically into earth. The maximum resistance to ground of driven ground rod must not exceed 25 ohms when tested in accordance with paragraph GROUNDING TESTS.

3.1.2 Ground Studs

****

NOTE: The last sentence presumes ground studs used with an existing concrete base slab. Other site conditions require a different design and wording.

****

Connect studs together electrically using a continuous No. 6 AWG copper wire brazed to each stud and to a common ground wire connected electrically to an approved ground. Place stud interconnecting wire on, shape, and fasten to existing concrete base slab to prevent wire from lifting when concrete topping is placed.

3.2 PREPARATION OF BASE SLAB

****

NOTE: This guide specification is based on use of a bonded floor topping with thickness of 50 mm 2 inches or greater or a monolithic base slab. For other installation procedures, edit specification accordingly. For a monolithic base slab delete paragraphs PREPARATION OF BASE SLAB, CLEANING, BOND COAT, PROPORTIONING AND MIXING OF CONCRETE TOPPING,

PROPORTIONING AND MIXING.
****

3.2.1 Cleaning

****
NOTE: Choose from one of the following three paragraphs. Use first paragraph for wet cured slabs less than 3 days old. Use second paragraph for cured slabs between 3 days and a week old. Use third paragraph for cured slabs more than a week old.
****

Wash dirt and debris from surface of base slab.

Remove dirt, oil, grease, laitance or other foreign matter from surface of base slab. Scrub surface and rinse thoroughly with clean water. Keep base slab wet for a period of not less than 12 hours preceding application of topping.

Remove dirt, oil, grease, laitance or other foreign matter from surface of base slab. Scrub surface with a 10 percent muriatic acid solution and rinse thoroughly with clean water. After rinsing, a litmus test of the wet surface must indicate no trace of acid solution.

3.2.2 Bond Coat

Remove excess water or dry slab until there is no free water. Apply a cement paste, latex, latex cement, or epoxy bond coat.

3.3 PROPORTIONING AND MIXING OF CONCRETE TOPPING

****
NOTE: Where bonded topping or base slab is of very low slump (less than 75 mm 3 inches) consider deletion of reference to excess water. Metallic surfacing material, which is a dry shake material, will require sufficient water to adequately mix with concrete topping or base slab.
****

3.3.1 Proportioning

****
NOTE: Use either compressive strength option or specified mix design.
****

[Proportion concrete topping mix to provide a 28-day compressive strength of 34.5 kPa 5,000 psi, with a maximum slump of 75 mm 3 inches or less. If high range water reducing admixture is used, slump may be increased to 200 mm 8 inches.][Proportion concrete topping mixture by volume with one part portland cement and 2 3/4 parts 10 mm 3/8 inch maximum size aggregate. Use a maximum water-cement ratio of 0.45 including moisture contained in aggregates.] Topping mix may be modified, as approved, to conform to requirements of manufacturer of metallic surfacing material. Submit concrete mix design for topping slab.

3.3.2 Mixing

Perform mixing in mechanical mixers of a type in which quantities of water can be controlled accurately and uniformly. Introduce and mix aggregates so that materials are distributed uniformly throughout the mass. Add water gradually. After cement, aggregates, and water are in mixer drum, mix for two minutes. Ready-mixed concrete must conform to ASTM C94/C94M. Do not retemper topping mixture with water. Additional dosage with high range water reducing admixture may be permitted with prior approval of the Contracting Officer as to methods and procedures. Use only admixture specified and approved in proposed mix design.

3.4 PLACING, FINISHING, AND CURING

3.4.1 Placing Concrete Topping

****

NOTE: For bonded toppings, use as thick a bonded topping as design constraints will allow. A 25 mm one inch bonded topping is extremely difficult to install. Bonded toppings of 50 mm 2 inches to a maximum of 75 mm 3 inchesare much easier to construct. Generally, the thinner the bonded topping, the more problems that will be encountered during construction and in future use. When using a monolithic base slab delete this paragraph.

****

Place, compact and strike-off topping mixture to the full depth of the [50] [_____] mm [2] [_____] inch screed strips. Tamp thoroughly with a grill-faced tamper (do not use a flat-faced tamper) or vibrate with a small vibrator to compact concrete topping, force out entrapped air, and ensure maximum density. Take extreme care in placing and tamping so that grounding system will not be damaged or misaligned. Form a slight cup-shaped pocket or depression, about 75 mm 3 inches in diameter and 20 mm 3/4 inch in depth in topping finish surrounding grounding connector disks on tops of [rods] [and] [studs]. Keep disk free of topping mix by protecting disk with a plastic sheet. After compacting, screeding and leveling floor surface, remove excess water by an approved method. Mechanically float surface.

[3.4.2 Placing and Finishing Base Slab

****

NOTE: Use this paragraph for monolithic slab placement.

****

Where metallic surfacing is to be placed directly upon base slab, place slab in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Take extreme care in placing and consolidating concrete so that grounding system is not damaged or misaligned. Form a slight cup-shaped pocket or depression, about 75 mm 3 inches in diameter and 20 mm 3/4 inch in depth in the finish surrounding grounding connector disks on the tops of the [rods] [and] [studs]. Keep disk free of concrete and mortar by protecting disk with plastic sheet. After placing, consolidating, striking off and leveling, remove excess water by an approved method. Mechanically float the surface.

]3.4.3 Metallic Surfacing

Before opening, shake surfacing material containers to ensure uniformity of ingredients. After floating floor surface, dust dry metallic surfacing material uniformly on surface at a rate of not less than 4.4 kilograms per square meter 0.9 pound per square foot of surface. When metallic aggregate has absorbed surface moisture, mechanically float surface. After floating, uniformly dust on surface remaining dry metallic surfacing material to achieve a total rate of not less than 8.8 kilograms per square meter 1.8 pound per square foot of surfacing material for the two dusting operations. Apply second shake at right angles to first for even application. Repeat floating operation. Submit manufacturer's instructions for application of metallic surfacing.

3.4.4 Finishing

****

NOTE: Use 6 mm in 3 meters 1/4 inch in 10 feet unless operational requirements dictate the flatter floor. For floors where floor flatness is critical, use the bracketed paragraph in place of the first paragraph. The numbers provided in brackets are typical numbers, but A/E should research and select F numbers high enough to get desired results but not so high as to cause undue cost increases and construction problems. Ff/FL 20/15 is equivalent to 8 mm in 5.05 mm 5/16 inches in 10 feet. This test method is not suitable for unshored deck. Fitted partitions need FL greater than or equal to 25.

****

Finish floor to a smooth surface, free from blemishes. Test floor surface with a straight edge to ensure a tolerance of plus or minus [6 mm 1/4 inch] [3 mm1/8 inch] in 3 meters 10 feet.

[Construct in accordance with one of the methods recommended in ACI 302.1R, Table 7.15.3, "Typical Composite Ff/FL Values for Various Construction Methods." ACI 117 for tolerance tested by ASTM E1155.

a. Specified Conventional Value:

Floor Flatness (Ff) [20] [_____] [13] [_____] minimum
Floor Levelness (FL) [15] [_____] [10] [_____] minimum

b. Specified Industrial:

Floor Flatness (Ff) [30] [_____] [15] [_____] minimum
Floor Levelness (FL) [20] [_____] [10] [_____] minimum

Test slab within 24 hours of the final troweling. Provide tests to Contracting Officer within 12 hours after collecting the data. Floor flatness inspector is required to provide a tolerance report which must include:

a. Key plan showing location of data collected.

b. Results required by ASTM E1155.

] Take extreme care so that conductive metallic aggregate contained in surfacing material is in full and firm contact with disks attached to top of grounding [rods][and][studs]. Do not float or trowel surfaces excessively in a manner that buries metallic aggregate or contaminates surfacing material during floating and trowelling operations. Protect flooring from contamination by subgrade material, tracked or spilled concrete, sand, stone, or other material during finishing operations. Remove flooring contaminated and replace with new flooring. Match approved finish floor sample in all respects.

3.4.5 Curing and Protection

Cure and protect floor finish for not less than 30 days unless a longer period is recommended by the manufacturer's printed instructions. Strip floor finish of conductive curing compounds only in those areas where acceptance tests will be performed. Strip non-conductive curing compounds completely. Submit manufacture's printed instructions for curing the floor finish.

3.5 FIELD TESTS

Conduct testing in the presence of the Contracting Officer.

3.5.1 Grounding Tests

Test ground [studs][and][rods] and interconnecting ground wire before the concrete slab is placed and again before the topping finish is placed. Before final wiring is connected to the ground rods, test each rod or group of rods for ground resistance using a portable ground testing megohmmeter developing an A.C. voltage. Equip the instrument with a meter reading directly in ohms. Use two reference ground rods of 20 mm 3/4 inch copper clad steel, not less than 1.2 meters 4 feet in length, driven 1 meter 3 1/2 feet deep. Install rods in a straight line from the ground being tested. Connect No. l4 AWG stranded wire leads with at least 600-volt insulation to the ground being tested and the two reference grounds and to proper binding posts on the instrument. Where there is more than one ground within a circle of 3 meters 10 feet at a particular location, use reference rods as driven for the "first" test for tests on the other rods without changing their location.

3.5.2 Acceptance Tests

Make tests for conductivity and spark resistance of metallic finish after floor finish has been cured and dried for 30 days. Perform at least one test for each 37 square meters 400 square feet or less of floor area for conductivity and for spark resistance. Submit test reports showing compliance with the conductivity and spark test criteria.

3.5.2.1 Conductivity Tests

Conduct conductivity tests of finished floor surface in accordance with ASTM F150. For compliance, the average of maximum resistances must be within the limits specified with no value greater than 5 megohms.

3.5.2.2 Spark Tests

Determine spark resistance of finished floor surfaces in a darkened space by stroking the floor vigorously with a 300 mm 12 inch metal file in a 1.8 meter 6 foot arc. Perform spark test five times in each 37 square meters 400 square feet or less of flooring area. Areas with no visible spark production will be accepted as having necessary spark resistance.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 97 23.16 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 23.16 (November 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-09 97 23.16 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-09 97 23.16 (November 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 97 23.16

LINSEED OIL PROTECTION OF CONCRETE SURFACES
08/24

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NOTE: This guide specification covers the requirements for sealing, waterproofing, and anti-spall protection of concrete where freezing temperatures may cause damage.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: The coating treatment can be linseed oil-mineral spirits compound for old concrete or linseed oil emulsion used as a curing compound on new concrete. It is used on roads, bridge decks, sidewalks, curbs, parking ramps, floors, walkways and other such concrete construction. Check with local air pollution control districts to see if these treatments are allowed.

****

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NOTE: The extent and location of the work should be indicated on the project drawings, or included in the project specifications.

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 233	(1986; R 2023) Standard Specification for Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D235	(2022) Standard Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

[Linseed Oil-Mineral Spirit Compound

][Linseed Oil Emulsion

]1.3 DELIVERY, STORAGE AND HANDLING

Deliver the[linseed oil-mineral spirit compound][linseed oil emulsion] in original sealed containers that show the designated name, specification number, batch number, date of manufacture, manufacturer's directions, and name of manufacturer.[Linseed oil-mineral spirits compound has a flash point of about 38 degrees C 100 degrees F and is readily flammable. Carefully guard against fire. Store wiping rags containing this material in metal cans filled with water with tight lids closed.] Dispose of contaminated rags according to applicable fire prevention and environmental requirements.

1.4 ENVIRONMENTAL CONDITIONS

Apply coating when air and concrete temperature are between 2 degrees C and 38 degrees C 35 degrees F and 100 degrees F.

1.5 TRAFFIC CONTROL

Allow no traffic, except sealing equipment, on the treated surface until dry.

1.6 EQUIPMENT

[1.6.1 Spray Equipment

****

NOTE: Choose this paragraph for medium and large jobs.

****

Portable, truck mounted, or self-contained, mechanized spray equipment with nozzles designed to produce a flat, overlapping fan-shaped spray pattern. Clean tank interior and spray system prior to use.

][1.6.2 Brushes and Rollers

****

NOTE: Choose this paragraph for small jobs.

****

Use brush with sufficient body and length of bristle to spread the compound in a uniform film. Use rollers of a type which do not leave a stippled texture.

]PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Linseed Oil-Mineral Spirits Compound

****

NOTE: The linseed oil-mineral spirits sealer compound is usually applied to old concrete. Do not use it as a curing compound on new concrete. Check local state highway specifications for guidance.

****

A blend of 60 percent boiled linseed oil and 40 percent mineral spirits conforming to ASTM D235, Type I, by volume and to AASHTO M 233.

2.1.2 Linseed Oil Emulsion

****

NOTE: Linseed oil emulsion is usually applied to new concrete as a curing compound. It may be hard to find, check local availability before specifying.

****

ASTM C309, Type 1.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

****

NOTE: For surfaces with moderate amounts of dirt, rubber, or paint, use the first bracketed sentence. For surfaces contaminated with oil, grease, or membrane forming compounds, use the second bracketed

sentence. Confirm concrete surface preparation complies with the manufacturer's written instructions.
****

Prepare hardened concrete surfaces to permit sealer penetration and meet sealer preparation requirements.[Use airblasting, sandblasting, waterblasting or other approved methods.][Sandblast first then waterblast.] Immediately before sealer application, remove dust by airblasting.

3.2 APPLICATION

3.2.1 Rate of Application

3.2.1.1 Hardened Concrete

Two-coat application of linseed oil-mineral spirits compound:

a. First Coat: One liter per 8.75 square meters One gallon per 360 square feet.

b. Second Coat: One liter per 15 square meters One gallon per 600 square feet. Apply the second coat as soon as the first coat is dry to the touch.

3.2.1.2 Fresh Concrete

Apply one-coat linseed oil emulsion before permanent set at the rate of 1 liter per 5 square meters 1 gallon per 200 square feet.

3.2.2 Method of Application

****
NOTE: Choose the first bracketed option for medium and large jobs. Choose the second bracketed option for small jobs.
****

Apply using[spray][brush and roller] technique.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-09 97 23.17 (August 2016)**
Change 1 - 11/16

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-09 97 23.17 (August 2016)**

Change 1 - 11/16

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 09 97 23.17

CORROSION INHIBITOR COATING OF CONCRETE SURFACES

08/16, CHG 1: 11/16

****

NOTE: This guide specification covers the requirements for corrosion inhibiting coatings for concrete surfaces.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

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to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 260	(2021) Standard Method of Test for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 228.2R	(2013) Report on Nondestructive Test Methods for Evaluation of Concrete in Structures

ASTM INTERNATIONAL (ASTM)

ASTM C876	(2015) Standard Test Method for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete
ASTM C900	(2015) Standard Test Method for Pullout Strength of Hardened Concrete
ASTM G59	(1997; R 2014) Standard Test Method for Conducting Potentiodynamic Polarization Resistance Measurements

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

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****

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SD-01 Preconstruction Submittals

List of Proposed Subcontractors; G, [_____]

List of Proposed Products; G, [_____]

Health and Safety Plan; G, [_____]

Reinforcement Corrosion Rate Testing Procedures and Equipment; G, [_____]

Environmental Protection Plan; G, [_____]

SD-02 Shop Drawings

Structure Corrosion Inhibitor System Application Areas; G, [_____]

Structure Repair Areas Prior to Inhibitor System Application; G, [_____]

Structure Testing Locations; G, [_____]

Structure Reinforcing Steel Test Wire Installation Locations and Installation Details; G, [_____]

SD-03 Product Data

Vapor Phase Corrosion Inhibitor; G, [_____]

Ionic Corrosion Inhibitor; G, [_____]

Surface Sealant; G, [_____]

Structure Repair Materials; G, [_____]

Structure Reinforcing Steel Test Wire; G, [_____]

Structure Reinforcing Steel Test Wire Enclosure; G, [_____]

Manufacturer's Storage and Handling Instructions; G, [_____]

SD-06 Test Reports

Corrosion Inhibitor Selection and Application Plan; G, [_____]

Pre-Project Test Application Report; G, [_____]

Daily Checklists; G, [_____]

Final Acceptance Test Report and Maintenance Test Procedure; G, [_____]

SD-07 Certificates

Manufacturer's Certificate; G, [_____]

Applicator's Certificate; G, [_____]

Evidence of Acceptable Variation Certificate; G, [_____]

SD-08 Manufacturer's Instructions

Safety Data Sheets (SDS); G, [_____]

Special Application Procedures For Extreme Temperatures; G, [_____]

SD-11 Closeout Submittals

Final acceptance Test Report; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

Submit Applicator's Certificate documenting a minimum of 5-years of experience in the application and testing of vapor phase and ionic corrosion inhibitors, including the test methods described herein. Submit a list of proposed subcontractors, including qualification statements, for review and approval if subcontractors will be utilized on the project.

1.3.2 Minimum Performance Requirements

1.3.2.1 Structure Life Extension

Submit Manufacturer's certificate that the proposed corrosion inhibitor system application will extend the structure service life a minimum of 10 years.

1.3.2.2 Corrosion Rate Reduction of Reinforcing Steel

Submit test data in the Final Acceptance Test Report that demonstrates a minimum reduction in reinforcement corrosion rate of 50 percent from the pre-application testing corrosion rate.

1.3.2.3 Water Penetration Rate Reduction of Concrete

Submit test data in the Final Acceptance Test Report that demonstrates a minimum reduction of 80 percent in the water penetration rate of concrete from the pre-application testing penetration rate.

1.3.2.4 Pullout Strength Increase of Concrete

Submit test data in the Final Acceptance Test Report that demonstrates a minimum increase of 3.4 MPa 500 psi in the pullout strength of the concrete from the pre-application testing strength.

1.3.3 Evidence of Acceptable Variation Certificate

Submit documentation of any variations from this section that certifies the variation will not prevent the inhibitor system application from achieving the minimum performance requirement.

1.4 REGULATORY REQUIREMENTS

1.4.1 Environmental Protection

Submit an environmental protection plan for the corrosion inhibitor system application project that addresses all requirements of the SDS for the products utilized and assures compliance with all applicable regulations.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver corrosion inhibitor products in sealed and properly labeled containers. Store and handle products in accordance with the manufacturer's instructions. Submit manufacturer's storage and handling instructions as part of the product data submittal.

1.6 SAFETY METHODS

Comply with all applicable OSHA and local authority standards for personal protection, including the required record keeping and training. Submit compliance plan as part of the Health and safety plan submittal.

1.7 ENVIRONMENTAL CONDITIONS

1.7.1 Weather and Substrate Conditions

Consider present and forecasted weather conditions for each structure prior to product application. Do not apply inhibitor system if rain is forecasted during the application or within 4 hours after the application is completed. The substrate temperature, air temperature, humidity and other environmental conditions must be within the limits recommended by the manufacturer for proper application. Document all relevant environmental conditions and include in the Daily Checklist submittals.

1.8 EQUIPMENT, TOOLS, AND MACHINES

Apply the inhibitor system utilizing methods, tools, and equipment approved by the manufacturer. Application equipment may include brushes, rollers, power rollers, spray equipment, squeegees, brooms, and pressure injection systems. Include the proposed application equipment and methods in the Corrosion Inhibitor Selection and Application Plan submittal.

1.9 SEQUENCING AND SCHEDULING

1.9.1 Structure Repair Areas Prior To Inhibitor System Application

Repair damaged and delaminated concrete areas and cracks in accordance with Section 03 01 00 REHABILITATION OF CONCRETE. Exothermically weld or pin braze a test wire to the reinforcing steel where reinforcing steel is exposed during the repair process. Prepare the surface of the wire attachment area in accordance with the coating manufacturer's recommended procedures and apply a 100 percent solids epoxy coating to the test wire attachment location that covers all bare wire and affected areas of the reinforcement. Allow the coating to cure in accordance with the manufacturer's instructions prior to proceeding with placement of structure repair materials. Terminate the test wire in an enclosure. Prepare and submit shop drawings showing the location of all repair areas and proposed test wire installations. The submittal shall include a list of all proposed repair materials, repair material SDS, and manufacturer's recommended application procedures. The Designer of Record will review and approve the structure reinforcing steel test wire installation locations and installation details required prior to installation.

1.9.2 Surface Preparation of Concrete

Remove all existing coatings, laitance, contaminants, and any other substances that could interfere with the inhibitor penetration. Select removal methods appropriate for the structure and materials to be removed. Include proposed removal methods in the Corrosion Inhibitor Selection and Application Plan submittal.

1.9.3 Pre-Application Testing

1.9.3.1 Reinforcement Corrosion Rate Testing Procedures And Equipment

Measure and document the corrosion rate of the reinforcing steel prior to inhibitor application. Document the location of test wires or reinforcing steel connections utilized for the corrosion rate measurements and each measurement location. Document the specific conditions of concrete moisture and surface temperature during the test. Identify a minimum of two separate test areas for each structure to be treated. Include a minimum of 25 measurement points in each test area. Utilize a combination of half-cell potential measurements collected in accordance with ASTM C876 and linear polarization resistance measurements collected in accordance with ASTM G59 to determine the corrosion rate of the reinforcing steel. Submit a list of all proposed corrosion rate testing procedures and test equipment within 2 weeks of the contract award. Alternate corrosion rate measurement techniques, such as electrochemical impedance spectroscopy (EIS) must be submitted to the Designer of Record for review and approval prior to testing. Report the corrosion rate in microamperes per square centimeter of reinforcing steel surface area in the test or in micrometers of steel loss per year.

1.9.3.2 Chloride Content of Cement

Measure the total chloride ion content of the structure's concrete sand/cement paste at the depth of the first course of reinforcing steel in accordance with AASHTO T 260. A pre-project test application of inhibitor is required for total chloride levels above 3,000 ppm in accordance with paragraph PRE-PROJECT TEST APPLICATION OF INHIBITOR. Include the chloride ion testing results and identify areas where pre-project test applications are required, if any, in the Corrosion Inhibitor Selection and Application Plan submittal.

1.9.3.2.1 Pre-Project Test Application of Inhibitor

A pre-project test application of inhibitor is required for structures with total chloride levels above 3,000 ppm. Apply the test application to a representative section of the high-chloride structure area to be treated. Follow the application procedures included in the Corrosion Inhibitor Selection and Application Plan and PART 3 EXECUTION. Include all pre-application and post-application testing in order to ensure the minimum performance requirements can be achieved. Prepare and submit a Pre-Project Test Application Report to the Designer of Record for review and approval prior to proceeding with inhibitor application to high-chloride structures.

1.9.3.3 pH of Concrete

Extract an approximate 25 mm 1 in. diameter core of concrete to a minimum depth of the first course of reinforcing steel. Apply a multiple range pH indicator dye to the core in accordance with the dye manufacturer's procedures. Report the depth from the concrete surface at which a pH value of 11 or greater is indicated. Include the pH testing data in the Corrosion Inhibitor Selection and Application Plan submittal.

1.9.3.4 Water Penetration Rate of Concrete

Measure the water penetration rate of the concrete surface in accordance with the Initial Surface Absorption Test described in ACI 228.2R for at least two locations within the area to be treated with the inhibitor system. Include the results of the testing in the Corrosion Inhibitor Selection and Application Plan submittal.

1.9.3.5 Pullout Strength of Concrete

Measure the pullout strength of the concrete in accordance with ASTM C900 at a minimum of two locations in the area to be treated with the inhibitor system. Include the test results in the Corrosion Inhibitor Selection and Application Plan submittal.

1.9.4 Corrosion Inhibitor Selection and Application Plan

Prepare and submit a specific plan for structure corrosion inhibitor system application areas included in the project. At a minimum, include the product selections, structure areas to be treated, surface preparation requirements, application methods, application sequence and timing, and application rates that are based on the pre-application testing results. Include all pre-application testing data and analysis in the plan. Include shop drawings identifying the structure testing locations. Identify areas that require pre-project test applications based on excessive chloride ion levels. Submit the Corrosion Inhibitor Selection and Application Plan for review by the Designer of Record.

1.9.5 Corrosion Inhibitor Application

Apply the corrosion inhibitor system in accordance with the approved plan. Monitor and record the quantity of inhibitor applied to the surface, application method, surface temperature, and any other data or observations required by the plan. Inspect the surface for residue upon completion of the inhibitor application to ensure all of the inhibitor has penetrated the concrete surface. Apply a light spray of water if necessary to aid inhibitor penetration. After the corrosion inhibitor application and penetration is complete clean the concrete surface of any remaining residue in accordance with the manufacturer's recommendations.

1.9.6 Post-Application Testing and Minimum Performance Requirements

Perform post-application testing a minimum of 60 days after completion of the corrosion inhibitor system application. Perform post-application testing utilizing the same instrumentation and test procedures at the same locations as those utilized during the pre-application testing. Include the post-application testing results in the Final Acceptance Test Report. The minimum acceptable performance criteria are included in paragraph MINIMUM PERFORMANCE REQUIREMENTS.

1.9.6.1 Corrosion Rate of Reinforcing Steel

Compare the pre-application test results and the post-application test results to determine the extent of corrosion rate reduction.

1.9.6.2 Water Penetration Rate of Concrete

Compare the pre-application test results and the post-application test results to determine the reduction in water penetration rate.

1.9.6.3 Pullout Strength of Concrete

Compare the pre-application test results and the post-application test results to determine the increase in pullout strength.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The corrosion inhibitor system will consist of an organic vapor phase inhibitor, an ionic inhibitor or a combination of both inhibitors. Apply the organic vapor phase inhibitor first when a combination of inhibitors is utilized. In addition to the inhibitor system a reactive silicone surface sealant or surface protection coating will be applied. Submit a list of proposed products for the corrosion inhibitor system application. Include product Safety Data Sheets (SDS), warranty information and the manufacturer's recommended special application procedures for extreme temperatures and testing procedures in the submittal.

2.2 MATERIALS

2.2.1 Penetrating Vapor Phase Corrosion Inhibitor

A solution of organic amine carboxylate compounds that migrate in the gas phase through the cement pores to form a corrosion inhibiting film on the reinforcing steel surface.

2.2.2 Penetrating Ionic Corrosion Inhibitor

A solution containing chemically reactive water-soluble inorganic silicates designed to act as an anodic inhibitor on the surface of the reinforcing steel.

2.2.3 Surface Sealant

A chemically reactive water dispersion of a silane/siloxane mixture that forms an insoluble cross-linked silicone membrane within the concrete matrix.

2.2.4 Structure Reinforcing Steel Test Wire

Type THWN stranded copper conductor, not less than No. 10 AWG, of sufficient length to extend from the structure connection to the test wire enclosure without splicing. Terminate structure test wires in the test wire enclosure with solderless copper lugs.

2.2.5 Structure Reinforcing Steel Test Wire Enclosure

A surface/wall or post mounted enclosure to suit field conditions. Enclosure and cover constructed of non-metallic materials or hot-dip galvanized steel containing an insulated terminal board. Mounting post, where necessary, constructed of galvanized rigid conduit fitted with insulating bushings to protect the test wire from damage.

PART 3 EXECUTION

3.1 DAILY CHECKLISTS

Complete a checklist for each day of work on the structures included in the project. Record, at a minimum, the following information on the daily checklist: concrete surface temperature immediately prior to and after inhibitor application, or every 2 hours if there is a possibility of extreme temperature; concrete surface cleaning and preparation equipment and methods; concrete relative moisture immediately prior to inhibitor application; time of application and application equipment for each component; rate of application of each component; extent of surface treated; application method utilized; tests performed; testing locations; and any other requirements identified in the Corrosion Inhibitor Selection and Application Plan.

3.2 SURFACE PREPARATION

Examine all surfaces for cleanliness prior to application. Clean surfaces of visible contamination, coatings, sealants, debris, oils and fuels, and other similar materials. Treatment areas may be damp but no water ponding is permitted on flat horizontal surfaces. Measure and record concrete surface temperature immediately prior to inhibitor application. Do not apply inhibitor if concrete surface temperature is below 2 degrees C 35 degrees F. Consult the manufacturer for special application procedures if the concrete surface temperature is in excess of 38 degrees C 100 degrees F. Submit the special application procedures to the Designer of Record for review prior to application. Prepare the concrete surface for inhibitor application in accordance with the manufacturer's recommendations. Provide protection for equipment and structures in close proximity to the inhibitor application area to guard against overspray or product spillage. Use plastic sheeting to protect glass and decorative structure components and equipment from unintended inhibitor contact.

3.3 APPLICATION OF VAPOR PHASE CORROSION INHIBITOR

Apply the vapor phase inhibitor to the structure surface at the rate identified utilizing the methods, tools and equipment identified in the

Corrosion Inhibitor Selection and Application Plan. Verify that the recommended amount of inhibitor has penetrated the structure surface. Multiple applications may be required to achieve the recommended application rate. Do not overspray or allow the inhibitor product to be lost due to run off. Replace any lost product with sufficient additional product to achieve the recommended application rate. Apply a light spray of water to the treated surface after each application to assist the inhibitor penetration into the concrete. Inspect the treated surface following application. Minimal to no residue should remain following the application. Clean the concrete surface of any residue in accordance with the manufacturer's recommendations. Perform post-application testing identified in this section.

3.4 APPLICATION OF IONIC CORROSION INHIBITOR

Apply the ionic inhibitor to the structure surface at the rate identified utilizing the methods, tools and equipment identified in the Corrosion Inhibitor Selection and Application Plan. Verify that the recommended amount of inhibitor has penetrated the structure surface. Multiple applications may be required to achieve the recommended application rate. Do not overspray or allow the inhibitor product to be lost due to run off. Replace any lost product with sufficient additional product to achieve the recommended application rate. Inspect the treated surface following application. Minimal to no residue should remain following the application. Clean the concrete surface of any residue in accordance with the manufacturer's recommendations. Perform post-application testing identified in this section.

3.5 APPLICATION OF COMBINED VAPOR PHASE AND IONIC CORROSION INHIBITOR SYSTEM

Apply the vapor phase organic inhibitor first when a combination of vapor phase and ionic inhibitors are used together on the same structure. Follow the manufacturer's recommendations regarding the time period between application of the vapor phase inhibitor and the ionic phase inhibitor. Utilize the application specifications identified above for each type of inhibitor. Perform post-application testing identified in this section.

3.6 APPLICATION OF SURFACE PROTECTION COATING

3.6.1 Surface Sealant

Prepare the concrete surface in accordance with the manufacturer's recommendations. Apply surface sealants to the structure surface at the rate identified utilizing the methods, tools and equipment identified in the Corrosion Inhibitor Selection and Application Plan. Verify that the recommended amount of sealant has penetrated the structure surface. Multiple applications may be required to achieve the recommended application rate.

3.6.2 Protective and Decorative Coatings

Inspect and clean the concrete surface of residue that may interfere with the bonding of a surface protective or decorative coating. Separate specifications will be provided when protective and decorative coatings are included in the project. Perform post-application testing prior to the application of the protective and decorative coatings.

3.7 FINAL ACCEPTANCE TEST REPORT AND MAINTENANCE TEST PROCEDURE

Prepare and submit a Final Acceptance Test Report. Include, at a minimum, the following: as-built drawings showing all structure repair areas, test wire installation locations, pre-application test locations, inhibitor application areas, and post application test locations; all post-application test results; post-application test data analysis and evaluation of acceptance criteria for corrosion rate reduction of the reinforcing steel, water penetration rate reduction of the concrete, and pullout strength increase of the concrete; a statement that the corrosion inhibitor system application will extend the life of the structure a minimum of 10 years; and recommended maintenance testing procedures and frequency to ensure compliance with the minimum 10 year structure life extension requirement.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-10 11 00 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-10 11 00 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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08/20

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USACE / NAVFAC / AFCEC **UFGS-10 11 00 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-10 11 00 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 10 11 00

VISUAL DISPLAY UNITS
08/20

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NOTE: This guide specification covers the requirements for visual communications specialties.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F148	(2013) Binder Durability of Cork Composition Gasket Materials
ASTM F152	(2024) Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F793/F793M	(2020) Standard Classification of Wall Coverings by Use Characteristics

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building

1.2 DEFINITIONS

****

NOTE: The designer has the option to require that visual display units for a project be provided by one manufacturer when appropriate. It is the designer's responsibility to determine if all products being specified for a project are available from a minimum of three manufacturers. Not all manufacturers produce the variety of visual display units offered in this specification.

Alternate frame methods such as: self-edge for fabric or vinyl covered tackboards, vinyl edge on tackboards, and markerboards are options but are not available from all manufacturers. Designer must research available sources.

****

The term visual display unit when used herein includes presentation boards, markerboards, tackboards, board cases, display track systems, horizontal sliding units, copyboards, interactive whiteboards, and projection screens; submit manufacturer's descriptive data and catalog cuts plus manufacturer's installation instructions, and cleaning and maintenance instructions. Provide visual display units from manufacturer's standard product line. Submit certificate of compliance signed by Contractor attesting that visual display units conform to the requirements specified.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Placement Schedule; G, [_____]

SD-03 Product Data

Visual Display Unit; G, [_____]

Projection Screen; G, [_____]

SD-04 Samples

Aluminum; G, [_____]

Hardwood; G, [_____]

Porcelain Enamel; G, [_____]

Cork; G, [_____]

Fabric; G, [_____]

Vinyl Wall Covering; G, [_____]

Glass; G, [_____]

SD-07 Certificates

[Indoor air quality for markerboards; S

][Indoor air quality for tackboards; S

][Indoor air quality for projection screen; S

] Certificate of Compliance

SD-08 Manufacturer's Instructions

Manufacturer's Cleaning Instructions

Manufacturer's Printed Installation Instructions

SD-10 Operation and Maintenance Data

Visual Display Units, Data Package 1; G, [_____]

1.4 CERTIFICATIONS

1.4.1 Indoor Air Quality

1.4.1.1 Indoor Air Quality for Visual Display Products

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NOTE: The Government's preference is for use of products that have been certified for indoor air quality by a third-party organization such as Greenguard or SCS Global Services. However, it must be verified there is a certified product available that is both cost effective and appropriate for the project. The requirements of this paragraph are invoked when the designer of record confirms local/regional availability of Greenguard or SCS products and includes the bracketed requirements for indoor air quality certified products in Part 2 of this Section.

****

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in the manufacturer's original unopened containers and store them in a clean dry area with temperature maintained above 10 degrees C 50 degrees F. Stack materials according to manufacturer's recommendations. Allow visual display units to acclimate to the building temperature for 24 hours prior to installation.

1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for period of [one year][_____][years] from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 MATERIALS

For each type, submit a section of core material and backing showing the lamination of porcelain enamel coating on steel, colored cork, natural cork, woven fabric, non-woven fabric, or vinyl wall covering, as applicable. Submit a sample of hardwood, plastic laminate finish, or glass type, as applicable. Provide minimum 102 by 102 mm 4 by 4 inch samples, or larger, showing range of color.

Submit manufacturers' descriptive product data for [each type of] visual display unit indicated. Include manufacturers' literature, finishes, profiles and thicknesses of materials.

Submit manufacturers' operations and maintenance data for [each type of] visual display unit in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

2.1.1 Porcelain Enamel

Provide markerboard writing surface composed of porcelain enamel fused to a nominal 0.378 mm 28 gauge thick steel, laminated to a minimum 6 mm 1/4 inch thick core material with a steel or foil backing sheet. Writing surface must be capable of supporting paper by means of magnets. Markerboard surface for display track system may be a powder paint dry erase surface adhered to a nominal 1.214 mm 18 gauge thick steel.

2.1.2 Cork

Provide a continuous resilient sheet made from soft, clean, granulated cork relatively free from hardback and dust and bonded with a binder suitable for the purpose intended; wearing surface to be free from streaks, spots, cracks or other imperfections that would impair its usefulness or appearance. Provide seasoned material and a clean cut made not less than 13 mm 1/2 inch from the edge and must show no evidence of soft sticky binder.

2.1.2.1 Colored Cork

Provide colored cork composed of pure cork and natural color pigments that are combined under heat and pressure with linseed oil. Colored cork must be colored throughout and be washable. The burlap backing must be deeply imbedded and keyed to the work sheet being partially concealed in it and meeting the requirements of ASTM F148.

2.1.2.2 Natural Cork

Provide a light tan natural cork composed of a single layer of pure grain natural cork without backing or facing. Cork sheets must have a tensile strength of not less than 275 kPa 40 psi when tested in accordance with ASTM F152.

2.1.3 Woven Fabric

****

NOTE: A multi-colored, patterned, textured fabric will aid in hiding pin and tack holes.

Fabric other than manufacturer's standard may be used; however there may be an upcharge cost and minimum quantity requirements. Provide minimum generic specifications to obtain fabric required.

****

Provide [plain][_____] weave fabric with [100 percent polyester] [_____] fiber content and[496 grams plus or minus 16 grams per linear meter 16 oz. plus or minus 0.5 oz. per lineal yard] for 1524 mm 60 inch wide fabric [_____] minimum total weight. Fabric must have a Class A flame spread rating of 0-50 and smoke development rating of 0-450 in accordance with ASTM E84.

2.1.4 Non-Woven Fabric

Provide a non-woven, hooktape compatible fabric with a [backed] [100 percent polyester][,][100 percent polyolefin][or][100 percent nylon] [_____] fiber content and[341 grams plus or minus 14 grams per linear meter 11 oz. plus or minus 0.5 oz. per lineal yard for 1524 mm 60 inch wide fabric] [_____] minimum total weight. Fabric must have a Class A flame spread rating of 0-50 and smoke development rating of 0-450 in accordance with ASTM E84.

2.1.5 Vinyl Wall Covering

****

NOTE: A multi-colored, textured, vinyl wall covering will aid in hiding pin and tack holes.

Vinyl wall covering other than manufacturer's standard may be used; however, there may be an upcharge cost and minimum quantity requirements. Provide minimum generic specifications to obtain fabric required.

****

Provide vinyl wall covering conforming to ASTM F793/F793M, Category V with a Class A flame spread rating of 0-50 and smoke development rating of 0-450 in accordance with ASTM E84.

2.1.6 Aluminum

Provide a minimum 1.5 mm 0.06 inch thick, 6063-T5 or 6063-T6 aluminum alloy frame extrusion conforming to ASTM B221M ASTM B221. Exposed aluminum must have [anodized, satin finish][_____]. Use straight, single lengths wherever possible and keep joints to a minimum. Provide mitered corners with a hairline closure. Submit sections of frame, map rail, and marker rail, and [two] [_____] map hooks.

2.1.7 Hardwood

Provide exposed oak, walnut or mahogany hardwood with manufacturer's standard durable factory-applied stain and lacquer finish for frames, cabinets, and cases.

2.1.8 Glass

Provide tempered glass in accordance with ANSI Z97.1 and ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class I (clear), thickness as specified.

2.1.8.1 Glass with Interlayer Color Coating

Provide glass markerboard writing surface composed of tempered, low-iron, extra clear, safety writing glass with polished edges. Provide glass with an interlayer color coating with a durable paint/glass bond that is fade resistant, water resistant, and heat resistant.

2.1.8.2 Magnetic Glass

Provide magnetic glass markerboard writing surface composed of tempered, low-iron, extra clear, safety writing glass with polished edges and steel backing permanently adhered to the back of the glass.

2.2 PRESENTATION BOARD

****

NOTE: A presentation board with an integral pull down projection screen is recommended if projection surface is required. Some units are not available with projection screens. Hot spots may occur if writing surface is used as a projection surface.

The type of doors, double or single, is dependent on the size of the presentation board.

****

Provide wall hung cabinet presentation board with lockable [double doors] [single door] [with] [without] a projection screen [that pulls down over the markerboard writing surface in the cabinet interior]. Attach doors to cabinet with piano hinges and include a catch or closure to keep doors closed when not in use. Provide a porcelain enamel markerboard writing surface on the interior of the cabinet with marker rail, a flip chart that can be hung on an interior door panel, and fabric covered tack surface on the interior door panels. Provide cabinet of [oak hardwood] [walnut hardwood] [mahogany hardwood] [plastic laminate] [_____], with [rectilinear] [bullnose or radius] [traditional] [_____] edge detailing. Dry erase markings must be removable with a felt eraser or dry cloth without ghosting. Provide each unit with an eraser and four different color compatible dry erase markers, and two keys.

2.3 MARKERBOARD

****

NOTE: Hot spots may occur if this product is used as a projection screen. A visual display unit with pull down projection screen should be specified if a projection surface is required.

Not all marker rails are available in the same material as the frame, determine if this is a requirement to acquire desired design aesthetics.

Indicate if a full length marker rail is needed to meet user requirements. A full length marker rail is not available from all manufacturers. This requirement may increase the cost and add lead time. Generally the full length marker rail is the same length material as the frame.

Specify the map rail if there is a requirement to display maps, drawings, or large sheets of paper. Not all markerboards are available with map rail and map rail accessories.

If necessary, add requirements for graphics. Graphics can include such items as a grid, ruled lines or logo.

Full wall application of markerboard writing surface is an option. Designer must modify the following

paragraph to meet specific requirements and must verify that application is in compliance with National Fire Protection Association (NFPA) Life Safety Code 101.

****

****

NOTE: Retain the last bracketed sentence requiring products with indoor air quality certification when the designer of record confirms local/regional availability of Greenguard or SCS products that does not impact cost effectiveness.

****

2.3.1 Porcelain Markerboard

Provide a factory assembled markerboard with a porcelain enamel[, magnetic] writing surface. Unit to be comprised of one piece, without joints whenever possible. When markerboard dimensions require delivery in separate sections, components must be prefit at the factory, disassembled for delivery and jointed at the site. Provide [hardwood oak][hardwood walnut][hardwood mahogany][aluminum][_____] frame with marker rail [constructed of the same material as the frame] [and] [[extending the full length of the markerboard] [_____] inches long]. The markerboard [does not include a map rail.] [includes a map rail with a tackable insert extending the full length of the markerboard, map hooks and clips for holding sheets of paper. Provide two map hooks for each 1219 mm 4 feet of map rail.] Dry erase markings must be removable with a felt eraser or dry cloth without ghosting. Supply each unit with an eraser and four different color compatible dry erase markers. [Provide magnetic glass markerboard with [10] [_____] rare each magnets.] [Provide markerboards that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type).] [Provide certification of indoor air quality for markerboards.] [Provide surface applied [direct print][_____] graphics where required. Graphic type is [semivisible writing guidelines][penmanship lines][grid][horizontal lines] [_____][as indicated].]

2.3.2 Glass Markerboards with Interlayer Color Coating

Provide markerboard with a smooth finish[, magnetic glass] writing surface units to be comprised of one piece, without joints whenever possible. When markerboard dimensions require delivery in separate sections, components must be prefit at the factory, disassembled for delivery and jointed at the site. [Extend marker rail the full length of the markerboard.] [Marker rail is [____] inches long]. The markerboard [does not include a map rail.] [includes a map rail with a tackable insert extending the full length of the markerboard, map hooks and clips for holding sheets of paper. Provide two map hooks for each 1219 mm 4 feet of map rail.] Dry erase markings must be removable with a felt eraser or dry erase cloth without ghosting. Supply each unit with an eraser and four different color compatible dry erase markers. [Provide magnetic glass markerboard with [10][_____] rare earth magnets.] [Provide markerboards that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type).] [Provide certification of indoor air quality for markerboards.] [Provide high resolution graphics[reverse surface applied][printed on paper for insert behind glass][surface applied, direct print][_____] where required. Graphic type is [semivisible writing guidelines][penmanship lines][grid][horizontal lines][_____][as indicated].]

2.4 TACKBOARDS

****

NOTE: Retain the last sentence below requiring products with indoor air quality certification when the designer of record confirms local/regional availability of Greenguard or SCS products that does not impact cost effectiveness.

****

[Provide tackboards that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type).][Provide certification or validation of indoor air quality for tackboards.]

2.4.1 Cork

****

NOTE: Tackboards with 6 mm 1/4 inch thick cork are more durable and higher in cost than tackboards with 3 mm 1/8 inch thick cork. Tackboards constructed with insulation board or fiberboard are generally less durable and less expensive than tackboards constructed of a hardboard. Cost of natural cork tackboards is generally less than colored cork tackboards.

****

Provide tackboard consisting of a minimum [3 mm 1/8 inch thick colored cork with burlap backing laminated to a minimum 10 mm 3/8 inch thick insulation board or fiber board] [6 mm 1/4 inch thick colored cork with burlap backing laminated to a minimum 6 mm 1/4 inch thick hardboard] [3 mm 1/8 inch thick natural cork laminated to a minimum 10 mm 3/8 inch thick insulation board or fiber board] [6 mm 1/4 inch thick natural cork laminated to a minimum 6 mm 1/4 inch thick hardboard], and [a] [hardwood oak] [hardwood walnut] [hardwood mahogany] [an] [aluminum] [_____] frame.

2.4.2 Vinyl Covered

Provide tackboard consisting of vinyl wall covering laminated to a minimum [3 mm 1/8 inch thick cork laminated to a minimum 10 mm 3/8 inch thick insulation board or fiberboard] [6 mm 1/4 inch thick cork laminated to a minimum 6 mm 1/4 inch thick hardboard or particleboard] [13 mm 1/2 inch thick insulation board or fiberboard], and [a][hardwood oak] [hardwood walnut] [hardwood mahogany] [an] [aluminum] [_____] frame.

2.4.3 Fabric Covered

Provide tackboard consisting of a [woven] [non-woven] fabric covering laminated to a minimum [3 mm 1/8 inch thick cork laminated to a minimum 10 mm 3/8 inch thick insulation board or fiberboard] [6 mm 1/4 inch thick cork laminated to a minimum 6 mm 1/4 inch thick hardboard or particleboard] [13 mm 1/2 inch thick insulation board or fiberboard], and [a][an] [hardwood oak] [hardwood walnut] [hardwood mahogany] [an] [aluminum] [_____] frame.

2.5 BOARD CASE

Provide [surface] [recess] mounted board case with [hinged minimum 5 mm 3/16 inch thick] [sliding minimum 6 mm 1/4 inch thick] tempered glass doors that are lockable. Provide [a][an] [aluminum][hardwood oak][hardwood walnut][hardwood mahogany][_____] case with mitered corners reinforced for rigidity. Provide doors [equipped with continuous piano hinges. Door glass framed with the case material, and reinforced at all corners. Door framing does not depend upon the glass for rigidity. Multiple door cases with an elbow catch] [sliding aluminum "H" molding at top and bottom of case]. The interior side of the back panel is tackable and composed of [a minimum 6 mm 1/4 inch colored cork] [a minimum 6 mm 1/4 inch natural cork] [a vinyl wall covering laminated to a minimum 6 mm 1/4 inch cork] [[_____] laminated to a minimum 6 mm 1/4 inch fiberboard] [_____]. Provide two keys for each unit.

2.6 DISPLAY TRACK SYSTEM

****

NOTE: Track systems with more than one level have increased component capacity. Not all components can be located on all levels, coordinate locations with manufacturer recommendations.

****

Method of display is a flexible and interchangeable system that consists of lightweight presentation components suspended from a wall mounted, linear, horizontal track. Track has [one] [two] [_____] levels to attach components. Track allows attached components to slide horizontally. Presentation components are capable of being lifted from the track and being relocated to allow for reconfiguration. Components must be capable of being installed on the track without the use of tools for installation, removal, and reconfiguration. The presentation components consist of a [retractable projection screen,] [tilted projection screen (top tilts forward),] [reversible panel with dry erase markerboard on both sides,] [reversible panel with markerboard on one side and woven fabric covered tack surface on the other,] [[1] [_____] [removable shelf],] [panel with adjustable flip chart,] [_____] and [display rail for setting presentation materials or a holder for displaying maps, presentation boards, drawings and other paper display materials up to a [3] [6] mm [1/8] [1/4] inch thickness]. Install and locate components on track in accordance with manufacturer's written recommendations. Provide markerboards with a marker rail Markerboard surface accepts magnets. Dry erase markings are removable with a felt eraser or dry cloth without ghosting. Provide each unit with an eraser and four different color compatible dry erase markers.

2.7 HORIZONTAL SLIDING UNITS

****

NOTE: Specify the number and types of panels. Identify which panels must be installed in which track.

****

Provide horizontal sliding unit composed of a fixed back panel, sliding panels, an aluminum track assembly, map rail and marker rail. Provide unit with [2] [3] [4] [_____] tracks. The fixed back panel is [markerboard] [tackboard]. Provide unit with [_____] markerboard sliding panel and [_____] tackboard sliding panel. The track assembly and exposed members, including panel edging and marker rail, are made of extruded aluminum. Reinforce frame assembly at corners. Sliding panels are suspended from the top and slide over the aluminum track using molded nylon ball bearing rollers at the top of the track and nylon guide rollers at the bottom of the track to eliminate vibration and to provide quiet and smooth operation of the panels. Sliding panels have finger pulls at each end. Provide a map rail with a tackable insert extending the length of the horizontal sliding unit. The map rail has map hooks with clips for holding sheets of paper. Provide two map hooks for each 1220 mm 4 feet of map rail. Marker rail extends the full length of the horizontal sliding unit. Dry erase markings are removable with a felt eraser or dry cloth without ghosting. Provide each unit with an eraser and four different color compatible dry erase markers.

2.8 COPYBOARD

****

NOTE: Models are available that have copy feature only and do not operate with a PC.

Copyboards are used to document and print information directly from the writing surface.

Specify PC ready or PC interface if required.

Coordinate PC requirements for PC ready and PC interface units with user to assure the Government furnished and Government installed PC and printer will be compatible with copyboard PC requirements.

Some models that have PC interface do not have a built-in printer since printer capability is obtained through interfacing with the PC and printer.

Coordinate copyboard requirements and locations with electrical engineer to assure that electrical outlets or hardwiring at the appropriate locations are included in the design.

****

Provide wall mounted copyboard, 120V, UL listed, with [2] [_____] sided rotating screens, and [a built-in printer that prints letter size copies] [and] [capability to save and print to a Government furnished and Government installed PC and printer]. Copyboard surface [has grid lines] [and] accepts dry erase markers. Dry erase markings are removable with a felt eraser or dry cloth without ghosting. [Copyboard [has PC interface] [or] [is PC ready].] [Provide PC interface kit for each PC ready unit.] Copyboards [are hardwired] [have an electrical cord that plugs into an electrical wall outlet]. Comply with electrical work requirements in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide each copyboard with an eraser and three different color compatible dry erase markers.

2.9 INTERACTIVE WHITEBOARDS

****

NOTE: Models are intended to be a collaboration system using a touchscreen/interactive panel.

Coordinate connectivity to local area network (LAN) and verify with the Government the need to address cybersecurity and Risk Management Framework (RMF).

Include size, resolution, input/output requirements, aspect ratio, touch points, and other salient points.

****

Provide interactive whiteboards are composed of a wall mounted interactive touch screen/panel with infrared touch technology. System includes keyboard, conference camera, [short throw projector] [[connection to local area network (LAN)] and built-in wireless], remote control, pen, and audio. [Provide a system compatible with Government furnished and Government installed PC and printer][Provide a system that includes a printer and that is compatible with a Government furnished and Government installed PC]. Interactive whiteboards [are hardwired] [have an electrical cord that plugs into an electrical wall outlet]. Comply with electrical work requirements in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.10 PROJECTION SCREEN

****

NOTE: The designer must make appropriate selections based on the type of projection screen required. Not all options are available for all screens. Designer must research available sources and edit accordingly.

A selection needs to be made between a standard screen and tab tensioned screen. The tab tensioned screens have better picture quality since the viewing screen is flat, they are recommended when the primary use for the screen is for computer generated images.

If required, specify extra drop to lower picture area. Identify length of extra drop and if extra drop must be white or black.

Seams may be required dependent on size of screen.

Coordinate projection screen requirements and locations with electrical engineer to assure that electrical outlets and hardwiring at the appropriate locations are included in the design.

****

****

NOTE: Retain the last bracketed sentence requiring products with indoor air quality certification when the designer of record confirms local/regional availability of Greenguard or SCS products that does not impact cost effectiveness.

****

Provide [wall mounted] [ceiling mounted] [recessed mounted] motorized projection screen with 120V motor that is lubricated for life, quick reversal type, has overload protector, integral gears, and preset accessible limit switches. [Provide recessed mounted projection screens with an operable closure door and access panel.]Provide flame retardant, mildew resistant, [glass beaded] [white matte] [_____] screen [with [white] [black] masking borders] [that is tab tensioned. Tab tensioned screens have a vinyl surface that is stretchable]. Bottom of screen fabric is weighted with a metal rod. Provide roller of rigid metal at least [76] [127] [_____] mm [3] [5] [_____] inches in diameter mounted on sound absorbing supports. Motor is [end mounted] [or] [motor-in-roller] design. Provide screen with a 3 position control switch to stop or reverse screen at any point. Install the switch in a flush electrical box with cover plate, location(s) as shown on the Electrical drawings. All conduit and wiring from the control switch to the projection screen is furnished and installed by the Contractor. [Provide ceiling recessed case of [extruded aluminum] [or] [wood with metal lined motor compartment]]. [Provide [wall] [ceiling] mounted case of [aluminum] [or] [steel] [or] [wood. Wood case is finished in [plastic laminate] [light oak] [medium oak] [walnut] [cherry] [mahogany] [_____]]]. Screen is UL listed. Comply with electrical work requirements in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. [Provide projection screens that meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type).]

[Provide certification of indoor air quality for projection screens.]

2.11 COLOR

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally, Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an architect or interior designer. Color must be selected from manufacturers standard colors or identified as a manufacturers color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located in the drawings a note must be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

****

Provide finish colors for required items [as specified in Section 09 06 00 SCHEDULES FOR FINISHES][as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers].

PART 3 EXECUTION

3.1 PLACEMENT SCHEDULE

****

NOTE: Identify location and mounting height of visual display units.

Identify size and type of visual display units only once in the contract documents.

Include additional information for the display track system. Specify the length of the wall track, and type and number of presentation components required per room.

****

[Location, size and mounting height of visual display units as shown on the drawings.] [Provide visual display units as follows:

Room Name and Number	Board Type	Board Size	Wall Location	Mounting Height
[_____]	[_____]	[_____]	[_____]	[_____]

]

Mounting height is defined as distance from finished floor to top of the visual display unit frame.

3.2 INSTALLATION

****

NOTE: Provide reinforcing at partitions to support visual display units.

****

Do not install items that show visual evidence of biological growth. Perform installation and assembly in accordance with manufacturer's printed installation instructions. Use concealed fasteners. Attach visual display units to the walls with suitable devices to anchor each unit. Furnish and install trim items, accessories and miscellaneous items in total, including but not limited to hardware, grounds, clips, backing materials, adhesives, brackets, and anchorages incidental to or necessary for a sound, secure, complete and finished installation. Do not initiate installation until completion of room painting and finishing operations. Install visual display units in locations and at mounting heights indicated. Install visual display units level and plumb, and if applicable align doors and adjust hardware. Repair or replace damaged units as directed by the Contracting Officer.

3.3 CLEANING

Clean writing surfaces in accordance with manufacturer's cleaning instructions.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-10 14 00.10 (August 2017)**
Change 1 - 11/18

Preparing Activity: USACE **Superseding**
UFGS-10 14 00.10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 10 14 00.10

EXTERIOR SIGNAGE

08/17, CHG 1: 11/18

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NOTE: This guide specification covers the requirements for common types of exterior signs, dimensional building letters, and metal plaques.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

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NOTE: Reference this specification and drawings to the standards of UFC 3-120-01, Sign Standards that includes graphics, lettering style and other key components.

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NOTE: Army facilities not excluded by TI 800-01 Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Drawings will indicate location, dimensions,

elevations, schedules, content, details and such other information as required to indicate the extent of the work. The same terminology or titles used in the specification, for the different types of signage, will be used on the drawings and schedules.

Designer must coordinate and incorporate existing signage policy and designs, as required, for new projects on existing facilities.

This section covers some of the more common exterior sign types. When other sign types are to be used, specifications will be modified accordingly.

Product selections must be based on aesthetic values, appearance, and cost as related to project needs.

Additional Guidance on the development of signage systems is available in USACE EP 310-1-6a and 6b, Sign Standards Manual. The document is available from the USACE Publications Depot, 2803 52nd Avenue, Hyattsville, MD 20781, 301-394-0081/82/83/84.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

AMERICAN WELDING SOCIETY (AWS)

AWS C1.1M/C1.1	(2019) Recommended Practices for Resistance Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C1036	(2021) Standard Specification for Flat Glass
ASTM D3841	(2016) Standard Specification for Glass Fiber-Reinforced Polyester Plastic Panels
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3611	(2011; Rev E; Stabilized (S) 2011) Plastic Sheet, Polycarbonate General Purpose

1.2 GENERAL REQUIREMENTS

All exterior signage must be provided by a single manufacturer. Exterior signage must be of the design, detail, sizes, types, and message content shown on the drawings, must conform to the requirements specified, and must be provided at the locations indicated. Submit exterior signage schedule in electronic media with spread sheet format. Spread sheet must include sign location, sign type, and message. Signs must be complete with lettering, framing as detailed, and related components for a complete installation. Each sample must consist of a complete sign panel with letters and symbols. Samples may be installed in the work, provided each sample is identified and location recorded. Submit [three] [_____] color samples for each material requiring color and 305 mm 12 inch square sample of sign face color sample.

1.2.1 Wind Load Requirements

Exterior signage must be designed to withstand [_____] km/h mph windload. Submit design analysis and supporting calculations performed in support of specified signage.

1.2.2 Character Proportions and Heights

Letters and numbers on indicated signs for handicapped-accessible buildings must have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs must be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G, [_____]

SD-03 Product Data

Modular Exterior Signage System

Installation

Exterior Signage; G, [_____]

Wind Load Requirements

SD-04 Samples

Exterior Signage; G, [_____]

SD-10 Operation and Maintenance Data

Protection and Cleaning; G, [_____]

1.4 QUALIFICATIONS

Signs, plaques, and dimensional letters must be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items of equipment must essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1.5 DELIVERY AND STORAGE

Materials must be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's instructions.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period must be provided.

1.7 EXTRA STOCK

****

NOTE: A sufficient number of message panels/bars and letters for future use for changes and message replacement must be specified.

****

Provide [_____] extra interchangeable message panels and extra stock of the following: [[_____] message bars of each color and size for sign types [_____].] [[_____] pressure-sensitive letters in each color and size for sign type [_____].] [[_____] changeable message strips for sign type [_____].]

PART 2 PRODUCTS

2.1 MODULAR EXTERIOR SIGNAGE SYSTEM

****

NOTE: Omit signage systems not required for project.

Signage for Navy projects should be designed in accordance with the Activity's Base Exterior Architectural Guide or Base Signage Guide. Check with activity concerning standards on safety regulatory signs (i.e. fire and radiation).

Enamel finish is more economical than anodized, but may not perform as well; therefore, may not be cost effective. Designer should investigate local conditions to make determination.

****

Exterior signage must consist of a system of coordinated directional, identification, and regulatory type signs located where shown. Dimensions, details, materials, message content, and design of signage must be as shown. Submit manufacturer's descriptive data and catalog cuts.

2.1.1 Free-Standing Base Mount Pylon/Monolith Type Signs

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NOTE: Drawings should show mounting heights and mounting details.

****

2.1.1.1 Framing

Interior framing must consist of [aluminum] [or] [galvanized steel] tube columns welded to companion plates. Perimeter framing must consist of [aluminum] [or] [steel] angle framing welded to the post and plate system as designed. Framing members must be designed to permit [access to electrical equipment] [and] [panel removal]. Mounting must be provided as shown. Framing members of steel must be finished with semi-gloss baked enamel or two-component acrylic polyurethane. Openings must be sealed from moisture and made tamper-proof.

2.1.1.2 Exterior Sheeting Panels

****

NOTE: If panels are to be nonremovable, use aluminum panels to permit welding to frame. Details will be used as applicable for locations for welding.

In project locations with Environmental Severity Classifications (ESC) C3 thru C5, do not use galvanized or enameled steel products for panels, brackets, posts, fasteners, or hardware; use anodized aluminum or fiberglass for panels. Also use anodized aluminum or stainless steel for brackets and posts, and use stainless steel for fasteners and hardware. See UFC 1-200-01 for determination of ESC for project locations.

****

Modular panels must be provided in sizes shown on drawings. Panels must be fabricated a minimum of [2.3 mm 0.090 inch thick [aluminum] [steel]] [3.2 mm 0.125 inch thick fiberglass reinforced plastic (FRP)]. [Panels must be heliarc welded to framing system [_____].] Top and end panels must be removable and must be secured by 5 mm 3/16 inch socket head jack nuts. Finish for metal panels must be [semi-gloss baked enamel] [two-component acrylic polyurethane] [anodized conforming to AA DAF45].

2.1.1.3 Mounting

Mount by securing to concrete foundation as indicated.

2.1.1.4 Finishes

Base finish must be [semi-gloss baked enamel] [or] [two-component acrylic polyurethane] [anodized conforming to AA DAF45] [_____]. Metal panel system finish must be [baked enamel or two-component acrylic polyurethane] [anodized conforming to AA DAF45 [_____], as shown].

2.1.2   Panel And Post/Panel Type Signs

****

NOTE: Show details of sign foundations on drawings. Include provision for concealed entry of electric service to internally illuminated signs through foundation to post.

****

2.1.2.1   Posts

One-piece [aluminum] [or] [galvanized steel] posts must be provided with minimum 3.2 mm 0.125 inch wall thickness. Posts must be designed to accept panel framing system described. The post must be designed to permit attachment of panel framing system without exposed fasteners. Caps must be provided for each post.

2.1.2.2   Panel Framing System

Panel framing consisting of aluminum sections and interlocking track components must be designed to interlock with posts with concealed fasteners.

2.1.2.3   Panels

Modular message panels must be provided in sizes shown on drawings. Panels must be fabricated a minimum of [[2.0] [2.3] [3.2] mm [0.080] [0.090] [0.125] inch aluminum] [3.2 mm 0.125 inch acrylic] [3.2 mm 0.125 inch fiberglass reinforced plastic (FRP)]. [Panels must be designed to be interchangeable.] [Panels with metal return sheeting must have welded corners, ground smooth.] [Panels must be heliarc welded to framing system.] [Face panels must be removable to provide access to electrical components.]

2.1.2.4   Finishes

Post finish must be [semi-gloss baked enamel] [or] [two-component acrylic polyurethane] [anodized conforming to AA DAF45] [_____]. Metal panel system finish must be [baked enamel or two-component acrylic polyurethane] [anodized conforming to AA DAF45 [_____], as shown].

2.1.2.5   Mounting

[Provide permanent mounting by embedding posts in concrete foundation as indicated.] [Provide removable mounting by [[a steel] [an aluminum]] [[sleeve] [flange]] embedded in concrete as indicated.]

2.1.3   Changeable Letter Directories

****

NOTE: The directories specified are standard changeable-letter type. Message strip types are also available. Cork board can be substituted for molded backing to provide bulletin boards. Lettering is available in sets of upper case, lower case, and numerals or as individual characters.

Melamine plastic (MP) header plates are a tough phenolic core material that is suitable for non-direct sun exterior usage and is recommended for

raised lettering and braille.
****

2.1.3.1 Frame and Trim

Aluminum alloy finish must be [_____].

2.1.3.2 Header Plates

[Header plate must consist of background metal matching frame and having raised letters attached through the back.] [Header plate must consist of acrylic with raised acrylic letters.] [Header plate must consist of MP plastic with raised letters.]

2.1.3.3 Door Glazing

Door glazing must be [clear safety or tempered glass minimum 6 mm 1/4 inch thick.] [clear acrylic sheet 4.8 mm 3/16 inch thick.] [clear polycarbonate sheet [4.8] [6.4] mm [3/16] [1/4] inch thick.]

2.1.3.4 Door Construction

Door frame must be of same material and finish as surrounding frame. Corners must be mitered [, reinforced] [, welded], and assembled with concealed fasteners. Hinges must be standard with manufacturer, in finish to match frames and trim. Glazing must be set in frame with resilient glazing channels.

2.1.3.5 Door Locks

Door locks must be manufacturer's standard and must be keyed alike.

2.1.3.6 Fabrication

Frames and trim must be assembled with corners [reinforced] [welded] and mitered to hairline fit, with no exposed fasteners. Removable changeable directory panel must consist of [6 mm 1/4 inch thick white acrylic with clear acrylic letter tracks] [exterior grade plywood] [aluminum] [rubber] back with [vinyl] [polycarbonate] [corkboard] covering backgrooved 6 mm 1/4 inch on centers to receive letters.

2.1.3.7 Finishes

Post finish must be [semi-gloss baked enamel] [or] [two-component acrylic polyurethane] [anodized conforming to AA DAF45] [_____]. Metal panel system finish must be [baked enamel or two-component acrylic polyurethane] [anodized conforming to AA DAF45 [_____], as shown].

2.1.3.8 Mounting

Directories must be mounted to supporting structures with concealed fasteners in accordance with manufacturer's instructions.

2.1.3.9 Changeable Letters

****
NOTE: Allow for changes and message replacement by specifying a sufficient number of letters for future use. For other lettering types, special equipment

may be required to apply messages. If so, be sure to include the equipment and operating instructions. In areas where vandalism is a problem, acrylic solvent may be used to glue letters to the background. This limits changing of the message.

****

Changeable letters must be upper-case or upper and lower-case [helvetica medium] [_____]. Tabbed vinyl letters and numbers must be furnished in accordance with the [drawings] [and] [schedule].

2.2 ILLUMINATION

****

NOTE: Coordinate illumination with Division 26 and available electric service.

Exterior signs with the message "EMERGENCY" should be connected to an emergency power source.

****

Concealed lighting must be provided within panel framing members. Lighting must be controlled by a photocell device. [Top] [Back] lighting must be provided by [T-12 slimline lamps, [120] [277] [_____] volt, 60-hertz, single-phase, Type 1, or Type 2 ballast] [_____]. Ballast must be integrally mounted, high power factor and rated for use down to minus 29 degrees C minus 20 degrees F ambient starting temperature. Ballast and wiring within the sign must be in metal raceways. Electrical equipment must be UL or FM listed and comply with NFPA 70. Illumination must be evenly distributed. A switch on the interior of the sign must be provided to turn off power in the sign. Switch must be readily accessible when sign is open.

2.3 GRAPHICS FOR EXTERIOR SIGNAGE SYSTEMS

2.3.1 Graphics

****

NOTE: Choose the appropriate paragraph for the graphics application. The process of silk-screening for large areas, type, etc. does not weather properly without proper protective overspray protection with UV inhibitors.

****

Signage graphics must conform to the following:

[a. [Cast] [Custom fabricated] [Plate] aluminum letters, [6] [13] [_____] mm [1/4] [1/2] [_____] inch thick must be provided and fastened to the message panel with concealed fasteners. Letters must project [_____] mm inches from face of panel.]

[b. Pressure sensitive precision cut vinyl letters [with reflecting surface] [_____] must be provided.]

[c. Message must be applied to panel using the silkscreen process. Silkscreened images must be executed with photo screens prepared from original art. Handcut screens will not be accepted. Original art must be defined as artwork that is a first generation pattern of the original specified art. Edges and corners must be clean. Rounded corners, cut or ragged edges, edge buildup, bleeding or surfaces pinholes will not be accepted.]

[d. Message letters must be cut out from panel. Panel cutouts must be backed with [2.0 mm 0.080 inch FRP] [3.2 mm 0.125 inch acrylic] where cutouts occur.]

[e. Message must be cut out from panel. Acrylic letters [3] [6] [13] mm [1/8] [1/4] [1/2] inch thick must be projected through the cutout area and chemically welded to 3.2 mm 0.125 inch thick acrylic backup sheet.]

[f. Message must be embedded in FRP sheet and completely covered with thermosetting polyester resin. Message must be embedded minimum 0.8 mm 1/32 inch. Sheets must be processed in one piece, in one process, to prevent delamination.]

[g. Message must be applied using the frisket method. Photomechanically reproduced graphic masks must be applied to the sign face which has been coated with the graphics color. A background must then be applied to the exposed surfaces. Handcut masks will not be accepted. Edges that are nicked, cut, or ragged will not be acceptable. A protective overcoat containing UV-resistant additives must be applied.]

[h. Message must be engraved in non-corrosive, three-ply fiberglass laminate. Message must be core color or paint filled multiple colors.]

2.3.2 Messages

****

NOTE: Choose typeface consistent with total signage system and Activity Standards. Show message content, sizes, and colors on drawings or in a message schedule.

****

See [drawings] [and] [schedule] for message content. Typeface: [Helvetica medium] [_____]. Type size [_____] [as indicated].

2.4 METAL PLAQUES

Design and location of plaques must be as indicated.

2.4.1 Cast Metal Plaques

2.4.1.1 Fabrication

Cast metal plaques must have the logo, emblem and artwork cast in the [bas relief] [flat relief] [_____] technique. Plaques must be fabricated from [prime aluminum] [bronze] [yellow brass].

2.4.1.2 Size

Plaque size must be [_____] [as indicated].

2.4.1.3 Border

Border must be [flat band] [plain edge] [bevel] [custom ornamental as indicated] [_____].

2.4.1.4 Background

Background texture must be [leather] [fine pebble] [_____].

2.4.1.5 Mounting

Mounting must be [concealed] [rosettes and anchors] [rosettes and toggle bolts] [invisible] [_____].

2.4.1.6 Finish

Finishes must consist of [aluminum light colored sandblasted background. Letters must be satin polished and entire plaque must be sprayed with two coats of clear lacquer.] [aluminum with background sprayed dark gunmetal colored lacquer. Letters must be satin polished and entire plaque sprayed with two coats clear lacquer.] [bronze with dark finish oxidized background. Letters must be satin polished and entire plaque sprayed with two coats of clear lacquer.] [[aluminum] [bronze] with sprayed background. Letters must be satin polished.]

2.4.2 Chemically Etched Metal Plaques

2.4.2.1 Fabrication

Plaque must be chemically [single-] [double-] etched one-piece [brass] [bronze] [_____] [0.8128] [1.6256] [3.175] [6.35] mm [0.032] [0.064] [0.125] [0.250] inch thick.

2.4.2.2 Size

Plaque size must be [_____] [as shown].

2.4.2.3 Finish

[Single-etched raised areas must be in [gold-tone] [silver-tone] [bronze-tone] finish and recessed areas must be colorfilled.] [Double-etched raised areas must be [gold-tone] [silver-tone] and recessed textured areas must be [gold-tone] [silver-tone] colorfilled.]

2.4.3 Frost and Surface Oxidized Plaques

2.4.3.1 Fabrication

Plaque must be frosted and surface oxidized one - piece [anodized aluminum] [brass] [bronze] [stainless steel] [1.02] [3.175] mm [0.040] [0.125] inch thick.

2.4.3.2 Size

Plaque size must be [_____] [as shown].

2.4.3.3 Finish

[Material finish must be [satin] [polished].] [Frosted areas must be oxidized [black for aluminum or stainless steel] [or] [black or brown, for brass or bronze].]

2.5 DIMENSIONAL BUILDING LETTERS

****

NOTE: These letters are for direct application to exterior building surfaces. Drawings must show mounting type details.

****

2.5.1 Fabrication

Letters must be fabricated from [cast aluminum] [cast bronze] [2.29 mm 0.090 inch aluminum sheet] [3.17 mm 0.125 inch aluminum sheet] [extruded aluminum] [_____]. Letters must be cleaned by chemical etching or cleaned ultrasonically in a special degreasing bath. Letters must be packaged for protection until installation.

2.5.2 Typeface

Typeface must be [helvetica medium] [_____] [as indicated].

2.5.3 Size

Letter size must be [_____] [as indicated].

2.5.4 Finish

[Anodized aluminum] [Baked enamel or two-component acrylic polyurethane] [[Polished] [Oxidized] bronze with clear coat] finish must be provided.

2.5.5 Mounting

[Threaded studs] [Steel U-bracket, cap screws, and expansion bolts] of number and size as recommended by manufacturer, must be used for concealed anchorage. Letters which project from the building line must have stud spacer sleeves. Letters, studs, and sleeves must be of the same material. Supply templates for mounting.

2.6 ALUMINUM ALLOY PRODUCTS

Aluminum alloy products must conform to ASTM B209M ASTM B209 for sheet or plate, ASTM B221M ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings. Aluminum extrusions must be provided at least 3 mm 1/8 inch thick and aluminum plate or sheet at least 16 gauge thick. Welding for aluminum products must conform to AWS C1.1M/C1.1.

2.7 ANODIC COATING

****

NOTE: Edit the following requirements as necessary for the project.

****

Anodized finish must conform to AA DAF45 as follows:

[Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.010 mm 0.4 mil or thicker.]

[Integrated color anodized designation AA-M10-C22-A32, Architectural Class 0.010 to 0.018 mm 0.4 to 0.7 mil.]

[Electrolytically deposited color - anodized designation AA-M10-C22-A34, Architectural Class II 0.010 to 0.018 mm 0.4 to 0.7 mil.]

2.8 ORGANIC COATING

****

NOTE: Edit this paragraph to include only types and finishes being used.

****

Clean, prime and give surfaces a [semi-gloss baked enamel] [or] [two-component acrylic polyurethane] finish in accordance with NAAMM AMP 500, AMP 505, with total dry film thickness not less than 0.030 mm 1.2 mils.

2.9 STEEL PRODUCTS

Structural steel products must conform to ASTM A36/A36M. Sheet and strip steel products must conform to ASTM A1011/A1011M. Welding for steel products must conform to AWS D1.2/D1.2M.

2.10 CAST BRONZE

Fabricate components with sharp corners, flat faces, and accurate profiles. Remove and polish burrs and rough spots. Finish faces to a uniform high luster. Cast bronze must be in accordance with ASTM B62.

2.11 VINYL SHEETING FOR GRAPHICS

Vinyl sheeting must be 5 to 7 year premium type and must be in accordance with the flammability requirements of ASTM E84 and must be a minimum 0.08 mm 0.003 inch film thickness. Film must include a precoated pressure sensitive adhesive backing, Class 1, or positionable pressure sensitive adhesive backing, Class 3.

2.12 GLASS

Glass must be in accordance with ASTM C1036, Type I, Class 1, Quality q3 and ANSI Z97.1.

2.13 FIBER-REINFORCED POLYESTER (FRP) PANELS

Fiber-reinforced polyester (FRP) must be in accordance with ASTM D3841, Type II, Grade 1, Class 124, [_____] [as indicated].

2.14 ACRYLIC SHEET

Acrylic sheet must be in accordance with the flammability requirements of ASTM E84 and must conform to ANSI Z97.1.

2.15 POLYCARBONATE SHEET

Polycarbonate sheet must conform to SAE AMS3611.

2.16 ANCHORS AND FASTENERS

Exposed anchor and fastener materials must be compatible with metal to which applied and must match in color and finish and must be non-rusting, non-corroding, and non-staining. Exposed fasteners must be tamper-proof.

2.17 SHOP FABRICATION AND MANUFACTURE

2.17.1 Factory Workmanship

Work must be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled must be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws must be drilled or punched. Drilling and punching must produce clean, true lines and surfaces. Welding to or on structural steel must be in accordance with AWS D1.1/D1.1M. Welding must be continuous along the entire area of contact. Exposed welds must be ground smooth. Exposed surfaces of work must have a smooth finish and exposed riveting must be flush. Fastenings must be concealed where practical. Items specified to be galvanized must be by hot-dip process after fabrication if practical. Galvanization must be in accordance with ASTM A123/A123M and ASTM A653/A653M, as applicable. Other metallic coatings of steel sheet must be in accordance with ASTM A924/A924M. Joints exposed to the weather must be formed to exclude water. Drainage and weep holes must be included as required to prevent condensation buildup.

2.17.2 Dissimilar Materials

****

NOTE: If signs are to have extensive metal parts or are to be anchored to structural steel, include this paragraph. Otherwise edit as appropriate.

****

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces must be protected with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.

2.17.3 Shop Painting

Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel, and zinc-coated work, must be given one coat of zinc-molybdate primer or an approved rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice. Surfaces of items to be embedded in concrete must not be painted. Upon completion of work, damaged surfaces must be recoated.

2.18 COLOR, FINISH, AND CONTRAST

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NOTE: Color must be specified in this paragraph unless identified elsewhere in finish paragraphs. Delete color portion if covered elsewhere.

Editing of color reference sentence(s) must be coordinated with the Government. Generally the 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an Architect or Interior designer. Color must be selected from manufacturers standard colors or identified as a manufacturers color in this specification only when the project is very simple and has minimal

finishes. Coordinate choice of colors with manufacturer's information as regards to color fastness. Coordinate color selections with installation standards, if one exists.

When the Government directs that color be located in the drawings a note must be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

****

Color must be [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.] [as indicated on the drawings.] [selected from manufacturers standard colors.] [[_______.] Color listed is not intended to limit the selection of equal colors from other manufacturers.] For buildings required to be handicapped-accessible, the characters and background of signs must be eggshell, matte, or other non-glare finish. Characters and symbols must contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION

3.1 INSTALLATION

Signs, plaques, or dimensional letters must be installed in accordance with approved manufacturer's instructions at locations shown on the approved detail drawings; submit drawings showing elevations of each type of sign; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction. A schedule showing the location, each sign type, and message must be included. Circuits installed underground must conform to the requirements of Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Steel conduits installed underground and illuminated signage mounted directly on buildings must be in conformance with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Signs must be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs mounted on other surfaces must not be installed until finishes on such surfaces have been completed. Submit manufacturer's installation instructions and cleaning instructions.

3.1.1 Anchorage

Anchorage and fastener materials must be in accordance with approved manufacturer's instructions for the indicated substrate. Anchorage not otherwise specified or indicated must include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

3.1.2 Protection and Cleaning

The work must be protected against damage during construction. Hardware and electrical equipment must be adjusted for proper operation. Glass, frames, and other sign surfaces must be cleaned in accordance with manufacturer's instructions. After signs are completed and inspected, cover all project identification, directional, and other signs which may mislead the public. Covering must be maintained until instructed to be removed by the Contracting Officer or until the facility is to be opened for business. Submit [six] [_____] copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions must include simplified diagrams for the equipment as installed. Signs must be cleaned, as required, at time of cover removal.

3.2 FIELD PAINTED FINISH

Miscellaneous metals and frames must be field painted in accordance with Section 09 90 00 PAINTS AND COATINGS. Anodized metals, masonry, and glass must be protected from paint. Finish must be free of scratches or other blemishes.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-10 14 00.20 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-10 14 00.20 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

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INTERIOR SIGNAGE

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-10 14 00.20 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-10 14 00.20 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 10 14 00.20

INTERIOR SIGNAGE
08/20

****

NOTE: This guide specification covers the requirements for common types of signs, dimensional letters, and metal plaques used inside buildings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: This section covers some of the more common interior sign types. When other sign types are to be used, such as elevator-related signs, occupancy load signs and structural load limit signs, specifications will be modified accordingly. Buildings will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ARA) Accessibility Guidelines except for Army buildings excluded by TI 800-01 Design Criteria.

Reference UFC 3-120-01 available at Unified Federal Criteria Design: Sign Standard for design,

construction and placement of signs.

In combination with this specification, drawings and attachments will include a location plan, dimensions, elevations, schedules, content, details and such other information as required to indicate the extent of the work. The same terminology and designations used in the specification will be used on the drawings, schedules and attachments.

Product selections must be based on quality, functionality, aesthetic values, appearance, and cost as related to project needs.

Use of personal names on interior signage is discouraged. If personal names are required, changeable message strips will be used. Consider coordination of interior signage within this specification with signage required on individual workstations which is specified in Section 12 59 00 SYSTEMS FURNITURE.

Interior stairwell signage will be provided in accordance with Life Safety Code NFPA 101, Chapter 5, and applicable occupancy chapters. Clearly define interstitial spaces or other doorways within stairwell that do not lead to a horizontal exitway with signage that states "Not an Exit".

Permanent information on room identification signs includes the room number on all room identification signs, symbol and message on toilet rooms, message on janitor closets, mechanical/electrical and communications rooms, and message identifying stairs, when those identification signs are placed at doorways to permanent spaces.

Where appropriate for MEDICAL FACILITIES, include the following requirements for signage:

1. Room numbering for spaces within the medical facility will be determined jointly by the using facility and the design team. See UFC 4-510-01 Design: Medical Military Facilities. Room numbering will be consistent throughout the facility. For inpatient medical facilities, rooms with audiovisual nurse call must have a unique user room number, since audiovisual nurse call is tied into a digital paging system. For outpatient clinics, rooms with tonevisual nurse call, do not need a unique user room number, since tonevisual nurse call is hardwired to a panel located at a nursing station. Room numbering should address the following issues:

a. Wayfinding within clinics and other departments (user room #).

b. Facility Maintenance (architectural room #).

c. Audiovisual Nurse Call (inpatient) (unique user room #).

d. Tonevisual Nurse Call (outpatient) (user room #).

2. The use of symbols/graphics on interior signage will be limited. International symbols and graphics will be used where needed. Symbols are not required to be raised. Recommended symbols include men/women symbol for toilet rooms and showers, men/women symbol with wheel chair for accessible toilets, men/women symbol with key for locker rooms, telephone symbol for public telephone areas, information symbol (?), radiation symbol, biohazard symbol, and the international symbol for accessibility.

3. Arrow placement order on interior signage will comply with UFC 4-510-01 Design: Medical Military Facilities. Left pointing arrows at top of sign, followed by up pointing arrows, then right pointing arrows at bottom of sign. Messages per arrow direction will be organized alphabetically. Example follows:

< EMERGENCY
< Pediatrics
< Radiology
^ Orthopedic Clinic
> Admissions

4. Signage schedule should be provided in electronic spreadsheet format. Schedule will include architectural room number, user room number, type of sign, message, symbol (if needed), color, and mounting location.

5. Building directories and accompanying orientation maps for the medical facility will be determined jointly by the using facility and the design team. Orientation maps, if required, will be included as part of the interior signage package, and should be of the same manufacturer. Include international symbols for information (?), parking areas (upper case P within circle), public toilet rooms, public telephones, and graphic north arrow on orientation maps. Orientation map is to be positioned so that building left is viewer's left.

6. Large, easy to read signs over reception counters, check-in counters, information desks, or departments will be provided. Signs should be either ceiling mounted or affixed to soffit directly above counters.

7. Room identification signs should be 203 mm by 203 mm 8 by 8 inch or 229 mm by 229 mm 9 by 9 inch.

Justification of room number and message will be flush left.

8. Fire evacuation signs will be provided in accordance with the local Fire Marshal, if required.

9. Overhead directional signs should not block fire exit signs.

10. Signage will clearly define all staff, public, or patient toilet rooms.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes
AA PK-1	(2015) Pink Sheets: Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings & Ingot

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2604	(2017a) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in

	Buildings - Safety Performance Specifications and Methods of Test

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2017) Standard And Commentary Accessible and Usable Buildings and Facilities
ICC/ANSI A117.1	(2009) Accessible and Usable Buildings and Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 101	(2024) Life Safety Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 800-82	(2015; Rev 2) Guide to Industrial Control Systems (ICS) Security

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems
DODI 8500.01	(2014) Cybersecurity
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Room Identification And Directional Signage System; G, [_____]

Room Identification Sign with Patient Information; G, [_____]

Stair Signage; G, [_____]

Exit Door Tactile Sign; G, [_____]

Building Directories; G, [_____]

Door Tags; G, [_____]

SD-04 Samples

Interior Signage; G, [_____]

Software; G, [_____]

Room Identification And Directional Signage System; G, [_____]

Room Identification Sign with Patient Information; G, [_____]

Stair Signage; G, [_____]

Exit Door Tactile Sign; G, [_____]

Building Directories; G, [_____]

Door Tags; G, [_____]

SD-10 Operation and Maintenance Data

Approved Manufacturer's Instructions; G, [_____]

Protection and Cleaning; G, [_____]

[1.3 EXTRA MATERIALS

Provide [_____] extra frames and extra stock of the following: [[_____] blank plates of each color and size for [all sign types included in project][_____].] [[_____] changeable message strips for sign type [_____].] Provide [[_____] paper inserts and [laser print templates to support end-user printing copy] [one][_____] copy of the software for user produced signs and inserts after project completion] [and equipment necessary for removal of signage parts and pieces.]

]1.4 QUALITY ASSURANCE

1.4.1 Samples

Submit interior signage samples of each of the following sign types showing typical quality, workmanship and color: [all sign types included in project] [Room Identification and Directional Signage System] [Room Identification with Patient Information], [Stair Signage], [Exit Door Tactile Sign], [Door Tags], [Building Directories], [Metal Plaques], [Dimensional Building Letters], [Pressure Sensitive Letters]. Approved samples may be installed in the work, provided each sample is identified and location recorded.

1.4.2 Detail Drawings

Submit detail drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, mounting height, shape and thickness of materials, and details of construction. Include a schedule showing the location, each sign type, and message.

1.4.3 Sign Fabricator

Sign Fabricator to follow room number strategies created by designer. The room numbering system to be reviewed and approved by the Contracting Officer and command end users during the shop drawing phase, and prior to fabrication.

1.4.4 Cybersecurity

a. The cybersecurity process is documented in DOD 8510.01 and NIST SP 800-82. Refer to UFC 4-010-06 and DODI 8500.01 for additional requirements.

b. All control systems or information technology equipment require certification to operate. Coordinate with the Government to initiate and complete the accreditation process.

c. Cybersecurity requires input from the system vendor or provider and support from the local IMD. The local IMD-IA office is the point of contact for all Cyber Security requirements. The local CMIO is the point of contact for all clinical and functional system requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

Package materials to prevent damage and deterioration during shipment, handling, storage and installation. Deliver products to the jobsite in manufacturer's original packaging and store in a clean, dry area in accordance with manufacturer's instructions.

1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective interior signage materials and workmanship for a period of [2] [_____] years from date of final acceptance of the work.

PART 2 PRODUCTS

****

NOTE: Delete signage systems, directories, etc., not required for project. Coordinate electrical requirements with Division 26 and building electrical design.

****

2.1 ROOM IDENTIFICATION AND DIRECTIONAL SIGNAGE SYSTEM

****

NOTE: Depending on the complexity of the project consider a modular signage system or a panel sign system. A modular sign system is one comprised of extruded aluminum structural rails and end caps. Each part of the sign is inserted into these rails separately. Modular signs are easily updatable in the field and do not require the whole sign to be removed to make changes. Panel signs are made up of a single backer unit, each portion of the sign is permanently attached to this backer unit. These signs are typically more affordable however any changes to the sign requires that the entire sign is removed and remade, except when using changeable inserts. Coordinate project requirements and specific signage system with user.

For the purpose of this specification, message strips are made of vinyl with applied or direct print characters or messages that slide into the aluminum extrusions of a modular sign. Inserts are paper or acetate that allow ease in changing and updating as required. These inserts are under a non-glare acrylic window.

****

Provide signs, plaques, directories, and dimensional building letters that are standard products of manufacturers regularly engaged in the manufacture of such products that essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening. Obtain signage from a single manufacturer with edges and corners of finished letter forms and graphics true and clean.

[2.1.1 Panel Sign Systems

Provide [direct print acrylic with applied [tactile] [second surface] graphics, sign is fabricated of 10 mm 0.375 inch acrylic in two layers with smooth edge conforming to ANSI Z97.1] [decorative laminate face with applied [tactile] graphics, sign is fabricated of a balanced core sandwiched between 0.89 mm 0.035 inch standard grade high pressure laminated faces]. Provide signs that can accept [images] [raised copy and Braille with printable message inserts] [printable message inserts]. Provide paper or acetate inserts with a 2 mm 0.080 inch thick non glare acrylic window to allow sign to be updated.[_____]

][2.1.2 Modular Sign Systems

Provide manufactured pre-engineered component-based sign system, consisting of a combination of aluminum extrusions and injection molded parts, pre-engineered and designed to create an updatable sign system that allows for easy and inexpensive updates and changes. Provide system with incremental widths and heights that permit the assembly of multiple inserts of variable size to create a single sign. Provide a tamper-resistant sign which requires a special tool to change inserts composed of [extruded aluminum for applied graphics] [rigid plastic for applied graphics] [extruded aluminum with slots for secondary inserts]. [Provide continuous [extruded aluminum] [_____] [[interlocking] [removable]] endcaps in [[square] [radius] [bevel] [contour]][3 mm 1/8 inch][6 mm 1/4 inch] [_____] thick] profile. Sign inserts are required to be [front] [side] loading.

]2.1.3 Standard Room Signs

Provide signs that include tactile letters, symbols and Braille for interior rooms or spaces where the sign is not likely to change over time. Tactile text descriptions are required for pictograms that are provided to identify a permanent room. Examples include interior signs that label restrooms, stairs, room numbers or letters, and room names. These permanent room signs can include paper inserts for updatable information.

2.1.3.1 Tactile Letters, Symbols and Braille

Provide ADA compliant material per 36 CFR 1191 which is raised 0.79 mm 1/32 inch from the first surface, has a minimum 16 mm 5/8 inch in height and is an ADA acceptable font. The color of the tactile letters is required to contrast with the sign face color per ADA standards. The ADA required Braille has a minimum durometer reading of 90. All raised letters, numbers and symbols are to comply.

2.1.4 Directional Signs

Directional signs provide arrows with messages which point to critical destinations such as departments, offices, or other pertinent destinations. These can be a panel sign system with a series of permanently attached messages or a modular system with updatable inserts. Directional signs have header panels with applied or direct print messages.

2.1.5 Message Inserts

****

NOTE: The insert preparation method most appropriate to each building should be chosen, and the same method should be used consistently throughout the building. Requirements for sign-making equipment or software will be determined jointly by the using facility and the designer. If using other than standard paper, require extra stock be provided.

****

Provide updatable message inserts covered with a clear matte 0.38 mm 0.015 inch vinyl protective overlay. The insert is [typeset message laser printed on paper card stock] [large format color print on white photo paper] [direct printed clear acetate over large format color print on white photo paper].[Provide[paper and] software with message template for creating text and symbols for computers identified for Government production of paper inserts after project completion.] Manufacturer is required to offer online ordering capabilities to facilitate and expedite ordering packages of replacement, color-coated paper inserts.[Furnish one [suction][_____] device to assist in removing face sheet.][Provide sliding inserts that slide horizontally exposing different graphic information as identified on the drawings.]

2.1.6 Type of Mounting for Signs

Provide surface mounted signs mounted with [concealed mechanical fastening through the holders] [countersunk mounting holes in plaques and mounting screws]. Secure inserts in holders [with flexible plastic clips] [when captured by side profiles of extruded aluminum holders]. [Mount framed plaques with manufacturer's standard (1/6 inch) 1.59 mm thick closed cell vinyl foam with adhesive backing. Adhesive must be transparent, long aging, high tech formulation on two sides of the vinyl foam. Double-faced tape consisting of acrylic adhesive on polyurethane foam used in conjunction with silicone adhesive [magnetic tape].] Provide signs with aluminum ceiling/projecting mount attachment extrusion to secure to ceiling or wall surface, along with matting ceiling/projecting mount track extrusion for hanging, projecting, and double-sided signs. Provide mounting for ceiling/projecting mount attachment extrusion by mechanical fasteners, selected based on wall or ceiling conditions. Mount track extrusion hinges over width of mount attachment and secured with 3.5 by 0.06 mm (6-32 inch) by 6 mm (1/4 inch) cone point stainless steel set screws.

2.1.7 Character Proportions and Heights

Letters and numbers on signs conform to 36 CFR 1191.

2.2 ROOM IDENTIFICATION SIGN WITH PATIENT INFORMATION

****

NOTE: Maintain this Article if designing a medical facility with in-patient rooms. Use this sign instead of room sign at the entrance to patient rooms.

****

2.2.1 Sign Faces

Provide sign faces of clear acrylic or PETG plastic with 3 mm 0.125 inch thickness minimum, with dimensions of sign face being [manufacturer's standard] [as indicated]. Sign faces can be direct printed and contain two window openings for acrylic inserts; include a space for ADA compliant room tactile and Braille. Sign faces may also have approved printed logos for brand recognition.

2.2.2 Sign Backs

Provide sign backs of acrylic or PETG plastic that is welded to the sign face and has two window openings for inserts. The window openings are minimum 5 mm 0.1875 inch in depth. The dimensions of the sign back are equal to the sign face.

2.2.3 Room Identification Tactile Letters

Provide ADA compliant material per 36 CFR 1191 which is raised 0.79 mm 1/32 inch from the first surface, has a minimum 16 mm 5/8 inch in height and is an ADA acceptable font. The color of the tactile letters is required to contrast with the sign face color per ADA standards. The ADA required Braille has a minimum durometer reading of 90.

2.2.4 Risk Management Alert Inserts (RM)

Provide all signs with RM inserts. The RM inserts are required to fit into one of the two window openings in the sign back and be visible through one of the two window openings of the sign face. The tabs can be in the same position on all the RM inserts and labeled differently.

2.2.5 Isolation Precaution Signage Inserts (IP)

Provide all signs with 5 IP inserts. The IP inserts are required to fit into the larger of the two window openings in the sign back and be visible through the corresponding window opening of the sign face. Stagger the tabs on each of the inserts.

2.3 STAIR SIGNAGE

Provide signs on stairs serving three or more stories with special signage within the enclosure at each floor landing conforming to NFPA 101. Indicate the floor level, the terminus of the top and bottom of the stair enclosure, and the identification of the stair enclosure. Also, state the floor level of, and the direction to, exit discharge. Locate the signage inside the enclosure in a position that is visible when the door is in the open or closed position and install in conformance with 36 CFR 1191. Provide tactile for floor level designation in accordance with ICC A117.1.

2.4 EXIT DOOR TACTILE SIGN

Provide tactile sign with the message EXIT at each exit door that requires an exit sign to conform with NFPA 101. Sign tactile message is to comply with ICC/ANSI A117.1.

2.5 BUILDING DIRECTORIES

Provide building directories as lobby directories or floor directories, with a changeable directory listing consisting of the areas, which can include departments, offices, personnel and other destinations located within the facility as well as a map with "you are here" locations. Provide dimensions, details, and materials of sign and message content as indicated on the drawings.

2.5.1 Header Panel

Header panel has [background metal to match frame] [acrylic with raised acrylic letters][ES/MP plastic with raised letters] [_____].

2.5.2 Directory Graphics

****

NOTE: All artwork is the responsibility of the sign fabricator for graphic content and nomenclature. The concept design and final solution will be developed with the Government's review and final approval.

****

Provide graphics and text that are first generation from camera ready art.

[2.5.2.1 Orientation Map

Provide a color-coded floor plan graphic outline for each building level. Individual building functions and public accessible departments are identified using a unique color and numerical "address" number. Building and department names are tied to the floor plan's numerical address.

][2.5.2.2 Monitor Graphic Displan

The orientation map for each level of the building is displayed at all times, along with the Department listing of names. The Government will verify their preference to list the names in alphabetical order, followed by the plan "address", or an alternate sequence.

][2.5.2.3 Other Graphics

Graphic artwork is used to indicate the location of elevators, stairways, public restrooms, and information stations. Graphic artwork includes the macro-wayfinding terminology and locations, i.e. 1A, 1B, 2A, & 2B, or alternate language developed by the Government for wayfinding destinations.

]2.5.3 Doors

2.5.3.1 Door Glazing

Provide door glazing with 6 mm 1/4 inch thick polished [clear] [tinted] glass, fully tempered in accordance with ASTM C1048 (Kind FT) and ANSI Z97.1.

2.5.3.2 Door Construction

Provide extruded aluminum door frame of same finish as surrounding frame; mitered corners [, welded], and assembled with concealed fasteners. Provide continuous concealed hinges in [finish to match frames and trim] [stainless steel]. Set glazing in frame with clear silicone adhesive.

2.5.3.3 Door Locks

Provide manufacturer's standard door locks; keyed alike. Provide two sets of keys.

2.5.4 Fabrication

Provide extruded aluminum frames and trim with welded corners and mitered to a hairline fit, with no exposed fasteners.

2.5.5 Illuminated Units

****

NOTE: Coordinate illumination with Division 26 and building electrical design.

****

Provide illuminated directory units with concealed internal [top] [back] lighting with [LED] [_____] light source, internal wiring, and lead at wire for connection. [Units using LED light sources must have integral LED drivers. Units with remote LED drivers are not acceptable.] Electrical work complies with NFPA 70; UL or FM listed. Directory consists of [backlit photo negative directory strips and a black background.][screen printed or vinyl copy applied to acrylic, metal, or high-pressure plastic laminate strips] [vinyl or screen printed lettering on plastic film held in interchangeable plastic carriers] [screen printed or vinyl copy laminated to magnetic tape] [updatable photo paper insert, printed and laminated] [changeable aluminum bands, painted and direct printed] [changeable aluminum insert slots that accept a user-printed cardstock insert]. Design of unit as indicated on the drawings. Provide unit with tinted [tempered safety solar glass][_____] door.

2.5.5.1 Construction

The directory is [25][51][102] mm [1][2][4][_____] inch[es] deep frame constructed of [aluminum with [[satin [black][painted][dark bronze]][natural satin] [_____] anodized finish]] [_____] [wood with [natural] [stained] finish]. Unit is [[semi][fully] recessed][surface][_____] mounted. Unit has a [76][_____] mm [3][_____] inch header size and lettering as shown. Unit has a [10][_____] mm [3/8][_____] inch face door frame with concealed hinges and locking system or other secure method. Door frame matches [directory material and finish][_____].

2.5.5.2 Message Strips

Message strips are [photo negative type updatable photo paper by user][sized in accordance with manufacturer's standard][as indicated on the drawings][_____]. Provide letters and numbers in accordance with the drawings.

2.5.6 Non-Illuminated Unit

Directory consists of a non-illuminated unit with [machine or laser engraved copy in interchangeable acrylic, metal, or high-pressure plastic laminate strips] [screen printed or vinyl copy applied to acrylic, metal, or high-pressure plastic laminate strips] [vinyl or screen printed lettering on plastic film held in interchangeable plastic carriers] [screen printed or vinyl copy laminated to magnetic tape][updatable photo paper insert, printed and laminated] [changeable aluminum bands, painted and direct printed] [changeable aluminum insert slots that accept a user-printed cardstock insert]. Design of unit as indicated on the drawings.

2.5.6.1 Construction

The directory is [25][51][102] mm [1][2][4][_____] inch[es] deep frame constructed of [aluminum with [[satin [black][painted][dark bronze]][natural satin] [_____] anodized finish]] [_____] [wood with [natural] [stained] finish]. Unit is [[semi][fully] recessed][surface][_____] mounted. Unit has a [76][_____] mm [3][_____] inch header size and lettering as shown. Unit has a [10][_____] mm [3/8][_____] inch face door frame with concealed hinges and locking system or other secure method. Door frame matches [directory material and finish][_____].

2.5.6.2 Message Strips

Message strips are [updatable by user][sized in accordance with manufacturer's standard][as indicated on the drawings][_____]. Provide letters and numbers in accordance with the drawings.

2.5.7 Electronic Directory System

****

NOTE: The electronic directory system is a limited usage item and must be fully justified prior to being specified. Coordinate power and data requirements with electrical drawings. When system is integrated into building or other electronic

controls, coordinate with the requirements of UFC 4-010-06 CYBERSECURITY OF FACILITY-RELATED CONTROL SYSTEMS and include the appropriate, edited Division 25 INTEGRATED AUTOMATION UFGS sections in the project.

****

Coordinate electronic directory system requirements with Division 25 INTEGRATED AUTOMATION UFGSs. Provide [non-interactive][interactive] electronic directory. Provide electronic directory system as a complete turnkey system consisting of digital display, hardware, software connected through the local area network (LAN) to a [server][cloud]. Electrical equipment is UL listed and complies with NFPA 70. Unit is [free-standing][wall mounted].

2.5.7.1 Hardware Requirements

Provide hardware as standard products of manufacturers regularly engaged in the production of electronic directory and digital wayfinding solutions. Hardware is [surface-mounted], [recessed], [free-standing kiosk] or [component system with mounting bracket]. [Landscape] [Portrait] orientation. Provide commercial grade, HD or UHD resolution flat panel LCD monitors. Provide commercial grade touch interfaces that can be serviced independently of the monitor itself. Enclosures and kiosks fabricated in a US based facility.

2.5.7.2 Accessibility Requirements

Provide an electronic display [with interactivity] that meets the following ADA requirements: Directory does not protrude more than 102 mm 4 inches from the wall, maintains a maximum touchable height of 1219 mm 48 inches with a reach of 254 mm 10 inches installed at a minimum of 686 mm 27 inches off the floor, and supports ADA compliance for hearing impaired by providing text based or video based messaging for any calling functionality.

2.5.7.3 Wayfinding Requirements

Provide mapping with animated wayfinding capable of sending maps digitally to users via SMS or QR codes.

2.5.7.4 Management and Support Requirements

All management of the digital directory is provided centrally through a password authenticated server. All listings and content must be backed up to a secondary or "cloud-based" location for redundancy. Providers of directory solutions must be capable of offering full initial input of tenant data, creation of all wayfinding maps, and any modifications to design through service or support offers.

****

NOTE: The comprehensive sign documents include a "Door Tag"sign type that reflects the architectural floor plan room number. These signs are used by facilities for reference to system schedules and are not for public wayfinding purpose.

****

2.6 DOOR TAGS

Provide one door tag plate for each room entry door. In size [as indicated on drawings][_____]. Provide room number [to match architectural floor plan room number][as determined by Contracting Officer].

2.6.1 Engraved Copy

Machine engrave letters, numbers, symbols, and other graphics into panel sign on face to produce precisely formed copy and sharp images, incised to uniform depth. Melamine plastic engraving stock used for ADA compliant graphic is three-ply lamination contrasting color core meeting ASTM D635.

2.7 METAL PLAQUES

2.7.1 Cast Metal Plaques

2.7.1.1 Fabrication

Provide cast metal plaques with the logo, emblem and artwork cast in the [bas relief] [flat relief] [_____] technique; fabricated from [prime aluminum] [bronze] [brass] [_____].

2.7.1.2 Border

Border is [flat band][single line][straight edge][single line bevel][double line][bevel][custom ornamental][_____].

2.7.1.3 Finish

Letter Finish	[satin] [polished]
Background Finish	[[light][dark] aluminum][[dark][ ] bronze]
Background Texture	[leather][pebble][smooth][sculpted][ ]

2.7.1.4 Mounting

Provide [concealed] [rosettes and anchors] [rosettes and toggle bolts] [_____] mounting.

2.7.2 Chemically Etched Metal Plaques

2.7.2.1 Fabrication

Plaque is chemically etched one-piece or photochemically engraved metal sheet or plate [aluminum][stainless steel][brass][commercial bronze][zinc][magnesium][_____] [0.81][1.63][3][6][_____] mm [0.032][0.064][0.125][0.250][_____] inch thick.

2.7.2.2 Finish

[Single-etched raised areas are [gold-tone] [silver-tone] [bronze-tone] finish and recessed areas are color filled.] [Double-etched raised areas are [gold-tone] [silver-tone] and recessed textured areas are [gold-tone] [silver-tone] color filled.]

2.8 DIMENSIONAL BUILDING LETTERS

****

NOTE: These letters are for direct application to interior building surfaces. Drawings must show mounting type details.

****

2.8.1 Fabrication

Letters are [cast][cutout][fabricated channel][molded plastic][aluminum][bronze][brass][acrylic][_____]. Package letters for protection until installation.

2.8.2 Size

Letter size is [_____] [as indicated]. Provide letter thickness that is [manufacturer's standard for the size of letter][_____].

2.8.3 Finish

Provide [[mill][clear anodized][[light][medium][dark] anodized bronze]] [[polished] bronze with clear coat] [baked enamel] [powder coat][two-component acrylic polyurethane] finish.

2.8.4 Mounting

[Threaded studs][Steel U-bracket, cap screws, and expansion bolts][concealed screw through structural rail] of number and size recommended by manufacturer; concealed anchorage. Letters which project from the mounting surface have [stud spacer sleeves] [_____]. Letters, studs, and sleeves are of the same material. Supply templates for mounting.

2.9 PRESSURE SENSITIVE LETTERS

****

NOTE: Use pressure sensitive letters for direct application to building interior surfaces such as glass and doors. Be sure surface of material will accept adhesion of letters. Show locations, message content, sizes, and colors on drawings or in a message schedule.

****

2.9.1 Fabrication

Ensure that vinyl letter edges and corners of finished letterforms and graphics are true and clean. Do not use letterforms and graphics with rounded positive or negative corners, nicked, cut, or ragged edges.

2.9.2 Size

Letter size: [as indicated][_____].

2.10 MATERIALS

2.10.1 Aluminum Alloy Products

Aluminum extrusions are at least 3 mm 1/8 inch thick, and aluminum plate or sheet are at least 1.3 mm 0.0508 inch thick. Extrusions conform to ASTM B221M ASTM B221; plate and sheet conforms to ASTM B209M ASTM B209. Where anodic coatings are specified, alloy conforms to AA PK-1 alloy designation 514.0. Exposed anodized aluminum finishes are as shown. Welding for aluminum products conforms to AWS D1.2/D1.2M.

2.10.2 Anodic Coating

Anodized finish conforms to AA DAF45 as follows:

a. [Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.010 mm 0.4 mil or thicker.]

b. [Integral color anodized designation AA-M10-C22-A32, Architectural Class 0.010 to 0.018 mm 0.4 to 0.7 mil.]

c. [Electrolytically deposited color-anodized designation AA-M10-C22-A34, Architectural Class II 0.010 to 0.018 mm 0.4 to 0.7 mil.]

2.10.3 Organic Coating

Organic coating conforms to AAMA 2604, with total dry film thickness not less than 0.030 mm 1.2 mils.

2.10.4 Plastic Laminate Sheet

ANSI/NEMA LD 3, general purpose HGS grade, 1.22 mm 0.048 inch nominal thickness.

2.10.5 Fabrication and Manufacture

2.10.5.1 Factory Workmanship

Holes for bolts and screws are drilled or punched. Drilling and punching produces clean, true lines and surfaces. Exposed surfaces of work have a smooth finish; exposed riveting is flush. Conceal fastenings where practicable.

2.10.5.2 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces prevent galvanic or corrosive action.

2.10.6 Typeface

[ADA-ABA compliant font for Room Signs][Helvetica Neue][_____].

2.11 GRAPHICS

****

NOTE: Edit the following requirements as necessary for the project. Graphics methods that are easily vandalized, such as vinyl first surface copy and acrylic characters bonded to acrylic will not be permitted. The direct print first surface copy method is generally used for mass produced signs. Surface applied graphics that can be easily picked off or peeled will not be accepted.

****

Provide signage graphics for modular signs to the following:

[2.11.1 Subsurface Copy

Copy is transferred to the back face of clear acrylic sheeting forming the panel face to produce precisely formed opaque image. This method bonds all sign elements (color, graphics, lettering, Braille and substrate) into a single unit.

][2.11.2 First Surface Copy Direct Print (Non-Tactile)

Message may be applied to panel using a direct print process. Original art is defined as artwork that is a first generation reproduction of the specified art. Provide clean edges and corners.

][2.11.3 Photopolymer

Integral graphics and Braille achieved by photomechanical stratification processes. Provide photopolymer used for ADA compliant graphics of the type that has a minimum durometer reading of 90. Tactile graphics are raised 0.79 mm 1/32 inch from the first surface of plaque by photomechanical stratification process.

][2.11.4 Engraved Copy

Machine engrave letters, numbers, symbols, and other graphics into panel sign on face to produce precisely formed copy and sharp images, incised to uniform depth. Melamine plastic engraving stock used for ADA compliant graphic is three-ply lamination contrasting color core meeting ASTM D635.

][2.11.5 Graphic Blast Raised Copy

Background is sandblasted to a uniform depth of 0.79 mm 1/32 inch leaving raised text and Braille. Background is factory-finished with polyurethane paint.

][2.11.6 [Cast][Fabricated][Solid] Aluminum Letters

Provide [3][6][_____] mm [1/8][1/4][_____] inch thick and fasten to the message panel with concealed fasteners.

]2.12 COLOR, FINISH, AND CONTRAST

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally, Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an architect or interior designer. Color must be selected from manufacturers' standard colors or identified as a manufacturers' standard color in this specification only when the project is very simple and has minimal finishes.

When the government directs that color be located in the drawings a note must be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another

manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

Signage background color should be in high contrast with signage copy. Dark background with light copy is preferred.

****

Provide color [as specified in Section 09 06 00 SCHEDULES FOR FINISHES] [as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers]. Finish of eggshell, matte, or other non-glare finish for all signs as required in handicapped-accessible buildings.

PART 3 EXECUTION

[3.1 PLACEMENT SCHEDULE

SIGNAGE PLACEMENT SCHEDULE				
Door/Room Number	Sign Type	Text	Insert(s)	Symbol/Remarks
[_______]	[_______]	[_______]	[_______]	[_______]

]3.2 INSTALLATION

Install signs plumb and true and in accordance with approved manufacturer's instructions at locations shown on the [detail drawings] [schedule below] [attachments]. Submit operating instructions outlining the step-by-step procedures required for system operation. The instructions include simplified diagrams for the system as installed, the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Provide each set permanently bound with a hard cover. The following identification must be inscribed on the covers: "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the facility, name of the Contractor, and contract number. Submit in accordance with Section 01 78 23 OPERATING AND MAINTENANCE DATA. Mounting height and mounting location complies with 36 CFR 1191. Install required blocking. Do not install signs on doors or other surfaces until finishes on such surfaces have been installed. Signs installed on glass surfaces are installed with matching blank back-up plates in accordance with manufacturer's instructions. [Provide illuminated signage in conformance with the requirements of Section 26 51 00 INTERIOR LIGHTING.]

Do not install items that show visual evidence of biological growth.

3.2.1 Anchorage

Provide anchorage in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown includes slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Provide exposed anchor and fastener materials compatible with metal to which applied with matching color and finish.

a. Signs mounted to painted gypsum board surfaces must be removable for painting maintenance.

b. Mount signs to lay-in ceiling grids with clip connections to ceiling tees.

c. Install signs mounted on metal surfaces with magnetic tape.

d. Install signs mounted on fabric surfaces with hook and loop tape or pin mount.

e. Install signs to workstation panels with panel clips.

3.2.2 Protection and Cleaning

Protect the work against damage during construction. Adjust hardware and electrical equipment for proper operation. Clean glass, frames, and other sign surfaces at completion of signage installation in accordance with the manufacturer's written instructions.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-10 14 53 (February 2015)**
Change 1 - 05/17

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

SECTION 10 14 53

TRAFFIC SIGNAGE

02/15, CHG 1: 05/17

****

NOTE: This guide specification covers the requirements for traffic signs and sign posts.

The use of state DOT specifications and standard detail drawings is encouraged.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 133	(2012; R 2016) Standard Specification for Preservatives and Pressure Treatment Processes for Timber
AASHTO M 168	(2007; R 2012) Standard Specification for Wood Products
AASHTO M 268	(2014) Standard Specification for Retroreflective Sheeting for Flat and Vertical Traffic Control Applications
AASHTO MASH	(2016) Manual for Assessing Safety Hardware - Second Edition

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA T1	(2024) Use Category System: Processing and Treatment Standard
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A499	(2015, R 2020) Standard Specification for Steel Bars and Shapes, Carbon Rolled from "T" Rails
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and

	Shapes
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM D4956	(2013) Standard Specification for Retroreflective Sheeting for Traffic Control
ASTM F436/F436M	(2024) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA SHS	(2004; Supplement 2012) Standard Highway Signs

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices
NCHRP 350	(1993) Recommended Procedures for the Safety Performance Evaluation of Highway Features

1.2 GENERAL

****

NOTE: If the project is located in a state that has their own MUTCD, signage must conform to the state DOT MUTCD. State DOT MUTCD's should be in substantial conformance with the national MUTCD. Where local standards are more stringent than the MUTCD, the local standards should be followed.

****

All signs must be in accordance with the MUTCD. Any signs not detailed on the drawings must be in accordance with the FHWA SHS.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Traffic Sign Posts

FHWA Acceptance Letter

Traffic Sign Retroreflective Sheeting

SD-04 Samples

Flexible Posts

PART 2 PRODUCTS

2.1 TRAFFIC SIGN POSTS

****

NOTE: Sign posts located within the clear zone of roads and streets must be a breakaway or yielding design meeting the crashworthiness criteria of NCHRP 350 or the Manual for Assessing Safety of Hardware (MASH) or must be shielded by guardrail, barrier, or an energy absorbing system meeting the requirements of NRCRP 350 or AASHTO MASH. FHWA acceptance letters for various breakaway supports for signs are available on the FHWA Safety Program webpage.

Ensure details of sign posts are included in the drawings. Breakaway support anchor posts may extend no more than 100 mm 4 inches above grade to lessen the probability of snagging the undercarriage of a vehicle after a support has broken away from its base. Extend anchor posts at least 450 mm 18 inches below grade.

****

2.1.1 Steel Flanged Channel Section (U-Shape)

Fabricate steel posts from steel conforming to ASTM A36/A36M or ASTM A499 and with a minimum yield strength of 207 MPa 30 ksi and a minimum tensile strength of 345 MPa 50 ksi. Punch or drill 7.9 to 9.5 mm 5/16 to 3/8 inch diameter holes spaced at 25.4 or 50.8 mm 1 or 2 inch centers along the centerline of the web prior to galvanizing for the entire length of the post. Galvanize posts after punching in accordance with ASTM A123/A123M.

2.1.2 Perforated Steel Tube

Fabricate steel posts from steel conforming to either ASTM A653/A653M, structural steel, Grade 340 50, Class 1, coating designation G90 or ASTM A1011/A1011M, structural steel, Grade 340 50, hot-dip galvanized after punching in accordance with ASTM A123/A123M. Prepunch holes approximately 11.1 mm 7/16 inch in diameter spaced at approximately 25.4 mm 1 inch centers along each side of the tube for the entire length of the post.

2.1.3 Steel Tube

****

NOTE: Fill in the required Test Level (TL) if triangular slip bases are used.

NOTE: Sign supports are tested at two levels under NCHRP 350. TL-2 includes four tests conducted at speeds of 35 and 70 km/hr. TL-3 includes four tests conducted at speeds of 35 and 100 km/hr.

Sign supports are tested at three levels under MASH. TL-1 includes three tests conducted at speeds of 30 and 50 km/hr. TL-2 includes three tests conducted at speeds of 30 and 70 km/hr. TL-3 includes three tests conducted at speeds of 30 and 100 km/hr.

****

Conform to ASTM A500/A500M, Grade B or C, and hot-dip galvanized in accordance with ASTM A123/A123M. [Manufactured triangular slip bases must be approved by the Federal Highway Administration (FHWA) for use under the provisions of NCHRP 350, TL-[_____] or AASHTO MASH, TL-[_____]. Submit a copy of the FHWA Acceptance Letter.]

2.1.4 Structural Steel H Section

Conform to ASTM A709/A709M, Grade 345 50 or 345W 50W. Galvanize posts, fuse plate and splice plate after fabrication in accordance with ASTM A123/A123M.

2.1.4.1 Slip Base, Fuse Plate and Splice Plate

Conform to ASTM A36/A36M, minimum yield strength 345 MPa 50,000 psi.

2.1.4.2 High-Strength Bolts, Nuts and Washers

High strength bolts must conform toASTM F3125/F3125M. Nuts must conform to ASTM A563M ASTM A563. Washers must conform to ASTM F436/F436M. High strength bolts, nuts and washers must be zinc coated.

2.1.5 Wood

****

NOTE: Wood species and preservative type conforming to applicable state DOT standards and specifications may be specified in lieu of the requirements below.

****

Wood posts must be dry no. 1 grade Douglas fir, southern or Ponderosa pine, hemlock, spruce, or western larch conforming to AASHTO M 168. Treat the posts with water-borne preservative according to AASHTO M 133, AWPA T1 and AWPA U1.

2.2 FLAT ALUMINUM SIGN PANELS

Aluminum sign panels must conform to ASTM B209M ASTM B209, alloy-temper 6061-T6 or 5052-H38. The blanks must be free from laminations, blisters, open seams, pits, holes, other defects that may affect their appearance or use. The thickness must be uniform and the blank commercially flat.

2.3 EXTRUDED ALUMINUM SIGN PANELS

****

NOTE: Extruded aluminum sign panels are used for large signs.

Delete aluminum edge molding if not used.

****

Conform to ASTM B221MASTM B221, alloy 6063-T6. The maximum allowable deviation from flat on the face is 4.2 mm per meter 0.05 inches per foot. [Aluminum edge molding must be in accordance with ASTM A320/A320M or SAE J405d austenitic steel, minimum yield strength of 207 MPa 30,000 psi.]

2.4 TRAFFIC SIGN RETROREFLECTIVE SHEETING

All background sheeting applied to flat sheet and extruded panel signs must be in accordance with ASTM D4956, Type III, IV, VII, VIII, IX or XI retroreflective sheeting and must have Class 1, 3, or 4 adhesive backing. Retroreflective sheeting must be high intensity that is an unmetallized micro prismatic reflective material.

Retroreflective sheeting must have sufficient adhesion, strength and flexibility such that the sheeting can be handled, processed and applied according to the manufacturer's recommendations without appreciable stretching, tearing, cracking or other damage.

2.4.1 Legend and Border

Apply retroreflective sheeting as legend and border in accordance with ASTM D4956, Type IX, XI, or AASHTO M 268 Type C or D, Class 1. Retroreflective sheeting must be an unmetallized cube corner microprismatic reflective material. Retroreflective sheeting applied as legend and border for specific signing applications, without a datum mark on the surface of the sheeting, must be evaluated for rotational sensitivity in accordance with AASHTO M 268, Section 3.3.1 and fabricated in accordance with AASHTO M 268, Section 3.3.2.

2.4.2 Screen Printed Transparent Colored Areas

For screen printed transparent colored areas or transparent colored overlay films on white sheeting, the coefficient of retroreflection (RA) must be no less than 70 percent of the original values for the corresponding color.

2.4.3 Adhesive Performance

Adhesive performance for retroreflective sheeting must be in accordance with ASTM D4956. The sheeting surface must be in condition to be readily screen processed and compatible with transparent overlay films, plus recommended transparent and opaque screen process colors. Furnish manufacturer's information as to the type of solvent or solvents that may be used to clean the surface of the sheeting without detrimental loss of performance and durability.

2.5 LETTERS, NUMERALS, ARROWS, SYMBOLS, AND BORDERS

Apply letters, numerals, arrows, symbols, and borders on the retroreflective sheeting or opaque background of the sign using the direct or reverse screen process. Apply messages and borders of a color darker than the background to the paint or the retroreflective sheeting using the direct process. Messages and borders must be of a color lighter than the sign background and applied using the reverse screen process. Use opaque or transparent colors, inks, and paints of the type and quality recommended by the retroreflective sheeting manufacturer in the screen process. Perform the screening in a manner that results in a uniform color and tone, with sharply defined edges of legends and borders and without blemishes on the sign background that will affect intended use. Air dry or bake the signs after screening according to the manufacturer's recommendations to provide a smooth hard finish. Reject any signs with blister's or other blemishes.

2.6 DELINEATOR POSTS

2.6.1 Steel Posts

Fabricate posts from steel conforming to ASTM A36/A36M or ASTM A499 and having a minimum yield strength of 207 MPa 30 ksi and a minimum tensile strength of 345 MPa 50 ksi. Galvanize posts after punching in accordance with ASTM A123/A123M.

2.6.2 Flexible Posts

****

NOTE: Indicate the color of post on the drawings.

****

Provide [one-piece driveable] [or] [two-piece with driveable steel anchor] flexible posts. Posts must be impact-resistant, integrally colored UV stabilized polymer or polycarbonate extrusion or fiberglass reinforced composite material. Other materials are subject to approval by the Contracting Officer's Representative. Include a retroreflective sheeting plate with each post as indicated.

2.7 DELINEATOR RETROREFLECTORS

2.7.1 Circular Prismatic Reflectors

Retroreflectors attached to steel posts must be a 75 mm 3-inch minimum diameter acrylic plastic lens with prismatic optical elements and a smooth, clear, transparent face. Fabricate the back from similar material and fuse to the lens around the entire perimeter to form a homogeneous unit. Permanently seal the units against the intrusion of dust, water, or air. Mount the retroreflector unit in a housing fabricated from 1.6 mm 0.063-inch aluminum alloy or similar, or from cold-rolled, hot dip, galvanized steel, having a thickness of 1.6 mm 0.064 inches. Provide the indicated color.

2.7.2 Retroreflective Sheeting

A retroreflective sheeting plate must be applied to each flexible post by the post manufacturer and must be in accordance with ASTM D4956, Type III, IV, V, VII, VIII, IX or XI retroreflective sheeting. Retroreflective sheeting must be high intensity that is an unmetallized cube corner micro prismatic reflective material. Provide the size and color of the retroreflective sheeting plate as indicated.

2.8 HARDWARE

Bolts, nuts, post clips, lock and flat washers must be either aluminum alloy or commercial quality stainless steel, hot-dip galvanized or cadmium plated after fabrication. [Bolts/nuts must be an approved tamper resistant design.] Provide fiber washers of commercial quality.

2.9 CONCRETE

ASTM C94/C94M, using 19 mm 3/4 inch maximum aggregate, and having minimum compressive strength of 21 MPa 3000 psi at 28 days.

PART 3 EXECUTION

3.1 SIGN POSTS

****

NOTE: Sign supports located within the roadway clear zone must be designed to yield, fracture, or separate when impacted by a vehicle. Although the clear roadside concept is still the goal of the designer, compromises are often required in urban or restricted environment areas. Chapter 10 of the AASHTO Roadside Design Guide provides guidance for roadside safety in urban or restricted area. In these areas, sign supports located within the enhanced lateral offset should be designed to yield, fracture, or separate when impacted by a vehicle.

****

3.1.1 [Steel Flanged Channel Section] [Perforated Square Steel Tube] [Round Steel Tube]

Sign posts consist of a base post and sign post. [Drive steel sign base posts with a suitable driving head. Attach sign posts to base posts. Replace any base posts damaged during driving or otherwise at no additional cost to the Government.] [Embed steel sign base posts in concrete as indicated.] [Install manufactured triangular slip bases in accordance with the manufacturer's instructions.]

3.1.2 Structural Steel H Section Posts

****

NOTE: Ensure the drawings indicate the procedure for tightening bolts and the required torque.

****

Tighten all breakaway assembly bolts in a systematic manner to the prescribed torque indicated. Loosen each breakaway assembly bolt and re-tighten to the required torque in the same order as the initial tightening. Burr the threads at the nut using a center punch to prevent the nut from loosening. Tighten nuts on hinge plate bolts to the required minimum bolt tension values indicated.

3.1.3 Wood

Drill holes in the post as indicated.

3.2 SIGN PANELS

Clean, degrease and etch the face of metal panels using methods recommended by the retroreflective sheeting manufacturer. After cleaning and degreasing, apply retroreflective sheeting material to the sign panels as recommended by the manufacturer. Perform shearing, cutting and punching prior to preparing the blanks for application of reflective material. Do not field drill holes in any part of the panel. Use nylon washers recommended by the sign sheeting manufacturer between the bolt heads and sign faces on flat sheet aluminum signs. Replace any damaged sign panels at no additional cost to the Government.

3.3 DELINEATORS

****

NOTE: Flexible delineators driven into the soil require a manufacturer's installation tool to install.

****

Drive steel delineator posts into the ground in a manner that will not damage the post. Attach flexible delineator posts to steel anchors [or drive into the soil in accordance with the manufacturer's instructions]. Demonstrate the method of installation for the Contracting Officer's Representative to verify that posts will be installed without being damaged.

3.4 LOCATION AND POSITION OF SIGNS

****

NOTE: Some State DOT single post sign mounting details bend the sign panel. If this type of mounting detail is used, delete the requirement for flat sign face surface.

****

Locate and erect all signs in accordance with the drawings and MUTCD. Vertically mount signs at right angles to the direction of, and facing, the traffic that they are intended to serve. Where mirror reflection from the sign face is encountered to such a degree as to reduce legibility, turn the sign slightly away from the road. Turn signs that are placed 9 m 30 feet or more from the pavement edge toward the road. On curved alignments, determine the angle of placement by the direction of approaching traffic rather than by the roadway edge at the point where the sign is located. Mounted signs must present a smooth flat surface varying no more than 10 mm 3/8 inch from a 1.2 m 4-foot straightedge placed in any position on the face of the sign after erection. Mount signs on traffic signal posts with strap or clamp type sign supports. Each installed sign will be inspected by the Contracting Officer's representative prior to acceptance by the Government.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-10 21 13 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-10 21 13 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

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TOILET COMPARTMENTS

08/20

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-10 21 13 (August 2020)**

Preparing Activity: USACE **Superseding**
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****

SECTION 10 21 13

TOILET COMPARTMENTS

08/20

****

NOTE: This guide specification covers the requirements for ceiling-hung, floor anchored, and overhead-braced toilet partitions.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Army facilities will meet the requirements of UFC 3-101-01 and will be accessible in accordance with 36 CFR 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Partition napkin disposal, toilet-tissue dispenser, grab bars, and other similar toilet-room accessories are specified in a separate section. Coordinate partition cutouts and reinforcement as required for the specified accessories.

If ceiling-hung toilet partitions are required for

the project, coordinate with metal fabrications and shop drawings for installation of indicated supporting members.

Include in the drawings:

Locations and dimensions of the partitions, doors, pilasters, screens, and door swings.

Heights of the bottoms of enclosures and screens above the floor

Method of support to be employed, using details where needed for clarity.

Provisions for attaching hardware to partitions.

A schedule to identify the finish and color to be used.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A336/A336M	(2023) Standard Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts
ASTM A385/A385M	(2022) Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM B36/B36M	(2023) Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar
ASTM B86	(2023) Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B456	(2017; R 2022) Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D2583	(2013a) Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D6386	(2022) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces

	for Painting
ASTM D7611/D7611M	(2013; E 2014) Standard Practice for Coding Plastic Manufactured Articles for Resin Identification
ASTM D7803	(2019) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CSA GROUP (CSA)

CSA B45.5-17/IAPMO Z124	(2017; Errata 2017; Errata 2018) Plastic Plumbing Fixtures

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2017) Standard And Commentary Accessible and Usable Buildings and Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NSF INTERNATIONAL (NSF)

NSF/ANSI 51	(2023) Food Equipment Materials

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS2460	(2023; Rev B) Plating, Chromium

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60003	(Basic; Notice 1) Partitions, Toilet, Complete

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

Cleaning and Maintenance Instructions

Colors And Finishes

Painted Metal

Sound-Deadening Cores

Anchoring Devices and Fasteners

Hardware and Fittings

Brackets

Door Hardware

Toilet Enclosures

Room Entrance Screens

Urinal Screens

Pilaster Shoes

Finishes; G, [_____]

[Recycled content for painted steel partitions and screens; S]

[Recycled content for stainless steel partitions and screens; S]

[Recycled content for plastic laminate partitions and screens; S]

[Recycled content for solid phenolic partitions and screens; S]

SD-04 Samples

Colors and Finishes; G, [_____]

Hardware and Fittings

Anchoring Devices and Fasteners

SD-07 Certificates

Warranty

[Indoor air quality for plastic laminate clad partitions and screens; S]

[Indoor air quality for solid phenolic, black core partitions and screens; S]

SD-10 Operation and Maintenance Data

Plastic Identification; G, [_____]

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality

1.3.1.1 Laminated Plastic and Solid Phenolic Products

****

NOTE: The Government's preference is for use of products that have been certified for indoor air quality by a third-party organization such as Greenguard or SCS Global Services. However, it must be verified there is a certified product available that is both cost effective and appropriate for the project. The requirements of this paragraph are invoked when the designer of record confirms local/regional availability of Greenguard or SCS products and includes the bracketed requirements for indoor air quality certified products in Part 2 of this Section.

****

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body.

1.4 REGULATORY REQUIREMENTS

Comply with to ICC A117.1 code for access for the handicapped operation of toilet compartment door and hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the manufacturer's original unopened packages with the brand, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated; free from dust, water, other contaminants, and damage during delivery, storage, and construction.

****

NOTE: Edit the warranty based on product selected. Depending on product used and manufacturer, warranties vary drastically between products. Also note some manufacturers have different warranties between construction, materials and hardware.

****

1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for a period of [one year][____] [years] from date of final acceptance of the work.

PART 2 PRODUCTS

****

NOTE: Painted metal (Finish 1) toilet enclosures, urinal screens, and room entrance screens are suitable for use in installations where the partitions are subjected to normal usage and exposure conditions. Solid phenolic black core (Finish 4), solid phenolic color through core (Finish 4A), solid polyethylene (Finish 5), and homogeneous filled acrylic (Finish 6) should be used unless not economically feasible. Composite materials are generally not recyclable at the end of their useful life. Any plastic or metal materials used must contain recycled materials as indicated. Plastic laminate clad (Finish 3) toilet partitions will not be used where severe water conditions will be encountered, such as where cleaning is to be performed by spraying water.

Where toilet partitions are indicated for hard usage or severe exposure areas, finishes other than painted metal (Finish 1) or plastic laminate clad (Finish 3) should be specified when their high initial cost can be justified through life cycle cost. The least expensive painted metal finish is generally the least durable of the finishes listed in CID A-A-60003. Plastic laminate clad (Finish 3) costs more than the painted metal and less than stainless steel (Finish 2), solid phenolic (Finish 4 or 4A), or solid polyethylene (Finish 5), or homogeneous filled acrylic (Finish 6). Plastic laminate clad (Finish 3) finishes are hard and smooth; resistant to wear, scratches, periodic moisture, impact, acids and alkalis, and cigarette burns.

Next to stainless steel (Finish 2), solid phenolic (Finish 4 and 4A), solidpolyethylene (Finish 5), and homogeneous filled acrylic (Finish 6) are the most durable finishes available. When finishes other than painted metal (Finish 1) are being considered, plastic laminate clad (Finish 3) should be the next logical choice, followed by solid phenolic (Finish 4 and 4A), solid polyethylene (Finish 5), homogeneous filled acrylic (Finish 6) and stainless steel (Finish 2). Solid polyethylene (Finish 5), stainless steel (Finish 2), homogeneous filled acrylic (Finish 6), and solid phenolic (Finish 4 and 4A) are highly resistant to humidity, steam, detergents, cleaning chemicals and corrosion. Interior fire and smoke finish classification must be addressed when materials other than metal partitions are being considered. Edit the following paragraphs for styles and finishes.

Generally, floor-supported enclosures, Style A, will be used; and overhead braced enclosures, Style C, and overhead braced-alcove, Style F, will be used when pilasters cannot be anchored into minimum 76 mm 3 inches thick structural concrete. Ceiling hung enclosures, Style B, will be used only when the

additional cost is justified for reasons of sanitation or appearance. Ceiling hung enclosures, Style B, are not recommended by manufacturers when ceiling height is greater than 2.59 m 8 feet 6 inches. Urinal screens, when deemed necessary, may be any of the 6 styles available, but the floor to ceiling hung screen, Style D, is the most justifiable for reasons of cost and sanitation. Type II, Style D, room entrance screens are generally the most durable style due to the floor to ceiling post support design. Edit as needed to meet project requirements.

If ceiling hung enclosures are to be used, details showing the structural steel channel support system should be shown on the drawings. This section should be coordinated with Section 10 28 13 TOILET ACCESSORIES and the drawings regarding toilet enclosures which will have partition-mounted accessories attached to the panels.

Screens and enclosures that are thicker than standard panels last longer, especially in high-use

****

2.1 SYSTEM REQUIREMENTS

Provide a complete and usable toilet partition system, including toilet enclosures, room entrance screens, urinal screens, system of panels, hardware, and support components. Furnish the partition system from a single manufacturer, with a standard product as shown in the most recent catalog data. Submit Fabrication Drawings for toilet partitions and urinal screens consisting of fabrication and assembly details to be performed in the factory. Submit manufacturer's Cleaning and Maintenance Instructions in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

2.1.1 Plastic Identification

****

NOTE: The marking system indicated below is intended to provide assistance in identification of products for making subsequent decisions as to handling, recycling, or disposal.

****

Verify that plastic products to be incorporated into the project are labeled in accordance with ASTM D7611/D7611M. Where products are not labeled, provide product data indicating polymeric information in the Operation and Maintenance Manual.

Type 1	Polyethylene Terephthalate (PET, PETE)
Type 2	High Density Polyethylene (HDPE)
Type 3	Vinyl (Polyvinyl Chloride or PVC)
Type 4	Low Density Polyethylene (LDPE)
Type 5	Polypropylene (PP)

Type 1	Polyethylene Terephthalate (PET, PETE)
Type 6	Polystyrene (PS)
Type 7	Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

2.2 MATERIALS

****

NOTE: Stainless steel is available in different textures. Determine the required texture and select appropriately under paragraph 2.3.2

****

2.2.1 Painted Metal (Finish 1)

Provide galvanized steel sheet cold-rolled, stretcher-level, commercial quality material, conforming to ASTM A653/A653M, with a Flame Spread Index of 0 and a Smoke Developed Index of 0. Surface preparation for painting to comply with [ASTM D6386, method for baked enamel] [or] [ASTM D7803 for powder coat].

2.2.2 Stainless Steel Sheet (Finish 2)

Provide stainless steel sheet conforming to ASTM A666, 300 series commercial stainless steel sheet suitable for exposed applications with a Flame Spread Index of 0 and a Smoke Developed Index of 0. Provide smooth material, without creases or ripples. Provide face sheet of minimum of 1.22 mm 0.048 inch (1.27 mm(18 gauge) thickness. Provide with [No. 4 finish] [manufacturer's standard textured finish][_____].

2.2.3 Plastic Laminate Clad (Finish 3)

Provide decorative matte finish plastic laminate bonded to resin impregnated particle board core with non-toxic adhesive, with a Flame spread Index of 75 or less and a Smoked Developed Index of 450 or less.

2.2.4 Phenolic Core (Finish 4) (Finish 4A)

Provide compressed cellulose fibers impregnated with resins. Provide smooth material without creases or ripples, with a Flame Spread Index of 75 or less and a Smoke Developed Index of 450 or less. The surface laminate is fused to the resin-impregnated core.

2.2.5 Solid Polyethylene Panels (Finish 5)

Provide high density polyethylene (HDPE) suitable for exposed application. Waterproof, non-absorbent and graffiti resistant textured surface with a Flame Spread Index of 75 or less, and a Smoke Developed Index of 450 or less.

2.2.6 Homogenous Filled Acrylic (Finish 6)

Cast, 100 percent acrylic solid polymer material composed of acrylic polymer, mineral fillers, and pigments that meets the following minimum performance requirements.

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Tensile Strength	281 kg/cm2 4000 psi (max.)	ASTM D638
Hardness	55-Barcol Impressor (min.)	ASTM D2583
Thermal Expansion	.0000414 cm/cm/degrees C .000023 in/in/degrees F (max.)	ASTM D696
Boiling Water Surface Resistance	No Change	ANSI/NEMA LD 3
High Temperature Resistance	No Change	ANSI/NEMA LD 3
Impact Resistance (Ball Drop)		ANSI/NEMA LD 3
6 mm 1/4 inch sheet	914 mm, 227 g 36 inches, 1/2 lb ball, no failure	
13 mm 1/2 inch sheet	3556 mm, 227 g 140 inches, 1/2 lb ball, no failure	
19 mm 3/4 inch sheet	5080 mm, 227 g 200 inches, 1/2 lb ball, no failure	
Mold and Mildew Growth	No growth	ASTM G21
Bacteria Growth	No growth	ASTM G21
Liquid Absorption (Weight in 24 hrs.)	0.1 percent max.	ASTM D570
Flammability		ASTM E84
Flame Spread	25 max.	
Smoke Developed	30 max.	
Sanitation	"Food Contact" approval	NSF/ANSI 51

2.2.7 Sound-Deadening Cores

****

NOTE: Leave this paragraph only if selecting Painted Metal (Finish 1) or Stainless Steel (Finish 2) partitions. All others do not have a sound deadening core.

****

Provide sound deadening consisting of treated kraft paper honeycomb cores with a cell size of not more than 25 mm 1 inch. Provide resin-material content weighing not less than 11 percent of the finished core weight. Face expanded cores on both sides with kraft paper.

2.2.8 Anchoring Devices and Fasteners

Provide steel anchoring devices and fasteners hot-dipped galvanized after fabrication, in conformance with ASTM A385/A385M and ASTM A123/A123M. Conceal all galvanized anchoring devices.

2.2.9 Brackets

Provide two-ear panel wall brackets, T-style, 25 mm 1 inch stock. Provide stirrup style panel-to-pilaster brackets.

2.2.10 Hardware and Fittings

2.2.10.1 General Requirements

Provide hardware for the toilet partition system that complies with CID A-A-60003 for the specified type and style of partitions. Provide hardware finish highly resistant to alkalis, urine, and other common toilet room acids. Comply with 36 CFR 1191 of latching devices and hinges for handicap compartments; provide [chrome-plated steel] [or] [stainless steel] devices and hinges with door latches that operate without either tight grasping or twisting of the wrist of the operator. Submit three samples of each item, including anchoring devices and fasteners. Approved hardware samples may be installed in the work if properly identified.

Material	Conformance Standard
Cold-rolled sheet steel	ASTM A336/A336M, commercial quality
Zinc-base alloy	ASTM B86, Alloy AC41-A
Brass	ASTM B36/B36M, Alloy C26800
Aluminum	ASTM B221M ASTM B221
Corrosion-resistant steel	ASTM A167, Type [302][304]

2.2.10.2 Finishes

[a. Provide chrome plating that complies with ASTM B456.

][b. Provide finish that complies with SAE AMS2460, Class I, Type [I][II].

][c. Provide aluminum with clear anodic coating that complies with AA DAF45.

][d. Provide corrosion-resistant steel with a No. 4 finish.

][e. Provide stainless steel with a No. 4 finish.

][f. Provide exposed fasteners that match the hardware and fittings.

]2.2.11 Door Hardware

2.2.11.1 Hinges

Provide adjustable hinges to hold in-swinging doors open at any angle up to 90 degrees and outswinging doors up to 10 degrees. Provide self-lubricating hinges with the indicated swing. Provide hinges that [are surface-mounted type] [are cutout-insert type] [are exposed pivot] [are semi-concealed] [and] [have the following type of return movement:

[a. Gravity return movement

][b. Spring-action cam return movement

][c. Torsion-rod return movement

]]2.2.11.2 Latch and Pull

Provide latch and pull that is a combination rubber-faced door strike and keeper equipped with emergency access. [Provide [surface mounted] [concealed] latch].

2.2.11.3 Coat Hooks

Provide coat hooks that are combination units with hooks and rubber tipped pins.

2.3 PARTITION PANELS AND DOORS

Fabricate partition panels, and pilasters of materials and construction listed:

Provide [[painted metal partition] [stainless steel partition] panels and doors in finished thickness of no less than 25 mm 1 inch and pilasters no less than 32 mm 1-1/4 inches, both with face sheets no less than [0.79 mm 0.031 inch] [0.97 mm 0.038 inch]]. [Phenolic partition panels not less than 13 mm 1/2 inch thick and door and pilasters not less than 19 mm 3/4 inch thick] [plastic laminated partition and door panels no less than [22 mm 7/8 inch] [25 mm 1 inch] thick and pilaster no less than 32 mm 1 1/4 inch thick] [plastic (HDPE) partition panels, doors and pilasters not less than 25 mm 1 inch thick] [homogenous filled acrylic partition panels and doors no less than 13 mm 1/2 inch thick and pilasters no less than 25 mm 1 inch thick].
[Provide painted metal toilet partitions and screens with recycled content of 27 percent minimum. Provide data identifying percentage of recycled content for painted steel partitions and screens.][Provide stainless steel toilet partitions and screens with recycled content of 50 percent minimum. Provide data identifying percentage of recycled content for stainless steel partitions and screens.] [Provide plastic laminate toilet partitions and screens with recycled content of 45 percent minimum. Provide data identifying percentage of recycled content for plastic laminate partitions and screens.] [Provide solid polyethylene toilet partitions and screens with recycled content of 30 percent minimum.]. [Provide homogeneous filled acrylic with recycled content of 6 percent minimum]. [Provide solid phenolic toilet partitions and screens with recycled content of 10 percent minimum].[Provide data identifying percentage of recycled content for solid phenolic partitions and screens.]

****

NOTE: Based on research, certain base materials such as plastic laminate clad and solid phenolic, black core are available from US national manufacturers as a reduced VOC product certified by Greenguard or SCS Global Services. Retain one of the last bracketed sentences requiring products with indoor air quality certification when the designer of record confirms local/regional availability of Greenguard or SCS products that does not impact cost effectiveness.

****

[[Provide plastic laminate clad and solid phenolic, black core toilet partitions and urinal screens to meet the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type)]. [Provide certification of indoor air quality for plastic laminate clad partitions and screens.][Provide certification of indoor air quality for solid phenolic, black core partitions and screens.]]

2.3.1 Toilet Enclosures

Provide toilet enclosures that comply with CID A-A-60003, Type I, Style [A, floor supported] [B, ceiling hung] [C, overhead braced] [F, overhead braced-alcove]. Furnish width, length, and height of toilet enclosures as shown. Finish surface of panels are [painted metal (Finish 1)][stainless steel (Finish 2)][plastic laminate clad (Finish 3)][solid phenolic, black core (Finish 4)][solid phenolic, color through the core (Finish 4A)][solid polyethylene (Finish 5)][homogenous filled acrylic (Finish 6)][_____]; water resistant; graffiti resistant; non-absorbent radius beveled edges. Reinforce panels indicated to receive toilet paper holders or grab bars for mounting of the items required, and provide cut outs for through partition toilet accessories. Provide grab bars to withstand a bending stress, shear stress, shear force, and a tensile force induced by 1112 N 250 lbf. Grab bars cannot rotate within their fittings.

2.3.2 Room Entrance Screens

****

NOTE: Delete the following paragraphs when screens are not required.

Length and height of room entrance screens will be shown on the drawings, using standard size panels and pilasters to the maximum extent practicable.

****

Provide room entrance screens that comply with CID A-A-60003, Type II, Style [A, floor anchored] [B, ceiling hung braced] [C, overhead braced] [D, wall hung] [_____]. Provide finish surface of screens to be [painted metal (Finish 1)][stainless steel (Finish 2)][plastic laminate clad (Finish 3)][solid phenolic, black core (Finish 4)][solid phenolic, color through the core (Finish 4A)][solid polyethylene (Finish 5)][homogenous filled acrylic (Finish 6)][_____]; water resistant; graffiti resistant; non-absorbent with radius beveled edges. Furnish length and height of screens as shown. Provide thickness to match toilet compartment panel construction. Fabricate screens from the same types of panels, pilasters, and fittings as the toilet partitions.

2.3.3 Urinal Screens

****

NOTE: Use of urinal screens between individual urinals will be dependent on the function of the facility. Use of urinal screens will normally be limited to those applications where sanitary protection is required, such as between a urinal and an immediately adjacent lavatory. Style A screens should normally be between 610 to 914 mm 24 to 36

inches wide. Style E screens should normally be between 457 to 610 mm 18 to 24 inches wide. Wall hung, Style E, urinal screens will be used only where the supporting construction is masonry or concrete. Where high use is expected, choose the last bracketed sentence.
****

Provide urinal screens that comply with CID A-A-60003, Type III, Style [A, floor supported] [B, ceiling hung] [C, overhead braced] [D, floor to ceiling hung] [E, floor to ceiling post supported] [F, wall hung]. Provide finish for surface of screens as [painted metal (Finish 1)][stainless steel (Finish 2)][plastic laminate clad (Finish 3)][solid phenolic, black core (Finish 4)][solid phenolic, color through the core (Finish 4A)][solid polyethylene (Finish 5)] [homogenous filled acrylic (Finish 6)][_____]; water resistant; graffiti resistant; non-absorbent with radius beveled edges; with manufacturer's standard post design of materials matching the thickness and construction of pilasters. Furnish width and height of urinal screens as shown. Provide thickness to match toilet compartment panel construction. Secure wall hung urinal screens with [a minimum of three wall stirrup brackets.] [1067 mm42 inches long, continuous flanges.] Fabricate screens from the same types of panels and pilasters as the toilet partitions. Use corrosion-resistant steel fittings and fasteners.

2.4   CEILING-HUNG PARTITIONS

****
NOTE: Delete this paragraph if ceiling-mounted partitions are not required.
****

Provide pilasters in size indicated that are manufacturer's standard corrosion resistant anchoring assemblies complete with leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Design anchoring device to transmit the strain and loading on the pilaster directly to the structural support above without putting strain or loading on the finished ceiling. Provide sleeves or caps at tops of pilasters to conceal anchorage.

2.5   FLOOR-ANCHORED PARTITIONS

****
NOTE: Delete this paragraph if floor-supported partitions are not required.
****

Provide pilasters in size indicated that are manufacturer's standard corrosion resistant anchoring assemblies complete with leveling adjustment nuts and pilasters for structural connection to floor. Provide anchoring device at the bottom of the pilaster consisting of a steel bar not less than 13 mm by 22 mm 1/2 by 7/8 inch welded to the reinforced face sheets and having not less than two 10 mm 3/8 inch round anchorage devices for securing to the floor slab. Provide anchorage devices complete with threaded rods, expansion shields, lock washers, and leveling-adjustment nuts. Provide shoes at pilasters to conceal anchorage.

2.6   OVERHEAD-BRACED PARTITIONS

****

NOTE: Delete this paragraph if overhead-braced partitions are not required.
****

Provide pilasters in sizes indicated that are manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism. Provide anchoring device at the bottom of the pilaster consisting of a channel-shaped floor stirrup fabricated from not less than 2 mm 0.0635 inch thick material and a leveling bolt. Secure the stirrup to the pilaster with not less than a 5 mm 3/16 inch bolt and nut after the pilaster is leveled. Secure the stirrup to the floor with not less than two lead expansion shields and sheetmetal screws. Fabricate overhead brace from a continuous extruded aluminum tube not less than 25 mm 1 inch wide by 38 mm 1-1/2 inch high, 3 mm 0.125 inch wall thickness. Finish is AA-C22A31 in accordance with AA DAF45. Set and secure brace into the top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.

2.7 PILASTER SHOES

Provide shoes at pilasters to conceal floor-mounted anchorage. Provide [aluminum] [stainless steel] [one piece molded HDPE] [_____] pilaster shoes. Height is a minimum 76 mm 3 inches.

2.8 HARDWARE

Provide hardware for the toilet partition system that complies with CID A-A-60003 for the specified type and style of partitions. [Provide hardware pre-drilled by manufacturer.] Use a hardware finish that is highly resistant to alkalis, urine, and other common toilet room acids. [Hardware includes: chrome plated nonferrous cast pivot hinges, gravity type, adjustable for door close positioning; nylon bearings; [black anodized] [chrome plated] [______] aluminum door latch; door strike and keeper with rubber bumper; and cast alloy chrome plated coat hook and bumper, [_____].] Provide latching devices and hinges for handicap compartments complying with 36 CFR 1191 and [chrome-plated steel] [or] [stainless steel] door latches that operate without either tight grasping or twisting of the wrist of the operator.[Use stainless steel, tamper proof type screws and bolts. Wall mounting brackets are continuous, full height, [aluminum] [stainless steel] [heavy duty plastic] [_____], in accordance with toilet compartment manufacturer's instructions.. Provide floor-mounted anchorage consisting of corrosion-resistant anchoring assemblies with threaded rods, lock washers, and leveling adjustment nuts at pilasters for structural connection to floor.]

2.9 COLORS AND FINISHES

2.9.1 Colors

****
NOTE: In areas where a high degree of damage, corrosion, and frequent replacement has been experienced or where, for reasons of sanitation or appearance, additional cost is justified, partition finishes should be selected on the basis of Life Cycle Cost Analysis (LCC). The LCC analysis should be performed for a period of not less than ten years. For any project requiring non-combustible

partitions, panels, screens, or door finishes, exclude finish No. 5.

Editing of color reference sentence(s) must be coordinated with the Government. Generally, Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an architect or interior designer. Color must be selected from manufacturers' standard colors or identified as a manufacturers' color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located in the drawings a note must be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

****

Provide color [as specified in Section 09 06 00 SCHEDULES FOR FINISHES.][as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.]

[Color of pilaster shoes matches the core of solid plastic compartments and screens.] Submit three samples showing color and a finished edge on two adjacent sides and core construction, each not less than 305 mm 12 inch square.

2.9.2 Finishes

2.9.2.1 Finishes No. 1 Through No. 3

Provide partitions, panels, screen, and door finishes that comply with CID A-A-60003 finished with [Painted Metal (Finish 1)][Stainless Steel (Finish 2)][Plastic Laminate Clad (Finish 3)].

2.9.2.2 Finishes No. 4, No 4A and No. 5

Provide manufacturer's standard [black core (Finish 4)][color through the core (Finish 4A)] [or] [solid polyethylene (Finish 5)] formed under high pressure rendering a single component section not less than 25 mm 1 inch thick. Colors extend throughout the panel thickness.

2.9.2.3 Finish No. 6

Provide homogeneous filled acrylic (Finish 6) with through body colors meeting CSA B45.5-17/IAPMO Z124.

PART 3 EXECUTION

3.1 PREPARATION

Take field measurements prior to the preparation of drawing and fabrication to ensure proper fits. Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work. Verify correct spacing of plumbing fixtures. Verify correct location of built in framing, anchorage, and bracing. Report in writing to Contracting Officer prevailing conditions that adversely affect satisfactory execution of the work of this section. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 METAL PARTITION FABRICATION

a. Fabricate metal partition panels, doors, screens, and pilasters required for the project from galvanized-steel face sheets with formed edges. Laminate face sheets via pressure to the sound-deadening core with edges sealed with a continuous locking strip and corners mitered and welded. Ground all welds smooth. Provide concealed reinforcement for installation of hardware, fittings, and accessories. Surface of face sheets must be , free from wave, warp, or buckle.

b. Before application of an enamel coating system, solvent-clean galvanized-steel surfaces to remove processing compounds, oils, and other contaminants harmful to coating-system adhesion. After cleaning,coat the surfaces with a metal-pretreatment phosphate coating. After pretreatment, finish exposed galvanized-steel surfaces with a baked-enamel coating system as specified.

c. Provide an enamel coating system consisting of a factory-applied baked acrylic enamel coating system. Provide a coating system that is a durable, washable, stain-resistant, and mar-resistant finish.

3.3 INSTALLATION

****

NOTE: Toilet partitions in barracks, and other hard usage areas, as well as those partitions on which grab bars are to be mounted, will be bolted to walls. Through-bolting will be specified for these applications; except, toggle bolts may be specified when through-bolting would be exposed in a finished room or would otherwise be unsuitable.

Select anchorage devices for types of wall construction as required.

****

Do not install items that show visual evidence of biological growth. Install partitions rigid, straight, plumb, and level, with the panels centered between the fixtures. Provide a panel clearance of not more than 13 mm 1/2 inch and secure the panels to walls and pilasters with continuous full height wall brackets. Locate wall brackets so that holes for wall bolts occur in masonry or tile joints. Secure panels to pilasters with brackets matching the wall brackets. Provide for adjustment due to minor floor variations. Locate head rail joints at pilaster center lines. Install adjacent components for consistency of line and plane. Equip each door with hinges, one door latch, and one coat hook and bumper. Align hardware to uniform clearance at vertical edges of doors.

a. Secure panels to hollow plastered walls with toggle bolts using not less than M6x1 1/4-20 screws of the length required for the wall thickness. Provide toggle bolts with a load-carrying strength of not less than 2668.9 N 600 pounds per anchor.

b. Secure panels to ceramic tile on hollow plastered walls or hollow concrete-masonry walls with toggle bolts using not less than M6x1 1/4-20 screws of the length required for the wall thickness. Provide toggle bolts with a load-carrying strength of not less than 2668.9 N 600 pounds per anchor.

c. Secure panels to solid masonry or concrete with lead or brass expansion shields designed for use with not less than M6x1 1/4-20 screws, with a shield length of not less than 38 mm 1-1/2 inches. Provide expansion shields with a load-carrying strength of not less than 2668.9 N 600 pounds per anchor.

d. Submit Installation Drawings for toilet partitions, room entrance screens, and urinal screens showing plans, elevations, details of construction, hardware, reinforcing and blocking, fittings, mountings and escutcheons. Indicate on drawings the type of partition, location, mounting height, cutouts, and reinforcement required for toilet-room accessories.

3.4 CEILING-HUNG PARTITIONS

****

NOTE: Delete this paragraph if ceiling-mounted partitions are not required.

****

Secure pilasters to the structural support above with the anchorage device specified. Make all leveling devices readily accessible for leveling, plumbing, and tightening the installation. Level the bottoms of doors with bottoms of pilasters when doors are in a closed position.

3.5 FLOOR-ANCHORED PARTITIONS

****

NOTE: Delete this paragraph if floor-anchored partitions are not required.

****

Secure pilasters to the floor with the anchorage device specified. Make all leveling devices readily accessible for leveling, plumbing, and tightening the installation. Level tops of doors with tops of pilasters when doors are in a closed position. Expansion shields have a minimum 51 mm 2 inch penetration into the concrete slab.

3.6 OVERHEAD-BRACED PARTITIONS

****

NOTE: Delete this paragraph if overhead-braced partitions are not required.
****

Secure pilasters to the floor with the anchorage device specified. Make all leveling devices readily accessible for leveling, plumbing, and tightening the installation. Secure overhead brace to the pilaster face with not less than two fasteners per face. Expansion shields have a minimum 51 mm 2 inch penetration into the concrete slab. Make tops of doors parallel with the overhead brace when doors are in a closed position.

3.7 FINAL ADJUSTMENT

After completion of the installation, make final adjustments to the pilaster-leveling devices, door hardware, and other working parts of the partition assembly. Doors have a uniform vertical edge clearance of approximately 5 mm 3/16 inch and rest open at approximately 30 degrees when unlatched.

3.8 CLEANING

Touch up baked enamel and powder coat finish with the same color of paint that was used for the finish. Clean all surfaces and adjacent surfaces soiled as a result of the work, in an approved manner compliant with the manufacturer's recommended cleaning and protection from damage procedures until accepted. Remove all equipment, tools, surplus materials, and work debris from the site.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-10 21 23.16 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 21 23.16 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 21 23.16

CUBICLE TRACK AND HARDWARE

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-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-10 21 23.16 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 21 23.16 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 10 21 23.16

CUBICLE TRACK AND HARDWARE
08/24

****

NOTE: This guide specification covers the requirements for the provision and installation of hospital cubicle tracks.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Cubicle tracks may be mounted directly to ceiling or suspended from hangers. Hanger option should be chosen when ceiling heights are over 2700 mm 9 feet to reduce curtain length. Use I-beam section where accumulation of dirt on track (which would impede carrier movement) would be a problem.

On the drawings, show:

1. Ceiling height

2. Anchorage system

3. Anchorage spacing and locations

4. If both heavy and light duty tracks are used,

indicate locations of each.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B456	(2017; R 2022) Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium

1.2 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cubicle Track Layout

SD-03 Product Data

Product Data; G

SD-04 Samples

Product Samples; G

SD-07 Certificates

Parts List

SD-08 Manufacturer's Instructions

Cubicle Track Installation

SD-10 Operation and Maintenance Data

Cubicle Track System, Data Package 1; ; G, [_____]

1.3 DRAWING REQUIREMENTS

Submit cubicle track layout drawings. Include[ceiling, surface-mounted installation details,][suspended track installation details,][number of carriers][, and][overlay drawing showing other trades installation within area]. Prepare drawings using field verified information and dimensions.

1.4 DELIVERY AND STORAGE

Deliver cubicle tracks to site in unopened containers clearly labeled with manufacturer's name and contents. Store in safe, dry, and clean location. Do not open containers until contents are to be installed.

1.5 QUALITY CONTROL

Allow smooth, rapid, and complete screening with no gaps at corners or ends of track. Provide tracks of a standard 2400 by 2400 mm 8 by 8 foot cubicle with no joints. Form corner bends in a single continuous piece on a 300 mm 12 inch radius to exactly 90 degrees. Provide track lengths to 4800 mm 16 feet with no joints.

PART 2 PRODUCTS

2.1 CUBICLE TRACK SYSTEM

****

NOTE: Heavy duty track can be mounted either on ceilings directly or from hangers. The hanger option should be chosen when ceiling heights are over 2700 mm 9 feet to reduce curtain length.

****

****

NOTE: If required, consider integration of related equipment that may be hung from tracks such as intravenous support assemblies, shower curtains, welding curtains, and similar materials.

****

[Heavy-duty type,[ceiling surface mounted][hanger mounted]. Provide tracks with a minimum 450 mm 18 inches radius. Submit product samples of track (254 mm10 inches), carriers, and hardware.

][Intravenous Track type,[ceiling surface mounted][hanger mounted]. Provide tracks with a minimum 450 mm 18 inches radius. Submit product samples of track (254 mm10 inches), carriers, and hardware.

][Shower Curtain track type,[ceiling surface mounted][hanger mounted]. Provide tracks with a minimum 450 mm 18 inches radius. Submit product samples of track (254 mm10 inches), carriers, and hardware.

]2.1.1 Cubicle Track

Channel Track (Surface Mounted Type) channel shaped with smooth inside raceway for curtain carriers[, curved track sections and curved connectors,] and all components and accessories required for a working installation.

Tubular Track (Suspended Type) seamless tubing 25 mm 1 inch minimum outside diameter[slotted for interior carriers][, curved track sections and curved connectors,] and all components and accessories required for a working installation.

2.1.2 Shower Curtain Track

Corrosion resistant surface mounted track system and glider hooks at 10 count per meter 40 inches[, curved track sections and curved connectors,] and all components and accessories required for a working installation.

2.1.3 Intravenous Track

Include track, carrier assembly, bottle holding pendant, curved track sections and curved connectors, and all components and accessories required for a working installation.

2.1.4 Extruded Aluminum Tracks

****

NOTE: Use I-beam section where accumulation of dirt on track (which would impede carrier movement) would be a problem. I-beam types of track generally use the one piece.

****

ASTM B221M ASTM B221 and ASTM B456; alloy 6063-TS, channel shape minimum 32 mm wide by 29 mm deep, 1.25 mm 1-1/4 inch wide by 1-1/8 inch deep, 0.050 inch minimum wall thickness. Inside raceway to be smooth for interior carriers and must be able to receive a double coated wheel carrier with hook. Finish as designated for aluminum finishes in AA DAF45.

2.2 CARRIER UNIT

Silent type with double canted wheel carrier. Provide wheels with nylon on stainless steel[chrome plated brass][chromium plated steel][stainless steel] hooks with swivel to support the curtain. Provide carriers that are removable only through access aperture or through end-cap that provides room for insertion or removal of carrier. Provide 2.2 carriers for every 300 mm foot of track length, plus one additional carrier. Provide a safety loading unit at one end of the channel track consisting of a section of channel track equipped with a hinge and end latch to permit lowering for installation of or removal of curtains from hooks without the use of a step-ladder and without removing carriers from track. Rivet moveable end of safety loading unit to be riveted to the hinge. Latching end of safety loading unit with a double locking fail-proof locking device for safety. Safety loading unit to be 1200 mm 4 feet in length of an 2400 mm 8 foot ceiling installation so latch end lowers to 1200 mm 4 feet from floor, for installation or removal of curtain without the use of a step-ladder. Increase length of safety loading unit to be increased according to ceiling height. Provide a key wand for every 20 units.

2.3 END STOP AND PULL-OUT

Fabricate from aluminum or nylon with an anodized finish matching the track finish. Provide[non-removable][removable (with carrier hook)] end stops as indicated.

2.4 SUPPORT DEVICES

[Provide hardware and brackets intended for the support of cubicle tracks[to ceiling grids][through to support framing above drywall or plaster ceilings] indicated.

][Provide 05 50 13 MISCELLANEOUS METAL FABRICATIONS support system(s) designed to support cubicle tracks and brackets intended for the support of cubicle tracks from the structure above.

]2.5 PARTS LIST

Provide complete product data and detailed parts list for replaceable and compatible hardware and fittings and items such as hooks and gliding carriers.

2.6 FASTENERS

Stainless steel.

2.7 FINISH

Satin, clear anodized.

PART 3 EXECUTION

3.1 INSTALLATION

Verify dimensions prior to installation. Install cubicle track after painting and finishing operations are complete. Provide labor and all materials indicated, specified or necessary for a complete finished installation. Install track plumb, level and true, and securely anchored to the ceiling to form a neat, rigid installation. Remove damaged or defective components and replace with new components.

3.1.1 Installation Details

****

NOTE: The types of ceilings to which the cubicle tracks or hangers will be fastened will differ. Therefore, in addition to showing the location of cubicle tracks on the drawings, the type of fastener or fasteners permitted for securing the tracks or hangers to the particular ceiling type for this project must be shown. Indicate intended support on the drawings, such as metal framing, lay in tile ceiling grids, or concrete structure.

****

****

NOTE: Generally, use hangers when room heights are 2700 mm 9 feet or more. Where hangers are used, indicate them on the drawings. Locate them:

1. At offsets or bends of 45 degrees or more.

2. At rises in track.

3. At 900 mm 3 feet on center, maximum, on straight

cubicle tracks over 2400 mm 8 feet long.

4. At termination of track if not at wall or other attachable vertical surface.

****

Install heavy-duty cubicle tracks[ceiling surface mounted][suspended from hangers]. Install cubicle tracks where indicated. Install carrier units at 150 mm 6 inches on center maximum. Install end cap at each end of the track and pull-out at the end where curtains are stacked to permit insertion and removal of carrier units. Securely fasten end stops to prevent their being forced out by striking weight of carrier units.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-10 22 13 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 22 13 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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WIRE MESH PARTITIONS

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USACE / NAVFAC / AFCEC **UFGS-10 22 13 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 22 13 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 10 22 13

WIRE MESH PARTITIONS

08/24

****

NOTE: This guide specification covers the requirements for wire mesh partitions for normal and for extra heavy industrial use.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The following information must be indicated on the project drawings:

1. Location, extent, height, and configuration of wire mesh partitions.

2. All openings, direction of door swing.

3. If the project includes both normal duty and heavy duty partitions, indicate the extent of each type.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A510/A510M	(2020) Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength

	Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	(2022) Standard Specification for Stainless Steel Nuts

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC70	(2019; R2021) Power-actuated Fasteners Driven into Concrete, Steel and Masonry Elements

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wire Mesh Partitions

SD-03 Product Data

Wire Mesh Partitions

[Recycled Content for Metal Post and Framing Materials; S

][Recycled Content for Wire Materials; S

] SD-04 Samples

[Samples For Verification; G

]1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials in manufacturer's original, unopened containers or packaging with labels intact and legible. Deliver, store, and handle materials so as to prevent damage. Replace damaged or defective materials with new.

1.4 DESCRIPTION OF WORK

Wire mesh partitions must be[all wire type][sheet metal base type],[normal duty for normal industrial use][heavy duty for extra heavy industrial use]. Provide partitions complete with fasteners, capping bars, adjustable floor sockets,[seismic] bracing, doors,[service windows,] hardware, and other items necessary for a complete, useable, and rigid installation. Verify field information and any penetration sizes and locations prior to preparing shop drawings. Show layout, details, materials, dimensions, finishes, and all information necessary for fabrication and installation.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness, and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available from US national manufacturers above the minimum recycled content percentages shown below. Some manufacturers and regions have higher percentages. Based on research, select or insert desired minimum percentages into the empty set of brackets.

Consider ASTM A240/A240M stainless steel for wire

mesh partitions exposed to high moisture, chlorides, or other corrosives that may lead to premature deterioration of wire mesh partitions. Indicate finishes such an ASTM A480/480M No.4 directional polish.

If ASTM A240/A240M stainless steel is used for wire mesh partition fabrication, use stainless steel for fasteners, operating hardware, and other accessories.

If volume to be contained within woven wire mesh require a ceiling, consider assemblies that are engineered to carry possible loads from personnel or storage such as mezzanine or bar grating assemblies. Do not use mesh for ceiling assemblies.

****

[Metal post and framing materials listed below must contain a minimum of[15] [_____] percent post-consumer recycled content and wire materials must contain a minimum of[50] [_____] percent post-industrial recycled content. Provide data identifying percentage of recycled content for metal post and framing materials. Also provide data identifying percentage of recycled content for wire materials. Submit 305 by 305 mm 12 by 12 inch samples of finished framed, corner, and mesh with hardware for verification. Submit product data for each type of partition, door, and window.

]2.1.1 Steel Shapes, Plates, and Bars

ASTM A36/A36M and ASTM A53/A53M.

2.1.2 Cold-Formed Steel

AISI SG03-3 and ASTM A1008/A1008M.

2.1.3 Wire Mesh

ASTM A510/A510M carbon steel wire, woven diamond mesh, intermediate crimped.

2.1.4 Floor Sockets

Cast or forged steel or ductile iron, adjustable, approximately 64 mm 2-1/2 inches high.

2.2 NORMAL DUTY PARTITIONS

2.2.1 Wire Mesh

10 gage wire, 38 mm 1-1/2 inch mesh.

2.2.2 Vertical Frames

32 by 16 mm 1-1/4 by 5/8 inch cold-rolled C section channels or 32 by 16 by 3 mm 1-1/4 by 5/8 by 1/8 inch channels.[Provide only C channels where frames are installed toe to toe without posts.]

2.2.3 Horizontal Frames

25 by 16 mm 1 by 5/8 inch channels.

2.2.4 Center Reinforcing Bar

One 25 by 13 by 3 mm 1 by 1/2 by 1/8 inch channel with all wires woven through, or two 25 by 10 by 3 mm 1 by 3/8 by 1/8 inch channels bolted together with mesh in between.

2.2.5 Capping Bar

56 by 25 by 3 mm 2-1/4 by 1 by 1/8 inch channel or 50 by 6 mm 2 by 1/4 inch flat bar.

2.2.6 Corner Posts

Structural steel angles, 32 by 32 by 3 mm 1-1/4 by 1-1/4 by 1/8 inch.

2.2.7 Line Posts

Unless otherwise indicated, provide partitions more than 3600 mm 12 feet high with flat bar line posts bolted between vertical frame channels. Sizes of posts must be as follows:

Partition Height	Size of Posts
3600 to 4400 mm	44 by 7.9 mm or 50 by 6 mm
4400 to 5900 mm	63 by 7.9 mm
5900 to 7100 mm	75 to 7.9 mm

Partition Height	Size of Posts
12 feet to 14 feet 8 inches	1-3/4 by 5/16 inch or 2 by 1/4 inch
14 feet 8 inches to 19 feet 8 inches	2-1/2 by 5/16 inch
19 feet 8 inches to 23 feet 8 inches	3 by 5/16 inch

2.2.8 Hinged Doors

Frames must be 32 by 13 by 3 mm 1-1/4 by 1/2 by 1/8 inch channels with 32 by 3 mm 1-1/4 by 1/8 inch flat bar cover on top and bottom rails and on hinge stile and a 35 by 20 by 3 mm 1-3/8 by 3/4 by 1/8 inch angle riveted to the lock stile. Provide 1-1/2 pairs of regular weight, wrought steel, non-removable pin, butt hinges riveted or welded to the door and the door opening frame for each door.

2.2.9 Sheet Metal Base

Hot- or cold-rolled sheet steel, not lighter than 16 gage.

2.3 HEAVY DUTY PARTITIONS

2.3.1 Wire Mesh

6 gage wire, 50 mm 2 inch mesh.

2.3.2 Panel Frames

38 by 20 by 3 mm 1-1/2 by 3/4 by 1/8 inch steel channels.

2.3.3 Center Reinforcing Bar

One 38 by 20 by 3 mm 1-1/2 by 3/4 by 1/8 inch channel with all wires woven through, or two 32 by 10 by 3 mm 1-1/4 by 3/8 by 1/8 inch channels bolted together with mesh in between.

2.3.4 Capping Bar

Structural steel channel, 75 mm by 1.9 kg 3 inch by 4.1 pounds.

2.3.5 Corner Posts

Structural steel angles, 45 by 45 by 3 mm 1-3/4 by 1-3/4 by 1/8 inch.

2.3.6 Line Posts

Unless otherwise indicated, provide partitions with flat bar line posts bolted between vertical frame channels. Sizes of posts must be as follows:

Partition Height	Size of Posts
2100 to 3600 mm	62 by 7.9 mm
3600 to 4800 mm	75 by 7.9 mm or 62 by 10 mm
4800 to 6000 mm	87 by 7.9 mm

Partition Height	Size of Posts
7 feet to 12 feet	2-1/2 by 5/16 inch
12 feet to 16 feet	3 by 5/16 inch or 2-1/2 by 3/8 inch
16 feet to 20 feet	3-1/2 by 5/16 inch

2.3.7 Hinged Doors

Frames must be 38 by 20 by 3 mm 1-1/2 by 3/4 by 1/8 inch channels with 38 by 3 mm 1-1/2 by 1/8 inch flat bar cover on top and bottom rails and on hinge stile and a 41 by 22 by 3 mm 1-5/8 by 7/8 by 1/8 inch angle riveted to the lock stile. Provide 1-1/2 pairs of heavyweight, wrought steel, non-removable pin, butt hinges riveted or welded to the door and the door opening frame for each door.

2.4 SLIDING DOORS

Frames must be 38 by 20 by 3 mm 1-1/2 by 3/4 by 1/8 inch channels with 38 by 3 mm 1-1/2 by 1/8 inch flat bar cover all around. Provide two four-wheel, roller bearing hangers and steel box track for each door.

2.5 DOOR OPENING FRAMES

Provide frames the same size and shape as the vertical frames for the mesh panels.

2.6 LOCKS

Provide each door with a mortise type lock with a six-pin tumbler lock cylinder on the outside and a recessed knob on the inside.

2.7 SERVICE WINDOWS

Slide up type, mounted in standard mesh panel reinforced with channel tracks. Opening must be 600 mm wide by 450 mm high 24 inches wide by 15 inches high unless otherwise indicated. Provide two spring loaded latches, operable only from the inside, to lock window in open and closed positions.[Form shelf of 12 gage sheet steel, 300 mm deep by 625 mm wide 12 inches deep by 25 inches wide, unless otherwise indicated.]

2.8 FABRICATION

2.8.1 Standard Panels

Wire must be woven into diamond mesh, intermediate crimped, and securely clinched to frames. Joints must be mortised and tenoned. Wire must be continuous at center reinforcing bars, either woven through a single channel or bolted between two channels. Panel vertical frames must have[6 mm 1/4 inch bolt holes 300 mm 12 inches o.c. for normal duty partitions][10 mm 3/8 inch bolt holes 450 mm 18 inches o.c. for heavy duty partitions].

2.8.2 Sheet Metal Base Panels

Upper portion must be as specified for standard panels, except that the wire must be clinched into the center reinforcing bar. Form sheet steel to fit between the panel frames and securely bolt to the frames.

2.8.3 Doors[and Service Windows]

Construction must be similar to that specified for panels. Wire mesh must be the same as that used in the adjacent partition panels. Operating hardware[as indicated on the drawings][as scheduled and required in 08 71 00 HARDWARE.]

2.8.4 Lateral Supports

Provide lateral[and seismic] bracing.[Confirm seismic details with the Structural Engineer.]

[2.8.5 Penetrations

Provide cut-outs for any penetration (i.e., pipes, ducts, conduit, structural members) of the wire mesh as shown on the drawings and as otherwise required. Frame cut-outs with 25.4 mm 1 inch box channel. Fabricate penetration openings to prevent contact between penetrations and wire mesh partitions.

]2.8.6 Post Shoes

Provide manufacturer's standard cast or fabricated metal shoes factory prepared with fastener holes. Provide corrosion protection and finish at shoes to match posts. Provide shoes that allow for vertical adjustability to accommodate floor flatness tolerances.

2.8.7 Fasteners

Manufacturer's standard[steel][metallic-coated steel][stainless steel] machine bolts, washers, and nuts of type suited to use and strength to withstand required loads between components[and between partitions and adjacent steel framing]. Provide with lock-nuts/lock-washers as required to prevent loosening.

Provide post-installed fasteners suitable to surrounding construction sized to provide no less than six times the required load at masonry and no less than four times the required load at concrete. Provide ASTM E488/E488M metallic coated fasteners at interior locations and[ASTM A153/A153M galvanized][or][ASTM F593 and ASTM F594 stainless steel] fasteners at exterior or wet locations[, and as indicated].

[Provide ICC-ES AC70 power-actuated fasteners where indicated.

]2.8.8 Finish

****

NOTE: If wire mesh partitions and hardware are stainless steel, indicate either mechanical finish or a mill finish primed and painted.

****

Thoroughly clean ferrous metal, treat with phosphate, and paint with[green][black][gray] [_____] enamel over suitable primer in the shop.[Provide zinc-rich primer where indicated.] Provide primer type(s) as directed by the paint manufacturer for each substrate and paint.

[Provide metallic-coated steel per ASTM A653/A653M[Z180G60 galvanized][ZF180A60 galvannealed] after fabrication[and prior to finishing].

]PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Wire Mesh Partitions

Install plumb, level, and true to line, within a tolerance of 3 mm in 3 m 1/8 inch in 10 feet or the height or run of the partition, if less than 3 meters 10 feet. Anchor floor sockets to the floor with expansion bolts. Bolt vertical frames and posts together with[6 mm bolts 300 mm o.c.1/4 inch bolts 12 inches o.c. for normal duty partitions][10 mm bolts 450 mm o.c.3/8 inch bolts 18 inches o.c. for heavy duty partitions]. Secure top frames to a continuous capping bar with 6 mm 1/4 inch diameter U bolts not more than 650 mm 28 inches o.c.

3.1.2 Doors[and Service Windows]

Install in accordance with the manufacturers' recommendations. Adjust as required so that doors[, windows,] and hardware operate freely and properly.

3.1.3 Bracing

Brace free standing partitions more than 6 meters 20 feet in length, at intervals not greater than 6 meters 20 feet[with a steel channel brace connected to the capping bar and anchored to the building wall or framing member][with a structural steel I section or tube post welded to a 225 by

225 mm 9 by 9 inch steel base plate anchored to the floor with four expansion bolts][or as indicated].

3.1.4 Touch-Up

Clean and paint scratches, abrasions, and other damage to shop painted surfaces to match the shop-applied finish.

Repair minor surface rust areas. Clean and prime with rust inhibitive primer paint. Apply final paint to match shop-applied finishes.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-10 22 19 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-10 22 19 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DEMOUNTABLE AND MOVABLE PARTITIONS

08/17, CHG 1: 08/18

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-10 22 19 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
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SECTION 10 22 19

DEMOUNTABLE AND MOVABLE PARTITIONS

08/17, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for demountable and movable partitions.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Partition layouts on the drawings must show partition dimensions, nominal sizes for doors, glazing panels, sound-resistance when required, details and any other information pertinent to partition layouts. Partition layout should be designed to allow for maximum reusability. Minimize the number of panel sizes specified on a project to increase flexibity of panel re-use.

Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM C1396/C1396M	(2024) Standard Specification for Gypsum Board
ASTM E72	(2022) Conducting Strength Tests of Panels for Building Construction
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E413	(2022) Classification for Rating Sound Insulation

BIFMA INTERNATIONAL (BIFMA)

ANSI/BIFMA X5.6	(2016) American National Standards For

Office Furnishings -Panel Systems

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

UL SOLUTIONS (UL)

UL 183	(2009) UL Standard for Safety Manufactured Wiring Systems
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

SD-03 Product Data

Warranty; G, [_____]

Partition System; G, [_____]

[Recycled content for gypsum board; S]

[Recycled content for paper facing; S]

[Recycled content for gypsum cores; S]

SD-04 Samples

Partition System Samples; G, [_____]

Mock-Up; G, [_____]

SD-07 Certificates

Burning Characteristics

Acoustical Performance

Structural Performance

Indoor air quality for gypsum board; S

Indoor air quality for aerosol adhesives; S

SD-10 Operation and Maintenance Data

Assembly Manuals; G, [_____]

Maintenance Manuals; G, [_____]

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

1.3.1.1 Gypsum Wall Systems

****

NOTE: The Government's preference is for use of products that have been certified for indoor air quality by a third-party organization such as Greenguard or SCS Global Services. However, it must be verified there is a certified product available that is both cost effective and appropriate for the project. The requirements of this paragraph are invoked when the designer of record confirms local/regional availability of Greenguard or SCS products and includes the bracketed requirements for indoor air quality certified products in Part 2 of this Section.

****

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body.

1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 QUALITY ASSURANCE

Manufacturer must have a minimum of [10] [_____] years of documented successful experience in designing and manufacturing partitions conforming to the requirements in this section. Provide product from a single manufacturer.

Partition installer must have a minimum of [5] [_____] years of documented successful experience in the installation of partitions similar to the requirements in this section. When required by the manufacturer, partitions must be installed by an authorized dealer with a certified installation crew.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to project site in accordance with manufacturer's instructions in original unopened and undamaged packages. Store in a clean, dry, and secure place free from damage during construction activities. Packages must contain labels indicating the manufacturer's name, brand name, size, finish and placement location.

1.6 PROJECT/SITE CONDITIONS

Temperature and humidity conditions within the area to receive partitions must be maintained as close as possible to the final occupancy standards. Maintain a minimum of 16 degrees C 60 degrees F and a relative humidity level of no higher than 70% continuously. Do not begin installation until the building envelope provides complete protection from the weather.

1.7 WARRANTY

****

NOTE: When site assembled demountable partitions are specified, the following warranty paragraph may be deleted in lieu of being covered under the one year standard construction warranty.

****

Warrant the partition system for a period of [10] [_____] years, and warrant fabrics and other covering materials for 3 years. Warranties must be signed by the authorized representative of the manufacturer. Warranties accompanied by document authenticating the signer as an authorized representative of the guarantor must be presented to the Contracting Officer upon the completion of the project. Guarantee that the partition system and installation are free from any defects in material and workmanship from the date of delivery.

PART 2 PRODUCTS

****

NOTE: Demountable and movable partitions should be used in areas susceptible to future partition rearrangement and substitution. Compared to traditional drywall construction, installation of these partitions are faster and eliminate the cost and mess of cutting and fitting flooring and ceilings around fixed walls. They offer maximum flexibility and reusability to accommodate frequent and quick relocation with minimal downtime, loss of materials, and damage or modification to panels or to adjoining structures such as ceilings, fixed walls and floors. These partitions can be specified as non-progressive allowing the removal of individual panels from any location without disturbing adjoining units. The partitions are point accessible meaning instant access of panels allows for electrical, telephone and communication lines to be installed quickly and easily. Furniture support is an optional added feature that makes these partition systems similar to systems furniture panels.

Terminology of partition systems within industry varies greatly including the terms "demountable", "movable", "modular", and "relocatable". For the purpose of this specification the terms demountable" and "movable" are used.

Demountable partitions are site assembled and are often used for aesthetic purposes with finishes other than paint and glazing. Panels are easy to change out when a different finish is desired, but more effort is required to relocate partitions than movable partitions. Also, electrical and communications are site installed.

Movable partitions are factory assembled, also known as unitized. They provide better quality control and a more uniform appearance. They can be installed and relocated very quickly and require less labor by an electrician because the partitions can be prewired with boxes.

****

2.1 SYSTEM DESCRIPTION

2.1.1 Burning Characteristics

Submit certification attesting that partition system has a Class A (under 25) Flame Spread Rating in conformance with ASTM E84.

****

NOTE: Performance requirements listed below are optional choices for designer; edit accordingly.

****

2.1.2 Acoustical Performance

Submit certification attesting that sound-rated partition assemblies have a minimum Sound Transmission Coefficient (STC) of [[36] [42] [44] [_____] for solid panel] [[30] [_____] for glass panel]. Determine STC range in accordance with Sound Transmission Test by Two-Room Method and reported in accordance with ASTM E90 and ASTM E413 for frequency data. Tested assembly must have been assembled in the same manner that the partitions will be installed on the project.

2.1.3 Structural Performance

Submit test results from an independent laboratory certifying the following results.

2.1.3.1 Transverse-Load Capacity

Provide partitions capable of [sustaining 24.4 kg/sq. m 5 psf minimum transverse load] [supporting furniture systems components] with lateral panel deflection no greater than [[1/120] [1/240] for solid panel][1/175 for glass panel] when tested in accordance with ASTM E72.

2.1.3.2 Load-Bearing Capability

Provide proof load of not less than [136 kg 300 lb concentrated] [0.041 kg/linear mm 3.2 lb/linear inch distributed] [_____] when tested according to ANSI/BIFMA X5.6.

2.1.3.3 Non-Load Bearing Capability

Wall system is designed for non-load bearing capability.

2.1.4 Electrical and Communication Capability

Electrical components, devices, systems and accessories must meet requirements of NFPA 70. Provide a partition system that accommodates electrical switches, outlets, voice/data cabling and jacks, and other components [at multiple heights in the panel] within the internal panel cavity. Surface mounted components will not be accepted. Provide [standard] [_____] size light switch boxes, electrical boxes, double gang outlet boxes for voice/data jacks, switches, outlets, faceplates, and conduit at mounting heights and locations as indicated on the electrical drawings. Coordinate finish of switches, outlets, and faceplates with building and other other componentry finishes. [Factory install all electrical components and accessories for partitions. Panels with factory installed electrical wiring must be UL listed or labeled and meet the requirements of UL 183. The label or listing of Underwriter's Laboratories, Inc. will be accepted as evidence that the material or equipment conforms to the applicable standards, and must be marked for intended use. In lieu of this label or listing, submit a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with the required procedures of UL and that the material and equipment comply with contract requirements.] Building electrical power will be [ceiling] [wall] [base] [access floor] [_____] fed. Coordinate the building and partition system electrical power. Electrical work must conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 PARTITION SYSTEM

Provide a partition system consisting of a series of individual, floor-supported, [[floor-to-ceiling] [partial height]] [[site assembled] [factory assembled]] panels as shown. [Provide a system that is non-progressive, allowing for removal and re-installation of panels, including door frames, at any position, without disturbing adjacent panels]. Provide panel faces that are removable,reusable, and attached to the panel frame without the use of screws or other mechanical fasteners. Provide a top channel that holds panels in place and accommodates floor-to-ceiling variations. System must be capable of attaching to multiple standard ceiling types in a non-marring manner. Provide floor attachment without mechanical fastening. Installation, modifications, and removal of the system must not damage adjacent building surfaces and elements, including floors, walls, ceilings, columns and window mullions. All system connectors to fixed building components must be removable, and reusable, and non-marring. Solid panels must be capable of field cutting to accommodate variations in floor and ceiling levels, end filler conditions, and other existing building conditions. The partition system must be complete with accessories to meet performance requirements.

Construct a Mock-up on site minimum 2430 x 2430 mm 8 x 8 foot [_____] in size for each color and type of panel specified after finish samples are approved, and prior to installation of partitions. Show partition construction and method of attachment to walls, floor, and ceiling. Review of the mock-up may result in adjustments to the product, layout and finishes. Once approved, use the mock-up as a standard of workmanship within the facility. Remove mock-ups when directed. Approved mock-ups may become part of the completed work if approved by the Contracting Officer.

Submit product data for partition system, to include catalog cuts, brochures, product information, and other necessary literature to indicate compliance with specifications.

2.3 MATERIALS AND COMPONENTS

2.3.1 Panels

****

NOTE: Use materials with recycled content, calculated on the basis of post-industrial or post-consumer percentage content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Section allows establishing recycled content requirements based on either the gypsum board product in its entirety, or on the paper facing and gypsum core separately. Research shows the product is available among US national manufacturers above the minimum recycled content percentages stated.

Choose first 2 sentences in the second paragraph below when using panels with recycled gypsum products.

Only choose the second set of optional sentences of the second paragraph if the desire is only to use gypsum products that contain recycled paper faces.

Only choose the third set of optional sentence of the second paragraph if the desire is only to use gypsum products that contain recycled gypsum cores.

****

Provide panel faces constructed of [steel] [gypsum board [minimum 13 mm 1/2 inch] [_____] thick conforming to ASTM C1396/C1396M, gypsum backing board conforming to ASTM C1396/C1396M] [wood composite] [fiber composite]. Include panels with [tongue-and-groove] [panel clips] [panel connectors] at joints to align panels. Provide concealed integrated slots to mount furniture components, accessories and equipment at multiple elevations. Maximum total load for bracket supports on one or both wall surfaces must not exceed 5500 N 1240 lb. Provide panels that are manufacturer's standard construction with fillers and bracing as required. Provide panel thickness of minimum[57 mm 2 1/4 inch] [88.90 mm 3 1/2 inches] [101.60 mm 4 inches] [_____]. [Provide panel face thickness of minimum[38 mm 1/2 inch] [_____].] Submit three sets of Assembly Manuals describing assembly and reconfiguration procedures.

[Provide gypsum board with a minimum of 5 percent post-consumer recycled content, or a minimum of 20 percent post-industrial recycled content.

Provide data identifying percentage of recycled content for gypsum board.] [Provide gypsum products with paper facings that contain a minimum of 100 percent post-consumer recycled paper content. Provide data identifying percentage of recycled content for paper facing.] [Provide gypsum cores containing a minimum of 95 percent post-industrial recycled gypsum content. Provide data identifying percentage of recycled content for gypsum cores.]

Provide gypsum wall board and panels that the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for gypsum board.

2.3.1.1 Adhesives

Provide sealants and non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of SCAQMD Rule 1168 or GS-36. Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building (inside of the weatherproofing system).

2.3.2 Framing System

Provide framing system that consists of extruded aluminum or roll-formed steel components which include ceiling runners, floor track, [studs or posts,] bracing, and suitable treated fasteners to prevent corrosion. Provide a rigid, stable partition system when the frame is assembled with the panels.

2.3.3 Glass and Glazing

****

NOTE: Coordinate glass requirements with Section 08 81 00 GLAZING.

****

Provide glass and glazing for partitions that are fully contained within the partition system and in locations as shown on the drawings. Provide [tempered] [laminated] glass that is [clear] [patterned] and complies with ANSI Z97.1 and ASTM C1048. [Provide [wood] [metal] mullions (muntins).] [All glass must be factory installed.] No protruding glazing beads or removable stops will be visible. [Provide glass and glazing in accordance with Section 08 81 00 GLAZING.]

2.3.4 Doors and Frames

****

NOTE: Single doors are normally available 910 mm wide x 2030 mm or 2135 mm high 3 feet wide x 6 feet 8 inches or 7 feet high. Some manufacturers offer other sizes.

****

Provide demountable partitions complete with [[single] [double]] [[sliding] [butt-hinged] [pivot-hinged]] doors and frames as shown on the drawings. Provide doors and frames that are fully contained with the panels and use standard panel connection methods. Provide 45 mm 1-3/4 inch thick flush type [hollow metal] [solid core] [wood veneer] [plastic laminate] [[tempered] [laminated] glass slab] [[tempered] [laminated] combination glass with [[wood]] [_____]] doors of manufacturer's standard construction. Door frames must be compatible in appearance with other trim components and allow for variations in floor level. [Provide doors in accordance with Section 08 14 16 FLUSH WOOD DOORS.]

****

NOTE: Verify keying requirements with the owner/tenant and include in specification if applicable.

****

2.3.5 Door Hardware

Door hardware to be [supplied and installed by partition manufacturer] [supplied by others and installed by partition manufacturer] [_____]. Provide hardware for doors in accordance with Section 08 71 00 DOOR HARDWARE. Provide hardware cutouts and reinforcement as required in doors and frames for hardware furnished.

2.3.6 Glazing Frames

Assemble glazing frames from minimum 1.7 mm 0.065 inch thick extruded anodized aluminum parts or minimum 1.2 mm 0.0478 inch cold-rolled steel and vinyl components. Indicate sizes and configurations of glazed openings on the drawings.

2.3.7 Trim

Provide [base] [ceiling] [panel] trim without exposed fasteners nominal [100 mm 4 inch] [_____] high, with [recessed] [projected] [flush] [_____] profile.

2.4 FINISHES

****

NOTE: Coordinate the editing of color reference sentence(s) with the Government. Generally Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an Architect or Interior designer. Select color from manufacturers standard colors or identified as a manufacturers color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located in the drawings, add a note that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is acceptable. Note there is often a minimum order

requirement which will affect future orders.
****

Provide panel finish of [factory-applied powder coat steel] [factory applied vinyl wallcovering finish, Type II (Medium Duty), UL Class A conforming to ASTM E84] [fabric] [tackable fabric] [high pressure laminate] [wood veneer] [factory primed gypsum board for field paint] [factory painted gypsum board] [tackable wallboard] [magnetic marker board] [marker board] [back painted glass] [_____]. Provide exposed metal trim finish of [aluminum [satin clear] [[light] [medium] [dark] bronze]] [[factory-applied powder coat] [factory primed for field paint] [steel] [_____]]. Non-metal panel trim to [match panel] [match exposed trim] [_____]. Non-metal base and ceiling trim to [match exposed trim] [match panel] [_____]. Provide [factory primed for field paint] [factory-applied powder coat] [wood veneer] [plastic laminate] [_____] doors. Painting must conform to the requirements of Section 09 90 00 PAINTS AND COATINGS. Provide color of all partition component finishes [in accordance with Section 09 06 00 SCHEDULE FOR FINISHES] [as indicated on the drawings] [_____]. Submit all exposed Partition System Samples to include panel and component finishes and electrical components such as faceplates. Samples must be actual samples and a minimum of 75 by 75 mm 3 by 3 inches in size.

PART 3 EXECUTION

3.1 EXAMINATION

Verify field dimensions before fabrication of partition system and record on installation drawings. Coordinate fabrication and installation schedule with construction schedule to avoid delay in the work. Examine and verify that site conditions are in agreement with the design package and manufacturer's requirements.

3.2 PREPARATION

Verify floor and ceiling dimensions in accordance with approved shop drawings prior to starting the work. Floor under partitions must be level to within 3 mm in 3048 mm 1/8 inch in 10 feet, non-accumulative. Correct conditions which may adversely affect the partition installation before installing partitions. Finishing operations, such as painting, carpeting, and ceiling grid installation, must be completed prior to partition installation.

3.3 INSTALLATION

Do not install items that show visual evidence of biological growth. Install partitions using certified installers in accordance with manufacturer's recommended installation instructions. Install partitions in conformance with details in the drawings and approved installation drawings. Assemble and erect the system with the least possible drilling and cutting of existing construction. Provide a complete partition installation with accessories to meet specified requirements and the capability of disassembly by means of ordinary tools. Provide concealed fastening devices and pressure-fit components that will not mar the floor, wall and ceiling surfaces and are free of exposed screws, nuts, rivets or bolts. Install panels rigid, straight and plumb, with horizontal lines level and aligned. Provide a complete installation with continuous light and sound seals at connections to ceilings, floors, fixed walls and abutting surfaces. Coordinate the partition system installation with the work of other trades that are affected. Provide dimensions on drawings verifying conformance to life safety code and electrical switch, outlet, infeed and jumper placements.

3.3.1 Doors and Windows

Hang doors to [swing] [slide] freely and fit hardware precisely. Install glass for glazed openings on shims in a vinyl or polyurethane foam gasket. Install glass stops without exposed fastenings.

3.3.2 Trim

Install trim in accordance with manufacturer's recommendations. [For site assembled partitions install wall base in the longest lengths possible. Joints must be fitted tight. Miter internal corners and scribe base to fit to door frames and other obstructions.] [Provide partition base covers that snap on.] Base must tightly adhere to wall surfaces.

3.4 ADJUSTMENTS

Repair or replace damaged partition finishes and components and damaged floor, wall and ceiling finishes to the original conditions.

3.5 CLEANING

Upon completion of installation, clean partition components and finishes in accordance with partition manufacturer's recommendations. Do not use alkaline or abrasive agents. Avoid scratching or marring partition finish surfaces. Submit three sets of Maintenance Manuals describing proper cleaning and minor repair procedures.

3.6 PROTECTION

Protect partitions from damage through the duration of construction activities.

-- End of Section --

****

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Preparing Activity: NAVFAC **Superseding**
UFGS-10 22 26.13 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 10 22 26.13

ACCORDION FOLDING PARTITIONS

08/24

****

NOTE: This guide specification covers the requirements for accordion folding partitions, manually and/or electrically operated.

Accordion partitions are folding partitions with independent covers enclosing a dead-air space and separated by an internal mechanism operating laterally across the face of the opening to a stack or closed position. Do not confuse accordion partitions with serpentine folding partitions which contain no internal operating mechanism or dead-air space between independent covers.

Folding partitions may be a sight barrier (noninsulated), or sound barrier (with sound liner), or both. Accordion-folding partitions have fabric covers which are joined to reflect a pantographic movement of the door surfaces when the door is either manually or electrically operated.

This section does not include folding or operable walls and partitions whose rigid panels are individually moved or hinged along their vertical edges to fold in serpentine fashion.

Associated work found in other sections includes:

Steel supporting members or hanger rods,[Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

Wood blocking, rough bucks, and headers, Section 06 10 00 ROUGH CARPENTRY.

Wood trim, wood or hardboard ceiling guard, or soffits, Section 06 20 00 FINISH CARPENTRY.

Lock cylinders, Section 08 71 00 DOOR HARDWARE.

Operator field connections to power sources and inner connection to control switches, Division 26, "Electrical."

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: The following information should be shown on the drawings:

1. Location, size, and folding area of accordion partitions.

2. Direction of operation, header conditions indicating height, track anchorage, track channel, and jamb conditions.

3. Partition supporting structure. The structural support for the partition is not part of this section; it must be indicated and specified separately.

4. A schedule of partitions by type, sizes, and stack space and identified by mark number or letter

5. For electrically operated partitions, show power source and desired switch location.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E336	(2024) Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E557	(2012; R 2020) Standard Guide for Architectural Design and Installation Practices for Sound Isolation between Spaces Separated by Operable Partitions

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 101	(2024) Life Safety Code
NFPA 286	(2024) Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

UL SOLUTIONS (UL)

UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

WALLCOVERINGS ASSOCIATION (WA)

WA W-101	(2017) Quality Standard for Polymer Coated Fabric Wallcovering

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

Manufacturer's Sample Warranty

Statement of Code Compliance; G, [_____]

Statement of Standards Conformity; G, [_____]

Verification of Field Measurements; G, [_____]

[Existing Electrical Data

] SD-02 Shop Drawings

Fabrication Drawings

Accordion Folding Partitions

Installation Drawings

Accordion Folding Partition Layouts; G, [_____]

Suspension System; G, [_____]

Finish Hardware; G, [_____]

Jamb Panels; G, [_____]

Accessories; G, [_____]

[Electrical Operators; G, [_____]

][Wiring Diagrams; G, [_____]

] SD-03 Product Data

Framework

Suspension System

[Recycled Content for Aluminum Components; S

][Recycled Content for Steel Components; S

] Finish Hardware

Sound Seals and Sweepstrips

Covering

Panels

Ceiling Guard

Meeting Posts

Jamb Panels

Rolling Post

Pull-In Latch

[Electrical Operator

][Switches

] SD-04 Samples

Covering; G, [_____]

Hardware; G

SD-06 Test Reports

Laboratory Acoustical Requirements

[Acoustical Test

][SD-07 Certificates

Indoor Air Quality for Fabrics and Wallcoverings; S

] SD-10 Operation and Maintenance Data

Folding Partitions, Data Package 1; G, [_____]

[Electrical Operators, Data Package 5; G, [_____]

] SD-11 Closeout Submittals

Manufacturer's Guarantee

[1.3 CERTIFICATIONS

****

NOTE: The Government's preference is for use of

products that have been certified for indoor air quality by a third-party organization such as Greenguard or SCS Global Services. However, it must be verified there is a certified product available that is both cost effective and appropriate for the project. Retain the following Section when the designer of record confirms local/regional availability of Greenguard or SCS products that does not impact cost effectiveness. In addition, when this Section is retained requiring Greenguard or SCS products, also include the Indoor Air Quality Certificates in SD-07 submittals of this section.
****

1.3.1 Indoor Air Quality Certification

1.3.1.1 Indoor Air Quality for Fabrics and Wallcoverings

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

]1.4 PRE-INSTALLATION REQUIREMENTS

1.4.1 Preconstruction Requirements

No less than 30 calendar days prior to the scheduled commencement of installation of Accordion Folding Partitions, submit the following to the Contracting Officer:

Manufacturer's Qualifications

Manufacturer's Sample Warranty

Statement of Code Compliance

Statement of Standards Conformity

Verification of Field Measurements and Existing Electrical Data

Fabrication Drawings and Installation Drawings

1.4.2 Product Data

Submit the following information for review:

Finish Hardware

Jamb Panels and Accessories

Sound Seals and Sweepstrips

Ceiling Guard, Meeting Posts, Rolling Post

Pull-In Latch

[Electrical Operator and Switches

]1.4.3   Manufacturer's Guarantee

Provide Manufacturer's Guarantee for partitions against defects in material and workmanship for a period of 2 years from date of installation. In addition, provide 10 year guarantee for the pantographs, trolleys and tracks from date of acceptance for beneficial use.

1.5   DELIVERY, HANDLING AND STORAGE

Deliver materials to project site in manufacturer's original, unopened, and undamaged packages with labels legible and intact. Labels must indicate the manufacturer, brand name, size, finish, and placement location. Store folding partitions and accessories in unopened packages in a manner that will prevent damage. Handle partition materials in accordance with manufacturer's instructions.

PART 2   PRODUCTS

2.1   FOLDING PARTITIONS

Provide full accordion type partitions, factory finished, supported from overhead track without floor guides, and complete with all hardware, track, and accessories necessary for operation. Provide partition framework with a mechanism that gives stability and maintains uniform spacing of partition folds in all partition positions. Provide completely concealed framework with a[vinyl-coated fabric covering][plastic laminate panel covering] [_____]. Provide partitions[manually][and][electrically] operated,[bi-parting][and][one-way] type as indicated. Provide patterns and colors of[fabric] [_____][approved by the Contracting Officer][as indicated].[Provide manufacturer's standard pendant pull on leading edge of manually operated partitions over 3600 mm 12 feet high.] Submit[three samples] [_____] of each covering and exposed hardware item.

2.2   MATERIALS

2.2.1   Aluminum Extrusions

ASTM B221MASTM B221, Alloy 3003.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available from US national manufacturers above the minimum recycled content percentages shown below. Some manufacturers and regions have higher percentages. Based on research, select or insert desired minimum percentages into the empty set of brackets.

****

[Provide aluminum components that contain a minimum of[30] [_____] percent recycled content. Provide data identifying percentage of recycled content for aluminum components.

]2.2.2 Steel Sheets

ASTM A653/A653M[, Z 180 G90 coating designation].

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available from US national manufacturers above the minimum recycled content percentages shown below. Some manufacturers and regions have higher percentages. Based on research, select or insert desired minimum percentages into the empty set of brackets.

****

[Provide steel components that contain a minimum of[10] [_____] percent recycled content. Provide data identifying percentage of recycled content for steel components.

]2.2.3 Fabric Covering

****

NOTE: Specify minimum total weight and minimum coating weight for the fabric covering type selected using the listing below:

Total Weight (kilograms per square meter): Type I - 0.237; Type II - 0.442; Type III - 0.748 (ounces per square yard): Type I - 7; Type II - 13; Type III - 22

Coating Weight (kilograms per square meter): Type I - 0.170; Type II - 0.237; Type III - 0.407 (ounces per square yard): Type I - 5; Type II - 7; Type III - 12

****

WA W-101, Type II. Fabrics and wallcoverings must meet emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for fabrics and wallcoverings. Provide antimicrobial treatments proven to inhibit the growth of bacteria, fungi, and yeasts.

[2.2.4 Panel Covering

****

NOTE: Steel skin should be a minimum of 0.6 mm 24 gage for 1219 mm 48 inch panels, and 0.8 mm 22 gage

for 1372 mm 54 inches, or larger panels. 1219 mm 48 inch panels are standard panel size and usually do not exceed 1372 mm 54 inches due to limitations of cladding finish materials. Gypsum board is used for tackable surfaces.
****

Provide covering panels of plastic laminate faced[fire retardant medium density fiberboard][_____] mounted to concealed support framing. Low profile hinges may not project more than 6 mm 1/4 inch maximum from panel edges. Each panel must be provided with manufacturer's standard prefinished metal trim.

****
NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content percentages shown below.
****

]2.2.5 Seals and Sweepstrips

****
NOTE: Accordion partitions need a floor and ceiling seal to avoid gaps that will lower the advertised sound transmission rating. For any partition that requires a sound rating, use seals and ceiling guards provided by the manufacturer of the partition. Provide a baffle in the ceiling plenum above the partition with a STC rating equal to the partition. Provide a floor surface that will allow the bottom sweep to make a positive seal.
****

Provide perimeter seals of manufacturer's standard product, without crack or craze when subjected to severe usage. Seals include vinyl, neoprene, or woven silica vertical seals; include top and bottom seals; and seals to jamb conditions.[Seals for fire-rated partitions must be products tested to meet the fire[, smoke][, and][draft] ratings indicated.]

2.2.6 Ceiling Guards

Furnish partitions with ceiling guards or integral track and ceiling guards as recommended by the manufacturer.

2.3 PERFORMANCE REQUIREMENTS

2.3.1 Fire Endurance

****
NOTE: Select flame spread and smoke developed criteria to suit project.
****

For partitions more than 5.6 square meters 60 square feet in area, provide fabric and lining with flame spread rating of 25 or less, fuel contribution rating of 15 or less, smoke generation of 50 or less when tested in accordance with ASTM E84. Complete assembly must also meet or surpass the requirements of NFPA 101 and UL 10B.

2.3.2 PFOS/PFOA Requirements

Provide materials free from perfluorooctanesulfonic acid (PFOS) or perfluorooctanoic acid (PFOA).

2.3.3 Laboratory Acoustical Requirements

****

NOTE: Specify sound transmission class as determined by project requirements. The requested rating should be between 35 and 45 STC. 39 and 40 STC are widely available. If more is required, another type of moveable partition should be used. Specify a panel weight of no less than 14 kg per square meter 3 psf for STC of 35, 24 kg per square meter 5 psf for STC of 45.

****

Provide certificates verifying folding partitions have been tested in accordance with ASTM C423 and ASTM E90 by a laboratory accredited by the U.S. Bureau of Standards and have attained a sound transmission class (STC) of not less than[40] [_____] in a fully extended position. Partition tested must be of the same construction, materials, and model number as the partition to be provided and be fully operable. Test specimen must be not less than [12 square meters in area] [4200 by 2700 mm] [126 square feet in area] [14 feet by 9 feet]. Panel weight must be [14][24] kg per square meter [3][5] lbs per square ft.

[2.4 ELECTRICAL OPERATORS

****

NOTE: Specify electrical operators for those partitions whose size and weight preclude manual operation. Refer to manufacturers' literature. Indicate those partitions requiring electrical operation on the project drawings. Delete this paragraph when electrically operated partitions are not required in the project.

****

Provide manufacturer's recommended standard electrical operator for[each partition][partitions indicated]. Provide wiring diagrams. Electrical components must be listed and labeled as required in NFPA 70 by a qualified testing agency. Systems must be marked for intended application and condition.

]2.5 FABRICATION

2.5.1 Framework

Fabricate framework, including posts, pantographs, hinges, hinge plates, and rods from either extruded aluminum or ferrous metal. Arrange frames requiring pantographs for horizontal pantograph action with pantographs located at top and bottom of the frame. Provide pantographs spaced not over 1200 mm 4 feet apart. Provide intermediate pantograph at center of doors less than 2400 mm 8 feet high unless the door has vertical metal reinforcing. The pantographs must operate smoothly with positive folding action and have a control device to prevent flattening of the folds when the panel is fully extended. Ferrous metal must be either cadmium plated or zinc coated. Posts, at the option of the door manufacturer, may have phosphate treatment and manufacturer's shop finish paint.

2.5.2 Suspension System

Provide a suspension system consisting of steel or aluminum track and trolleys designed to support the weight of the partition. Provide steel track of 1.5 mm 16 gage minimum, phosphate treated and finished, or zinc or cadmium coated. Provide extruded aluminum track with minimum thickness of 3 mm 1/8 inch. Tracks may have an integral ceiling guard. Trolleys must have at least two ball bearing nylon or steel tired wheels spaced according to manufacturer's design criteria and four at an end post.

2.5.3 Covering

Covering fabrics must conform to the requirements of ASTM D751, NFPA 286, and WA W-101.

Attach fabric to the framework with fasteners that permit easy removal of the cover but prevent sagging or separation. Position vertical seams in the bottoms of valleys and reinforce. Provide top and bottom edges of cover fabrics with 12 mm 1/2 inch minimum turned hems.

2.5.4 Sound Insulation

Provide sound insulation as necessary to achieve the specified sound transmission class, conforming to ASTM E413.

2.5.5 Air Release

Provide an air release system which allows trapped air within the partition to be released during the stacking process.

2.5.6 Seals

Provide perimeter seals as necessary to produce the sound transmission class specified[and to pass the visual field test specified].

2.5.7 Hardware

Provide hardware of the heavy-duty type standard with the manufacturer. Provide pulls and latches for all partitions. Provide partitions with[keyed locks][privacy latches][magnetic contact latches][foot bolts].

2.5.8 Accessories

Provide[multiple meeting posts][rolling posts][switches][ceiling guards][recessed tracks][curved tracks] as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.1.1 Existing Work

****

NOTE: Show the structural support necessary to accommodate the size and weight of the partition. ASTM E557 has design as well as installation criteria.

****

Check openings scheduled to receive accordion folding partitions for correct dimensions.

Install partitions in accordance with the approved Accordion Folding Partition Layouts, manufacturer's directions, and ASTM E557. Provide structural support for the track support elements as indicated.

Submit to the Contracting Officer a certification of the following:

Statement of Code Compliance for the completed partition installation.

Statement of Standards Conformity

[3.1.2 Electrical Operators

****

NOTE: Delete this paragraph when electrically operated partitions are not required.

****

Conform Electrical components and installation to the requirements of NFPA 70. Provide the partition manufacturer's standard drive and control components required to operate the partition properly. Power source is as indicated.

]3.1.3 Adjustment

[Adjust manually operated partitions to open and close from any position with a maximum horizontal force of 130 N 30 pounds applied to pendant pull, box or handle.][Adjust drive components and limit switches of electrically operated partitions to ensure the partitions operate properly upon activation of the control switch.]

3.2 FIELD TESTS

3.2.1 Operational Test

Operate partition at least three times to demonstrate that partition is capable of being moved from the stored position to the fully extended position smoothly and quietly[and without overloading the drive components].[Activate the emergency release mechanism and demonstrate proper operation of the partition in the manual mode.] Adjust partitions which do not operate properly and retest.

[3.2.2 Visual Test

****

NOTE: Delete this paragraph when light leakage will not be objectionable.

****

Conduct visual field tests for light leakage with all room lights turned on in the space on one side of the partition. Darken space on the other side of the partition. Light leakage from the lighted space to the darkened space is not acceptable. If light leakage does occur, adjust the partition to correct the problem and retest.

][3.2.3 Acoustical Test

****

NOTE: Delete this paragraph in projects requiring STC ratings of less than 40. Noise Isolation Class (NIC) is a number that can measured, and usually runs up to 10 points below laboratory results, i.e. lab STC 40, field NIC 30. This test is rarely necessary.

****

Field sound performance: provide partition testing by an independent certified acoustical consultant in accordance with ASTM E336, and achieve a Noise Isolation Class (NIC) of [_____] plus or minus two. Adjust or modify partitions which do not comply, and retest.

]3.3 CLEANING

Clean any soiled parts of the partition according to manufacturer's instructions.

3.4 SUPPORT SERVICE

Equipment and component maintenance must be supported by a service organization which is reasonably convenient to the site of installation.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-10 22 26.23 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 22 26.23 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 10 22 26.23

COILING PARTITIONS
08/24

****
NOTE: This guide specification covers the requirements for coiling partitions, manually and/or electrically operated.

Coiling partitions are partitions with independent covers enclosing a dead-air space and separated by an internal mechanism operating laterally across the face of the opening to a coiled closed position.

Coiling partitions may be a sight barrier (noninsulated), or sound barrier (with sound liner), or both. Coiling partitions have fabric or metal panel covers which are joined to reflect a pantographic movement of the door surfaces when the door is either manually or electrically operated.

This section does not include folding or operable walls and partitions whose rigid panels are individually moved or hinged along their vertical edges to fold in serpentine fashion.

Associated work found in other sections includes:

Steel supporting members or hanger rods,[Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

Wood blocking, rough bucks, and headers, Section 06 10 00 ROUGH CARPENTRY.

Wood trim, wood or hardboard ceiling guard, or soffits, Section 06 20 00 FINISH CARPENTRY.

Lock cylinders, Section 08 71 00 DOOR HARDWARE.

Operator field connections to power sources and inner connection to control switches, Division 26, "Electrical."

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: The following information should be shown on the drawings:

1. Location, size, and coiling area of coiling partitions.

2. Direction of operation, header conditions indicating height, track anchorage, track channel, and jamb conditions.

3. Partition supporting structure. The structural support for the partition is not part of this section; it must be indicated and specified separately.

4. A schedule of partitions by type, sizes, and stack space and identified by mark number or letter

5. For electrically operated partitions, show power source and desired switch location.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E336	(2024) Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E557	(2012; R 2020) Standard Guide for Architectural Design and Installation Practices for Sound Isolation between Spaces Separated by Operable Partitions

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor

	Sources using Environmental Chambers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 101	(2024) Life Safety Code
NFPA 286	(2024) Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

UL SOLUTIONS (UL)

UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies

WALLCOVERINGS ASSOCIATION (WA)

WA W-101	(2017) Quality Standard for Polymer Coated Fabric Wallcovering

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

Manufacturer's Sample Warranty

Statement of Code Compliance; G, [_____]

Statement of Standards Conformity; G, [_____]

Verification of Field Measurements; G, [_____]

[Existing Electrical Data

] SD-02 Shop Drawings

Fabrication Drawings

Coiling Partitions

Installation Drawings

Coiling Partition Layouts; G, [_____]

Suspension System; G, [_____]

Finish Hardware; G, [_____]

Jamb Panels; G, [_____]

Accessories; G, [_____]

[Electrical Operators; G, [_____]

][Wiring diagrams; G, [_____]

] SD-03 Product Data

Framework

Suspension System

Finish Hardware

Sound Seals and Sweepstrips

Covering

[Indoor Air Quality for Fabrics and Wallcoverings; S

] Ceiling Guard

Meeting Posts

Jamb Panels

Rolling Post

Pull-In Latch

[Electrical Operator

][Switches

] SD-04 Samples

Covering; G, [_____]

SD-06 Test Reports

Laboratory Acoustical Requirements

[Acoustical Test

] SD-10 Operation and Maintenance Data

Coiling Partitions, Data Package 1; G, [_____]

[Electrical Operators, Data Package 5; G, [_____]]

SD-11 Closeout Submittals

Manufacturer's Guarantee

1.3 PRE-INSTALLATION REQUIREMENTS

1.3.1 Preconstruction Requirements

No less than 30 calendar days prior to the scheduled commencement of installation of coiling partitions, submit the following to the Contracting Officer:

Manufacturer's Qualifications

Manufacturer's Sample Warranty

Statement of Code Compliance

Statement of Standards Conformity

Verification of Field Measurements and Existing Electrical Data

Fabrication Drawings and Installation Drawings

1.3.2 Product Data

Submit the following information for review:

Finish Hardware

Jamb Panels and Accessories

Sound Seals and Sweepstrips

Ceiling Guard

Meeting Posts

Rolling Post

Pull-In Latch

[Electrical Operator

Switches

]1.3.3 Manufacturer's Guarantee

Provide Manufacturer's Guarantee for partitions against defects in material and workmanship for a period of two years from date of installation. In addition, provide ten year guarantee for the pantographs, trolleys and tracks from date of acceptance for beneficial use.

1.4 DELIVERY, HANDLING AND STORAGE

Deliver materials to project site in manufacturer's original, unopened, and undamaged packages with labels legible and intact. Labels must indicate the manufacturer, brand name, size, finish, and placement location. Store coiling partitions and accessories in unopened packages in a manner that will prevent damage. Handle partition materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 COILING PARTITIONS

Provide full coiling type partitions, factory finished, supported from overhead track without floor guides, and complete with all hardware, track, and accessories necessary for operation. Provide partition framework with a mechanism that gives stability and maintains uniform spacing of partition folds in all partition positions. Provide completely concealed framework with a[vinyl-coated fabric covering] [_____]. Provide partitions[manually][and][electrically] operated,[bi-parting][and][one-way] type as indicated. Provide patterns and colors of[fabric] [_____][approved by the Contracting Officer][as indicated].[Provide manufacturer's standard pendant pull on leading edge of manually operated partitions over 3600 mm 12 feet high.]

2.2 MATERIALS

2.2.1 Aluminum Extrusions

ASTM B221M, ASTM B221, Alloy 3003.

2.2.2 Steel Sheets

ASTM A653/A653M[, Z 180 G90 coating designation].

****

NOTE: If a fabric covering is required, include the

following section.
****

[2.2.3 Fabric Covering

****
NOTE: Specify minimum total weight and minimum coating weight for the fabric covering type selected using the listing below:

Total Weight (kilograms per square meter): Type I - 0.237; Type II - 0.442; Type III - 0.748 (ounces per square yard): Type I - 7; Type II - 13; Type III - 22

Coating Weight (kilograms per square meter): Type I - 0.170; Type II - 0.237; Type III - 0.407 (ounces per square yard): Type I - 5; Type II - 7; Type III - 12
****

WA W-101, Type II. Fabrics and wallcoverings must meet emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide validation of indoor air quality for fabrics and wallcoverings.

]2.2.4 Seals and Sweepstrips

****
NOTE: Coiling partitions need a floor and ceiling seal to avoid gaps that will lower the advertised sound transmission rating. For any partition that requires a sound rating, use seals and ceiling guards provided by the manufacturer of the partition. Provide a baffle in the ceiling plenum above the partition with a STC rating equal to the partition. Provide a floor surface that will allow the bottom sweep to make a positive seal.
****

Provide perimeter seals of manufacturer's standard product, without crack or craze when subjected to severe usage.

2.2.5 Ceiling Guards

Furnish partitions with ceiling guards or integral track and ceiling guards as recommended by the manufacturer.

2.3 PERFORMANCE REQUIREMENTS

2.3.1 Fire Endurance

****
NOTE: Select flame spread and smoke developed criteria to suit project.
****

For partitions more than 5.6 square meters 60 square feet in area, provide fabric and lining with flame spread rating of 25 or less, fuel contribution rating of 15 or less, smoke generation of 50 or less when tested in accordance with ASTM E84. Complete assembly must also meet or surpass the requirements of NFPA 101 and UL 10B.

2.3.2 PFOS/PFOA Requirements

Provide materials free from perfluorooctanesulfonic acid (PFOS) or perfluorooctanoic acid (PFOA).

2.3.3 Laboratory Acoustical Requirements

****

NOTE: Specify sound transmission class as determined by project requirements. The requested rating should be between 35 and 45 STC. 39 and 40 STC are widely available. If more is required, another type of moveable partition should be used. Specify a panel weight of no less than 14 kg per square meter 3 psf for STC of 35, 24 kg per square meter 5 psf for STC of 45.

****

Provide certificates verifying coiling partitions have been tested in accordance with ASTM C423 and ASTM E90 by a laboratory accredited by the U.S. Bureau of Standards and have attained a sound transmission class (STC) of not less than[40] [_____] in a fully extended position. Partition tested must be of the same construction, materials, and model number as the partition to be provided and be fully operable. Test specimen must be not less than [12 square meters in area] [4200 by 2700 mm] [126 square feet in area] [14 feet by 9 feet]. Panel weight must be [14][24] kg per square meter [3][5] lbs per square ft.

[2.4 ELECTRICAL OPERATORS

****

NOTE: Specify electrical operators for those partitions whose size and weight preclude manual operation. Refer to manufacturers' literature. Indicate those partitions requiring electrical operation on the project drawings. Delete this paragraph when electrically operated partitions are not required in the project.

****

Provide manufacturer's recommended standard electrical operator for[each partition][partitions indicated]. Provide wiring diagrams.

]2.5 FABRICATION

2.5.1 Framework

Fabricate framework, including posts, pantographs, hinges, hinge plates, and rods from either extruded aluminum or ferrous metal. Arrange frames requiring pantographs for horizontal pantograph action with pantographs located at top and bottom of the frame. Provide pantographs spaced not over 1200 mm 4 feet apart. Provide intermediate pantograph at center of doors less than 2400 mm 8 feet high unless the door has vertical metal reinforcing. The pantographs must operate smoothly with positive coiling action and have a control device to prevent flattening of the folds when the panel is fully extended. Ferrous metal must be either cadmium plated or zinc coated. Posts, at the option of the door manufacturer, may have phosphate treatment and manufacturer's shop finish paint.

2.5.2 Suspension System

Provide a suspension system consisting of steel or aluminum track and trolleys designed to support the weight of the partition. Provide steel track of 1.5 mm 16 gage minimum, phosphate treated and finished, or zinc or cadmium coated. Provide extruded aluminum track with minimum thickness of 3 mm 1/8 inch. Tracks may have an integral ceiling guard. Trolleys must have at least two ball bearing nylon or steel tired wheels spaced according to manufacturer's design criteria and four at an end post.

2.5.3 Covering

Covering fabrics must conform to the requirements of ASTM D751 and NFPA 286.

Attach fabric to the framework with fasteners that permit easy removal of the cover but prevent sagging or separation. Position vertical seams in the bottoms of valleys and reinforce. Provide top and bottom edges of cover fabrics with 12 mm 1/2 inch minimum turned hems.

2.5.4 Sound Insulation

Provide sound insulation as necessary to achieve the specified sound transmission mission class, conforming to ASTM E413.

2.5.5 Air Release

Provide an air release system which allows trapped air within the partition to be released during the stacking process.

2.5.6 Seals

Provide perimeter seals as necessary to produce the sound transmission class specified[and to pass the visual field test specified].

2.5.7 Hardware

Provide hardware of the heavy-duty type standard with the manufacturer. Provide pulls and latches for all partitions. Provide partitions with[keyed locks][privacy latches][magnetic contact latches][foot bolts].

2.5.8 Accessories

Provide[multiple meeting posts][rolling posts][switches][ceiling guards][recessed tracks][curved tracks] as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.1.1 Existing Work

****

NOTE: Show the structural support necessary to accommodate the size and weight of the partition. ASTM E557 has design as well as installation criteria.

****

Check openings scheduled to receive coiling partitions for correct dimensions.

Install partitions in accordance with the approved coiling Partition Layouts, manufacturer's directions, and ASTM E557. Provide structural support for the track support elements as indicated.

Submit to the Contracting Officer a certification of the following:

Statement of Code Compliance for the completed partition installation.

Statement of Standards Conformity

[3.1.2 Electrical Operators

****

NOTE: Delete this paragraph when electrically operated partitions are not required.

****

Conform Electrical components and installation to the requirements of NFPA 70. Provide the partition manufacturer's standard drive and control components required to operate the partition properly. Power source is as indicated.

]3.1.3 Adjustment

[Adjust manually operated partitions to open and close from any position with a maximum horizontal force of 130 N 30 pounds applied to pendant pull, box or handle.][Adjust drive components and limit switches of electrically operated partitions to ensure the partitions operate properly upon activation of the control switch.]

3.2 FIELD TESTS

3.2.1 Operational Test

Operate partition at least three times to demonstrate that partition is capable of being moved from the stored position to the fully extended position smoothly and quietly [and without overloading the drive components].[Activate the emergency release mechanism and demonstrate proper operation of the partition in the manual mode.] Adjust partitions which do not operate properly and retest.

[3.2.2 Visual Test

****

NOTE: Delete this paragraph when light leakage will not be objectionable.

****

Conduct visual field tests for light leakage with all room lights turned on in the space on one side of the partition. Darken space on the other side of the partition. Light leakage from the lighted space to the darkened space is not acceptable. If light leakage does occur, adjust the partition to correct the problem and retest.

][3.2.3 Acoustical Test

****

NOTE: Delete this paragraph in projects requiring STC ratings of less than 40. Noise Isolation Class (NIC) is a number that can measured, and usually runs up to 10 points below laboratory results, i.e. lab STC 40, field NIC 30. This test is rarely necessary.

****

Field sound performance: provide partition testing by an independent certified acoustical consultant in accordance with ASTM E336, and achieve a Noise Isolation Class (NIC) of [_____] plus or minus two. Adjust or modify partitions which do not comply, and retest.

]3.3 CLEANING

Clean any soiled parts of the partition according to manufacturer's instructions.

3.4 SUPPORT SERVICE

Equipment and component maintenance must be supported by a service organization which is reasonably convenient to the site of installation.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-10 22 39 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-10 22 39 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 10 22 39

FOLDING PANEL PARTITIONS

08/20

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-10 22 39 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-10 22 39 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 10 22 39

FOLDING PANEL PARTITIONS
08/20

****

NOTE: This guide specification covers the requirements for folding panel partitions, also referred to as operable partitions.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.

Associated work found in other sections includes:

Steel supporting members or hanger rods, Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

Wood blocking, rough bucks, and headers, Section 06 10 00 ROUGH CARPENTRY.

Wood trim, wood or hardboard ceiling guard, or

soffits, Section 06 20 00 FINISH CARPENTRY.

Lock cylinders, Section 08 71 00 DOOR HARDWARE.

Operator field connections to power sources and inner connection to control switches, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

The following information should be shown on the drawings:

1. Location, size, and folding area of folding panel partitions.

2. Direction of operation, header conditions indicating height, track anchorage, track channel, and jamb conditions.

3. Partition supporting structure. The structural support for the partition is not part of this section; it must be indicated and specified separately.

4. A schedule of folding panel partitions by type (manually or electrically operated), sizes, and stack space and identified by mark number or letter

5. For electrically operated partitions, show power source and desired switch location.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E557	(2012; R 2020) Standard Guide for Architectural Design and Installation Practices for Sound Isolation between Spaces Separated by Operable Partitions

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CHEMICAL FABRICS AND FILM ASSOCIATION (CFFA)

CFFA-W-101-D	(2002) Quality Standard for Vinyl Coated Fabric Wallcovering

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 101	(2024) Life Safety Code
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies
NFPA 286	(2024) Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

UL SOLUTIONS (UL)

UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Coordination Drawings; G, [_____]

Wiring Diagrams; G, [_____]

Layouts; G, [_____]

Installation Drawings; G, [_____]

SD-03 Product Data

Folding Panel Partitions; G, [_____]

Recycled Content for Steel Components

Recycled Content for Aluminum Components

SD-04 Samples

Partition System Samples; G, [_____]

SD-06 Test Reports

Acoustical Test Reports; G, [_____]

Field Sound Test Reports

Flame and Smoke Development Tests; G, [_____]

SD-07 Certificates

Indoor Air Quality for Finish Covering; S

Installer Qualifications

Manufacturer's Qualifications

SD-08 Manufacturer's Instructions

Installation Instructions

SD-10 Operation and Maintenance Data

Folding Panel Partitions, Data Package 1 and 2; G, [_____]

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certification

1.3.1.1 Finish Covering

****

NOTE: The Government's preference is for use of products that have been certified for indoor air quality by a third-party organization such as Greenguard or SCS Global Services. However, it must be verified there is a certified product available that is both cost effective and appropriate for the project. The requirements of this paragraph are invoked when the designer of record confirms local/regional availability of Greenguard or SCS products and includes the bracketed requirements for indoor air quality certified products in Part 2 of this Section.

****

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 QUALITY ASSURANCE

1.4.1 Coordination Drawings

Provide reflected ceiling plans, applicable details and other drawings as required to suit conditions, drawn to scale, for the following coordinated items, using input from adjacent materials/systems installers, field measurements and verification of conditions:

a. Partition track, track supports and[seismic] bracing, switches,[turning space,] and storage layout.

b. Suspended ceiling system components and structural members used for attachment.

c. Items penetrating finished ceiling in vicinity of folding panel partition location.

[d. Accessories located within the folding panel partitions.

]1.4.2 Installer Qualifications

Installer must have a minimum of [5][_____] years of documented successful experience in the installation of folding panel partitions. When required by manufacturer, folding panel partitions must be installed by an authorized dealer with a certified crew.

1.4.3 Manufacturer's Qualifications

Manufacturer must have a minimum of [10][_____] years of documented successful experience in designing and manufacturing folding panel partitions conforming to the requirements specified in this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the jobsite in the manufacturer's original, unopened, and undamaged packages with labels legible and intact. Provide labels to indicate the manufacturer, brand name, size, finish, and placement location. Store partitions and accessories in unopened packages in a manner to prevent damage. Handle partition materials in accordance with manufacturer's instructions. Protect materials from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for specified warranty periods from date of final acceptance of the work as follows:

1.6.1 Warranty Periods

a. Structural: [10][_____] years

b. Plastic and Wood Materials: [3][_____]

c. Fabric Materials: [1 year][3][_____] years

d. Electrical Components: [1 year][5][_____] years

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: The designer will edit this specification for manual or electric operation of folding panel (operable) partitions as required for the project.

****

Provide [manual][and][electric] operation,[acoustical] folding panel partitions, factory finished, supported from overhead track [with][without] floor gliders, as shown on the drawings including all hardware, seals, track and rollers as needed to close the specified opening.

Submit detail coordination drawings and installation drawings of each folding panel partition indicated. Include elevations, dimensions, clearances, details of construction and anchorage, and details of joints and connections.

Submit manufacturers' descriptive product data for [each type of] folding panel partition indicated. Include manufacturers' literature, finishes, profiles and thicknesses of materials.

Submit manufacturers' operations and maintenance data for [each type of] folding panel partition in accordance with Section 01 78 23 OPERATIONS AND

MAINTENANCE DATA.

2.1.1 Manual Operation

Manual operation must be a force no greater than [89][_____] N [20][_____] lbf to start movement at the rate of 1.02 m/s 3.33 ft/s (200 ft/min). Use a removable handle to extend and retract the bottom operable seals; vertical movement of seals must be [51][_____] mm [2] [_____] inches. Provide closure to the lead wall with the use of a flexible bulb; accomplish final closing by means of a lever exerting pressure against the wall.

2.1.2 Electric Operation

Design the pressure-sensitive leading edge so that a force of [17.8] [_____] N [4] [_____] lbf stops the forward motion; system must stop the partition movement if people or objects are in the path of the partition when it is being extended or in the pocket area when the panels are being folded. Provide a weight-sensitive floor mat in the storage pocket to prevent partition movement with as little as 2.3 kg 5 lbs of weight applied. Wall mount the electric control.

2.1.3 Performance Requirements

2.1.3.1 Fire Resistance Ratings

****

NOTE: Select flame spread and smoke developed criteria to suit project.

****

Provide covering and lining with flame spread rating of 25 or less, fuel contribution rating of 15 or less, smoke generation of 50 or less in accordance with NFPA 101 when tested in accordance with ASTM E84. [Provide 1 hour fire rating, for operable panel assemblies[, including pass doors,] when tested in accordance with UL 10B, or NFPA 252.] Submit flame and smoke development tests reports. Provide door and partition finishes with a Class A rating when tested in accordance with ASTM E84.

2.1.3.2 Laboratory Acoustical Requirements

****

NOTE: Specify sound transmission class as determined by project requirements. The requested rating should be between 35 and 54 STC. 39 and 40 STC are widely available. If more is required, another type of moveable partition should be used. Specify a panel weight of no less than 24.4-34.2 kg per square meter 5-7 psf for STC of 35, 34.3-43.9 kg per square meter 7-9 psf for STC of 45.

Folding panel partitions are available in 75 mm 3 inch and 100 mm 4 inch nominal thicknesses. The STC rating for 75 mm 3 inch thick panels is less than a 100 mm 4 inch panel and some fabrication types (steel frame) do not come in a 75 mm 3 inch thick panel. The designer will confirm that STC and NRC rating requirements are met if selecting a 75 mm 3 inch nominal thickness panel.

****

Provide partitions tested in accordance with ASTM E90, by a laboratory accredited by the U.S. Bureau of Standards, that have attained a sound transmission class (STC) of not less than [39] [40] [_____] in a fully extended position, with a Noise Reduction Coefficient (NRC) of [0.25-0.30 for napped, tufted or looped fabric] [0.65-0.75 for perforated steel in accordance with ASTM C423] [_____]. Provide documentation that the partition tested is the same construction, materials, and model number as the partition to be provided and be fully operable. Test specimen is not less than [11.7 square meters in area] [4.27 by 2.74 m] [126 square feet in area] [14 feet by 9 feet]. Provide a minimum panel weight of 26 kg/square meter 5.5 per square foot for STC up to 40, 36 kg/square meter 7.5 psf for STC up to 45, 41 kg/ square meter 8.5 per square foot for STC up to 50, and 48 kg/square meter 10.0 per square foot for STC up to 53. Design panel thickness [(76 mm3 inch nominal)][(102 mm4 inch nominal)] and composition to provide the required STC rating in accordance with ASTM E90 and ASTM E413. Submit acoustical test reports in accordance with ASTM E90, ASTM C423 and ASTM E413.

2.1.3.3 Electrical Components, Devices and Accessories

Listed and labeled as defined in NFPA 70 by qualified testing agency, and marked for intended location and application.

2.2 MATERIALS

Provide heavy-duty type hardware standard with the manufacturer. Provide pulls and latches for all partitions. Provide partitions with [keyed locks][privacy latches][magnetic contact latches]. Provide [[clear][bronze] anodized aluminum][chrome plated][painted][_____] finish hardware. Provide horizontal and vertical trim painted [off white] [brown] [grey] [_____] with matching rubber.

2.3 FOLDING PANEL PARTITIONS

Provide folding panel partitions using top hung ball bearing carriers which support modular panels.

a. Provide partitions made up of a series of rigid panels, each panel being a one-piece assembly. Unless otherwise specified, use the least number of panels. The mechanical seal of the panel must actuate with a single operating action.

b. Provide [paired(centerfold)] [single (omni directional)] [continuously hinged(center folded) for electric operated only] type panels as indicated.

2.3.1 Panels

****

NOTE: Steel skin should be a minimum of 0.6 mm 24 gage for 1219 mm 48 inch panels, and 0.8 mm 22 gage for 1372 mm 54 inches, or larger panels. 1219 mm48 inch panels are standard panel size and usually do not exceed 1372 mm 54 inches due to limitations of cladding finish materials. Gypsum board is used for tackable surfaces.

****

Provide panels of [steel skin,] [reinforced aluminum,] [medium density fiberboard] [glass] [wood] [gypsum board,] laminated to appropriate structural acoustical backing, mounted in full perimeter protective frame. Steel for the panel frames must be [manufacturer's standard] [a minimum of [_____] mm (gauge) thick steel with minimum 0.76 mm 22 gauge thick face panels mechanically fasten to the frame]. Provide [aluminum frames for glass panels, with alloy and temper recommended by aluminum producer and furnished for type of use, corrosion resistance, and finish indicated] [wood frames, for glass panels, clear vertical-grain, straight, kiln-dried, [fire retardant treated]]. Frame must enclose and protect all edges of the surface material. Provide panels not more than 1.2 m 4 feet wide, except for end closure panels, and full height to track. Panels must lock in place to form a stable, rigid partition; low profile hinges may not project more than 6 mm 1/4 inch maximum from panel edge. Panel surfacing must wrap around the vertical panel edges without vertical trim.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content percentages shown below.

****

[Provide steel components that contain a minimum of 10 percent recycled content. Provide data identifying percentage of recycled content for steel components.]

[Provide aluminum components that contain a minimum of 30 percent recycled content. Provide data identifying percentage of recycled content for aluminum components.]

2.3.2 Partition System

****

NOTE: Wood veneer and glass are finish options for folding panel partitions.

****

Provide finish covering material minimum [1372 mm 54 inches] [_____] wide, [vertically-ribbed acoustical material of 100 percent polyolefin] [Type II vinyl with a minimum total weight of [441 grams/square m 13 ounces/square yard and 620 grams/linear m 20 ounces/linear yard] [_____] in accordance with CFFA-W-101-D, and conforming to ASTM D751 and NFPA 286.] Provide [vinyl containing a non-mercury based mildewcide and manufactured without the use of cadmium-based stabilizers][acrylic backed fabric of [100 percent polyolefin] [_____]].[Provide non-allergenic stain and mildew resistant fabric that does not rot or support growth of bacteria]. Provide finish covering that meets emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification of indoor air quality for finish covering.

[Glass and glazing type as specified in Section 08 81 00 GLAZING. Glaze operable panels in the factory where practical for applications indicated. Comply with manufacturer's written instructions.]

[Wood veneer laminated to [non combustible] [fire retardant-treated wood] core with moisture-resistant adhesive. Apply finish to wood species indicated with [transparent finish] [transparent finish over stain]].

[High pressure decorative laminate.]

[Paint, manufacturer's standard [factory] [field] painted finish.]

2.3.3 Track

Provide recess [extruded aluminum] [enamel finish steel] track as shown.[Provide aluminum that conforms to [ASTM B221] [ASTM B221M].] [Provide steel that conforms to ASTM A653/A653M.] Provide track that is the manufacturer's standard product designed for the weight of the finished partition, including door. Provide track sections in the maximum lengths practicable, and not less than 1.8 m 6 feet long except for narrow doors and at ends of runs where short length and "drop-out service" sections of track are required. Provide suitable joint devices such as interlocking keys at each joint to provide permanent alignment of track.

2.3.4 Suspension System

Provide a suspension system consisting of [steel][heavy duty extruded aluminum] track connected to the structural support by threaded rods, and trolleys designed to support the weight of the partition.[Provide steel track of 4.6 mm 7 gauge minimum, phosphate treated or painted.][Provide extruded aluminum track with minimum thickness of 3 mm 1/8 inch.] [Provide center hung panel with 1 trolley with four ball bearing nylon or steel tired wheels per panel.] [Provide 2 trolleys per panel with 2 ball bearing polymer or steel tired wheels.]

2.4 ACCESSORIES

2.4.1 Pass Doors

Provide ADA/ABA compliant pass door of the same [materials,] [construction,] [acoustical qualities,] [fire rating,] finish and thickness as the basic panels. Pass door panel legs require bottom thresholds. Provide pass door leaf with perimeter trim to protect face finish and to provide visual identification as required by International Building Code. Pass door leaf incorporates a self-adjusting retractable bottom seal providing sound control when door is closed. Hinges finished to match other exposed hardware.

2.4.1.1 Pass Door Hardware

a. [Mechanically operated floor seal on panels containing pass doors]. [Sweep floor seals]

b. [Automatic door closer]. [Concealed door closer].

c. Latchset: Passage set.

d. Lock: [Key operated lock with cylinder [keyed to master key system] operable from both sides of the door. Include two keys per lock.] [Deadlock to receive cylinder, operable from both sides of door.] [See Section 08 71 00 DOOR HARDWARE for lock cylinder and keying requirements.]

e. Exit Sign: [Passive screen printed]. [Recessed, self-illuminated].

f. Prepped for door window side light.

g. Door Viewer: Installed with view in direction of swing.

h. [Panic][Fire Exit] hardware for emergency exit with lock override feature.

2.4.2 Metal Soffit

Provide soffit when steel or aluminum track is recessed. Provide metal soffit of adequate thickness to protect the ceiling from damage by door operation and with the door manufacturer's standard neutral-color applied finish. Provide soffit on aluminum track that is an integral part of the track.

[2.4.3 Tackboard

Provide tackboard with [steel][aluminum] frame. Provide minimum 6 mm 1/4 inch thickness, tacking surface covered with self-sealing decorative vinyl. Provide tacking surfaces laminated to rigid backing substrate.

][2.4.4 Markerboards

Provide markerboards with [aluminum] [steel] frame with writing surface of [cast acrylic plastic with color fused to surface][porcelain steel] [tempered glass]. Markerboard must [not protrude more than 3 mm 1/8 inch beyond panel face][be flush]. Color: [white][_____].

]2.5 SEALS AND SWEEPSTRIPS

****

NOTE: Partitions need a floor and ceiling seal to avoid gaps that will lower the advertised sound transmission rating. For any partition that requires a sound rating, use seals and ceiling guards provided by the manufacturer of the partition. Provide a baffle in the ceiling plenum above the partition with a STC rating equal to the partition. Provide a floor surface that will allow the bottom sweep to make a positive seal. Panels need vertical and end seals.

****

Provide perimeter seals or sound insulation, of manufacturer's standard product, to achieve the sound transmission class specified [and to pass the visual field test specified], without crack or craze when subjected to severe usage. [Provide mechanical seal top and bottom of the fire rated panel.] [Provide mechanical bottom seal that can be raised or lowered for positive control.] Provide manufacturer's vertical seals between panels to ensure acoustical [and fire] rating. Bottom seals consist of a vinyl sweep mechanical seal which expands in place, or provide panels which can be lowered by a removable operating device. Provide vertical seal between panels which is anodized, architectural grade, aluminum extrusion with [vinyl] [_____] sound seal. Sweep strips must be vinyl or other material that will not crack or craze with severe usage. Provide sweep strip STC to the specified rating.

[2.6 ELECTRICAL OPERATORS

****

NOTE: Specify electrical operators for those partitions whose size and weight preclude manual operation. Refer to manufacturers' literature. Indicate those partitions requiring electrical operation on the project drawings. Delete this paragraph when electrically operated partitions are not required in the project.

****

Provide manufacturer's recommended standard electrical operator for [each partition] [partitions indicated]. Submit wiring diagrams.

Electrical Operators must comply with NFPA 70. Factory-assembled electric operation system of size and capacity recommended and provided by folding panel manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, control stations, control devices, and accessories required for operation. Include wiring from control stations to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system. Control equipment must comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

2.6.1 Motor Electrical Characteristics

Motor will be able to operate 50-60 hz., and [115][208][230][460][_____] volts, [single phase][polyphase] with [manufacturer's standard][_____] horsepower to operate partition effectively.

2.6.2 Control Stations

Two single key operated, constant-pressure control stations located remotely from each other on opposite sides and opposite ends of partition run. Wire in series to require simultaneous activation of both key stations to operate partition. Each three-position control station labeled "Open," "Close," and "[Off] [Stop]." Furnish two keys per station.

2.6.3 Obstruction-Detection Devices

Equip each motorized operable panel partition with indicated automatic safety sensor that causes operator to immediately [shut off motor] [stop and reverse direction].

2.6.4 Limit Switches

Adjustable switches, interlocked with motor controls and set to automatically stop operable panel partition at fully extended and fully stacked positions.

2.6.5 Emergency Release Mechanism

Quick disconnect-release of electric-motor drive system, permitting manual operation in event of operating failure.

2.6.6 Electric Interlock

Equip each motorized folding panel partition with electric interlocks at locations indicated, to prevent operation of folding panel partition under the following conditions:

a. On storage pocket door, to prevent operation if door is not in fully open position.

b. On partitions at location of convergence by another partition, to prevent operation if merging partitions are in place.

]2.7 COLOR

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally the Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an Architect or Interior designer. Color will be selected from manufacturers standard colors or identified in this spec only when the project has minimal finishes.

When the government directs that color be located in the drawings, add a Note stating: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

****

Provide partition system samples in sizes indicated below and colors [as specified in Section 09 06 00 SCHEDULES FOR FINISHES.] [as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.]

2.7.1 Sample Size

a. Textile Facing Material: Full width by not less than 900 mm [36] [_____] inches long.

b. Panel Facing Material: Manufacturer's standard size, not less than 150 mm [6] [_____] inches square.

c. Panel Edge and Chair Rail Materials: Manufacturer's standard size, not less than 150 mm [6] [_____] inches long.

d. Glass: 300 mm[12] [_____] inches square.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth. Install in accordance with the approved installation drawings and the manufacturer's written installation instructions.

3.1.1 Preparation Work

****

NOTE: Show the structural support necessary to accommodate the size and weight of the partition. ASTM E557 has design as well as installation criteria.

****

Verify dimensions and condition of openings scheduled to receive folding panel partitions. Install partitions in accordance with the approved partition layouts, manufacturer's directions, and ASTM E557. Provide structural support for the track support elements as indicated.

[3.1.2 Electrical Operators

****

NOTE: Delete this paragraph when electrically operated partitions are not required.

****

Conform electrical components and installation to the requirements of NFPA 70 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide the partition manufacturer's standard drive and control components required to operate the partition. Power source as indicated on the electrical drawings.

]3.1.3 Adjustment

[Adjust manually operated partitions to open and close from any position with a maximum horizontal force as specified in paragraph MANUAL OPERATION applied to pendant pull, box or handle.] [Adjust drive components and limit switches of electrically operated partitions to ensure the partitions operate properly upon activation of the control switch.]

3.2 FIELD TESTS

3.2.1 Operational Test

In the presence of the Contracting Officer, operate partition at least three times to demonstrate that partition is capable of being moved from the stored position to the fully extended position smoothly and quietly [and without overloading the drive components]. Activate [the emergency release mechanism and demonstrate proper operation of the partition in the manual mode] [mechanical seals top and bottom]. Adjust partitions which do not operate properly and retest.

3.2.2 Visual Test

****

NOTE: Delete this paragraph when light leakage will

not be objectionable.
****

Conduct visual field tests for light leakage with all room lights turned on in the space on one side of the partition. Darken space on the other side of the partition. Light leakage from the lighted space to the darkened space is not acceptable. If light leakage does occur, adjust the partition to correct the problem and retest.

****
NOTE: Delete this paragraph in projects requiring STC ratings of less than 40. Noise Isolation Class (NIC) is a number that can be measured, and usually runs up to 10 points below laboratory results, i.e. lab STC 40, field NIC 30. This test is expensive and rarely necessary.
****

[3.2.3 Acoustical Test

3.2.3.1 Sub Title

Provide partition testing by an independent certified acoustical consultant in accordance with ASTM E336, and achieve a Noise Isolation Class (NIC) of [_____] plus or minus two. Adjust and/or modify partitions which do not comply, and retest. Submit field sound test reports.

]3.3 CLEANING

Clean any soiled parts of the partition in accordance with manufacturer's written instructions.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-10 22 43 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-10 22 43 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-10 22 43 (November 2024)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 10 22 43

SLIDING PARTITIONS

11/24

****

NOTE: This guide specification covers the requirements for sliding partitions.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.

Associated work found in other sections includes:

Steel supporting members or hanger rods, Section 08 31 00 ACCESS DOORS AND PANELS.

Wood blocking, rough bucks, and headers, Section 06 10 00 ROUGH CARPENTRY.

Wood trim, wood or hardboard ceiling guard, or soffits, Section 06 20 00 FINISH CARPENTRY.

Lock cylinders, Section 08 71 00 DOOR HARDWARE.

Operator field connections to power sources and inner connection to control switches, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

The following information should be shown on the drawings:

1. Location, size, and pocket area of sliding panel partitions.

2. Direction of operation, header conditions indicating height, track anchorage, track channel, and jamb conditions.

3. Partition supporting structure. The structural support for the partition is not part of this section; it must be indicated and specified separately.

4. A schedule of sliding partitions by type (manually or electrically operated), sizes, and stack space and identified by mark number or letter

5. For electrically operated partitions, show power source and desired switch location.

Sliding glass partitions should be specified under 08 32 13 ALUMINUM SLIDING GLASS DOORS.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C1036	(2021) Standard Specification for Flat Glass
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E336	(2024) Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings
ASTM E413	(2022) Classification for Rating Sound Insulation
ASTM E557	(2012; R 2020) Standard Guide for Architectural Design and Installation Practices for Sound Isolation between Spaces Separated by Operable Partitions
ASTM E2068	(2000; R 2022) Standard Test Method for Determination of Operating Force of Sliding Windows and Doors

ASTM F793/F793M	(2020) Standard Classification of Wall Coverings by Use Characteristics

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 101	(2024) Life Safety Code
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies
NFPA 286	(2024) Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

UL SOLUTIONS (UL)

UL 10B	(2008; Reprint Oct 2024) Fire Tests of Door Assemblies
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

WALLCOVERINGS ASSOCIATION (WA)

WA W-101	(2017) Quality Standard for Polymer Coated Fabric Wallcovering

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

Manufacturer's Sample Warranty

Statement of Code Compliance; G, [_____]

Statement of Standards Conformity; G, [_____]

Verification of Field Measurements; G, [_____]

Existing Electrical Data

SD-02 Shop Drawings

Installation; G, [_____]

Wiring Diagrams; G, [_____]

Layouts; G, [_____]

Fabrication Drawings; G, [_____]

SD-03 Product Data

Sliding Partitions; G, [_____]

Installation Instructions; G, [_____]

Recycled Content for Steel Components; S

Recycled Content for Aluminum Components; S

SD-04 Samples

Sliding Partitions; G, [_____]

Finish and Color; G, [_____]

SD-06 Test Reports

Acoustical Tests

Flame and Smoke Development Tests

SD-07 Certificates

Materials

Sliding Partitions

Indoor Air Quality for Fabrics and Wallcoverings; S

SD-10 Operation and Maintenance Data

Operating Instructions; G, [_____]

Maintenance Instructions; G, [_____]

Data Package 1; G, [_____]

SD-11 Closeout Submittals

Warranty

****

NOTE: The Government's preference is for use of products that have been certified for indoor air quality by a third-party organization such as Greenguard or SCS Global Services. However, it must be verified there is a certified product available that is both cost effective and appropriate for the project. Retain the bracketed Section below when the designer of record confirms local/regional availability of Greenguard or SCS products that does not impact cost effectiveness. In addition, when this Section is retained requiring Greenguard or SCS products, also include the Indoor Air Quality Certificates in SD-07 submittals of this section.

****

[1.3 INDOOR AIR QUALITY CERTIFICATION

1.3.1 Fabrics and Wallcoverings

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the jobsite in the manufacturer's original, unopened, and undamaged packages with labels legible and intact. Provide labels to indicate the manufacturer, brand name, size, finish, and placement location. Store partitions and accessories in unopened packages in a manner that will prevent damage. Handle partition materials in accordance with manufacturer's instructions. Protect materials from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.5 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period. In addition, provide guarantee of the pantographs, trolleys and tracks for 10 years from date of acceptance for beneficial use.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: The designer will edit this specification for manual or electric operation of sliding panel partitions as required for the project.

****

a. Provide [manual] [and] [electric] operation, acoustical sliding partitions, factory finished, supported from overhead track [without] [with] floor guides, as shown on the drawings including all hardware, seals, track and rollers as needed to close the specified opening.

b. No less than 30 calendar days prior to the scheduled commencement of installation submit the following to the Contracting Officer:

Manufacturer's Qualifications
Manufacturer's Sample Warranty
Statement of Code Compliance
Statement of Standards Conformity
Verification of Field Measurements
Existing Electrical Data
Fabrication Drawings
Installation Instructions

c. Submit drawings to demonstrate that the system has been coordinated and will properly function as a unit. Show layout of the work; track and jamb fastening methods; seal and installation details; and equipment relationship to other parts of the work including clearances for maintenance and operation.

[d. Provide assemblies that are complete with vision panels when specified for doors or panels.[Provide metal loose stops and field install glass and glazing when shipped separately.]]

2.1.1 Manual Operation

For the manual operation provide a force no greater than [89] [_____] N [20] [_____] lbf to start movement at the rate of 1.02 m/s 3.33 ft/s (200 ft/min). Use a removable handle to extend and retract the bottom operable seals; vertical movement of seals must be [50] [_____] mm [2] [_____] inches. Use a flexible bulb for closure to the lead wall; accomplish final closing by means of a lever exerting pressure against the wall.

2.1.2 Electric Operation

Design the pressure-sensitive leading edge so that a force of [17.8] [_____] N [4] [_____] lbf will stop the forward motion; system must stop the partition movement if people or objects are in the path of the partition when it is being extended or in the pocket area, when the panels are being folded. Provide a weight-sensitive floor mat in the storage pocket to prevent partition movement with as little as 2.3 kg 5 lbs of weight applied. Wall mount the electric control.

2.1.3 Performance Requirements

2.1.3.1 Fire Endurance

****

NOTE: Select flame spread and smoke developed criteria to suit project.

****

For partitions more than 5.6 square meters 60 square feet in area, provide covering and lining with flame spread rating of 25 or less, fuel contribution rating of 15 or less, smoke generation of 50 or less in accordance with NFPA 101 when tested in accordance with ASTM E84. [1 hour fire rating, UL 10B, or NFPA 252.] Submit flame and smoke development tests reports. Door and partition finishes must have a Class A rating when tested in accordance with ASTM E84.

2.1.3.2 PFOS/PFOA Requirements

Provide materials free from perfluorooctanesulfonic acid (PFOS) or perfluorooctanoic acid (PFOA).

2.1.3.3 Laboratory Acoustical Requirements

****

NOTE: Specify sound transmission class as determined by project requirements. The requested rating should be between 35 and 54 STC. 39 and 40 STC are widely available. If more is required, another type of moveable partition should be used. Specify a panel weight of no less than 14 kg per square meter 3 psf for STC of 35, 24 kg per square meter 5 psf for STC of 45.

****

Provide partitions tested in accordance with ASTM E90, by a laboratory accredited by the U.S. Bureau of Standards, that have attained a sound transmission class (STC) of not less than [39] [40] [_____] in a fully extended position, with a Noise Reduction Coefficient (NRC) of [0.25-0.30 for napped, tufted or looped fabric] [0.65-0.75 for perforated steel in accordance with ASTM C423] [_____]. Partition tested must be of the same construction, materials, and model number as the partition to be provided and be fully operable. Test specimen must be not less than [12 square meters in area] [4200 by 2700 mm] [126 square feet in area] [14 by 9 feet], with a panel weight minimum of 26 kg/square meter 5.5 psf for STC up to 40, 36 kg/square meter 7.5 psf for STC up to 45, and 41 kg/square meter 8.5 psf for STC up to 50, 48 kg/square meter 10.0 psf for STC up to 53. Panel thickness (100 mm 4 inch nominal) and composition designed to provide the required STC rating in accordance with ASTM E90 and ASTM E413.

[2.1.3.4 Seismic Requirements

Provide partitions complying with the seismic requirements applicable to the project. Confirm that loads imparted from the partitions are adequately supported by the abutting construction. Coordinate requirements with applicable codes and the Structural Engineer.

]2.2 MATERIALS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 year prior to bid opening. Submit Certificate attesting that the materials meet the requirements specified. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Provide heavy-duty type hardware standard with the manufacturer, pulls and latches for all partitions, and partitions with [keyed locks] [privacy latches] [magnetic contact latches] [foot bolts]. Provide [anodized aluminum [clear] [bronze]] [chrome plated] [brass plated metal] [painted] [_____] finish hardware.

2.3 SLIDING PARTITIONS

Provide sliding partitions using top hung ball bearing carriers which support modular panels:

a. Made up of a series of rigid panels, each panel being a one-piece assembly. Unless otherwise specified, use the least number of panels. Actuate the mechanical seal of the panel with a single operating action.

b. [Paired] [Single] [Omni-directional] [Continuously hinged] type as indicated.

2.3.1 Panels

****

NOTE: Steel skin should be a minimum of 0.6 mm 24 gage for 1200 mm 48 inch panels, and 0.8 mm 22 gage for 1500 mm 60 inches panels.

****

Provide panels of [steel skin,] [reinforced aluminum,] [particleboard,] [wood] [_____] [tackable base,] laminated to appropriate structural acoustical backing, mounted in full perimeter protective frame. Steel for the panel frames must be a minimum of [_____] mm gauge thick steel with minimum 0.80 mm 22 gauge thick face panels spot welded to the frame. Frame must enclose and protect all edges of the surface material. Panels must be less than 1.2 m 4 feet wide, except for end closure panels, and be full height to track. Panels must lock in place to form a stable, rigid partition; low profile hinges may not project more than 6 mm 1/4 inch maximum from panel edge. Wrap panel surfacing around the vertical panel edges without vertical trim. Provide panel core sound insulation conforming to ASTM E336 and ASTM E413.

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available from US national manufacturers above the minimum recycled content percentages shown below. Some manufacturers and regions have higher percentages. Based on research, select or insert desired minimum percentages into the empty set of brackets.

****

[Provide steel components that contain a minimum of [10][_____] percent post-consumer recycled content. Provide data identifying percentage of recycled content for steel components.][

Provide aluminum components that contain a minimum of [30][_____] percent post-consumer recycled content. Provide data identifying percentage of recycled content for aluminum components.]

2.3.2 Finish Covering

****

NOTE: Wood veneer and framed tempered glass are finish options for sliding partitions.

****

Finish material must be minimum [1371 mm 54 inches] [_____] wide, [vertically-ribbed acoustical material of 100 percent polyolefin] [Type II vinyl with a minimum total weight of [441 grams/square m 13 ounces/square yard and 620 grams/linear m 20 ounces/linear yard] [_____] in accordance with WA W-101, and conforming to ASTM D751, ASTM F793/F793M, and NFPA 286.] Provide [vinyl containing a non-mercury based mildewcide and manufactured without the use of cadmium-based stabilizers] [acrylic backed fabric of [100 percent polyolefin] [_____]].[Provide non-allergenic stain and mildew resistant fabric which will not rot or support growth of bacteria]. Fabrics and wallcoverings must meet emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for fabrics and wallcoverings.

2.3.3 Track

Provide recess [extruded aluminum] [enamel finish steel] track as shown.[Aluminum must conform to [ASTM B221] [ASTM B221M].] [Steel must conform to ASTM A653/A653M.] Use manufacturer's standard track product designed for the weight of the finished partition, including door. Provide track sections in the maximum lengths practicable, and not less than 1.8 m 6 feet long except for narrow doors and at ends of runs where short length is required. Provide suitable joint devices such as interlocking keys at each joint to provide permanent alignment of track.

2.3.4 Suspension System

Provide a suspension system consisting of [steel] [heavy duty extruded aluminum] track connected to the structural support by threaded rods, and trolleys designed to support the weight of the partition.[Provide steel track of 5 mm 7 gage minimum, phosphate treated or painted.] [Provide extruded aluminum track with minimum thickness of 3 mm 1/8 inch.] [Provide center hung panel with 1 trolley with four ball bearing nylon or steel tired wheels per panel.] [Provide 2 trolleys per panel with 2 ball bearing polymer or steel tired wheels.]

[2.3.5 Tackboard

Provide tackboard with [steel] [aluminum] frame; a minimum 6 mm 1/4 inch thickness , tacking surface covered with self-sealing decorative vinyl and tacking surfaces laminated to rigid backing substrate.

][2.3.6 Markerboards

Provide markerboards with [aluminum] [steel] frame with writing surface of [cast acrylic plastic with color fused to surface] [porcelain steel]. Markerboard may not protrude more than 3 mm 1/8 inch beyond panel face. Color: [white] [_____].

][2.3.7 Vision Panels

****

NOTE: Delete the paragraph heading and the following paragraphs if vision panels are not required. Edit the first paragraph as required for metal or wood doors.

Coordinate with Section 08 81 00 GLAZING.
Glazing Type: As scheduled on Drawings.
Glazing Type: Category II safety glass.
Glazing Type: One-way vision Category II safety glass.
Glazing Type: 6 mm1/4 inch fire rated ceramic safety glass.

****

Furnish with vision panels complete with glazing and frames. Provide 1.90 millimeter 0.0747 inch steel or wood frames, moldings, and stop to match the panel finish, with profile indicated. Assemble with mitered corners and flush joints, and secured with countersunk phillips-head screws.

Provide either a single thickness of acoustical plate glass laminated to an inner face of water-clear plastic or multiple thicknesses of 6 millimeter 1/4 inch plate glass, clear or patterned as indicated, and set in glazing gaskets and frames as required to meet the specified STC.

Provide glass to conform to ASTM C1036 and ASTM C1048, Type I, Class 1; and ANSI Z97.1. Provide acoustical plate glass that has been tested and rated in accordance with ASTM E90, with an STC of not less than 36 and a minimum thickness of 7.14 millimeter 9/32 inch.

][2.4 Guarantee

Provide written guarantee that each sliding partition delivered to the project is equal in construction and sound transmission classification (STC) test rating where applicable, with appropriate labeling and markings, to that of the sample partition tested. Clearly state in written guarantee that each sliding partition, when installed in accordance with the manufacturer's printed instructions, has an in-place STC within 3 decibels of the specimen tested. Submit the following test data and Certificates with the written Guarantee:

a. Acoustical Tests.

]2.5 ACCESSORIES

2.5.1 Doors

Provide non-fire rated, manually operated doors with vinyl sweep top seals which compress against the bottom of the top track.

2.5.2 Ceiling Guards

Furnish partitions with ceiling guards or integral track and ceiling guards as recommended by the manufacturer.

2.5.3 Metal Soffit

Provide soffit when steel track is recessed. Provide metal soffit of adequate thickness to protect the ceiling from damage by door operation and with the door manufacturer's standard neutral-color applied finish. Soffit on aluminum track must be an integral part of the track

2.6 SEALS AND SWEEPSTRIPS

****

NOTE: Partitions need a floor and ceiling seal to avoid gaps that will lower the advertised sound transmission rating. For any partition that requires a sound rating, use seals and ceiling guards provided by the manufacturer of the partition. Provide a baffle in the ceiling plenum above the partition with a STC rating equal to the partition. Provide a floor surface that will allow the bottom sweep to make a positive seal. Panels need vertical and end seals.

****

Provide perimeter seals or sound insulation, of manufacturer's standard product, to achieve the sound transmission class specified [and to pass the visual field test specified], without crack or craze when subjected to severe usage. [Provide mechanical seal top and bottom of the fire rated panel.] [Provide mechanical bottom seal that can be raised or lowered for positive control.] Provide manufacturer's vertical seals between panels to ensure acoustical [and fire] rating. Use bottom seals consisting of a vinyl sweep mechanical seal that expands in place, or provide panels that can be lowered by a removable operating device. Vertical seal between panels must be anodized, architectural grade, aluminum extrusion with [vinyl] [_____] sound seal. Provide vinyl sweep strips or other material which will not crack or craze with severe usage. Provide sweep strip STC of the specified rating.

[2.7 ELECTRICAL OPERATORS

****

NOTE: Specify electrical operators for those partitions whose size and weight preclude manual operation. Refer to manufacturers' literature. Indicate those partitions requiring electrical operation on the project drawings. Delete this paragraph when electrically operated partitions are not required in the project.

****

Provide manufacturer's recommended standard electrical operator for [each partition] [partitions indicated]. Provide wiring diagrams.

]2.8 COLOR

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an Architect or Interior designer. Color will be selected from manufacturers standard colors or identified in this spec only when the project has minimal finishes.

When the government directs that color be located in the drawings, add a Note stating: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

****

Color [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [as indicated] [selected from manufacturers standard colors] [_____].[Color listed is not intended to limit selection of equal colors from other manufacturers].

Submit [three] [_____] color samples of specified surfaces and finishes to match those specified. Finish and color requirements are not limited to manufacturer's standard selections in order to meet these requirements. Also submit Certificate attesting that partitions have specified acoustical and flame retardant properties, as determined by test.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with the manufacturer's approved instructions. Do not install building construction materials that show visual evidence of biological growth.

3.1.1 Preparation Work

****

NOTE: Show the structural support necessary to accommodate the size and weight of the partition. ASTM E557 has design as well as installation criteria.

****

Verify dimensions and condition of openings scheduled to receive folding panel partitions. Install partitions in accordance with the approved partition layouts, manufacturer's directions, and ASTM E557. Provide structural support for the track support elements as indicated.

[3.1.2 Electrical Operators

****

NOTE: Delete this paragraph when electrically operated partitions are not required.

****

Conform electrical components and installation to the requirements of NFPA 70 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide the partition manufacturer's standard drive and control components required to operate the partition. Power source is as indicated.

]3.1.3 Adjustment

[Adjust manually operated partitions to open and close from any position with a maximum horizontal force as specified in paragraph Manual Operation applied to pendant pull, box or handle.] [Adjust drive components and limit switches of electrically operated partitions to ensure the partitions operate properly upon activation of the control switch.]

3.2 FIELD TESTS

3.2.1 Operational Test

In the presence of the Contracting Officer, operate partition at least three times to demonstrate that partition is capable of being moved from the stored position to the fully extended position smoothly and quietly [and without overloading the drive components].[Activate mechanical seals top and bottom.] Adjust partitions which do not operate properly and retest.

[

****

NOTE: Include this paragraph in projects requiring doors or sections of partitions to permit breakaway operation during emergencies to facilitate egress.

****

In accordance with ASTM E2068 provide:[Field breakaway performance testing confirming compliance with breakaway operation at locations indicated on the drawings.] [Activate the emergency release mechanism and demonstrate proper operation of the partition in the manual mode.][Confirm the operating force for sliding partitions.] Adjust or modify partitions which do not comply with requirements, and retest.

]

3.2.2 Visual Test

****

NOTE: Delete this paragraph when light leakage will not be objectionable.

****

Conduct visual field tests for light leakage with all room lights turned on in the space on one side of the partition. Darken space on the other side of the partition. Light leakage from the lighted space to the darkened space is not acceptable. If light leakage does occur, adjust the partition to correct the problem and retest.

3.2.3 Acoustical Tests

****

NOTE: Delete this paragraph in projects requiring STC ratings of less than 40. Noise Isolation Class (NIC) is a number that can be measured, and usually runs up to 10 points below laboratory results, i.e. lab STC 40, field NIC 30. This test is expensive and rarely necessary.

****

Field sound performance: provide partition testing by an independent certified acoustical consultant in accordance with ASTM E336, and achieve a Noise Isolation Class (NIC) of [_____] plus or minus two. Adjust or modify partitions which do not comply, and retest.

3.3 CLEANING

Clean any soiled parts of the partition in accordance with manufacturer's printed instructions.

3.4 OPERATION AND MAINTENANCE

3.4.1 Operating Instructions

Submit six complete copies of operating instructions outlining the procedures required for electrically operated partitions. The instructions must include the manufacturer's name, model number, service manual, parts list, brief description of all equipment and operating features, a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 year and 3 years of service.

3.4.2 Maintenance

Submit six complete copies of maintenance instructions explaining routine maintenance procedures including inspection, adjustments, lubrication, and cleaning; list possible breakdown, methods of repair, and include a troubleshooting guide. Include instructions for equipment layout and simplified wiring and control diagrams of the system as installed.

Submit Data Package 1 for sliding partitions, and Data Package 5 for electrical operators in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-10 26 00 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-10 26 00(August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-10 26 00 (August 2020)**

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****

SECTION 10 26 00

WALL AND DOOR PROTECTION

08/20

****

NOTE: This guide specification covers the requirements for corner guards, wall guards, door protectors, and wall panels.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Army facilities not excluded by TI 800-01 Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Drawings should show basic profiles and details but should not be so explicit as to become proprietary in nature. The following information must be shown on the project drawings:

1. Locations of crash rails and corner guards.

2. Locations of wall covering and panels, and door

protectors.

3. Mounting and anchorage details, and dimensions.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D543	(2020) Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F476	(2014) Standard Test Methods for Security of Swinging Door Assemblies
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)	
CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers
GREEN SEAL (GS)	
GS-36	(2013) Adhesives for Commercial Use
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
SCIENTIFIC CERTIFICATION SYSTEMS (SCS)	
SCS	SCS Global Services (SCS) Indoor Advantage
SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)	
SAE J1545	(2005; R 2021) Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Colored Trim
SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)	
SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications
UL SOLUTIONS (UL)	
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Corner Guards; G, [_____]

Wall Guards; G, [_____]

Door Protectors; G, [_____]

Wall Covering and Panels; G, [_____]

SD-03 Product Data

Corner Guards; G, [_____]

Wall Guards; G, [_____]

Door Protectors; G, [_____]

Wall Covering and Panels; G, [_____]

[Recycled content for aluminum component of corner guards; S

][Recycled content for steel component of corner guards; S

][Recycled content for aluminum component of wall guards, Combination Handrail/Wall guard and handrails; S

][Recycled content for aluminum component of crash rail/bed locators; S

][Recycled content for aluminum component of combination handrail/crash rail; S

][Recycled content for aluminum component of handrails; S

] SD-04 Samples

Corner Guards; G, [_____]

Wall Guards; G, [_____]

Door Protectors; G, [_____]

Wall Covering and Panels; G, [_____]

SD-06 Test Reports

Fire Resistance Rating

SD-07 Certificates

[Indoor air quality for wall covering/panels; S

][Indoor air quality for adhesives; S

] SD-10 Operation and Maintenance Data

Corner Guards, Data Package 1; G, [_____]

Wall Guards, Data Package 1; G, [_____]

Door Protectors, Data Package 1; G, [_____]

Wall Covering and Panels, Data Package 1; G, [_____]

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality

1.3.1.1 Wall Covering and Panels

Provide sheet and high impact resistant resilient materials certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this section. Provide current product certification documentation from certification body.

1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and trademarks intact. Keep materials dry, protected from weather and damage, and stored under cover. Store materials at approximately 21 degrees C 70 degrees F for at least 48 hours prior to installation.

1.5 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for a 1 year period of [one year] [_____] [years] from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

****

NOTE: All paragraphs must be carefully edited because of the broad number of possible requirements and the diverse combinations available with these products.

Some manufacturers will meet ASTM D256 and some ASTM F476, research to determine the specific test to what is specified.

****

To the maximum extent possible, provide wall and door protection items that are standard products of a single manufacturer and furnished as detailed. Drawings show general configuration of products required[, and items differing in minor details from those shown are acceptable].

Submit detailed shop drawings of each wall and door protection item indicated. Include elevations, dimensions, clearances, details of construction and anchorage, and details of joints and connections.

Submit manufacturers' descriptive product data for each wall and door protection item indicated. Include manufacturers' literature, finishes, profiles and thicknesses of materials.

Submit manufacturers' operations and maintenance data for each wall and door protection item indicated in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

2.1.1 Resilient Material

Provide resilient material consisting of high impact resistant extruded [PVC free][acrylic vinyl][or][injection molded thermal plastic] conforming to the following:

2.1.1.1 Minimum Impact Resistance

[Minimum impact resistance must be 3,857 kg/m 18 ft-lbs/sq. inch when tested in accordance with ASTM D256, (Izod impact, ft-lbs per sq inch notched).][Minimum impact resistance must be 10,633.4 kg/m 49.62 ft-lbs/sq.

inch when tested in accordance with ASTM F476.]

2.1.1.2 Fire Resistance Rating

Provide the following surface burning characteristics when tested and labeled in accordance with ASTM E84 by a qualified testing agency: maximum flame spread of 25 and a smoke developed rating of 450 or less. Provide material rated as self extinguishing when tested in accordance with ASTM D635. Provide resilient material used for protection on fire rated doors and frames listed by the qualified testing agency performing the tests. Provide resilient material installed on fire rated wood/steel door and frame assemblies tested on similar type assemblies. Test results of material tested on any other combination of door/frame assembly are not acceptable.

2.1.1.3 Integral Color

Provide colored components having integral color and matched in accordance with SAE J1545 to within plus or minus 1.0 on the CIE-LCH scales.

2.1.1.4 Chemical and Stain Resistance

Provide materials resistant to chemicals and stains reagents in accordance with ASTM D543.

2.1.1.5 Fungal and Bacterial Resistance

Provide materials resistant to fungi and bacteria in accordance with ASTM G21, as applicable.

2.2 CORNER GUARDS

****

NOTE: For medical facilities, corner guards must extend from floor to ceiling.

****

2.2.1 Resilient Corner Guards

Provide [flush mounted] [surface mounted] corner guards, radius formed to profile shown. Provide corner guards that [extend from floor to ceiling.] [are [_____] mm [____]feet high.] Furnish mounting hardware, cushions, and base plates. Provide assembly consisting of a snap-on corner guard formed from high impact resistant resilient material, mounted on a continuous aluminum retainer. Extruded aluminum retainer conforms to ASTM B221, alloy 6063, temper T5 or T6. Provide aluminum components that contain a minimum of 35 percent recycled content. Provide data identifying percentage of recycled content for aluminum component of corner guards. Flush mounted type guards act as a stop for adjacent wall finish material. Furnish factory fabricated end closure caps for top and bottom of surface mounted corner guards. Provide flush mounted corner guards installed in fire rated wall that maintain the rating of the wall. Manufacturer to provide insulating materials that are an integral part of the corner guard system. Provide exposed metal portions of fire rated assemblies with a paintable surface.

2.2.2 Stainless Steel Corner Guards

****

NOTE: 1.59 mm16 gauge stainless steel corner guards are the standard for most manufactures, it is very durable and able to stand up well to abuse in many situations. Depending on the amount of abuse a corner guard is expected to take, select a higher gauge. Some examples of higher abuse spaces include clean rooms, warehouses or manufacturing plants.

****

Provide stainless steel base material that contains a minimum of 60 percent recycled content. Provide data identifying percentage of recycled content for steel component of corner guards. Fabricate stainless steel base material of[1.98 mm 14 gauge][1.59 mm 16 gauge][1.27 mm 18 gauge][0.95 mm 20 gauge] thick material conforming to ASTM A167, type 430 or 304. Provide corner guards that [extend from floor to ceiling.][are [_____] mm [_____]feet high.] Form corner guard to dimensions shown.

2.3 WALL GUARDS

****

NOTE: Bed locators are used in healthcare facilities, specifically inside patient rooms. They help protect the wall from damage by positioning the patient bed in the right location. Remove references to bed locator if not editing this specification for a healthcare facility. For the intent of this specification wall guards include crash rails, bed locators, handrails and chair rails.

****

Provide product with prefabricated end closure caps, inside and outside corners, concealed splices, cushions, mounting hardware and other accessories standard with the manufacturer. Extruded continuous aluminum retainers must conform to ASTM B221, alloy 6063, temper T5 or T6. Provide aluminum components that contain a minimum of 35 percent recycled content. Provide data identifying percentage of recycled content for aluminum component of wall guards, combination handrail/wall guard and handrails. Field adjust all end caps and corners to assure close alignment.

2.3.1 Crash Rails and [Bed Locators]

Provide crash rails with snap-on covers of high impact resistant resilient material, minimum 2 mm 0.078 inch thick, mounted over [51] [_____] mm [2] [_____] inch wide aluminum, minimum 2 mm 0.062 inch thick retainer, anchored to wall at maximum 610 mm 24 inches on center. Provide aluminum components that contain a minimum of 35 percent recycled content. Provide data identifying percentage of recycled content for aluminum component of crash rail/bed locators.

2.3.2 Combination Handrail and Crash Rails

Provide combination handrail and crash rails with snap-on covers of high impact resistant resilient material, minimum 2 mm 0.078 inch thick, on a continuous, extruded aluminum retainer, minimum 1.83 mm 0.072 inch thick anchored to wall at maximum 813 mm 32 inches on center. Provide aluminum components that contain a minimum of 35 percent recycled content. Provide data identifying percentage of recycled content for aluminum component of combination handrail/crash rail.

2.3.3 Handrails

Provide handrails with snap-on covers of high impact resistant resilient material, minimum 2 mm 0.078 inch thick on a continuous extruded aluminum retainer, minimum 2 mm 0.072 inch thick anchored to wall at maximum 813 mm 32 inches on center. Provide aluminum components that contain a minimum of 35 percent recycled content. Provide data identifying percentage of recycled content for aluminum component of handrails. Provide aluminum components with prefabricated end closure caps, inside and outside corners, concealed splices, cushions, mounting hardware and other accessories standard with the manufacturer. Provide end caps and corners that are field adjustable to assure close alignment with handrails.

2.3.4 Chair Rails

Provide chair rails with a snap-on cover of high impact resistant resilient material, minimum 1.78 mm 0.070 inch thick, on a continuous extruded aluminum retainer, minimum 1.52 mm 0.060 inch thick anchored to wall at maximum 813 mm 32 inches on center. Provide chair rails with slices, cushions, mounting hardware and other accessories standard with the manufacturer. Field adjust all end caps and corners to assure close alignment with chair rails.

2.4 DOOR PROTECTORS

Provide[door] [door envelope] [door knob] [and] [door frame] protection items with [high impact resistant acrylic vinyl or polyvinyl chloride resilient material, minimum [2 mm 0.060 inch thick for doors] [and] [1.02 mm 0.040 inch thick for door frames]][1.59 mm 16 gauge, type 304 stainless steel for door]. Coordinate door and door frame protection material requirements with door and frame suppliers to insure fit for all components and color matching with other resilient materials. Provide adhesive as recommended by resilient material manufacturer.

2.5 WALL COVERING AND PANELS

****

NOTE: Recommended locations for various thicknesses of rigid wall covering andpanels are as follows: 1 mm 0.040 inch thick for lobbies and elevator areas, 1.02 to 1.52 mm 0.040 to 0.060 inch thick for service corridors, and 1.91 mm 0.075 inch thick for loading dock areas. A 10 mm 0.375 inch thick composite wall panel is recommended for installation over existing substrates such as ceramic tile, masonry block, or damaged plaster/drywall.

****

Provide wall covering and panels consisting of high impact [PVC free resilient material][rigid acrylic vinyl or polyvinyl chloride resilient material]. Panel sizes are[1219 mm by 2438 mm][4 by 8 feet][1219 mm by 3048 mm][4 by 10 feet]. Provide wall covering material used on the interior of the building (defined as inside of the weatherproofing system) that meets either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) the VOC content requirements of SCAQMD Rule 1168, or VOC content requirements of GS-36. Provide certification of indoor air quality for wall covering/panels.

2.5.1 Rigid Vinyl Acrylic Wall Covering

Provide[1.02 mm][0.040 inch][1.52 mm][0.060 inch][1.91 mm][0.075 inch][10 mm][0.375 inch] thick wall covering.

2.5.2 High Impact Wall Panels

Provide wall panel face and edge thickness that are [_____][1.02 mm][0.040 inch]. Factory bond panel face to a 10 mm 0.375 inch thick fiberboard core. Laminate the backside of the panel with a moisture resistant vapor barrier.

2.5.3 Rigid Vinyl Acrylic Digital Wall Covering

Provide wall covering thickness of minimum 1.02 mm 0.040 inch with high definition graphic file reverse printed on clear sheet and sealed with protective backer. Provide image as [selected from manufacturer standard.][custom artwork with copyright clearance.] Provide image [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.][as indicated on drawings.]

2.6 TRIM, FASTENERS AND ANCHORS

Provide [vinyl][aluminum][PVC free] trim, fasteners and anchors for each specific installation as indicated.

2.7 FINISH

Submit samples indicating color and texture of materials requiring color and finish.

2.7.1 Aluminum Finish

Provide aluminum finish accordance with AA DAF45; exposed aluminum with designation [AA-C22A31 chemically etched medium matte, with clear anodic coating] [AA-C22A32 chemically etched medium matte with integrally colored anodic coating]. Provide Class II architectural coating that is 0.010 mm 0.4 mil thick. Provide concealed aluminum with mill finish as fabricated, uniform in natural color and free from surface blemishes.

2.7.2 Stainless Steel Finish

Provide stainless steel finish in accordance with ASTM A167, Type 302 or 304, finish number 4.

2.7.3 Resilient Material Finish

****

NOTE: Coordinate resilient finishes with manufacturers. Certain finishes and textures are not available from some manufacturers.

****

Provide resilient material finish of [embossed [velour] [stipple] [_____]] [[fake woodgrain] [high gloss vinyl]] texture with colors in accordance with SAE J1545.

2.8 ADHESIVES

Provide adhesive for resilient material in accordance with manufacturers recommendations. Provide sealants and non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) the VOC content requirements of SCAQMD Rule 1168, or VOC content requirements of GS-36. Provide certification of indoor air quality for adhesives.

2.9 COLOR

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally, Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an Architect or Interior designer. Color must be selected from manufacturers standard colors or identified as a manufacturers color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located in the drawings a note must be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

****

Provide color [as specified in Section 09 06 00 SCHEDULES FOR FINISHES.] [as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.]

PART 3 EXECUTION

3.1 INSTALLATION

Do not install items that show visual evidence of biological growth. Install items on surfaces that are clean, smooth, and free of obstructions.

3.1.1 Corner Guards and Wall Guards

a. Mount guards [as indicated][on external corners of interior walls, partitions and columns] and in accordance with manufacturer's written installation instructions.

b. For wall guards, space brackets at no more than 914 mm 3 feet on centers and anchor to the wall in accordance with the manufacturer's written installation instructions.

3.1.1.1 Stainless Steel Guards

****

NOTE: For mounting of stainless steel corner guards tape is an option if holes are not wanted in the substrate, screws would be a more durable solution.

****

a. Mount guards [as indicated][on external corners of interior walls, partitions and columns] and in accordance with manufacturer's recommendations.

b. Where corner guards are installed on walls, partitions or columns finished with plaster or ceramic tile, [anchor corner guards as indicated][provide continuous 1.59 mm 16 gauge thick, perforated, galvanized z-shape steel anchors welded to back edges of corner guards and [wired to metal studs][expansion bolted to concrete or masonry with four 10 mm 3/8 inch diameter bolts, spaced 406 mm 16 inches on centers]]. Coat back surfaces of corner guards, where shown, with a non-flammable, sound deadening material. Overlap corner guards on finish plaster surfaces.

c. Where corner guards are installed on exposed structural glazed facing tile units or masonry wall, partitions or columns, [anchor corner guards as indicated][anchor corner guards to existing walls with 6 mm 1/4 inch oval head stainless steel countersunk expansion or toggle bolts][anchor corner guards with four nominal 1 mm 0.0516 inch thick, adjustable galvanized steel anchors, spaced as shown]. Grout spaces solid between guards and backing with portland cement and sand mortar.

d. Where corner guards are installed on gypsum board, clean surfaces and anchor guards with a neoprene solvent-type contact adhesive specifically manufactured for use on gypsum board construction. Remove excess adhesive from the guard edges and allow to cure undisturbed for 24 hours.

e. For wall guards, space brackets at no more than 914 mm 3 feet on center and anchor to the wall in accordance with the manufacturer's installation instructions.

3.1.2 Door Protectors

Install protectors after frames are in place, but prior to hanging of doors, in accordance with manufacturer's written instructions. Apply adhesives in controlled environment in accordance with manufacturer's written instructions. Install protection for fire doors and frames in accordance with NFPA 80.

3.1.3 Wall Coverings and Panels

Install as indicated in accordance with manufacturer's written instructions.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-10 28 13 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-10 28 13 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-10 28 13 (August 2020)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 10 28 13

TOILET ACCESSORIES

08/20

****

NOTE: This guide specification covers the requirements for toilet accessories suitable for a wide variety of applications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: For Army construction, buildings not excluded by the TI 800-01 Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Drawings will indicate location, dimensions, elevations, schedules, details, and such other information as required to indicate the extent of the work.

Product selections will be based on aesthetic values and cost as related to project needs.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z535.4	(2011) Product Safety Signs and Labels

ASTM INTERNATIONAL (ASTM)

ASTM F2285	(2004; R 2016; E 2016) Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-1691	(1994; Rev F; Notice 1 2024) Construction and Material Schedule for Military Medical and Dental Facilities

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Product Schedule; G, [_____]

Submit product Schedule indicating types, quantities, sizes, and installation locations by room for each toilet accessory item required. Identify locations using room designations indicated on the drawings.

SD-03 Product Data

Recycled content for stainless steel toilet accessories; S

[Item A4995 Table, Diaper Changing, Wall Mounted; G, [_____]

][Item A5030 Bench, Stall, Shower, Built In; G, [_____]

][Item A5047 Cabinet, Medicine; G, [_____]

][Item A5074 Soap Dish, Recessed, SS, Psychiatric; G, [_____]

][Item A5080 Dispenser, Paper Towel, SS, Surface Mounted; G, [_____]

][Item A5081 Dispenser, Paper Towel, SS, Recessed, Psychiatric; G, [_____]

][Item A5082 Dispenser, Paper Towel, Sensor, Hands Free; G, [_____]

][Item A5083 Dispenser, Paper Towel, Recessed; G, [_____]

][Item A5084 Dryer, Hands Free, Forced Air, Automatic; G, [_____]

][Item A5090 Disposal, Sanitary Napkin, SS, Surface Mounted; G, [_____]

][Item A5109 Grab Bar, 32 mm 1-1/4 inch Dia., SS, 2 Wall, W/C Accessible; G, [_____]

][Item A5110 Grab Bar, 32 mm 1-1/4 inch Dia., SS, 2 Wall, Shower Use; G, [_____]

][Item A5112 Grab Bar, Psychiatric; G, [_____]

][Item A5115 Grab Bar, Flip-Up, Heavy Duty; G, [_____]

][Item A5135 Shelf, Utility W/ Mop/Broom Holders, SS, Surf Mntd; G, [_____]

][Item A5140 Hook, Garment, Security; G, [_____]

][Item A5145 Hook, Garment, Double, SS, Surface Mounted; G, [_____]

][Item A5150 Hook, Garment, Triple, Surface Mounted; G, [_____]

][Item A5160 Shelf, 203 mm 8 inch Depth, SS, Surface Mounted; G, [_____]

][Item A5162 Shelf, Fold Down, Stainless Steel; G, [_____]

][Item A5165 Shelf, 127 mm 5 inch Depth, SS, Surface Mounted; G, [_____]

][Item A5166 Shelf, 305 mm 12 inch Depth, SS, Surface Mounted; G, [_____]

][Item A5170 Rod, Shower Curtain, 25 mm 1 inch Diameter, W/Curtain & Hooks; G, [_____]

][Item A5175 Soap Dish, With Bar, SS, Recessed; G, [_____]

][Item A5195 Dispenser, Toilet Tissue, SS, 1-Roll, Surface Mntd; G, [_____]

][Item A5196 Dispenser, Toilet Tissue, Psychiatric; G, [_____]

][Item A5200 Dispenser, Toilet Tissue, SS, 2-Roll, Surface Mntd; G, [_____]

][Item A5202 Dispenser, Toilet Paper w/Utility Shelf, SS, 2-Roll; G, [_____]

][Item A5205 Bar, Towel, 25 mm 1 inch Diameter, SS, Surface Mounted; G, [_____]

][Item A5207 Bar, Towel, 25 mm 1 inch Diameter, SS, Surface Mntd, Psych; G, [_____]

][Item L1200 Cabinet, Specimen, Pass Thru, CRS; G, [_____]

] Submit catalog numbers, literature, data sheets, construction details, profiles, anchoring and mounting requirements [,including cutouts in other work and substrate preparation,] [,electrical characteristics,] and other pertinent data for each toilet accessory item to evaluate function, materials, dimensions and appearance.

SD-07 Certificates

Baby Changing Stations

SD-10 Operation and Maintenance Data

[Item A4995 Table, Diaper Changing, Wall Mounted; G, [_____]

][Item A5030 Bench, Stall, Shower, Built In; G, [_____]

][Item A5047 Cabinet, Medicine; G, [_____]

][Item A5074 Soap Dish, Recessed, SS, Psychiatric; G, [_____]

][Item A5080 Dispenser, Paper Towel, SS, Surface Mounted; G, [_____]

][Item A5081 Dispenser, Paper Towel, SS, Recessed, Psychiatric; G, [_____]

][Item A5082 Dispenser, Paper Towel, Sensor, Hands Free; G, [_____]

][Item A5083 Dispenser, Paper Towel, Recessed; G, [_____]

][Item A5084 Dryer, Hands Free, Forced Air, Automatic; G, [_____]

][Item A5090 Disposal, Sanitary Napkin, SS, Surface Mounted; G, [_____]

][Item A5109 Grab Bar, 32 mm 1-1/4 inch Dia., SS, 2 Wall, W/C Accessible; G, [_____]

][Item A5110 Grab Bar, 32 mm 1-1/4 inch Dia., SS, 2 Wall, Shower Use; G, [_____]

][Item A5112 Grab Bar, Psychiatric; G, [_____]

][Item A5115 Grab Bar, Flip-Up, Heavy Duty; G, [_____]

][Item A5135 Shelf, Utility W/ Mop/Broom Holders, SS, Surf Mntd; G, [_____]

][Item A5140 Hook, Garment, Security; G, [_____]

][Item A5145 Hook, Garment, Double, SS, Surface Mounted; G, [_____]

][Item A5150 Hook, Garment, Triple, Surface Mounted; G, [_____]

][Item A5160 Shelf, 203 mm 8 inch Depth, SS, Surface Mounted; G, [_____]

][Item A5162 Shelf, Fold Down, Stainless Steel; G, [_____]

][Item A5165 Shelf, 127 mm 5 inch Depth, SS, Surface Mounted; G, [_____]

][Item A5166 Shelf, 305 mm 12 inch Depth, SS, Surface Mounted; G, [_____]

][Item A5170 Rod, Shower Curtain, 25 mm 1 inch Diameter, W/Curtain & Hooks; G, [_____]

][Item A5175 Soap Dish, With Bar, SS, Recessed; G, [_____]

][Item A5195 Dispenser, Toilet Tissue, SS, 1-Roll, Surface Mntd; G, [_____]

][Item A5196 Dispenser, Toilet Tissue, Psychiatric; G, [_____]

][Item A5200 Dispenser, Toilet Tissue, SS, 2-Roll, Surface Mntd; G, [_____]

][Item A5202 Dispenser, Toilet Paper w/Utility Shelf, SS, 2-Roll; G, [_____]

][Item A5205 Bar, Towel, 25 mm 1 inch Diameter, SS, Surface Mounted; G, [_____]

][Item A5207 Bar, Towel, 25 mm 1 inch Diameter, SS, Surface Mntd, Psych; G, [_____]

][Item L1200 Cabinet, Specimen, Pass Thru, CRS; G, [_____]

] Submit Data Package 1 for each toilet accessory item [, and Data Package 2 for each electrical toilet accessory item,] in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

[1.3 CERTIFICATIONS

****

NOTE: Insert the certification below for baby changing stations if baby changing stations are included in the project.

****

1.3.1 Baby Changing Stations

Provide certification that baby changing stations meet the performance criteria of ASTM F2285.

Provide certification that baby changing stations meet the requirements of ANSI Z535.4 Product Safety Signs and Labels.

Provide certification that baby changing stations meet the requirements of ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

]1.4 DELIVERY, STORAGE, AND HANDLING

Wrap toilet accessories for shipment and storage, then deliver to the jobsite in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism.

1.5 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for a period of [one year][_____] [years] from date of final acceptance of the work..

PART 2 PRODUCTS

****

NOTE: Only those accessories and finishes normally suitable for military construction are included in this guide specification. When other accessories and finishes are required to meet the needs of the project, the specifier must add them. Maximum use should be made of recessed accessories in areas of hard usage.

****

2.1 ACCESSORY ITEMS

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows these products are available among US national manufacturers above the minimum recycled content percentages shown below.

****

Provide toilet accessories where indicated in accordance with Contractor-provided product schedule. Conform to the requirements for accessory items specified herein which are based on MIL-STD-1691 Joint Schedule Numbers (JSN).[Porcelain type, tile-wall accessories are specified in Section 09 30 10 CERAMIC, QUARRY, AND GLASS TILING.] Provide each accessory item complete with the necessary mounting plates of sturdy construction with corrosion resistant surface.

Provide stainless steel products listed herein manufactured from materials containing a minimum of 50 percent recycled content. Provide data identifying percentage of recycled content for stainless steel toilet accessories.

2.1.1 Anchors and Fasteners

****

NOTE: Tamperproof fasteners will be specified for accessories which have exposed fasteners in areas used by neuropsychiatric patients or prisoners and where theft or vandalism would be a problem. This guide specification places the responsibility with

the Contractor for providing, subject to Government approval, fasteners and anchors of the type, size and number required to adequately secure the accessory items. Specific requirements for critical or unusual applications may refer to details on the drawings, or the specifications may be expanded to include the necessary requirements.

****

Provide corrosion-resistant anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide [tamperproof design] [oval heads] exposed fasteners with finish to match the accessory. Provide fasteners proposed for use for each type of wall construction and mounting.

2.1.2 Finishes

Except where noted otherwise, provide the following finishes on metal:

Metal	Finish
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, bright

[2.1.3 Item A4995 Table, Diaper Changing, Wall Mounted

Wall mounted diaper changing table. Construct unit of high density polyethylene plastic impervious to odors, mold and mildew; support a static load of minimum 136 kg 300 pounds. Provide unit to project out from wall approximately 114 mm 4-1/2 inches when in closed position. Provide contour shaped unit with safety strap. Mounting hardware included.

Approximate open dimensions: 508 mm 20 inches wide by 914 mm 36 inches long by 127 mm 5 inches deep. Approximate closed dimensions: 102 mm 4 inches deep by 914 mm 36 inches long by 533 mm 21 inches high.

][2.1.4 Item A5030 Bench, Stall, Shower, Built-In

Wall mounted shower seat. Frame made of 1.27 mm 18 gauge stainless steel with satin finish. Seat made of one piece of 13 mm 1/2 inch thick nonporous solid phenolic with slots to permit water to drain, secured to frame with stainless steel carriage bolts and acorn nuts. Mounting hardware included. Seat to support a minimum static load of 113 kg 250 pounds. Hinge seat to fold up when not in use. Seat complies with ADA guidelines.

Approximate size: 864 mm 34 inches wide by 559 mm 22 inches deep by 13 mm 1/2 inch thick.

][2.1.5 Item A5047 Cabinet, Medicine

Medicine cabinet constructed of heavy gauge stainless steel and have a mirror mounted in swinging door, a minimum of three shelves, magnetic catch and full length piano hinge. Mirror is 6 mm 1/4 inch thick first quality float glass electrolytically copper-plated and guaranteed against silver spoilage for 15 years. Cabinet door can be inverted to change from left to right hand swing. Unit has concealed mounting holes. Mounting hardware included.

Approximate size: 432 mm 17 inches wide by 635 mm 25 inches high by 102 mm 4 inches deep.

][2.1.6 Item A5074 Soap Dish, Recessed, SS, Psychiatric

Recessed mounted soap dish. Soap dish made of stainless steel with matte finish, drawn one-piece seamless construction. Back of unit has welded anchor nuts to receive threaded studs, which are provided with unit. Rim of unit beveled to insure tight fit to wall surface. Soap dish has raised dimples that allow water to drain away and provide a gripping surface to retain soap.

Approximate size: 178 mm 7 inches wide by 127 mm 5 inches high by 76 mm 3 inches deep.

][2.1.7 Item A5080 Dispenser, Paper Towel, SS, Surface Mounted

Surface mounted unit constructed of stainless steel with satin finish, welded construction, and have full length piano hinge, tumbler lock, refill indicator. Unit has smooth corners, free of burrs and sharp edges. Unit has a capacity of 400 single fold paper towels.

Approximate size: 279 mm 11 inches wide by 203 mm 8 inches high by 152 mm 6 inches deep.

][2.1.8 Item A5081 Dispenser, Paper Towel, SS, Recessed, Psychiatric

Recessed paper towel dispenser made of stainless steel with brushed finish and satin interior. Unit has no loose or protruding parts and have concealed mounting, anchored to wall with welded anchor nuts. Edges of unit beveled to insure a tight fit to wall surface.

Approximate size: 457 mm 18 inches wide by 102 mm 4 inches deep by 203 mm 8 inches high.

][2.1.9 Item A5082 Dispenser, Paper Towel, Sensor, Hands Free

Surface mounted paper towel dispenser with hands free operation. Unit made of high impact plastic in a dark translucent color. Unit has the capacity of one standard 203 mm 8 inch wide by 203 mm 8 inch diameter 800 ft roll with optional paper length settings. Unit is battery operated by four "D" size alkaline batteries, and have low battery indicator light, or optional AC power adapter. Unit has keyed lock.

Approximate size: 305 mm 12 inches wide by 381 mm 15 inches high by 254 mm 10 inches deep.

][2.1.10 Item A5083 Dispenser, Paper Towel, Recessed

Recess mounted paper towel dispenser. Unit constructed of heavy gauge stainless steel with satin finish, all welded construction, have full length piano hinge and tumbler lock. Unit dispenses 300 C-fold or 400 multifold paper towels and be self-feeding until supply is depleted. Towel dispensing slot is snag-free. Unit is ADA compliant.

Approximate size: 305 mm 12 inches wide by 432 mm 17 inches high by 102 mm 4 inches deep.

][2.1.11 Item A5084 Dryer, Hands Free, Forced Air, Automatic

Surface mounted high speed automatic hand dryer. Unit made of stainless steel with satin finish. Electronic sensor automatically turns dryer on when hands are held under the air outlet opening and cuts off when hands are removed, or after approximately 1-1/2 minutes after dryer turns on. Motor is 5/8 HP. Heating element raises the air temperature to approximately 135 degrees and be vandal proof. Unit meets UL requirements.

Unit requires individual 15 amp circuit.

][2.1.12 Item A5090 Disposal, Sanitary Napkin, SS, Surface Mounted

Surface mounted sanitary napkin receptacle. Unit made of stainless steel with satin finish and all welded construction. Unit has piano hinge attached at the top and an integral finger depression for opening. For use with disposable paper liners, available separately. Unit may be attached to wall or toilet partition.

Approximate size: 178 mm 7 inches wide by 102 mm 4 inches deep by 254 mm 10 inches high.

][2.1.13 Item A5109 Grab Bar, 32 mm 1-1/4 Inch Diameter, SS, 2 Wall, W/C Accessible

Grab bar of 32 mm 1-1/4 inch diameter satin finish stainless steel with peened gripping surface for use in toilet stall/room. Snap-on flange covers for concealed mounting are stainless steel and equipped with two screw holes for attachment to wall. Grab bars designed to meet and exceed ADA requirements for structural strength. Grab bars designed to withstand loads of 408 kg 900 pounds when properly installed. Clearance from wall to grab bar is 38 mm 1-1/2 inches to meet ADA and ANSI codes.

][2.1.14 Item A5110 Grab Bar, 32 mm 1-1/4 Inch Diameter, SS, 2 Wall, Shower Use

Grab bar of 32 mm 1-1/4 inch diameter satin finish stainless steel with peened gripping surface. Snap-on flange covers for concealed mounting stainless steel. Bent ends of tubing pass through the flanges and are Heliarc welded for maximum strength. Grab bars designed to meet and exceed ADA requirements for structural strength. Grab bars designed to withstand loads of 408 kg 900 pounds when properly installed. Clearance from wall to grab bar is 38 mm 1-1/2 inches to meet ADA and ANSI codes.

][2.1.15 Item A5112 Grab Bar, Psychiatric

Grab bar of 38 mm 1-1/2 inch diameter stainless steel with exposed surfaces in satin finish. Grab bar is 914 mm 36 inches long, with stainless steel closure plate welded on bottom to prevent an open tie-off gap between the bar and the wall. Flanges are completely Heliarc welded to tube end. Bent ends of tubing pass through the flanges and Heliarc welded for maximum strength.

][2.1.16 Item A5115 Grab Bar, Flip-Up, Heavy Duty

Flip up grab bar, 762 mm 30 inches long, made of 32 mm 1-1/4 inch diameter stainless steel with satin finish with peened or knurled grip. Hinge made from heavy duty cast alloy. All exposed surfaces to have satin finish. Grab bars designed to meet and exceed ADA requirements. Locking mechanism holds the grab bar in the vertical position when not in use. Bar operates with less than 2.27 kg 5 pounds of force. Bar designed to withstand more than 113 kg 250 pounds of downward force when properly installed.

][2.1.17 Item A5135 Shelf, Utility W/ Mop/Broom Holders, SS, Surf Mounted

Surface mounted mop/broom holder with shelf made of 1.27 mm 18 gauge stainless steel with all exposed surfaces in satin finish. Unit has shelf 203 mm 8 inches deep with shelf support brackets of satin finish stainless steel welded to mounting base, and a minimum of 3 hooks/3 holders. Mop holders have spring-loaded rubber cams and hold mop or broom handle with a diameter between 16 mm 5/8 inch and 25 mm 1 inch.

Approximate size: 914 mm 36 inches wide by 203 mm 8 inches deep.

][2.1.18 Item A5140 Hook, Garment, Security

Surface mounted safety hook made of stainless steel and secured to wall with tamper resistant mounting screws, exposed mounting. Mounting hardware to be included. Hook designed to snap down when it exceeds load limit.

][2.1.19 Item A5145 Hook, Garment, Double, SS, Surface Mounted

Surface mounted double garment hook made of stainless steel with satin finish. For use on door back or wall. Hook comes with concealed mounting bracket secured to concealed wall plate. Mounting hardware included. Flange size is approximately 51 mm 2 inches by 51 mm 2 inches.

][2.1.20 Item A5150 Hook, Garment, Triple, Surface Mounted

Surface mounted garment hook. Unit has three metal hooks with a backplate made of medium oak woodgrain or anodized or polished aluminum finished panel. For mounting directly on wall or to panel.

Approximate maximum weight capacity: 16 kg 35 pounds.

Approximate size: 457 mm 18 inches wide by 102 mm 4 inches high by 19 mm 3/4 inch deep.

][2.1.21 Item A5160 Shelf, 203 mm 8 Inch Depth, SS, Surface Mounted

Surface mounted shelf of 1.27 mm 18 gauge stainless steel with all exposed surfaces in satin finish. Shelf has minimum depth of 203 mm 8 inches. Center bracket and end brackets of stainless steel, welded to shelf. Shelf length [as indicated on drawings.][is][305 mm 12 inches.][406 mm 16 inches.][457 mm 18 inches.][610 mm 24 inches.][762 mm 30 inches.][914 mm 36 inches.][1219 mm 48 inches.][Shelves over 610 mm 24 inches long have center bracket for support.]

][2.1.22 Item A5162 Shelf, Fold Down, Stainless Steel

Fold down utility shelf of 1.27 mm 18 gauge stainless steel. Top surface of shelf has raised rim. Equipped with heavy-duty internal spring. Edges and corners radiused and burr free. Shelf automatically returns to upright position when not in use. Shelf holds 45 kg 100 pounds. Mount on wall or toilet partition. Mounting hardware included.

][2.1.23 Item A5165 Shelf, 127 mm 5 Inch Depth, SS, Surface Mounted

Surface mounted shelf of 1.27 mm 18 gauge stainless steel with all exposed surfaces in satin finish. Shelf has minimum depth of 127 mm 5 inches. Center bracket and end brackets of stainless steel, welded to shelf. Shelf length [as indicated on drawings.][is][305 mm 12 inches.][406 mm 16 inches.][457 mm 18 inches.][610 mm 24 inches.][762 mm 30 inches.][914 mm 36 inches.][1219 mm 48 inches.][Shelves over 610 mm 24 inches long have center bracket for support.]

][2.1.24 Item A5166 Shelf, 305 mm 12 Inch Depth, SS, Surface Mounted

Surface mounted shelf of 1.27 mm 18 gauge stainless steel with all exposed surfaces in satin finish. Shelf has a minimum depth of 305 mm 12 inches. Shelf is available in various widths. Center bracket and end brackets of stainless steel, welded to shelf. Shelf length [as indicated on drawings.][is][305 mm 12 inches.][406 mm 16 inches.][457 mm 18 inches.][610 mm 24 inches.][762 mm 30 inches.][914 mm 36 inches.][1219 mm 48 inches.][Shelves over 610 mm 24 inches long have center bracket for support.]

][2.1.25 Item A5170 Rod, Shower Curtain, 25 mm 1 Inch Diameter, W/Curtain & Hooks

Shower Curtain Rod with concealed mounting. Shower curtain rod made of satin finish stainless steel, 25 mm 1 inch diameter, with flanges included, and have white vinyl shower curtain, 1829 mm 72 inches high, and stainless steel curtain hooks. Shower curtain has corrosion resistant grommets, reinforced heading, and treated with antibacterial and flame retardant agents. Shower hooks are stainless steel. Length as indicated on drawings.

][2.1.26 Item A5175 Soap Dish, With Bar, SS, Recessed

Recessed mounted heavy duty stainless steel soap dish with soap lip and bar, of drawn one-piece seamless construction. Exposed surfaces to be satin finish. Soap dish has raised dimples on soap shelf to prevent soap from slipping. Unit includes dry wall clamp and mounting hardware.

Approximate size: 178 mm 7 inches wide by 127 mm 5 inches high by 70 mm 2-3/4 inches deep.

][2.1.27 Item A5195 Dispenser, Toilet Tissue, SS, 1-Roll, Surface Mounted

Concealed surface mounted single roll toilet tissue dispenser of satin finish stainless steel. Spindle to be free-spinning for non-controlled delivery, chrome-plated high impact resistant plastic and equipped with heavy-duty internal spring. Unit accommodates standard core toilet paper roll up to 140 mm 5-1/2 inches diameter. Mounting hardware included.

Approximate size: 197 mm 7-3/4 inches wide by 51 mm 2 inches high by 102 mm 4 inches deep.

][2.1.28 Item A5196 Dispenser, Toilet Tissue, Psychiatric

Recessed toilet tissue roll holder. Unit constructed of stainless steel with satin finish. Rim of holder to be beveled to insure tight fit to wall surface. Back mounting plate of galvanized steel to have welded anchor nuts to receive threaded studs. All mounting hardware included.

][2.1.29 Item A5200 Dispenser, Toilet Tissue, SS, 2-Roll, Surface Mounted

Concealed surface mounted, double roll, toilet tissue dispenser of stainless steel. Unit holds and dispenses two standard 133 mm 5-1/4 inch diameter rolls of toilet tissue. Spindles are free-spinning for non-controlled delivery, chrome-plated plastic equipped with heavy-duty internal springs.

Approximate size: 178 mm 7 inches diameter by 102 mm 4 inches deep.

][2.1.30 Item A5202 Dispenser, Toilet Paper w/Utility Shelf, SS, 2-Roll

Concealed surface mounted, double roll, toilet tissue dispenser and utility shelf of satin finish stainless steel. Mounting brackets to be welded to shelf. Unit holds two standard 133 mm 5-1/4 inch diameter rolls of toilet tissue. Spindles are free-spinning for non-controlled delivery, high impact-resistant plastic equipped with internal springs. Edges of shelf is 13 mm 1/2 inch, with hemmed lip on front edge for safety.

Approximate size of shelf: 457 mm 18 inches wide by 127 mm 5 inches deep.

][2.1.31 Item A5205 Bar, Towel, 25 mm (1 inch) Diameter, SS, Surface Mounted

Surface mounted satin finish stainless steel towel bar of 25 mm 1 inch diameter. Support posts fabricated of heavy solid cast brass with satin finish. Stainless steel set screw keeps bar from rotating in posts. Clearance between towel bar and wall is 38 mm 1-1/2 inches.

][2.1.32 Item A5207 Bar, Towel, 25 mm 1-Inch Diameter, SS, Surface Mounted, Psychiatric

Concealed surface mounted 25 mm 1 inch diameter satin finish stainless steel towel bar with peened gripping surface. Flanges for concealed mounting made of stainless steel. Bent ends of tubing pass through flanges and be Heliarc welded to tubing. Mounting kits and concealed anchoring devices are available from the manufacturers for different types of installations. Clearance between towel bar and wall is 38 mm 1-1/2 inches. Towel bar installed to meet or exceed ADA guidelines.

][2.1.33 Item L1200 Cabinet, Specimen, Pass-Through, CRS

Pass-through specimen cabinet of all welded stainless steel construction with burr-free edges and all exposed surfaces in satin finish. Flanges of one-piece seamless stainless steel in satin finish. Each door is spring-loaded and secured to cabinet with full-length stainless steel piano hinge. Doors equipped with pull knob, international decal identifying usage, and interlocking mechanism which prevents both doors from being open simultaneously. Unit has spill tray of stainless steel with welded seams.

Approximate size: 330 mm 13 inches wide by 305 mm 12 inches high by 152 mm 6 inches deep.

]PART 3 EXECUTION

3.1 INSTALLATION

Do not install items that show visual evidence of biological growth. Provide the same finish for the surfaces of fastening devices exposed after installation as the attached accessory. Provide oval exposed screw heads. Install accessories at the location and height indicated. Protect exposed surfaces of accessories with strippable plastic or by other means until the installation is accepted. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as their work progresses. [Use sealants for brackets, plates, anchoring devices and similar items in showers (a silicone sealantsealant specified in Section 07 92 00 JOINT SEALANTS) as they are set to provide a watertight installation.] After installation, thoroughly clean exposed surfaces and restore damaged work to its original condition or replace with new work.

3.1.1 Recessed Accessories

Fasten accessories with wood screws to studs, blocking or rough frame in wood construction. Set anchors in mortar in masonry construction. Fasten to metal studs or framing with sheet metal screws in metal construction.

3.1.2 Surface Mounted Accessories

****

NOTE: Shelf support brackets and through-bolting of accessories should be required and indicated on the project drawings when rough usage of accessories is anticipated. Attachment by through-bolting should be indicated for shelf brackets and mirrors.

****

Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with corrosion-resistant fasteners as required by the construction. Install backplates in the same manner, or provide with lugs or anchors set in mortar, as required by the construction. Fasten accessories mounted on gypsum board and plaster walls without solid backing into the metal or wood studs, or to backplates secured to metal studs.

3.2 CLEANING

Clean material in accordance with manufacturer's recommendations. Do not use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-10 44 16 (November 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 44 16 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 10 44 16

FIRE EXTINGUISHERS

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USACE / NAVFAC / AFCEC **UFGS-10 44 16 (November 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 44 16 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 10 44 16

FIRE EXTINGUISHERS

11/19

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NOTE: This guide specification covers the requirements for portable fire extinguishers, including wall brackets, accessories, maintenance servicing and inspection tagging requirements.

Portable fire extinguishers cannot be purchased by military construction contracts.

Associated work found in other sections includes non-portable fire protection systems, alarms and related accessories.

Consult with the local AHJ (Authority Having Jurisdiction) during design stage. Indicate on drawings the locations for proper placement and each type of portable extinguisher located within the installation.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E814	(2024) Standard Test Method for Fire Tests of Penetration Firestop Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1	(2021) Fire Code
NFPA 10	(2022; ERTA 1 2021) Standard for Portable Fire Extinguishers
NFPA 99	(2024) Health Care Facilities Code
NFPA 101	(2024) Life Safety Code
NFPA 241	(2022) Standard for Safeguarding Construction, Alteration, and Demolition Operations
NFPA 303	(2021) Fire Protection Standards for Marinas and Boatyards
NFPA 385	(2022) Standard for Tank Vehicles for Flammable and Combustible Liquids
NFPA 409	(2022) Standard on Aircraft Hangars
NFPA 418	(2024) Standard for Heliports

NFPA 505	(2024) Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.106	Flammable Liquids
29 CFR 1910.157	(2003) Portable Fire Extinguishers

UL SOLUTIONS (UL)

UL 8	(2016; Reprint Dec 2020) UL Standard for Safety Water Based Agent Fire Extinguishers
UL 154	(2005; Reprint May 2021) UL Standard for Safety Carbon-Dioxide Fire Extinguishers
UL 299	(2024) Dry Chemical Fire Extinguishers
UL 626	(2005; Reprint May 2021) 2-1/2 Gallon Stored-Pressure, Water-Type Fire Extinguishers
UL 2129	(2017; Reprint Apr 2021) UL Standard for Safety Halocarbon Clean Agent Fire Extinguishers

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fire Extinguishers[; G, [_____]]

Accessories[; G, [_____]]

Cabinets[; G, [_____]]

Wall Brackets[; G, [_____]]

Schedule[; G, [_____]]

SD-03 Product Data

Fire Extinguishers[; G, [_____]]

Accessories[; G, [_____]]

Cabinets[; G, [_____]]

Wall Brackets[; G, [_____]]

Replacement Parts List[; G, [_____]]

SD-04 Samples

Equipment Samples[; G, [_____]]

SD-07 Certificates

Fire Extinguishers Certifications[; G, [_____]]

Manufacturer's Warranty with Inspection Tag[; G, [_____]]

1.3 DELIVERY, STORAGE, AND HANDLING

Protect materials from weather, soil, and damage during delivery, storage, and construction.

Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

[Provide portable fire extinguishers in compliance with NFPA 505 for all ancillary vehicles where Fire Safety Standard for Powered Industrial Trucks, including type designations, special conditions relating to areas of use, conversions, maintenance, or specific operations apply.

]1.3.1 Samples

****
NOTE: Consider requesting the samples that are critical only.
****

Provide the following equipment samples: One of each type of fire extinguisher being installed; one full-sized sample of each type of cabinet being installed; three samples of wall brackets and accessories of each type being used.

Use approved samples for installation, with proper identification and storage.

1.4 WARRANTY

****
NOTE: Warranties for fire extinguishers are typically 6 years.
****

Guarantee that Fire Extinguishers are free of defects in materials, fabrication, finish, and installation and that they will remain so for a period of not less than [_____] years after completion.

Submit the manufacturer's warranty with inspection tag.

1.5 PROJECT SCHEDULE

For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

PART 2 PRODUCTS

Submit fabrication drawings consisting of fabrication and assembly details performed in the factory and product data for the following items: Fire Extinguishers; Accessories, cabinets, Wall Brackets.

2.1 SYSTEM DESCRIPTION

2.1.1 Types

****
NOTE: Select one or more of the following types of pressurized fire extinguishers, as required:

Water and Foam - Water extinguishers are for Class A fires only (paper, wood, cloth).

Foam extinguishers are for Class A and B fires only (common combustibles, flammable liquids and gases).

Carbon Dioxide - Carbon Dioxide extinguishers can be used on Class B and C fires (flammable liquids and gases, live electrical equipment).

Dry Chemical - Dry Chemical extinguishers can be used on Class A, B, and C fires (all the above elements) (not recommended for computers or sensitive electrical equipment - use clean agent or Carbon Dioxide).

Wet Chemical - Wet Chemical extinguishers are primarily for cooking media fires (high temperature oils and fats) (some may also be used on Class A fires in commercial kitchens).

Clean Agent - Newer Clean Agent extinguishers have replaced former halogenated extinguishers with less ozone depleting halocarbon agents, for Class B and C fires, with some larger units available for use on Class A, B, and C fires.

Dry Powder - Dry Powder extinguishers are for Class D or combustible metal fires only.

Water Mist - Water Mist extinguishers are primarily for Class A fires, although they are also safe for use in Class C fires.

The International Fire Code is a good source for explanations of the various fire extinguishers requirements.

****

Submit fire extinguishers certifications showing compliance with local codes and regulations.

Provide fire extinguishers conforming to NFPA 10. Provide quantity and placement in compliance with the applicable sections of NFPA 1, NFPA 101, [NFPA 99], [NFPA 241], [NFPA 303], [NFPA 385], [NFPA 409], [NFPA 418],[29 CFR 1910.106] and 29 CFR 1910.157.

[Provide [stored-pressure] [cartridge] [hand-pump] water type fire extinguishers.

][Provide [foam] type fire extinguishers.

][Provide carbon-dioxide type fire extinguishers compliant with UL 154.

][Provide dry chemical type fire extinguishers compliant with UL 299.

][Provide wet chemical type fire extinguishers compliant with UL 8.

][Provide clean agent type fire extinguishers compliant with UL 2129.

][Provide dry powder type fire extinguishers.

][Provide water mist type fire extinguishers compliant with UL 626.

]2.1.2 Material

****

NOTE: Select one or more of the following for the shell material. Check manufacturers to ensure that

the material and extinguisher type are compatible.
****

Provide [corrosion-resistant steel] [aluminum] [enameled steel] [_____] extinguisher shell.

2.1.3 Size

****
NOTE: Select one or more of the following for the size of the extinguisher. Size as indicated. The heavier the extinguisher, the more difficult it will be to lift and carry.
****

[9.5 liter 2 1/2 gallons extinguishers.

][1.1 kilogram 2 1/2 pounds extinguishers.

][[2.3] [4.5] [6.8] [9] [13.6] kilogram [5] [10] [15] [20] [30] pounds extinguishers.

]2.1.4 Accessories

****
NOTE: Select items as applicable. Indicate appropriate UL rating.
****

[Forged brass valve

][Fusible plug

][Safety release

][Antifreeze

][Pressure gage

]2.2 EQUIPMENT

2.2.1 Cabinets

****
NOTE: Include the following paragraphs if fire extinguishers are designated as cabinet mounted. If fire extinguishers are to be hung on wall brackets only, then delete cabinet requirements.
****

2.2.1.1 Material

****
NOTE: Select one of the following materials for cabinets.
****

Provide [enameled steel] [corrosion-resistant steel] [aluminum] cabinets.

2.2.1.2 Type

****
NOTE: Select one of the following types.
****

[Provide [recessed] [trimless] [surface] type cabinets.

] [Provide semi-recessed cabinet for a [150] [100] millimeter [6] [4] inch wall.

][Provide [recessed] [trimless] [surface] bubble type cabinets.

][Provide a fire rated cabinet, listed and labeled to comply with ASTM E814 for fire resistance wall rating.]

****
NOTE: Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function. According to NFPA 10, maximum mounting height for fire extinguishers weighing 18 kg 40 lb or less is 1.5 meters 60 inches from finished floor to top of extinguisher; for those weighing more, it is 1 meter 42 inches from finished floor to top of extinguisher.
****

2.2.1.3 Size

Dimension cabinets to accommodate the specified fire extinguishers.

2.2.2 Wall Brackets

****
NOTE: Delete the paragraph heading and the following paragraphs if cabinets are specified. Select one of the following.
****

Provide[running-board][spring-clip][wall-hook] fire extinguisher wall brackets.

Provide wall bracket and accessories as approved.

2.2.2.1 Identification

Provide lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by the drawings.

Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

Orientation: [Vertical][Horizontal].

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: For Class A light-hazard occupancies, such as office buildings, use a Class A extinguisher within a 25 meter 75 foot travel distance with one unit of 1A rating for every 280 square meter 3,000 square feet of floor area; ordinary hazard occupancies such as warehouses and department stores: 25 meter 75 foot travel distance with one unit of 2A rating for every 280 square meter 3,000 square feet; and extra hazard occupancies such as woodworking and spray painting locations: 25 meter 75 foot travel distance with one unit of 3A rating for every 280 square meter 3,000 square feet.

For Class B light-hazard occupancies, use a Class B extinguisher within 15 meter 50 foot travel distance with one unit of 4B rating; ordinary hazard occupancies: 15 meter 50 foot travel distance with one unit of 8B rating; extra hazard occupancies: 15 meter 50 foot travel distance with one unit of 12B rating. For deep-layer flammable-liquid fire hazards such as dip tanks, one unit of Class B extinguishing potential is required for each 0.1 square meter square foot of the largest individual hazard unless an approved automatic system is installed.

Class C extinguishers, where there are electrical hazards, are distributed on the same basis as Class B extinguishers.

Coordinate types and locations with the Life Safety Drawings. Comply with ADA-ABA Guidelines, mounting height for fire extinguishers is not to exceed 1.2 meters 48 inches to the handle.
****

Install Fire Extinguishers where indicated on the drawings. Verify exact locations prior to installation.

Provide extinguishers which are fully charged and ready for operation upon installation. Provide extinguishers complete with Manufacturer's Warranty with Inspection Tag attached.

Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

Comply with the manufacturer's recommendations for all installations.

3.2 PROTECTION

3.2.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the Government.

Submit replacement parts list indicating specified items replacement part, replacement cost, and name, address and contact for replacement parts distributor.

3.2.2 Cleaning

Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-10 51 13 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 51 13 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-10 51 13 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 51 13 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 10 51 13

LOCKERS

08/24

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NOTE: This guide specification covers the requirements for permanently installed metal lockers; single and double tier, used for temporary storage and security of personal belongings.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Show the following information on the drawings:

1. Location, type and size, quantity, and color of lockers

2. Mounting details and whether legs, base panels, or pre-built bases are required.

****

PART 1 GENERAL

1.1 REFERENCES

****

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B456	(2017; R 2022) Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D3451	(2006; R 2017) Standard Guide for Testing Coating Powders and Powder Coatings
ASTM D4976	(2012; R 2020) Standard Specification for Polyethylene Plastics Molding and

	Extrusion Materials
ASTM D6386	(2022) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 286	(2024) Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-22750	(2014; Rev G; Notice 1 2019) Coating, Epoxy, High Solids
MIL-PRF-23377	(2012; Rev K) Primer Coatings: Epoxy, High Solids

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS AA-L-00486	(Rev J) Lockers, Clothing, Steel

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Types; G, [_____]

Location; G, [_____]

Installation

[Numbering System

] SD-03 Product Data

Material

[Locking Devices

][Lock Control Chart

] Handles

Finish

Locker Components

Assembly Instructions

SD-04 Samples

Color Chips; G, [_____]

1.3 DELIVERY, HANDLING, AND STORAGE

Deliver lockers and associated materials in their original packages, containers, or bundles bearing the manufacturer's name and the name of the material. Protect from weather, soil, and damage during delivery, storage, and construction.

1.4 FIELD MEASUREMENTS

To ensure proper fits, make field measurements prior to the preparation of drawings and fabrication. Verify correct location.

1.5 QUALITY ASSURANCE

1.5.1 Color Chips

Provide a minimum of three color chips, not less than 75 mm 3 inches square, of each color[scheduled][indicated].

Government may request performance-characteristic tests on assembled lockers. Tests and results must conform to FS AA-L-00486.[Tests and results for HDPE lockers must conform to applicable requirements of ASTM D4976 and applicable requirements of FS AA-L-00486.][Phenolic core lockers must conform to applicable requirements of FS AA-L-00486 and be manufactured as high pressure phenolic panels with integral plastic laminate outer faces both sides of panels. Laminating faces to the core is not acceptable.] Lockers not conforming will be rejected.

PART 2 PRODUCTS

2.1 ACCESSIBILITY

Comply with 36 CFR 1191 with regard to accessibility of lockers[and locker benches], locker features, latching and locking, and signage.

2.2 TYPES

****

NOTE: Locker type and quantities must be indicated.

Add lockers for firearms, cellular phones, or other specialty purposes per specific using agency project requirements.

Lockers with closed bases (Type C) or legs and open bases (Type L) may be used for dry carpeted areas. Lockers without bases (Type W) may be used at locations with solid bases of other construction such as concrete curbs with tile wall bases not prone to water logging or water damage.

Add any locker requirements for promotion of drying damp clothing, such as athletic uniforms, that may require higher ventilation than standard lockers.

****

Locker must have the following type and size in the location and quantities indicated. Locker finish colors will be as scheduled.

Lockers must be manufactured as[fully welded steel][knocked-down for assembly in the field][prefabricated solid high-density polyethylene (HDPE)][prefabricated plastic laminate faced solid phenolic core] units.

[2.2.1 Single-tier Lockers

****

NOTE: Delete the paragraph heading and the following paragraphs if single-tier lockers are not required.
****

Single-tier lockers must be as follows:

****
Select from the following for single-tier lockers with legs to suit the project. Delete inapplicable paragraphs. HDPE lockers may not be available with legs.
****

[Type STL-1: Single-tier locker 380 millimeter wide, 380 millimeter deep, and 1830 millimeter high 15 inches wide, 15 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high legs

][Type STL-2: Single-tier locker 380 millimeter wide, 457 millimeter deep, and 1830 millimeter high 15 inches wide, 18 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high legs

][Type STL-3: Single-tier locker 457 millimeter wide, 533 millimeter deep, and 1830 millimeter high 18 inches wide, 21 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high legs

][Type STL-4: Single-tier locker 457 millimeter wide, 610 millimeter deep, and 1830 millimeter high 18 inches wide, 24 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high legs

] **
NOTE: Select from the following for single-tier lockers with a closed base to suit the project. Delete inapplicable paragraphs.
****

[Type STC-1: Single-tier locker 380 millimeter wide, 380 millimeter deep, and 1830 millimeter high 15 inches wide, 15 inches deep, and 72 inches high, attached to 150 millimeter 6-inch closed base

][Type STC-2: Single-tier locker 380 millimeter wide, 457 millimeter deep, and 1830 millimeter high 15 inches wide, 18 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high closed base

][Type STC-3: Single-tier locker 457 millimeter wide, 533 millimeter deep, and 1830 millimeter high 18 inches wide, 21 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high closed base

][Type STC-4: Single-tier locker 457 millimeter wide, 610 millimeter deep, and 1830 millimeter high 18 inches wide, 24 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high closed base

] **
NOTE: Select from the following for single-tier lockers without a base to be installed on a prebuilt base. Base must be detailed on the drawings.
****

[Type STW-2: Single-tier locker 380 millimeter wide, 457 millimeter deep, and 1830 millimeter 15 inches wide, 18 inches deep, and 72 inches high, without base

][Type STW-3: Single-tier locker 457 millimeter wide, 533 millimeter deep, and 1830 millimeter 18 inches wide, 21 inches deep, and 72 inches high, without base

][Type STW-4: Single-tier locker 457 millimeter wide, 610 millimeter deep and 1830 millimeter 18 inches wide, 24 inches deep, and 72 inches high, without base

]][2.2.2 Double-tier Lockers

****

NOTE: Delete the paragraph heading and the following paragraphs if double-tier lockers are not required.

****

Double-tier lockers must be as follows:

****

Select from the following for double-tier lockers with legs to suit the project. Delete inapplicable paragraphs. HDPE lockers may not be available with legs.

****

Type DTL-1: Double-tier locker 380 millimeter wide, 380 millimeter deep, and 1830 millimeter 15 inches wide, 15 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high legs

Type DTL-2: Double-tier locker 380 millimeter wide, 457 millimeter deep, and 1830 millimeter 15 inches wide, 18 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high legs

****

NOTE: Select from the following for double-tier lockers with a closed base to suit the project. Delete inapplicable paragraphs.

****

Type DTC-1: Double-tier locker 380 millimeter wide, 380 millimeter deep, and 1830 millimeter 15 inches wide, 15 inches deep, and 72 inches high, attached to a 150 millimeter 6-inch high closed base

Type DTC-2: Double-tier locker 380 millimeter wide, 457 millimeter deep, and 1830 millimeter 15 inches wide, 18 inches deep, and 72 inches high, attached to a 150 millimeter 6-inch high closed base

****

NOTE: Select from the following for double-tier lockers without a base to be installed on a prebuilt base. Base details must be detailed.

****

Type DTW-1: Double-tier locker 380 millimeter wide, 380 millimeter deep, and 1830 millimeter 15 inches wide, 15 inches deep, and 72 inches high, without base

Type DTW-2: Double-tier locker 380 millimeter wide, 457 millimeter deep, and 1830 millimeter 15 inches wide, 18 inches deep, and 72 inches high, without base

][2.2.3 Double-tier Z-style Lockers

****

NOTE: Delete the paragraph heading and the following paragraphs if double-tier z-style lockers are not required.

****

Double-tier Z-style lockers must be as follows:

****

NOTE: Select from the following for double-tier z-style lockers with legs to suit the project. Delete inapplicable paragraphs. HDPE lockers may not be available with legs.

****

Type DTZL-1: Double-tier Z-style locker 380 millimeter wide, 380 millimeter deep, and 1830 millimeter 15 inches wide, 15 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high legs

Type DTZL-2: Double-tier Z-style locker 380 millimeter wide, 457 millimeter deep, and 1830 millimeter 15 inches wide, 18 inches deep, and 72 inches high, attached to 150 millimeter 6-inch high legs

****

NOTE: Select from the following for double-tier z-style lockers with a closed base to suit the project. Delete inapplicable paragraphs.

****

Type DTZC-1: Double-tier Z-style locker 380 millimeter wide, 380 millimeter deep, and 1830 millimeter 15 inches wide, 15 inches deep, and 72 inches high, attached to a 150 millimeter 6-inch high closed base

Type DTZC-2: Double-tier Z-style locker 380 millimeter wide, 457 millimeter deep, and 1830 millimeter 15 inches wide, 18 inches deep, and 72 inches high, attached to a 150 millimeter 6-inch high closed base

****

NOTE: Select from the following for double-tier z-style lockers without a base to be installed on a prebuilt base. Base details must be detailed.

****

Type DTZW-1: Double-tier Z-style locker 380 millimeter wide, 380 millimeter deep, and 1830 millimeter 15 inches wide, 15 inches deep, and 72 inches high, without base

Type DTZW-2: Double-tier locker 380 millimeter wide, 457 millimeter deep, and 1830 millimeter 15 inches wide, 18 inches deep, and 72 inches high, without base

]2.3 MATERIAL

****

NOTE: Edit paragraphs that follow to select intended materials, finishes, and options.

****

2.3.1 [Galvanized]Steel Sheet

****

NOTE: Choose one of the following options.

Delete the word "Galvanized" in paragraph title and choose the first optional paragraph for normal applications where moisture is not a problem.

Include the word "Galvanized" in the paragraph title and choose the second optional paragraph for lockers located in high moisture areas such as shower rooms.

****

****

NOTE: Consider ASTM A240/A240M stainless steel as a sheet metal material for lockers where exposure to high moisture, chlorides, or other corrosives may lead to premature deterioration of metal lockers. Indicate finishes such an ASTM A480/480M No.4 directional polish.

****

[[ASTM A1008/A1008M,][ASTM A568/A568M,]commercial quality, minimized spangle material. Prepare material surfaces for[baked enamel][powder coat] [_____] finishing in accordance with FS AA-L-00486.[Fabricate locker bodies from not less than 0.607 millimeter 0.0239-inch thick steel sheet.][Fabricate locker frames from not less than 1.524 millimeter 0.060 inch thick steel sheet.][Minimum uncoated sheet thickness[as specified] [_____].]

][ASTM A653/A653M and ASTM A924/A924M, commercial quality, minimized spangle, galvanized steel sheet with not less than Z275 G60 zinc coating. Prepare surface of sheet for painting in accordance with ASTM D6386, Method A. Minimum uncoated sheet thickness[as specified] [_____].

][2.3.2 Solid High-Density Polyethylene (HDPE)

****

NOTE: If lockers other than metal are used, HDPE is preferred where available, such as projects located CONUS.

****

ASTM D4976 solid [10 mm][13 mm] [3/8 inch][1/2 inch] HDPE panels, extrusions, and casting forming locker bodies, doors, and shelves.[Include[bases,][sloped tops,][end panels,][and][infill panels].]

][2.3.3 Solid Plastic Laminate Faced Phenolic Core

****

NOTE: Phenolic lockers should only be used in

locations where HDPE is not available, such as projects located OCONUS.
****

ASTM D709 solid 13 mm 1/2 inch ANSI/NEMA LD 3 plastic laminate faced phenolic core panels forming locker bodies, doors, and shelves.[Include[bases,][sloped tops,][end panels,][and][infill panels]. Fire performance per NFPA 286.]

]2.3.4 Chromium Coating

Nickel and chromium electrodeposited on the specified base metal. Conform to ASTM B456, SC-3, as applicable to the base metal.

2.3.5 Finish

****
NOTE: Standard finish in FS AA-L-00486 is gray, baked enamel. Use the first paragraph when baked enamel finish is required. Use the second paragraph when powder coat finish is required. Use the third paragraph for epoxy-based primer and topcoat coatings.
****

****
NOTE: HDPE locker and locker bench colors are integral to the material.
****

[FS AA-L-00486.

][ASTM D3451.

][Primer,[MIL-PRF-23377] [_____]; topcoat,[MIL-PRF-22750] [_____].

]2.3.5.1 Color[s]

As selected.

2.4 COMPONENTS

****
NOTE: Delete items from the following paragraphs that are not required on the project.
****

****
NOTE: If ASTM A240/A240M stainless steel is used for locker fabrication, use stainless steel for fasteners and for locks, coat hooks, hanger rods, handles, hinges, number plates and other accessories.
****

2.4.1 Built-In Locks

****
NOTE: FS AA-L-00486 includes built-in locks as standard items. It includes built-in key locks and

built-in combination locks. It also includes a padlock eye in the door latching mechanism.

If built-in locks are required, use the first paragraph. If built-in locks are not required, use the second paragraph.

****

[FS AA-L-00486.[Provide locking devices as[built-in key locks][built-in combination locks][coin-operated locks][and][a padlock eye in the door latching mechanism].][Submit Lock Control Chart showing each lock required for the project, the locker identification plate number, and the lock combination.]

][Built-in locks are not required.

]2.4.2 Coat Hooks

FS AA-L-00486,[chromium plated zinc][stainless steel][HDPE].

[2.4.3 Hanger Rods

FS AA-L-00486,[chromium plated steel][stainless steel].

]2.4.4 Door Handles

****

NOTE: FS AA-L-00486 allows aluminum alloy, zinc alloy, or steel handles. Aluminum handles are required to have satin anodized finish. Zinc alloy and steel handles are required to have chromium or nickel plated finish.

****

FS AA-L-00486. Provide[chromium plated zinc alloy or steel handles][stainless steel handles][HDPE handles].

2.4.5 Doors

FS AA-L-00486, not less than 1.5 mm 0.0598 inch thick steel sheet. Provide[closed face][partial louvered face][full louvered face][perforated face] providing a minimum [_____] percent open area.

2.4.5.1 Hinges

In addition to the requirements of FS AA-L-00486, provide 5-knuckle hinges, minimum 50 mm 2 inches high. Fabricate knuckle hinges from not less than 2 mm 0.0787 inch thick steel[chromium plated steel][stainless steel].[A full height piano hinge may be provided if standard with the manufacturer.] Weld or bolt hinges to the door frame to suit materials. Weld, bolt, or rivet hinges to the door to suit materials.

2.4.5.2 Latching Mechanisms

FS AA-L-00486.

2.4.6 Latch Strikes

FS AA-L-00486. Fabricate from not less than 2 mm 0.0787 inch thick[

chromium plated steel][stainless steel] sheet, except latch strike must be continuous from top to bottom and fabricated as part of the door framing. Provide no less than two silencers per door strike.

[2.4.7 Solid HDPE Latches

Provide recessed door latch assembly of solid HDPE with latching devices compatible with the locker body construction. Include necessary metal components to provide latching[and locking] function with latches engaging the locker body at two locations for double tier doors and three locations for single tier full height doors.

]2.4.8 Silencers

FS AA-L-00486.

2.4.9 Back and Side Panels, Tops, and Bottoms

FS AA-L-00486, not less than[1.2 mm 0.0474 inch thick steel sheet][13 mm 1/2 inch solid HDPE panel][13 mm 1/2 inch plastic laminate faced solid phenolic core panel].[Provide concealed anchored[filler pieces][and][boxed end panels] where indicated that match side panel material.]

[2.4.10 Sloping Locker Tops

Provide sloping locker tops in addition to the locker-section flat tops. Sloping tops must be continuous in length. Provide fillers or closures at the exposed end of sloping tops. Fabricate sloping tops from not less than[1.214 millimeter 0.0478-inch thick steel sheet][10 mm 3/8 inch solid HDPE panels][10 mm 3/8 inch plastic laminate faced solid phenolic core panels].

]2.4.11 Shelves

FS AA-L-00486. Fabricate from not less than[1.5 mm 0.0598 inch thick steel sheet][13 mm 1/2 inch solid HDPE panels][13 mm 1/2 inch plastic laminate faced solid phenolic core panels].

[2.4.12 Base Panels

****

NOTE: Base panels must be specified if required. If none are required, delete this paragraph.

****

FS AA-L-00486.

]2.4.13 Legs

****

NOTE: FS AA-L-00486 normally includes legs unless specified otherwise. HDPE lockers may not be available with legs.

****

[FS AA-L-00486.][Provide lockers without legs, as indicated.]

2.4.14 Number Plates

****

NOTE: Choose one of the following paragraphs. If number plates are not required, use the second paragraph.
****

****
NOTE: Requirements for number plates are included in FS AA-L-00486. Select material requirement and range of numbers.
****

[FS AA-L-00486.[Aluminum][Brass][Zinc]. Provide consecutive numbers from [_____] to [_____].

][Number plates are not required.

][2.4.15 Label Holders

****
NOTE: Include if label holders are required. Otherwise, delete.
****

FS AA-L-00486.

][2.4.16 Locker Benches

Provide fixed locker benches as manufactured by the locker manufacturer. Match materials and finishes of bench tops to lockers. Provide stainless steel anchor types suited to the[floor substrate][and][wall substrate] designed to transfer full support and stability loads to the substrates.

][2.4.17 Locker Bench Tops

Support bench tops with welded metal tube pedestals or welded metal wall brackets with a minimum of two support points for each bench length. Maximum length 1829 mm 72 inches. Height from finished floor to top of bench [445][_____] mm [17-1/2][_____] inches. Fabricate pedestal and wall brackets from[powder coated galvanized steel][stainless steel]. Provide stainless steel fasteners and anchors. Space support points for each bench as required to support 150 kg/m 100 plf with maximum deflection not to exceed L/180 between supports.

Provide bench tops fabricated from [32][_____] mm [1-1/4][_____] inch thick solid[butcher block maple hardwood with polyurethane lacquered finish][HDPE with textured finish][plastic laminate faced phenolic core]. With top width of [241][305][381] mm [9-1/2][12][24] inches. Provide bench dimensions required for accessibility compliance.

]2.4.18 Fastening Devices

Provide bolts, nuts, and rivets as specified in FS AA-L-00486.

PART 3 EXECUTION

3.1 ASSEMBLY AND INSTALLATION

Assemble lockers according to the locker manufacturer's instructions. Align lockers horizontally and vertically. Secure lockers to wall[and base] with screws as indicated. Bolt adjacent lockers together. Adjust doors to operate freely without sticking or binding and to ensure they close tightly.

[3.2 NUMBERING SYSTEM

****

NOTE: If lockers require number plates, identify the system of numbering. Otherwise, delete this paragraph.

****

Install number plates on lockers consecutively[with odd numbers on top and even numbers on bottom][as indicated] [_____].

]3.3 FIELD QUALITY CONTROL

3.3.1 Testing

Government may request performance-characteristic tests on assembled lockers in accordance with FS AA-L-00486. Lockers not conforming will be rejected.

3.3.2 Repairing

Remove and replace damaged and unacceptable portions of completed work with new.

3.3.3 Cleaning

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work, in an approved manner. Remove equipment, surplus materials, and rubbish from the site.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-10 56 13 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-10 56 13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 10 - SPECIALTIES

SECTION 10 56 13

STEEL SHELVING

08/24

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC UFGS-10 56 13 (August 2024)

Preparing Activity: NAVFAC Superseding
UFGS-10 56 13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 10 56 13

STEEL SHELVING
08/24

****
NOTE: This guide specification covers the requirements for hand loaded steel shelving units.

For storage installations that will use pallet jacks, reference UFC 4-440-01 Warehouse and Storage Facilities for steel shelving criteria. Use UFC 4-440-01 Figure 2-1 System Selection Flowchart for determination of steel shelving requirements.

Use MHI MH28.2-2022, Design, Testing, and Utilization of Industrial Boltless Steel Shelving, for structural requirements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Show the following information on the project drawings.

1. Location, length, and type of shelving units.

2. Aisle layout

3. Loading and accessories

4. Mounting and anchorage requirements or details.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test

MATERIAL HANDLING INDUSTRY OF AMERICA (MHI)

MHI MH28.1	(2024) Design, Testing, and Utilization of Industrial Steel Bin Shelving

1.2 DEFINITIONS

For the purposes of this specification the shelf category, "medium weight," "heavy weight," will be as follows. Load is given per shelf in kilograms pounds for evenly distributed load. This does not limit the shelf size, only the shelving category.

Minimum Evenly Distributed Load Per Shelf in Kilograms		
Shelf Size	Type Medium Duty	Type Heavy Duty
450 by 900 mm	320	590
450 by 1200 mm	230	410

Minimum Evenly Distributed Load Per Shelf in Pounds		
Shelf Size	Type Medium Duty	Type Heavy Duty
18 by 36 in.	700	1300
18 by 48 in.	500	900

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

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Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shelving Units

SD-03 Product Data

Shelving Units

Accessories

Installation instructions

SD-04 Samples

Finish

SD-06 Test Reports

Shelving Units

Finish

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials in original packages, containers or bundles bearing the brand name and identification of the manufacturer. Store inside under cover. Protect surfaces from damage.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

MHI MH28.1. Provide shelving units[indicated][scheduled]. Provide shelving units designed for full dead and live load, designated[medium duty][heavy duty].[Provide units with base plates for floor anchorage indicated.][Provide wall connections for units over 2500 mm 8 feet 3 inches to top shelf.][Provide floor and wall anchorages for units in Seismic SDC Zones D, E, and F. Provide door and drawer earthquake stops.][Provide wall connections for drawer units if necessary.]

2.2 ACCESSORIES

a. Drawers, 180 kg 400 pound capacity, and mounting brackets

b. Partitions and dividers

c. Label holder [56 by 20 mm][75 by 125 mm] [2 1/4 by 3/4 inches][3 by 5 inches].

2.3 FINISH

****
NOTE: Specify special finish only if the conditions

of use are particularly harsh. Any finish other than the manufacturer's standard will be very expensive.

****

Provide the shelving units in the manufacturer's standard colors[as indicated][as chosen by the Contracting Officer]. Clean metal by multiple stage phosphatizing and sealing process, for rust resistance and paint adhesion. Provide electrostatically applied enamel finish coats, baked hard for a minimum of 30 minutes at 149 degrees C 300 degrees F.[Provide special finish meeting the flexibility, adhesion, and impact standards below.]

2.4 SOURCE QUALITY CONTROL

a. MHI MH28.1, for tests of shelf capacity, lateral stability and shelf connections.

[b. Finish flexibility, ASTM D522/D522M, Method A, 3 mm 1/8 inch diameter, 180 degree bend, no evidence of fracturing to the naked eye.

][c. Finish adhesion, ASTM D3359, Method B. There must be no film removed by tape applied to 11 parallel cuts space 3 mm 1/8 inch apart plus 11 similar cuts at right angles.

][d. Impact resistant finish, ASTM D2794, no loss of adhesion after direct and reverse impact equal to 1.5 times metal thickness in mm, expressed in N.m inch pounds.

]PART 3 EXECUTION

3.1 EXAMINATION

Before installation, examine shelving units for dents and scratches. Replace damaged shelving.

3.2 INSTALLATION

Install shelving according to manufacturer's installation instructions.[Make wall and floor connections as indicated.]

3.3 PROTECTION

Cover and protect shelving from damage during the completion of construction. Remove protection prior to acceptance of project.

[3.4 SCHEDULE

****

NOTE: Put on contract drawings by preference.

****

SHELVING						
Type	Width	Depth	Number of Shelves	Height	Accessories	Room
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

]   -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-11 05 40 (August 2017)**
Change 1 - 02/18

Preparing Activity: NAVFAC **Superseding**
UFGS-11 05 40 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 11 - EQUIPMENT

SECTION 11 05 40

COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT

08/17, CHG 1: 02/18

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-11 05 40 (August 2017)**

Change 1 - 02/18

Preparing Activity: NAVFAC **Superseding**

UFGS-11 05 40 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 11 05 40

COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT

08/17, CHG 1: 02/18

****

NOTE: This guide specification covers the requirements for general requirements and common works result for foodservice equipment[for all land-based naval facilities.].

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Use this section in conjunction with Section 11 06 40.13 FOOD SERVICE EQUIPMENT SCHEDULE; and other foodservice related sections within the project scope, to address general guidelines for the work results expected. Other food service sections include, but are not limited to:

Section 11 41 11 - REFRIGERATED AND FROZEN FOOD STORAGE EQUIPMENT

Section 11 42 00 - FOOD PREPARATION EQUIPMENT

Section 11 44 00 - FOOD COOKING EQUIPMENT

Section 11 46 00 - FOOD DISPENSING EQUIPMENT

Section 11 47 00 - ICE MACHINES

Section 11 48 00 - CLEANING AND DISPOSAL EQUIPMENT

Section 12 35 39 - COMMERCIAL KITCHEN CASEWORK.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.19.3/CSA B45.4	(2022) Stainless Steel Plumbing Fixtures
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy

	Fittings for Flared Copper Tubes

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D9.1/D9.1M	(2018) Sheet Metal Welding Code
AWS D10.4	(1986; R 2000) Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A270/A270M	(2024) Standard Specification for Seamless and Welded Austenitic and Ferritic/Austenitic Stainless Steel Sanitary Tubing
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A480/A480M	(2024a) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM B32	(2020) Standard Specification for Solder Metal

ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1330	(2023) Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants
ASTM D520	(2000; R 2011) Zinc Dust Pigment

CSA GROUP (CSA)

CSA Directory	(updated continuously online) Product Index

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF Food Equipment	(2005) NSF Product Listings of Food Equipment and Related Products, Components and Materials
NSF/ANSI 2	(2022) Food Equipment
NSF/ANSI 6	(2023) Dispensing Freezers

NSF/ANSI 7	(2023) Commercial Refrigerators and Freezers
NSF/ANSI 8	(2023) Commercial Powered Food Preparation Equipment
NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials
NSF/ANSI 35	(2020) High Pressure Decorative Laminates for Surfacing Food Service Equipment
NSF/ANSI 37	(2021) Air Curtains for Entranceways in Food and Food Service Establishments
NSF/ANSI 51	(2023) Food Equipment Materials
NSF/ANSI 59	(2020) Mobile Food Carts
NSF/ANSI 169	(2023)Special Purpose Food Equipment and Devices

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M	(2006) MILSTRIP - Military Standard Requisitioning and Issue Procedures

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
29 CFR 1910.145	Specifications for Accident Prevention Signs and Tags
29 CFR 1910.212	Safety Standard for Machinery and Machine Guarding
29 CFR 1910.306	Specific Purpose Equipment and Installations
PL 109-58	Energy Policy Act of 2005 (EPAct05)

UL SOLUTIONS (UL)

UL 197	(2010; Reprint Mar 2023) UL Standard for Safety Commercial Electric Cooking Appliances
UL 207	(2022) UL Standard for Safety Refrigerant-Containing Components and

	Accessories, Nonelectrical
UL 471	(2010; Reprint Sep 2019) UL Standard for Safety Commercial Refrigerators and Freezers
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 763	(2018; Reprint Jul 2023) UL Standard for Safety Motor-Operated Commercial Food Preparing Machines
UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires
UL Elec Equip Dir	(2011) Electrical Appliance and Utilization Equipment Directory

1.2 GENERAL REQUIREMENTS

****

NOTE: Indicate the configuration and layout for all food service equipment, with interior elevations and equipment identified by number. Show "Food Service Equipment Schedule" on the drawings using the same identification numbers as indicated in Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE. Ensure that all Contractor built-to-order items, per Food Service Equipment Schedule", are shown and coordinated with the specifications.

Designer must coordinate with other sections for final connection of equipment.

NOTE: Details of particular equipment and installations are provided on Naval Food Service Division drawings. Use these NAVFSD drawings as a basis for the project details. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

****

Provide detailed Food Service Equipment Schedule conforming to DOD 4000.25-1-M.

****

NOTE: If specifying or scheduling major equipment edit and include the following paragraph. Smaller countertop, food prep equipment specified in Section 11 42 00 FOOD PREPARATION EQUIPMENT is not ENERGY STAR labeled.

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Provide [Major electrically or gas powered] equipment specified within this section, [and] [Section 11 41 11 REFRIGERATED AND FROZEN FOOD STORAGE EQUIPMENT.] [Section 11 44 00 FOOD COOKING EQUIPMENT,][Section 11 46 00 FOOD DISPENSING EQUIPMENT,] [Section 11 47 00 ICE MACHINES,] conforming to

EPA Energy Star requirements and labeling. Special purpose equipment must conform to NSF/ANSI 169, NSF/ANSI 59, and NSF/ANSI 8.[Provide documentation conforming to Energy Star as required in Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.]

1.2.1 Mechanical General Requirements

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NOTE: Designate plumbing fixtures as "P" items on plumbing drawings with specific requirements added to Section 22 00 00 PLUMBING, GENERAL PURPOSE.

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Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section. Stainless steel plumbing fixtures must conform to ASME A112.19.3/CSA B45.4

Section 23 63 00.00 COLD STORAGE REFRIGERATION SYSTEMS applies to this section.

Section 22 00 00 PLUMBING, GENERAL PURPOSE applies to this section. Coordinate the location of drainage receptacles with food preparation equipment requiring plumbing connections. All plastics and piping system components must conform to NSF/ANSI 14. Materials must conform to NSF/ANSI 51. Refrigeration equipment must conform to ANSI/ASHRAE 15 & 34, NSF/ANSI 37, NSF/ANSI 6, NSF/ANSI 7, UL 207, and UL 471.

1.2.1.1 American Gas Association Laboratories Standards

Gas-burning equipment must be designed for operation with the type of gas specified and be approved by CSA. Acceptable evidence of meeting the requirements of the applicable CSA Directory standards must be either CSA mark on equipment, a photostatic copy of the CSA appliance certificate, a listing of the specific food service equipment or appliance in the CSA Directory, or a certified test report from a nationally recognized independent testing laboratory, indicating that the specified equipment has been tested and conforms to the requirements of the applicable CSA standards.

1.2.2 Electrical General Requirements

All electrical work must conform to NFPA 70, and NEMA 250. Motors and controllers must conform to the requirements of NEMA ICS 2, NEMA ICS 6, NEMA MG 1, NEMA MG 2 and UL 763.

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NOTE: Select the following for Army.

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Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, applies to this system.

[1.2.3 Electromagnetic Interference Suppression

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NOTE: Electromagnetic interference suppression is required only when there is a probability of radio frequency interference with the using activities radio communications systems.

****

Provide in accord with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

][1.2.4 Fungus Treatment of Electrical Components

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NOTE: Fungus treatment of electrical components is required only in extremely humid and tropical climates.

****

Provide fungus treatment of all electrical components.

]1.3 DESCRIPTION OF WORK

The work includes [furnishing and] [installing] [and modifying existing] food service preparation equipment and related work. Verify all existing dimensions, contract drawings, product data and all related conditions prior to commencing rough-in work. Advise the Contracting Officer of all discrepancies prior to ordering equipment. Submit Contractor's Field Verification Data prior to the preconstruction meeting addressing the following:

a. Field verify all horizontal and vertical dimensions.

b. Review contract drawings and submittal data for accuracy and completeness.

c. Field check installed utility capacity and location.

d. Review critical systems/components for application and capacities such as for exhaust hoods, refrigeration systems,fire suppression systems, gas, water, and steam/condensate line sizes and manifold configurations.

e. Coordinate and verify delivery for access through finished openings and vertical handling limitation within the building.

Provide rough-in and connect utilities to equipment in accord with requirements specified in other sections of this specification and in accord with the physical dimensions, capacities, manufacturer's instructions, and other requirements of the equipment furnished.

1.3.1 Design Requirements

****

NOTE: On the drawings, show:

1. A 1:50 1/4 inch scale floor plan with layout of all food service equipment and Naval Equipment Symbols.

2. Food Service Equipment Schedule laid out in accord with NAVSUP41, current US Army Quartermaster Center and School equipment schedule specified design requirements, including Energy Star Labeled model list.

3. Floor, wall, and ceiling penetrations.

4. Raised bases, retainer curbs, or depressions.

5. Recessed, grated floor drains required for equipment.

6. Insulated floors, including under-floor perforated drains and vent pipes.

7. Disconnect switches.

8. Electrical chases and raceways and plumbing chases.

9. Utility connections to building water, sanitary, electrical, and other utility systems. Convenience outlets at point of use for plug-in equipment.

10. All Contractor built-to-order items, per Food Service Equipment Schedule, shown and coordinated with the specifications.

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Submit detail drawings for all food service and storage equipment. Drawings must be 1:50 1/4 inch scale minimum.

Submit a complete Food Service Equipment Schedule, material data, and drawings as specified. Provide detail drawings showing complete wiring, piping, and schematic diagrams, and any other details required to demonstrate that the system is coordinated and properly functions as a unit. Drawings must show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work, including clearances for maintenance and operation.

a. Detail drawings by Contractor must be separate drawings and be the Contractor's standard sheet size, but not smaller than the contract drawings, indicating food service equipment and cold storage assemblies with itemized schedule, special conditions drawings indicating size and location of slab depressions, cores, wall openings, blockouts, ceiling pockets, blocking grounds,[ceiling,][wall,] access panels, rough-in plumbing/mechanical systems and rough-in electrical systems.

b. Prepare and submit detail drawings that show the size, type, and location of equipment drain lines, and floor drains. Indicate drain lines from equipment, distances of drain lines and floor drain receptacles from equipment and aisles, and elevation views of drain piping and floor drains.

c. Detail drawings by manufacturer must be separate drawings; manufacturer's standard size and indicate item number, name, and quantity, construction details, sections, and elevations, adjacent walls, columns, and equipment, plumbing and electrical schematics, and fabricated fixtures with single electrical or plumbing connection, and service access panels required for maintenance or replacement of mechanical or electrical components.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Field Verification Data; G, [_____]

Manufacturer's Qualifications; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Food Service Equipment Schedule; G, [_____]

Food Service Equipment Utilities Coordination Plan; G, [_____]

Custom Fabricated Equipment; G, [_____]

Installation Instructions and Diagrams; G, [_____]

SD-03 Product Data

Food Service Equipment

Food Preparation Equipment

SD-04 Samples

Exterior Panel Finish Material; G, [_____]

Interior Panel Finish Material; G, [_____]

Sample Warranty; G, [_____]

SD-05 Design Data

Manufacturer's Descriptive And Technical Literature; G, [_____]

SD-06 Test Reports

Manufacturer's Test Data; G, [_____]

Field Test Reports; G, [_____]

SD-07 Certificates

National Sanitation Foundation Standards

Underwriters Laboratories Standards

Energy Star Labeled

PL 109-58 Compliant

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G, [_____] for shipping, handling, storage, installation, and start-up.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

List of Authorized Local Service and Repair Entities; G, [_____]

SD-11 Closeout Submittals

Manufacturer's Warranty; G, [_____]

Contractor's Warranty for Installation; G, [_____]

1.5 QUALITY ASSURANCE

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NOTE: Selected equipment must conform to efficiency requirements as defined in Public Law (PL) 109-58 - "Energy Policy Act of 2005 (EPAct05)" for energy efficiency procurement and as specified by FEMP and ENERGY STAR. Equipment selected will have as a minimum the efficiency rating determined in "Energy-Efficient Products" at

http://www1.eere.energy.gov/femp/procurement.

Equipment having a lower efficiency may be specified if the designer determines the equipment to be more life-cycle cost effective. Indicate the equipment operating characteristics, including rated energy efficiency, on the drawings.
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1.5.1 Energy Star Labeled Model List

Provide documentation certifying that products provided are PL 109-58 compliant by meeting or exceeding Energy Star or FEMP efficiency requirements as defined at "Energy-Efficient Products at http://www1.eere.energy.gov/femp/procurement. Indicate Energy Efficiency Rating. Custom fabricated items, which do not bear the Energy Star label must be accompanied by energy efficiency data and submitted to the Contracting Officer for review.

1.5.2 National Sanitation Foundation Standards

Provide acceptable evidence of meeting the requirements of the applicable National Sanitation Foundation (NSF) equipment standards as listed in NSF Food Equipment displaying the NSF seal for the year the equipment was manufactured, a certification issued for special or specific food service equipment by NSF under their special one time contract evaluation and certification, or a certified test report from an independent testing laboratory, approved by the Office of the Surgeon General, indicating that the specific food service equipment has been tested and conforms to the applicable NSF standards.

1.5.3 Standard Products

Materials and equipment must be the standard products of manufacturer regularly engaged in the manufacture of the products and be essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Applications must be for equipment and materials under similar circumstances and of similar size. When two or more of the same products are supplied they must be products of one manufacturer. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.5.4 Nameplates

Provide each item of equipment bearing a stainless steel, aluminum, or engraved polyester nameplate, as standard with the manufacturer, located in a conspicuous position and permanently fastened to the equipment. Make name or identification plates the size standard with the manufacturer for the particular piece of equipment provided. Name plates must indicate the name of the manufacturer/trade name, serial number, make, and model number, pertinent ratings, operating characteristics, and other information as standard with the manufacturer, date of manufacture, electrical characteristics, and other applicable data, such as flow rate, temperature, pressure, capacity, and material of construction. Securely fasten separate equipment identification plates with the contract number marked thereon, to the surface of each piece of equipment.

1.5.5 Underwriters Laboratories Standards

Provide electrically operated equipment in accordance with applicable UL standards UL 489 and UL 763. Provide a UL label on the equipment as evidence of meeting the requirements, including a UL listing mark per UL Elec Equip Dir or a certified test report from a nationally recognized independent testing laboratory indicating that the specific food service equipment has been tested and conforms to the applicable UL standards or equivalent OSHA Nationally Recognized Testing Laboratory (NRTL) standard.

1.5.6 Pre-Installation Conference

Thirty [_____] days prior to the commencement of work, notify the Contracting Officer that the following items are prepared and ready for review:

a. Preconstruction Submittals:

   (1) Contractor's Field Verification Data

   (2) Manufacturer's Qualifications

b. Shop Drawings, product data and installation instructions

   (1) Detail Drawings

   (2) Food Service Equipment Schedule

   Submit in the same format as the equipment schedule on the drawings. Include Energy Star labeled model list.

   (3) Food service equipment utilities

   (4) Custom fabricated equipment

   (5) Installation Instructions and Diagrams

c. Product Data:

   food preparation equipment

d. Samples

   (1) Exterior panel finish material

   (2) Interior panel finish material

   (3) Sample Warranty

e. Design Data

   (1) Manufacturer's descriptive and technical literature

   (2) Manufacturer's Test Data

f. Manufacturer's Instructions

   Manufacturer's Instructions for shipping, handling, storage, installation, and start-up.

1.6 DELIVERY, STORAGE, AND HANDLING

Unless otherwise directed, the following procedures apply:

1.6.1 Delivery

a. Deliver field assembled fixed equipment integrated into structure to jobsite when required.

b. Deliver fixed equipment not integrated into structure to the jobsite after completion of finished ceilings, lighting, and acidizing of the finished floor and wall systems, including painting.

c. Deliver major movable equipment to inventory in a secured area for interim jobsite storage, or if secured area is not available, when fixed equipment installation/clean-up has been completed.

d. Deliver minor appliances and loose items to the jobsite when the Contracting Officer is prepared to receive and inventory such items.

1.6.2 Storage of Equipment and Accessories

Store delivered items with protection from weather, humidity, and temperature variation, dirt and dust, or other contaminants. Clearly label and identify all components with respective number as enumerated in approved Food Service Equipment Schedule.

1.6.3 Protection of Fixed/Fabricated Manufactured Equipment

Follow equipment manufacturer's recommendations to protect materials and equipment and prevent damage.[Tape fiberboard or plywood to surfaces as required by equipment shape and installation access requirements. Do not use tape which may possibly damage finished surface.]

1.6.4 Prohibited Use of Equipment

Do not use food service equipment as tool or material storage, work bench, scaffold, or stacking area.

1.6.5 Damaged Equipment

Immediately submit documentation to the Contracting Officer with a recommendation of action for repair or replacement and the impact on project schedule.

PART 2 PRODUCTS

2.1 MATERIALS

Food equipment must conform to OSHA standards 29 CFR 1910.144, 29 CFR 1910.145, 29 CFR 1910.212, 29 CFR 1910.306, and related NSF and UL standards

Floor areas adjacent to food preparation equipment point of operation, and working surfaces must conform to 29 CFR 1910-SUBPART D

Comply with EPA sustainable acquisition (SA) requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING; regarding insulation materials for all equipment designated within this section. Other materials must conform to the following:

2.1.1 Stainless Steel, Sheets and Formed, Nonmagnetic

ASTM A480/A480M or ASTM A240/A240M: 18-8, 300 Series, austenitic, polished to [No. 3 or]No.4 finish on exposed surfaces.

2.1.2 Stainless Steel Pipe, Tubing and Bars

ASTM A269/A269M, ASTM A270/A270M, ASTM A666. Provide seamless or welded pipe and tubing, of the gauge specified, of true roundness, and of material as specified for stainless steel. Seamless tubing must be thoroughly annealed, pickled, and ground smooth. Welded tubing must be thoroughly heat-treated, quenched to eliminate carbide precipitation and then drawn true to size and roundness, and ground. Provide No. 3 or 4 finish tubing when exposed to view.

Provide bars conforming to ASTM A276/A276M, ASTM A666, Type 302 or Type 304 or Type 316.

2.1.3 Galvanizing Repair Compound

ASTM D520, Type I pigment.

2.1.4 Brazing and Braze Welding Material

AWS A5.8/A5.8M, class as applicable.

2.1.5 Steel Structural Shapes for Framing

ASTM A36/A36M. Provide uniform structural shapes, ductile in quality, and of hard spots, runs, checks, cracks and other surface defects. Galvanize sections by the hot-dip process, conforming to ASTM A123/A123M.

2.1.6 Coatings

Provide durable, nontoxic, nondusting, nonflaking, and mildew-resistant type coatings, suitable for use with food service equipment and in conformance with NSF/ANSI 2. Application must be in accordance with the recommendations of the manufacturer.

2.1.6.1 Exterior Parts

Exterior, galvanized parts, exposed members of framework, and wrought steel pipe, where specified to be painted, must be cleaned, and free of foreign matter before applying a rust inhibiting prime and two coats of epoxy-based paint in accordance with Section 09 90 00 PAINTS AND COATINGS, unless otherwise specified. Color will be selected by the Contracting Officer from manufacturer's standard colors.

2.1.6.2 Chromium Plating

Apply chromium plating over nickel plating.

2.1.7 Zinc-Coated Steel

2.1.7.1 Sheets and Shapes

Provide zinc coated sheets conforming to ASTM A653/A653M, coating Class Z275 G90. Provide zinc coated shapes conforming to ASTM A36/A36M, in accord with ASTM A123/A123M.

2.1.8 Brass Piping and Fittings

Pipe must conform to ASTM B43. Fittings must conform to ASME B16.15.

2.1.9 Copper Tubing and Fittings

Provide copper tubing conforming to ASTM B88M ASTM B88, Type K, annealed, for buried or embedded in concrete installation and Type L, hard drawn, for above grade installation. Fittings must conform to ASME B16.18, above grade, ASME B16.22 or ASME B16.26, above or below grade.

2.1.10 Solder Material

ASTM B32, Sn96.

2.1.10.1 Lead-Free Solder

ASTM B32, 95.5 tin-antimony solder or other "lead-free" solder. Use for all potable water copper tubing and fitting connections, and for solder joints in contact with food.

2.1.10.2 Tin-Lead Solder

ASTM B32, alloy grade 50B for temperatures up to 65 degrees C 150 degrees F and alloy grade 95TA for temperatures over 65 degrees C 150 degrees F.

2.1.10.3 Silver Solder

AWS A5.8/A5.8M, 15 percent silver base brazing alloy, melting point not less than 540 degrees C 1000 degrees F.

2.1.11 Laminated Plastics

ANSI/NEMA LD 3 and NSF/ANSI 35.

2.1.12 Sealants

Sealants must conform to the requirements of ASTM C1330, ASTM C920.

2.2 CONSTRUCTION OF FABRICATED EQUIPMENT

2.2.1 Grinding, Polishing, and Finishing

Grind smooth all exposed welded joints and finish to match the adjoining material. Wherever materials have been depressed or sunken by welding operation, hammer and peen such depressions flush with the adjoining surface, and again grind to eliminate high spots. Polish and buff ground surfaces to match adjoining surfaces. Exercise care in the grinding operations to avoid excessive heating of the metal and metal discoloration. Abrasives, wheels, and belts used in grinding must be free of iron and not previously used on carbon steel. In all cases, the grain of rough grinding must be removed by several successively finer polishing operations. Final polishing operation must be uniform, smooth, and consistent. Make the grain direction of horizontal stainless steel surface longitudinal, including the splash back. Provide a mitered appearance when polishing at right angle corners. Provide close fit butt and contact joints not requiring solder as a filler. Wherever brake bends occur, the bends must be free of open texture or orange peel appearance. Where brake work does mar the uniform appearance of the material, remove such marks by grinding, polishing, and finishing. Make sheared edges free of burrs, projections, and fins. Where miters or bullnosed corners occur, finish such miters and corners with the underage of the material and grind to a uniform condition. Overlapping of material is not acceptable. Provide [No. 3][or][4][XL][XL Buff] finish for all exposed stainless steel surfaces. Finishes of materials, other than stainless steel, must be comparable in appearance to commercial mill finish. Exposed surfaces include:

a. Exterior surfaces exposed to view.

b. Interior surfaces exposed to view in doorless cabinets.

c. Undersides of shelves with a ground finish of No. 90 grit or finer.

2.2.2 Fastening Devices

Provide fastening devices of the same material as the metal being joined when joint pieces are of similar metal. Fastening devices must be stainless steel, ASTM A666 when stainless steel is joined to dissimilar metal. Provide minimum M6 1/4-20 stainless steel stud bolts with length necessary to accept washers, and required nuts, and weld 225 mm 9 inches on center maximum. Exposed surfaces of equipment must be free of bolts, screws, and rivet heads. Use stainless steel stud bolts to fasten tops of counters or tables to angle framing and trim to other surfaces. Such bolts must be the concealed type. Cap threads of stud bolts which are on the inside of fixtures and are either visible or might come in contact with a wiping cloth, with chrome plated washers, lock washers, and chromium-plated brass cap nuts. Wherever bolts are welded to the underside of trim or tops, uniformly finish the reverse side of the welds with the adjoining surface of the trim or the top. Dimples at these points are not be acceptable.

2.2.3 Welding

2.2.3.1 Welds

Use tungsten inert gas process. Use filler metal compatible with the material being welded. Do not use carbon arc welding on tops of counters, tables, drainboards, exposed shelving, or sinks. Make welds ductile and of same color as adjoining surfaces.

2.2.3.2 Welding Rods

Perform all welding with welding rods of the same composition as the sheets or parts welded. Factory weld long section components to the greatest lengths possible to minimize field welded joints.

2.2.3.3 Weld Quality

Weld quality must conform to the requirements of AWS A5.8/A5.8M, AWS D1.1/D1.1M, AWS D10.4 and AWS D9.1/D9.1M. Factory weld long section components to the greatest lengths possible to minimize field welded joint.

2.2.4 Built-in Equipment Lighting

Built-in lighting must conform to UL 1598.

2.2.5 Sound Deadening of Counters and Sinks

Provide sound deadening for counter tops and sinks with 13 mm 1/2 inch wide rope sealant positioned continuously between all contact surfaces of the frame-members and the underside of counter top, overshelves and undershelves. Tighten stud bolts for maximum compression and trim any excess sealant.

2.2.6 Heat Lamp/Display Wiring

Conceal heat lamp/display wiring in corner post(s).

2.2.6.1 Heat Lamps

Provide heat lamp units with consolidated chassis of longest possible length for multiple sections. Include integral incandescent display light with warm white lamps and wire to a recess mounted infinitely adjustable heat control with pilot light for each separate section. Tightly secure heat lamps to the underside of the serving shelf and provide a "USDA" approved heat protector between the heat lamps and the shelf. Maximum allowable temperature at the top of a serving shelf must not exceed 49 degrees C 120 degrees F.

2.2.6.2 Display Light Modules

Provide Energy Star Labeled under-cabinet, shelf-mounted fixtures (not included with heat lamps) in 450 mm 18 inch and 900 mm 36 inch increments. Wire fixtures to a single recess mounted master switch per serving shelf.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Prior to commencement of installation, perform a complete walk down of the facility with the Contracting Officer to verify readiness for installation.

Provide adequate protection of all finished surfaces, fixtures,[furnishings] and other equipment to prevent any damage during the installation work.

Conduct installation procedures conforming to applicable NSF, OSHA and UL standards specified, and the manufacturer's instructions.

[Set floor mounted equipment on 150 mm 6 inches thick concrete housekeeping pads, complete with anchor bolts and grouting. Finish housekeeping pads with two coats of oil-resistant epoxy polyamide coating.]Set all equipment plumb and level. Except for mobile and adjustable-leg equipment, securely anchor and attach items and accessories to walls, floors, or bases with stainless steel bolts.

Flash food service cabinets located in wall openings to the walls with 0.9 mm thick 20 gage stainless steel. Seal around equipment flashing and flanges, at walls, floor, and ceiling in accord with Section 07 92 00 JOINT SEALANTS. Fillers must be continuous, without opening.

No drilling, cutting, burning, or welding of structural parts of building is permitted. Provide access panels for concealed valves, vent controls, and control devices and items requiring periodic operation, inspection, or maintenance.

3.1.1 Equipment Connections

Complete equipment connections for all utilities. Unless otherwise specified, provide [chromium-plated copper alloy] [stainless steel] exposed piping. Provide access panels of sufficient size and so located that concealed items may be serviced and maintained or removed and replaced.

[3.1.2 Backflow Preventers

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NOTE: Clearly indicate on the drawings all locations where backflow preventers are required.

****

Furnish and install backflow preventers as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. The Contractor is responsible to install backflow preventers as shown on the contract drawings and at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any source of nonpotable water, or other contaminant. Install backflow preventers at all locations where the potable water outlet is below the flood level of the equipment, or will be located below the level of the contaminant. Provide backflow preventers of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of waste or other contamination into the potable water system.

]3.1.3 Gas Equipment

Installation of gas operated equipment must conform to NFPA 54. Fasten a heavy duty steel cable, 75 to 150 mm 3 to 6 inch shorter than the equipment connector, to the equipment and the walls.

3.1.4 Electrical Work

Electrical systems, components and accessories must be certified to be in accordance with NFPA 70 and the following:

3.1.4.1 Installed Equipment Load

If the electrical load of the approved equipment differs from that specified or shown on the drawings, provide and install electrical service compatible with the approved equipment.

3.1.4.2 Electrical Equipment and Components

Food service equipment furnished under this section must have loads, voltages, and phases compatible with building system, and conform to manufacturer standards.

3.1.4.3 Cords and Caps

Coordinate all food service equipment cord/caps with related receptacles. All 120/208/240 volt "plug-in" equipment must have Type SO or SJO cord and a plug with ground, fastened to frame/body of item. Provide mobile equipment with a strain-relief assembly at the cord connection of the appliance. Mobile electrical support equipment and counter appliances mounted on mobile stands must have cord/cap assembly with cord-hanger as provided by the manufacturer.

3.1.4.4 Switches and Controls

Equip each motor-driven appliance or electrically-heated unit with control switch and overload protection per UL 197 and UL 471. Switches, controls, control transformers, starters, equipment protection and enclosures must be Industry Standards for the related equipment environment.

3.1.4.5 Motors

Provide motors at 120, 240, 208/240 and 460/480 volts with starter, overload protection, and short circuit motor protection per manufacturer standards.

3.1.4.6 Heating Elements

Provide thermostatic controls for all electrically heated equipment. Equip water heating equipment with a positive low-water shut-off.

3.1.4.7 Receptacles and Switches

Install receptacles which are located in vertical panels of closed base bodies in 300 by 215 by 75 mm 12 by 8-1/2 by 3 inch deep recessed mounting panel sloped on a 60-degree angle and turned up to the top of the opening. Prewire receptacles which are located in closed base fixtures to a junction box located within 150 mm 6 inch from the bottom of the utility compartment. Horizontally mount receptacles which are installed in/on fabricated equipment in a metal box with a stainless steel cover plate.

3.1.4.8 Light Fixtures

Prewire light fixtures with lamps which are installed in/on fabricated or field-assembled equipment to a junction box for final connection (fixtures must be continuous run when indicated). Install fluorescent display light the full-length of the display stand and serving shelf with stud bolts or as indicated, and prewire through a support post to a recess-mounted switch. Install heat lamps to underside of serving shelf assemblies as specified. Heat lamp length for chassis must be sized per manufacturer or as indicated on the drawings. Electrically connect cold storage light fixtures through the hub fitting located on the top of the fixture. Horizontal conduit must be above the ceiling panels. Install plastic sleeves through ceiling panels for electrical conduit and seal all penetrations airtight at both sides of panel.

3.1.4.9 Final Electrical Connection Provisions

Tag final electrical connection points of equipment with item number, name (as indicated on FOOD SERVICE EQUIPMENT SCHEDULE) of devices on the circuit, total electrical load, voltage, and phase. Fabricated equipment containing electrically-operated components or fittings, indicated on utility connections drawings to be direct-connected, must have each component, fitting, or group thereof prewired to a junction box for final connection. Refer to the drawings for circuit loading.

Field-assembled equipment (example, prefabricated cold storage assemblies, conveyor systems, exhaust hoods) must have electrical components completely interconnected by this section for final connection as indicated on utility connection drawing. Prewire the following groups of cold storage assembly electrical devices to a top-mounted junction box for final connection per compartment grouping, unless otherwise indicated.

a. Light fixtures, switches, and heated pressure-relief vent.

b. Door/jamb heater and temperature monitors/alarms.

c. Evaporator fans, defrost elements, freezer fan door switch, and drain line heaters.

3.1.4.10 Lamps

Provide food service equipment containing light fixtures with standard appliance type bulbs or energy efficient appliance type bulbs as indicated on the drawings. Exposed fluorescent lamps above or within a food zone must have plastic coated T-8 energy efficient lamps or standard lamps, sleeved in plastic tube with end caps.

3.1.5 Plumbing Work

Tag all plumbing final connection points of equipment, indicating item number, name of devices or components, and type of utility (water, gas, steam, drain). Provide extensions of indirect waste fitting to open-sight hub drain, floor sink or floor drains from food service equipment.

3.1.5.1 Steam Connection Provisions

Provide all steam-injected equipment with a steam inlet globe control valve with cold handle, relief valve, strainer, condensate gate valve, bucket steam trap, and swing check valve. Compartment steam cookers must have piping manifolded from all compartment exhaust valves to a floor drain, floor sink, or drain trench. Provide steam generators specified within this section with automatic boiler blowdown and a cold water condenser. Separate equipment, devices or components indicated to be connected to a steam-generator, provided under this section, must be provided with all unions, ells, gate valves, nipples, brackets, clamps, etc., required for the complete operating system for final connection.

Steam supply piping must be insulated with 25 mm 1 inch fiberglass insulation (48 kg/cubic meter3 pounds/cubic foot density) and have factory-applied fire retardant. Install a full-length 1.6 mm 16 gauge stainless steel pipe enclosure with sloping top, jacket, and vapor barrier over steam lines.

3.2 MANUFACTURER'S FIELD SERVICES

Furnish manufacturer's representatives who are directly employed by the equipment manufacturers and trained to perform the services specified. The manufacturers representatives must provide advice and services on the following matters:

Starting equipment and training Government personnel as to its proper care, operation, maintenance and safety procedures.

3.3 LOCATIONS AND CLEARANCES

Locate equipment to provide working space for necessary servicing such as shaft removal, disassembling, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, lubrication, oil draining and working clearance.

3.4 IDENTIFICATION TAGS AND PLATES

Provide equipment with tags numbered and stamped for their use as indicated on the Food Service Equipment Schedule. Provide brass or non-ferrous plates and tags. Minimum letter and numeral sizes are 3.18 mm 1/8 inch high.

3.5 OPERATION AND MAINTENANCE MANUALS

Submit six copies of operating instructions outlining the step-by-step procedures required for equipment start-up, operation and shutdown. Include the manufacturer's name, model number, service manual, parts list, and a brief description of equipment and basic operating features.

Submit [6][_____] copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, trouble shooting guides, and containing the following:

a. Front and rear protective covers with labeled project name.

b. Index indicating item number, quantity, description, manufacturer's name, and model number.

c. Maintenance instructions for stainless steel and plastic laminate.

d. Manufacturer's catalog specification sheets and manufacturer's detail and control drawings.

e. Manufacturer's operation manual outlining the step-by-step procedures for equipment installation, startup, basic operation features, and operation shutdown.

f. Manufacturer's maintenance manual listing routine maintenance procedures, possible breakdowns, repairs, and troubleshooting guides. Include simplified diagrams for the equipment as installed.

g. Manufacturer's list of parts and supplies with current unit price and address of manufacturer's parts supply warehouse.

Include simplified wiring diagrams in the instructions. Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, must be posted where directed. Prepare in typed form, condensed operating instructions explaining preventative maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Submit proposed diagrams, instructions, and other sheets, prior to posting. Post the framed instructions, including wiring and control diagrams, before acceptance testing of the systems.

3.6 INSTRUCTIONS TO GOVERNMENT PERSONNEL

Prepare and conduct a training course for the operating staff as designated by the Contracting Officer. The training must consist of a total [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. Cover in the field instructions the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least [14][_____] days prior to date of proposed conduction of the training course.

Submit a list of authorized local service and repair entities to the Contracting Officer 14 days prior to conducting the training course.

3.7 TESTS

Perform the tests including everything required. Notify the Contracting Officer, in writing, [10][_____] days before performing tests. Perform tests in the presence of [a manufacturer's representative][and Contracting Officer].

3.7.1 Initial Start-Up and Operational Test

Provide all lubricants and accessories before initial start-up. Start and operate all equipment. Follow the manufacturer's procedures and place the systems under all modes of operation. Supplement initial charges of lubricating oil to assure maximum operating capacity. Adjust all safety and automatic control instruments. Record manufacturer's recommended readings hourly. Operational tests must cover a period of not less than [3][5][_____] days.

3.7.2 Test Reports

Submit the final field test reports for each system tested, describing test apparatus, instrumentation calculations, and equipment data based on industry standard forms or reasonable facsimiles thereof. Data must include: compressor suction and discharge pressure; refrigerant charge pump, compressor and air moving device ampere readings; power supply characteristics, including phase imbalance, with 1/2 percent accuracy; thermostatic expansion valve superheat-value as determined by field test; subcooling; high and low refrigerant temperature switch set-points; low oil pressure switch set-point; [defrost system timer and thermostat set-points;] moisture content; ambient, condensing and coolant temperatures; capacity control set-points; field data and adjustments which affect unit performance and energy consumption. Where final adjustments and settings cannot be permanently marked or drilled and pinned as an integral part of device, include adjustment and setting data in test report.

3.7.3 Cleaning and Adjusting

Test and adjust equipment for proper operation. Test rotating components and motors for proper rotation. Lubricate moving parts if suggested by manufacturer's literature. Prior to acceptance of project, clean and sanitize equipment both inside and outside.

3.8 MANUFACTURER'S WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.9 CONTRACTOR'S WARRANTY for INSTALLATION

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-11 06 40.13 (August 2017)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 06 40.13 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 11 - EQUIPMENT

SECTION 11 06 40.13

FOODSERVICE EQUIPMENT SCHEDULE

08/17

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-11 06 40.13 (August 2017)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 06 40.13 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 11 06 40.13

FOODSERVICE EQUIPMENT SCHEDULE
08/17

****

NOTE: This guide specification covers the requirements for foodservice equipment schedules.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This guide specification is to be used in conjunction with the following sections; subject to project scope requirements:

Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT

Section 11 41 11 REFRIGERATED AND FROZEN FOOD STORAGE EQUIPMENT

Section 11 42 00 FOOD PREPARATION EQUIPMENT

Section 11 44 00 FOOD COOKING EQUIPMENT

Section 11 46 00 FOOD DISPENSING EQUIPMENT

Section 11 47 00 ICE MACHINES

Section 11 48 00 CLEANING AND DISPOSAL EQUIPMENT

Section 12 35 39 COMMERCIAL KITCHEN CASEWORK.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NSF INTERNATIONAL (NSF)

NSF Food Equipment	(2005) NSF Product Listings of Food Equipment and Related Products, Components and Materials
NSF/ANSI 2	(2022) Food Equipment
NSF/ANSI 169	(2023)Special Purpose Food Equipment and Devices

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M	(2006) MILSTRIP - Military Standard Requisitioning and Issue Procedures

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA WaterSense	(2006) WaterSense Water Efficiency

Labeling System

1.2 DEFINITIONS

Terms used in paragraph FOOD SERVICE EQUIPMENT SCHEDULE are defined as follows:

a. Sheet Pan: Standard 450 by 650 by 25 mm 18 by 26 by 1 inchdeep pan, unless otherwise noted.

b. Pan: Standard 300 by 500 by 150 mm 12 by 20 by 6 inch deep pan.

c. Serving Tray: Cafeteria tray 350 by 450 mm 14 by 18 inch, unless otherwise noted.

d. 115-60-1: 115-volt, 60-hertz, 1-phase electric service and connection.

e. 208-60-1: 208-volt, 60-hertz, 1-phase electric service and connection.

f. 208-60-3: 208-volt, 60-hertz, 3-phase electric service and connection.

1.2.1 Abbreviations

Abbreviations used in paragraph FOOD SERVICE EQUIPMENT SCHEDULE are defined as follows:

AMPS:	Amperes
J:BTU:	JoulesBritish Thermal Units
CRS:	Corrosion Resistant Steel
CW:	Cold water
DIA:	Diameter
DR:	Drain
FED:	Federal Specification
G:	Gas
L:GAL:	LitersGallon
W:HP:	WattsHorsepower

HW:	Hot Water
mm:IN:	MillimetersInches
JSN:	Joint Schedule Numbers
KW:	Kilowatts
L:	Left
kg:LB:	KilogramsPounds
LOG CLASS:	Logistical Classification
MIL:	Military Specification
MIN:	Minimum
NSF:	National Sanitation Foundation
R:	Right
SS:	Stainless Steel
STM:	Steam
x:	By, in usage describing dimensions of a rectangular solid

1.2.2 Dimensions

Dimensions used in paragraph FOOD SERVICE EQUIPMENT SCHEDULE are in millimeters inches, unless otherwise noted. Dimensions are listed in order of length, width, and height, unless otherwise noted. Terms are defined as follows:

a. Length: Distance across front of equipment

b. Width: Distance from front edge to back edge

c. Height: Distance from bottom edge to top of equipment

d. Depth: Distance from rim to bottom at drain, as in a sink.

1.2.3 Measurements

Metric measurements in this section are based on mathematical conversion of English unit measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The English and metric units for the measurements shown are as follows:

Products	Metric Units	English Units
Stainless steel legs	100 mm	4 inches
Stainless Steel	2.5 mm	12 gage
	1.8 mm	14 gage
	1.5 mm	16 gage
	1.2 mm	18 gage
Channels	25 mm x 25 mm	one x one inch
	2.5 mm	12 gage
Angles	38 mm x 38 mm x 3 mm	1 1/2 x 1 1/2 x 1/8 inch

1.2.4 Logistical Classification

****

NOTE: The Logistical Classifications listed in the schedule assume Class A (funded with building project funds and provided by the Contractor) for all building equipment and Class C (funded with other than building project funds and provided by the Government) for all collateral equipment. (The latter are listed because they are connected to building services or otherwise need the Contractor's attention). If equipment is to be procured with any other funding or procurement method, revise the "Log Class" symbol as appropriate. Government-furnished equipment must also be addressed in Section 01 11 00 SUMMARY OF WORK.

****

Method of Procurement listed in paragraph FOOD SERVICE EQUIPMENT SCHEDULE is defined as follows:

a. Class A: Contractor-furnished and Contractor-installed.

[b. Class B: Government-furnished and Contractor-installed.

] c. Class C: Government-furnished and Government-installed.

[d. Class D: Government-furnished as leased equipment and Government-installed.

][e. Class E1: Government-furnished and Government-installed.

][f. Class E2: Government-furnished and Contractor-installed.

] Equipment designated Logistical Class ["C"] ["D"] ["El"] will be Government-provided. Equipment which is Government-provided will be furnished and installed by the Government in space made available by the Contractor and with rough-in made by the Contractor in accord with the information made available or referenced herein or indicated.

1.3 GENERAL REQUIREMENTS

****

NOTE: Indicate the configuration and layout for all food service equipment and accessory items on the floor plans, with interior elevations and equipment identified by number. Show "Food Service Equipment Schedule" on the drawings using the same identification numbers[as indicated on the current US Army Quartermaster Center and School equipment schedule]. Ensure that all Contractor built-to-order items, per Food Service Equipment Schedule", are shown and coordinated with the specifications.

Designer must coordinate with other sections for final connection of equipment.

NOTE: Details of particular equipment and installations are provided on Naval Food Service Division drawings. Use these NAVFSD drawings as a basis for the project details. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

****

Submit detailed Food Service Equipment Schedule conforming to DOD 4000.25-1-M. Electrically powered equipment specified within this section must conform to EPA Energy Star requirements and labeling. Food Service Equipment must conform to NSF/ANSI 2 and NSF Food Equipment standards. Special purpose equipment must conform to NSF/ANSI 169. Submit in the same format as the equipment schedule on the drawings. Include Energy Star Labeled models and EPA WaterSense Fixtures.

1.3.1 Design Requirements

****

NOTE: On the drawings, show:

1. A 1:50 1/4 inch scale floor plan with layout of all food service equipment and Naval Equipment Symbols.

2. Food Service Equipment Schedule laid out in accord with NAVSUP41, current US Army Quartermaster Center and School equipment schedule specified design requirements, including Energy Star Labeled model list.

3. Floor, wall, and ceiling penetrations.

4. Raised bases, retainer curbs, or depressions.

5. Recessed, grated floor drains required for equipment.

6. Insulated floors, including under-floor perforated drains and vent pipes.

7. Disconnect switches.

8. Electrical chases and raceways and plumbing chases.

9. Remote compressors and refrigeration systems.

10. Utility connections to building water, sanitary, electrical, and other utility systems. Convenience outlets at point of use for plug-in equipment.

11. All Contractor built-to-order items, per Food Service Equipment Schedule, shown and coordinated with the specifications.

****

Submit detail drawings for all food service equipment and accessory items. Drawings must be 1:50 1/4 inch scale minimum.

Submit a complete list of equipment, material data, and drawings as specified.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Food Service Equipment Schedule; G, [_____]

PART 2 PRODUCTS

2.1 LIST OF EQUIPMENT

****

NOTE: Edit the master "Food Service Equipment Schedule" carefully; retain items of equipment used for the project. The Equipment List is intended to be edited and included in the project Specification. List the information contained herein on the Equipment List on the Contract Drawings.

****

2.1.1 Format

Provide the equipment listed except as otherwise specified as a result of the Logistical Class listed. Entries in paragraph FOOD SERVICE EQUIPMENT SCHEDULE include the following information, when applicable:

****

NOTE: The Navy equipment symbols must be used on the drawings in a table keyed to plan location by a secondary designation. The Navy equipment symbols are intended to be used as shown, without renumbering for deleted items or because of added items. Contact NAVSUP41 for equipment table format.

****

a. Naval Equipment Symbol.

b. Logistical Classification.

c. Generic description of equipment.

d. Referenced applicable document or statement that equipment is Custom Fabricated or of Commercial design.

e. Classification: Type, Style, Class, Size, Group, Model and Grade for equipment defined by referenced applicable document.

f. Description for Custom Fabricated and Commercial design, and required features or accessories.

g. Dimension: listed in order of length, width and height.

h. Utility Requirements: Electrical: volts, hertz, phase; gas; plumbing: water, drain; listed in order.

2.1.2 Food Service Equipment Schedule

****

NOTE: Submit the proposed equipment list to the Naval Food Service System Office, who will furnish Naval Equipment Symbols and Descriptions. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

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NOTE: The Logistical Classification of the equipment listed at this Technical Note will depend on the Classification selected for associated work listed elsewhere. Coordination is required.

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NOTE: When equipment is added to this schedule, add the applicable Standard to the paragraph REFERENCES.

****

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NOTE: Per Energy Star (http://www.energystar.gov**), the following items have Energy Star labeled products:**

Commercial Hot Food Holding Cabinets
Commercial Griddles
Commercial Ovens
Commercial Steam Cookers
Commercial Refrigerators and Freezers
Commercial Fryers
Commercial Ice Makers
Commercial Dishwashers

Edit the schedule below to include Energy Star products.

****

****

NOTE: Per EPA WaterSense (http://www.epa.gov/watersense**), the following item is a Watersense labeled product:**

Pre -Rinse Spray Valves

Edit the schedule below to include Watersense products.

****

Naval Equipment Symbol	Logical Class	Description
[__-__-_]	[-]	[Air Screen Merchandiser]
[__-__-_]	[-]	[Back Bar and Storage Coolers, [1][2][3] door]
[__-__-_]	[-]	[Back Bar and Storage, [1][2][3] door]
[__-__-_]	[-]	[Baker's Racks][_____]
[__-__-_]	[-]	[Bake Oven(s)][_____]
[__-__-_]	[-]	[Beverage Dispenser][Tray Rail][_____]
[__-__-_]	[-]	[Blender][Guard][_____]
[__-__-_]	[-]	[Booster Heater][_____]
[__-__-_]	[-]	[Broiler][_____]
[__-__-_]	[-]	[Carts][insulated][_____]
[__-__-_]	[-]	[Casework][_____]
[__-__-_]	[-]	[Cashier Stand][_____]
[__-__-_]	[-]	[Coffee Maker][_____]
[__-__-_]	[-]	[Coffee Urn][_____]
[__-__-_]	[-]	[Coffee Warmer][_____]
[__-__-_]	[-]	[Cold Food Pans][_____]
[__-__-_]	[-]	[Condiment Racks][_____]
[__-__-_]	[-]	[Cookware][_____]
[__-__-_]	[-]	[Cooking Pans][_____]
[__-__-_]	[-]	[Cooking Pots][_____]
[__-__-_]	[-]	[Cooking Utensils][_____]
[__-__-_]	[-]	[Conveyor, soiled dish and tray][_____]
[__-__-_]	[-]	[Cup Dispenser][_____]
[__-__-_]	[-]	[Cutlery][_____][and Dispenser]
[__-__-_]	[-]	[Deli Merchandiser, [1][2][3] door][tray rail]

Naval Equipment Symbol	Logical Class	Description
[__-__-_]	[-]	[Desert Table][tray rail][_____]
[__-__-_]	[-]	[Dicer][Guard][_____]
[__-__-_]	[-]	[Dinnerware Dispenser][_____]
[__-__-_]	[-]	[Dish Machine][_____]
[__-__-_]	[-]	[Dish Racks][_____]
[__-__-_]	[-]	[Dispensing Freezer][_____]
[__-__-_]	[-]	[Display Table][with lights][and sneeze guard] [with tray rail]
[__-__-_]	[-]	[Dough Mixer][Fixed Bowl][Removable Bowl] [_____]
[__-__-_]	[-]	[Dough Sheeters][Bench Top][Floor Model] [_____]
[__-__-_]	[-]	[Food Prep Table][with sink]
[__-__-_]	[-]	[Food Service Line][Tray Rail][_____]
[__-__-_]	[-]	[Food Slicer][_____]
[__-__-_]	[-]	[FREEZER; AS SPECIFIED IN PARAGRAPH PREFABRICATED WALK-IN REFRIGERATORS AND FREEZERS]
[__-__-_]	[-]	[Fryer(s)][_____]
[__-__-_]	[-]	[Glass Dispenser][_____]
[__-__-_]	[-]	[Griddle][_____]
[__-__-_]	[-]	[Hand Sink][s][_____]
[KS-48-0]		[SINK, HAND]
[KS-48-3]	[A]	[COMMERCIAL; [_____]; AS SPECIFIED; CW, DW, DR]
[__-__-_]	[-]	[Heat Lamps][_____]
[__-__-_]	[-]	[Hood(s) (cooking exhaust)][self-cleaning with grease extractor][_____]
[KH-60-0]		[HOOD, CENTRIFUGAL GREASE EXTRACTING EXHAUST]

Naval Equipment Symbol	Logical Class	Description
[KH-60-1]	[A]	[COMMERCIAL; TYPE 1: SERVE OVER SHELF TYPE; AS SPECIFIED IN PARAGRAPH HOODS; 208-60-1 AND 115-60-1, HW, DR]
[KH-60-2]	[A]	[COMMERCIAL; TYPE 2: ISLAND TYPE; AS SPECIFIED IN PARAGRAPH HOODS; 208-60-1 AND 115-60-1, HW, DR]
[KH-60-3]	[A]	[COMMERCIAL; TYPE 3: WALL MOUNTED FREE STANDING; AS SPECIFIED IN PARAGRAPH HOODS; 208-60-1 AND 115-60-1, HW, DR]
[KH-60-4]	[A]	[COMMERCIAL; TYPE 4: LOW CEILING; AS SPECIFIED IN PARAGRAPH HOODS; 208-60-1 AND 115-60-1, HW, DR]
[__-__-_]	[-]	[Hood(s) (condensate exhaust)][_____]
[KH-64-0]	[-]	[Hood(s) (condensate exhaust)][_____]
[KH-64-5]	[A]	[CUSTOM FABRICATED; TYPE 5: OVER UTENSIL-WASHING SINK; AS SPECIFIED]
[KH-64-6]	[A]	[CUSTOM FABRICATED; TYPE 6: OVER UTENSIL WASHING MACHINE; AS SPECIFIED; DR]
[KH-64-7]	[A]	[CUSTOM FABRICATED; TYPE 7: OVER DISHWASHING MACHINE; AND AS SPECIFIED; DR]
[__-__-_]	[-]	[Hot Food Holding Cabinet(s)][_____]
[__-__-_]	[-]	[Hot Food Pans][_____]
[__-__-_]	[-]	[Ice Dispenser][_____]
[__-__-_]	[-]	[Ice Machine][_____]
[__-__-_]	[-]	[Juice Dispenser][_____]
[__-__-_]	[-]	[Microwave][_____]
[__-__-_]	[-]	[Milk Dispenser][_____]
[__-__-_]	[-]	[Mincer][Guard][_____]
[__-__-_]	[-]	[Mixer][Guard][_____]

Naval Equipment Symbol	Logical Class	Description
[__-__-_]	[-]	[Napkin Dispenser][_____]
[__-__-_]	[-]	[Ozone Generator][_____]
[__-__-_]	[-]	[Pan][standard],[_____]
[__-__-_]	[-]	[Personnel Protective Equipment][_____]
[__-__-_]	[-]	[Peeler],[Guard][_____]
[__-__-_]	[-]	[Pot and Pan Sink][Clean][Soiled][_____]
KS-50-0		SINK, POT WASHING
KS-50-7	A	CUSTOM FABRICATED; AS INDICATED AND SPECIFIED; CW, HW, DR
[__-__-_]	[-]	[Prep Table][s][_____]
[__-__-_]	[-]	[REFRIGERATOR; AS SPECIFIED IN PARAGRAPH PREFABRICATED WALK-IN REFRIGERATORS AND FREEZERS]
[KR-74-0]		[REFRIGERATORS AND FREEZERS, PREFABRICATED, WALK-IN]
[KR-74-4]	[A]	[REFRIGERATOR; AS SPECIFIED IN PARAGRAPH PREFABRICATED WALK-IN REFRIGERATORS AND FREEZERS]
[KR-74-8]	[A]	[FREEZER; AS SPECIFIED IN PARAGRAPH PREFABRICATED WALK-IN REFRIGERATORS AND FREEZERS]
[__-__-_]	[-]	[_____]
[__-__-_]	[-]	[Range Top][_____]
[__-__-_]	[-]	[Reach-in Refrigerators, [1][2][3] door]
[__-__-_]	[-]	[Reach-in Freezers, [1][2][3] door]
[__-__-_]	[-]	[Remote Syrup Containers][and racks][_____]
[__-__-_]	[-]	[Refrigerated Display Cases and Coolers, [1][2][3] door] [front loading][pass-thru][4 sided glass]
[__-__-_]	[-]	[Refrigerated Pizza and Prep Tables, [1][2][3][4]door]

Naval Equipment Symbol	Logical Class	Description
[__-__-_]	[-]	[Salad Bar][_____]
[__-__-_]	[-]	[Sandwich and Salad Prep Refrigerators, [1][2][3] door]
[__-__-_]	[-]	[Serving Tray][_____]
[__-__-_]	[-]	[Servingware][_____]
[__-__-_]	[-]	[Sheet Pan][standard]
[__-__-_]	[-]	[Shelving (dispensing)][_____]
[__-__-_]	[-]	[Shelving (prep area)][_____]
[__-__-_]	[-]	[Slip Resistant Mats][_____]
[__-__-_]	[-]	[Sneeze Guards][_____]
[__-__-_]	[-]	[Soiled Dish Table][Sprayer][Scrap Trough][_____]
[__-__-_]	[-]	[Soup Kettle][_____]
[__-__-_]	[-]	[Steam Cooker(s)][_____]
[__-__-_]	[-]	[Steam Table][with insert pans]
[__-__-_]	[-]	[Steam Exhaust Hood][_____]
[__-__-_]	[-]	[Storage Containers][S.S][plastic][_____]
[__-__-_]	[-]	[Tableware Dispenser][_____]
[__-__-_]	[-]	[Tray Rack][_____]
[__-__-_]	[-]	[Tureens][_____]
[__-__-_]	[-]	[Undercounter/Worktop Refrigerators and Freezers,[1][2][3] door]
[__-__-_]	[-]	[Undercounter Refrigerators, [1][2][3] door]
[__-__-_]	[-]	[Waste Containers][_____]
[__-__-_]	[-]	[Waste Disposal Unit][_____]
[__-__-_]	[-]	[Water Dispenser][_____]
[__-__-_]	[-]	[_____]

PART 3 EXECUTION

3.1 LABELING AND IDENTIFICATION

Clearly label and identify all components with respective number as enumerated in approved Food Service Equipment Schedule. Provide equipment with tags numbered and stamped for their use as indicated on the Food Service Equipment Schedule. Provide brass or non-ferrous plates and tags. Minimum letter and numeral sizes are 3.18 mm 1/8 inch high.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-11 13 19.13 (February 2024)**

Preparing Activity: USACE **Superseding**
UFGS-11 13 19.13 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-11 13 19.13 (February 2024)**

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SECTION 11 13 19.13

LOADING DOCK LEVELERS

02/24

****

NOTE: This guide specification covers requirements for dock bumpers, truck-trailer restraining devices, and industrial, mechanical and electro-hydraulic dock levelers of the fixed hinged type.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Use dock levelers (ramps) to span and compensate for space and height differentials between loading docks and freight carriers in order to facilitate safe and efficient freight transfer. The ramps are recessed into preformed pits in the loading docks.

****

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS C2.18	(1993; Errata 1993; R 2001) Guide for the Protection of Steel with Thermal Sprayed Coatings of Aluminum and Zinc and Their Alloys and Composites

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143/A143M	(2007; R 2020) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2632	(2015; R 2019) Standard Test Method for Rubber Property-Resilience by Vertical Rebound

MATERIAL HANDLING INDUSTRY OF AMERICA (MHI)

MHI MH30.1	(2015) Performance and Testing Requirements for Dock Leveling Devices
MHI MH30.3	(2005) Vehicle Restraining Devices

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters

1.2 DEFINITIONS

1.2.1 Industrial Dock Leveler

A manufactured structure designed to span and compensate space and height differentials between a loading dock and freight carrier to facilitate safe, efficient, freight transfer.

1.2.2 Adjustable Loading Ramp

Synonym for Fixed Type Industrial Dock Leveler.

1.2.3 Fixed Type Industrial Dock Leveler

A dock leveler that is permanently affixed to the dock structure, and usually incorporating [an electro-hydraulic] [a mechanical] [recessed into dock face further than 380 mm 15 inch] system to position the dock leveler with respect to the freight carrier at the lip end while being fixed at the opposite hinged end.

1.2.4 Velocity Fuse

A valve or similar device that goes into the hydraulic line. If the dock leveler becomes inadvertently or accidentally unsupported, this fuse will freeze the movement of dock leveler within 100 mm 4 inches of the dock leveler original position.

1.2.5 Carrier

A wheeled, enclosed trailer or container that, when attached to a heavy-duty truck or van, is used to carry bulk freight over long distances.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Loading Dock Levelers; G, [_____]

Dock Bumpers; G, [_____]

Restraining Device; G, [_____]

SD-04 Samples

Dock Bumpers

Rubber

SD-07 Certificates

Factory Test

SD-10 Operation and Maintenance Data

Loading Dock Levelers, Data Package 3; G, [_____]

Restraining Device, Data Package 2; G, [_____]

SD-11 Closeout Submittals

Record Drawings; G, [_____]

1.4 QUALITY CONTROL

1.4.1 Manufacturer's Representative

Furnish services of Fixed Type Industrial Dock Leveler technicians, experienced in installation and operation of the type of system being provided, to supervise installation, testing, adjustment of system, and instruction to Government personnel.

1.5 STANDARD PRODUCTS

Submit data including a complete list of equipment and materials, manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Provide materials and equipment, which are the standard products of a manufacturer regularly engaged in the manufacture of the products, and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this Section, with the additions and modifications specified herein.

1.6 DELIVERY, STORAGE, AND HANDLING

Matchmark and tag parts which are disassembled for shipment with metal tags. Provide waterproofed tags and markings. Protect the delivered equipment in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.7 EXTRA MATERIALS

After approval of the detail drawings, and no later than [_____] months before the Government takes possession, provide spare parts data for each different item of material and equipment specified. Furnish a complete list of parts and supplies, with current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after [1] [3] [_____]year(s) of service.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

2.1.1.1 Detail Drawings

Submit drawings depicting dimensions, tolerances, surface finishes, hardnesses, flush edge angles, method of mounting and anchoring, and control schematics and diagram. Show complete wiring, schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of equipment and appurtenances. Show the concrete pit details including flush edge angles, dock bumpers including fastening materials in compliance with ASTM A123/A123M and ASTM D2000, and sloped pit bottom; method of mounting and anchoring; and location of control stations and disconnect switches. For vertical, edge-of-dock, and free-standing board dock levelers, show details of required pit or foundation construction and dock bumpers and structural shapes installation, in lieu of concrete pit details. Show all proposed dock bumper locations on drawings.

2.2 MATERIALS

2.2.1 Exposed Surfaces

Exposed metal surfaces and fastening materials mustcomply with ASTM A123/A123M, ASTM A143/A143M, and ASTM A153/A153M.

2.2.2 Nameplate

Attach corrosion-resistant metal plate securely and legibly on the exterior surface of the dock leveler. Include the following information indented or embossed on the plate:

a. Description of the equipment: Describe procedures for operating and services equipment, and warnings or cautions of hazardous procedures.

b. Name of the manufacturer.

c. Serial and model number.

d. Rated capacity in kgpounds.

e. Date of manufacture (month and year).

2.2.3 Toe Guards or Skirts

Provide sides or edges, except front and rear edges, of the ramps which rise above the surrounding loading dock with sheet carbon steel skirts or toe guards of minimum 1.8 mm 14 U.S.S. gage nominal thickness. Furnish smooth faced toe guards or skirts and mount flush with the edges of the ramp surface. Ensure sufficient depth of toe guards or skirts to protect the full operating range of dock travel. Ensure the construction capable of resisting a minimum lateral force of 4.5 kg 10 pounds with a maximum deflection of 13 mm 1/2 inch.

2.3 LOADING DOCK LEVELERS

****

NOTE: Electro-hydraulic type loading dock levelers, supplied with electrical power from a building system, must be equipped with overload protection as provided by preset main system relief valve in the manufacturer's power unit, which will prevent operation of the elevating device when elevating device is loaded to 125 percent or more of the rated capacity. Determine total leveler gross dynamic loads by fork truck weight plus the maximum rated fork lift carrying capacity plus attachment handling device weight.

On small jobs, e.g. replacement of one dock leveler, not all submitted requirements are necessary and must be edited to fit each job.

****

Provide permanent loading dock levelers in accordance with MHI MH30.1 with minimum performance characteristics based on the following:

a. Service Period:
    (1) Number of shift operations: [1] [2] [3].
    (2) Maximum number of trucks per shift opening: [_____].
    (3) Maximum number of days per week: [_____].

b. Fork Lift Loads:
    (1) Design levelers to accommodate [3] [4] wheel fork trucks.
    (2) Design levelers to handle [_____] gross dynamic load.
    (3) Base load leveler design on number of cycles per loading/unloading operation per truck and of [_____].

Provide loading dock leveler with [electro-hydraulic type with electric motor and hydraulic pump operating a hydraulic cylinder that adjusts dock leveler board position] [mechanical type which is manually released at dock leveler and raises by spring action and is lowered by walk-on of dock operator] [air powered type with an industrial fan motor operating a polyvinylchloride air bag that adjusts dock leveler board position]. Coordinate a truck restraint system with the dock leveler via an interconnect function such that the restraint and dock leveler will engage with a single push-button, if a powered trailer restraint is selected to lock truck or trailer into position during loading and for overnight security. Incorporate a visual signal to inform dock operator and driver of locked or unlocked status. Make provision for maintenance access to understructure and lifting mechanism. Provide steel tread plate lip and platform, hinged and supported from beneath by steel framework that contains lifting, positioning, and lowering assembly. Ensure that platform surface is flush with surrounding floor surface of loading dock when not in service. Provide integral positive restraint when leveler is in maintenance position.

2.3.1 Design Requirements

Design, fabricate, and finish loading ramp to permit washing with water and detergents, and operating in an ambient temperature from minus 17 to plus 43 degrees C 0 to plus 110 degrees F.

2.3.2 Dock Leveler Height Adjustment

****

NOTE: Maximum vertical adjustment could be 900 mm 36 inches, if needed.

****

Provide a ramp whose incline can be adjusted to suit the height of the freight carrier. Allow the loading ramp a minimum of [0] [610] mm [0] [24] inches of vertical adjustment. Divide height adjustments [0] [305] mm [0] [12] inches above and [0] [305] mm [0] [12] inches below the dock level to provide coverage between [760] [685] [_____] mm [30] [27] [_____] inches and [1370] [1295] [_____] mm [54] [51] [_____] inches above grade.

2.3.3 Dock Leveler Extension and Retraction

Extend non-fixed end of the dock leveler from a retracted position behind the line of the loading dock platform bumpers to at least 300 mm 12 inches beyond the forward edge of the dock platform bumpers so as to rest on the bed of the freight carrier. The difference in length of the platform from its fully retracted position to its fully extended position must be constant throughout the ramp, including the ramp extension.

2.3.4 Loading Ramp Compensation

Provide automatic compensation with ramp platform loaded or unloaded for:

2.3.4.1 Freight Carrier Out of Level

Out of level freight carrier bed condition (difference in elevation from side to side at the rear of the carrier bed): Allow a minimum correction of 25 mm one inch for each 450 mm 18 inches and maximum 100 mm 4 inch correction of ramp width over the width of the ramp. Ensure the rear edge of the ramp parallel with the rear of the frame in order to prevent tripping or be a pinching hazard.

2.3.4.2 Loading and Unloading of the Freight Carrier

Provide mechanical type dock levelers with manual load compensation for truck beds lowered below dock height. Provide [semi automatic] [manual] air powered dock levelers for trailer movement. When the lip is extended so as to rest on the bed of motor truck or trailer, provide compensation of 100 mm 4 inches for carrier spring deflection so that contact will be maintained between lip and carrier bed.

2.3.5 Safety Devices

2.3.5.1 Electro-Hydraulic System

Provide velocity fuse, ballcheck valve, or other device to automatically prevent a drop of more than 100 mm 4 inches of the lip, should the freight carrier move away from the dock leaving the lip unsupported. Activate this device with a static, dynamic, or impact load exceeding 10 percent of the rated load on the lip and ramp.

2.3.5.2 Mechanical System

Include a three-position safety system to limit platform fall to dock level and 100 and 200 mm 4 and 8 inches below dock level by means of double structural steel safety legs. Do not deactivate safety legs by dock leveler. This ensures that safety legs are independent of dock leveler motion and retractable from the top of the platform for below dock level control.

2.3.5.3 Air Powered System

When in use, and the dock leveler is above the dock, provide an automatic safety device to prevent a drop of more than 50 mm 2 inches at the outer end of the board, should a truck or trailer be moved away leaving the board unsupported. When in use, and the dock leveler is below dock, the dock leveler will drop to the below dock stops, at the outer end of the board, should a truck or trailer be moved away leaving the board unsupported.

2.3.5.4 Dock Bumpers

Provide ramp and load dock face with laminated rubber, tire-fabric, or equivalent dock bumpers recommended by the dock leveler manufacturer. Submit one fully assembled Loading Dock Bumper with supporting rods, end angles, bolts, and nuts. (This may be the smallest size bumper required.) One section of 203 mm 8 inches wide by full depth and height of bumper including one end angle with the opposite end exposed for inspection.[Solid Rubber pieces conforming to ASTM D2000, Grade 4AA612A13B13F17 may be used instead of rubberized fabric.]

2.3.6 Rated Capacity

Minimum 9070 kg 20,000 pounds roll over capacity.

2.3.7 Ramp Load Carrying Surface

****

NOTE: Board width should be up to maximum leveler width of 2130 mm 7 feet nominal. Board length must be sized based on the maximum operating slopes of the loading equipment used. Manufacturer's literature must be checked to verify that desired length of boards are available. Pallet, skid, and electric fork trucks should not be required to negotiate greater than 10 percent grade. Gasoline fork trucks should not be required to negotiate greater than 15 percent grade. EXAMPLE:

Given:

Height differential (dock to truck bed): 300 mm 12 inch
Dock leveler nominal overall length: 2400 mm 96 inch

Required:

Check for use of electric fork truck.

Grade Calculation:

Percent grade equals height differential divided by overall leveler length times 100 which equals 300 mm 12 inch divided by 2400 mm 96 inch times 100 which

equals 12.5 percent.

Conclusion:

Grade exceeds 10 percent; therefore, length of dock leveler should be increased until grade is 10 percent or less. Use 3000 mm 120 inch; that way grade equals 300 mm 12 inch divided by 3000 mm 120 inch times 100 which equals 10 percent.

If dimensions for width and length of dock leveler ramp platform surface vary from that specified, so indicate.

****

The live load carrying surface of the ramp must be [1825] [_____] mm [6] [_____] feet plus or minus 75 mm 3 inch wide and [3050] [_____] mm [10] [_____] feet plus or minus 225 mm 9 inch long with the dock leveler lip retracted.

2.4 OPERATION

2.4.1 Mechanical Control

Manual chain activated system for raising and lowering platform, operated by counterbalance and extension spring. Once the freight carrier has departed, manually return the platform to the stored, level position. Ensure the ramp, in its stored position, is capable of being lowered below dock platform level without extending the lip of the ramp.

2.4.2 Electro-Hydraulic Control

Provide each dock leveler with a pushbutton station to activate motor, pump, and valves.

2.4.2.1 Pushbutton

Heavy-duty dust tight and oil tight type rated in accordance with NEMA ICS 2, Part 5, Pushbuttons, Selector Switches, Indicating Lights, and Pushbutton Stations. To prevent accidental operation and damage, ensure each button to be recessed in its station or be protected by a peripheral collar (ring) or shroud. Identify each pushbutton by means of cast or etched letters on the station. Provide emergency "STOP" button of momentary type with manual reset or continuous pressing (constant pressure) type. This stop button must stop all dock leveler movement, regardless of the position of the ramp or lip at the time the "STOP" button is depressed.

2.4.2.2 Hinged Lip Ramp Movement

Apply continuous pressure on the "UP" button to raise the loading ramp, descend the lip onto the bed of the freight carrier. Once the freight carrier has departed, the lip must automatically fall or retract to its down position, and the ramp must return to its stored dock level position. The ramp, in its stored position, must have the capability of being lowered below dock level without extending the lip of the ramp to service truck end loads which may be lower than loading dock surface position. Allow 4 to 6 seconds to fully extend or retract the lip.

2.5 CONSTRUCTION AND MATERIALS

Construct load carrying parts of forged or welded steel. Construct entire live load carrying surface of the ramp and rear attachment must be nwithin minimum 6 mm 1/4 inch thick, 350 MPa 55 ksi minimum yield strength, low alloy, nonskid steel tread plate. Provide minimum 16 mm 5/8 inch vertical projections on the live load carrying surface. Bevel the lip or ramp extension. Design load carrying surfaces to permit free movement of powered hand or platform trucks, low lift pallet trucks, and fork lift trucks. Fabricate lip hinge of not less than 6 mm 1/4 inch wall seamless steel tubing.

2.6 ELECTRO-HYDRAULIC SYSTEM

Provide a separate and complete system for each dock leveler. Include an electric motor, motor drive, hydraulic pump, hydraulic ram, pressure relief valve, fluid reservoir, strainer, filter, hydraulic control-valve cylinders, hose, piping, fittings, and hydraulic fluid. Incorporate a means for filling and draining hydraulic fluid. Design cylinders, pump, and control valves to withstand not less than 150 percent of the design operating pressure. Provide hydraulic hose, fittings, pipe, and tubing with working pressures based upon a minimum 4 to 1 safety factor of bursting pressure.

2.7 ELECTRICAL REQUIREMENTS

****

NOTE: Standard available ratings for 3 phase motors are 230 or 460 volts. If motors are used with 208 volt distribution systems, a booster transformer must be provided.

****

NFPA 70, NEMA ICS 2, NEMA ICS 6 and NEMA MG 1. Provide [230][460] volt electrical characteristics, three phase, 60 Hz alternating current power supply. Provide all electrical equipment on the loading ramp. Provide interconnecting wiring for components of packaged equipment as an integral part of the equipment. Include motor, switches, junction box, conduit, wiring cables, panel enclosed control station, motor controller, heater coils, timer, transformer, terminal blocks, and fuses. Provide NEMA ICS 6, Type 4, electrical enclosures. Color code all wiring.

2.7.1 Motor

****

NOTE: Only electrohydraulic and air powered loading dock levelers are equipped with electric motor which activate the power system to raise and operate leveler.

Totally enclosed, non-vented motor (TENV) is the preferred motor for loading dock applications since the motor is not run continuously and only for short periods to raise the dock and extend the lip.

****

Conform to NEMA MG 1 and continuous duty or 60-minute time rated, industrial type, single speed rated for operating conditions. Provide electrical insulation systems conforming to NEMA MG 1, Class B. Provide permanently lubricated antifriction ball or roller bearings. Equip each electrohydraulic loading dock leveler with a [totally enclosed fan cooled (TEFC)] [totally enclosed non-ventilated (TENV)] squirrel cage induction electric motor. Equip each air powered loading dock leveler with a 115v, single phase, 60 Hz, self cleaning, two stage, UL approved industrial fan motor, which will not exceed its rated capacity under full load conditions of the loading dock leveler.

2.7.2 Controls

****
NOTE: Controls are required for electrohydraulic ramps. If dual controls are provided, the designer will indicate the location on the drawings.
****

NEMA ICS 2, size 0 controller for heavy industrial service. Provide an electrically operated, full magnetic, non-reversing type controller for the motor. Equip all control enclosures with locks and keys.

2.7.3 Transformer

Totally enclosed, self-cooled, dry type. Feed the transformer from the load side of the main disconnecting device. Incorporate circuit breakers with ground fault interrupting protection conforming to UL 943.

2.8 ACCESSORIES

2.8.1 Restraining Device

Provide self-aligning restraining device in accordance with MHI MH30.3. Mount this device as recommended by the manufacturer to engage the ICC bar of the truck/trailer with a positive restraining force of not less than 8150 kg 18,000 pounds. This device must be able to service all trucks or trailers having ICC bars located between 300 and 750 mm 12 and 30 inch above ground level (when truck or trailer is unloaded) and recessed up to 225 mm 9 inch from the rear of truck or trailer. Provide a means to protect the device from disabling damage in the event that more than 8150 kg 18,000 pounds of force is exerted by the restrained truck or trailer. Manually control activation and deactivation from inside the building. Submit data packages in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA for restraining device and loading dock levelers.

2.8.2 Dock Bumpers

Provide bumpers in accordance with ASTM D2632 and ASTM D624 , and capable of sustaining repeated impacts from trucks or trailers without damage to the dock, dock levelers, or bumpers.

2.9 TESTS, INSPECTIONS, AND VERIFICATIONS

Indicate to Contracting Officer at time of bid, which field tests specified in FIELD TESTS article are not permitted by manufacturer. Provide equivalent factory test certificates for specified field tests not conducted.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

****

NOTE: As a minimum, the following are required on drawings:

a. 2.5 to 3 meters 8 to 10 feet wide loading dock space behind ramp for vehicle maneuvering.

b. Ramp located in the middle of one truck space.

c. Location of control station for power operated ramps.

d. Location of disconnect switch with provisions for padlocking in the open position which should be just inside the nearest building door.

e. Ramp pits which should have steel angles anchored to concrete on top three sides and dock wall edge in bottom front of dock leveler pit.

****

Install and adjust in accordance with NFPA 70, manufacturer's approved detail drawings, and as-built system assembly drawings. Install controls so operator can see dock leveler while manipulating controls. Do not pour the pit for the adjustable loading ramp until the design and detail drawings have been approved. If the pit size is limited by construction conditions involved, alter the dock leveler equipment to fit the pit. Clearly indicate these alterations or modifications on the drawings. Check and verify the appropriate measurements at the building. Do not exceed 50 mm 2 inch clearances between the ramp and pit.

3.3 CLEANING, TREATMENT AND PAINTING

Shop clean, treat and paint ferrous surfaces including platform, lip, frame, [springs,] [motor,] [pump,] cylinders, [valves,] and any other non-cadmium plated or non-galvanized surface in accordance with manufacturer's published instructions and recommendations. Do not paint bearings, gear contact surfaces, parts protected by lubrication, or other surfaces not usually painted or coated. Clean ferrous surfaces[, shot pen, and protect the base metal with an application of 99.9 percent pure zinc coating with a thickness of 0.010 to 0.012 in accordance with AWS C2.18] [and protect the base metal with an application of a paint manufactured with rust inhibiting chemical additives to a thickness of 0.062 to 0.075 mm 2.5 to 3 mils followed by a final coat of standard primer with a thickness of 0.062 to 0.075 mm 2.5 to 3 mils]. Protect nonferrous parts against corrosion.

3.3.1 Workmanship

Conduct field touch-up work as to avoid damaging other surfaces and public property in the area. Do not apply field applied paint during foggy, damp, rainy weather, or in ambient temperatures below 7 degrees C 45 degrees F and above 35 degrees C 95 degrees F.

3.3.2 Dissimilar Metals Protection

Insulate control surfaces with electrolytically inactive materials.

3.3.3 Finish Coat Color

Paint 75 mm 3 inch wide brilliant black and yellow diagonal stripes on all vertical surfaces of pit, skirts, and platform edges exposed above adjacent surfaces at any ramp position. Paint similar stripes on top of ramp surfaces in 150 mm 6 inch wide band around outside edges (except for fixed edge).

3.4 FIELD TESTS

****

NOTE: Determine local vendor policy with regard to conducting field tests on installed equipment and its effect on local vendor and manufacturer warranty if conducted. Consider requiring factory test certificates in lieu of field tests. See TESTS, INSPECTIONS, AND VERIFICATIONS article in Part 2.

****

Provide personnel, instruments, materials, and equipment, including test vehicles, for the administration and direction of the tests. Correct defects and repeat tests under the cognizance of the Contracting Officer and the dock leveler manufacturer. The Contracting Officer is responsible for certifying the test load.

3.4.1 Roll-Over Load Tests

Move roll-over load of 9070 kg 20,000 pounds over the dock leveler between the bed of a freight carrier and the building loading dock surface for 10 cycles. With the ramp extension retracted and the ramp platform leveled with the building loading dock surface, run a 9070 kg 20,000 pound roll-over load over the ramp in various directions for 20 cycles. Do not allow permanent deformation [or hydraulic system leakage] to occur subsequent to examination after these roll-over tests.

3.4.2 Acceptance Tests

Perform an acceptance test in the presence of the dock leveler manufacturer and the Contracting Officer subsequent to roll-over load tests and drop tests. Conduct operation of the equipment through all of its motions and specified checks as follows:

a. Extend lip to rest on a variety of freight carriers with beds up 300 mm 12 inch above and below dock level;
b. Test 100 mm 4 inch drop limitation with minimum 3175 kg 7000 pound load on ramp, evenly distributed;
c. Test level compensation with the ramp, loaded with minimum 3175 kg 7000 pounds;

d. Test proper compensation (float) for various compression of countersprings, with ramp loaded and unloaded.

3.5 INSTRUCTION TO GOVERNMENT PERSONNEL

****

NOTE: The brackets have been provided because replacement of one dock leveler at an existing facility may not require training. Check with facility before deciding whether this training is required since existing personnel may be knowledgeable of dock leveler operations and maintenance.

****

[Upon completion of the work and at a time designated by the Contracting Officer, provide the services of a competent Technician regularly employed or authorized by the manufacturer of the dock leveler to instruct Government personnel in the proper operation, maintenance, safety, and emergency procedures of the dock leveler. A minimum of one and no more than two eight-hour working days of instruction is required. Conduct the training at the job site or at another location mutually satisfactory to the Government and the Contractor.]

3.6 CLOSEOUT ACTIVITIES

3.6.1 Record Drawings

Record dimensions, tolerances, surface finishes, hardnesses, flush edge angles, method of mounting and anchoring, and control schematics and diagram, including mechanical and electrical components, testing and acceptance for each industrial dock leveler, in as-built drawings.

3.7 OPERATING MANUALS

Provide operating manuals that detail system startup, operation, and shutdown procedures. Include manufacturer's name, model number, parts list, and brief description of equipment and operating features. List routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides in the maintenance manuals. Include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-11 31 13 (August 2017)**
Change 2 - 11/24

Preparing Activity: NAVFAC **Superseding**
UFGS-11 31 13 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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08/17, CHG 2: 11/24

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USACE / NAVFAC / AFCEC **UFGS-11 31 13 (August 2017)**
Change 2 - 11/24

Preparing Activity: NAVFAC **Superseding**
UFGS-11 31 13 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 11 31 13

ELECTRIC KITCHEN EQUIPMENT

08/17, CHG 2: 11/24

****

NOTE: This guide specification covers the requirements for electric kitchen equipment for family housing, child care centers, and other similar facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The following information must be shown on the project drawings: Design kitchen systems for energy efficiency in compliance with FEMP/Energy Star requirements. Appliances and equipment are listed under "Energy-Efficient Products" at http://www1.eere.energy.gov/femp/procurement**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 96	(2024) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

NSF INTERNATIONAL (NSF)

NSF/ANSI 2	(2022) Food Equipment

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 197	(2010; Reprint Mar 2023) UL Standard for Safety Commercial Electric Cooking Appliances
UL 250	(1993; Reprint Feb 2013) Household Refrigerators and Freezers
UL 430	(2015; Reprint Sep 2021) UL Standard for Safety Waste Disposers
UL 710	(2024) UL Standard for Safety Exhaust Hoods for Commercial Cooking Equipment
UL 749	(2023) UL Standard for Safety Household Dishwashers
UL 858	(2014; Reprint Jul 2023) UL Standard for

	Safety Household Electric Ranges
UL 921	(2020; Reprint Dec 2024) UL Standard for Safety Commercial Dishwashers
UL 923	(2013; Reprint May 2024) UL Standard for Safety Microwave Cooking Appliances
UL 1086	(2016; Reprint May 2022) UL Standard for Safety Household Trash Compactors

1.2 RELATED REQUIREMENTS

****

NOTE: This Article is tailored for NAVY.

****

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Kitchen Equipment

Energy Star Label for Freezer; S

Energy Star Label for Refrigerator; S

Energy Star Label for Ice Maker; S

Energy Star Label for Dishwasher; S

SD-08 Manufacturer's Instructions

Kitchen Equipment

Exhaust Hood

SD-10 Operation and Maintenance Data

Kitchen Equipment, Data Package 2; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Manufacturer's Warranty

Contractor's Warranty for Installation

PART 2 PRODUCTS

2.1 KITCHEN EQUIPMENT

2.1.1 Materials

****

NOTE: In drawings, include information on quantities, physical dimensions, colors, and electrical characteristics of kitchen equipment.

****

Except as modified herein, provide manufacturer's standard materials for kitchen equipment. Provide quantities, physical dimensions, colors, and electrical characteristics as indicated.

2.1.2 Cooking Top

[UL 197][UL 858], spill catching, seamless, with [cast-iron] [or] [tubular plug-in] surface elements. Provide indicating "on" lights.

2.1.3 Freezer

UL 250, minimum [0.28][_____] cubic meter [10][_____] cubic feet,[chest model with manual defrost,][moisture-proof upright model with[left][right][reversible] swing door,] foam or fiberglass insulation, adjustable temperature control to maintain minus 18 degrees C zero degrees storage conditions,[[sliding] removable storage basket, and vertical dividers][minimum three package door shelves, minimum five full width removable interior shelves, and sliding bottom basket for odd shaped and bulky items, and adjustable leg levelers]. Provide safety indicating light for power failure or temperature fluctuation, magnetic door gasket, and lock with pop-out key. For freezer capacity larger than 0.42 cubic meters 15 cubic feet, provide interior light. Provide freezer that is Energy Star labeled. Provide data identifying Energy Star label for freezer.

2.1.4 Refrigerator

UL 250, refrigerator with frostproof[top][side by side] freezer, minimum [0.41][_____] cubic meter [14.6][_____] cubic feet, automatic defrosting, two vegetable bottom baskets, four adjustable shelves, two door shelves and minimum 12 egg container in the door, separate interior shelves, multiple door shelves, and two ice trays. Provide refrigerator that is Energy Star labeled. Provide data identifying Energy Star label for refrigerator.[For refrigerator with top freezer, provide reversible (left swing and right swing interchangeable) doors.] Provide four fixed rollers or adjustable leg levelers.

2.1.5 Ice Maker

UL listed and NSF approved; self-contained, air-cooled model, minimum ice cube production of [160][_____] kilograms [355][_____] pounds per 24 hours, and minimum bin storage capacity of [80][_____] kilograms [180][_____] pounds of ice cubes. Provide ice maker that is Energy Star labeled. Provide data identifying Energy Star label for ice maker. Provide stainless steel cabinet panels, solid state automatic thickness controls, built-in self-analyzing integrated circuits, removable access panels, and bin of polyethylene foam or equivalent noncorrosive construction.

2.1.6 Hot Plate

NSF/ANSI 2, built-in countertop model with[two] [_____] electrical heating elements and[5] [_____] total kilowatt rating. Provide adjustable thermostatic controllers.

2.1.7 Microwave Oven

UL 923,[built-in,] with black glass window door, minimum 28 liter one cubic foot capacity, automatic oven light, browning element, 10 power levels, automatic temperature controllers, minimum two automatic memory levels, digital time controllers, and electronic touch-control panel.

2.1.8 Oven

UL 858, self-cleaning,[[built-in][and][under counter]][countertop]. Equip oven with black glass window door, safety door lock during self-cleaning cycle, broiler pan, self-locking oven racks, digital clock with one-hour timer, automatic oven light, oven "on" light, oven cycling light and tempered glass control panel.

2.1.9 Trash Compactor

UL 1086, under counter model with storage compartment and [76 liter] [20 gallon] [_____] trash disposable bag, reversible front panel, odor control, minimum 900 kilograms 2,000 pounds ram force delivering constant and balancing pressure, and safety start lock with removable key knob guard.

2.1.10 Tray and Silver Dispenser

NSF/ANSI 2, factory assembled, under counter model with welded steel channel frame, polished stainless steel enclosure, removable access panel on three sides, and minimum 100 mm 4 inch diameter chrome plated and rubber tired swivel casters. Provide manufacturer's standard dispenser mechanism to maintain the dispensing height at a constant level with stainless steel carriers. Provide storage capacity for[350] [_____] trays, and[10] [_____] cylinders with[35 to 40] [[_____] to [_____]] pieces of silverware per cylinder.

2.1.11 Food Cabinet Cart

NSF/ANSI 2, factory assembled, aluminum construction under counter model with 270 degree swing door, door latch, minimum 100 mm 4 inch swivel casters, and angle ledge pan supports. Provide storage capacity for[seven 450 by 660 mm 18 by 26 inch] [_____] pans.

2.1.12 Kitchen Exhaust Hood

NFPA 96 and NSF/ANSI 2, factory fabricated,[island][wall-mounted] model of minimum 1.2 mm thick 18 gage stainless steel construction, with replaceable grease filters.

2.1.12.1 Hood Construction

Welded joints and seams, grounded and polished to match adjacent exterior surfaces. Provide stainless steel duct collars and risers.

2.1.12.2 Grease Gutter

1.2 mm thick 18 gage stainless steel gutter down center of hood and directly below filter frame sloping to drain outlet.

2.1.12.3 Accessories

Provide filter frame, minimum [405 by 510 by 50 mm] [16 by 20 by 2 inches] [_____] stainless steel grease extractor, hanger rods, vaporproof light fixtures, and wiring in conduit between light fixtures.

2.1.12.4 Exhaust Fan

UL 710; centrifugal fan with maximum kitchen sound pressure level 45 dB.[Provide factory fabricated[adjustable] roof curbs.]

2.1.13 Range Hood

UL 858,[vented][nonvented], with two-speed fan, permanent washable filter,[top][or][rear] exhaust, and eye level controls.

2.1.14 Kitchen Unit

NSF/ANSI 2, UL 250, and UL 858 consisting of refrigerator, range[and oven], wall cabinets, and sink and countertop.

2.1.14.1 Compact[or Undercounter] Refrigerator

****

NOTE: Automatic defrost feature is available for refrigerators as small as 0.14 cubic meter 5 cubic feet net capacity. Recommend a minimum net capacity of 0.14 cubic meter 5 cubic feet.

****

Refrigerator assembly with freezer, corrosion-resistant inner lining, and minimum net capacity of [_____]. Provide minimum one ice cube tray, removable shelves, automatic interior light, adjustable cold controls, and[automatic][manual (pushbutton)] defrost.

2.1.14.2 Range [and Oven]

[Three][or][four][cast-iron][or][tubular plug-in] surface elements of minimum 4,500 total watts at[208][230] volts, infinite control switches, and range indicating "on" lights.[Equip oven with one minimum 2,000-watt tubular broil element and one minimum 700-watt tubular bake element, oven indicating light, automatic oven-heat control, and utensil drawer.]

2.1.14.3 Sink and Countertop

One-piece, seamless, minimum 0.9 mm thick 20 gage stainless steel sink and countertop. Provide drainboard, swing spout faucet with aerator, 90 mm 3 1/2 inch drain, and continuous feed garbage disposer with minimum 1.2 liter 1 1/4 quart capacity conforming to paragraph HOUSEHOLD GARBAGE DISPOSAL in this section. Provide storage cabinet with cutlery tray or drawer.

2.1.14.4 Wall Cabinets

Double wall minimum 0.8 mm thick 22 gage[stainless steel][or][cold rolled] cabinets with chrome plated handles, self-aligning friction hatches, and concealed hinges for 180 degree opening. Furnish wall bracket hangers for flush to wall mounting. Provide manufacturer's standard heat deflector[and range hood].

2.1.15 Free-Standing Double-Oven Range

UL 858, a combination of cooking top range, microwave oven, and oven. Comply with paragraphs COOKING TOP, MICROWAVE OVEN, and OVEN in this section.

2.1.16 Dishwasher

[UL 921][UL 749], with detergent dispenser. Provide dishwasher that is Energy Star labeled. Provide data identifying Energy Star label for dishwasher. Provide automatic control to cycle machine through wash, rinse, dry or heat, and stop phases. Include manual setting to repeat or skip phases of cycle. Equip machine with safety switch which automatically stops spraying action when door is open.[For heavy duty dishwasher, provide stainless-steel commercial grade with approximately[300] [_____]-dish capacity per hour and[540] [_____]-glasses per hour ratings.][For medium duty dishwasher, provide household grade, with minimum 500-watt input for drying dishes.]

2.1.17 Instantaneous Booster Water Heater

UL listed and self-contained. Provide integral automatic thermostat set for 82 degrees C 180 degrees F.

2.1.18 Household Garbage Disposal

UL 430, stainless steel[continuous feed model, [245][375] watt [1/3][1/2] hp motor, and stainless steel grinding element with two 360 degree stainless steel swivel impellers.][batch feed model, lock cover, minimum 1.9 liter 2 quart capacity, 375 watt 1/2 hp motor, and automatic switch.] Provide polyethylene or polyester drain flow chamber. Equip motor with manual reset, thermal overload protection, and sound insulation.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install items that show visual evidence of biological growth.

NFPA 70, Section 22 00 00 PLUMBING, GENERAL PURPOSE and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install kitchen equipment in accordance with manufacturers' instructions.

3.2 FIELD QUALITY CONTROL

Conduct inspection and testing in the presence of the Contracting Officer.

3.2.1 Field Inspection

Before and after installation, inspect each piece of kitchen equipment for compliance with specified requirements.

3.2.2 Operation Tests

Upon completion, but before final acceptance, perform operation tests on each piece of equipment to determine that components, including controls, safety devices, and attachments, operate properly and in accordance with specified requirements.

3.3 MANUFACTURER'S WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.4 CONTRACTOR'S WARRANTY FOR INSTALLATION

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-11 41 11 (August 2017)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 41 11 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 11 - EQUIPMENT

SECTION 11 41 11

REFRIGERATED AND FROZEN FOOD STORAGE EQUIPMENT

08/17

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-11 41 11 (August 2017)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 41 11 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 11 41 11

REFRIGERATED AND FROZEN FOOD STORAGE EQUIPMENT
08/17

****
NOTE: This guide specification covers the requirements for refrigerated and frozen food and drink storage cases, walk-in coolers, and walk-in freezers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Coordinate this section and use in conjunction with the following:

Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT and Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 189.1	(2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

NSF INTERNATIONAL (NSF)

NSF Food Equipment	(2005) NSF Product Listings of Food Equipment and Related Products, Components and Materials
NSF/ANSI 2	(2022) Food Equipment
NSF/ANSI 6	(2023) Dispensing Freezers
NSF/ANSI 7	(2023) Commercial Refrigerators and Freezers

UL SOLUTIONS (UL)

UL 207	(2022) UL Standard for Safety Refrigerant-Containing Components and Accessories, Nonelectrical

UL 471	(2010; Reprint Sep 2019) UL Standard for Safety Commercial Refrigerators and Freezers
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires

1.2 GENERAL REQUIREMENTS

****

NOTE: Indicate the configuration and layout for all refrigerated and frozen food and drink storage cases, walk-in coolers, and walk-in freezers on the floor plans, with interior elevations and equipment identified by number. Show a Food Service Equipment Schedule on the drawings using the same identification numbers[as indicated on the current US Army Quartermaster Center and School equipment schedule]. Ensure that all Contractor built-to-order items on the Food Service Equipment Schedule", are shown and coordinated with the specifications.

Designer must coordinate with other Sections, including 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT and 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE for general requirements and final connection of equipment.

NOTE: Details of particular equipment and installations are provided on Naval Food Service Division drawings. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

****

Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for general requirements. Refer to Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE for detailed requirements.

1.3 DESCRIPTION OF WORK

The work includes [furnishing] [and installing] [and modifying existing] [refrigerated][and frozen] food service equipment and all related work necessary to provide a complete installation. Verify existing dimensions, site conditions, and required utility connections prior to commencement of work. Coordinate delivery of components with finished openings and other vertical handling limitations within the building. Advise the Contracting Officer of discrepancies prior to [procurement and] installation of equipment. Submit Contractor's Field Verification Data prior to the preconstruction meeting.

Provide rough-in and utility connections to equipment in accord with requirements specified in other sections of this specification. Coordinate physical dimensions, capacities, manufacturer's instructions, and other requirements of the equipment furnished.

1.3.1 Design Requirements

****

NOTE: On the drawings, show:

1. A 1:50 1/4 inch scale floor plan with layout of all food service equipment and Naval Equipment Symbols.

2. A Food Service Equipment Schedule laid out in accordance with current CNIC's Galleys Department or US Army Quartermaster Center and School equipment schedules, and specified design requirements.

3. Floor, wall, and ceiling penetrations.

4. Raised bases, retainer curbs, or depressions.

5. Recessed, grated floor drains required for equipment.

6. Insulated floors where applicable, including under floor perforated drains and vent pipes.

7. Disconnect switches.

8. Electrical chases and raceways and plumbing chases.

9. Remote compressors and refrigeration systems.

10. Utility connections to building water, sanitary, electrical, and other utility systems. Convenience outlets at point of use for plug-in equipment.

11. All Contractor built-to-order items, in accordance with the Food Service Equipment Schedule, shown and coordinated with the specifications.

****

Submit detail drawings as stated in Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for[refrigerated][and frozen][food][and drink][storage cases][.][, walk-in coolers][walk-in freezers]. Provide drawings at a minimum 1:50 1/4 inch scale.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Field Verification Data; G, [_____]

SD-02 Shop Drawings

Manufacturer's Detail Drawings; G, [_____]

Custom Fabricated Equipment; G, [_____]

Installation Instructions and Diagrams; G, [_____]

SD-03 Product Data

[Frozen Food and Drink Storage Cases; G, [_____]

][Refrigerated Food and Drink Storage Cases; G, [_____]

][Walk-in Refrigerators; G, [_____]

][Walk-in Freezers; G, [_____]

] SD-05 Design Data

Manufacturer's Descriptive and Technical Literature; G, [_____]

SD-06 Test Reports

Manufacturer's Test Data; G, [_____]

Field Test Reports; G, [_____]

SD-07 Certificates

NSF Certification

UL Certification

SD-08 Manufacturer's Instructions

Manufacturer's Instructions for Shipping, Handling, Storage, Installation, and Start-Up.

SD-11 Closeout Submittals

Manufacturer's Warranty

Contractor's Warranty for Installation

1.5 SHOP DRAWINGS

Submit manufacturer's detail drawings and custom fabricated equipment drawings for each refrigerated enclosure. Include insulation details, utility connections, and installation instructions and diagrams. Base shop drawings on verified field measurements and include contractor's field verification data.

1.6 QUALITY ASSURANCE

Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT.

1.6.1 Pre-Installation Conference

Thirty [_____] days prior to commencement of work, notify the Contracting Officer that the following items are prepared and ready for review:

a. Shop Drawings, product data and installation instructions

(1) Manufacturer's detail drawings

[(2) Custom fabricated equipment drawings and data

(a) Submit after approval of food service equipment drawings.

] (3) Installation instructions and diagrams

b. Product Data

[(1) Frozen food and drink storage cases

][(2) Refrigerated food and drink storage cases

][(3) Walk-in refrigerators

][(4) Walk-in freezers

] c. Design Data

(1) Manufacturer's descriptive and technical literature

(2) Manufacturer's Test Data

d. Manufacturer's Instructions

For shipping, handling, storage, installation, and start-up.

1.6.2 Factory Tests and Certifications

Submit Manufacturer's Test Data and certifications, including NSF Certification and UL Certification.

PART 2 PRODUCTS

****

NOTE: Choose one of the three bracketed options depending on whether all refrigerated components (including insulated floors) are metal faced; have automatic sprinklers within the units themselves or in the portion of the building(s) where they are located; or are non-metal faced components such as fiberglass.

****

2.1 MATERIALS

2.1.1 Insulation

Provide insulation materials for all equipment as follows:

[a. Insulated components must have a complete surface enclosure of not less than 0.8 mm 0.032 inches of aluminum or corrosion resistant steel having a base metal thickness of not less than 0.4 mm 0.0160 inches at any point.

][b. Insulated components must be protected by an automatic sprinkler system located within the refrigerated unit(s) themselves as well as in the portions(s) of the building(s) in which they are located.

] c. Insulation must comply with flame spread index limits of not more than 75 and smoke developed index of not more than 450 when tested, in the maximum thickness intended for use, in accordance with ASTM E84 or UL 723.

2.1.2 Other materials

Provide in accordance with Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT.

2.2 LIST OF EQUIPMENT

****

NOTE: Carefully edit the master Foodservice Equipment Schedule in Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE; retain items used for the project. Edit the Equipment List and

include in the project Specification. List the information contained on the Equipment List on the Contract Drawings.
****

Submit detailed Food Service Equipment List as specified in Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE.

2.3 CONSTRUCTION OF FABRICATED EQUIPMENT

Construct and finish fabricated equipment in accordance with Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT.

2.4 PREFABRICATED WALK-IN REFRIGERATORS AND FREEZERS

****
NOTE: Provide floor panel walk-in refrigerators and freezers, or floorless walk-in refrigerators and freezers installed over insulated floors, as directed. For floorless units, provide insulated floors under each walk-in refrigerator and freezer as if each unit were a freezer. Material for floors and surrounding areas should be quarry tile or other suitable material.

NOTE: Use floorless design where possible. When refrigerators are provided in existing buildings or over crawl spaces, floors must be prefabricated insulated floor panels. Note on the drawings that the exterior panel surfaces of prefabricated assemblies in contact with concrete must be treated to prevent deterioration caused by corrosion or chemical reaction of dissimilar materials. Indicate type and size of units on drawings and schedule.

NOTE: All insulated components, including insulated floor panels, must comply with IBC Chapter 26 Plastics in that assemblies must either: limit flame spread index to not more than 75 and smoke developed index to not more than 450 where tested in the maximum thickness intended for use in accordance with ASTM E84 or UL 723; or have a complete surface covering of not less than 0.8 mm 0.032 inches of aluminum or corrosion-resistant steel having a base metal thickness not less than 0.4 mm 0.0160 inches at any point; or the refrigerated unit(s) themselves, and the part(s) of the building(s) in which they are located, must be protected by automatic sprinklers. See Chapter 26 for provisions for non-sprinklered buildings.
****

Provide walk-in units manufactured for food service use in accordance with NSF/ANSI 7 UL 207, and UL 471. Provide [floorless assemblies with insulated floor screeds, installed over insulated floors.][floor panel walk-in refrigerators and freezers with appropriate insulated floor assemblies and [polished aluminum][galvanized][_____] finish floor.]

Provide prefabricated dispensing freezers in accordance with the requirements of NSF/ANSI 6.

2.4.1 Panel Construction

Interchangeable, 1200 mm 4 feet maximum width, 100 mm 4 inch thick, filled with insulation. Provide preformed corner panels extending not less than 300 mm 12 inches in each direction. Panels to have tongue and groove edges or flush joints with double seal serrated neoprene rubber gaskets to assure air and vapor tight joints. [Provide panels for separating sections.]

a. Insulation: 100 mm 4 inch minimum foamed-in-place polyurethane with manufacturer's rated "K" factor of not more than 0.15, free rise density of not less than 27 kilograms (kg) per cubic (cu) meter 1.7 pounds per cubic foot, or in-place density of not less than 32 kg per cu meter 2 pounds per cubic foot. Provide floor screeds with minimum of 63 mm 2 1/2 inches of foamed insulation.

b. Closures: Close the exposed exterior of the walk-in unit adjacent to walls and ceiling with panels of same material as used for exterior of walk-in unit panels.

c. I-Beam Supports: Wherever compartment dimension exceeds the clear-span ability of ceiling panels, provide I-beam supports on the exterior of the ceiling or supported by spline-hangers. Install 13 mm 1/2 inch diameter steel rods through beam/hangers and secure to the structure above. Beams or posts within compartments are not be acceptable.

d. Finish:

    (1) Exterior:[Stainless steel on all exposed surfaces and doors, aluminum on unexposed surfaces.][Aluminum with two coats of white, baked-on enamel paint.][High impact reinforced fiberglass panels, must comply with flame spread and smoke index limits when tested in accordance with ASTM E84 or UL 723 or protected by an automatic sprinkler system within the refrigeration unit and the location of the building in which the unit occurs. Color of panels as selected by Contracting Officer from manufacturer's complete range of choices.]

    (2) Interior:[Stainless steel][Aluminum with two coats of white, baked-on enamel paint][High impact reinforced fiberglass panels must comply with flame spread and smoke index limits when tested in accordance with ASTM E84 or UL 723 or protected by an automatic sprinkler system within the refrigeration unit and the location of the building in which the unit occurs. Color of panels as selected by Contracting Officer from manufacturer's complete range of choices].

2.4.2 Prefabricated Floor Panels

Provide prefabricated floor panels of the same construction as wall/ceiling except with 1.9 mm 14 gauge galvanized skin, sealed watertight.[Field apply one hard alloy aluminum tread plate, 5 mm 3/16 inch thick, with all joints caulked.][Provide nonskid floor strips 100 by 900 mm 4 by 36 inch and field apply at 300 mm 12 inch spacing in all aisles.] Provide prefabricated floor panels [laid on] [recessed], with[sloping interior floor ramps at exterior entrance doors][panels flush with surrounding building floor]. Furnish two sets of erection tools, compatible with fasteners, with each unit.

2.4.3 Floorless Refrigerator Floors

****

NOTE: Designer must determine appropriate insulation thickness, subfloor thickness subject to existing geographical and soil conditions.

****

Make floorless refrigerator floors flush with the surrounding building floor. Provide built-in floor with [two][three][four][_____] layers of [50 mm2 inch][_____ mm_____ inch] thick polyurethane board insulation with staggered joints set in mastic or other thickness of insulation as recommended in writing by the floor manufacturer and appropriate for the specific geographic, climate and soil conditions. Provide a watertight seal formed by [0.152 mm6 mil][_____ mm_____ mil] polyethylene sheets with all joints lapped 150 mm 6 inch and sealed, on the surface of the subfloor that will support the insulation and the refrigeration floor. Assembly must comply with flame spread and smoke index limits when tested in accordance with ASTM E84 or UL 723 or when protected throughout by an automatic sprinkler system within the refrigeration unit(s) and the location(s) of the building in which the unit(s) occur(s). Provide a 6.8 kg 15 pound felt slip sheet over insulation with 150 mm 6 inch lapped joints flashed up the height of finished floor base. The subfloor and [walk-in refrigerator][walk-in freezer] floor to each be a minimum 100 mm 4 inch thick reinforced concrete with insulation sandwiched between. Provide drain holes in subfloor to drain water seepage. Make insulation continuous by extending insulation at refrigerator walls and partitions, down to the insulation sandwiched between the subfloor and the refrigerator floor. Insulate the area beneath the door as recommended by the floor manufacturer. Support the subfloor on a fill of 50 mm 2 inch clean rock aggregate having a minimum depth of 375 mm 15 inch. Embed the perimeter within the gravel fill to allow for air circulation.

2.4.4 Doors

****

NOTE: Designer should configure refrigerator and freezer to allow access to freezer directly from refrigerator unit where possible for energy conservation measures.

****

Provide [one] [two] per [unit] [section], with 100 mm 4 inch thickness, filled with insulation. Provide each door panel with an outside pilot light, a light switch and a remote bulb sensor with exterior flush-mounted, waterproof thermometer for registering temperature inside box. Provide anti-condensing strip heaters around the perimeter of door panel jambs. Provide top and each side of door with a resilient, non-magnetic, or thermoplastic with magnetic steel core gasket. On bottom edge of door, provide a replaceable, adjustable rubber or vinyl wiper gasket.

a. Hardware [Polished Stainless Steel][_____]: Provide two self-closing, spring-loaded hinges for each door. Include plated steel pin and cam-lift type bearing. Provide door latch with cylinder lock and with provisions for padlock. Include safety-release handle to permit opening from inside when locked.

b. Door Stops: Provide door stops where necessary, to prevent walk-in refrigerator and freezer doors from striking adjacent walls, plumbing fixtures or food service equipment when door is open.

c. Protective Bumpers: Equip the exterior sides of refrigerator that are not installed against each other or against a wall with protective bumpers.[Fabricate bumpers from either 1.5 mm 0.059 inch thick galvanized steel or stainless steel channel or from solid rubber or rubber-like materials having a durometer hardness of 75plus 5.]

d. Gasket: Provide either natural or synthetic rubber gaskets and in accordance with NSF/ANSI 2. Where frames are used, the panels must fit together with gaskets that are designed for 50 percent compression.

2.4.5 Air flow Inhibiting Strip Curtains

Provide transparent flexible vinyl reinforced strip curtains anchored at top and able to be replaced individually. Provide strips a minimum of 200 mm 8 inch wide and 2 mm 0.08 inch thick.

2.4.6 Lights

Provide high efficiency rated two-tube fluorescent lamps in vaporproof fixtures with safety shields. Provide lighting in accordance with UL 1598. Provide diffuser and ballast capable of operating in minus 23 degrees C 10 degrees F temperature. Run lights the full length of walk-in units starting 600 mm 2 feet from front panel and extending within 600 mm 2 feet of back panel. [Run between shelf rows].

2.4.7 Identification Signs

Mount engraved phenolic plastic compartment identification signs 300 by 50 mm 12 by 2 inch high in selected color with 25 mm one inch high letters on door above view window.

2.4.8 Pressure Relief Port

Provide electrically heated, insulated pressure relief port[in each section].

2.5 REFRIGERATION UNIT SYSTEMS

****

NOTE: Refrigeration units may be located inside or outside, but if units are located outside in a cold climate they should have winter controls, heaters, and enclosed compressor housings.

****

****

NOTE: Indicate, on the drawings, the location and heights of the refrigerator coil and condensate drain lines. Locate all coils and drain lines so as not to restrict the full utilization of the food storage racks. Indicate on drawings and in specifications that the condensate drain lines are must be insulated. Locate on the drawings the funnel floor drain for the condensate drain. Floor drains and drain lines must not protrude into the walking surface or produce a tripping hazard.

Locate thermometer on the drawings, mounted outside the refrigerator, in a location that will preclude vibration, not interfere with the operation of the door, provide protection from damage, and allow easy reading. Locate the sensor to measure the air temperature in the warmest part of the refrigerator. Do not locate thermometer on the door panel.

****

Provide in accordance with ANSI/ASHRAE 15 & 34 and ASHRAE 189.1. Provide preassembled remote condensing unit assembly with all necessary components factory installed and wired including electrical box, time clock, drier, sight glass,[winter control and crankcase heater][enclosed compressor housing,] and compressor rack.[Set meat chiller to operate at minus one degree C 30 degrees F and other refrigerators to operate at one degree C 33 degrees F. Set freezers to operate at minus 18 degrees C 0 degrees F.] Mercury is prohibited for use in thermometers. Chlorofluorocarbon (CFC) based refrigerants are prohibited.

Provide refrigerant compressors, packaged compressors and condenser units, and refrigerant condensers as specified in Division 23 of these specifications.

****

NOTE: Select the first statement for NAVFAC projects, or the second statement for USACE.

****

[Provide refrigeration system equipment for cold storage in accordance with Section 23 69 00.00 20 REFRIGERATION EQUIPMENT FOR COLD STORAGE.]

[Provide refrigeration system equipment for cold storage in accordance with Section 23 63 00.00 COLD STORAGE REFRIGERATION SYSTEMS.]

2.5.1 Monitoring Alarm System

Provide an electronic monitoring and alarm system for[each section of] each unit. Alarm is to warn of abnormally low and high temperatures.

a. System components: Detecting thermostat, master control panel, interconnecting wiring,[remote, labeled, and audible alarm,] and defrost compensator. Provide dials showing temperatures and pilot lights, warning lights, switches, transformer, and buzzer, all as a part of the master control panel. Provide master control panel [and remote audible alarm]. Provide power fuse to protect system components.

b. System operation: Set alarms at 5 degrees C 10 degrees F above and below specified operating temperatures.

2.5.2 Personnel Alarm

For each unit, provide separate audible alarm system operable from inside unit, for use of personnel unable to exit unit. Locate remote audible alarm where indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install items that show visual evidence of biological growth.

Prior to commencement of installation, perform a complete walk through of the facility with the Contracting Officer to verify readiness for installation.

Provide adequate protection of all finished surfaces, fixtures,[furnishings] and other equipment to prevent any damage during the installation work.

Conduct installation procedures in accordance with ANSI/ASHRAE 15 & 34, ASHRAE 189.1, NSF Food Equipment and UL standards stated herein, and with the manufacturer's instructions.[Set floor mounted equipment on 150 mm 6 inch thick concrete housekeeping pads, complete with anchor bolts and grouting. Finish housekeeping pads with two coats of oil-resistant epoxy polyamide coating.]

3.1.1 Equipment Connections

Complete equipment connections for all utilities. Unless otherwise specified, provide [chromium-plated copper alloy] [stainless steel] exposed piping.

3.1.2 Plumbing Work

Tag all plumbing final connection points of equipment, indicating item number, name of devices or components, and type of utility (water, gas, steam, drain). Provide extensions of indirect waste fitting to open-sight hub drain, floor sink, or floor drains from food service equipment.

3.2 TESTS

Perform the tests as specified. Notify the Contracting Officer in writing, [10][_____] days prior to performing tests. Perform tests in the presence of[the manufacturer's representative][and the Contracting Officer].

3.2.1 Initial Start-Up and Operational Test

Provide all lubricants and accessories before initial start-up. Start and operate all equipment. Follow the manufacturer's procedures and place the systems in all modes of operation. Supplement initial charges of lubricating oil to ensure maximum operating capacity. Adjust all safety and automatic control instruments. Record manufacturer's recommended readings hourly. Operational tests must cover a period of not less than [3][5][_____] days. Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for detailed Operation and Maintenance Manuals requirements.

Upon completion of start-up and operational tests submit a list of authorized local service and repair entities.

3.2.2 Test Reports

Submit final field test reports for each system tested, describing test apparatus, instrumentation calculations, and equipment data based on industry standard forms or reasonable facsimiles thereof. Include in data: compressor suction and discharge pressure; refrigerant charge pump, compressor and air moving device ampere readings; power supply characteristics, including phase imbalance, with 1/2 percent accuracy; thermostatic expansion valve superheat-value as determined by field test; subcooling; high and low refrigerant temperature switch set points; low oil pressure switch set point; [defrost system timer and thermostat set points;] moisture content; ambient, condensing and coolant temperatures; capacity control set points; field data and adjustments which affect unit performance and energy consumption. Where final adjustments and settings cannot be permanently marked as an integral part of device, include adjustment and setting data in test report.

3.3 MANUFACTURER'S WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.4 CONTRACTOR'S WARRANTY for INSTALLATION

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-11 42 00 (August 2017)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 42 00 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 11 42 00

FOOD PREPARATION EQUIPMENT

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-11 42 00 (August 2017)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 42 00 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 11 42 00

FOOD PREPARATION EQUIPMENT

08/17

****

NOTE: This guide specification covers the requirements for non-heated, non-refrigerated equipment used for food preparation other than cooking and baking, such as prep tables and units, carts, racks, shelving, blenders, coffee makers, grinders, juicers, mixers, peelers, and slicers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Coordinate this section and use in conjunction with the following:

Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT and Section 11 06 40.13 FOOD SERVICE EQUIPMENT SCHEDULE.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.19.3/CSA B45.4	(2022) Stainless Steel Plumbing Fixtures

NSF INTERNATIONAL (NSF)

NSF Food Equipment	(2005) NSF Product Listings of Food Equipment and Related Products, Components and Materials
NSF/ANSI 2	(2022) Food Equipment
NSF/ANSI 8	(2023) Commercial Powered Food Preparation Equipment
NSF/ANSI 59	(2020) Mobile Food Carts

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
29 CFR 1910.145	Specifications for Accident Prevention Signs and Tags
29 CFR 1910.212	Safety Standard for Machinery and Machine Guarding
29 CFR 1910.306	Specific Purpose Equipment and Installations

1.2 GENERAL REQUIREMENTS

****

NOTE: Indicate the configuration and layout for all food preparation equipment, with interior elevations and equipment identified by number. Show a "Food Service Equipment Schedule" on the drawings using the same identification numbers[as indicated on the current US Army Quartermaster Center and School equipment schedule]. Ensure that all Contractor built-to-order items on the Food Service Equipment Schedule are shown and coordinated with the specifications.

Designer must coordinate with other Sections, including 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT and 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE for general requirements and final connection of equipment.

NOTE: Details of particular equipment and installations are provided on Naval Food Service Division drawings. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

****

Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for general requirements. Provide detailed schedule as specified in Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE.

1.3 DESCRIPTION OF WORK

The work includes [furnishing][providing][, and modifying existing,] food service preparation equipment and all related work necessary to provide a complete installation. Verify existing dimensions, site conditions, and required utility connections prior to commencement of work. Coordinate delivery of components with finished openings and other vertical handling limitations within the building. Advise the Contracting Officer of discrepancies prior to [procurement and] installation of equipment. Submit Contractor's Field Verification Data prior to the preconstruction meeting.

Provide rough-in and utility connections to equipment in accordance with requirements specified in other sections of this specification. Coordinate physical dimensions, capacities, manufacturer's instructions, and other requirements of the equipment[furnished].

1.3.1 Design Requirements

****

NOTE: On the drawings, show:

a. A 1:50 1/4 inch scale floor plan with layout of all food service equipment and Naval Equipment Symbols.

b. A Food Service Equipment Schedule laid out in accordance with current CNIC's Galleys Department or US Army Quartermaster Center and School equipment

schedules, and specified design requirements.

c. Floor, wall, and ceiling penetrations.

d. Raised bases, retainer curbs, or depressions.

e. Recessed, grated floor drains required for equipment.

f. Disconnect switches.

g. Electrical chases and raceways and plumbing chases.

h. Utility connections to building water, sanitary, electrical, and other utility systems. Convenience outlets at point of use for plug-in equipment.

i. All Contractor built-to-order items, in accordance with Food Service Equipment Schedule, shown and coordinated with the specifications.

****

Submit detail drawings as stated in Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for food preparation equipment and related food processing equipment. Provide drawings at a minimum 1:50 1/4 inch scale.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL

PROCEDURES.
****

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Contractor's Field Verification Data; G, [_____]

SD-02 Shop Drawings

Manufacturer's Detail Drawings; G, [_____]

Custom Fabricated Equipment; G, [_____]

Installation Instructions and Diagrams; G, [_____]

SD-03 Product Data

Food Preparation Equipment; G, [_____]

SD-05 Design Data

Manufacturer's Descriptive and Technical Literature; G, [_____]

SD-06 Test Reports

Manufacturer's Test Data; G, [_____]

Field Test Reports; G, [_____]

SD-07 Certificates

NSF Certification

UL Certification

SD-08 Manufacturer's Instructions

Manufacturer's Instructions for Shipping, Handling, Storage, Installation, and Start-Up.; G, [_____]

SD-11 Closeout Submittals

Manufacturer's Warranty

1.5 SHOP DRAWINGS

Submit manufacturer's detail drawings for all custom fabricated equipment. Include any utility connections, and installation instructions and diagrams. Base shop drawings on verified field measurements and include contractor's field verification data.

1.6 QUALITY ASSURANCE

Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT.

1.6.1 Pre-Installation Conference

Thirty [_____] days prior to the commencement of work, notify the Contracting Officer that the following items are prepared and ready for review:

a. Shop Drawings, product data and installation instructions:

(1) Manufacturer's detail drawings

[(2) Custom fabricated equipment drawings and data

(a) Submit custom fabricated equipment drawings after approval of food service equipment drawings.

] (3) Installation instructions and diagrams

b. Product Data:

Food preparation equipment

c. Design Data:

(1) Manufacturer's descriptive and technical literature

(2) Manufacturer's Test Data

d. Manufacturer's Instructions:

Manufacturer's Instructions for shipping, handling, storage, installation, and start-up.

PART 2 PRODUCTS

2.1 MATERIALS

Provide food preparation equipment and materials in accordance with Occupational Safety and Health Administration (OSHA) standards, 29 CFR 1910.144, 29 CFR 1910.145, 29 CFR 1910.212, 29 CFR 1910.306, NSF/ANSI 2, NSF/ANSI 59, NSF/ANSI 8, NSF Food Equipment, and related UL standards as specified in Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT.

Floor areas adjacent to food preparation equipment point of operation, and working surfaces must conform to 29 CFR 1910-SUBPART D.

2.2 LIST OF EQUIPMENT

****

NOTE: Carefully edit the master "Food Service Equipment Schedule" in Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE; retain items of equipment used for the project. The Equipment List is intended to be edited and included in the project specification. List the information contained on

the Equipment List on the drawings.
****

Submit a detailed Food Service Equipment List as specified in Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE. Include NSF Certification, and UL Certification for individual food preparation equipment components.

2.3 CONSTRUCTION OF FABRICATED EQUIPMENT

Provide construction and finishing of fabricated equipment in accordance with Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT.

2.4 HAND SINKS

****
NOTE: Handwashing sinks must be provided behind each serving line and in each food preparation area. Each handwashing sink must be provided with soap dispensers and either towel dispensers or electric hand dryers specified in Section 10 28 13 TOILET ACCESSORIES.
****

2.4.1 Sink Body

Provide sizes and mountings indicated and in accordance with requirements of NSF/ANSI 2 and ASME A112.19.3/CSA B45.4. Provide sinks in 1.8 mm thick 14 gage stainless steel with round vertical and horizontal corners radii used at not less than 19 mm 0.75 inch.

2.4.2 Mounting

[2.4.2.1 Leg Mounting

Provide sink legs as specified for counters except weld closed gussets to support channels.

][2.4.2.2 Wall Mounting

Provide stainless steel mounting brackets.

][2.4.2.3 Counter Mounting

Provide sink body [set in counter] [integral with counter].

]2.4.3 Faucets and Drain

Provide [backsplash] [countertop] [and] [ledge]. Provide gooseneck faucet spout, aerator, with two valves. Provide nozzle with anti-splash device without hose thread. Provide cleanout at location indicated on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for detailed installation procedures, operation and maintenance manual requirements, and training and project closeout procedures. Include all food service preparation Field Test Reports.

3.2 MANUFACTURER'S WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-11 44 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-11 44 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 11 44 00

FOOD COOKING EQUIPMENT

08/17, CHG 1: 08/18

PART 1 GENERAL

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****

USACE / NAVFAC / AFCEC **UFGS-11 44 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-11 44 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 11 44 00

FOOD COOKING EQUIPMENT
08/17, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for commercial cooking equipment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification includes baking ovens, broilers, cooking ovens, exhaust hoods (and related fire suppression and grease extraction equipment, fryers, griddles, grills, holding ovens, kettles, microwave ovens, ranges, rotisseries, steamers, steam kettles, etc.

On the drawings, show:

1. A 1:50 (1/4 inch) scale floor plan with layout of all food service equipment and Naval Equipment Symbols.

2. Food Service Equipment Schedule laid out in accordance with NAVSUP41, or current US Army Quartermaster Center and School equipment schedule specified design requirements.

3. Floor, wall, and ceiling penetrations.

4. Raised bases, retainer curbs, or depressions.

5. Recessed, grated floor drains required for equipment.

6. Exhaust fan curbs, supply fan curbs, exhaust duct, supply duct, and ductwork material.

7. Fire system CO2 tanks, actuating stations.

8. Hoods, plumbing enclosure housing and control panel of automatic washdown system.

9. Disconnect switches.

10. Electrical chases and raceways and plumbing chases.

11. Utility connections to building water, sanitary, electrical, and other utility systems. Convenience outlets at point of use for plug-in equipment.

12. All Contractor built-to-order items, per Food Service Equipment Schedule, shown and coordinated with the specifications.

14. Utility connections to building water, sanitary, gas, electrical, sprinkler, fire alarm, oil, compressed air, steam, and other utility systems. Convenience outlets at point of use for plug-in equipment.

****

1.1 SUMMARY

The work includes [furnishing and] [installing] [and modifying existing] food service cooking equipment and related work. Verify all existing dimensions, contract drawings, product data and all related conditions prior to commencing rough-in work.

1.2 GENERAL RELATED SECTIONS AND STANDARDS

****

NOTE: Designate plumbing fixtures as "P" items on plumbing drawings with specific requirements added to Section 22 00 00 PLUMBING, GENERAL PURPOSE.

****

a. Refer to section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for general requirements. Provide detailed Food Service Equipment Schedule as specified in Section 11 06 40.13 FOOD SERVICE EQUIPMENT

SCHEDULE.

b. Provide detailed Food Service Equipment Schedule conforming to DOD 4000.25-1-M.

c. Gas-burning equipment must be designed for operation with the type of gas specified and be approved by CSA, conforming to CSA C22.2 No. 109 and CSA Directory.

d. All electrical work must conform to NFPA 70.

e. Provide wet chemical fire extinguishing systems in accordance with Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS.

f. Provide connections as part of building sprinkler system, Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION.

g. Grease extracting type hoods that have an internal hood fire protection system do not require wet chemical fire extinguishing protection for those components of the exhaust system, and for cooking equipment protected by a UL listed internal hood fire protection system complying to NFPA 96.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2021) Performance Requirements for Atmospheric Type Vacuum Breakers

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D9.1/D9.1M	(2018) Sheet Metal Welding Code
AWS D10.4	(1986; R 2000) Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing

CSA GROUP (CSA)

CSA C22.2 No. 109	(2017; R 2022) Commercial Cooking Appliances
CSA Directory	(updated continuously online) Product Index

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 10	(2022; ERTA 1 2021) Standard for Portable Fire Extinguishers
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 96	(2024) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

NSF INTERNATIONAL (NSF)

NSF/ANSI 2	(2022) Food Equipment
NSF/ANSI 4	(2022) Commercial Cooking, Rethermalization and Powered Hot Food Holding and Transportation Equipment
NSF/ANSI 51	(2023) Food Equipment Materials
NSF/ANSI 52	(2020) Supplemental Flooring
NSF/ANSI 169	(2023)Special Purpose Food Equipment and Devices

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1767	(2001) Kitchen Ventilation Systems & Food Service Equipment Fabrication & Installation Guidelines, 1st Edition
SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M	(2006) MILSTRIP - Military Standard

	Requisitioning and Issue Procedures

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA WaterSense	(2006) WaterSense Water Efficiency Labeling System

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910-SUBPART D	Walking - Working Surfaces

UL SOLUTIONS (UL)

UL 197	(2010; Reprint Mar 2023) UL Standard for Safety Commercial Electric Cooking Appliances
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 710	(2024) UL Standard for Safety Exhaust Hoods for Commercial Cooking Equipment
UL 763	(2018; Reprint Jul 2023) UL Standard for Safety Motor-Operated Commercial Food Preparing Machines
UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires
UL Electrical Appliance	(2012) Electrical Appliance and Utilization Equipment Directory

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Field Verification Data

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Schedule; G, [_____]

Exhaust Hoods Over Cooking Equipment; G, [_____]

Utilities; G, [_____]

Custom Fabricated Equipment; G, [_____]

Installation Instructions and Diagrams

SD-03 Product Data

Commercial Food Cooking Equipment; G, [_____]

Exhaust Hoods Over Cooking Equipment; G, [_____]

[Energy Star label for Ice Machine; S]

[Energy Star label for Refrigerated Beverage Vending Machine; S]

[Energy Star label for Refrigerator; S]

[Energy Star label for Freezer; S]

[Energy Star label for Baking Oven; S]

[Energy Star label for Deep Fryer; S]

[Energy Star label for Griddle; S]

[Energy Star label for Steam Cooker; S]

[Energy Star label for Hot Food Holding Cabinet; S]

[EPA WaterSense label for Pre-Rinse Spray Valve; S]

SD-06 Test Reports

Field Test Reports

Exhaust Hood Air-Balance Report

SD-07 Certificates

NSF Certification

UL Certification

SD-08 Manufacturer's Instructions

Commercial Food Cooking Equipment

Exhaust Hoods over Cooking Equipment

SD-10 Operation and Maintenance Data

Commercial Food Cooking Equipment, Data Package 2; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Manufacturer's Warranty

Contractor's Warranty for Installation

PART 2 PRODUCTS

2.1 EQUIPMENT AND SYSTEM STAGING

****

NOTE: Indicate the configuration and layout for all food preparation equipment, with interior elevations and equipment identified by number. Show "Food Service Equipment Schedule" on the drawings using the same identification numbers and as indicated on the current US Army Quartermaster Center and School equipment schedule. Ensure that all Contractor built-to-order items, per Food Service Equipment Schedule", are shown and coordinated with the specifications.

Designer must coordinate with other sections for final connection of equipment.

Details of particular equipment and installations are provided on Naval Food Service Division drawings. Use these NAVFSD drawings as a basis for the project details. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

Indicate on drawings the location of each manual activation station.
****

a. Submit detail drawings, as specified, including insulation and utility requirements for all food cooking equipment, custom fabricated equipment, along with equipment schedule. Drawings scale 1:50 1/4 inch minimum. Schedule in the same format as the equipment schedule on the drawings.

b. Include coordination of delivery through existing finished opening and vertical handling limitations within the building. Advise the Contracting Officer of all discrepancies prior to ordering equipment. Submit Contractor's Field Verification Data prior to the preconstruction meeting.

c. Provide rough-in and connect utilities to equipment in accordance with requirements specified in other sections of this specification and in accordance with the physical dimensions, capacities, manufacturer's instructions, and other requirements of the equipment furnished. Submit all installation instructions and diagrams.

2.2 EXHAUST HOODS OVER COOKING EQUIPMENT

****
NOTE: Seismic restraints for kitchen hoods must conform to Guidelines for Seismic Restraints of Kitchen Equipment (SMACNA Los Angeles Chapter). See Appendix 1 of SMACNA Fabrication Guidelines. Include requirement in seismic zones 3 and 4.

Hood design will be in accordance with NFPA 96, ASHRAE, and the ACGIH Industrial Ventilation Handbook. Designer will indicate type, size, shape, make-up air, and detail of hoods and the required standard cubic meters per second cubic feet per minute, meters per second feet per minute (velocity), static pressure, and duct collar size for exhaust/make-up air on the drawings. Grease extracting automatic washdown hoods will be specified for new construction. Filter type hoods may be used in existing facilities where conditions prevent the use of grease extractor hoods.
****

Conform to NFPA 96 and UL 710. Conform to SMACNA 1966. [Provide seismic restraints in accordance with SMACNA 1767.] The hood must not vary from design listing of air requirements or static pressure by more than five percent. Fabricate from 1.2 mm 18 gage thick stainless steel. Run electrical wiring in conduit or raceways. When total hood length is more than 3600 mm 12 feet long, provide hoods individually complete in all respects, of approximately equal length less than 3600 mm 12 feet long, and mounted end to end.

2.2.1 Centrifugal Grease-Extracting Hoods

Fabricate in factory. Provide high-velocity type with average throat inlet air velocity of [5] [_____] mps [1,000] [_____] fpm and duct velocity of [9] [_____] mps [1,800] [_____] fpm. Provide air inlet above and parallel to equipment for full length of hood. Provide hood which will remove 95 percent of extraneous matter in air with non-removable grease-extracting baffles located in plenum chamber. The use of filters, cartridges, rotating parts, removable parts, or constantly running water is not acceptable.

2.2.1.1 Types of Hoods

****

NOTE: Delete types not indicated for the project. If a type is not used, state "not used" at the subparagraph, to avoid renumbering.

****

Provide the following hood types as indicated:

2.2.1.1.1 Serve-Over Shelf; Type l

Provide over [charbroilers,] [fryers,] [_____,] [and] [griddles] on serving lines. Mount hood 1370 to 1450 mm 54 to 57 inches above finished floor.

2.2.1.1.2 Island; Type 2

Provide over [steam-jacketed kettles,] [fry pans,] [ovens,] [broilers,] [_____,] [and] [steamers] located remote from walls. Mount at height indicated.

2.2.1.1.3 Wall-Mounted, Free-Standing; Type 3

Provide over [ranges,] [_____,] [broilers,] [doughnut fryers,] [griddles,] [ovens,] [steam-jacketed kettles,] [and] [fryers] located along wall. Mount at height indicated.

2.2.1.1.4 Low Ceiling; Type 4

Provide over [_____] [and] [_____] where low ceiling restricts installation of Type 1, 2, or 3.

2.2.1.2 Features

Provide the following:

a. Automatic washdown system.

b. Fan control.

****

NOTE: Delete references to fire dampers in air inlet if fire dampers are included in exhaust

ductwork connecting to hood.
****

c. Damper controls.

d. Fan control station and plumbing enclosure.

e. Fire protection system, for hoods over [tilting frying pans,] [charbroilers,] [fryers,] [griddles,] [doughnut fryers,] [_____,] [deep-fat fryers,] [and] [broilers].

f. Vapor-proof lights.

2.2.1.3 Automatic Washdown System

Provide system that automatically washes internal portions of hood for an adjustable period of between 0 and 15 minutes. Provide for activation by time clock or upon operation of fire damper.

2.2.1.3.1 Features of Operation

a. Shut off supply and exhaust fans, if running, at beginning of cleaning cycle.

b. Subject accumulated contaminates on internal surfaces with water at [60] [82] degrees C [140] [180] degrees F and a water pressure of 0.275 MPa 40 psi. Provide pressure reducing valve.

c. [Pump] [Inject] detergent into hot water supply line to create wash-water.

d. Provide scrubbing action by directing wash-water through manifolds and then through spray nozzles placed so that all internal surfaces are reached with streams of wash-water.

e. Collect wash-water and grease within hood and pipe to outside of hood to point indicated for indirect connection to building plumbing system.

f. End wash cycle by timer.

2.2.1.3.2 Plumbing Components

Provide brass or stainless steel spray heads or nozzles and stainless steel distribution manifold in each hood. Provide the following in fan control station and plumbing enclosure:

Water solenoid valve	
Shut-off valve	
Shock absorber	
Pressure gage	
Temperature gage	

Line strainer	
Vacuum breaker	conform to ASSE 1001
Detergent reservoir	3 L 1 gallon minimum
Detergent [pump] [injector]	
Check valve	
Timer	
Pressure reducing valve	

2.2.1.4 Fan Control

Locate in fan control station and plumbing enclosure. Provide delay-time starter on starter leg of exhaust fan so supply fan starts first and run 5 seconds before exhaust fan starts, to insure the required balance in exhausted and make-up air flow. Provide the following operations:

a. Interconnection with washdown system to effect shutoff.

****

NOTE: Delete references to fire dampers in air inlet if fire dampers are included in exhaust ductwork connecting to hood.

****

b. Interconnection with fire dampers to effect shutoff of fans.

c. Operation by time clock.

d. Operation by manual push buttons labeled "start" and "stop".

2.2.1.5 Fire Damper

****

NOTE: Delete references to damper if fire dampers are included in exhaust ductwork connecting to hood.

****

Provide mechanically driven damper and damper control. Activate by heat-sensing thermostat set to react to temperature of 176 degrees C 350 degrees F in exhaust duct at hood. Activation of damper must cause the following additional actions:

a. Shut off exhaust and supply fans of hood.

b. Shut off fuel source and electric power to equipment under hood.

c. Initiate automatic washdown system.

2.2.1.6 Fan Control Station and Plumbing Enclosure

****

NOTE: Do not locate control cabinet for hoods on

serving line tray slide support walls or on drop wall above serving line tray slide.
****

Provide flush-mounted enclosure. Wire and plumb in factory. Include the following:

a. Plumbing components of washdown system.

b. Components required for fan control, including manual push buttons and interlocks with other systems.

c. Components required to operate fire protection system.

d. Time clock capable of being programmed by the week to operate fan system and automatic washdown system and of maintaining time cycle after being overridden by manual push buttons.

e. Labeled light indicating when exhaust fan and supply fan are operating.

f. Labeled light indicating when automatic washdown system is operating.

2.2.1.7 Fire Protection Systems

****
NOTE: Select fire protection system based on cost and local regulations. If kitchen cannot tolerate time lost for clean-up in event of dry chemical release, or if kitchen return air is tied into building system return air, do not use that system. Ensure that actuating systems are indicated on drawings.
****

Provide a pre-engineered [[dry] [wet] chemical system in accordance with Division 21, Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS] [[liquid foam system] [water spray system] in accordance with NFPA 96]. [Include water spray in plenum of hood.] Include micro-switch for electric power and fuel shut off to equipment under hood and a fuel shut-off and reset button. Exposed piping under hood and surface nozzles to be stainless steel or chrome plated. Paint exposed piping running to hood with rust-inhibiting aluminum paint. Provide electrical wiring, contactors, shunt breakers, electrical control for gas valves, and other electrical components required to install fire systems in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2.1.7.1 Actuating Stations

Provide manual actuating station and remote manual actuating station as indicated. Clearly label actuating station as "Hood Fire Protection" and specific device protected.

2.2.1.7.2 Water Spray Fire System In Grease-Extracting Type Hood

****
NOTE: If water spray system is specified, make sure it is compatible with building sprinkler system.
****

Include wall-mounted control panel with pilot lights for indicating when system is operational, not operational, and on fire alert. Provide audible fire alarm, unions, hand valve, valve switch, and pressure switch. Include duct nozzles and plenum nozzles. Provide water pipe to control panel and from control panel to hood. Provide connections as part of building sprinkler system, Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION.

2.2.1.7.3 Alarm Connection

****

NOTE: If exhaust hood fire system is to be connected to building alarm system, the work must be included in other sections and coordinated.

****

Provide capability to signal operational readiness and to generate electronic signal when hood fire system is activated. Provide connection point for building alarm system. Provide system to connection point and connect in accordance with Section [_____][Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE].

2.2.1.8 Vapor proof Lights

Provide,[at Type 2 and Type 3 hoods,] incandescent or fluorescent lights in accordance with UL 1598 or UL 1598. Locate switches for operating hood lights on face of hood in lower [right] [_____] corner.

2.2.2 Protection

Protect each exhaust hood system that serves cooking equipment, associated exhaust hood system ducts, and all cooking equipment served by the exhaust hood system with a wet chemical fire extinguishing system.

2.3 COMMERCIAL FOOD COOKING EQUIPMENT

****

NOTE: The following commercial food cooking equipment must meet FEMP/ Energy Star energy efficiency requirements:

Beverage Vending Machines (Often Vendor supplied and installed)
Fryers
Griddles
Hot Food Holding Cabinets
Ice-Machines Air-Cooled
Ice-Machines Water Cooled
Ovens
Refrigerators
Freezers
Steam Cookers
The following item must meet EPA Watersense requirements
Pre-Rinse Spray Valves (WaterSense)

Cooking equipment selected will have as a minimum the efficiency rating determined in under

"Energy-Efficient Products" at . Indicate the equipment operating characteristics, including rated energy efficiency, on the drawings.

****

All commercial cooking equipment must conform to 29 CFR 1910, CSA, NSF, UL and other related standards as stated herein and in Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT. All equipment must bear NSF Certification and UL Certification labels.

a. Supply all gas fueled appliances with installed automatic shut-off device(s), as well as manual shut-offs device conforming to NFPA 96. In accordance with NFPA 54, equip gas burners and pilots located in enclosed compartments with automatic shut off of gas supply if burners fail to ignite, or pilot is extinguished.

[b. Provide electrical cooking appliances conforming to UL 197, UL 489, UL 763, and UL Electrical Appliance.

c. Provide specialty cooking equipment conforming to the requirements of NSF/ANSI 169, NSF/ANSI 2, NSF/ANSI 4, and NSF/ANSI 51. Floor areas adjacent to cooking areas must conform to NSF/ANSI 52 and 29 CFR 1910-SUBPART D.]

2.3.1 Ice Machines

[_____]. Provide ice machine that is Energy Star labeled. Provide data identifying Energy Star label for ice machine.

2.3.2 Refrigerated Beverage Vending Machines

****

NOTE: Vending Machines are often Vendor furnished and installed. Keep the bracketed text below if vending machines are part of the project requirements.

****

[[_____]. Provide refrigerated beverage vending machine that is Energy Star labeled. Provide data identifying Energy Star label for refrigerated beverage vending machine.]

2.3.3 Refrigerators

[_____]. Provide refrigerator that is Energy Star labeled. Provide data identifying Energy Star label for refrigerator.

2.3.4 Freezers

[_____]. Provide freezer that is Energy Star labeled. Provide data identifying Energy Star label for freezer.

2.3.5 Pre-Rinse Spray Valve

[_____]. Provide pre-rinse spray valve that is WaterSense labeled. Provide data identifying EPA WaterSense label for pre-rinse spray valve.

2.3.6 Baking Oven

[_____]. Provide baking oven that is Energy Star labeled. Provide data identifying Energy Star label for baking oven.

2.3.7 Broiler

[_____]

2.3.8 Deep Fryers

[_____]. Provide deep fryer that is Energy Star labeled. Provide data identifying Energy Star label for deep fryer.

2.3.9 Griddle

[_____]. Provide griddle that is Energy Star labeled. Provide data identifying Energy Star label for griddle.

2.3.10 Steam Cookers

[_____], [3][4][5][6] pan. Provide steam cooker that is Energy Star labeled. Provide data identifying Energy Star label for steam cooker.

2.3.11 Hot Food Holding Cabinets

[_____]. Provide hot food holding cabinet that is Energy Star labeled. Provide data identifying Energy Star label for hot food holding cabinet.

2.4 PORTABLE FIRE EXTINGUISHER

Provide [wall mount for] portable fire extinguisher conforming to NFPA 10, within [_____] feet of cooking area.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install items that show visual evidence of biological growth.

Perform installation in accordance with the manufacturer's printed instructions. Refer to section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for detailed installation, project closeout, and warranty requirements. Lay out work in advance to prevent damage to building, piping, wiring, or equipment as a result of cutting for installation.

3.1.1 Setting and Connecting

Install equipment plumb and level. Except for mobile and adjustable-leg equipment, securely anchor and attach items and accessories to walls, floors, or bases with stainless steel bolts. Flash food service cabinets located in wall openings to the walls with 0.9 mm 20 gage thick stainless steel. Seal around equipment flashing and flanges, at walls, floor, and ceiling in accordance with Section 07 92 00 JOINT SEALANTS. Provide continuous fillers without opening.

3.1.2 Welding Field Joints

Weld stainless steel by the electric fusion method. Provide where required by and in accordance with AWS A5.8/A5.8M, AWS D1.1/D1.1M, AWS D10.4, AND AWS D9.1/D9.1M. Accomplish brazing with silver solder for joining copper tubing to brass and bronze connection fitting and for no other purpose.

3.1.3 Cleaning and Adjusting

Test and adjust equipment for proper operation. Test rotating components and motors for proper rotation. Lubricate moving parts if suggested by manufacturer's literature. Prior to acceptance of project, clean and sanitize equipment both inside and outside.

3.1.4 Installation of Hoods

Install hoods in accordance with NFPA 96 to remain free from vibration under all conditions of operation.

3.2 FIELD INSPECTIONS AND TESTS

Inspect equipment, fixtures, and material after installation for compliance with the applicable standards. Upon completion of inspection perform operational tests on each piece of equipment to determine that equipment and components, including controls, safety devices, and attachments, operate as specified and are properly installed and adjusted. Test all water, drain, gas, steam, oil, refrigerant, and liquid carrying components for leaks. Notify the Contracting Officer 14 calendar days prior to testing. Submit Field Test Reports and [_____] copies of the Exhaust Hood Air-Balance Report to the Contracting Officer.

3.3 MANUFACTURER'S WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.4 CONTRACTOR'S WARRANTY FOR INSTALLATION

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-11 46 00 (January 2008)**

Preparing Activity: USACE **Superseding**
UFGS-11 40 00.00 20 (April 2006)
UFGS-11 46 01.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 11 - EQUIPMENT

SECTION 11 46 00

FOOD DISPENSING EQUIPMENT

01/08

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USACE / NAVFAC / AFCEC **UFGS-11 46 00 (January 2008)**

Preparing Activity: USACE **Superseding**
UFGS-11 40 00.00 20 (April 2006)
UFGS-11 46 01.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 11 46 00

FOOD DISPENSING EQUIPMENT
01/08

****

NOTE: This guide specification covers the requirements for food dispensing equipment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification includes, but is not limited to, bar equipment, coffee urns and warmers, salad bars, desert tables, food warmers, soup kettles, tureens and heat lamps; pre-packaged food dispensers, dish, tableware; ice, ice cream, beverage, juice and water dispensers.

On the drawings, show:

1. A 1:50 1/4 inch scale floor plan with layout of all food service equipment and Naval Equipment Symbols.

2. Food Service Equipment Schedule laid out in accordance with NAVFSSOcurrent US Army Quartermaster Center and School equipment schedule specified design requirements, including Energy Star qualified model list.

3. Floor, wall, and ceiling penetrations.

4. Raised bases, retainer curbs, or depressions.

5. Recessed, grated floor drains required for equipment.

6. Disconnect switches.

7. Electrical chases and raceways and plumbing chases.

8. Utility connections to building water, sanitary, electrical, and other utility systems. Convenience outlets at point of use for plug-in equipment.

9. All Contractor built-to-order items, per Food Service Equipment Schedule, shown and coordinated with the specifications.

****

1.1 GENERAL RELATED SECTIONS AND STANDARDS

****

NOTE: Edit the master "Food Service Equipment Schedule" in section 11 06 40.13 carefully; retain items of equipment used for the project. The Equipment List is intended to be edited and included in the project Specification. List the information contained on the Equipment List on the Contract Drawings.

****

Refer to section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for general requirements, and Section 11 06 40.13 FOOD SERVICE EQUIPMENT SCHEDULE when preparing the Food Service Equipment List.

Provide floor areas adjacent to food dispensing equipment point of operation, and working surfaces conforming to 29 CFR 1910-SUBPART D

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of

the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.19.3/CSA B45.4	(2022) Stainless Steel Plumbing Fixtures

NSF INTERNATIONAL (NSF)

NSF 53A	(2012) Drinking Water Treatment Units - Health Effects
NSF/ANSI 2	(2022) Food Equipment
NSF/ANSI 4	(2022) Commercial Cooking, Rethermalization and Powered Hot Food Holding and Transportation Equipment
NSF/ANSI 6	(2023) Dispensing Freezers
NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials
NSF/ANSI 18	(2023) Manual Food and Beverage Dispensing Equipment
NSF/ANSI 20	(2023) Commercial Bulk Milk Dispensing Equipment
NSF/ANSI 25	(2023) Vending Machines for Food and Beverages
NSF/ANSI 36	(2012) Dinnerware
NSF/ANSI 42	(2023) Drinking Water Treatment Units - Aesthetic Effects
NSF/ANSI 51	(2023) Food Equipment Materials
NSF/ANSI 169	(2023)Special Purpose Food Equipment and Devices

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
29 CFR 1910.145	Specifications for Accident Prevention Signs and Tags
29 CFR 1910.306	Specific Purpose Equipment and Installations

1.3 SUMMARY

****

NOTE: Indicate the configuration and layout for all food dispensing equipment, with elevations and equipment identified by number. Show "Food Service Equipment Schedule" on the drawings using the same identification numbers[as indicated on the current US Army Quartermaster Center and School equipment schedule]. Ensure that all Contractor built-to-order items, per Food Service Equipment Schedule", are shown and coordinated with the specifications.

Designer must coordinate with other sections for final connection of equipment.

NOTE: Details of particular equipment and installations are provided on Naval Food Service Division drawings. Use these NAVFSD drawings as a basis for the project details. Contact NAVFSD at commercial telephone (717) 790-7580 or DSN 430-7580.

Equipment Item	**NAVFSSO Dwg. File**
Clean Gear Dresser	**541**
Clean Gear Table	**553**
Service Stand	**851**
Steam Kettles and Water Metering	**983**

****

The work includes [furnishing and] [installing] [and modifying existing] food service dispensing equipment and related work. Verify all existing dimensions, contract drawings, product data and all related conditions prior to commencing rough-in work. Include coordination of delivery through existing finished opening and vertical handling limitations within the building. Advise the Contracting Officer of all discrepancies prior to ordering equipment. Submit Contractor's Field Verification Data prior to the preconstruction meeting.

Provide rough-in and connect utilities to equipment in accordance with requirements specified in other sections of this specification and in accordance with the physical dimensions, capacities, manufacturer's instructions, and other requirements of the equipment furnished.

1.4 PREINSTALLATION MEETING

[Thirty] [_____] days prior to the commencement of work, notify the Contracting Officer that the following items are prepared and ready for review at the Pre-Installation Meetings listed here as shown in the Submittals paragraph.

1.4.1 Detail Drawings

Submit Detail Drawings for food dispensing and related food processing equipment, as specified, including insulation and utility requirements, product data and installation instructions. Submit Custom fabricated equipment drawings after approval of food service equipment drawings. Submit Installation Instructions and Diagrams and food dispensing equipment. Provide Drawings at 1:50 1/4 inch scale minimum.

1.4.2 Design Data

Submit detailed Food Service Equipment List reflecting requirements in Section 11 06 40.13 FOOD SERVICE EQUIPMENT SCHEDULE. Submit Design Data consisting of Manufacturer's literature, Manufacturer's Test Data, and Energy Star Qualified for individual food dispensing components

1.4.3 Manufacturer's Instructions

Submit Manufacturer's Instructions for shipping, handling, storage, installation, and start-up

1.4.4 Certifications

Submit [_____] copies of all Manufacturer's Test Data and certifications, including NSF Certification; UL Certification, and Energy Star Qualified data to the Contracting Officer prior to the commencement of any installation work.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Field Verification Data; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Custom Fabricated Equipment; G, [_____]

Installation Instructions and Diagrams; G, [_____]

SD-03 Product Data

Food Service Equipment List

Food Dispensing Equipment

SD-05 Design Data

Manufacturer's Literature; G, [_____]

SD-06 Test Reports

Manufacturer's Test Data; G, [_____]

Field Test Reports; G, [_____]

SD-07 Certificates

NSF Certification; G, [_____]

UL Certification; G, [_____]

Energy Star Qualified

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G, [_____]

PART 2 PRODUCTS

2.1 EQUIPMENT

Provide equipment conforming to the applicable requirements of the following reference standards: NSF/ANSI 14, NSF/ANSI 169, NSF/ANSI 18, NSF/ANSI 2, NSF/ANSI 20, NSF/ANSI 25, NSF/ANSI 36, NSF/ANSI 4, NSF/ANSI 42, NSF/ANSI 51, NSF 53A, NSF/ANSI 6, and Energy Star for powered equipment. Provide food dispensing equipment conforming to OSHA standards 29 CFR 1910.144, 29 CFR 1910.145, 29 CFR 1910.306, and related NSF and UL standards.

[2.2 WATER FILTER

****

NOTE: Water filters will be used only where water taste and quality are poor. Delete if adequate water treatment is provided for the entire facility.

Designer will indicate the location of the water filters on the drawings. Water filters will be located in an accessible location. Water filters may be piped in parallel to obtain greater capacity.

****

Provide a cartridge-type water filter on water supply lines to equipment as shown.

2.2.1 Cartridge Filter

Provide filter, conforming to NSF/ANSI 42, NSF/ANSI 51, and NSF 53A, capable of removing dirt and off-taste items, such as chlorine and other medicinal items, and also reduce lime-scale problems when required by water conditions. Provide filter consisting of a stainless steel pressure vessel, which includes shell top, bracket check valve, fittings and accessories, and plastic disposable cartridge. Provide precoat filtration type cartridge in which a coating of particles is applied on a suitable fabric support. The filter must contain not less than 90 percent activated carbon and 10 percent inert binders, and remove particles 2 microns and larger. Install the filter with [an inlet valve] [a three-position valve header], activation faucet, and by-pass valve which will be normally closed. In addition, provide an indication gauge which indicates when cartridge requires replacement.

2.2.2 Working Pressure and Flow Rate

****

NOTE: Designer will select filter size with flow rate to accommodate equipment being filtered.

****

Install the filter as recommended by the manufacturer. Provide filter suitable for 860 kPa 125 psig maximum working pressure at 38 degrees C 100 degrees F water inlet temperature. Each filter must have a nominal flow rate of [11.34] [5.67] [3.78] L/minute [180] [90] [60] gph. Provide [1]

[2] [_____] additional replacement cartridge[s] for each filter.

]2.3 HAND SINKS

****

NOTE: Handwashing sinks must be provided behind each serving line . Each handwashing sink must be provided with soap dispensers and either towel dispensers or electric hand dryers specified in Section 10 28 13 TOILET ACCESSORIES.

****

2.3.1 Sink Body

Provide sizes and mountings as indicated; provide in accordance with requirements of NSF/ANSI 2. Provide in accordance with ASME A112.19.3/CSA B45.4. Fabricate of 1.8 mm thick 14 gage stainless steel. Round vertical and horizontal corners with a radius of not less than 19 mm 0.75 inch.

2.3.2 Mounting

2.3.2.1 Leg Mounting

Sink legs to be as specified for counters, except weld closed gussets to support channels.

2.3.2.2 Wall Mounting

Provide stainless steel mounting brackets.

2.3.2.3 Counter Mounting

Provide sink body [set in counter] [integral with counter].

2.3.3 Faucets and Drain

Provide [splashback] [counter top] [and] [ledge] mounted [as indicated]. Provide gooseneck faucet spout, aerator, with two valves. Provide nozzle with anti-splash device without hose thread. Provide cleanout at location indicated on drawings.

PART 3 EXECUTION

3.1 INSTALLATION

Refer to section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT for detailed installation procedures, operation and maintenance manual requirements, training and project closeout procedures. Include all food service dispensing equipment in the Field Test Reports.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-11 47 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-11 47 00 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 11 - EQUIPMENT

SECTION 11 47 00

ICE MACHINES

08/17, CHG 1: 08/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-11 47 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-11 47 00 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 11 47 00

ICE MACHINES

08/17, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for equipment used to produce, store, autoclean, and dispense ice.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This section does not address the manufacturing of block ice.

On the drawings, show:

1. A 1:50 1/4 inch scale floor plan with layout of all food service equipment and Naval Equipment Symbols.

2. Food Service Equipment Schedule laid out in accordance with NAVSUP41, current US Army Quartermaster Center and School equipment schedule, and specified design requirements.

3. Floor, wall, and ceiling penetrations.

4. Raised bases, retainer curbs, or depressions.

5. Recessed, grated floor drains required for equipment.

6. Disconnect switches.

7. Electrical chases and raceways and plumbing chases.

8. Utility connections to building water, sanitary, electrical, and other utility systems. Convenience outlets at point of use for plug-in equipment.

9. All Contractor built-to-order items, per Food Service Equipment Schedule, shown and coordinated with the specifications.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NSF INTERNATIONAL (NSF)

NSF/ANSI 12	(2023) Automatic Ice Making Equipment
NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials
NSF/ANSI 169	(2023)Special Purpose Food Equipment and Devices

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
29 CFR 1910.145	Specifications for Accident Prevention Signs and Tags
29 CFR 1910.306	Specific Purpose Equipment and Installations

1.2 SUMMARY

****

NOTE: Indicate the configuration and layout for all ice making equipment, with elevations and equipment identified by number. Show "Food Service Equipment Schedule" on the drawings using the same identification numbers[as indicated on the current US Army Quartermaster Center and School equipment schedule]. Ensure that all Contractor built-to-order items, per Food Service Equipment Schedule", are shown and coordinated with the specifications.

Designer must coordinate with other sections for final connection of equipment.

Details of particular equipment and installations are provided on Naval Food Service Division drawings. Use these NAVFSD drawings as a basis for the project details. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

****

The work includes [furnishing and] [installing] [and modifying existing] ice making equipment, including dispensing, production, storage [, and autocleaning]equipment and related work. Include coordination of delivery through existing finished opening and vertical handling limitations within the building.

a. Provide rough-in and connect utilities to equipment in accordance with requirements specified in other sections of this specification and in conformance with the physical dimensions, capacities, manufacturer's instructions, and other requirements of the equipment furnished.

b. Equipment specified must also conform to the applicable requirements of the following reference standards: NSF/ANSI 12, NSF/ANSI 14, NSF/ANSI 169, and Energy Star for powered equipment.

c. Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE

EQUIPMENT for general requirements. Refer to Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE for Food Service Equipment Schedule.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Field Verification Data; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Custom Fabricated Equipment; G, [_____]

Installation Instructions and Diagrams; G, [_____]

SD-03 Product Data

Ice Making Equipment

Ice Machine Autocleaning Equipment

Energy Star label for ice machine; S

SD-05 Design Data

Manufacturer's Applicable Literature; G, [_____]

SD-06 Test Reports

Manufacturer's Test Data; G, [_____]

Field Test Reports; G, [_____]

SD-07 Certificates

NSF Certification

UL Certification

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G, [_____]

SD-10 Operation and Maintenance Data

Ice Making equipment, Data Package 2; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Manufacturer's Warranty

Contractor's Warranty for Installation

1.4 ADMINISTRATIVE REQUIREMENTS

1.4.1 Pre-Installation Meeting

Thirty [_____] days prior to the commencement of work, notify the Contracting Officer that the following items are prepared and ready for review:

1.4.1.1 Shop Drawings

Detail drawings, as specified, including insulation and utility requirements, product data, installation instructions and diagrams. Submit custom fabricated equipment drawings after approval of ice machine equipment drawings. Drawings must be 1:50 1/4 inch scale minimum.

1.4.1.2 Product Data

Submit the product data for the following equipment, as well as the associated manufacturer's data:

a. ice making equipment

b. ice machine autocleaning equipment

c. Manufacturer's applicable literature

d. Manufacturer's Test Data

e. Energy Star Labeled

f. Manufacturer's Instructions for shipping, handling, storage, installation, and start-up.

1.4.2 LIST OF EQUIPMENT

****

NOTE: Edit the master "Food Service Equipment Schedule" in Section 11 06 40.13 carefully; retain items of equipment used for the project. The Equipment List is intended to be edited and included in the project Specification. List the information contained on the Equipment List on the Contract Drawings.

****

Submit detailed Food Service Equipment List. Include submittal of NSF Certification, Energy Star Labeled and UL Certification for ice making equipment[and autocleaning equipment].

PART 2 PRODUCTS

2.1 MATERIALS

Provide ice making equipment conforming to OSHA standards 29 CFR 1910.144, 29 CFR 1910.145, 29 CFR 1910.306, Energy Star, and related NSF and UL standards. Floor areas adjacent to ice making equipment point of operation must conform to 29 CFR 1910-SUBPART D. Ice making equipment materials must conform to the requirements of Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT.

Provide ice machine that is Energy Star labeled. Provide data identifying Energy Star label for ice machine.

2.2 CONSTRUCTION OF FABRICATED EQUIPMENT

Construction and finish of fabricated equipment must conform to the requirements of Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT.

2.3 FACTORY TESTS AND CERTIFICATIONS

Submit [_____] copies of all Manufacturer's Test Data and certifications, including NSF Certification; UL Certification, and Energy Star Labeled data to the Contracting Officer prior to the commencement of any installation work.

[2.4 AUTOMATIC CLEANING SYSTEM

****

NOTE: Use automatic cleaning systems for ice machines, and schedule and perform routine ice machine cleaning automatically, reducing the need for a service technician to perform manual cleaning. Cleaning cycles are normally scheduled for 2, 4 or 12 week cycles or less frequently.

****

Provide ice making equipment with [internal] [external] automatic cleaning system with cleaning and sanitizing capability. Provide [115/60/1] [208-230/50/60/1], 0.3 total amps, with 15 amp maximum fuse electrical system. Include one month supply of cleaning and sanitizing fluid plus initial start-up and testing supply.

]PART 3 EXECUTION

3.1 EXAMINATION

Do not install items that show visual evidence of biological growth.

After becoming familiar with all details of the work, verify all existing dimensions, contract drawings, product data and all related conditions prior to commencing rough-in work. Advise the Contracting Officer of any discrepancies prior to ordering equipment. Submit Contractor's Field Verification Data prior to the pre-installation meeting.

3.2 INSTALLATION

Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT for detailed installation procedures, operation and maintenance manual requirements, training and project closeout procedures. Include all ice making [and autocleaning]equipment Field Test Reports.[Coordinate ice machine equipment installation with water filter system as specified in section 11 46 00.]

3.3 MANUFACTURER'S WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.4 CONTRACTOR'S WARRANTY FOR INSTALLATION

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-11 48 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-11 48 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 11 - EQUIPMENT

SECTION 11 48 00

CLEANING AND DISPOSAL EQUIPMENT

08/17, CHG 1: 08/18

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-11 48 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: NAVFAC | **Superseding**
UFGS-11 48 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 11 48 00

CLEANING AND DISPOSAL EQUIPMENT

08/17, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for equipment used to clean food service tableware, utensils, pots, pans, spray units, booster heaters, steam exhaust hoods, waste containers and disposers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Coordinate this section and use in conjunction with the following sections:

11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT
11 06 40.13 FOOD SERVICE EQUIPMENT SCHEDULE

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH-2097	(2013) Industrial Ventilation: A Manual of Recommended Practice (Metric)
ACGIH-2106	(2007) Industrial Ventilation: A Manual of Recommended Practice for Operation and Maintenance

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1009	(1990) Performance Requirements for Commercial Food Waste Grinder Units

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 96	(2024) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

NSF INTERNATIONAL (NSF)

NSF Food Equipment	(2005) NSF Product Listings of Food Equipment and Related Products, Components and Materials
NSF/ANSI 2	(2022) Food Equipment
NSF/ANSI 3	(2021) Commercial Warewashing Equipment
NSF/ANSI 13	(2020) Refuse Processors and Processing Equipment
NSF/ANSI 21	(2022) Thermoplastic Refuse Containers
NSF/ANSI 29	(2021) Detergent and Chemical Feeders for Commercial Spray-Type Dishwashing Machines
NSF/ANSI 59	(2020) Mobile Food Carts
NSF/ANSI 222	(2006e; R 2011) Ozone Generators

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA WaterSense	(2006) WaterSense Water Efficiency Labeling System

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
29 CFR 1910.145	Specifications for Accident Prevention Signs and Tags
29 CFR 1910.212	Safety Standard for Machinery and Machine Guarding
29 CFR 1910.306	Specific Purpose Equipment and Installations

UL SOLUTIONS (UL)

UL 197	(2010; Reprint Mar 2023) UL Standard for Safety Commercial Electric Cooking Appliances

UL 471	(2010; Reprint Sep 2019) UL Standard for Safety Commercial Refrigerators and Freezers
UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires

1.2 GENERAL REQUIREMENTS

****

NOTE: Indicate the configuration and layout for all food preparation equipment, with interior elevations and equipment identified by number. Show "Food Service Equipment Schedule" on the drawings using the same identification numbers[as indicated on the current US Army Quartermaster Center and School equipment schedule]. Ensure that all Contractor built-to-order items, per Food Service Equipment Schedule", are shown and coordinated with the specifications.

Designer must coordinate with other sections, including Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT and Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE for general requirements and final connection of equipment.

NOTE: Details of particular equipment and installations are provided on Naval Food Service Division drawings. Use these NAVFSD drawings as a basis for the project details. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

****

Equipment Item	NAVFSSO Dwg. File
1. Soiled Dishtable Assembly	541
2. Soiled Gear Scrapping Assembly	541
3. Utensil Wash Table	553
4. Service Stand	851

Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for general requirements. Also refer to Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE.

1.3 DESCRIPTION OF WORK

The work includes [furnishing and] [installing] [and modifying existing] food service cleaning and disposal equipment, related accessories, and work. Verify all existing dimensions, contract drawings, product data and all related conditions prior to commencing rough-in work. Include coordination of delivery through existing finished opening and vertical handling limitations within the building. Advise the Contracting Officer of all discrepancies prior to ordering equipment. Submit Contractor's Field Verification Data prior to the preconstruction meeting.

Provide rough-in and connect utilities to equipment in accord with requirements specified in other sections of this specification and in accord with the physical dimensions, capacities, manufacturer's instructions, and other requirements of the equipment furnished.

1.3.1 Design Requirements

****

NOTE: On the drawings, show:

1. A 1:50 1/4 inch scale floor plan with layout of all food service equipment and Naval Equipment Symbols.

2. Food Service Equipment Schedule laid out in accord with NAVFSSO, current US Army Quartermaster Center and School equipment schedule specified design requirements, including Energy Star labeled model list.

3. Floor, wall, and ceiling penetrations.

4. Raised bases, retainer curbs, or depressions.

5. Recessed, grated floor drains required for equipment.

6. Disconnect switches.

7. Electrical chases and raceways and plumbing chases.

8. Utility connections to building water, sanitary, electrical, and other utility systems. Convenience outlets at point of use for plug-in equipment.

9. All Contractor built-to-order items, per Food Service Equipment Schedule, shown and coordinated with the specifications.

****

Submit detail drawings as stated in Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT for food service cleaning and disposal equipment and related accessory equipment. Drawings must be 1:50 1/4 inch scale minimum.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Field Verification Data; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

[Custom Fabricated Equipment; G, [_____]

] Installation Instructions and Diagrams; G, [_____]

Detail drawings, as specified,including insulation and utility requirements.

SD-03 Product Data

Food Service Cleaning and Disposal Equipment; G, [_____]

Garbage Disposal; G, [_____]

Energy Star Label for Commercial Dishwasher; S

EPA WaterSense Label for Pre-Rinse Spray Valve; S

SD-05 Design Data

Manufacturer's Descriptive and Technical Literature; G, [_____]

SD-06 Test Reports

Manufacturer's Test Data; G, [_____]

Field Test Reports; G, [_____]

SD-07 Certificates

NSF Certification

UL Certification

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G, [_____] for shipping, handling, storage, installation, and start-up.

SD-10 Operation and Maintenance Data

Food Service Cleaning and Disposal Equipment, Data Package 2; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Manufacturer's Warranty

Contractor's Warranty for Installation

1.5 QUALITY ASSURANCE

Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT.

1.5.1 Pre-Installation Conference

Thirty [_____] days prior to the commencement of work, notify the Contracting Officer that the following items are prepared and ready for review:

a. Shop Drawings, product data and installation instructions

    (1) Detail Drawings
[(2) Custom fabricated equipment
    (3) Submit custom fabricated equipment drawings after approval of food service equipment drawings.
]   (4) Installation Instructions and Diagrams

b. Product Data:

Food service cleaning and disposal equipment

c. Design Data

(1) Manufacturer's descriptive and technical literature
(2) (2) Manufacturer's Test Data

d. Manufacturer's Instructions

Manufacturer's Instructions for shipping, handling, storage, installation, and start-up.

PART 2 PRODUCTS

2.1 MATERIALS

Food service cleaning and disposal equipment must conform to the following;

OSHA standards:

29 CFR 1910.144
29 CFR 1910.145
29 CFR 1910.212
29 CFR 1910.306

NSF standards:

NSF/ANSI 13
NSF/ANSI 2
NSF/ANSI 21
NSF/ANSI 222
NSF/ANSI 3
NSF/ANSI 59
NSF Food Equipment

and other related standards as specified in Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT.

Floor areas adjacent to food preparation equipment point of operation, and working surfaces must conform to 29 CFR 1910-SUBPART D.

Preparation equipment materials must conform to the requirements as stated in Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT.

2.2 LIST OF EQUIPMENT

****

NOTE: Edit the master "Food Service Equipment Schedule" in Section 11 06 40.13 carefully; retain items of equipment used for the project. The Equipment List is intended to be edited and included in the project Specification. List the information contained on the Equipment List on the Contract Drawings.

****

Submit detailed Food Service Equipment List as specified in Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE. Include submittal of NSF Certification and UL Certification for individual food preparation equipment components.

2.3 CONSTRUCTION OF FABRICATED EQUIPMENT

Construction and finish of fabricated equipment must conform to the specifications as stated in Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT.

2.4 CUSTOM-FABRICATED WORKCOUNTERS, DISHWASHER COUNTERS, AND SINKS

2.5 COUNTER TOPS

Fabricate of 1.8 mm 14 gage stainless steel, with all shop seams and corners welded, ground smooth, and polished.

2.5.1 Counter Edges

Miter and weld corners, grind smooth, and polish.

2.5.2 Work, Landing, and Dump Tables

Roll down counter edges on work, landing, and dump tables 45 mm 1.75 inches at 180 degrees, with corners rounded and bullnosed.

2.5.3 Side and Back Splashes

Turn up counter edges to form side or backsplashes at 90 degrees on a 15 mm 0.625 inch radius with top edge turned back 50 mm 2 inches at 90 degrees with ends closed. Turn up 150 mm 6 inches unless 250 mm 10 inches is required.

2.5.3.1 Soiled Dish Tables, Vegetable, and Pot Sinks

****

NOTE: Designer will indicate dimension and details of the sinks on the drawings. Remove text regarding overflow where not applicable.

****

Turn up counter edges on dishtables and vegetable and pot sinks 75 mm 3 inches at 90 degrees on a 15 mm 0.625 inch radius with top edge rolled 45 mm 1.75 inch at 180 degrees to form a rolled rim. Turn up back edge 250 mm 10 inches at 90 degrees on a 15 mm 0.625 inch radius with top edge turned back 55 mm 2.2 inches at 45 degrees with ends closed.

2.5.3.2 Drain Plug and Overflow Fittings

Provide drain consisting of a 38 mm 1-1/2 inch quick opening brass body valve with side outlet overflow connection with a stainless steel twist lever handle. Provide a removable perforated stainless steel strainer plate of not less than 75 mm 3 inch in diameter. Provide 31 mm 1-1/4 inch diameter chrome-plated brass tubing overflow fittings of not less than 0.91 mm 0.036 inch thickness connected to an overflow head in the back of the sink compartment. Provide overflow head with a removable perforated chrome-plated brass or stainless steel strainer plate of not less than 38 mm 1-1/2 inch diameter. Install overflow head in die-stamped opening 25 mm one inch below counter top.

2.5.3.3 Final Rinse Compartment

Equip the final rinse compartment of the pot washing sink with a booster heater for sanitizing.

2.5.3.4 Temperature Gauge

Provide temperature gauge with a 75 mm 3 inch diameter face with stainless steel flange.

2.5.3.5 Mounting Valves, Temperature Gauge, and Controls

Mount valves, temperature gauge, and controls in a stainless steel recessed panel, ready for final connections. Provide a perforated stainless steel casing over the temperature bulb.

2.5.3.6 False Bottom

Provide false bottom constructed of 1.9 mm 14 gauge stainless steel, 13 mm 1/2 inch deep pan formed with a perforated top (13 mm1/2 inch holes punched 38 mm 1-1/2 inches on center), with welded corners and finger rings. Fit false bottom with 50 mm 2 inch high by 31 mm 1-1/4 inch outside diameter tubular stainless steel feet with closed ends.

2.5.4 Cutlery and Excess Liquid Sinks

Provide cutlery and excess liquid sinks with a removable standpipe overflow, in lieu of an overflow in the back of the sink. Install the overflow in the corner of the sink compartment. Provide compartments with snug-fitting removable basket strainers. Arrange drain plug with quick-opening valve for operation from the work side of the counter.

[2.5.5 Glass Washing Sinks

****

NOTE: Glass-washing sinks are not required in enlisted personnel dining facilities.

****

Construct and provide backsplashes suitable for mounting the glass washing machine. Reinforce back to eliminate vibration and noise.

]2.5.6 Counter Top Support

Provide supports under all edges of counter tops and tables, and at cross members. Stud-weld counter top to supports. Provide either of following types.

2.5.6.1 Channels

25 by 25 mm1 by 1 inch, 2.5 mm thick 12 gage galvanized steel channel. Space cross members 600 mm 30 inches on-center.

2.5.6.2 Angles

38 by 38 by 3 mm1.5 by 1.5 by 0.125 inch galvanized steel angles. Space cross members at 600 mm 2 feet on-center.

2.6 PASS-THROUGH WINDOWS

Except for sill of soiled dish counter, fabricate a mitered window frame of 1.8 mm thick 14 gage stainless steel channel forming a 85 mm 3.5 inch casing on each side of wall. Return flange 13 mm 0.5 inch, to wall. Weld joints; join only at corners of opening. Seal in accord with Section 07 92 00 JOINT SEALANTS.

2.6.1 Windows for Endless Belt Conveyors

Locate and size opening to allow 13 mm 0.5 inch clearance at each side and below conveyor and 300 mm 12 inch space above conveyor.

2.6.2 Windows for Soiled Dish Counter

Fabricate sill as integral extension of counter. At face of wall opposite counter, turn sill 13 mm 0.5 inch up, then down to form 100 mm 4 inch wide mitered casing.

2.7 CLEANING, DISHWASHING, AND DISPOSAL EQUIPMENT

****

NOTE: Show soiled dishware return service layout and related details on the drawings.

Ozone generators are sometimes required specific zoning or health regulatory agencies for the suppression/elimination of odors generated by food service waste facilities. Delete the statement if not required by project.

****

Commercial warewashing equipment must conform to NSF/ANSI 3. Thermoplastic refuse containers must conform to NSF/ANSI 21.[Ozone generators, used to eliminate odors, must conform to NSF/ANSI 222.]

Provide commercial dishwasher equipment that is Energy Star labeled. Provide data identifying Energy Star label for commercial dishwasher.

2.7.1 Dish Counters

Construct dish counters and sound deaden as specified for in Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT. Fit and flange the dish counters into the dishwashing machine with a water-tight joint.

2.7.2 Dish Counter Support Channels

Provide 25 by 100 by 25 mm 1 by 4 by 1 inch, 2.7 mm 12 gauge stainless steel dish counter support channels. Provide channels under dish counter top between each pair of legs and close ends. Provide cross members, on the centerline, between legs. Stud bolt channels to counter top at 150 mm 6 inch on center, maximum.

2.7.3 Dish Counter Components

2.7.3.1 Scupper Drain

Provide scupper drain the full width of dish counter with all corners coved, 150 mm 6 inch wide by 50 mm 2 inch deep, and integrally welded to the soiled/clean dish counter top at the entrance/exit of a rack-type dishwashing machine. Score and slope bottom of the scupper drain to 38 mm 1-1/2 inch brass drain with tailpiece. Provide removable drainer 1.6 mm 16 gauge stainless steel, flush-mounted, pan-formed, perforated top, with 13 mm

1/2 inch holes punched 38 mm 1-1/2 inches on center, and install in the scupper opening on 13 mm 1/2 inch diameter stainless steel legs with closed ends.

2.7.3.2 Prewash Sink

Weld integral 520 by 520 mm 20-1/2 by 20-1/2 inch prewash sink to the dish counter top with the corners rounded on 13 mm 1/2 inch radius. Pitch the sink bottom to 1.6 mm 16 gauge stainless steel[disposer throat flange] [38 mm 1-1/2 inch brass drain]. Provide a 520 mm 20-1/2 inch square 1.6 mm 16 gauge removable rack support/slide assembly, framed with two cross members. Weld two 25 by 3 mm 1 by 1/8 inch stainless steel angle rack guides on top of the frame at 500 mm 20 inch apart with ends flared at 45 degrees.

2.7.3.3 Pre-Rinse Spray Valve

Mount a prerinse spray assembly on the backsplash of the dish counter with vertical tubing, wall bracket, flexible gooseneck hose, and self closing squeeze-type valve and spray.

Provide pre-rinse spray valve that is WaterSense labeled. Provide data identifying EPA WaterSense label for pre-rinse spray valve.

2.7.3.4 Backsplash-Mounted Faucets

****

NOTE: Designer will detail location and type of faucets. Stainless steel will be specified for hospital faucets.

****

Provide combination fitting-type backsplash mounted faucets with concealed supply connections at the back of the sink. Provide fitting with a swinging spout of approximately 200 mm 8 inches in length and inlets with 19 mm 3/4 inch pipe thread. Faucets must have adjustable flanges. Provide valves with indexed metal lever handles and replaceable seats.

2.7.3.5 Hose Bib Faucet

Mount a hose bib faucet on a 2.7 mm 12 gauge stainless steel flange or inverted gusset below top of counter, ground and polished to match counter top.

2.7.3.6 Undershelves

Provide solid type undershelves, constructed as specified for open base shelves.

2.7.3.7 Scraping Trough

Provide a 1.9 mm 14 gauge stainless steel scraping trough in the soiled dish counter with all corners 19 mm 3/4 inch coved, and integrally welded to the dish counter. Provide trough 200 mm 8 inch wide minimum and sloped one percent 1/8 inch per foot or from 100 mm 4 inch depth to integral disposer or prewash sink. Form long sides of trough on a 60 degree angle with a 13 by 13 mm 1/2 by 1/2 inch recessed shoulder at juncture of the dish counter. Provide with removable stainless steel trough covers 197 by 500 mm 7-7/8 by 20 inch, 1.6 mm 16 gauge, pan formed, with perforated top.

Make perforations 13 mm 1/2 inch diameter holes punched 38 mm 1-1/2 inch on center. Provide one trough cover for each 900 mm 36 inch of trough.

Provide and install one inlet fitting at the shallow end of the scraping trough, and intermediate inlet fittings at 1200 mm 48 inch on center. Pipe inlet fittings to a blending valve, vacuum breaker, solenoid valve, and provide a globe valve at each intermediate inlet.

Integral disposer sink must be 450 by 450 by 188 mm 18 by 18 by 7-1/2 inch deep, 1.9 mm 14 gauge stainless steel with all corners coved, welded to dish counter/scraping trough and fitted with a removable silverware-trap. Provide with removable stainless steel flush cover 1.6 mm 16 gauge, 13 mm 1/2 inch pan-formed, and perforated 13 mm 1/2 inch holes punched at 38 mm 1-1/2 inch on center with welded corners. Provide a finger ring for the removal of the cover. Provide 6 mm 1/4 inch diameter stainless steel rod support clips, 50 mm 2 inch long, formed at 45 degree angle with two 19 mm 3/4 inch leg ends[and 6 mm 1/4 inch long threaded ends].

Insert rod-clips through tight clearance holes in sink corners, seal watertight, and secure with stainless steel acorn-nuts or tack-welded at exterior of sink wall. Set support clips for a flush cover position (approximately 13 mm 1/2 inch below top). Interconnect a solenoid valve with the disposer delay-relay control to initiate the blended water flow when the disposer is activated. All inlet fittings must 13 mm 1/2 inch [copper] [stainless steel] tubing from blending valve to inlet fittings. Chrome plate all exposed fittings.

2.7.4 Glass/Cup Rack Overshelf

Provide 1.9 mm 14 gauge stainless steel glass/cup rack overshelf with a 38 mm 1-1/2 inch deep "Vee" trough at free long sides with a 25 mm one inch tight hem at inside of trough. Provide a 13 mm 1/2 inch marine edge at free ends and a 100 mm 4 inch high splash at the wall.

a. Suspend shelf with bottom edge at 450 mm 18 inch above counter top.

b. Provide drain tubes at each end of trough through the backsplash to 19 mm 3/4 inch above top of table.

c. Provide a horizontal rack rest of 41 mm 1-5/8 inch outside diameter stainless steel tubing the full length of the shelf, supported 250 mm 10 inch above the shelf on 31 mm 1-1/4 inch outside diameter stainless steel tubing spaced at 1500 mm 60 inch on center.

2.7.5 Dish/Tray Return Shelf

Provide dish/tray return shelf as indicated on the drawings. Extend shelf through opening in wall to be flush with the wall at the deposit side. Turn down of shelf must be 25 mm one inch at 90 degrees at the front with 19 mm 3/4 inch return at bottom. Turn down rear long side 25 mm one inch at 90 degrees, and integrate with [conveyor slider pan] [dish counter] whenever adjacent.

2.7.5.1 Dish/Tray Return Opening Frame

Provide 1.3 mm 18 gauge stainless steel window shelf with the perimeter flange channel-formed, 25 by 19 mm 1 by 3/4 inch at both sides of the wall. Weld corners of the frame. Install frame with concealed attachments. Aligned/abut jamb of frame with the end splash of [conveyor slider pan] [dish counter], whenever adjacent.

[2.7.5.2 Overhead Rolling Door

****

NOTE: Designer will delete this paragraph if not used.

****

Provide and install an overhead rolling door into the dish/tray return. Coordinate enclosure and track installation with the splash/jambs, and partition bucks.

]2.8 CONVEYOR

****

NOTE: Indicate arrangement dimensions and details including enclosures, if required, of the conveyors on the drawings. Select either an electrically or gravity powered conveyor.

****

[2.8.1 Conveyor, Electrical

Provide endless belt type conveyor, electrically operated, straight, soiled dish type. Conveyor must be U.L. listed and NSF approved.

2.8.1.1 Trough (Slider Bed)

Provide a one-piece seamless pan constructed conveyor of 1.9 mm 14 gauge stainless steel with integral tracking trough. Pitch integral belt track longitudinally for drainage and equip with a timed/automatic detergent wash. Reinforce horizontal and vertical corners with 2.7 mm 12 gauge stainless steel closed end channels.

Turn up conveyor pan edges 75 mm 3 inch with 19 mm 3/4 inch at 90 degrees to form rolled rim. Pan must be sized to transport standard 356 by 457 mm 14 by 18 inch cafeteria trays. Mount slider pan on "U" shaped supports of 2.7 mm 12 gauge stainless steel, at 1500 mm 60 inch on center. Provide legs as specified for gussets, legs, and feet.

Conveyor drive housing frame must be constructed of 1.9 mm 14 gauge stainless steel. Provide enclosure with a 1.6 mm 16 gauge stainless steel, double insulated pan-formed access door with safety interlock, and set on stainless steel adjustable legs. Provide stainless steel monorail return system with slide rails.

2.8.1.2 Motor

Provide conveyor driven by a totally enclosed gearhead reduction motor of the size scheduled with overload and low voltage protection, with infinitely variable speed from 0.1 to 0.25 meters/second 20 to 50 fpm using solid state controls. The drive must be controlled manually through a water-tight control panel mounted[where indicated][as shown by the manufacturer]. Motor components must be factory prewired in accordance with NFPA 70 using waterproof conduit and NEMA ICS 6 and NEMA 250, Type 4 stainless steel waterproof enclosures. Provide motor with devices to automatically stop the conveyor belt without coasting.

2.8.1.3 Control Panel/Controls

Provide control panel controls with an exposed disconnect switch and overload protection with reset key control for AC motors and replaceable fuse for DC motors. Locate and prewire all components to a terminal strip, such as overload and low voltage protection, motor controller, and control relay, within the control panel. External controls must be 24 volt. Provide a remote on-off switch at each scrap station to manually control the conveyor operation. Also provide an automatic limit switch at the take off end. Provide a conveyor belt with an automatic shutoff jam switch.

2.8.1.4 Belt Washer

Provide belt washer with a stainless steel wash tank with a removable scrap basket, and waste extension. Provide a spray assembly to wash the belt on both sides, factory plumbed through a pump-type detergent injector. The wash assembly must be provided with a mixing valve, water pressure regulator, gauge, vacuum breaker, solenoid valve, and in-line strainers. Provide a timer to regulate the duration of the belt-wash system. The beltwasher must not be operable when the conveyor is stopped. Provide easily accessible stainless steel detergent dispenser cabinet with tank and low level indicator, conforming to NSF/ANSI 29.

2.8.1.5 Drip Pan

Provide a 1.3 mm 18 gauge stainless steel drip pan the full length of the conveyor. Turn up the drip pan on each side, creased for center drainage, and pitch or direct by a conveyor belt to an integral sump and removable strainer at the drain locations.

2.8.1.6 Conveyor Belt

The slat conveyor belt must be overlapping and of nonstaining plastic material. Belt slats must be 250 mm 10 inch wide and snap onto a stainless steel chain without the use of tools. The chain is the driving force. Belts must ride on high density plastic slide rails. Provide stainless steel sprocket hubs and shafts with [ultra-high density plastic] [stainless steel] teeth. Hinge 1.3 mm 18 gauge stainless steel enclosure panels to the slider pan, and the conveyor under-bracing assembly by means of concealed hinges at the top and screw fasteners or magnetic catch at the bottom.

2.8.1.7 Curve Guide

Where the conveyor negotiates a curve, equip with an antifriction device to reduce friction and wear. Apply lubrication, if necessary, to the curve by means of a remote electrical pump.

][2.8.2 Conveyor, Gravity Flow Type

Provide conveyor with [ultra high density plastic] [stainless steel] roller, gravity operated, soiled dish type, to transport standard 356 by 457 mm 14 by 18 inch cafeteria trays, constructed in accordance with NSF/ANSI 2, size and configuration as indicated on drawings.

2.8.2.1 Conveyor Trough (Pan)

Provide one-piece conveyor trough, seamless, constructed of 1.9 mm 14 gauge stainless steel with integral soiled landing table, with depressed trough to accept roller sections, and pan pitched to soiled dishtable where indicated.

]2.8.3 Gussets

Provide stainless steel gussets, fully enclosed, a minimum of 75 mm 3 inch in diameter at the top, reinforced with a bushing, continuously welded to channel or angle.

2.8.4 Legs

Provide 1.6 mm 16 gauge, 41 mm 1-5/8 inch outside diameter stainless steel tubing legs, continuously welded to gussets, channel, or angle as specified.

2.8.5 Feet

Provide sanitary, die-stamped stainless steel bullet-shaped, fully enclosed feet which provide for a 25 mm one inch adjustment without threads being exposed. Finish off the bottom of the legs with the stem overlapped to provide a sanitary closed fitting. Feet for free-standing fixtures requiring utility connections must be as above except with a flanged plate at the bottom which is anchored to the floor with noncorrosive bolts.

2.9 ROLLER ASSEMBLIES

Provide[PVC plastic][stainless steel] tubing style roller sections, with stainless steel ball bearings. Mount rollers to stainless steel hex shafts, set in 2.7 mm 12 gauge stainless steel side rails formed to maintain trays in proper alignment. Fit each section end of frame with stainless steel plate notched for easy removal. Mount roller section in trough to allow for free movement of trays without drag. Provide curved sections with 1.9 mm 14 gauge side rails with two rollers per shaft to negotiate corner turn.

[2.10 CONDENSATE HOODS AND EXHAUSTS

****

NOTE: Not all commercial warewashing equipment require condensate exhaust hoods, (i.e."Flight Type" dish machines). Coordinate this item with the project design requirements and the Contracting Officer.

****

****

NOTE: Indicate type, size, shape, and detail of hoods/ducts, and the required standard cubic meters per second (cubic feet per minute), meters per second (feet per minute) (velocity), static pressure, and duct collar size for exhaust/make-up air on the drawings.

****

****

NOTE: Size exhaust and supply fans and exhaust and supply ducts in accord with hood manufacturer's recommendations, to ensure proper balancing for a satisfactory exhaust system. Provide a separate and self-supporting system for each hood. Air changes

in the utensil washroom must be 5 changes per hour for general room exhaust and 30 changes per hour when all systems are operating.
****

****
NOTE: Delete types not used in project.
****

Provide hood and duct work systems conforming to ACGIH-2097 ACGIH-2106, SMACNA 1966, and NFPA 96. Unless otherwise specified, secure ducts and hoods to building so as to be level and free from vibrations under all conditions of operation. Supply and install exhaust fans for food service equipment and exhaust hoods as specified in Section [_____].

[2.10.1 Hood Over Utensil-Washing Sink, Type 5

****
NOTE: If Type 5 hood is not used, insert salient requirements regarding shape, mounting, and duct connection.
****

Provide a 1980 by 1065 by 450 mm 78 by 42 by 18 inch high hood. Provide condensate collecting gutter and drain to sink drainboard or floor drain. Slope top of hood 150 mm 6 inches down toward front of hood starting 300 mm 12 inches in from back edge. Mount to wall with anchors provided by manufacturer and hang from ceiling with 16 mm 0.625 inch stainless steel rods. Provide an opening in top of hood for exhaust duct. Center opening in top of hood from left to right and front to back. Provide a 50 mm 2 inch high stainless steel duct collar, welded to hood top. Mount at height indicated. Provide controls for fans.

][2.10.2 Hood Over Utensil-Washing Machine, Type 6

****
NOTE: If Type 6 hood is not used, insert salient requirements regarding shape, mounting, and duct connection.
****

Provide hood of same length and width as utensil washing machine. Provide condensate collecting gutter and drain to [floor drain] [_____]. Slope top, mount, and provide duct opening and collar as specified for Type 5 hoods. Mount at height which avoids interference with machine operation. Provide controls for fans.

][2.10.3 Exhaust Over Dishwashing Machines, Type 7

Provide two rectangular duct chambers, with connections at each end of dishwashing machine, not less than 150 mm 6 inches deep and extending width of dishwashing machine unless otherwise recommended by dishwashing machine manufacturer. Chambers must converge over dishwashing machine at a 45 degree angle to form a single outlet to exhaust duct. Provide controls for fans.

]2.10.4 Gutter and Drain

Provide inside bottom perimeter with a 75 mm 3 inch face with a 25 mm one inch high flange turned up at a 45 degree angle, to form gutter. Provide a 25 mm one inch stainless steel drain in back corner, extending to specified discharge.

2.10.5 Fan Controls

Provide, for each condensate hood, controls for operating fans. Include manual push buttons labeled "start" and "stop" and labeled light indicating when fans are operating.

2.10.5.1 Hood Exhaust and Supply Fans

****

NOTE: Exhaust fans for kitchen equipment should be centrifugal type with top discharge, adjustable pulleys, and disconnect switches. Protect motor against vapor-laden air stream.

****

Provide in accord with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.10.5.2 Hood Exhaust and Supply Duct

****

NOTE: Duct work to kitchen hoods and for dishwashing machines should be carefully incorporated into Section 23 30 00 HVAC AIR DISTRIBUTION and onto the drawings to assure coordination with kitchen equipment design. The following are necessary:

1. Curbs must conform to NFPA 96.

2. Hood exhaust and supply duct: Minimum 1.2 mm thick 18 gage stainless steel, welded water tight. (Unexposed duct can be galvanized steel). Conform to SMACNA HVAC Duct Const Stds.

****

Provide in accord with Division 23, Section 23 30 00 HVAC AIR DISTRIBUTION.

2.10.6 Condensate Exhaust Hood Connection Provisions

2.10.6.1 Exhaust Duct for Canopy or Noncanopy Condensate Hoods

Construct ducts with 1.3 mm 18 gauge stainless steel. Weld all external seams liquid-tight to hood duct collar as required by NFPA 96. Duct size is based on a minimum air velocity of 4.06 meter/second 800 fpm. Continuously weld duct, liquid tight, to hood duct collar as required by NFPA 96.

2.10.6.2 Hood Support

Support wall mounted or island type hoods from the ceiling structure with stainless steel mounting brackets provided with the hoods. Hanger rods must be 13 mm 1/2 inch diameter stainless steel, threaded at the bottom and designed at the top to fit into inserts in building slats above or hanger attachments fastened to structural steel members. Space hanger rods 1200 mm 48 inch on center, maximum.

2.10.6.3 Make-Up Air Tempered and Untempered

Replace the air volume which is exhausted from a kitchen as required by NFPA 96. Air supplied upstream of the hood suction opening does not qualify as make-up air. The exhaust air flow rate of ventilation of dishwashing equipment must be drawn through the open area between the dishwashing machine and the perimeter entrance of the hood. Provide make-up air diffusers the full length of the front panels, at both sides of the hood producing a low velocity discharge. Provide a supply air plenum with 25 mm one inch thick foil-faced fiberglass insulation at interior of plenum. The temperature differential between make-up air and the air in the conditioned space must not exceed12 degrees C 10 degrees F, except air that is part of the air conditioning system or air that does not decrease comfort conditions of the occupied space.

2.10.6.4 Vapor Proof Hood Lights and Wiring

Provide U.L. listed, recess mounted, gasketed vapor-proof fluorescent light fixtures conforming to UL 1598,[the full length of the hood][as shown on the drawings]. Provide, at Type 2 and Type 3 hoods, incandescent or fluorescent lights in accord with UL 1598. Prewire the light fixtures to junction box at a rear free corner. Use Cool white T-8 energy efficient lamps.

2.10.6.5 Closure Panels

Provide vertical corner mullions at removable closure panels, 50 by 50 mm 2 by 2 inch wide, 1.6 mm 16 gauge stainless steel, and weld integrally to furring and head channel. Provide exhaust hood closure panels 13 mm 1/2 inch pan-formed 1.3 mm 18 gauge stainless steel. Retain the upper edge of the panel in a 25 by 50 mm 1 by 2 inch continuous 1.6 mm 16 gauge stainless steel head channel secured to the hood superstructure. Mount the lower edge of the panels on perimeter furring cap, and turn back 25 mm one inch for "zee" clip retention.

2.10.7 Ducts at Dishwashing Machines

Provide ducts at dishwashing machines consisting of two vertical ducts, one at each end of the dishwasher. Construct exposed, seamless, ducts of not less than 1.3 mm 18 gauge stainless steel and size to accommodate the machine exhaust vent. The intake of each duct must be at the top edge of the dishwasher and extend to 150 mm 6 inch above the finished ceiling for final connection. Trim the duct at the ceiling with a 1.6 mm 16 gauge stainless steel angle flange with corners welded. Connect the exhaust outlet to the exhaust system.

2.10.8 Duct Openings

Provide duct openings with collars of quantity/size as indicated, with a stainless steel louvered grille at the openings. Trim and seal all penetrations of the dishwashing machine duct risers through the hood body.

[2.10.8.1 Ceiling Recessed Exhaust Hood at Dishwashing Machines

****

NOTE: Use this paragraph for projects where ceiling height limitations require a recessed hood.

****

Provide hood over dishwashing machines constructed of 1.6 mm 16 gauge stainless steel with all seams welded, ground, and polished. Slope both long sides up to 450 mm 18 inch interior height from 150 mm 6 inches above bottom edge. Body must have a 50 mm 2 inch wide perimeter flange turned-up 19 mm 3/4 inch at 90 degrees (increase to 250 mm 10 inch width at supply air diffusers). Provide make up air diffusers at vertical [interior] [exterior] length of hood. Provide duct openings with collars of quantity/size as indicated, with a stainless steel louvered grille at the openings. Trim and seal all penetrations of the dishwashing machine duct risers through the hood body.

]]2.11 GARBAGE DISPOSAL MACHINES

****

NOTE: When scrap trough is located on front of soiled dish table with a disposer in center and scrapping being done on each side, provide the disposer with an off-set head so disposer does not extend beyond dishtable.

****

Provide floor-mounted type disposer conforming to ASSE 1009, with cast alloy body supported on adjustable tubular legs. Attach waste chamber lid with quick-release clamps. Connect hopper to disposal with a flexible sleeve of molded neoprene, held in place with stainless steel clamps.[Provide an offset head.]

2.11.1 Disposal Cone

Fabricate with approximate diameters of 450 mm 18 inches inside unit and 200 mm 8 inches at throat. Provide neoprene silver trap at throat and water swirl inlet in cone to create counterclockwise rotation. Secure cone to disposer with flexible connector sleeve and stainless steel clamps.

2.11.2 Motor

Mount motor with 75 mm 3 inch minimum clearance above floor. Provide with magnetic starter with overload and under-voltage protection timer for 0 to 5 minutes, panel cover interlock, fused disconnect, prewired solenoid, vacuum breaker, two water flow controls, and automatic reversing action. Provide cast alloy rotor carrying rigid impact bars and fixed directly onto motor shaft. Provide motors of the following minimum sizes on disposals at locations listed:

a. Pot and pan sink: 3.75 kw 5 horsepower

b. Soiled dishtable: 5.60 kw 7.5 horsepower.

2.11.3 Disposal Control Center

Include time delay relay, start and stop buttons, panel cover interlock with fused safety disconnect switch and circuit breaker, door locking feature that prevents opening door with power on, full voltage magnetic starter with both overload and under-voltage protection, and solenoid valve. Control center must be waterproof and fabricated using stainless steel and in accord with NEMA ICS 6. Provide controls conforming to NEMA ICS 2.

2.12 DRAINS

Provide cleanout for all drains. Locate drains so that drain lines from equipment are not located in any portion of a walking surface or produce a tripping or burn hazard.

2.13 DRAIN TRENCH LINER/GRATING

****

NOTE: Indicate on the drawings, required dimensions, details, and coordinate with floor plan layout. Drain trench liner/grating system must be provided with a complete drainage system. Trench must be capable of being readily cleaned out without the removal of bolts or screws to gain access.

****

Provide 1.9 mm 14 gauge stainless steel drain trench liner/grating in sizes as indicated with a 25 mm one inch wide perimeter shoulder at the top, turned up flush and level with finished floor, tight-hemmed back down to the shoulder level and flanged out 50 mm 2 inch for attachment to the slab.

2.13.1 Interior of the Liner

Interior of the liner must be 150 mm 6 inch deep with corners coved on 19 mm 3/4 inch radius; sloped and scored 25 mm one inch to an integrally welded box pattern drain (drain housing only). Provide drains at 1200 mm 48 inch on center maximum and fit with 150 mm 6 inch long welded tailpiece. Connect a safety chain to the basket strainer assembly and the top of the liner wall. Underside of sloping portion of liner must have 50 mm 2 inch long "zee" clips.

2.13.2 Aluminum Grating

Provide aluminum grating, removable without the use of tools, with 38 by 5 mm 1-1/2 by 3/16-inch bearing bars and a perimeter frame. Close bearing bars must have a 33 by 100 mm 1-5/16 by 4 inch centerline to centerline grid. Provide section quantities and sizes as indicated on the drawings with a maximum of 600 mm 24 inch long sections.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install items that show visual evidence of biological growth.

3.1.1 General

Install in accord with the manufacturer's printed instructions.

3.1.2 Cutting and Patching of Construction

Lay out work in advance to prevent damage to building, piping, wiring, or equipment as a result of cutting for installation.

3.1.3 Setting and Connecting

Install equipment plumb and level. Except for mobile and adjustable-leg equipment, securely anchor and attach items and accessories to walls, floors, or bases with stainless steel bolts. Flash food service cabinets located in wall openings to the walls with 0.9 mm thick 20 gage stainless steel. Seal around equipment flashing and flanges, at walls, floor, and ceiling in accord with Section 07 92 00 JOINT SEALANTS. Fillers must be continuous, without opening.

3.1.4 Plumbing Work

Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT.

3.1.5 Electrical Work

Electrical systems, components and accessories must be certified to be in accordance with NFPA 70 and the following:

3.1.5.1 Installed Equipment Load

If the electrical load of the approved equipment differs from that specified or shown on the drawings, provide and install electrical service compatible with the approved equipment.

3.1.5.2 Electrical Equipment and Components

Food service equipment furnished under this section must have loads, voltages, and phases compatible with building system, and conform to manufacturer standards.

3.1.5.3 Cords and Caps

Coordinate all food service equipment cord/caps with related receptacles. All 120/208/240 volt "plug-in" equipment must have Type SO or SJO cord and a plug with ground, fastened to frame/body of item. Provide mobile equipment with a strain-relief assembly at the cord connection of the appliance. Mobile electrical support equipment (heated cabinets, dish carts, etc.) and counter appliances mounted on mobile stands (mixers, food cutter, toaster, coffee makers, microwave ovens, etc.) must have cord/cap assembly with cord-hanger as provided by the manufacturer.

3.1.5.4 Switches and Controls

Equip each motor-driven appliance or electrically-heated unit with control switch and overload protection per UL 197 and UL 471. Switches, controls, control transformers, starters, equipment protection and enclosures must be Industry Standards for the related equipment environment.

3.1.5.5 Motors

Provide motors at 120, 240, 208/240 and 460/480 volts with starter, overload protection, and short circuit motor protection per manufacturer standards.

3.1.5.6 Heating Elements

Provide thermostatic controls for all electrically heated equipment. Equip water heating equipment with a positive low-water shut-off.

3.1.5.7 Receptacles and Switches

Install receptacles which are located in vertical panels of closed base bodies in 300 by 215 by 75 mm 12 by 8-1/2 by 3 inch deep recessed mounting panel sloped on a 60-degree angle and turned up to the top of the opening. Prewire receptacles which are located in closed base fixtures to a junction box located within 150 mm 6 inch from the bottom of the utility compartment. Horizontally mount receptacles which are installed in/on fabricated equipment in a metal box with a stainless steel cover plate.

3.1.5.8 Light Fixtures

Prewire light fixtures with lamps which are installed in/on fabricated or field-assembled equipment to a junction box for final connection (fixtures must be continuous run when indicated). Install fluorescent display light the full-length of the display stand and serving shelf with stud bolts or as indicated, and prewire through a support post to a recess-mounted switch. Install heat lamps to underside of serving shelf assemblies as specified. Heat lamp length for chassis must be sized per manufacturer or as indicated on the drawings. Electrically connect cold storage light fixtures through the hub fitting located on the top of the fixture. Horizontal conduit must be above the ceiling panels. Install plastic sleeves through ceiling panels for electrical conduit and seal all penetrations airtight at both sides of panel.

3.1.5.9 Final Electrical Connection Provisions

Tag final electrical connection points of equipment with item number, name (as indicated on FOOD SERVICE EQUIPMENT SCHEDULE) of devices on the circuit, total electrical load, voltage, and phase. Fabricated equipment containing electrically-operated components or fittings, indicated on utility connections drawings to be direct-connected, must have each component, fitting, or group thereof prewired to a junction box for final connection. Refer to the drawings for circuit loading.

Field-assembled equipment (example, prefabricated cold storage assemblies, conveyor systems, exhaust hoods) must have electrical components completely interconnected by this section for final connection as indicated on utility connection drawing. Prewire the following groups of cold storage assembly electrical devices to a top-mounted junction box for final connection per compartment grouping, unless otherwise indicated.

a. Light fixtures, switches, and heated pressure-relief vent.

b. Door/jamb heater and temperature monitors/alarms.

c. Evaporator fans, defrost elements, freezer fan door switch, and drain line heaters.

3.1.5.10 Lamps

Provide food service equipment containing light fixtures with standard appliance type bulbs or energy efficient appliance type bulbs as indicated on the drawings. Exposed fluorescent lamps above or within a food zone must have plastic coated T-8 energy efficient lamps or standard lamps, sleeved in plastic tube with end caps.

3.1.6 Cleaning and Adjusting

Test and adjust equipment for proper operation. Test rotating components and motors for proper rotation. Lubricate moving parts if suggested by manufacturer's literature. Prior to acceptance of project, clean and sanitize equipment both inside and outside.

a. Light fixtures, switches, and heated pressure-relief vent.

b. Door/jamb heater and temperature monitors/alarms.

c. Evaporator fans, defrost elements, freezer fan door switch, and drain line heaters.

3.1.7 Installation of Hoods

Install in accord with NFPA 96. Install hoods to remain free from vibration under all conditions of operation.

3.1.8 Floor Screeds

Anchor, install, and seal in accord with the recommendations of the manufacturer of the walk-in unit.

3.2 FIELD INSPECTIONS AND TESTS

3.2.1 Inspections

Inspect equipment, fixtures, and material after installation for compliance with the applicable standards and as specified in Section 11 05 40 COMMON WORK RESULTS FOR FOOD SERVICE EQUIPMENT.

3.2.2 Field Test Reports

Upon completion of inspection perform operational tests on each piece of equipment to determine that equipment and components, including controls, safety devices, and attachments, operate as specified and are properly installed and adjusted. Test all water, drain, gas, steam, oil, refrigerant, and liquid carrying components for leaks. Notify the Contracting Officer 14 calendar days prior to testing.

3.3 MANUFACTURER'S WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.4 CONTRACTOR'S WARRANTY FOR INSTALLATION

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-11 53 00 (May 2011)**
Change 1 - 11/17

Preparing Activity: NAVFAC **Superseding**
UFGS-11 53 00 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-11 53 00 (May 2011)**
Change 1 - 11/17

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SECTION 11 53 00

LABORATORY EQUIPMENT AND FUMEHOODS

05/11, CHG 1: 11/17

****

NOTE: This guide specification covers the requirements for laboratory equipment and fume hoods.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Types of equipment normally specified in this section include fumehoods, furniture not specified in casework section, and related laboratory products. Laboratory fumehoods included by the guide specification are not to be utilized for perchloric acid handling operations. Perchloric acid is extremely dangerous because it is a very strong oxidizer. When this acid reacts with organic material, an explosive product may form.

****

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NOTE: On the drawings, show:

1. Location of equipment, utility connections and relation to other work.

2. Remotely located blower and ductwork, to create negative pressure at hood. Require weatherproof caution labels attached to outlet end of exhaust systems where warning of dangerous chemical fumes will be necessary.

3. Fans and ductwork needed to create negative pressure. Laboratory fume hoods are ventilated enclosures designed to provide safe working area for laboratory activities involving hazardous materials, generated fumes, aerosols, gases, and particulate matter. To operate satisfactorily, air is removed from enclosure at optimum face velocity. Require velocities measurable at maximum face area of hood, with maximum allowances for hood, filter, and appurtenance static pressure losses within specified limits.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH-2097	(2013) Industrial Ventilation: A Manual of Recommended Practice (Metric)

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability,

	Solution Hardened, and Bake Hardenable
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

CDC 21-1112	(2009) Biosafety in Microbiological and Biomedical Laboratories, 5th Edition

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 45	(2024) Standard on Fire Protection for Laboratories Using Chemicals
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

Conform to provisions of Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT and Section 12 35 70 HEALTHCARE CASEWORK. Provide final utility connections and utility service to equipment including waste, under Sections 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS; 22 00 00 PLUMBING SYSTEMS; 22 60 70 GAS AND VACUUM SYSTEMS FOR HEALTHCARE FACILITIES; and 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Laboratory equipment and fume hood layout; G, [_____]

Laboratory equipment and hood schedules

SD-03 Product Data

Fumehood assembly; G, [_____]

Radio isotope fumehood; G, [_____]

Biological safety cabinet; G, [_____]

Include descriptive literature, technical data sheets, and diagrams.

SD-04 Samples

Exterior hood paint; G, [_____]

SD-06 Test Reports

Fumehood test; G, [_____]

Base cabinet test; G, [_____]

SD-08 Manufacturer's Instructions

Fumehood assembly

Radio isotope fumehood

Biological safety cabinet

SD-10 Operation and Maintenance Data

Fumehood assembly, Data Package 2; G, [_____]

Radio isotope fumehood, Data Package 2; G, [_____]

Biological safety cabinet, Data Package 2; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 SUBMITTAL REQUIREMENTS

1.4.1 Hood Paint

Submit color chips of exterior hood paint. Submit [at least five] colors which are standard with the manufacturer.

1.4.2 Drawing Requirements

Show pertinent installation layout. Indicate details of construction and rough-in requirements.

1.4.3 Schedule

Include each type of equipment and hood and submit in accordance with Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT.

1.4.4 Tests

Submit fumehood test [and] cabinet test reports required by ACGIH-2097.

PART 2 PRODUCTS

2.1 MATERIALS, COMPONENTS, AND SPECIAL DESIGN REQUIREMENTS

****

NOTE: Use of certain chemicals such as hydrochloric and hydrofluoric acids may react with specified materials. Epoxy, mineral, or synthetic materials for hood interior working area, acid wastes, and drains may be required depending on chemicals to be used. If other materials are required, add text.

****

2.1.1 Aluminum Alloy

ASTM B221M ASTM B221 equivalent in ultimate tensile, yield, and shear strengths to Alloy 6063-T5 or 6063-T6.

2.1.2 Carbon Steel

ASTM A1008/A1008M, cold rolled sheets, commercial bright finish.

2.1.3 Stainless Steel

No 4 satin finish including welds and fabricated surfaces. Provide Type

302, 304, or 316 alloy unless otherwise specified. Provide minimum thickness of 1.5 mm U.S. Standard 16 gage, except 1.8 mm thick 14 gage for working surface.

2.1.4 Safety Glass

ASTM C1048, fully tempered "FT," clear.

2.1.5 Casework Components

Conform with Section 12 35 70 HEALTHCARE CASEWORK for base cabinets, counter tops, service fittings and finishes.

2.1.6 High Efficiency Particulate Air (HEPA) Filter

Meet requirements of UL 586.

2.1.7 Fumehood Design

Design, calculate face velocities, and test fume hoods in accordance with ACGIH-2097, Laboratory fume hoods, auxiliary systems, and associated equipment shall meet the requirements of NFPA 70 and NFPA 45.

2.1.8 Hood Static Pressure Loss

****

NOTE: For determining the system total static pressure loss for sizing blowers, use the hood maximum static pressure loss when operating at 46 mpm 150 fpm face velocity; allow 50 mm 2 inch water gage loss for dirty HEPA filter and 25 mm one inch water gage additional loss for a downstream charcoal filter or a prefilter (or the filter manufacturer's recommended resistance at the rated cfm of exhaust air).

****

With the sash in full-open position the static pressure loss through the fumehood shall not exceed 13 mm 1/2 inch water gage when operating at 23 mpm 75 feet per minute (fpm), 22 mm 7/8 inch water gage at 30 mpm 100 fpm, 29 mm 1.125 inch water gage at 38 mpm 125 fpm. For hoods equipped with bypass, the static pressure loss and exhaust volume shall remain relatively constant (within 5 percent) regardless of sash position.

2.1.9 Electrical Devices

Prewired at the factory to a common, integral junction box to provide easy exterior connection and disconnection.

2.2 UNITS

2.2.1 Unit [_____], [_____]

2.2.1.1 Base Cabinet Portion of Assembly

[_____].

2.2.1.2 Hood Interior

[_____].

2.2.1.3 Sash

[_____].

2.2.2 Fumehood Assembly, Constant Volume

****

NOTE: Provide packaged heater assembly for tempering cold outside air when auxiliary air type hoods are specified.

****

Constant volume, [auxiliary air] [bypass/airfoil] configuration, enclosed unit mounted on base cabinet; exterior dimensions maximum 1245 mm wide (across face) by 750 mm deep (front to back by 2400 mm high 49 inches wide (across face) by 30 inches deep (front to back) by 96 inches high; interior working area at least 900 mm wide by 600 mm deep by 1195 mm high 36 inches wide 24 inches deep by 47 inches high.

2.2.2.1 Base Cabinet Portion of Assembly

Carbon steel, modified to have recessed apron to contain electrical convenience outlets.

2.2.2.2 Hood Interior, Including Working Surface

Type 304 stainless steel, with interior vertical joints and intersections of vertical surface with working surface having an approximate 20 mm 3/4 inch radius. Provide working surface with a raised rim around all sides to prevent spillage from running out face of hood.

2.2.2.3 Sash

Safety glass, 5.6 mm 7/32 inch minimum thickness, counterbalanced, vertical sliding type, Type 304 stainless steel frame.

2.2.2.4 Baffle

Adjustable, with moving parts resistant to corrosion, removable for cleaning.

2.2.2.5 Lighting Fixtures

[Explosion proof] [Vapor proof], fluorescent, with cool white lamps and switch, providing 800 lux 75 foot candles on working area. Locate switch for fixture on exterior of hood frame, or in recess of base cabinet. Provide sealed safety glass window barrier between interior working and fixture spaces, and access for tube replacement exterior to hood interior working area.

2.2.2.6 Service Fixtures

Provide remote controls for piped services and locate on hood exterior frame. Provide serrated supply ends with nozzles arranged close to sash, precluding the need of reaching to interior back of hood to make connections to outlets. Base metal of fixtures shall be brass. Protect metal fixtures inside hood with chemical resistant coating of [clear plastic over polished chrome plate] [or] [_____].

a. Cold water: Remote controlled valve, with vacuum breaker; hood wall mounted gooseneck faucet with serrated nozzle. Arrange faucet parallel to hood wall and over cup sink.

b. Gas, air and vacuum: Provide fixtures for each service, each fitting with remote controlled valve and supply end (inside hood) consisting of a serrated hose nozzle and escutcheon trim. Provide natural gas, air at 685 kPa 85 psig, and vacuum at 750 mm 30 inches of HG.

c. Acid waste: Recessed cup sink, 75 by 150 mm 3 by 6 inches or 75 by 225 mm 3 by 9 inches, fabricated of Type 316 stainless steel, 2 liter capacity. Furnish with acid waste p-trap and locate under water faucet, integral with countertop. Provide acid vent.

d. Electrical convenience outlets: Two duplex, grounded, three-wire, 125 volt, 60 Hz, single phase [and one 240 volt single phase], 20 ampere. Locate in recessed area of base cabinet or on side posts of hood. Provide stainless steel or chrome-plated cover plate. [Provide 15 ampere circuit breaker protection.]

2.2.2.7 Blower Switch

****

NOTE: Coordinate switch requirements with specifications for the blowers for fume hoods. Fans requiring switches not discussed in the paragraph cited above (e.g., greater than one horsepower or 208-volt) shall have a single pole switch with an indicator light.

****

[Single-pole, 115-volt] [Double-pole, 208-volt], 60-Hz, with pilot light. Locate switch in hood frame or in recess of base cabinet.

2.2.2.8 Duct Stub

****

NOTE: Verify that ductwork to hoods is discussed in the appropriate documents and that blowers for the hoods are located at exhaust end. Avoid positive pressure in ducts.

****

Collar size suitable for ductwork indicated. Finish of areas that may come in direct contact with fumes shall be same material and finish as hood interior.

2.2.3 Radio Isotope Fumehood With Vent

Enclosed, isotope-type hood mounted on base cabinet of [auxiliary air] [bypass/airfoil] configuration. Maximum exterior dimensions: 900 mm wide (across face) by 750 mm deep (front to back) by 2400 mm high (including base) 36 inches wide (across face) by 30 inches deep (front to back) by 96 inches high (including base). Minimum interior working area: 750 by 600 mm deep by 1170 mm high 30 by 24 inches deep by 46 inches high.

2.2.3.1 Base Cabinet Portion of Assembly

Carbon steel comparable to a sink cupboard section, modified to have recessed apron to contain electrical convenience outlets.

2.2.3.2 Hood Interior, Including Working Surface

Type 304 stainless steel, with interior vertical joints and intersections of vertical surface with working surface having an approximate 20 mm 3/4 inch radius. Working surface shall have a raised rim all around to prevent spillage from running out face of hood.

2.2.3.3 Sash

****

NOTE: Several materials are available for sash. Clear safety glass is acceptable where minimum storage of materials allows use of lead bricks as a front barrier. Leaded safety glass provides excellent protection but scratches easily. Bulletproof glass and various plastics have good resistance to certain levels of radiation.

****

[Safety glass] [Leaded (equivalent to [_____] mm inch lead protection) safety glass] [_____], vertical sliding type, counterbalanced.

2.2.3.4 Lead Lining

Concealed, [_____] mm inch[es] thick. Provide with lapped seams, protecting areas adjacent to the three enclosed vertical sides of the hood [and the area below working surface of hood]. Lap sash area and intersections with adjacent surfaces at least 10 mm 3/8 inch.

2.2.3.5 Baffle

Adjustable with moving parts resistant to corrosion, removable for cleaning.

2.2.3.6 Lighting Fixture

Vapor proof, fluorescent, with cool white lamps and switch, providing 800 lux 75 foot candles on working area. Locate switch for fixture on exterior front of hood, or in recess of base cabinet.

2.2.3.7 Mirror

****

NOTE: Mirror is for view behind lead brick barrier. Clear safety glass is acceptable where minimum storage of materials allows use of lead bricks as a front barrier. Leaded safety glass provides excellent protection but scratches easily. Bulletproof glass and various plastics have good resistance to certain levels of radiation. It may be desirable for any sash finish. Delete if special equipment must be attached to back interior.

****

Fully framed, fully adjustable, and suitably backed to prevent fume damage to silvering.

2.2.3.8 Service Fixtures

Locate remote controls for piped services on hood exterior and provide serrated supply ends with nozzles arranged close to sash, precluding the need of reaching to interior back of hood to make connections to outlets. Base metal of fixtures shall be brass. Protect metal fittings inside hood with chemical resistant coating of [clear plastic over polished chrome plate] [or] [_____].

a. Cold water: Remote controlled valve with vacuum breaker; hood wall mounted gooseneck faucet with serrated nozzle. Arrange faucet parallel to hood wall.

b. Natural gas and vacuum: Provide fixtures for each service, each fitting with remote controlled valve. Supply end (inside hood) consisting of a serrated hose nozzle and escutcheon trim. Provide natural gas and vacuum 750 mm HG 30 inches HG.

c. Acid waste: Recessed cup sink, 750 by 150 or 75 by 225 mm 3 by 6 or 3 by 9 inches, fabricated of Type 316 stainless steel, 2 liter capacity. Furnish with acid waste p-trap and locate under water faucet, integral with countertop. Provide acid vent.

d. Electrical convenience outlet: Two polarized duplex, grounded, three-wire, 125 volt, 60 Hz, single phase [and one 240 volt single phase], 20 ampere. Locate in recessed area of base cabinet or on side posts of hood. Provide stainless steel or chrome-plated cover plate. [Provide 15 ampere circuit breaker protection.]

2.2.3.9 Blower Switch

****

NOTE: Coordinate switch requirements with specifications for the blowers for fume hoods. Fans requiring switches not discussed in the paragraphs cited above (e.g., greater than one horsepower or 208-volt) shall have a single pole switch with an indicator light.

****

[Single-pole, 115-volt] [Double-pole, 208-volt], 60-Hz, with pilot light. Locate switch in hood frame or in recess of base cabinet.

2.2.3.10 Duct Stub

****

NOTE: Verify that ductwork to hoods is discussed in the appropriate documents and that blowers for the hoods are located at exhaust end. Avoid positive pressure in ducts.

****

Collar size suitable for ductwork indicated. Material of collar same as hood interior or metal coated with epoxy having corrosion resistance comparable to finish on fittings in hood.

2.2.3.11 Replaceable Filter

[HEPA, efficiency [_____] percent] [and] [prefilter] [activated charcoal filter]; with stainless steel filter housing. HEPA filter static pressure loss shall not exceed 249 pascals one inch water gage when clean and operated at the rated airflow capacity.

2.2.3.12 Warning System

Ensure detection and alarm for insufficient air velocities caused by failure of supply or exhaust system or by dirty filter. [Provide static pressure sensing switch in exhaust duct to shut off auxiliary air blower when failure occurs].

2.2.4 Biological Safety Cabinet

Suitable for biological work and protecting the user from airborne infectious agents and similar hazardous particulate matter by providing an inward flow of air while preventing hazardous discharge into ambient atmosphere. Hood must meet the requirements for CDC 21-1112, and have overall approximate dimensions of 1800 mm wide (across front) by 790 mm deep (front to back) by 2160 high 72 inches wide (across front) by 31 inches deep (front to back) by 85 inches high.

2.2.4.1 Glove Panel

Removable, with two pairs of combination gloves, hand sections of surgical rubber, detachable from neoprene sleeves. Provide with built-in tubes connectable to air supply and appropriate "O" rings and clamps. Glove assembly removable, providing access into hood for bare-hand work. Hood shall meet the requirements for general purpose fume hoods of ACGIH-2097, when operated with glove panel removed.

2.2.4.2 Light Fixture[s]

Fluorescent, prewired, with cool white bulbs, with switch hood-mounted exterior to working area. [Ultraviolet, germicidal, prewired, single tube, with separate switch hood-mounted exterior to working area].

2.2.4.3 Service Fittings

Locate remote controls for piped services on hood exterior; provide serrated supply end. Base metal of fixtures shall be brass. Protect metal fixtures inside hood with [chemical resistant coating of clear plastic over polished chrome plate] [or] [______].

a. Natural gas, air at 685 kPa 85 psig minimum, and vacuum at 750 mm 30 inches HG.

b. Cold water: Remote controlled valve with vacuum breaker; hood-wall mounted gooseneck faucet with serrated nozzle. Arrange faucet parallel to hood wall.

c. Sink and drain: 300 mm long by 150 mm wide by 50 mm deep 12 inches long by 6 inches wide by 2 inches deep; minimum of 1.25 mm 0.050 inch thick stainless steel, welded into surface of cabinet, corners coved to not less than 6 mm 1/4 inchradius. Provide with stainless steel strainer; drain plug; and 38 mm 1 1/2 inch borosilicate glass non-syphon P-Trap, with compression joints and bottom clean-out fitting.

d. Electrical convenience outlets: Two polarized duplex, grounded, three-wire, 125 volt, 60-Hz., single phase [and one 240 volt single phase], 20 ampere. Locate on exterior of hood front or on hood side walls near hood front. Include stainless steel or chrome-plated cover plate. [Provide 15 ampere circuit breaker.]

2.2.4.4 Viewing Panel

Safety glass, 5.56 mm 7/32 inch minimum thickness.

2.2.4.5 Blower Switch

****

NOTE: Coordinate switch requirements with specifications for the blowers for fume hoods. Fans requiring switches not discussed in the paragraphs cited above (e.g., greater than 750 watt one horsepower or 208 volt) shall have a single pole switch with an indicator light.

****

[Single-pole, 115 volt] [Double-pole, 208 volt], 60 Hz, with pilot light. Include galvanized switch box and chrome-plated metal switch cover plate. Locate switch on hood exterior.

2.2.4.6 Duct Stub

****

NOTE: Verify that ductwork to hoods is discussed in the appropriate documents and that blowers for the hoods are located at exhaust end. Avoid positive pressure in ducts.

****

Collar size suitable for ductwork indicated. Finish of areas that may come in direct contact with fumes to be same as to hood interior.

2.2.4.7 Intake and Exhaust Filters

Replaceable HEPA filters having a minimum efficiency rating of 99.97 percent, including stainless steel housing. HEPA filter static pressure loss shall not exceed one inch water gage when clean and operated at the rated airflow capacity.

2.2.4.8 Warning System

Ensure detection and alarm for insufficient air velocities caused by failure of exhaust system or by dirty filters.

PART 3 EXECUTION

3.1 INSTALLATION

Install units at locations indicated. Conform to installation provisions of Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT [and utility installation provisions of] [Section 23 11 20 FACILITY GAS PIPING;] [Section 33 51 15 NATURAL-GAS / LIQUID PETROLEUM GAS DISTRIBUTION PIPELINES;] [Section 22 00 00 PLUMBING SYSTEMS;] [Section 22 60 70 GAS AND

VACUUM SYSTEMS FOR HEALTHCARE FACILITIES] [and] the ACGIH-2097 including provision for an adequate supply of tempered make-up air to meet the air flow requirements of fume hood(s). Provide interlocks for controls and alarms to maintain the required air balance between hood interiors and the room.

3.2 POSTED OPERATING INSTRUCTIONS

Provide in accordance with the requirements in Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.

3.3 FIELD QUALITY CONTROL

3.3.1 Inspection

Examine each unit for visual defects, operation and conformance to specifications.

3.3.2 Tests

Test each unit to ensure that the equipment is operational and conforms to specification requirements. Field tests for fume hood operation and performance shall meet the requirements of ACGIH-2097.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-11 68 13 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-11 68 13 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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08/17, CHG 1: 08/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-11 68 13 (August 2017)**
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****

SECTION 11 68 13

PLAYGROUND EQUIPMENT

08/17, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for furnishing and installing manufactured playground equipment in children's outdoor play areas.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Designer should require materials, products and innovative construction methods, and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in

this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A513/A513M	(2024) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B179	(2017) Standard Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM D173/D173M	(2003; R 2011; E 2012) Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D2454	(2014) Determining the Effect of Overbaking on Organic Coatings
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D6112	(2013) Compressive and Flexural Creep and Creep-Rupture of Plastic Lumber and Shapes
ASTM F1487	(2021) Standard Consumer Safety Performance Specification for Playground Equipment for Public Use
ASTM F2373	(2011) Standard Consumer Safety Performance Specification for Public Use Play Equipment for Children 6 Months through 23 Months

CONSUMER PRODUCT SAFETY COMMISSION (CPSC)

CPSC Pub No 325	(2015) Public Playground Safety Handbook

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

1.2 DEFINITIONS

1.2.1 Age-Appropriate

A term that describes equipment scale to include platform height, fall height and maximum equipment height, that allows safe and successful use by children of a specific chronological age; mental and physical ability; and anthropometric measurement. Maximum equipment height and complexity will not exceed a child's ability in that age group.

1.2.2 Composite Structure

Also "Composite Play Structure; Linked Structure". Two or more play events attached, directly adjacent or functionally linked, to create one integral unit that provides more than one play activity.

1.2.3 Designated Play Surface

Any elevated surface for standing, walking, sitting, or climbing; or a flat surface a minimum 50 mm 2 inches wide having up to a maximum 30 degree angle from horizontal. In some play events the platform surface will be the same as the designated play surface. However, the terms should not be interchanged as they do not define the same point of measurement in accordance with ASTM F1487.

1.2.4 Guardrail

A device around an elevated surface that prevents inadvertent falls from the elevated surface.

1.2.5 Maximum Equipment Height

The highest point on the equipment (i.e., roof ridge, top of support pole).

1.2.6 Play Event

A piece of manufactured playground equipment that supports one or more play activities.

1.2.7 Protective Barrier

An enclosing device around an elevated surface that prevents both inadvertent and deliberate attempts to pass through the device.

1.2.8 Protective Surfacing

Material to be used within the use zone that meets the fall attenuation requirements of Section 32 18 16.13 PLAYGROUND PROTECTIVE SURFACING.

1.2.9 Suspended Hazard

Cable, wire, rope or similar devices suspended up to a maximum2100 mm 7 feet high between play events; or installed up to a maximum 45 degree angle from the ground to the play event.

1.2.10 Tot

A child under 4 years of age in the pre-toddler and toddler age group.

1.2.11 Use Zone

The area beneath and immediately adjacent to a play structure or equipment that is designated for unrestricted circulation around equipment, and on whose surface it is predicted that a user would land when falling from or exiting the equipment.

1.3 SYSTEM DESCRIPTION

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NOTE: Drawings will indicate the perimeters of the play event use zone defining fall height, platform height and maximum equipment height; spot elevations and details as required to install protective surfacing to meet child safety requirements.

Accessibility: Drawings will indicate spot elevations; dimensions; ramp slope and rise; transfer platform height and transfer space; transfer step and height; and maneuvering space as required to install play events to meet child accessibility requirements.

****

1.3.1 Child Safety

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NOTE: Specify playground equipment in accordance with ASTM F1487.

Playground Areas Other Than Child Development Centers (CDC): Inactive UFC 3-210-04, Children's Outdoor Play Areas, provides guidance for the age groups defined in paragraph AGE GROUPS concerning design of outdoor play areas for children. Exercise caution when using this UFC as some of the code information may be outdated. Coordinate safety aspects with CPSC Pub No 325. UFC 3-210-04 describes the differences between unsupervised play areas such as family housing areas and supervised play areas such as child development centers. Site selection and analysis; user needs analysis; play area committee; age group criteria; play activities; play area relationships; child safety requirements; playground equipment; protective surfacing; and exterior plant materials are discussed in terms for designing a playground layout.

Child Development Centers (CDC): The CDC outdoor play area requirements are defined in the DA Standard Design Package for Child Development Centers and TI 800-01 Design Criteria, Appendix G, Child Development Centers. The CDC accommodate the age groups as defined in paragraph AGE GROUPS. UFC 4-740-14 discusses inspection frequency and preventative maintenance requirements to assist with selection of playground equipment.

Use Zones (Clear Area or Fall Zones): Play event use zone perimeters are measured in accordance with the requirements of paragraph CHILD SAFETY AND ACCESSIBILITY STANDARDS and paragraph FALL HEIGHT.

****

Provide play events that meet the child safety performance requirements described in CPSC Pub No 325 and ASTM F1487. The requirements include the following: Head and neck entrapment; sharp points, edges, and protrusions; entanglement; pinch, crush, and shear points; suspended hazards; play event access and egress points; play event use zone perimeter; and design criteria. Since ASTM F1487 criteria is defined for the minimum user through the maximum user (2 through 12 years of age), the requirements for the infant or pre-toddler age group are not prescribed. This specification and Section 32 18 16.13 PLAYGROUND PROTECTIVE SURFACING establish the requirements for the infant and pre-toddler age groups.

1.3.2 Child Accessibility

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NOTE: Facilities will be accessible in accordance with TI 800-01 and 36 CFR 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities. Ensure that elevated play events will reasonably accommodate a user with mobility impairments. One access and egress point for a furnished play event must meet accessibility. Some play events will need to be installed higher to accommodate the transfer system. The maximum equipment height should be reduced to lower the cost of the transfer system. Ensure all children are accommodated on the playground in a 'play for all' socialization skill development environment. When children with disabilities are allowed to choose play events, they are more eager to learn the skills necessary to participate.

****

The accessibility requirement in accordance with ASTM F1487 includes the following: When the play event use zone consists of a protective surfacing rated as inaccessible, provide at least one accessible route from the use zone perimeter to the play event. When there is more than one of the same play activity provided, only one must meet accessibility requirements (i.e., one swing seat or one spring rocking play event). When the access and egress points are not the same for a play event, provide an accessible route to both. The accessible route must access all accessible play events and elements. The protective surfacing performance requirements must be in accordance with Section 32 18 16.13 PLAYGROUND PROTECTIVE SURFACING.

1.3.3 Age Groups

Play areas are designed to provide challenging play activities by age group. Design playground equipment to be age appropriate for the age group designated to use it. There is no anthropometric or fall attenuation significance to the discrepancy for the school-age age group between paragraph CHILD DEVELOPMENT CENTERS (CDC) and paragraph PLAYGROUND AREAS OTHER THAN CDC as described below. The Army age groups are defined as follows:

1.3.3.1 Child Development Centers (CDC)

The age groups accommodated by the CDC program range from 6 weeks through 8 years of age defined as the following: infant age group (6 weeks through 12 months); pre-toddler age group (12 through 24 months); toddler age group (2 through 3 years of age); pre-school age group (3 through 5 years of age); and school-age age group (5 through 8 years of age).

1.3.3.2 Playground Areas Other Than CDC

The age groups accommodated at these areas range from less than 12 months through 12 years of age defined as the following: infant age group (less than 12 months); pre-toddler age group (12 through 24 months); composite toddler/pre-school age group (2 through 5 years of age); school-age age group (5 through 9 years of age); and pre-teen age group (9 through 12 years of age). A multi-age playground consists of the following age groups: infant, pre-toddler, and composite toddler/pre-school age groups.

1.3.4 Equipment Identification

Identify playground equipment with attached and durable label stating the age-group that the equipment is designed to accommodate. Provide permanent WARNING labels and manufacturer's identification labels, ASTM F1487. Submit a list to include part numbers of furnished play event and equipment materials and components.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Configuration

Shop Drawings

Fall Height

Finished Grade and Underground Utilities

SD-03 Product Data

Equipment

Equipment Identification

Delivery, Storage and Handling

Manufacturer Qualification

Wood

Spare Parts

Materials

[Recycled content for steel components; S]

[Recycled content for stainless steel components; S]

[Recycled content for aluminum components; S]

[Recycled Content for plastic molded as deck material; S]

[Recycled Content for plastic molded as rails; S]

[Recycled Content for Plastic Molded as roof planks or pickets; S]

SD-04 Samples

Color

SD-06 Test Reports

Wood Finishes

SD-07 Certificates

Materials

Manufacturer Qualification

Installer Qualification

Manufacturer's Representative

Wood Treatment

Substitution

Play Event Modification

Child Safety and Accessibility Evaluation

[Certified sustainably harvested wood components; S]

SD-10 Operation and Maintenance Data

Maintenance Instructions

SD-11 Closeout Submittals

Maintenance Instructions

[1.5 CERTIFICATIONS

****

NOTE: Use certified sustainably harvested wood wheresuitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Designer must verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably

harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects allow the entire list of third party certifications.
****

1.5.1 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

]1.6 QUALITY ASSURANCE

1.6.1 Manufacturer Qualification

Play events and equipment similar to those furnished must have been installed in a minimum 10 sites and been in successful service for a minimum 5 year calendar period. The manufacturer must provide a Certificate of Insurance AA rated for a minimum one million dollars covering both product and general liability. Submit name of the owner or user; service or preventive maintenance provider; date of the installation; point of contact and telephone number; and address for 10 sites.

1.6.2 Installer Qualification

The installer must be certified by the manufacturer for training and experience installing the play events and equipment. Submit the installer's company name and address, and training and experience certification.

1.6.3 Manufacturer's Representative

The manufacturer's certified playground safety inspector or the manufacturer's designated certified playground safety representative must supervise the installation and adjustment of the play events and equipment to verify the installation meets the requirements of the manufacturer, this specification, and paragraph CHILD SAFETY AND ACCESSIBILITY STANDARDS. Submit the individual's name, company name and address, and playground safety training certificate.

1.6.4 Technical Representative

1.6.4.1 Child Development Centers (CDC)

The technical representative for outdoor play areas at CDC is the installation Child Development Services (CDS) Coordinator. Base the design of the CDC outdoor play area on the developmental play program for the age groups accommodated at the CDC. The play area is designed to support the CDC program and to provide a stage set for creative play. Developmental activities are selected which promote the intellectual, social, emotional and physical growth of the children. The developmental play program is developed by the MACOM CDS Director, installation CDS Coordinator and CDC Director. They are responsible for the developmental play program and the selection of play events to meet that program.

1.6.4.2 Playground Areas Other Than CDC

The technical representative for outdoor play areas on sites other than CDCs must be the Director of Public Works or designated representative. Base the design of these outdoor play areas on the play program and the age groups to be accommodated as determined by the play area committee.

1.6.5 Prohibited Equipment

Equipment that does not meet the Army's developmental play program requirements and are prohibited on outdoor play areas include the following: chain balance beams; rotating equipment, such as merry-go-rounds, log rolls, whirls and may poles; fulcrum seesaws (teeter totters); spring rocking equipment intended for standing; animal figure swings; rope swings; multiple occupancy swings; swinging exercise and trapeze bars; swinging platforms; tire climbers; swinging dual exercise rings; roller slides; trampolines; swinging gates or doors; and new or used vehicle tires. Also play houses or enclosures made of horizontal posts or bars with space between them; wood components treated with creosote, pentachlorophenol, and tributyl tin oxide; and wood components coated with a finish containing pesticide.

1.6.6 Shop Drawings

When the use zone perimeter and play event configuration conflict with the requirements and paragraph CHILD SAFETY AND ACCESSIBILITY STANDARDS, submit scale drawings defining the revised use zone perimeters and play event layout and corrective measures to include the following: Adjustment to the play event with the use zone perimeter; use zone perimeter overlaps; hard surface area and pathway widths; structures; exterior plant material and planters; walls and fences; and bare or painted metal platform and slide bed orientation to the direct sun.

1.7 DELIVERY, STORAGE, AND HANDLING

Submit a delivery schedule and manufacturer's name at least 10 calendar days prior to the first day of delivery. Inspect playground equipment, upon arrival at the job site, for meeting age-appropriate requirements for the age-group that the equipment is designated to accommodate, and specified quality in accordance with paragraphs MATERIALS and CONFIGURATION. Equipment must be delivered, handled, and stored in accordance with the manufacturer's recommendations. Remove from the job site prohibited or unacceptable equipment. The storage area must be as designated. Store the materials in a dry, covered area until installed.

1.8 WARRANTY

Furnished play events and equipment must have a minimum 1 year calendar period warranty.

1.9 MAINTENANCE

Submit [two] [_____] bound copies of the manufacturer's operation and maintenance manuals containing the Maintenance Instructions and describing the recommended preventive maintenance, inspection frequency and techniques, periodic adjustments, lubricants, and cleaning requirements. Furnish play event and equipment spare parts provided by the manufacturer.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials which are the standard products of a manufacturer regularly engaged in the manufacture of play event products. Submit results of assembled play event structural integrity tests; vertical load tests; and the maximum number of users that can be on the play event. Prior to the delivery of materials, submit certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates must include composition and tests to which the material has been subjected.

2.1.1 Metal

Metal components must have factory-drilled holes and be corrosion resistant. The components must be free of excess weld and spatter. Metallic materials must conform to Section 08 31 00 ACCESS DOORS AND PANELS. Components with extra holes not filled by hardware or covered by components must be rejected.

2.1.1.1 Steel

****

NOTE: Use materials with recycled content where appropriate for use. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows the product is available among US national manufacturers above the minimum recycled content stated.

****

Steel components must comply with ASTM A135/A135M, ASTM A500/A500M, or ASTM A513/A513M. Minimum tensile strength must be 310 Mpa 45,000 psi. Minimum yield point must be 225 Mpa 33,000 psi. Provide steel components with pre-consumer recycled content of 40 percent minimum. [Provide data identifying percentage of recycled content for steel components.] Provide stainless steel components with recycled content of 60 percent minimum. Provide data identifying percentage of recycled content for stainless steel components.

2.1.1.2 Aluminum

****

NOTE: Use materials with recycled content where

appropriate for use. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows the product is available among US national manufacturers above the minimum recycled content stated.

****

Extruded aluminum components must be type 6061-T6, 6062-T6, or 6063-T6, and must conform to ASTM B221M ASTM B221. Minimum tensile strength of extruded aluminum components must be 270 Mpa 39,000 psi, and the minimum yield must be 250 Mpa 36,500 psi. Cast aluminum alloy must conform to ASTM B179, ASTM B26/B26M, and ASTM B108/B108M. Provide aluminum components with recycled content of 40 percent minimum. Provide data identifying percentage of recycled content for aluminum components.

2.1.1.3 Chain

Chain must be a minimum size 4/0 and must be corrosion resistant zinc plated. Polyvinyl chloride coating must be as specified.

2.1.1.4 Rope Cable

Rope cable must be composed of strands of steel cable with a polypropylene or Dacron synthetic covering that is UV stabilized. Cable ends must be capped to prevent fraying.

2.1.1.5 Hardware

Hardware must be corrosion resistant and consist of the following: aluminum, stainless steel, brass, zinc plated steel, zinc-chromate plated steel, or galvanized steel, ASTM A153/A153M. When secured, the hardware must require a tool to prevent unauthorized loosening and removal.

2.1.1.6 Rails, Loops, and Hand bars

Rails, loops, and hand bars must consist of corrosion resistant aluminum, powder-coated steel or galvanized steel. Polyvinyl chloride coating, if provided, must be as specified.

2.1.1.7 Anchors

Anchors must be in accordance with manufacturer's recommendations.

2.1.2 Wood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective.

Designer must verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.
****

Wood components must be exterior premium grade and free of knots. Wood components must have factory-drilled holes. Components with extra holes not filled by hardware or covered by other components will be rejected. [Provide certified sustainably harvested wood components.]

2.1.2.1 Wood Treatment

Treat wood components that are not naturally rot and insect resistant, by using standard treatment procedures. Any wood placed up to a maximum 150 mm 6 inches above, or any portion below the top elevation of the protective surfacing, must be treated after fabrication. Creosote, pentachlorophenol, and tributyl tin oxide are prohibited according to ASTM F1487. Submit wood treatment chemical content, toxicity level, and life-cycle durability. Submit certifications of wood treatment materials and processes.

2.1.2.2 Plywood

Provide plywood that is a minimum 19 mm 3/4 inch thick exterior premium grade, and adhered with a waterproof glue that will not separate under conditions of prolonged freezing temperatures, extreme heat, or excessive moisture. Face layers must be smooth, fine and tightly grained, free of knots, patches, or surface irregularities. Exposed surface must consist of a material with high paint adhesion and retention characteristics. Edges must be sanded smooth and eased to a minimum 3 mm 1/8 inch radius. Fill voids at edges with epoxy prior to sanding.

2.1.3 Plastic Components

2.1.3.1 Panels

Plastic panels must be molded of ultraviolet (UV) and color stabilized polyethylene or nylon with a minimum 5 mm 3/16 inch thickness, ASTM F1487. Edges must be a minimum 5 mm 3/16 inch radius.

2.1.3.2 Window

Plastic windows must be flat or molded into a bubble shape, consisting of clear polycarbonate plastic a minimum 5 mm 3/16 inch thick before forming in accordance with ASTM D1248. Material must be shatterproof and resistant to crazing, cracking, or fogging.

2.1.4 Plastic Components

Construct or manufacture material with a maximum 6 mm 1/4 inch deflection or creep in any member, ASTM D6112. Submit results of individual component and assembled unit structural integrity test; creep tolerance; deflection tolerance; and vertical load test results.

2.1.4.1 High Density Polyethylene

****
NOTE: Ensure manufacturers supply quality plastic products made from post-consumer recycled high

density polyethylene that is equal to the performance of metal or wood by providing tight performance standards. High density polyethylene can be manufactured using post-consumer recycled plastic resins from products such as milk containers. Recommend products using high density polyethylene.
****

Mold components of ultraviolet (UV) and color stabilized polyethylene consisting of a minimum 75 percent plastic profile of high-density polyethylene, low-density polyethylene, and polypropylene raw material. The material must be non-toxic, have no discernible contaminates such as paper, foil, or wood, and contain a maximum 3 percent air voids. The material must be free of splinters, chips, peels, buckling, and cracks and be resistant to deformation from solar heat gain. Material must have factory-drilled holes. Components with extra holes not filled by hardware or covered by other components will be rejected. The material must not be painted.

2.1.4.2 Panel

Panels must be a minimum 6 mm 1/4 inch thick; exposed edges must be smoothed, rounded, and free of burrs and points; and the material must be shatterproof and resistant to fading, cracking, or fogging.

2.1.4.3 Structural Component

Recycled plastic materials will not be used as load bearing structural members: framing, beams, columns or posts.

2.1.4.4 Recycled Plastic Molded As Deck Material

****
NOTE: Recycled plastic molded as lumber and wood-polymer lumber are susceptible to both creep and deflection; therefore, it cannot be used for a load bearing structural members (framing, beams, columns or posts) of playground equipment. To overcome creep and deflection, the deck product is increased in volume of material and dimension.
****

****
NOTE: Use materials with recycled content where appropriate for use. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows the product is available among US

national manufacturers above the minimum recycled content stated.

****

For deck or platform construction, the span of the structural support members must be a maximum 300 mm 12 inches on center and recycled plastic decking must connect to a minimum three joists. Material used for decking must have a non-slip texture surface. The assembly must deflect a maximum 1/360 of the span of the frame when exposed to a uniform live load of 585 N/m 40 lbs/ft. The product must meet the structural integrity test requirements, ASTM F1487 and ASTM D6112. Recycled plastic deck material must contain a minimum 95 percent of recycled content. Provide data identifying percentage of recycled content for plastic molded as deck material.

2.1.4.5 Recycled Plastic Molded as Rails

****

NOTE: Use materials with recycled content where appropriate for use. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows the product is available among US national manufacturers above the minimum recycled content stated.

****

Recycled plastic rails must contain a minimum 95 percent of recycled content. Provide data identifying percentage of recycled content for plastic molded as rails.

2.1.4.6 Recycled Plastic Molded as Roof Planks or Pickets

****

NOTE: Use materials with recycled content where appropriate for use. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows the product is available among US national manufacturers above the minimum recycled

content stated.
****

Recycled plastic must contain a minimum 95 percent of recycled content. Provide data identifying percentage of recycled content for plastic molded as roof planks or pickets.

2.1.5 Coatings

****
NOTE: Regional climatic conditions must be considered when selecting playground equipment. Regions that are extremely hot have considerations for equipment selection that are different from regions with freezing conditions. Contact burn injury or contact skin freezing are serious safety concerns. The coatings of the play equipment become extremely important to avoiding these conditions.
****

2.1.5.1 Galvanized

Metal components must be hot-dipped in zinc after fabrication according to ASTM A123/A123M. Remove tailings and sharp protrusions formed as a result of the hot-dip process; edges must be burnished.

2.1.5.2 Polyester Powder

Powder-coated surfaces must receive electrostatic zinc coating prior to painting. Powder coating must be electrostatically applied and must be oven cured. Polyester powder must be in accordance with the following: ASTM D3359 for adhesion; ASTM D173/D173M for flexibility; ASTM D3363 for hardness; ASTM D2794 for impact; ASTM D2454 for overbake resistance; ASTM B117 for salt spray resistance; and ASTM D822 for weatherability.

2.1.5.3 Polyvinyl Chloride (PVC)

Prime PVC coating with a clear acrylic thermosetting solution. The primed parts must be preheated prior to dipping. The liquid polyvinyl chloride must be UV stabilized and mold-resistant. The coated parts must be cured. The coating must be a minimum 2 mm 0.08 inch thick within a plus or minus 0.5 mm 0.020 inch tolerance. The coating must have an 85 durometer hardness, ASTM D3363. The finish must be slip-resistant.

2.1.5.4 Concrete

Provide concrete conforming to [_____].

2.1.5.5 Precast Concrete

Provide precast concrete material conforming to Section 03 45 00 PRECAST ARCHITECTURAL CONCRETE.

2.1.5.6 Cast-In Place Concrete

Provide cast-in-place concrete material in conformance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.6 Wood Sealants

Exposed wood surfaces must have factory applied prime coat with a minimum [2] [_____] spray coats of two-component polyurethane or approved preservative that meets paragraph WOOD TREATMENT.

2.1.6.1 Paint

Paint must be factory applied to a minimum of 2 coats. Paint must comply with Section 09 90 00 PAINTS AND COATINGS. Paint must be weather resistant, and resist cracking, peeling and fading.

2.1.6.2 Sealants

Seal all applied surfaces from air; sealants containing pesticide are prohibited.

2.1.7 Color

Color must be provided [as indicated] [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____]. Submit [2] [_____] color charts displaying the colors and finishes.

2.2 EQUIPMENT

****

NOTE: Ensure the play events selected are age-appropriate for the age group designated to use them.

Playground Areas Other Than Child Development Centers (CDC): CPSC Pub No 325 and ASTM F1487 both describe the requirements for children from the toddler through pre-teen age group (2 through 12 years of age). Consult Inactive UFC 3-210-04, Children's Outdoor Play Areas, and ASTM F2373 for guidance concerning children in the infant through pre-toddler age groups (less than 12 months through 2 years of age). Exercise caution when using the UFC as some of the code information may be outdated. Coordinate safety aspects with CPSC Pub No 325.

Child Development Centers (CDC): The CDC program accommodates children from 6 weeks through 8 years of age. The CDC outdoor play area requirements for these age groups are defined in the DA Standard Design Package for Child Development Centers and TI 800-01 Design Criteria, Appendix G, Child Development Centers. UFC 4-740-14 Child Development Centers, discusses inspection frequency and preventative maintenance requirements may assist with the selection of playground equipment.

****

Submit manufacturer's descriptive data; catalog cuts; references; and the latest edition of ASTM F1487[, ASTM F2373] and CPSC Pub No 325. Manufacturer's specifications, handling and storage requirements, installation procedures, and safety data sheets to include the following:

bare or painted metal platform and slide bed orientation from the direct sun; warnings; and child safety performance standards.

2.2.1 Configuration

Provide play event configuration, platform height, fall height, and maximum equipment height [as indicated] [_____]. When the configuration varies from the play event shown, submit scale drawings defining the revised configuration to include the following: equipment layout with the use zone perimeter; designated play surface spot elevations; maximum equipment height spot elevations; platform spot elevations; protective barriers; guardrails; bare or painted metal platform and slide bed orientation; and play events in relationship to the playground layout.

2.2.2 Substitution

Substitutions will not be allowed and play events will not be selected without written approval from the technical representative. Evaluate manufacturer substitutions which increase the play event platform height or maximum equipment height. The increased height requires additional protective surfacing in accordance with paragraph FALL HEIGHT. Submit technical representative's written approval.

2.2.3 Platform Height

Platform height is used to define the age group for age appropriate play events and composite structures. To be age appropriate, the platform height must meet the finished elevations of the age groups in the following paragraphs. For some play events, platform height and paragraph FALL HEIGHT are the same.

2.2.3.1 Pre-Toddler Age Group

Platforms designed for children 12 through 24 months of age must have a finished elevation a maximum 900 mm 36 inches above the finished elevation of the protective surfacing.

2.2.3.2 Toddler Age Group

Platforms designed for children 2 through 3 years of age must have a finished elevation a maximum 1200 mm 48 inches above the finished elevation of the protective surfacing.

2.2.3.3 Pre-School Age Group

Platforms designed for children 3 through 5 years of age must have a finished elevation a maximum 1200 mm 48 inches above the finished elevation of the protective surfacing.

2.2.3.4 School-Age Age Group

Platforms designed for children 5 through 8 years of age must have a finished elevation a maximum 1800 mm 72 inches above the finished elevation of the protective surfacing.

2.2.3.5 Pre-Teen Age Group

Platforms designed for children 8 through 12 years of age must have a finished elevation a maximum 1800 mm 72 inches above the finished elevation of the protective surfacing.

2.2.4 Protective Barrier and Guardrail

Provide protective barriers and guardrails in accordance with paragraph CHILD SAFETY AND ACCESSIBILITY STANDARDS. This specification establishes the protective barrier and guardrail requirements for the infant and pre-toddler age group.

2.2.4.1 Protective Barrier

The protective barrier for pre-toddler, toddler, and pre-school age groups must be provided on elevated surfaces a minimum 760 mm 30 inches above the protective surfacing. The protective barrier for school-age and pre-teen age groups must be provided on elevated surfaces a minimum 1200 mm 48 inches above the protective surfacing. The protective barrier must completely surround the elevated surface except for the access or egress route. As infants are not to be placed on an elevated surface, the protective barrier for the infant age group must be the same as the crawl wall defined in paragraph MEASURING FALL HEIGHT.

2.2.4.2 Guardrail

The guardrail for pre-toddler, toddler, and pre-school age groups must be provided on elevated surfaces a minimum 510 mm 20 inches above the protective surfacing. The guardrail for school-age and pre-teen age groups must be provided on elevated surfaces a minimum 760 mm 30 inches above the protective surfacing. The guardrail must completely surround the elevated surface except for the access or egress route. As infants are not to be placed on an elevated surface, the guardrail for the infant age group must be the same as the crawl wall defined in paragraph MEASURING FALL HEIGHT.

2.2.5 Sand Table

****

NOTE: Ensure sand tables are located where play activity will not restrict or conflict with circulation.

****

The sand table with a cover must be as shown. The cover must not be attached to the table. The sand sieve size must be provided as defined in Section 32 18 16.13 PLAYGROUND PROTECTIVE SURFACING.

2.2.6 Multiple-Axis (Rotating) Swing

The swivel mechanism must contain a durable long life bearing to reduce friction and wear. A tire manufactured specifically for a multiple-axis swing must be provided and must weigh a maximum 15.8 kg 35 lb. The tire must be composed of rotationally molded, low density elastomer, and internally reinforced with a steel ring. The tire must have no openings for insects or water. The multiple-axis swing must not be confused with the multiple occupancy swing as they are not the same.

2.2.7 Single-Axis (To-Fro) Swing

2.2.7.1 General Requirements

The swing seat must be molded of high quality rubber or polyurethane with an encapsulated steel reinforcement. The swing seat must be designed to accommodate one user

2.2.7.2 Full Bucket Swing Seat

A full bucket swing seat is designed to accommodate children up to a maximum 4 years of age; the seat is used by a child with adult assistance. The swing seat must be constructed of rubber with a tempered steel insert molded inside, must be double-sided, must be enclosed by rubber both front and back, and must include a 360 degree waist enclosure and leg enclosures. Leg enclosures must be sized to avoid head or neck entrapment. Finish must be smooth and edges must be rounded. These swing seats must not be mixed with other swing seats within a bay.

2.2.8 Spring Rocking Equipment

Spring mechanisms must conform to the requirements for pinch, crush, and shear points for a maximum 54 kg 120 lb weight limit in accordance with ASTM F1487. Seats must be designed to accommodate only the intended number of users.

2.2.9 Roofs

Roofs must contain no designated play surface.

2.2.10 Sliding Poles

Sliding poles must be a maximum 48 mm 1.9 inch diameter and a continuous surface with no protruding welds or joints along the sliding area.

2.2.11 Plastic Slide

****

NOTE: Plastic is the preferred slide material, and must be installed to face in any direction but north.

****

The slide must be molded of UV stabilized polyethylene or nylon with minimum of 5 mm 3/16 inch wall thickness. The edge must be a minimum 5 mm 3/16 inch radius, ASTM D1248, Type II, Class A, Grade G4.

2.2.12 Play House or Enclosures

Provide the play house with a shelf at the window. The play house and enclosures will be designed to provide other than direct outside visibility from a minimum 1.5 m 5 feet to all inside corners.

PART 3 EXECUTION

3.1 SITE PREPARATION

3.1.1 Finished Grade and Underground Utilities

Submit finished grade, underground utilities, storm-drainage system and irrigation system status; and location of underground utilities and facilities. Verify that finished grades are as indicated; the smooth grading has been completed in accordance with Section 31 00 00 EARTHWORK; installation of the underground utilities through the area has been completed in accordance with Section 31 00 00 EARTHWORK; installation of the storm-drainage system through the area has been completed in accordance with Section 33 40 00 STORMWATER UTILITIES; and the installation of underground sprinklers through the area has been completed in accordance with Section 32 84 24 UNDERGROUND SPRINKLER SYSTEMS. The location of underground utilities and facilities in the area of the operation must be verified. Damage to underground utilities and facilities must be repaired at the Contractor's expense.

3.1.2 Layout

3.1.2.1 General

The layout of the entire outdoor play area must be staked before excavation begins to include the following: all play event configuration access and egress points; use zone perimeters; hard surface areas and pathway widths; exterior plant material and planters; walls and fences; and structures. Provide sufficient space between all adjacent play events and individual play events for play activities and circulation. Moving and rotating play events must be located away from circulation to prevent collisions.

3.1.2.2 Use Zone

The use zone is associated with the following terms; "Clear Area," and "Fall Zone". The use zone must be free of hard surfaces, objects or obstacles that a child could run into or fall on top of and be injured. The use zone must consist of protective surfacing in accordance with the requirements of Section 32 18 16.13 PLAYGROUND PROTECTIVE SURFACING. Use zone perimeters must not overlap hard surfaces. The use zone perimeter must meet or exceed the requirements of paragraph CHILD SAFETY AND ACCESSIBILITY STANDARDS. Use zone perimeters must not overlap except for certain play events as defined in ASTM F1487.

3.1.3 Orientation

Bare or painted metal platforms and slide beds must be oriented from the direct sun; or shaded to reduce contact burn risk. Play events that require orientation to adjacent play events or to meet visibility requirements must be properly oriented.

3.1.4 Obstructions Below Ground

When obstructions below ground affect the work, submit shop drawings showing proposed adjustments for approval.

3.2 INSTALLATION

Play events must be installed according to the manufacturer's recommendations and as shown to meet the requirements of paragraph CHILD SAFETY AND ACCESSIBILITY STANDARDS.

3.2.1 Play Event Modification

Site modifications of play events affect the coverage provided in paragraph WARRANTY; therefore, play events and equipment must not be modified without the written approval of the manufacturer. Submit manufacturer's written approval.

3.2.2 Wood Finishes

Field applied or touch up of wood finishes must meet the same specifications as finishes applied at the factory. Submit wood finish chemical content and toxicity level.

3.2.3 Plastic Play Events

Plastic and recycled plastic components must be connected by stainless steel hardware. The hardware must be countersunk. Recycled plastic molded as lumber or wood-polymer lumber must be installed in accordance with the manufacturer's recommendations.

3.2.4 Footings

The top elevation of play event footings will be installed at the subbase of the protective surfacing.

3.2.5 Multiple-Axis (Rotating) Swing

The multiple-axis (rotating) swing must be located away from other play events and circulation. It must not be attached to a composite structure.

3.2.6 Single-Axis (To-Fro) Swing

The single-axis (to-fro) swing must be located on the perimeter of the outdoor play area. It must not be attached to a composite structure.

3.2.7 Slide

The required exit region clear area must be provided in accordance with ASTM F1487.

3.2.8 Chain or Rope Ladder, Climber or Net Climber

A chain or rope ladder; climber; net climber; and similar components must be installed in the vertical position. Angled or arch positions are not accepted.

3.2.9 Composite Structure

The composite structure use zone perimeter must be composed of the use zone perimeters of the play events that, when joined together, comprise the composite structure.

3.2.10 Fall Height

****

NOTE: To assist manufacturers in providing the required depth of protective surfacing, the fall height and the maximum equipment height dimensions and spot elevations for each play event must be shown on the drawings.

****

3.2.10.1 General

The fall height is defined as the vertical distance between the finished elevation of the designated play surface and the finished elevation of the protective surfacing beneath it. For some play events the fall height and paragraph PLATFORM HEIGHT are the same. For some play events the fall height and maximum equipment height are the same. When the furnished play event fall height varies from the play event shown, submit scale drawings defining the revised depth or type of protective surfacing to meet or exceed the requirements of Section 32 18 16.13 PLAYGROUND PROTECTIVE SURFACING must be provided.

3.2.10.2 Measuring Fall Height

EQUIPMENT	MEASURING FALL HEIGHT
Composite Structure	For a platform surrounded by protective barriers, measure from the platform finished elevation.
	For a platform surrounded by guardrails, measure from the guardrail top elevation.
Infant Crawl Area	A maximum 600 mm 24 inch height, measured from the crawl wall or barrier finished elevation.
Playhouse, Nonclimbable	Measure from the designated play surface finished elevation.
Spring Rocking Equipment	Measure from the seat top elevation.
Stationary Equipment, Climbable	Measure from the maximum equipment height finished elevation.
Stationary Equipment, Nonclimbable	Measure from the designated play surface finished elevation.
Swing	Measure from the bottom of the pivot point.

3.2.11 Signage

For playground areas other than CDC, durable permanent signage must be provided to identify the age group the equipment is designed to accommodate. Signage must be in accordance with Section 10 14 00.10 EXTERIOR SIGNAGE.

3.3 RESTORATION AND CLEAN UP

When the operation has been completed, clean up and protect the site. Existing areas that have been damaged from the operation must be restored to original condition at the Contractor's expense.

3.3.1 Clean Up

The site and play events must be cleaned of all materials associated with the operation. Play events and surfaces must be cleaned of dirt, stains, filings, and other blemishes occurring from shipment and installation. Cleaning methods and agents must be as recommended by the manufacturer. Required labeling must be undamaged and visible in accordance with paragraph EQUIPMENT IDENTIFICATION.

3.3.2 Protection

The area must be protected as required or directed by providing barricades and signage. Signage must be in accordance with Section 10 14 00.10 EXTERIOR SIGNAGE.

3.3.3 Disposal of Materials

Excess and waste material must be removed and disposed off Government property.

3.4 CHILD SAFETY AND ACCESSIBILITY EVALUATION

a. When the protective surfacing is installed the play events and protective surfacing must be thoroughly inspected and measured to verify the playground meets manufacturer's recommendations, paragraph CHILD SAFETY AND ACCESSIBILITY STANDARDS, and paragraph FALL HEIGHT.

b. The play events must be age appropriate for the age group using them in accordance with paragraph PLATFORM HEIGHT. Determine 1) secure anchoring; 2) all hardware and connectors are tight; 3) all hardware and connectors require tools to loosen; 4) all hooks are closed; 5) head and neck entrapment; 6) sharp points, edges, and protrusions; 7) entanglement; 8) pinch, crush, and shear points; 9) suspended hazards; 10) all component holes are filled; and 11) recycled plastic components used as load bearing structural members.

c. Use zone distances must be measured to determine the area is free of hard surfaces, objects or obstacles. Determine exceptions to use zone overlaps occur in accordance with paragraph USE ZONE. Play event fall height must be measured and compared to critical height value for thickness of installed protective surfacing. The slide exit region must have the required clear zone. Play events and surfaces must be properly oriented. Chain, rope, net climbers or similar components must be installed in a vertical position. Swing seat clearances must be measured while occupied by a maximum user for the age group using the equipment. Warning labels and manufacturer identification labels must be visible in accordance with paragraph EQUIPMENT IDENTIFICATION.

d. Play events that do not comply must be reinstalled. Fasteners, anchors, hardware and labels that do not comply must be replaced. Ensure positive drainage for the area and the lowest elevation of protective surfacing subgrade has been provided. A written report describing the results of the evaluation must be provided.

e. Submit records of measurements and findings by the certified playground safety inspector. Submit verification stating that the installed play events and equipment meet manufacturer's recommendations and paragraph CHILD SAFETY AND ACCESSIBILITY STANDARDS.

3.5 RE-INSTALLATION

When re-installation is required, accomplish the following: Re-install the product as specified. Provide new replacement materials supplied by the manufacturer. Material acquisition of replacement parts is the responsibility of the Contractor. Damage caused by the failed installation must be repaired at the Contractor's expense.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-11 70 00 (May 2020)**

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Preparing Activity: NAVFAC **Superseding**
UFGS-11 70 00 (May 2011)
UFGS-01 73 19 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 11 - EQUIPMENT

SECTION 11 70 00

GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT

05/20

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-11 70 00 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 70 00 (May 2011)
UFGS-01 73 19 (April 2006)

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References are in agreement with UMRL dated January 2025

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SECTION 11 70 00

GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT
05/20

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NOTE: This guide specification covers the requirements for general requirements for medical and dental equipment and similar related specialties specified in Sections 11 71 00 STERILIZERS AND ASSOCIATED EQUIPMENT; 11 72 13 MEDICAL EQUIPMENT, MISCELLANEOUS; 11 74 00 DENTAL EQUIPMENT; 13 17 43 HYDROTHERAPY EQUIPMENT; and 13 21 48 PREFABRICATED AUDIOMETRIC ROOMS.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: Specific product requirements are included in the technical Sections listed herein that make reference to this Section.

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NOTE: On the drawings show:

1. Location of equipment

2. Installation layout, details, and space requirements.
****

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

This Section covers general requirements for medical and dental equipment specified in Sections [11 71 00 STERILIZERS AND ASSOCIATED EQUIPMENT;] [11 72 13 MEDICAL EQUIPMENT, MISCELLANEOUS;] [11 74 00 DENTAL EQUIPMENT;] [and] [13 17 43 HYDROTHERAPY EQUIPMENT;] [13 21 48 PREFABRICATED AUDIOMETRIC ROOMS;] [.]

[See Section 01 20 00 PRICE AND PAYMENT PROCEDURES for Government's procurement policy for all Category A medical and dental equipment.

]1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

21 CFR 701	Cosmetic Labeling

UL SOLUTIONS (UL)

UL 674	(2022) UL Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations
UL 60601-1	(2003; Reprint Apr 2006) Medical Electrical Equipment, Part 1: General Requirements for Safety

1.3 LOGISTICAL CLASSIFICATION

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NOTE: The logistical classification listed in this guide specification follows MIL-STD-1691, "Military Standard Construction and Material for Military Medical and Dental Equipment."

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Methods of procurement are defined as follows:

a. Category A: Contractor furnished and Contractor installed.

b. Category B: Government furnished and Contractor installed.

c. Category C: Government furnished and Government installed.

Equipment designated Logistical Category ["B"] ["C"] will be Government provided. For equipment installed by the Government, the Contractor is required to make preparations for installation, as indicated.[See Section 01 11 00 SUMMARY OF WORK[, and drawings,] for list of Government provided equipment.]

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submittals are specified in Sections [11 71 00 STERILIZERS AND ASSOCIATED EQUIPMENT;] [11 72 13 MEDICAL EQUIPMENT, MISCELLANEOUS;] [11 74 00 DENTAL EQUIPMENT;] [and] [13 17 43 HYDROTHERAPY EQUIPMENT;] [13 21 48 PREFABRICATED AUDIOMETRIC ROOMS;] [.]

1.5 QUALITY ASSURANCE

1.5.1 Materials and Equipment

Provide standard products of a manufacturer regularly engaged in the manufacture of products which are of a similar material, design, and workmanship and are offered for sale on the commercial market through advertisements, manufacturer's catalogs, or sales brochures, and are in commercial or industrial use under similar circumstances and of similar size for 2 years prior to the bid opening.

1.5.2 Alternative Service Record

Products having less than a 2-year field service record will be acceptable if a certified record of the manufacturer's factory or laboratory tests demonstrating performance compliance is provided to the Contracting Officer.

1.5.3 Service Support

Provide equipment items supported by service organizations located near the equipment installation, and able to service the equipment on a regular basis and respond immediately on emergency calls throughout the warranty period.

1.5.4 Manufacturer's Nameplate

Provide each piece of equipment with the manufacturer's name, address, model number, and serial number utility ranges or capacities, including voltage and amperage rating if electrically powered on the nameplate, securely affixed in a conspicuous place. The name of only the distributing agent on the plate is not acceptable.

1.5.5 Design Parameters

Provide equipment meeting each of the following parameters specified in the cited Sections under RELATED REQUIREMENTS.

a. Size of equipment

b. Function of equipment

c. Standard and listed accessories

d. Equipment controls and performance of equipment

e. Construction of equipment.

[1.5.6 Contractor's Equipment Planner

Engage a full-time Equipment Planner. The Equipment Planner will be responsible to evaluate equipment specifications and requirements and to provide guidance on the proper installation and testing of equipment. The Equipment Planner must be present at the medical equipment Pre-Installation/Preparatory Conference with contractors, vendors, and installers and is responsible to provide written sign-off of medical equipment installations. The Equipment Planner must have a minimum of 5-years of experience with medical equipment planning and management.

][1.5.7 Biomedical Equipment Technician

[Engage a full-time Biomedical Equipment Technician.][The Government will provide a Biomedical Equipment Technician.] The Biomedical Equipment Technician must be present at the medical equipment Pre-Installation/Preparatory Conference with contractors, vendors, and installers and is responsible to provide written sign-off of medical equipment installations after thorough inspection.[The Biomedical Equipment Technician must have a minimum of 5-years of experience in Biomedical Equipment management.]

]1.5.8 Buy American Act

Provide "domestic end products" under the Buy America Act (i.e. end-product equipment is manufactured in the United States and, more than 50 percent of the cost of all the components of the equipment are manufactured in the United States).

1.6 STANDARDS COMPLIANCE

Submit the following, as applicable, as evidence of proof of conformance for materials or equipment specified to conform to the standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), ASME INTERNATIONAL (ASME), American Gas Association (AGA), Air Conditioning and Refrigeration Institute (ARI), and Underwriters Laboratories (UL).

a. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections.

b. In lieu of the label or listing, submit a certificate from an independent testing organization which is competent to perform acceptable testing and is approved by the Contracting Officer. The certificate includes statement that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.

c. For materials and equipment whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, submit a certificate of compliance from the manufacturer for approval, identifying the manufacturer, product, and referenced standard and certification stating that the product conforms to the requirements of the project specification and the referenced standards listed.

1.7 STANDARDS DEVIATIONS

Submit for approval a record of deviations from the following standards established for the specified product, before ordering equipment.

a. Size of equipment

b. Function of equipment

c. Standard and listed accessories

d. Equipment controls and performance of equipment

e. Construction of equipment.

1.8 SUBSTITUTIONS

Submit before ordering equipment.

a. Size: Layouts are based on the unit specified. If the size of a substituted unit differs from the item specified and is accepted, submit to the Contracting Officer for approval a revised layout, design calculations, drawings, and specifications for changes in the building to accommodate the substituted equipment.

b. Function: Additional functions and accessories of substituted equipment will not be considered as an improvement over the unit specified. If such functions are standard equipment of a substituted item but the function is not desired by the Government, then it is the Government's discretion to either have the Contractor completely remove that function from the unit, if the unit is otherwise acceptable, or allow the Contractor to retain that function on the unit under the following conditions:

   (1) The additional function is fully operational and its performance complies with the terms and conditions of this specification, including product quality and warranty;

   (2) The additional function does not eliminate or modify those functions required by the Government on the specified unit. Refinement in control or accessibility of the substituted unit will be considered an improvement over the specified unit.

c. Appearance: Only the following aesthetic qualities of design will be considered an improvement:

(1) Uniformity of finish

(2) Variety of finish selections

(3) Compatibility with substituted item.

1.9 PACKAGING, STORAGE AND PROTECTION

1.9.1 Packaging

Package each piece of equipment to ensure protection from damage during shipment and delivery. Legibly indicate on the exterior of each container or crate, the shipping address and a brief description of its contents. Outside of the container, fasten a waterproof envelope containing a packing list and complete instructions for uncrating and setting the equipment in place.

1.9.2 Storage and Protection

During storage and until completion and acceptance by the Contracting Officer, protect materials and equipment from damage. Before acceptance by the Contracting Officer, remove all protective coverings, thoroughly clean the inner and outer surfaces, and ensure that the equipment is free from defects.

1.10 WARRANTY

Equipment manufacturer agrees to repair or replace equipment or components that fail in materials or workmanship within specified warranty period.

a. Warranty Period: [One] [_____] year[s] from date of final acceptance of the work.

[b. Other Warranty Periods: As specified in Section[s] [11 71 00 STERILIZERS AND ASSOCIATED EQUIPMENT;] [11 72 13 MEDICAL EQUIPMENT, MISCELLANEOUS;] [11 74 00 DENTAL EQUIPMENT;] [and] [13 17 43 HYDROTHERAPY EQUIPMENT;] [13 21 48 PREFABRICATED AUDIOMETRIC ROOMS;] [.]

]PART 2 PRODUCTS

2.1 MATERIALS

Provide materials of the same quality used for the intended purpose in commercial practice, unless otherwise specified or indicated on drawings. Provide new equipment and materials incorporated in the work.

2.2 EQUIPMENT

2.2.1 Safety

Provide medical and dental equipment meeting the requirements of OSHA 21 CFR 701, NFPA 101, and UL 60601-1. In lieu of UL approval, consideration will be given to certified test reports from an approved laboratory meeting UL 60601-1 requirements.

2.2.2 Electrical Motors

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NOTE: Conform to UL 674 if motors and generators are used in hazardous locations.
****

Provide motors of sufficient size for the duty to be performed and not exceeding the nameplate rating when driven equipment is operating at specified capacity under the most severe conditions. Provide fractional horsepower motors conforming to [NEMA MG 1] [UL 674].

2.3 COMPONENTS

2.3.1 Plumbing

Provide components, such as piping, valves, and controls, conforming to the requirements specified in Section [22 00 00 PLUMBING GENERAL PURPOSE.] [22 00 70 PLUMBING, HEALTHCARE FACILITIES.]

2.3.2 Electrical

Provide components of equipment and systems, such as motors, starters, and controls as specified for complete operable systems. Extended voltage-range motors are prohibited. Provide interconnecting wiring for components of packaged equipment as an integral part of the equipment. Provide interconnecting power wiring and conduit for field-erected equipment and control wiring and conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide motor control equipment forming part of the motor control centers or switchgear assemblies, and the necessary conduit and wiring connecting such assemblies, centers, or other power sources to the equipment as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

PART 3 EXECUTION

3.1 EXAMINATION

Before laying out the equipment, inspect the site of work. Report to the Contracting Officer damage to the building, including piping and wiring systems related to and affecting the installation of the equipment.

3.2 INSTALLATION

Set and connect the equipment plumb and level in accordance with the manufacturer's written instructions. Attach items and accessories as indicated and as required. Make connections between equipment and other work in a neat manner, and install the equipment so as not to damage other work.

3.2.1 Mounting

Provide equipment supports as required to suit conditions in accordance with equipment manufacturer's written instructions.[Mount the equipment according to SMACNA 1981 seismic restraints guidelines. See also requirements specified in Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT.]

3.2.2 Utility Connections

Provide final utility connections and service to equipment, including waste, under Section[s] [23 03 00.00 20 BASIC MECHANICAL MATERIALS AND

METHODS[.][;]] [22 00 00 PLUMBING, GENERAL PURPOSE[.][;]] [22 00 70 PLUMBING, HEALTHCARE FACILITIES[.][;]] [22 60 70 GAS AND VACUUM SYSTEMS FOR HEALTHCARE FACILITIES[.][;]] [and] [26 20 00 INTERIOR DISTRIBUTION SYSTEM.]

3.2.3 Dissimilar Metals Protection

Make provisions to prevent electrolysis where dissimilar metal parts are welded or otherwise fastened together.

3.3 FIELD INSPECTIONS

Notify the Contracting Officer [and Contractor's Equipment Planner] [and] [the Contractor's Biomedical Equipment Technician,] [the Government's Biomedical Equipment Technician,] 5 days before the scheduled inspection. Perform acceptance inspection of the finished work with the Contracting Officer to examine each item to ensure that the equipment is operational.

3.4 CLEANING AND ADJUSTING

Clean and adjust equipment. Lubricate moving parts, as required, and test the equipment in accordance with the manufacturer's written instructions. Clean the medical equipment, both inside and outside. Ensure that equipment is free from construction related defects.

-- End of Section --

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USACE / NAVFAC / AFCEC UFGS-11 71 00 (May 2020)

Preparing Activity: USACE

Superseding
UFGS-11 71 00 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 11 - EQUIPMENT

SECTION 11 71 00

STERILIZERS AND ASSOCIATED EQUIPMENT

05/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-11 71 00 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-11 71 00 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 11 71 00

STERILIZERS AND ASSOCIATED EQUIPMENT

05/20

****

NOTE: This guide specification covers the requirements for warming cabinets, sterilizers, and associated equipment.

This Section refers to Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for general requirements; always include Section 11 70 00 when this Section is used.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Schedule equipment on the drawings and list required salient features on the schedule. These features include size of sterilizer, capacity of stills and storage tanks, manual, automatic or automatic microprocessor controls, sterilizer material handling accessories, and any optional exceptions to standards specified. Also include operating power requirements for each unit. Identify equipment on the schedule and in the

drawings by Joint Schedule Numbers (JSN) from MIL-STD-1691, Construction and Material Schedule for Military Medical and Dental Facilities.

On the project drawings show exhaust ventilation (to keep gas away from person opening sterilizer door).
****

1.1 RELATED REQUIREMENTS

The requirements of Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT apply to this Section.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A264	(2012; R 2019) Standard Specification for Stainless Chromium-Nickel Steel-Clad Plate
ASTM A265	(2012) Standard Specification for Nickel and Nickel-Base Alloy-Clad Steel Plate
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A285/A285M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B39	(1979; R 2023) Standard Specification for Nickel
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B127	(2019) Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate,

	Sheet, and Strip
ASTM B135/B135M	(2017) Standard Specification for Seamless Brass Tube
ASTM B163	(2022) Standard Specification for Seamless Nickel and Nickel Alloy Condenser and Heat-Exchanger Tubes
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B165	(2019) Standard Specification for Nickel-Copper Alloy (UNS N04400)* Seamless Pipe and Tube
ASTM B166	(2024) Standard Specification for Nickel-Chromium-Aluminum Alloy, Nickel-Chromium-Iron Alloys, Nickel-Chromium-Cobalt-Molybdenum Alloy, Nickel-Iron-Chromium-Tungsten Alloy, and Nickel-Chromium-Molybdenum-Copper Alloy Rod, Bar, and Wire
ASTM B167	(2023) Standard Specification for Nickel-Chromium-Aluminum Alloys, Nickel-Chromium-Iron Alloys, Nickel-Chromium-Cobalt-Molybdenum Alloy, Nickel-Iron-Chromium-Tungsten Alloy, and Nickel-Chromium-Molybdenum-Copper Alloy Seamless Pipe and Tube
ASTM B339	(2019; R 2024) Standard Specification for Pig Tin
ASTM B348/B348M	(2021) Standard Specification for Titanium and Titanium Alloy Bars and Billets

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2024) International Plumbing Code

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Item S0105, Sterilizer, STM, GV, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0107, Sterilizer, Elec, GV, 1DO, CAB, Small Chamber; G, [_____]

][Item S0125, Sterilizer, Stm, VAC, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0127, Sterilizer, Elec, VAC, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0137, Sterilizer,Stm,VAC,2DO,RCSD,1WLL,16x16x26 Chamber; G, [_____]

][Item S0145, Sterilizer, Stm, LAB, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0190, Rack, 2SH, 16x16x26 Chamber; G, [_____]

][Item S0210, Sterilizer,Stm,GV,1DO,RCSD, 1WLL, 20x20x38 Chamber; G, [_____]

][Item S0215, Sterilizer,Stm,GV,2DO,RCSD,1WLL, 20x20x38 Chamber; G, [_____]

][Item S0220, Sterilizer, Stm,GV, 2DO, RCSD 2WLL, 20x20x38 Chamber; G, [_____]

][Item S0225, Sterilizer, Stm, VAC, 1DO, CAB, 20x20x38 Chamber; G, [_____]

][Item S0235, Sterilizer,Stm,VAC,2DO,RCSD 1WLL, Medium Chamber; G, [_____]

][Item S0237, Sterilizer,ELEC,VAC,2DO,RCSD 1WLL, 20x20x38 Chamber; G, [_____]

][Item S0290, Rack, 2SH, 20x20x38 CHMBR; G, [_____]

][Item S0295, Loading Car & Transfer Carriage, 20x20x38 Chamber; G, [_____]

][Item S0332, Sterilizer,Stm,VAC,1DO,RCSD 1WLL,24x36x36 Chamber; G, [_____]

][Item S0395, Loading Car & Transfer Carriage, Large Chamber; G, [_____]

][Item S0405, Sterilizer; G, [_____]

][Item S0432, Sterilizer; G, [_____]

][Item S0442, Sterilizer; G, [_____]

][Item S0450, Sterilizer; G, [_____]

][Item S0495, Loading Car & Transfer Carriage; G, [_____]

][Item S0505, Sterilizer; G, [_____]

][Item S0530, Sterilizer; G, [_____]

][Item S0535, Sterilizer; G, [_____]

][Item S0595, Loading Car & Transfer Carriage; G, [_____]

][Item S0905, Washer; G, [_____]

][Item S0910, Washer, Multi-Chamber (4), Automated; G, [_____]

][Item S0915, Washer/Disinfector; G, [_____]

][Item S0920, Washer/Disinfector, STM, 1DO, CAB, 26X24X24 Cham; G, [_____]

][Item S0925, Washer/Disinfector, STM, 1DO, CAB, 23X19X24 Cham; G, [_____]

][Item S0930, Washer/Disinfector,STM,1DO,RCSD1WLL,23X19X24 Cham; G, [_____]

][Item S0940, Washer/Disinfector,STM,1DO,RSCD 1WLL,26X24X24 Cham; G, [_____]

][Item S0955, Washer/Disinfector,STM,2DO,RCSD1WLL,LDG/UNLDG STA; G, [_____]

][Item S0960, Washer/Disinfector; G, [_____]

][Item S0965, Washer/Disinfector, Dental; G, [_____]

][Item S1815, Generator; G, [_____]

][Item S1830, Generator; G, [_____]

][Item S1900, Rack, Pass-Through, Window & Door Assembly; G, [_____]

][Item S1905, Window, Sliding Service; G, [_____]

][Item S2635, Cleaner, Ultrasonic; G, [_____]

][Item S2640, Cleaner, Ultrasonic, Console; G, [_____]

][Item S3185, Washer, Cart & Utensil; G, [_____]

][Item S4300, Gun, Steam; G, [_____]

][Item S9765, Flusher/Disinfector, Disposal, Human Waste; G, [_____]

][Item S9800, Sterilizer; G, [_____]

][Item S9810, Sterilizer; G, [_____]

][Item S9815, Sterilizer; G, [_____]
]

Submit approved detail drawings for each item of equipment listed above that interfaces with other items of equipment or construction.

SD-03 Product Data

[Item S0105, Sterilizer, STM, GV, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0107, Sterilizer, Elec, GV, 1DO, CAB, Small Chamber; G, [_____]

][Item S0125, Sterilizer, Stm, VAC, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0127, Sterilizer, Elec, VAC, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0137, Sterilizer,Stm,VAC,2DO,RCSD,1WLL,16x16x26 Chamber; G, [_____]

][Item S0145, Sterilizer, Stm, LAB, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0190, Rack, 2SH, 16x16x26 Chamber; G, [_____]

][Item S0210, Sterilizer,Stm,GV,1DO,RCSD, 1WLL, 20x20x38 Chamber; G, [_____]

][Item S0215, Sterilizer,Stm,GV,2DO,RCSD,1WLL, 20x20x38 Chamber; G, [_____]

][Item S0220, Sterilizer, Stm, GV, 2DO, RCSD 2WLL, 20x20x38 Chamber;

G, [_____]

][Item S0225, Sterilizer, Stm, VAC, 1DO, CAB, 20x20x38 Chamber; G, [_____]

][Item S0235, Sterilizer, Stm, VAC, 2DO,RCSD 1WLL, Medium Chamber; G, [_____]

][Item S0237, Sterilizer,ELEC,VAC,2DO,RCSD 1WLL, 20x20x38 Cham; G, [_____]

][Item S0290, Rack, 2SH, 20x20x38 CHMBR; G, [_____]

][Item S0295, Loading Car & Transfer Carriage, 20x20x38 Chamber; G, [_____]

][Item S0332, Sterilizer,Stm,VAC,1DO,RCSD 1WLL,24x36x36 Chamber; G, [_____]

][Item S0395, Loading Car & Transfer Carriage, Large Chamber; G, [_____]

][Item S0405, Sterilizer; G, [_____]

][Item S0432, Sterilizer; G, [_____]

][Item S0442, Sterilizer; G, [_____]

][Item S0450, Sterilizer; G, [_____]

][Item S0495 Loading Car & Transfer Carriage; G, [_____]

][Item S0505, Sterilizer; G, [_____]

][Item S0530, Sterilizer; G, [_____]

][Item S0535, Sterilizer; G, [_____]

][Item S0595, Loading Car & Transfer Carriage; G, [_____]

][Item S0905, Washer; G, [_____]

][Item S0910, Washer, Multi-Chamber (4), Automated; G, [_____]

][Item S0915, Washer/Disinfector; G, [_____]

][Item S0920, Washer/Disinfector, STM, 1DO, CAB, 26X24X24 Cham; G, [_____]

][Item S0925, Washer/Disinfector, STM, 1DO, CAB, 23X19X24 Cham; G, [_____]

][Item S0930, Washer/Disinfector,STM,1DO,RCSD1WLL,23X19X24 Cham; G, [_____]

][Item S0940, Washer/Disinfector,STM,1DO,RSCD 1WLL,26X24X24 Cham; G, [_____]

][Item S0955, Washer/Disinfector,STM,2DO,RCSD1WLL,LDG/UNLDG STA; G,

[_____]

][Item S0960, Washer/Disinfector; G, [_____]

][Item S0965, Washer/Disinfector, Dental; G, [_____]

][Item S1815, Generator; G, [_____]

][Item S1830, Generator; G, [_____]

][Item S1900, Rack, Pass-Through, Window & Door Assembly; G, [_____]

][Item S1905, Window, Sliding Service; G, [_____]

][Item S2635, Cleaner, Ultrasonic; G, [_____]

][Item S2640, Cleaner, Ultrasonic, Console; G, [_____]

][Item S3185, Washer, Cart & Utensil; G, [_____]

][Item S4300, Gun, Steam; G, [_____]

][Item S9765, Flusher/Disinfector, Disposal, Human Waste; G, [_____]

][Item S9800, Sterilizer; G, [_____]

][Item S9810, Sterilizer; G, [_____]

][Item S9815, Sterilizer; G, [_____]
]
Submit catalog numbers, trade names, literature, data sheets, diagrams and other pertinent data for each item of equipment listed above to evaluate performance, function, materials, dimensions and appearance.

****

NOTE: Add "SD-04 Samples" only when color selections or color verifications are required for project-specific equipment items.

****

[SD-04 Samples

[Item [_____]; G, [_____]]

Submit manufacturer's [standard color charts for color selection] [color samples for color verification] for each item of equipment listed above.

] SD-06 Test Reports

[Item S0105, Sterilizer, STM, GV, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0107, Sterilizer, Elec, GV, 1DO, CAB, Small Chamber; G, [_____]

][Item S0125, Sterilizer, Stm, VAC, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0127, Sterilizer, Elec, VAC, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0137, Sterilizer,Stm,VAC,2DO,RCSD,1WLL,16x16x26 Chamber; G, [_____]

][Item S0145, Sterilizer, Stm, LAB, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0190, Rack, 2SH, 16x16x26 Chamber; G, [_____]

][Item S0210, Sterilizer,Stm,GV,1DO,RCSD, 1WLL, 20x20x38 Chamber; G, [_____]

][Item S0215, Sterilizer,Stm,GV,2DO,RCSD,1WLL, 20x20x38 Chamber; G, [_____]

][Item S0220, Sterilizer, Stm, GV, 2DO, RCSD 2WLL, 20x20x38 Chamber; G, [_____]

][Item S0225, Sterilizer, Stm, VAC, 1DO, CAB, 20x20x38 Chamber; G, [_____]

][Item S0235, Sterilizer,Stm,VAC,2DO,RCSD 1WLL, Medium Chamber; G, [_____]

][Item S0237, Sterilizer,ELEC,VAC,2DO,RCSD 1WLL, 20x20x38 Cham; G, [_____]

][Item S0290, Rack, 2SH, 20x20x38 CHMBR; G, [_____]

][Item S0295, Loading Car & Transfer Carriage, 20x20x38 Chamber; G, [_____]

][Item S0332, Sterilizer,Stm,VAC,1DO,RCSD 1WLL,24x36x36 Chamber; G, [_____]

][Item S0395, Loading Car & Transfer Carriage, Large Chamber; G, [_____]

][Item S0405, Sterilizer; G, [_____]

][Item S0432, Sterilizer; G, [_____]

][Item S0442, Sterilizer; G, [_____]

][Item S0450, Sterilizer; G, [_____]

][Item S0495, Loading Car & Transfer Carriage; G, [_____]

][Item S0505, Sterilizer; G, [_____]

][Item S0530, Sterilizer; G, [_____]

][Item S0535, Sterilizer; G, [_____]

][Item S0595, Loading Car & Transfer Carriage; G, [_____]

][Item S0905, Washer; G, [_____]

][Item S0910, Washer, Multi-Chamber (4), Automated; G, [_____]

][Item S0915, Washer/Disinfector; G, [_____]

][Item S0920,, Washer/Disinfector, STM, 1DO, CAB, 26X24X24 Cham; G, [_____]

][Item S0925, Washer/Disinfector, STM, 1DO, CAB, 23X19X24 Cham; G, [_____]

][Item S0930, Washer/Disinfector,STM,1DO,RCSD1WLL,23X19X24 Cham; G, [_____]

][Item S0940, Washer/Disinfector,STM,1DO,RSCD 1WLL,26X24X24 Cham; G, [_____]

][Item S0955, Washer/Disinfector,STM,2DO,RCSD1WLL,LDG/UNLDG STA; G, [_____]

][Item S0960, Washer/Disinfector; G, [_____]

][Item S0965, Washer/Disinfector, Dental; G, [_____]

][Item S1815, Generator; G, [_____]

][Item S1830, Generator; G, [_____]

][Item S1900, Rack, Pass-Through, Window & Door Assembly; G, [_____]

][Item S1905, Window, Sliding Service; G, [_____]

][Item S2635, Cleaner, Ultrasonic; G, [_____]

][Item S2640, Cleaner, Ultrasonic, Console; G, [_____]

][Item S3185, Washer, Cart & Utensil; G, [_____]

][Item S4300, Gun, Steam; G, [_____]

][Item S9765, Flusher/Disinfector, Disposal, Human Waste; G, [_____]

][Item S9800, Sterilizer; G, [_____]

][Item S9810, Sterilizer; G, [_____]

][Item S9815 Sterilizer; G, [_____]
]

Submit field tests and inspection reports for each item of equipment listed above signed by authorized official responsible for field tests and inspections.

SD-10 Operation and Maintenance Data

[Item S0105, Sterilizer, STM, GV, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0107, Sterilizer, Elec, GV, 1DO, CAB, Small Chamber; G,

[_____]

][Item S0125, Sterilizer, Stm, VAC, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0127, Sterilizer, Elec, VAC, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0137, Sterilizer,Stm,VAC,2DO,RCSD,1WLL,16x16x26 Chamber; G, [_____]

][Item S0145, Sterilizer, Stm, LAB, 1DO, CAB, 16x16x26 Chamber; G, [_____]

][Item S0190, Rack, 2SH, 16x16x26 Chamber; G, [_____]

][Item S0210, Sterilizer,Stm,GV,1DO,RCSD, 1WLL, 20x20x38 Chamber; G, [_____]

][Item S0215, Sterilizer,Stm,GV,2DO,RCSD,1WLL, 20x20x38 Chamber; G, [_____]

][Item S0220, Sterilizer, Stm, GV, 2DO, RCSD 2WLL, 20x20x38 Chamber; G, [_____]

][Item S0225, Sterilizer, Stm, VAC, 1DO, CAB, 20x20x38 Chamber; G, [_____]

][Item S0235, Sterilizer,Stm,VAC,2DO,RCSD 1WLL, Medium Chamber; G, [_____]

][Item S0237, Sterilizer,ELEC,VAC,2DO,RCSD 1WLL, 20x20x38 Cham; G, [_____]

][Item S0290, Rack, 2SH, 20x20x38 CHMBR; G, [_____]

][Item S0295, Loading Car & Transfer Carriage, 20x20x38 Chamber; G, [_____]

][Item S0332, Sterilizer,Stm,VAC,1DO,RCSD 1WLL,24x36x36 Chamber; G, [_____]

][Item S0395, Loading Car & Transfer Carriage, Large Chamber; G, [_____]

][Item S0405, Sterilizer; G, [_____]

][Item S0432, Sterilizer; G, [_____]

][Item S0442, Sterilizer; G, [_____]

][Item S0450, Sterilizer; G, [_____]

][Item S0495, Loading Car & Transfer Carriage; G, [_____]

][Item S0505, Sterilizer; G, [_____]

][Item S0530, Sterilizer; G, [_____]

][Item S0535, Sterilizer; G, [_____]

][Item S0595, Loading Car & Transfer Carriage; G, [_____]

][Item S0905, Washer; G, [_____]

][Item S0910, Washer, Multi-Chamber (4), Automated; G, [_____]

][Item S0915, Washer/Disinfector; G, [_____]

][Item S0920, Washer/Disinfector, STM, 1DO, CAB, 26X24X24 Cham; G, [_____]

][Item S0925, Washer/Disinfector, STM, 1DO, CAB, 23X19X24 Cham; G, [_____]

][Item S0930, Washer/Disinfector,STM,1DO,RCSD1WLL,23X19X24 Cham; G, [_____]

][Item S0940, Washer/Disinfector,STM,1DO,RSCD 1WLL,26X24X24 Cham; G, [_____]

][Item S0955, Washer/Disinfector,STM,2DO,RCSD1WLL,LDG/UNLDG STA; G, [_____]

][Item S0960, Washer/Disinfector; G, [_____]

][Item S0965, Washer/Disinfector, Dental; G, [_____]

][Item S1815, Generator; G, [_____]

][Item S1830, Generator; G, [_____]

][Item S1900, Rack, Pass-Through, Window & Door Assembly; G, [_____]

][Item S1905, Window, Sliding Service; G, [_____]

][Item S2635, Cleaner, Ultrasonic; G, [_____]

][Item S2640, Cleaner, Ultrasonic, Console; G, [_____]

][Item S3185, Washer, Cart & Utensil; G, [_____]

][Item S4300, Gun, Steam; G, [_____]

][Item S9765, Flusher/Disinfector, Disposal, Human Waste; G, [_____]

][Item S9800, Sterilizer; G, [_____]

][Item S9815, Sterilizer; G, [_____]
]

Submit Data Package 3, including training requirements, for each item of equipment listed above in accordance with requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA. [In addition, provide hard copies consisting of two Operator's Manuals and two Service Manuals.]

1.4 WARRANTY

[Provide warranties as specified in this Section.] Refer to Article WARRANTY in Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for [additional] requirements.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Carbon Steel

ASTM A36/A36M, ASTM A285/A285M, ASTM A515/A515M, or ASTM A568/A568M, cold rolled sheets, commercial bright finish.

2.1.2 Nickel

ASTM B39. Nickel-copper alloy or stainless steel or white metal.

2.1.3 Nickel and Nickel-Alloy Clad Steel

ASTM A265. Nickel or nickel-copper alloy and steel for pressure vessels, mill-rolled under heat and pressure until integrally bonded over entire interface.

2.1.4 Nickel-Copper Alloy (Monel Metal)

ASTM B127, ASTM B163, ASTM B164, or ASTM B165 plate sheet and strip.

2.1.5 Stainless Steel

ASTM A167, Type 301 or 316L; Class 304L for welded construction and Class 302 or 304 for construction formed without welding. Exposed surfaces of stainless steel to have satin finish.

2.1.6 Stainless Steel Bars and Rods

ASTM B166.

2.1.7 Stainless Steel for Pressure Vessels

ASTM A240/A240M.

2.1.8 Stainless Steel Clad

ASTM A264 for pressure vessels.

2.1.9 Tin

ASTM B339.

2.1.10 Titanium

For construction of products used in contact with distilled water, ASTM B348/B348M, Grade 2.

2.2 PIPING AND TUBING

Seamless, annealed, and ground smooth. Welded tubing to be thoroughly heat treated and properly quenched to eliminate carbide precipitation, drawn true to size and roundness. Provide piping and tubing conforming to the following:

2.2.1 Steam Supply and Return Condensate Lines

Copper pipe must conform to ASTM B42; brass pipe must conform to ASTM B43; brass tube must conform to ASTM B135/B135M, Alloy 230. Include strainer, shut-off valve and pressure gage suitable for steam pressure up to 552 kPa 80 psig. In return line include steam trap, check valve, and hand shut-off valves.

2.2.2 Gaseous Sterilant Lines

Brass pipe must conform to ASTM B43, Alloy 230; stainless steel tube must conform to ASTM A269/A269M, ASTM A312/A312M, or ASTM B167 as applicable.

2.2.3 Water and Waste Lines

Copper tube must conform to ASTM B88M, ASTM B88 Type K, hard-drawn or annealed for bending; brass tube must conform to ASTM B135/B135M, Alloy 230 or C23000.

2.2.4 Pipe Fittings

Wrought copper or wrought bronze, brazing or solder joint type in accordance with ASME B16.18 and ASME B16.22. Use ASTM B32,Alloy Sb5 tin-antimony solder to make joints for copper tubing.

2.2.5 Pressure Vessels

Design, construction, materials, and testing of each pressure vessel, including doors, must comply with applicable provisions of ASME BPVC SEC VIII D1. Submit a signed copy of ASME Form U-1 or U-1A, as shown in ASME BPVC SEC VIII D1 Appendix W, with each sterilizer, as applicable.

2.2.6 Welding Materials

Welding Materials must comply with ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes must be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

2.2.7 Connections to Equipment

****

NOTE: Specifications, covering supply to units specified herein, must provide cutoff of supply in vicinity of equipment so that unit may be removed for servicing. Make provisions for allowing steam lines to be blown down, prior to equipment connection, to prevent preservations and cleansers in piping and boiler from being blown into chamber.

****

Prewire and prepipe each unit of equipment complete with trim and fittings. Equipment includes fittings to prevent backflow of polluted water or waste into water supply system or equipment in accordance with ICC IPC. Provide reduced pressure or atmospheric type backflow preventer.

2.3 ELECTRICAL WORK

Provide electric motor-driven equipment complete with motors, motor starters, and controls. Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics are as specified herein or as indicated. Provide motor starters complete with thermal overload protection and other components necessary for the motor control specified. Provide each motor of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide manual or automatic control, protective or signal devices required for the operation specified, and any control wiring required for controls and devices specified.

****

NOTE: Select project-specific equipment items from the list below and delete equipment items not used. Additional equipment items may be added as required to suit project-specific conditions.

****

2.4 EQUIPMENT

[2.4.1 Item S0105, Sterilizer, STM, GV, 1DO, CAB, 16x16x26 Chamber

Provide gravity steam sterilizer with freestanding enclosed cabinet, single power vertical sliding door, and a minimum chamber size of 406 mm by 406 mm by 660 mm16 inches by 16 inches by 26 inches. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, utilizing facility steam, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 121 degrees C to 135 degrees C250 degrees F to 275 degrees F.

Approximate Size: 686 mm by 965 mm by 1905 mm 27 inches wide by 38 inches deep by 75 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 276 - 552 kPa40 - 80 PSI.

Drain: 50 mm2 inch ODT drain terminal.

][2.4.2 Item S0107, Sterilizer, Elec, GV, 1DO, CAB, Small Chamber

Provide gravity electric sterilizer with freestanding enclosed cabinet, single power vertical sliding door, and a minimum chamber size of 406 mm 406 mm16 inches by 16 inches 660 mm26 inches. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, integral steam generator, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 121 to 135 degrees C250 to 275 degrees F.

Approximate Size: 686 mm27 inches wide by 965 mm38 inches deep by 190575 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.3 Item S0125, Sterilizer, Stm, VAC, 1DO, CAB, 16x16x26 Chamber

Provide vacuum steam sterilizer with chamber size of 406 mm16 inches by 406 mm 16 inches by 660 mm26 inches, single power vertical door, and freestanding cabinet. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, utilizing facility steam, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 121 to 135 degrees C250 to 275 degrees F. [See drawings for door swing direction.]

Approximate Size: 1016 mm40 inches wide by 1499 mm59 inches deep by 1905 mm 75 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.4 Item S0127, Sterilizer, Elec, VAC, 1DO, CAB, 16x16x26 Chamber

Provide vacuum electric sterilizer with chamber size of 406 mm16 inches by 406 mm 16 inches by 660 mm26 inches, single power vertical door, and freestanding cabinet. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, integral steam generator, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 121 to 135 degrees C250 to 275 degrees F. [See drawings for door swing direction.]

Approximate Size: 711 mm28 inches wide by 965 mm38 inches deep by 1905 mm 75 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.5 Item S0137, Sterilizer,Stm,VAC,2DO,RCSD,1WLL,16x16x26 Chamber

Provide vacuum steam sterilizer with chamber size of 406 mm16 inches by 406 mm16 inches by 660 mm26 inches and double power vertical sliding doors, utilizing a remote electric steam generator. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, integrated steam generator (boiler), temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 121 to 135 degrees C250 to 275 degrees F.

Approximate Size: 711 mm28 inches wide by 991 mm39 inches deep by 1905 mm 75 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.6 Item S0145, Sterilizer, Stm, LAB, 1DO, CAB, 16x16x26 Chamber

Provide steam sterilizer with chamber size of 406 mm16 inches by 406 mm16 inches by 660 mm26 inches, single power vertical door, and freestanding cabinet. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, utilizing facility steam, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 110 to 135 degrees C230 to 275 degrees F. Recessed through one wall.

Approximate Size: 1016 mm40 inches wide by 1499 mm 59 inches deep by 1905 mm75 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.7 Item S0190, Rack, 2SH, 16x16x26 Chamber

Provide rack with two removable shelves for use with sterilizer having minimum chamber size of 406 mm16 inches by 406 mm16 inches by 660 mm26 inches. Construct rack of Type 304 stainless steel.

][2.4.8 Item S0210, Sterilizer, Stm, GV, 1DO, RCSD, 1WLL, 20x20x38 Chamber

Provide gravity steam sterilizer with single power vertical sliding door, and a minimum chamber size of 508 mm20 inches by 508 mm 20 inches by 965 mm 38 inches. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, utilizing facility steam, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 121 to 135 degrees C250 to 275 degrees F. Recessed through one wall.

Approximate Size: 863 mm34 incheswide by 1168 mm46 inches deep by 1905 mm 75 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm276 - 552 kPa1 inch NPT, 40 - 80 PSI.

Drain: 51 mm 2 inch ODT drain terminal.

][2.4.9   Item S0215, Sterilizer, Stm, GV, 2DO, RCSD, 1WLL, 20x20x38 Chamber

Provide gravity steam sterilizer with chamber size of 508 mm20 inches by 508 mm20 inches by 965 mm38 inches, and double power vertical sliding doors, utilizing facility steam. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Control unit by microcomputer technology, with vacuum pump, utilizing facility steam, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 100 to 121 degrees C212 to 250 degrees F. Recessed through one wall.

Approximate Size: 864 mm 34 inches wide by 1245 mm 49 inches deep by 1905 mm75 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 50 mm2 inch ODT drain terminal.

][2.4.10   Item S0220, Sterilizer, Stm GV, 2DO, RCSD 2WLL, 20x20x38 Chamber

Provide gravity steam sterilizer with chamber size of 508 mm20 inches by 508 mm20 inches by 965 mm38 inches, and double power vertical sliding doors, utilizing facility steam. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, utilizing facility steam, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 100 to 121 degrees C212 to 250 degrees F. Recessed through one wall.

Approximate Size: 762 mm30 incheswide by 1219 mm48 inches deep by 1905 mm 75 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.11   Item S0225, Sterilizer, Stm, VAC, 1DO, CAB, 20x 20x38 Chamber

Provide vacuum steam sterilizer with chamber size of 508 mm20 inches by 508 mm20 inches by 965 mm38 inches, and double power vertical sliding doors, utilizing facility steam. Construct unit of heavy-duty stainless steel Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, utilizing facility steam, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 100 to 121 degrees C212 to 250 degrees F. Recessed through one wall.

Approximate Size: 762 mm30 inches wide by 1270 mm50 inches deep by 1930 mm 76 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.12 Item S0235, Sterilizer, Stm, VAC, 2DO, RCSD 1WLL, Medium Chamber

Provide vacuum steam sterilizer with chamber size of 508 mm20 inches by 508 mm20 inches by 965 mm38 inches, and double power vertical sliding doors, utilizing facility steam. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, utilizing facility steam, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 100 to 121 degrees C212 to 250 degrees F. Recessed through two wall.

Approximate Size: 762 mm30 inches wide by 1219 mm48 inches deep by 1905 mm 75 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.13 Item S0237, Sterilizer, ELEC, VAC,2DO,RCSD 1WLL, 20x20x38 Cham

Provide vacuum electric sterilizer with chamber size of 508 mm20 inchesby 508 mm20 inches by 965 mm38 inches, and double power vertical sliding doors. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, integral steam generator, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 100 to 121 degrees C212 to 250 degrees F. Recessed through one wall.

Approximate Size: 864 mm34 inches wide by 1168 mm46 inches deep by 1930 mm 76 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.14 Item S0290, Rack, 2SH, 20x20x38 CHMBR

Provide rack with two removable shelves for use with sterilizer having minimum chamber size of 508 mm20 inches by 508 mm20 inches by 965 mm38 inches. Construct rack of stainless steel.

][2.4.15 Item S0295, Loading Car & Transfer Carriage, 20x20x38 Chamber

Provide loading car and transfer carriage unit that is compatible with sterilizer having minimum chamber size of 508 mm20 inches by 508 mm20 inches by 965 mm38 inches inches.

Construct loading car frame of Type 304 stainless steel. Provide loading car with one fixed and two adjustable shelves to allow maximum flexibility of load sizes, and with full length removable side rails.

Approximate Size: 1092 to 1219 mm43 to 48 inches long by 508 mm20 inches wide by 1092 mm43 inches high.

Shelf Load Capacity: 45.4 kg100 lbs.

Construct transfer carriage of stainless steel, height-adjustable, with four swivel casters. Provide transfer carriage with locking mechanism to secure loading car, and a hand operated latching mechanism to secure the carriage to the sterilizer.

Approximate Size: 508 mm20 inches wide by 381 mm15 inches high.

][2.4.16 Item S0332, Sterilizer, Stm, VAC,1DO,RCSD 1WLL,24x36x36 Chamber

Provide vacuum steam sterilizer with chamber size of 610 mm23 inches by 914 mm36 inches by 914 mm36 inches, and single automatic hinged door, utilizing facility steam. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, utilizing remote electric steam generator, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 100 to 121 degrees C212 to 250 degrees F. [See drawings for door swing direction.] Recessed through one wall.

Approximate Size: 1499 mm59 inches wide by 1854 mm73 inches deep by 1930 mm 76 inches high.

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.17 Item S0395, Loading Car & Transfer Carriage, Large Chamber

Provide loading car and transfer carriage unit that is compatible with sterilizer having minimum chamber size of 610 mm24 inches by 914 mm36 inches by 914 mm36 inches.

Construct loading car frame of Type 304 stainless steel. Provide loading car with one fixed and two adjustable shelves to allow maximum flexibility of load sizes, and with full length removable side rails.

Approximate Size: 1168 mm46 inches long by 559 mm22 inches wide by 965 mm 38 inches high.

Shelf Load Capacity: 45.4 kg100 lbs.

Construct transfer carriage of stainless steel, height-adjustable, with four swivel casters. Provide transfer carriage with locking mechanism to secure loading car, and with a hand operated latching mechanism to secure the carriage to the sterilizer.

Approximate Size: 559 mm22 inches wide by 457 mm18 inches high.

][2.4.18 Item S0405, Sterilizer, STM, GV, 1DO, CAB, 24x36x48 Chamber

Provide gravity steam sterilizer with freestanding enclosed cabinet, single automatic hinged door, and a minimum chamber size of 610 mm24 inches by 914 mm36 inches by 1219 mm48 inches, used for steam sterilization of hospital instruments and supplies. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 100 to 121 degrees C250 to 275 degrees F. [See drawings for door swing direction.]

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 275 - 552 kPa40 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.19 Item S0432, Sterilizer, Stm,VAC,1DO,RCSD 1WLL,24x36x48 Chamber

Provide gravity steam sterilizer with chamber size of 610 mm24 inches by 914 mm36 inches by 1219 mm48 inches, single automatic hinged door, recessed; used for steam sterilization of hospital instruments and supplies. Provide unit that accommodates 12 standard sterilization trays. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL)standards.

Provide unit controlled by microcomputer technology, with vacuum pump, integrated steam generator (boiler), temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 100 to 121 degrees C250 to 275 degrees F. [See drawings for door swing direction.]

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 2 inch ODT drain terminal.

][2.4.20 Item S0442, Sterilizer, Stm,VAC,2DO,RCSD 2WLL,24x36x48 Chamber

Provide large load capacity vacuum steam sterilizer with chamber size of 610 mm24 inches by 914 mm36 inches by 1219 mm48 inches, and automatic hinged double doors; used for steam sterilization of hospital instruments and supplies. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, integrated steam generator (boiler), temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 110 to 135 degrees C230 to 275 degrees F. Recessed through two walls. [See drawings for door swing direction.]

Electrical Characteristics: 110V 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 30 - 80 PS.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.21 Item S0450, Sterilizer, Stm,LAB,1DO,RCSD 1WLL, 24x36x48 Chamber

Provide steam sterilizer unit with single door, recessed mounted and with minimum chamber size of 610 mm24 inches by 914 mm36 inches by 1219 mm48 inches. Provide unit that accommodates 12 standard sterilization trays. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, with vacuum pump, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 104 to 135 degrees C219 to 275 degrees F. [See drawings for door swing direction.] Recessed through one wall.

Electrical Characteristics: 120V, 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.22 Item S0495, Loading Car & Transfer Carriage, 24x36x48 Chamber

Provide loading car and transfer carriage unit that is compatible with sterilizer having minimum chamber size of 610 mm24 inches by 914 mm36 inches by 1219 mm48 inches.

Construct loading car frame of Type 304 stainless steel. Provide loading car with one fixed and two adjustable shelves to allow maximum flexibility of load sizes, and with full length removable side rails.

Approximate Size: 1219 mm48 inches long by 610 mm24 inches wide by 826 mm 32.5 inches high.

Shelf Load Capacity: 54.4 kg120 lbs.

Car Load Capacity: 163.3 kg360 lbs.

Construct transfer carriage of stainless steel, height-adjustable, with two swivel and two fixed casters. Provide transfer carriage with locking mechanism to secure loading car, and with a hand operated latching mechanism to secure the carriage to the sterilizer.

Approximate Size: 610 mm24 inches wide by 508 mm20 inches high.

][2.4.23 Item S0505, Sterilizer, STM, GV, 1DO, CAB, 24x36x60 Chamber

Provide steam sterilizer unit with freestanding cabinet, a minimum chamber size of 610 mm24 inches by 914 mm36 inches by 1524 mm60 inches, and one single horizontal sliding door; utilize facility steam. Construct of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) Standards.

Provide unit controlled by microcomputer technology, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 104 to 135 degrees C219 to 275 degrees F.

Electrical Characteristics: 120V, 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.24 Item S0530, Sterilizer, Stm,VAC,1DO,RCSD 1WLL,24x36x60 Chamber

Provide vacuum steam sterilizer with chamber size of 610 mm24 inches by 914 mm36 inches by 1524 mm60 inches. Provide recessed unit with one single horizontal sliding door; utilize facility steam. Provide unit that accommodates 20 standard sterilization trays. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) Standards.

Provide unit controlled by microcomputer technology, vacuum pump, temperature control and display panel showing temperature and pressure, thermal printer. Provide unit with exposure temperature range of 219 to 275 degrees F. Recessed through one wall.

Electrical Characteristics: 120V, 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.25 Item S0535, Sterilizer,Stm,VAC,2DO,RCSD 1WLL, 24x36x60 Chamber

Provide vacuum steam sterilizer with chamber size of 610 mm 24 inches by 914 mm36 inches by 1524 mm60 inches. Provide recessed unit with two horizontal sliding doors; utilize facility steam. Provide unit that accommodates 20 standard sterilization trays. Construct unit of heavy-duty stainless steel, Type 316L, meeting Underwriters Laboratory (UL) standards.

Provide unit controlled by microcomputer technology, vacuum pump, temperature control and display panel showing temperature and pressure, and thermal printer. Provide unit with exposure temperature range of 104 to 135 degrees C219 to 275 degrees F. Recessed through two walls.

Electrical Characteristics: 120V, 50/60 Hz.

Steam Supply: 25 mm1 inch NPT, 207 - 552 kPa30 - 80 PSI.

Drain: 51 mm2 inch ODT drain terminal.

][2.4.26 Item S0595, Loading Car & Transfer Carriage, 24x36x60 Chamber

Provide loading car and transfer carriage unit for use with sterilizer having a minimum chamber size of 610 mm24 inches by 914 mm36 inches by 1524 mm60 inches.

Construct loading car frame of stainless steel. Provide loading car with one fixed and two adjustable shelves to allow maximum flexibility of load sizes, and with full length removable side rails.

Approximate Size: 1524 mm60 inches long by 610 mm24 inches wide by 813 mm 32 inches high.

Shelf Load Capacity: 68 kg150 lbs.

Car Load Capacity: 204 kg450 lbs.

Construct transfer carriage of stainless steel, height-adjustable, with two swivel and two fixed casters. Provide transfer carriage with locking mechanism to secure loading car, and a hand operated latching mechanism to secure the carriage to the sterilizer.

Approximate Size: 1524 mm60 inches long by 610 mm24 inches wide by 508 mm 20 inches high.

][2.4.27 Item S0905 Washer, Multi-Chamber (5), Automated

Provide automated multi-chamber washer with sloped horizontal fixed surfaces and equipped with five preprogrammed cycles (pre-wash, sonic wash, rinse, drying) controlled by computer based system with a remote printer to record cycle information. Construct chambers of 1.59 mm16-gauge stainless steel. Provide unit with automatic basket/rack accessory index tables on the load and unload end of unit. Unit must meet Underwriters Laboratory (UL) 61010-1.

Approximate Size: 4064 mm160 inches long by 1067 mm42 inches wide by 2134 mm84 inches high.

Minimum Ceiling Height Requirement: 2210 mm87 inches.

Electrical Characteristics: 200 V, Three-phase, 60 Hz.

][2.4.28 Item S0910, Washer, Multi-Chamber (4), Automated

Provide automated multi-chamber washer with sloped horizontal fixed surfaces and equipped with four preprogrammed cycles (pre-wash, wash, rinse, drying) controlled by computer based system with a remote printer to record cycle information. Construct chambers of 1.59 mm16-gauge stainless steel. Provide unit with automatic basket/rack accessory index tables on the load and unloads end of unit. Unit must meet Underwriters Laboratory (UL) standards.

Approximate Size: 4064 mm160 inches long by 1067 mm42 inches wide by 2134 mm84 inches high.

Minimum Ceiling Height Requirement: 2210 mm87 inches.

Electrical Characteristics: 200 V, Three-phase, 60 Hz.

][2.4.29 Item S0915, Washer/Disinfector, STM,2DO,RCSD1WLL,23X19X24 Chamber

Provide steam washer disinfector with a chamber size of 584 mm23 inches by 483 mm19 inches by 610 mm24 inches and controlled by microprocessor, with printer to record cycle phase performance. Provide unit with steam and electric heating with cycles pre-programmed to pre-wash, clean, rinse, disinfect and dry. Provide unit with two powered vertical sliding doors with tempered glass windows; utilize facility steam. Construct unit of stainless steel. Recessed through one wall. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3-phase, 60 Hz.

Steam Supply: 207 - 621 kPa30 to 90 PSIG.

Drain: 51 mm 2 inch diameter.

Hot Water Temperature Range: 43 to 90 degrees C110 degrees to 194 degrees.

Minimum Ceiling Height Requirement: 2388 mm94 inches.

Approximate Size: 1067 mm42 inches wide by 813 mm32 inches long by 2032 mm 80 inches high.

][2.4.30 Item S0920, Washer/Disinfector, STM, 1DO, CAB, 26X24X24 Cham

Provide steam washer disinfector with a chamber size of 584 mm26 inches by 610 mm24 inches by 610 mm24 inches and controlled by microprocessor with printer to record cycle phase performance. Provide unit with steam and electric heating with cycles pre-programmed to pre-wash, clean, rinse, disinfect and dry. Provide unit with one vertical sliding door with a tempered glass window; utilize facility steam. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3-phase, 60 Hz.

Steam Supply: 207 - 621 kPa30 to 90 PSIG.

Drain: 51 mm2 inch diameter.

Hot Water Temperature Range: 43 to 90 degrees C110 degrees to 194 degrees F.

Minimum Ceiling Height Requirement: 2388 mm94 inches.

Approximate Size: 16077 mm42 inches wide by 813 mm32 inches deep by 2032 mm 80 inches high.

][2.4.31 Item S0925, Washer/Disinfector, STM, 1DO, CAB, 23X19X24 Cham

Provide steam washer disinfector with approximate chamber size of 584 mm23 inches by 483 mm19 inches by 610 mm24 inches and controlled by microprocessor with printer to record cycle phase performance. Provide unit with steam and electric heating with cycles pre-programmed to pre-wash, clean, rinse, disinfect and dry. Provide unit with one vertical sliding door with a tempered glass window; utilize facility steam. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3-phase, 60 Hz.

Steam Supply: 207 - 621 kPa30 to 90 PSIG.

Drain: 51 mm2 inch diameter.

Hot Water Temperature Range: 43 to 90 degrees C110 degrees to 194 degrees.

Minimum Ceiling Height Requirement: 2388 mm94 inches.

Approximate Size: 1067 mm42 inches wide by 813 mm32 inches deep by 2032 mm 80 inches high.

][2.4.32   Item S0930, Washer/Disinfector, STM, 1DO, RCSD 1WLL, 23X19X24 Cham

Provide steam washer disinfector with approximate chamber size of 584 mm23 inches by 483 mm19 inches by 610 mm24 inches and controlled by microprocessor with printer to record cycle phase performance. Provide unit with steam and electric heating with cycles pre-programmed to pre-wash, clean, rinse, disinfect and dry. Provide unit with one vertical sliding door with a tempered glass window; utilize facility steam. Recessed through one wall. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3-phase, 60 Hz.

Steam Supply: 207 - 621 kPa30 to 90 PSIG.

Drain: 51 mm2 inch diameter.

Hot Water Temperature Range: 43 to 90 degrees C110 degrees to 194 degrees.

Minimum Ceiling Height Requirement: 2388 mm94 inches.

Approximate Size: 813 mm32 inches wide by 711 mm28 inches deep by 1930 mm76 inches high.

][2.4.33   Item S0940, Washer/Disinfector,STM,1DO,RSCD 1WLL,26X24X24 Cham

Provide steam washer disinfector with approximate chamber size of 660 mm26 inches by 610 mm24 inches by 610 mm24 inches and controlled by microprocessor, with printer to record cycle phase performance. Provide unit withsteam and electric heating with cycles pre-programmed to pre-wash, clean, rinse, disinfect and dry. Provide unit with one vertical sliding door with a tempered glass window; utilize facility steam. Recessed through one wall. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3-phase, 60 Hz.

Steam Supply: 207 - 621 kPa30 to 90 PSIG.

Drain: 51 mm2 inch diameter.

Hot Water Temperature Range: 43 to 90 degrees C110 degrees to 194 degrees.

Minimum Ceiling Height Requirement: 2388 mm94 inches.

Approximate Size: 1143 mm45 inches wide by 940 mm37 inches deep by 2057 mm 81 inches high.

][2.4.34   Item S0955, Washer/Disinfector, STM, 2DO, RCSD 1 WLL, LDG/UNLDG STA

Provide steam washer disinfector with approximate chamber size of 660 mm26 inches by 610 mm24 inches 610 mm24 inches and controlled by microprocessor with printer to record cycle phase performance. Provide unit with steam and electric heating with cycles pre-programmed to pre-wash, clean, rinse, disinfect and dry. Provide unit with two vertical sliding doors with a tempered glass windows; utilize facility steam. Recessed through one wall. Construct unit of stainless steel. Unit must be Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3-phase, 60 Hz.

Steam Supply: 207 - 621 kPa30 to 90 PSIG.

Drain: 51 mm2 inch diameter.

Hot Water Ttemperature Range: 43 to 90 degrees C110 degrees to 194 degrees.

Minimum Ceiling Height Requirement: 2388 mm94 inches.

Approximate Size: 1067 mm42 inches wide by 813 mm32 inches deep by 2032 mm 80 inches high.

][2.4.35 Item S0960, Washer/Disinfector,STM,2DO,RCSD1WLL,26X24X24 Chamber

Provide steam washer disinfector with chamber size of 660 mm26 inches by 610 mm24 inches by 610 mm24 inches and controlled by microprocessor with printer to record cycle phase performance. Provide unit with steam and electric heating with cycles pre-programmed to pre-wash, clean, rinse, disinfect and dry. Provide Unit with two powered vertical sliding doors with tempered glass windows; utilize facility steam. Recessed through one wall. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3-phase, 60 Hz.

Steam Supply: 207 - 621 kPa30 to 90 PSIG.

Drain: 51 mm2 inch diameter.

Hot Water Temperature Range: 43 to 90 degrees C110 degrees to 140 degrees.

Minimum Ceiling Height Requirement: 2388 mm94 inches.

Approximate Size: 1067 mm42 inches wide by 813 mm32 inches long by 2032 mm 80 inches high.

][2.4.36 Item S0965, Washer/Disinfector, Dental

Provide dental washer/disinfector unit to wash, disinfect and rinse. Provide unit with one door hinged at the bottom and with LED display and printer for documenting washing phases. Water temperature must be between 10 to 93 degrees C50 degrees and 200 degrees.

Electrical Characteristics: 208 V, 60 Hz.

Approximate Size: 610 mm24 inches wide by 610 mm24 inches deep by 914 mm36 inches high.

][2.4.37 Item S1815, Generator, Steam, Electric, 30 kW

Provide 30 kW electric steam generator/boiler with low water cut-off/level control, water feed system, automatic balance control, water level sight glass, main on/off switch, pilot light, blowdown valve, steam pressure gauge, and safety valve. The unit must provide high pressure steam up to 100 PSIG. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3 phase.

Approximate Size: 584 mm23 inches wide by 838 mm33 inches deep by 1118 mm 44 inches high.

][2.4.38 Item S1830, Generator, Steam, Electric, 75 KW

Provide 72 kW electric steam generator/boiler with low water cut-off/level control, water feed system, automatic balance control, water level sight glass, main on/off switch, pilot light, blowdown/drain valve, steam pressure gauge, and safety valve. The unit must provide high pressure steam up to 689 kPa100 PSIG. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3 phase, 60 Hz.

Approximate Size: 584 mm23 inches wide by 838 mm33 inches deep by 1118 mm 44 inches high.

][2.4.39 Item S1900, Rack, Pass-Through, Window & Door Assembly

Provide pass-through window and door assembly with vertical sliding window and tempered safety glass. Construct unit of 1.59 mm16 gauge Type 304 stainless steel with fixed top panel. Provide with clear opening of approximately 813 mm32 inches wide by 406 mm16 inches high.

Construct rack return doors of 1.59 mm16 gauge Type 304 stainless steel mounted with self-closing spring loaded hinges. Approximately 864 mm34 inches wide by 940 mm37 inches high.

Provide cantilevered counter with wall supports;. approximately 965 mm38 inches wide by 800 mm31-1/2 inches deep. Construct of 1.59 mm16 gauge Type 304 stainless steel.

Approximate Overall Size: 2134 mm84 inches high by 914 mm36 inches wide by 914 mm36 inches deep.

][2.4.40 Item S1905, Window, Sliding Service

Provide pass-through window assembly with vertical sliding window and tempered safety glass. Construct unit of 1.59 mm16 gauge Type 304 stainless steel with fixed top panel. Provide with clear opening is approximately 711 mm28 inches wide by 584 mm23 inches high.

Cantilever counter with wall supports on both sides of window. Approximately 914 mm36 inches wide by 864 mm34 inchesdeep. Provide unit with clean side of approximately 457 mm18 inches deep and decon side of be approximately 305 mm12 inches deep. Construct of 1.59 mm16 gauge Type 304 stainless steel.

Approximate Overall Size: 1321 mm52 inches high by 813 mm32 inches wide by 102 mm4 inches deep.

][2.4.41 Item S2635 Cleaner, Ultrasonic, SNGL Chamber, CAB, F/S

Provide floor mounted single tank ultrasonic cleaner. Construct unit of stainless steel with automatic lid, powered load tray elevator, automated hands-free controls, automatic fill, automatic detergent dosing, automatic timer and cycle start/stop, and locking castor wheels. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3 Phase, 60 Hz.

Drain: 40 mm1-1/2 inch.

Approximate Chamber Size: 457 mm18 inches wide by 368 mm14-1/2 inches deep by 635 mm25 inches high.

Approximate Overall Size: 686 mm27 inches wide by 826 mm33 inches deep by 1041 mm41 inches high.

][2.4.42 Item S2640, Cleaner, Ultrasonic, Console, DBL CHMBR, CAB, F/S

Provide free-standing self-contained ultrasonic cleaner. Construct unit of stainless steel with two chambers, one for rinse, and one for drying. Provide unit with automatic lid, powered load tray elevator, automated hands-free controls, automatic fill, automatic detergent dosing, automatic timer and cycle start/stop, automatic drying timer and temperature control, and locking castor wheels. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3 Phase, 60 Hz.

Drain: 40 mm1-1/2 inch.

Approximate Wash Chamber Size: 610 mm24 inches wide by 381 mm15 inches long by 330 mm13 inches deep.

Approximate Overall Size: 1524 mm60 inches long by 1016 mm40 inches deep by 1067 mm42 inches high.

][2.4.43 Item S3185, Washer, Cart & Utensil, 2 DO, PIT MNTD, RCSD 2 WLL

Provide pit mounted cart and utensil washer unit controlled by microcomputer, electrically heated, with digital control panel, and cycles to pre-wash, wash, rinse, and dry. Provide pit mounted unit with two doors for pass-through. Unit must meet Underwriters Laboratory (UL) standards.

Electrical Characteristics: 208 V, 3 Phase, 60 Hz.

Approximate Chamber Size: 991 mm39 inches wide by 1346 mm53 inches deep by 2007 mm79 inches high.

Approximate Unit Size: 2946 mm116 inches wide 2489 mm98 inches deep by 2718 mm107 inches high.

][2.4.44 Item S4300, Gun, Steam

Provide wall mounted steam gun with 3048 mm10 foot hose rated for high pressure steam, 3048 mm10 foot detergent hose, two nylon brushes, and one stainless steel brush; utilize facility steam. Provide unit with cool touch operator protection.

Approximate Overall Length: 1397 mm55 inches.

Approximate Weight of Steam Gun with Hoses: 4.5 kg10 lbs.

Detergent Contained Capacity: 9.46 liters2-1/2 gallons.

][2.4.45 Item S9765, Flusher/Disinfector, Disposal, Human Waste

Provide self contained [wall mounted], [floor mounted] flusher/disinfector. Provide unit with nine fixed and two rotating nozzles, stainless steel chamber without welded joints, and the following: read out display with three programmable options, auto lock during processing, and lockable space incorporated for detergent containers and integral steam generator. Unit must meet Under Writers Laboratory (UL) standards.

Cold Water: 15 mm1/2 inch, pressure 10 - 116 psi70-800 kPa, flow minimum 0.3 l/second.

Hot Water: 15 mm1/2 inch, pressure 10 - 116 psi70-800 kPa, flow minimum 0.3 l/second.

Freestanding and Wall Hung Approximate Sizes: 457 mm18 inches wide by 533 mm 21 inches deep by 1422 mm56 inches high.

Electrical Characteristics: 208 V, 3-phase, 60 Hz

][2.4.46 Item S9800, Sterilizer,Stm,VAC,1DO,RCSD1WLL,F/M, Large Chamber

Provide large chamber gravity steam sterilizer recessed unit with one door and hydraulic cart lift located at the door. Provide unit that is microcomputer controlled with printer to record cycle phase performance. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) standards. Provide unit with temperature range of 110 to 135 degrees C 230 degrees to 275 degrees and from 104 to 135 degrees C219 degrees to 275 degrees for liquid cycles. Utilize facility steam.

Electrical Characteristics: 208 V, 3 Phase, 60 Hz.

Drain: 51 mm 2 inch diameter.

Approximate Chamber Size: 660 mm26 inches wide, 1397 mm55 inches deep 1219 mm48 inches high.

Approximate Overall Size: 1905 mm75 inches wide by 1905 mm75 inches deep by 2007 mm79 inches high.

][2.4.47 Item S9810, Sterilizer,Stm,VAC,1DO,RCSD1WLL,PIT,26x62x42 Chamber

Provide vacuum steam sterilizer unit that is pit mounted, recessed, with single door; utilize facility steam. Provide unit that is microcomputer controlled with printer and capable of recording cycle phase performance. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) standards. Provide unit with temperature range of 110 to 135 degrees C 230 degrees to 275 degrees and from 104 to 135 degrees C219 degrees to 275 degrees for liquid cycles.

Electrical Characteristics: 208 V, 3 Phase, 60 Hz.

Drain: 51 mm2 inch diameter.

Approximate Chamber Size: 660 mm26 inches wide by 1676 mm66 inches deep by 1575 mm62 inches high.

Approximate Overall Size: 1880 mm74 inches wide by 2184 mm86 inches deep by 1981 mm78 inches high.

][2.4.48 Item S9815, Sterilizer,Stm,VAC,2DO,RCSD2WLL,F/M,26x62x42 Chamber

Provide vacuum steam sterilizer unit that is pit mounted, recessed, with two doors; utilize facility steam. Provide unit that is microcomputer controlled with printer, and capable of recording cycle phase performance. Construct unit of stainless steel. Unit must meet Underwriters Laboratory (UL) 61010-1, ASME (Section VIII, Division 1) Code for Pressure Vessels. Provide unit with temperature range of 110 to 135 degrees C230 degrees to 275 degrees and from 104 to 135 degrees C219 degrees to 275 degrees for liquid cycles. Provide unit with chamber capacity of 15 trays, maximum 7.7 kg17 lbs each.

Electrical Characteristics: 208 V, 3 Phase, 60 Hz.

Drain: 51 mm 2 inch diameter.

Approximate Chamber Size: 660 mm26 inches wide by 1702 mm67 inches deep by 1219 mm48 inches high.

Approximate Overall Size: 1905 mm75 inches wide by 2210 mm87 inches deep by 2007 mm79 inches high.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install equipment at locations indicated in accordance with manufacturer's printed installation instructions, Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT, and approved detail drawings. Submit detail drawings specifically prepared to illustrate required work for each item of equipment that interfaces with other items of equipment or construction, including, but not limited to, installation layout, coordination of equipment services, [drain piping connections,] [complete electrical wiring and control diagrams,] and details of construction and rough-in requirements. Furnish and install necessary items such as framing, mounting hardware and trim as required for the type of equipment furnished.

3.3 ADJUSTING

Following installation, adjust flows, timers, levelers, and similar components and operation devices as appropriate. After testing, and before acceptance, examine equipment to ensure that adjustments are correct and that any additional adjustments deemed necessary during product testing have been incorporated.

3.4 UTILITIES

3.4.1 Service Runs

Connect service runs from equipment to building services as indicated.

3.4.2 Dissimilar Metal Connectors

Provide connections between ferrous and nonferrous metallic pipe with dielectric waterways and flanges. Provide dielectric waterways with temperature and pressure rating equal to or greater than that specified for the connecting piping. Provide waterways with metal connections on both ends suited to match connecting piping. Internally line dielectric waterways with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges must meet the performance requirements described herein for dielectric waterways.

3.5 MANUFACTURER'S FIELD SERVICES

Provide the services of a manufacturer's representative[, in conjunction with] [, in addition to] [the Contractor's Equipment Planner,] [and] [the Contractor's Biomedical Equipment Technician,] [the Government's Biomedical Equipment Technician,] who is experienced in the installation, adjustment, and operation of the equipment specified, and responsible for supervising the installation, adjustment, and testing of the equipment.

3.6 FIELD TESTS AND INSPECTIONS

3.6.1 Before Testing

Clean pipes, equipment and components of grease, dirt, stains, and other foreign materials.

3.6.2 Testing

Perform testing in accordance with manufacturer's written instructions. Unless otherwise approved by the Contracting Officer, test all items of equipment to ensure that they are operational and installation conforms to specification requirements. Hydrostatically test piping system at pressure of 1.5 times system operating pressure with water at temperature not exceeding 38 degrees C100 degrees F. Before test, remove or isolate gage traps and apparatus that may be damaged by that pressure. Install calibrated test gage in system to observe any loss of pressure. Close off system and maintain test pressure for not less than one hour. Inspect joints and equipment connections for leaks. Retest and make repair until no further leaks are observed. Each test report must indicate compliance with specified performance criteria and the final position of controls.

3.6.3 Inspection

Examine each item for visual defects and conformance to specifications.

3.7 CLEANING

3.7.1 For Final Acceptance

Remove labels, fingerprints, and clean all surfaces both inside and out.

Tightly cover and protect fixtures and equipment against rust, dirt, water, and chemical or mechanical injury.

3.7.2 Marred Surfaces Exposed-to-View

Refinish marred exposed surfaces that affect appearance, such as both interior and exterior cabinet finishes, to match the adjacent finishes, like new; replace components that cannot be refinished in this manner.

3.7.3 Concealed Marred Surfaces

Refinish marred surfaces exposed to atmosphere, where such surfaces do not affect product's appearance but do affect resistance to elements, such as galvanized pipes and insulation, to equal resistance performance as the unmarred surfaces.

3.8 TRAINING

3.8.1 Training Course

Conduct training course for operation staff as designated by the Contracting Officer. Start the training period, for a total of [_____] hours of normal working time, after systems are functionally complete but prior to final acceptance. The field instructions must include all of the items contained in the approved operations and maintenance data, as well as demonstrations of routine maintenance operations. Notify Contracting Officer at least 14 days prior to date of the training course.

[3.8.1.1 Government's Biomedical Equipment Technician Training

Include operator's training for one Biomedical Equipment Technician (BMET) for each procured equipment item.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-11 72 13 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 72 13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 11 - EQUIPMENT

SECTION 11 72 13

MEDICAL EQUIPMENT, MISCELLANEOUS

05/20

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-11 72 13 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 72 13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 11 72 13

MEDICAL EQUIPMENT, MISCELLANEOUS
05/20

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NOTE: This guide specification covers the requirements for miscellaneous medical equipment.

This Section refers to Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for general requirements; always include Section 11 70 00 when this Section is used.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: On the drawings, show:

1. Location of equipment.

2. Height of turntable unit and control switch box above finish floor.

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PART 1 GENERAL

1.1 RELATED REQUIREMENTS

The requirements of Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT apply to this Section.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B819	(2000; R 2011) Standard Specification for Seamless Copper Tube for Medical Gas Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60601-1	(2012) Medical Electrical Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 99	(2024) Health Care Facilities Code

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Item A1100, Prefabricated Service ICU Column; G, [_____]

][Item A1105, Headwall, Prefabricated, ICU, With Equipment; G, [_____]

][Item A1107, Rail System, Utility, Gas and Electric; G, [_____]

][Item A1110, Headwall, Prefabricated, General, 1-2 bed; G, [_____]

][Item A1112, Column, Service, Overhead, Horizontal, Laboratory;G, [_____]

][Item A1115, Console, Service, Infant, Prefabricated; G, [_____]

][Item A1119, Pedestal, Medical Gas Service, Floor-Mounted; G, [_____]

][Item A1120, Column, Service, Prefab, Surgical, Ceiling Mounted; G, [_____]

][Item A1122, Column, Equipment Arm, Ceiling Mounted, Surgery; G, [_____]

][Item A1180, Scale, Roll On, Built In, 907 kg 2000 Pound Capacity; G, [_____]

][Item A1200, Lift System, Overhead, Patient Rooms; G, [_____]

][Item A1203 Lift System, Overhead, Bariatric; G, [_____]

][Item A1205 Lifts System, Overhead, Patient Room With Bath; G, [_____]

][Item A4015, Clock, Elapsed Time, Electric; G, [_____]

][Item A6010, Bumper, Wall, Bed Locator; G, [_____]

][Item L9711, Table, Autopsy, Stationary-Fixed-Height; G, [_____]

][Item L9715, Table, Autopsy, Mbl, w/Stationary Service Center; G, [_____]

][Item L9712, Table, Autopsy, Stationary-Elevating; G, [_____]

][Item L9720, Station, Pathology, Gross; G, [_____]

][Item M5015, Desk, Refraction, w/Sink, 33 by 92 by 25; G, [_____]

][Item M5016, Desk, Refraction w/console, w/o Sink; G, [_____]

][Item M8075 Lift, Patient, Physical Therapy; G, [_____]

][Item M8930 Suspension Unit, Utility, Ceiling, Microsurgery; G, [_____]

][Item M9085 Table, Operating, Floor Mounted; G, [_____]

][Item R8000, Refrigerator, Morgue, 4 Cadaver, 76 by 73 by 96; G, [_____]

][Item R8200, Refrigerated Room, Mortuary, 3 Cart; G, [_____]

][Item R8205, Refrigerated Room, Mortuary, 4 Cart; G, [_____]

][Item R8210, Refrigerated Room, Mortuary, 5 Cart; G, [_____]

][Item R8215, Refrigerated Room, Mortuary, 6 Cart; G, [_____]

] Submit detail drawings listed above for each item of equipment that interfaces with other items of equipment or construction.

SD-03 Product Data

[Item A1100, Prefabricated Service ICU column; G, [_____]

][Item A1105, Headwall, Prefabricated, ICU, With Equipment; G, [_____]

][Item A1107, Rail System, Utility, Gas and Electric; G, [_____]

][Item A1110, Headwall, Prefabricated, General, 1-2 Bed; G, [_____]

][Item A1112, Column, Service, Overhead, Horizontal, Laboratory; G, [_____]

][Item A1115, Console, Service, Infant, Prefabricated; G, [_____]

][Item A1119, Pedestal, Medical Gas Service, Floor-Mounted; G, [_____]

][Item A1120, Column, Service, Prefab, Surgical, Ceiling Mounted; G, [_____]

][Item A1122, Column, Equipment Arm, Ceiling Mounted, Surgery; G, [_____]

][Item A1180, Scale, Roll On, Built In, 2000 Pound Capacity; G, [_____]

][Item A1200, Lift System, Overhead, Patient Rooms; G, [_____]

][Item A1203 Lift System, Overhead, Bariatric; G, [_____]

][Item A1205 Lifts System, Overhead, Patient Room With Bath; G, [_____]

][Item A4015, Clock, Elapsed Time, Electric; G, [_____]

][Item A6010, Bumper, Wall, Bed Locator; G, [_____]

][Item L9711, Table, Autopsy, Stationary-Fixed-Height; G, [_____]

][Item L9715, Table, Autopsy, Mbl, w/Stationary Service Center; G, [_____]

][Item L9720, Station, Pathology, Gross; G, [_____]

][Item M5015, Desk, Refraction, w/Sink, 33 by 92 by 25; G, [_____]

][Item M5016, Desk, Refraction w/console, w/o Sink; G, [_____]

][Item M8075 Lift, Patient, Physical Therapy; G, [_____]

][Item M8930 Suspension Unit, Utility, Ceiling, Microsurgery; G, [_____]

][Item M9085 Table, Operating, Floor Mounted; G, [_____]

][Item R8000, Refrigerator, Morgue, 4 Cadaver, 76 by 73 by 96; G, [_____]

][Item R8200, Refrigerated Room, Mortuary, 3 Cart; G, [_____]

][Item R8205, Refrigerated Room, Mortuary, 4 Cart; G, [_____]

][Item R8210, Refrigerated Room, Mortuary, 5 Cart; G, [_____]

][Item R8215, Refrigerated Room, Mortuary, 6 Cart; G, [_____]

] Submit catalog numbers, trade names, literature, data sheets, diagrams and other pertinent data for each item of equipment listed above to evaluate performance, function, materials, dimensions and appearance.

SD-04 Samples

[Color/Wood Trim; G, [_____]

] SD-06 Test Reports

[Item A1100, Prefabricated Service ICU Column

][Item A1105, Headwall, Prefabricated, ICU, With Equipment

][Item A1107, Rail System, Utility, Gas and Electric

][Item A1110, Headwall, Prefabricated, General, 1-2 bed

][Item A1112, Column, Service, Overhead, Horizontal, Laboratory

][Item A1115, Console, Service, Infant, Prefabricated

][Item A1119, Pedestal, Medical Gas Service, Floor-Mounted

][Item A1120, Column, Service, Prefab, Surgical, Ceiling Mounted

][Item A1122, Column, Equipment Arm, Ceiling Mounted, Surgery

][Item A1180, Scale, Roll On, Built In, 2000 Pound Capacity

][Item A1200, Lift System, Overhead, Patient Rooms

][Item A1203 Lift System, Overhead, Bariatric

][Item A1205 Lifts System, Overhead, Patient Room with Bath

][Item A4015, Clock, Elapsed Time, Electric

][Item A6010, Bumper, Wall, Bed Locator

][Item L9711, Table, Autopsy, Stationary-Fixed-Height

][Item L9715, Table, Autopsy, Mbl, w/Stationary Service Center

][Item L9720, Station, Pathology, Gross

][Item M5015, Desk, Refraction, w/Sink, 33 by 92 by 25

][Item M5016, Desk, Refraction w/Console, w/o Sink

][Item M8075 Lift, Patient, Physical Therapy

][Item M8930 Suspension Unit, Utility, Ceiling, Microsurgery

][Item M9085 Table, Operating, Floor Mounted

][Item R8000, Refrigerator, Morgue, 4 Cadaver, 76 by 73 by 96

][Item R8200, Refrigerated Room, Mortuary, 3 Cart

][Item R8205, Refrigerated Room, Mortuary, 4 Cart

][Item R8210, Refrigerated Room, Mortuary, 5 Cart

][Item R8215, Refrigerated Room, Mortuary, 6 Cart

] Submit field tests and inspections report for each item of equipment listed above signed by authorized official responsible for field tests and inspections.

SD-10 Operation and Maintenance Data

[Item A1100, Prefabricated Service ICU column; G, [_____]

][Item A1105, Headwall, Prefabricated, ICU, With Equipment;G, [_____]

][Item A1107, Rail System, Utility, Gas and Electric; G, [_____]

][Item A1110, Headwall, Prefabricated, General, 1-2 Bed; G, [_____]

][Item A1112, Column, Service, Overhead, Horizontal, Laboratory; G, [_____]

][Item A1115, Console, Service, Infant, Prefabricated; G, [_____]

][Item A1119, Pedestal, Medical Gas Service, Floor-Mounted; G, [_____]

][Item A1120, Column, Service, Prefab, Surgical, Ceiling Mounted; G, [_____]

][Item A1122, Column, Equipment Arm, Ceiling Mounted, Surgery; G, [_____]

][Item A1180, Scale, Roll On, Built In, 2000 Pound Capacity; G, [_____]

][Item A1200, Lift System, Overhead, Patient Rooms; G, [_____]

][Item A1203 Lift System, Overhead, Bariatric; G, [_____]

][Item A1205 Lifts System, Overhead, Patient Room With Bath; G, [_____]

][Item A4015, Clock, Elapsed Time, Electric; G, [_____]

][Item A6010, Bumper, Wall, Bed Locator; G, [_____]

][Item L9711, Table, Autopsy, Stationary-Fixed-Height; G, [_____]

][Item L9715, Table, Autopsy, Mbl, w/Stationary Service Center; G, [_____]

][Item L9720, Station, Pathology, Gross; G, [_____]

][Item M5015, Desk, Refraction, w/Sink, 33 by 92 by 25; G, [_____]

][Item M5016, Desk, Refraction w/Console, w/o Sink; G, [_____]

][Item M8075 Lift, Patient, Physical Therapy; G, [_____]

][Item M8930 Suspension Unit, Utility, Ceiling, Microsurgery; G, [_____]

][Item M9085 Table, Operating, Floor Mounted; G, [_____]

][Item R8000, Refrigerator, Morgue, 4 Cadaver, 76 by 73 by 96; G, [_____]

][Item R8200, Refrigerated Room, Mortuary, 3 Cart; G, [_____]

][Item R8205, Refrigerated Room, Mortuary, 4 Cart; G, [_____]

][Item R8210, Refrigerated Room, Mortuary, 5 Cart; G, [_____]

][Item R8215, Refrigerated Room, Mortuary, 6 Cart; G, [_____]

] Submit Data Package 3, including training requirements, for each item of equipment listed above in accordance with requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.[In addition, provide hard copies consisting of two Operator's Manuals and two Service Manuals.]

1.4 WARRANTY

[Provide warranties as specified in this Section.]Refer to Article WARRANTY in Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for [additional] requirements.

PART 2 PRODUCTS

2.1 MATERIALS

Items not specified otherwise must conform to the following requirements:

a. Aluminum alloy: Equivalent in ultimate tensile, yield, and shear strengths to Alloy 6063-T5 or 6063-T6; conforming to ASTM B221M, ASTM B221.

b. Carbon steel: ASTM A1008/A1008M.

c. Laminated plastic: ANSI/NEMA LD 3; colors and patterns as selected by the Contracting Officer from the manufacturer's standard colors and patterns.

d. Stainless steel: Type 301, 302, or 304. Provide satin finish or a minimum No. 3 polished finish for exposed surfaces.

2.2 EQUIPMENT

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NOTE: Select project-specific equipment items from the list below and delete equipment items not used. Additional equipment items may be added as required to suit project-specific conditions

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[2.2.1 Item A1100, Prefabricated Service ICU column

Provide floor to ceiling prefabricated service column for equipment placement and support. Provide gas, electrical, and communications outlets mounted to any or all four sides. Provide vertical and horizontal accessory rails as shown in drawings. Approximate size 229 mm by 229 mm 9 inches by 9 inches minimum.

Additional Equipment and Devices (coordinate with drawings)

a. Electrical Receptacles: 20 amp, 125 volt, U.L. listed, "Hospital Grade". Quantity and type as indicated on drawings. Factory pre-wired by the Headwall module manufacturer. Coordinate requirements with applicable Division 26 Sections. Ensure compatibility of plug on equipment to used with these devices. Duplex: NEMA style 5-20R, "Red" color for critical branch power circuits.

b. Ground Receptacles: Integral with unit; 2.93 mm 10 AWG stranded copper wire conductor.

c. Medical Gas/Vacuum Manifold: Pre-assembled gas manifold with oxygen, air, vacuum connections and risers for all other gases.

d. Gas Outlets: Type to match existing in hospital, compatible with existing equipment. Refer to plumbing drawings for quantity of each specific gas outlet.

e. Telephone Provision: Provide telephone and data outlets. Coordinate installation requirements with applicable Division 26 and 27 Sections. Refer to communication drawings for quantity of each outlet.

f. Flat screen monitor holder/bracket.

][2.2.2 Item A1105, Headwall, Prefabricated, ICU, With Equipment

2.2.2.1 Head wall System

Provide a U.L. listed headwall consisting of a horizontal raceways that are surface mounted to the headwall behind the patient bed at specified levels. Electrical (normal or emergency power) services to raceway devices are supplied from a junction box in the wall or from optional vertical chase.

2.2.2.2 Raceways

Must provide for supporting movable ancillary equipment and cabinets. The center raceway provides track for mounting horizontally movable gas blocks. The raceway is low profile of 70 mm 2-3/4 inches deep. Each raceway contains barriers to accommodate any mix of emergency power or communication service desired. Single gang device outlets are spaced at 152 mm 6 inch intervals.

2.2.2.3 Medical Gas Distribution

Must be through a pre-assembled gas manifold located centrally below the (middle) gas raceway. Service to movable secondary gas outlets is through indexed hose assemblies connected to DISS check valves on the pre-assembled gas manifold. Supply to the pre-assembled gas manifold is through copper service drops. Copper drops are located in the wall or a cavity behind the surface mounted service chase. Access to the pre-assembled gas manifold may be accomplished by tilting or removing quick release HPL coved panels installed between the gas (middle) and bumper (bottom) raceways. Panel must cover indexed hose to keep out of view and protect patient from entanglement.

2.2.2.4 Materials

a. Service chase is 114 mm 4-1/2 inches deep by 330 mm 13 inches wide constructed of 1.52 and 0.9 mm 16 and 20 gauge steel box covered with FRL/steel front panels.

b. Horizontal raceway extruded aluminum and FRL covered with 0.91 mm 20 gauge steel.

c. Hose panels high density particle board and coved with FRL - 19 mm 3/4 inch thick.

d. Manifold Type K copper tubing (15.9 mm5/8 inch O.D. oxygen/air - 22.2 mm 7/8 inch O.D. vacuum).

e. Device faceplates - formed 0.51 mm 24 gauge anodized aluminum.

f. Wiring is 2.06 mm 12 gauge for receptacles and 2.06 and 2.59 mm 12 and 10 gauge for grounding.

2.2.2.5 Additional Headwall Equipment and Devices

a. Vacuum bottle Slide: 102 mm 4 inch, one piece extruded aluminum device, clear anodized with stop at the bottom. Slide must accept a 44 mm 1 3/4 inch wide by 3 mm 1/8 inch thick vacuum bottle bracket. Slides extend 381 mm 15 inches from the lower surface of the Headwall Module for use on either side of the bed. Slides swivel upward for storage.

b. Electrical Receptacles: 20 amp, 125 volt, 2 pole, grounding, U.L. listed, "Hospital Grade" duplex receptacles. Quantity as indicated on drawings. Factory pre-wired by the headwall module manufacturer. Coordinate requirements with applicable Division 26 Sections. Ensure compatibility of plug on equipment to used with these devices. Each receptacle cover plate is engraved to indicate the panel board and circuit from which it is served, refer to the electrical drawings for the engraving schedule. Fill-in the engraved portion with black paint.

(1) Duplex: NEMA style 5-20R, "Ivory" color on normal power circuits; "Red" color for critical branch power circuits.

(2) Single: NEMA style 5-20R, "Ivory" color on normal power circuits; "Red" color for critical branch power circuits.

c. Switches and switching arrangements: "Specification" grade 120/277 volt, 20 amp decora framed rocker switches, quiet action. Switch type SP-ST or 3-way as shown on drawings. Proved factory pre-installed and factory pre-wired switches to junction box for external lights. "Ivory" color on normal power circuits; "Red" color for critical branch power circuits. Provide compatible momentary contact switches for activation of the low voltage lighting controller where indicated on the drawings. "Ivory" color on normal power circuits; "Red" color for critical branch power circuits.

d. Telephone/Data Provision: Provide single gang faceplate factory-punched for six 8 position modular, category 5e rated jacks, provide blank inserts for 4 of the openings.

e. Code Blue Station Provision: Coordinate work with Section 27 52 24 NURSE CALL SYSTEM. Headwall module must allow adequate space and make provisions for the nurse call device.

f. Medical Gas/ Vacuum Outlets: Provide and extend the medical gas/vacuum outlets complete with valves and faceplates in locations shown on approved shop drawings. Medical gas/vacuum outlets are quick connect or diameter indexing safety system (DISS) type and of the outlet manufacturer's console model as defined on the approved shop drawing. Copper tubing for extending and manifolding is type K conforming to ASTM B819. Provide all copper tubing free of oil and foreign material. Nitrogen gas must flow through tubing during brazing to prevent carbon deposits. All brazing of joints must be with silver brazing alloy (melting point 538 degree C 1000 degree F minimum). Complete manifolded or extended system must be pressure tested to 1034 kPa 150 psi to ensure gas tight seal. Single gas outlets: 15 mm 1/2 inch nominal I.D. (16 mm5/8 inch O.D.) tubing. Each multiple oxygen and compressed air outlet is manifolded to a tube of 15 mm 1/2 inch nominal I.D. (16 mm5/8 inch O.D.) and multiple vacuum outlets are manifolded to a tube of 16 mm 5/8 inch nominal I.D. (19 mm3/4 inch O.D.). All manifolds and extensions extend into center raceway and are labeled and capped to prevent incorrect hook-up and contamination. Protect all copper tubing from contract with dissimilar metals to prevent galvanic corrosion by plastic bushings. Provide all primary connections to the extended gas outlets. Perform and certify all pressure tests as required by NFPA 99 and contractual documents.

g. Nurse Call Patient Station: Coordinate work with Section 27 52 24 NURSE CALL SYSTEM. Headwall module must allow adequate space and make provisions for the nurse call device.

h. Blank Opening with Faceplates: For future expansion of services, provide blank opening locations as indicated on drawings. Provide one or two gang size openings as noted on drawings. Provide blank faceplates (unpunched of formed aluminum) by headwall module manufacturer.

i. Bed Interface Receptacle: The bed interface receptacle must enable nurse call, television controls and lighting functions to be operated at the patient bed side rail controls. Mount the receptacle in the patient headwall rail system as indicated on the drawings. The receptacle includes 3 cables assembled to a 37 pin receptacle; two of the cables must be long enough to be connected to the nurse call patient station and the third cable must be connected to the low voltage lighting controller.

j. Provide a "Dummy Plug" which is inserted into the receptacle whenever the bed is disconnected. Attach the dummy plug to the face plate with a stainless steel ball chain. Provide a simulator which can be inserted into the interface receptacle and can duplicate the functions of the bedside controls for testing purposes.

k. Color/Wood Trim:[As specified in Section 09 06 00 SCHEDULES FOR FINISHES.][As indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.]

l. Bed Locator: Provide one set per headwall.

][2.2.3 Item A1107, Rail System, Utility, Gas and Electric

2.2.3.1 Rail System

Provide a U.L. listed headwall consisting of a vertical service chase used in conjunction with a series of 2 horizontal raceways that are surface mounted to the headwall behind the patient bed at specified levels. Provide chase with 3 barrier compartments. Electrical (normal or emergency power) services to raceway devices are supplied from the chase by pre-wired plug connectors. Final electrical connections are made below finished ceiling junction boxes in chase. Low voltage (for example, nurse call, code blue, and monitor). Provide barrier compartment for field routing of cables through service chase to location in raceway via pull strings.

2.2.3.2 Raceways

Must provide for supporting movable ancillary equipment and cabinets. The center raceway provides track for mounting horizontally movable gas blocks. The raceway is low profile of 70 mm 2-3/4 inches deep. Each raceway contains barriers to accommodate any mix of emergency power or communication service desired. Single gang device outlets are spaced at 152 mm 6 inch intervals.

2.2.3.3 Medical Gas Distribution

Must be through a pre-assembled gas manifold located centrally below the (middle) gas raceway. Service to movable secondary gas outlets is through indexed hose assemblies connected to DISS check valves on the pre-assembled gas manifold. Supply to the pre-assembled gas manifold is through copper service drops. Copper drops are located in a cavity behind the surface mounted service chase. Access to the pre-assembled gas manifold may be accomplished by tilting or removing quick release HPL coved panels installed between the gas (middle) and bumper (bottom) raceways. Panel must cover indexed hose to keep out of view and protect patient from entanglement.

2.2.3.4 Materials

a. Service chase is 114 mm 4-1/2 inches deep by 330 mm 13 inches wide constructed of 1.52 and 0.91 mm 16 and 20 gauge steel box covered with FRL/steel front panels.

b. Horizontal raceway is extruded aluminum and FRL covered with 0.91 mm 20 gauge steel.

c. Hose panels are high density particle board and coved with FRL - 19 mm 3/4 inch thick.

d. Manifold Type K copper tubing is (15.9 mm5/8 inch O.D. oxygen/air - 22.2 mm 7/8 inch O.D. vacuum).

e. Device faceplates are formed of 0.51 mm 24 gauge anodized aluminum.

f. Wiring is 2.06 mm 12 gauge for receptacles and 2.06 and 2.59 mm 12 and 10 gauge for grounding.

2.2.3.5 Additional Headwall Equipment and Devices

a. Vacuum bottle Slide: 102 mm 4 inch, one piece extruded aluminum device, clear anodized with stop at the bottom. Slide must accept a 44 mm 13/4 inch wide by 3 mm 1/8 inch thick vacuum bottle bracket. Slides extend 381 mm 15 inches from the lower surface of the headwall module for use on either side of the bed. Slides must swivel upward for storage.

b. Electrical Receptacles: 20 amp, 125 volt, 2 pole, grounding, U.L. listed, "Hospital Grade" duplex receptacles. Quantity as indicated on drawings. Factory pre-wired by the headwall module manufacturer. Coordinate requirements with applicable Division 26 Sections. Ensure compatibility of plug on equipment to used with these devices. Each receptacle cover plate is engraved to indicate the panel board and circuit from which it is served; refer to the electrical drawings for the engraving schedule. Fill in the engraved portion with black paint.

  (1) {1) Duplex: NEMA style 5-20R, "Ivory" color on normal power circuits; "Red" color for critical branch power circuits.

  (2) Single: NEMA style 5-20R, "Ivory" color on normal power circuits; "Red" color for critical branch power circuits.

c. Switches and switching arrangements: "Specification" grade 120/277 volt, 20 amp decora framed rocker switches, quiet action. Switch type SP-ST or 3-way as shown on drawings. Proved factory pre-installed and factory pre-wired switches to junction box for external lights. "Ivory" color on normal power circuits; "Red" color for critical branch power circuits. Provide compatible momentary contact switches for activation of the low voltage lighting controller where indicated on the drawings.

d. Telephone/Data Provision: Provide single gang faceplate factory-punched for six 8 position modular, category 5e rated jacks, provide blank inserts for 4 of the openings.

e. Code Blue Station Provision: Coordinate work with Section 27 52 24 NURSE CALL SYSTEM. Headwall module must allow adequate space and make provisions for the nurse call device.

f. Medical Gas/ Vacuum Outlets: Provide and extend the medical gas/vacuum outlets complete with valves and faceplates in locations shown on approved shop drawings. Medical gas/vacuum outlet is quick connect or diameter indexing safety system (DISS) type and of the outlet manufacturer's console model as defined on the approved shop drawing. Copper tubing for extending and manifolding is type K conforming to ASTM B819. Provide all copper tubing free of oil and foreign material. Nitrogen gas must flow through tubing during brazing to prevent carbon deposits. All brazing of joints must be with silver brazing alloy (melting point 538 degree C 1000 degree F minimum). Complete manifolded or extended system must be pressure tested to 150 psi to ensure gas tight seal. Single gas outlets: 15 mm 1/2 inch nominal I.D. (16 mm5/8 inch O.D.) tubing. Each multiple oxygen and compressed air outlet is manifolded to a tube of 15 mm 1/2 inch nominal I.D. (16 mm5/8 inch O.D.) and multiple vacuum outlets are manifolded to a tube of 16 mm 5/8 inch nominal I.D. (19 mm3/4 inch O.D.). All manifolds and extensions extend into center raceway and are labeled and capped to prevent incorrect hook-up and contamination. Protect all copper tubing from contact with dissimilar metals to prevent galvanic corrosion by plastic bushings. Provide all primary connections to the extended gas outlets. Perform and certify all pressure tests as required by NFPA 99 and as indicated.

g. Nurse Call Patient Station: Coordinate work with Section 27 52 24 NURSE CALL SYSTEM. Headwall module must allow adequate space and make provisions for the nurse call device.

h. Blank Opening with Faceplates: For future expansion of services, provide blank opening locations as indicated on drawings. Provide one or two gang size openings as noted on drawings. Blank faceplates (unpunched of formed aluminum) are provided by headwall module manufacturer.

i. Bed Interface Receptacle: The bed interface receptacle must enable nurse call, television controls and lighting functions to be operated at the patient bed side rail controls. Mount the receptacle in the patient headwall rail system as indicated on the drawings. The receptacle includes 3 cables assembled to a 37 pin receptacle, two of the cables must be long enough to be connected to the nurse call patient station and the third cable must be connected to the low voltage lighting controller.

j. Provide a "Dummy Plug" for the receptacle which is inserted into the receptacle whenever the bed is disconnected. The dummy plug is attached to the face plate with a stainless steel ball chain. Provide a simulator which can be inserted into the interface receptacle and duplicate the functions of the bedside controls for testing purposes.

k. Color/Wood Trim:[As specified in Section 09 06 00 SCHEDULES FOR FINISHES.][As indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.]

l. Bed Locator: Provide one set per headwall.

][2.2.4 Item A1110, Headwall, Prefabricated, General, 1-2 Bed

2.2.4.1 Head Wall System

Provide a U.L. listed headwall consisting of a horizontal raceways that are surface mounted to the headwall behind the patient bed at specified levels. Electrical (normal or emergency power) services to raceway devices are supplied from a junction box in the wall or from optional vertical chase.

2.2.4.2 Raceways

Must provide for supporting movable ancillary equipment and cabinets. The center raceway provides track for mounting horizontally movable gas blocks. The raceway is low profile of 70 mm 2-3/4 inches deep. Each raceway contains barriers to accommodate any mix of emergency power or communication service desired. Single gang device outlets are spaced at 152 mm 6 inch intervals.

2.2.4.3 Medical Gas Distribution

Must be through a pre-assembled gas manifold located centrally below the (middle) gas raceway. Service to movable secondary gas outlets is through indexed hose assemblies connected to DISS check valves on the pre-assembled gas manifold. Supply to the pre-assembled gas manifold is through copper service drops. Copper drops are located in the wall or a cavity behind the surface mounted service chase. Access to the pre-assembled gas manifold may be accomplished by tilting or removing quick release HPL coved panels installed between the gas (middle) and bumper (bottom) raceways. Panel must cover indexed hose to keep out of view and protect patient from entanglement.

2.2.4.4 Materials

a. Service chase is 114 mm 4-1/2 inches deep by 330 mm 13 inches wide constructed of 1.52 and 0.91 mm 16 and 20 gauge steel box covered with FRL/steel front panels.

b. Horizontal raceway is extruded aluminum and FRL covered with 0.91 mm 20 gauge steel.

c. Hose panels are high density particle board and coved with FRL - 19 mm 3/4 inch thick.

d. Manifold is Type K copper tubing (15 mm5/8 inch O.D. oxygen/air - 22 mm 7/8 inch O.D. vacuum).

e. Device faceplates are formed of 0.51 mm 24 gauge anodized aluminum.

f. Wiring is 2.06 mm 12 gauge for receptacles and 2.32 and 2.93 mm 12 and 10 gauge for grounding.

2.2.4.5 Additional Headwall Equipment and Devices: Coordinate with Drawings

a. Vacuum bottle Slide: 102 mm 4 inch, one piece extruded aluminum device, clear anodized with stop at the bottom. Slide must accept a 44 m 1-3/4 inch wide by 3 mm 1/8 inch thick vacuum bottle bracket. Slides extend 381 mm 15 inches from the lower surface of the Headwall Module for use on either side of the bed. Slides swivel upward for storage.

b. Electrical Receptacles: 20 amp, 125 volt, 2 pole, grounding, U.L. listed, "Hospital Grade" duplex receptacles. Quantity as indicated on drawings. Factory pre-wired by the headwall module manufacturer. Coordinate requirements with applicable Division 26 Sections. Ensure compatibility of plug on equipment to used with these devices. Each receptacle cover plate is engraved to indicate the panel board and circuit from which it is served, refer to the electrical drawings for the engraving schedule. Fill in the engraved portion with black paint.

(1) Duplex: NEMA style 5-20R, "Ivory" color on normal power circuits; "Red" color for critical branch power circuits.

(2) Single: NEMA style 5-20R, "Ivory" color on normal power circuits; "Red" color for critical branch power circuits.

c. Switches and switching arrangements: "Specification" grade 120/277 volt, 20 amp decora framed rocker switches, quiet action. Switch type SP-ST or 3-way as shown on drawings. Proved factory pre-installed and factory pre-wired switches to junction box for external lights. "Ivory" color on normal power circuits; "Red" color for critical branch power circuits. Provide compatible momentary contact switches for activation of the low voltage lighting controller where indicated on the drawings.

d. Telephone/Data Provision: Provide single gang faceplate factory-punched for six 8 position modular, category 5e rated jacks, provide blank inserts for 4 of the openings.

e. Code Blue Station Provision: Coordinate work with Section 27 52 24 NURSE CALL SYSTEM. Headwall module must allow adequate space and make provisions for the nurse call device.

f. Medical Gas/ Vacuum Outlets: Provide and extend the medical gas/vacuum outlets complete with valves and faceplates in locations shown on approved shop drawings. Medical gas/vacuum outlet is quick connect or diameter indexing safety system (DISS) type and of the outlet manufacturer's console model as defined on the approved shop drawing. Copper tubing for extending and manifolding is type K conforming to ASTM B819. Provide all copper tubing free of oil and foreign material. Nitrogen gas must flow through tubing during brazing to prevent carbon deposits. All brazing of joints must be with silver brazing alloy (melting point 538 degree C 1000 degree F minimum). Complete manifolded or extended system must be pressure tested to 1034 kPa 150 psi to ensure gas tight seal. Single gas outlets are 13 mm 1/2 inch nominal I.D. (16 mm5/8 inch O.D.) tubing. Each multiple oxygen and compressed air outlet is manifolded to a tube of 13 mm 1/2 inch nominal I.D. (16 mm5/8 inch O.D.) and multiple vacuum outlets are manifolded to a tube of 16 mm 5/8 inch nominal I.D. (19 m3/4 inch O.D.). All manifolds and extensions extend into center raceway and are labeled and capped to prevent incorrect hook-up and contamination. Protect all copper tubing from contract with dissimilar metals to prevent galvanic corrosion by plastic bushings. Provide all primary connections to the extended gas outlets. Perform and certify all pressure tests as required by NFPA 99 and as indicated.

g. Nurse Call Patient Station: Coordinate work with Section 27 52 24 NURSE CALL SYSTEM. Headwall module must allow adequate space and make provisions for the nurse call device.

h. Blank Opening with Faceplates: For future expansion of services, provide blank opening locations as indicated on drawings. Provide one or two gang size as noted on drawings. Blank faceplates (unpunched of formed aluminum) are provided by headwall module manufacturer.

i. Bed Interface Receptacle: The bed interface receptacle must enable nurse call, television controls and lighting functions to be operated at the patient bed side rail controls. Mount the receptacle in the patient headwall rail system as indicated on the drawings. The receptacle includes 3 cables assembled to a 37 pin receptacle; two of the cables must be long enough to be connected to the nurse call patient station and the third cable must be connected to the low voltage lighting controller.

j. Provide a "Dummy Plug" which is inserted into the receptacle whenever the bed is disconnected. Attach the dummy plug to the face plate with a stainless steel ball chain. Provide a simulator which can be inserted into the interface receptacle and can duplicate the functions of the bedside controls for testing purposes.

k. Color/Wood Trim:[As specified in Section 09 06 00 SCHEDULES FOR FINISHES.][As indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.]

l. Bed Locator: Provide one set per headwall.

][2.2.5 Item A1112, Column, Service, Overhead, Horizontal, Laboratory

Ceiling mounted horizontal laboratory service column. Must provide housing for gas, electrical, communications outlets, lighting and ventilation. Must be a U.L. listed, pre-wired and pre-plumbed.

Construct of steel with powder finish.

Approximate Size: 914 mm to 2438 mm 36 inches to 96 inches long by 610 mm 24 inches wide by 457 mm to 1372 mm 18 to 54 inches high. Must be configurable to join sections together for continuous runs.

][2.2.6 Item A1115, Console, Service, Infant, Prefabricated

2.2.6.1 Rail System

Provide a U.L. listed headwall consisting of a vertical service chase used in conjunction with a series of horizontal raceways that are surface mounted to the headwall behind the infant bed at specified levels. Chase must have 3 barrier compartments. Electrical (normal or emergency power), services to raceway devices are supplied from the chase by pre-wired plug connectors. Final electrical connections are made below finished ceiling junction boxes in chase. Low voltage (for example, nurse call, code blue, and monitor). Provide barrier compartment for field routing of cables through service chase to location in raceway via pull strings.

2.2.6.2 Raceways

Must provide for supporting movable ancillary equipment and cabinets. The center raceway provides track for mounting gas blocks. The raceway is low profile of 70 mm 2-3/4 inches deep. Each raceway contains barriers to accommodate any mix of emergency power or communication service desired.

2.2.6.3 Medical Gas Distribution

Must be through a pre-assembled gas manifold located centrally below the (middle) gas raceway. Service to movable secondary gas outlets is through indexed hose assemblies connected to DISS check valves on the pre-assembled gas manifold. Supply to the gas manifold is through copper service drops.

Copper drops are located in a cavity behind the service mounted service chase. Access to the pre-assembled gas manifold may be accomplished by tilting or removing quick release HPL coved panels installed between the gas (middle) and bumper (bottom) raceways. Panel must cover indexed hose to keep out of view and protect patient from entanglement.

2.2.6.4 Console/counter

Approximate Size Range: 1118 mm 44 inches wide by 610 mm 24 inches deep by 991 mm 39 inches high. Refer to drawings for exact size and configuration.

2.2.6.5 Materials

a. Service chase is approximately 114 mm 4-1/2 inches deep by 356 mm 14 inches wide constructed of 1.52 and 0.91 mm 16 and 20 gauge steel box covered with HPL/steel front panels.

b. Horizontal raceway is extruded aluminum and HPL covered with 0.91 mm 20 gauge steel.

c. Hose panels are high density particle board and covered with HPL - 19 mm 3/4 inch thick.

d. Manifold is type K copper tubing 16 mm 5/8 inch O.D. oxygen/air 22 mm 7/8 inch O.D. vacuum).

e. Device faceplates are formed 0.51 mm 24 gauge anodized aluminum.

f. Wiring is 2.06 mm 12 gauge for receptacles and 2.06 and 2.59 mm 12 and 10 gauge for grounding.

g. Approximate Size: 1118 mm 44 inches wide by 610 mm 24 inches deep.

2.2.6.6 Rail System

Provide with devices and equipment as indicated on the drawings.

2.2.6.7 Additional Headwall Equipment and Devices

a. Electrical Receptacles: 20 amp, 125 volt, U.L. listed, "Hospital Grade." Quantity and type as indicated on drawings. Factory pre-wired by the headwall module manufacturer. Coordinate requirements with applicable Division 26 Sections. Ensure compatibility of plug in equipment to be used with these devices. Each receptacle cover plate is engraved to indicate the panel board and circuit from which it is served, refer to electrical drawings for the engraving schedule. Fill in the engraved portion with black paint.

    (1) Duplex: NEMA style 5-20R, "Ivory" color on normal power circuits: "Red" color for critical branch power circuits.

    (2) Single: NEMA style 5-20R, "Ivory" color on normal power circuits: "Red" color for critical branch power circuits.

b. Ground Receptacles: Integral with unit; 10 AWG stranded copper wire conductor.

c. Telephone/Data Provision: Provide a single gang faceplate factory-punched for six 8 position modular, category 5e rated jacks, provide blank inserts for 4 of the openings.

d. Code Blue Emergency Call Button: Switch button and plate. Coordinate work with nurse call requirements. Allow adequate space and provide raceway to accommodate code blue wire pulls to nurse call back box headwall module.

e. Nurse Call Station: Provide nurse call equipment. Coordinate work with Section 27 52 24 NURSE CALL SYSTEM. Headwall module must allow adequate space and make provisions for nurse call. Include backbox and conduit to accommodate all nurse call wiring and nurse call remote jack for servicing access area of module.

f. Blank Opening with Faceplates: For future expansion of services, provide blank opening locations as indicated on drawings. Provide one or two gang size as are noted on drawings. Blank faceplates (unpunched of formed aluminum) provided by headwall module manufacturer.

g. Monitor Equipment Provisions: Provide raceway to service junction box for monitor wires and faceplates for monitor connection box. Factory install power receptacles, signal connection backbox and conduit for wire pulls. Provide monitor channel for monitor mounting.

h. Switches and switching arrangements: "Specification" grade 120 volt, 20 amp decora framed rocker switches, quiet action. Switch type SP-ST or 3-way as shown on drawings. Factory pre-installed and factory pre-wired switches to lights.

i. Vacuum slides as indicated on the drawings.

][2.2.7 Item A1119, Pedestal, Medical Gas Service, Floor-Mounted

Floor mounted prefabricated service pedestal. Must be UL listed and provide housing for gas and electrical outlets. Construct of Type 304 stainless steel with No. 4 satin finish. Provide with removable top for access. Gas outlets can be mounted on sides of pedestal.

Approximate Sizes: 254 mm 10 inches by 508 mm 20 inches by 305 mm to 457 mm 12 to 18 inches high.

][2.2.8 Item A1120, Column, Service, Prefab, Surgical, Ceiling Mounted

Ceiling mounted surgical prefabricated service column. Must provide housing for gas, electrical, and communications outlets, with positive pneumatic braking system locks at each joint, friction brakes. Motorized retractable column. Construct upper and lower sections of shroud of 1.59 mm 16 gauge Type 304 stainless steel with a No. 4 satin finish, including a removable access panel, stainless steel ceiling collar, a steel mounting plate equipped with console gas outlets above the ceiling line. Gas outlets can be mounted on both sides or bottom of column. Provide provisions for up 10 gas outlets. Electrical outlets can be added to any or all four sides of the column. Fully retracted length from ceiling is 914 mm 36 inches.

2.2.8.1 Additional Equipment and Devices

a. Electrical Receptacles: 20 amp, 125 volt, U.L. listed, "Hospital Grade". Quantity and type as indicated on drawings. Factory pre-wired by the Headwall module manufacturer. Coordinate requirements with applicable Division 26 Sections. Ensure compatibility of plug on equipment to used with these devices. Duplex: NEMA style 5-20R, "Red" color for critical branch power circuits.

b. Ground Receptacles: Integral with unit; 2.59 mm 10 AWG stranded copper wire conductor.

c. Medical Gas/Vacuum Manifold: Pre-assembled gas manifold with oxygen, air, vacuum connections and risers for all other gases.

d. Gas Outlets: Type to match existing in hospital, compatible with existing equipment. Refer to plumbing drawings for quantity of each specific gas outlet.

e. Telephone Provision: Provide telephone and data outlets. Coordinate installation with requirements of applicable Division 26 and 27 Sections. Refer to communication drawings for quantity of each outlet.

][2.2.9 Item A1122, Column, Equipment Arm, Ceiling Mounted, Surgery

Ceiling mounted prefabricated equipment articulating service column. Must provide for equipment placement and support. Provide gas, electrical, and communications outlets mounted to any or all four sides. Must accommodate a minimum of 12 gas outlets and 18 electrical duplex outlets. Provide three shelves and vertical accessory rails. Pneumatic moving and braking system. Provide range of motion up to 330 degrees with each arm.

Approximate Size: 584 mm to 940 mm 23 to 37 inches tall.

2.2.9.1 Additional Equipment and Devices

a. Electrical Receptacles: 20 amp, 125 volt, U.L. listed, "Hospital Grade". Quantity and type as indicated on drawings. Factory pre-wired by the Headwall module manufacturer. Coordinate requirements with applicable Division 26 Sections. Ensure compatibility of plug on equipment to used with these devices. Duplex: NEMA style 5-20R, "Red" color for critical branch power circuits.

b. Ground Receptacles: Integral with unit; 2.59 mm 10 AWG stranded copper wire conductor.

c. Medical Gas/Vacuum Manifold: Pre-assembled gas manifold with oxygen, air, vacuum connections and risers for all other gases.

d. Gas Outlets: Type to match existing in hospital, compatible with existing equipment. Refer to plumbing drawings for quantity of each specific gas outlet.

e. Telephone Provision: Provide telephone and data outlets. Coordinate installation with requirements of applicable Division 26 and 27 Sections. Refer to communication drawings for quantity of each outlet.

f. Flat screen monitor holder/bracket.

g. Optional second arm.

][2.2.10 Item A1180, Scale, Roll On, Built In, 2000 Pound Capacity

Provide recessed, flush mounted roll on scale, 1219 48 inches wide by 1219 mm 48 inches deep by 76 mm 3 inches high. Scale must have 907 kg 2,000 pound capacity. Standard powder coating. Provide unit with wall mounted digital weight indicator; weighing and counting indicator must have 4 button keypad, dual weighing units, green LED display. 115 VAC, single phase with Battery backup.

][2.2.11 Item A1200, Lift System, Overhead, Patient Rooms

Provide ceiling mounted patient bedroom lift consisting of a motor driven lift unit that traverses on an "H" ceiling mounted track system.

a. Ceiling mounted track system: High strength extruded aluminum in manufacture's standard profile and thickness to support lifting capacity indicated for lift unit. Provide track shapes and accessories as required to provide a complete system in layout indicated on drawings.

b. Lift unit: Construct unit of a steel frame system (1000 kg2205 pounds tested) driven by a gear reduced high torque motor. Unit must be in compliance with IEC 60601-1 Standard (or comparable UL).

    (1) Lifting capacity: 249 kg 550 pounds minimum.

    (2) Maximum lift range: 2438 mm 96 inches.

    (3) Safety features:

        (a) Emergency stopping device.

        (b) Current limiter for circuit protection in case of overload

        (c) Safety device that stops the motor to lift when batteries are low.

        (d) Emergency lowering device, mechanical and electrical

        (e) Control of lift strap

        (f) Cut off angle: 45 degrees along the rail; 10 degrees across the rail.

        (g) Hand held remote control

        (h) Quick release trolley

        (i) Entire external system (e.g. track, motor, strap, hanger) must be able to be cleaned according to infection control standards without the loss of strength and integrity of the system.

        (j) Control unit: Dual control - hand control and on the motor.

        (k) Continuous charging option.

        (l) IQ technology

c. Spreader bar

    (1) 6 point with spring loaded locking clips to secure sling loops

(2) Spreader bar must work for all lift and transfer tasks. 272 kg 600 pound

d. Batteries

(1) The batteries must be of deep discharge construction and must be non-proprietary.

(2) System must be capable of using batteries of same voltage and amp rating by different manufacturers without voiding the warranty.

e. Charger

(1) Charger input: 100-240 Vac 60 Hz

(2) Charger output: 27 Vdc, 1A max

(3) Continuous charge charging system.

f. Other system requirements:

(1) The system must operate in a smooth, consistent manner without and fast, slow or jerky starts and stops.

(2) Emergency lowering shall not require any special tools.

(3) Capable of adding scale to system. Capable of integrated scale.

g. Installation:

(1) Install ceiling mounted patient lift system as in accordance with manufacturer's instructions and under supervision of manufacturer's qualified representative.

(2) Contractor must provide all labor, materials, equipment, shipping and ancillary costs required for installation.

h. Test:

(1) Conduct a performance test on each lift system to show that the patient lift system equipment and control devices operate properly an in accordance with the design and specification requirements.

(2) Contractor must provide certifications for each lift system with the room number and building including a date and time and load test.

(3) Equipment certified after install. Certification must include weight test of maximum lift capacity plus 25 percent at the attachment point, otherwise 100 percent SWL. If the system fails, Contractor must make all necessary adjustments and re-test within 7 business days.

i. Warranty:

(1) Provide motor with a two year warranty from date of final acceptance of the work. The warranty includes all travel and shipping costs associated with any warranty repair. Refer to

Article WARRANTY in Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for additional requirements.

][2.2.12 Item A1203, Lift System, Overhead, Bariatric

Ceiling mounted patient bedroom lift consisting of a motor driven lift unit that traverses on an "H" ceiling mounted track system.

a. Ceiling mounted track system: High strength extruded aluminum in manufacture's standard profile and thickness to support lifting capacity indicated for lift unit. Provide track shapes and accessories as required to provide a complete system in layout indicated on drawings.

b. Lift Unit: Construct unit of a steel frame system (1000 kg2205 pounds tested) driven by a gear reduced high torque motor. Unit must be in compliance with IEC 60601-1 Standard (or comparable UL).

    (1) Lifting capacity: 454 kg 1000 pounds minimum.

    (2) Maximum lift range: 2438 mm 96 inches

    (3) Safety features:

        (a) Emergency stopping device.

        (b) Current limiter for circuit protection in case of overload

        (c) Safety device that stops the motor to lift when batteries are low.

        (d) Emergency lowering device, mechanical and electrical

        (e) Control of lift strap

        (f) Cut off angle: 45 degrees along the rail; 10 degrees across the rail.

        (g) Hand held remote control

        (h) Quick release trolley

        (i) Entire external system (e.g. track, motor, strap, hanger) must be able to be cleaned according to infection control standards without the loss of strength and integrity of the system.

        (j) Control unit: Dual control - hand control and on the motor.

        (k) Continuous charging option.

        (l) IQ technology

c. Spreader bar

    (1) 6 point with spring loaded locking clips to secure sling loops

    (2) Spreader bar must work for all lift and transfer tasks. 272 kg 600 pound

d. Batteries

    (1) The batteries must be of deep discharge construction and must be non-proprietary.

    (2) System must be capable of using batteries of same voltage and amp rating by different manufacturers without voiding the warranty.

e. Charger

    (1) Charger input: 100-240 Vac 60 Hz

    (2) Charger output: 27 Vdc, 1A max

    (3) Continuous charge charging system.

f. Other system requirements:

    (1) The system shall operate in a smooth, consistent manner without and fast, slow or jerky starts and stops.

    (2) Emergency lowering shall not require any special tools.

    (3) Capable of adding scale to system. Capable of integrated scale.

g. Installation:

    (1) Install ceiling mounted patient lift system as per manufacturer's instructions and under supervision of manufacturer's qualified representative.

    (2) Contractor must provide all labor, materials, equipment, shipping and ancillary costs required for installation.

h. Test:

    (1) Conduct a performance test on each lift system to show that the patient lift system equipment and control devices operate properly an in accordance with the design and specification requirements.

    (2) Contractor must provide certifications for each lift system with the room number and building including a date and time and load test.

    (3) Equipment certified after install. Certification must include weight test of maximum lift capacity plus 25 percent at the attachment point, otherwise 100 percent SWL. If the system fails, Contractor must make all necessary adjustments and re-test within 7 business days.

i. Warranty:

    (1) Provide motor with a two year warranty from date o final acceptance of the work. The warranty includes all travel and shipping costs associated with any warranty repair. Refer to Article WARRANTY in Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for additional requirements.

][2.2.13 Item A1205, Lift System, Overhead, Patient Room with bath

Provide ceiling mounted patient bedroom lift consisting of a motor driven lift unit that traverses on an "H" ceiling mounted track system.

a. Ceiling mounted patient toilet lift consisting of an "I" ceiling mounted track system

b. Ceiling mounted track system: High strength extruded aluminum in manufacture's standard profile and thickness to support lifting capacity indicated for lift unit. Provide track shapes and accessories as required to provide a complete system in layout indicated on drawings.

c. Lift unit: Construct unit of a steel frame system (1000 kg2205 pounds tested) driven by a gear reduced high torque motor. Must be in compliance with IEC 60601-1 Standard (or comparable UL).

    (1) Lifting capacity: 249 kg 550 pounds minimum.

    (2) Maximum lift range: 2438 mm 96 inches

    (3) Safety features:

        (a) Emergency stopping device.

        (b) Current limiter for circuit protection in case of overload

        (c) Safety device that stops the motor to lift when batteries are low.

        (d) Emergency lowering device, mechanical and electrical

        (e) Control of lift strap

        (f) Cut off angle: 45 degrees along the rail; 10 degrees across the rail.

        (g) Hand held remote control

        (h) Quick release trolley

        (i) Entire external system (e.g. track, motor, strap, hanger) must be able to be cleaned according to infection control standards without the loss of strength and integrity of the system.

        (j) Control unit: Dual control - hand control and on the motor.

        (k) Continuous charging option.

        (l) IQ technology

d. Spreader bar

    (1) 6 point with spring loaded locking clips to secure sling loops

    (2) Spreader bar must work for all lift and transfer tasks. (272 kg600 pound)

e. Batteries

    (1) The batteries must be of deep discharge construction and must be non-proprietary.

    (2) System must be capable of using batteries of same voltage and amp rating by different manufacturers without voiding the warranty.

f. Charger

    (1) Charger input: 100-240 Vac, 60 Hz

    (2) Charger output: 27 Vdc, 1A max

    (3) Continuous charge charging system.

g. Other system requirements:

    (1) The system must operate in a smooth, consistent manner without and fast, slow or jerky starts and stops.

    (2) Emergency lowering shall not require any special tools.

    (3) Capable of adding scale to system. Capable of integrated scale.

h. Installation:

    (1) Install ceiling mounted patient lift system in accordance with manufacturer's instructions and under supervision of manufacturer's qualified representative.

    (2) Contractor must provide all labor, materials, tolls, equipment, shipping and ancillary costs required for installation.

i. Test:

    (1) Conduct a performance test on each lift system to show that the patient lift system equipment and control devices operate properly an in accordance with the design and specification requirements.

    (2) Contractor must provide certifications for each lift system with the room number and building including a date and time and load test.

    (3) Equipment certified after install. Certification must include weight test of maximum lift capacity plus 25 percent at the attachment point, otherwise 100 percent SWL. If the system fails, contractor will make all necessary adjustments and re-test within 7 business days.

j. Warranty:

    (1) Provide motor with a two year warranty from date of final acceptance of the work. The warranty includes all travel and shipping costs associated with any warranty repair. Refer to Article WARRANTY in Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for additional requirements.

][2.2.14 Item A4015, Clock, Elapsed Time, Electric

Clock/Timer must be combination four digit time of day clock, elapsed time indicator or date display. 12 or 24-hour format. Electrical requirements: 120 volt, 60 Hz, single phase. Digits must be 13 mm 1/2 inch, vacuum fluorescent blue/green in color on black background, with readability beyond 6.1 m 20 feet and a viewing angle greater than 60 degree either side of normal viewing place. External line voltage power loss of less than 60 seconds must not effect time-of-day, elapsed time or day settings to permit transfer between standard line voltage power source and critical branch line voltage power source. Clock/timer internal power source must not be replaceable battery type and must maintain time accuracy during external loss. Remote control for all functions except Self-Test and Code Blue. Approximate size: 114 mm 4-1/2 inches high by 229 mm 9 inches wide by 64 mm 2-1/2 inches deep.

][2.2.15 Item A6010, Bumper, Wall, Bed Locator

Bed locator wall bumper. Construct of rigid vinyl over heavy gauge aluminum. Approximate size: 1270 mm 50 inches long by 610 mm 24 inches high. Depth: 64 mm to 127 mm 2-1/2 inches to 5 inches.

][2.2.16 Item L9711, Table, Autopsy, Stationary-Fixed-Height

Provide stationary autopsy table on pedestal. Construct the stationary service center of Type 304 welded and polished No. 4 stainless steel. Equip pedestal with mounting flanges. Provide unit with integrated sink, waste disposer, grid plates and perimeter downdraft. Factory install plumbing and electrical with single point connections. Provide GFCI duplex receptacle with waterproof cover. Provide backflow protection. Provide heavy duty 1/2 horsepower with switch. Sink size approximately: 356 mm by 305 mm by 203 mm 14 inches by 12 inches by 8 inches deep with spray hose assembly with cold water control valve, nozzle and 3.05 m 10 foot of flexible house. Mixing faucet with gooseneck spout and wrist blades. Provide with integral downdraft ventilation. Provide four grid plates constructed of 1.27 mm 18-gauge, Type 304 stainless steel with No. 4 finish, perforated and removable. Overall approximate size: 813 mm 32 inches wide by 2642 mm 104 inches long by 889 mm 35 inches high.

][2.2.17 Item L9712, Table, Autopsy, Stationary-Elevating

Provide height adjustable autopsy table on pedestal. Construct the height adjustable service center of Type 304 welded and polished No. 4 stainless steel. Equip pedestal with mounting flanges. Height must be adjustable by a hydraulic mechanism, capable of lifting maximum of 227 kg 500 pounds approximately 203 mm 8 inches. Provide unit with integrated sink, waste disposer, grid plates and perimeter downdraft. Factory install plumbing and electrical with single point connections. Provide GFCI duplex receptacle with waterproof cover. Provide backflow protection. Provide heavy duty 1/2 horsepower waste disposer with switch. Sink size approximately: 356 mm by 305 mm by 203 mm 14 inches by 12 inches by 8 inches deep with spray hose assembly with cold water control valve, nozzle and 3.05 m 10 foot of flexible house. Mixing faucet with gooseneck spout and wrist blades. Provide with integral downdraft ventilation. Provide four grid plates constructed of 1.27 mm 18-gauge, Type 304 stainless steel with No. 4 finish, perforated and removable. Overall approximate size: 813 mm 32 inches wide by 2462 mm 104 inches long by 889 mm 35 inches high.

][2.2.18 Item L9715, Table, Autopsy, Mbl, w/Stationary Service Center

Provide mobile autopsy table with stationary service center. Construct the mobile autopsy table of Type 304 welded and polished stainless steel. Provide with a hand crank to adjust pitch position, a lower rollout tray. Legs are 38 mm 1-1/2 inch square stainless steel, and all swivel casters are 203 mm 8 inches with locks and wheel brakes. Approximate size: 610 mm 24 inches wide by 2438 mm 96 inches long. Height adjustable up to 953 mm 37-1/2 inches high.

The stationary service center is equipped with operator work facilities. Construct of Type 304 welded and polished stainless steel. Provide unit with the legs, feet, sink basin, drainboards and back splash, including water powered vacuum generator with built in vacuum breaker, water service control, mixing faucet, sink faucet, table flushing system, dissecting trays, water proof electrical outlet, switches and lighting. Approximate size: 2438 mm wide by 711 mm deep by 864 mm 96 inches wide by 28 inches deep by 34 inches high.

][2.2.19 Item L9720, Station, Pathology, Gross

Provide pathology gross station. Unit size: 1219 mm 48 inches wide by 711 mm 28 inches deep by 232 mm 80 inches high. Provide unit with height adjustable stand with extruded aluminum frame and stainless steel shelf and back panel.

Power Requirements: 115 volt, 60 Hz. Two hospital grade duplex ground fault circuit interrupter receptacles.

Duct adaptor for connection to facility exhaust. Fume removal must be quiet, measuring less than 65 decibels.

Sink is 406 mm 16 inches wide by 305 mm 12 inches deep by 203 mm 8 inches high with rapid positive drain. Vacuum breaker protected cold water faucet with hands free infrared signal with manual override capability. Provide hand spray unit with stainless steel head. Dissection board must slope into sink, and faucet must include wrist blades. Provide paper towel holder above sink.

Microprocessor must be included for clock time and filter replacement alarm.

Provide three removable perforated grid plates on the flat stainless steel work surface.

Provide unit with magnetic tool bar, integral centimeter rulers, tea strainer, paper towel dispenser, side mounted magnifier lamp, and splash shield.

2.2.19.1 Exhaust System

Hood must be rated to provide 30.48 m/minute 100 feet per minute face velocity across hood with an quantity of 11.3 cm/m 400 CFM. Maximum air static pressure loss must not exceed 0.37 kPa 1.15 inches H20 W.G. Provide electronic airflow status monitoring system mounted to front of hood. Provide monitoring system with an electronic analog gage indicating actual face velocity, pilot lights indicating (green) normal operating status, and (red) alarm; low exhaust flow status. Furnish with 20 amp dry type contacts; one set for normal status, and one set for alarm status for use by laboratory airflow control system. Furnish with normal and alarm pilot lights, 65 db chime alarm and push to silence button.

][2.2.20 Item M5015, Desk, Refraction, w/Sink, 33 by 92 by 25

Provide ophthalmic refraction desk with control systems and sink cabinet. Provide unit with three rechargeable instrument wells, two accessory switches, five switch control panel for interior room lights with separate on/off dimmer control for room lights, trial lens drawer with full suspension, in-direct ophthalmoscope control with hanger and overhead lamp. Sink cabinet must include stainless steel sink, gooseneck faucet with wrist blades. Approximate size: 2235 mm 88 inches wide by 508 mm 20 inches deep / 813 mm 32 inches deep by 813 mm 32 inches high. Electrical: 120 Volts, 15 amp, 60 HZ. Cabinet must not be constructed separately by millwork manufacturer.

][2.2.21 Item M5016, Desk, Refraction w/console, w/o Sink

Provide ophthalmic refraction desk with control systems. Provide unit with three rechargeable instrument wells, two accessory switches, separate on/off dimmer control for room lights, trial lens drawer, in-direct ophthalmoscope control with hanger and overhead lamp. Approximate size: 1473 mm 58 inches wide by 508 mm 20 inches deep / 813 mm 32 inches deep by 813 mm 32 inches high. Electrical: 120 Volts, 15 amp, 60 HZ. Cabinet must not be constructed separately by millwork manufacturer.

][2.2.22 Item M8075, Lift, Patient, Physical Therapy

Provide physical therapy patient lift. Construct of passivated stainless steel, bolted to the floor with heavy duty base. Unit to provide 181 kg 400 pound minimum lifting capacity. Provide adjusted padded headrest, seat with lumbar support, polyethylene swing out footrest with non-slip surface, flip up outer arm, and adjustable height control valve.

][2.2.23 Item M8930 Suspension Unit, Utility, Ceiling, Microsurgery

Provide microsurgery ceiling suspension arm consisting of a ceiling mounted column with a power supply unit and a hydraulic control/pumping system. The unit to have a track or ceiling plate providing free movement with hand or foot switch. Provide power supply and hydraulic control system as required in drawings.

][2.2.24 Item M9085 Table, Operating, Floor mounted

Provide floor mounted operating table. Construct table top, side rails and base column of stainless steel. Table top is divided symmetrically divided and can be adjusted using plug in modules. Electromechanical controls, controlled gentle start up, hand controller to return to last patient position, controller to store up to 10 patient positions, support plates to be removed without tools, dual arm support section and hybrid cushioning with electrical discharging capacity. Electo-powered drive provides longitudinal shift with back plate up or down and leg plates up or down. Approximate size: 2057 mm 81 inches long by 584 mm 23 inches wide.

][2.2.25 Item R8000, Refrigerator, Morgue, 4 Cadaver, 76 by 73 by 96

Provide four cadaver mortuary refrigerators. The exterior front must be 0.032 Type 304 stainless steel with a No. 4 finish. Construct top, sides and back shall be 0.4 mm 26 gauge stucco embossed aluminum.

Approximate Size: 1829 mm 72 inches wide by 2438 mm 96 inches deep by 2007 mm 79 inches high.

Insulation: 102 mm 4 inch foamed in place urethane (UL listed, Class 1).

Doors: Four 686 mm 27 inches by 559 mm 22 inches, flush style with magnetic gasket.

Lighting: Four door controlled light switch and one vaporproof light.

Refrigeration: Condensing unit, 0.56 kw 3/4 hp air cooled with R404 refrigerant. Cooling unit - automatic off-cycle. Operating temperature 3.3 degrees C 38 degrees F.

Electrical: 208/230 volts, 50/60 Hz, single phase.

][2.2.26 Item R8200, Refrigerated Room, Mortuary, 3 Cart

Provide walk-in 3 cart mortuary refrigerated room. The exterior front must be 0.032 Type 304 stainless steel with a No. 4 finish. Construct top, sides and back 0.4 mm 26 gauge stucco embossed aluminum. Operating temperature of: 3.9 degrees C 39 degrees F.

Approximate Size: 2946 mm 116 inches wide (front) by 2692 mm 106 inches deep (side) by 2616 mm 103 inches high.

Doors: 1219 mm 48 inches wide by 1981 mm 78 inches high swing out type. Magnetic gasket must be provided on both sides and top of door. Hinges must be polished chrome, strap type with cam-left hinges. Door latch must be polished chrome with provisions for locking and a safety release to prevent entrapment of personnel within the box. View window: approximately 356 mm by 356 mm 14 inch by 14 inch.

Insulation: 102 mm 4 inch foamed in place Class 1 foam.

Exterior Ramp: Heavy usage roll-in traffic ramp. It must provide flush entrance, have non-skid strips and fasten to front of the walk-in floor. Ramp must be as wide as the door and 660 mm 26 inches deep minimum.

Lighting: One pre-installed vapor proof light must be provided.

Provide for 3 cart capacity. Provide a one manual cadaver lift, three carriers and three stainless steel trays.

Refrigeration: Air cooled condensing unit, welded hermetic compressor. Condensing unit must be UL listed. Refrigeration system must be factory assembled and pre-charged. Provide unit with evaporator mounting kit, sight glass, expansion valve, liquid line filter drier and control. R404 Refrigerant.

Electrical: 208 volts, 60 Hz, single phase

][2.2.27 Item R8205, Refrigerated Room, Mortuary, 4 Cart

Provide walk-in 4 cart mortuary refrigerated room. The exterior front must be 0.032 type 304 stainless steel with a No. 4 finish. Top, sides and back must be 0.4 mm 26 gauge stucco embossed aluminum. Operating temperature: 3.9 degrees C 39 degrees F.

Approximate Size: 2896 mm 114 inches wide (front) by 4877 mm 192 inches deep (side) by 2616 mm 103 inches high.

Doors: 1219 mm 48 inches wide by 1981 mm 78 inches high swing out type. Magnetic gasket must be provided on both sides and top of door. Hinges must be polished chrome, strap type with cam-left hinges. Door latch must be polished chrome with provisions for locking and a safety release to prevent entrapment of personnel within the box. View window: approximately 356 mm by 356 mm 14 inch by 14 inch.

Insulation: 102 mm 4 inch foamed in place Class 1 foam.

Exterior Ramp: Heavy usage roll-in traffic ramp. It shall provide flush entrance, have non-skid strips and fasten to front of the walk-in floor. Ramp shall be as wide as the door and 660 mm 26 inches deep minimum.

Lighting: One pre-installed vapor proof light shall be provided.

Provide for 4 cart capacity.

Provide a one manual cadaver lift, two, two tier carriers and four stainless steel trays.

Refrigeration: Air cooled condensing unit, welded hermetic compressor. Condensing unit must be UL listed. Refrigeration system must be factory assembled and pre-charged. Provide unit with evaporator mounting kit, sight glass, expansion valve, liquid line filter drier and control. R404 refrigerant.

Electrical: 208 volts, 60 Hz, single phase.

][2.2.28 Item R8210, Refrigerated Room, Mortuary, 5 Cart

Provide walk-in 5 cart mortuary refrigerated room. The exterior front shall be 0.032 type 304 stainless steel with a No. 4 finish. Top, sides and back shall be 0.4 mm 26 gauge stucco embossed aluminum. Operating temperature: 3.9 degrees C 39 degrees F.

Approximate size: 2896 mm 114 inches wide (front) by 4877 mm 192 inches deep (side) by 2616 mm 103 inches high. Doors: 1219 mm 48 inches wide by 1981 mm 78 inches high swing out type. Magnetic gasket shall be provided on both sides and top of door. Hinges shall be polished chrome, strap type with cam-left hinges. Door latch shall be polished chrome with provisions for locking and a safety release to prevent entrapment of personnel within the box. View window: approximately 356 mm by 356 mm 14 inch by 14 inch.

Insulation: 102 mm 4 inch foamed in place Class 1 foam.

Exterior Ramp: Heavy usage roll-in traffic ramp. It must provide flush entrance, have non-skid strips and fasten to front of the walk-in floor. Ramp must be as wide as the door and 660 mm 26 inches deep minimum.

Lighting: One pre-installed vapor proof light must be provided.

Provide for 5 cart capacity. Provide a one manual cadaver lift, three two tier carriers and five stainless steel trays.

Refrigeration: Air cooled condensing unit, welded hermetic compressor. Condensing unit must be UL listed. Refrigeration system must be factory assembled and pre-charged. Provide unit with evaporator mounting kit, sight glass, expansion valve, liquid line filter drier and control. R404 refrigerant.

Electrical: 208 volts, 60 Hz, single phase.

][2.2.29 Item R8215, Refrigerated Room, Mortuary, 6 Cart

Provide walk-in 6 cart mortuary refrigerated room. The exterior front must be 0.032 Type 304 stainless steel with a No. 4 finish. Top, sides and back must be 0.4 mm 26 gauge stucco embossed aluminum. Operating temperature: 4 degrees C 39 degrees F.

Approximate Size: 4115 mm 162 inches wide (front) by 4877 mm 192 inches deep (side) by 2616 mm 103 inches high.

Doors: 1219 mm 48 inches wide by 1981 mm 78 inches high swing out type. Magnetic gasket must be provided on both sides and top of door. Hinges must be polished chrome, strap type with cam-left hinges. Door latch must be polished chrome with provisions for locking and a safety release to prevent entrapment of personnel within the box. View window: approximately 356 mm by 356 mm 14 inch by 14 inch.

Insulation: 102 mm 4 inch foamed in place Class 1 foam.

Exterior Ramp: Heavy usage roll-in traffic ramp. It must provide flush entrance, have non-skid strips and fasten to front of the walk-in floor. Ramp must be as wide as the door and 660 mm 26 inches deep minimum.

Lighting: One pre-installed vapor proof light must be provided.

Provide for 6 cart capacity. Provide a one manual cadaver lift, three two tier carriers and six stainless steel trays.

Refrigeration: Air cooled condensing unit, welded hermetic compressor. Condensing unit must be UL listed. Refrigeration system must be factory assembled and pre-charged. Provide unit with evaporator mounting kit, sight glass, expansion valve, liquid line filter drier and control. R404 refrigerant.

Electrical: 208 volts, 60 Hz, single phase.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install equipment at locations indicated in accordance with manufacturer's printed installation instructions, Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT, and approved detail drawings. Submit detail drawings specifically prepared to illustrate required work for each item of equipment that interfaces with other items of equipment or construction, including, but not limited to, installation layout, coordination of equipment services, [drain piping connections,] [complete electrical wiring and control diagrams,] and details of construction and rough-in requirements. Furnish and install necessary items such as framing, mounting hardware and trim shall be furnished and installed as required for the type of equipment furnished.

3.3 ADJUSTING

Following installation, adjust flows, timers, levelers, and similar components and operation devices as appropriate. After testing, and before acceptance, examine equipment to ensure that adjustments are correct and that any additional adjustments deemed necessary during product testing, have been incorporated.

3.3.1 Ceiling Mounted Patient-Life Systems

Install tracks level and plumb, according to manufacturer's written instructions.

a. Support track directly from overhead supplementary framing using manufacturer's standard supports, anchors, and fasteners at intervals required by lifting capacity indicated, but not less than 914 mm 36 inches o.c.

b. Brace direct-to-structure track supports where distance between suspended ceiling and anchors is more than 457 mm 18 inches.

c. Provide supports at each track end, splice, and tangent point of each corner.

d. Install track accessories, splices, end caps, connectors, coupling and joining devices, and other accessories as required for a secure and operational installation.

3.4 UTILITIES

3.4.1 Service Runs

Connect service runs from equipment to building services as indicated.

3.4.2 Dissimilar Metal Connectors

Provide connections between ferrous and nonferrous metallic pipe with dielectric waterways and flanges. Provide dielectric waterways with temperature and pressure rating equal to or greater than that specified for the connecting piping. Provide waterways with metal connections on both ends suited to match connecting piping. Internally line dielectric waterways with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges meet the performance requirements described herein for dielectric waterways.

3.5 MANUFACTURER'S FIELD SERVICES

Provide the services of a manufacturer's representative [, in conjunction with] [, in addition to] [the Contractor's Equipment Planner,][and] [the Contractor's Biomedical Equipment Technician,] [the Government's Biomedical Equipment Technician,] who is experienced in the installation, adjustment, and operation of the equipment specified, and responsible for supervising the installation, adjustment, and testing of the equipment.

3.6 FIELD TESTS AND INSPECTIONS

3.6.1 Before Testing

Clean pipes, equipment and components of grease, dirt, stains, and other foreign materials.

3.6.2 Testing

Perform testing in accordance with manufacturer's written instructions. Unless otherwise approved by the Contracting Officer, test all items of equipment to ensure that they are operational and installation conforms to specification requirements. Hydrostatically test piping system at pressure of 1.5 times system operating pressure with water at temperature not exceeding 38 degrees C 100 degrees F. Before test, remove or isolate gage traps and apparatus that may be damaged by that pressure. Install calibrated test gage in system to observe any loss of pressure. Close off system and maintain test pressure for not less than one hour. Inspect joints and equipment connections for leaks. Retest and make repair until no further leaks are observed. Each test report must indicate compliance with specified performance criteria and the final position of controls.

3.6.3 Inspection

Examine each item for visual defects and conformance to specifications.

3.7 CLEANING

3.7.1 For Final Acceptance

Remove labels, fingerprints, and clean all surfaces both inside and out. Tightly cover and protect fixtures and equipment against rust, dirt, water, and chemical or mechanical injury.

3.7.2 Marred Surfaces Exposed-to-View

Refinish marred exposed surfaces that affect appearance, such as both interior and exterior cabinet finishes, to match the adjacent finishes, like new; replace components that cannot be refinished in this manner.

3.7.3 Concealed Marred Surfaces

Refinish marred surfaces exposed to atmosphere, where such surfaces do not affect product's appearance but do affect resistance to elements, such as galvanized pipes and insulation, to equal resistance performance as the unmarred surfaces.

3.8 TRAINING

3.8.1 Training Course

Conduct training course for operation staff as designated by the Contracting Officer. Start the training period, for a total of [_____] hours of normal working time, after systems are functionally complete but prior to final acceptance. The field instructions must include all of the items contained in the approved operations and maintenance data, as well as demonstrations of routine maintenance operations. Notify Contracting

Officer at least 14 days prior to date of the training course.

[3.8.1.1 Government's Biomedical Equipment Technician Training

Include operator's training for one Biomedical Equipment Technician (BMET) for each procured equipment item.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-11 74 00 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 74 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 11 - EQUIPMENT

SECTION 11 74 00

DENTAL EQUIPMENT

05/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-11 74 00 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 74 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 11 74 00

DENTAL EQUIPMENT

05/20

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NOTE: This guide specification covers the requirements for dental equipment including dental operating lights and similar related dental equipment.

This Section refers to Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for general requirements; always include Section 11 70 00 when this Section is used.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

The requirements of Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT apply to this Section.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Item D0750, Tank Assembly, Boilout; G, [_____]

][Item D0753, Tank Assembly, Curing; G, [_____]

][Item D0755, Assembly, Boilout/Curing, Double; G, [_____]

][Item D0760, Guard, Casting Machine; G, [_____]

][Item D0880, Blast Gate, Vacuum System; G, [_____]

][Item D0900 , Workstation, Dental Lab, Receiving; G, [_____]

][Item D0904, Workstation, Tech, Dental, Lab, Single Station; G, [_____]

][Item D0905, Workstation, Dental Lab, Four Station; G, [_____]

][Item D0910, Workstation, Dental Lab, Metal Grinding; G, [_____]

][Item D0915, Workstation, Dental Lab, Ceramic, Modular; G, [_____]

][Item D0920, Workstation, Dental Lab, Floor Standing; G, [_____]

][Item D0925, Hood, Fume, Dental Acrylic, Floor Standing; G, [_____]

][Item D0930, Workstation, Dental Lab, Casting; G, [_____]

][Item D0935, Workstation, Dental Lab, Investment; G, [_____]

][Item D0940, Workstation, Dental Lab, Equipment Bench; G, [_____]

][Item D0942, Workstation, Dental Lab, Microblasting; G, [_____]

][Item D0945, Workstation, Dental Lab, Surveying / Milling; G, [_____]

][Item D0950, Workstation, Dental Lab, Acrylic Processing; G, [_____]

][Item D0960, Workstation, Dental Lab, Plaster; G, [_____]

][Item D0970, Workstation, Dental Lab, Polishing, 2 Station; G, [_____]

][Item D0975, Workstation, Dental Lab, Die Trimming; G, [_____]

][Item D6155, Light, Dental, Operating, Ceiling, Column; G, [_____]

][Item D7090, Utility Center, Dental, Floor Mounted; G, [_____]

][Item D8650, Chute, Waste, Plaster, Counter Mounted ; G, [_____]

] Submit detail drawings listed above for each item of equipment that interfaces with other items of equipment or construction.

SD-03 Product Data

[Item D0750, Tank Assembly, Boilout; G, [_____]

][Item D0753, Tank Assembly, Curing; G, [_____]

][Item D0755, Assembly, Boilout/Curing, Double; G, [_____]

][Item D0760, Guard, Casting Machine; G, [_____]

][Item D0880, Blast Gate, Vacuum System; G, [_____]

][Item D0900, Workstation, Dental Lab, Receiving; G, [_____]

][Item D0904, Workstation, Tech, Dental, Lab, Single Station; G, [_____]

][Item D0905, Workstation, Dental Lab, Four Station; G, [_____]

][Item D0910, Workstation, Dental Lab, Metal Grinding; G, [_____]

][Item D0915, Workstation, Dental Lab, Ceramic, Modular; G, [_____]

][Item D0920, Workstation, Dental Lab, Floor Standing; G, [_____]

][Item D0925, Hood, Fume, Dental Acrylic, Floor Standing; G, [_____]

][Item D0930, Workstation, Dental Lab, Casting; G, [_____]

][Item D0935, Workstation, Dental Lab, Investment; G, [_____]

][Item D0940, Workstation, Dental Lab, Equipment Bench; G, [_____]

][Item D0942, Workstation, Dental Lab, Microblasting; G, [_____]

][Item D0945, Workstation, Dental Lab, Surveying / Milling; G, [_____]

][Item D0950, Workstation, Dental Lab, Acrylic Processing; G, [_____]

][Item D0960, Workstation, Dental Lab, Plaster; G, [_____]

][Item D0970, Workstation, Dental Lab, Polishing, 2 Station; G, [_____]

][Item D0975, Workstation, Dental Lab, Die Trimming; G, [_____]

][Item D6155, Light, Dental, Operating, Ceiling, Column; G, [_____]

][Item D7090, Utility Center, Dental, Floor Mounted; G, [_____]

][Item D8650, Chute, Waste, Plaster, Counter Mounted; G, [_____]

Submit catalog numbers, trade names, literature, data sheets, diagrams and other pertinent data for each item of equipment listed above to evaluate performance, function, materials, dimensions and appearance.

****

NOTE: Add "SD-04 Samples" only when color selections or color verifications are required for project-specific equipment items.

****

[SD-04 Samples

[_____];G, [_____]

Submit manufacturer's [standard color charts for color selection] [color samples for color verification] for each item of equipment listed above.

] SD-06 Test Reports

[Item D0750, Tank Assembly, Boilout

][Item D0753, Tank Assembly, Curing

][Item D0755, Assembly, Boilout/Curing, Double

][Item D0760, Guard, Casting Machine

][Item D0880, Blast Gate, Vacuum System

][Item D0900, Workstation, Dental Lab, Receiving

][Item D0904, Workstation, Tech, Dental, Lab, Single Station

][Item D0905, Workstation, Dental Lab, Four Station

][Item D0910, Workstation, Dental Lab, Metal Grinding

][Item D0915, Workstation, Dental Lab, Ceramic, Modular

][Item D0920, Workstation, Dental Lab, Floor Standing

][Item D0925, Hood, Fume, Dental Acrylic, Floor Standing

][Item D0930, Workstation, Dental Lab, Casting

][Item D0935, Workstation, Dental Lab, Investment

][Item D0940, Workstation, Dental Lab, Equipment Bench

][Item D0942, Workstation, Dental Lab, Microblasting

][Item D0945, Workstation, Dental Lab, Surveying / Milling

][Item D0950, Workstation, Dental Lab, Acrylic Processing

][Item D0960, Workstation, Dental Lab, Plaster

][Item D0970, Workstation, Dental Lab, Polishing, 2 Station

][Item D0975, Workstation, Dental Lab, Die Trimming

][Item D6155, Light, Dental, Operating, Ceiling, Column

][Item D7090, Utility Center, Dental, Floor Mounted

][Item D8650, Chute, Waste, Plaster, Counter Mounted

] Submit field tests and inspections reports for each item of equipment listed above signed by authorized official responsible for field tests and inspections.

SD-10 Operation and Maintenance Data

[Item D0750, Tank Assembly, Boilout; G, [_____]

][Item D0753, Tank Assembly, Curing; G, [_____]

][Item D0755, Assembly, Boilout/Curing, Double; G, [_____]

][Item D0760, Guard, Casting Machine; G, [_____]

][Item D0880, Blast Gate, Vacuum System; G, [_____]

][Item D0900, Workstation, Dental Lab, Receiving; G, [_____]

][Item D0904, Workstation, Tech, Dental, Lab, Single Station; G, [_____]

][Item D0905, Workstation, Dental Lab, Four Station; G, [_____]

][Item D0910, Workstation, Dental Lab, Metal Grinding; G, [_____]

][Item D0915, Workstation, Dental Lab, Ceramic, Modular; G, [_____]

][Item D0920, Workstation, Dental Lab, Floor Standing; G, [_____]

][Item D0925, Hood, Fume, Dental Acrylic, Floor Standing; G, [_____]]

][Item D0930, Workstation, Dental Lab, Casting; G, [_____]

][Item D0935, Workstation, Dental Lab, Investment; G, [_____]

][Item D0940, Workstation, Dental Lab, Equipment Bench; G, [_____]

][Item D0942, Workstation, Dental Lab, Microblasting; G, [_____]

][Item D0945, Workstation, Dental Lab, Surveying / Milling; G, [_____]

][Item D0950, Workstation, Dental Lab, Acrylic Processing; G, [_____]

][Item D0960, Workstation, Dental Lab, Plaster; G, [_____]

][Item D0970, Workstation, Dental Lab, Polishing, 2 Station; G, [_____]

][Item D0975, Workstation, Dental Lab, Die Trimming; G, [_____]

][Item D6155, Light, Dental, Operating, Ceiling, Column; G, [_____]

][Item D7090, Utility Center, Dental, Floor Mounted; G, [_____]

][Item D8650, Chute, Waste, Plaster, Counter Mounted; G, [_____]

] Submit Data Package 3, including training requirements, for each item of equipment listed above in accordance with requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.[In addition, provide hard copies consisting of two Operator's Manuals and two Service Manuals.]

1.4 WARRANTY

[Provide warranties as specified in this Section.]Refer to Article WARRANTY in Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for [additional] requirements

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Stainless Steel

Class 301, 302, or 304. Provide exposed surfaces with a No. 4 finish.

2.1.2 Aluminum Alloy

ASTM B221M ASTM B221; provide alloy equivalent in ultimate tensile, yield, and shear strengths to Alloy 6063-T5 or 6063-T6, as applicable.

2.1.3 Carbon Steel

ASTM A568/A568M; cold-rolled, stretcher level sheets 1.5 mm thick 16 gage and lighter with a commercial bright finish.

****

NOTE: Select project-specific equipment items from the list below and delete equipment items not used. Additional equipment items may be added as required

to suit project-specific conditions.
****

2.2 EQUIPMENT

[2.2.1 Item D0750, Tank Assembly, Boilout

Cabinet mounted, drop-in boilout tank assembly. Single Stainless steel tank. Approximate size: 254 mm 10 inches wide by 356 mm 14 inches deep by 305 mm 12 inches high. Installed in steel cabinet. Includes cover, gas burner, rectifier, and adjustable thermostat. Electrical requirements: [110 volts 50/60 Hz].

][2.2.2 Item D0753, Tank Assembly, Curing

Cabinet mounted, drop-in curing tank. Single Stainless steel tank. Approximate size: 254 mm 10 inches wide by 356 mm 14 inches deep by 305 mm 12 inches high. Installed in steel cabinet. Includes cover, gas burner, rectifier, and adjustable thermostat. Electrical requirements: [110 volts 50/60 Hz].

][2.2.3 Item D0755, Assembly, Boilout/Curing, Double

Double tank boilout/curing unit. Two 18 gauge stainless steel tanks: 254 mm 10 inches by 356 mm 14 inches by 305 mm 12 inches deep and 254 mm 10 inches by 356 mm 14 inches by 254 mm 10 inches deep with inside handles. Electrical requirements: 208 volts 50/60 Hz. Steel cabinet and stainless steel countertop included. Includes a backshelf and fifth spout. This should be provided together as one product. Cabinet must not be constructed separately by millwork manufacturer. Approximate Cabinet size 914 mm 36 inches wide by 787 mm 31 inches deep 940 mm 37 inches high.

][2.2.4 Item D0760, Guard, Casting Machine

Casting machine guard and rim. Provide the well of the guard minimum 330 mm 13 inches deep and 483 mm 19 inches in diameter. Construct the well of heavy duty rust resistant steel with a rim to align the guard to the casting cabinet working surface. Construct base of steel and fiberboard for attachment to workbench.

][2.2.5 Item D0880, Blast Gate, Vacuum System

Vacuum Blast gate. Compatible with bench or central vacuum system. Includes sliding open-close panel in a frame. Mount the gate in the vertical face of a laboratory bench service ledge. Includes front and back flanges adaptable to 76 mm 3 inch hoses in the vacuum system. Provide baked enamel finish.

][2.2.6 Item D0900, Workstation, Dental Lab, Receiving

Modular lab receiving workstation. Floor mounted stand consists of a 610 mm 24 inch wide base cabinet unit with four equal drawers, a 610 mm 24 inch wide single or double door base cabinet unit with an adjustable shelf and a 1880 mm 74 inch wide laminate counter supported by the two base cabinets. Provide an under counter 610 mm 24 inch wide single drawer unit between the two cabinets. Provide countertop 610 mm 24 inches deep, high pressure laminate.

][2.2.7 Item D0904, Workstation, Tech, Dental, Lab, Single Station

Single, self-contained, modular technician workstation with utility connections for air, gas, and electric. Approximate size: 1219 mm 48 inches wide by 610 mm 24 inches deep by 864 mm 34 inches high without light structure.

a. Load bearing steel frame on adjustable legs with end panels and supports.

b. Overhead color corrected task lighting.

c. Bunsen Burner, Bunsen Burner Tube, air gun, and bench mounted work tray holder. Remote control gas valve.

d. Dust extraction unit with support frame for waste drawer, filter drawer with Motor, Suction Hood.

e. Bench top includes one storage cabinet with four drawers and instrument inserts, one stainless steel debris drawer and a cast cement / fiberglass countertop; case pan shelf system with shelf and supports.

f. Gas pipeline connection with stop valves; compressed air connection with stop valves; and pressure reducing valve.

g. Electrical requirements: [110 volts 50/60 Hz].

][2.2.8 Item D0905, Workstation, Dental Lab, Four Station

Four station, self-contained, modular technician workstation with utility connections for air, gas, and electric. Approximate size of each station: 1219 mm 48 inches wide by 610 mm 24 inches deep by 864 mm 34 inches high without light structure. Overall approximate size: 2438 mm 96 inches wide by 1219 mm 48 inches deep by 864 mm 34 inches highwithout light structure. Each station should include:

a. Load bearing steel frame on adjustable legs with end panels and supports.

b. Overhead color corrected task lighting.

c. Bunsen Burner, Bunsen Burner Tube, air gun, and bench mounted work tray holder. Remote control gas valve.

d. Dust extraction unit with support frame for waste drawer, filter drawer with Motor, Suction Hood.

e. Bench top includes one storage cabinet with four drawers and instrument inserts, one stainless steel debris drawer and a cast cement / fiberglass countertop; case pan shelf system with shelf and supports.

f. Gas pipeline connection with stop valves; compressed air connection with stop valves; and pressure reducing valve.

g. Electrical requirements: [110 volts 50/60 Hz].

][2.2.9 Item D0910, Workstation, Dental Lab, Metal Grinding

Modular metal grinding dental lab workstation. Includes a full-length load-bearing steel frame, adjustable legs, end panels and supports, a 3-drawer storage cabinet, a 4-drawer storage cabinet with instrument inserts, a cast cement/fiberglass countertop, overhead task lighting (3000 Lux, natural daylight), and an air gun and a dust extraction unit. Approximate dimensions: 1219 mm 48 inches wide by 610 mm 24 inches deep by 813 mm 32 inches high. Electrical requirements: [110 volts 50/60 Hz].

][2.2.10 Item D0915, Workstation, Dental Lab, Ceramic, Modular

Modular ceramic dental lab workstation. Includes a full-length load-bearing steel frame, adjustable legs, end panels and supports, a 610 mm 24 inch wide extension table, a 4-drawer storage cabinet with instrument inserts, a 4-drawer storage cabinet with inserts, a cast cement/fiberglass countertop, overhead task lighting (3000 Lux, natural daylight), an air gun and a micro-filter (ceramic) extraction unit debris drawer. Approximate overall dimensions: 2134 mm 84 inches wide by 610 mm 24 inches deep by 813 mm 32 inches high. Electrical requirements: [110 volts 50/60 Hz].

][2.2.11 Item D0920, Workstation, Dental Lab, Floor Standing

Floor standing ceramic workstation. Includes two floor standing cabinets with adjustable shelves, a floor standing cabinet with four equal drawers and inserts, and a stainless steel sink with faucet and a 610 mm 24 inch deep stainless steel or plastic laminate counter top. Approximate sink size: 406 mm 16 inches long by 406 mm 16 inches wide by 406 mm 16 inches deep. Approximate dimensions: 1067 mm 42 inches wide by 762 mm 30 inches deep by 813 mm 32 inches high.

][2.2.12 Item D0925, Hood, Fume, Dental Acrylic, Floor Standing

Floor-standing dental acrylic fume hood. Construct of PVC plastic/fiberglass liner. Includes built-in lighting, an extraction fan with blower vented to atmosphere, water channel, polypropylene 76 mm 3 inch by 152 mm 6 inch cup sink, 110 electrical duplex receptacle and counter-balanced tempered glass vertically sliding front protective window. Fume hood approximate dimensions: 1194 mm 47 inches wide by 635 mm 25 inches deep by 1346 mm 53 inches high. Include cabinet base with work surface. Base cabinet approximate dimensions: 1219 mm 48 inches wide by 610 mm 24 inches deep by 914 mm 36 inches high (or 787 mm 31 inches for ADA). Cabinet supports up to 363 lbs 800 pounds. Construct of epoxy coated steel. Includes two manual closing doors and filler panel to increase cabinet depth to 762 mm 30 inches. Provide work surface with plumbing access openings.

][2.2.13 Item D0930, Workstation, Dental Lab, Casting

Floor standing casting dental lab workstation. Approximate dimensions: 1854 mm 73 inches wide by 660 mm 26 inches deep by 864 mm 34 inches high. Includes:

a. Full Length load bearing steel support frame on adjustable legs with end panels and supports.

b. Stainless steel wall shelf with brackets. 1219 mm 48 inches wide by 406 mm 16 inches deep.

c. Built in soldering unit.

d. Gas pipeline connection.

e. Compressed air connection.

f. Pull out casting ring cooling drawer with steel grid.

g. Soap Stone counter top.

h. Exhaust to atmosphere extraction Hood. 1829 mm 72 inches wide by 610 mm 24 inches deep. Provide stainless steel hood. Includes start delay and timer.

][2.2.14 Item D0935, Workstation, Dental Lab, Investment

Floor standing Investment dental lab workstation. Includes storage cabinet with door, sink base cabinet with door, storage cabinet with three drawers. Drawers: one 51 mm 2 inches and two equal sized. Waste disposal cabinet, with knife scrapper. Stainless steel counter top, 610 mm 24 inches deep. Stainless steel sink, 406 mm 16 inch wide by 406 mm 16 inch long by 191 mm 7-1/2 inch deep with plaster trap. Front panel with air nozzle. Approximate dimensions: 2464 mm 97 inches wide by 610 mm 24 inches deep.

][2.2.15 Item D0940, Workstation, Dental Lab, Equipment Bench

Modular investment equipment workstation. Includes two floor-mounted single or one double door storage cabinet with two adjustable shelves and a cast cement/fiberglass counter top. Approximate dimensions: 1219 mm 48 inches wide by 610 mm 24 inches deep by 914 mm 36 inches high (787 mm34 inches high for ADA).

][2.2.16 Item D0942, Workstation, Dental Lab, Microblasting

Microblasting Dental Lab Workstation with dust collector. Includes:

a. Load bearing steel support frame with end panels and supports.

b. Interior space: 0.062 cubic meter 2.2 cubic feet, 610 mm 24 inches wide by 254 mm 10 inches high by 356 mm 14 inches deep.

c. Window: tempered glass opening (hinged) 584 mm 23 inches by 279 mm 11 inches.

d. Lighting: 40 watt cool white fluorescent lamp.

e. Approximate dimensions: 762 mm 30 inches wide by 864 mm 34 inches deep by 1168 mm 46 inches high.

][2.2.17 Item D0945, Workstation, Dental Lab, Surveying / Milling

Floor standing surveying and milling dental laboratory workstation. Includes three 610 mm 24 inch wide single floor cabinets with one adjustable shelf each, a 610 mm 24 inch wide floor cabinet with four equal drawers, two 610 mm 24 inch wide undercounter single drawer units, end panels and a 610 mm 24 inch deep plastic laminate countertop.

Approximate dimensions: 3658 mm 144 inches long by 610 mm 24 inches deep by 864 mm 34 inches high.

][2.2.18 Item D0950, Workstation, Dental Lab, Acrylic Processing

Modular acrylic processing dental lab workstation. Includes one 610 mm 24 inch wide double door base cabinet with one adjustable shelf, one 610 mm 24 inch wide base cabinet with five drawers, one 610 mm 24 inch wide base cabinet with three equal drawers and a 610 mm 24 inch deep plastic laminate countertop.

Approximate dimensions: 2438 mm 96 inches long by 610 mm 24 inches deep by 864 mm 34 inches high.

][2.2.19 Item D0960, Workstation, Dental Lab, Plaster

Dental lab plaster workstation, 3658 mm 144 incheswide by 610 mm 24 inches deep by 940 mm 37 inches high. Includes:

a. Stainless steel counter top.

b. Stainless steel sink.

c. Counter mounted plaster waste disposal with knife scraper.

d. Trimmer console for rinser bath.

e. Two mixing faucets for cold and warm water.

f. Two plaster traps, one at each sink; plaster trap is 483 mm 19 inches in diameter by 521 mm 20-1/2 inches tall.

g. Panel with air gun module.

h. Pressure reducing valve.

i. Connection kits for sink and rinsing bath.

j. Two 457 mm 18 inches wide floor mounted base cabinets with four drawers.

k. One 1219 mm 48 inch wide floor mounted sink base cabinet, half of cabinet has one single 610 mm 24 inch wide door and the other half has two 610 mm 24 inch wide stacked drawers for housing the rinsing bath.

l. One 610 mm 24 inch wide floor mounted sink base cabinet with door, for housing the sink.

m. Two 457 mm 18 inch single doors base cabinet with one adjustable shelf each.

n. One floor mounted waste disposal base cabinet with waste container.

o. Four ground fault receptacles, 15 amp.

p. Upright water valve.

q. Electrical requirements: [110 Volts 50/60 Hz].

][2.2.20 Item D0970, Workstation, Dental Lab, Polishing, 2 Station

Modular two station polishing workstation. Includes:

a. Suction Motor: 3/4 HP, 115 Volts/60 Hz.

b. Two polishing hoods with Polishing Motor: No 26 Red wing, two speed lathe.

c. Suction Capacity: 170 cubic meter/min 600 CFM.

d. Filter Area: 5.8 square meters 62 Square feet, 24 shakable cloth filter bags.

e. Cleaning: External foot shaker, internal cabinet dust tray, self contained dust collector with lathe.

f. Approximate unit dimensions: 1422 mm 56 inches high by 813 mm 32 inches to 1219 mm 48 inches wide by 457 mm 18 inches to 610 mm 24 inches deep. Stainless steel work surface with rolled edges approximately 1016 mm 40 inches to table top, adjustable table frame.

g. Over top lighting.

h. Finish: baked coating.

i. Electrical requirements: [110 Volts 50/60 Hz].

][2.2.21 Item D0975, Workstation, Dental Lab, Die Trimming

Modular die trimming dental lab workstation. Includes full-length load bearing steel frame, adjustable legs with end panels and supports, overhead task lighting (3000 Lux, natural daylight), two storage cabinets with four drawers and inserts, an adjustable air pressure and air gun, a dust extraction unit with particle filter, a collection hood and stainless steel debris drawer and a cast cement/fiberglass countertop. Approximate dimensions: 1067 mm 42 inches wide by 762 mm 30 inches deep by 813 mm 32 inches high. Electrical requirements:[110 volts 50/60 Hz].

][2.2.22 Item D6155, Light, Dental, Operating, Ceiling, Column

Ceiling mounted LED dental operating light used to illuminate the field of work for the dentist.

Provide 76 mm 3 inch by 152 mm 6 inch light pattern with uniform intensity. Long depth of field generated within 457 mm 18 inch to 914 mm 36 inchrange. Vibration and shock resistant. Third axis rotation. Provide flex arm capable of movement travel up to 40 degrees above and below horizontal and up to 27 degrees vertically. 5000 degree and 4200 degree Kelvin selections with high/medium/low intensity settings. Electrical requirements: [110 Volts 50/60 Hz].

][2.2.23 Item D7090, Utility Center, Dental, Floor Mounted

Surface mounted dental utility center floor box by the same manufacturer as the Government provided dental chair that it interfaces with. Coordinate with the Government prior to purchasing. Contractor required to coordinate all final connections to dental operating system. Provide air shut off valve, electrical receptacle box, oral evacuation and stub ups for communication cables. Refer to plumbing, electrical, and communication drawings for location and specific connections.

Provide cover box approximately 432 mm 17 inches long by 356 mm 14 inches wide by 127 mm 5 inches high. Unit includes a contoured floor box frame and a contoured floor box cover.

][2.2.24 Item D8650, Chute, Waste, Plaster, Counter Mounted

Counter mounted plaster waste chute. Construct of stainless steel and shaped round or square. Includes a scraper bar. Approximate size: 152 mm 6 inch diameter by 102 mm 4 inches deep.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install equipment at locations indicated in accordance with manufacturer's printed installation instructions, Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT, and approved detail drawings. Submit detail drawings specifically prepared to illustrate required work for each item of equipment that interfaces with other items of equipment or construction, including, but not limited to, installation layout, coordination of equipment services, [drain piping connections,] [complete electrical wiring and control diagrams,] and details of construction and rough-in requirements. Furnish and install necessary items such as framing, mounting hardware and trim as required for the type of equipment furnished.

3.3 ADJUSTING

Following installation, adjust flows, timers, levelers, and similar components and operation devices as appropriate. After testing, and before acceptance, examine equipment to ensure that adjustments are correct and that any additional adjustments deemed necessary during product testing have been incorporated.

3.4 UTILITIES

3.4.1 Service Runs

Connect service runs from equipment to building services as indicated.

3.4.2 Dissimilar Metal Connectors

Provide connections between ferrous and nonferrous metallic pipe with dielectric waterways and flanges. Provide dielectric waterways with temperature and pressure rating equal to or greater than that specified for the connecting piping. Provide waterways with metal connections on both ends suited to match connecting piping. Internally line dielectric waterways with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges must meet the performance requirements described herein for dielectric waterways.

3.5 MANUFACTURER'S FIELD SERVICES

Provide the services of a manufacturer's representative [, in conjunction with] [,in addition to][the Contractor's Equipment Planner,] [and] [the Contractor's Biomedical Equipment Technician,] [the Government's Biomedical Equipment Technician,]who is experienced in the installation, adjustment, and operation of the equipment specified, and responsible for supervising the installation, adjustment, and testing of the equipment.

3.6 FIELD TESTS AND INSPECTIONS

3.6.1 Before Testing

Clean pipes, equipment and components of grease, dirt, stains, and other foreign materials.

3.6.2 Testing

Perform testing in accordance with manufacturer's written instructions. Unless otherwise approved by the Contracting Officer, test all items of equipment to ensure that they are operational and installation conforms to specification requirements. Hydrostatically test piping system at pressure of 1.5 times system operating pressure with water at temperature not exceeding 38 degrees C 100 degrees F. Before test, remove or isolate gage traps and apparatus that may be damaged by that pressure. Install calibrated test gage in system to observe any loss of pressure. Close off system and maintain test pressure for not less than one hour. Inspect joints and equipment connections for leaks. Retest and make repair until no further leaks are observed. Each test report must indicate compliance with the specified performance criteria and the final position of controls.

3.6.3 Inspection

Examine each item for visual defects and conformance to specifications.

3.7 CLEANING

3.7.1 For Final Acceptance

Remove labels, fingerprints, and clean all surfaces both inside and out. Tightly cover and protect fixtures and equipment against rust, dirt, water, and chemical or mechanical injury.

3.7.2 Marred Surfaces Exposed-to-View

Refinish marred exposed surfaces that affect appearance, such as interior and exterior cabinet finishes, to match the adjacent finishes, like new; replace components that cannot be refinished in this manner.

3.7.3 Concealed Marred Surfaces

Refinish marred surfaces exposed to atmosphere, where such surfaces do not affect product's appearance but do affect resistance to elements, such as galvanized pipes and insulation, to equal resistance performance as the unmarred surfaces.

3.8 TRAINING

3.8.1 Training Course

Conduct training course for operation staff as designated by the Contracting Officer. Start the training period, for a total of [_____]

hours of normal working time, after systems are functionally complete but prior to final acceptance. The field instructions must include all of the items contained in the approved operations and maintenance data, as well as demonstrations of routine maintenance operations. Notify Contracting Officer at least 14 days prior to date of the training course.

[3.8.1.1 Government's Biomedical Equipment Technician Training

Include operator's training for one Biomedical Equipment Technician (BMET) for each procured equipment item.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-11 82 19 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-11 82 20 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-11 82 19 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-11 82 20 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 11 82 19

PACKAGED INCINERATORS
05/20

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NOTE: This guide specification covers the requirements for packaged, and modular field-erected; starved, and excess air incinerators.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: The packaged incinerator specified herein is intended to burn waste materials for residential and nonresidential structures in batch burning applications. Waste includes combustible material, rubbish, garbage, and classified materials.

This section addresses incinerators having a capacity ranging from 1.05 MW 3.58 MBtuh or 378 kg/hr 833 pounds/hr, 9 metric tons/day 10 TPD up to 7.91 MW (27 MBtuh), or approximately 2.7 metric tons/hr 3 tons per hour, 68 metric tons/day 75 TPD of Type 2 waste 10 MJ/kg 4300 Btu per pound, or the Joule Btu

equivalent amount of Types 0, 1, or 3.

Excess air incinerators covered by this guide specification are expected to operate in a "controlled air" mode, similar to starved air incinerators, but constructed as a single chamber rather than two separate chambers. These units may have either an integral, or a separate heat recovery boiler. Auxiliary burners are fired with gas, oil, or a combination thereof and sized to supply the input required to ensure complete combustion of the refuse in the primary and secondary combustion zones.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13/CSA 4.9	(2022) Gas-Fired Low Pressure Steam and Hot Water Boilers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN,

	UNR, and UNJ Thread Form)
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME PTC 4	(2013; R 2023) Fired Steam Generators
ASME PTC 10	(2022) Performance Test Code on Compressors and Exhausters
ASME PTC 19.2	(2010; R 2015; R 2020; R 2024) Pressure Measurement
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes
ASME PTC 19.10	(1981) Flue and Exhaust Gas Analyses

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A297/A297M	(2021a) Standard Specification for Steel Castings, Iron-Chromium and

	Iron-Chromium-Nickel, Heat Resistant, for General Application
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A319	(1971; R 2024) Standard Specification for Gray Iron Castings for Elevated Temperatures for Non-Pressure Containing Parts
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings
ASTM B68/B68M	(2011) Standard Specification for Seamless Copper Tube, Bright Annealed (Metric)
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C27	(1998; R 2022) Fireclay and High-Alumina Refractory Brick
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C195	(2007; R 2024) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C196	(2000; R 2016) Standard Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement
ASTM C401	(2012; R 2022) Alumina and Alumina-Silicate Castable Refractories
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM E230/E230M	(2012) Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
ASTM F1097	(2017; R 2022) Standard Specification for Mortar, Refractory (High-Temperature, Air-Setting)

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 7.0.01	(1996) Quality Standard for Instrument Air

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment

NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 82	(2024) Standard on Incinerators and Waste and Linen Handling Systems and Equipment
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1403	(2008) Accepted Industry Practice for Industrial Duct Construction, 2nd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-15024	(2018; Rev G; Notice 1 2022) Plates and Tags for Identification of Equipment, General Specification for
MIL-STD-461	(2015; Rev G) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-59222	(Basic; Notice 1; CANC Notice 1 2021) Fans, Centrifugal, Draft, Forced and Induced

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60	Standards of Performance for New Stationary Sources

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating

	Equipment
UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.2 DEFINITIONS

1.2.1 Waste Type 0, Trash

A mixture of highly combustible waste such as paper, cardboard cartons, wood boxes, and floor sweepings from commercial and industrial activities. The mixture consists of up to 10 percent by weight plastic bags, coated paper, laminated paper, treated corrugated cardboard, oily rags, and plastic or rubber scraps. This type of waste contains up to 10 percent moisture and not more than 5 percent non-combustible solids, and has a heating value of 19,805 kJ/kg 8,500 BTU per pound as fired.

1.2.2 Waste Type 1, Rubbish

A mixture of combustible waste such as paper, cardboard cartons, wood scraps, foliage, and floor sweepings from domestic, commercial, and industrial activities. The mixture consists of up to 20 percent by weight restaurant waste, but contains little or no treated paper, plastic, or rubber wastes. This type of waste contains up to 25 percent moisture and not more than 10 percent incombustible solids, and has a heating value of 15,145 kJ/kg 6,500 BTU per pound as fired.

1.2.3 Waste Type 2, Refuse

An approximately even mixture of rubbish and garbage by weight. This type of waste, common to apartment and residential occupancy, consists of up to 50 percent moisture and not more than 7 percent incombustible solids, and has a heating value of 10,019 kJ/kg 4,300 BTU per pound as fired.

1.2.4 Waste Type 3, Garbage

Garbage such as animal and vegetable wastes from restaurants, hotels, hospitals, markets, and similar installations. This type of waste contains up to 70 percent moisture and up to not more than 5 percent incombustible solids, and has a heating value of 5825 kJ/kg 2,500 BTU per pound as fired.

1.2.5 Waste Type 4, Pathological

Human and animal remains, such as organs, animal carcasses, and solid organic wastes from hospitals, laboratories, slaughterhouses, animal pounds, and similar sources. This type of waste contains up to 85 percent moisture and not more than 5 percent incombustible solids, and has a heating value as low as 2330 kJ/kg 1,000 BTU per pound as fired.

1.2.6 Waste Type 5, Classified

A mixture of highly combustible waste such as paper, plastics, or other items that have been used for intelligence purposes, or deemed sensitive to completing a sensitive mission on behalf of our National security. This mixture consists of up to 10 per cent by weight plastic bags, coated paper, laminated paper, and plastic products. This type waste has approximately zero percent moisture content and non-combustible solids, and has a heating value of 16,310 to 23,300 kJ/kg 7,000 to 10,000 BTU per pound as fired.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Installation Drawings; G, [_____]

SD-03 Product Data

Incinerator; G, [_____]

Controls and Instruments; G, [_____]

Spare Parts; G, [_____]

Framed Instructions; G, [_____]

SD-06 Test Reports

Testing; G, [_____]

Instrument Readings; G, [_____]

Computations; G, [_____]

Methods; G, [_____]

Performance; G, [_____]

SD-07 Certificates

Incinerator System Equipment; G, [_____]

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

Incinerator; G, [_____]

Data Package 4 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 QUALITY ASSURANCE

1.4.1 Pollution Control

****

NOTE: Research air pollution emission requirements by State and local agencies early in the project, including any anticipated changes that the project has to comply with, including particulates, carbon monoxide, HCL, sulfur oxides, heavy metals in the ash, and dioxins and furans. Hydrogen sulfide, hydrocarbons, and carbonyl emissions are normally not of concern in the design and operation of an incinerator at a military facility unless the State or local environmental regulatory agency requires them, in which case compliance needs to be indicated.

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Provide incinerators meeting all applicable Federal, State, and local environmental requirements.

1.4.1.1 Gaseous Emissions

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NOTE: In states with stringent air pollution control requirements, a baghouse and scrubber may be needed and should be specified in a separate specification section. Section 44 10 00 AIR POLLUTION CONTROL may not be adequate for this application, but may form a basis for writing this section.

****

[Limits for carbon monoxide emissions are [_____] ppm [to be corrected to [_____]].] [Limits for acid gases in the form of hydrogen chloride are restricted [to 30 ppm] [to 50 ppm] [by 90 percent removal] [_____] through the use of pollution control equipment specified in Section [_____].] [Exposure limitations for dioxins and furans of the flue gases are restricted to temperatures of [982 degrees C 1800 degrees F] [[_____] degrees C degrees F] for [2] [_____] seconds.] If the incinerator equipment furnished cannot meet the above emission limits, it is the responsibility of the Contractor to provide additional emission control equipment to meet the emission standards.

1.4.1.2 Particle Size and Particulate Limits

****

NOTE: If requirements are more stringent, specify them in the blanks. Unless proven otherwise as a result of actual testing of the completed unit, the two-chambered, controlled-air incinerator is inherently nonpolluting and does not require the provision of supplemental special scrubbers, precipitators, or other air pollution control devices in most states, unless acid gas requirements have been established. In the event that actual testing of a unit indicates that pollutants are in excess of Federal, State, or local requirements, provide proper control devices as integral elements of the basic installation. Local air pollution control authorities must be contacted during the initial stages of design to determine what their requirements are and whether any changes are anticipated with which the Army will have to comply.

****

The emission of particles larger than 60 micrometers microns during normal operation is not allowed. At maximum designed charging rate, [emission can not exceed [229] [193] [_____] mg per standard cubic meter [0.1] [0.08] [_____] grains per standard cubic foot of dry flue gas adjusted to 12 percent carbon dioxide without the contribution of carbon dioxide from auxiliary fuel.] [emission minus water vapor, corrected to standard conditions containing 6 percent oxygen by volume, and as if no auxiliary fuel had been used, cannot contain particulate matter in excess of a concentration of [229] [_____] mg per dry cubic meter [0.1] [_____] grains per dry cubic foot of exhaust gas.] Measure visible emissions in accordance with and not exceeding zero on the Ringelmann scale. Emissions may be as high as 1 on the Ringelmann scale, but not for more than 3 cumulative minutes.

1.4.2 Noise Level

****

NOTE: Select the noise level required by the location of the equipment. Equipment in remote areas can be allowed to produce noise at a level slightly higher than the normal 85 dBA. OSHA regulations and Corps of Engineers safety regulations should be consulted for the most current 8-hour exposure limits.

****

Noise level at 305 mm 1 foot from any operating equipment cannot exceed [85] [_____] dBA.

[1.4.3 Electromagnetic Interference Control

****

NOTE: This paragraph should be used only for projects located in electromagnetic sensitive areas.

****

Provide equipment conforming to Class IIIC electromagnetic interference control and test limit requirements specified in MIL-STD-461.

]1.4.4 Welding

****

NOTE: Where pipeline, structural, or other welding is required on the same project, tests will be required accordingly. Testing may be by the coupon method as prescribed in the welding code or by special radiographic methods.

****

Perform all welding in accordance with qualified procedures using performance qualified welders and welding operators. Qualify procedures and welders in accordance with AWS B2.1/B2.1M. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform the tests at the work site if practical. Furnish the Contracting Officer with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Apply each welder's or welding operator's assigned symbol near each weld made as a permanent record. Weld structural members in accordance with AWS D1.1/D1.1M. Perform welding and nondestructive testing of piping systems in accordance with ASME B31.1.

1.4.5 Prohibition of Asbestos

Asbestos and asbestos-containing products are prohibited.

1.4.6 Permits

****

NOTE: Preliminary applications required before awarding of contract will be filed by the District. The Contractor cannot be held liable for changes in environmental requirements after award of contract. USAEHA must be contacted well in advance (approximately six months minimum.) in order to determine if they can do the testing. If they cannot do the testing, delete references to USAEHA.

****

Submit an operating and environmental test plan containing detailed, step-by-step actions and explain the expected result to demonstrate compliance with the requirements of this specification. Written approval by the Government of the test plan is one of the prerequisites for beginning the specified testing. Incinerator system must comply with the requirements of all applicable municipal, State and Federal emission regulations. Obtain all permits to construct and test the units, and conduct all tests required by regulatory authorities in order for the owner to obtain a final permit to operate the facility. Perform environmental tests [by the U.S. Army Environmental Hygiene Agency (USAEHA)] [_____].

1.4.7 Quality Control

****
NOTE: A QA/QC paragraph should be inserted using the District's most current QA/QC policy and plans.
****

Inspection will be continued during installation, after installation, and during tests. Ensure the Contracting Officer is present for tests. Furnish bound reports certifying instrument readings indicated are actual, computations required for testing are accurate, acceptable methods were used, and units satisfactory performed in accordance with requirements as specified.

1.4.8 Detailed Installation Drawings

Submit detailed installation drawings consisting of a complete list of equipment and materials, including illustrations, schedules, manufacturer's descriptive and technical literature, performance charts, catalog cuts, and installation instructions. Include complete wiring and piping diagrams and schematics, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of equipment and appurtenances, and the equipment's relationship to other parts of the work including clearances for installation, maintenance, and operation.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of drawings and not later than [_____] days prior to the date of beneficial occupancy. Include in the data a list of parts and supplies, with current unit prices and source of supply, and the recommended number to be maintained in inventory for [_____] months of facility operation.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

****
NOTE: An incinerator is normally supplied with a boiler for heat recovery in the form of steam or hot water. However, in some cases, it is possible that heat recovery is not included in the project. An example would be where a boiler already exists in an adjacent boiler plant. There may also be cases where an insufficient thermal demand exists relative to the amount of available waste, but high disposal costs by other methods dictate the use of incineration. In those cases, references to the boiler, steam system, and thermal efficiency must be deleted. A thorough economic analysis must be done

to determine the economic impact of having or not having heat energy recovery. When part of the project, the boiler is normally supplied by the incinerator manufacturer and is compatible with his equipment.

Delete the bracketed sentences regarding multiple units if only one system is to be provided.
****

Provide a complete and properly operating waste incineration facility [designed to operate with a steam boiler],consisting of [_____] [a] complete modular type waste incineration system[s] (unit systems) [each] with the capability of fully independent[or simultaneous] operation.[Ordinary mode of operation is for any [two] [_____] of the [three] [_____] unit systems to be operated simultaneously with the [third] [_____] system on stand-by. Provide each unit system with identical features to create redundancy and capability for maintaining continuous operation of the facility at full rated capacity.] [Each system] [System] must include:

a. An automatic or semi-automatic, hydraulically operated loader to inject waste into the incinerator.

b. A primary combustion chamber or zone consisting of the grate area within the furnace, or a separate chamber with internal rams.

c. A secondary combustion chamber or zone which consisting of an area above the grate within the furnace, or a separate chamber. Include auxiliary burners to maintain adequate combustion temperatures in either arrangement.

d. An ash removal system including a water quench system adequate to extinguish any combustion still occurring in the ash.

e. All auxiliary fans, burners, controls, and any additional air pollution control equipment required.

2.1.1 Waste Reduction

****
NOTE: Indicate the effectiveness and burnout capability of the incinerator to be provided. The combustible (carbon) content of the ash cannot exceed 10 percent with a minimum volume reduction of 90 percent of the combustible portion of the waste. Allowable weight reduction is only 45 percent measured on a dry basis. If the waste has a high amount of noncombustibles, either the 90 percent volume reduction is to be decreased, or only the combustible content of the ash can be specified. Indicate which criteria is to be used based upon ease of measurement and other project specific considerations.
****

[Provide incinerator which reduces waste to an ash not to exceed [45.0 percent (dry basis) by weight] [10 percent by volume] of the total combustible portion of the charge as specified.] [Combustible content of the ash cannot exceed [10] [_____] percent.]

2.1.2 Heat Recovery Boiler

****

NOTE: HHV is usually used in the United States while the LHV value is usually used in Europe. LHV is being advocated for use in the United States for thermal efficiency calculations. Indicate which value to use.

****

When equipped with a heat recovery boiler, the thermal efficiency of the total unit cannot be less than [_____] percent including all auxiliary fuel consumption while producing [_____] kg/hour pounds/hour of steam at a pressure of [_____] kPa psig and a temperature of [_____] degrees C degrees F. Provide soot-blowers for fire-tube and water-tube boilers to maintain thermal efficiency. Thermal efficiency is determined by the input-output method in accordance with ASME PTC 4.

2.1.3 Stack Design

****

NOTE: Indicate wind force the stack design will have to withstand. Structural design will include seismic resistance, see next paragraph.

****

Provide stack support in accordance with NFPA 82 and NFPA 211, as applicable. Design vertical and lateral supports for exterior chimneys to withstand wind forces of [129] [_____] km/hour [80] [_____] mph.

2.1.4 Structural Supports

****

NOTE: Provide seismic requirements for stack and equipment supports, if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS must be included in the contract documents. Designer should investigate bearing requirements of several manufacturers and design footings accordingly.

****

Design structural steel equipment supports shown in accordance Section 05 12 00 STRUCTURAL STEEL. Design support steel to resist all applicable dead loads, live loads, and seismic loads as [specified in UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS] [indicated]. Show a complete loading and support diagram on the detail drawings. Equipment supports shown on the contract drawings are for a general equipment layout and may not conform to the system furnished. Piers and footings may be relocated to suit equipment furnished provided they do not interfere with other footings. Fabricate support steel in accordance with the provisions of AWS D1.1/D1.1M or field bolt using ASTM A325M ASTM A325 high strength bolts.

2.1.5 Special Tools

Furnish, as standard accessories, any special tools required for assembly, adjustment, setting, or maintenance of equipment specified under this section.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

****

NOTE: In lieu of the label or listing, the Contractor may submit a written certificate from any nationally recognized testing organization adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the requirements, including methods of testing, of the specified agency.

****

Provide materials, incinerator system equipment, and controls which are the standard products of a manufacturer regularly engaged in the manufacture of the incinerator systems and essentially duplicate equipment that has been in satisfactory use for at least [2] [3] [_____] years prior to bid opening.

a. Where materials or equipment are specified to conform to the requirements of, or listed in rating publications of, agencies such as the Underwriter's Laboratories (UL), American Gas Association (AGA), American National Standards Institute (ANSI), the Hydronics Institute (formerly SBI and IBR) and American Boiler Manufacturers Association (ABMA), submit proof of such conformance. Label or listing of the specified agency is acceptable evidence. Where equipment is specified to conform to the requirements of the ASME Boiler and Pressure Vessel Code, also ensure code conformance of the design, fabrication, testing, and installation.

b. Submit certificates attesting that the incinerator equipment to be furnished is of a type that has been used on at least [three][_____] jobs of similar design and capacity as that specified for this project, accompanied with documentation that in a commercially operating industrial plant, the incineration system[and the steam generating system] [has][have] operated continuously and without interruption for a period of not less than [100] [_____] consecutive hours. Certify this documentation by an independent organization, such as an environmental testing firm or design consultant, who witnessed such operation, the actual plant owner if other than the incinerator manufacturer, or the energy customer.

c. Submit evidence that the incinerator[s] proposed to be furnished [meets] [meet] the applicable air pollution requirements and the emission requirements specified for pollution control. Test data must be for the model proposed to be furnished and for Incinerator Institute of America (IIA) Type.

d. Identify an equipment supporting service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the plant site. Controls that have been shown to have operated satisfactorily for the period may have modifications, provided it can be clearly shown that the modifications will not increase maintenance and operating costs and will not decrease the life of the equipment.

e. Submit framed instructions of proposed diagrams, instructions procedures, and other required sheets for review and approval by the Contracting Officer.

2.2.2 Nameplates

Furnish all field items with a permanent metal tag suitable for tag number or service identification; back-of-panel items are included in this category. Identify front-of-panel items by panel nameplates affixed to the item or panel surface, consistent in appearance from panel to panel and including the service function of the item involved. Color code or otherwise identify all wiring and piping within the panel. Install wires and cables without joints or splices except at terminal points. Label wires at each end. Identification of equipment must conform to MIL-DTL-15024. Each nameplate is to contain the following:

a. The manufacturer's name and address.
b. Equipment catalog or model number.
c. Equipment serial number.
d. Maximum refuse fuel feed rate of incinerator in kg/hour lbs/hour.
e. Incinerator volume in cubic meters cubic feet.

2.2.3 Equipment Guards and Access

****

NOTE: Catwalk, ladder, and guardrail, if required, will be indicated on drawings.

****

Provide enclosures and/or guards for all belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located to protect any person coming in close proximity thereto. Guard or cover high-temperature equipment and piping so located as to endanger personnel or create a fire hazard with insulation of the type specified for service. Provide items such as [catwalk,][stair,][ladder,][and guardrail] where shown in accordance with paragraph Catwalks and Access Platforms.

2.3 ELECTRICAL WORK

****

NOTE: Indicate on the drawings the type and class of motor enclosure depending on the environment in which the motor is to be used.

****

Provide electric-motor driven equipment specified herein complete with motor, motor starter and controls, conforming to NEMA MG 1, with enclosures as indicated. For motors smaller than 746 W fractional horsepower motors provide Type I, Class 1B or Class 2A or 2B, Continuous Duty. For motors larger than 746 watts integral horsepower motors provide Type I or II, Class 2 Continuous Duty, Design L or M. Provide motor starters of one manufacturer and install in a motor control center located in the control room. Provide electrical equipment and power supply wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide motor starters complete with properly sized thermal-overload protection and other appurtenances necessary for the motor control specified. Select motors of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices, but not shown on the electrical plans, under this section.

2.4 INCINERATOR

****

NOTE: House the equipment in a pre-engineered, industrialized metal building which is specified using Section 13 34 19 PREENGINEERED METAL BUILDINGS. Include a sprinkler system in the building.

****

Provide incinerators suitable for indoor installation and consisting of a primary combustion chamber or furnace zone (grate area) for partial burning of and conversion of combustible material to a gas, and a secondary combustion chamber or furnace zone that consumes combustible gases and entrained particles. Select an incinerator of the starved air (pyrolytic) [or controlled air grate] type designed for continuous duty, with a gas tight constructed shell. Equip both combustion chambers or zones with combination natural gas/No. 2 oil burners, each designed to use [No. 2 fuel oil] [gas] as a supplementary fuel. Equip burners with an electronic ignition. Minimize supplementary fuel consumption for normal operations, not to exceed [326] [_____] MJ/metric ton [281,000] [_____] Btu per ton of waste fuel. Furnish a complete unit including combustion air and burner controls, interconnected ducts, breaching and piping, facilities for charging of the unit, a means of heat dissipation, [heat recovery unit], stack and air pollution control devices.

2.4.1 Type of Unit and Unit Capacity

****

NOTE: The incinerators should be capable of burning Types 0, 1, 2, 3, and 5 wastes. The approximate general characteristics of each type are indicated in the following table:

WASTE VS CONTENT

Type	Plastics, Rubber, Treated Paper (Max. Percent)	Noncombustible Solids (Max. Percent by Weight	Moisture Content (Max. Percent)	Heating Value MJ/Kg Btu Per Pound
0 (Trash	10	5	10	19.76 8,500
1 (Rubbish)	0	10	25	15.11 6,500
2 (Refuse)	-	7	50	9.99 (4,300)

WASTE VS CONTENT				
Type	**Plastics, Rubber, Treated Paper (Max. Percent)**	**Noncombustible Solids (Max. Percent by Weight**	**Moisture Content (Max. Percent)**	**Heating Value MJ/Kg Btu Per Pound**
3 (Garbage)	**-**	**5**	**70**	**5.81 2,500**
4 (Pathological)	**(not applicable to this section)**			
5 (Classified)	**10**	**0**	**0**	**16.3-23.37-10,000**

Rubbish is a maximum 20 percent by weight of restaurant waste. The waste stream at each installation must be carefully quantified and analyzed. The information should be utilized for the final design to ensure that each incinerator is correctly sized. Wastes may contain polyurethane foam which may result in the release of cyanide or cyanide products in the exhaust. Include specific instructions regarding the hazardous materials that may be incinerated and excluded by the particular installation. Indicate capacity and operating schedule. Complete design sizing.

****

Provide incinerator with a continuous capacity not less than [_____] kg/hour pounds/hour when provided with the waste fuel specified below. This rate is a continuous burning rate and is not to be considered a charging rate, with no manual stoking required to accomplish the destruction of this waste. Design for each incinerator to normally be in operation [_____] days per week for [one] [two] [three] 8-hour shifts daily, with a primary fuel of unsorted and unprocessed municipal solid waste (MSW) as specified and delivered to the incinerator site including non-homogeneous combustible materials, cans, bottles, metal banding, and other non-combustible materials and significant concentrated quantities of combustible high energy Btu cellulose materials. Provide incinerator[s] [each] capable of burning municipal waste [of IIA Type [_____]] [with the following proximate analysis:

Waste Component	Range	Typical
Moisture	[_____] - [_____] percent	[_____] percent
Volatile matter	[_____] - [_____] percent	[_____] percent
Fixed carbon	[_____] - [_____] percent	[_____] percent
Glass, metal, ash	[_____] - [_____] percent	[_____] percent

Waste Component	Range	Typical
Btu/lb [LHV] [HHV]	[_____] - [_____]	[_____] (as received)

]

During normal, steady-state operations, use the self-sustained incineration process when burning waste as characterized above. Do not exceed auxiliary fuel limits given above except during start-up or burn-down, or when charging waste with an excessive moisture content. [When fired at the rate of [_____] metric tons/24-hour day tons/24-hour day with municipal solid waste, IIA Type [_____], each system must be capable of producing a minimum of [_____] kg/hour lb/hr of dry saturated steam at a pressure of [_____] kPa psig when furnished with entering water at [_____] degrees C degrees F] Incorporate accessibility for maintenance and service into equipment design and accessory installations.

2.4.2 Unit

****

NOTE: Indicate the type of incinerator to be provided by optional wording.

****

Equip unit for mechanical charging and operation, and to operate under negative pressure. Equip each unit system with automatic, continuous flow ash removal and ash conveyor equipment to remove all ash and residue as generated. Provide each incinerator as a complete [package-type unit,] [factory fabricated and field assembled,] self-contained, [free standing, mounted on a heavy steel frame,] [and erected at the project site], ready for immediate mounting on a foundation and for attachment of water supply, fuel, electrical, and vent connections, including lifting eye rings for adjusting and setting.

2.4.2.1 Supports

Support each incinerator upon the foundations with structural steel, independent of all refractory, conforming to ASTM A36/A36M. Design the incinerator supports to allow for free expansion and contraction of each portion of the incinerator without placing undue stress on any part of the incinerator or setting.

2.4.2.2 Access Doors

Provide gastight doors in sufficient numbers, adequately sized and properly located, to allow for cleaning, inspection and repair of all areas in the unit. Line interior surfaces exposed to direct radiation and high temperatures with an approved refractory material to prevent excessive heat losses and warping of doors. Hinge doors that are too large or bulky for hand removal or that weigh more than 11 kg 25 pounds.

2.4.3 Minimum Requirements

****

NOTE: During design phase, contact manufacturers of the type and size of equipment to be used and obtain typical values. If this information is difficult to obtain or varies widely between manufacturers, delete the indicated optional sentences. Check with local regulatory authorities concerning residence

time at elevated temperatures if dioxin and furan control are required.
****

Provide incinerator with total furnace volume in which the heat released per cubic meter cubic foot of furnace volume will not exceed [_____] W Btu/hr, and the gas velocity does not exceed [_____] m/second feet/second through the primary combustion zone and [_____] m/second feet/second through the secondary combustion zone and flue. Minimum secondary combustion zone volume is at least [_____] cubic m/kg cubic feet/pound of gas produced per second including excess air required for cooling purposes, and primary combustion zone operating temperature is sufficient for near complete carbon burn-out. After warm-up, maintain a minimum primary combustion zone temperature of at least 704 to 871 degrees C 1300 to 1600 degrees F, but do not exceed 982 degrees C 1800 degrees F at any time. Combustion time in the secondary combustion zone is to be at least [_____] seconds total time with temperatures maintained at 927 to 982 degrees C 1700 to 1800 degrees F with momentary and infrequent peaks not to exceed 1149 degrees C 2100 degrees F.

2.5 FURNACE CONSTRUCTION

2.5.1 General

Provide incinerator[s] meeting the requirements of NFPA 82, for IIA Types 1 and 2 waste, and Class III incinerators. When exposed to the internal environment of the incinerator, provide materials that are compatible with the temperature and atmospheric conditions which they will encounter. Ensure connections between dissimilar materials are electrically isolated from each other with dielectric unions or flanges. Provide galvanizing, where specified, in accordance with ASTM A123/A123M or ASTM A153/A153M.

2.5.2 Lubrication

Provide all sliding, moving, or rotating parts normally requiring lubrication, except those provided with "sealed-for-life" lubrication, with suitable means for such lubrication. Design equipment to operate efficiently and satisfactorily when lubricated using standard military lubricants.

2.5.2.1 Lubrication Fittings

Locate lubrication fittings in accessible protected positions, with a bright red circle painted around each point. Provide carbon steel balls, bodies and tips of fittings threaded with a 1/4-28 taper, straight or 1/8 pipe threads. Incorporate into fittings a surface ball-check valve located at the surface of the inlet tip. Cadmium plate carbon steel fittings in accordance with ASTM B766, Type I, Class 5, or zinc coat in accordance with ASTM B633, Type I, Class 1, except that the salt spray test period for red rust corrosion is a minimum of 50 hours.

2.5.2.2 Lubrication Equipment, 6.9 MPa 1,000 psi and Higher

When the use of high-pressure lubrication equipment, 6.9 MPa 1,000 psi and higher, could possibly damage grease seals or other parts, affix a suitable warning or caution plate to the equipment in a conspicuous location.

2.5.3 Lifting Attachments

Equip each unit with lifting attachments designed and installed to enable the equipment to be lifted in its normal position without undue stress on the units.

2.5.4 Accessibility

Make all parts subject to wear, breakage, or distortion, and all parts which require periodic maintenance, readily accessible for adjustment or replacement.

2.5.5 Interchangeability

Provide only parts manufactured to standards that permit replacement without modification to parts or equipment.

2.5.6 Fastening Devices

Use suitable bolts and nuts conforming to ASME B18.2.1 and ASME B18.2.2 respectively, and screw threads conforming to the requirements of ASME B1.1. Install all screws, pins, bolts, hydraulic fittings, and similar parts with means for preventing loss of tightness. Do not swag, peen, stake, or otherwise permanently deform parts subject to removal or adjustment.

2.5.7 Electrical

Factory wire equipment complete with all necessary accessory devices, with all wiring brought to a single location, requiring only a source of power at [_____] volts, [_____] phase, 60 hertz, to make the equipment operable.

2.5.8 Castings and Forgings

Use gray iron conforming to ASTM A48/A48M; cast iron conforming to ASTM A319; and heat-resistant alloy conforming to ASTM A297/A297M Grade HF. Provide castings and forgings free from defects such as scale, mismatching, blowholes, or any other defect that will affect the life, or function of the part.

2.5.9 Welding, Brazing, Soldering, Riveting, or Wiring

Employ welding, brazing, soldering, riveting, or wiring only where these operations are required in the original design.

2.5.10 Incinerator Furnace Lining

Line furnace and flue connection with high-heat-duty firebrick conforming to ASTM C27 and ASTM C155 laid in high-heat-duty mortar conforming to ASTM F1097, suitable for use up to 1427 degrees C 2600 degrees F. At the Contractor's option, plastic or castable refractory containing high-duty or super-duty fireclay may be used, except that firebrick must be used in floors and hearths. Attach plastic refractory with anchors. Provide regular castable refractory conforming to ASTM C401, High Strength, Class C, except that the minimum modulus of rupture for transverse strength cannot be less than 4.14 MPa 600 psi after being heat soaked for 5 hours or more at a temperature in excess of 1371 degrees C 2500 degrees F.

a. Provide insulating castable refractory conforming to ASTM C401, Class R , with hydraulic setting of a type especially suitable for incinerators required to burn wet material. Install plastic refractory in accordance with the manufacturer's recommendations and by workmen skilled in its application.

b. Make joints for firebrick as thin as practicable, not exceeding 3.2 mm 1/8 inch in thickness buildup as a buttered joint. Cover the entire surface of the adjoining faces with mortar. Construct arches and circular linings with the necessary radial or wedge brick, straight brick, and special shapes for skewbacks, so as [to conform to the radius shown and] to produce approximately the same joint thickness at the inner and outer curves. Use 228.6 mm 9 inch series firebrick in the main arches of the furnace and flue connection, laid on end with joints interlocking one-half the width of the brick. Except in the ash pit, lay firebrick on edge with interlocking joints in the hearths and floors.

c. Provide a casing construction not thinner than 3.213 mm 10 gauge steel sheet conforming to ASTM A1011/A1011M for the incinerator roof, with steel sheets and strips conforming to ASTM A568/A568M for incinerator casings, housings, and components. Provide other uncoated black sheet steel of composition and finish best suited to the end use. Use galvanized steel sheets conforming to ASTM A653/A653M and ASTM A924/A924M for incinerator casings, housing, and components. Gauge numbers specified are United States Standard gauge.

d. Use special rounded shapes for the exposed edges of the openings for the charging, firing, and stoking doors. Make the thickness of the refractory furnace lining as necessary to comply with the outer surface temperature requirements specified. Attach refractory walls to the casing with alloy steel or refractory anchors to form a monolithic structure which will resist heat and support the walls with a Safety Factor of 4. Prevent bulging and destruction of refractory due to heat stress by reinforcing, expansion joints, ties, and anchors. Provide manholes and other inspection and access openings, identification plates, and stamps with insulation finished neatly against a metal ring provided for this purpose.

2.5.11 Castable Refractory

Use castable refractory in [guillotine doors, and door sills,] dampers and lids for charging throats. Thoroughly dry-mix material from each original container to ensure uniform distribution of constituents and particle sizes and then mix with water to the consistency of a stiff concrete. Place the mixture in the molds or frames in such manner as to exclude air bubbles and keep moist for 24 hours. Castings may be premolded or molded in place and conform to the details shown. Firmly set premolded castings in place and, where required, bond to the firebrick masonry with firebrick mortar.

2.5.12 Refractory Wall Construction

****

NOTE: Values for minimum thickness of refractory:

REFRACTORY THICKNESS VS. CAPACITY	
Capacity (grams per second) (pounds per hour)	**Min. Refractory Thickness (mm) (inches)**

REFRACTORY THICKNESS VS. CAPACITY	
For Walls	
Up to 63Up to 500	1084-1/4
63 to 252500 to 2,000	1084-1/4
For Hearths	
Indoors Up to 63	1144-1/2
Indoors 63 to 252 500 to	1144-1/2
Outdoors	63.52-1/2

****

Suspended wall construction with a spring arch type roof may be utilized. Install structural steel columns around the perimeter of the furnace, designed to support a succession of low sections of refractory wall, and framed to carry the heavy refractory walls by suspension while allowing gaps to remain in the walls for expansion of the chamber.

2.5.13 Insulation

****

NOTE: The values for minimum thickness of insulation are in the following table:

INSULATION THICKNESS VS. CAPACITY	
Capacity (grams per second) (pounds per hour)	Min. Refractory Thickness (mm) (inches)
For Walls	
Up to 63Up to 500	50.802
63 to 252500 to 2,000	63.52-1/2
For Hearths	
Indoors Up to 63	63.52-1/2
Indoors 63 to 252 500 to	101.604
Outdoors	38.101-1/2

****

Where specified or indicated, provide insulating block insulation conforming to ASTM C612, containing no asbestos material, and designed to prevent damage to foundation and incinerator exterior due to excessive heat. Unless otherwise specified, comply with the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

a. Provide Class 5 mineral fiber block, laid in approved mortar specially manufactured for this purpose or recommended by the insulating material manufacturer. Provide insulating cement conforming to ASTM C195 or

ASTM C196.

b. Provide firebrick conforming to ASTM C27 or ASTM C155 for insulating firebrick, laid up in air-setting mortar. Interpret firebrick to include straight brick, radial brick, wedge brick, skew-type brick, cupola blocks, and other similar shapes. Dip each brick in mortar, rub, shove into place, and then tap with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel is not permitted, maximum mortar joint thickness cannot exceed 3.2 mm 1/8 inch, and average joint thickness cannot exceed 1.6 mm 1/16 inch. Insulate main arches of the furnace and flue connection above the firebrick and, where exposed to the weather, protect with a suitable sheath. Insulate firebrick floors from any supporting floors with insulating brick except full bearing supporting floors on earth, on which a 75 mm 3 inch layer of contained dry sand may be used in lieu of insulating brick. Provide walls with a minimum thickness to limit the temperature of the outer incinerator surface to 49 degrees C 120 degrees F in an ambient temperature of 21 degrees C 70 degrees F when the unit is operating at full rated capacity.

2.5.14 Expansion Joints

Provide joints in the firebrick masonry [at approximately the locations as shown] [at spacings of approximately 2.4 m 8 feet], 13 mm 1/2 inch wide, as completely separated sections without any interlocking of the bricks. [Locations may be changed from those indicated by as much as 300 mm 12 inches in either direction to suit convenience of construction. Change as necessary, by offset or otherwise, to avoid weakening the arch over an opening.] Allow no expansion joint to be closer than 300 mm 12 inches to the vertical side of an arched opening or to the top of the brick forming the arch over the opening. When joints are offset, do not allow bonding of the horizontal faces between the two courses of brick along the offset. In addition, to allow for expansion of the inner face, construct a series of 3.2 mm 1/8 inch wide vertical openings spaced 1.8 m 6 feet apart on the furnace side of the wall. Make proper provision for expansion and contraction between incinerator foundation and floor.

2.5.15 Exterior Walls of the Furnace

Provide a plate steel shell wall at least 6.4 mm 1/4 inch thick separated from the firebrick by suitable insulation, with exterior walls of the flue connection of plate steel shell at least [4.8][6.4] mm [3/16][1/4] inch thick separated from the firebrick by insulation. Structurally reinforce shells as necessary to support burners, combustion air blowers, stack, refractories, and other components.

2.5.16 Primary Chamber

Construct the primary chamber for dual chamber systems of a steel casing supported by a steel frame and provide with insulation and refractory as necessary to comply with the specified outer surface temperature requirements specified. Make the casing not less than 2.657 mm 12 gauge sheet steel reinforced to withstand internal pressures without deflection or damage to refractory or other components of the incinerator. Construct frame and all reinforcing members of structural steel, free standing, and capable of supporting the weight of all components of the incinerator, including doors, burners, breaching, stack connections, and appurtenant assemblies without binding or warping. Provide frame and casing consisting of all-welded construction, complete and erect prior to installation of the refractory and insulation. Build all access doors and parts with seals to prevent emission of smoke or admission of significant amounts of air during incinerator operation. Primary chamber with openings permitting leakage of waste fluids is not acceptable.

2.5.17 Secondary Chamber

a. Construct the secondary chamber of dual chamber systems with minimum 4.8 mm 3/16 inch thick hot-rolled steel lined with mineral wool insulation and high strength refractory, rated at not less than 1427 degrees C 2600 degrees F, as necessary to comply with the specified outer surface temperature requirements. [A make-up air preheater of the manufacturer's standard design may be installed for this chamber.]

b. Provide secondary chamber burner capable of firing with [No. 2 fuel oil] [gas] with an electric ignition system, having a net out put rating capable of reducing the emission of combustible gases and particulate material to meet the current local, State and Federal air pollution emission standards. Equip burners with an FM approved flame sensor and direct spark ignition. Design combustion air supply for the secondary chamber to ensure complete combustion of all volatiles in the flue gas. Equip combustion air supply fans with control dampers to vary the air supply as required to provide complete air pollution control. Control temperature in the secondary chamber through the use of a temperature controller to vary the firing rate of the burner and combustion air supply.

[2.5.18 Primary and Secondary Cowling

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NOTE: Check with manufacturers of the type and size of equipment expected to be used to determine the availability of this option. If available, preheating the combustion air will improve thermal efficiency and enhance the completeness of the combustion process.

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The primary and secondary chambers of dual chamber systems may be provided with cowling in such a way as to preheat incinerator combustion air.

][2.5.19 Grates

When so equipped, construct grates of cast iron of size and configuration to support the rated capacity of the type of waste specified. Provide flat type grates, step type grates, or a combination of the two, as standard with the manufacturer of the incinerator, with a minimum weight of 195 kg/square meter 40 psf. Design grates to rest on supporting cast iron channels, I-beams, angles, or similar cast-iron shapes. Make stoker grates of heat-resistant alloy castings with holes or slots in metal surfaces through which combustion air enters. Size these openings to minimize plugging by ash or slag. Design grates to resist distortion, growth, cracking, and oxidation. Actuate grates or internal ram by mechanical or hydraulic means so as to move the refuse through the furnace, agitate the refuse to promote complete combustion, and remove the ash and residue from the furnace. Provide a [traveling,] [reciprocating,] [reverse reciprocating,] [rocking,] [or vibrating] stoker grate.

[2.5.19.1 Stoker Design

Design the stoker or internal ram (when so equipped) with a hydraulically or mechanically operated, self-contained mechanism located inside the furnace comprising a means of moving, shearing, or tumbling the waste material while burning to ash, admitting waste at one end while causing ash to fall off the other end continuously. Design stoker and feed equipment for thin layer distribution of the incoming waste, and slow and thorough agitation of the bed length to ensure ample aeration and complete burnout prior to discharge into the residue quench area. In the drying and ignition zone, retain the refuse long enough for the volatile combustible gases, water vapor, and smoke to be driven off from the refuse and flow into the secondary combustion zone where they are mixed with air and retained for a sufficient length of time to ensure complete combustion.

]2.5.19.2 Stoker or Ram Operation

Devise a means of activation for hydraulic cylinders of adequate size with a minimum stroke of [_____] mm inches to ensure progressive movement of the refuse. Mount cylinders under the [stoker] [ram] carriages or side girders on specially designed mounting brackets and beams arranged so that all thrusts and stresses are contained within the [stoker] [ram] structure without transmission into the furnace structure.

]2.5.20 Furnace Doors

Provide doors as necessary for inspection, stoking, cleanout, and charging areas, with door frames securely attached to the frame of the incinerator, having minimum edge thickness of 16 mm 5/8 inch increasing to 19 mm 3/4 inch around the door, to provide a seat for the door. Construct doors and frames of cast iron or steel, with a minimum door thickness of 10 mm 3/8 inch, gastight and when exposed to flame or direct heat of combustion gases and lined with the same type and thickness of refractory and insulation used in the combustion chamber to prevent excessive heat losses and warping. Secure refractory to the doors to prevent sagging. Design refractory with tapered edges to clear door frames during the movement of swinging doors. Weld alloysteel hooked bars to the door cover to anchor the refractory, with doors safely operable by one person. Temperature of door handles must permit operation of doors without gloves or other protective devices. Interlock charging doors with primary burners and air supply so that burner ignition shuts off and under-fire air dampers close when doors open. Gasket door closure with nonasbestos packing suitable for the service.[Provide guillotine-type doors that lift completely off the seals to effect opening.] Provide doors with hasps or brackets to permit locking. Also make provision to lock the doors in an open position during maintenance to prevent accidental closure while someone is inside the incinerator.

2.5.20.1 Mechanical Charging Doors

Provide guillotine type doors, with a charging door that opens with operation of the charger. Interlock charging and feed hopper doors to prevent simultaneous opening during operation of incinerator. Insulate combustion chamber doors, including guillotine doors as specified above for furnace doors. Provide doors with means for manual operation, which are raised and lowered by flexible steel cables operating over a system of smoothly operated sheaves or hydraulic or pneumatic cylinders attached to a steel frame. Construct doors which, in closed position, rest tightly against the frames.

2.5.20.2 Stoking and Cleanout Doors

Provide access doors for cleanout, stoking mechanism and visual inspection of the entire interior of the incinerator without permitting leakage of waste fluids.

2.5.21 Observation Ports

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NOTE: Requirements for observation ports and test holes depend upon the specific project, including competence and availability of operating and maintenance personnel, and type of material to be burned. Conform the number and location of the test holes to the requirements of the regulatory authority, and provide test holes for monitoring operating efficiency as needed.

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Provide [one] [two] observation port[s] 75 mm 3 inches in diameter on the access door for viewing the primary combustion chamber or zone during operation. Make ports no less than 2.7 mm 12 gauge black steel or cast iron tube or duct with a heat-resistant glass cover or an angular steel frame and closure plate with handle for operation without gloves or other protective devices. Extend the tube or duct from the exterior of the casing to not less than one-half the thickness of the refractory opening and make gastight. Make provision for air purging of the port to avoid ash buildup.

2.5.22 Test Holes

Provide incinerators with test holes as indicated and fit with standard weight, 50 mm 2 inch diameter, black steel pipe. Extend sleeve from the exterior of the casing to not less than one-half the thickness of the refractory lining. Form the refractory opening from the end of the pipe sleeve to the interior wall surface to shield the end of the sleeve from reflected heat. Fit the sleeve with a brass screw cap, and each test pipe with two or more sturdy lugs welded approximately in the middle of its length to prevent the pipe from turning when the cap is being removed.

2.5.23 Safety Devices

Provide incinerators with safety devices to provide safe operation, including automatic overheat shutdown and manual shutoff for each burner and main fuel supply, and equipment meeting the requirements of the Occupational Safety and Health Administration (OSHA).

2.5.24 Freeze Protection

Equip low points of all piping and tubing with drains for freeze protection.

2.5.25 Incinerator Cooling System

Provide the manufacturer's standard cooling system for the incinerator furnished, including all necessary equipment, piping, valves and control devices.

2.6 INCINERATOR AUXILIARY EQUIPMENT

2.6.1 Charging Method

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NOTE: It is not expected that cranes will be used in most military incinerator plants. The referenced standards may not be sufficient for the severe service conditions the crane would encounter. A separate section based upon Division 41, may be required to adequately deal with the crane.

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a. Mechanically charge incinerator and operate the combustion chamber at negative air pressure when the loading door is open, to prevent injury to the operator and the escape of smoke and gases. Provide a mechanical charger, including an inner door and an outer door, or other form of isolation from the combustion chamber, to discharge the contents of the loading and holding chamber into the combustion chamber. Flange loader directly to the feed opening of the incinerator.

b. Provide charger with a manual control and an adjustable timer to permit semi-automatic charging, with the manual box next to the ram loader opening as indicated. Provide an indication light to show when the incinerator can be charged and when the incinerator cannot be loaded due to insufficient temperature. Mount the light on the control box, visible to the operator when the box is closed. Include an interlock to prevent operation of the charger when a predetermined safe operating temperature is exceeded.

c. Locate the charger on the end of the incinerator. [Provide cranes to load the charger as specified in [Section 41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING] [Section 41 22 13.14 BRIDGE CRANES, OVERHEAD, TOP RUNNING] [Section 41 22 13.15 BRIDGE CRANES, OVERHEAD ELECTRIC, UNDER RUNNING] to load the charger.] Design charging chambers with a minimum capacity of not less than [0.5] [1.0] [_____] cubic meter [0.5] [1.0] [_____] cubic yard, with an installed digital counter to count the number of loads delivered by the automatic ram loader into the combustion chamber.

2.6.1.1 Feed Hopper

Provide a hopper-type chamber for top loading chargers, constructed of heavy-duty welded steel plate and structural shapes throughout, fabricated of 6 mm 1/4 inch minimum thickness hot-rolled steel, with steel plates and shapes conforming to ASTM A36/A36M. Orient hoppers loaded directly from the tipping floor to be loaded from the side of their longest dimension whenever physically possible, with the opening flush with the tipping floor.

2.6.1.2 Charging Ram

Provide a hydraulically operated ram, self-contained type with directional control, which injects small loads of refuse at frequent intervals, to ensure relatively uniform burning rates, and limits the amount of air entering the primary chamber with each charge through the use of double gates or similar device. Provide a ram which continuously pushes the burning waste toward the cleanout area, constructed to minimize the possibility of refuse becoming trapped in areas that would interfere with the operation of the ram and its seals. Provide sufficient cooling by either air or water to preclude warpage or excessive thermal expansion of the ram. Parts of the ram that come in direct contact with or ride upon the combustion zone refractory or grating are not acceptable.

2.6.2 Auxiliary Burners

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NOTE: Indicate if auxiliary fuel system is to be gas and/or oil by deleting the inappropriate subparagraphs.

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Provide [gas] [oil] [combination gas and oil] [LPG] burners for the primary and secondary combustion zones, meeting the requirements set forth in UL 296, UL 726, UL 795, and NFPA 85. Provide each burner as a complete assembly, including fuel and control systems, and accessories. Locate primary chamber burners so that the burner flame impinges directly on the waste materials when present during start-up, but does not impinge directly on the refractory when waste is not present during warm-up.

a. Provide primary burners with a capacity of not less than [_____] W Btu/hr and capable of maintaining a minimum continuous temperature of 760 degrees C 1400 degrees F and a maximum of 871 degrees C 1600 degrees F in that chamber or zone.

b. Provide secondary burners with a minimum capacity of [_____] J Btu and capable of maintaining a minimum continuous temperature in the secondary chamber of [982] [_____] degrees C [1800] [_____] degrees F. [Maintain a minimum continuous temperature of 760 degrees C 1400 degrees F at the roof near the exit of the primary chamber.]

c. Provide burners that are electrically spark-ignited and regulated by a variable set point indicator-controller adjustable from 427 degrees C 800 degrees F to 1316 degrees C 2400 degrees F to operate within the temperature limits recommended by the manufacturer. Include an on/off firing burner in the primary chamber. Provide a modulating burner with continuous burning capability for the secondary chamber, which modulates from high-to low-fire to off, based on the temperature of the secondary chamber. Provide secondary burner that cycles automatically as a function of the chamber temperature in order to minimize the consumption of auxiliary fuel and to minimize temperature peaks.

d. Actuate controllers by a thermocouple or shielded bimetallic sensor located in the upper 1/3 of the combustion chamber. Provide Type K thermocouples in the primary and secondary chambers, suitable for a maximum temperature of 1538 degrees C 2800 degrees F. Incorporate FM-IRI components in burner controls and meet NFPA current standards for gas- and oil-fired boilers, including ultraviolet flame scanners as specified in paragraph Flame Sensor, or flame rods for flame failure safety shutoff for burner and pilot and pre-ignition and postcombustion purging control. Mounting, flame shape, and characteristics of each burner must be suitable for the incinerator chamber in which the burner is installed, with burners that are easily moved out of firing position for inspection, cleaning, adjustment, and maintenance. On mechanically charged incinerators, include an interlock to prevent operation of the charger until secondary chamber or zone temperature has reached 871 degrees C 1600 degrees F.

2.6.2.1 Oil Burners

Provide air-atomizing or mechanical-pressure-atomizing type oil burners (when required), capable of burning unheated Grade No. 2 fuel oil. Provide only oil-burning equipment which meets the requirements of UL FLAMMABLE & COMBUSTIBLE and is installed in accordance with NFPA 30 and NFPA 31.

[2.6.2.2 Mechanical Pressure Atomizer

When so equipped, provide mechanical pressure atomizers which operate solely by the use of oil pressure and have no moving parts within the atomizer, and are capable of completely atomizing the oil through a minimum capacity range of 4 to 1 without changing nozzles or sprayer plates when furnished with oil at the manufacturer's required pressure. Design to supply a constant volume of oil to the atomizer, with variable capacity obtained by adjusting a control valve on the return line. Mount a diffuser to stabilize the flame near the furnace end of the atomizer but in such a position that oil will not strike it.

][2.6.2.3 Air Jet Atomizer

When so required, provide inside mix type air jet atomizers utilizing air mixing with the oil inside the nozzle, with no moving parts required within the atomizer assembly. Furnish the air compressor with the burner, from the burner manufacturer and capable of completely atomizing the oil through a minimum capacity range of 6 to 1 without changing nozzles or sprayer plates, when supplied with air at a maximum pressure of 689 kPa 100 psi gauge, and varying unit capacity by adjusting air pressure supplied to the unit. Furnish unit with a blow-out valve so that air may be blown through the oil passages to clear them of any accumulation. Mount a diffuser to stabilize the flame near the furnace end of the atomizer but in such a position that oil will not strike it.

]2.6.2.4 Air Register

Provide the most suitable type air registers for the atomizer furnished and arrange for connection to the forced-draft fan duct, with adjustable air-volume louvers with all louvers operated by a single, easily accessible lever. Register is to support atomizer and closely related components, and fastened directly to the front of the incinerator. Properly size the throat ring to match the atomizer. Mount a diffuser to stabilize the flame near the furnace end of the atomizer but in such a position that oil will not strike it. Design the register and diffuser to ensure complete mixing of air and fuel with a minimum of excess air.

2.6.2.5 Throat Openings

Construct burner throat openings of superduty plastic refractory or matched sections of refractory tile. Make the throat concentric with the burner, of proper contour to ensure complete mixing of the air and oil, and designed to assist in complete combustion by radiating heat to the fuel. Position the burner so that the flame parallels the contour of the throat but avoids striking the refractory.

2.6.2.6 Electric Ignition System

Provide an ignition system suitable for operation with [No. 2 fuel oil] [gas]. Furnish igniter assembly complete for each burner, with a suitable ignition transformer and electrode rated for not less than 5,000 volts on the secondary side, as a unit readily removable from the incinerator setting for repair. Make provisions in the igniter assembly for manual operation and for inspection of the pilot flame. Provide components in conformance with NFPA 85 requirements, as applicable.

[2.6.3 Fuel Oil System

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NOTE: Delete these paragraphs and their subparagraphs if oil is not used.

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Install fuel oil system (when applicable) in strict accordance with NFPA 31 and Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS, unless otherwise indicated. Equip oil supply line to each burner with an automatically operated valve designed to shut off the oil supply in case of fire in the immediate vicinity of the burner. Provide a thermoelectrically or thermomechanically actuated type valve and locate immediately downstream of the manual shutoff valve or other building shutoff devices where oil supply line enters the building. Locate a thermoelectrical or thermomechanical detection device over the oil burner to activate the valve. A fire shutoff valve may be combined with other automatic shutoff devices if listed in UL FLAMMABLE & COMBUSTIBLE.

2.6.4 Fuel-Oil Piping

Furnish piping required between the oil storage tank, burners, and pumps complete with valves, strainers, traps, insulation, and accessories, conforming to Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.6.5 Fuel-Oil Storage Tank

Provide storage tanks constructed of steel or fiberglass, suitable for underground installation, constructed and labeled in accordance with NFPA 30, NFPA 31 and Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

][2.6.6 Gas Meter

Furnish and install gas meters where indicated, having the full capacity indicated when receiving gas at [100] [_____] kPa [15] [_____] psig. Maximum differential pressure across any meter at full capacity is 3 kPa 0.5 psi. Provide meter housing of pressed steel, cast aluminum or cast iron, suitable for natural gas at [172] [_____] kPa [25] [_____] psig. Provide meters with a 3-valve bypass, with valves and bypass the same size as the gas line in which they are installed. Equip meter with an accessory instrument that indicates a corrected volume reading and an uncorrected volume reading of the gas passed, where the corrected volume reading is in standard cubic meters/second and cubic feet/minute cubic feet/minute. Install the meter in strict accordance with the manufacturer's recommendation. Provide positive displacement type meter of either rotary or diaphragm type. Provide gas piping, fittings, valves, regulators, test, cleaning and adjustments in accordance with Section 23 11 20 FACILITY GAS PIPING. Comply with requirements of ANSI Z21.13/CSA 4.9 as applicable unless otherwise specified herein and appropriate certification is submitted.

]2.6.7 Stack

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NOTE: Depending on requirements at location and personnel involved, temperature of the casing can be 66 to 93 degrees C 150 to 200 degrees F. The casing temperature is limited to 49 degrees C 120 degrees F maximum when personnel safety is involved. Provide spark arrester if there are no pollution control devices between the incinerator and the stack. References to heat recovery and boilers may have to be deleted if that feature has been excluded from the project.

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a. Provide sectional, energy recovery and heat dump stacks set on a concrete foundation or otherwise adequately supported. [Make provisions in the ducting to bypass the flue gas around the heat recovery boiler to the normal stack, or direct it to a separate dump stack in the event of a boiler failure.] Provide the , size, and number of sections in accordance with the requirements of the stack and refractory manufacturer to adequately support the refractory lining, permit expansion, and prevent cracking of the refractory.

b. Line the entire height of the chimney with refractory as specified for the furnace, and provide with a cleanout door frame and a protective cap. Where the chimney is in the open, furnish a metal side-rail-and-rung ladder, with a [ladder cage or]fall protection device, designed for a live load of 890 N 200 pounds with a safety factor of at least 2 based on the yield strength of ductile metals, or a safety factor of 4 based on the ultimate strength of cast metals.

c. Provide a stack conforming to NFPA 82 and NFPA 211. Secure refractory to the casing by steel anchors. [Attach a corrosion-resistant steel spark arrester fabricated of 18 gauge, 13 mm 1/2 inch mesh wire screen to the top of the stack.] Provide a corrosion-resistant steel weather cap. The temperature of the casing of any stack must not exceed [_____] degrees C degrees F in an ambient temperature of 21 degrees C 70 degrees F while passing [_____] actual cubic meters/second ACFM of flue gas at[232] [_____] degrees C [450] [_____] degrees F. Provide fire stops, thimbles, and support assemblies conforming to NFPA 211. Extend stacks at least 1 m 3 feet above the highest point where they pass through the roof of the building and at least 600 mm 2 feet higher than any portion of the roof or building located within 3 m 10 feet horizontally of such chimney. Design and construct each stack to withstand winds up to[210] [_____] km/hour [130] [_____] mph. Provide adequate support, without placing any of the load on the refractory walls of the incinerator, for any stack installed on top of the incinerator.

d. Provide [freestanding stacks with painter's ring and trolley.][required aircraft markings.] Weld stack sampling ports into each stack, consisting of two collars, at least 100 mm 4 inches in diameter.[Use one hundred fifty mm six inch collars if particle-size sampling is required.] Locate and set collars at a right angle to each other at least ten stack diameters downstream from a fan or change of direction for stack sampling. Provide ports with suitable, removable, replaceable caps.

2.6.8 Breaching

Construct breaching of not lighter than 3.416 mm 0.1345 inch thick, black-steel sheets conforming to ASTM A568/A568M. Reinforce and brace breaching with structural steel angles not smaller than 50.8 by 50.8 by 6.4 mm 2 by 2 by 1/4 inch and weld all joints and seams in the sheets and angles . Construct flexible type expansion joints requiring no packing and install where required. Provide breaching with angle flanges for connection to boilers or other equipment with breaching full size of opening. Supply breaching in bolted or welded sections for ease of handling or erection. Connectors must be in accordance with NFPA 211. Line breaching with a minimum of 75 mm 3 inch thick refractory, and seal tightly all around with a nonasbestos type rope and cement to form an airtight joint where required. Provide cleanout openings of suitable size, with tight fitting hinged doors and frames, at approved locations for access to all sections of the breaching. [Locate one 406 by 406 mm 16 by 16 inch inspection door in the side of the breaching just preceding the boiler unit.] [Locate a similar inspection door in the side of the breaching just following the boiler unit.]

2.6.9 Draft Equipment

Supply combustion air in the primary and secondary zones by a motor-driven blower as specified for draft fans. Design control circuits to shut down incinerator in case of a power failure, and to purge the chamber prior to ignition of the burners. Provide an air compressor for soot blowing or oil atomization. Also provide equipment to supply the correct amount of air to permit complete, controlled combustion, including forced draft fans, draft gauges, dampers, damper actuators, linkage, and appurtenances necessary to maintain a negative draft in the primary chamber, in order to provide optimum incinerator performance at all operating rates.

2.6.9.1 Combustion Air Damper

Regulate secondary, under-fire, and over-fire air with controller actuated dampers, constructed of black-sheet steel, not less than 1.519 mm 16 gauge, which operate without noise or flutter. Provide electric motor actuators [at [110] [220] [440] volt ac], hydraulic, or pneumatic operated.

2.6.9.2 Flue Gas Damper

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NOTE: Optional wording applicable to guillotine-type dampers.

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[Install a [guillotine-type] [butterfly] [shutter] damper [of the thickness indicated] [at least 63 mm 2 1/2 inches thick] and consisting of a steel frame enclosing refractory material at the entrance of the waste heat recovery boiler for the purpose of isolation from the incinerator during emergency boiler repairs.] Also install a damper in the dump stack which opens upon occurrence of [excess boiler steam pressure,] induced draft fan failure [, and boiler shutoff]. [Provide a boiler damper operated by a controller actuated motor based on the [boiler steam pressure] [boiler water temperature.] When the boiler damper is open, the stack damper will close. Furnish [a chain hoist for raising and lowering][a manual lever for][an electrical control for] the boiler damper of correct size and design to ensure freedom of movement by the damper. [Secure the hoist cable to the damper frame by means of shackles and bolts, and a damper slot with a steel plate cover 6 mm 1/4 inch thick and of the length and width indicated or required. Provide the cover with a slot to permit the passage of the cable for raising and lowering the damper, and for easy removal of the cover. Provide a spur-geared hoist which is a product of a manufacturer regularly engaged in the manufacture of hoists. Design unit for high-speed lifting, with high mechanical efficiency, an automatic load brake and a built-in load limit.] Maximum effort to operate the unit must not exceed 311 N 70 pounds, with the capacity to move the required load freely and maintain the damper in the desired position within the limits of the flue opening].

2.6.9.3 Blowers

Provide auxiliary fuel burner blowers capable of delivering the necessary amount of air at an atmospheric temperature of [16] [_____] degrees C [60] [_____] degrees F and a barometric pressure of 101 kPa absolute 14.7 psia to allow the burners to achieve rated capacity. Provide single-inlet, single-width, non-overloading blowers designed for quiet operation with as little vibration as practicable, with grease lubricated bearings, ball or roller type, to accommodate all radial and end thrust. Construct housing of 1.897 mm 14 gauge sheet steel with a smooth interior that will eliminate unnecessary turbulence.

2.6.9.4 Draft Fans

Furnish centrifugal, forced-draft fans conforming to CID A-A-59222 as an integral part of incinerator design, conforming to AMCA 801, Type [I] [II] and AMCA 99, applicable to centrifugal furnace fans and rated for flow rate, pressure, power, speed of rotation, and efficiency in accordance with AMCA 210 and ASME PTC 10, with [backward curved blades] [forward curved blades]. Size each fan for operation at an elevation of [_____] m feet, with an output volume and static pressure rating sufficient for pressure losses, excess air requirements at the secondary zone exit, leakages, temperatures and elevation corrections for worst ambient conditions. Include in the design conditions, at full combustion, net rated output at normal firing condition capacity plus additional capacity sufficient to provide a 15 percent excess volume against a 32 percent static overpressure, and air temperature 14 degrees C 25 degrees F above operating temperature. Provide fan that is driven by a totally enclosed, fan-cooled electric motor. Connect fan directly or indirectly to the driving motor. If the fan is indirectly connected, provide a V-belt drive designed for 50 percent overload capacity, with the motor mounted on the base in a manner that permits tightening of the belt. Noise levels for fans exceeding 85 decibels at 914 mm 3 foot station are not permitted. Provide air-cooled fan bearings, of the backward curved fan blade type with bearings not requiring water cooling of the self-aligning antifriction type. [Provide scroll sheets and rotor blades with liners.] Factory paint fans with the manufacturer's standard finish. Design control circuits to shut down incinerator in case of power failure and to purge the chamber prior to ignition of the burners.

2.6.9.5 Control Equipment

Furnish each motor with a manually operated starter, of the enclosed, across-the-line type with manually reset thermal-overload protection. Provide a separate pole for each ungrounded conductor.

2.6.9.6 Air Ducts

Supply over-fire and under-fire air from the blowers through ducts conforming to SMACNA 1403. Introduce combustion air to the primary chamber below the waste material by means of under-fire air lines or ducts. Regulate over-fire air by controlled air ports located in the wall of the incinerator for completing combustion of combustible materials in the gases. Size ducts to minimize pressure drops and construct of sheet steel with all seams and connections air tight. Construct duct work of galvanized sheet metal, with galvanizing conforming to ASTM A123/A123M and ASTM A153/A153M. Provide access and inspection doors as required. Provide duct wall thickness as follows:

Ducts, Maximum Dimension	Steel (Gauge, Thickness)
1200 mm48 inches	0.759 mm22 gauge, 0.0299 inch thick
1225 mm49 inches thru 1500 mm 60 inches	0.912 mm20 gauge, 0.0359 inch thick
1525 mm61 inches thru 1800 mm 72 inches	1.214 mm18 gauge, 0.0478 inch thick
1825 mm73 inches and larger	1.519 mm16 gauge, 0.0598 inch thick

[2.6.10 Heat Recovery System

Boilers for the heat recovery system are as indicated in Section 23 52 30.00 10 HEAT RECOVERY BOILERS.

]2.6.11 Ash Removal

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NOTE: Where required, include complete requirements for pretreatment of quench water and liquid waste. Pretreatment may include pH adjustment, solids removal, and toxic compound treatment as necessary. Ash systems that directly discharge from the incinerator into the disposal container should be allowed for very small 9 metric tons per day 10 TPD incinerators.

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Provide a unit with provisions for mechanical removal of the ash or residue, which is to discharge from the combustion of the refuse from the far end of the incinerator, opposite the location where waste is introduced. Provide an ash plow or other device, automatically interlocked with the doors for the removal operation, combined with a water quench, spray, or bath which will extinguish live embers and control airborne dust. Also make provisions for manual removal of ash for maintenance purposes upon completion of the cool-down cycle, through the access door. Treat waste liquids (ash water) as necessary to be compatible with, and discharged to, the sewage collection system. Remove ash and residue from the area by mechanical conveyors, constructed of corrosion resistant material, and portable containers. Equip each unit system with an independent ash removal and ash conveyor system designed to conform to the equipment arrangement shown.

2.6.11.1 Ash Pits

Provide funnel shaped ash pits, containing receiving hoppers constructed of 6 mm 1/4 inch steel plate, minimum, covered with a heavy grating with openings approximately 50 mm 2 inches square for personnel protection. Discharge ashes and clinkers from the incinerator into the ash hopper located directly below the ash discharge opening. Arrange a combination drag chain conveyor for horizontal conveying and an elevator conveyor for vertical conveying of ashes as indicated to take ashes from the bottom of the ash hopper for discharge into the ash container. Provide conveyors with a capacity of not less than [_____] kg/hour pounds/hour when handling ashes weighing approximately [_____] kg/cubic meter pcf at a maximum speed of [0.5] [_____] m/second [100] [_____] fpm. Provide doors for access to all parts as required. Provide totally enclosed, [nonventilated type][fan-cooled type][fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70] electric motors, with [manual] [magnetic] [across-the-line] [reduced voltage start] type motor starter and [general-purpose] [weather-resistant] [watertight] [dust-tight] [explosion-proof] enclosure.

[2.6.11.2 Drag Chain Conveyor

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NOTE: Both types of conveyors may not be applicable to the project. Select the appropriate paragraph based on the conveyors required.

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Provide a drag chain conveyor consisting of a [single] [double] strand of wide, malleable iron, drag chain with a [_____] mm inch overall width, and [_____] N pounds working strength. The upper strand of the chain must convey the ash in a trough constructed of10 mm 3/8 inch cast iron, or other suitable material, extending from [_____] mm inches in front of the foot shaft to [_____] mm inches behind the head shaft and set flush with the floor. Carry the return strand of chain in angle runways set flush with the trench floor, without passing through the falling ash.

][2.6.11.3 Elevator Conveyor

Provide a double strand elevator conveyor, chain type with head and takeup and an extended foot shaft to provide a drive for the drag conveyor. Construct casing of 2.657 mm 12 gauge black steel, minimum, with 4.8 mm 3/16 inch thick boot plates. Include with head-end drive a gear motor and steel roller chain complete with drive brackets, guards, and backstop. Equip elevator with head-end platform and ladder. Factory prime all exposed metal surfaces for field painting.

][2.6.12 Steam Piping

Steam piping system consists of those piping sections actually conducting steam, condensate return piping, and vent piping. Provide steam piping conforming to the provisions of Section 33 63 23 ABOVEGROUND HEAT DISTRIBUTION SYSTEM, unless otherwise specified, designed for [_____] kPa psi steam.

]2.7 COMBUSTION CONTROL EQUIPMENT

2.7.1 General

Provide and install all locally indicating instrumentation and local controls complete, as required to suit equipment furnished and as shown. Also provide and install all remote instrumentation, controls, and their connection points as indicated, or as specified, as well as an automatic combustion-control system for each incinerator in accordance with the incinerator manufacturer's recommendations. If controls are manufactured by a manufacturer other than the incinerator manufacturer, install the controls in accordance with the control manufacturer's instructions. Locate automatic controllers on the control room panel as specified. Provide pneumatically, electrically, or electronically operated equipment. If pneumatic controls are provided in lieu of electric, provide duplex air compressors, with a drier between the compressors and tank. Size air compressor unit to run not more than 60 percent of the time when all controls are in service. Install air filter regulator sets at each control valve and transmitter in the system. Provide dual type master air filter regulator set on the control panel such that one side can be cleaned and repaired while the other is in operation. Provide each system with a selector switch or other means to permit manual control of the firing rate when required. Provide two-wire 120 volts nominal or less, 60 Hz with grounded neutral power supply to the electrical circuit. Wire all operating and limit controls to interrupt the ungrounded circuit conductor.

2.7.2 Equipment

Include in control equipment and instruments burner and fan controls, time clocks, relays, operating switches, indicating lights, gauges, motor starters, fuses, alarms, and circuit elements of the control system, and other controls and instruments necessary for unit operation, in accordance with FM APP GUIDE. Provide proportioning control of the overfire and underfire air supply and of the air supply and fuel supply to the burners. Ensure a visual indication for safe loading of the incinerator and excessive high temperature conditions which may require control or adjustment by the operator are provided within temperature indicator controllers or other indicators. Provide indicating and recording instruments for pressure, flow of air and liquids, as well as for alarm circuitry. Interlock automatic control circuit systems and manual switches to prevent hazardous conditions or the discharge of excessive amounts of air pollutants.

2.7.3 Combustion Control

Control of the products of combustion is based on maintaining a pre-set temperature, not to exceed limits as specified for minimum design requirements under paragraph INCINERATOR. Design the system to minimize auxiliary fuel usage by controlling the quantity of air and waste fuel introduced into the primary chamber or zone in accordance with the temperature. Provide over-fire protection by controlling the upper chamber or zone combustion air as a function of the chamber or zone temperature, with a fully automated and integrated control system, which operates at near the design conditions, and at near constant temperature output.

2.7.4 Incinerator System Operation Sequence

2.7.4.1 Starting

Provide a "START" button which causes the secondary (pollution control) chamber or zone burner to ignite to preheat that area prior to charging the system, using auxiliary fuel only as a heat source during the preheat period. The secondary burner, after ignition, must be under the control of a modulating thermal controller which controls the air/fuel ratio in the secondary chamber or zone. Burner for the primary chamber or zone may be either automatically or manually activated. Interlock the burner control circuit with a timer or temperature sensor which functions to shut off and lock out the burner after a predetermined and preset time or temperature has been achieved.

2.7.4.2 Loading

After a predetermined warm-up period, the system must be ready for loading. Feeder controls allow for two modes of operation, automatic cycle and manual. Control automatic system by a timer or speed control, interlocked with limit switches and temperature sensors. Initiate automatic feed cycle by a single push button when the operator is ready for that unit to begin the cycle. After cycle initiation, the vertical charging door (when present) must open and the ram or other stoking device must start moving forward to discharge the refuse into the primary chamber or zone. After the ram or other stoking device has reached the end of its stroke, it withdraws back into the hopper to a position where the charging door (when present) is allowed to close, and the ram returns to its original start position.

2.7.4.3 Overrriding

Equip feeder with a charging ram water spray system. Equip loader control with a manual override system which enables the operator to override the automatic sequence if necessary to correct a malfunction of the loader. In the event of a malfunction, provide a flashing light and an audible alarm to signal the operator that a problem has occurred. In the manual mode of operation, provide selector switches to individually control the motions of the charge door, hopper door and ram.

2.7.5 Controllers

Mount controllers on the instrument panel to indicate and control measurement in the areas shown. Provide proportional type controllers with reset, and automatic/manual operation. Provide a set point with a manual adjustment on the front of the instrument. Install controllers complete with wiring or piping between the controller, transmitter, and the final control device. Provide proportional type combustion control equipment capable of maintaining optimum combustion conditions. Set point controllers may be used for on/off functions only. Maintain combustion efficiency without appreciable manual adjustment.

2.7.5.1 Automatic Controller

Provide each automatic controller with a manual-to-automatic station and indicator on the control panel that offers selecting either automatic control or manual control and also allows manual operation. Arrange manual controls to allow any one or more of the functions of the control system to be controlled manually while the other functions remain on automatic control. Provide manual control station complete with all necessary indicators to facilitate changing from automatic control to manual control and vice versa.

2.7.5.2 Fuel-Flow, Air-Flow Type

Provide proportional, reset type combination fuel-flow, air-flow type combustion control equipment for the auxiliary burners , which positions the feed or air flow and then adjusts one to the other by a ratio controller operating from airflow and feed. Include in controls fuel-flow measuring elements and airflow measuring elements which are field-mounted and separate from panel devices. Panel mount separate fuel feed and air-flow controllers along with a fuel-to-air ratio controller. Airflow index may be set by a measuring element in the air stream or in the gas stream exiting the incinerator. Systems controlling fuel and air by line shafting and mechanical connections are not acceptable.

2.7.6 Damper Control

Size power units for the damper movement to operate the device to be positioned, and mounted to allow for a rigid mechanical connection to the device being operated. Provide automatic draft control by controlling the main damper or uptake damper. Main damper or uptake damper must open to allow air purging of the incinerator and control draft to suit burner operation, and automatically close units in event of failure of the operating medium except for any dump stack damper which fails to open. Provide manual operation of the controller without disconnecting the linkages during power failure or other emergency. Include position switches on fuel and air-drive units for interlock with safety systems. Place retransmitting devices on all power units for remote indication on the control panel of the position of the operator at any time. If electric operators are utilized, provide oil-immersed gear trains on the units.

2.7.7 Fuel Feed Controls

Control automatic feed cycle by an adjustable timer for rams and a speed control for feed grates. Provide an interlock to interrupt the automatic cycle in the event of an emergency such as an extreme overtemperature condition in the primary chamber or zone.

2.7.8 Burner Controls and Safety System

Burner control and safety system must provide for the start, purge, ignition, main flame supervision, safe shutdown and alarm of the incinerator fuel burning equipment, such that a burner malfunction at any time prevents the burners from operating by tripping a burner relay. Integrate control of the burner and incinerator system to ensure overall safety. Provide safety shutoff valves and fuel trains for main burners as required by FM APP GUIDE and NFPA 85. Automatically control sequence of burner operation by programming relays to start a mandatory pre-purge cycle with full protection against flame failure during both electric spark ignition and normal burner operation. Normal cycling of burners that require system pre-purge is prohibited. Govern operation of the programming relays by a [steam pressure limit switch,] approved draft switch, low fuel pressure switch, [low drum level cut-off switch] and an electronic flame failure protection device. A flame failure condition will cause the burner to shut down on safety and require a manual reset before the burner can be restarted. Control normal cycling by means of temperature switch as described earlier.

2.7.8.1 Incinerator Burners

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NOTE: Insert appropriate fuel oil or gas specification section(s) associated with this project. Only allow direct electric spark ignition for burners up to 732,500 watt 2,500,000 BTU/hour. Values of minimum burner input capacity:

SIZE OF BURNERS, (x1000) Watts BTU/Hr Primary Burners						
Capacity of Incinerator, (grams/sec) (lb/hr)	2490 Min. kJ/kg 8500 Min. BTU/lb	1905 Min. kJ/kg 6500 Min. BTU/lb	1260 Min. kJ/kg 4300 Min. BTU/lb	733 Min. kJ/kg 2500 Min. BTU/lb	293 Min. kJ/kg 1000 Min. BTU/lb	Secondary Burners All Refuse
6.3050	350150	350150	582250	815350	990425	466200
12.60100	466200	466200	1282550	1631700	1980850	699300
18.90150	582250	559240	1514650	23301000	32621400	932400
31.50250	699300	699300	1748750	26801150	37281600	1514650
63.00500	1282550	1282550	25631100	38451650	51262200	23301000
94.50750	1748750	1748750	34951500	52422250	69903000	30291300
126.001000	2097900	2097900	39611700	55922400	72233100	39611700
189.001500	2563 1100	2563 1100	51262200	76893300	10,252 4400	48932100
252.002000	3728 1600	3728 1600	76893300	11,650 5000	15,378 6600	62912700

NOTE: Insert appropriate Section number and title

in blank below using format per UFC 1-300-02.
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Provide [gas] [oil] [combination gas and oil] burners for the primary and secondary combustion chambers. Design burners for [natural type gas] [or] [No. 2 fuel oil conforming to ASTM D396]. [Fuel oil] [Gas] piping is covered in [______]. Design incinerator burners for fully automatic nonrecycling operation, with a combustion-safety control system conforming to FM APP GUIDE or NFPA 85, as appropriate. Certify that the installed control system conforms to FM APP GUIDE or NFPA 85. Provide UL listed and FM approved system components, designed for use with industrial grade burners. Include the following with all accessories for a complete system.

2.7.8.2 Combustion-Safety Controls System

Provide a combustion-safety control system which includes a flame safeguard relay or control unit that has solid state electronic circuitry and continuous self-check feature. Provide relay or control unit consisting of amplifiers, transformers, power supply, relays, indicating lights, and terminal strips factory prewired and assembled in a NEMA ICS 6, Type 12 steel cabinet with door. Provide a cabinet made of steel, 1.897 mm 14 gauge minimum thickness, with gray enamel finish throughout or any other color selected by the Contracting Officer. Provide cabinet door with piano hinges and latch, with components and supporting chassis which is easily removed for replacement and repair. Provide plug-in or similar units. Provide a flame safeguard relay or control unit which checks itself and the detector circuit for flame simulating component failure at start-up and at intervals not to exceed manufacturer's recommendation or the specified flame failure response time throughout the burner operation. Loss of combustion airflow, flame failure and flame simulating component failure must cause the flame safeguard relay or control unit to de-energize all fuel levels for the burner and initiate a non-recycling burner shutdown and alarm. Provide flame safeguard relay or control unit to program the burner operation to conform to FM APP GUIDE or NFPA 85.

2.7.8.3 Purge Timer

Provide a purge timer to prevent the operation of the flame safeguard relay or control unit until the minimum purges, as required in NFPA 85 or FM APP GUIDE, have been completed. Volume to be purged includes the volume of the combustion chamber, boiler passes and breachings. Interlock the purge timer with the airflow differential pressure switch and igniter and main firing valves to ensure that all fuel lines are closed. Provide a green indicating light as specified above to indicate purge completion.

2.7.8.4 Safety Shutdown Interlocks

Provide safety shutdown interlocks in the flame safeguard relay or control unit for the conditions specified by FM APP GUIDE or NFPA 85. Provide low and high fuel pressure interlock switches, interlocked with the flame safeguard relay or control unit to prevent burner operation if low or high fuel pressure is detected.

2.7.9 Combustion Temperature Control

Provide a separate temperature control for each combustion chamber which controls the firing rate within that chamber. Provide Type "K" thermocouple temperature sensors in a ceramic protection tube, suitable for operation up to 1538 degrees C 2800 degrees F. Temperature is to be transmitted to the controller mounted in the control panel. Provide the type of controllers that can be operated in the automatic or manual mode. Control the temperature within plus or minus 5 percent of the set point over the full operating range required by the manufacturer of the incinerator.

2.7.9.1 Primary Combustion Chamber or Zone Controller

This controller varies the combustion rate through control of the primary air supply and auxiliary burners, and also prevent overfeeding the primary chamber or zone by locking out the feed system during extreme over or under temperature situations.

2.7.9.2 Secondary Combustion Chamber or Zone Controller

The temperature controller in the secondary chamber maintains the required temperature for complete combustion of the gases and reduction of particulates. This controller varies the firing rate of the burner and the flow of combustion air to the secondary chamber or zone.

2.7.10 Draft Fan Control

Provide forced-draft centrifugal fans with inlet vane controls [and variable speed control where indicated]. [Provide axial propeller fans with variable propeller pitch control.] Provide inlet vanes suitable for use with combustion control equipment. Provide a means for operating the draft fans for 15 minutes after last charge in the incinerator has burned down.

2.7.11 Draft Fan Drives

Provide a draft fan driven by [an electric motor] [or] [a steam turbine]. [Electric motor must be [drip-proof] [totally enclosed nonventilated] [totally enclosed fan-cooled] [totally enclosed fan-cooled, suitable for installation in a Class 1, Division 1, Group F, hazardous location conforming to NFPA 70].] [Motor starter must be magnetic [across-the-line] [reduced voltage start] type with [general-purpose] [weather resistant] [watertight] [dust-tight] [explosion-proof] enclosure and furnished with four auxiliary interlock contacts.] [Provide a steam turbine with horizontally-split, centerline supported casings, water-cooled bearing housings with ring-oiled, babbitt-lined, bronze packing sleeve bearings, and equipped with a mechanical shaft speed governor and valve, and independent emergency over-speed governor and trip valve, reed tachometer, constant pressure type governor, insulation with removable metal jacket, oil-sight glasses with guards, removable stainless steel steam strainer [without disconnecting piping], any special wrenches and tools required for servicing turbine, and a sentinel warning on the exhaust casings. Provide turbines conforming to NEMA SM 23.]

2.7.12 Ash System Control

Provide controls for the ash discharge system which allow for two modes of operation, automatic and manual. Manually initiate and control automatic cycle by cycle programmers or automatically initiated by the charging system programmer. Install lights, controls and interlocks as described earlier for automatic ash removal control in and on the main cabinet with manual controls installed near the ash removal equipment of each incinerator.

2.7.13 Soot Blower

Mount all controls, lights, switches, and indicator provided for operation of soot blower on the control cabinet.

2.7.14 Incinerator Shutdown

When the primary chamber or zone temperature exceeds a control limit of 982 degrees C 1800 degrees F, lock out feed system and suspend waste feeding until manually reset.. Shutdown the entire incinerator at 1538 degrees C 2800 degrees F in the furnace, 400 degrees C 750 degrees F at the induced draft fan, or 260 degrees C 500 degrees F at the combustion air fan. In the event of a complete shutdown, reset the system manually and go through a normal start-up procedure including purging, prior to starting the burners.

2.7.15 Control Panel

Provide wall mounted cabinets conforming to UL 50 and free standing cabinets or panels conforming to NEMA ICS 6, Type 6 or Type 4. Provide prewired, steel, and weathertight panel. Unless enclosed in a booth or separate room, construct the panel to protect the instruments and controls from dust. Instrumentation fabricator must wire all instrument connectors and cable termination connectors in the factory. Flush mount all controls, instruments, and other equipment at the factory and assembly-test prior to shipment. Furnish a lock and two keys. Identify all controls and instruments with nameplates. [Provide a heater to prevent condensation.]

2.7.15.1 Panel Details

a. Size panels to contain all controls, instruments, gauge, and meters. Provide free standing panels with faceplate of not less than 6.4 mm 1/4 inch reinforced steel plate, coated with an approved laminated plastic suitable for the duty and finished with the manufacturer's standard finish coating. Flush mount controls and instrumentation on the panel as far as practicable.

b. Enclose back of panel with sheet metal, with adequate access panels for maintenance and removal of any component without interfering with other components. Provide door-latching equipment and hardware.

c. Identify each recorder, indicator, and control unit with engraved metal or laminated plastic nameplates secured to the panel. Provide panel with a continuous rapid-start fluorescent light fixtures mounted with reflectors providing suitable shielding to illuminate all controls, instruments, gauges, and meters.

d. Terminate field piping connections for each panel in one bulkhead-mounted manifold located to conform with the installation requirements of the system. Terminate field electrical connections in a mounted color-coded terminal strip located to conform with the installation requirements of the system.

e. If a pneumatic control system is provided, mount the panel air supply filter and regulator set on the rear of the panel with properly identified pneumatic terminal blocks. No high pressure lines are allowed to enter the panel. If packaged-type burner units with integral controls are furnished, the control equipment may be mounted on a separate panel for each incinerator. Panel mount and test controller and indicators specified or required at the factory, complete with relays, transformers, switches, wiring, valves, and piping.

f. Completely isolate thermocouple and low energy signal conductors from power and alarm conductors, subject to approval by the Contracting Officer. Provide visual and audible alarms to protect personnel and equipment. Mount annunciator system on each control panel. Provide visual signals consisting of backlighted nameplates for each point. Provide a common audible alarm signal and a common acknowledge pushbutton for each control panel. Indicate malfunctions on the annunciator panel as specified [in Section 23 52 30.00 10 HEAT RECOVERY BOILERS] plus the following as a minimum:

(1) Loader
(2) Burner (each)
(3) Ash Discharge System
(4) Ash Transfer Rams (if used)
(5) Ash Conveyor

g. Also include in the panel visual indication of the various modes of the main system components such as loading and charging system, burners, ash discharge system, ash conveyor, damper positions, [induced draft fans]. Additionally, include in the incinerator/[boiler] panel [as specified in Section 23 52 30.00 10 HEAT RECOVERY BOILERS plus]the following:

(1) Temperature Recorder (lower chamber, upper chamber)
(2) Clock with minimum 200 mm 8 inch diameter face (one panel only)

2.7.15.2 System Diagram

Mount laminated, color-coded system diagram on the control panel indicating all system components and location of all sensors and alarm points.

2.7.16 Indicating Lights

Mount lights on the door of the control cabinet. Integrate components through appropriate electromechanical devices with push-to-test type indicating lights. Install indicators complete with all necessary wiring and conduit between the indicator and the transmitter in the equipment room. Operating ranges for each indicator as indicated. Provide industrial oiltight construction in the following colors for the indication functions:

Function	Indicator Color
Power on the system	Amber
Incinerator/boiler purge completion (one per unit)	Green
Energizing main fuel valves	White or manufacturer's standard color
High temperature in primary chamber	Red
High temperature in secondary chamber	Red

Function	Indicator Color
High temperature at induced draft fan inlet	Red
System operation	Red
Emergency damper open	Red

2.7.17 Selector Switches

As a minimum, provide the following hand-auto-off selector switches:

a. Each oil burner
[b. Induced draft fan]
c. [b.][c.] Combustion air fan (FD)
d. [c.][d.] Secondary air fan

2.7.18 Clock

Recess mount a single synchronous 120-volt ac, motor-driven, with shatterproof, crystal-covered white dial clock, a minimum of 200 mm 8 inches in diameter with black Arabic numerals, black hour and minute hands, red sweep hand, and anodized brushed aluminum bezel. Totally enclose clock motor and mechanism in a heavy plastic cover.

2.7.19 Recorders

Mount recorders on the instrument panel to record and indicate measurement in the areas shown. Make the record in ink on a [24-hour] [31-day], [100 mm 4 inch linear] [circular] [strip] chart driven by an electric-clock mechanism. Make each recorder point with a different colored ink. Install recorders complete with all necessary wiring or pipe between the recorder and the transmitter. Provide the unit with sufficient blank charts and ink for 1 year's operation.

2.7.20 Water Meters

Provide meters conforming to AWWA C700 of the disk type with reinforced disk for hot water above 66 degrees C 150 degrees F, and a rubber or carbon disk for cold water. Construct meters of bronze composition and cast iron protected by noncorrosive coating, with easily replaceable moving parts.

2.7.21 Annunciator

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NOTE: Edit to indicate the number of points desired and specific items in the list.

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Provide an engraved, back-lit window annunciator complete with pushbuttons and alarm horn to indicate abnormal operating conditions of the incinerator. Include a common alarm silencing relay in the alarm circuit to permit the incinerator operator to silence the audible horn while retaining visual indication until the malfunction or abnormal condition has been cleared. Furnish one [_____]-point annunciator for each incinerator and install in the annunciator and pump control panel. Provide alarm module nameplates, nominal 70 mm 2-3/4 inches high by 75 mm 3 inches wide in translucent white acrylic plexiglass. Engrave all nomenclature on front surface in black lettering. Mount and prewire flasher module with silence and test pushbuttons. Provide alarm points and window engraving as [specified in Section 23 52 30.00 10 HEAT RECOVERY BOILERS plus the additional points] shown below. Provide an annunciator from the same manufacture and type as furnished by the supplier of other control panels, with interchangeable spare parts between annunciators.

ALARM POINT	WINDOW ENGRAVING
TSH-[_____]	Temp. - high primary chamber
TSL-[_____]	Temp. - low primary chamber
TSH-[_____]	Temp. - high secondary chamber
TSL-[_____]	Temp. - low secondary chamber
PSL-[_____]	Press. - low hydraulic
PSL-[_____]	Press. - low fuel oil
LSL-[_____]	Level - low, F.O. storage tank
LSH-[_____]	High flue gas opacity

2.7.22 Flame Sensor

Provide an ultraviolet flame-sensing device for each burner and install in accordance with the manufacturer's recommendations. The flame-sensing device must not respond to ignition spark, hot refractory, reflection of flame on atomizing media or oil spray. Sight flame safeguard sensor to detect only the burner flame for which it is designed. Perform a pilot turndown test, spark response test for ultraviolet detector, and manufacturer's approved test for rectification detectors to verify reliable sensor installation. Weld or fix sensor mount to prevent altering orientation to flame being proven.

2.7.23 Temperature Indicators

Provide temperature gauges to match pressure gauges in appearance and match requirements of the transmitters supplied. Use any of the following temperature sensors unless otherwise specified. Include the following:

a. Outdoor air
b. Incinerator room
c. Primary chamber or zone
d. Secondary chamber or zone
e. Flue gas leaving incinerator

2.7.23.1 Thermometers

Provide thermometers conforming to ASME PTC 19.3 TW, Type 1, Class 3, with wells and separable corrosion-resistant steel sockets and temperature range suitable for the use encountered. Provide dial type thermometers 90 mm 3-1/2 inch diameter chromium-plated case, remote-type bulb or direct-type bulb as required, with plus or minus 1 degree C 1 degree F accuracy and white face with black digits graduated in 2-degree increments. Do not use mercury in thermometers, and install as indicated, to be easily read from the operating floor.

2.7.23.2 Thermocouples

Provide thermocouples conforming to ASTM E230/E230M, Type K, indicating gas passage temperatures. Thermocouples must control burner operation, be suitable for continuous operation up to 1538 degrees C 2800 degrees F, and accurate to 0.75 percent of the operating and indicating temperature range. Provide thermocouples in the combustion chamber or as otherwise directed, long enough to be inserted 150 mm 6 inchesinto the furnace. Provide thermocouple with an adjustable flange and a high-temperature, metal alloy, closed-end protection tube suitable for inserting into the furnace without support of the projecting end. Supply thirty meters one hundred feet of 1.519 mm 16 gauge compensating lead wire with a weatherproof braid for connecting the thermocouple to the instrument. Transmit temperature to the instrument in the control panel as shown.

2.7.23.3 Pyrometers

Provide indicating [recording] pyrometers at the locations indicated or directed, with a temperature range from minus 18 to 1316 degrees C 0 to 2400 degrees, and accurate to within plus or minus 0.25 percent of the range. Indicate temperature on a large scale with prominent black letters on a white background [and record with a continuous ink line on a circular chart at least 300 mm 12 inches in diameter, with 24-hour revolution]. Provide instrument with automatic cold-junction compensation. Provide a simple means of pyrometer standardization, which will not be affected by vibration, dust, or air currents when the door of the instrument is open. Operate instrument on 110 volts ac.

2.7.24 Pressure and Vacuum Gauges

Provide gauges conforming to ASME B40.100, Type I, Class 1 or 2, as applicable, style as required; heavy-duty industrial type, suitable for pressure or vacuum specified, with minimum 150 mm 6 inch diameter dial, except as otherwise specified. Gauge piping must be copper tubing conforming to ASTM B68/B68M, Type K or L.

2.7.25 Draft Indicator and Control

Provide Draft Gauges conforming to ASME B40.100, Style I, with approved operating ranges, and with a diaphragm or bellows actuating system and a circular scale. Provide gauges with a zero adjustment screw and a connection to atmosphere and with suitable shutoff cocks. Gauges must be remote-reading to the control panel. Install gauges complete with all necessary piping between them and the points at which the drafts are measured. Provide an indicator which continuously indicates pressure in primary chamber. Also provide a separate draft controlling instrument maintaining a constant 0.10 to 0.15 inch negative pressure in the primary chamber.

2.7.26 Opacity Alarm

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NOTE: This paragraph may be simplified based upon the monitoring requirements of the state in which

the incinerator is to be located. Not all states may require continuous monitoring and recording. However, an opacity alarm should always be included to alert the operator to operational problems.
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a. Provide a stack gas opacity alarm indicator and recorder system consisting of a stack unit, control or transmitter unit, chart recorder, red alarm, manufacturer's standard color Power On signal lights, and alarm bell on the instrument panel for each incinerator. Provide self compensating system, and provide continuous measurement, indication, and recording of smoke opacity from the incinerator. Include in stackunits a light source, a light detecting or receiving unit mounted in the stack or main breaching as recommended by the manufacturer, and fixed access to the units.

b. Provide the control or transmitter unit with electronic solid-state circuitry and meter or digital indicator, indicating smoke density by 0 to 100 percent opacity. In addition, furnish the control unit or transmitter with calibration and alarm adjustments, in a dust-tight metal enclosure. Provide a purging air system to clean light source lens and light detector lens. Make the control unit adjustable for various smoke densities at which alarm bell will sound and at which warning lights will operate. Warning bell must sound in conjunction with the red light.

c. Provide an electrical or electronic type recorder with a 250 mm 10 inch minimum diameter recorder chart having 24-hour rotation scale, graduated in 0 to 100 percent smoke density. Provide the smoke alarm indicator and recorder system with provisions to field-check 0 and 100 percent smoke density calibration points without shutdown of incinerator or removal of stack units, indicator, and recorder. Provide equipment suitable for ambient temperatures not more than [_____] degrees C degrees F and up to 100 percent humidity. Provide smoke alarm indicator and recorder, including air purging system, which operates on 115-volt, single-phase, 60 Hz electric power. Provide four hundred blank charts and a 1-year ink supply.

2.8 TOOLS

Provide uncommon tools necessary for the operation, cleanout and maintenance of the incinerator, [boilers,] burners, pumps, fans, valves, traps, strainers, [other steam piping equipment,] and other auxiliary equipment. Also provide any special wrenches as required for opening [boiler manholes], handholes, and cleanouts . Provide a smoke pipe cleaner to clean the breaching and smoke connections, with a jointed handle of sufficient length to clean breaching and smoke connections without dismantling.

2.9 PAINTING AND FINISHING

2.9.1 Treatment

Clean all surfaces of castings, forgings, molded parts, stampings, welded parts, inner surfaces of the outer casing of the incinerator, the exterior surfaces of the outer casing, the control panel, and piping, except corrosion-resistant steel, to base metal for removal of oil, rust, sand, dirt, fins, spurs, scale, slag, flux and other extraneous materials before primer is applied at the factory. Make external surfaces smooth and all edges rounded or beveled, unless sharpness is required to perform a necessary function.

2.9.2 Incinerator Coating

Paint incinerator in accordance with the manufacturer's standard practice with a minimum of one primer coat and two finish coats. Paint metal subject to heat with heat resistant (up to 648 degrees C1200 degrees F) silicone aluminum paint. Apply paint directly to clean bare metal surfaces and attain a minimum dry film thickness of 1 mil per coat. Do not apply paint when the temperature is 10 degrees C 50 degrees F or below or above 32 degrees C 90 degrees F.

2.9.3 Equipment Coating

Factory finish equipment and component items, when fabricated from ferrous metal, with the manufacturer's standard finish if located within buildings. Provide items to be located outside with weather-resistant finishes that will withstand 500 hours of exposure to the salt spray test specified in ASTM B117, using a 20-percent sodium chloride solution. This test may be performed on test specimens coated and finished in the same manner as the actual equipment. Immediately after completion of the test, the specimens must show no sign of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Paint all exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum sheath over insulation.

2.10 FACTORY TESTS

Conduct initial capacity and performance tests of factory assembled incinerator components at the manufacturer's plant. Correct or replace any material and equipment rejected before installation.

PART 3 EXECUTION

3.1 EXAMINATION

****

NOTE: Equipment dimensions vary widely between different manufacturers. Although the general arrangement of the building will remain the same, some structural dimensions may have to be changed after award of the contract to accommodate the specific equipment being proposed.

****

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work. Because of the small scale of the drawings, it is not possible to detail all runs and indicate all offsets, fittings, and accessories which may be required. Investigate structural and finish conditions affecting all work, arranged accordingly, and furnish such fittings and accessories as may be required to meet such conditions. Plans are generally diagrammatic. Harmonize the work of the different trades so interference between conduit, piping, equipment, architectural, and structural work is avoided. Submit building design modifications required for the specific equipment being supplied prior to start of construction.

3.2 MANUFACTURER'S FIELD SERVICES

Obtain the services of the manufacturer's representative experienced in, and to supervise the installation, adjustment, operation, and testing of the equipment specified. Ensure that sufficient lead time is given to prevent late delivery of equipment and materials and installation delay problems.

3.3 INCINERATOR INSTALLATION

****

NOTE: Delete inapplicable NFPA and FM Standards not to be employed.

****

Install equipment and material as indicated and in accordance with the manufacturer's written instructions, industry standards, and NFPA 82. Provide combustion air supply and ventilation in accordance with NFPA 31 or NFPA 54.

3.3.1 Gas Systems

****

NOTE: Specify the utilities to which connections will be made by the Contractor. Show utilities on the drawings. Delete inapplicable paragraphs.

****

Provide gas service as specified in Section 23 11 20 FACILITY GAS PIPING.

3.3.2 Fuel Oil System

Install fuel oil system in accordance with NFPA 31 and Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS, unless otherwise indicated.

3.3.3 Foundation

Construct foundations for the incinerator and for other heating equipment specified, when required, as indicated and recommended by the manufacturer. Construct incinerator foundation of [3000] [_____] psi concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Set anchor bolts accurately and of adequate length to install the incinerator. When embedded in concrete, install anchor bolts with plates welded on the head and protect them against damage until the equipment is installed.

3.3.4 Steel Ladders

Provide a steel ladder where the depth of manhole exceeds 3.6 m 12 feet, not less than 406 mm 16 inches in width, with 19 mm 3/4 inch diameter rungs spaced 300 mm 12 inches apart, with two stringers a minimum 10 mm 3/8 inch thick and 50 mm 2 inches wide. Rigidly affix the ladder to the tank bottom with pipe guides or slip bars, secured with slip bars at the top, and spaced not more than 1.8 m 6 feet apart vertically, to accommodate expansion of the stringers. Install stringers to provide at least 150 mm 6 inches of space between the wall and the rungs. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M. The wall along the line of the ladder must be vertical for its entire length.

3.3.5 Equipment Structural Support

3.3.5.1 Column Base Plates

Design column base plates to bear on a [21] [_____] MPa [3000] [_____] psi concrete floor slab.

3.3.5.2 Anchor Bolts

Provide ASTM A307 anchor bolts. Show anchor bolt sizes and locations on the detail drawings.

3.3.6 Insulation

Provide shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS unless otherwise specified. Insulate breaching [and dust collectors] with magnesia, mineral wool, calcium silicate, or approved mineral insulation. Insulation may be either block or blanket type. Fill joints in the insulation with magnesia, mineral wool, or other equally suitable cement.

3.3.7 Catwalks and Access Platforms

Catwalks, access platform stairs, ladders, and handrails shown, depict a general scheme of ingress and egress. Furnish and install all necessary platforms and stairs for safe and efficient operation and maintenance of the equipment. They may be relocated from the wall openings and passageways shown in order to suit the incineration equipment provided. Provide all railings with 100 mm 4 inch wide toe-board located not more than 6 mm 1/4 inch above the floor level. Conform construction, as close as practical, to similar items as indicated.

3.3.8 Control System Installation

Install equipment in accordance with the manufacturer's approved instructions. Provide all control conduit, wiring and/or tubing under this section of the specifications, except as specified elsewhere. Copper, stainless steel, or non-metallic tubing may be used as appropriate. Provide copper consisting of ASTM B88M ASTM B88, Type K with flare type, cast brass, or wrought copper fittings. Provide pneumatic tubing consisting of 6 mm 1/4 inch OD with a minimum wall thickness of 0.762 mm 0.030 inch unless otherwise indicated. Where 10 mm 3/8 inch or 13 mm 1/2 inch O D tubing is used, provide a minimum wall thickness of 1.245 mm 0.049 inch. Extent, general location, and arrangement of the system will be as indicated on the drawings. Locate control panels as indicated relative to the incinerator, loader [and heat recovery system] and placed so that operating personnel may effectively monitor incinerator operations, but will not be in a position that would interfere with those operations. Fit equipment, instruments, piping, wiring and tubing into the space allotted allowing adequate clearances for entry, servicing, and maintenance. Install locally mounted instruments in such a manner as to prevent interference with mechanical installations and to ensure readability from the front aisles or operating area of the various items of equipment. Provide and install all materials and equipment indicated, specified, and/or required to provide a complete and operable system, including material and items required to arrange the system to compensate for the actual field conditions, whether or not the items required are specifically specified or shown. Carefully coordinate installation of the instrumentation with the work of other trades.

3.3.9 Field Tubing

Provide compression type tube fittings compatible with tubing material, of materials suited to the tubing (brass for copper tubing, stainless steel for stainless steel tubing, and nonmetallic for nonmetallic). Check each tubing connection for proper tightness and installation. All piping between primary connections and instruments must be a minimum of 10 mm 3/8 inch OD tubing. Provide all copper instrument connecting lines that require only a single line with brass, ASTM B61, 21 MPa 3000 psi rating, forged body screw or tube ends.

3.3.9.1 Tubing Supports

Use PVC coated expansion metal troughs or epoxy coated vertical unistrut racks as tubing supports. Do not use any elbows, tees, or crosses. Where the trough changes direction or branches, a suitable gap for the transition is acceptable; use unsupported tubing over the gap.

3.3.9.2 Air Supply

Instrument air supply headers are as shown. Instrument air is to be distributed through the area at nominally 620 kPa 90 psig. Pressure is to be reduced to that required at the instrument by installation of a local regulator. Furnish and install an air set unit for each instrument that has a pneumatic output signal, such as transmitter, transducer, controllers, positioner and relay. Provide air set units with a filter regulator with integral drip-well and drain cock and output gauge.

3.3.10 Electrical

Provide instrumentation and power-interconnecting wiring as [shown] [recommended by the manufacturer] and as specified in NFPA 70. Terminate all external wiring to the control panels on terminal boards or on devices in the panels. Carry all cable wire and cable runs in conduit or wireways. Run all signal-wiring used for alarm or measurement of control circuits in conduit separate from power circuits. Direct current signals used for electronic transmission may be run in multi-conductor cables. Wiring for control, shutdown, or interlock circuits may be run in the same conduit with power wiring as shown. Do not feed instruments from lighting branch circuits. Make termination of all wires on instrument binding screws with solderless type insulated shoulder ring-tongue lugs of the proper size for the wire and binding screw use. Crimp lugs properly and securely to the wire using the tool recommended by the lug manufacturer. Cut off any termination which is improperly made and install a new lug. Strip all wire with an approved stripping tool or in such a manner as not to damage the conductor.

3.3.10.1 Cable-Conductor Identification

Permanently attach identification to each wire terminating on a terminal board or binding screw to facilitate maintenance. Provide identification by means of plastic sleeving with printed markings, permanently attached stamped foil markers, or by other approved means. Provide wire numbers corresponding to wire numbers shown.

3.3.10.2 Relays

Provide industrial type relays for interlocking circuits, with contacts and coils accessible for cleaning and replacement.

3.3.11 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory, are as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 FRAMED INSTRUCTIONS

Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, equipment, piping, valves, and control sequence, where directed. Prepare in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Post framed instructions before acceptance testing of the systems.

3.5 TESTING

3.5.1 General

Prior to requesting commencement of the performance and acceptance test, conduct final checking of system installation in accordance with the manufacturer's recommendations and the requirements of the other sections of the project specifications. Include in final checking: preliminary operation testing and adjustments of facilities as necessary to ensure completeness of installation and satisfactory operation of all systems. Schedule all tests in advance, conduct at times approved, and perform in the presence of the Contracting Officer.

3.5.1.1 Schedule for Testing

Notify the Contracting Officer in writing at least [20] [_____] days in advance of his intent to test the incinerator, and submit a testing schedule. The Contracting Officer will notify the appropriate authorities.

3.5.1.2 Visual Inspection

Examine each incinerator for defects outlined below:

a. Parts of components missing
b. Improper assembly
c. Parts or components not functioning properly
d. Workmanship not as specified
e. Exposed edges of metal not smooth
f. Materials not as specified

3.5.1.3 Repairs

Replace defective parts and make all repairs disclosed to be necessary by capacity and operating tests to those items furnished and installed by the Contractor.

3.5.2 Instrumentation

Test all after completing the following activities:

a. Inspect complete work and make any non-operating checks required to ensure operability in the manner required for the process application.

b. Check instrument air lines and wiring for proper hook-up.

c. Test air lines for tightness according to the requirement of ISA 7.0.01.

d. Commissioning of instruments, controls, interlocks, alarms, and related items including operating checks, provision and installation of seals as required, checking and adjusting settings, standardizing and calibration and proof tests.

e. Installation of relief valves and filter regulator sets.

f. Insulation and winterizing of instruments. If such cannot be completed before startup, advise the Contract Officer in writing 2 weeks before testing.

3.5.3 Dielectric Tests

Test electrical system for dielectric strength. Subject electrical system, excluding control and recording instruments, to a voltage of twice its rated voltage, plus [500] [_____] volts, for a period of not less than [1] [_____] minute[s]. Prior to testing, disconnect all instruments and operators that could be damaged. After this test, the circuit must still register a resistance value of not less than 1 megohm at [600] [_____] volts, dc. Apply this test between all insulated circuits and external metal parts.

3.5.4 Fuel Systems Test

Hydrostatically test auxiliary fuel piping at a pressure of 1.5 times the working pressure. Remove gauges and other apparatus that may be damaged by the test pressure from the system prior to on-site testing. Maintain required test pressure for not less than 2 hours to provide sufficient time for inspection of joints and connections in all piping systems. Correct all defects that develop during testing and retest until no defects or leaks are found.

3.5.5 Fuel Burning Equipment Test

Perform test of fuel burning equipment to demonstrate that the equipment installed meets the requirements of the specifications.

3.5.6 Controls Test

Test incinerator under actual firing conditions. Verify with test that all controls function within the maximum and minimum limits for temperature or timing. Simulate unsafe conditions, such as high temperatures and flame failure, by reducing the settings for the activation of limit and safety controls. Test the stoking mechanism to demonstrate control and operational conformance with the requirements of the specification under varying load conditions.

3.5.7 Performance Testing

Upon completion of all related work and prior to acceptance, test the incinerator [heat recovery], associated equipment, and instrumentation to demonstrate indicated performance. Perform stack sampling for compliance with applicable emission limits by [the AEHA or] an approved independent qualified testing laboratory. Adjust all equipment and controls before the scheduled operating test. Test in accordance with the test procedures indicated below and in accordance with the requirements of ASME PTC 19.10. Take all pressure measurements in accordance with ASME PTC 19.2, and all temperature measurements in accordance with ASME PTC 19.3 TW. Furnish all instruments, equipment, and personnel required for the tests. The Government will supply fuel, water, electric power, and waste materials. Make two instruction manuals available at all times during the tests.

3.5.7.1 Procedure

****

NOTE: Indicate performance requirements.

****

Preheat incinerators for [4] [_____] hours to reach the firing temperature of [982] [_____] degrees C [1800] [_____] degrees F. Charge incinerator with waste at the rated burning capacity in pounds per hour for a minimum of 72 hours and operate in accordance with the manufacturer's written instructions. Include in performance testing the operation of the mechanical charging facilities, the incinerator, [the heat recovery boiler,] the air pollution control equipment, the ash handling equipment, and the operation monitoring facilities. Test full-scale, for three 24-hour runs accomplished within five days. Monitor performance to verify compliance with the contract requirements. If serious inconsistencies in the observed data are noted during any test run, or in later computational analysis, that run is to be rejected completely.[Heat recovery unit is to supply the rated amount of steam at the temperature, pressure,[and at the thermal efficiency specified] when the unit is charged with waste at the rated burning capacity. Entire unit must be able to maintain this efficiency during the entire test period.] Reduce waste to a fine ash residue. Follow normal burnout procedure. After the residue has cooled, analyze samples taken during testing.[The residue must not exceed [45.0 (dry basis)][10] percent of the total combustible portion of the charge when tested by [weight][volume] as specified.][The combustible content of the ash must not exceed [_____] percent.] After cleanout, inspect the incinerator for deterioration such as slagged or spalling refractory, warping of parts, and discolored exterior paint.

3.5.7.2 Efficiency and Operating Tests Procedures

Run an efficiency and capacity test, on one incinerator, conducted in accordance with ASME PTC 4 utilizing the input-output method, except for use of alternate measuring or metering devices properly calibrated before the test, for the purpose of [metering the water used and] weighing the amount of fuel burned as approved by the Contracting Officer.[Use water meter in the test suitable for hot water. Efficiency less than specified in paragraph Heat Recovery Boiler is not acceptable. Provide maximum moisture content of saturated steam leaving the boiler as specified in Section 23 52 30.00 10 HEAT RECOVERY BOILERS.] Conduct efficiency and general performance tests on the incinerators[and boilers] using a qualified test engineer. Furnish calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in efficiency and capacity tests before the test. Read all indicating instruments at half-hour intervals unless otherwise directed.

3.5.7.3 Alternate Efficiency Testing Procedures

If equipped with a full-size, backup burner of its own, test the heat recovery boiler for thermal efficiency independent of the incinerator using hot gases supplied by that burner. Analyze ash from the incinerator, which is to show no more than [_____] percent carbon by weight. The entire system is required to produce the rated amount of steam while burning the rated amount of waste for the durations specified for testing procedures and comply with all other test requirements. This alternate method of testing is intended for use where the additional burner capacity exists, in order to avoid determining the actual heat content of the waste used for the tests.

3.5.7.4 Shell Temperature

Operate incinerator under normal load conditions for not less than [4] [_____] hours. After [4] [_____] hours, temperature instrument readings of the outer shell, taken at not less than five random locations, must not exceed the temperature limitation specified.

3.5.7.5 Test Reports

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion of construction and testing of the installed system. Indicate in each test report the final position of controls, including logs [thermal efficiency calculations,] and tabulated results together with conclusions. Include the following in the reports:

a. Time, date, and duration of test.
b. Incinerator make, model, rated capacity, grate area.
c. Proximate analysis of waste used during tests.
d. Flue-gas temperature at [boiler] [incinerator] outlet.
e. Percent O2 in flue gas.
f. Quantity of waste consumed.
g. Heat content of waste.
h. Any other data required by ASME PTC 4.

3.5.8 Emission Test

****

NOTE: Local regulatory authorities should be contacted at an early stage of the project design to determine if they consider the methods cited to be adequate, and if they have any additional requirements.

****

Test one incinerator for excessive emissions in accordance with 40 CFR 60, methods 1, 2, 3, and 5 for incinerators or as required by local authorities. Do not exceed the specified emissions limits. Stack emissions sampling is required for a minimum period of [_____] continuous hour[s] of incinerator operation and done concurrently with the efficiency tests. Perform emissions tests by [the USAEHA, or] an independent laboratory recognized by the appropriate authorities. If it is determined during the tests specified above, that the incinerators fail to comply with the applicable air pollution regulations, the incinerator manufacturer is responsible for correcting the problem by modifying the equipment or by adding air pollution control equipment and also be responsible for any additional testing required to prove compliance.

3.6 TRAINING

Conduct a training course for the operating, maintenance, and supervising staff as designated by the Contracting Officer. Start the training period, a total of [_____] hours of normal working time, after the system is functionally complete but prior to final acceptance tests.

3.6.1 Content

During field instructions cover all of the items contained in the Operating and Maintenance Instructions, and include recommendations for total staffing and job descriptions.

3.6.2 Operating Instructions

Submit [six] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation, and emergency procedures, prior to the start of the training course. Include the manufacturer's name, model number, service manual, parts list, and a brief description of all equipment and their basic operating features.

3.6.3 Maintenance Instructions

Submit [six] [_____] complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns repairs, and trouble shooting guide, prior to the start of the training course. Include simplified wiring, piping, and control diagrams for the system as installed and other information necessary for the equipment maintenance.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-12 00 01.00 20 (February 2023)**

Preparing Activity: NAVFAC **NEW**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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FURNITURE, FIXTURES AND EQUIPMENT (FF&E) PACKAGE

02/23

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USACE / NAVFAC / AFCEC **UFGS-12 00 01.00 20 (February 2023)**

Preparing Activity: NAVFAC **NEW**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 12 00 01.00 20

FURNITURE, FIXTURES AND EQUIPMENT (FF&E) PACKAGE
02/23

****
NOTE: This guide specification covers the requirements for the design, procurement and installation of furniture, fixtures and equipment (FF&E) for new construction and building renovation projects for Navy and Marine Corps (USMC) projects. This specification is not typically used for Army or Air Force projects, but if Naval Facilities Engineering Systems Command (NAVFAC) is administering a project for the Army or Air Force this specification can be used. The use of this specification for Army or Air Force must be coordinated through the Army or Air Force representatives and Army or Air Force Interior Designers for Army or Air Force specific requirements. Use this specification only when it has been determined by the Government that the Contractor will be responsible for the purchase and installation of the FF&E. The following are exceptions: Do not use this specification for Navy projects in which Naval Supply Systems Command (NAVSUP) will be purchasing and installing the FF&E, or for USMC projects in which Asset Management Branch (AMD) or Supply Management Division (SMD) will be purchasing and installing the FF&E.

FF&E is not purchased with building construction funds. Operations & Maintenance (O&M) funding is typically used; coordinate funding source with Government. Since other than building construction funding is used, a separate FF&E Option Item for the FF&E purchase and installation is required on the project Contract Price Schedule to track different funding sources. Coordinate funding sources with the NAVFAC Project Manager. Coordinate the FF&E Option Item requirements with the NAVFAC Contracting Officer, NAVFAC Project Manager, NAVFAC Interior Designer, and when applicable, the Interior Designer of Record (IDOR).

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: There are three Interior Design Services processes for FF&E design and specification for Design Bid Build (DBB) projects.

DBB PROCESS 1:
The Architectural/Engineering's (A/E's) Interior Designer (ID) or NAVFAC ID (for in-house projects) develops the FF&E Package from design start to the Concept Design submittal, at approximately 35 percent, during the overall building Design Phases. After the Construction Contract Award, the Contractor must hire a different ID to validate the schematic or Concept package requirements with the Activity and make any necessary revisions, develop specifications, perform the Best Value Determination (BVD) and prepare the Pre-Final and Final FF&E submittals during the Construction Phase. The Construction Contractor may not hire the ID who prepared the Concept Design submittal. All required effort by the Construction Contractor's ID described above, from validation to preparation of the Final FF&E submittal, must be included in the Base Bid Item and is separate and excluded from the FF&E Option Item to procure and install the FF&E.

DBB Process 2:
The contracted A/E's Interior Designer or NAVFAC Interior Designer (for in-house projects) develops the FF&E package from design start to Concept Design submittal, through BVD and to the Pre-Final and Final FF&E submittals during the overall building Design Phases and prior to Construction Contract Solicitation. The awarded Contractor must hire an Interior Designer to validate the FF&E package pricing and product availability during the Construction Phase and submit any required changes to the Government for approval prior to award of the FF&E Option Item. The Contractor may not hire the A/E's Interior Designer. The pricing validation

effort of the FF&E design package must be included in the Construction Base Bid Item and is separate and excluded from the FF&E Option Item.

DBB Process 3:
The contracted A/E's Interior Designer or NAVFAC Interior Designer (for in-house projects) develops the FF&E package from design start to Concept Design submittal, through BVD and to the Pre-Final and Final FF&E submittals during the overall building Design Phases and prior to Construction Contract Solicitation. The same Interior Designer validates the FF&E package pricing and product availability during the Construction Phase and submits any required changes to the Government for approval. Additional tasks such as coordinating FF&E mock-ups and performing punch lists may also be required. The updated and approved Final FF&E Package is provided to the Contractor prior to award of the FF&E Option Item. Unlike DBB Processes 1 and 2 above, the Contractor is not required to hire an Interior Designer to develop or validate the FF&E Package.
****

PART 1 GENERAL

1.1 CONTRACTOR'S FURNITURE, FIXTURES AND EQUIPMENT (FF&E) HANDLING AND ADMINISTRATION RATE (HAR)

The HAR accounts for all administrative costs, overhead, FF&E subcontractor bonding fees deemed necessary by the Contractor, administration of subcontracts, profit, and any other costs associated with, and related to, the coordination and processing of the procurement and installation of FF&E. Offerors must propose a HAR for the FF&E not to exceed 5 percent. Do not include costs associated with INTERIOR DESIGN SERVICES in the HAR. The proposed HAR percentage is a fixed rate and will be incorporated into the contract award. The HAR will not be adjusted regardless of fluctuations from the estimate amount for the FF&E.

****
NOTE: The following paragraph contains tailoring options for PROCESS 1 and PROCESS 2 and PROCESS 3.
****

The Government will indicate the FF&E estimate in the FF&E Option Item in the Price Schedule based on the Concept Final FF&E Design. The Government estimated price is to provide Offerors with the projected magnitude of effort and includes the actual estimated cost of the FF&E including freight, installation, and other applicable vendor charges. The Government estimated price is only an estimated amount and must not be altered by the Contractor during the solicitation process.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

FC 1-300-09N	(2024) Navy and Marine Corps Design
UFC 3-120-10	(2018; with Change 2, 2021) Interior Design

1.3 DEFINITIONS - FF&E TURNKEY EFFORT

The Furnishings, Fixtures, and Equipment Package may include, but is not limited to; systems and modular furniture, workstations, desks, seating, storage, filing, visual display items, accessories, artwork, command graphics, training and conference furniture, soft window treatments (draperies, valances, and cornices), shop equipment, fitness equipment, Child Development Center furniture, appliances, portable weapons cabinets, dorm and quarters furnishings and other miscellaneous items to support facility functions.[For NAVFAC PACIFIC projects, the term Collateral Equipment (CEQ) Package may be used interchangeably with the term FF&E Package.]

The project may also include Specialty CEQ Package for which the Activity may assist in specifying items, which may include, but not limited to: Audio Visual (AV) equipment, commercial kitchen equipment, medical equipment and wharf equipment. For the purposes of this specification, if a Specialty CEQ Package is required, the same requirements identified for the FF&E Package apply to the Specialty CEQ Package or as outlined by project-specific UFC or requiring Agency.

1.3.1 FF&E Option Item

As an option, provide procurement and installation coordination of the approved complete and usable Final FF&E Package.

[a. [The Specialty CEQ Package will be identified as a separate Option Item, priced separately from the FF&E and funded as a separate Option.] [The Specialty CEQ Package will be funded as part of the FF&E Package as one Option.]

] b. The Government is not obligated to award the FF&E Option Item. Should the Government choose to award the FF&E Option, the Item(s) will be awarded as a negotiated option to the contract or task order. The Contractor's proposed HAR will be applied to all vendor and supplier costs for the FF&E.

c. The Government will provide separate funding for procurement and installation coordination of the FF&E Package. Construction funds will not be used. Upon receipt of required funding, the Contracting Officer will authorize the Contractor, as an option to the construction contract, to provide the Government-approved Final FF&E Package exactly as specified and complying with priorities found in the Federal Acquisition Regulation (FAR) 8.404 Use of Federal Supply Schedules. The amount of the option will be the actual cost of these items from the Federal Government price schedules and, when necessary, Open Market sources. The option amount will also include shipping, freight, handling, installation, vendor design fees, project management fees, applicable sales tax, Contractor's FF&E Handling and Administration Rate percentage as applied to the Final FF&E or Specialty CEQ total cost(s) and the NAVFAC required bond fee.

****

NOTE: The following item contains tailoring options for PROCESS 1 and PROCESS 2.

****

d. If awarded, the FF&E Option Item will be awarded at least 6 months prior to the contract completion date. A minimum of 6 months is required for the Contractor to purchase, deliver and install the product without impacting the overall completion date of the project. The Contractor's schedule must assume the award of the FF&E as an option. Government Fiscal Year funding availability must be considered and incorporated into the FF&E Schedule. No schedule extensions will be granted if the option item is awarded at least 6 months prior to the contract completion date. If the Government decides to negotiate and award the option item with less than 6 months prior to the contract completion date, the Contractor may be entitled to a contract extension and extended field overhead. A contract extension and extended field overhead will only be granted in those cases where the Contractor demonstrates that the accepted Final FF&E Package was submitted within the approved schedule deadlines, sufficient lead time is not available, and the Government's award of the FF&E Option Item is within the last 6 months of the contract.

e. The FF&E Option Item (and any Specialty Equipment and Audio Visual (A/V) Option Item(s)) are exempt from NAVFAC Procedures, Guidance and Instruction (NPGI) 17.202(a)(ii) option restriction to award within 365 days of contract award. Per NPGI 17.202(a)(ii), Note 2, "Options for Collateral Equipment (CEQ) to include Furniture, Fixtures and Equipment (FF&E) and Audio-Visual (A/V) are not limited to the 365 day time period from date of award. Written approval for a longer period to exercise options for FF&E and A/V is not required."

1.3.2 Authorization for Use of Government Supply Sources

The Contracting Officer will authorize the Contractor to purchase the required products through the specified sources and will provide a letter of authorization to the Contractor in accordance with FAR 51.102 Authorization to use Government supply sources (e)(1) through (5) citing the name of the furniture dealer(s) and other information to use when accessing the Federal Government supply sources. The Contractor must procure and coordinate the installation of the approved Final FF&E Package exactly as specified.

1.3.3 Buy American Act (BAA) and Trade Agreement Act (TAA)

All products under the FF&E Option Item are subject to the rules and regulations governing the acquisition of foreign supplies, e.g., Buy American Act (BAA) (FAR 25.1 Buy American-Supplies). This also includes all supplies procured through Government Supply Sources. Solicitations are required to meet the Trade Agreement Act (TAA) Designated Countries (FAR 25.4 Trade Agreements), as part of the BAA. In addition to the applicable BAA clauses and provisions for construction materials, the Contracting Officer must also insert the appropriate BAA or TAA clauses and provisions for supplies. The Contractor is responsible for ensuring the FF&E is compliant with the BAA or TAA.

1.3.4 Prohibition on Procurement of Certain Items Containing Perfluorooctane Sulfonate (PFOS) or Perfluorooctanoic Acid (PFOA)

Effective April 1, 2023, in accordance with section 333 of the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, the Department of Defense must not procure any covered items that contain PFOS or PFOA. The Contractor must not provide any covered items containing PFOS or PFOA in performance of this contract, task order, delivery order, or blanket purchase agreement order. A covered item means the following:

a. Nonstick cookware or cooking utensils for use in galleys or dining facilities.

b. Upholstered furniture, carpets, and rugs that have been treated with stain-resistant coatings.

1.3.5 Procurement and Installation

The Contractor must coordinate the building completion date with the installation dealer(s) specified in the FF&E Package. It is recommended that the Contractor order the products once the option is awarded to avoid incurring additional costs. Production and delivery dates should be requested of manufacturers or dealers at the time of order placement to coincide with the Beneficial Occupancy Date (BOD). The Contractor must anticipate possible manufacturer price increases if order placement is delayed. Any costs incurred due to manufacturer price increases as a result of order placement delays will be the burden of the Contractor.

1.3.6 Deposits

The Contractor must anticipate providing a deposit of between 30 percent and 50 percent of the product costs when placing the orders with the manufacturer's dealerships. The Government will not fund deposits.

1.3.7 Construction Wage Rate Requirements Statute

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NOTE: The following paragraph contains tailoring options for PROCESS 1, PROCESS 2, and PROCESS 3.

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Prior to the Interior Designer sending out the Best Value Determination

(BVD) Request for Quote (RFQ) Package[s] to vendors, the NAVFAC Contracting Officer, Contract Specialist, Project Manager, Design Manager, NAVFAC Interior Designer and Collateral Equipment Manager must make made made a determination as to whether the FF&E [and Specialty CEQ]installation is covered by the Construction Wage Rate Requirements statute. The BVD RFQ Package must identify identified any items with installation that is subject to the Construction Wage Rate Requirements statute.

1.3.7.1 Construction Wage Rate Requirements Statute is Not Applicable

The Construction Wage Rate Requirements Statute is Not Applicable if the FF&E assembly and installation work is:

a. Segregable from the construction of the facility (i.e., procured in a separate FF&E Option (Item)); and

b. The assembly and installation work is performed by the FF&E vendor or dealer or subcontractor(s); and

c. The onsite FF&E work does not include a substantial amount of construction work; and

d. The workforce for the FF&E installation and delivery is separate and distinct from the labor workforce performing the construction effort by the Contractor.

If the above a. through d. are true, the Construction Wage Rate Requirements Statute is not applicable to FF&E installed by General Services Administration (GSA), other Government Supply Sources or Open Market.

1.3.7.2 Construction Wage Rate Requirements Statute is Applicable

The Construction Wage Rate Requirements Statute is Applicable if the FF&E assembly and installation work is:

a. Performed by the Contractor; and

b. Is not physically or functionally separate from the other construction work required by the contract; and

c. Is not capable of being performed on a segregated basis from the other construction work required by the contract.

d. -OR-

e. The assembly and installation work is performed by the FF&E vendor or dealer or subcontractor(s); and

f. The onsite FF&E work does include a substantial amount of construction work.

If the above a. through c. are true or d. through e. are true, the Construction Wage Rate Requirements statute would be applicable to the installation of all FF&E that is installed and attached to the facility.

1.3.8 Taxes

1.3.8.1 Exemptions

Exemptions for certain state or local taxes may be available to the Contractor and its subcontractors. The Contractor must take maximum advantage of all exemptions, including obtaining a resale permit from state and local taxation authorities whether available directly to the Contractor or based on an exemption afforded the Government. The responsibility for paying applicable taxes rests with the Contractor. Applicable state and local taxes to the FF&E Package must be included with the subcontractor's quote, if required by the state or locality.

1.3.8.2 Construction Contract Requirements

As prescribed in FAR 29.401-3 Federal, State, and local taxes, the Contracting Officer must insert FAR clause 52.229-3, Federal, State and Local Taxes, in the construction contract. In accordance with this clause:

a. The contract price includes all applicable Federal, State, and local taxes and duties; and

b. The Government must, without liability, furnish evidence appropriate to establish exemption from any Federal, State, or local tax when the Contractor requests such evidence and a reasonable basis exists to sustain the exemption.

1.3.9 Performance and Payment Bonds

1.3.9.1 No Bond Requirement for FF&E at Time of Construction Contract Award

FAR 28.102-1(a) requires that performance and payment bonds be included in all construction contracts exceeding the Simplified Acquisition Threshold (SAT), except under the conditions listed. Since the FF&E Option Item is not part of the original contract award, the Contractor is not required to secure bond for the FF&E at the time the basic construction contract is awarded.

1.3.9.2 Additional Bond at FF&E Option Item Award

FAR 28.102-2(d) requires the Government to secure additional bond from the Contractor for any contract price increases. An increase to the original contract bond is required at the time of the FF&E Option Item award to protect the Government against the Contractor not providing FF&E ordered and to ensure that the FF&E vendor(s) receive payment if the Contractor goes out of business. The increased cost of the Government required bond must come from the FF&E funding source and is not a part of the Contractor's HAR.

1.3.9.3 Bonds Required by the Contractor

If the Contractor requires bonding from the FF&E subcontractor(s), the cost must be covered in the Contractor's HAR.

1.3.10 Item Unique Identification (IUID) and Valuation

Item Unique Identification (IUID) and valuation is a system of marking and valuing items delivered to Department of Defense (DoD) that enhances logistics, contracting, and financial business transactions. Utilize the

IUID policy for all DoD contracts that require the delivery of items. An item is a single article or a single unit formed by a grouping of subassemblies, components or constituent parts. In accordance with DFARS 211.274-2 Policy for item unique identification, IUID is required for all delivered items for which the Government's unit acquisition cost is $5,000 or more. Items identified by the requiring activity to be serially managed, mission essential, controlled inventory or for other reasons requiring permanent identification, must be marked with a unique item identifier.

1.3.10.1 IUID

The two main steps involved in IUID requirements are:

a. Item marking, and

b. Delivery of data about items as a part of the acceptance and delivery process.

1.3.10.2 Data Matrix Requirements

Item marking requires that qualifying items contain a data matrix either directly inscribed on the individual item or on a permanent label or data plate attached to the item. Delivery of data is executed by submitting to the IUID Registry information such as: description of the item, its value, and the date of acceptance by the government. The IUID Registry is the repository established to capture and store all IUID data.

1.3.10.3 Government's Unit Acquisition Cost

In accordance with DFARS 211.274-3 Policy for valuation, Contractors must be required to identify the Government's unit acquisition cost for all items delivered even if none of the criteria for placing a unique item identification mark applies.

1.4 ADMINISTRATIVE REQUIREMENTS

1.4.1 FF&E Pre-Installation Walk-Through

The Contractor must coordinate and participate in a walk-through to ensure that the building interior is substantially complete in all areas scheduled to receive FF&E to include floor, wall and ceiling finishes and building systems located on or in the ceilings. Attendees must include the FF&E vendor(s) in-person (if geographically feasible) or virtually and the NAVFAC Construction Manager. Approval by the NAVFAC Construction Manager to proceed with the FF&E installation is required. The walk-through date must occur prior to the commencement of the FF&E installation and accommodate sufficient time in the construction schedule for transportation of FF&E to the job site upon approval by the NAVFAC Construction Manager.

1.4.2 Sequencing

The Contractor must coordinate the building completion, occupancy, and furniture installation dates with the installation dealer(s) specified in the FF&E Package. Any costs associated with or delaying furniture shipments to accommodate the construction schedule is the responsibility of the Contractor.

1.5 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

The NAVFAC Interior Designer is required to receive a copy of all submittals with a "G" Classification.

SD-01 Preconstruction Submittals

FF&E Schedule and Schedule Updates; G, [_____]

Contractor's Interior Designer's Qualifications; G, [_____]

SD-04 Samples

[BVD FF&E Mock-Up; G, [_____]

][Final FF&E Mock-Up; G, [_____]

] Interior Finish Construction Submittals; G, [_____]

Post Option Award FF&E Finish Submittals; G, [_____]

SD-05 Design Data

FF&E Basis of Design Package; G, [_____]

FF&E BVD Request for Quotation (RFQ) Package; G, [_____]

BVD Package; G, [_____]

Pre-Final FF&E Package "Over the Shoulder"; G, [_____]

Pre-Final FF&E Package; G, [_____]

Final FF&E Package; G, [_____]

Final FF&E Package Price Validation; G, [_____]

SD-10 Operation and Maintenance Data

Warranty and Maintenance Information; G, [_____]

SD-11 Closeout Submittals

Punch List(s) Submittal; G, [_____]

[Interior Photography; G, [_____]

]1.6 QUALITY CONTROL

1.6.1 Installation Qualifications

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NOTE: The following paragraph contains tailoring options for PROCESS 1 and PROCESS 2.

****

All FF&E must be installed by the manufacturer's dealer of record and not by the Contractor.[In addition, installation dealer(s) must be located within a [100] [_____] mile radius of the project site unless approved by the NAVFAC Interior Designer.]

1.7 DELIVERY, STORAGE, AND HANDLING

FF&E must be shipped to and stored at the vendor or dealer's conditioned warehouse, until all items are received unless dealer has coordinated just-in-time delivery with the Contractor. Vendor or dealer is responsible for any orders arriving before or after the agreed upon delivery and installation date with the Contractor, including storage of items.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 INTERIOR DESIGN SERVICES

Provide Interior Design FF&E services and deliverables in accordance with FC 1-300-09N, UFC 3-120-10, Interior Design Procedures: Furniture Fixtures and Equipment (FF&E) located at https://www.wbdg.org/ffc/navy-navfac/collateral-equipment/navfac-id-procedures-ffe and as further defined in the paragraphs below. Utilize NAVFAC templates, criteria and procedures documents located at https://www.wbdg.org/ffc/navy-navfac/collateral-equipment.

3.1.1 SYSTEM DESCRIPTION: CONTRACTOR'S INTERIOR DESIGN SERVICES

****
NOTE: The following paragraphs contain tailoring options for PROCESS 1, PROCESS 2, and PROCESS 3.
****

The Final FF&E or CEQ Concept Design Package submittal (approximately 35 percent), as prepared by the [A/E's] [NAVFAC] Interior Designer, was sufficiently developed to fully integrate with the building systems (e.g., electrical, mechanical) to include product sizes and communications, data, and electrical requirements. The Contractor must hire a different Interior Designer to validate the pricing and availability of the Final FF&E Concept Design Package requirements with the Activity or End User and NAVFAC Interior Designer and make any necessary revisions. **The Contractor is not required to hire an Interior Designer to develop or validate the Final FF&E Package.**

Provide and comply with Interior Design Procedures: Furniture Fixtures and Equipment (FF&E) CHAPTER(s) 1 through 4 and specific Design, Meeting and Submittal deliverables identified below and as defined for the Contractor's Interior Designer in CHAPTER 567 ID SERVICES - DESIGN BID BUILD (DBB) - PROCESS 123. The Contractor may not hire the A/E's Interior Designer who prepared the ConceptFinal FF&E Design Package submittal. All required effort by the Contractor's Interior Designer described above must be included in the Construction Base Price and is separate and excluded from the FF&E Option Item.

3.1.1.1 Contractor's Interior Designer's Qualifications

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NOTE: These paragraph are tailored for PROCESS 1 and PROCESS 2.
****

Provide the services of an Interior Designer. Qualification of Interior Designer is based on education, experience and examination. The Contractor's Interior Designer must have completed a program accredited by the Council for Interior Design Accreditation (CIDA) or equal accreditation program of academic training in Interior Design. For all Interior Design Services, the Interior Designer must have attained National Council for Interior Design Qualification (NCIDQ) certification and state licensure, certification or registration. In addition, the Contractor's Interior Designer must have experience as the primary Interior Designer on projects, to include NAVFAC projects, of similar type, size, scope and complexity to this contract project. Experience using GSA contracts is required. Writing non-proprietary, technical performance criteria and the evaluation of vendor proposals for competitive furniture and specialty equipment Best Value Determinations (BVDs) is required and must be clearly indicated in the resume.[The Contractor must obtain the services of equipment specialists to provide design product availability and pricing validation services and assist the Interior Designer with the development of non-proprietary performance criteria for any specialty equipment.] **The Contractor may not hire the A/E's Interior Designer[or A/E's equipment specialist(s)].**

The Contractor, the Contractor's Interior Designer, Design Firm owners, and any Equipment Specialists must NOT have any affiliation or partnership with any furniture, fixture, and equipment products, manufacturers, furniture or equipment vendor or dealerships used on this project in order to avoid any organizational conflict of interest. For the Contractor's Interior Designer's Qualifications submittal, provide a detailed resume, client references and documentation of the Contractor's Interior Designer's qualifications and significant interior design experience to the NAVFAC Contracting Officer and Interior Designer for approval PRIOR to the Pre-Construction Conference (PRECON). The Government will approve or disapprove the Contractor's Interior Designer based on the provided documentation and past performance.

3.1.1.2 Concept Final FF&E Package

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NOTE: The following paragraph contain tailoring options for PROCESS 1, PROCESS 2 and PROCESS 3.

****

The Final FF&E or CEQ Concept Package indicating the salient characteristics for with all required FF&E items and Computer Aided Design and Drafting (CADD)/BIM drawings, will be provided by the NAVFAC Contracting Officer upon request. The Contractor must request to receive the package prior to the PRECON.

3.1.1.3 FF&E Schedule and Schedule Updates Submittal

For all projects, including fast track projects and renovations, the Contractor is responsible for sufficiently scheduling all FF&E meetings and deliverables early enough to:

a. Obtain the required government approvals,

b. Meet all FF&E funding, award, ordering and installation lead times and deadlines, and

c. Complete the FF&E installation by the Beneficial Occupancy Date (BOD).

****

NOTE: The following paragraph contains tailoring options for PROCESS 1 and PROCESS 2, and PROCESS 3.

****

All submittal due dates for the FF&E and any Specialty CEQ must be noted in the FF&E Schedule and Schedule Updates Submittal and reflected in the Contractor's construction schedule. Provide a FF&E Schedule and Schedule Updates Submittal for all FF&E and Specialty CEQ services and deliverables to the NAVFAC Construction Manager, Interior Designer and Contracting Officer 7 business days after the Interior Design Orientation MeetingPRECON.

Submit FF&E Schedule and Schedule Updates Submittal to the NAVFAC Interior Designer within 7 days of any construction schedule revisions.

All submittal due dates for the FF&E [and specialty equipment]must be reflected in the Contractor's construction schedule. Submit proposed changes to the NAVFAC Interior Designer for review. The Contracting Officer must approve all revisions or deviations.

3.1.1.4 Services

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NOTE: The following paragraphs are tailored for PROCESS 1 and PROCESS 2.

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The Contractor's Interior Designer and any Equipment Specialists are responsible for developing Final FF&E and Specialty CEQ Packages required in the project.

3.1.1.4.1 Validation of Requirements

The Contractor's Interior Designer and Equipment Specialist(s) must meet with the Activity at the PRECON to discuss the function of each area, validate all FF&E or CEQ requirements pricing and product availability, make any necessary changes and additions to the Concept Final FF&E Package and recommend any adjustments or revisions to the interior building finishes and building infrastructure.

3.1.1.4.2 Building Infrastructure and Systems

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NOTE: The following paragraphs contain tailoring options for PROCESS 1, PROCESS 2, and PROCESS 3.

****

The Contractor's Interior Designer is responsible for ordering samples of all interior building finishes if required for coordination. The FF&E and CEQ Package(s) must be fully integrated with the design, construction, and schedule of all building finishes and all building infrastructure and systems (such as heating, ventilation and air conditioning (HVAC), plumbing, fire protection, communications, electrical, data, architecture). All electrical, data and communications outlets, switches, fire extinguishers, thermostats, sprinkler heads and Architectural Barriers Act (ABA) clearances must be accommodated for and be fully accessible once equipment is installed. The Contractor's [A/E's] [NAVFAC] Interior Designer and Equipment Specialist(s) must work with the Contractor and the electrical, telecommunication, and mechanical subcontractors to coordinate all infrastructure with the recommended vendors to include connection of power, data, communications, waterlines and gas lines, and calibration, testing and training prior to facility turnover and operation.

Provide coordination with the building infrastructure and provide revisions to the building infrastructure if required to support the FF&E Package and Specialty CEQ Package. Provide dimensioned locations on plans and elevations for multi-user telecommunications outlet assemblies (MUTOAs), junction boxes, wall outlets and floor boxes based on sizes, layouts and configurations of the equipment items in the FF&E Package and any Specialty CEQ Package.

3.1.1.4.3 Government-Furnished, Government Installed Equipment (GFGI) and Government-Furnished, Contractor-Installed Equipment (GFCI)

****

NOTE: The following paragraphs contain tailoring options for PROCESS 1, PROCESS 2, and PROCESS 3.

****

The FF&E and CEQ plans included in each submittal must take into consideration the Final FF&E Package identify all FF&E or CEQ to include specialty CEQ, existing and future Government-Furnished, Government Installed (GFGI) Equipment and Government-Furnished, Contractor-Installed Equipment (GFCI). These items may include, but are not limited to, multi-function devices, printers, shredders, safes and vending machines.

[3.1.1.4.4 Inventory of Existing FF&E or CEQ

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NOTE: The following paragraphs are tailored for PROCESS 1 and PROCESS 2.

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[The Contractor's Interior Designer is responsible for creating an inventory of existing FF&E or CEQ to be relocated to the new or renovated facility and incorporating both new and existing FF&E or CEQ into the FF&E plans.

][The Activity will supply the Contractor's Interior Designer with a complete list of all existing FF&E or CEQ, to include e.g., sizes, utility requirements and weight, to be relocated or used in the new or renovated facility. If revisions to the Final FF&E Package are required, the The Contractor's Interior Designer is responsible for incorporating this equipment into the FF&E plan.

]]3.1.2 FF&E MEETINGS, PRESENTATIONS AND SUBMITTALS FOR THE INTERIOR DESIGN SERVICES

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NOTE: The following paragraph contains tailoring options for PROCESS 1, PROCESS 2, and PROCESS 3.

****

The Contractor's Interior Designer must attend all design meetings, site visits, walk-throughs, coordinate required mock-ups with the [A/E's and]NAVFAC Interior Designer, obtain Activity and NAVFAC approvals and provide a complete and functional FF&E Package. All meetings must be coordinated with advance notice to the FF&E vendor(s), and [A/E's and]NAVFAC Interior Designer, so that schedule and travel can be coordinated. Each submittal must demonstrate thorough interaction with the Activity's functional requirements and complete coordination with the facility design and the Structural Interior Design (SID).

These are minimum requirements and the Contractor must be prepared to provide all additional meetings and submittals that may be necessary to support the Interior Design effort and FF&E coordination. Submit any revisions or deviations caused by discontinued items or NAVFAC required changes to the NAVFAC Interior Designer for review. The Contracting Officer must approve all revisions and deviations.

3.1.2.1 Interior Design Orientation Meeting

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NOTE: The following paragraph is tailored for PROCESS 1.

****

The Interior Design Orientation Meeting must occur[at the PRECON.][at NAVFAC, located in [_____].][virtually.] [_____.][This meeting must occur within 7 days of PRECON meeting.][This meeting must include a validation of FF&E requirements with the Activity and a walk-through of the Activity's existing facility(s) or similar facility.] Submit minutes of this meeting to the NAVFAC Interior Designer within 7 business days of this meeting and include the preliminary schedule for the FF&E Meetings and Submittals.

3.1.2.2 Interior Design Orientation Meeting

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NOTE: The following paragraph is tailored for PROCESS 2.

****

The Interior Design Orientation Meeting must occur[at the PRECON.][at NAVFAC, located in [_____].][virtually.] [_____.][This meeting must occur within 7 days of PRECON meeting.] Submit minutes of this meeting to the NAVFAC Interior Designer within 7 business days of this meeting and include the preliminary schedule for the FF&E Meetings and Submittals.

3.1.2.3 "Over the Shoulder" Review Meeting of the FF&E Basis of Design Package Submittal

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NOTE: The following paragraphs are tailored for PROCESS 1.

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3.1.2.3.1 "Over the Shoulder" Review Meeting

The "Over the Shoulder" Review Meeting will be held[[at NAVFAC] [_____] located in [_____]][virtually].[If the meeting is held virtually, submit one hard copy and one digital copy of the presentation to the NAVFAC Interior Designer prior to the meeting.]

The Contractor's Interior Designer must present the FF&E Basis of Design Package Submittal to the NAVFAC Interior Designer prior to presenting to the Activity. The submittal may be presented in a "loose" format or binder for NAVFAC approval prior to the Activity presentation. No presentation boards are required.

3.1.2.3.2 FF&E Basis of Design Package Submittal

Provide FF&E Basis of Design Package Submittal in accordance with Interior Design Procedures: Furniture, Fixtures and Equipment (FF&E).

3.1.2.4 FF&E Basis of Design Package Submittal Presentation to the Activity

This FF&E Basis of Design Presentation will be held[at the Activity's location in _____][virtually] [_____]. After implementing all feedback from the NAVFAC Interior Designer, the Contractor's Interior Designer must present the FF&E Basis of Design Package Submittal to the Activity for feedback and approval.[This meeting must include a walk-through of the Activity's existing facility(s) or similar facility.] Minutes of this meeting with photos of the approved FF&E product must be submitted to the NAVFAC Interior Designer within 7 business days.

During this meeting, a detailed, functional review of the entire project must occur, with the FF&E presentation to follow, to ensure that all current FF&E requirements have been validated and captured. The submittal may be presented to the Activity in a "loose" format or binder. No presentation boards are required.

3.1.2.5 "Over the Shoulder" Review Meeting of the BVD Request for Quotation (RFQ) Package Submittal

Meet with the NAVFAC ID for an "over-the-shoulder" review meeting. Hold meeting[at NAVFAC, located in [_____]][virtually] [_____].

3.1.2.6 FF&E BVD Request for Quotation (RFQ) Package Submittal

Provide FF&E BVD Request for Quotation (RFQ) Package Submittal in accordance with Interior Design Procedures: Furniture, Fixtures and Equipment (FF&E).

[3.1.2.7 BVD FF&E Mock-Up Submittal Requirements

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NOTE: BVD Mock-Up(s) may be required for FF&E items used repetitively throughout a facility such as chairs, workstations and Bachelor Enlisted Quarters (BEQ) Berthing Room furniture. Mock-up(s) may be required for evaluation during the Best Value process.

****

The Contractor's Interior Designer must coordinate a mock-up for best value review of [Identify REQUIRED FURNITURE TYPICAL(s)]. Mock-ups must be provided by [all vendors] [the top three vendors]. The reviewers must include the NAVFAC Interior Designer, the Contracting Officer,[Asset Management Branch (AMD) or Supply Management Division (SMD) (USMC projects),] and the Activity.[Provide [3] [_____] weeks notice to NAVFAC prior to scheduling the mock-up to allow time for travel arrangements.] The mock-up must be completed prior to the BVD Vendor(s) Recommendation.

All vendors must have a technical representative on site to demonstrate the functional aspects of their product and review the following:

[a. Interface of furniture system from wall, column, floor, or power pole.

][b. Distribution of all data, communications and power through the systems furniture panels, including segregated paths for Secure Internet Protocol Router Network (SIPRnet) and Non-classified Internet Protocol Router Network(NIPRnet), other networks, and faceplate locations and types, as required to support a group of [four] [six] [eight] [_____] workstations.

][c. Wire management solutions for all cords and cables, both internal and external to the furniture panels.

][d. Comfort and expected durability

][e. Representative finish offerings based on RFQ Package

][f. Seating

][g. [_____]

]]3.1.2.8 BVD Package Submittal and "Over the Shoulder" Review Meeting

The Contractor's Interior Designer must schedule an "Over the Shoulder" virtual meeting to review the results of the responses to each FF&E BVD RFQ Package and discuss the best value vendor recommendation(s). If clarifications, updates or revisions are required, documentation must be revised and resubmitted. The Contractor's Interior Designer must submit [one hard copy in a 3-ring binder and] one book-marked PDF copy of this submittal to the NAVFAC Interior Designer. Book-marked PDF copies must also be sent to the NAVFAC Construction Manager[, Asset Management Branch (AMD) or Supply Management Division (SMD) (USMC projects),] and the NAVFAC Contracting Officer.

3.1.2.9 Vendor Recommendation Letter and De-Briefs

Following the approval of the vendor recommendation, the Contractor's Interior Designer must send out notification to the vendors that submitted pricing proposals. A template for the notification letter will be provided by the NAVFAC Interior Designer. If a de-brief is requested by a vendor, the Contractor's Interior Designer must not reveal any pricing or proprietary information from other vendors in the de-brief.

[3.1.2.10 Final FF&E Mock-Up Submittal

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NOTE: The following paragraph contains tailoring options for PROCESS 1 and PROCESS 2.

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The Contractor and theirthe [A/E's] [NAVFAC] Interior Designer must coordinate [a] [an on-site] Final FF&E Mock-Up Submittal and review of[IDENTIFY REQUIRED FURNITURE TYPICAL(s)] with the recommended, best-valued vendor(s). Complete mock-up exercise prior to the submittal of the Final FF&E Package Price Validation and award of the FF&E Option Item.[Building finishes and fixtures must be installed in the affected area(s) to the greatest extent practicable in order to assess building systems and fixture coordination.] The reviewers must include the[A/E's Interior Designer,] NAVFAC Interior Designer and Construction Manager, the Contractor, the Contractor's Interior Designer,[Asset Management Branch (AMD) or Supply Management Division (SMD) (USMC projects),] and the Activity.[The vendor(s) technical representative must be available on-site to respond to questions, must identify specifically what is included in their proposal and what must be provided by the Contractor.] The technical representative must be prepared to demonstrate the functional aspects of their product and review the following:

[a. Interface of furniture system from wall, column, floor, or power pole.

][b. Distribution of all data, communications and power through the systems furniture panels, including segregated paths for SIPRnet and NIPRnet, other networks, and faceplate locations and types, as required to support a group of [six] [eight] [_____] workstations.

][c. Wire management solutions for all cords and cables, both internal and external to the furniture panels.

][d. Comfort and expected durability

][e. Representative finish offerings based on RFQ Package

][f. Seating

][g. [_____]

][3.1.2.10.1 Coordination of all Trades

The Contractor must have all coordinating trades available at the mock-up to discuss items such as size of wiring and fiber bundles, MUTOAs, junction box locations, wall plates, and cover plates in furniture. Provide [3] [_____] weeks notice to NAVFAC prior to scheduling the mock-up to allow time for travel arrangements. Complete the Final FF&E Mock-up prior to the submittal of the Pre-Final and Final FF&E submittals.

]]3.1.2.11 Pre-Final FF&E Package "Over the Shoulder" Submittal Review Meeting

****

NOTE: The following paragraphs are tailored for PROCESS 1.

****

The meeting is to occur[at the Activity, located [at [_____]]][at NAVFAC, located in [_____]][virtually]. The Contractor's Interior Designer must present the Pre-Final FF&E Package "Over the Shoulder" Submittal for NAVFAC and Activity approval. The submittal may be presented in a "loose" format or binder. No presentation boards required.

3.1.2.12 Pre-Final FF&E Package Submittal

****

NOTE: The number of binder and electronic copies is dependent on whether the project is NAVY or USMC.

****

Provide the following number of Pre-Final FF&E Package Submittals; [Two binder copies and four electronic copies total, as follows:

a. One binder copy and one electronic copy for the NAVFAC Interior Designer

b. One binder copy and one electronic copy for the Activity

c. One electronic copy for the Facilities Engineering and Acquisition Division (FEAD) or Resident Officer in Charge of Construction (ROICC)

d. One electronic copy for the NAVFAC Project Manager

][Three binder copies and five electronic copies total, as follows:

a. One binder copy and one electronic copy for the NAVFAC Interior Designer

b. One binder copy and one electronic copy for the Activity

c. One binder copy and one electronic copy for Asset Management Branch (AMD) or Supply Management Division (SMD) (USMC projects)

d. One electronic copy for the Facilities Engineering and Acquisition Division (FEAD) or Resident Officer in Charge of Construction (ROICC)

e. One electronic copy for the NAVFAC Project Manager

][In addition, include:

[a. 406 mm x 508 mm 16-inch x 20-inch color boards of furniture and finishes specified for Activity presentation to indicate overall design intent. One physical copy required for Activity. One electronic copy required for the NAVFAC Interior Designer.

][b. 203 mm x 254 mm 8-inch x 10-inch color photographs of the color boards. One electronic copy required for the NAVFAC Project Manager.

]]3.1.2.13 Final FF&E Package Submittal

****

NOTE: The following paragraphs are tailored for PROCESS 1. The number of binder and electronic copies is dependent on whether the project is NAVY or USMC.

****

Provide the Final FF&E Package Submittal [9][10][11][12][_____] months prior to BOD, following the receipt of review comments on the Pre-Final FF&E Package Submittal and as determined by the approved FF&E schedule developed and incorporated into the Contractor's Schedule.

Submit the Final FF&E Submittal in a 3-ring binder for review and approval. Provide the following number of Final FF&E submittals; [Three binder copies and four electronic copies, as follows:

a. One binder copy and one electronic copy for the NAVFAC Interior Designer

b. One binder copy and one electronic copy for the Facilities Engineering and Acquisition Division (FEAD) or Resident Officer in Charge of Construction (ROICC)

c. One binder copy and one electronic copy for the Activity

d. One electronic copy for the NAVFAC Project Manager

][Four binder copies and five electronic copies total, as follows:

a. One binder copy and one electronic copy for the NAVFAC Interior Designer

b. One binder copy and one electronic copy for the Activity

c. One binder copy and one electronic copy for Asset Management Branch (AMD) or Supply Management Division (SMD) (USMC projects)

d. One binder copy and one electronic copy for the Facilities Engineering and Acquisition Division (FEAD) or Resident Officer in Charge of Construction (ROICC)

e. One electronic copy for the NAVFAC Project Manager

]3.1.2.14 Final FF&E Package Price Validation Submittal

****

NOTE: The following paragraphs are tailored for PROCESS 2. The number of binder and electronic copies is dependent on whether the project is NAVY or USMC.

****

Provide the Final FF&E Package Price Validation Submittal [9][10][11][12][_____] months prior to BOD, following the receipt of review comments on the Pre-Final FF&E Package Submittal as determined by the approved FF&E schedule developed and incorporated into the Contractor's Schedule.

Submit the Final FF&E Submittal in a 3-ring binder for review and approval. Provide the following number of Final FF&E submittals; [Three binder copies and four electronic copies, as follows:

a. One binder copy and one electronic copy for the NAVFAC Interior Designer

b. One binder copy and one electronic copy for the Facilities Engineering and Acquisition Division (FEAD) or Resident Officer in Charge of Construction (ROICC)

c. One binder copy and one electronic copy for the Activity

d. One electronic copy for the NAVFAC Project Manager

][Four binder copies and five electronic copies total, as follows:

a. One binder copy and one electronic copy for the NAVFAC Interior Designer

b. One binder copy and one electronic copy for the Activity

c. One binder copy and one electronic copy for Asset Management Branch (AMD) or Supply Management Division (SMD) (USMC projects)

d. One binder copy and one electronic copy for the Facilities Engineering and Acquisition Division (FEAD) or Resident Officer in Charge of Construction (ROICC)

e. One electronic copy for the NAVFAC Project Manager

]3.1.2.15 Interior Finish Construction Submittals

Some building interior finishes (Structural Interior Design) may need to be revised to coordinate with the Final FF&E Package. Submit any revisions or deviations to the building interior finishes to the NAVFAC Interior Designer for review. The Contracting Officer must approve any changes to the building interior finishes.

3.2 POST-AWARD FF&E OPTION ITEM CHANGES

3.2.1 Requests for Price Changes

****

NOTE: The following paragraph contains tailoring options for PROCESS 2.

****

The FF&E Option has been priced, negotiated, and awarded based on specific line items as detailed in the approved Final FF&E Package Price Validation Submittal. These items have been approved considering color, specific type and quality of material, price, and usable life. The Government will expect and require the Contractor to provide exactly those items. Any requests to change FF&E items that will cause a price change must be submitted in writing for approval by the NAVFAC Contracting Officer and Interior Designer before purchase and installation.

3.2.2 Requests for Item Changes

****

NOTE: The following paragraphs are tailored for PROCESS 1 and PROCESS 2.

****

Should changes become necessary, careful consideration is required to ensure that equivalent quality, price and other aspects of the items are maintained. Any adjustments must be negotiated. Provide BVD documentation for each substituted item if the extended cost for the item exceeds the micro-purchase threshold (MPT). If multiple items from the same SIN must be substituted, include in the same BVD. Unexpired vendor quotes from the original FF&E RFQ may be used in the new BVD, provided that they are the same SIN and all quotes are from the same procurement category, i.e., GSA or Open Market. The Contractor must coordinate with the NAVFAC Interior Designer and Collateral Equipment Manager, in consultation with the Activity, for any changes to the FF&E. The Contracting Officer must approve any changes.

3.2.3 Post Option Award FF&E Finish Submittals

FF&E finishes may need to be revised due to discontinued product finishes. Submit any revisions or deviations to the FF&E finishes to the NAVFAC Interior Designer for review. The Contracting Officer must approve any changes to the FF&E finishes.

3.2.4 Validation of Pricing

The Contractor must validate pricing with the FF&E vendor(s) prior to FF&E Option award. Cost increases due to authorized GSA schedule price increases must be allowed prior to the FF&E Option award to purchase the FF&E. Reimbursement for price increases after FF&E Option award will not be considered.

3.2.5 Post Option Award Price Increases

****

NOTE: The following paragraph is tailored for PROCESS 3.

****

Reimbursement for price increases after FF&E Option award will not be considered.

3.2.6 Progress Payments

Per FAR 52.232-5 Payments under Fixed-Price Construction Contracts, the Contracting Officer may authorize a progress payment on the FF&E ordered as material delivered to the Contractor, at locations other than the site if:

a. Consideration is specifically authorized by this contract; and

b. The Contractor furnishes satisfactory evidence, including a copy of the order acknowledgment and proof of payment, that it has acquired title to such material, the material is stored in a secure, climate controlled location, and that the material will be used to perform this contract.

3.3 INSTALLATION

****

NOTE: The following paragraph contains tailoring options for PROCESS 2.

****

The FF&E Package includes the installation of all furniture and furnishings as specified in the Final FF&E Package Price Validation. The FF&E installation dealer(s) specified in the FF&E Package must receive, store as required, transport to the project site, off load, inside deliver, unpack, assemble, install, clean, and dispose of all the trash for all FF&E. It is the Contractor's responsibility to coordinate the building completion, occupancy, and furniture installation dates with the installation dealer(s) specified in the FF&E Package. Any costs associated with or delaying furniture shipments to accommodate the construction schedule is the responsibility of the Contractor.

3.3.1 FF&E Pre-Installation Walk-Through

The Contractor must coordinate and participate in a walk-through to ensure that the building interior is substantially complete in all areas scheduled to receive FF&E to include floor, wall and ceiling finishes and building systems located on or in the ceilings. Attendees must include the NAVFAC Construction Manager and the FF&E vendor(s) in-person (if geographically feasible) or virtually. Approval by the NAVFAC Construction Manager to proceed with the FF&E installation is required. The walk-through date must occur prior to the commencement of the FF&E installation and accommodate sufficient time in the construction schedule for transportation of FF&E to the job site upon approval by the NAVFAC Construction Manager.

3.3.2 Walk Through(s) and Punch List(s) Submittal

****

NOTE: The following paragraph contains tailoring options for PROCESS 1 and PROCESS 2.

****

The Contractor, Contractor's Interior Designer,[A/E's Interior Designer,] NAVFAC Interior Designer, FF&E vendor(s) or dealer(s) representative and installation superintendent, other specialty consultants (if applicable), NAVFAC Construction Manager[, Asset Management Branch (AMD) or Supply Management Division (SMD) (USMC projects),] and the Activity will attend [one] [two] punch list site visits.[The site visit must be held at the installation dealer's 98 percent completion and must identify and record all punch list items in the Punch List(s) Submittal.][The site visit must be held at the installation dealer's 100 percent completion and must confirm that all punch list items have been resolved.]

The Contractor must repair, to the Government's satisfaction, all damage to any facility finish that is a result of the furniture installation and correct all punch list items for the FF&E. Any damage or loss of FF&E after installation will be the responsibility of the Contractor and not the FF&E vendor or installer. Daily installation walk-throughs by the Contractor and the FF&E installation dealer are encouraged to document any damage and identify the responsible party(s).

3.4 INSTALLATION WARRANTY

Install all movable furnishings in accordance with the manufacturer's instructions and warranty requirements. All movable furnishings must be level and aligned. All doors, drawers and accessories must be level and aligned to open, close and otherwise operate smoothly and securely.

All FF&E and Specialty CEQ must be installed by the manufacturer's dealer of record and not by the Contractor.

3.5 CLOSEOUT SUBMITTALS

3.5.1 Warranty And Maintenance Information

Provide to the Contracting Officer at the final FF&E walk-thru one electronic copy and one binder copy of all ordering documentation, including but not limited to, quotes, purchase orders, factory order numbers (FO), IUID, and warranty and maintenance information for all products.

[3.5.2 Interior Photography Submittal

Upon completion of the FF&E installation, provide professional Interior Photography of the completed interior. The photographer must be in the business of specializing in architectural and interior photography. The submittal must be a minimum of six photos. "Before" and "After" photos are required for all renovation projects. Permission for publishing and using the photos by NAVFAC is required. Images must be submitted electronically as a Joint Photographic Experts Group (JPEG) or Portable Document Format (PDF) with a resolution of no less than 300 Dots Per Inch (dpi) as well as 200 mm x 250 mm 8-inch x 10-inch matte photographs. The photographs must be taken prior to occupancy and staged with accessories as needed. Additional lighting may be needed to ensure quality images.

All costs associated with the Interior Photography Submittal must be included in the Construction Base Price and must not be included in the FF&E Option item.

] -- End of Section --

****

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Change 2 - 11/18

Preparing Activity: USACE **Superseding**
UFGS-12 21 00 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 12 21 00

WINDOW BLINDS
08/17, CHG 2: 11/18

****
NOTE: This guide specification covers the requirements for window blinds and hardware.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

PART 1 GENERAL

****
NOTE: Use Section 12 22 00 for CURTAINS AND DRAPES. Use Section 12 24 13 for ROLLER WINDOW SHADES.
****

1.1 SUMMARY

Provide window treatment, conforming to NFPA 701, complete with necessary brackets, fittings, and hardware. Provide each window treatment type as a complete unit in accordance with paragraph WINDOW TREATMENT PLACEMENT SCHEDULE. Mount and operate equipment in accordance with manufacturer's instructions. Completely cover windows to receive a treatment.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES

SD-02 Shop Drawings

Installation

SD-03 Product Data

Window Blinds; G, [_____]

[Recycled Content for aluminum components; S]

SD-04 Samples

Window Blinds; G, [_____]

Valance; G, [_____]

SD-06 Test Reports

Window Blinds

SD-07 Certificates

[Indoor Air Quality for window blinds; S]

SD-08 Manufacturer's Instructions

Window Blinds; G, [_____]

SD-10 Operation and Maintenance Data

Window Blinds; G, [_____]

[1.4 CERTIFICATIONS

1.4.1 Window Blinds

Provide products certified to meet indoor air quality requirements by UL 2818 Greenguard [Gold], SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

]1.5 DELIVERY, STORAGE, AND HANDLING

Deliver components to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated and free from dust, water, or other contaminants and has easy access for inspection and handling. Store materials flat in a clean dry area with temperature maintained above 1 0 degrees C 50 degrees F. Do not open containers until needed for installation unless verification inspection is required.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

****

NOTE: Coordinate with the drapery hardware specified for the project.

****

2.1 WINDOW BLINDS

Provide each blind, including hardware, accessory items, mounting brackets and fastenings, as a complete unit produced by one manufacturer. Unless otherwise indicated, all parts will be the same color and will match the color of the blind slat. Treat steel features for corrosion resistance. Submit product data and samples of each type and color of window treatment. Provide [slat][louver] samples 150 mm 6 inch in length for each color.[Window blinds must meet emissions requirements of CDPH SECTION 01350 (use the office or classroom requirement, regardless of space type). Provide certification or validation of indoor air quality for window blinds.]

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets.

****

[Provide Aluminum Components with a minimum of [24][_____] percent recycled content. Provide data identifying percentage of recycled content for aluminum components.]

****

NOTE: Include bracketed sentence below requiring products with indoor air quality certifications when it is verified there is a product available that is certified by a third-party organization such as Greenguard or SCS Global Services. Also, verify that the certified product is both cost effective and appropriate for the project.

****

[Provide certification of indoor air quality for window blinds.]

2.1.1 Horizontal Blinds

****

NOTE: Typically horizontal blinds are fabricated to fill the openings from head-to-sill and jamb-to-jamb with inside mounted brackets. A clearance of 6 mm 1/4 inch should be allowed at each jamb. This typical mounting procedure may not be appropriate under certain conditions for 25 mm 1 inch slats and for windows in special frames, sliding glass doors, or windows in doors. Check specifications of glass manufacturer for recommended clearances when detailing the mounting

****

Provide horizontal blinds with[50 mm 2 inch][25 mm 1 inch] slats. Blind units must be capable of nominally 180 degree partial tilting operation and full-height raising. Blinds must be [inside][outside] mount. Provide tapes for 50 mm 2 inch slats with longitudinal reinforced vinyl plastic in 1-piece turn ladder construction. Tapes for 25 mm1 inch slats must be braided polyester or nylon.

2.1.1.1 Head Channel and Slats

****

NOTE: For clarification purposes, 0.006 inch refers to 0.006 gauge and 0.008 refers to 0.008 gauge. For 25 mm 1 inch venetian blinds, aluminum slats should be specified, unless justification exists for using steel. Steel slats have a tendency to cut the thin-line tape used with 25 mm 1 inch slats.

Do not use steel materials in humid locations or

project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid project locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Provide window blinds of prefinished aluminum with a minimum thickness of 0.032 inch (0.813 mm) for recommended spans.

****

Provide head channel made of[steel or] aluminum with corrosion-resistant finish nominal[0.46 mm 0.018 inch for 50 mm 2 inch][0.61 mm 0.024 inch for 25 mm 1 inch] slats. Provide slats of aluminum, not less than [0.203][0.152][0.813] mm [0.008][0.006][0.032] inch thick, and of sufficient strength to prevent sag or bow in the finished blind. Provide a sufficient amount of slats to assure proper control, uniform spacing, and adequate overlap. Enclose all hardware in the headrail.

2.1.1.2 Controls

A transparent tilting wand will be provided to tilt the slats, it will hang vertically by its own weight, and will swivel for easy operation. Provide a tilter control of enclosed construction. Provide moving parts and mechanical drive made of compatible materials which do not require lubrication during normal expected life. The tilter will tilt the slats to any desired angle and hold them at that angle so that any vibration or movement of ladders and slats will not drive the tilter and change the angle of slats. Include a mechanism to prevent over tightening. Provide a wand of sufficient length to reach to within 1500 mm 5 feet of the floor. [Provide cordless blinds or blinds with cords that are out of reach of children and strangle proof.]

2.1.1.3 Intermediate Brackets

****

NOTE: Appropriate spacing for placement of intermediate brackets at 1200 mm 48 inch and 1500 mm 60 inch are typical for Type 25 mm 1 inch blinds and 2100 mm 84 inch for 50 mm 2 inch blinds.

****

Provide intermediate brackets for installation, as recommended by the manufacturer, of blinds over [1200][1500][2100] mm[48][60][84] inch wide.

2.1.1.4 Bottom Rail

Provide bottom rail made of corrosion-resistant steel with factory applied finish. Provide closed oval shaped bottom rail with double-lock seam for maximum strength. Bottom rail and end caps to match slats in color.

2.1.1.5 Braided Ladders

Provide braided ladders of 100 percent polyester yarn, color to match the slat color. Space ladders 15.2 slats per 300 mmfoot of drop in order to provide a uniform overlap of the slats in a closed position.

2.1.1.6 Hold-Down Brackets

****

NOTE: Holddown brackets should not be specified for windows except where air movement may cause the blinds to sway excessively.
****

Provide universal type hold-down brackets for sill or jamb mount where indicated on placement list.

2.1.2 Light Control and Privacy Blinds

****
NOTE: Light control and privacy blinds are special purpose blinds to be used only when more than average blocking of light and privacy is required. Refer to UFGS SECTION 12 24 13 ROLLER WINDOW SHADES for black out shades.
****

In addition to requirements for horizontal blinds, provide each unit with a feature that offers hidden slat holes for maximum light control and privacy.

2.1.3 Vertical Blinds

****
NOTE: Typically, vertical blinds will be wall mounted with outside brackets, sill length. Certain instances will call for different installation methods. When selecting a ceiling mount with inside brackets, the designer should verify that the window recess will accommodate this type installation.
****

Provide vertical blind units capable of nominal 180 degree partial tilting operation and full stackback. Provide blinds that are listed by the manufacturer as designed for heavy duty strength applications including heavy duty hardware. Provide [ceiling][wall] mounted vertical blinds with [outside][inside] brackets. Provide blinds that are [sill][floor] length. Outside mount type installation must provide adequate overlap to control light and privacy.

2.1.3.1 Louvers

****
NOTE: Fabric louvers are freehanging and different from groover louvers. Groovers are vinyl louvers with fabric inserts included. Edit accordingly and do not use groovers and fabric louvers together.

Generally, 90 mm 3-1/2 inch blinds will be specified because they are more economical. In some cases, 50 mm 2 inch blinds will be more aesthetically pleasing because of the window size.
****

Provide louvers [which are fire resistant solid vinyl, UV stable, and impact resistant.][which are flame retardant fabric having straight, flat, unfrayed edges and flat, without noticeable twists. Provide a weight at the bottom of the louver without the insert discoloring the fabric.] [which are groover extruded from solid vinyl with clear non-yellowing channel lips to accept fabric inserts. Provide fabric inserts that are flame retardant and colorfast.] Louvers that are[90 mm 3-1/2 inch must overlap not less than 10 mm 3/8 inch][50 mm 2 inch must overlap not less than mm 1/4 inch] and be dimensionally stable.

2.1.3.2 Carriers

Provide carriers to support each louver made of molded plastic to transverse on self-fabricated wheels for smooth, easy operation. The hook of the carrier must have an automatic latch to permit easy installation and removal of the louver, and to securely lock the louver for tilting and traversing.

2.1.3.3 Headrail System

Provide headrail system not less than 1.19 mm 0.047 inch thick and made of anodized aluminum alloy or 0.635 mm 0.027 inch thick phosphate treated steel with a baked on ivory gloss enamel paint finish. Provide a headrail that extends the full width of the blind and can be closed with an end cap at each end. One cap will contain the traversing and tilting controls. The opposite cap will house the pulley for the traversing cord.

2.1.3.4 Valance

Attach the manufacturer's standard valance to the headrail by metal or plastic holders which grip the top and bottom edge of the valance and accept an insert of the same material as the slats. Provide sufficient clearance behind the valance to permit the louvers to tilt without interference. Extend the headrail cover the full width of the blind.[Provide returns].

2.1.3.5 Controls

****

NOTE: Typically, a tilting control baton is used because it is unobtrusive. Control mechanisms generally are on the right side, but window placement may require the controls to be placed on the left side for ease of operation.

Select which direction the vertical blind will traverse in the Placement Schedule, considering there must be adequate space for the width of the stack without concealing any electrical or mechanical components.

****

Provide tilting and traversing controls that hang compactly at the side of the blinds and reach within 1500 mm5 feet of the floor. Provide [tilt/traverse control][bead chain tilting control] that tilts all vanes simultaneously to any desired angle and hold them at that angle. Provide louvers that traverse [one way to the right] [one way to the left] [two-way split].[The traversing control cord will be minimum 1.78 mm 0.070 inch in diameter with a minimum breaking strength of 556 N 125 pounds. Anchor the cord to a lead carrier linked to all adjacent carriers.] Provide louvers that traverse along the headrail by pulling one side of the looped cord [fastened to a cord tension pulley][or][a fiberglass wand that tilts the louvers by turning the wand and traverses the louvers by using the wand as a control]. Sliding glass doors will have a one way draw with stackback occurring opposite door openings.

2.1.3.6 Connectors and Spacers

The connector must be flexible, smooth and flat to slide unhindered when carriers move independently of each other, and to nest compactly when carriers are stacking. Relate the length of the links to the louver width in order to equally space the traversing louvers, to maintain uniform and adequate overlap of louvers, and to fully cover the width of the opening.

2.1.3.7 Intermediate Brackets

Provide intermediate installation brackets for blinds over 1575 mm 62 inches wide.

2.2 COLOR

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally, Section 09 06 00 SCHEDULES FOR FINISHES or drawings are used when the project is designed by an Architect or Interior designer. Color must be selected from manufacturer's standard colors or identified as a manufacturer's color in this specification only when the project has minimal finishes.

When the government directs that color be located in the drawings, a note will be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

When more than one type, pattern or color is specified, identify location.

When a manufacturer's name, stock number, pattern, and color is specified for color, be certain that the product conforms to the specification, as edited.

****

Provide color, pattern and texture [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES][as indicated][selected from manufacturer's standard colors][[_____]. Color listed is not intended to limit the selection of equal colors from other manufacturers.]

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 WINDOW TREATMENT PLACEMENT SCHEDULE

****

NOTE: The Window Treatment Placement Schedule will be provided at the designer's option to clarify placement of the treatments. When all exterior windows are to receive a window treatment, a note can be made to this effect instead of filling out the schedule. The location of the window treatment should be clearly defined within this specification.

****

[All exterior windows include [_____].] [Provide window covering as follows:

Room Number/Name	Window Covering Type	Vertical Blind Draw Direction	Window Type	Quantity
[_____]	[_____]	[_____]	[_____]	[_____]

]

3.3 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Submit drawings showing fabrication and Installation details. Show layout and locations of track, direction of draw, mounting heights, and details. Provide Manufacturer's Instructions and Operation and Maintenance Data. Perform installation of window blinds in accordance with the approved detail drawings and manufacturer's installation instructions. Install units level, plumb, secure, and at proper height and location relative to window units. Provide and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Do not start installation until completion of room painting and finishing operations.

3.4 CLEAN-UP

Upon completion of the installation, inspect window treatments for soiling, damage or blemishes; and adjust them for form and appearance and proper operating condition. Repair or replace damaged units as directed by the Contracting Officer. Isolate metal parts from direct contact with concrete, mortar, or dissimilar metals. Ensure blinds installed in recessed pockets can be removable without disturbing the pocket. The entire blind, when retracted, must be contained behind the pocket. For blinds installed outside the jambs and mullions, overlap each jamb and mullion 20 mm 0.75 inch or more when the jamb and mullion sizes permit. Include all hardware, brackets, anchors, fasteners, and accessories necessary for a complete, finished installation.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-12 22 00 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-12 22 00 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

SECTION 12 22 00

CURTAINS AND DRAPES

08/16, CHG 1: 08/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-12 22 00 (August 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 12 22 00

CURTAINS AND DRAPES
08/16, CHG 1: 08/18

****
NOTE: This guide specification covers the requirements for draperies, drapery hardware, and installation.

Note: Use Section 12 21 00 for WINDOW BLINDS

Note: Use Section 12 24 13 for ROLLER WINDOW SHADES

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

This guide specification includes tailoring options for Motorized Drapery Rods. Selection or deselection of a tailoring option (select view-tailoring options) will include or exclude that option in the section. Specific project editing is still required for the resulting section.

Motorized drapery systems must be coordinated with electrical and HVAC systems (energy conservation measures), as well as the drapery manufacturer to verify weight and related carrying hardware.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****

NOTE: On the drawings, show:

1. Windows and other locations requiring drapery. Indicate whether drapery extends to ceiling or to specific height above windows.

2. Location of each different drapery fabric when more than one type, pattern or color is to be provided.

3. Width of window and width of drapery extension if bay window.

4. Location of sample window installation, if appropriate.

5. Indicate draw direction when one-way draw traverse rods or tracks are to be provided.

6. Indicate motor location and any integrated components or accessories.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D3691/D3691M	(2019) Standard Performance Specification for Woven, Lace, and Knit Household Curtain and Drapery Fabrics

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G, [_____]

SD-03 Product Data

Drapery System

SD-04 Samples

Drapery Fabric; G, [_____]

Submit a range of three samples, 900 by 900 mm 36 by 36 inches or larger, to match the fabric quality, weight, pattern, and color shown or specified. Once selected, label approved samples to identify locations for their use in the project. Maintain identification and approval markings until final acceptance of the work.

Motor and Controller; G, [_____]

****

NOTE: Coordinate with the drapery hardware specified for the project. Should the designer choose to indicate the location for the sample window installation, clearly indicate the location on the project drawings and edit the paragraph accordingly.

****

Finished Drapery

Provide one full size window sample installation including hardware. Install the finished drapery on a [stationary] [traverse] [rod] [or] [track] [at the location indicated].

SD-06 Test Reports

Flame Resistance

SD-07 Certificates

Indoor Air Quality for Fabrics; S

SD-08 Manufacturer's Instructions

Drapery Hardware

Motor and Controller

Special Fabrication

Before fabrication, submit the manufacturer's printed instructions for fabrics requiring special fabrication methods.

SD-10 Operation and Maintenance Data

Drapery System, Data Package 1; G, [_____]

Motor and Controller

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

****

NOTE: The Government's preference is for use of products that have been certified for indoor air quality by a third-party organization such as Greenguard or SCS Global Services. However, it must be verified there is a certified product available that is both cost effective and appropriate for the project. Retain the bracketed sentences when the designer of record confirms local/regional availability of Greenguard or SCS products that does not impact cost effectiveness. In addition, when these sentences are retained requiring Greenguard or SCS products, also include the Indoor Air Quality Certificates in SD-07 submittals of this section.

****

[1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

1.3.1.1 Fabrics

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification orvalidation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

]1.4 DRAWINGS

Submit drawings indicating the following:

Windows and other locations requiring drapery extent of drapery, to ceiling or to specific height above windows; location of each different drapery fabric when more than one type, pattern or color is to be provided; width of window and width of drapery extension if bay window. Motor and Controller location and any integrated components or accessories.

1.5 SYSTEM REQUIREMENTS

Submit data for completed drapery system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include laundering and dry cleaning instructions for fabrics requiring special care. Furnish separate instruction sheet for each material (one for fiberglass, one for Verel). For fabrics which are not permanently or inherently flame resistant, furnish instruction to include frequency and process required for retreating the fabric to renew the effectiveness of the flame resistant treatment. Head each sheet with name and number of room or rooms in which each material is hung. In lieu of instruction sheets, provide instructions on small, permanent labels (either iron-on type or sewn-on) affixed to back of the heading of each panel.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver draperies and hardware to the site in sealed containers clearly labeled with manufacturer's name and contents. Store in a safe, dry, clean, and well ventilated area. Do not open containers until needed for installation, unless verification inspection is required.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Fabrics

Provide fabrics meeting the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for fabrics.

2.1.1.1 Drapery Fabric

****

NOTE: Generic descriptions are preferred in order to promote competition. However, due to variety of fabrics available, manufacturer's names and designations may be the more practical method of describing desired fabrics. When a manufacturer's name and designation are used, add the following note to text: "Manufacturer's name and fabric designation are provided to identify the fabric weight, pattern, weave, texture, and color desired. Other manufacturers' products meeting the requirements specified and having similar fabric weight, pattern, weave, texture, and color will be acceptable."

When project requires matching a standard sample, include last sentence. Make fabric sample available at location stated for inspection by prospective bidders when special fabrics are required.

If more than one fabric is required, repeat the listing as necessary.

****

ASTM D3691/D3691M. Provide fabric manufactured from [man-made] [or] [natural] fibers. Fabric physical characteristics must be as [indicated.] [follows:]

a. Finished fabric weight: [_____] to [_____] kilograms per square meter ounces per square yard

b. Pattern: [Printed] [Woven] [_____]

c. Weave: [Open (25.1 to 50 percent)] [Semi-open (7.1 to 25 percent)] [Closed (0 to 7 percent)]

d. Texture: [Burlap] [Smooth] [Twill] [_____]

e. Color: [_____]

f. Shading coefficient (single glass with drapery): [_____]

[g. A sample of each drapery fabric to be matched is on display at [_____].

]2.1.1.2 Drapery Lining

****

NOTE: Delete this paragraph if unlined draperies are specified. Other lining fabrics may be specified in the blank space provided. Specify lining color.

****

[Insulated], [soft blackout,] [_____], color [_____] [as indicated].

2.1.1.3 Flame Resistance

****

NOTE: NFPA 701 includes small and large scale test procedures. The large scale test is more severe than the small scale test. NFPA 701 provides for optional use at the discretion of the authority having jurisdiction. National Fire Protection Association 101, "Code for Safety to Life from Fire in Buildings and Structures", requires both tests for fabrics used in assembly, educational, health care, detention and correctional, and residential occupancies.

For other occupancies, the large scale test should be specified only when stringent flame resistance requirements are necessary, or when the nature of the fabric specified is such that excessive melting or shrinkage will render the small scale test ineffective. Otherwise, the small scale test requirements are adequate in most cases.

A variety of flame-retardant treatments are available. Generally, they fall into two broad categories: (1) permanent type, and (2) the less expensive, renewable type. Permanent treatments retain their effectiveness through a number of cleanings without reapplication. Renewable treatments, however, must be reapplied periodically, frequently after each cleaning, which imposes a continuing maintenance burden. Permanent treatments can be successfully applied to most fabrics. Only a few fibers or fabrics are limited to renewable treatments. Specify permanent treatment except where the fiber type or other fabric characteristics prohibit use of this type.

****

NFPA 701. Drapery fabric and lining must pass the [small] [and] [large] scale test. Treatment to enhance flame resistance must be [permanent] [renewable] type. If treated, fabric must pass the [small] [and] [large] scale test after being subjected to the accelerated dry cleaning or laundering cycles specified in NFPA 701.

2.1.2 Sewing Thread

Pre-shrunk mercerized cotton (50/3) or monofilament in equivalent size, except do not use monofilament in the heading.

2.1.3 Heading

2.1.3.1 Heading Hooks

Slip-in-type,[bright zinc-plated][chromium-plated,][nickel-plated steel,] and of a size adequate to hold the heading upright. Provide one hook for each pleat. Provide 10 percent [_____] surplus hooks for possible lost or damaged hooks.

2.1.3.2 Snap-Tape System (Ripplefold)

Heavy vinyl or nylon tape with locking fasteners attached to tape to form desired pleat spaces and fullness. Cut tapes to size and sew to drapery fabric to form the heading.

2.1.4 Drapery Hardware

****

NOTE: Unless both stationary and traverse rods or tracks are required, delete the type not to be used. When traverse, indicate whether two or one-way draw; when one-way, select whether left-to-right or right-to-left.

****

****

NOTE: Permit Contractor's option of steel or aluminum rods and tracks unless the desired finish cannot be provided with both materials or the installation dictates the use of one particular material.

****

[Stationary] [and] [traverse] [wall-mounted rods] [and] [ceiling mounted tracks] of heavy-duty type.[Traverse rods or tracks must be [manually operated][motorized], [center close two-way] [one-way draw] [left-to-right] [right-to-left]]. Rods and tracks must be cold-rolled, commercial quality steel minimum 0.75 mm 0.030 inch thick or extruded aluminum minimum 1.27 mm 0.050 inch thick. Rod and track cross section width and depth must be sufficient to carry the drapery without sagging. Track configuration (number of channels) must be such so as to permit drapery operation as specified or indicated. Finish steel components with a [white] [_____] baked enamel, vinyl, or epoxy coating as standard with the manufacturer. Finish aluminum components with [an anodic [clear (natural)] [bronze] [_____] coating] [a baked enamel, vinyl, or epoxy coating] as standard with the manufacturer. Provide smooth and non-sticking sliding surfaces.

Provide one-piece rod and track up to 4875 mm 16 feet long. Provide steel brackets and intermediate supports. Provide one manufacturer's design throughout.

2.1.4.1 Track Sets

Include ceiling track, sliding or rolling carriers, and caps for stationary draperies; ceiling track, sliding or rolling carriers, master sliding or rolling carriers, ball bearing end pulleys, and traverse cord with cord [tassels] [tension pulleys] for traverse draperies.

2.1.4.2 Rod Sets

Include wall-hung rod, sliding or rolling carriers, brackets, and intermediate supports with 65 to 90 mm 2-1/2 to 3-1/2 inch projection for stationary draperies; wall-hung rod, sliding or rolling carriers, master sliding or rolling carriers, ball bearing end pulleys, brackets, intermediate supports with 65 to 90 mm 2-1/2 to 3-1/2 inch projection, and traverse cord with cord [tassels] [tension pulleys] for traverse draperies.

2.1.4.3 Traverse Cord

****

NOTE: When traverse draperies are required, select cord tassels or tension pulleys.

****

Size No. 4 with fiberglass center. Provide cord [tassel with lead weight center and plastic coating] [tension pulley, metal tube type, with mounting bracket, helical spring, and ball bearing pulley wheel]. Finish color, white or off-white.

2.1.4.4 Hand Traverse Cordless Track System

Extra heavy duty track assembly with baton on roomside of draperies where it is readily visible and easily used. [Ceiling mounted] [side-wall mounted] in extruded aluminum track anodized in [clear (natural)] [bronze] [_____] finish.

2.1.4.5 Motor and Controller

Provide motor[s] for [single][double] track system, complete with remote controller and manufacturer's instructions for installation and operation. Verify motor size is adequate for drapery system to be installed. Coordinate with [existing][new] electrical system for power supply and location of motor mounting.[Coordinate thermostatic setting instructions for automated systems.]

2.1.4.6 Snap-Tape System Track

Dovetail slots in clear folding linkage. Provide one-piece molded plastic snap tab type carriers with snap-on components sewn to drapery heading.

2.1.5 Fasteners

Provide [zinc][cadmium][_____] plated.

2.2 FABRICATION

Prior to cutting and fabrication, field measure each drapery location paying particular attention to field conditions affecting the work.

2.2.1 Drapery Fabrication

2.2.1.1 Panels

****

NOTE: Select fullness required, enter percentage and edit fullness definition to suit (i.e. 200 percent fullness is defined as 2 times the rod width plus overlaps and returns.) Select appropriate length.

****

Make from full or half widths of fabric to give a minimum of [200] [250] [300] [_____] percent fullness. [_____] percent fullness is defined as [2] [2 1/2] [3] [_____] times the rod width plus overlaps and returns. Provide [conventional french pleats] [ripplefold]. Draperies must be [floor] [sill] [apron] length. [Floor length draperies must hang 25 mm 1 inch above finish floors.] [Sill length draperies must hang 13 mm 1/2 inch above window sills and heating-air conditioning units.] [Apron length draperies must hang 25 mm 1 inch below bottom of window aprons.] Provide table-sized drapery panels with a plus or minus tolerance of 6 mm 1/4 inch accurately laid-out before cutting. Cut fabric to allow for pleats and for outside ends to return to the walls. For traverse draperies, allow for a minimum overlap of 75 mm 3 inches at the center. Accurately match patterned fabrics to provide identical designs horizontally and vertically on each window within each room. Where variations in length or placement of windows occur in a room, match patterns horizontally. When fabricating panels from fabrics which require special methods or instructions, conform to the workroom instructions provided by the fabric manufacturer. Sew seams and hems using a firm interlocking stitch at a stitch rate per millimeter inch appropriate to fabric being sewn. Sew with enough slack present so that thread shrinkage due to laundering and dry cleaning will not pucker seams and hems. Do not expose seam and hem raw edges.

2.2.1.2 Headings

****

NOTE: This specification covers conventional triple french pleat and ripplefold construction and heavy-duty rodding. Special "architectural" type patented pleating systems are not included. Where special heading treatment is required, appropriate requirements should be incorporated into the project specification.

****

Pleat evenly to required widths. Make headings 100 mm 4 inches high with triple french pleats, and double fold. Include permanent finish stiffener of buckram, crinoline, or pellon across entire heading. Paper stiffening is not acceptable. Machine stitch pleats for a depth of at least 95 millimeters 3-3/4 inches. Do not use horizontal stitching across the width of the heading.

2.2.1.3 Seams

Join widths by serging, overlock, and safety stitch. Retain selvage when practical.

2.2.1.4 Hems

****

NOTE: When sheer fabrics are used, suitable cotton covered beaded tape should be specified in lieu of standard covered weights for better appearance.

****

Double fold hems (top and bottom) and blind stitch so as not to show on the panel face. Make side seams 38 mm 1-1/2 inches wide and bottom seams 100 mm 4 inches deep with weights sewn 13 mm 1/2 inch above hem bottom. Provide weights at corners and each vertical seam. When lining is attached to the drapery fabric, single fold heading is acceptable, however, double fold the bottom hem.

[2.2.2 Lining Fabrication

****

NOTE: Delete this paragraph if unlined draperies are specified.

****

Lock stitch lining to the back of the fabric panel. Hem fabric panel and lining panel separately at the bottom.

][2.2.3 Tie-Backs

****

NOTE: Delete this paragraph if drapery tie-backs are not required. Specify tie-back materials, if other than same as draperies. Specify tie-back width and length, if other than specified.

****

Make from [same material as draperies] [_____], [75] [_____] millimeters wide by [750] [_____] millimeters [3] [_____] inches wide by [30] [_____] inches long. Fabricate from a double thickness of fabric, press flat to provide specified width, and locate seam at the bottom fold so as to permit the tie-back to be reversible. Provide bone or plastic ring end fastenings to loop over tie-back hooks.

][2.2.4 Valances

****

NOTE: Delete paragraph if valances not required.

****

[Rod-hung, fabricated in the same manner as draperies and of [same material] [_____].] [Box-type, with sides and top constructed of 25 mm 1 inch thick [softwood pine] [_____], and 10 mm 3/8 inch thick plywood front. Cover front, sides and bottom edges of valance with batting, stretch fabric [and trim] evenly and neatly over valance exterior, and fasten to the inside. Provide [same fabric as draperies] [_____]. Paint interior of valance. Shape valance bottom front edge [straight] [_____].]

Make valance of required width to span the window, and [_____] millimeters inches high. Make depth of valance adequate to ensure proper appearance and to permit proper operation of traverse draperies.

]PART 3 EXECUTION

3.1 EXAMINATION

Ensure that work of other trades and cleaning operations are completed. Test completed installation to ensure smooth and continuous operation of all draperies, hardware and accessories.

3.2 INSTALLATION

Install draperies in rooms and areas [indicated] [as scheduled herein]. Include all material indicated, specified, or necessary for a complete finished drapery installation. Contractor is responsible for the required quantities of draperies and hardware.

Do not install building construction materials that show visual evidence of biological growth.

3.2.1 Hardware

Install in accordance with the manufacturer's printed instructions and as specified herein. Install ceiling tracks parallel to walls and windows, fasten at each end, at 400 mm 16 inches from each end and with additional intermediate fasteners spaced not more than 1200 mm 48 inches apart. Install wall rods with end brackets and provide intermediate support brackets 600 mm 24 inches from each end with additional intermediate support brackets spaced not more than 1200 mm 48 inches apart. Provide fasteners for installation as follows:

Fastener	Structural Material
Wood or sheet metal screw	Wood
Self tapping screw	Metal
Case hardened, self-tapping sheet metal screw	Sheet metal
Screw or bolt in expansion shield	Solid masonry
Toggle or molly bolt	Hollow masonry, wallboard, plaster

3.2.2 Draperies

Install with a minimum clearance of 6 mm 1/4 inch between the ceiling and top of drapery heading. Floor length draperies must hang 25 mm 1 inch above finished floors; sill length, 13 mm 1/2 inch above window sills and heating-air conditioning units; and apron length, 25 mm 1 inch below bottom of window aprons. Insert heading hooks at rear of each pleat, placed to obtain the clearance specified. Press well before hanging, except fiberglass. Dress-down and adjust hung draperies to provide best form and appearance. Traverse draperies must operate smoothly and easily over the full range of travel. Remove incorrectly sized drapery and remake to correct size. Remove damaged, spotted, or otherwise defective fabric and repair to original state or replace with new material.

3.2.3 Valances

Install with top edge parallel to ceiling.

3.3 DRAPERY SCHEDULE

****
NOTE: Some projects require several drapery treatments. Where such variations exist, a drapery schedule made a part of this section or should be included in the drawings. The schedule and any necessary detailed drawings should be cross-referenced. Schedule and drawing data should include all necessary information, such as: areas and rooms to receive draperies; size and placement of each; type and location of rods or tracks, (ceiling-hung, stationary, center close two-way, etc.); drapery length, (floor, sill, or apron); whether lined or unlined; fabric type, color, and pattern unless covered in paragraph FABRICS.
****

[All exterior windows include [_____].

][Provide window covering as follows:

Room Number/Name	Window Covering Type	Drapery Draw Type/Direction	Window Type	Quantity
[_____]	[_____]	[_____]	[_____]	[_____]

]3.3.1 IDENTIFICATION

****
NOTE: Projects requiring large quantities of window treatments or a variety of window treatment types may need a numbering plan.
****

In accordance with the numbering plan, mark each opening and the corresponding window treatment with identical numbers. For multiple windows separated by mullions, the space required by each blind must be numbered separately. Use brass, aluminum, plastic, durable paper plates, or stamp to place corresponding numbers on unexposed surfaces of openings and inside or on top of the headrail track.

-- End of Section --

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USACE / NAVFAC / AFCEC UFGS-12 24 13 (August 2020)

Preparing Activity: USACE

Superseding
UFGS-12 24 13 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

SECTION 12 24 13

ROLLER WINDOW SHADES

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-12 24 13 (August 2020)**

Preparing Activity: USACE **Superseding**
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SECTION 12 24 13

ROLLER WINDOW SHADES
08/20

****

NOTE: This guide specification covers the requirements for roller window shades and hardware.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

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PART 1 GENERAL

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NOTE: Use Section 12 21 00 for WINDOW BLINDS. Use Section 12 22 00 for CURTAINS AND DRAPES

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1.1 REFERENCES

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AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/WCMA A100.1	(2018) American National Standard for Safety of Window Covering Products

ASTM INTERNATIONAL (ASTM)

ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

UL SOLUTIONS (UL)

UL 325	(2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES

SD-02 Shop Drawings

Detailed Drawings; G, [_____]

Location Schedule; G, [_____]

SD-03 Product Data

Window Shades; G, [_____]

[Recycled Content for various fiber components; S

] SD-04 Samples

Window Shades; G, [_____]

SD-06 Test Reports

Flammability Requirements; G, [_____]

SD-07 Certificates

[Indoor Air Quality for roller window shades; S

] Qualifications

SD-10 Operation and Maintenance Data

Window Shades, Data Package 1; G, [_____]

SD-11 Closeout Submittals

Submit Data Package 1 for roller window shades, and Data Package 2 for electrical operators, in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

[1.3 CERTIFICATES

1.3.1 Indoor Air Quality Certifications

1.3.1.1 Roller Window Shades

****

NOTE: The Government's preference is for use of products that have been certified for indoor air quality by a third-party organization such as Greenguard or SCS Global Services. However, verify there is a certified product available that is both cost effective and appropriate for the project.

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Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) [Gold], SCS Global Services Indoor Advantage Gold or provide validation by other third-party program that products meet the requirements of this paragraph. Provide current product certification documentation from certification body.

]1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 Installer's Qualifications

Installer trained and certified by the manufacturer with a minimum of ten years of experience in installing products comparable to those specified in this section.

1.4.2 Flammability Requirements

Passes in accordance with NFPA 701 small and large-scale vertical burn. Materials tested are identical to products proposed for use.

1.4.3 Electrical Requirements

NFPA Article 100 listed and labeled in accordance with UL 325 or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components is not acceptable in lieu of system testing.

1.4.4 Anti-Microbial Requirements

'No Growth' per ASTM G21 results for fungi ATCC9642, ATCC 9644, ATCC9645.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver components to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated and free from dust, water, or other contaminants and has easy access for inspection and handling. Store materials flat in a clean dry area with temperature maintained above 10 degrees C 50 degrees F. Do not open containers until needed for installation unless verification inspection is required. Handle and store shades in accordance with manufacturer's recommendations.

1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for a period of [10] [_____] years from date of final acceptance of the work.

PART 2 PRODUCTS

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NOTE: Coordinate with the drapery hardware specified for the project.

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2.1 WINDOW SHADES

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NOTE: Window shade options will include manual single or dual shade and motor-operated single or dual shade. Light filtering shade cloth is translucent in varying shades of opacity. Room darkening shades are opaque and block out light completely.

The designer should specify a complete room darkening system only if total light block is necessary, as in an audio visual application. A room darkening shade is typically made of a vinyl coated fiberglass cloth. Do not specify cotton cambric fabric for room darkening shades since it cannot provide total light block. Coordinate maximum unit sizes available with the window sizes.

Attachment of fabric to roller tube with double sided adhesive is not recommended.

Recycled content is affected by openness factor. Projects need to balance the desired openness factor with all other requirements including recycled content, aesthetics, color and energy efficiency.

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Submit drawings showing plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to work. Submit a location schedule showing location, size and quantity of shades. Include the use of same room designations as indicated on the drawings.

Provide product data composed of catalog cuts, brochures, and operating and maintenance instructions on each product to be used. Include styles, profiles and features.

Furnish samples of each type and color of roller shade fabric and roller shade channel. Provide shade material minimum 150 by 150 mm 6 by 6 inches in size. Mark face of material to indicate interior faces.

Mock up: Install shade in area designated by Contracting Officer. Do not proceed with remaining work until the Contracting Officer approves workmanship and operation. Rework mock up as required to produce acceptable work. The approved shade can be used in the installation.

Submit fire resistance data, flame spread and smoke contribution data.

Provide roller tube that operates smoothly and of sufficient diameter and thickness to prevent excessive deflection. Provide brackets that are appropriate for [inside][outside][ceiling] mount. Provide shade cloth meeting the performance described in NFPA 701, small scale test. Treat steel features for corrosion resistance.

Provide Various Fiber Components with a minimum of 60 percent recycled content. Provide data identifying percentage of recycled content for various fiber components.

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NOTE: Included bracketed sentence below requiring products with indoor air quality certifications when product will be located in offices or classrooms.

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[Provide certification of indoor air quality for roller window shades.]

2.1.1 Manufacturer's Qualifications

Obtain motor-controlled roller shades through one source from a single manufacturer with a minimum of twenty years of experience and minimum of three projects of similar scope and size in manufacturing products comparable to those specified in this section. Furnish manual and motorized shades produced by the same manufacturer to provide matching appearance.

2.1.2 Manually Operated Shades with Single Rollers

2.1.2.1 Chain-and-Clutch Operating Mechanisms

Provide continuous-loop bead chain and clutch that stops shade movement when bead chain is released; shade to be permanently adjusted and lubricated.

2.1.2.2 Bead Chains

Provide bead chain from #10 stainless steel rated to 400N 90 lb. minimum breaking strength with pull chain tensioning device complying with ANSI/WCMA A100.1

a. Loop Length: [Full length of roller shade][As indicated].

b. Limit Stops: Allows shade to stop when chain is released. Provide limit stops to prevent shade from being raised or lowered too far.

c. Chain-Retainer Type: [Clip, jamb mount][Chain tensioner, jamb mounted][Chain tensioner, sill mounted].

[2.1.2.3 Crank-and-Gear Operating Mechanisms

Sealed gearbox drive system controlled by crank handle, [detachable][permanently mounted].

a. Crank-Handle Length: [Manufacturer's standard for height of shade][As indicated on drawings].

[b. Coupling system: Provide system to operate shades from single crank by coupling shade rollers together. System to consist of endcaps, plus couplings to connect rollers.

]]2.1.2.4 Rollers

Provide corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade cloth for service.

a. Roller Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated].

b. Direction of Shade cloth Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

c. Shade cloth-to-Roller Attachment: [Manufacturer's standard method][Removable spline fitting into integral channel in tube]. Adhesive attachment is not acceptable.

2.1.2.5 Mounting Hardware

Provide corrosion resistant brackets or endcaps compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without removal of brackets and end or center supports.

2.1.2.6 Shade Cloth

a. Shade Material: [Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____]][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade band material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.2.7 Installation Accessories

a. Front Fascia: L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

[b. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

] c. Endcaps: Extruded aluminum with universal design suitable for mounting to window mullions. Provide size compatible with roller size. Provide end cap covers matching fascia/headbox finish.

[d. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open. Provide pocket with lip at lower edge to support acoustical ceiling panel.

][e. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

][2.1.2.8 Room Darkening Shades

Provide room darkening (black-out) window shades designed to eliminate all visible light gaps when shades are fully closed and conform with the following:

a. Provide roller tube made of aluminum. Provide shop fabricated light traps consisting of a head box to house the roller shade, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.

b. Provide light trap made of sheet steel having a minimum thickness of 0.64 mm 22 gauge or anodized, extruded, aluminum. Provide legs of the channels not less than 44 mm 1-3/4 inches long and separated by the minimum distance that permits free operation of the shade. Edges of light trap coming into contact with the shade cloth are smooth pile light seal. The exposed face of the head box is hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap have a finish coat of flat black enamel. The exposed portions of the light trap have a factory-applied priming coat of gray paint.

c. Provide type of cloth for blackout purposes. Provide shade from a single piece of [PVC polyester][PVC fiberglass][PVC free material][_____].

d. Fit the bottom edge of the shade with a steel operating bar. Shades to engage positively with bottom rail through operating bar or chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 778 N 175 pounds breaking strength.

]2.1.3 Manually Operated Shades with Dual Rollers

2.1.3.1 Chain-and-Clutch Operating Mechanisms

Provide continuous-loop bead chain and clutch that stops shade movement when bead chain is released; shade to be permanently adjusted and lubricated.

2.1.3.2 Bead Chains

Provide bead chain from #10 stainless steel rated to 400 N 90 lb. minimum breaking strength with pull chain tensioning device complying with ANSI/WCMA A100.1. Provide positive mechanical engagement of drive mechanism to shade roller tube. Center bead chain placement for right or left- hand operation.

a. Loop Length: [Full length of roller shade][As indicated].

b. Limit Stops: Allows shade to stop when chain is released. Provide limit stops to prevent shade from being raised or lowered too far.

c. Chain-Retainer Type: [Clip, jamb mount][Chain tensioner, jamb mounted][Chain tensioner, sill mounted].

[2.1.3.3 Crank-and-Gear Operating Mechanisms

Sealed gearbox drive system controlled by crank handle, [detachable][permanently mounted].

a. Crank-Handle Length: [Manufacturer's standard for height of shade][As indicated].

[b. Coupling system: Provide system to operate shades from single crank by coupling shade rollers together. System to consist of endcaps, plus couplings to connect rollers.

]]2.1.3.4 Rollers

Provide corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade bands for service.

a. Dual Shade-Roller Mounting Configuration: [Side by Side][Offset][_____].

b. Inside Roller: Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated on drawings]. Direction of Shade cloth Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

c. Outside Roller: Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated]. Direction of Shade cloth Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

d. Shade cloth-to-Roller Attachment: [Manufacturer's standard method][Removable spline fitting into integral channel in tube]. Adhesive attachment is not acceptable.

2.1.3.5 Mounting Hardware

Provide corrosion resistant brackets or endcaps compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without removal of brackets and end or center supports.

2.1.3.6 Inside Shade Cloth

a. Shade Material: [Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____]][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.3.7 Outside Shade Cloth

a. Shade Material: [Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____]][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.3.8 Installation Accessories

a. Front Fascia: L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

[b. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

] c. Endcaps: Extruded aluminum with universal design suitable for mounting to window mullions. Provide size compatible with roller size. Provide end cap covers matching fascia/headbox finish.

[d. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open. Provide pocket with lip at lower edge to support acoustical ceiling panel.

][e. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

][2.1.3.9 Room Darkening Shades

Provide room darkening (black-out) window shades designed to eliminate all visible light gaps when shades are fully closed, and conform with the following:

a. Provide roller tube made of aluminum. Provide shop fabricated light traps, consisting of a head box to house the shade roller, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.

b. Provide light trap made of sheet steel having a minimum thickness of 0.64 mm 22 gauge or anodized, extruded, aluminum. Provide legs of the channels not less than 44 mm 1-3/4 inches long and separated by the minimum distance that permits free operation of the shade. Edges of light trap coming into contact with the shade cloth are smooth pile light seal. The exposed face of the head box is hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap have a finish coat of flat black enamel. The exposed portions of the light trap have a factory-applied priming coat of gray paint.

c. Provide type of cloth for blackout purposes. Provide shade from a single piece of [PVC polyester][PVC fiberglass][PVC free material][_____].

d. Fit the bottom edge of the shade with a steel operating bar. Shades to engage positively with bottom rail through operating bar or chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 778 N 175 pounds breaking strength.

][2.1.4 Motor-Operated Shades with Single Rollers

Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

2.1.4.1 Motors

Provide motors that are [hardwired, wired into the building electrical system and][plug-in to standard AC electrical outlets and] concealed from interior view. The position of the motor and electrical connection is [left][right] side of roller, based on the hand of the user facing the shade from inside, unless otherwise indicated [on drawing][in the ROLLER WINDOW SHADE PLACEMENT SCHEDULE]. Provide motors capable of operating at or below 44 dBA measured 914 mm 3 feet from the center of the shade depending on the electronic drive unit selected; no audible clicks when motor starts and stop. Motors are [120V, 60 Hz][low voltage with Class 2 power supply].

2.1.4.2 Controls

Provide electric controls with NEMA ICS 6 Type 1 enclosure for [surface][recessed or flush] mounting. Controls are able to electronically set and reconfigure shade open and close limits, shade preset positions, system groups and system subgroups at the control without rewiring and without access to the Electronic Drive Unit. Provide wall control engraved with button, group, or scene description as indicated on the drawings.

[a. Key Pad: Three-position, switch-operated control station with open, close, and off functions. Provide two keys per station. Battery operated key pads are not allowed.

][b. Switches: Wall-switch-operated control station with open, close, and center off functions. Switch Positions: [Three][Five]. Switch Style: [Toggle][Rocker].

][c. Group Control Station: Three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.

][d. Individual/Group Control Station: Three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.

][e. Sun Sensor Control: Provide solar adaptive shading software that automatically adjusts motorized shades throughout the day in response to the changing position and intensity of the sun. Customized shade schedules are developed combining information about building location and facade orientation. Wireless mullion sensors to be provided for cloudy-day override.

][f. Low Voltage Controls: Provide a digital system that includes a low-voltage interface to communicate with both wired and wireless inputs. Wireless controls to utilize radio frequency in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.

][g. Provide a whole building shade control system that can be preprogrammed and reprogrammed to accomplish different operations for management flexibility.

][2.1.4.3 Timer Controls

Clock timer, [24-hour][seven-day][_____] programmable for regular events.

[a. Provide switches that are adjustable and interlocked with motor controls and set to automatically stop the shade at fully raised and fully lowered positions.[Low voltage switching is required.]

][b. Operating Function: [Stop and hold shade at any position][Stop and hold shade at open, midpoint, and closed positions][Stop and hold shade at 3 pre-determined positions including open, closed and user-programmed position][Stop and hold shade at 5 pre-determined position including open, closed, and 3 user-programmed positions][_____].

][c. Provide the following options: [Low voltage system][Group switching with integrating switch control].[Capable of interface with [audiovisual][multi-room][_____] control system][Capable of accepting input from building automation control system][Override switch][Power failure memory for the life of the systems which protects presets][_____].

]]2.1.4.4 Rollers

Provide corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade cloth for service.

a. Roller Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated on drawings].

b. Direction of Shade Cloth Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

c. Shade Cloth-to-Roller Attachment: [Manufacturer's standard method][Removable spline fitting into integral channel in tube]. Adhesive attachment is not acceptable.

2.1.4.5 Mounting Hardware

Provide corrosion resistant brackets or endcaps compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without removal of brackets and end or center supports.

2.1.4.6 Shade Cloth

a. Shade Material: Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.4.7 Installation Accessories

a. Front Fascia: L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

[b. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

] c. Endcaps: Extruded aluminum with universal design suitable for mounting to window mullions. Provide size compatible with roller size. Provide end cap covers matching fascia/headbox finish.

[d. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open. Provide pocket with lip at lower edge to support acoustical ceiling panel.

][e. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

][2.1.4.8 Room Darkening Shades

Provide room darkening (black-out) window shades designed to eliminate all visible light gaps when shades are fully closed, and conform with the following:

a. Provide roller tube made of aluminum. Provide shop fabricated light traps consisting of a head box to house the roller shade, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.

b. Provide light trap made of sheet steel having a minimum thickness of 0.64 mm 22 gauge or anodized, extruded, aluminum. Provide legs of the channels not less than 44 mm 1-3/4 inches long and separated by the minimum distance that permits free operation of the shade. Edges of light trap coming into contact with the shade cloth are smooth pile light seal. The exposed face of the head box is hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap have a finish coat of flat black enamel. The exposed portions of the light trap have a factory-applied priming coat of gray paint.

c. Provide type of cloth for blackout purposes. Provide shade from a single piece of [PVC polyester][PVC fiberglass][PVC free material][_____].

d. Fit the bottom edge of the shade with a steel operating bar. Shades to engage positively with bottom rail through operating bar or chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 778 N 175 pounds breaking strength.

]][2.1.5 Motor-Operated, with Dual Rollers

Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

2.1.5.1 Motors

Provide motors that are [hardwired, wired into the building electrical system and][plug-in to standard AC electrical outlets and] concealed from interior view. The position of the motor and electrical connection is [left][right] side of roller, based on the hand of the user facing the shade from inside, unless otherwise indicated [on drawing][in the ROLLER WINDOW SHADE PLACEMENT SCHEDULE]. Provide motors capable of operating at or below 44 dBA measured 914 mm 3 feet from the center of the shade depending on the electronic drive unit selected; no audible clicks when motor starts and stops. Motors are [120V, 60 Hz] [low voltage with Class 2 power supply].

2.1.5.2 Controls

Provide electric controls with NEMA ICS 6, Type 1 enclosure for [surface][recessed or flush] mounting. Controls are able to electronically set and reconfigure shade open and close limits, shade preset positions, system groups and system subgroups at the control without rewiring and without access to the Electronic Drive Unit. Provide wall control engraved with button, group, or scene description as indicated on the drawings.

[a. Key Pad: Three-position, switch-operated control station with open, close, and off functions. Provide two keys per station. Battery operated key pads are not allowed.

][b. Switches: Wall-switch-operated control station with open, close, and center off functions. Switch Positions: [Three][Five]. Switch Style: [Toggle][Rocker].

][c. Group Control Station: Three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.

][d. Individual/Group Control Station: Three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.

][e. Sun Sensor Control: Provide solar adaptive shading software that automatically adjusts motorized shades throughout the day in response to the changing position and intensity of the sun. Customized shade schedules are developed combining information about building location and facade orientation. Wireless mullion sensors to be provided for cloudy-day override.

][f. Low Voltage Controls: Provide a digital system that includes a low-voltage interface to communicate with both wired and wireless inputs. Wireless controls to utilize radio frequency in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.

][g. Provide a whole building shade control system that can be preprogrammed and reprogrammed to accomplish different operations for management flexibility.

]2.1.5.3 Timer Controls

Clock timer, [24-hour][seven-day][_____] programmable for regular events.

[a. Provide switches that are adjustable and interlocked with motor controls and set to automatically stop the shade at fully raised and fully lowered positions.[Low voltage switching is required.]

][b. Operating Function: [Stop and hold shade at any position][Stop and hold shade at open, midpoint, and closed positions][Stop and hold shade at 3 pre-determined positions including open, closed and user-programmed position][Stop and hold shade at 5 pre-determined position including open, closed, and 3 user-programmed positions][_____].

][c. Provide the following options: [Low voltage system][Group switching with integrating switch control].[Capable of interface with [audiovisual][multi-room][_____] control system][Capable of accepting input from building automation control system][Override switch][Power failure memory for the life of the systems which protects presets][_____].

]2.1.5.4 Rollers

Provide corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shade bands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shade cloth for service.

a. Dual Shade Mounting Configuration: [Side by Side][Offset][_____].

b. Inside Roller: Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated on drawings]. Direction of Shade Cloth Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

c. Outside Roller: Drive-End Location: [Right side of interior face of shade][Left side of interior face of shade][As indicated on drawings]. Direction of Shade Band Roll: [Regular, from back (exterior face) of roller][Reverse, from front (interior face) of roller].

d. Shade Cloth-to-Roller Attachment: [Manufacturer's standard method][Removable spline fitting into integral channel in tube]. Adhesive attachment is not acceptable.

2.1.5.5 Sub Title

Provide corrosion resistant brackets or endcaps compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without removal of brackets and end or center supports.

2.1.5.6 Inside Shade Cloth

a. Shade Material: [Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____]][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.5.7 Outside Shade Cloth

a. Shade Material: [Light-filtering fabric: Openness [1 percent][3 percent][5 percent][_____]][Light-blocking fabric].

b. Shade Cloth Bottom (Hem) Bar: Steel or extruded aluminum. Provide shade bar [enclosed in sealed pocket of shade cloth material][exposed with endcaps][exposed with endcaps and integral light seal at bottom where it meets the sill].

2.1.5.8 Installation Accessories

a. Front Fascia: L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

[b. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open.

] c. Endcaps: Extruded aluminum with universal design suitable for mounting to window mullions. Provide size compatible with roller size. Provide end cap covers matching fascia/headbox finish.

[d. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel. Provide manufacturers standard height fascia as required to conceal roller and shade band assembly when shade is fully open. Provide pocket with lip at lower edge to support acoustical ceiling panel.

][e. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

][2.1.5.9 Room Darkening Shades

Provide room darkening (black-out) window shades designed to eliminate all visible light gaps when shades are fully closed, and conform with the following:

a. Provide roller tube made of aluminum. Provide shop fabricated light traps consisting of a head box to house the roller shade, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.

b. Provide light trap made of sheet steel having a minimum thickness of 0.64 mm 22 gauge or anodized, extruded, aluminum. Provide legs of the channels not less than 44 mm 1-3/4 inches long and separated by the minimum distance that permits free operation of the shade. Edges of light trap coming into contact with the shade cloth are smooth pile light seal. The exposed face of the head box is hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap have a finish coat of flat black enamel. The exposed portions of the light trap have a factory-applied priming coat of gray paint.

c. Provide type of cloth for blackout purposes. Provide shade from a single piece of [PVC polyester][PVC fiberglass][PVC free material][_____].

d. Fit the bottom edge of the shade with a steel operating bar. Shades to engage positively with bottom rail through operating bar or chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 778 N 175 pounds breaking strength.

]]2.2 COLOR

****

NOTE: Editing of color reference sentence(s) must

be coordinated with the Government. Generally, Section 09 06 00 SCHEDULES FOR FINISHES or drawings are used to indicate color references. Color must be selected from manufacturer's standard colors or identified as a manufacturer's color in this specification only when the project has minimal finishes.

When the government directs that color be located in the drawings, a note must be added to the drawings that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Considerations of fabric selection include: glare control, view maintenance, privacy and heat build-up. Identify if solar reflective property is required on the backside of the fabric and specify a dual-sided fabric if applicable.

When more than one type, pattern or color is specified identify location.

When a manufacturer's name, stock number, pattern, and color is specified for color, verify that the product conforms to the specification, as edited and is not a proprietary product.

****

Provide color, pattern and texture for metal trim and shade fabric [as specified in Section 09 06 00 SCHEDULES FOR FINISHES.] [as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.]

PART 3 EXECUTION

3.1 FIELD MEASUREMENTS

After becoming familiar with details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 ROLLER WINDOW SHADE PLACEMENT SCHEDULE

****

NOTE: The Roller Window Shade Placement Schedule will be provided at the designer's option when it will clarify placement of the window treatments. When all exterior windows are to receive a window treatment, a note can be added to this effect instead of filling out the schedule completely. The location of window treatment placement should be clearly defined within this specification. The Placement Schedule will be completely filled out with the room number/name, window covering type,

window type and quantity.
****

[All exterior windows include [_____].] [Provide window covering as follows:

Room Number/Name	Roller Window Shade Covering Type	Window Type/Size	Window Quantity
[_____]	[_____]	[_____]	[_____]

]

3.3 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Provide roller window shades, complete with necessary brackets, fittings, and hardware [in accordance with paragraph ROLLER WINDOW SHADE PLACEMENT SCHEDULE][as indicated].

Perform installation in accordance with the approved detailed drawings and manufacturer's installation instructions. Install units level, plumb, secure, and at proper height and location relative to window units. Provide and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Do not start installation until completion of room painting and finishing operations.

3.4 CLEAN-UP

Upon completion of the installation, clean window treatments and exposed components as recommended by manufacturer. Adjust window treatment for form and appearance and proper operating condition. Repair or replace damaged units as directed by the Contracting Officer. Isolate metal parts from direct contact with concrete, mortar, or dissimilar metals. Ensure shades installed in recessed pockets can be removed without disturbing the pocket. The entire shade, when retracted, is contained inside the pocket. For shades installed outside the jambs and mullions, overlap each jamb and mullion 19 mm 0.75 inch or more when the jamb and mullion sizes permit. Include all hardware, brackets, anchors, fasteners, and accessories necessary for a complete, finished installation.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-12 35 30.23 20 (August 2011)**

Preparing Activity: NAVFAC **Superseding**
UFGS-12 36 00.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

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BATHROOM CASEWORK

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-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-12 35 30.23 20 (August 2011)**

Preparing Activity: NAVFAC **Superseding**
UFGS-12 36 00.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 12 35 30.23 20

BATHROOM CASEWORK

08/11

****
NOTE: This guide specification covers the requirements for vanities for Bachelor Enlisted Quarters (BEQ).

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: Lavatories and wall base, if desired, must be specified in other sections. If the project requires custom wood millwork such as required in locations like the Marine Corps Air Station, Cherry Point and Marine Corps Base, Camp Lejeune, North Carolina, do not use this section. Custom wood vanities require the designer to show elevations, sections, and details which clarify materials, thicknesses, size, finishes, and support framing on the contract drawings and use Section 06 20 00 FINISH CARPENTRY to specify the product.
****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50565	(Basic; CANC Notice 1) Cabinet, Storage; Wardrobe, Three Drawer

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Vanities; G, [_____]

Show configuration, materials, thicknesses, hardware, finishes, and colors of vanities for the project.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver vanities undamaged and store in a safe, dry, and clean location. Handle so as to prevent damage.

PART 2 PRODUCTS

2.1 VANITIES

****

NOTE: Insert type and size required. Sizes listed should be used unless otherwise approved by the Engineering Field Division Code 04 in writing. If other sizes are required, determine whether modification of door/intermediate panel configuration is required to maintain proper door size and structural support.

****

Provide, [single lavatory type with double doors, Size [(750 mm30 inches wide)] [(900 mm36 inches wide)] [(1050 mm42 inches wide)] [(1200 mm48 inches wide)]] [double lavatory type with two sets of double doors, Size (1500 mm 60 inches wide)] [The type and size shall be [as indicated] [[_____] mm inches wide]], and except as specified herein. Wood construction shall be used. Particleboard shall not be used. Countertop, doors, and all wood panels shall be 20 mm 3/4 inch plywood, APA L870, Exterior Type, Grade A-A. Chromium-plated brass pulls or aluminum pulls and chromium-plated, spring-loaded, self-closing, adjustable, European type hinges may be used in lieu of pulls, hinges, and magnetic catches.

2.1.1 Quantity

[_____] [As indicated].

2.2 FINISHES

****

NOTE: Since a wood or steel constructed vanity is the Contractor's option, specify finish, pattern, and color for laminated plastic for both and a paint color for steel.

****

Five-digit designations refer to SAE AMS-STD-595A.

2.2.1 Exposed Surfaces

Exterior of doors and exposed surfaces of cabinet body shall be decorative laminated plastic of color and pattern [indicated] [specified].

2.2.2 Concealed Surfaces

Interior of doors and cabinet body, and concealed exterior surfaces of cabinet body, shall be nondecorative laminated plastic.

2.3 END CURBS

****

NOTE: Delete this paragraph if end curbs are not required.

****

Provide end curbs to match back splash where end of countertop abuts a wall.

2.4 DRAWERS

****

NOTE: Delete this paragraph if drawers are not required.

****

Where drawers are indicated in vanities, comply with CID A-A-50565 for drawers, drawer slides, and slide supports.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Final Assembly

Distribute vanities to rooms [as indicated] [as directed]. Uncrate, assemble, adjust as necessary, and place as specified or indicated, complete with accessories and hardware. Position vanities [as indicated] [as directed].

3.1.2 Fastening

****

NOTE: Ensure that work referred to is actually specified in the referenced sections.

****

Fasten wood vanities as indicated on the drawings and as specified. Fasten steel vanities through the holes in vanity back flanges. Fasteners shall be appropriate for use with the wall construction. Seal joint between back splash and wall and between end curb and wall as specified in Section 07 92 00 JOINT SEALANTS.

-- End of Section --

****

USACE / NAVFAC / AFCEC | **UFGS-12 35 39 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE | **Superseding**
UFGS-12 35 39 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

SECTION 12 35 39

COMMERCIAL KITCHEN CASEWORK

08/17, CHG 1: 08/18

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-12 35 39 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-12 35 39 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 12 35 39

COMMERCIAL KITCHEN CASEWORK
08/17, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for foodservice casework, countertops, slide rails, food shields, pass through shelves, and other accessories.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Coordinate this section and use in conjunction with the following sections:

11 05 40 - COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT
11 06 40.13 - FOODSERVICE EQUIPMENT SCHEDULE

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NSF INTERNATIONAL (NSF)

NSF/ANSI 2	(2022) Food Equipment
NSF/ANSI 35	(2020) High Pressure Decorative Laminates for Surfacing Food Service Equipment

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M	(2006) MILSTRIP - Military Standard Requisitioning and Issue Procedures

1.2 DEFINITIONS

Refer to Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE.

1.3 SUMMARY

****

NOTE: Indicate the configuration and layout for all casework, countertops, slide rails, sneeze guards, and other accessories, with casework and counter details, and each equipment item identified by number. Show "FoodService Equipment Schedule" on the drawings using the same identification numbers as indicated in Section 11 06 40.13 FOODSERVICE EQUIPMENT SCHEDULE[, as indicated on the current US Army Quartermaster Center and School equipment schedule]. Ensure that all Contractor built-to-order items, per equipment schedule, are shown and coordinated with the specifications.

Coordinate with other sections for final connection of equipment.

Details of particular equipment and installations are provided on Naval Food Service Division

drawings. Use these NAVFSD drawings as a basis for the project details. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

****

General requirements, including all mechanical, electrical, health and safety, are specified in Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT. Provide detailed equipment Schedule conforming to DOD 4000.25-1-M.

1.3.1 General Requirements

The work includes [furnishing] [and] [installing] [and modifying existing] [casework] [countertops] [slide rails] [_____] for foodservice and related work. Verify all existing dimensions, contract drawings, product data and all related conditions prior to commencing rough-in work. Include coordination of delivery through existing finished opening and vertical handling limitations within the building. Advise the Contracting Officer of all discrepancies prior to ordering equipment. Submit Field Verification Data prior to the preconstruction meeting. Provide rough-in and connect utilities to equipment in accordance with requirements specified in Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT and with the physical dimensions, capacities and other requirements of the equipment furnished. Submit Detail Drawings for foodservice casework, countertops, and rails in the same format as the equipment schedule on the drawings.

1.3.2 Foodservice Configuration

****

NOTE: Details of particular equipment and installations are provided on Naval Food Service Division drawings. Use these NAVFSD drawings as a basis for the project details. Contact Supported Command to assist with identification of kitchen equipment necessary to meet mission requirements.

Equipment Item	**NAVFSSO Dwg. File**
Clean Gear Dresser	**541**
Clean Gear Table	**553**
Service Stand	**851**
Counter Front With Tray Slide	**857**

On the drawings, show:

1. A 1:50 1/4 inch scale floor plan with layout of all foodservice equipment, casework, counters and rails using Naval Equipment Symbols.

2. A food Service Equipment Schedule laid out in accordance with current CNIC's Galleys Department or US Army Quartermaster Center and School equipment

schedules, and specified design requirements.

3. Wall and ceiling penetrations.

4. Raised bases, retainer curbs, or depressions.

5. Recessed, grated floor drains required for equipment.

6. Utility connections to building water, sanitary, electrical, and other utility systems coordinated with all casework. Convenience outlets at point of use for plug-in equipment.

7. All Contractor built-to-order items, per equipment schedule, shown and coordinated with the specifications.

8. Electrical chases and raceways and plumbing chases.

****

Submit coordinated detail drawings for [casework] [countertops] [slide rails] [_____]. On layout drawing, use Naval Equipment Symbols designated herein. Refer to Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT for complete detail drawing requirements. Follow all the applicable NSF International standards for equipment. Submit within [60] [_____] days of award of contract. Drawings scale: 1:50 (1/4 inch) minimum..

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Field Verification Data; G, [_____]

SD-02 Shop Drawings

Foodservice Configuration; G, [_____]

Food Service Equipment Schedule; G, [_____]

SD-03 Product Data

Recycled Content for steel components; S

SD-04 Samples

Closure Panels; G, [_____]

1.5 PRE-INSTALLATION MEETINGS

Thirty [_____] days prior to the commencement of work, notify the Contracting Officer that the submittal items listed above are prepared and ready for review.

1.6 DELIVERY, STORAGE AND HANDLING

Submit and comply with manufacturer's instructions for shipping, handling, storage, installation and start-up.

PART 2 PRODUCTS

2.1 STEEL COMPONENTS

Provide Steel Components with a minimum of 60 percent recycled content. Provide data identifying percentage of recycled content for steel components.

2.2 CAFETERIA; BUFFET; HOT AND COLD COUNTERS

2.2.1 Counter Edges and Backsplashes

2.2.1.1 Counter Edges

Provide counter edges, as required by design, of the following types:

2.2.1.1.1 Turned Down

50 mm 2 inch at 90 degrees with 19 mm 3/4 inch tight hem at bottom. Round free corners with 19 mm 3/4 inch radius.

2.2.1.1.2 Marine Edge

Turned up[13 mm 1/2 inch] [and] [38 mm 1-1/2 inch] at 45-degree angle and turned down 50 mm 2 inch at 135 degree angle with 19 mm 3/4 inch tight hem at bottom.

2.2.1.1.3 Rolled Rim

Coved up 75 mm 3 inch with 38 mm 1-1/2 inch wide rim rolled 180 degrees and turned down to table top; hem edges, and bullnose corners.

2.2.1.2 Counter Backsplash

Provide counter backsplash of the following types:

2.2.1.2.1 Coved Up

Coved up [250] [_____] mm [10] [_____] inch and sloped back 38 mm 1-1/2 inch at the top on a 45-degree angle; 63 mm 2-1/2 inch slope where piping occurs. Turned down 25 mm 1 inch at 135 degrees at the rear of the splash with the ends closed to the bottom of the top turn down. Secure splash turn down to wall with 100 mm 4 inch long, 1.9 mm 14 gauge stainless steel "zee" clips anchored to wall, 900 mm 36 inches on center.

2.2.1.2.2 Turned Up

Turned up [150] [_____] mm [6] [_____] inch at 90 degrees on a 16 mm 5/8 inch radius with edge turned back[25 mm 1 inch] [50 mm 2 inch] at 90-degree angle with 25 mm 1 inch turn down at 90 degrees at rear of splash with the ends closed to the bottom of the top turn down. Secure splash turn down to wall with 100 mm 4 inch long, 1.9 mm 14 gauge stainless steel "zee" clips anchored to wall, 900 mm 36 inch on center.

2.2.2 Counter Bases

****

NOTE: Indicate the type desired for the individual pieces of equipment or specify which is to be used. Alternatively, both types may be specified as a Contractor's option.

****

2.2.2.1 Closed Counter Bases

Fabricate with 38 by 38 by 3 mm 1.5 by 1.5 by 0.125 inch galvanized steel angles with all corners mitered, welded and ground smooth. Provide horizontal and vertical angles at 600 mm 2 feet on-center. Fabricate closure panels of 1.2 mm 18 gage thick stainless steel or 1.2 mm 18 gage thick galvanized steel with laminated plastic material in accordance with NSF/ANSI 35. Fabricate joint trim of 50 mm 2 inch wide, 1.8 mm 14 gage thick stainless steel; attach with concealed bolts or screws. For enclosed bases provide double-wall at ends and partitions. Weld support legs to body support angles. [Use closed-type bases on [_____].]

2.2.2.2 Open Counter Bases

Fabricate and crossbrace with 40 mm 1.625 inch outside diameter, 1.5 mm 16 gage thick stainless steel tubing. Weld crossbraces to legs to reinforce each leg. Weld legs to gussets. Make gussets of stainless steel, fully enclosed, a minimum of 75 mm 3 inches in diameter at top, reinforced with bushing, and continuously welded to support channels located under the counter top. [Use open-type bases on [_____].]

2.2.3 Legs

Fabricate of 1.5 mm 16 gage thick, 40 mm 1.625 inch outside diameter stainless steel tubing. Continuously weld to angles on closed bases and gussets on open bases. Finish bottom of legs smoothly. Overlap stem of feet to provide a sanitary fitting.

2.2.4 Pedestal Bases

Fabricate of 2.5 mm 12 gage thick stainless steel for serving line counters. Make pedestal 200 mm high, 250 mm wide, and 600 mm long 8 inches high, 10 inches wide, and 24 inches long with top and bottom edges flanged 38 mm 1.5 inch to the inside at 90 degrees. Provide holes in both flanges for 13 mm 0.5 inch lag screws. Locate utility stub-ups inside pedestal and run to designated equipment.

2.2.5 Feet

Die-stamped stainless steel, bullet shaped, fully enclosed, with slightly rounded bottom. Fit top of feet with male threaded stem to mate with end of legs and provide for a 25 mm 1 inch adjustment without threads being exposed.

2.2.6 Casters

Provide heavy-duty, ball bearing disc wheel, with replaceable grease-proof rubber or neoprene tires and brakes. Provide tires with minimum 125 mm 5 inch diameter and minimum 25 mm one inch width of tread and 90 kilograms 200 pounds capacity per caster. Provide pressure-type grease fittings, threaded guards, and plated finish.

2.2.7 Open Base Shelves

Fabricate of 1.5 mm 16 gage thick stainless steel with all edges turned down 50 mm 2 inches at 90 degrees on a 6 mm 0.25 inch radius with bottom edges turned back 13 mm 0.5 inch at 45 degrees. Notch corners 90 degrees, and intersections 180 degrees. Weld to legs at corners and intersections. Locate legs maximum 1200 mm 48 inches apart. Shelving to be removable without use of tools.

2.2.8 Closed Base Interior Shelves

Fabricate of 1.5 mm 16 gage thick stainless steel. Turn back and side edges up 50 mm 2 inches at 90 degrees on a 6 mm 0.25 inch radius. Turn front edge down 50 mm 2 inches at 90 degrees on a 6 mm 0.25 inch radius and back 6 mm 0.25 inch at 45 degrees. Reinforce shelves longer than 750 mm 30 inches with 38 by 38 by 3 mm 1.5 by 1.5 by 0.125 inch galvanized steel angles under front edge and horizontal center of the shelf. Shelving to be removable without use of tools.

2.2.9 Shelf Pan Slides

Provide 1.8 mm 14 gage thick stainless steel 38 by 38 by 3 mm 1.5 by 1.5 by 0.125 inch angles, with front and back corners rounded and finished smooth. Set angles at 50 mm 2 inches on-center for 450 by 660 mm 18 by 26 inch bun pans and 300 by 500 mm 12 by 20 inch serving pans.

2.2.10 Drawers

Provide die-stamped 1.2 mm 18 gage thick stainless steel, 500 by 500 by 125 mm 20 by 20 by 5 inch deep. Ensure drawer body can be easily removed for cleaning with top edges flanged out 13 mm 0.5 inch. Round interior horizontal corners on a 25 mm one inch radius and interior vertical corners on a 50 mm 2 inch radius. Fabricate supporting frame of 1.8 mm 14 gage thick stainless steel channel. Weld drawer face to frame. Die-stamp drawer face with raised border for rigidity. Die-form an integral open sanitary handle into face. Mount drawer slides with ball bearing nylon or stainless steel rollers on channel frame. Provide with slides and frame which allow for full opening of drawer, and are reinforced to support a weight of 22.5 kg 50 pounds when fully extended. Provide stops for each drawer at fully open position. Enclose drawers on open-base tables in 1.2 mm 18 gage thick stainless steel housing.

2.2.11 Doors

Provide stainless steel double-cased doors, 1.2 mm 18 gage thick outer pan with corners welded, ground smooth and polished; 0.9 mm 20 gage thick inner pan fitted tightly into outer pan with core of sound deadening material. Tack-weld outer and inner pans together with solder-filled seam. Provide doors approximately 20 mm 0.75 inch thick and fitted with flush-recessed, stainless steel door pulls. Mount doors on stainless steel piano or concealed hinges.

2.3 TRAY SLIDE

****

NOTE: Install tray slides for Enlisted General Messes as an integral fabrication of serving line counterfront; NAVFSSO drawing 11103-857 and as specified in the applicable Standard for other equipment.

****

[Solid] [Tube] type, 300 mm 12 inch wide; mounted 865 mm 34 inches above floor. Extend to full length of supporting counter.

[2.3.1 Solid Type

Provide solid type constructed with 1.8 mm 14 gage thick stainless steel with front and back edges rolled 45 mm 1.75 inch at 180 degrees. Ensure top edge of roll is 10 mm 0.375 inch above flat surface of slide. Provide three inverted "V" forms, approximately 10 mm 0.375 inch high, in flat surface of slide as running surface for trays. Close ends of slide.

][2.3.2 Tube Type

Provide four 25 mm one inch diameter 1.5 mm 16 gage thick stainless steel tubes with supporting hardware. Close both ends of each tube.

]2.3.3 Support Brackets

Stainless steel or chromium plated. Secure to counter with stainless steel bolts. Space 1200 mm 4 feet on-center. Provide [stationary] [fold-down] type extending under full width of tray slide.

2.3.4 Protector Shelf

Install and locate protector shelf as indicated on the drawings. Fabricate top of 1.8 mm 14 gage thick stainless steel with all edges rolled down 180 degrees for 38 mm 1.5 inches with bullnosed corners. Shelf to be minimum 250 mm 10 inches wide.

2.3.5 Shelf Frame

Provide 25 by 25 mm one by one inch, 1.5 mm 16 gage thick stainless steel square tubing under all edges of shelf at 750 mm 30 inches on center.

2.3.6 Shelf Frame Support

Form front uprights of 30 by 30 mm 1.25 by 1.25 inch, 1.5 mm 16 gage thick stainless steel tubing. Form back uprights of 25 by 25 mm one by one inch, 1.5 mm 16 gage thick stainless steel square tubing. Provide a horizontal brace, 25 mm one inch above bottom of front uprights. Space front uprights 750 mm 30 inches apart or less, fit with die-formed flanges to be attached to counter top from underside with bolts, and slope 10 degrees to rear.

2.4 PROTECTOR GLASS

6 mm0.25 inch thick, transparent [clear tempered plate glass] [heat and mar resistant clear acrylic]. Frame edges with 13 mm 0.5 inch, 0.09 mm 20 gage thick stainless steel channel. [Glass] [Acrylic] to be easily replaced in the event of [breakage] [damage]. Provide matching [glass] [acrylic] end panels. Round all free corner on 19 mm 3/4 inch radius.

2.5 FOOD SHIELD

Provide self-serve food shield conforming to NSF/ANSI 2 constructed of 1.6 mm (16 gauge) 16 gauge stainless steel, with a minimum width of at least 300 mm 12 inch with a full 25 mm 1 inch skirt with 19 mm 3/4 inch tight hem on all sides. Support on stainless steel uprights [at front] [as indicated on drawings]. Round all free corners with 19 mm 3/4 inch radius.

a. Provide adjustable louver brackets below the top fitted with 6 mm 1/4 inch polished, [tempered plate glass][heat and mar-resistant clear acrylic] framed in an all welded stainless steel channel and installed with a 175 mm 7 inch clearance above counter top.

b. Install fluorescent light fixtures the full length of the non-heated undershelf displays, with translucent protection guard. Conceal display light wiring in a corner post. Prewire fixtures to a single recess-mounted master switch per serving shelf.

2.6 DRIP GUTTER

Provide drip gutter as integral part of counter tops, where indicated. Provide a 25 mm one inch brass drain tube centered in bottom of gutter with bottom pitched to drain. Make drip gutter 100 mm wide, 25 mm deep 4 inches wide, one inch deep, and length indicated. Provide removable, stainless steel, die-stamped, anti-splash strainer with finger hole.

[2.7 COLORS

[Refer to Section 09 06 00 - SCHEDULES FOR FINISHES.][As indicated on drawings.]

]PART 3 EXECUTION

3.1 INSTALLATION,

Install as specified in Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT.

3.2 MANUFACTURER'S FIELD SERVICES

As specified in Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENT.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-12 35 70 (August 2016)**
Change 2 - 11/18

Preparing Activity: USACE **Superseding**
UFGS-12 35 70 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 12 - FURNISHINGS

SECTION 12 35 70

HEALTHCARE CASEWORK

08/16, CHG 2: 11/18

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC	**UFGS-12 35 70 (August 2016)** **Change 2 - 11/18**
Preparing Activity: USACE	**Superseding** **UFGS-12 35 70 (August 2010)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 12 35 70

HEALTHCARE CASEWORK

08/16, CHG 2: 11/18

****

NOTE: This guide specification covers the requirements for metal and wood casework for medical and dental facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This specification covers metal and wood casework, normally preassembled, for installation as fixed or built-in elements in medical and dental facilities. The "casework" includes: Cabinets, singularly or in assemblies; treatment room units wardrobes; deck units; reagent racks; countertops and sink; plus their components; hardware and service fixture trim. All casework must be shown on the drawings.

A schedule of casework, shown in alpha-numerical order, will be included on the drawings. Schedules will include the Joint Schedule Number (JSN) designator, and dimensions. The schedule or

elevations should indicate the number of shelves required. Joint Schedule Numbers (JSN) or the National Stock Numbers are specified in MIL-STD-1691. Any additional specially required casework items which are not covered by MIL-STD-1691 should be described herein and identified on the drawings and schedule.

On the drawings, show:

1. Sizes and spacing of casework units, plumbing fixtures and utility outlets.

2. Schedule of casework including all component parts and accessories.

3. Details of connections and anchorage where special conditions exist. Size and spacing of anchors.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants

CALIFORNIA AIR RESOURCES BOARD (CARB)

CARB 93120	(2007) Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-1691	(1994; Rev F; Notice 1 2024) Construction and Material Schedule for Military Medical and Dental Facilities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 770	Formaldehyde Standards for Composite Wood Products

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Casework

Recycled Content for Baked Enamel Carbon Steel Medical Casework; S

Recycled Content for Corrosion Resisting Steel Medical Casework; S

Recycled Content for Wood Core Medical Casework; S

Recycled Content for Carbon Steel Medical Casework; S

Recycled Content for Wood Core Dental Casework; S

Recycled Content for Carbon Steel Dental Casework; S

Recycled Content for Baked Enamel Carbon Steel Dental Prosthetics Casework; S

Recycled Content for Corrosion Resisting Steel Dental Prosthetics Casework; S

Recycled Content for Corrosion Resisting Steel Countertops; S

Recycled Wood Content for Plastic Laminate Countertops; S

SD-04 Samples

Casework; G, [_____]

Wall Hung Cabinets; G, [_____]

Floor Mounted Cabinets; G, [_____]

Countertops; G, [_____]

Laminated Plastic Sheets; G, [_____]

SD-07 Certificates

Certified Sustainably Harvested Wood for Medical Casework; S

Certified Sustainably Harvested Wood for Countertops; S

Indoor Air Quality for Composite Wood and Agrifiber Products Used In Countertops; S

SD-08 Manufacturer's Instructions

Installation

1.3 CERTIFICATIONS

1.3.1 Certified Sustainably Harvested Wood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects pursuing third-party certification allow the entire list of third party certifications.

****

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

[1.3.2 Indoor Air Quality Certification

****

NOTE: Include this subparagraph when composite wood or agrifiber products are included in project.

****

For purposes of this specification, composite wood and agrifiber products include particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, and door cores. Provide products certified to meet requirements of both 40 CFR 770 and CARB 93120. Provide current product certification documentation from certification body.

]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver casework to the jobsite in the original individual containers, complete with screws, keys, and instructions. Mark each container with the manufacturer's name and catalog number. Store casework in an adequately ventilated, dry location that is free of dust, water, or other contaminates and in a manner to permit access for inspection and handling. Handle casework carefully to prevent damage to the surfaces. Replace damaged items that cannot be restored to like-new condition.

PART 2 PRODUCTS

2.1 CASEWORK

****

NOTE: Joint schedule numbers used in MIL-STD-1691 provide the Military Medical Services a uniform basis for identifying casework items in medical and dental facilities. Any items required which are not covered by MIL-STD-1691 should be described appropriately and identified on the drawings with a new assigned number.

Tempered or high-density hardboard is suitable for drawer bottoms. In plastic laminate covered cabinets, back doors with plastic-laminate backing sheets.

Require non-ferrous metal fasteners, fittings, and hardware wherever possible, especially in high humidity areas of facilities.

****

Submit for approval Drawings showing layout of casework at 1:20 3/4 inch equals one foot scale. Indicate details of construction and rough-in requirements. Indicate whether cabinets are metal or wood, whether countertop is corrosion-resisting steel or plastic laminate, and whether sink is coated with [modified epoxy resin] [polypropylene] [polyethylene] or corrosion-resisting steel. All wood products must be formaldehyde free. Verify job condition affecting the work and obtain accurate field measurements for incorporation into drawings. Locate structural members, required utilities and services provided by other sections of this specification. Submit details and information necessary for fabrication and installation, manufacturer's printed data, catalog cuts, and instructions for installation and cleaning. Provide casework as scheduled on the detail drawings. Factory fabricate of manufacturer's standard sizes and finishes and conform to MIL-STD-1691, and the requirements specified below. Supplementary ordering data are as follows: [_____]. Casework items are identified on drawings with numbers preceded by the letters "C" and "D". These numbers are Joint Schedule Numbers in MIL-STD-1691.[Provide material finish and color [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [_____].]

2.1.1 Medical Casework

****

NOTE: Plastic laminated casework may be used in non corrosive areas such as hospital rooms and nursing stations. Corrosion resisting steel should be specified for areas, such as laboratories, where highly corrosive chemicals are handled. Enameled carbon steel casework should be utilized to the maximum practicable extent in lieu of corrosion-resistant steel.

****

Provide medical casework of [baked enamel carbon steel] [corrosion resisting steel] [wood core or carbon steel covered with laminated plastic sheets]. Color of finish [_____] [in accordance with color schedule as indicated] [selected by the Contracting Officer from the manufacturer's standard colors].

2.1.1.1 Recycled Content

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is commonly available above the minimum recycled content percentages shown below. However, higher percentages may be available. Based on research, insert desired minimum percentages into the empty set of brackets.

****

[Baked enamel carbon steel must contain a minimum of [40][____] percent recycled content. Provide data identifying percentage of recycled content for baked enamel carbon steel medical casework.] [Corrosion resisting steel must contain a minimum of [40][____] percent recycled content. Provide data identifying percentage of recycled content for corrosion resisting steel medical casework.] [Wood core must contain a minimum of [50][____] percent recycled content. Provide data identifying percentage of recycled content for wood core medical casework.] [Carbon steel covered with laminated plastic sheets must contain a minimum of [40][____] recycled content. Provide data identifying percentage of recycled content for carbon steel medical casework.]

2.1.1.2 Sustainably Harvested Wood

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying this certification.
****

Wood materials must contain a minimum of [50][_____] percent wood that is certified sustainably harvested. Provide documentation that certified sustainably harvested wood for medical casework is used and identify percentage.

2.1.2 Dental Casework

****
NOTE: When selection is to be made from manufacturer's standard samples, specify whether solids or woodgrains are required.
****

Provide dental operator casework of [wood core] [carbon steel] covered with laminated plastic sheets. Pattern, color and finish of decorative laminated plastic for exteriors of casework [_____] [in accordance with color schedule as indicated] [selected by the Contracting Officer from the manufacturer's standard [color] [woodgrain] samples].[

****
NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is commonly available above the minimum recycled content percentages shown below. However, higher percentages may be available. Based on research, insert desired minimum percentages into the empty set of brackets.
****

Wood core covered laminated plastic sheets must contain a minimum of [50][____] percent recycled wood content. Provide data identifying percentage of recycled content for wood core dental casework.] [Carbon steel covered laminated plastic sheets must contain a minimum of [40][____] percent recycled steel content. Provide data identifying percentage of recycled content for carbon steel dental casework.]

2.1.3 Dental Prosthetics Casework

Provide dental prosthetics casework of [baked enamel carbon steel] [corrosion resisting steel]. Color of finish [_____] [in accordance with color schedule as indicated] [selected by the Contracting Officer from the manufacturer's standard colors].[

****
NOTE: Use materials with recycled content where appropriate for use. Verify suitability,

availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is commonly available above the minimum recycled content percentages shown below. However, higher percentages may be available. Based on research, insert desired minimum percentages into the empty set of brackets.

****

Baked enamel carbon steel must contain a minimum of [40][____] percent recycled steel content. Provide data identifying percentage of recycled content for baked enamel carbon steel dental prosthetics casework.] [Corrosion resisting steel must contain a minimum of [40][____] percent recycled steel content. Provide data identifying percentage of recycled content for corrosion resisting steel dental prosthetics casework.]

2.1.4 Countertops

****

NOTE: Do not specify countertops constructed of particle board for high humidity locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. See UFC 1-200-01 for determination of ESC for project locations.

****

Provide countertops of [corrosion-resisting steel] [plastic laminate covered plywood] [plastic laminate covered particleboard] [modified epoxy resin] [or] [resin coated laminated pressed wood fiber]. In lieu of individual samples, complete minimum size casework may be submitted as samples. Mock-up units are not acceptable. Provide samples of sufficient size to show color, pattern, and method of assembly. Some requirements are:

Countertop and backsplash	One section, containing both
Door and drawer front	One of each, with hardware mounted
Melamine plastic color samples	approx 50 X 75 mm 2 X 3 inch size
Stain/color samples	approx 50 by 75 mm 2 by 3 inch size

[2.1.4.1 Recycled Content

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Research shows the product is commonly available above the minimum recycled content percentages shown below. However, higher percentages may be available. Based on research, insert desired minimum percentages into the empty set of brackets.
****

[Corrosion-resisting steel must have a minimum of [40][_____] percent recycled steel content. Provide data identifying percentage of recycled content for corrosion resisting steel countertops.] [Plastic Laminate (plywood or particleboard) must have a minimum of [50][_____] percent recycled wood content. Provide data identifying percentage of recycled wood content for plastic laminate countertops.]

]2.1.4.2 Sustainably Harvested Wood

Wood materials must contain a minimum of [50][_____] percent wood that is certified sustainably harvested. Provide documentation that certified sustainably harvested wood for countertops is used and identify percentage.

2.1.4.3 Indoor Air Quality Requirements

Provide certification of indoor air quality for composite wood and agrifiber products used in countertops.

2.2 PLUMBING FIXTURES

Provide faucet, trap and drain fittings, gas, air and vacuum cocks as required. Provide connection conforming to the requirements specified in Section 22 00 70 PLUMBING, HEALTHCARE FACILITIES.

PART 3 EXECUTION

3.1 INSTALLATION

Install casework in a manner that does not damage the work of other trades. Secure the casework in place in true alignment, level, and plumb. Secure units with screws through backs to cleats that have been anchored to building structure with toggle or expansion bolts.

Do not install building construction materials that show visual evidence of biological growth.

3.1.1 Wall Hung Cabinets

Install wall-hung cabinets to support the weight of the cabinets plus the normally expected weight of the contents of the cabinets. Space fasteners 300 mm 12 inch on center using at least three bolts in each 900 or 1200 mm 3 or 4 foot unit width. Join adjacent cabinets in an assembly together at top and bottom with inconspicuous bolts or clips. Seal joints between the casework and wall surfaces which are not larger than the joints between casework sections with sealant conforming to ASTM C920, Type M, Grade NS, Class 25, Use NT. Close larger joints with filler strips of the same material and finish as adjacent casework. Cut filler strips to the contour of the wall surface and secure to the casework with concealed nails or screws. Use filler strips no wider than 150 mm 6 inch.

3.1.2 Floor Mounted Cabinets

Set floor-mounted metal cabinets on a common metal base or integral base, in assemblies up to 1800 mm 6 feet in length in rooms having concrete or resilient flooring. Bolt cabinets to bases at cabinet corners. Face metal bases with resilient material to match wall base in space where the cabinets are located. Fasten together adjoining cabinets at top and bottom of front and back with bolts placed inconspicuously inside cabinets. Set metal cabinets in rooms having terrazzo or ceramic-tile floors on concrete or masonry bases with exposed faces finished the same as other bases in the room. Seal flush openings between cabinet and wall surfaces, due to irregularity of surfaces, with Type S or M, Grade NS, Class 12.5, use NT, conforming to ASTM C920. Close exposed-to-view openings larger than joints in tile work with filler or scribing strip of the same material and finish as adjacent casework. Cut filler to contour of wall surface and secure to casework with concealed sheet-metal screws. Use minimum width and number of fillers consistent with need and do not use filler exceeding 150 mm 6 inch in width.

3.1.3 Countertops

Height of counter tops as indicated. Where required, provide toe space at front of cabinets by installing front face of cabinets 75 mm 3 inch in front of face of base. Where toe space is not required, face of base and cabinets must be flush. Bases must have a height of approximately 100 mm 4 inch. Install all items as required for proper operation in accordance with the manufacturer's directions.

3.2 INSPECTION AND CLEANING

Inspect placed items for proper location, fastening, connection to utilities, operation, and for damage which may have occurred during installation. Put each item into service to prove proper operation. Correct defects disclosed during inspection. Clean cabinets and countertops in accordance with manufacturer's instructions.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-12 48 13 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-12 48 13 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

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SECTION 12 48 13

ENTRANCE FLOOR MATS AND FRAMES

08/23

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-12 48 13 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-12 48 13 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 12 48 13

ENTRANCE FLOOR MATS AND FRAMES
08/23

****

NOTE: This guide specification covers the requirements for entrance floor mats and frames.

Indicate on drawings the location, size, and shape of mats.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM D2047	(2017) Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUSTAINABILITY REPORTING

Materials in this technical specification may increase contract compliance with sustainability requirements.

****
NOTE: The bracketed items are representative of LEED material documentation and requirements that may apply to this project. These items should be edited to reflect the project requirements.
****

1.2.1 EPA Comprehensive Procurement Guidelines

See Section 01 33 29 SUSTAINABILITY REPORTING for requirements associated with EPA-designated products.

1.2.2 USDA Biobased

See Section 01 33 29 SUSTAINABILITY REPORTING for requirements associated with USDA Biobased products.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

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****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G, [_____]

Detail Drawings; G, [_____]

Custom Graphics Drawings; G, [_____]

SD-03 Product Data

Entrance Floor Mats and Frames; G, [_____]

Adhesives and Concrete Primers; G, [_____]

SD-04 Samples

Entrance Floor Mats and Frames; G, [_____]

Custom Graphics; G, [_____]

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-10 Operation and Maintenance Data

Protection, Maintenance, and Repair Information

****

NOTE: Entryways in heavy-use facilities may require entrance mat and frame systems with a higher structural loading requirement. Coordinate floor requirements such as recessed systems with appropriate building designers.

****

1.4 QUALITY CONTROL

Comply with 36 CFR 1191 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines for installed entrance floor mats and frames. Ensure that entrance floor mats and frames are slip-resistant in accordance with ASTM D2047, with a minimum 0.60 coefficient of friction, for accessible routes and are structurally capable of withstanding a [uniform floor load of 14 kPa 300 lb/sq ft][wheel load of 160 kg/wheel 350 lb/wheel]. Ensure that flammability is in accordance with ASTM E648, Class 1, Critical Radiant Flux, minimum 0.45 watts/square centimeter.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the project site in their original packages or containers bearing labels clearly identifying the manufacturer, brand name, and quality or grade.

Store materials in their original unbroken packages or containers in the area in which they will be installed. Unwrap, inspect, and place mats at indicated locations. Remove all excess packing materials.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

2.1.1 Entrance Floor Mats and Frames

Submit the manufacturer's catalog data. Submit samples of assembled sections of floor mats showing corners, intersections, and other details of construction. Submit samples of custom graphics, exposed floor mats, frame finishes and accessories.

2.1.1.1 Resilient-Link Mats

Provide [rubber][vinyl][rubber-tire] resilient-link mats, [9.5][11] mm [3/8][7/16] inch thick with [galvanized-spring][stainless] steel wire link rods. Ensure that nosing is vulcanized and [beveled for surface installation extending approximately 50 mm 2 inches around the perimeter][square for recess or mats butted one to another]. Provide mats with steel-reinforced end trim that is [close-weave with link openings of 1.6 mm by 12 mm 1/16 inch by 1/2 inch][open-weave with link openings of 38 mm by 12 mm 1 1/2 inches by 1/2 inch].

2.1.1.2 [Rubber][Vinyl] Mats

Provide mats [6.4][9.6][1.6][_____] mm [1/4][3/8][1/16][_____] inches thick with [square edges for recessed installations][beveled edges for surface applications]. Provide mats with [solid sheet (no perforations) style][perforated style, 6 mm 1/4-inch diameter on standard spacing] [perforated style, 5 mm by 19 mm 3/16 inch by 3/4 inch on standard spacing][standard pyramid design with knob back][standard wide-wale corrugated][hi-rib, narrow-wale corrugated] top profile and [low-rib, narrow-wale corrugated][standard knob-base][flat-base] bottom surface. Ensure that mats are made of a nonslip prime-quality compound free of calendaring and curing defects, and resistant to weather aging and ozone in normal concentrations.

2.1.1.3 Coco Mats

****

NOTE: Coco (also spelled cocoa) matting makes ideal scraper mats, which effectively remove dirt, debris and moisture from shoes.

****

Provide coco brush mats made of high-quality coir yarn from coconut husk fibers. Secure mats with a heavy-duty vinyl backing, woven tightly together and securely bound around the perimeter with matching coir yarn rope. Overall thickness is [16][19][25][32] mm [5/8 inch][3/4 inch][1 inch][1 1/4 inches].

2.1.1.4 Recycled Rubber Tire [Tiles][Mats]

Provide recycled rubber tire [tiles] [mats] that are made from recycled truck, bus and aircraft tires, with sidewall cords and are buffed to a chenille finish. Ensure that the [tiles] [mats] are bonded to a woven flexible backing to form 9.5 to 11.1 mm 3/8- to 7/16- inch-thick[300 mm 12-inch -wide tiles][300 mm 12-inch-wide rolls up to 7.5 m 25 feet long].

2.1.1.5 Carpet-Type Mats

Provide a [nylon][polypropylene][olefin][polyester][____] carpet bonded to a 3 mm to 6 mm 1/8-inch to 1/4-inch-thick, flexible vinyl backing to form mats that are [9.5][11] mm [3/8][7/16] inch thick with nonraveling edges.

2.1.1.6 Loop Filament Mats

Provide loop filament vinyl material [9.5][13] mm [3/8][1/2] inch thick, with [solid vinyl sheet] [foam sheet] backing. Ensure that chemical agents are built into the backing to reduce fungus and mildew.

2.1.1.7 Roll-Up Mats

Provide roll-up mats with [mill finish] [[clear][bronze]] [black] [anodized] [_____] aluminum tread rails spaced a maximum 51 mm 2 inches on center and running counter to the traffic flow. Ensure that the mats must allow debris to fall to subfloor. Ensure that tread rails are connected by [aluminum] [vinyl] hinges and include [an aluminum] [a vinyl] edge around the perimeter and a continuous vinyl cushion.

Provide [recessed] [surface] mats mounted with [carpet consisting of nylon or polypropylene carpet fibers fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths. Carpet has antistatic and antistain treatments] [carpet/bristle filament mix] [vinyl] [abrasive tape] [poured abrasive] [recycled rubber] [serrated aluminum] [_____] inserts.

2.1.1.8 Floor Grids

Provide a floor grid consisting of a series of [aluminum][bronze] tread rails spaced [38] [_____] mm [1 1/2] [_____] inches on center and running counter to the traffic flow. Ensure that floor grids allow debris to fall to the subfloor. Provide a [drain pan] [trench drain] [_____] deep. Rest grid assemblies on a continuous vinyl cushion mounted to each continuous foot at [_____] on center. [Ensure that pits are [_____] deep and rest on a continuous vinyl cushion with additional support members [_____] on center, including adjustable support legs.] [Provide a drain pan to include a drain and a stainless-steel strainer.] For a [stainless-steel grid, provide satin-finished stainless-steel rails [_____] apart, electronically welded joints, and a stainless-steel frame [_____] deep.] Provide all anchors, fasteners, accessories, and other parts required for a complete installation.

2.1.1.9 Frames

[Provide surface-mounted frames that have a tapered flexible vinyl edge at least [50][38] mm [2][1 1/2] inches wide, with welded corners and attached to the mat at all four edges.] [Ensure that surface-mounted frames are tapered, at least [2][1 1/2] inches wide, screwed into an opening in the floor to create an opening for the mat to sit in.] [Provide recessed frames in extruded aluminum Alloy 6061-T6 or Alloy 6063-T5 ASTM B221M ASTM B221. Ensure that the frame depth accommodates the mat and system specified.] Frame color is [mill finish] [clear] [black] [[light] [medium] [dark] bronze] [_____]. Ensure that edge-frame members are fabricated in single lengths or with the fewest pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins. Ensure that any concealed surfaces of aluminum frames that contact cementous material are coated with the manufacturer's standard protective coating. Ensure that frames include accessories and devices required for a complete installation.

2.1.1.10 Tread Insert Options

****

NOTE: Tread inserts are to be specified with floor grid systems or frames provided in two previous paragraphs.

****

Provide tread inserts consisting of [carpet composed of solution-dyed nylon or polypropylene carpet fibers fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths; carpet has antistatic and antistain treatments. Ensure that pile weight is a minimum 30 ounces per square yard] [carpet/bristle filament mix] [vinyl] [abrasive tape] [poured abrasive] [recycled rubber] [serrated aluminum] [_____].

2.1.2 Adhesives and Concrete Primers

Provide adhesives and concrete primers, where required, according to the manufacturer's recommendations.

2.1.3 Graphics

Clearly illustrate details in drawing of custom graphic [emblem] [logo][design].

2.1.4 Color and Size

Ensure that color is in accordance with [Section 09 06 00 SCHEDULES FOR FINISHES][the drawings][_____]. Ensure that the size of mat is [_____][as indicated].

PART 3 EXECUTION

3.1 EXAMINATION

Comply with the manufacturer's requirements for substrates and floor conditions affecting installation of floor mats and frames. Ensure that all unsatisfactory conditions have been corrected before installation.

3.2 INSTALLATION

Submit detail drawings, and custom graphics drawings as required. Provide installation drawings. Provide the manufacturer's protection, maintenance, and repair information.

Install floor mats and frames according to manufacturer's instructions. Set mat tops at the height recommended by the manufacturer for the most effective cleaning action. Provide clearance between bottoms of doors and tops of mats. [Coordinate recess frame installation with concrete construction to ensure that frame anchorage is correct and that the base is level and flat. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-12 50 00.13 10 (August 2017)**
Change 1 - 11/18

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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****

SECTION 12 50 00.13 10

FURNITURE AND FURNITURE INSTALLATION

08/17, CHG 1: 11/18

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NOTE: Use this specification for new construction and building renovation projects for Army and Air Force projects. This specification is not typically used for Navy projects, but if the Army is administering a project for the Navy this specification can be used but must be coordinated through the Navy representatives and Navy Interior Designers for Navy specific requirements. Use this specification only when it has been determined by the Government that the Contractor will be responsible for the purchase and installation of the furniture. This specification can also be used for furniture purchases that are not associated with building construction. Following are exceptions:

- Do not use this specification for Army projects in which the U.S. Army Corps of Engineers Huntsville Engineering and Support Center (HNC) will be purchasing and installing the furniture.

Furniture is not purchased with building construction funds. O&M funding is typically used; coordinate funding source with Government. Since other than building construction funding is used, a separate line item for the FF&E purchase and installation is required on the project Contract Line Item Number (CLIN) Bidding Schedule in the specifications to track different funding sources. Coordinate funding sources with the Government Project Manager. Coordinate the CLIN Schedule requirements with the Contracting Officer, Government Project Manager and Project Specification Editor. If a project also includes System Furniture, Section 12 59 00, include it as part of the FF&E line item on the CLIN Bidding Schedule.

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NOTE: This Guide Specification covers the requirements for furniture and furniture installation.

NOTE: Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: The FF&E Package must be attached and be designed in accordance with the Government Scope of Services document. The FF&E Package must comply with the Federal Acquisition Requirements (FAR), Buy American Act (BAA), User Requirements and Government Contracting Office's procurement methodology. Coordination is required with the Government Contracting Office to insure that the FF&E Package is procurable.

The FF&E Package furnishings order form contains ordering information, such as but not limited to description, size, finish and fabric information (see Government Scope of Services for more information). The description must include and identify minimum product requirements, be non-proprietary and contain project specific salient characteristics. This information must be sufficient so the Contractor understands the design and furniture intent and furniture minimum requirements. Dependent on the project Scope of Services this form may have different names, for example: data sheet, furniture data sheet, specification sheet or procurement information.

Do not include a cost estimate or furniture item costs in the FF&E Package included in the construction contract documents. Provide copies of the cost estimate for the project design reviews as required by the Government.

For coordination purposes with the other design disciplines (architectural, electrical, mechanical, etc.) include the furniture drawings in the building construction contract drawing set. Also include the furniture drawings in the FF&E binder for the project design review submittals as required by the

Government.

Provide information on existing furniture to be reused and not reused in the FF&E if required for project. See paragraph titled EXISTING FURNITURE in Part 1 of this specification for more information.

Various provisions of this guide specification may be irrelevant to or in conflict with the requirements of any given project. This spec should be carefully edited to fit the needs of each specific application. Portions must be deleted, if not applicable, and additional material inserted where necessary to adequately delineate requirements. Brackets and blanks identify provisions which involve alternates; the editor must select and/or insert the appropriate requirements.

****

Purchase and install furniture as identified within this specification. This specification section includes a Furniture, Fixtures and Equipment (FF&E) Package attachment.[

The requirements of this specification also apply to systems furniture unless otherwise specified in Section 12 59 00 Systems Furniture.]

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM D4157	(2013; R 2017) Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E1537	(2016) Standard Test Method for Fire Testing of Upholstered Furniture
ASTM E1590	(2017) Standard Test Method for Fire Testing of Mattresses

BIFMA INTERNATIONAL (BIFMA)

ANSI/BIFMA X5.1	(2017) American National Standards For Office Furnishings - General Purpose Office Chairs
ANSI/BIFMA X5.3	(2007; R2012) American National Standards For Office Furnishings - Vertical Files
ANSI/BIFMA X5.4	(2012) American National Standards For Office Furnishings - Lounge Seating
ANSI/BIFMA X5.5	(2014) American National Standards For Office Furnishings -Desk Products
ANSI/BIFMA X5.6	(2016) American National Standards For Office Furnishings -Panel Systems
ANSI/BIFMA X5.9	(2012) American National Standards For Office Furnishings - Storage Units

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code
NFPA 260	(2013) Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture
NFPA 265	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls

STATE OF CALIFORNIA BUREAU OF HOUSEHOLD GOODS AND SERVICES (BHGS)

TB 117-2013	(2013) Requirements, Test Procedure and Apparatus for Testing the Smolder

	Resistance of Materials Used in Upholstered Furniture
TB 133	(1991) Flammability Test Procedure for Seating Furniture in Public Occupancies

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.2	(2024e) Balanced Twisted-Pair Telecommunications Cabling and Components Standards

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1632	Standard for the Flammability of Mattresses and Mattress Pads (FF 4-72 Amended)
36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Storage Location; G, [_____]

SD-02 Shop Drawings

Installation Drawings; G, [_____]

[Grommet[, Power and Communication Units][, and Wire Management] Locations; G, [_____]]

SD-03 Product Data

Product Data; G, [_____]

Product Style Options; G, [_____]

SD-04 Samples

Fabric and Finishes; G, [_____]

SD-07 Certificates

Authorized Dealer; G, [_____]

Certified Furniture Installers; G, [_____]

Licensed Electrician; G, [_____]

Certified Telecommunications Installer; G, [_____]

Manufacturer's Certification; G, [_____]

Warranty; G, [_____]

SD-10 Operation and Maintenance Data

Furniture, Data Package 1; G, [_____]

SD-11 Closeout Submittals

Energy Efficient Equipment; S

Reduced VOC's for Furniture; S

Recycled Content of Furniture; S

Bio-Based Content of Furniture; S

1.3 SERVICES

****

NOTE: These services are for Contractor Furnished/ Contractor Installed (CF/CI) furniture and can also be used for Government Furnished/Contractor Installed (GF/CI) furniture. For the purposes of this specification as written, Government furnished furniture includes existing furniture provided by the Government.

Clearly identify in the FF&E Package and on furniture drawings CF/CI and GF/CI furniture, and when required Government Furnished/Government Installed (GF/GI) furniture and equipment. This information clarifies the responsibilities of the Contractor and the Government and aids in space planning and coordination with other design disciplines.

Determine if the Contractor will be responsible for disassembling, packing, storing, moving and reinstalling existing furniture (GF/CI)or if existing furniture will be handled by the User (GF/GI). See EXISTING FURNITURE for more information.

****

Provide services to include furniture purchase, field measuring, installation drawings, shipping and delivery coordination, receiving, inspection, submitting and processing freight and warranty claims, unpacking, storing, assembly, installation and other related activities or tasks for a complete and functional installation. Reference Section 01 45 00 QUALITY CONTROL for inspection requirements. The Contracting Officer must be allowed to participate in inspections.[In addition provide services for existing furniture as specified, reference paragraph on EXISTING FURNITURE for more information.] Develop project timelines and establish shipping, receiving and installation dates that coordinate with the building construction schedule. Hold at a minimum weekly team meetings to brief the project team, include the Contracting Officer. Notify the Contracting Officer immediately of any scheduling problems, discontinued furniture items including fabrics and finishes, or other conditions which may cause delays, and recommend available substitutes, solutions, and provide updated timeline to coordinate with building construction schedule. Substitutes and solutions must comply with the specification and be approved by the Contracting Officer.

1.4 FURNITURE PURCHASE

****

NOTE: Once the Government determines that the furniture can be purchased by the Contractor, coordinate furniture procurement method (such as GSA Schedules and Open Market) with the Government. (This note applies to new construction and renovation projects.)

FURNITURE FROM THE GSA SCHEDULES: Select this bracketed option if it has been determined that the Government will authorize the Contractor to purchase furniture using the Government Supply Sources. If this option is selected make sure that FAR clause 52.251-1 Government Supply Sources is included in the project FAR requirements. This FAR provides the Government the ability to write a letter to the Contractor authorizing the Contractor to use Government Supply Sources to purchase furniture. Coordinate the inclusion of the FAR clause requirement with the Project Specification Editor.

FURNITURE FROM THE OPEN MARKET: Select this bracketed option if it has been determined that the Government will not authorize the Contractor to purchase furniture using the Government Supply Sources.

If another source for furniture is necessary to meet project requirements, for example Navy or Air Force BPA's, edit specification accordingly and add the requirement. Verify that source and processes are appropriate for use within the framework of this specification. Use of any other sources must recieve approval by the Government before proceeding.

Delete bracketed sentence on the quick-ship programs and coordinating factory times if project is not on a tight schedule and not applicable to the project.
****

Purchase furniture, including checking accuracy of all acknowledgements and schedules from manufacturers and making necessary corrections to insure that the manufacturer has a correct understanding of the order and requirement.[Provide furniture from the GSA Schedules and provide GSA pricing. Provide furniture from open market only when an item is not available on the GSA Schedules. See FAR clause 52.251-1 Government Supply Sources.][Purchase furniture from the open market. The furniture provided needs to be available on the GSA Schedules to assist the User with future purchases. GSA information is provided FOR INFORMATIONAL PURPOSES ONLY. It is encouraged to solicit and provide GSA pricing on furniture.] Compete the furniture purchase by obtaining a minimum of (3) separate proposals. Furniture is subject to FAR clause 52.236-5 Materials and Workmanship.[If necessary to meet project timeline requirements, furniture may be purchased using manufacturers quick-ship programs or by coordinating factory times.]

1.5 ALTERNATE DESIGN

****
NOTE: Minor differences exist among different manufacturer's product. This paragraph pertaining to "alternate design" is included in order to not exclude a manufacturer when an equally acceptable solution is proposed.
****

When a manufacturer's product is unable to provide desk and workstation configurations and filing/storage that conform exactly to the furniture layouts shown in the contract drawings and specifications, alternate designs may be submitted for consideration by the Contracting Officer. Alternate designs must meet or exceed the following criteria. Alternate designs that are submitted but do not meet these criteria will be rejected.

1.5.1 Desk and Workstation Size and Configuration

The alternate design must provide desks and workstations of the same basic size and configuration shown, with only the sizes of the individual components within the desk and workstation changed to meet the standard product of the manufacturer.

1.5.2 Filing and Storage Size and Configuration

The alternate design must provide filing and storage of the same basic size and configuration shown, with only the size changed to meet the standard product of the manufacturer. The storage capacity must not be reduced.

1.5.3 Furniture Requirements

The furniture provided must comply with the drawings, specifications, and the requirements identified in the FF&E Package Attachment.

1.5.4 Layout

The storage capacity, number of desks and workstations, number of persons accommodated, width of aisles, and functionality must be maintained. Layout must comply with NFPA 101 and 36 CFR 1191.

1.6 AUTHORIZED DEALER, CERTIFIED FURNITURE INSTALLERS, LICENSED ELECTRICIAN AND CERTIFIED TELECOMMUNICATIONS INSTALLER

When required by the furniture manufacturer, furniture must be installed by an authorized dealer and a certified furniture installation crew must be used on the project.[Services provided to reuse existing furniture must comply with manufactures warranty requirements to maintain warranty. If warranty for existing furniture to be reused has expired, services must be completed by a furniture installation crew with a minimum of 5 years experience.] All furniture requiring hardwiring must be completed by a licensed electrician. Communications installers must be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level or have a minimum of [3][_____] years experience in the installation of the specified cables and components. All installers, furniture, electrical and communications, must be on-site if questions arise. Submit copies of authorized dealer, furniture installation crew, licensed electrician and certified telecommunications installer certifications.

1.7 DELIVERY, STORAGE AND HANDLING

1.7.1 Delivery

Deliver furniture to the jobsite in manufacturer's original packaging or blanket wrapping. Original packaging must be marked with the manufacturer name, item identification, and project reference clearly marked.

1.7.2 Furniture Inspection

Inspect furniture and provide notification of damage within the time frame required by the shipping company while carrier is still on-site. Complete claims for concealed damage within the time frame required by the shipping company and furniture manufacturer. A claim file must be maintained that documents each claim. Forward copies of claims to the Contracting Officer on a [daily][_____] basis.

1.7.3 Storage

Storage space is not available on-site and furniture must be stored at an off site location. Provide any storage space required for furniture and transport stored furniture to the project site for installation. Storage location must be approved by the Contracting Officer at the time of the furniture order. If storage is required, furniture must be stored in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, in a manner that permits easy access for inspection and handling, and in an environment in accordance with furniture manufacturers instructions.

1.7.4 Furniture Staging Area

Coordinate location of the furniture staging area with the Contracting Officer.

1.8 WARRANTY

****

NOTE: Revise, add and/or delete warranty information as applicable to meet project requirements.

****

Provide manufacturer performance guarantees or warranties for single-shift service and include parts, labor and transportation as follows, unless otherwise noted:

a. Systems Furniture - [see Section12 59 00 Systems Furniture][12 year minimum][lifetime]

b. Desks and Workstations - 12 year minimum

c. Filing and Storage - 12 year minimum

d. Seating

    (1) Seating, unless otherwise noted - 10 year minimum

    (2) 24/7 Seating (multiple shift use) - 10 year minimum

    (3) Seating Mechanisms and Pneumatic Cylinders - 10 year minimum

    (4) Lounge Seating - 10 year minimum

    (5) Stacking Chairs - 10 year minimum

e. Tables

(1) Unless otherwise noted - 10 year minimum

(2) Table Mechanisms - 5 year minimum

(3) Table Ganging Device - 1 year minimum

f. Miscellaneous

(1) Fabric - 3 year minimum

(2) LED Task Lighting - 5 year minimum

(3) Task Lighting - [2][3][_____] year minimum

Provide items not listed with a 1 year minimum. When manufacturers standard performance guarantees or warranties exceed the minimum requirements identified, provide the standard performance guarantee or warranty. Submit manufacturer's warranty information for all furniture items.

PART 2 PRODUCTS

2.1 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

2.1.1 Energy Efficient Equipment

Coordinate requirement for energy efficient equipment, such as appliances and lighting, and provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph ENERGY EFFICIENT EQUIPMENT.

2.1.2 Reduced VOC's for Furniture

Coordinate requirement for reduced VOC requirements for furniture and provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph REDUCE VOLATILE ORGANIC COMPOUNDS.

2.1.3 Recycled Content of Furniture

Coordinate requirement for recycled content for furniture and provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph RECYCLED CONTENT.

2.1.4 Bio-Based Content of Furniture

Coordinate requirement for biobased content for furniture and provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph BIO-BASED PRODUCTS.

2.2 REFERENCE TO MANUFACTURER NAMES AND COLORS

Where product and color is shown as being specific to one manufacturer in the FF&E Package Attachment, an equivalent color or product by another manufacturer may be submitted for approval. Manufacturers, style lines, model numbers, finish, and fabric information are provided to establish design intent and are not intended to limit the selection of equal products and colors from other manufacturers.

2.3 FURNITURE REQUIREMENTS

****

NOTE: Coordinate with electrical engineer to comply with LED and task lighting guidance in UFC 3-530-01 Interior and Exterior Lighting Systems and Controls. Add information as appropriate to this specification or the FF&E Package to identify project requirements.

If product data for all furniture items should be submitted at the the same time

****

Use the FF&E Package Attachment in conjunction with the drawings and specifications for the furniture requirements.[Systems furniture is specified in Section 12 59 00 SYSTEMS FURNITURE.] Provide furniture from manufacturer's standard product as shown in the most current published price list or amendment. Furniture provided must be part of current line as indicated with no intent to discontinue within two years. Provide furniture that is intended for commercial use not residential. submit product data for all furniture items, to include catalog cuts, brochures, product information, and other necessary literature to indicate compliance with specifications.[Provide product data for all items together in a single submittal.][Provide product data for all similar types of items together as a group, such as [desks/workstations,] [seating,] [storage,] [tables,] and [_____]. Submit each grouping of similar type items in a single submittal.] When applicable, include GSA schedule information to confirm that items are available on GSA schedule. Tag product data sheets with applicable furniture item code and name. Submit data for all product style options for selection when options are available. This applies to but is not limited to furniture items that have options such as edge details, hardware options, and grommet colors. Submit manufacturer's certification stating that furniture meets the specifications.[

2.3.1 EXISTING FURNITURE (GOVERNMENT FURNISHED/CONTRACTOR INSTALLED-GF/CI)

****

NOTE: Existing furniture typically applies to renovation projects in which the User wants the project to be turnkey and have the Contractor also be responsible for handling existing furniture. Note that adding this requirement increases project cost.

Determine if the Contractor will be responsible for disassembling, packing, storing, moving and reinstalling existing furniture (GF/CI)or if existing furniture will be handled by the User (GF/GI). If User will be responsible for existing furniture delete this paragraph.

If it is determined existing furniture will be reused (disassembled, moved and re-installed)or excessed, the existing furniture must be inventoried and clearly tagged to be reused or excessed as part of the FF&E design. Inventory must also include

identifying condition of existing furniture to be reused. Inventory and tagging can be accomplished by the FF&E interior designer, the User or other method determined during design but must be completed as part of the FF&E Package design.

Verify if certified installers are required to maintain the warranty when existing furniture is disassembled and reinstalled and to insure the furniture is handled properly. If this is the case, it is suggested that the Contractor be involved or at a minimum the User contract with a certified furniture installer for this effort.

Supply sufficient information in the FF&E Package attachment and construction contract drawings for a Contractor to provide a bid on the existing furniture requirement. This information can include current and new locations of existing furniture, item name and code for existing furniture, manufacturer information if available, drawings, photographs, description and size of furniture, and other necessary information to clearly indicate intent. Also provide information and locations for existing building and furniture electrical and communication features.

****

2.3.1.1 Existing Furniture to be Reused

Disassemble, pack, move, store, transport to the project site and install existing furniture identified to be reused. This includes disconnecting and reconnecting furniture electrical connections at the building source. Coordinate with electrician for safe terminations or removal of disconnected building electric system supply circuits.

[2.3.1.2 Existing Furniture that is Not Reused

****

NOTE: Coordinate with the Government to insure that furniture that will not be reused and requires excessing is handled according to the base or post requirements and modify verbiage accordingly to reflect the requirements.

****

[Disassemble and have ready for excessing and pick up any furniture identified as not to be reused. Furniture will be picked up by Government directed vendors. Coordinate pick-up times with Contracting Officer and User.][Disassemble and relocate any furniture identified as not to be reused to the [Defense Logistics Agency Disposition Services (DLADS)][_____] facility.] This includes disconnecting furniture electrical connections at the building source. Coordinate with electrician for safe terminations or removal of disconnected building electric system supply circuits. Protect all items from damage and provide security and weather protection prior to and during[pickup][relocation].

][2.3.1.3 Existing Furniture Communications

Remove existing Information Technology (IT) cables (i.e. SIPRNET, NIPRNET, J-WIC'S, etc.) and telephone wiring from existing furniture systems identified to be reused or requiring excessing.

]]2.3.2 Construction

a. Provide furniture that complies with the following testing requirements:

(1) ANSI/BIFMA

[(a) Office Seating - ANSI/BIFMA X5.1

][(b) Vertical Files - ANSI/BIFMA X5.3

][(c) Lounge Seating - ANSI/BIFMA X5.4

][(d) Desk Products - ANSI/BIFMA X5.5

][(e) Panel Systems - ANSI/BIFMA X5.6

][(f) Storage - ANSI/BIFMA X5.9]

(2) Flammability

****

NOTE: Comply with NFPA 101. Review occupancy chapter requirements for smoldering ignition of upholstered furniture and mattresses and for upholstered furniture and mattresses requiring limited rates of heat release.

****

[(a) Systems furniture and workstation panel components must meet requirements for flame spread and smoke development as specified by NFPA 101 except as follows. Conduct testing in accordance with either ASTM E84 or UL 723 on the entire assembled panel of the worst case (most combustible) combination of fabric and interior construction. In addition, fabric must meet the requirements of NFPA 265. Do not exceed panel flame spread [25 for Class A] [75 for Class B] [200 for Class C], and do not exceed panel smoke development 450 for Class A, B, and C.][

(b) Upholstered furniture must comply with[TB 117-2013 or NFPA 260][TB 133 or ASTM E1537].][

(c) Mattresses must comply with 16 CFR 1632[and ASTM E1590].]

b. Provide furniture with no rough or sharp edges or exposed connections. Clips, screws, and other construction elements must be concealed wherever possible.

****

NOTE: Recommend that desks, workstations and systems furniture be designed so they do not require attachment to the walls; this provides the User with more flexiblity in reconfiguring the furniture.

When they are attached to the wall, the User must patch and repair the walls when furniture is reconfigured or replaced in the future. Prior to specifying wall mounted furniture make sure that User is aware of the ramifications and agrees with design approach.
****

c. Items such as desks, workstations and systems furniture must include all necessary components to be structurally sound and must not be attached to the wall unless specified to be wall mounted in the contract documents.

d. Desks, workstations, storage, and tables must have leveling devices to compensate for uneven floors.

e. The underside of desks, workstations, and tables must be completely and smoothly finished.

f. The backside of freestanding desks, workstations, [_____] and storage must be finished.

g. Provide chair casters and glides appropriate for the floor material they are located on, such as carpet and resilient flooring.

2.3.3 Locks and Keying

a. All drawers and doors, including but not limited to overhead storage cabinets, storage towers, supply cabinets, storage cabinets, desk and workstation pedestals, and filing cabinets must be lockable.

b. Key each desk and workstation in an office differently and key locks within each desk and workstation alike.

c. Furniture storage components in private offices must be keyed alike. Key each private office differently.

d. Provide field changeable lock cylinders in desks and workstations with a minimum of 100 different key options. Number keys and lock cylinders for ease of replacement or clearly label locks with a key number, except for those manufacturers who have removable format locks.

e. Drawers within a pedestal must be lockable either by a central lock that controls all pedestals under one work surface or an individual keyed lock in each pedestal.

f. Central file and storage units which are grouped together but are not a part of a workstation must be keyed [alike][differently] unless otherwise specified.

g. Provide two keys for each workstation when components are keyed alike. Also provide two keys for each miscellaneous item such as filing cabinets, supply cabinets, storage cabinets, and similar type furniture items.

h. Provide three copies of each master key to the Contracting Officer.[

i. [Leave keys in locks] [Inventory keys, label keys by lock number, room number and furniture item and turn over inventory and keys to the

Contracting Officer].]

2.3.4 Receptacle Bodies and Device Cover Plates

****

NOTE: Coordinate isolated ground receptacle requirements with the electrical/telecommunications engineer.

****

Provide furniture panel faceplates and receptacle body types [and color] as specified in [FF&E Package Attachment] [12 59 00 SYSTEMS FURNITURE] [_____]. [Provide color as follows:

a. Faceplate: [match panel trim color][_____]

b. Receptacle Bodies: [match panel trim color][_____]

c. Communication Cable Jackets: [match receptacle device cover plates in color][_____]

d. Isolated Ground Receptacles:[orange][or][have distinct markings][be of a different color than other receptacles]]

2.3.5 Keyboard Tray

Provide worksurfaces that are capable of accepting an articulating keyboard tray at locations indicated. The keyboard tray must be capable of fully recessing under the work surface and extending to give the user full access to the keyboard. The keyboard tray must have height adjustability and positive and negative tilting capability and have 180-degree swing side travel rotation. The keyboard tray must have a wrist support and include a mouse pad at the same level as the keyboard that can accommodate both right and left handed users.

2.3.6 Fabric and Finish

Submit samples of all furniture fabric and finishes. Samples must be actual samples, not photographic representations, size must be a minimum of 75 by 75 mm 3 by 3 inches. If necessary, provide larger size samples to clearly represent pattern. Label samples with fabric or finish code, furniture item code and name, manufacturer name, and color information. Fabric samples must also be labeled with fiber content and double rub testing information.

2.3.6.1 Fabric

****

NOTE: Recommended minimum requirement for double rubs is typically 55,000 for an office environment. Some areas within a facility may require a higher double rub number where seating is located in heavy use and high traffic areas. Modify information as necessary on double rubs to meet project requirements, information may vary if different types of fabrics are specified.

Verify with Government if use of customer's own material (COM) is acceptable.

When required, identify which seating requires a topical or inherent soil retardant treatment.

Recommend specifying acceptable minimums for pattern size to establish design intent for aesthetics and to help hide soiling. Typically the use of solid colors are not recommended unless furniture is located in a command type area or the fabric is a vinyl, polyurethane, leather, faux leather or other similar type of fabric.

Coordinate pattern size and terminology used in this specification with fabric pattern information included in the FF&E Package Attachment.
****

a. Fabric must be from manufacturer's standard line[and][,] graded-in textile manufacturer's fabrics[, and customer's own material (COM)].[Do not provide COM fabrics.]

b. Provide a mid grade fabric[, unless otherwise noted]. Example: manufacturer available grades 1 through 4 (even number of grades), provide grade 3; manufacturer available grades A through D (even number of grades), provide grade C; manufacturer available grades A through E (odd number of grades), provide grade C (middle grade).

c. Provide a topical or inherent soil retardant treatment where indicated.

d. [Comply with double rub testing as specified in the FF&E Package Attachment.][Fabric for seating must comply with a minimum of [55,000][_____] double rubs unless otherwise noted.] Perform double rub testing in accordance with the ASTM D4157 Wyzenbeek Method.

e. Provide vinyl, polypropylene or similar type fabric for seating only if allowed in FF&E Package Attachment.

f. Pattern:

    (1) Provide patterned upholstery fabric to help hide soiling. Pattern is defined as follows:

        (a) Solid Color: [textured,] [single color] [or] [pattern smaller in size than the small size pattern][_____]

        (b) Small Size Pattern: minimum [12 mm1/2 inch] [_____]

        (c) Medium Size Pattern: minimum [50 mm2 inch] [_____]

        (d) Large Size Pattern: minimum [125 mm5 inch] [_____]

    (2) Provide patterns [as specified in the FF&E Package Attachment.] [as follows:

        (a) Desk Chairs: [solid color] [small] [_____] size pattern

        (b) Side or Guest Chairs: [small] [medium] [_____] size pattern

        (c) Lounge Type Chairs: [small] [medium] [large] [_____] size pattern

(d) [_____]: [small] [medium] [large] [_____] size pattern]

g. See FF&E Package Attachment for additional information.

2.3.6.2 Finishes

Provide furniture finishes as listed below unless otherwise noted:

a. Finishes must be able to be cleaned with ordinary household cleaning solutions. Wood finishes must be able to be cleaned with damp cloth as directed by the manufacturer.

b. The finish of steel surfaces must be the manufacturer's most durable finish such as factory powder coat or baked enamel.

c. Grommet colors must be compatible and coordinated with desk, workstation, and table finish colors.

[d. Finishes must be neutral in color.

][e. Plastic laminate worksurfaces and table tops must be neutral in color and must have a pattern to help hide soiling.

] f. See FF&E Package Attachment for additional information.

2.4 FURNITURE LAYOUT

Provide furniture layout as indicated.

PART 3 EXECUTION

3.1 BUILDING EXAMINATION

Become familiar with details of the work, inspect all areas and conditions under which furniture is to be installed, and coordinate scheduling of dedicated elevators and docks. Notify the Contracting Officer in writing of any conditions detrimental to the proper and timely completion of the installation. Work will proceed only when conditions have been corrected.

3.2 BUILDING PROTECTION

Protect building surfaces to prevent soiling and damage during delivery and installation. Any soiling and damage that occurs to the building during the installation of furniture must be cleaned and repaired, or replaced to its original condition and must be approved by the Contracting Officer.

3.3 INSTALLATION

3.3.1 Installation Drawings

Installation drawings must include furniture layout, critical dimensions and locations of electrical and communications. Reflect field verified conditions in furniture layouts. Drawings must be at 1:100 1/4 inch = 1 foot scale, unless otherwise specified. Provide typical plans and isometrics/elevations of desks and workstations at a scale of 1:50 1/2 inch = 1 foot. When applicable, provide desk and workstation electrical and communications locations. When applicable include controlled-circuit identification for each furniture receptacle and coordinate with the building electrical system circuits in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP. Critical dimensions include, but are not limited to clearances and aisle widths. Drawings must include layout for furniture systems workstations for coordination purposes. Label furniture with furniture item code identified in this specification. Submit grommet[, power and communication units][, and wire management] locations.

3.3.2 Furniture Installation Procedures

Complete installation in accordance with manufacturer's installation instructions, assembly manuals, warranty requirements and approved installation drawings. Also comply with the following requirements:

a. Use material handling equipment with rubber wheels.

b. Furniture and components must be installed level, plumb, square, and with proper alignment with adjoining furniture.

c. Match keys to locks and check locking mechanisms.

d. Check drawers, doors, lighting, and other operable items and mechanisms for proper operation.

e. Remove all protective wrapping tape, residue, and related type items.

f. Securely interconnect furniture components where required.

g. Securely attach and anchor furniture components to the building when required.

h. Securely anchor furniture such as shelving and storage units to the building when required by the manufacturer.

i. All items with an electrical plug, such as but not limited to task lighting and tables with electrical power, must be fully operational.

j. All hardwired furniture, such as but not limited to furniture systems, must be fully operational. Verify that voltage is present in electrical outlets. Verify controlled-circuit outlets are properly configured in accordance with the installation drawings.

k. Furniture must not block SIPRNET[and][_____] jacks or the jack enclosures on walls. Report conflicts to Contracting Officer to discuss resolution.

l. Upon completion of installation, all furniture must be completely cleaned, finished, leveled, aligned, operational and functional.[

m. Install artwork with security mount hardware as recommended by the manufacturer.]

3.3.3 Furniture Communications Installation

****

NOTE: Coordinate with the User and electrical/telecommunications engineer if the Contractor or others will be providing all IT cables (i.e. SIPRNET, NIPRNET, J-WIC'S, etc.) and phone

wiring up to and including the face plate/box of all furniture as required and the services to install new cables/phone wiring and face plates/boxes in the furniture. Furniture may include, but not be limited to desks and workstations, systems furniture and tables.

If required for a project, the requirement for the Contractor to provide the IT cables (i.e. SIPRNET, NIPRNET, J-WIC'S, etc.) and phone wiring up to and including the face plate/box of the furniture should also be indicated in the applicable project UFGS Communications specifications.

Revise language as necessary to meet project specific requirements.
****

[Provide all Information/Technology (IT) cables (i.e. SIPRNET, NIPRNET, J-WIC'S, etc.) and phone wiring up to and including the face plate/box of all furniture as required and the services to install the cables, wiring and face plates/boxes in the furniture. Coordinate cable type, cable jacket and outlet jack color with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. Furniture communication installers must be on site to install communication cables, wiring and other components for furniture during furniture installation. Coordinate the TIA-568.2 pin/pair assignments for communication outlets to match the configuration of the building's non-furniture outlets; coordinate with Contracting Officer. All items with a communication interface must be fully operational.][Installation of Information/Technology (IT) wiring, cables and face plates/boxes in the furniture will be completed by others.]

3.4 CLEANING

Remove all packing materials and other trash from the jobsite. Upon completion of installation, all products must be clean, including inside all drawers and doors, and the area must be free of debris and left in a clean and neat condition. Any defects in or damage to furniture must be repaired or replaced and approved by the Contracting Officer. Damaged products that cannot be satisfactorily repaired must be replaced. Correct any problems with assembly and installation. Prior to any furniture repair, replacement, and/or assembly and installation corrections, protect the building surfaces.

3.5 OPERATION AND MAINTENANCE MANUALS

Submit the Furniture, Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and include the following:

3.5.1 Assembly Manuals

Describe assembly and re-configuration procedures. Provide three sets of installation video tapes if available.

3.5.2 Installation Instructions

Provide a copy of the instructions used to install the furniture. Also describe any special procedures or helpful hints learned during the installation process.

3.5.3 Maintenance Manuals

Describe proper cleaning and minor repair procedures, include cleaning instructions for fabrics.

3.5.4 Electrical System Manuals

Describe the functions, configuration, and maintenance of the furniture electrical system (power[, communication][, and data]). This information may be included in the assembly or maintenance manuals.

3.5.5 Special Tools

Provide [three][____] sets of special tools necessary for assembly and disassembly of furniture and components from each manufacturer. Mark tool(s) with manufacturer and product information.

3.5.6 Furniture Drawings

Provide hard copy and electronic, showing installed furniture layout. Include all modifications. Provide electronic copies on a CD-ROM. Coordinate type (such as but not limited to Microstation, AutoCad and Revit) and version required with User. Include critical dimensions, and locations of building and furniture electrical and communications. Provide drawings at 1:100 1/4 inch = 1 foot scale, unless otherwise specified. Provide typical plans and isometrics/elevations of workstations at a scale of 1:50 1/2 inch = 1 foot. Code all furniture with furniture item code identified in this specification.

3.5.7 Furniture Listing

Provide complete listing, hard copy and electronic, of furniture provided. Include all modifications. Provide electronic copies on a CD-ROM. Coordinate type of electronic file required with User (such as but not limited to Word and Excel). Listing must include furniture item code and name used in FF&E Package, part/model numbers, fabrics and finishes for all components furnished. Organize listing by item name and code and provide building totals.

3.5.8 Order Form Documentation

Provide Order Form Documentation with Purchase Order number and project name and location to allow the User to follow up on warranty issues and help with future purchases.

[3.5.9 Key Control System

Key Control System. Provide system in excel format; indicate lock number, room number and location of lock within rooms if more than one lock number.
]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-12 55 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-12 55 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

SECTION 12 55 00

DETENTION FURNITURE AND ACCESSORIES

08/24

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-12 55 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-12 55 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 12 55 00

DETENTION FURNITURE AND ACCESSORIES
08/24

****

NOTE: This guide specification covers the requirements for detention furniture, and accessories for use in brigs and detention facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Show the following information on the project drawings:

1. Locations of each piece of furniture, equipment, and accessory item.

2. Details of equipment and accessories to convey design intent and coordinate any details with this specification.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1633	(2006) Standard for the Flammability (Open Flame) of Mattress Sets

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Specifier to confirm if samples of large items are needed and edit appropriately.

****

SD-02 Shop Drawings

Mirrors; G, [_____]

Pass Window; G, [_____]

Grab Bars; G, [_____]

Pistol Locker; G, [_____]

Safety Clothes Hooks; G, [_____]

Key Cabinet; G, [_____]

Bunks; G, [_____]

Mattresses; G, [_____]

Desks; G, [_____]

Dining Table; G, [_____]

Seats; G, [_____]

SD-03 Product Data

Mirrors; G, [_____]

Pass Window; G, [_____]

Grab Bars; G, [_____]

Pistol Locker; G, [_____]

Safety Clothes Hooks; G, [_____]

Key Cabinet; G, [_____]

Bunks; G, [_____]

Mattresses; G, [_____]

Desks; G, [_____]

Dining Table; G, [_____]

Seats; G, [_____]

SD-04 Samples

Mirrors; G, [_____]

Pistol Locker; G, [_____]

Key Cabinet; G, [_____]

Desks; G, [_____]

Dining Table; G, [_____]

Seats; G, [_____]

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver furniture and accessories in packaging to provide protection during transit and job storage. Leave in unopened original containers, clearly labeled for location of installation.

1.4 COORDINATION

Coordinate installation of anchorages for detention furniture. Provide setting drawings, templates, and directions for installing anchorages; including sleeves, concrete inserts, detention grade anchor bolts, and items with integral anchors that are to be embedded in adjacent construction. Deliver such items to project site in time for installation. Coordinate size and location of recess in wall construction to receive detention furniture.

1.5 QUALITY ASSURANCE

****

NOTE: If full size samples are required, retain paragraph below to allow samples to remain on site as part of the project.

****

1.5.1 Mock-ups

Prior to final approval of shop drawings, provide a full size sample of items identified under samples. Upon disapproval, remove rejected units from the job site. Approved mock-ups may remain as part of the finished work.

PART 2 PRODUCTS

2.1 MATERIAL

Steel plate, ASTM A36/A36M.

2.2 MIRRORS

a. Provide mirrors with a minimum 0.8 mm 0.031 inches thick sheet steel[bright annealed][polished to #8 mirror finish].

b. Provide a frame formed from [16][18] gauge cold-finished steel with 8 mm 5/16 inch inner and outer flanges.

c. Provide mirror with a minimum overall size of [203 by 254 mm][279 by 432 mm] [8 by 10 inches][11 by 17 inches] [_____].

d. Provide one framed mirror over lavatory in each prisoner housing area.

e. Frame to be secured with stainless steel flat head security fasteners.

2.3 PASS WINDOW

Window consists of a pass drawer below a speaker panel with a security glazing panel above. The glazing panel must be the same type as the adjacent glazing. The pass drawer must be 100 mm 4 inches deep, 400 mm 16 inches wide, 300 mm 12 inches long, and roll horizontally with an interlocking hinged cover on both sides. The speaker panel must be constructed of perforated metal (T-304 stainless steel), 16 gauge, 5 mm 3/16 inch perforated holes,[rectangular][circular] in shape, with 14 gauge baffles to prevent direct line of sight from one side to the other. Integrate this unit into the hollow metal of the adjacent unit.

2.4 GRAB BARS

Provide stainless steel security grab bars with safety gap filler between the round tube bar and the wall. For standard grab bars, refer to Section 10 28 13 TOILET ACCESSORIES. Provide in lengths and configurations indicated.

2.5 PISTOL LOCKER UNITS

Provide an outer shell and compartment doors made up of [10][16] gauge steel with continuous steel hinges. With[Hinged][Drop][Tilt-out] door compartments size at a minimum of 350 mm wide by 90 mm deep by 150 mm high 14 inches wide by 3-1/2 inches deep by 6 inches high lined with felt and individually keyed. Provide two master keys per locker. Provide a powder coat finish. Provide unit designed for recessed installation in masonry. Units have [3][6][9] compartments. Locate units as indicated.

2.6 SAFETY CLOTHES HOOKS

Provide[single][grouped] safety clothes hook[s] with a collapsible ball joint, encased in a [10][14] gauge stainless steel housing. Hook is designed to collapse under a heavy load of a maximum of 18 kg 40 lbs. Hook can be attached to wall plates or steel walls. Provide a brushed stainless steel finish. Provide manufacturer standard flat head spanner machine security screws to fit widely spaced holes designed to resist abuse.

2.7 BUNKS

****

NOTE: Retain first option for floor mounted single or double bunks and retain second option for wall mounted bunks, but not both.

****

[Provide floor mounted[single][double] cell bunks. Each bunk frame consists of a bunk pan made from [3.42][2.66] mm [0.134][0.105] inch steel measuring a minimum of 689 mm wide by 1930 mm long by 356 mm deep 27 inches wide by 75 inches long by 14 inches deep with bunk pan 256 mm 10 inches above floor. Turn up edges of[back and sides and turn down edge of front][back, sides and front], with minimum 51 mm 2 inch flanges.[Provide drawer minimum 533 mm wide by 610 deep by 127 mm high 21 inches wide by 24 inches deep by 5 inches high, formed from 3.42 mm 0.134 inch nominal thickness steel sheet.] Legs and frames formed from 51 by 51 by 4.8 mm 2 by 2 inches by 3/16 inch steel angle welded at connections to each other and to bunk pan; provide four legs for each bunk. Mounting plates formed from 6 mm 1/4 inch thick, steel plate punched with one hole for floor anchorage; provide one mounting plate for each leg.

][Provide wall mounted single cell bunks. Each bunk frame consists of a bunk pan made from [3.42][2.66] mm [0.134][0.105] inch steel measuring a minimum of 689 mm wide by 1930 mm long by 356 mm 27 inches wide by 75 inches long by 14 inches with bunk pan 256 mm 10 inches above floor. Turn up edges of[back and sides and turn down edge of front][back, sides and front], with minimum 51 mm 2 inch flanges.[Provide drawer minimum 533 mm wide by 610 deep by 127 mm high 21 inches wide by 24 inches deep by 5 inches high, formed from 3.42 mm 0.134 inch nominal thickness steel sheet.] Combination end panel and mounting plate is formed from 0.048 mm 3/16 inch thick steel sheet welded to a connection to bunk pan, with 51 mm 2 inch flange for wall mounting. Provide two end panel and mounting plates for each bunk.

] Provide a[steel factory prime finish][[baked enamel][powder coat]finish].

2.8 MATTRESSES

Provide mattress core consisting of[Fire-resistive solid foam][Fire-resistive densified polyester fiber][Cotton, with 10 percent boric acid treatment, tufted to nylon netting to retain shape]. Mattress cover to be vinyl bonded to nylon scrim. Fabricate cover using[all sealed-seam construction with radio-frequency welded inverted seams][four-corner box construction with seams facing inside of detention mattress except end closing seam located at foot of mattress; sew with nylon thread in a double-lock stitch][, with integral pillow]. Cover to be[Fire retardant vinyl][Fire retardant polyurethane coated]. Overall size to be minimum 738 mm wide by 1956 mm long by 102 mm thick 29 inches wide by 77 inches long by 4 inches thick. Comply with 16 CFR 1633 and California Technical Bulletin 121 as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

2.9 DETENTION DESKS

Provide desk designed for wall mounting to masonry walls. Overall desk height to be no less than 762 mm 30 inches. Top size must be minimum 457 mm wide by 381 mm deep 18 inches wide by 15 inches deep; constructed of[10 gauge minimum, stainless steel, with minimum 38 mm 1-1/2 inch flanged edges for mounting to wall][single piece, molded high impact polyethylene with holes for concealed mounting to wall]. Provide a minimum seat size of 300 mm 12 inch diameter; constructed of[10 gauge minimum, stainless steel and supported by steel tubing][single piece, molded high impact polyethylene]. Seat to be securely bolted to floor. Steel tubing to be welded to desk top and mounting plate when desk top and seat are one assembly. Provide 6 mm 1/4 inch thick steel mounting plates punched with holes for floor anchorage.

2.10 SEATS

Include details of frames, conditions of openings, details of construction, location and installation requirements of hardware and reinforcements, and details of joints and connections showing sizes and locations of welds. Indicate fabrication, erection, anchorage, and accessories.

****

NOTE: Retain only one option depending on seating utilization

****

[Provide floor mounted stool minimum seat 305 mm 12 inch diameter, formed from[3.42 mm 0.134 inch nominal-thickness steel][1.90 mm 0.075 inch nominal-thickness steel][3.18 mm 0.125 inch thick, stainless steel][1.59 mm 0.062 inch thick, stainless steel] sheet; reinforced with 3.42 mm 0.134 inch thick steel sheet cut to interior dimension of seat, with minimum 38 mm 1-1/2 inch flanged edges. Seat support formed from steel pipe or 51 mm OD by 1.90 mm 2 inch deep by 0.075 inch thick steel tubing welded to seat reinforcement and base plate for an overall stool height of not less than 457 mm 18 inches. Base plate minimum 152 by 6 mm 6 by 1/4 inch thick,[square][round][steel] punched with four holes for floor anchorage.

][Provide wall mounted stool, seat minimum 305 mm 12 inch diameter, formed from[3.42 mm 0.134 inch nominal-thickness steel][1.90 mm 0.075 inch nominal thickness steel][3.18 mm 0.125 inch thick, stainless steel][1.98 mm 0.078 inch thick, stainless steel] sheet; reinforced with 3.42 mm 0.134 inch thick steel sheet cut to interior dimension of seat, with minimum 38 mm 1-1/2 inch flanged edges. Seat support is formed from 25 by 51 by 1.90 mm 1 by 2 by 0.075 inch thick, steel tubing; 51 mm OD by 1.90 mm 2 inch deep by 0.075 inch thick steel tubing; or 9.5 mm 3/8 inch thick steel plate bar; welded to seat reinforcement and wall bracket. Swivel wall bracket is a minimum 12.7 mm 1/2 inch pivot pin, with 9.5 mm 3/8 inch thick steel plate[for welding to embedded steel plate][for welding to steel wall][punched with four holes for wall anchorage].

]2.11 KEY CABINET

****

NOTE: Verify location of duplicate cabinet with the Chief of Naval Personnel, PERS-84.

****

Provide for detention lock keys with a capacity of 1.75 times the number of door locks and a complete dual-tag system. Provide cabinet with concealed-type hinges, rounded sides, and panels with individual hook and label pockets formed as an integral part of the panel. Cabinet is made of [10][14] gauge stainless steel. Provide tags of two types, one set for permanent holding of at least four keys. Provide indexing to record information concerning locks and keys, alphabetically; hook, numerically; and master key. Provide permanent loan registry to protect identity of key borrowers. Provide receipt tabs to protect identity of key borrowers and supply receipt tabs for temporary loan. Provide one cabinet in the main control center, one duplicate cabinet in the Station Security Office, and one duplicate cabinet in the Commanding Officer Office. Finish in manufacturer's standard powder coat finish.

2.12 DINING TABLE

Provide table designed for institutional use that permits seating in groups of four. Provide table top formed of minimum [10][12] gauge stainless steel, reinforced with steel plate. Cut corners at a 45 degree angle. Provide top, seat, and leg supports with heavy wall square steel tubing. Provide 300 mm 12 inch diameter seats made of high strength [14][16] gauge stainless steel. Provide a one piece table with seats, welded assembly, with welds neatly finished. Assembly framing must be painted, except for stainless steel, with one shop coat of primer. Provide a table top with a minimum top dimension of 900 mm 36 inches in the least dimension. Provide as indicated on drawings in location and quantity indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Provide anchorage devices and fasteners where necessary for securing detention furniture to in-place construction. Include threaded fasteners for[concrete][and][masonry] inserts, security fasteners, and other connectors. Set detention furniture accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels. Provide temporary bracing or anchors in formwork for items that are to be built into[concrete][or][masonry] or similar construction. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. If field welding is necessary, use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish exposed welds and surfaces smooth and blended at exposed connections so that no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.2 ADJUSTMENT

Adjust items and components of items specified in this section to ensure proper operation.

Assemble detention furniture requiring field assembly with security fasteners with no exposed fasteners on exposed faces and frames. Anchor furniture[with security fasteners][by welding][as indicated on Drawings] to floors and walls at intervals required by expected loads, but not more than 305 mm 12 inches On Center. Install anchors through backup reinforcing plates where necessary to avoid metal distortion. Use security fasteners with head styles appropriate for installation requirements, strength, and finish of adjacent materials, except that a maximum of two different sets of tools must be required to operate security fasteners for

Project.[Provide stainless steel security fasteners in painted materials.] Weld nuts onto cast-in-place anchors after installation so as to be nonremovable. Apply[polyurethane][epoxy] security sealant at all exposed gaps between detention furniture and adjacent construction greater than 1.6 mm 1/16 inch.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-12 59 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-12 59 00(February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 12 - FURNISHINGS

SECTION 12 59 00

SYSTEMS FURNITURE

08/17, CHG 1: 08/18

PART 1 GENERAL

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-12 59 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
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References are in agreement with UMRL dated January 2025

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SECTION 12 59 00

SYSTEMS FURNITURE

08/17, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for systems furniture which include panels, workstations and components.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Various provisions of this guide specification may be irrelevant to or in conflict with the requirements of any given project. This specification should be carefully edited to fit the needs of each specific application. Portions must be deleted, if not applicable, and additional material inserted where necessary to adequately delineate requirements. Brackets and blanks identify provisions which involve alternates; the editor must select and/or insert the appropriate requirements.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building

	Materials
ASTM E290	(2022) Bend Testing of Material for Ductility

BIFMA INTERNATIONAL (BIFMA)

ANSI/BIFMA M7.1	(2011; R 2016) Test Method for Determining VOC Emissions from Office Furniture Systems, Components and Seating
ANSI/BIFMA X5.5	(2014) American National Standards For Office Furnishings -Desk Products
ANSI/BIFMA X5.6	(2016) American National Standards For Office Furnishings -Panel Systems

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2021) Wiring Devices Dimensions Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 101	(2024) Life Safety Code
NFPA 265	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.2	(2024e) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 1286	(2022; Reprint Mar 2024) UL Standard for Safety Office Furnishings
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Warranty; G, [_____]

Workstations

Power and Communications

Communications

Recycled Content for system furniture components; S

Energy Star Label for Task Lighting; S

SD-04 Samples

Workstations; G, [_____]

Mock-up; G, [_____]

Samples

SD-06 Test Reports

Selected Components; G, [_____]

Panel Acoustics; G, [_____]

Fire Safety; G, [_____]

Electrical System; G, [_____]

SD-07 Certificates

Workstations

[Certified Sustainably Harvested door panels; S

] SD-10 Operation and Maintenance Data

Assembly Manuals; G, [_____]

Maintenance Manuals; G, [_____]

Cleaning; G, [_____]

Electrical System; G, [_____]

Maintenance Agreements

Installation; G

1.3 CERTIFICATIONS

[1.3.1 Certified Sustainably Harvested Wood

Provide wood door panels certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Provide current product certification documentation from certification body. Submit copies of invoices bearing certification numbers.

]1.3.2 Indoor Air QualityCertifications

1.3.2.1 Office Furniture Systems and Seating

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold, ANSI/BIFMA M7.1 Certification or provide certification by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 QUALITY ASSURANCE

1.4.1 General Safety

Provide workstation products free of rough or sharp edges. [Provide panel supported components with a positive, integral locking device which secures components without the use of additional screws or clamps to prevent the components from being accidentally pulled or knocked off the panels.] [Provide desk-based workstation components with an option for a positive, integral locking device that secures components to the base units.]

1.4.2 Fire Safety

Components must meet requirements for flame spread and smoke development as specified by NFPA 101 except as follows. Conduct testing in accordance with either ASTM E84 or UL 723 on the entire assembled panel of the worst case (most combustible) combination of fabric and interior construction. In addition, fabric must meet the requirements of NFPA 265. Do not exceed [[25 for Class A] [75 for Class B] [200 for Class C]] for panel flame spread and 450 for Class A, B and C panel smoke development .

1.4.3 Electrical System

Task lights are required to be UL listed and installation of task lighting must meet the requirements of NFPA 70. The electrical system must meet the requirements of UL 1286. Submit three sets of electrical system manuals describing the functions, configuration, and maintenance of the electrical system (power [, communications] [, data]). This material may be included in the Assembly or Maintenance manuals at the Contractor's option.

1.4.4 Detail Drawings

Submit detail drawings showing communications, electronic data processing (EDP) and local area network (LAN); locations may be provided as a separate submittal from remaining workstation drawings. Provide drawing requirements, which are the furniture manufacturer's responsibility, as a single submittal. Provide electronic drawings to the user for future re-configuration in the software package requested by the user. Include in the electronic drawings all modifications made during installation. As a minimum, submit the following:

a. Overall reference drawings: Drawings showing workstation locations and overall plan view within each floor in a scale of [1:400 (1/16 inch = 1 foot) 1/16 inch = 1 foot] [1:200 (1/8 inch = 1 foot) 1/8 inch = 1 foot]. Layouts must reflect field verified conditions and clearly illustrate the overall space planning concept and intent.

b. Installation drawings: Drawings showing workstations, panels, components, and plan view within each floor. Identify workstations by workstation type; submit drawings showing the proposed workstation installation at a scale of 1:100 (1/4 inch = 1 foot) 1/4 inch = 1 foot, unless otherwise specified. Installation drawings must reflect field verified conditions.

c. Workstation elevations: Dimensioned workstation elevations showing each type of workstation with panel frame configurations and all components identified with manufacturer's catalog numbers. Draw elevations at 1:50 (1/2 inch = 1 foot) 1/2 inch = 1 foot scale.

d. Panel drawings: Panel drawings showing locations and critical dimensions from finished face of walls, columns, panels, including clearances and aisle widths. Key assemblies to a legend which includes width, height, configuration and composition of frame covers finishes and fabrics (if different selections exist within a project), power or nonpower, connectors and wall mount hardware. Coordinate panel placement with location of electrical, voice/date LAN,[SIPRNet,][NIPERNet,] mechanical and fire protection fixtures. Drawings must reflect field verified conditions.

****

NOTE: NOTE TO INTERIOR DESIGNER for "e. Electrical Drawings": Coordinate with electrical engineer the furniture wiring configuration, receptacle quantities, and receptacle locations for compliance with ASHRAE 90.1 automatic receptacle control requirements.

NOTE TO ELECTRICAL ENGINEER for "e. Electrical Drawings": Provide a separate set of electrical drawings for furniture coordination identifying switched/unswitched supply circuits, furniture wiring configuration(s), switched/unswitched furniture line voltage conductors, switched/unswitched receptacles (or specifically which furniture line voltage spade to which each receptacle is connected), and receptacle locations. Recommend naming drawing series "EF" for "Electrical Power - Furnishings". Coordinate furniture wiring configurations, receptacle quantities, and receptacle locations with the interior designer and this specification. Consult UFC 3-520-01 for systems furniture power guidance. Where shared neutrals are used, provide oversized neutrals to match the harness configuration and balance loads between circuits and phases. A single circuit must not serve more than four (4) cubicles under any circumstances.

****

e. Electrical drawings: Drawings showing power provisions including type and location of feeder components (service entry poles, base or ceiling feeds), activated power receptacles and other electrical components. Wiring configuration (circuiting, switching, internal and external connections) identified and a legend provided as applicable. Identify which receptacles in typical furniture configurations will be connected to controlled building power circuits as applicable to meet [ASHRAE 90.1 - IP][ASHRAE 90.1 - SI] requirements. Coordinate with electrical drawings.

f. Wire management capacity drawings.

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NOTE: NOTE TO INTERIOR DESIGNER for "g/h/i/j. Communications Drawings": Coordinate with communications designer the quantity, types, locations, and minimum separations of communications outlets.

NOTE TO COMMUNICATIONS DESIGNER for "g/h/i/j. Communications Drawings": Provide a separate set of communications drawings for furniture coordination identifying quantity, types, locations, and minimum separations of communications outlets. Recommend naming drawing series "TF" for "Telecommunications - Furnishings". Consult UFC 3-580-01 for furniture communications guidance.

****

g. Communication drawings showing telephone provisions: Drawings indicating the type and location of feeder components and communications jacks with wiring configuration identified where applicable.

h. Communication drawings showing electronic data processing provisions: Drawings indicating the type and location of feeder components, communications jacks, or accessories with wiring configuration identified where applicable.

i. Communication drawings showing local area network provisions: Drawings indicating the type and location of feeder components and data jacks with extra ports for future expansion with wiring configuration identified where applicable.

j. Communications drawings indicating the TIA-568.2 pin/pair assignment that will be used for communications outlet as coordinated with the COR.

k. Reflected ceiling plan for projects specified with power poles.

l. Drawings indicating cabling is protected at all transition points, and that metallic separation is provided between telecommunication and power wiring in the utility columns and systems furniture track in accordance with TIA-569 and NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

****

NOTE: Materials with high short-term emissions include, but are not limited to: adhesives, sealants and glazing compounds (specifically those with petrochemical vehicles or carriers); paint, wood preservatives, and finishes; control and/or expansion joint fillers; hard finishes requiring adhesive installation; gypsum board (with associated finish processes and products); and composite or engineered wood products with formaldehyde binders. Absorbent systems furniture includes, among others, fabric-covered components.

****

Deliver components to the jobsite in the manufacturer's original packaging with the brand, item identification, and project reference clearly marked. Remove furniture from packaging and store in an unoccupied, dry location that is ventilated. Provide storsge that is free from dirt and dust, water, and other contaminants, and that permits easy access for inspection and handling.

1.6 WARRANTY

Warrant the systems furniture for a minimum period of [12 years][lifetime] with the following exceptions: fabrics and other covering materials, and paper handling products for 3 years, LED drivers/power supplies for 5 years, and electromagnetic ballasts for [2][3] years. Warranties must be signed by the authorized representative of the manufacturer. Present warranties, accompanied by document authenticating the signer as an authorized representative of the guarantor, to the Contracting Officer upon the completion of the project. Guarantee that the workstation products and installation are free from any defects in material and workmanship from the date of delivery. Submit two copies of the warranty.

1.7 MAINTENANCE AGREEMENTS

****

NOTE: Maintenance agreements are standard practice in the building industry. Under a green lease, when the customer no longer requires the use of the particular product or requires an updated model, the manufacturer is obligated to reclaim it and refurbish it or disassemble it for recycling as appropriate. Coordinate with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

****

Collect information from the manufacturer about [maintenance agreement] [green lease] [take back program] options, and submit to Contracting Officer. Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse and avoid landfilling and burning reclaimed materials. When such a service is not available through a manufacturer, local recyclers should be sought after to reclaim the materials.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

****

Provide System Furniture Components with a minimum of 55 percent recycled content. Provide data identifying percentage of recycled content for system furniture components.

Provide certification of indoor air quality for Office Furniture Systems and Seating.

****

NOTE: Adjustments to workstations and workstation componentry such as height adjustable work surfaces and storage design must be made when ADA-ABA conformance within the workstation is required. Consider the use of existing reconditioned systems furniture when appropriate. The aesthetics and function of all componetry within this specification must be compatible.

****

2.2 SYSTEM DESCRIPTION

2.2.1 Workstations

This specification establishes the minimum requirements for the acquisition and installation of a complete and usable system of workstations composed of panels, freestanding work surfaces or base units, supporting components, electrical hardware, communications, special electrical features, and accessories. Provide workstation requirements and configurations in accordance with the furniture layout and typical workstation types shown in drawings and specified herein. Provide components and hardware from a single manufacturer that are standard products as shown in the most recent published price lists or amendments. Proposed product must be part of the manufacturer's current line with no intent to discontinue within two years. Submit complete listing of part/model numbers for all components to be provided, including names and codes of components referenced on updated drawings. Provide electrical components from a single manufacturer to the extent practicable (different types of components may be of different manufacturers, but all units of a given component must be from a single source). Conformance with NFPA 70, UL 1286, NFPA 101, and 36 CFR 1191 is required. Coordinate the work of this section with that to be performed under other sections. This specification may include items which are not manufactured by the furniture manufacturer; provide any such items under this section. Submit two complete sets of certificates attesting that the proposed workstation meets specified requirements. Date the certificate after the award of the contract, include the name of the project, and list specific requirements being certified.

2.2.2 Samples

Submit samples as required to obtain final approval. The Government reserves the right to reject any finish samples that do not satisfy the technical or color requirements. Work can not proceed without sample approval in writing from the Contracting Officer. Submit four sets of the finish samples listed below:

a. Panel, tackboard and overhead door fabric. Minimum 150 by 150 mm 6 by 6 inches with label designating the manufacturer, pattern, color, fiber content, fabric width, fabric weight, fire rating, and use (panel and/or tackboard).

b. Workstation component finishes. Minimum 60 by 75 mm 2-1/2 by 3 inches with label designating the manufacturer, material composition, thickness, color, and finish.

c. Personal Task lights (Not overhead task lights).

d. Panel glazing. Glazing samples with label designating the material and safety ratings.

****

NOTE: Limit mock-up requirement to sizeable projects involving at least 10 workstations or as required for individual projects.

****

2.2.3 Mock-up

Submit a Mock-up of an actual workstation reflecting approved finishes and fabrics. Locate the mock-up installation at [the local dealership][approved off-site location][_____]. Do not order product for the project until the mock-up has been approved. Submit manufacturer's product and construction specifications which provide technical data for furniture system and components specified, including task lighting and illumination performance information. Include adequate information in the literature to verify that the proposed product meets the specification. Review of the mock-up may result in adjustments to the product, layout and finishes. The approved mock-up can be used in installation.

2.2.4 Alternate Design

****

NOTE: Minor differences exist among different manufacturer's product. This paragraph pertaining to an "alternate design" was written to not exclude a manufacturer when an equally acceptable solution is proposed.

****

Manufacturers who are unable to provide workstations that conform exactly to the furniture layouts and typical workstation types shown in the contract drawings, may submit alternate designs for consideration by the Contracting Officer. Alternate designs must meet or exceed the following criteria. Alternate designs that are submitted but do not meet these criteria will be rejected. In the alternate design provide workstations and components of the same basic size and configuration shown, with only the sizes of the individual components within the workstation changed to meet the standard product of the manufacturer or site conditions.

2.2.4.1 Component Requirements

Provide the types of components or elements as shown on the drawings and as specified in PART 2 PRODUCTS of this specification. Do not reduce the storage capacity, number of workstations accommodated, width of aisles, or workstation configuration.

2.2.4.2 Wiring Configuration

Provide alternate configurations that support the circuiting and connection capabilities identified under the provisions pertaining to power distribution of paragraph POWER AND COMMUNICATIONS. Generally any alternate will be acceptable which involves only a variation in size or quantity that exceeds the specified configuration.

2.2.5 Performance Requirements

Panels, frames and frame covers, connection system, work surfaces, pedestals, shelf units, overhead door cabinets, lateral files, locks, accessories, and miscellaneous hardware must meet testing as specified. ISO 9001 certified manufacturers may perform in-house testing. Manufacturers not ISO 9001 qualified will be required to produce testing by an independent testing laboratory. Component specific requirements are listed in appropriate paragraphs.

2.2.5.1 Selected Components

Workstation conformance to ANSI/BIFMA X5.5 and ANSI/BIFMA X5.6 is required with the following exceptions: Panels, or panel supported components conformance to ANSI/BIFMA X5.6 is required. Representative items will be selected for testing based on worst case situations (i.e., the deepest and widest work surface or shelf). Perform the keyboard drawer or shelf test applying a 19 kg 50 lb load to the center of the keyboard shelf for a period of 5 minutes. Any loosening of attachments or damage to the operation of the drawer or shelf will be cause for rejection.

2.2.5.2 Panel Acoustics

****

NOTE: Consider using non-acoustical panels when storage units cover more than half of the panel surface as the acoustical advantage is lost and the non-acoustical unit is less expensive.

Acoustical performance ratings should be based upon the workstation design. While NRC and STC ratings contribute to overall acoustical performance, the acoustical role of panels is relatively minimal in the overall environment when compared to sound absorptive properties of other finish surfaces. Most major manufacturers do not comply with the higher 0.80 NRC and 24 STC without providing their more costly high performance panels. The designer must determine if the additional acoustical performance is worth the added cost to the Government.

Delete paragraph if acoustical panels are not required.

****

Provide acoustical panels with a minimum noise reduction coefficient (NRC) of [0.65] [0.80] [_____] when tested in accordance with ASTM C423 and a minimum sound transfer coefficient (STC) of [14] [20] [24] [26] [_____] when tested in accordance with ASTM E290. Conduct the test on the entire assembled panel, full face area (the complete core, adhesive, decorative fabric, frame and joining components).

2.2.5.3 Panel Glazing

****

NOTE: Curved glazed panels should not be specified since most products utilize an acrylic glazing. Acrylic glazing is not acceptable since it does not meet flame spread and smoke development requirements.

****

Tempered glass must conform to ANSI Z97.1 and ASTM C1048, Kind FT, Condition A, Type I, [Class 1 Transparent] [Class 3 - Light reducing, tinted or translucent].

2.2.6 Pattern and Color

****

NOTE: Include a reference in Section 09 06 00 SCHEDULES FOR FINISHES or drawings for all items requiring a finish color. This includes, but is not limited to, the following items: Work Surfaces, Storage Units, Tackboards, Erasable Marker Boards, Signage, Slat Tile, Panels, Panel Frames, Screens, Connectors, Trim and Accessories. Specify finish of both sides of panels.

****

Provide pattern and color of finishes and fabrics for panel systems, components, and trim [in accordance with Section 09 06 00 SCHEDULES FOR FINISHES] [as shown on the drawings] [_____].

2.3 SYSTEMS FURNITURE

****

NOTE: A term sometimes used for the main run of panels distributing the power and data throughout the system is spine wall. For the purpose of this specification, panel systems comprehensively include un-powered, powered, and spine wall panels.

****

2.3.1 Panel System Components

Supply aaccessories and appurtenances for a completely finished panel assembly with the system. Provide a system capable of structurally supporting cantilevered work surfaces, shelves, files, overhead cabinets, and other components in the configurations shown on the drawings plus more than one fully loaded component per panel per side. Provide panels that are[tackable][or][capable of accommodating fabric covered tackboards,] [acoustical,] [stackable with a system capable of lowering or raising the overall panel assembly height at horizontal connections by removing or adding panel-frames on-site without disturbing adjacent panel components,] [segmented as designated on the drawings]. [Segments will be field removable from both sides of the panel]. [Provide capability for worksurfaces to attach to the panels in 25 - 50mm 1 - 2 inch increments.] [Provide a spine wall system where electrical and data management will be easily accessible by removable wall covers that can be removed while workstation components are still attached. [Cables must be laid in the system, not threaded through the frame.]] Provide a panel system that is available in a variety of nominal widths and heights as designated on the drawings. Measure heights from the finished floor to the top of the panel. Supply powered and nonpowered panels that are compatible in height. Coordinate panel heights with the HVAC and electrical designs. [Minimum panel thickness is 76 mm 3 inches thick.] [System to have 100 percent off-modular capability with no defacement of any element caused by components when used in an off-modular application. Unique panel frames must not be required for off modular connections.] Submit three sets of Assembly Manuals describing assembly and reconfiguration procedures.

****

NOTE: Specify a finish and fabric for applicable items. Include fabric content, for example: 50 percent Nylon, 50 percent Wool. The designer must verify that fabric content, pattern, and color specified are not proprietary and that several manufacturers can provide a similar product.

Filler trim incurs added cost.

****

2.3.2 Panel Finishes

Provide panels in the following options: [safety glazed,] [open frame,] [tackable fabric,] [acoustical fabric,] [wood veneer,] [marker surface,] [paint,] [slat tile,] [perforated metal,] [_____]. [Frame covers may have different options on either side of the frame.] Exposed panel trim to have a [factory baked enamel or epoxy powder] [wood] finish. [Filler trim will either match the panel trim or be fabric covered to match the panel fabric.] [Do not provide filler trim.] Provide each fabric-faced panel with a seamless width of fabric stretched over the entire face of the panel. The fabric color throughout the installation must be consistent. Curved panels may use adhesives on curved sections. Attach the fabric securely and continuously along the entire perimeter of the panel and allow for easy removal and replacement in the field (with the exception of curved panels). Fabric must be factory installed with [   ] panel fabric content.2.3.3 Raceways

Provide raceways and covers as an integral part of the panel whether powered or nonpowered. Magnet held base covers will not be accepted.

2.3.4 Leveling Glides

Provide precise alignment of adjacent panels and include leveling glides to compensate for uneven floors. Provide quantity and location of leveling glides as recommended by the manufacturer. A minimum 19 mm 3/4 inch adjustment range is required.

2.3.5 Connection System

****

NOTE: Delete "...connection of 2 panels for setting the panels at any angle" if not required. This connection limits sources.

****

Provide connectors which accommodate a variety of configurations as indicated on the drawings to include: a straight line connection of 2 panels (180 degrees), corner connection of 2 panels (90 degrees), T connection of 3 panels (90 degrees), cross connection of 4 panels (all 90 degrees),[angle connection of 2 panels (120 degrees),][and a connection of 2 panels for setting the panels at any angle]. Provide tight connections with continuous visual and acoustical seals. Plastic, painted metal, fabric or wood finish connections are required to match system. Provide connector system that allows removal of a single panel within a typical workstation configuration, without requiring disassembly of the workstation or removal of adjacent panels. Provide for connection of similar or dissimilar heights to include trim pieces to finish the exposed edge. Right angle (90 degree) connections between panels must not interfere with the capability to hang work surfaces and other components on any adjacent panel. Provide, as required, the continuation of electrical and communications wiring within workstations and from workstation to workstation. Filler posts must be level with the top rail.

2.3.6 Wall Mounted Panels

Use wall-mount components when it is necessary to attach panels or vertical panel-frame assemblies to the building walls. Provide structural support for wall panels as required. Panels and other systems furniture components are not be wall mounted unless they are included in the original design.

2.3.7 Glazed Panel Inserts

Provide safety glass glazed panel inserts in accordance with ANSI Z97.1 and ASTM C1048. Acrylic glazing will not be accepted.

2.3.8 Door Panels

Provide door panels with a rigid metal frame with rails, a threshold, and a [wood] [laminate] [safety glazed] [_____] clad door adaptable to either hand swing. Allow for a 810 mm minimum 32 inch clear opening. Include connectors, hinges, and [brushed chrome] [epoxy powder] [baked enamel] finished ADA compliant door knob or handle.

2.3.9 Sliding Doors

Attach sliding or rolling doors to the panel as shown on the drawings. Provide doors that the direction in which the door slides can be changed in the field. Supply [translucent][_____] door in same width or wider than the opening to be covered. Provide door pulls for each side of door. Door frame to match the panel frame color.

2.4 DESK-BASED SYSTEM

Supply accessories and appurtenances for a completely finished desk-based assembly within the system. Provide a desk-based system that is free-standing, independent of panel system support and capable of structurally supporting work surfaces, shelves, and other components in the configurations shown on the drawings. Provide a variety of nominal widths and depths as indicated on drawings.

2.5 WORK SURFACES

2.5.1 Construction

Construct work surfaces to prevent warpage. [Fully support work surfaces from the panels or support jointly by the panels and supplemental legs, pedestals, or furniture end panels. Use supplemental end supports only under work surfaces when the work station configuration does not permit full support by the panels. Use metal support brackets to support work surfaces from the panels, provide metal-to-metal fitting to the vertical uprights of the panels, vertically adjustable, to lock the work surfaces in place without panel modifications.] [Support work surfaces with legs, pedestals, or furniture end panels.] Abutting work surfaces must line up closely and be at equal heights when used in side-by-side configurations in order to provide a continuous and level work surface. Provide pre-drilled holes to accommodate storage components, pedestals and additional supports in work surfaces, or drill holes at the job site to accommodate these items. Provide work surfaces in sizes and configurations shown on the drawings. Provide work surfaces in nominal depths of [510 mm 20 inches,][and][610 mm 24 inches,][and][760 mm 30 inches,] plus or minus 50 mm 2 inches, nominal lengths from 610 to 1830 mm 24 to 72 inches, and a nominal thickness from 25 to 45 mm 1 to 1-3/4 inches. [Provide height adjustable work surfaces from 630 to 1040 mm 25 to 52 inches above the finished floor with a [crank-based][mechanical][electrical] control.] Provide [corner,] [peninsula,] [and][counter/transaction] work surfaces as shown on the drawings and include hardware necessary to provide firm and rigid support.[Work surfaces must have 100 percent off-modular capability with no defacement of any element caused by components when used in an off-modular application.][Provide mobile half round table to include casters of which a minimum 2 must be locking[, and table must lock to the adjacent worksurface].]

2.5.2 Finishes

Provide work surfaces with a finished top surface of [high pressure plastic laminate], [veneer] and a smoothly finished underside. The work surface must not be damaged by ordinary household solvents, acids, alcohols, or salt solutions. Provide metal support brackets that match the color and finish of trim. Provide [PVC] [ABS] [laminate] [solid wood] [wood veneer] [synthetic wood] edges

2.6 PEDESTALS

Provide drawer configurations and pedestal height as shown on the drawings. Provide the deepest possible pedestal for each work surface size specified. [Free standing mobile pedestals to include[an attached upholstered seat cushion,][a handle for moving,][and] casters. Mobile pedestals must be load bearing and equipped with counterbalance as standard. Provide appropriate height of mobile pedestal so it can be stored under a standard height worksurface.]

2.6.1 Construction

Provide pedestals and drawers of steel construction[with the exception of drawer fronts]. Securely attach drawer faces to the drawer front.

2.6.2 Finishes

Provide a factory baked enamel finish or powder coated for steel surfaces. Provide [steel][plastic laminate][molded plastic][veneer] drawer fronts.

2.6.3 Drawer Requirements

Pedestals must be field interchangeable from left to right, and right to left, and must retain the pedestal locking system capability. Design pedestals to protect wires from being damaged by drawer operation. Provide pedestals that are [work surface hung,][support work surfaces,][free standing][mobile]. Drawers must stay securely closed when in the closed position and provide each drawer with a safety catch to prevent accidental removal when fully open. File drawers to be provided with full extension ball bearing drawer slides or rack and pinion suspension. File drawers to be provided with hanging folder frames or rails and capable of hanging side-to-side or front-to-back. [Provide dividers with vertical files.] [Provide box drawers with pencil trays.] [Provide center pencil drawer and mount under the work surface.]

2.7 STORAGE

Provide storage units in the sizes and configurations shown on the drawings. [Provide task lights under overhead cabinets][and][shelf units]. Depth to accommodate [a standard three ring binder][_____][Panel attached storage is required to have 100 percent off-modular compatibility with no defacement of any element caused by components when used in an off-modular application.]

2.7.1 Shelf Unit Construction

Provide metal construction shelf pan with formed edges. Provide shelf supporting end panels of metal, high density particle board, molded phenolic resin, or molded melamine. Provide relocatable shelf dividers with shelf units.

2.7.2 Overhead Cabinet Construction

Provide metal construction overhead cabinets. Provide doors with a suspension system. [Provide overhead cabinet door that retracts over the top of the cabinet[and is curved].][Provide overhead cabinet door that retracts into the cabinet.] [Provide upmounted overheads.] [Provide sliding doors on overheads.] [Overhead cabinet must be ADA accessible.]

2.7.3 Lateral File[, Vertical File][and Book Case] Construction

Provide units and file fronts, top and end panels of steel construction. File drawers to be provided with full extension ball bearing drawer slides or rack and pinion suspension. File drawers to be provided with hanging folder frames or rails and capable of hanging side-to-side or front-to-back. [Provide dividers with vertical files.]

2.7.4 Personal Storage Tower Construction

Provide personal storage tower and components of steel construction. Height of the unit to be [the same height as the surrounding panels][_____]. The personal storage tower will include one full height wardrobe unit with coat rod, two file drawers, bookcase with two adjustable shelves, [_____] and hinged lockable doors.

2.7.5 Finish

Provide a factory baked enamel or epoxy powder coat finish for shelves, dividers and top dust cover. Provide either a factory baked enamel, epoxy powder coat or laminate finish for shelf supporting end panels. Shelf bottom is required to match end panel color. Provide metal doors with an exterior finish of factory baked enamel and an interior finish of factory baked enamel or epoxy powder coat. Provide a factory baked enamel finish or epoxy powder coat on metal drawers. [Provide a wood veneer surface on [overhead cabinets] [pedestals] [book cases] [towers],[and] [lateral files].]

2.8 ACCESSORIES

2.8.1 Coat Hook

Provide one mounted coat hook per workstation.

2.8.2 Keyboard Tray

Provide work surfaces that are capable of accepting an articulating keyboard in locations as shown on the drawings. The keyboard tray must be capable of fully recessing under the work surface and extending to give the user full access to the keyboard. Provide height adjustability, 180-degree swing side travel rotation and negative tilting capability. Include a wrist support and a mouse pad at the same level as the keyboard tray to accommodate either right or left-handed users.

2.8.3 Tackboards

Fabric must be factory installed. Provide [ ] fabric content of tackboards. Location and size [as shown on the drawings][_____].

2.8.4 Erasable Marker Boards

Provide marker boards with a white writing surface that can be easily written on and erased and unaffected by common marker board cleaning/conditioning agents. Include a storage tray and minimum two markers with the markerboard. Size and location [as shown on the drawings][_____].

2.8.5 Paper Management Unit

Provide paper management units as indicated [on the drawings] [_____]. Construct these units of coated steel or injection molded plastic to accommodate either legal or letter size lengths.

2.8.6 Wall Mounted Components

Provide wall tracks when components are shown attached directly to wall surfaces. Provide tracks of heavy duty extruded metal with finish and color matching the the panel trim. Provide vertically aligned tracks slotted on 25 mm 1 inch centers in heights required that match slot spacing for components.

2.8.7 CPU Holder

Provide a mounting to support the computer hard drive. Desk top and floor locations are not acceptable.

2.8.8 Signage

Provide [panel mounted][_____] signage composed, at a minimum, of aluminum frame, back panel, clear plastic cover, and hanging device. Provide signage approximately[76 by 203 mm 3 by 8 inches][_____] and capable of receiving a replaceable [standard white][_____] paper insert. Match [_____]text type.[Include name of occupant on signage for each workstation with names provided by customer prior to installation [_____].][Provide software for creating text in PC computers for owner production of replacement paper inserts after project completion.]

2.8.9 Slat Tile

Provide slat tile with channels to accommodate attachments such as monitor arm, task light and organizer accessories. Provide maximum slat tile height of [_____] and a length [as shown on the drawings][_____]. Slat tile must be integral to the panel and not attached to the surface of the panel. [Provide slat tile that is able to support the weight of two monitor arms and two flat panels simultaneously.]

2.8.10 Monitor Arm

Provide monitor arm that allows 360 degree monitor rotation for portrait and landscape viewing, and 60 degree range of lateral and vertical monitor tilt for additional viewing adjustability. Provide monitor arm that supports monitors weighing[3 to 8 kg 7 to 19 lbs][_____]. [Provide [dual monitor arm for 2 screens] [   ].] Mount monitor arm on [slat walls][work surface].

2.9 MISCELLANEOUS HARDWARE

Provide brackets, supports, hangers, clips, panel supported legs, connectors, adjustable feet, cover plates, stabilizers, and other miscellaneous hardware that contribute to a complete and operable furniture system.

2.10 LOCKS AND KEYING

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NOTE: The quantity of different key operations required is dependent on the size of the project. The number specified should not exceed the total quantity of workstations. The maximum quantity utilized should not exceed 150.

****

Provide [overhead cabinets,][vertical files,][personal storage towers,] pedestals and lateral files with keyed locks, unless otherwise noted. Provide field changeable lock cylinders with a minimum of [100] [_____] different key options. Key each workstation individually, and key locks alike within a workstation. Provide lockable drawers within a pedestal either by a central lock that controls all pedestals under one work surface or an individual keyed lock in each pedestal. Key alike central file and storage units which are grouped together but are not a part of a workstation unless otherwise specified. Provide two keys for each lock or two keys per workstation when keyed alike, and provide three master keys per area as indicated. Number keys and lock cylinders for ease of replacement. Clearly label locks with a key number, except for those manufacturers who have removable format locks. [Provide door panels withkeyed [door knob][_____] set.]

2.11 POWER AND COMMUNICATIONS

****

NOTE: It is recommended that the type of cabling assembly (wiring, harnesses, or buses) be left as a Contractor selection unless it is necessary to restrict for compatibility with existing equipment.

Furniture designer must coordinate with the building power designer to select a systems furniture power distribution wiring system which aligns with the circuit quantities provided to the furniture and satisfies the ASHRAE 90.1 Automatic Receptacle Control requirements. The quantity of receptacles required to be integral for each furniture type should be determined to allow for consistent automatic control of supply circuits for typical furniture of a given type. See additional designer notes within Paragraph 1.3.4 "Detail Drawings" of this specification.

****

Provide both powered and nonpowered panels with base raceways capable of distributing power circuits, [communication cables] [and] [data lines]. Provide nonpowered bases that are capable of easy field conversion to powered base without requiring the panel to be dismantled or removed from the workstation. [Provide panels able to support lay-in cabling and having a large capacity for power and data. Provide ample space for storing excess wires and fiber optic cables in the interior of the spine wall frame. Provide easy access to power and data systems in the spine wall without having to move return panels or components. Provide the ability for the spine wall system to supply power to a wall-attached panel system and/or an adjacent desk system. A termination center or utility closet may be utilized in the wall or at the end of a panel run.] Provide copper [cable assemblies,] [wiring harnesses][or][electrified bus] for the system and meet the requirements of UL 1286 and NFPA 70, Article 605. Provide conductors with 20 amp [90] [75] degree C, #12 AWG wires (unless indicated otherwise) or the equivalent in the bus configuration. A single circuit must not serve more than four (4) cubicles or workstations under any circumstances. The label or listing of Underwriter's Laboratories, Inc. will be accepted as evidence that the material or equipment conforms to the applicable standards of that agency. In lieu of this label or listing, submit a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures of UL and that the materials and equipment comply with contract requirements. Electrical work not addressed in this section must conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.11.1 Panel Raceways

****

Coordinate raceway locations with workstation components such as overhead storage units.

****

Provide panels that have hinged or removable covers that permit easy access to the raceway when required but are securely mounted and cannot be accidentally dislodged under normal conditions. Place raceways in locations such as the base, beltline, and below and above the beltline. The raceway must not extend past either [panel face] [frame cover] by more than 13 mm 1/2 inch. Provide metal or plastic covers which attach securely to the raceway as required and match the finish and color of the panel trim. Provide a minimum of 2 knockouts (doors) per side for power receptacles and communications jacks as indicated in raceways [in full size over 610 mm 24 inches powered panels] [on panel frames]. Provide other raceways that are flush with [panel face][frame covers].

2.11.2 Power Distribution

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NOTE: The 8-wire system is currently the most common system utilized for applications serving mixed loads including electronic data processing equipment. This is available in several configruations from which to choose. Since EDP equipment generates high levels of harmonics (* see footnote below), a full size neutral should be provided for each EDP circuit. Alternately, it is recommended that the phase conductor not be loaded to more than 12A or that an oversized neutral be specified. To minimize interference from electronic noise to sensitive data processing components, the EDP equipment should be placed on the dedicated

circuits.

In the absence of other criteria, use of an isolated ground conductor is not recommended for the EDP circuits (See IEEE Std. 1100). If the amount of EDP load is extensive and the conventional load is minimal, a modified 8-wire system should be provided.

Non-linear loads such as computers, copiers, laser printers, electronic lighting ballasts, and uninterruptible power supplies cause harmonic distortion on power distribution systems. The majority of workstation loads are non-linear, harmonic producing loads. Designers must ensure that the building power distribution equipment can support these non-linear loads. IEEE 519 and 1100 provide details concerning the causes, effects, and means of compensation for non-linear, harmonic producing loads on power systems. Harmonic compensation may include, but is not limited to: specifying harmonic-mitigating transformers, derating transformers, oversizing neutrals to 200 percent of the ampacity of the phase conductors or phase bus, using phase conductors and terminals with higher ampacities and/or higher temperature ratings, supplying non-linear loads from dedicated isolation transformers, and installing shunt filters. See UGGS-16415A for further guidance. Refer to UFC 3-501-01 for discussion on non-linear loads.

Surge suppression and power conditioning receptacle modules are available. However power conditioning for specific loads (particularly portable equipment) is normally a User responsibility and is not provided as part of the construction contract. The Air Force has identified specific responsibilities of the user and suppliers of end-use equipment. (See Air Force ETL 89-6 for specific criteria or verify specific requirements for electrical support.)

****

Provide power distribution as indicated on the drawings. Provide an internal [power][and][communications] raceway and the capability of disconnecting and connecting external circuits to the electrified raceway in the panel. Capacity for at least [six][twelve][twenty] 4-pair category 6 cables is required for the communications receiving raceway. Power and communications wiring may share a common wireway if a metal divider is included to ensure electrical isolation. Provide doors or access openings for entry of communications cable. Provide the electrified power raceway for the [10-wire][8-wire][6-wire][or][5-wire] configuration indicated.[Unless otherwise indicated, allocate conductors of the 8-wire system as follows: the three-phase system will have one equipment ground, one isolated ground, [one neutral] [one oversized (133 percent minimum) neutral], and two each dedicated phase.][Unless otherwise indicated, allocate conductors of the 8-wire system as follows (4-2-2 shared neutrals, 2+2): the three-phase system will have one equipment ground, one isolated ground, two oversized (133 percent minimum) neutral, and four phase conductors; each neutral will be used by two phase conductors, no neutral conductor will be connected to multiple phase conductors of the same phase, and no ground conductor will be on the same circuit as two phase conductors from the same phase; circuits sharing a given neutral conductor will share the same ground conductor.][Unless otherwise indicated, allocate conductors of the 8-wire system as follows (4-2-2 shared neutral plus dedicated circuit, 3+1): the three-phase system will have one equipment ground, one isolated ground, two oversized (133 percent minimum) neutral, and four phase conductors; one neutral will be dedicated to a single phase conductor, one neutral will be shared by three phase conductors, and no neutral conductor will be connected to multiple phase conductors of the same phase; the isolated ground conductor will use by the circuit with the dedicated neutral conductor and the equipment ground conductor will use by the circuit with the shared neutral conductor.]

[Unless otherwise indicated, allocate conductors of the 8-wire system as follows (3-3-2 independent neutrals, 2+1): the three-phase system will have one equipment ground, one isolated ground, three neutral, and three phase conductors; one neutral will be dedicated to each phase conductor; the isolated ground conductor will use by one circuit and the equipment ground conductor will use by the other two circuits.]

[Unless otherwise indicated, allocate conductors of the 10-wire system as follows (6-2-2 shared neutrals, 3+3): the three-phase system will have one equipment ground, one isolated ground, two oversized (133 percent minimum) neutral, and six phase conductors; each neutral will be shared by three phase conductors and no neutral conductor will be connected to multiple phase conductors of the same phase; circuits sharing a given neutral conductor will share the same ground conductor.]

[Unless otherwise indicated, allocate conductors of the 10-wire system as follows (4-4-2 independent neutrals, 3+1): the three-phase system will have one equipment ground, one isolated ground, four neutral, and four phase conductors; one neutral will be dedicated to each phase conductor; the equipment ground conductor will be shared by three circuits, the isolated ground will be dedicated to the other circuit, and no ground conductor will be on the same circuit as two phase conductors from the same phase.]

[Unless otherwise indicated, allocate conductors of the 10-wire system as follows (4-4-2 independent neutrals, 2+2): the three-phase system will have one equipment ground, one isolated ground, four neutral, and four phase conductors; one neutral will be dedicated to each phase conductor; one ground conductor will be shared by two circuits, the other ground will be shared by the other two circuits, and no ground conductor will be on the same circuit as two phase conductors from the same phase.]

2.11.2.1 Receptacles

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NOTE: 15 AMP receptacles are the current industry standard. If 20 amp receptacles are required, the channel depth for the receptacle may have to be increased. Coordinate with the panel wall thickness.

****

Provide power receptacles in the powered panels. Place devices at the locations indicated on the plans connected to the designated circuits. [Electrical power receptacles and communications jacks should have the ability to be hung at [200 mm 8 inch] [multiple] [_____] vertical increments throughout the frame via power harnesses.] Unless otherwise indicated, receptacles must be [15 amp (NEMA 5-15R)] [20 amp (NEMA 5-20R)] commercial grade conforming to NEMA WD 1 and NEMA WD 6. Provide 10 percent spare devices of each type shown on these plans if receptacles are not interchangeable or will not permit field adjustment of phase and circuit selection. [All][General use] receptacles are required to be of the duplex configuration; unless otherwise indicated, special use receptacles are required to be of the simplex configuration with the blade/pin arrangement identified on the plans. Coordinate the color of receptacle bodies with the color of the panel trim. Isolated ground receptacles must [be orange] [or] [have distinct markings][be of a different color than other receptacles]. Furniture receptacles whose building power supply circuit is controlled by an energy management system, timer, or some other automatic means or are provided with local automatic control, will be identified using the standard symbol shown in NFPA 70 Figure 406.3(E); identify each outlet on a multi-outlet receptacle individually. Provide field applied identification that is permanent; stick-on or non-setting adhesives are not acceptable. Provide [5][_____] percent spare devices for each configuration and type of receptacle. Provide a minimum of [5][_____] receptacle removal tools for systems that require special tools for proper receptacle removal.

2.11.2.2 Power Cabling Variations

The paragraph Power Distribution has identified specific cabling configurations. Since universal conventions have not been established, variant configurations available from various manufacturers will be considered. Provide alternates that allow the same circuiting, device connections, neutral and ground separation, and upstream feeder connections as shown on the plans. See paragraph ALTERNATE DESIGN. An example of an acceptable variation includes the use of a manufacturer's configuration which allocates individual conductors differently, but which has the same quantity of conductors and allows devices to be physically connected in the field as shown on the plans. It is not necessary that the manufacturer's labeling codes or terminology match the designations used on project plans or in the specifications; however, color code insulation for neutrals and grounds per standard practice or provide with tags, colored tape, colored ribbons or similar identification. (The reference to "dedicated" conductors in this specification pertains to circuit connections upstream and load connections downstream of panels; it is not necessary that manufacturer's designations correspond.)

2.11.3 Electrical Connections

****

NOTE: The direct wired configurations should be suitable for most applications. All wiring should be contained within raceways or wireways. The exposed cord/plug arrangement should not be used, unless specifically requested by the user. If used, ensure that the design conforms to the limitations of Article 605-8 of NFPA 70.

Code-enforcing personnel in some areas require separate hard wired junction box interfaces from building services to furniture system installations. If the facility will be under their jurisdiction, the design must conform and the junction box configuration must be provided in lieu of the direct wired. If the facility will not be under local jurisdiction, the direct wired configuration could be provided per User request; however, it is preferred that the Government design be consistent with local practice. If top entry

service poles are used for power interfacing, the junction box configuration is preferred for all locations.
****

2.11.3.1 Internal Connections

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NOTE: Some local codes require hardwired connections with the panels. If local codes are to be followed, this item will need to be verified.
****

Utilize [straight or flexible plug/receptacle connector assemblies] [hardwired connections] for internal panel-to-panel power connections and provide the powered configurations shown on the drawings.

2.11.3.2 Connections to Building Services

Supply external [power][and][communications] services to the panels via [direct-wired [top][base] entry modules.][hard wired [top][base] entry junction box assemblies.][Extend wiring from building services to the entry modules or panel bases in metal conduit or tubing or in flexible liquidtight conduit 1830 mm 6 foot maximum.][Extend wiring from building services to junction box assemblies in metal conduit or tubing. Provide wiring from junction boxes that is flexible liquid-tight conduit 1830 mm 6 foot maximum or in metal conduit or tubing.] Do not use cord and plug assemblies for any portion of external links.[Provide base feed modules that plug into the end or either side of the raceway at receptacle doors.][Top entry [modules][junction box assemblies] are required to extend the [power][and][communications] wiring into service entry poles attached to the electrified panels.] External wiring must conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.11.4 Wire Management

Provide wire management capability at all workstations and accommodate all cable types specified, including the applicable manufacturer required bending radius at corners. Design raceways and interfaces to the raceways to accommodate the bend radius as shown in TIA-569 for Category [6][6A][7][_____][and][fiber optic cables] communication wiring [whichever is greater]. Provide copper and fiber cabling meeting the requirements of Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. The capability may be accomplished by cable access cutouts (1 minimum per work surface), covered wire management troughs in vertical end panels, horizontal wiring troughs, internal midpanel (beltline) raceways, or rear gaps (between the back edge of the work surface and the facing support panel). Provide grommet kits or another suitable finish arrangement for all cable cutouts. Provide accessories for an externally mounted vertical and horizontal wire management and concealment system [as indicated on the contract drawings] [as recommended by the manufacturer]. Supply horizontal wire managers for mounting under all work surfaces. Attach the wire managers either to the underside of the work surface or to the vertical panel without damaging the face. Exposed or loose wiring will not be acceptable. Wire managers must be prefinished and secure, conceal, and accommodate outlet cords as well as electrical and communications wiring. Wire channels are required to match color of panel trim, attach by means of clip-on attachment, and conceal wires routed vertically. Separate power wiring from communication wiring by use of separate raceways or by placement of channels in joint use troughs or wireways.

2.11.5 Circuit Layout

Provide the circuit layout for workstations on the drawings. Connect devices to the designated circuits in the neutral, ground, and automatic control configurations indicated. Connections must be made to the building electrical distribution system as shown on the contract drawings and in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.11.6 Service Entry Poles

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NOTE: Coordinate requirements with paragraph Power Distribution. Power and communications separation is required if the power is not in any metallic conduit when run in the pole or channel.

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Provide service poles, as indicated on the contract drawings, and capable of minimally accommodating the [8-wire][10-wire][_____] power configuration and the equivalent of [six][twelve][twenty] 4-pair category 6 cables.[Poles musthave metal barriers or channels to separate power and communications wiring.] Pole dimensions can be equal to maximum panel thickness. Designated poles are required to have the capability of being opened along the vertical access to permit the lay-in of wiring. Provide each pole with a wiring interface, an end cap and a ceiling trim plate which extends a minimum of 40 mm 1-1/2 inches from all sides of the pole. Include a junction box either as part of the pole assembly or in a field installed configuration with poles for power service. Service poles must be securely attached to the panels and installed plumb. Provide wiring and interface components as required to connect the building power supply to power poles.

2.11.7 Task Lighting

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NOTE: Coordinate with electrical engineer to comply with LED and task lighting guidance in UFC 3-530-01 Interior and Exterior Lighting Systems and Controls. Base the decision to use linear fluorescent or LED task lighting on a life-cycle cost analysis.

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Provide task lights with [linear fluorescent lamp][light emitting diode (LED) technology] to include a built-in reflector and shielding device that prevents direct glare into an occupant's eyes when they are in a typical working position. [Provide adjustable arm task lights with adjustable, fully articulated and balanced head and arms, minimum 254 mm 10 inch adjustable arm range, linear, circular, or compact fluorescent lamp technology, cord set for plug in, built in reflector, that is [panel mounted][desk mounted][freestanding][_____].] Provide task light size and placement on the contract drawings. It is required that lights be a standard component of the manufacturer's workstation products, and the ends of the task light length can not extend beyond the edges of the overhead cabinet. Enclose task light power cords within vertical wire cover or clips. Provide UL approved luminaires for use in the configurations indicated on the drawings.Provide task lighting that is Energy Star labeled. Provide data identifying Energy Star label for task lighting.

2.11.7.1 Luminaire Configuration

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NOTE: The lamp and ballast/driver types should be indicated on the drawings. Ballast and driver technical requirements are covered in Section 26 51 00 INTERIOR LIGHTING. When used, the electrical design must consider the harmonics and electromagnetic energy generated by these ballasts/drivers. Specific areas which must not have electronic ballasts/drivers are medical electronic equipment areas and areas equipped with infrared remote control or security devices. It is important to inform Users of the benefits and risks of electronic ballasts/drivers and to involve them in the decision regarding their use.

****

Provide luminaires and lamps as specified in Section 26 51 00 INTERIOR LIGHTING and modified herein. For undershelf or undercabinet lighting, provide luminaires that are [linear fluorescent lamp][light emitting diode (LED)] type and have prismatic lenses, baffles, or other shielding device configured to minimize glare by shielding the lamp from view of the seated user.[For adjustable arm task lights, provide luminaires that are linear, circular, or compact fluorescent lamp or LED type and have prismatic lenses, baffles, or other shielding device configured to minimize glare by shielfing the lamp from view of the seated user.] For fluorescent-type luminaires, provide built-in reflectors. Provide task lights for each workstation with a minimum of [[810][650] lx][[75][60] footcandles] of light (horizontally measured) without veiling reflections, on the work surface directly below and a maximum of [500mm][20 inches] from the luminaire. Easily removable diffusers, grilles, or other coverings are required to allow for cleaning and relamping.[Use F32T8 lamps in [1220 mm][4 foot] units for fluorescent-type task lighting.][For LED-type task lighting, power consumption exceeding 8 watts per foot is prohibited.] Match Correlated Color Temperature (CCT) of task lighting to the CCT of the ambient room lighting. Provide an easily accessible on-off switch and one ballast or driver per luminaire. A variable intensity control is acceptable if the low setting is equivalent to "off" with zero energy consumption. Multiple level switching is also acceptable.[For fluorescent type technology, do not use ganged luminaires or shared ballasts.][For LED type technology, ganged luminaires or shared drivers are permitted for up to 4 continuous feet in length. A single driver designed for use with an individual LED housing of greater than 4 feet in length is allowed.]

2.11.7.2 Wiring

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NOTE: If the facility will be under the jurisdiction of a city code, verify requirements. Some locations require hard wired connections.

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Provide each luminaire with a 1830 mm 6 foot minimum, factory installed, heavy duty electrical cordset with a grounded plug for luminaries that are mounted on the same wall as the receptacle. Provide luminaires mounted on non-powered wall with a 2743 mm 9 foot minimum, factory installed heavy duty electrical cordset with a grounded plug. Direct or hard wire connections are not acceptable. Unless otherwise indicated, conceal cord. Built-in cord concealment is required within panels or utilize field installed, manufacturer approved accessories. Cords may be extended through dedicated channels located at any point within panels or may be placed in vertical slots or in the space between panels if held in place by retainers and concealed by a cover plate. Vertical wire managers are required to be prefinished and cut to size and to extend from the task light level down to the top of the work surface below the task light. Attach each manager to a panel vertical edge or connector strip without damage to the surfaces.

2.11.7.3 Control Device

****

NOTE: Coordinate with the appropriate version of ASHRAE 90.1 to comply with the requirements for task lighting control. For ASHRAE 90.1-2007, the requirements are found in Paragraph 9.4.1.4.d. For ASHRAE 90.1-2010, the requirements are found in Paragraph 9.4.1.6.d. For ASHRAE 90.1-2013, the requirements are found in Paragraph 9.4.1.3(c). Coordinate with the electrical engineer.

****

[Provide task lighting with an automatic shutoff control device integral to the luminaires.][Provide occupancy sensors with "manual ON", "automatic OFF" controls for luminaire control.][For furniture with automatically-controlled building supply power circuits, connect task lighting to an automatically-controlled circuit.][Provide task lighting with a manual ON/OFF switch.]

2.11.8 Communications

Communications wiring will be extended to, and installed in, the electrified panels as shown on the plans. Install communications jacks at designated locations.[Provide a communication consolidation point at the end of the cubicle. The consolidation point will consist of a [24][48] port patch panel that is rated for Category [6][6A][7]. The panel that covers the consolidation panel is required to be lockable with all locks keyed alike. These locks must not be keyed the same as any other item associated with the workstations.] Communications work may be performed in conjunction with the installation of workstations or may be separately executed at the Contractor's option; however, equipment, materials, and installation must conform to the requirements of [Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM] [Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM][_____], and properly coordinate all interfaces.

2.11.9 Special Systems

****

NOTE: Include this paragraph only in projects where requirements for shielded facilities (TEMPEST, Red/Black, EMP, etc.) and secure wiring have been called out in project criteria. Specific requirements for cable arrangement, separation of Red/Black lines, etc., need to be verified for each

project. Provide metal raceway, channels, etc. throughout. Separation distances required for exposed cable or wiring in nonmetallic raceways are much greater than for wiring installed in totally enclosed metal raceway. Site specific details and/or notes should be prepared for each project.
****

Provide management for secure and nonsecure power, computer and telecommunications cabling through designated raceway systems. Separate secure distribution from nonsecure distribution [in accordance with details shown on the plans][by running secure lines along top located raceway and nonsecure along the bottom of the workstation panel].

PART 3 EXECUTION

3.1 INSTALLATION

Install the workstations using certified installers in accordance with manufacturer's recommended installation instructions. A licensed electrician is required to hardwire the workstations. Install workstation components level, plumb, square, and with proper alignment with adjoining furniture. Securely interconnect and attach components to the building where required. Provide three sets of special tools and equipment necessary for the relocation of panels and other components. Verify that equipment is properly installed, connected, and adjusted.

3.2 CLEANING

Provide cleanup as specified in Section 01 78 00 CLOSEOUT SUBMITTALS. Upon completion of installation, clean and polish all products and leave the area in a clean and neat condition. Any defects in material and installation are required to be repaired, and damaged products that cannot be satisfactorily repaired are required to be replaced. Submit three sets of Maintenance Manuals describing proper cleaning and minor repair procedures.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-12 61 13 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-12 61 13 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-12 61 13 (August 2020)**

Preparing Activity: USACE **Superseding**
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****

SECTION 12 61 13

UPHOLSTERED AUDIENCE SEATING
08/20

****

NOTE: This guide specification covers the requirements for upholstered fixed seating.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: On the drawings, show: (1) Seating layout, including row length and locations for wheelchair seating and ADA armrests as required by Architectural & Transportation Barriers Compliance Board, "ADA Title III, Americans with Disabilities Act - Buildings and Facilities"; and (2) Row and seat number identification.

Design must comply with all applicable fire and electrical codes, to include NFPA Life Safety Codes.

Coordinate aisle lighting, communication and electrical requirements with Electrical Engineer. Add requirements as appropriate for the project.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

	AMERICAN FOREST FOUNDATION (AFF)
ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability
	ASTM INTERNATIONAL (ASTM)
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A513/A513M	(2024) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM D4157	(2013; R 2017) Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)
ASTM F851	(1987; R 2020) Standard Test Method for Self-Rising Seat Mechanisms
	CALIFORNIA AIR RESOURCES BOARD (CARB)
CARB Regulation	Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood

Products

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

HARDWOOD PLYWOOD AND VENEER ASSOCIATION (HPVA)

ANSI/HPVA HP-1	(2020) American National Standard for Hardwood and Decorative Plywood

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

STATE OF CALIFORNIA, DEPARTMENT OF CONSUMER AFFAIRS, BUREAU OF HOME FURNISHINGS AND THERMAL INSULATION (CTB)

CTB 117-2000	Requirements, Test Procedure and Apparatus for Testing the Flame Retardance of Resilient Filling Materials Used in Upholstered Furniture
CTB 117-2013	Requirements, Test Procedure and Apparatus for Smolder Resistance of Materials Used in Upholstered Furniture

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

U.S. DEPARTMENT OF COMMERCE (DOC)

DOC CS 191	Commercial Standard for the Flammability

	of Clothing Textiles

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1610	Standard for the Flammability of Clothing Textiles

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Drawings; G, [_____]

SD-03 Product Data

Seating System; G, [_____]

[Recycled Content for upholstered audience seating; S

][No added Urea-formaldehyde for Composite Wood or Agrifiber Products; S

] SD-04 Samples

Seating System; G, [_____]

SD-06 Test Reports

Fire Test Response Characteristics; G, [_____]

Double Rub Tests; G, [_____]

SD-07 Certificates

[Installer's Qualifications

][Certified Sustainably Harvested plywood; S

][Certified Sustainably Harvested solid hardwood and wood veneer; S

] Indoor Air Quality for upholstered audience seating; S

[Indoor Air Quality for fabrics; S

][Indoor Air Quality for composite wood and agrifiber products; S

] SD-10 Operation and Maintenance Data

Assembly Manuals, Data Package 1; G, [_____]

SD-11 Closeout Submittals

Seating System, Data Package 1; G, [_____]

Submit Data Package 1 for upholstered audience seating in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

1.3 CERTIFICATIONS

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood

certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects allow the entire list of third party certifications.

****

[1.3.1 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Submit copies of invoices bearing certification numbers.

]1.3.2 Indoor Air Quality Certifications

****

NOTE: The Government's preference is for use of products that have been certified for indoor air quality by third-party organizations such as Greenguard or SCS Global Services. However, verify there is a certified product available that is both cost effective and appropriate for the project.

Research has shown that manufacturer's that out-source their fabric because of customer's demands cannot obtain a third-party certification for the assembly. When out-sourcing is deemed necessary, consider requiring Indoor Air Quality for fabrics and composite wood separately. Choose paragraph entitled "Seating System Products" if out-sourcing is not identified as a problem. Choose paragraphs entitled "Fabrics" and "Low-Emitting Composite Wood or Agrifiber Products" in lieu of paragraph entitled "Seating System Products" if outsourcing is identified as an issue.

****

[1.3.2.1 Seating System Products

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body.

][1.3.2.2 Fabrics

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body.

][1.3.2.3 Composite Wood or Agrifiber Products

For purposes of this specification, composite wood and agrifiber products include particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, and door cores. Provide current product certification documentation from certification body.

][1.3.3 Installer's Qualifications

When recommended by the manufacturer, deliver and install seating by an authorized dealer with a certified installation crew. Complete all hardwiring by a licensed electrician.

]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver components to the site in unopened containers clearly labeled with the manufacturer's name and container contents. Store materials in a safe, dry, and clean, well ventilated area (100 percent outside air supply, minimum of 1.5 air changes per hour, and no recirculation), protected from damage, soiling, and moisture, and strong contaminant sources and residues, maintained at a temperature above 16 degrees C 60 degrees F for 2 days prior to installation. Do not s with materials which have high emissions of volatile organic compounds (VOC's) or other contaminants, including [_____]. Do not store seating near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives. Handle the items in a manner that will protect the materials from damage.

1.5 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for specified warranty periods from date of final acceptance of the work as follows:

1.5.1 Warranty Periods

a. Structural: [5 years][10 years][_____]

b. Plastic, Wood and Paint Components: [3 years][_____]

[c. Electrical Components: [5 years][_____]

][d. Operating Mechanism: [5 years][_____]

] e. Fabric: [1 year][3 years][_____]

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled

content are also acceptable when meeting all requirements of this specification.

Research shows the product is available among US national manufacturers above the minimum recycled content shown.

****

[Provide Upholstered Audience Seating with a minimum of 20 percent recycled content. Provide data identifying percentage of recycled content for upholstered audience seating.]

****

NOTE: For manufacturers outsourcing fabrics, delete the bracketed sentence below.

****

[Provide certification of indoor air quality for Upholstered Audience Seating.]

2.2 PERFORMANCE REQUIREMENTS

2.2.1 Fire Test Response Characteristics

****

NOTE: Specify "Fabric and Padding" paragraph where required by authorities having jurisdiction.

****

2.2.1.1 Fabric and Padding

Provide fabric that is flame and smolder ignition resistant, and self-extinguishing, Class 1 fabric according to DOC CS 191 or 16 CFR 1610, as applicable per authorities having jurisdiction, tested according to California Technical Bulletin CTB 117-2000. Provide padding that complies with California Technical Bulletin CTB 117-2000. Provide fabric and padding that comply with NFPA 101.

****

NOTE: Specify "Upholstery Assembly" paragraph where required by authorities having jurisdiction. This test is required in California.

****

[2.2.1.2 Upholstery Assembly

Comply with component-testing requirements of California Technical Bulletin CTB 117-2013.

]2.3 MATERIALS

2.3.1 Upholstery Fabric

****

NOTE: Consider the following when selecting upholstery fabric:
- **frequency of use**
- **length of use**

- double rub or performance testing
- pilling
- are food and drink to be allowed

Add information on recycled material or natural fibers as applicable for the project.

****

Provide fabric meeting specified fire test response characteristics which is a [plain][decorative][_____] weave, fiber content of [100 percent polypropylene][100 percent polyester][100 percent nylon][_____] treated to resist staining and soiling. Provide fabric upholstery for seating with [minimum [55,000][75,000][_____] double rub tests according to ASTM D4157.]

****

NOTE: Retain the bracketed sentences below when the manufacturer outsources their fabrics due to customer demands.

****

[Provide fabrics meeting emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification of indoor air quality for fabrics.]

2.3.2   Polyurethane Foam Padding

Provide polyurethane foam padding meeting specified fire test response characteristics which is nonhardening, non-oxidizing and has a high resistance to alkalies, oils, grease, soaps, abrasions, moisture, mildew, and tearing.

2.3.3   Sub Title

Provide plywood conforming to ANSI/HPVA HP-1, made of hardwood and of crossbanded construction. Provide face veneers for exposed surfaces of Grade A hardwood, vertical grain, [maple][oak][cherry][_____] with manufacturer's standard finish. Provide unexposed veneers of sound grade hardwood or Grade A fir.

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability with the region, cost effectiveness, and adequate competition before specifying these certifications.

****

[Provide certified sustainably harvested plywood.]

2.3.4   Solid Hardwood and Wood Veneer

Provide solid hardwood and wood veneer of first grade [maple][oak][cherry][_____]. Finish exposed wood with manufacturers standard finish.

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Verify suitability, availability with the region,

cost effectiveness, and adequate competition before specifying these certifications.
****

[Provide certified sustainably harvested solid hardwood and wood veneer.]

2.3.5 Composite Wood or Agrifiber Products

For purposes of this specification, composite wood and agrifiber products include particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, and door cores.

Provide products containing no added urea-formaldehyde resins. Provide current product literature showing no added urea-formaldehyde for composite wood or agrifiber products.

[Provide products certified to meet emissions requirements of either CARB Regulation or CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification of indoor air quality for Composite wood and agrifiber products.]

2.3.6 Plastic Laminate

Plastic laminate conforms to ANSI/NEMA LD 3, Horizontal General Purpose Standard (HGS) Grade, 1.22 mm (plus or minus 0.127 mm) 0.048 inches (plus or minus 0.005 inches) in thickness.

2.3.7 Plastic

Plastic has built-in inhibitors to retard fading and anti-static compounds to retard dirt attraction. Pigment quality eliminates need to paint plastic parts. Component surfaces have a textured finish. Color is integral to the plastic.

2.3.8 Cast Iron

Cast iron complies with ASTM A48/A48M. Finish is [powder coat][_____].

2.3.9 Steel

Steel complies with ASTM A513/A513M or ASTM A1011/A1011M. Finish is [powder coat][_____].

2.4 SEATING SYSTEM

****
NOTE: Determine on project by project basis if sample chair is required.
****

Construct components and assembly free from objectionable projections or irregularities. Make corners and edges smooth and rounded. Unless otherwise noted, bolts, nuts, and other fastenings are concealed where possible. Steel is well-formed to shape and size required. Connections of members are by welding, riveting, or interlocking. Casting is fine textured, sound, and free of pits, blow holes, and fins. Lines are true, accurate, and true-to-pattern with excess metal or imperfections removed. Submit Assembly Manuals, manufacturer's descriptive data, catalog cuts, installation instructions and the following:

a. Minimum 152 by 150 mm 6 by 6 inches samples of upholstery, exposed plywood, plastic laminate, wood, identification plate, paint, armrest and plastic finish materials. Furnish fabric samples of sufficient size to show color range, pattern, and finish.

b. Two complete sets of certificates attesting that the proposed seating system meets specified requirements. Date the certificate after the award of contract, include name of the project and a list of specific requirements being certified. Three sets of assembly manuals describing assembly procedures.

c. One complete chair that meets requirements specified. Chair sample may be incorporated into the installation, provided the sample is approved and its location is noted.

2.4.1 Backs

****

NOTE: The option of an upholstered steel, plywood or polypropylene inner panel should remain since manufacturers use such a variety of materials for the inner panel.

Specification of hard surface backs is recommended for durability and maintenance reasons. Although, fully upholstered backs are available and may be substituted as appropriate to meet project requirements.

To achieve a certain aesthetic, it may be determined that hardware be visible. Edit to meet desired appearance. Example: It may be desired or acceptable that screws and bolts be visible on units composed of seat backs with exposed plywood.

Rocker type mechanism is an option but not available from all manufacturers. If required, research availability.

****

Provide back assembly of the fixed type and consisting of [a hard injection molded surface rear panel with an upholstered inner panel] [an exposed plywood front and rear panel]. Attach back assembly to standards with 14 gauge steel wings/back brackets; wings/back brackets have back pitch adjustability option, back assembly length is between [508] [_____] and [724] [_____] mm [20] [_____] and [28-1/2] [_____] inches for a total height of [762] [_____] to [914] [_____] mm [30] [_____] to [36] [_____] inches above the floor measured parallel to the back. Rear panel extends below the seat unit to completely conceal and protect the seat assembly.

2.4.1.1 Plastic Rear Panels

Panels are one-piece injection molded high impact resistant polypropylene or polyethylene with textured outer surface. Panel is formed to enclose and protect the edges of the inner upholstery panel at the top and sides.

2.4.1.2 [Plastic Laminate Finish][Wood] Rear Panels

Panels are fabricated from minimum [5 ply, 8 mm 5/16 inch] [7 ply, 16 mm 5/8 inch] thick plywood. [Exposed back surface is plastic laminate.] Rear panel is formed on the same radius as the upholstered inner panel. Sand smooth exposed wood edges.[Exposed bolts, fasteners or other hardware are not acceptable.]

2.4.1.3 Upholstered Inner Panels

Fabricate upholstered inner panels from 5 ply, 11 mm 7/16 inch minimum thick plywood, compound steel or compound curved 20 percent glass filled polypropylene with deep web reinforcing. Cushion consists of [51 mm 2 inch] [_____] thick polyurethane foam padding and have an upholstery cover. Padding is cemented to plywood inner panel. Upholstery cover is securely stapled to the inner plywood panel or held in place with draw strings for ease of re-upholstering. Upholstery cover cannot be attached with the use of nails, tacks, or screws.

2.4.1.4 Exposed Plywood Front & Rear Panel [Plastic Laminate Finish]

Back is fabricated from minimum [5-ply, 11 mm 7/16 inch] [7-ply, 19 mm 3/4 inch] thick contour molded plywood. [Exposed back and front surfaces are finished with plastic laminate.] Smoothly sand and finish all exposed edges.

2.4.2 Seats

****

NOTE: To achieve a certain aesthetic it may be determined that hardware be visible. Edit to meet desired appearance. Example: It may be desired or acceptable that screws and bolts be visible on units composed of seats with exposed plywood.

An acoustical or perforated seat bottom is available from some manufacturers. If needed to meet project requirements, research availability and add requirement to specification.

****

Provide foundation for upholstered seats free from visible screws, bolts, open holes, and projections on the bottom, front, and sides. [The front center edge of each seat has an identification plate. The area to receive the plate is recessed to prevent wear and abrasion. Method of attachment is tamper-resistant.] The seat unit is removable without disturbing the standards, and the upholstered seat cover is easily removable without removing the seat unit. The fabric covering is fastened to the frame in a manner that will permit easy reupholstering.

2.4.2.1 Polypropylene Seat Unit

Provide foundation consisting of a one-piece, injection molded polypropylene foundation fabricated with a minimum 25 percent glass-filled polypropylene or an inner structural panel constructed of 20 percent glass-filled polypropylene with deep web reinforcing and a wraparound polypropylene shell outer panel. Polypropylene foundation seat is serpentine spring or ergonomic seat cushion. Serpentine spring cushion contains at least five serpentine design springs spanning an injection molded plastic frame with molded polyurethane foam padding fitting firmly on springs. Frame and spring assembly are covered with a chafing barrier to protect foam padding from abrasion. Ergonomic seat cushion consists of a 5 mm 3/16 inch thick contoured polypropylene substrate supporting a polyurethane foam pad. Seat unit consisting of an inner structural panel has padding that is a molded polyurethane foam pad and has a minimum thickness of 76 mm 3 inches at the center, 38 mm 1-1/2 inches at the front with an overall thickness of 51 mm 2 inches. Upholstery cover fits the cushion size, is fastened with drawstring closure or staples for ease of re-upholstering, and does not have welts. Upholstery cover cannot be attached with the use of nails, tacks, or screws.

2.4.3 Hinges

****

NOTE: Three quarter fold is recommended for safety reasons; it is easier to open when hands are full and opens to 100 percent when additional pressure is applied to seat.

****

Hinges are a counterweight mechanism using gravity to return to the upright position, compensating type or spring lift mechanism, completely enclosed in the seat assembly, totally independent, free and easy in operation, and capable of compensating for circular installation, variation in installation conditions, and unevenness of floors. Each hinge has a noiseless, self-rising seat device, rises automatically to a uniform safety position of 3/4 fold at all times, and folds 100 percent when additional pressure is applied, to provide additional clearance. Seat hinge mechanism complies with ASTM F851 and requires no adjustment after installation. The compensating type and spring lift mechanism hinge is self-lubricating requiring no maintenance. Cushion both the up and down stops on the seat to reduce noise.

2.4.4 Standards

Provide standards which are minimum 1.9 mm 14 gauge tubular or sheet steel or one integral piece of cast iron. Steel standards are welded. Standards with ADA hinged armrests are provided with a label displaying the handicapped symbol and located and installed as shown on drawings.

2.4.4.1 Floor Standards

****

NOTE: Not all manufacturers produce both steel and cast iron standards; it is recommended that both options be left in the specification.

****

Form floor standards to fit the floor incline so that the standards will be vertical and the hinge point will be at a height that will maintain proper relation of seat to floor. Form the feet to eliminate tripping hazards, with a minimum of two holes for bolt attachment to the floor.

2.4.4.2 Riser Standards

Form riser standards to approach the riser face at an angle to allow maximum clearance, formed to fit the riser so that the standards will be vertical and the hinge point will be at a height that will maintain proper relation of seat to floor. Projection of the standard is not permitted in order to avoid a stumbling hazard or interfere with sweeping and cleaning. Provide riser attachment through a 6 mm 1/4 inch steel plate welded to the standard or on an integrally cast foundation. Provide securely attached standard to the riser without the use of shims or filler strips and attach at a minimum of 2 points.

2.4.4.3 [Aisle] [and] [End] Standards

[Aisle] [and] [end] standard complies with standard specifications and have a [molded plastic] [plastic laminate] [upholstered] [solid hardwood or wood veneer] [_____] decorator panel. [Shape of decorator panel is [open] [tapered] [rectangular] [radius on lower edge] [_____].] Decorator panels are not required for standards that have the ADA armrest. Install all decorator panels with concealed hardware.

2.4.5 Armrests

****

NOTE: Specification of hard surface armrests are recommended for durability and maintenance reasons.

****

Armrests are [solid hardwood with [rounded corners] [_____] and manufacturer's standard finish] [with cup holder] [wood with laminated plastic] [plastic] [plastic with cup holder] [_____]. Provide ADA armrest in locations as shown on drawings. ADA armrest is hinged at rear to allow easy access for limited mobility occupants.

2.4.6 Tablet Arm

****

NOTE: There are varying sizes of tablet arms, but not all manufacturers offer all sizes. Some only have one size. If size other than standard is required, add requirements to paragraph. Note some manufacturer have a size that accommodates a laptop computer.

****

Equip each chair with a fold-away tablet arm assembly. Tablet arm will automatically return to the stored position when raised manually to a vertical position in one motion and fall to the stored position by force of gravity, fold smoothly and quietly, store completely out of the way and be easily accessible when needed by the occupant without bending or reaching. Tablet arm is fabricated using balanced construction and is composed of manufacturer's standard core material faced with plastic laminate on the writing surface and supported by a minimum 3 mm 11 gauge steel bracket. All edges are rounded. When in a writing position, the arm locks firmly in place so that it cannot be accidentally disengaged. [Tablet arm[is capable of supporting a laptop computer][and is a minimum of[53548 square mm 83 square inches][64516 square mm 100 square inches][77419 square mm 120 square inches][84516 square mm 131 square inches][97419 square mm 151 square inches.]]] Provide both left and right handed tablet arms as show.

[2.4.7 Sub Title

****

NOTE: Some manufacturers offer power, data or USB

connection. If this option is selected, coordinate electrical requirements. When power and data modules are included as an option, end panels are required on aisle ends.
****

Provide power [and data] to each seat in a location that is convenient to the occupant. Include a 120 Volt wiring with duplex receptacle [and a telecommunications and data port] per seat. Provide power [and data] from the building power source and insure that all power [and data] components are UL listed and conform to Article No. 604 of the National Electric Code.

Connect all chairs in a row with a formed aluminum raceway with [molded] [or] [extruded] polymer covers to conceal power [and data] wiring [in the arm rest] [on raceway beneath the seating] [in fully enclosed wireways]. Provide 120 Volt, A.C. electrical power throughout the row [by means of a [two circuit, 4 wire system to power up to 16 chairs] [three circuit, 5 wire system to power up to 24 chairs][with a doubled sized neutral]]. [Use a separate molded polymer module to accommodate owner supplied ethernet, USB, phone and HDMI wiring.]

]2.4.8 Identification Plates

****
NOTE: Identify row and seat numbering system on drawings.

Address placement of identification plates when seat unit is fully upholstered.

Delete paragraph if not required.
****

Provide seating with number and letter plates for seat and row designations. Plates are constructed of manufacturer's standard [brass or bronze][clear anodized aluminum] [_____] finish and have black letters and numbers. Provide [tamper resistant] hardware with finish compatible with plates. Provide text font and seat numbering system [per manufacturer's standard.][as indicated.]

2.4.9 Aisle Lighting

****
NOTE: Determine if aisle lighting is required to meet project requirements. Delete paragraph if not required.

Coordinate design requirements with electrical engineer.
****

Provide [aisle] [and] [end] standard panels with [concealed] [surface mounted] [_____] LED aisle lights. Aisle lights are low voltage, 12 Volt, D.C., system with manufacture's voltage reduction device housed in safety enclosure equipped with fuses, terminal blocks, and safety disconnect. Aisle lighting is prewired, UL approved and wiring is routed through concealed casing into floor. Provide low heat generating lighting fixture components that are easily accessible for replacement. Aisle light wiring is hardwired to the building electric distribution system. The installation, proper safe mounting, and connection of the voltage reduction device, is the responsibility of a certified electrician.

[2.4.10 Electrical [and Telecommunications] Work

Provide electrical materials conforming to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM[and telecommunications materials conforming to the requirements of Section 27 10 00 BUILDING TELECOMMUNICATIONS SYSTEM]..

]2.5 COLOR

****

NOTE: Editing of color reference sentence(s) must be coordinated with the Government. Generally Section 09 06 00 SCHEDULES FOR FINISHES or drawing is used when the project is designed by an Architect or Interior designer. Color must be selected from manufacturers standard colors or identified as a manufacturers color in this specification only when the project is very simple and has minimal finishes.

When the Government directs that color be located in the drawings, a note must be added that states: "Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers. The word "color" as used herein includes surface color and pattern."

Prior to specifying a custom color finish, research to determine if additional cost and lead time is feasible. Note there is often a minimum order requirement; this requirement will also affect future orders.

When a manufacturer's name, stock number, pattern, and color is used, be certain that the product conforms to this specification, as edited.

****

Provide colors [as specified in Section 09 06 00 SCHEDULES FOR FINISHES.][as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.]

PART 3 EXECUTION

3.1 EXAMINATION

Examine floor, riser, and other adjacent work and conditions prior to layout and installation. Verify compliance with requirements and other conditions affecting performance of the work. [Verify that electrical connections are properly located.][Verify HVAC air-distribution locations are correct.] Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PLACEMENT OF STANDARDS

****

NOTE: Generally, the width of seat units should be 533 or 559 mm with 508 mm 21 or 22 inches with 20 inch wide units restricted to the exit seat location if needed to meet specific dimension requirements.

****

The system permits the standards to be installed on radial lines from a common center for which concentric circles are determined with each row of units utilizing common middle standards. Standards in each row are placed laterally so the aisle-end standards will be in alignment as indicated on seating layout drawing. The angle of inclination of backs adjusted for variations in sightlines. Mechanical attachment of components is of sufficient flexibility so that when permanently assembled they will compensate for the changing dimensions laterally between standards caused by convergence toward the center. Seat and back attachments absorb inaccuracies in lateral spacing of standards at point of attachment caused by unevenness of floor. Varying lateral dimensions of backs and seats are in accordance with approved seating layout. Minimum width of seating unit is 508 mm 20 inches and may be used only to complete a specific row dimension.

3.3 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Installation of the seating system is in accordance with the approved detailed drawings and manufacturer's recommended installation instructions. Submit seating plans dimensioned and showing row spacing, row lengths, the varying lateral spacing at backs and seats, back pitch, and seat widths for the various section lengths, placement of standards, floor pitch, and riser height, where applicable. Submit drawings indicating metal thickness, fastenings, details of hinge mechanism, seat and back dimensions, and proposed finish.

3.4 CLEANING

Clean and polish all products and leave the area in a clean and neat condition upon completion of installation. Repair any defects in material and installation and replace damaged products that cannot be satisfactorily repaired.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-12 93 00 (August 2017)**
Change 1 - 08/18

Preparing Activity: USACE **Superseding**
UFGS-12 93 00 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 12 93 00

SITE FURNISHINGS

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-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC
Preparing Activity: USACE

UFGS-12 93 00 (August 2017)
Change 1 - 08/18

Superseding
UFGS-12 93 00 (February 2009)

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References are in agreement with UMRL dated January 2025
****

SECTION 12 93 00

SITE FURNISHINGS
08/17, CHG 1: 08/18

****
NOTE: This guide specification covers the requirements for miscellaneous site and street furniture and furnishings including shelters.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: Units of work normally included in this section require specific fabrication to meet the desired project requirements. The Key Word Index of the CSI "Masterformat" should be consulted for the proper location of most items.

The following information will be shown on the drawings:

1. Location and configuration of all furniture and furnishings.

2. All sizes and dimensions.

3. Special fastenings, attachments or anchoring.

4. Location and size of expansion shields larger than 10 mm 3/8 inch in diameter.

5. Location of products to be galvanized.

6. Connection details, other than manufacturer's standard.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS	(2021) American Tree Farm System Standards of Sustainability

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings
ANSI/AISC 303	(2022) Code of Standard Practice for

	Structural Steel Buildings and Bridges

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

ANSI/AITC A190.1	(2007) American National Standard, Structural Glued Laminated Timber

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.6.2	(2020) Square Head Set Screws and Slotted Headless Set Screws (Inch Series)
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.21.2M	(1999; R 2014) Lock Washers (Metric Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.3	(2020) Safety Requirements for Powder-Actuated Fastening Systems American National Standard for Construction and Demolition Operations

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M2	(2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard

	Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2014) Standard Specification for Aluminum

	and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B429/B429M	(2010; E 2012) Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C979/C979M	(2024) Standard Specification for Pigments for Integrally Colored Concrete
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM D1187/D1187M	(1997; R 2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM D2990	(2017) Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
ASTM D3451	(2006; R 2017) Standard Guide for Testing Coating Powders and Powder Coatings
ASTM D4060	(2019) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4802	(2016) Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F1487	(2021) Standard Consumer Safety Performance Specification for Playground

	Equipment for Public Use

CSA GROUP (CSA)

CSA Z809-16	(R2021) Sustainable Forest Management

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA Rules	(2023) Rules for the Measurement & Inspection of Hardwood & Cypress

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-117	(2013) Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, 3rd Edition
PCI MNL-128	(2001) Recommended Practice for Glass Fiber Reinforced Concrete Panels, 4th Edition

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)

PEFC ST 2002:2013	(2015) PEFC International Standard Chain of Custody of Forest Based Products Requirements

REDWOOD INSPECTION SERVICE (RIS) OF THE WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

RIS Grade Use	(2019) California Redwood Lumber Grades and Uses

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 25	(1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003	(2021) Standard Grading Rules for Southern Pine Lumber

SUSTAINABLE FOREST INITIATIVE (SFI)

SFI 22	(2022) Standards and Rules for Forest Management, Fiber Sourcing, Chain of Custody, and Certified Sourcing

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1925	(Rev A; Notice 1; Notice 2; Notice 3; Notice 4) Shield Expansion (Nail Anchors)

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17	(2015; R 2018) Standard Grading Rules for West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5	(2021) Western Lumber Grading Rules

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Benches and Chairs; G, [_____]

Tables; G, [_____]

Shelters; G, [_____]

Bicycle Racks; G, [_____]

Planters; G, [_____]

Bollards; G, [_____]

Tree Grates; G, [_____]

Assembly Instruction Drawings

SD-03 Product Data

Benches and Chairs

Tables

Shelters

Bicycle Racks

Planters

Bollards

Tree Grates

Recycled Content for steel components; S

Recycled Content for aluminum components; S

Recycled Content for HDPE components; S

Waste Receptacles

SD-04 Samples

Finish; G, [_____]

SD-06 Test Reports

Testing

SD-07 Certificates

Primer Certificate

Powder Coatings Certificate

[Certified Sustainably Harvested lumber; S]

[Certified Sustainably Harvested wood for wood seats and table tops; S]

[Certified Sustainably Harvested wood for wood benches and chairs; S]

[Certified Sustainably Harvested wood for wood containers; S]

[Certified Sustainably Harvested wood for wood shelters; S]

[Certified Sustainably Harvested wood for wood tables; S]

1.3 CERTIFICATIONS

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective. Sustainably Harvested Wood is a product which comes from a third-party Forestry Certification Program and thus carries certain characteristics: 1) Protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration (e.g., replanting and reforestation); 2) Third-party certification audits performed by accredited certification bodies; 3) Publicly available certification audit summaries; 4) Multi-stakeholder involvement in a standards development process; 5) Complaints and appeals process.

Designer must verify suitability, availability within the region, cost effectiveness and adequate competition before specifying these sustainably harvested wood certifications - if these conditions are verified for the project locale, include the following section. For projects pursuing LEED, delete certifications other than FSC; for all other projects allow the entire list of third party certifications.

****

1.3.1 Certified Sustainably Harvested Wood

Provide wood certified as sustainably harvested by FSC STD 01 001[, ATFS STANDARDS, CSA Z809-16, SFI 22, or other third party program certified by PEFC ST 2002:2013]. Provide a letter of Certification of Sustainably Harvested Wood signed by the wood supplier. Identify certifying organization and their third party program name and indicate compliance with chain-of-custody program requirements. Submit sustainable wood certification data; identify each certified product on a line item basis. Provide current product certification documentation from certification body. Submit copies of invoices bearing certification numbers.

1.4 QUALITY ASSURANCE

Qualify welders in accordance with AWS D1.1/D1.1M using procedures, materials, and equipment of the type required for the work.

1.4.1 Fabrication Drawings

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in ANSI/AISC 303.

1.4.2 Installation Drawings

Submit templates, erection and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation.

1.4.3 Assembly Instruction Drawings

Submit assembly instruction drawings showing layout(s), connections, bolting and anchoring details in accordance with manufacturer's standards. Submit drawings showing scaled details of proposed site furnishings, elevations for each type of site furnishing; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction.

1.4.4 Primer Certificate

Submit a certificate from the manufacturer stating that the primer conforms to requirements of SSPC Paint 25.

1.4.5 Powder Coatings Certificate

Submit a certificate from the manufacturer stating that the powder coat conforms to ASTM D3451.

1.5 DELIVERY, STORAGE, AND HANDLING

Ship items knocked-down (KD) ready for site assembly. Packaged components must be complete including all accessories and hardware. Materials must be delivered, handled, and stored in accordance with the manufacturer's recommendations. Site furnishings must be inspected upon arrival at the job site for conformity to specifications and quality in accordance with paragraph MATERIALS. Protect from corrosion, staining, and other types of damage. Store items in designated area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials which are the standard products of a manufacturer regularly engaged in the manufacture of such products. Provide materials with proven satisfactory usage for at least 2 years.

2.1.1 Metals

Metallic materials and products must conform to Section 08 31 00 ACCESS DOORS AND PANELS. Furnish metal components with factory drilled holes and free of excess weld and spatter. Metal components with holes that will not be filled by hardware or hidden by other components will be rejected. Structural steel products must conform to ASTM A36/A36M, ASTM A500/A500M and ASTM A501/A501M. Provide Steel Components with a minimum of 70 percent recycled content. Provide data identifying percentage of recycled content for steel components.

2.1.2 Structural Tubing

ASTM A500/A500M

2.1.3 Steel Pipe and Fittings

Steel pipe must conform to ASTM A53/A53M, Type E or S, Grade B; standard malleable iron fittings must conform to ASTM A47/A47M.

2.1.4 Gray Cast Iron

Gray cast iron must conform to ASTM A48/A48M Class 35 or better. Provide castings manufactured true to pattern and component parts that fit together in a satisfactory manner. Castings must be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. Smooth castings must be well-cleaned by sand or shot blasting.

2.1.5 Aluminum Products

****

NOTE: Use materials with recycled content where appropriate for use. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research shows the product is available among US national manufacturers above the minimum recycled content stated.

****

Provide Aluminum Components with a minimum of 50 percent total recycled content. Provide data identifying percentage of recycled content for aluminum components

2.1.6 Cast Aluminum

Cast aluminum must conform to ASTM B26/B26M and ASTM B108/B108M. Provide castings manufactured true to pattern and component parts that fit together in a satisfactory manner. Provide castings of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. Smooth castings must be well-cleaned by sand or shot blasting.

2.1.7 Aluminum Alloy Products

Conform to ASTM B209M ASTM B209 for sheet plate, ASTM B221M ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 3 mm 1/8 inch thick and aluminum plate or sheet at least 1.3 mm 0.050 inch thick.

2.1.8 Anchors and Hardware

Provide anchors, where necessary, for fastening site furnishings securely in place and in accordance with approved manufacturer's instructions. Anchoring devices that may be used, when no anchors are otherwise specified or indicated, include anchor bolts, slotted inserts, expansion shields for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; and lag bolts and screws for wood. Anchor bolts must conform to ASTM A307. Hardware must be [stainless steel] [brass] [zinc-plated][zinc-chromate plated] [or] [galvanized steel] in accordance with ASTM A153/A153M and compatible with the material to which applied. All exposed hardware must match in color and finish. Mounting hardware must be concealed, recessed, and plugged.

2.1.8.1 Threaded Inserts and Expansion Anchors

Provide inserts recessed not less than [65] [_____] mm [2.5] [_____] inches into concrete or masonry. Pullout [90] [_____] kg [198] [_____] pounds in concrete with f'c of 20 MPa 3,000 psi, as tested in accordance with ASTM E488/E488M. Expansion shields must conform to CID A-A-1925, group II, type 4, class 1. Provide embedment required by manufacturer.

2.1.8.2 Lag Screws and Bolts

ASME B18.2.1, type and grade best suited for the purpose.

2.1.8.3 Toggle Bolts

ASME B18.2.1.

2.1.8.4 Bolts, Nuts, Studs and Rivets

ASME B18.2.2 or ASTM A307.

2.1.8.5 Power Driven Fasteners

Follow safety provisions of ASSP A10.3.

2.1.8.6 Screws

ASME B18.2.1, ASME B18.6.2, and ASME B18.6.3.

2.1.8.7 Washers

Provide plain washers to conform to ASME B18.22M ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers to conform to ASME B18.21.2M ASME B18.21.1.

2.1.9 Ounce Metals

Bronze, copper, and other ounce metals must conform to ASTM B62.

2.1.10 Concrete

Ready-mixed concrete must conform to ASTM C94/C94M, using 19 mm 3/4 inch maximum size aggregate, and having minimum compressive strength of 20 MPa 3000 psi at 28 days. Portland cement must conform to ASTM C150/C150M. Cast-in-place concrete materials and products must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE. Precast concrete material and products must conform to Section 03 45 33 PRECAST[PRESTRESSED] STRUCTURAL CONCRETE. Reinforcing steel must conform to ASTM A615/A615M. Welded wire fabric must conform to ASTM A1064/A1064M.

2.1.11 Masonry

Masonry material and products must conform to Section 04 20 00 UNIT MASONRY

2.1.12 Tempered Glass

ASTM C1048, Kind FT (fully tempered), condition A (uncoated), Type 1 (transparent, Quality q3, [6.35] [_____] mm [1/4] [_____] inch thick, [clear] [bronze] [_____] in color.

2.1.13 Plastics

****

NOTE: It is important for the designer to ensure manufacturers supply quality plastic products made from post-consumer recycled high density polyethylenes. High density polyethylene can be manufactured using post-consumer recycled plastic resins from products such as milk containers. Designer should insist on products utilizing high-density polyethylene. Use materials with recycled content where appropriate for use. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. Research shows the product is available among US national manufacturers above the minimum recycled content stated.

Plastic lumber is susceptible to both creep and deflection; therefore, it cannot be used for structural members of furnishings. To overcome creep and deflection, the product is increased in volume of material and dimension.

****

Provide High Density Polyethylene (HDPE) Components with a minimum of 90 percent total recycled content. Provide data identifying percentage of recycled content for HDPE components. Recycled materials must be constructed or manufactured with a maximum 6 mm 1/4 inch deflection or creep in any member in conformance with ASTM D2990. Provide panels and components molded of ultraviolet (UV) and color stabilized polyethylene, with minimum 6 mm 1/4 inch wall thickness; exposed edges must be smoothed, rounded, and free of burrs and points; and the material must be resistant to fading, cracking, fogging, and shattering. The material must be non-toxic and have no discernible contaminates such as paper, foil, or wood. The material must contain no more than 3 percent air voids and be resistant to deformation from solar radiation heat gain. Recycled materials to include plastic lumber will not be used as structural components of site furnishings. Submit a report of site furnishing parts consisting of recycled materials. Product specification data, providing test information for deflection and creep in accordance with ASTM D2990 for site furnishings which use plastic lumber as a component, must be submitted. Provide data for comparison of deflection and creep measurements to other comparable materials.

2.1.13.1 Extruded Acrylic Sheet

ASTM D4802 [Type I, regular] [Type II, heat resistant] [6] [_____] mm [1/4] [_____] inch thick, [clear] [_____] in color.

2.1.13.2 Cast Acrylic Sheet

ASTM D4802, Item A, [Type I, Heat resistant and ultraviolet light absorbing] [Type II, heat resistant], 6 mm 1/4 inch thick, [clear] [bronze] [_____] in color.

2.1.14 Lumber

Provide premium grade wood free of knots; boards with eased edges and ends; and wood components with factory drilled holes. Components with holes that will not be filled by hardware or hidden by other components will be rejected. Wood products must be selected to withstand the climatic conditions of the region in which the site is located.

****

NOTE: Use certified sustainably harvested wood for all specialty items where suitable for application and cost effective. The Editor may wish to selectively apply this requirement to the specialty items within this specification and delete the general requirement here

****

[Provide certified sustainably harvested lumber.]

Lumber grades must meet manufacturers standards of the grading rules under which they are manufactured. Where no standards exist the following must be the minimum acceptable grades for species used.

a. WWPA G-5 grading rules, [Douglas Fir] [Western Cedars],[Choice & Btr,] [Select or A & Btr.] in accordance with special western red cedar rules.

b. WCLIB 17 standard grading rules, [Douglas Fir] [Western Cedars], A & Btr.

c. SPIB 1003 grading rules, Southern Pine, C & Btr.

d. NHLA Rules standard specification, Cypress, C-Select.

e. RIS Grade Use standard specifications, Redwood, [Clear] [Clear All Heart].

f. NHLA Rules rules, [Cypress] [Teak], [B Finish] [Select or Btr.].

2.1.14.1 Moisture Content

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products at time of delivery must be in accordance with manufacturers standard. If no manufacturer's standard exists, then moisture content must be based on requirements for the product, grade and intended use.

2.1.14.2 Treatment

Wood that is not naturally rot and insect resistant must be treated in accordance with AWPA U1, as applicable, and inspected in accordance with AWPA M2. Provide treatment of wood in accordance with ASTM F1487.

2.1.14.3 Wood Seats and Table Tops

Clear teak, maple, oak, Jarrah, Ipe or other suitable hardwood, not less than 40 mm 1-5/8 inches thick with rounded edges.

****

NOTE: Use certified sustainably harvested wood

where suitable for application and cost effective.
****

[Provide certified sustainably harvested wood for wood seats and table tops.]

2.1.15 Fiberglass

Fiberglass must consist of at least 3 laminations of chopped glass fibers impregnated with polyester resin, with colors and textures molded into all exposed surfaces so that colors resist fading. Fiberglass must be resistant to cleaners, fertilizers, high power spray and salt.

2.2 PRETREATMENT, PRIMING AND PAINTING

****
NOTE: Use manufacturers standard treatment when painting and finishing is required.
****

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. [On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 0.03 mm 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.]

2.2.1 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.2.2 Aluminum Surfaces

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.3 COATINGS AND FINISHES

****
NOTE: The content of volatile organic compounds (VOC), and marking, must be in compliance with air quality regulations for the type of application and jurisdiction where used.
****

2.3.1 Galvanizing

****
NOTE: Specify galvanizing for items installed in exterior exposures subject to salt spray or corrosive fumes and interior areas subject to continual wetting or high humidity.
****

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing must conform to ASTM A123/A123M, ASTM A153/A153M or ASTM A653/A653M, as applicable. Tailings and sharp protrusions formed as a result of the hot-dip process must be removed and exposed edges burnished. Galvanize anchor bolts, grating fasteners, washers and parts or devices necessary for proper installation, unless otherwise indicated.

2.3.2 Polyester Powder

Powder-coated surfaces must receive electrostatic zinc coating prior to painting. Powder coating must be electrostatically applied and oven cured. Polyester powder coating must be resistant to ultraviolet (UV) light.

2.3.3 Polyvinyl-Chloride (PVC)

PVC coating must be primed with a clear acrylic thermosetting solution. The primed parts must be preheated prior to dipping. The liquid polyvinyl chloride must be ultraviolet (UV) stabilized and mold-resistant. The coated parts must be cured. The coating must be a minimum 2 mm 2/25 inches thick plus or minus 0.5 mm 0.020 inches and must have an 85 durometer hardness with a slip-resistant finish.

2.3.4 Finish

Finish must be as specified by the manufacturer or as indicated. Exposed surfaces and edges must be rounded, polished, or sanded. Finish must be non-toxic, non-glare, and resistant to corrosion. Exposed surfaces must be smooth and splinter-free exposed surfaces. Submit [two] [_____] sets of color data for each furnishing displaying manufacturer's color selections and finishes, and identifying those colors and finishes proposed for use.

2.3.4.1 Wood Sealants

Exposed wood surfaces must have, as a minimum, two shop coats of paint, varnish, sealer, or other approved preservative. Sealants must seal all applied surfaces from air.

2.3.4.2 Paint

Paint must be factory applied with a minimum of 2 coats. Paint must be weather-resistant and resistant to cracking, peeling and fading.

2.3.4.3 Color

Color of site furnishing components must be in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.

2.4 SITE STANDARDS

Site furnishings must be furnished with the dimensions and requirements indicated. Site furnishings placed in children's outdoor play areas must meet the safety requirements of ASTM F1487 for entrapment; sharp points, edges, and protrusions; entanglement; pinch, crush, and shear points. Site furnishings to be included in children's outdoor play areas must be free from sharp vertical edges and any protruding elements and designed with a minimum radius of 13 mm 1/2 inch on all vertical edges; this includes, but is not limited to, seat walls, containment curbs and planters. Where practical, horizontal edges exposed to children's activities must be rounded.

2.5 BENCHES AND CHAIRS

Furnish benches and chairs with no sharp edges or protruding hardware.

a. Height: The height above finished grade or specified surface must be between 450-500 mm 18-20 inches and level.

b. Seat: The seat surface must be pitched or slotted to shed water; the seat depth must be between 300-460 mm 12-18 inches and pitched down at the back at a 0-5 degree angle. Seat must have a minimum width of 610 mm 24 inches per person, and must overhang the support base by a minimum of 100 mm 4 inches for heel space and to facilitate rising from a seating position.

c. Back Rest: When back rests are required, the height must be between 380-460 mm 15-18 inches from the top of the seat and the connection must be at a 90-110 degree angle to the seat.

d. Arm Rest: When arm rests are required, a minimum of 150 mm 6 inches height from the seat and a minimum arm rest width of 38.3 mm 1-1/2 inches must be provided.

e. Weight Limit: Seats must support a minimum 136 kg 300 lbs for each person they are designed to accommodate.

[2.5.1 Precast Units

Design precast units in accordance with manufacturer's standards, size as indicated. Finish and color as indicated selected from manufacturer's standards.

[2.5.1.1 Glass Fiber Reinforced Concrete (GFRC) Units

Provide glass fiber reinforced concrete (GFRC) units at locations indicated on the drawings. Comply with PCI MNL-128 recommended practice for glass fiber reinforced concrete, including Appendix G, Polymer Modified Glass Fiber Reinforced Concrete Panels.

a. Design precast benches to sustain a live load of not less than 10 kPa 200 pounds per square foot.

b. Provide ASTM C150/C150M cement, use only one brand and type of cement throughout project.

c. Provide alkali resistant (AR) glass fibers produced specifically for use in glass fiber reinforced concrete, minimum three percent glass fiber content.

d. Provide clear silica sand aggregate passing 1.18 mm No. 16 sieve; washed, dried and free from deleterious materials. Provide type with successful history of uses in GFRC fabrication standard with the manufacturer.

e. Provide 20.7 MPa 3000 psi concrete, 28 day minimum compressive strength with approximately 1921 kg/cubic meter 120 pcf density; shell thickness of 10 to 16 mm 3/8 to 5/8 inch.

f. Provide manufacturer's standard acrylic thermoplastic copolymer admixture.

g. Provide factory finished units standard with the manufacturer; texture and color as selected.

   (1) Provide white or grey cement consistent with final finish.

   (2) Provide ASTM C33/C33M (less gradation) facing aggregates, clean, hard, durable, inert and free of staining and deleterious materials; as required to match approved samples.

   (3) Provide color meeting ASTM C979/C979M, pure, non-fading mineral oxides, maximum ten percent cement weight; as required to match approved samples without impairing strength of GFRC.

   (4) Apply finish meeting ASTM D4060 waterborne crosslinked acrylic 49.5 +/- two percent solids by weight providing 1000 cycles per 0.0254 mm 1000 cycles per 0.001 inch resistance to abrasion.

h. Prefabricate units within following maximum fabrication tolerances.

   (1) Dimension: Plus or minus 3 mm 1/8 inch in any direction, noncumulative.

   (2) Material Thickness: Plus 6 mm 1/4 inch and minus 0-inch.

   (3) Total Unit Thickness: Plus 6 mm 1/4 inch and minus 3 mm 1/8 inch.

   (4) Insert Locations: Plus or minus 6 mm 1/4 inch.

][2.5.1.2 Precast Concrete/Cast Stone Units

Provide reinforced precast concrete units consisting of a mixture of cement, aggregates and mineral colors suitable for exterior use, located as indicated. Design benches to sustain a live load of not less than 10 kPa 200 pounds per square foot.

2.5.1.2.1 Portland Cement

ASTM C150/C150M Type I II or III

2.5.1.2.2 Aggregate

ASTM C33/C33M, maximum size 19 mm 3/4 inch

2.5.1.2.3 Reinforcing Steel

ASTM A615/A615M

2.5.1.2.4 Galvanized Wire Mesh

ASTM A1064/A1064M

2.5.1.2.5 Integral Color

ASTM C979/C979M, pure mineral oxide, limeproof and non-fading

2.5.1.2.6 Concrete Strength

Provide minimum 35 MPa 5000 psi 28 day compressive strength concrete, maximum five percent absorption.

2.5.1.2.7 Admixture

ASTM C260/C260M for air-entraining

]][2.5.2 Wood Units

Provide manufacturer's standard wood units with wood, metal, fiberglass or concrete pedestals as indicated. Provide fasteners and accessories required for onsite assembly. Kiln dry and pressure treat wood components to manufacturer's standards. Pre-treat metal components and provide manufacturer's standard primer and powder coat finish complying with ASTM D3451, color as selected. Provide fiberglass non-fading gel coat color as indicated. Provide manufacturer's standard exposed aggregate or sandblasted finish and protection coating on concrete pedestals.

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective.

****

[Provide certified sustainably harvested wood for wood benches and chairs.]

a. Design wood benches to sustain a live load of not less than 10 kPa 200 pounds per square foot.

b. Provide kiln dried, surfaced four sides (S4S), clear all sides wood slats of species and sizes indicated.

    (1) Species: [Teakwood] [Marine Teak] [Clear All Heart Redwood] [Red Cedar] [Alaska Yellow Cedar] [Clear Douglas Fir] [Ipe] [Mahogany] [Purple Heart].

    (2) Nominal wood slat sizes: 25 by 63 mm 1 by 2-1/2 inch [25 by 75 mm 1 by 3 inch] [50 by 75 mm 2 by 3 inch] [50 by 100 mm 2 by 4 inch]. Top and bottom rail may be larger in size and configuration for comfort of seating.

2.5.2.1 Support Pedestals

Provide [cast iron] [cast aluminum] [steel] [wood] [concrete] [fiberglass] support pedestals in accordance with manufacturer's standard.

2.5.2.1.1 Cast Grey Iron

ASTM A48/A48M Class 30 or recycled cast grey iron ASTM A48/A48M Class 25

2.5.2.1.2 Cast Aluminum

ASTM B26/B26M or ASTM B108/B108M as applicable

2.5.2.1.3 Steel

ASTM A653/A653M

2.5.2.1.4 Wood

Match in species, grade, grain, color and finish of the wood slats.

2.5.2.1.5 Concrete

Concrete must be of the same quality and finish as specified for precast concrete.

2.5.2.1.6 Fiberglass

Design fiberglass pedestals to support the loads imposed in design of bench. Color as approved.

[2.5.2.2 Steel Arms

Provide 9 mm 3/8 inch thick by 75 mm 3 inch wide steel bench arms conforming to ASTM A653/A653M.

]][2.5.3 Fiberglass Benches

Provide reinforced fiberglass benches molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins, minimum thickness of 3 mm 1/8 inch and reinforced in accordance with manufacturer's standard practice.

a. Design bench to sustain a live load of not less than 10 kPa 200 pounds per square foot.

b. Provide manufacturer's finish, 12-15 mil color impregnated polyester gel coat, of color as selected from manufacturer's standard colors and finishes, [smooth matte] [orange peel] [polished granite].

]2.5.4 Steel Units

[2.5.4.1 Perforated Steel

Provide [1.9 mm 14 gage] [1.6 mm 16 gage] perforated steel sheet, electrostatically coated with two component polyester enamel.

a. Design bench to sustain a live load of not less than 10 kPa 200 pounds per square foot.

b. [b. Provide 9 mm 3/8 inch thick by 100 mm 4 inch wide hot rolled steel pedestals conforming to ASTM A653/A653M.]

c. [c. Provide 38.3 mm 1-1/2 inch O.D. ASTM A53/A53M schedule 40 steel pipe pedestals.]

][2.5.4.2 All-Welded Wire

Provide all-welded wire construction of 3.8 mm 9 gage, 3.1 mm 11 gage wire with 13 mm 1/2 inch clear spacing and 8 mm 5/16 inch wire with 63 mm 2 1/2 inch spacing.

a. Design benches to sustain a live load of not less than 10 kPa 200 pounds per square foot.

b. Provide 33 mm one inch O.D. by 1.3 mm 18 gage [38.3 mm 1-1/2 inch O.D. by 1.6 mm 16 gage] galvanized tubing for bench frames.

c. [c. Provide 38.2 mm 1-1/2 inch O.D. by 3.1 mm 11 gage galvanized tubing for armrest.]

d. Provide cadmium or zinc plated hardware; nuts, bolts, screws, and lock washers with a clean chromate finish.

]2.5.5 Aluminum Units

[AA DAF45] [AAMA 611]. Provide [extruded] [formed] aluminum benches in accordance with manufacturers standard, with [dark] [medium] [light] bronze [clear anodized] [black anodized] [acrylic paint] [powder coat] finish, color as selected from manufacturer's standards.

a. Design benches to sustain a live load of not less than 10 kPa 200 pounds per square foot.

b. Provide manufacturer's standard [cast grey iron] [cast aluminum] [steel] [precast concrete] [fiberglass] pedestals.

2.5.6 Accessories

Provide manufacturer's standard materials and accessories as required for assembly of units and as indicated on the assembly drawings. Provide unexposed aluminum, stainless steel or steel plates, angles and supports as required for complete assembly. Separate dissimilar materials to prevent electrolytic action.

2.5.7 Fasteners

Provide concealed fasteners except where specifically approved; types as required for specific usage.

2.5.8 Anchoring Brackets

Provide 6 mm 1/4 inch zinc plated steel angle anchoring brackets, 47 mm 1-7/8 inch wide by 50 mm 2 inches deep by 63 mm 2-1/2 inches high [47 mm 1-7/8 inch wide by 90 mm 3-1/2 inch deep by 150 mm 6 inch high], pre-drilled for bolting benches to substrate.

2.6 BICYCLE RACKS

Design bicycle racks (stanchions) in accordance with manufacturer's standards and to meet design conditions indicated. Locate as shown on the drawings. Provide powder coat finish in color as selected from manufacturer's standards. Racks must accommodate locking devices and secure, as a minimum, one wheel and part of the frame simultaneously. The spacing between racks must be a minimum of 610 mm 24 inches.

[2.6.1 Metal Pipe Bicycle Racks

Provide ASTM A53/A53M schedule 40 steel pipe bicycle racks in configuration and of [114] [_____] mm [4-1/2] [_____] inch pipe size. Type of mounting, bicycle rack capacity and height above the ground as shown on the drawings.

][2.6.2 Precast Concrete Bicycle Rack

Provide one-piece precast concrete bicycle rack base with embedded galvanized metal hitching loops. Design bicycle rack with wheel notches for bike support and wheel locking device.

]2.7 BOLLARDS

****
NOTE: Bollards are often included as a site furnishing but function primarily as a vehicle barrier; for bollard specification, verify cross reference with Section 34 75 13.13 CRASH RATED ACTIVE VEHICLE BARRIERS AND CONTROLS.
****

Provide reinforced concrete bollards [300] [450] mm [12] [18] inch [square] [round], height as indicated, suitable for ground mount installation. Provide exposed aggregate or sandblast finish as indicated; manufacturer's standard clear acrylic sealer. Submit manufacturer's descriptive data and catalog cuts.

2.7.1 Portland Cement

ASTM C150/C150M Type I II or III

2.7.2 Aggregate

ASTM C33/C33M, maximum size 19 mm 3/4 inch

2.7.3 Reinforcing Steel

ASTM A615/A615M

2.7.4 Integral Color

ASTM C979/C979M, pure mineral oxide, limeproof and non-fading

2.7.5 Concrete Strength

35 MPa 5000 psi, 28 day minimum compressive strength

2.7.6 Admixture

ASTM C260/C260M for air-entraining

2.8 PLANTERS [WASTE RECEPTACLES] [ASH RECEPTACLES]

[Provide for waste receptacles [spun aluminum] [reinforced fiberglass] [flat] [domed] tops and removable semi-rigid plastic liner insert.] [Provide top-mounted ash trays for ash receptacles.] Waste receptacles must be furnished with weather protection, odor containment, and insect/animal-proofing. Container size must be [as directed] [_____].

2.8.1 Height

Trash and litter deposit openings must be between 800-1000 mm 30-40 inches above the ground.

2.8.2 Liners

Trash and litter receptacles must be furnished with [disposable inner-linings] [removable/reusable inner containers]. Self-dumping type designs to include hinged bottom, top or sides will be rejected.

2.8.3 Anchors

Trash and litter receptacles that can be anchored to resist overturning by typical use, high winds, or animals must be furnished and anchored in accordance with the manufacturer's recommendations.

2.8.4 Openings

Openings for trash and litter insertion must be a minimum of 100 mm 4 inches in diameter. Edges of the openings must be crimped, rounded and smoothed.

2.8.5 Ash Receptacles

Provide ash receptacles with a fire-proof metal bowl or screen or sand-filled containers for ash containment. Ash receptacles must have a minimum diameter of 200 mm 8 inches; ash containers must have a fire-proof metal bowl or screen and must be easily removable for cleaning.

2.8.6 Planter Size

The planter size must be determined according to the spacial root requirements at 2/3 maturity size of the designated plant material, in conformance with Section 32 93 00 EXTERIOR PLANTS.

2.8.7 Drainage

Drainage for the planter must be as follows: a minimum of one drainage hole in the base of each planter and a minimum 3 mm 1/8 inch space, in 2 locations, between the base of the planter and the supporting surface.

2.8.8 Base

The planter base must be capable of supporting the weight of the planter filled with both the designated plant material and fully saturated soil. The planter must not crack, overturn, or sink below the existing grade. Planters must allow for relocation.

[2.8.9 Glass Fiber Reinforced Concrete (GFRC) Precast

Provide glass fiber reinforced concrete (GFRC) precast [planters] [waste receptacles] [ash receptacles] at locations indicated on the drawings. Comply with PCI MNL-117 and PCI MNL-128.

[2.8.9.1 Materials

Provide manufacturer's standard shell thickness of 9 to 16 mm 3/8 to 5/8 inch.

2.8.9.1.1 Cement

ASTM C150/C150M, use only one brand and type of cement throughout the Project.

2.8.9.1.2 Glass Fibers

Alkali resistant (AR) glass fibers produced specifically for use in glass fiber reinforced concrete. Glass content of GFRC unit to be a minimum of three percent.

2.8.9.1.3 Aggregates

Clear silica sand passing 1.18 mm No. 16 sieve; washed, dried, and free from deleterious materials; provide type with successful history of use in GFRC and as standard with the manufacturer.

2.8.9.1.4 Compressive Strength

Minimum20.7 MPa 3000 psi 28 day strength

2.8.9.1.5 Density

Approximately 1921 kg/cu. m 120 pcf

2.8.9.1.6 Polymer Admixture

Manufacturer's standard acrylic thermoplastic copolymer

][2.8.9.2 Finishes

Provide factory finished units with manufacturer's standard texture or sandblasted finish as selected.

2.8.9.2.1 Cement

White or grey as consistent with final finish

2.8.9.2.2 Facing Aggregates

ASTM C33/C33M (less gradation), clean, hard, durable, inert, and free of staining and deleterious materials; as required to match approved samples

2.8.9.2.3 Color

ASTM C979/C979M, pure, non-fading mineral oxides which do not impair strength of GFRC; designed and mixed to provide color matching approved samples; maximum 10 percent cement weight

2.8.9.2.4 Applied Finishes

ASTM D4060 waterborne crosslinked acrylic 49.5 +/-2 percent solids by weight providing 1000 cycles per 0.0254 mm 1000 cycles per 0.001 inch resistance to abrasion

]][2.8.10 Precast Concrete/Cast Stone Planters

Provide reinforced precast concrete planters [waste receptacles] [ash receptacles] consisting of a mixture of cement, aggregates, and mineral colors suitable for exterior use as located on the drawings. Provide manufacturer's standard exposed aggregate or sandblast finish (with clear acrylic coating) as selected.

2.8.10.1 Portland Cement

ASTM C150/C150M, gray, Type I

2.8.10.2 Aggregate

ASTM C33/C33M, 2.36 mm No. 8 crushed limestone and sand

2.8.10.3 Galvanized Steel Mesh

ASTM A1064/A1064M

2.8.10.4 Integral Color

ASTM C979/C979M, pure mineral oxide, limeproof and non-fading

2.8.10.5 Concrete Strength

30 MPa 4000 psi minimum compressive strength at 28 days

2.8.10.6 Admixture

ASTM C260/C260M for air-entraining

][2.8.11 Wood Containers

Provide manufacturer's standard [wood planter][waste receptacle][ash receptacle] fabricated of 19 mm 3/4 inch thick tongue and grooved wood slats permanently bonded with fiberglass interior shell. For top-trim, provide wood for square containers and fiberglass for round containers. Interior shell must be sufficient to protect wood from deterioration due to contact with soil and/or moisture

****

NOTE: For wood species other than Redwood or Cedar use the next sentence in order to avoid contact with ground or finish grade in order to avoid moisture and insect damage. Redwood and Cedar are naturally rot and insect resistant.

****

[Elevate wood finishes at minimum 13 mm 1/2 inch above finish grade.]Freestanding wood planters must be structurally sufficient to support saturated soil and designated plant materials at the designated mature size.

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective.

****

[Provide certified sustainably harvested wood for wood containers.]

2.8.11.1 Wood Species

[Marine Teak] [Alaska Yellow Cedar] [Clear All-Heart California Redwood] [Purple Heart] [Ipe] [_____]

2.8.11.2 Fiberglass

Molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins with a finish of 0.30-0.38 mm 12-15 mil color impregnated polyester gel coat.

2.8.11.3 Metal Frame

Black color-coated steel frame

][2.8.12 Wood Planters with Metal Frames

Provide manufacturer's standard [wood planter][waste receptacle][ash receptacle] with galvanized steel welded frames, and nominal 50 mm two inch tongue and grooved, beveled or square cut wood staves. Attach wood staves to metal frame from inside with steel plated screws.

2.8.12.1 Wood Species

Kiln dried, maximum 19 percent moisture content, [Clear All Heart California Redwood] [Western Yellow Cedar] [Red Oak] [Phillipine Mahogany] [Purple Heart] [Ipe]

2.8.12.2 Metal Frame

Reinforced with steel bars in accordance with manufacture's standard construction, black color factory finish coated.

2.8.12.3 Bottom

6.25 mm 1/4 inch exterior grade redwood with drain holes

[2.8.12.4 Liners

Removable galvanized steel or manufacturer's standard

][2.8.12.5 Tops

[Hinged top opening] [spun aluminum open top with molded rim] [ash top]

]]2.8.13 Fiberglass Planters [Waste Receptacles] [Ash Receptacles]

Provide reinforced fiberglass planters [waste receptacles] [ash receptacles] molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins; with 0.30-0.38 mm 12-15 mil color impregnated polyester gel coat finish; minimum thickness of 6.35 mm 1/4 inch; color as selected.

2.8.14 Metal Planters [Waste Receptacle]

Provide metal planters [waste receptacles] as indicated, fabricated from [perforated steel sheet material] [wire or diamond mesh steel sheet] [steel frame with steel staves welded to frame] [cast aluminum] [cast iron]; powder coat finish, color as selected.

a. Metal thickness, width, and configuration must be manufacturer's standard. Chemically clean and phosphate coat prior to final powdercoat.

b. Provide 5 mm 3/16 inch thick fiberglass-reinforced polyester resin liner in black for planter liners.

2.9 SHELTERS

****

NOTE: It is important that the drawings reflect the type and size of Shelter intended. The specifications are intended to cover everything from

small BUS STOP SHELTERS to large PAVILION SHELTERS. Types of structural frames, roofing materials and facias, glazing systems, and foundations must be carefully coordinated with the drawings. These systems are all factory designed and prefabricated ready for site assembly.
****

AISC 360. Provide prefabricated shelter systems to meet design conditions indicated. Shelter design must conform to all applicable State and Local Building Codes and must meet manufacturer's standards of construction and materials. Shelter systems must be [preglazed] pre-drilled and pre-cut, shipped with all hardware and accessories necessary for complete field assembly.

2.9.1 Framing Systems

Framing system; columns, rafters, ridge, purlins and other structural framing members must be [aluminum] [steel] [wood] as indicated. Manufacturer must provide shop drawings and calculations prepared by a structural engineer.

[2.9.1.1 Aluminum

Extruded aluminum alloy tubing must conform to ASTM B429/B429M 6063-T5 or 3003-H14, dark [medium] [light] bronze [black] [clear anodized] [powder coat] finish. Framing sizes and configurations must be as required for size of structure indicated meeting manufacturer's standards and applicable building codes.

][2.9.1.2 Steel

Structural steel must conform to ASTM A36/A36M or ASTM A500/A500M, 248 MPa 36,000 psi yield strength and 400 MPa 58,000 psi tensile strength, factory finished with rust inhibited primer and powder coat conforming to ASTM D3451. Framing sizes and configurations must be as required for size of structure indicated meeting manufacturer's standard and applicable building codes.

][2.9.1.3 Wood

Wood framing system must consist of surfaced four sides (S4S), #2 grade southern yellow pine [_____] solid timber columns with eased edges, pressure treated against decay, fungi and insect infestation, surfaced four sides (S4S), #1 grade, southern pine, [_____] glue-laminated columns manufactured in accordance with ANSI/AITC A190.1 and AITC certified glue-laminated structural grade southern yellow pine [_____] beams, rafters and purlins, factory sealed and individually wrapped for protection during shipment. Factory stain all wood members prior to shipment.
****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective.
****

[Provide certified sustainably harvested wood for wood shelters.]

]2.9.2 Roof Panels [Decking]

Provide manufacturer's standard [molded acrylic translucent roof panel] [standing seam metal roof panel] [wood decking] [V-beam aluminum roof panels] [FRP roof panels] [_____] roof panels as indicated. Materials must be factory finished and shipped with all necessary fasteners and accessories as required for complete site assembly.

2.9.3 Glazing

Factory installed in separate structural window frames, gasketed and glazed in accordance with manufacturer's standard, interchangeable, glazing system. Provide [6.35 mm 1/4 inch acrylic sheet] [6.35 mm 1/4 inch tempered glass] [6.35 mm 1/4 inch polycarbonate plastic sheet] [6.35 mm 1/4 inch mar-resistant polycarbonate plastic sheet], [clear] [_____] color.

2.10 TABLES

Picnic tables must be furnished with attached benches that have no backrests. Table's exposed edges and corners must be rounded, eased or chamfered.

2.10.1 Height

Between 750-1200 mm 29-48 inches from the finished grade to the lowest surface of the top, or as noted.

2.10.2 Clearance

A minimum vertical clearance of 230 mm 9 inches between the seat top and the bottom edge of the table top must be provided. A minimum of 460 mm 18 inches of leg space under tables, measured from the inside edge of the seat top to the nearest table support, must be provided. A minimum of 460 mm 18 inches from the end of the table top to the nearest support leg must be provided.

2.10.3 Top

Table top surfaces must not contain recesses that might hold water or food particles. The table top width must be a minimum of 460 mm 18 inches when utilized from one side only, and a minimum of 900 mm 36 inches when utilized from two sides. The table top length must be a minimum of 610 mm 24 inches per person.

2.10.4 Wheelchair Access

A minimum clear space of 740 mm 29 inches from the finished grade to the underside of the table must be provided for persons with disability to be able to pull a wheelchair beneath the table top at the end of the table; the minimum clear width must be 860 mm 34 inches.

2.10.5 Precast Concrete Tables

Provide reinforced precast concrete tables with smooth tops; minimum 35 MPa 4500 psi concrete, 28 day minimum compressive strength, consisting of a mixture of cement, aggregates, and mineral colors suitable for exterior use as located on the drawings. Provide manufacturer's standard exposed aggregate or sandblast finish with clear acrylic coating.

a. Portland cement: ASTM C150/C150M, gray, Type I.

b. Aggregate: ASTM C33/C33M, washed 2.36 mm No. 8 limestone and sand.

c. Galvanized wire mesh: 1.9 mm 14 gage, 50 by 50 mm 2 by 2 inch.

d. Welded wire fabric: ASTM A1064/A1064M

e. Reinforcing steel: ASTM A615/A615M

f. Integral color: ASTM C979/C979M, pure mineral oxide, limeproof and non-fading

g. Admixture: ASTM C260/C260M for air-entraining.

2.10.6 Fiberglass Tables

Provide reinforced fiberglass table tops molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins, minimum thickness of 6 mm 1/4 inch with 0.30-0.38 mm 12-15 mil thickness color impregnated polyester gel coat, color as selected.

a. Steel pedestal base: ASTM A53/A53M Schedule 40 steel pipe, [38] [41] [60] mm [1-1/2] [1-5/8] [2-3/8] inch O.D.

b. Mounting: Type as indicated.

c. Metal finish: Powder coating conforming to ASTM D3451 testing.

2.10.7 Perforated Steel Tables

Provide 1.9 mm 14 gage [1.6 mm 16 gage] perforated steel sheet table tops with solid metal edges in accordance with manufacturer's standard. Weld tops to base as required for frame support.

a. Steel pedestal base: ASTM A53/A53M Schedule 40 steel pipe, 60 mm 2-3/8 inch O.D.

b. Mounting: Type as indicated.

c. Hardware: Zinc or cadmium plated nuts, bolts, screws, and lock washers.

d. Metal finish: Powder coating conforming to ASTM D3451 testing.

2.10.8 [Wood Tables

Provide manufacturer's standard wood tables with wood [metal] [_____] bases as indicated. Provide fasteners and accessories required for onsite assembly. Kiln dry and pressure treat wood components to manufacturer's standard, maximum 19 percent moisture content. [Pre-treat metal components and provide manufacturer's standard primer and powder coat finish complying with ASTM D3451, color as selected].

****

NOTE: Use certified sustainably harvested wood where suitable for application and cost effective.

****

[Provide certified sustainably harvested wood for wood tables.]

a. Design wood tables to sustain a live load of not less than 10 kPa 200 pounds per square foot.

b. Provide kiln dried, surfaced four sides (S4S), clear all sides wood slats of species and sizes indicated.

    (1) Species: [Teakwood] [Marine Teak] [Clear All Heart Redwood] [Red Cedar] [Alaska Yellow Cedar] [Clear Douglas Fir] [Ipe] [Mahogany] [Purple Heart].

    (2) Nominal wood slat sizes: 25 by 63 mm 1 by 2-1/2 inch [25 by 75 mm 1 by 3 inch] [50 by 75 mm 2 by 3 inch] [50 by 100 mm 2 by 4 inch].

c. Design bases of the materials listed below to support the loads imposed in the design of the tables.

d. Wood Support: Match in species, grade, grain, color and finish of the wood slats.

e. [e. Steel Support: ASTM A653/A653M].

f. [f. Cast Grey Iron Support: ASTM A48/A48M, Class 30 or recycled cast grey iron ASTM A48/A48M, Class 25.]

g. [g. Cast Aluminum Support: ASTM B26/B26M or ASTM B108/B108M as applicable.]]

2.11 [TREE GRATES

Provide [cast aluminum] [cast iron] [cast bronze] [punched steel] [stainless steel] tree grates in [round] [square] model of sizes indicated on the drawings. Furnish complete with angle steel frames with finish to match tree grates.

]PART 3 EXECUTION

3.1 CHILDREN'S PLAY AREAS

Install the site furnishings outside the play structure use zone in accordance with ASTM F1487. Verify and mark the locations of the use zone. These zones are to be free from obstacles and hard surfaces. When child accessibility requirements are to be met, child anthropometric dimensions must be used and not adult anthropometric dimensions.

3.2 INSTALLATION

Verify that finished grades and other operations affecting mounting surfaces have been completed prior to the installation of site furnishings. Site furnishings must be installed plumb and true, at locations indicated, in accordance with the approved manufacturer's instructions.

3.2.1 Assembly and Erection of Components

New parts must be acquired from the manufacturer; substitute parts will not be accepted unless approved by the manufacturer. When the inspection of parts has been completed, the site furnishings must be assembled and anchored according to manufacturer's instructions or as indicated. When site furnishings are assembled at the site, assembly must not interfere with other operations or pedestrian and vehicular circulation.

3.2.2 Anchorage, Fastenings, and Connections

Furnish metal work, mounting bolts or hardware in ample time for securing into concrete or masonry as the work progresses. Provide anchorage where necessary for fastening furniture or furnishings securely in place. Provide, for anchorage not otherwise specified or indicated, slotted inserts, expansion shields, and power-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish the fastenings to which they are applied. Conceal fastenings where practicable.

3.3 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.4 TESTING

Test each site furnishing to ascertain a secure and correct installation. A correct installation must be according to the manufacturer's recommendations and by the following procedure: Measure the physical dimensions and clearance of each installed site furnishing for compliance with manufacturer's recommendations and as indicated. Site furnishings which do not comply must be reinstalled. Fasteners and anchors determined to be non-compliant must be replaced. Submit a written report describing the results of the testing and a report of post-installation test results.

3.5 FINISHES

3.5.1 Field Finishes

Where indicated, field finishes must be applied in accordance with Section 09 90 00 PAINTS AND COATINGS. Where dissimilar metals are in contact, protect surfaces with a coat conforming to SSPC Paint 25 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

3.5.2 Repair of Zinc-Coated Surfaces

****

NOTE: Delete this paragraph when no galvanized items are specified.

****

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by the application of stick or thick paste material specifically designed for repair of galvanizing, as approved by the Contracting Officer. Clean areas to be repaired and remove the slag from the welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread the molten material uniformly over surfaces to be coated and wipe the excess material off.

3.6 BOLLARDS

Install in pipe sleeves embedded in concrete and filled with non-shrink grout or quick setting anchoring cement.

3.7 BICYCLE RACKS

Affix to base structure by flanges anchored to concrete or other existing masonry by expansion shields. Provide Series 300 stainless steel bolts to anchor aluminum alloy flanges, of a size appropriate to the standard product of the manufacturer. Where aluminum or alloy fittings or extrusions are to be in contact with dissimilar metals or concrete, give the contact surface a heavy coating of bituminous paint.

3.8 SHELTERS

Secure to the adjacent construction with the clip angles attached to the concrete. Secure to concrete with not less than two 13 mm 1/2 inch diameter expansion bolts.

3.8.1 Glazing

Factory install windows into separate structural frame. Miter corners and connect internally by extruded aluminum corner keys or screw bosses with tamper-proof stainless steel screws. Provide continuous gasketing around windows set to metal frames. Provide 13 to 19 mm 1/2 to 3/4 inch deep pocket for polycarbonate glazing. Fully gasket and frame in independent interchangeable factory assembled units. Affix to shelter frame with 5 mm 3/16 inch mustow head aluminum rivets at approximately 331 mm13-1/4 inches on centers for full 6.28 rad 360 degrees, rivet from inside of shelter.

3.8.2 Roof

Provide manufacturer's standard roof system including facia [gutter] assembly, ensuring a weather-tight seal and installation.

3.9 RESTORATION AND CLEAN UP

When the installation has been completed, clean up and protect the site. Existing areas that have been damaged from the installation operation must be restored to original condition at Contractor's expense.

3.9.1 Clean Up

The site must be cleaned of all materials associated with the installation. Site furnishing surfaces must be cleaned of dirt, stains, filings, and other blemishes occurring from shipment and installation. Cleaning methods and agents must be according to manufacturer's instructions or as indicated.

3.9.2 Protection

The area must be protected as required or directed by providing barricades and signage. Signage must be in accordance with Section 10 14 00.10 EXTERIOR SIGNAGE.

3.9.3 Disposal of Materials

Excess and waste material must be removed and disposed off Government property [_____].

3.10 RE-INSTALLATION

Where re-installation is required, the following must be accomplished:

a. Re-install the product as specified. Material acquisition of replacement parts is the responsibility of the Contractor. Provide replacement materials that are new and supplied by the original manufacturer to match.

b. Damage caused by the failed installation must be repaired.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-13 17 43 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-13 17 43 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13 17 43

HYDROTHERAPY EQUIPMENT

05/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-13 17 43 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-13 17 43 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 13 17 43

HYDROTHERAPY EQUIPMENT
05/20

****
NOTE: This guide specification covers the requirements for prefabricated hydrotherapy equipment and required accessories.

This Section refers to Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for general requirements; always include Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT when this Section is used.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

The requirements of Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT apply to this Section.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 99	(2024) Health Care Facilities Code

UL SOLUTIONS (UL)

UL 60601-1	(2003; Reprint Apr 2006) Medical Electrical Equipment, Part 1: General Requirements for Safety

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

****

NOTE: Delete any items that are not used; add any additional items requiring shop drawings.

****

[Item M8000, Shower Trolley System, Complete; G, [_____]

][Item M8002, Shower Cabinet, Complete; G, [_____]

][Item M8005, Bath, Hydrotherapy, Full Body; G, [_____]

][Item M8010, Pool, Hydrotherapy, Tank; G, [_____]

][Item M8015, Bath, Hydrotherapy, Sitting; G, [_____]

][Item M8020, Bath, Hydrotherapy, with Elevating Tub; G, [_____]

][Item M8025, Bath, Hydrotherapy, Burn, with Lift; G, [_____]

][Item M8035, Whirlpool, Arm, Pedestal Mounted; G, [_____]

][Item M8040, Whirlpool, Extremity, Floor Mounted; G, [_____]

][Item M8050, Whirlpool, Leg, CRS, Floor Mounted; G, [_____]

][Item M8055, Whirlpool, Leg, Floor Mounted; G, [_____]

] Submit detail drawings for each item of equipment listed above that interfaces with other items of equipment or construction.

SD-03 Product Data

[Item M8000, Shower Trolley System, Complete; G, [_____]

][Item M8002, Shower Cabinet, Complete; G, [_____]

][Item M8005, Bath, Hydrotherapy, Full Body; G, [_____]

][Item M8010, Pool, Hydrotherapy, Tank; G, [_____]

][Item M8015, Bath, Hydrotherapy, Sitting; G, [_____]

][Item M8020; Bath, Hydrotherapy, with Elevating Tub; G, [_____]

][Item M8025, Bath, Hydrotherapy, Burn, with Lift; G, [_____]

][Item M8035, Whirlpool, Arm, Pedestal Mounted; G, [_____]

][Item M8040, Whirlpool, Extremity, Floor Mounted; G, [_____]

][Item M8050, Whirlpool, Leg, CRS, Floor Mounted; G, [_____]

][Item M8055, Whirlpool, Leg, Floor Mounted; G, [_____]

] Submit catalog numbers, trade names, literature, data sheets, diagrams and other pertinent data for each item of equipment listed above to evaluate performance, function, materials, dimensions and appearance.

SD-04 Samples

****

NOTE: Add "SD-04 Samples" only when color selections or color verifications are required for project-specific equipment items.

****

[Item [_____]; G, [_____]

][Submit manufacturer's [standard color charts for color selection] [color samples for color verification] foreach item of equipment listed above.

] SD-06 Test Reports

[Item M8000, Shower Trolley System, Complete

][Item M8002, Shower Cabinet, Complete

][Item M8005, Bath, Hydrotherapy, Full Body

][Item M8010, Pool, Hydrotherapy, Tank

][Item M8015, Bath, Hydrotherapy, Sitting

][Item M8020, Bath, Hydrotherapy, with Elevating Tub

[] Item M8025, Bath, Hydrotherapy, Burn, with Lift

][Item M8035, Whirlpool, Arm, Pedestal Mounted

][Item M8040, Whirlpool, Extremity, Floor Mounted

][Item M8050, Whirlpool, Leg, CRS, Floor Mounted

][Item M8055, Whirlpool, Leg, Floor Mounted

] Submit field tests and inspection reports for each item of equipment listed above signed by authorized official responsible for field tests and inspections.

SD-10 Operation and Maintenance Data

[Item M8000, Shower Trolley System, Complete; G, [_____]

][Item M8002, Shower Cabinet, Complete; G, [_____]

][Item M8005, Bath, Hydrotherapy, Full Body; G, [_____]

][Item M8010, Pool, Hydrotherapy, Tank; G, [_____]

][Item M8015, Bath, Hydrotherapy, Sitting; G, [_____]

][Item M8020, Bath, Hydrotherapy, with Elevating Tub; G, [_____]

][Item M8025, Bath, Hydrotherapy, Burn, with Lift; G, [_____]

][Item M8035, Whirlpool, Arm, Pedestal Mounted; G, [_____]

][Item M8040, Whirlpool, Extremity, Floor Mounted; G, [_____]

][Item M8050, Whirlpool, Leg, CRS, Floor Mounted; G, [_____]

][Item M8055, Whirlpool, Leg, Floor Mounted; G, [_____]

] Submit Data Package 3, including training requirements, for each item of equipment listed above in accordance with requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.[In addition, provide hard copies consisting of two Operator's Manuals and two Service Manuals.]

1.4 WARRANTY

[Provide warranties as specified in this Section.]Refer to Article WARRANTY in Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT for [additional] requirements.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Stainless Steel

Class 301, 302, or 304. Satin finish for exposed surfaces and No. 4 finish for interior surfaces.

2.1.2 Aluminum Alloy

ASTM B221MASTM B221 equivalent in ultimate tensile, yield, and shear strengths to Alloy 6063-T5 or 6063-T6, as applicable.

****

NOTE: Select project-specific equipment items from the list below and delete equipment items not used. Additional equipment items may be added as required to suit project-specific conditions.

****

2.2 EQUIPMENT

[2.2.1 Item M8000, Shower Trolley System, Complete

Adjustable height shower trolley with locking castors and shower panel.

Provide shower trolley that is hydraulically height-adjustable from minimum 622 mm 24-1/2 to 1016 mm 40 inches, with a load limit of 149.7 kg 330 lbs. Shower trolley includes mattress, pillow, and protective side rails which can be lowered for ease of patient transfer. Shower trolley includes a combination of directional castors and straight steering castors with a minimum of two braking castors. Provide trolley stretcher that is sloped, tilt-able, have automatic leveling, and drain plug.

Approximate total size of unit is 2108 mm 83 inches long by 686 mm 27 inches wide.

Provide shower trolley complete with wall-mounted Shower Panel with sink and includes patient shower hose, thermostatic mixing valve, hot and cold water supply, temperature gauge and cleaning system. Approximate size of Shower Wall Panel with valve and hoses is 762 mm 30 inches wide by 191 mm 20 inches high by 508 mm 7-1/2 inches deep.

][2.2.2 Item M8002, Shower Cabinet, Complete

Provide freestanding Shower Cabinet with Shower Wall Panel with a max load of 149.7 kg 330 lbs. The unit includes shower hose, safety straps, water temperature gauge, back flow prevention, drain size of at least 40 mm 1-1/2 inches, thermostatic mixing valve, and disinfecting system.

Approximate size of the Cabinet is 762 mm 30 inches wide, 940 mm 37 inches high, 1092 mm 43 inches deep. Electrical Characteristics: 120 Volt / 60 Hz. Approximate Size of Wall Panel: 432 mm 17 inches wide, 483 mm 19 inches high.

Unit includes a mobile lift chair to assist in transferring patient to and from the shower cabinet in a seated position. Mobile lift chair includes hand grips, safety belts to secure the patient, and a weight capacity of 149.7 kg 330 lbs. Unit is battery powered.

Adjustable working height range is 483 mm to 965 mm 19 inches to 38 inches. Approximate dimensions of the mobile lift chair unit is 1143 mm 45 inches long, 737 mm 29 inches wide, 1778 mm 70 inches high. Approximate dimensions of the seat is 483 mm 19 inches wide, 356 mm 14 inches deep.

][2.2.3 Item M8005, Bath, Hydrotherapy, Full Body

Stationary full body whirlpool immersion tank. Construction is seamless welded heavy gauge stainless steel. Tank capacity is 1609 liters 425 gallons. Tank is reinforced stainless steel base, cove bottom, adjustable legs, adjustable head rest, thermometer, thermostatic mixing valve. Tank fittings are two 32 mm 1-1/4 inch overflows and one 32 mm 1-1/4 inch filler spout. Water level and direction are adjustable.

Twin turbine assembly has UL listed 1/2 HP jet pump motor with automatic thermal overload protector and lifetime-sealed bearings. Twin turbine assembly is mounted on carriages with automatic counter balance and function as agitator. All parts of turbine assembly that contact the water are stainless steel, chrome plated brass or bronze.

Unit includes patient lift device and attachment providing means of connecting patient lift device.

Approximate Size: 2692 mm 106 inches long, 1956 mm 77 inches wide, 559 mm 22 inches deep.

][2.2.4 Item M8010, Pool, Hydrotherapy, Tank

Provide unit shell constructed of fiberglass and includes adjustable speed water current and multiple depths. Unit includes treadmill, patient entry and exit stairs, and handrails. Unit includes electric heater, pump, filter, skimmers, water testing and maintenance kit, and accessible steps and handrail.

Length: Up to 6.096 m 20 feet.

Width: Up to 6.096 m 20 feet.

Height: Up to 1.829 m 6 feet.

Separate mechanical pit to house electrical equipment, pumps and filtration system is required.

][2.2.5 Item M8015, Bath, Hydrotherapy, Sitting

Freestanding hydrotherapy sitting bath with freestanding mobile lift.

Provide freestanding hydrotherapy sitting bath constructed of gel coated molded fiberglass plastic. Shape allows for comfort and safety with foot rests and seat.

Approximate Outside Size: 2388 mm 94 inches long by 838 mm 33 inches wide. Approximate Inside Size: 1753 mm 69 inches long by 762 mm 30 inches wide at shoulders and 559 mm 22 inches wide at feet. Adjustable Rim Height: 686 mm 27 inches to 1143 mm 45 inches max

The unit includes a minimum of two whirlpool outlets, maximum of four, anti-scald thermostatic mixing valve for filling and showering, integrated control console, auto fill and auto shut-off, scalding protection, cleaner/disinfection system, a bath oil/shampoo dispensing system, and hand-held shower spray wand.

Electrical Characteristics: 120 Volt, single phase, 60 Hz.

Freestanding mobile lift includes sitting bath system. Height adjustable lift is battery operated, with molded polyurethane seat and toilet opening, non-slip grip handles, integral resident handles, handset control and operator panel, visual brake indicator, safety belt or strap, emergency up and down, and 158.8 kg 350 lb work load.

Unit includes two interchangeable batteries and wall charger.

][2.2.6 Item M8020, Bath, Hydrotherapy, with Elevating Tub

The bathtub unit is freestanding with adjustable height. The unit includes whirlpool system, handheld shower wand, water temperature display, and a cleaning system. The unit includes thermostatic mixing valve and backflow prevention. Hot / Cold water supply lines are 20 mm 3/4 inch, and the drain is 40 mm 1-1/2 inches. Weight capacity is 149.7 kg 330 lbs. Water capacity is 178 liters 47 gallons minimum.

Approximate Size: 889 mm 35 incheswide, 2286 mm 90 inches long, 610 mm to 991 mm 24 inches to 39 inches high.

][2.2.7 Item M8025, Bath, Hydrotherapy, Burn, with Lift

Provide hydrotherapy treatment bathing system that is height-adjustable. The unit is a chemical-resistant stainless steel tub. Unit includes digital temperature control, treatment hose with wall attachment, thermostatic mixing valve, and cleaning disinfecting system. Weight capacity of the unit is 149.7 kg 330 lbs. Unit has 20 mm 3/4 inch supply lines.

Electric characteristics: 120 V single phase AC, 60 Hz.

Approximate size of unit: 2337 mm 92 inches long, 838 mm 33 inches wide, 584 mm to 991 mm 23 inches to 39 inches high.

Unit includes mobile patient lift with hand grips, safety belts, low-friction castors, and emergency stop button. Mobile lift unit is height-adjustable, with working load of 158.8 kg 350 lbs.

Approximate size of mobile lift unit is864 mm 34 inches wide, 813 mm 32 inches deep, 1727 mm 68 inches high.

][2.2.8 Item M8035, Whirlpool, Arm, Pedestal Mounted

Mobile whirlpool tank recommended for treatment of extremities. Tank is seamless welded construction, of heavy gauge type 304 stainless steel. Tank rim is reinforced with concealed stainless steel rod. Tank bottom is seamless, coved design to minimize bacteria build-up. Provide unit with thermometer. Tank has a minimum of 57 liters 15 gallon capacity.

Unit has heavy duty swivel casters with locking device on rear pair.

Unit has turbine assembly with raising and lowering device which functions as agitator and emptying device, permits adjustment of water height, direction of water agitation, and locks in place. Turbine assembly has UL listed 1/2 HP jet pump motor with automatic thermal overload protector and lifetime-sealed bearings. All parts contacting water are stainless steel, chrome plated brass or bronze.

Unit includes lift to raise and lower the mobile whirlpool tank to allow for treatment of upper and lower extremities. Lift frame includes clamp for attaching whirlpool unit and push bar to assist when moving whirlpool unit. Frame, clamp and push bar are steel. Crank handle includes brake lever to lock handle into place.

Approximate Size of Unit: 635 mm 25 incheslong, 330 mm 13 inches wide, 381 mm 15 inches deep.

][2.2.9 Item M8040, Whirlpool, Extremity, Floor Mounted

Stationary whirlpool tank recommended for treatment of extremities. Tank is seamless welded construction, of heavy gauge type 304 stainless steel. Tank rim is reinforced with concealed stainless steel rod. Tank bottom is seamless, coved design to minimize bacteria build-up. Unit has thermostatic mixing valve, and thermometer. Tank has a minimum 136 liter 36 gallon capacity.

Provide unit with a 50 mm 2 inch combination drain and overflow and filler spout.

Unit has turbine assembly with raising and lowering device which functions as agitator and emptying device, permits adjustment of water height, direction of water agitation, is spring balanced and locks in place. Turbine assembly has UL listed 1/2 HP jet pump motor with automatic thermal overload protector and lifetime-sealed bearings. All parts contacting water are stainless steel, chrome plated brass or bronze.

Approximate Size of Unit: 813 mm 32 incheslong, 381 mm 15 inches wide, 635 mm 25 inches deep.

][2.2.10 Item M8050, Whirlpool, Leg, CRS, Floor Mounted

Stationary whirlpool tank recommended for treatment of extremities. Tank is seamless welded construction, of heavy gauge type 304 stainless steel. Tank rim is reinforced with concealed stainless-steel rod. Tank bottom is seamless, coved design to minimize bacteria build-up. Unit has thermostatic mixing valve, and dual scale thermometer with adjustable calibration. Tank has a minimum 227 liter 60 gallon capacity.

Provide unit with a 50 mm 2 inch combination drain and overflow and filler spout.

Unit has turbine assembly with raising and lowering device which functions as agitator and emptying device, permits adjustment of water height, direction of water agitation, is spring balanced and locks in place. Turbine assembly has UL listed 1/2 HP jet pump motor with automatic thermal overload protector and lifetime-sealed bearings. All parts contacting water are stainless steel, chrome plated brass or bronze.

Approximate Size of Unit: 1067 mm 42 inches long, 508 mm 20 incheswide, 711 mm 28 inches deep.

][2.2.11 Item M8055, Whirlpool, Leg, Floor Mounted

Stationary whirlpool tank recommended for treatment of extremities, hip and back area. Tank is seamless welded construction, of heavy gauge type 304 stainless steel. Tank rim is reinforced with concealed stainless steel rod. Tank bottom is seamless, coved design to minimize bacteria build-up. Unit has thermostatic mixing valve, and dual scale thermometer with adjustable calibration. Tank has a minimum 341 liter 90 gallon capacity.

Provide unit with a 50 mm 2 inch combination drain and overflow and filler spout.

Unit has turbine assembly with raising and lowering device which functions as agitator and emptying device, permits adjustment of water height, direction of water agitation, is spring balanced and locks in place. Turbine assembly has UL listed 1/2 HP jet pump motor with automatic thermal overload protector and lifetime-sealed bearings. All parts contacting water are stainless steel, chrome plated brass or bronze.

Approximate Size of Unit: 1524 mm 60 inches long, 610 mm 24 inches wide, 457 mm 18 inches deep.

]PART 3 EXECUTION

3.1 WORKMANSHIP

Comply with UL 60601-1. Surfaces to be welded are to be free from grease, oil, dirt or other foreign materials. Grind exposed welds smooth to blend with adjacent surfaces. Welds to be continuous, sound, unbroken, clean, and free from pitting, splatter and discoloration.

Exposed corners and edges to be rounded to eliminate sharp edges. All exposed surfaces, including inside of tank, to be free from pit-marks, weld seams, and scale. Finish to be No. 4 commercial, uniform and free of course grind marks or scratched areas.

3.2 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.3 INSTALLATION

Install equipment at locations indicated in accordance with manufacturer's printed installation instructions, Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT, NFPA 70, NFPA 99 and approved detail drawings. Submit detail drawings specifically prepared to illustrate required work for each item of equipment that interfaces with other items of equipment or construction, including, but not limited to, installation layout, coordination of equipment services, [drain piping connections,] [complete electrical wiring and control diagrams,] and details of construction and rough-in requirements. Furnish and install necessary items such as framing, mounting hardware and trim required for the type of equipment furnished.

3.4 ADJUSTING

Following installation, adjust flows, timers, levelers, and similar components and operation devices as appropriate. After testing, and before acceptance, examine equipment to ensure that adjustments are correct and that any additional adjustments deemed necessary during product testing have been incorporated.

3.5 UTILITIES

3.5.1 Service Runs

Connect service runs from equipment to building services as indicated.

3.5.2 Dissimilar Metal Connectors

Provide connections between ferrous and nonferrous metallic pipe with dielectric waterways and flanges. Provide dielectric waterways with temperature and pressure rating equal to or greater than that specified for the connecting piping. Provide waterways with metal connections on both ends suited to match connecting piping. Internally line dielectric waterways with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges must meet the performance requirements described herein for dielectric waterways.

3.6 MANUFACTURER'S FIELD SERVICES

Provide the services of a manufacturer's representative [, in conjunction with][, in addition to] [the Contractor's Equipment Planner,] [and] [the Contractor's Biomedical Equipment Technician,] [the Government's Biomedical Equipment Technician,]who is experienced in the installation, adjustment, and operation of the equipment specified, and responsible for supervising the installation, adjustment, and testing of the equipment.

3.7 FIELD TESTS AND INSPECTIONS

3.7.1 Before Testing

Clean pipes, equipment and components of grease, dirt, stains, and other foreign materials.

3.7.2 Testing

Perform testing in accordance with manufacturer's written instructions. Unless otherwise approved by the Contracting Officer, test all items of equipment to ensure that they are operational and installation conforms to specification requirements. Hydrostatically test piping system at pressure of 1.5 times system operating pressure with water at temperature not exceeding 38 degrees C 100 degrees F. Before test, remove or isolate gage traps and apparatus that may be damaged by that pressure. Install calibrated test gage in system to observe any loss of pressure. Close off system and maintain test pressure for not less than one hour. Inspect joints and equipment connections for leaks. Retest and make repair until no further leaks are observed. Each test report must indicate compliance with specified performance criteria and the final position of controls.

3.7.3 Inspection

Examine each item for visual defects and conformance to specifications.

3.8 CLEANING

3.8.1 For Final Acceptance

Remove labels, fingerprints, and clean all surfaces both inside and out. Tightly cover and protect fixtures and equipment against rust, dirt, water, and chemical or mechanical injury.

3.8.2 Marred Surfaces Exposed-to-View

Refinish marred exposed surfaces that affect appearance, such as interior and exterior cabinet finishes, to match the adjacent finishes, like new; replace components that cannot be refinished in this manner.

3.8.3 Concealed Marred Surfaces

Refinish marred surfaces exposed to atmosphere, where such surfaces do not affect product's appearance but do affect resistance to elements, such as galvanized pipes and insulation, to equal resistance performance as the unmarred surfaces.

3.9 TRAINING

3.9.1 Training Course

Conduct training course for operation staff as designated by the Contracting Officer. Start the training period, for a total of [_____] hours of normal working time, after systems are functionally complete but prior to final acceptance. The field instructions must include all of the items contained in the approved operations and maintenance data, as well as demonstrations of routine maintenance operations. Notify Contracting Officer at least 14 days prior to date of the training course.

[3.9.1.1 Government's Biomedical Equipment Technician Training

Include operator's training for one Biomedical Equipment Technician (BMET) for each procured equipment item.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-13 21 26 (February 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-13 21 26 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13 21 26

COLD-STORAGE ROOMS (PREFABRICATED PANEL TYPE)

02/16, CHG 1: 08/18

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-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-13 21 26 (February 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-13 21 26 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 13 21 26

COLD-STORAGE ROOMS (PREFABRICATED PANEL TYPE)
02/16, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for requirements for walk-in refrigerators and freezers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Lighting and refrigeration equipment are included in this guide specification.

****

****

NOTE: Indicate the following information on the project drawings for each cold storage room:

1. Configuration and dimensions (width, length, and height).

2. Schematic design of the cold storage room showing locations of shelves, light fixtures, and equipment. Include depressed pad for tile flooring applications.

3. Sections showing supporting steel for ceiling panels if required for the project.

4. Details of shelves.

5. Details and location of light fixtures.

6. Location of refrigeration equipment.

7. Storage temperature, cooler capacity, evaporator air flow rate, and evaporator temperature.

8. Electrical characteristics for lights, condensing units, and evaporators.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 365	(2009) Commercial and Industrial Unitary Air-Conditioning Condensing Units
AHRI 366	(2009) Commercial and Industrial Unitary Air-Conditioning Condensing Units
AHRI 420	(2008) Performance Rating of Forced-Circulation Free-Delivery Unit Coolers for Refrigeration

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 189.1	(2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NSF INTERNATIONAL (NSF)

NSF/ANSI 7	(2023) Commercial Refrigerators and Freezers

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-R-43900	(1985; Rev B; Notice 1; CANC Notice 2) Refrigerators, Freezers, Prefabricated, Mechanical, Commercial, Walk-In

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-52128	(1993; Notice 1) Shelving, Storage, Stationary and Mobile, Food Storage

UL SOLUTIONS (UL)

UL 412	(2011; Reprint Jun 2022) UL Standard for Safety Refrigeration Unit Coolers
UL 427	(2011; Reprint Jun 2020) UL Standard for Safety Refrigerating Units
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cold-Storage Rooms; G, [_____]

SD-03 Product Data

Cold-Storage Rooms; G, [_____]

Shelves; G, [_____]

Refrigeration Equipment; G, [_____]

Energy Star Label For Refrigeration Equipment; S

SD-06 Test Reports

Start-Up and Initial Operational Tests; G, [_____]

Flame Spread and Smoke Index; G, [_____]

SD-08 Manufacturer's Instructions

Cold-Storage Rooms

Refrigeration Equipment

SD-10 Operation and Maintenance Data

Cold-Storage Rooms, Data Package 1; G, [_____]

Refrigeration Equipment, Data Package 2; G, [_____]

SD-11 Closeout Submittals

Posted Operating Instructions for Refrigeration Equipment; G, [_____]

1.3 REFRIGERATION PIPING

****

NOTE: Insert appropriate Section number and title in blank below using format in accordance with UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard.

****

Provide as specified in Section [_____].

PART 2 PRODUCTS

2.1 COLD-STORAGE ROOMS

****

NOTE: Select the appropriate type, size, and style from the latest edition of MIL-R-43900.

****

2.1.1 Requirements

MIL-R-43900, factory fabricated type with the following requirements:

a. Type [_____]

b. Size [_____]

c. Style [_____]

d. Entrance doors must be [swing] [sliding] type with [right-handed] [left-handed] openings.

e. Refrigeration systems must be the [remote] [self-contained] type.

f. Electrical characteristics.

g. Preservation and packing must be commercial grade.

h. Recording thermometer.

i. Temperature alarm system [with connector for remote temperature alarm].

j. Interior lighting.

[k. Outdoor weather cap.

][l. Outdoor condensing unit cover.

][m. Strip curtains.

] n. Condensing unit outdoor controls for operation down to [_____] degrees C [_____] F ambient temperature.

o. Foam plastic insulation flame spread and smoke index limits in accordance with requirements in ICC IBC Chapter 26 Plastic.

2.2 SHELVES

CID A-A-52128, stationary type, slotted shelves, stainless steel construction, 450 to 500 mm 18 to 20 inches front to rear, by 1200 mm 48 inches long, by 1470 to 1680 mm 58 to 66 inches high, except where indicated otherwise.

2.3 REFRIGERATION EQUIPMENT

****

NOTE: Select the first statement for NAVFAC projects, or the second statement for USACE.

****

Refrigeration system equipment for cold storage to be as specified under Section 23 63 00.00 COLD STORAGE REFRIGERATION SYSTEMS.

[Provide refrigeration system equipment for cold storage in accordance with Section 23 63 00.00 COLD STORAGE REFRIGERATION SYSTEMS.

] MIL-R-43900, except as modified in this section. Design refrigerant equipment for [remote][self-contained] installation. Design units for 16 to 18 hour operation at the indicated interior temperature in [_____] degrees C [_____] F ambient temperature. Provide equipment with capacities, air delivery, and dimensions indicated. Provide refrigeration equipment that is Energy Star labeled. Provide data identifying Energy Star label for refrigeration equipment.

2.3.1 Remote Condensing Units

Factory fabricated and rated in accordance with UL 1995 andAHRI 366 (SI) AHRI 365 (I-P). Provide with motor, [air-cooled] [water-cooled] condenser, receiver, compressors, mounted on a common base. Provide [hermetic] [accessible hermetic] type compressors.

Provide in accordance with ANSI/ASHRAE 15 & 34 and ASHRAE 189.1. Provide preassembled remote condensing unit assembly with all necessary components factory installed and wired including electrical box, time clock, drier, sight glass,[winter control and crankcase heater][enclosed compressor housing,] and compressor rack.[Set chiller to operate at [[1][minus 1][minus 18][_____] degrees C[33][30][0][_____] degrees F] [temperature shown on plans]]. Mercury is prohibited for use in thermometers. Chlorofluorocarbon (CFC) based refrigerants are prohibited.

2.3.2 Evaporators

Factory fabricated and rated in accordance with UL 412 and AHRI 420. Provide forced convection, unit cooler type, made to be suspended from the ceiling panels, with forced air discharged parallel to the ceiling. Provide with air circulating motor, multifin tube-type coil and grille assembled within a protective housing. Air circulation motors must be lifetime sealed. The entire unit cooler assembly must be accessible for cleaning. Provide a drip pan and drain connection. When the cold storage room is used for freezing, provide an automatic [hot gas] [electric heat] defrosting system. Provide [timer] [demand] type defrost controllers.

2.3.3 Self-Contained Refrigerant Systems

****

NOTE: Select mounting. Side-mounted units are available in sizes up to 6 kW 7 1/2 horsepower. Top-mounted units are available in sizes up to 4 kW 5 horsepower.

****

Factory fabricated in accordance with UL 427 for [side-wall] [top-wall] mounting. Systems to include a condensing unit mounted on the exterior and a forced air evaporator mounted on the interior directly opposite.

Provide in accordance with ANSI/ASHRAE 15 & 34 and ASHRAE 189.1. Provide condensing unit assembly with all necessary components factory installed and wired including electrical box, time clock, drier, sight glass,[winter control and crankcase heater][enclosed compressor housing,] and compressor rack.[Set chiller to operate at [[1][minus 1][minus 18][_____] degrees C [33][30][0][_____] degrees F][temperature shown on plans]] Mercury is prohibited for use in thermometers. Chlorofluorocarbon (CFC) based refrigerants are prohibited.

2.4 HEATING CABLE

****

NOTE: The following paragraph is for units operating at below-freezing temperatures.

****

Provide condensate drain lines and drains below freezer floors with electric heating cable, thermostatically controlled to maintain [_____] degrees C [_____] F at zero flow rate. Provide [_____] cable size and [_____] watts per meter (linear foot).

PART 3 EXECUTION

3.1 INSTALLATION

Provide in accordance with NSF/ANSI 7, ANSI/ASHRAE 15 & 34, ASHRAE 189.1, and with the manufacturer's printed instructions. Submit installation instructions covering both assembly of the rooms and installation of the refrigeration equipment, for approval by the Contracting Officer's Representative prior to starting installation. Include equipment start-up and initial operation as well as evacuation and charging procedures for refrigeration equipment in the installation instructions.

3.2 MANUFACTURER'S FIELD SERVICES

3.2.1 Services

Provide manufacturer's representatives who are trained to perform the services specified. Representatives to provide training services on the following procedures:

a. Erection, alignment, and testing.

b. Charging equipment with refrigerant and oil.

c. Starting equipment and training government personnel in proper care, operation, and maintenance.

3.3 TESTS

Perform the tests for each room and provide everything required. Notify the Contracting Officer 10 days before performing the tests. Perform tests in the presence of a manufacturer's representative.

3.3.1 Start-Up and Operational Tests

Upon completion of equipment and refrigerant piping installation, start-up and operate systems for a period of not less than 24 hours. Place safety and automatic controls in operation and sequence. Record manufacturer's recommended readings hourly.

3.3.2 Performance Tests

Upon completion of operational tests, performance test systems for not less than 8 hours. Include the following information in the test report with conclusions regarding the adequacy of systems:

a. Time, dates and duration of tests.

b. Inside dry-bulb and wet-bulb temperatures maintained in each room during tests employing recording instruments calibrated before the tests.

c. Outside dry-bulb and wet-bulb temperatures obtained from recording instruments calibrated and checked hourly with a sling psychrometer.

d. Evaporator and condenser entering and leaving temperatures taken hourly with compressors in operation.

e. Make, model and capacity of each evaporator and condensing unit.

f. Voltmeter and ammeter readings for condensing units and evaporators.

3.4 OPERATING INSTRUCTIONS

Provide a framed and glassed control chart indicating layout of refrigeration systems, including piping, valves, wiring, and control mechanisms. Install control chart where directed. Submit printed instructions covering the maintenance and operation of refrigeration equipment. Tag shutoff valves in accordance with printed instructions. Provide special tools necessary for repair and maintenance of the equipment. Submit data package 2 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA

3.5 CLEANING

Remove masking protection from stainless steel and other finished surfaces. Wash and clean floors, walls, shelves, and ceilings inside rooms and on exposed exterior surfaces. Clean glass, fixtures and fittings.

3.6 INSTRUCTING OPERATING PERSONNEL

Upon completion of the work and at a time designated by the Contracting Officer, provide instruction to Government personnel in the operation and maintenance of each refrigeration system. Duration of instruction must be a minimum of one 8-hour working day.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-13 21 48 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-13034 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13 21 48

PREFABRICATED AUDIOMETRIC ROOMS

04/06

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-13 21 48 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-13034 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 13 21 48

PREFABRICATED AUDIOMETRIC ROOMS
04/06

****

NOTE: This guide specification covers the requirements for prefabricated audiometric rooms.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The following information shall be shown on the project drawings:

1. Location of equipment:
 a. Location of the space to be used for testing;
 b. The size of the space: length X width X height;
 c. A plan view of the space to determine the location of the window and the door swing;
 d. Electric outlets;
 e. The power supply access.
 f. The number of chamber positions.

2. Site selection ambient noise measurement:
 a. The ambient noise levels in the selected site shall be measured prior to the installing of audiometric test chamber. The octave-band levels shall not exceed the values given in the following

table:

Octave-band Center Frequency-Hz	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Exterior (outside room) ambient noise level in db	**65**	**61**	**61**	**80**	**90**	**95**	**95**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.1	(1999; R 2018) American National Standard Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms (ASA 99)

ASTM INTERNATIONAL (ASTM)

ASTM C423	(2023; E 2024) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM D2859	(2016) Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
ASTM E84	(2023) Standard Test Method for Surface

	Burning Characteristics of Building Materials
ASTM E596	(2022) Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-1691	(1994; Rev F; Notice 1 2024) Construction and Material Schedule for Military Medical and Dental Facilities

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel

1.2 RELATED REQUIREMENTS

Conform to Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT. Provide the final utility connections and utility service to the equipment in accordance with Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS; and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Noise Dampening Performance

a. Noise reduction: The noise reduction from the outside to the inside of a properly installed audiometric test chamber, as tested in accordance with ASTM E596 and performed in a recognized, independent and approved laboratory, shall be not less than the values in the following table:

Octave-band Center Frequency-Hz	125	250	500	1000	2000	4000	8000
Noise reduction in dB	24	30	40	50	55	55	55

b. Sound absorption: The sound absorption of the composite metal and sound-absorbing panel assembly, as tested in accordance with ASTM C423 and performed in a recognized independent and approved laboratory, shall not be less than the values in the following table:

Octave-band Center Frequency-Hz	125	250	500	1000	2000	4000	8000	NRC

Sound Absorption Coefficients	.41	1.1	1.1	1.02	.93	.89	--	.95

c. Interior noise level: The interior ambient noise level measured inside of a properly installed audiometric test chamber, as tested in accordance with ASA S3.1 and performed in a recognized independent and approved laboratory, shall be not greater than the values in the following table (ventilation fan on):

Octave-band Center Frequency-Hz	500	1000	2000	4000	8000
Maximum permissible interior noise in dB	21.5	29.5	34.5	39.0	41.0

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Conform to submittal requirements of Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT.

SD-02 Shop Drawings

[M-0250, Audiometric Testing Room

][M-0300, Audiometric Examination Booth

] SD-03 Product Data

M-0250, Audiometric Testing Room

M-0300, Audiometric Examination Booth

SD-04 Samples

****

NOTE: All available item specifications applicable to this section have been furnished in joint schedule number (JSN) alpha-numerical order. The JSN is referenced from MIL-STD-1691.

****

****

NOTE: Delete any items not used, and add additional items as required.

****

[M-0250, Audiometric Testing Room; G, [_____]]

[M-0300, Audiometric Examination Booth; G, [_____]]

SD-06 Test Reports

Noise Reduction Test

Sound Absorption Test

Interior Noise Level Test

Submit test reports indicating compliance with the performances listed in paragraph PERFORMANCE REQUIREMENTS.

SD-07 Certificates

****

NOTE: All item specifications applicable to this section have been furnished in joint schedule number (JSN) alpha-numerical order. The JSN is referenced from MIL-STD-1691.

****

****

NOTE: Delete any items not used, and add additional items as required.

****

[M-0250, Audiometric Testing Room

][M-0300, Audiometric Examination Booth

] Include written certification that the test data were taken on sample components identical to the material supplied under this specification.

SD-10 Operation and Maintenance Data

M-0250, Audiometric Testing Room, Data Package 3; G, [_____]

M-0300, Audiometric Examination Booth, Data Package 3; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 GENERAL CHARACTERISTICS

a. The manufacturer shall certify the audiometric testing [room] [booth] as a quiet environment for the testing of hearing.

b. Construct the audiometric testing [room] [booth] of modular panels to allow expeditious installation and relocation of the booths.

c. Equip the audiometric testing [room] [booth] with a window, an audiometric jack panel underneath the window, an inside light, and a ventilation system.

d. Design the [room] [booth] to allow for installation within 4 inches of walls.

2.2 MATERIALS AND CONSTRUCTION

[Single wall] [Double wall].

2.2.1 Walls and Roof Panels

Construct the walls and roof panels as a multilayered sandwich of acoustical materials. The overall thickness of the panels shall be 100 mm 4 inches. The outer panels shall be 16 gage, cold-rolled steel. The inner surface shall be 22 gage, cold-rolled steel with 2 mm 3/32 inch perforations at 5 mm 3/16 inch staggered-on-centers. Frame the panels using 16 gage channels with continuous arch-welded joints. The average weight of the panels shall be a minimum of 50 kg per square meter 10 pounds per square foot. The total weight of the panel shall be a maximum of 182 kg 400 pounds.

2.2.2 Floor Panel

Construct the floor panel as a multilayered sandwich of materials to allow for the support of a load of 240 kg per sq m 50 pounds per square foot. The overall thickness of the floor shall be 100 mm 4 inches. The walking surface shall consist of a minimum of 11 gage, corrosion-resistant steel; the bottom surface shall consist of a minimum of 16-gage steel, structurally reinforced. The average weight of the floor panel shall be a minimum of 50 kg per sq m 10 pounds per square foot. The total weight of the panel shall be a maximum of 182 kg 400 pounds.

2.2.3 Vibration Isolation

Provide vibration isolation by mounting the audiometric test chamber mounted on vibration isolation rails, consisting of rubber-in-shear isolators mounted to 75 mm 3 inch structural channels for weight distribution. The vibration isolators shall have a natural resonant frequency of 6 1/4 Hz for maximum elimination of structure-borne vibration.

2.2.4 Door

The door shall be acoustically sealed and provide a minimum clear opening of 810 mm 32 inches. Unless otherwise indicated, the door shall be hinged on the right (facing outward) and shall swing out of the chamber. The door shall be constructed using materials similar to those used for the wall panels. Equip the door with two magnetic compression seals spaced to provide dead airspace. Equip the bottom of the door with either a gravity-activated seal or a compression seal activated by a cam seating of the door within the frame. Provide either surface mounted or butt-type hinges. If butt-type hinges are used, the magnetic seals shall not be broken by the hinges. The hinges shall contain a cam-lift mechanism to ensure proper seating of the door.

2.2.5 Wall and Corner Joiners

All wall and roof panels shall be acoustically and structurally joined together using a member shaped according to the corner or joint configuration. The member shall be made of 16-gage steel and shall be made to allow for the use of pop rivets or sheet metal screws to fasten it in place. The dead airspace between the panels and the member shall be filled with acoustical material and shall be caulked for air-tight integrity.

2.2.6 Acoustical Fill

Fill all panels, walls, and doors with inert mildew- and vermin-resistant acoustical attenuating and absorbing material. When tested in accordance with ASTM E84, the material shall have maximum fire hazard ratings of 25 for flame spread, zero for fuel contribution, and 50 for smoke density.

2.2.7 Windows

600 mm wide by 760 mm24 inches wide by 30 inches high, double-glazed, using 6 mm 1/4 inch safety glass. Mount glass with acoustically tight rubber gaskets.

2.3 UTILITY FEATURES

2.3.1 Jack Panel

The jack panel shall be insulated and shall contain six 3 wire, phone-type jacks with covers with one three-pin and one four-pin connector per panel, in accordance with the manufacturers standard. Each phone jack shall be insulated from the booth and from the other jacks. The jack panels shall be designed to preserve the acoustical integrity of the room.

2.3.2 Ventilation System

The ventilation system shall be incorporated into the roof panel, except where a multiposition chamber is specified the vent system shall be incorporated into the wall. The silencer for the ventilation system shall not intrude into the room. The noise from the ventilation system shall be below the threshold of hearing when measured 900 mm 3 feet from the opening. The airflow shall be a minimum of 50 L/s 100 cubic feet per minute, except where a multiposition chamber is specified.

2.3.3 Electrical System

Equip the chamber with a recessed 110 volt light fixture with a 40 watt incandescent lamp, except in multiposition test chambers, where indicated. The chamber shall be prewired and shall include switches mounted 1400 mm 4 feet 8 inches above the floor, opposite the side of the door hinges for the light fixture and the ventilation fan. Electrical components shall be UL approved. Factory installed internal wiring shall be in rigid conduits conforming to UL 6, concealed in the chamber. Wiring shall extend to the outside of the enclosure connecting to a prewired electrical harness terminating in a 4 meter 12 footpowercord with a hospital grade plug. Provide convenience outlets as indicated.

2.3.4 Floor Covering

Cover the floor with a 100-percent, continuous-filament nylon carpet on a pad. The carpet and pad system shall comply with ASTM D2859 and shall have a minimum average critical radiant flux of 0.25 watt per square centimeter when measured in accordance with ASTM E648.

2.3.5 Finish

Exposed sheet metal surfaces shall be cleaned and degreased. Fill and grind welds smooth. Prime metal with a rust-inhibiting chromate modified alkyd primer. The finish coat shall be an acrylic enamel-type paint. The quality standards of the NAAMM AMP 500 National Association of Architectural Metal Manufacturers shall apply. Color shall be selected from the manufacturers color standards.

2.4 MULTIPOSITION TEST CHAMBERS

The following additional requirements shall be provided:

a. The jack panels shall provide two 3-wire phone jacks per position. The wiring for the group system jacks shall be Contractor-furnished but Government-installed.

b. Each position within the test chamber shall be divided by a heavy canvas divider.

c. Provide metal stools with upholstered tops.

d. Vibration isolator rails shall extend the full length of the long dimension of the test chamber.

e. Ventilation systems shall be installed on the exterior walls. The airflow shall be a minimum of 140 L/s 300 cubic feet per minute for 4 position rooms, 210 L/s 450 cubic feet per minute for 6 position rooms, and 240 L/s 500 cubic feet per minute for 10 position rooms.

f. The window shall be mounted in the door.

2.5 ITEMS

Items are listed by joint schedule number (JSN) referenced from MIL-STD-1691.

****

NOTE: 1. All available item specifications applicable to this section have been furnished in joint schedule number (JSN) alpha-numerical order. The JSN is referenced from MIL-STD-1691.

2. Delete any items not used, and add additional items as required.

****

****

NOTE: The first paragraph following is a sample guide to be used in generating an item specification. The item number should correspond with the JSN used on the schedule. If no JSN is available, have the item number correspond with the appropriate identification code used on the contract documents.

****

2.5.1 Item [_____], [_____]:

****

NOTE: In paragraph entitled "Item [_____], [_____]" insert the item identification number and the item name in the first blank space, respectively. Insert a description of the item in the second blank space to determine the type of product required. Avoid repetition of detailed information which is to appear in the salient features listed thereafter. In paragraphs entitled "Item M-0250, Audiometric Testing Room" and "Item M-0300, Audiometric Examination Booth" use the second bracketed option for double wall construction.

****

The unit shall be [[_____].]

2.5.1.1 Include the following:

[a. [_____].

][b. [_____].

][c. [_____].

]2.5.2 Item M-0250, Audiometric Testing Room

****

NOTE: In paragraph entitled "Item [_____], [_____]" insert the item identification number and the item name in the first blank space, respectively. Insert a description of the item in the second blank space to determine the type of product required. Avoid repetition of detailed information which is to

appear in the salient features listed thereafter. In paragraphs entitled "Item M-0250, Audiometric Testing Room" and "Item M-0300, Audiometric Examination Booth" use the second bracketed option for double wall construction.
****

The audiometric testing room shall be prefabricated; approximately [1980 mm high by 2100 mm wide by 2235 mm deep inside, 2235 mm high by 2340 mm wide by 2440 mm deep outside,] [1980 mm high by 2100 mm wide by 2235 mm deep inside, 2235 mm high by 2740 mm wide by 2840 mm deep outside,] [78 inches high by 84 inches wide by 88 inches deep inside, 88 inches high by 92 inches wide by 96 inches deep outside,] [78 inches high by 84 inches wide by 88 inches deep inside, 96 inches high by 108 inches wide by 112 inches deep outside,] and shall have a continuous ventilating system and a shelf mounted on the outer wall beneath the observation window.

2.5.3 Item M-0300, Audiometric Examination Booth

****
NOTE: In paragraph entitled "Item [_____], [_____]" insert the item identification number and the item name in the first blank space, respectively. Insert a description of the item in the second blank space to determine the type of product required. Avoid repetition of detailed information which is to appear in the salient features listed thereafter. In paragraphs entitled "Item M-0250, Audiometric Testing Room" and "Item M-0300, Audiometric Examination Booth" use the second bracketed option for double wall construction.
****

The audiometric examination booth shall be prefabricated; approximately [1980 mm high by 1000 mm wide by 900 mm deep inside, 2235 mm high by 1200 mm wide by 1120 mm deep outside,] [1980 mm high by 1000 mm wide by 900 mm deep inside, 2440 mm high by 1625 mm wide by 1500 mm deep outside,] [78 inches high by 40 inches wide by 36 inches deep inside, 88 inches high by 48 inches wide by 44 inches deep outside,] [78 inches high by 40 inches wide by 36 inches deep inside, 96 inches high by 64 inches wide by 60 inches deep outside,] and shall have a continuous ventilation system and a shelf mounted on the outside wall beneath the observation window.

PART 3 EXECUTION

3.1 INSTALLATION

****
NOTE: Provide a ramp of sufficient size to facilitate the use of wheeled equipment.
****

Install the items at the locations indicated. Conform to the installation requirements of Section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT.

3.1.1 [Audiometric Testing Rooms][and][Examination Booths]

Assemble the [audiometric testing rooms][and][examination booths] on the site using prefabricated panels, doors, windows, ventilation silencers, and assembly hardware, meeting all the requirements specified in this section.

3.2 FIELD QUALITY CONTROL

3.2.1 Inspection

Examine each item for visual defects, and correct all defects to conform to the specifications.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-13 31 33 (February 2023)**

Preparing Activity: NAVFAC **NEW**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 13 31 33

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USACE / NAVFAC / AFCEC **UFGS-13 31 33 (February 2023)**

Preparing Activity: NAVFAC **NEW**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 13 31 33

FRAME SUPPORTED MEMBRANE STRUCTURES FOR PROTECTION OF AIRCRAFT

02/23

****

NOTE: This guide specification covers the requirements for frame supported membrane structures on airfields which are commonly referred to as Aircraft Protective Equipment or Sunshades. These structures are not aircraft hangars and cannot have walls. Please note, requirements such as AFI 21-101 specifically states that aircraft sunshades are not considered temporary or relocatable facilities.

These types of structures have had numerous and significant failures. The intent of this guide specification is to help eliminate and mitigate known issues and causes of these failures. Because these types of structures are often procured as equipment versus real property, normal designer of record responsibilities, technical review and technical coordination may be inadvertently avoided, overlooked or not performed due to the process. This guide specification, including notes to the specifier, should be followed regardless of the procurement process being used to help direct proper responsibilities and coordination.

Causes of failures have included frame corrosion, excessive frame deflection, inadequate wind-load design, inadequate fabric strength, fabric deterioration, inadequate foundation design, lack of foundation design, lack of maintenance, and more.

There is a history of foundation failures due to improper or inadequate foundations and anchorage being relied upon by the manufacturer without a licensed professional engineer being involved. The foundation and anchorage design must be sealed and signed by a licensed professional engineer and provided to the frame supported membrane structure manufacturer for coordination and compatibility. It is imperative that there is a plan in place for the procurement for both foundation design by a licensed

professional engineer, the frame supported membrane structure and the installation.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: It is beyond the intent of this specification to include items such as Insulated Roof Systems, Insulated Wall Systems, Doors, Windows, Heating, Fire Protection, or other such building systems which are more in line with an aircraft maintenance hangar and the criteria of which are governed by UFC 4-211-01.

****

****

NOTE: Foundations are not included in this specification and must be designed by a Professional Engineer in accordance with UFC 3-301-01 and the support conditions (layout, configuration, reactions, anchorage, and other design elements) provided by the frame supported membrane structure manufacturer. Special attention shall be paid to uplift forces and attachment to the foundations. If this is an equipment procurement, validate who is responsible to design and coordinate the foundation.

****

****

NOTE: Aircraft rated pavements are not included in this specification and must be designed by a Professional Engineer in accordance with UFC 3-260-02. Provide aircraft tie-down/anchorage and grounding as required.

****

****

NOTE: Accessory items, if required, are not specified in this specification. Examples of accessory items are included below in the list of items to show in Drawings. If these accessory items are required by the project specifier, please refer to potential reference sources such as UFC 3-260-02

or UFC 4-211-01 for guidance on design standards. For these designs, utilize a Professional Engineer to perform the design including system detailing suitable for the environment and project need. While accessory items are not required to be provided by the manufacturer, they are required to be supported by the manufacturer, by this specification. Carefully consider any accessories as some DoD policy may consider these as real property versus equipment, depending on utility services.

****

****

NOTE: On the design drawings, show:

1. Location and quantity of the frame supported membrane structures. Locate in accordance with Chapter 2-1 of UFC 4-211-01, specifically considering Airport Operations Area (AOA) safety, clearances, and security as well as Construction Phasing for ongoing airfield operations.

2. Appropriate design loads for Live, Snow, Wind, Rain, Ice and Earthquake (Seismic) Loads, including resistance to Hail Impact. Show design wind pressures based on the design wind velocity, including component and cladding loads by contributory area.

3. Size and arrangement of frame supported membrane structures, including, but not limited to, permissible column locations, permissible x-bracing locations (if any), and roof configuration with slope(s) or radii. In the case of more than one sunshade, also note whether each sunshade is stand alone or shares bracing frames. If sharing bracing frames, note Air Force Instruction (AFI) 21-101 requirement for each fourth frame in adjacent sunshades to be designed for twice the required lateral bracing strength.

4. Show size, type and location of ventilation if required to meet Air Force Instruction (AFI) 21-101 requirement.

5. Clearances for frame supported membrane structure and any accessory items to the parked aircraft, aircraft operations, equipment, and aircraft ingress and egress. If applicable to the operation, clearances shall include consideration for heat associated with Engines and Auxiliary Power Units (APU) as well as thrust from engines (jet blast).

6. Fabric membrane color and specular gloss. Surfaces shall not produce glare to aircraft in flight or to the control tower. Provide roofs and other external surfaces with a specular reflectance

compatible with the location of structure on the airfield. If located such that glare is an operational hazard, provide surfaces of the structure with a light reflectance of not more than 10, measured at an angle of 85 degrees in accordance with American Society of Testing and Materials (ASTM) D523 (Specular Gloss) at critical surfaces of the structure.

7. Foundation design, including layout of the columns and their attachment to the foundation. Configuration, type, size, spacing, minimum embedment and minimum projection of anchor bolts, or anchoring system, to the foundation must be provided to resist the column reactions with special attention to uplift forces. This design must be provided by a licensed professional engineer experienced in the design of foundation and anchoring systems.

If the intent of the specifier is to anchor the structures to airfield/apron pavement, which is often unreinforced flexural concrete rather than reinforced compressive concrete, the licensed (foundation) professional engineer must provide details of anchorage, method for resisting uplift forces, thrust, base shear and gravity loads. An emphasis must be placed on how joints in airfield/apron will be accommodated in terms load transfer and anchor "edge" distance to the joint.

There is a history of foundation failures due to improper or inadequate foundations and anchorage being relied upon by the manufacturer without a licensed professional engineer being involved. The foundation and anchorage design must be sealed and signed by a licensed professional engineer and provided to the frame supported membrane structure manufacturer for coordination and compatibility.

8. Aircraft rated pavements, including thickness, joint locations/detailing, aircraft tie-down/anchorage and grounding as required. Include SECTION 32 13 14.13, CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS, at a minimum, in order to properly specify aircraft rated pavements.

9. Accessory items, if required. Examples of accessory to be shown elsewhere in the Contract documents for coordination with this product include Aviation Obstruction Lighting, Apron Lighting, Understructure Security/Task Lighting, Utilities (such as power, communications/data, compressed air, water), Ventilation/Destratification, Eyewashes, Lightning Protection, Fall Protection, and any other applicable items. Include system detailing suitable for the environment. Accessory items are not required to be provided by the manufacturer but are

required to be supported and braced by the manufacturer if shown in the Contract Documents.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 55	(2016) Tensile Membrane Structures

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc

	(Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM D2136	(2002; R 2012) Coated Fabrics - Low-Temperature Bend Test
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-889	(2021; Rev D) Galvanic Compatibility of Electrically Conductive Materials
UFC 1-200-01	(2022; with Change 4, 2024) DoD Building Code
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

SD-02 Shop Drawings sealed by the frame supported membrane structure's Registered Professional Engineer.

Frame Supported Membrane Structure; G, [_____]

Erection Plan; G, [_____]

SD-03 Product Data

Fabric (Membrane); G, [_____]

Product Data

SD-04 Samples

Fabric (Membrane); G, [_____]

SD-05 Design Data sealed by the frame supported membrane structure's Registered Professional Engineer.

Frame Supported Membrane Structure; G, [_____]

Sealed and Signed Calculations

Sealed and Signed Shop Drawings

SD-07 Certificates

Welding Procedures and Qualifications; G, [_____]

SD-10 Operation and Maintenance Data

Frame Supported Membrane Structure O&M, Data Package 1; G, [_____]

SD-11 Closeout Submittals

Final Completion Certification; G, [_____]

Manufacturer's Warranty; G, [_____]

1.3 DESIGN REQUIREMENTS

The frame supported membrane structure depicted in the Construction Documents is representative of a permanent, custom designed, prefabricated, commercially available system. Design and fabricate the structure and fabric membrane in accordance with ASCE 55, to fit within the space allocated, including support and bracing for accessory items, and in accordance with the criteria specified herein, including all aircraft clearances and permissible bracing locations, if permitted. The structure's fabric membrane cladding cannot be utilized to brace or support any structural member such that, should any damage of the fabric membrane occur, the integrity of the structural framework is not adversely affected. Contractor will [utilize the sealed and signed foundation and anchorage design included in the Construction Documents][include a sealed and signed foundation and anchorage design]. Submit complete sealed and signed calculations for the frame supported membrane structure prepared by the manufacturer's registered professional engineer, including bracing locations, column reactions and attachment to the foundation for verification of compatibility with the foundation design, including column uplift. Calculations shall be provided in a logical and orderly manner for independent review. Submit complete sealed and signed shop drawings for the frame supported membrane structure prepared by the manufacturer's registered professional engineer.

1.3.1 Loads

Design the frame supported membrane structure to support all dead loads, including weights of accessory items, combined with Live, Snow, Wind, Rain, Ice, Earthquake (Seismic) and Temperature Loads as required by the Contract

Documents, UFC 1-200-01 and UFC 3-301-01. Provide separate reactions for each load combination used in the design of the structure in accordance with ASCE 55.

****

NOTE: Delete the following subsections if Loads are specified elsewhere in the Contract Documents, such as in the Structural Drawings Sheets.

In the paragraphs below, use the appropriate Risk Category as determined from UFC 4-211-01.

****

[1.3.1.1 Live Load

Design the structure and fabric membrane to support a [non-reducible] uniform live load of [575 Pa12 psf] [______] [plus a point load of 1.33 KN 300 pounds acting over any 1 square foot area].

1.3.1.2 Snow Load

Design the structure and fabric membrane to support a uniform snow load of [_____] Pa psf. Include unbalanced snow loads and loads due to snow drifts as required by the geometry of the roof including adjacent roofs.

1.3.1.3 Wind Loads

Design the structure and fabric membrane for a wind speed of [_____] kmh mph, Risk Category [III] [_____], and Exposure Category [_____]. Utilize the appropriate wind pressures for Main Frame, and Components and Cladding, based upon the appropriate tributary area. Design all components to withstand both the highest positive and negative pressures [including a minimum jet blast pressure of [960 Pa20 psf] [_____]]. Design and provide support and bracing for accessories.

1.3.1.4 Rain

The structure shall be capable of withstanding the effects of rainfall up to [_____] cm inches per hour for a minimum of [2] [_____] hours.

1.3.1.5 Ice

Design all exposed elements, including the fabric membrane, to support a uniform ice accumulation of [_____] mm inches on all sides of all surfaces. Provide system to resist damage from hail.

1.3.1.6 Earthquake (Seismic)

Design the structure using a Short Period Acceleration [_____]g, Long Period Acceleration [_____]g, Soil Site Class [_____], Risk Category [III] [_____], along with codified factors, coefficients and methods consistent with the type of seismic force resisting system(s) being designed and provided. Design and provide support and bracing for accessory items.

1.3.1.7 Temperature

Design all structural elements, including the fabric membrane to be capable of being assembled, utilized and dismantled in all ambient temperatures between [_____] C and [_____] C [_____] degrees F and [_____] degrees F.

Provide a fabric membrane designed to withstand a temperature of [_____] C degrees F.

]1.3.2   Deflections

Deflection due to the imposed loading of any truss panel point or joint where a purlin or column connects to one of the main structural frames shall be less than the clear width (span width) of the structure divided by 180 (span width/180).

1.3.3   Structural Frame System

Provide a steel structure, including all connections and attachments. Design the structure in accordance with the requirements of the Contract Documents, UFC 1-200-01 and UFC 3-301-01. Design all structural members in accordance with the specified loads and the requirements of AISC 325, AISC 360. Thin-walled steel, less than 5mm 3/16 inches structural material thickness, or cold-formed steel are prohibited. Design connections for structural elements and fabric membrane to transfer all forces present in each joint, including required factors of safety. Connection eccentricities, where lines of force do not align with nodal points, are not permitted unless accounted for and modeled in the calculations. Where sleeve joints are used, the material shall be appropriately sized and reinforced to avoid sheer failure of the material.

1.3.3.1   Roof Structure

Provide a steel structure of the shape indicated in the Contract Documents. Surfaces shall be planar, sloped or radiused as indicated. Structure shall also be square and plumb. Provide the interior of the structure clear of any structural members or obstructions. Provide purlin [and girt]spacing to ensure structural stability, to minimize unsupported areas of fabric membrane in the roof and to provide for installation and support of accessory items. Laterally brace the main structural frames with purlins [and girts] at intervals no greater than [2 m6.5 feet] [______].

1.3.3.2   Lateral Force Resisting System(s)

****

NOTE: Based upon historical failures, the second paragraph below prohibits use of cable x-bracing. Based upon the size of the structure, the second paragraph below should be edited to not permit tension only bracing or to allow tension only rod bracing, depending upon applicable seismic limitations.

****

Provide a complete lateral and diagonal bracing system to properly stabilize the structural frame elements in all directions, to fit within the space allocated, including all aircraft clearances and permissible braced bay locations, if permitted. Provide moment frames where braced bays are not permitted as determined by anticipated movement of people and equipment around the aircraft parking position(s). Coordinate the lateral force resisting system with the foundation, including anchorage to the foundation. The fabric membrane is not permitted to serve as a diaphragm in the lateral force resisting system.

[Tension only bracing is not permitted.][Tension only rod assemblies are permitted to serve as bracing. The minimum permitted rod diameter for bracing is [10 mm3/8 inch] [_____]. Design rod connections to the structural frame using attachment clips, or lugs, not less than [10 mm3/8 inch] [_____] thick steel and detail and install in a manner to prevent slacking or loosening over time. The use of cables is not permitted.]

[1.3.3.3 Accessory Items

Provide framing and points of attachment to support and brace all accessory items. Accessory items are indicated in the Contract Documents and include [Aviation Obstruction Lighting,][Apron Lighting,][Understructure Security/Task Lighting,][Utilities (communications/data, compressed air, water),][Eyewashes,][Lightning Protection,][_____].

]1.3.4 Fabric Membrane System

Design to form a continuous, uninterrupted cover over the framework. Cover the entire roof of the structure with the fabric membrane in accordance with the design drawings included with this specification.

1.3.4.1 Fabric Membrane Joints and Seams

Provide adjacent cladding sections with a mechanical tensioning system which allows the fabric membrane to be fully tensioned around the structure. Maintain proper gaps between sections to allow sufficient distance to enable full tensioning of the material resulting in the fabric membrane secured tightly and neatly over the structural frame with a remaining range of adjustment. Overlap seams such that the fabric membrane panels are supplied with overlapping joints to allow adjacent panels to be field heat-sealed together.[Seal around all required penetrations for accessory items, such as vents.]

Provide fabric pretensioning in frame-supported fabric membrane structures to prevent the fabric membrane from making contact with structural framing members during buffeting or flutter and include a factor of safety to account for the loss of tensioning likely to occur over the service life of the fabric.

1.3.4.2 Design Factor of Safety

Design the fabric membrane, using the load combinations and strength reduction factors as required by ASCE 55 and utilize minimum net factors of safety as indicated in Table 4-2 of ASCE 55 compared to the tensile strength of the fabric membrane while accounting for degradation due to UV and temperature effects.

[1.3.5 Bird Nesting/Roosting Mitigation

Design a mitigation system, using bird netting, to prevent bird access, roosting and nesting within the structure and accessory items. Coordinate the design and installation of the bird netting with all accessory items and their function.[Alternatives to bird netting which function to eliminate nesting surfaces under the roof and inside the covered areas of the sunshade may be accepted as alternatives to bird netting.]

]1.4 QUALITY ASSURANCE

1.4.1 Manufacturer's Qualifications

Provide a complete system from a manufacturer who has regularly engaged in the design, fabrication, erection, and service of frame supported membrane structures of the type and size required for this project. The manufacturer shall have at least 5 years of similar design experience in membrane clad, steel framed structures. The manufacturer's Professional Engineer in Responsible Charge shall have at least 5 years of similar design experience, including height and clear span, in membrane clad, steel framed structures. Perform all aspects of design, fabrication, erection, and service of these frame supported membrane structures in accordance with a comprehensive quality system, such as ISO 9000 certification or other comparable and proven quality program.

Contractor must submit written evidence of each of the above requirements for similar past designs, fabrications and installations and include a list of the names, locations, contact information of owners, installation dates, overall sizes, features, and other relevant information for experience, qualifications and quality evaluation. Only manufacturers who can submit this evidence of actual installations where the products have proven practical, durable, and require a minimum of maintenance, will be qualified under this specification.

1.4.2 Installer's Qualifications

Installation of the frame supported membrane structures shall be supervised by a manufacturer's representative, performed by an authorized representative of the manufacturer and in accordance with approved shop drawings and manufacturers written instructions, including coordination with the foundation and anchorage design. Installers shall be skilled and experienced in the erection of similar membrane clad, steel framed structures of the type specified herein, including height and clear span.

Installers must submit written evidence of each of the above requirements for similar past designs, fabrications and installations and include a list of the names, locations, contact information of owners, installation dates, overall sizes, features, and other relevant information for experience, qualifications, and quality evaluation. Only installers who can submit this evidence of actual installations, will be qualified under this specification.

1.5 SHIPPING, HANDLING AND STORAGE

Provide shipping documents with lists showing the description, quantity and piece marks of the various parts, components, and elements. Clearly mark all individual parts or bundles and packages of identical parts for identification or otherwise identify by clear installation procedures. Package bolts and fasteners according to type, size, and length. Package loose nuts and washers according to size and type. Deliver materials in original rolls, packages, containers, boxes, or crates bearing the manufacturer's name, brand, and project reference numbers.

Handle carefully to prevent damage. At no time shall materials be dropped, thrown, or dragged over the transport equipment or the ground. Store materials and equipment in dry locations with adequate ventilation, free from dust and water, and to permit access for inspection and handling. Remove damaged items that cannot be restored to like-new condition and provide new items.

1.6 WARRANTY

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NOTE: Intention of this specification is to obtain a steel structure, designed to meet minimum loading conditions with sufficient corrosion protection and have it perform similarly to a permanent structure. For the fabric membrane component, the below warranty is reasonable for many environments with current materials. Specifier should consult with manufacturers when in harsh environments regarding warranty and coordinate with Government/User expectations regarding establishment of reasonable fabric membrane replacement intervals.

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For the fabric membrane, provide a warranty for all materials and workmanship for a period of [15] [_____] years beginning from the date of final acceptance. Include full repair or replacement coverage, including labor and materials. Include in the warranty for fabric membrane, failure due to deterioration, breakdown, mildew, heat, cold, fading, discoloration, or other failure under design conditions. Include in the contractor's warranty, a copy of the fabric manufacturer's warranty which indicates a minimum of 70 percent strength is maintained for the full duration of the warranty.

PART 2 PRODUCTS

2.1 FRAME SUPPORTED MEMBRANE STRUCTURE

Provide new materials without defects and free of repairs. Provide materials of the quality and requirements specified herein.

Submit frame supported membrane structure drawings showing details of construction and installation, including column/bracing orientation and proving attachment to the foundation meets the requirements for the foundation design as provided by the Government. Demonstrate aircraft clearances have been met and show size, shapes, and thickness of materials; hardware; joints; connections; reinforcing; devices; support/bracing for accessory items; and design and detail data for the work of other trades.

2.1.1 Structural Steel

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NOTE: Use of pre-galvanized/in-line galvanized (ASTM G-60, G-90, or similar method) steel or painted steel is not deemed to be of sufficient corrosion resistance to meet the design intent and shall not be utilized for structural steel components. Post fabrication hot-dip galvanizing to ASTM A123/123M provides a substantially thicker, more durable and long lasting surface protection than pre-galvanized and single coat paint systems and it is typically more cost effective than higher quality multi-coat epoxy or powder coat systems which do not provide the cathodic/sacrificial protection offered by zinc coated steel. Post

fabrication hot-dip galvanizing of welded steel fabrications also provides protection for concealed surfaces as compared to pre-galvanized and painted systems where the heat of the welding process leaves concealed surfaces unprotected and subject to corroding from the inside out.

Pre-galvanized tubular fabrications, especially thin wall systems, have demonstrated full failure due to rusting from the inside out in less than ten years from installation (with significantly compromised structural capacity in less than 10 years) and therefore do not meet the design requirement for a thirty-year useful life. Similarly cold-formed steel is not permitted for this same reason.

****

Provide all members of the structure in accordance with AISC 325 and AISC 360 using ASTM A500/A500M, [Grade B][Grade C] tubular steel, ASTM A992/A992M W-shapes, or ASTM A53/A53M Grade B pipes and then hot-dip galvanize all members in accordance with ASTM A123/A123M. Provide connections using ASTM A36/A36M or ASTM A572/A572M for miscellaneous shapes such as angles, plates, and flat bars.[Fabricate tension only members, if utilized, from ASTM A36/A36M rods and design and install to prevent clapping, slacking or loss of tension. In all locations where rods may be encountered by people or equipment moving around the structure, provide rods with high visibility, reflective protection sleeves.]

Utilize welding only where specified in the manufacturer's design and as approved shop drawings or where approved in writing by the manufacturer. Perform welding in accordance with AWS D1.1/D1.1M utilizing welders tested and qualified to perform the required type of weld. Submit welding procedures and qualifications for all welds and welders performing work either in the shop or in the field. Inspect all welded joints for proper size, placement, thorough penetration, good fusion and free from scabs, blisters, abnormal pocket marks, cracks, voids, scab inclusion, and other defects. Welded steel work shall be hot dip galvanized to ASTM A123/A123M after manufacture to provide corrosion protection.

2.1.2   Fabric Membrane

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NOTE: Technically acceptable membrane suppliers include: Seaman, Ferrari, HeyTex/Bondcoat, Protan, and Mehler; however editor should consult the Contracting Officer for procurement compliance requirements regarding the FAR and the Berry Amendment. Other PVC coated manufacturers and materials may be considered; however, the membrane manufacturer must demonstrate experience with PVC coated polyester cladding in use on structures of the type contemplated in this specification in addition to demonstrating minimum field performance consistent with the required warranty. PVC degrades with UV exposure coatings are available that can extend fabric life.

When in harsh environments, specifier should consult with experienced, reputable manufacturers regarding

fabric membrane materials and warranty and then coordinate with Government/User for requirements and expectations regarding acceptable fabric membrane replacement intervals.

Translucent fabric is not recommended in all geographies (i.e., extremely high UV index areas, such as the Middle East). Additionally, very high fabric tension forces may require heavier fabric (i.e., 800 plus gram/square meter) which limits its intended purpose. Prior to including any of the below options for translucent panels, consult with a manufacturer.

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Supply the fabric membrane from a manufacturer with a demonstrated experience supplying PVC coated polyester cladding on structures of the type required by this specification. Provide a heavy-duty, PVC coated polyester fabric membrane with a demonstrated minimum field performance consistent with this structure's use, environment and required warranty for a minimum service life of 15 years. Minimum fabric membrane weight is 950 grams/square meter 28 ounces per square yard and laminated with a polyester with a minimum base fabric weight of 250 grams/square meter 7.5 ounces per square yard. Minimum permitted tensile strength is 4160/3940 N/50mm 475/450 lb/in according to Strip Tensile ASTM D751 Procedure B. A minimum of 70 percent strength is to be maintained for the full duration of the warranty period. Provide a fabric membrane that is free from defects, fully waterproof, ultraviolet (UV) stabilized, self-extinguishing (0-75 flame spread), flame retardant in accordance with NFPA 701 Test Method 2 and suitable to withstand temperatures between 71 C to minus 34 C 160 degrees F to minus 31 degrees F in compliance with ASTM D2136. Test the fabric to meet the criteria of ASTM E84 (flame spread - Class A interior wall and ceiling finish), ASTM D2136 (cold cracking, brittleness and temperature), and ASTM D751 (tensile and tear strength). Submit product data demonstrating compliance with strength, durability and standards.

Provide continuous, uninterrupted, cover. Provide fabric that is impervious and resistant to solvents, fuel, lubricants, and other similar fluids commonly found around aircraft. The fabric membrane shall cover the entire structure as indicated. Depending on the size of the structure, the membrane may be fabricated in one large section or can be fabricated in smaller sections connected and sealed together as specified in this specification to provide a continuous, uninterrupted, cover over the indicated framework.[The fabric membrane will be selected from the manufacturer's standard colors.][The fabric membrane will match the existing, adjacent sunshades.][The fabric membrane will be translucent white.][Fabric will be opaque with reflective white coating on the underside to increase visibility for maintainers.] Submit fabric (membrane) samples for weight, strength, color approval. Submit fabric (membrane) product data, including all certificates and test report data to demonstrate compliance with strength, durability and referenced standards. Laminated PVC materials, Polyethylene/Polypropylene fabrics and other "poly tarp" materials are not acceptable materials.

2.1.3 Hardware

Hot-dip galvanize all hardware in accordance with ASTM A153/A153M.

2.1.3.1 Structural Bolts

Provide minimum [13 mm1/2 inch] [______] diameter structural bolts that conform to ASTM F3125/F3125M. Provide a minimum of two bolts per connection and provide all bolts with lock washers or locking nuts. Install and tighten all bolts in accordance with AISC 325 and AISC 360.

2.1.3.2 Tensioning Hardware

Provide tensioning hardware which permits full and free rotation at the connections to avoid fatigue failure of threaded assemblies. Hot-dip galvanize load rated hardware utilized to tension the fabric membrane to prevent corrosion.

2.1.3.3 Non-Structural Fasteners

Provide standard non-structural fasteners, such as tek screws, of standard commercial quality and hot dip galvanized.

2.1.3.4 Exterior Trim

Battens or washers used for final seal of the PVC fabric membrane are permitted to be stainless steel or aluminum, in lieu of hot-dip galvanizing, to resist corrosion.

2.2 LIGHTING

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NOTE: Task/Security Lighting "Accessory" Coordination. In the Contract documents, specify LED fixtures/luminaires and power/disconnects suitable for wet locations and include desired color temperature, uniform illumination levels and locate fixtures/luminaires to physically avoid aircraft clearance envelope, including exhaust, blast shields and areas which produce undesirable shadows.

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Coordinate the frame supported membrane structure with the light fixtures in accordance with [Drawings and][Section 26 51 00 INTERIOR LIGHTING] [______].

2.3 LIGHTNING PROTECTION SYSTEM

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NOTE: Lightning Protection "Accessory" Coordination. In the Contract documents, specify the complete Lightning Protection System including counterpoise loop, ground rods and aircraft grounding locations. Specify interconnection of all ground rods with copper bonding conductors. Specify interconnection of all air terminals with copper bonding conductors and provide copper down conductors to connect to the counterpoise loop (and ground rods).

****

Coordinate frame supported membrane structure with the Lightning Protection System in accordance with [Drawings and][Section 26 41 00 LIGHTNING

PROTECTION SYSTEM] [______], including air terminals and copper conductors. Do not utilize the frame supported membrane structure for the lightning protection (electrical) load path. Design the frame supported membrane structure to facilitate replacement of fabric to minimize, as much as possible, the removal and reinstallation of air terminals.

[2.4 FALL PROTECTION

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NOTE: Fall Protection "Accessory" Coordination. In the Contract documents specify type, extent/coverage and number of people to be supported by the fall protection system.

****

Coordinate frame supported membrane structure with the fall protection system in accordance with [Drawings and] [______].

]2.5 FABRICATION

Provide bolted or welded construction. When required, prepare splices to facilitate field assembly in accordance with standard practice. Provide structural members which are true to dimensions and square in all directions. Fabrication tolerances for steel components shall conform to the requirements in the AISC Steel Construction Manual. For clarity in final and future structural inspections, it is not permitted to leave any connections, including base plates, with open bolt or anchor holes.

2.6 SIGNAGE

Provide permanent signage in an obvious and visible location on the structure which lists the manufacturer's name, manufacturer's phone number, manufacturer's project specific identification number, month and year of installation and the SERVICE level wind speed (in km/hr and mph) which corresponds to the factored/ultimate wind speed used in the design of the facility. Service Level Wind Speed may be calculated using IBC Equation 16-33.

PART 3 EXECUTION

3.1 EXAMINATION

Examine the foundation and anchor bolts for completeness of installation and compatibility with the column attachment of the frame supported membrane structure. Do not begin to erect the structure until the foundation and anchor bolts are correct, or until revised attachment of the columns has been engineered by the manufacturer and the revised submittal is approved.

3.2 INSTALLATION

Submit sealed and signed erection plan for the frame supported membrane structure. Upon confirming compatibility with the foundations and attachment/anchorage as sealed and signed by a licensed professional engineer, install and erect the structure and install the fabric membrane in accordance with the approved shop drawings, manufacturer's written instructions and approved erection plan. Adjust for ground slope (if occurring) and site conditions, ensuring a uniform appearance throughout the Installation. Install required signage[and place [yellow] [_____]

reflective tape on all perimeter columns to improve visibility].

3.3 CLEANING

After installation, clean all surfaces thoroughly of all mill scale, rust, oil, grease and other foreign substances. Touch-up finishes of ferrous materials immediately after cleaning.

3.4 TOUCH-UP FINISHES

After installation of the structure, prep and coat all areas of missing or damaged galvanized finishes on ferrous materials, including welds. Apply a zinc cold galvanizing compound for corrosion protection conforming to ASTM A780/A780M. Provide cold galvanizing compound that contains a minimum of 95 percent zinc dust in the dried film in accordance with the coating manufacturer's written instructions.

3.5 METAL PROTECTION

Provide in accordance with Chapter 4 of UFC 1-200-01 when structure is in a corrosion prone location or where structural components use dissimilar metals. If dissimilar metals are used, also provide in accordance with MIL-STD-889. Provide added corrosion protection to the design such as, but not limited to, the following. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact masonry or concrete, protect against corrosion by painting contact surfaces with bituminous coating.

3.6 FIELD QUALITY CONTROL

Provide a qualified and authorized representative of the manufacturer familiar with the design and approved shop drawings to supervise installation of the frame supported membrane structure on site. The authorized representative is responsible for providing quality control inspections, including all connections. When the installation of the structure is complete, provide a final completion certification signed by a representative of the Manufacturer, a representative of the Installer, and onsite Authorized Representative of the manufacturer performing field quality control.

3.7 EXTRA MATERIALS

Provide a patch kit with color matched fabric membrane and associated repair materials and tools. Supply approximately 4.2 square meters 45 square feet of fabric for each frame supported membrane structure.

3.8 OPERATION AND MAINTENANCE DATA

Provide routine inspection, maintenance, cleaning and repair instructions for the frame supported membrane structure, including intervals. Include detailed instructions for re-tensioning, if required. Include inspection recommendations for assessing signs of fabric degradation, fabric connection issues, tightness of x-bracing or other lateral force resisting system, and any additional manufacturer items deemed critical to the performance of the structure.

Submit Frame Supported Membrane Structure O&M in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-13 34 19 (August 2020)**
Change 1 - 02/21

Preparing Activity: NAVFAC **Superseding**
UFGS-13 34 19 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-13 34 19 (August 2020)**
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SECTION 13 34 19

METAL BUILDING SYSTEMS
08/20, CHG 1: 02/21

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NOTE: This guide specification covers the requirements for fabricated, pre-engineered metal structures. This specification is not intended to be used for gas station or petroleum/oil/lubricants (POL) facility canopies.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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NOTE: All references, including dates, should be verified that they comply with the requirements of UFC 1-200-01.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual
AA ASD1	(2024) Aluminum Standards and Data

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 341	(2016) Seismic Provisions for Structural Steel Buildings
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121	(2007) Standard Definitions for Use in the Design of Steel Structures
AISI D100	(2017) Cold-Formed Steel Design Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings

	Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A529/A529M	(2019) Standard Specification for

	High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A606/A606M	(2023) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A755/A755M	(2018; R 2024) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum

	and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C273/C273M	(2020) Standard Test Method for Shear Properties of Sandwich Core Materials
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C665	(2024) Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C991	(2023) Flexible Glass Fiber Insulation for Metal Buildings
ASTM C1289	(2023a) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C1363	(2024) Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints

ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622/D1622M	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D5359	(1998; R 2021) Standard Specification for Glass Cullet Recovered from Waste for Use in Manufacture of Glass Fiber
ASTM D6226	(2021) Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM DEFONLINE	(2008) ASTM Online Dictionary of Engineering Science and Technology
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building

	Materials
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E1646	(1995; R 2024) Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Air Pressure Difference
ASTM E1680	(2016) Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems
ASTM F436/F436M	(2024) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F1852	(2014) Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch

	Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA MBSM	(2018) Metal Building Systems Manual

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA RoofMan	(2020) The NRCA Roofing Manual

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 15	(1999; E 2004) Steel Joist Shop Primer/Metal Building Primer
SSPC Painting Manual	(2002) Good Painting Practice, Steel Structures Painting Manual, Volume 1
SSPC SP 2	(2024) Hand Tool Cleaning

STEEL WINDOW INSTITUTE (SWI)

SWI AGSW	(2002) Architect's Guide to Steel Windows

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military Assets
UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

UL SOLUTIONS (UL)

UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 GENERAL REQUIREMENTS

1.2.1 Design Parameters

Design and construct pre-engineered metal buildings of size, shape, height, fenestration, siting, and configuration indicated. Coordinate site utility services, accessibility requirements, vehicular and pedestrian access, mechanical, electrical, plumbing and fire protection requirements, interior construction and finishes, and such other items as may be necessary for a complete, functional building.

1.2.2 Structural Performance

Provide metal building systems capable of withstanding the effects of gravity loads and the following loads and stresses within the limits and conditions indicated.

1.2.2.1 Engineering

Design metal building systems conforming to procedures described in MBMA MBSM.

1.2.2.2 Design Loads

Design and construct to the requirements of UFC 3-301-01, Structural Engineering.

[1.2.3 Anti-terrorism Requirements

****

NOTE: Confirm occupancy classification and occupancy load and refer to UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings to determine if antiterrorism standards will apply. If they apply include this section.

****

Design metal building systems to comply with the requirements of UFC 4-010-01.

]1.2.4 Thermal Performance

Provide insulated metal panel assemblies with the following maximum U-factors when assemblies are tested or calculated according to ASHRAE 90.1 - SI ASHRAE 90.1 - IP Appendix A, and minimum R-values for opaque elements when tested according to ASTM C1363 or ASTM C518.

1.2.4.1 Metal Roof Panel Assemblies

****

NOTE: Insert the required U factors and R values.

****

a. U-Factor: [_____]

b. R-Value: [_____]

1.2.4.2 Metal Wall Panel Assemblies

a. U-Factor: [_____]

b. R-Value: [_____]

1.2.5 Air Infiltration for Metal Roof Panels

****

NOTE: Select or insert infiltration volume and negative pressure. The default values stated are based on the requirements of ASHRAE 90.1 for assemblies; this represents the maximum leakage rate allowed on DoD projects. These leakage requirements are for lab testing of the roof panel assemblies only; leakage rate requirements for field testing of the whole building's air barrier would be stated in 07 27 10 BUILDING AIR BARRIER SYSTEM with procedures for this testing outlined in Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING - include these additional sections for air barrier system field testing when required by UFC 3-101-01.

****

Air leakage through assembly must not exceed [0.2 L/s per sq. m] [_____] [0.04 cfm/sq.ft.] [_____] of roof area when lab tested according to ASTM E1680 at negative test-pressure difference of [75 Pa] [_____] [1.57 lb/sq.ft.] [_____].

1.2.6 Air Infiltration for Metal Wall Panels

****

NOTE: Select or insert infiltration volume and negative pressure. The default values stated are based on the requirements of ASHRAE 90.1 for assemblies; this represents the maximum leakage rate allowed on DoD projects. These leakage requirements are for lab testing of the wall panel assemblies only; leakage rate requirements for field testing of the whole building's air barrier would be stated in 07 27 10 BUILDING AIR BARRIER SYSTEM with procedures for this testing outlined in Section 01 91 19

BUILDING ENCLOSURE COMMISSIONING - include these additional sections for air barrier system field testing when required by UFC 3-101-01.

****

Air leakage through assembly of not more than [0.2 L/s per sq. m] [_____] [0.04 cfm/sq.ft.] [_____] of wall area when labtested according to ASTM E283 at static-air-pressure difference of [75 Pa] [_____] [1.57 lbf/sq.ft.] [_____].

1.2.7 Water Penetration for Metal Roof Panels

No water penetration when tested according to ASTM E1646 at test-pressure difference of [137 Pa] [_____] [2.86 lbf/sq.ft.] [_____].

1.2.8 Water Penetration for Metal Wall Panels

No water penetration when tested according to ASTM E331 at a minimum differential pressure of [20] [_____] percent of inward-acting, wind-load design pressure of not less than [300 Pa] [_____] [6.24 lbf/sq.ft.] [_____] and not more than 575 Pa 12 lbf/sq. ft.

1.2.9 Specular Gloss

****

NOTE: Specify the first bracketed option for most roof conditions.

For roofs of structures along airfields where glare would be objectionable and may be an operational hazard, the specular gloss value should be limited to 10 or less at an angle of 85 degrees. Limited paint systems can meet this reflectance value. Panel embossing also reduces the gloss, or reflectance value, and may be specified in combination with the paint system specification to meet the necessary requirement.

****

Finished roof surfaces to have a specular gloss value of [30 plus or minus 5 at an angle of 60 degrees] [10 or less at an angle of 85 degrees] when measured in accordance with ASTM D523.

1.2.10 Wind-Uplift Resistance

Design for wind-uplift resistance in accordance with UFC 3-301-01.

1.2.11 Erection Plan

Provide plans and a written erection/lifting procedure with required plans clearly showing the intended sequence and method of erection in accordance with EM 385-1-1 "Safety - Safety and Health Requirements". Indicate required crane lifting requirements, temporary support structures, member size and locations of braced or guyed temporary supports, and locations of bracing or guys anchor points. Clearly define the required framing sequence and conditions necessary to ensure the structure is maintained in a properly braced and stable condition throughout the complete erection process.

1.3 DEFINITIONS

a. Bay: Dimension between main frames measured normal to frame (at centerline of frame) for interior bays, and dimension from centerline of first interior main frame measured normal to end wall (outside face of end-wall girt) for end bays.

b. Clear Span: Distance between supports of beams, girders, or trusses (measured from lowest level of connecting area of a column and a rafter frame or knee).

c. Eave Height: Vertical dimension from finished floor to eave (the line along the sidewall formed by intersection of the planes of the roof and wall).

d. Terminology Standard: Refer to MBMA "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 SYSTEM DESCRIPTION

General: Provide a complete, integrated set of[metal building system manufacturer's standard] mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing,[metal roof panels,][metal wall panels,] and accessories complying with requirements indicated.

Provide metal building system of size and with spacing, slopes, and spans indicated.

1.4.1 Primary Frame Type

****

NOTE: Select the appropriate primary frame type from the following.

****

[a. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

][b. Rigid Modular: Solid-member, structural-framing system with interior columns.

][c. Truss-Frame Clear Span: Truss-member, structural-framing system without interior columns.

][d. Truss-Frame Modular: Truss-member, structural-framing system with interior columns.

][e. Long Bay: Solid- or truss-member, structural-framing system without interior columns.

][f. Lean To: Solid- or truss-member, structural-framing system without interior columns, designed to be partially supported by another structure.

][1.4.2 Fixed End-Wall Framing

****

NOTE: Select desired end wall type from the next two paragraphs and delete the other.

****

Provide manufacturer's standard fixed end wall, for buildings not required to be expandable, consisting of[primary frame, capable of supporting one-half of a bay design load, and end-wall columns][load-bearing end-wall with corner columns, and rafters].

][1.4.3 Expandable End-Wall Framing

Provide engineered end walls to be expandable. Provide primary frame, capable of supporting full-bay design loads, and end-wall columns.

]1.4.4 Secondary Frame Type

Provide manufacturer's standard purlins and joists and [flush-framed] [partially inset-framed] [exterior-framed (bypass)] girts.

1.4.5 Eave Height

Eave height must be [4.9 m] [6.1 m] [7.3 m] [8.5 m] [_____] [16 feet] [20 feet] [24 feet] [28 feet] [_____] [Manufacturer's standard height, as indicated by nominal height on Drawings].

1.4.6 Bay Spacing

Bay Spacing must be [6.1 m] [7.6 m] [9.1 m] [_____] [20 feet] [25 feet] [30 feet] [_____] [As determined by manufacturer].

1.4.7 Roof Slope

Roof slope must be [1:24] [1:12] [1:3] [_____] [1/2 inch per 12 inches] [1 inch per 12 inches] [4 inches per 12 inches] [_____] [manufacturer's standard for frame type required].

1.4.8 Roof System

Provide manufacturer's standard[vertical-rib, standing-seam][trapezoidal-rib standing-seam][lap-seam] metal roof panels[with insulation].

1.4.9 Exterior Wall System

****

NOTE: Coordinate this Section with information shown on the drawings.

****

Provide[field-assembled, insulated][field-assembled, un-insulated][factory-assembled, insulated] metal wall panels[complete with vapor barrier conforming to ASTM E96/E96M][or, where required, an exterior wall system complying with UFC 4-010-01 and these specifications for the project location and site characteristics].

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Erection Plan; G, [_____]

SD-03 Product Data

Manufacturer's Catalog Data; G, [_____]

Recycled Content for Structural Steel Shapes and Plates; S

Recycled Content for Steel Pipe; S

Recycled Content for Aluminum Sheet Materials; S

Recycled Content for Steel Sheet Materials; S

Recycled Content for Insulation Materials; S

SD-04 Samples

Coil Stock, 304.8 mm 12 inches long by the actual panel width; G, [_____]

Roof Panels, 304.8 mm 12 inches long by actual panel width; G, [_____]

Wall Panels, 304.8 mm 12 inches long by actual panel width; G, [_____]

Fasteners; G, [_____]

Metal Closure Strips 250 mm 10 inches long of each type; G, [_____]

Insulation, approximately 200 by 280 mm 8 by 11 inches; G, [_____]

Vapor Barrier; G, [_____]

Manufacturer's Color Charts and Chips, 101.6 mm by 101.6 mm 4 by 4 inches; G, [_____]

SD-05 Design Data

Manufacturer's Descriptive and Technical Literature; G, [_____]

Manufacturer's Building Design Analysis; G, [_____]

Lateral Force Calculations; G, [_____]

SD-06 Test Reports

Test Reports; G, [_____]

Coatings and Base Metals; G, [_____]

Factory Color Finish Performance Requirements; G, [_____]

SD-07 Certificates

System Components; G, [_____]

Coil Stock Certificates; G, [_____]

Aluminized Steel Repair Paint; G, [_____]

Galvanizing Repair Paint; G, [_____]

Enamel Repair Paint; G, [_____]

Qualification of Manufacturer; G, [_____]

Qualification of Erector; G, [_____]

SD-08 Manufacturer's Instructions

Installation of Roof and Wall panels; G, [_____]

Shipping, Handling, and Storage; G, [_____]

SD-11 Closeout Submittals

Manufacturer's Warranty; G, [_____]

Contractor's Warranty for Installation; G, [_____]

1.6 QUALITY ASSURANCE

1.6.1 Pre-Erection Conference

After submittals are received and approved but before metal building system work, including associated work, is performed, the Contracting Officer will hold a pre-erection conference to review the following:

a. The detail drawings, specifications, and manufacturer's descriptive and technical literature.

b. Finalize construction schedule and verify availability of materials, erector's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to metal building system erection, including, but not limited to: qualification of manufacturer, qualification of erector, manufacturer's catalog data, manufacturer's building design analysis,lateral force calculations, written instructions and test reports. Lateral force calculations must include all analysis and confirmation of system components required to transfer lateral forces to the foundation.

d. Support conditions for compliance with requirements, including alignment between and erection of structural members.

e. Flashing, special roofing and siding details, roof and wall penetrations, openings, and condition of other construction that will affect the metal building system, including coatings and base metals, factory color finish performance requirements, system components, and coil stock certificates.

f. Governing regulations and requirements for, certificates, insurance, tests and inspections if applicable.

g. Temporary protection requirements for metal panel assembly during and after installation.

h. Samples of roof panels, wall panels, aluminized steel repair paint, galvanizing repair paint, and enamel repair paint.

1.6.1.1 Pre-Roofing and Siding Installation Conference

After structural framing system erection and approval but before roofing, siding[, insulation and vapor barrier] work, including associated work, is performed; the Contracting Officer will hold a pre-roofing and siding conference to review the following:

a. Examine purlins, sub-girts and formed shapes conditions for compliance with requirements, including flatness and attachment to structural members.

b. Review structural limitations of purlins, sub-girts and formed shapes during construction and after roofing and siding.

c. Review flashings, special roof and wall details, roof drainage, roof and wall penetrations, roof equipment curbs, and condition of other construction that will affect the metal building system.

d. Review temporary protection requirements for metal roof and wall panels' assembly during and after installation.

e. Review roof and wall observation and repair procedures after metal building system erection.

1.6.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products, erection of structural framing and installation of roof and wall panels in the geographical area where construction will take place.

1.6.3 Manufacturer's Qualifications

Metal building system manufacturer must have a minimum of five years experience as a qualified manufacturer and a member of MBMA of metal building systems and accessory products.

Provide engineering services by an authorized currently licensed engineer in the geographical area where construction will take place, having a minimum of four years experience as an engineer knowledgeable in building design analysis, protocols and procedures for the "Metal Building Systems Manual" (MBMA MBSM); ASCE 7-16,[the building code in the geographic area where the construction will take place] and ASTM E1592. Provide certified engineering calculations using the products submitted for:

a. Roof and Wall Wind Loads with basic wind speed, exposure category, co-efficient, importance factor, designate type of facility, negative pressures for each zone, methods and requirements of attachment.

b. Roof Dead and Live Loads

c. Collateral Loads

d. Foundation Loads

e. Roof Snow Load

f. Seismic Loads

1.6.4 Qualification of Erection Contractor

An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and must be approved and certified by the metal building system manufacturer.

1.6.5 Single Source

Obtain primary and secondary components and structural framing members, each type of metal roof, wall and liner panel assemblies, clips, closures and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.6.6 Welding

Qualify procedures and personnel according to AWS A5.1/A5.1M, AWS D1.1/D1.1M, and AWS D1.3/D1.3M.

1.6.7 Structural Steel

Comply with AISC 325,[AISC 341 for seismic impacted designs,] AISC 360, for design requirements and allowable stresses.

1.6.8 Cold-Formed Steel

Comply with AISC/AISI 121 and AISI D100 for design requirements and allowable stresses.

1.6.9 Fire-Resistance Ratings

Where indicated, provide metal panels identical to those of assemblies tested for fire resistance in accordance with ASTM E119, as certified by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Indicate design designations from UL Bld Mat Dir or from the listings of another qualified testing agency. Combustion Characteristics must conform to ASTM E136.

1.6.10 Surface-Burning Characteristics

Provide metal panels having[field-insulation][insulation core][insulation and vapor barrier] material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency showing:

a. Flame-Spread Index: [25] [_____] or less.

b. Smoke-Developed Index: [450] [_____] or less.

1.6.11 Fabrication

Fabricate and finish metal panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles with dimensional and structural requirements. Provide metal panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel. Aluminum and aluminum-alloy sheet and plate must conform to ASTM B209. Fabricate metal panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within panel assembly.

Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA or by metal building system manufacturer for application, but not less than thickness of metal being secured.

1.6.12   Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.7   SHIPPING, HANDLING AND STORAGE

1.7.1   Delivery

Package and deliver components, sheets, metal panels, and other manufactured items so as not to be damaged or deformed and protected during transportation and handling.

1.7.2   Storage

Stack and store metal panels horizontally on platforms or pallets, covered with suitable weather-tight and ventilated covering to ensure dryness, with positive slope for drainage of water. Store in a manner to prevent bending, warping, twisting, and surface damage. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage. Retain strippable protective covering on metal panel for entire period up to metal panel installation.

1.7.3   Protection of Materials

Protect foam-plastic insulation as follows:

a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.

b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to project site before installation time.

Complete installation and concealment of plastic materials as rapidly as possible in each area of construction to minimize ultraviolet exposure.

1.8 PROJECT CONDITIONS

1.8.1 Weather Limitations

Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into existing panel system or building.

1.8.2 Field Measurements

1.8.2.1 Established Dimensions for Foundations

Comply with established dimensions on approved anchor-bolt plans, established foundation dimensions, and proceed with fabricating structural framing. Do not proceed without verifying field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.

1.8.2.2 Established Dimensions for Metal Panels

Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements, or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.8.2.3 Verification Record

Verify locations of all framing and opening dimensions by field measurements before metal panel fabrication and indicate measurements on Shop Drawings.

1.9 COORDINATION

Coordinate final design and placement of foundation between structural engineer of record, geotechnical engineer, MBMA and Contractor. Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in section on CAST-IN-PLACE CONCRETE.

Coordinate installation of [fire suppression system] [equipment supports] [piping and supports][and][accessories], which are specified in Division 21 - FIRE SUPPRESSION.

Coordinate installation of [plumbing system] [equipment supports] [piping and supports] [and] [accessories], which are specified in Division 22 - PLUMBING.

Coordinate installation of [HVAC system] [equipment supports] [ductwork and supports] [piping and supports][and][accessories], which are specified in Division 23 - HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

Coordinate installation of [roof curbs] [equipment supports][and][roof penetrations], which are specified in Division 07 - THERMAL AND MOISTURE PROTECTION.

Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak-proof, secure, and non-corrosive installation.

1.10 WARRANTY

1.10.1 Building System Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal building system. The warranty period is to be no less than [5] [10] [15] [20] years from the date of acceptance of the work and be issued directly to the Government. The warranty must provide that if within the warranty period, the metal building system shows evidence of deterioration resulting from defective materials or workmanship, correcting of any defects is the responsibility of the metal building system manufacturer. Repairs that become necessary because of defective materials and workmanship while metal building system is under warranty are to be performed within [32] [_____] hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within [32] [_____] hours of notification will constitute grounds for having emergency repairs performed by others and will not void the warranty.

1.10.2 Roof System Weather-Tightness Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than [10] [20] [_____] years from the date of acceptance of the work and be issued directly to the Government.

The warranty is to provide that if within the warranty period the roof panel system shows evidence of corrosion, perforation, rupture, lost of weather-tightness or excess weathering due to deterioration of the panel system resulting from defective materials and correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.

Repairs that become necessary because of defective materials and workmanship while roof panel system is under warranty are to be performed within [24] [_____] hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform [temporary] repairs within [24] [_____] hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty. Immediate follow-up and completion of permanent repairs must be performed within [_____] days from date of notification.

1.10.3 Roof and Wall Panel Finish Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than [10] [20] [_____] years from the date of acceptance of the work and be issued directly to the Government.

The warranty is to provide that if within the warranty period the metal panel system shows evidence of checking, delaminating cracking, peeling, chalk in excess of a numerical rating of eight, as determined by ASTM D4214 test procedures; or change colors in excess of five CIE or Hunter units in accordance with ASTM D2244 or excess weathering due to deterioration of the panel system resulting from defective materials and finish or correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.

Liability under this warranty is exclusively limited to replacing the defective coated materials.

Repairs that become necessary because of defective materials and workmanship while roof and wall panel system is under warranty are to be performed within [32] [_____] hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within [32] [_____] hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty.

PART 2 PRODUCTS

2.1 STRUCTURAL FRAMING MATERIALS

****

NOTE: ASTM A992/A992M covers W shapes (rolled wide flange shapes) intended for use in building framing. ASTM A36 covers S, M, and HP shapes, channels, angles, and plates. ASTM A572/A572M and ASTM A529/A529M cover high strength steels.

Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Where minimums are stated, research shows the product is available among US national steel manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets and delete the first set of brackets. AISC 2017 white paper "More than Recycled Content: The Sustainable Characteristics of Structural Steel" indicates that the industry average recycled content is 93 percent.

****

2.1.1 Steel Shapes and Plates

Wide flange and WT shapes: ASTM A992/A992M; ASTM A572/A572M or ASTM A529/A529M. Angles, Channels and Plates: ASTM A36/A36M, ASTM A572/A572M or ASTM A529/A529M. Provide structural steel shapes and plates containing a minimum of [80] [_____] percent recycled content. Submit data identifying percentage of recycled content for structural steel shapes and plates.

2.1.2 Steel Pipe

ASTM A36/A36M, ASTM A53/A53M, ASTM A572/A572M or ASTM A529/A529M. Provide steel pipe containing a minimum of [50] [_____] percent recycled content. Submit data identifying percentage of recycled content for steel pipe.

2.1.3 Cold-Formed and Hot Formed Hollow Structural Sections

Cold formed: ASTM A500/A500M or ASTM B221, ASTM B221M. Hot-formed: ASTM A501/A501M.

2.1.4 Structural-Steel Sheet

Hot-rolled, ASTM A1011/A1011M or cold-rolled, ASTM A1008/A1008M.

2.1.5 Metallic-Coated Steel Sheet

ASTM A653/A653M, ASTM A606/A606M.

2.1.6 Metallic-Coated Steel Sheet Pre-painted with Coil Stock Coating

Steel sheet metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A755/A755M.

[a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, and ASTM A123/A123M.

][b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, and ASTM A463/A463M.

]2.1.7 Joist Girders

Refer to Section 05 21 00 STEEL JOIST FRAMING

2.1.8 Steel Joists

Refer to the following sections subject to project design requirements:

Section 05 21 00 STEEL JOIST FRAMING

2.1.9 High-Strength Bolts, Nuts, and Washers

ASTM F3125/F3125M, heavy hex steel structural bolts; ASTM A563M ASTM A563 heavy hex carbon-steel nuts; and ASTM F436/F436M hardened carbon-steel washers.

Finish: [Plain] [Hot-dip zinc coating, ASTM A153/A153M] [Mechanically deposited zinc coating, ASTM B695].

Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F1852, heavy-hex-head steel structural bolts with spline.

Finish: [Plain] [Mechanically deposited zinc coating, ASTM B695] [Mechanically deposited zinc coating, ASTM B695 baked epoxy coated].

2.1.10 Non-High-Strength Bolts, Nuts, and Washers

ASTM A307, ASTM A563M ASTM A563, and ASTM F844.

Finish: [Plain][ASTM A153/A153M][ASTM B695].

2.1.11 Anchor Rods

[ASTM F1554] [ASTM A572/A572M] [ASTM A36/A36M] [ASTM A307].

a. Configuration: Straight.

b. Nuts: ASTM A563M ASTM A563 [heavy] hex carbon steel.

c. Plate Washers: ASTM A36/A36M carbon steel.

d. Washers: ASTM F436/F436M hardened carbon steel.

e. Finish: [Plain] [Hot-dip zinc coating, ASTM A153/A153M] [Mechanically deposited zinc coating, ASTM B695].

2.1.12 Threaded Rods

[ASTM A193/A193M] [ASTM A572/A572M] [ASTM A36/A36M] [ASTM A307].

a. Nuts: ASTM A563MASTM A563 [heavy] hex carbon steel.

b. Washers: [ASTM F436/F436M hardened] [ASTM A36/A36M] carbon steel.

c. Finish: [Plain] [Hot-dip zinc coating, ASTM A153/A153M] [Mechanically deposited zinc coating, ASTM B695].

2.1.13 Primer

SSPC-Paint 15, Type I, red oxide.

2.2 FABRICATION

2.2.1 General

Comply with MBMA MBSM - "Metal Building Systems Manual": Chapter IV, Section 9, "Fabrication and Erection Tolerances."

2.3 STRUCTURAL FRAMING

2.3.1 General

Clean all framing members to remove loose rust and mill scale. Provide 1 shop coat of primer to an average dry film thickness of 1 mil according to SSPC SP 2. Balance of painting and coating procedures must conform to SSPC Paint 15 and SSPC Painting Manual.

2.3.2 Primary Framing

Manufacturer's standard structural primary framing system includes transverse and lean-to frames; rafter, rakes, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing designed to withstand required loads and specified requirements. Provide frames with attachment plates, bearing plates, and splice members. Provide frame span and spacing indicated.

Shop fabricate framing components by welding or by using high-strength bolts to the indicated size and section with base-plates, bearing plates, stiffeners, and other items required. Cut, form, punch, drill, and weld framing for bolted field erection.

[a. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.

][b. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from [steel round pipe] [steel tube] [shop-welded, built-up steel plates.]

] c. Frame Configuration: [Single gable] [One-directional sloped] [Lean to, with high side connected to, and supported by, another structure] [Multiple gables] [Load-bearing-wall type] [Multistory].

d. Exterior Column Type: [Uniform depth] [Tapered].

e. Rafter Type: [Uniform depth] [Tapered].

2.3.3 Secondary Framing

Manufacturer's standard secondary framing members, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet pre-painted with coil coating, unless otherwise indicated.

Shop fabricate framing components by roll-forming or break-forming to the indicated size and section with base-plates, bearing plates, stiffeners, and other plates required for erection. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

a. Purlins: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; minimum depth [as indicated] [as required to comply with system performance requirements] [_____].

b. Girts: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees to flange minimum depth[as indicated][as required to comply with system performance requirements] [_____].

c. Eave Struts: Unequal-flange, C-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; to provide adequate backup for metal panels.

d. Flange Bracing: Structural-steel angles or cold-formed structural tubing to stiffen primary frame flanges.

e. Sag Bracing: Structural-steel angles.

f. Base or Sill Angles: Zinc-coated (galvanized) steel sheet.

g. Purlin and Girt Clips: Steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.

h. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from [zinc-coated (galvanized) steel sheet] [structural-steel sheet].

i. Framing for Openings: Channel shapes; fabricated cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings, and head, jamb, and sill of other openings.

j. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

2.3.4 Bracing

Provide adjustable wind bracing as follows:

a. Rods: ASTM A36/A36M; ASTM A572/A572M; or ASTM A529/A529M [threaded full length] [threaded a minimum of [_____]] at each end.

b. Cable: ASTM A475, [_____] diameter, extra-high-strength grade, zinc-coated, [_____]-strand steel; with threaded end anchors.

c. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.

d. Rigid Portal Frames: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

e. Fixed-Base Columns: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

f. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

g. Bracing: Provide wind bracing using any method specified above, at manufacturer's option.

2.4 PANEL MATERIALS

2.4.1 Aluminum Sheet

Roll-form aluminum [roof] [wall] [liner] panels to the specified profile, with fy = [30] [40] [50] [80] ksi [.032] [.040] [.050] inch thickness and depth as indicated. Aluminum sheets must contain a minimum recycled content of 20 percent. Provide data identifying percentage of recycled content for aluminum sheet materials. Material must be plumb and true, and within the tolerances listed:

a. Aluminum Sheet conforming to ASTM B209M ASTM B209, AA ADM and AA ASD1.

b. Individual panels to have continuous length to cover the entire length of any [roof slope] [wall area] with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

c. Provide panels with thermal expansion and contraction consistent with the type of system specified.

****

NOTE: Select the desired profile from below and delete remaining items.

****

(1) . Profile and coverage to be a minimum height and width from manufacturer's standard for the indicated [roof slope] [wall area].

[(2) . Profile to be a 38 mm 1-1/2 inch high rib at 304.8 mm 12 inches o.c. with small stiffening ribs, 965.2 mm 38 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][(3) . Profile to be a 38 mm 1-1/2 inch high rib at 182.9 mm 7.2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][(4) . Profile to be a 25.4 mm 1 inch high rib at 101.6 mm 4 inches o.c., 1260.5 mm 49-5/8 inch overall width with [1219.2] [1117.6] mm [48] [44] inch coverage and exposed fasteners.

][(5) . Profile to be a 25.4 mm 1 inch high rib at 203.2 mm 8 inches o.c., 1057.3 mm 41-5/8 inch overall width with 1016 mm 40 inch coverage and exposed fasteners.

][(6) . Profile to be a 44.5 mm 1-3/4 inch high V-beam rib at 127 mm 5 inches o.c., 1139.9 mm 44-7/8 inch overall width with 1066.8 mm 42 inch coverage and exposed fasteners.

][(7) . Profile to be a 22.2 mm 7/8 inch high corrugated rib at 50 mm 2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][(8) . Profile to be a 76 mm 3 inch high standing seam, 609.6 mm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) . Profile to be a [25.4] [44.5] [50.8] [63.5] mm [1] [1-3/4] [2] [2-1/2] inch high standing seam, [304.8] [406.4] [457.2] mm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(10) . [Smooth, flat] [Embossed] Surface Texture.

][(11) . Custom profile to be [_____][as shown on drawings].

]2.4.2 Steel Sheet

Roll-form steel [roof] [wall] [liner] panels to the specified profile, with fy = [30] [40] [50] [80] ksi [26] [24] [22] [20] [18] gauge and depth as indicated. Steel sheets must contain a minimum recycled content of 25 percent. Provide data identifying percentage of recycled content for steel sheet materials. Material must be plumb and true, and within the tolerances listed:

****

NOTE: Select subparagraph "a" below for projects with Environmental Severity Classification (ESC) C1

through C3 and subparagraph "b" below for ESC C4 and C5. See UFC 1-200-01 for determination of ESC for project locations.
****

[a. Galvanized Steel Sheet conforming to ASTM A653/A653M and AISI D100.

][b. Aluminum-Zinc Alloy-coated Steel Sheet conforming to ASTM A792/A792M and AISI D100.

] c. Individual panels to have continuous length to cover the entire length of any unbroken [roof slope] [wall area] with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

d. Provide panels with thermal expansion and contraction consistent with the type of system specified;

[profile and coverage to be a minimum height and width from manufacturer's standard for the indicated [roof slope] [wall area].

][profile to be a 38 mm 1-1/2 inch high rib at 304.8 mm 12 inches o.c. with small stiffening ribs, 965.2 mm 38 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][profile to be a 38 mm 1-1/2 inch high rib at 182.9 mm 7.2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][profile to be a 25.4 mm 1 inch high rib at 101.6 mm 4 inches o.c., 1260.5 mm 49-5/8 inch overall width with [1219.2] [1117.6] mm [48] [44] inch coverage and exposed fasteners.

][profile to be a 25.4 mm 1 inch high rib at 203.2 mm 8 inches o.c., 1057.3 mm 41-5/8 inch overall width with 1016 mm 40 inch coverage and exposed fasteners.

][profile to be a 22.2 mm 7/8 inch high corrugated rib at 50 mm 2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][profile to be a 76 mm 3 inch high standing seam, 609.6 mm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][profile to be a [25.4] [44.5] [50.8] [63.5] mm [1] [1-3/4] [2] [2-1/2] inch high standing seam, [304.8] [406.4] [457.2] mm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][[Smooth, flat] [Embossed] Surface Texture.

][profile to be custom as shown on drawings.

]2.4.3 Foam-Insulation Core Wall Panel

Provide factory-formed [aluminum] [steel] [roof] [wall] panel assembly fabricated from two sheets of metal with modified polyisocyanurate or polyurethane foam insulation core [foamed-in-place] [board] during fabrication with joints between panels designed to form weather-tight seals. Include accessories required for weather-tight installation.

a. Closed-Cell Content: 90 percent when tested according to ASTM D6226, ASTM C1289.

b. Density: 32 to 42 kg/cu. m 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622/D1622M.

c. Compressive Strength: Minimum 140 kPa 20 psi when tested according to ASTM D1621.

d. Shear Strength: 179 kPa 26 psi when tested according to ASTM C273/C273M.

2.4.4 Insulated Panel Construction

Shop fabricate or field assemble insulated panel construction with specified exterior and interior [aluminum] [steel] sheet in accordance with manufacturer's printed instructions.

Insulation to be [glass-fiber-ASTM C991] [slag-wool-fiber] [rock-wool-fiber] conforming to ASTM C553 and ASTM C612 of thickness and density as required for the geographical area where construction will take place.

Insulation fasteners to be adhesively attached, plate welded to projecting spindle anchors; capable of holding insulation of thickness indicated, secured in position with self-locking washer and complying with the following requirements:

a. Plate: Perforated galvanized carbon-steel sheet, 0.762 mm 0.030 inch thick by 50 mm 2 inches square.

b. Spindle: Copper-coated, low carbon steel; fully annealed; 2.67 mm 0.105 inch in diameter; length to suit depth of insulation indicated.

c. Insulation-Retaining Washers: Self-locking washers formed from 0.41-mm- 0.016-inch- thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 38 mm 1-1/2 inches square or in diameter.

d. Anchor adhesive to be a product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

2.4.5 Finish

All panels are to receive a factory-applied polyvinylidene fluoride of Kynar 500/Hylar 5000 finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. This prime coat must be oven cured prior to application of finish coat.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll coating to dry film thickness of 0.80 plus 0.05 mils for a total dry film thickness of 1.00 plus 0.10 mils. This finish coat must be oven-cured.

d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll coating to a dry film thickness of 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. The wash-coat must be oven-cured.

e. Color: The exterior finish chosen from the manufacturer's color charts and chips.

f. Physical Properties: Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

    (1) Chalking: ASTM DEFONLINE
    (2) Color Change and Conformity: ASTM D2244
    (3) Weatherometer: ASTM G152, ASTM G153 and ASTM D822
    (4) Humidity: ASTM D2247 and ASTM D714
    (5) Salt Spray: ASTM B117
    (6) Chemical Pollution: ASTM D1308
    (7) Gloss at 60 degrees: ASTM D523
    (8) Pencil Hardness: ASTM D3363
    (9) Reverse Impact: ASTM D2794
    (10) Flexibility: ASTM D522/D522M
    (11) Abrasion: ASTM D968
    (12) Flame Spread: ASTM E84

2.4.6 Repair Of Finish Protection

Repair paint for enameled metal panel must be compatible paint of the same formula and color as the specified finish furnished by the metal panel manufacturer, conforming to ASTM A780/A780M.

2.5 MISCELLANEOUS METAL FRAMING

2.5.1 General

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M and specified in Section 05 40 00 COLD-FORMED METAL FRAMING unless otherwise indicated.

2.5.2 Fasteners for Miscellaneous Metal Framing

Refer to the following paragraph FASTENERS.

2.6 FASTENERS

2.6.1 General

Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 25.4 mm 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the metal panel manufacturer's and ASCE 7-16

requirements.

2.6.2 Exposed Fasteners

Fasteners for metal panels to be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads. Fasteners for accessories to be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately .09 mm 3/32 inch thick.

2.6.3 Screws

Screws to be corrosion resistant coated steel, aluminum or stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

2.6.4 Rivets

Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

2.6.5 Attachment Clips

Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A653/A653M or Series 300 stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.7 FRAMES AND MATERIALS FOR OPENINGS

2.7.1 Doors

Fire-Rated and Non-Fire-Rated Door Assemblies conforming with NFPA 80 and based on testing according to NFPA 252 as specified in Division 08 - OPENINGS unless otherwise indicated.

2.7.2 Windows

[Aluminum][Steel]Window Assemblies conforming to [AAMA/WDMA/CSA 101/I.S.2/A440] [SWI AGSW] as specified in Division 08 - OPENINGS unless otherwise indicated.

2.8 ACCESSORIES

2.8.1 General

All accessories to be compatible with the metal panels; sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the metal panels. Exposed metal accessories/finishes to match the panels, except as otherwise indicated. Molded foam rib, ridge and other closure strips to be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

2.8.2 Roof and Wall Accessories and Specialties

[Aluminum][Galvanized Steel] roof curbs, equipment supports, roof hatches, dropout-type heat and smoke vents, hatch-type heat and smoke vents, gravity and roof ridge ventilators, wall louvers and other miscellaneous roof and wall equipment or penetrations conforming to AAMA, ASTM, and UL as specified in Division 07 unless otherwise indicated.

2.8.3 Insulation

Faced, Glass-Fiber Blanket Insulation: ASTM C665, Type [I, blankets without membrane coverings][and][II, blankets with non-reflecting coverings][and][III, blankets with reflective coverings]; Class [A, membrane-faced surface with a flame spread of 25 or less] [B, membrane-faced surface with a flame propagation resistance; critical radiant flux of 0.12 W/m2 0.11 Btu/ft2 or greater], except a flame spread rating of [25] [75] [100] or less [and a smoke developed rating of 150 or less] when tested in accordance with ASTM E84. Provide insulation materials containing the following minimum percentage of recycled content by weight: 20 percent glass cullet complying with ASTM D5359. Provide data identifying percentage of recycled content for insulation materials.

2.8.3.1 Polyethylene Vapor Retarder

Install polyethylene vapor retarder membrane over entire [wall][and roof]surface. Use fully compatible polyethylene tape to seal the edges of the sheets to provide a vapor tight membrane. Lap sheets not less than 150 mm 6 inch. Provide sufficient material to avoid inducing stresses in sheets due to stretching or binding. All tears or punctures visible in the finished surface, at any time during the construction process, must be sealed with polyethylene tape.

2.8.3.2 Wall Liner

Securely fasten wall liner into place in accordance with the manufacturer's recommendation and in a neatly presented appearance.

2.8.4 Rubber Closure Strips

Closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified metal panel and in lengths supplied by the metal panel manufacturer.

2.8.5 Metal Closure Strips

Factory fabricated closure strips to be the same material, thickness, color, finish and profile of the specified [roof] [wall] panel.

2.8.6 2.6.6 Joint Sealants

2.8.6.1 Sealants

Sealants are to be an approved gun type for use in hand or air-pressure caulking guns at temperatures above 4 degrees C 40 degrees F(or frost-free application at temperatures above minus 12 degrees C 10 degrees F with minimum solid content of 85 percent of the total volume. Sealant is to dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the metal panel manufacturer.

2.8.6.2 Shop-Applied

Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

2.8.6.3 Field-Applied

****

NOTE: Where Section 07 92 00 JOINT SEALANTS is included in the specifications, select the first bracketed option; if this section not included, select second option.

****

[See Section 07 92 00 JOINT SEALANTS for sealant requirements.] [Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C920, Type II. Color to match panel colors.]

2.8.6.4 Tape Sealant

Pressure sensitive, 100 percent solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the metal panel manufacturer.

2.9 SHEET METAL FLASHING AND TRIM

2.9.1 Fabrication

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.10 FINISHES

2.10.1 General

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

2.10.2 Appearance of Finished Work

Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

Before erection proceeds, examine with the erector present, the concrete foundation dimensions, concrete and masonry bearing surfaces, anchor bolt size and placement, survey slab elevation, locations of bearing plates, and other embedments to receive structural framing with the metal building manufacturer's templates and drawings before erecting any steel components for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

Examine primary and secondary framing to verify that rafters, purlins, angles, channels, and other structural and metal panel support members and anchorages have been installed within alignment tolerances required by metal building manufacturer, UL, ASTM, ASCE 7-16 and as required by the building code for the geographical area where construction will take place.

Examine roughing-in for components and systems penetrating metal roof or wall panels to verify actual locations of penetrations relative to seam locations of metal panels before metal roof or wall panel installation.

Submit to the Contracting Officer a written report, endorsed by Erector, listing conditions detrimental to performance of the Work.

Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

Provide temporary shoring, guys, braces, and other supports during erection to keep the structural framing secure, plumb, and in alignment against temporary construction loading or loads equal in intensity of the building design loads. Remove temporary support systems when permanent structural framing, connections, and bracing are in place, unless otherwise indicated.

Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment and performance.

Miscellaneous Framing: Install sub-purlins, girts, angles, furring, and other miscellaneous support members or anchorage for the metal roof or wall panels, doors, windows, roof curbs, ventilators and louvers according to metal building manufacturer's written instructions.

3.3 ERECTION OF STRUCTURAL FRAMING

Erect metal building system according to manufacturer's written erection instructions, approved shop drawings and other erection documents in accordance with MBMA MBSM - "Metal Building Systems Manual".

Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer and the Contracting Officer.

Set structural framing accurately in locations and to elevations indicated and according to AISC 325 specifications. Maintain structural stability of frame during erection.

Clean and roughen concrete and masonry bearing surfaces prior to setting plates. Clean bottom surface of plates.

Align and adjust structural framing before permanent bolt-up and connections. Perform necessary adjustments and alignment to compensate for changes or discrepancies in elevations.

Maintain erection tolerances of structural framing in accordance with AISC 360.

3.4 METAL WALL PANEL INSTALLATION

Provide metal wall panels of full length from sill to eave as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, in accordance with MBMA MBSM.

Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the metal building manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Do not install bent, chipped, or defective sheets.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated eave, and sill.

Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

Field cutting metal wall panels by torch is not permitted.

3.5 ROOF PANEL INSTALLATION

Provide metal roof panels of full length from eave to ridge or eave to wall as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of the Work securely in place in accordance with NRCA RoofMan and MBMA MBSM.

Erect roofing system in accordance with the approved erection drawings, the printed instructions and safety precautions of the metal building manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Do not install bent, chipped, or defective sheets.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated rake and eave overhang.

Work must allow for thermal movement of the roofing, movement of the building structure, and provide permanent freedom from noise due to wind pressure.

Field cutting metal roof panels by torch is not permitted.

Roofing sheets must be laid with corrugations in the direction of the roof slope. End laps of exterior roofing must not be less than 203.2 mm 8 inches; the side laps of standard exterior corrugated sheets must be not less than 2-1/2 corrugations.

Do not permit storage, walking, wheeling, or trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to the installed roofing materials, and to distribute weight to conform to the indicated live load limits of roof construction.

3.6 METAL PANEL FASTENER INSTALLATION

Anchor metal panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

3.7 FLASHING, TRIM AND CLOSURE INSTALLATION

a. Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

b. Sheet metalwork is to be accomplished to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

3.8 DOOR AND FRAME INSTALLATION

Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with metal panel flashings and other components. Caulk and seal perimeter of each door frame with elastomeric sealant compatible with metal panels. Comply with installation requirements in Division 08 - OPENINGS.

3.9 WINDOW INSTALLATION

Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with metal panel flashings and other components. Caulk and seal perimeter of each window frame with elastomeric sealant compatible with for metal panels. Comply with installation requirements in Division 08 - OPENINGS.

3.10 ACCESSORY INSTALLATION

3.10.1 General

Install accessories with positive anchorage to building and weather-tight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

3.10.2 Dissimilar Metals

Where dissimilar metals contact one another or corrosive substrates are present, protect against galvanic action by painting dissimilar metal surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each surface, or by other permanent separation techniques as recommended by the metal building manufacturer.

3.10.3 Gutters and Downspouts

Comply with performance requirements, manufacturer's written installation instructions, and install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA 1793 recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

3.10.4 Insulation

Comply with performance requirements and manufacturer's written installation instructions. Install insulation concurrently with metal panel installation, in thickness indicated to cover entire roof and wall area, as specified in Division 07 - THERMAL AND MOISTURE PROTECTION.

3.10.5 Roof and Wall Accessories and Specialties

Install roof and wall accessories and specialties complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports as specified in Division 07 - THERMAL AND MOISTURE PROTECTION, unless otherwise indicated.

3.11 CLEAN-UP AND PROTECTION

3.11.1 Structural Framing

Clean all exposed structural framing at completion of installation. Remove metal shavings, filings, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

3.11.2 Metal Panels

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove protective coverings/films, grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

3.11.3 Touch-Up Painting

After erection, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted structural framing and accessories. Clean and touch-up paint [with manufacturer's touch-up paint][as specified in Section 09 90 00 PAINTS AND COATINGS, unless otherwise indicated].

3.12 WASTE MANAGEMENT

Dispose of construction waste in accordance with the requirements of Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

3.13 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

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NOTE: When geographically applicable, this paragraph will be applicable to both new buildings and existing building seismic rehabilitation designs done according to UFC 3-301-01, "Structural Engineering".

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required. This includes indicating the locations of all structural components and connections requiring inspections.

Add any additional requirements as necessary

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS. When buildings are classified as Risk Category V, perform special inspections and testing in accordance with UFC 3-301-02.

3.14 WARRANTY

3.14.1 Manufacturer's Warranty

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.14.2 Contractor's Warranty For Installation

Submit warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

3.14.3 Contractor's Five Year No Penal Sum Warranty

CONTRACTOR'S FIVE YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM

FACILITY DESCRIPTION:____

BUILDING NUMBER:____

CORPS OF ENGINEERS CONTRACT NUMBER:____

CONTRACTOR

CONTRACTOR:____
ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

OWNER

OWNER:____
ADDRESS:____

POINT OF CONTACT:____

TELEPHONE NUMBER:____

CONSTRUCTION AGENT

CONSTRUCTION AGENT:____
ADDRESS:____

POINT OF CONTACT:____
_
TELEPHONE NUMBER:____

CONTRACTOR'S FIVE YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE METAL BUILDING SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY [_____] FOR A PERIOD OF FIVE [5][10][20][_____] YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE AND STRUCTURAL FAILURE WITHIN PROJECT SPECIFIED DESIGN LOADS, AND LEAKAGE. THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY INCLUDES, BUT IS NOT LIMITED TO, THE FOLLOWING:

FRAMING AND STRUCTURAL MEMBERS, ROOFING AND SIDING PANELS AND SEAMS, INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS, ACCESSORIES, TRIM, FLASHINGS AND MISCELLANEOUS BUILDING CLOSURE ITEMS SUCH AS DOORS AND WINDOWS (WHEN FURNISHED BY THE MANUFACTURER), CONNECTORS, COMPONENTS, AND FASTENERS, AND OTHER SYSTEM COMPONENTS AND ASSEMBLIES INSTALLED TO PROVIDE A WEATHERTIGHT SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THESE SPECIFICATIONS THAT BECOME PART OF THE METAL BUILDING SYSTEM.

ALL MATERIAL AND WORKMANSHIP DEFICIENCIES, SYSTEM DETERIORATION CAUSED BY EXPOSURE TO THE ELEMENTS OR INADEQUATE RESISTANCE TO SPECIFIED SERVICE DESIGN LOADS, WATER LEAKS AND WIND UPLIFT DAMAGE MUST BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE AND LEAKAGE ASSOCIATED WITH THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY MUST BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER.

THIS WARRANTY COVERS THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON [_____] AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

____

(Company President)   (Date)

CONTRACTOR'S FIVE YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE CONTRACTOR HEREBY SUPPLEMENTS THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE METAL BUILDING SYSTEM, WHICH IS SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR IS ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL,INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE BUILDING SYSTEM DUE TO ACTIONS BY THE OWNER WHICH INHIBIT FREE DRAINAGE FROM THE ROOF, GUTTERS AND DOWNSPOUTS; OR CONDITIONS WHICH CREATE PONDING WATER ON THE ROOF OR AGAINST THE BUILDING SIDING.

6. THIS WARRANTY APPLIES TO THE METAL BUILDING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR AND THIS WARRANTY AND THE CONTRACT PROVISIONS TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES. REPORTS OF LEAKS AND BUILDING SYSTEM DEFICIENCIES MUST BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE BY TELEPHONE OR IN WRITING FROM EITHER THE OWNER, OR CONTRACTING OFFICER. EMERGENCY REPAIRS, TO PREVENT FURTHER ROOF LEAKS, MUST BE INITIATED IMMEDIATELY; A WRITTEN PLAN MUST BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT MUST BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED

CONTRACTOR'S FIVE YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(Exclusions from Coverage Continued)

POST A FRAMED COPY OF THIS WARRANTY IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-13 34 23.12 10 (May 2024)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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RELOCATABLE BUILDING UNITS (RLB)

05/24

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC UFGS-13 34 23.12 10 (May 2024)

Preparing Activity: USACE New

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 13 34 23.12 10

RELOCATABLE BUILDING UNITS (RLB)

05/24

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NOTE: This guide specification covers the performance, material, and production requirements for Relocatable Building (RLB) units, which are habitable prefabricated structures that are developed and manufactured to be readily moved (transportable over public roads), erected, disassembled, stored, and reused. Excluded from this specification are tension fabric structures assembled from modular components and air supported structures.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 211	(2013; Rev 2017) Certified Ratings Program Product Rating Manual for Fan Air Performance
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA CRP	(Online) Directory of Products Licensed Under the AMCA International Certified Ratings Program

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 210/240	(2023) Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant COndensers

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.6.1M	(1997; R 2017) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2022) Floor Drains
ASME A112.14.1	(2003; R 2017; R 2022) Backwater Valves
ASME A112.19.2/CSA B45.1	(2024) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME A112.19.3/CSA B45.4	(2022) Stainless Steel Plumbing Fixtures

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1012	(2023) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent
ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA M14	(2024) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C534/C534M	(2024) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C564	(2020a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2855	(2020) Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
ASTM D3138	(2004; R 2016) Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components

ASTM D3311	(2017) Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM F409	(2022) Standard Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
ASTM F493	(2022) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

BRITISH STANDARDS INSTITUTION (BSI)

BS 1363-1	(2023) 13 A Plugs, Socket-Outlets, Adaptors and Connection Units Part 1
BS 1363-2	13 A Plugs, Socket-Outlets, Adaptors and Connection Units Part 2
BS 7671	(2018) Requirements for Electrical Installations
BS EN 13121-3	(2016) GRP Tanks and Vessels for Use Above Ground — Part 3: Design and Workmanship

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.1	(2021) Butts and Hinges

CSA GROUP (CSA)

CSA B45.5-17/IAPMO Z124	(2017; Errata 2017; Errata 2018) Plastic Plumbing Fixtures

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
EN 1990 Eurocode	(2023) Basis of Structural and Geotechnical Design

EN 1991 Eurocode	(2005; AMD: Jan 2011) Actions on Structures - Part 1-4
EN 1993 Eurocode	(2023) Design of Steel Structures
EN 1997 Eurocode	(2010; AMD: Jul 2014) Geotechnical Design
EN 1998 Eurocode	(2005; AMD: may 2013) Design of Structures for Earthquake Resistance
EN 1999 Eurocode	(2023) Design of Aluminum Structures

ILLUMINATING ENGINEERING SOCIETY (IES)

IES Lighting Library	IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code
ICC IPC	(2024) International Plumbing Code
IPC D330	(1992) Design Guide Manual

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60884-1	(2022) PLugs and Socket-Outlets for Household and Similiar Purposes - Part 1: General Requirements
IEC 60947-4-1	(2023) Low-voltage Switchgear and Controlgear, Part 4-1: Contactors and Motor Starters - Electromechanical Contactor and Motor Starters
IEC 62053-22	(2020) Electricity Metering Equipment (A.C.) - Particular Requirements - Part 22: Static Meters for Active Energy (Classes 0,2 S and 0,5 S)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual
NAAMM HMMA 861	(2014) Guide Specifications for Commercial Hollow Metal Doors and Frames
NAAMM HMMA 863	(2014) Guide Specifications for Detention Security Hollow Metal Doors and Frames

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2021) Wiring Devices Dimensions Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 101	(2024) Life Safety Code
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

RUBBER MANUFACTURERS ASSOCIATION (RMA)

RMA IP-20	(2007) Specifications for Drives Using Classical V-Belts and Sheaves. Specifications for A, B, C, and D Cross Sections
RMA IP-22	(2007) Specifications for Drives Using Narrow V-Belts and Sheaves (Joint RMA/MPTA), 4th Edition

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8	(2023) Specifications for Standard Steel Doors and Frames

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-201-01	(2022; with Change 4, 2023) Non-Permanent DoD Facilities in Support of Military Operations
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

24 CFR 3280	(2019) Manufactured Home Construction and Safety Standards

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone
PL 109-58	Energy Policy Act of 2005 (EPAct05)

UL SOLUTIONS (UL)

UL 20	(2018; Reprint May 2023) UL Standard for Safety General-Use Snap Switches
UL 67	(2018; Reprint Aug 2023) UL Standard for Safety Panelboards
UL 174	(2004; Reprint Nov 2024) UL Standard for Safety Household Electric Storage Tank Water Heaters
UL 580	(2006; Reprint Apr 2024) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1699	(2017; Reprint Feb 2022) UL Standard for Safety Arc-Fault Circuit-Interrupters
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 GENERAL REQUIREMENTS

1.2.1 Relocatable Building Type Options

RLB units and the final assembled facilities must comply with UFC 1-201-01. The Facility Level is [Temporary][Semi-Permanent] as defined in UFC 1-201-01. Provide structural designer's qualifications, electrical designer's qualifications, mechanical designer's qualifications, fire protection designer's qualifications, RLB manufacturer qualifications. In addition provide erection plan, erection procedures, qualifications of installer and shipping, handling, and storage for each RLB type. The list below defines the define RLB Types (areas are nominal, not actual):

a. RLB Type A: Single 14.8 square meters 160 SF units that can be connected together for use as billeting or as an administrative space.

b. RLB Type B: Two 14.8 square meters 160 SF units for use as latrine, shower, and shave (LSS) units. Total of 29.7 square meters 320 SF. These units are to be ground level only.

c. RLB Type C: Single 14.8 square meters 160 SF units for laundry uses. These units are to be ground level only.

d. RLB Type D: Four connected 14.8 square meters 160 SF units to create a 59.5 square meters 640 SF pod. This pod is for medical related uses including health and dental clinics. (Risk category 2.) These units are to be ground level only.

e. RLB Type E: Four connected 14.8 square meters 160 SF units to create a 59.5 square meters 640 SF pod. This pod is for medical related units complying with Emergency Risk category 4. These units are to be ground level only

f. RLB Type F: Four connected 14.8 square meters 160 SF units to create a 59.5 square meters 640 SF pod. This pod is for general types of assembly uses, such as MWR, religious assembly, open space admin, fitness centers, DFAC, and others.

1.2.2 Use of Euro Codes

The following Eurocodes may be used for design: EN 1990 Eurocode; EN 1991 Eurocode; EN 1993 Eurocode; EN 1997 Eurocode; EN 1998 Eurocode; EN 1999 Eurocode; and Directive 2011/65/EU.

1.2.3 Construction Configuration

Are to be single level rectangular configuration. Non-combustible construction in accordance with UFC 1-201-01, except that, for some delivery orders, the Government may require that the Contractor build combustible RLB units in accordance with the Government's own design, which will be required to comply with UFC 1-201-01 as combustible RLB units. Adhere to the following:

a. Use of Spray Plastic Foam Insulation (SPFI) is not allowed. Use of pre-insulated panels (with any surface – metal, wood, plastic or other) containing foam insulation is not allowed.

b. Provide minimum clear height from finished floor to underside of ceiling assembly no less than 2134 mm84 inches clear ceiling height.

c. Provide a uniform prefinished exterior. The Contracting Officer will select exterior and interior colors from the manufacturer's proposed color offerings.

d. Types A and F are to be capable of being stacked, two high, directly on top of each other.

e. Vertical circulation between stacked units is to be accommodated by the use of independent self-supporting exterior stairs, handrails and railing assemblies that are code compliant and field installed.

f. Units must be able to be joined together to create any of the five RLB types indicated.

g. Provide units with a method to level and plumb that will be manually adjustable with durable support pads, if needed. Restraint anchor systems, if used, must be corrosion resistant.

h. A sound transmission coefficient (STC) of no less than 25.

i. Provide concealed blocking for accessories mounting devices, and do not have screws, nails or bolts penetrating the interior.

j. Fasteners and connections are to have galvanized coating to reduce corrosion and requires no maintenance.

k. Pre-assemble units in the factory and confirm components, including walls, floor, doors and roof are built square and plumb and fit together per design intent.

1.2.4 Components

Components are to be metric standard. Individual components, as shipped, cannot exceed 90.72 kg </Met>200 lbs in weight and be able to be picked up and handled and assembled by able bodied military personnel. The unit and the unit's individual components must be capable of being shipped in standard ISO intermodal containers. Components are to be able to be assembled or disassembled without the use of custom tools.

1.2.5 Interior

Utility systems are to be developed, located, and manufactured to be easily, simply, and quickly connected to the RLB unit's exterior face surface. Adhere to the following:

a. Plumbing will not be permitted on the second floor of stacked RLB facilities.

b. Conduits, if used, for wiring and cables may be exposed on walls and ceiling.

c. Provide electric breaker panel, energy efficient LED light fixtures, and outlets.

d. Provide fire, phone, data conduits and wiring.

1.2.6 Basic Module Interior Envelope

The basic module interior envelope size is limited to no larger than 2300 mm 92 inches wide by 5900 mm233 inches long by 2300 mm92 inches high. The minimum requirements for insulation are: Floors R-11+ insulation; Walls R-20+ insulation; Roof and ceilings of lower level stacked units R-40 insulation.

1.2.7 Fire Protection and Life Safety

Provide egress in accordance with UFC 1-201-01. Emergency lighting and exit signs, are to be provided at each facility in accordance with NFPA 101. Provide emergency lighting and exit sign operating and maintenance manuals.

Fire alarm/detection systems conduits are to be marked for their use in accordance with NFPA 72 and NFPA 101. Installation is to be done in the most economical and efficient way.

1.2.8 Structural Performance

Units are to be structurally sound and capable of withstanding the effects of self-weight gravity loads, and the loads and stresses listed in the following paragraph, within the limits and conditions indicated.

a. Guy wires are not permitted.

b. Use Risk Category II, except for Unit Type E which will be assigned Risk Category IV, unless otherwise required by UFC 1-201-01.

c. Comply with UFC 1-201-01.

Permanently mark each component to ensure correct coordination with each envelope. Provide each shipping container with a packing list that is readily visible upon opening the container and indicates how many containers are included in the shipment.

1.2.8.1 Floor Live Loads

Module floor framing systems must be in accordance with UFC 3-301-01. The minimum uniform live load will be 4.8 kPa100 psf.

1.2.8.2 Roof Live Loads

Facility roof framing systems must be in accordance with UFC 3-301-01 and be able to support equipment and materials. The minimum uniform live load for single level units will be 0.96 kPa20 psf.

1.2.8.3 Collateral Loads

Include an additional dead load of 0.50 kPa10 psf to roof loads, other than the weight of the facility building system. Wall framing must be capable of supporting an additional point load of 11 kg24 lbs at wall face to account for shelves or equipment.

1.2.8.4 Wind Loads

Facility structural elements, including components and cladding and main wind force resisting systems, must be in accordance with UFC 3-301-01 using the following minimum criteria: Exposure Category C, Basic Wind Speed 177 kph110 mph for single and stacked units.

1.2.8.5 Seismic

Single and stacked RLB facilities will be capable of withstanding the effects of earthquake motions determined in accordance with UFC 3-301-01 using the following minimum criteria: Ss 0.57, S1 0.27.

1.2.8.6 Load Combinations

RLB facilities must be able to withstand the most critical effects of load factors and load combinations as required by UFC 3-301-01.

1.2.8.7 Load Application

RLB units must support the worst-case loading conditions assuming units are stacked two high and connected side-by-side or connected side-by-side. Each unit will be able to support dead, live wind, seismic, and collateral loads assuming the worst-case position.

1.2.8.8 Deflection Limits

RLB units must be in accordance with UFC 3-301-01 with regard to deflection limitations. RLB facilities must withstand design loads with deflections no greater than the following:

a. Floor and Roof Framing: vertical deflection of 1/360 of the span.

b. Wall Framing: horizontal deflection of 1/240 of the span.

c. Wall Cladding: horizontal deflection of 1/180 of the span.

1.2.8.9 Thermal Movements

Provide cladding systems that allow for thermal movements resulting from the maximum change (range) in ambient and surface temperatures, 67 degrees C 120 degrees F ambient and 100 degrees C180 degrees F material surfaces, preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculations on the surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1.2.8.10 Wind-Uplift Resistance

Provide roof cladding assemblies that comply with UL 580 for Class 60.

1.2.8.11 Foundation Design

The foundation will be designed for a soil bearing capacity of 72 kPa1,500 PSF, [_____].

1.2.9 Heating, Ventilating, and Air Conditioning (HVAC)

****

NOTE: Base selection on the project location with the most extreme temperature.

****

1.2.9.1 HVAC Units

HVAC units are to be able to operate in an ambient temperature of [50 degrees C122 degrees F],[-6.67 degrees C-20degrees F],[____] and have a seasonal energy efficiency ratio of 16 or greater.

1.2.9.2 Service Labeling

Label equipment with labels made of self-sticking, non-corrosive metal designed for permanent installation. Labels are to be in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Ductless Mini Split	SU-XXX [______](Indoor Portion); CU-XXX [______](Outdoor Portion)
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF-XXX [_____]

1.2.9.3 Prevention of Corrosion

Protect metallic materials against corrosion. Manufacturer is to provide rust-inhibiting treatment for components exposed to ambient atmosphere and standard finish for the equipment enclosures for a minimum of ten years. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials are to be hot-dip galvanized in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations.

1.2.9.4 Asbestos Prohibition

Do not use asbestos and asbestos-containing products, or other hazardous material.

1.2.9.5 Ozone Depleting Substances Used as Refrigerants

Minimize releases of Ozone Depleting Substances (ODS) during repair, maintenance, servicing or disposal of appliances containing ODS's by complying with applicable sections of 40 CFR 82, Subpart F as though every project site were located in the United States. The use of R-22 refrigerant for HVAC systems is expressly prohibited. Persons conducting repair, maintenance, servicing or disposal of equipment containing refrigerants must comply with the following:

a. Do not knowingly vent or otherwise release into the environment, Class I or Class II substances used as a refrigerant.

b. Do not open appliances without meeting the requirements of 40 CFR 82, regarding required practices for evacuation and collection of refrigerants, and 40 CFR 82, regarding standards of recycling and recovery equipment.

c. Only persons who comply with 40 CFR 82, regarding technician certification, can conduct work on appliances containing refrigerant.

1.2.10 Electrical Systems

1.2.10.1 General

Except as noted otherwise, electrical work is to comply with 24 CFR 3280, Subpart I. Additionally, RLB modules are to have a [UL certificate of compliance] Certificate of Inspection as described in the UL White Book for Prefabricated Buildings (QRAR), Commercial and Industrial Prefabricated Buildings and Units (QRXA) or [CE conformite Europeenne]equivalent.

1.2.10.2 Compliance with Codes

[Option 1: 50Hz system. Relocatable Building Units connected to [415/240], [400/230], or [380/220], 50 Hz power systems will comply with the electrical requirements of BS EN 13121-3, BS 7671 and internationally recognized host nation electrical code for the region installed. In addition, the 50 Hz power system will comply with article 545 and article 550 of NFPA 70 as applicable. If there is a conflict BS 7671 will take precedence over other codes listed above. Electrical material and equipment is to be IEC manufactured and type-tested by an independent testing laboratory. The independent testing laboratory must be certified by the Worldwide System for Conformity Testing and Certification of Electrotechnical Equipment and Components (IECEE). Contractor is to supply product-specific testing certification and IECEE certification for IEC manufactured equipment. After construction submittals are to be sent to USACE, product-specific certificates will be verified with the independent testing agency. Material tested and marked by a Nationally Recognized Testing Laboratory (NRTL), such as Underwriters Laboratories (UL) or Canadian Standards Association (CSA) may be used in lieu of IEC-manufactured, type-tested material as long as the material/equipment is rated for use at the system voltage and frequency.]

[Option 2: 60Hz system. Relocatable Building Units connected to [120], [120/240], [208/120], or [208/480] 60 Hz systems will comply with NFPA 70. Electrical material and equipment will be tested and marked by a Nationally Recognized Testing Laboratory (NRTL), such as Underwriters Laboratories (UL) or Canadian Standards Association (CSA). After construction submittals are to be sent to USACE, product-specific certificates will be verified with the independent testing agency.]

1.2.11 Minimum Expected Service Life

The minimum expected service life for RLB units is 15 years from the date of acceptance by the Government, and subsequent to initial assembly, the erected RLB units will be able to be disassembled and re-deployed to other sites a minimum of 3 times within that time span without degradation. Ensure manufacturer supplied documentation is sufficiently detailed such that untrained personnel will be able to perform assembly activities. RLB components (to include fixtures, equipment, accessories, or related items.) are to be new, free of defects, and meet minimum quality standards.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Structural Designer's Qualifications; G, [_____]

Electrical Designer's Qualifications; G, [_____]

Mechanical Designer's Qualifications; G, [_____]

Fire Protection Designer's Qualifications; G, [_____]

Rlb Manufacturer Qualifications; G, [_____]

Qualifications Of Installer; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Erection Plan; G, [_____]

Luminaire Drawings

Structural Shop Drawings; G, [_____]

Panelboards; G, [_____]

Cable Trays; G, [_____]

Grounding And Bonding; G, [_____]

SD-03 Product Data

UL Certificate Of Compliance

Ce Conformite Europeenne

Luminaire Warranty; G, [_____]

Catalog Data; G, [_____]

Toilet Enclosures; G, [_____]

Air-Conditioning Systems; G, [_____]

Heating And Ventilating Units; G, [_____]

Circuit Breakers; G, [_____]

Receptacles (Socket-Outlets); G, [_____]

Cable Tray Design; G, [_____]

Light Sources; G, [_____]

Light Source; G, [_____]

Led Drivers; G, [_____]

Emergency Drivers; G, [_____]

Emergency Lighting Egress Units; G, [_____]

Exit Signs; G, [_____]

Switches; G, [_____]

Wire And Cable; G, [_____]

Surge Protection Device (SPD); G, [_____]

SD-04 Samples

Roof Panels, 304.8 mm 12 inches long by actual panel width; G, [_____]

Wall Panels, 304.8 mm 12 inches long by actual panel width; G, [_____]

Fasteners; G, [_____]

Manufacturer's Color Charts and Chips, 101.6 mm by 101.6 mm 4 by 4 inches; G, [_____]

Flooring Systems; G, [_____]

Exterior Panel Finish Material; G, [_____]

Luminaire Samples; G, [_____]

SD-05 Design Data

Lateral Force Calculations; G, [_____]

Photometric Plan; G, [_____]

Interior Finishes Scheme; G, [_____]

Structural Calculations; G, [_____]

SD-06 Test Reports

Mill Test Reports; G, [_____]

Ansi/Ies Lm-79 Test Report; G, [_____]

Ansi/Ies Lm-80 Test Report; G, [_____]

Ansi/Ies Tm-21 Test Report; G, [_____]

Ansi/Ies Tm-30 Test Report; G, [_____]

Emergency Light Test; G, [_____]

600-Volt Wiring Test; G, [_____]

Ground-Fault Receptacle Test; G, [_____]

Arc-Fault Receptacle Test; G, [_____]

Grounding System Test; G, [_____]

SD-07 Certificates

Manufacturer Qualifications; G, [_____]

SD-08 Manufacturer's Instructions

Shipping, Handling, and Storage; G, [_____]

Erection Procedures; G, [_____]

SD-10 Operation and Maintenance Data

Emergency Lighting And Exit Sign Operating And Maintenance Manuals

Electrical System; G, [_____]

SD-11 Closeout Submittals

Manufacturer's Warranty; G, [_____]

Installer's Warranty; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Welding

Qualify procedures and personnel for welding according to AWS A5.1/A5.1M, AWS D1.1/D1.1M, and AWS D1.3/D1.3M or Euro code equivalent.

1.4.2 Structural Steel

Comply with AISC 360, for design requirements and allowable stresses.

1.4.3 Fire-Resistance Ratings

Where indicated, provide materials identical to those of assemblies tested for fire resistance per ASTM E119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency. Indicate design designations from UL Fire Resistance or from the listings of another qualified testing agency. Combustion Characteristics must conform to ASTM E136.

1.4.4 Surface-Burning Characteristics

Provide materials having material with Class A fire ratings. The surface-burning characteristics must be determined by testing identical products according to ASTM E84by a qualified testing agency. Identify products with appropriate markings of applicable testing agency showing:

a. Flame-Spread Index: 25 or less.

b. Smoke-Developed Index: 450 or less.

1.4.5 Fabrication

Fabricate and finish roof, floor, and wall components and accessories at the factory, by manufacturer's standard procedures and processes to fulfill indicated performance requirements.

1.4.6 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes. Appearance of finished work with noticeable variations in same piece is not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

1.4.7 Plumbing

1.4.7.1 Regulatory Requirements for Plumbing

Plumbing work will be in accordance UFC 1-201-01. Energy consuming products and systems will be in accordance with [PL 109-58], [ASHRAE 90.1 - SI], or [ASHRAE 90.1 - IP].

1.4.7.2 Accessibility of Equipment

Install work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

1.4.8 Mechanical Systems

Provide manufacturer's certificate of compliance, evidence of conformance to [UL certificate of compliance][or][CE conformite Europeenne]. Also submit detail drawings in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

1.4.9 Electrical

Provide manufacturer's certificate of compliance, evidence of conformance to [UL certificate of compliance][or][CE Conformite Europeenne], detail drawings and calculations in accordance with UFC 1-201-01 APPENDIX A-3, Luminaire Drawings, and photometric plan in accordance with Section 26 56 00 EXTERIOR LIGHTING.

1.4.10 Interior Finishes

Interior wall and ceiling finish materials will be classified for fire performance and smoke development in accordance with ICC IBC Section 803.1.1 or 803.1.2, except as shown in Sections 803.2 through 803.13. Materials tested in accordance with Section 803.1.2 will not be required to be tested in accordance with Section 803.1.1.

Interior wall and ceiling finish materials are to be classified in accordance with ASTM E84 or UL 723. Such interior finish materials must be classified in the flame spread and smoke-developed index. Class A, flame spread index 0-25; smoke developed index 0-450.

1.5 WARRANTY

Provide material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard manufacturer warranty as required to comply with the specified requirements. Provide a manufacturer's warranty that has no dollar limit, covers full system water-tightness, durability and workmanship that has a minimum duration of [15][_____] years.

1.5.1 Manufacturer's Warranty

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NOTE: Consult with the end user regarding desired length of warranty. The following is general guidance to facilitate the warranty discussion and decision. Facilities containing sensitive equipment or operations require a warranty of not less than 15 years. Designer may specify 1, 5 or 10 year manufacturer warranty on facilities of minor importance or where the length of use is less than 15 years.

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Furnish the manufacturer's no-dollar-limit materials and assembly workmanship warranty for the following:

a. Structure - including structural components, fasteners, moisture and thermal protection, exterior finishes, roof, doors, and windows.

b. Interior - including finishes, flooring, walls, and ceiling.

c. Electrical system - including panelboards, circuit breakers, lighting fixtures, wiring, electrical and electronic devices.

d. Mechanical- Heating ventilation and air conditioning system - including components, systems, and devices.

e. Plumbing systems - Provide Luminaire warranty in accordance with

Section 26 51 00 INTERIOR LIGHTING, and Section 26 56 00 EXTERIOR LIGHTING for Panelboards, circuit breakers, wiring, electrical and electronic devices in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

f. Communication Systems-including wiring, data outlets, tray system and communication racks.

Write the warranty directly to the Government to commence at the time of the Government's acceptance of the work. The warranty must state that:

a. If within the warranty period listed materials, as installed at the factory or supplied by the manufacturer for field installation becomes non-functional, shows evidence of moisture intrusion within the assembly, splits, tears, cracks, delaminates, separates at the seams, shrinks, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials and correction of defective workmanship is the responsibility manufacturer. The manufacturer is responsible for costs associated with the repair or replacement work.

b. When the manufacturer or its approved repair agent fails to perform the repairs within 72 hours of notification or ship repair parts within 48 hours, emergency temporary repairs performed by others will not void the warranty.

1.5.2 Installer's Warranty

The installer must warrant for a period equal to the manufacturer warranty that the installation and minor construction procured under this contract are free from defects in installation workmanship, to include the structures maintaining level, field installed items. The work warranted includes site civil work performed, and specifically includes a warranty that structures installed will remain level (aligned with a horizontal plane and plumb with the vertical plane). Write the warranty directly to the Government. The installer is responsible for correction of defective workmanship and replacement of materials damaged or adversely affected by installation or construction workmanship. The installer is responsible for costs associated with the repair or replacement work.

1.5.3 Continuance of Warranty

Approve repair or replacement work that occurs within the warranty period and accomplish repairs in a manner so as to ensure or restore, as required, the applicability of the Manufacturer's Warranty for the remainder of the warranty period. The Contractor is obligated to pass these warranty requirements through to RLB manufacturers and installers or suppliers of minor construction services under this Contract, and it guarantees obligations to the Government under subparagraph Warranty.

1.6 MAINTENANCE

1.6.1 Electrical System

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein. Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide standard products (i.e. commercial off the shelf RLB components not specially manufactured for use in this contract) such as hardware, interior finishes, fixtures, and equipment that have been in satisfactory commercial or industrial use. Damaged products will not be accepted. Floors, ceilings, partitions, walls and wall bases will have a smooth, hard, nonabsorbent surface assembly. Interior finishes will have a light colored semi-gloss finish. Provide manufacturer qualifications, interior finishes scheme, and catalog data.

The types of interior finishes selected can not impact the ability of the units to be disassembled and relocated.

2.1.1 Shower Assemblies

Provide 915 mm36 inches by 915 mm36 inches enclosed shower assemblies with individual control valves for hot and cold water. Provide an internal gravity drain system with single above floor exit through exterior wall of unit. Provide method of producing sufficient hot water for all showers to run simultaneously for 10 minutes with no decrease in water flow or change in temperature. Shower assemblies are to provide a means of obscuring the view of the occupant within the shower and between adjacent showers. Plumbing is to be surface mounted, protected, and accessible.

The interior of the shower assembly unit is to resist mold and mildew growth, be easily sanitized, waterproof and have durable surface. The floor is to be slip resistant, reinforced, and sloped to drain.

2.1.2 Latrine Accessories

Accessories such as [grab bars], [paper dispensers], [toilet paper roll holder], [soap dishes], [soiled feminine hygiene products receptacle], [_____]provided on or within walls, are to be installed and sealed to protect structural elements from moisture and mold. Accessories are to be stainless steel.

2.1.3 Laundry Drains

Washing machines and sinks are to drain into a continuous trench drain sized to accommodate load, sloped to drain and have one code compliant exit from RLB. Size trench drain to accommodate simultaneous drain of all washing machines and sinks.

2.1.4 Lavatory Drains

Lavatories are to be wall hung and have a clear working space of not less than 915 mm36 inches in front and comply with paragraph SHOWER DRAINS and have one code compliant exit from RLB.

2.1.5 Flooring Systems

Floor cavities are to be insulated with flame retardant insulation in accordance with 24 CFR 3280. Floors, ceilings, partitions, walls and wall bases are to have a smooth, hard, nonabsorbent surface assembly and be free of sharp, pointed, or jagged edges. Floor thickness may be thicker to accommodate shower drains and sloped base.

2.1.6 Exterior Walls, Roof, and Underside of RLB Facilities

Prefinished non-corrosive metal or fiberglass sheathing assembly compliant with UL Fire Resistance one hour fire resistant rating. Wall assembly be a waterproof and a vermin proof assembly. Spray-foam insulation is prohibited. Roof assembly is to be insulated with flame retardant insulation in accordance with 24 CFR 3280. Provide the roof with positive drainage to the exterior edge without ponding. Two-story unit assemblies are to be designed to be square, plumb, and attached to the unit below. Provide samples for exterior panel finish material, manufacturer's color charts and chips, roof panels, wall panels, fasteners.

2.1.7 Doors

2.1.7.1 Interior Doors

Doors are to be tight evenly fitting to the jamb, head, and threshold. When in an open position, interior doors are to remain stationary. Each door is to be an industry standard 915 mm36 inches by 2032 mm80 inches by 44 mm1.75 inches insulated prefinished hollow metal door with a minimum RSI-0.6 (R3.5) rated insulation.

Door assemblies are to comply with NAAMM HMMA 861 and NAAMM HMMA 863 and be SDI/DOOR A250.8 certified. Pre-hung door and frame is to be rated for high use and moderate impact resistance, and frame is to be 14 gauge minimum with a consistent frame profile. Door assemblies are to be equipped with three silencers per leaf.

2.1.7.2 Exterior Doors

Each door is to be an industry standard 915 mm36 inches by 2032 mm80 inches by 44 mm1.75 inches insulated prefinished hollow metal door with a minimum RSI-0.6 (R3.5) rated insulation. Door assemblies are to comply with NAAMM HMMA 861 and NAAMM HMMA 863 and be SDI/DOOR A250.8 certified or equivalent. Provide exterior door and frame assembly.

Pre-hung door and frame is to be rated for high use and moderate Impact resistance, frame is to be 14 gauge minimum and have a consistent frame profile. Exit doors are to have a threshold and be fully weather stripped and have a protective rain shield at door head.

2.1.7.3 Door Hardware

Door Hardware is to be appropriate Grade 1 hardware compliant or equivalent with 08 71 00 DOOR HARDWARE, ANSI/BHMA A156.1, SDI and NFPA. The hardware set is to consist of the following:

a. 1 ½ pair Hinges #A5111.

b. 1 each lockset, Grade 1, Locksets are to be cipher combination locks or an approved equal with levers and key override at all building entrances.

c. Combination or approved equal.

d. 1 each door closer #C02061.

e. 1 each threshold #J32130.

[2.1.7.4 Keys and Locksets

[Provide labeled matching keys, hardware schedules for each RLB unit type, a master key system, five extra keys, and for each five RLB units, a lockable prefinished metal key cabinet sized to accommodate the extra keys for five RLB units regardless of type.]

[Exterior door hinges and lock sets are to be stainless steel with BHMA 630 finish. Interior door hinges are to be steel with BHMA 600 finish.][Exterior door assembly is to comply with wall rating and have compliant hardware and locksets installed with a 62 mm2.75 inch backset.]

]2.1.7.5 Water Closet (Toilet) Partitions

Each water closet is to occupy a separate compartment with non-corrosive privacy partitions and a lockable door enclosing the fixtures to ensure privacy. Compartments clear interior dimension is to be no less than 915 mm 36 inches wide by 1820 mm60 inches deep. Door is to have one robe hook and gravity, stainless steel piano 14 gauge, cam close hinges. Provide toilet enclosures.

Solid Phenolic Core Partitions and door assemblies are to have a high-pressure matte surface finish as an integral part of the core material and have structural integrity to resist deflection, warping, cracking or spalling.

2.1.8 Ice and Water Shield

Roof perimeter edges and all exterior penetrations (e.g. doors, vents, lighting, and power outlets) are to be equipped with ice and water shields and sealant.

2.2 STRUCTURAL

2.2.1 Floor and Roof Framing

The floor and roof framing are to meet the requirements of UFC 1-201-01. Floor framing is to be spaced according to the span limitations of the floor decking. Splicing of the floor framing is not acceptable. A framing member is to be placed around the entire perimeter of the RLB facility floor. Provide structural shop drawings, mill test reports, and structural calculations including lateral force calculations.

2.2.2 Floor Decking

The floor decking is to meet the requirements of UFC 1-201-01. The decking is to be placed perpendicular to the joist span. All decking must be installed and secured so that the ends terminate on structural members for proper securing.

2.2.3 Exterior Walls

The exterior wall framing must meet the requirements of UFC 1-201-01.

2.3 HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)

2.3.1 Energy Efficient Equipment

Exhaust fans and ductless mini splits are to comply with the energy efficiency requirements in UFC 1-201-01, local law, and local building codes.

2.3.2 HVAC Identification Plates

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Letters are to be upper case.

2.3.3 Indoor Air Quality

Provide equipment and components that comply with the requirements of UFC 1-201-01 unless more stringent requirements are specified.

2.3.3.1 Ventilation Air

Ventilation air is to be supplied to each room in accordance with UFC 1-201-01 unless more stringent requirements are specified.

2.3.3.2 Latriney Exhaust

Provide exhaust in accordance with UFC 1-201-01 unless more stringent requirements are specified. Exhaust is to be continuous or interlocked with a light switch. Use of a sensible heat recovery unit is to be investigated to determine if they are life cycle cost effective when the 1.0 percent dry bulb occurrence exceeds 32 degrees C90 degrees F or when the 99 percent dry bulb temperature occurrence is less than 10 degrees C 50 degrees F.[Paragraph SENSIBLE HEAT RECOVERY UNIT.]

[A cross-flow, air-to-air (z-duct) heat exchanger must recover the heat in the exhaust and supply air streams. Z-ducts must be constructed entirely of sheet metal.]

2.3.4 Air Systems Equipment

2.3.4.1 Exhaust Fans

2.3.4.1.1 General Performance, Component, and Other Requirements

Fans must have certified performance ratings as evidenced by conformance to the requirements of AMCA 211, and must be listed in AMCA CRP, or must be currently eligible for such listing. Fans must generally be in accordance with AMCA 99 unless superseded by other requirements stated elsewhere herein. Determine performance data for fans in accordance with AMCA 210. Select fans to minimize the exposure of personnel working in or occupying the immediate installation area. The total sound power level of the fan tests must not exceed 85 dBA when tested per AMCA 300 and rated per AMCA 301, or it must be provided with an appropriate attenuation device or devices. Scheduled fan performance is the performance required under specified or indicated installation conditions with specified or indicated accessories. The net installed air performance of the fan, with accessories/appurtenances in place, must be sufficient to meet the scheduled performance within the limits of the fan rating certification tolerance.

Affix the manufacturer's product identification nameplate to each unit. Apply additional requirements for specific service or generic type or class of fan. If non-uniform air flow conditions are likely to be encountered, contact the fan manufacturer to ensure that the fan is rated for the additional fan inlet and outlet effect. Install fans to minimize fan system effect in accordance with AMCA 201. Fans must be listed in the Directory of Products licensed to use AMCA seal.

2.3.4.1.2 Bearings and Lubrication

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NOTE: Sleeve type bearings are to be specified or indicated on drawings where low noise levels as outlined in Section 23 35 19.00 20 INDUSTRIAL VENTILATION AND EXHAUST SECTION are required.

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Precision anti-friction or sleeve type with provisions for self-alignment and for radial and thrust loads imposed by the service. Provide water-cooled bearings where required for the service or recommended by the manufacturer.

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NOTE: Select one of the following: Continuous 8-hour service 20,000, Continuous 24-hour service 40,000, Continuous 24-hour service 80,000 (extreme reliability).

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2.3.4.1.3 Anti-friction Bearings

Constructed of steel alloys with a certified L-10 minimum rated life of [20,000][40,000][80,000] hours under load conditions imposed by the service. Rated and selected in accordance with ABMA 9 and ABMA 11. Provide with dust-tight seals for environment and lubricant pressures encountered; cast ferrous metal housing, bolted-split pillow block type where located within fan casings; grease lubricated with provisions to prevent overheating due to excess lubricant; surface ball check type grease supply fittings. Provide manual or automatic grease pressure relief fittings visible from normal maintenance locations. Include lubrication extension tubes where required to facilitate safe maintenance during operation and fill tubes with lubricant prior to equipment operation. Prelubricated, sealed, anti-friction bearings, which conform to above specified materials and L-10 life requirements, may be provided for fans requiring less than 0.37 kW1/2 horsepower.

2.3.4.1.4 Sleeve Bearings

Premounted, self-aligning, continuous oil supply, single or double ring lubricated, insert type, with provisions for shaft expansion and such thrust as may be imposed by service loads. Provide water cooling for shaft surface speed exceeding 6.1 m/s1200 feet per minute. Provide each sleeve bearing with approximately than 473 ml16 ounce capacity constant level oiler and oil level gage. Include on sleeve bearing submittal data: Bearing manufacturing source, type, lubricant, clearances, "L/D" ratio, antifriction metal, belt angle, shaft speed, shaft critical speed, Brinell hardness at journal, and shaft surface finish at journal in micro-inches.

2.3.4.1.5 Motors and Motor Starters

Power (kW)	Voltage (V)	Type Starter
Up to 5 1/2	208-230	Across-the-line magnetic
5 1/2 to 11 delta	208-230	Across-the-line magnetic part winding
11 to 22 3/8 delta	400-460	Across-the-line magnetic part winding
Above 11	208-230	Part winding or wye delta
Above 22 1/2	400-460	Part winding or wye delta

Motor (HP)	Voltage (V)	Type Starter
Up to 7 1/2	208-230	Across-the-line magnetic
7 1/2 to 15 delta	208-230	Across-the-line magnetic part winding
15 to 30 delta	400-460	Across-the-line magnetic part winding
Above 15	208-230	Part winding or wye delta
Part winding or wye delta	400-460	Part winding or wye delta

Conform to NEMA MG 1, NEMA ICS 1, and NEMA ICS 2. Motors less than 0.75 kW one hp must meet NEMA High Efficiency requirements. Motors 0.75 kWone hp and larger must meet NEMA Premium Efficiency requirements. Motors are not to exceed 1800 rpm, unless otherwise indicated, and must be variable-speed, [[open] [drip proof] enclosure] [totally enclosed fan cooled] [explosion proof] type. Provide [manual] [magnetic-across-the-line] [reduced voltage] [part-winding] [wye-delta] type motor starters with [general-purpose NEMA 1] [weather resistant NEMA 3R] [watertight NEMA 4] [moisture and dust tight NEMA 12] enclosure in accordance with NEMA ICS 6. Provide single-phase motors with inherent thermal overload protection with manual reset. Provide three-phase motors with thermal overload protection in the control panel. Provide permanently lubricated or grease-lubricated ball or roller bearings; auxiliary lubrication and relief fittings on outside of fan casing; arrange grease lines to minimize pressure on bearing seals. Motor power must not be less than brake power required with blades set at maximum pitch angle at the air delivery from the indicated amount down to 50 percent.

2.3.4.1.6 Guards and Screens

Construct guards and screens to provide, as applicable, required strength and clearance with minimal reduction in free area at fan inlets and discharges. Cooling access panels for tachometer readings ease of sectional disassembly for maintenance and inspection functions where guard total weight exceeds 22.70 kg50 pounds. Weather protection where components are weather exposed. Installed guards and screens must not negate noise control and vibration isolation provisions.[For burn protection, insulate surfaces when service temperatures exceed 60 degrees C 140 degrees F.]

2.3.4.1.7 Fan Drives

Direct or V-belt type as appropriate. V-belt drives must conform to RMA IP-20 and RMA IP-22. Drives must be applied in accordance with the manufacturer's published recommendations, unless specified otherwise. Base power rating of a V-belt drive on maximum pitch diameter of sheaves. Provide classical belt section adjustable sheave type, with a minimum service factor of 1.5 for drives with motors rated up to and including 22 kW 30 hp. Provide classical section or narrow section, fixed sheave or adjustable sheave type with a minimum 1.5 service factor for drives with motors rated over 22 kW30 hp. Provide at least two belts for drives with motors rated one hp and above.

2.3.4.1.8 Sheaves

Statically and dynamically balanced, machined cast ferrous metal or machined carbon steel, bushing type, secured by key and keyway. Pitch diameter or fixed sheaves and adjustable sheaves, when adjusted to specified limits, are to be no less than recommended by NEMA MG 1. Select adjustable sheaves that provide the required operating speed with the sheave set at midpoint of its adjustment range. The adjustment range for various size and type belts must be: 16 percent, minimum for Classical section belts; 12 percent, minimum for Narrow section belts. Belt deflection in adjustable sheave drives must not exceed 1 1/2 degrees. Provide companion sheaves for adjustable sheave drives with wide groove spacing to match driving sheaves, except that standard fixed pitch spacing may be used for all two-through-four groove drives whose center-to-center dimensions exceed the following: "A" and "B" Section 406 mm16 inches, "C" Section 635 mm25 inches, "D" Section 915 mm36 inches. Furnish endless, static dissipating, oil-resistant, synthetic cloth or filament reinforced elastomer construction belts.

2.3.4.2 Mini-Split-System Air Conditioners [Heat Pumps] (Not Exceeding 11 kW 40,000 Btu/Hr)

A remote condensing unit includes both the condensing coil and the compressor. A remote condenser includes only the condensing coil. Air-cooled, water-cooled, and evaporatively-cooled air conditioning units with capacities less than 11 kW mm40,000 BTU/hr are to be rated in accordance with AHRI 210/240. Air-cooled heat pump units with capacities less than 11 kW mm40,000 BTU/hrare to be rated in accordance with AHRI 210/240. At a minimum, efficiencies for split-systems will be in accordance with ASHRAE 90.1 - SI.

Provide an air-cooled, split system which employs a remote condensing unit, a separate [floor mounted] [wall mounted] indoor unit, and interconnecting refrigerant piping. Provide the [air conditioning] [heat pump] type unit that meets applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with AHRI 210/240. Provide indoor unit with required fans, air filters, and galvanized steel cabinet construction. The remote unit must be as specified in paragraph CONDENSING

UNIT. Provide double-width, double inlet, forward curved backward inclined, or airfoil blade, centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard condenser or outdoor fans for the unit specified and may be either propeller or centrifugal scroll type. Fan and condenser motors must have totally enclosed or explosion proof enclosures. Design unit to operate at outdoor ambient temperatures up to [46][_____] degrees C[115][_____] degrees F. Provide product data for Air-conditioning systems and Heating and ventilating units.

[2.3.4.3 Energy Efficiency

Air Conditioners must have[[a minimum [seasonal]] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____]].

]2.3.4.4 Air-to-Refrigerant Coil

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NOTE: Delete the copper or aluminum tubes and the coating requirement except in coastal or corrosive environments.

****

Provide condensing coils with [copper][or][aluminum] tubes of 10 mm0.125 inches minimum diameter with [copper][or][aluminum] fins that are mechanically bonded or soldered to the tubes. Casing must be [galvanized steel] [or] [aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging. Coat [condenser] [evaporator] [condenser and evaporator] coil with a uniformly applied [epoxy electrodeposition] [phenolic] [vinyl] [epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation and be capable of withstanding a minimum [500][1,000][_____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.3.4.5 Compressor

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NOTE: Delete this paragraph if a remote condensing unit is specified.

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Provide direct drive [hermetic reciprocating] [variable speed] [digital scroll] [scroll] type compressor. Provide compressor with internal over temperature and pressure protector, sump heater, oil pump, high pressure and low pressure controls, and liquid line dryer.

2.3.4.6 Refrigeration Circuit

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide refrigerant charging valves. Provide filter-drier in liquid line.to prevent freeze-up in event of loss of water flow during heating cycle.

2.3.4.7 Unit Controls

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NOTE: In regards to head pressure control, insert the appropriate minimum or lowest expected ambient temperature. Delete head pressure controls if inapplicable. Delete low cost cooling if inapplicable. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated. Enthalpy controls will not be used. Ensure that all controls equipment meets the requirements of UFC 4-010-06 CYBERSECURITY OF FACILITY-RELATED CONTROL SYSTEMS.

****

Provide unit internally prewired with a [24][120][_____] volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Internally protect unit by fuses or a circuit breaker in accordance with UL 1995. Equip units with three-phase power with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal.[Provide unit with microprocessor controls to provide all 24V control functions.][Control unit by a [two stage heating and cooling thermostat][one stage heating and cooling thermostat] with [manual][automatic] changeover.][Control unit by a programmable electronic thermostat with heating setback and cooling setup with 7-day programming capability.]

2.3.4.8 Condensing Coil

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive environments.

****

Provide coils with [nonferrous] [copper] [or] [aluminum] tubes of 10 mm 0.125 inches minimum diameter with [copper] [or] [aluminum] fins that are mechanically bonded or soldered to the tubes.[Protect coil in accordance with paragraph CORROSION PROTECTION.] Provide galvanized steel or aluminum casing. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide separate expansion devices for each compressor circuit.

2.3.4.8.1 Remote Condenser or Condensing Unit

Fit each remote condenser coil fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 49 degrees C120 degrees F at 40 degrees C104 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of [-6][13][_____]

degrees C[20][55][_____] degrees F. Provide fan and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Fan and condenser motors must have [open] [drip proof] [totally enclosed] [explosion proof] enclosures.[Condensing unit must have controls to initiate a refrigerant pump down cycle at system shut down on each refrigerant circuit.]

2.3.4.8.2 Air-Cooled Condenser

Provide unit in accordance with AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit. Complete with casing, [propeller] [or] [centrifugal] type fans, heat rejection coils, connecting piping and wiring, and all required accessories.

2.3.4.9 Primary (Supplemental) Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed in accordance with ASTM E84.

[2.3.4.10 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum].[Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.]

[Construct electric heater of heavy-duty nickel chromium elements. Achieve staging through the unit control processor. Each heater must have automatically reset high limit control. Heaters must be individually fused from the factory and comply with NFPA 70. Power assemblies must provide single point connection. Electric heat modules must be listed and labeled by a national recognized testing laboratory acceptable to authorities having jurisdiction. Electric heater controls must confirm the supply fan is operating before electric elements are energized. Operate electric heater in [2][3] stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.]

]2.3.4.11 Air Filters

Provide filters of the [sectional] [or] [panel] [cleanable] type that are capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible [by hinged access panel(s)]. [25][50] mm[1][2] inches MERV [7][8][13], provide throwaway filter on all units below 19.6 kW6 tons. Provide filter rack that can be converted to 50 mm2 inchescapability. Filters must have an average dust spot efficiency of [25-35][90-95] percent and an average resistance of [90][_____] percent when tested in accordance withASHRAE 52.2. Provide UL Class 1 filters.

2.3.4.12 Fans

Provide direct driven, statically and dynamically balanced, centrifugal or propeller type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

2.3.5 Factory Painting

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M.

2.3.6 Supplemental Components and Services

The requirements for refrigerant piping are per manufacturer written specifications.

2.3.7 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate and route to nearest drain or exterior of the facility. If routed to the exterior, condensate will drain within than 200 mm8 inches from the ground on to a standard concrete splash block.

2.4 PLUMBING

2.4.1 Materials

Acceptable materials include PEX, PVC, and CPVC.

2.4.1.1 Pipe Joint Materials

Joints and gasket materials are to conform to the following:

a. Solvent Cement for Transition Joints between ABS and PVC Non-pressure Piping Components: ASTM D3138.

b. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D2564 and ASTM D2855.

c. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F493.

d. PEX use compatible PEX connectors.

2.4.1.2 Miscellaneous Materials

Miscellaneous materials are to conform to the following:

a. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material is to be nonvolatile non-asphaltic and contain germicide and provide watertight, gastight, odor proof and vermin proof properties.

b. Thermometers: ASTM E1. Mercury is not to be used in thermometers.

2.4.1.3 Pipe Insulation Material

Insulation for pipes are to be flexible elastomeric cellular insulation that meets ASTM C534/C534M. Insulation thickness must be at least 25 mm1 inch for interior pipes and 50 mm2 inch for exterior pipes. Vinyl cladding is to be installed in areas of high abuse. Sanitary and vent pipes are not to be insulated.

All exposed pipes and drains are to be protected from freezing. Heat tracing is to be provided as required. Provide a protective skirt around the perimeter with appropriately sized, lockable and hinged access panels for maintenance.

2.4.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports are to conform to MSS SP-582.4.3 Valves

Valves are to be provided on supplies to equipment and fixtures. Valves are to be acceptable for, and compatible with the piping material. Pressure ratings are to be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves are to conform to the following standards:

Description	Standard
Ball Valves Threaded, Socket-Welding, Solder Joint,	MSS SP-110
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASME BPVC SEC IV, Part HLW-810: Requirements for Potable-Water Heaters Bottom Drain Valve
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22/CSA 4.4

2.4.4 Fixtures

2.4.4.1 Flush Tank Water Closets (Toilets)

ASME A112.19.2/CSA B45.1, white vitreous china, siphon jet, elongated bowl, closed front, pressure assisted, floor-mounted, comfort height and wall outlet. Provide wax bowl ring including plastic sleeve. Water conservation requirements, such as gallons per flush, are to meet all applicable requirements contained in the ICC IPC. Provide white solid plastic closed-front seat with cover.

2.4.4.2 Wall Hung Lavatories

Meet ASME A112.19.2/CSA B45.1, material is to be white vitreous china, straight back type, minimum dimensions of 483 mm19 inches wide by 432 mm17 inches front to rear. Water conservation requirements, such as gallons per flush, are to meet all applicable requirements contained in ICC IPC. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports and concealed arms for the lavatory. Mount lavatories with the front rim 864 mm34 inches above floor and with 737 mm29 inches minimum clearance from bottom of the front rim to floor.

2.4.4.3 Service Sinks

Meet ASME A112.19.2/CSA B45.1, [white] [_____] vitreous china [ASME A112.19.3/CSA B45.4] 302 stainless steel with integral back and wall hanger supports, minimum dimensions of than 559 mm22 inches wide by 508 mm 20 inches front to rear, with two supply openings in than 254 mm10 inches high back. Provide floor supported wall outlet P-trap and stainless steel rim guards as recommended by service sink manufacturer. Provide back mounted washerless service sink faucets with vacuum breaker and 19 mm0.75 inches external hose threads.

2.4.4.4 Shower Stalls

CSA B45.5-17/IAPMO Z124 four piece [white][_____] solid acrylic, pressure molded fiberglass reinforced plastic shower stalls. Shower stalls assemblies are to be scratch resistant, waterproof, and have reinforced wall panels and base.[Provide flow restrictor in hand shower to flow 6.6 L/min1.75 gpm.][Provide filters for chlorine in supply piping to showerheads.] Provide full height separation wall between shower stalls and recessed type shower stalls 915 mm36 inches wide, 915 mm36 inches front to rear, 1829 mm76 inches high, and 125 mm5 inches curb with shower stall bottom or feet firmly supported by a smooth level floor. Provide PVC shower floor drains and stainless steel strainers. Shower stalls are to meet performance requirements of CSA B45.5-17/IAPMO Z124.

Install shower stall in accordance with the manufacturer's written instructions. Finish installation by covering shower stall attachment flanges with mildew resistant surfaces in accordance with shower stall manufacturer's recommendation. Provide smooth 100 percent silicone rubber [white][_____] mold and mildew resistant caulk between the top, sides, and bottom of shower stalls and bathroom walls and floors.

2.4.5 Backflow Preventers

Comply with ASSE 1012 or ASSE 1013. Reduced pressure principal assemblies, double check valve assemblies, atmospheric (non-pressure) type vacuum breakers, and pressure type vacuum breakers are to meet all applicable requirements of ICC IPC.

2.4.6 Drains

2.4.6.1 Shower Drains

Provide galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Drains are to be of double drainage pattern for embedding in the floor construction. The seepage pan is to have weep holes or channels for drainage to the drainpipe. The strainer is to be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane is to be provided when required. Drains are to be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket that meets ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Shower drains are to conform to ASME A112.6.3 and drain through the exterior wall. Provide mechanical trap guard seals.

2.4.6.2 Trench Drains

Provide trench drain sized to accommodate load, sloped to drain and have one code compliant exit from RLB.

2.4.7 Traps

Unless otherwise specified, traps are to be [plastic per ASTM F409] [or] [copper-alloy adjustable tube type with slip joint inlet and swivel]. Traps are to be without a clean-out.[Provide traps with removable access panels for easy clean-out at sinks and lavatories.] Tubes are to be copper alloy with walls not less than 0.813 mm0.032 inches thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets are to have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints are to be below the discharge level and are to be of metal-to-metal or metal-to-plastic type as required for the application. Nuts are to have flats for wrench grip. Outlets are to have internal pipe thread, except that when required for the application, the outlets are to have sockets for solder-joint connections. The depth of the water seal is to be not less than 50 mm2 inches. The interior diameter is to be no more than 3.2 mm0.125 inches over or under the nominal size, and interior surfaces are to be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange is to be provided for lavatories. The assembly is to be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.4.8 Water Heaters

Provide hot water to each wet RLB unit. Water heater types and capacities are to be an electric dual element quick recovery water heater designed and sized according to ASHRAE 90.1 - IP and ASHRAE 90.1 - SI. The water heater will be complete with a pressure relief valve, drain pan, and a metal tank drain valve. Each water heater is to have replaceable anodes. The water drip collection pan, relief valve and drain pan is to be separately piped to the exterior. Each primary water heater is to have controls with an adjustable range that includes 32 degrees C90 degrees F to 71 degrees C160 degrees F.

Electric Type. Electric type water heaters are to conform to UL 174 with dual heating elements. Each element is to be 4.5 KW. The elements are to be wired so that both elements can operate simultaneously.

2.4.9 Expansion Tanks

A factory pre-charged expansion tank is to be installed on the cold water supply to each water heater. Expansion tanks are to be specifically designed for use on potable water systems and are to be rated for 93 degrees C200 degrees F water temperature and 1000kPa150 psi working pressure.

2.4.10 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors.

Sleeves Not in Masonry and Concrete. Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves. Fill remaining voids with sealant.

2.4.11 Pipe Hangers (Supports)

Provide MSS SP-58 Type 1 with adjustable type steel support rods. Provide Type 40 insulation protection shield for insulated piping.

2.4.12 Heat Tape

Each wet unit will be provided with a heat tape receptacle located on the unit and within approximately 600 mm24 inches of the water pipe inlet. Receptacles are to be easily accessible and within 0.3 m1 foot from the edge of the facility. The heat tape receptacle is to be a single outlet with a weatherproof case. The exterior receptacle for the heat tape is to not be protected by a ground fault circuit interrupter.

2.5 FIRE PROTECTION AND LIFE SAFETY

Fire Protection and Life Safety is to be in accordance with UFC 1-201-01. Smoke alarms must be provided and operate in accordance with UFC 1-201-01. Install smoke detectors in accordance with NFPA 72 and carbon monoxide detectors in accordance with NFPA 72. A manual alarm system must be provided when required by UFC 1-201-01.

2.6 ELECTRICAL

2.6.1 Materials

a. Material and equipment installed under this contract is to be for the appropriate application and installed in accordance with manufacturers recommendations.

b. Equipment enclosure types are to be in compliance with the National Electrical Manufacturer's Association (NEMA) or the International Electro-Technical Committee (IEC) standards.

c. Major components of equipment are to have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a non-corrosive and non-heat sensitive plate, attached to the equipment. All equipment delivered and placed in storage, prior to installation, is to be protected from the weather, humidity and temperature variation, dirt and dust, and other contaminants. All equipment is to be in new condition, undamaged and unused

d. All material and equipment is to be a standard product of a manufacturer regularly engaged in the manufacture of the product and is to essentially duplicate items that have been in satisfactory use for at least two years prior to bid opening.

2.6.2 Panelboards

a. [UL 67][or][IEC 60947-4-1-manufactured, and type-tested assembly (TTA)].

b. All panelboards are to be circuit breaker 'bolt-on' type panels.

c. Enclosures for exterior and interior applications are to be NEMA Type 3 (IEC Classification IP54) and NEMA Type 1 (IEC Classification IP10) respectively.

d. Circuit breakers are to be connected to copper bus bars within the panelboards. Daisy chain (breaker-to-breaker) connection(s) made with conductor or interconnecting busbar are not acceptable. A 3-pole circuit breaker is to be a single unit and not made up of 3 single pole circuit breakers connected with a wire[or bridge to make a 3-pole breaker].

e. For large panels (225 Ampere and above) provide an ammeter, voltmeter and kilowatt-hour meter to monitor energy usage. Selector switches are to be provided for each meter to read all 3 phases.

f. All panelboards are to be surface mounted. All panels are to be provided with a minimum of 25% spare capacity for future load growth.

g. Buildings with branch circuit breakers larger than 32A, 3 pole are to have at least one distribution panel for the larger breakers.

2.6.3 Circuit breakers

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NOTE: Provide host nation specified sockets if known and if other than one of these types.

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a. [UL 67][or][IEC 62053-22-manufactured].

b. Circuit breakers are to be rated no less than 16-amperes.

c. All breakers feeding wet areas are to be Residual Current Breakers with Overload (RCBO) or Ground Fault Circuit Interrupter (GFCI).

2.6.4 Receptacles (Socket-outlets)

[For 60 Hz systems, receptacles are to be heavy duty type, NEMA Type 5-20R in accordance with NEMA WD 6.] or [For 50 Hz systems, socket-outlets are to be heavy duty type, 13A in accordance with BS 1363-2 or 16A, Type CEE 7/3 ("schuko" type F) in accordance with IEC 60884-1].

2.6.5 Weatherproof Receptacles

Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle must be listed for IP 66 use in "wet locations with plug in use."

2.6.6 Ground-Fault or Residual-Current Device (RCD) Receptacles

BS 1363-1, duplex type for mounting in standard outlet box. Device must be capable of detecting current leak of 10 milliamperes per requirements of BS 1363-1 for RCD devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.6.7 Arc-Fault Receptacles

UL 1699, duplex type for mounting in standard outlet box. Provide device capable of detecting series arcing current when the current to ground is 5 amperes or higher, and tripping per requirements of UL 1699.

2.6.8 Cable Trays

Provide cable tray product and cable tray design in accordance with Section 26 20 00INTERIOR DISTRIBUTION SYSTEM.

2.6.9 Luminaires

All light fixtures, interior and exterior, are to be LED (light emitting diode) type. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the driver and light sources provided. All lights are to comply with Section 26 51 00 INTERIOR LIGHTING and Section 26 56 00 EXTERIOR LIGHTING. Design levels are to be in accordance with IES Lighting Library at a minimum.

Living room/Quarters	35 FC 350 LUX
Toilets, Showers, Latrines, washrooms	20 FC 200 LUX
Mechanical/Electrical rooms	30 FC 300 LUX
Corridors and Stairways	20 FC 200 LUX
Offices (private)	20 FC 200 LUX
Office areas (open)	30 FC 300 LUX
Kitchens (commercial)	70 FC 700 LUX
Dining Areas	20 FC 200 LUX
Conference	30 FC 300 LUX
Video Conference	50 FC 500 LUX
Patient Rooms (general)	Per UFC 4-510-01
Patient Rooms (critical)	Per UFC 4-510-01
Egress path (incl. exterior)	1 FC 10.8 Lux

2.6.9.1 Luminaire Samples

Submit one sample of each luminaire type , complete with light source,LED drivers rated for Multi 120-400 Volt operation, and 2 meters 6 feet pigtail with 3-prong Edison plug. Sample will be returned to the Contractor for installation in the project work. In addition, provide test reports for ANSI/IES LM-79 test report, ANSI/IES LM-80 test report, ANSI/IES TM-21 test report, ANSI/IES TM-30 test report in accordance with Section 26 51 00 INTERIOR LIGHTING and Section 26 56 00 EXTERIOR LIGHTING.

2.6.9.2 Emergency Lighting

Provide emergency drivers, emergency lighting egress units, and exit signs to comply with Section 26 51 00 INTERIOR LIGHTING and Section 26 56 00 EXTERIOR LIGHTING.

2.6.9.3 Switches

2.6.9.3.1 Toggle Switches

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NOTE: Do not use solderless pressure type toggle switches on Navy projects.

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NEMA WD 1, UL 20,[single pole][, double pole][, three-way][, and four-way], totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

a. Handles: [white][ivory][brown] thermoplastic.

b. Wiring terminals: screw-type, side-wired[or of the solderless pressure type having suitable conductor-release arrangement].

c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.

d. Switches: rated quiet-type ac only, [120/208 volts][or][400/230 volts], with current rating and number of poles indicated.

2.6.10 Wire and Cable

All wiring is to have copper conductors with thermoplastic insulation. Aluminum conductors are not allowed. Provide wires and cables in accordance with NFPA 70 and UL for type of insulation, jacket, and conductors.

2.6.10.1 Color Coding

Color Coding of Conductor Insulation [For 60 Hz systems: Phase conductors are to be black, red and blue with a white neutral for three phase. Phase conductors are to be black or red with a white neutral for single phase.][For 50 Hz systems: Phase conductors are to be brown, black and gray with a blue neutral for three phase. Phase conductors are to be brown with a blue neutral for single phase.][For systems, grounding (earthing) conductors are to be green with a yellow stripe.]

2.6.11 Grounding and Bonding

Grounding and bonding is to comply with the requirements of [BS 7671 for 50 Hz system] [or] [NFPA 70 and NFPA 780 for 60 Hz system]. All raceways are to include insulated equipment grounding conductor (protective earth conductor), and grounding electrodes (earthing) are to be installed at every building or structure. Grounding electrodes are to include, at a minimum:
Concrete encased electrode, bond to building steel, bond to metallic water pipe, and ground rod(s). All grounding electrodes present at a building or structure, including lightning protection and communications electrodes, are to be bonded together, and underground connections are to be exothermally welded.

All exposed non-current carrying metallic parts of electrical equipment in the electrical system are to be grounded. Final measurement of the ground resistance is to not exceed 25 ohms when measured more than 48 hours after rainfall. Ground rods are to be copper clad steel, with minimum diameter of 20 mm0.75 inches and minimum length of 3000 mm118 inches.

2.6.12 Surge Protection Device (SPD)

Provide Surge Protection Device (SPD) or Transient Voltage Surge Suppression (TVSS) in accordance with UL 1449 at the service entrance Main Distribution Panel and communication panels. Provide surge protectors in a NEMA [1][_____] enclosure in accordance with NEMA ICS 6.

PART 3 EXECUTION

3.1 RLB UNIT IDENTIFICATION

Each unit is to have appropriate signage to number and identify each unit's type and components. The Contractor is to provide a legible non-corrosive metal identification plate on each unit to indicate type, serial number, and year of production.

3.2 RLB ENVELOPE

The RLB envelope is to be composed of durable, and fire resistant materials to mitigate issues with weather, termites, vermin, rot, mold, mildew, fumes, swelling, and warping. Individual RLB Types and RLB Types that are combined units, each are to be designed as one independent facility, economically and efficiently connected, code and UFC compliant, and readily connected to utilities including water, sewer, power, and communication.

Individual RLB components are to be developed to be used interchangeably with each type of RLB. This includes but is not limited to exterior door locations, electric meters and panel boxes, switches and outlets, communication, water service and sewer discharge, wall and roof panels, components, and means and methods of connection. Pipes, conduits, switches, outlets and lights and ductwork are to be mounted and secured to exposed surfaces and readily accessible. Adhere to the following:

a. Pipes, conduits, switches, outlets and lights and ductwork are to be mounted and secured to exposed surfaces and readily accessible.

b. Provide a Class "A" roof assembly on each RLB Type.

c. Manufacture RLB per standard floor plans.

d. Assemble and install fixtures and appliances per standard floor plan and manufacturers' printed installation directions.

e. Penetrations or openings in RLB units for piping, electrical devices, recessed cabinets, showers, soffits, or heating, ventilating or exhaust ducts are to be sealed and rated as required.

3.3 HVAC

3.3.1 Installation

3.3.1.1 Condensate Drain Lines

Condensate lines are to be discharged at the facility exterior near grade according to manufacturer installation requirements.

3.3.1.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, ductless mini-splits, fans, coils, dampers, and other similar items requiring supports.

3.3.1.3 Insulation

Provide thickness and application of insulation materials for piping and equipment according to paragraph HVAC INSULATION.

3.3.2 Cleaning

Clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material before such surfaces are prepared for final finish painting or are enclosed within the structure. Clean mechanical equipment, including piping and fixtures. Deliver free from dirt, grease, and finger marks.

3.3.3 Identification Systems

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum; indicating service and item number on all valves and dampers. Make indentations black for reading clarity.

3.3.4 Performance Tests

Test each system as a whole, to ensure that all items perform as integral parts of the system. Confirm temperatures and conditions are evenly controlled throughout. Make corrections and adjustments as required to produce the conditions indicated or specified. Conduct capacity tests and general operating tests by an experienced engineer.

3.4 PLUMBING

3.4.1 General Installation Requirements

The plumbing system is to be installed complete with required fixtures, fittings, traps, valves, and accessories. Provide all fixtures with an adequate drainage system, each connecting to a main sewer line. The exit pipe is to protrude a minimum of than 150 mm6 inches, but no more than 200 mm8 inches and be capped with a removable plastic cap and chain. Water closet privacy partitions and shower partitions are to be continuously fastened to floor, wall, and ceiling. Water closets are to be centered in compartment width in accordance with IPC D330. Shower enclosures (partitions) are to be continuously fastened to floor, wall, and ceiling.

3.4.1.1 Water Pipe, Fittings, and Connections

3.4.1.1.1 Utilities

The piping is to be extended to fixtures and outlets. The hot-water and cold-water piping system is to be arranged and installed to permit draining and easy access. The supply line to each fixture, is to be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices are to be exposed and anchored to prevent movement.

3.4.1.1.2 Pipe Drains

Pipe drains are to consist of 20 mm0.75 inches hose bibb with renewable seat and gate valve ahead of hose bibb.

3.4.1.1.3 Plastic Pipe

PVC and CPVC pipe are to have joints made with solvent cement elastomeric. PEX pipe is to have PEX compatible connectors.

3.4.1.1.4 Pipe Sleeves and Flashing

Pipe sleeves are to be furnished and set in their proper and permanent location.

3.4.1.1.5 Sleeve Requirements

Provide pipe sleeves meeting the following requirements:

a. Secure sleeves in position. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.

b. Sleeves are to not be installed in structural members. Rectangular and square openings are to be as detailed. Each sleeve is to extend through its respective floor, or roof, and is to be cut flush with each surface. Pipe sleeves passing through floors in wet areas. Lavatories, kitchens, and other plumbing fixture areas are to extend a minimum of than 100 mm4 inches above the finished floor.

c. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve is to be filled with fire sealant in all walls, roofs, and floors.

3.4.1.1.6 Waterproofing

Waterproofing is to be in accordance with IPC D330.

3.4.1.1.7 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations are to be sealed to prevent infiltration of air, insects, and vermin. Penetrations in fire-resistant rated walls are to use UL listed or FM approved fire stopping.

3.4.1.2 Supports

3.4.1.2.1 General

Pipes, valves and hangars are generally intended to be exposed, installed and be code compliant. Hangers used to support piping than 50 mm2 inches and larger are to be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors are to be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain.

3.4.1.2.2 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports are to conform to MSS SP-58 except as described below:

a. Types 5, 12, and 26 are to not be used.

b. Type 3 is to not be used on insulated pipe.

c. Type 19 and 23 C-clamps are to be torqued per MSS SP-58 and are to have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

d. Type 20 attachments used on angles and channels are to be furnished with an added malleable-iron heel plate or adapter.

e. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

f. Horizontal pipe supports are to be spaced as specified in MSS SP-58 and a support are to be installed not over than 300 mm12 inches from the pipe fitting joint at each change in direction of the piping. Pipe supports are not to be spaced over 1500 mm60 inches apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe are to be 49 degrees C120 degrees Ffor PVC and 82 degrees C180 degrees F for CPVC. Horizontal pipe runs are to include allowances for expansion and contraction.

g. Pipe hangers on horizontal insulated pipe are to be the size of the outside diameter of the insulation. The insulation is to be continuous through the hanger on all pipe sizes and applications.

h. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide are to include a pipe cradle, welded to the guide structure and strapped to the pipe. The pipe is to be separated from the slide material by at least than 100 mm4 inches or by an amount adequate for the insulation, whichever is greater.

i. Hangers and supports for plastic pipe are not to compress, distort, cut or abrade the piping, and are to allow free movement of pipe except where otherwise required in the control of expansion and contraction.

3.4.2 Water Heaters

Water heaters are to be electric, high efficiency, fast recovery, and sized to accommodate the need based on amount of fixtures in each unit and assumed frequency of use. Water heaters are to be selected and sized, and installed in compliance with current codes and include a plastic drain pan and anti-scald measures.

3.4.2.1 Relief Valves

No valves are to be installed between a relief valve and its water heater. The P&T relief valve is to be installed where the valve actuator comes in contact with the hottest water in the heater. A vacuum relief valve is to be provided on the cold water supply line to the water heater and mounted above and within than 150 mm6 inches above the top of the tank or water heater.

3.4.2.2 Expansion Tank

A pre-charged expansion tank is to be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve.

The Contractor is to adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

3.4.3 Fixtures and Fixture Trimmings

3.4.3.1 Backflow Prevention Devices

Backflow preventers are to be installed in accordance with IPC D330 at all locations required to preclude a cross-connect or interconnect between a potable water supply and non-potable substance. In addition, backflow preventers are to be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the non-potable substance. Backflow preventers are to be located so that no part of the device will be submerged. Backflow preventers are to be of sufficient size to allow unrestricted flow of water to the equipment and preclude the backflow of non-potable substances into the potable water system. Bypass piping is to not be provided around backflow preventers. Access is to be provided for maintenance and testing. Each device is to be a standard commercial unit.

3.4.3.2 Access Panels

Access panels are to be provided for concealed valves and controls, or items requiring inspection or maintenance. Access panels are to be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Panels are to be attached and match the adjacent material finish.

3.4.3.3 Traps

Each trap is to be placed as near the fixture as possible, and no fixture is to be double trapped. Traps installed on plastic pipe may be plastic that meets ASTM D3311.

3.4.4 Plumbing Identification Tags

The main supply inlet shut-off valve is to have an identification tag made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number is to be installed on valves, except those valves installed on supplies at plumbing fixtures.

3.4.5 Escutcheons

Escutcheons are to be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons are to be fastened to pipe or pipe covering and are to be satin-finish, [corrosion-resisting steel] [polished chromium-plated zinc alloy], or [polished chromium-plated copper alloy].

3.4.6 Tests, Flushing, and Disinfection

3.4.6.1 Plumbing System

The following tests are to be performed on the plumbing system in accordance with ICC IPC, except that the drainage and vent system final test are to include the smoke test. A peppermint test in lieu of the smoke test is optional. If a peppermint test is chosen, a submittal detailing a testing procedure and reasons for choosing this option in lieu of the smoke test must be received.

a. Drainage and Vent Systems Test.

b. The final test is to include a smoke test.

c. Water Supply Systems Tests.

3.4.6.2 Test of Backflow Prevention Assemblies

Backflow prevention assembly is to be tested using gauges specifically designed for the testing of backflow prevention assemblies. Backflow prevention assembly test gauges are to be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges are to be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection AWWA M14, or other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly are to include, as a minimum, the following:

a. Data on Device   Data on Testing Firm

b. Type of Assembly   Name

c. Manufacturer   Address

d. Model Number   Certified Tester

e. Serial Number   Certified Tester No.

f. Size   Date of Test

g. Size   Date of Test

h. Test Pressure Readings   Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit is to be repaired and retested.

3.4.6.3 Defective Work

If inspection or test shows defects, such defective work or material is to be replaced or repaired as required and inspection and tests are to be repeated. Repairs to piping are to be made with new materials.

3.5 ELECTRICAL

3.5.1 Service Entrance and Main Panel

Electrical installation must be in accordance with of NFPA 70 and IEEE C2. The units electrical service entrance is to consist of a circuit breaker type panelboard, complete with main and branch circuit breakers. The panelboard is to be dead-front type, equipped with thermal magnetic molded case circuit breakers having trip indicators and common trip on multiple breakers. A circuit directory is to be permanently affixed to the inside of the panel door. Circuits will be clearly and legibly identified. The service entrance cable is to be sized at a minimum of 125% of the size of the main distribution switchboard or the main circuit breaker ampere rating whichever is larger. The Main distribution switchboard is to include required circuit breakers for RLB electrical loads, plus 15% spare circuit breakers, plus spaces for breakers for the future loads.

When a fire alarm system is required and a circuit breaker is the main shut-off, the circuit breaker is to be red for identification and lockable to prevent unwanted deactivation.

3.5.2 Light Fixtures

Lighting is to be designed for an illumination level required for functional usage of rooms in accordance with IES Lighting Library level criteria by space calculations. In general, indoor lighting for areas will be LED, depending on the ceiling type, be recessed, surface or pendant mounted fixtures. Surface mounted LED light fixtures with photocell will be provided above exterior doors. Recessed light fixtures are to be provided in drop acoustical tile ceilings. Lighting fixtures are to be standard fixtures, no hanging lights are permitted. As a minimum bathroom(s) are to have one lighted exhaust ceiling or wall fan. A minimum of one light switch is provided in every room. Lighting in large rooms or areas may be controlled from multiple switches.

Exterior building lighting for doorway lighting is to be LED low maintenance, high efficiency, wall pack type units at the doorway entrance and provided above each man door. Exterior lights are to be controlled with a single photocell and lighting contactor controlled. The contactor photocell is generally located on the north side of the building in the shade approximately 1m above exterior building mounted fixtures. Emergency lighting is provided throughout building to facilitate movement and exit of personnel during power failure. Emergency lighting fixtures illuminate points on the path of egress (corridors to exit doors) to an illumination level of 11 Lux in accordance with NFPA 101 requirements.

3.5.3 Lightning Protection

Provide a lightning risk assessment in accordance with NFPA 780 Annex L and document the required level of protection. If lightning protection is a design requirement, provide a lightning protection system in accordance with NFPA 780.

3.5.4 Telecom Service Entrance

Provide than 50 mm2 inches entrance conduit. Provide a proper seal around the telecom service entrance conduit and provide a re-enterable sealant inside the telecom service entrance conduit. Provide the highest rated NEMA enclosure for maximum corrosion resistance and weather-proofing on the exterior of the RLB unit. Provide a NEMA Type 3 with a 3X/IP55 rating in order to satisfy the use of CATV terminal and a wireless access device (WAP) antenna.

3.5.5 Communication Interior Distribution System

a. Type A and Type D - Two communications outlet boxes are to be provided in each room; one outlet on each long wall. In the office space an outlet box is to be installed every 1800 mm71 inches along the interior walls. Conference Rooms are to have three outlet boxes.

b. Outlet boxes are to be installed 610 mm24 inches above finished floor.

c. An electrical receptacle is to be provided within 300 mm12 inches of each communications outlet.

d. Surface-mounted nonmetallic raceway is to be provided for communication cable only (not to be used for electrical wiring), and spaced at least 150 mm6 inches from electrical conduit.

3.6 FIELD QUALITY CONTROL

Provide test equipment and personnel and submit written copies of test results. Give Contracting Officer [5][_____] working days notice prior to[each][_____] test[s]. Where applicable, test electrical equipment in accordance with NETA ATS.

3.6.1 Electrical Systems Test

Perform 600-volt wiring test, ground-fault receptacle test, arc-fault receptacle test, and grounding system test in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS and emergency light test in accordance with Section 26 51 00 INTERIOR LIGHTING.

3.7 SHIPPING, HANDLING AND STORAGE

3.7.1 Delivery

Package and deliver RLB components, and other manufactured items so as not to be damaged or deformed and protected during transportation and handling.

3.7.2 Handling and Storage

Stack, secure, and store RLB components in an organized manner on platforms or pallets, covered with weather-tight and ventilated covering to ensure dryness, with positive slope for drainage of water.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-13 48 73 (May 2022)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-13 48 73 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-13 48 73 (May 2022)**

Preparing Activity: USACE **Superseding without Revision**
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SECTION 13 48 73

SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT

05/22

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NOTE: This guide specification covers the requirements for seismic structural elements for protection of miscellaneous equipment.

This guide specification [also] covers all equipment bracing requirements (including mechanical, electrical and architectural) for antiterrorism protection from equipment falling on building occupants in accordance with UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Projects only having antiterrorism equipment bracing requirements with no seismic protection requirements will require significant editing to this UFGS because most of the requirements apply to seismic protection. Projects having both antiterrorism equipment bracing and seismic protection requirements will require the specification to be edited such that the most stringent of both requirements is met.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The intent of this specification is to provide for adequate resistance to lateral forces induced by earthquakes for listed mechanical, electrical and miscellaneous equipment and systems. The design seismic lateral forces are in addition to the "normal" gravity forces (weight) acting on the components of a system. This guide specification will be used in conjunction with Sections 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS, 01 45 35 SPECIAL INSTRUCTIONS, and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

Seismic protection design for anchorage and bracing of all equipment will be based on UFC 3-301-01 Seismic Design for Buildings and UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings.

The designer has 3 options to provide seismic protection for a project:

1) Issue a contract requiring the Contractor to hire a registered structural engineer to submit the stamped calculations and drawings in accordance with this section. The contracting Officer will "accept" the design but the registered engineer (Engineer of Record) will have final responsibility for the adequacy of the structural members and their connections.

2) Hire an A-E who will use this section and will submit calculations and drawings stamped by a registered structural engineer. The Contracting Officer will "accept" the design but the registered engineer (Engineer of Record) will have final responsibility for the adequacy of the structural members and their connections. One of the disadvantages of this approach may be that the actual equipment dimensions, weights and mounting details may not be known until the equipment is acquired. The structural engineer should be retained during the construction phase to review seismic bracing shop drawings and perform field inspections as part of the final responsibility.

3) Perform the design in house, in which case the Government designer will have final responsibility for the adequacy of the structural members and their connections. One of the disadvantages of this approach may be that the actual equipment dimensions, weights and mounting details may not be known until the equipment is acquired. The structural engineer should be retained during the construction phase to review seismic bracing shop drawings and perform field inspections as part of the final responsibility

Regardless of who performs the design, this section, properly edited, must be included in the construction documents to allow the Contractor to install the seismic protection features.

This section can be used for bracing details of medical equipment by editing the specification accordingly.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 355.2	(2007) Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary
ACI 355.4	(2011) Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4) and Commentary

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A603	(2019) Standard Specification for Zinc-Coated Steel Structural Wire Rope
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC ES AC156	(2012) Acceptable Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
ICC-ES AC23	(2012; R 2016) Acceptance Criteria for Sprayed Fire-resistant Materials (SFRMs), Intumescent Fire-resistant Coatings and Mastic Fire-resistant Coatings Used to Protect Structural Steel Members

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

METAL FRAMING MANUFACTURERS ASSOCIATION (MFMA)

MFMA-4	(2004) Metal Framing Standards Publication

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military Assets
UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

VIBRATION ISOLATION AND SEISMIC CONTROL MANUFACTURERS ASSOCIATION (VISCMA)

VISCMA 412	(2014) Installing Seismic Restraints for Mechanical Equipment

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

****

NOTE: Designer should verify that specified details do not interfere with the performance of the cathodic protection system (when used) or of the vibration isolation systems.

For systems and equipment in RC V buildings that have a performance objective higher than non-mission critical, the designer should show a "G" classification for the items under SD-02 Shop Drawings in the SUBMITTALS paragraph. This will allow the Engineer of Record (EOR) to: 1)Do a QC review on the anchorage and bracing details of these essential systems, and 2)Assess the impact of the bracing and anchorage details on the structural supporting system of the essential building. This also includes Designated Seismic Systems that must remain operational after an earthquake.

Design done by the Contractor must be in accordance with UFC 3-301-01 and UFC 4-010-01. Loadings determined using UFC 3-301-01 are based on strength design; therefore, 2018 IBC, ASCE 7-16-10, and ASCE/SEI 41-13 should be used to design the steel members in the bracing and anchorage systems.

****

Apply the requirements for seismic protection measures, described in this section and on the drawings, of the miscellaneous equipment and systems listed below, in accordance with UFC 3-301-01 and additional data furnished by the Contracting Officer. Provide seismic protection measures in addition to any other requirements called for in other sections of these specifications. Where there is a conflict between the specifications and the drawings, the specifications will take precedence. Accomplish resistance to lateral forces induced by earthquakes without consideration of friction resulting from gravity loads
.

1.2.2 Miscellaneous Equipment and Systems

****

NOTE: The designer must ensure that the lists below includes all miscellaneous items to be braced. Delete the items which are not part of the project and add items which are not included in the list. The lists should be broken out as follows: For nonstructural equipment, components and systems in Risk Category V structures, the designer should provide three separate lists of equipment and systems; non-Mission Critical (NMC), Mission Critical Level 1 (MC-1 equipment and components must be fully operational immediately after a seismic event), or Mission Critical Level 2 (MC-2 equipment and components must be repairable and operable within 3 days after a seismic event). For nonstructural equipment/components/systems in Risk Category I, II, III, or IV structures, two separate lists of nonstructural systems/components must be provided; components/systems with Ip = 1.0 and components/systems with Ip = 1.5 (Designated Seismic Systems).

****

Provide bracing and attachment for the following miscellaneous equipment and components developed by the [Contractor] [A-E] in accordance with the requirements of this specification:

[Equipment/Components with Ip = 1.0
Storage cabinets
Ornamentations
Storage Racks
Signs and Billboards
Shelving
Furnishings
Partitions
Stacks
Pole or frame supported equipment
Storage tanks for water and oil
[_____]]

[Equipment/Components with Ip = 1.5 (Designated Seismic Systems)
Insert edited list here similar to one above for Ip = 1.0]
[Non-Mission Critical (NMC) Equipment/Components in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]
[Mission Critical Level 1 (MC-1) Equipment/Components in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]
[Mission Critical Level 2 (MC-2) Equipment/Components in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]

1.2.3 Contractor Designed Bracing

****

NOTE: Retain this paragraph when the Contractor will design the bracing. The designer will refer and/or modify the listings above or will list below the equipment and systems to receive seismic

bracing. Delete this paragraph when all bracing details and locations are indicated on the drawings and calculations are included in the Design Analysis.

****

Submit copies of the design calculations with the drawings. Calculations must be approved, certified, stamped and signed by a registered Professional Structural Engineer. Calculations must verify the capability of structural members to which bracing is attached for carrying the load from the brace. Design the bracing in accordance with UFC 3-301-01, UFC 4-010-01 and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes must be accomplished without consideration of friction resulting from gravity loads. UFC 3-301-01 uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas must be required. Loadings determined using UFC 3-301-01 are based on strength design; therefore, AISC 325 Specifications must be used for the design. The bracing for the equipment designated in paragraph 1.2.2 must be developed by the Contractor. [Provide documentation of an independent design review for mission critical (MC) equipment bracing design. Documentation must be signed by the independent reviewer who must also be a registered structural engineer.]

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project. This includes Designated Seismic Systems and Mission Critical Systems that must remain operational after an earthquake.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL

PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Bracing; G, [_____]

Resilient Vibration Isolation Devices; G, [_____]

Equipment Requirements; G, [_____]

SD-03 Product Data

Bracing; G, [_____]

Equipment Requirements; G, [_____]

Anchor Bolts; G, [_____]

Vibration Isolators; G, [_____]

Snubbers; G, [_____]

SD-05 Design Data

Design Calculations; G, [_____]

SD-06 Test Reports

Anchor Bolts; G, [_____]

SD-07 Certificates

ICC ES AC156 Shake Table Test; G, [_____]

PART 2 PRODUCTS

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NOTE: Appropriate materials for structural supports must be used in corrosive environments. Dissimilar metals must be isolated.
****

2.1 EQUIPMENT REQUIREMENTS

****
NOTE: Seismic Control Bracing does not guarantee that the equipment itself is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, include paragraph 3.11 Special Testing

for Seismic Resisting Equipment.
****

Submit detail drawings of bracing along with calculations, catalog cuts, templates, and erection and installation details, as appropriate, for the items listed in Paragraph 1.2.2. Indicate thickness, type, grade, class of metal, and dimensions; and show construction details, reinforcement, anchorage, and installation with relation to the building construction. Provide calculations and drawings that are stamped by a registered structural engineer, and that verify the capability of structural members to which bracing is attached for carrying the load from the brace. Design must be based on actual equipment and system layout. Design must include calculated dead loads, static seismic loads and capacity of materials utilized for the connection of the equipment or system to the structure. Analysis must detail anchoring methods.

Include drawing for [Mission Critical Equipment and] Designated Seismic System Equipment indicating the equipment location in the facility sufficient to be used for the installation. Equipment must be rigidly or flexibly mounted as indicated in the specifications and/or drawings depending on vibration isolation requirements as follows below. Roof mounted equipment both vibration isolated and nonisolated, must have support members designed and anchored to building structural steel or concrete as required for seismic restraint and wind loads.

2.1.1 Rigidly (Base and Suspended) Mounted Equipment

****
NOTE: List items that may require additional reinforcements (internally) to prevent permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake and to meet the specified requirements. Coordinate with note in paragraph BRACING.
****

Equipment furnished under this contract must be [rigidly mounted] [rigidly mounted using cast-in-place anchor bolts to anchor them or post-installed anchors that are qualified for earthquake loading in accordance with ACI 355.2 and ACI 355.4. Anchor bolts must conform to ASTM F1554-07ae1]. For any rigid equipment which is rigidly anchored, provide flexible joints for piping, electrical conduit, etc., that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions. Suspended equipment bracing attachments should be located just above the center of gravity to minimize swinging. [Mission critical base mounted and suspended equipment for Risk Category (RC) V,] and Designated Seismic Systems (DSS) RC IV buildings assigned to Seismic Design Category Coefficient (SDC) C, D, E, or F and Risk Category IV components needed for continued operation after an earthquake must have two nuts provided on each anchor bolt.

2.1.2 Nonrigid or Flexibly-Mounted Equipment

Select vibration isolation devices so that the maximum movement of equipment from the static deflection point is 6 mm 1/4 inch. Equipment flexibly mounted on vibration isolators must have a bumper restraint or snubber in each horizontal direction and vertical restraints must be provided where require to resist overturning. Isolator housing and restraints must be constructed of ductile materials. A viscoelastic pad or similar material of appropriate thickness must be used between the bumper and components to limit the impact load. Restraints must be designed to resist the calculated horizontal lateral and vertical forces.

Spring vibration isolators must be seismically rated, restrained isolators for equipment subject to load variations and large external forces. The seismically rated housing must be sized to meet or exceed the force requirements applicable to the project and meet the required isolation criteria. Spring vibration isolator manufacturer's will be a member of VISCMA. Design force, Fp, must be doubled for vibration isolators with an air gap greater than 0.25 inches as specified in ASCE 7-16, Chapter 13.

2.2 BOLTS AND NUTS

Hex head bolts, and heavy hexagon nuts must be ASTM A325 or ASTM A490 bolts and ASTM A563 nuts. Provide bolts and nuts galvanized in accordance with ASTM A153/A153M when used underground or exposed to weather.

2.3 SWAY BRACING

Material used for members listed [in this section] [and] [on the drawings], must be structural steel conforming with the following:

a. Plates, rods, and rolled shapes, ASTM A36/A36M.

b. Wire rope, ASTM A603.

c. Tubes, ASTM A500/A500M, Grade B.

d. Pipes, ASTM A53/A53M, Grade B.

e. Angles, ASTM A36/A36M.

f. Channels (Struts) with in-turned lips and associated hardware for fastening to channels at random points conforming to MFMA-4.

PART 3 EXECUTION

3.1 BRACING

****

NOTE: Designs must include complete seismic details showing bracing requirements. The design is for the supports of the equipment, not the equipment itself. Bracing does not guarantee that the equipment is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, the manufacturer should be consulted regarding the capabilities of the equipment to withstand seismic loading.

****

Provide bracing conforming to the arrangements shown. Install cables at a 45-degree slope. Where interference is present, the slope may be minimum of 30 degrees or a maximum of 60 degrees per VISCMA 412.

3.2 BUILDING DRIFT

****

NOTE: The designer will be guided by the results of the seismic analysis to determine the expected drift of the building; this information is needed for equipment bracing design.

****

Do not attach sway braces for equipment to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided. Bracing must be capable of accommodating building drift due to seismic displacements.

3.3 ANCHOR BOLTS

3.3.1 General

Submit copies of test results to verify the adequacy of the specific anchor and application, as specified.

Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices allowing adequate edge distance and embedment depth for restraint anchor bolts. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Install neoprene grommet washers or till the gap with epoxy on equipment anchor bolts where clearance between anchor and equipment support hole exceeds 0.125 inches.

3.3.2 Cast-In-Place

****

NOTE: The designer will ensure that foundations and anchor bolts for pad-mounted or floor-mounted equipment are detailed and designed in accordance with UFC 3-301-01. When the designer has the necessary size, weight, and other information for a piece of equipment, the anchorage details including sizes, length and number of bolts, thickness and reinforcing of pads and foundations for that piece of equipment will be shown by the designer on the drawings. When this information is not available, it will be the A-E responsibility to design the support and anchorage for the equipment in accordance with the specified requirements.

If the calculated seismic forces would cause the equipment to uplift, the anchor bolts should be designed for combined shear and tension.

****

Use templates to locate cast-in-place bolts accurately and securely in formwork. Provide anchor bolts with an embedded straight length equal to at least 12 times nominal diameter of the bolt. Anchor bolts that exceed the normal depth of equipment foundation piers or pads must either extend into concrete floor or the foundation or be increased in depth to accommodate bolt lengths. Use templates to locate cast-in-place bolts accurately and securely in formwork.

3.3.3 Drilled-In Anchor Bolts

****

NOTE: Verify if restrictions exist on the type of drilling equipment to be used for the project.

****

Drill holes with rotary impact hammer drills. Drill bits must be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the drawings, all holes must be drilled perpendicular to the concrete surface. Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the COR if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines. Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Perform anchor installation in accordance with manufacturer instructions. For Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors, protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10 percent of the specified torque, 100 percent of the specified torque must be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor must be removed and replaced unless otherwise directed by the Engineer.

For Cartridge Injection Adhesive Anchors where approved for seismic application, clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive must be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed. For Capsule Anchors where approved for seismic application, perform drilling and setting operations in accordance with manufacturer instructions. Clean all holes to remove loose material and drilling dust prior to installation of adhesive. Remove water from drilled holes in such a manner as to achieve a surface dry condition. Capsule anchors must be installed with equipment conforming to manufacturer recommendations. Do not disturb or load anchors before manufacturer specified cure time has elapsed. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

3.3.4 Anchor Bolt Testing

****

NOTE: Expansion and chemically bonded anchors should be tested after installation. Testing every expansion anchor is not necessary or practical;

therefore a reasonable rate of testing should be developed depending on the importance of the job. There are two methods of testing: Torque wrench and pullout testing. The torque test is easier and cheaper and usually gives a good indication of installation quality; the pullout test gives a better indication of the strength of both expansion and chemically bonded anchors. The torque test does not apply to expansion bolts which are anchored by hammering the sleeve over a cone such as self drilling anchors.

****

Test in place expansion and chemically bonded anchors not more than [24] [_____] hours after installation of the anchor, conducted by an independent testing agency; testing must be performed on random anchor bolts as described below.

3.3.4.1 Torque Wrench Testing

****

NOTE: Delete this paragraph for expansion anchors which are not anchored by an applied torque, such as self drilling anchors.

Torque wrench testing verifies that a torqued expansion anchor has seated properly. If it has not seated, the applied torque on the nut will cause the bolt to twist in the hole. Torque wrench testing does not load the bolt up to allowable load and therefore does not verify the capacity of the installed bolt.

****

Perform torque wrench testing on not less than [50] [_____] percent of the total installed expansion anchors and at least [one anchor] [[_____] anchors] for every piece of equipment containing more than [two] [_____] anchors. The test torque must equal the minimum required installation torque as required by the bolt manufacturer. Calibrate torque wrenches at the beginning of each day the torque tests are performed. Recalibrate torque wrenches for each bolt diameter whenever tests are run on bolts of various diameters. Apply torque between 20 and 100 percent of wrench capacity. Reach the test torque within one half turn of the nut, except for 9 mm 3/8 inch sleeve anchors which must reach their torque by one quarter turn of the nut. If any anchor fails the test, test similar anchors not previously tested until [20] [_____] consecutive anchors pass. Failed anchors must be retightened and retested to the specified torque; if the anchor still fails the test it must be replaced.

3.3.4.2 Pullout Testing

****

NOTE: Pullout testing is expensive and labor intensive because of the apparatus needed to pull on the anchor bolt. Pullout testing determines the tension capacity of the anchor bolt. The amount of load to be applied can vary between 0.5 to 2 times the calculated load, depending on the importance of the bolt. There is not a significant cost

difference between testing to 0.5 or 2 times the calculated load; since most anchor bolts have a factor of safety of 4, testing to twice the specified load should not cause any distress. The typical tension failure causes a shear cone to be pulled out of the concrete, the slope of the cone is about a 45 degree angle so there should be nothing on the concrete surface in the vicinity of the bolt to prevent the cone from pulling out. Shear testing is usually not needed unless the bolt is heavily loaded in shear and close to an edge.

****

Test expansion and chemically bonded anchors by applying a pullout load using a hydraulic ram attached to the anchor bolt. Testing must be done in accordance with ASTM E488/E488M or ICC-ES AC23. At least [5] [_____] percent of the anchors, but not less than [3] [_____] per day must be tested. Apply the load to the anchor without removing the nut; when that is not possible, the nut must be removed and a threaded coupler must be installed of the same tightness as the original nut. Check the test setup to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus must be at least 1.5 times the embedment length away from the bolt being tested. Load each tested anchor to [1] [_____] times the design tension value for the anchor. The anchor must have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested must be tested until [10] [_____] consecutive anchors pass. Failed anchors must be retightened and retested to the specified load; if the anchor still fails the test it must be replaced.

3.4 RESILIENT VIBRATION ISOLATION DEVICES

Where the need for these devices is determined, based on the magnitude of the design seismic forces, select anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations that follow the same procedure as in paragraph ANCHOR BOLTS, except use an equipment weight equal to [five] [_____] times the actual equipment weight.

3.4.1 Spring-Type Vibration Devices

****

NOTE: Designer must double design force Fp for vibration isolators where maximum movement of equipment from static deflection point is greater than 0.25 inches as specified in ASCE 7-16, Table 13.6-1, footnote b.

****

Select vibration isolation devices so that the maximum movement of equipment from the static deflection point is 13 mm 1/2 inch. Equipment flexibly mounted on vibration isolators must have a bumper restraint or snubber in each horizontal direction and vertical restraints must be provided where required to resist overturning. Isolator housing and restraints must be constructed of ductile materials. A viscoelastic pad or similar material of appropriate thickness must be used between the bumper and components to limit the impact load. Restraints must be designed to resist the calculated horizontal lateral and vertical forces.

Spring vibration isolators must be seismically rated, restrained isolators for equipment subject to load variations and large external forces. The seismically rated housing must be sized to meet or exceed the force requirements applicable to the project and meet the required isolation criteria. Spring vibration isolator manufacturers will be a member of VISCMA.

3.4.2 Multidirectional Seismic Snubbers

****

NOTE: Details of multidirectional seismic snubbers will be shown in drawings if paragraph is retained.

Designer must double design force Fp for vibration isolators where maximum movement of equipment from static deflection point is greater than 0.25 inches as specified in ASCE 7-16, Table 13.6-1, footnote b.

****

Install multidirectional seismic snubbers employing elastomeric pads on floor- or slab-mounted equipment. Use snubbers that provide 6 mm 1/4 inch free vertical and horizontal movement from the static deflection point. Provide snubber medium consisting of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

3.5 EQUIPMENT SWAY BRACING

3.5.1 Suspended Equipment

****

NOTE: Equipment weighing more than one-fifth of the dead load of slabs above grade at the equipment level or equipment weighing more than one-tenth of the building weight must be checked by structural analysis to conform with building seismic provisions. Such equipment has a pronounced effect on the response of the building. The following items must be checked structurally and specific seismic bracing and/or anchoring requirements must be incorporated on appropriate drawings and in the relevant specifications.

Pole or frame supported equipment.

Storage tanks for water and oil.

Storage racks with upper storage level more than 2.4 m 8 feet in height.

Smoke stacks taller than 15 m 50 feet in height.

****

Provide equipment sway bracing for items supported from floor, overhead floor or roof structural systems. Provide braces that consist of angles, rods, wire rope, bars, channels (struts) or pipes arranged as shown in bracing submittals and secured at both ends with not less than 13 mm 1/2 inch bolts. Provide sufficient braces for equipment to resist a horizontal force as specified in UFC 3-301-01 without exceeding safe working stress of bracing components. Provide, for approval, specific force calculations in accordance with UFC 3-301-01 for the equipment in the project. Submit details of equipment bracing for acceptance. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

3.5.2 Floor or Pad Mounted Equipment

3.5.2.1 Shear Resistance

Bolt to the floor, floor mounted equipment. Provide the number and installation of bolts to resist shear forces in accordance with paragraph ANCHOR BOLTS.

3.5.2.2 Overturning Resistance

****

NOTE: See UFC 3-301-01 for guidance on design of anchor bolts.

****

Use the ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads to determine if overturning forces need to be considered in the sizing of anchor bolts. Provide calculations to verify the adequacy of the anchor bolts for combined shear and overturning.

3.6 SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT

****

NOTE: Include this paragraph only for special testing for seismic-resisting equipment and components designated as Risk Category V Mission Critical Level 1 (MC-1) by the building owner and specified by the Structural Engineer. MC-1 equipment and components must be fully operable immediately after a seismic event. This paragraph may also apply to Designated Seismic System (DSS)(assigned to SDC C thru F) equipment and components that must remain operational after an earthquake to function for life safety purposes or is needed for continued operation in a Risk Category IV structure.

This paragraph will be applicable to both new buildings designed according to UFC 3-301-01 STRUCTURAL ENGINEERING, UFC 3-301-02 DESIGN OR RISK CATEGORY V STRUCTURES, NATIONAL STRATEGIC MILITARY ASSETS, and to existing building seismic rehabilitation designs.

The designer must indicate on the drawings all locations and all components for which special

inspection and testing is required for MC-1 equipment.

Add any additional requirements as necessary.

****

Equipment and components designated as [MC-1 (Mission Critical Level 1)] Designated Seismic Systems required to remain operational after an earthquake will be seismic qualified by shake table testing conforming to ICC ES AC156 Shake Table Test procedures. The manufacturer is to provide a certification by a fully qualified testing agency for the specific equipment and/or components. Prequalified certifications are acceptable unless noted otherwise.[Seismic component qualification documentation for each piece of equipment must contain the information required in UFC 3-301-02, Section 2-17.2.5 Component Qualification Documentation.]

Miscellaneous components that are required to be certified must bear permanent marking or nameplates constructed of a durable heat and water resistant material. Nameplates must be mechanically attached to such nonstructural components and placed on each component for clear identification. The nameplate must not be less than 5 inches x 7 inches with red letters 1 inch in height on a white background stating "Certified Equipment." The following statement must be on the nameplate: "This equipment/component is certified. No modifications are allowed unless authorized in advance and documented in the Equipment Certification Documentation file." The nameplate must also contain the component identification number in accordance with the drawings/specifications and the O&M manuals.

3.7 SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS AND EQUIPMENT

****

NOTE: Include this paragraph only for special inspection of seismic-resisting systems that serve Risk Category V Structures; designated seismic systems and equipment per IBC 1705.12.4; and storage racks per IBC 1705.12.7. The designer must indicate on the drawings all locations and all features for which special inspection is required. This includes indicating the locations of all structural components and connections requiring inspection. Designated Seismic Systems are required to be operational after a design earthquake. MC-1 equipment and components must be fully operable immediately after a seismic event. MC-2 equipment and components must be repairable and operable within 3 days after a seismic event. This paragraph will be applicable to both new buildings designed according to UFC 3-301-01 SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs.

****

Perform special inspections for seismic-resisting systems, equipment and components [for structures assigned to Risk Category V;] designated seismic systems and equipment per ICC IBC 1705.12.4; and storage racks per ICC IBC 1705.12.7. Periodic special inspections will be conducted on miscellaneous equipment as required by Section 1705.12 of the International Building Code and paragraph 2-2.4.3 of UFC 3-301-01. Provide a Statement of Special

Inspections and Final Report in accordance with paragraph 2-2.4.3 of UFC 3-301-01.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-13 49 10 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-13 49 10 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-13 49 10 (November 2020)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 13 49 10

X-RAY SHIELDING

11/20

****

NOTE: This guide specification covers the requirements for x-ray shielding for medical and dental radiological facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM B749	(2020) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C129	(2023) Standard Specification for Nonloadbearing Concrete Masonry Units
ASTM C840	(2024) Standard Specification for Application and Finishing of Gypsum Board
ASTM C1396/C1396M	(2024) Standard Specification for Gypsum Board
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

HARDWOOD PLYWOOD AND VENEER ASSOCIATION (HPVA)

ANSI/HPVA HP-1	(2020) American National Standard for Hardwood and Decorative Plywood

NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS (NCRP)

NCRP 145	(2003) Radiation Protection in Dentistry
NCRP 147	(2004) Structural Shielding Design for Medical X-Ray Imaging Facilities
NCRP 148	(2004) Radiation Protection in Veterinary Medicines

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8	(2023) Specifications for Standard Steel Doors and Frames

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing

Materials

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

ANSI/WDMA I.S.1A	(2013) Interior Architectural Wood Flush Doors

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shielding Delegated Design; G, [_____]

Installer Experience

SD-03 Product Data

Lead-Lined Concrete Masonry Units

Lead Lined Plywood

Lead-Lined Gypsum Wallboard

Interlocking Lead Bricks

Lead Glass

Lead-Lined Wood Doors

Lead-Lined Steel Doors

Door Frames

Window Frames

Louvers

SD-06 Test Reports

Testing and Certification

1.3 QUALITY CONTROL

1.3.1 Preinstallation Meeting

Hold a pre-installation meeting with the subcontractors and installers working in, on, or near the X-Ray Shielding. Review requirements and coordination to ensure the integrity of the shielding including sequence, schedule, penetrations, methods of attachment, service installations and unauthorized modifications.

[1.3.2 Shielding Delegated Design

****

NOTE: This section is used when the contractor designs the x-ray shielding protection. Typically delete this section.

****

Shielding design in accordance with [NCRP 145][NCRP 147][NCRP 148] by a qualified medical or health physicist. Calculate, design, detail and specify the x-ray shielding system requirements comprising of walls, [partitions, floor[s], ceiling,]doors, window[s], joints, patches, sleeves, and mazes as necessary to ensure shielding continuity at penetrations as well as embedded items including ducts, pipes, conduits, service boxes and hardware. Include the thickness of lead, concrete, lead glass and any other relevant materials.

Submit complete x-ray shielding system design comprising of calculations, detail drawings, specifications and product data sufficient to validate the design and for construction, to the Contracting Officer for approval prior to construction.

a. Medical or Health Physicist Qualifications: Regularly engaged in the design of radiation shielding, and certified by American Board of Radiology, American Board of Medical Physics, American Board of Health

Physics, or Canadian College of Physicists in Medicine.

]1.3.3 Installer Experience

An experienced firm that has been regularly and successfully engaged in the installation of radiation protection systems, similar to the work required, for at least the previous 5 years.

a. Submit a project experience list on projects of similar scope completed during the previous 5 years for approval. Include project completion dates, name and telephone number of the user and/or owner.

1.3.4 Source Responsibility

Procure radiation protection materials, components and accessories as standard products. Obtain each type of product from a single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials and components in original packaging, labeled with the manufacturer/vendor, brand name and part number as appropriate.

Inspect materials and components upon receipt. Remove and replace damaged items. Minor damage may be repaired at the discretion of the Contracting Officer where repair matches new condition.

Comply with manufacturers/vendors instructions and recommendations for storage and handling of all materials and components.

Protect materials and components from deleterious environments including weather, direct sunlight, moisture, contamination, corrosion, and construction traffic.

PART 2 PRODUCTS

2.1 X-RAY SHIELDING SYSTEM

A continuous x-ray shielding system in accordance with [NCRP 145][NCRP 147][NCRP 148], comprising of walls, [partitions, floor[s], ceiling,]doors, window[s], joints, patches, sleeves, and mazes as necessary to ensure shielding continuity at penetrations as well as embedded items including ducts, pipes, conduits, service boxes and hardware.

Minimum sheet lead thickness as indicated.

Nominal sheet lead overlap as indicated to achieve a minimum overlap of not less than 0.4 inch in the field including sheet to sheet joints, sheet to shielded element/component joints, and sheet to patches, sleeves, and mazes, unless specified otherwise.

2.2 LEAD SHEET

Sheet Lead: conform to ASTM B749, Grade C, thickness as indicated.

2.3 LEAD-LINED CONCRETE MASONRY UNITS

Single thickness of unpierced sheet lead bonded or permanently anchored to concrete masonry units conforming to ASTM C129, Type 1. Nominal sheet lead overlap between blocks [1 inch][1-1/2 inch]. Provide preformed half block lengths to ensure bond and shielding without cutting in the field. 300 by 300 by [100] [150] mm 150 by 300 by [100] [150] mm 100 mm

2.4 LEAD LINED PLYWOOD

Single thickness of unpierced sheet lead laminated to plywood, PS 1 Structural grade, Grade C-C or better, sanded; APA span rated to suit application, [5/8 inch] [3/4 inch] thick conforming to ANSI/HPVA HP-1.

a. Fire-Retardant Treated Plywood: Where indicated, fire-retardant treated plywood complying with performance requirements in ASTM E84, Interior Type A.

2.5 LEAD-LINED GYPSUM WALLBOARD

Single thickness of unpierced sheet lead laminated to [13][16] mm [1/2][5/8] inch thick gypsum board conforming to ASTM C1396/C1396M, Type III, Grade R, Class 1, Form a, [Style 1][Style 3].

[2.6 CONCRETE SHIELDING MATERIAL

2355 kg/cubic meterRefer to Section 03 30 00 CAST-IN-PLACE CONCRETE.

][2.7 INTERLOCKING LEAD BRICKS

99.9 percent pure lead, free from inclusions, scale, laminations, blisters, cracks, and projections that could affect interlock. Nominal lead overlap between bricks [1 inch].

]2.8 LEAD GLASS

Clear x-ray protective quality glass in single or multiple thicknesses. Shielding equivalent not less than the adjacent construction. Permanently labeled as "X-Ray Lead Glass" and with the equivalent lead shielding thickness identified.

a. Lead Safety Glass: Laminated clear float glass, permanently labeled as impact resistant in compliance with ANSI Z97.1 and 16 CFR 1201, CAT II.

2.9 LEAD-LINED WOOD DOORS

[Hardwood veneer, solid core, lead-lined wood doors to ANSI/WDMA I.S.1A, with manufacturer's standard lead core thickness to achieve shielding equivalent to not less than the adjacent construction.][Add door description.][Refer to Section 08 14 00 WOOD DOORS.]

2.9.1 Door Hardware

Provide sheet lead and lead plugs to maintain shielding at hardware locations not less than the shielding equivalent in the adjacent construction.

[2.9.2 Thresholds

****

NOTE: Threshold construction may not be required for installations operating below critical power levels where the primary beam does not strike the door area.

****

Line thresholds with a single thickness of sheet lead to provide not less than the shielding equivalent in the adjacent construction.

]2.10 LEAD-LINED STEEL DOORS

[SDI/DOOR A250.8, Level 2 Heavy Duty, Model 1, minimum 0.042 inch faces with vertical steel stiffeners throughout and manufacturer's standard lead core thickness to achieve shielding equivalent to not less than the adjacent construction.][Add door description.][Refer to Section 08 11 13 STEEL DOORS AND FRAMES.]

2.10.1 Door Hardware

Provide sheet lead and lead plugs to maintain shielding at hardware locations not less than the shielding equivalent in the adjacent construction.

[2.10.2 Thresholds

****

NOTE: Threshold construction may not be required for installations operating below critical power levels where the primary beam does not strike the door area.

****

Line thresholds with a single thickness of sheet lead to provide not less than the shielding equivalent in the adjacent construction.

]2.11 DOOR FRAMES

[SDI/DOOR A250.8, Level 2 welded frame, minimum 0.053 inch frame thickness and manufacturer's standard lead core thickness to achieve shielding equivalent to not less than the adjacent construction.][Add door frame description.][Refer to Section 08 11 13 STEEL DOORS AND FRAMES.]

Continuously lined with a single thickness of factory installed sheet lead to provide the shielding equivalent not less than the adjacent construction. Include sheet lead and lead plugs to maintain shielding at hardware locations and adjoining lead shielding.

2.12 WINDOW FRAMES

[Add window frame description.][Refer to Section 08 51 13 ALUMINUM WINDOWS.][Refer to Section 08 51 23 STEEL WINDOWS.]

Continuously lined with manufacturer's standard lead core thickness to provide the shielding equivalent not less than the adjacent construction. Overlap frames a minimum of 9 mm 3/8 inch at the perimeter of the lead glass or twice the thickness of the sheet lead shielding, whichever is greater. Lead frames and glazing panel to provide shielding equivalent not less than the adjacent construction. Include sheet lead and lead plugs to maintain shielding to adjoining lead shielding.

2.13 LOUVERS

[Add louver description]

One-unit with a maze-type blade to allow [30 percent] free area and continuously lined with a single thickness of factory installed sheet lead to provide the shielding equivalent not less than the adjacent construction.

2.14 DESIGNATING PLAQUES

Aluminum, plastic, or other durable material recording the shielding thicknesses for the enclosure types listed below.

2.14.1 Continuous X-Ray Shielding System

Provide one sign, [_____] mm inches tall by [_____] mm inches wide, for each shielded room as follows:

"SURFACES OF THIS ROOM HAVE BEEN INSULATED WITH SHEET LEAD OF THE FOLLOWING THICKNESSES:

	LEAD THICKNESS	TOTAL LEAD EQUIVALENT SHIELDING
DOORS	[_____]inches	[_____]inches
WALLS TO [7] FEET ABOVE FLOOR SLAB	[_____]inches	[_____]inches
FLOOR	[_____]inches	[_____]inches

DO NOT REMOVE"

2.14.2 Shielded Partitions

Provide one sign, [_____] mm inches tall by [_____] mm inches wide, for each shielded partition as follows:

"THIS PARTITION HAS X-RAY SHIELDING

[FULL HEIGHT][FROM FLOOR SLAB TO A HEIGHT OF[_____] FEET]
LEAD SHIELDING THICKNESS: [_____] mm INCH
TOTAL LEAD EQUIVALENT SHIELDING: [_____] INCHES

DO NOT REMOVE"

PART 3 EXECUTION

3.1 INSTALLATION

Perform installation in accordance with drawings, manufacturer's instructions and recommendations, and [NCRP 145][NCRP 147][NCRP 148].

3.1.1 Workmanship

Install sheet lead free of waves, lumps, and wrinkles and with a minimum number of joints. Finish joints smooth and neat.

3.1.2 Protection

Provide patches, plugs, sleeves, and mazes to ensure shielding continuity at penetrations and embedded items including ducts, pipes, conduits, service boxes, and hardware. Coordinate service installations.

Nominal sheet lead overlap as indicated to achieve a minimum overlap of not less than 0.4 inch in the field, including sheet to sheet joints, sheet to shielded element/component joints, and sheet to patches, sleeves, and mazes. Use sheet lead not less than the thickness of the sheet lead being jointed. Ensure all joints are robust and close fitting.

3.2 LEAD-LINED CONCRETE FLOORS

3.2.1 Preparation

Ensure concrete surface is clean, dry, and free of projections that could deform, damage or penetrate the sheet lead. When necessary, apply self leveling underlayment over rough or uneven concrete surfaces. Apply a coat of [asphalt][latex] paint to the concrete surface prior to installation of the sheet lead.

3.2.2 Shielding

Apply sheet lead 1/8 inch thick or less in a single layer with a 1-1/2 inch nominal lap at joints. Apply sheet lead more than 1/8 inch thick in two or more layers 1/8 inch or less in thickness with 1-1/2 inch nominal lap at joints, or in a single layer with joints butted and covered with lead strips 2 inches wide, placed centrally over the joint. Strip thickness not less than the thickness specified for the floor.

3.2.3 Protection from Damage

Apply a coat of [asphalt][latex] paint to the top surface of the sheet lead prior to application of [concrete]surfacing. Do not permit traffic or work in the area until protection is applied over the sheet lead.

3.3 LEAD-LINED BLOCKS

Lay lead-lined blocks in running bond courses with staggered vertical joints. Erect blocks with minimum 0.40 inch wide tight sheet lead lap. Use preformed half block lengths to ensure bond and shielding without cutting in the field.

3.3.1 Joints

Fill mortar joints solid with 3/8 inch thick Type N mortar. Do not place mortar between lead laps.

3.3.2 Pipe and Conduit Chases

Remove concrete from one side of the block only as needed to permit installation. Fill voids with mortar and finish flush. Reinstall continuous sheet lead and overlap the adjoining sheet a minimum of 0.40 inch. Do not install pipe and conduit chases directly opposite each other within the same wall.

3.4 LEAD-LINED PLYWOOD

Provide studs at vertical joint locations[and blocking at horizontal joint locations]. Secure 2 inch wide sheet lead strips, not less than the shielding thickness, centrally at the location of each panel vertical[and horizontal] joint. Butt joint lead lined plywood centrally over lead strips, with shielding on inside face and long edges parallel to vertical supports. Use bent 4 inch wide sheet lead strips at corners. Fasten edges at 8 inch on center and 16 inch on center in the field. Finish fasteners flush to the surface without distortion.

3.5 LEAD-LINED GYPSUM WALLBOARD

Provide studs at vertical joint locations[and blocking at horizontal joint locations]. Secure 2 inch wide sheet lead strips, not less than the shielding thickness, centrally at the location of each panel vertical[and horizontal] joint. Butt joint lead lined gypsum wallboard centrally over lead strips, with shielding on inside face and long edges parallel to vertical supports. Use bent 4 inch wide sheet lead strips at corners. Fasten edges at 8 inch on center and 12 inch on center in the field. Install and finish lead-lined gypsum wallboard in accordance with ASTM C840.

[3.6 INTERLOCKING LEAD BRICKS

Apply a coat of [asphalt][latex] paint to the concrete floor surface prior to installation of lead bricks. Erect bricks with minimum 0.40 inch wide tight lead lap. Use preformed half block lengths to ensure bond and shielding without cutting in the field.

][3.7 SUSPENDED LEAD-LINED CEILINGS

Provide suspended lead-lined ceilings consisting of ceiling bars, and hangers. Space continuous bars approximately [315] [415] mm [12-1/2][16-1/2] inch on center and supported by steel hangers from overhead structure. Use bent 4 inch wide sheet lead strips at ceiling to wall junctions.

]3.8 LEAD DOOR THRESHOLDS

Install thresholds in accordance with approved detail drawings. Apply a coat of [asphalt][latex] paint to the concrete surface prior to installation of the sheet lead.

3.9 LEAD-LINED DOORS

Install doors with a clearance of 1/16 inch at sides and top and minimum clearance at bottom. Provide 1/8 inch beveled lock edge and adjust hardware as required. Do not exceed a warp or twist of 1/4 inch in any face dimension of door including full diagonal, after doors have been hung and finished. [Seal cuts required for installation with a clear varnish or sealer.]

3.9.1 Door Hardware

Patch cutouts for lock sets and latch cases with sheet lead not less than the thickness of the door shielding. Lap sheet lead lining of the lock set and sheet lead lining of the door to achieve a minimum overlap of not less than 0.4 inch.

3.9.2 View Windows

Provide stops and moldings around glazed view windows where indicated. Install view windows in doors with hardwood stops to match face veneer. Glue stops to door on corridor side and fasten with countersunk[oval head screws][finishing nails].

[a. Install view windows in doors with hardwood stops to match face veneer. Glue stops to corridor side of door(s) and fasten with countersunk[oval head screws][finishing nails].]

[b. Install view windows in doors with fixed frame moldings on corridor side of door(s). Provide loose stops and moldings on inside of hollow-metal doors and fasten with countersunk [flat-] [or] [oval-]head machine screws spaced uniformly not more than [9] inches o.c. and not more than [2] inches o.c. from each corner.]

3.9.3 Lead Louvers

Install lead louvers in doors with [cadmium-] [or] [chromium-]plated screws.

3.10 TESTING AND CERTIFICATION

Perform shielding verification, by a qualified medical or health physicist, to determine that the barrier requirements specified in the shielding design were correctly installed. Perform the verification during construction by physically observing and documenting the installation of the barrier materials or after construction by taking transmission measurements. Prior to building occupancy, submit this shielding verification to the Contracting Officer for approval. Correct or replace any part of x-ray shielding work found to be defective.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-13 49 20.00 10 (October 2007)**

Preparing Activity: USACE **Nontechnical Title Revision (August 2015)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-13 49 20.00 10 (October 2007)**

Preparing Activity: USACE **Nontechnical Title Revision**
(August 2015)

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References are in agreement with UMRL dated January 2025
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SECTION 13 49 20.00 10

RFI/EMI SHIELDING
10/07

****
NOTE: This guide specification covers the requirements for electromagnetic shielded facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: The following information must be shown on the project drawings:

1. Assembly details.

2. Typical penetration details.

3. Method of mounting shielded enclosure within building.

4. Shield penetration plan containing wall elevations, floor and ceiling plans showing the locations of all penetrations (to include all mechanical, electrical, fire protection, etc.) to the HEMP shield.

5. Location of mechanical and electrical equipment within shielded enclosure.

6. Detail equipment mounted or suspended from the shielded ceiling.

7. Shield penetration schedule to include:
  a. Location of the waveguide.
  b. Size of waveguide (dimensions).
  c. No. of penetrations in the waveguide.
  d. Penetration designation of each penetration in the waveguide (if more than one).
  e. Size of pipe for each penetration in the waveguide.
  f. Type of pipe for each waveguide penetration.
  g. Type of penetration.
  h. The detail/sheet no. of the waveguide detail.
  i. Any remarks pertaining to the waveguide.

8. Filter schedule to include:
  a. Location of filter.
  b. Type of filter (power or signal).
  c. No. Of filters in the filter enclosure.
  d. Electrical characteristics of the filter (, amperage, no. of poles, frequency).
  e. Purpose of the filter.
  f. The detail/sheet no. Of the typical filter detail.
  g. Any remarks pertaining to the filter.

9. Typical filter details.

10. Hardness critical items (HCI) should be identified using the (HCI) symbol on project drawings.

Refer to MIL-HDBK 419 for special grounding and bonding requirements for EM shielded enclosures. Refer to the U.S. Air Force Handbook for the Design and Construction of HEMP/TEMPEST and Other Shields in Facilities (March 1993). This document can be obtained from HQ AFIC/LEEE, San Antonio, Texas 78243-5001. Also refer to AR 380-19. MIL-HDBK 423 should be used for projects requiring HEMP protection. The designer should consult these documents and other appropriate sources before applying this guide specification to large-scale EM shielded enclosures or to HEMP or TEMPEST projects. The requirement for thermal expansion joints inherent to large-scale enclosures is not addressed in this guide specification. The extent and location of the work to be accomplished and wiring, equipment, and accessories necessary for a complete installation should be indicated on the project drawings. The Air Force contracts with an independent testing laboratory to perform their acceptance testing. The test can consist of a SELDS or equivalent test and H-field and plane wave CW

tests per MIL-STD-188-125 and/or IEEE 299. See the U.S. Air Force Handbook for the Design and Construction of HEMP/TEMPEST and Other Shields in Facilities for more details. Methodology and procedures for setting up equipment are contained in MIL-HDBK-423. Full MIL-STD-188-125 acceptance testing (PCI tests as specified in appendix B) should be avoided. (Also see designer notes K and U). Although not addressed in this specification, fiber optic cable has gained acceptance as an effective method of transmitting data across the boundary of shielded enclosures without filtering. If fiber optic cable is used, describe the waveguide penetration of the shield in detail. Fiber optic cable is specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN WELDING SOCIETY (AWS)

AWS A5.18/A5.18M	(2023) Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel
AWS D9.1/D9.1M	(2018) Sheet Metal Welding Code

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A227/A227M	(2024) Standard Specification for Steel Wire, Cold-Drawn for Mechanical Springs
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B194	(2022) Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM B545	(2022) Standard Specification for Electrodeposited Coatings of Tin
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E90	(2023) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

COMPOSITE PANEL ASSOCIATION (CPA)

ANSI/CPA A135.4	(2012; R2020) Basic Hardboard

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice

	for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 299	(2006; R 2012) Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE C62.33	(2016) Test Methods and Performance Values for Metal-Oxide Varistor Surge Protective Components
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 77	(2024; ERTA 1 2023) Recommended Practice on Static Electricity
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 80A	(2022) Recommended Practice for Protection of Buildings from Exterior Fire Exposures
NFPA 101	(2024) Life Safety Code
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-HDBK-419	(1987; Rev A) Grounding, Bonding, and Shielding for Electronic Equipments and Facilities Volumes 1 of 2 Basic Theory

MIL-STD-188-124	(1998; Rev B; Notice 2 1998; Notice 3 2000; Notice 4 2013) Grounding, Bonding and Shielding for Common Long Haul/Tactical Communications Systems, Including Ground Based Communications - Electronics Facilities and Equipments
MIL-STD-188-125-1	(1998; Rev A; Notice 1 2021) High-Altitude Electromagnetic Pulse (HEMP) Protection for Ground-Based Facilities Performing Critical, Time-Urgent Missions, Part I Fixed Facilities
MIL-STD-220	(2009; Rev C; Notice 2 2024) Method of Insertion Loss Measurement
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, [_____]

Approved Drawings; G, [_____]

SD-03 Product Data

EM Shielding System; G, [_____]

Installation; G, [_____]

Quality Control Plan; G, [_____]

Qualifications; G, [_____]

Qualifications of Welders; G, [_____]

EM Door; G, [_____]

Filter Assemblies; G, [_____]

Penetrations; G, [_____]

SD-06 Test Reports

Impulse Sparkover Voltage

ESA Extinguishing Test

ESA Extreme Duty Discharge Test

Field Testing

SD-07 Certificates

Qualifications of Welders

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G, [_____]

Service Organization; G, [_____]

1.3 QUALITY ASSURANCE

Work performed under this section must be supervised and inspected by the shielding specialist. Approve and verify materials and equipment before submitting to the Contracting Officer for approval. The submittal must be date stamped and signed by the shielding specialist. The shielding specialist is responsible for coordinating the required shielding work with the work of all other trades that will interface or affect the shielding work in any way.

1.3.1 Shielding Specialists, Installers and Testing Specialists

Provide the name and background qualifications of individuals who will be responsible for installation, supervision, and testing of the shielding systems on this project. Include credentials such as a bachelor's degree in science or engineering and post-degree training and experience with EM shielding for shielding and testing specialists.

1.3.1.1 Testing Experience

The testing specialist must have experience during the previous 5 years in shielded enclosure leak detection system (SELDS), IEEE 299, and other methods of shielded enclosure testing.

1.3.1.2 Work Experience

Provide EM shielded system by an experienced firm or individual that has been regularly and successfully engaged in the installation, supervision, and/or testing of equivalent EM shielded systems for at least the previous 5 years. The principal work of this firm or individual must be the satisfactory installation and construction of EM shielded protection systems. Include experience such as achieving specified requirements for shielded system attenuation and maintainability of attenuation levels on work performed.

1.3.1.3 Project Experience

Furnish a project experience list on projects of similar scope which have been completed during the previous 5 years. Include project completion dates and the name and telephone number of the user and/or owner of each project. Indicate project experience for installers such as installation responsibilities, performance, materials, and methods used. Project experience for the shielding specialist must indicate the responsibilities performed. Project experience for the testing specialist must indicate the test methods performed.

1.3.2 Qualifications of Welders

Perform welding by certified welders. Provide the names of the welders to be employed and certification that each welder has passed qualification tests within the last 2 years in the processes specified in AWS D1.1/D1.1M, AWS D9.1/D9.1M, and as required by the Contracting Officer.

1.3.3 Filter and Electrical Work Requirements

Perform filter and electrical work in compliance with NFPA 70, UL 486A-486B, and UL 1283. The label and listing of the Underwriters Laboratories or other nationally recognized testing laboratory will be acceptable evidence that the material or equipment conforms to the applicable standards of that agency. In lieu of the label or listing, a certificate may be furnished from an acceptable testing organization adequately equipped and competent to perform such services. State that the items have been tested and that they conform to the specified standard.

1.3.4 Field Samples

****

NOTE: Requests for field samples and mock-ups usually add cost to the project. Samples should only be required for special applications and should be limited to scaled-down items. For example, the designer may ask for a welded floor/wall corner section. Do not normally ask for samples of filters and full-size waveguide vents.

****

Provide field samples for the following: [shielding sheet installation,] [shielding fastening,] [doors,] [[30] [100] [_____] ampere power filter,] [communication filter,] [waveguide,] [penetration,] and [_____].

1.3.5 Pre-Installation Meeting

Hold a pre-installation meeting with the subcontractors and installers working in, on, or near the EM shield. Discuss coordination requirements and instructions to ensure the integrity of the EM shield.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and stored from excessive humidity and temperature variation, dirt, and other contaminants.

1.5 PROJECT/SITE CONDITIONS

Perform welding of EM shielding material and sheet steel at an ambient temperature of 10 degrees C 50 degrees F minimum to 32 degrees C 90 degrees F. Do not install shielding until the building has been weather enclosed. Do not perform sheet steel welding in direct sunlight.

1.6 MAINTENANCE

1.6.1 Maintenance Supplies and Procedures

Provide maintenance supplies sufficient for a [3] [_____] year period or [50,000] [_____] open-close cycles, whichever is greater, for each EM shielded door. Prominently display maintenance instructions required to maintain the door through the cycle count nearby.

1.6.2 Extra Materials

1.6.2.1 Filters

Furnish [one extra EM power filter] [[_____] extra EM power filters] and [one extra communications filter] [[_____] extra communications filters] of each different type furnished on the project as a spare.

1.6.2.2 EM Shielded Doors

Furnish one set of finger stock and EM gaskets (if used) for each hinged EM shielded door provided. In addition, provide one set of manufacturer recommended and Contracting Officer approved spare parts for EM shielded doors of each style installed.

1.6.2.3 Tools

Furnish one full set of tools that are required to maintain the doors and are not typically available from tool vendors. Furnish environmentally safe lubricants, cleaning solvents, or coatings in sufficient quantities to last for [6] [_____] months.

1.6.2.4 Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment as follows: [SELDS Test Set][_____]

1.6.3 Operating and Maintenance Manuals

Submit manufacturer's written instructions for operation and maintenance of EM Shielding system. Address all components and aspects of the EM shielding and include, but not be limited to, the following:

a. A complete set of assembly drawings to include penetration locations and installation details.

b. The construction specification on EM shielding.

c. Shield penetration schedule.

d. Power/signal filter schedule.

e. Test plan.

f. The prepared preventive maintenance instructions for periodic inspection, testing and servicing, lubrication, alignment, calibration, and adjustment events normally encountered. Extract complex preventive maintenance events from or refer to detailed vendor or manufacturer data. Derive this information from an evaluation of engineering data considering local environmental conditions, manufacturer's recommendations, estimated operating life for the specific application and use of the equipment, and types of job skills available at the operating site.

g. Spare parts data approved and verified by the shielding specialist prior to submission. Include a complete list of recommended parts and supplies with current unit prices and source of supply.

h. Provide a list of hardness critical items (HCI) requiring periodic inspection to maintain EM shield integrity. Hardness critical items are those components and/or construction features which singularly and collectively provide specific levels of HEMP protection, such as the EM shield, surge arresters, EM shielded doors, shield welding, electrical filters, honeycomb waveguides, and waveguides-below-cutoff.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

****

NOTE: Projects involving military communications equipment must be designed to incorporate the applicable requirements of MIL-STD-188-124, which will be provided in the ELECTRICAL WORK, INTERIOR specification.

****

2.1.1 General

Provide shielded facility that meets or exceeds minimum attenuation decibel (dB) levels specified. The EM shielding system includes, but is not limited to, the following:

a. The [welded steel] [bolted] EM shield.

b. EM shielded doors for access into the facility.

c. Electrical and electronic penetrations of the shield.

d. EM filter/surge arrester assemblies, including their EM enclosures.

e. EM shielded pull boxes and junction boxes.

f. EM shielded conduit runs.

g. Special protective measures for mission-essential equipment outside the EM shield.

h. Structural penetrations.

i. Mechanical and utility penetrations (such as air ducts, gas, and water).

j. Instrumentation and control.

k. Equipment door/access panels.

l. Sufficient supervisory and/or quality control personnel onsite to supervise the installation crew and to conduct in-progress quality assurance tests.

2.1.2 Factory Tests

Perform factory tests as specified. The Contracting Officer reserves the right to witness the specified factory tests. Notify the Contracting Officer at least 30 days before factory tests are scheduled to be performed. Include a detailed description of the test instrumentation and equipment, including calibration dates, a detailed description of the test procedure, and the recorded test data.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials and equipment which are the standard products of a

manufacturer regularly engaged in the manufacture of such products and essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Support equipment by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.2   Nameplates

For each major item of equipment, secure a plate with the manufacturer's name, address, type or style, model or serial number, and catalog number to the item of equipment.

2.2.3   Testability

Design and build equipment and materials of the EM shielding to facilitate testing and maintenance.

2.3   EM SHIELDING EFFECTIVENESS

****

NOTE: The designer will consider the shield as early in the design as possible while the geometry of the shielded enclosure can be located to utilize components inherent in the structure. Failure to consider the shield configuration first in the design will increase design costs, cause problems in its incorporation into the structure, and lose installation simplicity. The EM shielded enclosure design should be coordinated by the structural, mechanical, and electrical engineers and architect. The structural and shielding systems should drive each other on large projects. Multi-story shielded enclosures require continuous connections of shielding steel interconnected to the structural steel. In these cases, the shielding wall layout should coincide with the structural steel beam layout. The shield within an exterior building concept must employ a design which allows for settling, seismic motion, and differential thermal expansion between the steel and concrete of the building and the steel of the EM shielding.

****

Provide EM shielded enclosure complete with all filters, doors, and/or waveguides with the following minimum EM shielding effectiveness attenuation. Use minimum magnetic field attenuation of [20 dB] [_____] at 14 kHz increasing linearly to [50 dB] [100 dB] at [200 kHz] [1 MHz] [_____]. Use minimum electric field and plane wave attenuation of [50 dB] [100 dB] [_____] from 14 kHz to [1 GHz] [10 GHz] [_____].

2.4   EM SHIELDING ENCLOSURE REQUIREMENTS (WELDED CONSTRUCTION)

****

NOTE: For the EM shielding enclosure, choose either welded or bolted construction. The unused method should be deleted from the project specification. Welded construction will usually consist of continuous 1.897 mm 14 gauge thick steel plate and angles to form the enclosure. Thicker material may

be used if it is more cost-effective or required for structural reasons. Welded construction is used when a shielded facility requires a long maintainable service life of high-level protection, 100 dB attenuation, or HEMP protection, 100 dB. Bolted construction is associated with a lower level (50 dB) of maintained shielding effectiveness. Bolted construction will usually consist of modular panels bolted together with metal strips or channels. Panels are commonly plywood with steel sheets laminated to one or both sides. Bolted construction is used when a shielded facility's service life is short, 10 years or less, or the system is required to be demountable for change of location. This system requires more maintenance than a welded system and requires access to the panels. The EM shield layout may restrict attenuation testing of the enclosure. It is desirable for large facilities to place the shield at least 1 meter 3.3 feet inside the exterior walls, although cost and construction restrict this consideration. The floor shielding can be tested by SELDS test but not by IEEE 299 if it is on grade. The facility layout must be carefully planned to allow for testing and shield maintenance.

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2.4.1 Welded Shielding Enclosure

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NOTE: Shielding steel thickness should not be based solely on the minimum thickness required for HEMP/TEMPEST attenuation. Thicker steel may be necessary because of structural factors and heat deformation or burn-through from seam welding.

****

The intent of this section and the drawings is to provide a complete metal enclosure including floor, walls, ceiling, doors, penetrations, welds, and the embedded structural members to form a continuous EM shielded enclosure. Provide shielding sheets and closures consisting of [3.416] [_____] mm [10] [_____] gauge thick hot-rolled steel conforming to ASTM A568/A568M. Use steel plates, channels, or angles of minimum 6 mm 1/4 inch thick to reinforce shield sheets for attachments of ducts, waveguides, conduit, pipes, and other penetrating items. Use furring channels to attach shielding sheets to walls or floors that are the minimum gauge of the shielding steel. The shielding sheet steel gauge may be thicker at the Contractor's option to reduce labor and welding effort only if structurally tolerable with the existing design. Use steel that is free of oil, dents, rust, and defects.

2.4.2 Metal Members

Provide structural steel shapes, plates, and miscellaneous metal conforming to ASTM A36/A36M.

2.4.3 Steel and Welding Material

Provide welding materials complying with the applicable requirements of

AWS D1.1/D1.1M and AWS D9.1/D9.1M. Provide steel and welding material conforming to AISC 325. Use welding electrodes conforming to AWS D1.1/D1.1M for metal inert gas (MIG) welding method. Use weld filler metal conforming to AWS A5.18/A5.18M.

2.4.4 Fasteners

Do not use self-tapping screws for attachment of shielding. Use zinc-coated steel, Type I, pin size No. 4 power-actuated drive pins to secure steel sheets to concrete surfaces and to light gauge furring channels. The drive pins must conform to ASTM A227/A227M Class 1 for materials and ASTM B633 for plating.

2.4.5 Miscellaneous Materials and Parts

Provide miscellaneous bolts and anchors, supports, braces, and connections necessary to complete the miscellaneous metal work. Provide the necessary lugs, rebars, and brackets to assemble work. Drill or punch holes for bolts and screws. Poor matching of holes will be cause for rejection. Thickness of metal and details of assembly and supports must provide ample strength and stiffness. The materials must be galvanically similar.

2.4.6 Penetrations

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NOTE: Configure the facility to minimize the number of metallic structural elements required to penetrate the barrier.

****

Seal penetrations of the shield, including bolts or fasteners, with puddle welds or full circumferential EM welds. Provide structural penetrations including beams, columns, and other metallic structural elements with continuously welded or brazed seams and joints between the penetrating element and the shield. Nonmetallic structural elements are not allowed to penetrate the electromagnetic barrier.

2.4.7 Penetration Plates (Welded Construction)

The penetration plate is the central location for treatment of penetrations. Construct panel of 6 mm 1/4 inch thick ASTM A36/A36M steel plate welded to the shield. Weld waveguide, conduit, and piping penetrations circumferentially at the point of penetration to the inner surface of the penetration plate. Extend penetration plates at least 150 mm 6 inch beyond all penetrations.

2.4.8 Floor Finish

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NOTE: Indicate or specify whether other flooring is to be provided or higher floor loads are required. This is most critical when raised floors are specified. Allowances must be made for elevated door thresholds. Specify special requirements for laboratory loads, provide seismic requirements, if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Pertinent portions of UFC 3-310 04 and Sections 13 48 73 and 23 05 48.19 must be

enclosed in the contract documents.

If concrete floor wearing slabs are specified, they should be thick enough to hold anchor bolts for equipment, supports, and interior partitions. Concrete wearing slabs may be provided in most applications with a minimum thickness of 100 mm 4 inches. The Air Force is opposed to placing concrete wearing slabs over shielding steel because of problems with testing and repair. Placing concrete over floor shielding requires a waiver from HQ AFCEC/ENE.

****

Cover floor EM shielding by a reinforced cast-in-place concrete slab [100] [_____] mm [4] [_____] inch thick. Conform to seismic requirements [in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS and [09 69 13 RIGID GRID ACCESS FLOORING][09 69 19 STRINGERLESS ACCESS FLOORING] (if needed)].

2.5 EM SHIELDING ENCLOSURE REQUIREMENTS (BOLTED CONSTRUCTION)

****

NOTE: For the EM shielding enclosure, choose either welded or bolted construction. The unused method should be deleted from the project specification. Welded construction will usually consist of continuous 1.897 mm 14 gauge thick steel plate and angles to form the enclosure. Thicker material may be used if it is more cost-effective or required for structural reasons. Welded construction is used when a shielded facility requires a long maintainable service life of high-level protection, 100 dB attenuation, or HEMP protection, 100 dB. Bolted construction is associated with a lower level (50 dB) of maintained shielding effectiveness. Bolted construction will usually consist of modular panels bolted together with metal strips or channels. Panels are commonly plywood with steel sheets laminated to one or both sides. Bolted construction is used when a shielded facility's service life is short, 10 years or less, or the system is required to be demountable for change of location. This system requires more maintenance than a welded system and requires access to the panels. The EM shield layout may restrict attenuation testing of the enclosure. It is desirable for large facilities to place the shield at least 1 meter 3.3 feet inside the exterior walls, although cost and construction restrict this consideration. The floor shielding can be tested by SELDS test but not by IEEE 299 if it is on grade. The facility layout must be carefully planned to allow for testing and shield maintenance.

****

2.5.1 Panel Construction

Laminate flat steel sheets to each side of a 19 mm 3/4 inch thick structural core of either plywood or hardboard. Provide panels with a flame spread rating of less than 25 when tested according to ASTM E84. Provide flat steel conforming to ASTM A653/A653M with G-60 coating, minimum 0.5512 mm 26 gauge thick, zinc-coated phosphatized. Use plywood conforming to APA L870 for exterior, sound grade hardwood, Type I. Provide hardboard conforming to ANSI/CPA A135.4, Class 4, SIS, for standard type hardboard. Use waterproof type adhesive for laminating steel sheets to structural core which maintains a permanent bond for the lifetime of the enclosure.

2.5.2 Framing

Join and support panels by specially designed framing members that clamp the edges of the panels and provide continuous, uniform, and constant pressure for contact to connect the shielding elements of the panels. Provide walls that are self supporting from floor to ceiling with no bracing. Deflection of walls under a static load of 335 N 75 pounds applied normally to the wall surface at any point along the framing members must not exceed 1/250 of the span between supports. [Ceilings must be self-supporting from wall to wall.] [Support ceilings by adjustable, nonconducting, isolated hangers from the structural ceiling above.] Design ceilings to have a deflection under total weight, including ceiling finish, of no more than 1/270 of the span. Provide a one-piece factory pre-welded corner section or trihedral corner framed with a brass machine cast corner cap assembly consisting of inner and outer parts at all corner intersections of walls and floor or ceiling. Design the modular enclosure for ease of erection, disassembly, and reassembly.

2.5.3 Channel

The framing-joining system members must consist of 3 mm 1/8 inch thick zinc-plated steel channels having a minimum 16 mm 5/8 inch overlap along each side of the contacting surface. Space screw fasteners at 75 or 100 mm 3 or 4 inch intervals. Use screw fasteners that are either zinc or cadmium-plated steel, minimum size 6 mm 1/4 inch, with a pan or flat Phillips head. Heat-treat and harden fasteners with a minimum tensile strength of 931 MPa 135,000 psi.

2.5.4 Sound Transmission Class (STC)

Provide enclosure panels with an STC of [30] [_____] dB minimum when tested according to ASTM E90.

2.5.5 Penetration Plates (Bolted Construction)

Provide a minimum 3 mm 1/8 inch thick ASTM A36/A36M steel plate, sized [450] [_____] by [450] [_____] mm [18] [_____] by [18] [_____] inch with a 6 mm 1/4 inch thick extruded brass frame for mounting to the shielded enclosure wall panel. Extend penetration plates at least 150 mm inch beyond all penetrations.

2.6 EM SHIELDED DOORS

****

NOTE: Edit these paragraphs depending on type of door used on project.

****

2.6.1 General

Material in shielded doors and frames must be steel conforming to ASTM A36/A36M or ASTM A568/A568M and stretcher-leveled and installed free of mill scale. Use thicker metal where indicated or required for its use and purpose. Provide metal thresholds of the type for proper shielding at the floor. Provide fire rated shielded doors and assemblies meeting NFPA 80 and NFPA 80A requirements and bearing the identifying label of a nationally recognized testing agency qualified to perform certification programs. Provide EM shielded doors by a single supplier who has been regularly engaged in the manufacture of these items for at least the previous 5 years. Supply assemblies complete with a rigid structural frame, hinges, latches, and parts necessary for operation. Duplicate assemblies that have been in satisfactory use for at least 2 years. Provide door frame consisting of steel suitable for [welding] [bolting] to the surrounding structure and shield. Provide EM filters, EM waveguide penetrations for door systems, and miscellaneous material for a complete system. Provide nonsagging and nonwarping enclosure door. The EM shielded door must provide a shielding effectiveness of [10 dB] [20 dB] greater than the minimum EM shielding effectiveness requirements. Provide door with a clear opening [as shown on the drawings] [of [915] [_____] mm [36] [_____] inch wide and [2135] [_____] mm [84] [_____] inch] high. The door and frame assembly must have a sound rating of STC [30] [_____] minimum. Perform testing in accordance with ASTM E90.

2.6.1.1 Door Latch

The door latch must be lever controlled with roller cam action requiring no more than 67 N 15 pounds of operating force on the lever handle for both opening and closing. Equip door with a latching mechanism having a minimum of three latching points that provides proper compressive force for the EM seal. The mechanism must be operable from both sides of the door with permanently lubricated ball or thrust bearings as required at points of pivot and rotation.

2.6.1.2 Hinges

Equip doors with a minimum of three well-balanced adjustable ball-bearing or adjustable radial thrust bearing hinges suitable for equal weight distribution of the shielded doors. Hinges must allow adjustment in two directions. Do not exceed a force of 22 N 5 pounds to move the doors.

2.6.1.3 Threshold Protectors

Furnish threshold protectors for each EM shielded door. Provide protectors consisting of portable ramps that protect the threshold when equipment carts or other wheeled vehicles are used to move heavy items across the threshold. The ramps may be asymmetrical to account for different floor elevations on each side, but the slope of the ramp must not exceed 4:1 on either side. Design ramps to support a [227] [_____] kg [500] [_____] pound vertical force applied to a 75 by 13 mm 3 by 1/2 inch area for a personnel door, and a [907] [_____] kg [2,000] [_____] pound vertical force applied to a 75 by 13 mm 3 by 1/2 inch area for an equipment double leaf door. Apply force to the contact area between the threshold and the door. Provide mounting brackets, convenient to the entry, to store the ramp when not in use.

2.6.1.4 Frequency of Operation

With proper maintenance, door assemblies must function properly through 100,000 cycles and 15-year service life minimum without the shielding effectiveness decreasing below the overall shield required attenuation.

2.6.1.5 Electric Interlocking Devices

Provide electric interlocking devices for vestibules equipped with shielded doors at each end. Provide electric interlocking devices so that shielded doors at the ends of the vestibule cannot be opened at the same time during normal operation. Provide a manual override to allow emergency egress, and provide an audible alarm to indicate that doors at each end of the vestibule are open. The alarm will continue to sound while both doors are open. Provide a low- piezoelectric-type alarm, in a tamperproof enclosure, at a location shown on the project drawings or as directed by the Contracting Officer's representative. The sound intensity must be 45 dBA minimum at 3.05 m 10 feet. Provide lights on the side of each door outside the vestibule to indicate that the other door is open. Interlock systems may be integrated into a cypher lock system. Power the interlock system by an uninterruptible power source which is fail-safe in an unlocked condition in the event of a power failure.

2.6.1.6 Electric Connectivity

Install electric connectivity for sensors, alarms, and electric interlocking devices in accordance with the door manufacturer's instructions, the approved drawings, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Submit detail drawings showing location, number, and method of penetrating the shielding material. Fabrication details for penetrations of the shielding material and the complete EM shielded enclosure to include doors and filters. Show erection details and sequence of erection and clearly indicate the methods necessary to ensure shield integrity under all columns and other structural members.

2.6.1.7 Threshold Alarm

Apply a press-at-any-point ribbon switch to the threshold. The switch must enunciate an alarm whenever pressure is applied to the threshold of the EM shielded door.

2.6.1.8 Hold Open and Stop Device

Provide each EM shielded door leaf with a hold open and stop device permanently attached to the door leaf. Weld a fastener plate onto the door. The device must not interfere with the finger stock. Drilling or tapping of the shielded door will not be allowed.

2.6.1.9 Emergency Exit Hardware

Equip emergency exit EM shielded doors with single motion egress hardware. The force required to latch and unlatch emergency exit hardware on EM shielded doors must meet life safety code NFPA 101. Field alterations or modifications to panic hardware will not be allowed.

2.6.1.10 Finish

Factory prime paint EM shielded doors with zinc chromate primer. Doors may be factory finish painted or galvanized. Touch up any damaged finish.

2.6.1.11 Door Counter

Provide a door operation counter on the enclosure interior.

2.6.1.12 Additional Hardware

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NOTE: Alarms would normally be specified in Section 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS). Hardware will be specified in the hardware section.

****

See door schedule on drawings and Section 08 71 00 DOOR HARDWARE, for additional hardware requirements. Provide fire rating and STC sound ratings as required by the door finish schedule on the drawings or in the specifications.

2.6.2 Latching Type Doors

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NOTE: Make the knife edge of stainless steel 430 series if it will be exposed to moist air containing salt (near the sea coast) or in an uncontrolled or corrosive environment.

****

Provide [steel] [laminated] type doors. [Provide steel doors that are a minimum of 3.416 mm 10 gauge thick steel sheet electrically and mechanically joined by welded steel frames overlapping joints with continuous EM welds.] [Laminated type must be the same construction as enclosure panels, except electrically and mechanically join the steel faces by channels or overlapping seams, both of which are continuously seam welded or soldered along all joined surfaces.] The closure seal must utilize an extruded brass channel containing a recess into which [two] [_____] sets of [beryllium copper condition HT in accordance with ASTM B194] [stainless steel 430 (magnetic type) series] contact fingers and a closed cell foam rubber air seal are fitted and can be easily removed and replaced without the use of special tools and without the application of solders. Mate the door to the frame in a manner that allows the insertion of a brass knife edge between the two rows of the radio frequency finger stock, to obtain optimum conductivity and electromagnetic shielding. Use high-temperature silver solder to attach the brass knife edge components to the door panels and the frame. Protect the fingers that form a contact between the door and its frame from damage due to physical contact and conceal within the door and frame assembly.

2.6.3 Pneumatic Sealing Doors

Pneumatic sealing mechanisms must achieve EM shielding by using pressure to force the door panel against the frame surface. Contact areas of door and frame must be a peripheral strip no less than 75 mm 3 inch wide completely around the door with a tinned or highly conductive noncorrosive surface. After the door is in a closed position, the pneumatic sealing mechanism must exert pressure in no more than 10 seconds. Actuate sealing mechanism release in no more than 5 seconds. Manual [override] [operation] must not exceed a maximum of [155] [_____] N [35] [_____] pounds. When the door is sealed, the attenuation around the edges must meet the EM shielding effectiveness requirements of this specification. Provide swinging doors with a threshold of zinc-plated steel, no less than 9.5 mm 3/8 inch thick. Provide door with a pneumatic system that maintains a nominal sealing pressure of [240] [_____] kPa [35] [_____] psi. Attach a label to pneumatic doors warning against painting of the mating surfaces.

2.6.3.1 Door and Enclosure Design

Design doors for long life and reliability without the use of EM gaskets, EM finger stock, or other sealing devices other than the direct metal-to-metal contact specified. Provide EM sealing device that is fail-safe upon loss of air pressure and readily allows manual opening of the door. For either normal or fail-safe operation, the maximum time to reach the open position must be no more than 7 seconds. Include provision for removing the door for routine maintenance without disturbing its alignment and EM sealing properties.

2.6.3.2 Control Panel

Provide a control panel including the necessary opening and closing pneumatic valves on the inside and outside of the shielded enclosure. The outside control panel must also have a pressure regulator and filter. Ensure door air supply is capable of quick opening from inside the enclosure to allow escape when opening pneumatic valves fail or malfunction.

2.6.3.3 Air System for Pneumatic Sealing

Provide complete air system including compressor, filter alarm, tank, lines, air filter, dryer, air control valves, and controls. Size air tank capacity so that the air volume and pressure are sufficient to operate the door through ten complete cycles after the loss of normal power.

2.6.4 Magnetic Sealed Door Type

Form an EM seal by a solid metal-to-metal contact around the periphery of the door frame. Provide materials at the contact area which are compatible and corrosion resistant. Provide contact force for the door EM seal by electromagnets. When the electromagnet is energized, pull the door leaf in to ensure a solid and continuous contact with the door frame. When the electromagnet is de-energized, the door leaf must be free to swing. The EM shielded doors may use electromagnets or a combination of permanent magnets and electromagnets.

2.6.5 Sliding Type Door

Provide a sliding shielded door of the size and operating direction indicated. Clear openings indicated on the drawings must not require dismantling of any part of the door. Manually operate door from either side, inside or outside, with a maximum pull (force) of 155 N 35 pounds to set the shielded door in motion. Construct shielded door face panels and frames of reinforced steel suitable for achieving the specified attenuation. Construct frames of steel shapes welded together to form a true rectangular opening. In the sealed position, the shielded doors must provide the minimum shielding effectiveness specified without any derating. Design doors for long life and reliability and do not use EM gaskets, EM finger stocks, or other sealing devices other than the specified direct metal-to-metal contact. Attach a label to sliding doors warning against painting of the mating surfaces.

2.6.6 Power Operators

Provide [pneumatic] [electric] type power operators conforming to NFPA 80 and the requirements specified. Provide readily adjustable limit switches to automatically stop the door in its full open or closed position. Ensure all operating devices are suitable for the hazardous class, division, and group defined in NFPA 70.

2.6.6.1 Pneumatic Operators

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NOTE: Designer will coordinate with the drawings to ensure compressed air is available at door locations.

****

Provide heavy-duty industrial type pneumatic operators designed to operate the door at no less than 0.2 m/s 2/3 fps or more than 0.3 m/s 1 fps with air pressure of [_____] kPa psi. Provide a pressure regulator if the operator is not compatible with available air pressure. Provide dryer, filter, and filter alarm Provide pneumatic piping up to the connection with building compressed air, but no more than 6 m 20 feet from door jambs. Make provisions for immediate emergency manual operation of the door in case of failure. The operator must open, close, start, and stop the door smoothly. Control must be [electrical, conforming to NEMA ICS 2 and NEMA ICS 6; enclosures must be Type 12 (industrial use), Type 7 or 9 in hazardous locations, or as otherwise indicated] [pneumatic] [with] [pushbutton wall switches] [ceiling pull switches] [rollover floor treadle] [as indicated].

2.6.6.2 Electric Operators

Provide heavy-duty industrial type electrical operators designed to operate the door at no less than 0.2 m/s 2/3 fps or more than 0.3 m/s 1 fps. Provide electrical controls that are [pushbutton wall switches] [ceiling pull switches] [rollover floor treadle] [as indicated]. Provide electric power operators complete with an electric motor, brackets, controls, limit switches, magnetic reversing starter, and other accessories necessary. Design the operator so that the motor may be removed without disturbing the limit switch timing and without affecting the emergency operator. Provide power operator with a slipping clutch coupling to prevent stalling of the motor. Make provisions for immediate emergency manual operation of the door in case of electrical failure. Where controls differ from motor voltage, provide a control voltage transformer inside as part of the starter. Use control voltage of 120 volts or less.

2.6.6.2.1 Motors

Provide drive motors conforming to NEMA MG 1 that are the high-starting torque reversible type and of sufficient output to move the door in either direction from any position at the required speed without exceeding the rated capacity. Provide motors that are suitable for operation on [[120] [208] [277] [480] volts, 60 Hz] [[220] [240] [380] volts, 50 Hz], [single] [three] phase and suitable for across-the-line starting. Design motors to operate at full capacity over a supply variation of plus or minus 10 percent of the motor voltage rating.

2.6.6.2.2 Controls

Provide an enclosed reversing across-the-line type magnetic starter with thermal overload protection, limit switches, and remote control switches for each door motor. Provide control equipment conforming to NEMA ICS 2; provide enclosures conforming to NEMA ICS 6, which are Type 12 (industrial use), Type 7 or 9 in hazardous locations, or as otherwise indicated. Each wall control station must be of the three-button type, with the controls marked and color coded: OPEN - white; CLOSE - green; and STOP - red. When the door is in motion and the stop control is pressed, the door must stop instantly and remain in the stop position. From the stop position, operate the door in either direction by the open or close controls. Use full-guarded type controls to prevent accidental operation.

2.6.6.3 Leading Edge Safety Shutdown

Provide a safety shutdown switch strip the entire length of the leading edge of the door with operators. The safety strip must be press-at-any-point ribbon switches. Activate the strip to shut down the operator and release the door with reset required to continue door operation.

2.6.7 EM Shielded Door Factory Test

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NOTE: When specifying nonlatching doors, delete door static load and sag tests and cycle test for door latches. Retain cycle test for door hinges.

****

Provide test data on at least one shielded door of each type provided for the facility to verify that the EM shielded doors of the design supplied have been factory tested for compliance with this specification. Do not furnish test doors on the project. Submit test data reports in accordance with paragraph SUBMITTALS.

2.6.7.1 Swinging Door Static Load Test

Mount and latch the door to its frame, then set down in a horizontal position such that it will open downward with only the frame rigidly and continuously supported from the bottom. Apply a load of 195 kg/psm 40 lb/psf uniformly over the entire surface of the door for at least 10 minutes. The door will not be acceptable if this load causes breakage, failure, or permanent deformation which causes the clearance between door leaf and stops to vary more than 1.6 mm 1/16 inch from the original dimension.

2.6.7.2 Swinging Door Sag Test

Install the door and its frame normally and open 90 degrees. Suspend two 45 kg 100 pound weights, one on each side of the door, from the door within 130 mm 5 inch of the outer edge for at least 10 minutes. The door will not be acceptable if this test causes breakage, failure, or permanent deformation which causes the clearance between the door leaf and door frame to vary more than 1.6 mm 1/16 inch from the original dimension.

2.6.7.3 Door Closure Test

Operate each door design 100,000 complete open-close cycles. The door will not be acceptable if the closure test causes any breakage, failure, or permanent deformation which causes the clearance between the door and door frame to vary more than 1.6 mm 1/16 inch from the original dimension.

2.6.7.4 Handle-Pull Test

Mount and latch the door to its frame. Provide handle with a force of 1100 N 250 pounds applied outward (normal to the surface of the door) at a point within 50 mm 2 inch of the end of the handle. The door will not be acceptable if this test causes any breakage, failure, or permanent deformation exceeding 3 mm 1/8 inch.

2.6.7.5 Door Electromagnetic Shielding Test

Factory test EM shielded door in accordance with the requirements of this specification both before and after the mechanical tests described above.

2.7 ELECTROMAGNETIC FILTERS

****

NOTE: All EM filters for power and signal lines should be scheduled on the drawings.

This guide specification covers electromagnetic filters for 50, 60, and 400 Hz power lines and signal lines for General Use Only. This specification is NOT applicable for filters to be used with a specific individual item of electronic equipment. Filters for use with specific individual items of equipment must be scheduled on the drawings showing voltage, current, insertion loss, passband, frequency, baud rate, and cutoff frequency.

****

Provide a filter for each power, data, and signal line penetrating the enclosure. These lines include, but are not limited to, power lines, lines to dummy loads, alarm circuits, lighting circuits, and signal lines such as telephone lines, antenna lines, HVAC control, and fire alarm. Enclose filters [and ESAs] in metallic cases which protect the filter elements from moisture and mechanical damage. Ensure all external bonding or grounding surfaces are free from insulating protective finishes. Protect all exposed metallic surfaces against corrosion by plating, lead-alloy coating, or other means. The finish must provide good electrical contact when used on a terminal or as a conductor, have uniform texture and appearance, be adherent, and free from blisters, pinholes and other defects. The filter [and ESA] assemblies must also meet the requirements of UL 1283. Insertion loss in the stop band between the load side of the filter and the power supply side must be no less than the EM shielding attenuation specified. Provide filter used for 400 Hz with power factor correcting coil to limit the reactive current to 10 percent maximum of the full load current rating. Each filter unit must be capable of being mounted individually and include one filter for each phase conductor of the power line and the neutral conductor. Include one filter for each conductor.

2.7.1 Enclosure

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NOTE: The intent of this paragraph is to preserve the integrity of the filter and to shield the input and output circuits from each other. Usually, this is accomplished by mounting the filters in an EM-modified NEMA Type 1 enclosure with separate

compartments for the input and the output terminals. If a weatherproof or hazardous area type enclosure is needed, it must be specified.
****

Mount filter units in an EM modified NEMA Type [1] [_____] enclosure in accordance with NEMA ICS 6 and meet the requirements of UL 1283. Make enclosures of corrosion resistant steel of 1.9837 mm 14 gauge minimum thickness with welded seams and galvanized bulkhead cover plates. Finish enclosure nonconductive surfaces with a corrosion-inhibiting primer and two coats of baked or finish enamel. The input compartment must house the individual line filters and the input terminals of the filters and mounting for the surge arrestor. Space live parts in accordance with NFPA 70. Use copper filter leads. Test filter enclosures for shielding effectiveness in accordance with IEEE 299 and Table I of this specification. [Provide test leads and coaxial connectors through the enclosure for HEMP testing.] [Use the imbedded configuration for filter enclosures as required by MIL-STD-188-125-1.]

2.7.1.1 Filter Unit Mounting

Mount each filter unit individually in an enclosure containing one filter for each penetrating conductor. Attach one end of the individual filter case to the rf barrier plate between the two compartments to provide a rf tight seal between the rf barrier plate and the filter case. The terminals of the filters must project through openings in the rf barrier plate into the inner terminal compartment. Attach the case of each filter to both the enclosure and to the barrier plate to prevent undue stress being applied to the rf seal between the filter case and the rf barrier plate. Individual filters must be removable from the enclosure. Like filters must be interchangeable.

2.7.1.2 Conduit Connections to Enclosures

Provide load terminal and input compartments without knockouts, and provide each compartment with weldable threaded conduit hubs. EM weld hubs circumferentially in place and size and locate as required for the conduits indicated.

2.7.1.3 Access Openings and Cover Plates

Provide enclosures with separate clear front access cover plates on terminal and power input compartments. Provide access cover plates which are hinged with EM gaskets and 75 mm 3 inch maximum bolt spacing. Include thick cover plates and folded enclosure edges to prevent enclosure deformation, bolt spacers to prevent uneven gasket compression, and gasket mounting to facilitate replacement. All gasket contact areas must be tin-plated using the electrodeposited type I method in accordance with ASTM B545. Permanently fasten nuts and bolts to the enclosure by welding or captive attachments.

2.7.1.4 Operating Temperature

Provide filter and ESA assembly which is rated for continuous operation, with filters at rated voltage and full-load currents, in ambient temperatures from minus 55 to plus 65 degrees C (measured outside the EM filter enclosure). Useilter components that are suitable for continuous full load operation at a temperature from minus 55 to plus 85 degrees C.

2.7.1.5 Short Circuit Withstand

Label and build filters to have standard short circuit withstand ratings in accordance with UL 1283. The minimum ratings are as follows:

FILTER RATED CURRENT, RMS AMPERE	SHORT CIRCUIT FULL LOAD AMPERES SYMMETRICAL
0-100	10,000
101-400	14,000

2.7.1.6 Filter Connections

Provide individual filters with prewired standoffs and solderless lugs. Provide hexagonal head bolt or screw type lugs conforming to UL 486A-486B. Space live parts in accordance with NFPA 70.

2.7.2 Internal Encapsulated Filters (Filter Units)

****

NOTE: There are two kinds of power filters, commonly known as "W" and "X" series. The "W" series filters are designed to achieve rated insertion loss under load when tested in accordance with MIL-STD-220, which only requires testing under load conditions from 100 kHz to 20 MHz. The "X" series device data sheets will contain the phrase "tested using extended range buffer networks" and will satisfy the stated performance under full load at frequencies below 100 kHz. The "X" series filters will also be tested in accordance with MIL-STD-220. The "X" series filters can also be differentiated from "W" devices by the fact that they are usually two to three times greater in weight.

Fire alarm, signal, energy monitoring and control system, telephone, and control lines require filters that pass a specific frequency, voltage, and number of conductors. Fire alarm circuits with ground fault indicators will show a ground fault when connected through a filter and should be avoided. A fiber optic connection through the shield is recommended. Keepconductors penetrating the shield perimeter to a minimum. Systems penetrating the shield will have special requirements in their specifications for compatibility between system signal and control circuits and the EM filters.

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2.7.2.1 Filter Construction

Individual filters must be heavy-duty type sealed in a steel case. After the filter is filled with an impregnating or encapsulating compound, weld the seams. When a solid potting compound is used to fill the filter, the filters may be mechanically secured and sealed with solder. Use hermetically sealed impregnated capacitors, or vacuum impregnate the complete filter assembly. Faricate individual filter cases of no less than 2 mm 14 gauge thick steel and finish with a corrosion-resistant plating,or one coat of corrosion-resistant primer and two coats of finish enamel. Fill the filter with an impregnating or potting compound that is chemically inactive with respect to the filter unit and case. The compound, either in the state of original application or as a result of having aged, must have no adverse effect on the performance of the filter. Use the same material for impregnating as is used for filling. Use copper filter terminals that can withstand the pull requirements specified and measured in accordance with paragraph ELECTROMAGNETIC FILTERS.

2.7.2.2 Ratings

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NOTE: Indicate maximum current, voltage, and pass band frequency ratings on the drawings. If no drawings are furnished with the specifications, specify the ratings here.

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[Provide filters in the current, voltage, and frequency ratings indicated on the drawings.] [Filter current must be [_____].] [Filter voltage must be [[120] [208] [277] [480] volts, 60 Hz] [[230] [250] [400] volts, 50 Hz].] [The pass band frequencies [_____] Hz to [_____] Hz must be suitable for use with the [50] [60] [_____] [and] [400] [_____] Hz power source and signal line filters as indicated.]

2.7.2.3 Voltage Drop

Voltage drop through the filter at operation frequency must not exceed 2 percent of the rated line voltage when the filter is fully loaded with a resistive load (unity power factor). Measure voltage drop in accordance with paragraph Voltage Drop Measurements.

2.7.2.4 Input Elements

Provide filters with inductive inputs. If inductive input is used an ESA is required to protect the filter. The inductor must ensure firing potential for the preceding ESA and limit the current through the filter capacitor. Design the input inductor to withstand at least a 10,000-volt transient.

2.7.2.5 Drainage of Stored Charge

Provide filters with bleeder resistors to drain the stored charge from the capacitors when power is shut off. Drain stored charge in accordance with NFPA 70.

2.7.2.6 Insertion Loss

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NOTE: Use 100 dB insertion loss at 14 kHz to 10 GHz for applications such as secure communications installations. For other applications, insert appropriate insertion loss and frequency range for the specific product. Consult filter manufacturer for detailed requirements. Also consult the manufacturer when leakage current is important, such as in life safety areas. There is a tradeoff

between leakage current and insertion loss when insertion loss is measured according to MIL-STD-220 because of the test connection and the line-to-ground capacitance. Harmonic loading of EM filters will require alterations to the electrical system design to protect the filters from damage. Large individual loads, such as adjustable speed drive and uninterruptible power supplies, should have shielded isolation transformers on their input line side. Multiple small individual loads, such as computers, should have EM filters derated or shielded isolation transformers between filter output and the harmonic generating loads. EM filters should be derated by 50 percent when serving loads with substantial harmonic components. If a facility is formally required to fully comply with MIL-STD-188-125, filter and ESA characteristics should meet the standard's requirements as applied to the facility. The facility's electrical system should be designed to meet the requirements of MIL-STD-188-125 with commercially available filters and ESA. The commercial electrical power feeder should be arranged in a manner that will meet MIL-STD-188-125 requirements. Voice and data lines should be converted to fiber optics prior to penetration of the EM shield. The requirements of MIL-STD-188-125 should be applied by a shielding specialist experienced in the standard's requirements and applications.

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Insertion loss must meet or exceed the levels complying with EM shielding effectiveness attenuation requirements herein when measured in accordance with MIL-STD-220. Perform insertion loss measurements in accordance with MIL-STD-220 and the paragraph ELECTROMAGNETIC FILTERS.

2.7.2.7 Operating Temperature Range

Mount individual filters in the filter enclosure operating at full load amperage and rated voltage that do not exceed plus 85 degrees C 185 degrees F based on an ambient temperature of 65 degrees C 150 degrees F outside the filter enclosure. Demonstrate continuous operation from minus 55 to plus 85 degrees C minus 67 to plus 185 degrees F according to paragraph "Filter Life Test (at Elevated Ambient Temperature)". Filters must also withstand temperature cycling as specified in paragraph ELECTROMAGNETIC FILTERS. Maintain the filter at rated voltage and full-load current until temperature equilibrium is reached or 24 hours, whichever is greater.

2.7.2.8 Current Overload Capability

Provide filters that are capable of operating at 140 percent of rated current for 15 minutes, 200 percent of rated current for 1 minute, and 500 percent of rated current for 1 second when tested in accordance with paragraph Overload Test.

2.7.2.9 Reactive Shunt Current

The reactive shunt current drawn by the filter operating at rated voltage must not exceed 30 percent of the rated full-load current when measured in accordance with paragraph Reactive Shunt Current Measurements.

2.7.2.10 Dielectric Withstand Voltage

Provide filters which conform to the minimum values of dielectric withstanding voltage. Perform filter dielectric withstand voltage test in accordance with paragraph "Dielectric Withstand Voltage Test". Provide HEMP filters that are capable of operating continuously at full-rated voltage and of withstanding an overvoltage test of 2.8 times the rated voltage for 1 minute. In addition, ensure each filter is capable of withstanding a 20-kV or 4-kA peak transient pulse of approximately 20 ns pulse width at full operating voltage, without damage.

2.7.2.11 Insulation Resistance

The insulation resistance between each filter terminal and ground must be greater than 1 megohm when tested in accordance with paragraph Insulation Resistance Test.

2.7.2.12 Parallel Filters (Current Sharing)

Where two or more individual filters are electrically tied in parallel to form a larger filter, they must equally share the current. Equally sharing is defined to be within 5 percent of the average current. Perform tests in accordance with paragraph ELECTROMAGNETIC FILTERS.

2.7.2.13 Harmonic Distortion

Harmonics generated by the insertion of a filter must not increase line voltage distortion more than 2.5 percent when measured with a unity power factor in accordance with the paragraph ELECTROMAGNETIC FILTERS.

2.7.3 Marking of Filter Units

Mark each filter case with HCI tags and with the rated current, rated voltage, manufacturer s name, type of impregnating or potting compound, operating frequency, and model number. In addition, provide individual filter cases, the filter enclosures, and supply and load panelboards of filtered circuits marked by the manufacturer with the following: "WARNING: Before working on filters, terminals must be temporarily grounded to ensure discharge of capacitors. Attach nameplates and warning labels securely.

2.7.4 Minimum Life

Design filter assemblies for a minimum service life of 15 years. Submit filter schedule including voltage, amperage, enclosure type (low, high, band pass), location, cut-off frequency, band pass frequencies, and electrical surge arresters (ESA). Submit data and/or calculations for design of EM door including schedule of EM penetrations.

2.7.5 Power and Signal Line Factory Testing

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NOTE: In most cases, test results for equal filters are sufficient to determine compliance with specification requirements. Factory tests on individual filters may be required for higher than average temperature applications, special filter

configurations, and other special project requirements.

Filters with nonstandard configuration or ratings may require testing by an independent testing organization. These ratings would be for filters above 1,000 amperes.

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Submit factory test report data for each filter configuration, voltage, and amperage which shows the ability of filters to meet the specified requirements. Base filter test reports on prior tests of the same filter assembly design and components. Submit test data reports in accordance with paragraph SUBMITTALS. Include the following in the test data:

a. Voltage Drop Measurements.

b. Insertion Loss Measurements.

c. Filter Life Test.

d. Thermal Shock Test.

e. Overload Test.

f. Reactive Shunt Current Measurements.

g. Dielectric Withstand Voltage.

h. Insulation Resistance Test.

i. Current Sharing.

j. Harmonic Distortion.

k. Terminals.

2.7.5.1 Voltage Drop Measurements

Perform voltage drop measurements on both ac and dc filters with the components mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method that will be used for mounting in the enclosure. For ac rated filters, make measurements by using expanded scale-type meters. For dc rated filters, make measurements by using a dc meter when the filter is carrying rated current and rated voltage.

2.7.5.2 Insertion Loss Measurements

Insertion loss measurements for power filters must have the following modifications. Install filters in the filter/ESA assembly enclosure. Operate load current power supply at the rated voltage of the filters and provide any current from no-load through rated full-load current. The rf signal generator must be a swept continuous wave (cw) source. Modify buffer networks to permit valid measurements over the entire frequency band on which insertion loss requirements are specified (14 kHz-1 Ghz). Provide receiver or network analyzer capable of operating over the entire frequency band on which insertion loss requirements are specified (14 kHz-1 Ghz). Use adequate sensitivity to provide a measurement dynamic range at least 10 dB greater than the insertion loss requirement. Use resistive load impedance which is capable of dissipating the rated full-load filter current. Make insertion loss measurements at 20 percent, 50 percent, and 100 percent of the filter full-load operating current. Perform insertion loss measurements for communication/signal line filters the same as for power filters except that the insertion loss measurements are required at a load impedance equal to the image impedance of the filter. Do not perform load insertion loss measurements over the frequencies defined in the EM shielding effectiveness attenuation requirements for both power and communication filters. [Perfom load to source testing for TEMPEST.] [Perform source to load testing for HEMP.]

2.7.5.3 Filter Life at High Ambient Temperature

This test is conducted for the purpose of determining the effects on electrical and mechanical characteristics of a filter, resulting from exposure of the filter to a high ambient temperature for a specified length of time, while the filter is performing its operational function. Surge current, total resistance, dielectric strength, insulation resistance, and capacitance are types of measurements that would show the deleterious effects due to exposure to elevated ambient temperatures. Use a suitable test chamber which will maintain the temperature at the required test temperature and tolerance. Make temperature measurements within a specified number of unobstructed mm inches from any one filter or group of like filters under test. Make this test in still air. Mount specimens by their normal mounting means. When groups of filters are to be tested simultaneously, specify the mounting distance between filters for the individual groups otherwise use sufficient mounting distance to minimize the temperature on one filter affecting the temperature of another. Do not test filters fabricated of different materials simultaneously. Use a test temperature of 85 + 2 degrees C 184 + 34 degrees F. Perform test for a length of 5,000 hours. Make specified measurements prior to, during, or after exposure.

2.7.5.4 Thermal Shock Test

This test is conducted for the purpose of determining the resistance of a filter to exposures at extremes of high and low temperatures, and to the shock of alternate exposures to these extremes. Use suitable temperature controlled systems to meet the temperature requirements and test conditions. Use environmental chambers to meet test requirements and to reach specified temperature conditions. Place filters so that there is no obstruction to the flow of air across and around the filter. Subject filter to the specified test condition. Run the first five cycles continuously. After five cycles, the test may be interrupted after the completion of any full cycle, and the filter allowed to return to room ambient temperature before testing is resumed. One cycle consists of steps 1 through 4 of the applicable test condition for dual environmental test chambers (one low temperature and one high temperature test chamber) and steps 1 and 3 for single compartment test chambers where both high and low temperatures are achieved without moving the filter. The test conditions are as follows:

1. -55 deg C. 0 deg and -3 deg
2. 25 deg C. +10 deg and -5 deg
3. 85 deg C. + 3 deg and -0 deg
4. 25 deg C. +10 deg and -5 deg

Do not exceed an effective total transfer time from the specified low temperature to the specified high temperature of 5 minutes. The exposure time in air at the extreme temperatures is a function of the weight of the filter. Use minimum exposure time per the weight of the filter as follows:

1 oz. and below	15 minutes
Above 1 oz. to 4.8 oz.	30 minutes
Above 4.8 oz. to 3 lb.	1 hour
Above 3 lb. to 30 lb.	2 hours
Above 30 lb. to 300 lb.	4 hours
Above 300 lb.	8 hours

Make specified measurements prior to the first cycle and upon completion of the final cycle, except base failures on measurements made after the specimen has stabilized at room temperature following the final cycle.

2.7.5.5 Overload Test

Mount filters in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method that will be used for mounting in the enclosure. Apply a specified current for a specified period of time. After the filter has returned to room temperature, measure the insulation resistance and voltage drop. Measure the insulation resistance using the method in paragraph ELECTROMAGNETIC FILTERS. Make AC voltage drop measurements by using expanded scale-type meters which will enable voltage differences of less than 1 volt to be read. Make DC voltage drop measurements by using a dc reading meter when the filter is carrying rated current and rated voltage. The insulation resistance and the voltage drop will be measured after each separate overload test. Filters will also be visually examined for evidence of physical damage after each test.

2.7.5.6 Reactive Shunt Current Measurements

Perform reactive shunt current measurements with the filters mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method that will be used for mounting in the enclosure. Terminate filter in the inner compartment in an open circuit. Apply rated ac voltage between the filter outer compartment terminal and the enclosure or metal plate. Monitor the ac current into the outer compartment terminal. The measured current is equal to the filter reactive shunt current.

2.7.5.7 Dielectric Withstand Voltage Test

The dielectric withstanding voltage test (also called high-potential, over potential, .voltage breakdown, or dielectric-strength test) consists of the application of a voltage higher than rated voltage for a specific time between mutually insulated portions of a filter or between insulated portions and ground. Repeated application of the test voltage on the same filter is not recommended as even an overpotential less than the breakdown voltage may injure the insulation. When subsequent application of the test potential is specified in the test routine, make succeeding tests at reduced potential. When an alternating potential (ac) is used, the test voltage must be 60 Hz. and approximate a true sine wave in form. Express all ac potentials as root-mean-square values. The KVA rating and impedance of the source must permit operation at all testing loads without serious distortion of the waveform and without serious change in voltage for any setting. When a direct potential (dc) is used, the ripple content must not exceed 5 percent rms of the test potential. Use a voltmeter to measure the applied voltage to an accuracy of 5 percent. When a transformer is used as a high-voltage source of ac, connecta voltmeter across the primary side or across a tertiary winding provided that the actual voltage across the filter will be within the allowable tolerance under any normal load condition. Unless otherwise specified, use the dc test voltage as follows:

DC rated only	2.5 times rated voltage
For filters with ac and dc ratings	2.5 times rated dc voltage
AC rated only	4.2 times rated rms voltage

The duration of the dc test voltages must be 5 seconds minimum, 1 minute maximum, after the filter has reached thermal stability at maximum operating temperature produced by passage of rated current. Apply the test voltage between the case (ground) and connect all live (not grounded) terminals of the same circuit together. Raise test voltage from zero to the specified value as uniformly as possible, at a rate of approximately 500 volts (rms or dc) per second. Upon completion of the test, reduce the test voltage gradually to avoid voltage surges. The changing current is 50 mA maximum. During the dielectric withstanding voltage test, monitor the fault indicator for evidence of disruptive discharge and leakage current. Use sufficient sensitivity of the breakdown test equipment to indicate breakdown when at least 0.5 mA of leakage current flows through the filter under test. Perform test with the components mounted in the filter/ESA assembly enclosure. Test filters for ac circuits with an ac source. Test filters for dc circuits with a dc source. After the test, examine the filter and perform measurements to include insulation resistance measurements to determine the effect of the dielectric withstanding voltage test on specific operating characteristics.

2.7.5.8 Insulation Resistance Test

This is a test to measure the resistance offered by the insulating members of a filter to an impressed direct voltage tending to produce a leakage current through or on the surface of these filters. Make insulation-resistance measurements on an apparatus suitable for the characteristics of the filter to be measured such as a megohm bridge, megohm-meter, insulation-resistance test set, or other suitable apparatus. Perform test with the components mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method that will be used for mounting in the enclosure. Disconnect the bleeder resistor. Apply direct potential to the specimen which is the largest test condition voltage (100, 500, or 1,000 volts +10 percent) that does not exceed the rated peak ac voltage or the rated dc voltage. A separate dc power supply may be used to charge the filters to the test voltage. Do not exceed a measurement error of 10 percent at the insulation-resistance value required. Use proper guarding techniques to prevent erroneous readings due to leakage along undesired paths. Make insulation-resistance measurements between the mutually insulated points or between insulated points and ground. Read the insulation resistance value with a megohmmeter and record after the reading has stabilized. When more than one measurement is specified, make subsequent measurements of insulation resistance using the same polarity as the initial measurements.

2.7.5.9 Current Sharing

Perform testing with the filters mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method that will be used for mounting in the enclosure. Load filter inner compartment terminals with a resistor equal in value to the rated operating voltage divided by the sum of the current ratings of the devices in parallel. Use resistor capable of dissipating the total current. Apply rated operating voltage at the filter outer compartment terminals. Monitor the current into each filter outer compartment terminal.

2.7.5.10 Harmonic Distortion Test

Make harmonic distortion measurements using a spectrum analyzer having a dynamic range of [70 dB] [_____] and a frequency range from [10 kHz to 1.7 GHz] [_____]. Measure total harmonic distortion at the input and output terminals of the filter when operating at 25, 50, and 100 percent of rated full-load current.

2.7.5.11 Terminals Pull Test

The purpose of this test is to determine whether the design of the filter terminals can withstand the mechanical stresses to which they will be subjected during installation or disassembly in equipment. Perform testing with the components mounted in the filter/ESA assembly enclosure or mounted on a plate by the same holding method that will be used for mounting in the enclosure. Apply a force of 89 N 20 pounds to the terminal. The point of application of the force and the force applied must be in the direction of the axes of the terminations. Apply force gradually to the terminal and maintain for a period of 5 to 10 seconds. Check the terminals before and after the pull test for poor workmanship, faulty designs, inadequate methods of attaching of the terminals to the body of the part, broken seals, cracking of the materials surrounding the terminals, and the changes in electrical characteristics such as shorted or interrupted circuits. Measurements are to be made before and after the test.

2.8 ELECTRICAL SURGE ARRESTERS (ESA)

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NOTE: ESA application guidance is found in MIL-HDBK 423.

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2.8.1 Power and Signal Line ESA

2.8.1.1 ESA General

Provide ESAs consisting of metal oxide varistors (MOVs) or spark gaps. When a spark gap is specified, enclose the ESA within a metal case. Contain discharges within the case; no external corona or arcing will be permitted. Provide factory installed ESAs with minimum lead lengths within the outer compartment. For all power filter/ESA assemblies, install the ESAs a minimum of 75 mm 3 inch apart, with terminals at least 75 mm3 inch from a grounded surface. For telephone filter/ESA assemblies, install the ESAs with a minimum clearance spacing of 25 mm 1 inch, and place terminals at least 75 mm 3 inch from a grounded surface. Connect each phase, neutral and telephone circuit conductor through an ESA to the ground bus. Install the ESA [in the power input compartment of the filter] [in a separate EM shielded enclosure]. Provide ESA units within the filter/ESA assembly that are individually replaceable. Like ESAs must be interchangeable. ESA terminals mus withstand the 89 N 20 lb pull test. Space live parts in accordance with NFPA 70. Use copper ESA leads. Mark individual ESAs with HCI tags containing the manufacturer's name or trademark and part number. Provide ESA meeting the requirements of IEEE C62.11, IEEE C62.41.1, IEEE C62.41.2, and UL 1449.

2.8.1.2 Wiring

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NOTE: Some designers prefer coiling the wire between the ESA and the filter, because it creates enough inductance to develop the ESA firing potential during transients for HEMP applications. Short leads, as recommended herein, improve the voltage-limiting effectiveness of the ESA. Fusing of the ESA is not recommended because protection may be lost without the operator's knowledge. If fusing is necessary, a light to indicate a blown fuse will be provided on the ESA enclosures.

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Locate ESAa so that leads of minimum length connect the ESA ground terminal to the enclosure. The total lead length connecting the ESA to the filter and the ESA ground terminal to the enclosure must be less than 300 mm 12 inch. Power line ESA wiring must be No. 4 AWG minimum. Provide communication/signal line ESA wiring of the same or heavier gauge than the communication/signal line conductor.

2.8.1.3 Voltage Characteristics

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NOTE: Clamping voltage requirement is intended to ensure that the ESA does not have excessive series resistance. The specific value should be chosen after reviewing manufacturer's data.

Specified dc breakdown voltage (or MOV voltage at 1 milliampere dc current) for dc and single phase ac power should be in the range of 150 to 200 percent of the peak (not rms) operating voltage. Use 200 to 250 percent on three-phase circuits, so that a short-circuit fault in one phase will not fire ESA on the other two phases.

The spark gap dc breakdown voltage requirement is intended to ensure that the spark gap is a low-inductance, fast device. The precise values are not critical and should be chosen after reviewing ESA catalog information.

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Make measurements of (MOV) voltage at 1 mA dc current and spark gap dc breakdown voltage in accordance with the following procedure. Perform testing with the ESAs mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method which will be used for mounting in the enclosure. Connect a variable dc power supply between the

ESA terminal and the enclosure (or plate). Increase the applied dc voltage at a rate not to exceed 10 percent of the rated firing voltage per second. The (MOV) voltage at 1 mA dc current is the power supply output voltage, when the output current is 1 milliampere. The spark gap dc breakdown voltage is the applied voltage just prior to breakdown (indicated by a rapid decrease in the voltage across the device). De-energize the power supply immediately after the value has been recorded. MOV direct current breakdown voltage at 1 milliampere dc current must be at least [340] [500] [1,000] [_____] volts and less than [425] [1,500] [_____] volts. Perform MOV testing in accordance with IEEE C62.33. Spark gap direct current breakdown (sparkover) voltage must be at least [500] [1,000] [_____] volts and less than [1,500] [3,000] [_____] volts. Spark gap impulse sparkover voltage of the ESA must be less than 4,000 volts. This voltage must be on surges of either polarity having a rate of rise of 1,000 volts/nanosecond. Perform testing of the ESA impulse sparkover voltage with the spark gaps mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method which will be used for mounting in the enclosure. Connect the pulse generator between the spark gap terminal and the enclosure (or plate) with a minimum inductance connection. Use pulse generator capable of providing a ramp voltage of 1 kV/ns to a peak voltage which is at least twice the open circuit impulse sparkover voltage. Monitor voltage across the spark gap on an oscilloscope or transient digitizing recorder, capable of at least 1 ns resolution. The peak transient voltage during the pulse is the impulse sparkover voltage. Response time must be less than 4 nanoseconds. Clamping voltage of the ESA must be less than [900] [_____] volts at a current pulse of 10 kA. Perform ESA clamping voltage measurements with the ESAs mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method which will be used for mounting in the enclosure. Connect the pulse generator between the ESA terminal and the enclosure (or plate) with a minimum inductance connection. Use pulse generator capable of providing a 10 kA current pulse, on an 8- by 20-microsecond waveshape into the ESA. Monitor current through the ESA and monitor voltage across the ESA on oscilloscopes or transient digitizing recorders. The asymptotic voltage during the 10 kA portion of the pulse is the clamping voltage.

2.8.1.4 ESA Extinguishing Characteristics

The ESA must extinguish and be self-restoring to the normal nonconductive state within one-half cycle at the operating frequency. Perform ESA extinguishing test with the ESA mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method which will be used for mounting in the enclosure. Use an ac power source connected between the ESA terminal and ground at the rated voltage and frequency capable of providing at least 25 amperes into a short-circuit load. Also connect a pulse generator capable of providing a short pulse which will fire the ESA across the ESA. Monitor voltage across the ESA on an oscilloscope or transient digitizing recorder. Inject a series of ten pulses. Performance of the ESA is satisfactory if the arc extinguishes (indicated by re-occurrence of the sinusoidal waveform) within 8.5 milliseconds after the start of each pulse.

2.8.1.5 ESA Extreme Duty Discharge Current

Provide ESA which is rated to survive the extreme duty discharge current of a single 8- x 20-microsecond pulse with a 10 to 90 percent rise time of 8 microseconds and fall time to a value of 36.8 percent of peak in 20 microseconds. Use ESA for high voltage power lines (above 600 volts) with an extreme duty discharge capability equal to or greater than 70 kA. The

ESA for low voltage power lines (below 600 volts) to such things as building interiors, area lighting, and external HVAC equipment with an extreme duty discharge capability equal to or greater than 50 kA. Provide ESAs for control circuits such as interior alarms, indicator lights, door access controllers, HVAC controls, and telephones, with an extreme duty discharge capability equal to or greater than 10 kA. Perform ESA extreme duty discharge test with the ESA mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method which will be used for mounting in the enclosure. Connect a pulse generator between the ESA terminal and the enclosure (or plate) with a minimum inductance connection. Use pulse generator capable of supplying an 8- x 20-microsecond waveshape and a only single pulse is required. Monitor current through the ESA and monitor voltage across the ESA on oscilloscopes or transient digitizing recorders. Monitor the ESA visually during the test and after the pulse inspected for charring, cracks, or other signs of degradation or damage. Test must be on a prototype only. Repeat the dc breakdown voltage test.

2.8.1.6 Minimum Operating Life

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NOTE: Surge life test will be performed only when required by the user. Coordinate current amplitude with manufacturer.

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Perform ESA operating life tests with the ESA mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method which will be used for mounting in the enclosure. Connect a pulse generator between the ESA terminal and the enclosure (or plate) with a minimum inductance connection. Use pulse generator capable of supplying repetitive 4 kA current pulses, with a 50 ns x 500 ns waveshape, to the ESA. A series of ten pulses is required. Monitor current through the ESA and voltage across the ESA on oscilloscopes or transient digitizing recorders. Monitor the ESA visually during the series of pulses for indications of external breakdown. The ESA must be able to conduct 2,000 pulses at a peak current of 4 kA and 50 nanoseconds x 500 nanoseconds waveform. Post-test includes inspection for charring, cracks, or signs of degradation. Repeat the dc breakdown voltage test.

2.8.1.7 Operating Temperature

The ESA must be rated for continuous operation in ambient temperatures from minus 25 to plus 125 degrees C minus 12 to plus 255 degrees F.

2.8.2 ESA Testing

Submit ESA factory test data which shows the ability to meet the requirements herein, based on prior tests of the same ESA assembly components and design. Perform testing with the ESA mounted in the filter/ESA assembly enclosure or mounted on a metal plate by the same holding method which will be used for mounting in the enclosure. Connect the pulse generator between the ESA terminal and the enclosure (or plate) with a minimum inductance connection. Monitor current through the ESA and voltage across the ESA on oscilloscopes or transient digitizing recorders. Include the following in the test data:

a. Breakdown Voltage.

b. Impulse Sparkover Voltage.

c. Clamping Voltage.

d. Extinguishing.

e. Extreme Duty Discharge.

f. Surge Life.

2.9 WAVEGUIDE ASSEMBLIES

Provide waveguide-below-cutoff (WBC) protection for all piping, ventilation, fiber optic cable penetrations and microwave communications barrier penetrations of the HEMP electromagnetic barrier. Protect these WBC penetrations with cutoff frequencies and attenuation no less than the EM shielding effectiveness values listed herein. Ensure cutoff frequencies are no less than 1.5 times the highest frequency of the shielding effectiveness. For 1 GHz, the maximum rectangular linear diagonal dimension must be 100 mm 4 inch and the maximum circular diameter must be 100 mm 4 inch. The length-to-cell cross-section dimension ratio of the waveguide must be a minimum of [5:1 to attain 100 dB] [3:1 to attain 50 dB]. Arrange penetration locations to facilitate installation and testing by minimizing the number of locations. Factory test waveguides of each assembly type in accordance with IEEE 299 and Table I of this specification.

2.9.1 Waveguide-Type Air Vents

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NOTE: Occurrence of dissimilar metals will use corrosion resistant design.

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Each ventilation WBC array must be a honeycomb-type air vent with a core fabricated of corrosion resistant steel as shown on the drawings. Include heavy frames to dissipate the heat of welding to the shield in waveguide construction. Construct a welded WBC array from sheet metal or square tubes. Form array cells by welding the sheets at intersections or welding adjacent tubes along the entire length of the WBC section. Use a maximum cell size of 100 mm 4 inch on a diagonal. Use a WBC section length of at least five times the diagonal dimension of the cells. Provide air vents with a shielding effectiveness equal to that of the total enclosure as a permanent part of the shielded enclosure. Do not exceed a static pressure drop through the vents of 3.4 gpscm 0.01 inch of water at an air velocity of 305 m/s 1000 fpm. Provide waveguides for air vents (honeycomb) with access doors in duct work for maintenance. [Weld] [Bolt] the frame of the honeycomb panel into the penetration plate [with continuous circumferential EM welds.] [with bolts 75 mm 3 inch on center.] Welds for fabrication and installation of honeycomb waveguide panels are primary shield welds and inspect as indicated. Include acceptance testing of all honeycomb panels with the final acceptance test. Do not pass conductors, such as wires and louver operating rods, through the waveguide openings.

2.9.2 Piping Penetrations

Make all piping penetrations of the HEMP barrier to include utility piping, fire mains, vent pipes, and generator and boiler exhausts with piping WBC sections. Provide steel WBC material with a composition suitable for welding to the HEMP shield. Provide a minimum wall thickness of 3.2 mm

0.125 inch. Provide a maximum inside diameter of 100 mm 4 inch or install a metallic honeycomb insert with a maximum cell dimension of 100 mm 4 inch. Provide WBC section with an unbroken length of at least five diameters to form a minimum cutoff frequency of 1.5 times the highest frequency of the shield effectiveness. Weld or braze the piping WBC section circumferentially to the HEMP shield, pipe sleeve or a penetration plate as shown on the drawings. Construct generator and boiler exhausts as shown in the drawings and configure as a WBC or WBC array. The circumferential penetration welds are primary shield welds and inspect and test as indicated.

2.9.3 Waveguide Penetrations

Implement waveguide penetrations for dielectric fibers or hoses in the same manner as piping penetrations. Convert dielectric hoses or pipes to metal waveguide piping before penetrating the shield. Do not pass conductors, such as wires and fiber cable strength members, through the waveguide opening.

2.9.4 GROUNDING STUD

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NOTE: Grounding stud will be provided only for small (under 100 square meters 1,000 square feet of floor area) bolted and welded enclosures.

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Provide enclosure with 13 mm 1/2 inch diameter stud circumferentially welded to each side of the shielding penetration plate.

2.10 PENETRATION PLATES

Provide penetration plates that are minimum 6 mm 1/4 inch thick and sized as shown on the drawings. The penetration plate must overlap the shield penetration cutout dimension by a minimum of 150 mm 6 inch on each side. [Weld] [Bolt] the penetration plate to the HEMP shield [with continuous circumferential EM welds.] [with bolts 75 mm 3 inch on center.]

2.11 GALVANIZING

Galvanizing, when practical and not otherwise indicated, must be hot-dipped processed after fabrication. Galvanizing must be in accordance with ASTM A123/A123M, or ASTM A653/A653M, as applicable. Exposed fastenings must be galvanically compatible material. Avoid electrolytic couples and dissimilar metals that tend to seize or gall.

2.12 EM SHIELDED CABINETS AND PULL BOXES

Provide cabinets and pull boxes which are modified NEMA [1] [_____] in accordance with NEMA ICS 6 made of corrosion resistant steel of no less than 2 mm 14 gauge thick with welded seams and galvanized bulkhead cover plates. Provide hinged access cover plates with EM gaskets and 75 mm 3 inch maximum bolt spacing. Include thick cover plates, folded enclosure edges, and bolt spacers to prevent uneven gasket compression and enclosure deformation in the design. Gasket must be easy to replace. Gasket contact areas must be tin-plated using the electrodeposited type I method in accordance with ASTM B545. EM weld conduit hub circumferentially to the enclosure. Finish cabinets with a corrosion-inhibiting primer and two coats of baked or finish enamel. Provide cabinets with mounting brackets for wall mounting or legs for floor mounting. Factory test cabinets and boxes of each type in accordance with IEEE 299 and Table I of this specification.

2.13 QUALITATIVE MONITORING SYSTEM

Provide a built-in shield monitoring system for SELDS testing. Provide system consisting of either multiple injection points or a surface loop system. Bring driving conductors to a single lockable EM shielded connection box, located outside the shield in a controlled space.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

3.2.1 Coordination

The EM shielding installer must instruct other trades in the presence and with the direction of the Government representative, in advance of the EM shielding system installation, to ensure that all individuals are aware of the critical installation requirements. Submit manufacturer's data, catalog cuts, and printed documentation regarding the work. Provide cleaners, solvents, coatings, finishes, physical barriers, and door threshold protectors as required to protect the shielding system from corrosion, damage, and degradation. Obatin approval of the shielding installation plan before construction begins.

3.2.2 Verification

Before, during, and after the EM shielding and penetration protection subsystem installation, the shielding specialist must verify and approve the installation for compliance with the specifications. Provide materials and methods, shop drawings, and other items for the shielding subsystem bearing an approval stamp of the shielding specialist. Provide compliance notification to the Contracting Officer before materials are installed or methods performed.

3.2.3 Inspection

During and after EM shielding and penetration protection subsystem installation, including EM filters and waveguides, a qualified shielding specialist must inspect the installation for compliance with the specifications. Complete the inspection before a finish or concrete topping coat is installed.

3.2.4 Manufacturer's Services

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Supervise the installation, adjustment, and testing of the equipment.

3.2.5 Posting Framed Instructions

Post framed instructions containing wiring and control diagrams under glass or in laminated plastic. Frame condensed operating instructions, prepared in typed form, as specified above and post beside the diagrams before acceptance testing of the system.

3.3 ENCLOSURE INSTALLATION - WELDED STEEL CONSTRUCTION

****

NOTE: Either the welded or bolted construction will be used for the EM shielding enclosure. Choose the appropriate construction and delete the non-applicable paragraphs.

Welded construction will usually consist of continuous 1.897 mm 14 gauge thick steel plate and angles to form the enclosure. Thicker material may be used if it is more cost-effective or required for structural reasons. Welded construction is used when a shielded facility requires a long maintainable service life of high-level protection, 100 dB attenuation, or HEMP protection, 100 dB. For bolted construction see the NOTE and paragraphs below under the title ENCLOSURE INSTALLATION - BOLTED CONSTRUCTION

****

Install the EM shielded enclosure in accordance with this specification, the drawings, and the recommendations of the manufacturer and EM shielding specialist. Handle and install shielding steel without damage. Penetrations of the shield, other than those indicated on the drawings, will not be permitted, including fasteners and mounting bolts, without prior written authorization from the Contracting Officer.

3.3.1 Surface Preparation

Clean and buff contacting surfaces to ensure firm contact with shielding steel.

3.3.2 Control of Warping

****

NOTE: Steel plates exposed to sunlight and changing environmental conditions increase warpage and buckling.

****

Keep warping of steel shielding plates during installation and welding within 1 mm in 1 meter 1/8 inch in 10 feet. use embeds, drive pins, and/or anchor bolts or ties to hold plates in place during welding. Also use other techniques such as skip welding to reduce warpage. The system chosen must be fully coordinated and approved by the Contracting Officer. Seal fasteners, drive pins, and other shield penetrations with full penetration circumferential EM welds.

3.3.3 Placement of Floor Shield

****

NOTE: The shingle overlap method is one successful method of floor shield placement. Designers have the option to select other methods.

****

Do not begin placement of the floor shield until at least 14 days after the pouring of the floor slab and Contracting Officer approval of all required submittals. [The placement of the floor shield must utilize [the shingle overlap method] [_____].] [Attach individual floor sheet on the top and one side only with air-pressure drive tools to the floor. Oerlap floor shielding sheets 50 mm 2 inch at joints, Bend and lay flat on the concrete floor without voids or gaps, and seal with continuous EM welds at all seams and joints.] Start floor shield installation at the center of the space.

3.3.4 Placement of Overslab

Before placement of the overslab over any portion of the floor shield, the Contracting Officer's approval is required. Successfully complete both visual and SELDS testing of the shielding within the area to be covered, repair and retest any defects, and supply full test results to the Contracting Officer prior to placement of the overslab. Place a vapor barrier over the floor shield.

3.3.5 Welding

Provide shielding work in accordance with the performance criteria specified. Shielding steel structurally welded to the steel frame must be welded in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M. Seal EM shielding seams EM-tight by the MIG method, using electrodes structurally and electrically compatible with the adjacent steel sheets. [Weld sheet steel to support steel by plug or tack welding at 300 mm 12 inch on center, and then EM weld sheet seams continuously to seal the enclosure] [_____]. Slag inclusions, gas pockets, voids, or incomplete fusion will not be allowed anywhere along welded seams. Correct weld failures by grinding out such welds and replacing with new welds. A qualified welder must perform welding, both structural and EM sealing. Weldments critical to shielding effectiveness are shown on the drawings and perform in the manner shown on the drawings. Where both structural integrity and shielding quality are required for a given weldment, meet both criteria simultaneously. Perform brazing conforming to the documents discussed above, where practical, and also conform to requirement of AWS BRH. Seal structural, mechanical, or electrical systems penetrations by providing a continuous solid perimeter weld, or braze to the shield as specified. Provide all shield joints and seams with a minimum 50 mm 2 inch overlap and seal with a continuous solid weld. After testing, the Contracting Officer will inspect and approve the installation prior to covering by other trades.

3.3.6 Wall Shielding Attachment

****

NOTE: The wall attachment method outlined in this paragraph is one successful example. Site-specific methods must be edited at this point in this specification. Note that all attachment penetrations must be welded closed. Metal wall studs or furring strips should be of equal or greater thickness (gauge) than the shield steel when shield steel is welded to supporting metal.

****

Secure continuous [1.613] [_____] mm [16] [_____] gauge thick furring channels spaced no more than 600 mm 24 inch on center to steel wall studs by using self-tapping sheet metal screws. Tack weld steel sheets to the furring strips every 400 mm 16 inch on center horizontally and 600 mm 24 inch on center vertically. Make a continuous full penetration EM weld to join the sheets and form the shield. Welds must not form dimples or depressions causing fish mouths at the edge of the sheet.

3.3.7   Formed Closures

Install formed closures where indicated and/or necessary to completely close all joints, openings, enclosures of pipe chases, and structural penetrations, columns, and beams.

3.3.8   Sequence of Installation

Sequence erection of the steel to prevent steel sheet warpage. Install shielding components that have passed initial testing (part 1) before construction of any features that would limit access for repairs to the shield.

3.3.9   Door Assemblies

Mount doors to perform as specified. Weld door framing continuously to the EM shield. The structural system supporting the door frame must provide proper support for doors and frame.

3.4   ENCLOSURE INSTALLATION - BOLTED CONSTRUCTION

****

NOTE: Either welded or bolted construction will be used for the EM shielding enclosure. For welded construction see the NOTE and paragraphs above.

Bolted construction is associated with a lower level (50 dB) of maintained shielding effectiveness. Bolted construction will usually consist of modular panels bolted together with metal strips or channels. Panels are commonly plywood with steel sheets laminated to one or both sides. Bolted construction is used when a shielded facility's service life is short, 10 years or less, or the system is required to be demountable for change of location. This system requires more maintenance than a welded system and requires access to the panels. The EM shield layout may restrict attenuation testing of the enclosure. It is desirable for large facilities to place the shield at least 1 meter 3.3 feet inside the exterior walls, although cost and construction restrict this consideration. The floor shielding can be tested by SELDS test but not by IEEE 299 if it is on grade. The facility layout must be carefully planned to allow for testing and shield maintenance.

****

3.4.1 Enclosure Panel Installation

Install panels, without damage to the shielding steel, in accordance with the shielding manufacturer's recommendations. Clean exposed surfaces of dirt, finger marks, and foreign matter resulting from manufacturing processes, handling, and installation. Install electrical conduits as close to the EM shield as possible. Do not use framing-joining system bolts to mount material and equipment. Seam weld or solder material and equipment which penetrate the shielded enclosure to both shielding surfaces.

3.4.2 Surface Preparation

Clean and buff surfaces to ensure good electrical contact with shielding surface. Remove paint or other coverings on mating surfaces of special boxes such as for fire alarm systems, buzzers, and signal lights, including areas between box and cover, box and wall, and box and conduit. Remove insulating material to maintain a low-resistance ground system and to ensure firm mating of metal surfaces.

3.4.3 Floor Panel Setting

Place a polyethylene film 0.15 mm 6 mil thick vapor barrier over the structural floor of the parent room before any other work is set thereon. Provide a 3 mm 1/8 inch thick layer of hardboard over this film with joints loosely butted. Over this layer, provide an additional layer of similar filler material of equal thickness as the projection of the framing-joining member from the bottom surface of the floor panel leaving no more than 6 mm 1/4 inch of space between the hardboard and the framing-joining member.

3.4.4 Framing-Joining System

Tighten screws with a calibrated adjustable torque wrench with equal torque set for each screw. Use proper torque values in accordance with the manufacturer's requirements.

3.4.5 Door Assemblies

Mount the door to perform as specified. The door must be through-bolted to the EM shield.

3.4.6 Filter Installation

****

NOTE: When the filter unit must be installed inside the shielded enclosure, the input terminal compartment will be EM-tight instead of the load terminal compartment, and the filters will be located in the load terminal compartment. This arrangement is necessary to prevent radiated EM energy within the shielded enclosure from inducing EM energy in the power conductors between the filters and the point where the conductors pass through the shielded enclosure wall. To provide for this arrangement, change the wording as necessary; i.e., change the word "load" to read "input" and change the words "input" to read "output" or "load," as appropriate.

****

Support filters independently of the wall shielding. Conduct inspections on filters provided under this specification, to verify compliance with the specified requirements. Ship filters after successful testing and examine prior to installation to determine if damage occurred during shipment. Damage, no matter how slight, will be reason for rejection of the filter.

3.5 WAVEGUIDE INSTALLATION

Treat penetrations of the EM shield with the appropriate waveguide method. Provide waveguides suitable for piping and for fluids or gases contained within, in accordance with specified requirements.

3.6 SHIELDING PENETRATION INSTALLATION

Install penetrations in accordance with requirements of the penetration schedule and coordinate with system installation.

3.7 FIELD QUALITY CONTROL

Develop a quality control plan to ensure compliance with contract requirements; maintain quality control records for construction operations required under this section; and submit the quality control plan to the Contracting Officer. Furnish a copy of testing records, as well as the records of corrective actions taken. Perform in-progress and final acceptance testing of EM shielding and penetration protection system work as specified. Correct deficiencies at no additional cost to the Government. Maintain legible copies of the daily inspection reports by the shielding specialist at the project site, and deliver copies of the Construction Quality Control Report to the Contracting Officer on the third workday following the date of the report. Include the type of work being performed during the report period and locations, type of testing, deficiencies, corrective actions, unsolved problems, and recommendations to assure adequate quality control in the daily inspections. Attach results of inspections and tests performed in accordance with this specification to the daily Construction Quality Control Report.

3.8 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [8] [_____] hours of normal working time and start after the system is functionally complete but prior to the final acceptance test. Cover all the items contained in the Operating and Maintenance Manuals.

3.9 SHIELDING QUALITY CONTROL

Integrate the Contractor's organizational structure for shielding quality control into the jobsite management. Perform testing by [an independent testing firm] [the shielding installer].

3.9.1 HEMP Hardness Critical Item Schedule

Identify hardness critical items during the detail drawing submittal period. These items are those components and/or construction features which singularly and collectively provide specified levels of HEMP protection, such as the EM shield, surge arresters, EM shielded doors, shield welding, electrical filters, honeycomb waveguides, and waveguides-below-cutoff.

3.9.1.1 Performance Test Plan

Submit a performance test plan for Contracting Officer approval. Accomplish testing in three parts: (1) in-progress; (2) initial shielded enclosure effectiveness; and (3) final acceptance, shield enclosure effectiveness. Include in the test plan equipment listings (including calibration dates and antenna factors) and the proposed test report format. Also include specific test dates and durations during the overall construction period so that the Contracting Officer may be scheduled to observe the testing and so that repairs may be made to the shield and retests conducted. This separate testing schedule for the EM enclosure must show the points, during construction, when it begins and ends as well as a day-by-day test schedule. Indicate proposed dates and duration of lowest and highest frequency tests so that the Contracting Officer may be available for these final acceptance tests. Identify a test grid and provide plan for correlation of that grid to the structure.

3.9.1.2 Test Reports

****

NOTE: Specifications and/or quality assurance test results of this paragraph may be classified for some projects. Provide appropriate instructions when this occurs.

****

Include the method of testing, equipment used, personnel, location of tests, and test results. Submit daily reports of results of each test performed on each portion of the shielding system to the Contracting Officer within 3 working days of the test. Clearly identify location of the area tested. Identify leaks detected during testing with sufficient accuracy to permit relocation for testing in accordance with test procedures. Submit reports of testing to the Contracting Officer with required certification by the testing agency representative or consultant. Submit three reports (in-progress test report, initial test report, and final acceptance test report) in accordance with the format described below.

Cover Page:
A cover page is required.

Administrative Data:
Test personnel.
Contract number.
Date of test.

Authentication. Contractor personnel responsible for performance of the tests and witnessing organization or representatives.

Contents:
Shielded facility description.
Nomenclature of measurement equipment.

Serial numbers of measurement equipment. Date of last calibration of measurement equipment. Type of test performed. Measured level of reference measurements and ambient level at each frequency and test point. Measured level of attenuation in decibels at each frequency and test point. Dynamic range at each test frequency and test point. Test frequencies. Location on the shielded enclosure of each test point. Actual attenuation level at each test point.

Conclusions: Include results of the tests in brief narrative form in this section.

Number of Copies of the Report:
[Three] [_____] copies.

3.9.2 Field Testing

****

NOTE: If a facility is required to fully comply with MIL-STD-188-125 by the Joint Chiefs of Staff, a military department headquarters, or a major command, coordinate with the using organization to establish test requirements. Quality assurance and the testing required by appendix A of that standard should be performed. However, the using organization may insist on full testing in accordance with appendix B as well. In that case, advise the user that, based on limited testing to date, no existing EM filter/ESA devices have survived the E-2 and E-3 waveforms. Include appropriate cost and scheduling considerations if appendix B testing is required. If MIL-STD-188-125 is not a requirement, avoid its reference.

****

Submit reports of certified test results and results of all field and factory tests as specified and as required by the Contracting Officer. Accomplish testing in the three parts described below.

3.9.2.1 Testing - Part 1

Perform Part 1 as in-progress testing including inspection, visual seam inspection, and seam testing of all EM shielding materials and installation. [In-progress testing of welded shielding must include testing the structural welds to be embedded prior to concrete placement by dye penetrant and magnetic particle testing and 100 percent testing of wall, ceiling, and floor shielding welds by the SELDS tests.] [In-progress testing of bolted construction must include 100 percent testing of floor, wall, and ceiling shielding seams by the SELDS testing.] After successful completion of in-progress testing, including defect repairs and retest, and with prior approval of the Contracting Officer, placement of embedments covering may be made to complete the structural systems. Submit an in-progress test report.

3.9.2.2 Testing - Part 2

Part 2 initial testing consists of inspection, visual seam inspection, seam testing, and shielded enclosure effectiveness testing after shielding and shielding penetrations are completed, but before the installation of finish materials over the shielding. Access to penetrations is required. SELDS test all [seams] [welds], including shielding and penetrations not tested in part 1. Prform initial shielded enclosure effectiveness acceptance test consisting of a MIL-STD-188-125-1 test utilizing specified test frequencies for magnetic and plane wave. Conduct testing in accordance with the paragraph EM Shielding Effectiveness Testing. Perform these tests with the number of shield penetrations limited to those required to support the test. After successful completion of Part 2 initial testing, including defect repairs and retest, and with prior approval of the Contracting Officer, placement of any covering may be made except in areas where penetrations are located. Submit an initial test report.

3.9.2.3 Testing - Part 3

Perform Part 3 final acceptance testing consisting of a visual inspection and a shielded enclosure effectiveness test of the EM shielding materials and installation. SELDS test all [seams] [welds], including shielding and penetrations not tested in parts 1 and 2. Perform part 3 testing upon completion of construction and when the building is ready for occupancy. Test facilities requiring HEMP protection for shielding effectiveness in accordance with acceptance test procedures in MIL-STD-188-125-1. Notify the Contracting Officer in writing 14 days prior to tests to permit adequate monitoring by authorized representatives. Accomplish corrective work immediately upon detection that any area has failed to meet the requirements specified. Perform retesting to verify that remedial work done to meet the required attenuation has been properly installed. Submit a final acceptance test report.

3.9.3 Weld Inspection

****

NOTE: Additional welding tests may be specified, such as ultrasonic or radiographic tests, but these tests are costly.

****

Inspect weld seams visually by a qualified welder during the welding operation and after welding is completed. Inspect completed welds after the welds have been thoroughly cleaned by hand or power wire-brush. Inspect welds with magnifiers under bright light for surface cracking, porosity, slag inclusion, excessive roughness, unfilled craters, gas pockets, undercuts, overlaps, size, and insufficient throat and concavity. Grind out defective welds and replace with sound welds.

3.9.4 Shielded Enclosure Leak Detection System (SELDS) Testing

****

NOTE: SELDS testing the welds in the floor shielding is usually performed on the interior only because it is not possible to "sniff" on both sides (assuming the shield is on the ground level). Dye penetrant may also be used to test the welds where SELDS testing is not possible. The SELDS can be obtained commercially from the following: 1. Carnel Labs Corporation 21434 Osborne Street Canoga Park, CA 91304 Telephone: (818) 882-3977 2. Rayproof Shielding Systems Corporation 50 Keeler Avenue Norwalk, CT 06854 Telephone: (203) 838-4555 3. Retlif Corporation 795 Marconi Avenue Ronkonkoma, NY 11779 Telephone: (516) 737-1500

****

The leak detection system must use a 95- to 105-kHz oscillator and a battery operated hand-held receiver. Provide receiver or "sniffer" with a ferrite loop probe capable of sensing leaks within 6 mm 1/4 inch of the probe location with a dynamic range of 140 dB. Conduct testing in accordance with test equipment manufacturer's instructions. Place test loops or leads under the shield floor or into inaccessible locations prior to installation to assist in the detection of seam leaks in the floor, ceiling and walls. Place the loop or lead wires between the vapor barrier and the structural slab for the floor shield with the leads brought to an accessible location. Provide test leads that are insulated stranded copper conductors 2 to 2.5 mm 5/64 to 3/32 inch diameter and bond to the shield only at the end. Place test leads in plastic conduit for protection and do not exceed 45 m 150 ft in length. The surface area of the shield will determine the number of test leads (drive points) that are required. Install drive points on the shielding exterior and attach to two sets of diagonally opposing corners during construction. The distance between test lead connections on a shield surface must not be more than 20 m 66 ft. The maximum testing area must be 400 sm 4300 sf. If the shield area exceeds this requirement, provide additional drive points. Bonding of the test leads to the shield is accomplished by brazing or high-temperature soldering. Run test leads from the drive points to a lockable test cabinet for connection to the SELDS oscillator. If more than one test cabinet is required for a given area or building, duplicate test leads that would be common to different surface areas at each test cabinet to ensure that test point parings are maintained. Record the location of the permanent test leads and provide this information to the Contracting Officer for permanent reference. Welds and seams must be 100 percent tested. Probe seams continuously with the test receiver set to detect abrupt changes of shielding level greater than 10 dB on the shielding unit scale. Mark points having a change greater than 10 dB clearly and have the weld repaired to meet the specified requirement. Retest each repaired point until there are no points on seams which fail the test.

3.9.5   EM Shielding Effectiveness Testing

Furnish services of an EM shielding testing specialist, approved by the Contracting Officer, to test the shielded enclosure. Equip and staff the laboratory to perform field tests of EM shielded enclosures and perform these tests as a normal service. Use test equipment which has been calibrated within the last 12 months.

3.9.5.1   Test Procedure

Provide test procedure and equipment similar to that specified in MIL-STD-188-125-1. Test frequencies are specified herein. Test points are as indicated in Table I. Corner points of the grid must occur at the intersection of three planes (two-wall surfaces and ceiling or two wall surfaces and floor). Record measurement data at all test points, and provide a grid map for each surface tested. For any test point where required attenuation is not provided, correct the discrepancy and retest. Provide the results of the test failure as well as the successful results. Perform enclosure effectiveness test for magnetic attenuation with the antennas located directly opposite each other and separated by a distance of 600 mm 2 ft plus the wall thickness. Perform plane wave attenuation tests with the antennas located directly opposite each other and with the transmitting antenna placed 300 mm 1 ft away from the enclosure wall and with the receiving antenna set 300 mm 1 ft from the wall for stationary measurements and 50 to 600 mm 2 inch to 2 ft from the wall for swept measurements. Perform the magnetic field test and the plane wave test using the following sequence. Perform calibrations at the beginning of each test day. Then set up the test area for the 100 to 400 MHz stationary measurement in on to the two required polarizations. With the transmitter off check the receiver sensitivity. Energize the transmitter, and record the fixed measurement data. Remove the receiving antenna from the test stand and perform the swept measurement at the same frequency and transmitting antenna polarization. Rotate the transmitting antenna, and perform the second 100 to 400 MHz stationary measurement. Perform the swept measurement for the second transmitting antenna polarization. Reconfigure the equipment for the 900 to 1000 MHz test frequency, and repeat the series of four measurements. To perform the swept measurement, remove the receiving antenna from the test stand and hold with a dielectric rod at least 300 mm 12 inch in length. Attach a dielectric spacer to the sweeping antenna to assist in maintaining the 50 mm 2 inch distance from the shield. Make a rapid sweep to locate hot spots by rotating the polarization and waving the antenna through the specified volume. The final activity of each test day is to repeat the calibrations and verify the consistency with the previous calibration results. Include a definition of all test points including but not limited to walls, door frames, accessible joints, and around filters and penetrations in the test procedures. Test each EM door at the locations indicated in Table I.

TABLE I - SHIELDING EFFECTIVENESS TEST POINTS

Testing Location	Test Points Spacing
Joints between steel panels for roof, walls, and floors	Test every 3 m 10 feet (Note 1; minimum of one test point per side)
Corner seams for walls to floor, walls to roof, and wall to wall	Test every 3 m 10 feet (Note 1; minimum of one test point per corner seam)
Corners (intersection of three surfaces)	Test at all corners in Shield
Single doors	Test at each corner; at midpoint of each side longer than 1.5 m 5 feet; and at center
Double doors	Test each separately at same test point as single doors
WBC vents and panels	Test in center (on axis) for all sizes (including single); at all four corners if 300 by 300 mm 12 by 12 inches or larger; and at the midpoint of each side longer than 1.5 m 5 feet
At treated penetrations of shield (and entry panel and backshield)	Test as close to "an-axis" as possible, or orient for maximum signal
All other shield joints, seams, or corners	Sweep all surfaces at one frequency in the range of 400 MHz to 1 GHz. Test every 3 m 10 feet max. plane wave
Doors	Door handles

TABLE I - SHIELDING EFFECTIVENESS TEST POINTS	
Testing Location	Test Points Spacing
EM filter enclosures	Test at each seam corner and midpoint of each side longer than 1.5 m 5 feet at center
EM cabinets and enclosures	Test at each seam corner and each side 1.5 m 5 feet on center
NOTE 1. Sweep each point in space 600 mm 2 feet around the point.	

3.9.5.2 Test Points

Measure additional test points in accordance with MIL-STD-188-125-1 for facilities requiring HEMP protection. Test points include the periphery of doors and covers, handles, latches, power filter penetrations, air vent filters, communications line filter penetrations, and points of penetration by pipes, tubes, and bolts.

3.9.5.3 Test Methodology

Orient antennas for maximum signal pickup. Probe each test point for area of maximum leakage, such as around door frames, accessible joints, filters, pipes, and air ducts. Determine magnitude and location of maximum signal levels emanating from the enclosure for each accessible wall at a minimum of two locations on each wall, around doors, and at penetrations and seams of the enclosure. Accomplish measurement of attenuation in accordance with Table I.

3.9.5.4 Test Frequencies

****
NOTE: Test frequencies will be in accordance with MIL-STD-188-125 when applicable.
****

Testing frequencies for shielded enclosures are as follows:

Magnetic field	[14 kHz,] [400 kHz,] and [10.1 MHz] [_____]
Electric field	[200 kHz] and [16 MHz] [_____]
Plane wave	[100 MHz], [415 MHz], and [1.29] [18] [_____] [GHz]
MIL-STD-188-125-1 frequencies are as follows:	
Magnetic	[_____]
Plane wave	[_____]

3.9.6 Weld Testing

Test structural welds to be embedded in accordance with AWS D1.1/D1.1M using magnetic particle inspection or dye penetrant inspection and 100 percent of the shielding seams by the SELDS testing prior to embedment.

3.10 GROUNDING

****

NOTE: Grounding method will be in accordance with MIL-STD-188-124. An equipotential ground plane is recommended for shielded facilities.

****

The contract drawings indicate the extent and general arrangement of the shielded enclosure grounding system. The grounding methods must be an equipotential grounding plane method in accordance with UL 1283, NFPA 70, NFPA 77, NFPA 780, IEEE 142, MIL-STD-188-124, and MIL-HDBK-419. For additional facility grounding requirements, see Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-13 49 21 (November 2020)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 13 49 21

RADIO FREQUENCY (RF) SHIELDING: MAGNETIC RESONANCE IMAGING (MRI)

11/20

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NOTE: This guide specification covers the requirements for radio frequency (RF) interference shielding for magnetic resonance imaging (MRI) facilities of copper construction with a delegated design by the RF Shielding Vendor in conjunction with a Medical Physicist/MR Scientist, and evaluation of site conditions with electromagnetic interference (EMI) field measurements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN COLLEGE OF RADIOLOGY (ACR)

ACR	MRI Accreditation Program Requirements, Latest Edition

ASTM INTERNATIONAL (ASTM)

ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 299	(2006; R 2012) Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

RF Shielding Vendor Qualifications[; G, [_____]]

RF Shielding Supervisor Qualifications[; G, [_____]]

Medical Physicist/MR Scientist Qualifications[; G, [_____]]

Field Quality Control Plan[; G, [_____]]

RF Attenuation Performance Requirements[; G, [_____]]

SD-02 Shop Drawings

RF Shielding Shop Drawings[; G, [_____]]

SD-03 Product Data

Materials, Equipment, and Manufactured Units [; G, [_____]]

SD-06 Test Reports

In Progress RF Testing[; G, [_____]]

Preliminary RF Testing[; G, [_____]]

Final RF Testing[; G, [_____]]

SD-10 Operation and Maintenance Data

Operating And Maintenance Manual[; G, [_____]]

SD-11 Closeout Submittals

RF Shielding Enclosure Warranty[; G, [_____]]

1.3 QUALITY CONTROL

Supervise and inspect all work under this section, approve all materials and equipment, coordinate shielding work with all other work and trades.

Ensure that RF shielding system fully complies with the MRI equipment manufacturer's requirements, is fully compatible with ACR accreditation, and complies with all applicable codes.

1.3.1 Qualifications

Ensure minimum qualifications as indicated.

1.3.1.1 RF Shielding Vendor Qualifications

A firm that has continuously executed the design installation, supervision, and testing of equivalent RF shielding systems for the previous 5 years for all the RF shielding work.

Submit a project experience list of projects of similar scope completed during the previous 5 years for approval. Include project completion dates, name and contact information of the user and/or owner. Include installation materials, construction system, responsibilities, and performance.

1.3.1.2 RF Shielding Supervisor Qualifications

RF Shielding Vendor to provide a supervisor continuously engaged in the design, installation, supervision, and testing of equivalent RF shielded systems for the previous 5 years to supervise all RF shielding installation work.

Submit the name, qualifications and a list of projects of similar scope completed during the previous 5 years for approval. Include project completion dates, name and contact information of the user and/or owner. Include field investigations and measurements, installation materials, construction system, testing method, responsibilities, and performance.

1.3.1.3 Medical Physicist/MR Scientist Qualifications

RF Shielding Vendor to engage a Medical Physicist/MR Scientist, meeting the minimum ACR requirements, who has been continuously engaged in the design, installation, supervision, and testing of equivalent RF shielded systems for the previous 5 years.

Submit the name, qualifications and a list of projects of similar scope completed during the previous 5 years for approval. Include, project completion dates, name and contact information of the user and/or owner.

Include field investigations and measurements, installation materials, construction system, testing method, responsibilities, and performance.

1.3.2 RF Shielding Shop Drawings

Submit shop drawings for the RF shielding system including: the construction method, materials, arrangement and attachment of the RF walls, ceiling and floor, method of RF sealing joints, the connection and method of RF sealing RF shielding system components and any other attachment to the RF shield. Include attachment details for interior elements, including suspended ceiling, wall finish and floor finish systems.

Locate and label all RF shielding system components and equipment locations.

1.3.3 Material and Component Certification

Where certification is required, provide materials and equipment with Underwriters Laboratories or other nationally recognized testing laboratory label and listing. Comply with NFPA 70, [UL 486A-486B,]and UL 1283 for filter and electrical work.

1.3.4 Field Quality Control Plan

Submit a field quality control plan to demonstrate compliance with contract requirements. Include: schedule, personnel, methodology, inspection and testing stages and procedures, test equipment and the proposed test report format.

1.3.5 Pre-Construction Conference

Hold a pre-construction conference with all contractors and installers associated with the RF shielding construction and fit out. Review requirements and coordination to ensure the integrity of the RF shielding. Include: Sequence and schedule, coordination of trades, penetrations, attachment of other construction and equipment, and modification and notification procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver equipment, components, and materials in original packaging, labeled with the manufacturer/vendor, brand name and part number.

Inspect equipment, components, and materials upon receipt. Remove and replace damaged items. Minor damage may be repaired at the discretion of the Contracting Officer and the repair matches the new condition.

Comply with manufacturers/vendors instructions and recommendations for storage and handling of all equipment, components, and materials.

Protect materials and components from deleterious environments including weather, direct sunlight, moisture, contamination, corrosion, and construction traffic.

1.5 [PROJECT][SITE] CONDITIONS

Construct the RF shield in a weather enclosed building or environmentally controlled building, according to the RF shielding vendor's or MRI manufacturers' requirements, whichever is more stringent.

1.6 MAINTENANCE

1.6.1 Maintenance Materials

1.6.1.1 [Filters

Provide one RF power filter and one communications filter of each type used on the project as a spare.

]

1.6.1.2 RF Shielded Doors

Provide one set of manufacturer recommended spare parts for each type of RF shielded door[and 2 sets of knife edge RF door seals].

Provide one full set of tools required to maintain the doors if not typically available from tool vendors.

1.6.2 Operating And Maintenance Manual

Submit an Operation and Maintenance Manual for the RF Shielding system. Address all components and aspects of the RF shielding and including:

a. The system RF attenuation performance requirements.

b. The RF shielding shop drawings.

c. The construction specification for the RF shielding.

d. RF shielding penetration schedule.

e. RF power filter schedule.

f. RF signal filter schedule.

g. RF test plan.

h. Vendor/manufacturer maintenance data.

i. Spare parts data.

1.7 RF SHIELDING ENCLOSURE WARRANTY

Submit an RF shielding system warranty for the RF attenuation performance of the complete RF shielding system, to meet the MRI equipment manufacturer's requirements and be fully compatible with ACR accreditation of [5] [_____] years from date of completion of the final RF test for defective design, materials and/or workmanship.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 RF Shielding System Components

The RF shielding system includes, but is not limited to:

a. RF complete metallic enclosure including walls, floor and ceiling.

b. RF shielded doors.

c. RF shielded windows.

d. Over-pressure relief hatch.

e. Magnet delivery access panel.

f. All electrical, mechanical, utility, signal, and cryogen ventilation penetrations, penetration plates and wave guides.

g. Dielectric fittings.

h. Power filters.

i. Signal filters.

j. Access panels.

2.1.2 RF Attenuation Performance Requirements

Submit RF attenuation performance requirements based on Medical Physicist/MR Scientist electromagnetic interference (EMI) field measurements,and evaluation of site conditions, in consultation with the MRI equipment manufacturer. Ensure that RF shielding system fully complies with the MRI equipment manufacturer's requirements and is fully compatible with ACR accreditation.

2.2 MATERIALS

2.2.1 Materials, Equipment, And Manufactured Units

Provide equipment and manufactured units that have been continuously in production and documented for at least 2 years, with a service organization that provides maintenance, parts and support.

Submit product data for all materials, equipment, and manufactured units forming or integrated with the RF shielding including the RF shielding walls, floor and ceiling materials/construction, doors, windows, overpressure relief hatch, power filters, signal filters, and wave guides.

2.2.2 Nameplates

Provide the manufacturers' nameplate including: name, model type, model number, and serial number, on all items of equipment and manufactured units.

2.3 RF SHIELDING ENCLOSURE CONSTRUCTION

2.3.1 Copper Enclosure Construction

Form a continuous RF shielding enclosure including floor, walls, and ceiling, incorporating all RF shielding system components, and conforming to the Medical Physicist/MR Scientist RF attenuation performance requirements. Acceptable enclosure types:

a. Solid copper sheet conforming to ASTM B370 on non-ferrous sub-frame.

b. Annealed copper foil on non-ferrous panel or composite substrate.

c. Other enclosure types pre-approved in writing.

Use soldered connections only on horizontal joints of solid copper sheet. Overlap copper a minimum of 51 mm 2 inches at all joints, and continuously solder.

Use continuously fastened mechanical connections on all vertical or overhead joints. Seal over all mechanical connection fastener penetrations with not less than 51 mm 2 inches wide conductive copper foil tape with conductive adhesive.

Use stainless steel screws to attach RF doors, windows, overpressure relief hatch, and other opening frame assemblies or attachments.

Provide a minimum 51 mm 2 inches deep isolation space between the back of the RF shielding walls and any adjacent building walls or structure.

Provide vapor barrier isolation membrane below RF shielding floor where required/recommended.

Provide isolated support for RF shielding walls and ceiling as required by the Medical Physicist/MR Scientist.

Use copper material free of oil, dents, and defects.

Comply with all applicable codes.[

Include seismic bracing as required by code.]

2.3.2 Dielectric Decoupling

Provide dielectric decoupling of conductive services including piping and ductwork. Do not penetrate RF shielding with continuously conductive elements.

2.3.3 Grounding

Electrically ground the shielding enclosure at a single point, with a minimum resistance to alternate ground of 1,000 ohms. Coordinate with Medical Physicist/MR Scientist.

2.4 RF SHIELDED DOORS

Provide door[s], frame[s], hardware and threshold[s] as indicated with purpose manufactured MRI door system with a demonstrated life cycle test rating of at least [10,000] operational cycles without loss of specified RF attenuation, from a single manufacturer with a minimum of 5 years track record[and 2 years for the products supplied]. Supply assemblies complete with a rigid structural frame, hardware, seals and parts necessary for operation.

Provide door[s] meeting MRI manufacturer's acoustic requirements/recommendations.

2.5 RF SHIELDED WINDOWS

Provide window[s] as indicated with purpose manufactured high visibility MRI window system from a single manufacturer with a minimum of 5 years track record[and 2 years for the products supplied]. Supply assemblies complete with frame, glazing, and seals.

2.6 OVERPRESSURE RELIEF HATCH

Provide a clearly visible, easily accessible and instantly operable overpressure relief hatch for an overpressure emergency. Operate from inside by pushing the hatch. Operate from outside by pulling the hatch, with an appropriate device operated by a person located a minimum of four feet from the hatch. Mitigate the effects of the outflow of super-cooled gas when locating the hatch to avoid injury or hazardous conditions in adjacent areas.

Provide permanent signage inside and outside the MRI room stating: "OVERPRESSURE RELIEF HATCH OPEN IN CASE OF EMERGENCY"

2.7 MAGNET DELIVERY ACCESS PANEL

Provide a magnet delivery access panel for removal and replacement of the MRI magnet without dismantling the RF shielding enclosure. Coordinate the location and dimensions with the magnet delivery path, the MRI equipment manufacturer and clearances for rigging.

2.8 POWER AND COPPER SIGNAL RF FILTERS

Provide a filter for each power, and cable signal line penetrating the enclosure, including power, lighting, HVAC control, alarms, and communications to achieve RF attenuation specified. Factory test filters. Comply with NFPA 70, UL 486A-486B, and UL 1283.

2.9 WAVEGUIDE ASSEMBLIES

Provide waveguide-below-cutoff (WBC) protection for all piping, ventilation, fiber signal and cable penetrations of the RF shielding to achieve RF attenuation performance requirements. Use no less than 1.5 times the highest frequency of the RF attenuation performance requirements for the cutoff frequency.

Provide exterior dielectric collars to maintain a minimum of [1,000] ohms DC resistance to ground earth.

Provide exhaust cryogenic gas waveguide assemblies of sufficient structural strength for magnet quench.

PART 3 EXECUTION

3.1 EXAMINATION

Verify site dimensions, conditions, and electromagnetic interference (EMI) measurements before commencing work.

3.2 INSTALLATION

3.2.1 Coordination

Ensure that all relevant construction, testing, and supply organizations, and personnel are aware of RF attenuation critical installation requirements.

Co-ordinate internal services and finishes to MRI equipment manufacturer's requirements, all applicable codes and to be fully compatible with ACR accreditation.

Ensure that the interior suspended ceiling and walls within the RF shielding enclosure are constructed entirely with non-ferrous materials.

Ensure that fluorescent fixtures, magnetic ballasts, magnetic dimmers or similar equipment are not located within the RF shielding enclosure.

Ensure that building elements or equipment that require access, maintenance or servicing are not located in inaccessible spaces including between the RF shielding enclosure and adjacent walls, floors or ceilings.

Ensure that building services that cross the MRI room pass[in the interstitial space] above the RF shielding enclosure and do not pass through the enclosure.

3.2.2 Process

Verify the installation process for compliance with the contract documentation, shop drawings, equipment and material submissions and specifications, and coordinate the work of all trades.

3.3 FIELD QUALITY CONTROL

3.3.1 Inspection

Inspect installation for compliance with the contract documentation, shop drawings, equipment and material submissions and specifications. Inspect prior, during and following the application of coverings and finishes.

3.3.2 Ground Isolation Monitoring

Continuously monitor alternate ground earth isolation for a minimum of [1,000] ohms DC resistance prior to connection to ground earth.

3.3.3 RF Attenuation Field Testing

Perform systematic field control inspection and testing. Include the method of inspection and testing, equipment used, personnel, location of tests, test results and corrective action taken or to be taken within RF test reports.

3.3.3.1 In Progress RF Testing

Perform in-progress RF enclosure inspection and testing by the RF shielding vendor as construction proceeds to monitor shielding effectiveness and rectify shielding defects as shielding construction progresses. Include visual inspection and where possible, RF shielded enclosure leak detection system (SELDS) testing of all component parts including seams, penetrations and installations as work progresses.[Submit in progress RF test reports within 3 days of inspection/testing.] Conduct testing to IEEE 299, to validate the minimum RF attenuation performance requirements.

3.3.3.2 Preliminary RF Testing

Perform preliminary RF enclosure inspection and testing, by the[RF shielding vendor,][and the Medical Physicist/MR Scientist,][and the MRI equipment manufacturer,] prior to the application of coverings and finishes to demonstrate completed RF shielding RF attenuation prior to installation of any closure over the RF shield. Include visual inspection and RF SELDS testing of all component parts including seams, corners, penetrations and installations. Conduct testing to IEEE 299 to validate the minimum RF attenuation performance requirements. Submit preliminary RF test report for approval prior to installation of any closure or finish.

3.3.3.3 Final RF Testing

Perform final RF enclosure inspection and testing, by[RF shielding vendor,][and the Medical Physicist/MR Scientist,][and MRI equipment manufacturer,] following the application of all coverings and finishes, when the facility is complete and is ready for occupancy to demonstrate completed construction RF attenuation. Include visual inspection and RF SELDS testing of all component parts including seams, corners, penetrations and installations. Conduct testing to IEEE 299 to validate the minimum RF attenuation performance requirements. [Notify the Contracting Officer in writing 14 days prior to tests and assist monitoring by client representatives.] Submit the final RF test report.

3.4 GROUNDING

Use an equipotential grounding plane method in accordance with IEEE 142, NFPA 70, and UL 1283.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-14 21 13 (May 2016)**
Change 1 - 05/18

Preparing Activity: NAVFAC **Superseding**
UFGS-14 21 00.00 20 (May 2012)
UFGS-14 21 13 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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ELECTRIC TRACTION FREIGHT ELEVATORS

05/16, CHG 1: 05/18

PART 3 EXECUTION

-- End of Section Table of Contents --

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SECTION 14 21 13

ELECTRIC TRACTION FREIGHT ELEVATORS

05/16, CHG 1: 05/18

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NOTE: This guide specification covers the requirements for electric traction freight elevators.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: All Army and Navy facility designs which include elevators shall comply with the "NAVFAC ITG 2013-01 Elevator Design". This guide is available from the NAVFAC facilitator at http://www.wbdg.org/ffc/navy-navfac/interim-technical-guidance-itg **under Interim Technical Guidance.**

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NOTE: For NAVY projects, any editing of non-bracketed requirements in this specification must be approved through the NAVFAC FEC VTE Program Lead Certifying Official.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2022) Safety Code for Elevators and Escalators
ASME A17.2	(2023) Guide for Inspection of Elevators, Escalators, and Moving Walks

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL ELEVATOR INDUSTRY, INC. (NEII)

NEII-1	(2000; R thru 2017) Building Transportation Standards and Guidelines, including the Performance Standards Matrix for New Elevator Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 101	(2024) Life Safety Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-560-01	(2017; with Change 3, 2023) Operation and Maintenance: Electrical Safety

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

****

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SD-02 Shop Drawings

Elevator System; G, [_____]

Elevator Components; G, [_____]

Elevator Machine; G, [_____]

Elevator Controller; G, [_____]

Wiring Diagrams; G, [_____]

SD-03 Product Data

****
NOTE: For Army projects, delete the bracketed items. For Navy projects, keep the bracketed items.
****

Elevator and Accessories[; G, [_____]]

Elevator Components[; G, [_____]]

Data Sheets[; G, [_____]]

Elevator Microprocessor Controller; G, [_____]

SD-05 Design Data

Emergency Power Systems

Heat Loads

Reaction Loads

SD-07 Certificates

Elevator Parts and Components Price Lists; G, [_____]

Warranty

Endorsement Letter

Welders' Qualifications

Elevator Controller Certification; G, [_____]

SD-10 Operation and Maintenance Data

Elevator, Data Package 4; G, [_____]

Maintenance Control Program (MCP); G, [_____]

Software and Documentation; G, [_____]

Submit in accordance with Sections 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW).

1.2.1 Shop Drawing Requirements

Provide assembly and arrangement of elevators, accessories, and elevator components. Show location of elevator machine in elevator machine room (MR) or machinery space (MS). Show location of elevator controller in elevator machine room or elevator control room (CR). Provide details for materials and equipment, including but not limited to operating and signal fixtures, doors, door and car frames, car enclosure, controllers, motors, guide rails and brackets, layout of hoistway in plan and elevation, and other layout information and clearance dimensions.

1.2.2 Product Data Requirements

Provide manufacturers' product data for all elevator components, including but not limited to the following: elevator controller, hoist machine and drive motor, design counterbalance, hoist ropes and shackles, overspeed governor, emergency braking system, car and hall fixture buttons and switches, cab, machine room, control room, and machinery space communication devices, door operator, door protection system, and car and counterweight roller guides and buffers. For data sheets, provide document identification number or bulletin number, published or copyrighted prior to the date of contract bid opening. Provide controller manufacturer's published procedures for performance of each and all testing required by ASME A17.1/CSA B44.

1.2.3 Design Data

1.2.3.1 Reaction Loads

Provide calculations by registered professional engineer for reaction loads imposed on building by elevator system. Calculations must comply with ASCE 7-16 and ASME A17.1/CSA B44

1.2.3.2 Heat Loads

Provide calculations from elevator manufacturer, or by registered professional engineer, for total anticipated heat loads generated by all of the elevator equipment.

1.2.3.3 Emergency Power Systems

Where the facility does have an emergency power system, confirm the elevators that will be connected to the emergency power system. Confirm the complete emergency power system and sequence of operation for all elevators, including operation of the elevator lobby manual selection switch. Provide wiring diagrams for building emergency power interface with elevator controls. For elevators not supplied by an emergency power system, provide manufacturers' product data for auxiliary power systems.

1.2.4 Welders' Requirements

Comply with AWS D1.1/D1.1M, Section 5. Include certified copies of field welders' qualifications. List welders' names with corresponding code marks to identify each welder's welding work

1.2.5 Maintenance Control Program (MCP)

For each elevator, prepare and provide a written Maintenance Control Program (MCP) that complies with ASME A17.1/CSA B44 Section 8.6, including written documentation that details the test procedures for each and every test that is required to be performed by ASME A17.1/CSA B44. Assemble all MCP documentation, and supporting technical attachments, in a single MCP package and provide in both electronic and hard copy. Assemble entire hard copy MCP in 3-ring binders. For each elevator provided, the MCP must include only documentation and instruction that apply to the elevator specified.

For each elevator, provide an additional, separate binder that includes all maintenance, repair, replacement, call back, and other records required by ASME A17.1/CSA B44. The records binder must be kept in the elevator mechanical room, maintained by elevator maintenance and service personnel, and be available at all times to authorized personnel.

Provide detailed information regarding emergency service procedures and elevator installation company personnel contact information. Provide a listing of all tools to be provided to the Contracting Officer as components of the elevator system.

1.3 QUALITY ASSURANCE

1.3.1 Qualification

Provide a designed and engineered elevator system by an elevator contractor regularly engaged in the installation of elevator systems. Provide elevator components manufactured by companies regularly engaged in the manufacture of elevator components. Utilize only licensed and certified elevator personnel for the installation, adjusting, testing, and servicing of the elevators.

1.3.1.1 Elevator Contractor's Elevator Technicians

For elevator installations in the United States, including United States territories, perform all elevator related work under the direct guidance of a state certified elevator technician with a minimum of three years of experience in the installation of elevator systems of the type and complexity specified in the contract documents. Provide an endorsement letter from the elevator manufacturer, certifying that the elevator specialist is qualified. All elevator technicians must carry a current certification issued by one of the following organizations:

a. National Association of Elevator Contractors (NAEC)

b. National Elevator Industry Education Program (NEIEP)

1.3.2 Manufacturers' Technical Support

Provide elevator components from manufacturers that provide factory training and online and live telephone elevator technical support to any elevator installation, service, and maintenance contractor. Provide elevator components from manufacturers that guarantee accessibility to all replacement and repair parts and components to any elevator installation, service, and maintenance contractor. Use only elevator component manufacturers that provide current published price lists for all elevator parts and components.

1.3.3 Operation and Maintenance Data

Assemble all shop drawing and product data material into O&M Data Packages in accordance with Article SUBMITTALS. Provide two complete O&M Data Packages in hard copy and two complete electronic O&M data packages on separate CDs, in PDF format. Provide all O&M Data Packages to Contracting Officer. Include controller diagnostic documentation and software as required under Article CONTROL EQUIPMENT.

1.3.4 Wiring Diagrams

Provide complete wiring diagrams and sequence of operations, which show electrical connections and functions of elevator systems. Provide one set (279 mm by 432 mm11 inch by 17 inch minimum size) of wiring diagrams, with individual sheets laminated in plastic and assembled in binder, to be stored in the machine room or control room cabinet. Provide one additional hard copy set and two complete electronic sets on separate CDs, in PDF format. Provide all wiring diagram sets to the Contracting Officer. Coded diagrams are not acceptable unless fully identified.

1.3.5 Machine Room/Control Room Cabinet

For storage of O&M Data Packages and Wiring Diagrams, provide locking metal cabinet with a minimum size of 508 mm W by 305 mm D by 762 mm H 20 inch W by 12 inch D by 30 inch H. Cabinet must be sized large enough to accommodate all O&M Data and hardware required in paragraphs OPERATION AND MAINTENANCE DATA and WIRING DIAGRAMS. Secure cabinet to machine room or control room wall.

1.4 NEW INSTALLATION SERVICE

****

NOTE: Use Bi-weekly option for Hospitals and other high use facilities.

****

Provide elevator warranty service in accordance with the manufacturer's maintenance plan, warranty requirements and applicable safety codes, for a period of 12 months after the date of acceptance by Contracting Officer. Perform this work during regular working hours. Provide supplies and parts to keep elevator system in operation. Perform service only by factory trained personnel. Provide [Monthly][Bi-weekly] services to include repairs, adjustments, greasing, oiling, and cleaning. Provide service log in elevator machine room or control room cabinet and update [Monthly][Bi-weekly], throughout the one-year warranty period.

****

NOTE: One hour emergency service below is standard; only use two hour for remote locations.
****

Provide 24-hour emergency service, with [one hour][two hour] on-site response time, during this period without additional cost to the Government.

1.4.1 Periodic Elevator Certification Inspection and Testing

Provide elevator mechanic to support [NAVFAC]QEI Certified Elevator Inspector in the periodic six-month and the annual Category 1 elevator certification inspection and testing. Perform Category 1 inspection and testing no greater than 30 days prior to the end of the warranty period. Perform all elevator certification testing in the presence of QEI Certified Elevator Inspector.

In conjunction with the testing noted above, test systems for Emergency Power Operation, Earthquake Emergency Operation, and Hospital Emergency Commandeering Service Operation, as applicable. Schedule so that testing does not interfere with building operations.

1.5 FIRE PROTECTION SYSTEM

****
NOTE: Confirm that sections listed throughout this article are part of project. Add or delete sections as needed for project.
****

Coordinate interface between building fire protection system and elevator controls.

Additional fire protection requirements are located in: [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE,][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE,][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE,][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE,][Section 28 31 32 FIRE ALARM REPORTING SYSTEM, DIGITAL COMMUNICATOR TYPE,][Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION,][_____] and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.5.1 Fire Alarm Initiating Devices

Fire alarm initiating devices are specified in [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE][_____], including conduit and wiring from each detector to fire protection addressable modules in elevator machine room or control room.

1.5.2 Fire Sprinklers

Provide fire sprinklers in accordance with all applicable safety codes and with [Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION][_____]. Provide shutoff valve, check valve, and non-adjustable, zero time-delay flow switch, in each sprinkler line immediately outside of each machine room, control room and hoistway, as applicable. Provide inspectors' test valve for periodic testing of flow switch and shunt trip disconnect.

Pipe sprinkler piping serving these spaces in a series manner with no laterals. Locate inspectors' test connection at the end of pipe runs such that operation of the test connection will purge air from system piping.

1.5.3 Shunt Trip Disconnect

Provide flow switches specified in paragraph FIRE SPRINKLERS to comply with ASME A17.1/CSA B44 and NFPA 72 for shunt trip of the main line power supply. For each elevator, provide control wiring connecting the flow switch to a shunt trip equipped circuit breaker located in the elevator machine room or control room. Upon flow of water, flow switch will instantaneously cause opening of the shunt-trip circuit breaker and remove power from the elevator. Flow switch must also send a signal to fire alarm control panel to indicate water flow condition.

PART 2 PRODUCTS

2.1 ELEVATOR DESCRIPTION

Provide elevator system that complies with ASME A17.1/CSA B44 in its entirety, ASME A17.2 in its entirety, and additional requirements specified herein. Provide elevator system that meets or exceeds the NEII-1 Ride Quality Performance Standards Matrix (RQPSM). For elevator speeds of 500 fpm and higher, comply with the RQPSM "High Performance" criteria. For elevator speeds 350 fpm, up to but not including 500 fpm, comply with the RQPSM "Intermediate Performance" criteria.

Provide and install elevators in accordance with 36 CFR 1191 - ABAAS, ICC IBC, IEEE C62.41, NFPA 70 and NFPA 101 requirements.

2.1.1 Elevator Design Parameters

****

NOTE: Traffic Analysis and Minimum Cab Size

Perform a traffic analysis and conduct interviews with the facility user to determine number, size, and type of elevators necessary to serve the needs of the facility user. For Army and Navy projects, utilize NAVFAC ITG 2013-01 Elevator Design to determine Design Type. For minimum elevator speed, specify 200 fpm for 2-4 story, 350 fpm for 5-9 story, and 500 fpm, gearless for 10-or-more story elevators.

Specify gearless traction elevators for all buildings more than 10 stories tall.

****

a. Type: [Geared] [Gearless]

b. Rated load: [_____] lb.

c. Rated Speed: [200][350][500] fpm

d. Car Inside Dimensions: [_____] cm ft. [_____] cm in. wide, [_____] cm ft. [_____] cm in. deep and [_____] cm ft. [_____] cm in. high

e. Hoistway Door Type & Size: [Manual] [Power operated] Vertical [Rising] [Bi-Parting] [_____] cm ft. [_____] cm in. wide and [_____] cm ft. [_____] cm in. high

f. Car Gate Type: [Manual] [Power operated] Vertical Rising

****

NOTE: Refer to ASME A17.1/CSA B44 for Classes of loading.

****

g. Loading Type: Class [A][B][C]

2.1.2 Cab Enclosure and Hoistway Entrance Assemblies

****

NOTE: If retaining first option in sentence below, ensure that finishes are indicated, most likely somewhere on the drawings. In either case, indicate finish colors of elevator materials in finish schedule on drawings.

****

****

NOTE: Specify stainless steel doors, side panels and wall trim in hospital cars.

****

Provide finishes [as indicated.][as listed below:

a. Floor; [mill finish steel diamond plate][painted steel diamond plate][aluminum diamond plate][tongue and groove hardwood][_____].

b. Walls; [prefinished steel panels][stainless steel][_____].

    (1) Wall trim; [prefinished steel][stainless steel][_____].

    (2) Accessories; [handrail][_____].

****

NOTE: Retain bracketed phrase for freight elevators that do not have Front and Rear openings.

****

    (3) Accessories; Provide in-car horizontal buck-board wall protection on full length of side walls [and back wall] of elevator cab.

c. Car doors, car door returns, and wall reveals; [prefinished steel panels][stainless steel][_____].

d. Ceilings;[prefinished steel panels][stainless steel][anodized aluminum] [_____].

e. Hoistway Entrance Assembly Material and Finishes; [prefinished steel][stainless steel][_____].]

2.2 ELEVATOR OPERATION

ASME A17.1/CSA B44, Introduction, Section 3, Definitions.

****
NOTE: Choose one of the following four types of elevator operation.
****

[2.2.1 Single, Two-Stop, Automatic Operation

****
NOTE: Choose for single elevator serving two landings.
****

Provide Single Two-Stop Automatic Operation.

][2.2.2 Selective Collective Automatic Operation

****
NOTE: Choose for single elevator serving three or more landings.
****

Provide Selective Collective Automatic Operation.

][2.2.3 Duplex Selective Collective Automatic Operation

****
NOTE: Choose for two adjacent elevators.
****

Provide Duplex Selective Collective Automatic Operation. If a car is taken out of service or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to the other car functioning as a single car Selective Collective elevator until the out-of-service car is returned to the system.

][2.2.4 Group Automatic Operation

****
NOTE: Choose for three or more elevators that serve the same elevator lobby.
****

Provide Group Automatic Operation. If a car is taken out of service, or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to another car until out-of-service car is returned to the system.

]2.3 SPECIAL OPERATION AND CONTROL

Provide the following special operations and control systems.

2.3.1 Keys for Elevator Key Switches

Provide a minimum of twelve keys per unique cylinder used on all key switches for a single elevator. If there is more than one elevator, additional keys will not be required unless there are additional unique lock cylinders. Provide keys with brass or fiberglass tags marked "PROPERTY OF THE U.S. GOVERNMENT" on one side with function of key or approved code number on the other side.

2.3.2 Firefighters' Emergency Operation (FEO)

****

NOTE: Coordinate FEO Designated Landing with Fire Protection Designer.

****

Provide FEO equipment and signaling devices. The designated level for the FEO Phase I key operated switch is the [ground][_____] floor. In the FEO Phase I fixture, provide FEO Operating Instructions.

2.3.2.1 Firefighters' Emergency Operation (FEO) Key Box

Provide flush mounted, locking, FEO Key Box of a minimum size of 127 mm W by 229 mm H by 38 mm D 5 inch W by 9 inch H by 1.5 inch D. Install at a height of 183 cm 6 feet above floor level and directly above the FEO Phase I key switch. Provide box equipped with lock that uses the FEO K1 key.

2.3.3 Hoistway Access Operation

Provide hoistway access operation with switches at top and bottom terminal landings. Locate switch 183 cm 6 feet above floor level, within 305 mm 12 inches of elevator hoistway entrance frame or with the ferrule exposed when located in the elevator entrance frame.

2.3.4 In-Car Inspection Operation

Provide In-Car Inspection Operation.

2.3.5 Independent Service

Provide exposed key-operated switch in car operating panel to enable independent service and simultaneously disable in-car signals and landing-call responses. Provide indicator lights that automatically illuminate during independent service. For duplex or group operation, if one car is removed from group another car will respond to its hall calls.

2.3.6 Selective Door Operation

For elevator with one or more rear openings at same level as front opening, provide full-selective operation with car and door operating buttons clearly marked for front and rear openings, front and rear car button for each such floor, and front and rear "DOOR OPEN" and "DOOR CLOSE" buttons. Only door for which the button was operated opens or closes.

[2.3.7 Elevator Emergency Power Operation

****

NOTE: Electrical design shall identify the elevators to be connected to the building emergency power system. Identify and define the complete emergency power system for all elevators. When using the 2nd bracketed option in either of the next two paragraphs, edit as required for project-specific requirements.

For any elevator that is not included in the

building emergency power operation, utilize paragraph ELEVATOR AUXILIARY POWER OPERATING SYSTEM.
****

Provide elevator emergency power operation for [all elevators] [elevator 1,2,3...]. Coordinate power supply and control wiring to accomplish initiation and operation of elevators on emergency power.

][2.3.8 Elevator Auxiliary Power Operating System

Provide elevator auxiliary power operating system for [all elevators] [elevator 1,2,3...].

]2.4 ELEVATOR DRIVE MACHINE, HOIST MOTOR, AND DRIVE MOTOR

Provide elevator drive machine, hoist motor, and motor drive system that is designed to be installed in an elevator machine room (MR) or in an elevator machinery space. The elevator machine, motor, and drive configuration and installation design must be mechanically and electrically interchangeable with a minimum of two other elevator manufacturer's drive machines that are readily available in the elevator industry. Paint or finish ferrous surfaces with a minimum of one coat of manufacturer applied rust-inhibiting paint.

Design the elevator drive system so that the hoist motor amperage does not exceed the motor data tag full load amperage in any operating condition, exclusive of acceleration and deceleration. Provide elevator hoist motor that is designed with Class F insulation and rated for 120 starts/hr. Design the elevator drive system to limit Total Harmonic Distortion to a maximum of 5 percent. No single harmonic may exceed 3 percent.

Provide an elevator drive machine designed for and provided with stranded steel wire rope for elevator suspension and counterbalance. The minimum acceptable diameter of suspension and counterweight ropes is 9.52 mm 3/8 inches. Aramid fiber ropes, coated steel ropes, and non-circular coated steel belts may not be used for elevator suspension or counterbalance.

The elevator drive machine must be equipped with machine manufacturer's designed and installed standard means for the manual release of the driving-machine brake.

2.4.1 Manufacturer's Factory Training and Technical Support

Provide an elevator drive machine from a manufacturer that provides comprehensive factory training and technical support for installation, adjustment, service, and maintenance of the drive system. The training and support must be identified as available to any licensed elevator contractor. Provide verification of an established and documented training schedule, with pricing, for factory training classes that have been provided for a minimum period of one year prior to contract award date.

The elevator drive system must be identified as available for purchase and installation by any licensed elevator contractor. All drive system related components, parts, diagnostic tools, and software must be available for purchase, installation, and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable.

2.4.2 Ascending Car Overspeed and Unintended Car Movement Protection

Provide elevator Ascending Car Overspeed and Unintended Car Movement Protection means that is designed to act directly upon, and apply a retarding force to, the elevator suspension ropes. In addition to the requirements of ASME A17.1/CSA B44, the means must be designed to detect and stop movement of the elevator suspension ropes that occurs as a result of loss of traction between the suspension ropes and the elevator machine drive sheave.

2.5 CONTROL EQUIPMENT

Enclose all elevator control equipment in factory-primed and baked-enamel coated sheet-metal cabinets with ventilation louvers and removable or hinged doors. Mount cabinets at a height of 254 mm 10 inches above machine room or control room finish floor.

2.5.1 Motor Control Equipment

Provide variable voltage with silicon controlled rectifier (SCR) or Variable-Frequency Variable Voltage (VVVF) alternating current (ac) drive control.

2.5.1.1 Electrical Isolation Protection

Provide individual isolation transformers and individual choke reactors for each individual hoist motor. Provide filtering to maintain harmonic distortion below IEEE C62.41 standards as measured at the elevator machine room or control room disconnect.

2.5.2 Elevator Microprocessor Controller

For each individual elevator controller, and for each group controller, provide a microprocessor controller that complies with the following paragraphs. Provide controller(s) package that includes all hardware and software required for the installation, maintenance, and service of the elevator, in its' entirety. Provide verification of technical support service that the controller manufacturer provides to any licensed elevator installation, service, and maintenance company.

Provide an elevator controller from a manufacturer that provides comprehensive factory training to include controller installation, adjustment, service, and maintenance. The training must be identified as available to any licensed elevator contractor. Provide verification of an established and documented training schedule, with pricing, for factory training classes that manufacturer has provided for a minimum period of one year prior to contract award date.

The elevator controller must be identified as available for purchase and installation by any licensed elevator contractor. All components, parts, diagnostic tools, and software must be available for purchase and installation and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable. The elevator controller manufacturer must publish an industry competitive price listing for all controller parts, diagnostic tools, and software.

Provide verification of telephone and internet based technical support service that the elevator controller manufacturer provides to any licensed elevator installation, service, and maintenance company at an industry competitive price. The service must include live telephone based technical support for installation, adjustment, maintenance, and troubleshooting of the elevator controller and related elevator components. The service must be available during standard working hours.

Provide an elevator controller that is designed to automatically reestablish normal elevator operation following any temporary loss of power, regardless of duration.

2.5.2.1 Elevator Controller Interface Cabinet

For each individual elevator microprocessor controller, provide a separate elevator control cabinet with an integrated human interface system. For group elevator installations, a single cabinet and interface system with full access to each elevator controller may be utilized. The separate controller interface cabinet must be supplied by the elevator controller manufacturer and include a minimum 305 mm 12 inch wide keyboard and a minimum 254 mm 10 inch monitor. The elevator controller interface cabinet must comply with arc-flash protection requirements of NFPA 70E and UFC 3-560-01.

2.5.2.1.1 Elevator Microprocessor Human Interface

The interface system must provide complete elevator controller interface capability and must include the elevator controller manufacturer's comprehensive package of installation and diagnostic software. The microprocessor interface system must provide unrestricted access to all parameters, all levels of adjustment, and all flags necessary for installation, adjustment, maintenance, and troubleshooting of each elevator and for the elevator group. All software programming must be stored in non-volatile memory. The elevator controller fault log must provide non-volatile memory fault log storage of all faults, trouble calls, and fault history for a minimum of one year and the ability to download or print the fault log. The controller interface must also provide the capability to display and diagnose trouble calls, faults, and shutdowns. Expiring software, degrading operation, and "key" access controls are not acceptable.

2.5.2.2 Software and Documentation

Provide three copies of the manufacturer's maintenance and service diagnostic software, with complete software documentation, that will enable the same level of unrestricted access to all controllers of the same make and model, regardless of the installation date or location. Provide signed certification, from the manufacturer's corporate headquarters, that guarantees that the microprocessor software and access system will not terminate the unlimited and unrestricted access at any future date.

2.5.2.3 Elevator Controller Certification

For elevator installations in the United States, including United States territories, provide an elevator microprocessor controller that has a current certificate of safety code compliance issued by the Technical Standards and Safety Authority (TSSA), Toronto, Canada.

2.6 OPERATING PANELS, SIGNAL FIXTURES, AND COMMUNICATIONS CABINETS

For all panels and fixtures, provide identical and uniform fixture design, material, finish, and components for all elevators. For all panels and fixtures, legibly and indelibly identify all buttons and all operating positions for each device. Use engraving and backfilling, or photo etching, for button and switch designations. Do not use attached signs. Provide elevator manufacturers' standard grade for all key switches unless otherwise specified. All illuminating panels and fixture components must utilize LED lighting for energy efficiency.

2.6.1 Car and Hall Buttons

For all cab and landing fixture buttons, provide industry-standard, vandal resistant push buttons with positive-stop assembly design. Buttons must be minimum 19 mm 3/4 inch diameter, satin-finish stainless steel, with illuminating LED halo.

2.6.1.1 Hall Station Door-Operating Buttons

****

NOTE: Use the following for freight elevators with power-operated bi-parting doors.

****

Provide hall station door-operating buttons, identical in size and design to hall call buttons, but not illuminating.

2.6.2 Freight Car-Operating Panel

****

NOTE: Use two Car Operating Panels for front and rear opening elevators.

****

Provide each car with [one] [two] car operating panel[s] that contain[s] operation controls and communication devices. Provide exposed, flush mounted buttons for the controls identified in subparagraph OPERATOR CONTROLS. Provide a lockable service cabinet for the controls listed in subparagraph SERVICE CONTROLS. Use engraving and backfilling or photo etching for button and switch designations. Do not use attached signs.

2.6.2.1 Operator Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. LED illuminating car-call buttons identified to correspond to landings served by the elevator.

b. "DOOR OPEN" and "DOOR CLOSE" buttons. For front and rear openings at the same floor, include the identification "F" and "R" for each opening.

c. Red, illuminating "ALARM" button.

d. Key-operated "Independent Service" switch.

e. "Help" communication device to include communication between elevator cab and elevator machine room or control room.

2.6.2.2 Service Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Provide a key-operated, three-position switch for "In car Inspection Operation" and "Hoistway Access". The center switch position will provide normal, automatic operation.

b. "Car Light" switch.

c. "Car Fan" switch with two speed settings identified.

d. 120-volt ac 60 Hz single-phase duplex electrical outlet of ground-fault-circuit-interrupt (GFCI) design.

2.6.2.3 Certificate Window

Provide a minimum 102 mm wide by 152 mm high 4 inch wide by 6 inch high certificate window for elevator inspection certificate. Locate window in the Service Controls door of the Car Operating Panel.

2.6.2.4 Emergency Signaling Devices

Provide an audible signaling device, operable from the Car Operating Panel button marked "ALARM". The audible signaling device must have a sound pressure rating between 80 and 90 dBA at 3 meters 10 ft. Provide battery backup power capable of operating the audible signaling device for at least one hour.

2.6.3 Elevator In-Car Position Indicators

For all elevators, provide illuminating LED position indicator in the Car Operating Panel.

2.6.4 Elevator In-Car Direction Indicators

For 2-stop elevator installations, provide visual direction indicators and audible car arrival signal in the elevator car door jamb, in accordance with ABA Standards. Visual indicators must be visible from the hall call fixture.

2.6.5 Hall Call Landing Fixtures

Provide a hall call fixture adjacent to each elevator. Provide a single push-button for terminal landings and dual push-buttons, up and down, at intermediate landings.

2.6.5.1 Designated Landing Hall Call Fixture

2.6.5.1.1 Location of COMMUNICATION MEANS FAILURE (CMF) Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator CMF audible and illuminating signal, and reset switch, in the FEO Designated Landing hall call fixture. Mount the signal and reset switch at a minimum of 178 mm 7 inches above the "UP" hall call button.

2.6.5.1.2 COMMUNICATION MEANS FAILURE (CMF) Visual and Audible Signal Operation

Provide a CMF visual and audible signal system that conforms to ASME A17.1/CSA B44. Provide continuous verification of operability of the telephone line and immediate activation of audible and visual signals when verification means determines that the telephone line is not functioning. Provide illumination of visual signal at one second intervals. Provide a minimum of 65 dBA audible signal at 30 second intervals.

2.6.5.1.3 Firefighters' Emergency Operation Phase I Switch and Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator Firefighters' Emergency Operation Phase I switch and illuminating visual signal in the FEO Designated Landing hall call fixture. Provide FEO Phase I visual signal that is designed with intermittent, flashing, illumination when actuated by the machine room, control room, or hoistway fire alarm initiating device. Locate FEO Phase I key switch above the CMF visual signal with a minimum of 152 mm 6 inches vertical between the centerlines of the CMF signal and the FEO Phase I key switch. Locate FEO Phase I visual signal directly above the Phase I switch. In addition, locate Elevator Corridor Call Station Pictograph at top of hall call fixture.

2.6.6 Elevator Car Position and Direction Indicators and Car Arrival Signal

For elevator installations with three or more stops, provide a separate hall landing fixture that includes the visual elevator position indicator, visual direction indicators, and audible car arrival signal, in accordance with ABA Standards.

2.6.7 Designated Landing Elevator Identification Fixture

For duplex and group elevator installations, provide a separate elevator identification fixture for each elevator, with identification engraved and backfilled with a contrasting color. Number elevators from left to right, as seen during primary approach from building main entrance to elevator lobby. For multiple elevator groups, begin numbering with group that is closest to the building main entrance.

2.6.8 Emergency or Standby Power

When emergency or standby power is provided for elevator operation, provide an elevator emergency power visual indicator that conforms to ASME A17.1/CSA B44. Locate the visual signal in the Firefighters Emergency Operation fixture for each simplex elevator and for each elevator group. When an emergency power selector switch is required, provide switch in a separate, flush mounted fixture located at the designated level, in view of all elevator entrances.

2.7 CAR DOOR EQUIPMENT

2.7.1 Car Door Operator

Provide elevator door operator equipment and circuitry that is designed and installed as discreet communication. Serial communication must not be used for this system.

2.7.2 Infra-red Curtain Unit

Provide Infra-red Curtain Unit (ICU) with multiple infra-red beams that protect to the full height and width of the door opening. Provide door nudging operation.

2.8 FREIGHT ELEVATOR GUIDES, PLATFORM, AND ENCLOSURE

2.8.1 Guides

Provide coil-spring loaded roller guide assemblies in adjustable mountings on each side of car and counterweight frames in accurate alignment at top and bottom of frames. For freight elevators with a rated load greater than 10,000 lbs., slide guides may be used in lieu of roller guides.

2.8.2 Car Shell Return Panels, Doors, Entrance Columns, and Transom

Provide 14 Gauge minimum [prefinished steel][stainless steel] cab wall panels and entrance components. Use same material and finish for all hoistway and car entrance assemblies. Apply sound-deadening material on exterior of all cab wall panels.

2.8.3 Car Enclosure Top

Provide reinforced, 12 gauge minimum steel car enclosure top. Provide hinged emergency exit with lock that complies with the seismic risk zone 2 or greater design requirements of ASME A17.1/CSA B44. Locate emergency exit hinge towards the rear of the elevator cab. Design and configure the elevator cab interior ceiling to provide convenient and unobstructed access to, and use of, emergency exit from inside the elevator cab.

2.8.4 Car Door

Provide [two section]vertical rising gate with power door operator.

2.8.5 Car Entrance Sill

Provide one piece steel car entrance sill(s). Set sill(s) level and flush with cab finish floor.

2.8.6 In-Car Horizontal Buck-Board Wall Protection

****

NOTE: Retain bracketed phrase for freight elevators that do not have Front and Rear openings.

****

Provide minimum 64 mm thick by 305 mm high 2-1/2 inch thick by 12 inch high #2 Oak protection boards on all side walls [and back wall] of the elevator cab. Position boards at a height to prevent damage from fork lift traffic.

2.8.7 Cab Finish Floor

Provide cab finish floor with top of finish floor flush with the cab sill.

2.8.8 Car Fan

Provide 2-speed fan for car enclosure forced ventilation. Fan must be mounted in the car enclosure top.

2.8.9 Car Lighting

Utilize LED lighting for elevator car interior illumination. Provide a minimum of 10 foot-candles, measured at all areas of the car enclosure floor. Provide automatic car lighting operation that will turn off car lights after 3 minutes of inactivity. Car lights must automatically turn on upon actuation of an elevator car or hall call.

2.9 FREIGHT ELEVATOR HOISTWAY DOORS AND ENTRANCES

Provide hoistway entrance assemblies with a minimum 1-1/2 hour fire rating. Use same material and finish for all hoistway and car entrance assemblies.

2.9.1 Hoistway Entrance Frames

Provide 14 gage minimum [prefinished carbon sheet steel][stainless steel] hoistway entrance frames. Provide door panels with truckable sill. Provide minimum 102mm width by 229 mm height 4 inch width by 9 inch height vision panel in upper door panel.

2.9.2 Hoistway Entrance Sills

Provide one-piece 8 mm thick, 152 mm by 152 mm 5/16 inch thick, 6 inch by 6 inch steel angle iron sill with top of sill flush with hoistway landing finish floor. Steel angle-iron sill must be set into and fully supported by the concrete floor or the steel building structure. Use same material for all hoistway and car entrance sills.

2.10 HOISTWAY EQUIPMENT

2.10.1 Car and Counterweight Guide Rails and Fastenings

Provide T-section type guide rails for car and counterweight. Paint rail shanks with one coat of black enamel.

2.10.2 Pit Equipment

Provide rail-to-rail pit channels to serve as mounting surface for main guide rails and counterweight guide rails. In addition, pit channels will serve as mounting surfaces for car and counterweight buffers. Method of installation of channels, brackets and buffer mounts will be such that pit waterproofing is not punctured.

2.10.3 Pit "STOP" Switch

Provide push-to-stop/pull-to-run type pit "STOP" switch.

2.10.4 Traveling Cables

Suspend traveling cables by means of self-tightening webbed devices or internal suspension members.

2.10.5 Hoistway Pit Ladder

Provide continuous horizontal rungs for the full height of the pit ladder.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with DOD design criteria, contract specifications, manufacturer's instructions, NEII-1 Building Transportation Standards and Guidelines, and all applicable building and safety code requirements.

3.1.1 Structural Members and Finish Materials

Do not cut or alter structural members. Do not alter finish materials from manufacturer's original design. Restore any damaged or defaced work to original condition.

3.1.2 Miscellaneous Requirements

Provide recesses, cutouts, slots, holes, patching, grouting, and refinishing to accommodate elevator installation. Use core drilling to drill all new holes in concrete. Finish work to be straight, level, and plumb. During installation, protect machinery and equipment from dirt, water, or mechanical damage. At completion, clean all work and spot paint.

3.2 FIELD QUALITY CONTROL

The Contractor will provide and utilize a third-party licensed and certified Qualified Elevator Inspector (QEI) to conduct elevator pre-acceptance inspection and testing. The QEI must perform inspections and witness tests to ensure that the installation conforms to all applicable safety codes and contract requirements. The QEI will be directly employed by the Contractor and independent of the elevator contractor.

Upon completion, the QEI must provide written test data for all ASME A17.1/CSA B44 Acceptance Tests and written certification that the elevator is complete and ready for final Acceptance Inspection, Testing, and Commissioning.

3.3 ACCEPTANCE INSPECTION, TESTING AND COMMISSIONING

When elevator system installation is complete and ready for final inspection, notify Contracting Officer that elevator system is ready for Acceptance Inspection, Testing, and Commissioning. Provide QEI certification specified in Article FIELD QUALITY CONTROL.

****

NOTE: Use the first bracketed paragraph for all Navy Facilities and for all projects managed by NAVFAC FEAD. Use the second bracketed paragraph for Air Force and Army projects that are not managed by NAVFAC FEAD.

****

[Contracting Officer will obtain services of Naval Facilities Engineering Systems Command (NAVFAC) QEI Certified Elevator Inspector. NAVFAC QEI will utilize the applicable NAVFAC Elevator Acceptance Inspection Form to record the results of inspection and testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the NAVFAC QEI will sign a copy of the completed forms and provide the signed copy to the Contracting Officer or representative. Within 2 weeks of the inspection, the QEI will also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, NAVFAC Certified Elevator Inspector will complete, sign and post form NAVFACENGCOM 9-11014/23(Rev.9-2009), Elevator Inspection Certificate.

][Contracting Officer will obtain the services of a third-party QEI Certified Elevator Inspector. The QEI must utilize an Elevator Acceptance Inspection Form to record the results of inspection and all testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the QEI must sign a copy of the completed forms and provide to the Contracting Officer. Within 2 weeks of the inspection, the QEI must also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, the QEI will complete, sign, and provide a certificate of compliance with ASME A17.1/CSA B44.

]3.3.1 Acceptance Inspection Support

Prime and Elevator Contractors must provide inspection support and perform all required tests, in order to demonstrate proper operation of each elevator system and to prove that each system complies with contract requirements and all applicable building and safety codes. Inspection procedures in ASME A17.2 form a part of this inspection and acceptance testing. All inspection and testing must be conducted in the presence of the Qualified Elevator Inspector (QEI).

If the elevator does not comply with all contract and safety code requirements on the initial Acceptance Inspection and Test, the Contractor is responsible for all costs involved with re-inspection and re-testing required as a result of contractor delays and discrepancies discovered during inspection and testing.

3.3.2 Testing Materials and Instruments

Provide all testing materials and instruments necessary for Acceptance Inspection, Testing and Commissioning. At a minimum, include calibrated test weights, tachometer, accelerometer, hydraulic pressure gauge, 600-volt megohm meter, volt meter and ammeter, infrared temperature gauge, door pressure gage, dynamometer, and 6 meter 20 foot tape measure.

3.3.3 Field Tests

3.3.3.1 Endurance Tests

Test each elevator for a period of one hour continuous, automatic operation, with specified rated load in the elevator cab. During the one hour test, stop car at each floor, in both directions of travel, and allow automatic door open and close operation. The requirements for Automatic Operation, Rated Speed, Leveling, Temperature Rise and Motor Amperes must be met throughout the duration of the Endurance Test. Restart the one hour test period from the beginning, following any shutdown or failure.

3.3.3.2 Speed Tests

Determine actual speed of each elevator, in both directions of travel, with rated load and with no load in elevator car. Make Speed tests at the beginning and at the end of the Endurance test. Determine speed by tachometer reading or accelerometer, excluding accelerating and slow-down zones. Under all conditions, minimum acceptable elevator speed is the Rated speed specified. Maximum acceptable elevator speed is 110 percent of Rated speed.

3.3.3.3 Leveling Tests

Test elevator car leveling operation and provide a leveling accuracy equal to or less than 3 mm 1/8 inch at each floor with no load in car, balanced load in car, and with rated load in car, in both directions of travel. Determine leveling accuracy at the beginning and at the end of the endurance tests.

3.3.3.4 Temperature Rise Tests

Determine temperature rise of elevator drive machine motor during one-hour full-load test run. Under these conditions, maximum temperature rise must not exceed acceptable temperature rise indicated on manufacturer's data plate. Start test only when equipment is within 5 degrees C of ambient temperature.

3.3.3.5 Balanced Load Test

Place balanced load in the elevator cab, according to the manufacturer's designed counterbalance. Perform electrical and mechanical balanced load tests of car and counterweight.

3.3.3.6 Motor Ampere Tests

At beginning and end of Endurance test, measure and record motor amperage in both directions of travel and in both no-load and rated load conditions.

3.3.3.7 Elevator Performance and Ride Quality Testing

Evaluate elevator performance to ensure compliance with specification requirements related to the NEII-1 Performance Standards Matrix for New Elevator Installations.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-14 21 23 (May 2016)**
Change 1 - 05/18

Preparing Activity: NAVFAC **Superseding**
UFGS-14 21 00.00 20 (May 2012)
UFGS-14 21 23 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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ELECTRIC TRACTION PASSENGER ELEVATORS

05/16, CHG 1: 05/18

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-14 21 23 (May 2016)**
Change 1 - 05/18

Preparing Activity: NAVFAC **Superseding**
UFGS-14 21 00.00 20 (May 2012)
UFGS-14 21 23 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 14 21 23

ELECTRIC TRACTION PASSENGER ELEVATORS

05/16, CHG 1: 05/18

****
NOTE: This guide specification covers the requirements for electric traction passenger elevators.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: All Army and Navy facility designs which include elevators shall comply with the "NAVFAC ITG 2013-01 Elevator Design". This guide is available from the NAVFAC facilitator at http://www.wbdg.org/ffc/navy-navfac/interim-technical-guidance-itg **under Interim Technical Guidance.**
****

****
NOTE: For NAVY projects, any editing of non-bracketed requirements in this specification must be approved through the NAVFAC FEC VTE Program Lead Certifying Official.
****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2022) Safety Code for Elevators and Escalators
ASME A17.2	(2023) Guide for Inspection of Elevators, Escalators, and Moving Walks

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL ELEVATOR INDUSTRY, INC. (NEII)

NEII-1	(2000; R thru 2017) Building Transportation Standards and Guidelines, including the Performance Standards Matrix for New Elevator Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 101	(2024) Life Safety Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-560-01	(2017; with Change 3, 2023) Operation and Maintenance: Electrical Safety

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Elevator System; G, [_____]

Elevator Components; G, [_____]

Elevator Machine; G, [_____]

Elevator Controller; G, [_____]

Wiring Diagrams; G, [_____]

SD-03 Product Data

****

NOTE: For Army projects, delete the bracketed items. For Navy projects, keep the bracketed items.

****

Elevator and Accessories[; G, [_____]]

Elevator Components[; G, [_____]]

Data Sheets[; G, [_____]]

Elevator Microprocessor Controller; G, [_____]

SD-05 Design Data

Emergency Power Systems

Heat Loads

Reaction Loads

SD-07 Certificates

Elevator Parts and Components Price Lists; G, [_____]

Warranty

Endorsement Letter

Welders' Qualifications

Elevator Controller Certification; G, [_____]

SD-10 Operation and Maintenance Data

Elevator, Data Package 4; G, [_____]

Maintenance Control Program (MCP); G, [_____]

Software and Documentation; G, [_____]

Submit in accordance with Sections 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW).

1.2.1 Shop Drawing Requirements

Provide assembly and arrangement of elevators, accessories, and elevator components. Show location of elevator machine in elevator machine room (MR) or machinery space (MS). Show location of elevator controller in elevator machine room or elevator control room (CR). Provide details for materials and equipment, including but not limited to operating and signal fixtures, doors, door and car frames, car enclosure, controllers, motors, guide rails and brackets, layout of hoistway in plan and elevation, and other layout information and clearance dimensions.

1.2.2 Product Data Requirements

Provide manufacturers' product data for all elevator components, including but not limited to the following: elevator controller, hoist machine and drive motor, design counterbalance, hoist ropes and shackles, overspeed governor, emergency braking system, car and hall fixture buttons and switches, cab, machine room, control room, and machinery space communication devices, door operator, door protection system, and car and counterweight roller guides and buffers. For data sheets, provide document identification number or bulletin number, published or copyrighted prior to the date of contract bid opening. Provide controller manufacturer's published procedures for performance of each and all testing required by ASME A17.1/CSA B44.

1.2.3 Design Data

1.2.3.1 Reaction Loads

Provide calculations by registered professional engineer for reaction loads imposed on building by elevator system. Calculations must comply with ASCE 7-16 and ASME A17.1/CSA B44

1.2.3.2 Heat Loads

Provide calculations from elevator manufacturer, or by registered professional engineer, for total anticipated heat loads generated by all of the elevator equipment.

1.2.3.3 Emergency Power Systems

Where the facility does have an emergency power system, confirm the elevators that will be connected to the emergency power system. Confirm the complete emergency power system and sequence of operation for all elevators, including elevator sequential operation and operation of the elevator lobby manual selection switch. Provide wiring diagrams for building emergency power interface with elevator controls. For elevators not supplied by an emergency power system, provide manufacturers' product data for auxiliary power systems.

1.2.4 Welders' Requirements

Comply with AWS D1.1/D1.1M, Section 5. Include certified copies of field welders' qualifications. List welders' names with corresponding code marks to identify each welder's welding work

1.2.5 Maintenance Control Program (MCP)

For each elevator, prepare and provide a written Maintenance Control Program (MCP) that complies with ASME A17.1/CSA B44 Section 8.6, including written documentation that details the test procedures for each and every test that is required to be performed by ASME A17.1/CSA B44. Assemble all MCP documentation, and supporting technical attachments, in a single MCP package and provide in both electronic and hard copy. Assemble entire hard copy MCP in 3-ring binders. For each elevator provided, the MCP must include only documentation and instruction that apply to the elevator specified.

For each elevator, provide an additional, separate binder that includes all maintenance, repair, replacement, call back, and other records required by ASME A17.1/CSA B44. The records binder must be kept in the elevator mechanical room, maintained by elevator maintenance and service personnel, and be available at all times to authorized personnel.

Provide detailed information regarding emergency service procedures and elevator installation company personnel contact information. Provide a listing of all tools to be provided to the Contracting Officer as components of the elevator system.

1.3 QUALITY ASSURANCE

1.3.1 Qualification

Provide a designed and engineered elevator system by an elevator contractor regularly engaged in the installation of elevator systems. Provide elevator components manufactured by companies regularly engaged in the manufacture of elevator components. Utilize only licensed and certified elevator personnel for the installation, adjusting, testing, and servicing of the elevators.

1.3.1.1 Elevator Contractor's Elevator Technicians

For elevator installations in the United States, including United States territories, perform all elevator related work under the direct guidance of a state certified elevator technician with a minimum of three years of experience in the installation of elevator systems of the type and complexity specified in the contract documents. Provide an endorsement letter from the elevator manufacturer, certifying that the elevator specialist is qualified. All elevator technicians must carry a current certification issued by one of the following organizations:

a. National Association of Elevator Contractors (NAEC)

b. National Elevator Industry Education Program (NEIEP)

1.3.2 Manufacturers' Technical Support

Provide elevator components from manufacturers that provide factory training and online and live telephone elevator technical support to any elevator installation, service, and maintenance contractor. Provide elevator components from manufacturers that guarantee accessibility to all replacement and repair parts and components to any elevator installation, service, and maintenance contractor. Use only elevator component manufacturers that provide current published price lists for all elevator parts and components.

1.3.3 Operation and Maintenance Data

Assemble all shop drawing and product data material into O&M Data Packages in accordance with Article SUBMITTALS. Provide two complete O&M Data Packages in hard copy and two complete electronic O&M data packages on separate CDs, in PDF format. Provide all O&M Data Packages to Contracting Officer. Include controller diagnostic documentation and software as required under Article CONTROL EQUIPMENT.

1.3.4 Wiring Diagrams

Provide complete wiring diagrams and sequence of operations, which show electrical connections and functions of elevator systems. Provide one set (279 mm by 432 mm11 inch by 17 inch minimum size) of wiring diagrams, with individual sheets laminated in plastic and assembled in binder, to be stored in the machine room or control room cabinet. Provide one additional hard copy set and two complete electronic sets on separate CDs, in PDF format. Provide all wiring diagram sets to the Contracting Officer. Coded diagrams are not acceptable unless fully identified.

1.3.5 Machine Room/Control Room Cabinet

For storage of O&M Data Packages and Wiring Diagrams, provide locking metal cabinet with a minimum size of 508 mm W by 305 mm D by 762 mm H 20 inch W by 12 inch D by 30 inch H. Cabinet must be sized large enough to accommodate all O&M Data and hardware required in paragraphs OPERATION AND MAINTENANCE DATA and WIRING DIAGRAMS. Secure cabinet to machine room or control room wall.

1.4 NEW INSTALLATION SERVICE

****

NOTE: Use Bi-weekly option for Hospitals and other high use facilities.

****

Provide elevator warranty service in accordance with the manufacturer's maintenance plan, warranty requirements, and applicable safety codes, for a period of 12 months after the date of acceptance by Contracting Officer. Perform this work during regular working hours. Provide supplies and parts to keep elevator system in operation. Perform service only by factory trained personnel. Provide [Monthly][Bi-weekly] services to include repairs, adjustments, greasing, oiling, and cleaning. Provide service log in elevator machine room or control room cabinet and update [Monthly][Bi-weekly], throughout the one-year warranty period.

****

NOTE: One hour emergency service below is standard; only use two hour for remote locations.

****

Provide 24-hour emergency service, with [one hour][two hour] on-site response time, during this period without additional cost to the Government.

1.4.1 Periodic Elevator Certification Inspection and Testing

Provide elevator mechanic to support [NAVFAC]QEI Certified Elevator Inspector in the periodic six-month and the annual Category 1 elevator certification inspection and testing. Perform Category 1 inspection and testing no greater than 30 days prior to the end of the warranty period. Perform all elevator certification testing in the presence of QEI Certified Elevator Inspector.

In conjunction with the testing noted above, test systems for Emergency Power Operation, Earthquake Emergency Operation, and Hospital Emergency Commandeering Service Operation, as applicable. Schedule so that testing does not interfere with building operations.

1.5 FIRE PROTECTION SYSTEM

****

NOTE: Confirm that sections listed throughout this article are part of project. Add or delete sections as needed for project.

****

Coordinate interface between building fire protection system and elevator controls.

Additional fire protection requirements are located in: [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE,][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE,][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE,][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE,][Section 28 31 32 FIRE ALARM REPORTING SYSTEM, DIGITAL COMMUNICATOR TYPE,][Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION,][_____] and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.5.1 Fire Alarm Initiating Devices

Fire alarm initiating devices are specified in [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE][_____], including conduit and wiring from each detector to fire protection addressable modules in elevator machine room or control room.

1.5.2 Fire Sprinklers

Provide fire sprinklers in accordance with all applicable safety codes and with [Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION][_____]. Provide shutoff valve, check valve, and non-adjustable, zero time-delay flow switch, in each sprinkler line immediately outside of each machine room, control room, and hoistway, as applicable. Provide inspectors' test valve for periodic testing of flow switch and shunt trip disconnect.

Pipe sprinkler piping serving these spaces in a series manner with no laterals. Locate inspectors' test connection at the end of pipe runs such that operation of the test connection will purge air from system piping.

1.5.3 Shunt Trip Disconnect

Provide flow switches specified in paragraph FIRE SPRINKLERS to comply with ASME A17.1/CSA B44 and NFPA 72 for shunt trip of the main line power supply. For each elevator, provide control wiring connecting the flow switch to a shunt trip equipped circuit breaker located in the elevator machine room or control room. Upon flow of water, flow switch will instantaneously cause opening of the shunt-trip circuit breaker and remove power from the elevator. Flow switch must also send a signal to fire alarm control panel to indicate water flow condition.

PART 2 PRODUCTS

2.1 ELEVATOR DESCRIPTION

Provide elevator system that complies with ASME A17.1/CSA B44 in its entirety, ASME A17.2 in its entirety, and additional requirements specified herein. Provide elevator system that meets or exceeds the NEII-1 Ride Quality Performance Standards Matrix (RQPSM). For elevator speeds of 500 fpm and higher, comply with the RQPSM "High Performance" criteria. For elevator speeds 350 fpm, up to but not including 500 fpm, comply with the RQPSM "Intermediate Performance" criteria.

Provide and install elevators in accordance with 36 CFR 1191 - ABAAS, ICC IBC, IEEE C62.41, NFPA 70 and NFPA 101 requirements.

2.1.1 Elevator Design Parameters

****

NOTE: Traffic Analysis and Minimum Cab Size

Perform a traffic analysis and conduct interviews with the facility user to determine number, size, and type of elevators necessary to serve the needs of the facility user. For Army and Navy projects, utilize NAVFAC ITG 2013-01 Elevator Design to determine Design Type. For minimum elevator speed, specify 200 fpm for 2-4 story, 350 fpm for 5-9 story, and 500 fpm, gearless for 10-or-more story elevators.

Specify gearless traction elevators for all buildings more than 10 stories tall.

Size and capacity configurations are limited to three basic configurations as listed in the subparagraphs below. In the rare case that the listed configurations do not meet project requirements, more extensive project-specific editing will be required.

****

2.1.1.1 Elevator No.[_____] - Emergency Medical Service Accessibility (EMSA)

****

NOTE: Emergency Medical Service Accessibility (EMSA): For each building of two stories or greater, provide at least one elevator with a minimum size and arrangement to accommodate an ambulance stretcher 24" by 84" (610 mm by 2134 mm), with not less than 5" radius corners, in the open, horizontal, position. For buildings with multiple elevators, an EMSA elevator must be accessible from all locations in the building; otherwise additional elevator(s) shall also be EMSA.

Two size and capacity configurations of elevators will meet this requirement. For standard passenger applications use the 1588 kg 3500 lb capacity, single speed side slide described in this subparagraph. The larger elevator sized to accommodate pallet-size light freight loading described in next subparagraph below will also meet EMSA requirements.

****

Provide elevator(s) with minimum size and arrangement to accommodate an ambulance stretcher 610 mm by 2134 mm with not less than 127 mm 24-inch by 84-inch with not less than 5-inch radius corners, in the open, horizontal position.

a. Type: [Geared] [Gearless]

b. Rated load: 3500 lb.

c. Rated Speed: [200][350][500] fpm

d. Car Door Type: Single-speed side slide.

e. Car Door Opening Width: 107 cm 3 ft.-6 in. minimum, or [_____].

2.1.1.2 Elevator No.[_____] - Larger Capacity (Pallet-Sized) Loading

****

NOTE: Where a larger capacity elevator is required to accommodate light freight, typically pallet-size loading, use this subparagraph. Elevator shall typically be 4000-4500 lb capacity (may be upwards of 6000 lbs. in rare instances), single speed center opening, 48 inch door opening width, and will typically be deeper than the 3500 lb. EMSA elevator above.

This larger elevator will also meet the EMSA requirements described above.

****

a. Type: [Geared] [Gearless]

b. Rated load: [4000][4500][_____] lb.

c. Rated Speed: [200][350][500] fpm

d. Car Door Type: Single-speed, center opening, horizontally sliding.

e. Car Door Opening Width:[122 cm4 ft.-0 in][137 cm4 ft.-6 in].

2.1.1.3 Elevator No.[_____] - Non-EMSA Elevator

****

NOTE: For smaller elevators where EMSA is not required (covered by one of the two elevator types above), this subparagraph may be used. Typical application would be an elevator bank where one elevator meets EMSA requirements. Elevator shall be 2500 lb capacity, 42 inch door opening width, and either side slide or center opening, typically to match other elevators in the bank.

This elevator will not meet EMSA requirements.

****

a. Type: [Geared] [Gearless]

b. Rated load: 2500 lb.

c. Rated Speed: [200][350][500] fpm

d. Car Door Type: Single speed [side slide][center opening], horizontally sliding.

e. Car Door Opening Width: 107 cm 3 ft.-6 in. minimum, or [_____].

2.1.2 Cab Enclosure and Hoistway Entrance Assemblies

****

NOTE: If retaining 1st option in sentence below, ensure that finishes are indicated, most likely somewhere on the drawings. In either case, indicate finish colors of elevator materials in finish schedule on drawings.

****

****

NOTE: Specify stainless steel doors, side panels and wall trim in hospital elevator cabs.

****

Provide finishes [as indicated.][as listed below:

a. Floor; [carpet][vinyl composition tile][vinyl sheet tile][_____].

b. Walls; [prefinished steel][laminated plastic] on plywood [stainless steel][_____]. Provide each cab wall with equally spaced and equally sized wall panels. All wall panel fasteners must be concealed.

    (1) Wall trim; [prefinished steel][stainless steel][_____].

    (2) Accessories; Provide hand rails on full length of back wall and side walls of elevator cab.

c. Car doors, car door returns, and wall reveals; [prefinished steel panels][stainless steel][_____].

d. Ceilings; [supported][prefinished steel panels][anodized aluminum][egg crate][_____].

    (1) Ceiling frame; [prefinished steel][stainless steel][anodized aluminum][_____].

e. Hoistway Entrance Assembly Material and Finishes; [prefinished steel][stainless steel][_____].]

2.2 ELEVATOR OPERATION

ASME A17.1/CSA B44, Introduction, Section 3, Definitions.

****

NOTE: Choose one of the following four types of elevator operation.

****

[2.2.1 Single, Two-Stop, Automatic Operation

****

NOTE: Choose for single elevator serving two landings.

****

Provide Single Two-Stop Automatic Operation.

][2.2.2 Selective Collective Automatic Operation

****

NOTE: Choose for single elevator serving three or more landings.

****

Provide Selective Collective Automatic Operation.

][2.2.3 Duplex Selective Collective Automatic Operation

****

NOTE: Choose for two adjacent elevators.

****

Provide Duplex Selective Collective Automatic Operation. If a car is taken out of service or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to the other car functioning as a single car Selective Collective elevator until the out-of-service car is returned to the system.

][2.2.4 Group Automatic Operation

****

NOTE: Choose for three or more elevators that serve the same elevator lobby.

****

Provide Group Automatic Operation. If a car is taken out of service, or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to another car until out-of-service car is returned to the system.

]2.3 SPECIAL OPERATION AND CONTROL

Provide the following special operations and control systems.

2.3.1 Keys for Elevator Key Switches

Provide a minimum of twelve keys per unique cylinder used on all key switches for a single elevator. If there is more than one elevator, additional keys will not be required unless there are additional unique lock cylinders. Provide keys with brass or fiberglass tags marked "PROPERTY OF THE U.S. GOVERNMENT" on one side with function of key or approved code number on the other side.

2.3.2 Firefighters' Emergency Operation (FEO)

****

NOTE: Coordinate FEO Designated Landing with Fire Protection Designer.

****

Provide FEO equipment and signaling devices. The designated level for the FEO Phase I key operated switch is the [ground][_____] floor. In the FEO Phase I fixture, provide FEO Operating Instructions.

2.3.2.1 Firefighters' Emergency Operation (FEO) Key Box

Provide flush mounted, locking, FEO Key Box of a minimum size of 127 mm W by 229 mm H by 38 mm D 5 inch W by 9 inch H by 1.5 inch D. Install at a height of 183 cm 6 feet above floor level and directly above the FEO Phase I key switch. Provide box equipped with lock that uses the FEO K1 key.

2.3.3 Hoistway Access Operation

Provide hoistway access operation with switches at top and bottom terminal landings. Locate switch 183 cm 6 feet above floor level, within 305 mm 12 inches of elevator hoistway entrance frame or with the ferrule exposed when located in the elevator entrance frame.

2.3.4 In-Car Inspection Operation

Provide In-Car Inspection Operation.

2.3.5 Independent Service

Provide exposed key-operated switch in car operating panel to enable independent service and simultaneously disable in-car signals and landing-call responses. Provide indicator lights that automatically illuminate during independent service. For duplex or group operation, if one car is removed from group another car will respond to its hall calls.

2.3.6 Selective Door Operation

For elevator with one or more rear openings at same level as front opening, provide full-selective operation with car and door operating buttons clearly marked for front and rear openings, front and rear car button for each such floor, and front and rear "DOOR OPEN" and "DOOR CLOSE" buttons. Only door for which the button was operated opens or closes.

[2.3.7 Elevator Emergency Power Operation

****

NOTE: Electrical design shall identify the elevators to be connected to the building emergency power system. Identify and define the complete emergency power system for all elevators. When using the 2nd bracketed option in either of the next two subparagraphs, edit as required for project-specific requirements.

For any elevator that is not included in the building emergency power operation, utilize paragraph ELEVATOR AUXILIARY POWER OPERATING SYSTEM.

****

Provide elevator emergency power operation for [all elevators] [elevator 1,2,3...]. Coordinate power supply and control wiring to accomplish initiation and operation of elevators on emergency power.

][2.3.8 Elevator Auxiliary Power Operating System

Provide elevator auxiliary power operating system for [all elevators] [elevator 1,2,3...].

][2.3.9 Hospital Emergency Commandeering Service (HECS)

****

NOTE: Only keep this HECS paragraph for hospital elevators or for projects in which this operation is specifically requested by the building owner or facility user.

****

Provide Hospital Emergency Commandeering Service.

]2.4 ELEVATOR DRIVE MACHINE, HOIST MOTOR, AND DRIVE MOTOR

Provide elevator drive machine, hoist motor, and motor drive system that is designed to be installed in an elevator machine room (MR) or an elevator machinery space. The elevator machine, motor, and drive configuration and installation design must be mechanically and electrically interchangeable with a minimum of two other elevator manufacturer's drive machines that are readily available in the elevator industry. Paint or finish ferrous surfaces with a minimum of one coat of manufacturer applied rust-inhibiting paint.

Design the elevator drive system so that the hoist motor amperage does not exceed the motor data tag full load amperage in any operating condition, exclusive of acceleration and deceleration. Provide elevator hoist motor that is designed with Class F insulation and rated for 120 starts/hr. Design the elevator drive system to limit Total Harmonic Distortion to a maximum of 5 percent. No single harmonic may exceed 3 percent.

Provide an elevator drive machine designed for and provided with stranded steel wire rope for elevator suspension and counterbalance. The minimum acceptable diameter of suspension and counterweight ropes is 9.52 mm 3/8 inches. Aramid fiber ropes, coated steel ropes, and non-circular coated steel belts may not be used for elevator suspension or counterbalance.

The elevator drive machine must be equipped with machine manufacturer's designed and installed standard means for the manual release of the driving-machine brake.

2.4.1 Manufacturer's Factory Training and Technical Support

Provide an elevator drive machine from a manufacturer that provides comprehensive factory training and technical support for installation, adjustment, service, and maintenance of the drive system. The training and support must be identified as available to any licensed elevator contractor. Provide verification of an established and documented training schedule, with pricing, for factory training classes that have been provided for a minimum period of one year prior to contract award date.

The elevator drive system must be identified as available for purchase and installation by any licensed elevator contractor. All drive system related components, parts, diagnostic tools, and software must be available for purchase, installation, and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable.

2.4.2 Ascending Car Overspeed and Unintended Car Movement Protection

Provide elevator Ascending Car Overspeed and Unintended Car Movement Protection means that is designed to act directly upon, and apply a retarding force to, the elevator suspension ropes. In addition to the requirements of ASME A17.1/CSA B44, the means must be designed to detect and stop movement of the elevator suspension ropes that occurs as a result of loss of traction between the suspension ropes and the elevator machine drive sheave.

2.5 CONTROL EQUIPMENT

Enclose all elevator control equipment in factory-primed and baked-enamel coated sheet-metal cabinets with ventilation louvers and removable or hinged doors. Mount cabinets at a height of 254 mm 10 inches above machine room or control room finish floor.

2.5.1 Motor Control Equipment

Provide variable voltage with silicon controlled rectifier (SCR) or Variable-Frequency Variable Voltage (VVVF) alternating current (ac) drive control.

2.5.1.1 Electrical Isolation Protection

Provide individual isolation transformers and individual choke reactors for each individual hoist motor. Provide filtering to maintain harmonic distortion below IEEE C62.41 standards as measured at the elevator machine room or control room disconnect.

2.5.2 Elevator Microprocessor Controller

For each individual elevator controller, and for each group controller, provide a microprocessor controller that complies with the following paragraphs. Provide controller(s) package that includes all hardware and software required for the installation, maintenance, and service of the elevator, in its' entirety. Provide verification of technical support service that the controller manufacturer provides to any licensed elevator installation, service, and maintenance company.

Provide an elevator controller from a manufacturer that provides comprehensive factory training to include controller installation, adjustment, service, and maintenance. The training must be identified as available to any licensed elevator contractor. Provide verification of an established and documented training schedule, with pricing, for factory training classes that manufacturer has provided for a minimum period of one year prior to contract award date.

The elevator controller must be identified as available for purchase and installation by any licensed elevator contractor. All components, parts, diagnostic tools, and software must be available for purchase and installation and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable. The elevator controller manufacturer must publish an industry competitive price listing for all controller parts, diagnostic tools, and software.

Provide verification of telephone and internet based technical support service that the elevator controller manufacturer provides to any licensed elevator installation, service, and maintenance company at an industry competitive price. The service must include live telephone based technical support for installation, adjustment, maintenance, and troubleshooting of the elevator controller and related elevator components. The service must be available during standard working hours.

Provide an elevator controller that is designed to automatically reestablish normal elevator operation following any temporary loss of power, regardless of duration.

2.5.2.1 Elevator Controller Interface Cabinet

For each individual elevator microprocessor controller, provide a separate elevator control cabinet with an integrated human interface system. For group elevator installations, a single cabinet and interface system with full access to each elevator controller may be utilized. The separate controller interface cabinet must be supplied by the elevator controller manufacturer and include a minimum 305 mm 12 inch wide keyboard and a minimum 254 mm 10 inch monitor. The elevator controller interface cabinet must comply with arc-flash protection requirements of NFPA 70E and UFC 3-560-01.

2.5.2.1.1 Elevator Microprocessor Human Interface

The interface system must provide complete elevator controller interface capability and must include the elevator controller manufacturer's comprehensive package of installation and diagnostic software. The microprocessor interface system must provide unrestricted access to all parameters, all levels of adjustment, and all flags necessary for installation, adjustment, maintenance, and troubleshooting of each elevator and for the elevator group. All software programming must be stored in non-volatile memory. The elevator controller fault log must provide non-volatile memory fault log storage of all faults, trouble calls, and fault history for a minimum of one year and the ability to download or print the fault log. The controller interface must also provide the capability to display and diagnose trouble calls, faults, and shutdowns. Expiring software, degrading operation, and "key" access controls are not acceptable.

2.5.2.2 Software and Documentation

Provide three copies of the manufacturer's maintenance and service diagnostic software, with complete software documentation, that will enable the same level of unrestricted access to all controllers of the same make and model, regardless of the installation date or location. Provide signed certification, from the manufacturer's corporate headquarters, that guarantees that the microprocessor software and access system will not terminate the unlimited and unrestricted access at any future date.

2.5.2.3 Elevator Controller Certification

For elevator installations in the United States, including United States territories, provide an elevator microprocessor controller that has a current certificate of safety code compliance issued by the Technical Standards and Safety Authority (TSSA), Toronto, Canada.

2.6 OPERATING PANELS, SIGNAL FIXTURES, AND COMMUNICATIONS CABINETS

For all panels and fixtures, provide identical and uniform fixture design, material, finish, and components for all elevators. For all panels and fixtures, legibly and indelibly identify all buttons and all operating positions for each device. Use engraving and backfilling, or photo etching, for button and switch designations. Do not use attached signs. Provide elevator manufacturers' standard grade for all key switches unless otherwise specified. All illuminating panels and fixture components must utilize LED lighting for energy efficiency.

2.6.1 Car and Hall Buttons

For all cab and landing fixture buttons, provide industry-standard, vandal resistant push buttons with positive-stop assembly design. Buttons must be minimum 19 mm 3/4 inch diameter, satin-finish stainless steel, with illuminating LED halo.

2.6.2 Passenger Car-Operating Panel

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NOTE: Choose "two" Car Operating Panels for high traffic passenger elevators in hospital buildings and office buildings. Choose "one" for elevator system where traffic is moderate such as in barracks, warehouses, clinics or shops.

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Provide each car with [one] [two] car operating panel[s] that contain[s] operation controls and communication devices. Provide exposed, flush mounted buttons for the controls identified in subparagraph PASSENGER CONTROLS. Provide a lockable service cabinet for the controls listed in subparagraph SERVICE CONTROLS. Use engraving and backfilling or photo etching for button and switch designations. Do not use attached signs.

2.6.2.1 Passenger Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. LED illuminating car-call buttons identified to correspond to landings served by the elevator.

b. "DOOR OPEN" and "DOOR CLOSE" buttons. For front and rear openings at the same floor, include the identification "F" and "R" for each opening.

c. Red, illuminating "ALARM" button.

d. Key-operated "Independent Service" switch.

e. "Help" communication device to include communication between elevator cab and elevator machine room or control room.

[f. Key-operated "HOSPITAL EMERGENCY COMMANDEERING SERVICE" switch.

]2.6.2.2 Service Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Provide a key-operated, three-position switch for "In car Inspection Operation" and "Hoistway Access". The center switch position will provide normal, automatic operation.

b. "Car Light" switch.

c. "Car Fan" switch with two speed settings identified.

d. 120-volt ac 60 Hz single-phase duplex electrical outlet of ground-fault-circuit-interrupt (GFCI) design.

2.6.2.3 Certificate Window

Provide a minimum 102 mm wide by 152 mm high 4 inch wide by 6 inch high certificate window for elevator inspection certificate. Locate window in the Service Controls door of the Car Operating Panel.

2.6.2.4 Emergency Signaling Devices

Provide an audible signaling device, operable from the Car Operating Panel button marked "ALARM". The audible signaling device must have a sound pressure rating between 80 and 90 dBA at 3 meters 10 ft. Provide battery backup power capable of operating the audible signaling device for at least one hour.

2.6.3 Elevator In-Car Position Indicators

For all elevators, provide illuminating LED position indicator in the Car Operating Panel.

2.6.4 Elevator In-Car Direction Indicators

For 2-stop elevator installations, provide visual direction indicators and audible car arrival signal in the elevator car door jamb, in accordance with ABA Standards. Visual indicators must be visible from the hall call fixture.

2.6.5 Hall Call Landing Fixtures

Provide a hall call fixture adjacent to each elevator. Provide a single push-button for terminal landings and dual push-buttons, up and down, at intermediate landings.

2.6.5.1 Designated Landing Hall Call Fixture

2.6.5.1.1 Location of COMMUNICATION MEANS FAILURE (CMF) Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator CMF audible and illuminating signal, and reset switch, in the FEO Designated Landing hall call fixture. Mount the signal and reset switch at a minimum of 178 mm 7 inches above the "UP" hall call button.

2.6.5.1.2 COMMUNICATION MEANS FAILURE (CMF) Visual and Audible Signal Operation

Provide a CMF visual and audible signal system that conforms to ASME A17.1/CSA B44. Provide continuous verification of operability of the telephone line and immediate activation of audible and visual signals when verification means determines that the telephone line is not functioning. Provide illumination of visual signal at one second intervals. Provide a minimum of 65 dBA audible signal at 30 second intervals.

2.6.5.1.3 Firefighters' Emergency Operation Phase I Switch and Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator Firefighters' Emergency Operation Phase I switch and illuminating visual signal in the FEO Designated Landing hall call fixture. Provide FEO Phase I visual signal that is designed with intermittent, flashing, illumination when actuated by the machine room, control room, or hoistway fire alarm initiating device. Locate FEO Phase I key switch above the CMF visual signal with a minimum of 152 mm 6 inches vertical between the centerlines of the CMF signal and the FEO Phase I key switch. Locate FEO Phase I visual signal directly above the Phase I switch. In addition, locate Elevator Corridor Call Station Pictograph at top of hall call fixture.

2.6.6 Elevator Car Position and Direction Indicators and Car Arrival Signal

For elevator installations with three or more stops, provide a separate hall landing fixture that includes the visual elevator position indicator, visual direction indicators, and audible car arrival signal, in accordance with ABA Standards.

2.6.7 Designated Landing Elevator Identification Fixture

For duplex and group elevator installations, provide a separate elevator identification fixture for each elevator, with identification engraved and backfilled with a contrasting color. Number elevators from left to right, as seen during primary approach from building main entrance to elevator lobby. For multiple elevator groups, begin numbering with group that is closest to the building main entrance.

2.6.8 Emergency or Standby Power

When emergency or standby power is provided for elevator operation, provide an elevator emergency power visual indicator that conforms to ASME A17.1/CSA B44. Locate the visual signal in the Firefighters Emergency Operation fixture for each simplex elevator and for each elevator group. When an emergency power selector switch is required, provide switch in a separate, flush mounted fixture located at the designated level, in view of all elevator entrances.

2.7 CAR DOOR EQUIPMENT

2.7.1 Car Door Operator

Provide elevator door operator equipment and circuitry that is designed and installed as discreet communication. Serial communication must not be used for this system.

2.7.2 Infra-red Curtain Unit

Provide Infra-red Curtain Unit (ICU) with multiple infra-red beams that protect to the full height and width of the door opening. Provide door nudging operation.

2.8 PASSENGER ELEVATOR GUIDES, PLATFORM, AND ENCLOSURE

2.8.1 Roller Guides

Provide coil-spring loaded roller guide assemblies in adjustable mountings on each side of car and counterweight frames in accurate alignment at top and bottom of frames.

2.8.2 Car Enclosure Wall Panels, Return Panels, Doors, Entrance Columns, and Transom

Provide 14 Gauge minimum [prefinished steel][stainless steel] cab wall panels and entrance components. Use same material and finish for all hoistway and car entrance assemblies. Apply sound-deadening material on exterior of all cab wall panels.

2.8.3 Car Enclosure Top

Provide reinforced, 12 gauge minimum steel car enclosure top. Provide hinged emergency exit with lock that complies with the seismic risk zone 2 or greater design requirements of ASME A17.1/CSA B44. Locate emergency exit hinge towards the rear of the elevator cab. Design and configure the elevator cab interior ceiling to provide convenient and unobstructed access to, and use of, emergency exit from inside the elevator cab.

2.8.4 Car Door

Provide 16 gauge minimum [prefinished steel][stainless steel] car doors of sandwich construction with flush surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading and one at trailing door edge with guides in the sill groove their entire length of travel.

2.8.5 Car Entrance Sill

Provide one piece cast nickel silver, stainless steel, or white bronze entrance sill(s). Set sills level and flush with floor finish. Use same material for hoistway and car entrance sills.

2.8.6 Cab Finish Floor

Provide cab finish floor with top of finish floor flush with the cab sill.

2.8.7 Car Fan

Provide 2-speed fan for car enclosure forced ventilation. Fan must be mounted in the car enclosure top.

2.8.8 Car Lighting

Utilize LED lighting for elevator car interior illumination. Provide a minimum of 10 foot-candles, measured at all areas of the car enclosure floor. Provide automatic car lighting operation that will turn off car lights after 3 minutes of inactivity. Car lights must automatically turn on upon actuation of an elevator car or hall call.

2.8.9 Car Protection Pads and Hooks

Provide fire retardant, hanging car protection pads that provide protection for all car interior wall panels. Provide permanently installed studs in car that are designed for hanging the car protection pads in the car.

2.9 PASSENGER ELEVATOR HOISTWAY DOORS AND ENTRANCES

Provide hoistway entrance assemblies with a minimum 1-1/2 hour fire rating. Use same material and finish for all hoistway and car entrance assemblies.

2.9.1 Hoistway Entrance Frames

Provide 14 gage minimum [prefinished carbon sheet steel][stainless steel] hoistway entrance frames. Solidly grout uprights of entrance ways to height of 5 feet.

2.9.2 Hoistway Entrance Sills

Provide one-piece cast nickel silver, stainless steel, or white bronze entrance sills. Set top of landing sill flush with top of finish floor. Solidly grout under full length of sill. Use same material for all hoistway and car entrance sills.

2.9.3 Hoistway Entrance Doors

Provide [hollow metal][stainless steel] non-vision construction hoistway entrance doors with flush surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading edge and one at trailing edge with guides in the sill groove the entire length of door travel. Use same material and finish for all hoistway and car entrance assemblies.

2.9.4 Hoistway Entrance Door Track Dust Covers

Provide sheet metal hoistway door track dust covers at each landing. Dust covers must cover top and hoistway side of door locks and door roller tracks, and extend the full width of the door track and associated hardware. Dust cover sections will not exceed 3 feet in length.

2.10 HOISTWAY EQUIPMENT

2.10.1 Car and Counterweight Guide Rails and Fastenings

Provide T-section type guide rails for car and counterweight. Paint rail shanks with one coat of black enamel.

2.10.2 Pit Equipment and Support Channels

Provide rail-to-rail pit channels to serve as mounting surface for main guide rails and counterweight guide rails. In addition, pit channels will serve as mounting surfaces for car and counterweight buffers. Method of installation of channels, brackets and buffer mounts will be such that pit waterproofing is not punctured.

2.10.3 Pit "STOP" Switch

Provide push-to-stop/pull-to-run type pit "STOP" switch.

2.10.4 Traveling Cables

Suspend traveling cables by means of self-tightening webbed devices or internal suspension members.

2.10.5 Hoistway Pit Ladder

Provide continuous horizontal rungs for the full height of the pit ladder.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with DOD design criteria, contract specifications, manufacturer's instructions, NEII-1 Building Transportation Standards and Guidelines, and all applicable building and safety code requirements.

3.1.1 Structural Members and Finish Materials

Do not cut or alter structural members. Do not alter finish materials from manufacturer's original design. Restore any damaged or defaced work to original condition.

3.1.2 Miscellaneous Requirements

Provide recesses, cutouts, slots, holes, patching, grouting, and refinishing to accommodate elevator installation. Use core drilling to drill all new holes in concrete. Finish work to be straight, level, and plumb. During installation, protect machinery and equipment from dirt, water, or mechanical damage. At completion, clean all work and spot paint.

3.2 FIELD QUALITY CONTROL

The Contractor will provide and utilize a third-party licensed and certified Qualified Elevator Inspector (QEI) to conduct elevator pre-acceptance inspection and testing. The QEI must perform inspections and witness tests to ensure that the installation conforms to all applicable safety codes and contract requirements. The QEI will be directly employed by the Contractor and independent of the elevator contractor.

Upon completion, the QEI must provide written test data for all ASME A17.1/CSA B44 Acceptance Tests and written certification that the elevator is complete and ready for final Acceptance Inspection, Testing, and Commissioning.

3.3 ACCEPTANCE INSPECTION, TESTING AND COMMISSIONING

When elevator system installation is complete and ready for final inspection, notify Contracting Officer that elevator system is ready for Acceptance Inspection, Testing, and Commissioning. Provide QEI certification specified in Article FIELD QUALITY CONTROL.

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NOTE: Use the first bracketed paragraph for all Navy Facilities and for all projects managed by NAVFAC FEAD. Use the second bracketed paragraph for Air Force and Army projects that are not managed by NAVFAC FEAD.

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[Contracting Officer will obtain services of Naval Facilities Engineering Systems Command (NAVFAC) QEI Certified Elevator Inspector. NAVFAC QEI will utilize the applicable NAVFAC Elevator Acceptance Inspection Form to record the results of inspection and testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the NAVFAC QEI will sign a copy of the completed forms and provide the signed copy to the Contracting Officer or representative. Within 2 weeks of the inspection, the QEI will also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, NAVFAC Certified Elevator Inspector will complete, sign and post form NAVFACENGCOM 9-11014/23(Rev.9-2009), Elevator Inspection Certificate.

][Contracting Officer will obtain the services of a third-party QEI Certified Elevator Inspector. The QEI must utilize an Elevator Acceptance Inspection Form to record the results of inspection and all testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the QEI must sign a copy of the completed forms and provide to the Contracting Officer. Within 2 weeks of the inspection, the QEI must also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, the QEI will complete, sign, and provide a certificate of compliance with ASME A17.1/CSA B44.

]

3.3.1 Acceptance Inspection Support

Prime and Elevator Contractors must provide inspection support and perform all required tests, in order to demonstrate proper operation of each elevator system and to prove that each system complies with contract requirements and all applicable building and safety codes. Inspection procedures in ASME A17.2 form a part of this inspection and acceptance testing. All inspection and testing must be conducted in the presence of the Qualified Elevator Inspector (QEI).

If the elevator does not comply with all contract and safety code requirements on the initial Acceptance Inspection and Test, the Contractor is responsible for all costs involved with re-inspection and re-testing required as a result of contractor delays and discrepancies discovered during inspection and testing.

3.3.2 Testing Materials and Instruments

Provide all testing materials and instruments necessary for Acceptance Inspection, Testing and Commissioning. At a minimum, include calibrated test weights, tachometer, accelerometer, hydraulic pressure gauge, 600-volt megohm meter, volt meter and ammeter, infrared temperature gauge, door pressure gage, dynamometer, and 6 meter 20 foot tape measure.

3.3.3 Field Tests

3.3.3.1 Endurance Tests

Test each elevator for a period of one hour continuous, automatic operation, with specified rated load in the elevator cab. During the one hour test, stop car at each floor, in both directions of travel, and allow automatic door open and close operation. The requirements for Automatic Operation, Rated Speed, Leveling, Temperature Rise and Motor Amperes must be met throughout the duration of the Endurance Test. Restart the one hour test period from the beginning, following any shutdown or failure.

3.3.3.2 Speed Tests

Determine actual speed of each elevator, in both directions of travel, with rated load and with no load in elevator car. Make Speed tests at the beginning and at the end of the Endurance test. Determine speed by tachometer reading or accelerometer, excluding accelerating and slow-down zones. Under all conditions, minimum acceptable elevator speed is the Rated speed specified. Maximum acceptable elevator speed is 110 percent of Rated speed.

3.3.3.3 Leveling Tests

Test elevator car leveling operation and provide a leveling accuracy equal to or less than 3 mm 1/8 inch at each floor with no load in car, balanced load in car, and with rated load in car, in both directions of travel. Determine leveling accuracy at the beginning and at the end of the endurance tests.

3.3.3.4 Temperature Rise Tests

Determine temperature rise of elevator drive machine motor during one-hour full-load test run. Under these conditions, maximum temperature rise must not exceed acceptable temperature rise indicated on manufacturer's data plate. Start test only when equipment is within 5 degrees C of ambient temperature.

3.3.3.5 Balanced Load Test

Place balanced load in the elevator cab, according to the manufacturer's designed counterbalance. Perform electrical and mechanical balanced load tests of car and counterweight.

3.3.3.6 Motor Ampere Tests

At beginning and end of Endurance test, measure and record motor amperage in both directions of travel and in both no-load and rated load conditions.

3.3.3.7 Elevator Performance and Ride Quality Testing

Evaluate elevator performance to ensure compliance with specification requirements related to the NEII-1 Performance Standards Matrix for New Elevator Installations.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-14 24 13 (May 2016)**
Change 1- 05/18

Preparing Activity: NAVFAC **Superseding**
UFGS-14 24 00 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-14 24 13 (May 2016)**
Change 1- 05/18

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 14 24 13

HYDRAULIC FREIGHT ELEVATORS

05/16

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NOTE: This guide specification covers the requirements for hydraulic freight elevators.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: All Army and Navy facility designs which include elevators shall comply with the "NAVFAC ITG 2013-01 Elevator Design". This guide is available from the NAVFAC facilitator at http://www.wbdg.org/ffc/navy-navfac/interim-technical-guidance-itg under Interim Technical Guidance.

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NOTE: For NAVY projects, any editing of non-bracketed requirements in this specification shall be approved through the NAVFAC FEC VTE Program Lead Certifying Official.

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2022) Safety Code for Elevators and Escalators
ASME A17.2	(2023) Guide for Inspection of Elevators, Escalators, and Moving Walks
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL ELEVATOR INDUSTRY, INC. (NEII)

NEII-1	(2000; R thru 2017) Building Transportation Standards and Guidelines, including the Performance Standards Matrix for New Elevator Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 101	(2024) Life Safety Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-560-01	(2017; with Change 3, 2023) Operation and Maintenance: Electrical Safety

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Elevator System; G, [_____]

Elevator Components; G, [_____]

Elevator Machine; G, [_____]

Elevator Controller; G, [_____]

Wiring Diagrams; G, [_____]

SD-03 Product Data

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NOTE: For Army projects, delete the bracketed items. For Navy projects, keep the bracketed items.

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Elevator and Accessories[; G, [_____]]

Elevator Components[; G, [_____]]

Data Sheets[; G, [_____]]

Elevator Microprocessor Controller; G, [_____]

SD-05 Design Data

Emergency Power Systems

Heat Loads

Reaction Loads

SD-07 Certificates

Elevator Parts and Components price lists; G, [_____]

Warranty

Endorsement Letter

Welders' Qualifications

Elevator Controller Certification; G, [_____]

SD-10 Operation and Maintenance Data

Elevator, Data Package 4; G, [_____]

Maintenance Control Program (MCP); G, [_____]

Software and Documentation; G, [_____]

Submit in accordance with Sections 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW).

1.2.1 Shop Drawing Requirements

Provide assembly and arrangement of elevators, accessories, and elevator components. Show location of elevator machine in elevator machine room (MR) or in elevator machinery space (MS). Show location of elevator controller in elevator machine room or elevator control room (CR). Provide details for materials and equipment, including but not limited to operating and signal fixtures, doors, door and car frames, car enclosure, controllers, motors, guide rails and brackets, layout of hoistway in plan and elevation, and other layout information and clearance dimensions.

1.2.2 Product Data Requirements

Provide manufacturers' product data for all elevator components, including but not limited to the following: elevator controller, hydraulic pump unit, hydraulic pump and motor, hydraulic cylinder, hydraulic piping and fittings, car and hall fixture buttons and switches, cab and machine room or control room communication devices, door operator, door protection system, car roller guides, and buffers. For data sheets, provide document identification number or bulletin number, published or copyrighted prior to the date of contract bid opening. Provide controller manufacturer's published procedures for performance of each and all testing required by ASME A17.1/CSA B44.

1.2.3 Design Data

1.2.3.1 Reaction Loads

Provide calculations by registered professional engineer for reaction loads imposed on building by elevator system. Demonstrate calculations complying with ASME A17.1/CSA B44

1.2.3.2 Heat Loads

Provide calculations from elevator manufacturer, or by registered professional engineer, for total anticipated heat loads generated by all of the elevator equipment.

1.2.3.3 Emergency Power Systems

Where the facility does have an emergency power system, confirm the elevators that will be connected to the emergency power system. Confirm the complete emergency power system and sequence of operation for all elevators, including operation of the elevator lobby manual selection switch. Provide wiring diagrams for building emergency power interface with elevator controls. For elevators not supplied by an emergency power system, provide manufacturers' product data for auxiliary power systems.

1.2.4 Welders' Requirements

Comply with AWS D1.1/D1.1M, Section 5. Include certified copies of field welders' qualifications. List welders' names with corresponding code marks to identify each welder's welding work.

1.2.5 Maintenance Control Program (MCP)

For each elevator, prepare and provide a written Maintenance Control Program (MCP) that complies with ASME A17.1/CSA B44 Section 8.6, including written documentation that details the test procedures for each and every test that is required to be performed by ASME A17.1/CSA B44. Assemble all MCP documentation, and supporting technical attachments, in a single MCP package and provide in both electronic and hard copy. Assemble entire hard copy MCP in 3-ring binders. For each elevator provided, the MCP must include only documentation and instruction that apply to the elevator specified.

For each elevator, provide an additional, separate binder that includes all maintenance, repair, replacement, call back, and other records required by ASME A17.1/CSA B44. The records binder must be kept in the elevator mechanical room, maintained by elevator maintenance and service personnel, and be available at all times to authorized personnel.

Provide detailed information regarding emergency service procedures and elevator installation company personnel contact information. Provide a listing of all tools to be provided to the Contracting Officer as components of the elevator system.

1.3 QUALITY ASSURANCE

1.3.1 Qualification

Provide a designed and engineered elevator system by an elevator contractor regularly engaged in the installation of elevator systems. Provide elevator components manufactured by companies regularly engaged in the manufacture of elevator components. Utilize only licensed and certified elevator personnel for the installation, adjusting, testing, and servicing of the elevators.

1.3.1.1 Elevator Contractor's Elevator Technicians

For elevator installations in the United States, including United States territories, perform all elevator related work under the direct guidance of a state certified elevator technician with a minimum of three years of experience in the installation of elevator systems of the type and complexity specified in the contract documents. Provide an endorsement letter from the elevator manufacturer, certifying that the elevator specialist is qualified. All elevator technicians must carry a current certification issued by one of the following organizations:

a. National Association of Elevator Contractors (NAEC)

b. National Elevator Industry Education Program (NEIEP)

1.3.2 Manufacturers' Technical Support

Provide elevator components from manufacturers that provide factory training and online and live telephone elevator technical support to any elevator installation, service, and maintenance contractor. Provide elevator components from manufacturers that guarantee accessibility to all replacement and repair parts and components to any elevator installation, service, and maintenance contractor. Use only elevator component manufacturers that provide current published price lists for all elevator parts and components.

1.3.3 Operation and Maintenance Data

Assemble all shop drawing and product data material into O&M Data Packages in accordance with Article SUBMITTALS. Provide two complete O&M Data Packages in hard copy and two complete electronic O&M data packages on separate CDs, in PDF format. Provide all O&M Data Packages to Contracting Officer. Include controller diagnostic documentation and software as required under Article CONTROL EQUIPMENT.

1.3.4 Wiring Diagrams

Provide complete wiring diagrams and sequence of operations, which show electrical connections and functions of elevator systems. Provide one set (279 mm by 432 mm11 inch by 17 inch minimum size) of wiring diagrams, with individual sheets laminated in plastic and assembled in binder, to be stored in the machine room or control room cabinet. Provide one additional hard copy set and two complete electronic sets on separate CDs, in PDF format. Provide all wiring diagram sets to the Contracting Officer. Coded diagrams are not acceptable unless fully identified.

1.3.5 Machine Room/Control Room Cabinet

For storage of O&M Data Packages and Wiring Diagrams, provide locking metal cabinet with a minimum size of 508 mm W by 305 mm D by 762 mm H 20 inch W by 12 inch D by 30 inch H. Cabinet must be sized large enough to accommodate all O&M Data and hardware required in paragraphs OPERATION AND MAINTENANCE DATA and WIRING DIAGRAMS. Secure cabinet to machine room or control room wall.

1.4 NEW INSTALLATION SERVICE

****

NOTE: Use Bi-weekly option for Hospitals and other high use facilities.

****

Provide elevator warranty service in accordance with the manufacturer's maintenance plan, warranty requirements and applicable safety codes, for a period of 12 months after the date of acceptance by Contracting Officer. Perform this work during regular working hours. Provide supplies and parts to keep elevator system in operation. Perform service only by factory trained personnel. Provide [Monthly][Bi-weekly] services to include repairs, adjustments, greasing, oiling, and cleaning. Provide service log in elevator machine room or control room and update [Monthly][Bi-weekly], throughout the one-year warranty period.

****

NOTE: One hour emergency service below is standard; only use two hour for remote locations.

****

Provide 24-hour emergency service, with [one hour][two hour] on-site response time, during this period without additional cost to the Government.

1.4.1 Periodic Elevator Certification Inspection and Testing

Provide elevator mechanic to support [NAVFAC]QEI Certified Elevator Inspector in the periodic six-month and the annual Category 1 elevator certification inspection and testing. Perform Category 1 inspection and testing no greater than 30 days prior to the end of the warranty period. Perform all elevator certification testing in the presence of QEI Certified Elevator Inspector.

In conjunction with the testing noted above, test systems for Emergency Power Operation, Earthquake Emergency Operation, and Hospital Emergency Commandeering Service Operation, as applicable. Schedule so that testing does not interfere with building operations.

1.5 FIRE PROTECTION SYSTEM

****

NOTE: Confirm that sections listed throughout this article are part of project. Add or delete sections as needed for project.

****

Coordinate interface between building fire protection system and elevator controls.

Additional fire protection requirements are located in: [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE,][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE,][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE,][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE,][Section 28 31 32 FIRE ALARM REPORTING SYSTEM, DIGITAL COMMUNICATOR TYPE,][Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION,][_____] and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.5.1 Fire Alarm Initiating Devices

Fire alarm initiating devices are specified in [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE][_____], including conduit and wiring from each detector to fire protection addressable modules in elevator machine room or control room.

1.5.2 Fire Sprinklers

Provide fire sprinklers in accordance with all applicable safety codes and with [Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION][_____]. Provide shutoff valve, check valve, and non-adjustable, zero time-delay flow switch, in each sprinkler line immediately outside of each machine room, control room, and hoistway, as applicable. Provide inspectors' test valve for periodic testing of flow switch and shunt trip disconnect.

Pipe sprinkler piping serving these spaces in a series manner with no laterals. Locate inspectors' test connection at the end of pipe runs such that operation of the test connection will purge air from system piping.

1.5.3 Shunt Trip Disconnect

Provide flow switches specified in paragraph FIRE SPRINKLERS to comply with ASME A17.1/CSA B44 and NFPA 72 for shunt trip of the main line power supply. For each elevator, provide control wiring connecting the flow switch to a shunt trip equipped circuit breaker located in the elevator machine room or control room. Upon flow of water, flow switch will instantaneously cause opening of the shunt-trip circuit breaker and remove power from the elevator. Flow switch must also send a signal to fire alarm control panel to indicate water flow condition.

PART 2 PRODUCTS

2.1 ELEVATOR DESCRIPTION

Provide elevator system that complies with ASME A17.1/CSA B44 in its entirety, ASME A17.2 in its entirety, and additional requirements specified herein. Provide elevator system that meets or exceeds the NEII-1 Ride Quality Performance Standards Matrix (RQPSM). Comply with the RQPSM "Intermediate Performance" criteria.

Provide and install elevators in accordance with 36 CFR 1191 - ABAAS, ICC IBC, IEEE C62.41, NFPA 70 and NFPA 101 requirements.

2.1.1 Elevator Design Parameters

****

NOTE: Traffic Analysis and Minimum Cab Size

Perform a traffic analysis and conduct interviews with the facility user to determine number, size, and type of elevators necessary to serve the needs of the facility user. For Army and Navy projects, utilize NAVFAC ITG 2013-01 Elevator Design to determine Design Type. For minimum elevator speed, specify 0.64 MPs 125 fpm for 2 story and 0.75 MPs 150 fpm for 3 and 4 story elevators.

Use of a holeless type elevator will be limited to a maximum travel distance of 386 cm 12 ft-8 in.

****

a. Type: [In-Ground Direct Plunger] [Holeless]

b. Rated load: [_____] kg lb.

c. Rated Speed: [0.64][0.75] MPs [125][150] fpm

d. Car Inside Dimensions: [_____] cm ft. [_____] cm in. wide, [_____] cm ft. [_____] cm in. deep and [_____] cm ft. [_____] cm in. high

e. Hoistway Door Type & Size: [Manual] [Power operated] Vertical [Rising] [Bi-Parting] [_____] cm ft. [_____] cm in. wide and [_____] cm ft. [_____] cm in. high

f. Car Gate Type: [Manual] [Power operated] Vertical Rising

****

NOTE: Refer to ASME A17.1/CSA B44 for Classes of loading.

****

g. Loading Type: Class [A][B][C]

2.1.2 Cab Enclosure and Hoistway Entrance Assemblies

****

NOTE: If retaining 1st option in sentence below, ensure that finishes are indicated, most likely somewhere on the drawings. In either case, indicate finish colors of elevator materials in finish schedule on drawings.

****

****

NOTE: Specify stainless steel doors, side panels and wall trim in hospital cars.

****

Provide finishes [as indicated.][as listed below:

a. Floor; [mill finish steel diamond plate][painted steel diamond plate][aluminum diamond plate][tongue and groove hardwood][_____].

b. Walls; [prefinished steel panels][stainless steel][_____].

    (1) Wall trim; [prefinished steel][stainless steel][_____].

    (2) Accessories; [handrail][_____]

****

NOTE: Retain bracketed phrase for freight elevators that do not have Front and Rear openings.

****

    (3) Accessories; Provide in-car horizontal buck-board wall protection on full length of side walls [and back wall] of elevator cab.

c. Car doors, car door returns, and wall reveals; [prefinished steel panels][stainless steel][_____].

d. Ceiling; [prefinished steel panels][stainless steel][anodized aluminum][_____].

e. Hoistway Entrance Assembly Material and Finishes; [prefinished steel][stainless steel][_____].]

2.2 ELEVATOR OPERATION

ASME A17.1/CSA B44, Introduction, Section 3, Definitions.

****

NOTE: Choose one of the following four types of elevator operation.

****

[2.2.1 Single, Two-Stop, Automatic Operation

****

NOTE: Choose for single elevator serving two landings.

****

Provide Single Two-Stop Automatic Operation.

][2.2.2 Selective Collective Automatic Operation

****

NOTE: Choose for single elevator serving three or more landings.

****

Provide Selective Collective Automatic Operation.

][2.2.3 Duplex Selective Collective Automatic Operation

****

NOTE: Choose for two adjacent elevators.

****

Provide Duplex Selective Collective Automatic Operation. If a car is taken out of service or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to the other car functioning as a single car Selective Collective elevator until the out-of-service car is returned to the system.

][2.2.4 Group Automatic Operation

****

NOTE: Choose for three or more elevators that serve the same elevator lobby.

****

Provide Group Automatic Operation. If a car is taken out of service, or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to another car until out-of-service car is returned to the system.

]2.3 SPECIAL OPERATION AND CONTROL

Provide the following special operations and control systems.

2.3.1 Keys for Elevator Key Switches

Provide a minimum of twelve keys per unique cylinder used on all key switches for a single elevator. If there is more than one elevator, additional keys will not be required unless there are additional unique lock cylinders. Provide keys with brass or fiberglass tags marked "PROPERTY OF THE U.S. GOVERNMENT" on one side with function of key or approved code number on the other side.

2.3.2 Firefighters' Emergency Operation (FEO)

****

NOTE: Coordinate FEO Designated Landing with Fire Protection Designer.

****

Provide FEO equipment and signaling devices. The designated level for the FEO Phase I key operated switch is the [ground][_____] floor. In the FEO Phase I fixture, provide FEO Operating Instructions.

2.3.2.1 Firefighters' Emergency Operation (FEO) Key Box

Provide flush mounted, locking, FEO Key Box of a minimum size of 127 mm W by 229 mm H by 38 mm D 5 inch W by 9 inch H by 1.5 inch D. Install at a height of 183 cm 6 feet above floor level and directly above the FEO Phase I key switch. Provide box equipped with lock that uses the FEO K1 key.

2.3.3 Hoistway Access Operation

Provide hoistway access operation with switches at top and bottom terminal landings. Locate switch 183 cm 6 feet above floor level, within 305 mm 12 inches of elevator hoistway entrance frame or with the ferrule exposed when located in the elevator entrance frame.

2.3.4 In-Car Inspection Operation

Provide In-Car Inspection Operation.

2.3.5 Independent Service

Provide exposed key-operated switch in car operating panel to enable independent service and simultaneously disable in-car signals and landing-call responses. Provide indicator lights that automatically illuminate during independent service. For duplex or group operation, if one car is removed from group another car will respond to its hall calls.

2.3.6 Selective Door Operation

For elevator with one or more rear openings at same level as front opening, provide full-selective operation with car and door operating buttons clearly marked for front and rear openings, front and rear car button for each such floor, and front and rear "DOOR OPEN" and "DOOR CLOSE" buttons. Only door for which the button was operated opens or closes.

[2.3.7 Elevator Emergency Power Operation

****

NOTE: Electrical design shall identify the

elevators to be connected to the building emergency power system. Identify and define the complete emergency power system for all elevators. When using the 2nd bracketed option in either of the next two subparagraphs, edit as required for project-specific requirements.

For any elevator that is not included in the building emergency power operation, utilize paragraph ELEVATOR AUXILIARY POWER OPERATING SYSTEM.

****

Provide elevator emergency power operation for [all elevators] [elevator 1,2,3...]. Coordinate power supply and control wiring to accomplish initiation and operation of elevators on emergency power.

][2.3.8 Elevator Auxiliary Power Operating System

Provide elevator emergency auxiliary power operating system for [all elevators] [elevator 1,2,3...].

]2.4 ELEVATOR DRIVE SYSTEM

Provide hydraulic elevator drive system, including pump unit, piping, cylinder/plunger assembly, and associated equipment, which will operate at a maximum working pressure of 3447 kPag 500 psi or less. Provide complete elevator system that meets or exceeds the NEII-1 Ride Quality Standard, including elevator ride quality and noise levels in car and in elevator machine room and machinery space.

2.4.1 Hydraulic Pump Unit

Provide self-contained pump unit, including oil-hydraulic elevator pump, electric motor, suction-line oil strainer, and structural steel outer base with tank supports and isolation pads. Provide oil tank capacity for full plunger displacement plus at least 38 liters 10 gallons. Provide means to maintain oil temperature between 38 and 54 degrees C 100 and 130 degrees F regardless of ambient temperature. Limit acoustic output in elevator machine room and machinery space to 80 dbA.

2.4.1.1 Pump Motor

Provide intermittent-duty pump motor rated at 120 starts/hour. Provide motor that is sized so that the motor amperage does not exceed the motor data tag amperage in any operating condition, exclusive of acceleration and deceleration. Provide minimum of one mega ohm insulation resistance between conductors and motor frame. Provide motor and pump nameplate and data tags permanently mounted on the outside of the pump unit frame, with all data viewable without the use of mirrors or other tools.

2.4.2 Hydraulic Controls and Equipment

Provide control valve, overspeed safety valve, blowout-proof muffler, and hydraulic pump discharge strainer in the hydraulic oil supply line. Provide two 1/4 turn, ball valve type manual shutoff valves. Provide one in the elevator hoistway pit and one in the elevator machine room or machinery space.

2.4.2.1 Hydraulic Control Valve

Provide constant-velocity, down-speed regulated, control valve. Down-speed regulated control valve allows the car to travel at the same speed in the down direction, regardless of the load on the elevator. In addition, the hydraulic control valve must have built-in adjustment capability to operate the elevator at 140 percent of rated speed to facilitate periodic testing of the overspeed safety valve.

2.4.2.2 Hydraulic Overspeed Safety Valve

Provide overspeed safety valve in hydraulic oil supply line, directly adjacent to the hydraulic cylinder. Provide threaded pipe connections between the hydraulic cylinder and the overspeed valve. Provide valve equipped with manufacturer's manual shutoff feature. Overspeed valve must not be equipped with a manual or automatic lowering feature. Provide adjustable valve with means to seal adjustment after inspection and testing by certified elevator inspector.

2.4.3 Hydraulic Piping and Accessories

****

NOTE: Retain bracketed sentence for in-ground direct plunger type elevators.

****

Provide ASTM A53/A53M or ASTM A106/A106M, Schedule 80, black steel piping with ASME B16.9 or ASME B16.11 fittings for supply piping. Extend schedule 80 piping from the pump control valve body, inside the pump unit, to the hydraulic cylinder in the hoistway. Provide welded or threaded forged pipe fittings for all fittings and components of the hydraulic oil supply line. [For in-ground direct plunger cylinders, provide dielectric union or isolation couplings at each end of the hydraulic oil supply line.]Provide hangers or supports for all piping and components.

2.4.3.1 Containment of Hydraulic Oil Supply Line

Protect all portions of hydraulic oil supply line that are installed below ground, including portions encapsulated in concrete or covered by construction, with continuous, Schedule 80, PVC. Inside diameter of PVC must be 76 mm 3 inches larger than the outside diameter of the hydraulic oil supply line pipe and couplings.

2.4.4 Hydraulic Elevator Type

****

NOTE: Use of a holeless type elevator with a non-telescoping jack will be limited to a maximum travel distance of 12 ft-8 in.

****

Provide a [in-ground direct plunger] [holeless] direct plunger type hydraulic elevator. Elevator with telescopic or inverted cylinder-plungers are not acceptable and may not be used. Rope hydraulic elevator design is not acceptable and may not be used.

2.4.4.1 Cylinder-Plunger (Jack) Unit

Provide a single-stage plunger of seamless steel construction. Provide cylinder with self-stabilizing mount that will support and hold cylinder plumb without the need for stabilization means at the bottom of the cylinder. Provide a threaded, 6 mm 1/4 inch bleeder valve at the top of the cylinder, just below packing gland.

[2.4.5 Cylinder Well System

****

NOTE: Retain this paragraph and associated subparagraphs for in-ground direct plunger type elevators only.

****

For direct plunger, in-ground type hydraulic elevator, provide a dry, sealed cylinder well system.

2.4.5.1 Well Casing

Locate and drill well for the cylinder well system. Line well with steel casing, minimum 6 mm 1/4 inch wall with welded 13 mm 1/2 inch steel bottom. Set casing plumb.

2.4.5.2 PVC or HDPE Liner

Provide Schedule 80 PVC or HDPE liner with bottom cap and couplings; joints sealed watertight using pipe manufacturer's recommended adhesive or heat welding methods. Provide liner inside diameter not less than 76 mm 3 inches larger than elevator cylinder maximum outside diameter. Liner may be provided as a cylinder manufacture's applied liner or as a separate component. For separate liner, set liner plumb in well casing, located for cylinder installation. Provide dry, salt-free sand below and around liner to top of well casing.

2.4.5.3 Cylinder Installation

Remove all moisture from inside of liner. Install cylinder plumb, inside liner. Provide a 6 mm 1/4 inch copper evacuation tube inside the liner. The bottom of the evacuation tube must be within 152 mm 6 inch of the bottom of the liner. Top of evacuation tube must extend at least 152 mm 6 inch above pit floor. Provide top of test tube with removable cap to exclude foreign matter. Provide air inlet pressure fitting in top of liner and accessible in pit, for performance of air pressure test. Secure Liner/Cylinder Assembly as recommended by cylinder manufacturer.

2.4.5.4 Cylinder Liner Moisture Sensor System

Provide moisture and oil sensors inside the cylinder liner for detection of oil and water at the bottom of the cylinder liner. Provide sensor monitoring system that will actuate audible and visual alarms and identify the presence of water and identify the presence of oil inside the liner.

2.4.5.5 Seal Top of Well Casing

Upon successful test and certification of Liner/Cylinder assembly, seal gap between steel well casing and liner with foam insert strong enough to retain and support final grouting. Provide 21 MPa 3000 psi grout to a minimum of 102 mm 4 inch thickness and level top of final grouting with pit floor.

]2.5 CONTROL EQUIPMENT

Enclose all elevator control equipment in factory-primed and baked-enamel coated sheet-metal cabinets with ventilation louvers and removable or hinged doors. Mount cabinets at a height of 254 mm 10 inches above machine room or control room finish floor.

2.5.1 Motor Control Equipment

Provide elevator motor control with electronic, soft-start motor starter.

2.5.2 Elevator Microprocessor Controller

For each individual elevator controller, and for each group controller, provide a microprocessor controller that complies with the following paragraphs. Provide controller(s) package that includes all hardware and software required for the installation, maintenance, and service of the elevator, in its' entirety. Provide verification of technical support service that the controller manufacturer provides to any licensed elevator installation, service, and maintenance company.

Provide an elevator controller from a manufacturer that provides comprehensive factory training to include controller installation, adjustment, service, and maintenance. The training must be identified as available to any licensed elevator contractor. Provide verification of an established and documented training schedule, with pricing, for factory training classes that manufacturer has provided for a minimum period of one year prior to contract award date.

The elevator controller must be identified as available for purchase and installation by any licensed elevator contractor. All components, parts, diagnostic tools, and software must be available for purchase and installation and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable. The elevator controller manufacturer must publish an industry competitive price listing for all controller parts, diagnostic tools, and software.

Provide verification of telephone and internet based technical support service that the elevator controller manufacturer provides to any licensed elevator installation, service, and maintenance company at an industry competitive price. The service must include live telephone based technical support for installation, adjustment, maintenance, and troubleshooting of the elevator controller and related elevator components. The service must be available during standard working hours.

Provide an elevator controller that is designed to automatically reestablish normal elevator operation following any temporary loss of power, regardless of duration.

2.5.2.1 Elevator Controller Interface Cabinet

For each individual elevator microprocessor controller, provide a separate elevator control cabinet with an integrated human interface system. For group elevator installations, a single cabinet and interface system with full access to each elevator controller may be utilized. The separate controller interface cabinet must be supplied by the elevator controller manufacturer and include a minimum 305 mm 12 inch wide keyboard and a minimum 254 mm 10 inch monitor. The elevator controller interface cabinet must comply with arc-flash protection requirements of NFPA 70E and

UFC 3-560-01.

2.5.2.1.1 Elevator Microprocessor Human Interface

The interface system must provide complete elevator controller interface capability and must include the elevator controller manufacturer's comprehensive package of installation and diagnostic software. The microprocessor interface system must provide unrestricted access to all parameters, all levels of adjustment, and all flags necessary for installation, adjustment, maintenance, and troubleshooting of each elevator and for the elevator group. All software programming must be stored in non-volatile memory. The elevator controller fault log must provide non-volatile memory fault log storage of all faults, trouble calls, and fault history for a minimum of one year and the ability to download or print the fault log. The controller interface must also provide the capability to display and diagnose trouble calls, faults, and shutdowns. Expiring software, degrading operation, and "key" access controls are not acceptable.

2.5.2.2 Software and Documentation

Provide three copies of the manufacturer's maintenance and service diagnostic software, with complete software documentation, that will enable the same level of unrestricted access to all controllers of the same make and model, regardless of the installation date or location. Provide signed certification, from the manufacturer's corporate headquarters, that guarantees that the microprocessor software and access system will not terminate the unlimited and unrestricted access at any future date.

2.5.2.3 Elevator Controller Certification

For elevator installations in the United States, including United States territories, provide an elevator microprocessor controller that has a current certificate of safety code compliance issued by the Technical Standards and Safety Authority (TSSA), Toronto, Canada.

2.6 OPERATING PANELS, SIGNAL FIXTURES, AND COMMUNICATIONS CABINETS

For all panels and fixtures, provide identical and uniform panel and fixture design, material, finish, and components for all elevators. For all panels and fixtures, legibly and indelibly identify all buttons, devices, and all operating positions for each device. Use engraving and backfilling, or photo etching, for button and device designations. Do not use attached signs. Provide elevator manufacturers' standard grade for all key switches unless otherwise specified. All illuminating panels and fixture components must utilize LED lighting for energy efficiency.

2.6.1 Car and Hall Buttons

For all cab and landing fixture buttons, provide industry-standard, vandal resistant push buttons with positive-stop assembly design. Buttons must be minimum 19 mm 3/4 inch diameter, satin-finish stainless steel, with illuminating LED halo.

2.6.1.1 Hall Station Door-Operating Buttons

****

NOTE: Use the following for freight elevators with power-operated bi-parting doors.

****

Provide hall station door-operating buttons, identical in size and design to hall call buttons, but not illuminating.

2.6.2 Freight Car-Operating Panel

****

NOTE: Use two Car Operating Panels for front and rear opening elevators.

****

Provide each car with [one] [two] car operating panel[s] that contains operation controls and communication devices. Provide exposed, flush mounted buttons for the controls identified in subparagraph OPERATOR CONTROLS. Provide a lockable service cabinet for the controls listed in subparagraph SERVICE CONTROLS. Use engraving and backfilling or photo etching for button and switch designations. Do not use attached signs.

2.6.2.1 Operator Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Illuminating car-call buttons identified to correspond to landings served by the elevator.

b. "DOOR OPEN" and "DOOR CLOSE" buttons. For front and rear openings at the same floor, include the identification "F" and "R" for each opening.

c. Red, illuminating "ALARM" button.

d. Key-operated "Independent Service" switch.

e. "Help" communication device to include communication between elevator cab and elevator machine room or control room.

2.6.2.2 Service Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Provide a key-operated, three-position switch for "In car Inspection Operation" and "Hoistway Access". The center switch position will provide normal, automatic operation.

b. "Car Light" switch.

c. "Car Fan" switch with two speed settings identified.

d. 120-volt ac 60 Hz single-phase duplex electrical outlet of ground-fault-circuit-interrupt (GFCI) design.

2.6.2.3 Certificate Window

Provide a minimum 102 mm wide by 152 mm high 4 inch wide by 6 inch high certificate window for elevator inspection certificate. Locate window in the Service Controls door of the Car Operating Panel.

2.6.2.4 Emergency Signaling Devices

Provide an audible signaling device, operable from the Car Operating Panel button marked "ALARM". The audible signaling device must have a sound pressure rating between 80 and 90 dBA at 3 meters 10 ft. Provide battery backup power capable of operating the audible signaling device for at least 1 hour.

2.6.3 Elevator In-Car Position Indicators

For all elevators, provide illuminating position indicator in the Car Operating Panel.

2.6.4 Elevator In-Car Direction Indicators

For 2-stop elevator installations, provide visual direction indicators and audible car arrival signal in the elevator car door jamb, in accordance with ABA Standards. Visual indicators must be visible from the hall call fixture.

2.6.5 Hall Call Landing Fixtures

Provide a hall call fixture adjacent to each elevator. Provide a single push-button for terminal landings and dual push-buttons, up and down, at intermediate landings.

2.6.5.1 Designated Landing Hall Call Fixture

2.6.5.1.1 Location of COMMUNICATION MEANS FAILURE (CMF) Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator CMF audible and illuminating signal, and reset switch, in the FEO Designated Landing hall call fixture. Mount the signal and reset switch at a minimum of 178 mm 7 inches above the "UP" hall call button.

2.6.5.1.2 COMMUNICATION MEANS FAILURE (CMF) Visual and Audible Signal Operation

Provide a CMF visual and audible signal system that conforms to ASME A17.1/CSA B44. Provide continuous verification of operability of the telephone line and immediate activation of audible and visual signals when verification means determines that the telephone line is not functioning. Provide illumination of visual signal at one second intervals. Provide a minimum of 65 dBA audible signal at 30 second intervals.

2.6.5.1.3 Firefighters' Emergency Operation Phase I Switch and Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator Firefighters' Emergency Operation Phase I switch and illuminating visual signal in the FEO Designated Landing hall call fixture. Provide FEO Phase I visual signal that is designed with intermittent, flashing, illumination when actuated by the machine room, control room or hoistway fire alarm initiating device. Locate FEO Phase I key switch above the CMF visual signal with a minimum of 152 mm 6 inches vertical between the centerlines of the CMF signal and the FEO Phase I key switch. Locate FEO Phase I visual signal directly above the Phase I switch. In addition, locate Elevator Corridor Call Station Pictograph at top of hall call fixture.

2.6.6 Elevator Car Position and Direction Indicators and Car Arrival Signal

For elevator installations with three or more stops, provide a separate hall landing fixture that includes the visual elevator position indicator, visual direction indicators, and audible car arrival signal, in accordance with ABA Standards.

2.6.7 Designated Landing Elevator Identification Fixture

For duplex and group elevator installations, provide a separate elevator identification fixture for each elevator, with identification engraved and backfilled with a contrasting color. Number elevators from left to right, as seen during primary approach from building main entrance to elevator lobby. For multiple elevator groups, begin numbering with group that is closest to the building main entrance.

2.6.8 Emergency or Standby Power

When emergency or standby power is provided for elevator operation, provide an elevator emergency power visual indicator that conforms to ASME A17.1/CSA B44. Locate the visual signal in the Firefighters Emergency Operation fixture for each simplex elevator and for each elevator group. When an emergency power selector switch is required, provide switch in a separate, flush mounted fixture located at the designated level, in view of all elevator entrances.

2.7 CAR DOOR EQUIPMENT

2.7.1 Car Door Operator

Provide elevator door operator equipment and circuitry that is designed and installed as discreet communication. Serial communication must not be used for this system.

2.7.2 Infra-red Curtain Unit

Provide Infra-red Curtain Unit (ICU) with multiple infra-red beams that protect to the full height and width of the door opening. Provide door nudging operation.

2.8 FREIGHT ELEVATOR GUIDES, PLATFORM, AND ENCLOSURE

2.8.1 Guides

Provide coil-spring loaded roller guide assemblies in adjustable mountings on each side of car and counterweight frames in accurate alignment at top and bottom of frames. For freight elevators with a rated load greater than 10,000 lbs., slide guides may be used in lieu of roller guides.

2.8.2 Car Shell Return Panels, Doors, Entrance Columns, and Transom

Provide 16 Gauge minimum [prefinished steel][stainless steel] cab wall panels and entrance components. Use same material and finish for all hoistway and car entrance assemblies. Apply sound-deadening material on exterior of all cab wall panels.

2.8.3 Car Enclosure Top

Provide reinforced, 12 gauge minimum steel car enclosure top. Provide hinged emergency exit with lock that complies with the seismic risk zone 2 or greater design requirements of ASME A17.1/CSA B44. Locate emergency exit hinge towards the rear of the elevator cab. Design and configure the elevator cab interior ceiling to provide convenient and unobstructed access to, and use of, emergency exit from inside the elevator cab.

2.8.4 Car Door

Provide [two section]vertical rising gate with power door operator.

2.8.5 Car Entrance Sill

Provide one piece steel car entrance sill(s). Set sills level and flush with cab finish floor.

2.8.6 In-Car Horizontal Buck-Board Wall Protection

****

NOTE: Retain bracketed phrase for freight elevators that do not have Front and Rear openings.

****

Provide minimum 64 mm thick by 305 mm high 2 1/2 inch thick by 12 inch high #2 Oak protection boards on all side walls [and back wall] of the elevator cab. Position boards at a height to prevent damage from fork lift traffic.

2.8.7 Cab Finish Floor

Provide cab finish floor with top of finish floor flush with the cab sill.

2.8.8 Car Fan

Provide 2-speed fan for car enclosure forced ventilation. Fan must be mounted in the car enclosure top.

2.8.9 Car Lighting

Utilize LED lighting for elevator car interior illumination. Provide a minimum of 10 foot-candles, measured at all areas of the car enclosure floor. Provide automatic car lighting operation that will turn off car lights after 3 minutes of inactivity. Car lights must automatically turn on upon actuation of an elevator car or hall call.

2.9 FREIGHT ELEVATOR HOISTWAY DOORS AND ENTRANCES

Provide hoistway entrance assemblies with a minimum 1-1/2 hour fire rating. Use same material and finish for all hoistway and car entrance assemblies.

2.9.1 Hoistway Entrance Frames

Provide 14 gage minimum [prefinished carbon sheet steel][stainless steel] hoistway entrance frames. Provide door panels with truckable sill. Provide minimum 102 mm by 229 mm 4 inch by 9 inch height vision panel in upper door panel.

2.9.2 Hoistway Entrance Sills

Provide one-piece 8 mm thick, 152 mm by 152 mm 5/16 inch thick, 6 inch by 6 inch steel angle iron sill with top of sill flush with hoistway landing finish floor. Steel angle-iron sill must be set into and fully supported by the concrete floor or the steel building structure. Use same material for all hoistway and car entrance sills.

2.10 HOISTWAY EQUIPMENT

2.10.1 Car Guide Rails and Fastenings

Provide T-section type guide rails for car. Paint rail shanks with one coat of black enamel.

2.10.2 Pit Equipment

****

NOTE: Delete bracketed phrase for holeless applications.

****

Provide rail-to-rail pit channels to serve as mounting surface for main guide rails [, hydraulic cylinder]and car buffers. Method of installation of channels, brackets and buffer mounts must be such that pit waterproofing is not punctured.

2.10.3 Pit "STOP" Switch

Provide push-to-stop/pull-to-run type pit "STOP" switch.

2.10.4 Traveling Cables

Suspend traveling cables by means of self-tightening webbed devices or internal suspension members.

2.10.5 Hoistway Pit Ladder

Provide continuous horizontal rungs for the full height of the pit ladder.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with DOD design criteria, contract specifications, manufacturer's instructions, NEII-1 Building Transportation Standards and Guidelines, and all applicable building and safety code requirements.

3.1.1 Structural Members and Finish Materials

Do not cut or alter structural members. Do not alter finish materials from manufacturer's original design. Restore any damaged or defaced work to original condition.

3.1.2 Miscellaneous Requirements

Provide recesses, cutouts, slots, holes, patching, grouting, and refinishing to accommodate elevator installation. Use core drilling to drill all new holes in concrete. Finish work to be straight, level, and plumb. During installation, protect machinery and equipment from dirt, water, or mechanical damage. At completion, clean all work and spot paint.

3.2 FIELD QUALITY CONTROL

The Contractor will provide and utilize a third-party licensed and certified Qualified Elevator Inspector (QEI) to conduct elevator pre-acceptance inspection and testing. The QEI must perform inspections and witness tests to ensure that the installation conforms to all applicable safety codes and contract requirements. The QEI will be directly employed by the Contractor and independent of the elevator contractor.

Upon completion, the QEI must provide written test data for all ASME A17.1/CSA B44 Acceptance Tests and written certification that the elevator is complete and ready for final Acceptance Inspection, Testing, and Commissioning.

3.3 ACCEPTANCE INSPECTION, TESTING AND COMMISSIONING

When elevator system installation is complete and ready for final inspection, notify Contracting Officer that elevator system is ready for Acceptance Inspection, Testing, and Commissioning. Provide QEI certification specified in Article FIELD QUALITY CONTROL.

****

NOTE: Use the first bracketed paragraph for all Navy Facilities and for all projects managed by NAVFAC FEAD. Use the second bracketed paragraph for Air Force and Army projects that are not managed by NAVFAC FEAD.

****

[Contracting Officer will obtain services of Naval Facilities Engineering Systems Command (NAVFAC) QEI Certified Elevator Inspector. NAVFAC QEI will utilize the applicable NAVFAC Elevator Acceptance Inspection Form to record the results of inspection and testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the NAVFAC QEI will sign a copy of the completed forms and provide the signed copy to the Contracting Officer or representative. Within two weeks of the inspection, the QEI will also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, NAVFAC Certified Elevator Inspector will complete, sign and post form NAVFACENGCOM 9-11014/23(Rev.9-2009), Elevator Inspection Certificate.

][Contracting Officer will obtain the services of a third-party QEI Certified Elevator Inspector. The QEI must utilize an Elevator Acceptance Inspection Form to record the results of inspection and all testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the QEI must sign a copy of the completed forms and provide to the Contracting Officer. Within two weeks of the inspection, the QEI must also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, the QEI will complete, sign, and provide a certificate of compliance with ASME A17.1/CSA B44.

]3.3.1 Acceptance Inspection Support

Prime and Elevator Contractors must provide inspection support and perform all required tests, in order to demonstrate proper operation of each elevator system and to prove that each system complies with contract requirements and all applicable building and safety codes. Inspection procedures in ASME A17.2 form a part of this inspection and acceptance testing. All inspection and testing must be conducted in the presence of the Qualified Elevator Inspector (QEI).

If the elevator does not comply with all contract and safety code requirements on the initial Acceptance Inspection and Test, the Contractor is responsible for all costs involved with re-inspection and re-testing required as a result of contractor delays and discrepancies discovered during inspection and testing.

3.3.2 Testing Materials and Instruments

Furnish all testing materials and instruments necessary for Acceptance Inspection, Testing and Commissioning. At a minimum, include calibrated test weights, tachometer, accelerometer, hydraulic pressure gauge, 600-volt mega ohm meter, volt meter and ammeter, infrared temperature gauge, door pressure gage, dynamometer, and 6 meter 20 foot tape measure.

3.3.3 Field Tests

3.3.3.1 Endurance Tests

Test each elevator for a period of one hour continuous, automatic operation, with specified rated load in the elevator cab. During the one hour test, stop car at each floor, in both directions of travel, and allow automatic door open and close operation. The requirements for Automatic Operation, Rated Speed, Leveling, Temperature Rise and Motor Amperes must be met throughout the duration of the Endurance Test. Restart the one hour test period from the beginning, following any shutdown or failure.

3.3.3.2 Speed Tests

Determine actual speed of each elevator, in both directions of travel, with rated load and with no load in elevator car. Make Speed tests at the beginning and at the end of the Endurance test. Determine speed by tachometer reading or accelerometer, excluding accelerating and slow-down zones. Under all conditions, minimum acceptable elevator speed is the Rated speed specified. Maximum acceptable elevator speed is 110 percent of Rated speed.

3.3.3.3 Leveling Tests

Test elevator car leveling operation and provide a leveling accuracy equal to or less than 3 mm 1/8 inch at each floor with no load in car, and with rated load in car, in both directions of travel. Determine leveling accuracy at the beginning and at the end of the endurance tests.

3.3.3.4 Temperature Rise Tests

Determine temperature rise of elevator pump motor and hydraulic fluid during one-hour full-load test run. Under these conditions, maximum temperature rise must not exceed acceptable temperature rise indicated on manufacturer's data plate. Start test only when equipment is within 5 degrees C of ambient temperature.

3.3.3.5 Motor Ampere Tests

At beginning and end of Endurance test, measure and record motor amperage in both directions of travel and in both no-load and rated load conditions.

3.3.3.6 Elevator Performance and Ride Quality Testing

Evaluate elevator performance to ensure compliance with specification requirements related to the NEII-1 Performance Standards Matrix for New Elevator Installations.

3.3.3.7 Hydraulic Safety Valve (Automatic Shutoff Valve) Tests

In order to ensure consistent performance, regardless of hydraulic oil temperature, test the Hydraulic Safety Valve twice. Test once before the one-hour endurance test and once immediately after the one-hour test. For elevator certification, safety valve must perform to code in both tests.

3.3.3.8 Hydraulic Pressure Tests

Check the hydraulic static pressure and rated-speed operating pressure at the hydraulic control valve, under both no load and rated load conditions.

3.3.3.9 Pressure Test of Liner/Cylinder Assembly

Perform 138 kPag 20 psig pressure test of the completed and installed liner/cylinder assembly. Test liner/cylinder assembly as a sealed unit. Provide safety relief valve set to relieve at 138 kPag; 114 mm 20 psig; 4.5 inch diameter dial pressure gage scaled for 0 to 175 kPag 0 to 50 psig and calibrated to 0.5 percent accuracy; and an air pressure admission throttle and shutoff valve. For safety, pressure test must only be performed when liner and cylinder are fully inserted and assembled in the well casing. Perform the test from remote location outside of the elevator pit. Perform test in the presence of, and witnessed by, a Certified Elevator Inspector.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-14 24 23 (May 2016)**
Change 1- 05/18

Preparing Activity: NAVFAC **Superseding**
UFGS-14 24 00 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 14 24 23

HYDRAULIC PASSENGER ELEVATORS
05/16

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NOTE: This guide specification covers the requirements for hydraulic passenger elevators.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: All Army and Navy facility designs which include elevators shall comply with the "NAVFAC ITG 2013-01 Elevator Design". This guide is available from the NAVFAC facilitator at http://www.wbdg.org/ffc/navy-navfac/interim-technical-guidance-itg **under Interim Technical Guidance.**

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NOTE: For NAVY projects, any editing of non-bracketed requirements in this specification must be approved through the NAVFAC FEC VTE Program Lead Certifying Official.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2022) Safety Code for Elevators and Escalators
ASME A17.2	(2023) Guide for Inspection of Elevators, Escalators, and Moving Walks
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

NATIONAL ELEVATOR INDUSTRY, INC. (NEII)

NEII-1	(2000; R thru 2017) Building Transportation Standards and Guidelines, including the Performance Standards Matrix for New Elevator Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 101	(2024) Life Safety Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-560-01	(2017; with Change 3, 2023) Operation and Maintenance: Electrical Safety

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Elevator System; G, [_____]

Elevator Components; G, [_____]

Elevator Machine; G, [_____]

Elevator Controller; G, [_____]

Wiring Diagrams; G, [_____]

SD-03 Product Data

****

NOTE: For Army projects, delete the bracketed items. For Navy projects, keep the bracketed items.

****

Elevator and Accessories[; G, [_____]]

Elevator Components[; G, [_____]]

Data Sheets[; G, [_____]]

Elevator Microprocessor Controller; G, [_____]

SD-05 Design Data

Emergency Power Systems

Heat Loads

Reaction Loads

SD-07 Certificates

Elevator Parts and Components Price Lists; G, [_____]

Warranty

Endorsement Letter

Welders' Qualifications

Elevator Controller Certification; G, [_____]

SD-10 Operation and Maintenance Data

Elevator, Data Package 4; G, [_____]

Maintenance Control Program (MCP); G, [_____]

Software and Documentation; G, [_____]

Submit in accordance with Sections 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW).

1.2.1 Shop Drawing Requirements

Provide assembly and arrangement of elevators, accessories, and elevator components. Show location of elevator machine in elevator machine room (MR) or machinery space (MS). Show location of elevator controller in elevator machine room or elevator control room (CR). Provide details for materials and equipment, including but not limited to operating and signal fixtures, doors, door and car frames, car enclosure, controllers, motors, guide rails and brackets, layout of hoistway in plan and elevation, and other layout information and clearance dimensions.

1.2.2 Product Data Requirements

Provide manufacturers' product data for all elevator components, including but not limited to the following: elevator controller, hydraulic pump unit, hydraulic pump and motor, hydraulic cylinder, hydraulic piping and fittings, car and hall fixture buttons and switches, cab and machine room or control room communication devices, door operator, door protection system, car roller guides, and buffers. For data sheets, provide document identification number or bulletin number, published or copyrighted prior to the date of contract bid opening. Provide controller manufacturer's published procedures for performance of each and all testing required by ASME A17.1/CSA B44.

1.2.3 Design Data

1.2.3.1 Reaction Loads

Provide calculations by registered professional engineer for reaction loads imposed on building by elevator system. Demonstrate calculations complying with ASME A17.1/CSA B44

1.2.3.2 Heat Loads

Provide calculations from elevator manufacturer, or by registered professional engineer, for total anticipated heat loads generated by all of the elevator equipment.

1.2.3.3 Emergency Power Systems

Where the facility does have an emergency power system, confirm the elevators that will be connected to the emergency power system. Confirm the complete emergency power system and sequence of operation for all elevators, including operation of the elevator lobby manual selection switch. Provide wiring diagrams for building emergency power interface with elevator controls. For elevators not supplied by an emergency power system, provide manufacturers' product data for auxiliary power systems.

1.2.4 Welders' Requirements

Comply with AWS D1.1/D1.1M, Section 5. Include certified copies of field welders' qualifications. List welders' names with corresponding code marks to identify each welder's welding work

1.2.5 Maintenance Control Program (MCP)

For each elevator, prepare and provide a written Maintenance Control Program (MCP) that complies with ASME A17.1/CSA B44 Section 8.6, including written documentation that details the test procedures for each and every test that is required to be performed by ASME A17.1/CSA B44. Assemble all MCP documentation, and supporting technical attachments, in a single MCP package and provide in both electronic and hard copy. Assemble entire hard copy MCP in 3-ring binders. For each elevator provided, the MCP must include only documentation and instruction that apply to the elevator specified.

For each elevator, provide an additional, separate binder that includes all maintenance, repair, replacement, call back, and other records required by ASME A17.1/CSA B44. The records binder must be kept in the elevator mechanical room, maintained by elevator maintenance and service personnel, and be available at all times to authorized personnel.

Provide detailed information regarding emergency service procedures and elevator installation company personnel contact information. Provide a listing of all tools to be provided to the Contracting Officer as components of the elevator system.

1.3 QUALITY ASSURANCE

1.3.1 Qualification

Provide a designed and engineered elevator system by an elevator contractor regularly engaged in the installation of elevator systems. Provide elevator components manufactured by companies regularly engaged in the manufacture of elevator components. Utilize only licensed and certified elevator personnel for the installation, adjusting, testing, and servicing of the elevators.

1.3.1.1 Elevator Contractor's Elevator Technicians

For elevator installations in the United States, including United States territories, perform all elevator related work under the direct guidance of a state certified elevator technician with a minimum of three years of experience in the installation of elevator systems of the type and complexity specified in the contract documents. Provide an endorsement letter from the elevator manufacturer, certifying that the elevator specialist is qualified. All elevator technicians must carry a current certification issued by one of the following organizations:

a. National Association of Elevator Contractors (NAEC)

b. National Elevator Industry Education Program (NEIEP)

1.3.2 Manufacturers' Technical Support

Provide elevator components from manufacturers that provide factory training and online and live telephone elevator technical support to any elevator installation, service, and maintenance contractor. Provide elevator components from manufacturers that guarantee accessibility to all replacement and repair parts and components to any elevator installation, service, and maintenance contractor. Use only elevator component manufacturers that provide current published price lists for all elevator parts and components.

1.3.3 Operation and Maintenance Data

Assemble all shop drawing and product data material into O&M Data Packages in accordance with Article SUBMITTALS. Provide two complete O&M Data Packages in hard copy and two complete electronic O&M data packages on separate CDs, in PDF format. Provide all O&M Data Packages to Contracting Officer. Include controller diagnostic documentation and software as required under Article CONTROL EQUIPMENT.

1.3.4 Wiring Diagrams

Provide complete wiring diagrams and sequence of operations, which show electrical connections and functions of elevator systems. Provide one set (279 mm by 432 mm11 inch by 17 inch minimum size) of wiring diagrams, with individual sheets laminated in plastic and assembled in binder, to be stored in the machine room or control room cabinet. Provide one additional hard copy set and two complete electronic sets on separate CDs, in PDF format. Provide all wiring diagram sets to the Contracting Officer. Coded diagrams are not acceptable unless fully identified.

1.3.5 Machine Room/Control Room Cabinet

For storage of O&M Data Packages and Wiring Diagrams, provide locking metal cabinet with a minimum size of 508 mm W by 305 mm D by 762 mm H 20 inch W by 12 inch D by 30 inch H. Cabinet must be sized large enough to accommodate all O&M Data and hardware required in paragraphs OPERATION AND MAINTENANCE DATA and WIRING DIAGRAMS. Secure cabinet to machine room or control room wall.

1.4 NEW INSTALLATION SERVICE

****

NOTE: Use Bi-weekly option for Hospitals and other high use facilities.

****

Provide elevator warranty service in accordance with the manufacturer's maintenance plan, warranty requirements and applicable safety codes, for a period of 12 months after the date of acceptance by Contracting Officer. Perform this work during regular working hours. Provide supplies and parts to keep elevator system in operation. Perform service only by factory trained personnel. Provide [Monthly][Bi-weekly] services to include repairs, adjustments, greasing, oiling, and cleaning. Provide service log in elevator machine room or control room and update [Monthly][Bi-weekly], throughout the one-year warranty period.

****

NOTE: One hour emergency service below is standard; only use two hour for remote locations.

****

Provide 24-hour emergency service, with [one hour][two hour] on-site response time, during this period without additional cost to the Government.

1.4.1 Periodic Elevator Certification Inspection and Testing

Provide elevator mechanic to support [NAVFAC]QEI Certified Elevator Inspector in the periodic six-month and the annual Category 1 elevator certification inspection and testing. Perform Category 1 inspection and testing no greater than 30 days prior to the end of the warranty period. Perform all elevator certification testing in the presence of QEI Certified Elevator Inspector.

In conjunction with the testing noted above, test systems for Emergency Power Operation, Earthquake Emergency Operation, and Hospital Emergency Commandeering Service Operation, as applicable. Schedule so that testing does not interfere with building operations.

1.5 FIRE PROTECTION SYSTEM

****

NOTE: Confirm that sections listed throughout this article are part of project. Add or delete sections as needed for project.

****

Coordinate interface between building fire protection system and elevator controls.

Additional fire protection requirements are located in: [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE,][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE,][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE,][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE,][Section 28 31 32 FIRE ALARM REPORTING SYSTEM, DIGITAL COMMUNICATOR TYPE,][Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION,][_____] and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.5.1 Fire Alarm Initiating Devices

Fire alarm initiating devices are specified in [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE][_____], including conduit and wiring from each detector to fire protection addressable modules in elevator machine room or control room.

1.5.2 Fire Sprinklers

Provide fire sprinklers in accordance with all applicable safety codes and with [Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION][_____]. Provide shutoff valve, check valve, and non-adjustable, zero time-delay flow switch, in each sprinkler line immediately outside of each machine room, control room, and hoistway, as applicable. Provide inspectors' test valve for periodic testing of flow switch and shunt trip disconnect.

Pipe sprinkler piping serving these spaces in a series manner with no laterals. Locate inspectors' test connection at the end of pipe runs such that operation of the test connection will purge air from system piping.

1.5.3 Shunt Trip Disconnect

Provide flow switches specified in paragraph FIRE SPRINKLERS to comply with ASME A17.1/CSA B44 and NFPA 72 for shunt trip of the main line power supply. For each elevator, provide control wiring connecting the flow switch to a shunt trip equipped circuit breaker located in the elevator machine room or control room. Upon flow of water, flow switch will instantaneously cause opening of the shunt-trip circuit breaker and remove power from the elevator. Flow switch must also send a signal to fire alarm control panel to indicate water flow condition.

PART 2 PRODUCTS

2.1 ELEVATOR DESCRIPTION

Provide elevator system that complies with ASME A17.1/CSA B44 in its entirety, ASME A17.2 in its entirety, and additional requirements specified herein. Provide elevator system that meets or exceeds the NEII-1 Ride Quality Performance Standards Matrix (RQPSM). Comply with the RQPSM "Intermediate Performance" criteria.

Provide and install elevators in accordance with 36 CFR 1191 - ABAAS, ICC IBC, IEEE C62.41, NFPA 70 and NFPA 101 requirements.

2.1.1 Elevator Design Parameters

****

NOTE: Traffic Analysis and Minimum Cab Size

Perform a traffic analysis and conduct interviews with the facility user to determine number, size, and type of elevators necessary to serve the needs of the facility user. For Army and Navy projects, utilize NAVFAC ITG 2013-01 Elevator Design to determine Design Type. For minimum elevator speed, specify 0.64 MPs 125 fpm for 2 story and 0.75 MPs 150 fpm for 3 and 4 story elevators.

Use of a holeless type elevator will be limited to a maximum travel distance of 386 cm 12 ft-8 in.

Size and capacity configurations are limited to three basic configurations as listed in the

subparagraphs below. In the rare case that the listed configurations do not meet project requirements, more extensive project-specific editing will be required.

****

2.1.1.1 Elevator No.[_____] - Emergency Medical Service Accessibility (EMSA)

****

NOTE: Emergency Medical Service Accessibility (EMSA): For each building of two stories or greater, provide at least one elevator with a minimum size and arrangement to accommodate an ambulance stretcher 610 mm by 2134 mm 24 inch by 84 inch, with not less than 127 mm 5 inch radius corners, in the open, horizontal, position. For buildings with multiple elevators, an EMSA elevator must be accessible from all locations in the building; otherwise additional elevator(s) shall also be EMSA.

For Two size and capacity configurations of elevators will meet this requirement. For standard passenger applications use the 1588 kg 3500 lb. capacity, single speed side slide described in this subparagraph. The larger elevator sized to accommodate pallet-size light freight loading described in next subparagraph below will also meet EMSA requirements.

****

Provide elevator(s) with minimum size and arrangement to accommodate an ambulance stretcher 610 mm by 2134 mm with not less than 127 mm 24-inch by 84-inch with not less than 5-inch radius corners, in the open, horizontal position.

a. Type: [In-Ground Direct Plunger] [Holeless]

b. Rated load: 1588 kg 3500 lb.

c. Rated Speed: [0.64][0.75] MPs [125][150] fpm

d. Car Door Type: Single-speed side slide.

e. Car Door Opening Width: 107 cm 3 ft.-6 in. minimum, or [_____].

2.1.1.2 Elevator No.[_____] - Larger Capacity (Pallet-Sized) Loading

****

NOTE: Where a larger capacity elevator is required to accommodate light freight, typically pallet-size loading, use this subparagraph. Elevator shall typically be 1814-2040 kg 4000-4500 lb. capacity (may be upwards of 2722 kg 6000 lbs. in rare instances), single speed center opening, 48 inch door opening width, and will typically be deeper than the 1588 kg 3500 lb. EMSA elevator above.

This larger elevator will also meet the EMSA requirements described above.

****

a. Type: [In-Ground Direct Plunger] [Holeless]

b. Rated load: [1814][2040] kg [4000][4500][_____] lb.

c. Rated Speed: [0.64][0.75] MPs [125][150] fpm

d. Car Door Type: Single-speed center opening, horizontally sliding.

e. Car Door Opening Width: [122 cm4 ft.-0 in.][137 cm4 ft.-6 in.]

2.1.1.3 Elevator No.[_____] - Non-EMSA Elevator

****

NOTE: For smaller elevators where EMSA is not required (covered by one of the two elevator types above), this subparagraph may be used. Typical application would be an elevator bank where one elevator meets EMSA requirements. Elevator shall be 2500 lb. capacity, 42 inch door opening width, and either side slide or center opening, typically to match other elevators in the bank.

This elevator will not meet EMSA requirements.

****

a. Type: [In-Ground Direct Plunger] [Holeless]

b. Rated load: 1134 kg 2500 lb.

c. Rated Speed: [0.64][0.75] MPs [125][150] fpm

d. Car Door Type: Single speed [side slide][center opening].

e. Car Door Opening Width: 107 cm 3 ft.-6 in. minimum, or [_____].

2.1.2 Cab Enclosure and Hoistway Entrance Assemblies

****

NOTE: If retaining 1st option in sentence below, ensure that finishes are indicated, most likely somewhere on the drawings. In either case, indicate finish colors of elevator materials in finish schedule on drawings.

****

****

NOTE: Specify stainless steel doors, side panels and wall trim in hospital elevator cabs.

****

Provide finishes [as indicated.][as listed below:

a. Floor; [carpet][vinyl composition tile][vinyl sheet tile][_____].

b. Walls; [prefinished steel][laminated plastic on plywood][stainless steel][_____]. Provide each cab wall with equally spaced and equally sized wall panels. All wall panel fasteners must be concealed.

(1) Wall trim; [prefinished steel][stainless steel][_____].

(2) Accessories; Provide hand rails on full length of back wall and side walls of elevator cab.

c. Car doors, car door returns, and wall reveals; [prefinished steel panels][stainless steel][_____].

d. Ceilings; [supported][prefinished steel panels][anodized aluminum][eggcrate][_____].

(1) Ceiling frame; [prefinished steel][stainless steel][anodized aluminum][_____].

e. Hoistway Entrance Assembly Material and Finishes; [prefinished steel][stainless steel][_____].]

2.2 ELEVATOR OPERATION

ASME A17.1/CSA B44, Introduction, Section 3, Definitions.

****

NOTE: Choose one of the following four types of elevator operation.

****

[2.2.1 Single, Two-Stop, Automatic Operation

****

NOTE: Choose for single elevator serving two landings.

****

Provide Single Two-Stop Automatic Operation.

][2.2.2 Selective Collective Automatic Operation

****

NOTE: Choose for single elevator serving three or more landings.

****

Provide Selective Collective Automatic Operation.

][2.2.3 Duplex Selective Collective Automatic Operation

****

NOTE: Choose for two adjacent elevators.

****

Provide Duplex Selective Collective Automatic Operation. If a car is taken out of service or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to the other car functioning as a single car Selective Collective elevator until the out-of-service car is returned to the system.

][2.2.4 Group Automatic Operation

****

NOTE: Choose for three or more elevators that serve the same elevator lobby.

****

Provide Group Automatic Operation. If a car is taken out of service, or fails to respond to a landing call within a predetermined adjustable time limit of approximately 40 to 180 seconds, transfer calls to another car until out-of-service car is returned to the system.

]2.3 SPECIAL OPERATION AND CONTROL

Provide the following special operations and control systems.

2.3.1 Keys for Elevator Key Switches

Provide a minimum of twelve keys per unique cylinder used on all key switches for a single elevator. If there is more than one elevator, additional keys will not be required unless there are additional unique lock cylinders. Provide keys with brass or fiberglass tags marked "PROPERTY OF THE U.S. GOVERNMENT" on one side with function of key or approved code number on the other side.

2.3.2 Firefighters' Emergency Operation (FEO)

****

NOTE: Coordinate FEO Designated Landing with Fire Protection Designer.

****

Provide FEO equipment and signaling devices. The designated level for the FEO Phase I key operated switch is the [ground][_____] floor. In the FEO Phase I fixture, provide FEO Operating Instructions.

2.3.2.1 Firefighters' Emergency Operation (FEO) Key Box

Provide flush mounted, locking, FEO Key Box of a minimum size of 127 mm W by 229 mm H by 38 mm D 5 inch W by 9 inch H by 1.5 inch D. Install at a height of 183 cm 6 feet above floor level and directly above the FEO Phase I key switch. Provide box equipped with lock that uses the FEO K1 key.

2.3.3 Hoistway Access Operation

Provide hoistway access operation with switches at top and bottom terminal landings. Locate switch 183 cm 6 feet above floor level, within 305 mm 12 inches of elevator hoistway entrance frame or with the ferrule exposed when located in the elevator entrance frame.

2.3.4 In-Car Inspection Operation

Provide In-Car Inspection Operation.

2.3.5 Independent Service

Provide exposed key-operated switch in car operating panel to enable independent service and simultaneously disable in-car signals and landing-call responses. Provide indicator lights that automatically illuminate during independent service. For duplex or group operation, if one car is removed from group another car will respond to its hall calls.

2.3.6 Selective Door Operation

For elevator with one or more rear openings at same level as front opening, provide full-selective operation with car and door operating buttons clearly marked for front and rear openings, front and rear car button for each such floor, and front and rear "DOOR OPEN" and "DOOR CLOSE" buttons. Only door for which the button was operated opens or closes.

[2.3.7 Elevator Emergency Power Operation

****

NOTE: Electrical design shall identify the elevators to be connected to the building emergency power system. Identify and define the complete emergency power system for all elevators. When using the 2nd bracketed option in either of the next two subparagraphs, edit as required for project-specific requirements.

For any elevator that is not included in the building emergency power operation, utilize paragraph ELEVATOR AUXILIARY POWER OPERATING SYSTEM.

****

Provide elevator emergency power operation for [all elevators] [elevator 1,2,3...]. Coordinate power supply and control wiring to accomplish initiation and operation of elevators on emergency power.

][2.3.8 Elevator Auxiliary Power Operating System

Provide elevator auxiliary power operating system for [all elevators] [elevator 1,2,3...].

][2.3.9 Hospital Emergency Commandeering Service (HECS)

****

NOTE: Only keep this HECS paragraph for hospital elevators or for projects in which this operation is specifically requested by the building owner or facility user.

****

Provide Hospital Emergency Commandeering Service.

]2.4 ELEVATOR DRIVE SYSTEM

Provide hydraulic elevator drive system, including pump unit, piping, cylinder/plunger assembly, and associated equipment, which will operate at a maximum working pressure of 3447 kPag 500 psi or less. Provide complete elevator system that meets or exceeds the NEII-1 Ride Quality Standard, including elevator ride quality and noise levels in car and in elevator machine room and machinery space.

2.4.1 Hydraulic Pump Unit

Provide self-contained pump unit, including oil-hydraulic elevator pump, electric motor, suction-line oil strainer, and structural steel outer base with tank supports and isolation pads. Provide oil tank capacity for full plunger displacement plus at least 38 liters 10 gallons. Provide means to maintain oil temperature between 38 and 54 degrees C 100 and 130 degrees F regardless of ambient temperature. Limit acoustic output in elevator machine room and machinery space to 80 dbA.

2.4.1.1 Pump Motor

Provide intermittent-duty pump motor rated at 120 starts/hour. Provide motor that is sized so that the motor amperage does not exceed the motor data tag amperage in any operating condition, exclusive of acceleration and deceleration. Provide minimum of one mega ohm insulation resistance between conductors and motor frame. Provide motor and pump nameplate and data tags permanently mounted on the outside of the pump unit frame, with all data viewable without the use of mirrors or other tools.

2.4.2 Hydraulic Controls and Equipment

Provide control valve, overspeed safety valve, blowout-proof muffler, and hydraulic pump discharge strainer in the hydraulic oil supply line. Provide two 1/4 turn, ball valve type manual shutoff valves. Provide one in the elevator hoistway pit and one in the elevator machine room or machinery space.

2.4.2.1 Hydraulic Control Valve

Provide constant-velocity, down-speed regulated, control valve. Down-speed regulated control valve allows the car to travel at the same speed in the down direction, regardless of the load on the elevator. In addition, the hydraulic control valve must have built-in adjustment capability to operate the elevator at 140 percent of rated speed to facilitate periodic testing of the overspeed safety valve.

2.4.2.2 Hydraulic Overspeed Safety Valve

Provide overspeed safety valve in hydraulic oil supply line, directly adjacent to the hydraulic cylinder. Provide threaded pipe connections between the hydraulic cylinder and the overspeed valve. Provide valve equipped with manufacturer's manual shutoff feature. Overspeed valve must not be equipped with a manual or automatic lowering feature. Provide adjustable valve with means to seal adjustment after inspection and testing by certified elevator inspector.

2.4.3 Hydraulic Piping and Accessories

****

NOTE: Retain bracketed sentence for in-ground direct plunger type elevators.

****

Provide ASTM A53/A53M or ASTM A106/A106M, Schedule 80, black steel piping with ASME B16.9 or ASME B16.11 fittings for supply piping. Extend schedule 80 piping from the pump control valve body, inside the pump unit, to the hydraulic cylinder in the hoistway. Provide welded or threaded forged pipe fittings for all fittings and components of the hydraulic oil supply line. [For in-ground direct plunger cylinders, provide dielectric union or isolation couplings at each end of the hydraulic oil supply line.]Provide hangers or supports for all piping and components.

2.4.3.1 Containment of Hydraulic Oil Supply Line

Protect all portions of hydraulic oil supply line that are installed below ground, including portions encapsulated in concrete or covered by construction, with continuous, Schedule 80, PVC. Inside diameter of PVC must be 76 mm 3 inches larger than the outside diameter of the hydraulic oil supply line pipe and couplings.

2.4.4 Hydraulic Elevator Type

****

NOTE: Use of a holeless type elevator with a non-telescoping jack will be limited to a maximum travel distance of 12 ft-8 in.

****

Provide a [in-ground direct plunger] [holeless] direct plunger type hydraulic elevator. Elevators with telescopic or inverted cylinder-plungers are not acceptable and may not be used. Rope hydraulic elevator design is not acceptable and may not be used.

2.4.4.1 Cylinder-Plunger (Jack) Unit

Provide a single-stage plunger of seamless steel construction. Provide cylinder with self-stabilizing mount that will support and hold cylinder plumb without the need for stabilization means at the bottom of the cylinder. Provide a threaded, 6 mm 1/4 inch bleeder valve at the top of the cylinder, just below packing gland.

[2.4.5 Cylinder Well System

****

NOTE: Retain this paragraph and associated subparagraphs for in-ground direct plunger type elevators only.

****

For direct plunger, in-ground type hydraulic elevator, provide a dry, sealed cylinder well system.

2.4.5.1 Well Casing

Locate and drill well for the cylinder well system. Line well with steel casing, minimum 6 mm 1/4 inch wall with welded 13 mm 1/2 inch steel bottom. Set casing plumb.

2.4.5.2 PVC or HDPE Liner

Provide Schedule 80 PVC or HDPE liner with bottom cap and couplings; joints sealed watertight using pipe manufacturer's recommended adhesive or heat welding methods. Provide liner inside diameter not less than 76 mm 3 inches larger than elevator cylinder maximum outside diameter. Liner may be provided as a cylinder manufacture's applied liner or as a separate component. For separate liner, set liner plumb in well casing, located for cylinder installation. Provide dry, salt-free sand below and around liner to top of well casing.

2.4.5.3 Cylinder Installation

Remove all moisture from inside of liner. Install cylinder plumb, inside liner. Provide a 6 mm 1/4 inch copper evacuation tube inside the liner. The bottom of the evacuation tube must be within 152 mm 6 inch of the bottom of the liner. Top of evacuation tube must extend at least 152 mm 6 inch above pit floor. Provide top of test tube with removable cap to exclude foreign matter. Provide air inlet pressure fitting in top of liner and accessible in pit, for performance of air pressure test. Secure Liner/Cylinder Assembly as recommended by cylinder manufacturer.

2.4.5.4 Cylinder Liner Moisture Sensor System

Provide moisture and oil sensors inside the cylinder liner for detection of oil and water at the bottom of the cylinder liner. Provide sensor monitoring system that will actuate audible and visual alarms and identify the presence of water and identify the presence of oil inside the liner.

2.4.5.5 Seal Top of Well Casing

Upon successful test and certification of Liner/Cylinder assembly, seal gap between steel well casing and liner with foam insert strong enough to retain and support final grouting. Provide 21 MPa 3000 psi grout to a minimum of 102 mm 4 inch thickness and level top of final grouting with pit floor.

]2.5 CONTROL EQUIPMENT

Enclose all elevator control equipment in factory-primed and baked-enamel coated sheet-metal cabinets with ventilation louvers and removable or hinged doors. Mount cabinets at a height of 254 mm 10 inches above machine room or control room finish floor.

2.5.1 Motor Control Equipment

Provide elevator motor control with electronic, soft-start motor starter.

2.5.2 Elevator Microprocessor Controller

For each individual elevator controller, and for each group controller, provide a microprocessor controller that complies with the following paragraphs. Provide controller(s) package that includes all hardware and software required for the installation, maintenance, and service of the elevator, in its' entirety. Provide verification of technical support service that the controller manufacturer provides to any licensed elevator installation, service, and maintenance company.

Provide an elevator controller from a manufacturer that provides comprehensive factory training to include controller installation, adjustment, service, and maintenance. The training must be identified as available to any licensed elevator contractor. Provide verification of an established and documented training schedule, with pricing, for factory training classes that manufacturer has provided for a minimum period of one year prior to contract award date.

The elevator controller must be identified as available for purchase and installation by any licensed elevator contractor. All components, parts, diagnostic tools, and software must be available for purchase and installation and use by any licensed elevator contractor; "exchange-only" provisions for the purchase of spare parts are not acceptable. The elevator controller manufacturer must publish an industry competitive price listing for all controller parts, diagnostic tools, and software.

Provide verification of telephone and internet based technical support service that the elevator controller manufacturer provides to any licensed elevator installation, service, and maintenance company at an industry competitive price. The service must include live telephone based technical support for installation, adjustment, maintenance, and troubleshooting of the elevator controller and related elevator components. The service must be available during standard working hours.

Provide an elevator controller that is designed to automatically reestablish normal elevator operation following any temporary loss of power, regardless of duration.

2.5.2.1 Elevator Controller Interface Cabinet

For each individual elevator microprocessor controller, provide a separate elevator control cabinet with an integrated human interface system. For group elevator installations, a single cabinet and interface system with full access to each elevator controller may be utilized. The separate controller interface cabinet must be supplied by the elevator controller manufacturer and include a minimum 305 mm 12 inch wide keyboard and a minimum 254 mm 10 inch monitor. The elevator controller interface cabinet must comply with arc-flash protection requirements of NFPA 70E and UFC 3-560-01.

2.5.2.1.1 Elevator Microprocessor Human Interface

The interface system must provide complete elevator controller interface capability and must include the elevator controller manufacturer's comprehensive package of installation and diagnostic software. The microprocessor interface system must provide unrestricted access to all parameters, all levels of adjustment, and all flags necessary for installation, adjustment, maintenance, and troubleshooting of each elevator and for the elevator group. All software programming must be stored in non-volatile memory. The elevator controller fault log must provide non-volatile memory fault log storage of all faults, trouble calls, and fault history for a minimum of one year and the ability to download or print the fault log. The controller interface must also provide the capability to display and diagnose trouble calls, faults, and shutdowns. Expiring software, degrading operation, and "key" access controls are not acceptable.

2.5.2.2 Software and Documentation

Provide three copies of the manufacturer's maintenance and service diagnostic software, with complete software documentation, that will enable the same level of unrestricted access to all controllers of the same make and model, regardless of the installation date or location. Provide signed certification, from the manufacturer's corporate headquarters, that guarantees that the microprocessor software and access system will not terminate the unlimited and unrestricted access at any future date.

2.5.2.3 Elevator Controller Certification

For elevator installations in the United States, including United States territories, provide an elevator microprocessor controller that has a current certificate of safety code compliance issued by the Technical Standards and Safety Authority (TSSA), Toronto, Canada.

2.6 OPERATING PANELS, SIGNAL FIXTURES, AND COMMUNICATIONS CABINETS

For all panels and fixtures, provide identical and uniform panel and fixture design, material, finish, and components for all elevators. For all panels and fixtures, legibly and indelibly identify all buttons, devices, and all operating positions for each device. Use engraving and backfilling, or photo etching, for button and device designations. Do not use attached signs. Provide elevator manufacturers' standard grade for all key switches unless otherwise specified. All illuminating panels and fixture components must utilize LED lighting for energy efficiency.

2.6.1 Car and Hall Buttons

For all cab and landing fixture buttons, provide industry-standard, vandal resistant push buttons with positive-stop assembly design. Buttons must be minimum 19 mm 3/4 inch diameter, satin-finish stainless steel, with illuminating LED halo.

2.6.2 Passenger Car-Operating Panel

****

NOTE: Choose "two" Car Operating Panels for high traffic passenger elevators in hospital buildings and office buildings. Choose "one" for elevator system where traffic is moderate such as in barracks, warehouses, clinics or shops.

****

Provide each car with [one] [two] car operating panel[s] that contains operation controls and communication devices. Provide exposed, flush mounted buttons for the controls identified in subparagraph PASSENGER CONTROLS. Provide a lockable service cabinet for the controls listed in subparagraph SERVICE CONTROLS. Use engraving and backfilling or photo etching for button and switch designations. Do not use attached signs.

2.6.2.1 Passenger Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Illuminating car-call buttons identified to correspond to landings served by the elevator.

b. "DOOR OPEN" and "DOOR CLOSE" buttons. For front and rear openings at the same floor, include the identification "F" and "R" for each opening.

c. Red, illuminating "ALARM" button.

d. Key-operated "Independent Service" switch.

e. "Help" communication device to include communication between elevator cab and elevator machine room or control room.

[f. Key-operated "HOSPITAL EMERGENCY COMMANDEERING SERVICE" switch.

]2.6.2.2 Service Controls

In addition to ASME A17.1/CSA B44 requirements, provide the following operating controls, identified as indicated:

a. Provide a key-operated, three-position switch for "In car Inspection Operation" and "Hoistway Access". The center switch position will provide normal, automatic operation.

b. "Car Light" switch.

c. "Car Fan" switch with two speed settings identified.

d. 120-volt ac 60 Hz single-phase duplex electrical outlet of ground-fault-circuit-interrupt (GFCI) design.

2.6.2.3 Certificate Window

Provide a minimum 102 mm wide by 152 mm high 4 inch wide by 6 inch high certificate window for elevator inspection certificate. Locate window in the Service Controls door of the Car Operating Panel.

2.6.2.4 Emergency Signaling Devices

Provide an audible signaling device, operable from the Car Operating Panel button marked "ALARM". The audible signaling device must have a sound pressure rating between 80 and 90 dBA at 3 meters 10 ft. Provide battery backup power capable of operating the audible signaling device for at least one hour.

2.6.3 Elevator In-Car Position Indicators

For all elevators, provide illuminating position indicator in the Car Operating Panel.

2.6.4 Elevator In-Car Direction Indicators

For 2-stop elevator installations, provide visual direction indicators and audible car arrival signal in the elevator car door jamb, in accordance with ABA Standards. Visual indicators must be visible from the hall call fixture.

2.6.5 Hall Call Landing Fixtures

Provide a hall call fixture adjacent to each elevator. Provide a single push-button for terminal landings and dual push-buttons, up and down, at intermediate landings.

2.6.5.1 Designated Landing Hall Call Fixture

2.6.5.1.1 Location of COMMUNICATION MEANS FAILURE (CMF) Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator CMF audible and illuminating signal, and reset switch, in the FEO Designated Landing hall call fixture. Mount the signal and reset switch at a minimum of 178 mm 7 inches above the "UP" hall call button.

2.6.5.1.2 COMMUNICATION MEANS FAILURE (CMF) Visual and Audible Signal Operation

Provide a CMF visual and audible signal system that conforms to ASME A17.1/CSA B44. Provide continuous verification of operability of the telephone line and immediate activation of audible and visual signals when verification means determines that the telephone line is not functioning. Provide illumination of visual signal at one second intervals. Provide a minimum of 65 dBA audible signal at 30 second intervals.

2.6.5.1.3 Firefighters' Emergency Operation Phase I Switch and Visual Signal

When required by ASME A17.1/CSA B44, provide an elevator Firefighters' Emergency Operation Phase I switch and illuminating visual signal in the FEO Designated Landing hall call fixture. Provide FEO Phase I visual signal that is designed with intermittent, flashing, illumination when actuated by the machine room, control room, or hoistway fire alarm initiating device. Locate FEO Phase I key switch above the CMF visual signal with a minimum of 152 mm 6 inches vertical between the centerlines of the CMF signal and the FEO Phase I key switch. Locate FEO Phase I visual signal directly above the Phase I switch. In addition, locate Elevator Corridor Call Station Pictograph at top of hall call fixture.

2.6.6 Elevator Car Position and Direction Indicators and Car Arrival Signal

For elevator installations with three or more stops, provide a separate hall landing fixture that includes the visual elevator position indicator, visual direction indicators, and audible car arrival signal, in accordance with ABA Standards.

2.6.7 Designated Landing Elevator Identification Fixture

For duplex and group elevator installations, provide a separate elevator identification fixture for each elevator, with identification engraved and backfilled with a contrasting color. Number elevators from left to right, as seen during primary approach from building main entrance to elevator lobby. For multiple elevator groups, begin numbering with group that is closest to the building main entrance.

2.6.8 Emergency or Standby Power

When emergency or standby power is provided for elevator operation, provide an elevator emergency power visual indicator that conforms to ASME A17.1/CSA B44. Locate the visual signal in the Firefighters Emergency Operation fixture for each simplex elevator and for each elevator group. When an emergency power selector switch is required, provide switch in a separate, flush mounted fixture located at the designated level, in view of all elevator entrances.

2.7 CAR DOOR EQUIPMENT

2.7.1 Car Door Operator

Provide elevator door operator equipment and circuitry that is designed and installed as discreet communication. Serial communication must not be used for this system.

2.7.2 Infra-red Curtain Unit

Provide Infra-red Curtain Unit (ICU) with multiple infra-red beams that protect to the full height and width of the door opening. Provide door nudging operation.

2.8 PASSENGER ELEVATOR GUIDES, PLATFORM, AND ENCLOSURE

2.8.1 Roller Guides

Provide coil-spring loaded roller guide assemblies in adjustable mountings on each side of car and counterweight frames in accurate alignment at top and bottom of frames.

2.8.2 Car Enclosure Wall Panels, Return Panels, Doors, Entrance Columns, and Transom

Provide 14 Gauge minimum [prefinished steel][stainless steel] cab wall panels and entrance components. Use same material and finish for all hoistway and car entrance assemblies. Apply sound-deadening material on exterior of all cab wall panels.

2.8.3 Car Enclosure Top

Provide reinforced, 12 gauge minimum steel car enclosure top. Provide hinged emergency exit with lock that complies with the seismic risk zone 2 or greater design requirements of ASME A17.1/CSA B44. Locate emergency exit hinge towards the rear of the elevator cab. Design and configure the elevator cab interior ceiling to provide convenient and unobstructed access to, and use of, emergency exit from inside the elevator cab.

2.8.4 Car Door

Provide 16 gauge minimum [prefinished steel][stainless steel] car doors of sandwich construction with flush surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading and one at trailing door edge with guides in the sill groove their entire length of travel.

2.8.5 Car Entrance Sill

Provide one piece cast nickel silver, stainless steel, or white bronze entrance sill(s). Set sills level and flush with floor finish. Use same material for hoistway and car entrance sills.

2.8.6 Cab Finish Floor

Provide cab finish floor with top of finish floor flush with the cab sill.

2.8.7 Car Fan

Provide 2-speed fan for car enclosure forced ventilation. Fan must be mounted in the car enclosure top.

2.8.8 Car Lighting

Utilize LED lighting for elevator car interior illumination. Provide a minimum of 10 foot-candles, measured at all areas of the car enclosure floor. Provide automatic car lighting operation that will turn off car lights after 3 minutes of inactivity. Car lights must automatically turn on upon actuation of an elevator car or hall call.

2.8.9 Car Protection Pads and Hooks

Provide fire retardant, hanging car protection pads that provide protection for all car interior wall panels. Provide permanently installed studs in car that are designed for hanging the car protection pads in the car.

2.9 PASSENGER ELEVATOR HOISTWAY DOORS AND ENTRANCES

Provide hoistway entrance assemblies with a minimum 1-1/2 hour fire rating. Use same material and finish for all hoistway and car entrance assemblies.

2.9.1 Hoistway Entrance Frames

Provide 14 gage minimum [prefinished carbon sheet steel][stainless steel] hoistway entrance frames. Solidly grout uprights of entrance ways to height of 5 feet.

2.9.2 Hoistway Entrance Sills

Provide one-piece cast nickel silver, stainless steel, or white bronze entrance sills. Set top of landing sill flush with top of finish floor. Solidly grout under full length of sill. Use same material for all hoistway and car entrance sills.

2.9.3 Hoistway Entrance Doors

Provide [hollow metal][stainless steel] non-vision construction hoistway entrance doors with flush surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading edge and one at trailing edge with guides in the sill groove the entire length of door travel. Use same material and finish for all hoistway and car entrance assemblies.

2.9.4 Hoistway Entrance Door Track Dust Covers

Provide sheet metal hoistway door track dust covers at each landing. Dust covers must cover top and hoistway side of door locks and door roller tracks, and extend the full width of the door track and associated hardware. Dust cover sections will not exceed 3 feet in length.

2.10 HOISTWAY EQUIPMENT

2.10.1 Car Guide Rails and Fastenings

Provide T-section type guide rails for car. Paint rail shanks with one coat of black enamel.

2.10.2 Pit Equipment and Support Channels

****

NOTE: Delete bracketed phrase for holeless applications.

****

Provide rail-to-rail pit channels to serve as mounting surface for main guide rails [, hydraulic cylinder]and car buffers. Method of installation of channels, brackets and buffer mounts must be such that pit waterproofing is not punctured.

2.10.3 Pit "STOP" Switch

Provide push-to-stop/pull-to-run type pit "STOP" switch.

2.10.4 Traveling Cables

Suspend traveling cables by means of self-tightening webbed devices or internal suspension members.

2.10.5 Hoistway Pit Ladder

Provide continuous horizontal rungs for the full height of the pit ladder.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with DOD design criteria, contract specifications, manufacturer's instructions, NEII-1 Building Transportation Standards and Guidelines, and all applicable building and safety code requirements.

3.1.1 Structural Members and Finish Materials

Do not cut or alter structural members. Do not alter finish materials from manufacturer's original design. Restore any damaged or defaced work to original condition.

3.1.2 Miscellaneous Requirements

Provide recesses, cutouts, slots, holes, patching, grouting, and refinishing to accommodate elevator installation. Use core drilling to drill all new holes in concrete. Finish work to be straight, level, and plumb. During installation, protect machinery and equipment from dirt, water, or mechanical damage. At completion, clean all work and spot paint.

3.2 FIELD QUALITY CONTROL

The Contractor will provide and utilize a third-party licensed and certified Qualified Elevator Inspector (QEI) to conduct elevator pre-acceptance inspection and testing. The QEI must perform inspections and witness tests to ensure that the installation conforms to all applicable safety codes and contract requirements. The QEI will be directly employed by the Contractor and independent of the elevator contractor.

Upon completion, the QEI must provide written test data for all ASME A17.1/CSA B44 Acceptance Tests and written certification that the elevator is complete and ready for final Acceptance Inspection, Testing, and Commissioning.

3.3 ACCEPTANCE INSPECTION, TESTING AND COMMISSIONING

When elevator system installation is complete and ready for final inspection, notify Contracting Officer that elevator system is ready for Acceptance Inspection, Testing, and Commissioning. Provide QEI certification specified in Article FIELD QUALITY CONTROL.

****
NOTE: Use the first bracketed paragraph for all Navy Facilities and for all projects managed by NAVFAC FEAD. Use the second bracketed paragraph for Air Force and Army projects that are not managed by NAVFAC FEAD.
****

[Contracting Officer will obtain services of Naval Facilities Engineering Systems Command (NAVFAC) QEI Certified Elevator Inspector. NAVFAC QEI will utilize the applicable NAVFAC Elevator Acceptance Inspection Form to record the results of inspection and testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the NAVFAC QEI will sign a copy of the completed forms and provide the signed copy to the Contracting Officer or representative. Within 2 weeks of the inspection, the QEI will also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, NAVFAC Certified Elevator Inspector will complete, sign and post form NAVFACENGCOM 9-11014/23(Rev.9-2009), Elevator Inspection Certificate.

][Contracting Officer will obtain the services of a third-party QEI Certified Elevator Inspector. The QEI must utilize an Elevator Acceptance Inspection Form to record the results of inspection and all testing and to identify safety code and contract deficiencies. Specific values must be provided for all tests required by ASME A17.1/CSA B44, ASME A17.2, and contract documents. Upon completion of inspection and testing, the QEI must sign a copy of the completed forms and provide to the Contracting Officer. Within 2 weeks of the inspection, the QEI must also prepare a formal inspection report, including all test results and deficiencies. Upon successful completion of inspection and testing, the QEI will complete, sign, and provide a certificate of compliance with ASME A17.1/CSA B44.

]3.3.1 Acceptance Inspection Support

Prime and Elevator Contractors must provide inspection support and perform all required tests, in order to demonstrate proper operation of each elevator system and to prove that each system complies with contract requirements and all applicable building and safety codes. Inspection procedures in ASME A17.2 form a part of this inspection and acceptance testing. All inspection and testing must be conducted in the presence of the Qualified Elevator Inspector (QEI).

If the elevator does not comply with all contract and safety code requirements on the initial Acceptance Inspection and Test, the Contractor is responsible for all costs involved with re-inspection and re-testing required as a result of contractor delays and discrepancies discovered during inspection and testing.

3.3.2 Testing Materials and Instruments

Furnish all testing materials and instruments necessary for Acceptance Inspection, Testing and Commissioning. At a minimum, include calibrated test weights, tachometer, accelerometer, hydraulic pressure gauge, 600-volt mega ohm meter, volt meter and ammeter, infrared temperature gauge, door pressure gage, dynamometer, and 6 meter 20 foot tape measure.

3.3.3 Field Tests

3.3.3.1 Endurance Tests

Test each elevator for a period of one hour continuous, automatic operation, with specified rated load in the elevator cab. During the one hour test, stop car at each floor, in both directions of travel, and allow automatic door open and close operation. The requirements for Automatic Operation, Rated Speed, Leveling, Temperature Rise and Motor Amperes must be met throughout the duration of the Endurance Test. Restart the one hour test period from the beginning, following any shutdown or failure.

3.3.3.2 Speed Tests

Determine actual speed of each elevator, in both directions of travel, with rated load and with no load in elevator car. Make Speed tests at the beginning and at the end of the Endurance test. Determine speed by tachometer reading or accelerometer, excluding accelerating and slow-down zones. Under all conditions, minimum acceptable elevator speed is the Rated speed specified. Maximum acceptable elevator speed is 110 percent of Rated speed.

3.3.3.3 Leveling Tests

Test elevator car leveling operation and provide a leveling accuracy equal to or less than 3 mm 1/8 inch at each floor with no load in car, and with rated load in car, in both directions of travel. Determine leveling accuracy at the beginning and at the end of the endurance tests.

3.3.3.4 Temperature Rise Tests

Determine temperature rise of elevator pump motor and hydraulic fluid during one-hour full-load test run. Under these conditions, maximum temperature rise must not exceed acceptable temperature rise indicated on manufacturer's data plate. Start test only when equipment is within 5 degrees C of ambient temperature.

3.3.3.5 Motor Ampere Tests

At beginning and end of Endurance test, measure and record motor amperage in both directions of travel and in both no-load and rated load conditions.

3.3.3.6 Elevator Performance and Ride Quality Testing

Evaluate elevator performance to ensure compliance with specification requirements related to the NEII-1 Performance Standards Matrix for New Elevator Installations.

3.3.3.7 Hydraulic Safety Valve (Automatic Shutoff Valve) Tests

In order to ensure consistent performance, regardless of hydraulic oil temperature, test the Hydraulic Safety Valve twice. Test once before the one-hour endurance test and once immediately after the one-hour test. For elevator certification, safety valve must perform to code in both tests.

3.3.3.8 Hydraulic Pressure Tests

Check the hydraulic static pressure and rated-speed operating pressure at the hydraulic control valve, under both no load and rated load conditions.

3.3.3.9 Pressure Test of Liner/Cylinder Assembly

Perform 138 kPag 20 psig pressure test of the completed and installed liner/cylinder assembly. Test liner/cylinder assembly as a sealed unit. Provide safety relief valve set to relieve at 138 kPag; 114 mm 20 psig; 4.5 inch diameter dial pressure gage scaled for 0 to 175 kPag 0 to 50 psig and calibrated to 0.5 percent accuracy; and an air pressure admission throttle and shutoff valve. For safety, pressure test must only be performed when liner and cylinder are fully inserted and assembled in the well casing. Perform the test from remote location outside of the elevator pit. Perform test in the presence of, and witnessed by, a Certified Elevator Inspector.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-14 92 00 (February 2009)**
Change 1 - 02/15

Preparing Activity: USACE **Superseding**
UFGS-14 92 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 14 - CONVEYING EQUIPMENT

SECTION 14 92 00

PNEUMATIC-TUBE SYSTEM

02/09, CHG 1: 02/15

PART 1 GENERAL

PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-14 92 00 (February 2009)**
Change 1 - 02/15

Preparing Activity: USACE **Superseding**
UFGS-14 92 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 14 92 00

PNEUMATIC-TUBE SYSTEM
02/09, CHG 1: 02/15

****

NOTE: This guide specification covers the requirements for computer controlled pneumatic tube system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

PL 109-58	Energy Policy Act of 2005 (EPAct05)

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Provide a pneumatic-tube system which is computer controlled and designed with not less than [_____] separate zones interconnected to permit automatic unattended transmission of carriers from any station to any other station. Design and locate system components in such a manner that in the event of a defect occurring, components may readily be removed and replaced. Provide full access type carriers[, capable of handling 1000 ml I.V. bottles or 1000 ml I.V. bags]. Other system characteristics are as follows:

a. Future capacity of not less than [_____] stations without the need for modifications to the central control and existing station control.

b. Each zone capable of serving not less than [_____] stations even though a fewer number may be indicated in a given zone at this time.

c. [Stations within a zone connected to the storage lanes via a single line and diverter unit.] Control spacing, direction, [storage,] and path of the carriers.

d. Destination selection by means of push buttons or rotary dials on the station control panel.

e. Carriers taking the shortest route to their destinations. A central exchanger is not required. [Perform carrier processing between zones through the central storage lanes.]

f. Carriers routed by means of diverters or in-line transfer units.

g. Carrier rejections indicated at the dispatching station for non-existing, signed-off, or malfunctioning station destinations. Do not use reject station.

h. Failure of one station must not interfere with the normal functioning of any other station. Failure of any diverter will shut down that section of the system. Failure of an in-line sensor except zero-level sensor must not shut down that section of the system.

i. Automatic sequencing of sending and receiving carriers.

j. Each zone [and the central storage lanes] act independently with separate power units as required.

k. Automatic recovery of a carrier will be required only after a transaction has been initiated and a failure occurs that prevents the completion. In such a case the carrier in process will be either returned to its source station or processed to the destination station after the failure has been repaired and cleared.

l. Selection of the shortest, most direct routing of all carriers to their destinations.

m. Complete "route proofing" of transaction paths before acceptance of the carrier to assure all components in the routing are operating.

n. Intra-zone transactions must take the most direct path within the zone.

o. Self-adjusting priority within the system to load balance according to traffic.

p. Carriers may be positioned in senders simultaneously and destination selected on the station control panel.

q. Deliver carriers in transit at the time a power failure occurs to their selected destinations upon restoration of power.

r. Direct processing of simultaneous, multiple transactions to assure maximum operational efficiency of the system.

s. Deliver carriers in transit at the time of station sign-off to their destination.

t. Reject carriers addressed to any non-existing or signed off station.

u. Automatic time clock sign off to allow any station to be automatically signed-off.

v. Preventive overload feature at station receiver. Carriers will not be dispatched to a station that is overloaded.

w. Automatic redistribution of empty carriers to return empty carriers to the locations with the greatest need.

x. Automatic purge by zone or system.

y. Each completed transaction, alarm condition that occurs and sign off schedule automatically printed out on printer.

1.2.2 Electrical Work

Provide electrical motor-driven equipment specified herein complete with motors, motor starters and controls complying with NEMA MG 1. Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics are as indicated. Provide extension to equipment from junction box and all control wiring as specified in this section and complying with NFPA 70. Provide motor starters under this section complete with properly sized thermal-overload protection in each phase and other appurtenances necessary for the motor control specified. Size each motor to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage. Provide control and protective or signal devices required for the operation specified and wiring required for controls and devices but not shown on the electrical plans.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pneumatic-Tube System

SD-03 Product Data

Pneumatic-Tube System

Materials and Equipment

Spare Parts

Pneumatic-Tube System

Tests

SD-06 Test Reports

Tests

SD-07 Certificates

Energy Efficiency

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.5 EXTRA MATTERIALS

Submit spare parts data for each different item of materials and equipment specified, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide Materials and Equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Submit a complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

2.2 ENERGY EFFICIENCY

****

NOTE: Selected equipment must conform to efficiency requirements as defined in Public Law (PL) 109-58 - "Energy Policy Act of 2005 (EPAct05)" for energy efficiency procurement and as specified by FEMP and ENERGY STAR. Equipment selected will have as a minimum the efficiency rating determined in under "Energy-Efficient Products" at http://www1.eere.energy.gov/femp/procurement
Equipment having a lower efficiency may be specified if the designer determines the equipment to be more life-cycle cost effective.
Indicate the equipment operating characteristics, including rated energy efficiency, on the drawings.

****

Provide products that meet or exceed the specified energy efficiency requirements of FEMP designated or Energy Star qualified products. Submit documentation certifying that product conforms to PL 109-58 by meeting or exceeding Energy Star or FEMP efficiency requirements as defined at "Energy-Efficient Products" at http://www.energystar.gov.. Indicate Energy Efficiency Rating. Indicate Energy Efficiency Rating.

2.3 CARRIER TUBING

2.3.1 Tubing

Provide tubing for carrier transmission lines consisting of [152.4] [101.6] [1.613] mm OD [[6] [4] in] [16 U.S. gauge] OD galvanized electric welded steel with flash removed, conforming to ASTM A123/A123M. Size air lines as required for proper system operation.

2.3.2 Bends

Provide bends of the same material as straight tubing, formed on the centerline to a radius of not less than 1200 mm 4 feet, free from wrinkles or distortion. Make joints between sections with sleeve couplings, bolted couplings or bell end tubing. When bends are cut for offsets and small angle turns, squarely cut the ends. File and straighten by mandreling. Do not use expanded bends.

2.3.3 Fittings

Provide fittings that are cast iron, cast aluminum or fabricated steel with the inside fitting snugly on the tubing. Provide box connectors, close elbows, tees, coupling sleeves and other fittings required for proper installation of the system.

2.4 POWER UNITS

Provide power units for each zone and for lanes when required that are capable of operating all lines simultaneously and producing an average carrier speed of 7.6 m/s 25 fps. Design power units for floor or ceiling mounting. Provide a timer or similar device to shut the unit off after a predetermined time without carrier movement. Provide power units complete with vibration isolators, intake and exhaust mufflers, intake and exhaust piping, screen box, air valves if required, and designed for easy access.

2.5 AUTOMATIC CENTRAL-CONTROL CENTER

2.5.1 Operation of the System

Provide a solid state memory computer to control the system. The computer must perform logic, control, supervisory and alarm functions and provide permanent storage for system operating program. Provide program memory protection during power loss. Provide interface controls to transmit operating data to and from stations. Keyboard must request information and must simulate operation of components throughout entire system. Print transactions and failures.

2.5.2 Control Program

The control program is the property of the user. Allow the user to add, delete, and/or relocate components of the system, onsite, without the need for a new program or programming assistance.

2.5.3 Computer Circuits and Keyboard

Provide modular interface circuits, monitor and keyboard consisting of solid state components throughout. For ease of maintenance, provide readily removable circuit modules.

2.5.3.1 Cathode Ray Tube

Video Display Monitor to display in English language data for the following functions:

a. Failure Location - Zone, [central storage lane,] station, power unit or transfer unit.

b. Failure Type - Mechanical, electrical or component position.

c. Present transactions - Station carrier is leaving from and station carrier is going to, backlog per station or zone [and carrier in storage lanes].

d. Carrier Distribution - Number of carriers assigned to each station, number of carriers presently at each station.

e. Station sign-off schedule.

f. Failure Action - Locate where carrier is and corrective action to be taken.

g. System History Display - Show all system traffic for the past 24-hour period with totals for stations, zones, and the entire system. This display must be automatically printed.

2.5.3.2 Keyboard

The keyboard must be interactive with the video monitor to perform the following functions:

a. Request video monitor displays listed above.

b. Simulate components for trouble shooting. Make simulation of all components to determine the malfunctioning unit.

2.5.3.3 Printer

****

NOTE: Selected printers are required to meet performance requirements specified by Energy Star. Information on the requirements can be found at http://www.energystar.gov/ia/partners/product_specs/program_reqs/Imaging_Equip As of September 6, 2012, the specific performance requirements were as follows:

Printer	**Standard**	**High Performance IJ, DT, DS, EP, SI, TT**	**TEC**
		IJ, Impact	**OM**
	Large or Small	**DT, DS, EP, Impact, IJ, SI, TT**	**OM**

These are referenced in Energy Star Program Requirements for Residential Air Source Heat Pump (ASHPs) and Central Air Conditioner Equipment, Volume 4.1. These specifications conform to the efficiency requirements as defined in Public Law (PL) 109-58 - "Energy Policy Act of 2005 (EPAct05)" for energy efficiency procurement and as specified by ENERGY STAR. Equipment selected will have as a minimum the efficiency rating determined in under "Energy-Efficient Products" at http://www1.eere.energy.gov/femp/procurement**.**

Equipment having a lower efficiency may be specified if the designer determines the equipment to be more life-cycle cost effective. Indicate the equipment operating characteristics, including rated energy efficiency, on the drawings. A list of compliant products can be found at http://downloads.energystar.gov/bi/qplist/image_equip_prod_list.xls?be70-acfd

****

Provide [Energy Star compliant]laser jet printer with at least 128 MB of random access memory, 1200 dots per inch resolution, and support normal and postscript fonts and drivers. Type face supported must be True Type fonts. Printer must support HP PCL 6, HP PCL 5e and Post Script emulation. Equip printer with 10/100 Base Ethernet card, a serial and parallel port. Provide all Ethernet connectivity cables, power cables and printer drivers with the printer. Equip printer with at least two paper drawers. Each drawer must have a capacity of at least 600 sheets of standard paper.

2.5.3.4 Alarm Module

Provide an alarm module for remote audio-visual signaling of system alarms. The alarm module must have a "Press to Silence" button. The alarm must automatically activate should a system alarm condition occur.

2.6 STORAGE AREAS

****

NOTE: Storage areas will be deleted if a single zone system is specified.

****

Design Storage Areas to initially serve [_____] zones. Storage must be expandable to a maximum of [_____] storage lanes without the need to replace the initial unit. Storage area must consist of storage lanes connected directly to every other zone in the system.

2.7 AUTOMATIC SWITCHING EQUIPMENT

Automatically orient diverters to route carriers to or from intermediate stations. Provide air or electro-mechanically operated units designed to accommodate two or more stations or sublevels and enclosed in sheet metal housing with access panels. Design diverter so that when a carrier does not clear the diverter completely, no other carrier can be routed to that diverter.

2.8 SUBSTATION EQUIPMENT

Enclose substation equipment in a self-supporting "rough-in" recessed type enclosure. Install the operating components after the adjacent walls have been finished. Factory paint exposed sheet metal surfaces. Provide stainless steel, brushed aluminum or chrome plated bright metal parts.

2.8.1 Receiving Units

Provide down receive, air cushion, soft delivery type units. Design carrier receiver tray to receive and store carriers to the front of the received tray. Full carrier capacity must cause audible alarm to sound or the reject light to illuminate.

2.8.2 Sending Units

Units must be up-send in conjunction with the receiving unit.

2.8.3 Carrier Storage Receptacle

Storage receptacle must store not less than four carriers and must be integral with the terminal front.

2.8.4 Station Control Panel

2.8.4.1 Operating Controls and Indicators

Include the following operating controls and indicators:

a. Carrier destination selectors, "Carrier Accepted" signal, "Send" buttons.

b. "Carrier Rejected" signal when a carrier cannot be dispatched because of destination sign off, an alarm condition, a nonexisting selection or an overloaded station.

c. "Carrier in Receiver" to indicate a carrier is in the receiving unit when the carrier is not visible.

d. "Cancellation Button."

2.8.4.2 Non-operating Requirements

Include the following:

a. "Operating Instructions" display.

b. Independent carrier dispatch and receive functions.

c. The memory within the programmable microprocessor available to all stations.

d. Request to dispatch handled immediately on a local or central control basis.

2.8.5 Directory

Provide station consisting of a framed directory or photo plate clearly showing the location, name, and number of each station in the system. Provide a glass or plastic cover for the framed directory.

2.9 CARRIERS

Furnish four carriers for each station in the system. Carriers less than [82.6 x 381.0] [114.3 x 381.0] mm [3-1/4 x 15] [4-1/2 x 15] inch inside dimensions are not acceptable. Provide carriers that are capable of transporting 1000 ml I.V. bottles.

2.9.1 Access

Provide carriers that are side opening, full access type, bi-directional.

2.9.2 Carrier Inserts

Furnish foam lining for transporting fragile items for [_____] of the total system carriers [and furnish [_____] of the total system carriers with foam lining for transporting 1000 ml I.V. bottles].

2.10 SYSTEM TESTER

Provide system tester with the ability to test any station, transfer unit, or blower with onsite verification of malfunctions. A portable test device which supplements the control center may be used.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install the pneumatic-tube system as indicated and as recommended by the manufacturer. Submit diagrams, instructions, and other sheets proposed for posting.

a. Submit detail drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation.

b. Submit [six] [_____] copies of design manual consisting of manufacturer's standard literature. Identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. Include a description of hardware and software functions, interfaces, and requirements for all system operating modes. Describe all equipment provided, including general description and specifications.

3.2.1 Sound Insulation

Deaden the sound of tubing and bends run over patient rooms or offices by applying a 38.1 mm 1-1/2 inch thick layer of 24 kg/cubic meter 1-1/2 pcf density fiberglass insulation with a dust cover and taped joints over the tubing. Do not extend sound insulation material no less than 1.5 meters 5 feet outside the patient rooms or offices. Provide insulation conforming to EPA requirements in conformance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

3.2.2 Hangers and Supports

Space hangers and supports on 3 meters 10 foot centers for horizontal runs of tubing. Support vertical runs at every floor. Support each horizontal bend and in-line component. Hangers for one or two lines of tubing must be 10 mm 3/8 inch plated and threaded rods attached to row clamps. Form hangers for three or more lines with row clamps or 38.1 mm 1-1/2 inch channels laid flat against the bottom of the tubing and support by no less than two rods spaced no more than 900 mm 3 feet apart. Row clamps must maintain centerlines of horizontal runs of multiple tubes straight and level and spaced apart in a consistent configuration.

3.2.3 Installation of Tubing

Make joints airtight by methods recommended by the manufacturer. Install lines where indicated and securely hold in place and brace against any motion caused by the passage of carriers. Install tubing passing through openings in floors suitable sleeves or slots, stuff with 25 mm 1 inch fiberglass blanket and seal on both ends with a continuous bead of nonhardening mastic at least 6.4 mm 1/4 inch deep.

3.2.4 Firewall Penetrations

Where holes are required in fire and smoke walls for the passage of tubing and other accessories, fill the annular space between pipe and hole with a UL approved fireproof material. Seal penetrations through fire rated walls as specified in Section 07 84 00 FIRESTOPPING.

3.3 PAINTING AND FINISHING

Furnish field-applied paint as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 ACCESS PANELS

Provide access panels as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.5 ACOUSTIC COUPLER

****

NOTE: Delete acoustic coupler if manufacturer has a service organization conveniently located to the site.

****

Provide an acoustic coupler that will permit the facility to have direct communications with the manufacturer for one year. Provide a communication tie-in to a cathode ray tube (CRT) at the manufacturer's facility through the handset of an ordinary telephone and the acoustic coupler at the facility. The coupler will be used to examine or modify computer memory and may command any system component and determine its status.

3.6 FRAMED INSTRUCTIONS

Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system where directed. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, frame as specified above and post beside the diagrams. Post the framed instructions before acceptance testing of the systems.

3.7 MANUFACTURER'S FIELD SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Supervise the installation, adjustment, and testing of the equipment.

3.8 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [_____] hours of normal working time and start after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the Operating and Maintenance Instructions. Submit [six] [_____] complete copies of operation manual outlining the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Submit [six] [_____] complete copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. Include piping layout, equipment layout, simplified wiring and control diagrams of the system as installed. Operation and maintenance manuals must be approved prior to the training course.

3.9 TESTS

****
NOTE: If a single zone system is specified, delete subparagraphs "c," "e," and "f" below.
****

Submit test plan and procedures, not later than [_____] days prior to the start of testing. Explain in detail, step-by-step, actions and expected results to demonstrate compliance with the requirements of this specification, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system. Conduct tests in accordance with the approved test procedures to determine that the system is functional, operational and installed in accordance with the specifications. Notify the Contracting Officer in writing [_____] days prior to conducting tests. Conduct the following test:

a. Computer simulation and interrogation.

b. Consecutive dispatching to random stations within the zone.

c. Consecutive dispatching to random stations outside the zone.

d. Multi-station dispatching within the zone where all dispatchers are loaded with carriers, random stations selected and dispatching begins.

e. Multi-station dispatching outside the zone where all dispatchers are loaded with carriers, random stations selected and dispatching begins.

f. Two stations in each zone will be randomly selected to dispatch carriers into other zones.

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion of installation and testing of the installed system. Indicate the final position of controls.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-21 13 13 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-21 13 13.00 10(May 2009)
UFGS-21 13 13.00 20 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION TABLE OF CONTENTS

DIVISION 21 - FIRE SUPPRESSION

SECTION 21 13 13

WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION

08/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-21 13 13 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-21 13 13.00 10(May 2009)
UFGS-21 13 13.00 20 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 21 13 13

WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION
08/20

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NOTE: This guide specification covers the requirements for wet pipe fire protection sprinkler systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information. The designer is permitted to edit all of this section for the project. If the designer is modifying/deleting non-bracketed items and text, the Designated Fire Protection Engineer (DFPE) should be consulted prior to incorporating final changes.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
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NOTE: For OCONUS projects, this specification section should be edited for specific Host Nation requirements. Coordinate compliance with Host Nation requirements with the DFPE.
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NOTE: This specification section includes requirements from UFC 3-600-01 (change 4, 7 February 2020)
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PART 1   GENERAL

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NOTE:

The Designer must edit this specification section for either a performance-designed system or a fully designed system as applicable.

This section is primarily intended for performance designed systems, e.g. systems where the size, layout, and support of branch lines and cross mains, and the layout of sprinklers will be designed by the Contractor.

This section is not intended to be used for NFPA 13D systems.

The Designer must provide the following information in the contract documents for performance designed systems. This information must be in accordance with UFC 3-600-01.

(1) Show the layout and size of all piping and equipment from the point of connection to the water supply, to the sprinkler riser. The contract drawings must include a detailed sprinkler riser diagram.

(2) Show location and size of service laterals, sprinkler risers, control valves, drain lines, sectional valves, and inspector's test valves and switches on the drawings.

(3) Specify waterflow data including hydrant flow test results, including the location where the hydrant flow test was conducted, the location and size of existing mains and new water supply lines that will serve the sprinkler system.

(4) Highlight or clearly indicate the area(s) to be protected by sprinklers on the drawings.

(5) Specify waterflow requirements including the design density, design area, the hose stream demand (including location of the hose stream demand), the duration of supply, and sprinkler spacing and area of coverage in this section.

(6) Show the location of the backflow preventer (including provisions for a drain and access for maintenance) on the drawings.

(7) Show all provisions necessary for forward flow testing of the backflow preventer at system demand as required by NFPA 13 on the drawings.

(8) Highlight all concealed spaces on the drawings

that require sprinkler protection, such as spaces above suspended ceilings that are built of combustible material or that can contain combustible materials, such as storage, and communication cabling that is not fire-rated.

(9) Provide details on the drawings of pipe restraints for underground piping. This includes details of pipe clamps, tie rods, mechanical retainer glands, and thrust blocks.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1015	(2021) Performance Requirements for Double Check Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M14	(2024) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube

ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM F442/F442M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)

FM GLOBAL (FM)

FM 1637	(2010) Flexible Sprinkler Hose with Threaded End Fittings
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INTELLIGENCE COMMUNITY STANDARD (ICS)

ICS 705-1	(2010) Physical and Technical Security Standard for Sensitive Compartmented Information Facilities

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2024) Standard for the Installation of Sprinkler Systems
NFPA 13R	(2025) Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies
NFPA 15	(2022) Standard for Water Spray Fixed Systems for Fire Protection
NFPA 24	(2025) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 101	(2024) Life Safety Code
NFPA 291	(2025) Recommended Practice for Fire Flow Testing and Marking of Hydrants
NFPA 1963	(2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire

	Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UL SOLUTIONS (UL)

UL 193	(2016) UL Standard for Safety Alarm Valves for Fire-Protection Service
UL 199	(2020) UL Standard for Safety Automatic Sprinklers for Fire-Protection Service
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service
UL 312	(2022) UL Standard for Safety Check Valves for Fire-Protection Service
UL 405	(2013; Bul. 2020) UL Standard for Safety Fire Department Connection Devices
UL 668	(2004; Reprint Oct 2021) UL Standard for Safety Hose Valves for Fire-Protection Service
UL 789	(2004; Reprint May 2024) UL Standard for Safety Indicator Posts for Fire-Protection Service
UL 1626	(2008; Bul. 2018) UL Standard for Safety Residential Sprinklers for Fire-Protection Service
UL 1767	(3013; Bul. 2015) UL Standard for Safety Early-Suppression Fast-Response Sprinklers
UL 2443	(2015; Reprint May 2020) UL Standard for Safety Flexible Sprinkler Hose with Fitings for Fire Protection Service
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SYSTEM DESCRIPTION

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NOTE: Residential Occupancies: NFPA 13R is applicable for residential occupancies up to and including four stories in height. This standard should be referenced and followed only for such occupancies. NFPA 13R differs from NFPA 13 relative to type of sprinkler, design criteria, sprinkler coverage, and other requirements; therefore, care must be taken when using this specification for residential occupancies to assure that the final project specification clearly indicates design requirements.

NOTE: Residential Occupancies: Allowable area and

height (not story) increases noted in UFC 3-600-01 Chapter 5 are not permitted when using a sprinkler system designed in accordance with NFPA 13R or NFPA 13D.

NOTE: Seismic protection/bracing is to be provided for seismic design categories C or greater only, unless specifically requested by the DFPE. Consideration should also be giving to utilizing seismic protection/bracing to limit pipe movement.
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Provide wet pipe [sprinkler][water spray] system(s) in [all areas of the building][areas indicated on the drawings] [_____]. Except as modified herein, the system must meet the requirements of NFPA 13[NFPA 13R][and][NFPA 15]. Pipe sizes which are not indicated on the Contract drawings must be determined by hydraulic calculations.

1.2.1 Hydraulic Design

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NOTE: Applications requiring multiple densities/design areas must be referred to and shown on the drawings.

For sprinkler systems in residential occupancies, which are designed to NFPA 13R standards, paragraphs which address hydraulic design and sprinkler spacing must be edited according to NFPA 13R requirements.

Discharge density for non-storage occupancies must be in accordance with UFC 3-600-01. Specific densities must be listed on the drawings or noted in the specification when drawings are not provided. Stating "comply with UFC 3-600-01 is not acceptable.

Hazard classification of miscellaneous storage must comply with NFPA 13. Discharge density for the hazard classification must comply with UFC 3-600-01.

The paragraph below must be listed on the drawings. If this information is not listed on the drawings, provide the information in paragraph 1.1.1.3 (with brackets completed).

Hydraulically design the system to discharge a minimum density [of [_____] L/min per square meter gpm/square foot over the hydraulically most demanding [280] [_____] square meters[_____] square feet of floor area][as indicated on the drawings]. The minimum pipe size for branch lines in gridded systems must be 32 mm1 1/4-inch. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13.
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NOTE: The addition, modification or relocation of no more than twenty sprinklers to an existing system

or modifications to existing sprinkler systems fed from domestic supplies are permitted to be designed using the pipe schedule method in NFPA 13 based on the layout of the existing system.

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1.2.1.1 Basis for Calculations

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NOTE: The design must include an adequate water supply to meet the sprinkler water demand. The designer must provide waterflow test results and hydraulic calculations to ensure that the system demand will be met.

Design Calculations: The designer must provide detailed hydraulic calculations that clearly demonstrate that the water supply will meet the demand of the sprinkler system and hose streams. Calculations must be submitted with the concept design submission.

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A waterflow test was performed on [DATE] at [LOCATION] and resulted in a static pressure of [_____ kPapsi] with a residual pressure of [_____ kPapsi] while flowing [_____ L/mingpm]. Perform a fire hydrant flow test prior to shop drawing submittal in accordance with NFPA 291. Results must include hydrant elevations relative to the building and hydrant number/identifiers for the tested hydrants, including which were flowed, which had a gauge. This information must be presented in a tabular form if multiple hydrants were flowed. The results must be included with the hydraulic calculations. Hydraulic calculations must be based on flow test noted in this paragraph, unless [verified by the NAVFAC[_____] Fire Protection Engineer and] approved by Contracting Officer. Hydraulic calculations must be based upon the Hazen-Williams formula with a "C" value noted in NFPA 13 for piping, [and [_____] for existing underground piping].[Hydraulic calculations must be based on operation of the fire pump(s) provided in Section 21 30 00 FIRE PUMPS.] [The minimum residual pressure in a service lateral (lead-in) at the [design flow rate][150 percent of the fire pump rated flow] must be 138 kPa20 psi at [the inlet to the backflow preventer][the suction side of the fire pump]].

1.2.1.2 Hydraulic Calculations

a. Water supply curves and system requirements must be plotted on semi-logarithmic graph (N^1.85) paper so as to present a summary of the complete hydraulic calculation.

b. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, minimum discharge pressures and minimum flows. Elevations of hydraulic reference points (nodes) must be indicated.

c. Documentation must identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe.

d. Where the sprinkler system is supplied by interconnected risers, the sprinkler system must be hydraulically calculated using the hydraulically most demanding single riser. The calculations must not assume the simultaneous use of more than one riser.

e. All calculations must include the backflow preventer manufacturer's stated friction loss at the design flow or [83 kPa12 psi for reduced pressure][55 kPa8 psi for double check] backflow preventer, whichever is greater.

f. All calculations must be performed back to the actual location of the flow test, taking into account the direction of flow in the service main at the test location.

g. For gridded systems, calculations must show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. A flow diagram indicating the quantity and direction of flows must be included.

1.2.1.3 Design Criteria

Hydraulically design the system to discharge a minimum density [of [_____] L/min per square metergpm/square foot over the hydraulically most demanding [_____] square meterssquare feet of floor area][as indicated on the drawings]. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13. Add an allowance for exterior hose streams of [_____] L/min gpm to the sprinkler system demand [at the fire hydrant shown on the drawings closest to the point where the water service enters the building] [at the point of connection to the existing water system].[An allowance for interior hose stations of [_____] L/min gpm must be added to the sprinkler system demand.]

1.2.2 Sprinkler Coverage

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NOTE: The exception in NFPA 13 to eliminate sprinklers in electrical rooms is not applicable per UFC 3-600-01.

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Sprinklers must be uniformly spaced on branch lines. Provide coverage throughout 100 percent of the [building][area noted on the Contract drawings]. This includes, but is not limited to, telephone rooms, electrical equipment rooms (regardless of the fire resistance rating of the enclosure), boiler rooms, switchgear rooms, transformer rooms, attached electrical vaults and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13. Provide sprinklers below all obstructions in accordance with NFPA 13. Exceptions are as follows:

a. Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.

b. Facilities that are designed in accordance with NFPA 13R.

1.2.3 Qualified Fire Protection Engineer (QFPE)

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NOTE: UFC 3-600-01 requires that shop drawings must bear the Review Stamp and professional engineering

stamp of the QFPE prior to submission to the Government for approval.

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NOTE: The term Qualified Fire Protection Engineer (QFPE) should be considered interchangeable with the terms "Fire Protection Designer of Record (FPDOR)" and/or "Fire Protection QC Specialist" where referred to in other applicable contract documents. The intent of defining the QFPE roles and responsibilities here is NOT to require personnel in addition to the QFPE, FPDOR, and/or FPQC specialist referenced elsewhere in the applicable contract documents.

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An individual who is a licensed professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Working (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Provide a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting all outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government [and final Government]functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

NOTE: When 20 or less sprinklers are added, modified or relocated, shop drawings, hydraulic calculations and product data are not required to be submitted. Edit this section accordingly.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Partial submittals and submittals not fully complying with NFPA 13 and this specification section must be returned disapproved without review. SD-02, SD-03 and SD-05 must be submitted simultaneously.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE must be returned disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G, [_____]

Sprinkler System Designer; G, [_____]

Sprinkler System Installer; G, [_____]

SD-02 Shop Drawings

Shop Drawing; G, [_____]

SD-03 Product Data

Pipe; G, [_____]

Fittings; G, [_____]

Valves, including gate, check, butterfly, and globe; G, [_____]

Alarm Valves; G, [_____]

Relief Valves; G, [_____]

Sprinklers ; G, [_____]

Pipe Hangers and Supports ; G, [_____]

Sprinkler Alarm Switch; G, [_____]

Valve Supervisory (Tamper) Switch; G, [_____]

Fire Department Connection; G, [_____]

Backflow Prevention Assembly; G, [_____]

Air Vent; G, [_____]

Hose Valve; G, [_____]

[Seismic Bracing; G, [_____]

] Nameplates; G, [_____]

SD-05 Design Data

[Seismic Bracing; G, [_____]

Load calculations for sizing of seismic bracing

] Hydraulic Calculations; G, [_____]

SD-06 Test Reports

Test Procedures; G, [_____]

SD-07 Certificates

Verification of Compliant Installation; G, [_____]

Request for Government Final Test; G, [_____]

SD-10 Operation and Maintenance Data

Operating and Maintenance (O&M) Instructions; G, [_____]

Spare Parts Data; G, [_____]

SD-11 Closeout Submittals

As-built drawings

1.4 QUALITY ASSURANCE

1.4.1 Preconstruction Submittals

Within 36 days of contract award but no less than [14 days][_____] prior to commencing work on site, the prime Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications will be returned Disapproved Without Review.

1.4.1.1 Shop Drawing

[_____] copies of the shop drawings, no later than 28 days prior to the start of system installation. Working drawings conforming to the requirements prescribed in NFPA 13 and must be no smaller than [ISO A1][ANSI D][the Contract Drawings]. Each set of drawings must include the following:

a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

b. Floor plans drawn to a scale not less than 1:100 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, and other details required to clearly describe the proposed arrangement.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross mains and branch lines to finished floor and roof or ceiling. A detail must show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross main pipe routing, elevation of each typical sprinkler above finished floor and elevation of "cloud" or false ceilings in relation to the building ceilings.

e. Plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance.

f. Riser layout drawings drawn to a scale of not less than 1:25 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

g. Details of each type of riser assembly, pipe hanger, [sway bracing for earthquake protection,]and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) must be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.

h. Details of each type of pipe hanger[, seismic bracing/restraint] and related components.

[i. Include fire pump curve with shop drawings and hydraulic calculations.

]1.4.1.2 Product Data

[_____] copies of annotated catalog data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, options, and other pertinent information, that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

1.4.1.3 Hydraulic Calculations

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NOTE: Include the first bracketed item for Army Corps projects.

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Calculations must be as outlined in NFPA 13 except that calculations must be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings.[Calculations must include isometric diagram indicating hydraulic nodes and pipe segments.][Include fire pump curve with submittal.]

1.4.1.4 Operating and Maintenance (O&M) Instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA as supplemented and modified by this specification section.

Provide [six][_____] manuals[and one pdf version on electronic media]. The manuals must include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment.[Each service organization submitted must be capable of providing [4][_____]-hour on-site response to a service call on an emergency basis.]

Submit spare parts data for each different item of material and equipment specified. The data must include a complete list of parts and supplies, and a list of parts recommended by the manufacturer to be replaced after 1-year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

1.4.2 Qualifications

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NOTE: NICET (National Institute for Certification in Engineering Technologies) establishes the qualifications of an individual as an Engineering Technologist with verification of experience by having a current NICET certification.

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1.4.2.1 Sprinkler System Designer

The sprinkler system designer must be certified as a Level [III][IV] Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.4.2.2 Sprinkler System Installer

The sprinkler system installer must be regularly engaged in the installation of the type and complexity of system specified in the contract documents, and must have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of an item or equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation are mandatory requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. All pipes must be either capped or plugged until installed.

1.6 EXTRA MATERIALS

Spare sprinklers and wrench(es) must be provided as spare parts in accordance with NFPA 13.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices listed for fire protection service when so required by NFPA 13 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for a classification of material. Material and equipment must be standard products of a manufacturer regularly engaged in the manufacture of the products for at least [2][_____] years prior to bid.

2.1.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Nameplates must be etched metal or plastic, permanently attached by screws to control units, panels or adjacent walls.

2.1.3 Identification and Marking

Pipe and fitting markings must include name or identifying symbol of manufacturer and nominal size. Pipe must be marked with ASTM designation. Valves and equipment markings must have name or identifying symbol of manufacturer, specific model number, nominal size, name of device, arrow indicating direction of flow, and position of installation (horizontal or vertical), except if valve can be installed in either position. Markings must be included on the body casting or on an etched or stamped metal nameplate permanently on the valve or cover plate.

2.1.4 Pressure Ratings

Valves, fittings, couplings, alarm switches, and similar devices must be rated for the maximum working pressures that can be experienced in the system, but in no case less than [1207][1724] kPa[175][250] psi.

2.2 UNDERGROUND PIPING COMPONENTS

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NOTE: The design drawings must show the service connection details and the underground service lateral for the sprinkler system. The drawings must show details of the water service point-of-entry into the building and through the floor slab, and underground piping restraints, including number and size of restraining rods and thrust blocks. 4-inch piping is the minimum permitted for service laterals serving NFPA 13R systems. 6-inch piping is the minimum permitted for NFPA 13 systems.

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2.2.1 Pipe

Pipe must comply with NFPA 24. Minimum pipe size is [100 mm4 inches][150 mm 6 inches]. Piping more than 1.50 meters5 feet outside the building walls must comply with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING. A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 304 mm 1-foot above the finished floor within the building is acceptable.

2.2.2 Fittings and Gaskets

Fittings must be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets must be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints must conform to AWWA C111/A21.11.

2.2.3 Gate Valve[and Indicator Posts]

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NOTE: This paragraph will be deleted if underground valves are either not required or are specified elsewhere.

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Installation must comply with NFPA 24. Gate valves for use with indicator post must conform to UL 262.[Indicator posts must conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.]

[2.2.4 Valve Boxes

Except where indicator posts are provided, for each buried valve, provide a cast-iron, ductile-iron, or plastic valve box of a suitable size. Plastic boxes must be constructed of acrylonitrile-butadiene-styrene (ABS) or inorganic fiber-reinforced black polyolefin. Provide cast-iron, ductile-iron, or plastic cover for valve box with the word "WATER" cast on the cover. The minimum box shaft diameter must be 133 mm5.25 inches. Coat cast-iron and ductile-iron boxes with bituminous paint applied to a minimum dry-film thickness of 0.254 mm10 mils.

]2.2.5 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape, 80 mm3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification must read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING COMPONENTS

****

NOTE: Specify steel piping exposed to the weather or corrosive atmospheres to properly protect against corrosive effects.

NOTE: GALVANIZED PIPING IS ONLY PERMITTED FOR DELUGE SYSTEMS, VALVE TRIM PIPING AND DRAIN PIPING WHEN EXPOSED TO THE EXTERIOR.

NOTE: The following are basic restrictions on the use of CPVC pipe and fittings:

a. Will be used only in residential occupancies.

b. Will not be used in combustible concealed spaces that are required to be sprinklered.

c. Will not be used in spaces where ambient temperature exceed 65 degrees C150 degrees F.

d. Must be protected, as a minimum, by either (1) one layer of 9.525 mm3/8-inch thick gypsum board, or (2) a suspended membrane ceiling with lay-in ceiling panels or tiles having a weight of not less than 1.7 kg per square meter0.35 psf installed on metallic support grids, or by other method approved by UL. Method or protection of piping must be indicated and detailed in the contract documents.

e. Will not be used where water pressure surges could exceed 1207 kPa175 psi.

f. Will not be used in areas where the system could be subject to impact or physical stress or abuse.

g. Can be used only in wet pipe sprinkler systems.

h. Quick-response sprinklers will be used with plastic piping.

i. CPVC is permitted to be used in accordance with its listing.
****

2.3.1 Steel Piping Components

2.3.1.1 Steel Pipe

****
NOTE: For DLA, use Schedule 40 steel pipe only.

NOTE: Grooved pipe must be cut grooved for WHS projects.
****

Except as modified herein, steel pipe must be black as permitted by NFPA 13 and conform to the applicable provisions of ASTM A53/A53M, ASTM A135/A135M or ASTM A153/A153M.

[Steel pipe must be minimum Schedule 40 for sizes 50 mm2 inches and less; and minimum Schedule 10 for sizes larger than 50 mm2 inches.][Steel pipe must be Schedule 40 only.] Steel piping with wall thickness less than Schedule 40 must not be threaded. [Grooved pipe must be cut-grooved.]

2.3.1.2 Fittings

Fittings must be welded, threaded, or grooved-end type. Threaded fittings must be cast-iron conforming to ASME B16.4, malleable-iron conforming to ASME B16.3 or ductile-iron conforming to ASTM A536. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, steel press fittings and field welded fittings are not permitted. Fittings, mechanical couplings, and rubber gaskets must be supplied by the same manufacturer. Threaded fittings must use Teflon tape or manufacturer's approved joint compound.[Saddle tees using rubber gasketed fittings are permitted only when connecting to existing piping for additions or modifications. Saddle tees must use a connection method that completely wraps around the pipe.] Reducing couplings are not permitted except as allowed by NFPA 13.

2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings must be designed for not less than 1200 kPa175 psi service and the product of the same manufacturer. Field welded fittings must not be used. Fitting and coupling housing must be malleable-iron conforming to ASTM A47/A47M, Grade 32510; ductile-iron conforming to ASTM A536, Grade 65-45-12. Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 50 mm2 inches and larger. Gasket must be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts must be heat-treated steel conforming to ASTM A183 and must be cadmium-plated or zinc-electroplated.

2.3.1.4 Flanges

Flanges must conform to NFPA 13 and ASME B16.1. Gaskets must be non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16-inch thick, and full face or self-centering flat ring type.

[2.3.2 Copper Tube Components

2.3.2.1 Copper Tube

Copper tube must conform to ASTM B88MASTM B88, Types L and M.

2.3.2.2 Copper Fittings and Joints

Cast copper alloy solder-joint pressure fittings must conform to ASME B16.18 and wrought copper and bronze solder-joint pressure fittings must conform to ASME B16.22 and ASTM B75/B75M. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

][2.3.3 Plastic Piping Components

****

NOTE: See Note in Paragraph "Aboveground Piping Components" for restrictions on use of plastic piping. When plastic pipe is not permitted, delete this paragraph.

****

2.3.3.1 Plastic Pipe

Plastic pipe must be chlorinated polyvinyl chloride (CPVC) conforming to ASTM F442/F442M, 1207 kPa175 psi rating and listed for use in wet pipe sprinkler systems.

2.3.3.2 Plastic Fittings

Plastic fittings must be chlorinated polyvinyl chloride (CPVC) and listed for use in wet pipe sprinkler systems.

]2.3.4 Flexible Sprinkler Hose

****

NOTE: The use of flexible sprinkler hose must be approved by the AHJ per UFC 3-600-01.

****

[The use of flexible hose is [not]permitted.][Flexible sprinkler hose must comply with UL 2443 and FM 1637.]

2.3.5 Pipe Hangers and Supports

****

NOTE: Seismic parameters must follow UFC 3-301-01 Structural Engineering. The writer of this section must coordinate with the Structural Engineer or Government to determine the proper seismic design category for the project, in accordance with the IBC or ASCE guidelines. See UFC 3-310-04 for more information.

****

Provide galvanized pipe hangers[, supports and seismic bracing][and supports] in accordance with NFPA 13.[Design and install seismic protection in accordance with the requirements of NFPA 13 section titled "Protection of Piping Against Damage Where Subject to Earthquakes for Seismic Design Category ["D"]["_____"]].

2.3.6 Valves

Provide valves of types approved for fire service. Valves must open by counterclockwise rotation.

2.3.6.1 Control Valve

Manually operated sprinkler control/gate valve must be[outside stem and yoke (OS&Y) type][or][butterfly type][as indicated on the drawings] and must be listed.

2.3.6.2 Check Valves

Check valves must comply with UL 312. Check valves 100 mm4 inches and larger must be of the swing type, have a clear waterway and meet the requirements of MSS SP-71, for Type 3 or 4. Inspection plate must be provided on valves larger than 150 mm6 inches.

2.3.6.3 Hose Valve

****

NOTE: Hose valves are required as part of the backflow prevention test header.

****

Valve must comply with UL 668.

2.3.7 [Alarm][Riser Check] Valves

****

NOTE: Alarm valves should only be used when the preference of the Installation due to the additional maintenance requirements.

****

[Provide riser check valve, pressure gauges and main drain.][Provide variable pressure type alarm check valve, standard trim piping, pressure gauges, bypass, retarding chamber, testing valves, and main drain, and other components as required for a fully operational system. Alarm valves must comply with UL 193.]

2.4 ALARM INITIATING AND SUPERVISORY DEVICES

****

NOTE: Water motor alarms and pressure alarm switches can be used only with an alarm check valve.

****

2.4.1 Sprinkler Alarm Switch

Vane or pressure-type flow switch(es). [Connection of switch must be by the fire alarm installer]. [Vane type alarm actuating devices must have mechanical diaphragm controlled retard device adjustable from 10 to 60 seconds and must instantly recycle.][Flow switches for elevator power shunt must not have a retard feature.]

2.4.2 Valve Supervisory (Tamper) Switch

Switch must be integral to the control valve or suitable for mounting to the type of control valve to be supervised open. The switch must be tamper resistant and contain SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

[2.5 BACKFLOW PREVENTION ASSEMBLY

****

NOTE: Indicate piping, type of connection and equipment, such as a test header with hose valves, required for flow testing of the backflow preventer at full system demand as required by NFPA 13. Arrangement of test assembly should be coordinated with the installation.

****

[Reduced-pressure principle][Double-check] valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve must have a drain. Backflow prevention assemblies must have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List is acceptable as the required documentation.

2.5.1 Backflow Preventer Test Connection

****

NOTE: Delete the backflow preventer test connection when approved by the DFPE.

****

Test connection must consist of a series of listed hose valves with 65-mm2 1/2-inch National Standard male hose threads with cap and chain.

]2.6 FIRE DEPARTMENT CONNECTION

****

NOTE: The designer will coordinate the desired location and thread type for the fire department connection with the responding fire department.

****

Fire department connection must be [freestanding][projecting][flush] type with cast-brass body, matching [wall] escutcheon lettered "Auto Spkr" with a [polished-brass][chromium-plated] finish. [The connection must have individual self-closing clappers, caps with drip drains and chains.] Female inlets must have [65-mm2 1/2-inch][100 mm4-inch][125 mm5-inch][_____] diameter [American National Fire Hose Connection Screw Threads (NH) per NFPA 1963] [Storz][_____]. Comply with UL 405.

2.7 SPRINKLERS

****

NOTE: The designer will indicate on the contract drawings the type of sprinklers for each area if

more than one type of sprinkler is to be provided. Delete sprinkler types from this paragraph that are not intended for use in the system(s) used in the Contract.

Areas that are classified as light hazard will be equipped with quick-response sprinklers. Residential areas will be equipped with residential sprinklers.

****

Sprinklers must comply with UL 199 and NFPA 13. Sprinklers with internal O-rings are not acceptable. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters must have temperature classification in accordance with NFPA 13. Extended coverage sprinklers are permitted for loading docks, residential occupancies and high-piled storage applications only.

2.7.1 Pendent Sprinkler

Pendent sprinkler must be[recessed][quick-response][dry pendent] type with nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____]. Pendent sprinklers must have a [polished chrome][stainless steel][white polyester][_____] finish. Assembly must include an integral escutcheon.

2.7.2 Upright Sprinkler

Upright sprinkler must be [brass][chrome-plated][stainless steel][white polyester] [quick-response type][_____] and have a nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____].

2.7.3 Sidewall Sprinkler

Sidewall sprinkler must be the [quick-response][standard-response] [recessed][dry sidewall] type. Sidewall sprinkler must have a nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____]. Sidewall sprinkler must have a [brass][polished-chrome][stainless steel][white polyester][_____] finish.

[2.7.4 Concealed Sprinkler

Concealed sprinkler must be [chrome-plated][stainless steel][white polyester] [quick-response type][_____] and have a nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____]. Coverplate must be [chrome][white][_____].

]2.7.5 Residential Sprinkler

Residential sprinkler must be [recessed pendent][pendent][sidewall] type with nominal K-factor of [60][80][4.2][5.6]. Residential sprinkler must have a [polished-chrome][white polyester][_____] finish. Sprinkler must comply with UL 1626.

[2.7.6 Corrosion-Resistant Sprinkler

****

NOTE: The use of corrosion-resistant sprinklers is generally limited to industrial type occupancies such as electroplating, steam rooms, salt storage,

and piers and wharves.
****

Corrosion-resistant sprinkler must be the [upright][pendent] type installed in locations as indicated. Corrosion-resistant coatings must be factory-applied by the sprinkler manufacturer.

][2.7.7 Dry Sprinkler Assembly

Dry sprinkler assembly must be of the[pendent][sidewall][45-degree] type as indicated. Assembly must include an integral escutcheon. Maximum length must not exceed maximum indicated in its listing. Sprinkler must have a [polished chrome][polyester coating][white enamel] finish.

][2.7.8 Control Mode Specific Application Sprinkler

Control mode specific application sprinkler must be of the [pendent][upright][dry sidewall] type as indicated. Sprinkler must be specifically listed for high-piled storage only. Sprinkler must have a [polished chrome][rough brass] finish.

][2.7.9 ESFR Sprinkler

ESFR sprinkler must be [pendent][upright] and comply with UL 1767. Nominal K-factor must be [_____].

][2.7.10 Intermediate Level Rack Sprinkler

Intermediate level rack sprinkler must be of the [upright][pendent] type with nominal K-factor of [80][115][5.6][8.0]. The sprinkler must be equipped with a deflector plate to shield the fusible element from water discharged above it.

]2.8 ACCESSORIES

2.8.1 Sprinkler Cabinet

Provide spare sprinklers in accordance with NFPA 13 and must be placed in a suitable metal or plastic cabinet of sufficient size to accommodate all the spare sprinklers and wrenches in designated locations. Spare sprinklers must be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed as required by NFPA 13. At least one wrench of each type required must be provided.

2.8.2 Pendent Sprinkler Escutcheon

Escutcheon must be one-piece metallic type with a depth of less than 19 mm 3/4-inch and suitable for installation on pendent sprinklers. The escutcheon must have a factory finish that matches the pendent sprinkler.

2.8.3 Pipe Escutcheon

Provide split hinge metal plates for piping entering walls, floors, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.8.4 Sprinkler Guard

Listed guard must be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards must be provided on sprinklers located [_____][within 2.1 meters7 feet of the floor][as indicated].

2.8.5 Relief Valve

Relief valves must be listed and installed at the riser in accordance with NFPA 13.

2.8.6 Air Vent

Air vents must be of the automatic type and piped to drain to the building exterior.

2.8.7 Identification Sign

Valve identification sign must be minimum 150 mm wide by 50 mm high6 inches wide by 2 inches high with enamel baked finish on minimum 1.214-mm18 gage steel or 0.6-mm0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign must include, but not be limited to "main drain", "auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required to identify operational components. Where there is more than one sprinkler system, signage must include specific details as to the respective system.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work that is dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative a condition that prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

The installation must be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein.[Installation of in-rack sprinklers must comply with applicable provisions of NFPA 13.] Locate sprinklers in a consistent pattern with ceiling grid, lights, and air supply diffusers. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

a. Piping offsets, fittings, and other accessories required must be furnished to provide a complete installation and to eliminate interference with other construction.

b. Wherever the contractor's work interconnects with work of other trades the Contractor must coordinate with other Contractors to insure all Contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers and similar equipment) that are concealed above hung ceilings by permanent color coded pins/tabs in the ceiling directly below the item.

c. Provide required supports and hangers for piping, conduit, and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid must be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

3.2.1 Waste Removal

At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash which may have accumulated during the day as a result of work by the contractor and of his presence on the job. Sidewalks and streets adjoining the property must be kept broom clean and free of waste, debris, trash and obstructions caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities, and property.

3.3 UNDERGROUND PIPING INSTALLATION

****

NOTE: Restraint of the underground piping must be detailed on the contract drawings.

****

The fire protection water main must be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover must be [900][_____] mm [3][_____] feet or the frost line, whichever is deeper. The supply line must terminate inside the building with a flanged piece, the bottom of which must be set not less than 304 mm1-foot above the finished floor. A blind flange must be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block must be provided at the elbow where the pipe turns up toward the floor. In addition, joints must be anchored in accordance with NFPA 24. Buried steel components must be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 1500 mm5 feet outside the building walls must meet the requirements of Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.4 ABOVEGROUND PIPING INSTALLATION

The methods of fabrication and installation of the aboveground piping must fully comply with the requirements and recommended practices of NFPA 13 and this specification section.

3.4.1 Protection of Piping Against Earthquake Damage

****

NOTE: The writer of this section must coordinate with the Structural Engineer or Government to determine the proper seismic design category for the project, in accordance with the IBC or ASCE guidelines. See UFC 3-310-04 for more information.

****

Seismic restraint is [not]required.

3.4.2 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, must be installed to provide maximum headroom.

3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping must be concealed above ceilings. Piping must be inspected, hydrostatically tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas must be concealed.

3.4.4 Pendent Sprinklers

****

NOTE: Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 6.9 bar100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 300 mm12 inches for steel pipe and 1500 mm6 inches for copper tube.

****

a. Drop nipples to pendent sprinklers must consist of minimum 25-mm1-inch pipe with a reducing coupling into which the sprinkler must be threaded.

b. Where sprinklers are installed below suspended or dropped ceilings, drop nipples must be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling must not extend below the underside of the ceiling.

c. Recessed pendent sprinklers must be installed such that the distance from the sprinkler deflector to the underside of the ceiling must not exceed the manufacturer's listed range and must be of uniform depth throughout the finished area.

d. Pendent sprinklers in suspended ceilings must be located in the center of the tile (plus or minus 2 inches).[

e. Dry pendent sprinkler assemblies must be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space.][

f. Dry pendent sprinklers must be of the required length to permit the sprinkler to be threaded directly into a branch line tee.][

g. Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 6.9 bar100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 300 mm12 inches for steel pipe and 1500 mm6 inches for copper tube.]

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers must contain no fittings between the branch line tee and the reducing coupling at the sprinkler.

3.4.6 Pipe Joints

Pipe joints must conform to NFPA 13, except as modified herein. Not more than four threads must show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints must be provided where indicated or required by NFPA 13. Grooved pipe and fittings must be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools must be products of the same manufacturer. For copper tubing, pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.4.7 Reducers

Reductions in pipe sizes must be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face or hex type will be permitted. Where used, face bushings must be installed with the outer face flush with the face of the fitting opening being reduced. Bushings cannot be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 13 mm1/2-inch.

3.4.8 Pipe Penetrations

a. Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors must be core-drilled and provided with pipe sleeves. Each sleeve must be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and extend through its respective wall or floor and be cut flush with each wall surface. Sleeves must provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe must be firmly packed with mineral wool insulation.

b. Where pipes and sleeves penetrate fire walls, fire partitions, or floors, pipes/sleeves must be firestopped in accordance with Section 07 84 00 FIRESTOPPING.

c. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe must be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

d. All penetrations through the boundary of rooms/areas identified as secure space area must meet ICS 705-1.

3.4.9 Escutcheons

Escutcheons must be provided for pipe penetration in finished areas of ceilings, floors and walls. Escutcheons must be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

****

NOTE: Designer will indicate location of the inspector's test connections and all associated valves on the contract drawings, and will provide details of drain piping.

****

Unless otherwise indicated, the test connection must consist of 25-mm1-inch pipe connected [to the remote branch line][at the riser as a combination test and drain valve]; a test valve located approximately 2 meters7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test". All test connection piping must be inside of the building and penetrate the exterior wall at the location of the discharge orifice only. The discharge orifice must be located outside the building wall no more than 0.6 meters2 feet above finished grade, directed so as not to cause damage to adjacent construction or landscaping during full flow discharge, or to the sanitary sewer. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building. Do not discharge to the roof. Discharge to floor drains, janitor sinks or similar fixtures is not permitted.

Provide concrete splash blocks at all drain and inspector's test connection discharge locations if not discharging to a concrete surface. Splash blocks must be large enough to mitigate erosion and not become dislodged during a full flow of the drain. Ensure all discharged water drains away from the facility and does not cause property damage.

3.4.11 Backflow Preventer

Locate within the building or in a heated enclosure in locations subject to freezing. For heated enclosures, provide a low temperature supervisory alarm connected to the facility fire alarm system. Heat trace is not permitted to be used.

Install backflow preventers so that the bottom of the assembly is a minimum of 150 mm6 inches above the finished floor/grade. Install horizontal backflow preventers so that the bottom of the assembly is no greater than [_____]610 mm24 inches above the finished floor/grade. Install vertical backflow preventers so that the upper operating handwheel is no more than [_____]1.8 meters6 feet above the finished floor/grade. Clearance around control valve handles must be minimum 150 mm6 inches above grade/finished floor and away from walls.

[3.4.11.1 Test Connection

Provide downstream of the backflow prevention assembly UL 668 hose valves with 65-mm2.5-inch National Standard male hose threads with cap and chain. Provide one valve for each 946 L/min250 gpm of system demand or fraction thereof. Provide a permanent sign in accordance with paragraph entitled

"Identification Signs" which reads, "Test Valve". Indicate location of test header. If an exterior connection, provide a control valve inside a heated mechanical room to prevent freezing.

]3.4.12 Drains

a. Main drain piping must be provided to discharge [at a safe point outside the building, no more than 0.6 meters2 feet above finished grade][at the location indicated][to the sanitary sewer]. Provide a concrete splash block at drain outlet. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building.

b. Auxiliary drains must be provided as required by NFPA 13. Auxiliary drains are permitted to discharge to a floor drain if the drain is sized to accommodate full flow (min 151 L/min40 gpm). Discharge to service sinks or similar plumbing fixtures is not permitted.

3.4.13 Installation of Fire Department Connection

Connection must be mounted [on the exterior wall approximately 900 mm3 feet above finished grade][adjacent to and on the sprinkler system side of the backflow preventer]. The piping between the connection and the check valve must be provided with an automatic drip in accordance with NFPA 13 and piped to drain to the outside or a floor drain within the same room.

3.4.14 Identification Signs

Signs must be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Main drain test results must be etched into main drain identification sign. Hydraulic design data must be etched into the nameplates and permanently affixed to each sprinkler riser as specified in NFPA 13. Provide labeling on the surfaces of all feed and cross mains to show the pipe function (e.g., "Sprinkler System", "Fire Department Connection", "Standpipe") and normal valve position (e.g. "Normally Open", "Normally Closed"). For pipe sizes 100 mm4-inch and larger provide white painted stenciled letters and arrows, a minimum of 50 mm2 inches in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 100 mm4-inch, provide white painted stenciled letters and arrows, a minimum of 18 mm0.75-inch in height and visible from the floor.[Provide properly lettered and approved metal sign to elevator flow switch stating the circuits' voltage, and identify the switch as an "Elevator Power Shunt Flow Switch".]

3.5 ELECTRICAL

****

NOTE: Coordinate power and alarm requirements with the contract drawings and other specification sections.

****

Except as modified herein, electric equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.[Alarm signal wiring connected to the building fire alarm control system must be by the fire alarm installer.]

3.6 PAINTING

****

NOTE: Designer will coordinate color code marking with Section 09 90 00 PAINTS AND COATINGS. Color code marking for piping which are not listed in Table I of Paragraph 3.5 Pipe Color Code Marking of UFGS Section 09 90 00 will be added to the table.

****

Color code mark piping [red][as specified in Section 09 90 00 PAINTS AND COATINGS].

3.7 FIELD QUALITY CONTROL

3.7.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level [III][or][IV] Fire Sprinkler Technician, and the representative of the installing company,[and reviewed by the QFPE] [60][_____] days prior to performing system tests. Detailed test procedures must list all components of the installed system. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 13). The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government final testing.

a. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.7.2 Pre-Government Testing

3.7.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that equipment is functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" and "System Acceptance" as noted in NFPA 13. The Contractor [and QFPE] must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 13 and the test reports noted below.

a. NFPA 13 Aboveground Material and Test Certificate

b. NFPA 13 Underground Material and Test Certificate

3.7.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the [_____][Designated Fire Protection Engineer (DFPE)][Contracting Officers Designated Representative (COR)]. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports.

Government final testing will not be performed until after the connections to the [building fire alarm system][installation fire alarm reporting system] have been completed and tested to confirm communications are fully functional. Submit request for test at least [15][_____] calendar days prior to the requested test date.

3.7.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.7.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. [b. The contractor's Qualified Fire Protection Engineer (QFPE).]

c. Marked-up red line drawings of the system as actually installed.

Government Final Tests will be witnessed by the [_____], [Designated Fire Protection Engineer][Contracting Officer][, Qualified Fire Protection Engineer (QFPE)]. At this time, all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.8 MINIMUM SYSTEM TESTS

The system, including the underground water mains, and the aboveground piping and system components, must be tested to ensure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure must be tested in accordance with NFPA 13 and NFPA 24.

3.8.1 Underground Piping

3.8.1.1 Flushing

****

NOTE: Designer should check the site water section for inconsistencies and to verify flushing of all underground pipe will be performed prior to connection to the sprinkler system.

****

Underground piping must be flushed at a minimum of 3 mps10 fps in accordance with NFPA 24.

3.8.1.2 Hydrostatic Test

New underground piping must be hydrostatically tested in accordance with NFPA 24.

3.8.2 Aboveground Piping

3.8.2.1 Hydrostatic Test

Aboveground piping must be hydrostatically tested in accordance with NFPA 13. There must be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure must be read from a gauge located at the low elevation point of the system or portion being tested.

3.8.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly must be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor must provide all equipment and instruments necessary to conduct a complete forward flow test, including 65-mm2.5-inch diameter hoses, playpipe nozzles or flow diffusers, calibrated pressure gauges, and pitot tube gauge. The Contractor must provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction loss) across the assembly must be recorded. A metal placard must be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate determined during the preliminary testing. The pressure drop must be compared to the manufacturer's data and the readings observed during the final inspections and tests.

3.8.3 Main Drain Flow Test

Following flushing of the underground piping, a main drain test must be made to verify the adequacy of the water supply. Static and residual pressures must be recorded on the certificate specified in paragraph SUBMITTALS.

3.9 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the final acceptance test.

[a. Provide one set of full size paper as-built drawings and schematics. The drawings must be prepared electronically and sized no less than the contract drawings.] [Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation][AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]

b. Provide operating and maintenance (O&M) instructions.

3.10 ONSITE TRAINING

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NOTE: The number of hours of instruction should be determined based of the number and complexity of the

systems specified.
****

Conduct a training course for the responding fire department and operating and maintenance personnel as designated by the Contracting Officer. Training must be performed on two separate days (to accommodate different shifts of Fire Department personnel) for a period of [_____][4] hours of normal working time and must start after the system is functionally complete and after the final acceptance test. The on-site training must cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-21 13 16 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-21 13 16.00 20 (April 2006)
UFGS-21 13 17.00 10 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 21 13 16

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08/20

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PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-21 13 16 (August 2020)**

Preparing Activity: USACE **Superseding**
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****

SECTION 21 13 16

DRY PIPE SPRINKLER SYSTEMS, FIRE PROTECTION

08/20

****

NOTE: This guide specification covers the requirements for dry pipe fire protection sprinkler systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information. The designer is permitted to edit any and all of this section for the project. If the designer is modifying/deleting non-bracketed items and text, the Designated Fire Protection Engineer (DFPE) should be consulted prior to incorporating final changes.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: For OCONUS projects, this specification section should be edited for specific Host Nation requirements. Coordinate compliance with Host Nation requirements with the DFPE.

****

****

NOTE: This specification section includes requirements from UFC 3-600-01 (change 4, 7 February 2020)

****

PART 1 GENERAL

****

NOTE:

The Designer must edit this specification section for either a performance-designed system or a fully designed system as applicable.

This section is primarily intended for performance designed systems, e.g. systems where the size, layout, and support of branch lines and cross mains, and the layout of sprinklers will be designed by the Contractor.

This section is not intended to be used for NFPA 13D systems.

The Designer must provide the following information in the contract documents for performance designed systems. This information must be in accordance with UFC 3-600-01.

(1) Show the layout and size of all piping and equipment from the point of connection to the water supply, to the sprinkler riser. The contract drawings must include a detailed sprinkler riser diagram.

(2) Show location and size of service laterals, sprinkler risers, control valves, drain lines, sectional valves, and inspector's test valves and switches on the drawings.

(3) Specify waterflow data including hydrant flow test results, including the location where the hydrant flow test was conducted, the location and size of existing mains and new water supply lines that will serve the sprinkler system.

(4) Highlight or clearly indicate the area(s) to be protected by sprinklers on the drawings.

(5) Specify waterflow requirements including the design density, design area, the hose stream demand (including location of the hose stream demand), the duration of supply, and sprinkler spacing and area of coverage in this section.

(6) Show the location of the backflow preventer (including provisions for a drain and access for maintenance) on the drawings.

(7) Show all provisions necessary for forward flow testing of the backflow preventer at system demand as required by NFPA 13 on the drawings.

(8) Highlight all concealed spaces on the drawings that require sprinkler protection, such as spaces above suspended ceilings that are built of combustible material or that can contain combustible materials, such as storage, and communication cabling that is not fire-rated.

(9) Provide details on the drawings of pipe restraints for underground piping. This includes details of pipe clamps, tie rods, mechanical retainer glands, and thrust blocks.

(10) Nitrogen generators, including controls and complete installation details, including piping, control valves, mounting base.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe

	Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1015	(2021) Performance Requirements for Double Check Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M14	(2024) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM B62	(2017) Standard Specification for

	Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INTELLIGENCE COMMUNITY STANDARD (ICS)

ICS 705-1	(2010) Physical and Technical Security Standard for Sensitive Compartmented Information Facilities

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2024) Standard for the Installation of Sprinkler Systems
NFPA 24	(2025) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 101	(2024) Life Safety Code
NFPA 291	(2025) Recommended Practice for Fire Flow Testing and Marking of Hydrants
NFPA 1963	(2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UL SOLUTIONS (UL)

UL 199	(2020) UL Standard for Safety Automatic Sprinklers for Fire-Protection Service
UL 262	(2004; Reprint Jul 2023) Gate Valves for

	Fire-Protection Service
UL 312	(2022) UL Standard for Safety Check Valves for Fire-Protection Service
UL 405	(2013; Bul. 2020) UL Standard for Safety Fire Department Connection Devices
UL 668	(2004; Reprint Oct 2021) UL Standard for Safety Hose Valves for Fire-Protection Service
UL 789	(2004; Reprint May 2024) UL Standard for Safety Indicator Posts for Fire-Protection Service
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SYSTEM DESCRIPTION

****

NOTE: Seismic protection/bracing is to be provided for seismic design categories C or greater only, unless specifically requested by the DFPE. Consideration should also be giving to utilizing seismic protection/bracing to limit pipe movement.

****

Provide dry pipe [sprinkler] system(s) in [areas indicated on the drawings] [_____]. Except as modified herein, the system must meet the requirements of NFPA 13[and]. Dry pipe systems must utilize nitrogen.Pipe sizes which are not indicated on the Contract drawings must be determined by hydraulic calculations.

1.2.1 Hydraulic Design

****

NOTE: Applications requiring multiple densities/design areas must be referred to and shown on the drawings.

Discharge density for non-storage occupancies must be in accordance with UFC 3-600-01. Specific densities must be listed on the drawings or noted in the specification when drawings are not provided. Stating "comply with UFC 3-600-01 is not acceptable.

Hazard classification of miscellaneous storage must be per NFPA 13. Discharge density for the hazard classification must be per UFC 3-600-01.

The paragraph below must be listed on the drawings. If this information is not listed on the drawings, provide the information in paragraph 1.1.1.3 (with brackets completed).

Hydraulically design the system to discharge a minimum density [of [_____] L/min per square meter

gpm/square foot over the hydraulically most demanding [280] [_____] square meters[_____] square feet of floor area][as indicated on the drawings]. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13.
****

****
NOTE: The addition, modification or relocation of no more than twenty sprinklers to an existing system or modifications to existing sprinkler systems fed from domestic supplies are permitted to be designed using the pipe schedule method in NFPA 13 based on the layout of the existing system.
****

1.2.1.1 Basis for Calculations

****
NOTE: The design must include an adequate water supply to meet the sprinkler water demand. The designer must provide waterflow test results and hydraulic calculations to ensure that the system demand will be met.

Design Calculations: The designer must provide detailed hydraulic calculations that clearly demonstrate that the water supply will meet the demand of the sprinkler system and hose streams. Calculations must be submitted with the concept design submission.
****

A waterflow test was performed on (DATE) at (LOCATION) and resulted in a static pressure of [_____ kPapsi] with a residual pressure of [_____ kPapsi] while flowing [_____ L/mingpm]. Perform a fire hydrant flow test prior to shop drawing submittal in accordance with NFPA 291. Results must include hydrant elevations relative to the building and hydrant number/identifiers for the tested hydrants, including which were flowed, which had a gauge. This information must be presented in a tabular form if multiple hydrants were flowed. The results must be included with the hydraulic calculations. Hydraulic calculations must be based on flow test noted in this paragraph, unless [verified by the NAVFAC[_____] Fire Protection Engineer and] approved by Contracting Officer. Hydraulic calculations must be based upon the Hazen-Williams formula with a "C" value noted in NFPA 13 for piping, [and [_____] for existing underground piping]. A "C" value of 120 is permitted to be used in hydraulic calculations when nitrogen is utilized.[Hydraulic calculations must be based on operation of the fire pump(s) provided in Section 21 30 00 FIRE PUMPS.] [The minimum residual pressure in a service lateral (lead-in) at the [design flow rate][150% of the fire pump rated flow] must be 138 kPa20 psi at [the inlet to the backflow preventer][the suction side of the fire pump]].

1.2.1.2 Hydraulic Calculations

a. Water supply curves and system requirements must be plotted on semi-logarithmic graph (N^1.85) paper so as to present a summary of the complete hydraulic calculation.

b. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, minimum discharge pressures and minimum flows. Elevations of hydraulic reference points (nodes) must be indicated.

c. Documentation must identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe.

d. Where the sprinkler system is supplied by interconnected risers, the sprinkler system must be hydraulically calculated using the hydraulically most demanding single riser. The calculations must not assume the simultaneous use of more than one riser.

e. All calculations must include the backflow preventer manufacturer's stated friction loss at the design flow or [83 kPa12 psi for reduced pressure][55 kPa8 psi for double check] backflow preventer, whichever is greater.

f. All calculations must be performed back to the actual location of the flow test, taking into account the direction of flow in the service main at the test location.

1.2.1.3 Design Criteria

Hydraulically design the system to discharge a minimum density [of [_____] L/min per square metergpm/square foot over the hydraulically most demanding [_____] square metersquare feet of floor area][as indicated on the drawings]. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13. Add an allowance for exterior hose streams of [_____] L/min gpm to the sprinkler system demand [at the fire hydrant shown on the drawings closest to the point where the water service enters the building] [at the point of connection to the existing water system].[An allowance for interior hose stations of [_____] L/min gpm must be added to the sprinkler system demand.]

1.2.2 Sprinkler Coverage

****

NOTE: The exception in NFPA 13 to eliminate sprinklers in electrical rooms is not applicable per UFC 3-600-01.

****

Sprinklers must be uniformly spaced on branch lines. Provide coverage throughout 100 percent of the [building][area noted on the Contract drawings]. This includes, but is not limited to, telephone rooms, electrical equipment rooms (regardless of the fire resistance rating of the enclosure), boiler rooms, switchgear rooms, transformer rooms, attached electrical vaults and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13. Provide sprinklers below all obstructions in accordance with NFPA 13. Exceptions are as follows:

a. Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.

[1.2.3 System Volume Limitations

Where the volume of an individual system piping exceeds 1890 liters500 gallons, provide the dry pipe valve with a quick-opening device. The maximum system capacity controlled by one dry pipe valve must not exceed 2800 liters750 gallons, unless it complies with the dry pipe system water delivery calculations noted in NFPA 13.

]1.2.4 Qualified Fire Protection Engineer (QFPE)

****

NOTE: UFC 3-600-01 requires that shop drawings must bear the Review Stamp and professional engineering stamp of the QFPE prior to submission to the Government for approval.

****

****

NOTE: The term Qualified Fire Protection Engineer (QFPE) should be considered interchangeable with the terms "Fire Protection Designer of Record (FPDOR)" and/or "Fire Protection QC Specialist" where referred to in other applicable contract documents. The intent of defining the QFPE roles and responsibilities here is NOT to require personnel in addition to the QFPE, FPDOR, and/or FPQC specialist referenced elsewhere in the applicable contract documents.

****

An individual who is a licensed professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Working (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Provide a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government [and final Government]functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

NOTE: When 20 or less sprinklers are added, modified or relocated, shop drawings, hydraulic calculations and product data are not required to be submitted. Edit this section accordingly.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Partial submittals and submittals not fully complying with NFPA 13 and this specification section must be returned disapproved without review. SD-02, SD-03 and SD-05 must be submitted simultaneously.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE must be returned disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G, [_____]

Sprinkler System Designer; G, [_____]

Sprinkler System Installer; G, [_____]

Nitrogen Generation System Commissioning Technician ; G, [_____]

SD-02 Shop Drawings

Shop Drawing; G, [_____]

SD-03 Product Data

Pipe; G, [_____]

Fittings; G, [_____]

Valves, including gate, check, butterfly, and globe; G, [_____]

Relief Valves; G, [_____]

Sprinklers ; G, [_____]

Pipe Hangers and Supports ; G, [_____]

Sprinkler Alarm Switch; G, [_____]

Valve Supervisory (Tamper) Switch; G, [_____]

Fire Department Connection; G, [_____]

Backflow Prevention Assembly; G, [_____]

Hose Valve; G, [_____]

[Seismic Bracing; G, [_____]

][High/Low-Nitrogen Pressure Supervisory Switch; G, [_____]

][Nitrogen Generation System; G, [_____]

] Nameplates; G, [_____]

Dry Pipe Valve; G, [_____]

SD-05 Design Data

[Seismic Bracing; G, [_____]

Load calculations for sizing of seismic bracing

] Hydraulic Calculations; G, [_____]

SD-06 Test Reports

Test Procedures; G, [_____]

SD-07 Certificates

Verification of Compliant Installation; G, [_____]

Request for Government Final Test; G, [_____]

SD-10 Operation and Maintenance Data

Operating and Maintenance (O&M) Instructions; G, [_____]

Spare Parts Data; G, [_____]

SD-11 Closeout Submittals

As-built drawings

1.4 QUALITY ASSURANCE

1.4.1 Preconstruction Submittals

Within 36 days of contract award but no less than [14 days][_____] prior to commencing work on site, the prime Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications must be returned Disapproved Without Review. All resultant delays are the sole responsibility of the prime Contractor.

1.4.1.1 Shop Drawing

[_____] copies of the shop drawings, no later than 28 days prior to the start of system installation. Working drawings conforming to the requirements prescribed in NFPA 13 and must be no smaller than [ISO A1][ANSI D][the Contract Drawings]. Each set of drawings must include the following:

1. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

2. Floor plans drawn to a scale not less than 1:100 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, electrical power connections and other details required to clearly describe the proposed arrangement.

3. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross mains and branch lines to finished floor and roof or ceiling. A detail must show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

4. Longitudinal and transverse building sections showing typical branch line and cross main pipe routing, elevation of each typical sprinkler above finished floor and elevation of "cloud" or false ceilings in relation to the building ceilings.

5. Plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance.

6. Riser layout drawings drawn to a scale of not less than 1:25 1/2-inch

equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

7. Details of each type of riser assembly, pipe hanger, [sway bracing for earthquake protection,]and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) must be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.

8. Details of each type of pipe hanger[, seismic bracing/restraint] and related components.

[9. Include fire pump curve with shop drawings and hydraulic calculations.]

10. The calculated volume of each system.

1.4.1.2 Product Data

[_____] copies of annotated catalog data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, options, and other pertinent information, that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

1.4.1.3 Hydraulic Calculations

****

NOTE: Include the first bracketed item for Army Corps projects.

****

Calculations must be as outlined in NFPA 13 except that calculations must be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings.[Calculations must include isometric diagram indicating hydraulic nodes and pipe segments.][Include fire pump curve with submittal.]

1.4.1.4 Operating and Maintenance (O&M) Instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA as supplemented and modified by this specification section.

Provide [six][_____] manuals[and one pdf version on electronic media]. The manuals must include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment.[Each service organization submitted must be capable of providing [4][_____]-hour on-site response to a service call on an emergency basis.]

Submit spare parts data for each different item of material and equipment specified. The data must include a complete list of parts and supplies, and a list of parts recommended by the manufacturer to be replaced after

1-year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

1.4.2 Qualifications

****

NOTE: NICET (National Institute for Certification in Engineering Technologies) establishes the qualifications of an individual as an Engineering Technologist with verification of experience by having a current NICET certification.

****

1.4.2.1 Sprinkler System Designer

The sprinkler system designer must be certified as a Level [III][IV] Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.4.2.2 Sprinkler System Installer

The sprinkler system installer must be regularly engaged in the installation of the type and complexity of system specified in the contract documents, and must have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.2.3 Nitrogen Generation System Commissioning Technician

Commissioning technician of nitrogen generation system(s) must have one of the following qualifications. Qualifications must be provided prior to preliminary inspection and tests.

a. Commissioning of nitrogen generation system must be carried out by technician employed by and certified by the nitrogen generation system manufacturer.

b. In lieu of manufacturer's commissioning technician, the fire sprinkler contractor must provide proof their commissioning technician has manufacturer's certified training for the equipment being installed and proof of at least five previous installations of manufacturer's equipment where the contractor's commissioning technician has successfully conducted commissioning under the direct supervision of the manufacturer's commissioning representative. Contractor must provide proof the five supervised commissioning occurred AFTER contractor's commissioning agent has obtained the certified training. Commissioning carried out prior to factory training, or without supervision of manufacturer's technician or commissioning of other manufacturer's equipment does not qualify as applicable experience. Conduct preliminary inspections and testing does not qualify as applicable experience.

1.4.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of an item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation are mandatory requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. All pipes must be either capped or plugged until installed.

1.6 EXTRA MATERIALS

Spare sprinklers and wrench(es) must be provided as spare parts in accordance with NFPA 13.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices listed for fire protection service when so required by NFPA 13 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for a particular classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least [2][_____] years prior to bid.

2.1.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Nameplates must be etched metal or plastic, permanently attached by screws to control units, panels or adjacent walls.

2.1.3 Identification and Marking

Pipe and fitting markings must include name or identifying symbol of manufacturer and nominal size. Pipe must be marked with ASTM designation. Valves and equipment markings must have name or identifying symbol of manufacturer, specific model number, nominal size, name of device, arrow indicating direction of flow, and position of installation (horizontal or vertical), except if valve can be installed in either position. Markings must be included on the body casting or on an etched or stamped metal nameplate permanently on the valve or cover plate.

2.1.4 Pressure Ratings

Valves, fittings, couplings, alarm switches, and similar devices must be rated for the maximum working pressures that can be experienced in the system, but in no case less than [1207][1724] kPa[175][250] psi.

2.2 UNDERGROUND PIPING COMPONENTS

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NOTE: The design drawings must show the service connection details and the underground service lateral for the sprinkler system. The drawings must show details of the water service point-of-entry into the building and through the floor slab, and underground piping restraints, including number and size of restraining rods and thrust blocks. 4-inch piping is the minimum permitted for service laterals serving NFPA 13R systems. 6-inch piping is the minimum permitted for NFPA 13 systems.

****

2.2.1 Pipe

Pipe must comply with NFPA 24. Minimum pipe size is [100 mm4 inches][150 mm 6 inches]. Piping more than 1.50 meters5 feet outside the building walls must comply with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING. A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 304 mm 1-foot above the finished floor within the building is acceptable.

2.2.2 Fittings and Gaskets

Fittings must be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets must be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints must conform to AWWA C111/A21.11.

2.2.3 Gate Valve[and Indicator Posts]

****

NOTE: This paragraph will be deleted if underground valves are either not required or are specified elsewhere.

****

Installation must comply with NFPA 24. Gate valves for use with indicator post must conform to UL 262.[Indicator posts must conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.]

[2.2.4 Valve Boxes

Except where indicator posts are provided, for each buried valve, provide a cast-iron, ductile-iron, or plastic valve box of a suitable size. Plastic boxes must be constructed of acrylonitrile-butadiene-styrene (ABS) or inorganic fiber-reinforced black polyolefin. Provide cast-iron, ductile-iron, or plastic cover for valve box with the word "WATER" cast on the cover. The minimum box shaft diameter must be 133 mm5.25 inches. Coat cast-iron and ductile-iron boxes with bituminous paint applied to a minimum dry-film thickness of 0.254 mm10 mils.

]2.2.5 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape, 80 mm3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification must read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING COMPONENTS

****

NOTE: Specify steel piping exposed to the weather or corrosive atmospheres to properly protect against corrosive effects.

NOTE: GALVANIZED PIPING IS ONLY PERMITTED FOR DELUGE SYSTEMS, VALVE TRIM PIPING AND DRAIN PIPING WHEN EXPOSED TO THE EXTERIOR.

****

2.3.1 Steel Piping Components

2.3.1.1 Steel Pipe

****

NOTE: For DLA, use Schedule 40 steel pipe only.

NOTE: Grooved pipe must be cut grooved for WHS projects.

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Except as modified herein, steel pipe must be black as permitted by NFPA 13 and conform to the applicable provisions of ASTM A53/A53M, ASTM A135/A135M or ASTM A153/A153M.

[Steel pipe must be minimum Schedule 40 for sizes 50 mm2 inches and less; and minimum Schedule 10 for sizes larger than 50 mm2 inches.][Steel pipe must be Schedule 40 only.] Steel piping with wall thickness less than Schedule 40 must not be threaded. [Grooved pipe must be cut-grooved.]

2.3.1.2 Fittings

Fittings must be welded, threaded, or grooved-end type. Threaded fittings must be cast-iron conforming to ASME B16.4, malleable-iron conforming to ASME B16.3 or ductile-iron conforming to ASTM A536. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, steel press fittings and field welded fittings are not permitted. Fittings, mechanical couplings, and rubber gaskets must be supplied by the same manufacturer. Threaded fittings must use Teflon tape or manufacturer's approved joint compound.[Saddle tees using rubber gasketed fittings are permitted only when connecting to existing piping for additions or modifications. Saddle tees must use a connection method that completely wraps around the pipe.] Reducing couplings are not permitted except as allowed by NFPA 13.

2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings must be designed for not less than 1200 kPa175 psi service and the product of the same manufacturer. Field welded fittings must not be used. Fitting and coupling housing must be malleable-iron conforming to ASTM A47/A47M, Grade 32510; ductile-iron conforming to ASTM A536, Grade 65-45-12. Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 50 mm2 inches and larger. Gasket must be of silicon compound and listed for dry fire protection systems. Gasket must be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts must be heat-treated steel conforming to ASTM A183 and must be cadmium-plated or zinc-electroplated.

2.3.1.4 Flanges

Flanges must conform to NFPA 13 and ASME B16.1. Gaskets must be non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16-inch thick, and full face or self-centering flat ring type.

[2.3.2 Copper Tube Components

2.3.2.1 Copper Tube

Copper tube must conform to ASTM B88MASTM B88, Types L and M.

2.3.2.2 Copper Fittings and Joints

Cast copper alloy solder-joint pressure fittings must conform to ASME B16.18 and wrought copper and bronze solder-joint pressure fittings must conform to ASME B16.22 and ASTM B75/B75M. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

]2.3.3 Pipe Hangers and Supports

****

NOTE: Seismic parameters must follow UFC 3-301-01 Structural Engineering. The writer of this section must coordinate with the Structural Engineer or Government to determine the proper seismic design category for the project, in accordance with the IBC or ASCE guidelines. See UFC 3-310-04 for more information.

****

Provide galvanized pipe hangers[, supports and seismic bracing][and supports] in accordance with NFPA 13.[Design and install seismic protection in accordance with the requirements of NFPA 13 section titled "Protection of Piping Against Damage Where Subject to Earthquakes for Seismic Design Category ["C"]["D"]["_____"]].

2.3.4 Valves

Provide valves of types approved for fire service. Valves must open by counterclockwise rotation.

2.3.4.1 Control Valve

Manually operated sprinkler control/gate valve must be [outside stem and yoke (OS&Y) type][or][butterfly type][as indicated on the drawings] and must be listed.

2.3.4.2 Check Valves

Check valves must comply with UL 312. Check valves 100 mm4 inches and larger must be of the swing type, have a clear waterway and meet the requirements of MSS SP-71, for Type 3 or 4. Inspection plate must be provided on valves larger than 150 mm6 inches.

2.3.4.3 Hose Valve

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NOTE: Hose valves are required as part of the backflow prevention test header.

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Valve must comply with UL 668.

2.4 DRY PIPE VALVE ASSEMBLY

The dry pipe valve must be a listed, latching differential type be complete with trim piping, valves, fittings, pressure gauges, priming water fill cup, velocity drip check, drip cup, and other ancillary components as required for proper operation. The assembly must include a quick-opening device by the same manufacturer as the dry pipe valve for systems over 1890 liters500 gallons in capacity and in all cases when needed to achieve the timed test requirements in part 3 of this specification section.

2.5 SUPERVISORY NITROGEN SYSTEM

Provide a nitrogen supply system in accordance with NFPA 13. The connection pipe from the nitrogen generator must not be less than 13 mm 1/2-inch in diameter and must enter the system above the priming water level of the dry pipe valve. Install a check valve in the system supply nitrogen piping from the generator. A shutoff valve of the renewable disc type must be installed upstream of this check valve. The nitrogen supply system must be sized to pressurize the sprinkler system to [275][_____] kPa [40][_____] psi within 20 minutes.

2.5.1 Nitrogen Generation System

The nitrogen generation system (NGS) must be installed with a compressor sized appropriately for the application and capable of achieving system pressure within 30 minutes in accordance with the requirements of NFPA 13. The nitrogen generation system must be designed to achieve a nitrogen concentration of 98% or greater and maintain that concentration within the fire sprinkler system continuously. The output nitrogen quality must be confirmed by using a gas stream analyzer. Where multiple dry pipe sprinkler risers are present, provide a manifold adjacent to the dry pipe sprinkler risers. Manifold system must include automatic vent and air maintenance devices for each sprinkler system riser. Nitrogen generation system requires a dedicated, hardwired 120V AC power supply.

2.5.1.1 Design of Nitrogen Generation System

Design the system so all equipment is installed within the confines of the riser room with the exception of a connection for a manual or automatic gas analyzer. Provide a system that is capable of delivering a minimum of 98 percent nitrogen composition throughout all of the system piping within 14 days from the commencement of the inerting process. Provide membrane type nitrogen generators that provide "instant on-instant off" nitrogen gas production without the need for nitrogen storage tanks. The complete nitrogen generator system must be self-contained and skid mounted with "drop-in" operability with a simple one step direct connection of the nitrogen gas supply line to each zone/riser. Provide an automatic "fill and purge" breathing process. This must be done while the sprinkler system is fully functional and must not alter the design performance of the sprinkler system. A process that involves continuous venting of the piping network is not permitted. Air maintenance devices used in conjunction with the nitrogen generation system must be listed for use on sprinkler systems. At the riser and at the end of each zone, provide a connection for a [manual][automatic] gas analyzer.

2.5.1.2 Nitrogen Air Compressor

Air compressors to be used in conjunction with the nitrogen generator must be capable of the following:

a. Capable of producing a continuous stream of compressed air at 100+ psig.

b. Capable of automatic cut in and cut out.

c. Equipped with an on-board after-cooler.

d. Equipped with an on-board automatic water blow down system.

e. Equipped with vibration dampening system.

f. Equipped with an air storage tank to provide continuous delivery of compressed air to the nitrogen generator.

g. Rated for continuous duty service.

h. Compressors less than 3.0 hp must be an oil-less design.

i. Oil-less compressors must be such that the manufacturer has designed the oil-less compressor to provide 5000 hours of continuous duty service before requiring a gasket and seal rebuild.

2.5.1.3 Nitrogen Venting Device

The functional component of the nitrogen venting device for use in the "fill and purge" breathing process must:

a. Be NRTL listed for use on sprinkler systems.

b. Not require plumbing to drain.

c. Close automatically at the completion of the nitrogen inerting process without manual intervention.

d. Be installed on each zone in the riser room.

2.5.1.4 Supervision of Nitrogen Generator

Nitrogen generator must be able to provide the following monitoring options:

a. Power supply "on" for nitrogen generators.

b. Power supply "on" for compressor.

c. Amp draw for compressor.

d. Line pressure (psig).

e. Nitrogen purity at discharge (sample port for use with [manual][automatic] gas analyzer).

2.5.2 Nitrogen Pressure Maintenance Device

Device must be a pressure regulator that automatically reduces supply air pressure to the minimum pressure required to be maintained in the piping system. The device must have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1.6-mm1/16-inch restriction to prevent rapid pressurization of the system, and adjustment screw. The device must be capable of reducing maximum inlet pressure of 680 kPa100 psi to a fixed outlet pressure adjustable to [70][_____] kPa[10][_____] psi.

2.6 ALARM INITIATING AND SUPERVISORY DEVICES

2.6.1 Sprinkler Alarm Switch

pressure-type flow switch(es). [Connection of switch must be by the fire alarm installer].

2.6.2 High/Low-Nitrogen Pressure Supervisory Switch

Each dry pipe valve must be provided with a nitrogen pressure switch connected to the control unit. The pressure switch must supervise the nitrogen pressure in the system and set to activate at 70 kPa10 psi above the dry pipe valve trip point pressure (low) and 70 kPa10 psi above normal nitrogen pressure (high). The switch must have an adjustable range between 35 and 500 kPa5 and 80 psi. The switch must have screw terminal connection and capable of being wired for normally open or normally closed circuit.

2.6.3 Valve Supervisory (Tamper) Switch

Switch must be integral to the control valve or suitable for mounting to the type of control valve to be supervised open. The switch must be tamper resistant and contain SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

[2.7 BACKFLOW PREVENTION ASSEMBLY

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NOTE: Indicate piping, type of connection and equipment, such as a test header with hose valves, required for flow testing of the backflow preventer at full system demand as required by NFPA 13. Arrangement of test assembly should be coordinated with the installation.

****

[Reduced-pressure principle][Double-check] valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve must have a drain. Backflow prevention assemblies must have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List is acceptable as the required documentation.

2.7.1 Backflow Preventer Test Connection

Test connection must consist of a series of listed hose valves with 65-mm2 1/2-inch National Standard male hose threads with cap and chain.

]2.8 FIRE DEPARTMENT CONNECTION

****

NOTE: The designer will coordinate the desired location and thread type for the fire department connection with the responding fire department.

****

Fire department connection must be [freestanding][projecting][flush] type with cast-brass body, matching [wall] escutcheon lettered "Auto Spkr" with a [polished-brass][chromium-plated] finish. [The connection must have individual self-closing clappers, caps with drip drains and chains.] Female inlets must have [65-mm2 1/2-inch][100 mm4-inch][125 mm5-inch][_____] diameter [American National Fire Hose Connection Screw Threads (NH) per NFPA 1963] [Storz][_____]. Comply with UL 405.

2.9 SPRINKLERS

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NOTE: The designer will indicate on the contract drawings the type of sprinklers for each area if more than one type of sprinkler is to be provided. Delete sprinkler types from this paragraph that are not intended for use in the system(s) used in the Contract.

Areas that are classified as light hazard will be equipped with quick-response sprinklers.

****

Sprinklers must comply with UL 199 and NFPA 13. Sprinklers with internal O-rings are not acceptable. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters must have temperature classification in accordance with NFPA 13. Extended coverage sprinklers are permitted for loading docks, residential occupancies and high-piled storage applications only.

2.9.1 Pendent Sprinkler

Pendent sprinkler must be[recessed][quick-response][dry pendent] type with nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____]. Pendent sprinklers must have a [polished chrome][stainless steel][white polyester][_____] finish. Assembly must include an integral escutcheon.

2.9.2 Upright Sprinkler

Upright sprinkler must be [brass][chrome-plated][stainless steel][white polyester] [quick-response type][_____] with a nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____].

2.9.3 Sidewall Sprinkler

Sidewall sprinkler must be the [quick-response][standard-response] [recessed][dry sidewall] type. Sidewall sprinkler must have a nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____]. Sidewall sprinkler must have a [brass][polished-chrome][stainless steel][white polyester][_____] finish.

[2.9.4 Corrosion-Resistant Sprinkler

****

NOTE: The use of corrosion-resistant sprinklers is generally limited to industrial type occupancies such as electroplating, steam rooms, salt storage, and piers and wharves.

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Corrosion-resistant sprinkler must be the [upright][pendent] type installed in locations as indicated. Corrosion-resistant coatings must be factory-applied by the sprinkler manufacturer.

]2.10 ACCESSORIES

2.10.1 Sprinkler Cabinet

Provide spare sprinklers in accordance with NFPA 13 and must be placed in a suitable metal or plastic cabinet of sufficient size to accommodate all the spare sprinklers and wrenches in designated locations. Spare sprinklers must be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed as required by NFPA 13. At least one wrench of each type required must be provided.

2.10.2 Pendent Sprinkler Escutcheon

Escutcheon must be one-piece metallic type with a depth of less than 19 mm 3/4-inch and suitable for installation on pendent sprinklers. The escutcheon must have a factory finish that matches the pendent sprinkler.

2.10.3 Pipe Escutcheon

Provide split hinge metal plates for piping entering walls, floors, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.10.4 Sprinkler Guard

Listed guard must be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards must be provided on sprinklers located [_____][within 2.1 meters7 feet of the floor][as indicated].

2.10.5 Relief Valve

Relief valves must be listed and installed at there riser in accordance with NFPA 13.

2.10.6 Identification Sign

Valve identification sign must be minimum 150 mm wide by 50 mm high6 inches wide by 2 inches high with enamel baked finish on minimum 1.214-mm18 gage steel or 0.6-mm0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign must include, but not be limited to "main drain", "auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required to identify operational components. Where there is more than one sprinkler system, signage must include specific details as to the respective system.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work that is dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative a condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

The installation must be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein.[Installation of in-rack sprinklers must comply with applicable provisions of NFPA 13.] Locate sprinklers in a consistent pattern with ceiling grid, lights, and air supply diffusers. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

a. Piping offsets, fittings, and other accessories required must be furnished to provide a complete installation and to eliminate interference with other construction.

b. Wherever the contractor's work interconnects with work of other trades the Contractor must coordinate with other Contractors to insure all Contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers and similar equipment) concealed above hung ceilings by permanent color coded pins/tabs in the ceiling directly below the item.

c. Provide required supports and hangers for piping, conduit, and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid must be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

3.2.1 Waste Removal

At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash which may have accumulated during the day as a result of work by the contractor and of his presence on the job. Sidewalks and streets adjoining the property must be kept broom clean and free of waste, debris, trash and obstructions caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities, and property.

3.3 UNDERGROUND PIPING INSTALLATION

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NOTE: Restraint of the underground piping must be detailed on the contract drawings.
****

The fire protection water main must be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover must be [900][_____] mm [3][_____] feet or the frost line, whichever is deeper. The supply line must terminate inside the building with a flanged piece, the bottom of which must be set not less than 304 mm1-foot above the finished floor. A blind flange must be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block must be provided at the elbow where the pipe turns up toward the floor. In addition, joints must be anchored in accordance with NFPA 24. Buried steel components must be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 1500 mm5 feet outside the building walls must meet the requirements of Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.4 ABOVEGROUND PIPING INSTALLATION

The methods of fabrication and installation of the aboveground piping must fully comply with the requirements and recommended practices of NFPA 13 and this specification section.

3.4.1 Protection of Piping Against Earthquake Damage

****
NOTE: The writer of this section must coordinate with the Structural Engineer or Government to determine the proper seismic design category for the project, in accordance with the IBC or ASCE guidelines. See UFC 3-310-04 for more information.
****

Seismic restraint is [not]required.

3.4.2 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, must be installed to provide maximum headroom.

3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping must be concealed above ceilings. Piping must be inspected, hydrostatically tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas must be concealed.

3.4.4 Pendent Sprinklers

****
NOTE: Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds

6.9 bar100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 300 mm12 inches for steel pipe and 1500 mm6 inches for copper tube.
****

a. Drop nipples to pendent sprinklers must consist of minimum 25-mm1-inch pipe with a reducing coupling into which the sprinkler must be threaded.

b. Where sprinklers are installed below suspended or dropped ceilings, drop nipples must be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling must not extend below the underside of the ceiling.

c. Recessed pendent sprinklers must be installed such that the distance from the sprinkler deflector to the underside of the ceiling must not exceed the manufacturer's listed range and must be of uniform depth throughout the finished area.

d. Pendent sprinklers in suspended ceilings must be located in the center of the tile (+/- 2 inches).[

e. Dry pendent sprinkler assemblies must be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space.][

f. Dry pendent sprinklers must be of the required length to permit the sprinkler to be threaded directly into a branch line tee.][

g. Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 6.9 bar100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 300 mm12 inches for steel pipe and 1500 mm6 inches for copper tube.]

h. Sprinklers installed in the pendent position must be of the listed dry pendent type or on return bends, unless otherwise indicated.

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers must contain no fittings between the branch line tee and the reducing coupling at the sprinkler.

3.4.6 Pipe Joints

Pipe joints must conform to NFPA 13, except as modified herein. Not more than four threads must show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints must be provided where indicated or required by NFPA 13. Grooved pipe and fittings must be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools must be products of the same manufacturer. For copper tubing, pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.4.7 Reducers

Reductions in pipe sizes cannot be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face or hex type will be permitted. Where used, face bushings must be installed with the outer face flush with the face of the fitting opening being reduced. Bushings must not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 13 mm 1/2-inch.

3.4.8 Pipe Penetrations

a. Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors must be core-drilled and provided with pipe sleeves. Each sleeve must be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and extend through its respective wall or floor and be cut flush with each wall surface. Sleeves must provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe must be firmly packed with mineral wool insulation.

b. Where pipes and sleeves penetrate fire walls, fire partitions, or floors, pipes/sleeves must be firestopped in accordance with Section 07 84 00 FIRESTOPPING.

c. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe must be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

d. All penetrations through the boundary of rooms/areas identified as secure space area must meet ICS 705-1.

3.4.9 Escutcheons

Escutcheons must be provided for pipe penetration in finished areas of ceilings, floors and walls. Escutcheons must be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

****

NOTE: Designer will indicate location of the inspector's test connections and all associated valves on the contract drawings, and will provide details of drain piping.

****

Unless otherwise indicated, the test connection must consist of 25-mm1-inch pipe connected to the remote branch line; a test valve located approximately 2 meters7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test". All test connection piping must be inside of the building and penetrate the exterior wall at the location of the discharge orifice only. The discharge orifice must be located outside the building wall no more than 0.6 meters2 feet above finished grade, directed so as not to cause damage to adjacent construction or landscaping during full flow discharge, or to the sanitary sewer. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building. Do not discharge to the roof. Discharge to floor drains, janitor sinks or similar fixtures is not permitted.

Provide concrete splash blocks at all drain and inspector's test connection discharge locations if not discharging to a concrete surface. Splash blocks must be large enough to mitigate erosion and not become dislodged during a full flow of the drain. Ensure all discharged water drains away from the facility and does not cause property damage.

3.4.11 Backflow Preventer

Locate within the building or in a heated enclosure in locations subject to freezing. For heated enclosures, provide a low temperature supervisory alarm connected to the facility fire alarm system. Heat trace is not permitted to be used.

Install backflow preventers so that the bottom of the assembly is a minimum of 150 mm6 inches above the finished floor/grade. Install horizontal backflow preventers so that the bottom of the assembly is no greater than [_____]610 mm24 inches above the finished floor/grade. Install vertical backflow preventers so that the upper operating handwheel is no more than [_____]1.8 meters6 feet above the finished floor/grade. Clearance around control valve handles must be minimum 150 mm6inches above grade/finished floor and away from walls.

[3.4.11.1 Test Connection

Provide downstream of the backflow prevention assembly UL 668 hose valves with 65-mm2.5-inch National Standard male hose threads with cap and chain. Provide one valve for each 946 L/min250 gpm of system demand or fraction thereof. Provide a permanent sign in accordance with paragraph entitled "Identification Signs" which reads, "Test Valve". Indicate location of test header. If an exterior connection, provide a control valve inside a heated mechanical room to prevent freezing. The piping between the backflow preventer test header control valve and the exterior test header must be provided with an automatic drip arranged to drain to the outside.

]3.4.12 Drains

a. Main drain piping must be provided to discharge [at a safe point outside the building, no more than 0.6 meters2 feet above finished grade][at the location indicated][to the sanitary sewer]. Provide a concrete splash block at drain outlet. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building.

b. Auxiliary drains must be provided as required by NFPA 13. Auxiliary drains are permitted to discharge to a floor drain if the drain is sized to accommodate full flow (min 151 L/min40 gpm). Discharge to service sinks or similar plumbing fixtures is not permitted.

3.4.13 Installation of Fire Department Connection

Connection must be mounted [on the exterior wall approximately 900 mm3 feet above finished grade][adjacent to and on the sprinkler system side of the backflow preventer]. The piping between the connection and the check valve must be provided with an automatic drip in accordance with NFPA 13 and piped to drain to the outside or a floor drain within the same room.

3.4.14 Identification Signs

Signs must be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Main drain test results must be etched into main drain identification sign. Hydraulic design data must be etched into the nameplates and permanently affixed to each sprinkler riser as specified in NFPA 13. Provide labeling on the surfaces of all feed and cross mains to show the pipe function (e.g., "Sprinkler System", "Fire Department Connection", "Standpipe") and normal valve position (e.g. "Normally Open", "Normally Closed"). For pipe sizes 100 mm4-inch and larger provide white painted stenciled letters and arrows, a minimum of 50 mm2 inches in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 100 mm4-inch, provide white painted stenciled letters and arrows, a minimum of 18 mm0.75-inch in height and visible from the floor.[Provide properly lettered and approved metal sign to elevator flow switch stating the circuits' voltage, and identify the switch as an "Elevator Power Shunt Flow Switch".]

3.5 ELECTRICAL

****

NOTE: Coordinate power and alarm requirements with the contract drawings and other specification sections.

****

Except as modified herein, electric equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.[Alarm signal wiring connected to the building fire alarm control system must be by the fire alarm installer.]

3.6 PAINTING

****

NOTE: Designer will coordinate color code marking with Section 09 90 00 PAINTS AND COATINGS. Color code marking for piping which are not listed in Table I of Paragraph 3.5 Pipe Color Code Marking of UFGS Section 09 90 00 will be added to the table.

****

Color code mark piping [red][as specified in Section 09 90 00 PAINTS AND COATINGS].

3.7 FIELD QUALITY CONTROL

3.7.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level [III][or][IV] Fire Sprinkler Technician, and the representative of the installing company,[and reviewed by the QFPE] [60][_____] days prior to performing system tests. Detailed test procedures must list all components of the installed system. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 13 .) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government final testing.

a. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.7.2 Pre-Government Testing

3.7.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that equipment is functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" and "System Acceptance" as noted in NFPA 13. The Contractor [and QFPE] must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 13 and the test reports noted below.

a. NFPA 13 Aboveground Material and Test Certificate

b. NFPA 13 Underground Material and Test Certificate

3.7.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the [_____][Designated Fire Protection Engineer (DFPE)][Contracting Officers Designated Representative (COR)]. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the [building fire alarm system][installation fire alarm reporting system] have been completed and tested to confirm communications are fully functional. Submit request for test at least [15][_____] calendar days prior to the requested test date.

3.7.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.7.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. [b. The contractor's Qualified Fire Protection Engineer (QFPE).]

c. Marked-up red line drawings of the system as actually installed.

Government Final Tests will be witnessed by the [_____], [Designated Fire Protection Engineer][Contracting Officer][, Qualified Fire Protection Engineer (QFPE)]. At this time, all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.8 MINIMUM SYSTEM TESTS

The system, including the underground water mains, and the aboveground piping and system components, must be tested to ensure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure must be tested in accordance with NFPA 13 and NFPA 24.

3.8.1 Underground Piping

3.8.1.1 Flushing

****

NOTE: Designer should check the site water section for inconsistencies and to verify flushing of all underground pipe will be performed prior to connection to the sprinkler system.

****

Underground piping must be flushed in accordance with NFPA 24.

3.8.1.2 Hydrostatic Test

New underground piping must be hydrostatically tested in accordance with NFPA 24.

3.8.2 Aboveground Piping

3.8.2.1 Hydrostatic Test

Aboveground piping must be hydrostatically tested in accordance with NFPA 13. There must be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure must be read from a gauge located at the low elevation point of the system or portion being tested.

[3.8.2.2 Air Pressure Test

As specified in NFPA 13, an air pressure leakage test at 350 kPa50 psi must be conducted for 24 hours. There must be no drop in gauge pressure in excess of 10 kPa1.5 psi for the 24 hours. This air pressure test is in addition to the required hydrostatic test.

]3.8.2.3 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly must be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor must provide all equipment and instruments necessary to conduct a complete forward flow test, including 65-mm2.5-inch diameter hoses, playpipe nozzles or flow diffusers, calibrated pressure gauges, and pitot tube gauge. The Contractor must provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction loss) across the assembly must be recorded. A metal placard must be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate determined during the preliminary testing. The pressure drop must be compared to the manufacturer's data and the readings observed during the final inspections and tests.

3.8.3 Dry Pipe Valve Trip Test

Each dry pipe valve must be trip-tested by reducing normal system nitrogen pressure through operation of the inspector's test connection. Systems equipped with quick-opening devices must first be tested without the operation of the quick-opening device and then with it in operation. Test results will be witnessed and recorded. Test results must include the number of seconds elapsed between the time the test valve is opened and tripping of the dry valve; trip-point nitrogen pressure of the dry pipe valve; water pressure prior to valve tripping; and number of seconds elapsed between time the inspector's test valve is opened and water reaches the orifice. The delivery of water from the dry pipe valve to the system test connection must not exceed 60 seconds, regardless of system size. Water delivery times must be measured starting at the normal nitrogen pressure on the system.

3.8.4 Main Drain Flow Test

Following flushing of the underground piping, a main drain test must be made to verify the adequacy of the water supply. Static and residual pressures must be recorded on the certificate specified in paragraph SUBMITTALS.

3.8.5 Supervisory Nitrogen System Test

****

NOTE: Delete this paragraph for deluge system applications and preaction systems not requiring supervisory nitrogen.

****

System supervisory nitrogen pressure must be reduced from the normal system pressure to the point at which a low-pressure alarm is sounded. Nitrogen pressure must be restored to verify trouble signal restoration. Automatic start/stop features of nitrogen generator must be tested.

3.9 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the final acceptance test.

[a. Provide one set of full size paper as-built drawings and schematics. The drawings must be prepared electronically and sized no less than the contract drawings.] [Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation][AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]

b. Provide operating and maintenance (O&M) instructions.

3.10 ONSITE TRAINING

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NOTE: The number of hours of instruction should be determined based of the number and complexity of the systems specified.

****

Conduct a training course for the responding fire department and operating and maintenance personnel as designated by the Contracting Officer. Training must be performed on two separate days (to accommodate different shifts of Fire Department personnel) for a period of [_____][4] hours of normal working time and must start after the system is functionally complete and after the final acceptance test. The on-site training must cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-21 13 18 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-21 13 18.00 10 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-21 13 18 (August 2020)**

Preparing Activity: USACE **Superseding**
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SECTION 21 13 18

PREACTION SPRINKLER SYSTEMS, FIRE PROTECTION

08/20

****

NOTE: This guide specification covers the requirements for preaction fire protection sprinkler systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information. The designer is permitted to edit any and all of this section for the project. If the designer is modifying/deleting non-bracketed items and text, the Designated Fire Protection Engineer (DFPE) should be consulted prior to incorporating final changes.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

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NOTE: For OCONUS projects, this specification section should be edited for specific Host Nation requirements. Coordinate compliance with Host Nation requirements with the DFPE.

****

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NOTE: This specification section includes requirements from UFC 3-600-01 (change 4, 7 February 2020)

****

PART 1 GENERAL

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NOTE: Because preaction systems are more costly, less reliable, and require more maintenance than wet pipe systems, they should be used only where justified by occupancy conditions.

The Designer must edit this specification section for either a performance-designed system or a fully designed system as applicable.

This section is primarily intended for performance designed systems, e.g. systems where the size, layout, and support of branch lines and cross mains, and the layout of sprinklers will be designed by the Contractor.

This section is not intended to be used for NFPA 13D systems.

The Designer must provide the following information in the contract documents for performance designed systems. This information must be in accordance with UFC 3-600-01.

(1) Show the layout and size of all piping and equipment from the point of connection to the water supply, to the sprinkler riser. The contract drawings must include a detailed sprinkler riser diagram.

(2) Show location and size of service laterals, sprinkler risers, control valves, drain lines, sectional valves, and inspector's test valves and switches on the drawings.

(3) Specify waterflow data including hydrant flow test results, including the location where the hydrant flow test was conducted, the location and size of existing mains and new water supply lines that will serve the sprinkler system.

(4) Highlight or clearly indicate the area(s) to be protected by sprinklers on the drawings.

(5) Specify waterflow requirements including the design density, design area, the hose stream demand (including location of the hose stream demand), the duration of supply, and sprinkler spacing and area of coverage in this section.

(6) Show the location of the backflow preventer (including provisions for a drain and access for maintenance) on the drawings.

(7) Show all provisions necessary for forward flow testing of the backflow preventer at system demand

as required by NFPA 13 on the drawings.

(8) Highlight all concealed spaces on the drawings that require sprinkler protection, such as spaces above suspended ceilings that are built of combustible material or that can contain combustible materials, such as storage, and communication cabling that is not fire-rated.

(9) Provide details on the drawings of pipe restraints for underground piping. This includes details of pipe clamps, tie rods, mechanical retainer glands, and thrust blocks.

(10) Nitrogen generators, including controls and complete installation details, including piping, control valves, mounting base.

(11) Show location of the control unit, batteries and charger (if remotely mounted), supervising station transmitter, annunciator, primary power supply, remote annunciator, detectors, notification appliances (unless performance requirements are specified), and each alarm initiating device including fire extinguishing system switches.

(12) Show single-line releasing systems riser diagram. Each device on the riser should be identified by type. Indicate connection of equipment.

(13) Show a releasing system operating matrix . Show actions of input devices such as detectors, manual stations, waterflow switches, initiating devices, etc. on one axis and output functions such as door releases, smoke control fans, elevator relays, indicating/notification appliances etc. on the other. Entries which require descriptions, explanation of processes, sequences, interfaces, etc. can be flagged by symbols keyed to supplementary notes. Alternately provide a zone-by-zone sequence of operation or a schedule identifying all initiators, outputs, and interfaces.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the

Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1015	(2021) Performance Requirements for Double Check Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

AWWA M14	(2024) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTELLIGENCE COMMUNITY STANDARD (ICS)

ICS 705-1	(2010) Physical and Technical Security Standard for Sensitive Compartmented Information Facilities

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 13	(2024) Standard for the Installation of Sprinkler Systems
NFPA 24	(2025) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 101	(2024) Life Safety Code
NFPA 291	(2025) Recommended Practice for Fire Flow Testing and Marking of Hydrants
NFPA 1963	(2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UL SOLUTIONS (UL)

UL 199	(2020) UL Standard for Safety Automatic Sprinklers for Fire-Protection Service
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service
UL 268	(2023) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 312	(2022) UL Standard for Safety Check Valves for Fire-Protection Service

UL 405	(2013; Bul. 2020) UL Standard for Safety Fire Department Connection Devices
UL 464	(2023) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 521	(2024) UL Standard for Safety Heat Detectors for Fire Protective Signaling Systems
UL 668	(2004; Reprint Oct 2021) UL Standard for Safety Hose Valves for Fire-Protection Service
UL 789	(2004; Reprint May 2024) UL Standard for Safety Indicator Posts for Fire-Protection Service
UL 864	(2023; Reprint Oct 2024) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1638	(2023) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Feb 2024) UL Standard for Safety Signaling Devices for the Deaf and Hard of Hearing
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SYSTEM DESCRIPTION

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NOTE: Seismic protection/bracing is to be provided for seismic design categories C or greater only, unless specifically requested by the DFPE. Consideration should also be giving to utilizing seismic protection/bracing to limit pipe movement.

****

Provide [single-interlock][electric-pneumatic double-interlock]preaction[_____] [sprinkler] system(s) in [areas indicated on the drawings] [_____]. Except as modified herein, the system must meet the requirements of NFPA 13[and] and NFPA 72. Preaction systems must utilize nitrogen in lieu of air. Pipe sizes which are not indicated on the Contract drawings must be determined by hydraulic calculations.

1.2.1 Hydraulic Design

****

NOTE: Applications requiring multiple densities/design areas must be referred to and shown on the drawings.

Discharge density for non-storage occupancies must be in accordance with UFC 3-600-01. Specific densities must be listed on the drawings or noted in the specification when drawings are not provided. Stating "comply with UFC 3-600-01 is not acceptable.

Hazard classification of miscellaneous storage must be per NFPA 13. Discharge density for the hazard classification must be per UFC 3-600-01.

The paragraph below must be listed on the drawings. If this information is not listed on the drawings, provide the information in paragraph 1.1.1.3 (with brackets completed).

Hydraulically design the system to discharge a minimum density [of [_____] L/min per square meter gpm/square foot over the hydraulically most demanding [280] [_____] square meters[_____] square feet of floor area][as indicated on the drawings]. The minimum pipe size for branch lines in gridded systems must be 32 mm1 1/4-inch. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13.

****

****

NOTE: The addition, modification or relocation of no more than twenty sprinklers to an existing system or modifications to existing sprinkler systems fed from domestic supplies are permitted to be designed using the pipe schedule method in NFPA 13 based on the layout of the existing system.

****

1.2.1.1 Basis for Calculations

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NOTE: The design must include an adequate water supply to meet the sprinkler water demand. The designer must provide waterflow test results and hydraulic calculations to ensure that the system demand will be met.

Design Calculations: The designer must provide

detailed hydraulic calculations that clearly demonstrate that the water supply will meet the demand of the sprinkler system and hose streams. Calculations must be submitted with the concept design submission.

****

A waterflow test was performed on (DATE) at (LOCATION) and resulted in a static pressure of [_____ kPapsi] with a residual pressure of [_____ kPapsi] while flowing [_____ L/mingpm]. Perform a fire hydrant flow test prior to shop drawing submittal in accordance with NFPA 291. Results must include hydrant elevations relative to the building and hydrant number/identifiers for the tested hydrants, including which were flowed, which had a gauge. This information must be presented in a tabular form if multiple hydrants were flowed. The results must be included with the hydraulic calculations. Hydraulic calculations must be based on flow test noted in this paragraph, unless [verified by the NAVFAC[_____] Fire Protection Engineer and] approved by Contracting Officer. Hydraulic calculations must be based upon the Hazen-Williams formula with a "C" value noted in NFPA 13 for piping, [and [_____] for existing underground piping]. A "C" value of 120 is permitted to be used in hydraulic calculations when nitrogen is utilized.[Hydraulic calculations must be based on operation of the fire pump(s) provided in Section 21 30 00 FIRE PUMPS.] [The minimum residual pressure in a service lateral (lead-in) at the [design flow rate][150% of the fire pump rated flow] must be 138 kPa20 psi at [the inlet to the backflow preventer][the suction side of the fire pump]].

1.2.1.2 Hydraulic Calculations

a. Water supply curves and system requirements must be plotted on semi-logarithmic graph (N^1.85) paper so as to present a summary of the complete hydraulic calculation.

b. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, minimum discharge pressures and minimum flows. Elevations of hydraulic reference points (nodes) must be indicated.

c. Documentation must identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe.

d. Where the sprinkler system is supplied by interconnected risers, the sprinkler system must be hydraulically calculated using the hydraulically most demanding single riser. The calculations must not assume the simultaneous use of more than one riser.

e. All calculations must include the backflow preventer manufacturer's stated friction loss at the design flow or [83 kPa12 psi for reduced pressure][55 kPa8 psi for double check] backflow preventer, whichever is greater.

f. All calculations must be performed back to the actual location of the flow test, taking into account the direction of flow in the service main at the test location.

g. For gridded systems, calculations must show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. A flow diagram indicating the quantity and direction of flows must be included.

1.2.1.3 Design Criteria

Hydraulically design the system to discharge a minimum density [of [_____] L/min per square metergpm/square foot over the hydraulically most demanding [_____] square metersquare feet of floor area][as indicated on the drawings]. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13. Add an allowance for exterior hose streams of [_____] L/min gpm to the sprinkler system demand [at the fire hydrant shown on the drawings closest to the point where the water service enters the building] [at the point of connection to the existing water system].[An allowance for interior hose stations of [_____] L/min gpm must be added to the sprinkler system demand.]

1.2.2 Sprinkler Coverage

****

NOTE: The exception in NFPA 13 to eliminate sprinklers in electrical rooms is not applicable per UFC 3-600-01.

****

Sprinklers must be uniformly spaced on branch lines. Provide coverage throughout 100 percent of the [building][area noted on the Contract drawings]. This includes, but is not limited to, telephone rooms, electrical equipment rooms (regardless of the fire resistance rating of the enclosure), boiler rooms, switchgear rooms, transformer rooms, attached electrical vaults and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13. Provide sprinklers below all obstructions in accordance with NFPA 13. Exceptions are as follows:

a. Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.

[1.2.3 System Volume Limitations

Where the volume of an individual system piping exceeds 1890 liters500 gallons, provide the dry pipe valve with a quick-opening device. The maximum system capacity controlled by one dry pipe valve must not exceed 2800 liters750 gallons, unless it complies with the dry pipe system water delivery calculations noted in NFPA 13.

]1.2.4 Control System

****

NOTE: All areas to be protected with preaction sprinklers must be equipped with the detectors necessary to activate the sprinkler system.

****

The control system must meet the requirements of NFPA 72. The control unit must be listed for "Releasing Device Service". The control unit and the solenoid valve that activates the water control valves must be compatible with each other. Compatibility must be in accordance with the specific listing of the control equipment.

1.2.4.1 Circuit Requirements

Connect alarm initiating devices to initiating device circuits (IDC), Class [B][_____] or to signal line circuits (SLC), Class [B][_____], in accordance with NFPA 72.[Alarm notification or indicating appliances must be connected to notification appliance circuit (NAC), Class [B][_____] in accordance with NFPA 72.] Provide a separate circuit for actuation of each individual automatic water control valve. Fully supervise the circuits that actuate the water control valves so that the occurrence of a single open or a single ground fault condition in the interconnecting conductors will be indicated at the control unit.

1.2.5 System Operational Features

****

NOTE: Delete manual actuation stations when not required.

****

Include in the system a detection system, manual actuation stations, supervisory and alarm switches,[alarm notification appliances,] control unit and associated equipment. Provide preaction sprinkler system piping with supervisory nitrogen pressure not to exceed 210 kPa30 psig.

1.2.5.1 System Actuation

Activation of [a single][two][smoke][heat] detector[s] [or a single manual actuation station] must actuate alarm zone circuits of the control unit that, in turn, actuate the corresponding automatic water control valve. Actuation of the automatic water control valve must cause water to [fill the discharge piping after loss of nitrogen pressure][fill the discharge piping].

1.2.5.2 Alarm Functions

****

NOTE: Drawings must indicate and detail the connection of the system control unit to the building alarm system and/or to the base-wide fire reporting system.

****

Activation of a [heat detector][smoke detector], sprinkler pressure (waterflow) alarm switch or manual actuation station must cause the illumination of the respective device at the releasing control unit, and [activation of the building fire alarm system][transmission of the alarm to the base-wide fire reporting system].

1.2.5.3 Supervisory Functions

The reduction of supervisory nitrogen pressure within the sprinkler system piping to less than [70][_____] kPa[10][_____] psi or the increase in nitrogen pressure more than [70][_____] kPa[10][_____] psi above normal set pressure must be transmitted to the building fire alarm system via the releasing control unit as a supervisory condition. Valve tamper switches must be monitored by the releasing control unit and transmitted to the building fire alarm system as a supervisory condition.

1.2.6 Qualified Fire Protection Engineer (QFPE)

****

NOTE: UFC 3-600-01 requires that shop drawings must bear the Review Stamp and professional engineering stamp of the QFPE prior to submission to the Government for approval.

****

****

NOTE: The term Qualified Fire Protection Engineer (QFPE) should be considered interchangeable with the terms "Fire Protection Designer of Record (FPDOR)" and/or "Fire Protection QC Specialist" where referred to in other applicable contract documents. The intent of defining the QFPE roles and responsibilities here is NOT to require personnel in addition to the QFPE, FPDOR, and/or FPQC specialist referenced elsewhere in the applicable contract documents.

****

An individual who is a licensed professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Working (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Provide a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting all outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government [and final Government]functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

NOTE: When 20 or less sprinklers are added, modified or relocated, shop drawings, hydraulic calculations and product data are not required to be submitted. Edit this section accordingly.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Partial submittals and submittals not fully complying with NFPA 13 and this specification section must be returned disapproved without review. SD-02, SD-03 and SD-05 must be submitted simultaneously.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE must be returned disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G, [_____]

Sprinkler System Designer; G, [_____]

Sprinkler System Installer; G, [_____]

Releasing System Designer; G, [_____]

Releasing System Technician; G, [_____]

Releasing System Installer; G, [_____]

Nitrogen Generation System Commissioning Technician ; G, [_____]

Releasing System Site-Specific Software Acknowledgement; G, [_____]

SD-02 Shop Drawings

Shop Drawing; G, [_____]

[Notification Appliances; G, [_____]

] Initiating Devices; G, [_____]

Battery Power; G, [_____]

Voltage Drop Calculations; G, [_____]

SD-03 Product Data

Pipe; G, [_____]

Fittings; G, [_____]

Valves, including gate, check, butterfly, and globe; G, [_____]

Relief Valves; G, [_____]

Sprinklers ; G, [_____]

Pipe Hangers and Supports ; G, [_____]

Sprinkler Alarm Switch; G, [_____]

Valve Supervisory (Tamper) Switch; G, [_____]

Fire Department Connection; G, [_____]

Backflow Prevention Assembly; G, [_____]

Hose Valve; G, [_____]

[Seismic Bracing; G, [_____]

][High/Low-Nitrogen Pressure Supervisory Switch; G, [_____]

] Deluge Valve; G, [_____]

[Nitrogen Generation System; G, [_____]

] Releasing Control Unit (RCU); G, [_____]

Terminal Cabinets; G, [_____]

Supplemental Notification Appliance Circuit Panels; G, [_____]

Auxiliary Power Supply Panels; G, [_____]

Nameplates; G, [_____]

Batteries; G, [_____]

Battery Charger; G, [_____]

Smoke Detectors; G, [_____]

Air Sampling Smoke Detectors; G, [_____]

Heat Detectors; G, [_____]

[Notification Appliances; G, [_____]

] Addressable Interface Devices; G, [_____]

Addressable Control Modules; G, [_____]

Isolation Modules; G, [_____]

Remote Annunciator Panel; G, [_____]

Graphic Annunciator Panel; G, [_____]

Document Storage Cabinet; G, [_____]

Wire; G, [_____]

Surge Protective Devices; G, [_____]

[Back Boxes and Conduit; G, [_____]

][Ceiling Bridges for Ceiling-Mounted Appliances; G, [_____]

] SD-05 Design Data

[Air Sampling Smoke Detection System Calculations; G, [_____]

][Seismic Bracing; G, [_____]

Load calculations for sizing of seismic bracing

] Hydraulic Calculations; G, [_____]

Voltage Drop Calculations; G, [_____]

SD-06 Test Reports

Test Procedures; G, [_____]

SD-07 Certificates

Verification of Compliant Installation; G, [_____]

Request for Government Final Test; G, [_____]

SD-10 Operation and Maintenance Data

Operating and Maintenance (O&M) Instructions; G, [_____]

Spare Parts Data; G, [_____]

SD-11 Closeout Submittals

As-built drawings

1.4 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The releasing system manufacturer must submit written confirmation of this contract provision as "Releasing System Site-Specific Software Acknowledgement". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must include the following:

a. Items identified in NFPA 72, titled "Site-Specific Software".

b. Identification of programmable portions of the system equipment and capabilities.

c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

d. Provision of operational software data on all modes of programmable portions for foam releasing system.

e. Description of releasing system equipment operation.

f. Description of auxiliary and remote equipment operations.

g. Library of application software.

h. Operation and maintenance manuals.

1.5 QUALITY ASSURANCE

1.5.1 Preconstruction Submittals

Within 36 days of contract award but no less than [14 days][_____] prior to commencing work on site, the prime Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications will be returned Disapproved Without Review.

1.5.1.1 Shop Drawing

[_____] copies of the shop drawings, no later than 28 days prior to the start of system installation. Working drawings conforming to the requirements prescribed in NFPA 13 and must be no smaller than [ISO A1][ANSI D][the Contract Drawings]. Each set of drawings must include the following:

1. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

2. Floor plans drawn to a scale not less than 1:100 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, electrical power connections and other details required to clearly describe the proposed arrangement.

3. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross mains and branch lines to finished floor and roof or ceiling. A detail must show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

4. Longitudinal and transverse building sections showing typical branch line and cross main pipe routing, elevation of each typical sprinkler above finished floor and elevation of "cloud" or false ceilings in relation to the building ceilings.

5. Plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance.

6. Riser layout drawings drawn to a scale of not less than 1:25 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

7. Details of each type of riser assembly, pipe hanger, [sway bracing for earthquake protection,]and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) must be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.

8. Details of each type of pipe hanger[, seismic bracing/restraint] and related components.

[9. Include fire pump curve with shop drawings and hydraulic calculations.]

10. The calculated volume of each system.

11. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the RCU and remote fire alarm control units, initiating circuits, switches, relays and terminals.

12. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

1.5.1.2 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least [25][_____] percent spare capacity for notification appliances.

Annotate data for each circuit on the drawings.

1.5.1.3 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least [25][_____] percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.5.1.4 Battery Power

Provide battery calculations as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.5.1.5 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.5.1.6 Product Data

[_____] copies of annotated catalog data to show the specific model, type, and size of each item. Catalog cuts must indicate the NRTL listing. The data must be highlighted to show model, size, options, and other pertinent information, that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

1.5.1.7 Air Sampling Smoke Detection System Calculations

Submit air sampling detection system design analysis calculations consisting of battery capacity, loading calculations, and fan speed and air flow/transport calculations. Include schematic diagrams showing pipe segments, pipe diameters, lengths of pipe, node numbers, and sample port diameters to verify the requirements are met.

1.5.1.8 Hydraulic Calculations

****

NOTE: Include the first bracketed item for Army Corps projects.

****

Calculations must be as outlined in NFPA 13 except that calculations must be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings.[Calculations must include isometric diagram indicating hydraulic nodes and pipe segments.][Include fire pump curve with submittal.]

1.5.1.9 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.5.1.10 Operating and Maintenance (O&M) Instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA as supplemented and modified by this specification section.

Provide [six][_____] manuals[and one pdf version on electronic media]. The manuals must include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment.[Each service organization submitted must be capable of providing [4][_____]-hour on-site response to a service call on an emergency basis.]

Submit spare parts data for each different item of material and equipment specified. The data must include a complete list of parts and supplies, and a list of parts recommended by the manufacturer to be replaced after 1-year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

1.5.2 Qualifications

****

NOTE: NICET (National Institute for Certification in Engineering Technologies) establishes the qualifications of an individual as an Engineering Technologist with verification of experience by having a current NICET certification.

****

1.5.2.1 Sprinkler System Designer

The sprinkler system designer must be certified as a Level [III][IV] Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.5.2.2 Sprinkler System Installer

The sprinkler system installer must be regularly engaged in the installation of the type and complexity of system specified in the contract documents, and must have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.5.2.3 Releasing System Designer

The system designer must be certified as a Level [III][IV] (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7, or meet the qualifications for a QFPE.

1.5.2.4 Releasing System Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings[, and must be thoroughly experienced in the design and installation of air sampling detection systems].

1.5.2.5 Releasing System Installer

[Fire alarm installer with a minimum of two years of experience utilized to assist in the installation of devices, cabinets and control units.][NICET Level II technician to assist in the installation of devices, cabinets and control units.]A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.5.2.6 Nitrogen Generation System Commissioning Technician

Commissioning technician of nitrogen generation system(s) must have one of the following qualifications. Qualifications must be provided prior to preliminary inspection and tests.

a. Commissioning of nitrogen generation system must be carried out by technician employed by and certified by the nitrogen generation system manufacturer.

b. In lieu of manufacturer's commissioning technician, the fire sprinkler contractor must provide proof their commissioning technician has manufacturer's certified training for the equipment being installed and proof of at least five previous installations of manufacturer's equipment where the contractor's commissioning technician has successfully conducted commissioning under the direct supervision of the manufacturer's commissioning representative. Contractor must provide proof the five supervised commissioning occurred AFTER contractor's commissioning agent has obtained the certified training. Commissioning carried out prior to factory training, or without supervision of manufacturer's technician or commissioning of other manufacturer's equipment does not qualify as applicable experience. Conduct preliminary inspections and testing does not qualify as applicable experience.

1.5.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of an item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation are mandatory requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. All pipes must be either capped or plugged until installed.

1.7 EXTRA MATERIALS

Spare sprinklers and wrench(es) must be provided as spare parts in accordance with NFPA 13.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices listed for fire protection service when so required by NFPA 13 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for a classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least [2][_____] years prior to bid.

2.1.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Nameplates must be etched metal or plastic, permanently attached by screws to control units, panels or adjacent walls.

2.1.3 Identification and Marking

Pipe and fitting markings must include name or identifying symbol of manufacturer and nominal size. Pipe must be marked with ASTM designation. Valves and equipment markings must have name or identifying symbol of manufacturer, specific model number, nominal size, name of device, arrow indicating direction of flow, and position of installation (horizontal or vertical), except if valve can be installed in either position. Markings must be included on the body casting or on an etched or stamped metal nameplate permanently on the valve or cover plate.

2.1.4 Keys

Keys and locks for equipment, control units, panels and devices must be identical.[Master all keys and locks to a single key as required by the [Installation Fire Department][_____].][Keys must be CAT [60][_____].]

2.1.5 Pressure Ratings

Valves, fittings, couplings, alarm switches, and similar devices must be rated for the maximum working pressures that can be experienced in the system, but in no case less than [1207][1724] kPa[175][250] psi.

2.1.6 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a

Lexan plastic or glass cover in a stainless steel or aluminum frame.[Install the instructions on the interior of the RCU.][Install the frame in a conspicuous location observable from the RCU.] The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.2 UNDERGROUND PIPING COMPONENTS

****

NOTE: The design drawings must show the service connection details and the underground service lateral for the sprinkler system. The drawings must show details of the water service point-of-entry into the building and through the floor slab, and underground piping restraints, including number and size of restraining rods and thrust blocks. 4-inch piping is the minimum permitted for service laterals serving NFPA 13R systems. 6-inch piping is the minimum permitted for NFPA 13 systems.

****

2.2.1 Pipe

Pipe must comply with NFPA 24. Minimum pipe size is [100 mm4 inches][150 mm 6 inches]. Piping more than 1.50 meters5 feet outside the building walls must comply with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING. A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 304 mm 1-foot above the finished floor within the building is acceptable.

2.2.2 Fittings and Gaskets

Fittings must be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets must be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints must conform to AWWA C111/A21.11.

2.2.3 Gate Valve[and Indicator Posts]

****

NOTE: This paragraph will be deleted if underground valves are either not required or are specified elsewhere.

****

Installation must comply with NFPA 24. Gate valves for use with indicator post must conform to UL 262.[Indicator posts must conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.]

[2.2.4 Valve Boxes

Except where indicator posts are provided, for each buried valve, provide a cast-iron, ductile-iron, or plastic valve box of a suitable size. Plastic boxes must be constructed of acrylonitrile-butadiene-styrene (ABS) or inorganic fiber-reinforced black polyolefin. Provide cast-iron, ductile-iron, or plastic cover for valve box with the word "WATER" cast on the cover. The minimum box shaft diameter must be 133 mm5.25 inches. Coat cast-iron and ductile-iron boxes with bituminous paint applied to a minimum dry-film thickness of 0.254 mm10 mils.

]2.2.5 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape, 80 mm3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification must read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING COMPONENTS

****

NOTE: Specify steel piping exposed to the weather or corrosive atmospheres to properly protect against corrosive effects.

NOTE: GALVANIZED PIPING IS ONLY PERMITTED FOR DELUGE SYSTEMS, VALVE TRIM PIPING AND DRAIN PIPING WHEN EXPOSED TO THE EXTERIOR.

****

2.3.1 Steel Piping Components

2.3.1.1 Steel Pipe

****

NOTE: For DLA, use Schedule 40 steel pipe only.

NOTE: Grooved pipe must be cut grooved for WHS projects.

****

Except as modified herein, steel pipe must be black as permitted by NFPA 13 and conform to the applicable provisions of ASTM A53/A53M, ASTM A135/A135M or ASTM A153/A153M.

[Steel pipe must be minimum Schedule 40 for sizes 50 mm2 inches and less; and minimum Schedule 10 for sizes larger than 50 mm2 inches.][Steel pipe must be Schedule 40 only.] Steel piping with wall thickness less than Schedule 40 must not be threaded. [Grooved pipe must be cut-grooved.]

2.3.1.2 Fittings

Fittings must be welded, threaded, or grooved-end type. Threaded fittings must be cast-iron conforming to ASME B16.4, malleable-iron conforming to ASME B16.3 or ductile-iron conforming to ASTM A536. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, steel press fittings and field welded fittings are not permitted. Fittings, mechanical couplings, and rubber gaskets must be supplied by the same manufacturer. Threaded fittings must use Teflon tape or manufacturer's approved joint compound.[Saddle tees using rubber gasketed fittings are permitted only when connecting to existing piping for additions or modifications. Saddle tees must use a connection method that completely wraps around the pipe.] Reducing couplings are not permitted except as allowed by NFPA 13.

2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings must be designed for not less than 1200 kPa175 psi service and must be the product of the same manufacturer. Field welded fittings must not be used. Fitting and coupling housing must be malleable-iron conforming to ASTM A47/A47M, Grade 32510; ductile-iron conforming to ASTM A536, Grade 65-45-12. Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 50 mm2 inches and larger. Gasket must be of silicon compound and listed for dry fire protection systems. Gasket must be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts must be heat-treated steel conforming to ASTM A183 and must be cadmium-plated or zinc-electroplated.

2.3.1.4 Flanges

Flanges must conform to NFPA 13 and ASME B16.1. Gaskets must be non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16-inch thick, and full face or self-centering flat ring type.

[2.3.2 Copper Tube Components

2.3.2.1 Copper Tube

Copper tube must conform to ASTM B88MASTM B88, Types L and M.

2.3.2.2 Copper Fittings and Joints

Cast copper alloy solder-joint pressure fittings must conform to ASME B16.18 and wrought copper and bronze solder-joint pressure fittings must conform to ASME B16.22 and ASTM B75/B75M. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

]2.3.3 Pipe Hangers and Supports

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NOTE: Seismic parameters must follow UFC 3-301-01 Structural Engineering. The writer of this section must coordinate with the Structural Engineer or Government to determine the proper seismic design category for the project, in accordance with the IBC or ASCE guidelines. See UFC 3-310-04 for more information.

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Provide galvanized pipe hangers[, supports and seismic bracing][and supports] in accordance with NFPA 13.[Design and install seismic protection in accordance with the requirements of NFPA 13 section titled "Protection of Piping Against Damage Where Subject to Earthquakes for Seismic Design Category ["D"]["_____"]].

2.3.4 Valves

Provide valves of types approved for fire service. Valves must open by counterclockwise rotation.

2.3.4.1 Control Valve

Manually operated sprinkler control/gate valve must be [outside stem and yoke (OS&Y) type][or][butterfly type][as indicated on the drawings] and must be listed.

2.3.4.2 Check Valves

Check valves must comply with UL 312. Check valves 100 mm4 inches and larger must be of the swing type, have a clear waterway and meet the requirements of MSS SP-71, for Type 3 or 4. Inspection plate must be provided on valves larger than 150 mm6 inches.

2.3.4.3 Hose Valve

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NOTE: Hose valves are required as part of the backflow prevention test header.

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Valve must comply with UL 668.

2.4 AUTOMATIC WATER CONTROL VALVE (DELUGE VALVE)

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NOTE: "Automatic water control valve" is a generic term synonymous with "deluge valve" and is used for both preaction and deluge systems. "Automatic water control valve" is consistent with what is used in the UL Fire Protection Equipment Directory. Delete reset capability when not required.

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Automatic water control valve (deluge valve) must be [electrically][hydraulically][pneumatically]-actuated and rated for a working pressure of 1207 kPa175 psi. Valve must be capable of being reset without opening the valve. Electrical solenoid valve used to actuate the water control valve must be an integral component of the valve or must be approved for use by the water control valve manufacturer. Solenoid valve must be rated at 24 volts direct current, and must be normally closed type that operates when energized. Solenoid valves must be rated for a maximum pressure differential of 1207 kPa175 psi. Water control valve must be equipped with a means to prevent the valve from returning to the closed position until being manually reset. Assembly must be complete with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances. Include with each assembly an emergency release device for manually tripping the water control valve in the event of a power or other system failure. Device must be a standard accessory component of the valve manufacturer and labeled as to its function and method of operation. Valves located in hazardous locations must be approved for the hazard classification of the area where located.

2.5 SUPERVISORY NITROGEN SYSTEM

Provide a nitrogen supply system in accordance with NFPA 13. The connection pipe from the nitrogen generator must not be less than 13 mm 1/2-inch in diameter and must enter the system above the priming water level of the dry pipe valve. Install a check valve in the system supply nitrogen piping from the generator. A shutoff valve of the renewable disc type must be installed upstream of this check valve. The nitrogen supply system must be sized to pressurize the sprinkler system to [275][_____] kPa [40][_____] psi within 20 minutes.

2.5.1 Nitrogen Generation System

The nitrogen generation system (NGS) must be installed with a compressor sized appropriately for the application and capable of achieving system pressure within 30 minutes in accordance with the requirements of NFPA 13. The nitrogen generation system must be designed to achieve a nitrogen concentration of 98% or greater and maintain that concentration within the fire sprinkler system continuously. The output nitrogen quality must be confirmed by using a gas stream analyzer. Where multiple preaction sprinkler risers are present, provide a manifold adjacent to the preaction sprinkler risers. Manifold system must include automatic vent and air maintenance devices for each sprinkler system riser. Nitrogen generation system requires a dedicated, hardwired 120V AC power supply.

2.5.1.1 Design of Nitrogen Generation System

Design the system so all equipment is installed within the confines of the riser room with the exception of a connection for a manual or automatic gas analyzer. Provide a system that is capable of delivering a minimum of 98 percent nitrogen composition throughout all of the system piping within 14 days from the commencement of the inerting process. Provide membrane type nitrogen generators that provide "instant on-instant off" nitrogen gas production without the need for nitrogen storage tanks. The complete nitrogen generator system must be self-contained and skid mounted with "drop-in" operability with a simple one step direct connection of the nitrogen gas supply line to each zone/riser. Provide an automatic "fill and purge" breathing process. This must be done while the sprinkler system is fully functional and must not alter the design performance of the sprinkler system. A process that involves continuous venting of the piping network is not permitted. Air maintenance devices used in conjunction with the nitrogen generation system must be listed for use on sprinkler systems. At the riser and at the end of each zone, provide a connection for a [manual][automatic] gas analyzer.

2.5.1.2 Nitrogen Air Compressor

Air compressors to be used in conjunction with the nitrogen generator must be capable of the following:

a. Capable of producing a continuous stream of compressed air at 100+ psig.

b. Capable of automatic cut in and cut out.

c. Equipped with an on-board after-cooler.

d. Equipped with an on-board automatic water blow down system.

e. Equipped with vibration dampening system.

f. Equipped with an air storage tank to provide continuous delivery of compressed air to the nitrogen generator.

g. Rated for continuous duty service.

h. Compressors less than 3.0 hp must be an oil-less design.

i. Oil-less compressors must be such that the manufacturer has designed the oil-less compressor to provide 5000 hours of continuous duty service before requiring a gasket and seal rebuild.

2.5.1.3 Nitrogen Venting Device

The functional component of the nitrogen venting device for use in the "fill and purge" breathing process must:

a. Be NRTL listed for use on sprinkler systems.

b. Not require plumbing to drain.

c. Close automatically at the completion of the nitrogen inerting process without manual intervention.

d. Be installed on each zone in the riser room.

2.5.1.4 Supervision of Nitrogen Generator

Nitrogen generator must be able to provide the following monitoring options:

a. Power supply "on" for nitrogen generators.

b. Power supply "on" for compressor.

c. Amp draw for compressor.

d. Line pressure (psig).

e. Nitrogen purity at discharge (sample port for use with [manual][automatic] gas analyzer).

2.5.2 Nitrogen Pressure Maintenance Device

Device must be a pressure regulator that automatically reduces supply air pressure to the minimum pressure required to be maintained in the piping system. The device must have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1.6-mm1/16-inch restriction to prevent rapid pressurization of the system, and adjustment screw. The device must be capable of reducing maximum inlet pressure of 680 kPa100 psi to a fixed outlet pressure adjustable to [70][_____] kPa[10][_____] psi.

2.6 ALARM INITIATING AND SUPERVISORY DEVICES

2.6.1 Sprinkler Alarm Switch

pressure-type flow switch(es). [Connection of switch must be by the fire alarm installer].

2.6.2 High/Low-Nitrogen Pressure Supervisory Switch

Each automatic water control valve must be provided with a nitrogen pressure switch connected to the control unit. The pressure switch must supervise the nitrogen pressure in the system and must be set to activate at 70 kPa10 psi above the automatic water control valve trip point pressure (low) and 70 kPa10 psi above normal nitrogen pressure (high). The switch must have an adjustable range between 35 and 500 kPa5 and 80 psi. The switch must have screw terminal connection and must be capable of being wired for normally open or normally closed circuit.

2.6.3 Valve Supervisory (Tamper) Switch

Switch must be integral to the control valve or suitable for mounting to the type of control valve to be supervised open. The switch must be tamper resistant and contain SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

[2.7 BACKFLOW PREVENTION ASSEMBLY

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NOTE: Indicate piping, type of connection and equipment, such as a test header with hose valves, required for flow testing of the backflow preventer at full system demand as required by NFPA 13. Arrangement of test assembly should be coordinated with the installation.

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[Reduced-pressure principle][Double-check] valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve must have a drain. Backflow prevention assemblies must have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List is acceptable as the required documentation.

2.7.1 Backflow Preventer Test Connection

Test connection must consist of a series of listed hose valves with 65-mm2 1/2-inch National Standard male hose threads with cap and chain.

]2.8 FIRE DEPARTMENT CONNECTION

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NOTE: The designer will coordinate the desired location and thread type for the fire department connection with the responding fire department.

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Fire department connection must be [freestanding][projecting][flush] type with cast-brass body, matching [wall] escutcheon lettered "Auto Spkr" with a [polished-brass][chromium-plated] finish. [The connection must have individual self-closing clappers, caps with drip drains and chains.] Female inlets must have [65-mm2 1/2-inch][100 mm4-inch][125 mm5-inch][_____] diameter [American National Fire Hose Connection Screw Threads (NH) per NFPA 1963] [Storz][_____]. Comply with UL 405.

2.9 SPRINKLERS

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NOTE: The designer will indicate on the contract drawings the type of sprinklers for each area if more than one type of sprinkler is to be provided. Delete sprinkler types from this paragraph that are not intended for use in the system(s) used in the Contract.

Areas that are classified as light hazard will be equipped with quick-response sprinklers.

****

Sprinklers must comply with UL 199 and NFPA 13. Sprinklers with internal O-rings are not acceptable. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters must have temperature classification in accordance with NFPA 13. Extended coverage sprinklers are permitted for loading docks, residential occupancies and high-piled storage applications only. Sprinklers for preaction systems must be automatic, fusible solder or glass bulb type.

2.9.1 Pendent Sprinkler

Pendent sprinkler must be of the dry pendent type, unless otherwise indicated. Pendent sprinkler must be[recessed][quick-response][dry pendent] type with nominal K-factor of [80][115][160][_____] [5.6][8.0][11.2][_____]. Pendent sprinklers must have a [polished chrome][stainless steel][white polyester][_____] finish. Assembly must include an integral escutcheon.

2.9.2 Upright Sprinkler

Upright sprinkler must be [brass][chrome-plated][stainless steel][white polyester] [quick-response type][_____] with a nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____].

2.9.3 Sidewall Sprinkler

Sidewall sprinkler must be the [quick-response][standard-response] [recessed][dry sidewall] type. Sidewall sprinkler must have a nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____]. Sidewall sprinkler must have a [brass][polished-chrome][stainless steel][white polyester][_____] finish.

[2.9.4 Corrosion-Resistant Sprinkler

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NOTE: The use of corrosion-resistant sprinklers is generally limited to industrial type occupancies such as electroplating, steam rooms, salt storage, and piers and wharves.

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Corrosion-resistant sprinkler must be the [upright][pendent] type installed in locations as indicated. Corrosion-resistant coatings must be factory-applied by the sprinkler manufacturer.

]2.10 ACCESSORIES

2.10.1 Sprinkler Cabinet

Spare sprinklers must be provided in accordance with NFPA 13 and must be placed in a suitable metal or plastic cabinet of sufficient size to accommodate all the spare sprinklers and wrenches in designated locations. Spare sprinklers must be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed as required by NFPA 13. At least one wrench of each type required must be provided.

2.10.2 Pendent Sprinkler Escutcheon

Escutcheon must be one-piece metallic type with a depth of less than 19 mm 3/4-inch and suitable for installation on pendent sprinklers. The escutcheon must have a factory finish that matches the pendent sprinkler.

2.10.3 Pipe Escutcheon

Provide split hinge metal plates for piping entering walls, floors, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.10.4 Sprinkler Guard

Listed guard must be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards must be provided on sprinklers located [_____][within 2.1 meters7 feet of the floor][as indicated].

2.10.5 Relief Valve

Relief valves must be listed and installed at there riser in accordance with NFPA 13.

2.10.6 Identification Sign

Valve identification sign must be minimum 150 mm wide by 50 mm high6 inches wide by 2 inches high with enamel baked finish on minimum 1.214-mm18 gage steel or 0.6-mm0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign must include, but not be limited to "main drain", "auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required to identify operational components. Where there is more than one sprinkler system, signage must include specific details as to the respective system.

2.11 RELEASING CONTROL UNIT (RCU)

The RCU must be listed, analog-addressable and compatible with the system, devices and functions specified.[Route all supervision of the RCU through the main FACU.] The RCU must perform all functions necessary to operate the system detection, actuation, and auxiliary functions independent of the FACU. The control system must be microprocessor-based utilizing distributed processing concept. A single microprocessor failure must not impact operation of additional modules on the system. The control system must be capable of supporting an air aspirating smoke detection system. The control system's initiating circuits must be capable of Class A or Class B operation. The solenoid must be listed for use with the releasing unit and extinguishing equipment. Each circuit must be capable of monitoring contact devices configured for manual release, trouble input or auxiliary (non-fire) input. The RCU must contain release circuits for activation of an extinguishing system[s]. Each release circuit must be capable of Class B operation. The RCU must contain at least two notification appliance circuits for annunciation. Each notification circuit must be capable of Class A or Class B operation. Provide alarm/trouble reset switches to reset a cleared device in alarm or trouble. Alarm or trouble signals are not to be self-restoring without activating the switch.

Annunciator must be integral with the RCU. Annunciation must be by an indicator lamp, alphanumeric display, or other equivalent means in which each indication provides status information about a circuit, condition, or location and visible through the cabinet door. Supervision is not required provided that a fault in the annunciator circuits results only in loss of annunciation and does not affect the normal functional operation of the remainder of the system. Ensure each visible indicator provides specific identification of the [zone][area][device]. Do not use generic nondescript wording such as "Zone 1", or "Zone 2", for the label identification.

An operator at the RCU, having the proper access level must have the capability to manually access the following information for each initiating device:

a. Primary status.

b. Device type.

c. Present average value.

d. Present sensitivity selected.

e. Sensor range (normal, dirty, etc).

2.12 ANNUNCIATOR

[2.12.1 Remote Annunciator Panel

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NOTE: Provide a remote annunciator only for very large spaces with 10 or more smoke detectors.

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Provide a [semi-recessed][flush] mounted annunciator that includes an LCD display. The display must indicate the device in trouble/alarm or the supervisory device. Display the device name, address[, and actual building location]. The remote annunciator must duplicate functions of the RCU for message display, fire alarm, supervisory alarm, and trouble conditions, visual and audible notification, and system reset functions. Remote annunciator must require the use of a key for accessing the reset, control and other functions.

][2.12.2 Graphic Annunciator Panel

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NOTE: Graphic annunciator panels should be provided only when a large number of concealed devices are installed. Normally, exposed devices will be

annunciated by zone only on the fire alarm control unit zone annunciator and remote zone annunciator. Edit accordingly. Locate panel(s) at or near building entrance to allow fire department quick access to panel.
****

Panel must be of the [interior][weatherproof] type, [flush][surface][pedestal]-mounted. Panel must be provided with the [building][room] floor plan, drawn to scale, with alarm lamps mounted to represent the location of [each concealed detector][each initiating device]. Panel graphic must also show the locations of the annunciator panel and control unit, and must have a "you are here" arrow showing its location. Orient building floor plan on graphic to location of person viewing the graphic, i.e. the direction the viewer is facing must be toward the top of the graphic display. Provide a North arrow.[Principal rooms and areas shown must be labeled with room numbers or titles.] Detectors mounted above ceilings[, on ceilings,] and beneath raised floors and different types of initiating devices must have different symbols or lamps of different colors for identification. Lamps must illuminate upon activation of corresponding device and must remain illuminated until the system is reset. Panel must have a lamp test switch.

2.12.2.1 Materials

Construct the graphic annunciator face plate of [smoked Plexiglas][non-glare matte finish][anodized bronze][anodized aluminum]. The face plate must be backlit with LEDs. Control equipment and wiring must be housed in a [recessed][semi-recessed][surface mounted] back box. The exposed portions of the back box must be [chrome plated][anodized bronze][anodized aluminum] without knockouts.

2.12.2.2 Programming

Where programming for the operation of the graphic annunciator is accomplished by a separate software program other than the software for the RCU, the software program must not require reprogramming after loss of power. The software must be reprogrammable in the field.

]2.13 SMOKE DETECTORS

2.13.1 Photoelectric Smoke Detectors

Smoke detector must be photoelectric type and listed for use with the RCU.

a. Provide analog/addressable photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke detectors must be listed for use with the RCU.

b. Provide self-restoring type detectors that do not require readjustment after actuation at the RCU to restore them to normal operation. Detectors must be listed as smoke-automatic fire detectors.

c. Components must be rust and corrosion resistant. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases for the detectors. The detectors must maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The detector must have a visual indicator to show actuation.

e. The detector address must identify the particular unit, its location within the system, and its sensitivity setting. Detectors must be of the low voltage type rated for use on a 24 VDC system.

f. An operator at the control unit, having a proper access level, must have the capability to manually access the following information for each initiating device.

    (1) Primary status.

    (2) Device type.

    (3) Present average value.

    (4) Present sensitivity selected.

    (5) Sensor range (normal, dirty, and other similar information).

2.13.2 Laser Smoke Detectors

a. Addressable laser smoke detectors must utilize laser diode and patented smoke sensing chamber, designed to amplify signals from smoke but diminish stray internal reflections and must, on command from the RCU, send data to the panel representing the analog level of smoke density.

b. Smoke detector must be listed for use with the RCU. Detector must be able to achieve sensitivities from 0.02 percent-per-foot to 2 percent-per-foot obscuration.

c. Laser smoke detector must provide point identification of the fire location through addressability, must experience no delay in response time due to smoke dilution or smoke transportation time, and must offer complete supervision of wiring and detector.

[2.13.3 Air Sampling Smoke Detectors

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NOTE: Detector selection and spacing should be based on the applicable cooling system in the hazard area. Detection should be listed for the anticipated temperature and airflow in the hazard area.

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The [addressable]air sampling smoke system must consist of a detector assembly housing an integral aspiration fan, filter, laser-based detection chamber and control, output and supervision circuitry.[Each sampling point must be capable of being independently addressable.] The system must consist of a piping or tubing distribution network that runs from the detector assembly(s) to the protected area(s) and is supported by air sampling smoke detection system calculations from a computer-based design modeling tool. The system must include configurable alarm and trouble relay outputs for interface to other systems where required.

a. System must be complete in all ways. It must include all engineering, and electrical installation, all detection and control equipment, auxiliary devices and controls, alarm interface, functional checkout and testing, training and all other operations necessary for a functional system.

b. System base detectors and modules must each accommodate up to [40 addressable][_____] microbore sampling tubes where each tube has a sampling point at the end. Additional modules may be used to provide up to [20 addressable][_____] sampling holes per system.

c. Program alarm thresholds to the following values unless the results of the system acceptance tests indicate a clear need to change them. In the event that such a need is indicated, notify the Contracting Officer and provide complete documentation concerning the need to deviate from these values. Include within the deviation documentation request, information that complies with the paragraph entitled "Sensitivity Verification Test". Ensure initial threshold levels are approved prior to the final acceptance test.

    (1) Alarm Level 1: set ALERT at [_____][0.0250] percent obscuration/foot.

    (2) Alarm Level 2: set PRE-ALARM at [_____][0.0500] percent obscuration/foot.

    (3) Alarm Level 3: set FIRE 1 at [_____][0.1000] percent obscuration/foot.

    (4) Alarm Level 4: set FIRE 2 at [_____][0.2000] percent obscuration/foot.

d. All air sampling smoke detection devices and associated components must be new, standard products or the manufacturer's latest design and suitable to perform the functions intended.

e. The laser detection chamber must be of the mass light scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method must be employed for the purposes of:

    (1) Preventing large particles from affecting the true smoke reading.

    (2) Monitoring contamination of the filter, e.g., dust and dirt, to automatically notify when maintenance is required. The particle counting method must not be used for the purpose of smoke density measurement.

f. Detector(s) must be self-monitoring for filter contamination and provide indication through system fault when replacement is necessary. Detectors which allow automatic reset of filter status upon removal and re-insertion are not permitted.

g. Detector(s) must contain relays for alarm and fault conditions. The relays must be software programmable to the required functions.

h. Detector(s) must permit configuration by programmers that are either integral to the system, portable or PC based.

i. Detector(s) must allow programming of:

(1) Smoke threshold alarm levels; ALERT, PRE-ALARM, FIRE 1 and FIRE 2.

(2) Time delays. Ensure the display control unit contains individual adjustable alarm time delay features for each of the alarm threshold levels. Provide an adjustment range between 0 and 60 seconds. Program the alarm threshold time delays to 30 seconds for alarm levels 1 and 2, and 15 seconds for alarm levels 3 and 4.

(3) Faults, including airflow, detector, power, filter and network, as well as an indication of the urgency of the fault.

(4) Configuration of relay outputs for remote indication of alarm and fault conditions.

(5) General purpose input functionality.

]2.14 HEAT DETECTORS

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NOTE: The location and type of heat detectors and alarm devices must be indicated on project drawings. Delete descriptive paragraphs of detectors types not used. Alarm indicator should be used only if necessary to meet project requirements.

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2.14.1 Heat Detectors

Heat detectors must be analog/addressable and designed for detection of fire by [fixed temperature][combination fixed temperature and rate-of-rise principle] [rate-compensating principle] in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values.. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations[as defined by NFPA 70][and][as indicated], must be types approved for such locations.

[2.14.1.1 Rate Compensating Detectors

Detector back box must be [surface][flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring and hermetically sealed. The detector assembly must be [weatherproof][and][explosionproof].

][2.14.1.2 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-resetting Detector must operate at [57.2][90] degrees C[135][194] degrees F. Detector must feature rate compensation. [Detectors rated to operate at 57.2 degrees C135 degrees F will not respond to momentary temperature fluctuations less than 16.7 degrees C30 degrees F per minute between 16 and 38 degrees C60 and 100 degrees F.][Detectors rated to operate at 90 degrees C194 degrees F will not respond to momentary temperature fluctuations less than 27.8 degrees C 50 degrees F per minute between 16 and 66 degrees C60 and 150 degrees F].[The detector assembly must be [weatherproof][and][explosionproof].]

][2.14.1.3 Fixed Temperature Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. The detectors must have a specific temperature setting [of [57.2][_____] degrees C[135][_____] degrees F][as shown]. [The detector assembly must be [weatherproof][and][explosionproof].]

]2.15 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored must be configured as a [Class "A"][Class "B"] initiating device circuit. The module must be listed as compatible with the control unit. The monitor module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED.[Existing releasing system initiating device circuits must be connected to a single module to supervise the circuit.] Modules must be listed for the environmental conditions in which they will be installed.

2.16 ADDRESSABLE CONTROL MODULES

The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders. The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as a Class "B" notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and prevent power from being applied to the circuit. The control model must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

2.17 ISOLATION MODULES

a. Provide isolation modules to subdivide each signaling line circuit [into groups of not more than [20 addressable devices][_____]][each floor][in accordance with NFPA 72] between adjacent isolation modules.

b. Isolation modules must provide short circuit isolation for signaling line circuit wiring.

c. Power and communications must be supplied by the SLC and report faults to the RCU.

d. After the wiring fault is repaired, the fault isolation modules must test the lines and automatically restore the connection.

[2.18 NOTIFICATION APPLIANCES

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NOTE: The notification appliances are for providing

local notification of a sprinkler system operation. These devices are not intended to provide general building fire alarm evacuation.

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Notification appliances must be suitable for connection to supervised notification appliance circuits. Appliance must have a separate screw terminal for each conductor. The surface of the appliance must be red in color.

2.18.1 Horns

Horns must conform to the applicable requirements of UL 464. Horns must be [semi-flush mounted][surface mounted], with the matching mounting backbox surface mounted vibrating type suitable for use in an electrically supervised circuit. Horns must produce a sound rating of at least 85 dBA at 3 meters10 feet. Horns used in exterior locations must be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

2.18.2 Visual Notification Appliances

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NOTE: 1. ABA requires that Visual Notification Appliances be provided in buildings and facilities in each of the following areas: restrooms, and any general usage area (e.g., meeting rooms), hallways, lobbies, and any other area for common use and other areas stated at www.access-board.gov. The Visual Notification Appliance must be mounted as required by ABA that directs compliance with NFPA 72 except that the maximum allowable sound level of audible notification appliances must have a sound level no more than 110 dB at the minimum hearing distance from the audible appliance. In addition, alarms in guest rooms required to provide communication features must comply with sections 18.5.4.6 of NFPA 72. Shop drawings must indicate location, dimensions, content, details, and other required information to indicate extent of complying with ABA requirements.

2. Currently NFPA 72 requires "clear color" strobes for Fire Alarm Notification. NFPA 72 requires the strobe must be marked "Fire" to clearly identify the function.

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Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED). The light pattern must be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of [15][30][75][_____] candela based on the UL 1971 test. Strobe must be [surface][semi-flush] mounted.

]2.19 ELECTRICAL

****
NOTE: Coordinate power and alarm requirements with the contract drawings and other specification sections.
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2.19.1 Wire

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.19.2 Alarm Wiring

IDC and SLC wiring must be [fiber optic][or][solid copper] cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. [14][16][18][_____] AWG size conductors at a minimum.[Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 14 AWG size conductors at a minimum.] Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors, appliances, or combination thereof. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with NFPA 70.

2.20 SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage RCU components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on the signaling line circuits. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the releasing control unit breaker is located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. A unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for releasing system wiring. The base assembly must accept "plug-in" surge protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

  (1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

  (2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

  (3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

  (4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.21 ELECTRIC POWER

2.21.1 Primary Power

Power must be [120][_____] VAC [50][60] Hz service for the RCU from the AC service to the building in accordance with NFPA 72.

2.22 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.22.1 Batteries

Provide sealed, maintenance-free,[valve regulated lead acid] batteries as the source for emergency power to the RCU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.22.1.1 Capacity

Battery size must apply to every control unit and panel associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, and fire alarm transmitters.

a. Sufficient capacity to operate the releasing system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes (or minimum required time for automatice water control valve release).

2.22.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

  (1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit or panel component, and compliance with UL 864.

  (2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

  (3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries. Calculations must be performed using the minimum rated voltage of each component.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing devices, appliances, or combination of devices and appliances remote from the power sources.

2.22.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work that is dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative all conditions that prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

The installation must be in accordance with the applicable provisions of NFPA 13, NFPA 24, NFPA 72 and publications referenced therein.[Installation of in-rack sprinklers must comply with applicable provisions of NFPA 13.] Locate sprinklers in a consistent pattern with ceiling grid, lights, and air supply diffusers. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

a. Piping offsets, fittings, and other accessories required must be furnished to provide a complete installation and to eliminate interference with other construction.

b. Wherever the contractor's work interconnects with work of other trades the Contractor must coordinate with other Contractors to insure all Contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers and similar equipment) concealed above hung ceilings by permanent color coded pins/tabs in the ceiling directly below the item.

c. Provide required supports and hangers for piping, conduit, and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid must be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

3.2.1 Waste Removal

At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash which may have accumulated during the day as a result of work by the contractor and of his presence on the job. Sidewalks and streets adjoining the property must be kept broom clean and free of waste, debris, trash and obstructions caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities, and property.

3.3 UNDERGROUND PIPING INSTALLATION

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NOTE: Restraint of the underground piping must be detailed on the contract drawings.

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The fire protection water main must be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover must be [900][_____] mm [3][_____] feet or the frost line, whichever is deeper. The supply line must terminate inside the building with a flanged piece, the bottom of which must be set not less than 304 mm1-foot above the finished floor. A blind flange must be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block must be provided at the elbow where the pipe turns up toward the floor. In addition, joints must be anchored in accordance with NFPA 24. Buried steel components must be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 1500 mm5 feet outside the building walls must meet the requirements of Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.4 ABOVEGROUND PIPING INSTALLATION

The methods of fabrication and installation of the aboveground piping must fully comply with the requirements and recommended practices of NFPA 13 and this specification section.

3.4.1 Protection of Piping Against Earthquake Damage

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NOTE: The writer of this section must coordinate with the Structural Engineer or Government to determine the proper seismic design category for the project, in accordance with the IBC or ASCE guidelines. See UFC 3-310-04 for more information.

****

Seismic restraint is [not]required.

3.4.2 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, must be installed to provide maximum headroom.

3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping must be concealed above ceilings. Piping must be inspected, hydrostatically tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas must be concealed.

3.4.4 Pendent Sprinklers

****

NOTE: Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 6.9 bar100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 300 mm12 inches for steel pipe and 1500 mm6 inches for copper tube.

****

a. Drop nipples to pendent sprinklers must consist of minimum 25-mm1-inch pipe with a reducing coupling into which the sprinkler must be threaded.

b. Where sprinklers are installed below suspended or dropped ceilings, drop nipples must be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling must not extend below the underside of the ceiling.

c. Recessed pendent sprinklers must be installed such that the distance from the sprinkler deflector to the underside of the ceiling must not exceed the manufacturer's listed range and must be of uniform depth throughout the finished area.

d. Pendent sprinklers in suspended ceilings must be located in the center of the tile (+/- 2 inches).[

e. Dry pendent sprinkler assemblies must be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space.][

f. Dry pendent sprinklers must be of the required length to permit the sprinkler to be threaded directly into a branch line tee.][

g. Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 6.9 bar100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 300 mm12 inches for steel pipe and 1500 mm6 inches for copper tube.]

h. Sprinklers installed in the pendent position must be of the listed dry pendent type or on return bends, unless otherwise indicated.

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers must contain no fittings between the branch line tee and the reducing coupling at the sprinkler.

3.4.6 Pipe Joints

Pipe joints must conform to NFPA 13, except as modified herein. Not more than four threads must show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints must be provided where indicated or required by NFPA 13. Grooved pipe and fittings must be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools must be products of the same manufacturer. For copper tubing, pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.4.7 Reducers

Reductions in pipe sizes must be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face or hex type will be permitted. Where used, face bushings must be installed with the outer face flush with the face of the fitting opening being reduced. Bushings cannot be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 13 mm1/2-inch.

3.4.8 Pipe Penetrations

a. Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors must be core-drilled and provided with pipe sleeves. Each sleeve must be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and extend through its respective wall or floor and be cut flush with each wall surface. Sleeves must provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe must be firmly packed with mineral wool insulation.

b. Where pipes and sleeves penetrate fire walls, fire partitions, or floors, pipes/sleeves must be firestopped in accordance with Section 07 84 00 FIRESTOPPING.

c. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe must be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

d. All penetrations through the boundary of rooms/areas identified as secure space area must meet ICS 705-1.

3.4.9 Escutcheons

Escutcheons must be provided for pipe penetration in finished areas of ceilings, floors and walls. Escutcheons must be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

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NOTE: Designer will indicate location of the inspector's test connections and all associated valves on the contract drawings, and will provide details of drain piping.

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Unless otherwise indicated, the test connection must consist of 25-mm1-inch pipe connected to the remote branch line; a test valve located approximately 2 meters7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test". All test connection piping must be inside of the building and penetrate the exterior wall at the location of the discharge orifice only. The discharge orifice must be located outside the building wall no more than 0.6 meters2 feet above finished grade, directed so as not to cause damage to adjacent construction or landscaping during full flow discharge, or to the sanitary sewer. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building. Do not discharge to the roof. Discharge to floor drains, janitor sinks or similar fixtures is not permitted.

Provide concrete splash blocks at all drain and inspector's test connection discharge locations if not discharging to a concrete surface. Splash blocks must be large enough to mitigate erosion and not become dislodged during a full flow of the drain. Ensure all discharged water drains away from the facility and does not cause property damage.

3.4.11 Backflow Preventer

Locate within the building or in a heated enclosure in locations subject to freezing. For heated enclosures, provide a low temperature supervisory alarm connected to the facility fire alarm system. Heat trace is not permitted to be used.

Install backflow preventers so that the bottom of the assembly is a minimum of 150 mm6 inches above the finished floor/grade. Install horizontal backflow preventers so that the bottom of the assembly is no greater than [_____]610 mm24 inches above the finished floor/grade. Install vertical backflow preventers so that the upper operating handwheel is no more than [_____]1.8 meters6 feet above the finished floor/grade. Clearance around control valve handles must be minimum 150 mm6inches above grade/finished floor and away from walls.

[3.4.11.1 Test Connection

Provide downstream of the backflow prevention assembly UL 668 hose valves with 65-mm2.5-inch National Standard male hose threads with cap and chain. Provide one valve for each 946 L/min250 gpm of system demand or fraction thereof. Provide a permanent sign in accordance with paragraph entitled "Identification Signs" which reads, "Test Valve". Indicate location of test header. If an exterior connection, provide a control valve inside a heated mechanical room to prevent freezing. The piping between the backflow preventer test header control valve and the exterior test header must be provided with an automatic drip arranged to drain to the outside.

]3.4.12 Drains

a. Main drain piping must be provided to discharge [at a safe point outside the building, no more than 0.6 meters2 feet above finished grade][at the location indicated][to the sanitary sewer]. Provide a concrete splash block at drain outlet. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building.

b. Auxiliary drains must be provided as required by NFPA 13. Auxiliary drains are permitted to discharge to a floor drain if the drain is sized to accommodate full flow (min 151 L/min40 gpm). Discharge to service sinks or similar plumbing fixtures is not permitted.

3.4.13 Installation of Fire Department Connection

Connection must be mounted [on the exterior wall approximately 900 mm3 feet above finished grade][adjacent to and on the sprinkler system side of the backflow preventer]. The piping between the connection and the check valve must be provided with an automatic drip in accordance with NFPA 13 and piped to drain to the outside or a floor drain within the same room.

3.4.14 Identification Signs

Signs must be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Main drain test results must be etched into main drain identification sign. Hydraulic design data must be etched into the nameplates and permanently affixed to each sprinkler riser as specified in NFPA 13. Provide labeling on the surfaces of all feed and cross mains to show the pipe function (e.g., "Sprinkler System", "Fire Department Connection", "Standpipe") and normal valve position (e.g. "Normally Open", "Normally Closed"). For pipe sizes 100 mm4-inch and larger provide white painted stenciled letters and arrows, a minimum of 50 mm2 inches in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 100 mm4-inch, provide white painted stenciled letters and arrows, a minimum of 18 mm0.75-inch in height and visible from the floor.[Provide properly lettered and approved metal sign to elevator flow switch stating the circuits' voltage, and identify the switch as an "Elevator Power Shunt Flow Switch".]

[3.4.15 Isolation Valve

Provide a control valve on the riser assembly, downstream of the backflow preventer test connection and waterflow indicator, to allow isolation of riser when testing (tripping) the automatic water control valve without allowing water to enter the system piping. The control valve must be electrically supervised in the open position.

]3.5 ELECTRICAL

****

NOTE: Coordinate power and alarm requirements with the contract drawings and other specification sections.

****

Except as modified herein, electric equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.[Alarm signal wiring connected to the building fire alarm control system must be by the fire alarm installer.]

3.5.1 Overcurrent and Surge Protection

All equipment connected to alternating current circuits must be protected from surges. Cables and conductors that serve as communications links, except fiber optics, must have surge protection circuits installed at each end. Fuses must not be used for surge protection.

3.5.2 Grounding

Grounding must be provided to building ground.

3.5.3 System Field Wiring

3.5.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and professional manner and installed parallel with or at right angles to the sides and back of the box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in an enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the RCU and remote RCU, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.5.3.2 Terminal Cabinets

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NOTE: Provide terminal cabinets on each floor where the fire alarm system supply riser is located and where the fire alarm return riser is located.
****

Provide a terminal cabinet at the base of the circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 200 mm by 200 mm8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "RELEASING SYSTEM TERMINAL CABINET" with 50-mm2-inch lettering, on the front of the terminal cabinet.

3.5.3.3 Alarm Wiring

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NOTE: Do not penetrate SCIF perimeters with copper signal line circuits. SCIF penetrations should be either fiber optic cable or IDC. IDC circuits penetrating the SCIF must be filtered.
****

a. Voltages must not be mixed in junction boxes, housing or device, except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the RCU.

c. [Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.][T-tapping using screw terminal blocks is allowed for Class "B" initiating device circuitssignaling line circuits.]

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the [_____] Designated Fire Protection Engineer (DFPE).

3.5.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 19 mm3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits 2 meters6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

g. [g. For Class "A" or "X" circuits with conductor lengths of 3 meters10 feet or less, the conductors must be permitted to be installed in the same raceway in accordance with NFPA 72.]

3.5.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, and RCU must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet and RCU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12-point lettering minimum size, and mounted within each cabinet, panel, or control unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.6 RELEASING CONTROL SYSTEM

3.6.1 Releasing Control Unit (RCU)

The RCU must be located in a year round environmentally conditioned space and not in the hazard area served but adjacent to it. Locate the RCU [where indicated on the drawings][_____]. [Recess][Semi-recess][Surface mount] the enclosure with the top of the cabinet 2 meters6 feet above the finished floor or center the cabinet at [1.5][_____] meters[5][_____] feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the RCU.

3.6.2 Smoke Detectors

Locate detectors [as required by NFPA 72 and their listing][as indicated on the drawings] on a 100-mm4-inch mounting box. Smoke detectors are permitted to be on the wall no lower than 300 mm12 inches from the ceiling with no minimum distance from the ceiling.[In raised floor spaces, install the smoke detectors to protect [21 square meters225 square feet per detector][_____].] Install smoke detectors no closer than 1-meter3 feet from air handling supply diffusers.[Detectors mounted in acoustical ceiling tiles must be centered in the tiles +/- 50 mm2 inches.]

3.6.3 Air Sampling Smoke Detector

Locate air sampling smoke detectors in accordance with the manufacturer's instructions. Air sampling smoke detectors must be installed as follows:

a. Air Sampling Smoke Detector Assembly:

   (1) Detector assembly must be mounted to a wall at a height between 1200 to 1800 mm48 to 60 inches to top of detector measured above the finished floor.

   (2) Mounting must be in a fully accessible and visible location.

   (3) Mounting or attachment to site equipment, cable trays, movable walls, other equipment or equipment supports is not permitted.

   (4) Piping network insertion into the detector inlet must not be glued.

   (5) Air sampling smoke detector assembly must be installed in accordance with this specification section and the manufacturer's installation and instruction manuals.

   (6) Flexible tubing for termination of the sampling pipe network into detector inlet is not permitted unless allowed by its listing.

   (7) Provide red background with white lettering labels that are plastic or phenolic type with a minimum of 6.4 mm0.25-inch block lettering to indicate detector and zone. For example: "AIR SAMPLING SMOKE DETECTOR No. 1-1 No. 5".

   (8) Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the ASD panel. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must be approved by the Contracting Officer before being posted.

b. Pipe and Sampling Tube Mounting:

   (1) The pipe and sampling tubing detection network must be mounted as per the design and manufacturer's specification. The hardware used for mounting will depend upon the design and site requirements.

   (2) To minimize flexing, pipes must be secured every 1.5 meters5 feet.

(3) Pipes must be suspended between 25 and 100 mm1 and 4 inches below the ceiling. In areas with a suspended ceiling, the pipe network must be installed above the ceiling utilizing the manufacturer's capillary sample port supported by the ceiling.

(4) The sampling tubes must be of the same length or use the manufacturer's guidelines to run tubes of the required lengths.

(5) When installing a pipe network in areas subject to high temperature fluctuations allow for the contraction and expansion of pipes.

(6) Where expansion or contraction of pipes is likely either after installation or on a continuous basis, do not place pipe clips adjacent to couplings and socket unions as these may interfere with the movement of the pipe.

(7) No bends are permitted within the first 450 mm18 inches from the detector inlet.

(8) The routing of the piping and sample tube network must be coordinated with potential obstructions, including cable trays, grounding bars, and HVAC ductwork.

(9) All changes in direction must be made with standard elbows or tees.

(10) All joints must be air-tight and made by using solvent cement, except at the entry to the detector assembly. Refer to ASTM F402.

(11) All pipes must be supported by mechanical hangers attached to the structure of the building. Not more than 300 mm1-foot of pipe must extend beyond the last hanger of each sampling pipe. The final installation must result in no noticeable deflection in the piping network.

(12) Attachment of air sampling pipes to cable trays, "gray iron", and telecommunications equipment is prohibited.

(13) Clearly label pipe network to distinguish the pipe from other facility pipe work or protective cabling enclosures. For example: "SMOKE DETECTION SAMPLING TUBE - DO NOT DISTURB". In open rooms and exposed areas, provide labels at no greater than 6.1-meter 20-foot intervals. Provide labels every 3 meters10 feet where piping is installed above suspended ceilings and every 609 mm2 feet, centered in the floor panels, where piping is installed within the raised floor cavity.

(14) Placement of the sampling tube must take into consideration appropriate sampling point locations and spacing.

c. Air Sampling Points:

(1) Open area ceiling sampling points must be oriented downward and must be within 25 to 100 mm1 to 4 inches below the underside of the ceiling above where the ceiling is smooth.

(2) Label all air sampling points with a round red label, each with a center hole to match the diameter of the drilled sampling point. For example: "AIR SAMPLING POINT DIA 3.2 MM0.125 INCHES".

Indicate fractional dimensions in decimal format with a minimum of three decimal places.

[3.6.4 Manual Stations

Locate manual stations as required by NFPA 72[and as indicated on the drawings]. Mount stations so they are located no farther than [1.5][_____] meters[5][_____] feet from the exit door they serve, measured horizontally. Manual stations must be mounted at [1067][1117][_____] mm [42][44][_____] inches measured to the operating handle.

][3.6.5 Notification Appliances

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NOTE: Locate strobes wall mounted in corridors no more than 4.5 meters15 feet from the end of a corridor with 30meters100 feet maximum distance between strobes. Where there is an obstruction to the viewing path in the corridors, such as a cross-corridor door or ceiling elevation change, consider the obstruction as defining a new corridor. Provide ceiling mounted strobes in rooms accessible to the public, such as conference rooms, restrooms, courtrooms, cafeterias, and auditoriums in accordance with NFPA 72. In Child Development Centers only chimes must be used as the pre-alert tone prior to voice messages.

****

a. Locate notification appliance devices [as required by NFPA 72][where indicated]. Where more than two appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring.[Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles +/- 50 mm2 inches.]

b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.

][3.6.6 Graphic Annunciator

Locate the graphic annunciator as shown on the drawings. Mount the panel, with the top of the panel 1830 mm6 feet above the finished floor or center the panel at [1525][_____] mm[5][_____] feet, whichever is lower. [Locate the graphic annunciator as shown on the drawings. Surface-mount the panel, with the top of the panel 1830 mm6 feet AFF or center the panel at [1525][_____] mm[5][_____] feet, whichever is lower.]

]3.6.7 Remote LCD Annunciator

Locate the remote LCD annunciator as shown on the drawings. Mount the panel, with the top of the panel 2 meters6 feet above the finished floor or center the panel at [1.5][_____] meters[5][_____] feet, whichever is lower.

3.6.8 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.7 PAINTING

****

NOTE: Designer will coordinate color code marking with Section 09 90 00 PAINTS AND COATINGS. Color code marking for piping which are not listed in Table I of Paragraph 3.5 Pipe Color Code Marking of UFGS Section 09 90 00 will be added to the table.

****

Color code mark piping [red][as specified in Section 09 90 00 PAINTS AND COATINGS].

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving releasing system equipment), releasing system conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving releasing system equipment), releasing system conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Releasing System" and the conduit must have painted red bands 19 mm3/4-inch wide at 3-meter10-foot centers and at each side of a floor, wall, or ceiling penetration.

3.8 FIELD QUALITY CONTROL

3.8.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level [III][or][IV] Fire Sprinkler Technician, and the representative of the installing company,[and reviewed by the QFPE] [60][_____] days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, [notification appliances and circuits,] signaling line devices and circuits, control devices/equipment, batteries, power sources/supply, annunciators, special hazard equipment, and interface equipment. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 13 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government final testing.

a. Identify the NFPA Class of all initiating device circuits (IDC),[notification appliance circuits (NAC),] and signaling line circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing. The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.8.2 Pre-Government Testing

3.8.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that equipment is functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" and "System Acceptance" as noted in NFPA 13 and NFPA 72. The Contractor [and QFPE] must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 13 and the test reports noted below.

a. NFPA 13 Aboveground Material and Test Certificate

b. NFPA 13 Underground Material and Test Certificate

c. NFPA 72 Record of Completion

d. NFPA 72 Record of Inspection and Testing

3.8.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the [_____][Designated Fire Protection Engineer (DFPE)][Contracting Officers Designated Representative (COR)]. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the [building fire alarm system][installation fire alarm reporting system] have been completed and tested to confirm communications are fully functional. Submit request for test at least [15][_____] calendar days prior to the requested test date.

3.8.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required

for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. [b. The contractor's Qualified Fire Protection Engineer (QFPE).]

c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results.

e. Complete program printout including input/output addresses.

f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

Government Final Tests will be witnessed by the [_____], [Designated Fire Protection Engineer][Contracting Officer][, Qualified Fire Protection Engineer (QFPE)]. At this time, all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.9 MINIMUM SYSTEM TESTS

The system, including the underground water mains, and the aboveground piping and system components, must be tested to ensure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure must be tested in accordance with NFPA 13 and NFPA 24.

3.9.1 Underground Piping

3.9.1.1 Flushing

****

NOTE: Designer should check the site water section for inconsistencies and to verify flushing of all underground pipe will be performed prior to connection to the sprinkler system.

****

Underground piping must be flushed in accordance with NFPA 24.

3.9.1.2 Hydrostatic Test

New underground piping must be hydrostatically tested in accordance with NFPA 24.

3.9.2 Aboveground Piping

3.9.2.1 Hydrostatic Test

Aboveground piping must be hydrostatically tested in accordance with NFPA 13. There must be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure must be read from a gauge located at the low elevation point of the system or portion being tested.

[3.9.2.2 Air Pressure Test

As specified in NFPA 13, an air pressure leakage test at 350 kPa50 psi must be conducted for 24 hours. There must be no drop in gauge pressure in excess of 10 kPa1.5 psi for the 24 hours. This air pressure test is in addition to the required hydrostatic test.

]3.9.2.3 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly must be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor must provide all equipment and instruments necessary to conduct a complete forward flow test, including 65-mm2.5-inch diameter hoses, playpipe nozzles or flow diffusers, calibrated pressure gauges, and pitot tube gauge. The Contractor must provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction loss) across the assembly must be recorded. A metal placard must be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate determined during the preliminary testing. The pressure drop must be compared to the manufacturer's data and the readings observed during the final inspections and tests.

3.9.3 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the preliminary test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device[and notification appliance] and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

e. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

f. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

g. Determine that the system is operable under trouble conditions as specified.

h. Visually inspect wiring.

i. Test the battery charger and batteries.

j. Verify that software control and data files have been entered or programmed into the releasing control unit. Hard copy records of the software must be provided to the Contracting Officer.

k. Verify that red-line drawings are accurate.

l. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

m. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

n. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.

[
o. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.]

p. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.9.4 Alarm Device Test

Each alarm switch/device must be tested by flowing water through the inspector's test connection.

[3.9.5 Audibility Tests

Sound pressure levels from audible notification appliances must not exceed 110 dBA in occupiable areas. The provisions for audible notification (audibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

]3.9.6 Main Drain Flow Test

Following flushing of the underground piping, a main drain test must be made to verify the adequacy of the water supply. Static and residual pressures must be recorded on the certificate specified in paragraph SUBMITTALS.

3.9.7 Automatic Water Control Valves Trip Test

Each water control valve must be independently trip-tested in accordance with the manufacturer's published instructions. Each valve must be electrically trip-tested by actuating a respective heat detector, a manual actuation station connected to the system control unit and the manual release which is part of the valve trim. Each valve must be returned to normal condition after each test. Prior to trip testing sprinkler deluge system, precautionary steps must be taken to prevent water damage to the building and equipment from sprinkler discharge. Water delivery times must be measured starting at the normal nitrogen pressure on the system. Control valves on preaction systems must remain open until piping is filled with water.

3.9.8 Supervisory Nitrogen System Test

****

NOTE: Delete this paragraph for deluge system applications and preaction systems not requiring supervisory nitrogen.

****

System supervisory nitrogen pressure must be reduced from the normal system pressure to the point at which a low-pressure alarm is sounded. Nitrogen pressure must be restored to verify trouble signal restoration. Automatic start/stop features of nitrogen generator must be tested.

3.10 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the final acceptance test.

[a. Provide one set of full size paper as-built drawings and schematics. The drawings must be prepared electronically and sized no less than the contract drawings.] [Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation][AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide operating and maintenance (O&M) instructions.

3.11 ONSITE TRAINING

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NOTE: The number of hours of instruction should be determined based of the number and complexity of the systems specified.

****

Conduct a training course for the responding fire department and operating and maintenance personnel as designated by the Contracting Officer. Training must be performed on two separate days (to accommodate different shifts of Fire Department personnel) for a period of [_____][4] hours of normal working time and must start after the system is functionally complete and after the final acceptance test. The on-site training must cover all of the items contained in the approved Operating and Maintenance Instructions.

3.12 EXTRA MATERIALS

3.12.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturer[s]. Installing fire alarm contractor is NOT responsible for damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.12.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed system[s]. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the final acceptance testing and must be accompanied by an inventory list.

3.12.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. Site-specific software data package

e. All documentation required by SD-06

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-21 13 19 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-21 13 19.00 20 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-21 13 19 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-21 13 19.00 20 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 21 13 19

DELUGE SPRINKLER SYSTEMS, FIRE PROTECTION

08/20

****

NOTE: This guide specification covers the requirements for deluge fire protection sprinkler systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information. The designer is permitted to edit any and all of this section for the project. If the designer is modifying/deleting non-bracketed items and text, the Designated Fire Protection Engineer (DFPE) should be consulted prior to incorporating final changes.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: For OCONUS projects, this specification section should be edited for specific Host Nation requirements. Coordinate compliance with Host Nation requirements with the DFPE.

****

****

NOTE: This specification section includes requirements from UFC 3-600-01 (change 4, 7 February 2020)

****

PART 1 GENERAL

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NOTE: Deluge systems are "open sprinkler" systems which discharge all sprinklers upon system actuation. The use of deluge systems should be limited to special hazard situations.

The Designer must edit this specification section for either a performance-designed system or a fully designed system as applicable.

This section is primarily intended for performance designed systems, e.g. systems where the size, layout, and support of branch lines and cross mains, and the layout of sprinklers will be designed by the Contractor.

This section is not intended to be used for NFPA 13D systems.

The Designer must provide the following information in the contract documents for performance designed systems. This information must be in accordance with UFC 3-600-01.

(1) Show the layout and size of all piping and equipment from the point of connection to the water supply, to the sprinkler riser. The contract drawings must include a detailed sprinkler riser diagram.

(2) Show location and size of service laterals, sprinkler risers, control valves, drain lines, sectional valves, and inspector's test valves and switches on the drawings.

(3) Specify waterflow data including hydrant flow test results, including the location where the hydrant flow test was conducted, the location and size of existing mains and new water supply lines that will serve the sprinkler system.

(4) Highlight or clearly indicate the area(s) to be protected by sprinklers on the drawings.

(5) Specify waterflow requirements including the design density, design area, the hose stream demand (including location of the hose stream demand), the duration of supply, and sprinkler spacing and area of coverage in this section.

(6) Show the location of the backflow preventer (including provisions for a drain and access for maintenance) on the drawings.

(7) Show all provisions necessary for forward flow testing of the backflow preventer at system demand

as required by NFPA 13 on the drawings.

(8) Highlight all concealed spaces on the drawings that require sprinkler protection, such as spaces above suspended ceilings that are built of combustible material or that can contain combustible materials, such as storage, and communication cabling that is not fire-rated.

(9) Provide details on the drawings of pipe restraints for underground piping. This includes details of pipe clamps, tie rods, mechanical retainer glands, and thrust blocks.

(10) Show location of the control unit, batteries and charger (if remotely mounted), supervising station transmitter, annunciator, primary power supply, remote annunciator, detectors, notification appliances (unless performance requirements are specified), and each alarm initiating device including fire extinguishing system switches.

(11) Show single-line releasing systems riser diagram. Each device on the riser should be identified by type. Indicate connection of equipment.

(12) Show a releasing system operating matrix . Show actions of input devices such as detectors, manual stations, waterflow switches, initiating devices, etc. on one axis and output functions such as door releases, smoke control fans, elevator relays, indicating/notification appliances etc. on the other. Entries which require descriptions, explanation of processes, sequences, interfaces, etc. can be flagged by symbols keyed to supplementary notes. Alternately provide a zone-by-zone sequence of operation or a schedule identifying all initiators, outputs, and interfaces.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1015	(2021) Performance Requirements for Double Check Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M14	(2024) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTELLIGENCE COMMUNITY STANDARD (ICS)

ICS 705-1	(2010) Physical and Technical Security Standard for Sensitive Compartmented

Information Facilities

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 13	(2024) Standard for the Installation of Sprinkler Systems
NFPA 15	(2022) Standard for Water Spray Fixed Systems for Fire Protection
NFPA 24	(2025) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 101	(2024) Life Safety Code
NFPA 291	(2025) Recommended Practice for Fire Flow Testing and Marking of Hydrants
NFPA 1963	(2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UL SOLUTIONS (UL)

UL 199	(2020) UL Standard for Safety Automatic Sprinklers for Fire-Protection Service
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service
UL 268	(2023) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 312	(2022) UL Standard for Safety Check Valves for Fire-Protection Service

UL 405	(2013; Bul. 2020) UL Standard for Safety Fire Department Connection Devices
UL 464	(2023) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 521	(2024) UL Standard for Safety Heat Detectors for Fire Protective Signaling Systems
UL 668	(2004; Reprint Oct 2021) UL Standard for Safety Hose Valves for Fire-Protection Service
UL 789	(2004; Reprint May 2024) UL Standard for Safety Indicator Posts for Fire-Protection Service
UL 864	(2023; Reprint Oct 2024) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1638	(2023) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Feb 2024) UL Standard for Safety Signaling Devices for the Deaf and Hard of Hearing
UL 2351	(2004; Bul. 2018) UL Standard for Safety Spray Nozzles for Fire-Protection Service
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SYSTEM DESCRIPTION

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NOTE: Seismic protection/bracing is to be provided for seismic design categories C or greater only, unless specifically requested by the DFPE. Consideration should also be giving to utilizing seismic protection/bracing to limit pipe movement.

****

Provide [single-interlock][electric-pneumatic double-interlock]deluge[_____] [sprinkler][water spray] system(s) in [areas indicated on the drawings] [_____]. Except as modified herein, the system must meet the requirements of NFPA 13[and][NFPA 15] and NFPA 72. Pipe sizes which are not indicated on the Contract drawings must be determined by hydraulic calculations.

1.2.1 Hydraulic Design

****

NOTE: Applications requiring multiple densities/design areas must be referred to and shown on the drawings.

Discharge density for non-storage occupancies must be in accordance with UFC 3-600-01. Specific densities must be listed on the drawings or noted in the specification when drawings are not provided. Stating "comply with UFC 3-600-01 is not acceptable.

Hazard classification of miscellaneous storage must be per NFPA 13. Discharge density for the hazard classification must be per UFC 3-600-01.

The paragraph below must be listed on the drawings. If this information is not listed on the drawings, provide the information in paragraph 1.1.1.3 (with brackets completed).

Hydraulically design the system to discharge a minimum density [of [_____] L/min per square meter gpm/square foot over the hydraulically most demanding [280] [_____] square meters[_____] square feet of floor area][as indicated on the drawings]. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13.

****

****

NOTE: The addition, modification or relocation of no more than twenty sprinklers to an existing system or modifications to existing sprinkler systems fed from domestic supplies are permitted to be designed using the pipe schedule method in NFPA 13 based on the layout of the existing system.

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1.2.1.1 Basis for Calculations

****

NOTE: The design must include an adequate water supply to meet the sprinkler water demand. The designer must provide waterflow test results and hydraulic calculations to ensure that the system demand will be met.

Design Calculations: The designer must provide

detailed hydraulic calculations that clearly demonstrate that the water supply will meet the demand of the sprinkler system and hose streams. Calculations must be submitted with the concept design submission.
****

A waterflow test was performed on (DATE) at (LOCATION) and resulted in a static pressure of [_____ kPapsi] with a residual pressure of [_____ kPapsi] while flowing [_____ L/mingpm]. Perform a fire hydrant flow test prior to shop drawing submittal in accordance with NFPA 291. Results must include hydrant elevations relative to the building and hydrant number/identifiers for the tested hydrants, including which were flowed, which had a gauge. This information must be presented in a tabular form if multiple hydrants were flowed. The results must be included with the hydraulic calculations. Hydraulic calculations must be based on flow test noted in this paragraph, unless [verified by the NAVFAC[_____] Fire Protection Engineer and] approved by Contracting Officer. Hydraulic calculations must be based upon the Hazen-Williams formula with a "C" value noted in NFPA 13 for piping, [and [_____] for existing underground piping].[Hydraulic calculations must be based on operation of the fire pump(s) provided in Section 21 30 00 FIRE PUMPS.] [The minimum residual pressure in a service lateral (lead-in) at the [design flow rate][150% of the fire pump rated flow] must be 138 kPa20 psi at [the inlet to the backflow preventer][the suction side of the fire pump]].

1.2.1.2 Hydraulic Calculations

a. Water supply curves and system requirements must be plotted on semi-logarithmic graph (N^1.85) paper so as to present a summary of the complete hydraulic calculation.

b. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, minimum discharge pressures and minimum flows. Elevations of hydraulic reference points (nodes) must be indicated.

c. Documentation must identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe.

d. Where the sprinkler system is supplied by interconnected risers, the sprinkler system must be hydraulically calculated using the hydraulically most demanding single riser. The calculations must not assume the simultaneous use of more than one riser.

e. All calculations must include the backflow preventer manufacturer's stated friction loss at the design flow or [83 kPa12 psi for reduced pressure][55 kPa8 psi for double check] backflow preventer, whichever is greater.

f. All calculations must be performed back to the actual location of the flow test, taking into account the direction of flow in the service main at the test location.

1.2.1.3 Design Criteria

Hydraulically design the system to discharge a minimum density [of [_____] L/min per square metergpm/square foot over the hydraulically most demanding [_____] square metersquare feet of floor area][as indicated on the drawings]. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13. Add an allowance for exterior hose streams of [_____] L/min gpm to the sprinkler system demand [at the fire hydrant shown on the drawings closest to the point where the water service enters the building] [at the point of connection to the existing water system].[An allowance for interior hose stations of [_____] L/min gpm must also be added to the sprinkler system demand.]

1.2.2 Sprinkler Coverage

****

NOTE: The exception in NFPA 13 to eliminate sprinklers in electrical rooms is not applicable per UFC 3-600-01.

****

Sprinklers must be uniformly spaced on branch lines. Provide coverage throughout 100 percent of the [building][area noted on the Contract drawings]. This includes, but is not limited to, telephone rooms, electrical equipment rooms (regardless of the fire resistance rating of the enclosure), boiler rooms, switchgear rooms, transformer rooms, attached electrical vaults and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13. Provide sprinklers below all obstructions in accordance with NFPA 13. Exceptions are as follows:

a. Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.

1.2.3 Control System

The control system must meet the requirements of NFPA 72. The control unit must be listed for "Releasing Device Service". The control unit and the solenoid valve that activates the water control valves must be compatible with each other. Compatibility must be in accordance with the specific listing of the control equipment.

1.2.3.1 Circuit Requirements

Connect alarm initiating devices to initiating device circuits (IDC), Class [B][_____] or to signal line circuits (SLC), Class [B][_____], in accordance with NFPA 72.[Alarm notification or indicating appliances must be connected to notification appliance circuit (NAC), Class [B][_____] in accordance with NFPA 72.] Provide a separate circuit for actuation of each individual automatic water control valve. Fully supervise the circuits that actuate the water control valves so that the occurrence of a single open or a single ground fault condition in the interconnecting conductors will be indicated at the control unit.

1.2.4 System Operational Features

****

NOTE: Delete manual actuation stations when not required.

****

Include in the system a detection system, manual actuation stations, supervisory and alarm switches,[alarm notification appliances,] control unit and associated equipment.

1.2.4.1 System Actuation

Activation of [a single][two][smoke][heat] detector[s] [or a single manual actuation station] must actuate alarm zone circuits of the control unit that, in turn, must actuate the corresponding automatic water control valve. Actuation of the automatic water control valve must cause water to [fill the discharge piping][discharge from the open sprinklers of the deluge system].

1.2.4.2 Alarm Functions

****

NOTE: Drawings must indicate and detail the connection of the system control unit to the building alarm system and/or to the base-wide fire reporting system.

****

Activation of a [heat detector][smoke detector], sprinkler pressure (waterflow) alarm switch or manual actuation station must cause the illumination of the respective device at the releasing control unit, and [activation of the building fire alarm system][transmission of the alarm to the base-wide fire reporting system].

1.2.4.3 Supervisory Functions

Valve tamper switches must be monitored by the releasing control unit and transmitted to the building fire alarm system as a supervisory condition.

1.2.5 Qualified Fire Protection Engineer (QFPE)

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NOTE: UFC 3-600-01 requires that shop drawings must bear the Review Stamp and professional engineering stamp of the QFPE prior to submission to the Government for approval.

****

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NOTE: The term Qualified Fire Protection Engineer (QFPE) should be considered interchangeable with the terms "Fire Protection Designer of Record (FPDOR)" and/or "Fire Protection QC Specialist" where referred to in other applicable contract documents. The intent of defining the QFPE roles and responsibilities here is NOT to require personnel in addition to the QFPE, FPDOR, and/or FPQC specialist referenced elsewhere in the applicable contract documents.

****

An individual who is a licensed professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Working (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Provide a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting all outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government [and final Government]functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

NOTE: When 20 or less sprinklers are added, modified or relocated, shop drawings, hydraulic calculations and product data are not required to be

submitted. Edit this section accordingly.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Partial submittals and submittals not fully complying with NFPA 13 and this specification section must be returned disapproved without review. SD-02, SD-03 and SD-05 must be submitted simultaneously.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE must be returned disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G, [_____]

Sprinkler System Designer; G, [_____]

Sprinkler System Installer; G, [_____]

Releasing System Designer; G, [_____]

Releasing System Technician; G, [_____]

Releasing System Installer; G, [_____]

Releasing System Site-Specific Software Acknowledgement; G, [_____]

SD-02 Shop Drawings

Shop Drawing; G, [_____]

[Notification Appliances; G, [_____]

] Initiating Devices; G, [_____]

Battery Power; G, [_____]

Voltage Drop Calculations; G, [_____]

SD-03 Product Data

Pipe; G, [_____]

Fittings; G, [_____]

Valves, including gate, check, butterfly, and globe; G, [_____]

Relief Valves; G, [_____]

Sprinklers ; G, [_____]

Pipe Hangers and Supports ; G, [_____]

Sprinkler Alarm Switch; G, [_____]

Valve Supervisory (Tamper) Switch; G, [_____]

Fire Department Connection; G, [_____]

Backflow Prevention Assembly; G, [_____]

Hose Valve; G, [_____]

[Seismic Bracing; G, [_____]

] Deluge Valve; G, [_____]

Releasing Control Unit (RCU); G, [_____]

Terminal Cabinets; G, [_____]

Supplemental Notification Appliance Circuit Panels; G, [_____]

Auxiliary Power Supply Panels; G, [_____]

Nameplates; G, [_____]

Manual Release Station; G, [_____]

Batteries; G, [_____]

Battery Charger; G, [_____]

Smoke Detectors; G, [_____]

Air Sampling Smoke Detectors; G, [_____]

Heat Detectors; G, [_____]

[Notification Appliances; G, [_____]

] Addressable Interface Devices; G, [_____]

Addressable Control Modules; G, [_____]

Isolation Modules; G, [_____]

Remote Annunciator Panel; G, [_____]

Graphic Annunciator Panel; G, [_____]

Document Storage Cabinet; G, [_____]

Wire; G, [_____]

Surge Protective Devices; G, [_____]

[Back Boxes and Conduit; G, [_____]

][Ceiling Bridges for Ceiling-Mounted Appliances; G, [_____]

] SD-05 Design Data

[Air Sampling Smoke Detection System Calculations; G, [_____]

][Seismic Bracing; G, [_____]

Load calculations for sizing of seismic bracing

] Hydraulic Calculations; G, [_____]

Voltage Drop Calculations; G, [_____]

SD-06 Test Reports

Test Procedures; G, [_____]

SD-07 Certificates

Verification of Compliant Installation; G, [_____]

Request for Government Final Test; G, [_____]

SD-10 Operation and Maintenance Data

Operating and Maintenance (O&M) Instructions; G, [_____]

Spare Parts Data; G, [_____]

SD-11 Closeout Submittals

As-built drawings

1.4 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The releasing system manufacturer must submit written confirmation of this contract provision as "Releasing System Site-Specific Software Acknowledgement". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must also include the following:

a. Items identified in NFPA 72, titled "Site-Specific Software".

b. Identification of programmable portions of the system equipment and capabilities.

c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

d. Provision of operational software data on all modes of programmable portions for foam releasing system.

e. Description of releasing system equipment operation.

f. Description of auxiliary and remote equipment operations.

g. Library of application software.

h. Operation and maintenance manuals.

1.5 QUALITY ASSURANCE

1.5.1 Preconstruction Submittals

Within 36 days of contract award but no less than [14 days][_____] prior to commencing work on site, the prime Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications will be returned Disapproved Without Review.

1.5.1.1 Shop Drawing

[_____] copies of the shop drawings, no later than 28 days prior to the start of system installation. Working drawings conforming to the requirements prescribed in NFPA 13 and must be no smaller than [ISO A1][ANSI D][the Contract Drawings]. Each set of drawings must include the following:

1. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

2. Floor plans drawn to a scale not less than 1:100 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, electrical power connections and other details required to clearly describe the proposed arrangement.

3. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross mains and branch lines to finished floor and roof or ceiling. A detail must show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

4. Longitudinal and transverse building sections showing typical branch line and cross main pipe routing, elevation of each typical sprinkler above finished floor and elevation of "cloud" or false ceilings in relation to the building ceilings.

5. Plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance.

6. Riser layout drawings drawn to a scale of not less than 1:25 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

7. Details of each type of riser assembly, pipe hanger, [sway bracing for

earthquake protection,]and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) must be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.

8. Details of each type of pipe hanger[, seismic bracing/restraint] and related components.

[9. Include fire pump curve with shop drawings and hydraulic calculations.]

10. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the RCU and remote fire alarm control units, initiating circuits, switches, relays and terminals.

11. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

1.5.1.2 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least [25][_____] percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.5.1.3 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least [25][_____] percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.5.1.4 Battery Power

Provide battery calculations as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.5.1.5 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.5.1.6 Product Data

[_____] copies of annotated catalog data to show the specific model, type, and size of each item. Catalog cuts must indicate the NRTL listing. The data must be highlighted to show model, size, options, and other pertinent information, that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

1.5.1.7 Air Sampling Smoke Detection System Calculations

Submit air sampling detection system design analysis calculations consisting of battery capacity, loading calculations, and fan speed and air flow/transport calculations. Include schematic diagrams showing pipe segments, pipe diameters, lengths of pipe, node numbers, and sample port diameters to verify the requirements are met.

1.5.1.8 Hydraulic Calculations

****

NOTE: Include the first bracketed item for Army Corps projects.

****

Calculations must be as outlined in NFPA 13 except that calculations must be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings.[Calculations must include isometric diagram indicating hydraulic nodes and pipe segments.][Include fire pump curve with submittal.]t

1.5.1.9 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.5.1.10 Operating and Maintenance (O&M) Instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA as supplemented and modified by this specification section.

Provide [six][_____] manuals[and one pdf version on electronic media]. The manuals must include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment.[Each service organization submitted must be capable of providing [4][_____]-hour on-site response to a service call on an emergency basis.]

Submit spare parts data for each different item of material and equipment specified. The data must include a complete list of parts and supplies, and a list of parts recommended by the manufacturer to be replaced after 1-year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

1.5.2 Qualifications

****

NOTE: NICET (National Institute for Certification in Engineering Technologies) establishes the qualifications of an individual as an Engineering Technologist with verification of experience by having a current NICET certification.

****

1.5.2.1 Sprinkler System Designer

The sprinkler system designer must be certified as a Level [III][IV] Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.5.2.2 Sprinkler System Installer

The sprinkler system installer must be regularly engaged in the installation of the type and complexity of system specified in the contract documents, and must have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.5.2.3 Releasing System Designer

The system designer must be certified as a Level [III][IV] (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7, or meet the qualifications for a QFPE.

1.5.2.4 Releasing System Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings[, and must be thoroughly experienced in the design and installation of air sampling detection systems].

1.5.2.5 Releasing System Installer

[Fire alarm installer with a minimum of two years of experience utilized to assist in the installation of devices, cabinets and control units.][NICET Level II technician to assist in the installation of devices, cabinets and control units.]A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.5.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of an item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation are mandatory requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. All pipes must be either capped or plugged until installed.

1.7 EXTRA MATERIALS

Spare sprinklers and wrench(es) must be provided as spare parts in accordance with NFPA 13.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices listed for fire protection service when so required by NFPA 13 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for a classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least [2][_____] years prior to bid.

2.1.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Nameplates must be etched metal or plastic, permanently attached by screws to control units, panels or adjacent walls.

2.1.3 Identification and Marking

Pipe and fitting markings must include name or identifying symbol of manufacturer and nominal size. Pipe must be marked with ASTM designation. Valves and equipment markings must have name or identifying symbol of manufacturer, specific model number, nominal size, name of device, arrow indicating direction of flow, and position of installation (horizontal or vertical), except if valve can be installed in either position. Markings must be included on the body casting or on an etched or stamped metal nameplate permanently on the valve or cover plate.

2.1.4 Keys

Keys and locks for equipment, control units, panels and devices must be identical.[Master all keys and locks to a single key as required by the [Installation Fire Department][_____].][Keys must be CAT [60][_____].]

2.1.5 Pressure Ratings

Valves, fittings, couplings, alarm switches, and similar devices must be rated for the maximum working pressures that can be experienced in the system, but in no case less than [1207][1724] kPa[175][250] psi.

2.1.6 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame.[Install the instructions on the interior of the RCU.][Install the frame in a conspicuous location observable from the RCU.] The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.2 UNDERGROUND PIPING COMPONENTS

****

NOTE: The design drawings must show the service connection details and the underground service lateral for the sprinkler system. The drawings must show details of the water service point-of-entry into the building and through the floor slab, and underground piping restraints, including number and size of restraining rods and thrust blocks. 4-inch piping is the minimum permitted for service laterals serving NFPA 13R systems. 6-inch piping is the minimum permitted for NFPA 13 systems.

****

2.2.1 Pipe

Pipe must comply with NFPA 24. Minimum pipe size is [100 mm4 inches][150 mm 6 inches]. Piping more than 1.50 meters5 feet outside the building walls must comply with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING. A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 304 mm 1-foot above the finished floor within the building is acceptable.

2.2.2 Fittings and Gaskets

Fittings must be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets must be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints must conform to AWWA C111/A21.11.

2.2.3 Gate Valve[and Indicator Posts]

****

NOTE: This paragraph will be deleted if underground valves are either not required or are specified elsewhere.

****

Installation must comply with NFPA 24. Gate valves for use with indicator post must conform to UL 262.[Indicator posts must conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.]

[2.2.4 Valve Boxes

Except where indicator posts are provided, for each buried valve, provide a cast-iron, ductile-iron, or plastic valve box of a suitable size. Plastic boxes must be constructed of acrylonitrile-butadiene-styrene (ABS) or inorganic fiber-reinforced black polyolefin. Provide cast-iron, ductile-iron, or plastic cover for valve box with the word "WATER" cast on the cover. The minimum box shaft diameter must be 133 mm5.25 inches. Coat cast-iron and ductile-iron boxes with bituminous paint applied to a minimum dry-film thickness of 0.254 mm10 mils.

]2.2.5 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape, 80 mm3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification must read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING COMPONENTS

****

NOTE: Specify steel piping exposed to the weather or corrosive atmospheres to properly protect against corrosive effects.

NOTE: GALVANIZED PIPING IS ONLY PERMITTED FOR DELUGE SYSTEMS, VALVE TRIM PIPING AND DRAIN PIPING WHEN EXPOSED TO THE EXTERIOR.

****

2.3.1 Steel Piping Components

2.3.1.1 Steel Pipe

****

NOTE: For DLA, use Schedule 40 steel pipe only.

NOTE: Grooved pipe must be cut grooved for WHS projects.

****

Except as modified herein, steel pipe must be black or galvanized as permitted by NFPA 13 and conform to the applicable provisions of ASTM A53/A53M, ASTM A135/A135M or ASTM A153/A153M.

[Steel pipe must be minimum Schedule 40 for sizes 50 mm2 inches and less; and minimum Schedule 10 for sizes larger than 50 mm2 inches.][Steel pipe must be Schedule 40 only.] Steel piping with wall thickness less than Schedule 40 must not be threaded. [Grooved pipe must be roll-grooved.]

2.3.1.2 Fittings

Fittings must be welded, threaded, or grooved-end type. Threaded fittings must be cast-iron conforming to ASME B16.4, malleable-iron conforming to ASME B16.3 or ductile-iron conforming to ASTM A536. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, steel press fittings and field welded fittings must not be permitted. Fittings, mechanical couplings, and rubber gaskets must be supplied by the same manufacturer. Threaded fittings must use Teflon tape or manufacturer's approved joint compound.[Saddle tees using rubber gasketed fittings are permitted only when connecting to existing piping for additions or modifications. Saddle tees must use a connection method that completely wraps around the pipe.] Reducing couplings are not permitted except as allowed by NFPA 13.

2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings must be designed for not less than 1200 kPa175 psi service and must be the product of the same manufacturer. Field welded fittings must not be used. Fitting and coupling housing must be malleable-iron conforming to ASTM A47/A47M, Grade 32510; ductile-iron conforming to ASTM A536, Grade 65-45-12. Rubber gasketed grooved-end pipe and fittings with mechanical couplings must be permitted in pipe sizes 50 mm 2 inches and larger. Gasket must be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts must be heat-treated steel conforming to ASTM A183 and must be cadmium-plated or zinc-electroplated.

2.3.1.4 Flanges

Flanges must conform to NFPA 13 and ASME B16.1. Gaskets must be non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16-inch thick, and full face or self-centering flat ring type.

[2.3.2 Copper Tube Components

2.3.2.1 Copper Tube

Copper tube must conform to ASTM B88MASTM B88, Types L and M.

2.3.2.2 Copper Fittings and Joints

Cast copper alloy solder-joint pressure fittings must conform to ASME B16.18 and wrought copper and bronze solder-joint pressure fittings must conform to ASME B16.22 and ASTM B75/B75M. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

]2.3.3 Pipe Hangers and Supports

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NOTE: Seismic parameters must follow UFC 3-301-01 Structural Engineering. The writer of this section must coordinate with the Structural Engineer or Government to determine the proper seismic design category for the project, in accordance with the IBC or ASCE guidelines. See UFC 3-310-04 for more information.

****

Provide galvanized pipe hangers[, supports and seismic bracing][and supports] in accordance with NFPA 13.[Design and install seismic protection in accordance with the requirements of NFPA 13 section titled "Protection of Piping Against Damage Where Subject to Earthquakes for Seismic Design Category ["D"]["_____"]].

2.3.4 Valves

Provide valves of types approved for fire service. Valves must open by counterclockwise rotation.

2.3.4.1 Control Valve

Manually operated sprinkler control/gate valve must be [outside stem and yoke (OS&Y) type][or][butterfly type][as indicated on the drawings] and must be listed.

2.3.4.2 Check Valves

Check valves must comply with UL 312. Check valves 100 mm4 inches and larger must be of the swing type, have a clear waterway and meet the requirements of MSS SP-71, for Type 3 or 4. Inspection plate must be provided on valves larger than 150 mm6 inches.

2.3.4.3 Hose Valve

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NOTE: Hose valves are required as part of the backflow prevention test header.

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Valve must comply with UL 668.

2.4 AUTOMATIC WATER CONTROL VALVE (DELUGE VALVE)

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NOTE: "Automatic water control valve" is a generic term synonymous with "deluge valve" and is used for both preaction and deluge systems. "Automatic water control valve" is consistent with what is used in the UL Fire Protection Equipment Directory. Delete reset capability when not required.

****

Automatic water control valve (deluge valve) must be [electrically][hydraulically][pneumatically]-actuated and rated for a working pressure of 1207 kPa175 psi. Valve must be capable of being reset without opening the valve. Electrical solenoid valve used to actuate the water control valve must be an integral component of the valve or must be approved for use by the water control valve manufacturer. Solenoid valve must be rated at 24 volts direct current, and must be normally closed type that operates when energized. Solenoid valves must be rated for a maximum pressure differential of 1207 kPa175 psi. Water control valve must be equipped with a means to prevent the valve from returning to the closed position until being manually reset. Assembly must be complete with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances. Include with each assembly an emergency release device for manually tripping the water control valve in the event of a power or other system failure. Device must be a standard accessory component of the valve manufacturer and labeled as to its function and method of operation. Valves located in hazardous locations must be approved for the hazard classification of the area where located.

2.5 ALARM INITIATING AND SUPERVISORY DEVICES

2.5.1 Sprinkler Alarm Switch

pressure-type flow switch(es). [Connection of switch must be by the fire alarm installer].

2.5.2 Valve Supervisory (Tamper) Switch

Switch must be integral to the control valve or suitable for mounting to the type of control valve to be supervised open. The switch must be tamper resistant and contain SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

[2.6 BACKFLOW PREVENTION ASSEMBLY

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NOTE: Indicate piping, type of connection and equipment, such as a test header with hose valves, required for flow testing of the backflow preventer at full system demand as required by NFPA 13. Arrangement of test assembly should be coordinated with the installation.

****

[Reduced-pressure principle][Double-check] valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve must have a drain. Backflow prevention assemblies must have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List must be acceptable as the required documentation.

2.6.1 Backflow Preventer Test Connection

Test connection must consist of a series of listed hose valves with 65-mm2 1/2-inch National Standard male hose threads with cap and chain.

]2.7 FIRE DEPARTMENT CONNECTION

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NOTE: The designer will coordinate the desired location and thread type for the fire department connection with the responding fire department.

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Fire department connection must be [freestanding][projecting][flush] type with cast-brass body, matching [wall] escutcheon lettered "Auto Spkr" with a [polished-brass][chromium-plated] finish. [The connection must have individual self-closing clappers, caps with drip drains and chains.] Female inlets must have [65-mm2 1/2-inch][100 mm4-inch][125 mm5-inch][_____] diameter [American National Fire Hose Connection Screw Threads (NH) per NFPA 1963] [Storz][_____]. Comply with UL 405.

2.8 SPRINKLERS

****

NOTE: The designer will indicate on the contract drawings the type of sprinklers for each area if more than one type of sprinkler is to be provided. Delete sprinkler types from this paragraph that are not intended for use in the system(s) used in the Contract.

Areas that are classified as light hazard will be

equipped with quick-response sprinklers.
****

Sprinklers must comply with UL 199 or UL 2351 and NFPA 13. Sprinklers with internal O-rings are not acceptable. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters must have temperature classification in accordance with NFPA 13. Extended coverage sprinklers are permitted for loading docks, residential occupancies and high-piled storage applications only. Sprinklers for deluge systems must be open type without the fusible element.

2.8.1 Pendent Sprinkler

Pendent sprinkler must be[recessed][quick-response][dry pendent] type with nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____]. Pendent sprinklers must have a [polished chrome][stainless steel][white polyester][_____] finish. Assembly must include an integral escutcheon.

2.8.2 Upright Sprinkler

Upright sprinkler must be [brass][chrome-plated][stainless steel][white polyester] [quick-response type][_____] with nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____].

2.8.3 Sidewall Sprinkler

Sidewall sprinkler must be the [quick-response][standard-response] [recessed][dry sidewall] type. Sidewall sprinkler must have a nominal K-factor of [80][115][160][_____][5.6][8.0][11.2][_____]. Sidewall sprinkler must have a [brass][polished-chrome][stainless steel][white polyester][_____] finish.

[2.8.4 Corrosion-Resistant Sprinkler

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NOTE: The use of corrosion-resistant sprinklers is generally limited to industrial type occupancies such as electroplating, steam rooms, salt storage, and piers and wharves.
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Corrosion-resistant sprinkler must be the [upright][pendent] type installed in locations as indicated. Corrosion-resistant coatings must be factory-applied by the sprinkler manufacturer.

]2.9 ACCESSORIES

2.9.1 Sprinkler Cabinet

Spare sprinklers must be provided in accordance with NFPA 13 and must be placed in a suitable metal or plastic cabinet of sufficient size to accommodate all the spare sprinklers and wrenches in designated locations. Spare sprinklers must be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed as required by NFPA 13. At least one wrench of each type required must be provided.

2.9.2 Pendent Sprinkler Escutcheon

Escutcheon must be one-piece metallic type with a depth of less than 19 mm 3/4-inch and suitable for installation on pendent sprinklers. The escutcheon must have a factory finish that matches the pendent sprinkler.

2.9.3 Pipe Escutcheon

Provide split hinge metal plates for piping entering walls, floors, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.9.4 Sprinkler Guard

Listed guard must be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards must be provided on sprinklers located [_____][within 2.1 meters7 feet of the floor][as indicated].

2.9.5 Relief Valve

Relief valves must be listed and installed at there riser in accordance with NFPA 13.

2.9.6 Identification Sign

Valve identification sign must be minimum 150 mm wide by 50 mm high6 inches wide by 2 inches high with enamel baked finish on minimum 1.214-mm18 gage steel or 0.6-mm0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign must include, but not be limited to "main drain", "auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required to identify operational components. Where there is more than one sprinkler system, signage must include specific details as to the respective system.

2.10 RELEASING CONTROL UNIT (RCU)

The RCU must be listed, analog-addressable and compatible with the system, devices and functions specified.[Route all supervision of the RCU through the main FACU.] The RCU must perform all functions necessary to operate the system detection, actuation, and auxiliary functions independent of the FACU. The control system must be microprocessor-based utilizing distributed processing concept. A single microprocessor failure must not impact operation of additional modules on the system. The control system must be capable of supporting an air aspirating smoke detection system. The control system's initiating circuits must be capable of Class A or Class B operation. The solenoid must be listed for use with the releasing unit and extinguishing equipment. Each circuit must be capable of monitoring contact devices configured for manual release, trouble input or auxiliary (non-fire) input. The RCU must contain release circuits for activation of an extinguishing system[s]. Each release circuit must be capable of Class B operation. The RCU must contain at least two notification appliance circuits for annunciation. Each notification circuit must be capable of Class A or Class B operation. Provide alarm/trouble reset switches to reset a cleared device in alarm or trouble. Alarm or trouble signals are not to be self-restoring without activating the switch.

Annunciator must be integral with the RCU. Annunciation must be by an indicator lamp, alphanumeric display, or other equivalent means in which each indication provides status information about a circuit, condition, or location and visible through the cabinet door. Supervision is not required provided that a fault in the annunciator circuits results only in loss of annunciation and does not affect the normal functional operation of the remainder of the system. Ensure each visible indicator provides specific identification of the [zone][area][device]. Do not use generic nondescript wording such as "Zone 1", or "Zone 2", for the label identification.

An operator at the RCU, having the proper access level must have the capability to manually access the following information for each initiating device:

a. Primary status.

b. Device type.

c. Present average value.

d. Present sensitivity selected.

e. Sensor range (normal, dirty, etc).

2.11 ANNUNCIATOR

[2.11.1 Remote Annunciator Panel

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NOTE: Provide a remote annunciator only for very large spaces with 10 or more smoke detectors.

****

Provide a [semi-recessed][flush] mounted annunciator that includes an LCD display. The display must indicate the device in trouble/alarm or the supervisory device. Display the device name, address[, and actual building location]. The remote annunciator must duplicate functions of the RCU for message display, fire alarm, supervisory alarm, and trouble conditions, visual and audible notification, and system reset functions. Remote annunciator must require the use of a key for accessing the reset, control and other functions.

][2.11.2 Graphic Annunciator Panel

****

NOTE: Graphic annunciator panels should be provided only when a large number of concealed devices are installed. Normally, exposed devices will be annunciated by zone only on the fire alarm control unit zone annunciator and remote zone annunciator. Edit accordingly. Locate panel(s) at or near building entrance to allow fire department quick access to panel.

****

Panel must be of the [interior][weatherproof] type, [flush][surface][pedestal]-mounted. Panel must be provided with the [building][room] floor plan, drawn to scale, with alarm lamps mounted to represent the location of [each concealed detector][each initiating device]. Panel graphic must also show the locations of the annunciator panel and control unit, and must have a "you are here" arrow showing its location. Orient building floor plan on graphic to location of person viewing the graphic, i.e. the direction the viewer is facing must be toward the top of the graphic display. Provide a North arrow.[Principal rooms and areas shown must be labeled with room numbers or titles.] Detectors mounted above ceilings[, on ceilings,] and beneath raised floors and different types of initiating devices must have different symbols or lamps of different colors for identification. Lamps must illuminate upon activation of corresponding device and must remain illuminated until the system is reset. Panel must have a lamp test switch.

2.11.2.1 Materials

Construct the graphic annunciator face plate of [smoked Plexiglas][non-glare matte finish][anodized bronze][anodized aluminum]. The face plate must be backlit with LEDs. Control equipment and wiring must be housed in a [recessed][semi-recessed][surface mounted] back box. The exposed portions of the back box must be [chrome plated][anodized bronze][anodized aluminum] without knockouts.

2.11.2.2 Programming

Where programming for the operation of the graphic annunciator is accomplished by a separate software program other than the software for the RCU, the software program must not require reprogramming after loss of power. The software must be reprogrammable in the field.

]2.12 SMOKE DETECTORS

2.12.1 Photoelectric Smoke Detectors

Smoke detector must be photoelectric type and listed for use with the RCU.

a. Provide analog/addressable photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke detectors must be listed for use with the RCU.

b. Provide self-restoring type detectors that do not require readjustment after actuation at the RCU to restore them to normal operation. Detectors must be listed as smoke-automatic fire detectors.

c. Components must be rust and corrosion resistant. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases for the detectors. The detectors must maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The detector must have a visual indicator to show actuation.

e. The detector address must identify the particular unit, its location within the system, and its sensitivity setting. Detectors must be of the low voltage type rated for use on a 24 VDC system.

f. An operator at the control unit, having a proper access level, must have the capability to manually access the following information for each initiating device.

(1) Primary status.

(2) Device type.

(3) Present average value.

(4) Present sensitivity selected.

(5) Sensor range (normal, dirty, and other similar information).

2.12.2 Laser Smoke Detectors

a. Addressable laser smoke detectors must utilize laser diode and patented smoke sensing chamber, designed to amplify signals from smoke but diminish stray internal reflections and must, on command from the RCU, send data to the panel representing the analog level of smoke density.

b. Smoke detector must be listed for use with the RCU. Detector must be able to achieve sensitivities from 0.02 percent-per-foot to 2 percent-per-foot obscuration.

c. Laser smoke detector must provide point identification of the fire location through addressability, must experience no delay in response time due to smoke dilution or smoke transportation time, and must offer complete supervision of wiring and detector.

[2.12.3 Air Sampling Smoke Detectors

****

NOTE: Detector selection and spacing should be based on the applicable cooling system in the hazard area. Detection should be listed for the anticipated temperature and airflow in the hazard area.

****

The [addressable]air sampling smoke system must consist of a detector assembly housing an integral aspiration fan, filter, laser-based detection chamber and control, output and supervision circuitry.[Each sampling point must be capable of being independently addressable.] The system must consist of a piping or tubing distribution network that runs from the detector assembly(s) to the protected area(s) and is supported by air sampling smoke detection system calculations from a computer-based design modeling tool. The system must include configurable alarm and trouble relay outputs for interface to other systems where required.

a. System must be complete in all ways. It must include all engineering, and electrical installation, all detection and control equipment, auxiliary devices and controls, alarm interface, functional checkout and testing, training and all other operations necessary for a functional system.

b. System base detectors and modules must each accommodate up to [40 addressable][_____] microbore sampling tubes where each tube has a sampling point at the end. Additional modules may be used to provide up to [20 addressable][_____] sampling holes per system.

c. Program alarm thresholds to the following values unless the results of the system acceptance tests indicate a clear need to change them. In the event that such a need is indicated, notify the Contracting Officer and provide complete documentation concerning the need to deviate from these values. Include within the deviation documentation request, information that complies with the paragraph entitled "Sensitivity Verification Test". Ensure initial threshold levels are approved prior to the final acceptance test.

(1) Alarm Level 1: set ALERT at [_____][0.0250] percent obscuration/foot.

(2) Alarm Level 2: set PRE-ALARM at [_____][0.0500] percent obscuration/foot.

(3) Alarm Level 3: set FIRE 1 at [_____][0.1000] percent obscuration/foot.

(4) Alarm Level 4: set FIRE 2 at [_____][0.2000] percent obscuration/foot.

d. All air sampling smoke detection devices and associated components must be new, standard products or the manufacturer's latest design and suitable to perform the functions intended.

e. The laser detection chamber must be of the mass light scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method must be employed for the purposes of:

(1) Preventing large particles from affecting the true smoke reading.

(2) Monitoring contamination of the filter, e.g., dust and dirt, to automatically notify when maintenance is required. The particle counting method must not be used for the purpose of smoke density measurement.

f. Detector(s) must be self-monitoring for filter contamination and provide indication through system fault when replacement is necessary. Detectors which allow automatic reset of filter status upon removal and re-insertion are not permitted.

g. Detector(s) must contain relays for alarm and fault conditions. The relays must be software programmable to the required functions.

h. Detector(s) must permit configuration by programmers that are either integral to the system, portable or PC based.

i. Detector(s) must allow programming of:

(1) Smoke threshold alarm levels; ALERT, PRE-ALARM, FIRE 1 and FIRE 2.

(2) Time delays. Ensure the display control unit contains individual adjustable alarm time delay features for each of the alarm threshold levels. Provide an adjustment range between 0 and 60 seconds. Program the alarm threshold time delays to 30 seconds for alarm levels 1 and 2, and 15 seconds for alarm levels 3 and 4.

(3) Faults, including airflow, detector, power, filter and network, as well as an indication of the urgency of the fault.

(4) Configuration of relay outputs for remote indication of alarm and fault conditions.

(5) General purpose input functionality.

]2.13 HEAT DETECTORS

****

NOTE: The location and type of heat detectors and alarm devices must be indicated on project drawings. Delete descriptive paragraphs of detectors types not used. Alarm indicator should be used only if necessary to meet project requirements.

****

2.13.1 Heat Detectors

Heat detectors must be analog/addressable and designed for detection of fire by [fixed temperature][combination fixed temperature and rate-of-rise principle] [rate-compensating principle] in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values.. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations[as defined by NFPA 70][and][as indicated], must be types approved for such locations.

[2.13.1.1 Rate Compensating Detectors

Detector back box must be [surface][flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring and hermetically sealed. The detector assembly must be [weatherproof][and][explosionproof].

][2.13.1.2 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-resetting Detector must operate at [57.2][90] degrees C[135][194] degrees F. Detector must feature rate compensation. [Detectors rated to operate at 57.2 degrees C135 degrees F will not respond to momentary temperature fluctuations less than 16.7 degrees C30 degrees F per minute between 16 and 38 degrees C60 and 100 degrees F.][Detectors rated to operate at 90 degrees C194 degrees F will not respond to momentary temperature fluctuations less than 27.8 degrees C 50 degrees F per minute between 16 and 66 degrees C60 and 150 degrees F].[The detector assembly must be [weatherproof][and][explosionproof].]

][2.13.1.3 Fixed Temperature Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. The detectors must have a specific temperature setting [of [57.2][_____] degrees C[135][_____] degrees F][as shown]. The detector assembly must be [weatherproof][and][explosionproof].

]2.14 MANUAL RELEASE STATION

****

NOTE: Manual actuation stations are needed for

deluge systems only. Delete this paragraph for preaction systems.
****

Provide metal or plastic, semi-flush mounted, [single][double]-action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations must be equipped with screw terminals for each conductor. Stations that require the replacement of a portion of the device after activation are not permitted. Stations must be finished in yellow with molded raised lettering operating instructions of contrasting color. The use of a[key][wrench] must be required to reset the station. Stations must have a separate screw terminal for each conductor. Manual release stations must be a different color from building fire alarm pull stations. Station must be weatherproof type and must be provided with an engraved label indicating DELUGE SYSTEM.

2.15 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored must be configured as a [Class "A"][Class "B"] initiating device circuit. The module must be listed as compatible with the control unit. The monitor module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED.[Existing releasing system initiating device circuits must be connected to a single module to supervise the circuit.] Modules must be listed for the environmental conditions in which they will be installed.

2.16 ADDRESSABLE CONTROL MODULES

The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders. The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as a Class "B" notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and must prevent power from being applied to the circuit. The control model must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

2.17 ISOLATION MODULES

a. Provide isolation modules to subdivide each signaling line circuit [into groups of not more than [20 addressable devices][_____]][each floor][in accordance with NFPA 72] between adjacent isolation modules.

b. Isolation modules must provide short circuit isolation for signaling line circuit wiring.

c. Power and communications must be supplied by the SLC and must report faults to the RCU.

d. After the wiring fault is repaired, the fault isolation modules must test the lines and automatically restore the connection.

[2.18 NOTIFICATION APPLIANCES

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NOTE: The notification appliances are for providing local notification of a sprinkler system operation. These devices are not intended to provide general building fire alarm evacuation.

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Notification appliances must be suitable for connection to supervised notification appliance circuits. Appliance must have a separate screw terminal for each conductor. The surface of the appliance must be red in color.

2.18.1 Horns

Horns must conform to the applicable requirements of UL 464. Horns must be [semi-flush mounted][surface mounted], with the matching mounting backbox surface mounted vibrating type suitable for use in an electrically supervised circuit. Horns must produce a sound rating of at least 85 dBA at 3 meters10 feet. Horns used in exterior locations must be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

2.18.2 Visual Notification Appliances

****

NOTE: 1. ABA requires that Visual Notification Appliances be provided in buildings and facilities in each of the following areas: restrooms, and any general usage area (e.g., meeting rooms), hallways, lobbies, and any other area for common use and other areas stated at www.access-board.gov. The Visual Notification Appliance must be mounted as required by ABA that directs compliance with NFPA 72 except that the maximum allowable sound level of audible notification appliances must have a sound level no more than 110 dB at the minimum hearing distance from the audible appliance. In addition, alarms in guest rooms required to provide communication features must comply with sections 18.5.4.6 of NFPA 72. Shop drawings must indicate location, dimensions, content, details, and other required information to indicate extent of complying with ABA requirements.

2. Currently NFPA 72 requires "clear color" strobes for Fire Alarm Notification. NFPA 72 requires the strobe must be marked "Fire" to clearly identify the function.

****

Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED). The light pattern must be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of [15][30][75][_____] candela based on the UL 1971 test. Strobe must be [surface][semi-flush] mounted.

]2.19   ELECTRICAL

****

NOTE: Coordinate power and alarm requirements with the contract drawings and other specification sections.

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2.19.1   Wire

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.19.2   Alarm Wiring

IDC and SLC wiring must be [fiber optic][or][solid copper] cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. [14][16][18][_____] AWG size conductors at a minimum.[Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 14 AWG size conductors at a minimum.] Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors, appliances, or combination thereof. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with NFPA 70.

2.20   SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage RCU components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on a signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the releasing control unit breaker is located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. A unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for releasing system wiring. The base assembly must accept "plug-in" surge protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

  (1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

  (2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

  (3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

  (4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.21 ELECTRIC POWER

2.21.1 Primary Power

Power must be [120][_____] VAC [50][60] Hz service for the RCU from the AC service to the building in accordance with NFPA 72.

2.22 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.22.1 Batteries

Provide sealed, maintenance-free,[valve regulated lead acid] batteries as the source for emergency power to the RCU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.22.1.1 Capacity

Battery size must apply to every control unit and panel associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, and fire alarm transmitters.

a. Sufficient capacity to operate the releasing system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes (or minimum required time for automatic water control valve release).

2.22.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

    (1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit or panel component, and compliance with UL 864.

    (2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

    (3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries. Calculations must be performed using the minimum rated voltage of each component.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing devices, appliances, or combination of devices and appliancesremote from the power sources.

2.22.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work that is dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative all conditions that prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

The installation must be in accordance with the applicable provisions of NFPA 13, NFPA 24, NFPA 72 and publications referenced therein.[

Installation of in-rack sprinklers must comply with applicable provisions of NFPA 13.] Locate sprinklers in a consistent pattern with ceiling grid, lights, and air supply diffusers. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

a. Piping offsets, fittings, and other accessories required must be furnished to provide a complete installation and to eliminate interference with other construction.

b. Wherever the contractor's work interconnects with work of other trades the Contractor must coordinate with other Contractors to insure all Contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers and similar equipment) concealed above hung ceilings by permanent color coded pins/tabs in the ceiling directly below the item.

c. Provide required supports and hangers for piping, conduit, and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid must be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

3.2.1 Waste Removal

At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash which may have accumulated during the day as a result of work by the contractor and of his presence on the job. Sidewalks and streets adjoining the property must be kept broom clean and free of waste, debris, trash and obstructions caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities, and property.

3.3 UNDERGROUND PIPING INSTALLATION

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NOTE: Restraint of the underground piping must be detailed on the contract drawings.

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The fire protection water main must be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover must be [900][_____] mm [3][_____] feet or the frost line, whichever is deeper. The supply line must terminate inside the building with a flanged piece, the bottom of which must be set not less than 304 mm1-foot above the finished floor. A blind flange must be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block must be provided at the elbow where the pipe turns up toward the floor. In addition, joints must be anchored in accordance with NFPA 24. Buried steel components must be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 1500 mm5 feet outside the building walls must meet the requirements of Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.4 ABOVEGROUND PIPING INSTALLATION

The methods of fabrication and installation of the aboveground piping must fully comply with the requirements and recommended practices of NFPA 13 and this specification section.

3.4.1 Protection of Piping Against Earthquake Damage

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NOTE: The writer of this section must coordinate with the Structural Engineer or Government to determine the proper seismic design category for the project, in accordance with the IBC or ASCE guidelines. See UFC 3-310-04 for more information.

****

Seismic restraint is [not]required.

3.4.2 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, must be installed to provide maximum headroom.

3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping must be concealed above ceilings. Piping must be inspected, hydrostatically tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas must be concealed.

3.4.4 Pendent Sprinklers

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NOTE: Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 6.9 bar100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 300 mm12 inches for steel pipe and 1500 mm6 inches for copper tube.

****

a. Drop nipples to pendent sprinklers must consist of minimum 25-mm1-inch pipe with a reducing coupling into which the sprinkler must be threaded.

b. Where sprinklers are installed below suspended or dropped ceilings, drop nipples must be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling must not extend below the underside of the ceiling.

c. Recessed pendent sprinklers must be installed such that the distance from the sprinkler deflector to the underside of the ceiling must not exceed the manufacturer's listed range and must be of uniform depth throughout the finished area.

d. Pendent sprinklers in suspended ceilings must be located in the center of the tile (+/- 2 inches).[

e. Dry pendent sprinkler assemblies must be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space.][

f. Dry pendent sprinklers must be of the required length to permit the sprinkler to be threaded directly into a branch line tee.][

g. Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 6.9 bar100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 300 mm12 inches for steel pipe and 1500 mm6 inches for copper tube.]

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers must contain no fittings between the branch line tee and the reducing coupling at the sprinkler.

3.4.6 Pipe Joints

Pipe joints must conform to NFPA 13, except as modified herein. Not more than four threads must show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints must be provided where indicated or required by NFPA 13. Grooved pipe and fittings must be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools must be products of the same manufacturer. For copper tubing, pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.4.7 Reducers

Reductions in pipe sizes must be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face or hex type will be permitted. Where used, face bushings must be installed with the outer face flush with the face of the fitting opening being reduced. Bushings cannot be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 13 mm1/2-inch.

3.4.8 Pipe Penetrations

a. Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors must be core-drilled and provided with pipe sleeves. Each sleeve must be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and extend through its respective wall or floor and be cut flush with each wall surface. Sleeves must provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe must be firmly packed with mineral wool insulation.

b. Where pipes and sleeves penetrate fire walls, fire partitions, or floors, pipes/sleeves must be firestopped in accordance with Section 07 84 00 FIRESTOPPING.

c. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe must be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

d. All penetrations through the boundary of rooms/areas identified as secure space area must meet ICS 705-1.

3.4.9 Escutcheons

Escutcheons must be provided for pipe penetration in finished areas of ceilings, floors and walls. Escutcheons must be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

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NOTE: Designer will indicate location of the inspector's test connections and all associated valves on the contract drawings, and will provide details of drain piping.

****

Unless otherwise indicated, the test connection must consist of 25-mm1-inch pipe connected to the remote branch line; a test valve located approximately 2 meters7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test". All test connection piping must be inside of the building and penetrate the exterior wall at the location of the discharge orifice only. The discharge orifice must be located outside the building wall no more than 0.6 meters2 feet above finished grade, directed so as not to cause damage to adjacent construction or landscaping during full flow discharge, or to the sanitary sewer. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building. Do not discharge to the roof. Discharge to floor drains, janitor sinks or similar fixtures is not be permitted.

Provide concrete splash blocks at all drain and inspector's test connection discharge locations if not discharging to a concrete surface. Splash blocks must be large enough to mitigate erosion and must not become dislodged during a full flow of the drain. Ensure all discharged water drains away from the facility and does not cause property damage.

3.4.11 Backflow Preventer

Locate within the building or in a heated enclosure in locations subject to freezing. For heated enclosures, provide a low temperature supervisory alarm connected to the facility fire alarm system. Heat trace is not permitted to be used.

Install backflow preventers so that the bottom of the assembly is a minimum of 150 mm6 inches above the finished floor/grade. Install horizontal backflow preventers so that the bottom of the assembly is no greater than [_____]610 mm24 inches above the finished floor/grade. Install vertical backflow preventers so that the upper operating handwheel is no more than [_____]1.8 meters6 feet above the finished floor/grade. Clearance around control valve handles must be minimum 150 mm6inches above grade/finished floor and away from walls.

[3.4.11.1 Test Connection

Provide downstream of the backflow prevention assembly UL 668 hose valves with 65-mm2.5-inch National Standard male hose threads with cap and chain. Provide one valve for each 946 L/min250 gpm of system demand or fraction thereof. Provide a permanent sign in accordance with paragraph entitled "Identification Signs" which reads, "Test Valve". Indicate location of test header. If an exterior connection, provide a control valve inside a heated mechanical room to prevent freezing. The piping between the backflow preventer test header control valve and the exterior test header must be provided with an automatic drip arranged to drain to the outside.

]3.4.12 Drains

a. Main drain piping must be provided to discharge [at a safe point outside the building, no more than 0.6 meters2 feet above finished grade][at the location indicated][to the sanitary sewer]. Provide a concrete splash block at drain outlet. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building.

b. Auxiliary drains must be provided as required by NFPA 13. Auxiliary drains are permitted to discharge to a floor drain if the drain is sized to accommodate full flow (min 151 L/min40 gpm). Discharge to service sinks or similar plumbing fixtures is not permitted.

3.4.13 Installation of Fire Department Connection

Connection must be mounted [on the exterior wall approximately 900 mm3 feet above finished grade][adjacent to and on the sprinkler system side of the backflow preventer]. The piping between the connection and the check valve must be provided with an automatic drip in accordance with NFPA 13 and piped to drain to the outside or a floor drain within the same room.

3.4.14 Identification Signs

Signs must be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Main drain test results must be etched into main drain identification sign. Hydraulic design data must be etched into the nameplates and must be permanently affixed to each sprinkler riser as specified in NFPA 13. Provide labeling on the surfaces of all feed and cross mains to show the pipe function (e.g., "Sprinkler System", "Fire Department Connection", "Standpipe") and normal valve position (e.g. "Normally Open", "Normally Closed"). For pipe sizes 100 mm4-inch and larger provide white painted stenciled letters and arrows, a minimum of 50 mm2 inches in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 100 mm4-inch, provide white painted stenciled letters and arrows, a minimum of 18 mm0.75-inch in height and visible from the floor.[Provide properly lettered and approved metal sign to elevator flow switch stating the circuits' voltage, and identify the switch as an "Elevator Power Shunt Flow Switch".]

[3.4.15 Isolation Valve

Provide a control valve on the riser assembly, downstream of the backflow preventer test connection and waterflow indicator, to allow isolation of riser when testing (tripping) the automatic water control valve without allowing water to enter the system piping. The control valve must be electrically supervised in the open position.

]3.5 ELECTRICAL

****

NOTE: Coordinate power and alarm requirements with the contract drawings and other specification sections.

****

Except as modified herein, electric equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.[Alarm signal wiring connected to the building fire alarm control system must be by the fire alarm installer.]

3.5.1 Overcurrent and Surge Protection

All equipment connected to alternating current circuits must be protected from surges. Cables and conductors that serve as communications links, except fiber optics, must have surge protection circuits installed at each end. Fuses must not be used for surge protection.

3.5.2 Grounding

Grounding must be provided to building ground.

3.5.3 System Field Wiring

3.5.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and professional manner and installed parallel with or at right angles to the sides and back of the box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in an enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the RCU and remote RCU, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.5.3.2 Terminal Cabinets

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NOTE: Provide terminal cabinets on each floor where the fire alarm system supply riser is located and where the fire alarm return riser is located.
****

Provide a terminal cabinet at the base of the circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 200 mm by 200 mm8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "RELEASING SYSTEM TERMINAL CABINET" with 50-mm2-inch lettering, on the front of the terminal cabinet.

3.5.3.3 Alarm Wiring

****
NOTE: Do not penetrate SCIF perimeters with copper signal line circuits. SCIF penetrations should be either fiber optic cable or IDC. IDC circuits penetrating the SCIF must be filtered.
****

a. Voltages must not be mixed in junction boxes, housing or device, except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the RCU.

c. [Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.][T-tapping using screw terminal blocks is allowed for Class "B" initiating device circuitssignaling line circuits.]

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the [_____] Designated Fire Protection Engineer (DFPE).

3.5.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 19 mm3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits 2 meters6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

g. [g. For Class "A" or "X" circuits with conductor lengths of 3 meters10 feet or less, the conductors must be permitted to be installed in the same raceway in accordance with NFPA 72.]

3.5.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, and RCU must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet and RCU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12-point lettering minimum size, and mounted within each cabinet, panel, or control unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.6 RELEASING CONTROL SYSTEM

3.6.1 Releasing Control Unit (RCU)

The RCU must be located in a year round environmentally conditioned space and not in the hazard area served but adjacent to it. Locate the RCU [where indicated on the drawings][_____]. [Recess][Semi-recess][Surface mount] the enclosure with the top of the cabinet 2 meters6 feet above the finished floor or center the cabinet at [1.5][_____] meters[5][_____] feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the RCU.

3.6.2 Smoke Detectors

Locate detectors [as required by NFPA 72 and their listing][as indicated on the drawings] on a 100-mm4-inch mounting box. Smoke detectors are permitted to be on the wall no lower than 300 mm12 inches from the ceiling with no minimum distance from the ceiling.[In raised floor spaces, install the smoke detectors to protect [21 square meters225 square feet per detector][_____].] Install smoke detectors no closer than 1-meter3 feet from air handling supply diffusers.[Detectors mounted in acoustical ceiling tiles must be centered in the tiles +/- 50 mm2 inches.]

3.6.3 Air Sampling Smoke Detector

Locate air sampling smoke detectors in accordance with the manufacturer's instructions. Air sampling smoke detectors must be installed as follows:

a. Air Sampling Smoke Detector Assembly:

(1) Detector assembly must be mounted to a wall at a height between 1200 to 1800 mm48 to 60 inches to top of detector measured above the finished floor.

(2) Mounting must be in a fully accessible and visible location.

(3) Mounting or attachment to site equipment, cable trays, movable walls, other equipment or equipment supports is not permitted.

(4) Piping network insertion into the detector inlet must not be glued.

(5) Air sampling smoke detector assembly must be installed in accordance with this specification section and the manufacturer's installation and instruction manuals.

(6) Flexible tubing for termination of the sampling pipe network into detector inlet is not permitted unless allowed by its listing.

(7) Provide red background with white lettering labels that are plastic or phenolic type with a minimum of 6.4 mm0.25-inch block lettering to indicate detector and zone. For example: "AIR SAMPLING SMOKE DETECTOR No. 1-1 No. 5".

(8) Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the ASD panel. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must be approved by the Contracting Officer before being posted.

b. Pipe and Sampling Tube Mounting:

(1) The pipe and sampling tubing detection network must be mounted as per the design and manufacturer's specification. The hardware used for mounting will depend upon the design and site requirements.

(2) To minimize flexing, pipes must be secured every 1.5 meters5 feet.

(3) Pipes must be suspended between 25 and 100 mm1 and 4 inches below the ceiling. In areas with a suspended ceiling, the pipe network must be installed above the ceiling utilizing the manufacturer's capillary sample port supported by the ceiling.

(4) The sampling tubes must be of the same length or use the manufacturer's guidelines to run tubes of the required lengths.

(5) When installing a pipe network in areas subject to high temperature fluctuations allow for the contraction and expansion of pipes.

(6) Where expansion or contraction of pipes is likely either after installation or on a continuous basis, do not place pipe clips adjacent to couplings and socket unions as these may interfere with the movement of the pipe.

(7) No bends are permitted within the first 450 mm18 inches from the detector inlet.

(8) The routing of the piping and sample tube network must be coordinated with potential obstructions, including cable trays, grounding bars, and HVAC ductwork.

(9) All changes in direction must be made with standard elbows or tees.

(10) All joints must be air-tight and made by using solvent cement, except at the entry to the detector assembly. Refer to ASTM F402.

(11) All pipes must be supported by mechanical hangers attached to the structure of the building. Not more than 300 mm1-foot of pipe must extend beyond the last hanger of each sampling pipe. The final installation must result in no noticeable deflection in the piping network.

(12) Attachment of air sampling pipes to cable trays, "gray iron", and telecommunications equipment is prohibited.

(13) Clearly label pipe network to distinguish the pipe from other facility pipe work or protective cabling enclosures. For example: "SMOKE DETECTION SAMPLING TUBE - DO NOT DISTURB". In open rooms and exposed areas, provide labels at no greater than 6.1-meter 20-foot intervals. Provide labels every 3 meters10 feet where piping is installed above suspended ceilings and every 609 mm2 feet, centered in the floor panels, where piping is installed within the raised floor cavity.

(14) Placement of the sampling tube must take into consideration appropriate sampling point locations and spacing.

c. Air Sampling Points:

(1) Open area ceiling sampling points must be oriented downward and must be within 25 to 100 mm1 to 4 inches below the underside of the ceiling above where the ceiling is smooth.

(2) Label all air sampling points with a round red label, each with a center hole to match the diameter of the drilled sampling point. For example: "AIR SAMPLING POINT DIA 3.2 MM0.125 INCHES".

Indicate fractional dimensions in decimal format with a minimum of three decimal places.

[3.6.4 Manual Stations

Locate manual stations as required by NFPA 72[and as indicated on the drawings]. Mount stations so they are located no farther than [1.5][_____] meters[5][_____] feet from the exit door they serve, measured horizontally. Manual stations must be mounted at [1067][1117][_____] mm [42][44][_____] inches measured to the operating handle.

][3.6.5 Notification Appliances

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NOTE: Locate strobes wall mounted in corridors no more than 4.5 meters15 feet from the end of a corridor with 30meters100 feet maximum distance between strobes. Where there is an obstruction to the viewing path in the corridors, such as a cross-corridor door or ceiling elevation change, consider the obstruction as defining a new corridor. Provide ceiling mounted strobes in rooms accessible to the public, such as conference rooms, restrooms, courtrooms, cafeterias, and auditoriums in accordance with NFPA 72. In Child Development Centers only chimes must be used as the pre-alert tone prior to voice messages.

****

a. Locate notification appliance devices [as required by NFPA 72][where indicated]. Where more than two appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring.[Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles +/- 50 mm2 inches.]

b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.

][3.6.6 Graphic Annunciator

Locate the graphic annunciator as shown on the drawings. Mount the panel, with the top of the panel 1830 mm6 feet above the finished floor or center the panel at [1525][_____] mm[5][_____] feet, whichever is lower. [Locate the graphic annunciator as shown on the drawings. Surface-mount the panel, with the top of the panel 1830 mm6 feet AFF or center the panel at [1525][_____] mm[5][_____] feet, whichever is lower.]

]3.6.7 Remote LCD Annunciator

Locate the remote LCD annunciator as shown on the drawings. Mount the panel, with the top of the panel 2 meters6 feet above the finished floor or center the panel at [1.5][_____] meters[5][_____] feet, whichever is lower.

3.6.8 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.7 PAINTING

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NOTE: Designer will coordinate color code marking with Section 09 90 00 PAINTS AND COATINGS. Color code marking for piping which are not listed in Table I of Paragraph 3.5 Pipe Color Code Marking of UFGS Section 09 90 00 will be added to the table.

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Color code mark piping [red][as specified in Section 09 90 00 PAINTS AND COATINGS].

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving releasing system equipment), releasing system conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving releasing system equipment), releasing system conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Releasing System" and the conduit must have painted red bands 19 mm3/4-inch wide at 3-meter10-foot centers and at each side of a floor, wall, or ceiling penetration.

3.8 FIELD QUALITY CONTROL

3.8.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level [III][or][IV] Fire Sprinkler Technician, and the representative of the installing company,[and reviewed by the QFPE] [60][_____] days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, [notification appliances and circuits,] signaling line devices and circuits, control devices/equipment, batteries, power sources/supply, annunciators, special hazard equipment, and interface equipment. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 13 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government final testing.

a. Identify the NFPA Class of all initiating device circuits (IDC),[notification appliance circuits (NAC),] and signaling line circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing. The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.8.2 Pre-Government Testing

3.8.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that equipment is functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" and "System Acceptance" as noted in NFPA 13 and NFPA 72. The Contractor [and QFPE] must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 13 and the test reports noted below.

a. NFPA 13 Aboveground Material and Test Certificate

b. NFPA 13 Underground Material and Test Certificate

c. NFPA 72 Record of Completion

d. NFPA 72 Record of Inspection and Testing

3.8.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the [_____][Designated Fire Protection Engineer (DFPE)][Contracting Officers Designated Representative (COR)]. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the [building fire alarm system][installation fire alarm reporting system] have been completed and tested to confirm communications are fully functional. Submit request for test at least [15][_____] calendar days prior to the requested test date.

3.8.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required

for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. [b. The contractor's Qualified Fire Protection Engineer (QFPE).]

c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results.

e. Complete program printout including input/output addresses.

f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

Government Final Tests will be witnessed by the [_____], [Designated Fire Protection Engineer][Contracting Officer][, Qualified Fire Protection Engineer (QFPE)]. At this time, all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.9 MINIMUM SYSTEM TESTS

The system, including the underground water mains, and the aboveground piping and system components, must be tested to ensure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure must be tested in accordance with NFPA 13 and NFPA 24.

3.9.1 Underground Piping

3.9.1.1 Flushing

****

NOTE: Designer should check the site water section for inconsistencies and to verify flushing of all underground pipe will be performed prior to connection to the sprinkler system.

****

Underground piping must be flushed in accordance with NFPA 24.

3.9.1.2 Hydrostatic Test

New underground piping must be hydrostatically tested in accordance with NFPA 24.

3.9.2 Aboveground Piping

3.9.2.1 Hydrostatic Test

Aboveground piping must be hydrostatically tested in accordance with NFPA 13. There must be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure must be read from a gauge located at the low elevation point of the system or portion being tested.

3.9.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly must be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor must provide all equipment and instruments necessary to conduct a complete forward flow test, including 65-mm2.5-inch diameter hoses, playpipe nozzles or flow diffusers, calibrated pressure gauges, and pitot tube gauge. The Contractor must provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction loss) across the assembly must be recorded. A metal placard must be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate determined during the preliminary testing. The pressure drop must be compared to the manufacturer's data and the readings observed during the final inspections and tests.

3.9.3 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the preliminary test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device[and notification appliance] and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

e. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

f. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

g. Determine that the system is operable under trouble conditions as specified.

h. Visually inspect wiring.

i. Test the battery charger and batteries.

j. Verify that software control and data files have been entered or programmed into the releasing control unit. Hard copy records of the software must be provided to the Contracting Officer.

k. Verify that red-line drawings are accurate.

l. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

m. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

n. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.

[

o. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.]

p. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.9.4 Alarm Device Test

Each alarm switch/device must be tested by flowing water through the inspector's test connection.

[3.9.5 Audibility Tests

Sound pressure levels from audible notification appliances must not exceed 110 dBA in occupiable areas. The provisions for audible notification (audibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

]3.9.6 Main Drain Flow Test

Following flushing of the underground piping, a main drain test must be made to verify the adequacy of the water supply. Static and residual pressures must be recorded on the certificate specified in paragraph SUBMITTALS.

3.9.7 Automatic Water Control Valves Trip Test

Each water control valve must be independently trip-tested in accordance with the manufacturer's published instructions. Each valve must be electrically trip-tested by actuating a respective heat detector, a manual actuation station connected to the system control unit and the manual release which is part of the valve trim. Each valve must be returned to normal condition after each test. Prior to trip testing sprinkler deluge system, precautionary steps must be taken to prevent water damage to the building and equipment from sprinkler discharge. Control valves on deluge systems must[be shut off immediately after automatic water control valve trips][remain open until open sprinklers have discharged for a minimum of [10][_____] seconds].

3.10 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the final acceptance test.

[a. Provide one set of full size paper as-built drawings and schematics. The drawings must be prepared electronically and sized no less than the contract drawings.] [Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation][AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide operating and maintenance (O&M) instructions.

3.11 ONSITE TRAINING

****

NOTE: The number of hours of instruction should be determined based of the number and complexity of the systems specified.

****

Conduct a training course for the responding fire department and operating and maintenance personnel as designated by the Contracting Officer. Training must be performed on two separate days (to accommodate different shifts of Fire Department personnel) for a period of [_____][4] hours of normal working time and must start after the system is functionally complete and after the final acceptance test. The on-site training must cover all of the items contained in the approved Operating and Maintenance Instructions.

3.12 EXTRA MATERIALS

3.12.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturer[s]. Installing fire alarm contractor is NOT responsible for damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.12.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed system[s]. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the final acceptance testing and must be accompanied by an inventory list.

3.12.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. Site-specific software data package

e. All documentation required by SD-06

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-21 13 24.00 10 (October 2007)**

Preparing Activity: USACE **Superseding**
UFGS-21 13 24.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 21 - FIRE SUPPRESSION

SECTION 21 13 24.00 10

AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM

10/07

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-21 13 24.00 10 (October 2007)**

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SECTION 21 13 24.00 10

AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM
10/07

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NOTE: This guide specification covers requirements for foam-water AFFF fire protection sprinkler and nozzle systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The complete design of the AFFF system must be shown on the project drawings. There are no provisions in this UFGS for the Contractor to perform hydraulic calculations or to lay out the system. (For aircraft hangar applications, refer to ETL 1110-3-484.) Use sprinkler hydraulics software for hydraulic calculation of the fire protection system. Assure that the design analysis clearly describes the design approach and includes hydraulic calculations. The drawings SHOULD include complete pipe and equipment layout WITH SPACE ENVELOPE REQUIRED FOR INSTALLATION AND OPERATION OF EACH SYSTEM COMPONENT SHOWN. THE DRAWINGS SHOULD ALSO INCLUDE sprinkler and nozzle locations, elevation

views of the piping showing vertical location of sprinklers and piping with respect to the ceiling and floor heat detectors, control panels, AFFF control panel zoning, wiring, foam storage tank, pumps, and other associated equipment. Consider pipe hanger requirements when laying out the system to ensure that the Contractor can provide hangers per NFPA 13.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A351/A351M	(2024) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A795/A795M	(2021) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use

ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 11	(2024) Standard for Low-, Medium- and High- Expansion Foam
NFPA 13	(2024) Standard for the Installation of Sprinkler Systems
NFPA 16	(2015) Standard for Installation of Foam-Water Sprinkler and Foam-Water Spray Systems
NFPA 20	(2025) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 24	(2025) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 1963	(2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-24385	(1992; Rev F; Am 1 1994; Am2 2017; Am3 2019; Am4 2020) Fire Extinguishing Agent,

	Aqueous Film Forming Foam (AFFF) Liquid Concentrate, for Fresh and Seawater
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Materials and Equipment; G, [_____]

Spare Parts

AFFF System; G, [_____]

Installer's Qualifications; G, [_____]

Post-Discharge Test Requirements; G, [_____]

SD-06 Test Reports

Test Reports

SD-07 Certificates

Materials and Equipment

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings; G, [_____]

1.3 QUALITY ASSURANCE

In the event of a conflict between referenced NFPA standards and this specification, this specification governs. Interpret reference to "authority having jurisdiction" to mean the Contracting Officer.

1.3.1 Submittal Preparer's Qualifications

Prepare fire protection system submittals, including as-built drawings, by an individual who is either a registered professional engineer with ten years experience designing AFFF systems or who is certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. Submit one set of reproducibles and six copies, within 14 calendar days after successful completion of required testing. Maintain a separate set of approved submittal drawings of the overall system, marked up to indicate as-built conditions, onsite in a current condition at all times and make available for review immediately upon request during normal working hours. Indicate variations from the approved drawings, for whatever reason, including those occasioned by modifications, change orders, optional materials, and/or required for coordination between trades in sufficient detail to accurately reflect the as-built conditions.

1.3.2 Installer's Qualifications

Provide a statement attesting that the proposed installer is regularly engaged in the installation of the type and complexity of system included in this project. Submit, in addition, data identifying the locations of at least three systems recently installed by the proposed installer which are comparable to the system specified. Certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

1.3.3 Detail Drawings

Submit detail drawings conforming to the requirements prescribed in NFPA 13; drawings must be 841 x 594 mm 30 x 42 inches. Include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Include the following for each set of drawings:

a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

b. Floor plans drawn to a scale not less than 1:100 1/8 inch equals 1 foot clearly showing locations of devices, equipment, risers, electrical power connections, flame detector viewing areas, areas covered by each nozzle, and other details required to clearly describe the proposed arrangement.

c. Piping plan for each individual sprinkler system and each nozzle system. Show sprinklers, nozzles and associated piping. Abbreviated presentation forms will not be accepted. Identify each type of fitting used and the locations of bushings, reducing couplings, and welded joints. Provide a separate plan for each overhead sprinkler system and each nozzle system.

d. Piping plan and isometric drawing of the AFFF concentrate system and details of all associated pumps, valves, fittings, and other components. Indicate all operational features including, but not limited to, settings for pump start/stop, relief valve open/close, pressure sustaining valve open/close.

e. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; and from sprinkler feed mains, crossmains and branchlines to finished floor and roof or ceiling.

f. Location of control panels, detectors, manual stations, supervisory switches, solenoids, notification appliances, and other electrical devices. In addition, indicate conduit routing and sizes, and the number of conductors contained in each.

g. Longitudinal and transverse building sections showing typical branch line and crossmain pipe routing and elevation of each typical sprinkler above finished floor.

h. Equipment room layout drawings drawn to a scale of not less than 1:20 1/2 inch equals 1 foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

i. Details of each type of pipe hanger, sway bracing for earthquake protection, restraint of underground water main at point-of-entry into the building, proportioners, nozzles and mounting details, AFFF system control valve header and related components.

j. Connection drawings and control diagrams indicating overall electrical and mechanical operation of the AFFF system. Include identification and operation of each major component of the system. Supplement diagrams with a narrative description of the system. Point-to-point wiring diagrams must indicate foam system control panel wiring and make and model of devices and equipment connected thereto.

k. Detail drawings depicting actual wiring of AFFF pump controller and all interconnecting wiring to foam concentrate pumps and other components connected to the controller. Prepare such drawing specifically for the project installation. Manufacturer's standard wiring diagrams will not be accepted.

1.4 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified. Include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

****

NOTE: General operation of the system should be described here. This description is not intended to replace a controls matrix or sequence of operation otherwise required or provided on the drawings. Select the appropriate system and delete the others.

****

a. Provide an AFFF System consisting of an automatic [wet-pipe] [preaction] [deluge] foam-water fire protection system used for the areas indicated on the drawings. Submit a copy of the proposed diagrams and instructions for the overall AFFF system, prior to posting. Except as modified herein, meet the requirements of NFPA 11, NFPA 13, NFPA 16, NFPA 24 and NFPA 72.

b. [Operate the wet-pipe sprinkler system so that actuation of a single sprinkler will cause water to flow through the alarm check valve, foam concentrate to enter the affected proportioners, and foam-water solution to be discharged from actuated sprinklers and the nozzle system.]

c. [Operate the single-interlocked preaction sprinkler system (without supervisory air) so that actuation of a single heat detector or manual release will cause the automatic water control (deluge) valve to open, foam concentrate to enter the affected proportioners, and foam-water solution to be discharged from actuated sprinklers and the nozzle system.]

d. [Operate the deluge sprinkler system so that actuation of a single heat detector or manual release will cause the automatic water control (deluge) valve to open, foam concentrate to enter the affected proportioners, and foam-water solution to be discharged from all sprinklers on the system and the nozzle system.]

2.2 STANDARD PRODUCTS

Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit manufacturer's catalog data for each separate piece of equipment proposed for use in the system. Indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, provide a complete equipment list with equipment description, model number, and quantity and certificates from manufacturers to substantiate that components, equipment and material proposed for installation and use meet requirements as specified. Make certificates on a form for this purpose or on official letterhead of the manufacturer with specified information stated as required. Certificate must be signed by an officer of the corporation. Submit certificates for the following:

2.2.1 AFFF Concentrate

Certification that AFFF concentrate proposed for use has been tested and is in compliance with MIL-PRF-24385.

2.2.2 AFFF Concentrate Control Valve

Certification that the valve is designed and, constructed as specified and will function as intended.

2.2.3 AFFF Proportioning System

Certification that the foam proportioning system complies with contract specifications and manufacturer's recommendations.

2.2.4 Control Panel

Certification that the control panel releasing module is electrically compatible with the electrically-actuated automatic water control valve.

2.3 NAMEPLATES

Provide major components of equipment with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate permanently affixed to the item of equipment.

2.4 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Provide equipment and material that has been tested by Underwriters Laboratories, and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, such terms mean listed in UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described are not be construed as waiving this requirement.

2.5 PRESSURE RATINGS

Provide valves, fittings, couplings, proportioners, alarm switches, strainers, and similar devices rated for the maximum working pressures that can be experienced in the system, but in no case less than 1200 kPa 175 psi.

2.6 UNDERGROUND PIPING SYSTEMS

****

NOTE: Assure that this provision is coordinated with drawings and other specification sections.

****

Provide ductile iron pipe conforming to AWWA C151/A21.51, working pressure not less than 1034 kPa 150 psi, with cement-mortar lining conforming to AWWA C104/A21.4 for piping under the building and to a point 1.5 m 5 feet outside the building walls. Provide ductile iron fittings conforming to AWWA C110/A21.10. Piping more than 1.5 m 5 feet outside the building walls must be [outside-coated cement-lined ductile iron pipe] [provided under SECTION 33 11 00 WATER UTILITY DISTRIBUTION PIPING].

2.7 ABOVEGROUND PIPING SYSTEMS FOR WATER OR AFFF SOLUTION

2.7.1 Pipe

Provide standard weight pipe conforming to ASTM A795/A795M or ASTM A53/A53M. Pipe 150 mm 6 inch diameter and smaller must be Schedule 40. Mark pipe as to the brand or name of the manufacturer, kind of pipe and the ASTM designation in accordance with the "Product Marking" provisions of the ASTM standard.

2.7.2 Grooved Fittings and Couplings

Provide grooved fittings, couplings and bolts by the same manufacturer. Provide malleable iron fittings and couplings complying with ASTM A47/A47M or ductile iron complying with ASTM A536. Provide rigid type couplings except provide flexible type where flexible joints are specifically required by NFPA 13. Ensure coupling gaskets are Grade E (EPDM) approved for dry pipe fire protection service. Provide flush type gasket that fills the entire cavity between the coupling and the pipe. Provide heat-treated, cadmium plated or zinc electroplated steel nuts and bolts conforming to ASTM A183.

2.7.3 Non-Grooved Fittings

Provide threaded or flanged non-grooved fittings. Ensure threaded fittings are cast iron conforming to ASME B16.4 or malleable iron conforming to ASME B16.3. Ensure flanged fittings are cast iron conforming to ASME B16.1. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed must be threaded type. Do not use plain-end fittings with mechanical couplings, fittings which require drilling a hole in the pipe, and fittings which use steel gripping devices to bite into the pipe.

2.7.4 Flanges and Gaskets

Provide flanges conforming to NFPA 13 and ASME B16.1 that are welded or threaded to the pipe. Flanges which are bolted to grooved pipe will not be permitted. Provide gaskets that are full face type EPDM or other approved material.

2.7.4.1 Bolts

Ensure bolts are ASTM A449, Type [1] [2]. Extend bolts no less than three full threads beyond the nut with bolts tightened to the required torque.

2.7.4.2 Nuts

Provide [ASTM A193/A193M, Grade 5] [ASTM A563M ASTM A563, Grade [C3] [DH3]] nuts.

2.7.4.3 Washers

Meet the requirements of ASTM F436M ASTM F436. Provide flat circular washers under all bolt heads and nuts.

2.7.5 Pipe Hangers

Provide hangers listed in UL Fire Prot Dir or FM APP GUIDE and suitable for the application, construction and size pipe involved.

2.7.6 Control Valve

Unless otherwise indicated, valves must be indicating type in accordance with NFPA 13. Valves 65 mm 2-1/2 inch and larger must be flanged outside screw and yoke (OS&Y) type.

2.7.7 Check Valve

Check valves 100 mm 4 inches and larger must be flanged, swing type, cast or ductile iron body and cover, cast or ductile iron clapper with replaceable EPDM rubber facing. Provide valves that are suitable for either vertical or horizontal mounting and equip with a removable handhole cover. Indicate the direction of flow by an arrow cast in the valve body. Include plugged pipe thread connections for a 50 mm 2 inch drain.

2.8 ABOVEGROUND PIPING SYSTEMS FOR AFFF CONCENTRATE

2.8.1 Pipe

Provide standard weight stainless steel pipe conforming to ASTM A312/A312M, Grade TP 304L.

2.8.2 Fittings

Provide seamless socket weld type or flanged type fittings conforming to ASTM A403/A403M, Grade WP 304L, and compatible with the pipe. Grooved type fittings and couplings must be of Type 316 Stainless Steel conforming to ASTM A351/A351M.

2.8.3 Pipe Hangers

Provide hangers listed in UL Fire Prot Dir or FM APP GUIDE and suitable for the application, construction and size pipe involved.

2.8.4 Control Valves

Provide indicating type valve with full port ball and operating handle that indicates the on/off position of the valve. Provide socket weld or flanged type unit. Provide valve body and ball consisting of 316 stainless steel complying with ASTM A351/A351M. Provide the valve handle with a suitable and substantial means for securing the valve open with a key-operated locking device.

2.9 ALARM CHECK VALVE ASSEMBLY

****

NOTE: Specify 1724 kPa 250 psi rated valve for applications where the working pressure exceeds, or may exceed, 1207 kPa 175 psi.

****

Provide variable pressure type alarm check valve assembly rated for working pressures of [1207 kPa175 psi] [1724 kPa250 psi]. Provide assembly with standard trimmings including pressure gauges, retarding chamber, alarm line vent, testing bypass, and necessary pipe, fittings, and accessories required for a complete installation. Provide brass valve trim piping. Include provision for installing an alarm pressure switch in a non-interruptible arrangement whereby shutting off of other alarm devices will not shutoff the switch in the non-interruptible location.

2.10 AUTOMATIC WATER CONTROL VALVE ASSEMBLY (DELUGE VALVE)

****

NOTE: The term "automatic water control valve" is found in the FM Approval Guide and is synonymous with "special system water control valves" found in the UL Fire Prot Dir. This term is used for "deluge," "preaction" and "flow control" valves.

****

Provide an electrically-actuated type water control valve rated for a maximum working pressure of [1207 kPa175 psi] [1724 kPa250 psi] that is resettable without opening the valve and without the use of special tools. Electrical solenoid valve used to actuate the water control valve must be an integral component of the valve or approved for use by the water control valve manufacturer and the control panel manufacturer. Ensure solenoid valve is the normally closed, de-energized type which opens when energized upon receipt of an electrical signal from the control panel to which it is connected. Ensure solenoid valves used with diaphragm-type valves are rated for a maximum pressure equal to that of the associated valve. Equip water control valve with a means to prevent the valve from returning to the closed position until being manually reset. Provide complete assembly with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances. Include an emergency release device for manually tripping the water control valve in the event of a power or other system failure for each assembly. Ensure device is a standard accessory component of the valve manufacturer and labeled as to its function and method of operation. Use valves located in hazardous locations that are approved for the hazard classification of the area where located.

2.11 MECHANICAL ALARM DEVICE

Provide water-powered device including body housing, impeller wheel, drive shaft, striker assembly, gong, wall plate and related components necessary for complete operation. Provide minimum 19 mm 3/4 inch piping between the housing and the alarm line trim. Ensure drain piping from the body housing is minimum 25 mm 1 inch steel and arranged to drain to the outside of the building. Galvanize piping both on the inside and on the outside surfaces.

2.12 FIRE DEPARTMENT CONNECTION

****

NOTE: Verify the type of threads used by the local fire department.

****

Provide [projecting] [flush] type connection with cast brass body, a [polished brass] [chromium plated] finish, and matching wall escutcheon lettered "Auto Spkr". Ensure connection has two inlets with individual self-closing clappers, caps with drip drains, and chains. Provide female inlets with 65 mm 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) in accordance with NFPA 1963.

2.13 BASKET STRAINER

****

NOTE: Strainers are generally not required on systems utilizing only wet-pipe sprinklers. Indicate strainer size and friction loss limits based upon specific design.

****

Provide unit with cast iron flanged body and cover flanges. Provide strainer basket that is formed of perforated brass or stainless steel sheet with 6 mm 1/4 inch perforations, with strainer size of [_____] mm inch and a maximum friction loss of [_____] kPa psi at a flow rate of [_____] L/second gpm. Assemble to allow access to the strainer basket by removing the flange on the top of the strainer.

2.14 REDUCED PRESSURE BACKFLOW PREVENTION ASSEMBLY

****

NOTE: Backflow preventers are not required in systems supplied by dedicated fire protection storage and pumping facilities. Where systems are supplied from domestic water systems, reduced pressure type backflow preventers are required and must be located on the discharge side of booster fire pumps directly supplying the system.

****

Provide unit that is capable of preventing backsiphonage and back pressure backflow from the fire protection system into the potable water system. Include a pressure differential relief valve located in a zone between two positive seating check valves. Include resilient seated outside stem and yoke (OS&Y) gate valves upstream and downstream of the valve and test cocks. Provide main valve body consisting of ductile iron with fused bonded epoxy coating. Provide assembly in compliance with ASSE 1013 and listed in UL Fire Prot Dir or FM APP GUIDE.

2.15 DISCHARGE DEVICES

2.15.1 Sprinkler

Sprinkler must be 13 mm 1/2 inch orifice spray type. For deluge systems, provide open type sprinkler without heat responsive and actuating elements. For wet-pipe or preaction systems, provide upright type sprinkler with [standard response] [quick response] glass bulb heat responsive and actuating element having a temperature rating of [79 degrees C 175 degrees F] [_____]. Provide spare sprinklers in accordance with NFPA 13 housed in metal or plastic containers.

2.15.2 Fixed Nozzle

****

NOTE: Verify availability of nozzles required to meet design flows and pressures as needed to achieve nozzle coverage indicated on the drawings.

****

Provide nozzle that is fixed constant flow type, cast brass construction [25] [40] [_____] mm [1] [1-1/2] [_____] inch male NPT, suitable for use with AFFF solution. Factory set nozzle for required discharge characteristic. Indicate discharge characteristic or k-factor(s) on the drawings. Nozzle discharge pattern must be field adjustable and lockable. Use nozzle flow and effective reach of discharge at various nozzle patterns that have been determined by the manufacturer's actual discharge tests with nozzles in horizontal pattern at nozzle pressures of 345 kPa 50 psi, 517 kPa 75 psi and 689 kPa 100 psi. Use factory set nozzle settings. Field disassembly, adjustment or assembly which could alter discharge characteristic will not be permitted.

2.15.3 Oscillating Monitor Nozzle Assembly

Include water-powered oscillator, monitor, nozzle, and related ancillary components which are to be the product of one manufacturer. Equip water-powered oscillating mechanism with a strainer. Include a test connection for operating the oscillator from an auxiliary water source without requiring discharge through the nozzle. Provide adjustable angle of elevation from 20 degrees below to 60 degrees above horizontal. Provide adjustable oscillation arc from 10 degrees to 165 degrees and adjustable speed from 0 degrees to 30 degrees per second. Components in contact with the AFFF solution must be compatible with the foam concentrate and metallic components must be brass, bronze or stainless steel. Provide manufacturer's standard model nozzle with a fixed discharge characteristic that has been determined by discharge tests. Provide monitor nozzle assembly approved by Factory Mutual and listed in FM APP GUIDE.

2.16 AFFF LIQUID CONCENTRATE

Provide 3 percent AFFF concentrate conforming to MIL-PRF-24385. Provide concentrate that is the product of one manufacturer. Mixing of non-identical brands of concentrate will not be permitted.

2.17 DIAPHRAGM TANK BALANCED PRESSURE PROPORTIONING SYSTEM

****

NOTE: Delete paragraph PUMPED BALANCED PRESSURE PROPORTIONING SYSTEM if this paragraph is used. Specify tank to be horizontal type unless project requirements specifically require vertical.

****

Tank must be a steel pressure vessel constructed in accordance with ASME BPVC SEC VIII D1. Affix ASME label permanently to the tank. Mount tank containing a full internal diaphragm (bladder) with a minimum capacity of [_____] L gallons horizontally on steel saddles. Provide nylon-reinforced Buna-N rubber diaphragm or other approved material conforming to the inside shape of the tank. Store AFFF concentrate inside the diaphragm and the concentrate.must not be in contact with the steel tank. Install perforated PVC tubes inside the diaphragm to assure full displacement of the stored concentrate. Equip tank with the manufacturer's standard fittings and trim, including AFFF fill and drain connections, water fill and drain connections, and concentrate sight gauge.

2.18 PUMPED BALANCED PRESSURE PROPORTIONING SYSTEM

****

NOTE: Delete paragraph DIAPHRAGM TANK BALANCED PRESSURE PROPORTIONING SYSTEM if the following paragraphs are used.

****

2.18.1 AFFF Concentrate Storage Tank

****

NOTE: Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Remove the second bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19 must be included in the contract docments.

****

Design tank for storage of AFFF concentrate at atmospheric pressure consisting of vertical cylindrical, high density cross-linked polyethylene construction. Provide individual tank capacity a minimum of [_____] L gallons. Provide translucent tank equipped with level gauge strip for approximating quantity of tank contents. Equip tank with the following: inspection hatch; valved drain/fill connection; foam concentrate pump suction and return connections (with flex connectors); pressure/vacuum vent; low liquid level float switch; seismic tie downs and other accessories required for proper operation [in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS] [as shown on the drawings]. Install openings and tank connections at the factory, do not make holes in the tank shell in the field. Include necessary supports for free standing installation.

2.18.2 AFFF Concentrate Pump

****

NOTE: Pump capacity must be sufficient to supply AFFF concentrate under design conditions with operation of sprinklers and nozzles as provided. Pump pressure should be approximately 206 kPa 30 psi above maximum system water pressure.

****

Provide a positive displacement rotary gear or vane type pump operating at a speed no greater than 1800 rpm with a pump capacity of [_____] L/second gpm. Provide pump discharge pressure that is a minimum of [_____] kPa psi. Metallic pump components in contact with AFFF concentrate must be of bronze or stainless steel construction. Furnish each pump with suction strainer, relief valve, and suction and discharge gauges. Mount pump on a carbon steel base with guards over couplings. Direct-connect pump to electric motor with drip-proof enclosure. Provide minimum [_____] kW hp motor size.

2.18.3 AFFF Pump Controller

Provide automatic type controller that is UL listed or FM approved for fire pump service and arranged for automatic start and stop, and manual push-button stop of the AFFF pump it controls. Provide controller that is completely terminally wired, ready for field connections, and mounted in a [NEMA Type 2 drip-proof] [NEMA Type 4 watertight and dust tight] enclosure arranged so that controller current carrying parts will not be less than 300 mm 12 inches above the floor. Equip the controller with an externally operable isolating switch which manually operates the motor circuit. Provide means in the controller for measuring current for all motor circuit conductors. Controller must cause pump to run for a minimum of ten (10) minutes prior to automatic shutdown. Accomplish automatic stopping only after all starting causes have returned to normal and after the minimum pump run time has elapsed. Controller must also cause pump to stop upon signal from low liquid level switch installed in the AFFF concentrate tank. Monitor and provide individually displayed audible and visual alarms on the front panel for loss of a phase or line power, phase reversal, low AFFF concentrate level, and pump room temperature. Label each alarm lamp with rigid etched plastic labels. Equip the controller with the following:

a. Voltage surge arresters installed in accordance with NFPA 20.

b. Bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments, automatic starting relay actuated from normally closed contacts, visual alarm lamps and supervisory power light.

c. Thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 5 degrees C 40 degrees F.

d. Terminals for remote monitoring of pump running, pump power supply trouble (loss of power or phase and phase reversal), and pump room trouble (pump room temperature and low reservoir level, and for remote start.

e. A 7-day electric pressure recorder with 24-hour spring wound back-up. Provide a readout of the system pressure from 0 to 2067 kPa 0 to 300 psi, time, and date.

2.18.4 Power Supply

****

NOTE: Verify that project drawings indicate power supply in accordance with NFPA 20 requirements.

****

Provide source and arrangement of power supply to the pumps as shown on the drawings and in accordance with NFPA 20.

2.18.5 AFFF Pressure Maintenance Pump

****

NOTE: A pressure maintenance pump is required only if AFFF concentrate piping length exceeds 15 meters

50 ft. or extends beyond the equipment room.
****

Provide pump as indicated to maintain pressure on the AFFF concentrate distribution piping. Pump construction and components must be similar to those provided for the primary AFFF concentrate pump. Provide pressure maintenance pump with a capacity and pressure rating of [_____] L/second gpm at a discharge pressure of at least [_____] kPa psi.

2.18.6 Pressure Balancing Valve

****
NOTE: This valve is used in pumped proportioning systems that do NOT utilize in-line balanced pressure proportioners (ILBP).
****

Provide diaphragm type pressure balancing valve for balancing AFFF concentrate with water pressure. Provide bronze or stainless steel valve body and other metallic components normally in contact with the AFFF concentrate. Provide unit rated for working pressure of 1379 kPa 200 psi and include a manual bypass and duplex gauge for monitoring water pressure and AFFF concentrate pressure.

2.18.7 Pressure Sustaining Valve

****
NOTE: A regulating valve is used in pumped proportioning systems to maintain constant pressure to in-line balanced pressure proportioners (ILBP). Delete this paragraph for applications using pressure balancing valves instead of ILBP's.
****

Provide pressure regulating valve that is a pressure sustaining back pressure type, hydraulically operated, pilot controlled, modulating type arranged to maintain constant upstream pressure in the AFFF concentrate piping system as the flow rate varies. Provide valve body and other metallic components normally in contact with the AFFF concentrate consisting of bronze or stainless steel construction. Design valve body with flat-faced flanges to match flanges of the same nominal size. Valve must pass the unused portion of the AFFF liquid back to the storage tank under low system flow conditions. Size valve to pass the full AFFF liquid pump output of a single foam concentrate pump.

2.19 BALANCED PRESSURE PROPORTIONER (RATIO CONTROLLER)

****
NOTE: Edit this paragraph to suit the type and size or sizes of proportioners required. In-line type proportioners can be used only with concentrate pumping systems. The size of the foam proportioner (ratio controller) used in closed-head sprinkler systems is critical. If the proportioner is too large, it may not correctly proportion at low flows, and if it is too small, it may not correctly proportion at high flows. A 150 mm 6-inch proportioner will be appropriate for most sprinkler applications.

****

Provide [a standard] [an in-line] balanced pressure type unit capable of proportioning AFFF liquid at 3 percent, (3 parts concentrate to 97 parts water by volume solution) at flow rates within the flow range of the proportioner. Major components of the proportioner, including the body, inlet nozzle and metering orifice must be brass, bronze or stainless steel. Mark the body clearly with a flow-direction arrow, and the type and percent of AFFF concentrate that it was designed to proportion. Provide proportioner size of [150] [_____] mm [6] [_____] inch with a maximum friction loss of [_____] kPa psi at a flow rate of [_____] L/second gpm. The in-line balanced pressure proportioner must be an assembly that includes a proportioner as described, integral pressure balancing valve with duplex pressure gauge, inlet pressure gauge and manual ball valve. The proportioner assembly must be factory assembled and tested as an assembly by one manufacturer. Field disassembly or assembly of any component part will not be accepted. Provide components that are the make/model required by the specific UL listing or FM approval.

2.20 AFFF CONCENTRATE CONTROL VALVE ASSEMBLY

Design and construct assembly specifically to control AFFF concentrate to proportioners and arrange to open upon application of water or AFFF solution pressure from the alarm check or automatic water control valve to which it is connected. Provide valve that is a listed or approved automatic control valve specifically intended for this application or a full port ball valve. Construct all components of brass, bronze or stainless steel, except provide the internal portions of listed or approved fire protection valves subjected to AFFF concentrate with a coating warranted by the manufacturer to protect the valve from the deleterious effects of the concentrate. All components must be rated for working pressure of 1200 kPa 175 psi or maximum working pressure to which they could be subjected, whichever is greater. Valve must be certified by the manufacturer to be operable with water inlet pressure as low as 207 kPa 30 psi. Provide brass, bronze or stainless steel valve components.

2.21 FOAM SYSTEM CONTROLS

****

NOTE: A foam system control panel is required for preaction and deluge sprinkler systems, as well as for systems with nozzles. Systems using "hardwired" devices are the simplest and will provide reliable service with minimum maintenance and testing. Such systems are appropriate for most applications.

****

Provide UL listed or FM approved panel for "Releasing Device Service" or have modules approved for this purpose. Panel must contain components and equipment required to provide the specified operational and supervisory functions of the system. House components in a [surface] [flush] mounted steel cabinet with hinged door and cylinder lock. Provide a clean, uncluttered, and orderly factory assembled and wired unit. Include integral "power on," "alarm," and "trouble" lamps with annunciation of each alarm, supervisory and trouble signal. Provide panel that has prominent rigid plastic or metal identification plates for zones, indicating lights, controls, meters, and switches. Identify lamps and fuses mounted on circuit boards by permanent markings on the circuit board. Also include ampere rating on nameplates for fuses. Locate control panel switches within the locked cabinet. Provide a suitable means for testing the control panel visual indicating devices (meter and lamps). Ensure meters and lamps are plainly visible when the cabinet door is closed. Provide signals to indicate and annunciate, by zone, any alarm, supervisory or trouble condition on the system. Upon restoration of power, start-up automatically, and do not require manual operation. Do not affect the transmission of alarm, supervisory or trouble signals, due to the loss of primary power or the sequence of applying primary or emergency power. Where the panel controls continuous linear thermal detection cable, the panel must be fully compatible with the cable, as certified by the cable manufacturer. In such applications, control multiple independent adjustable fixed temperature set points to achieve the effect of a rate-of-rise detector. Provide panel that is capable of identifying the location of a hot spot along the length of the detector cable and providing a constant temperature readout.

2.21.1 Zone Annunciator

Provide visual annunciators for each active zone and spare zone. Provide a separate alarm and trouble lamp for each zone and locate them on the exterior of the cabinet door or be visible through the door. Provide a minimum of [two] [_____] spare alarm zones that are fully operational. Provide specific identification of the zone by permanently attaching a rigid plastic or metal sign with either raised, engraved or silk-screened letters to each lamp. Provide zone identification consisting of a unique zone number as well as a word description of the zone. Arrange zones as shown on the drawings.

2.21.2 System Zoning

****

NOTE: Correlate the zoning of the foam system control panel with what is shown in the riser diagram/schematic and controls matrix shown on the drawings. Differentiate groups of ALARM zones and SUPERVISORY zones as well as indicate specific devices in each circuit or zone. Generally, separate alarm initiating zones will be for heat detectors, waterflow switches, manual actuation stations, etc.

****

Zone the system as follows:

ZONE NO.	DESCRIPTION
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

2.21.3 Primary Power Supply

****

NOTE: The drawings will indicate a dedicated power supply circuit for each preaction and deluge sprinkler system control panel. The power circuit will be arranged so that power and lighting system can be shut down for building modifications without shutting down primary power to the control panel.
****

Supply primary power and trouble alarm power to control panel from two 120 VAC circuits. [Provide power to the control panel as indicated.] [Provide a [separate panel] [fused two-pole disconnect switch] connected ahead of [the main building panel] [the indicated panel].] Equip panel with two 20-amp circuit breakers for each control panel and with key lock. Permanently mark [panel] [disconnect switch] "FOAM FIRE PROTECTION SYSTEM".

2.21.4 Emergency Power Supply

Provide emergency power for system operation in the event of failure of the primary power supply consisting of rechargeable storage battery system. Provide automatic transfer from normal to emergency power or restoration from emergency to normal power and do not cause transmission of a false alarm.

2.21.4.1 Storage Batteries

****
NOTE: Indicate if batteries will be located in a compartment within the control panel or in a separate cabinet. Delete last sentence when battery is not located within the control panel.
****

Provide sealed, lead-calcium type storage batteries that require no additional water. Provide batteries that have ample capacity, with primary power disconnected, to operate the system for a period of 90 hours. Following this period of operation via batteries, the batteries must have ample capacity to operate alarm indicating devices in the alarm mode for a minimum period of [15] [_____] minutes. Battery cabinet must be a separate [compartment within the control panel] [cabinet]. Provide battery compartment or cabinet that is twice the volume of the batteries. Set batteries on a non-corrosive and non-conductive base or pad. Locate batteries in the control panel at the bottom of the panel.

2.21.4.2 Battery Charger

Provide completely automatic battery charger, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 24 hours. Provide a separate ammeter for indicating rate of charge. Provide a separate voltmeter to indicate the state of the battery charge. Provide a pilot light indicating when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided. Locate charger in control panel cabinet.

2.22 ALARM INITIATING DEVICES

2.22.1 Waterflow Pressure Alarm Switch

****
NOTE: The adjustable retard switch is similar to

the Potter Model WFSR-F and should be used where detection of sprinkler waterflow is used to perform critical functions such as actuating nozzles. This switch should be piped in the alarm valve trim such that it cannot be shutoff. The retard feature is not appropriate for use in preaction or deluge systems. "Standard" pressure switches are typically installed downstream of the retard chamber of the alarm valve alarm line trim.

****

Include a 13 mm 1/2 inch NPT male pipe thread, two 13 mm 1/2 inch conduit knockouts, and two sets of SPDT (Form C) contacts in unit. Provide factory adjusted switches to transfer the contacts at 27.6 to 55.1 kPa 4 to 8 psi on rising pressure. Include a water-tight NEMA 4 die-cast aluminum housing with a tamper resistant cover which requires a special key for removal. Provide cover with a tamper switch which will operate upon removal of the cover. Use units on wet-pipe systems that have an adjustable, instantly recycling pneumatic retard to prevent false alarms due to water pressure variation. Factory set retard adjustment at approximately 20-40 seconds and adjustable between 0-90 seconds.

2.22.2 Vane-type Waterflow Switch

****

NOTE: Vane-type flow switches cannot be used on preaction, deluge or other system piping which is not normally filled with water or AFFF solution.

****

Provide assembly consisting of a cast aluminum pipe saddle housing an electro-mechanical device to which is attached a flexible, low-density polyethylene paddle. Provide paddle conforming to the inside diameter of the fire protection pipe and sense water or solution movements. Provide waterflow indicator capable of detecting a sustained flow exceeding 0.63 L/second 10 gpm. Assembly must contain a pneumatic retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. Include two sets of SPDT (Form C) contacts. Equip the unit with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

2.22.3 Heat Detector-Spot Type

****

NOTE: Include description of the type of heat detection shown on drawings. Delete the inapplicable type.

****

Provide weatherproof detector, of the rate-compensation type with a nominal temperature rating of [76] [_____] degrees C [170] [_____] degrees F. Detector must be listed or approved for spacing between detectors as shown. Detectors listed or approved as "rate anticipation" type will be accepted. Detectors utilizing the fixed-temperature, rate-of-rise, or combination fixed-temperature/rate-of-rise principles will not be accepted. Provide six spare detectors of each type and temperature rating.

2.22.4 Continuous Linear Thermal Detector

Provide detector consisting of line-type electrical conductivity fixed temperature coaxial wire capable of sensing temperature changes along its entire length and operate over a wide range of temperatures. Construct the detector cable of a center conductor having a maximum diameter of 2.2 mm 0.087 inch, a ceramic thermistor core and an outer metallic sheath. Provide center conductor with a maximum diameter of 2.2 mm 0.087 inch. Provide individual cable sections no greater than 15 m 50 ft in length and equip with hermetically sealed connectors. It must be possible to couple together lengths of cable not greater than 15 m 50 ft together to form maximum lengths of 305 m 1,000 ft for individual circuit configurations. The detector must be able to sense temperatures from 21 up to 649 degrees C 70 up to 1,200 degrees F and withstand temperature extremes of from -51.1 to 1,093 degrees C -60 to 2,000 degrees F. The detector cable must be self-restoring and thus not require replacement of affected portions of the cable after exposure to a high temperature such as would occur in a fire situation. It must be possible to supervise the cable against an open or short circuit along the entire length of the cable such that either condition will cause a "trouble" signal on the control panel to which it is connected. Ensure cable is fully compatible with the control panel to which it is connected.

2.22.5 Combination Ultraviolet-Infrared Flame Detector

Operate flame detector on the dual spectrum ultraviolet/infrared (UV-IR) principle. Utilize a solar-blind UV sensor with a high signal-to-noise ratio and a narrow band IR sensor. Detector logic must require both UV and IR signals to be present, in a predetermined ratio or signature as emitted by a hydrocarbon fire, to put the detector in an alarm condition. Detector must not respond to non-fire sources of UV or IR radiation, including intermittent or continuous solar radiation, arc welding, lightning, radiant heat, x-ray, artificial lighting, radio transmissions and jet engine exhaust. Provide detector with an automatic through-the-lens self-testing feature. Ensure malfunction of the detector circuitry, or degradation of the sensors' lens cleanliness to the point where the detector will not detect the design fire signature, causes operation of the system trouble alarm. Logic circuits necessary for operation of the detector must be integral to the detector or located in a separate flame detector control panel mounted adjacent to the foam system control panel. Provide detector with a 120 degrees field-of-view, capable of operating in a temperature range of -40 to 85 degrees C -40 to 186 degrees F, and suitable for use in Class I, Division I hazardous locations. The detector must be listed or approved for use with the control panel to which it is connected.

2.22.6 Nozzle System Actuation Station

****

NOTE: Modify as appropriate to achieve required operation. Assure that stations are clearly labeled and distinguished from other fire alarm system stations which might be similar.

****

Provide dual-action type unit requiring the lifting of a cover and pulling of a ring to actuate. Do not require the breaking of glass to actuate. Paint unit [lime yellow] [_____] and include a cast or engraved label indicating [Foam Nozzle System] [_____] with operating instructions clearly marked on the station cover. Alarm contacts must have a minimum rating of

120 VAC, 60 Hz, 6 amps. Factory set contact gap distance and do not adjust in the field. Ensure unit is compatible with the control panel to which it is connected. Unit [must] [must not] be listed or approved for use in hazardous locations.

2.22.6.1   Enclosure

Provide unit consisting of a tamper-resistant, clear polycarbonate shield and frame that fits over the manual actuation station. The unit must be hinged of the top and suitably labeled "Lift Here" on the bottom to indicate means of gaining access to the manual actuation station it protects. Include a spacer as required to accommodate its use with a surface mounted manual actuation station.

2.22.6.2   Horn

Include an 85 db at 3 m 10 ft integral horn powered by a 9 VDC alkaline battery. Upon lifting of the cover, provide a local supervisory alarm. Suitably label the enclosure "TO ACTIVATE NOZZLES, LIFT COVER AND OPERATE STATION."

2.23   VALVE SUPERVISORY (TAMPER) SWITCH

Design switch to monitor the open condition of each water or AFFF concentrate control valve to which it is mounted. Include a cast aluminum housing, tamper proof cover, two sets of single pole, double throw (SPDT) contacts and brackets and J-bolts needed for mounting. Removal of the cover must cause both switches to operate.

2.24   NOTIFICATION APPLIANCES

****

NOTE: The notification appliances are for providing local notification of a system operation. They are not intended to provide general building fire alarm evacuation. Fire alarm evacuation systems are covered in Sections 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE; 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE; 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE; and 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE.

****

Provide notification appliances that are suitable for connection to supervised alarm indicating circuits. Provide a separate screw terminal for each conductor.

2.24.1   Electronic Signaling Device

****

NOTE: It's important that AFFF system audible signals be distinctively different from building evacuation alarms, door alarms, etc. Because of their field-selectable sounds and higher sound output levels, electronic devices are recommended.

****

Provide surface-mounted device which can be mounted to a standard 100 mm 4 inch square back box. Operate electronic device on nominal 24 VDC, polarize for line supervision and have screw terminals for in-out wiring. Provide device with three field-selectable sounds (horn, warble, siren) and three sound output levels to 102 DBA in an anechoic chamber at 3 m 10 feet.

2.24.2 Alarm Horn

Provide surface mounted horn, with the matching mounting back box [surface mounted] [recessed] [[single] [double] projector,] [grill and] vibrating type suitable for use in an electrically supervised circuit. Operate horns on nominal 24 VDC and have screw terminals for in-out wiring connection. Provide a minimum of [85] [_____] DBA at 3 m 10 feet sound output. Use horns in exterior locations that are specifically listed or approved for outdoor use and provide with metal housing and protective grills.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Aboveground Piping

Install piping straight and bear evenly on hangers and supports. Pitch preaction sprinkler system piping as if it were being installed in areas subject to freezing. Conceal piping in areas with suspended ceiling and inspect, test and approve before concealing.

3.1.1.1 Joints

Provide pipe joints conforming to NFPA 13. Do not show more than four threads after joint is made up. Apply joint compound to male threads only. Ensure joints are faced true, provided with gaskets and made square and tight. Provide flanged joints or mechanical groove couplings where indicated or required by NFPA 13. Prepare grooved pipe and fittings in accordance with the manufacturer's latest published installation instructions. Provide grooved couplings and fittings from the same manufacturer. Do not use grooved joints in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.1.1.2 Reducers

Make reductions in pipe sizes with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, install face bushings with the outer face flush with the face of the fitting opening being reduced. Do not use bushings in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 13 mm 1/2 inch.

3.1.1.3 Sprinkler Riser Nipples (Sprigs)

Do not use riser nipples (sprigs) 25 mm 1 inch in size between sprinkler branch lines and individual sprinklers unless necessitated by roof or ceiling conditions. In such cases, do not installfittings between the branch line tee and the reducing coupling below the sprinkler.

3.1.1.4 Sprinkler Deflectors

Install sprinkler deflectors parallel to the roof or ceiling. Ensure deflector distances from the underside of the roof or ceiling are in accordance with NFPA 13 except do not exceed, in no case, a distance of 300 mm 12 inches. Sprinkler clearances from obstructions must be in accordance with NFPA 13.

3.1.1.5 Pipe Supports and Hangers

****

NOTE: To provide added protection against damage from pressure transients, specify thrust restraint for earthquake protection to be in accordance with NFPA 13 requirements for earthquake protection. Consult UFC 3-301-01 for any aspect of seismic design.

****

Installation methods outlined in NFPA 13 are mandatory. Protect piping against damage from earthquakes. Provide longitudinal and lateral sway bracing for piping 65 mm 2-1/2 inch diameter and larger.

3.1.1.6 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Provide pipes penetrating concrete or masonry walls or concrete floors with pipe sleeves fitted into place at the time of construction through its respective wall or floor, and cut flush with each surface. Provide sleeve sizes and clearance between pipe and sleeve in accordance with NFPA 13. Where pipes pass through fire walls, fire partitions, or floors, place a fire seal between the pipe and sleeve in accordance with Section 07 84 00 FIRESTOPPING.

3.1.1.7 Piping Pitch

Pitch piping to the main drain or to auxiliary drains provided as required to facilitate draining. Pitch branch lines at least 4 mm in 1 m 1/2 inch in 10 feet and pitch crossmains and feedmains to at least 2 mm in 1 m 1/4 inch in 10 feet.

3.1.1.8 Escutcheons

Provide escutcheons at finished surfaces where exposed piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Fasten chromium-plated iron or chromium-plated brass, either one-piece or split-pattern, escutcheons securely to pipe and hold in place by internal spring tension or setscrew.

3.1.1.9 Drains

Provide main drain piping to discharge at safe points outside each building. Provide drains of adequate size to readily receive the full flow from each drain under maximum pressure. Provide auxiliary drains as required by NFPA 13 except use drain valves where drain plugs are otherwise permitted. Where branch lines terminate at low points and form trapped sections, manifold such branch lines to a common drain line. Provide each drain valve with a metal sign identifying the type of drain connection or function of the valve.

3.1.1.10 Identification Signs

Provide signs in accordance with NFPA 13. Affix properly lettered and approved metal signs to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate.

3.2 UNDERGROUND PIPING

****

NOTE: Coordinate selections with drawings. Restraint of the riser under the floor will be detailed on the drawings to be consistent with the description included here.

****

Lay the fire protection water main and anchor joints in accordance with NFPA 24. Provide minimum cover depth of [1] [_____] m [3] [_____] feet. Terminate the supply line inside the building with a flanged piece, set the bottom no less than 150 mm 6 inches) above the finished floor. Install a blind flange temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. Provide a concrete thrust block at the elbow where the pipe turns up toward the floor. In addition, anchor joints in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Coat buried steel components with a bituminous material.

3.3 ELECTRICAL WORK

Unless otherwise specified, provide power supply equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.3.1 Overcurrent and Surge Protection

Protect equipment connected to alternating current circuits from surges in accordance with IEEE C62.41.1, IEEE C62.41.2 and NFPA 70. Install surge protection circuits at each end of cables and conductors which serve as communication links, except fiber optics. Do not use fuses for surge protection.

3.3.2 Grounding

Provide grounding to building ground.

3.3.3 Wiring

Install system field wiring in 19 mm 3/4 inch minimum diameter electrical metallic tubing or metallic conduit. Install wiring for the sprinkler system fire detection and control system in tubing or conduits dedicated for that use only and do not install in conduit, outlet boxes or junction boxes which contain lighting and power wiring or equipment. Connect circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet to screw terminals with each terminal marked and label in accordance with the wiring diagram. Install no more than one conductor under any screw terminal. Make connections and splices using screw terminal blocks. The use of wire nut type connectors is not permitted. Provide wiring within any control equipment that is readily accessible without removing any component parts. Color code conductors and identify within each enclosure where a connection or termination is made. Identify conductor by plastic coated, self-sticking, printed markers, or by heat-shrink type sleeves. Wire circuits to maintain electrical supervision so that removal of any single wire from any device will cause a "trouble" condition on the control panel.

3.3.4 Control Panel

Mount the control panel and its assorted components so that no part of the enclosing cabinet is less than 600 mm 24 inches nor more than 2000 mm 78 inches above the finished floor.

3.3.5 Detectors

Ceiling mount detectors in accordance with NFPA 72 at least 300 mm 12 inches from any part of any lighting fixture. Locate detectors at least 900 mm 3 feet from diffusers of air handling systems. Provide each detector with appropriate mounting hardware as required by its mounting location.

3.3.6 Manual Actuation Stations

Mount manual actuation stations readily accessible and 1060 mm 42 inches above the finished floor.

3.3.7 Notification Appliances

Mount notification appliances a minimum of 2400 mm 8 feet above the finished floor unless limited by ceiling height.

3.4 PIPE PAINTING AND LABELING

3.4.1 Painting

Paint black steel pipe in accordance with the requirements specified under SECTION 09 90 00 PAINTS AND COATINGS. Paint pipe in equipment rooms red. Paint pipe in other areas to match finishes in those areas. Do not paint stainless steel pipe.

3.4.2 Pipe Identification

Identify aboveground pipe 50 mm 2 inch diameter and larger with legends. Include FOAM CONCENTRATE, FOAM-WATER SPRINKLER, FOAM-WATER NOZZLE, and FIRE PROTECTION WATER. Utilize WHITE letters on a RED color field and include arrows to indicate the direction of flow. Use length of color field, letter size and locations on piping as recommended in ASME A13.1.

3.5 PRELIMINARY TESTS

Perform tests to make adjustments in the fire protection system operation and to verify that the system will function as intended and that it is ready for service. Include all components and subsystems in such tests. Clearly document and include test reports with the written request for Final Test.

3.5.1 Flushing

Flush underground water mains in accordance with NFPA 13 and NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the maximum water demand rate of the system.

3.5.2 Hydrostatic Tests

Hydrostatically test the underground and aboveground piping systems, including AFFF concentrate, in accordance with NFPA 13 at no less than 1379 kPa 200 psi, or 345 kPa 50 psi in excess of maximum system operating pressure, for 2 hours. There must be no visible leakage from the piping when the system is subjected to the hydrostatic test.

3.5.3 Alarm Check and Automatic Water Control Valves

Test each valve to verify operation in accordance with manufacturer's published operating instructions. This includes tests of valves and switches connected thereto.

3.5.4 Nozzles

Test nozzle discharge for proper operation and coverage. Operate oscillating nozzles to verify that angle of elevation, angle of oscillation, and discharge range, are in accordance with requirements.

3.5.5 AFFF Concentrate System

Conduct tests under the supervision of a technical representative employed by the AFFF concentrate manufacturer. Adjust the complete AFFF concentrate system and test to assure proper operation. Record test results, including all pressure settings and readings, on an appropriate test form signed and dated by manufacturer's representative certifying that the system is in compliance with contract requirements and the manufacturer's recommended practices. Testing includes, but is not limited to, the following:

a. Filling the AFFF concentrate tank.

b. Adjustment of pressure sustaining valves, pump relief valves, and proportioners.

c. Collection of AFFF samples and testing with a conductivity meter to verify proportioning accuracy.

d. Testing AFFF concentrate pumps for proper automatic operation. This includes start and stop settings, automatic shutoff, and relief valve operation.

e. Testing low liquid level alarms and pump shutoff.

f. Other operational checks recommended by the AFFF proportioner manufacturer.

3.5.6 Control System Tests

****

NOTE: The specified tests are based upon preaction and deluge systems with integral detection and control systems. Revise to suit applications using wet-pipe systems.

****

Conduct tests under the supervision of a factory-trained representative of the control panel manufacturer. Test the electrical control system to verify that the control panel and all wiring have been installed correctly and that all components function as intended. Conduct tests using normal operating and battery power. Testing includes, but is not limited to, each of the following:

a. Alarm initiating circuit and device. Include heat detectors, manual actuation stations, waterflow and pressure switches, and similar devices connected to the control panel.

b. Supervisory circuit and device. Include valve supervisory (tamper) switches, pump power circuits, pump running, low liquid level in foam concentrate tank, and similar circuits and devices.

c. Actuation circuit and device. Include circuits to automatic water control valves, foam concentrate pumps, fire pumps, and similar circuits related to system activation.

d. Annunciator lamp and notification appliance. Include bells, horns, electronic signaling, and similar devices.

3.6 FINAL TEST

****

NOTE: This paragraph must be modified to suit specific project requirements and preferences.

****

3.6.1 Requirements

The Final Test is a repeat of Preliminary Tests, except do not repeat flushing and hydrostatic tests. In addition, actuate the system automatically and allow to discharge for a period of at least one minute prior to shutting the system off. Correct system failures and other deficiencies identified during testing and retest portions of the system affected by the required corrections.

3.6.1.1 Pretest Requirements

The system will be considered ready for final testing only after the following have been accomplished.

a. The required test plan has been submitted and approved.

b. Preliminary tests have been made and deficiencies determined to have been corrected to the satisfaction of the equipment manufacturer's technical representatives and the Contracting Officer.

c. Test reports, including the required videotape of the preliminary tests, have been submitted and approved.

d. The control panels and detection systems have been in service for a break-in period of at least 14 consecutive days prior to the final test.

e. The Contractor has provided written notification to the Contracting Officer, at least [21] [_____] days prior to date of Final Test, that preliminary tests have been successfully completed.

3.6.1.2 Videotaping

Videotape the tests in VHS format and record the date and time-lapse, in seconds, from start to finish of each portion of the test as directed by the Contracting Officer. Submit four copies of the tape before the system will be considered accepted.

3.6.1.3 Manufacturer's Services

Experienced technicians regularly employed by the Contractor in the installation of the system and manufacturer's representative referred to elsewhere in this specification must conduct the testing.

3.6.1.4 Materials and Equipment

Provide AFFF concentrate, gauges, AFFF sample collection apparatus, instruments, hose, personnel, elevating platforms, scaffolding, ladders, appliances and any other equipment necessary to fulfill testing requirements specified.

3.6.1.5 Facility and Environmental Protection

Provide protection for the facility, including electrical and mechanical equipment exposed to possible damage during discharge tests. Include provision of sandbags or similar means for preventing migration of foam solution into adjacent areas. Provide temporary measures to prevent AFFF solution from entering storm drains, sanitary sewers, drainage ditches, streams and other water sources. Contain discharged AFFF on paved surfaces and do not allow to come in contact with the earth.

3.6.2 Control System Tests

Test and demonstrate operational features of the control system. Include testing of control panels and each input and output circuit. Tests of circuits include actuation and simulated circuit fault at each initiating, notification, supervisory and actuation device or appliance. As a practical matter, these tests are a repeat of preliminary tests required under paragraph PRELIMINARY TESTS.

3.6.3 AFFF Proportioning System Tests

Flow test each AFFF proportioner (ratio controller) to determine that proportioning accuracy is within specified limits. Test each proportioner supplying sprinkler systems with closed heads at two flow rates; the minimum flow rate specified in the manufacturer's published data and a flow rate at least four times the minimum. Test each proportioner supplying a deluge system or a nozzle system at the design flow rate. Collect AFFF samples from each proportioner in accordance with NFPA 16, and the approved test plan. Determine foam solution concentrations using the methods outlined in NFPA 16. Proportioning for nominal 3 percent concentrate must be between 3 percent and 4 percent. If test results indicate proportioning below or above this range, make necessary adjustments and retest as directed by the Contracting Officer.

3.6.4 Post-discharge Test Requirements

****

NOTE: Discharge tests using AFFF solution are necessary in order to verify proportioner accuracy

as well as to demonstrate performance of the overall system at final acceptance. The collection and disposal of the solution is often a problem in many areas due to the real and perceived environmental effects of the solution. Thus it is important that the project design or the existing site addresses the need to collect and dispose of the solution. If adequate means are not otherwise available or provided, the responsibility for collection and disposal will have to be placed on the Contractor. This needs to be made clear in the project documents to preclude problems and misunderstandings at time of final testing.

****

Following the successful completion of the tests, remove the foam solution from the site as indicated on the approved AFFF waste containment and disposal plan. Replenish AFFF concentrate consumed during the tests. Return the entire fire protection system to automatic operation and restore the facility operational capability. Contain and dispose discharged solution in a manner acceptable to local authorities and as identified on the approved test plan. Once tests are completed, return systems to fully operational status, including filling of AFFF concentrate tanks with concentrate and filling of solution piping with premix as required. Submit details of method proposed for required tests at Final Acceptance, including step-by-step test procedures; list of equipment to be used; names, titles, and affiliations and qualifications of personnel who will participate in the tests; methods for protecting the facility and equipment during testing; means for containing the AFFF solution during discharge tests; and proposed means for disposal. Include a drawing showing proposed number and arrangement of fire hoses and nozzles proposed for use in testing foam proportioners in the test plan. Include blank forms to be used for recording test results. Submit test reports and videotapes as specified herein:

a. Reports as outlined in NFPA 13 documenting results of flushing and hydrostatic tests.

b. Trip tests of [alarm check] [and] [automatic water control] valves.

c. Test report of AFFF concentrate proportioning system. Include all pressure readings and settings of pumps, pressure sustaining valves, relief valves and similar system components. Include conductivity readings for foam samples taken from each AFFF proportioner. Report must be signed by the factory-trained technical representative employed by the AFFF concentrate manufacturer.

d. Test report of the foam system control panel and initiating and indicating devices. Include a unique identifier for each device with an indication of test results. Report must be signed by the factory-trained technician employed by the control panel manufacturer.

e. Videotapes of tests specified to be recorded.

3.7 POSTED INSTRUCTIONS

Post framed description of system operation, instructions and schematic diagrams of the overall AFFF system and each subsystem, where directed. Include condensed operating instructions explaining the system for normal operation, refilling the AFFF storage tank, and routine testing.

3.8 TRAINING

Provide at least two training sessions of at least 6 hours each to explain system's operation and maintenance. Conduct training sessions on alternate days to afford flexibility by shift personnel and other attendees. Provide training aids as necessary to clearly describe the systems. Training sessions include classroom instruction and explanation of approved Operation and Maintenance Manuals. Submit [6] [_____] manuals in loose-leaf binder format and grouped by technical sections consisting of manufacturer's brochures, schematics, printed instructions, general operating procedures, and safety precautions. Include a narrative description of the sequence or sequences of operation of the overall fire protection system and a separate description for each major subsystem. Include specific start/stop settings for pumps, open/close settings for all adjustable valves (including pressure sustaining and relief valves). List routine maintenance procedures, possible breakdowns, and repairs, and troubleshooting guide in the manuals. Include conduit layout, equipment layout, simplified wiring and control diagrams for the system as installed, procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair. In addition to classroom instruction, operate systems to provide hands-on demonstrations. Include a system actuation using water only, to demonstrate system operation and procedures for resetting the system. Training areas will be provided by the Government in the building where the systems are installed. Coordinate dates and times of the training sessions with the Contracting Officer no less than 15 calendar days prior to the first session.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-21 13 25 (February 2019)**

Change 1 - 02/21

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-21 13 25 (February 2019)**
Change 1 - 02/21

Preparing Activity: USACE **New**

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SECTION 21 13 25

HIGH-EXPANSION FOAM SYSTEM, FIRE PROTECTION

02/19, CHG 1: 02/21

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NOTE: This guide specification covers the requirements for optical flame detection and high-expansion foam fire suppression systems for aircraft hangars for the Army and Air Force.

Tailoring Options are used upon opening this section to select Army or Air Force. The unselected service will be hidden. Notes are provided to describe the tailoring options.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The Designer will edit this section for either a performance designed system or a fully designed system as applicable.

This section is primarily intended for performance designed systems, i.e., systems where the foam generators, foam and sprinkler risers, foam tanks, foam pumps and proportioning, fire water entrance

piping, and releasing panels are shown on the plans. The size, layout, and support of branch lines and cross mains will be designed by the Contractor.

The Designer will provide the following design, and indicate the following information in the contract documents, for performance designed systems. This design and information will be in accordance with UFC 3-600-01, Fire Protection Engineering for Facilities, and UFC 4-211-01, Aircraft Maintenance Hangars.

1. Perform calculations in accordance with UFC 4-211-01 to determine the required number of foam generators and locations, foam spread calculations, amount of foam concentrate and storage capacity.

2. Size and locate on the plans, and provide detailed drawings of, the foam system risers, foam generators, foam pumps (Army only), foam proportioning equipment, and foam storage tank. Provide drawing schedules showing capacity and quantity of foam generators, foam pumps (Army only), and foam concentrate storage tank. Sprinkler plans are to be provided under the UFGS 21 13 XX series.

3. Include a detailed sprinkler riser diagram which is submitted under the UFGS 21 13 13 series in the contract drawings.

4. Area(s) of foam system coverage, with zone designations (if multiple zones). Do not show layout of pipes smaller than 6 inches. Include basis of design for generator sizing so contractor can compare with the product they are using.

5. For pipe larger than 152.4 mm 6 inches, routing of pipe on the plans.

6. Show locations of foam system releasing panels, annunciator(s), beacons for foam system, foam start stations, and foam stop stations. For Army: Show locations of diverter valve control panels, diverter valve location on civil site plans, and underground containment tank on site plans.

7. Provide locations for mounting of optical flame detectors and cone of vision within the hangar bay, and location of associated foam releasing panel by the flame detector manufacturer.

8. Show single line riser diagram, and matrix, for all detection, activation, and alarm circuits for the foam system. Indicate connection of equipment by circuit runs and not conduit runs. Do not indicate number and size of conductors for interconnection of fire alarm components.

9. Specify fire waterflow data.

10. Provide a foam generator schedule on the drawings, with unique tags on the plans for each generator. Indicate the generator minimum output (CFM), maximum weight (LBS), maximum water flow (GPM), maximum required pressure (PSI), with a maximum size (height and diameter).

11. Provide a foam concentrate tank schedule on the drawings, with minimum tank capacity (gallons), maximum diameter (inches), and maximum height (inches), and the amount of high-expansion foam required in the tank (gallons).

12. For Army: Provide a foam concentrate pump schedule, and foam concentrate jockey pump schedule (if required), showing the rated flow (GPM), rated pressure (PSI), and electrical requirements.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this section to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe,

	Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61508	(2010) Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 11	(2024) Standard for Low-, Medium- and High- Expansion Foam
NFPA 13	(2024) Standard for the Installation of Sprinkler Systems
NFPA 20	(2025) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 24	(2025) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 101	(2024) Life Safety Code

NFPA 170	(2024; ERTA 1 2023) Standard for Fire Safety and Emergency Symbols
NFPA 704	(2022) Standard System for the Identification of the Hazards of Materials for Emergency Response

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 11	(2020) Surface Preparation Standard No. 11 - Power Tool Cleaning to Bare Metal

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 864	(2023; Reprint Oct 2024) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems

1.2 SUMMARY

Design and provide a new automatic low-level high-expansion foam fire extinguishing system, including optical flame detection, control, and releasing system, as indicated on the drawings and in accordance with applicable codes and standards. The system(s) must provide a uniform distribution of high-expansion foam solution for complete coverage over the protected area as indicated on drawings. Balance the system(s) to operate both independently and with simultaneous operation of the overhead sprinkler system specified in [Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION][Section 21 13 18 PREACTION SPRINKLER SYSTEMS, FIRE PROTECTION] [Section 21 13 16 DRY PIPE SPRINKLER SYSTEMS, FIRE PROTECTION].

The electronic detection, control, and release system includes wiring, raceways and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described.

Provide design, equipment, materials, installation, and workmanship in compliance with the NFPA 11, NFPA 13, NFPA 70, and NFPA 72, except as modified herein. For each system, include all materials, accessories and equipment necessary so that it is complete and ready for use. Design and install each system to give full consideration to blind spaces, piping, electrical equipment, ductwork, and all other construction and equipment to provide complete coverage in accordance with the drawings to be submitted. Provide devices and equipment that are listed by a Nationally Recognized

Testing Laboratory unless otherwise specified. In the publications referred to herein, reference to the "authority having jurisdiction" is [Air Force Civil Engineer Center Operations Directorate (AFCEC/CO)] [Naval Facilities Engineering Systems Command Fire Protection Engineer [ATLANTIC (_____)][PACIFIC (_____)]] [USACE_____]. Begin work at the point indicated.

Furnish piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction. Design any portions of the system that are not indicated on the drawings, including locating and sizing piping and equipment when this information is not indicated on the drawings or is not specified herein. Base the design of the system on hydraulic calculations, and the other provisions specified herein.

The Contractor is responsible for the installation, testing, and acceptance testing of the High-Expansion Foam systems as required by this specification section and the plans. The contractor is also responsible for portions of the design per this specification section and the plans.

1.3 GENERAL DESIGN REQUIREMENTS

1.3.1 Definitions

Fire Area. A "fire area" is the aggregate floor area enclosed and bounded by fire walls, fire barriers, exterior walls or horizontal assemblies of a Facility. Include Areas of the Facility not provided with surrounding walls in the Fire Area if such areas are included within the horizontal projection of the roof or floor above.

Review Stamp. A "review stamp" certifies that the fire protection specialist has reviewed the documents and finds that it meets all contractual requirements. A "review stamp" is not a professional engineer stamp or seal.

1.3.2 Performance Requirements

****

NOTE: Locate generators to discharge within close proximity, but not directly upon the aircraft. Mount generators in the overhead roof support structure and/or high on the walls just below the roof support structure. Initial discharge of foam must protect under aircraft and underwing area and then spread to the remaining hangar floor area. Do not provide generators in locations which block exits from the hangar bay within the first minute of discharge.

****

Provide foam application from foam generators by aeration specified herein and as indicated on the drawings.

Cover 90 percent of the aircraft’s projected silhouette on the floor with high-expansion foam within 60 seconds upon system actuation (e.g. manual foam releasing station). For fixed winged aircraft, the areas under engines extending beyond the wing edge and under the rear elevators are not considered part of the silhouette. For rotary winged aircraft, the rotor sweep is considered part of the silhouette.

Additionally, cover the aircraft servicing area and adjacent floor areas not cut-off from the hangar bay (e.g. self-closing or automatically closing doors/shutters) with high-expansion foam to a depth of 1 meter 3.2 ft. within four minutes.

Where more than one high expansion (Hi-Ex) foam system is present within a fire area, design the releasing system to only release the Hi-Ex foam system associated with the fire event. Such as where a hangar bay is subdivided by a non-rated wall into two bays with independent Hi-Ex foam systems or where a large hangar bay is provided with multiple Hi-Ex foam systems, zone the initiation devices to only release the Hi-Ex foam system associated with the fire event. However, design the fire flow and concentrate supply to allow for sufficient simultaneous operation of all Hi-Ex Foam Systems within the fire area.

1.3.3 Rate of Foam Discharge

The rate of discharge is as shown on the drawings.

1.3.4 Foam Concentrate Proportioning System

****

NOTE: Air Force requires proportioning by foam inductor. Army requires proportioning by a foam concentrate pumping system and ILBP.

****

Provide foam proportioning by a foam inductor taking suction from an atmospheric high-expansion foam concentrate storage tank located directly beneath/adjacent the inductor.

Provide a foam concentrate pumping system, with an atmospheric foam concentrate storage tank. Provide In-Line Balanced Pressure Proportioner Assembly (ILBP) that is listed.

1.3.5 Concentrate and Water Supply

Apply foam solution over the protected area for a minimum of 15 minutes while simultaneously discharging water through the overhead wet pipe sprinkler system specified in[Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION] [Section 21 13 18 PREACTION SPRINKLER SYSTEMS, FIRE PROTECTION] [Section 21 13 16 DRY PIPE SPRINKLER SYSTEMS, FIRE PROTECTION]. Reduction of the discharge duration based on a discharge rate higher than the specified minimum is not permitted.

Provide a concentrate storage tank with a supply of concentrate to support a 15 minute discharge at the hydraulically calculated waterflow rate and 130 percent of the nominal concentrate injection rate.

1.3.6 Activation

Control system activation by an addressable foam system control panel listed for releasing service.

The following will release the low-level high-expansion foam systems:

****

NOTE: For Air Force: Provide manual foam releasing stations within each zone for the release of that zone, as stated below.

****

a. Manual foam releasing stations located as shown on drawings. Provide manual foam releasing stations within each zone for the release of that zone.

****

NOTE: For Army: Zoned manual foam release stations are not permitted. Program the foam release stations to simultaneously release the foam/water discharge from all zones viewable from the foam release station as stated below.

****

b. Manual foam releasing stations located as shown on drawings. Zoned manual foam release stations are not permitted. Program the foam release stations to simultaneously release the foam/water discharge from all zones viewable from the foam release station.

****

NOTE: For Army: Automatic release of high expansion foam will occur when two optical flame detectors are simultaneously activated. Automatic release of high expansion foam will also occur when an optical flame detector activates simultaneously with a sprinkler flow switch. See paragraph below.

****

c. The operation of one water flow switch simultaneous with one optical flame detector, or two simultaneous optical flame detectors. Actuation of the fire sprinkler system must not activate the high-expansion foam system, unless an optical flame detector alarms simultaneously. The first automatic initiating device must activate the general fire alarm, blue beacons, and report to the fire department. The second automatic initiating device must activate the foam system, and report to the fire department.

****

NOTE: For Air Force: Automatic release of high expansion foam will occur by activation of two simultaneous optical flame detectors, as stated below.

****

d. The simultaneous operation of two optical flame detector in the hangar bay is required to automatically release the high-expansion foam. Actuation of the fire sprinkler system must not activate the high-expansion foam system. The first optical flame detector must activate the general fire alarm, the blue beacons, and report to the fire department. The second optical flame detector must activate the foam system, and report to the fire department.

1.3.7 Hydraulic Calculations

Design low-level high-expansion foam systems by hydraulic calculations for uniform distribution of HIGH-EXPANSION FOAM solution over the protected area as defined on the drawings and conform to the NFPA standards listed above and to the requirements specified herein.

For systems supplied from a non-potable fire service water distribution system, begin hydraulic calculations at the fire water tank or reservoir.

For systems supplied from the potable water distribution, begin hydraulic calculations at the point of connection to the existing distribution system piping.

Base hydraulic calculations on the operation of the minimum number of pumps running necessary to supply the high-expansion generators and the sprinkler design area. Pumps are specified under [Section 21 30 00 FIRE PUMPS].

Hydraulically design the system as follows:

a. Include pressure discharge graphs or tables showing pressure discharge relationship for foam generators. [Design must be such that operating pressure of foam solution nozzles is maintained between (the foam generator's manufacturer's minimum operating pressure plus 5 psig and the foam generators' maximum pressure minus10 psig during system discharge.] Include the manufacturer’s minimum pressure drop across flow control valve for the features indicated in hydraulic calculations. Include "Demand Calculations" and "Supply Calculations".

b. Provide a combined hydraulic demand calculation of the foam/water system based on the foam generator output, water flows, and pressure, and the most hydraulically demanding area of the sprinkler system in the hangar bay, as indicated on the drawings. Demonstrate the combined fire water demand calculation does not exceed the available fire water supply. Confirm that the resulting foam/water supply from this calculation does not exceed the quantity of foam concentrate shown on the plans.

****

NOTE: Army requires foam concentrate pumps as stated below.

****

Confirm that the foam/water demand does not exceed capacity of the foam concentrate pumps.

****

NOTE: Air Force requires foam inductors as stated below.

****

Provide a design that indicates the inductor's flow rate, inlet pressure, back pressure, and concentrate lift height for a near empty concentrate tank. Hydraulically calculate the back pressure for the inductor using the Hazen-Williams equation with a C-factor of a 100 for all piping downstream of the inductor.

c. Provide a Foam Spread/Coverage Calculations/diagram demonstrating the performance requirements to cover the aircraft silhouette are met within one minute. This calculation method does not remove the obligation to demonstrate system compliance during testing. Include the following parameters in determining the maximum foam spread after one minute:

    (1) . Time for the FSCP to open the flow control valve after initiation.

(2) . Time for the foam/water reach the each generator based on the piping velocities in the hydraulic supply calculation.

(3) . Time for the foam to reach the floor of the hangar bay after discharging from the generator based on the height and orientation of each generator.

(4) . Time for the foam to spread across the floor based on the manufacturer's foam spread diagrams, or at a rate not to exceed 1 ft. /sec.

1.3.8 Flow Control Valves

****

NOTE: Air Force: The reference to "(inductor)" below applies to Air Force. Air Force uses inductors for foam proportioning.

****

****

NOTE: Army: The reference below "(and in corridors)" and also "(ILBP proportioner)" applies to Army. Army provides foam stop stations in the corridors and uses ILBP proportioners.

****

Control water flow through the foam concentrate proportioning system (ILBP proportioner) (inductor)and to the foam generator system by flow control valves. Flow control valves include control of the opening and closing speed of the valve, and provide pressure regulation to the discharge devices, and provide for remote closing of the valve from foam stop stations. Once activated, the system must remain activated. However, foam flow will be interrupted/stopped momentarily by depressing and holding a manual foam stop station button which are placed on the hangar bay walls (and in corridors) as shown on the plans.

1.3.9 Foam Concentrate Pump and Foam Jockey Pump Control

****

NOTE: Army: This paragraph applies to Army. Foam concentrate pumps are only used by Army.

****

Upon activation of the foam/water system, remote start the foam concentrate pump from the Foam System Control Panel (FSCP). Do not start the foam concentrate pump upon a drop in pressure. Upon depressing the manual foam stop station, stop the foam concentrate pump and the foam concentrate jockey pump to prevent excessive concentrate from being pumped into the foam solution piping. As long as the foam/water system is in alarm, releasing the manual foam stop station will restart the foam concentrate pump and foam concentrate jockey pump.

1.3.10 Manual Foam Stop Station Operation

****

NOTE: Army: The portion of the sentence below; "(and stop the foam concentrate pump and foam

concentrate jockey pump)" applies to Army. Foam concentrate jockey pumps are only used by Army.
****

Once depressed, and so long as the button is held down, design the system so the stop station prevents/stops discharge of the foam/water system regardless of whether or not the foam/water system was activated automatically or manually, and whether or not the activation occurs prior to or after the stop station is pressed and held. Program the stop stations to simultaneously stop the foam/water discharge from all zones viewable from the depressed stop station. Unless the FSCP has been reset and all activation alarms (manual and automatic) have been cleared; restore the foam/water system operation when the foam stop station button is released. Do not exceed 15 seconds to fully close the flow control valve (and stop the foam concentrate pump and foam concentrate jockey pump) when the foam stop station button is depressed under full flow. Where the foam/water system is still in alarm, do not exceed 5 seconds to fully open the flow control valve upon release of the foam stop station button.

1.3.11 Hose System

Do not provide hose systems including hose reels.

1.3.12 System Hydraulic Surge Analysis

Manufacturer's calculations are required for determining the minimum surge arrestor capacities where the following distances are exceeded from the fire pump discharge to the most remote dry-pipe, pre-action, or foam/water riser. Include the surge arrestor calculations performed by the manufacturer in the design calculations.

a. 457 meters1,500 feet for a system not exceeding a working pressure of 175 psi.

b. 305 meters1,000 feet for a system not exceeding a working pressure of 250 psi.

c. 152 meters500 feet for a system not exceeding a working pressure of 175 psi, and plastic piping is used (e.g. PVC, HDPE).

d. 91 meters300 feet for a system not exceeding a working pressure of 250 psi, and plastic piping is used (e.g. PVC, HDPE).

Perform a surge protection analysis to study the entire fire suppression system, including the foam water system, sprinkler system, site piping, fire pumps, and reservoirs using commercially available software. Determine the pressure surges or water hammer due to pump starting and stopping, valves opening and closing, and foam water initially reaching the foam generators. Consider fire water pumps starting when foam system is activated. Perform the study under the supervision of and certified by the Fire Protection Specialist.

1.3.13 Controls to Activate Diverter Valve

****
NOTE: Army: This paragraph on diverter valve controls applies to Army.

Consider the local environmental regulations to

determine the control, treatment and/or remediation measures for the discharge of fire suppression effluent from the hangar bay. Discharge effluent from the containment system as directed by the department overseeing environmental policy for the installation. Base the conditions for disposal upon the capability and location of the facility that would treat the effluent from the containment system. Verify fire suppression effluent containment discharge requirements with the appropriate installation environmental engineer, including local and state environmental requirements.

Route the wet pipe, dry pipe, preaction or foam/water system runoff from the hangar bay to automatically discharge to an underground containment tank, unless required otherwise by the local environmental regulations.

Provide capacity to contain 15 minutes of the hydraulically calculated demand from the overhead sprinkler system in the hangar bay, plus the hose stream demand. Do not include the Hi-Ex foam system fire flow in the containment capacity. Design the containment system to accommodate the entire calculated fire suppression effluent discharge volume for the duration noted. Do not use the trenches, piping to the containment system, etc. to contain any of the required volume.

Empty tank in accordance with environmental regulations. Install the sump pump inside the tank and operate the pump manually. Discharge the fire suppression effluent from the sump pump in accordance with environmental regulations. Locate controls for the sump pump near the inspection port to the containment tank.

****

Trench Drainage Diverter Valve Controls. Design and install controls to activate diverter valve in site sanitary drainage system. This valve diverts hangar bay trench drain flow to the underground containment tank when the foam system is activated. In normal operation (when the foam system is not activated) trench drain flow is through the oil water separator to the waste water treatment plant. Initiate activation by the fire alarm system. See civil site plans for location of motorized diverter valve, which will be outside the hangar on the site.

1.3.14 Foam System Control

****

NOTE: Air Force: The reference below "(which is Det-tronics)" applies to the Air Force. Air Force requires Det-tronics.

****

****

NOTE: Consider the local environmental regulations to determine the control, treatment and/or

remediation measures for the discharge of fire suppression effluent from the hangar bay. Do not provide a containment system for the collection of fire suppression effluent, unless required by local environmental regulations.
****

Provide a foam system alarm and control consisting of an addressable foam system control panel (FSCP), optical flame detectors, manual foam releasing stations, manual foam stop stations, signage panels, visual notification appliances, and miscellaneous appurtenances and circuit wiring in conduit, as required for a complete, operational, and fully functioning system. Source all components comprising the foam system alarm and control through the manufacturer of the FSCP and optical flame detectors (which is Det-tronics), to ensure compatibility.

1.4 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.

****

NOTE: Air Force: Air Force requires the review stamp of the fire protection specialist as stated below.

****

Shop drawings and calculations must be prepared by the sprinkler system designer and reviewed by the fire protection specialist. The fire protection specialist must review the shop drawings, hydraulic calculations and material submittals. The shop drawings must bear the Review Stamp of the fire protection specialist.

****

NOTE: Army: Army requires the registered professional engineering seal of the fire protection specialist on shop drawings as stated below. The shop drawings may be prepared by the sprinkler system designer or the fire protection specialist.

****

Develop shop drawings, product data and calculations under the supervision of the fire protection specialist. The fire protection specialist must place their registered professional engineer stamp on all drawings and the cover sheet for the product data and calculations prior to submittal to the Government.[Shop drawings and calculations must be prepared by the [sprinkler system designer][fire protection specialist].]

Submit the following in accordance with [Section 01 33 00 SUBMITTAL PROCEDURES] [_____].

The [AFCEC/COSM fire protection engineer, Judy Biddle, judy.biddle.1@us.af.mil] [Naval Facilities Engineering Systems Command [ATLANTIC] [PACIFIC] fire protection engineer] [USACE fire protection engineer] will review and approve all submittals in this section requiring Government approval.

SD-01 Preconstruction Submittals

OPTICAL FLAME DETECTOR AND FOAM/WATER DISCHARGE TESTING, SAFETY, AND ENVIRONMENTAL PLAN; G[, [_____]]

Submit high-expansion foam solution containment and disposal plan as required under paragraph entitled "PRELIMINARY ACCEPTANCE TEST (PAT) AND FINAL ACCEPTANCE TEST (FAT) CHECKLIST FOR THE HIGH-EXPANSION FOAM SYSTEM."

SD-02 Shop Drawings

High-Expansion Foam Systems; G, [_____]

Prepare shop drawings in accordance with the requirements for "Plans" as specified in NFPA 11, "Working Plans" as specified in NFPA 13, and "Shop Drawings" as specified in NFPA 72. Drawings must be the same size as the contract drawings or minimum 24 by 36 inches. Unless otherwise noted, draw floor plans to a scale no less than 1/8" = 1'-0". Show data essential for proper installation of each system. Show details, plan view, elevations and sections of the systems supply and piping. Show piping schematic of systems supply, devices, valves, pipe and fittings. Show point to point electrical wiring diagrams. Submit drawings stamped by the Fire Protection Specialist.

Do not commence work until the design of each system and the various components have been approved. Show:

a. Room, space or area layout and include data essential to the proper installation of each system

b. Foam generators and system piping layout annotated with reference points for design calculations. Piping plan for high-expansion foam system incorporating that shown. Abbreviated presentation forms will not be accepted. Identify each type of fitting used and the locations of bushings, reducing couplings, and welded joints. Provide a separate plan for each overhead sprinkler system and each foam system. Piping plan and isometric drawing of the concentrate system and details of all associated valves, fittings, and other components.

c. Field wiring diagrams showing locations of devices and points of connection and terminals used for all electrical field connections in the system, with wiring color code scheme

d. Optical flame detector manufacturer's recommended detector layout (plan view) including horizontal and vertical angles for correct aiming. Provide a plan with the cone-of-visions and respective aim points. Provide elevation showing cone-of-visions and respective aim points demonstrating that the cone-of-visions do not extend more than 5 feet outside the hangar doors.

e. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions in accordance with symbols shown in NFPA 170 used in the package.

****

NOTE: Air Force: Air Force requires proportioning by foam inductor which is described below.

****

f. Shop drawings of each inductor. Accompany shop drawings with an inductor datasheet fully annotated with the flow rate, inlet pressure, back pressure, inlet K-factor, and outlet K-factor to which the inductor will be calibrated.

****

NOTE: Army: Army requires a foam concentrate pumping system and ILBP proportioner which is described below.

****

f. Piping plan and isometric drawing of the concentrate pumping system, ILBP proportioner, and details of all associated valves, fittings, and other components. Drawing must incorporate that shown.

g. Location of control panels, detectors, manual foam start stations, manual foam stop stations, supervisory switches, solenoids, notification appliances, and other electrical devices. Incorporate that shown. In addition, indicate conduit routing and sizes, and the number of conductors contained in each.

h. Longitudinal and transverse building sections showing typical pipe routing and elevation above finished floor.

i. Equipment room layout drawings drawn to a scale of not less than 1:20 1/2 inch equals 1 foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

j. Details of all components required for support of the sprinkler piping from the building structural system, including hangers and bracing, and details of all connections to the components of the metal building system. Provide plans, elevation drawings, and details as required to fully convey the clearances required for the floor and wall penetrations.

k. Connection drawings and control diagrams indicating overall operation of the high-expansion foam system. This includes identification and operation of each major component of the system. Supplement diagrams with a narrative description of the system. Indicate foam system control panel, make and model of devices and equipment to which the system is connected.

l. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems which are supervised or controlled by the system. Show connections from field devices to the Foam System Control Panel (FSCP) and remote foam system control units, initiating circuits, switches, relays and terminals.

m. Field wiring diagrams showing locations of devices and points of connection and terminals used for all electrical field connections in the system, with wiring color code scheme

n. Indicate interfacing with fire suppression control components clearly on drawings.

o. Details of each foam generator and mounting details, High-Expansion foam system control valve header and related components.

SD-03 Product Data

Pipe, Fittings and Couplings; G, [_____]

Valves, including gate, check, and globe; G, [_____]

Pipe hangers and supports; G, [_____]

Waterflow Pressure Alarm Switch; G, [_____]

Surge Arresters; G, [_____]

Foam System Control Panel (FSCP); G, [_____]

Battery Chargers; G, [_____]

Batteries; G, [_____]

Annunciator Panel; G, [_____]

FOAM SYSTEM BEACONS; G, [_____]

Battery Chargers; G, [_____]

Manual Foam Releasing Stations; G, [_____]

Manual Foam Stop Stations; G, [_____]

Manual Foam Stop Station Operation; G, [_____]

Optical Flame Detectors and Controller; G, [_____]

In-Line Balanced Pressure Proportioner Assembly; G, [_____]

FOAM GENERATORS; G, [_____]

Sway Bracing; G, [_____]

Water Tight Junction Boxes; G, [_____]

Foam/Water Flow Control ValvesG, [_____]

Strainer; G, [_____]

Foam Concentrate; G, [_____]

CONCENTRATE STORAGE TANK; G, [_____]

Foam System Control Panel (FSCP); G, [_____]

****

NOTE: Army: Army requires a foam concentrate pumping system, ILBP, containment, diverter valve, and optical flame detector supervised disconnect, with required submittals below.

****

Containment Tank Remote Capacity Monitoring and Diverter Valve Panel - Army; G, [_____]

Foam Concentrate Pump; G, [_____]

Foam Concentrate Jockey Pump; G, [_____]

FOAM/WATER PROPORTIONING BY ILBP PROPORTIONER; G, [_____]

Trench Drainage Diverter Valve Controls; G, [_____]

OPTICAL FLAME DETECTION SUPERVISED DISCONNECT IN HANGAR BAY; G, [_____]

****

NOTE: Air Force: Air Force requires proportioning

by foam inductor with submittal required below.
****

FOAM/WATER PROPORTIONING BY INDUCTOR; G, [_____]

Surge Arresters; G, [_____]

Manufacturer's catalog data for each separate piece of equipment proposed for use in the system. Indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate, for instance model, size, and options, proposed for installation. In addition, provide a complete equipment list with equipment description, model number, and quantity.

Spare Parts; G, [_____]

Spare parts data for each different item of material and equipment specified. Include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor.

Foam Systems; G, [_____]

A copy of the proposed diagrams and instructions for the overall foam system, prior to posting.

Sprinkler System Designer; G, [_____]

Fire Protection Specialist; G, [_____]

The name and documentation of certification of the proposed Fire Protection Specialist and Sprinkler System Designer, no later than 14 days after the Notice to Proceed and prior to the submittal of the system drawings and hydraulic calculations.

Installer's Qualifications; G, [_____]

Data approved, prior to submittal of any other data or drawings, to substantiate that the proposed installer is regularly engaged in the installation of the type and complexity of fire protection system included in this project. Identify the location of three systems recently installed by the proposed installer which are comparable to the system specified. Certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

Post-discharge Test Requirements; G, [_____]

Details of method proposed for post-discharge testing.

SD-05 Design Data

Standby Battery Power requirements calculations; G, [_____]

Substantiating standby power calculations showing battery capacity, supervisory and alarm power requirements.

Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere hour requirements for each system component with the calculations.

System hydraulic surge analysis; G, [_____]

System hydraulic transit (surge) analysis showing hydraulic transit pressure occurring throughout the system at both design flow and non-flow conditions.

Flow Test Data; G, [_____]

Hydraulic Calculations; G, [_____]

Provide hydraulic calculations complying with the requirement of this section.

Foam Spread/Coverage Calculations; G, [_____]

Seismic Calculations; G, [_____]

Submit load calculations for sizing of sway bracing, for systems that are required to be protected against damage from earthquakes. Include the required features identified therein that are applicable to the specific piping system.

SD-06 Test Reports

Tests; G, [_____]

Test Plan: Describe completely what measurements are to be made and how they will be collected. Describe what tests are to be conducted, what data is to be collected, acceptable findings, corrective action for failure to meet acceptable findings, equipment required, personnel required, notification procedure for notifying contracting officer, list of manufacturers employees to assist, integration of test for sprinkler systems, fire pumps, high-expansion foam, and fire alarm systems. Verify that the fire pumps are adequate to support the fire protection systems.

Provide an initial test plan with test procedures prior to final acceptance test. Include the following information:
a. Schedule of tests for each day, Example: Day 1, Day 2, Day 3 .
b. List of tests.
c. Blank forms for recording test data for each test.
d. Test procedure for each test.
e. List of equipment required for each test.
f. Calibration certificate for testing equipment

Submit the preliminary acceptance test report to the Contracting Officer and AFCEC/COSM before requesting a Final Acceptance Test. Provide the complete preliminary acceptance test report, to include digital recording (video) of the preliminary test, a "Punch List" (list of deficiencies prepared at the completion of preliminary test) to AFCEC/COSM for review. AFCEC requires 10 working days to review a complete PAT report. After the review of the complete package is acceptable, AFCEC or their designated representative will be present for the Final Acceptance Testing. The FAT will be scheduled no sooner than two weeks after the acceptance of the complete PAT report.

Provide the Final Acceptance Test Report within 15 days after the completion of the Final Acceptance Test. Provide the final acceptance test report in booklet form showing field tests performed with the digital recording of the final test to document compliance with the specified performance criteria. Provide documentation of readings, test results, and indicate the final position of control valves. Include all required Final Acceptance Test NFPA forms. Include the resolution of punch list items developed during preliminary acceptance testing.

Reports for tests, as follows:

a. Reports as outlined in NFPA 13 documenting results of flushing and hydrostatic tests.

b. Trip tests of sprinkler system and foam deluge system.

c. Test report of foam concentrate proportioning system. Include all pressure readings and settings of system components. Include conductivity or refractive index readings for foam samples taken from the high-expansion foam proportioner. Report must be signed by the factory-trained technical representative the foam concentrate manufacturer.

d. Test report of the foam system control panel and initiating and indicating devices. Include a unique identifier for each device with an indication of test results. Report must be signed by the factory-trained technician employed by the control panel manufacturer.

e. Digital recording of preliminary and final Hi-Ex foam discharge test.

f. Submit pressure discharge graphs or tables showing pressure discharge relationship for foam generators.

SD-07 Certificates

INSTALLER'S QUALIFICATIONS; G, [_____]

Submit installer and systems technician qualifications as required under paragraph entitled Qualifications of Installer.

Materials and Equipment; G, [_____]

Certificates from manufacturers to substantiate that components, equipment and material proposed for installation and use meet requirements as specified, concurrent with submittal of manufacturer's catalog data of equipment proposed for installation. Certificates must be on a form for this purpose or on official letterhead of the manufacturer with specified information stated as required. Provide certificates for the following:

a. Control panel. Certification that the foam system control panel is electrically compatible with the solenoid on the electrically-actuated automatic water control valve, and the solenoid is compatible with the electrically-actuated valve.Electronic solenoids used for release of the suppression system must be listed for use with both the Foam System Control Panel and the foam/water flow control valve.

b. Gaskets. Certification from the manufacturer and Fire Protection Specialist that gasket material is listed or approved for dry-pipe service on all foam/water solution piping.

c. Compliance with foam system control panel ground fault detection requirement.

SD-10 Operation and Maintenance Data

Foam System; G, [_____]

Manuals in loose-leaf binder format and grouped by technical sections consisting of manufacturer's brochures, schematics, printed instructions, general operating procedures, and safety precautions. Include a narrative description of the sequence or sequences of operation of the overall fire protection system and a separate description for each major subsystem. Include specific settings for all adjustable valves. List routine maintenance procedures, possible breakdowns, and repairs, and troubleshooting guide. Include conduit layout, equipment layout, and simplified wiring and control diagrams for the system as installed. Include procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

SD-11 Closeout Submittals

As-built Drawings for the fire extinguishing system; G, [_____]

Six copies, within 14 calendar days after successful completion of required testing. Maintain a separate set of approved submittal drawings of the overall system, marked up to indicate as-built conditions, on site. Maintain these drawings in a current condition at all times and make available for review immediately upon request during normal working hours. Indicate variations from the approved drawings, for whatever reason, including those occasioned by modifications, change orders, optional materials, and/or required for coordination between trades in sufficient detail to accurately reflect the as-built conditions.

1.5 SUBMITTAL PREPARER'S QUALIFICATIONS AND GENERAL RESPONSIBILITIES

1.5.1 Fire Protection Specialist

An individual who is a registered professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

1.5.2 Sprinkler System Designer

The sprinkler system designer must be certified as a Level [III] [IV] Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.6 INSTALLER'S QUALIFICATIONS

Prior to commencing work, submit data showing that the Contractor has successfully installed automatic high-expansion foam fire extinguishing systems of the same type and design as specified herein, or that he has a firm contractual agreement with a subcontractor having the required experience. Include the names and locations of at least three installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system, and certify that the system has performed satisfactorily for a period of at least 18 months.

1.7 QUALITY ASSURANCE

1.7.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Provide standard products that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use includes applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.7.2 Source Limitations

Obtain foam concentrate, proportioning system, foam generators, and major accessories through one manufacturer. List all components for use together as single system.

1.7.3 Code Compliance

1.8 SPARE PARTS

Provide six (6) complete sets of system keys that are [CAT 60] [_____]. Also, furnish 10 percent of each type of device below but no less than two:

a. Detectors (including optical flame detectors).

b. Notification appliances

c. Fuses required by the system.

d. Initiating devices(including Manual foam releasing station and stop stations.)

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR FIRE PROTECTION SERVICE

****

NOTE: Air Force: A Pressure Reducing Valve (PRV) is commonly needed for wet pipe sprinkler systems in high expansion foam (HEF) designs. Also, a small pressure relief valve is typically required downstream of the PRV as a requirement of its FM approval. Due to the high pressures that are frequently needed in HEF systems a PRV is used to reduce the pressure to the wet pipe sprinkler system. A typical wet pipe sprinkler system wouldn't need a PRV but a note is added here in the HEF spec for consideration to include in the wet pipe sprinkler system spec and design.

****

List all equipment and material unless otherwise noted in this section. Listed, as used in this section, means listed or approved by a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA.

2.2 NAMEPLATES

For major components of equipment permanently affix the manufacturer's name, address, type or style, and model or serial number on a plate to the item of equipment.

2.3 ABOVEGROUND PIPING SYSTEMS HANDLING WATER OR FOAM/WATER SOLUTION

2.3.1 General Requirements for Piping Handling Water or Foam/Water Solution

Galvanized piping is not permitted.

Provide pipe conforming to ASTM A53/A53M. Mark pipe as to the brand or name of the manufacturer, kind of pipe and the ASTM designation in accordance with the "Product Marking" provisions of the ASTM standard.

2.3.2 Piping Handling Water

Piping 50 mm 2 inches and less must be minimum schedule 40. Piping larger than 50 mm 2 inches must be minimum schedule 10.

2.3.3 Piping Handling Foam/Water Solution

Provide schedule 40 black steel foam/water solution piping.

Provide listed/approved gaskets for dry-pipe service on all foam/water solution piping.

2.3.4 General Fitting Requirements

Use of restriction orifices, reducing flanges, and plain-end fittings with mechanical couplings which utilize steel gripping devices to bite into the pipe when pressure is applied are not permitted.

Plain end fittings with mechanical couplings and fittings that use steel gripping devices to bite into the pipe are prohibited.

Saddle tees using rubber gasket fittings are not permitted.

Provide fittings, mechanical couplings, and rubber gaskets from the same manufacturer.

2.3.5 Grooved Fittings and Couplings

Provide grooved fittings, couplings and bolts by the same manufacturer. Provide fittings and couplings consisting of malleable iron or ductile iron complying with ASTM A536. Provide couplings that are the rigid type except that flexible type will be provided where flexible joints are specifically required by NFPA 13. Provide Grade E (EPDM) approved coupling gaskets for dry pipe fire protection service. Gasket must be the flush type that fills the entire cavity between the coupling and the pipe. Provide cadmium plated or zinc electroplated, heat-treated steel nuts and bolts conforming to ASTM A183.

2.3.6 Non-Grooved Fittings

Provide threaded or flanged non-grooved fittings. Do not use fittings that couple plain-end pipe, welded sprinkler fittings or outlets for foam-water solution. Threaded fittings must be cast iron or malleable iron.

2.3.7 Flanges and Gaskets

Provide flanges conforming to NFPA 13. Provide flanges that are welded or threaded to the pipe. Listed and approved grooved flange adapter fittings are also acceptable. Flange gaskets must be full face type EPDM or other approved material. Provide gaskets that are compatible with foam concentrate and to foam/water solution to which it will be exposed.

2.3.7.1 Bolts

Provide ASTM A449, Type 1 or 2 bolts that extend no less than three full threads beyond the nut with bolts tightened to the required torque.

2.3.7.2 Nuts

Provide ASTM A193/A193M, Grade 5ASTM A563M nuts.

2.3.7.3 Washers

Meet the requirements of ASTM F436M ASTM F436. Provide flat circular washers under all bolt heads and nuts.

2.3.8 Pipe Hangers

Hangers must be suitable for the application, construction and size pipe involved.

2.3.9 Valves Affecting the Flow of Foam Solution or Concentrate Throughout the System

Unless otherwise indicated, provide indicating type valves in accordance with NFPA 13.

Open gate valves by counterclockwise rotation.

2.3.9.1 Tamper Switches

Provide tamper switches to supervise in the normal position all foam system valves including foam generator isolation valves and drain valves.

2.3.9.2 Exception

Drain valves serving foam generators in aircraft hangars may be supervised by locking or sealing in the normal position as allowed by NFPA 11.

2.3.10 Check Valve

Check valves 100 mm 4 inches and larger must be flanged, swing type, cast or ductile iron body and cover, cast or ductile iron clapper with replaceable EPDM rubber facing. Provide valves that are suitable for either vertical or horizontal mounting and equipped with a removable handhole cover. Indicate the direction of flow by an arrow cast in the valve body. The valve body includes plugged pipe thread connections for a 50 mm 2 inch drain.

2.3.11 Foam System Test Header

Provide a linear test header to meet the demand of the foam/water system.

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NOTE: Air Force: For Air Force, the foam/water test system header and fire pump test header (when provided) may be combined as stated below.

****

The foam/water test system header and fire pump test header (when provided) may be combined. When a common test header is used, provide valving to permit independent testing of each foam/water riser and each fire pump.

Provide one 64 mm2-1/2 inch hose valve connection for each 1420 Lpm375 gpm of flow, rounding up. Provide a control valve to isolate the test header from the remainder of the system.

Locate test header inside the aircraft servicing area within 6.1 m 20 ft. of an exterior door or directly outside the fire protection equipment room on an exterior wall. Locate test header to discharge effluent to a hard surface within 30.5 m 100 ft. hose lay.

In geographic locations having a 99.6 percent dry bulb temperature less than 0 degrees C 32 degrees F per UFC 3-400-02 Engineering Weather Data, provide test header with automatic ball drip routed to the exterior.

2.3.12 Pressure and Vacuum Gauges

Provide gauges conforming to ASME B40.100 and provide with throttling type needle valve or a pulsation dampener and shut-off valve. Provide gauge that is a minimum of 89 mm3-1/2 inches in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Select each gauge range so that at normal operating pressure, the needle is within the middle-third of the range. Provide liquid-filled type gauge.

2.4 FOAM CONCENTRATE PIPING AND FITTINGS

2.4.1 Pipe

Provide schedule 40 stainless steel pipe.

2.4.2 Fittings

Provide stainless steel foam concentrate fittings. Fittings must be of the same material as the pipe. Acceptable pipe joining methods are roll grooved fittings, welded joints and fittings, or flanged joints and fittings. If using welded joints and fittings, consideration must be given to the maintenance of the system and provide flanged joints at certain locations to allow for the ease of maintenance and equipment removal. Gasket material must be approved by the foam concentrate manufacturer.

2.4.3 Pipe Hangers

Hangers must be listed or approved.

2.5 STRAINER

Provide strainer baskets with stainless steel mesh sized no greater than 1.59 mm1/4 inches.

Welded steel body fire main basket-type pipeline strainer. ASTM A53/A53M pipe and class 150 steel flanges.

Design the strainer to permit removal of the strainer screen for replacement and repair without removing the body from the line. Provide a flush outlet with each strainer. Provide an open screen area at least 6 times greater than the nominal pipe size open area. Do not exceed a friction loss of 1 PSI at design flow when tested with clean strainer screen and clean water.

2.6 FOAM/WATER FLOW CONTROL VALVES

Provide a flow control valve with remote resetting capability for each foam/water system. Provide flow control valve with automatic re-closing feature and adjustable speed control. For hydraulic calculations, include the manufacturer’s minimum pressure drop across flow control valve for the features indicated.

Arrange valve for manual release at the valve. Provide pressure gages and other appurtenances at the flow control valves as required by NFPA 13. Provide brass trim piping with compatible fittings. Provide factory configured and installed trim piping. Provide gaskets made of EPDM. Operate valves by a control system listed for releasing service and independent of the building fire alarm system. List valves located in electrical classified locations for the classification of the area where located. Include the following features as standard elements of the valve and trim package:

a. Provide solenoid valve of the normally closed, de-energized type, which opens when energized upon receipt of an electrical signal from the releasing control panel to which it is connected. Solenoids used for release of the high-expansion foam must be listed for use with the foam system control panel and the foam/water control valve.

b. Flow control valves must gradually open upon receipt of power from the foam system releasing panel and must slowly close upon interruption of power. Provide speed control setting such that valve closure occurs within 15 seconds after depression manual foam stop station, and will fully open the flow control valve within 5 seconds upon release of the manual stop station.

****

NOTE: Air Force: For Air Force, the field adjustable pressure reducing trim and constant pressure at the inductor is required as stated below.

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c. Provide field adjustable pressure reducing trim.

d. Regulate pressure to maintain a constant pressure at the inductor and the discharge device (foam generator). Do not exceed pressure deviation of plus or minus 0.34 bar/70 Kpa 10 psig.

2.7 EMERGENCY FOAM/WATER SYSTEM SHUTDOWN

Provide sequential signage on the control valves for the emergency shutdown of the foam/water system. Locate these signs so they are readily visible near each valve used in the shutdown sequence.

Provide signs with white background and a minimum 12.7 mm1/2 inch wide blue border with red lettering not less than 25.4 mm1 inch high. At a minimum, provide each sign with the language “EMERGENCY FOAM SHUTDOWN PROCEDURE" and the order and action to be performed (e.g. "1 - CLOSE FOAM CONCENTRATE VALVE", "2 - CLOSE FOAM/WATER RISER CONTROL VALVE"). Continue the sequence as require for shutdown.

2.8 HIGH-EXPANSION FOAM LIQUID CONCENTRATE

Foam Concentrate

Provide concentrate that is the product of one manufacturer that is listed or approved for use with the foam generator system, and does not contain PFOS/PFOA components. Concentrate must have a minimum 20-year shelf life. Manufacture date must be no more than six months before ship date to site. Mixing of non-identical specification concentrate will not be permitted.

2.9 CONCENTRATE STORAGE TANK

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NOTE: Air Force: Air Force requires a double wall foam storage tank, and no taps on the bottom or sides of the tank, as described below.

****

Provide a vertical, closed cell double wall polyethylene concentrate storage tank compatible with the required concentrate. Enter the tank only through the top with no taps on the bottom or sides of the tank. Taps in the bottom or sides of the tank are not permitted. Inductor dip tube must enter through the top of the tank.

****

NOTE: Army: Army requires a single wall foam storage tank as described below.

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Provide a vertical, closed cell single wall polyethylene concentrate storage tank compatible with the required concentrate.

Provide a reverse float level gauge with minimum 50 gallon increments permanently marked on the tank or gauge. Indicate on the tank or gauge the empty, full, and minimum level required to operate the system. Do not include the inaccessible portion of concentrate at the bottom of the tank that cannot be accessed by the suction line, in the tank's capacity markings. Provide a closeable fill opening and pressure/vacuum vent assembly.

2.9.1 Tank Marking

Permanently label each tank with its capacity, concentrate manufacturer, and concentrate type and percentage of concentrate induction. Specifically identify the required concentrate manufacturer's name, concentrate name, concentrate identifying product numbers/codes, concentrate manufacturer's contact information including process to obtain 24-hour concentrate re-supply. Include a warning statement indicating only this specific concentrate is permitted to be used in this system.

Tank must have a NFPA 704 diamond sign indicating Health = 1; flammability = 2; and instability = 0.

2.10 FOAM/WATER PROPORTIONING BY INDUCTOR

****

NOTE: Air Force: This paragraph is for Air Force. Air Force requires proportioning by single foam inductor as described below.

****

Foam proportioning must be by a single foam inductor for each foam-water riser.

a. Tune the inductor specifically for the system required flow rate, inlet pressure, back pressure, concentrate type, proportioning ratio, and lift height of a near empty concentrate tank. Off the shelf pre-tuned generic model inductors are not permitted.

b. Design inductor to 115 percent of the nominal injection rate.

c. Size inductor for the exact orifice of foam/water pipe.

d. Fit concentrate suction line of the inductor with a low loss bronze or brass check valve assembly by the manufacturer that is included in the device's hydraulic design.

e. Potential manufacturers at the time of this publication include Fomtec, Skum, Matre Maskin, Wilson Foam, Ansul, Chemguard, and Delta Fire. Inductors from these manufacturers are approved.

2.11 FOAM/WATER PROPORTIONING BY ILBP PROPORTIONER

****

NOTE:Army: This paragraph is for Army. Army requires proportioning by ILBP proportioner and pumped concentrate system.

Proportioning foam concentrate through the use of a ratio flow controller and bladder tank, or a foam inductor is not permitted. Provide a foam concentrate pumping system, with an atmospheric foam

concentrate storage tank. Provide a foam concentrate pumping system in compliance with NFPA 11, NFPA 20, and NFPA 409, except as modified by UFC 3-600-01 and UFC 4-211-01.

****

2.11.1 Foam Concentrate Pump

****

NOTE: Pump capacity must be sufficient to supply foam concentrate under design conditions with operation of sprinklers as provided. Pump pressure should be approximately 206 kPa 30 psi above maximum system water pressure.

Use UFC 3-600-01 for reliable power requirements. Where reliable power is not available, provide diesel driven concentrate pumps

****

Provide foam concentrate pump that is electric motor driven. Provide a positive displacement rotary gear or vane type pump operating at a speed no greater than 1800 rpm. Provide pump capacity as shown on the plans. Provide pump discharge pressure as shown on the plans. Metallic pump components in contact with foam concentrate must be of bronze or stainless steel construction. Furnish each pump with suction strainer, relief valve, and suction and discharge gauges. Mount pump on a carbon steel base and have guards over couplings. Direct-connect pump to electric motor with drip-proof enclosure. Provide motor size as shown on plans.

Provide a reserve foam concentrate pump of equal capacity. Automatically operate the reserve pump upon failure of the primary pump. Arrange concentrate supply piping to meet the foam concentrate demand from either the primary or reserve foam pump.

2.11.2 Foam Concentrate Jockey Pump

****

NOTE: When the foam concentrate line to the proportioner exceeds a linear distance of 15.2 m 50 ft., provide a positive displacement foam concentrate jockey pump to maintain pressure in the foam concentrate piping.

****

Provide foam concentrate jockey pump consisting of bronze construction, TEFC motor, horizontal close coupled regenerative turbine pump. Mechanical seal with stainless steel metal parts. Buna elastomers, ceramic seat, carbon washers. Stainless steel shaft or shaft sleeve. Vertically split pump casing, end suction. Ensure motor prevents overloading at the highest head condition.

2.11.3 Pump Controller

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NOTE: Only start and stop the foam concentrate pump from a signal from the Foam System Control Panel (FSCP). Disable the pressure switch in the fire pump controller.

****

Provide a full Service Electric Fire Pump Controller, with NEMA 2 Enclosure. Provide automatic type controller that is listed for fire pump service and arranged for starting from the manual foam releasing stations or automatic fire detection system, and stopping from manual foam stop stations, all via signals from the Foam System Control Panel (FSCP). Monitor the status of the foam concentrate pump it controls(by voltage or other suitable means), and start the back-up foam pump upon failure of the primary foam pump. Provide controller that is completely terminally wired, ready for field connections, and mounted in a NEMA Type 2 drip-proof enclosure arranged so that controller current carrying parts will not be less than 300 mm 12 inches above the floor. Equip the controller with an externally operable isolating switch which manually operates the motor circuit. Provide means in the controller for measuring current for all motor circuit conductors. Monitor and provide individually displayed audible and visual alarms on the front panel for loss of a phase or line power, phase reversal, low foam concentrate level, and pump room temperature. Label each alarm lamp with rigid etched plastic labels. Equip the controller with the following:

a. Voltage surge arresters installed in accordance with NFPA 20.

b. Disable the pressure switch for automatic starting of foam concentrate pump. Only start and stop the foam concentrate pump from a signal from the Foam System Control Panel.

c. Thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 5 degrees C 40 degrees F.

d. Terminals for remote monitoring of pump running, pump power supply trouble .

2.11.4 Power Supply

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NOTE: Verify that project drawings indicate power supply in accordance with NFPA 20 requirements.

****

Provide source and arrangement of power supply to the pumps as shown on the drawings and in accordance with NFPA 20.

2.11.5 In-Line Balanced Pressure Proportioner Assembly

Provide In-Line Balanced Pressure Proportioner Assembly (ILBP) that is factory assembled and tested by the manufacturer. Disassembly, reassembly, or modification of the ILBP by the installing contractor is prohibited.

Contain all necessary components including foam proportioner; pressure balancing spool valve; duplex gauge; control, drain and check valves; interconnecting brass pipe; and valve identification nameplates. Provide proportioner consisting of a body, inlet nozzle, and metering orifice, all of which are corrosion resistant brass. Clearly mark the flow direction arrow on the proportioner, as well as the type and percentage of concentrate the proportioner was designed. The metering orifice will be sized according to the type and percentage of concentrate used. Provide brass, bronze, or stainless steel proportioner body. Accomplish balancing

through the use of a spool-type pressure balancing valve. This valve must sense foam concentrate and water inlet pressures at the outer ends of a dumbbell-shaped piston and must react to pressure changes by covering or uncovering the foam supply port to the proportioner. Provide balancing valve consisting of 83600 brass construction with a phosphor-bronze piston and Buna-N rubber O-rings and seals. Provide in-line balanced pressure proportioner that is completely pressure tested by the manufacturer. Provide interconnecting foam concentrate piping consisting of brass construction.
Provide Teflon® pressure sensing hoses with stainless braid cover and permanently attached brass couplings. Provide valve nameplates and specify valve function and normal operating position.

2.12 FOAM GENERATORS

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NOTE: Air Force: The reference below, "(except for upstream of the inductor)" applies to the Air Force.

****

Provide generator capable of producing no less than [_____] cubic feet of high expansion foam-water solution per minute.

Generator discharge characteristics must not result in any foam solution being discharged on aircraft fuselage and wing components from direct impingement or misting. Provide generator operating pressure such that high pressure fittings and system components are not used(except for upstream of the inductor).

Total nozzle obstruction must not negatively impact the distribution system hydraulics or foam induction capabilities.

List the foam generator for use with the foam concentrate. Power the foam generator by a water reaction motor. Use the water reaction motor to provide both the screen wetting solution and the energy to drive the fan. The foam generator must not require an outside power source, such as electricity. Provide a stainless steel screen for maximum reliability under fire conditions.

Design system to provide at each generator the [manufacturer's minimum operating pressure] [plus 10 psi] [plus or minus 5 psi] [_____ psi].

2.13 CONTROLS TO ACTIVATE DIVERTER VALVE - ARMY

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NOTE: Army: This paragraph is for Army. Army requires diverter valve. Locate diverter valve panel in the Maintenance Bay adjacent to the containment system monitoring panel.

****

Provide a Containment Tank Remote Capacity Monitoring and Diverter Valve Panel - Army. Provide monitoring panel with audible and visual (yellow strobe or beacon) alarms. Automatically activate audible and visual alarms when the capacity level exceeds 5 percent. Provide a silence switch for the audible alarm. Constantly illuminate visual alarms at the panel until the level condition is returned to normal.

Provide indication of the diverter valve position at the monitoring panel through the use of limit switches. Provide indication of when the valve is fully open or closed. Provide the valve with remote manual reset capability through a “Valve Position Restore” button. Provide the panel with a visual alarm (yellow strobe or beacon) that automatically illuminates when the valve position is "off normal" or "closed", and remains illuminated until valve is restored to the full normal "open" position. Install the diverter valve motorized operator above grade or list it for a submersible environment.

The containment system monitoring panel and diverter valve panel may be combined. At a minimum, provide NEMA 250 Type 4 panel(s).

Rate any devices, conduits, or electrical enclosures installed below grade or within the containment tank for prolonged submersion, minimum NEMA 250 Type 6P.

2.14   FOAM RELEASING SYSTEM

2.14.1   General

Provide a separate Fire Alarm Control Unit (FACU) and Foam System Control Panel (FSCP) for each building. Where multiple releasing systems are provided within a single building, they may be combined into a single FSCP. Combining the FACU and FSCP into a common control unit is not permitted.

Provide a FSCP for the control and release of the foam/water system. Design the system so the loss of a FACU or another FSCP does not prohibit the FSCP from functioning as intended. Do not connect the FSCP to other control unit through the use of a network cable. Communicate functionality between panels through addressable modules only. A common FSCP may control multiple releasing systems or agents.

Connect and supervise only initiating and notification devices used by the foam/water system. Release the foam/water system only by the initiating devices. Additional devices are not permitted to release the foam/water system.

2.14.2   Foam System Control Panel (FSCP)

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NOTE: Army: This paragraph is for Army. Army does not require a specific manufacturer of the FSCP.

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Provide Foam System Control Panel (FSCP) that is addressable and listed for "Releasing Device Service". Panel must contain components and equipment required to provide the specified operational and supervisory functions of the system. House components in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel must be a clean, uncluttered, and orderly factory assembled and wired unit. Include integral "power on," "alarm," and "trouble" lamps with annunciation of each alarm, supervisory and trouble signal. Provide prominent rigid plastic or metal identification plates for zones, indicating lights, controls, meters, and switches. Identify lamps and fuses mounted on circuit boards by permanent markings on the circuit board. Also include ampere rating on nameplates for fuses. Locate control panel switches within the locked cabinet. Provide a suitable means for testing the control panel visual indicating devices (meter and lamps). Ensure meters and lamps are plainly visible when the cabinet door is closed. Provide an integral graphical annunciator to indicate and annunciate, by zone, any alarm, supervisory or trouble condition on the system, including the optical detection system, by use of LED and LCD indication. Upon restoration of power, start-up automatically, and do not require any manual operation. Do not affect the transmission of alarm, supervisory or trouble signals due to the loss of primary power or the sequence of applying primary or emergency power.

2.14.3 Foam System Control Panel (FSCP)

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NOTE: Air Force: This paragraph is for Air Force. Air Force requires the Det-tronics Eagle Quantum Primier Fire Detection/Releasing System.

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The Foam System Control Panel (FSCP) must be Det-Tronics Eagle Quantum Premier Fire Detection/ Releasing System, and must be furnished complete with minimum 60-node Safety Systems Software (S3) configuration/logic programming/diagnostic tools software package including USB dongle key and RS232 cable.

FSCP drawings must be provided by the manufacturer (Det-Tronics), and the contractor must provide funding to the manufacturer as required to provide these drawings.

Provide FSCP alarm, supervisory, and trouble signal reporting to the Fire Alarm Control Panel via discrete dry contact output points.

Modular type panel installed in a surface mounted NEMA Type 4 painted steel cabinet with hinged door and cylinder lock. List all detectors for use with that panel.

Network IR detectors with the panel so that during commission IR detectors can be calibrated from the releasing panel.

Provide a real time display of current IR levels at any detector, have the ability to set the detector sensitivity for each detector from the panel, be able to download detector level log history, have remote test and diagnostics capability (manual self-test, lens dirty, sensor failure, power out of tolerance, device non-responsive), and remote setup and programming of detector options (lens heater power level, detector alarm LED function, alarm latching or non-latching, device address, sensitivity level, timing and gate count for alarm).

FSCP must be electro-magnetic interference/radio frequency interference (EMI)/(RFI) tolerant at all frequenciesand rated to SIL level 2 capability (IEC 61508), a safety assessment evaluation which evaluates critical fault paths, redundancies, and statistical measurement/prediction to ensure a specific level of long term reliable performance and stability to co-exist with aircraft radar systems.

Provide control panel consisting of a neat, compact, factory-wired assembly containing all parts and equipment required to provide specified operating and supervisory functions of the system. Provide panel cabinet that is finished on the inside and outside with factory-applied enamel finish. Provide main annunciator located on the exterior of the cabinet door or visible through the cabinet door. Provide audible trouble signal. Provide prominent engraved rigid plastic or metal identification plates, or silk-screened labels attached to the rear face of the panel viewing window, for all lamps and switches. Provide system power of 120 volts AC service, transformed through a two winding isolation transformer and rectified to 24 volts DC for operation of all system initiating, actuating, signal sounding, trouble signal and fire alarm tripping circuits. Electrically supervise system on all circuits. A ground fault condition or a single break in any circuit which prevents the required operation of the system must result in the operation of the system trouble signal. Loss of AC power, a break in the standby battery power circuits, or abnormal AC power or low battery voltage must result in the operation of the system trouble signals. The abnormal position of any system switch in the control panel must result in the operation of the system trouble signals. Operate trouble signals continuously until the system is restored to normal at the control panel. Also annunciate system trouble on the appropriate zone of the building fire alarm and mass notification control panel. The manual foam releasing stations, abort stations, optical flame detectors, and all associated wiring must be connected to and supervised by the foam system control panel. Equip control panel with a NEMA Type 4 enclosure. Provide system control panel that is [UL][FM][LPC][Vds][JFRA] listed, approved, or type accredited for extinguishing system control (releasing device service). Permanently label all switches. Provide panel with the following switches:

a. Trouble silencing switch which transfers audible trouble signals (including remote trouble devices, if provided) to an indicating lamp. Upon correction of the trouble condition, audible signals will again sound until the switch is returned to its normal position, or restore the trouble signal circuit automatically to normal upon correction of the trouble condition. The silencing switch may be a momentary action, self-resetting type.

b. Alarm silencing switch which when activated will silence all associated alarm devices without resetting the panel, and cause operation of system trouble signals.

c. Individual zone disconnect switches which when operated will disable only their respective initiating circuit and cause operation of the system and zone trouble signals.

d. Reset switch which when activated will restore the system to normal standby status after the cause of the alarm has been corrected, and all activated initiating devices reset.

e. Lamp test switch.

f. System release disable switch to disable the releasing functions of the panel while leaving all detection and other functions of the panel operational. Activation of this switch will transmit a non-latching supervisory alarm signal to the building fire alarm control panel. Provide switch within a lockable control panel.

2.14.4 Annunciator Panel

Provide integral with the main control panel. Supervision will not be required provided a fault in the annunciator circuits results only in loss of annunciation and will not affect the normal functional operation of the remainder of the system. Provide annunciator with an alpha-numeric display. Provide the description of the device.

2.14.5 Primary Power Supply

Provide power to the control panel as indicated. Permanently mark panel "FOAM FIRE PROTECTION SYSTEM".

2.14.6 Secondary Power Supply

Provide for system operation in the event of primary power source failure. Provide automatic transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power. Do not cause transmission of a false alarm.

2.14.6.1 Batteries

Provide sealed, maintenance-free, [sealed lead acid] [lead-calcium] [gel cell] batteries as the source for emergency power to the FSCP. Provide batteries that contain suspended electrolyte. Maintain the battery system in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.14.6.1.1 Capacity

Sufficient capacity to operate the FSCP under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and under alarm conditions for an additional 15 minutes. Include full current draw of solenoid in battery calculations.

2.14.6.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. Provide charger capable of providing 120 percent of the connected system load and maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.14.7 Optical Flame Detection Inhibit Switch

Provide a 2-position non-key operated switch located within the FSCP enclosure, that when activated disables the releasing function of all optical flame detectors in the hangar bay through programming at the FSCP. When the switch is placed in inhibit mode, only the releasing functions of the optical flame detectors are disabled while leaving all other functions of the FSCP operational. Monitor the inhibit switch at the FSCP. Provide a supervisory signal to the receiving station indicating the optical flame detectors are inhibited, a trouble signal is not permitted. Label the switch "INHIBIT OPTICAL FLAME DETECTION." Provide engraved labels on the inhibit switch indicating when the optical flame detectors are in "NORMAL" or "INHIBIT" mode.

2.15 ALARM

2.15.1 Fire Alarm

Provide equipment and interconnections for the automatic transmittal of an alarm over the building fire alarm system as specified in Section 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM. Arrange so that actuation of any alarm initiating device (OFD or manual foam releasing station), trouble and supervisory conditions will cause activation of the fire alarm and reporting systems.

2.15.2 Waterflow Pressure Alarm Switch

Include a 13 mm 1/2 inch NPT male pipe thread, two 13 mm 1/2 inchconduit knockouts, and two sets of SPDT (Form C) contacts. Factory adjust switches to transfer the contacts at 27.6 to 55.1 kPa 4 to 8 psi on rising pressure. Include a water-tight NEMA 4 die-cast aluminum housing with a tamper resistant cover which requires a special key for removal. Provide cover with a tamper switch which will operate upon removal of the cover. Use units on wet-pipe systems that have an adjustable, instantly recycling pneumatic retard to prevent false alarms due to water pressure variation. Factory set retard adjustment at approximately 20-40 seconds and adjustable between 0-90 seconds.

2.16 CONTROL VALVE SUPERVISORY (TAMPER) SWITCH

Electrically supervise normally open control valves.

Provide tamper switches that are UL listed as "Extinguishing System Attachment" for the location and type of valve supervised. Provide device containing double pole, double throw contacts. Operate switch to cause a supervisory signal to be transmitted to the FACU upon no more than two complete turns of the valve wheel or a closure of 10 percent, whichever is less. Equip tamper switches with screw terminals for each conductor.

2.17 FOAM SYSTEM BEACONS

Blue rotating beacons will not be less than 400 cd (208/120VAC) powered from a dedicated emergency panel.

2.18 MANUAL FOAM RELEASING STATIONS

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NOTE: Provide detail on drawings showing manual foam releasing station design as depicted in UFC 4-211-01.

****

Provide weatherproof Manual Foam Releasing Stations as shown on the plans.

Provide conventional manual foam releasing stations. Provide distinctively different NEMA 250 Type 4 manual foam releasing stations and signage from the manual fire alarm pull stations. Provide tamper cover with colored portions in yellow and lettering on the cover reading “FOAM”; the words “FIRE”, “ALARM”, or “AGENT” are prohibited to appear on the cover. Provide locking type manual foam releasing stations that when activated require a key to be reset.

Provide stations consisting of all metal construction that have a dual action release configuration to prevent accidental system discharge. Break-glass-front stations are not permitted. Provide positive visible indication of operation. Use a key for restoration.

2.19 MANUAL FOAM STOP STATIONS

****
NOTE: Provide detail on drawings showing manual foam stop station design as depicted in UFC 4-211-01.
****

Provide NEMA 250 Type 4 manual foam stop stations of the "dead-man" type. Provide manual foam stop stations with distinctive signage at each device. Provide a red mushroom type push button and include the word “PUSH”. Provide the colored portions of the tamper cover in blue and lettering on the cover stating “STOP”; the words “FIRE”, “ALARM”, or “AGENT” are prohibited to appear on the cover or station.

2.20 OPTICAL FLAME DETECTORS

Optical Flame Detectors and Controller:

Provide triple infrared (IR) optical flame detectors that are listed/approved for the expected fuel hazards in the hangar bay. Provide detectors that are immune to radar and radio frequency emissions from hand held equipment or equipment on-board the aircraft. Provide shielded circuiting for both the signaling line circuit (SLC) and power circuit from the optical detectors to the Foam System Control Panel (FSCP) and ground shielding in accordance with the optical flame detector manufacturer.

Optical flame detectors must not alarm on non-fire sources, including but not limited to, arc welding, lightning, sunlight, radiant heaters, aircraft engine exhaust, hot surfaces, strobes, and beacons. Provide detectors that are immune to radar and radio frequency emissions.

Interface the optical detection system with the building fire alarm and reporting system, but do not rely on it for operation.

Provide continuous and automated detection, while monitoring system operation through continuous supervision of its inputs/outputs. Include continuous automatic periodic self-testing and calibration during operation, including lens cleanliness check, and IR sensor testing and automatic calibration. Provide detector with manual testing capability of the lens and sensors, that is easily performed and verified at the detector, without disassembly of the detector. Provide an integral indicator lamp, visible from the hangar floor, indicating whether it is in alarm (red), fault (amber), normal (green) status for each detector.

2.20.1 Manufacturer of Optical Flame Detectors and Controller

****
NOTE: Air Force. This paragraph is for Air Force . Air Force requires Det-tronics X3301 IR flame detectors and EQP releasing/control unit
****

Provide X3301 Multispectrum IR Flame Detectors manufactured by Det-Tronics. Provide Detectors with Hangar Mode as the factory default. Control and monitor optical flame detectors from a factory assembled Eagle Quantum Premier fire detection/releasing control unit manufactured by Det-Tronics. Set detector lens heating option to [zero][_____]. Use a [low][medium][high] setting

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Protection of System Against Earthquake Damage

Seismically protect the system against damage from earthquakes. Install the seismic protection of the system components and piping, including sway bracing as required, in accordance with UFC 3-301-01, NFPA 13 and Annex A.

Seismically brace foam/water solution piping regardless of geographic location. Base bracing calculations on an Ss of 0.95 or as indicated in the seismic analysis, whichever is greater.

3.1.2 Aboveground Piping

Install piping straight and bear evenly on hangers and supports. Conceal piping in areas with suspended ceiling and inspect, test and approve before concealing.

3.1.2.1 Joints

Provide pipe joints conforming to NFPA 13. Do not show more than four threads after joint is made up. Apply joint compound to male threads only. Joints must be faced true, provided with gaskets and made square and tight. Provide flanged joints or mechanical groove couplings where indicated or required by NFPA 13. Prepare grooved pipe and fittings in accordance with the manufacturer's latest published installation instructions. Provide all grooved couplings and fittings from the same manufacturer. Do not use grooved joints in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.1.2.2 Fittings

Use flanged or welded fittings to transition the fire protection water service entrance from horizontal to vertical as it enters the building. Do not use gasketed compression fittings (including locking type) or flanged fittings with set screws.

3.1.2.3 Reducers

Make reductions in pipe sizes with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, install face bushings with the outer face flush with the face of the fitting opening being reduced. Do not use bushings in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 13 mm 1/2 inch.

3.1.2.4 Valves

Provide an [OS&Y] [butterfly] valve beneath each flow control valve in each riser, when more than one valve is supplied from the same water supply pipe.

3.1.2.5 Pipe Supports and Hangers

Installation methods outlined in NFPA 13 are mandatory. Provide protection of piping and all foam equipment including foam tanks and generators against damage from earthquakes. Provide longitudinal and lateral sway bracing for piping.

3.1.2.6 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings is not permitted.

3.1.2.6.1 Escutcheon Plates

Provide escutcheons at finished surfaces where exposed piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Fasten chromium-plated iron or chromium-plated brass, either one-piece or split-pattern escutcheons securely to pipe and hold in place by internal spring tension or setscrew.

3.1.2.6.2 Pipe Sleeves

Provide pipes penetrating concrete or masonry walls or concrete floors with pipe sleeves fitted into place at the time of construction through its respective wall or floor, and cut flush with each surface. Provide sleeve sizes and clearance between pipe and sleeve in accordance with NFPA 13. Provide no less than 6.35 mm 1/4 inch space between exterior of piping and interior of sleeve. Firmly pack space with insulation and calk at both ends of the sleeve with plastic waterproof cement. ASTM A53/A53M, schedule 40 or standard weight, zinc-coated steel pipe sleeves. Extend sleeves in floor slabs 76 mm 3 inches above the finished floor.

Where pipes pass through fire walls, fire partitions, or floors, place a fire seal between the pipe and sleeve in accordance with Section 07 84 00 FIRESTOPPING.

3.1.2.6.3 Sleeves in Partitions

Provide zinc-coated steel sheet having a nominal weight of not less than 0.90 pounds per square foot.

3.1.2.7 Drains

Provide main drain piping to discharge at safe points outside each building. Provide drains of adequate size to readily receive the full flow from each drain under maximum pressure. Provide auxiliary drains as required by NFPA 13 except use drain valves where drain plugs are otherwise permitted. Where branch lines terminate at low points and form trapped sections, manifold such branch lines to a common drain line. Provide each drain valve with a metal sign identifying the type of drain connection or function of the valve.

3.1.2.8 Identification Signs

Provide signs in accordance with NFPA 13. Suitably affix lettered and approved metal signs to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate. See drawings for additional sign requirements. Indicate Normally Open or Normally Closed as appropriate

3.1.3 Surge Arresters

****
NOTE: See UFC 4-211-01 for the surge arrestor requirements for the sprinkler risers and any fire pumps, as well as those required for foam/water risers.
****

At a minimum, provide the following surge arresters. Increase the minimum capacities listed below, when manufacturer's calculations are required and demonstrate a large capacity.

a. Provide 95 liters 25 gal of capacity for each foam/water riser located on the riser manifold supplying a hangar bay.

b. For each riser room, combine the surge capacity of the risers in the room into a single common surge arrestor. Where risers feed different fire areas, only use the greatest combined surge capacity from one fire area. Connect this common surge arrestor to the riser manifold immediately upstream of the protected risers.

c. Coordinate with surge arresters required for sprinkler riser and any fire pumps

d. Where surge arresters are 380 liters 100 gal or larger in capacity, provide floor stands.

Provide each arrestor with an indicating isolation valve to separate it from the system. Electrically supervise this valve in the normally open position. Provide a drain after the isolation valve to relieve pressure from the surge arrestor during testing and maintenance. When connecting the surge arrestor to the riser, the use of piping, fittings, and valving smaller than the connecting orifice on the surge arrestor is not permitted.

After the surge arrestor is installed and pressurized in the field with nitrogen per the manufacturer’s written directions, provide a permanent label indicating the set pressure of the arrestor. Do not pressurize the surge arrestor during hydrostatic testing of the system.

3.1.4 Foam/Water Flow Control Valves

Install the manual release for the flow control valve no higher than 1524 mm 5 ft. above finished floor. For hydraulic calculations, include the manufacturer’s minimum pressure drop across flow control valve for the features indicated.

Provide pressure gages and other appurtenances at the flow control valves as required by NFPA 13.

3.1.5 Isolation Valve and Strainer

Provide an isolation valve and basket strainer in the piping ahead of foam system risers.

3.1.6 Foam Concentrate Appurtenances

****

NOTE: Air Force. This paragraph is for Air Force .
****

Provide a brass, bronze, or stainless steel full bore quarter turn ball valve with an electrically supervised tamper switch in the concentrate line. The use of automatically controlled valves in the concentrate line is prohibited. For testing purposes, equip the concentrate line with fittings and valving to accommodate the connection to an auxiliary tank of alternate test foam concentrate. Cap auxiliary tank connection at all times, except when testing.

Provide a 19 mm 3/4 inch copper line with ball valve from the fire water supply, that is used for flushing the concentrate line after use. Provide sign with the following instructions, "Flush concentrate line after discharge or testing. Close concentrate tank shut-off valve prior to opening this valve. After flushing, drain concentrate line through test connection prior to re-opening concentrate tank shut-off valve.

3.2 ELECTRICAL WORK

****
NOTE: Coordinate power and alarm requirements with the contract drawings and other specification sections.
****

Except as modified herein, provide electric equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. [Alarm signal wiring connected to the building fire alarm control system must be in accordance with [Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE] [Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE] [Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE] [and] [Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE.]] Maintain uniform wiring color code throughout the system.

3.2.1 Panels and Component Installation

Where panels are located in normally occupied areas, provide recessed panels and combine miscellaneous components in common recessed enclosures to provide a clean installation. Where an auxiliary battery supply is required and cannot be recessed within the wall, locate it remotely in a normally unoccupied area.

Where panels, devices, and appliances are subjected to water spray/runoff under normal operating conditions, provide NEMA 250 Type 4 enclosures and water tight conduit. Regardless of environmental conditions, do not provide openings or conduit entry into the top of the FSCP.

3.2.2 System Wiring

Provide signaling line circuits that are Class B wiring, No. 18 AWG size conductors at a minimum. Provide notification appliance and initiating device circuits that are No. 16 AWG size conductors at a minimum. Circuits operating at [24 VDC] [_____] must not operate at less than [21.6] [_____] volts. [Circuits operating at any other voltage must not have a voltage drop exceeding 10 percent of nominal voltage.] Power wiring, operating at 120 VAC minimum, must be No. 12 AWG solid copper having similar insulation. Run conduit or tubing concealed unless specifically shown otherwise on the drawings. Install all wiring splice free. Pull a dedicated earth ground conductor on all runs and bond to enclosures, boxes, and field devices which have ground terminals. Color coding is required for circuits and maintain throughout the circuit.

All conductors must be installed in conduit (EMT minimum).

Pull all conductors splice free; conductors must be continuous from device to device. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited.

Run all wiring to and within control panels in the vertical or horizontal plane, make all turns at 90 degree angles, and tightly bundle and wrap conductors.

Wiring may be solid copper or stranded as permitted by NFPA 70.

All devices must have screw terminals. Where devices are only provided with pigtails from the manufacturer, pigtails must be landed on terminal strips mounted within the junction box.

All terminations must be at a terminal strip or the device screw terminals. Terminal strips are only permitted where direct connection to a device is not possible.

3.2.3 Operating Power

Provide 120 volts AC service power, transformed through a two winding isolation type transformer and rectified to 24 volts DC for operation of all signal initiating, signal sounding, trouble signal, and actuating (releasing) circuits. Provide secondary DC power supply for operation of system in the event of failure of the AC supply. Provide fully automatic transfer from normal to emergency power or restoration from emergency to normal power and do not cause transmission of a false alarm. Obtain AC operating power for control panel, and battery charger as indicated on the drawings.

3.2.4 Conductor Identification

Identify all conductors individually with permanent markings. Conductor markings must be printed labels, permanently affixed to the conductor via shrink wrap.

All conduit, junction/back boxes, covers and couplings, when provided, must be factory painted red in unfinished areas (e.g., above ceilings, mechanical rooms).

All conduit, junction/back boxes, covers and couplings, when provided, are permitted to be painted to match the room finishing in finished areas. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 20 mm 3/4-in. wide at 6 meters 20 feet intervals and on both sides of all floor, wall, and ceiling penetrations.

3.3 CONDUIT INSTALLATION

Flexible conduit is only permitted when connecting to the following devices and appliances. Devices located on fire suppression equipment such as flow/pressure switches, solenoids, and tamper switches. Devices and appliances located in removable ceiling tiles, and where flexible conduit is specifically noted in this UFC (e.g. optical flame detectors). Where flexible conduit is permitted, it is limited to 1.8 meters 6 feet.

A maximum of two conduit penetrations are permitted into a secured area. Most areas only require one penetration.

3.3.1 Conduit and Enclosure Installation within the Hangar Bay

Provide NEMA 250 Type 4 wall mounted devices and appliances within the hangar bay (including backboxes). Provide watertight conduit and Water Tight Junction Boxes throughout the hangar bay.

Route conduit into the bottom of the backbox for manual foam releasing stations, stop stations, and flame detectors. Provide the low point of this conduit with a drain. Where the conduit is in a hazardously classified area, provide breathers in isolated portions of the conduit (e.g. sealed off from the remaining conduit system). Rate drains and breathers for the electrical (hazard) classification in which they are installed, but not be less than NEMA 250 Type 4.

3.4 SURGE PROTECTIVE DEVICES (SPD)

Provide SPDs to protect all power supply circuits to the FACU and FSCP, including any subpanels such as autonomous control units, amplifier panels, notification appliance circuit(NAC) booster panels. Provide SPD to protect all fire alarm circuits leaving or entering the building. Devices mounted on an exterior wall such as wall mounted exterior speakers do not require an SPD when lighting protection is provided on the building. Mount SPDs in a separate enclosure, unless the SPD is listed and installed in the control panel by the factory. Installing SPDs not listed with the panel is prohibited.

3.5 FOAM RELEASING SYSTEM

Install the FSCP in a location readily accessible to the emergency responders and maintenance personnel.

3.5.1 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements.

    (1) . Substantiate the battery calculations for alarm, alert, and supervisory power requirements. Include ampere-hour requirements for each system component and each panel component, and compliance with UL 864.

    (2) . Provide complete battery calculations for both the alarm, alert, and supervisory power requirements. Include full current draw of solenoid in battery calculations. Submit ampere-hour requirements for each system component with the calculations.

    (3) . A voltage drop calculation to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries.

b. For battery calculations use the following assumptions: Assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period. Using this voltage perform a voltage drop calculation for circuit containing device and/or appliances remote from the power sources.

(1) . Include full current draw of solenoid in battery calculations.

3.5.2 FSCP Supervised Disconnect

Provide a key operated FSCP Supervised Disconnect switch to physically disable the solenoid for each foam/water and pre-action riser (if provided). Provide switch that disables the releasing functions without the use of programming, while leaving all other functions of the panel operational. Do not provide a trouble signal upon operation of the disconnect.

Locate the disconnect switch in the riser room, in a readily accessible location near the solenoid. Provide a sign near the disconnect switch with a white background and a minimum 12.7 mm 1/2 inch wide blue border, with “DISABLE FOAM SYSTEM" or "DISABLE PRE-ACTION SYSTEM" in red lettering not less than 25.4 mm 1 inch high. Provide engraved labels on the disconnect switch indicating when the system is "ENABLED" or "DISABLED". Do not install backboxes or route conduit in front of sign in a manner that obstructs any lettering.

3.6 VALVE SUPERVISION

Electrically supervise normally open control valves. This includes, but is not limited to, providing tamper switches on all manual valves in the foam concentrate system and in-line Balanced Pressure Proportioning System.

Supervise all valves which control alarm functions or the flow of water, foam, foam concentrate, or that when closed will disrupt the proper operation of a system electronically. This includes, but is not limited to, deluge valve alarm isolation valve, foam concentrate tank outlet line valve, foam concentrate tank water inlet valve, and water operated foam mixing valve pilot line valve.

Electrical or mechanical supervision is not required for normally closed control valves, unless opening the valve is detrimental to the system operation. When supervision is required on normally closed valves, provide electrical supervision.

Mechanically lock or provide tamper seals such as zip-ties on trim valves, that when opened or closed are detrimental to the operation of the foam/water system such as the shutoff for the foam system pressure switch. Provide signage indicating the valve’s normal operating position.

Mechanically lock or provide tamper seals such as zip-ties on drain or trim valving in the closed position, that when opened will cause the discharge of the foam/water system such as the manual release valve on the foam/water system riser. Provide this valve with the following signage, "OPENING THIS VALVE WILL RELEASE THE FOAM SYSTEM."

3.7 SUPERVISION AND SIGNAGE

Report supervisory alarms as independent addresses as indicated on the plans. Grouped switches on common addresses are not permitted. Provide non-latching electronically supervisory devices.

3.8 FOAM SYSTEM BEACONS

Provide blue visual alarm signals (rotating beacons) within the aircraft servicing area to indicate foam system activation as shown on the plans.

Control the beacon initiation through the FSCP. A backup power supply or supervision of the power supply supplying the beacons is not required when supplied from the dedicated emergency panel. Mount beacons 6.1 - 9.1 m 20 - 30 ft. above the floor of the hangar bay. Provide a sign next to each blue beacon with a yellow or lime-yellow background matching the manual foam releasing station signage, with "FOAM RELEASE WHEN ILLUMINATED" in red lettering not less than 76 millimeters 3 inches high. Blue beacons are in addition to any general fire alarm notification such as the general fire alarm strobes.

[[For single door hangars, provide one beacon approximately centered on each of the three walls.][For drive through hangars, provide one beacon 3.0 - 7.6 m 10 - 25 ft. from each corner of the hangar bay.]] Provide additional beacons where at least one beacon is not viewable from normally occupied areas of the hangar bay. Locate beacons to take into account building construction, aircraft configuration and positioning in the hangar bay.

3.9 FOAM GENERATOR INSTALLATION

Install Hi-Ex foam generators to provide a minimum 510 mm 20 inches clearance in front of the generator inlet. The use of all-thread rod for supporting generators is not permitted.

Tap the generator foam/water supply piping with a valve to allow for the attachment of a pressure gauge or sampling hose during testing.

Locate Hi-Ex generators to discharge within close proximity, but not directly upon the aircraft. When mounting generators in the horizontal position, take into account the throw pattern of the Hi-Ex foam discharge. Do not locate the generator where the Hi-Ex foam discharge is obstructed (e.g. structural members) or in areas that obstruct service equipment (e.g. crane travel path). Use the initial discharge from the foam generators to protect under the aircraft fuselage and underwing area, prior to spreading to the remaining hangar bay floor area.

Do not provide generators in locations where the developing foam blanket will block exits from the hangar bay within the first minute of discharge. Blocked exits are defined as an exit that is obstructed by a foam blanket exceeding 1.5 m 5 ft. in depth. In small hangar bays where the entire floor may be covered with foam within the first minute, provide generator locations so exits are one of the last areas blocked.

3.10 INDUCTOR INSTALLATION

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NOTE: Air Force. This paragraph is for Air Force .

****

Provide a single foam inductor per foam/water riser meeting the requirements outlined below. Where more than one foam inductor is used, they may take suction from a common concentrate tank. Do not supply more than one fire area from a single inductor.

Install inductor in the horizontal piping over the top of the concentrate tank. Provide the minimum straight pipe on both sides of the inductor in accordance with the manufacturer. Install these sections of piping free of elbows, tees, and reducers. Provide liquid filled gauges, located no closer than 610 mm 2 ft. before and after the inductor.

3.11 IN-LINE BALANCED PRESSURE PROPORTIONER ASSEMBLY

****

NOTE: Army. This paragraph is for Army.

****

Install ILBP proportioners downstream of the flow control valve, and ensure that the ILBP meets the manufacturer's recommendation with regards to horizontal or vertical installation.

3.12 FOAM RELEASING SYSTEM

Locate the FSCP, releasing modules, and monitor modules integral to the releasing and stopping of the foam/water system in a normally occupied conditioned space with the following parameters: temperature between 15.6 - 26.7 degrees C 60 - 80 degrees F and a relative humidity of 85 percent at 29.5 degrees C 86 degrees F. Do not install these components in the hangar bay.

Where panels are located in normally occupied areas, provide recessed panels and combine miscellaneous components in common recessed enclosures to provide a clean installation. Where an auxiliary battery supply is required and cannot be recessed within the wall, locate it remotely in a normally unoccupied area.

Where panels, devices, and appliances are subjected to water spray/runoff under normal operating conditions, provide NEMA 250 Type 4 enclosures and water tight conduit. Regardless of environmental conditions, do not provide openings or conduit entry into the top of the FSCP.

3.13 FOAM RELEASING SYSTEM

****

NOTE: Air Force. This paragraph is for Air Force .

****

For the purposes of this contract, all Det-Tronics installation recommendations are considered as mandatory requirements. Ground all devices in strict accordance with the Det-Tronics installation instructions. Install all circuit wiring as part of shielded cable assemblies, in rigid galvanized steel conduit, and grounded in strict conformance with the Det-Tronics installation instructions.

3.14 MANUAL FOAM RELEASING STATIONS INSTALLATION

****

NOTE: Air Force: The sentence below, "Manual foam releasing stations are not required outside the hangar bay." applies to Air Force.

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NOTE: Air Force: The requirement below for signs indicating the zone served by the manual releasing station applies to Air Force.

****

Install manual foam releasing stations within the hangar bay so they are unobstructed, readily accessible, and located within 3.0 m 10 ft. of each required exit or exit access from the hangar bay. Manual foam releasing stations are not required outside the hangar bay. Maintain a minimum separation distance of 1.5 m 5 ft. between general fire alarm pull stations (if provided) and the manual foam releasing stations. When located at required exit doors, install the foam releasing station and the fire alarm pull station on opposite sides of the door.

Provide low-level high-expansion manual foam releasing stations where shown. Provide stations that are not subject to operation by jarring or vibration. Mount station on signage panel as specified herein and detailed on drawings. Provide locking manual foam releasing stations that, when activated, require a key to be reset. Surface mount foam releasing stations.

Where a manual foam releasing station is installed near an exit or exit access, install it on the opposite side of the door from the general fire alarm pull station, if provided.

Do not locate addressable monitor modules for the manual foam releasing stations in the hangar bay.

Protect foam releasing stations located in the hangar bay from mechanical damage. Provide a clear plastic tamper cover over the manual foam releasing station that when lifted emits an audible alarm. Exception: Audible alarm is not required where a manual foam releasing station is installed in a hazardous (classified) location.

Provide additional 25 mm 1 inch high black block lettering on the sign indicating which zone is served by the manual foam releasing station.

3.15 MANUAL FOAM STOP STATIONS

Provide manual foam stop stations at each manual foam releasing station. Use stop stations in conjunction with valves and equipment that stop the discharge of foam/water from the suppression system. Do not locate addressable monitor modules for the manual foam stop stations in the hangar bay.

Protect manual foam stop stations located in the aircraft servicing area from mechanical damage. Provide a clear plastic tamper cover (without audible alarm) over the manual foam stop station.

3.16 MANUAL FOAM STOP STATIONS IN CORRIDORS

****

NOTE: Army: This paragraph is for Army. The requirement for a manual foam stop stations outside the hangar bay in the corridors applies to Army. Coordinate the vision panel in the fire rated door with architectural trades.

****

Provide a manual foam stop station in the corridor of each required exit from the hangar bay through the support space. Locate the station on the support side of the door, such that it is within 1.5 m 5 ft. of the door and not obstructed when the door is fully open. Provide a 0.065 sq. m 100 sq. in. fire rated door vision panel in these doors, such that an occupant can view into the hangar bay while operating the manual foam stop station.

3.17 MANUAL FOAM RELEASING STATION AND STOP STATION SIGNAGE

****

NOTE: Provide details on design drawings showing start and stop station signage as depicted in the relevant Figures in UFC 4-211-01, Aircraft Maintenance Hangars.

****

Provide two separate but adjacent metal signs a minimum of 610 mm 24 inches high by 508 mm 20 inches wide. Provide no more than 305 mm 12 inches of separation between the two signs. Do not use the words "FIRE", "ALARM", or "AGENT" on these signs. Do not install backboxes or route conduit in front of sign in a manner that obstructs any lettering.

Provide the sign for the manual foam releasing station with a yellow or lime-yellow background with “START FOAM SYSTEM” in red lettering not less than 76 mm 3 inches high. Locate the manual foam releasing station with tamper cover on the lower portion of the sign. Provide the word “START” in minimum 25.4 mm 1 inch high green lettering placed directly above the manual foam releasing station.

Provide the sign for the manual foam stop station with a white background and a minimum 12.7 mm 1/2 inch wide blue border with “STOP FOAM SYSTEM” in blue lettering not less than 76 mm 3 inches high. Locate the manual foam stop station with tamper cover on the lower left portion of the sign. Provide the word “STOP” in minimum 25.4 mm 1 inch high red lettering placed directly above the manual foam stop station.

To the right of the stop button provide the following in minimum 12.7 mm 1/2 inch high black lettering "To stop foam system, press and continuously hold STOP button until relieved by emergency responders. There may be up to a 30 second delay after pressing the STOP button before the foam stops."

3.18 OPTICAL FLAME DETECTION SUPERVISED DISCONNECT IN HANGAR BAY

****

NOTE: Army: This paragraph is for Army.

****

Provide a key operated supervised disconnect switch to disable all optical flame detectors in the hangar bay. Provide a switch that disables the releasing and notification functions of the optical flame detectors, while leaving all other functions of the Foam System Control Panel (FSCP) operational. Operation of the switch will not create a trouble signal. Monitor the disconnect at the Foam System Control Panel (FSCP). Provide a supervisory signal to the receiving station upon operation of the disconnect. While the switch is in the disable mode, the optical flame detectors will not retain any history of alarm conditions such that when the switch is placed in the enable mode the FSCP will not immediately go into alarm.

Locate the disconnect switch in the hangar bay, in a readily accessible location near a manual foam stop station. Provide a NEMA 250 Type 4 switch and backbox or house the components in a NEMA 250 Type 4 enclosure. Provide a non-flashing or rotating red indicating light not less than 400 cd (208/120VAC) powered from a dedicated emergency panel. Control light initiation through the FSCP. A backup power supply or supervision of the power supply to the light is not required when supplied from the dedicated emergency panel. Mount the light above the disconnect switch. Provide a sign with a white background and a minimum 12.7 mm 1/2 inch wide blue border, with "OPTICAL FLAME DETECTION DISABLED WHEN ILLUMINATED" in red lettering not less than 25.4 mm 1 inch high. Provide engraved labels on the disconnect switch indicating when the optical flame detectors are "ENABLED" or "DISABLED". Do not install backboxes or route conduit in front of sign in a manner that obstructs any lettering.

3.19 OPTICAL FLAME DETECTOR INSTALLATION

Provide a sufficient number of optical flame detectors around the perimeter of the hangar bay, such that all portions of the hangar bay are within the range and cone-of-vision of at least three detectors. Exception: The area of the hangar bay within 1.5 m 5 ft. of the perimeter wall is not required to be within the cone-of-vision of an optical flame detector. No aircraft silhouette will be solely visible from optical flame detectors located on one side of the fuselage. A minimum of two optical flame detectors covering the aircraft silhouette are required on each side of the fuselage.

Provide flame detector installation shop drawings directly from the manufacturer.

Angle detectors and provide blinds (field of view inhibitors) so the cone-of-vision is contained within its designated suppression zone and does not extend more than 1.5 m 5 ft. outside the hangar bay, into another fire area such as through a normally open roll-up fire door, or is within the view of hot sources such as radiant heaters. Locate optical flame detectors at a sufficient distance per the manufacturer's recommendations from sources that may cause false alarms such as welding, solar glare, radiant heaters, aircraft engine exhaust, strobes, hot surfaces and other relevant sources.

Mount detectors in accordance with their listing at approximately 2.4 m 8 ft. above the finished floor of the hangar bay. Do not mount optical detectors in inaccessible locations. Provide optical flame detectors with 1.5 m 5 ft. of flexible conduit to allow for minor adjustments during testing or changes in the mission of the hangar bay.

Provide at least three separate dedicated zones for reporting the status of the optical detection system to the remote location. One dedicated zone for the first optical detector in alarm, a second dedicated zone for the second optical detector in alarm, and a third dedicated zone for a fault signal in the optical detections system.

Calibrate optical flame detectors to operate upon viewing the flame signature of the expected fuel(s) to be in the hangar bay. Use a 610 mm x 610 mm 2 ft. x 2 ft. pool fire as the bases to set the sensitivity of the optical flame detectors. Upon the 610 mm x 610 mm 2 ft. x 2 ft. pool fire reaching full development, all detectors within the cone-of-vision are required to activate within 30 seconds.

3.20 PIPE PAINTING AND LABELING

3.20.1 Painting

Paint all exposed, interior, black steel piping the same color as the walls and or ceiling, or a complementing color. Do not paint exposed interior fire protection piping red. Exposed piping in the fire protection equipment room and mechanical rooms may be left unpainted. Stainless steel piping may be cleaned and left unpainted.

Clean, prime, and paint new foam systems including valves, piping, conduit, hangers, miscellaneous metal work, and accessories. Clean the surfaces in accordance with SSPC SP 11. Immediately after cleaning, prime the metal surfaces with one coat of SSPC Paint 25 or SSPC Paint 25 primer applied to a minimum dry film thickness of 1.5 mils. Exercise care to avoid the painting of sprinklers and operating devices. Upon completion of painting, remove materials which were used to protect sprinklers and operating devices while painting is in process. Remove sprinklers and operating devices which have been inadvertently painted and provide new clean sprinklers and operating devices of the proper type. Finish primed surfaces as follows:

3.20.2 Pipe Identification,

Mark all exposed interior piping with plastic wrap around-type pipe labels conforming to ASME A13.1. Indicate the type of fluid carried and direction of flow. Labels that stick-on (adhesive backed) or are held on with straps/adhesive tape are not permitted. Labels are not required on any fire suppression system branch lines regardless of size, or mains and cross-mains less than a nominal 64 mm 2-1/2 in. Labels are not required on piping routed below the floor line in trenches or pits. At a minimum, the following labels are required.

a. FIRE PROTECTION WATER - Used on dedicated potable and non-potable fire protection water supply piping.

b. FOAM CONCENTRATE - Used on foam concentrate piping.

c. FIRE SPRINKLER - Used on water-only sprinkler piping.

d. HIGH-EXPANSION FOAM - Used on Hi-Ex foam/water piping.

3.21 FIRE PROTECTION SPECIALIST

Inspect the system periodically during the installation to assure the system is being provided and installed in accordance with the contract requirements. Witness all the preliminary and final acceptance tests, and review and sign the test reports. After the preliminary acceptance testing has been completed, certify in writing that the system is ready for the final acceptance inspections and tests. Document any discrepancies found and what actions will be taken to correct. Bring any discrepancy noted during the periodic site visits or the preliminary testing to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

3.22 FACTORY AUTHORIZED PERSONNEL

Provide a factory authorized representative for the startup and/or testing of the following systems as outlined below:

a. Fire Pump System, as applicable (Start Up)

b. Fire Alarm and Mass Notification System (FACU/ACU) (Preliminary and Final Acceptance Testing)

c. Foam Proportioning, Foam Suppression, and Foam/Water Releasing System (FSCP) (Preliminary and Final Acceptance Testing). Provide the services of representatives or technicians from the manufacturers of the low-level high-expansion foam system and foam system control panel experienced in the installation and operation of the type of system being provided, to supervise installation, adjustment, preliminary testing, and final testing of the system and to provide instruction to Government personnel. The foam system control panel manufacturer must provide a minimum of 4-days startup assistance.

d. Optical Flame Detection System (Preliminary and Final Acceptance Testing). The representative from the manufacturer of the optical flame detection system must perform all programming on, and witness and certify acceptance testing (including witnessing pan fire tests on site), on the triple IR detection system. The manufacturer's representative, who programs, and certifies and witness the acceptance tests, must submit qualifications to the government for approval.

3.23 OPTICAL FLAME DETECTOR AND FOAM/WATER DISCHARGE TESTING, SAFETY, AND ENVIRONMENTAL PLAN

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NOTE: Consider the local environmental regulations to determine the control, treatment and/or remediation measures for the discharge of fire suppression effluent from the hangar bay. Base the conditions for disposal upon the capability and location of the facility that would treat the effluent from the containment system. Verify fire suppression effluent containment discharge requirements with the appropriate installation environmental engineer, including local and state environmental requirements

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Prepare a plan for conducting the test, to include the duties of the test team members, as follows:

a. Who will perform the testing and who will be the onsite factory authorized representatives.

b. What are the safety precautions taken during testing. Provide a safety plan for conducting the test of the High-Expansion Foam system. Remove any mobile / portable equipment from the hangar servicing area that is not needed for the test. Provide a sketch of safe egress path for persons conducting and witnessing the test to exit the building without entering the foam blanket. Obtain approval from the installation Safety Manager.

c. Describe how the foam/water system will be tested to demonstrate that the performance criteria is been met.

d. How will the event be recorded for future review.

e. What are the testing procedures to demonstrate the coordination and communication of the fire protection systems associated with the foam/water discharge.

f. Provide protection for the facility, including electrical and mechanical equipment exposed to possible damage during foam discharge tests. This includes provision of sandbags or similar means for preventing migration of foam solution into adjacent areas. Cover the hangar walls and surface mounted equipment with plastic sheeting from the finished floor to 6 meters 20 feet above the finished floor. Protect doors into adjacent areas to prevent foam-water solution leaking into the adjacent areas during the test and subsequent clean-up. The test and any re-test will begin with the system in normal configuration; no recharging of the system piping is allowed. Hangar doors will be closed and will remain closed until the hangar is released to the contractor's clean-up team.

g. How will the foam be captured during the discharge and disposed. Provide temporary measures to prevent high-expansion foam solution or high-expansion foam concentrate from entering storm drains, sanitary sewers, drainage ditches, streams and water courses. Do not allow high-expansion foam concentrate or solution to come in contact with earth. Contain all discharged HIGH-EXPANSION FOAM on paved surfaces. Collect all discharged high-expansion foam solution; all rinse and flushing water and dispose of it in an [State/EPA - approved sanitary waste-water], [State/EPA - approved industrial waste-water], [installation sanitary waste water]; [installation industrial waste-water] treatment facility which provides secondary (biological) treatment. Prior to the start of construction, submit written plan for high-expansion foam containment and disposal methods(s) to the Contracting Officer for approval.

   Provide temporary measures to prevent foam solution from entering storm drains, sanitary sewers, drainage ditches, streams and other water sources. Contain discharged foam on paved surfaces and do not allow to come in contact with the earth.

h. Submit the test, safety, and environmental plan to the Contractor Officer for approval.

i. Submit the test plan to the Fire Protection Specialist for approval.

j. Obtain local, state or federal environmental permits as applicable.

k. Obtain approval from Base Environmental Engineer or Base Civil Engineer.

l. Obtain approval from the fire department.

m. Provide Hi-Ex Foam Disposal Plan and Procedures.

3.24 PRELIMINARY TESTING

Provide the following preliminary testing reports before performing acceptance testing for the foam fire suppression, foam releasing system, optical flame detection system, and fire alarm and mass notification systems.

Testing reports must have been reviewed and approved by the Contracting Officer and Fire Protection Specialist.

a. Contractor's Material and Testing Certificate for Underground Piping per NFPA 13 and NFPA 24. Provide photos of installation prior to burial.

b. Contractor's Material and Test Certificate for Aboveground Piping per NFPA 13 for each riser, manifold, and fire department connection.

c. Fire pump test report demonstrating compliance with NFPA 20 acceptance testing criteria. Where a concentrate pumping system is also provided, demonstrate compliance with NFPA 11 and NFPA 20 acceptance testing criteria.

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NOTE: Army: The following paragraph is for Army.

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d. Residual pressure test report for the most remote generator with the simultaneous operation of the foam/water system, overhead hangar bay sprinkler system simulation, and exterior hose demand (when applicable). A water only test is acceptable.

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NOTE: Air Force: The following paragraph is for Air Force.

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e. Residual pressure test report for the most remote generator with only the foam/water system operating. Include the inlet and outlet pressures of the flow control valve and inductor. A water only test is acceptable. Include verification of the hydraulic performance of the system.

f. Provide a proportioning system test report demonstrating compliance in accordance with NFPA 11.

g. System record of Inspection and Testing, Notification appliance supplementary Record of Inspection and Testing, Initiating Device Supplementary Record of Inspection and Testing, Interface Component Supplementary Record of Inspection and Testing, and Mass Notification System Supplementary Record of Inspection and Testing per NFPA 72 for the FACU and FSCP.

3.25 FLUSHING

Flush underground water mains in accordance with NFPA 13 and NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the maximum water demand rate of the system.

3.26 HYDROSTATIC TESTS

Hydrostatically test the aboveground piping systems, including foam concentrate, in accordance with NFPA 13 at no less than 1379 kPa200 psi, or 345 kPa50 psi in excess of maximum system operating pressure, whichever is greater, for 2 hours. There must be no visible leakage from the piping when the system is subjected to the hydrostatic test.

3.27 TEST TRENCH DRAINAGE SYSTEM DIVERTER VALVE TO UNDERGROUND CONTAINMENT TANK

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NOTE: Army: The following paragraph is for Army .

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Test and verify operation of trench drainage system diverter valve to underground containment tank.

3.28 FOAM CONCENTRATE SYSTEM

Provide high-expansion foam concentrate for all testing (initial and acceptance) and any required retesting. Concentrate tanks must be full (not less than that shown in the contract, or not less than the minimum quantity intended to provide the 15 minute operating time, whichever is greater) for all tests. Do not reuse foam concentrate removed from the tank for repairs or adjustments unless the concentrate manufacturer certifies the removed concentrate is of the same quality as original new concentrate. Following approval of all testing by the Contracting Officer and completion of all "punch list items", replenish the concentrate storage tank with no less than the minimum design quantity shown on the contract, or at least enough to provide 15 minutes of operating time, whichever is greater.

Conduct tests under the supervision of a technical representative employed by the foam concentrate manufacturer. Adjust and test the complete foam concentrate system to assure proper operation. Record test results, including all pressure settings and readings, on an appropriate test form signed and dated by manufacturer's representative certifying that the system is in compliance with contract requirements and the manufacturer's recommended practices. Testing includes, but is not limited to, the following:

a. Filling the foam concentrate tank.

b. Adjustment of proportioners.

c. Collection of foam samples and testing with a conductivity meter to verify proportioning accuracy.

d. Other operational checks recommended by the Hi-Ex proportioner manufacturer.

e. Take readings of high-expansion foam in tanks before and after testing, along with test time, to determine adequacy of tank for 15 minute supply.

3.28.1 ILBP Proportioning System Tests

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NOTE: Army: This paragraph is for Army.

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Flow test the in-line balanced pressure proportioning system (ILBP) to determine that proportioning accuracy is within specified limits. Test the ILBP proportioner at the design flow rate with the overhead sprinkler flow being simulated using the test header. Accomplish foam samples from ILBP in accordance with NFPA 11 and the approved test plan. Determine foam solution concentrations using a refractometer or conductivity measurements and the methods outlined in NFPA 11.

3.28.2 Inductor Tests

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NOTE: Air Force: This paragraph is for Air Force .
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Flow test the inductor to determine that proportioning accuracy is within specified limits. Test the inductor at the design flow rate with the overhead sprinkler flow being simulated using the test header. Accomplish foam samples from inductor in accordance with NFPA 11 and the approved test plan. Determine foam solution concentrations using a refractometer or conductivity measurements and the methods outlined in NFPA 11.

3.29 BREAK-IN PERIOD FOR FACU AND FSCP

Provide a break-in period of at least 14 consecutive days after the FACU and FSCP have been enabled, prior to any formal testing. Provide a written request for a final test from the Fire Protection Specialist, after preliminary testing is complete, adjustments have been made to the system, and the system is ready for service.

3.30 FIRE ALARM, MASS NOTIFICATION AND FOAM RELEASING SYSTEM PRELIMINARY ACCEPTANCE TESTING (PAT) AND FINAL ACCEPTANCE TESTING (FAT)

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NOTE: Perform the testing below on the fire alarm and mass notification system at the same time as testing of the foam releasing system. Coordinate with the specification section on fire alarm and mass notification systems.
****

Operate every feature and function of the FACU and FSCP, including initiating, alarm, and actuation systems.

Conduct these test under the direction of [USACE][NAVFAC] and the fire department. The PAT and FAT must be witnessed by the Contracting Officer's Representative, the fire department, [USACE][NAVFAC], and the fire protection specialist. Additionally, after successful PAT, the AHJ (USACE FPE)(AFCEC FPE), Fire Protection Specialist, and fire protection designer of record, must witness and approve the FAT.

At a minimum, demonstrate operation and supervision of the following functions and devices:

a. All operational and supervisory functions of the control and annunciator panels.

b. Each foam system manual foam releasing station and manual stop stations and associated circuit(s) without foam discharge. For this test, remove the actuating solenoid from the foam system control valve, and place a bolt in it to indicate when it receives power.

c. All optical flame detectors and associated circuits.

d. Each general alarm initiating device (manual pull stations, flow switches, pressure switches, and associated circuit(s).

e. Each supervisory initiating device or function (for instance valve tamper switch, tank level supervisory panels, fire pump controllers) and associated circuit(s).

f. All alarms and associated circuits.

g. All actuator circuits and system control valve(s) (without foam discharge).

h. Activation of the building fire evacuation alarm system.

i. Activation of the installation fire alarm reporting system (receipt of fire alarm, trouble, supervisory signals at receiving station).

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NOTE: Army: The following paragraph is for Army .

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j. j. Automatic and manual operation of the HIGH-EXPANSION FOAM containment system diverter valve. Not Used.

k. Repeat all of the above tests with the system on battery power only.

l. Annunciator lamp and notification appliance. Include bells, horns, electronic signaling, and similar devices.

m. Test of each function of the control panel.

n. Test of each circuit in both trouble and normal modes.

****

NOTE: Coordinate the battery tests below with the specification section on fire alarm and mass notification and adjust accordingly.

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o. Tests of the battery charger and batteries. For this test, use the batteries to operate the fire alarm, mass notification, and foam releasing system, for 72 hours under supervisory conditions. After 48 hours in standby, operate the solenoid at full current draw for 15 minutes. Remove the actuating solenoid from the foam system control valve, and place a bolt in it to indicate when it receives power. Coordinate this testing with Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM.

p. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.

q. Visual inspection of wiring connections.

r. Ground fault testing.

s. Short circuit fault testing.

t. Demonstrate the functionality of the fire alarm system is in compliance with the FACU and FSCP functional matrixes.

u. Verify the proper operation of the Low Level Auto Disable Switch in the FSCP, if provided.

v. Verify whether the foam start and stop stations, associated conduit and back boxes, meet watertight and NEMA 4 requirements to prevent moisture entry.

w. Verify whether power supplies to FSCP panels are provided and identified in accordance with NFPA 72.

x. Verify that wire-nuts are not used in the fire alarm, mass notification, and releasing systems. Perform random checks by opening junction boxes to verify that screw type terminal blocks have been used throughout.

y. Verify that conduit routing for alarm systems are in accordance with NFPA 72 for conduit separation distances for horizontal and vertical runs.

z. Verify that if a valve is installed in the connection between an alarm initiating device intended to signal activation of a fire suppression system, the valve is supervised per NFPA 72. Presence of TS should be noted on Tamper Switch matrix.

aa. 100 percent Circuit Integrity Testing of devices (open, short, ground on 100 percent of devices) will be completed at the PAT (not necessary to repeat at FAT).

3.31 FOAM/WATER FLOW CONTROL VALVE (FCV) FUNCTIONAL TESTING

Foam/Water Flow Control Valve (FCV) functional testing. Operate flow control valves and adjust valve open/closure speed and discharge pressure settings as specified. Demonstrate proper pressure settings and valve operation speed by utilizing the nozzle test/drain assembly at the most remote nozzle to record system pressure and by using the system abort station to stop and restart flow. Seal the pressure regulator, opening speed, and closure speed valves in their final "set" position with safety wire in the same manner as aviation mechanics seal critical fasteners on powerplants. Provide wire seals to prohibit casual movement of valves. Permanently record the final FCV discharge pressure setting on each valve.

3.32 FINAL ACCEPTANCE TESTING WITNESS AND APPROVAL

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NOTE: Air Force: Air Force requires final acceptance testing to be witnesses and approved by a delegated representative of the Air Force Civil Engineer Center, Operations Director (AFCEC/CO

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NOTE: Army: Army requires a Fire Protection Engineer from the Corps of Engineers who is a registered professional engineer who has passed the NCEES test in FPE with relevant experience.

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The Final Acceptance Test (FAT) is a repeat of Preliminary Acceptance Tests

(FAT).

Provide written notification from the Fire Protection Specialist requesting the Final Acceptance Test, at least 14 days prior to date of Final Test, that preliminary tests have been successfully completed. The Contracting Officer will notify immediately the [USACE district fire protection engineer][NAVFAC] and AHJ (USACE FPEAFCEC FPE)and Fire Protection Specialist.

Final testing of the high expansion foam system, optical flame detection system, and fire alarm & mass notification system must be witnessed and approved in writing by a delegated representative of the Air Force Civil Engineer Center, Operations Director (AFCEC/CO). the Army Corps of Engineers Fire Protection Engineer who is a registered professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

Additionally, the manufacturer's representative (including the representatives for fire alarm, releasing, optical flame detection, and foam systems), Fire Protection Specialist, and fire protection designer of record, must witness and approve the FAT.

3.33 PRELIMINARY ACCEPTANCE TESTING (PAT) AND FINAL ACCEPTANCE TESTING (PAT) OF THE OPTICAL FLAME DETECTION SYSTEM

The contractor and optical flame detector manufacturer's representative must conduct pan fire testing under the direction of the fire protection specialist, [USACE][NAVFAC] and the fire department.

Post suitable signs the day prior to and during testing indicating the date and time fire detection testing is to occur.

During testing, disconnect all suppression systems. Deactivate the foam system prior to beginning testing, to prevent accidental discharge. Remove solenoid from the foam/water control valve.

Make corrections to triple IR detectors or controls not responding and repeat tests as necessary. [If the sensitivity of a detector(s) needs to be changed to pass a test, all other tests, and certifications/qualifications for immunity against false alarms, performed up to that time need to be repeated.] Protect the building and installed equipment from possible smoke and/or fire damage.

Demonstrate the performance requirements of the optical flame detector coverage has been met through pan fire acceptance testing.

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NOTE: Air Force: The following paragraph is for Air Force. The Air Force requires the cleaner burning fuel, and test pan, designed by the optical flame detector manufacturer (Det-tronics) to simulate the expected aviation fuel.

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Use a clean burning fuel in a 2 foot x 2 foot test pan, all of which is approved and provided by the optical flame detector manufacturer to simulate the expected fuel.

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NOTE: Army: The following paragraph is for Army . Choose whether to require a cleaner burning fuel such as propane, with the test apparatus and fuel approved by the optical flame detector manufacturer as equivalent to the expected aviation fuel, or whether to use the expected aviation fuel. The cleaner burning fuel will limit smoke and soot, and will allow for easier testing. However, requiring the cleaner burning fuel may increase cost and limit the manufacturers.
****

[Use a clean burning fuel in a 2 foot x 2 foot test pan, all of which is approved and provided by the optical flame detector manufacturer to simulate the expected fuel.] [Use the expected fuel in a 2 foot by 2 foot test pan. Obtain fuel from the Government. Provide a liquid tight welded steel fire pan, with closable lid, and steel sub-frame with rollers/casters to allow for convenient relocation, or equivalent. Pre-heat the fuel oil in the fire pan to its flash point temperature prior to each test, for a rapid full fire development in the pan.]

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NOTE: Army: The following requirement is for Army .
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At a minimum, place the test fire in each designated aircraft parking position (minimum of three).

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NOTE: Air Force: The following requirement is for Air Force.
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Place the test fires at locations provided by AFCEC.

To pass, all detectors within the cone-of-vision of this test fire must activate within 30 seconds of fuel ignition.

Center the test fire 3 m 10 ft. outside the hangar bay opening. To pass, no detectors should active after 30 seconds of full fire development.

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NOTE: Army: The following requirement is for Army .
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Disconnect the signal to the foam concentrate pump and foam jockey pumps.

In addition to the pan fire test, perform the following tests in the hangar bay:

a. Activate each optical flame detector manually (e.g. using a magnet per manufacturer's recommendation) and individually, and confirm that blue beacons are activated, and confirm that a single optical detector does not activate the foam system.

b. Simultaneously manually activate each optical flame detector with each of the other optical flame detectors individually, and confirm that blue beacons are activated, that the disconnected foam/water control valve solenoid is activated, that the start signal is sent to the foam concentrate pump and fire water pump (Army only), and that fire alarm speakers and strobes are turned on via the fire alarm mass notification control panel.

c. Ensure that the following outputs from the triple IR controller are received by the releasing panel, fire alarm control panel, and fire reporting receiving station: triple IR first alarm, triple IR second alarm, and triple IR fault. Confirm that the triple IR bypass switch disables the triple IR system.

****

NOTE: Army: The following requirements to perform welding activities is for Army. Include as appropriate.

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[d. At each aircraft parking location, and one additional location determined by the COR, perform arc welding of plate steel inside the hangar bay, at 125 amps for five minutes, and confirm that the detectors do not activate.

e. Perform welding activities on the facility for a maximum of five minutes, at one location determined by the COR, and confirm there is no feedback through the building ground to the triple IR detection system.]

Provide written documentation of tests and state that the system is fully functional in accordance with all criteria.

Properly dispose of fire testing materials.

3.34 PRELIMINARY ACCEPTANCE TEST (PAT) AND FINAL ACCEPTANCE TEST (FAT) FOR THE HIGH-EXPANSION FOAM SYSTEM

Furnish all high-expansion foam concentrate, instruments, and equipment for testing. Provide concentrate, gauges, sample collection apparatus, instruments, hose, personnel, elevating platforms, scaffolding, ladders, appliances and any other equipment necessary to fulfill testing requirements specified. Make all necessary tests encompassing all aspects of system operation including the following, and correctany deficiency found and retest the system at no cost to the Government.

Provide written documentation of a successful PAT for the optical flame detection, fire alarm, mass notification, and foam releasing system PAT before scheduling the High-Expansion Foam System FAT and state that these systems are fully functional in accordance with all criteria.

Preliminary Acceptance Test reports, including the required video of the Preliminary Acceptance Tests, have been submitted and approved by the Contracting Officer, [USACE district fire protection engineer][NAVFAC] and AHJ (USACE FPEAFCEC FPE), Fire Protection Specialist, and fire protection specialist before scheduling the Final Acceptance Test.

When all of these systems operate to the satisfaction of the system manufacturer's technical representative and the [NAVFAC] [USACE] [AFCEC] Fire Protection Engineer; conduct a full complete discharge test of the each system servicing each separated fire area. Perform the test to demonstrate satisfactory performance, proper high expansion foam concentration,operation of valves, release devices, alarms, and interlocks which control the protected areas. Conduct these tests by experienced personnel according to the equipment and high expansion foam manufacturers' recommendations.

Develop a check list prior to commencing preliminary and final acceptance tests which includes the following:

a. Conduct a safety meeting(s) with attendance required for all witnesses (government and non-government personnel)immediately before the test.

b. Provide a safety plan as described in this specification in the applicable paragraph for conducting test of High-Expansion Foam System (Hi-Ex). Provide a sketch of safe egress path for persons conducting and witnessing the test to exit the building without entering the foam blanket. During the discharge test, no one is permitted on the floor of aircraft servicing area. Persons witnessing the test will be required to view from an elevated position (or equivalent) that does not require them to exit the building through the foam. Ensure that there is adequate egress off the elevated position (or equivalent) which complies with NFPA 101. The foam blanket will reach a level above the average person's height causing spatial and acoustic disorientation possibly resulting in injury. Provide procedures for taking protective measures to avoid damage to life and property during and after the test, as described in the applicable paragraph in this specification section. Obtain approval from the Base Safety Manager, Contracting Officer, and the fire department.

c. Provide a signup sheet with signature mandatory for all witnesses. No person will be permitted in the hangar vicinity during the test who has not signed the signup sheet and also attended the safety meeting.

d. The contractor must have a countdown commencing an adequate time prior to the test, to allow all witnesses to get into position. Announce time points for all witnesses in the hangar vicinity.

e. Provide environmental permits as described in this specification section in the applicable paragraph.

f. Provide a test plan for each day of the test such as Day 1, Day 2.

g. One hundred percent testing will be done during PAT and FAT. Simultaneously conducting more than one test is not permitted. The contractor and foam system manufacturer's representatives must conduct these test under the direction of [USACE][NAVFAC] and the fire department. The PAT and FAT must be witnessed by the Contracting Officer's Representative, the fire department, [USACE][NAVFAC], and the fire protection specialist. Additionally, after successful PAT, the FAT must be witnessed and approved by the personnel stated in the paragraph above.

h. Provide a procedure for each test.

i. Provide blank test data recording form for each test. The attendee-sign-up sheet is separate from test data recording form. Use NFPA forms when available.

j. Provide calibration certificates for each instrument used for testing. Calibrate testing equipment within previous 12 months from the date of testing. The flow tests are invalid without calibration certificates.

k. Obtain and provide test procedures (from the equipment manufacturer and NFPA) for the following equipment:

(1) . Foam System.
(2) . Foam proportioner test.
(3) . Foam System Control Panel (FSCP).

l. Provide names and credentials of manufacturers' representatives who will be conducting the tests.

m. Provide foam tank volume graph indicating volume in gallons corresponding to foam concentrate level in foam tank. This information will be used to calculate concentrate volume required to flow the foam for 15 minutes. The foam tank levels must be checked by foam manufacturer's representative.

n. Measure foam tank level at the beginning and end of the foam test. Calculate concentrate volume required to flow the foam for 15 minutes. The foam tank levels must be checked by foam manufacturer's representative.

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NOTE: Army: The following requirement is for Army .

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o. o. Provide a procedure for simulating maximum sprinkler system demand based on sprinkler hydraulic calculations. Measure the flow using calibrated equipment such as liquid-filled gages and pitot tubes. Prior to the foam test, with the foam system disconnected, simulate the overhead sprinkler system and hose demand (as applicable) through the test header, using fire hose, hose monsters, pitot measurements and liquid filled pressure gages, or equivalent. The overhead foam generators in the hangar should be simultaneously flowing water only. The fire protection specialist must witness the flow simulation. When the test is complete, and before the foam test, clear the hangar floor of any water and allow to dry.

p. o. Not Used.

q. Provide liquid filled test gages at each foam generator and at the foam system riser. This information is used to substantiate the hydraulic calculations and to determine actual flow from each generator. It is recommended that sufficient length of hose or tube is provided to take pressure reading at the floor during water only flow. Alternately, pressure transducers may be used to take readings. Note that there may be difficulty transmitting signals from pressure transducers through the high expansion foam.

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NOTE: Air Force: The following requirement is for Air Force only.

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r. Measure the residual pressure at the most remote generator with only the foam/water system operating. Measure the inlet and outlet pressures of the flow control valve and inductor. A water only test is acceptable. Use this information to verify the hydraulic performance of the system.

****

NOTE: Army: The following requirement is for Army only.

****

s. Measure the residual pressure at the most remote generator with the simultaneous operation of the foam/water system, overhead hangar bay sprinkler system simulation, and exterior hose demand (when applicable). Measure the inlet and outlet pressures of the flow control valve. A water only test is acceptable. Use this information to verify the hydraulic performance of the system.

t. 5. Mark aircraft outline (silhouette) on the floor with bright red tape and 1 meter cones. This is to determine the amount of time required to cover the aircraft silhouette from the activation of manual foam releasing station. Mark the floor with additional colored tape as required to subdivide the aircraft outline into sections to assist in determining the foam coverage percent during the test and review of the video. Ensure that the tape can be readily seen in the video used during the test.

u. Do not exceed 60 seconds for the amount of time required to cover 90 percent of the aircraft silhouette from the activation of manual foam releasing station. No foam is allowed to fall from the foam generators within the projected aircraft silhouette.

v. Mark the walls or place 1 meter cones or posts at or near the walls, and along and within the aircraft silhouette. Ensure that the 1 meter cones do not interfere with the flow of foam. This is needed to determine the amount of time needed to cover the hangar floor to a depth of 1 meter 3 feet.

w. The High-Expansion foam system discharge test is to begin with the fire pump(s) not running.

x. Record the amount of time required to cover the entire floor area with foam to a depth of 1 meter 3 feet which must not exceed 4 minutes. Once the test director indicates the 1 meter depth has been achieved, depress a "Foam Stop" button on a station remote to the activation station used to initiate the discharge. The foam control valve must close no faster than 5 seconds and no more than 15 seconds. Upon release of the "foam stop" button, open the foam/water control valve completely within 5 seconds.

y. Foam Test:

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NOTE: Army: The requirement below, "of the combined system flowing simultaneously (with foam)" is for Army only.

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(1) . Perform foam flow test of the combined system flowing simultaneously (with foam) to verify both one minute criteria and 4 minute criteria.
2. Develop Foam Spread diagrams if not available from the manufacturer.

z. Provide values of design parameters including:

(1) . Design pressure at the base of foam system riser.
(2) . Design pressure at hydraulically most remote foam generator.
(3) . Value of maximum fire water demand.
(4) . Value of maximum foam solution flow.
(5) . Limits of foam solution concentration in accordance with the UL listing of foam and contract requirements.

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NOTE: Air Force: The requirement below is for Air Force only.

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(6) . Design inlet and discharge pressures at the inductor.
(7) . Not Used.

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NOTE: Adjust the requirement below as needed.

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aa. Designate a person to stop the foam test (e.g. by appropriate means such as closing the manual control valve) based on radio communications, etc. when receiving notification that the 1 meter 3 feet depth has been achieved or in case of an emergency. In case of a loss of communication, this person should be given instructions that the foam test should be stopped no later than 4 minutes after the foam test has commenced.

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NOTE: Army: The following requirement is for Army only.

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ab. Sprinkler Flow Test:

(1) . Provide the number of playpipes used for each flow test.
(2) . Indicate GPM per playpipe.
(3) . Indicate pitot pressure for each playpipe.

ac. Not Used

ad. Demonstrate that the foam test header isolation valve is working properly.

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NOTE: Army: The following requirement is for Army only.

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ae. Test the foam proportioner prior to the full foam test at a flow and for a time recommended by the manufacturer. The intent is to ensure that the foam proportioner is performing as intended prior to the full foam test. Repeat this test during the foam test.

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NOTE: Air Force: The requirement below is for Air Force only.

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af. Test the foam inductor prior to the full foam test at a flow and for a time recommended by the manufacturer. The intent is to ensure that the foam inductor is performing as intended prior to the full foam test. Repeat this test during the foam test.

ag. Do not conduct the foam test with standing water on the hangar floor. Provide crews and equipment to remove standing water. The hangar floor must not be wet at the start of the test.

ah. Provide equipment used for the test such as radios, stop watch, foam fill pump, foam to top the foam tank, lifts, ladders, extension pole, smoke generator, manometer, sufficient cameras and tripods.

ai. Designate personnel to witness test readings, and video record (digitally) each test as follows:

(1) . Provide an adequate number of cameras in the hangar area to facilitate complete coverage without panning across the hangar floor. At least one video view will be from a ceiling mounted camera. Use stationary overhead cameras with a full view of the aircraft silhouette during the foam test, to use for later determination of the percent aircraft silhouette coverage at 60 seconds and 1-meter depth in 4 minutes. Cameras must have a full view of the bright red tape on the floor to outline the aircraft silhouette, and additional bright red tape on the floor to subdivide the silhouette into sections. The subdivision will assist in reviewing the video for percent silhouette coverage with foam at 60 seconds.

(2) . Video the tests in disc (or digital)format and record the date and time-lapse, in seconds, from start to finish of each portion of the test as directed by the Contracting Officer. The high-expansion foam (HEF) discharge test will most likely require several cameras for complete documentation. The cameras filming the high-expansion foam discharge on the hangar floor cannot pan. Submit four copies of the disc (or digital) before the system will be considered accepted.

(3) . Sound an air horn or equivalent from the location of the foam start station used to activate the system. Sound this horn when the system is activated. The government will bear witness that the horn is sounded simultaneously with activation of the foam start station, and will note and record any time difference in seconds. The horn must be capable of being heard in the video and by all witnesses throughout the hangar, for time zero determination. This air horn will be used to establish the start time in the video to evaluate the foam coverage of the silhouette in 60 seconds and the foam depth of one meter in four minutes.

(4) . A government witness at the foam start station will radio a government witness in the foam room the exact moment the start station is enabled, so that the government witnesses in the foam room and fire pump room can provide a visible or audible signal for the recording cameras indicating time zero.

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NOTE: Army: The following requirement is for Army only.

****

The government witness in the foam room will record how many seconds after the test start time before the sprinkler test header valve is fully open.

(5) . Provide a camera in foam room and pump house to record gage pressures, fire pump start time, foam water control valve opening time, and the foam water control valve is closed at the end of the test.

****

NOTE: Air Force: The requirement below is for Air Force only.

****

Record gauge pressures at the inlet and outlet of the inductor.

(6) . All cameras must show the elapsed time on the video.

****

NOTE: Army: The following requirement is for Army only.

****

aj. Verify and and record whether a fire pump start signal is provided from the foam system control panel to fire pump and foam pump controllers
ak. Not used.

****

NOTE: Army: The following requirement is for Army only.

****

al. Verify and specifically note that under no circumstances the fire suppression system pressure exceeds 175 psi.
am. Not Used.

an. Verify and specifically note that surge arrestor pre-charge pressure is indicated on surge arresters.

ao. Verify and specifically note that a pressure gage with isolation valve is provided at surge arresters to monitor pressure. Record pressure.

****

NOTE: Army: The following requirement is for Army only.

****

ap. Verify that a tamper switch is provided for foam concentrate shutoff valve. Presence of TS should be noted on Tamper Switch matrix.
aq. 38. Not Used.

ar. Demonstrate the performance criteria for opening and closing the flow control valve is met upon actuation of the manual foam stop stations. A water only test is acceptable.

as. Verify that any and all valves in the system that when closed will disrupt or stop the flow of foam solution, foam concentrate, water, or that will disrupt or prevent an alarm signal or disrupt or prevent the opening of the deluge valves are electronically supervised. Presence of TS should be noted on Tamper Switch matrix.

at. Verify and specifically note that all pipe and conduit penetrations are sealed with listed fire proofing material. Provide catalog cut of fireproofing material.

au. Verify and specifically note that all fire protection pipes, valves, test headers, FDC are labeled and that labels have been adapted to properly indicate flow direction.

av. Provide system restoration and flushing procedure after the completion of acceptance test.

aw. Ensure sufficient quantity of foam is available to top the foam tank at the end of the tests.

ax. Provide a pump for filling the foam tank from the foam drums.

ay. Preliminary Test Report:

(1) . Provide preliminary test report for all fire protection related specification sections with table of contents in a binder for approval prior to scheduling final acceptance test.
(2) . Include copies of all test reports required by the specifications and NFPA codes such as NFPA 11, NFPA 13, NFPA 20, NFPA 24, and NFPA 72.
(3) . Include copies of test procedures for each fire protection related specification section.
(4) . Include copies of forms to record test readings.
(5) . Include copies of credentials of manufacturer's representatives who will actually be present at the site.

az. Final Acceptance Test Plan:

(1) . Please include table of contents.
(2) . Please submit hard copy of Final Acceptance Testing Plan and Procedures, and forms for recording test data in a three ring binder with tabs. This will be very help full during final acceptance test.
(3) . Provide electronic copy of Final Acceptance Testing Plan and Procedures.
(4) . Note that the Final Acceptance Test is a repeat of the Preliminary Acceptance Test, with the exception of hydrostatic tests of aboveground and underground pipe, underground pipe flush, and loop resistance tests.

ba. General:
(1) . Determine the status of each item prior to commencing final acceptance test.
(2) . Take appropriate action to make this a successful test.
(3) . Determine the status of each item after the completion of final acceptance test.

bb. Correct any and all tests which are left as incomplete after the FAT then successfully retest in the presence of the [USACE district fire protection engineer][NAVFAC] and AHJ (USACE FPEAFCEC FPE), Fire Protection Specialist, and fire protection designer of record.

bc. The purpose of the PAT is to ensure that the FAT is conducted flawlessly. It is the contractor's responsibility to perform tests and make repairs to the system until they can conduct a "perfect" PAT completely and without incident or failure. If a failure is noted during any portion of the PAT, correct the item and then repest the entire testing process until it is completed flawlessly from start to finish. Then a successful PAT has been completed. Only after a successful PAT is completed and the report reviewed and accepted by government can a FAT be scheduled.

3.35 POST-DISCHARGE TEST REQUIREMENTS

****

NOTE: Discharge tests using foam solution are necessary in order to verify proportioner accuracy as well as to demonstrate performance of the overall system at final acceptance. The collection and disposal of the solution is often a problem in many areas due to the real and perceived environmental effects of the solution. Thus it is important that the project design or the existing site addresses the need to collect and dispose of the solution. If adequate means are not otherwise available or provided, the responsibility for collection and disposal will have to be placed on the Contractor. This needs to be made clear in the project documents to preclude problems and misunderstandings at time of final testing.

****

Following the successful completion of the tests, completely drain any water or foam water solution between foam system control valves and foam generators. Thus all piping between the foam control deluge valves and foam generators is dry. Remove the foam solution from the site as indicated on the approved foam waste containment and disposal plan. Replenish foam concentrate consumed during the tests. Return the entire fire protection system to automatic operation and restore the facility to operational capability. Contain and dispose discharged solution in a manner acceptable to local authorities and as identified on the approved test plan. Once tests are completed, return systems to fully operational status, including filling of High-Expansion Foam concentrate tanks with concentrate and filling of solution piping with premix as required.

3.36 DISPOSAL PLAN AND PROTECTION

Provide Foam Containment Plan and Procedures. Provide Foam Disposal Plan and Procedures.

3.36.1 Protective Measures

Provide procedures for taking protective measures to avoid damage to property during and after the test protection of property during the Final Acceptance Test.

3.37 PRELIMINARY ACCEPTANCE TEST REPORT

Submit the Preliminary Acceptance Test report, and video recording of the event, to the Contracting Officer Representative, before requesting a Final Acceptance Test. Provide the “Punch List” (list of deficiencies prepared at the completion of preliminary test), and a Final Acceptance Test plan 15 days prior to final acceptance test

3.38 FINAL ACCEPTANCE TEST REPORT AND AS-BUILT DRAWINGS

Provide the Final Acceptance Test Report within 15 days after the completion of the Final Acceptance Test. Provide the final acceptance test report in booklet form showing field tests performed with the digital or videotape of the final test to document compliance with the specified performance criteria. Provide documentation of readings, test results, and indicate the final position of control valves. Include all required Final Acceptance Test NFPA forms. Include the resolution of punch list items developed during preliminary acceptance testing. Submit As-built Drawings

3.39 FLUSHING AND RINSING

After completion of tests flush all piping carrying HIGH-EXPANSION FOAM solution with fresh water. Rinse with fresh water all equipment and building surfaces exposed to HIGH-EXPANSION FOAM discharge.

3.40 POSTED INSTRUCTIONS

Post framed description of system operation, instructions and schematic diagrams of the overall foam system and each subsystem, where directed. Include condensed operating instructions explaining the system for normal operation, refilling the foam storage tank, and routine testing.

Provide instructions for operating the fire extinguishing system at control equipment and at each remote control station. Clearly indicate all necessary steps for the operation of the system. Submit the proposed legend for operating instructions for approval prior to installation. Instructions must be in engraved white letters on red rigid plastic or red enameled steel backgrounds and must be of adequate size to permit them to be easily read.

3.41 TRAINING

Prior to final acceptance, provide two sessions of at least 8 hours each of operation and maintenance training to the installation [Public Works Department][Installation Engineering Activity][Civil Engineering]; [Installation Fire Emergency Service]; [Installation Ground Safety Activity] personnel on two different days to accommodate both shifts of the Installation Fire Emergency Services. Include a walk-through of the facility while describing the operation of the equipment and system, and video of this description for future review by maintenance personnel in each training session. Also include emergency procedures, and demonstrate how to perform all the routine maintenance, and unique maintenance and safety requirements. The contractor or subcontractor (e.g. foam contractor, optical flame detector contractor, fire pump contractor) must demonstrate (on or at the equipment itself), and video for future review by maintenance staff, all the routine maintenance (e.g. weekly, monthly, yearly,) in the equipment manuals and cut sheets, and required by military criteria or NFPA standards. The contractor or subcontractor, during walk thru of the facility, must describe the warning signs of equipment failure, but the contractor is not required to demonstrate how to repair equipment. Training areas will be provided by the Government in the same building as the protected areas. Use operation and maintenance manuals specified in paragraph entitled "Operations and Maintenance Manuals". Coordinate dates and times of the training period through the Contracting Officer not less than two weeks prior to the sessions.

Submit a lessons plan prior to the training, that will outline the scope of the training. Furnish lesson plans, operating instructions, maintenance procedures, and training data in manual format for the training courses. The operations training course must familiarize designated government personnel with proper operation of the fire protection systems. The maintenance training course must provide designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system. Give training sessions for two different work shifts. The schedule of training must be approved by the Contracting Officer. Start training sessions after successful completion of the Final Acceptance Test. Ccover all of the items contained in the approved O&M manual. Film or tape all training sessions and provide to the Government.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-21 21 01 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-21 21 01.00 20 (November 2009)
UFGS-21 21 02.00 20 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 21 - FIRE SUPPRESSION

SECTION 21 21 01

CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS

05/24

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-21 21 01 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-21 21 01.00 20 (November 2009)
UFGS-21 21 02.00 20 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 21 21 01

CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS
05/24

****

NOTE: This guide specification covers the requirements for high-pressure and low-pressure carbon-dioxide fire-extinguishing systems.

Adhere to UFC 1-300-02**: UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS) FORMAT STANDARD when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions, and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Ensure that system requirements conform to UFC 3-600-01**: FIRE PROTECTION ENGINEERING FOR FACILITIES and** NFPA 12**: STANDARD ON CARBON DIOXIDE EXTINGUISHING SYSTEMS. A concerted effort was put forth to ensure that requirements from NFPA 12 were not repeated within this UFGS section. NFPA 12 includes many specific requirements for designing, installing, and operating carbon-dioxide fire-extinguishing systems. Carefully review and comply with the requirements of NFPA 12.**

****

****

NOTE: If the total carbon-dioxide capacity required, including reserves, does not exceed 908

kilograms (kg) 2,000 pounds, design a high-pressure carbon-dioxide fire-extinguishing system.

****

****

NOTE: Do not specify total flooding carbon-dioxide fire-extinguishing systems for use in normally occupied spaces. In other spaces, consider the possibility that personnel could be trapped in an untenable atmosphere created by the discharge or migration of carbon-dioxide. Provide keyed inhibit switches, lockout valves, and audible and visual pre-discharge signals in the design. Provide a sufficient time delay between activation of pre-discharge signals and agent release to allow for evacuation prior to discharge under worst case conditions. Refer to the safety cautions in NFPA 12. If there are questions concerning system design, consult with the Government's Designated (or Service) Fire Protection Engineer (DFPE).

****

****

NOTE: Indicate at least the following on the Contract Drawings:

1. Locations and types of storage tank(s) or cylinders, manual release stations, releasing service fire alarm control units, and associated connections.

2. The arrangement and location of zone selector valves.

****

****

NOTE: Tailoring options are used throughout this Section to differentiate between High Pressure System specific requirements and Low Pressure System specific requirements. To ensure that all applicable requirements are included in the edited Section, select either "HIGH-PRESSURE" or "LOW-PRESSURE" tailoring, as appropriate for the project. Do not leave both options unselected, and do not select both options.

****

****

NOTE: Tailoring options are used throughout this Section to differentiate between Army specific requirements and those requirements applicable to all other entities. To ensure that all applicable requirements are included in the edited Section, select either "ARMY" or "NON-ARMY" tailoring, as appropriate for the project. Do not leave both options unselected, and do not select both options.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2024) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-127	(2014; Rev A) Bracing for Piping Systems: Seismic-Wind-Dynamic Design, Selection, and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing

NFPA 12	(2025) Standard on Carbon Dioxide Extinguishing Systems
NFPA 13	(2024) Standard for the Installation of Sprinkler Systems
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 170	(2024; ERTA 1 2023) Standard for Fire Safety and Emergency Symbols

UL SOLUTIONS (UL)

UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SYSTEM DESCRIPTION

****

NOTE: Identify the rooms, spaces, areas, or pieces of equipment, which are to be protected by each system.

****

****

NOTE: Coordinate with the structural engineer to establish the seismic design category for this project.

****

****

NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.

****

Provide[a] high-pressure[total flooding][local application] carbon-dioxide fire-extinguishing system(s) for protection of [the areas indicated on the Contract Drawings][_____].Provide[a] low-pressure[total flooding][local application] carbon-dioxide fire-extinguishing system(s) for protection of [the areas indicated on the Contract Drawings][_____].[Include protection of areas beneath raised floors in the system design.] Provide piping offsets, fittings, and any other accessories as required to provide a complete and usable system and to eliminate interference with other construction.

Design any portions of the fire-extinguishing system that are not indicated on the Contract Drawings, including but not limited to locating and sizing nozzles, piping, tanks, pressure switches, valves, and equipment. Design any portions of the releasing system that are not indicated on the Contract Drawings, including but not limited to locating initiating devices, notification appliances, inhibit switches, terminal cabinets, raceways, and pathways.[Provide seismic bracing appropriate for the seismic design category and short-period spectral acceleration value applicable to the project.]

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) and edit the following list and corresponding submittal items in the text to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed and approved by the Contractor's Quality Control System, and only submitted to the Government for reference. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Non-Army projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Provide all submittals to the Government, whether for approval or surveillance. Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification require Contractor Quality Control approval and are submitted to the Government for surveillance purposes. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

Supervisor's Qualifications; G, [_____]

Designer's Qualifications; G, [_____]

SD-02 Shop Drawings

Shop Drawings; G, [_____]

SD-03 Product Data

Carbon-Dioxide Supply; G, [_____]

Pipe and Fittings; G, [_____]

Piping Accessories; G, [_____]

Manual Release Stations; G, [_____]

Inhibit Switches; G, [_____]

Discharge Pressure Switches; G, [_____]

Alarm Notification Appliances; G, [_____]

Operating Instructions; G, [_____]

Signs; G, [_____]

SD-05 Design Data

Carbon-Dioxide Supply Calculations; G, [_____]

Pipe and Orifice Sizing Calculations; G, [_____]

Seismic Bracing Calculations; G, [_____]

SD-06 Test Reports

Site Observation Report(s)

Test Procedures; G, [_____]

Request for Formal Inspection and Tests; G, [_____]

Final Test Report; G, [_____]

SD-10 Operation and Maintenance Data

Operation And Maintenance Instructions; G, [_____]

SD-11 Closeout Submittals

Special Tools

Spare Parts Data

Spare Parts

As-Built Drawings; G, [_____]

Recordings

1.4 SUBMITTAL REQUIREMENTS

****

NOTE: Review Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) to ensure specific quantities and formats of submittals are included therein as desired. Coordinate with the DFPE and Contracting Officer on required quantities and formats to be provided.

****

Provide submittals in quantities, formats, and transmission means as dictated by Section 01 33 00 SUBMITTAL PROCEDURES. Draw floor plans to a scale no less than 1:100 1/8 inch equals one foot. Utilize NFPA 170 compliant symbols.

Submit Shop Drawings (SD-02), Product Data (SD-03), and Calculations (SD-05) simultaneously. Submit all Product Data as a single combined package. Partial submittals; SD-02, SD-03, and SD-05 submittals not submitted simultaneously; SD-02, SD-03, and SD-05 submittals submitted prior to SD-01 submittals approval; and submittals not fully complying with the requirements of applicable NFPA standards and this specification; are not acceptable.

1.4.1 Submittal Schedule

Submit all Preconstruction Submittals (SD-01) within [14][_____] days following Notice to Proceed and before any other classification of submittal. Provide submittals for SD-02, SD-03,[SD-04,] and SD-05 no less than [21][_____] days prior to the proposed start of construction on the subject system. Provide other submittals as specified in other paragraphs of this specification.

1.4.2 Shop Drawings

Provide job specific shop drawings reflecting the actual proposed installation conditions for this project. Do not submit the manufacturer's generic system layout plans, details, and diagrams. Provide drawings that are compliant with the Plans section of NFPA 12 and the following. Submit plan views showing system layout, including nozzles, piping, hangers, [seismic separation assemblies, seismic zones of influence, sway bracing,]and carbon-dioxide storage tank(s) or cylinders. Ensure drawings reflect the actual proposed pipe routing as it will be installed in the field. Clearly indicate the location, size, orientation, and type of all valves, pipe size reductions, and pipe fittings. Show an isometric view of the fire-extinguishing system. Show details of each type of hanger[,][and] pipe support[,][and seismic brace] to be provided.

1.4.3 Product Data

****

NOTE: Include the bracketed text when specifying an electric releasing system.

****

Provide manufacturer's product data sheets for each system component to be provided, including at least each item specified herein. Annotate product data sheets to indicate precise equipment that is to be provided, including an indication of all options selected. Submit copies of current listings or approvals for all equipment furnished. Submit listing or approval documentation from a nationally recognized testing laboratory (NRTL) for each piece of equipment showing that such equipment is listed or approved for use in fire protection systems.[Submit listing or approval documentation from a NRTL showing that the proposed releasing solenoid is compatible with the proposed releasing system fire alarm control unit (RSFACU).]

1.4.4 Design Data

1.4.4.1 Supply Calculations

Submit carbon-dioxide supply calculations to substantiate that the provided carbon-dioxide storage capacity is adequate to protect the anticipated hazard(s). Ensure calculations consider residual carbon-dioxide that will be left in the supply piping, capacity for uncloseable openings, and sufficient redundant capacity as required herein.

1.4.4.2 Pipe and Orifice Size Calculations

Submit pipe and orifice size calculations to substantiate that the carbon-dioxide fire-extinguishing system piping and discharge orifices are sized appropriately to protect the anticipated hazard within the required period of time.[Use system manufacturer provided sizing software or provide manufacturer supplied calculations.]

1.4.4.3 Seismic Bracing Design

****

NOTE: Coordinate with the geotechnical and structural engineers to establish the seismic design category and Ss value to include in this specification.

****

[Prepare seismic bracing calculations and details as described in NFPA 13. The seismic design information applicable to this project includes: design category ["_____"], Ss=[_____g].][The seismic design category applicable to this project is design category ["_____"], and seismic bracing is not required.]

1.4.5 Test Reports

Submit reports for inspections and tests specified under paragraphs titled "FIELD QUALITY CONTROL". Submit test reports in booklet form showing field tests performed to prove compliance with the specified performance criteria upon completion and testing of the installed system. Document readings, test results, and the final position of controls on each test report.

1.4.6 Operation and Maintenance Instructions

****

NOTE: Edit brackets based on whether hard copy manuals (first bracketed options) or electronic only manuals (second bracketed options) will be provided.

****

Submit the Operation and Maintenance Instructions indexed and in booklet form as a single[volume][file] or in separate[volumes][files]. Inscribe the following identification on the[cover][cover sheet]: the words "CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEM OPERATION AND MAINTENANCE MANUAL", the name of the building, the number of the building, the name of the Installer, the name of the system manufacturer, and the Contract number. Provide instructions that are legible and easily read, with full size drawings[folded in][included].

Provide submittals for SD-10 at least [21][_____] days prior to the proposed start of training. Do not provide training prior to approval of SD-10 submittals. Include at least the following in the Operation and Maintenance Instructions:

a. "Data Package Five" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Routine maintenance checklist arranged in a columnar format. List all installed components in the first column, state the maintenance activity or state no maintenance required in the second column, state the frequency of the maintenance activity in the third column, and provide a fourth column for additional comments or reference.

1.4.7 As-Built Drawings

Show the system as installed, including deviations from both the Contract Drawings and the approved shop drawings. Ensure the accuracy of the as-built drawings is plus or minus 150 millimeters (mm) 6 inches for all discharge orifices and equipment locations, and plus or minus 300 mm 12 inches for all piping. Maintain redlined as-built mark-ups throughout the duration of construction and incorporate these mark-ups into the native drawing files for the final As-Built Drawings Submittal.

Prepare the drawings in the same format, size, and layout as the approved shop drawings.

1.5 SPECIAL TOOLS AND SPARE PARTS

Furnish special tools necessary for the maintenance of the equipment. Submit spare parts data for each different item of material and equipment specified, after approval of shop drawings, and not later than [60][_____] days prior to the anticipated date of beneficial occupancy. Include a complete list of parts and supplies with the current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [one][_____] year[s] of service.

Furnish the following spare parts:

****

NOTE: Edit this list as desired by the contracting organization. Generally, spare parts are discouraged by UFC 1-300-02: UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS) FORMAT STANDARD, but some hard to replace or easily lost items may be warranted for inclusion.

****

a. [_____]

b. [_____]

1.6 QUALITY ASSURANCE

1.6.1 Materials

Provide all labor, material, tools, and equipment necessary for and incidental to a complete and usable carbon-dioxide fire-extinguishing system.

****

NOTE: For OCONUS projects, use the blank brackets to insert local certification organizations that are considered equivalent to United States (U.S.) Nationally Recognized Testing Laboratories (NRTLs) for your project.

****

Ensure all devices, appliances, and equipment for fire protection service are listed or approved by [UL Fire Prot Dir, FM APP GUIDE, or another NRTL acceptable to the Government's Designated (or Service) Fire Protection Engineer (DFPE)][_____] for the intended use. For components that must function together to form a system, ensure they are listed or approved by the same NRTL.

1.6.2 Codes, Standards, and Manufacturer's Literature

Provide the system in accordance with NFPA 12, NFPA 70, NFPA 72, NFPA 90A, and as specified herein. Interpret reference to "authority having jurisdiction" to mean the Contracting Officer.

Follow all recommended installation and start-up practices stated in the manufacturer's literature or documentation.

1.6.3 Qualifications

****

NOTE: Section 01 45 00 QUALITY CONTROL includes requirements related to the Fire Protection Quality Control Specialist (FPQC). Edit that Section as necessary to refine the requirements for the FPQC to the project. Coordinate with the DFPE to ensure edits meet their expectations. The intent is for the FPQC defined in the 01 45 00 QUALITY CONTROL Section to provide the review and oversight required by UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES. Only include the requirements related to that FPQC in the 01 45 00 QUALITY CONTROL Section; do not include them in this Section. The tailoring applied to all mentions of a Qualified Fire Protection Engineer (QFPE) in this Section is intentional. A QFPE, as discussed in this Section, is only required for Army projects and is in addition to the FPQC required by the 01 45 00 QUALITY CONTROL Section. The QFPE specified in this Section for Army projects is not permitted to also fulfill the role of FPQC as specified in the 01 45 00 QUALITY CONTROL Section.

****

1.6.3.1 Qualified Fire Protection Engineer (QFPE)

Provide the services of a Qualified Fire Protection Engineer (QFPE). A QFPE is an individual who is a licensed Professional Engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Ensure that the QFPE is an integral part of the construction team and is involved in every aspect of the system's submittals, installation, and testing. Ensure that the QFPE does not also serve as the Fire Protection Quality Control Specialist (FPQC) as defined by Section 01 45 00 QUALITY CONTROL. Submit the Qualified Fire Protection Engineer's Qualifications, including the name and documentation of qualifications of the proposed QFPE.

Ensure the QFPE:

****

NOTE: UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES requires that shop drawings, calculations, and material data sheets bear the Professional Engineer seal and signature of the QFPE prior to submission to the FPQC for approval.

****

a. Prepares, or directly supervises preparation of, construction (shop) drawings and calculations.

b. Reviews all required shop drawings, material data, calculations, qualifications, test procedures, test reports, as-built drawings, and O&M manuals for completeness and compliance with the provisions of this Contract prior to submitting them to the FPQC.

c. Affixes his or her Professional Engineer seal with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting them to the FPQC.

d. Performs in-progress construction surveillance prior to installation of ceilings (rough-in inspection)[or closure of trenches]. Performs at least [one][_____] interim site observation visit[s] prior to completion of installation, separate from the preliminary testing, to confirm that all systems are being installed in accordance with the Contract.

e. Witnesses and approves all preliminary and final functional performance testing and performs a final installation review.

f. Signs applicable certificates under SD-07.

1.6.3.2 Installer

Provide an Installer that is regularly engaged in the installation of the type and complexity of system specified herein. Submit the Installer's Qualifications including written certificate demonstrating that the carbon-dioxide fire-extinguishing system Installer has been regularly engaged in the installation of such systems meeting NFPA standards for a minimum of three years immediately preceding commencement of this Contract. Include proof of satisfactory performance on at least three projects similar to that required by these specifications, including the names and telephone numbers of using agency points of contact for each of these projects. Indicate the type of each system installed and include a written certification that each system has performed satisfactorily in the manner specified for a period of not less than 18 months following completion. Ensure Installer is able to provide service within 24 hours.

1.6.3.3 Supervisor

Provide the services of a qualified technician, factory trained, certified, and experienced in the installation and operation of the type of system being provided to supervise the installation, adjustment, preliminary testing and final testing of the system, and to provide instruction to Government operating and maintenance personnel.

Submit the Supervisor's Qualifications including name(s) of the Supervisor(s) who will oversee installation and testing of the system, and who will provide instruction to Government personnel, along with the manufacturer's certification of the qualifications of the proposed Supervisor(s).

1.6.3.4 Designer

****

NOTE: Tailoring options are included in this paragraph to differentiate between the duties of the Designer under Army projects versus Non-Army projects.

****

****

NOTE: UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES specifically requires that the Designer be certified by the National Institute for Certification in Engineering Technology (NICET). In order for a Designer holding a certification from another entity to be considered acceptable, they must request an equivalency be approved by the Component Fire Protection Engineer (CFPE).

****

Prepare shop drawings, product data, design data, O&M manual(s), and as-built drawings by, or under the direct supervision of, the Designer. Ensure that the Designer is an individual who is experienced with the types of work specified herein and is currently certified by the National Institute for Certification in Engineering Technologies (NICET) as an engineering technician with Level IV certification in Special Hazards Systems. Submit the Designer's Qualifications including the name and documentation of certification of the proposed Designer.

Ensure that the Designer:

a. Reviews all required shop drawings, material data, calculations, qualifications, test procedures, test reports, as-built drawings, and O&M manuals for completeness and compliance with the provisions of the Contract prior to submitting them to the FPQC.

b. Performs in-progress construction surveillance prior to installation of ceilings (rough-in inspection)[or closure of trenches]. Performs at least [one][_____] interim site observation visit[s] prior to completion of installation, separate from the preliminary testing, to confirm that all systems are being installed in accordance with the Contract.

c. Witnesses and approves all preliminary and final functional performance testing and performs a final installation review.

d. Signs applicable certificates under SD-07.

[1.7 EXISTING CONDITIONS

****

NOTE: Include this paragraph if adding onto or modifying an existing system.

****

Provide new equipment that is compatible with the existing system, manufactured by [_____]. Ensure that new equipment does not negatively impact existing system operations or reliability.

]PART 2 PRODUCTS

2.1 DESIGN CRITERIA

****

NOTE: Ensure that no suffocation hazard will exist in any rooms with underfloor total flooding systems or within any space to which the carbon-dioxide might migrate after discharge. Consult with the DFPE if in doubt.

****

****

NOTE: It is critically important that the design engineer take into account the potential pressure changes within the protected space upon carbon-dioxide release. Coordinate with the architect, structural engineer, and mechanical engineer to ensure that proper venting is provided to avoid overpressurization of the protected space.

****

Design the system in accordance with NFPA 12, except as modified herein.

****

NOTE: Include applicable paragraphs based on the type of system being provided.

****

[2.1.1 Underfloor Total Flooding Systems

****

NOTE: If there is more than one underfloor area (separated from other underfloor areas by essentially gas-tight partitions) which require protection, list them as separate areas and delineate each area by reference to room numbers, space designations, or zones. Show such zones on the Contract Drawings.

****

****

NOTE: Calculate the flooding factor and design concentration in accordance with NFPA 12. Whenever possible, provide for automatic closing of openings and shutting down of ventilation systems prior to start of gas discharge. When this cannot be done, identify the size of openings and capacity of ventilation systems and adjust the gas quantity accordingly.

****

Provide uniform discharge to each protected space to achieve a flooding factor of [_____] grams (g) [_____] pounds of carbon-dioxide for each cubic meter cubic foot of protected volume in one minute, in order to produce a minimum design carbon-dioxide concentration of [50][34][_____] percent. Provide a minimum supply of carbon-dioxide of [_____] grams [_____] pounds.[Provide additional carbon-dioxide discharge as required by NFPA 12 to compensate for[[_____] square centimeterssquare feet of openings that cannot be closed][,][and][[_____] cubic centimeters per minutecubic feet per minute of ventilating systems that cannot be shut down][,][and][[high][low] ambient temperatures of [_____] degrees Celsius (C) Fahrenheit (F)].] Ensure the protected space, carbon-dioxide system(s), and supply of carbon-dioxide are configured to maintain the required carbon-dioxide design concentration for the minimum hold time of [10][20][_____] minutes.

Supply each protected space with carbon-dioxide through a selector valve from the storage tank(s) or cylinders, so that activation of the system in one space does not cause discharge of carbon-dioxide into another space.

][2.1.2 Room Total Flooding Systems

****

NOTE: Calculate the flooding factor and design concentration in accordance with NFPA 12. Whenever possible, provide for automatic closing of openings and shutting down of ventilation systems prior to start of gas discharge. When this cannot be done, identify the size of openings and capacity of ventilation systems and adjust the gas quantity accordingly.

****

Provide uniform discharge to each protected space to achieve a flooding factor of [_____] grams [_____] pounds of carbon-dioxide for each cubic meter cubic foot of protected volume in one minute, in order to produce a minimum design carbon-dioxide concentration of [34][_____] percent. Provide a minimum supply of carbon-dioxide of [_____] grams [_____] pounds.[Provide additional carbon-dioxide discharge as required by NFPA 12 to compensate for[[_____] square centimeterssquare feet of openings that cannot be closed][,][and][[_____] cubic centimeters per minutecubic feet per minute of ventilating systems that cannot be shut down][,][and][[high][low] ambient temperatures of [_____] degrees C F].] Ensure the protected space, carbon-dioxide system(s), and supply of carbon-dioxide are configured to maintain the required carbon-dioxide design concentration for the minimum hold time of [10][20][_____] minutes.

][2.1.3 Local Application Systems

****

NOTE: Use this paragraph for dip tanks, quench

tanks, and similar hazards that cannot be totally flooded because they are not enclosable. Follow NFPA 12 for design requirements.

****

Provide local application of carbon-dioxide for the protection of [_____]. Calculate the quantity of carbon-dioxide required for local application in accordance with NFPA 12. Base calculations on the total rate of discharge needed to blanket the[area][or][volume] protected, and the time that discharge must be maintained to ensure complete extinguishment. Ensure the minimum discharge time is[30 seconds][[_____] minute[s]]. Base calculations on the[rate-by-area method for flat surfaces][and][rate-by-volume method for three-dimensional hazards].

]2.2 CARBON-DIOXIDE SUPPLY

****

NOTE: Calculate the anticipated size of tank(s) or number of cylinders to determine the area required for installation and coordinate required clearances and structural support with other disciplines.

****

****

NOTE: Edit the specification to include the requirement to provide 100 percent reserve supply unless otherwise directed by the DFPE.

****

****

NOTE: Odorizer is an optional component that should be considered for use especially when personnel may be exposed to leaking or migrating carbon-dioxide.

****

****

NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.

****

Provide a low-pressure (2068 kilopascal (kPa)300 pounds per square inch (psi)), refrigerated, carbon-dioxide storage tank, complete with a full charge of carbon-dioxide, a liquid level indicator, and other necessary components and appurtenances.[Provide liquid level gauge capable of being monitored by the RSFACU to indicate a low carbon-dioxide supply condition.] Calculate the size of tank to include sufficient carbon-dioxide for the hazard requiring the largest volume of carbon-dioxide[plus 100 percent reserve supply]. In the event this calculated amount falls between available sizes of tanks, provide the next largest tank. Provide carbon-dioxide supply calculations to validate the size of tank selected. Supply[all][underfloor total flooding][,][and][room total flooding][,][and][local application] systems from this tank. Provide high-pressure carbon-dioxide storage cylinders complete with a full charge of carbon-dioxide, racks, manifolds, beam scales, and necessary components and appurtenances. Provide [34][45][23][_____] kilogram (kg) [75][100][50][_____] pound cylinders. Calculate the quantity of cylinders to include sufficient carbon-dioxide for the hazard requiring the largest volume of carbon-dioxide[plus 100 percent reserve supply]. In the event this calculated amount results in a partial cylinder, round the quantity of cylinders required up to the next highest whole number. Provide carbon-dioxide supply calculations to validate the number of cylinders selected. Supply[all][underfloor total flooding][,][and][room total flooding][,][and][local application] systems from these cylinders. Arrange cylinders to differentiate between primary and reserve cylinder banks.

[2.2.1 Odorizer

Provide a pressure actuated wintergreen odorizer assembly on each system.

]2.3 PIPE AND FITTINGS

2.3.1 Layout

Do not locate carbon-dioxide piping in any area where a pipe break or leak could make a normally occupied area untenable. Provide pipe and orifice sizing calculations to validate the system design.

2.3.2 Pipe

****

NOTE: If the system is being installed in a highly corrosive atmosphere, consider specifying the use of stainless steel piping in lieu of black or galvanized steel as described below. Consult with the DFPE regarding the appropriateness of specifying stainless steel due to the significantly higher cost of materials.

****

****

NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.

****

Provide[ASTM A53/A53M, Type E or Type S, Grade A or Grade B,][or][ASTM A106/A106M, Grade A, Grade B, or Grade C,][black][or][galvanized] steel pipe. Ensure pipe nipples 150 mm 6 inches long and shorter are Schedule 80 or stronger steel pipe.

Comply with the manufacturer's written installation instructions or the following, whichever is more stringent. For piping under continuous pressure, provide Schedule 80 or stronger pipe. For piping not under continuous pressure, provide Schedule 40 or stronger pipe.Comply with the manufacturer's written installation instructions or the following, whichever is more stringent. Provide Schedule 40 or stronger pipe for sizes 20 mm 0.75 inch and smaller. Provide Schedule 80 or stronger pipe for sizes 25 mm one inch through 100 mm 4 inch. Calculate the required minimum pipe strength in accordance with ASME B31.1 for all other sizes of pipe.

2.3.3 Fittings

Provide fittings of the type and class required by NFPA 12. Provide tapered-reducing pipe fittings for changes in piping size; do not use bushings.

2.3.4 Lockout Valves

Provide each zone with a manually operated lockout valve that includes positive visual indication of valve position.[Equip each lockout valve with a status switch capable of reporting the valve's position to the

RSFACU.]

2.3.5 Discharge Orifices

Provide discharge orifices in accordance with NFPA 12.

2.4 PIPING ACCESSORIES

2.4.1 Escutcheon Plates

Provide one piece or split hinge type metal plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces. Securely anchor plates in place with setscrews or other approved positive means.

2.4.2 Pipe Sleeves

Provide pipe sleeves where piping passes entirely through walls, ceilings, roofs, and floors. Provide sleeves of sufficient length to pass through the entire thickness of walls, ceilings, roofs, and floors.

a. Sleeves in Masonry and Concrete: Provide hot-dipped galvanized steel, ductile-iron, or cast iron sleeves at walls, ceilings, roofs, and floors. Core-drilling of masonry and concrete may be provided in lieu of sleeves as long as cavities in the core-drilled holes are completely grouted smooth.

b. Sleeves in Other Than Masonry and Concrete: Provide 551 micrometer (µm) 26 gage galvanized steel sheets.

Secure sleeves in proper position and location. Provide 25 mm one inch minimum clearance between exterior of piping and interior of sleeve or core-drilled hole. Firmly pack annular space with mineral wool insulation and seal both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide mechanically adjustable segmented elastomeric seal. Protect penetrations of fire resistance rated construction with listed firestopping assemblies.

2.4.3 Pipe Hangers and Supports

****

NOTE: Specify MSS SP-58 for projects where seismic qualification is not required. Specify MSS SP-127 for projects where seismic qualification is required.

****

Provide[MSS SP-58][MSS SP-127] compliant, Type 1 pipe hangers and supports, with adjustable type steel support rods, except as modified herein or indicated otherwise on the Contract Drawings. Attach to steel joists with Type[19][or][23] clamps and retaining straps. Attach to steel W or S beams with Type[21][,][or][28][,][or][29][,][or][30] clamps. Attach to steel angles and vertical web steel channels with Type 20 clamps with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor.[Provide seismic bracing calculations to validate seismic bracing designs.]

2.4.4 Pressure Relief Device

****
NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.
****

Provide each section of closed piping with a pressure relief device designed to operate at 3102 kPa 450 psi.Provide each section of closed piping with a pressure relief device designed to operate at no less than 16500 kPa 2,400 psi and no more than 20700 kPa 3,000 psi.

2.5 SYSTEM CONTROL

****
NOTE: The Fire Protection Engineering Design Working Group (FPE DWG) has evaluated the impact of inserting almost all of the requirements from Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE into this Section in order to keep the releasing service fire alarm system requirements included in the same section as the rest of the carbon-dioxide fire-extinguishing system requirements. They determined that this approach is undesirable, and have provided direction to use Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE as the base specification for the releasing service fire alarm system associated with the carbon-dioxide fire-extinguishing system. Eventually, the FPE DWG intends to develop a dedicated specification section for releasing service fire alarm systems. Until such a section is created, edit Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE to cover the releasing service fire alarm system requirements associated with this project (if applicable).
****
****
NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.
****

Provide apparatus, accessories, components, and associated materials specified or required. Provide[an][a][automatic][and][manual][combination][electric][and][pneumatic][and][mechanical] type actuating control system complete and ready for operation.[For electrically actuated systems, provide complete "Class B" electrical supervision. Achieve automatic actuation by[smoke][and][or][heat] detectors.][For electrically actuated systems, provide main and reserve switch. Configure switch to select between main and reserve carbon-dioxide supplies, located adjacent to the cylinder bank or at the control panel. Provide complete "Class B" electrical supervision. Achieve automatic actuation by[smoke][and][or][heat] detectors.][

Provide the releasing service fire alarm system in accordance with Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, as supplemented by this

Section.]

2.5.1 Manual Release Stations

****

NOTE: Locate stations at or near exits from the protected areas. Provide separate stations for each hazard.

****

Provide manual release stations for[underfloor total flooding][,][and][room total flooding][,][and][local application] systems. Provide dual action manual release stations that do not incorporate break-glass elements. Ensure manual release stations include language clearly indicating the intended use and are clearly distinguishable as different from fire alarm system manual pull stations in the building.

2.5.2 Sequence of Operation

****

NOTE: If system is electrically actuated, include the sequence of operations requirements within Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, and select the first bracketed text in this paragraph unless specifically directed otherwise by the DFPE. If the system is pneumatically or mechanically actuated, select the second bracketed text in this paragraph.

****

****

NOTE: Generally, a discharge time of one minute is appropriate for underfloor and room total flooding applications. A discharge time of 30 seconds may be appropriate for a local application system. Edit the discharge duration to match the hazard being protected.

****

2.5.2.1 General

[Refer to Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, for sequence of operations.][Configure the system such that upon activation of a manual release station, the system immediately activates discharge notification appliances in the protected areas; signals the building fire alarm control unit to activate the building fire evacuation alarms; sends a signal to the supervising station[via the building fire alarm control unit's connection to the Installation fire alarm reporting system]; shuts down[computer][,][and][air handling][,][and][_____] equipment; closes dampers[,][and][doors][,][and][windows]; and initiates an adjustable zero to 60 second discharge time delay. Configure the system such that upon expiration of the discharge time delay, carbon-dioxide flows from the storage tank(s) or cylinders, through the selector valve associated with the zone protected by the activated manual release station, and discharges into the protected space for a period of[one minute][30 seconds][[_____] minute(s)], and activates the post-discharge notification appliances.

[Configure the system such that upon activation of the emergency manual discharge lever on the tank or cylinder the system immediately activates post-discharge notification appliances in the protected areas; signals the building fire alarm control unit to activate the building fire evacuation alarms; sends a signal to the supervising station[via the building fire alarm control unit's connection to the Installation fire alarm reporting system]; shuts down[computer][,][and][air handling][,][and][_____] equipment; closes dampers[,][and][doors][,][and][windows]; and initiates carbon-dioxide discharge into the protected area.]

][2.5.2.2 Pressure-Switch Operation

****

NOTE: Only include this paragraph if the system is pneumatically or mechanically actuated and equipped with a discharge pressure switch.

****

Provide a pressure-switch to initiate the following functions upon discharge of carbon-dioxide if not already initiated: activate post-discharge notification appliances in the protected areas; signal the building fire alarm control unit to activate the building fire evacuation alarms; send a signal to the supervising station[via the building fire alarm control unit's connection to the Installation fire alarm reporting system]; shut down[computer][,][and][air handling][,][and][_____] equipment; and close dampers[,][and][doors][,][and][windows].

][2.5.3 Inhibit Switches

****

NOTE: Include this paragraph only when electrical actuation is specified.

****

Provide one switch per zone. Arrange the switch such that activation physically disables carbon-dioxide release by breaking the releasing circuit. Ensure that the switch requires a key to operate, and supervise with the RSFACU such that operation of the switch causes a supervisory signal to be transmitted to the supervising station[via the building fire alarm control unit's connection to the Installation fire alarm reporting system].

][2.5.4 Discharge Pressure Switches

****

NOTE: Include this paragraph only when a discharge pressure switch is to be provided. If the carbon-dioxide fire-extinguishing system is electrically actuated, monitor the discharge pressure switch with the RSFACU. If the carbon-dioxide fire-extinguishing system is pneumatically or mechanically actuated, monitor the discharge pressure switch with the building's fire alarm control unit.

****

Provide each system with a discharge pressure switch monitored by the[RSFACU][building's fire alarm control unit]. Ensure that the pressure switch supervises the pressure in the piping downstream of the releasing solenoid such that it is activated when gas is discharged. Provide switch with two sets of single-pole double-throw (SPDT) form-C contacts capable of connection to 24 VDC and [100-120][200-240] VAC outputs. Ensure the switch has screw terminal connections and is capable of being wired for a normally open or normally closed circuit.

]2.5.5 Alarm Notification Appliances

****

NOTE: If the carbon-dioxide fire-extinguishing system is electrically actuated, power and supervise the notification appliances from the releasing service fire alarm system. If the carbon-dioxide fire-extinguishing system is pneumatically or mechanically actuated, power and supervise the notification appliances from the building's fire alarm system.

****

Provide each protected area with audible and visual alarms located[to provide public mode notification in accordance with NFPA 72][as shown on the Contract Drawings]. Electrically supervise all alarm circuits with the[RSFACU][building's fire alarm control unit]. Power notification appliances from the[releasing service fire alarm system][building's fire alarm system]. Provide separate and distinct audible and visual pre-discharge, discharge, and post-discharge signals. Where the building is equipped with a separate fire evacuation alarm system, ensure that the discharge signals are also distinct from those used by the building fire evacuation system. Provide each notification appliance with a rigid plastic or metal identification sign with lettering a minimum of 40 mm 1.5 inches high. Label the pre-discharge alarms with the word "FIRE". Label the discharge alarms with the words "CARBON-DIOXIDE DISCHARGE". Locate the post-discharge alarms outside entrances to protected areas and provide them with warning signs reading "CARBON-DIOXIDE DISCHARGED WHEN FLASHING - DO NOT ENTER".

2.5.5.1 Alarm Horns

****

NOTE: Select the horn output patterns included below unless they conflict with the building's fire evacuation system horn pattern. If they conflict with the building's fire evacuation horn pattern, consult with the DFPE to determine the appropriate horn patterns to specify.

****

Provide[surface mounted,][recessed,] 24 VDC, red, vibrating type, alarm horns suitable for use in an electrically supervised circuit that produce a sound output of at least 90 decibels at 3 meters 10 feet. Configure pre-discharge horns to produce a march-time horn pattern, and configure discharge and post-discharge horns to produce a high-low horn pattern.

2.5.5.2 Visual Alarms

Provide[surface][flush] mounted, 24 VDC, visual alarms suitable for use in an electrically supervised circuit. Ensure visual alarm appliances are the flashing stroboscopic type. Select strobe candela rating in accordance with NFPA 72 criteria for the given space, taking into consideration any de-rating required for the colored lens. Ensure flash rate is between 60 and 120 flashes per minute. Provide visual alarm appliances with a colored thermoplastic lens, red for pre-discharge alarms and blue for discharge and post-discharge alarms. Visual alarms may be part of an audio-visual alarm assembly. Where more than two stroboscopic type appliances are located in the same field of view, provide synchronized operation.

[2.6 AUTOMATIC FIRE-SMOKE DAMPERS

****

NOTE: It is imperative that close coordination occur between the fire protection engineer and the mechanical engineer to ensure that requirements for dampers are coordinated between disciplines and specification sections are aligned.

****

****

NOTE: Ensure that the mechanical design for the project includes a detail of the fire-smoke dampers, addresses heating, ventilation, and air conditioning unit shut down (if applicable), and clearly differentiates between the locations of fire dampers and of fire-smoke dampers controlled as a part of the fire-extinguishing system sequence of operations on the Contract Drawings.

****

****

NOTE: If the carbon-dioxide fire-extinguishing system is electrically actuated, power, control, and monitor the dampers from the releasing service fire alarm system. If the carbon-dioxide fire-extinguishing system is pneumatically or mechanically actuated, power, control, and monitor the dampers from the building's fire alarm system.

****

Provide automatic control of fire-smoke dampers in openings and ductwork penetrating the envelope of the protected area. Dampers are specified in Section [23 30 00 HVAC AIR DISTRIBUTION][_____], as supplemented below. Ensure that dampers close in sequence as specified in the paragraph entitled "Sequence of Operation".

2.6.1 Power

Provide automatic fire-smoke dampers that operate on 24 VDC. Power each automatic fire-smoke damper with the[RSFACU][building's fire alarm control unit].

2.6.2 Control

Control each automatic fire-smoke damper with the[RSFACU][building's fire alarm control unit]. Do not rely on the heating, ventilation, and air conditioning system controls system to control these dampers in a fire event.

2.6.3 Monitoring

Monitor the position of each automatic fire-smoke damper with the[RSFACU][building's fire alarm control unit]. Provide each damper with two sets of factory installed SPDT (Form C) switches for use in monitoring the position of the damper. Ensure one set of switches changes state to indicate when the damper is fully open and the other set of switches changes state to indicate when the damper is fully closed.

2.6.4 Fail-Safe

Ensure automatic fire-smoke dampers are configured to close upon loss of power.

][2.7 SMOKE AND CARBON-DIOXIDE EXHAUST SYSTEM

****

NOTE: It is imperative that close coordination occur between the fire protection engineer and the mechanical engineer to ensure that requirements for the smoke and carbon-dioxide exhaust system are coordinated between disciplines and specification sections are aligned.

****

Provide under Section [23 30 00 HVAC AIR DISTRIBUTION][_____] and as specified herein. Provide a key-operated ON-OFF switch with red and green indicator lights for control of exhaust fans from each protected space. Ensure the green light remains illuminated when the exhaust system is in standby status. Ensure that green light extinguishes and red light illuminates when the system is operating. Provide an interlock from the carbon-dioxide system to prevent operation of the exhaust system during carbon-dioxide system discharge and for a minimum of [10][20][_____] minutes after carbon-dioxide discharge. Configure the system such that the exhaust system is operable by key switch [10][20][_____] minutes after carbon-dioxide discharge, even if smoke detectors are still in alarm mode. Locate switch(es) outside of the protected space(s).

]2.8 OPERATING INSTRUCTIONS

Provide operating instructions at each manual release station and at the emergency manual actuation lever. Ensure that the instructions clearly indicate the steps for system operation. Submit a graphical representation of the proposed operating instructions as a part of the shop drawings or product data submittals. Provide instructions that incorporate raised or embossed white letters on red rigid plastic or enameled steel backgrounds. Ensure that lettering is a minimum of 6 mm 0.25 inch high.

2.9 SIGNS

Provide signs in accordance with NFPA 12.

PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

Become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of discrepancies before performing the work.

[3.2 CONTINUITY OF PROTECTION

During installation of the system, ensure there is no loss of function of the existing building carbon-dioxide fire-extinguishing system. Temporary interruption in operability of the existing system, not to exceed eight hours in duration, may be permitted at the discretion of the Contracting

Officer.

]3.3 INSTALLATION

Provide equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing in accordance with NFPA 12, NFPA 70, NFPA 72, and NFPA 90A, except as modified herein. Install piping straight and true to bear evenly on hangers and supports. Keep the interior and ends of new piping[and existing piping affected by the Contractor's operations] thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter. Inspect piping before placing into position.

3.3.1 Electrical

****

NOTE: Include the first bracketed text if the carbon-dioxide fire-extinguishing system is electrically actuated. Include the second bracketed text if the carbon-dioxide fire-extinguishing system is pneumatically or mechanically actuated.

****

Provide electrical work associated with this Section in accordance with NFPA 70 and as specified under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM[and Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE].[Provide electrical work associated with connections to the building's fire alarm system under Section[28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE].] Provide wiring in rigid metal conduit or intermediate metal conduit, except electrical metallic tubing may be provided in dry locations not enclosed in concrete and where not subject to mechanical damage.

3.3.2 Manual Release Stations

Provide manual release stations [at the principal exits from each protected space][and][where shown on the Contract Drawings][_____]. For systems that are mechanically or pneumatically activated, provide a separate station for main supply and for reserve supply of carbon-dioxide at each location. For electrically activated systems, provide one station at each location. Mark each station to indicate its function.

3.3.3 Pipe and Fittings

Test, inspect, and approve piping before concealing. Provide fittings for direction changes in piping and for connections. Provide polytetrafluoroethylene (PTFE) pipe thread tape, pipe cement and oil, or PTFE powder and oil for pipe jointing compound; apply only to male threads. Provide exposed ferrous pipe threads with one coat of zinc molybdate primer applied to a minimum dry film thickness of 25 µm one mil.

3.3.4 Pipe Hangers and Supports

Provide additional supports for the concentrated loads in piping between hangers and supports, such as for valves. Support steel piping as follows:

Nominal Pipe Size (mm)	25 and Under	32	40	50	65	80	100	125	150
Maximum Spacing (mm)	2100	2400	2750	3000	3400	3700	4300	4600	5200

Nominal Pipe Size (inches)	1.0 and Under	1.25	1.5	2	2.5	3	4	5	6
Maximum Spacing (feet)	7	8	9	10	11	12	14	15	17

3.4 FIELD PAINTING

****

NOTE: Coordinate Section 09 90 00 PAINTS AND COATINGS with this paragraph.

****

Clean, pretreat, prime, and paint new carbon-dioxide fire-extinguishing systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories. Apply coatings to clean, dry surfaces, using clean brushes. Clean surfaces to remove dust, dirt, rust, and loose mill scale. Immediately after cleaning, provide the metal surfaces with one coat of zinc molybdate primer applied to a minimum dry film thickness of 25 µm one mil. Shield operating devices with protective covering while painting is in process. Upon completion of painting, remove protective covering from operating devices. Remove devices which are painted and replace with new devices. Provide primed surfaces with the following:

3.4.1 Systems in Unfinished Areas

Unfinished areas are defined as attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, and spaces where walls or ceilings are not painted nor constructed of a prefinished material. Provide primed surfaces with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 25 µm one mil.

3.4.2 Systems in Other Areas

Provide primed surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 25 µm one mil. Provide piping with 50 mm 2 inch wide red enamel bands or self-adhering red plastic tape bands spaced at a maximum of 6 meter 20 foot intervals throughout the piping systems with at least one band in each space.

3.5 CORROSION AND FUNGUS PREVENTION

Coat outdoor equipment with a rust inhibiting treatment and standard finish by the manufacturer. Do not use aluminum in contact with the earth. Protect dissimilar metals with approved fittings and treatment. Coat steel conduits installed underground with an approved asphaltic paint or plastic coating, or wrap with a single layer of a pressure sensitive plastic tape, half-lapped. Protect components against corrosion and fungus.

3.6 FIELD QUALITY CONTROL

Ensure installed piping is tested, inspected, and approved before covering or concealing.

Perform integrated systems testing in accordance with NFPA 4.

3.6.1 Interim Construction Observation Visit[s]

Perform interim construction observation visit[s] when construction is[sufficiently underway to provide sufficient evidence of installation practices being followed, but not so far along as to cause major schedule delays to correct any deficiencies observed][approximately[25 percent][,][50 percent][,][and][75 percent] complete]. Document each site observation visit with a separate site observation report documenting what was observed and any corrective actions required as a result of the visit. Submit site observation report(s) within [14][_____] days of conclusion of respective site observation visit.

3.6.2 Test Procedures

Submit detailed test procedures at least [30][______] days prior to proposed start of performing system tests. List all components of the installed system such as piping, hangers, nozzles, and tanks or cylinders. Include sequence of testing, time estimate for each test, and sample test data forms. Provide test data forms in a check-off format (pass or fail with space to add applicable test data; similar to the format in NFPA 72), and use them for the preliminary testing and the final testing. Provide test data forms that record the test results and:

a. Identify each test required by NFPA 12 Approval of Installations, NFPA 12 Testing of Systems, NFPA 12 Test and Maintenance Procedures, and herein, to be performed on each component, and describe how the test must be performed.

b. Identify each component as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan and site plan sheets showing each component location, test location, and alphanumeric identity.

c. Identify all test equipment and personnel required to perform each test.

d. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.6.3 Test Stages

3.6.3.1 Preliminary Tests

****

NOTE: Tailoring options have been used in this paragraph to differentiate requirements between low-pressure and high-pressure systems.

****

****
NOTE: Tailoring has been used in this paragraph to differentiate between Army and Non-Army requirements for who attends the preliminary testing.
****

[Perform a room pressurization test (fan test) in each protected space, separated by zone. Determine the total leakage area present in each tested space. Use these results to ensure that adequate extra carbon-dioxide is included in the supply tank(s) or cylinders to maintain the required concentration for the required duration. Also use these results to ensure that adequate relief venting area is provided to avoid overpressurization of the enclosure upon carbon-dioxide release.

] Ensure that the QFPE, as well as the Supervisor, are in attendance at the preliminary testing and sign off on the certification letter. Ensure that the Designer, as well as the Supervisor, are in attendance at the preliminary testing and sign off on the certification letter. Prior to commencing other required tests, discharge a minimum of 45400 g 100 pounds of carbon-dioxide to demonstrate reliability and proper functioning of pressure-operated switches and discharge of carbon-dioxide gas from each system discharge nozzle. After discharge, clean wire screens at nozzles, when provided. When screens or nozzles show evidence of plugging, discharge an additional 45400 g 100 pounds of carbon-dioxide gas with the nozzles removed prior to continuing on with full system discharge testing. Provide carbon-dioxide required for tests. Individually test each manual release station and other components and accessories to demonstrate proper functioning. Correct deficiencies prior to formal functional and operating tests of the system.Ensure that the QFPE, as well as the Supervisor, are in attendance at the preliminary testing and sign off on the certification letter. Ensure that the Designer, as well as the Supervisor, are in attendance at the preliminary testing and sign off on the certification letter. Prior to commencing other required tests, discharge a minimum of one 34000 g 75 pound cylinder of carbon-dioxide to demonstrate the reliability and proper functioning of each pressure-operated switch and the discharge of carbon-dioxide gas from each system discharge nozzle. After discharge, clean wire screens at nozzles, if provided. If screens or nozzles show evidence of plugging, discharge an additional cylinder of carbon-dioxide gas with the nozzles removed prior to continuing on with full system discharge testing. Provide carbon-dioxide required for tests. Individually test each manual release station and other components and accessories to demonstrate proper functioning. Correct deficiencies prior to formal functional and operating tests of the system.

3.6.3.2 Request for Formal Inspection and Tests

After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable with the Request for Formal Inspection and Tests. Include the draft Carbon Dioxide System Acceptance Test Report from NFPA 12 as well as the names and titles of the witnesses to the preliminary tests in the letter. Submit request for final test at least [30][_____] days prior to the proposed test date.

3.6.3.3 Final Testing

****
NOTE: The Government's representative to witness final testing may vary by project, by branch, by location, or by any other number of factors.

Coordinate with the DFPE to ensure the appropriate Government Representative is specified herein.

****

****

NOTE: Tailoring has been used in this paragraph to differentiate between Army and Non-Army requirements for who attends the final testing.

****

Furnish instruments, labor, and materials required for the tests. Arrange for the Supervisor to conduct the tests. Repeat tests performed during preliminary testing as directed by the [DFPE][Contracting Officer][_____]. If deficiencies are found, make corrections and retest the system to ensure that they are resolved. Costs for witnessing of retesting incurred by the Government and their representatives may be charged to the Contractor at the discretion of the Contracting Officer. Ensure that the final tests are witnessed by the [DFPE][Contracting Officer][_____] and the QFPE.Ensure that the final tests are witnessed by the [DFPE][Contracting Officer][_____] and the Designer. After successful completion of tests, refill the storage tank(s) or cylinders with carbon-dioxide.

3.6.3.4 Additional Tests

When deficiencies, defects, or malfunctions develop during required tests, suspend further testing of the system until proper adjustments, corrections, or revisions have been made to ensure proper performance of the system. When these revisions require more than a[one hour][four hour][one day] delay, notify the Contracting Officer when the additional work has been completed to arrange a new final test of the carbon-dioxide fire-extinguishing system. Repeat tests required prior to final acceptance, unless directed otherwise by the [DFPE][Contracting Officer][_____].

3.6.3.5 Final Test Report

Provide a letter certifying that the installation is complete and fully operable with the Final Test Report. Include the finalized Carbon Dioxide System Acceptance Test Report from NFPA 12 as well as the names and titles of the witnesses to the final tests in the letter. Ensure that the QFPE, as well as the Supervisor, sign off on the letter.Ensure that the Designer, as well as the Supervisor, sign off on the letter. Submit the final test report within [14][_____] days of test completion.

3.6.4 System Acceptance

Following successful completion of final testing of the system, deliver as-built drawings and operation and maintenance instructions (O&M Manuals) to the Contracting Officer for review and acceptance. Submit the drawings and manuals within [14][_____] days after the final testing of the system. Provide at least one set of as-built (marked-up) drawings at the time of, or prior to, the final testing for use in field verification.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Training

3.7.1.1 Instruction of Government Personnel

Instruct Government operating and maintenance personnel, as designated by the Contracting Officer, for a minimum of [eight][_____] total hours covering at least the following for all items of equipment provided under this Contract:

a. Theory of operation.

b. Procedures for start-up, operation, and shutdown.

c. Maintenance instructions.

d. Safety precautions.

e. Test procedures.

f. Field troubleshooting and diagnostic procedures.

g. Repair procedures for field repairs that can be made by replacing plug-in components.

Provide instruction by the manufacturer's technical representative at the project site using the documents specified in the paragraph entitled "Operation and Maintenance Manuals".

3.7.1.2 Recordings

Record all training presented on-site utilizing recording equipment acceptable to the Contracting Officer. Perform recording such that all visual aids are clearly visible and all discussion is clearly understandable. Provide record copies of the recordings to the Contracting Officer within [14][_____] days following completion of training.

[3.7.1.3 Advanced Maintenance Training

****

NOTE: Advanced Maintenance Training is intended for those Installations where the government personnel are going to be responsible for making programming changes to the equipment or installing new equipment without the involvement of a manufacturer's representative. This training is intended to provide those individuals with manufacturer's certification level training to enable them to be competent to make such changes.

****

Within one year of contract completion, provide [one][two][_____] Government-designated maintenance personnel assigned to the site a complete technical repair training session of [40][_____] hours covering repair of the carbon-dioxide fire-extinguishing system equipment. Include in the training an in-depth explanation and review of the theory of operation, function, description, and troubleshooting of all equipment provided down to the component level. Include a review of manuals, drawings, and parts lists, together with any clarifications required. Ensure that at least one period of eight hours is spent troubleshooting equipment with actual faults being introduced for training purposes. Provide instructional personnel that are certified by the related equipment manufacturer to provide technical instruction services. Transportation, lodging, and meal costs for Government personnel attending this off-site training is not a part of this Contract.

]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-21 22 00.00 20 (May 2011)**

Preparing Activity: NAVFAC **Superseding**
UFGS-21 22 00.00 20 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 21 22 00.00 20

HALON 1301 FIRE EXTINGUISHING

05/11

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-21 22 00.00 20 (May 2011)**

Preparing Activity: NAVFAC **Superseding**
UFGS-21 22 00.00 20 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 21 22 00.00 20

HALON 1301 FIRE EXTINGUISHING
05/11

****

NOTE: This guide specification covers the requirements for Halon 1301 fire extinguishing systems for protection of data processing equipment and similar electronics occupancies.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Use of this guide specification requires a waiver in accordance with NAVFAC Ozone Depleting Substances (ODS) Procurement Policy and Procedures with the approval of a Senior Acquisition Officer (SAO). With minor changes, this guide can be adapted to other occupancies or needs, such as the protection of electric generators and flight simulators. The extent and location of the work to be accomplished, and the type of electric service, cables, wire, conduit, location of storage cylinders, actuating stations, control panels, storage batteries, battery chargers, and accessories indicated, specified, or necessary for the complete installation required shall be indicated on the project drawings. If there are questions concerning

system design, the cognizant Engineering Field Division Fire Protection Engineer should be consulted. Due to the toxicity of decomposed Halon, an engineered smoke and Halon removal system (not part of this specification) will be required for each protected space. Such a system shall be manually key operated, for fire department use only. See also NFPA 12A section on relief venting.

****

****

NOTE: The following information should be shown on the drawings:

1. On the electrical power floor plans show locations of control panel, annunciator(s), audible and visual alarm devices, manual actuation stations, point of connection to the building fire evacuation alarm system, remote trouble device, and point of connection to the incoming power supply and fusible safety switch. Do not show conduit sizes or number of conductors for DC circuits. Do not show locations of smoke detectors.

2. Show single line riser diagram for all detection, activation, and alarm circuits. Connection of equipment shall be indicated by circuit runs and not conduit runs. Do not indicate number and size of conductors for interconnection of fire alarm components.

3. On the mechanical floor plans, show locations for Halon storage containers. Show areas of system coverage, with zone designations (if multiple zones). Do not show Halon piping layout and nozzle placement.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project

specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 12A	(2022) Standard on Halon 1301 Fire Extinguishing Systems
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 75	(2024) Standard for the Protection of Information Technology Equipment
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-2962	(Rev A; Notice 2) Enamel, Alkyd, Gloss, Low VOC Content
CID A-A-58092	(Basic; Notice 1; Notice 2) Tape, Antiseize, Polytetrafluoroethylene
FS TT-P-645	(Rev C; Notice 1) Primer, Paint, Zinc-Molybdate, Alkyd Type

UL SOLUTIONS (UL)

UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 GENERAL REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein.

1.2.1 Description of Work

****

NOTE: Identify the rooms, spaces or areas, as appropriate, which are to be protected by each type of system.

****

The work includes the designing and providing of approved Halon 1301 underfloor [and room] flooding extinguishing system(s) for protection of [_____]. The design, equipment, materials, installation and workmanship shall be in strict accordance with the required and advisory provisions of NFPA 12A, except as modified herein. Each system shall include all materials, accessories and equipment inside and outside the building necessary to provide each system complete and ready for use. Design and install each system to give full consideration to built-in spaces, piping, electrical equipment, ductwork and all other construction and equipment and to be free from operating and maintenance difficulties, all in accordance with detailed drawings to be submitted to the Contracting Officer for approval. Devices and equipment for fire protection service shall be of a make and type listed by the Underwriter's Laboratories, Inc., or approved by the Factory Mutual System. In the publications referred to herein, the advisory provisions shall be considered to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; reference to the "authority having jurisdiction" shall be interpreted to mean the [_____] Division Fire Protection Engineer.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

[The fire protection engineer, [_____] Division, Naval Facilities Engineering Systems Command will review any approve all submittals in this section requiring Government approval.]

****

NOTE: For projects administered by the Pacific Division, Naval Facilities Engineering Systems Command, use the optional "SUBMITTALS" article immediately below and delete the general "SUBMITTALS" article above for Navy projects.

****

[The [_____] Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer delegates the authority to the Quality Control (QC) Representative's U.S. Registered Fire Protection Engineer for review and approval of submittals required by this section. Submit to the [_____] Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer one set of all approved submittals and drawings immediately after approval but no more later than 15 working days prior to final inspection.]

SD-02 Shop Drawings

Halon System Piping Layout; G, [_____]

Field Wiring Diagrams; G, [_____]

SD-03 Product Data

Storage Cylinders; G, [_____]

Discharge Heads; G, [_____]

Manifolds; G, [_____]

Valves; G, [_____]

Discharge Nozzles; G, [_____]

Pipe; G, [_____]

Pipe Hangers and Supports; G, [_____]

Control Panel; G, [_____]

Manual Actuation Stations; G, [_____]

Pressure Switches; G, [_____]

Storage Batteries; G, [_____]

Smoke Detectors; G, [_____]

Audible Alarms; G, [_____]

Visual Alarms; G, [_____]

Annunciator Panels; G, [_____]

Electromagnetic Door Holder Release; G, [_____]

Battery Charger; G, [_____]

Fittings; G, [_____]

SD-05 Design Data

Halon Discharge Calculations; G, [_____]

Battery Capacity Calculations; G, [_____]

SD-07 Certificates

****

NOTE: The qualifications clause in this guide specification has been approved by NAVFACENGCOMHQ in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS). NFAS can be found at the following link: https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_forbusinesses_pp/smallbusiness/contracting/navfac**. The paragraph in this guide specification may be used without any other NAVFACHQ approval or request for waiver.**

****

Record of Prior Installations; G, [_____]

Halon Fire Extinguishing System; G, [_____]

SD-10 Operation and Maintenance Data

Halon Fire Extinguishing System, Data Package 3; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Remote Control Station Operating Instructions; G, [_____]

Record Drawings; G, [_____]

1.4 QUALITY ASSURANCE

****

NOTE: The qualifications clause in this guide specification has been approved by NAVFACHQ in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS). NFAS can be found at the following link: https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_forbusinesses_pp/smallbusiness/contracting/navfac. The paragraph in this guide specification may be used without any other NAVFACHQ approval or request for waiver.

****

1.4.1 Record of Prior Installations

Prior to installation, submit data showing of Halon fire extinguishing systems of the same type and design as specified herein. The data shall include the names and locations of at least two locations where the Contractor has installed such systems. The Contractor shall indicate the type and design of these systems and certify that these systems have performed satisfactorily in the manner intended for a period of not less than 18 months.

****

NOTE: For projects administered by the Pacific Division, Naval Facilities Engineering Systems Command, include the following optional paragraph requiring the minimum qualification of a NICET Level-III technician for preparation of all fire protection system drawings.

****

[Qualifications of System Technician: Installation drawings, shop drawing and as-built drawings shall be prepared, by or under the supervision of, an individual who is experienced with the types of works specified herein, and is currently certified by the National Institute for Certification in Engineering Technologies (NICET) as an engineering technician with minimum Level-III certification in Special Hazard System program. Contractor shall submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.

] Contractor shall have successfully installed Halon fire extinguishing systems of the same type and design as specified herein.

1.4.2 Halon Fire Extinguishing System

When preliminary field tests have been completed and all necessary corrections made, submit to the Contracting Officer a signed and dated letter attesting to the satisfactory completion of testing and stating that the systems is in operating condition. The letter shall include a written request for a formal inspection and test.

1.4.3 Manufacturer's Representative

Provide the services of a manufacturer's authorized representative or technician, experienced in the installation and operation of the type of system being provided to supervise the installation and testing, including final testing, adjustment of the system and to provide instruction to Government personnel.

1.5 DESIGN OF HALON FIRE EXTINGUISHING SYSTEMS

****

NOTE: Delete reference to NFPA 75 only if the protected space(s) contain no automatic data processing requirement.

****

Design and installation of Halon fire extinguishing systems shall conform to NFPA 12A, NFPA 70, NFPA 72, [and NFPA 75] and to the requirements as hereinafter specified.

1.5.1 Piping Layout and Wiring Diagrams

Annotate halon system piping layout with reference points for design. In field wiring diagrams, show locations of devices and points of the system. Prepare working drawings on sheets not smaller than A0 1189 by 841 mm 30 by 42 inches, in accordance with the requirements for "Plans" as specified in NFPA 12A. Include data essential to the proper installation of each system.

1.5.2 Calculations

Submit halon discharge calculations verifying total storage requirements, flooding concentrations, discharge times, flow through the piping network, pipe sizes, and nozzle orifice sizes, in accordance with the manufacturer's listed design manual and NFPA 12A. Submit substantiating battery capacity calculations showing capacity, supervisory and alarm power requirements.

1.5.3 Flooding Concentration

The system shall totally flood the protected area(s) providing a volumetric concentration of Halon 1301 of not less than 5 percent nor more than 7 percent at 21 degrees C 70 degrees F.

1.5.3.1 Halon Concentration

The Halon concentration shall be based upon shutting down the heating, ventilation and air conditioning (HVAC) systems at the time of agent discharge. The required Halon concentration shall be maintained in the protected area(s) for a minimum of ten minutes.

1.5.4 Discharge Time

The maximum Halon liquid discharge time shall be 10 seconds.

1.5.5 Reserve Supplies

Each system shall be provided with its own connected reserve supply of Halon 1301. Each reserve supply shall contain an amount of Halon 1301 equal to the primary supply of the system to which it is connected.

1.5.6 Record Drawings

Upon completion, and before final acceptance of the work, submit a complete set of as-built (record) working drawings, [including complete as-built circuit diagrams,] of each Halon 1301 system for record purposes. The as-built working drawings shall be not smaller than A0 1189 by 841 mm 30 by 42 inches reproducible drawings on mylar film with title block (200 by 100 mm 8 by 4 inches) similar to full size contract drawings. The as-built working drawings shall be furnished in addition to the record drawings required by Section 01 78 00 CLOSEOUT SUBMITTALS.

1.6 SYSTEM CONTROL

Provide all apparatus, accessories, components and associated materials specified or necessary to furnish each system complete and ready for operation. All equipment shall be the current products of their manufacturers.

1.6.1 Controls

Detection and actuating control system shall be complete, Class A electrically supervised combination automatic and manual. Automatic actuation shall be accomplished by smoke detectors. Manual actuation shall be accomplished by electrical manual actuation stations.

1.6.2 Sequence of Operation

Smoke detection system shall be cross-zoned, priority matrix, or have common circuit individual detector verification capability. If a cross-zoned system is used, each protected area shall contain two smoke detection circuits (zones), with each circuit having an equal number of detectors connected thereto and no two adjacent detectors connected to the same zone. Upon activation of any smoke detector, the system shall simultaneously activate pre-discharge alarms in the protected area(s), signal the building fire alarm control panel(s) to activate the building fire evacuation alarms, and send a signal to the base fire department via the base fire alarm system. Upon activation of a second detector (on the opposite zone of a cross-zoned system), the systems shall immediately shut down [computer] [_____] equipment and air conditioning power, close all fire dampers [release all doors to permit closing] activate the discharge alarms, and initiate an adjustable 0-60 second time delay. At the end of the time delay, Halon shall discharge into the protected area[and post-discharge visual alarms shall activate].

1.6.2.1 Activation By Manual Station

Upon activation by a manual station, the system shall immediately perform all the above listed alarm functions and shut-down functions, and initiate the adjustable time delay. At the end of the delay, Halon shall discharge into the protected area.

[1.6.2.2 Manual Activation of Inhibit Switch

****

NOTE: Inhibit switches are optional devices which decrease system reliability and shall not be used without approval of the Division Fire Protection Engineer.

****

Upon manual activation of the inhibit switch, equipment shutdown and agent discharge shall be delayed. All other functions shall continue unimpeded. Upon release of inhibit switch, shutdown and discharge functions shall resume. Time delay shall not reset and shall resume countdown to discharge after release of switch.

]1.6.3 Transfer to reserve supply

Transfer from system main supply to reserve supply shall be controlled by a "main-reserve" switch at the system control panel.

1.6.4 Remote Control Station Operating Instructions

Submit the proposed legend for remote control station operating instructions.

PART 2 PRODUCTS

2.1 PIPING

Conceal piping to the maximum extent possible. Piping shall be inspected, tested and approved before being concealed. Provide fittings for changes in direction of piping and for all connections. Make changes in piping sizes through standard reducing pipe fittings; the use of bushings is not permitted.

2.1.1 Pipe

ASTM A53/A53M or ASTM A106/A106M, black or zinc-coated, threaded, Schedule 40.

2.1.2 Fittings

ASME B16.11 or ASME B16.3, Class 300, zinc-coated, threaded, except Class 150 or 300 for pipe 20 mm 3/4 inch or smaller.

2.1.3 Pipe Hangers and Supports

MSS SP-58, adjustable type. Rods, hangers and supports shall be zinc plated. Provide pipe hangers and supports as follows:

Nominal Pipe Size (mm)	Maximum Spacing (meters)
25 and under	2.00
32	2.50
40	2.75
50	3.00
65	3.25
80	3.75
90	4.00
100	4.25
125	4.50
150	5.00

Nominal Pipe Size (inches)	Maximum Spacing (feet)
1 and under	7
1.25	8
1.5	9
2	10
2.5	11
3	12
3.5	13
4	14
5	15
6	16

2.1.4 Pipe Sleeves

Provide where piping passes through masonry or concrete walls, floors, roofs and partitions. Sleeves in outside walls below and above grade, in floor, and in roof slabs, shall be standard weight zinc coated steel pipe. Sleeves in partitions shall be zinc coated sheet steel having a nominal weight of not less than 4.40 kg per sq meters 0.90 pounds per square foot. Space between piping and the sleeve, shall be not less than 13 mm 0.5 inch.

Sleeves shall be of sufficient length to pass through the entire thickness of walls, partitions and slabs. Extend sleeves in floor slabs 50 mm 2 inches above the finished floor. Pack space between the pipe and sleeve with asbestos free insulation and caulk at both ends of the sleeve with plastic waterproof cement.

2.1.5 Escutcheon Plates

Provide piping passing through floors, walls and ceilings with one piece or split type plates. Plates where pipe passes through finished ceilings shall be chromium plated. Other plates shall be of steel or cast iron, with aluminum paint finish. Securely anchor plates in place.

2.1.6 Discharge Nozzles

Fabricated of corrosion resistant materials. All nozzles shall be designed so that the orifice piece is connected directly to the supply pipe. The size of pipe and nozzles shall be determined from the calculated flow and terminal pressures in accordance with established, recognized test data contained in the manufacturer's listed design manual.

2.1.7 Storage Cylinders

Constructed of high strength alloy steel, conforming to all applicable specifications of the Department of Transportation. Container design shall permit on-site reconditioning and refilling when required. Safety valves, manifolds, pressure gauges, and pressure switches shall be provided.

2.1.8 Jointing Compound

Tape conforming to CID A-A-58092.

2.2 CONTROL PANEL

Provide complete electrical supervision of all circuits. Install modular type panel in a [flush] [surface] mounted steel cabinet with hinged door and cylinder lock. Switches and other controls shall not be accessible without the use of a key. The control panel shall be a neat, compact, factory-wired assembly containing all parts and equipment required to provide specified operating and supervisory functions of the system. Panel cabinet shall be finished on the inside and outside with factory-applied enamel finish. [Provide separate alarm and trouble lamps located on the exterior of the cabinet door or visible through the cabinet door for each zone initiating circuit.] Provide prominent rigid plastic or metal identification plates for all lamps and switches. A single open or ground fault condition in any detection or actuation circuit shall not result in any loss of system function, but shall cause the actuation of system trouble signals. A ground fault condition or single break in any other circuit shall result in the activation of the system trouble signals. [Supervision of wiring external to the control panel for mechanical equipment shutdown is not required, provided a break in such wiring will cause the associated mechanical equipment to shut down.] Loss of AC power, a break in the standby battery power circuits, or abnormally low battery voltage shall also result in the operation of the system trouble signals. The abnormal position of any system switch in the control panel shall also result in the operation of the system trouble signals. Trouble signals shall operate continuously until the system has been restored to normal at the control panel. Provide a 100 mm 4 inch remote system trouble bell, installed [in a constantly attended area] [where shown], arranged to operate in conjunction with the integral trouble signals of the panel. Provide remote bell with a rigid plastic or metal identification sign which reads "Halon System Trouble." Lettering on identification sign shall be a minimum of 25 mm one inch high. Panel shall be provided with the following switches:

a. Trouble silencing switch which transfers trouble signals to an indicating lamp. Upon correction of the trouble condition, audible signals will again sound until the switch is returned to its normal position, or the trouble circuit shall be automatically restored to normal upon correction of the trouble condition.

b. Evacuation alarm silence switch which when activated will silence all alarm devices and cause operation of system trouble signals.

[c. [Master box]Disconnect switch which when activated will disconnect the system from the base fire alarm system and cause operation of the Halon system trouble signals.

] System control panel shall be UL Fire Prot Dir listed or FM APP GUIDE approved for extinguishing system control (releasing device service).

2.3 SECONDARY POWER SUPPLY

Supply shall include nickel cadmium, lead calcium or sealed lead acid batteries and charger. Drycell batteries are not allowed. House batteries in a well constructed steel cabinet with cylinder lock.

2.3.1 Storage Batteries

Provide batteries of adequate ampere-hour rating to operate the system under supervisory conditions for 60 hours at the end of which time batteries shall be capable of operating the entire system in a full alarm condition for not less than 30 minutes. Provide calculations substantiating the battery capacity. Provide reliable separation between cells to prevent contact between terminals of adjacent cells and between battery terminals and other metal parts.

2.3.2 Battery Charger

Provide completely automatic high/low charging rate type charger capable of recovery of the batteries from full discharge to full charge in 24 hours or less. Provide an ammeter for recording rate of charge and a voltmeter to indicate the state of battery charge. Provide a red pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high-rate switch is provided.

2.4 MANUAL ACTUATION STATIONS

****

NOTE: Where there is no room flooding or no raised floor space, omit requirement for separate actuation stations.

****

Provide actuation stations for systems at the exits from the protected areas. Operation of a manual station shall cause the control panel to go into full alarm condition and discharge Halon into the protected area following the adjustable time delay. [Provide separate, clearly labeled, manual stations for control of underfloor discharge and room flooding.] Stations shall be of a type not subject to operation by jarring or vibration. Stations shall have a dual action release configuration to prevent accidental system discharge. Break-glass-front stations are not permitted; however a pull lever break-glass-rod type is acceptable. Station color shall be red or orange. Warning signs shall be placed at each station indicating that operation of the station will cause immediate Halon discharge. Where building fire alarm pull stations are also mounted at the exits from the protected areas, they shall be separated from Halon actuation stations by at least one meter 3 feet horizontally, labels shall be provided to clearly distinguish building fire alarm stations from Halon stations and stations shall be of different colors.

2.5 SMOKE DETECTORS

Designed for detection of abnormal smoke densities by the [ionization] [photoelectric] principle. Necessary control and/or power modules required for operation of the device shall be integral with the main control panel. Detectors shall be compatible with main control panel provided and shall be suitable for use in a supervised circuit. Detectors shall not draw power from the initiating circuit. Operating power shall be taken from a separate supervised power supply circuit. Malfunction of the electrical circuitry to the detector or its control or power units shall result in the operation of the system trouble devices. Detectors shall not be susceptible to operation by changes in relative humidity. Each detector shall contain a visible indicator lamp that shall show when the unit is activated. Each detector shall be the plug-in type in which the detector base contains screw terminals for making all wiring connections. Remote indicator lamp shall be provided for each detector that is located above suspended ceilings, beneath raised floors or otherwise concealed from view.

2.5.1 Ionization Detectors

Multiple chamber type which is responsive to both visible and invisible products of combustion. The sensitivity of each detector shall be field adjustable to compensate for the conditions under which it is to operate.

2.5.2 Photoelectric Detectors

Operate on a multiple cell concept using a light-emitting diode (LED) light source. Failure of the LED shall not cause an alarm condition but shall operate the detector trouble indicating lamp.

2.5.3 Detector Spacing and Location

****

NOTE: Do not show detector locations on plans, however a detail for mounting smoke detectors to the raised flooring system in compliance with this paragraph should be shown.

****

In accordance with the requirements of NFPA 72, the manufacturer's recommendations and the requirements stated herein. Spacing and location of detectors shall take into account the airflow into the room and supply diffusers. Detectors shall not be placed closer than 1 1/2 meters 5 feet from any discharge grille. Spacing of detectors on room ceilings shall not exceed 41.80 square meter 450 square feet per detector. Spacing of detectors under raised floors shall not exceed 23.25 square meter 250 square feet per detector. Detectors installed beneath raised floors shall be mounted with the detector base within 50 mm 2 inches of the underside of the raised floor framing, with the detector facing downward. Where the space under the raised floor is less than 305 mm 12 inches in height, detectors shall be mounted with their bases either horizontal or vertical, with the detection chambers mounted in the upper half of the underfloor space. Under no circumstances shall detectors be mounted facing upward.

[2.6 DUCT SMOKE DETECTORS

****

NOTE: Automatic dampers are required in all ducts passing through walls, floors, and ceilings, to prevent the leakage of Halon from the protected space, and to prevent the communication of fire and smoke. Locations of dampers should be shown on HVAC plans. Additional smoke dampers may be required in systems over 424,740 L/m 15,000 cfm by NFPA 90A, Air Conditioning and Ventilating Systems. Coordinate with Section 23 09 53.00 20, SPACE TEMPERATURE CONTROL SYSTEMS. Provide access door in duct at each damper location. Connect duct detectors to Halon system control panel only if no building fire alarm system is provided. Otherwise delete paragraph entitled "Duct Smoke Detectors."

****

In accordance with the requirements of NFPA 90A, the manufacturer's recommendations and the requirements stated herein. Detectors required in ducts shall be ionization type and listed by UL Fire Prot Dir or FM APP GUIDEfor duct installation. Provide duct detectors with an approved duct housing, mounted exterior to the duct, with perforated sampling tubes extending across the width of the duct. Activation of duct detectors shall cause shut down of the associated air-handling unit, annunciation at the control panel, tripping of the [master box] [transmitter], and sounding of building fire evacuation alarms. Detector shall have a test port or switch.

][2.7 INHIBIT SWITCH

****

NOTE: Inhibit switches are optional devices which decrease system reliability and shall not be used without approval of the Division Fire Protection Engineer.

****

Provide one switch where shown. Activation of switch shall delay only equipment shutdown and agent discharge. Switch shall be guarded, spring-loaded type which operates only when pressure is manually applied to the switch. Upon release of manual pressure, switch shall de-activate allowing delayed functions to resume. After start of agent discharge, switch shall have no effect. Activation of switch during normal (non-alarm) conditions shall cause activation of system trouble signals.

]2.8 ALARM SIGNALING DEVICES

Provide each protected area with audible and visual alarms located where shown. All alarm circuits shall be electrically supervised. Provide separate and distinct audible and visual pre-discharge and discharge signals. Where the building is equipped with a separate fire evacuation alarm system the discharge signals shall also be distinct from those used by the building fire evacuation system. Each signal device shall be provided with a rigid plastic or metal identification sign with lettering a minimum of 40 mm 1.5 inches high. The pre-discharge alarm shall be labeled "FIRE" and the discharge alarm shall be labeled "HALON DISCHARGE." [Post-discharge visual alarms shall be located outside all entrances to the protected areas, and shall be provided with signs reading "HALON DISCHARGED WHEN FLASHING - DO NOT ENTER].

2.8.1 Audible Alarms

a. Alarm bells

b. 250 mm 10 inch [surface mounted] [recessed] with matching mounting back box. Bells shall be of the vibrating type suitable for use in an electrically supervised circuit. Bells shall be of the underdome type and produce a sound output rating of at least 90 decibels at 3 meters 10 feet.

c. Alarm horns

d. [Recessed,][Surface mounted,]vibrating type suitable for use in an electrically supervised circuit and shall have a sound output rating of at least 90 decibels at 3 meters 10 feet.

2.8.2 Visual Alarms

[Flush][Surface mounted]lamp assembly suitable for use in an electrically supervised circuit. Lamp shall be the flashing [stroboscopic] [incandescent] [rotary beacon] type and powered from the control panel alarm circuit. Lamps shall provide a minimum of 50 candle power. Flash rate shall be between 60 and 120 flashes per minute. Lamps shall be protected by a thermo-plastic lens, red for pre-discharge alarms and blue for discharge[and post-discharge] alarms.[Visual alarms may be part of an audio-visual alarm assembly.]

2.9 MAIN ANNUNCIATOR

Annunciator shall be integral with the main control panel. Provide separate alarm and trouble lamps for each zone alarm initiating circuit located on the exterior of the cabinet door or visible through the cabinet door. Supervision will not be required provided a fault in the annunciator circuits results only in loss of annunciation and will not affect the normal functional operation of the remainder of the system. Each lamp shall provide specific identification of the [zone] [area] [device] by means of a permanent label. In no case shall zone identification consist of the words "Zone 1," "Zone 2," etc., but shall consist of the description of the [zone] [area] [device].

2.9.1 Annunciation Zones

Shall be arranged as follows:

2.9.2 Annunciator Panels

a. Remote annunicator panels

b. Locate as shown. Panel shall duplicate all requirements specified for the main control panel annunciator, except that in lieu of individual zone trouble lamps a single common system trouble lamp may be provided. Panel shall have a lamp test switch. Zone identification shall be by means of [permanently attached rigid plastic or metal plate(s).][Silk-screened labels attached to the reverse face of backlighted viewing windows(s).] Panel shall be of the [interior][weatherproof]type, [flush][surface] [pedestal]-mounted.

c. Graphic Annunciator Panel

d. Locate as shown. Panel shall be of the [interior][weatherproof]type, [flush][surface][pedestal]-mounted. Panel shall be provided with the [building][room] floor plan, drawn to scale, with remote alarm lamps mounted to represent the location of[each concealed detector][each alarm in initiating device].[Principal rooms and areas shown shall be labeled with their room numbers or titles.] The panel location shall be shown on the floor plan. Detectors mounted above ceilings, [on ceilings,] and beneath raised floors[and different types of initiating devices] shall have different symbols or lamps of different colors for identification. Lamps shall illuminate upon actuation of their corresponding device and shall remain illuminated until the system is reset. Panel shall have a lamp test switch.

2.10 AUTOMATIC FIRE DAMPERS

****

NOTE: Automatic dampers are required in all ducts passing through walls, floors, and ceilings, to prevent the leakage of Halon from the protected space, and to prevent the communication of fire and smoke. Locations of dampers should be shown on HVAC plans. Additional smoke dampers may be required in systems over 424,740 L/m 15,000 cfm by NFPA 90A, Air Conditioning and Ventilating Systems. Coordinate with Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS. Provide access door in duct at each damper location. Connect duct detectors to Halon system control panel only if no building fire alarm system is provided. Otherwise delete paragraph entitled "Duct Smoke Detectors."

****

Provide automatic control of fire dampers in air conditioning supply duct work as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS. Activation of fire dampers shall occur upon second zone detection, or upon activation of Halon discharge by manual pull station. Fire dampers are specified in Section 23 30 00 HVAC AIR DISTRIBUTION. Provide heaters for fusible links.

[2.11 ELECTROMAGNETIC DOOR HOLDER RELEASE

Provide where shown. The armature portion shall be mounted on the door and shall have an adjusting screw for setting the angle of the contact plate. The electro-magnetic release shall be wall mounted, with a total horizontal projection not exceeding 100 mm 4 inches. All doors shall release to close upon first stage (pre-discharge) alarm. Electrical supervision of wiring external of control panel for magnetic door holding circuits is not required.

]2.12 ELECTRICAL WORK

[Electrical work is specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, except for control and fire alarm wiring.

]2.12.1 Wiring

Control and fire alarm wiring, including connections to fire alarm systems, shall be provided under this section and shall conform to NFPA 70. Wiring for 120 volt circuits shall be No. 12 AWG minimum. Wiring for low voltage DC circuits shall be No. [14] [16] AWG minimum. All wiring shall be color coded. Use rigid metal conduit or intermediate metal conduit, except electrical metallic tubing may be used in dry locations not enclosed in concrete and where not subject to mechanical damage.

2.12.2 Operating Power

Power shall be 120 volts AC service, transformed through a two winding isolation type transformer and rectified to 24 volts DC for operation of all signal initiating, signal sounding, trouble signal and [master box] [transmitter] tripping circuits. Provide secondary DC power supply for operation of system in the event of failure of the AC supply. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and shall not cause transmission of a false alarm. Obtain AC operating power to control panel and battery charger from the line side of the incoming building power source ahead of all building services. Provide independent properly fused safety switch, with provisions for locking the cover and operating handle in the "POWER ON" position for these connections and locate adjacent to the main distribution panel. Paint switch box red and suitably identify by a lettered designation.

2.12.3 Conductor Identification

All circuit conductors shall be identified within each enclosure where a tap, splice or termination is made. Conductor identification shall be by plastic coated self sticking printed markers or by heat-shrink type sleeves. Attach the markers in a manner that will not permit accidental detachment. Properly identify control circuit terminations.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

Cut screw-jointed pipe accurately and work into place without springing or forcing. Ream pipe ends and free pipe and fittings from burrs. Clean with solvent to remove all varnish and cutting oil prior to assembly. Make screw joints with tetrafluoroethylene tape applied to male thread only.

3.2 FIELD PAINTING

****

NOTE: Coordinate Section 09 90 00, PAINTS AND COATINGS with this paragraph.

****

Clean, pretreat, prime, and finish paint new Halon 1301 fire extinguishing systems, including piping, conduit, hangers and miscellaneous metalwork. Apply coatings only to clean, dry, surfaces using clean brushes. Clean surfaces to remove all dust, dirt, rust and loose mill scale. Immediately after cleaning, the metal surfaces shall receive one coat of primer conforming to FS TT-P-645 applied to a minimum dry film thickness of 0.025 mm one mil. Exercise due care to avoid the painting of operating devices. Materials which are used to protect devices, while painting is in process, shall be removed upon the completion of painting. Remove all devices which are painted and provide new clean devices of the proper type in lieu thereof.

3.2.1 Systems in Unfinished Areas

Unfinished areas are defined as attic spaces, spaces above suspended ceilings, spaces under raised floors, crawl spaces, pipe chases, and spaces where walls or ceiling are not painted or not constructed of a prefinished material. Primed surfaces shall receive one coat of red enamel conforming to CID A-A-2962 applied to a minimum dry film thickness of 0.025 mm one mil and color coded in accordance with MIL-STD-101.

3.2.2 Systems in All Other Areas

Primed surfaces shall receive two coats of paint to match adjacent surfaces, except stop valves and accessories shall receive one coat of red enamel conforming to CID A-A-2962 applied to a minimum dry film thickness of 0.025 mm one mil. Provide piping with 50 mm 2 inch wide red bands spaced at maximum of 6 meters 20 feet intervals throughout the piping systems, except in finished areas such as offices, the red bands may be deleted. Red bands shall be red enamel or self adhering red plastic tape and color coded in accordance with MIL-STD-101.

3.3 FIELD TESTING

Perform tests in the presence of the Contracting Officer to determine conformance with the specified requirements.

3.3.1 Preliminary Tests

Each piping system shall be pneumatically tested at 1034 kPa (gage) 150 psig and shall show no leakage or reduction in gage pressure after 30 minutes. The contractor shall conduct complete preliminary tests, which shall encompass all aspects of system operation. Individually test all detectors, manual actuation stations, alarms, control panels, and all other components and accessories to demonstrate proper functioning.

3.3.2 Formal Inspection and Tests

The [_____] Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer, will witness formal tests and approve all systems before they are accepted. The system shall be considered ready for such testing only after all necessary preliminary tests have been made and all deficiencies found have been corrected to the satisfaction of the equipment manufacturer's technical representative and the Contracting Officer. Submit the request for formal inspection at least 15 days prior to the date the inspection is to take place. The control panel(s) and detection system(s) shall be in service for a "break-in" period of at least 15 consecutive days prior to the formal inspection. Experienced technicians regularly employed by the contractor in the installation of both the mechanical and electrical portions of such systems shall be present during the inspection and shall conduct the testing. All Halon 1301, instruments, personnel, appliances and equipment for testing shall be furnished by the contractor. All necessary tests encompassing all aspects of system operation shall be made including the following, and any deficiency found shall be corrected and the system retested at no cost to the Government.

3.3.2.1 System Function Tests Without Halon Discharge

The entire detection/alarm/actuation system shall be operated. As a minimum, operation and supervision of the following functions and devices shall be demonstrated.

a. All operational and supervisory functions of the control and annunciator panels, including the cross-zoning, pre-discharge alarm, discharge alarm[, post-discharge alarm] and time delay features.

b. Each manual actuation station and associated circuit(s).

c. All smoke detectors and associated circuits.

d. All pre-discharge[,][and] discharge[and post-discharge] alarms and associated circuits.

e. All actuator circuits and discharge heads (without Halon discharge).

f. Air handing[and computer] equipment shutdown.

g. Automatic fire dampers.

h. Activation of the building fire evacuation alarm system.

i. Activation of the Base fire alarm system (receipt of fire alarm at alarm office).

j. All of the above tests shall be repeated with the system on battery power only.

3.3.2.2 Halon Discharge Tests

When all of the detection/alarm/actuation, and supervisory functions of the system operate to the satisfaction of manufacturer's technical representative, the Division Fire Protection Engineer, and the Contracting Officer, a complete discharge test of Halon system shall be performed to demonstrate satisfactory performance, Halon concentration, uniformity of Halon concentration, system discharge time, mechanical operation and operation of valves, release devices, alarms, and interlocks which control the protected area. Halon 1301 shall be used for this test; substitution of agents is not permitted. This test shall be conducted by experienced personnel according to the equipment and Halon manufacturer's recommendations. All personal required to be in the protected area during or immediately after the test shall wear self-contained, positive pressure breathing apparatus. Contractor shall provide all breathing apparatus, except apparatus for Government personnel shall be provided by the Government. Halon concentration shall be monitored at a minimum of 3 sampling points in each protected area. Provide a calibrated strip chart recorder for continuous recording of concentrations at each monitoring point. Table I at end of this section shall be completed using observations taken during this test.

3.4 OPERATING INSTRUCTIONS

Provide operating instructions at each remote control station. Instructions shall clearly indicate all necessary steps for the operation of the system. Instructions shall be in raised or embossed white letters on red rigid plastic or red enameled steel backgrounds and shall be of adequate size to permit them to be easily read.

3.5 TRAINING REQUIREMENTS

Prior to final acceptance, the Contractor shall provide operation and maintenance training to the Base Fire Department and [Public Works] [Civil Engineering] [and] [Computer] personnel. Each training session shall include [computer] emergency procedures, and unique maintenance and safety requirements. Training areas will be provided by the Government in the same building as the protected areas. The training conducted shall use operation and maintenance manuals called for in paragraph entitled "Operation and Maintenance Instructions, Parts and Testing." Dates and times of the training period shall be coordinated through the Contracting Officer not less then two weeks prior to the session. Government shall be provided with a simplified training manual providing a description of operation and controls, possible hazards to personnel, and restart procedures for[computers and] air handling units.

TABLE I

HALON 1301 DATA (EACH ROOM & UNDER FLOOR)

Date:____________

Room Description ____
Dimensions (m) Length _______________ Height _____________ Width __________
Area ______________ Sq Meters Volume _________________________________
Ventilation Rate into Room ____________ Cubic Meter per Second
Specific Volume At Design Temp. ____
Design Temp. ______________ Deg C Max. Temp Expected _____________ Deg C
Percent Design Concentration _________ kg 1301 Required ______________
Number of Nozzles ______________ Sq Meter/Nozzle___________________
Kg 1301 to be Supplied/Nozzle ____________(Based on no air flow)
Discharge Time _________________________
Concentration at Design Temperature ________________________ percent
Concentration at Max Temperature ___________________________ percent

Concentration	Point A	Point B	Point C
0 Seconds after end of Discharge percent C	________	________	________
5 Seconds after end of Discharge percent C	________	________	________
10 Seconds after end of Discharge percent C	________	________	________
15 Seconds after end of Discharge percent C	________	________	________
20 Seconds after end of Discharge percent C	________	________	________
25 Seconds after end of Discharge percent C	________	________	________
30 Seconds after end of Discharge percent C	________	________	________
40 Seconds after end of Discharge percent C	________	________	________
50 Seconds after end of Discharge percent C	________	________	________
60 Seconds after end of Discharge percent C	________	________	________
120 Seconds after end of Discharge percent C	________	________	________

Agent Tanks to be Supplied for test use ________________________kg Each
Free Venting Requirements ___________ kg/sq meter allowable strength
this requires ___________ sq mm free venting area

TABLE I

HALON 1301 DATA (EACH ROOM & UNDER FLOOR)

Date:____________

Room Description ____
Dimensions (Ft) Length _____________ Height ______________ Width __________
Area ______________ Sq Ft Volume _________________________________
Ventilation Rate into Room ___________ Cubic Feet per Minute
Specific Volume At Design Temp. ____
Design Temp. ______________ Deg F Max. Temp Expected _____________ Deg F
Percent Design Concentration _________ lbs 1301 Required ______________
Number of Nozzles ______________ Sq Ft/Nozzle ____________________
Lbs 1301 to be Supplied/Nozzle ____________(Based on no air flow)
Discharge Time _________________________
Concentration at Design Temperature ________________________ percent
Concentration at Max Temperature ___________________________ percent

Concentration	Point A	Point B	Point C
0 Seconds after end of Discharge percent C	________	________	_________
5 Seconds after end of Discharge percent C	________	________	_________
10 Seconds after end of Discharge percent C	________	________	_________

TABLE I

HALON 1301 DATA (EACH ROOM & UNDER FLOOR)

15 Seconds after end of Discharge percent C ________ ________ _________
20 Seconds after end of Discharge percent C ________ ________ _________
25 Seconds after end of Discharge percent C ________ ________ _________
30 Seconds after end of Discharge percent C ________ ________ _________
40 Seconds after end of Discharge percent C ________ ________ _________
50 Seconds after end of Discharge percent C ________ ________ _________
60 Seconds after end of Discharge percent C ________ ________ _________
120 Seconds after end of Discharge percent C ________ ________ _________
Agent Tanks to be Supplied for test use ________________________Lb Each
Free Venting Requirements __________ lbs/SF allowable strength
this requires __________ sq. in. free venting area

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-21 23 00 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-21 21 03.00 10 (February 2009)
UFGS-21 23 00.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 21 - FIRE SUPPRESSION

SECTION 21 23 00

WET CHEMICAL FIRE EXTINGUISHING SYSTEMS

05/24

PART 3 EXECUTION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-21 23 00 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-21 21 03.00 10 (February 2009)
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 21 23 00

WET CHEMICAL FIRE EXTINGUISHING SYSTEMS
05/24

****

NOTE: This guide specification covers the requirements for wet chemical fire extinguishing systems that protect kitchen equipment and exhaust systems.

Adhere to UFC 1-300-02**: UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS) FORMAT STANDARD when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions, and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Ensure that system requirements conform to UFC 3-600-01**: FIRE PROTECTION ENGINEERING FOR FACILITIES and** NFPA 17A**: STANDARD FOR WET CHEMICAL EXTINGUISHING SYSTEMS. A concerted effort was put forth to ensure that requirements from NFPA 17A were not repeated within this UFGS section. NFPA 17A includes many specific requirements for designing, installing, and operating wet chemical fire extinguishing systems. Carefully review and comply with the requirements of NFPA 17A.**

****

****

NOTE: Tailoring options are used throughout this Section to differentiate between Army specific

requirements and those requirements applicable to all other entities. To ensure that all applicable requirements are included in the edited Section, ensure that you select either "ARMY" or "NON-ARMY" tailoring, as appropriate for your project. Do not leave both options unselected and do not select both options.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 17A	(2024) Standard for Wet Chemical Extinguishing Systems
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 96	(2024) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
NFPA 170	(2024; ERTA 1 2023) Standard for Fire

	Safety and Emergency Symbols

UL SOLUTIONS (UL)

UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SYSTEM DESCRIPTION

1.2.1 General

****

NOTE: Indicate the location of wet chemical containers, release mechanisms, manual actuators, wiring point of connection to the building fire alarm system or location of building fire alarm control unit, fuel shut-off valves, power shut-down equipment, and ductwork access doors on the Contract Drawings. Ensure the Contract Drawings clearly convey which and to what extent exhaust systems are to be protected.

****

Provide[a] new pre-engineered wet chemical fire extinguishing system[s] for the protection of[existing][and][new] cooking equipment including exhaust hoods, ducts, and related work where required by NFPA 96 or indicated on the Contract Drawings. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 17A and NFPA 96, except as modified herein. Also, comply with the required and advisory provisions of the manufacturer's installation manual, except as modified herein. Ensure that each system includes all materials, accessories, and equipment necessary to provide each system complete and ready for use.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in the project) and edit the following list and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed and approved by the Contractor's Quality Control System, and only submitted to the Government for reference. Only add a “G” to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Non-Army projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Provide all submittals to the Government, whether for approval or surveillance. Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification require Contractor Quality Control approval and are submitted to the Government for surveillance purposes. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

Supervisor's Qualifications; G, [_____]

Designer's Qualifications; G, [_____]

SD-02 Shop Drawings

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1.4 SUBMITTAL REQUIREMENTS

****

NOTE: Review Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in the project) to ensure specific quantities and formats of submittals are included therein as desired. Coordinate with the Government's Designated (or Service) Fire Protection Engineer (DFPE) and Contracting Officer on required quantities and formats to be provided.

****

Provide submittals in quantities, formats, and transmission means as dictated by Section 01 33 00 SUBMITTAL PROCEDURES. Draw floor plans to a scale no less than 1:100 1/8 inch equals one foot. Utilize NFPA 170 compliant symbols.

Submit Shop Drawings (SD-02) and Product Data (SD-03) simultaneously. Submit all Product Data as a single combined package. Partial submittals; SD-02 and SD-03 submittals not submitted simultaneously; SD-02 and SD-03 submittals submitted prior to SD-01 submittals approval; and submittals not fully complying with the requirements of applicable NFPA standards and the specification; are not acceptable.

1.4.1 Submittal Schedule

Submit all Preconstruction Submittals (SD-01) within [14][_____] days following Notice to Proceed and before any other classification of submittal. Provide submittals for SD-02[,][and] SD-03[,][SD-04][,][and][SD-05] no less than [21][_____] days prior to the proposed start of construction on the subject system. Provide other submittals as specified in other paragraphs of the specification.

1.4.2 Shop Drawings

Provide job specific shop drawings reflecting the actual proposed installation conditions for this project, prepared by a representative of the manufacturer to ensure compliance with the requirements listed herein and with all manufacturer's requirements and recommendations. Do not submit the manufacturer's generic system layout plans, details, and diagrams. Provide drawings that are compliant with the Plans section of NFPA 17A, consisting of system layout including assembly and installation details, electrical connection diagrams, and piping layout showing pipe sizes, lengths, and supports. Include any information on the drawings required to demonstrate that the system has been coordinated and will function as intended, and show system relationship to items being protected and clearances required for operation and maintenance. Also, include locations and connections of conduit, cables, manual actuators, fusible links, fuel shut-off valves, and power shut-off equipment on the drawings.

Include detail drawings for the following items:

a. Storage containers and mounting brackets

b. Fusible links, cables, conduits, corner pulleys, and link mounting frames or brackets

c. Release mechanisms

d. Valves

e. Discharge nozzles

f. Piping components

g. Manual actuators

h. Fuel and power shut-offs

i. Alarms, alarm devices, alarm interface(s), and control panels

1.4.3 Product Data

Provide manufacturer's product data sheets for each system component to be provided, including at least each item specified herein. Annotate product data sheets to indicate precise equipment that is to be provided, including an indication of all options selected. In addition, provide a complete equipment list that includes equipment description, model number, and quantity. Submit copies of current listings or approvals for all equipment furnished. Submit listing or approval documentation from a nationally recognized testing laboratory (NRTL) for each piece of equipment showing that such equipment is listed or approved for use in fire protection systems.

1.4.4 Test Reports

Submit reports for inspections and tests specified under paragraphs titled "FIELD QUALITY CONTROL". Submit test reports in booklet form showing field tests performed to prove compliance with the specified performance criteria upon completion and testing of the installed system. Document readings, test results, and the final position of controls on each test report.

1.4.5 Operation and Maintenance Instructions

****

NOTE: Edit brackets based on whether hard copy manuals (first bracketed options) or electronic only manuals (second bracketed options) will be provided.

****

Submit the Operating and Maintenance (O&M) Instructions indexed and in booklet form as a single[volume][file] or in separate[volumes][files]. Inscribe the following identification on the[cover][cover sheet]: the words "WET CHEMICAL FIRE EXTINGUISHING SYSTEMS OPERATION AND MAINTENANCE MANUAL", the name of the building, the number of the building, the name of the Contractor, the name of the system manufacturer, and the Contract number. Provide instructions that are legible and easily read, with full size drawings[folded in][included].

Provide submittals for SD-10 at least [21][_____] days prior to the proposed start of training. Do not provide training prior to approval of SD-10 submittals. Include at least the following in the Operation and Maintenance Instructions:

a. "Data Package Five" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Routine maintenance checklist arranged in a columnar format. List all installed devices, appliances, and components in the first column, state the maintenance activity or state no maintenance required in the second column, state the frequency of the maintenance activity in the third column, and provide a fourth column for additional comments or notes.

1.4.6 As-Built Drawings

Show the system as installed, including deviations from both the Contract Drawings and the approved shop drawings. Ensure the accuracy of the as-built drawings is plus or minus 150 millimeters (mm) 6 inches. Maintain redlined as-built mark-ups throughout the duration of construction and incorporate these mark-ups into the native drawing files for the final As-Built Drawings Submittal.

a. Prepare the drawings in the same format, size, and layout as the approved shop drawings.

b. Include complete wiring diagrams showing connections between devices, appliances, and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices, appliances, and equipment.

1.5 SPECIAL TOOLS AND SPARE PARTS

Furnish special tools necessary for the maintenance of the equipment. Submit spare parts data for each different item of material and equipment specified, after approval of shop drawings, and no later than [60][_____] days prior to the anticipated date of beneficial occupancy. Include a complete list of parts and supplies with the current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [one][_____] year[s] of service.

Furnish the following spare parts:

****

NOTE: Edit the list as desired by the contracting organization. Generally, spare parts are discouraged by UFC 1-300-02: UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS) FORMAT STANDARD, but some hard to replace or easily lost items may be warranted for inclusion.

****

a. [Five][_____] fusible links.

b. [Five][_____] release actuation cartridges.

c. [Five][_____] complete sets of system keys.

1.6 QUALITY ASSURANCE

1.6.1 Materials

Provide all labor, material, tools, and equipment necessary for and incidental to a complete and usable wet chemical fire extinguishing system.

****

NOTE: For OCONUS projects, use the blank brackets to insert local certification organizations that are considered equivalent to United States (U.S.) Nationally Recognized Testing Laboratories (NRTLs) for your project.

****

Ensure all devices, appliances, and equipment for fire protection service are listed or approved by [UL Fire Prot Dir, FM APP GUIDE, or another Nationally Recognized Testing Laboratory (NRTL) acceptable to the Government's Designated (or Service) Fire Protection Engineer (DFPE)][_____] for the intended use. For components that must function together to form a system, ensure they are listed or approved by the same NRTL.

1.6.2 Codes, Standards, and Manufacturer's Literature

Provide the system in accordance with NFPA 17A, NFPA 70, NFPA 96, and as specified herein. Interpret reference to "Authority Having Jurisdiction" to mean the Contracting Officer.

Follow all recommended installation and start-up practices stated in the manufacturer's literature or documentation.

1.6.3 Coordination of Trades

Coordinate each system with the equipment, hood, and exhaust ducts being protected along with other construction in order to eliminate any interference.

1.6.4 Qualifications

****

NOTE: Section 01 45 00 QUALITY CONTROL includes requirements related to the Fire Protection Quality Control Specialist (FPQC). Edit that Section as necessary to refine the requirements for the FPQC to the project. Coordinate with the DFPE to ensure edits meet their expectations. The intent is for the FPQC defined in the 01 45 00 QUALITY CONTROL Section to provide the review and oversight required by UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES. Only include the requirements related to that FPQC in the 01 45 00 QUALITY CONTROL Section; do not include them in this Section. The tailoring applied to all mentions of a Qualified Fire Protection Engineer (QFPE) in this Section is intentional. A QFPE, as discussed in this Section, is only required for Army projects and is in addition to the FPQC required by the 01 45 00 QUALITY CONTROL Section. The QFPE specified in this Section for Army projects is not permitted to also fulfill the role of FPQC as specified in the 01 45 00 QUALITY CONTROL Section.

****

1.6.4.1 Qualified Fire Protection Engineer (QFPE)

Provide the services of a Qualified Fire Protection Engineer (QFPE). A QFPE is an individual who is a licensed Professional Engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Ensure that the QFPE is an integral part of the construction team and is involved in every aspect of the system's submittals, installation, and testing. Ensure that the QFPE does not also serve as the Fire Protection Quality Control Specialist (FPQC) as defined by Section 01 45 00 QUALITY CONTROL. Submit the Qualified Fire Protection Engineer's Qualifications, including the name and documentation of qualifications of the proposed QFPE.

Ensure that the QFPE:

****

NOTE: UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES requires that shop drawings, calculations, and material data sheets bear the Professional Engineer seal and signature of the QFPE prior to submission to the FPQC for approval.

****

a. Reviews all required shop drawings, material data, calculations, qualifications, test procedures, test reports, as-built drawings, and O&M manuals for completeness and compliance with the provisions of the

Contract prior to submitting them to the FPQC. Ensure that construction (shop) drawings and calculations are prepared by, or prepared under the immediate supervision of, the QFPE. Affix the QFPE's Professional Engineer seal with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting them to the FPQC.

b. Performs in-progress construction surveillance prior to installation of ceilings (rough-in inspection)[or closure of trenches]. Performs at least [one][_____] interim site observation visit[s] prior to completion of installation, separate from the preliminary testing, to confirm that all systems are being installed in accordance with the Contract.

c. Witnesses and approves all preliminary and final functional performance testing and performs a final installation review.

d. Signs applicable certificates under SD-07.

1.6.4.2 Installer

Provide an Installer that is regularly engaged in the installation of the type and complexity of system specified herein. Submit the Installer's Qualifications including written certificate demonstrating that the wet chemical fire extinguishing system Installer has been regularly engaged in the installation of such systems meeting NFPA standards for a minimum of three years immediately preceding commencement of the Contract. Include proof of satisfactory performance on at least three projects similar to that required by these specifications, including the names and telephone numbers of using agency points of contact for each of these projects. Indicate the type of each system installed and include a written certification that each system has performed satisfactorily in the manner specified for a period of not less than 18 months following completion. Ensure Installer is able to provide service within 24 hours.

1.6.4.3 Supervisor

Provide the services of a qualified technician, factory trained, certified, and experienced in the installation and operation of the type of system being provided to supervise the installation, adjustment, preliminary testing and final testing of the system, and to provide instruction to Government maintenance and operating personnel.

Submit the Supervisor's Qualifications including name(s) of the Supervisor(s) who will oversee installation and testing of the system, and who will provide instruction to Government personnel, along with the manufacturer's certification of the qualifications of the proposed Supervisor(s).

1.6.4.4 Designer

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NOTE: Tailoring options are included in this paragraph to differentiate between the duties of the Designer under Army projects versus Non-Army projects.

****

****

NOTE: UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR

FACILITIES specifically requires that the Designer be certified by the National Institute for Certification in Engineering Technology (NICET). In order for a Designer holding a certification from another entity to be considered acceptable, they must request an equivalency be approved by the Component Fire Protection Engineer (CFPE).
****

Prepare shop drawings, product data, design data, O&M manual(s), and as-built drawings by, or under the direct supervision of, the Designer. Ensure that the Designer is an individual experienced with the types of work specified herein and currently certified by the National Institute for Certification in Engineering Technologies (NICET) as an engineering technician with Level IV certification in special hazards systems. Submit the Designer's Qualifications including the name and documentation of certification of the proposed Designer.

Ensure that the Designer:

a. Reviews all required shop drawings, material data, calculations, qualifications, test procedures, test reports, as-built drawings, and O&M manuals for completeness and compliance with the provisions of the Contract prior to submitting them to the FPQC.

b. Performs in-progress construction surveillance prior to installation of ceilings (rough-in inspection)[or closure of trenches]. Performs at least [one][_____] interim site observation visit[s] prior to completion of installation, separate from the preliminary testing, to confirm that all systems are being installed in accordance with the Contract.

c. Witnesses and approves all preliminary and final functional performance testing and performs a final installation review.

d. Signs applicable certificates under SD-07.

1.7 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

a. Provide system components that are the standard products of a manufacturer regularly engaged in the manufacturing of products that are of similar material, design, and workmanship, and that have been in satisfactory commercial or industrial use under similar circumstances and of similar size for at least two years before bid opening. Provide systems that are supported by a service organization.

b. Only use system components that are referenced in or permitted by the manufacturer's design, installation, and maintenance manual or alternative components that are listed for use with the specific extinguishing system.

2.2 PIPE AND FITTINGS

****

NOTE: If the piping between the hood and storage canister(s) is mounted against a porous surface (such as gypsum wallboard) that has a painted enamel finish, specify black steel. If the piping between the hood and the storage canister(s) is mounted to a stainless steel wall plate or other nonporous prefinished surface, specify chrome-plated or stainless steel. Do not specify galvanized pipe or fittings for use with wet chemical extinguishing systems.

****

Provide Schedule 40[stainless steel][,][or][chrome-plated steel][,][or][black steel] pipe. Provide standard weight[stainless steel][,][or][malleable iron][,][or][ductile iron][,][or][cast iron] fittings.[Stainless steel tubing is permitted if provided in accordance with the manufacturer's recommendations.] Do not provide galvanized pipe or fittings.

2.3 HANGERS AND SUPPORTS

Provide hangers and supports in accordance with the manufacturer's recommendations.

2.4 NOZZLES

Provide stainless steel nozzles and equip nozzles with an integral strainer to prevent matter inside the distribution piping from clogging the nozzle orifice. Provide each nozzle orifice with a cap to protect the nozzle from clogging by grease or other obstructions. Ensure that the cap detaches upon actuation.

2.5 WET CHEMICAL

Provide wet chemical that is appropriate for the particular hazard and system, and is recommended by the manufacturer of the system. Ensure that the wet chemical does not have an adverse effect on stainless steel during exposure periods of up to 24 hours.

2.6 AGENT CYLINDERS AND DISCHARGE VALVES

Provide the quantity and size of agent cylinder(s) required by the manufacturer for the hazard to be protected. Ensure the cylinder(s) is appropriately rated for the pressure anticipated and is compatible with the wet chemical being provided. Provide each cylinder with a discharge valve that is appropriate for the particular system and recommended by the manufacturer of the system.

2.7 SYSTEM CONTROLS

****

NOTE: This specification is written around providing a mechanical release type system. While pneumatic and electronic release type systems are available in the industry, they require additional cost to install and maintain, and the Government

personnel responsible for these systems are not as familiar with these other types of releasing systems.
****

2.7.1 Fusible Links

Provide fusible links for automatic mechanical actuation of the system. Ensure fusible links do not require any external power for operation. Select fusible link temperature rating based on the manufacturer's recommendations.

2.7.2 Manual Actuators

Provide manual actuators for manual mechanical actuation of the system. Ensure manual actuators do not require any external power for operation.

2.7.3 Release Mechanism

Provide a release mechanism to actuate the agent cylinder discharge valve upon operation of a fusible link or manual actuator.

2.7.4 Cables and Pulleys

Provide stainless steel cables with corner pulleys employing stainless steel ball bearings at all corners.

2.8 IDENTIFICATION SIGNS

[Provide the English translation on each sign provided in any language other than English.

]2.8.1 Manual Actuator Sign

Provide red rigid plastic signs with engraved 6 mm 0.25 inch high white lettering at each manual actuator. Include the verbiage "ACTUATE FIRE EXTINGUISHING SYSTEM" followed by a brief description of the equipment protected on each sign. Submit full manual actuator sign verbiage for approval with the Shop Drawings submittal.

2.8.2 Portable Fire Extinguisher Sign

Provide red rigid plastic signs with engraved 6 mm 0.25 inch high white lettering at each Class K portable fire extinguisher. Coordinate with the Contract Drawings and Section 10 44 16 FIRE EXTINGUISHERS for location and other requirements related to portable fire extinguishers. Include the verbiage "ACTUATE FIRE EXTINGUISHING SYSTEM PRIOR TO USING PORTABLE FIRE EXTINGUISHER" on the sign. Submit full portable fire extinguisher sign verbiage for approval with the Shop Drawings submittal.

PART 3 EXECUTION

3.1 INSTALLATION

Perform installation in accordance with the system manufacturer's instructions and NFPA 17A. Provide ductwork access doors where indicated on the Contract Drawings and at any item requiring service and inspection, including nozzles and fusible links. Provide ductwork access doors in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.1.1 System Controls

Arrange each system to be mechanically actuated by fusible links and by manual actuators connected to the extinguishing system release mechanisms by stainless steel cables. Enclose all cable and wiring in conduit. Provide operating instructions at all manual actuators.

Provide manual actuators in the normal path of egress, at least 3000 mm 10 feet, and no more than 6000 mm 20 feet, from the protected cooking appliances. Do not group manual actuators for different systems together.

3.1.2 Fire Alarm Integration

****

NOTE: UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES requires that fire extinguishing systems be monitored by the Installation's fire alarm reporting system. If the Installation is not equipped with a fire alarm reporting system, the fire extinguishing system must be monitored by a remote supervising station. Connect the fire extinguishing system to the building's fire alarm system, if provided. If the building has no fire alarm system, connect the fire extinguishing system directly to the Installation's fire alarm reporting system or a remote supervising station. If connection to the Installation's fire alarm reporting system or a remote supervising station is required, a separate specification should be developed to direct that portion of the work.

****

Configure the system(s) such that discharge of the wet chemical fire extinguishing system[activates the building's fire alarm control unit in the same manner as other fire alarm initiating devices][sends an alarm signal to the Installation's fire alarm receiving system][sends an alarm signal to a remote supervising station]. Supervise extinguishing system wiring in the same manner as other devices connected to the fire alarm[reporting] system.[

3.1.2.1 Existing Building Fire Alarm Control Unit

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NOTE: Use this paragraph only where connection to an existing building fire alarm system is required.

****

****

NOTE: Verify whether or not spare capacity is available in the existing building fire alarm system for the addition of the wet chemical fire extinguishing system. Where an existing fire alarm system does not have sufficient spare zone modules or capacity for additional addressable modules, consult with the DFPE for the means of resolution.

****

The existing building fire alarm control unit was manufactured by [_____], Model [_____], and presently has [[_____] spare zone modules][the capacity for [_____] additional addressable monitor modules]. Connect the wet chemical fire extinguishing system to [the zone currently serving [_____]][a spare zone module][a new addressable monitor module].]

3.1.3 Electrical Work

Except as modified herein, provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and NFPA 70.[Provide alarm signal wiring connected to the building fire alarm system in accordance with Section [28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE] and NFPA 70.] Provide wiring in rigid metal conduit or intermediate metal conduit, except electrical metallic tubing may be provided above suspended ceilings or exposed where not subject to mechanical damage.

3.1.4 System Diagrams And Instructions

Provide system diagrams and instructions that show the system layout and typed, condensed, normal and emergency operating procedures; methods for checking the system for normal, safe operation; and procedures for manual actuation; framed under glass or laminated plastic. After approval, post these items where directed by the Contracting Officer.

3.1.5 Pipe and Fittings

Prior to assembly, ream pipe and clean pipe internally by means of swabbing, using a suitable nonflammable cleaner. Once piping is assembled and prior to nozzle installation, blow out the entire piping system with nitrogen or dry air. Securely support the piping system with pipe hangers or brackets fastened to rigid surfaces, and ensure the piping system is not subjected to mechanical, chemical, or other damage. Install piping mounting brackets, hangers, and support fixtures in a manner that ensures nozzles are properly aligned and that prevents nozzles from being moved out of alignment. Provide a union between the extinguishing agent storage container and the supply line.

Provide fittings for direction changes in piping and for connections. Do not provide pipe thread tape or pipe jointing compound unless specifically recommended by the manufacturer.

[3.2 FIELD PAINTING

****

NOTE: Coordinate Section 09 90 00 PAINTS AND COATINGS with this paragraph.

****

Clean, pretreat, prime, and paint exposed black steel piping and associated fittings. Apply coatings to clean, dry surfaces, using clean brushes. Clean surfaces to remove dust, dirt, rust, and loose mill scale. Immediately after cleaning, provide the metal surfaces with one coat of zinc molybdate primer applied to a minimum dry film thickness of 25 micrometer (µm) one mil. Provide primed surfaces with[one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 25 µm one mil][two coats of paint to match adjacent surfaces]. Shield operating devices and other adjacent systems with protective coverings while painting is occurring. Upon completion of painting, remove protective coverings.

]3.3 FIELD QUALITY CONTROL

Test, inspect, and approve piping before covering or concealing. Perform integrated systems testing in accordance with NFPA 4.

3.3.1 Interim Construction Observation Visit[s]

Perform interim construction observation visit[s] when construction is[sufficiently underway to provide sufficient evidence of installation practices being followed, but not so far along as to cause major schedule delays to correct any deficiencies observed][approximately 50 percent complete]. Document each site observation visit with a separate site observation report documenting what was observed and any corrective actions required as a result of the visit. Submit site observation report(s) within [14][_____] days of conclusion of respective site observation visit.

3.3.2 Test Procedures

Submit detailed test procedures at least [30][______] days prior to proposed start of performing system tests. List all components of the installed system such as piping, hangers, hoses, nozzles, tanks, and actuating devices. Include sequence of testing, time estimate for each test, and sample test data forms. Provide test data forms in a check-off format (pass or fail with space to add applicable test data) and use them for the preliminary testing and the final testing. Provide test data forms that record the test results and:

a. Identify each test required by NFPA 17A Approval of Installations section; Inspection, Maintenance, and Recharging section; and herein; to be performed on each component, and describe how to perform the test.

b. Identify all test equipment and personnel required to perform each test.

c. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.3.3 Test Stages

3.3.3.1 Preliminary Tests

****

NOTE: Tailoring has been used in this paragraph to differentiate between Army and Non-Army requirements for who attends the preliminary testing.

****

After installation has been completed, actuate each system by both fusible link and by each manual actuator to demonstrate proper function of all components, including alarms and[fuel][and][power] shut-off. Actuate by fusible link as approved by the system manufacturer. Discharge contents of test containers, pressurized with either nitrogen or air to normal system operating pressure and of the same size as actual operating containers, into the system. Ensure that the seals on all nozzles release as during normal actuation. After each discharge, remove and disassemble the nozzles, and clean the strainers. Inspect and clean system piping. Verify all functions of system operation, including switches, shutdown of[fuel][and][power] to appliances protected by the system or served by the same ventilation system, uniform delivery of air or nitrogen to all nozzles, and activation of alarms. Replace nozzle seals after the preliminary tests are complete. In the event portions of the tests are unsuccessful, make repairs and repeat the entire test until successful. Ensure that the QFPE, as well as the Supervisor and an authorized representative from each supplier of equipment, are in attendance at the preliminary testing and sign off on the certification letter. Ensure that the Designer, as well as the Supervisor and an authorized representative from each supplier of equipment, are in attendance at the preliminary testing and sign off on the certification letter.

3.3.3.1.1 Preliminary Test Report

Submit a preliminary test report in booklet form, upon completion of testing. Document test results including repairs and adjustments made, and final test results, in the report. As a part of the report, provide a letter certifying that the installation is complete and fully operable. State in the letter that each actuation device was tested in place and functioned properly, that control functions were tested and operated properly, and include the names and titles of the witnesses to the preliminary tests. Along with the letter, include a request for formal inspection and tests. Notify the Contracting Officer in writing when the system is ready for final testing. Submit request for final test at least [30][_____] days prior to the proposed test date.

3.3.3.2 Final Testing

****

NOTE: The Government's representative to witness final testing may vary by project, by branch, by location, or by any other number of factors. Coordinate with the DFPE to ensure the appropriate Government Representative is specified herein.

****

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NOTE: The requirement to conduct an actual liquid discharge test comes from UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES.

****

****

NOTE: Tailoring has been used in this paragraph to differentiate between Army and Non-Army requirements for who attends the final testing.

****

Utilize the same test procedures as the preliminary tests for the final tests, except perform liquid discharge test using the manufacturer's recommended flushing concentrate to demonstrate equal distribution of chemical and no leakage at pipe joints. Provide each nozzle with a plastic container, hose, and hose fitting arranged to capture all liquid discharged. In the event portions of the tests are unsuccessful, make repairs and repeat the entire test until successful. Costs for witnessing of retesting incurred by the Government may be charged to the Contractor at the discretion of the Contracting Officer. Replace nozzle seals and return the system to normal operating condition after the final tests are complete. Reconnect the wet chemical container[s] and verify the connection[s][is][are] not leaking. Clean the extinguishing system and the equipment and duct protected by the extinguishing system after completion of testing. Repair any damage. Ensure that the final testing is witnessed by the [DFPE][Contracting Officer][_____] and the QFPE.Ensure that the final testing is witnessed by the [DFPE][Contracting Officer][_____] and the Designer. Ensure that the Supervisor is present to operate the system during tests.

3.3.3.2.1 Final Test Report

****

NOTE: Tailoring has been used in this paragraph to differentiate between Army and Non-Army requirements for who signs the final test report.

****

Provide a final test report including a letter certifying that the installation is complete and fully operable. Document test activities, including repairs and adjustments made, and final test results in the report. Also, record the final weight of each storage container. Include the names and titles of the witnesses to the final tests in the letter. Ensure that the QFPE, as well as the Supervisor, sign off on the letter. Ensure that the Designer, as well as the Supervisor, sign off on the letter. Submit the final test report within [14][_____] days of test completion.

3.3.4 System Acceptance

Following acceptance of the system, deliver as-built drawings and operating and maintenance (O&M) instructions (O&M Manuals) to the Contracting Officer for review and acceptance. Submit the drawings and manuals within [14][_____] days after the final testing of the system. Provide at least one set of as-built (marked-up) drawings at the time of, or prior to, the final testing for use in field verification.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Training

****

NOTE: Determine the number of hours of instruction based on the number and complexity of the systems specified.

****

3.4.1.1 Instruction of Government Personnel

Instruct Government operating and maintenance personnel, as designated by the Contracting Officer, for a minimum of [two][_____] total hours covering at least the following for all items of equipment provided under this Contract:

a. Theory of operation.

b. Procedures for start-up, operation, and shutdown.

c. Maintenance instructions.

d. Safety precautions.

e. Test procedures.

f. Field troubleshooting and diagnostic procedures.

g. Repair procedures for field repairs that can be made by replacing plug-in components.

Provide instruction by the manufacturer's technical representative at the project site using the documents specified in the paragraph entitled "Operation and Maintenance Manuals".

3.4.1.2 Recordings

Record all training presented on-site utilizing recording equipment acceptable to the Contracting Officer. Perform recording such that all visual aids are clearly visible and all discussion is clearly understandable. Provide record copies of the recordings to the Contracting Officer within [14][_____] days following completion of training.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-21 30 00 (April 2008)**
Change 1 - 08/13

Preparing Activity: USACE **Superseding**
UFGS-21 30 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 21 - FIRE SUPPRESSION

SECTION 21 30 00

FIRE PUMPS

04/08, CHG 1: 08/13

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-21 30 00 (April 2008)**
Change 1 - 08/13

Preparing Activity: USACE **Superseding**
UFGS-21 30 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 21 30 00

FIRE PUMPS
04/08, CHG 1: 08/13

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Note: This guide specification covers the requirements for fire pumps.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: Combustion engine drive must be provided, unless electric power is provided from two separate sources. Dual drive pumps are not permitted. The primary design references for fire pump installations are NFPA 20 Installation of Centrifugal Fire Pumps, Unified Facilities Criteria (UFC) 3-600-01 Design: Fire Protection Engineering for Facilities.

The Designer will coordinate this specification section with any applicable contract sprinkler system. The designer will provide a fully designed fire pump installation in all instances, including projects where the sprinkler system will be performance designed. The following information

will be included in the contract documents as the basis for any installation:

(1) All piping, valves, pipe hangers, and equipment including sizes will be indicated.

(2) Freeze protection and ventilation for the pump room or pump house.

(3) Where a pump has a diesel-engine-driver, the pump room or pump house will be protected by automatic sprinklers.

(4) The location of either the double-check valve or the reduced-pressure-principle backflow preventer where the potable water supply system is at risk of contamination by the fire pump(s). If required, backflow preventers will be installed on the discharge side of the pump.

(5) The sequence of operation for the pressure maintenance pump, the primary fire pump, and the secondary fire pump.

(6) An equipment schedule for the pressure maintenance pump, the primary fire pump, and the secondary fire pump that includes all pertinent information for the pumps and their respective drivers.

(7) Waterflow data including hydraulic flow graph and the location where the hydrant flow test was conducted, the location and size of existing mains and new water supply lines that will serve the fire pump(s) (including all supervisory valves), and the location and size of all risers.

(8) Other design considerations: Horizontal fire pumps will be provided only under a positive head and will not be used where a static suction or lift may be involved.

Vertical shaft pumps should take suction from a reliable source that serves a wet pit. Velocities of wet pits and approach channels serving vertical shaft turbine fire pumps will not exceed 0.3 m/s 1 ft/sec. Vertical shaft pumps mounted over and taking suction from tanks will be avoided.

Hose stream demands must be accounted for in the design so that the pump output will not be affected due to low suction pressure and deprive the sprinklers of water.

The size of the suction pipe should be such that the velocity does not exceed 4.5 m/s 15 ft/sec when pumps are operating at 150 percent capacity.

Pumps will be located at or above surrounding ground

level to avoid any possible impairment due to flooding.

Design will indicate pump units and base mounted on a raised reinforced concrete pad that is an integral part of an adequately reinforced and supported concrete floor. Vibration isolation for fire pump(s) will be in accordance with UFC 3-450-01, Noise and Vibration Control.

In most installations, fire pumps will be automatically activated by a change in water pressure in accordance with the recommended pressure settings listed in NFPA 20. Where the water supply pressure fluctuates to the extent that the pressure cannot be reliably used or where the water pressure is too low to activate the fire pumps, the pumps will be activated by waterflow in the sprinkler or fire protection system.

There may be conditions when manually stopping of the fire pump is required instead of automatic stopping. For example, NFPA 409, Standard on Aircraft Hangars, requires that fire pumps serving aircraft hangars be manually stopping only. For these special cases, Paragraph Sequence of Operation would require editing.

The following information will be shown on the project drawings:

1. Configuration, slope and sizes for each piping system;

2. Location and type of each pump, including associated equipment and appurtenances;

3. Capacity of each item of equipment, including showing the size of all floor drains and their locations. Ensure the minimum size floor drain is 150 mm 6 inches. Show the pitch of the floor also.

4. Locations and details for special supports for piping; and

5. For pipe larger than 300 mm 12 inches, details of anchoring piping including pipe clamps and tie rods.

For questions concerning system design in Navy projects, the Engineering Field Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer, should be consulted.

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1.1 SUMMARY

Except as modified in this Section or on the drawings, install fire pumps in conformance with NFPA 20, NFPA 70, and NFPA 72. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification governs. Devices and equipment for fire protection service must be UL Fire Prot Dir listed or FM APP GUIDE approved. Interpret all reference to the authority having jurisdiction to mean the Contracting Officer or the [_____] Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer for Navy projects.

1.2 SEQUENCING

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NOTE: The sequence of operation for each pump must be written in complete details to suit requirements for each project. Items that should be considered and specified as necessary in this paragraph include cut-in pressures, sequential starting arrangements, manual remote start features, AC power failure start, and provision of a pump starting circuit which is activated by deluge valve tripping.

For Navy projects use automatic shutdown of fire pump with running timer only after consultation with Engineering Field Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer.

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1.2.1 Primary Fire Pump

Provide primary fire pump that [automatically operates when the pressure drops to [758][_____] kPa [110][_____] psi] [automatically upon tripping of the [_____] sprinkler system][, [and][or] manually when the starter is operated]. [Provide pump[s] that continue to run until shut down manually.] [Provide pump[s] that automatically shut down after a running time of [_____] minutes unless manually shutdown.] The fire pump must automatically stop operating when the system pressure reaches [862][_____] kPa [125][_____] psi and after the fire pump has operated for the minimum pump run time specified herein.

1.2.2 Secondary Fire Pump

Operate secondary fire pump at 69 kPa 10 psi increments, set below the primary fire pump starting pressure. The fire pump must automatically stop running at [862][_____] kPa [125][_____] psi and after the fire pump has operated for the minimum pump run time. Prevent fire pumps from starting simultaneously and start sequentially at intervals of 5 to 10 seconds.

1.2.3 Pressure Maintenance Pump

Operate pressure maintenance pump when the system pressure drops to [793][_____] kPa [115][_____] psi. Stop pump automatically when the system pressure reaches [862][_____] kPa [125][_____] psi and after the pump has operated for the minimum pump run time specified herein.

1.3 FIRE PUMP INSTALLATION RELATED SUBMITTALS

The Fire Protection Specialist must prepare a list of the submittals, from the Contract Submittal Register, that relate to the successful installation of the fire pump(s), no later than [7] [_____] days after the approval of the Fire Protection Specialist and the Manufacturer's Representative.

Include a letter of approval signed and dated by the Fire Protection Specialist with the submittals identified on this list when submitted to the Government.

1.4 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250,

	and 300
ASME B31.1	(2024) Power Piping

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2024) Hypochlorites
AWWA B301	(2024) Liquid Chlorine
AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C606	(2022) Grooved and Shouldered Joints

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A536	(2024) Standard Specification for Ductile Iron Castings

ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A795/A795M	(2021) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B135/B135M	(2017) Standard Specification for Seamless Brass Tube
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 20	(2025) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 24	(2025) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 37	(2024) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 1963	(2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UL SOLUTIONS (UL)

UL 80	(2007; Reprint Oct 2024) Standard for Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids
UL 142	(2006; Reprint Jan 2021) UL Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service
UL 448	(2020) UL Standard for Safety Centrifugal Stationary Pumps for Fire-Protection Service
UL 1247	(2023) Diesel Engines for Driving Stationary Fire Pumps
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

[The [_____] Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer, will review and approve all submittals in this section requiring Government approval.]

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NOTE: For projects administered by the Pacific Division, Naval Facilities Engineering Systems Command, use the optional approval paragraph immediately below and delete the general approval statement above for Navy projects.

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[The [_____] Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer delegates the authority to the Quality Control (QC) Representative's U.S. Registered Fire Protection Engineer for review and approval of submittals required by this section. Submit to the [_____]

Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer one set of all approved submittals and drawings immediately after approval but no more later than 15 working days prior to final inspection.]

SD-01 Preconstruction Submittals

Fire Pump Installation Related Submittals

Fire Protection Specialist; G, [_____]

No later than [14] [_____] days after the Notice to Proceed and prior to the submittal of the fire pump installation drawings

SD-02 Shop Drawings

Installation Drawings; G, [_____]

[3] [_____] copies

As-Built Drawings; G, [_____]

Piping Layout; G, [_____]

Pump Room; G, [_____]

SD-03 Product Data

Catalog Data; G, [_____]

Spare Parts

Preliminary Tests

At least [14] [_____] days prior to the proposed date and time to begin Preliminary Tests

Field Tests; G, [_____]

At least 2 weeks before starting field tests

Manufacturer's Representative; G, [_____]

Field Training; G, [_____]

Army Final Acceptance Test

Navy Formal Inspection and Tests

SD-06 Test Reports

Preliminary Tests

[3] [_____] copies of the completed Preliminary Tests Reports, no later that [7] [_____] days after the completion of the Preliminary Tests.

Army Final Acceptance Test
Navy Formal Inspection and Tests; G, [_____]

SD-07 Certificates

Fire Protection Specialist

No later than [14] [_____] days after the Notice to Proceed and prior to the submittal of the fire pump installation drawings

Qualifications of Welders

Qualifications of Installer

Preliminary Test Certification

Final Test Certification

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

At least [14] [_____] days prior to conducting field training

Flow Meter

Submit Data Package 2 for flow meter and controllers in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6 EXTRA MATERIALS

Submit Spare Parts data for each different item of equipment and material specified. Include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor.

1.7 QUALITY ASSURANCE

1.7.1 Fire Protection Specialist

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NOTE: For Navy projects administered by the Pacific Division and Engineering Field Activity Chesapeake, Naval Facilities Engineering Systems Command, include this paragraph requiring the minimum qualification of a NICET Level-III technician for preparation of all fire protection system drawings.

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Perform work specified in this section under the supervision of and certified by the Fire Protection Specialist. Submit the name and documentation of certification of the proposed Fire Protection Specialists. The Fire Protection Specialist is an individual who is a registered professional engineer and a Full Member of the Society of Fire Protection Engineers or who is certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. Engage the Fire Protection Specialist regularly in the design and installation of the type and complexity of system specified in the Contract documents. The specialist is an individual who has served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.7.2 Qualifications of Welders

Submit certificates of each welder's qualifications prior to site welding; certifications more than one year old are not acceptable.

1.7.3 Qualifications of Installer

Prior to installation, submit data for approval showing that the Contractor has successfully installed fire pumps and associated equipment of the same type and design as specified herein, or that he has a firm contractual agreement with a subcontractor having such required experience. Include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months.

1.7.4 Preliminary Test Certification

When preliminary tests have been completed and corrections made, submit a signed and dated certificate with a request for a formal inspection and tests.

1.7.5 Final Test Certification

Concurrent with the Final Acceptance Test Report, submit certification by the Fire Protection Specialist that the fire pump installation is in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports.[Submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.]

1.7.6 Manufacturer's Representative

Perform work specified in this section under the supervision of and certified by a representative of the fire pump manufacturer. Submit the name and documentation of certification of the proposed Manufacturer's Representative, concurrent with submittal of the Fire Protection Specialist Qualifications. Engage the Manufacturer's Representative regularly in the installation of the type and complexity of fire pump(s) specified in the Contract documents. The representative is an individual who has served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.8 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. Additionally, either cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

a. Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicates items that have been in satisfactory use for at least 2 years prior to bid opening.

b. Submit manufacturer's catalog data included with the Fire Pump Installation Drawings for each separate piece of equipment proposed for use in the system. Indicate the name of the manufacturer of each item of equipment, with data annotated to indicate model to be provided. In addition, provide a complete equipment list that includes equipment description, model number and quantity. Catalog data for material and equipment includes, but is not limited to, the following:

   (1) Fire pumps, drivers and controllers including manufacturer's certified shop test characteristic curve for each pump. Shop test curve may be submitted after approval of catalog data but must be submitted prior to the final tests.

   (2) Pressure maintenance pump and controller.

   (3) Piping components.

   (4) Valves, including gate, check, globe and relief valves.

   (5) Gauges.

   (6) Hose valve manifold test header and hose valves.

   (7) Flow meter.

   (8) Restrictive orifice union.

   (9) Associated devices and equipment.

c. Provide a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, [contract number and accepted date; capacity or size; system in which installed and system which it controls] and catalog number for all equipment. Affix standard nameplates securely in a conspicuous place and easy to read to pumps and motors. Provide nameplates and markings in accordance with UL 448. Provide nameplate and markings in accordance with UL 1247 for diesel driver. Provide electric motor nameplates with the minimum information required by NFPA 70, Section 430-7.

2.2 FIRE PUMP

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NOTE: In selecting rated head pressures of fire pumps, the fact that horizontal split case fire pumps and vertical turbine fire pumps develop 140 percent of rated head pressure when operating under shutoff or "churn" conditions should be considered. Maximum desired fire pump rated head pressures are 862 kPa 125 psig for horizontal split case pumps and 690 kPa 100 psig for vertical turbine pumps.

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Provide [electric motor driven] [diesel engine driven] fire pump. Provide pump capacity rated at [_____] L/second gpm with a rated net pressure of [_____] kPa psi. Furnish no less than 150 percent of rated flow capacity at not less than 65 percent of rated net pressure. Provide centrifugal [horizontal split case][water lubricated, vertical shaft turbine][end-suction][in-line] fire pump. Equip horizontal pump with automatic air release devices. Use maximum rated pump speed of 2100 rpm when driving the pump at rated capacity. Provide pump that is [automatic start and manual stop][manual pushbutton start and stop][automatic start and automatic stop]. Provide pump conforming to the requirements of UL 448. Ensure fire pump discharge and suction gauges are oil-filled type.

2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

2.3.1 General Requirements

Provide Materials and Equipment that have been tested by Underwriters Laboratories, Inc. and are listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, such means listed in UL Fire Prot Dir or FM APP GUIDE.

2.3.2 Alarms

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NOTE: Power for alarms must be from a source other than the engine starting batteries and must not exceed 125 volts. Do not supply power from the same circuit supplying power to the fire pump controllers or from an emergency circuit.

The preferred arrangement for detecting an abnormal pump condition is via a remote pump trouble panel located in a constantly attended space. The preferred locations for this panel are the Fire Department or Fire Alarm Headquarters. Other locations which are acceptable, providing they are constantly attended, include Public Works Trouble Desks, Duty Water Offices, and Power Plant Control Stations.

For installations where there is a base fire alarm system which is capable of distinguishing between alarms and supervisory signals (e.g., radio systems, multiplex systems, digital alarm communication systems, or other supervised systems with similar capabilities,) the preferred method of remote pump supervision is via the supervised alarm system, not via a remote pump trouble panel. A remote pump panel should be used only as a last resort, and only if the wiring between the pump and the panel is supervised in accordance with NFPA 72.

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Provide audible and visual alarms as required by NFPA 20 on the controller. Provide remote supervision as required by NFPA 20, in accordance with NFPA 72 under Section [_____]. Provide remote alarm devices located [at [_____]][as indicated]. Activate alarm signal upon the following conditions: [electric motor controller has operated into a pump running condition, loss of electrical power to electric motor starter, and phase reversal on line side of motor starter] [engine drive controller has operated into an engine running condition, engine drive controller main switch has been turned to OFF or to MANUAL position, trouble on engine driven controller or engine]. Provide weatherproof exterior alarm devices. Provide alarm silencing switch and red signal lamp, with signal lamp arranged to come on when switch is placed in OFF position.

2.4 UNDERGROUND PIPING COMPONENTS

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NOTE: The drawings must show the service connection details and the piping from the water supply. The drawings must show details of the water service point-of-entry into the pump room or pump house and through the floor slab, and underground piping restraints, including number and size of restraining rods and thrust blocks.

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2.4.1 Pipe and Fittings

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NOTE: In last sentence, use first phrase in brackets for connection to existing water distribution system; delete first phrase in brackets only for connection to new water distribution system. For pipe larger than 300 mm 12 inches, detail methods for anchoring piping including pipe clamps and tie rods. Consult NFPA 24 for required depth of coverage of buried fire mains.

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Provide outside-coated, cement mortar-lined, ductile-iron pipe (with a rated working pressure of [1034][1207][_____] kPa [150][175][_____] psi) conforming to NFPA 24 for piping under the building and less than 1.50 m 5 feet outside of the building walls. Anchor the joints in accordance with NFPA 24; provide concrete thrust block at the elbow where the pipe turns up toward the floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. Provide minimum pipe size of 150 mm 6 inches. Provide minimum cover depth as required by NFPA 24, but no less than 1 m 3 feet. Piping more than 1.50 m 5 feet outside of the building walls must be [outside coated, AWWA C104/A21.4cement mortar-lined, AWWA C151/A21.51 ductile-iron pipe, and AWWA C110/A21.10 fittings conforming to NFPA 24][provided under Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING].

2.4.2 Fittings and Gaskets

Provide ductile iron fittings conforming to AWWA C110/A21.10. Provide gaskets that are suitable in design and size for the pipe with which such gaskets are to be used. Provide gaskets for ductile iron pipe joints conforming to AWWA C111/A21.11.

2.4.3 Valves and Valve Boxes

Provide gate valves conforming to AWWA C500 or UL 262. Provide valves with cast-iron body and bronze trim and that open by counterclockwise rotation. Except for post indicator valves, provide all underground valves with an adjustable cast-iron or ductile iron valve box of a size suitable for the valve on which the box is to be used, but no less than 133 mm 5.25 inches in diameter. Coat the box with bituminous coating. Provide a cast-iron or ductile-iron cover with the word "WATER" cast on the cover for each box.

2.4.4   Gate Valve and Indicator Posts

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NOTE: This paragraph will be deleted if underground valves are either not required or are specified elsewhere.

The Air Fore requires tamper switches on the indicator posts.

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Provide inside screw type gate valves for underground installation with counterclockwise rotation to open. Where indicating type valves are shown or required, use indicating valves consisting of gate valves with an approved indicator post of a length to permit the top of the post to be located 900 mm 3 feet above finished grade. Provide gate valves and indicator posts with one coat of primer and two coats of red enamel paint and that are listed in UL Fire Prot Dir or FM APP GUIDE.

2.4.5   Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping for all buried piping. Ensure tape is detectable by an electronic detection instrument. Provide tape in rolls, 80 mm 3 inches minimum width, color-coded for the utility involved and imprinted in bold black letters continuously and repeatedly over the entire tape length. Warning and identification must be "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and lettering that is unaffected by moisture and other substances contained in the trench backfill material. Bury tape at a depth of 300 mm 12 inches below the top surface of earth or the top surface of the subgrade under pavement.

2.5   ABOVEGROUND PIPING COMPONENTS

2.5.1   Pipe Sizes 65 mm 2.5 inches and Larger

2.5.1.1   Pipe

Provide piping consisting of [ASTM A53/A53M][ASTM A795/A795M], Weight Class STD (Standard), Schedule 40 (except for Schedule 30 for pipe sizes 200 mm 8 inchesand greater in diameter), Type E or Type S, Grade A; black steel pipe. Join steel pipe by means of flanges welded to the pipe or mechanical grooved joints only. Do not join piping by welding or weld fittings. Galvanize suction piping on the inside in accordance with NFPA 20.

2.5.1.2   Grooved Mechanical Joints and Fittings

Provide joints and fittings that are designed for no less than 1200 kPa 175 psi service and are the product of the same manufacturer. Provide malleable iron fitting and coupling houses conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12. Provide flush type gasket that fills the entire cavity between the fitting and the pipe. Provide cadmium plated or zinc electroplated, heat-treated steel nuts and bolts conforming to ASTM A183.

2.5.1.3 Flanges

Provide ASME B16.5, Class 150 flanges. Provide flanges at valves, connections to equipment, and where indicated.

2.5.1.4 Gaskets

Provide AWWA C111/A21.11, cloth inserted red rubber gaskets.

2.5.1.5 Bolts

Provide [ASTM A449, Type [1][2]][ASTM A193/A193M, Grade B7] bolts. Do not extend bolts less than three full threads beyond the nut with bolts tightened to the required torque.

2.5.1.6 Nuts

Provide [ASTM A194/A194M, Grade 7][ASTM A193/A193M, Grade 5][ASTM A563M ASTM A563, Grade [C3][DH3]] nuts.

2.5.1.7 Washers

Provide washers meeting the requirements of ASTM F436M ASTM F436. Provide flat circular washers under all bolt heads and nuts.

2.5.2 Piping Sizes 50 mm 2 inches and Smaller

2.5.2.1 Steel Pipe

Provide [ASTM A795/A795M, Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A][ASTM A53/A53M, Weight Class XS (Extra Strong)], zinc-coated steel pipe with threaded end connections. Provide [ASME B16.3][ASME B16.39], Class 150, zinc-coated threaded fittings. Provide ASME B16.39, Class 150, zinc-coated unions.

2.5.2.2 Copper Tubing

Provide copper tubing that is ASTM B88M ASTM B88, Type L or K, soft annealed. Provide ASME B16.26, flared joint fittings. Provide pipe nipples consisting of ASTM B42 copper pipe with threaded end connections.

2.5.3 Pipe Hangers and Supports

Provide adjustable hangers and supports that are [MSS SP-58][UL listed UL Fire Prot Dir or FM approved FM APP GUIDE]. Finish of rods, nuts, washers, hangers, and supports must be zinc-plated after fabrication.

2.5.4 Valves

Provide valves that are UL listed UL Fire Prot Dir or FM approved FM APP GUIDE for fire protection service and with flange or threaded end connections.

2.5.4.1 Gate Valves and Control Valves

Provide outside screw and yoke (O.S.&Y.) type gate valves and control valves which open by counterclockwise rotation. Butterfly-type control valves are not permitted.

2.5.4.2 Tamper Switch

****

NOTE: Provide tamper switches on control valves when preferred by the user or when valves are subject to tampering. An alternate allowed by NFPA is to lock OS& Y valves open with chain and padlock.

****

Equip the suction control valves, the discharge control valves, valves to test header and flow meter, and the by-pass control valves with valve tamper switches for monitoring by the fire alarm system.

2.5.4.3 Check Valve

Check valve must be clear open, swing type check valve with flange or threaded inspection plate.

2.5.4.4 Relief Valve

****

NOTE: Piping of a relief valve back to the pump suction connection should be avoided except when it is not possible to dispose of the discharge water. In such cases, the relief valve discharge piping tee connection to the suction should have its centerline plane perpendicular to the pump shaft. The tee connection should be at least 10 diameters from the pump suction flange.

****

Provide [pilot operated][or][spring operated] type relief valve conforming to NFPA 20. Provide a means of detecting water motion in the relief lines where the discharge is not visible within the pump house.

2.5.4.5 Circulating Relief Valve

Provide an adjustable circulating relief valve for each fire pump in accordance with NFPA 20.

2.5.4.6 Suction Pressure Regulating Valve

****

NOTE: Delete suction pressure regulating valve unless required for the specific water supply.

When an oversized pump has been installed on a water distribution system, the pump should satisfy the demand without drawing the residual pressure of the water system below a safe level, which is normally between 69 and 138 kPa 10 and 20 psi. A pilot-controlled, hydraulically-actuated, minimum suction pressure sustaining valve may be necessary when suction pressures can be drawn down to unsafe levels. These valves are provided on the discharge line of the fire pump. The pump suction pressure is monitored through a pressure line to the controlling mechanism of the regulating valve.

****

Provide suction pressure regulating valve that is FM approved FM APP GUIDE. Monitor suction pressure through a pressure line to the controlling mechanism of the regulating valve. Arrange valve in accordance with the manufacturer's recommendations.

2.5.5 Hose Valve Manifold Test Header

****

NOTE: Use this paragraph for Navy projects.

A detail of the hose valve manifold test header must be indicated on the contract drawings showing supply arrangement, size of header supply piping, number of hose valves, valve arrangement, and test header location. Where possible, a "straight line manifold" test header which allows the pump to be tested without the use of fire hoses should be provided in lieu of the standard "rosebud" test header. The straight line manifold test header is not a stock item and must be shop fabricated in accordance with the contract drawings. In lieu of the hose valve manifold test header, this paragraph may be changed to specify an inline water metering device in accordance with NFPA 20, subject to the approval of the Engineering Field Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer.

****

Construct header of steel pipe. Provide ASME B16.5, Class 150 flanged inlet connection to hose valve manifold assembly. Provide approved bronze hose gate valve with 65 mm 2.5 inch National Standard male hose threads with cap and chain; locate one meter 3 feet above grade in the horizontal position for each test header outlet. Ensure welding is metallic arc process in accordance with ASME B31.1.

2.5.6 Pipe Sleeves

Provide a pipe sleeve at each location where piping passes entirely through walls, ceilings, roofs, and floors, including pipe entering buildings from the exterior. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, and floors. Provide 25 mm one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of the sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, provide a fire seal between the pipe and the sleeve in accordance with Section 07 84 00 FIRESTOPPING.

a. Sleeves in Masonry and Concrete Walls, Ceilings, Roofs, and Floors: Provide hot-dip galvanized steel, ductile-iron, or cast-iron pipe sleeves. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves provided that cavities in the core-drilled hole be completely grouted smooth.

b. Sleeves in Other Than Masonry and Concrete Walls, Ceilings, Roofs, and

Floors: Provide galvanized steel sheet pipe not less than 4.4 kg/square m 0.90 psf.

2.5.7 Escutcheon Plates

Provide one-piece or split-hinge metal plates for piping entering floors, walls, and ceilings in exposed areas. Provide polished stainless steel or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on plates in unfinished spaces. Secure plates in place.

2.6 DISINFECTING MATERIALS

2.6.1 Liquid Chlorine

Provide liquid chlorine conforming to AWWA B301.

2.6.2 Hypochlorites

Provide calcium hypochlorite and sodium hypochlorite conforming to AWWA B300.

2.7 ELECTRIC MOTOR DRIVER

****

NOTE: The design of the power supply to the electric drive fire pumps will comply with Chapter 6 of NFPA 20 and to NFPA 70. The fire pump power supply and fire pump power supply circuits and feeders will be indicated and detailed on the drawings.

Power supply protective devices installed in the power supply circuits and in the fire pump feeder circuits will be designed not to open at the sum of the locked rotor currents (continuous) of the fire pump motor and any other maximum loads on the circuit per NFPA 20.

Fire pump feeder circuit conductors will be physically routed outside of the building(s), excluding the electrical switchgear room and the pump room. When the fire pump feeder conductors must be routed through buildings, they will be buried or enclosed by 50 mm 2 inches of concrete or equivalent fire-rated construction.

Designer will indicate and detail the grounding of the controller per NFPA 20.

****

Provide motors, controllers, contactors, and disconnects with their respective pieces of equipment, as specified herein and provide electrical connections under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide controllers and contactors with a maximum of 120-volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, include the cost of providing additional electrical service and related work under this section. Provide motor conforming to NEMA MG 1 Design B type. Provide premium efficiency type integral size motors in accordance with NEMA MG 1. Provide motor wattage horsepower of sufficient size so that the nameplate wattage horsepower rating will not be exceeded throughout the entire published pump characteristic curve. The motor and fire pump controller must be fully compatible.

2.8 DIESEL ENGINE DRIVER

****

NOTE: Special caution must be exercised in specifying power requirements because, once a proper pump is selected, only that diesel engine driver in the UL Fire Protection Equipment Directory corresponding to pump requirements is acceptable. Selection of a specific power may then further limit the suppliers of the equipment. Where diesel-engine-driven pumps are provided because reliable electrical power is not available to the pump, design the pump room so that electrical power is not required to supply ventilation required for engine operation or engine cooling, or provide two totally independent sources of

Ambient design temperature will be based on 6 degrees C 10 degrees F above the 2-1/2 percent summer design dry bulb temperature in UFC 3-400 02 Engineering Weather Data.

****

Provide diesel engine driver conforming to the requirements of UL 1247 which is UL listed UL Fire Prot Dir or FM approved FM APP GUIDE for fire pump service. Driver must be of the make recommended by the pump manufacturer. The engine must be closed circuit, liquid-cooled [with raw water heat exchanger][with radiator and engine-driven fan]. Diesel engine must be electric start type taking current from 2 battery units. Equip engine with a fuel in-line filter-water separator. Monitor engine conditions with engine instrumentation panel that has a tachometer, hour meter, fuel pressure gauge, lubricating oil pressure gauge, water temperature gauge, and ammeter gauge. Connect engine to horizontal-shaft pump by flexible couplings. For connections to vertical-shaft fire pumps, use right-angle gear drives and universal joints. Provide an engine jacket water heater to maintain a temperature of 49 degrees C 120 degrees F in accordance with NFPA 20.

2.8.1 Engine Capacity

Provide engine with adequate wattage horsepower to drive the pump at all conditions of speed and load over the full range of the pump performance curve. Provide wattage horsepower rating of the engine driver as recommended by the pump manufacturer and derate for temperature and elevation in accordance with NFPA 20. Provide ambient temperature at the pump location of [_____] degrees C degrees F. Site elevation must be [_____] meters feet above mean sea level (MSL).

2.8.2 Exhaust System External to Engine

****

NOTE: Indicate and specify adequate safeguards for exhaust piping passing through walls and roof. Provide suitable thimble and clearance when pipe passes through combustible construction or roofing.

****

Provide exhaust system complying with the requirements of NFPA 20 and NFPA 37. Provide an exhaust muffler for each diesel engine driver to reduce noise levels less than [85][95] dBA. Provide a flexible connector with flange connections at the engine. Use stainless steel flexible sections suitable for diesel-engines exhaust gas at 538 degrees C 1000 degrees F.

2.8.2.1 Steel Pipe and Fittings

ASTM A53/A53M, [Schedule 40][Weight Class XS (Extra Strong], black steel, welding end connections. Provide ASME B16.9 or ASME B16.11 welding fittings of the same material and weight as the piping.

2.8.2.2 Flanges

ASME B16.5, Class [300][150]. Provide flanges at connections to diesel engines, exhaust mufflers, and flexible connections. Provide gaskets that are ASME B16.21, composition ring, 1.5875 mm 0.0625 inch. Provide ASTM A193/A193M, Grade [B8][B7] bolts and ASTM A194/A194M, Grade [8][7] nuts.

2.8.2.3 Piping Insulation

Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Products containing asbestos will not be permitted. Insulate exhaust piping system including the muffler with ASTM C533 calcium silicate insulation, minimum of 75 mm 3 inches. Secure insulation with no less than 9.525 mm 0.375 inch width fibrous glass reinforced waterproof tape or Type 304 stainless steel bands spaced no more than 200 mm 8 inches on center. Provide an aluminum jacket encasing the insulation. Provide aluminum jacket with a minimum thickness of 0.406 mm 0.016 inches, a factory-applied polyethylene and kraft paper moisture barrier on the inside surface. Secure the jacket with no less than 13 mm 0.5 inch wide stainless steel bands, spaced no less than 200 mm 8 inches on centers. Lap longitudinal and circumferential seams of the jacket no less than 75 mm 3 inches. Install jackets on horizontal line so that the longitudinal seams are on the bottom side of the pipe. Place the seams of the jacket for the vertical lines on the off-weather side of the pipe. On vertical lines, overlap the circumferential seams of the jacket so the lower edge of each jacket overlaps the upper edge of the jacket below.

2.9 FIRE PUMP CONTROLLER

****

NOTE: The designer will coordinate with the base fire department any connections required from the fire pump controller and alarms to a central alarm panel (usually located in the fire department that services the area where the pump is installed). Details regarding this connection will be shown on the drawings.

****

Provide automatic type controller which is UL listed UL Fire Prot Dir or FM approved FM APP GUIDE for fire pump service. Arrange pump for automatic start and stop, and manual push-button stop. Accomplish automatic stopping only after all starting causes have returned to normal and after a minimum pump run time has elapsed. Provide controllers that are completely terminally wired, ready for field connections, and mounted in a [NEMA Type 2 drip-proof][NEMA Type 4 watertight and dust tight] enclosure arranged so that controller current carrying parts will not be less than 300 mm 12 inches above the floor. Provide controller with voltage surge arresters installed in accordance with NFPA 20. Equip controller with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments, automatic starting relay actuated from normally closed contacts, visual alarm lamps and supervisory power light. Equip controller with a thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 5 degrees C 40 degrees F [Equip controller with a sequential start timer/relay feature to start multiple fire pumps in sequence.][Provide controller which is factory-equipped with a heater operated by thermostat to prevent moisture in the cabinet.]

2.9.1 Controller for Electric Motor Driven Fire Pump

****

NOTE: Designer will determine requirement for across-the-line or reduced voltage starting. If reduced voltage starting is needed, designer must determine most suitable type or types. Selections should be based on the motor size, electrical system capacity and characteristics, etc. Fire pumps that are served by back-up generators should be equipped with electronic soft start or auto-transformer reduced voltage type controller.

****

Controller must be [electronic soft start][across the line][auto-transformer][wye-delta, open circuit transition][wye-delta, closed circuit transition] starting type. Design controller [for [_____] kW HP at [_____] volts][as indicated]. Provide controller[and transfer switch] with a short circuit rating [of [_____] amps r.m.s. symmetrical at [_____] volts a.c.][as indicated].[Provide an automatic transfer switch (ATS) for each fire pump in compliance with NFPA 20 and specifically listed for fire pump service. The ATS must transfer source of power to the alternate source upon loss of normal power.] Controller must monitor pump running, loss of a phase or line power, phase reversal[, low reservoir] and pump room temperature. Display alarms individually in front of panel by lighting of visual lamps. Label each lamp with rigid etched plastic labels. Equip controller with terminals for remote monitoring of pump running, pump power supply trouble (loss of power or phase and phase reversal), and pump room trouble (pump room temperature [and low reservoir level]), and for remote start. Limited service fire pump controllers are not permitted, except for fire pumps driven by electric motors rated less than 11 kW 15 hp. Equip controller with a 7-day electric pressure recorder with 24-hour spring wound back-up. Provide a readout of the system pressure from 0 to 207 Pa 0 to 15 hp, time, and date. Controller must require the pumps to run for ten minutes for pumps with driver motors under 149 kW 200 horsepower and for 15 minutes for pumps with motors 149 kW 200 horsepower and greater, prior to automatic shutdown. Equip the controller with an externally operable isolating switch which manually operates the motor circuit. Provide means in the controller for measuring current for all motor circuit conductors.

2.9.2 Controller for Diesel Engine Driven Fire Pump

****

NOTE: Pump alarms will be constantly monitored and will usually require transmission to a constantly attended location. Pump alarms may be monitored by the building alarm system or base fire reporting system. Designer will indicate and specify remote alarm transmission devices, controls, conductors, conduit, connections, etc. Pump running, loss of pump power, and pump room trouble alarms must be remotely transmitted for electric fire pumps. Pump running, main switch mis-set, engine trouble, pump room trouble will be remotely transmitted for diesel fire pumps. Designer should coordinate transmission of alarms with the base fire department.

****

Controller must require the pump to run for 30 minutes prior to automatic shutdown. Equip controller with two battery chargers; two ammeters; two voltmeters, one for each set of batteries. Automatically alternate the battery sets for starting the pumps. Equip the controller with the following supervisory alarm functions:

a. Engine Trouble (individually monitored)

    (1) Engine overspeed

    (2) Low Oil Pressure

    (3) High Water Temperature

    (4) Engine Failure to Start

    (5) Battery

    (6) Battery Charger/AC Power Failure

b. Main Switch Mis-set

c. Pump Running

d. Pump Room Trouble (individually monitored)

    (1) Low Fuel

    (2) Low Pump Room Temperature

    (3) Low Reservoir Level

Display alarms individually in front of panel by lighting of visual lamps, except that individual lamps are not required for pump running and main switch mis-set. Equip controller with a 7-day electric pressure recorder with 24-hour back-up mounted inside the controller. Provide a readout of the system pressure from 0 to 207 Pa 0 to 300 psi, time, and date. Equip the controller with an audible alarm which will activate upon any engine trouble or pump room trouble alarm condition and alarm silence switch. Equip the controller with terminals for field connection of a remote alarm for main switch mis-set, pump running, engine trouble and pump room trouble; and terminals for remote start. When engine emergency overspeed device operates, the controller must cause the engine to shut down without time delay and lock out until manually reset.

2.10 BATTERIES

Provide sealed lead calcium batteries for diesel engine driver. Mount batteries in a steel rack with non-corrosive, non-conductive base, no less than 300 mm 12 inches above the floor.

2.11 PRESSURE SENSING LINE

Provide a completely separate pressure sensing line for each fire pump and for the jockey pump. Arrange the sensing line in accordance with Figure A-7-5.2.1. of NFPA 20. Provide sensing line of 13 mm 1/2 inchH58 brass tubing complying with ASTM B135/B135M. Equip the sensing line with two restrictive orifice unions each. Provide restricted orifice unions consisting of ground-face unions with brass restricted diaphragms drilled for a 2.4 mm 3/32 inch. Mount restricted orifice unions in the horizontal position, no less than 1.5 m 5 feet apart on the sensing line. Provide two test connections for each sensing line. Test connections consist of two brass 13 mm 1/2 inch globe valves and 8 mm 1/4 inch gauge connection tee arranged in accordance with NFPA 20. Equip one of the test connections with a 0 to 2100 kPa 0 to 300 psi water oil-filled gauge. Connect sensing line to the pump discharge piping between the discharge piping control valve and the check valve.

2.12 PRESSURE MAINTENANCE PUMP

****

NOTE: Include this item when it is required that a higher pressure be provided in the water system than that available from primary protection supplies such as elevated storage tanks, standpipes, and city water mains.

****

2.12.1 General

Provide pressure maintenance pump that is electric motor driven,[horizontal shaft][or][in-line vertical shaft,] centrifugal type with a rated discharge of [0.63][_____] L/second [10][_____] gpm at [862][_____] kPa [125][_____] psig. Pump must draft [from the suction supply side of the suction pipe gate valve of the fire pump][as indicated] and discharge into the system at the downstream side of the pump discharge gate valve. Provide an approved indicating gate valve of the outside screw and yoke (O.S.&Y.) type in the maintenance pump discharge and suction piping. Provide oil-filled water pressure gauge and approved check valve in the maintenance pump discharge piping. Provide swing type check valve with removable inspection plate.

2.12.2 Pressure Maintenance Pump Controller

Arrange pressure maintenance pump controller for automatic and manual starting and stopping and equip with a "manual-off-automatic" switch. Provide controller which is completely prewired, ready for field connections, and wall-mounted in a NEMA Type 2 drip-proof enclosure. Equip the controller with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments for automatic starting and stopping. Provide a sensing line connected to the pressure maintenance pump discharge piping between the control valve and the check valve. Provide sensing line conforming to paragraph, PRESSURE SENSING LINE. The sensing line must be completely separate from the fire pump sensing lines. Provide an adjustable run timer to prevent frequent starting and stopping of the pump motor. Set the run timer for [2][_____] minutes.

2.13 DIESEL FUEL SYSTEM EXTERNAL TO ENGINE

****

NOTE: Fuel supply system for the diesel engine must be shown and detailed on the drawings. Design will follow the recommended design listed in the appendix of NFPA 20. Fuel tanks will be sized to have a capacity at least 5.1 L/kw 1 gallon per horsepower plus 10 percent. Larger tanks or a reserve supply with transfer facilities may be needed where prompt refilling is unlikely. Provide a separate fuel tank for each pump. Tanks will be located in the pump room. For tanks located above the lowest story, cellar or basement, the designer will provide proper fuel containment such as a sealed containment curbs or walls that will contain the entire volume of each tank. Delete low reservoir level alarm where it is not needed.

****

Provide fuel system that meets all requirements of NFPA 20 and NFPA 37. Equip fuel tank vent piping with screened weatherproof vent cap. Extend vents to the outside. Equip each tank with a fuel level gauge. Provide flexible bronze or stainless steel piping connectors with single braid at each piping connection to the diesel engine. Use steel piping for supply, return, and fill piping, except supply and return piping may be copper tubing. Protect fuel lines against mechanical damage. Equip fill line with 16 mesh removable wire screen. Extend fill lines to the exterior. Mount a weatherproof tank gauge on the exterior wall near each fill line for each tank. The fill cap must be able to be locked by padlock. Locate the engine supply (suction) connection on the side of the fuel tank so that 5 percent of the tank volume provides a sump volume not useable by the engine. The elevation of the fuel tank must be such that the inlet of the fuel supply line is located so that its opening is no lower than the level of the engine fuel transfer pump. Pitch the bottom of the tank 21 mm/m 1/4 inch/foot to the side opposite the suction inlet connection, and to an accessible 25 mm 1 inchplugged globe drain valve.

2.13.1 Fuel Piping

As specified in NFPA 20.

2.13.2 Diesel Fuel Tanks

UL 80 or UL 142 for aboveground tanks.

2.13.3 Valves

Provide an indicating and lockable ball valve in the supply line adjacent to the tank suction inlet connection. Provide a check valve in fuel return line. Valves mustl be suitable for oil service. Valves must have union end connections or threaded end connections.

2.13.3.1 Globe Valve

MSS SP-80 Class 125

2.13.3.2 Check Valve

MSS SP-80, Class 125, swing check

2.13.3.3 Ball Valve

Full port design, copper alloy body, 2-position lever handle

2.14 JOINTS AND FITTINGS FOR COPPER TUBE

Provide wrought copper and bronze solder-joint pressure fittings conforming to ASME B16.22 and ASTM B75/B75M. Provide cast copper alloy solder-joint pressure conforming conform to ASME B16.18. Provide cast copper alloy fittings for flared copper tube conforming to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Provide grooved mechanical joints and fittings that are designed for no less than 862 kPa 125 psig service and are the product of the same manufacturer. Provide ductile iron grooved fitting and mechanical coupling housing conforming to ASTM A536. Use gaskets in grooved joints consisting of molded synthetic polymer of pressure responsive design and conforming to ASTM D2000 for circulating medium up to 110 degrees C 239 degrees F. Provide grooved joints conforming to AWWA C606 Use steel coupling nuts and bolts in grooved joints conforming to ASTM A183.

2.15 PUMP BASE PLATE AND PAD

Provide a common base plate for each horizontal-shaft fire pump for mounting pump and driver unit. Construct the base plate of cast iron with raised lip tapped for drainage or welded steel shapes with suitable drainage. Provide each base plate for the horizontal fire pumps with a 25 mm 1 inchgalvanized steel drain line piped to the nearest floor drain. For vertical shaft pumps, provide pump head with a cast-iron base plate which serves as the sole plate for mounting the discharge head assembly. Mount pump units and bases on a raised [100][150] mm [4] [6] inchesreinforced concrete pad that is an integral part of the reinforced concrete floor.

2.16 HOSE VALVE MANIFOLD TEST HEADER

****

NOTE: The design will include method of flow testing the fire pump and the suction supply piping. This should be accomplished by providing an exterior hose test header and a flow meter. The exterior test header is necessary for testing the condition of suction supply, valves and piping. Hydrants will not be used for this purpose. The design will clearly indicate the test arrangement. See NFPA 20, Figure A-2-14.2.1.

****

Connect hose valve test header by ASME B16.5, Class 150 flange inlet connection. Provide UL listed UL Fire Prot Dir or FM approved FM APP GUIDE bronze hose gate valves with 65 mm 2.5 inches American National Fire Hose Connection Screw Standard Threads (NH) in accordance with NFPA 1963. Provide number of valves in accordance with NFPA 20. Equip each hose valve with a cap and chain, and locate no more than 900 mm 3 feet and no less than 600 mm 2 feet above grade.

2.17 FLOW METER

****

NOTE: On the drawings, show a straight line run of pipe without valves or fittings equal to at least 10 times the pipe diameter on the intake side and at least 5 times the pipe diameter on the discharge side of the flow meter. Where possible, arrange the piping so that the metered flow can be discharged through the pump test header and/or back into the pump suction supply by the proper configuration of valves.

****

Provide meter that is UL listed UL Fire Prot Dir or FM approved FM APP GUIDE as flow meters for fire pump installation with direct flow readout device. Provide flow meter that is capable of metering any waterflow quantities between 50 percent and 150 percent of the rated flow of the pumps. Arrange piping to permit flow meter to discharge to pump suction and to discharge through test header. The meter throttle valve and the meter control valves must be O.S.&Y. valves. Provide automatic air release if flow meter piping between pump discharge and pump suction forms an inverted "U". Provide [venturi][annular probe][orifice plate][_____] type meter.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSPECTION BY FIRE PROTECTION SPECIALIST

Periodically perform a thorough inspection of the fire pump installation, including visual observation of the pump while running, to assure that the installation conforms to the contract requirements. Excessive vibration, leaks (oil or water), unusual noises, overheating, or other potential problems are not acceptable. Inspection includes piping and equipment clearance, access, supports, and guards. Bring any discrepancy to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered. The Fire Protection Specialist must witness the preliminary and final acceptance tests and, after completion of the inspections and a successful final acceptance test, sign test results and certify in writing that the installation the fire pump installation is in accordance with the contract requirements.

3.3 INSTALLATION

Provide equipment, materials, workmanship, fabrication, assembly, erection, installation, examination, inspection and testing in accordance with NFPA 20, except as modified herein. In addition, install the fire pump and engine in accordance with the written instructions of the manufacturer.

3.3.1 Installation Drawings

Submit Fire Pump Installation Drawings consisting of a detailed plan view, detailed elevations and sections of the pump room, equipment and piping, drawn to a scale of not less than 1:20 1/2 inch = 1 foot. Indicate equipment, piping, and associated pump equipment to scale. Indicate all clearance, such as those between piping and equipment; between equipment and walls, ceiling and floors; and for electrical working distance clearance around all electrical equipment. Include a legend identifying all symbols, nomenclatures, and abbreviations. Indicate a complete piping and equipment layout including elevations and/or section views of the following:

a. Fire pumps, controllers, piping, valves, and associated equipment.

b. Sensing line for each pump including the pressure maintenance pump.

c. Engine fuel system for diesel driven pumps.

d. Engine cooling system for diesel driven pumps.

e. Pipe hangers and sway bracing including support for diesel muffler and exhaust piping.

f. Restraint of underground water main at [entry-point][entry-and exit-points] to the building including details of pipe clamps, tie rods, mechanical retainer glands, and thrust blocks.

g. A one-line schematic diagram indicating layout and sizes of all piping, devices, valves and fittings.

h. A complete point-to-point connection drawing of the pump power, control and alarm systems, as well as interior wiring schematics of each controller.

3.3.2 Pump Room Configuration

Provide detail plan view of the pump room including elevations and sections showing the fire pumps, associated equipment, and piping. Submit working drawings on sheets not smaller than A1 594 by 841 mm 24 by 36 inches; include data for the proper installation of each system. Show piping schematic of pumps, devices, valves, pipe, and fittings. [Provide an isometric drawing of the fire pump and all associated piping]. Show point to point electrical wiring diagrams. Show piping layout and sensing piping arrangement. Show engine fuel and cooling system. Include:

a. Pumps, drivers, and controllers

b. Hose valve manifold test header

c. Circuit diagrams for pumps

d. Wiring diagrams of each controller

3.3.3 Accessories

Furnish tank supports, piping offsets, fittings, and required accessories as specified to provide a complete installation and to eliminate interference with other construction.

3.4 PIPE AND FITTINGS

Piping must be inspected, tested and approved before burying, covering, or concealing. Provide fittings for changes in direction of piping and for all connections. Make changes in piping sizes using tapered reducing pipe fittings. Do not use bushings.[Photograph all piping prior to burying, covering, or concealing.]

3.4.1 Cleaning of Piping

Interior and ends of piping must be clean and free of any water or foreign material. Keep piping clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of the piping so that no water or foreign matter will enter the pipes or fittings. Inspect piping before placing in position.

3.4.2 Threaded Connections

Provide jointing compound for pipe threads consisting of [polytetrafluoroethylene (PTFE) pipe thread tape conforming to ASTM D3308][Teflon pipe thread paste] and apply to male threads only. Provide exposed ferrous pipe threads with one coat of zinc molybdate primer applied to a minimum of dry film thickness of 0.025 mm 1 mil.

3.4.3 Pipe Hangers and Supports

Provide additional hangers and supports for concentrated loads in aboveground piping, such as for valves and risers.

3.4.3.1 Vertical Piping

Support piping at each floor, at no more than 3 meters 10 foot intervals.

3.4.3.2 Horizontal Piping

Space horizontal piping supports as follows:

MAXIMUM SPACING (METERS) (FEET)										
Nominal Pipe Size (mm) (inches)	25 1 and Under	321.25	401.5	502	652.5	803	903.5	1004	1255	150+6+
Copper Tube	1.86	27	2.48							

MAXIMUM SPACING (METERS) (FEET)										
Steel Pipe	27	2.48	2.79	310	3.311	3.612	3.913	4.214	4.816	5.017

3.4.4 Underground Piping

Install underground piping and fittings in conformance to NFPA 24. Anchor joints in accordance with NFPA 24. Provide concrete thrust block at elbow where pipe turns up towards floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. After installation in accordance with NFPA 24, clean rods and nuts thoroughly and coat with asphalt or other corrosion-retard material approved by the Contracting Officer. Provide minimum cover depth of 900 mm 3 feet.

3.4.5 Grooved Mechanical Joint

Prepare grooves according to the coupling manufacturer's instructions. Use grooved fittings, couplings, and grooving tools which are products of the same manufacturer. Ensure pipe and groove dimensions comply with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Measure groove width and dimension of groove from end of pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Do not use grooved joints in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.5 ELECTRICAL WORK

****

NOTE: Coordinate wiring with the contract drawings and other specification sections.

Include Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE; Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE; Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE; or Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE or Section 28 31 33 FIRE ALARM REPORTING SYSTEM, RADIO TYPE when a fire alarm panel or transmitter is required to transmit pump supervisory signals to a constantly attended location as required by NFPA 20 and to reference Section 28 31 33 whenever included in the contract.

****

Provide electric motor and controls in accordance with NFPA 20, NFPA 72 and NFPA 70, unless more stringent requirements are specified herein or are indicated on the drawings. Provide electrical wiring and associated equipment in accordance with NFPA 20 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide wiring in rigid metal conduit or intermediate metal conduit, except electrical metallic tubing conduit may be provided in dry locations not enclosed in concrete or where not subject to mechanical damage.

3.6 PIPE COLOR CODE MARKING

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NOTE: Designer will coordinate color code marking with Section 09 90 00 PAINTS AND COATINGS. Color code marking for piping which are not listed in Table I of UFGS Section 09 90 00 will be added to the table.

****

Color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS.

3.7 FLUSHING

Flush the fire pump suction and discharge piping at [120][150] percent of rated capacity of each pump. Where the pump installation consists of more than one pump, the flushing is the total quantity of water flowing when all pumps are discharging at [120][150] percent of their rated capacities. The new pumps may be used to attain the required flushing volume. Do not flush underground piping using the fire pumps. Continue flushing operations until water is clear, but no less than 10 minutes. Submit a signed and dated flushing certificate before requesting field testing.

3.8 FIELD TESTS

Submit system diagrams that show the layout of equipment, piping, and storage units, and typed condensed sequence of operation, wiring and control diagrams, and operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system must be framed under glass or laminated plastic. After approval, post these items where directed.

3.8.1 Hydrostatic Test

Hydrostatically test piping at 1551 kPa 225 psigfor a period of 2-hours, or at least 345 kPa 50 psiin excess of the maximum pressure, when the maximum pressure in the system is in excess of [1207][1379] kPa [175][200] psi in accordance with NFPA 20.

3.8.2 Preliminary Tests

Submit proposed procedures for Preliminary Tests prior to the proposed date and time to begin Preliminary Tests. The Fire Protection Specialist must take all readings and measurements. The Manufacturer's Representative, a representative of the fire pump controller manufacturer, and a representative of the diesel engine manufacturer (when supplied) must witness the complete operational testing of the fire pump and drivers. The fire pump controller manufacturer's representative and the diesel engine manufacturer's representative must each be an experienced technician employed by the respective manufacturers and capable of demonstrating operation of all features of respective components including trouble alarms and operating features. Thoroughly inspect and test fire pumps, drivers and equipment to insure that the system is correct, complete, and ready for operation. Ensure that pumps are operating at rated capacity, pressure and speed. Include manual starting and running to ensure proper operation and to detect leakage or other abnormal conditions, flow testing, automatic start testing, testing of automatic settings, sequence of operation check, test of required accessories; test of pump alarms devices and supervisory signals, test of pump cooling, operational test of relief valves, and test of automatic power transfer, if provided. Pumps must run without abnormal noise, vibration or heating. If any component or system was found to be defective, inoperative, or not in compliance with the contract requirements during the tests and inspection, make corrections and repeat the entire preliminary. Submit Preliminary Tests Reports, to include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Report must be signed by the Fire Protection Specialist and the Manufacturer's Representative.

3.8.3 Navy Formal Inspection and Tests

The [_____] Division, Naval Facilities Engineering Systems Command, Fire Protection Engineer will witness formal tests and approve all systems before they are accepted. Submit the request for formal inspection at least [15] [_____] days prior to the date the inspection is to take place. An experienced technician regularly employed by the pump installer must be present during the inspection. Where pumps are engine driven, an experienced technician regularly employed by the engine manufacturer capable of demonstrating that all engine trouble alarms and operating features perform as required must be present. Submit proposed date and time to begin Navy Formal Inspection and Tests, with the Acceptance Procedures. Provide notification at least [14] [_____] days prior to the proposed start of the test. Include a copy of the Contractor's Material & Test Certificates. Submit [3] [_____] copies of the completed Navy Formal Inspection and Tests Reports, no later that [7] [_____] days after the completion of the tests. All items in the reports must be signed by the Fire Protection Specialist and the Manufacturer's Representative. Test reports in booklet form (each copy furnished in a properly labeled three ring binder) showing all field tests and measurements taken during the preliminary and final testing, and documentation that proves compliance with the specified performance criteria, upon completion of the installation and final testing of the installed system. Indicate the final position of the controls and pressure switches in each test report. Include the description of the hydrostatic test conducted on the piping and flushing of the suction and discharge piping. Include a copy of the manufacturer's certified pump curve for each fire pump in the report.

3.8.3.1 Full Water Flow Test

Include a full water flow test in the acceptance test. The securing of all hoses and nozzles during the tests is the responsibility of the Contractor. Conduct water flow testing in a safe manner with no destruction to the existing facility or new construction. Tests include 100 and 150 percent capacity flows and pressures, and no-flow pressures for compliance with manufacturer's characteristic curves. At this inspection repeat the required tests as directed.

3.8.3.2 Correcting Defects

Correct defects in the work, and make additional tests until the Contractor has demonstrated that the system complies with the contract requirements.

3.8.3.3 Documentation of Test

Manufacturer's certified shop test characteristic curves for each pump being tested must be furnished by the Contractor at the time of the pump acceptance test.

3.8.4 Army Final Acceptance Test

The Fire Protection Specialist must take all readings and measurements. The Manufacturer's Representative, the fire pump controller manufacturer's representative, and the diesel engine manufacturer's representative (when supplied) must also witness for the final tests. Repair any damage caused by hose streams or other aspects of the test. Submit proposed date and time to begin Army Final Acceptance Test, with the Acceptance Procedures. Provide notification at least [14] [_____] days prior to the proposed start of the test. Submit [3] [_____] copies of the completed Army Final Acceptance Test Reports, no later that [7] [_____] days after the completion of the tests. All items in the reports must be signed by the Fire Protection Specialist and the Manufacturer's Representative. Test reports in booklet form (each copy furnished in a properly labeled three ring binder) showing all field tests and measurements taken during the preliminary and final testing, and documentation that proves compliance with the specified performance criteria, upon completion of the installation and final testing of the installed system. Indicate the final position of the controls and pressure switches in each test report. Include the description of the hydrostatic test conducted on the piping and flushing of the suction and discharge piping. Include a copy of the manufacturer's certified pump curve for each fire pump in the report. Include a copy of the Contractor's Material & Test Certificates. Include the following in the final acceptance test:

3.8.4.1 Flow Tests

Conduct flow tests using the test header, hoses and playpipe nozzles. Perform flow tests at churn (no flow), 75, 100, 125 and 150 percent capacity for each pump and at full capacity of the pump installation. Take flow readings from each nozzle by means of a calibrated pitot tube with gauge or other approved measuring equipment. Take rpm, suction pressure and discharge pressure reading as part of each flow test. Take voltage and ampere readings on each phase as part of each flow test for electric-motor driven pumps.

3.8.4.2 Starting Tests

Test pumps for automatic starting and sequential starting. Test setting of the pressure switches when pumps are operated by pressure drop. Tests may be performed by operating the test connection on the pressure sensing lines. As a minimum, start each pump automatically 10 times and manually 10 times, in accordance with NFPA 20. Divide tests of engine-driven pumps equally between both set of batteries. Operate fire pumps for a period of a least 10 minutes for each of the starts; except operate electric motors over 149 kW 200 horsepower for at least 15 minutes and do not start more than 2 times in 10 hours. Indicate pressure settings that include automatic starting and stopping of the fire pump(s) on an etched plastic placard, attached to the corresponding pump controller.

3.8.4.3 Battery Changeover

Test diesel driven fire pumps for automatic battery changeover in event of failure of initial battery units.

3.8.4.4 Alarms

Test all pump alarms, both local and remote. Electrically test supervisory alarms for diesel drivers for low oil pressure, high engine jacket coolant temperature, shutdown from overspeed, battery failure and battery charger failure.

3.8.4.5 Miscellaneous

Test valve tamper switches. Verify pressure recorder operation relief valve settings, valve operations, operation and accuracy of meters and gauges, and other accessory devices.

3.8.4.6 Alternate Power Source

On installations with an alternate source of power and an automatic transfer switch, simulate and transfer loss of primary power while the pump is operating at peak load. Do not cause opening of overcurrent devices in either line when transferring from normal to emergency source and retransferring from emergency to normal source. Perform at least half of the manual and automatic starting operations listed with the fire pump connected to the alternate source.

3.8.4.7 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Conduct tests and repeat if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.4.8 Test Documentation

The Manufacturer's Representative must supply a copy of the manufacturer's certified curve for each fire pump at the time of the test. The Fire Protection Specialist must record all test results and plot curve of each pump performance during the test. Record complete pump acceptance test data of each fire pump. The pump acceptance test data must be on forms that give the detail pump information such as that which is indicated in Figure A-11-2.6.3(f) of NFPA 20. Submit all test data records in a three ring binder.

3.8.5 Test Equipment

Provide all equipment and instruments necessary to conduct a complete final test, including 65 mm 2.5 inch diameter hoses, playpipe nozzles, pitot tube gauges, portable digital tachometer, voltage and ampere meters, and calibrated oil-filled water pressure gauges. Provide all necessary supports to safely secure hoses and nozzles during the test. The [Government will][Contractor must] furnish water for the tests.

3.9 DISINFECTION

****

NOTE: For modification of existing systems, provide specific procedures for disinfection of new equipment. If piping specified in this Section is isolated from the domestic water piping systems by

means of a reduced pressure backflow prevention assembly or if sprinkler piping in not connected to the domestic water piping, this paragraph should be deleted.

****

After all system components are installed including pumps, piping, and other associated work, and all hydrostatic tests are successfully completed, thoroughly flush the pumps and all piping to be disinfected with potable water until there is no visible sign of dirt or other residue, and hydrostatic test are successfully completed, flush each portion of the piping specified in this Section system to be disinfected thoroughly with potable water until all entrained dirt and other foreign materials are removed before introducing chlorinating material.

3.9.1 Chlorination

Provide chlorinating material consisting of hypochlorites or liquid chlorine. Feed the chlorinating material into the sprinkler piping at a constant rate of 50 parts per million (ppm). Use a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump. Continue chlorination application until the entire system is filled. Keep the water in the system for a minimum of 24 hours. Open and close each valve in the system several times to ensure its proper disinfection. Following the 24-hour period, allow no less than 25 ppm chlorine residual to remain in the system.

3.9.2 Flushing

Flush the system with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer.

3.9.3 Sample Testing

Test samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. Use either the multiple-tube fermentation technique or the membrane-filter technique testing method. Repeat disinfection until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.10 SYSTEM STARTUP

****

NOTE: Provide adequate clearance and access space to safely install, test and maintain the fire pump system.

****

Fully enclose or properly guard coupling, rotating parts, gears, projecting equipment, etc. so as to prevent possible injury to persons that come in close proximity of the equipment. Conduct testing of the fire pumps in a safe manner and ensure that all equipment is safely secured. Use hoses and nozzles to conduct flow tests that are in excellent condition and safely anchor and secure to prevent any misdirection of the hose streams.

Post operating instructions for pumps, drivers, controllers, and flow meters.

3.11 CLOSEOUT ACTIVITIES

3.11.1 Field Training

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NOTE: The number of hours of instruction should be determined based of the number and complexity of the systems specified.

****

Conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Submit the proposed schedule for field training at least 14 days prior to the start of related training. Provide training for a period of [2] [8] hours of normal working time and start after the fire pump installation is functionally complete and after the Final Acceptance Test. Cover all of the items contained in the approved Operating and Maintenance Instructions. Submit manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance. Include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Submit Data Package 3 for fire pumps and drivers in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. [Submit service organization that is capable of providing [4] [_____] hour onsite response to a service call on an emergency basis.]

3.11.2 As-Built Drawings

Submit As-Built Drawings, no later than [14][_____] days after completion of the Final Tests. Update the Fire Pump Installation Drawings to reflect as-built conditions after all related work is completed and prepare drawings on reproducible full-size mylar film.

3.12 PROTECTION

Carefully remove materials so as not to damage material which is to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-22 00 00 (May 2024)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Superseding**
UFGS-22 00 00 (November 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 22 - PLUMBING

SECTION 22 00 00

PLUMBING, GENERAL PURPOSE

05/24, CHG 1: 11/24

PART 3   EXECUTION

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USACE / NAVFAC / AFCEC **UFGS-22 00 00 (May 2024)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Superseding**
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SECTION 22 00 00

PLUMBING, GENERAL PURPOSE

05/24, CHG 1: 11/24

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NOTE: This guide specification covers the requirements for general purpose plumbing systems including plumbing fixtures, equipment, and piping which is located within, on, under, and adjacent to buildings. Plumbing system requirements must conform to Federal Standard FED-STD-795, "Uniform Federal Accessibility Standards (UFAS)," Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities, and Department of Defense (DoD) adopted and approved Plumbing Code (ICC IPC) which is required by UFC 1-200-01.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: This guide specification covers general purpose type plumbing systems. This specification essentially implements the requirements of the International Plumbing Code (IPC). Equipment supports and connections, for either equipment on the ground or in the building, will conform to these

requirements.

This section contains tailoring options for PIPING, FIXTURES, WATER HEATERS, PUMPS, PRESSURE PIPING, COMPRESSED AIR SYSTEM, ARMY, AIR FORCE,and NAVY.
****

****
NOTE: The following information must be shown on project drawings (Item 6 is tailored for ARMY):

1. Only drawings (not specifications) must indicate capacity, efficiency, dimensions, details, plan view, sections, elevations, and locations of fixtures and equipment; space required to replace strainers, filters, and for maintenance of equipment.

2. Show location of wye strainer on building side of water supply valve in each building; indicate wye strainer blow-off outlet with piping to adjacent exterior wall hydrant. Note: This will clean the strainer each time the wall hydrant is used.

3. Show configuration, slope, and location of each piping system such as: above or below floors, above or below ceilings, above or below roofs, above or below ground.

4. Show location of each sectionalizing valve in each water system. Sectionalizing valves should be ball valves.

5. Show location of each solenoid-operated flush valve and solenoid-operated lavatory faucet on project drawings.

6. Minimize the risk of Legionellosis in building water systems by following guidance in the U.S. Army Corps of Engineers Engineering Manual (EM) 200-1-13 (2016), Minimizing The Risk of Legionellosis Associated with Building Water Systems on Army Installations.

7. For Tri-Service projects, minimize the risk of legionellosis in building water systems by utilizing the guidance in the Association of Water Technologies, (2019) Legionella: A Position Statement and Guidance Document, ASHRAE Guideline 12, ASHRAE Standard 188 and the Cooling Technology Institute GDL 159 and (2008) Legionellosis Guideline: Best Practices for Control of Legionella.
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1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

ANSI/AHRI 1160 I-P	(2022) Performance Rating of Heat Pump Pool Heaters
ANSI/AHRI 1161 SI	(2014) Performance Rating of Heat Pump Pool Heaters

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.10.1/CSA 4.1	(2019; R 2024) Gas Water Heaters Vol. I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less
ANSI Z21.10.3/CSA 4.3	(2019; R 2024) Gas-Fired Water Heaters Vol.III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous
ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 18	(2008; R 2013) Methods Of Testing For Rating Drinking Water Coolers With Self-Contained Mechanical Refrigeration
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 146	(2020) Method of Testing and Rating Pool Heaters (ANSI Approved)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.1.2	(2012; R 2017; R 2022) Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
ASME A112.6.1M	(1997; R 2017) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2022) Floor Drains
ASME A112.6.4	(2022) Roof, Deck and Balcony Drains
ASME A112.14.1	(2003; R 2017; R 2022) Backwater Valves
ASME A112.18.1/CSA B125.1	(2024) Plumbing Supply Fittings
ASME A112.19.1/CSA B45.2	(2024) Enameled Cast Iron and Enameled Steel Plumbing Fixtures
ASME A112.19.2/CSA B45.1	(2024) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME A112.19.3/CSA B45.4	(2022) Stainless Steel Plumbing Fixtures
ASME A112.19.5	(2022) Flush Valves and Spuds for Water Closets, Urinals, and Tanks
ASME A112.19.17	(2010; R 2018; R 2023) Manufactured Safety Vacuum Release Systems (SVRS) for Residential and Commercial Swimming Pool, Spa, Hot Tub, and Wading Pool Suction Systems
ASME A112.36.2M	(2022) Cleanouts
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.12	(2019) Cast Iron Threaded Drainage Fittings
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe

	Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(2021) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.29	(2022) Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings - DWV
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.50	(2021) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME B16.51	(2013) Copper and Copper Alloy Press-Connect Pressure Fittings
ASME B31.1	(2024) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B31.9	(2020) Building Services Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2021) Performance Requirements for Atmospheric Type Vacuum Breakers
ASSE 1003	(2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI

	approved 2010)
ASSE 1010	(2021) Performance Requirements for Water Hammer Arresters
ASSE 1011	(2017) Performance Requirements for Hose Connection Vacuum Breakers
ASSE 1012	(2023) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent
ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1016	(2017) Performance Requirements for Automatic Compensating Valves for individual Showers and Tub/Shower Combinations
ASSE 1017	(2023) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)
ASSE 1018	(2023) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002
ASSE 1019	(2023) Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies
ASSE 1037	(2015; R 2020) Performance Requirements for Pressurized Flushing Devices for Plumbing Fixtures
ASSE 1044	(2023) Performance Requirements for Trap Seal Primer - Drainage Types and Electric Design Types
ASSE 1069	(2020) Performance Requirements for Automatic Temperature Control Mixing Valves
ASSE 1070	(2020) Performance Requirements for Water Temperature Limiting Devices
ASSE 1071	(2012) Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment
ASSE 1072	(2020) Performance Requirements for Barrier Type Trap Seal Protection for Floor Drains

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2024) Hypochlorites
AWWA B301	(2024) Liquid Chlorine
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(2022) Grooved and Shouldered Joints
AWWA C651	(2023) Standard for Disinfecting Water Mains
AWWA C652	(2019) Disinfection of Water-Storage Facilities
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C701	(2019) Cold-Water Meters - Turbine Type for Customer Service
AWWA D100	(2021) Welded Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2/B2.2M	(2016) Specification for Brazing Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A74	(2021) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and

	Other Special Purpose Applications
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A518/A518M	(1999; R 2022) Standard Specification for Corrosion-Resistant High-Silicon Iron Castings
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A888	(2024) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B306	(2020) Standard Specification for Copper Drainage Tube (DWV)
ASTM B370	(2022) Standard Specification for Copper

	Sheet and Strip for Building Construction
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B828	(2023) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C564	(2020a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1053	(2000; R 2010) Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D1004	(2013) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2235	(2004; R 2016) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D2239	(2012) Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2661	(2014; E 2018) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40, Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2672	(2014) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D2683	(2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D2737	(2012a) Polyethylene (PE) Plastic Tubing
ASTM D2846/D2846M	(2019) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
ASTM D2855	(2020) Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3035	(2022) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3122	(1995; R 2009) Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings

ASTM D3138	(2004; R 2016) Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3311	(2017) Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
ASTM D4551	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM F409	(2022) Standard Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
ASTM F437	(2024) Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	(2023) Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	(2024) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

ASTM F441/F441M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F442/F442M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	(2022) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F628	(2024) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core
ASTM F877	(2024) Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
ASTM F891	(2024) Standard Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core
ASTM F1290	(2019) Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F1760	(2016; R 2020) Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
ASTM F2387	(2021) Standard Specification for Manufactured Safety Vacuum Release Systems (SVRS) for Swimming Pools, Spas, and Hot Tubs
ASTM F2389	(2024a) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(2018) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(2012) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

CSA GROUP (CSA)

CSA B45.5-17/IAPMO Z124	(2017; Errata 2017; Errata 2018) Plastic Plumbing Fixtures

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

ANSI/IAPMO Z1001	(2021) Standard For Prefabricated Gravity Grease Interceptors
IAPMO PS 117	(2021) Press Connections
IAPMO UPC	(2024) Uniform Plumbing Code
IAPMO Z124.8	(2013 E2; R 2018) Plastic Bathtub Liners

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2017) Standard And Commentary Accessible and Usable Buildings and Facilities
ICC IPC	(2024) International Plumbing Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z358.1	(2014; R 2020) American National Standard for Emergency Eyewash and Shower Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-44	(2019) Steel Pipeline Flanges
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2022) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(2014) Class 3000 Steel Pipe Unions Socket Welding and Threaded
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-91	(2009) Guidelines for Manual Operation of Valves
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NACE INTERNATIONAL (NACE)

NACE SP0169	(2024) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 372	(2022) Drinking Water System Components - Lead Content
NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials
NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA Fire Man	(2016) Firestopping: Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(2010) Water Hammer Arresters Standard

POOL & HOT TUB ALLIANCE (PHTA)

ANSI/APSP-16	(2017) American National Standard for Suction Outlet Fitting Assemblies (SOFA) for Use in Pools, Spas and Hot Tubs

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508	(2023) Hose Clamp Specifications

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SM 9223	(2004) Enzyme Substrate Coliform Test
PL 93-523	(1974; A 1999) Safe Drinking Water Act

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 430	Energy Conservation Program for Consumer Products
21 CFR 175	Indirect Food Additives: Adhesives and Components of Coatings
40 CFR 141.80	National Primary Drinking Water Regulations; Control of Lead and Copper; General Requirements

UL SOLUTIONS (UL)

UL 174	(2004; Reprint Nov 2024) UL Standard for Safety Household Electric Storage Tank Water Heaters
UL 399	(2017; Reprint May 2019) UL Standard for Safety Drinking Water Coolers
UL 430	(2015; Reprint Sep 2021) UL Standard for Safety Waste Disposers
UL 499	(2014; Reprint May 2023) UL Standard for Safety Electric Heating Appliances
UL 732	(2023) UL Standard for Safety Oil-Fired Storage Tank Water Heaters
UL 1951	(2011; Reprint Jun 2020) UL Standard for Safety Electric Plumbing Accessories

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Use SD-02 for specialty items or non everyday type systems.

****

SD-02 Shop Drawings

Plumbing System; G, [_____]

SD-03 Product Data

Backflow Prevention Assemblies; G, [_____]

****

NOTE: The following submittals are tailored for

PIPING. Use of press fittings to be verified if allowed on project.
****

Recycled Content for Steel Pipe; S

Recycled Content for Cast Iron Pipe; S

Swimming Pool [and Spa]Suction Fittings; G, [_____]

[Press Fittings; G, [_____]

] **
NOTE: The following submittals are tailored for FIXTURES.
****

Fixtures

Shower Faucets; G, [_____]

Flush Valve Water Closets

WaterSense Label for Flush Valve Water Closet; S

Flush Valve Urinals

WaterSense Label for Urinal; S

Flush Tank Water Closets

WaterSense Label for Flush Tank Water Closet; S

Wall Hung Lavatories

Countertop Lavatories

WaterSense Label for Lavatory Faucet; S

Kitchen Sinks

Service Sinks

Drinking-Water Coolers; G, [_____]

Energy Star Label for Freestanding Bottled Water Coolers/Dispensers; S

WaterSense Label for Showerhead; S

Plastic Bathtubs

Plastic Shower Stalls

Plastic Bathtub Liners

Plastic Bathtub Wall Surrounds

Washfountains

****
NOTE: The following three submittals are tailored for WATER HEATERS.
****

Water Heaters; G, [_____]

Energy Star Label for Gas Storage Water Heater; S

Energy Star Label for Gas Instantaneous Water Heater; S

****
NOTE: The following two submittals are tailored for PUMPS.
****

Pumps; G, [_____]

Pool Water Pump Safety Vacuum Release System; G, [_____]

Welding

Vibration-Absorbing Features; G, [_____]

Plumbing System

Thermostatic Mixing Valves

Temperature Controlled Mixing Valve

Point-Of-Use Mixing Valve

Automatic Temperature And/Or Pressure Compensating Valve

Temperature Actuated Mixing Valve

Single Supply Line Automatic Temperature Control

SD-06 Test Reports

Tests, Flushing and Disinfection

Test of Backflow Prevention Assemblies; G, [_____].

SD-07 Certificates

Materials and Equipment

Bolts

SD-10 Operation and Maintenance Data

Plumbing System; G, [_____]

1.3 SHOP DRAWINGS

****
NOTE: The following paragraph contains tailoring

for PIPING.
****

Submit Plumbing System Detail drawings consisting of schedules, performance charts, instructions, diagrams, and other information to illustrate the requirements and operations of systems that are not covered by the Plumbing Code. Submit Plumbing System Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings must indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details must include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, must be drawn to scale.

1.4 STANDARD PRODUCTS

Specified materials and equipment must be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment must essentially duplicate equipment that has performed satisfactorily at least 2 years prior to bid opening. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation must conform to the code and a certificate must be submitted for the equipment.

1.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.2 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.4.3 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.4.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" must be interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.4.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 PERFORMANCE REQUIREMENTS

1.6.1 Welding

****

NOTE: The designer will indicate welding requirements on the project drawings. Normally, delete the second bracketed statement. If the need exists for more stringent requirements for weldments, delete the first bracketed statement and the welding submittal.

The following paragraph contains tailoring for PIPING and ARMY.

****

[Piping must be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.9, unless temperature and pressure limits specified then may be accepted as permitted by ASME B31.1. The Contracting Officer must be notified 24 hours in advance of tests, and the tests must be performed at the work site if practicable.

Welders or welding operators must apply their assigned symbols near each weld they make as a permanent record. Structural members must be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING.][Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.6.2 Cathodic Protection and Pipe Joint Bonding

****

NOTE: The following paragraph contains tailoring for ARMY and NAVY.

****

Cathodic protection and pipe joint bonding systems must be in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM][and][Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]

??? [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM][and][Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

1.7 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work must be in accordance with ICC IPC.

1.8 PROJECT/SITE CONDITIONS

The Contractor must become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.9 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work. Submit Plumbing System Operation and Maintenance Data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.10 ACCESSIBILITY OF EQUIPMENT

****

NOTE: The following requirement is intended to

solicit the installer's help in the prudent location of equipment when he has some control over locations. However, designer's should not rely on it at all since enforcing this requirement in the field would be difficult. Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Some materials listed are superior to others for specific requirements. Therefore, information should be obtained from the Installation Department of Public Works or Base Civil Engineer for any special requirements before selection of material is made. The type of tubing or pipe required will be as determined by local experience.

Preference must be given to the following materials for waste pipe: 100 percent recycled content cast iron, minimum 25 percent recycled content PVC, and ABS drain pipe. Preference must be given, in this order, to the following materials for supply pipe: copper, galvanized steel, polyethylene pipe, polypropylene, and PVC.

If PEX is used, tube I.D. sizes are to be copper equivalent I.D. sizes. (PEX is not to be used on Navy, Marine Corps and Air Force projects.)

This specification allows drainage systems up to 375 mm 15 inch diameter only; designer will ensure the availability of materials when drainage line exceeds 375 mm 15 inch diameter.

Push on type fittings must not be used.

Manufacturer to provide references for successful installation currently in service.

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****

NOTE: Nonpressure pipe is an EPA designated product for recycled content. Use materials with recycled content where appropriate for use. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. A

resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at https://www.epa.gov/. Other products with recycled content are also acceptable when meeting all requirements of this specification.
****

****
NOTE: The following paragraph contains tailoring for PIPING and NAVY.
****

Materials for various services must be in accordance with TABLES I and II. Cement pipe must contain recycled content as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Steel pipe must contain a minimum of 25 percent recycled content, with a minimum of 16 percent post-consumer recycled content. Provide data identifying percentage of recycled content for steel pipe. Pipe schedules must be selected based on service requirements. Pipe fittings must be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement must meet NSF/ANSI 14 and must be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service must bear the NSF seal "NSF-PW." Polypropylene pipe and fittings must conform to dimensional requirements of Schedule 40, Iron Pipe size and must comply with NSF/ANSI 14, NSF/ANSI/CAN 61 and ASTM F2389. Polypropylene piping that will be exposed to UV light must be provided with a Factory applied UV resistant coating. Pipe threads (except dry seal) must conform to ASME B1.20.1. Grooved pipe couplings and fittings must be from the same manufacturer. Material or used in any potable water system intended for human consumption be certified in accordance with NSF 372 with the exception of brazing materials. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers must comply with PL 93-523 and NSF/ANSI/CAN 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF/ANSI/CAN 61, Section 9. Hubless cast-iron soil pipe must not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors (for Air Force/Army/Navy projects). Cast-iron pipe must contain a minimum of 95 percent recycled content. Provide data identifying percentage of recycled content for cast iron pipe. Plastic pipe must not be installed in air plenums. Plastic pipe must not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

2.1.1 Pipe Joint Materials

****
NOTE: The following paragraphs are tailored for PIPING.
****

Grooved pipe and hubless cast-iron soil pipe must not be used underground. Solder containing lead must not be used with copper pipe. Cast iron soil pipe and fittings must be marked with the collective trademark of the Cast Iron Soil Institute. Joints and gasket materials must conform to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A74, AWWA C606. For hubless type: CISPI 310.

b. Coupling for Steel Pipe: AWWA C606.

c. Couplings for Grooved Pipe:[Ductile Iron ASTM A536 (Grade 65-45-12)][Malleable Iron ASTM A47/A47M, Grade 32510].[Copper ASTM B584].

d. Flange Gaskets: Gaskets must be made of non-asbestos material in accordance with ASME B16.21. Gaskets must be flat, 1.6 mm 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets must be the full face or self centering flat ring type. Gaskets used for hydrocarbon service must be bonded with NBR.

e. Brazing Material: Brazing material must conform to AWS A5.8/A5.8M, BCuP-5.

f. Brazing Flux: Flux must be in paste or liquid form appropriate for use with brazing material. Flux must be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.

g. Solder Material: Solder metal must conform to ASTM B32.

h. Solder Flux: Flux must be liquid form, non-corrosive, and conform to ASTM B813, Standard Test 1.

****

NOTE: Low corrosion flux for copper pipe can help reduce potentially toxic releases from soldered copper pipe.

****

i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.

j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C564.

k. Rubber Gaskets for Grooved Pipe: ASTM D2000, maximum temperature 110 degrees C 230 degrees F.

l. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.

m. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A183.

n. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D3138.

o. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D2235.

p. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D2564 and ASTM D2855.

q. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F493.

r. Flanged fittings including, but not limited to, flanges, bolts, nuts and bolt patterns must be in accordance with ASME B16.5 class 150 and must have the manufacturer's trademark affixed in accordance with

MSS SP-25. Flange material must conform to ASTM A105/A105M. Blind flange material must conform to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Bolts must be high strength or intermediate strength with material conforming to ASTM A193/A193M. Submit written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements.

s. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D3122.

****

NOTE: For Navy, Marine Corps, and Army projects, coordinate with the Department of Public Works or Base Civil Engineer on the use of press fittings for copper pipe and tube.

****

[t. Press fittings for Copper Pipe and Tube: Copper press fittings must conform to the material and sizing requirements of ASME B16.51 and performance criteria of IAPMO PS 117. Sealing elements for copper press fittings must be EPDM, FKM or HNBR. Sealing elements must be factory installed or an alternative supplied fitting manufacturer. Sealing element must be selected based on manufacturer's approved application guidelines. Provide manufacturer data to show product has been installed on multiple projects of similar type.

] u. Copper tubing must conform to ASTM B88M ASTM B88, Type K, L or M.

v. Heat-fusion joints for polypropylene piping: ASTM F2389.

2.1.2 Miscellaneous Materials

Miscellaneous materials must conform to the following:

****

The following list contains tailoring: Items a., h., i., and j. are tailored for PIPING; Items e., f., and g. are tailored for FIXTURES.

****

a. Water Hammer Arrester: PDI WH 201.[Water hammer arrester must be [diaphragm][or][piston] type.]

b. Copper, Sheet and Strip for Building Construction: ASTM B370.

c. Asphalt Roof Cement: ASTM D4586/D4586M.

d. Hose Clamps: SAE J1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material must be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.100.

l. Thermometers: ASTM E1. Mercury must not be used in thermometers.

2.1.3 Pipe Insulation Material

****

NOTE: The following paragraph is tailored for PIPING.

****

Insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

****

NOTE: The following paragraph is tailored for PIPING.

****

Pipe hangers, inserts, and supports must conform to MSS SP-58.

2.3 VALVES

****

NOTE: The list below contains tailoring: Items a. and b. are tailored for FIXTURES; Item c. is tailored for WATER HEATERS.

Drawings will indicate equipment isolation, branch, and sectionalizing valves for water systems. Valves will be provided so that system maintenance can be performed without complete system shutdown. In general, valves should be provided in the following locations:

a. Each branch serving a group of fixtures.

b. Each riser serving a group of fixtures.

c. Isolation valves will be provided on the supply and discharge of booster and circulating pumps and on all water heaters.

d. In nonfreezing climates, wall faucets will be installed on outside walls and lawn faucets in parking, garden, and lawn areas. In freezing climates, freezeproof wall hydrants will be installed on outside walls and yard hydrants in parking, garden, and lawn areas. Indicate on the drawings height of hydrants and faucets above finished grade.

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****

NOTE: The following paragraph contains tailoring for PIPING.

Select the bracketed option to ensure large manually operated valves can be operated by hand without aid of additional mechanical leverage. Especially applicable for valves with high seating torque such as resilient seat wedge gate valves.

****

Valves must be provided on supplies to equipment and fixtures. Valves 65 mm 2-1/2 inches and smaller must be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 80 mm 3 inches and larger must have flanged iron bodies and bronze trim. Pressure ratings must be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard.[Valve actuators for manually operated valves 300 mm 12 inches and larger must be sized and provided by manufacturer assuming the standard operator input forces listed in MSS SP-91.]" Valves must conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1

Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASME BPVC SEC IV, Part HLW-810: Requirements for Potable-Water Heaters Bottom Drain Valve
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22/CSA 4.4
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

2.3.1 Backwater Valves

****

NOTE: The following paragraph is tailored for PIPING.

****

Backwater valves must be either separate from the floor drain or a combination floor drain, P-trap, and backwater valve, as indicated on drawings. Valves must have cast-iron bodies with cleanouts large enough to permit removal of interior parts. Valves must be of the flap type, hinged or pivoted, with revolving disks. Hinge pivots, disks, and seats must be nonferrous metal. Disks must be slightly open in a no-flow no-backwater condition. Cleanouts must extend to finished floor and be fitted with threaded countersunk plugs.

2.3.2 Wall Faucets

****

NOTE: The following paragraph is tailored for PIPING.

****

Wall faucets with vacuum-breaker backflow preventer must be brass with 20 mm 3/4 inch male inlet threads, hexagon shoulder, and 20 mm 3/4 inch hose connection. Faucet handle must be securely attached to stem.

2.3.3 Wall Hydrants (Frostproof)

****

NOTE: In locations where the design temp is 32 degrees F 0 degrees C or less provide Freezeproof

will hydrants.
****

ASSE 1019 with vacuum-breaker backflow preventer must have a[nickel-brass or nickel-bronze wall plate and flange with nozzle and detachable key handle][recessed box, with locking cover]. A brass or bronze operating rod must be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat must be provided. Valve rod and seat washer must be removable through the face of the hydrant. The hydrant must have 20 mm 3/4 inch exposed hose thread on spout and 20 mm 3/4 inch male pipe thread on inlet.

2.3.4 Lawn Faucets

****
NOTE: The following paragraph is tailored for PIPING.
****

Lawn faucets must be brass, with either straight or angle bodies, and must be of the compression type. Body flange must be provided with internal pipe thread to suit 20 mm 3/4 inch pipe. Body must be suitable for wrench grip. Faucet spout must have 20 mm 3/4 inch exposed hose threads. Faucet handle must be securely attached to stem.

2.3.5 Yard Hydrants

Yard box or post hydrants must have valve housings located below frost lines. Water from the casing must be drained after valve is shut off. Hydrant must be bronze with cast-iron box or casing guard. "T" handle key must be provided.

2.3.6 Outlet Boxes

2.3.6.1 Washer Box

One-piece, recessed,[high-impact plastic][metal] box with quarter turn shut-off valves,[water hammer arresters] 12.7 mm 1/2 inch hot and cold supplies, 50.8 mm 2 inch drain.

2.3.6.2 Ice Maker Box

One-piece, recessed,[high impact plastic][metal] box with quarter turn shut-off valves, 12.7 mm 1/2 inch supply.

2.3.7 Relief Valves

****
NOTE: The following paragraph is tailored for WATER HEATERS.
****

Water heaters and hot water storage tanks must have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve must have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve must have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves must be rated according to ANSI Z21.22/CSA 4.4. Relief valves for systems where the maximum rate of heat input is less than 59 kW 200,000 Btuh must have 20 mm 3/4 inch minimum inlets, and 20 mm 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 59 kW 200,000 Btuh must have 25 mm 1 inch minimum inlets, and 25 mm 1 inch outlets. The discharge pipe from the relief valve must be the size of the valve outlet.

2.3.8 Thermostatic Mixing Valves

****

NOTE: For combination potable water heating and space heating systems, see UFC 3-420-01 Section 501.2.

****

Each valve must be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element must be of an approved type. The body must be of heavy cast bronze, and interior parts must be brass, bronze, corrosion-resisting steel or copper. The valve must be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets.

2.3.9 Temperature Controlled Mixing Valve

Provide an ASSE 1017 temperature controlled (master mixing valve) to lower temperature per UFC 3-420-01 immediately downstream of the water heater [and][or] storage tank as close to the fixture(s) as possible in order to reduce the amount of stored tempered water in the pipes in accordance with ASSE 1017.

2.3.10 Point-of-Use Mixing Valve

Provide a point-of-use mixing valve in accordance with ASSE 1070 at lavatories, hand-wash sinks, and washfountain locations. Point-of-use mixing valve must limit the tempered water to not greater than 43.4 degrees C 110 degrees F.

2.3.11 Automatic Temperature [and][or] Pressure Compensating Valve

Provide automatic temperature and/or pressure compensating valve installed at each individual shower or tub/shower combination in accordance with ASSE 1016. The compensating valve must be integrated with each individual shower or tub/shower combination valve and must be installed at point of use. The valve must be equipped with a device to limit the maximum temperature to 48.9 degrees C 120 degrees F.

2.3.12 Temperature Actuated Mixing Valve

Provide ASSE 1071 temperature actuated mixing valve to provide tepid water for emergency eyewash, shower/eyewash, drench shower and combination units that comply with ANSI/ISEA Z358.1. Valves must have a means to limit the maximum outlet temperature and must include a means of preventing cross-flow. Valves can be located[in a wall-mounted bracket][in a cabinet][in a cabinet with window].

2.3.13 Single Supply Line Automatic Temperature Control

Provide ASSE 1069 automatic temperature control valve on single supply line to gang showers or sitz baths to provide tempered water control to multiple fixtures. Valves must be installed where end user does not have means to adjust temperature setting. Temperature setting must be set as indicated with a maximum set point of 48.9 degrees C 120 degrees F.

2.4 FIXTURES

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NOTE: This SUBPART is tailored for FIXTURES.

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NOTE: For NAVFAC Mid-Atlantic and Newport, R.I. use copper alloy bathtub waste drains.

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NOTE: The systems specified for water use in a building can dramatically impact both the quantity of water resources used and the quality. Installed fixtures and systems must be life-cycle cost-effective. Low-flow and zero-flow fixtures and accessories (such as no-water urinals, composting toilets, and sensor operators) may require special training. Because these technologies may be different from the systems and materials with which the Government personnel are familiar, education about the environmental qualities as well as the operation and maintenance requirements may be necessary. Refer to Section 01 45 00 QUALITY CONTROL.

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NOTE: Water quality for most buildings is largely determined by the municipal water treatment facility. Most water treatment facilities rely upon chemicals, including chlorine, to combat pathogens. Chlorine is highly reactive and readily forms chlorinated compounds, many of which are considered to be dangerous. Chlorinated hydrocarbons, such as DDT, have been and are used as pesticides. If this is a concern for a given location, include the bracketed chlorine filter requirement in the lavatory, sink, cooler, shower and bathtub specification paragraphs below.

****

Submit list of fixtures with manufacturer, model, and flow rate. Water closet replacements in major renovations may have a flush valve of up to 6.1 LPF 1.6 GPF to accommodate existing plumbing capacity. Fixtures for use by the physically handicapped must be in accordance with ICC A117.1.[ASME A112.19.3/CSA B45.4 302 stainless steel] [Vitreous China], nonabsorbent, hard-burned, and vitrified throughout the body must be provided. Porcelain enameled ware must have specially selected, clear [white][_____], acid-resisting enamel coating evenly applied on surfaces.

No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures must be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, must be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts must be provided for supports, and polished chromium-plated pipe, valves, and fittings must be provided where exposed to view. Fixtures with the supply discharge below the rim must be equipped with backflow preventers. Internal parts of flush valves and flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains [may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years][must be copper alloy with all visible surfaces chrome plated].[Plastic in contact with hot water must be suitable for 82 degrees C 180 degrees F water temperature.]

2.4.1 Lavatories

****

NOTE: This paragraph is tailored for ARMY. Lavatories installed in male barracks or dormitories and in male gang toilets (three or more water closets) or other types of buildings should be provided with brackets to prevent uplifting. In central toilets allow only enameled cast-iron lavatories.

****

[Enameled cast-iron lavatories must be provided with two cast-iron or steel brackets secured to the underside of the apron and drilled for bolting to the wall in a manner similar to the hanger plate. Exposed brackets must be porcelain enameled.][Vitreous china lavatories must be provided with two integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.][Provide public faucet with a maximum flow rate of 1.9 L/min 0.5 gpm at a maximum flowing pressure of 414 kPa 60 psi.][Provide WaterSense labeled private faucet with a maximum flow rate of 5.7 L/min 1.5 gpm and a minimum flow rate of 3 L/min 0.8 gpm at a maximum flowing pressure of 414 kPa 60 psi.][Provide WaterSense labeled metering faucet with a maximum flow rate of 1.0 L 0.25 gal per metering cycle.]Provide data identifying WaterSense label for lavatory faucet.

[2.4.2 Automatic Controls

****

NOTE: This paragraph contains tailoring for NAVY. Include this paragraph only if automatic controls is a project requirement. Use photovoltaic cells or hydropower generators to extend sensor battery life. This should be discussed with the user and an automatic control specified if requested by the user. If using battery operated, sensor activated valves, ensure approval from user or maintenance personnel for the replacing and maintaining batteries on the controls.

****

Provide[hard wired][battery operated] automatic, sensor operated faucets and flush valves to comply with ASSE 1037 and UL 1951 for lavatory faucets, urinals, and water closets. Flushing and faucet systems must consist of solenoid-activated valves with light beam sensors. Flush valve for water closet must include an override pushbutton. Flushing devices must be provided as described in paragraph FIXTURES AND FIXTURE TRIMMINGS.

]2.4.3 Flush Valve Water Closets

2.4.3.1 Flush Valve Water Closet Type and Mount

ASME A112.19.2/CSA B45.1, [white][_____] vitreous china,[ASME A112.19.3/CSA B45.4 302 Stainless Steel,] siphon jet,[elongated][round] bowl,[floor-mounted, floor outlet][wall mounted, wall outlet, provide with carrier]. Top of toilet seat height above floor must be 356 to 381 mm 14 to 15 inches, except 432 to 483 mm 17 to 19 inches for wheelchair water closets. Provide wax bowl ring including plastic sleeve. Provide [white][_____] solid plastic[elongated][round][open-front seat][closed-front seat with cover].

2.4.3.2 Flush Valve Water Closet Flush and Flow

Water flushing volume of the water closet and flush valve combination must not exceed 4.85 liters 1.28 gallons per flush.[Provide a dual-flush water closet and flush valve combination that will also provide a second flushing water volume not to exceed 4.8 liters 1.28 gallons per flush.] Water closets must meet the EPA WaterSense product definition and must be EPA WaterSense labeled products. Provide data identifying WaterSense label for flush valve water closet. Fixtures that require the WaterSense label but are located in countries where the label is unavailable, see table below or see https://uwla.eu/for WaterSense label substitutes.

WaterSense Equivalencies	
Australia	WELs
Canada	WaterSense

Non-Mandatory Labels*	
European Union	European Water Label
Taiwan	Water Saving Label
China, Hong Kong	WELS

*Water efficiency labels recognized as market transformational, and are recommended, but not required for LEED projects.

2.4.3.3 Flush Valve Water Closet Control Valve

Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components must be chromium-plated or polished stainless steel. Flush valves must be nonhold-open type. Mount flush valves not less than 279 mm 11 inches above the fixture. Mounted height of flush valve must not interfere with the hand rail in ADA stalls.[Provide solenoid-activated flush valves including electrical-operated light-beam-sensor to energize the solenoid.]

2.4.4 Flush Valve Urinals

ASME A112.19.2/CSA B45.1, [white][_____] vitreous china, [ASME A112.19.3/CSA B45.4 302 stainless steel,] wall-mounted, wall outlet, siphon jet, integral trap, and extended side shields. Provide urinal with the rim 610 mm 24 inches above the floor. Water flushing volume of the urinal and flush valve combination must not exceed 1.9 liters 0.5 gallons per flush. Urinals must be EPA WaterSense labeled products. Provide data identifying WaterSense label for urinal. Fixtures that require the WaterSense label but are located in countries where the label is unavailable, see table below or see https://uwla.eu/for WaterSense label substitutes.

WaterSense Equivalencies	
Australia	WELs
Canada	WaterSense

Non-Mandatory Labels*	
European Union	European Water Label
Taiwan	Water Saving Label
China, Hong Kong	WELS

*Water efficiency labels recognized as market transformational, and are recommended, but not required for LEED projects.

Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports. Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components must be chromium-plated or polished stainless steel. Flush valves must be nonhold-open type. Mount flush valves not less than 279 mm 11 inches above the fixture.[Provide solenoid-activated flush valves including electrical-operated light-beam-sensor to energize the solenoid.]

2.4.5 Wheelchair Flush Valve Type Urinals

ASME A112.19.2/CSA B45.1, [white][_____] vitreous china,[ASME A112.19.3/CSA B45.4 302 stainless steel,] wall-mounted, wall outlet, blowout action, integral trap, elongated projecting bowl, a minimum of 343 mm 13.5 inches long from wall to front of flare, and ASME A112.19.5 trim. Provide large diaphragm (not less than 66 mm 2.625 inches upper chamber inside diameter at the point where the diaphragm is sealed between the upper and lower chambers), nonhold-open flush valve of chrome plated cast brass conforming to ASTM B584, including vacuum breaker and angle (control-stop) valve with back check. The water flushing volume of the flush valve and urinal combination must not exceed 1.9 liters 0.5 gallon per flush. Urinals must be EPA WaterSense labeled products. Provide data identifying WaterSense label for wheelchair flush valve urinal. Fixtures that require the WaterSense label but are located in countries where the label is unavailable, see table below or see https://uwla.eu/for WaterSense label substitutes.

WaterSense Equivalencies	
Australia	WELs
Canada	WaterSense

Non-Mandatory Labels*	
European Union	European Water Label
Taiwan	Water Saving Label
China, Hong Kong	WELS

*Water efficiency labels recognized as market transformational, and are recommended, but not required for LEED projects.

Furnish urinal manufacturer's certification of conformance. Provide ASME A112.6.1M concealed chair carriers. Mount urinal with front rim a maximum of 432 mm 17 inches above floor and flush valve handle a maximum of 1118 mm 44 inches above floor for use by handicapped on wheelchair.[Provide solenoid-activated flush valves including electrical-operated light-beam-sensor to energize the solenoid.]

2.4.6 No-Water Urinals

****

NOTE: This paragraph is tailored for NAVY and AIR FORCE. Use the following paragraph for Navy and Air Force projects only. Confirm selection with Installation Department of Public Works/Base Civil Engineer.

****

ASME A112.19.2/CSA B45.1, [white][_____] vitreous china,[ASME A112.19.3/CSA B45.4 302 stainless steel,] wall-mounted, wall outlet. Provide with urine trap and 100 percent biodegradable sealant liquid as approved by manufacturer.[For ADA, provide urinal with the rim 430 mm 17 inches above the floor.][For non-ADA, provide urinal with the rim 609.6 mm 24 inches above the floor.] Provide ASME A112.6.1M concealed chair carriers.

2.4.7 Non-Water Use Urinals

****

NOTE: This paragraph is tailored for ARMY. Use the following paragraph for Army projects only. For FY10 and beyond MILCON projects, Army Installation Design Standard requires the use of non-water using urinals for new construction and major repairs. Confirm selection with Installation Department of Public Works/Base Civil Engineer.

****

ASME A112.19.2/CSA B45.1, [white][_____] vitreous china,[ASME A112.19.3/CSA B45.4 302 stainless steel,] wall-mounted, wall outlet, non-water using, integral drain line connection. The trap design must comply with the IPC. Sealed replaceable cartridge or integral liquid seal trap must use a biodegradable liquid to provide the seal and maintain a sanitary and odor-free environment. Install with urinal rim 610 mm 24 inches above the floor. Urinals installed in compliance with ADA requirements must be mounted with the rim 430 mm 17 inches above the floor. Provide ASME A112.6.1M concealed chair carriers. Installation, maintenance and testing must be in accordance with the manufacturer's recommendations. Slope the sanitary sewer branch line for non-water use urinals a minimum of 6.35 mm per meter 0.25 inches per foot. Drain lines that connect to the urinal outlet must not be made of copper tube or pipe. For urinals that use a replaceable cartridge, provide four additional cartridges for each urinal installed along with any tools needed to remove/install the cartridge. Provide an additional quart of biodegradable liquid for each urinal installed. Manufacturer must provide an operating manual and on-site training for the proper care and maintenance of the urinal.

2.4.8 Flush Tank Water Closets

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NOTE: Dual-flush toilets allow the user to choose the flush rate needed for each use instead of flushing at maximum capacity every time.

****

ASME A112.19.2/CSA B45.1, [white][_____] vitreous china,[ASME A112.19.3/CSA B45.4 302 stainless steel,] siphon jet,[round bowl,][pressure assisted,] floor-mounted, floor outlet. Top of toilet seat height above floor must be 356 to 381 mm 14 to 15 inches, except 432 to 483 mm 17 to 19 inches for wheelchair water closets.[Nonfloat swing type flush tank valves are not acceptable.][Gravity tank type water closets are not permitted.] Provide wax bowl ring including plastic sleeve. Water flushing volume of the water closet must not exceed 4.8 liters 1.28 gallons per flush.[Provide a dual-flush toilet with a second flushing option that must not exceed 4.1 liters 1.1 gallons per flush.] Tank-type water closets must be EPA WaterSense labeled products. Provide data identifying WaterSense label for flush tank water closet. Fixtures that require the WaterSense label but are located in countries where the label is unavailable, see table below or see https://uwla.eu/for WaterSense label substitutes.

WaterSense Equivalencies	
Australia	WELs
Canada	WaterSense

Non-Mandatory Labels*	
European Union	European Water Label
Taiwan	Water Saving Label

Non-Mandatory Labels*	
China, Hong Kong	WELS

*Water efficiency labels recognized as market transformational, and are recommended, but not required for LEED projects.

Provide [white][_____] solid plastic[round][elongated][open-front][closed-front] seat with cover.

2.4.9 Non-Flushing Toilets

****

NOTE: Composting toilets reduce water usage and create soil amendment. Electric fans, mixing tines, and electric heat accelerate decomposition, although electric heat is energy intensive. Vacuum toilet systems, traditionally associated with water conservation in marine, air, and railroad transports are also available for application in commercial/residential buildings. Vacuum toilets not only reduce water consumption, but they reduce piping and can eliminate need for toilet vent pipes, allowing for flexibility in design layout.

****

[Provide composting toilets in accordance with manufacturer's recommendations.][Provide vacuum toilet systems in accordance with manufacturer's recommendations.]

2.4.10 Wall Hung Lavatories

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NOTE: This paragraph contains tailoring for AIR FORCE.

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ASME A112.19.2/CSA B45.1, [white][_____] vitreous china,[ASME A112.19.3/CSA B45.4 302 stainless steel,][straight back][ledge back][corner] type, minimum dimensions of [483 mm wide by 432 mm][407 mm wide by 407 mm] [19 inches wide by 17 inches][16 inches wide by 16 inches] front to rear, with supply openings for use with top mounted centerset faucets, and openings for concealed arm carrier installation.[Provide aerator with faucet.] Provide lavatory faucets and accessories meeting the flow rate and product requirements of the paragraph LAVATORIES. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports and concealed arms for the lavatory. Mount lavatory with the front rim 864 mm 34 inches above floor and with 737 mm 29 inches minimum clearance from bottom of the front rim to floor.[Provide top mounted washerless centerset lavatory faucets.][Provide top-mounted solenoid-activated lavatory faucets including electrical-operated light-beam-sensor to energize the solenoid.][Provide filters for chlorine in supply piping to faucets.] Provide piping covers for P-traps, valves, and exposed drain piping per ADA requirement.

2.4.11 Countertop Lavatories

****

NOTE: This paragraph contains tailoring for AIR FORCE
****

ASME A112.19.2/CSA B45.1,[self-rimming][under-counter mount][white][_____] vitreous china,[ASME A112.19.3/CSA B45.4 302 stainless steel], minimum dimensions of 483 mm wide by 432 mm 19 inches wide by 17 inches front to rear, with supply openings for use with top mounted centerset faucets. Furnish template and mounting kit by lavatory manufacturer.[Provide aerator with faucet.]Provide lavatory faucets and accessories meeting the flow rate and product requirements of the paragraph LAVATORIES. Mount counter with the top surface 864 mm 34 inches above floor and with 737 mm 29 inches minimum clearance from bottom of the counter face to floor.[Provide top mounted washerless centerset lavatory faucets.][Provide top-mounted solenoid-activated lavatory faucets including electrical-operated light-beam-sensor to energize the solenoid.][Provide filters for chlorine in supply piping to faucets.]

2.4.12 Washfountains

ASME A112.19.3/CSA B45.4 and ASME A112.18.1/CSA B125.1. Provide[wall-mounted][floor-supported], [3][4][5][8] User[accessible,][vandal-resistant,][circular][semi-circular][corner] washfountain. Constructed of[solid surface material][reinforced thermoset polyester][precast terrazzo][stainless steel][recycled solid surface material]. Unit to include individual spray heads per station with flow rate of 1.89 L/min .5 GPM, ASSE 1070 mixing valve, volume control valve, waste and supply connections with stops, strainers, and check valves. Operation to be[foot control][hand control pushbutton][infrared sensor operation]. Unit height to be [711][737][864] mm [28][29][34] inches.[Provide with stainless steel overhead shroud].

2.4.13 Lavatory Systems, Single or Multiple Stations

ASME A112.18.1/CSA B125.1, provide wall hung, solid surface counter with integral bowls and 410 mm 16-1/8 inches access panel. Provide with[one][two][three][four] bowls. Height to rim dimensions [864 mm 34 inches][_____], provide manufacturer's standard, chrome plated solid brass faucet at each bowl with[manual, push button][hard wired, sensor activated][battery powered, sensor activated] control. Provide ASSE 1070 point-of-use mixing valve with check stops per[single][multiple] user station, set to maximum 43.3 degrees C 110 degrees F.[Provide integral hand dryer.][Provide integral soap dispenser.]

2.4.14 Kitchen Sinks

****
NOTE: Pedal valves provide savings in locations where water is unnecessarily left running continuously during use, like kitchens.

NOTE: This paragraph contains tailoring for AIR FORCE.
****

ASME A112.19.3/CSA B45.4,[single][double][triple] compartment, 20 gage stainless steel with integral mounting rim for flush installation, minimum dimensions of [762 mm wide by 534 mm][838 mm wide by 533 mm][1600 mm wide by 534] [30 inches wide by 21 inches][33 inches wide by 21 inches][63 inches wide by 21 inches] front to rear, with undersides fully sound deadened, with supply openings for use with top mounted washerless sink faucets with hose spray, and with 89 mm 3.5 inch drain outlet.[Provide aerator with faucet.] Water flow rate must not exceed 8.3 L per minute 2.2 gpm when measured at a flowing water pressure of 414 kPa 60 psi. Provide stainless steel drain outlets and stainless steel cup strainers. Provide separate 38 mm 1.5 inch P-trap and drain piping to vertical vent piping from each compartment. Provide top mounted washerless sink faucets with hose spray.[Provide filters for chlorine in supply piping to faucets.][Provide UL 430 waste disposer in right compartment.][Provide pedal valve for foot-operated flow control.][Provide secondary kitchen sink that drains to graywater system.][Provide sink with disposal chute to compost bucket under sink.]

2.4.15 Service Sinks

ASME A112.19.2/CSA B45.1, [white][_____] vitreous china [ASME A112.19.3/CSA B45.4 302 stainless steel] with integral back and wall hanger supports, minimum dimensions of 559 mm 22 inches wide by 508 mm 20 inches front to rear, with two supply openings in 254 mm 10 inch high back. Provide floor supported wall outlet cast iron P-trap and stainless steel rim guards as recommended by service sink manufacturer. Provide back mounted washerless service sink faucets with vacuum breaker and 19 mm 0.75 inch external hose threads.

2.4.16 Drinking-Water Coolers for Standing Person

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NOTE: This paragraph contains tailoring for AIR FORCE.

****

ANSI/ASHRAE 18, UL 399, NSF/ANSI/CAN 61, ADA and ICC A117.1. Dual or Bi-Level water coolers to conform to the requirements of DRINKING-WATER COOLER FOR STANDING PERSON and WHEELCHAIR DRINKING WATER COOLER conforming to ICC A117.1, ANSI/ASHRAE 18, UL 399, NSF/ANSI/CAN 61. Wall mounted height water cooler with more than a single thickness of metal between the potable water and the refrigerant in the heat exchanger, wall-hung, bubbler style, air-cooled condensing unit, 8.4 ml per second 8 gph minimum capacity, stainless steel splash receptor and basin,[bottle filler,][vandal resistant,][touchless control,][filter,] and stainless steel cabinet. Bubblers must be controlled by push levers or push bars, front mounted or side mounted near the front edge of the cabinet. Bubbler spouts must be mounted at maximum of 965 mm to 1092 mm 38 inches to 43 inches above floor. Spouts must direct water flow at least 102 mm 4 inches above unit basin and trajectory parallel or nearly parallel to the front of unit. [Provide filters for chlorine in supply piping to faucets.] Provide ASME A112.6.1M concealed steel pipe chair carriers.

2.4.17 Wheelchair Drinking Water Cooler

****

NOTE: Use 4.99 ml per second 4.75 gph minimum capacity for single height water cooler and 8.4 ml per second 8 gph minimum capacity for dual height water cooler.

This paragraph contains tailoring for AIR FORCE.

****

ANSI/ASHRAE 18, UL 399, NSF/ANSI/CAN 61, ADA and ICC A117.1. [Single][and][Dual] height water cooler with more than a single thickness of metal between the potable water and the refrigerant in the heat exchanger, wall-mounted bubbler style with ASME A112.6.1M concealed chair carrier, air-cooled condensing unit, [4.99 mL per second 4.75 gph minimum capacity][and][8.4 ml per second 8 gph minimum capacity], stainless steel splash receptor, and all stainless steel cabinet, with 686 mm 27 inch minimum knee clearance from front bottom of unit to floor and 914 mm 36 inch maximum spout height above floor for ADA side and 965 mm to 1092 mm 38 inches to 43 inches above floor for standing person side[and bottle filler][vandal resistant][touchless control][filter][cane apron]. Bubblers must also be controlled by push levers, by push bars, or touch pads one on each side or one on front and both sides of the cabinet.[Provide filters for chlorine in supply piping to faucets.]

2.4.18 Energy Star Label for Freestanding Bottled Water Coolers/Dispensers

2.4.18.1 Bottled Water Dispenser

Energy star labeled, [cold][and][hot] bottled water dispenser, [18.9][11.4] liter [5][3] gallon capacity,[top load][bottom load],[floor standing][countertop] unit.[Provide with a cold water temperature of 8.3 degrees C 47 degrees F.][Provide with a hot water temperature of 85 degrees C 185 degrees F.]

2.4.18.2 Bottleless Water Dispenser

Energy Star Labeled, [cold][and][hot] bottleless water dispenser with filters, 1.89 L/minute 0.5 gpm flow rate,[floor standing][countertop] unit.[Provide with a cold water temperature of 8.3 degrees C 47 degrees F.][Provide with a hot water temperature of 85 degrees C 185 degrees F.]

2.4.19 Shower Faucets

Provide ball joint self-cleaning shower heads. Provide WaterSense labeled showerhead with a maximum flow rate of 6.6 L/min 1.75 gpm. Provide data identifying WaterSense label for showerhead. Fixtures that require the WaterSense label but are located in countries where the label is unavailable, see table below or see https://uwla.eu/ for WaterSense label substitutes.

WaterSense Equivalencies	
Australia	WELs
Canada	WaterSense

Non-Mandatory Labels*	
European Union	European Water Label
Taiwan	Water Saving Label
China, Hong Kong	WELS

*Water efficiency labels recognized as market transformational, and are recommended, but not required for LEED projects.

2.4.20   Plastic Bathtub/Shower Units

****
NOTE: This paragraph is also tailored for NAVY and AIR FORCE.
****

CSA B45.5-17/IAPMO Z124 four piece [white][_____] solid acrylic pressure molded fiberglass reinforced plastic bathtub/shower units. Units must be scratch resistant, waterproof, and reinforced. Provide showerheads meeting the requirements of the paragraph BATHTUB AND SHOWER FAUCETS AND DRAIN FITTINGS.[Provide flow restrictor in handshower to flow 6.6 L/min 1.75 gpm.] [Provide filters for chlorine in supply piping to faucets and showerheads.] Provide recessed type units approximately 1524 mm 60 inches wide, 762 mm 30 inches front to rear, 1829 mm 72 inches high with 381 mm 15 inches high rim for through-the-floor drain installation with unit bottom or feet firmly supported by a smooth level floor. Provide left or right drain outlet units as required. Units must have built-in soap dish and minimum of 305 mm 12 inch long stainless steel horizontal grab bar located on back wall for standing use. Units must meet performance requirements of CSA B45.5-17/IAPMO Z124 and must be labeled by NAHB Research Foundation, Inc. for compliance. Install unit in accordance with the manufacturer's written instructions. Finish installation by covering unit attachment flanges with wall board in accordance with unit manufacturer's recommendation. Provide smooth 100 percent silicone rubber [white][_____] bathtub caulk between the unit and the adjacent walls and floor surfaces.

2.4.21   Plastic Bathtubs

****
NOTE: This paragraph is also tailored for NAVY and AIR FORCE.
****

CSA B45.5-17/IAPMO Z124 one piece [white][_____] solid acrylic pressure molded fiberglass reinforced plastic bathtubs. Bathtubs must be scratch resistant, waterproof, and reinforced. Provide recessed type bathtubs approximately 1524 mm 60 inches wide, 762 mm 30 inches front to rear, 381 mm 15 inches high rim for through-the-floor drain installation with bathtub bottom or feet firmly supported by a smooth level floor. Provide left or right drain outlet bathtub as required.[Provide filters for chlorine in supply piping to faucets.] Bathtubs must meet performance requirements of CSA B45.5-17/IAPMO Z124 and must be labeled by NAHB Research Foundation, Inc. for compliance. Install bathtub in accordance with the manufacturer's written instructions. Finish installation by covering bathtub attachment flanges with dry-wall in accordance with bathtub manufacturer's recommendation. Provide smooth 100 percent silicone rubber [white][_____] bathtub caulk between the bathtub and the adjacent walls and floor surfaces.

2.4.22   Plastic Shower Stalls

****
NOTE: This paragraph is also tailored for NAVY and AIR FORCE.
****

CSA B45.5-17/IAPMO Z124 four piece [white][_____] solid acrylic pressure molded fiberglass reinforced plastic shower stalls. Shower stalls must be scratch resistant, waterproof, and reinforced. Provide showerheads meeting the requirements of the paragraph BATHTUB AND SHOWER FAUCETS AND DRAIN FITTINGS.[Provide filters for chlorine in supply piping to showerheads.] Provide PVC shower floor drains and stainless steel strainers. Shower stalls must meet performance requirements of CSA B45.5-17/IAPMO Z124 and must be labeled by NAHB Research Foundation, Inc. for compliance. Install shower stall in accordance with the manufacturer's written instructions. Finish installation by covering shower stall attachment flanges with dry-wall in accordance with shower stall manufacturer's recommendation. Provide smooth 100 percent silicone rubber [white][_____] bathtub caulk between the top, sides, and bottom of shower stalls and bathroom walls and floors.

2.4.22.1 Standard Shower Stall

Provide recessed type shower stall approximately 914.4 mm 36 inches wide, 914.4 mm 36 inches front to rear, 1930.4 mm 76 inches high, with a 127 mm 5 inch high curb with shower stall bottom or feet firmly supported by a smooth level floor.

2.4.22.2 Transfer Type Shower Stall (ADA)

Provide recessed type, barrier free threshold type shower stall approximately 914.4 mm 36 inches wide, 914.4 mm 36 inches front to rear, 1930.4 mm 76 inches high. Clearance of 914.4 mm 36 inches wide minimum by 1219 mm 48 inches long minimum measured from the control wall must be provided, with shower stall bottom or feet firmly supported by a smooth level floor. Provide shower seat and grab bars. Provide flow restrictor in handshower[with slidebar] to flow 6.63 L/min 1.75 gpm.

2.4.22.3 Standard Roll-in Type Shower Stall (ADA)

Provide recessed type, barrier free threshold shower stall, minimum 1524 mm 60 inches wide, 762 mm 30 inches front to rear with shower stall bottom or feet firmly supported by a smooth level floor. Provide shower seat and grab bars. Provide flow restrictor in handshower[with slidebar] to flow 6.63 L/min 1.75 gpm.

2.4.23 Plastic Bathtub Liners

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NOTE: This paragraph is also tailored for NAVY and AIR FORCE.

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IAPMO Z124.8 one piece [white][_____] plastic bathtub liners. Existing bathtubs must be identified and measured to insure proper identification in order that each new bathtub liner must be custom molded to fit the exact contours of the existing bathtubs. Provide left or right drain outlet bathtub liners as required. Bathtub liners must be inserted over and into the existing bathtubs without disturbing the existing ceramic tile wainscot walls and existing floor material. Prepare the existing cast-iron bathtubs, ceramic tile wainscots, and floor to receive the new bathtub liners in accordance with the bathtub liner manufacturer's written instructions. Installation personnel must be trained by the bathtub liner manufacturer. Seal the bathtub liner to existing bathtub with waterproof adhesive as required to keep moisture out from behind the bathtub liner. Provide smooth [white][_____] waterproof bathtub sealant between bathtub drains, bathtub, and bathtub liners. Provide replacement chromium-plated overflow cover plates and push-pull bathtub drain stopper assembly. Provide smooth 100 percent silicone rubber [white][_____] bathtub caulk between the bathtub liner and the adjacent walls and floor surfaces in accordance with the bathtub liners manufacturer's written instructions.

2.4.24 Plastic Bathtub Wall Surrounds

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NOTE: This paragraph is also tailored for NAVY and AIR FORCE.

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CSA B45.5-17/IAPMO Z124 three piece [white][_____] sectional pressure molded fiberglass plastic bathtub wall surrounds suitable for installation with existing bathtubs which are approximately 1524 mm 60 inches wide by 762 mm 30 inches front to rear. Wall surrounds must have built-in soap dish and minimum of 305 mm 12 inch long stainless steel horizontal grab bar located on back wall for standing use. Bathtub wall surrounds must meet performance requirements of CSA B45.5-17/IAPMO Z124 and must be labeled by NAHB Research Foundation, Inc. for compliance. Install bathtub wall surrounds in accordance with the manufacturers written instructions. Finish installation by covering bathtub wall surround attachment flanges with dry-wall in accordance with bathtub wall surround manufacturer's recommendations. Provide smooth 100 percent silicone rubber [white][_____] bathtub caulk between the bathtubs and the adjacent walls and floor surfaces.

2.4.25 Precast Terrazzo Shower Floors

Terrazzo must be made of marble chips cast in white portland cement to produce 25 mPa 3000 psi minimum compressive strength 7 days after casting. Provide floor or wall outlet copper alloy body drain cast integral with terrazzo, with polished stainless steel strainers.

2.4.26 Precast Terrazzo Mop Sinks

Terrazzo must be made of marble chips cast in white portland cement to produce 25 mPa 3000 psi minimum compressive strength 7 days after casting. Terrazzo can include[corner type][stainless steel curb cap][wall guard] additions with minimum dimensions of [610 mm 24 inches][_____] wide by [610 mm 24 inches][_____] length by [305 mm 12 inches][_____] height. Provide floor or wall outlet copper alloy body drain cast integral with terrazzo, with polished stainless steel strainers.

2.4.27 Bathtubs, Cast Iron

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NOTE: This paragraph contains tailoring for AIR FORCE.

****

ASME A112.19.1/CSA B45.2, [white][_____] enameled cast iron, recessed type, minimum dimensions of 1524 mm 60 inches wide by 762 mm 30 inches front to rear by 406 mm 16 inches high with drain outlet for above-the-floor drain installation. Provide left or right drain outlet bathtub as indicated.[Provide filters for chlorine in supply piping to faucets.]

2.4.28 Bathtubs, Porcelain

****

NOTE: This paragraph contains tailoring for AIR FORCE.

This tub type is meant to be used in conjunction with the above type (Bathtubs, Cast Iron). Do not use alone, but as an option in concurrence with cast iron.

****

ASME A112.19.1/CSA B45.2, [white][_____] porcelain bonded to enameling grade metal, bonded to a structural composite, recessed type, minimum dimensions of 1524 mm 60 inches wide by 762 mm 30 inches front to rear by 406 mm 16 inches high with drain outlet for above-the-floor drain installation. Provide left or right drain outlet bathtub as indicated.[Provide filters for chlorine in supply piping to faucets.]

2.4.29 Emergency Eyewash and Shower

ANSI/ISEA Z358.1, floor supported free standing[freeze protected] unit[with privacy curtain]. Provide deluge shower head, stay-open ball valve operated by pull rod and ring or triangular handle. Provide eyewash dust[caps][cover] and stay-open ball valve operated by foot treadle or push handle. Unit must deliver a minimum of 75.7 L/min 20 gpm of water at 207 kPa 30 psig flow pressure for 15 minutes. Eye wash unit must have a minimum of 1.51 L/min 0.4 gpm of water at 207 kPa 30 psig flow pressure for 15 minutes. Position eye wash nozzles 838 mm 33 inches to 1143 mm 45 inches above finished floor. Provide copper alloy control valves. Provide an air-gap with the lowest potable eye wash water outlet located above the overflow rim by not less than the International Plumbing Code minimum. [Provide a pressure-compensated tempering valve, with leaving water temperature setpoint adjustable throughout the range 15.6 degrees C 60 degrees F to 35 degrees C 95 degrees F.] [Provide packaged, UL listed, alarm system; including an amber strobe lamp, horn with externally adjustable loudness and horn silencing switch, mounting hardware, and waterflow service within NEMA Type 3 or 4 enclosures[and for explosion proof service within NEMA Type 7 or 9 enclosures].]

2.4.30 Emergency Eye and Face Wash

ANSI/ISEA Z358.1,[floor][wall-mounted][freeze protected], self-cleaning, nonclogging eye and face wash with quick opening, full-flow valves,[dust covers,][stainless steel][plastic] eye and face wash receptor. Unit must deliver a minimum of 0.19 L/s 3 gpm of aerated water at 207 kPa (gage) 30 psig flow pressure, with eye and face wash nozzles 838 to 1143 mm 33 to 45 inches above finished floor. Provide copper alloy control valves. Provide an air-gap with the lowest potable eye and face wash water outlet located above the overflow rim by not less than the International Plumbing Code minimum.[Provide a pressure-compensated tempering valve, with leaving water temperature setpoint adjustable throughout the range 15.5 to 35 degrees C 60 to 95 degrees F.][Provide packaged, UL listed, alarm system; including an amber strobe lamp, horn with externally adjustable loudness and horn silencing switch, mounting hardware, and waterflow service within NEMA Type 3 or 4 enclosures[and for explosion proof service within NEMA Type 7 or 9 enclosures].]

2.4.31 Emergency Eyewash

ANSI/ISEA Z358.1,[floor][wall-mounted],[freeze protected,] nonclogging eye-wash with quick opening, full-flow valves,[dust covers,][stainless steel][plastic] eye-wash receptor. Unit must deliver a minimum of 1.51 L/min 0.4 gpm of water at 207kPa 30 psig flow pressure, with eye wash nozzles 838 mm to 1143 mm 33 inches to 45 inches above finished floor. Provide copper alloy control valves. Provide an air-gap with the lowest potable eye wash water outlet located above the overflow rim by not less than the International Plumbing Code minimum.[Provide a pressure-compensated tempering valve, with leaving water temperature setpoint adjustable throughout the range 15.6 degrees C to 35 degrees C 60 degrees F to 95 degrees F.][Provide packaged, UL listed, alarm system; including an amber strobe lamp, horn with externally adjustable loudness and horn silencing switch, mounting hardware, and waterflow service within NEMA Type 3 or 4 enclosures[and for explosion proof service within NEMA Type 7 or 9 enclosures].]

2.4.32 Portable, Self-Contained Eyewash Unit

ANSI/ISEA Z358.1. For locations without access to a continuous potable water source, provide unit with pressure tank [57][140] L [15][37] gallons. [ASME][Non-ASME], stainless steel, cylindrical, with pressure gage, and suitable for on-floor installation, two spray heads mounted on tank. Unit must deliver minimum 1.51 L/min 0.4 gpm for at least 15 minutes. Provide with flushing fluid.

2.5 BACKFLOW PREVENTERS

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NOTE: Indicate on the drawings all locations where backflow preventers are required (and type of device) to protect water supply and distribution system against backflow and backsiphonage in accordance with International Plumbing Code. If a drain is required, ensure it is shown. Backflow prevention device requirements for connection to nongovernment potable water systems will be coordinated with the local jurisdiction [and][or] water service agency.

****

Backflow prevention devices must be approved by the State or local regulatory agencies. If there is no State or local regulatory agency requirements, the backflow prevention devices must be listed by the Foundation for Cross-Connection Control & Hydraulic Research, or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention devices and assemblies. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers must be meet the above requirements.

Backflow preventers with intermediate atmospheric vent must conform to ASSE 1012. Reduced pressure principle backflow preventers must conform to ASSE 1013. Hose connection vacuum breakers must conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers must conform to ASSE 1001. Pressure vacuum breaker assembly must conform to ASSE 1020. Air gaps in plumbing systems must conform to ASME A112.1.2.

2.6 DRAINS

****
NOTE: Provide potable, reclaimed or gray water supply trap primer, waste water supplied trap primer, barrier-type trap seal protection or electronic trap primer device where there will be a problem with the trap drying out.
****

2.6.1 Floor and Shower Drains

Floor and shower drains must consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains must be cast iron except where metallic waterproofing membrane is installed. Drains must be of double drainage pattern for embedding in the floor construction. The seepage pan must have weep holes or channels for drainage to the drainpipe. The seepage pan and weep holes must not be filled or plugged and have pervious materials (such as pea gravel) or a weep hole protection device to allow drainage. The strainer must be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane must be provided when required. Drains must be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains must conform to ASME A112.6.3.[Provide drain with trap primer connection, trap primer, and connection piping. Primer must meet ASSE 1018.]

2.6.1.1 Metallic Shower Pan Drains

Where metallic shower pan membrane is installed, polyethylene drain with corrosion-resistant screws securing the clamping device must be provided. Polyethylene drains must have fittings to adapt drain to waste piping. Polyethylene for floor drains must conform to ASTM D1248. Drains must have separate cast-iron "P" trap, circular body, seepage pan, and strainer, unless otherwise indicated.

2.6.1.2 Drains and Backwater Valves

Drains and backwater valves installed in connection with waterproofed floors or shower pans must be equipped with bolted-type device to securely clamp flashing.

2.6.2 Bathtub and Shower Faucets and Drain Fittings

****
NOTE: For Marine Air Corps Station, New River, and Camp LeJeune NC, use ball type control handles, not lever type control handle, when handicap accessibility is not required for the faucets
****

Provide single control pressure equalizing bathtub and shower faucets with body mounted from behind the wall with threaded connections. Provide ball joint self-cleaning shower heads. Provide WaterSense labeled showerhead with a maximum flow rate of 6.6 L/min 1.75 gpm. Provide showerheads meeting the requirements in the paragraph SHOWER FAUCETS. Provide tubing mounted from behind the wall between bathtub faucets and shower heads and bathtub diverter spouts. Provide separate globe valves or angle valves with union connections in each supply to faucet. Provide trip-lever pop-up drain fittings for above-the-floor drain installations. The top of drain pop-ups, drain outlets, tub overflow outlet, and; control handle for pop-up drain must be chromium-plated or polished stainless steel. Linkage between drain pop-up and pop-up control handle at bathtub overflow outlet must be copper alloy or stainless steel. Provide 40 mm 1.5 inch copper alloy adjustable tubing with slip nuts and gaskets between bathtub overflow and drain outlet; chromium-plated finish is not required.[Provide bathtub and shower valve with ball type control handle.]

2.6.3 Area Drains

Area drains must be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain must be circular or square with a 300 mm 12 inch nominal overall width or diameter and 250 mm 10 inch nominal overall depth. Drains must be cast iron with manufacturer's standard coating. Grate must be easily lifted out for cleaning. Outlet must be suitable for inside caulked connection to drain pipe. Drains must conform to ASME A112.6.3.

2.6.4 Floor Sinks

Floor sinks must be [circular][square], with 300 mm 12 inch nominal overall width or diameter and 250 mm 10 inch nominal overall depth. Floor sink must have an acid-resistant enamel interior finish with cast-iron body, [aluminum][ABS] sediment bucket, and perforated grate of cast iron in industrial areas and stainless steel in finished areas. The outlet pipe size must be as indicated or of the same size as the connecting pipe.

2.6.5 Boiler Room Drains

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NOTE: Boiler room drain will be used where coal is the heating fuel.

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Boiler room drains must have combined drain and trap, hinged grate, removable bucket, and threaded brass cleanout with brass backwater valve. The removable galvanized cast-iron sediment bucket must have rounded corners to eliminate fouling and must be equipped with hand grips. Drain must have a minimum water seal of 100 mm 4 inches. The grate area must be not less than 0.065 square meters 100 square inches.

2.6.6 Pit Drains

Pit drains must consist of a body, integral seepage pan, and nontilting perforated or slotted grate. Drains must be of double drainage pattern suitable for embedding in the floor construction. The seepage pan must have weep holes or channels for drainage to the drain pipe. Membrane or flashing clamping device must be provided when required. Drains must be cast iron with manufacturer's standard coating. Drains must be circular and provided with bottom outlet suitable for inside caulked connection, unless otherwise indicated. Drains must be provided with separate cast-iron "P" traps, unless otherwise indicated.

2.6.7 Sight Drains

Sight drains must consist of body, integral seepage pan, and adjustable strainer with perforated or slotted grate and funnel extension. The strainer must have a threaded collar to permit adjustment to floor thickness. Drains must be of double drainage pattern suitable for embedding in the floor construction. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane must be provided for other than concrete construction. Drains must have a galvanized heavy cast-iron body and seepage pan and chromium-plated bronze, nickel-bronze, or nickel-brass strainer and funnel combination. Drains must be provided with threaded connection and with a separate cast-iron "P" trap, unless otherwise indicated. Drains must be circular, unless otherwise indicated. The funnel must be securely mounted over an opening in the center of the strainer. Minimum dimensions must be as follows:

Area of strainer and collar:	0.023 square meters 36 square inches
Height of funnel:	95 mm 3-3/4 inches
Diameter of lower portion:	50 mm 2 inches of funnel
Diameter of upper portion:	100 mm 4 inches of funnel

2.6.8 Roof Drains and Expansion Joints

Roof drains must conform to ASME A112.6.4, with dome and integral flange, and must have a device for making a watertight connection between roofing and flashing. The whole assembly must be galvanized heavy pattern cast iron. For aggregate surface roofing, the drain must be provided with a gravel stop. On roofs other than concrete construction, roof drains must be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane must be provided when required to suit the building construction. Strainer openings must have a combined area equal to twice that of the drain outlet. The outlet must be equipped to make a proper connection to threaded pipe of the same size as the downspout. An expansion joint of proper size to receive the conductor pipe must be provided. The expansion joint must consist of a heavy cast-iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve must have a nominal thickness of not less than 3.416 mm 0.134 inch. Gaskets and packing must be close-cell neoprene, O-ring packing must be close-cell neoprene of 70 durometer. Packing must be held in place by a packing gland secured with bolts.

2.6.9 Swimming Pool [and Spa]Suction Fittings

Pool water suction fittings in swimming pools[and spas] must comply with ANSI/APSP-16. The compliance of the fitting must include of the associated drain cover, sump, and hardware. The fitting must be permanently marked to indicate compliance with the ASME standard, or permanently marked with the symbol "VGB 2008".

2.6.10 Trap Seal Protection

2.6.10.1 Potable Water-Supplied Trap Seal Valve

Trap must be supplied with a source of[potable water][non-potable, reclaimed or gray water]. The trap seal primer valve must conform to ASSE 1018. The discharge from the valve must connect to the trap seal on the inlet side of the trap.

2.6.10.2 Reclaimed Or Gray Water-Supplied Trap Seal Valve

Trap must be supplied with a source of reclaimed or gray water in accordance with manufacturer of valve. The trap seal primer valve must conform to ASSE 1018. The discharge from the valve must connect to the trap seal on the inlet side of the trap.

2.6.10.3 Waste Water-Supplied Trap Seal Device

Trap will be supplied with a source of waste water conforming to ASSE 1044. The discharge from the device must connect to the trap above the trap seal on the inlet side of the trap.

2.6.10.4 Barrier-Type Trap Seal Protection Device

Trap must be protected with a barrier-type trap seal protection device conforming to ASSE 1072 and must be installed in accordance with the manufacturer's instructions.

2.6.10.5 Electronic Trap Seal Primer

Electronic[recessed][surface mount] trap primer consisting of a solenoid valve, vacuum breaker and timer will deliver a timed discharge of water to trap. Provide electronic trap seal primer with [_____] ports[and hinged access door]. ASSE and UL 1951 listed.

2.7 SHOWER PAN

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NOTE: NOTE: Show shower pans on the architectural detail. Shower pans may be omitted for showers located on floors with slab-on-grade construction, unless special local conditions necessitate waterproofing.

****

Shower pan may be copper, or nonmetallic material.

2.7.1 Sheet Copper

Sheet copper must be 4.9 kg per square meter 16 ounce weight.

2.7.2 Plasticized Polyvinyl Chloride Shower Pan Material

Material must be sheet form. The material must be 1.016 mm 0.040 inch minimum thickness of plasticized polyvinyl chloride or chlorinated polyethylene and must be in accordance with ASTM D4551.

2.7.3 Nonplasticized Polyvinyl Chloride (PVC) Shower Pan Material

Material must consist of a plastic waterproofing membrane in sheet form. The material must be 1.016 mm 0.040 inch minimum thickness of nonplasticized PVC and must have the following minimum properties:

a. or ASTM D638:

Ultimate Tensile Strength: 1.79 MPa 2600 psi
Ultimate Elongation: 398 percent
100 Percent Modulus: 3.07 MPa 445 psi

b. ASTM D1004:

Tear Strength: 53 kilonewtons per meter 300 pounds per inch

c. ASTM E96/E96M:

Permeance: 0.46 ng per Pa per second per sq meter 0.008 perms

d. Other Properties:

Specific Gravity: 1.29
PVC Solvent: Weldable
Cold Crack: minus 47 degrees C 53 degrees F
Dimensional stability 100 degrees C 212 degrees F minus 2.5 percent
Hardness, Shore A: 89

2.8 TRAPS

Unless otherwise specified, traps must be [plastic per ASTM F409][or][copper-alloy adjustable tube type with slip joint inlet and swivel]. Traps must be without a cleanout.[Provide traps with removable access panels for easy clean-out at sinks and lavatories.]Tubes must be copper alloy with walls not less than 0.813 mm 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets must have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints must be below the discharge level and must be of metal-to-metal or metal-to-plastic type as required for the application. Nuts must have flats for wrench grip. Outlets must have internal pipe thread, except that when required for the application, the outlets must have sockets for solder-joint connections. The depth of the water seal must be not less than 50 mm 2 inches. The interior diameter must be not more than 3.2 mm 1/8 inch over or under the nominal size, and interior surfaces must be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange must be provided for lavatories. The assembly must be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.9 INTERCEPTORS

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NOTE: Concrete pit must be detailed on structural drawings for exterior interceptor pits.

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2.9.1 Grease Interceptor

2.9.1.1 Gravity Grease Interceptor

Gravity grease interceptor[s] of the size indicated must be of[reinforced concrete][precast concrete construction][or steel][polyethylene] with removable[one][two][three]-section,[solid manhole cover][9.5 mm 3/8 inch checker-plate cover], and must be installed outside the building.[Provide sampling manhole.][Steel grease interceptor must be installed in a concrete pit and must be epoxy-coated to resist corrosion as recommended by the manufacturer.] Interceptors must be tested and rated in accordance with ANSI/IAPMO Z1001. Concrete must have 21 MPa 3,000 psi minimum compressive strength at 28 days.

2.9.1.2 Hydromechanical Grease Interceptor

Hydromechanical grease interceptor[s] of the size indicated must be of [polyethylene][steel] with removable[solid][checker-plate] cover, and can be installed[inside][outside] the building.[Provide sampling port.] Provide vented flow control device at inlet of hydromechanical grease interceptor in order to match flow downstream of control device with the interceptor's certified flow rate.

2.9.2 Oil Interceptor

Cast iron or welded steel, coated inside and outside with white acid resistant epoxy, with internal air relief bypass, bronze cleanout plug, double wall trap seal, removable combination pressure equalizing and flow diffusing baffle and sediment bucket, horizontal baffle, adjustable oil draw-off and vent connections on either side, gas and watertight gasketed nonskid cover, and flow control fitting.

2.9.3 Sand Interceptors

Sand interceptor of the size indicated must be of reinforced concrete,[or precast concrete construction][or equivalent capacity commercially available steel sand interceptor] with manufacturer's standard checker-plate cover, and must be installed[outside the building][top flush with the floor][floor mounted]. Steel sand interceptor must be installed in accordance with manufacturer's recommendations and must be coated to resist corrosion as recommended by the manufacturer.[Concrete must have 21 MPa 3,000 psi minimum compressive strength at 28 days.]

2.9.4 Lint Interceptors

Provide Lint Interceptor for laundry areas not in individual dwelling units. Interceptor to have removable lid and removable [screen][wire basket] to prevent passage of 12 mm 1/2 inch minimum size solids into the sanitary drainage system.

2.10 WATER HEATERS

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NOTE: This SUBPART is tailored for WATER HEATERS.

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NOTE: Coordinate with the HVAC engineer the availability of heating sources and control air in order to make proper selection of bracketed choices.

Show locations of water heaters on the drawings. Also show the type, capacity and typical data of each water heater on an equipment schedule on the drawings in accordance with UFC 3-420-01 "Plumbing Systems".

Except for gas-fired water heaters, water temperatures in excess of 60 degrees C 140 degrees F should be obtained by using a booster heater in series with a primary heater. Hot water systems utilizing recirculation systems should be tied into building off-hour controls. When using a gas-fired water heater, provide thermostatic, pressure-balanced, or combination thermostatic and pressure-balanced type mixing valves to obtain water temperatures below 60 degrees C 140 degrees F.

Ensure that values for efficiencies in Table III of PART 3 are equal to or greater than the latest "recommended" values currently released by the Department of Energy Federal Energy Management Program (FEMP). The latest values can be found on FEMP's Internet site: https://www.energy.gov/femp/incorporate-minimum-efficiency-requirements-heating-and-cooling-products-federal-acquisition

Select expansion tank based on incoming water pressure, water heater volume and temperature rise of water. Consult expansion tank manufacturer for sizing recommendations. Show the expansion tank size and acceptance volume on the drawings.

****

Water heater types and capacities must be as indicated. Each water heater must have replaceable anodes. Each primary water heater must have controls with an adjustable range that includes 32 to 71 degrees C 90 to 160 degrees F. Each gas-fired water heater and booster water heater must have controls with an adjustable range that includes 49 to 82 degrees C 120 to 180 degrees F. Hot water systems utilizing recirculation systems must be tied into building off-hour controls. The thermal efficiencies and standby heat losses must conform to TABLE III in PART 3 of this Section for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 2000 liters 500 gallons storage capacity need not meet the standard loss requirement if the tank surface area is insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. A factory pre-charged expansion tank must be installed on the cold water supply to each water heater. Expansion tanks must be specifically designed for use on potable water systems and must be rated for 93 degrees C 200 degrees F water temperature and 1034 kPa 150 psi working pressure. The expansion tank size and acceptance volume must be [_____] [as indicated].

2.10.1 Automatic Storage Type

****

NOTE: Gas-fired water heaters are more efficient in source energy use than electric resistance water heaters. Avoid use of electric type when possible. Heat pump water heaters can use waste heat from air conditioners and heat pumps to produce hot water in an efficient manner. Consider this when waste heat is available.

****

Heaters must be complete with [control system,] [control system, temperature gauge, and pressure gauge,] and must have ASME rated combination pressure and temperature relief valve.

2.10.1.1 Oil-Fired Type

Oil-fired type water heaters must conform to UL 732.

2.10.1.2 Gas-Fired Type

****

NOTE: Include bracketed statements below when project includes gas storage water heater with a nominal input of 75,000 British thermal units (Btu) per hour or less and having a rated storage capacity of not less than 20 gallons nor more than 100 gallons.

****

Gas-fired water heaters must conform to ANSI Z21.10.1/CSA 4.1 when input is 22 KW 75,000 BTU per hour or less or ANSI Z21.10.3/CSA 4.3 for heaters with input greater than 22 KW 75,000 BTU per hour.[Provide Energy Star labeled gas storage water heater. Provide data identifying Energy Star label for gas storage water heater.]

2.10.1.3 Electric Type

Electric type water heaters must conform to UL 174 with dual heating elements. Each element must be 4.5 KW. The elements must be wired so that only one element can operate at a time.

2.10.1.4 Indirect Heater Type

****

NOTE: The titles of the sections covering the applicable systems will be inserted in the blanks.

Cast-iron heads will be used in steam-to-steam or non fired boiler application. Bronze heads will be used in steam-to-water application. Carbon steel heads will be used in water-to-water applications. For most applications, copper coils will be acceptable. Copper-nickel coils will be used with high pressure steam, 1.034 MPa 150 psi or above, high temperature water, or salty water conditions.

Single wall type exchangers may be allowed if the

requirements in the plumbing code are satisfied (one requirement is that the heat transfer medium is potable or recognized as safe). The option for phenolic resin coating for heaters with service water in the shell and steam or hot water in the coil should be used only at locations where scaling on coil surfaces due to water hardness is severe or where corrosion-induced leaks are a severe problem.

****

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NOTE: Steam and high temperature hot water (HTHW) systems are NOT normally used in Air Force and almost never used in Navy jobs. When using these systems keep all steam and (HTHW) piping in the mechanical rooms and does not pass through occupied portions of the facilities.

****

Steam and high temperature hot water (HTHW) heaters with storage system must be the assembled product of one manufacturer, and be ASME tested and "U" stamped to code requirements under ASME BPVC SEC VIII D1. The storage tank must be as specified in paragraph HOT-WATER STORAGE TANKS. The heat exchanger must be [double wall] [single wall] type that separates the potable water from the heat transfer medium with a space vented to the atmosphere in accordance with ICC IPC.

a. HTHW Energy Source: The heater element must have a working pressure of 2758 kPa 400 psig with water at a temperature of 204 degrees C 400 degrees F. The heating surface must be based on 0.093 square meter 1 square foot of heating surface to heat 76 L 20 gallons or more of water in 1 hour from 4 to 82 degrees C 40 to 180 degrees F using hot water at a temperature of 178 degrees C 350 degrees F. Carbon steel heads must be used. Tubing must conform to ASTM B111/B111M, Copper Alloy No. 706 (90-10 copper-nickel). Heating elements must withstand an internal hydrostatic pressure of 4137 kPa 600 psig for not less than 15 seconds without leaking or any evidence of damage.

b. Steam Energy Source: The heater element must have a working pressure of 1034 kPa per square meter 150 pounds per square inchgauge (psig) with steam at a temperature of 185 degrees C 365 degrees F. The heating surface must be based on 0.093 square meter 1 square foot of heating surface to heat 76 L 20 gallons or more of water in 1 hour from 4 to 82 degrees C 40 to 180 degrees F using steam at atmospheric pressure.[Cast iron] [bronze] heads must be used. Tubing must be light-drawn copper tubing conforming to ASTM B75/B75M. Heating elements must withstand an internal hydrostatic pressure of 1551 kPa 225 psig for not less than 15 seconds without leaking or any evidence of damage.

2.10.2 Instantaneous Water Heater

Heater must be crossflow design with service water in the coil and [steam] [hot water] in the shell. An integral internal controller must be provided, anticipating a change in demand so that the final temperature can be maintained under all normal load conditions when used in conjunction with [pneumatic control system] [pilot-operated temperature control system]. Normal load conditions must be as specified by the manufacturer for the heater. Unit must be manufactured in accordance with ASME BPVC SEC VIII D1, and must be certified for 1.03 MPa 150 psi working pressure in the shell and 1.03 MPa 150 psi working pressure in the coils. Shell must be carbon steel with copper lining. Heads must be [cast iron] [bronze] [carbon steel plate with copper lining]. Coils must be [copper] [copper-nickel]. Shell must have metal sheathed fiberglass insulation, combination pressure and temperature relief valve, and thermometer. Insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. For gas service, provide Energy Star labeled gas instantaneous water heater. Provide data identifying Energy Star label for gas instantaneous water heater.

2.10.3 Electric Instantaneous Water Heaters (Tankless)

UL 499 and UL listed flow switch activated, tankless electric instantaneous water heater for wall mounting below sink or lavatory. Temperature rise at Flow Rate: [[_____] degrees C at [_____] L/min [_____] degrees F at [_____] gpm][as indicated on drawings].

2.10.4 Phenolic Resin Coatings for Heater Tubes

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NOTE: The option for phenolic resin coating for heaters with service water in the shell and steam or hot water in the tubes should be used only at locations where scaling on waterside tube surfaces due to water hardness is severe or where corrosion-induced leaks are a severe problem.

****

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NOTE: If interior erosion of the tubes at or near the tube sheet is expected to be a severe problem, change the wording of this paragraph and its subparagraphs to require the coating to be applied to the first 125 to 200 mm 5 to 8 inches inside the tubes.

****

The phenolic resin coating system must be applied at either the coil or coating manufacturer's factory in accordance with manufacturer's standard proven production process. The coating system must be a product specifically intended for use on the material the water heating tubes/coils are made of and must be acceptable for use in potable water systems. The coating system must be capable of withstanding temperatures up to 204 degrees C 400 degrees F dry bulb; and meet the requirements of 21 CFR 175.

[The entire exterior surface][and][The first 125 mm to 200 mm 5 to 8 inches inside the tubes] of each coil must be coated with phenolic resin coating system.

2.10.4.1 Standard Product

Provide a phenolic resin coating system that is a standard product of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design, and workmanship.

Standard products are defined as components and equipment that have been in satisfactory commercial or industrial use in similar applications of similar size for at least 2 years before bid opening. Prior to this 2 year period, these standard products were sold on the commercial market using advertisements in manufacturers' catalogs or brochures. These manufacturers' catalogs, or brochures must have been copyrighted documents or be identified with a manufacturer's document number.

2.10.4.2 Expansion Tank

Provide a[n][ASME] potable water expansion tank of steel construction with a NSF/ANSI/CAN 61 Butyl diaphragm separating the air chamber from the water containing container. Tank must have a stainless steel inlet connector. Diaphragm must be FDA approved. Maximum operating temperature 93 degrees C 200 degrees F, Maximum Working Pressure: 1034 kPa 150 PSIG (10.3 bar).

2.11 HOT-WATER STORAGE TANKS

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NOTE: This SUBPART is tailored for WATER HEATERS.

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Hot-water storage tanks must be constructed by one manufacturer, ASME stamped for the working pressure, and must have the National Board (ASME) registration. The specification AWWA D100 provides standards for water storage tanks, not domestic hot water storage tanks under domestic water pressure. The statement prior describes the tanks being ASME, it must be ASME BPVC (Boiler and Pressure Vessel Code), stamped for working pressure. The two statements combined describe a hot water storage tank under domestic water pressure. The tank must be cement-lined or glass-lined steel type in accordance with AWWA D100. The heat loss must conform to TABLE III in PART 3 of this Section as determined by the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP. Each tank must be equipped with a thermometer, conforming to ASTM E1, Type I, Class 3, Range C, style and form as required for the installation, and with 175 mm 7 inch scale. Thermometer must have a separable socket suitable for a 20 mm 3/4 inch tapped opening. Tanks must be equipped with a pressure gauge 155 mm 6 inch minimum diameter face. Insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Storage tank capacity must be as shown. Install hot water storage tanks with access hatches in order to facilitate annual cleaning and inspections.

2.12 PUMPS

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NOTE: This SUBPART is tailored for PUMPS.

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2.12.1 Sump Pumps

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NOTE: Designer will indicate location, sizes, horsepower, and capacities of equipment on drawings. Provide duplex pumps, if discharge capacity is greater than 1.6 L/s 25 gpm and total head is at least 6 m 20 feet. Delete "totally enclosed and fan cooled" when not required.

****

Sump pumps must be of capacities indicated. The pumps must be of the automatic, electric motor-driven, submerged type, complete with necessary control equipment and with a split or solid cast-iron or steel cover plate. The pumps must be direct-connected by an approved flexible coupling to a vertical electric motor having a continuous oiling device or packed bearings sealed against dirt and moisture. Motors must be totally enclosed, fan-cooled of sizes as indicated and must be equipped with an across-the-line magnetic controller in a NEMA 250, Type [1][4] enclosure. Integral size motors must be the premium efficiency type in accordance with NEMA MG 1. Each pump must be fitted with a high-grade thrust bearing mounted above the floor. Each shaft must have an alignment bearing at each end, and the suction inlet must be between 75 and 150 mm 3 and 6 inches above the sump bottom. The suction side of each pump must have a strainer of ample capacity. A float switch assembly, with the switch completely enclosed in a NEMA 250, Type [1][4] enclosure, must start and stop each motor at predetermined water levels. Duplex pumps must be equipped with an automatic alternator to change the lead operation from one pump to the other, and for starting the second pump if the flow exceeds the capacity of the first pump. The discharge line from each pump must be provided with a union or flange, a nonclog swing check valve, and a stop valve in an accessible location near the pump.

2.12.2 Circulating Pumps

Domestic hot water circulating pumps must be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump and motor must be[integrally mounted on a cast-iron or steel subbase,][close-coupled with an overhung impeller,][or][supported by the piping on which it is installed]. The shaft must be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze.

2.12.2.1 Circulating Pump Enclosure

Motor must be totally enclosed, fan-cooled and must have sufficient wattage horsepower for the service required. Each pump motor must be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover.

2.12.2.2 Circulating Pump Size and Efficiency

Integral size motors must be premium efficiency type in accordance with NEMA MG 1. Pump motors smaller than 746 W 1 hp Fractional horsepower pump motors must have integral thermal overload protection in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Guards must shield exposed moving parts.

2.12.3 Booster Pumps

2.12.3.1 Centrifugal Pumps

Horizontal split-case centrifugal-type booster pumps must be furnished. The capacities must be as indicated on drawings, and the speed must not exceed 1800 rpm. Pumps must have a casing of close-grained iron or steel with smooth water passages. A gasket must be provided between the upper and lower halves of the casing. Suction and discharge connections must be flanged. Impellers must be nonoverloading, bronze, balanced to eliminate vibration, and must be keyed to corrosion-resisting steel shafts. The casings must be fitted with bronze wearing or sealing rings. Bearings must be cartridge type, enabling the entire rotating element to be removed without disturbing alignment or exposing the bearings to dirt, water, and other foreign matter. Pumps must be provided with mechanical seals. Seal boxes must be machined in the pump casing and at both sides of the pump, and must be of sufficient depth to include a conventional bronze seal ring and rows of shaft packing. Bedplates must be close-grain cast iron or steel with ribs and lugs, complete with foundation bolts, and must have a drip lip with drain hole. Each pump must be tested at the manufacturer's plant for operating characteristics at the rated capacity and under specified operating conditions. Test curves must be furnished showing capacity in L/s gpm, head in meters feet, efficiency, brake wattage horsepower, and operation in parallel with similar pumps. Multiple pump installations must have pump characteristics compatible for operation in parallel with similar pumps. The electric motor must be sized for non-overload when operating at any point along the characteristic curve of the pump. Guards must shield exposed belts and moving parts.

2.12.3.2 Controls

Each pump motor must be provided with enclosed across-the-line-type magnetic controller complete in a NEMA 250 Type 1 enclosure with three position, "HAND-OFF-AUTOMATIC," selector switch in cover. Pumps must be automatically started and stopped by float or pressure switches, as indicated. The pumps must start and stop at the levels and pressures indicated. A multiposition sequence selector switch must be provided so that any two pumps may be operated simultaneously keeping a third pump as a standby.

2.12.4 Flexible Connectors

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NOTE: Flexible connectors should be provided for the suction and discharge of each centrifugal pump only as a solution to alignment problems to accommodate retrofits. Flexible connectors should also be provided for fluid media temperatures in access of 82 degrees C 180 degrees F.

****

Flexible connectors must be provided at the suction and discharge of each pump that is 1 hp or larger. Connectors must be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors must be line size and suitable for the pressure and temperature of the intended service.

2.12.5 Sewage Pumps

Provide single type duplex type with automatic controls to alternate the operation from one pump to the other pump and to start the second pump in the event the first pump cannot handle the incoming flow. Provide high water alarm and check valve.

2.13 WATER PRESSURE BOOSTER SYSTEM

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NOTE: This SUBPART is tailored for PUMPS.

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NOTE: One of the following systems will be used to boost the water pressure to the value required for service within the building. Indicate location, sizes, horsepower, and capacities of equipment on

drawings. Provide duplex pumps, if discharge capacity is greater than 1.6 L/s 25 gpm and total head is at least 59.78 kPa 20 feet.

****

2.13.1 Constant Speed Pumping System

Constant speed pumping system with pressure-regulating valves must employ one lead pump for low flows, and one or more lag pumps for higher flows. Pressure-regulating valves must be provided with nonslam check feature. The factory prepiped and prewired assembly must be mounted on a steel frame, complete with pumps, motors, and automatic controls. The system capacity and capacity of individual pumps must be as indicated. Current sensing relays must provide staging of the pumps. The pumps must be protected from thermal buildup, when running at no-flow, by a common thermal relief valve. Pressure gauges must be mounted on the suction and discharge headers. The control panel must bear the UL listing label for industrial control panels and must be in a NEMA 250, Type 1 enclosure. The control panel must include the following: No-flow shutdown; 7-day time clock; audiovisual alarm; external resets; manual alternation; magnetic motor controllers; time delays; transformer; current relays; "HAND-OFF-AUTOMATIC" switches for each pump; minimum run timers; low suction pressure cutout; and indicating lights for power on, individual motor overload, and low suction pressure. The control circuit must be interlocked so that the failure of any controller must energize the succeeding controller.

2.13.2 Hydro-Pneumatic Water Pressure System

An ASME code constructed tank stamped for 862 kPa 125 psig water working pressure must be provided. The tank must have a flexible diaphragm made of material conforming to FDA requirements for use with potable water and must be factory precharged to meet required system pressure.

2.13.3 Variable Speed Pumping System

Variable speed pumping system must provide system pressure by varying speed and number of operating pumps. The factory prepiped and prewired assembly must be mounted on a steel frame complete with pumps, variable speed drives, motors, and controls. The variable speed drives must be the oil-filled type capable of power transmission throughout their complete speed range without vibration, noise, or shock loading. Each variable speed drive must be run-tested by the manufacturer for rated performance, and the manufacturer must furnish written performance certification. System must have suppressors to prevent noise transmission over electric feed lines. Required electrical control circuitry and system function sensors must be supplied by the variable speed drive manufacturer. The primary power controls and magnetic motor controllers must be installed in[the controls supplied by the drive manufacturer][the motor control center]. The sensors must be located in the system to control drive speed as a function of[constant pump discharge pressure][constant system pressure at location indicated]. Connection between the sensors and the variable speed drive controls must be accomplished with[hydraulic sensing lines][copper wiring][telemetry]. Controls must be in NEMA 250, Type 1 enclosures.

2.14 COMPRESSED AIR SYSTEM

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NOTE: This SUBPART is tailored for COMPRESSED AIR SYSTEM. Reference UFC 3-420-02 Compressed Air for additional requirements.
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2.14.1 Air Compressors

Air compressor unit must be a factory-packaged assembly, including [_____] phase, [_____] volt motor controls, switches, wiring, accessories, and motor controllers, in a NEMA 250, Type [1][4] enclosure. Tank-mounted air compressors must be manufactured to comply with UL listing requirements. Air compressors must have manufacturer's name and address, together with trade name, and catalog number on a nameplate securely attached to the equipment. Each compressor must[start and stop automatically at upper and lower pressure limits of the system][regulate pressure by constant speed compressor loading and unloading][have a manual-off-automatic switch that when in the manual position, the compressor loads and unloads to meet the demand and, in the automatic position, a time delay relay must allow the compressor to operate for an adjustable length of time unloaded, then stop the unit]. Guards must shield exposed moving parts. Each duplex compressor system must be provided with [automatic][manual] alternation system. Each compressor motor must be provided with an across-the-line-type magnetic controller, complete with low-voltage release. An intake air filter and silencer must be provided with each compressor. Aftercooler and moisture separator must be installed between compressors and air receiver to remove moisture and oil condensate before the air enters the receiver. Aftercoolers must be either air- or water-cooled, as indicated. The air must pass through a sufficient number of tubes to affect cooling. Tubes must be sized to give maximum heat transfer. Water to unit must be controlled by a solenoid or pneumatic valve, which opens when the compressors start and closes when the compressors shut down. Cooling capacity of the aftercooler must be sized for the total capacity of the compressors. Means must be provided for draining condensed moisture from the receiver by an automatic float type trap. Capacities of air compressors and receivers must be as indicated.

2.14.2 Lubricated Compressors

****
NOTE: Where a suitable compressing station is shown for delivering air to laundries and linen-repair rooms, in addition to the shops, a duplicate compressor will be required for compressing and delivering air. Lubricated type compressors are required for delivery of air to linen repair at 552 kPa 80 psig, laundry at 586 kPa 85 psig, and general laboratories and shops at 345 kPa 50 psig.
****

Compressors must be two-stage, V-belt drive, capable of operating continuously against their designed discharge pressure, and must operate at a speed not in excess of 1800 rpm. Compressors must have the capacity and discharge pressure indicated. Compressors must be assembled complete on a common subbase. The compressor main bearings must be either roller or ball. The discharge passage of the high pressure air must be piped to the air receiver with a copper pipe or tubing. A pressure gauge calibrated to 1.03 MPa 150 psi and equipped with a gauge cock and pulsation dampener must be furnished for installation adjacent to pressure switches.

2.14.3 Air Receivers

Receivers must be designed for 1.38 MPa 200 psi working pressure. Receivers must be factory air tested to 1-1/2 times the working pressure. Receivers must be equipped with safety relief valves and accessories, including pressure gauges and automatic and manual drains. The outside of air receivers may be galvanized or supplied with commercial enamel finish. Receivers must be designed and constructed in accordance with ASME BPVC SEC VIII D1 and must have the design working pressures specified herein. A display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code must be provided.

2.14.4 Intake Air Supply Filter

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NOTE: Indicate location and capacities of the air filters on the drawings. Specially filtered air should be provided for all locations, except laundries and garages.

****

Dry type air filter must be provided having a collection efficiency of 99 percent of particles larger than 10 microns. Filter body and media must withstand a maximum 862 kPa 125 psi, capacity as indicated.

2.14.5 Pressure Regulators

The air system must be provided with the necessary regulator valves to maintain the desired pressure for the installed equipment. Regulators must be designed for a maximum inlet pressure of 862 kPa 125 psi and a maximum temperature of 93 degrees C 200 degrees F. Regulators must be single-seated, pilot-operated with valve plug, bronze body and trim or equal, and threaded connections. The regulator valve must include a pressure gauge and must be provided with an adjustment screw for adjusting the pressure differential from 0 kPa to 862 kPa 0 to 125 psi. Regulator must be sized as indicated.

2.15 DOMESTIC WATER SERVICE METER

****

NOTE: Size meters using AWWA (not IPC) fixture value method for determining maximum flow (AWWA M22 figures 4-2 and 4-3). Best practice to select the smallest possible meter where maximum flow, using AWWA M6 and M22, does not exceed 90 percent of the meter's maximum rated flow. For maximum flows exceeding those of a 50 mm 2 inch positive displacement meter (approximately 545 L/min 144 gpm), a compound meter should be used. Limit use of turbine meters to applications having consistent medium to high flows such as on the discharge of a water pump station. Expect the water meter size to be at least on to tow pipe sizes smaller than the pipe. Provide lockable by-pass for all meters 40 mm 1-1/2 inch and greater.

NOTE: This paragraph contains tailoring for Navy, Army, and Air Force projects.

****

The requirements for metering and submetering are specified in Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

[Cold water meters 50 mm 2 inches and smaller must be positive displacement type conforming to AWWA C700.[Cold water meters 64 mm 2-1/2 inches and larger must be turbine type conforming to AWWA C701.] Water meters must be[positive displacement,][ultrasonic magnetic inductive] type. Meter register may be round or straight reading type,[indicating [_____]][as provided by the local utility]. Meter must be provided with a pulse generator, remote readout register and all necessary wiring and accessories. Meters must be connected to the base wide energy and utility monitoring and control system (if this system exists) using the installation's advanced metering protocols.

]2.16 POOL WATER PUMP SAFETY VACUUM RELEASE SYSTEM (SVRS)

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NOTE: This section is tailored for PUMPS.

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Safety vacuum release system (SVRS) must meet the requirements specified in ASME A112.19.17, or ASTM F2387, as modified and supplemented by this specification. System must include:

Vacuum monitoring at least 60 times per second.
Power supply monitoring at least 50 times per second.
Capable of integration with existing timer box.
Low vacuum sensing and alarm.
Maintenance override.
Power back-up.
Display of error readout.
Turns off power to pump in milliseconds upon detecting sudden vacuum change.
Multiple audible alarm capabilities for multiple harmful situations.

2.17 ELECTRICAL WORK

****

NOTE: 1. Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm in the equipment schedules on the drawings.

2. Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other

electrical equipment and circuits and when recommended by the manufacturer.

3. Use the bracketed item specifying high efficiency single-phase motors for applications where the use of high efficiency motors is determined to be cost effective.

4. Use the third bracketed item where polyphase motors are part of an assembly, and the use of premium efficiency motors is cost-effective. Premium efficiency motors are required by Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM for individual motors that are not part of a packaged system.

****

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide [high efficiency type,]single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11.[In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide polyphase, squirrel-cage medium induction motors with continuous ratings, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.] Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

2.17.1 Electrical Requirements for Motors

Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of the enclosure.

2.17.2 Electrical Requirements for Controllers and Contactors

Controllers and contactors must have auxiliary contacts for use with the controls provided. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided. For packaged equipment, the manufacturer must provide controllers, including the required monitors and timed restart.

2.17.3 Electrical Requirements for Power Wiring

Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.18 MISCELLANEOUS PIPING ITEMS

2.18.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

2.18.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Sleeves are not required where[supply] drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade, except where penetrating a membrane waterproof floor. For multiple pipe penetrations through load bearing masonry or concrete walls, minimum spacing must be [_____] mm [_____] inches center of pipe to center of pipe.

2.18.2.1 Sleeves in Masonry and Concrete

Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2.18.2.2 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

2.18.3 Pipe Hangers (Supports)

Provide MSS SP-58 Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

2.18.4 Nameplates

Provide 3.2 mm 0.125 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 6.4 mm 0.25 inch high normal block lettering into the white core. Minimum size of nameplates must be 25 by 63 mm 1.0 by 2.5 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

2.18.5 Water Conditioning

Refer to Section 22 31 00 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

****

NOTE: This paragraph is tailored for PIPING.

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Piping located in air plenums must conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts must be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA Fire Man. The plumbing system must be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Submit diagrams, instructions, and other sheets proposed for posting for Plumbing System. Submit for Plumbing System manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe. Water and drainage piping must be extended 1.5 m 5 feet outside the building, unless otherwise indicated. A[gate valve][full port ball valve][ball valve] and drain must be installed on the water service line inside the building approximately 150 mm 6 inches above the floor from point of entry. Piping must be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes must be laid in separate trenches, except when otherwise shown. Exterior underground utilities must be at least 300 mm 12 inches below the [average local frost depth] [finish grade] or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility must be marked with a stake or other acceptable means. Valves must be installed with control no lower than the valve body. Avoid the use of combination double wye and one-eighth bend fittings in the horizontal orientation below grade or below slab.

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

****

NOTE: This paragraph is tailored for PIPING.

****

The piping must be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system must be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, must be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices must be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

****

NOTE: This paragraph is tailored for PIPING.

****

The work must be carefully laid out in advance, and unnecessary cutting of construction must be avoided. Damage to building, piping, wiring, or equipment as a result of cutting must be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

****

NOTE: This paragraph is tailored for PIPING.

****

Pipe openings must be closed with caps or plugs during installation. Fixtures and equipment must be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment must be thoroughly cleaned, adjusted, and operated. Safety guards must be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

****

NOTE: This paragraph is tailored for PIPING and contains tailoring for ARMY.

****

Piping must be installed as indicated. Pipe must be accurately cut and worked into place without springing or forcing. Structural portions of the building must not be weakened. Aboveground piping must run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings must be kept a sufficient distance from other work and other services to permit not less than 12 mm 1/2 inch between finished covering on the different services. Bare and insulated water lines must not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe must not be buried in or under floors unless specifically indicated or approved. Buried domestic waste vent piping must not be less than 51 mm 2 inch diameter. Changes in pipe sizes must be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction must be made with fittings, except that bending of pipe 100 mm 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends must be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

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NOTE: This paragraph is tailored for PIPING. Designer will indicate location of pipe drains on the drawings.

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Pipe drains indicated must consist of 20 mm 3/4 inch hose bibb with renewable seat and[gate][full port ball][ball] valve ahead of hose bibb. At other low points, 20 mm 3/4 inch brass plugs or caps must be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.1.6 Expansion and Contraction of Piping

****
NOTE: This paragraph is tailored for PIPING.
****

Allowance must be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser must have expansion loops or other provisions such as offsets and changes in direction where indicated and required. Risers must be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers must be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 15 m 50 feet in length must be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility must be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility must be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 100 mm 4 inches in diameter or larger must be provided with thrust blocks, where indicated, to prevent movement. Thrust blocking must be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa 2000 psi after 28 days. Blocking must be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed on drawings, the base and thrust bearing sides of the thrust block must be poured against undisturbed earth. The side of the thrust block not subject to thrust must be poured against forms. The area of bearing will be as indicated on drawings. Blocking must be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, must be used to anchor vertical down bends into gravity thrust blocks.

3.1.1.8 Commercial-Type Water Hammer Arresters

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NOTE: Designer will indicate location, quantity and size of commercial-type water hammer arresters on the drawings. Commercial-type water hammer arresters will be sized and located in accordance with PDI WH 201. Piping serving equipment having quick-closing valves must have suitably sized arresters. The ICC International Plumbing Code defines a quick-closing valve and the Codes 1997 Commentary provides examples of what are and are not considered quick-closing valves. PDI-WH 201 also defines quick valve closure. Review of these documents will help the designer provide the proper number of arresters.

For pressures of 450 kPa 65 psi or less, commercial

water hammer arresters may be reduced by the designer in number and size, if the system does not contain quick-acting valves. Water pressure regulating or reducing valves may be provided in lieu of commercial-type water hammer arresters, if local use has provided satisfactory performance. When required, install arresters as close as possible to quick-acting valves, ends of long pipe runs, and near batteries of fixtures.
****

Commercial-type water hammer arresters must be provided on hot- and cold-water supplies and must be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, must be accessible by means of access doors or removable panels. Commercial-type water hammer arresters must conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

3.1.2 Compressed Air Piping (Non-Oil Free)

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NOTE: This paragraph is tailored for COMPRESSED AIR SYSTEM. Compressed air piping must be installed in accordance with UFC 3-420-02.
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Compressed air piping must have supply lines and discharge terminals legibly and permanently marked at both ends with the name of the system and the direction of flow.

3.1.3 Joints

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NOTE: This SUPBART is tailored for PIPING.
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NOTE: Where environmental conditions do not warrant the use of dielectric unions or flanges the requirement for such unions and flanges will be deleted.
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Installation of pipe and fittings must be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints must be made up with fittings of compatible material and made for the specific purpose intended.

3.1.3.1 Threaded

Threaded joints must have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads must be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or must have a polytetrafluoroethylene tape applied.

3.1.3.2 Mechanical Couplings

****

NOTE: Do not use this paragraph on NAVFAC projects.
****

[Mechanical couplings may be used in conjunction with grooved pipe for aboveground, ferrous or non-ferrous, domestic hot and cold water systems, in lieu of unions, brazed, soldered, welded, flanged, or threaded joints.

]3.1.3.2.1 Mechanical Coupling Permissibility

Mechanical couplings are permitted in accessible locations including behind access plates. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints must incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to ensure positive rigid clamping of the pipe. Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications will not be permitted.

3.1.3.2.2 Grooved Fittings and Couplings

Grooved fittings and couplings, and grooving tools must be provided from the same manufacturer. Segmentally welded elbows must not be used. Grooves must be prepared in accordance with the coupling manufacturer's latest published standards. Grooving must be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations. The Contracting Officer must be notified 24 hours in advance of test to demonstrate operator's capability, and the test must be performed at the work site, if practical, or at a site agreed upon. The operator must demonstrate the ability to properly adjust the grooving tool, groove the pipe, and to verify the groove dimensions in accordance with the coupling manufacturer's specifications.

3.1.3.3 Unions and Flanges

Unions, flanges and mechanical couplings must not be concealed in walls, ceilings, or partitions. Unions must be used on pipe sizes 65 mm 2-1/2 inches and smaller; flanges must be used on pipe sizes 80 mm 3 inches and larger.

3.1.3.4 Grooved Mechanical Joints

****
NOTE: Do not use this paragraph on NAVFAC projects.
****

[Grooves must be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools must be products of the same manufacturer. Pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints must not be used in concealed locations.

]3.1.3.5 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping must be installed per the manufacturer's recommendations.

3.1.3.6 Copper Tube and Pipe

a. Brazed. Brazed joints must be made in conformance with AWS B2.2/B2.2M, ASME B16.50, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints must include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) must include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints must be made with flux and are only acceptable for piping 50 mm 2 inches and smaller. Soldered joints must conform to ASME B31.5 and CDA A4015. Soldered joints must not be used in compressed air piping between the air compressor and the receiver.

c. Copper Tube Extracted Joint. Mechanically extracted joints must be made in accordance with ICC IPC.

****

NOTE: Coordinate with the Department of Public Works or Base Civil Engineer on the use of press fittings for copper pipe and tube.

****

[d. Press connection. Copper press connections must be made in **strict** accordance with the manufacturer's installation instructions for manufactured rated size. The joints must be pressed using the tool(s) approved by the manufacturer **of that joint**. Minimum distance between fittings must be in accordance with the manufacturer's requirements.

]3.1.3.7 Plastic Pipe

Acrylonitrile-Butadiene-Styrene (ABS) pipe must have joints made with solvent cement. PVC and CPVC pipe must have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.3.8 Glass Pipe

Joints for corrosive waste glass pipe and fittings must be made with corrosion-resisting steel compression-type couplings with acrylonitrile rubber gaskets lined with polytetrafluoroethylene.

3.1.3.9 Corrosive Waste Plastic Pipe

Joints for polyolefin pipe and fittings must be made by mechanical joint or electrical fusion coil method in accordance with ASTM D2657 and ASTM F1290. Joints for filament-wound reinforced thermosetting resin pipe must be made in accordance with manufacturer's instructions. Unions or flanges must be used where required for disconnection and inspection.

3.1.3.10 Polypropylene Pipe

Joints for polypropylene pipe and fittings must be made by heat fusion welding socket-type or butt-fusion type fittings and must comply with ASTM F2389.

3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe must be made with dielectric unions or flange waterways. Dielectric waterways must have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways must have metal connections on both ends suited to match connecting piping. Dielectric waterways must be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges must meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe must be made with transition fitting for the specific purpose.

3.1.5 Corrosion Protection for Buried Pipe and Fittings

****

NOTE: Both cathodic protection and protective coatings, regardless of soil resistivity, are to be provided for steel, ductile iron, and cast iron pressurized piping under floor (slab on grade) in soil. The results of an economic analysis and recommendations by a "corrosion expert" will govern the application of CP and protective coatings on gravity sewer lines, regardless of soil resistivity, and for potable water lines in resistivities above 10000 ohm-centimeters. For a large majority of new facilities, a sacrificial type of cathodic protection system, as specified in Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM, would be the applicable section to reference; however, the plumbing designer must coordinate with the cathodic protection designer for selection of one or both of the CP specification options.

****

Ductile iron, cast iron, and steel pipe, fittings, and joints must have a protective coating. Additionally, ductile iron, cast iron, and steel pressure pipe must have a cathodic protection system and joint bonding. The cathodic protection system, protective coating system, and joint bonding for cathodically protected pipe must be in accordance with[Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM][and][Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Coatings must be selected, applied, and inspected in accordance with NACE SP0169 and as otherwise specified. The pipe must be cleaned and the coating system applied prior to pipe tightness testing. Joints and fittings must be cleaned and the coating system applied after pipe tightness testing. For tape coating systems, the tape must conform to AWWA C203 and must be applied with a 50 percent overlap. Primer utilized with tape type coating systems must be as recommended by the tape manufacturer.

3.1.6 Pipe Sleeves and Flashing

Pipe sleeves must be furnished and set in their proper and permanent location.

3.1.6.1 Sleeve Requirements

****

NOTE: Indicate the locations of all pipe sleeves on the design drawings. Indicate sleeves at locations where piping pass entirely through walls, ceilings, roofs, and floors. The designer will detail type of pipe sleeves on the drawings, illustrating method of sealing annular space between pipe and sleeve. The designer will coordinate requirements for clearances around sleeves with Section 23 05 48.19 [SEISMIC] BRACING FOR HVAC.

****

Unless indicated otherwise, provide pipe sleeves meeting the following requirements:

a. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.

b. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals must consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links must be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt must cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly must be sized as recommended by the manufacturer to fit the pipe and sleeve involved.

c. Sleeves must not be installed in structural members, except where indicated or approved. Rectangular and square openings must be as detailed. Each sleeve must extend through its respective floor, or roof, and must be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas must extend a minimum of 100 mm 4 inches above the finished floor.

d. Unless otherwise indicated, sleeves must be of a size to provide a minimum of [6][25] mm [1/4][1] inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors must be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.

e. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, must be sealed as indicated with sealants conforming to ASTM C920 and with a primer, backstop material and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve must not be sealed for interior walls which are not designated as fire rated.

f. Sleeves through below-grade walls in contact with earth must be recessed 12 mm 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve must be filled with backing material and sealants in the joint between the pipe and[concrete][masonry] wall as specified above. Sealant selected for the earth side of the wall must be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls must conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.1.6.2 Flashing Requirements

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NOTE: The applicable detail plates will be completed and included on the contract drawings. Sleeve thickness and square and rectangular opening details will be determined and indicated on the drawings. Indicate pipe chase areas on the drawings.

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Pipes passing through roof must be installed through a 4.9 kg per square meter 16 ounce copper flashing, each within an integral skirt or flange. Flashing must be suitably formed, and the skirt or flange must extend not less than 200 mm 8 inches from the pipe and must be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing must extend up the pipe a minimum of 250 mm 10 inches. For cleanouts, the flashing must be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs must be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 200 mm 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation must be sealed as indicated. Flashing for dry vents must be turned down into the pipe to form a waterproof joint. Pipes, up to and including 250 mm 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield must be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane must be sleeved as described above. A waterproofing clamping flange must be installed.

3.1.6.3 Waterproofing

****

NOTE: Drawings will detail method of attaching waterproofing membranes to sleeves passing through walls or floors that are subject to a static head of water.

****

Waterproofing at floor-mounted water closets must be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet must be perforated and turned down approximately 40 mm 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard must be embedded in sealant to a depth of approximately 40 mm 1-1/2 inches; then the sealant must be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper must extend not less than 200 mm 8 inches from the drainpipe and must be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe must be sealed with sealant and the flashing guard must be upturned approximately 40 mm 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange must be sealed.

3.1.6.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 150 mm 6 inches in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.1.6.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs FLASHING REQUIREMENTS and WATERPROOFING, a groove 6 to 13 mm 1/4 to 1/2 inch wide by 6 to 10 mm 1/4 to 3/8 inch deep must be formed around the pipe, fitting or drain. The groove must be filled with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.1.6.6 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations must be sealed to prevent infiltration of air, insects, and vermin.

3.1.7 Fire Seal

****

NOTE: Normally, fire walls and fire partitions will be designated on the architectural drawings.

****

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal must be provided as specified in Section 07 84 00 FIRESTOPPING.

3.1.8 Supports

3.1.8.1 General

Hangers used to support piping 50 mm 2 inches and larger must be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors must be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures must be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp must be used where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods must not be formed or bent.

3.1.8.2 Pipe Supports and Structural Bracing, Seismic Requirements

****

NOTE: Provide seismic requirements or piping and related equipment supports and show on the drawings.

****

Piping and attached valves must be supported and braced to resist seismic loads as specified in Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and[Section 23 05 48.19 [SEISMIC] BRACING FOR HVAC][as shown]. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, must be provided. Material used for supports must be as specified in[Section 05 12 00 STRUCTURAL STEEL][Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

3.1.8.3 Pipe Hangers, Inserts, and Supports

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NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 22.7 kg 50 pounds must have the excess hanger loads suspended from panel points.

****

Installation of pipe hangers, inserts and supports must conform to MSS SP-58 except as modified herein.

a. Types 5, 12, and 26 must not be used.

b. Type 3 must not be used on insulated pipe.

c. Type 18 inserts must be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps must be torqued per MSS SP-58 and must have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels must be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles must be used on insulated pipe 100 mm 4 inches and larger when the temperature of the medium is 15 degrees C 60 degrees F or higher. Type 39 saddles must be welded to the pipe.

h. Type 40 shields must:

    (1) Be used on insulated pipe less than 100 mm 4 inches.

    (2) Be used on insulated pipe 100 mm 4 inches and larger when the temperature of the medium is 15 degrees C 60 degrees F or less.

    (3) Have a high density insert for all pipe sizes. High density inserts must have a density of 128 kg per cubic meter 8 pcf or greater.

i. Horizontal pipe supports must be spaced as specified in MSS SP-58 and a support must be installed not over 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports must be spaced not over 1.5 m 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe must be 49 degrees C 120 degrees F for PVC and 82 degrees C 180 degrees F for CPVC. Horizontal pipe runs must include allowances for expansion and contraction.

j. Vertical pipe must be supported at each floor, except at slab-on-grade, at intervals of not more than 4.5 m 15 feet nor more than 2 m 8 feet from end of risers, and at vent terminations. Vertical pipe risers must include allowances for expansion and contraction.

k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides must be provided to allow longitudinal pipe movement. Slide materials must be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints must be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

    (1) On pipe 100 mm 4 inches and larger when the temperature of the medium is 15 degrees C 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

    (2) On pipe less than 100 mm 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

    (3) On pipe 100 mm 4 inches and larger carrying medium less that 15 degrees C 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

l. Pipe hangers on horizontal insulated pipe must be the size of the outside diameter of the insulation. The insulation must be continuous through the hanger on all pipe sizes and applications.

m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe must be separated from the slide material by at least 100 mm 4 inches or by an amount adequate for the insulation, whichever is greater.

n. Hangers and supports for plastic pipe must not compress, distort, cut or abrade the piping, and must allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.8.4 Structural Attachments

Attachment to building structure concrete and masonry must be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors must be applied with a safety factor not less than 5. Supports must not be attached to metal decking. Supports must not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications must be constructed of ferrous materials only.

3.1.9 Welded Installation

Plumbing pipe weldments must be as indicated. Changes in direction of piping must be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings must be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld must conform to ASME B31.1. Weld defects must be removed and repairs made to the weld, or the weld joints must be entirely removed and rewelded. After filler metal has been removed from its original package, it must be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating must not be used.

3.1.10 Pipe Cleanouts

****

NOTE: Specify cast-iron adjustable heads where heads are subject to loads, cleaning agents, and chemicals which will destroy heads made of plastic materials.

****

Pipe cleanouts must be the same size as the pipe except that cleanout plugs larger than 100 mm 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe must consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug must be caulked into the hub of the fitting and must be flush with the floor. Cleanouts in connection with other pipe, where indicated, must be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs must be installed in plastic pipe. Plugs must be the same size as the pipe up to and including 100 mm 4 inches. Cleanout tee branches with screw plug must be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 450 mm 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions must be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers must be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls must have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic must be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws must not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads must be [cast iron][or][plastic].

3.1.11 Condensate Drain Piping for Tropical Environments

Condensate drain piping materials must be rated for Drain, Waste and Vent service. Above grade use[Cast Iron ASTM A74][CISPI 301][Copper Type DWV ASTM B306][or][Polyvinyl Chloride (PVC) drain, waste and vent pipe and fittings, ASTM D2665, (Sch 40) ASTM F1760]. Condensate piping must maintain a horizontal slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1 percent). Do not use PVC above grade in mechanical rooms, fire riser rooms, generator rooms or other high-abuse areas. The following condensate pipe diameters must be sized in accordance with equipment capacity refrigeration shown below:

EQUIPMENT CAPACITY	MINIMUM CONDENSATE PIPE DIAMETER
Up to 17.6 kW 5 tons	25.4 mm 1 inch
Over 17.6 kW 5 tons to 140.7 kW 40 tons	31.75 mm 1-1/4 inch
Over 140.7 kW 40 tons to 316.5 kW 90 tons	38.1 mm 1-1/2 inch
Over 316.5 kW 90 tons to 439.5 kW 125 tons	50.8 mm 2 inch
Over 439 kW 125 tons to 879.5 kW 250 tons of refrigeration	63.5 mm 2-1/2 inch

3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

****

NOTE: This SUBPART is tailored for WATER HEATERS.

****

3.2.1 Relief Valves

****

NOTE: A discharge pipe the full size of the relief valve outlet will be shown connected to the outlet and shown on the drawings terminated at a safe location. The discharge pipe should not be directly connected to the drainage system and will conform to the requirements of the International Plumbing Code (for commercial and industrial hot water heaters ASME BPVC SEC IV also applies).

****

No valves must be installed between a relief valve and its water heater or storage tank. The P&T relief valve must be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve must be installed directly in a tapping in the tank or heater; otherwise, the P&T valve must be installed in the hot-water outlet piping. A vacuum relief valve must be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 150 mm 6 inches above the top of the tank or water heater.

3.2.2 Installation of Gas- and Oil-Fired Water Heater

Installation must conform to NFPA 54 for gas fired and NFPA 31 for oil fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers must be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 600 mm 24 inches just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

3.2.3 Heat Traps

****

NOTE: Piping arrangement for the heat trap should be shown on the drawings.

****

Piping to and from each water heater and hot water storage tank must be routed horizontally and downward a minimum of 610 mm 24 inches before turning in an upward direction.

3.2.4 Connections to Water Heaters

Connections of metallic pipe to water heaters must be made with dielectric unions or flanges. Use of dielectric nipples is prohibited unless internally lined and specifically designed to limit current flow between dissimilar metals.

3.2.5 Expansion Tank

A pre-charged expansion tank must be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve. The Contractor must adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

3.2.6 Direct Fired and Domestic Water Heaters

****

NOTE: This paragraph is also tailored for NAVY. For Navy projects, any boilers or direct fired domestic water heaters over 117,124.2 Watts 400,000 BTU/hour are required to be inspected and certified in accordance with Unified Facilities Criteria UFC 3-430-07, "Operations and Maintenance: Inspection and Certification of Boilers and Unfired Pressure Vessels". If the inspection is performed by contract, the inspector must be certified by one of the NAVFAC Senior Boiler Inspectors. If this project has a water heater meeting these requirements, add the following paragraph.

****

Notify the Contracting Officer when any direct fired domestic water heater over 117,124.2 Watts 400,000 BTU/hour is operational and ready to be inspected and certified.

3.3 FIXTURES AND FIXTURE TRIMMINGS

****

NOTE: This paragraph is tailored for FIXTURES.

****

Polished chromium-plated pipe, valves, and fittings must be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets must be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool must be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment must be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons must be as specified. Drain lines and hot water lines of fixtures for handicapped personnel must be insulated and do not require polished chrome finish. Plumbing fixtures and accessories must be installed within the space shown.

3.3.1 Fixture Connections

****

NOTE: This paragraph is tailored for FIXTURES.

****

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings must be provided. Connections between earthenware fixtures and flanges on soil pipe must be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges must be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.2 Flushometer Valves

****

NOTE: This paragraph is tailored for FIXTURES. Include bracketed requirement for water closets in male barracks and dormitories. Bumpers for water closet seat on flushometer spud work only with closed front seat. Delete sentence describing location of flush valve handle when an automatic flushing system is provided.

****

Flushometer valves must be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket.[Flushometer valves for water closets must be installed 1 m 39 inches above the floor, except at water closets intended for use by the physically handicapped where flushometer valves must be mounted at approximately 760 mm 30 inches above the floor and arranged to avoid interference with grab bars. In addition, for water closets intended for handicap use, the flush valve handle must be installed on the wide side of the enclosure.][Bumpers for water closet seats must be installed on the[wall][flushometer stop][flushometer spud].]

3.3.3 Height of Fixture Rims Above Floor

****
NOTE: This paragraph is tailored for FIXTURES.
****

Lavatories must be mounted with rim 775 mm 31 inches above finished floor. Wall-hung drinking fountains and water coolers must be installed with rim 1020 mm 42 inches above floor. Wall-hung service sinks must be mounted with rim 700 mm 28 inches above the floor. Installation of fixtures for use by the physically handicapped must be in accordance with ICC A117.1.

3.3.4 Shower Bath Outfits

****
NOTE: This paragraph is tailored for FIXTURES.
****

The area around the water supply piping to the mixing valves and behind the escutcheon plate must be made watertight by caulking or gasketing.

3.3.5 Fixture Supports

****
NOTE: This subpart is tailored for FIXTURES. Project drawings will detail methods of hanging lavatories and wall-hung urinals. Normally, these fixtures will be supported by one of the methods described.
****

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, must be of the chair-carrier type. The carrier must provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability must be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, must be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.5.1 Support for Solid Masonry Construction

Chair carrier must be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate must be imbedded in the masonry wall.

3.3.5.2 Support for Concrete-Masonry Wall Construction

Chair carrier must be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate must be fastened to the concrete wall using through bolts and a back-up plate.

3.3.5.3 Support for Steel Stud Frame Partitions

Chair carrier must be used. The anchor feet and tubular uprights must be of the heavy duty design; and feet (bases) must be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, must be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.5.4 Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier must be used. Where entire construction is wood, wood crosspieces must be installed. Fixture hanger plates, supports, brackets, or mounting lugs must be fastened with not less than No. 10 wood screws, 6 mm 1/4 inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces must extend the full width of the fixture and must be securely supported.

3.3.5.5 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets must be provided. The type of gasket furnished must be as recommended by the chair-carrier manufacturer.

3.3.6 Backflow Prevention Devices

****

NOTE: This paragraph contains tailoring for AIR FORCE, ARMY, and NAVY. The Air Force uses the Uniform Plumbing Code, for Air Force jobs backflow prevention equipment and installation must meet the UPC code.

****

Plumbing fixtures, equipment, and pipe connections must not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers must be installed where indicated and in accordance with [ICC IPC] [ICC IPC] [IAPMO UPC] at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers must be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers must be located so that no part of the device will be submerged. Backflow preventers must be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping must not be provided around backflow preventers. Access must be provided for maintenance and testing. Each device must be a standard commercial unit.

3.3.7 Access Panels

****

NOTE: This paragraph is tailored for FIXTURES.

****

Access panels must be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels must be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels must be as specified in[Section 08 31 00 ACCESS DOORS AND PANELS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

3.3.8 Sight Drains

****
NOTE: This paragraph is tailored for PIPING.
****

Sight drains must be installed so that the indirect waste will terminate 50 mm 2 inches above the flood rim of the funnel to provide an acceptable air gap.

3.3.9 Traps

****
NOTE: This paragraph is tailored for PIPING.
****

Each trap must be placed as near the fixture as possible, and no fixture must be double-trapped. Traps installed on cast-iron soil pipe must be cast iron. Traps installed on steel pipe or copper tubing must be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D3311. Traps for acid-resisting waste must be of the same material as the pipe.

3.3.10 Shower Pans

Before installing shower pan, subfloor must be free of projections such as nail heads or rough edges of aggregate. Drain must be a bolt-down, clamping-ring type with weepholes, installed so the lip of the subdrain is flush with subfloor.

3.3.10.1 General

The floor of each individual shower, the shower-area portion of combination shower and drying room, and the entire shower and drying room where the two are not separated by curb or partition, must be made watertight with a shower pan fabricated in place. The shower pan material must be cut to size and shape of the area indicated, in one piece to the maximum extent practicable, allowing a minimum of 150 mm 6 inches for turnup on walls or partitions, and must be folded over the curb with an approximate return of 1/4 of curb height. The upstands must be placed behind any wall or partition finish. Subflooring must be smooth and clean, with nailheads driven flush with surface, and must be sloped to drain. Shower pans must be clamped to drains with the drain clamping ring.

3.3.10.2 Metal Shower Pans

When a shower pan of required size cannot be furnished in one piece, metal pieces must be joined with a flintlock seam and soldered or burned. The corners must be folded, not cut, and the corner seam must be soldered or burned. Pans, including upstands, must be coated on all surfaces with one brush coat of asphalt. Asphalt must be applied evenly at not less than 1 liter per square meter 1 gallon per 50 square feet. A layer of felt covered with building paper must be placed between shower pans and wood floors. The joining surfaces of metal pan and drain must be given a brush coat of asphalt after the pan is connected to the drain.

3.3.10.3 Plasticized Chlorinated Polyethylene Shower Pans

Corners of plasticized chlorinated polyethylene shower pans must be folded against the upstand by making a pig-ear fold. Hot-air gun or heat lamp must be used in making corner folds. Each pig-ear corner fold must be nailed or stapled 12 mm 1/2 inch from the upper edge to hold it in place. Nails must be galvanized large-head roofing nails. On metal framing or studs, approved duct tape must be used to secure pig-ear fold and membrane. Where no backing is provided between the studs, the membrane slack must be taken up by pleating and stapling or nailing to studding 12 mm 1/2 inch from upper edge. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it will be applied must be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane must be pressed into place. Surfaces to be solvent-welded must be clean. Surfaces to be joined with xylene must be initially sprayed and vigorously cleaned with a cotton cloth, followed by final coating of xylene and the joining of the surfaces by roller or equivalent means. If ambient or membrane temperatures are below 4 degrees C 40 degrees F the membrane and the joint must be heated prior to application of xylene. Heat may be applied with hot-air gun or heat lamp, taking precautions not to scorch the membrane. Adequate ventilation and wearing of gloves are required when working with xylene. Membrane must be pressed into position on the drain body, and must be cut and fit to match so that membrane can be properly clamped and an effective gasket-type seal provided. On wood subflooring, two layers of 0.73 kg per square meter 15 pound dry felt must be installed prior to installation of shower pan to ensure a smooth surface for installation.

3.3.10.4 Nonplasticized Polyvinyl Chloride (PVC) Shower Pans

Nonplasticized PVC must be turned up behind walls or wall surfaces a distance of not less than 150 mm 6 inches in room areas and 75 mm 3 inches above curb level in curbed spaces with sufficient material to fold over and fasten to outside face of curb. Corners must be pig-ear type and folded between pan and studs. Only top 25 mm 1 inch of upstand must be nailed to hold in place. Nails must be galvanized large-head roofing type. Approved duct tape must be used on metal framing or studs to secure pig-ear fold and membrane. Where no backing is provided between studs, the membrane slack must be taken up by pleating and stapling or nailing to studding at top inch of upstand. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it is to be applied must be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane must be pressed into place. Trim for drain must be exactly the size of drain opening. Bolt holes must be pierced to accommodate bolts with a tight fit. Adhesive must be used between pan and subdrain. Clamping ring must be bolted firmly. A small amount of gravel or porous materials must be placed at weepholes so that holes remain clear when setting bed is poured. Membrane must be solvent welded with PVC solvent cement. Surfaces to be solvent welded must be clean (free of grease and grime). Sheets must be laid on a flat surface with an overlap of about 50 mm 2 inches. Top edge must be folded back and surface primed with a PVC primer. PVC cement must be applied and surfaces immediately placed together, while still wet. Joint must be lightly rolled with a paint roller, then as the joint sets must be rolled firmly but not so hard as to distort the material. In long lengths, about 600 or 900 mm 2 or 3 feet at a time must be welded. On wood subflooring, two layers of 0.73 kg per square meter 15 pound felt must be installed prior to installation of shower pan to ensure a smooth surface installation.

3.4 VIBRATION-ABSORBING FEATURES

****

Indicate on the drawings where equipment should be mounted resiliently. Details for proper mounting of equipment will be indicated on the drawings. Insert required isolation efficiency in the blank space for installations where specific values for reduction of noise and vibration transmission are necessary; otherwise the sentence will be deleted. For areas where the maximum tolerable transmissibility in percent is considered necessary, the isolation efficiency will be given. Recommended transmissibility in percentages is as follows: 10 percent for equipment mounted in very critical areas, 10 to 20 percent for critical areas, and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors or conditions surrounding the equipment, which is to be provided with vibration isolation units, favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values, because of different equipment locations, the paragraph may be revised to indicate the appropriate values on the drawings.

Delete submittal of Vibration-Absorption Features when not required.

This paragraph contains tailoring for PUMPS and PIPING.
****

Mechanical equipment, including compressors and pumps, must be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Submit details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications. Each foundation must include an adequate number of standard isolation units. Each unit must consist of machine and floor or foundation fastening, together with intermediate isolation material, and must be a standard product with printed load rating. Piping connected to mechanical equipment must be provided with flexible connectors. Isolation unit installation must limit vibration to [_____] percent of the lowest equipment rpm.

3.4.1 Tank- or Skid-Mounted Compressors

****
NOTE: This paragraph is tailored for COMPRESSED AIR SYSTEM and also contains tailoring for ARMY.
****

Floor attachment must be as recommended by compressor manufacturer. Compressors must be mounted to resist seismic loads as specified in Section 23 05 48.19 [SEISMIC] BRACING FOR HVAC.

3.4.2 Foundation-Mounted Compressors

****
NOTE: This paragraph is tailored for COMPRESSED AIR SYSTEM and also contains tailoring for ARMY.

****

[Foundation attachment must be as recommended by the compressor manufacturer.][Foundation must be as recommended by the compressor manufacturer, except the foundation must weigh not less than three times the weight of the moving parts.]Compressors must be mounted to resist seismic loads as specified in Section 23 05 48.19 [SEISMIC] BRACING FOR HVAC.

3.5 WATER METER REMOTE READOUT REGISTER

The remote readout register must be mounted at the location indicated or as directed by the Contracting Officer.

3.6 IDENTIFICATION SYSTEMS

3.6.1 Identification Tags

****

NOTE: Delete when identification tags are not considered necessary on small projects.

****

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number must be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags must be 35 mm 1-3/8 inch minimum diameter, and marking must be stamped or engraved. Indentations must be black, for reading clarity. Tags must be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.6.2 Pipe Color Code Marking

****

NOTE: Designer will coordinate color code marking with Section 09 90 00 PAINTS AND COATINGS. Color code marking for piping not listed in Table I of Section 09 90 00, will be added to the table.

****

Color code marking of piping must be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6.3 Color Coding Scheme for Locating Hidden Utility Components

****

NOTE: The Color Code Table will be developed to suit the installation. The colors of metal disks used in Army projects will be as directed by the Facilities Engineer. Identification plate specified in Section 09 90 00 PAINTS AND COATINGS will be deleted if color coding scheme is specified.

****

Scheme must be provided in buildings having suspended grid ceilings. The color coding scheme must identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components must include valves, dampers, switches, linkages and thermostats. The color coding scheme must consist of a color code board and colored metal disks. Each colored metal disk must be approximately 12 mm 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners must be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners must be manually removable without tools and must not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks must follow completion of the finished surface on which the disks are to be fastened. The color code board must have the approximate dimensions of 1 m 3 foot width, 750 mm 30 inches height, and 12 mm 1/2 inch thickness. The board must be made of wood fiberboard and framed under glass or 1.6 mm 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols must be approximately 20 mm 3/4 inch in diameter and the related lettering in 12 mm 1/2 inch high capital letters. The color code board must be mounted and located in the mechanical or equipment room. The color code system must be as indicated below:

Color	System	Item	Location
[_____]	[_____]	[_____]	[_____]

3.7 ESCUTCHEONS

****

NOTE: This SUBPART is tailored for PIPING.

****

Escutcheons must be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons must be fastened securely to pipe or pipe covering and must be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons must be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS.

3.8.1 Painting of New Equipment

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.8.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for the temperature service.

3.8.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm one mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm one mil per coat.

b. Temperatures Between 50 and 205 Degrees C 120 and 400 Degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F must receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 Degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F must receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

3.9 TESTS, FLUSHING AND DISINFECTION

****

NOTE: Some facilities may require a conditioning/flushing of water fountains and faucets that are listed as end point devices by NSF/ANSI/CAN 61, Section 9. This is to meet possible customer expectations that these devices produce drinking water that meets the lead leaching requirements of NSF/ANSI/CAN 61 immediately upon beneficial occupancy.

****

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report must indicate the final position of controls.

3.9.1 Plumbing System

****

NOTE: This paragraph is tailored for PIPING and also contains tailoring for AIR FORCE, ARMY, and NAVY.

NOTE: The Air Force uses the Uniform Plumbing Code, for Air Force jobs backflow prevention equipment and installation must meet the UPC code.

****

The following tests must be performed on the plumbing system in accordance with [ICC IPC][IAPMO UPC], except that the drainage and vent system final test must include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure and reasons for choosing this option in lieu of the smoke test to the Contracting Officer for approval.

a. Drainage and Vent Systems Test. The final test must include a smoke test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

3.9.1.1 Test of Backflow Prevention Assemblies

Certification of proper operation must be submitted and must be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor must have the manufacturer's representative test the device to ensure the unit is properly installed and performing as intended. The Contractor must provide written documentation of the tests performed and signed by the individual performing the tests. Backflow prevention assembly must be tested using gauges specifically designed for the testing of backflow prevention assemblies.

Backflow prevention assembly test gauges must be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges must be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly must include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester

Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit must be repaired and retested.

3.9.1.2 Shower Pans

After installation of the pan and finished floor, the drain must be temporarily plugged below the weep holes. The floor area must be flooded with water to a minimum depth of 25 mm 1 inch for a period of 24 hours. Any drop in the water level during test, except for evaporation, will be reason for rejection, repair, and retest.

3.9.1.3 Compressed Air Piping (Nonoil-Free)

****

NOTE: This paragraph is tailored for COMPRESSED AIR SYSTEM.

****

Piping systems must be filled with oil-free dry air or gaseous nitrogen to 1.03 MPa 150 psig and hold this pressure for 2 hours with no drop in pressure.

3.9.2 Defective Work

****

NOTE: This paragraph contains tailoring for PIPING.

****

If inspection or test shows defects, such defective work or material must be replaced or repaired as necessary and inspection and tests must be repeated. Repairs to piping must be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.9.3 System Flushing

****

NOTE: This subpart is tailored for PIPING.

****

3.9.3.1 During Flushing

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NOTE: Hot water flushing dissolves most excess petrolatum-based flux inside piping, helping to avoid future corrosion problems.

****

Before operational tests or disinfection, potable water piping system must be flushed with [hot]potable water. Sufficient water must be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 1.2 meters per second 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) must specify the number of fixtures to be operated during flushing. Contractor must provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor must be responsible for any flood damage resulting from flushing of the system. Flushing must be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF/ANSI/CAN 61, Section 9, must be flushed a minimum of 1 L 0.25 gallons per 24 hour period, ten times over a 14 day period.

3.9.3.2 After Flushing

System must be drained at low points. Strainer screens must be removed, cleaned, and replaced. After flushing and cleaning, systems must be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system must be repaired by the Contractor. When the system flushing is complete, the hot-water system must be adjusted for uniform circulation. Flushing devices and automatic control systems must be adjusted for proper operation according to manufacturer's instructions. Flow rates on fixtures must not exceed those stated in PART 2 of this Section. Unless more stringent local requirements exist, lead levels must not exceed limits established by 40 CFR 141.80 (c)(1). The water supply to the building must be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.9.4 Operational Test

****

NOTE: The following list contains tailoring: Items b. and c. are tailored for FIXTURES; Item e. is tailored for PUMPS; Item f. is tailored for WATER HEATERS, Items g. and h. are tailored for PIPING; Item i. is tailored for PRESSURE PIPING; and Item j. is tailored for COMPRESSED AIR SYSTEM.

****

Upon completion of flushing and prior to disinfection procedures, the Contractor must subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests must cover a period of not less than 8 hours for each system and must include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of each domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

j. Compressed air readings at each compressor and at each outlet. Each indicating instrument must be read at 1/2 hour intervals. The report of the test must be submitted in quadruplicate. The Contractor must furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

3.9.5 Disinfection

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NOTE: If government laboratory facilities are available to conduct the bacterial examination of the test samples, revise this paragraph accordingly. The option of having the Contracting Officer perform the sampling and testing will be selected only if Government laboratory facilities are available and with concurrence from appropriate laboratory personnel. At some locations, either county or installation health officers inspect the disinfection process. If this is required, add a notification requirement and give the office to be notified, including phone number. For modification of existing systems, provide special procedures for disinfection of new equipment. For Army-only projects, use EPA SM 9223. For Navy-only projects, use AWWA 10084.

****

After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system must be disinfected. Before introducing disinfecting chlorination material, entire system must be flushed with potable water until any entrained dirt and other foreign materials have been removed.

****

NOTE: The following paragraph contains tailoring for PIPING and PUMPS.

****

Water chlorination procedure must be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material must be hypochlorites or liquid chlorine. The chlorinating material must be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

3.9.5.1 Water Chlorination Monitoring

Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet must be opened and closed several times. After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

3.9.5.2 Water Chlorination Flushing

Upon the specified verification, the system including tanks must then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet must be opened and closed several times.

3.9.5.3 Sample Testing

Take additional samples of water in disinfected containers, for bacterial examination, at locations specified by the Contracting Officer. Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with[EPA SM 9223][AWWA 10084]. The testing method used must be EPA approved for drinking water systems and must comply with applicable local and state requirements.

3.9.5.4 Disinfection Acceptance

Disinfection must be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

[3.9.6 OPTIONAL DISINFECTION METHOD

****

NOTE: This paragraph is tailored for NAVY. For Iceland projects only, include the following option.

****

Disinfect new potable water piping and affected portions of existing potable water piping with geothermal water. Geothermal water must be not less than 90 degrees C 194 degrees F and contact time must be not less than 30 minutes. After disinfection, thoroughly flush new portable water piping and affected portions of existing potable water piping with the chlorinated base water supply for a minimum of 2 hours.

]3.10 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, must be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system must be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions must be posted before acceptance testing of the systems.

3.11 PERFORMANCE OF WATER HEATING EQUIPMENT

****
NOTE: This SUBPART is tailored for WATER HEATERS.
****

Standard rating condition terms are as follows:

DP = Draw pattern

EF = Energy factor, minimum overall efficiency.

ET = Minimum thermal efficiency with 21 degrees C 70 degrees F delta T.

SL = Standby loss is maximum (Btu/h) based on a 21 degrees C 70 degrees F temperature difference between stored water and ambient requirements.

UEF = Uniform energy factor

V = Rated volume in gallons

Q = Nameplate input rate in kW (Btu/h)

3.11.1 Storage Water Heaters

3.11.1.1 Electric

a. Storage capacity more than or equal to 75.7 liters 20 gallons and less than or equal to 208 liters 55 gallons with a draw pattern (DP) of: very small must have a uniform energy factor (UEF) of 0.8808 - (0.0008 x V), low must have a uniform energy factor (UEF) of 0.9254 - (0.0003 x V), medium must have a uniform energy factor (UEF) of 0.9307 - (0.0002 x V), high must have a uniform energy factor (UEF) of 0.9349 - (0.0001 x V) per 10 CFR 430.

b. Storage capacity more than 208 liters 55 gallons and less than or equal to 454 liters 120 gallons with a draw pattern (DP) of: very small must have a uniform energy factor (UEF) of 1.9236 - (0.0011 x V), low must have a uniform energy factor (UEF) of 2.0440 - (0.0011 x V), medium must have a uniform energy factor (UEF) of 2.1171 - (0.0011 x V), high must have a uniform energy factor (UEF) of 2.418 - (0.0011 x V) per 10 CFR 430.

3.11.1.2 Gas

a. Storage capacity more than or equal to 75.7 liters 20 gallons and less than or equal to 208 liters 55 gallons with a draw pattern (DP) of: very small must have a uniform energy factor (UEF) of 0.3456 - (0.0020 x V), low must have a uniform energy factor (UEF) of 0.5982 - (0.0019 x V), medium must have a uniform energy factor (UEF) of 0.6483 - (0.0017 x V), high must have a uniform energy factor (UEF) of 0.6920 - (0.0013 x V) per 10 CFR 430.

b. Storage capacity more than 208 liters 55 gallons and less than or equal to 378.5 liters 100 gallons with a draw pattern (DP) of: very small must have a uniform energy factor (UEF) of 0.6470 - (0.0006 x V), low must have a uniform energy factor (UEF) of 0.7689 - (0.0005 x V), medium must have a uniform energy factor (UEF) of 0.7897 - (0.0004 x V), high must have a uniform energy factor (UEF) of 0.8702 - (0.0003 x V) per 10 CFR 430.

c. Storage capacity less than or equal to 454 liters 120 gallons with input rating more than 22980 W 75,000 Btu/h and less than 30773 W 105,000 Btu/h with a draw pattern (DP) of: very small must have a uniform energy factor (UEF) of 0.2674 - (0.0009 x V), low must have a uniform energy factor (UEF) of 0.5362 - (0.0012 x V), medium must have a uniform energy factor (UEF) of 0.6002 - (0.0011 x V), high must have a uniform energy factor (UEF) of 0.6597 - (0.0009 x V) per 10 CFR 430.

3.11.1.3 Oil

a. Storage capacity less than or equal to 189 liters 50 gallons with a draw pattern (DP) of: very small must have a uniform energy factor (UEF) of 0.2509 - (0.0012 x V), low must have a uniform energy factor (UEF) of 0.5330 - (0.0016 x V), medium must have a uniform energy factor (UEF) of 0.6078 - (0.0016 x V), high must have a uniform energy factor (UEF) of 0.6815 - (0.0014 x V) per 10 CFR 430.

b. Storage capacity less than or equal to 454 liters 120 gallons with input rating more than 30773 W 105,000 Btu/h and less than or equal to 41030 W 140,000 Btu/h with a draw pattern (DP) of: very small must have a uniform energy factor (UEF) of 0.2932 - (0.0015 x V), low must have a uniform energy factor (UEF) of 0.5596 - (0.0018 x V), medium must have a uniform energy factor (UEF) of 0.6194 - (0.0016 x V), high must have a uniform energy factor (UEF) of 0.6740 - (0.0013 x V) per 10 CFR 430.

3.11.2 Unfired Hot Water Storage

All volumes and inputs: must meet or exceed R-12.5.

3.11.3 Instantaneous Water Heater

3.11.3.1 Electric

a. Storage capacity less than 7.57 liters 2 gallons with a draw pattern (DP) of: very small must have a uniform energy factor (UEF) of 0.91, low must have a uniform energy factor (UEF) of 0.91, medium must have a uniform energy factor (UEF) of 0.91, high must have a uniform energy factor (UEF) of 0.92 per 10 CFR 430.

3.11.3.2 Gas

a. Storage capacity less than 7.57 liters 2 gallons input rating greater than 14654 W 50,000 Btu/h with a draw pattern (DP) of: very small must have a uniform energy factor (UEF) of 0.80, low must have a uniform energy factor (UEF) of 0.81, medium must have a uniform energy factor (UEF) of 0.81, high must have a uniform energy factor (UEF) of 0.81 per 10 CFR 430.

b. Rating of 309.75 W/L 4,000 Btu/h/gal and storage capacity less than 37.85 L 10 gallons with an input of 58.62 kW 200,000 Btu/h must have a minimum thermal efficiency (ET) of 80 percent per ANSI Z21.10.3/CSA 4.3.

c. Rating of 309.75 W/L 4,000 BTU/h/gal and storage capacity more than

37.85 L 10 gallons with an input more than 58.62 kW 200,000 Btu/h must have a minimum thermal efficiency (ET) of 80 percent and the maximum SL must be Q/800+110x(V^^1/2)) per ANSI Z21.10.3/CSA 4.3.

3.11.3.3 Oil

a. Rating of 309.75 W/L 4,000 Btu/h/gal and storage capacity less than 7.57 L 2 gallons with an input more than 14.7 kW 50,000 Btu/h and less than 61.55 kW 210,000 Btu/h must have an energy factor (EF) of0.59 - (0.0005 x V per 10 CFR 430.

b. Rating of 309.75 W/L 4,000 Btu/h/gal and storage capacity less than 37.85 L 10 gallons with an input more than 37.85 L 10 gallons with an input more than 61.55 kW 210,000 Btu/h must have a minimum thermal efficiency (ET) of 80 percent per ANSI Z21.10.3/CSA 4.3.

c. Rating of 309.75 W/L 4,000 Btu/h/gal and storage capacity more than 37.85 L 10 gallons with an input of more than 61.55 kW 210,000 Btu/h must have a minimum thermal efficiency (ET) of 78 percent and the maximum SL must be Q/800+110x(V^^1/2)) per ANSI Z21.10.3/CSA 4.3.

3.11.4 Pool Heaters

a. Gas/oil fuel, capacities and inputs: ET must be 78 percent per ASHRAE 146.

b. Heat Pump, All capacities and inputs must meet a COP of 4.0 per ASHRAE 146

3.12 TABLES

****

NOTE: TABLE I is tailored for PIPING.

NOTE: Corrosive waste, indicated in column F of Table I below, is a broad category; how well a pipe material will respond to a specific application will depend on the type of waste and its concentration. Column F was developed based on corrosive waste typically found at military or civil works facilities, e.g., battery acid at normal concentration levels. The designer should consider each specific application and research which type of pipe would work best. To help, The Plastic Pipe Institute published a report titled "TR-19/2020 Chemical Resistance of Plastic Piping Materials" that contains a data table listing the chemical resistance of piping located at web site: http://www.plasticpipe.org/common/Uploaded%20files/Technical/tr-19.pdf

Use copper condensate drain piping on any equipment that utilizes R-410A refrigerant or any refrigerant that contains polyolester lubricating oil. Add working pressure ratings for plastic pipe after material description in Table I.

****

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS								
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F	SERVICE G
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A74 with compression gaskets. Pipe and fittings must be marked with the CISPI trademark.	X	X	X	X	X		
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A888. Pipe and fittings must be marked with the CISPI trademark.		X		X	X		
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X			
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	X		

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS								
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F	SERVICE G
5	Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A536 And ASTM A47/A47M	X	X		X	X		
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A536 and ASTM A47/A47M for use with Item 5	X	X		X	X		
7	Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B584, for use with Item 5	X	X		X	X		
8	Wrought copper grooved joint pressure fittings for non-ferrous pipe ASTM B75/B75M C12200, ASTM B152/B152M, C11000, ASME B16.22 ASME B16.22 for use with Item 5	X	X					

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS								
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F	SERVICE G
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X	X		
10	Steel pipe, seamless galvanized, ASTM A53/A53M, Type S, Grade B				X	X		
11	Seamless red brass pipe, ASTM B43				X	X		X
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X		X
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X	X		X
14	Seamless copper pipe, ASTM B42						X	X
15	Cast bronze threaded fittings, ASME B16.15				X	X		

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS								
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F	SERVICE G
16	Copper drainage tube, (DWV), ASTM B306	X*	X	X*	X	X		X
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X		X
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X		X
19	Acrylonitrile-Butadiene-Styrene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D2661, ASTM F628	X	X	X	X	X	X	
20	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D2665, ASTM F891, (Sch 40) ASTM F1760	X	X	X	X	X	X	X
21	Process glass pipe and fittings, ASTM C1053						X	

TABLE I								
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS								
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E	SERVICE F	SERVICE G
22	High-silicon content cast iron pipe and fittings (hub and spigot, and mechanical joint), ASTM A518/A518M		X			X	X	
23	Polypropylene (PP) waste pipe and fittings, ASTM D4101						X	
24	Filament-wound reinforced thermosetting resin (RTRP) pipe, ASTM D2996						X	
25	Cast Iron pipe and fittings, CEN EN 877 piping	X	X	X	X	X	X	

SERVICE:

A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent
E - Interior Rainwater Conductors Aboveground
F - Corrosive Waste And Vent Above And Belowground
G - Condensate Drain Aboveground

* - Hard Temper

****

NOTE: TABLE II is tailored for PRESSURE PIPING.

NOTE: If PEX is used, tube I.D. sizes are to be copper equivalent I.D. sizes. PEX is not to be used on Navy, Marine Corps, and Air Force projects.

For Navy, Marine Corps, and Army projects, coordinate with the user on the use of item 38 (Press Fittings) in TABLE II below.

****

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
1	Malleable-iron threaded fittings:				
	a. Not galvanized for use with Item 4b			X	
2	Grooved pipe couplings, ferrous pipe ASTM A536 and ASTM A47/A47M non-ferrous pipe, ASTM A536 and ASTM A47/A47M	X	X	X	
3	Ductile iron grooved joint fittings for ferrous pipe ASTM A536 and ASTM A47/A47M, for use with Item 2	X	X	X	
4	Steel pipe:				
	a. Seamless, black, ASTM A53/A53M, Type S, Grade B			X	
5	Seamless red brass pipe, ASTM B43	X	X		X
6	Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7	X	X		X
7	Seamless copper pipe, ASTM B42	X	X		X

TABLE II					
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS					
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
8	Seamless copper water tube, ASTM B88, ASTM B88M	X**	X**	X**	X***
9	Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7	X	X		X
10	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 5, 7 and 8	X	X	X	X
11	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Item 8	X	X	X	X
12	Bronze and sand castings grooved joint pressure fittings for non-ferrous pipe ASTM B584, for use with Item 2	X	X	X	
13	Polyethylene (PE) plastic pipe, Schedules 40 and 80, based on outside diameter	X			X
14	Polyethylene (PE) plastic pipe (SDR-PR), based on controlled outside diameter, ASTM D3035	X			X
15	Polyethylene (PE) plastic pipe (SIDR-PR), based on controlled inside diameter, ASTM D2239	X			X
16	Butt fusion polyethylene (PE) plastic pipe fittings, ASTM D3261 for use with Items 14, 15, and 16	X			X
17	Socket-type polyethylene fittings for outside diameter-controlled polyethylene pipe, ASTM D2683 for use with Item 15	X			X
18	Polyethylene (PE) plastic tubing, ASTM D2737	X			X

TABLE II					
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS					
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
19	Chlorinated polyvinyl chloride (CPVC) plastic hot and cold water distribution system, ASTM D2846/D2846M	X	X		X
20	Chlorinated polyvinyl chloride (CPVC) plastic pipe, Schedule 40 and 80, ASTM F441/F441M	X	X		X
21	Chlorinated polyvinyl chloride (CPVC) plastic pipe (SDR-PR) ASTM F442/F442M	X	X		X
22	Threaded chlorinated polyvinyl chloride (chloride CPVC) plastic pipe fittings, Schedule 80, ASTM F437, for use with Items 20, and 21	X	X		X
23	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 40, ASTM F438 for use with Items 20, 21, and 22	X	X		X
24	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings Schedule 80, ASTM F439 for use with Items 20, 21, and 22	X	X		X
25	Polyvinyl chloride (PVC) plastic pipe, Schedules 40, 80, and 120, ASTM D1785	X			X
26	Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D2241	X			X
27	Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D2466	X			X

TABLE II					
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS					
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
28	Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D2467 for use with Items 26 and 27	X			X
29	Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D2464	X			X
30	Joints for IPS PVC pipe using solvent cement, ASTM D2672	X			X
31	Polypropylene (PP) plastic pipe and fittings; ASTM F2389	X	X		X
32	Steel pipeline flanges, MSS SP-44	X	X		
33	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B828	X	X		
34	Carbon steel pipe unions, socket-welding and threaded, MSS SP-83	X	X	X	
35	Malleable-iron threaded pipe unions ASME B16.39	X	X		
36	Nipples, pipe threaded ASTM A733	X	X	X	
37	Crosslinked Polyethylene (PEX) Plastic Pipe ASTM F877	X	X		X
38	Press Fittings	X	X		

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
	SERVICE: A - Cold Water Service Aboveground B - Hot and Cold Water Distribution 82 degrees C 180 degrees F Maximum Aboveground C - Compressed Air Lubricated D - Cold Water Service Belowground Indicated types are minimum wall thicknesses. ** - Type L - Hard *** - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors **** - In or under slab floors only brazed joints				

****

NOTE: TABLE III is tailored for WATER HEATERS.

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TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

FUEL	STORAGE CAPACITY LITERS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
A. STORAGE WATER HEATERS				

TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

FUEL	STORAGE CAPACITY LITERS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE	
Elect.	≥75.7 L and ≤208 L		10 CFR 430	DP	UEF
				Very Small	0.8808 - (0.0008 x V)
				Low	0.9254 - (0.0003 x V)
				Medium	0.9307 - (0.0002 x V)
				High	0.9349 - (0.0001 x V)
Elect.	≥208 L and ≤454 L		10 CFR 430	DP	UEF
				Very Small	1.9236 - (0.0011 x V)
				Low	2.0440 - (0.0011 x V)
				Medium	2.1171 - (0.0011 x V)
				High	2.2418 - (0.0011 x
Elect.		≤24 Amps and ≤ 250 Volts	10 CFR 430	Rating Condition	UEF
				Integrated heat pump water heater (HPWH)	UEF ≥3.3 and First Hour Rating ≥ 170 L/h
				Integrated HPWH, >120 V/15 Amp Circuit or Split-system HPWH	UEF ≥2.2 and First Hour Rating ≥ 170 L/h
Elect. Heat Pump		>12 kW	10 CFR 430	HPWH COP ≥3.0	

TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

FUEL	STORAGE CAPACITY LITERS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE	
Gas	≥75.7 L and ≤208 L		10 CFR 430	DP	UEF
				Very Small	0.3456 - (0.0020 x
				Low	0.5982 - (0.0019 x
				Medium	0.6483 - (0.0017 x
				High	0.6920 - (0.0013 x
Gas	>208 L and ≤ 378.5 L		10 CFR 430	DP	UEF
				Very Small	0.6470 - (0.0006 x
				Low	0.7689 - (0.0005 x
				Medium	0.7897 - (0.0004 x
				High	0.8072 - (0.0003 x
Gas	≤454 L	>22 kW	10 CFR 430	DP	UEF
				Very Small	0.2674 - (0.0009 x
				Low	0.5362 - (0.0012 x
				Medium	0.6002 - (0.0011 x
				High	0.6597 - (0.0009 x
Oil	≤189 L		10 CFR 430	DP	UEF
				Very Small	0.2509 - (0.0012 x
				Low	0.5330 - (0.0016 x
				Medium	0.6078 - (0.0016 x
				High	0.6815 - (0.0014 x

TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

FUEL	STORAGE CAPACITY LITERS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE	
Oil	≤454 L	>30.8 kW and ≤ 41 kW	10 CFR 430	DP	UEF
				Very Small	0.2932 - (0.0015 x
				Low	0.5596 - (0.0018 x
				Medium	0.6194 - (0.0016 x
				High	0.6740 - (0.0013 x
B. Unfired Hot Water Storage, R = 2.2 minimum					
C. Instantaneous Water Heater					
Elect.	<7.6 L		10 CFR 430	DP	UEF
				Very Small	0.91
				Low	0.91
				Medium	0.91
				High	0.92
Gas	<7.6 L and >14.7 kW		10 CFR 430	DP	UEF
				Very Small	0.80
				Low	0.81
				Medium	0.81
				High	0.81
Gas	309.75 W/L min. and 37.85 L max.	58.62 kW min.	ANSI Z21.10.	ET = 80 percent	
Gas	309.75 W/L min. and 37.85 L max.	58.62 kW min.	ANSI Z21.10.	ET = 80 percent and SL + (Q/800+110x(V^^1/2)	

TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

FUEL	STORAGE CAPACITY LITERS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
Oil	309.75 W/L and 7.6 L max.	14.7 kW min. and 61.552	10 CFR 430	ET = 80 percent and EF = 0.59-0.005V
Oil	309.75 W/L and 37.85 L max.	61.552 kW max.	ANSI Z21.10.	ET = 80 percent
Oil	309.75 W/L and 37.85 L min.	61.552 kW max.	ANSI Z21.10.	ET = 78 percent and SL = (Q800+110x(V^^1/2))
D. Pool Heater				
Gas or Oil	All	All	ASHRAE 146	ET = 82 percent
Heat Pump All	All	All	ANSI/AHRI 11	COP = 4.0

TERMS:

DP = Draw Pattern
EF = Energy factor, minimum overall efficiency.
ET = Minimum thermal efficiency with 21 degrees C delta T.
SL = Standby loss is maximum Watts based on a 21 degrees C temperature difference between stored water and ambient requirements.
UEF = Uniform energy factor
V = Rated storage volume in gallons
Q = Nameplate input rate in Watts

TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

FUEL	STORAGE CAPACITY OR RATING CONDITION	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE	
A. STORAGE WATER HEATERS					
Elect.	≥20 gal and ≤55 gal		10 CFR 430	DP	UEF
				Very Small	0.8808 - (0.0008 x V)
				Low	0.9254 - (0.0003 x V)
				Medium	0.9307 - (0.0002 x V)
				High	0.9349 - (0.0001 x V)
Elect.	>55 gal and ≤120 gal		10 CFR 430	DP	UEF
				Very Small	1.9236 - (0.0011 x V)
				Low	2.0440 - (0.0011 x V)
				Medium	2.1171 -
				High	2.2418 - (0.0011 x V)
Elect. Heat Pump		≤24 Amps and ≤250 Volts	10 CFR 430	Rating Condition	UEF
				Integrated heat pump water heater (HPWH)	UEF ≥3.3 and First Hour Rating ≥45 gal/h
				Integrated HPWH, >120 V/15 Amp Circuit or Split-System HPWH	UEF ≥2.2 and First Hour Rating ≥45 gal/h
Elect. Heat Pump		>12 kW	10 CFR 430	HPWH COP ≥3.0	

TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

FUEL	STORAGE CAPACITY OR RATING CONDITION	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE	
Gas	≥20 gal and ≤55 gal		10 CFR 430	DP	UEF
				Very Small	0.3456 - (0.0020 x V)
				Low	0.5982 - (0.0019 x V)
				Medium	0.6483 - (0.0017 x V)
				High	0.6920 - (0.0013 x V)
Gas	>55 gal and ≤100 gal		10 CFR 430	DP	UEF
				Very Small	0.6470 -
				Low	0.7689 -
				Medium	0.7897 - (0.0004 x V)
				High	0.8072 - (0.0003 x V)
Gas	≤120 gal	75,000 Btu/h	10 CFR 430	DP	UEF
				Very Small	0.2674 - (0.0009 x V)
				Low	0.5362 - (0.0012 x V)
				Medium	0.6002 - (0.0011 x V)
				High	0.6597 - (0.0009 x V)
Oil	≤50 gal		10 CFR 430	DP	UEF
				Very Small	0.2509 - (0.0012 x V)
				Low	0.5330 -
				Medium	0.6078 - (0.0016 x V)
				High	0.6815 - (0.0014 x V)

TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

FUEL	STORAGE CAPACITY OR RATING CONDITION	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE	
Oil	≤120 gal	>105,000 Btu/h and ≤ 140,000 Btu/h	10 CFR 430	DP	UEF
				Very Small	0.2932 - (0.0015 x V)
				Low	0.5596 - (0.0018 x V)
				Medium	0.6194 - (0.0016 x V)
				High	0.6740 - (0.0013 x V)
B. Unfired Hot Water Storage, R-12.5 min.					
C. Instantaneous Water Heater					
Elect.	<2 gal		10 CFR 430	DP	UEF
				Very Small	0.91
				Low	0.91
				Medium	0.91
				High	0.92
Gas	<2 gal and >50,000 Btu/h		10 CFR 430	DP	UEF
				Very Small	0.80
				Low	0.81
				Medium	0.81
				High	0.81
Gas	4,000 (btu/h)/g and 10 gal max.	200,000 Btu/h min.	ANSI Z21.10.3	ET = 80 percent	
Gas	4,000 (btu/h)/g and 10 gal max.	200,000 Btu/h min.	ANSI Z21.10.3	ET = 80 percent SL = (Q/800+110x(V^^1/2))	
Oil	4,000 (btu/h)/g and 2 gal max.	50,000 Btu/h min. 210,000	10 CFR 430	ET = 80 percent and EF = 0.59-0.0005V	

TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

FUEL	STORAGE CAPACITY OR RATING CONDITION	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
Oil	4,000 (btu/h)/g and 10 gal max.	210,000 Btu/h min.	ANSI Z21.10.3	ET = 80 percent
Oil	4,000 (btu/h)/g and 10 gal max.	210,000 Btu/h min.	ANSI Z21.10.3	ET = 78 percent SL = (Q/800+110x(V^^1/2)) max.
D. Pool Heater				
Gas or Oil	All	All	ASHRAE 146	ET = 82 percent
Heat Pump All	All	All	ANSI/AHRI 1160	COP = 4.0

TERMS:

DP = Draw Pattern
EF = Energy factor, minimum overall efficiency.
ET = Minimum thermal efficiency with 70 degrees F delta T.
SL = Standby loss is maximum Btu/h based on a 70 degree F temperature difference between stored water and ambient requirements.
UEF = Uniform energy factor
V = Rated storage volume in gallons
Q = Nameplate input rate in Btu/h

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-22 00 70 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-22 00 70 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 22 00 70

PLUMBING FOR HEALTHCARE FACILITIES

05/20

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USACE / NAVFAC / AFCEC **UFGS-22 00 70 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-22 00 70 (November 2011)

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References are in agreement with UMRL dated January 2025

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SECTION 22 00 70

PLUMBING FOR HEALTHCARE FACILITIES

05/20

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NOTE: This specification covers the requirements for plumbing systems in healthcare facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: This guide specification includes plumbing fixtures, equipment, and piping which is located within, on, under, and adjacent to buildings. Plumbing system requirements must conform to Federal Standard FED-STD-795, "Uniform Federal Accessibility Standards (UFAS)," Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities, and Department of Defense (DoD) adopted and approved International Plumbing Code (ICC IPC), as modified by UFC 1-200-1 "General Building Requirements", UFC 3-101-01 Architecture, UFC 4-510-01, "Design: Medical Military Facilities", and UFC 3-420-1, "Plumbing Systems". Equipment supports and connections, for either equipment on the ground or in the building, must conform to these

requirements.

Show following information on project drawings:

1. Only drawings (not specifications) must indicate capacity, efficiency, dimensions, details, plan view, sections, elevations, locations of fixtures and equipment, and space required to replace strainers, filters, and for maintenance of equipment.

2. Location of wye strainer on building side of water supply valve in each building; indicate wye strainer blow-off outlet with piping to adjacent exterior wall hydrant (this will clean the strainer each time the wall hydrant is used).

3. Configuration, slope, and location of each piping system such as: above or below floors, above or below ceilings, above or below roofs, above or below ground.

4. Location of each sectionalizing valve in each water system. Sectionalizing valves must be ball valves.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a reference ID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.10.1/CSA 4.1	(2019; R 2024) Gas Water Heaters Vol. I, Storage Water Heaters with Input Ratings

	of 75,000 Btu Per Hour or Less
ANSI Z21.10.3/CSA 4.3	(2019; R 2024) Gas-Fired Water Heaters Vol.III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous
ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME A112.1.2	(2012; R 2017; R 2022) Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
ASME A112.6.1M	(1997; R 2017) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2022) Floor Drains
ASME A112.6.4	(2022) Roof, Deck and Balcony Drains
ASME A112.14.1	(2003; R 2017; R 2022) Backwater Valves
ASME A112.19.2/CSA B45.1	(2024) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME A112.19.3/CSA B45.4	(2022) Stainless Steel Plumbing Fixtures
ASME A112.36.2M	(2022) Cleanouts
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe

	Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(2021) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.29	(2022) Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings - DWV
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B31.1	(2024) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2021) Performance Requirements for Atmospheric Type Vacuum Breakers
ASSE 1003	(2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1010	(2021) Performance Requirements for Water Hammer Arresters
ASSE 1011	(2017) Performance Requirements for Hose Connection Vacuum Breakers
ASSE 1012	(2023) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent
ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies

ASSE 1017	(2023) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)
ASSE 1018	(2023) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002
ASSE 1019	(2023) Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies
ASSE 1037	(2015; R 2020) Performance Requirements for Pressurized Flushing Devices for Plumbing Fixtures
ASSE 1070	(2020) Performance Requirements for Water Temperature Limiting Devices

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2024) Hypochlorites
AWWA B301	(2024) Liquid Chlorine
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(2022) Grooved and Shouldered Joints
AWWA C651	(2023) Standard for Disinfecting Water Mains
AWWA C652	(2019) Disinfection of Water-Storage Facilities
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C701	(2019) Cold-Water Meters - Turbine Type for Customer Service
AWWA D100	(2021) Welded Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification

AWS B2.2/B2.2M	(2016) Specification for Brazing Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A74	(2021) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A518/A518M	(1999; R 2022) Standard Specification for Corrosion-Resistant High-Silicon Iron Castings
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A755/A755M	(2018; R 2024) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A815/A815M	(2024a) Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and

	Martensitic Stainless Steel Piping Fittings
ASTM A861	(2004; R 2023) Standard Specification for High-Silicon Iron Pipe and Fittings
ASTM A888	(2024) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B36/B36M	(2023) Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B306	(2020) Standard Specification for Copper Drainage Tube (DWV)
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM C564	(2020a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1053	(2000; R 2010) Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications

ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2729	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D2846/D2846M	(2019) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
ASTM D2855	(2020) Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3311	(2017) Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials

ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E2129	(2024) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F656	(2021) Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F1290	(2019) Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F1412	(2022) Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems
ASTM F2618	(2024) Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Fittings for Chemical Waste Drainage Systems

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(2018) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(2012) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

CSA GROUP (CSA)

CSA B45.5-17/IAPMO Z124	(2017; Errata 2017; Errata 2018) Plastic Plumbing Fixtures

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR Manual	(10th Edition) Manual of Cross-Connection Control

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

IAPMO Z124.5	(2013; E 2013; R 2018) Plastic Toilet Seats

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2017) Standard And Commentary Accessible and Usable Buildings and Facilities
ICC IPC	(2024) International Plumbing Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z358.1	(2014; R 2020) American National Standard for Emergency Eyewash and Shower Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2022) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NACE INTERNATIONAL (NACE)

NACE SP0169	(2024) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors
NEMA Z535.1	(2022) Safety Colors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials
NSF/ANSI 42	(2023) Drinking Water Treatment Units - Aesthetic Effects
NSF/ANSI 53	(2019) Drinking Water Treatment Units
NSF/ANSI 372	(2016) Drinking Water System Components - Lead Content
NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA Fire Man	(2016) Firestopping: Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI G 101	(2010) Testing and Rating Procedure for Hydro Mechanical Grease Interceptors with Appendix of Installation and Maintenance
PDI WH 201	(2010) Water Hammer Arresters Standard

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508	(2023) Hose Clamp Specifications

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

PL 93-523	(1974; A 1999) Safe Drinking Water Act

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 430	Energy Conservation Program for Consumer Products
29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
40 CFR 50.12	National Primary and Secondary Ambient Air Quality Standards for Lead
40 CFR 141.74	(2019) National Primary Drinking Water Regulations
40 CFR 143	National Secondary Drinking Water Regulations

UL SOLUTIONS (UL)

UL 174	(2004; Reprint Nov 2024) UL Standard for Safety Household Electric Storage Tank Water Heaters
UL 399	(2017; Reprint May 2019) UL Standard for Safety Drinking Water Coolers
UL 499	(2014; Reprint May 2023) UL Standard for Safety Electric Heating Appliances
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 732	(2023) UL Standard for Safety Oil-Fired Storage Tank Water Heaters
UL 778	(2016; Reprint Jul 2024) UL Standard for Safety Motor-Operated Water Pumps
UL 1951	(2011; Reprint Jun 2020) UL Standard for Safety Electric Plumbing Accessories

1.2 SYSTEM DESCRIPTION

Provide complete and operable plumbing systems including sanitary and storm drainage, domestic water, plumbing fixtures, valves, pumps, water heaters, supports, and all associated appurtenances.

1.2.1 Performance Requirements

1.2.1.1 Cathodic Protection and Pipe Joint Bonding

Provide cathodic protection and pipe joint bonding systems in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [and] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

1.2.2 Accessibility of Equipment

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NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when he has some control over locations. However, designers should not rely on it at all since enforcing this requirement in the field would be difficult. Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, and equipment requiring access, in locations freely accessible through access doors.

[1.2.3 Sustainable Design Requirements

1.2.3.1 Environmental Data

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NOTE: ASTM E2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products. This is optional for Army projects.

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Submit Table 1 of ASTM E2129 for products provided under work of this Section.

]1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Environmental Data; G, [_____]

SD-02 Shop Drawings

Plumbing System; G, [_____]

Domestic Water Systems Flushing Program; G, [_____]

SD-03 Product Data

Pipe and Fittings; G, [_____]

Pipe Hangers, Inserts, and Supports; G, [_____]

Valves; G, [_____]

Plumbing Fixtures; G, [_____]

Backflow Preventers; G, [_____]

Drains and Backwater Valves; G, [_____]

Cleanouts; G, [_____]

Interceptors; G, [_____]

Water Heaters; G, [_____]

Storage Tanks; G, [_____]

Pumps; G, [_____]

Water Pressure Booster System; G, [_____]

Water Service Meter; G, [_____]

Copper-Silver Ionization System; G, [_____]

Potable Water Monitoring System; G, [_____]

Vibration-Absorbing Features; G, [_____]

Recycled content for cast iron pipe; S

Recycled content for steel pipe; S

WaterSense label for shower head; S

Energy Star label for electric water cooler; S

WaterSense label for urinal; S

WaterSense label for water closet; S

Energy Star label for gas storage water heater; S

Energy Star label for gas instantaneous water heater; S

Plumbing System

SD-06 Test Reports

Tests, Flushing and Disinfection

Test of Backflow Prevention Assemblies

SD-07 Certificates

Materials and Equipment

Welding

Bolts

Pressure-Seal (Press-Fit) System Installation Training

Pressure-Seal (Press-Fit) Tools Calibration

EPA Registration for Copper-Silver Ionization

NSF Certification for Copper-Silver Ionization

SD-10 Operation and Maintenance Data

Plumbing System; G, [_____]

Maintenance Data Package; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 Manufacturer Qualifications

Engage manufacturers regularly manufacturing, supplying, and servicing of specified products and equipment, as well as, providing engineering and/or start-up services as specified. Provide evidence demonstrating compliance for a minimum of 5 years, and on 5 projects of similar complexity.

1.4.1.2 Installer Qualifications

Installer must be licensed, and must provide evidence of the successful completion of at least five projects of equal or greater size and complexity. Provide tradespeople skilled in the appropriate trade. Installation of the following items/systems must be done by authorized representatives of respective manufacturers:

a. Water Pressure Booster Pump System.

b. Copper-silver Ionization System.

1.4.2 Welding

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NOTE: The designer will indicate welding requirements on the project drawings. Normally, delete the second bracketed statement. If the need exists for more stringent requirements for weldments, delete the first bracketed statement and the welding submittal.

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[Weld piping in accordance with qualified procedures using performance-qualified welders and welding operators. Submit a list of names and identification symbols of qualified welders and welding operators. Provide documentation that welders, and welding operators are certified in accordance with American Welding Society Standard AWS B2.1/B2.1M. Qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests, and perform the tests at the work site if practicable. Welders or welding operators must apply their assigned symbols near each weld they make as a permanent record.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.] [Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.]

1.4.3 Regulatory Requirements

1.4.3.1 International Code Council (ICC) Codes

Unless otherwise required herein, perform plumbing work in accordance with the ICC IPC.

a. For ICC Codes, interpret reference to the "code official" to mean the "Contracting Officer." For Government-owned property, interpret references to the "owner" to mean the "Contracting Officer." For leased facilities, interpret references to the "owner" to mean the "lessor." Interpret references to the "permit holder" to mean the "Contractor."

b. For ICC Codes referenced in the Contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this Contract and by the authority granted to the [Officer in Charge of Construction][Resident Engineer] to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by their administrative cognizance and the FAR.

1.4.4 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.5 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the Contract. Provide Maintenance Data Package [1] [2] [3] [4] [5]. Submit manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 MAINTENANCE

Provide extra materials as follows:

a. Four additional cartridges for each waterless urinal installed along with any tools needed to remove/install the cartridge. Provide an additional quart of biodegradable liquid for each urinal installed.

b. One spare electrode cell for the copper-silver ionization system.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a

manufacturer regularly engaged in the manufacture of such products. Specified equipment must essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Provide standard products that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

2.2 MANUFACTURER'S NAMEPLATE

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. See also paragraph "Nameplates" in PART 3.

2.3 MATERIALS AND EQUIPMENT

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NOTE: Some materials listed are superior to others for specific requirements. Therefore, information should be obtained from the using service for any special requirements before selection of material is made. The type of tubing or pipe required will be as determined by local experience. In the absence of actual experience with water characteristics, the selection of materials for pipe, tubing, and tanks will be made by reference to the classification of water into categories as listed in UFC 3-420-01. Chap 4. Preference will be given to the following materials for waste pipe: 100 percent recycled content cast iron. Preference should be given, in this order, to the following materials for supply pipe: copper, galvanized steel.

This specification allows drainage systems up to 375 mm 15 inch diameter only; designer will ensure the availability of materials when drainage line exceeds 375 mm 15 inch diameter.

Nonpressure pipe is an EPA designated product for recycled content. Use materials with recycled content where appropriate for use. Designer must verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

The use of plastic pipe for domestic water service is not acceptable. Plastic pipe is acceptable for pure water systems such as deionized water and reverse osmosis water systems.

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Submit manufacturer's catalog data with highlighting to show model, size, options, and other features, that are intended for consideration. Provide adequate data to demonstrate compliance with Contract requirements. Submit certificate stating that the design, fabrication, and installation conform to the code, where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code.

a. Provide NSF/ANSI 14 and NSF listed plastic pipe, fittings, and solvent cement for the service intended. Provide plastic pipe, fittings, and solvent cement used for potable hot and cold water service bearing the NSF seal "NSF-PW." Provide polypropylene pipe and fittings conforming to dimensional requirements of Schedule 40, Iron Pipe size. Do not install plastic pipe in air plenums. Do not install plastic pipe in pressure piping systems in buildings greater than three stories including any basement levels.

b. [Provide cast-iron pipe containing a minimum of 95 percent recycled content. Provide data identifying percentage of recycled content for cast iron pipe.] Hubless cast-iron soil pipe installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors is not acceptable.

c. Provide cement pipe containing recycled content as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

d. Provide steel pipe containing a minimum of 25 percent recycled content, with a minimum of 16 percent post-consumer recycled content. Provide data identifying percentage of recycled content for steel pipe. Select pipe schedules based on service requirements. Provide pipe fittings compatible with the applicable pipe materials. Provide pipe threads (except dry seal) conforming to ASME B1.20.2M ASME B1.20.1. Provide grooved pipe couplings and fittings from the same manufacturer.

e. The use of lead containing materials or equipment in any potable water system is not acceptable. Comply with PL 93-523, NSF/ANSI/CAN 61, Section 8, and NSF/ANSI 372 for inline devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers. Comply with NSF/ANSI/CAN 61, Section 9, and NSF/ANSI 372 for endpoint devices such as water coolers, lavatory faucets, kitchen and bar faucets, ice makers, supply stops and endpoint control valves used to dispense water for drinking.

2.4 PIPE AND FITTINGS

2.4.1 Domestic Water Piping

Domestic water piping at service entrance (from 305 mm 1 foot inside building to 1525 mm5 feet outside): Provide same as indicated for outside utilities.

a. 50 mm2 inches and smaller after service entrance above grade:

    (1) Provide copper tube conforming to ASTM B88M ASTM B88, type L, with soldered joints and wrought copper ASME B16.22 or cast brass ASME B16.18 fittings.

    (2) Provide stainless steel pipe conforming to ASTM A312/A312M, Schedule 40, with threaded and butt weld joints. Provide stainless

steel fittings conforming to ASTM A815/A815M, stainless steel casting dimensions matching stainless steel pipe for threaded and butt weld connections.

****

NOTE: Do NOT use paragraphs 3 and 4 for Navy projects.

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(3) Pressure-seal (press-fit) fittings for Copper Pipe and Tube: Provide copper pressure-seal(press-fit) fittings conforming to the material and sizing requirements of ASME B16.18 or ASME B16.22. Provide EPDM, FKM, or HNBR sealing elements for copper pressure-seal (press-fit) fittings. Sealing elements must be factory installed or an alternative supplied fitting manufacturer. Select sealing elements based on manufacturer's approved application guidelines.

(4) Provide stainless steel pipe conforming to ASTM A312/A312M, Schedule 40, iron pipe size. Provide pressure-seal (press-fit) fittings for ASTM A312/A312M Schedule 40 stainless steel IPS pipe and tube. Stainless steel pressure-seal (press-fit) fittings conforming to the material and sizing requirements of ASTM A312/A312M or ASTM A403/A403M; NSF/ANSI/CAN 61 listed. Provide EPDM or FKM sealing elements for stainless steel pressure-seal (press-fit) fittings. Sealing elements must be factory installed or an alternative supplied fitting manufacturer. Select sealing elements based on manufacturer's approved application guidelines.

b. 65 mm 2 1/2-inch and larger after service entrance above grade:

(1) Provide copper tube conforming to ASTM B88MASTM B88, type L, with brazed joints and wrought copper ASME B16.22 or cast brass ASME B16.18 fittings.

(2) Provide stainless steel pipe conforming to ASTM A312/A312M, Schedule 40, with threaded and butt weld joints. Provide stainless steel fittings conforming to ASTM A815/A815M or ASTM A403/A403M, stainless steel casting dimensions matching stainless steel pipe for threaded and butt weld connections.

****

NOTE: Do NOT use paragraphs 3, 4, 5, and 6 for Navy projects.

****

(3) Provide copper tube conforming to ASTM B88M ASTM B88, type L, with roll-groove joints and manufactured grooved fittings conforming to ASTM A755/A755M C12200 or ASTM B152/B152M C11000 and ASME B16.22 for wrought copper, or in accordance with ASTM B584 copper alloy CDA 836 (85-5-5-5) in accordance with ASME B16.18.

(4) Provide copper tube conforming to ASTM B88M ASTM B88, type L. Provide pressure-seal (press-fit) fittings for copper pipe and tube. Copper pressure-seal (press-fit) fittings conforming to the material and sizing requirements of ASME B16.18 or ASME B16.22. Provide EPDM, FKM, or HNBR sealing elements for copper pressure-seal (press-fit) fittings. Sealing elements must be

factory installed or an alternative supplied fitting manufacturer. Select sealing elements based on manufacturer's approved application guidelines.

(5) Provide stainless steel pipe conforming to ASTM A312/A312M, Schedule 40, iron pipe size. Provide pressure-seal (press-fit) fittings for ASTM A312/A312M Schedule 40 stainless steel IPS pipe and tube. Stainless steel pressure-seal (press-fit) fittings conforming to the material and sizing requirements of ASTM A312/A312M or ASTM A403/A403M; NSF/ANSI/CAN 61 listed. Provide EPDM or FKM sealing elements for stainless steel pressure-seal (press-fit) fittings. Sealing elements must be factory installed or an alternative supplied fitting manufacturer. Select sealing elements based on manufacturer's approved application guidelines.

(6) Provide stainless steel pipe conforming to ASTM A312/A312M, Schedule 10, with roll-groove joints and manufactured grooved fittings conforming to ASTM A815/A815M with stainless steel casting dimensions matching stainless steel pipe.

c. Below grade:

(1) Provide copper tube conforming to ASTM B88MASTM B88, type K soft, with brazed joints and wrought copper ASME B16.22 fittings.

(2) Where below-grade run of piping is shorter than 15 m50 feet, below-grade joints are not acceptable.

d. Connections to Existing Galvanized Piping:

(1) Provide threaded, mechanical groove, mechanical plain-end, or flanged connections.

2.4.2 Deionized and Reverse Osmosis Water Piping

CPVC Plastic Pipe, Fittings, and Solvent Cement: Provide ASTM D2846/D2846M, Schedule 80 CPVC. Provide transition union connections or threaded gate valve between copper tubing and chlorinated polyvinyl chloride (CPVC) piping. Provide male threaded adapters with PTFE (polytetrafluoroethylene) pipe thread paste for threaded connections to valves, strainers, and equipment.

2.4.3 Drainage Piping (Soil, Waste, Vent, Indirect, and Storm)

a. Above grade:

(1) Provide cast-iron conforming to ASTM A74, hubbed pipe and fittings with ASTM C564 elastomeric push joints.

(2) Provide cast-iron conforming to CISPI 301 or ASTM A888, hubless pipe, fittings, and CISPI 310 elastomeric sealing sleeves with stainless-steel or cast iron clamps.

(3) Provide copper tube conforming to ASTM B306, type DWV or heavier, with soldered joints and wrought copper ASME B16.29 or cast brass ASME B16.23 drainage and vent fittings. Provide copper piping systems within MRI shielding assemblies.

(4) Provide seamless or welded, hot-dipped galvanized steel conforming to ASTM A53/A53M or ASTM B36/B36M, cast iron drainage type fittings, galvanized malleable vent fittings and threaded joints.

b. Below grade:

(1) Provide cast-iron conforming to ASTM A 74, hubbed pipe and fittings with ASTM C564 elastomeric push joints.

(2) Provide PVC solid-wall pipe, iron pipe size (IPS), conforming to ASTM D1785 and ASTM D2665. PVC socket fittings conforming to ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe. ASTM F656 adhesive primer and ASTM D2564 solvent cement. Provide PVC pipe and fittings manufactured from ASTM D1784 PVC compound cell class of 12454 and conforming to NSF/ANSI 14.

c. Foundation Drain:

(1) Provide PVC solid-wall pipe, iron pipe size (IPS), 100 mm 4 inches in diameter, perforated, conforming to ASTM D2729. PVC socket fittings conforming to ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe. ASTM F656 adhesive primer and ASTM D2564 solvent cement. Provide PVC pipe and fittings manufactured from ASTM D1784 PVC compound cell class of 12454 and conforming to NSF/ANSI 14.

2.4.4 Drainage Piping (Corrosive Waste)

a. Above grade:

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NOTE: Provide cast-iron materials below grade where the discharge of waste water may be 60 degrees C 140 degrees F or greater (i.e. commercial dishwashers, sterilizers, boiler and water heater relief valve discharge and blowdown). Route cast-iron materials to a flowing main and transition to PVC materials (if applicable). Make transitions between cast-iron and PVC materials with compression joint sealers that insert into cast-iron piping; the use of over the pipe couplings are not acceptable. Note changes in materials on the Contract Drawings.

****

(1) Provide corrosive waste borosilicate glass conforming to ASTM C1053, with mechanical joints and borosilicate glass fittings.

(2) Provide corrosive waste cast iron (14 percent silica) pipe and fittings conforming to ASTM A518/A518M and ASTM A861. Mechanical joints, and bell and spigot joints are acceptable in exposed (accessible) locations. Bell and spigot joints only are acceptable in concealed (non-accessible) locations.

[(3) Provide corrosive waste Schedule 40 fire retardant polypropylene DWV pipe and fittings conforming to ASTM D4101, ASTM F1412, ASTM D635, and ASTM D3311. Mechanical joints, and fused joints are acceptable in exposed (accessible) locations. Fused joints only are acceptable in concealed (non-accessible) locations.]

(4) Provide CPVC drainage pipe and drainage pattern fittings conforming to ASTM F2618. ASTM F656 adhesive primer and ASTM D2564 solvent cement. Provide CPVC pipe and fittings manufactured from ASTM D1784 CPVC Type IV compound cell class of 23447 and conforming to NSF/ANSI 14.

b. Below grade:

(1) Corrosive waste cast iron (14 percent silica) pipe and fittings conforming to ASTM A518/A518M and ASTM A861, with bell and spigot joints.

[(2) Corrosive waste Schedule 80 polypropylene DWV pipe and fittings conforming with ASTM D4101 and ASTM D3311 with fused joints.]

(3) Provide CPVC drainage pipe and drainage pattern fittings conforming to ASTM F2618. ASTM F656 adhesive primer and ASTM D2564 solvent cement. Provide CPVC pipe and fittings manufactured from ASTM D1784 CPVC Type IV compound cell class of 23447 and conforming to with National Sanitation Foundation (NSF) Standard 14..

2.4.5 Pressure Drainage Piping

[a. Cast iron pressure pipe and fittings, with mechanical joints.]

b. Galvanized steel, cast iron drainage fittings with threaded joints.

2.4.6 Exposed Piping in Finished Areas

a. Chrome or nickel plated brass to wall or floor.

b. Piping 50 mm2 inches and larger may be provided with chrome or nickel plated brass sleeves to cover pipe and fittings in lieu of plating.

[2.4.7 Trap Primer Pipe Between Primer Device and Drain

a. Above grade: Copper tube conforming to ASTM B88MASTM B88, type K or L, with soldered joints and wrought copper ASME B16.22 or cast brass ASME B16.18 fittings.

b. Below grade: Copper tube conforming to ASTM B88MASTM B88, type K soft, with soldered joints and wrought copper ASME B16.22 or cast brass ASME B16.18 fittings.

]2.5 PIPE JOINT MATERIALS

The use of grooved pipe and hubless cast-iron soil pipe underground is not acceptable. Mark cast iron soil pipe and fittings with the collective trademark of the Cast Iron Soil Pipe Institute. Provide joints and gasket materials conforming to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A74, AWWA C606. For hubless type: CISPI 310

b. Couplings for Stainless Steel Pipe: AWWA C606.

****

NOTE: Do NOT use the following paragraph for Navy

projects.

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c. Couplings for Grooved Pipe: [Ductile Iron ASTM A536 (Grade 65-45-12)] [Malleable Iron ASTM A47/A47M, Grade 32510]. [Copper ASTM A536].

d. Flange Gaskets: Provide gaskets of non-asbestos material in accordance with ASME B16.21. Provide flat gaskets, 1.6 mm1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Provide full face or self centering flat ring type gaskets. Provide gaskets bonded with NBR for hydrocarbon service.

e. Brazing Material: Conform to AWS A5.8/A5.8M, BCuP-5.

f. Brazing Flux: Provide flux in paste or liquid form appropriate for use with brazing material. Provide flux as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.

g. Solder Material: Solder metal conforming to ASTM B32 and Code approved "Lead Free" having a chemical composition equal to or less than 0.2 percent lead.

h. Solder Flux: Liquid form, non-corrosive, Code approved "Lead Free" and conforming to ASTM B813, Standard Test 1.

****

NOTE: Low corrosion flux for copper pipe can help reduce potentially toxic releases from soldered copper pipe.

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i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.

j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C564.

k. Rubber Gaskets for Grooved Pipe: ASTM D2000, rated for a maximum temperature of not less than 110 degrees C230 degrees F.

l. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.

m. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A183.

n. Flanged fittings including flanges, bolts, nuts, bolt patterns, and related features, in accordance with ASME B16.5 class 150 and having the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material conforming to ASTM A105/A105M. Blind flange material conforming to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Provide high strength or intermediate strength bolts with material conforming to ASTM A193/A193M. Submit written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements.

2.6 MISCELLANEOUS MATERIALS

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NOTE: For jobs at Newport, R.I. use diaphragm type

only.

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Miscellaneous materials conforming to the following:

a. Water Hammer Arrester: PDI WH 201. [Provide [diaphragm] [or] [piston] type water hammer arrester.]

b. Copper, Sheet, and Strip for Building Construction: ASTM B370.

c. Asphalt Roof Cement: ASTM D4586/D4586M.

d. Hose Clamps: SAE J1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material must be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof, and verminproof properties.

h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Gauges - Pressure Indicating Dial Type - Elastic Element: ASME B40.100.

l. Thermometers: ASTM E1. Mercury in thermometers is not acceptable.

2.7 PIPE INSULATION MATERIAL

Provide insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 PIPE HANGERS, INSERTS, AND SUPPORTS

Provide pipe hangers, inserts, and supports conforming to MSS SP-58. Provide non-ferrous (copper, aluminum, stainless steel hangers in MRI Suites.

2.9 VALVES

****

NOTE: Drawings will indicate equipment isolation, branch, and sectionalizing valves for water systems. Valves will be provided so that system maintenance can be performed without complete system shutdown. In general, valves should be provided in the following locations:

a. Each branch serving a group of fixtures.

b. Each riser serving a group of fixtures.

c. Isolation valves will be provided on the supply and discharge of booster and circulating pumps and on all water heaters.

****

Provide valves on supplies to equipment and fixtures. Valves 65 mm2-1/2 inches and smaller must be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 80 mm3 inches and larger must have flanged iron bodies and bronze trim. Base valve pressure ratings on the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Provide valves conforming to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ANSI Z21.22/CSA 4.
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASME BPVC SEC IV, Part HLW-810
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22/CSA 4.
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code, Part CW, Article 5

2.9.1 Thermostatic Mixing Valves

2.9.1.1 Master Mixing Valve Assemblies

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NOTE: Select appropriate master mixing valve specification.

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[ASSE 1017. Provide lead-free high/low type mixing valve assembly with large type thermostatic water mixing valve and intermediate type thermostatic water mixing valve. Provide union angle strainers, checkstops on inlets outlets, and ball valves on outlets of mixing valves. Provide pilot actuated regulating valve with pressure gage, thermostat, adjustable limit stop, and dial thermometer (range -18 to 93 degrees C) (range 0 to 200 degrees F). Provide mixing valve components with rough bronze finish and mount on welded strut with corrosion resistant wall support and inlet piping manifold. Provide entire assembly factory assembled and tested. Pipe mixing valve assembly and domestic hot water return according to manufacturer's recommended piping method. Set mixing valve outlet temperature as indicated on Contract Drawings. Provide mixing valves which maintain water temperature within 2 degrees C 4 degrees F of setpoint.]

[ASSE 1017. Provide lead-free digital water temperature control and monitoring system with full-color touchscreen interface configurable on site without dedicated software, computer interface and no required factory pre-programming and control of water temperature setpoint within 1 degree C 2 degrees F through full flow range of mixing valve. Provide password protected controller with user-adjustable outlet temperature range of 27 to 82 degrees C 80 to 180 degrees F, digital monitoring of inlet water pressures and temperatures, mixed outlet temperature, mixed outlet setpoint, pressure, flow and return water temperature, user-set high-temperature sanitization mode. Provide controller with Bacnet and Modbus protocols for interface with building automation systems. Shutdown mixing valve assembly hot water supply upon the loss of cold water or power. Set mixing valve outlet temperature as indicated on Contract Drawings.]

2.9.1.2 Lavatory and Sink Mixing Valves

ASSE 1070. Provide line size mixing valves for each lavatory and/or sink faucet in restrooms. Provide mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced constructed with rough or finish bodies either with or without plating. Each valve must be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. Provide heavy cast bronze body, and interior parts of brass, bronze, corrosion-resisting steel or copper materials. Equip the valve with stop valves, check valves, unions, and sediment strainers on the inlets. Set mixing valves at 41 degrees C 105 degrees F. Mixing valves must maintain water temperature within 2 degrees C 4 degrees F of setpoint.

2.10 PLUMBING FIXTURES

****

NOTE: The systems specified for water use in a building can dramatically impact both the quantity of water resources used and the quality. Installed fixtures and systems should be life-cycle cost-effective. Low-flow and zero-flow fixtures and accessories (such as waterless urinals and sensor operators) may require special training. Because these technologies may be different from the systems and materials with which the Government personnel are familiar, education about the environmental qualities as well as the operation and maintenance requirements may be necessary. Refer to Section

01 45 00 QUALITY CONTROL.

Reducing potable water consumption and wastewater discharge in buildings contributes to achieving sustainability requirements. Flow rates listed as options in this section are in accordance with ASHRAE 189.1 section 6.3.2.1 as required by UFC 1-200-02.

Water quality for most buildings is largely determined by the municipal water treatment facility. Most water treatment facilities rely upon chemicals, including chlorine, to combat pathogens. Chlorine is highly reactive and readily forms chlorinated compounds, many of which are considered to be dangerous. Chlorinated hydrocarbons, such as DDT, have been and are used as pesticides. If this is a concern for a given location, include the bracketed chlorine filter requirement in the lavatory, sink, cooler, shower and bathtub specification paragraphs below. The ARMY and the NAVY do not provide chlorine filters to their domestic water outlets.

These paragraphs cover fixtures most often specified. The selection of fixture requirements is based on MIL-STD-1691 to the most practicable extent. The fixture listing will be revised for each project by deleting inapplicable items. Tank type water closets are not typically utilized in healthcare settings and these requirements need to be added if these fixture types are used. The various types of fixtures will be identified by corresponding mark numbers shown on the drawings. A maximum of acceptable fixture and trim options should be allowed for materials in this specification, unless life cycle analysis or local experience indicates that one type of material is better suited than others. Use separate hot and cold water valves. For fixture mounting heights see paragraph FIXTURES AND FIXTURE TRIMMINGS.

****

2.10.1 General

Provide water conservation type fixtures. Provide fixtures for use by the physically handicapped in accordance with ICC A117.1. Provide vitreous china fixtures that are nonabsorbent, hard-burned, and vitrified throughout the body. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Equip fixtures with appurtenances such as traps, faucets, stop valves, and drain fittings. Equip each fixture and piece of equipment requiring connections to the drainage system with a trap. Provide brass expansion or toggle bolts capped with acorn nuts for supports, and provide polished chromium-plated pipe, valves, and fittings where exposed to view. Equip fixtures with the supply discharge below the rim with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, [may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years] [must be copper alloy with all visible surfaces chrome plated].[Plastic in contact with hot water must be suitable for 82 degrees C 180 degrees F water temperature.] Maximum allowable lead content in wetted surfaces of pipes, pipe fittings, plumbing fittings and fixtures, as determined by a weighted average must not exceed 0.25 percent. Provide water closets, urinals, flush valves, lavatory faucets, bathroom sink faucets, and shower heads with WaterSense label [or host nation equivalent labeling].

2.10.2 Flushometer Valves

Provide flushometer valves with an ADA compliant, metal oscillating, non-hold-open handle, backcheck angle control stop, and vacuum breaker. Flushometer valves must be either a large diaphragm, or fixed volume piston type with filtered metering bypass. Valve must not be able to be converted externally or internally to exceed a low consumption flush. Provide handle packing, main seat, stop seat and vacuum breaker molded from a chloramine resistant rubber compound. Provide valve body, cover, tailpiece and control stop in conformance with ASTM Alloy Classification for semi-red brass. Provide all exposed surfaces chrome plated. Provide handle with factory applied antimicrobial coating. Provide flushometer valves conforming to ASSE 1037.

2.10.3 Automatic Controls

Where specified with a fixture, provide automatic, sensor operated faucets complying with ASSE 1037 and UL 1951. Provide faucet systems consisting of solenoid-activated valves with light beam sensors.

2.10.4 Fixture Descriptions

2.10.4.1 Electric Water Coolers

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NOTE: Designer will indicate location, type, and capacity of the water cooler on the drawings. All requirements will be indicated. Designer will add to the specification required data on construction, supports, and insulation.

****

Provide self-contained, mechanically refrigerated electric water coolers with more than a single thickness of metal between the potable water and the refrigerant in the heat exchanger, wall-hung, bubbler style, air-cooled condensing unit, stainless steel splash receptor and basin, and stainless steel cabinet. Provide 8.4 mL/s 8 gph minimum capacity of 10 degrees C 50 degrees F water when supplied with 27 degrees C 80 degrees F inlet water and a 32 degrees C 90 degrees F room temperature. Control bubblers by push levers or push bars, front mounted or side mounted near the front edge of the cabinet. Mount bubbler spouts at a maximum of 914 mm 36 inches above floor and at front of unit basin with 686 mm 27 inch minimum knee clearance from bottom of unit to finished floor. Spouts must direct water flow at least 102 mm 4 inches above unit basin and trajectory parallel or nearly parallel to the front of unit. Provide chrome plated 10 mm 3/8 inch OD soft-copper tube supplies with set-screw escutcheons, and loose key stops. Provide chrome plated 32 mm by 40 mm 1-1/4 by 1-1/2 inch semi-cast P-trap with cleanout with 1.1 mm by 40 mm 17 gage by 1-1/2 inch chrome plated copper tube trap arm with set-screw escutcheon.[Provide filters for chlorine in supply piping to faucets.] Provide ASME A112.6.1M concealed steel pipe chair carriers. Provide electric water cooler that is Energy Star labeled. Provide data identifying Energy Star label for electric water cooler. Mount electric water coolers for use by the physically handicapped at heights in accordance with ICC A117.1.

2.10.4.1.1 EWC-1 (JSN R2200)

In-wall recessed bottle filling station. Provide stainless steel construction with plastic ABS alcove and lower hinged grille panel for access and servicing. Sensor-activation with an auto 20-second shut-off timer. Provide display indicating count of plastic bottles saved from waste. Provide bottle filler with a flow rate of 4.2-5.7 lpm 1.1-1.5 gpm and laminar flow to minimize splashing. Provide 11,355 liters 3000-gallon capacity filter, certified to NSF/ANSI 42 and NSF/ANSI 53, with visual monitor to indicate when replacement is necessary. Provide integrated silver ion anti-microbial protection in key areas. Provide unit in conformance with ABA guidelines. Provide unit with lead free design certified to NSF/ANSI/CAN 61 and NSF/ANSI 372 and meets Federal and State low-lead requirements. Provide unit certified to UL 399.

2.10.4.1.2 EWC-2 (JSN R2201)

Self-contained, wall hung, mechanically refrigerated, dual-level, brushed stainless steel finish, top mounted bottle filler on non-accessible water cooler, receptors designed to eliminate splashing and standing waste water. Control bubblers by push levers or push bars, front mounted and side mounted near the front edge of the cabinet.

2.10.4.1.3 EWC-3 (Similar to JSN R2202)

Self-contained, wall hung, mechanically refrigerated, single-level, accessible, brushed stainless steel finish, top mounted bottle filler, receptor designed to eliminate splashing and standing waste water. Control bubbler by push levers or push bars, front mounted and side mounted near the front edge of the cabinet.

2.10.4.1.4 EWC-4 (JSN R2203)

Accessible (forward facing), dual-level, recessed, brushed stainless steel, recessed refrigeration unit, dual level extensions with oval receptors, recessed bottle filler, access panel cover, rounded corners, rounded edges, designed to eliminate splashing and standing waste water. Provide self-closing, semi-circular push bars with full 180 degree activation.

2.10.4.2 Emergency Fixtures

Provide copper alloy control valves. Provide an air-gap with the lowest potable eye and face wash water outlet located above the overflow rim by not less than the International Plumbing Code minimum. [Provide a pressure-compensated tempering valve, with leaving water temperature setpoint adjustable throughout the range 16 to 35 degrees C 60 to 95 degrees F.] [Provide packaged, UL listed, alarm system; including an amber strobe lamp, horn with externally adjustable loudness and horn silencing switch, mounting hardware, and waterflow service within NEMA Type 3 or 4 enclosures[and for explosion proof service within NEMA Type 7 or 9 enclosures].]

2.10.4.2.1 EW-1 (Similar to JSN P1965)

Eye/face wash, ANSI/ISEA Z358.1, deck-mounted, swing down, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valve. Spray heads swing down from storage to operational position activating water flow. Coordinate configuration with sink faucet location. Provide eye/face wash with a minimum flow rate of 0.19 L/s 3 gpm of aerated water at 207 kPa 30 psig flow pressure.

2.10.4.2.2 EW-2 (JSN P2000)

Eye/face wash, ANSI/ISEA Z358.1, wall-mounted self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, corrosion-resisting steel eye and face wash receptor. Provide unit with a minimum flow rate of 0.19 L/s 3 gpm of aerated water at 207 kPa 30 psig flow pressure, with eye and face wash nozzles 838 to 1143 mm 33 to 45 inches above finished floor. Provide 32 mm 1-1/4 inch standard chrome drain fitting.

EW-3 (Similar to JSN P2000)

Eye/face wash, ANSI/ISEA Z358.1. Recessed eye/face wash assembly. Eye/face wash, swing down, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valve. Spray heads swing down from storage to operational position activating water flow. Provide eye/face wash with a minimum flow rate of 0.19 L/s 3 gpm of aerated water at 207 kPa30 psig flow pressure. Mount eye/face wash actuator in [separate] [combined] stainless steel fully recessed cabinet with flanged rim and suitable for installation in a 92 mm 3 5/8 inch stud wall. Provide all exposed surfaces with stainless steel finishes. [Provide unit suitable for and installed for handicap access.]

2.10.4.2.3 ES-1 (Similar to JSN P5210)

****

NOTE: Intended for use in finished areas such as laboratories.

****

Combination drench shower and eye/face wash, ANSI/ISEA Z358.1. Recessed eye/face wash and shower actuator assembly. Eye/face wash, swing down, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valve. Spray heads swing down from storage to operational position activating water flow. Provide eye/face wash with a minimum flow rate of 0.19 L/s 3 gpm of aerated water at 207 kPa30 psig flow pressure. Provide a minimum 203 mm 8 inch diameter shower head designed for [vertical] [horizontal] [recessed] supply piping. Provide 25 mm 1 inch IPS brass stay-open shower valve with stainless steel "panic bar" actuator. Provide shower with a minimum flow rate of 1.26 L/s 20 gpm flow and 508 mm 20 inch pattern at 1524 mm 60 inches above floor. Mount eye/face wash and shower actuator in [separate] [combined] stainless steel fully recessed cabinet with flanged rim and suitable for installation in a 92 mm 3 5/8 inch stud wall. Provide all exposed surfaces with stainless steel finishes. [Provide unit suitable for and installed for handicap access.]

2.10.4.2.4 ES-2 (JSN P5210)

****

NOTE: Intended for use in unfinished areas such as mechanical rooms.

****

Combination drench shower and eye/face wash, ANSI/ISEA Z358.1. Mount components on a minimum 32 mm 1-1/4 inch diameter [stainless steel] [chrome plated brass] [galvanized steel] pipe stanchion with floor flange. Provide chrome plated split ring support to adjacent wall surface 305 mm 12 inches below shower arm connection. Eye/face wash, swing down, self-cleaning, non-clogging eye and face wash with quick opening, 15 mm1/2 inch IPS chrome-plated brass full-flow push to activate stay-open valve. Provide eye/face wash with a minimum flow rate of 0.19 L/s 3 gpm of aerated water at 207 kPa 30 psig flow pressure. Provide a minimum 203 mm 8 inch diameter shower head. Provide 25 mm 1 inch IPS chrome-plated brass stay-open shower valve with stainless steel actuating arm and pull rod. Provide shower with a minimum flow rate of 1.26 L/s 20 gpm flow and 508 mm 20 inch pattern at 1524 mm 60 inches above floor. [Provide unit suitable for and installed for handicap access.]

2.10.4.3 Lavatories

a. Provide ASME A112.19.2/CSA B45.1, white vitreous china, integral back type wall hung lavatories with supply openings for use with top mounted faucet, and openings for concealed arm carrier installation. Provide chrome plated 10 mm 3/8 inch OD soft-copper tube supplies with set-screw escutcheons, and loose key stops. Provide chrome plated 32 by 40 mm 1-1/4 by 1-1/2 inch semi-cast P-trap with cleanout with 1.1 by 40 mm 17 gage by 1-1/2 inch chrome plated copper tube trap arm with set-screw escutcheon. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports and concealed arms for the lavatory. Mount lavatory with the front rim 787 mm 31 inches above the floor, except 864 mm 34 inches maximum above floor and with 737 mm 29 inches minimum clearance from bottom of the front rim to floor for accessible lavatories.

****

NOTE: L-1, L-2, L-6 and L-7 are intended for use in public toilet rooms. Where sensor operation is indicated, battery (or solar with battery backup) operated unit is preferred but provide hard wired unit if desired by the using agency/facility. L-6 is a countertop mounted lavatory. L-2 is not sensor operated. L-1 is not intended for accessible locations.

****

(1) L-1 (Similar to JSN P3200): 508 by 457 mm 20 by 18 inches. Equip fixture with, electronic infra-red operated 102 mm 4 inch centerset combination faucet with aerator, drain fitting with grid strainer, "P" trap, and angle or straight stop valves. Automatic water flow starts electronically by proximity of individual. [Provide wiring box, 120/24 volt solenoid, remote mounted transformer. Transformer may be sized for multiple adjacent lavatories.] [Provide either a battery operated unit or a solar powered unit with battery backup.] Provide WaterSense labeled faucet with a maximum flow rate of 1.9 L/min 0.5 gpm at a flowing pressure of 414 kPa 60 psig. Limit water volume to a maximum of 1.0 L 0.25 gal per metering cycle.

****

NOTE: Intended for use in public toilet rooms for

accessible locations.

****

(2) L-2: Same as L-1 except accessible mounting height per ICC A117.1. Provide accessible protection on exposed water supplies and "P" trap and drain piping.

****

NOTE: Intended for use in patient/staff toilet rooms.

****

(3) L-3 (Similar to JSN P3100): 508 by 457 mm 20 by 18 inches. Equip fixture with combination faucet, elevated gooseneck spout with laminar flow outlet, 102 mm 4 inch wrist action handles, drain fitting with grid strainer, "P" trap, and angle or straight stop valves. Faucet bodies with a pop-up drain rod hole are not acceptable. Plugged holes are not acceptable. Limit faucet flow rate to a maximum of 5.7 L/min 1.5 gpm at a flowing water pressure of 414 kPa 60 psig.

****

NOTE: Intended for use in patient/staff toilet rooms for accessible locations.

****

(4) L-4: Same as L-3 except accessible mounting height per ICC A117.1. Provide accessible protection on exposed water supplies and "P" trap and drain piping.

****

NOTE: Intended for use in exam rooms for USACE projects. For Navy projects use S-1 in exam rooms.

****

(5) L-5 (Similar to JSN P3100): 508 by 457 mm 20 by 18 inches. Equip fixture with combination faucet, elevated gooseneck spout with laminar flow outlet, 102 mm 4 inch wrist action handles, drain fitting with grid strainer, "P" trap, and angle or straight stop valves. Faucet bodies with a pop-up drain rod hole are not acceptable. Plugged holes are not acceptable. Limit faucet flow rate to a maximum of 5.7 L/min 1.5 gpm at a flowing water pressure of 414 kPa 60 psig. Accessible mounting height per ICC A117.1. Provide accessible protection on exposed water supplies and "P" trap and drain piping.

b. ASME A112.19.2/CSA B45.1, white vitreous china, self-rimming counter-mounted lavatories with supply openings for use with top mounted faucet. Furnish template and mounting kit by lavatory manufacturer. Provide chrome plated 10 mm 3/8 inch OD soft-copper tube supplies with escutcheons, and loose key stops. Provide chrome plated 32 by 40 mm 1-1/4 by 1-1/2 inch semi-cast P-trap with cleanout with 1.1 by 40 mm 17 gage by 1-1/2 inch chrome plated copper tube trap arm with escutcheon.

****

NOTE: Intended for use in public toilet rooms. Battery operated unit (or solar powered unit with battery backup) is preferred, provide hard wired

unit if desired by the using agency/facility.
****

(1) L-6 (Similar to JSN P3070): 508 by 457 mm 20 by 18 inches. Equip fixture with, electronic infra-red operated 102 mm 4 inch centerset combination faucet with spray outlet, drain fitting with grid strainer, "P" trap, and angle or straight stop valves. Automatic water flow starts electronically by proximity of individual. Provide wiring box, 120/24 volt solenoid, remote mounted transformer. Transformer may be sized for multiple adjacent lavatories. [Provide either a battery operated unit or a solar powered unit with battery backup.] Limit faucet flow rate to a maximum of 1.9 L/m 0.5 gpm at a flowing pressure of 414 kPa 60 psig. Limit water volume to a maximum of 1.0 L 0.25 gal per metering cycle.

****
NOTE: Intended for use in public toilet rooms for accessible locations.
****

(2) L-7: Same as L-6 except provide accessible protection on exposed water supplies and "P" trap and drain piping.

****
NOTE: Intended for use in patient toilet rooms.
****

(3) L-8 (Similar to JSN P3070): 508 by 457 mm 20 by 18 inches. Equip fixture with 100 mm 4 inch centerset combination faucet, elevated gooseneck spout with laminar flow outlet, 102 mm 4 inch wrist action handles, drain fitting with grid strainer, "P" trap, and angle or straight stop valves. Faucet body must not have a pop-up drain rod hole. Plugged holes are not acceptable. Flow must be limited to 5.7 L/m 1.5 gpm at a flowing pressure of 414 kPa 60 psig. Accessible mounting height per ICC A117.1. Provide accessible protection on exposed water supplies and "P" trap and drain piping.

2.10.4.4 Mop Service Basin

a. [Provide terrazzo mop sinks made of marble chips cast in white portland cement to produce 21 MPa 3000 psig minimum compressive strength 7 days after casting. Provide floor or wall outlet copper alloy body drain cast integral with terrazzo, with polished stainless steel strainers.]

b. MS-1 (JSN P4700): 914 by 610 by 305 mm 36 by 24 by 12 inches, precast terrazzo with integral stainless steel caps with tiling flange, 80 mm 3-inch cast brass drain with stainless strainer, lead caulk drain connection and 0.95 mm 20 gage, type 304 stainless steel 305 mm 12-inch high splash/wall guards. Provide chrome plated, 203 mm 8-inch centers, wall mounted cast brass service sink faucet with rigid spout with integral vacuum breaker, 20 mm 3/4-inch hose threads, pale hook, wall brace, indexed lever handles, hose, hose bracket, and mop hanger. Provide ball type shutoff valves and check valves above ceiling in supply piping to mop sink faucet.

2.10.4.5 Plaster Traps

2.10.4.5.1 PT-1 (JSN P7600)

Large, 406 mm 16 inches high by 356 mm 14 inches wide by 356 mm 14 inches long; heavy gray cast-iron body, white porcelain-enamel inside and outside; clamps, cage of heavy galvanized material, and brass screens; with 50 mm 2 inch low inlet and 50 mm 2 inch high outlet fitted with hood seal.

2.10.4.5.2 PT-2 (JSN P7650)

Small, 305 mm 12 inches high by 152 mm 6 inches wide by 152 mm 6 inches long; cast aluminum, rectangular with solid top and hinged bottom having integral baffles and 6 mm 1/4 inch drain plug; provide bolted bottom for easy access for removal of screens for cleaning and recovery of items in sediment bucket.

2.10.4.6 Showers

****

NOTE: For Marine Air Corps Station, New River, and Camp LeJeune NC, use ball type control handles, not lever type control handle, when handicap accessibility is not required for the shower valves.

****

Provide single control pressure equalizing shower valves with body mounted from behind the wall with threaded connections. Provide tubing mounted from behind the wall between faucets and shower assembly. Provide separate globe valves or angle valves with union connections in each supply to faucet. Provide top of drain outlets of chromium-plated or polished stainless steel finish. [Provide shower valve with ball type control handle.] [Provide precast terrazzo shower floors made of marble chips cast in white portland cement to produce 21 MPa 3000 psi minimum compressive strength 7 days after casting. Provide floor or wall outlet copper alloy body drain cast integral with terrazzo floor, with polished stainless steel strainers.]

2.10.4.6.1 SH-1 (JSN P5040)

****

NOTE: Intended for use in patient toilet rooms with ceramic tile enclosures.

****

Wall mounted detachable spray assembly, 610 mm 24 inch wall bar, elevated vacuum breaker, supply elbow and flange and valve. All external trim, chrome plated metal. Plastic shower head 1525 mm 5 foot length of rubber lined corrosion resistant steel, chrome plated metal flexible, or white vinyl reinforced hose and supply wall elbow. Provide WaterSense labeled shower head with a maximum flow rate of 5.7 L/Min 1.5 gpm. Provide data identifying WaterSense label for shower head. Design showerhead to fit in palm of hand. Provide corrosion resistant steel or chrome plated metal wall bar with an adjustable swivel hanger for showerhead. Fasten wall bar securely to wall for hand support. Combination thermostatic and pressure anti-scald balancing valve, with chrome plated metal lever type operating handle adjustable for rough-in variations and chrome plated metal or corrosion resistant steel face plate. Provide copper alloy valve body. Internal parts must be copper, nickel alloy, corrosion resistant steel or thermoplastic material. Provide 15 mm 1/2 inch IPS valve inlets and outlet. Provide external screwdriver check stops, vacuum breaker and temperature limit stops. Set stops for a maximum temperature of 40 degrees C 105 degrees F. Provide vandal resistant exposed fasteners. Provide valve with a maximum flow rate of 5.7 L/min 1.5 gpm at a flowing pressure of 552 kPa 80 psig.

2.10.4.6.2 SH-2 (Similar to JSN P5040)

****

NOTE: Intended for use in staff toilet rooms with ceramic tile enclosures.

****

Wall mounted, shower head connected to shower arm. Provide all external trim of chrome plated metal. Chrome plated metal head, adjustable ball joint, self cleaning with automatic flow control device to limit discharge to not more than 5.7 L/min 1.5 gpm. Provide valve body, internal parts of shower head and flow control fittings of copper alloy or corrosion resistant steel. Install showerhead 1829 mm 72 inches above finished floor. Combination thermostatic and pressure anti-scald balancing valve, with chrome plated metal lever with adjustment for rough-in variations, type operating handle and chrome plated brass or corrosion resistant steel face plate. Provide copper alloy valve body. Provide copper, nickel alloy, corrosion resistant steel or thermoplastic material internal parts. Provide 15 mm 1/2 inch IPS valve inlets and outlet. Provide external screwdriver check stops, and temperature limit stops. Set stops for a maximum temperature of 40 degrees C 105 degrees F. Install valve 1372 mm 54 inches from bottom of shower receptor. Provide vandal resistant exposed fasteners. Provide valve with a maximum flow rate of 5.7 L/min 1.5 gpm at a flowing pressure of 552 kPa 80 psig.

2.10.4.6.3 SH-3 (JSN P5350)

Psychiatric patient, vandal-resistant with thermostatic valve in cabinet; provide shower head designed for prison use. Provide fixture with smooth surfaces with no projection that can be used as a catch or hook; provide flat back arranged for bolting directly to the wall; tapped for 15 mm 1/2 inch pipe connection to tempered water line; provide tamperproof shower head with removable face not less than 90 mm 3-1/2 inch diameter; install shower head not less than 1829 mm 6 feet above the floor and with spray delivery within a 900 mm 3 foot circle. Limit flow to a maximum rate of 7.6 L/min 2.0 gpm at a flowing water pressure of 552 kPa 80 psig.

[2.10.4.6.4 Shower Enclosure

****

NOTE: Provide dimensions.

****

Provide [_____] mm [_____] inches wide, [_____] mm [_____] inches deep, and [_____] mm [_____] inches high shower enclosure. Provide reinforced acrylic cabinet conforming to CSA B45.5-17/IAPMO Z124.

]2.10.4.7 Sinks

****

NOTE: Confirm casework dimensions prior to selection of sinks.

Pedal valves provide savings in locations where water is unnecessarily left running continuously during use, like kitchens.
****

Provide ASME A112.19.3/CSA B45.4, Type 302(18-8) or 304(18-8) stainless steel sinks with integral mounting rim for flush installation, with undersides fully sound deadened, with supply openings for use with top mounted faucet, and with 89 mm 3.5 inch drain outlet. Provide 1.27 mm18 gage sinks for basin depths less than or equal to 254 mm 10 inch. Provide 1.59 mm16 gage sinks for basin depths greater than 250 mm 10 inch. [Provide faucet with gooseneck spout with plain-end and laminar flow fitting in base of gooseneck spout.] [Provide faucet with flow restrictor and non-aerated flow outlet.] Aerators are not acceptable. Provide faucets with a maximum flow rate of 5.7 L/min 1.5 gpm when measured at a flowing water pressure of 414 kPa 60 psig. Provide chrome plated 10 mm 3/8 inch OD soft-copper tube supplied with escutcheons, and loose key stops. Provide chrome plated 40 mm 1-1/2 inch semi-cast P-trap with cleanout with 1.1 by 40 mm 17 gage by 1-1/2 inch chrome plated copper tube trap arm with escutcheon. Provide separate 40 mm 1.5 inch P-trap and drain piping to vertical vent piping from each compartment. Coordinate hole quantities, locations, and centerings with faucet types indicated in fixture descriptions. Provide exact numbers of holes necessary. Use of faucet hole covers is not acceptable. Dimensions given are overall, and bowl in the following order: front to back, left to right, depth. [Provide filters for chlorine in supply piping to faucets.] Provide sinks located in casework designated as handicap accessible same as specified except basin depths not greater than 152 mm 6 inches and drain outlets located to the rear of basins.

2.10.4.7.1 S-1 (JSN CS010)

****
NOTE: S-1 is typically used for Navy projects as exam room sink.
****

Single bowl, counter-mounted, 457 by 381 by 165 mm 18 by 15 by 6-1/2 inches, bowl 305 by 305 by 152 mm 12 by 12 by 6 inches. Locate drain outlet to the rear of the basin. Provide 102 mm 4 inch centerset faucet with two 100 mm 4 inch wristblades and 127 mm 5 inch diameter fixed gooseneck spout.

2.10.4.7.2 S-2 (JSN CS080)

Single bowl, counter-mounted, 508 by 559 by 191 mm 20 by 22 by 7-1/2 inches, bowl 356 by 457 by 191 mm 14 by 18 by 7-1/2 inches. Faucet must be 102 mm 4 inch centerset with two 102 mm 4 inch wristblades and 127 mm 5 inch diameter fixed gooseneck spout.

2.10.4.7.3 S-3 (JSN CS090)

Single bowl, counter-mounted, 559 by 559 by 191 mm 22 by 22 by 7-1/2 inches, bowl 406 by 483 by 191 mm 16 by 19 by 7-1/2 inches. Provide 102 mm 4 inch centerset faucet with two 102 mm 4 inch wristblades and 127 mm 5 inch diameter fixed gooseneck spout.

2.10.4.7.4 S-4 (JSN CS140)

Single bowl, counter-mounted, 559 by 432 by 254 mm 22 by 17 by 10 inches, bowl 406 by 356 by 254 mm 16 by 14 by 10 inches. Provide 102 mm 4 inch centerset faucet with two 102 mm 4 inch wristblades and 127 mm 5 inch diameter fixed gooseneck spout.

2.10.4.7.5 S-5 (JSN CS150)

Single bowl, counter-mounted, 559 by 559 by 254 mm 22 by 22 by 10 inches, bowl 406 by 483 by 254 mm 16 by 19 by 10 inches. Provide 102 mm 4 inch centerset faucet with two 102 mm 4 inch wristblades and 127 mm 5 inch diameter fixed gooseneck spout.

2.10.4.7.6 S-6 (JSN CS180)

Single bowl, counter-mounted, 559 by 635 by 305 mm 22 by 25 by 12 inches, bowl 406 by 559 by 305 mm 16 by 22 by 12 inches. Provide 102 mm 4 inch centerset faucet with two 102mm 4 inch wristblades and 127 mm 5 inch diameter fixed gooseneck spout.

2.10.4.7.7 S-7 (JSN CS200)

Single bowl, counter-mounted, 559 by 787 by 305 mm 22 by 31 by 12 inches, bowl 406 by 711 by 305 mm 16 by 28 by 12 inches. Provide 102 mm 4 inch centerset faucet with two 102 mm 4 inch wristblades and 127 mm 5 inch diameter fixed gooseneck spout.

2.10.4.7.8 S-8 (JSN CS230)

Double bowl, counter-mounted, 559 by 838 by 254 mm 22 by 33 by 10 inches, each bowl 406 by 357 by 254 mm 16 by 14 by 10 inches. Provide 200 mm 8 inch spread faucet, single handle, swing spout.

2.10.4.7.9 S-9 (JSN CS250)

Single bowl, counter-mounted, 381 by 381 by 152 mm 15 by 15 by 6 inches, bowl 229 by 305 by 152 mm 9 by 12 by 6 inches. Provide 102 mm 4 inch centerset faucet with two 100 mm 4 inch wristblades and 125 mm 5 inch diameter fixed gooseneck spout.

2.10.4.7.10 S-10 (JSN P3520)

Sink, plaster, 559 by 762 by 241 mm 22 by 30 by 9-1/2 inches; vitreous china; faucet with 51 mm 2 inch spray, 152 mm 6 inch handles, screwdriver stops, grid drain 40 mm 1-1/2 inch tailpieces, 50 mm 2 inch O.D. drain connection to trap and wall; provide plaster-interceptor trap (PT-1), install plaster trap with manufacturer's recommended clearances above the unit for removal of screens. Provide with floor-mounted heavy-duty type sink carrier with acid-resisting white coated exposed arms and hanger support plate.

2.10.4.8 Sink, Flushing Rim SF-1 (JSN P6350)

[Wall mounted flushing rim sink with stainless steel spring type front and side rim guards, 100 mm 4 inch wall outlet, nominal dimensions of 635 by 533 by 445 mm 25 by 21 by 17 1/2 inches; vitreous china with an integral flushing rim. Provide floor mounted carrier.] [Floor mounted flushing rim sink with stainless steel spring type front and side rim guards, 100 mm 4 inch floor outlet, nominal dimensions of 711 by 508 by 457 mm 28 by 20 by 18 inches; vitreous china with an integral flushing rim. Provide 254 mm 10 inch high terrazzo base.] Provide faucet with fork brace 152 mm 6 inch handles, 260 mm 10-1/4 inches wall to spout outlet, and plain end spout with bucket hook. Provide 24.6 lpf 6.5 gpf flushometer valve.

[2.10.4.9   Service Sinks

ASME A112.19.2/CSA B45.1, white enameled cast iron with integral back and wall hanger supports, minimum dimensions of 559 mm 22 inches wide by 457 mm 18 inches front to rear, with two supply openings in 254 mm 10 inch high back. Provide floor supported wall outlet cast iron P-trap and stainless steel rim guards. Provide back mounted washerless service sink faucets with vacuum breaker and 19 mm 3/4 inch external hose threads.

]2.10.4.10   Sink, Surgeons Scrub

2.10.4.10.1   SSS-1 (JSN P6980)

Three station, wall-mounted, gooseneck spouts, knee push controls. Provide seamless welded 1.59 mm16 gage construction, Type 304, stainless steel. Sound-deaden cabinet with a fire-resistant material. Provide wall mounted unit using a mounting carrier. Provide removable front panels for access to the water control valves, waste connections, stops and strainers. Provide sloped sink bottoms to minimize splashing and a 40 mm 1-1/2 inch OD tailpiece with an 80 mm 3 inch flat strainer drain. Provide each compartment (station) with a gooseneck assembly with a 40 mm 1-1/2 inch sprayhead that can be removed for sterilization. Provide adjustable thermostatic mixing valve with anti-scald feature for each compartment and controlled from the top mounted control panel. Provide mechanical pilot type water control valves for each compartment actuated by one push of a knee-operated front panel and turned off by a second push. Provide plastic splash shield between each compartment. Provide knee-controlled soap dispensers at each compartment.

[2.10.4.10.2   SSS-2 (Similar to JSN P6990)

Two station, wall-mounted, gooseneck spouts, electronically timed with long (10 minute) and short (3, 4, 5 minute) cycles. Provide seamless welded 1.59 mm16 gage construction, Type 304, stainless steel. Sound-deaden cabinet with a fire-resistant material. Provide wall mounted unit using a mounting carrier. Provide removable front panels for access to the water control valves, waste connections, stops and strainers. Provide sloped sink bottoms to minimize splashing and a 40 mm 1-1/2 inch OD tailpiece with an 80 mm 3 inch flat strainer drain. Provide each compartment (station) with a gooseneck assembly with a 40 mm 1-1/2 inch sprayhead that can be removed for sterilization. Provide adjustable thermostatic mixing valve with anti-scald feature for each compartment and controlled from the top mounted control panel. Provide watertight and top mounted control panel. Provide internal timing device to reduce tampering. Provide plastic splash shield between each compartment. Provide foot-controlled soap dispensers at each compartment. Provide sink with 120 volt, 2 ampere power to an internal junction box.

]2.10.4.11   Urinals

Provide ASME A112.19.2/CSA B45.1, white vitreous china, wall-mounted, wall outlet, urinals with integral trap, drain line connection, and extended side shields. Provide urinals with trap design complying with the IPC.

Install urinal rim 610 mm 24 inches above the floor at non-accessible locations. Mount urinals installed in compliance with ADA requirements with the rim 432 mm 17 inches above the floor. Provide ASME A112.6.1M concealed chair carriers. Provide urinals equipped with flush valves with a flushing volume of the urinal and flush valve combination not exceeding the fixture design rating. Mount flush valves not less than 279 mm 11 inches above the fixture.

2.10.4.11.1 U-1 (Similar to JSN P8150)

****

NOTE: Battery operated unit (or solar powered with battery backup) is preferred, but hard wired unit must be used if desired by the using agency/facility.

****

High efficiency washout for solenoid valve. Provide WaterSense labeled urinal with a maximum water use of 0.47 Lpf 0.125 gpf. Provide data identifying WaterSense label for urinal. Flushing cycle must be activated by an electronic infrared sensor operated by proximity of individual. [Provide wiring box, 120/24 volt solenoid, and transformer.] [Provide either battery operated unit or solar powered unit with battery backup.]

2.10.4.11.2 U-2

Same as U-1 except accessible mounting height per ICC A117.1.

2.10.4.11.3 U-3: (Similar to JSN P8150)

High efficiency washout for solenoid valve. Provide WaterSense labeled urinal with a maximum water use of 1.9 Lpf 0.5 gpf. Provide data identifying WaterSense label for urinal. Flushing cycle must be activated by an electronic infrared sensor operated by proximity of individual. [Provide wiring box, 120/24 volt solenoid, and transformer.] [Provide either battery operated unit or solar powered unit with battery backup.]

2.10.4.11.4 U-4

Same as U-3 except accessible mounting height per ICC A117.1.

2.10.4.12 Water Closets

Provide ASME A112.19.2/CSA B45.1, white vitreous china, elongated bowl, wall-hung water closets. Provide water closets with trap design complying with the IPC. Install top of toilet seat 356 to 381 mm 14 to 15 inches, above the floor at non-accessible locations. Mount water closets installed in compliance with ADA requirements with the rim 432 mm to 483 mm 17 to 19 inches above the floor. Provide water closets equipped with flush valves with a flushing volume of the water closet and flush valve combination not exceeding the fixture design rating. Provide water flushing volume of the water closet and flush valve combination not exceeding 4.85 liters 1.28 gallons per flush unless indicated otherwise. Provide white solid plastic elongated open-front seat without cover, with check hinge. Provide seats conforming to IAPMO Z124.5. Mount flush valves not less than 279 mm 11 inches above the fixture. Mounted height of flush valve must not interfere with the hand rail in ADA stalls. Provide ASME A112.6.1M heavy duty 227 kg 500 pound capacity chair carriers.

2.10.4.12.1 WC-1 (Similar to JSN P9050)

****

NOTE: Intended for use in public/staff toilet rooms. Battery operated unit (or solar powered with battery backup) is preferred, but hard wired unit must be used if desired by the using agency/facility.

****

Siphon-jet for direct flushometer valve. Flushing cycle must be activated by an electronic infrared sensor operated by proximity of individual. [Provide wiring box 120/24 volt solenoid and transformer.] [Provide either a battery operated unit or a solar powered unit with battery backup.] Provide WaterSense labeled water closet with a maximum water use of 4.85 Lpf 1.28 gpf. Provide data identifying WaterSense label for water closet.

2.10.4.12.2 WC-2 (Similar to JSN P9050)

Same as WC-1 except accessible mounting height per ICC A117.1 Provide riser with grab bar offset.

2.10.4.12.3 WC-3 (Similar to JSN P9050)

High efficiency (HET), siphon-jet for flushometer valve. High efficiency washout for solenoid valve. Flushing cycle must be activated by an electronic infrared sensor operated by proximity of individual. Provide WaterSense labeled water closet with a maximum water use of 4.85 Lpf 1.28 gpf. Provide data identifying WaterSense label for water closet. [Provide wiring box, 120/24 volt solenoid, and transformer.] [Provide battery operated unit or solar operated unit with battery backup.]

2.10.4.12.4 WC-4 (Similar to JSN P9050)

Same as WC-3 except accessible mounting height per ICC A117.1. Provide riser with grab bar offset.

2.10.4.12.5 WC-5 (Similar to JSN P9050)

****

NOTE: Intended for use in patient toilet rooms.

****

Siphon jet with bowl provided with lugs or slots for holding bedpan. Provide bedpan cleaner (P1150) for mounting on exposed water closet flush valves; provide with wall support bracket; and brass valve body having a taper machined type leakproof, raise and lower spray arm; and using one-third of flush water volume to rinse pan, balance to flush waste. Water flushing volume of the water closet and flush valve/bedpan washer combination must not exceed 6.0 liters 1.6 gallons per flush.

2.10.4.12.6 WC-6 (Similar to JSN P9050)

Same as WC-5 except accessible mounting height per ICC A117.1. Provide riser with grab bar offset.

2.10.4.12.7 WC-7 (Similar to JSN P9050)

****

NOTE: Intended for use in PACU.

****

High efficiency (HET), siphon-jet for manual, lever operated flushometer valve, accessible mounting height per ICC A117.1. Provide riser with grab bar offset. Provide water closets with a maximum water use for the water closet and flush valve combination of 4.85 lpf 1.28 gallons per flush at a flowing water pressure of 552 kPa 80 psig. Provide WaterSense labeled water closet with a maximum water use of 4.85 lpf 1.28 gpf. Provide data identifying WaterSense label for water closet.

2.10.4.13 Hose Bibbs and Hydrants

****

NOTE: Indicate on the drawings height of hose bibbs and hydrants above finished grade. In locations where the 99.6 percent design temp is 0 degrees C 32 degrees F or less provide freezeproof hydrants.

****

2.10.4.13.1 HB-1

Hose bibb with vacuum-breaker backflow preventer, brass construction with 19 mm 3/4 inch male inlet threads, hexagon shoulder, and 20 mm 3/4 inch hose connection. Provide handle securely attached to stem.

2.10.4.13.2 HB-2

Wall hydrant (freezeproof) ASSE 1019 with vacuum-breaker backflow preventer and must have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. Provide brass or bronze operating rod within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. Provide brass or bronze valve with coupling and union elbow having metal-to-metal seat. Valve rod and seat washer must be removable through the face of the hydrant. Provide hydrant with 19 mm 3/4 inch exposed hose thread on spout and 20 mm 3/4 inch male pipe thread on inlet.

2.10.4.13.3 HB-3

Yard hydrant (non-freezeproof) of brass construction, with either straight or angle bodies, and must be of the compression type. Provide body flange with internal pipe thread to suit 20 mm 3/4 inch pipe. Provide bodies suitable for wrench grip. Provide faucet spout with 20 mm 3/4 inch exposed hose threads. Provide faucet handle securely attached to stem.

2.10.4.13.4 HB-4

Yard hydrants (freezeproof), yard box or post hydrants with valve housings located below frost lines. Water from the casing must be drained after valve is shut off. Provide bronze hydrant with cast-iron box or casing guard. Provide "T" handle key.

2.11 BACKFLOW PREVENTERS

****

NOTE: Indicate on the drawings all locations where backflow preventers are required (and type of device) to protect water supply and distribution

system against backflow and backsiphonage in accordance with the International Plumbing Code. If a drain is required, ensure it is shown. Backflow prevention device requirements for connection to nongovernment potable water systems will be coordinated with the local jurisdiction and/or water service agency. Reduced-pressure principle assemblies must be used for all domestic water services.
****

Provide backflow preventers approved and listed by the Foundation For Cross-Connection Control & Hydraulic Research. Provide reduced-pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers tested, approved, and listed in accordance with FCCCHR Manual. Provide backflow preventers with intermediate atmospheric vent conforming to ASSE 1012. Provide reduced pressure principle backflow preventers conforming to ASSE 1013. Provide hose connection vacuum breakers conforming to ASSE 1011. Provide pipe applied atmospheric type vacuum breakers conforming to ASSE 1001. Provide pressure vacuum breaker assembly conforming to ASSE 1020. Provide air gaps in plumbing systems conforming to ASME A112.1.2.

2.12 DRAINS AND BACKWATER VALVES

****
NOTE: Where a trap seal is subject to loss by evaporation, a deep-seal trap consisting of a 102 mm 4 inch seal or a trap seal primer valve must be used. Deep-seal traps are the preferred method in lieu of trap primers. If a trap seal primer valve is chosen, provide electrically timed, solenoid valve type not dependent on pressure fluctuations to operate.
****

Provide drains and backwater valves installed in connection with waterproofed floors or shower pans equipped with bolted-type device to securely clamp flashing.

2.12.1 Area Drains

****
NOTE: Area drains intended for use in accessible areaways such as at the bottom of exterior stairs.
****

a. Provide area drains with coated [galvanized] cast iron bodies for embedding in the floor construction. Provide plain pattern perforated or slotted grate/strainer. Provide with threaded outlet connection. Between the outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Provide drains conforming to ASME A112.6.3. Grate/strainer weight loading classification is based on ASME A112.6.3. Dimensions are nominal.

b. AD-1: 305 mm 12 inch overall [diameter] [width], 203 mm 8 inch diameter grate, 152 mm 6 inch depth, with [removable] [hinged], light-duty cast iron grate with minimal free area of 2 times free area of outlet pipe size. Provide with backwater valve.

2.12.2 Floor and Shower Drains

Provide floor and shower drains with coated [galvanized] cast iron bodies, double drainage pattern for embedding in the floor construction, and seepage pan having weep holes or channels for drainage to the drainpipe. Provide adjustable grate/strainers to compensate for floor thickness. Provide an integral clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane when required. Provide with threaded outlet connection. Between the outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Provide floor and shower drains conforming to ASME A112.6.3. Grate/strainer weight loading classification is based on ASME A112.6.3. Dimensions are nominal.[Provide drain with trap primer connection, trap primer, and connection piping.]

2.12.2.1 FD-1

****

NOTE: FD-1 intended for use in mechanical equipment rooms and unfinished spaces.

****

305 mm 12 inch diameter flashing collar, 102 mm 4 inch deep body and 203 mm 8 inch diameter removable, non-tilt heavy-duty cast iron grate with minimal free area of 1.5 times free area of outlet pipe size.

2.12.2.2 FD-2

****

NOTE: FD-2 intended for use in toilet rooms, shower floors, and finished spaces.

****

254 mm 10 inch diameter invertible flashing collar, 51 mm 2 inch deep body, and minimum 152 mm 6 inch [square] [diameter] removable, secured, [stainless steel] [light-duty nickel bronze] strainer with minimum free area of 1.5 times free area of outlet pipe size.

[2.12.2.3 FD-3

****

NOTE: FD-3 intended for use in mechanical equipment rooms with isolated floor slabs.

****

305 mm 12 inch diameter flashing collar, 51 mm 2 inch deep body, and 203 mm 8 inch diameter non-tilt heavy-duty cast iron grate with minimal free area of 1.5 times free area of outlet pipe size.[Provide with 406 mm 16 inch diameter isolation floor drain body with flange, integral clamping collar, and standpipe.]

]2.12.2.4 FD-4

****

NOTE: FD-4 intended for use in kitchens.

****

305 mm 12 inch diameter invertible flashing collar, 178 mm 7 inch deep body, stainless steel sediment basket with 5 mm 3/16 inch perforations with lift handle, and minimum 305 mm 12 inch square, removable, stainless steel strainer with minimum free area of 1.5 times free area of outlet pipe size.

2.12.3 Floor Sinks

Provide floor sinks with [type 304 stainless steel bodies] [coated [galvanized] cast iron bodies, with acid-resisting interior,] and double drainage pattern for embedding in the floor construction, and seepage pan having weep holes or channels for drainage to the drainpipe. Provide an integral clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane when required. Provide with threaded outlet connection. Between the outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Provide floor sinks conforming to ASME A112.6.3. Provide aluminum sediment bucket. Grate/strainer weight loading classification is based on ASME A112.6.3. Dimensions are nominal. Provide full grate free area a minimum of 1.5 times the free area of the outlet pipe size. [Provide drain with trap primer connection, trap primer, and connection piping.]

2.12.3.1 FS-1

****
NOTE: FS-1 (square) intended for use in unfinished spaces such as below sterilizer locations, or concealed within an enclosure.
****

305 mm 12 inch square top, 254 mm 10 inch deep [with] [full] [3/4] [1/2] [type 304 stainless steel] [light-duty nickel bronze] [less] [grate].

2.12.3.2 FS-2

****
NOTE: FS-2 (round) intended for use in unfinished spaces such as below sterilizer locations, or concealed within an enclosure.
****

305 mm 12 inch diameter top, 254 mm 10 inch deep [with] [full] [3/4] [1/2] [type 304 stainless steel] [light-duty nickel bronze] [less] [grate].

2.12.3.3 FS-3

****
NOTE: FS-3 (square) intended for use in finished exposed locations except kitchens.
****

305 mm 12 inch square top, 254 mm 10 inch deep [with] [full] [3/4] [1/2] [light-duty acid-resisting] [less] [grate].

2.12.3.4 FS-4

****
NOTE: FS-4 (round) intended for use in finished exposed locations except kitchens.
****

305 mm 12 inch diameter top, 254 mm 10 inch deep [with] [full] [3/4] [1/2] [light-duty acid-resisting] [less] [grate].

2.12.3.5 FS-5

****
NOTE: FS-5 intended for use in kitchens. Provide kitchen floor sinks with stainless steel bodies.
****

305 mm 12 inch square top, 254 mm 10 inch deep with stainless steel rim and [full] [3/4] [1/2] [stainless steel] [removable] [less] [grate] and suspended stainless steel sediment basket with 5 mm 3/16 inch perforations and lift handle.

2.12.4 Kettle Drain KD-1

****
NOTE: KD-1 intended for use where steam-jacketed kettles and tilt frying pans are used in kitchens.
****

Provide 457 mm 18 inches wide by [914 mm 36 inches] [1219 mm 48 inches] [1525 mm 60 inches] long kettle drain, 1.98 mm14 gage type 304 stainless steel kettle drain body with 100 mm 4 inch no-hub bottom outlet centered in kettle drain, removable stainless steel perforated sediment bucket, and stainless steel bar grating with 5 mm 3/16 inch by 25 mm 1 inch bars at 13 mm 1/2 inch bar spacing. Provide kettle drain pitched to bottom outlet

2.12.5 Roof Drains and Expansion Joints

Provide roof drains conforming to ASME A112.6.4, with dome and integral flange, with a device for making a watertight connection between roofing and flashing. Provide roof drains designated as secondary (emergency) overflow drains with 51 mm 2 inch high dam. Provide [galvanized] heavy pattern cast iron assemblies, including the dome strainer. Provide drain with a gravel stop. On roofs other than concrete construction, provide drains complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. Provide a clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane when present. Provide trainer openings with a combined area equal to twice that of the drain outlet. Provide roof drains with outlets equipped to make a proper connection to threaded pipe of the same size as the rain leader. Provide an expansion joint of proper size to receive each rain leader. Provide heavy cast-iron housing expansion joint, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. Provide sleeves with a nominal thickness of not less than 3.4 mm 0.134 inch. Provide close-cell neoprene gaskets and packing, Provide 70 durometer close-cell neoprene O-ring packing. Provide packing held in place by a packing gland secured with bolts.

2.12.5.1   RD-1

****

NOTE: RD-1 intended for use as primary roof drain. These can also be used at bottom of usually non-accessible areaways. See AD-1 for accessible areaways.

****

406 to 463 mm 16 to 19 inch diameter flashing clamp, 279 to 357 mm 11 to 14 inch diameter by 127 mm 5 inch high dome strainer.

2.12.5.2   RD-2

****

NOTE: RD-2 intended for use as secondary (emergency) roof drain.

****

406 to 483 mm 16 to 19 inch diameter flashing clamp, 279 to 357 mm 11 to 14 inch diameter by 127 mm 5 inch high dome strainer. Provide minimum 51 mm 2 inch high internal or external water dam.

2.12.6   Sight Drains

a. Provide sight drains with coated [galvanized] cast iron bodies, double drainage pattern for embedding in the floor construction, and seepage pan having weep holes or channels for drainage to the drainpipe. Provide adjustable grate/strainer to compensate for floor thickness. Provide an integral clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane when required. Provide with threaded outlet connection. Between the outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Provide sight drains conforming to ASME A112.6.3. Grate/strainer weight loading classification is based on ASME A112.6.3. Dimensions are nominal. [Provide drain with trap primer connection, trap primer, and connection piping.]

b. SD-1: 254 mm 10 inch diameter invertible flashing collar, 51 mm 2 inch deep body, and minimum 152 mm 6 inch [square] [diameter] removable, secured, light-duty nickel bronze strainer with minimum free area of 1.5 times free area of outlet pipe size with funnel extension. Provide minimum funnel dimensions as follows:

    (1) Height of funnel 95 mm 3-3/4 inches.

    (2) Diameter of lower portion of funnel 51 mm 2 inches.

    (3) Diameter of upper portion of funnel 102 mm 4 inches.

2.12.7   Backwater Valves

Provide backwater valves either separate from the floor drain or a combination floor drain, P-trap, and backwater valve, as shown. Provide backwater valves with cast-iron bodies and cleanouts large enough to permit removal of interior parts. Provide valves of the flap type, hinged or pivoted, with revolving disks. Provide hinge pivots, disks, and seats of nonferrous metal. Provide backwater valves with disks slightly open in a no-flow, no-backwater condition. Extend cleanouts to finished floor fit with threaded countersunk plugs.

2.13 CLEANOUTS

a. Provide cleanouts with coated cast-iron bodies (unless otherwise noted) with extra-heavy, threaded, tapered, brass plug with solid square nut and American Standard pipe threads. Provide flashing collars and clamps for cleanout bodies being installed in floors with finishes installed over waterproofing. Cleanouts on piping completely accessible from within pipe chases do not require covers. Cleanouts in exposed piping in equipment rooms do not require covers.

b. Provide interior floor-mounted cleanouts with a two-piece, threaded, adjustable housing. Provide top and cover based on floor finish:

(1) Resilient tile and sheet finish: Round flange top with scoriated cover.

(2) Ceramic tile finish: Square flange top with scoriated cover.

(3) Poured finish: Round, wide-flange top with scoriated cover.

(4) Carpet finish: Round top with standard top tapped for carpet-marker bolt.

(5) Terrazzo finish: Round top with recessed-for-terrazzo cover.

(6) Quarry tile finish: Square, heavy-duty top with heavy-duty scoriated cover.

(7) Concrete finish (unfinished areas): Heavy, round frame; satin-bronze, scoriated tractor top, ANSI heavy duty load class.

****

NOTE: Isolation cleanouts are used in floating floors.

****

[c. Provide isolation cleanouts with a lower and an upper flashing collar, flashing clamps with seepage openings, and adjustable ferrule with 102 mm 4 inch diameter bronze top. Provide with ferrule must be tapped for cleanout plug. Seal ferrule to lower clamping collar with press-fit neoprene gasket. Seal cleanout plug with neoprene gasket.]

2.14 TRAPS

2.14.1 Fixture Traps

Unless otherwise specified, provide copper-alloy adjustable tube type traps with slip joint inlet and swivel. Provide traps [without] [with] a cleanout. [Provide traps with removable access panels for easy clean-out at sinks and lavatories.] Provide tubes of copper alloy with walls not less than 0.81 mm 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Provide inlets with rubber washer and copper alloy nuts for slip joints above the discharge level. Provide swivel joints below the discharge level and must be of metal-to-metal type as required for the application. Provide nuts nuts flats for wrench grip. Provide outlets with internal pipe thread, except that when required for the application, the provide outlets with sockets for solder-joint connections. The depth of the water seal must be not less than 51 mm 2 inches and not more than 102 mm 4 inches. The interior diameter must be not more than 3 mm 1/8 inch over or under the nominal size, and interior surfaces must be reasonably smooth throughout. Provide a copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange for lavatories. The assembly must be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.14.2 Drain Traps

Unless otherwise specified, provide cast iron traps, one piece pattern, deep seal with depth of water seal of 102 mm 4 inches. The interior diameter must be not more than 3 mm 1/8 inch over or under the nominal size, and interior surfaces must be reasonably smooth throughout. Provide standard manufactured trap assemblies. Traps for drains located in fan and plenum housings must maintain seal against the static pressure.

[2.15 TRAP PRIMER ASSEMBLIES

Provide fully automatic trap primer assemblies, factory assembled and prepiped and including 20 mm 3/4 inch NPT female inlet, bronze body 20 mm 3/4 inch female NPT ball valve, 20 mm 3/4 inch water hammer arrester, ASSE 1001 atmospheric vacuum breaker, and ASTM B88 20 mm 3/4 inch Type L copper tubing distribution manifold. Provide calibrated distribution manifold to provide equal water distribution to each trap. Provide minimum supply of 60 mL 2 ounces of water to each trap. Provide manifold with 16 mm by 15 mm 5/8 inch by 1/2 inch compression fitting outlets. Provide solder joints made of lead free solder. Provide electronic assembly tested and certified per UL 73 and including circuit breaker, 5 second dwell function, manual override, 24 hour geared timer, and solenoid valve. Provide single point water supply and power supply connections. Provide components in a NEMA 250 Type 1 [surface mounted] [recessed] cabinet.

]2.16 INTERCEPTORS

****

NOTE: Concrete pit must be detailed on structural drawings for exterior interceptor pits.

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2.16.1 Grease Interceptor

Provide grease interceptor of the size indicated of reinforced concrete, [or precast concrete construction] [or equivalent capacity commercially available steel grease interceptor] with removable three-section, 10 mm 3/8 inch checker-plate cover, and installed outside the building. Install steel grease interceptors concrete pits and provide epoxy-coating to resist corrosion as recommended by the manufacturer. Provide interceptors tested and rated in accordance with PDI G 101. Concrete must have 21 MPa 3,000 psi minimum compressive strength at 28 days. Provide flow control fitting.

2.16.2 Oil Interceptor

Cast iron or welded steel, coated inside and outside with white acid resistant epoxy, with internal air relief bypass, bronze cleanout plug, double wall trap seal, removable combination pressure equalizing and flow diffusing baffle and sediment bucket, horizontal baffle, adjustable oil draw-off and vent connections on either side, gas and watertight gasketed nonskid cover, and flow control fitting.

2.17 WATER HEATERS

****

NOTE: Coordinate with the HVAC engineer the availability of heating sources and control air in order to make proper selection of bracketed choices.

Show locations of water heaters on the drawings. Also show the type, capacity, and related features of each water heater on the drawings.

Except for gas-fired water heaters, water temperatures in excess of 60 degrees C 140 degrees F should be obtained by using a booster heater in series with a primary heater.

Provide thermostatic, pressure-balanced, or combination thermostatic and pressure-balanced type mixing valves to obtain water temperatures below60 degrees C 140 degrees F.

Ensure that efficiencies are equal to or greater than the latest "recommended" values currently released by the Department of Energy Federal Energy Management Program (FEMP). The latest values can be found on FEMP's Internet site: https://energy.gov/eere/femp.

Select expansion tank based on incoming water pressure, water heater volume and temperature rise of water. Consult expansion tank manufacturer for sizing recommendations. Show the expansion tank size and acceptance volume on the drawings.

Per Energy Independence and Security Act (EISA) Section 523, meet at least 30% of the annual domestic hot water requirement through the installation of solar water heating unless it is not life cycle cost effective.

****

Provide water heaters with replaceable anodes. Provide each primary water heater with controls having an adjustable range that includes 32 to 71 degrees C 90 to 160 degrees F. [Provide water heaters with BACnet or Modbus protocols for interface with building automation systems.] Provide each gas-fired water heater and booster water heater with controls having an adjustable range that includes 49 to 82 degrees C 120 to 180 degrees F. Connect hot water systems utilizing recirculation systems into building off-hour controls. The thermal efficiencies and standby heat losses must conform to or exceed the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP, or 10 CFR 430 whichever is the most stringent for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 1893 liters 500 gallons storage capacity need not meet the standard loss requirement if the tank surface area is insulated to R-12.5 and if a standing pilot-light is not used. Plastic materials, polyetherimide (PEI) and polyethersulfone (PES), are forbidden to be used for vent piping of combustion gases. Provide a factory pre-charged expansion tank on the cold water supply to each water heater. Provide expansion tanks specifically designed for use on potable water systems and rated for 93 degrees C 200 degrees F water temperature and 1034 kPa 150 psig working pressure.

2.17.1 Performance of Water Heating Equipment

Standard rating condition terms are as follows:

ET	Thermal efficiency with 21 degrees C 70 degrees F delta T.
EC	Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).
SL	Standby loss in W/0.093 sq. m. W/sq. ft. based on 27 degrees C 80 degrees F delta T, or in percent per hour based on nominal 38 degrees C 90 degrees F delta T.
HL	Heat loss of tank surface area.
V	Storage volume in liters

2.17.1.1 Storage Water Heaters

2.17.1.1.1 Electric

Storage Capacity or Input Rating of		Rating Condition
454 liters 120 gallons or less	12 kW or less	minimum EF 0.93-0.00132V per 10 CFR 430
more than 454 liters 120 gallons	more than 12 kW	maximum SL (0.3 + 27Vm) per ANSI Z21.10.3/CSA 4.3

2.17.1.1.2 Gas

Storage Capacity or Input Rating of		Rating Condition
379 liters 100 gallons or less	21980 W 75,000 Btu/h or less	minimum EF 0.67-0.0019V per 10 CFR 430
more than 379 liters 100 gallons	more than 21980 W 75,000 Btu/h	ET 80 percent; maximum SL 0.2931(Q/800+110 square root of V), W Q/800+110 square root of V, Btu/h per ANSI Z21.10.3/CSA 4.3.

2.17.1.1.3 Oil

Storage Capacity or Input Rating of		Rating Condition
189 liters 50 gallons or less	30765 W 105,000 Btu/h or less	minimum EF 0.59-0.0019V per 10 CFR 430
more than 189 liters 50 gallons or less	more than 30765 W 105,000 Btu/h	ET 80 percent; maximum SL 0.2931(Q/800+110 square root of V), W Q/800+110 square root of V, Btu/h per ANSI Z21.10.3/CSA 4.3.

2.17.1.2 Unfired Hot Water Storage

All volumes and inputs: Provide tank surface thermally insulated to a minimum of R12.5.

2.17.1.3 Instantaneous Water Heater

2.17.1.3.1 Gas

Input Rating	Rating Condition	In accordance with
14655 to 58620 W 50,000 to 200,000 Btu/h	EF 0.62-0.0019V	10 CFR 430
more than 58620 W 200,000 Btu/h	ET 80 percent	ANSI Z21.10.3/CSA 4.3

2.17.1.3.2 Oil

Input Rating	Rating Condition	In accordance with
61551 W 210,000 Btu/h or less	minimum EF 0.59-0.0019V	10 CFR 430
more than 61551 W 210,000 Btu/h	ET 80 percent	ANSI Z21.10.3/CSA 4.3

2.17.2 Automatic Storage Type

****

NOTE: Gas-fired water heaters are more efficient in source energy use than electric resistance water heaters. Avoid use of electric type unless they are shown through calculations to be life cycle cost effective. Heat pump water heaters can use waste heat from air conditioners and heat pumps to produce hot water in an efficient manner. Consider this when waste heat is available.

****

Provide heaters complete with [control system,] [control system, temperature gauge, and pressure gauge,] and ASME rated combination pressure and temperature relief valve.

2.17.2.1 Oil-Fired Type

Provide oil-fired type water heaters conforming to UL 732.

2.17.2.2 Gas-Fired Type

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NOTE: Include bracketed statements below when project includes gas storage water heater with a nominal input of 75,000 British thermal units (Btu) per hour or less and having a rated storage capacity of not less than 20 gallons nor more than 100 gallons.

****

Provide gas-fired water heaters conforming to ANSI Z21.10.1/CSA 4.1 when input is 22 KW 75,000 BTU per hour or less, or ANSI Z21.10.3/CSA 4.3 for heaters with input greater than 22 KW 75,000 BTU per hour.[Provide Energy Star labeled gas storage water heater. Provide data identifying Energy Star label for gas storage water heater.]

2.17.2.3 Electric Type

Provide electric type water heaters conforming to UL 174 with dual heating elements. Provide 4.5 kW elements. Provide elements wired for non-simultaneous operation so that only one element can operate at a time.

2.17.2.4 Indirect Heater Type

****

NOTE: The titles of the sections covering the applicable systems will be inserted in the blanks.

Cast-iron heads will be used in steam-to-steam or non fired boiler application. Bronze heads will be used in steam-to-water application. Carbon steel heads will be used in water-to-water applications. For most applications, copper coils will be acceptable. Copper-nickel coils will be used with high pressure steam, 1.034 MPa 150 psig or above, high temperature water, or salty water conditions.

Single wall type exchangers may be allowed if the requirements in the plumbing code are satisfied (one requirement is that the heat transfer medium is potable or recognized as safe).

Steam and high temperature hot water HTHW systems are NOT normally used in Air Force and almost never used in Navy jobs. When using these systems keep all steam and HTHW piping in the mechanical rooms and do not route the distribution piping through occupied portions of the facilities.
****

Steam and high temperature hot water (HTHW) heaters with storage system must be the assembled product of one manufacturer, and be ASME tested and "U" stamped to code requirements under ASME BPVC SEC VIII D1. Provide storage tank as specified in paragraph HOT-WATER STORAGE TANKS. Provide heat exchangers of the double wall type that separates the potable water from the heat transfer medium with a space vented to the atmosphere in accordance with ICC IPC.

2.17.2.4.1 HTHW Energy Source

Provide heater elements with a working pressure of 2758 kPa 400 psig with water at a temperature of 204 degrees C 400 degrees F. Base heating surface on 0.093 square meter 1 square foot of heating surface to heat 76 liters 20 gallons or more of water in 1 hour from 4 to 82 degrees C 40 to 180 degrees F using hot water at a temperature of 178 degrees C 350 degrees F. Provide carbon steel heads. Provide tubing conforming to ASTM B111/B111M, Copper Alloy No. 706 (90-10 copper-nickel). Provide heating elements able to withstand an internal hydrostatic pressure of 4137 kPa 600 psig for not less than 15 seconds without leaking or any evidence of damage.

2.17.2.4.2 Steam Energy Source

Provide heater elements with a working pressure of 1034 kPa 150 psig with steam at a temperature of 185 degrees C 365 degrees F. Base heating surface on 0.093 square meter 1 square foot of heating surface to heat 76 liters 20 gallons or more of water in 1 hour from 4 to 82 degrees C 40 to 180 degrees F using steam at atmospheric pressure. Provide [cast iron] [bronze] heads. Provide light-drawn copper tubing conforming to ASTM B75/B75M. Provide heating elements able to withstand an internal hydrostatic pressure of 1551 kPa 225 psig for not less than 15 seconds without leaking or any evidence of damage.

2.17.3 Instantaneous Water Heater

Provide crossflow design type heater with service water in the coil and [steam] [hot water] in the shell. Provide an integral internal controller, anticipating a change in demand so that the final temperature can be maintained under all normal load conditions when used in conjunction with [pneumatic control system] [pilot-operated temperature control system]. Normal load conditions must be as specified by the manufacturer for the heater. Provide units manufactured in accordance with ASME BPVC SEC VIII D1, and certified for 1.03 MPa 150 psig working pressure in the shell and 1.03 MPa 150 psig working pressure in the coils. Provide carbon steel shell with copper lining. Provide [cast iron] [bronze] [carbon steel plate with copper lining] heads. Provide [copper] [copper-nickel] coils. Provide shell with metal sheathed fiberglass insulation, combination pressure and temperature relief valve, and thermometer. Provide insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. For gas service, provide Energy Star labeled gas instantaneous water heater. Provide data identifying Energy Star label for gas instantaneous water heater.

2.17.4 Electric Instantaneous Water Heaters (Tankless)

UL 499 and UL listed flow switch activated, tankless electric instantaneous water heater for wall mounting below sink or lavatory.

2.17.5 Relief Valves

Provide water heaters and hot water storage tanks with a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve must have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve must have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Provide relief valves rated according to ANSI Z21.22/CSA 4.4. Provide relief valves for systems where the maximum rate of heat input is less than 59 kW 200,000 Btuh with 20 mm 3/4 inch minimum inlets, and 20 mm 3/4 inch outlets. Provide relief valves for systems where the maximum rate of heat input is greater than 59 kW 200,000 Btuh with 25 mm 1 inch minimum inlets, and 25 mm 1 inch outlets. Provide discharge pipe from the relief valve full size of the valve outlet to the termination point.

2.18 HOT-WATER STORAGE TANKS

Provide hot-water storage tanks constructed by one manufacturer, ASME stamped for the working pressure, and having the National Board (ASME) registration. Provide cement-lined or glass-lined steel type tanks in accordance with AWWA D100. Provide tanks with heat losses conforming to TABLE III as determined by the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP. Equip each tank with a thermometer, conforming to ASTM E1, Type I, Class 3, Range C, style and form as required for the installation, and with 178 mm 7 inch scale. Provide thermometers having a separable socket suitable for a 20 mm 3/4 inch tapped opening. Equip tanks with a pressure gauge 152 mm 6 inch minimum diameter face. Provide insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide storage tanks capacities as shown.

2.19 PUMPS

2.19.1 Sump Pumps

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NOTE: 1. Designer will indicate location, sizes, horsepower, and capacities of equipment on the drawings.
2. Delete "totally enclosed and fan cooled" when not required.
3. For Army and Air Force projects, provide duplex pumps, if discharge capacity is greater than 1.6 liters per second 25 gpm and total head is at least 6.1 m 20 feet.

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Provide sump pumps of the automatic, electric motor-driven, submerged type, complete with necessary control equipment and with a split or solid cast-iron or steel cover plate. Provide pumps direct-connected by an approved flexible coupling to a vertical electric motor having a continuous oiling device or packed bearings sealed against dirt and moisture. Provide totally enclosed motors, fan-cooled of sizes as indicated and equipped with an across-the-line magnetic controller in a NEMA 250, Type 4 enclosure. Provide each pump fitted with a high-grade thrust bearing mounted above the floor. Provide each shaft with an alignment bearing at each end, and suction inlets between 76 and 152 mm 3 and 6 inches above the sump bottom. Provide the suction side of each pump with a strainer of ample capacity and [bronze] [or] [stainless steel] pump impeller. Provide a float switch assembly, with the switch completely enclosed in a NEMA 250, Type 4 enclosure, to start and stop each motor at predetermined water levels. Equip duplex pumps with an automatic alternator to change the lead operation from one pump to the other, and for starting the second pump if the flow exceeds the capacity of the first pump. Provide the discharge line from each pump with a union or flange, a nonclog swing check valve, and a stop valve in an accessible location near the pump.

2.19.2 Hydraulic Elevator Sump Pumps

Provide sump pump and control system capable of pumping water while containing oil. The system must function automatically and provide an alarm in the event of the presence of oil in the sump, high liquid in the sump, or high amps or a locked rotor condition. An alarm that sounds only in the event of a high liquid condition is not acceptable. Provide submersible type pump. Provide pumps conforming to UL 778 standards and include thermal and overload protection. Provide motor capable of operating continuously or intermittently. Provide motor housing constructed of 304 stainless steel, and mechanical seals housed in a separate oil-filled compartment. Provide controls approved to UL 508 standards and housed in a NEMA 4X enclosure with stainless steel hinged hardware. Provide controls with dual relays with variable sensitivity settings, magnetic contactor with separate over-current relay, self-cleaning stainless steel sensor probe, high decibel warning horn with illuminated red light and alarm silencing switch, dual floats, clearly marked terminal board and remote monitoring contact. Provide all cables between the pump and control unit a minimum of 4.9 meters 16 feet long and the cable and plug from the control unit a minimum of 2.4 meters 8 feet long. Provide control unit, pump, floats, and sensor probe factory assembled as a complete, ready to use system and tested and approved by a nationally recognized testing laboratory such as ENTELA.

2.19.3 Sewage Pumps

Provide duplex type with automatic controls to alternate the operation from one pump to the other pump and to start the second pump in the event the first pump cannot handle the incoming flow. Provide high water alarm and check valve.

2.19.4 Circulating Pumps

Provide electrically driven, single-stage, centrifugal domestic hot water circulating pumps with mechanical seals, suitable for the intended service and capacities not less than indicated. Provide pumps with revolutions per minute not exceeding 3600. Provide pump and motor [integrally mounted on a cast-iron or steel subbase,] [close-coupled with an overhung impeller,] [or] [supported by the piping on which it is installed]. Provide one-piece, heat-treated, corrosion-resisting steel shaft with [bronze] [or] [stainless steel] impeller, sleeve bearings and glands of bronze to accommodate mechanical seals and the housing of close-grained cast iron. Provide pump seals capable of withstanding 115 degrees C 240 degrees F temperature without external cooling. Provide motors with sufficient wattage horsepower for the service required, of a type approved by the manufacturer of the pump, and suitable for the available electric service. Provide pump motors smaller than 746 watts 1 horsepower with integral thermal overload protection in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide guards to shield exposed moving parts.

2.19.5 Booster Pumps

2.19.5.1 Centrifugal Pumps

Provide horizontal split-case centrifugal-type booster pumps. Provide pumps with revolutions per minute not exceeding 1800. Provide pump casings of close-grained iron or steel with smooth water passages. Provide a gasket between the upper and lower halves of the casing. Provide flanged suction and discharge connections. Provide nonoverloading, [bronze][stainless steel] impellers, balanced to eliminate vibration, and keyed to corrosion-resisting steel shafts. Provide casings fitted with bronze wearing or sealing rings. Provide cartridge type bearings, enabling the entire rotating element to be removed without disturbing alignment or exposing the bearings to dirt, water, and other foreign matter. Provide pumps with mechanical seals. Provide seal boxes machined in the pump casing and at both sides of the pump, and of sufficient depth to include a conventional bronze seal ring and rows of shaft packing. Provide close-grain cast iron or steel bedplates with ribs and lugs, complete with foundation bolts, and a drip lip with drain hole. Provide pumps tested at the manufacturer's plant for operating characteristics at the rated capacity and under specified operating conditions. Provide test curves showing capacity in liters per second gpm, head in meters feet, efficiency, brake wattage horsepower, and operation in parallel with similar pumps. Provide multiple pump installations with pump characteristics compatible for operation in parallel with similar pumps. Provide electric motors sized for non-overload when operating at any point along the characteristic curve of the pump. Provide guards to shield exposed belts and moving parts.

2.19.5.2 Controls

Provide each pump motor with enclosed across-the-line-type magnetic controller complete in a NEMA 250 Type 1 enclosure with three position, "HAND-OFF-AUTOMATIC," selector switch in cover. Pumps must be automatically started and stopped by float or pressure switches. The pumps must start and stop at the levels and pressures indicated. Provide a multiposition sequence selector switch so that any two pumps may be operated simultaneously keeping a third pump as a standby.

2.19.6 Flexible Connectors

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NOTE: Flexible connectors should be provided for the suction and discharge of each centrifugal pump only as a solution to alignment problems to accommodate retrofits and/or for fluid media temperatures in access of 82 degrees C 180 degrees F.

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Provide flexible connectors at the suction and discharge of each pump that is 746 watts 1 horsepower or larger. Provide connectors constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Provide line size flexible connectors and suitable for the pressure and temperature of the intended service.

2.20 WATER PRESSURE BOOSTER SYSTEM

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NOTE: One of the following systems will be used to boost the water pressure to the value required for service within the building. Indicate location, sizes, horsepower, and capacities of equipment on drawings. Provide duplex pumps, if discharge capacity is greater than 1.6 liter per second 25 gpm and total head is at least 59.78 kPa 20 feet.

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[2.20.1 Constant Speed Pumping System

Provide constant speed pumping system with pressure-regulating valves employing one lead pump for low flows, and one or more lag pumps for higher flows. Provide pressure-regulating valves with nonslam check feature. Provide factory prepiped and prewired assembly mounted on a steel frame, complete with pumps, motors, automatic controls, and ASME code constructed hydro-pneumatic tank. Provide current sensing relays to stage the pumps. Protect pumps from thermal buildup, when running at no-flow, by a common thermal relief valve. Provide pressure gauges mounted on the suction and discharge headers. Provide control panels bearing the UL listing label for industrial control panels and in a NEMA 250, Type 1 enclosure. Provide control panels with the following: no-flow shutdown; 7-day time clock; audiovisual alarm; external resets; manual alternation; magnetic motor controllers; time delays; transformer; current relays; "HAND-OFF-AUTOMATIC" switches for each pump; minimum run timers; low suction pressure cutout; and indicating lights for power on, individual motor overload, and low suction pressure. Interlock control circuits so that the failure of any controller must energize the succeeding controller. Provide an ASME code constructed hydro-pneumatic tank stamped for 862 kPa 125 psig water working pressure. Provide the tank with a flexible diaphragm made of material conforming to FDA requirements for use with potable water and factory precharged to meet required system pressure.

][2.20.2 Variable Speed Pumping System

Provide variable speed pumping system to provide system pressure by varying speed and number of operating pumps. Provide factory prepiped and prewired assembly mounted on a steel frame complete with pumps, variable speed drives, motors, automatic controls, and ASME code constructed hydro-pneumatic tank. Provide oil-filled type variable speed drives, capable of power transmission throughout their complete speed range without vibration, noise, or shock loading. Provide variable speed drives run-tested by the manufacturer for rated performance, and manufacturer furnished written performance certification. Provide system with suppressors to prevent noise transmission over electric feed lines. Required electrical control circuitry and system function sensors must be supplied by the variable speed drive manufacturer. The primary power controls and magnetic motor controllers must be installed in [the controls supplied by the drive manufacturer] [the motor control center]. Locate sensors in the system to control drive speed as a function of [constant pump discharge pressure] [constant system pressure at location indicated]. Provide connection between the sensors and the variable speed drive controls with [hydraulic sensing lines] [copper wiring] [telemetry]. Provide controls in NEMA 250, Type 1 enclosures. Provide an ASME code constructed hydro-pneumatic tank stamped for 862 kPa 125 psig water working pressure. Provide tank with a flexible diaphragm made of material conforming to FDA requirements for use with potable water and factory precharged to meet required system pressure.

]2.21 DOMESTIC WATER SERVICE METER

Provide positive displacement type cold water meters 50 mm 2 inches and smaller conforming to AWWA C700. Provide turbine type cold water meters 65 mm 2-1/2 inches and larger conforming to AWWA C701. Meter register may be round or straight reading type, [indicating [_____]] [as provided by the local utility]. Provide meters with pulse generators, remote readout registers and all necessary wiring and accessories.

2.22 COPPER-SILVER IONIZATION SYSTEM

a. Provide a complete copper-silver ionization system consisting of a controller, electrode cell(s), and flow meter.

b. Provide a microprocessor-based controller that automatically controls the rate of copper and silver ion release. Provide controllers able to generate a minimum concentration of 0.25 mg/L 25 ug/L copper on a continuous basis. Controller must perform under all types of water conditions without limiting its current due to lack of voltage. Provide controller which operate primarily in proportional copper and silver ion level control mode to prevent over or under ionization, and capable of operating in secondary control modes, to include continuous, timer, and flow switch. Provide controllers which incorporate anti-scaling features.

c. Provide on-board and remote alarm connection capabilities. Provide auxiliary contacts for remote monitoring capability. Provide controllers conforming to UL 508 for Industrial Control Panels.

d. Provide electrode cell(s) incorporating reduced scaling features. Provide CPVC, epoxy coated aluminum, or Schedule 40 stainless steel housing. Provide with electrical quick connections. Provide sacrificial electrodes of an extruded alloy of 99.99 percent pure copper and 99.99 percent pure medical grade silver, with minimum ratio of 30 percent silver to 70 percent copper.

e. Provide a flow meter with a transmitter that displays the flow rate and total water usage. Provide clamp on transducers (non pipe invasive) with a flow response time of 0.3 seconds and flow sensitivity of 0.0003 m/s 0.001 fps.

f. Submit EPA registration for Copper-Silver Ionization as pesticide product (disinfectant).

g. Submit written NSF certification for Copper-Silver Ionization that the system (or components in contact with potable water) are certified.

2.23 POTABLE WATER MONITORING SYSTEM

For each potable cold-water and hot-water system, provide the following:

a. Skid mounted system for automatic monitoring of free or total chlorine residuals, temperature, pH, and pressure. The system must continuously monitor potable water systems. Provide components in direct contact with water conforming to NSF/ANSI/CAN 61 approved. Provide pre-wired and pre-plumbed unit on a single skid in a NEMA 4X enclosure.

b. Chlorine monitor minimum requirements:

  (1) Measure free residual oxidant or total residual oxidant in potable water systems using the EPA accepted DPD colorimetric test method for measuring chlorine.

  (2) Measure chlorine residuals at configurable frequencies as short as 110 seconds.

  (3) Support water sample temperatures directly of up to 55 degrees C 131 degree F, and up to 66 degrees C 150 degree F using a sample cooler.

  (4) Comply with US EPA regulation, 40 CFR 141.74 Standard Method 4500-CLG, and US EPA method 334.0 "Determination of Residual Chlorine in Drinking Water Using an Online Chlorine Analyzer."

  (5) Support a Modbus interface.

c. Temperature, pH, and pressure sensors minimum requirements:

  (1) Compact and Programmable sensors with built-in transmitters programmed by a computer.

  (2) 4 mA to 20 mA output signals.

  (3) 13 mm to 25 mm 1/2-inch to 1-inch probe lengths.

  (4) Type 316L stainless steel bodies.

  (5) Operational temperature range of -50 degrees C to 120 degrees C -58 degrees F to 248 degrees F for each sensor.

  (6) Provide cables for hard wiring of sensors to Potable Water Monitoring System.

d. Data logging device minimum requirement:

  (1) Automatically collect and log data at user selected intervals.

(2) Log device data date/time stamps and store in non-volatile memory.

(3) Store interval data locally until the next scheduled upload.

(4) Support a Modbus interface plus eight additional analog or pulse input signals.

e. Provide a minimum of one sampling point from each potable cold-water and hot-water system.

2.24 ELECTRICAL WORK

****

NOTE:

1. Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm in the equipment schedules on the drawings.

2. Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer.

3. Use the bracketed item specifying high efficiency single-phase motors for applications where the use of high efficiency motors is determined to be cost effective.

4. Use the second bracketed item where polyphase motors are part of an assembly, and the use of premium efficiency motors is cost-effective. Premium efficiency motors are required by Section 26 20 00 for individual motors that are not part of a packaged system.

****

a. Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide [high efficiency type,] single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11. [In addition to the requirements of Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM, provide polyphase, squirrel-cage medium induction motors with continuous ratings, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.] Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

b. Provide motors rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor bearings fitted with grease supply fittings and grease relief to outside of the enclosure.

c. Provide controllers and contactors with auxiliary contacts for use with the controls provided. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown. For packaged equipment, the manufacturer must provide controllers, including the required monitors and timed restart.

d. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.25 FACTORY PAINTING

a. Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark.

b. The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 49 degrees C 120 degrees F, the factory painting system must be designed for the temperature service.

2.26 IDENTIFICATION MATERIALS

General: Provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.26.1 Plastic Pipe Markers

Provide snap-on or adhesive type pipe markers with nomenclature that closely matches Contract Drawings. Comply with designations indicated on Contract Drawings for piping system nomenclature and abbreviate only as necessary for each application length. Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

a. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ASME A13.1.

b. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ASME A13.1.

c. Application: For exterior diameters greater than 50 mm2-inch (including insulation if any), provide continuous directional flow arrow tape around pipe circumference; two places, before and after pipe marker. Provide adhesive plastic pipe markers. For external diameters less than 50 mm 2-inch (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

(1) Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

(2) Adhesive lap joint in pipe marker overlap.

(3) Laminated or bonded application of pipe marker to pipe (or insulation).

2.26.2 Valve Tags

Provide 1.11 mm19 gage polished brass valve tags with stamp-engraved piping system abbreviation in 6 mm 1/4-inch high letters and sequenced valve numbers 13 mm 1/2-inch high, and with hole for fastener, or engraved plastic laminate valve tags, with piping system abbreviation in 6 mm 1/4-inch high letters and sequenced valve numbers 13 mm 1/2-inch high, and with hole for fastener. Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose. Compile valve schedule for each service. For each page of valve schedule, provide laminated plastic coated cardboard stock sheets.

a. Provide 38 mm 1 1/2-inch diameter tags, except as otherwise indicated.

b. Provide size and shape as specified or scheduled for each piping system.

c. Fill tag engraving with black enamel.

2.26.3 Engraved Plastic Laminate Signs

Provide engraving stock melamine plastic laminate, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.26.4 Plasticized Tags

Provide pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately, 51 mm by 152 mm 2-inch by 6-inch with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.26.5 Lettering and Graphics

Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Mixing Valve No. 2, Pump No. 1).

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 GENERAL INSTALLATION REQUIREMENTS

a. Provide piping located in air plenums conforming to NFPA 90A requirements. [Installation of plastic pipe in air plenums is prohibited.] Piping located in shafts that constitute air ducts or that enclose air ducts must be noncombustible in accordance with NFPA 90A. [Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA Fire Man.] Install the plumbing system complete with necessary fixtures, fittings, traps, valves, and accessories. Piping must be concealed wherever possible. Under no circumstances reduce pipe size on Contract Documents without written consent of Contracting Officer. Extend water and drainage piping 1525 mm 5 feet outside the building, unless otherwise indicated. Provide a [OS&Y valve] [full port ball valve] and drain on the water service line inside the building approximately 152 mm 6 inches above the floor from point of entry. Piping must be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Lay sewer and water pipes in separate trenches, except when otherwise shown. Exterior underground utilities must be at least 305 mm 12 inches below the average local frost depth or 457 mm 18 inches below finish grade whichever is greater. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, mark the location of the end of each plumbing utility with a stake or other acceptable means. Install valves with control no lower than the valve body.

b. Provide piping to fixtures, outlets, and equipment requiring drainage, vent, and water utilities. Arrange and install hot-water and cold-water piping systems to permit draining. Equip the supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Anchor supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices to prevent movement.

c. The work must be carefully laid out in advance, and unnecessary cutting of construction must be avoided. Repair damage to building, piping, wiring, or equipment as a result of cutting by mechanics skilled in the trade involved.

d. Close pipe openings with caps or plugs during installation. Fixtures and equipment must be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, thoroughly clean, adjust and operate the fixtures, materials, and equipment. Provide safety guards for exposed rotating equipment.

e. Branch sizes to individual fixtures must be as scheduled. Consult manufacturer's data, Architectural drawings, and/or Plumbing drawings of rooms containing equipment and plumbing fixtures prior to roughing in piping. Stub piping through wall directly behind equipment item, or fixture being served. Connect equipment furnished by Owner or other divisions of the specification in accordance with this section.

f. Piping must not be routed over communications, electrical and server rooms unless dedicated to serving the room.

3.3 DOMESTIC WATER PIPING SYSTEMS

3.3.1 General

Accurately cut and work piping into place without springing or forcing. Weakening of structural portions of the building is not acceptable. Run aboveground piping parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings must be kept a sufficient distance from other work and other services to permit not less than 13 mm 1/2 inch between finished covering on the different services. Bare and insulated water lines must not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Do not bury water pipe in or under floors unless specifically indicated or approved. Make changes in pipe sizes with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Make changes in direction with fittings.

3.3.2 Service Entrance

Provide service entrance installation through [below grade exterior wall with water-stop pipe sleeves.] [slab on grade with reaction anchor at buried elbow where water service pipe turns up below floor. Terminate end of exterior piping material with flange connection and tie flange back to buried elbow with tie rods of same diameter as flange bolts. Provide minimum of one tie rod for each two flange bolt holes. Provide permanent corrosion protection for below-grade tie rods.]

3.3.3 Pipe Drains

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NOTE: Designer will indicate location of pipe drains on the drawings.

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Provide pipe drains consisting of 20 mm 3/4 inch hose bibb with renewable seat and [gate] [full port ball] [ball] valve ahead of hose bibb. At other low points, provide 20 mm 3/4 inch brass plugs or caps. Disconnection of the supply piping at the fixture is an acceptable drain.

3.3.4 Valves

Provide manual isolation valves at base of risers, on branch runouts from piping mains, on each branch serving a rest room, on each branch serving an equipment item, and on each branch to hose bibb or wall hydrant. [Wire isolation valves on emergency fixture supply open and tag "Do Not Close".] Balance hot water circulation system.

3.3.5 Expansion and Contraction of Piping

Allowance must be made throughout for expansion and contraction of water pipe. Provide each hot-water and hot-water circulation riser with expansion loops or other provisions such as offsets, changes in direction, or manufactured expansion fittings. Securely anchor risers to force expansion to loops. Make branch connections from risers with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Anchor horizontal runs of pipe over 15 m 50 feet in length to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility must be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility must be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.3.6 Thrust Restraint

Provide thrust blocks at plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 100 mm 4 inches in diameter or larger to prevent movement. Provide thrust blocking concrete of a mix not leaner than: 1 cement, 2.5 sand, 5 gravel; and having a compressive strength of not less than 14 MPa 2000 psi after 28 days. Place blocking between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, pour the base and thrust bearing sides of the thrust block against undisturbed earth. Pour t side of the thrust block not subject to thrust against forms. The area of bearing will be as shown. Place blocking so that the joints of the fitting are accessible for repair. Provide steel rods and clamps, protected by galvanizing or by coating with bituminous paint, to anchor vertical down bends into gravity thrust blocks.

3.3.7 Commercial-Type Water Hammer Arresters

****

NOTE: Designer will indicate location, quantity and size of commercial-type water hammer arresters on the drawings. Commercial-type water hammer arresters will be sized and located in accordance with PDI WH 201. Piping serving equipment having quick-closing valves must have suitably sized arresters. The ICC International Plumbing Code defines a quick-closing valve and the Codes 1997 Commentary provides examples of what are and are not considered quick-closing valves. PDI-WH 201 also defines quick valve closure. Review of these documents will help the designer provide the proper number of arresters.

For pressures of 450 kPa 65 psig or less, commercial water hammer arresters may be reduced by the designer in number and size, if the system does not

contain quick-acting valves. Water pressure regulating or reducing valves may be provided in lieu of commercial-type water hammer arresters, if local use has provided satisfactory performance. When required, install arresters as close as possible to quick-acting valves, ends of long pipe runs, and near batteries of fixtures.

****

Provide commercial-type water hammer arresters on hot- and cold-water supplies. Locate arresters as generally indicated, with precise location and sizing to be in accordance with PDI WH 201 Sizing and Placement Data. Water hammer arresters, where concealed, must be accessible by means of access doors or removable panels. Provide commercial-type water hammer arresters conforming to ASSE 1010. Vertical capped pipe columns (air chambers) are not be permitted.

3.3.8 Water Meter Remote Readout Register

a. Provide true absolute remote readout encoder register providing direct electronic transfer of meter reading information from water meter to automatic meter reading device. Mount the remote register at the location indicated, or as directed by the Contracting Officer.

b. Provide permanently sealed register to exclude dirt and/or moisture infiltration. Provide with a straight reading odometer-type display, and 360 degree test circle with center sweep hand and low flow (leak) detector. Provide tamperproof locking feature to resist tampering with the register. Provide factory potted moisture resistant wire assembly for pit applications.

c. Provide registers with full 6-wheel encoding, and a 6-wheel odometer assembly for direct manual reading. The register must transmit data using open architecture variable length protocol in ASCII format (American Standard Code for Information Interchange). Provide with capacity of remote installation up to 91.4 meters 300 feet to an outside wall mounted touch pad.

d. The register must use an absolute encoder to directly read the actual position of the index odometer wheels, when interrogated by a reading device. The reading device must provide all necessary power. Pulse outputs and/or memory must not require programming. Battery powered registers are not acceptable. When a reading device interrogates the register, the translator encoder must communicate to the device in ASCII computer language the absolute meter reading, and an eight-digit identification number. Any error or nonread must be immediately indicated by the meter reading equipment.

3.3.9 Backflow Prevention Devices

Do not cross connect or interconnect plumbing fixtures, equipment, and pipe connections between a potable water supply and any source of nonpotable water. Install backflow preventers where indicated and in accordance with ICC IPC at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition, install backflow preventers at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Locate backflow preventers so that no part of the device will be submerged. Provide backflow preventers of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Do not provide bypass piping around backflow preventers. Maintain backflow preventers manufacturers access clearances for maintenance and testing. Each device must be a standard commercial unit. Install reduced pressure principle backflow prevention devices horizontally and located in an accessible location not more than 1219 mm 4 feet above finished floor. Pipe drain from reduced pressure principle backflow prevention devices to the exterior, or a floor drain of adequate capacity, or a mop sink.

3.3.10 Copper-Silver Ionization Systems

3.3.10.1 System Bypass

Provide 3 valve bypass around system.

3.3.10.2 System Startup

Start-up and activation of the copper-silver ionization system must include testing and documenting the baseline (pre-activation) water quality and ionization levels and the post-activation ionization levels. These tests must be performed by an independent laboratory in addition to any field testing required/performed by the manufacturer. A plan for on-going distal flushing and monitoring of ion levels must be established in accordance with the manufacturer's recommendations and implemented immediately upon system activation (prior to turnover or building occupancy). The plan must initially be implemented by the construction contractor and then integrated into the facility's ongoing maintenance plans.

3.3.10.3 Testing

After the facility has been turned over to the Government, provide one year of laboratory testing from [_____] distal sites for copper and silver ion levels to demonstrate appropriate levels for copper and silver. Copper level must be 0.2 to 0.4 mg/L over baseline not to exceed Safe Drinking Water Act (40 CFR 143) level of 1.0 mg/L (1.3 mg/L is enforceable limit by EPA unless the applicable State has established a lower level). Silver level must be 0.03 to 0.05 mg/L over baseline not to exceed Safe Drinking Water Act (40 CFR 143) of 0.1 mg/L (no maximum enforceable limit). Provide one test per quarter during the first year following Government acceptance of the facility. Provide factory test certifications attesting unit performance is meeting the requirements of this specification.

3.3.11 Potable Water Monitoring System

Install equipment on concrete housekeeping pads[as indicated on the Contract Drawings]. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor base-mounted accessories to substrate. Provide interconnecting control wiring for sensors and Potable Water Monitoring System. Provide sensors in piping circuits. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installation, including connections.

3.4 DRAINAGE AND VENT PIPING SYSTEMS

3.4.1 General

a. Provide wye fittings and eighth bends, or combination wye and eighth fittings at changes of direction and junctions. Provide sanitary tee fittings only in vertical pipe. Sanitary crosses are not permitted. Provide P-trap for each direct waste-pipe connection to equipment. Provide ice makers with an indirect drain consisting of either a floor sink or a dedicated, under-counter P-trap. Provide air gaps at indirect drains.

b. Install horizontal soil, waste, and storm piping with the following minimum slopes; 80 mm 3 inch and smaller pipes must be 20 mm/m 1/4 inch per foot; 100 mm 4 inch to 150 mm 6 inch must be 10 mm/m 1/8 inch per foot; 200 mm 8 inch and larger pipes: 5 mm/m 1/16 inch per foot. Slopes indicated on plans override those indicated here.

c. Provide vent stacks parallel to soil and waste stacks to receive branch vents from fixtures. Each vent stack must originate from a soil or waste stack at its base. To permit proper flashing, offset through-the-roof piping away from walls on roof before passing through roof. Carry vent stacks 100 mm 4 inch and larger full size through roof. Install vent lines so they will drain and not trap water. Where possible, combine soil, waste or vent stacks before passing through roof to minimize roof openings. Where minimum vent-through-roof size is larger than vent size, provide an increaser a minimum of 305 mm 12 inch below roof line.

d. Provide drip pans under drainage piping installed over critical areas to include but not limited to: operating rooms, recovery rooms, delivery rooms, nurseries, food preparation areas, food serving areas, food storage areas, central service areas, and electronic data processing areas. Provide drain piping from drip pans. Discharge drain piping to drain in exposed area.

e. Do not insulate, conceal, or fur around installed piping until it has been tested to satisfaction of the Contracting Officer. If inspection or test indicates defects, replace such defective work or material and repeat inspection and tests. Make repairs with new materials. Peening and chiseling of holes or screwed joints is not allowed.

f. Install underground PVC piping according to ASTM D2321. Clean and dry joining surfaces of PVC piping. Join PVC piping according to ASTM D2855 and ASTM D2665 appendixes. Comply with ASTM D2564 for solvent cements. Comply with ASTM F656 for PVC primers. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Provide all pipe and fittings produced by a single manufacturer and install in accordance with manufacturer's recommendations. Do not test with or transport/store compressed air or gas in PVC pipe or fittings.

g. Install PVC waste piping underground or below slab. PVC piping installed aboveground or slab is not acceptable.

h. Install foundation drainage piping as indicated. Lay perforated drain pipe with perforations facing down.

3.4.2 Pipe Cleanouts

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NOTE: Specify cast-iron adjustable heads where heads are subject to loads, cleaning agents, and chemicals which will destroy heads made of plastic materials.

****

Provide pipe cleanouts of the same size as the pipe except that cleanout plugs larger than 100 mm 4 inches will not be required. Provide cleanouts installed in connection with cast-iron soil pipe consisting of a long-sweep 1/4 bend or one or two 1/8 bends extended to the location shown. Caulk an extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug into the hub of the fitting and flush with the floor. Cleanouts in connection with other pipe must be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs[, except install plastic plugs in plastic pipe]. Provide plugs of the same size as the pipe up to and including 100 mm 4 inches. Provide cleanout tee branches with screw plug at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drains where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 457 mm 18 inches of crawl space is provided under the floor. Provide cleanouts on pipe concealed in partitions with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Provide round access covers secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls must have access covers and frames installed flush with the finished wall. Provide cleanouts installed in finished floors subject to foot traffic with a [stainless steel], [chrome-plated cast brass],[nickel brass], or [nickel bronze] cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws must not project above the cover surface. Where cleanouts are provided with adjustable heads, provide cast iron heads. Provide cleanout extensions through floor above where cleanouts are required in piping above critical areas, or to an accessible location outside of critical area.

3.4.3 Sight Drains

Install sight drains so that the indirect waste will terminate a minimum of 51 mm 2 inches above the flood rim of the funnel to provide an acceptable air gap.

3.4.4 Traps

Place traps as near the fixture as possible, and no fixture must be double-trapped. Provide cast-iron traps on cast-iron soil pipe. Traps installed on steel pipe or copper tubing must be recess-drainage pattern, or brass-tube type.[Traps installed on plastic pipe may be plastic conforming to ASTM D3311.] Traps for acid-resisting waste must be of the same material as the pipe.

3.5 JOINTS

****

NOTE: Where environmental conditions do not warrant the use of dielectric unions or flanges the

requirement for such unions and flanges will be deleted.

****

Install pipe and fittings in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees is not be permitted. Make joints with fittings of compatible material and made for the specific purpose intended.

3.5.1 Threaded

Provide threaded joints with American Standard taper pipe threads conforming to ASME B1.20.2MASME B1.20.1. Coat only male pipe threads with graphite or with an approved graphite compound, or with an inert filler and oil, or have polytetrafluoroethylene tape applied.

3.5.2 Mechanical Couplings

****

NOTE: Do NOT use the following paragraph for Navy projects.

****

Prepare grooved mechanical joints according to the coupling manufacturer's instructions. Pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Measure and record groove width and dimension of groove from end of the pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Do not use grooved joints in concealed locations. Grooved joints are only permissible in mechanical rooms.

3.5.3 Unions and Flanges

Do not conceal unions, flanges and mechanical couplings in walls, ceilings, or partitions. Provide unions on pipe sizes 65 mm 2-1/2 inches and smaller; provide flanges on pipe sizes 80 mm 3 inches and larger.

3.5.4 Grooved Mechanical Joints

****

NOTE: Do NOT use the following paragraph for Navy projects.

****

Prepare grooves according to the coupling manufacturer's instructions. Provide grooved fittings, couplings, and grooving tools of the same manufacturer. Pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Measure and record groove width and dimension of groove from end of pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Do not use grooved joints. Grooved joints are only permissible in mechanical rooms.

3.5.5 Cast Iron Soil Pipe

Install bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping per the manufacturer's recommendations.

3.5.6 Copper Tube and Pipe

3.5.6.1 Brazed Joint

In conformance with AWS B2.2/B2.2M and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints must include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) must include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

3.5.6.2 Soldered Joint

Make with flux. Provide soldered joints conforming to ASME B31.5 and CDA A4015.

3.5.6.3 Pressure-Seal (Press-Fit) Connections

****

NOTE: Do NOT use the following paragraph for Navy projects.

****

Calibrate pressure-seal (press-fit) tools within 24 months of pipe installation. Submit calibration certification prior to commencing with pressure-seal (press-fit) piping system installation. Maintain 24-month pressure-seal (press-fit) tools calibration certification during installation of piping systems. Pressure-seal (press-fit) piping system installers must be trained by the manufacturer of the pressure-seal (press-fit) system to be installed. Submit pressure-seal (press-fit) system installation training certificates prior to commencing with pressure-seal (press-fit) piping system installation. Make copper pressure-seal (press-fit) connections in strict accordance with the manufacturer's installation instructions for manufactured rated size. Press joints using the tool(s) approved by the manufacturer of that joint. Maintain minimum distances between fittings in accordance with the manufacturer's requirements.

[3.5.7 Glass Pipe

Make joints for corrosive waste glass pipe and fittings with corrosion-resisting steel compression-type couplings with acrylonitrile rubber gaskets lined with polytetrafluoroethylene.

][3.5.8 Corrosive Waste Plastic Pipe

Make joints for polypropylene pipe and fittings by mechanical joint or electrical fusion coil method in accordance with ASTM D2657 and ASTM F1290.

][3.5.9 Other Joint Methods

****

NOTE: Coordinate with paragraph MATERIALS.

****

Make connections between ferrous and non-ferrous copper water pipe with dielectric unions or flange waterways. Provide dielectric waterways with temperature and pressure rating equal to or greater than that specified for the connecting piping. Provide waterways with metal connections on both ends suited to match connecting piping. Provide dielectric waterways internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges must meet the performance requirements described herein for dielectric waterways. Make connecting joints between plastic and metallic pipe with transition fitting for the specific purpose.

]3.6 CORROSION PROTECTION FOR BURIED PIPE AND FITTINGS

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NOTE: Both cathodic protection and protective coatings, regardless of soil resistivity, are to be provided for steel, ductile iron, and cast iron pressurized piping under floor (slab on grade) in soil. The results of an economic analysis and recommendations by a "corrosion expert" will govern the application of cathodic protection and protective coatings on gravity sewer lines, regardless of soil resistivity, and for potable water lines in resistivities above 10000 ohm-centimeters. For a large majority of new facilities, a sacrificial type of cathodic protection system, as specified in Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM, would be the applicable section to reference; however, the plumbing designer must coordinate with the cathodic protection designer for selection of one or both of the CP specification options.

****

Ductile iron, cast iron, and steel pipe, fittings, and joints must have a protective coating. Additionally, provide ductile iron, cast iron, and steel pressure pipe with a cathodic protection system and joint bonding. Provide the cathodic protection system, protective coating system, and joint bonding for cathodically protected pipe in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [and] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Select, apply, and inspect coatings in accordance with NACE SP0169 and as otherwise specified. Clean piping and apply the coating system prior to pipe tightness testing. Clean joints and fittings and apply the coating system after pipe tightness testing. For tape coating systems, provide tape conforming to AWWA C203 and apply with a minimum 50 percent overlap. Provide primer utilized with tape type coating systems as recommended by the tape manufacturer.

3.7 PIPE SLEEVES AND FLASHING

Provide pipe sleeves set in their proper and permanent location.

3.7.1 Sleeve Requirements

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NOTE: The designer will detail type of pipe sleeves

on the drawings, illustrating method of sealing annular space between pipe and sleeve. The designer will coordinate requirements for clearances around sleeves with Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT.

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Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Sleeves are not required for supply, drainage, waste and vent pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals must consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links must be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt must cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe and sleeve involved. Do not install sleeves in structural members, except where indicated or approved. Rectangular and square openings must be as detailed. Extend each sleeve through its respective floor, or roof, and cut flush with each surface, except for special circumstances. Extend pipe sleeves passing through floors, exposed or within partitions, in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas a minimum of 102 mm 4 inches above the finished floor. Unless otherwise indicated, provide sleeves of a size to provide a minimum of 6 mm 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Provide steel pipe or cast-iron pipe sleeves in bearing walls and concrete slab on grade floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic. Except as otherwise specified, seal the annular space between pipe and sleeve, or between jacket over insulation and sleeve, with sealants conforming to ASTM C920 and with a primer, backstop material and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. Do not seal the annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve for interior walls which are not designated as fire rated. Recess sleeves through below-grade walls in contact with earth 13 mm 1/2 inch from wall surfaces on both sides. Fill annular space between pipe and sleeve with backing material and sealants in the joint between the pipe and [concrete] [masonry] wall as specified above. Sealant selected for the earth side of the wall must be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls must conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.7.2 Flashing Requirements

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NOTE: The applicable details will be completed and included on the contract drawings. Sleeve thickness and square and rectangular opening details will be determined and indicated on the drawings. Indicate pipe chase areas on the drawings.

****

Install pipes passing through roof through a 0.55 mm 16 ounce copper flashing, each within an integral skirt or flange. Flashing must be suitably formed, and extend the skirt or flange not less than 203 mm 8 inches from the pipe and set over the roof or floor membrane in a solid coating of bituminous cement. Extend the flashing up the pipe a minimum of 254 mm 10 inches. For cleanouts, the turn down the flashing into the hub and caulked after placing the ferrule. Flash pipes passing through pitched roofs, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 203 mm 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. Seal the annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation as indicated. Turn down flashing for dry vents into the pipe to form a waterproof joint. Pipes, up to and including 250 mm 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Fit flashing shield into the sleeve clamping device. Sleeve pipes passing through wall waterproofing membranes as described above. Install a waterproofing clamping flange.

3.7.3 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 150 mm 6 inches in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.7.4 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, form a groove 6 to 13 mm 1/4 to 1/2 inch wide by 6 to 10 mm 1/4 to 3/8 inch deep around the pipe, fitting or drain. Fill the groove with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.7.5 Pipe Penetrations

Provide sealants for all pipe penetrations. Seal all pipe penetrations to prevent infiltration of air, insects, and vermin.

3.7.6 Fire Seal

****

NOTE: Normally, fire walls and fire partitions will be designated on the architectural drawings.

****

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, provide a fire seal as specified in Section 07 84 00 FIRESTOPPING.

3.8 PIPE HANGERS, INSERTS, AND SUPPORTS

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NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 22.7 kg 50 pounds must have the excess hanger loads suspended from panel points.

****

Install pipe hangers, inserts and supports conforming to MSS SP-58, except as modified herein.

a. Type 1, provide with adjustable type steel support rods.

b. Types 5, 12, and 26 are not be permitted.

c. Type 3 is not permitted on insulated pipe.

d. Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

e. Provide Type 19 and 23 C-clamps for attachment to steel joists and torque per MSS SP-58. Provide both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

f. Provide Type 20 attachments on steel angles and vertical web steel channels and furnish with an added malleable-iron heel plate or adapter. Attach to horizontal web steel channel with drilled hole on centerline and double nut and washer.

g. Provide Type 21, 28, 29, and 30 clamps for attachment to steel W or S beams.

h. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

i. Provide Type 39 saddles on insulated pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher. Provide Type 39 saddles welded to the pipe.

j. Provide Type 40 shields:

    (1) On insulated pipe less than 100 mm 4 inches.

    (2) On insulated pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or less.

    (3) Have a high density insert for all pipe sizes. High density inserts must have a density of 128 kg per cubic meter 8 pcf or greater.

k. Space horizontal pipe supports as specified in MSS SP-58 and install a support not over 305 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Space pipe supports not over 1.5 m 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe must be 49 degrees C 120 degrees F for PVC and 82 degrees C 180 degrees F for CPVC. Include allowances for expansion and contraction in horizontal pipe runs.

l. Support vertical pipe at each floor, except at slab-on-grade, at intervals of not more than 4.6 m 15 feet nor more than 2.4 m 8 feet from end of risers, and at vent terminations. Include allowances for expansion and contraction in vertical pipe risers.

m. Provide Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides to allow longitudinal pipe movement. Slide materials must be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints must be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

  (1) On pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

  (2) On pipe less than 100 mm 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

  (3) On pipe 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

n. Pipe hangers on horizontal insulated pipe must be the size of the outside diameter of the insulation. The insulation must be continuous through the hanger on all pipe sizes and applications.

o. Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 102 mm 4 inches or by an amount adequate for the insulation, whichever is greater.

p. Hangers and supports for plastic pipe must not compress, distort, cut or abrade the piping, and must allow free movement of pipe except where otherwise required in the control of expansion/contraction.

q. Hangers used to support piping 50 mm 2 inches and larger must be fabricated to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support piping subjected to vertical movement when operating temperatures exceed ambient temperatures by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, provide a clip or clamp where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Formed or bent threaded sections of rods are not permitted.

3.8.1 Seismic Requirements

****

NOTE: Provide seismic requirements or piping and

related equipment supports and show on the drawings.

****

Support and brace piping and attached valves to resist seismic loads as specified in Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS [as shown]. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, must be provided. Provide materials used for supports as specified in[Section 05 12 00 STRUCTURAL STEEL] [Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS].

3.8.2 Structural Attachments

Provide attachment to building structure concrete and masonry by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Provide inserts and anchors with a safety factor not less than 5. Supports attached to metal decking is not permitted. Supports to the underside of concrete filled floor or concrete roof decks is not permitted, unless approved by the Contracting Officer. Construct masonry anchors for overhead applications of ferrous materials only.

3.9 FIXTURES AND FIXTURE TRIMMINGS

Provide polished chromium-plated pipe, valves, and fittings where exposed to view. Provide angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, use a beading tool to mechanically deform the tubing above the compression fitting. Connect exposed traps and supply pipes for fixtures and equipment to the rough piping systems at the wall, unless otherwise specified under the item. Insulate drain lines and hot water lines of fixtures for handicapped/accessible fixtures and do not require polished chrome finish. Install plumbing fixtures and accessories within the space shown.

3.9.1 Fixture Connections

Make connections between earthenware fixtures and flanges on soil pipe gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty is not be permitted. Set fixtures with outlet flanges the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.9.2 Flushometer Valves

****

NOTE: Delete sentence describing location of flush valve handle when an automatic flushing system is provided.

****

Secure flushometer valves to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Arrange flushometer valves for water closets to avoid interference with grab bars. In addition, for water closets intended for handicap use, install the flush valve handle on the wide side of the enclosure. Install bumpers for water closet seats on the wall.

3.9.3 Height of Fixture Rims Above Floor

Unless otherwise noted, mounting heights must be as indicated. Comply with ICC A117.1 for the installation of fixtures for use by the physically handicapped.

3.9.4 Shower Bath Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate must be made watertight by caulking or gasketing.

3.9.5 Fixture Supports

****

NOTE: Project drawings will detail methods of hanging lavatories and wall-hung urinals. Normally, these fixtures will be supported by one of the methods described.

****

Provide fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, of the chair-carrier type. The carrier must provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability must be provided to locate the fixture at the desired height and in proper relation to the wall. The use of support plates, in lieu of chair carrier, fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.9.5.1 Support for Solid Masonry Construction

Anchor chair carrier to the floor slab. Where a floor-anchored chair carrier cannot be used, imbed a suitable wall plate in the masonry wall.

3.9.5.2 Support for Concrete-Masonry Wall Construction

Anchor chair carrier to floor slab. Where a floor-anchored chair carrier cannot be used, fasten a suitable wall plate to the concrete wall using through-bolts and a back-up plate.

3.9.5.3 Support for Steel Stud Frame Partitions

Provide chair carriers. The anchor feet and tubular uprights must be of the heavy duty design; and feet (bases) must be steel and welded to a square or rectangular steel tube upright. The use of wall plates, in lieu of floor-anchored chair carriers, are permitted only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.9.5.4 Support for Wood Stud Construction

Where floor is a concrete slab, provide a floor-anchored chair carrier. Where entire construction is wood, install wood crosspieces. Fasten fixture hanger plates, supports, brackets, or mounting lugs with not less than No. 10 wood screws, 6 mm 1/4 inch thick minimum steel hanger, or toggle bolts with nut. Extend wood crosspieces the full width of the fixture and securely support.

3.9.5.5 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, provide reinforced wax, treated felt, or neoprene gaskets. Provide gasket type as recommended by the chair-carrier manufacturer.

3.9.6 Access Panels

Provide access panels for concealed valves and controls, or any item requiring inspection or maintenance. Provide access panels of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Provide access panels as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

3.9.7 Escutcheons

Provide escutcheons at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Fasten escutcheons securely to pipe or pipe covering and must be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Provide one-piece escutcheons held in place by silicon caulk.

3.10 WATER HEATERS AND HOT WATER STORAGE TANKS

3.10.1 Relief Valves

****

NOTE: A discharge pipe the full size of the relief valve outlet will be shown connected to the outlet and shown on the drawings terminated at a safe location. The discharge pipe must not be directly connected to the drainage system and will conform to the requirements of the International Plumbing Code (for commercial and industrial hot water heaters ASME BPVC SEC IV also applies).

****

Valves installed between a relief valve and its water heater or storage tank are not permitted. Install pressure and temperature relief valves where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, install the relief valve directly in a tapping in the tank or heater; otherwise, install the pressure and temperature valve in the hot-water outlet piping. Provide a vacuum relief valve on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 152 mm 6 inches above the top of the tank or water heater.

3.10.2 Connections to Water Heaters

Make connections of metallic pipe to water heaters with dielectric unions or flanges.

3.10.3 Expansion Tank

Install a pre-charged expansion tank on the cold water supply between the water heater inlet and the cold water supply shut-off valve. Adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

3.10.4 Gas- and Oil-Fired Water Heaters

Install in accordance with [NFPA 54] [NFPA 58] for gas fired and NFPA 31 for oil fired.

[3.10.5 Direct Fired Domestic Water Heaters

****

NOTE: For Navy projects, any boilers or direct fired domestic water heaters over 117,124 Watts 400,000 BTU/hour are required to be inspected and certified in accordance with Unified Facilities Criteria UFC 3-430-7, "Operations and Maintenance: Inspection and Certification of Boilers and Unfired Pressure Vessels". If the inspection is performed by Contract, the inspector must be certified by one of the NAVFAC Senior Boiler Inspectors. If this project has a water heater meeting these requirements, add the following paragraph.

****

Notify the Contracting Officer when any direct fired domestic water heater over 117,124.2 Watts (400,000 BTU/hour) is operational and ready to be inspected and certified.

]3.11 IDENTIFICATION SYSTEMS

Identify piping and physical hazards in accordance with 29 CFR 1910.144, ASME A13.1, NEMA Z535.1. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Identify each piping system and item of equipment indicated on contract drawings.

3.11.1 Piping System Identification

Install plastic pipe markers on each system, and include arrows to show normal direction of flow. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, crawl spaces) and exterior non-concealed locations.

a. Near each valve and control device.

b. Near each branch; mark each pipe at branch, where there could be question of flow pattern.

c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

d. At access doors, manholes and similar access points which permit view of concealed piping.

e. Near major equipment items and other points of origination and termination.

f. Spaced intermediately at maximum spacing of 6.1 meters 20 feet along each piping run, except reduce spacing to 3 meters 10 feet in congested areas of piping and equipment. Provide a minimum of one pipe label in each space where partitions extend to structure.

3.11.2 Valves

Provide valve tag on every valve, cock and control device in each piping system. List each tagged valve in valve schedule for each piping system. Mount laminated valve schedules under glass in mechanical equipment rooms. Coordinate location with Contracting Officer. Provide 13 mm1/2-inch red adhesive identification dots on ceiling tiles located immediately below balancing valves and shutoff valves.

3.11.3 Plumbing Equipment

Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device. Provide minimum 6 mm 1/4-inch high lettering for name of unit where viewing distance is less than 0.9 meters 3 feet; 13 mm 1/2-inch high for distances up to 1.8 meters 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering. In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.11.4 Identification Tags

****

NOTE: Delete when identification tags are not considered necessary on small projects.

****

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number must be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags must be 35 mm 1-3/8 inch minimum diameter, with stamped or engraved marking. Provide black indentations, for reading clarity. Attach tags to valves with No. 12 AW, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.11.5 Nameplates

Provide 3 mm 1/8 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 6 mm 1/4 inch high normal block lettering into the white core. Minimum size of nameplates must be 25 by 64 mm 1 by 2-1/2 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

3.11.6 Labels

****

NOTE: Labeling of components is an inexpensive and effective method for helping building occupants

properly operate the systems and for helping facilities personnel properly maintain the systems. The labels should be easy to read when standing next to the equipment, and durable to match the life of the equipment to which they are attached. Delete item c for non-battery operated units.

This is optional for Army projects.

****

Provide labels for sensor operators at flush valves and faucets. Include the following information on each label:

a. Identification of the sensor and its operation with [graphic] [written] [Braille] description.

b. Range of the sensor.

c. Battery replacement schedule.

3.11.7 Pipe Color Code Marking

****

NOTE: Designer will coordinate color code marking with Section 09 90 00. Color code marking for piping not listed in Table I of Section 09 90 00, will be added to the table.

****

Provide color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS.

3.11.8 Color Coding Scheme for Locating Hidden Utility Components

****

NOTE: The Color Code Table will be developed to suit the installation. The colors of metal disks used in Army projects will be as directed by the Facilities Engineer. Identification plate specified in Section 09 90 00 PAINTS AND COATINGS will be deleted if color coding scheme is specified.

****

Provide scheme in buildings having suspended grid ceilings. The color coding scheme must identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. Operable components include valves. The color coding scheme must consist of a color code board and colored metal disks. Each colored metal disk must be approximately 10 mm 3/8 inch in diameter and secured to removable ceiling panels with fasteners. Insert fasteners into the ceiling panels so that the fasteners will be concealed from view. The fasteners must be manually removable without tools and must not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks must follow completion of the finished surface on which the disks are to be fastened. Provide the color code board with approximate dimensions of 914 mm 3 foot width, 762 mm 30 inches height, and 13 mm 1/2 inch thickness. Provide board made of wood fiberboard and framed under glass or 1.6 mm 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols must be approximately 19 mm 3/4 inch in diameter and the related lettering in 13 mm 1/2 inch high capital letters. Mount and locate the color code board in the mechanical or equipment room. Provide color code system as indicated below:

Color	System	Item	Location
[_____]	[_____]	[_____]	[_____]

3.12 PAINTING

3.12.1 General

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS. Provide new equipment with factory applied or shop applied paint, and as specified herein or in PART 2 paragraph FACTORY PAINTING, and provided under each individual section.

3.12.2 Shop Painting Systems for Metal Surfaces

a. Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 49 degrees C 120 degrees F must be cleaned to bare metal.

b. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

   (1) 950 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm one mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm one mil per coat.

   (2) Temperatures Between 49 and 204 Degrees C 120 and 400 Degrees F: Metal surfaces must receive two coats of 204 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

   (3) Temperatures Greater Than 204 Degrees C 400 Degrees F: Metal surfaces must receive two coats of 316 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

[3.13 VIBRATION-ABSORBING FEATURES

****

NOTE: Indicate on the drawings where equipment should be mounted resiliently. Details for proper mounting of equipment will be indicated on the drawings. Insert required isolation efficiency in the blank space for installations where specific values for reduction of noise and vibration

transmission are necessary; otherwise the sentence will be deleted. For areas where the maximum tolerable transmissibility in percent is considered necessary, the isolation efficiency will be given. Recommended transmissibility in percentages is as follows: 10 percent for equipment mounted in very critical areas, 10 to 20 percent for critical areas, and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors or conditions surrounding the equipment, which is to be provided with vibration isolation units, favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values, because of different equipment locations, the paragraph may be revised to indicate the appropriate values on the drawings.

Delete submittal of Vibration-Absorption Features when not required.

****

Isolate mechanical equipment, including pumps, from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation must include an adequate number of standard isolation units. Each unit must consist of machine and floor or foundation fastening, together with intermediate isolation material, and must be a standard product with printed load rating. Provide piping connected to mechanical equipment with flexible connectors. Isolation unit installation must limit vibration to [_____] percent of the lowest equipment rpm. Submit details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

]3.14 TRAINING

a. Provide the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

b. Provide instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

c. When significant changes or modifications in the equipment or system are made under the terms of the Contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

3.15 POSTED INSTRUCTIONS

Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system where directed. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

3.16 TESTS, FLUSHING AND DISINFECTION

****

NOTE: Some facilities may require a conditioning/flushing of water fountains and faucets that are listed as end point devices by NSF/ANSI 372, Section 9. This is to meet possible customer expectations that these devices produce drinking water that meets the lead leaching requirements of NSF/ANSI 372 immediately upon beneficial occupancy. If the customer is not willing to allow the end point devices to "self-condition" after project turn-over, then the designer should edit the paragraph titled System Flushing, requiring the Contractor to flush the drinking water fountains and faucets.

****

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Indicate the final position of controls in each test report.

3.16.1 Plumbing System

****

NOTE: For Air Force projects backflow prevention equipment and installation must meet the IAPMO UPC code.

****

Perform the following tests on the plumbing system in accordance with the ICC IPC , except that the drainage and vent system final test must include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, submit a testing procedure to the Contracting Officer for approval.

a. Drainage and Vent Systems Test. Include a smoke test in the final test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

3.16.1.1 Test of Backflow Prevention Assemblies

Test backflow prevention assemblies using gauges specifically designed for the testing of backflow prevention assemblies. Certification of proper operation must be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended.

Submit written documentation of the tests performed and signed by the individual performing the tests. Gauges must be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly must include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit must be repaired and retested.

3.16.1.2 Submittal Requirements

Submit the following:

a. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Indicate clearances required for maintenance and operation on the detail drawings. Where piping and equipment are to be supported other than as indicated, include loadings and proposed support methods details. Draw plan, elevation, view, and detail drawings to scale.

b. Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

c. Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.16.2 Defective Work

If inspections or test shows defects, replace or repair such defective work or material as necessary and repeat inspections and tests. Make repairs to piping with new materials. Caulking of screwed joints or holes is not acceptable.

3.16.3 Pressure-Seal (Press-Fit) Fittings Connection Tests

****

NOTE: Do NOT use the following paragraph for Navy projects.
****

Perform a step-test on all piping systems containing pressure-seal (press-fit) connections. Test may utilize air, water, or dry nitrogen, to pressurize the system at a pressure not to exceed 586 kPa85 psig. Examine and check each joint in the pressurized piping system for leaks. If a leaking joint is identified, relieve the pressure from the system, ensure the tube is full inserted into the fitting and proceed to press the fitting. Remove and replace any fitting that has already been pressed but is identified as leaking. Repeat the step-test until the system is determined to be leak-free.

3.16.4 System Flushing

3.16.4.1 During Flushing

****
NOTE: Hot water flushing dissolves most excess petrolatum-based flux inside piping, helping to avoid future corrosion problems.
****

Before operational tests or disinfection, flush potable water piping system with [hot] potable water. Sufficient water must be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 1.2 meters per second 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) must specify the number of fixtures to be operated during flushing. Provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor is responsible for any flood damage resulting from flushing of the system. Continue flushing until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. [Flush all faucets and drinking water fountains, including any device considered as an end point device by NSF/ANSI 372, a minimum of 1 L 0.25 gallons per 24 hour period, ten times over a 14 day period.]

3.16.4.2 After Flushing

Drain system at low points. Remove, clean, and replace strainer screens. After flushing and cleaning, prepare systems for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system must be repaired. When the system flushing is complete, adjust the hot-water system for uniform circulation. Adjust flushing devices and automatic control systems for proper operation according to manufacturer's instructions. Flow rates on fixtures must not exceed those stated in Part 2 of this Section.[Unless more stringent local requirements exist, lead levels must not exceed limits established by 40 CFR 50.12 Part 141.80(c)(1). Test the water supply to the building separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.]

3.16.5 Operational Test

Upon completion of flushing and prior to disinfection procedures, subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests must cover a period of not less than 8 hours for each system and include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of each domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

3.16.6 Disinfection

****

NOTE: If government laboratory facilities are available to conduct the bacterial examination of the test samples, revise this paragraph accordingly. The option of having the Contracting Officer perform the sampling and testing will be selected only if Government laboratory facilities are available and with concurrence from appropriate laboratory personnel. At some locations, either county or installation health officers inspect the disinfection process. If this is required, add a notification requirement and give the office to be notified, including phone number. For modification of existing systems, provide special procedures for disinfection of new equipment.

****

After operational tests are complete, disinfect the entire domestic hot- and cold-water distribution system. Flush the system as specified, before introducing chlorinating material. Provide hypochlorites or liquid chlorine chlorinating materials. Except as herein specified, water chlorination procedure must be in accordance with AWWA C651 and AWWA C652. Feed the chlorinating material into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Use a properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. Flush the system, including the tanks, with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period, open and close each valve and faucet several times. Obtain samples of water in disinfected containers from several locations selected by the Contracting Officer. The samples of water must be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method used must be either the multiple-tube fermentation technique or the membrane-filter technique. Repeat disinfection procedure until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

[3.16.7 Optional Disinfection Method

****

NOTE: For Iceland projects only, include the following option.

****

Disinfect new potable water piping and affected portions of existing potable water piping with geothermal water. Geothermal water must be not less than 90 degrees C 194 degrees F and contact time must be not less than 30 minutes. After disinfection, thoroughly flush new portable water piping and affected portions of existing potable water piping with the chlorinated base water supply for a minimum of two hours.

]3.16.8 Domestic Water Systems Flushing Program

Perform System Flushing, Operational Test, and Disinfection within three weeks of turnover of the facility to the Government. Develop and institute a Domestic Water Systems Flushing Program for domestic water systems. Institute the Program during the period between the conclusion of domestic water systems disinfection and turnover of the facility to the Government. Measure each domestic water system residual oxidant (disinfectant) level with a digital colorimeter at distal plumbing fixtures on each building [floor] [level] daily. Distal plumbing fixtures must be as selected by the Contracting Officer. Measurement of residual oxidant levels by pool test kits or color-wheel test kits is not acceptable. Flush each domestic water system with fresh water when residual oxidant levels fall below or exceed the limits prescribed in PL 93-523. Retest residual levels and continue flushing until oxidant levels are within the limits prescribed by PL 93-523. Provide test results to the Government upon [building] [__________] turnover to the Government.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-22 13 29 (February 2011)**

Preparing Activity: USACE **Superseding**
UFGS-44 46 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 22 13 29

SANITARY SEWERAGE PUMPS

02/11

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NOTE: This guide specification covers the requirements for sewage and sludge pumps for domestic type waste.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: This specification guide covers pumps for domestic sewage and sludge. Industrial wastewater and sludge may require special consideration and design. Refer to UFC 3-240-01 and consult the published data of representative manufacturers and the Hydraulics Institute. The following are the types of pumps included and the general uses:

a. Centrifugal solids handling pumps have high head (up to 69 m 225 feet) and high capacity (up to 2840 L/second 45,000 gpm) capabilities and high efficiency relative to other solids handling pumps. They are ideal for sewage applications.

b. Submersible centrifugal pumps have high head (up to 55 m 180 feet) and high capacity (up to 1390 L/second 22,000 gpm) capabilities but are less efficient than standard centrifugal pumps. They have higher operating costs but lower installation costs than standard centrifugal pumps. They are ideal for sewage and low concentration sludge applications.

c. Self-priming centrifugal pumps have moderate head (up to 31 m 100 feet) and moderate capacity (up to 158 L/second 2,500 gpm) capabilities and are less efficient than standard centrifugal pumps. They have higher operating costs but lower installation costs than standard centrifugal pumps. They are ideal for raw sewage applications where occasional service interruptions are acceptable.

d. Screw pumps have low head (up to 9 m 30 feet) and high capacity (up to 5050 L/second 80,000 gpm) capabilities and are relatively efficient (70 to 75 percent). They are ideal for raw sewage, storm water, and activated sludge lift stations.

e. Plunger pumps have high head 76 to 92 m 250 to 300 feet and moderate capacity (up to 35 L/second 550 gpm) capabilities. They are ideal for sludges of various consistencies.

f. Progressive cavity pumps have high head (up to 54 m 175 feet per stage) and moderate capacity (up to 35 L/second 500 gpm) capability. They may not perform well under abrasive conditions.

g. Diaphragm pumps have low head (up to 8 m 25 feet static head) and low capacity (up to 10 L/second 150 gpm) capabilities. They are ideal for pumping primary sludges and corrosives, abrasives, and slurries to 75 percent solids.

h. Recessed impeller pumps have high head (up to 69 m 225 feet) and high capacity (up to 316 L/second 5,000 gpm) capabilities. They are ideal for sludges up to 4 percent solids and possibly as high as 5 percent solids.

i. Rotary lobe pumps have high head (up to 107 m 350 feet) and moderate capacity (up to 95 L/second 1500 gpm) capabilities. They are ideal for sludges of various consistencies.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in

this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment Installation; G, [_____]

SD-03 Product Data

Materials and Equipment

Framed Instructions

Spare Parts

SD-06 Test Reports

Field Testing and Adjusting Equipment

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G, [_____]

1.3 DELIVERY, STORAGE, AND HANDLING

Protect from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants all equipment delivered and placed in storage.

1.4 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals, and not later than [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Provide pump casings constructed of cast iron of uniform quality and free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Impellers must be [cast iron] [ductile iron] [unless otherwise specified for rotors].

2.1.1 Nameplates

Provide each major item of equipment with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.2 Equipment Guards

Enclose or guard belts, pulleys, chains, gears, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto.

2.1.3 Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

2.1.4 Electric Motors

Provide motors conforming to NEMA MG 1.

2.1.5 Motor Controls

Provide controls conforming to NEMA ICS 1.

2.1.6 Bolts, Nuts, Anchors, and Washers

Provide steel bolts, nuts, anchors, and washers; galvanized in accordance with ASTM A153/A153M.

2.1.7 Pressure Gauges

Provide compound gauges on the suction side of pumps and standard pressure gauges on the discharge side of pumps complying with ASME B40.100. Use gauge ranges as appropriate for the particular installation.

2.1.8 Seal Water Systems

****

NOTE: Alternate seal water systems utilize filtered effluent recirculated back to pump seals as water supply. Consult water seal manufacturers for details. Delete entire paragraph if seal water not specified for pumps.

****

Utilize [potable] [_____] water for pumping systems requiring seal water. Provide a factory assembled package seal water system, consisting of a [189 L 50 gallon] [_____] galvanized tank, float valve mounted directly on the tank, and 2 centrifugal pumps of equal capacity, with close coupled motors, that is supplied as a single self-contained unit.

2.1.8.1 Float Valve

Mount float valve on the tank to maintain a water level below an overflow provided near the top of the tank and to maintain a 152 mm 6 inch air gap between the water system and the top of the tank.

2.1.8.2 Auxiliary Equipment

Provide auxiliary equipment required to complete the system as indicated and include the necessary piping, valving, pressure gauges, pressure regulators, pressure switches, solenoid valves, strainers, and accessories.

2.1.8.3 Controls

Ensure solenoid valve opens whenever the process pump motor is energized. Ensure pressure switch signals an alarm and stops the process pump whenever the seal pressure is below a set point. Locate the pressure regulating valve on a bypass line back to the seal water reservoir tank. Determine the pressure switch and pressure regulating valve set points by the process pump manufacturer. Also provide a valved bypass around each solenoid valve.

2.1.8.4 System Characteristics

****

NOTE: Insert data for each seal water system required. Repeat paragraph as necessary for seal water systems with different characteristics.

****

Size the seal water systems for pump number[s] [_____] for [_____] L/second gpm at [_____] kPa psi and [_____] W horsepower.

2.2 CENTRIFUGAL SOLIDS HANDLING PUMPS

Provide centrifugal solids handling pumps of the nonclogging centrifugal type designed to pump solids up to 76 mm 3 inches in diameter and which provide no internal interstices that catch solids and stringy materials to cause clogging.

2.2.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must have the following operating characteristics:

Pump Service	[_____]
Design Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Maximum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Minimum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Impeller Type	[_____]
Operating Speed	[_____] rpm
Maximum NPSH Required at Maximum Operating Point	[_____]
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.2.2 Pump Casing

Construct pump casing with tapped and plugged holes for venting and draining the pump. Provide casing that is capable of withstanding pressures 50 percent greater than the maximum operating pressure. The volute must have smooth passages. Construct casing such that the impeller can be removed without disturbing the suction and discharge connections. Provide casing with a handhole to permit inspection and cleaning of the pump interior. Provide lifting eyes to facilitate handling of the pump.

2.2.3 Impeller

Design the impeller with smooth passages to prevent clogging and pass stringy or fibrous materials. Statically, dynamically, and hydraulically balance the impeller within the operating range and to the first critical speed at 150 percent of the maximum operating speed. Key the impeller securely to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

2.2.4 Wearing Rings

Provide renewable wearing rings on the impeller and casing and have wearing surfaces normal to the axis of rotation. Construct wearing rings of [steel] [cast iron]. Design wearing rings for ease of maintenance and secure to prevent rotation. Replaceable steel wear plates fastened to casing may be used in lieu of wearing rings on casing and impeller.

2.2.5 Pump Shaft

Provide stainless or high grade alloy steel pump shaft of adequate size and strength to transmit the full driver horsepower with a liberal safety factor.

2.2.6 Pump Shaft Sleeve

Protect pump shaft from wear by a stainless steel, high grade alloy steel, or bronze shaft sleeve. Seal the joint between the shaft and sleeve to prevent leakage.

2.2.7 Stuffing Box

Provide stuffing box of the same material as the casing and provide [grease] [or] [water] seal. Design the stuffing box for a minimum of five rings of packing and with easily removable split type glands.

2.2.8 Mechanical Seals

****

NOTE: Specify double mechanical seals in high pressure applications.

****

Provide [single] [double] mechanical seals to seal the pump shaft against leakage. Hold each seal interface in contact by its own spring system, supplemented by external liquid pressures. Construct the seal system to be readily removable from the shaft.

2.2.9 Bearings

Provide ball or roller type pump bearings designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable. Provide bearings that have an ABMA L-10 life of 50,000 hours minimum, as specified in ABMA 9 or ABMA 11.

2.2.10 Lubrication

****

NOTE: Delete the inapplicable types of lubrication. Normally use grease for vertical shaft pumps. Use either grease or oil for horizontal shaft pumps.

****

Provide [oil bath] [or] [grease] lubricated bearings. [Provide an oil reservoir for oil bath lubricated bearings. Provide reservoir with an overflow opening to prevent overfilling and a drain at the lowest point.] [Provide a grease fitting for grease-lubricated bearings that prevents overlubrication and the building up of pressure injurious to the bearings. If the grease fitting is not easily accessible, provide grease tubing to a convenient location.]

2.2.11 Pump Support

****
NOTE: Delete inapplicable types of support.
****

Provide horizontal centrifugal pumps with a common base plate for the pump and motor. Provide vertical shaft centrifugal pumps with separate bases for the pump and motor. Support vertical dry pit centrifugal pumps by a heavy cast iron base with adequate legs to provide maximum rigidity and balance.

2.2.12 Coupling

****
NOTE: Delete inapplicable types of couplings.
****

Provide couplings of the heavy-duty flexible type, keyed or locked to the shaft. Make disconnecting of the coupling possible without removing the driver half or the pump half of the coupling from the shaft. Couplings for extended shaft vertical centrifugal pumps may be of the universal type.

2.3 SUBMERSIBLE CENTRIFUGAL PUMPS

Provide submersible centrifugal pumps which are centrifugal type pumps designed to pump solids up to 76 mm 3 inches in diameter and are capable of withstanding submergence as required for the particular installation.

2.3.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must have the following operating characteristics:

Pump Service	[_____]
Design Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Maximum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Minimum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Impeller Type	[_____]
Operating Speed	[_____] rpm
Depth of Submergence	[_____] mm feet

Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.3.2 Pump Casing

Provide casing capable of withstanding operating pressures 50 percent greater than the maximum operating pressures. Provide volute with smooth passages which provide unobstructed flow through the pump.

2.3.3 Mating Surfaces

Machine and fit surfaces where watertight seal is required, including seal between discharge connection elbow and pump, with nitrile rubber O-rings. Accomplish sealing by metal-to-metal contact between mating surfaces, resulting in proper compression of the O-rings without the requirement of specific torque limits.

2.3.4 Coatings

Protect exterior surfaces of the casing in contact with sewage by a sewage resistant coal tar epoxy coating. All exposed nuts and bolts must be stainless steel.

2.3.5 Impeller

Provide impeller of the [single] [double] shrouded non-clogging design to minimize clogging of solids, fibrous materials, heavy sludge, or other materials found in sewage. Statically, dynamically, and hydraulically balance the impeller within the operating range and to the first critical speed at 150 percent of the maximum operating speed. Key the impeller securely to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

2.3.6 Wearing Rings

Provide renewable type wearing rings, when required, on the impeller and casing with wearing surfaces normal to the axis of rotation. Use pump manufacurer's standard material for wear rings. Design wearing rings for ease of maintenance and adequately secure to prevent rotation.

2.3.7 Pump Shaft

Provide pump shaft consisting of high grade alloy steel and of adequate size and strength to transmit the full driver horsepower with a liberal safety factor.

2.3.8 Seals

****

NOTE: Do not specify ceramic seals where sudden changes in temperature can occur and cause the seal to crack. Tungsten carbide seals are standard for

many manufacturers. Delete last sentence if conventional seals are acceptable.

****

Provide a tandem mechanical shaft seal system running in an oil bath. Provide seals consisting of [_____] with each interface held in contact by its own spring system. [Conventional mechanical seals which require a constant pressure differential to effect sealing will not be allowed.]

2.3.9 Bearings

Provide ball or roller type pump bearings designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable. Provide bearings that have an ABMA L-10 life of 50,000 hours minimum, as specified in ABMA 9 or ABMA 11.

2.3.10 Motor

Provide pump motor that has Class F insulation, NEMA B design, in accordance with NEMA MG 1, and is watertight. Provide motor that is either oil filled, air filled with a water jacket, or air filled with cooling fins which encircles the stator housing.

2.3.11 Power Cable

****

NOTE: Last sentence may eliminate several manufacturers. However, this requirement may be needed for protection of motor and to reduce maintenance costs. Evaluate for each specific pump application.

****

Provide power cable complying with NFPA 70, Type SO, and of standard construction for submersible pump applications. The power cable must enter the pump through a heavy duty entry assembly provided with an internal grommet assembly to prevent leakage. Separate the cable entry junction chamber and motor by a stator lead sealing gland or terminal board which isolates the motor interior from foreign material gaining access through the pump top. [Epoxies, silicones, or other secondary sealing systems are not acceptable.]

2.3.12 Installation Systems

****

NOTE: In following three paragraphs, delete inapplicable installation systems.

****

2.3.12.1 Rail Mounted Systems

Provide rail mounted installation systems consisting of guide rails, a sliding bracket, and a discharge connection elbow. Provide guide rails of the size and type standard with the manufacturer that do not support any portion of the weight of the pump. The sliding guide bracket must be an integral part of the pump unit. Permanently install the discharge connection elbow in the wet well along with the discharge piping. Connect the pump automatically to the discharge connection elbow when lowered into place and easily remove for inspection and service without entering the pump well.

2.3.12.2 Bolt Down Systems

The pump mount system must include a base designed to support the weight of the pump. The base must be capable of withstanding all stresses imposed upon it by vibration, shock, and direct and eccentric loads.

2.3.12.3 Lifting Chain

Provide lifting chain to raise and lower the pump through the limits indicated. Provide galvanized chain capable of supporting the pump.

2.4 SELF-PRIMING CENTRIFUGAL PUMPS

Design self-priming centrifugal pumps to pump solids up to 76 mm 3 inches in diameter and of the centrifugal type capable of repeated reprime when handling trash-laden sewage.

2.4.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must have the following operating characteristics:

Pump Service	[_____]
Design Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Maximum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Minimum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Maximum Priming Lift	[_____] mm feet
Maximum Reprime Lift	[_____] mm feet
Impeller Type	[_____]
Rotation Direction	[Clockwise] [Counterclockwise]
Operating Speed	[_____] rpm
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.4.2 Pump Casing

Provide casing that is capable of withstanding pressures 50 percent greater than the maximum operating pressures and that contains no openings of smaller diameter than the specified sphere size. Internal devices that will inhibit maintenance or interfere with priming and performance are not permitted. Design the pump to retain sufficient liquid in the casing to ensure unattended operation. Provide casing such that the impeller can be removed without disturbing the suction and discharge connections. Provide front access to the pump interior to permit inspection and cleaning of the pump interior without removing suction or discharge piping.

2.4.3 Impeller

Provide two-vane, semi-open, non-clog type impeller with pump-out vanes cast integrally on its backside. Statically, dynamically, and hydraulically balance the impeller within the operating range and to the first critical speed at 150 percent of the maximum operating speed. Key the impeller securely to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

2.4.4 Wear Plate

****

NOTE: Steel is standard with most manufacturers.

****

Provide a replaceable wear plate constructed of [cast iron] [alloy steel].

2.4.5 Pump Shaft

Provide pump shaft consisting of high grade alloy steel or stainless steel and of adequate size and strength to transmit the full driver wattage horsepower with a liberal safety factor.

2.4.6 Pump Shaft Sleeve

Protect the pump shaft from wear by a high grade alloy steel or stainless steel shaft sleeve. Place a seal, if needed, between the shaft and sleeve to prevent leakage.

2.4.7 Seals

Seal the pump shaft against leakage by [oil lubricated] [water lubricated] mechanical seal. Provide stationary sealing member consisting of [tungsten carbide] [silicon carbide] and the rotating member consisting of [tungsten carbide] [silicon carbide]. Ensure the seal is such that the faces will not lose alignment during shock loads that cause deflection, vibration, and axial or radial movement of the pump shaft.

2.4.8 Bearings

Provide ball or roller type pump bearings designed to handle all thrust loads in either direction.

2.4.9 Lubrication

****

NOTE: Delete the inapplicable types of lubrication. Normally use grease for vertical shaft pumps. Use either grease or oil for horizontal shaft pumps.

****

Provide [oil bath] [or] [grease] lubricated bearings. [Provide an oil reservoir for oil bath lubricated bearings with an overflow opening to prevent overfilling and a drain at the lowest point.] [Provide a grease fitting to add grease for grease-lubricated bearings. Provide grease fitting of the type that prevents overlubrication and the building up of pressure injurious to the bearings. If the grease fitting is not easily accessible, provide grease tubing to a convenient location.]

2.4.10 Suction Check Valve

****

NOTE: If the pump is in an application where a high degree of reliability is desired, retain the last sentence.

****

The pump must contain a suction check valve to maintain prime. Provide suction check valve which is removable without disturbing the suction piping. [The pump must be capable of prime or reprime in the event of check valve failure.]

2.4.11 Pump Support

Provide a common fabricated steel base plate for the pump and motor.

2.4.12 Coupling

****

NOTE: Delete inapplicable type of couplings.

****

Transmit power from the motor to the pump by a [flexible coupling] [V-belt drive assembly]. [Flexible couplings must be of the heavy duty type, keyed or locked to the shaft.] Provide V-belt drive assembly that has a minimum of two belts. Select the drive assembly on the basis of the power to be transmitted from the motor to the pump. Enclose the drive on all sides by a solid metal guard.

2.5 SCREW PUMPS

****

NOTE: Edit paragraph for enclosed or tube mounted screw pumps. Tube mounted screw pumps do not require concrete trough.

****

Ensure screw pumps have a spiral flight screw operating in a concrete trough with the screw rotation elevating the liquid up the inclined trough. Provide pump consisting of a lower bearing assembly, a spiral screw with deflectors, an upper bearing assembly, a drive assembly, and an automatic grease lubricated system for the lower bearing.

2.5.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must have the following characteristics:

Pump Service	[_____]
Total Lift	[_____] mm feet
Angle of Inclination	[22] [30] [38] [_____] degrees from horizontal
Spiral Screw Diameter	[_____] mm feet [_____] inches
Flight Thickness	[_____] mm feet
Quantity of Flights	[1] [2] [3]
Design Capacity	[_____] L/second gpm
Tube Diameter	[_____] mm feet [_____] inches
Screw Speed	[_____] rpm
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.5.2 Lower Bearing Assembly

The lower bearing assembly must be sleeve or roller bearing type design. If sleeve bearing is utilized, either rotate the bronze phosphor sleeve around stationary shaft or attach shaft to bronze bushing which rotates inside stationary cartridge. Ensure sleeve bearing is hermetically sealed, automatic grease lubricated. Provide oil lubricated roller bearings designed to guard against oil leakage. Arrange labyrinth to protect fire seal from damage. Provide bearings that have L-10 life of 100,000 hours. The bearing housing must permit precise adjustment in the field. Provide a spare lower bearing assembly.

2.5.2.1 Seals

Prevent contaminants from entering the bearing by two spring-loaded lipseals, one to exclude wastewater and contaminants and one to retain the grease in the bearing, or by a fixed journal with hollow axis to allow grease to the top end of the bearing where it flows the length of the bearing sealing out contaminants.

2.5.2.2 Bearing Shield

Provide a heavy-duty bearing shield to protect the bearing assembly from heavy debris.

2.5.3 Spiral Screw

Provide spiral screw consisting of a steel torque tube with steel flights welded to the exterior of the tube, a drive shaft, and lower stub shaft.

2.5.3.1 Torque Tube

Seal torque tube at both ends with welded steel plates. Take care to insure that the end plates are parallel after welding. Weld flights continuously to the tube on both sides. Bolt the drive shaft and lower stub shaft to the torque tube ends with a registered fit to ensure axial alignment of the tube and shafting.

2.5.3.2 Shafts

Ensure the upper and lower shafts and the outside diameter of the flights of the completed spiral screw have the same axis. Do not exceed a maximum deflection at midspan of 4 mm 5/32 inch when calculated as a uniformly loaded horizontal simple beam supported between the upper and lower bearings. Statically balance the completed spiral screw.

2.5.4 Flow Defector Plates

****

NOTE: Deflector plates may be extended to completely enclose pump or pump may be tube mounted.

****

Provide flow deflector plates for installation in the pump trough along the uptake side of the spiral screw for the full length of the spiral. Ensure deflector plates are concave to effect an extension of the circular arch of the trough to at least the height of the top surface of the torque tube. Fabricate deflector plates from no less than 3 mm 1/8 inch thick steel plate complete with stiffeners and anchors where required.

2.5.5 Upper Bearing Assembly

Provide upper bearing assembly consisting of an upper bearing housing, bearing, seals, mounting, and cover.

2.5.5.1 Housing

Provide cast iron upper bearing housing with grease fittings on the exterior of the housing for periodic manual lubrication.

2.5.5.2 Bearing

Provide upper bearing which hasan ABMA L-10 life of 50,000 hours minimum, as specified in ABMA 9 or ABMA 11, and is one of the following: a dual bearing consisting of a spherical roller thrust type bearing for pump thrust loads and a spherical roller bearing for radial loads; or a single combination radial and thrust, self-aligning, spherical roller bearing.

2.5.5.3 Seals

Provide two seals for protection of the upper bearings. Attach one seal to the extended shaft of the spiral screw to prevent contamination from entering the bearing top side. Locate the other seal on the bottom side to retain the grease within the bearing.

2.5.5.4 Mounting Plate

Provide a fabricated steel mounting plate and anchor bolts for mounting the upper bearing assembly.

2.5.5.5 Cover

Provide a fabricated steel cover to close the opening in the wall for the spiral shaft.

2.5.6 Drive Assembly

Provide drive assembly consisting of a motor, gear reducer, and backstop.

2.5.6.1 Gear Reducer

Provide gear reducer that has the torque rating for the spiral speed based upon continuous operation with a uniform load. Ensure the gear reducer has an outer cast iron housing, totally enclosed and rigidly constructed to maintain precise alignment of the gears and bearings. Design gear reducer with a service factor of no less than [_____] based on the torque requirements of the screw or [_____] based on the motor horsepower, whichever is greater. Splash lubricate gears and bearings or, if necessary, pressure lubricate to ensure oil is provided to all gears and bearings. Positively secure shaft-mounted gear reducers to the screw shaft and anchor a torque arm to the floor. Provide double lip oil seals on the shaft. Provide non-shaft-mounted gear reducers with an adjustable base and connect to the screw shaft by a flexible coupling.

2.5.6.2 Backstop

Provide a backstop to prevent the reverse rotation of the spiral screw and drive assembly when the power to the motor is disconnected.

2.5.6.3 Drive

Connect the gear reducer to the drive motor by means of belts and sheaves designed with the same service factor as the gear reducer. Provide a safety cover for the belt drive.

2.5.7 Lubrication System

Provide an automatic grease lubricator with grease pump and reservoir to continuously grease the lower bearing when the pump is operating. Provide grease pump with a [_____] W hp, [_____] volts ac, [_____] phase, [60] [_____] Hz motor. Interlock the grease pump with the screw pump motor to prevent the screw pump from operating if the lubricator malfunctions. Provide a visual or automatic indicator to confirm that the lower bearing is receiving grease from the lubrication system.

2.5.8 Radius Screed

Provide a radius screed and any additional sheaves and belts as necessary to adjust screw speed to enable the installation of the grout in the trough with the screw installed.

2.6 PLUNGER PUMPS

Provide positive displacement type plunger pumps designed to pump sewage sludges with a minimum amount of clogging.

2.6.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must have the following operating characteristics:

Pump Service	[_____]
Design Capacity	[_____] L/second gpm
Design Head	[_____] mm feet
Suction Lift	[_____] mm feet
Stroke Speed	[_____] strokes per minute
Pump Type	[simplex] [duplex] [triplex] [quadraplex]
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.6.2 Pump Base

Provide a common, welded steel, drip-rim base with a 25 mm 1-inch threaded drain connection for the pump and motor. Provide base consisting of heavy section, fully braced to withstand all shock loads and to resist buckling when properly anchored.

2.6.3 Pump Body

Provide cast iron pump body. The pump must be of heavy construction, designed to handle its maximum rated capacity and head on a continuous duty basis and hydrostatically test at 1.5 times the maximum rated head of the pump. The pump body must be of sectional construction so that the stuffing box, valve bodies, and air chamber adapters are independently removable. Ensure construction permits removal of the stuffing box, plunger, and connecting rod without disturbing the body, valve chambers, manifolds, piping, or shaft.

2.6.4 Valves

Provide valve chambers on both the inlet and discharge connections of each cylinder. Construct valve chambers with contoured interiors to minimize clogging. Provide ball type valves, at least 130 mm 5-1/8 inches in diameter, and constructed of neoprene. Provide valve seats consisting of independent, fully machined plates which may be replaced without disturbing valve bodies or piping.

2.6.5 Connecting Rod, Eccentric, Eccentric Bearings, and Shaft

Provide connecting rod and eccentric strap assembly that is cast as one piece and has a quality hot-poured Babbitt lining. Design the eccentric, bearings, and shaft to handle the stresses and deflections imposed upon it by the specified service. Offset the shaft from the vertical centerline of the cylinder by an amount appropriate to the cylinder diameter to reduce lateral thrust on the cylinder during the discharge stroke.

2.6.6 Plungers

Provide ductile iron plungers with a plugged drain hole in the bottom which are accessible through the top of the plunger.

2.6.7 Cylinders

Machine cylinders to a smooth bore to provide a uniform surface throughout the full travel of the plunger.

2.6.8 Stuffing Box

Ensure the cylinder and plunger has an effective packing arrangement to provide lubrication for the plunger and maintain the most effective vacuum. Provide stuffing box heavy cast construction with a circular drain lip and 25 mm 1 inch threaded drain connection. Provide stuffing box with a minimum of four rings of [_____] packing.

2.6.9 Air Chambers

****

NOTE: Generally provide air chambers on suction side of all pumps and always on discharge side of all pumps.

****

Provide air chambers on [the discharge side] [both suction and discharge sides] of the pump with a minimum capacity of 0.0295 cubic meters 1800 cubic inches and a minimum 76 mm 3 inch diameter opening.

2.6.10 Sampling Valve

Provide a 50 mm 2 inch sampling valve on the discharge side of the pump.

2.6.11 Pressure Relief Valve

Provide a pressure relief valve with a bypass line from the main suction and discharge manifolds. Ensure valve is factory set to prevent motor overload or pump damage.

2.6.12 Lubrication

Provide each pump eccentric with a sight-feed oil lubricator.

****

NOTE: Delete inapplicable drive systems. The gear reducer is recommended for 11.2 kW 15 hp and larger applications.

****

2.6.13 Chain Drive

Provide capacity variations by stroke adjustment accomplished at each eccentric assembly, through the use of eccentric flanges coupled to the eccentric body. Obtain overall drive reduction through the combination of a gearhead motor and silent roller chain. Ensure motor gearhead is totally enclosed and running in oil. Provide chain capacity that is at least 150 percent of the chain manufacturers published horsepower rating. Enclose the entire chain drive assembly completely in a sealed lip, dust resistant steel guard.

2.6.14 V-Belt and Integral Gear Drive

Provide capacity variations by stroke adjustment accomplished at each eccentric assembly, through the use of eccentric flanges coupled to the eccentric body. Obtain overall drive reduction through a combination of gears and V-belts. Run gears in an oil bath contained in an oil-tight cast iron or aluminum enclosure. Select the gear reduction design, gear materials and face widths, shafting, and bearings for the specified operating conditions. Cover the entire V-Belt drive assembly by a rigid safety guard.

2.6.15 Gear Reducer Drive

Provide capacity variations by pump speed change only. Connect the low speed shaft of the reducer directly to the main shaft of the pump through a flexible coupling with shear pin protection. Design the shear pin overload protection for release at 150 percent to 175 percent of normal torque. Connect the high speed shaft of the reducer to the motor by a heavy duty flexible coupling. Enclose the entire gear reduction unit in a dustproof and oil-tight housing.

2.7 PROGRESSIVE CAVITY PUMPS

****

NOTE: For sludges of solids concentration exceeding 18 percent, installation of bridge breaker on the inlet port should be investigated. Designs vary and manufacturer's specifications should be consulted.

****

Provide progressive cavity pumps consisting of a single helical rotor rotating in a double helical stator.

2.7.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must have the following operating characteristics:

Pump Service	[_____]
Design Capacity	[_____] L/second gpm
Operating Head	[_____] mm feet
Operating Speed	[_____] rpm
[Single] [Double] stage	
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.7.2 Casing

[Cradle mount the pump body such that the suction chamber can be rotated to allow the suction port to accommodate any piping configuration.] Incorporate two inspection ports 180 degrees apart in the suction housing to provide access to internal parts. Provide a drain plug in the casing.

2.7.3 Rotor

****

NOTE: Tool steel and stainless steel are common rotor materials. Other materials are also available. Chrome plating is standard for most manufacturers but may be deleted, depending upon the application.

****

The pump rotor must be a helix constructed of machined and polished [high quality tool steel] [stainless steel] [and must be covered with a layer of hard chrome plate].

2.7.4 Stator

The rotor must revolve in a helix elastomeric stator consisting of Buna-N chemically bonded to a steel tube.

2.7.5 Drive Shaft and Connecting Rod

****
NOTE: Universal joint design is critical since this is a common problem area for this type pump. The pin or cardan type joints are inferior to the gear type but may be acceptable for some applications. Deleting the pin or cardan type joints will eliminate many manufacturers.
****

Provide rotor driven by a connecting rod between the rotor and drive shaft, connected at each end with a crowned gear [or pin or cardan] type universal joint. Design the universal joints to transmit the required thrust and torque. The connecting rod and universal joint in combination must impart no thrust on the seal. Provide universal joints that are [grease] [_____] lubricated and totally sealed and shielded. Ensure seal prevents liquid from contaminating the joints, and the shields prevent foreign objects from damaging the seal.

2.7.6 Flexible Drive Shaft

****
NOTE: The spring steel flexible one-piece drive shaft is proprietary and should not be specified alone.
****

Provide rotor which is driven by a one-piece, flexible, high strength spring steel drive shaft with a corrosion and abrasion-resistant thermoplastic coating.

2.7.7 Seals

Provide pump seals consisting of a stuffing box with a split packing gland and lantern ring or a mechanical seal. Provide fittings for [grease] [water] lubrication.

2.7.8 Bearings

Design bearings for an ABMA L-10 life of at least 50,000 hours minimum, as specified in ABMA 9 or ABMA 11, and grease lubricate. Provide lubrication fittings in the bearing housing.

2.8 DIAPHRAGM PUMPS

Provide diaphragm pumps of the self-priming, positive displacement type designed to pump sludge of various concentrations and levels of abrasiveness. Design pump such that operating the pump without liquid in the pump casing will not damage any portion of the pump.

2.8.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must have the following operating characteristics:

Pump Service	[_____]

Operator	[mechanical] [air]
Design Head	[_____] mm feet
Peak Capacity	[_____] L/second gpm flow
Total Dynamic Head	[_____] mm feet
Suction and Discharge Check Valve Size	[_____] mm inches
Pump Speed	[_____] strokes per minute
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.8.2 Casing

Line all interior wetted parts with [6.4 mm 1/4 inch thick chlorosulfonated polyethylene]. Design pump body to permit access to the casing interior without disassembling the suction and discharge piping.

2.8.3 Suction and Discharge Check Valves

****

NOTE: Specify the appropriate type of valve for the material to be pumped. If large, pipe-size solids are to be pumped, specify the flap check valve. If maintenance will be infrequent, specify the in-line ball check valve. For other applications specify the quick-opening ball check valve.

****

Provide [quick opening ball check type,] [in-line ball check type,] [or] [in-line flap check type] suction and discharge check valves. [Provide quick-opening ball check valves that have replaceable [stainless steel,] [bronze,] [or] [cast iron] seats and an easily removable cover plate to permit inspection and cleaning of the valve interior without disassembling the adjacent piping.] [Provide in-line ball check valves that have a streamlined internal design, eliminating projections on which material can collect.] [Provide in-line flap check valves that have an elastomeric seal on the disc to insure sealing and a removable cover to permit inspection and cleaning of the valve interior without disassembling the adjacent piping.]

2.8.4 Pulsation Dampers

****

NOTE: Specify inlet pulsation dampers for pumps with high suction head and discharge pulsation dampers for pumps with high discharge head.

****

Provide an air chamber type pulsation damper on the pump [inlet] [and] [discharge].

2.8.5 Air-Operated Actuators

****

NOTE: Delete inapplicable drive type, mechanical or air-operated.

****

Provide a complete air operated actuator with all accessories required for proper operation, including the following:

2.8.5.1 Valve

A three-way solenoid valve on the air supply line. Operate the valve on a signal from the flow control timer.

2.8.5.2 Timer

An adjustable solid state flow control timer to control pump stroke rate and length. Ensure stroke rate is adjustable from 0 to [40] [_____] strokes per minute. Ensure stroke length is adjustable from [0.75] [_____] to [1.25] [_____] seconds.

2.8.5.3 Muffler

An air exhaust muffler to ensure quiet operation.

2.8.5.4 Pressure Regulator

An air pressure regulator to maintain a constant air supply pressure to the pumping system. Ensure the air pressure regulator is field adjustable from [_____] to [_____] kPa [_____] to [_____] psi.

2.8.5.5 Strainer

Provide an air supply strainer to remove particles larger than [_____] microns from the air supply with a removable cover to permit cleaning without dismantling adjacent piping.

2.8.5.6 Assist

Spring assist or air cylinder assist as required for adequate suction lift.

2.8.6 Mechanical Actuators

Provide mechanical actuator consisting of an electric motor and [gear reducer] [belt drive] connected to the diaphragm by a connecting rod and eccentric.

2.9 RECESSED IMPELLER PUMPS

Provide recessed impeller pumps of the vortex type designed to handle fluids containing solids, air, and stringy material normally found in sewage. Design pumps to pump solids up to 76 mm 3 inches in diameter.

2.9.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must have the following operating characteristics:

Pump Service	[_____]
Design Operating Point	[_____] L/second gpm flow at [_____] mm feet head
Maximum Operating Point	[_____] L/second gpm flow at [_____] mm feet head
Minimum Operating Point	[_____] L/second gpm flow at [_____] mm feet head
Discharge Diameter	[_____] mm feet
Suction Diameter	[_____] mm feet
Operating Speed	[_____] rpm
Maximum NPSH Required at Maximum Operating Point	[_____]
Seal Type	[packing] [mechanical]
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.9.2 Pump Casing

Construct pump casing with tapped and plugged holes for priming, venting, and drainage of the pump. Provide casing capable of withstanding pressures 50 percent greater than the maximum operating pressure. Ensure all internal casing clearances are equal to the discharge nozzle diameter so that all material that can pass through the discharge nozzle can pass through the casing. Provide flanged casing connections.

2.9.3 Impeller

The impeller must be of the recessed design. Key the impeller securely to the shaft with a locking arrangement whereby the impeller cannot be loosened from either forward or reverse direction.

2.9.4 Pump Shaft

****

NOTE: Specify manufacturer's standard pump shaft material. High grade alloy steel is standard with most manufacturers.

****

Provide [high grade alloy steel] [or] [stainless steel] pump shaft that is sized to provide a minimum amount of deflection.

2.9.5 Sleeve

****

NOTE: Specify manufacturer's standard pump shaft sleeve material. Stainless steel is standard with most manufacturers.

****

Protect the pump shaft throughout the packing area by a removable [stainless steel] [or] [bronze] sleeve.

2.9.6 Seals

Provide a stuffing box, designed for the interchangeable use of packing or mechanical seals, and suitable for use of grease, oil, or water as the sealing liquid.

2.9.6.1 Packing

Design the stuffing box to accommodate a minimum of [_____] rings of [graphite] [oil] impregnated [nonasbestos] [metallic] packing with lantern ring and packing gland. Ensure packing is readily removable from the shaft.

2.9.6.2 Mechanical Seals

Provide mechanical seals concicting of the [single] [double] type of [carbon-ceramic] [tungsten carbide] construction. Hold each seal interface in place by its own [stainless steel] spring system. Construct the seal system to be readily removable from the shaft.

2.9.7 Bearings

Provide antifriction ball or roller type pump bearings designed to carry all radial or thrust loads. Provide bearing that are [grease] [oil] lubricated and contained in dust- and moisture-proof housings. [Provide an oil reservoir with overflow and drain openings.] [Provide a grease fitting of the type that prevents overlubrication. If the grease fitting is not readily accessible, provide an extension tube.]

2.10 ROTARY LOBE PUMPS

Provide positive displacement type rotary lobe pumps consisting of two tri-lobe rotors which draw product into pockets formed between the rotors and rotor case and push pumped material 180 degrees around the interior of the contoured rotor case and out through the discharge port.

2.10.1 Pump Characteristics

Pump number[s] located in [_____] must have the following characteristics:

Pump Service	[_____]
Design Capacity	[_____] to [_____] L/second [_____] to [_____] gpm
Operating Head	[_____] mm feet maximum to [_____] mm feet minimum
Operating Speed	[_____] rpm
Discharge Diameter	[_____] mm feet
Suction Diameter	[_____] mm feet
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.10.2 Casing

Construct rotor casing of [ductile iron] [cast iron]. Construct the gear casing of cast iron. Use a removable end cover to allow access to tri-rotor elements without need to disturb packing glands, bearings, suction, or discharge connections.

2.10.3 Rotors

Provide pump rotors that are tri-lobe form [profile machined in cast iron] [high quality tool steel encapsulated in urethane] [stainless steel]. Provide a removable and replaceable wear plate between the rotors and rotor case to protect the rotor case from wear. Locate rotors on shafts by positive locking assembly.

2.10.4 Shafts and Sleeves

Provide shafts consisting of [high grade alloy steel] [_____] fitted with replaceable stainless shaft sleeves where passing through gland area. Time shafts in their rotation by zero backlash timing gears keyed to shafts and running in a separate oil chamber gear case. Ensure seals prevent ingress of pumped material into gear case.

2.10.5 Packing Glands

Provide adjustable packing gland type seals. Provide stuffing box glands with split lantern rings for through water flush.

2.10.6 Bearings

****

NOTE: Specify L-10 life expectancy based on check with manufacturers for actual pump models under consideration.

****

Provide pump with heavy duty antifriction roller or ball type bearings for shaft support, with a ABMA L-10 life of [40,000] [100,000] hours at maximum operating conditions. Ensure oil seals prevent ingress of pumpage into gear case. Provide a slinger for each shaft.

2.11 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, controls and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Specify or indicate electrical characteristics. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Provide manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices but are not shown.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 EQUIPMENT INSTALLATION

Submit Drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show on the Drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

3.2.1 Pump Installation

Install pumping equipment and appurtenances in the position indicated and in accordance with the manufacturer's written instructions. Provide all appurtenances required for a complete and operating pumping system, including such items as piping, conduit, valves, wall sleeves, wall pipes, concrete foundations, anchors, grouting, pumps, drivers, power supply, seal water units, and controls.

3.2.2 Concrete

Provide concrete conforming to Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 Grouting Screw Pump Flow Channel

****

NOTE: Delete if no screw pumps.

****

After installation and adjustment of the screw pump, place grout in the flow channel to the configuration and dimensions indicated and as required to insure a proper fit between the screw pump and flow channel. Attach a radius screed provided by the pump manufacturer temporarily to provide proper clearance between the screw and the flow channel. Grout the flow channel in strict accordance with the manufacturer's instructions.

3.3 PAINTING

Pumps and motors must be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. Field painting required for ferrous surfaces not finished at the factory is specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 FRAMED INSTRUCTIONS

Post, where directed, framed instructions containing wiring and control diagrams under glass or in laminated plastic. Frame condensed operating instructions, prepared in typed form, as specified above and posted beside the diagrams. Post the framed instructions before acceptance testing of the system. Submit pump characteristic curves showing capacity in gpm, net positive suction head (NPSH), head, efficiency, and pumping horsepower from 0 gpm to 110 percent (100 percent for positive displacement pumps) of design capacity. Submit a complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Diagrams, instructions, and other sheets proposed for posting.

3.5 FIELD TESTING AND ADJUSTING EQUIPMENT

3.5.1 Operational Test

Prior to acceptance, perform an operational test of all pumps, drivers, and control systems to determine if the installed equipment meets the purpose and intent of the specifications. Demonstrate that the equipment is not electrically, mechanically, structurally, or otherwise defective; is in safe and satisfactory operating condition; and conforms with the specified operating characteristics. Prior to applying electrical power to any motor driven equipment, rotate the drive train by hand to demonstrate free operation of all mechanical parts. Include checks for excessive vibration, leaks in all piping and seals, correct operation of control systems and equipment, proper alignment, excessive noise levels, and power consumption.

3.5.2 Retesting

If any deficiencies are revealed during any test, correct such deficiencies and reconduct the tests.

3.5.3 Performance Test Reports

Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. In each test report indicate the final position of controls.

3.6 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Supervise the installation, adjustment, and testing of the equipment.

3.7 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [_____] hours of normal working time and start after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the operating and maintenance manuals. Submit [six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Detail the step-by-step procedures required for system startup, operation, and shutdown. Include in the operation manuals the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include piping and equipment layout and simplified wiring and control diagrams of the system as installed in the maintenance manuals. Manuals must be approved prior to the field training course.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-22 14 29.00 (Feb 2023)**

Preparing Activity: USACE **Superseding**
UFGS-22 14 29.00 40 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 22 - PLUMBING

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SUMP PUMPS

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PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-22 14 29.00 (Feb 2023)**

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****

SECTION 22 14 29.00

SUMP PUMPS
02/23

****
NOTE: This guide specification covers the requirements for automatic, electric-motor-driven, centrifugal, wet-pit and submersible sump pumps up to 1000 gpm. For larger submersible pumps use 35 45 04.00 10 Submersible Pump, Centrifugal Type or 35 45 04.00 10 Submersible Pump, Axial-Flow and Mixed-Flow Type.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

HYDRAULIC INSTITUTE (HI)

HI ANSI/HI 11.6	(2016) Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests
HI M100	(2009) HI Pump Standards Set

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances
ISO 2858	(1975) End Suction Centrifugal Pump (Rating 16 Bar) Designation Nominal Duty Point and Dimensions - International Restrictions
ISO 5199	(2002) Technical Specifications for Centrifugal Pumps, Class II

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA MG 1 (2021) Motors and Generators

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Connection Diagrams; G, [_____]

Control Diagrams; G, [_____]

Installation Drawings; G, [_____]

SD-03 Product Data

Manufacturer's Catalog Data; G, [_____]

Pump Performance Curve; G, [_____]

Spare Parts List; G, [_____]

Special Tools; G, [_____]

Wet-Pit Sump Pumps; G, [_____]

Submersible Pumps; G, [_____]

Accessories; G, [_____]

Floatless Electrode Level Controls; G, [_____]

SD-06 Test Reports

Hydrostatic Leak; G, [_____]

Static Heads; G, [_____]

Pump Flow Capacity; G, [_____]

SD-07 Certificates

Manufacturer's Certification of Bearing Life

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Vibration Specifications

1.3 DELIVERY, STORAGE, AND HANDLING

Inspect the pump for damage or other distress when received at the project site. Store the pump and associated equipment indoors as recommended by the pump manufacturer, protected from construction or weather hazards at the project site. Before installation, provide adequate short-term storage for the pump and equipment in a covered, dry, and ventilated location. Follow the manufacturer's instructions for extended storage.

PART 2 PRODUCTS

Provide a pump and motor with vibration levels conforming to ISO 1940-1 unless otherwise noted. Ensure that motor vibration levels conform to NEMA MG 1, Motors and Generators, Part 7, unless otherwise noted.

2.1 SYSTEM DESCRIPTION

Show details of connection of cables and pump motors on connection diagrams for sump pumps.

Submit control diagrams for sump pumps showing motor starters, relays, or any other component necessary for safe operation.

Ensure that installation drawings for sump pumps are in accordance with the manufacturer's recommended instructions.

Submit manufacturer's catalog data for sump pumps showing the sump pump size, type, and efficiency rating along with performance data, including pump performance curve, indicating brake horsepower, head, flow rate, and NPSH (net positive suction head). Also include equipment foundation data and equipment data.

Provide manufacturer's installation instructions and vibration specifications.

2.2 EQUIPMENT

****

NOTE: Tailoring options are set up for wet-pit (line shaft) and submersible pump options. At least one selection should be made.

The designer should consider whether a line shaft driven pump or submersible motor type pump is preferred. A line shaft arrangement can provide some cost savings as the motor will not need to be submersible. Shaft length is a factor in this decision. Longer shafts can introduce additional alignment problems.

****

2.2.1 Wet-Pit Sump Pumps

****

NOTE: Select simplex or duplex pump units; delete the parts and the paragraphs not applicable to the project requirements.

The designer should indicate when specified pumps use a separate motor and line shaft.

Unit capacity conditions should be specified herein or shown on the drawings.

Show dimensions of the cast-iron, carbon steel, or concrete cast-in-place sumps or basins on the drawings. Capacities for each pump of the simplex or duplex unit range from 150 to 3800 liter 40 to 1,000 gallons per minute; total dynamic heads range from 3 to 40 meter 10 to 130 feet.

Indicate on the drawings the number of pump units required.

The difference between a wet-pit sump pump and a submersible pump is that the motor of a wet-pit pump is not submerged, it is elevated above the water level. A submersible pump has a submersible motor.

****

Provide a pump with duty conditions as [indicated on drawings.][follows: [_____]].

Construct and furnish pumps in accordance with the applicable requirements of ISO 2858 and ISO 5199 HI M100 standards and those specified herein.

[Include with the simplex pump unit a vertical, submerged, volute, centrifugal pump mounted below a coverplate; a vertical, flexible-connected, solid-shaft motor; a motor and bearing support housing attached to the coverplate; pump support and shaft housing pipe; discharge pipe; and automatic controls.

][Include with the duplex pump unit two individual, vertical, submerged, volute, centrifugal pumps mounted below a coverplate; vertical, flexible-connected, solid-shaft motors; motor and bearing support housing attached to the coverplate; pump support and shaft housing pipes; discharge pipes; and automatic controls. Design the installation of the unit to permit removal of one pump assembly without disturbing the operation of the other.

] Ensure that requirements for each material designation are in accordance with the applicable definition listed in the centrifugal pump section of ISO 2858 and ISO 5199 HI M100 standards. Ensure that materials for components and accessories not covered by these definitions are as specified herein.

Avoid contact between dissimilar metals. Where such contact cannot be avoided, protect joints between dissimilar metals against galvanic corrosion by plating, organic-insulation coatings, gaskets, or other suitable means.

2.2.1.1 Pump Selection

Where parallel pump operation is indicated, select pumps with characteristics specifically suited for the service, without unstable operation.

Provide a self-priming pump unit that delivers, at rated speed, not less than the specified liters gallons per minute against the specified or indicated discharge head while the liquid level is not more than 300 millimeters 1 foot above the datum elevation of the pump. Use the level of the entrance eye of the impeller as the datum elevation. Include in the calculations of the discharge head both the friction head of the system piping external to the pump unit and the static head measured from a point of reference on the sump to the highest point in the system. Base ratings on pumping clear, fresh water at a temperature of20 degrees C 68 degrees F.

2.2.1.2 Pump Casing

Provide cast-iron pump casing. Provide a volute and discharge nozzle of the pump casing cast as one piece. Construct the casing with a bolted plate to permit inspection and removal of the impeller. Ensure that the casing can withstand a hydrostatic pressure of not less than 1-1/2 times the design shutoff head of the pump.

2.2.1.3 Impeller

Provide a cast-iron or bronze impeller, enclosed or semi-open, with vanes on the back shroud. Refer to paragraph BEARINGS AND LUBRICATION for additional requirements. Ensure that the impeller is dynamically balanced.

[2.2.1.4 Strainer

Protect the intake with a large cast-iron, slotted intake strainer with an effective free area sufficient to prevent cavitation and degradation of efficiency. Ensure that the strainer has a free area of at least four times the cross-sectional area of the suction casing.

]2.2.1.5 Pump Shaft

Construct the pump shaft of ground and polished AISI Type 304 or 316 corrosion-resistant steel with hardened wearing surfaces at intermediate shaft-bearing locations. Hardened surfaces may be overlays of 500 Brinell, Deloro Stellite, Wall Colmonoy, or similar proprietary metals, or plasma-spray-applied ceramic materials of not less than 900 Brinell hardness. Provide 1 shaft bearing for every five feet of elevation minimum.

****

NOTE: Identify the mechanical properties and diameter of the shaft to ensure that whip, deflection, or vibration is not of sufficient magnitude to impose greater than design loads on the specified shaft bearings under normal operating conditions.

****

2.2.1.6 Motor

****

NOTE: Motor specicications are covered in 26 29 01.00 10. The designer may chose to move migrate some of those motor specifications to this section if the design is deemed simple enough.

****

See 26 29 01.00 10 ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE for motors.

2.2.1.7 Bearings and Lubrication

Furnish one or more antifriction ball- or roller-bearings in the motor and bearing support housing above the coverplate surface, with full provision for the mechanical and hydraulic radial and thrust loads imposed. Provide sealed and grease-lubricated bearings that have an L-10 rating of at least 80,000 hours in accordance with ABMA 9 or ABMA 11. Ensure that the shop drawings bear the manufacturer's certification of bearing life. Provide bearings manufactured from vacuum-processed or degassed-alloy steels.

Provide sleeve-type intermediate shaft bearings. Ensure that the center distance between any two bearings on the shaft does not exceed 1370 millimeter 4-1/2 feet for pumps operating between 1,700 and 1,800 revolutions per minute (rpm) or 1520 millimeter 5 feet for pumps operating at 1,200 rpm or less. Provide a sleeve bearing at least two times the shaft diameter and locate the bearing near the lower extremity of the shaft.

****

NOTE: Select the appropriate paragraphs for grease or water-lubricated intermediate bearings.

Where water contains suspended matter, such as sand, supply solenoid-operated flush water to bearings from a protected potable water source or other clean water source.

If heads are sufficiently high, a plastic centrifugal separator may be provided to cleanse suspended matter from flushing water taken from pump discharge. Drain the separator underflow back to the sump.

****

[Provide heavy-duty bronze or bronze-backed, babbitt-lined sleeve bearings.

Provide appropriate nonferrous piping and fittings to permit individual lubrication of the intermediate and lower bearings from above the sump coverplate. Provide a means to prevent the pumped fluid from entering the lower bearing. Include a suitable seal or a system wherein a partial vacuum developed below the bearing by the impeller rotation induces a positive flow of lubricant into the bearing. Fit bearings with a centralized grease lubricator that is manually or electrically operated from a single point.

][Provide heavy-duty bronze- or corrosion-resistant steel-backed cutless-rubber sleeve bearings.

]

****

NOTE: Where flushing water is used, delete the previous paragraph and select the following paragraph.

****

[Provide heavy-duty bronze- or corrosion-resistant steel-backed cutless-rubber sleeve bearings with nonferrous piping and fittings provided for individual flushing of intermediate and lower bearings.

][2.2.1.8 Potable Water

****

NOTE: Where potable water is used, include the following paragraph. If discharge water is centrifugally cleaned, delete the following paragraph and specify centrifugal separator and performance requirements.

****

Supply potable water through a piping system containing a pressure regulator, a solenoid, and a backflow preventer. Provide plastic, nonmetallic composition, elastomer, or nonferrous metal for all wetted components.

]2.2.1.9 Flexible Couplings

Connect the pump shaft to the motor shaft through a flexible coupling. Provide a tire shape or a solid-mass, serrated-edge, flexible disk-shaped member made of chloroprene material and retained by fixed flanges. Provide a flexible coupling that acts as a dielectric connector, that does not transmit vibration or end thrust, and that permits up to 4-degree misalignment under normal duty.

2.2.1.10 Support Pipe

Provide a wrought-iron or steel support pipe concentric with the pump shaft that connects the pump to the sump coverplate. Provide support pipe flanges that are machined and doweled to ensure proper alignment of the pump and shaft whenever the pipe is disassembled and reassembled in the field.

2.2.1.11 Discharge Pipe

Furnish a discharge pipe running from the pump discharge outlet to the sump coverplate as an integral part of the pump unit. Arrange the discharge pipe to preclude discharge piping beyond the pump assembly from imposing loads that could cause shaft misalignment. Provide black steel or wrought-iron pipe, with wall thickness not less than that specified in ASTM A53/A53M for Schedule 40 pipe. Ensure that the discharge pipe is gastight through the sump coverplate. Ensure that the discharge end of the pipe terminates in a screwed or flanged connection in accordance with the manufacturer's standard practice.

2.2.1.12 Liquid-Level Control

[Provide a simplex unit with a float mechanism to provide automatic operation of the pump unit when the liquid in the sump rises to a predetermined level. Provide a means of adjustment, such as a float-rod stop, to allow for variation in the start and stop level-control points. Provide an AISI Type 304 or 316 corrosion-resistant steel float and stem. For all other parts of the fluid-level-sensing mechanism below the coverplate, provide bronze, brass, or material of equivalent resistance to the corrosive effects of sewage.

][Provide a duplex pump unit with the electrical and mechanical devices necessary to provide automatic operation of the pump unit when the liquid in the sump rises to a predetermined level. Ensure that controls automatically transfer the operating cycle from one pump to the other and operate both pumps simultaneously whenever the inflow to the sump exceeds the capacity of the operating pump. Provide a means of adjustment such as float-rod stops to allow for variations in the start and stop level-control points. Provide AISI Type 304 or 316 corrosion-resistant steel float and rod. For all other parts of the fluid-level-sensing mechanism below the coverplate, provide bronze, brass, or material of equivalent resistance to the corrosive effects of sewage.
]

****

NOTE: Select the following paragraph for deep settings and where a great deal of turbulence may be expected.

****

Provide stilling tubes where indicated.

Floatless electrode level controls may be submitted for approval, provided that the electrodes are isolated from the fluid being sensed.

2.2.1.13 Sump Tank and Coverplate

Provide a [cast-iron or steel][polypropylene, corrosion-resistant][aluminum] sump tank, strong enough to support the pumps without distortion and to safely support maintenance personnel.

****

NOTE: Delete the following paragraph if a concrete sump is designed.

If the size of the tank is such that a fabricated steel tank is specified, provide coal-tar epoxy internal protection.

Show the size of the tank and influent line on the drawings or specifications.

For deep settings, show anti-sway bracing of the

shaft column on the drawings.
****

[a. Tank

Provide a [cast-iron][polypropylene, corrosion-resistant], sump tank sized to provide a clearance of 150 millimeter 6 inches or one discharge pipe iron pipe size (ips) diameter, whichever is larger, between the bottom of the pump and the bottom of the tank.

Furnish a standard opening for connection to the sewage inflow pipe in the indicated size and location with respect to the top of the tank.

[Polypropylene tanks require a minimum compacted subbase of 100 millimeter 4 inches.
]
****
NOTE: When a concrete sump is provided, include the following paragraph if the concrete requires protection from sewage components.
****

[Protect the concrete interior surface of the sump tank by not less than a two-coat, two-component system of amine-cured coal-tar epoxy totaling 0.381 millimeter 15 mils in thickness.

]]b. Coverplate

Provide gasketed openings through the sump tank coverplate, unless otherwise specified. Provide a 50 mm 2-inch ips or larger threaded outlet to permit installation of a vent pipe. Ensure that the sump coverplate has a [manhole][handhole] access to the tank.

2.2.2   Submersible Pumps

****
NOTE: Select simplex or duplex; delete the parts and the paragraphs not applicable to the project.

Specify unit capacity conditions herein or show on the drawings.

indicate the number of pump units required on the drawings.
****

Construct and furnish pumps and accessories in accordance with the requirements of ISO 2858 and ISO 5199 HI ANSI/HI 11.6 and HI M100 standards and those specified herein.

****
NOTE: Take precautions to properly identify pumps.

Revise if other types of controls are required.
****

[Provide a simplex pump unit that includes a submersible pump with an automatic level-control mechanism mounted above water level.

][Provide a simplex pump unit that includes a submersible pump with an integral diaphragm or float-switch automatic level-control mechanism.

] Install an operating switch such that in case of failure, the operating switch does not require breaking of pump-motor seals for repairs.

[Provide a duplex unit that includes float level controls for each submersible pump.

] Ensure that requirements for each material designation are in accordance with the applicable definition listed in the centrifugal pump section of ISO 2858 and ISO 5199 HI M100 standards.

Avoid contact between dissimilar metals. Where such contact cannot be avoided, protect joints between dissimilar metals against galvanic corrosion by plating, organic-insulation coatings, gaskets, or other suitable means.

2.2.2.1 Pump Selection

****

NOTE: Modify to include project duty conditions.

Because submersible pump motors are not always nonoverloading for a given motor-volute-impeller series, avoid possible operation at low heads.

****

Provide a pump with duty conditions as [indicated on drawings.] [follows:]

a. [_____]

b. [_____]

c. [_____]

Ensure that pump seals, lubricant, and electrical insulation are suitable for service in liquids up to 60 degrees C 140 degrees F.

2.2.2.2 Pump Housing

Provide a pump housing that encloses the pump motor and volute with its integrally cast feet. Provide a cast-iron pump housing that is watertight under all heads normal to the service, and constructed to permit inspection and repair. Furnish a volute designed to withstand a hydrostatic pressure of not less than 1-1/2 times the design shutoff head of the pump.

2.2.2.3 Impeller

Provide a dynamically balanced and totally enclosed [bronze][_____] impeller.

****

NOTE: Submersible pumps may be furnished for heavy debris or sewage service by specifying as follows and deleting the preceding paragraph.

Modify the solid-sphere handling-capability dimension as required. The lower the capacity, the

smaller the passable solid sphere.
****

Provide a [cast-iron][_____] nonclogging impeller designed to provide maximum freedom from clogging when liquid-containing rags and stringy material is handled. Provide an impeller that is dynamically balanced and that has a minimum solid-sphere handling capability of[40 millimeter 1-1/2 inches][_____].

2.2.2.4 Pump Shaft

Provide a pump shaft that is an extension of the motor shaft and constructed of ground and polished AISI Type 300 or 400 series corrosion-resistant steel with hard-wearing surfaces (over 300 Brinell).

[]2.2.2.5 Mechanical Seal

Provide the manufacturer's standard mechanical pump shaft seal specifically constructed for the service duty temperature and resistance to pumped fluid.

2.2.2.6 Bearings and Lubrication

Furnish antifriction ball- or roller-bearings with full provision for the mechanical and hydraulic, radial, and thrust loads imposed. Provide bearings which are sealed and lubricated for life with either grease or oil.

2.2.2.7 Motor and Power Cord

Provide a fully submersible motor which conforms to the requirements of NEMA MG 1. Size the motor to avoid overload when operating at any point along the characteristic curve of the pump. Provide 3-phase, 60-Hz, [_____] V, squirrel cage induction type motors, NEMA Design B Type. Insulate the stator windings and stator leads with a moisture-resistant Class F insulation with temperature resistance of 155 degrees C 311 degrees F. Use a service factor of 1.0. The temperature rise above ambient for continuous full load rated conditions and for the class of insulation used cannot exceed the values in NEMA MG 1. The motor must be rated for continuous duty when submerged and also be capable of operation in the dry for short periods of time for testing and maintenance purposes.

Provide a permanently sealed, oil-filled, and watertight motor of the manufacturer's standard construction for the service. Fit the motor space with watertight expansion provisions to accommodate the temperature normal to the specified duty. Ensure that the motor seals remain watertight under any pressure developed in the volute and under a sump-level static head of not less than 9 meters 30 feet of water.

Ensure that circuits for three-phase motors provide overload protection.

****
NOTE: Some submersible pumps are available as three-phase in 560 watt 3/4 horsepower and larger only.

Select the following paragraph for single-phase motors only.
****

[Provide single-phase motors with automatic-reset thermal-overload protection.

Provide a waterproof, internally grounded, oil-resistant, Type SO chloroprene power cord, with a three-prong plug of the indicated length.]

2.2.2.8 Liquid-Level Control

****

NOTE: Simplex unit controls are specified to be integral with the housing. The following remote controls may be specified upon revision of selected paragraphs under the general heading.

****

Furnish simplex units with a float-operated switch mechanism to ensure automatic operation of the pump unit when the liquid in the sump rises to a predetermined level. Provide a cover-mounted switch and Type 1, general-purpose enclosure in accordance with NEMA 250. Provide a means of adjustment such as float-rod stops to allow for variation in the start and stop level-control points. Provide an AISI Type 304 or 316 corrosion-resistant steel float and stem. Provide bronze, brass, or materials of equivalent resistance to the corrosive effects of the pumped fluid for all other wetted parts of the fluid-level sensing mechanism.

****

NOTE: Select two of the following three paragraphs if duplex units are used.

****

Furnish a duplex pump unit with the electrical and mechanical devices necessary to provide automatic operation of the pump unit when the liquid in the sump rises to a predetermined level. Provide controls that automatically transfer the operating cycle from one pump to the other and that operate both pumps simultaneously whenever the inflow to the sump exceeds the capacity of the operating pump. Provide a means of adjustment such as float-rod stops to allow for variations in the start and stop level-control points. Provide an AISI Type 304 or 316 corrosion-resistant steel float and rod. For all other wetted parts of the fluid-level sensing mechanism, use bronze, brass, or other material of equivalent resistance to the corrosive effects of the pumped fluid.

Mount the controls on the discharge pipe below the basin cover. Provide Type 6 enclosures in accordance with NEMA 250.

Pedestal-mount the controls above the coverplate. Provide Type 1, general-purpose enclosures conforming to NEMA 250.

****

NOTE: Select the following paragraph for deep settings and where a great deal of turbulence may be expected.

****

Provide stilling tubes where indicated.

Floatless electrode level controls may be submitted for approval provided that the electrodes are isolated from the fluid being sensed.

2.2.2.9 Sump Tank and Coverplate

****

NOTE: Delete the following paragraph if a concrete sump is designed.

If the size of tank is such that a fabricated steel tank is specified, provide coal-tar epoxy internal protection.

Drawings should show size of tank and influent line.

For deep settings, show antis-way bracing and support of power cord and discharge pipe on the drawings.

****

a. Tank

Provide a [cast-iron,] [high-density linear polyethylene,] sump tank sized as indicated.

Furnish a standard opening for connection to the drainage inflow pipe in the indicated size and location with respect to the top of the tank.

****

NOTE: When a concrete sump is provided, include the following paragraph if the concrete requires protection from sewage components.

****

Protect the interior surfaces of the concrete-sump by not less than a two-coat, two-component system of amine-cured coal-tar epoxy totaling 0.381 millimeter 15 mils in thickness.

b. Coverplate

Provide a [cast-iron or steel][aluminum] sump coverplate, of adequate strength to support not less than 9500 pascal 200 pounds per square foot without distortion. Seal all openings through the sump cover to be gastight and watertight. Provide a standard outlet for a vent pipe. Ensure that the sump cover provides a [manhole][handhole] access to the interior.

2.3 HIGH-WATER ALARM

****

NOTE: Coordinate with project requirements and electrical drawings.

****

Provide a high-water alarm switch complete with actuating mechanism for operation on an electrical circuit other than the motor circuit. Design the switch to operate the indicated alarm devices whenever a predetermined high-water level is reached in the sump. Provide a switch enclosure that is the same as the level-control switch.

2.4 PAINTING

Treat and paint equipment in accordance with the manufacturer's standard practice for the specified duty.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

3.1.1 Alignment

Before attempting alignment, demonstrate that the pump does not have any load/force imposed by the piping system. Minimum alignment values (below) are for pump and driver at normal running temperatures. Compensate values for thermal growth. Correct limited movement of the pump or driver (commonly known as bolt-bound) to ensure alignment capability. Ensure that holddown bolts are not undercut in order to perform adjustment.

Ensure that shims are commercially die-cut, without seams or folds, and are made of corrosion-resistant stainless steel. Do not use more than four shims at any single point.

For units with drive motors over [5.6] [7.5] [11.2] [14.9] [18.6] Kw[7.5] [10] [15] [20] [25] hp, install alignment jack bolts.

Pump and driver may have an intermediate shaft, spacer, or spool piece (sometimes called a jackshaft) Based on the motor's nominal operating speed, align the pump and driver to the following minimum specifications:

Speed(RPM)	close-coupled offset(mils)	close-coupled angle(mils/in)	spool piece angle (mils/in @ coupling pt.)
600	6.0	2.0	3.0
900	5.0	1.5	2.0
1200	4.0	1.0	1.5
1800	3.0	0.5	1.0
3600	1.5	0.4	0.5
7200	1.0	0.3	0.4

Provide final alignment settings as part of the final test data.

3.2 FIELD QUALITY CONTROL

3.2.1 Vibration Analyzer

Use a Fast Fourier Transform (FFT) analyzer to measure vibration levels. Provide an FFT analyzer with the following characteristics: a dynamic range greater than 70 dB; a minimum of 400 line resolution; a frequency response range of 5 Hz to 10 kHz (300 to 600,000 cpm); the capacity to perform ensemble averaging; the capability to use a Hanning window; autoranging frequency amplitude; a minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB.

Use an accelerometer (either stud-mounted or mounted using a rare-earth, low-mass magnet) and sound disk(or finished surface) with the FFT analyzer to collect data. Ensure that the mass of the accelerometer and its mounting has minimal influence on the frequency response of the system over the selected measurement range.

3.2.2 Pump Acceptance

Ensure that vibration analysis verifies pump conformance to specifications. Ensure that vibration levels are not more than1.9 mm/sec 0.075 in/sec at 1 times run speed and at pump frequency, and1 mm/sec 0.04 in/sec at other multiples of run speed.

Perform tests, including hydrostatic leak checking of piping and operation of equipment, in accordance with the manufacturer's instructions.

Operate pumps against static heads indicated, and verify pump flow capacity.

Provide final test reports to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.3 CLOSEOUT ACTIVITIES

Submit [six][_____] copies of the manufacturer' complete spare parts list, showing all parts, spare parts, and bulletins for pumps. Clearly show all details and parts, and adequately describe parts or furnish proper identification marks. Drawings incorporated in the parts lists may be reduced to one-page size provided that they are clear and legible, or the full-size drawings may be folded to the size of the list pages. Photographs or catalog cuts of components may be included for identification.

Furnish one set of all special tools necessary to completely assemble, disassemble, or maintain the pumps. "Special tools" refers to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-22 15 19.13 20 (November 2009)**

Preparing Activity: NAVFAC **Superseding**
UFGS-22 15 19.13 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 22 - PLUMBING

SECTION 22 15 19.13 20

LARGE NONLUBRICATED RECIPROCATING AIR COMPRESSORS (OVER 300 HP)

11/09

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-22 15 19.13 20 (November 2009)**

Preparing Activity: NAVFAC **Superseding**
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References are in agreement with UMRL dated January 2025

****

SECTION 22 15 19.13 20

LARGE NONLUBRICATED RECIPROCATING AIR COMPRESSORS (OVER 300 HP)

11/09

****

NOTE: This guide specification covers the requirements for large nonlubricated reciprocating air compressors larger than 224 kW 300 hp.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Cooling towers or closed-circuit coolers, cooling water piping, and other items are not included and must be included in other sections of the project specification.

****

****

NOTE: The following information must be shown on the project drawings:

1. Compressor, accessory equipment, and piping arrangement and details.

2. Equipment foundations.

3. Equipment schedules. If equipment schedules

include operating conditions for the compressor, delete the information from this section.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Std 618	(2007; R 2016) Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASME PTC 9	(1970; R 1997) Displacement Compressors, Vacuum Pumps and Blowers (for historical reference only)

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B171/B171M	(2024) Standard Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers and Heat Exchangers
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7.1	(2011) Commodity Specification for Air; 5th Edition

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2151	(2004) Acoustics - Noise Test Code for Compressors and Vacuum Pumps - Engineering Method (Grade 2)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation
MIL-T-19646	(1990; Rev A; Notice 1 2021) Thermometer, Gas Actuated, Remote Reading

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

1.2 GENERAL REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section except as specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Air Compressor System

Include wiring diagrams of the air compressor system with all accessories. The minimum acceptable scale is [1:50 1/4 inch to one foot] [_____].

SD-03 Product Data

****
NOTE: Include carbon monoxide monitor in systems which are used for breathing air per DM 3.5, Section 3.
****

Air Compressor

Inlet Air Filters

Inlet Line Silencer

Air Flow Rate and Pressure Recorder

[Carbon Monoxide Monitor

] Filter Housing

Submit manufacturer's catalog data for compressor and auxiliary equipment in the format provided in API Std 618, Appendix A. For air compressors, include aftercooler, intercoolers, oil cooler, lubrication system, and control valves. Submit air compressor intercooler, and aftercooler performance curves at specified summer design conditions.

SD-05 Design Data

Intake and Discharge Pipe Calculations

SD-06 Test Reports

Air Compressor Performance Tests

Sound Level and Run-In Tests

Obtain approval prior to shipping compressor.

Air Compressor Performance Tests

Instrumentation Test

Sound Level Tests

Air Compressor System Test

The test supervisor must certify performance by test to be in compliance with specifications.

SD-07 Certificates

Work Plan

Factory Test Procedures

Factory Testing Certification

Qualifications of Field Supervisors

Field Test Procedures

Training Material

Air Compressor System

Air Compressor System Installation

SD-10 Operation and Maintenance Data

****

NOTE: Obtain approval of equipment with proprietary maintenance requirements from the appropriate contracts office.

****

Air Compressor System, Data Package 3

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions for Air Compressor

Submit text.

1.4 QUALITY ASSURANCE

1.4.1 Intake and Discharge Pipe Calculations

Submit intake and discharge pipe calculations to show intake and discharge piping are not subject to damaging resonance pulsations. Include effects of pulsation dampers and surge chambers, if required to limit pulsation.

1.4.2 Work Plan

Submit a written schedule of dates of installation, start-up, checkout, and test of equipment.

1.4.3 Factory Testing Certification

Submit a statement that the air compressor factory is equipped to perform all required factory tests. Submit in accordance with paragraph MANUFACTURER'S CERTIFICATIONS.

1.4.4 Qualifications of Field Supervisors

Submit the name and certified written resume of the engineer or technician, listing education, factory training and installation, start-up, and testing supervision experience for at least two projects involving compressors similar to those in this contract.

1.4.5 Training Material

Submit a detailed training program syllabus for training of government personnel, including instructional materials at least three weeks prior to start of tests.

1.4.6 System Installation

Submit certification of air compressor system performance conforming to ASME PTC 9. Submit certification of proper system installation in accordance with paragraph SUPERVISION.

1.4.7 Air Compressor System

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Air compressor system data must contain information required for maintenance and repair and must contain no evidence that proprietary maintenance arrangements with the manufacturer will be necessary. Compressors which will require proprietary maintenance arrangement with the manufacturer require Government review and approval. The compressors may be disapproved if circumstances do not justify approval of compressors with limited availability of maintenance.

1.5 SAFETY

Construct all components of the unit in accordance with the requirements of OSHA 29 CFR 1910.219. Requirements include shaft coupling guards as specified in Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, insulation and jacketing with manufacturer standard covering or aluminum sheet of all surfaces at 52 degrees C 125 degrees F and higher within a height of 2.10 meter 7 feet from floor level, and use of electrical safety devices. Thermal insulation, furnished by equipment manufacturer, must conform to ASTM C553, Type I (flexible resilient), Class B-5 (up to 204 degrees C 400 degrees F), 32 kg/m3 2 pcf nominal. Cement insulation to surface with MIL-A-3316, Class 2, adhesive and fasten with 16 gage wire bands at maximum 405 mm 16 inches on center spacing. Cover insulation with ASTM B209M ASTM B209 sheet aluminum jacket.

1.6 EQUIPMENT ARRANGEMENT

Arrangement selected must maintain 0.90 meters 3 foot clearance for access passage and 1.20 meters 4 foot clearance for personnel to operate equipment. There are substantial physical and connection point differences among the several air compressors which comply with this specification. The Contractor must be responsible for selecting equipment and submitting arrangement drawings covering required changes for approval by the Contracting Officer. Changes from the equipment arrangement shown on the contract drawings must be performed by the Contractor at no additional cost to the Government.

1.7 ELECTRICAL REQUIREMENTS

Comply with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM,[and [_____]].

1.8 SUPERVISION

The Contractor must obtain the services of a qualified engineer or technician from the compressor manufacturer to supervise installation, start-up, and testing of the compressor. After satisfactory installation of the equipment, the engineer or technician must provide a signed certification that the equipment is installed in accordance with the manufacturer's recommendations.

1.9 DEFINITIONS

API Std 618 and the following:

Compressor power is shaft power at shaft coupling, including all losses and connected appurtenances.

1.10 INSULATION

Thermal and acoustical insulation must have flame spread rating not higher than 75, and smoke developed rating not higher than 150 when tested in accordance with ASTM E84.

1.11 POSTED OPERATING INSTRUCTIONS

Provide for air compressor. Include start-up and shutdown sequence instructions.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment complete with accessories must be selected by the Contractor for performance compatibility.

2.2 AIR COMPRESSOR

****

NOTE: Provide sound attenuating enclosure or make other provisions to comply with OPNAV 5100.23, Chapter 18, paragraph 18202, "Preventive Measures," which contains noise abatement requirements for new

machinery and equipment. If manufacturers do not furnish sound attenuating enclosure as a factory-built option, delete the sound enclosure from this section and consider other means for meeting noise abatement requirements, such as: (1) other types of compressors which are furnished with sound attenuating enclosures, (2) field erected equipment enclosures from sources other than the compressor manufacturer, and (3) soundproofed office or personnel enclosure.

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The air compressors must be positive displacement, reciprocating, double-acting compressors delivering oil-free air. No lubricant must be used within the compression cylinders. Include air compressor, electric motor driver, coolers, lubrication system, and regulation and control systems mounted on a common base frame, and, if required, completely enclosed for noise control.

2.2.1 Manufacturer's Certifications

The manufacturer must certify that the air compressors proposed are of the same design, construction, size, and of equal or not more than 10 percent smaller in capacity as compressors which have been in satisfactory continuous service for at least 2 years at not less than two locations. Furnish the name of the owner, the address of the installation, and the name of a person at the installation who can be contacted for verification. The manufacturer must also certify that the factory is equipped to perform all required factory tests.

2.2.2 Guaranteed Performance

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NOTE: Designer should furnish required information to complete the specification.

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a. Net compressed air output (All packing and seal losses must be considered internal and not included in the net output) (plus or minus 2 percent): [_____] standard liter per second (L/s) SCFM

b. Output pressure immediately downstream of aftercooler (minus zero plus 4 percent): 862 kPa (gage) 125 psig

c. Output air maximum temperature downstream of aftercooler: 38 degrees C 100 degrees F

d. Inlet air pressure at first stage: [_____] kPa (absolute) psig

e. Inlet air temperature at first stage: [_____] degrees C F

f. Inlet air filtration efficiency: 99.9 percent of 0.5 micron size

g. Barometric pressure: [_____] kPa (absolute) psig

h. Relative humidity: [_____] percent

i. Cooling water inlet temperature: [_____] degrees C F

j. Total cooling water flow rate: [_____] L/s gpm

k. Maximum cooling water pressure drop through the compressor and any intercooler, aftercooler, or oil cooler: [_____] [55 kPa] [8 psi]

l. Maximum compressor power required. (Plus or minus 4 percent): [_____] kW hp

m. Unloaded compressor horsepower (max.): [_____] kW hp

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NOTE: Provide sound attenuating enclosure or make other provisions to comply with OPNAV 5100.23, Chapter 18, paragraph 18202, "Preventive Measures," which contains noise abatement requirements for new machinery and equipment. If manufacturers do not furnish sound attenuating enclosure as a factory-built option, delete the sound enclosure from this section and consider other means for meeting noise abatement requirements, such as: (1) other types of compressors which are furnished with sound attenuating enclosures, (2) field erected equipment enclosures from sources other than the compressor manufacturer, and (3) soundproofed office or personnel enclosure.

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n. Maximum sound levels one meter horizontal from compressor and 1.5 meters 5 feet above floor as measured per ISO 2151: 84 dBA, 90 dB for any octave band.

o. Maximum compressor speed: 550 rpm

p. Maximum piston speed: 3 m/s 590 fpm

q. Maximum power per 47 L/s 100 ACFM: 16.40 kW 22 hp.

2.2.3 Additional Performance Requirements

2.2.3.1 Air Quality

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NOTE: Compressors used to provide breathing air must be situated to avoid entry of contaminated air into the system and suitable in-line filters installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in the event of compressor failure is also required.

****

Air at compressor intake will be considered breathing air quality conforming to CGA G-7.1, Type I, Grade D or better. Air compressors must introduce no material, gases, or particles, or chemically alter any materials that will adversely affect or reduce the quality of the air passing through the unit.

2.2.3.2 Ambient and Inlet Conditions Operating Ranges

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NOTE: Designer should furnish required information to complete the specification.

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Allowing for rational engineering performance adjustments due to variations in ambient and inlet conditions, the compressor must be designed, equipped, and furnished to be fully operational without abnormal wear throughout the entire range between and including the limits of the winter and summer design conditions specified.

a. Summer design conditions:

Inlet air: [_____] degrees C F dry bulb and [_____] degrees C F wet bulb temperatures, [_____] percent relative humidity Inlet cooling water: [_____] degrees C F, Ambient compressor room temperature: [_____] degrees C F, Barometric pressure: [_____] kPa (absolute) psig

b. Winter design conditions:

Inlet air: [_____] degrees C F dry bulb and [_____] degrees C F wet bulb temperatures, [_____] percent relative humidity Inlet cooling water: [_____] degrees C F, Ambient compressor room temperature: [_____] degrees C F, Barometric pressure: [_____] kPa (absolute) psig.

2.2.3.3 Critical Speeds

API Std 618, paragraph 2.5.1.

2.2.4 Electrical Service Conditions

2.2.4.1 Air Compressor Drive Motor

[_____] Volts, 3 phase, 3 wire, 60 hertz electrical service.

2.2.4.2 Accessory electrical Service

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NOTE: Change accessory voltages if required for site conditions.

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See Table I.

TABLE I - COMPRESSOR ACCESSORY ELECTRICAL SERVICE SCHEDULE

Item	Voltage	Phase	Frequency
Control Power and Motors under 3/8	120	1	60 Hz
Accessory Power	460	3	60 Hz

TABLE I - COMPRESSOR ACCESSORY ELECTRICAL SERVICE SCHEDULE

Item	Voltage	Phase	Frequency
Control Power and Motors under 1/2	120	1	60 Hz
Accessory Power	460	3	60 Hz

2.2.5 Compressor Controls

Provide a complete load regulation and control system with the compressor. Provide additional electrical, electro-pneumatic, or solid state electronic controls for other specified control and monitor functions. All electrical controls must conform to NEMA ICS 2 as selected by the compressor manufacturer. Control system enclosure must conform to NEMA ICS 6. Controls must be suitable for individual operation of the compressor or parallel operation with one or more other compressors.

2.2.5.1 Compressor Start-Up

The compressor must start unloaded. The manual starting circuit for the compressor must have interlocks to prevent the compressor drive motor from starting until pre-lubrication pump (if provided), oil pressure, and cooling water pump water flow have been established to the required values for safe operation as determined by the compressor manufacturer.

2.2.5.2 Load Regulation

The compressor must operate continuously at constant speed after being started. Provide means to load and unload the compressor automatically at preset minimum and maximum pressure settings. Minimum pressure must be 689 kPa (gage) 100 psig, and maximum pressure must be 862 kPa (gage) 125 psig. Loading and unloading must be accomplished by a minimum of[three steps (full load, one-half load, and no load).][five steps (full load, three-quarter load, one-half load, one-quarter load, and no load).] Unloading must be accomplished by suction valve unloading, clearance pockets, or a combination of both suction valve unloading and clearance pockets. Input power at fully unloaded operation must not exceed 15 percent of full load input.

2.2.5.3 Monitor and Safety Controls

Supplementary electric, electro-pneumatic, or solid state electronic controls must be provided to provide alarm and shutdown requirements, plus interlocks with accessories. Requirements are as follows:

a. Shutdown requirements must cause the controlled compressor to shut down, energize alarms, and light labeled red lights.

b. Alarm only requirements must not cause the controlled compressor to shut down, but must sound the same alarms and light labeled amber lights.

c. Light only requirements must not cause the controlled compressor to shut down, but must light labeled amber lights.

d. The individual monitor and safety controls must be as shown on Table 2.

TABLE 2 - MONITOR AND SAFETY CONTROL SCHEDULE

Item	Light and Shutdown	Indicating Alarm	Light Only
1. High Discharge Air Temperature 135 degrees C 275 degrees F	Yes	Yes	-
2. High Intercooler Discharge Water Temperature, Each Intercooler	No	Yes	-
3. High Aftercooler Discharge Water Temperature	No	Yes	-
4. High Cooling Water Supply Temperature	No	Yes	-
5. High Lube Oil Temperature	Yes	Yes	-
6. Low Lube Oil Pressure	Yes	Yes	-
7. Low Oil Reservoir Level	No	Yes	-
8. High Condensate Level Intercooler (wired to one light)	Yes	Yes	-
9. High Motor Stator Temperature	Yes	Yes	-
10. High Condensate Level Aftercooler	No	No	Yes
11. High Inlet Pressure Drop Across Inlet Air Filters (combined, 3 stage)	No	Yes	-
12. High CO Level	Yes	Yes	-

2.2.5.4 Monitoring Instruments

Provide the following monitoring instruments in addition to the monitor and safety controls. Pressure gages must conform to ASME B40.100, 115 mm 4 1/2 inch diameter, red marking pointer, single bourdon tube, brass case, black enamel finish. Provide pressure gages with a pressure snubber and a stainless steel barstock needle isolation valve. Thermometers must be extended stainless steel sheathed bimetallic stem, 90 mm 3 1/2 inch dial, and separable 100 mm 4 inchstainless steel wells. Temperature measurements at inaccessible locations must be made with remote reading thermometers conforming to MIL-T-19646, Class C separable well of Type 304 stainless steel. Select pressure and temperature gage ranges to give a normal operating reading near the midpoint of the scale range.

a. Oil cooler outlet temperature gages for oil.

b. Oil cooler inlet and outlet temperature gages for water.

c. Lubrication oil pump discharge pressure gage.

d. Inlet air filter differential pressure gage with 1992, zero, 1992 Pa 8, zero, 8 inch water gage. Provide selector valve, tubing, and tap to measure static gage pressure downstream of each filter stage.

e. Total running time readout.

f. Interstage air pressure gages for each interstage.

g. Cooling water supply to compressor pressure gage.

h. Cooling water return from compressor pressure gage.

i. Compressed air pressure downstream of aftercooler pressure gage.

j. Compressed air temperature downstream of aftercooler temperature gage.

k. Interstage air temperature after intercooler of each stage temperature gages.

l. Compressor inlet air temperature gage.

m. Cooling water to compressor temperature gage.

n. Cooling water outlet temperature at outlet of each intercooler and aftercooler temperature gages.

2.2.6 Compressor Design Features

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NOTE: Provide sound attenuating enclosure or make other provisions to comply with OPNAV 5100.23, Chapter 18, paragraph 18202, "Preventive Measures," which contains noise abatement requirements for new machinery and equipment. If manufacturers do not furnish sound attenuating enclosure as a factory-built option, delete the sound enclosure from this section and consider other means for meeting noise abatement requirements, such as: (1) other types of compressors which are furnished with sound attenuating enclosures, (2) field erected equipment enclosures from sources other than the compressor manufacturer, and (3) soundproofed office or personnel enclosure.

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The compressor must be a multistage, nonlubricated, oil-free reciprocating, double-acting compressor, with a minimum of two compressor stages and water-cooled cylinders and heads. The cylinder arrangement may be horizontal, vertical, V-type, radial, or semi-radial, which will fit in space indicated. An intercooler must be provided between stages, and aftercooler must be provided after the final stage of compression. Silencers, lubricating system, cooling system, control system, and driver must be mounted as part of the package. Provide a common base frame for the compressor system and driver.[Provide a sound enclosure over the compressor and driver.] Equipment must be designed for economical and rapid maintenance. Frame, cylinders, cylinder heads, bearing housings, and other major parts must be shouldered, dowelled, or designed with other provisions, to facilitate accurate alignment or reassembly. Packing, seals, and bearings must be accessible for inspection or replacement with a minimum of disassembly.

2.2.6.1 Frame

Frame must be one-piece cast iron, ribbed for strength, and must provide support for crankshaft main bearings and crossheads, and a sump or reservoir for lubricating oil. The frame must be completely enclosed and provided with gasketed access covers for inspection and maintenance.

2.2.6.2 Crankshaft and Main Bearings

Crankshaft must be one-piece solid forged steel, heat treated, machined, and ground, with hardened bearing surfaces. Counterweights may be removable. Passages for pressure lubrication must be rifle drilled into the crankshaft. The crankshaft must be free of sharp corners with drilled holes or changes in section finished with generous radii and highly polished. Main bearings must be steel backed babbit type or anti-friction, roller type. Crankshaft must be counterweighted and balanced.

2.2.6.3 Connecting Rod

Connecting rod must be of heat treated forged steel, drilled for pressure lubrication, and removable without removing crankshaft. The crankpin bearings must be the steel backed babbit type. The crosshead pin bearings must be bronze. Crosshead pin must be full floating.

2.2.6.4 Crossheads

Crossheads must be box type, cast iron or steel with babbitted wearing surfaces or shoes which are adjustable and replaceable unless means of adjustment are provided in the crosshead guides.

2.2.6.5 Distance Pieces

Distance pieces must be extra long, single compartment, and of sufficient length to prevent oil carryover. No part of the piston rod must alternately enter the crankcase (crosshead housing) and the air compression cylinder stuffing box. The rod must be fitted with an oil slinger or wiper to prevent oil loss from the crankcase, preferably of a split design for easy access to the piston rod packing. Access openings of adequate size must be provided to permit removal of the assembled packing case.

2.2.6.6 Pistons and Piston Rods

a. Pistons must be lightweight castings of anodized aluminum alloy or cast iron. Cast iron pistons must be chromium plated or otherwise treated for corrosion resistance. Pistons must be fitted with not less than two fluorocarbon compression rings in individual ring grooves. Wear bands of fluorocarbon material, if required, must be of one-piece construction. Pistons which are removable from the rod must be attached to the rod by a shoulder and lock nut design. The nuts on the end of the rod must be positively locked in place. The rod must be positively locked to the crosshead to prevent rotation.

b. Piston rods: Piston rods must be of SAE 4140 alloy steel as a minimum with rolled or ground threads. Rods must be surface hardened to 50 Rockwell C hardness in the packing or other wear areas and nondestructively tested for cracks by the magnetic particle or liquid penetrant methods. Rod finish in the packing area must be 0.25 to 0.51 micrometers 10 to 20 microinches, except that for carbon packing the finish must be 0.15 to 0.20 micrometers 6 to 8 microinches. Piston rods must be hard chrome plated.

2.2.6.7 Piston Rod Packing

The piston rod must be sealed against air leakage by floating, self-adjusting seal rings. The packing box must be water cooled. Packing box and packing gland clearances must be adequate to prevent scoring of the piston rod, when maximum wear of the piston wear band occurs.

2.2.6.8 Cylinder and cylinder Heads

a. Cylinders and cylinder heads must be cast iron with integral cooling water passages. Air-cooled cylinders must not be permitted. Cylinders must be spaced and arranged to permit access to all openings and components, including water jacket opening covers, distance piece covers, packing, valves, unloaders, or other controls mounted on the cylinder, without removing the cylinders, the cylinder head, or major piping. Water jackets must be arranged so that there are no gasketed joints which might allow water to enter the cylinder.

b. Cylinder liners or provisions for reboring: Replaceable hardened stainless steel cylinder liners must be provided or the cylinder walls must be of thickness to permit reboring to a radial depth of at least 1.60 mm 1/16 inch without encroaching on the maximum allowable working pressure or the maximum allowable rod load. Cylinder walls or liners using fluorocarbon rings and wear bands must be honed to a finish of 0.25 to 0.51 micrometers 10 to 20 microinches and fluorocarbon burnished.

c. Fasteners: Cylinder heads, stuffing boxes for packing, clearance pockets, and valve covers must be secured with studs. Cylinder lips supporting these devices must be fabricated so that overtorquing studs or nuts will not cause lip failure. Studs must be ASTM A307, Grade B, and must have each end chamfered to remove the first one-and-a-half threads. Studs must be secured into tapped holes by interference fit or other approved means.

d. Cylinder coolant system: Cylinder and cylinder head coolant systems must be designed for not less than [_____] [517 kPa (gage)] [175 psig] working pressure and for a [_____] [69 kPa (gage)] [10 psig] maximum pressure drop. Recommended flow rates must be based on no more than a 6 degrees C 10 degree F temperature rise and a 0.002 fouling factor on the coolant side. Provisions must be made for complete drainage of coolant.

2.2.6.9 Valves

a. Valves must be alloy steel selected for long life, and must be ring, plate, or leaf form, direct or pilot pressure actuated. Suction valves must be provided with unloading devices for capacity control regulation. Each individual unloading device must be provided with a visual indication of its position and its load (loaded or unloaded) condition.

b. The valve design (including that for double-decked valves) must be such that valve assemblies cannot be inadvertently reversed, nor a suction valve assembly be fitted into a discharge port.

c. Valve seats must be removable. Valve seat-to-cylinder gaskets and valve cover-to-cylinder gaskets must be solid metal. Nonmetallic gaskets must not be used.

d. The valve and cylinder designs must be such that the valve cage or the assembly bolting (or both) cannot fall into the cylinder even if the valve assembly bolting breaks or unfastens.

e. The ends of coil valve springs must be squared and ground to protect the plate against damage by the spring ends.

f. Valve hold-downs must bear at not less than three points on the valve cage. The bearing points must be arranged as symmetrically as possible.

g. Metal valve discs or plates, when furnished, must be suitable for installation with either-side sealing and must be lapped on both sides. Edges must be suitably finished to remove stress risers. Valve seats must also be lapped.

2.2.6.10 Compressor Connections

Flanged compressor connections must conform to ASME B16.1 or ASME B16.5. Threaded connections must conform to ASME B1.20.1.

2.2.6.11 Intercoolers, Aftercooler, and Oil Coolers

Intercoolers, aftercooler, and oil cooler must include ASTM B111/B111M admiralty brass or other corrosion resistant tubes in ASTM B171/B171M admiralty or steel tube sheets and baffles for optimum cooling and fouling resistance using [fresh] [_____] water. Provide intercoolers between stages of compression either integral with unit or factory assembled on unit base with piping. The aftercooler must be mounted separately from the unit base. Intercoolers, aftercooler, and oil cooler must be factory tested at 1.5 times operating pressure. External intercoolers and aftercooler must be constructed in accordance with ASME BPVC SEC VIII D1 requirements and be ASME code stamped for [_____] [1207 kPa (gage)] [175 psig] working pressure. Intercoolers and aftercooler must be capable of one piece bundle removal. Intercoolers and aftercooler must be equipped with an integral or direct connected moisture separator with condensate trap assembly. Design intercoolers and aftercooler for 11 and 8 degrees C 20 and 15 degrees F approach, respectively; however, the approach temperature used to size the coolers must be reduced if required to meet aftercooler maximum air outlet temperature specified. Nonstandard coolers must be provided if required to meet the aftercooler maximum air outlet temperature requirement. All coolers must be of counter-flow design, with a fouling factor of 0.002 for both sides of the coolers.

2.2.6.12 Lubrication System

Include an integral sump, shaft driven positive displacement pump, oil cooler, and duplex filter/strainer (readily replaceable cartridges while operating). System must be factory assembled and tested. Lubricating oil must conform to recommendations of the compressor manufacturer. Bearings and crosshead shoes must be pressure lubricated. Provide the oil sump with a level indicator and drain and fill connections.

Lube oil heater: Provide thermostatically controlled electric heater in lubrication oil sump of sufficient capacity to heat up and maintain manufacturer's recommended oil temperature when unit is cold at [_____] [0 degrees C] [32 degrees F] ambient. Provide low level indicator with light for protection of the heater.

2.2.6.13 Pulsation Control

If pulsation problems exist, provide pulsation dampers or surge chambers.

2.2.7 Electric Motors

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NOTE: Polyphase motors must be selected based on requirements of the driven equipment, service conditions, motor power factor, life cycle cost, and high efficiency in accordance with NEMA MG 10.

Use Motor Master software program to identify the most efficient and cost effective polyphase motor for a specific application. Motor Master is located in the "TOOLS" section of Construction Criteria Base (CCB). For additional guidance contact Charlie Mandeville of the NAVFAC Criteria Office at (757) 322-4208. Another source of information on energy efficiency is E-source, accessible to Navy, users on the Naval Facilities Engineering Service (NFESC) energy home page http://energy.navy.mil/.

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Efficiency and losses must be determined in accordance with IEEE 112. Unless otherwise specified horizontal polyphase squirrel cage motors rated one to 125 horsepower must be tested by dynamometer Method B as described in Section 6.4 of IEEE 112. Motor efficiency must be calculated using Form B of IEEE 112 calculation procedure.

Polyphase motors larger than 125 horsepower must be tested in accordance with IEEE 112 with stray load loss determined by direct measurement or indirect measurement (test loss minus conventional loss).

The efficiency must be identified on the motor nameplate by the caption NEMA Nominal efficiency or NEMA Nom eff.

2.2.7.1 Main Electric Drive Motor

The main drive motor for each compressor must be a polyphase [induction][or][synchronous] motor, [_____] kW horsepower, with a continuous service factor of 1.0. Size the motor so that the nameplate kW horsepower rating is not exceeded under the entire range of operating conditions specified.[Design of induction motor must be high efficiency type, rated not less than 95 percent, based on IEEE 112 testing and labeling.] Electrical service will be as specified. Motor must be designed for reduced voltage starting [at [50] [65] [80] percent of full voltage], allowing for characteristics of the connected load, and must start without undervoltage tripping. Provide resistance temperature detectors (RTD) attached to or imbedded in motor winding for control system. The motor must meet the requirements of NEMA MG 1 with Class F insulation. Provide space heaters for protection of windings during motor shutdowns.

2.2.7.2 Accessory and Related Equipment Motors

Motors less than 3/8 kW 1/2 horsepower must be single phase induction motors and must conform to NEMA MG 1. Motors 3/8 through 3.75 kW 1/2 through 5 horsepower must be three-phase induction motors and must conform to NEMA MG 1. Single-phase and three-phase motors must have bimetallic disk thermostats attached to or imbedded in the motor winding. Motors must have NEMA MG 1, Class B insulation.

2.2.8 Control Panel

Control unit panel must conform to NEMA ICS 6, floor or frame mounted, factory designed, and assembled, and must be provided complete. The panel must be fabricated of formed stretcher leveled sheet steel, reinforced, and assembled into a rigid unit. Gasketed access doors must be provided as required. Panel must be factory finish painted. The panel must meet NEMA 12 requirements.

a. Panel must contain electric and safety control work required, including either alarm annunciator or individual labeled pilot lights arranged in a group. Panel must contain alarm device with light and silencing. Generalized arrangement in accordance with drawings.

b. Panel must contain start and stop buttons (the latter with lockout feature), discharge air pressure gage, control test switch and lights, reset button, green unit running light, and control selector switch.

c. Oil pressure gages must be mounted separately from panel.

2.2.9 Accessories

Required accessories include:

2.2.9.1 Compressor Air Inlet

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NOTE: Change air compressor inlet description to suit project if required.

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Compressor air inlet must be piped to the outside of the building and consist of the following:

a. Intake weather hood with rain hood and bird screen. Material must be galvanized steel or aluminum alloy, minimum 20 gage.

b. Intake pipe, ASTM A36/A36M steel, ASTM A123/A123M or ASTM A153/A153M galvanized, 12 gage or Schedule 5 minimum, from intake weather hood to filter housing flange, welded construction.

c. Filter housing by filter manufacturer to include filter frames, access door(s). Material for housing must be 1.65 mm 0.065 inch thick Class 5000 aluminum alloy. Unit must be rigid and free from distress with all seams sealed.

d. Intake pipe from filter enclosure to compressor: Steel pipe, ASTM A53/A53M, seamless or welded, 6.35 mm 0.250 inchminimum wall thickness. Fittings butt welding, ASME B16.9, 6.35 mm 0.250 inch minimum wall thickness. Flanges: ASME B16.5, Class 150, welding neck or slip-on, flat-faced.

2.2.9.2 Compressor Air Outlet

Compressor air outlet flexible connection of stainless steel bellows with braided steel cover jacket, with stainless steel liner sleeve, 460 mm 18 inch nominal length bellows, flanged ends, Class 150.

2.2.10 Inlet Air Filters

Provide a three-stage filter system, complete with mounting racks (horizontal flow), interstage seals, and replaceable filters. Filter unit must be provided complete including enclosure or housing, and frames. Enclosure must be Class 5000 aluminum alloy with inlet and outlet flanges. Construction must be welded or, where welding is not practical, close riveted and caulked, weathertight, with access doors for filter replacement and cleaning. Access doors must be reinforced, fully gasketed with continuous flexible neoprene gaskets, corrosion-resistant continuous hinges and quarter-turn latches to ensure tightness. All internal ferrous surfaces, including galvanized, must receive a factory-applied epoxy prime and finish coat for corrosion resistance. Filters must consist of three separate stages and sized to fit the available space.

2.2.10.1 First-Stage Filter

First-stage filter must be flat, 50 mm 2 inch thickness, replaceable media, and rated for the required air quantity at 2.54 m/s 500 FPM nominal face velocity, friction clean 62 Pa 0.25 inch water gage, efficiency 98 percent of 15 microns and 90 percent of 5 microns.

2.2.10.2 Second-Stage Filter

Second-stage filter must be deep pleated type, 230 mm 9 inchesnominal depth and rated for the required air quantity at 1.78 m/s 350 FPM nominal face velocity, friction clean 50 Pa 0.20 inch watergage, efficiency 98 percent of 5 microns and 90 percent of 3 microns.

2.2.10.3 Third-Stage Filter

Third stage filter must be deep pleated type 305 mm 12 inchesminimum depth and rated for the required air quantity at 1.78 m/s 350 FPM nominal face velocity, friction clean 75 Pa 0.30 inch watergage, efficiency 99.9 percent of 0.5 micron.

2.2.10.4 Filter Media

Filter media must be rated and listed UL Class 2. Filter efficiencies must be based on National Bureau of Standards (NBS) type discoloration gravimetric test method using atmospheric dust.

2.2.11 Inlet Line Silencer

An inlet line silencer must be furnished with each compressor as selected by compressor manufacturer for sufficient noise attenuation to meet OSHA sound level criteria but not greater than 84 dBA measured at an elevation of 1.50 meter 5 feet, and 3 meter 10 feet horizontally from silencer.

2.2.12 Sound Attenuating Enclosure

****

NOTE: Provide sound attenuating enclosure or make other provisions to comply with OPNAV 5100.23, Chapter 18, paragraph 18202, "Preventive Measures," which contains noise abatement requirements for new machinery and equipment. If manufacturers do not furnish sound attenuating enclosure as a factory-built option, delete the sound enclosure from this section and consider other means for meeting noise abatement requirements, such as: (1) other types of compressors which are furnished with sound attenuating enclosures, (2) field erected equipment enclosures from sources other than the compressor manufacturer, and (3) soundproofed office or personnel enclosure.

****

The compressor package, including the driver motor, must be contained within a noise reducing enclosure. Design of the enclosure must be such as to limit noise transmission to 84 dBA or less at a distance of one meter from the compressor in any direction.

2.2.12.1 Enclosure Frame

The enclosure frame must be designed to support the weight of the sound suppression panels and to be easily demountable. Connections to the base frame must be designed to allow the enclosure frame to be detached and lifted away without damage to the connections, enclosure frame or base frame, and to allow accessibility and replacement of any component.

2.2.12.2 Panels

The panels must be of rigid construction to allow repeated access without damage or distortion. Sound absorbing material must be mineral fiber, treated to preclude shedding of fibers. Other approved insulation may be used except that polyurethane foam must not be permitted. Top panels must be secured to the enclosure frame with quick disconnect fittings and fabricated to allow easy hand removal for maintenance. End and side panels must be hinged or lift out with positive closure latches. Panels must be designed to allow the maximum access area when opened. Provide acoustic seals as required. Controls and instrumentation mounted on the panels must have flexible connections for panel opening and disconnects for enclosure removal. Disconnects must be of the male-female plug type. Panels must split around all piping connections to allow enclosure removal without detaching piping. Controls must be visible and operable from outside the enclosure.

2.2.12.3 Ventilation

Fan(s) and sound baffled ventilation grilles must be provided as part of the enclosure. Ventilation must be sufficient to limit interior temperature to that required for cooling the motor.

2.3 AIR FLOW RATE AND PRESSURE RECORDER MEASUREMENT

Provide a complete flow and pressure measurement and recording package. Provide orifice flanges with pressure taps, square edged stainless steel paddle orifice plate. The orifice plate must be concentric type, of 3 mm 0.125 inch thickness and must meet ASME Standards. Orifice must be sized for 10 kPa 40 inch water column differential at a full scale flow rate of [_____] L/s SCFM at compressor based on 827 kPa (gage) 120 psig upstream pressure. Static gage pressure measurement device of the recorder must have a range of zero to 1379 kPa (gage) 200 psig. Provide copper interconnecting tubing between the pressure taps and the recorder as part of this measurement and recording package. Provide a two-pen recorder for the measurement station. Pens must record pressure (0 to 1379 kPa (gage) 200 psig range) and air flow (0 to [_____] L/s SCFM). Recorder must be electric drive and housed in dust-tight steel cabinet. Charts must be 305 mm 12 inchdiameter with evenly divided graduations. Drive must be 7 day circle. Provide continuous flow integration of a 7 digit counter type. Pens must be supplied with long-life cartridges and capillary supply. Chart case must be internally illuminated. Access to charts must be through front access window door. Calibrated overall accuracy of the recorded measurements must be within plus or minus 1.0 percent of full scale. Furnish a supply of 400 charts with the recorder.

2.4 CARBON MONOXIDE MONITOR

****

NOTE: Include carbon monoxide monitor in systems which are used for breathing air per DM 3.5, Section 3.

****

The carbon monoxide (CO) monitor unit must be of the pressure type with attached sampling system. The unit must be solid state type operation, 2 to 50 ppm range, CO indicating, with provisions for milliamp signal to remote recorder, adjustable set point, and normally open/normally closed contacts for remote signal. Power must be 120 volt, single phase, 60 hertz with power cord and plug. Response time normally 2 minutes per sample/purge. Unit must be mounted in a gasketed enclosure with face gage indicating CO readings.

2.4.1 Sampling System

Sampling system must include shutoff valve filter/regulator, pressure gage, manual drainer, and line humidifier set at 50 percent. Draw sample from compressor discharge.

2.4.2 Test System

Test system must include calibration gas (20 ppm CO) cylinder test gas (200 ppm CO) cylinder, and calibration connectors with quick disconnect.

2.5 SOURCE QUALITY CONTROL

2.5.1 Factory Test Procedures

The completely assembled air compressor package including the actual contract drive motor, intercooler, lubrication system, and control panel must be subjected to air compressor performance tests and sound level and run-in tests. Unit must comply with guarantee requirements applying engineering adjustments to guarantee conditions. Test must be certified by the manufacturer. Test may be run on the manufacturer's test stand using driver for this contract. Tests must be in accordance with ASME PTC 9 format. Full-range performance tests must indicate performance at maximum rated flow, rating point, and unloaded conditions. All accessory performance conditions must be reported, including intercoolers, aftercoolers, and lubrication and control systems. Completed unit must be factory tested with sound meters in accordance with ISO 2151. Location must be one horizontal meter from unit at 1.5 meters above the floor. Test must include readings at each octave band midpoint and the "A" scale, and must not exceed 84 dBA and 90 decibels at any octave band. Results of test must be included in the factory test report on the ISO 2151 format. Factory test data may be corrected to the levels of an equivalent background noise level of 60 dBA showing calculations for reference use.

2.5.2 Supervision of Testing

System and components testing must be conducted or supervised by either a designated authorized and factory trained representative of the compressor manufacturer supplying the unit or a registered Mechanical Engineer experienced in such work.

2.5.3 System Test

Testing of system must conform to requirements outlined and must be witnessed by the Contracting Officer.

2.5.4 Approval of Testing Procedure

Proposed testing procedure must be approved by the Contracting Officer and the individual in charge of testing prior to conducting tests.

2.5.5 Certification of Performance Tests

The test supervisor must certify performance by test to be in compliance with specifications.

PART 3 EXECUTION

3.1 INSTALLATION

The Contractor must install the air compressors and accessories in accordance with manufacturer's recommendations and as indicated on the drawings. All equipment must be installed plumb and level and anchored to structure, matching holes provided. Install the compressor under the direct supervision of an authorized representative of the manufacturer.

3.2 GENERAL REQUIREMENTS FOR INSTALLING AIR COMPRESSORS

****

NOTE: Delete or modify requirements on existing building and weight handling equipment to suit the project.

****

Air compressors with contract motor and accessories must be factory assembled, run in, and tested complete before shipment to job site.[The Contractor is advised that there are limitations to door opening sizes and available crane lifting capacity. Crane unit is specified to permit single lifts of complete compressor under special approval only.] Should the unit require disassembly for installation, reassembly must be under the direct supervision of the compressor manufacturer's authorized representative. Complete unit must be mounted on a rigid single or equivalent mechanically joined steel or iron base. Submit installation sequence plans to the Contracting Officer for approval prior to installation.[Any building materials removed to accomplish installation must be reinstalled if undamaged, by removal procedures; or if damaged, must be replaced with new materials to match original configuration.]

3.2.1 Prompt Installation

The Contractor is advised that any compressor received must be installed and placed in operation promptly to prevent time deterioration when not installed. Should the Contractor sustain a delay exceeding 90 days prior to actual installation, the Contracting Officer must have the option of requiring breakdown and reassembly to inspect and clean prior to placing in operation. This work must be at no additional cost to the Government.

3.2.2 Start-Up Services

The Contractor must furnish the services of a compressor manufacturer's authorized representative to supervise prestart checkout, initial start-up, performance testing, and operator instruction. Time available must be as required to properly start up but not less than three consecutive days for the compressor.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Test Procedures

Complete field performance testing of the total system must be performed by the Contractor and witnessed by the Contracting Officer. Air compressor system test must be conducted by either a compressor manufacturer's factory trained and authorized representative approved by the Contracting Officer or a qualified registered Mechanical Engineer. Tests may be run on individual components or on the system as a whole at Contractor option. Field tests require use of the actual compressor drive motor. Test must include operation at rated capacity for not less than 4 hours.

3.3.1.1 Performance Tests

Complete performance test must be run at maximum load, rated load, at point of unload but prior to unload, and unloaded condition. Data must be recorded listing:

a. Air flow, inlet pressure and temperature, humidity; discharge pressure and temperature.

b. Intercooler water flows, temperatures, and pressures.

c. Aftercooler water flow, temperatures, and pressures.

d. Lube oil cooling water flow, temperatures, and pressures.

e. Lube oil flow, pressures, and temperature.

f. Cooling water pump flow, pressures, and motor amperage.

g. [Cooling tower][Closed circuit cooler]air flow, water and air temperatures, water pressure, and motor amperage.

h. Electrical load in volts and amperes for compressor motor (loaded and unloaded) and compressor auxiliaries.

i. Intake filter pressure differential (clean).

j. Start-up sequence, alarm signals and automatic system shutdown.

k. Test compressor intake and discharge for conformance to CGA G-7.1. Compressor discharge must show no increase in contaminants.

3.3.1.2 Instrumentation Test

The Contractor may use instrumentation provided in the contract and instrumentation provided by the Contractor to conduct the test. The testing procedure and instrumentation must be submitted to the Contracting Officer for approval prior to conducting tests. The format of ASME PTC 9 is required. It is intended that a full field test be performed. However, in lieu of precise instrumentation, the Contractor may use certified cooling water pump curves[and[cooling tower][closed circuit cooler] fan curves]. Shutdown signals must be caused by throttling selected fluids. Test data, such as air intake temperature and humidity, must be mathematically corrected to performance test requirement levels.

3.3.1.3 Sound Level Tests

Sound level tests must be conducted concurrently. Broad Band "A" scale readings and Octave Band readings must be taken and recorded at the same positions as on the factory testing. Maximum permissible level must be 84 decibels one horizontal meter from the compressor and 1.5 meters above the floor, with unit in operation and all other significant equipment not required for test within the same building bay shutdown at the same location previously described. A background noise correction to 60 decibels is permissible.

3.3.1.4 Operational Deficiencies

Any operational deficiencies noted in the tests must be promptly corrected and affected portions of the test rerun.

3.3.1.5 Field Test Tolerances

A tolerance of plus or minus 2 percent on flow, plus or minus 4 percent on power, or plus or minus 5 percent on any other variable for each item of equipment or fluid with all others conforming is permissible on field test results when compared to factory test data and to guarantee performance data except that compressor air flow, discharge pressure, and motor power must be met.

3.3.2 Approval of Testing Procedure

Proposed testing procedure must be approved by the Contracting Officer and the individual in charge of testing prior to conducting tests.

3.4 TRAINING OF GOVERNMENT PERSONNEL

During start-up and field testing, train Government station personnel in the operation and maintenance of compressor,[cooling tower,][closed circuit cooler,] associated equipment, and all control and safety devices. Training must not commence until equipment is operational and station personnel are in attendance. At least one day of classroom training and one day of field training must be furnished for each designated Government personnel. When factory training is required by the compressor manufacturer for proper maintenance and overhaul of the compressor, such training will be furnished by the compressor manufacturer at no additional cost to the Government. The Government will bear the cost of travel and living expenses for Government personnel as necessary for the factory training.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-22 15 19.19 20 (May 2011)**

Preparing Activity: NAVFAC **Superseding**
UFGS-22 15 19.19 20 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 22 15 19.19 20

NONLUBRICATED ROTARY SCREW AIR COMPRESSORS (100 HP AND LARGER)

05/11

****

NOTE: This guide specification covers the requirements for large nonlubricated rotary screw air compressors 75 kW 100 hp and larger.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Cooling towers, closed-circuit coolers, cooling water piping, and other items are not included and must be included in other sections of the project specification. Nonlubricated rotary screw compressors should be checked for compliance with the 50 percent or more domestic components requirement Buy American Act when submitted by Contractors for installation on construction contracts since they incorporate major parts not made in the U.S.A. For supply contracts, a memorandum of understanding may fulfill requirement of the Buy American Act. CENTRIFUGAL COMPRESSORS MUST BE PERMITTED AS AN OPTION IF NONLUBRICATED ROTARY SCREW COMPRESSORS ARE SPECIFIED IN THE PROJECT, using Section 22 16 19.26 20 LARGE CENTRIFUGAL AIR COMPRESSORS (OVER 200 HP).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2011	(2014B) Cylindrical Wormgearing Tolerance and Inspection Methods
ANSI/AGMA 2009	(2001B; R 2008) Bevel Gear Classification, Tolerances, and Inspection Methods

AMERICAN PETROLEUM INSTITUTE (API)

API Std 619	(2010) Rotary-Type Positive Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged

	Fittings Classes 25, 125, and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 9	(1970; R 1997) Displacement Compressors, Vacuum Pumps and Blowers (for historical reference only)

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B171/B171M	(2024) Standard Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers and Heat Exchangers
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7.1	(2011) Commodity Specification for Air; 5th Edition

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2151	(2004) Acoustics - Noise Test Code for Compressors and Vacuum Pumps - Engineering Method (Grade 2)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation
MIL-T-19646	(1990; Rev A; Notice 1 2021) Thermometer, Gas Actuated, Remote Reading

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

1.2 GENERAL REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section except as specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification

and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Air Compressor System

SD-03 Product Data

****
NOTE: Include carbon monoxide monitor in systems which are used for breathing air per DM 3.5, Section 3.
****

Air Compressor

Inlet Air Filters

Line Silencer

Air Flow Rate and Pressure Recorder

[Carbon Monoxide Monitor

] Filter Housing

Submit manufacturer's catalog data for compressor and auxiliary equipment in the format provided in API Std 619, Appendix A. For air compressors, include intercoolers, oil cooler, lubrication system, and control valves. Submit air compressor, intercooler, aftercooler, and bypass cooler performance curves at specified summer and winter design conditions. For electric motors include overall physical features dimensions, ratings, service requirements, efficiency, and weight of equipment.

SD-06 Test Reports

Air compressor performance tests

Sound Level Tests

Obtain approval prior to shipping compressor.

Government must have the option to observe test procedures and vendor will provide two (2) copies of test results and two (2) copies of maintenance manuals.

Air Compressor Performance Tests

Instrumentation Test

Sound Level and Run-in Tests

Air Compressor System Test

The test supervisor must certify performance by test to be in compliance with specifications.

SD-07 Certificates

Work Plan

Factory Test Procedures

Factory Testing Certification

Qualifications of Field Supervisors

Field Test Procedures

Training Material

Air Compressor System

Air Compressor System Installation

SD-10 Operation and Maintenance Data

****

NOTE: Obtain approval of equipment with proprietary maintenance requirements from the appropriate contracts office.

****

Air Compressor System, Data Package 3

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Data must contain information required for maintenance and repair and must contain no evidence that proprietary maintenance arrangements with the manufacturer will be necessary. Compressors which will require proprietary maintenance arrangement with the manufacturer require Government review and approval. The compressors may be disapproved if circumstances do not justify approval of compressors with limited availability of maintenance.

SD-11 Closeout Submittals

Posted Operating Instructions for Air Compressor

Submit text.

1.4 QUALITY ASSURANCE

1.4.1 Work Plan

Submit a written schedule of dates of installation, start-up, checkout, and test of equipment.

1.4.2 Factory Testing Certification

Submit a statement that the air compressor factory is equipped to perform all required factory tests. Submit in accordance with paragraph entitled "Manufacturer's Certifications."

1.4.3 Qualifications of Field Supervisors

Submit the name and certified written resume of the engineer or technician, listing education, factory training and installation, start-up, and testing supervision experience for at least two projects involving compressors similar to those in this contract.

1.4.4 Training Material

Submit a detailed training program syllabus for training government personnel, including instructional materials at least three weeks prior to start of tests.

1.4.5 System Installation

Submit certification of performance conforming to ASME PTC 9 and ASME BPVC SEC VIII D1. Submit certification of proper installation in accordance with paragraph entitled "Supervision."

1.5 SAFETY

Construct all components of the unit in accordance with the requirements of OSHA 29 CFR 1910.219. Requirements include shaft coupling guards as specified in Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS insulation and jacketing with manufacturer standard covering or aluminum sheet of all surfaces at 52 degrees C 125 degrees F and higher within a height of 2.10 meter 7 feet from floor level, and use of electrical safety devices. Thermal insulation, furnished by equipment manufacturer, must conform to ASTM C553, Type I (flexible resilient), Class B-5 (up to 204 degrees C 400 degrees F), 32 kg/m3 2 pcf nominal. Cement insulation to surface with MIL-A-3316, Class 2, adhesive and fasten with 16-gage wire bands at maximum 405 mm 16 inches on center spacing. Cover insulation with ASTM B209M ASTM B209 sheet aluminum jacket. However, insulation is not required for hot piping inside sound enclosure.

1.6 EQUIPMENT ARRANGEMENT

Arrangement selected must maintain 0.9 meters 3 foot clearance for access passage and 1.20 meters 4 foot clearance for personnel to operate equipment. There are substantial physical and connection point differences among the several air compressors which comply with this specification. The Contractor must be responsible for selecting equipment and submitting arrangement drawings covering required changes for approval by the Contracting Officer. Changes from the equipment arrangement shown on the contract drawings must be performed by the Contractor at no additional cost to the Government.

1.6.1 Air Compressor System

Include wiring diagrams of the air compressor with all accessories. The minimum acceptable scale is [1:50 1/4 inch to one foot] [_____].

1.7 ELECTRICAL REQUIREMENTS

Comply with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM [and [_____]].

1.8 SUPERVISION

The Contractor must obtain the services of a qualified engineer or technician from the compressor manufacturer to supervise installation, start-up, and testing of the compressor. After satisfactory installation of the equipment, the engineer or technician must provide a signed certification that the equipment is installed in accordance with the manufacturer's recommendations.

1.9 DEFINITIONS

Conform to API Std 619 and the following:

Compressor power is shaft power at shaft coupling, including all losses and connected appurtenances.

1.10 INSULATION

Thermal and acoustical insulation must have flame spread rating not higher than 75, and smoke developed rating not higher than 150 when tested in accordance with ASTM E84.

1.11 POSTED OPERATING INSTRUCTIONS

Provide for air compressor. Include start-up and shutdown sequence instructions.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment complete with accessories must be selected by the Contractor for performance compatibility.

2.2 AIR COMPRESSOR

****

NOTE: The use of restrictive requirements for the nonlubricated rotary screw air compressor specified in this guide specification has been approved by NAVFACENGCOM HQ (Code 021) in accordance with the requirements of the Naval Facilities Acquisition Supplement (NFAS). NFAS can be found at the following link:
https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_forbusinesses_pp/smallbusiness/contracting/navfac
The paragraphs in this guide specification may be used without any further NAVFACENGCOM HQ approval or request for waiver.

****

The air compressors must be packaged, positive displacement rotary screw compressors capable of delivering oil-free air. No lubricant must be used within the compression chamber. Include air compressor, electric motor driver, coolers, lubrication system, and regulation and control systems mounted on a common base frame, and completely enclosed for noise control.

2.2.1   Manufacturer's Certifications

The manufacturer must certify that the air compressors proposed are of the same design, construction, size, and of equal or not more than 10 percent smaller in capacity as compressors which have been in satisfactory continuous service for at least 2 years at not less than two locations. Furnish the name of the owner, the address of the installation, and the name of a person at the installation who can be contacted for verification. The manufacturer must also certify that the factory is equipped to perform all required factory tests.

2.2.2   Guaranteed Performance

****

NOTE: Designer should furnish required information to complete the specification.

****

a. Net compressed air output (All seal losses must be considered internal and not included in the net output) (plus or minus 2 percent): [_____] standard liter per second (L/s) SCFM

b. Output pressure immediately downstream of aftercooler (minus zero plus 4 percent): 862 kPa (gage) 125 psig

c. Output air maximum temperature downstream of aftercooler: 38 degrees C 100 degrees F

d. Inlet air pressure at first stage: [_____] kPa (absolute) psig

e. Inlet air temperature at first stage: [_____] degrees C F

f. Inlet air filtration efficiency: 99.9 percent of 0.5 micron size

g. Barometric pressure: [_____] kPa (absolute) psig

h. Relative humidity: [_____] percent

i. Cooling water inlet temperature: [_____] degrees C F

j. Total cooling water flow rate: [_____] L/s gpm

k. Maximum cooling water pressure drop through the compressor and any intercooler, aftercooler, or oil cooler: [_____] [55 kPa (gage)] [8 psig]

l. Maximum compressor power required. (Plus or minus 4 percent): [_____] kW hp

m. Unloaded compressor power (maximum): [_____] kW hp

n. Maximum sound levels one meter horizontal from compressor and 1.5 meters above floor as measured per ISO 2151 Test Code for the Measurement of Sound from Pneumatic Equipment: 84 dBA, 90dB for any octave band.

2.2.3 Additional Performance Requirements

2.2.3.1 Air Quality

Air at compressor intake will be considered breathing air quality conforming to CGA G-7.1, Type I, Grade D or better. Air compressors must introduce no material, gases, or particles, or chemically alter any materials that will adversely affect or reduce the quality of the air passing through the unit.

2.2.3.2 Ambient and Inlet Conditions Operating Ranges

****

NOTE: Designer should furnish required information to complete the specification.

****

Allowing for rational engineering performance adjustments due to variations in ambient and inlet conditions, the compressor must be designed, equipped, and furnished to be fully operational without abnormal wear throughout the entire range between and including the limits of the winter and summer design conditions specified.

a. Summer Design Conditions:

Inlet Air: [_____] degrees C F dry bulb and [_____] degrees C F wet bulb temperatures, [_____] percent relative humidity, Inlet Cooling Water: [_____] degrees C F, Ambient Compressor Room Temperature: [_____] degrees C F, Barometric Pressure: [_____] kPa (absolute) psig

b. Winter Design Conditions:

Inlet Air: [_____] degrees C F dry bulb and [_____] degrees C F wet bulb temperatures, [_____] percent relative humidity, Inlet Cooling Water: [_____] degrees C F, Ambient Compressor Room Temperature: [_____] degrees C F, Barometric Pressure: [_____] kPa (absolute) psig.

2.2.3.3 Critical Speeds

Actual critical speeds must not encroach upon operating speed ranges at specified loads ranges. Rotors must be of a stiff shaft construction with the first actual rotor bending critical speed at least 120 percent of the maximum operating speed.

2.2.3.4 Vibration and Balance

Major parts of rotating elements, such as rotors, gears, and similar items must be individually dynamically balanced. During the factory and site tests of the assembled machine at operating speed, the double amplitude of vibration in any plane measured on the shaft adjacent and relative to a radial bearing must not exceed the limits of API Std 619, paragraph 2.7.2.5. For shafts which are not accessible, the manufacturer must submit a testing procedure to the Contracting Officer for approval.

2.2.4 Electrical Service Conditions

2.2.4.1 Air Compressor Drive Motor

[_____] volts, 3 phase, 3 wire, 60 hertz electrical service.

2.2.4.2 Accessory electrical Service

****

NOTE: Change accessory voltages if required for site conditions.

****

See Table I.

TABLE I - COMPRESSOR ACCESSORY ELECTRICAL SERVICE SCHEDULE

Item	Voltage	Phase	Frequency
Control Power and Motors under 3/8	120	1	60 Hz
Accessory Power	460	3	60 Hz

TABLE I - COMPRESSOR ACCESSORY ELECTRICAL SERVICE SCHEDULE

Item	Voltage	Phase	Frequency
Control Power and Motors under 1/2	120	1	60 Hz
Accessory Power	460	3	60 Hz

2.2.5 Compressor Controls

Provide a complete load regulation and control system with the compressor. Provide additional electrical, electro-pneumatic, or solid state electronic controls for other specified control and monitor functions. All electrical controls must conform to NEMA ICS 2 as selected by the compressor manufacturer. Control system enclosure must conform to NEMA ICS 6. Controls must be suitable for individual operation of the compressor or parallel operation with one or more other compressors.

2.2.5.1 Compressor Start-Up

The compressor must start unloaded. The manual starting circuit for the compressor must have interlocks to prevent the compressor drive motor from starting until pre-lubrication pump (if provided), oil pressure, and cooling water pump water flow have been established to the required values for safe operation as determined by the compressor manufacturer.

2.2.5.2 Load Regulation

The compressor must operate continuously at constant speed after being started. Provide means to load and unload the compressor automatically at preset minimum and maximum pressure settings. Minimum pressure must be 689 kPa (gage) 100 psig, and maximum pressure must be 862 kPa (gage) 125 psig. Unloading must be accomplished by a combination of closing the inlet valve and bypassing or venting the outlet of the compressor; however, input power at fully unloaded operation must not exceed 20 percent of full load input. Bypassed air must be cooled by the bypass cooler and if returned to the inlet of the first stage through an internal loop and must be limited to the minimum flow required to maintain compressor cooling. Air vented to the atmosphere when unloading need not be cooled.

2.2.5.3 Monitor and Safety Controls

Provide supplementary electric, electro-pneumatic, or solid state electronic controls to provide alarm and shutdown requirements, plus interlocks with accessories. Requirements are as follows:

a. Shutdown requirements must cause the controlled compressor to shut down, energize alarms, and light labeled red lights.

b. Alarm only requirements must not cause the controlled compressor to shut down, but must sound the same alarms and light labeled amber lights.

c. Light only requirements must not cause the controlled compressor to shut down, but must light labeled amber lights.

d. The individual monitor and safety controls must be as shown on Table 2.

TABLE 2 - MONITOR AND SAFETY CONTROL SCHEDULE

Item	Light and Shutdown	Indicating Alarm	Light Only
1. High Discharge Air Temperature 135 degrees C 275 degrees F	Yes	Yes	-
2. High Intercooler Discharge Water Temperature, Each Intercooler	No	Yes	-
3. High Aftercooler Discharge Water Temperature	No	Yes	-
4. High Cooling Water Supply Temperature	No	Yes	-
5. High Lube Oil Temperature	Yes	Yes	-
6. Low Lube Oil Pressure	Yes	Yes	-
7. Low Cooling Water Flow	No	Yes	-
8. Low Oil Reservoir Level	No	Yes	-
9. High Condensate Level Intercooler (wired to one light)	No	No	Yes
10. High Bleed-Off Air Pressure	Yes	Yes	-

11. High Motor Stator Temperature	Yes	Yes	-
12. High Condensate Level Aftercooler	No	No	Yes
13. High Inlet Pressure Drop Across Inlet Air Filters (combined, 3 stage)	No	Yes	-
14. High CO Level	Yes	Yes	-

2.2.5.4 Monitoring Instruments

Provide the following monitoring instruments in addition to the monitor and safety controls. Pressure gages must conform to ASME B40.100, 114 mm 4 1/2 inch diameter, red marking pointer, single bourdon tube, brass case, black enamel finish. Provide pressure gages with a pressure snubber and a stainless steel barstock needle isolation valve. Thermometers must be extended stainless steel sheathed bimetallic stem, 90 mm 3 1/2 inch dial, and separable 100 mm 4 inchstainless steel wells. Temperature measurements at inaccessible locations must be made with remote reading thermometers conforming to MIL-T-19646, Class C separable well of Type 304 stainless steel. Select pressure and temperature gage ranges to give a normal operating reading near the midpoint of the scale range.

a. Oil cooler outlet temperature gages for oil.

b. Oil cooler inlet temperature gages for water.

c. Lubrication oil bearing supply pressure gage.

d. Compressor seal air pressure gage (if applicable).

e. Inlet air filter differential pressure gage with 1992, zero, 1992 Pa 8, zero, 8 inch water gage. Provide selector valve, tubing, and tap to measure static gage pressure downstream of each filter stage.

f. Total running time readout.

g. Cooling water supply to compressor pressure gage.

h. Cooling water return from compressor pressure gage.

i. Interstage air pressure gages for each interstage.

j. Compressed air pressure downstream of aftercooler pressure gage.

k. Compressed air temperature downstream of aftercooler temperature gage.

l. Compressed air temperature at discharge of each stage of compression before cooling temperature gages.

m. Interstage air temperature after intercooler of each stage temperature gages.

n. Compressor inlet air temperature gage.

o. Cooling water to compressor temperature gage.

p. Cooling water outlet temperature at each outlet of each intercooler, aftercooler, and bypass air cooler temperature gages.

[2.2.5.5 Gages on Schematics

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NOTE: Delete paragraph if control schematics are not shown on project drawings.

****

Certain pressure and temperature gages are designed on schematic flow diagrams in the drawings. Where a monitor gage satisfies the required location on a schematic, no additional gage needs to be furnished.

][2.2.5.6 Control Schematics

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NOTE: Delete paragraph if control schematics are not shown on project drawings.

****

The drawings show a generalized overall control system for compressor, auxiliaries, remote panel transmitting and receiving, and remote panel. The system is shown using relay symbology. Contractor and equipment suppliers may use standard panel features to accomplish the total requirements using other methods of signal, solid state devices, or revised lamping. All wiring diagrams and required devices must be approved by the Contracting Officer prior to installation.

]2.2.6 Compressor Design Features

The compressor must be a multistage, oil-free rotary screw compressor, with a minimum of two compressor stages, flanged to an integral speed increaser. Each stage must be driven from a common bull gear to ensure optimum speed and efficiency. An intercooler must be provided between stages and aftercooler must be provided after the final stage of compression. Silencers, lubricating system, cooling system, control system, and driver must be mounted as part of the package. Provide a common base frame for the compressor system and driver. Provide a sound enclosure over the compressor and driver. Equipment must be designed for economical and rapid maintenance. Casing components, bearing housings, and other major parts must be shouldered, dowelled, or designed with other provisions to facilitate accurate alignment or reassembly. Shaft seals and bearings must be accessible for inspection or replacement with a minimum of disassembly; however, compressors with compression elements (air end) provided as a factory-assembled not repairable in the field may be approved by the Contracting Officer if determined to be in the interest of the Government.

2.2.6.1 Casings

Casings must be cast iron, ductile iron, cast steel, or fabricated steel. Casing stresses must be within the limits allowed by ASME BPVC SEC VIII D1. Casings, supports, and baseplates must be designed and fabricated to preclude excessive and injurious distortion from temperatures, pressures, and forces encountered in service conditions. Provide jackscrews, lifting lugs, eyebolts, guide dowels, and casing alignment dowels to facilitate disassembly and reassembly. When using jackscrews for parting contacting faces, relieve one of the faces by counterboring or recessing to prevent marring the face, which result in leaking or improper fit. Provide lifting lugs or eyebolts for removable portions of the casings. Flanged casing connections for external piping must conform to ASME B16.1 or ASME B16.5. Threaded connections for external piping must conform to ASME B1.20.1. Air compression portion of the casing must be one-piece and must be provided with integral coolant passages and a large inlet port. Gear cases must be enclosed, accessible, force lubricated, and designed with seals and slingers to keep oil out of air system.

2.2.6.2 Shafts

Shafts must be of forged or rolled alloy steel and must have a machined finish throughout their entire length. All rotating components must be positively secured to shafts by approved mechanical means or interference shrink fits.

2.2.6.3 Rotors

Rotors must be steel, and of one-piece construction, with an asymmetric profile to minimize leakage losses, and ensure high efficiency. Rotors must be treated for corrosion resistance. It rotors are welded to the shaft, the assembly must be stress relieved and heat treated for proper strength. Rotors must be dynamically balanced to ensure vibration-free operation.

2.2.6.4 Gears

Gears must be of alloy steel, ANSI/AGMA 2009 and AGMA 2011 Quality Number 12 or better for both bull and pinion gears. Gears must be hardened to 275 Brinell for bull gear and 320 Brinell for pinion, unless otherwise approved. Gears must be ground to the required contours, checked for proper contact during assembly at the factory, and must not require a break-in period in the field for proper operation. All gears must be pressure lubricated.

Timing gears must be provided on the rotor shafts to maintain the rotors in correct relative position. The compressor design must allow the timing gears to absorb no more than 10 percent of the total input power at full load.

2.2.6.5 Seals

Separate air and oil shaft seals must be provided to confine air in the casing and prevent contamination of the air stream by lubricating oil. Shaft seals must be the restrictive ring type. The seal rings must be stainless steel, brass, or carbon, and retainers must be made of stainless steel. Provide an air space vented to the atmosphere between the air and oil seals. Seals must be suitable for all operating conditions including suction throttling, start-up, and shutdown.

2.2.6.6 Thrust Bearings

Thrust bearings must be anti-friction ball or roller type or hydrodynamic (fluid film) type. Anti-friction bearings must have an L-10 life of 80,000 hours in accordance with ABMA 9 or ABMA 11. Axial rotor thrusts due to air compression must be absorbed by main thrust bearings or transferred to auxiliary thrust bearings by a load balancing arrangement. Hydrodynamic thrust bearings must be Kingsbury type or other approved type and must be adequate to accommodate all operating conditions. Speed increaser bull gear thrust bearings must be sized for equal thrust in both directions and must be adequate for any axial loads transmitted through the driver coupling.

2.2.6.7 Radial Bearings

Radial bearings must be anti-friction roller or ball type or hydrodynamic type. Anti-friction bearings must have an L-10 life of 40,000 hours in accordance with ABMA 9 or ABMA 11. Hydrodynamic bearings must be precision bored sleeve or pad type, designed for easy replacement by a split design or axially removable arrangement. High speed hydrodynamic pinion bearings must be anti-oil whip, tilting pad type. Hydrodynamic bearing design must provide low vibration and sufficient damping at rated speed and all operating modes, including rated capacity and unloading down to 20 percent of unloaded power.

2.2.6.8 Speed Increaser

The speed increaser must be an integral part of the compressor unit and must include the main drive shaft and bull gear. The main drive shaft must be supported through anti-friction bearings.

2.2.6.9 Intercoolers, Aftercooler, Bypass Cooler, and Oil Coolers

Intercoolers, aftercooler, bypass cooler, and oil cooler must include ASTM B111/B111M admiralty brass or other corrosion resistant tubes in ASTM B171/B171M admiralty or steel tube sheets and baffles for optimum cooling and fouling resistance using [fresh] [_____] water. Provide an intercooler between stages of compression factory assembled on unit base with piping. The aftercooler must be mounted on the unit base. Intercoolers, aftercooler, bypass cooler, and oil cooler must be factory tested at 1.5 times operating pressure. External intercoolers and aftercooler must be constructed in accordance with ASME BPVC SEC VIII D1 requirements and be ASME code stamped for 1034 kPa (gage) 150 psig working pressure. Intercoolers and aftercooler must be capable of one piece bundle removal. Intercoolers and aftercooler must be equipped with an integral or direct connected moisture separator with condensate trap assembly. Design intercoolers and aftercooler for 11 and 8 degrees C 20 and 15 degrees F approach, respectively; however, the approach temperature used to size the coolers must be reduced if required to meet aftercooler maximum air outlet temperature specified. Nonstandard coolers must be provided if required to meet the aftercooler maximum air outlet temperature requirement. All coolers must be of counter-flow design, with a fouling factor of 0.002 for both sides of the coolers.

2.2.6.10 Lubrication System

Include an integral sump, positive displacement pump, oil cooler, and twin filter\strainer (readily replaceable cartridges while operating). Provide a prelube lubrication oil pump for start-up and standby for hydrodynamic bearings or if required by the compressor design. System must be factory assembled and tested. Lubricating oil must conform to recommendations of the compressor manufacturer. Spray lubricate drive gear, anti-friction bearings, and timing gear in each stage. Pressure lubricate hydrodynamic bearings. Provide the oil sump with a level indicator and drain and fill connections.

a. Prelubrication pump, if required, or motor-driven main lubrication pump must be sized by air compressor manufacturer for the requirements of the system, but must meet the following requirements. Pump must be positive displacement gear pump separately mounted with motor on a common base plate with drip lip and drain.

(1) Performance: Pump must have separate safety valve bypass set at [_____] [172 kPa] [25 psi] above peak expected pressure.

(2) Materials must be hardened steel gears and shaft, cast iron case, bronze bearings, mechanical seal.

(3) Flexible coupling with shaft guard must be provided, except that these items are not required for a close-coupled pump.

(4) Motor must be NEMA MG 1, Design A or B, Class B insulation, of open drip-proof type. Furnish combination type starter for motor.

b. Lube Oil Heater: Provide thermostatically controlled electric heater in lubrication oil sump of sufficient capacity to heat up and maintain manufacturer's recommended oil temperature when unit is cold at [_____] [0 degrees C] [32 degrees F] ambient. Provide low oil level indicator with light for protection of heater.

2.2.7 Electric Motors

2.2.7.1 Main Electric Drive Motor

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NOTE: Polyphase motors must be selected on requirements of the driven equipment, service conditions, motor power factor, life cycle cost, and high efficiency in accordance with NEMA MG 10.

Use Motor Master software program to identify the most efficient and cost effective polyphase motor for a specific application. Motor Master is located in the "TOOLS" section of Construction Criteria Base (CCB). For additional guidance contact Charles Mandeville of the NAVFAC Criteria Office at (757) 322-4208. Another source of information on energy efficiency is E-source, accessible to Navy users on the Naval Facilities Engineering Service Center (NFESC) energy home page http://energy.navy.mil/.

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The main drive motor for each compressor must be [an induction,] [or] [a synchronous] motor, [_____] kilowatt (kW) horsepower (hp), with a continuous service factor of 1.0. Size the motor so that the name plate kW hp rating is not exceeded under the entire range of operating conditions specified. Efficiency and losses must be determined in accordance with IEEE 112. Unless otherwise specified horizontal polyphase squirrel cage motors rated one to 125 horsepower must be tested by dynamometer Method B as described in Section 6.4 of IEEE 112. Motor efficiency must be calculated using Form B of IEEE 112 calculation procedures. Polyphase motors larger than 125 horsepower must be tested in accordance with IEEE 112 with stray load loss determined by direct measurement or indirect measurement (test loss minus conventional loss). The efficiency must be identified on the motor nameplate by the caption NEMA Nominal efficiency or NEMA Nom eff. Electrical service will be as specified. Motor must be designed for reduced voltage starting [at [50] [65] [80] percent of full voltage], allowing for characteristics of the connected load, and must start without undervoltage tripping. Provide resistance temperature detectors (RTD) attached to or imbedded in motor winding for control system. The motor must meet the requirements of NEMA MG 1 with Class F insulation. Provide space heaters for protection of windings during motor shutdowns.

2.2.7.2 Accessory and Related Equipment Motors

Motors less than 3/8 kW 1/2 hp must be single-phase induction motors and must conform to NEMA MG 1. Motors 3/8 through 3.75 kW 1/2 through 5 hp must be three-phase induction motors and must conform to NEMA MG 1. Single-phase and three-phase motors must have bimetallic disk thermostats attached to or imbedded in the motor winding. Motors must have NEMA MG 1 Class B insulation.

2.2.8 Control Panel

Control unit panel must conform to NEMA ICS 6, floor or frame mounted, factory designed, and assembled, and must be provided complete. The panel must be fabricated of formed stretcher leveled sheet steel, reinforced, and assembled into a rigid unit. Gasketed access doors must be provided as required. Panel must be factory finish painted. The panel must meet NEMA 12, requirements.

a. Panel must contain electric and safety control work required, including either alarm annunciator or individual labeled pilot lights arranged in a group. Panel must contain alarm device with light and silencing. Generalized arrangement in accordance with drawings.

b. Panel must contain start and stop buttons (the latter with lockout feature), discharge air pressure gage, control test switch and lights, reset button, green unit running light, and control selector switch.

c. Oil pressure gages must be mounted separately from panel.

2.2.9 Accessories

Required accessories include:

2.2.9.1 Control Valves

Pneumatically or hydraulically controlled valves on suction inlet of compressor and on bypass or vent line.

2.2.9.2 Intake Devices

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NOTE: Change compressor air inlet description to suit project if required.

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Compressor air inlet must be piped to the outside of the building and consist of the following:

a. Intake weather hood with rain hood and bird screen. Material must be galvanized steel or aluminum alloy, minimum 20 gage.

b. Intake pipe, ASTM A36/A36M steel galvanized, 12 gage or Schedule 5 minimum, from intake weather hood to filter housing flange, welded construction.

c. Filter housing by filter manufacturer to include filter frames, access door(s). Material for housing must be 1.65 mm 0.065 inch thick, Class 5000 aluminum alloy. Unit must be rigid and free from distress with all seams sealed.

d. Intake Pipe from Filter Enclosure to Compressor: Aluminum alloy ASTM B209M ASTM B209, Alclad alloy 5052-H32 or equivalent, minimum 10 gage, flanged, welded with 5XXX welding rod using TIG method and including expansion bellows.

2.2.9.3 Outlet Connectors

Compressor air outlet flexible connection of stainless steel bellows with braided steel cover jacket, with stainless steel liner sleeve, 18-inch (457-mm) nominal length bellows, flanged ends, Class 150. If air bypass connects separately to the compressor from the outlet line, provide a second flexible connection of stainless steel bellows with braided jacket for the bypass.

2.2.10 Inlet Air Filters

Provide a three-stage filter system, complete with mounting racks (horizontal flow), interstage seals, and replaceable filters. Filter unit must be provided complete including enclosure or housing, and frames. Enclosure must be Class 5000 aluminum alloy with inlet and outlet flanges. Construction must be welded or, where welding is not practical, close riveted and caulked, weathertight, with access doors for filter replacement and cleaning. Access doors must be reinforced, fully gasketed with continuous flexible neoprene gaskets, corrosion-resistant continuous hinges and quarter-turn latches to ensure tightness. All internal ferrous surfaces, including galvanized, must receive a factory-applied epoxy prime and finish coat for corrosion resistance. Filters must consist of three separate stages and sized to fit the available space.

2.2.10.1 First-Stage

First-stage filter must be flat, 51 mm 2 inch thickness, replaceable media, and rated for the required air quantity at 2.54 m/s 500 FPM nominal face velocity, friction clean 62 Pa 0.25 inch water gage, efficiency 98 percent of 15 microns and 90 percent of 5 microns.

2.2.10.2 Second-Stage

Second-stage filter must be deep pleated type, 229 mm 9 inchesnominal depth and rated for the required air quantity at 1.78 m/s 350 FPM nominal face velocity, friction clean 50 Pa 0.20 inch watergage, efficiency 98 percent of 5 microns and 90 percent of 3 microns.

2.2.10.3 Third-Stage

Third-stage filter must be deep pleated type 305 mm 12 inchesminimum depth and rated for the required air quantity at 1.78 m/s 350 FPM nominal face velocity, friction clean 75 Pa 0.30 inch watergage, efficiency 99.9 percent of 0.5 micron.

2.2.10.4 Filter Ratings

Filter media must be rated and listed UL Class 2. Filter efficiencies must be based on National Bureau of Standards (NBS) type discoloration gravimetric test method using atmospheric dust.

2.2.11 Bypass or Vent Line Silencer

A bypass or vent line silencer must be furnished with each compressor as selected by compressor manufacturer for sufficient noise attenuation to meet OSHA sound level criteria, but not greater than 84 dBA measured at an elevation of 1.50 meter 5 feet, and 3 meter 10 feethorizontally from silencer.

2.2.12 Sound Attenuating Enclosure

The compressor package, including the driver motor, must be contained within a noise reducing enclosure. Design of the enclosure must be such as to limit noise transmission to 84 dBA or less at a distance of one meter from the compressor in any direction.

2.2.12.1 Enclosure Frame

The enclosure frame must be designed to support the weight of the sound suppression panels and easily demountable. Connections to the base frame must be designed to allow the enclosure frame to be detached and lifted away without damage to the connections, enclosure frame or base frame, and to allow accessibility and replacement of any component.

2.2.12.2 Panels

The panels must be of rigid construction to allow repeated access without damage or distortion. Sound absorbing material must be mineral fiber, treated to preclude shedding of fibers. Other approved insulation may be used except that polyurethane foam must not be permitted. Top panels must be secured to the enclosure frame with quick disconnect fittings and fabricated to allow easy hand removal for maintenance. End and side panels must be hinged or lift out with positive closure latches. Panels must be designed to allow the maximum access area when opened. Provide acoustic seals as required. Controls and instrumentation mounted on the panels must have flexible connections for panel opening and disconnects for enclosure removal. Disconnects must be of the male-female plug type. Panels must split around all piping connections to allow enclosure removal without detaching piping. Controls must be visible and operable from outside the enclosure.

2.2.12.3 Ventilation

Fan(s) and sound baffled ventilation grilles must be provided as part of the enclosure. Ventilation must be sufficient to limit interior temperature to that required for cooling the motor.

2.2.13 Isolating Pad

If specifically recommended by the compressor manufacturer, each compressor steel or iron base frame must be mounted on a neoprene waffle or rib type isolator pad which extends uniformly and continuously along the base mounting surface. The neoprene material must be of bridge bearing pad quality neoprene and must be formulated for 40 durometer hardness. The maximum bearing pressure on the isolating pad must be 345 kPa 50 psi. The pads must be composed of two layers or 8 mm 5/16 inchneoprene bonded to and sandwiching 16 gage galvanized steel. Compressor bolt down through the pad must be accomplished using 6 mm 1/4 inchthick neoprene impregnated duck washers. Neoprene bushings are not acceptable.

2.3 AIR FLOW RATE AND PRESSURE RECORDER AND MEASUREMENT

Provide a complete flow and pressure measurement and recording package. Provide orifice flanges with pressure taps, square edged stainless steel paddle orifice plate. The orifice plate must be concentric type, of 3 mm 0.125 inch thickness and must meet ASME Standards. Orifice must be sized for 1016 mm 40 inch water column differential at a full scale flow rate of [_____] L/s SCFM at compressor based on 827 kPa (gage) 120 psig upstream pressure. Static gage pressure measurement device of the recorder must have a range of zero to 1379 kPa (gage) 200 psig. Provide copper interconnecting tubing between the pressure taps and the recorder as part of this measurement and recording package. Provide a two-pen recorder for the measurement station. Pens must record pressure (0 to 1379 kPa (gage) 200 psig range) and air flow (0 to [_____] L/s SCFM). Recorder must be electric drive and housed in dust-tight steel cabinet. Charts must be 305 mm 12 inchdiameter with evenly divided graduations. Drive must be 7 day circle. Provide continuous flow integration of a 7 digit counter type. Pens must be supplied with long-life cartridges and capillary supply. Chart case must be internally illuminated. Access to charts must be through front access window door. Calibrated overall accuracy of the recorded measurements must be within plus or minus 1.0 percent of full scale. Furnish a supply of 400 charts with the recorder.

2.4 CARBON MONOXIDE MONITOR

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NOTE: Include carbon monoxide monitor in systems which are used for breathing air per DM 3.5, Section 3.

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The carbon monoxide (CO) monitor unit must be of the pressure type with attached sampling system. The unit must be solid state type operation, 2 to 50 ppm range, CO indicating, with provisions for milliamp signal to remote recorder, adjustable set point, and normally open/normally closed contacts for remote signal. Power must be 120 volt, single phase, 60 hertz with power cord and plug. Response time normally 2 minutes per sample/purge. Unit must be mounted in a gasketed enclosure with face gage indicating CO readings.

2.4.1 Sampling System

Sampling system must include shutoff valve filter/regulator, pressure gage, manual drainer, and line humidifier set at 50 percent. Draw sample from compressor discharge.

2.4.2 Test System

Test system must include calibration gas (20 ppm CO) cylinder test gas (200 ppm CO) cylinder, and calibration connectors with quick disconnect.

2.5 SOURCE QUALITY CONTROL

2.5.1 Factory Test Procedures

The completely assembled air compressor package including the actual contract drive motor, intercooler, lubrication system, and control panel must be subjected to performance tests and sound level and run-in tests. Unit must comply with guarantee requirements applying engineering adjustments to guarantee conditions. Test must be certified by the manufacturer. Test may be run on the manufacturer's test stand using driver for this contract. Tests must be in accordance with ASME PTC 9 format. Full-range performance tests must indicate performance at maximum rated flow, rating point, and unloaded conditions. Motor performance conditions must be reported, including motor efficiency and losses, motor power factor, motor service factor, motor temperature rise, motor noise and balance, and motor torque at full load, locked rotor, pull up, and break down. Include intercoolers, aftercoolers, and lubrication and control systems performance. Completed unit must be factory tested with sound meters in accordance with ISO 2151. Location must be one horizontal meter from unit at 1.5 meters above the floor. Test must include readings at each octave band midpoint and the "A" scale, and must not exceed 84 dBA and 90 decibels at any octave band. Results of test must be included in the factory test report on the ISO 2151 format. Factory test data may be corrected to the levels of an equivalent background noise level of 60 dBA showing calculations for reference use.

2.5.2 Supervision of Testing

System and components testing must be conducted or supervised by either a designated authorized and factory trained representative of the compressor manufacturer supplying the unit or a registered Mechanical Engineer experienced in such work.

2.5.3 System Test

Testing of system must conform to requirements outlined and must be witnessed by the Contracting Officer.

2.5.4 Approval of Testing Procedure

Proposed testing procedure must be approved by the Contracting Officer and the individual in charge of testing prior to conducting tests.

2.5.5 Certification of Performance Tests

The test supervisor must certify performance by test to be in compliance with specifications.

PART 3 EXECUTION

3.1 INSTALLATION

The Contractor must install the air compressors and accessories in accordance with manufacturer's recommendations and as indicated on the drawings. All equipment must be installed plumb and level and anchored to structure, matching holes provided. Install the compressor under the direct supervision of an authorized representative of the manufacturer.

3.2 GENERAL REQUIREMENTS FOR INSTALLING AIR COMPRESSORS

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NOTE: Delete or modify requirements on existing building and weight handling equipment to suit the project.

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Air compressors with contract motor and accessories must be factory assembled, run in, and tested complete before shipment to job site. [The Contractor is advised that there are limitations to door opening sizes and available crane lifting capacity. Crane unit is specified to permit single lifts of complete compressor under special approval only.] Should the unit require disassembly for installation, reassembly must be under the direct supervision of the compressor manufacturer's authorized representative. Complete unit must be mounted on a rigid single or equivalent mechanically joined steel or iron base. Submit installation sequence plans to the Contracting Officer for approval prior to installation. [Any building materials removed to accomplish installation must be reinstalled if undamaged, by removal procedures; or if damaged, must be replaced with new materials to match original configuration.]

3.2.1 Prompt Installation

The Contractor is advised that any compressor received must be installed and placed in operation promptly to prevent time deterioration when not installed. Should the Contractor sustain a delay exceeding 90 days prior to actual installation, the Contracting Officer must have the option of requiring breakdown and reassembly to inspect and clean prior to placing in operation. This work must be at no additional cost to the Government.

3.2.2 Start-Up Services

The Contractor must furnish the services of a compressor manufacturer's authorized representative to supervise prestart checkout, initial start-up, performance testing, and operator instruction. Time available must be as required to properly start up but not less than 3 consecutive days for the compressor.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Test Procedures

Complete field performance testing of the total system must be performed by the Contractor and witnessed by the Contracting Officer. Air compressor system test must be conducted by either a compressor manufacturer's factory trained and authorized representative approved by the Contracting Officer or a qualified registered Mechanical Engineer. Tests may be run on individual components or on the system as a whole at Contractor option. Field tests require use of the actual compressor drive motor. Test must include operation at rated capacity for not less than 4 hours.

3.3.1.1 Air Compressor Performance Tests

Complete performance test must be run at maximum load, rated load, at point of unload but prior to unload, and unloaded condition. Data must be recorded listing:

a. Air flow, inlet pressure and temperature, humidity; discharge pressure and temperature.

b. Intercooler water flows, temperatures, and pressures.

c. Aftercooler water flow, temperatures, and pressures.

d. Bypass cooler water flow, temperatures, and pressures.

e. Lube oil cooling water flow, temperatures, and pressures.

f. Lube oil flow, pressures, and temperature.

g. Cooling water pump flow, pressures, and motor amperage.

h. [Cooling tower][Closed circuit cooler] air flow, water and air temperatures, water pressure, and motor amperage.

i. Electrical load in volts and amperes for compressor motor (loaded and unloaded), prelube oil pump motor, and compressor auxiliaries.

j. Intake filter pressure differential (clean).

k. Start-up sequence, alarm signals and automatic system shutdown.

l. Test compressor intake and discharge for conformance to CGA G-7.1. Compressor discharge must show no increase in contaminants.

3.3.1.2 Instrumentation Test

The Contractor may use instrumentation provided in the contract and instrumentation provided by the Contractor to conduct the test. The testing procedure and instrumentation must be submitted to the Contracting Officer for approval prior to conducting tests. The format of ASME PTC 9 is required. It is intended that a full field test be performed. However, in lieu of precise instrumentation, the Contractor may use certified cooling water pump curves[and [cooling tower] [closed circuit cooler] fan curves]. Shutdown signals must be caused by throttling selected fluids. Test data, such as air intake temperature and humidity, must be mathematically corrected to performance test requirement levels.

3.3.1.3 Sound Level Tests

Sound level tests must be conducted concurrently. Broad Band "A" scale readings and Octave Band readings must be taken and recorded at the same positions as on the factory testing. Maximum permissible level must be 84 decibels one horizontal meter from the compressor and 1.5 meters above the floor, with unit in operation and all other significant equipment not required for test within the same building bay shutdown at the same location previously described. A background noise correction to 60 decibels is permissible.

3.3.1.4 Operational Deficiencies

Any operational deficiencies noted in the tests must be promptly corrected and affected portions of the test rerun.

3.3.1.5 Testing Tolerances

A tolerance of plus or minus 2 percent on flow, plus or minus 4 percent on power, or plus or minus 5 percent on any other variable for each item of equipment or fluid with all others conforming is permissible on field test results when compared to factory test data and to guarantee performance data except that compressor air flow, discharge pressure, and motor power must be met.

3.3.2 Approval of Testing Procedure

Proposed testing procedure must be approved by the Contracting Officer and the individual in charge of testing prior to conducting tests.

3.4 TRAINING OF GOVERNMENT PERSONNEL

During start-up and field testing, train Government station personnel in the operation and maintenance of compressor, [cooling tower,] [closed circuit cooler,] associated equipment, and all control and safety devices. Training must not commence until equipment is operational and station personnel are in attendance. At least one day of classroom training and one day of field training must be furnished for each designated Government personnel. When factory training is required by the compressor manufacturer for proper maintenance and overhaul of the compressors, such training must be furnished by the compressor manufacturer at no additional cost to the Government. The Government will bear the cost of travel and living expenses for Government personnel as necessary for the factory training.

-- End of Section --

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Preparing Activity: NAVFAC **Replacing without change**
UFGS-15212N (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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HIGH AND MEDIUM PRESSURE COMPRESSED AIR PIPING

04/06

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USACE / NAVFAC / AFCEC **UFGS-22 15 26.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15212N (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 22 15 26.00 20

HIGH AND MEDIUM PRESSURE COMPRESSED AIR PIPING

04/06

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NOTE: This guide specification covers the requirements for non-breathing air compressed air systems inside of buildings with pressures up to 34,470 kPa (gage) 5000 psig.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Project requirements may require supplemental information added to the paragraphs contained herein.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

ANSI/AHRI 520	(2004) Performance Rating of Positive Displacement Condensing Units

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.20	(2023) Metallic Gaskets for Pipe Flanges
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing

	Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A351/A351M	(2024) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A380/A380M	(2017) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM B127	(2019) Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate,

	Sheet, and Strip
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B165	(2019) Standard Specification for Nickel-Copper Alloy (UNS N04400)* Seamless Pipe and Tube
ASTM B564	(2022) Standard Specification for Nickel Alloy Forgings
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM E381	(2022) Standard Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FLUID POWER ASSOCIATION (NFLPA)

ANSI/NFLPA T3.12.3	(1992; Rev 2) Pneumatic Fluid Power - Pressure Regulator - Industrial Type

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS7276	(2020; Rev J) Rings, Sealing Fluorocarbon (FKM) Rubber High-Temperature Fluid Resistant Low Compression Set 70 to 80
SAE AS4841	(2021; Rev D) Fittings, 37 Degree Flared, Fluid Connection
SAE AS4842	(2016; Rev A) Fittings and Bosses, Pipe Threaded, Fluid Connection
SAE AS4842/1	(2016; Rev A) Fittings, 37 Degree Flared to Pipe Threaded, Fluid Connection
SAE AS4843	(2016; Rev A) Fittings, Beaded, Fluid Connection
SAE AS4843/1	(2016; Rev A) Fittings, Beaded to 37 Degree Flared, Fluid Connection
SAE AS4843/2	(2016; Rev A) Fittings, Beaded to Pipe Threaded, Fluid Connection
SAE AS4875	(2016; Rev A) Fittings, Straight Threaded Boss, Fluid Connection
SAE AS4875/1	(2021; Rev B) Fittings, Straight Thread Boss or Flanged to 37 Degree Flared, Fluid Connection
SAE AS4875/2	(2016; Rev A) Fittings, Flanged to Beaded, Fluid Connection
SAE J514	(2012) Hydraulic Tube Fittings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-15726	(1988; Rev F; Am 1 1991; Notice 1 2020) Copper-Nickel Alloy, Sheet, Plate, Strip, Bar, Rod, and Wire
MIL-T-16420	(1978; Rev K; Am 1 1988) Tube, Copper-Nickel Alloy, Seamless and Welded (Copper Alloy Numbers 715 and 706)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689	(Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film)
CID A-A-58092	(Basic; Notice 1; Notice 2) Tape, Antiseize, Polytetrafluoroethylene
CID A-A-60001	(Rev A) Traps, Steam
FS QQ-B-654	(Rev A; Notice 1; Notice 2) Brazing Alloys, Silver

FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

U.S. NAVAL SEA SYSTEMS COMMAND (NAVSEA)

QPL-24109	(2014) Valve, Globe, Angle, Quick Change Cartridge Trim, High Pressure (H.P.) Hydraulic and Pneumatic (Sizes 1/8 - 1-1/4 Inches)

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

High Pressure Compressed Air System

SD-03 Product Data

Air Compressor

Air Dryer

Instrumentation and Controls

Air Receivers [and] [Separators]

Desiccant Air Dryers

Piping and Tubing

Fittings

Valves

Adapters

Pressure gages

Snubbers

Timed Solenoid Drain

Traps

Filters

Strainers

Unions

O-ring Gaskets

Flexible connections

Hangers and Supports

Valve box

Identification Labels For Piping

For receivers[and separators] include Manufacturer's Data Report Form U-1 or U-1A.

SD-06 Test Reports

Non-Destructive Examination (NDE) Report For Welding of Piping

Leak Tightness Test

SD-07 Certificates

Employer's Record Documents

Welding Procedures and Qualifications

SD-08 Manufacturer's Instructions

Air receivers [and] [Separators]

Include recommended certification test procedure and procedure for cleaning, external painting, and delivery preparation.

SD-10 Operation and Maintenance Data

Air Compressor, Data Package 4

Air Dryer, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions for Air Compressor

Posted Operating Instructions for Air Dryer

Posted Operating Instructions for Compressed Air Systems

1.4 QUALITY ASSURANCE

****

NOTE: The SMACNA Seismic Restraint Manual referenced in the paragraph below must be applied to locations subject to significant risk of seismic induced loads. The degree to which this manual is to be used for contract drawings and specifications must be determined by the designer of record in coordination with the NAVFAC Engineering Field Division's Mechanical Design Branch.

****

Provide all work specified in this section, including design, materials, fabrication, assembly, erection, installation, and examination, inspection and testing of compressed air systems in conformance with ASME B31.1, ASME BPVC SEC VIII D1 [and ASME BPVC SEC IX] [ASME BPVC SEC IX and SMACNA 1981], as modified and supplemented by this specification section and accompanying drawings. In ASME B31.1, ASME BPVC SEC VIII D1 and ASME BPVC SEC IX, the advisory provisions must be considered mandatory, as though the word "must" had been substituted for "should" wherever it appears; reference to the "authority having jurisdiction" and "owner" must be interpreted to mean the Contracting Officer.

1.4.1 Equipment Data

Submit the following data for equipment listed for "Operation and

Maintenance Instructions, Parts and Testing."

a. Name and address of authorized branch or service department.

b. Characteristic curves.

c. Following applicable data completely filled in:

   (1) Manufacturer and model number [_____]

   (2) Operating speed [_____]

   (3) Capacity [_____] (CMS) (CFM)

   (4) Type of bearings in unit [_____]

   (5) Type of lubrication [_____]

   (6) Type and adjustment of drive [_____]

   (7) Capacity of tank [_____]

   (8) Electric motor: Manufacturer, frame and type [_____]

   (9) Motor speed [_____] rad/sec RPM

   (10) Current characteristics and kW HP of motor [_____]

   (11) [_____] Thermal cut-out switch: Manufacturer, type and model [_____]

   (12) Starter: Manufacturer: Type and model [_____]

1.4.2 High Pressure Compressed Air System

Show location, length, and type of welds or brazes, and indicate welding and brazing procedures to be used, preheat, postweld heat treatment, and nondestructive welding and brazing testing required.

1.4.3 Laboratory Test Reports and Material Control

Laboratory Test Reports and Material Control for high Pressure Compressed Air Systems:

1.4.3.1 Laboratory Test Reports

Furnish the following laboratory test reports for pipe, tube, fittings, valves, and other pressure containing components (except pressure gages) for each heat and lot of material.

a. Full chemical analyses.

b. Physical properties.

c. Etch test per ASTM E381 as modified for the alloy to verify pipe and tube are seamless and free of defects.

1.4.3.2 Material Control

Where more than one type of corrosion resistant alloy (stainless steel and copper-nickel or nickel-copper for example) is to be installed at project site, the Contractor must implement and maintain a material control system with markings and/or tags to identify positively each piece as to the type of metal.

1.4.4 Welding Requirements

****

NOTE: The drawings should be checked to ensure that any supplementary information required by the welding and Non-Destructive Examination (NDE) paragraphs has been shown and that there is not conflict between the project drawings and the specifications.

****

****

NOTE: Drawings must indicate, or test of the project specifications must specify, the tensile strength, elongation, shear strength, size, length, type, and location of the welds, as necessary.

****

Provide all welding work specified in this section for compressed air piping systems and in conformance with ASME B31.1, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, brazing procedures, welders, brazers, welding operators, brazing operators, inspection personnel, nondestructive examination personnel, maintenance of welding records, and examination methods for welds.

1.4.4.1 Butt Welded Joints

Butt welded joints must be full penetration joints. Butt welded joints in systems with working pressures over 2068 kPa (gage) 300 psig must be full penetration welds with consumable inserts or backing rings.

1.4.5 Employer's Record Documents

Submit to the ROICC for his review and approval the following documentation. This documentation and the subject qualifications must be in compliance with ASME B31.1.

a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.

b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.

c. List of qualified weld inspection personnel that are proposed to be used to provide the work specified in this specification section.

1.4.6 Welding Procedures and Qualifications

Determine performance qualification in accordance with ASME B31.1 and as specified.

1.4.6.1 Specifications and Test Results

Submit copies of the welding procedure specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

1.4.6.2 Certification

Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification must state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.4.6.3 Renewal of Qualification

Requalification of a brazer or brazing operator must be required under any of the following conditions:

a. When a brazer or brazing operator has not used the specific brazing process for a period of 6 months.

b. There is specific reason to question his ability to make brazes that will meet the requirements of the specifications.

1.4.7 Experience for Installation and Testing

Experience for Installation and Testing Of [Medium] [and] [High] Pressure Air System: Install and test [medium] [and] [high] pressure air piping and equipment in accordance with ASME B31.1 and only with competent personnel specially trained and experienced in installation and testing of [medium] [and] [high] pressure air systems. The supervisors and personnel performing installation and testing must have had previous experience in the satisfactory installation and testing of at least two [medium] [and] [high] pressure air systems. Submit data substantiating this experience to the Contracting Officer for approval prior to performing any work. Supervisors and personnel with experience not acceptable to the Contracting Officer will be prohibited from working on these systems. Experience data must include the following.

a. Name of employee

b. Employer

c. List educational background and specialized training on installation and testing [medium] [and] [high] pressure systems, including safety precautions.

d. List at least two installations of each type of system worked on and installed and tested satisfactorily.

    (1) Type of system and operating or design pressure; for medium

pressure 869 to 2751 kPa (gage) 126 to 399 psig; for high pressure 2758 kPa (gage) 400 psig and higher.

(2) Company or owner.

(3) Location.

(4) Name, address, and phone number of a person who can be contacted for verification at the installation.

e. If registered engineer, give the state in which registration is held, and branch of engineering. An engineer is required to supervise safety during testing of medium and high pressure air systems.

1.4.8 Qualification of Pressure Vessel (Receiver) Inspectors

State Certification of Competency and active commission from the National Board of Boiler and Pressure Vessel Inspectors (NBBI), Columbus, Ohio.

1.4.9 Training

Where special cleaning, flushing, material control, testing, and other special requirements are used on a contract, such as required for high pressure compressed air systems, conduct formal training programs for employees on the special requirements. Maintain records on such training which must be available for inspection by the Contracting Officer. Certify that employees have satisfactorily completed the required training prior to performing work on the contract.

1.5 SAFETY PRECAUTIONS

1.5.1 Temperature Restriction

****

NOTE: The designer must assure that the piping design temperature is not exceeded, especially for high pressure systems. Provide aftercoolers and high temperature shutdown devices as required for safe operation of the systems.

****

Compressors or other equipment must not discharge compressed air to the piping systems above [38] [_____] degrees C [100] [_____] degrees F unless approved by the Contracting Officer. Aftercoolers or other devices must be provided to comply with the temperature restriction.

1.5.2 Rotating Equipment

Fully guard couplings, motor shafts, gears and other exposed rotating or rapidly moving parts in accordance with OSHA 29 CFR 1910.219. Provide rigid and suitably secured guard parts readily removable without disassembling guarded unit.

1.5.3 Welding and Brazing

Safety in welding, cutting, and brazing of pipe must conform to AWS Z49.1.

PART 2   PRODUCTS

2.1   HIGH PRESSURE AIR COMPRESSOR

****

NOTE: Prepare section for cooling water and include in project specification. See Section 23 64 26 for piping and equipment which may be useful.

****

****

NOTE: Select aftercooler for 38 degrees C 100 degrees F discharge or design special piping for higher temperature discharge. Paragraphs entitled "High Pressure Air Piping for 34,470 kPa (gage) at 38 degrees C 5000 psig at 100 degrees F System," and "High Pressure Air Piping for 20,682 kPa (gage) at 38 degrees C 3000 psig at 100 degrees F System" are rated for 38 degrees C 100 degrees F.

****

2758 to 34,470 kPa (gage) 400 to 5000 psig system, multi-cylinder, multi-stage, [air] [water] cooled, reciprocating, [belt][direct]-driven, base-mounted type, rated for continuous duty at [20,682] [_____] kPa (gage) [3,000] [_____] psig and capacity indicated. Mount compressor, motor, controls, and instruments on a welded steel base plate. [Provide means to adjust V-belt tension.] Provide splash lubricated compressor not to exceed 105 rad/sec 1000 rpm, or pressure lubricated compressor not to exceed 188 rad/sec 1800 rpm. Provide three phase squirrel cage induction motor not exceeding 188 rad/sec 1800 rpm, with voltage characteristics as indicated, and open drip-proof enclosure. Crankshaft and connecting rods must be steel. Frame (crankcase), cylinders, and cylinder heads must be close grain cast iron. Fully enclose frame. Provide automatic unloaders to permit the compressor to start unloaded. Provide [air] [water] cooled coolers after every stage of compression to cool discharge air to within [4] [-7] [_____] degrees C [40] [20] [_____] degrees F of ambient air temperature. Provide automatic condensate drains to drain condensate during operation and when the compressor stops. Conform to NEMA MG 1for motor and NEMA ICS 2 and NEMA ICS 6 for controls.

2.1.1   Controls

****

NOTE: Select the first paragraph for only start-stop control or the second paragraph and subparagraphs for dual control.

****

[Start-stop control compressors by means of pressure switches[and arrange for a lead compressor and a lag compressor]. [Lead]Compressor must start when the pressure falls to [17,235] [_____] kPa (gage) [2,500] [_____] psig and stop when the pressure reaches [20,682] [_____] kPa (gage) [3,000] [_____] psig.[Lag compressor must start when the pressure falls to [13,788] [_____] kPa (gage) [2,000] [_____] psig and stop when the pressure reaches [20,682] [_____] kPa (gage) [3,000] [_____] psig.] When both compressors stop at cutout pressure, the lead and lag positions of compressors must be interchanged automatically by means of an electric alternator.

][Regulate compressor by dual control. Dual system must consist of a combination of constant speed control and an automatic start-and-stop control by automatic or manual selector switch.
]

****

NOTE: Include "Start-and-Stop Control" and "Constant Speed Control" below only for "Dual Control" option.

****

2.1.1.1 Start-and-Stop Control

When set for start-and-stop control, motor must stop automatically when discharge pressure reaches maximum pressure setting and start automatically when discharge pressure falls to minimum setting. Cylinders must unload during periods of motor shutdown.

2.1.1.2 Constant Speed Control

Compressor must operate continuously at constant speed. Provide means to automatically load and unload compressor at preset minimum and maximum pressure settings, respectively. Provide means for automatic release of pressure within cylinders when the unit is operating without load. Also provide means for manual or automatic unloading of cylinders during starting of unit. Equip compressor with a timed control to stop compressor after a 10-minute unloaded period if air is not used.

2.1.2 Safety Controls

Provide safety controls to shutdown [each] compressor on high discharge air temperature or low oil pressure for pressure lubricated compressor and low oil level for splash lubricated compressor. Set high temperature shutdown at [54] [_____] degrees C [130] [_____] degrees F. Indicate each shutdown condition by a light on the compressor control panel.

2.1.3 Accessories

Provide pressure gages and relief valves on intercoolers and on the aftercoolers. Provide [totally enclosed belt guards,] discharge check valves, and pressure switches.

2.1.4 Noise

84 dBA maximum sound level one meter from compressor unit.

2.2 HIGH PRESSURE COMPRESSED AIR DRYER

Include component equipment, inter-connecting piping, wiring and controls, mounted in a cabinet and requiring only the connection to utilities. Degrease dryer cabinet, prime coat, and finish coat with baked enamel. Contractor must furnish integral components whether specifically required by this specification or not. Air must leave the dryer at a temperature of [_____] degrees C F and a dew point of [_____] degrees C F, based on an inlet temperature of [38] [_____] degrees C [100] [_____] degrees F. Pressure drop must not exceed [21] [_____] kPa [3] [_____] psi. Provide complete internal tubing, wiring, and piping, such that only connections to air inlet and outlet, to refrigerant compressor contactor, and to condensate drain are necessary.

2.2.1 Construction

Heat sink type dryer consisting of a mechanical refrigeration system equipped with an automatic temperature shutdown switch to prevent freezing, a large aluminum granule heat sink to allow a minus 16 degrees C 4 degrees F automatic temperature control, regenerative air to air exchanger, and main compressed air cooling exchanger. Refrigeration system must cool thermal mass heat sink which must, in turn, lower compressed air temperature to dry air. A direct air to refrigerant gas heat exchanger is not acceptable. Dryer must have no internal traps or filters and must have large internal air passages to minimize pressure drop.

2.2.2 Air Circuit

Include the following:

a. Regenerative heat exchanger: ASTM A269/A269M, Type 304L seamless stainless steel tube construction, inlet compressed air to outlet compressed air heat exchanger designed to reduce cooling load at design conditions minus 7 degrees C 20 degrees F by inlet air precooling.

b. Main heat exchanger: ASTM A269/A269M, Type 304L seamless stainless steel tube construction, single-pass, designed for minimum air pressure drop with air in the tubes surrounded by aluminum granules.

c. Separator: Fabricated of ASTM A269/A269M, Type 304L seamless stainless steel in accordance with ASME B31.1. Code stamp is not required. Provide moisture separator, low velocity type, incorporating change of air flow direction to prevent moisture carryover.

d. Dryer operating pressure: [20,682] [34,470] [_____] kPa (gage) [3,000] [5,000], [_____] psig working pressure.

e. Drain line: Provide drain line to exterior of dryer with [condensate trap] [or] [automatic drain valve].

f. Exterior piping connections: Provide with square ends.

2.2.3 Refrigeration System

Include the following:

a. Compressor: ANSI/AHRI 520. Hermetic reciprocating compressor equipped with automatic start-stop control, inherent motor protection, crankcase oil strainer, and suction screen. Refrigerant must be R-22.

b. Dryer controls: Capable of automatic 0 to 100 percent capacity control with an automatic control expansion valve with sensing bulb to control capacity, with automatic shutdown switch sensor located at point of lowest temperature to prevent freezing.

c. Air cooled condenser.

2.2.4 Instrumentation and Controls

Provide control panel in dryer cabinet containing:

a. Indicators:

(1) Inlet air pressure gage

(2) Discharge air pressure gage

(3) Inlet air temperature gage

(4) Main exchanger temperature gage

(5) Refrigeration compressor suction pressure gage

(6) Refrigeration compressor discharge pressure gage

(7) Power interruption light

(8) High temperature light

(9) Power on light

b. Electrical relays: Locate in an enclosed portion of panel, accessible for easy servicing.

c. Controls and interlocks:

(1) Condenser fan

(2) Compressor across the line contactor

(3) Thermostatic control switch

2.3 HIGH PRESSURE AIR RECEIVERS [AND] [SEPARATORS]

****

NOTE: Do not permit field welding on high pressure air receivers unless controls over welding processes and nondestructive testing required by the military specification can be implemented in the field.

****

ASME BPVC SEC VIII D1, constructed and stamped, seamless, forged, [20,682] [34,470] kPa (gage) [3,000] [5,000] psig design working pressure, minimum safety factor of 4, corrosion allowance of [1.60] [_____] mm [1/16] [_____] inch, straight thread, O-ring sealed, forged steel inlet, outlet, and drain plugs, straight or angle connection as indicated or required. [Capacity] [Capacities] as indicated. After heat treatment, examine exterior of vessel by liquid penetrant or magnetic particle test; no defects are permitted. Furnish certified (non-destructive examination) NDE report for high pressure air receiver. After hydrostatic testing at the factory, clean the flask to oil-free condition. Abrasive blast interior and exterior to near white condition in accordance with SSPC SP 10/NACE No. 2. Vacuum clean surfaces to remove dust and debris. Check surfaces with black light to ensure there is no oil. Apply 2 or 3 coats of epoxy coating 0.20 mm 8 mils minimum dry film thickness, with white finish coat for the interior and gray finish coat for the exterior. Provide certification of factory tests. Securely support receiver and equip with pressure gage, drain valve, and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX code stamped pressure relief valve set as indicated and piped to discharge in a safe manner. Piping must conform to [20,682] [34,470] kPa (gage) [3,000] [5,000] psig standards. Provide each receiver with internal or external blowdown and drain line with manual valve in accessible location, or with extension stem, discharging through a visible open sight drain. Do not manifold cylinder drain piping together. Attachment welds to receiver [and separator] must not be permitted. Register vessel with NBBI and mark registration number on vessel.

2.4 MEDIUM PRESSURE AIR COMPRESSOR

****

NOTE: Prepare section for cooling water and include in project specification. See Section 23 64 26 for piping and equipment which may be useful.

****

869 to 2751 kPa (gage)126 to 399 psig system. [Multi-stage][Two-stage][Single-stage], [air] [water] cooled reciprocating, [belt] [direct] driven type, suitable for supplying compressed air at pressures indicated. Provide compressor with ball or roller type bearing, pressure lubricated, thermal overload protection as required by NEMA, pressure switch, inlet filter-mufflers, vibration isolators, intercoolers, aftercooler, and flexible connectors. Provide safety control for shutdown and alarm on high discharge air temperature or low oil pressure. Capacity and operating pressure as indicated on drawings. Mount compressor and motor on a base plate[and set on the receiver. Design receiver for additional load of compressor and motor].

2.4.1 Receiver

Build receiver (tank) of welded steel, in accordance with ASME BPVC SEC VIII D1, Unfired Pressure Vessels, for [2751] [_____] kPa (gage) [399] [_____] psig working pressure at [232] [_____] degrees C [450] [_____] degrees F, complete with pressure gage, ASME BPVC SEC VIII D1 and ASME BPVC SEC IX code stamped safety valve, check valve, shut-off valve on tank outlet, and automatic tank drain on tank. Provide tank with steel supports and bolt to a concrete foundation. Capacity as indicated.

2.4.2 Motor and Starter

Provide motor and starter 40 degrees C 72 degrees F ambient temperature rise, continuous duty, drip-proof type motor, ball bearings, for operation with current of voltage, phase, and cycle indicated on the electrical drawings. Motor of such capacity that brake horsepower required by driven equipment at normal rated capacity will not exceed nameplate rating of motor. Provide each motor with automatic, fully enclosed, magnetic starter. Conform to NEMA MG 1 for motor and NEMA ICS 2and NEMA ICS 6 for starter and controls.

2.4.3 Controls

****

NOTE: Select the first paragraph for only start-stop control or the second paragraph and subparagraphs for dual control.

****

[Provide start-and-stop control. Motor must stop automatically when discharge pressure reaches maximum pressure setting and start automatically when discharge pressure falls to minimum setting. Cylinders must unload automatically during periods of motor shutdown.

][Regulate compressor by dual control. Dual system must consist of a combination of constant speed control and an automatic start-and-stop control by automatic or manual selector switch.
]

****

NOTE: Include "Start-and-Stop Control" and "Constant Speed Control" below only for the "Dual Control" option.

****

2.4.3.1 Start-and-Stop Control

When set for start-and-stop control, motor must stop automatically when discharge pressure reaches maximum pressure setting and start automatically when discharge pressure falls to minimum setting. Cylinders must unload during periods of motor shutdown.

2.4.3.2 Constant Speed Control

Compressor must operate continuously at constant speed. Provide means to automatically load and unload compressor at preset minimum and maximum pressure settings, respectively. Provide means for automatic release of pressure within cylinders when the unit is operating without load. Also provide means for manual or automatic unloading of cylinders during starting of unit.[Equip compressor with a timed control to stop compressor after a 10-minute unloaded period if air is not used.]

2.4.4 Intercoolers and Aftercoolers

Provide intercoolers between all intermediate stages of multi-stage compressors and provide aftercoolers with compressors. Intercoolers for air-cooled compressors must be the tube-and-fin type. Intercoolers for water-cooled compressors must be the shell-and-tube type, except that tube-and-fin type may be used when the intercooler is supported by the compressor frame or attached to the compressor. Air or water cooled intercoolers may be the integral cast type when compressor is 19 kW 25 hp or less. Aftercoolers must be of the water-cooled shell-and-tube type or air-cooled tube-and-fin type. Water-cooled aftercoolers and intercoolers must be of sufficient capacity to cool the compressed air to within minus 9 degrees C and minus 7 degrees C 15 degrees F and 20 degrees F, respectively, of the temperature of the water entering the coolers. Air-cooled intercoolers and aftercoolers must have sufficient capacity to cool the compressed air to within minus 7 degrees C 20 degrees F of the ambient temperature under the atmospheric conditions indicated. Provide water-cooled intercoolers and aftercoolers with sight-flow indicator to visually observe the flow of water to the cooler. The pressure drop of compressed air through the cooler must not exceed 7 kPa one psi. Provide intercoolers and aftercoolers with a moisture separator and drain trap to remove the condensed moisture and oil from the air leaving the cooler.

2.4.4.1 Shell-and-Tube

Floating-head type consisting of a removable and cleanable nest of corrosion-resistant tubes within a steel shell. Air may pass either through the tubes or the shell.

2.4.4.2 Tube-and-Fin

Copper, aluminum, copper-aluminum, or copper-alloy construction. Fins must be securely bonded to the tubing. Provide tube-and-fin coolers with a fan for circulation of the cooling air. The fan must be adequately guarded for safety and be driven either from the compressor crankshaft or by an independent electric motor.

2.4.5 Noise

84 dBA maximum sound level one meter from compressor unit.

2.5 MEDIUM PRESSURE Air receivers [and] [separators]

ASME BPVC SEC VIII D1, labeled and rated for [1896] [_____] kPa (gage) [275] [_____] psig, equipped with required valves and trimmings, including gage and automatic drain valve and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX pressure safety relief valve. Pressure as indicated. [Sandblast exterior and interior to SSPC SP 10/NACE No. 2, near-white. Lining must be a factory applied 0.20 mm 8 mil minimum epoxy coating.] Exterior finish must be [standard factory finish] [two coats of rust inhibitor primer and one coat epoxy enamel].

2.6 MEDIUM PRESSURE COMPRESSED AIR DRYERS

****

NOTE: Make changes for medium pressure systems and insert the desired operating pressure. Normally used for under 944 scms 2000 scfm capacity systems. CAUTION: ASSURE CORRECT SYSTEM PRESSURE IS SPECIFIED.

****

Provide medium pressure compressed air dryers of the mechanical refrigeration type, equipped with an automatic temperature shutdown switch to prevent freezing, a regenerative air to air exchanger (in capacity sizes above 5 to 28 scms 10 or 60 scfm as standard with the manufacturer), and a main compressed air cooling exchanger. Refrigeration system must cool compressed air to dry the air. Dryer must have no internal traps or filters and must have pressure drop not greater than [21 kPa] [_____ kPa] [3 psi] [_____ psi] [indicated]. Air must leave the dryer at a temperature of [_____] degrees C F and dew point of [_____] degrees C F, based on an inlet temperature of [38] [_____] degrees C [100] [_____] degrees F. Provide internal tubing, wiring, and piping complete, such that only connections to air inlet and outlet, to refrigerant compressor contactor, and to condensate drain are necessary.

2.6.1 Air Circuit

a. Regenerative heat exchanger: Inlet compressed air to outlet compressed air heat exchanger (in capacity sizes above 5 to 28 scms 10 or 60 scfm as standard with the manufacturer) designed to reduce cooling load at design conditions minus 7 degrees C 20 degrees F by inlet air precooling.

b. Main heat exchanger: Single-pass, with air in the tubes, heat sink, direct expansion, or flooded cooler type.

c. Separator: Fabricated in accordance with ASME B31.1; code stamp not required; moisture separator low velocity type incorporating change of air flow direction to prevent moisture carryover.

d. Dryer operating pressure: [1896] [_____] kPa (gage) [275] [_____] psig working pressure.

e. Drain line: Provide with exterior mounted condensate trap to facilitate servicing.

2.6.2 Refrigeration System

a. Refrigeration compressor: ANSI/AHRI 520. Hermetic, semi-hermetic, or open reciprocating type equipped with automatic start-stop or unloading capacity control; standard components include inherent motor protection, crankcase oil strainer, and suction screen. Refrigerant must be R-22.

b. Dryer controls: Capable of automatic 0 to 100 percent capacity control. Refrigeration controls must maintain pressure dew point within the specified range without freezing of condensate. Controls must include such devices as capillary tube, expansion valve, suction pressure regulator, thermostat, or other approved devices as standard with the manufacturer. Dryer must have automatic shutdown switch sensor located at point of lowest temperature to prevent freezing.

c. Refrigerant dryer and suction line strainer.

d. Air-cooled condenser, with condenser fan and motor.

2.6.3 Instrumentation and Control

Include control panel in dryer cabinet containing:

a. Indicators for the following services: Inlet air pressure gage, discharge air pressure gage, inlet air temperature gage, main exchanger temperature gage, refrigeration compressor suction pressure gage, refrigeration compressor discharge pressure gage, green "Power On" light, power interruption light, and high temperature light.

b. Electrical relays: Locate in an enclosed portion of the panel, accessible for ease of servicing.

c. Controls and interlocks: To maintain required compressed air dew point and to cycle air-cooled condenser with refrigeration compressor [while maintaining head pressure control with low ambient temperature].

2.7 MEDIUM PRESSURE COMPRESSED AIR DRYER (CHILLED WATER TYPE)

****

NOTE: Edit for medium pressure systems and insert the operating pressure. Chilled water air dryers are usually provided for 944 scms 2000 scfm and larger capacities. CAUTION: Specify correct system pressure. If specification is edited to use a dryer with direct heat exchange between air and refrigerant, assure that air is not used for breathing since refrigerant leakage into the compressed air may be hazardous to personnel; warning signs may be required.

****

Provide medium pressure compressed air dryer of the mechanical refrigerator type, with closed chilled water system, regenerative air to air exchanger, and main compressed air to water heat exchanger. Refrigeration system must produce chilled water which, in turn, circulates through air-water exchanger to dry the air. Provide internal tubing, wiring and piping complete, such that only connections to air inlet and outlet, to pump contactor, to refrigerant compressor contactor, to condensate drain, and to air cooled condenser need be provided. Dryer must be suitable for a compressed air operating pressure of [1896] [_____] kPa (gage) [275] [_____] psig, with air leaving temperature of [_____] degrees C F and dew point of [_____] degrees C F at rated pressure.

2.7.1 Air Circuit

a. Regenerative heat exchanger: Air to air exchanger, with inlet air passing through tubes and outlet air in shell, designed to reduce cooling load at design conditions by precooling inlet air minus 7 degrees C 20 degrees F.

b. Main heat exchanger: Shell and tube construction, single-pass, with air in tubes and water in shell, designed for minimum air pressure drop, flanged connections, tubes rolled into tube sheets, and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped.

c. Separator: Fabricated of carbon steel to ASME BPVC SEC VIII D1and ASME BPVC SEC IX Code and stamped.

d. Drain: With condensate trap.

2.7.2 Chilled Water Circuit

a. Circulating pump: Single stage, mechanical seals, electric motor driven with line shut-off valves.

b. Liquid cooler: Direct expansion, refrigerant in tubes, water in shell, designed for 2068 kPa (gage) 300 psig working pressure, removable tube bundle, ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped and insulated with foam type insulation.

c. Expansion tank: With sight glass, vent, and fill cock.

d. Flow switch: To shut down refrigeration compressor on loss of chilled water flow.

2.7.3 Refrigeration System

a. Refrigeration compressor: ANSI/AHRI 520. Hermetic or semihermetic reciprocating type, with 183 rad/sec 1750 rpm motor, integral capacity control, oil pressure pump, oil scavenger pump, full-flow oil filter, oil sight glass, inherent motor protection, crankcase heater, suction and discharge service valve, crankcase oil strainer, Monel suction screen, and hot gas bypass capacity control below last step of unloading. Refrigerant must be R-22.

b. Accessories: Include a discharge line muffler, sight glass, refrigerant dryer, solenoid valve, thermostatic expansion valve, and suction line strainer.

c. Air-cooled condenser: As indicated. Complete air-cooled condenser factory-fabricated and assembled unit consisting of coils, fans, and electric-motor drive. Base capacity at design conditions on minus 7 degrees C 20 degrees F temperature differential between entering air and condensing refrigerant. Saturated refrigerant condensing temperature not over 40 degrees C 105 degrees F. Base entering dry bulb outside air temperature on [32] [_____] degrees C [90] [_____] degrees F. Do not take subcooling into account in determining compressor and condenser capacities. Air-cooled condenser may be used for refrigerant storage in lieu of a separate receiver, provided that condenser storage capacity is 20 percent in excess of fully charged system. [Provide head pressure control during low ambient temperature.]

2.7.4 Instrumentation and Control

Provide a control panel on the dryer containing:

a. Pressure gages (114 mm 4 1/2 inches diameter) for the following services:

    (1) Inlet air

    (2) Condenser water inlet

    (3) Refrigeration compressor suction

    (4) Refrigeration compressor oil pressure

    (5) Outlet air

    (6) Condenser water outlet

    (7) Refrigeration compressor discharge

b. Electrical relays: Locate in an enclosed portion of the panel, accessible from front of panel.

c. Start-stop buttons and green running indicating light.

d. Controls and interlocks.

    (1) 115-volt control transformer

    (2) Circulating pump across the line contactor

    (3) Compressor across the line contactor

    (4) Condenser water pressure safety switch

    (5) Freeze protection safety switch

    (6) Pump-out relay with normally open and normally closed contacts

    (7) Oil safety switch

    (8) Four stage thermostatic control

    (9) Refrigerant dual pressure switch

2.7.5 Temperature Indicators

a. Air inlet

b. Air outlet

c. Chilled water in

d. Chilled water out

e. Dew point

2.8 DESICCANT AIR DRYERS

Chamber of welded steel, [_____] kPa (gage) psig working pressure, ASME labeled conforming to ASME BPVC SEC VIII D1, with flanged or threaded fittings, and [manual] [automatic] drain valve. Manufacturer's recommended desiccant in tablet form which will not nest or cake. Contractor must provide a supply of desiccant for initial operations in unbroken shipping containers equal to not less than four charges of desiccant for the dryer.

2.9 HIGH PRESSURE (HP) AIR PIPING AND ACCESSORIES

****

NOTE: The high pressure air system materials listed are tentative suggestions. The designer must calculate required minimum wall thicknesses for pipe and tube in accordance with ASME B31.1 and verify adequacy of the materials listed. Select material for corrosion resistance required in the service environment. Allowance for corrosion or fabrication, factor "A" in ASME B31.1, paragraph 104.1, must be selected by the designer. If carbon steel is selected as the piping material, special attention should be given to the corrosion allowance for the higher pressures such as 20,682 kPa (gage) 3000 psig and 34,470 kPa (gage) 5000 psig systems since commercial sizes per ASME B36.10M would not permit selection of large corrosion allowance factors.

****

2.9.1 HP Air Piping and Tubing

HP air piping and tubing for 34,470 kPa (gage) at 38 degrees C 5000 psig at 100 degrees F system must conform to the following:

a. Stainless steel pipe: ASTM A312/A312M, seamless stainless steel, annealed Type [304L] [316L], Schedule 160 up to 25 mm one inch IPS, double extra strong (XXS) for 32 to 65 mm 1 1/4 to 2 1/2 inches IPS [,larger sizes must be special as indicated]. Wall thickness "schedule" and "weight" designations must conform to ASME B36.10M. Fittings for pipe 40 mm 1 1/2 inches IPS and smaller: ASTM A403/A403M, ASME B16.11, forged stainless steel, Type [304L] [316L], socket welding, Class 6000 for 6 to 25 mm 1/4 to one inch IPS, Class 9000 for 32 and 40 mm 1 1/4 and 1 1/2 inches IPS. Fittings for pipe 50 to 65 mm 2 to 2 1/2 inches IPS: ASTM A403/A403M, ASME B16.9, butt welding, seamless wrought stainless steel Type [304L] [316L], double extra strong (XXS).

b. Nickel-copper pipe: ASTM B165, seamless, annealed, Schedule 160 up to 25 mm one inch IPS, double extra strong (XXS) for 32 to 80 mm 1 1/4 to 3 inches IPS, [,larger sizes must be special as indicated.] Wall thickness "schedule" and "weight" designations must conform to ASME B36.10M. Fittings 40 mm 1 1/2 inches IPS and smaller: ASME B16.11, forged nickel-copper ASTM B564, socket welding, Class 6000 for 6 to 25 mm 1/4 to one inch IPS, Class 9000 for 32 and 40 mm 1 1/4 and 1 1/2 inches IPS. Fittings for pipe 50 mm 2 inches IPS and larger: ASME B16.9, butt welding, seamless wrought 70-30 nickel-copper, double extra strong (XXS), 50 to 80 mm 2 to 3 inches IPS.

****

NOTE: Use only one type of fitting for the entire project.

****

c. Stainless steel tubing: ASTM A269/A269M, stainless steel, Type [304] [304L] [316], seamless, annealed, with wall thicknesses as specified below. Fittings for tubing: stainless steel, Type [304] [304L] [316], conforming to [SAE AS4841,] [SAE AS4842,][SAE AS4842/1,][SAE AS4843,][SAE AS4843/1,][SAE AS4843/2,][SAE AS4875][SAE AS4875/1,][SAE AS4875/2,][SAE J514,] flared type, suitable for 34,470 kPa 5000 psi service. Fittings must have a minimum burst strength of 138 MPa (gage) 20,000 psig; furnish laboratory burst test reports. Do not use flareless fittings or bite type fittings. Do not weld tubing.

MINIMUM WALL THICKNESS FOR STAINLESS STEEL TUBING	
Size (mm O.D.)	Thickness (mm)
10	1.47
15	2.11
16	2.41
20	3.05

MINIMUM WALL THICKNESS FOR STAINLESS STEEL TUBING	
Size (Inches O.D.)	Thickness (Inches)
3/8	.058
1/2	.083
5/8	.095
3/4	.120

d. Copper-nickel tube: MIL-T-16420, Composition 70-30, temper-annealed, Type I - seamless Class 6000 (41,364 kPa (gage) 6000 psig working pressure), Grade 2 (material with heat identification), IPS outside diameter sizes. Fittings 40 mm 1 1/2 inches IPS and smaller: ASME B16.11, MIL-C-15726, forged copper-nickel, socket welding, except that body wall thickness must not be less than the minimum wall thickness for the size listed in MIL-T-16420 for Class 6000, and the average socket wall thickness must be 1.25 times, and the minimum socket wall 1.09 times the minimum wall thickness for that size listed in MIL-T-16420 for Class 6000. Fittings 50 to 80 mm 2 to 3 inches IPS: ASME B16.9, butt welding, seamless wrought 70-30 copper-nickel, with minimum wall thickness as listed for that size in MIL-T-16420 for Class 6000.

2.9.2 High Pressure Air Piping

High pressure air piping for 20,682 kPa (gage) at 38 degrees C 3000 psig at 100 degrees F system must conform to the following:

a. Stainless steel pipe: ASTM A312/A312M, seamless stainless steel, annealed Type [304L] [316L], Schedule 80 up to 25 mm one inch IPS, Schedule 160 32 to 150 mm 1 1/4 to 6 inches IPS. Wall thickness "schedule" and "weight" designations must conform to ASME B36.10M. Fittings for pipe 40 mm 1 1/2 inches IPS and smaller: ASTM A403/A403M, ASME B16.11, forged stainless steel, Type [304L], [316L], socket welding, Class 3000 for 6 to 25 mm 1/4 to one inchIPS, Class 6000 for 32 and 40 mm 1 1/4 and 1 1/2 inchesIPS. Fittings for pipe 50 to 150 mm 2 inches to 6 inchesIPS: ASTM A403/A403M, ASME B16.9, butt welding, seamless wrought stainless steel Type [304L] [316L], Schedule 160.

****

NOTE: Use only one type of fitting for the entire project.

****

b. Stainless steel tubing: ASTM A269/A269M, stainless steel, Type [304] [304L] [316], seamless, annealed, with minimum wall thicknesses as specified below. Fittings for tubing: stainless steel, Type [304] [304L] [316], conforming to [SAE AS4841,] [SAE AS4842,][SAE AS4842/1,][SAE AS4843,][SAE AS4843/1,][SAE AS4843/2,][SAE AS4875,][SAE AS4875/1,][SAE AS4875/2,] [SAE J514,] flared type, suitable for 20,682 kPa 3000 psi service. Fittings must have a minimum burst strength of 139 MPa 20,000 psig; furnish laboratory burst test reports. Do not use flareless fittings or bite type fittings. Do not weld tubing. Brazed 20,682 kPa 3000 psi tubing fittings may be used where flared fitting connections are not required for equipment. Use FS QQ-B-654, Grade V, brazing alloy where tubing or fitting or both tubing and fitting are stainless steel.

MINIMUM WALL THICKNESS FOR STAINLESS STEEL TUBING	
Size (mm O.D.)	Thickness (mm)
10	1.47
15	2.11
16	2.41
20	3.05

MINIMUM WALL THICKNESS FOR STAINLESS STEEL TUBING	
Size (Inches O.D.)	Thickness (Inches)
3/8	.058
1/2	.083
5/8	.095
3/4	.120

c. Copper-nickel tube: MIL-T-16420, Composition 70-30, temper-annealed, Type I - seamless, Class 3300 (22,750 kPa (gage) 3300 psig working pressure), Grade 2 (material with heat identification). Fittings, Brazing: bronze or copper-nickel, silver brazed ends, rated for not less than 20,682 kPa 3000 psi working pressure. Limit brazed joints to required connections to existing piping. Use welded joints for new and existing piping to the maximum extent practical. Fittings, welding, 40 mm 1 1/2 inches IPS and smaller: ASME B16.11, MIL-C-15726, forged copper-nickel, socket welding, except that body wall thickness must not be less than the minimum wall thickness for the size listed in MIL-T-16420 for Class 3300, and the average socket wall thickness must be 1.25 times, and the minimum socket wall 1.09 times the minimum wall thickness for that size listed in MIL-T-16420 for Class 3300; however, for 6 mm 1/4 inch IPS, ASME B16.11, Class 3000 dimensions may be used when approved by the Contracting Officer. Fittings, welding, 50 to 80 mm 2 to 3 inches IPS: ASME B16.9, butt welding, seamless wrought 70-30 copper-nickel, with minimum wall thickness as listed for that size in MIL-T-16420 for Class 3300.

2.9.3 Globe and Angle Valves

QPL-24109, bronze body.

2.9.4 Needle Valves

QPL-24109, bronze body, except provide needle valve cartridges in lieu of shutoff valve cartridges.

2.9.5 Safety Valves

ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped safety valve, [Type [304L] [316L] stainless steel,] [70-30 copper-nickel,] [70-30 nickel-copper,] [bronze,] [carbon steel,] with O-ring seal union thread piece ends as provided for QPL-24109 valves; factory set and sealed.

2.9.6 Pressure Reducing Valves

ANSI/NFLPA T3.12.3, nominal pressure rating of [2758] [10,341] [20,680] [41,364] kPa (gage) [400] [1500] [3000] [6000] psig, body of [stainless steel,] [bronze,] [aluminum bronze,] [naval brass,] outlet pressure and capacity as indicated, shock and vibration test not required, allowance lists not required.

2.9.7 Adapters

Provide suitable tailpiece adapters for installation of valves conforming to QPL-24109 and for other components with similar union end connections. Tailpieces must match pipe material: [Type 304L or 316L stainless steel,] [70-30 nickel-copper,] [70-30 copper-nickel,] socket welding type for 40 mm 1 1/2 inches IPS and smaller. Tailpieces for tubing: [brazed O.D. type suitable for 20,682 kPa 3000 psi]. Provide thread piece adapters for O-ring union installation of components made of material different from pipe or where welded joint installation is not suitable.

2.9.8 Pressure Gages (High Pressure)

Pressure gages for high pressure systems must conform to ASME B40.100, for air, with a scale approximately twice the system working pressure, nonshatterable safety glass, and pressure blowout back to prevent glass from flying out in case of an explosion. Gages: [90] [114] mm [3 1/2] [4 1/2] inches in diameter with a steel case and tubing and an accuracy of one percent full scale in middle half section of scale and 1 1/2 percent of full scale value in first and last 1/4 sections of scale. Do not fasten bourdon tube pressure-sensitive elements with low-melting-point solder. Print on gage faces in red letters "USE NO OIL." Provide pressure snubbers or equalizer in pressure gage installations on inflow side of a gage valve. Mount gage branches vertically on top of an air line to avoid branch flow of condensate and dirt. Connect a gage to an air line or component through an equalizer, gage valve (slow-opening needle type), and branch with provision for bleed-off.

2.9.9 Snubbers (or Equalizers)

[Type 304L or Type 316L stainless steel] [70-30 copper-nickel] [70-30 nickel-copper] body with a rated working pressure not less than system design pressure. Snubber element: sintered stainless steel or other approved type.

2.9.10 Timed Solenoid Drain

Packaged solenoid drain with 6 mm, [20,682] [34,470] kPa (gage) 1/4 inch, [3000] [5000] psig, direct acting, normally closed solenoid valve, solid state timer, drain cycle adjustable from zero to 50 minutes, valve open duration adjustable from one to 14 seconds, power on light, valve open light, operation on 115 or 230 VAC, and housed in NEMA [1] [_____] enclosure.

2.9.11 Compressed Air Filters

Provide high pressure compressed air filter, single cartridge type, designed for operating pressures not less than the system design pressure. Filter housing of [Type [304L] [316L] stainless steel] [70-30 copper-nickel] [70-30 nickel-copper] construction. Provide a cellulose cartridge filter of graded density construction capable of removing liquids and solids of 5 microns and larger. Provide filter with a bottom drain and [manual drain valve] [timed solenoid drain].

2.9.12 Strainers

Y-pattern type with [cast stainless steel body, ASTM A351/A351M CF8M (Type 316), CF8 (Type 304), CF3 (Type 304L) or CF3M (Type 316L,] [70-30 copper-nickel,] [70-30 nickel-copper,] [forged alloy steel body ASTM A182/A182M, Grade F-22,] rated for the system design working pressure, with 20-mesh Monel or stainless steel screen. Net strainer area not less then 2.5 times the inlet connection area.

2.9.13 Unions

O-ring seal type compatible with union ends of QPL-24109 valves, material and end preparation compatible with pipe and fittings.

2.9.14 O-Ring Gaskets

SAE AMS7276.

2.9.15 Hangers and Supports

Provide pipe hangers and supports conforming to MSS SP-58 and ASME B31.1, except as specified or indicated otherwise. Hangers for high pressure air lines must be rigid or braced and sufficiently strong to prevent "whipping" of a pipe if a break occurs while the line is under pressure. Furnish zinc plated pipe hangers and supports except for copper plated inserts for copper piping. Provide tubing supports of U-shaped steel bolts and nuts firmly secured to adequately support structures such as walls, columns, floors, or brackets. Clips must fit closely around piping but must have sufficient clearance to permit longitudinal movement of piping during normal expansion and contraction. Provide supports at valves, fittings, branch lines, outlets, changes in direction, equipment, and accessories.

2.10 MEDIUM PRESSURE COMPRESSED AIR PIPING AND ACCESSORIES

****

NOTE: Components are listed based on operation at maximum temperature of 66 degrees C 150 degrees F. Class 300 steam rated components have water-oil-gas (WOG) ratings above 2758 kPa (gage) at 66 degrees C 400 psig at 150 degrees F. If higher operating temperatures are expected, change component descriptions to higher ratings as required after reviewing appropriate component specification.

****

Medium pressure compressed air piping and accessories 869 to 2751 kPa (gage) at 66 degrees C 126 to 399 psig at 150 degrees F must conform to the following:

2.10.1 Pipe

ASTM A53/A53M or ASTM A106/A106M, seamless carbon steel, Schedule 40, black.

2.10.2 Fittings, Size 50 Millimeters 2 Inches and Larger

ASME B16.9, carbon steel, butt welding, Schedule 40, or ASME B46.1, carbon steel welding neck flanges, Class 300, ASME B46.1, flanged fittings, carbon steel, Class 300, gaskets ASME B16.20, spiral wound metallic, Class 300, bolts ASTM A193/A193M, Grade B7, and nuts, ASTM A194/A194M, Grade 7. Butt welded joints must be full penetration consumable insert or backing ring type.

2.10.3 Fittings, Size 40 Millimeters 1 1/2 Inches and Smaller

ASME B16.11, forged carbon steel, Class 3000 socket welding or Class 2000 threaded. Seal weld threaded joints not required to disassemble piping for maintenance. Joints may also be butt welded or flanged, as specified for sizes 50 mm 2 inches and larger.

2.10.4 Flat-faced Steel Flanges

Where connections are made to Class 250 cast iron flanges with steel flanges, use only flat-faced Class 300 steel flanges.

2.10.5 Unions

ASME B16.39, Class 2 (3447 kPa (gage) 500 psig WOG, cold, non-shock).

2.10.6 Valves

2.10.6.1 Globe and Angle Valves

Sizes 50 mm 2 inches and smaller, bronze, MSS SP-80, Type 3 (Metallic Disc, Renewable Seat), Class 300, threaded ends, or carbon steel, ASME B16.34, Class 300, threaded ends. Sizes larger than 50 mm 2 inches, ASME B16.34, carbon steel, tapered disk, Class 300, flanged ends.

2.10.6.2 Check Valves

ASME B16.34 or MSS SP-71, Class 300, steel, lift or swing type.

2.10.6.3 Pressure Reducing Valves

ANSI/NFLPA T3.12.3, with nominal pressure rating of not less than inlet system pressure indicated. Provide pressure reducing valves capable of being adjusted to specified flow and pressure, and suitable for intended service. Provide pilot valve for dome loaded type if required for proper operation.

2.10.6.4 Safety Valves

ASME BPVC SEC VIII D1 and ASME BPVC SEC IX, Code stamped safety valve, bronze body with bronze trim, for unfired pressure vessels, threaded or flanged connection; factory set and sealed.

2.10.7 Pressure Gages

ASME B40.100, Accuracy Grade A, for air, with steel or brass case, and nonshatterable safety glass, and a pressure blowout back to prevent glass from flying out in case of an explosion. Gages must have a 90 mm 3 1/2 inch minimum diameter dial and a dial range of approximately twice working pressure.

2.10.8 Pipe Hangers and Supports

MSS SP-58 and ASME B31.1, except as specified or indicated otherwise. Provide zinc plated pipe hangers and supports. Provide tubing supports of U-shaped steel bolts and nuts firmly secured to adequately support structures such as walls, columns, floors, or brackets. Clips must fit closely around piping but must have sufficient clearance to permit longitudinal movement of piping during normal expansion and contraction. Provide supports at valves, fittings, branch lines, outlets, changes in direction, equipment, and accessories.

2.10.9 Strainers

FS WW-S-2739, Class 250, Style Y, simplex type, with 20-mesh Monel or stainless steel screen.

2.10.10 Traps

CID A-A-60001, to drain water and other liquids from system. Type of traps, as indicated, and rated working pressure not less than system operating pressure.

2.10.11 Flexible Connections

Vibration isolation, wire braid reinforced corrugated metal hose type, line-sized, with bronze end connections, suitable for pressure indicated. Length as recommended by manufacturer but not less than [457] [_____] mm [18] [_____] inches.

2.10.12 Tetrafluoroethylene Tape

CID A-A-58092 for screw-jointed pipe.

2.11 SLEEVES

2.11.1 Floor Slabs, Roof Slabs, and Outside Walls Above and Below Grade

Galvanized-steel pipe having an inside diameter at least 15 mm 1/2 inch larger than the outside diameter of the pipe passing through it. Provide sufficient sleeve length to extend completely through floors, roofs, and walls, so that sleeve ends are flush with finished surfaces except that ends of sleeves for floor slabs must extend 15 mm 1/2 inch above finished floor surface. Sleeves located in waterproofed construction must include flange and clamping ring.

2.11.2 Partitions

Galvanized sheet steel, 26 gage or heavier, of sufficient length to completely extend through partition thickness with sleeve ends flush with partition finished surface.

2.12 VALVE BOX

Provide rectangular concrete design with words "Compressed Air" cast or otherwise marked on the cover. Size must be large enough for removal of valve without removing box. Provide valve box for areas as follows:

a. Roads and traffic areas: Heavy Duty, cast iron cover

b. Other areas: Standard duty, heavy steel plate or concrete cover

2.13 IDENTIFICATION LABELS FOR PIPING

Labels for pipes 20 mm 3/4 inch O.D. and larger must bear printed legends to identify contents of pipes and arrows to show direction of flow. Except that of pipes smaller than 20 mm 3/4 inch O.D., labels must have color coded backgrounds to signify levels of hazard in accordance with ASME A13.1. Legends and type and size or characters must also conform to ASME A13.1. Labels must be made of plastic sheet in conformance with CID A-A-1689 with pressure-sensitive adhesive suitable for the intended applications or they may be premolded of plastic to fit over specific pipe outside diameters 20 mm 3/4 inch and larger. For pipes smaller than 20 mm 3/4 inch O.D., furnish brass identification tags 40 mm 1 1/2 inches in diameter with legends in depressed black-filled characters.

2.14 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

Polyethylene plastic tape manufactured specifically for warning and identification of buried utility lines. Tape must be of the type provided in rolls, 152 mm 6 inches minimum width, color codes for compressed air (gray) with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification must be "CAUTION BURIED COMPRESSED AIR LINE BELOW" or similar wording. Code and letter coloring must be permanent, unaffected by moisture and other substances contained in trench backfill material.

2.15 FRESH WATER

Fresh water for cleaning, flushing, and testing must be clean and potable.

2.16 BASIC PIPING AND COMPONENT MATERIALS

Conform to the following where material is specified by generic type and no specification is listed.

2.16.1 Stainless Steel

Austenitic type, annealed, ASTM A182/A182M.

2.16.2 Nickel-Copper

70-30 nickel-copper, annealed, ASTM B164, alloy N04400, ASTM B127.

2.16.3 Copper-Nickel

70-30 copper-nickel, soft temper, MIL-C-15726.

2.16.4 Other Materials

For materials where no specification is listed above, conform to material specifications listed in ASME B31.1 or ASME BPVC SEC VIII D1.

2.17 SOURCE QUALITY CONTROL

Test air compressors and compressed air dryers at the factory to assure proper operation. Certify satisfactory accomplishment of tests.

PART 3 EXECUTION

3.1 INSTALLATION

Install materials and equipment as indicated and in accordance with manufacturer's recommendations.

3.1.1 Excavation and Backfilling

Section 31 00 00 EARTHWORK.

3.1.2 Corrosion Protection

Provide corrosion protection for buried steel [and corrosion resistant steel] piping in accordance with Section 09 97 13.28 PROTECTION OF BURIED STEEL PIPING AND STEEL BULKHEAD TIE RODS.

3.1.3 Piping

Provide Non-Destructive Examination (NDE) report for welding of piping. Unless specifically stated to the contrary, fabrication, assembly, welding, and brazing must conform to ASME B31.1 for all piping of the air system. Piping must follow the general arrangement shown. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing, except where cold-springing is specified. Piping and equipment within buildings must be entirely out of the way of lighting fixtures and doors, windows, and other openings. Locate overhead piping in buildings in the most inconspicuous positions. Do not bury or conceal piping until it has been inspected, tested, and approved. Where pipe passes through building structure, pipe joints must not be concealed, but must be located where they may be readily inspected and building structure must not be weakened. Avoid interference with other piping, conduit, or equipment. Except where specifically shown otherwise, vertical piping must run plumb and straight and parallel to walls. Piping connected to equipment must be installed to provide flexibility for vibration. Adequately support and anchor piping so that strain from weight of piping is not imposed on the equipment.

3.1.3.1 Fittings

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NOTE: Delete bending of medium or high pressure pipe when not included in project.

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Use long radius ells where appropriate to reduce pressure drops. Pipe bends in lieu of fittings may be used for piping where space permits. Pipe bends must have a uniform radius of at least five times the pipe diameter and must be free from any appreciable flattening, wrinkling, or thinning of the pipe. Mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction must not be used. Make branch connections with welding tees, except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1 may be used.

Bending of High Pressure Pipe: Prior to bending pipe for high pressure systems, the Contractor must submit for approval written fabrication and inspection procedures and calculations showing the required minimum wall thickness of pipe after bending. Only cold bending must be permitted. The fabrication procedure must indicate the required pipe wall thickness prior to bending, equipment to be used, set up and bending procedures, and inspection and acceptance criteria. Inspection must include verification of minimum wall thickness by ultrasonic or other methods if deemed necessary by the Contracting Officer. No wrinkles or other contour irregularities will be permitted in the bent pipe. Check flattening in accordance with ASME B31.1. Include required dimensional checks in inspection procedures and acceptable values tabulated for each pipe size to be bent. Qualified personnel must perform nondestructive examinations required in accordance with qualified procedures.

3.1.3.2 Clearances for Welding

Provide clearances from walls, ceilings, and floors to permit the installation of joints. The clearances must be at least 150 mm 6 inches for pipe sizes 100 mm 4 inches and less, 250 mm 10 inches for pipe sizes over 100 mm 4 inches, and sufficient in corners. However, the specified clearances must not waive requirements for welders to be qualified for the positions to be welded.

3.1.3.3 Cleaning

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NOTE: Special cleaning requirements are mainly intended for high pressure systems. Special cleaning should also be considered for medium pressure systems over 1724 kPa (gage) 250 psig which may be subject to dieseling explosions when oil contamination is present. Objective cleaning standards are specified to simplify inspection and acceptance in the field.

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Before jointing and erection of piping or tubing, thoroughly clean interiors of pipe sections, tube, and components. In steel pipe, loosen scale and other foreign matter by rapping sharply and expel by wire brush and swab. Blow out both steel pipe and copper tube and components with compressed air at 690 kPa (gage) 100 psig or more. Maintain cleanliness by closure of pipe/tube openings with caps or plugs. Before making final terminal connections, blow out complete system with compressed air at 690 kPa (gage) 100 psig or more. Cleaning and cleanness of medium pressure systems over 1724 kPa (gage) 250 psig and high pressure systems must conform to the paragraph entitled "Cleaning and Cleanness Requirements."

3.1.3.4 Changes in Pipe Size

Use reducing fittings for changes in pipe size. The use of bushings will not be permitted. In horizontal lines, 65 mm 2 1/2 inches and larger, reducing fittings must be of the eccentric type to maintain the bottom of the lines in the same plane.

3.1.3.5 Drainage and Flexibility

Compressed air piping must be free of unnecessary pockets and pitched approximately one mm per 400 mm 3 inches per 100 feet in the direction of flow to low points. Where pipes must be sloped so that condensate flows in opposite direction to air flow, slope one mm per 200 mm 6 inches per 100 feet or greater. Provide flexibility by use of fittings, loops, and offsets in piping. Install branches at top of a main to prevent carryover of condensate and foreign matter.

3.1.4 Threaded Joints

Where possible use pipe with factory cut threads, otherwise cut pipe ends square, remove fins and burrs, and cut taper pipe threads in accordance with ASME B1.20.1. Threads must be smooth, clean, and full cut. Apply thread tape to male threads only. Work piping into place without springing or springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed.

3.1.5 Flanged Joints in High Pressure System

Install using calibrated torque wrenches or feeler gage methods to assure proper gasket compression. Calibrate torque wrench immediately prior to use.

3.1.6 Welding and Brazing

Perform welding and brazing in accordance with qualified procedures using qualified welders and welding operators and brazers. Do not perform welding and brazing when the quality of the completed weld or braze could be impaired by the prevailing working or weather conditions. The Contracting Officer will determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural members must be in accordance with AWS D1.1/D1.1M. Mark welding and brazing detail drawings to identify the welder or brazer making the joint.

3.1.6.1 Cleaning for Welding and Brazing

Surfaces to be welded or brazed must be free from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces must be smooth and free from defects which might affect proper welding. Clean each layer of weld metal thoroughly by wire brushing, grinding, or chipping prior to inspection or deposition of additional weld metal. Conform to paragraph entitled "Cleaning and Cleanness Requirements" [for medium pressure systems over 1724 kPa (gage) 250 psig] [and] [for high pressure] systems.

3.1.6.2 Stress Cracking During Brazing

For austenitic stainless steel and other material susceptible to stress corrosion cracking from molten brazing filler metal, avoid applying stress during brazing.

3.1.6.3 Welding or Brazing of Valves

Welding or Brazing of Valves: Disassemble valves subject to damage from heat during welding or brazing and reassemble after installation. Open valves two or three turns off the seat when not subject to heat damage during welding or brazing; do not backseat valve.

3.1.7 Valves

Install valves in conformance with ASME B31.1 at the locations indicated and elsewhere as required for the proper functioning of the system.

3.1.7.1 Globe Valves

Install globe valves so that the pressure will be below the disk. Install globe valves with the stems vertical.

3.1.7.2 Pressure-Reducing Valves

Provide compressed air entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two block valves and with a globe or angle bypass valve and bypass pipe. Provide a bypass around a reducing valve of reduced size to restrict its capacity to approximately that of the reducing valve. Provide each pressure reducing valve unit with an indicating gage to show the reduced pressure, and a safety valve on the lower pressure side. These requirements do not apply to small pressure regulating valves used to adjust pressure for pneumatic equipment.

3.1.8 Hangers and Supports

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NOTE: See UFC 1-200-01, "General Building Requirements" and UFC 3-301-01, "Structural Engineering", for calculating pipe support spacing for schedules not shown. Also, space supports for high pressure air piping to provide restraint against whipping and damage to other piping if the high pressure line breaks; see DM 3.5, "Compressed Air and Vacuum Systems," Section 7, "Piping Systems." Delete Table I and reference to seismic requirements if not required.

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Selection, fabrication, and installation of piping hangers and supports must conform to MSS SP-58[except that spacing of the hangers and supports must be as per Table I].[Provide seismic restraints for piping in accordance with SMACNA 1981.]

TABLE I. MAXIMUM SPAN FOR PIPE

DIAMETER MM	STD. WT. STEEL PIPE SCHEDULE 40	EX. STRONG STEEL PIPE SCHEDULE 80
15	1.52	1.52
20	1.75	1.75
25	1.98	1.98
40	2.29	2.36
50	2.59	2.59
65	2.82	2.90
80	3.125	3.20
90	3.35	3.35
100	3.51	3.58
125	3.89	3.96
150	4.19	4.27
200	4.73	4.88
250	5.18	5.34

300	5.56	5.79

TABLE I. MAXIMUM SPAN FOR PIPE		
DIAMETER INCHES	STD. WT. STEEL PIPE SCHEDULE 40	EX. STRONG STEEL PIPE SCHEDULE 80
1/2	5'-0"	5'-0"
3/4	5'-9"	5'-9"
1	6'-6"	6'-6"
1-1/2	7'-6"	7'-9"
2	8'-6"	8'-6"
2-1/2	9'-3"	9'-6"
3	10'-3"	10'-6"
3-1/2	11'-0"	11'-0"
4	11'-6"	11'-9"
5	12'-9"	13'-0"
6	13'-9"	14'-0"
8	15'-6"	16'-0"
10	17'-0"	17'-6"
12	18'-3"	19'-0"

3.1.9 Pressure Gages

Provide pressure gauges with a shut-off valve or petcock installed between the gage and the line.

3.1.10 Strainers

Provide strainers with meshes suitable for the services where indicated, or where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.1.11 Equipment Foundations

Provide equipment foundations of sufficient size and weight and of proper design to preclude shifting of equipment under operating conditions or under any abnormal conditions which could be imposed upon the equipment. Provide foundations which meet the requirements of the equipment manufacturer, and when required by the Contracting Officer, obtain from the equipment manufacturer approval of the foundation design and construction for the equipment involved. Equipment vibration must be maintained within acceptable limits, and must be suitably dampened and isolated.

3.1.12 Equipment Installation

Install equipment strictly in accordance with these specifications, and the manufacturers' installation instructions. Grout equipment mounted on concrete foundations before piping is installed. Install piping in a manner that does not place a strain on any of the equipment. Do not bolt flanged joints tight unless they match properly. Extend expansion bends adequately before installation. Grade, anchor, guide and support piping without low pockets.

3.1.13 Cleaning of System

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NOTE: Special cleaning requirements are mainly intended for high pressure systems. Special cleaning should also be considered for medium pressure systems over 1724 kPa (gage) 250 psig which may be subject to dieseling explosions when oil contamination is present. Objective cleaning standards are specified to simplify inspection and acceptance in the field.

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Clean the various system components before final closing as the installations are completed. Remove foreign matter from equipment and surrounding areas. [Cleaning and cleanliness must conform to paragraph entitled "Cleaning and Cleanliness Requirements" for pressures over 1724 kPa (gage) 250 psig.] Preliminary or final tests will not be permitted until the cleaning is approved by the Contracting Officer.

3.1.14 Pipe Sleeves

Provide pipe sleeves where pipes and tubing pass through masonry or concrete walls, floors, roofs, and partitions. Hold sleeves securely in proper position and location before and during construction. All sleeves must be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Extend sleeves in floor slabs 50 mm 2 inches above the finished floor. Pack space between the pipe or tubing and the sleeve firmly with oakum and caulk both ends of the sleeve with elastic cement.

3.1.15 Floor, Wall, and Ceiling Plates

Provide chromium-plated steel or nickel-plated cast iron plates on pipes passing through floors and partitions of finished rooms. Provide painted cast-iron, malleable iron, or steel for other areas.

3.1.16 Flashing for Buildings

Provide flashing [as required] [in accordance with Section 07 60 00 FLASHING AND SHEET METAL] where pipes pass through building roofs and outside walls.

3.1.17 Unions and Flanges

Provide unions and flanges where necessary to permit easy disconnection of piping and apparatus, and as indicated. Provide a union for each connection having a screwed-end valve. [Provide unions or flanges not farther apart than 30 meters 100 feet.] [Provide unions or flanges as indicated.] Provide unions on piping under 50 mm 2 inches in diameter, and provide flanges on piping 50 mm 2 inches and over in diameter. Install dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous to non-ferrous connections.

3.1.18 Painting of Piping and Equipment

Paint piping and equipment in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.1.19 Identification of Piping

Identify piping in accordance with ASME A13.1. Use commercially manufactured piping identification labels. Space identification marking on runs not farther apart than 15 meters 50 feet. Provide two copies of the piping identification code framed under glass and install where directed.

3.1.20 Warning and Identification Tape

Coordinate installation of utility warning and identification tape with backfill operation. Provide tape above buried lines at a depth of 200 to 305 mm 8 to 12 inches below finish grade.

3.2 CLEANING AND CLEANNESS REQUIREMENTS

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NOTE: Special cleaning requirements are mainly intended for high pressure systems. Special cleaning should also be considered for medium pressure systems over 1724 kPa (gage) 250 psig which may be subject to dieseling explosions when oil contamination is present. Objective cleaning standards are specified to simplify inspection and acceptance in the field.

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Cleaning and cleanness requirements must conform to ASTM A380/A380M and the following.

3.2.1 Substitution

The word "must" must be substituted for "should" in ASTM A380/A380M.

3.2.2 Prohibited Methods and Processes

The following methods and processes must not be used.

a. Chemical descaling (acid pickling).

b. Abrasive blasting and vapor blasting.

c. Alkaline cleaning.

d. Emulsion cleaning.

e. Chelate cleaning.

f. Acid cleaning.

g. Passivation.

h. Corrosion inhibitors must not be used.

3.2.3 Approval of Methods and Procedures

Prepare and submit written cleaning procedures for approval. Perform production cleaning in accordance with approved procedures.

3.2.4 Tools Used on Corrosion-Resistant Alloys

Tools used on corrosion-resistant alloys such as grinding, polishing, filing, deburring, and brushing tools must be visually clean and must not have been used on carbon or low alloy steels, aluminum, lead or materials containing lead or lead components, or other low melting point materials. Wire brushes must be 300 series stainless steel. Unless otherwise approved, each tool must be used on only one type of corrosion-resistant metal.

3.2.5 Cleaning Before Installation

Clean piping, components, and equipment before installation.

3.2.6 Cleaning Requirements

Clean surfaces containing no crevices or inaccessible areas by any of the procedures described herein. Clean surfaces containing crevices by immersion in unused or redistilled acetone, ethanol, or isopropanol only.

3.2.6.1 Vapor Degreasing

Vapor degreasing may be used on surfaces containing no crevices or inaccessible areas and must be accomplished by the following procedures:

a. Dry all parts entering degreaser.

b. Load parts onto racks in the condensing zone so that they do not touch each other, and in such a manner to insure complete draining of solvents.

c. Use perchloroethylene bath. Maintain bath at 121 to 127 degrees C 250 to 260 degrees F. The bath must contain a neutral inhibitor to prevent acid formation due to hydrolysis. Other types of inhibitors are not permitted.

d. Change solvent when boiling point of perchloroethylene exceeds 127 degrees C 260 degrees F. Dump solvent earlier if cleanliness standards are not attained.

e. Lower or raise parts in the degreaser at a rate not to exceed 5 mm/s 12 inches per minute and immerse in vapor phase. Spray with clean solvent during immersion time. Keep the spray nozzle at least 305 mm one foot below the vapor line during spraying. Allow part to remain in vapor until condensation ceases (3 to 5 minutes). Dry parts completely before removing from degreaser.

3.2.6.2 Degreasing by Immersion or Wiping

Degreasing of parts having no inaccessible areas or crevices may be performed by immersion in solvent or by wiping with a clean lintless wiping cloth saturated with the solvent perchloroethylene, unused or redistilled acetone, ethanol, or isopropanol, or Stoddard solvent for preliminary degreasing. Dry in accordance with paragraph entitled "Drying Requirements."

3.2.6.3 Trisodium-Phosphate Detergent Cleaning (Degreasing)

Trisodium-phosphate detergent cleaning may be used on surfaces containing no crevices or inaccessible areas and must be accomplished as follows:

a. Remove heavy dirt by either scrubbing with a non-shedding bristle brush using a solution of up to 112.2 mL one fluid ounce of nonionic detergent per liter gallon of tap water or immersing the parts in a hot (approximately 71 - 88 degrees C 160 - 190 degrees F) solution consisting of 207 to 296 mL 7 to 10 ounces of trisodium phosphate and up to 112.2 mL one fluid ounce of the nonionic detergent per liter gallon of tap water for about 20 minutes. Agitate and use brush as necessary.

b. Rinse parts thoroughly in hot water at a minimum of 49 degrees C 120 degree F.

c. Dry the parts in accordance with paragraph entitled "Drying Requirements."

3.2.6.4 Ultrasonic Cleaning

Cleaning methods using ultrasonic equipment may be used.

3.2.7 Drying Requirements

Accomplish drying by still or forced clean air or inert gas, drying oven, or by evacuation. When using evacuation, exercise care to prevent evacuating-pump lubricant from entering the equipment. Check compressed air used for drying to ensure cleanliness by blowing through a clean, white, cotton filter cloth for about 5 minutes at full drying velocity.

3.2.8 Inspection and Acceptance Criteria for Cleanliness

Conform to ASTM A380/A380M and the following:

3.2.8.1 Cleanness Criteria

All surfaces of piping material, equipment, instruments, and other components which will come in contact with compressed air must be clean to the extent that no contamination is visible to a person with normal visual acuity (natural or corrected) under a lighting level of at least 1076 lux 100 footcandles on the surface being inspected. Cleanness of surface which cannot be visually inspected due to inaccessibility or geometry must be determined by an interpretation of the discoloration or dirt obtained by wiping with a clean, white, wet or dry cloth. Free of contamination must mean free of oil, dirt, metallic flakes, preservatives, paint, and any other substances which may present a safety hazard or impair the quality of the compressed air.

3.2.8.2 Critical Surfaces

No rust must be allowed on valve seats, orifice plates or other critical surfaces. Thin films of rust are acceptable on other corrosion-resistant material surfaces provided there is no visible thickness or evidence of pitting and the total area involved does not exceed one percent of the total surface area of the component in contact with compressed air.

3.2.8.3 Carbon and Low Alloy Steels

A uniform light rust that can be removed by brushing or wiping is acceptable.

3.2.9 Maintaining Cleanness During Installation

Maintain cleanness of piping, components, and equipment during installation. Dirt and debris producing operations must be performed so that dirt and debris fall away from system openings; otherwise, provide covers over openings to preclude contamination. Cap, plug, cover, or bag openings and pipe ends and secure with tape when they are not required to be open for the performance of work. Metal caps, plugs, and covers must be austenitic stainless steel. Plastic items and tape must be free of substances that can have a harmful effect on stainless steel and other corrosion-resistant metals in the system.

3.2.10 Cleanness Verification Flushes

After installation, check the systems for cleanness by flushing with water. Perform flushing so that the minimum velocity through any part of the system is not less than [1.1] [_____] meters [3.6] [_____] feet per second. Pass flush water through a filter for cleanness evaluation. Filter element must be corrosion-resistant wire cloth with mesh size conforming to ASTM E11, No. 20 (850 micrometers), No. 25 (710 micrometers), or No. 30 (600 micrometers). Filter area must be sufficient to limit pressure drop so that required flushing velocity can be attained.

3.2.10.1 Flush Acceptance Criteria

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NOTE: Select flush acceptance criteria based on how critical the system is and the volume of system to be flushed. More particles may be expected and may be acceptable in larger systems.

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The system must be flushed until there is no more than [slight speckling] [[0.1] [0.5] [_____] cubic centimeters] of particulates on the filter screen. There must be no particles larger than 0.79 by 1.59 mm 1/32 by 1/16 inch long. The flush water must show no visual evidence of contamination such as oil particles, discoloration, or iridescent surface film characteristic of oil.

3.2.10.2 Recleaning of Systems

Systems which fail to meet acceptance flush criteria after flushing for more than 4 hours must be recleaned by the Contractor at no additional cost to the Government. Prepare recleaning procedures and submit to the Contracting Officer for approval. Remove instruments, components, and any other items that may be damaged by recleaning. Perform recleaning by flushing with hot water at not less than 60 degrees C 140 degrees F.

3.3 CLEANING SILVERBRAZED PIPING

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NOTE: All silverbrazed piping, including low pressure systems, should be cleaned to preclude corrosion from residual brazing flux.

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Clean silverbrazed piping to remove residual flux remaining in the system after fabrication. Use one of the procedures below. The hot flush and hot recirculating flush are preferred. Minimum flow rate through any part of the system in liters gallons per second minute must be 0.0037 1.5 times the inside diameter of the pipe in mm inches. For any flushing method used, the system must be full of water so that joints are completely submerged at all times.

3.3.1 Hot Flushing Method

Hot flush the system for one hour using heated fresh water. No part of the system must go below 43 degrees C 110 degrees F.

3.3.2 Hot Recirculating Flush Method

Perform hot recirculating flush for one hour. Heat water during flushing so that no part of the system falls below 43 degrees C 110 degrees F. After completing the hot recirculating flush, flush the system with cold fresh water for 15 minutes.

3.3.3 Cold Soak Method

Cold soak the system using fresh water at not less than 15.50 degrees C 60 degrees F for 12 hours. Following the 12 hour soak, flush the system with fresh water at not less than 15.50 degrees C 60 degrees F for 4 hours.

3.4 FIELD QUALITY CONTROL

3.4.1 Examinations

3.4.1.1 Welding Examinations

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NOTE: The paragraphs will be edited and inserted if necessary to ensure proper implementation of the "CONTRACTOR QUALITY CONTROL PROGRAM." The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible, i.e., primarily the Contractor or the Government. Rarely will a project require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing and must indicate the extent in this section of the project specifications or on the project drawings by notes, nondestructive test symbols, or other means. Table II at the end of this section was developed from MIL-STD-278, "Fabrication, Welding and Inspection,

and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels in Ships of the United States Navy." The referenced applicable publications and Army Technical Manual, "WELDING DESIGN, PROCEDURES AND INSPECTION," TM-5-805-7, may be used for guidance in determining inspection and testing requirements. The specifications or drawings must clearly indicate which joints require 100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the drawings must indicate the location, number of joints, and minimum increment length of weld that will be subject to NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods must be subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for other nondestructive examinations should be deleted from these paragraphs and from paragraph entitled "QUALIFICATION OF INSPECTION AND NONDESTRUCTIVE PERSONNEL."

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NOTE: Information based on Table II must be developed and included in each project specification. Table must clearly define the systems to be inspected and the type of NDE required. Revise Table II if required for the project.

****

[The Government will][The Contractor must]perform visual and nondestructive examinations to detect surface and internal discontinuities in completed welds, and submit a Non-Destructive Examination (NDE) report meeting the requirements specified in ASME B31.1.[The Contractor must obtain the services of a qualified commercial inspection or testing laboratory or technical consultant, approved by the Contracting Officer.] Visually examine welds. Perform [radiographic,][liquid penetrant,][or][magnetic particle] examination as specified in Table II of this section. For systems operating at 6894 kPa (gage) 1000 psig or higher, all welds must be examined. For high pressure systems operating less than 6894 kPa (gage) 1000 psig, perform random NDE. When examination and testing indicate defects in a weld joint, the weld must be repaired by a qualified welder. Remove and replace defects as specified in ASME B31.1, unless otherwise specified. Repair defects discovered between weld passes before additional weld material is deposited. Whenever a defect is removed, and repair by welding is not required, blend the affected area into the surrounding surface, eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, examine the area by the same test methods which first revealed the defect to ensure that the defect has been eliminated. After rewelding, reexamine the repaired area by the same test methods originally used for that area. Any indication of a defect must be regarded as a defect unless reevaluation by surface conditioning [and NDE] shows that no unacceptable defects are present. The use of any foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

3.4.1.2 Brazing Examinations

The Contractor must perform brazing examinations.

a. Visual Examinations

Visually examine all compressed air systems as follows:

(1) Check brazed joint fit-up. Diametrical clearances must conform to brazing procedure requirements.

(2) Check base material of pipe and fitting for conformance to the applicable drawing or specification.

(3) Check grade of brazing alloy for conformance to the brazing procedure before fit-up or brazing.

(4) Check completed brazed joint for a complete ring of brazing alloy between the outside surface of the pipe and the face of the fitting, and for a visible fillet.

(5) Check stainless steel and other susceptible material for evidence of stress cracks. Check inside of joint if possible with borescope or other aids.

b. Nondestructive Examination

For high pressure compressed air systems, any fitting, copper-nickel pipe, or stainless steel tubing which is reused after unsweating a brazed joint must be liquid penetrant examined for cracks. Any crack detected must be cause for rejection of the fitting or pipe. Liquid penetrant examination must be performed by qualified personnel.

c. Repair of Brazed Joints

Defective joints may be repaired. However, no more than two attempts to repair by reheating and additional face feeding of brazing filler metal will be permitted, after which the defective joint must be unsweated, reprepared as a new joint, examined for defects on pipe and fittings, and rebrazed. Perform required NDE.

3.4.2 Testing

****

NOTE: If air (pressure) drop tests are used for system acceptance, assure that leakages at acceptable rates through valves (or other components) are not causing pressure drop. Most hard-seated valves have some allowable leakage rate (about 10 cubic centimeters 0.0026 gal per hour of water per 25 mm one inch valve size or 3 liters per hour 0.1 cubic feet per hourof gas per 25 mm one inch of valve size). Delete check for cross-connection if only one type of system is involved in project.

****

3.4.2.1 General Requirements, Testing

Perform testing after cleaning and acceptance of cleanness. Contractor must provide everything required for tests. Tests must be subject to the approval of the Contracting Officer. Calibrate the test pressure gage with a dead weight tester within [15] [_____] days before use and certify by initial and date on a sticker applied to dial face. [Pressurize each piping system individually and check to assure that there are no cross-connections between different systems prior to hydrostatic and operational tests.]

Supervision of Testing

For [high] [and] [medium] pressure system, an experienced registered professional engineer responsible for safety and employed by the Contractor must be present during testing.

3.4.2.2 Hydrostatic and Leak Tightness Tests

a. Preliminary Preparation

Remove or isolate from the system the compressor, air dryer, filters, instruments, and equipment which would be damaged by water during hydrostatic tests and reinstall after successful completion of tests.

b. Performance of Hydrostatic Tests

****

NOTE: Specify or show on the drawings the design working pressure of each system in the project.

****

Hydrostatically test piping systems in accordance with ASME B31.1. Vent or flush air from the piping system. Pressurize system for 10 minutes with water at one and one-half times design working pressure, then reduce to design working pressure and check for leaks and weeps.

c. Compressed Air Leak Tightness Test

After satisfactory completion of hydrostatic pressure test, blow systems dry with clean, oil-free compressed air, and test with clean, dry air at design working pressure. Brush joints with soapy water solution to check for leaks. Install a calibrated test pressure gage in piping system to observe any loss in pressure. Maintain required test pressure for a sufficient length of time to enable an inspection of joints and connections.

d. Compressed Air Pressure Test For High Pressure Systems

For high pressure systems, compressed air at system design pressure must then stand in a system to equalize temperature. Pressure drop, corrected for temperature change, must not be more than one percent in 24 hours for a test pressure 6894 kPa (gage) 1000 psig and above, and not over 5 percent in 6 hours for test pressures from 2758 to 6894 kPa (gage) 400 to 1000 psig. Use formula below to correct pressure for temperature change.

PF + 101.32 = (PI + 101.32)(TF + 273)/(TI + 273) PF + 14.7 = (PI + 14.7)(TF + 460)/(TI + 460)

Where PF = Final Pressure, (kPa (gage)) (psig)

Where PI = Initial Pressure, (kPa (gage)) (psig)

Where TF = Final Temperature, (degrees C F)

Where TI = Initial Temperature (degrees C F)

3.4.2.3 Operational Tests

Test equipment as in service to determine compliance with contract requirements and warranty. During the tests, test equipment under every condition of operation. Test safety controls to demonstrate performance of their required function. Completely test system for compliance with specifications.

3.5 INSTRUCTION TO GOVERNMENT PERSONNEL

Provide [2] [_____] man-days of instruction to [2] [_____] Government personnel in accordance with Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS for each type of compressor and compressed air dryer in the project.

TABLE II

HP Piping (2758 kPa (Gage) Higher) Inspection Requirements 1/

Required Nondestructive Examination

Welded Joint type and pipe size, mm	VISUAL EXAMINATION		T/PT TEST		RADIOGRAPHY	
	Root Layer	omplete Weld	Root Layer	Completed Weld	Completed Weld	Extent Of
Butt 100 and greater	X2/	X	X2/	X3/	X	6.28 radian
Butt 65 to 90 incl	X2/	X	X2/	X3/	X4/5/	At least 105 radian
Butt less than 65	X2/	X	X2/	X3/	X4/5/6/	At least 105 radian
All socket and fillets	X2/	X	X2/	X	--	--

TABLE II

HP Piping (400 psig and Higher) Inspection Requirements 1/

Required Nondestructive Examination

Welded Joint type and pipe size, inches	VISUAL EXAMINATION		T/PT TEST		RADIOGRAPHY	
	Root Layer	omplete Weld	Root Layer	Completed Weld	Completed Weld	Extent Of
Butt 4 and greater	X2/	X	X2/	X3/	X	360 degrees
Butt 2-1/2 to 3-1/2 incl.	X2/	X	X2/	X3/	X4/5/	At least 60 degrees
Butt less than 2-1/2	X2/	X	X2/	X3/	X4/5/6/	At least 60 degrees
All socket and fillets	X2/	X	X2/	X	--	--

Legend: X - Indicates that test is required.

MT Magnetic Particle Inspection

PT Liquid Penetrant Inspection

RT Radiographic Examination

NOTES:

__1/ Where new welds in piping intersects existing or older welds, the latter welds must be inspected for a distance of 150 mm 6 inches or a distance equal to 50 percent of the pipe size diameter, whichever is less, as measured from points of intersection. The existing or older weld and adjacent base material must be free from cracks. Where non-intersecting adjacent existing welds are inadvertently radiographed, only cracks must be cause for rejection.

__2/ MT/PT inspect the first or root pass of welds and when accessible, the reverse or back-chipped ground, gouged or machined side prior to depositing metal on the reverse side. Visual examination at 5X magnification may be substituted for MT/PT inspection. Linear discontinuities must be unacceptable. Use 5X inspection where crevices cannot be cleaned thoroughly.

__3/ MT/PT test must be performed only when post-weld heat treatment is required and when specified on drawing. The test must be conducted after heat treatment and must include 6.28 radian 360 degrees of circumferential weld surface and adjacent base material. Where 6.28 radian 360 degrees RT is performed after heat treatment, MT/PT is not required, except where specified on drawing.

__4/ RT of welds on piping in the horizontal fixed position must represent a sector which was welded in the vertical or overhead position.

__5/ In lieu of 1.05 radian 60 degree RT, PT or MT may be performed on the inside of a joint where weld is within 2 1/2 nominal pipe diameters from the open end is back welded, has backing ring removed or used consumable insert.

__6/ RT is required where the working pressure exceeds 3964 kPa (gage) 575 psig. For working pressure 3964 kPa (gage) 575 psig and below, inspection may be performed in lieu of RT.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-22 16 19.26 20 (November 2009)**

Preparing Activity: NAVFAC **Superseding**
UFGS-22 16 19.26 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-22 16 19.26 20 (November 2009)**

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 22 16 19.26 20

LARGE CENTRIFUGAL AIR COMPRESSORS (OVER 200 HP)

11/09

****

NOTE: This guide specification covers the requirements for large centrifugal air compressors over 150 kW 200 hp and certain accessories.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Cooling towers, closed-circuit coolers, cooling water piping, and other items are not included and must be included in other sections of the project specification. CENTRIFUGAL COMPRESSORS MUST BE PERMITTED AS AN OPTION IF NONLUBRICATED ROTARY SCREW COMPRESSORS ARE SPECIFIED IN THE PROJECT.

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****

NOTE: The following information must be shown on the project drawings:

1. Compressor, accessory equipment, and piping arrangement and details.

2. Equipment foundations.

3. Equipment schedules. If equipment schedules include operating conditions for the compressor, delete the information from this section.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2011	(2014B) Cylindrical Wormgearing Tolerance and Inspection Methods
ANSI/AGMA 2009	(2001B; R 2008) Bevel Gear Classification, Tolerances, and Inspection Methods

AMERICAN PETROLEUM INSTITUTE (API)

API Std 672	(2004; Errata 2007; Errata 2010) Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Services

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 10	(2022) Performance Test Code on Compressors and Exhausters

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B171/B171M	(2024) Standard Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers and Heat Exchangers
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7.1	(2011) Commodity Specification for Air; 5th Edition

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2151	(2004) Acoustics - Noise Test Code for Compressors and Vacuum Pumps - Engineering Method (Grade 2)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and

	Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation
MIL-PRF-17331	(2019; Rev L) Lubricating Oil, Steam Turbine and Gear, Moderate Service
MIL-T-19646	(1990; Rev A; Notice 1 2021) Thermometer, Gas Actuated, Remote Reading

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

1.2 GENERAL REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section except as specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL

PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Air Compressor System

Include wiring diagrams of the air compressor with all accessories. The minimum acceptable scale is [1:50 1/4 inch to one foot] [_____].

SD-03 Product Data

****

NOTE: Include carbon monoxide monitor in systems which are used for breathing air per DM 3.5, Section 3.

****

Air Compressor

Air Intake Devices

Bypass Line Silencer

Air Flow Rate and Pressure Recorder

[Carbon Monoxide Monitor

] Submit manufacturer's catalog data for compressor and auxiliary equipment in the format provided in API Std 672, Appendix A. Submit all applicable information. For air compressor, include aftercooler, intercoolers, oil cooler, lubrication system, and control valves. Submit air compressor and intercooler performance curves at specified summer and winter design conditions.

SD-06 Test Reports

Air compressor performance tests

Balance Tests

Sound Level and Run-In Tests

Obtain approval prior to shipping compressor.

Air Compressor Performance Tests

Instrumentation Test

Sound Level Tests

Air Compressor System Tests

The test supervisor must certify performance by test to be in compliance with specifications.

SD-07 Certificates

Air Compressor System

Air Compressor System Installation

Work Plan

Factory Test Procedures

Factory Testing Certification

Qualifications of Field Supervisors

Field Test Procedures

Training Material

SD-10 Operation and Maintenance Data

****

NOTE: Obtain approval of equipment with proprietary maintenance requirements from the appropriate contracts office.

****

Air Compressor System, Data Package 3

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions for Air Compressor

Submit text.

1.4 QUALITY ASSURANCE

1.4.1 Work Plan

Submit a written schedule of dates of installation, start-up, checkout, and test of equipment.

1.4.2 Factory Testing Certification

Submit a statement that the air compressor factory is equipped to perform all required factory tests. Submit in accordance with paragraph entitled "Manufacturer's Certifications."

1.4.3 Qualifications of Field Supervisors

Submit the name and certified written resume of the engineer or technician, listing education, factory training and installation, start-up, and testing supervision experience for at least two projects involving compressors similar to those in this contract.

1.4.4 Training Material

Submit a detailed training program syllabus for training of government personnel, including instructional materials at least three weeks prior to start of tests.

1.4.5 System Installation

Submit certification of air compressor system performance conforming to ASME PTC 10 and ASME BPVC SEC VIII D1. Submit certification of proper system installation in accordance with paragraph entitled "Supervision."

1.4.6 Air Compressor System

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Data must contain information required for maintenance and repair and must contain no evidence that proprietary maintenance arrangements with the manufacturer will be necessary. Compressors which will require proprietary maintenance arrangement with the manufacturer require Government review and approval. The compressors may be disapproved if circumstances do not justify approval of compressors with limited availability of maintenance.

1.5 SAFETY

Construct all components of the unit in accordance with the requirements of OSHA 29 CFR 1910.219. Requirements include shaft coupling guards as specified in Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, thermal insulation and jacketing with manufacturer standard covering or aluminum sheet of all surfaces at 52 degrees C 125 degrees F and higher within a height of 2.10 m 7 feet from floor level, and use of electrical safety devices. Thermal insulation, furnished by equipment manufacturer, must conform to ASTM C553, Type I (flexible resilient), Class B-5 (up to 204 degrees C 400 degrees F), 32 kg/m3 2 pcf nominal. Cement insulation to surface with MIL-A-3316, Class 2, adhesive and fasten with 16 gage wire bands at maximum 405 mm 16 inches on center spacing. Cover insulation with ASTM B209M ASTM B209 sheet aluminum jacket. The thermal insulation is required for unit with separate intercooler and aftercooler units.

1.6 EQUIPMENT ARRANGEMENT

Arrangement selected must maintain 0.9 m 3 foot clearance for access passage and 1.20 m 4 foot clearance for personnel to operate equipment. There are substantial physical and connection point differences among the several air compressors which comply with this specification. The Contractor must be responsible for selecting equipment and submitting arrangement drawings covering required changes for approval by the Contracting Officer. Changes from the equipment arrangement shown on the contract drawings must be performed by the Contractor at no additional cost to the Government.

1.7 ELECTRICAL REQUIREMENTS

Comply with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, [and [_____]].

1.8 SUPERVISION

The Contractor must obtain the services of a qualified engineer or technician from the compressor manufacturer to supervise installation, start-up, and testing of the compressor. After satisfactory installation of the equipment, the engineer or technician must provide a signed certification that the equipment is installed in accordance with the manufacturer's recommendations.

1.9 DEFINITIONS

Conform to API Std 672 and the following:

Compressor power is shaft power at shaft coupling, including all aerodynamic and mechanical losses.

1.10 INSULATION

Thermal and acoustical insulation must have flame spread rating not higher than 75, and smoke developed rating not higher than 150 when tested in accordance with ASTM E84.

1.11 POSTED OPERATING INSTRUCTIONS

Provide for air compressor. Include start-up and shutdown sequence instructions.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment complete with accessories must be selected by the Contractor for performance compatibility.

2.2 AIR COMPRESSOR

The air compressors must be the packaged, integrally geared, centrifugal type. Include the electric motor driver, integral gears and cases, staged compressors, intercoolers and moisture separators, aftercoolers and moisture separators, instruments, controls, pressure lubrication system with prelubrication pump and shaft-driven lubrication pump, steel base and accessories. The aftercoolers may be mounted separately to meet the performance requirements.

2.2.1 Manufacturer's Certifications

The manufacturer must certify that the air compressors proposed are of the same design, construction, and frame size, and of equal or not more than 10 percent smaller in capacity as compressors which have been in satisfactory continuous service for at least 2 years at not less than two locations. Furnish the name of the owner, the address of the installation, and the name of a person at the installation who can be contacted for verification. The manufacturer must also certify that the factory is equipped to perform all required factory tests.

2.2.2 Guaranteed Performance

****

NOTE: Designer should furnish required information to complete the specification.

****

a. Net Compressed Air Output (All seal losses must be considered internal and not included in the net output) (Minus zero plus 4 percent): [_____] liters per second (L/s) [_____] SCFM

b. Output Pressure Immediately Downstream of Aftercooler (Minus zero plus 4 percent): 862 kPa (gage) 125 psig

c. Output Air Maximum Temperature Downstream of Aftercooler: 38 degrees C 100 degrees F

d. Inlet Air Pressure at First Stage: [_____] kPa (absolute) psig

e. Inlet Air Temperature at First Stage: [_____] degrees C F

f. Inlet Air Filtration Efficiency: 99.9 percent of 0.5 micrometer size

g. Barometric Pressure: [_____] kPa (absolute) psig

h. Relative Humidity: [_____] percent

i. Cooling Water Inlet Temperature: [_____] degrees C F

j. Total Cooling Water Flow Rate: [_____] L/s gpm

k. Maximum Cooling Water Pressure Drop Through the Compressor and Any Intercooler, Aftercooler, or Oil Cooler: [_____] [55 kPa] [8 psi]

l. Maximum Compressor Power Required. (Plus or minus 4 percent): [_____] kW hp

m. Unloaded Compressor Power and Compressor Interconnections: [_____] kW hp

n. Maximum sound levels one meter horizontal from compressor and 1.5 meters 5 feet above floor as measured per ISO 2151 Test Code for the Measurement of Sound from Pneumatic Equipment: 84 dBA, 90 dB for any octave band.

2.2.3 Additional Performance Requirements

2.2.3.1 Air Quality

Air at compressor intake will be considered breathing air quality conforming to CGA G-7.1, Type I, Grade D or better. Air compressors must introduce no material, gases, or particles, or chemically alter any materials that will adversely affect or reduce the quality of the air passing through the unit.

2.2.3.2 Surge Output Pressure

API Std 672, paragraph 2.1.12.

2.2.3.3 Unloading

The compressor must be designed to unload prior to surge limit. The surge limit must not occur at a capacity greater than 70 percent of the guarantee point capacity. Unloaded compressor power must not exceed 20 percent of full load power.

2.2.3.4 Ambient and Inlet Conditions Operating Ranges

****

NOTE: Designer should furnish required information to complete the specification.

****

Allowing for rational engineering performance adjustments due to variations in ambient and inlet conditions, the compressor must be designed, equipped, and furnished to be fully operational without abnormal wear throughout the entire range between and including the limits of the winter and summer design conditions specified.

a. Summer Design Conditions:

(1) Inlet Air: [_____] degrees C F dry bulb and [_____] degrees C F wet bulb temperatures, [_____] percent relative humidity

(2) Inlet Cooling Water: [_____] degrees C F

(3) Ambient Compressor Room Temperature: [_____] degrees C F

(4) Barometric Pressure: [_____] kPa (absolute) psig

b. Winter (Low Ambient) Design Conditions:

(1) Inlet Air: [_____] degrees C F dry bulb and [_____] degrees C F wet bulb temperatures, [_____] percent relative humidity

(2) Inlet Cooling Water: [_____] degrees C F

(3) Ambient Compressor Room Temperature: [_____] degrees C F

(4) Barometric Pressure: [_____] kPa (absolute) psig.

2.2.3.5 Critical Speeds

Conform to API Std 672, paragraph entitled "Critical Speed."

2.2.3.6 Vibration and Balance

Conform to API Std 672, paragraphs entitled "Vibration and Balance."

2.2.4 Electrical Service Conditions

2.2.4.1 Air Compressor Drive Motor

[_____] volts, 3 phase, 3 wire, 60 hertz electrical service.

2.2.4.2 Accessory electrical Service

****

NOTE: Change accessory voltages if required for site conditions.

****

See Table I.

TABLE I - COMPRESSOR ACCESSORY ELECTRICAL SERVICE SCHEDULE			
Item	Voltage	Phase	Frequency
Control Power and Motors under 3/8	120	1	60 Hz
Accessory Power	460	3	60 Hz

TABLE I - COMPRESSOR ACCESSORY ELECTRICAL SERVICE SCHEDULE			
Item	Voltage	Phase	Frequency
Control Power and Motors under 1/2	120	1	60 Hz
Accessory Power	460	3	60 Hz

2.2.5 Compressor Controls

Provide complete pneumatic load range control system with each compressor with a manually selectable capability for two modes of load range control as specified. Provide additional electrical, electro-pneumatic, or solid state electronic controls for other specified control and monitor functions. All controls must conform to NEMA ICS 2 as selected by the compressor manufacturer. Control system enclosure must conform to NEMA ICS 6. Controls must be suitable for individual operation of the compressor or parallel operation with one or more other compressors.

2.2.5.1 Two-Step Control Mode

The two-step control mode must actuate the compressor suction inlet control valve to either a full open position or to a full closed position in accordance with specified, adjustable pressure settings. The pressure settings must be an adjustable band width plus and minus percentage of an adjustable output gage pressure set point. The compressed air output gage set point must be adjustable in the range of 724 to 862 kPa 105 to 125 psig, and the gage pressure sensor measurement for this set point must be made downstream of the aftercooler. The adjustable band width about the set point must be from plus or minus 2 1/2 percent to plus or minus 5 percent. Controls must close the compressor inlet valve at the high pressure limit of the band width and simultaneously open a bypass vent valve which must also be provided. Controls must open the compressor inlet valve at the low pressure limit of the band width and simultaneously close the bypass vent valve.

2.2.5.2 Dual Control Mode

A pressure regulation control mode must be furnished to control compressor output pressure to within plus or minus one percent of an adjustable output pressure set point. Provide an adjustment range of 724 to 862 kPa 105 to 125 psig. When the compressor operates at capacities above surge limit unload setting and below maximum flow stonewall conditions, the control system must throttle flow at the compressor suction inlet control valve in response to increasing discharge pressure due to decreased demand for compressed air. At lower demand, prior to reaching surge limit at a flow capacity not more than 70 percent of guarantee point capacity, the compressor must unload by closing the compressor inlet suction control valve and simultaneously opening the bypass vent valve. Use of the bypass vent valve alone to achieve pressure control by a modulation technique of spilling excess air is prohibited. At the low discharge pressure limit, the inlet valve must open and the bypass vent valve must close to load the compressor.

2.2.5.3 Unloaded Compressor Start-Up

Each of the two pneumatic control mode systems must have provision for start-up of the compressor in the unloaded control setting with the compressor inlet valve closed and the bypass valve open.

2.2.5.4 Electrical Start-Up Interlocks

The manual starting circuit of each compressor must have interlocks to prevent starting until pre-lubrication pump oil pressure and cooling water pump water flow have been established to the required values for safe operation as determined by the compressor manufacturer.

2.2.5.5 Monitor and Safety Controls

Provide supplementary electric, electro-pneumatic, or solid state electronic controls to provide alarm and shut down requirements, plus interlocks with accessories. Requirements are as follows:

a. Shutdown requirements must cause the controlled compressor to shut down, energize alarms, and light labeled red lights.

b. Alarm only requirements must not cause the controlled compressor to shut down, but must sound the same alarms and light labeled amber lights.

c. Light only requirements must not cause the controlled compressor to shut down, but must light labeled amber lights.

d. The individual monitor and safety controls must be as shown on Table 2.

TABLE 2 - MONITOR AND SAFETY CONTROL SCHEDULE

Item	Light and Shutdown	Indicating Alarm	Light Only
1. High Discharge Air Temperature 135 degrees C 275 degrees F	Yes	Yes	-
2. High Intercooler Discharge Water Temperature, Each Intercooler	No	Yes	-
3. High Aftercooler Discharge Water Temperature	No	Yes	-
4. High Cooling Water Supply Temperature	No	Yes	-

5. High Lube Oil Temperature	Yes	Yes	-
6. Low Lube Oil Pressure	Yes	Yes	-
7. Low Cooling Water Flow	No	Yes	-
8. Low Oil Reservoir Level	No	Yes	-
9. High Condensate Level Intercooler (wired to one light)	Yes	Yes	-
10. Vibration Monitors Each Pinion	Yes	Yes	-
11. Surge Limit Approach	Yes	Yes	-
12. High Motor Stator Temperature	Yes	Yes	-
13. High Condensate Level Aftercooler	No	No	Yes
14. High Inlet Pressure Drop Across Inlet Air Filters (combined, 3 stage)	No	Yes	-
15. High CO Level	Yes	Yes	-

2.2.5.6 Monitoring Instruments

Provide the following monitoring instruments in addition to the monitor and safety controls. Pressure gages must conform to ASME B40.100, 115 mm 4 1/2 inch, red marking pointer, single bourdon tube, brass case, black enamel finish. Provide pressure gages with a pressure snubber and a stainless steel barstock needle isolation valve. Thermometers must be extended stainless steel sheathed bimetallic stem, 90 mm 3 1/2 inch dial, and separable 100 mm 4 inch stainless steel wells. Temperature measurements at inaccessible locations must be made with remote reading thermometers conforming to MIL-T-19646, Class C separable well of Type 304 stainless steel. Select pressure and temperature gage ranges to give a normal operating reading near the midpoint of the scale range.

a. Oil cooler outlet temperature gages for oil.

b. Oil cooler inlet and outlet temperature gages for water.

c. Lubrication oil pump discharge pressure gage.

d. Compressor seal air pressure gage, if applicable.

e. Inlet air filter differential pressure gage with 1992, zero, 1992 Pa 8, zero, 8 inch water gage. Provide selector valve, tubing, and tap to measure static gage pressure downstream of each filter stage.

f. Pinion shaft vibration monitor readout with stage selection switch.

g. Total running time readout.

h. Cooling water supply to compressor pressure gage.

i. Cooling water return from compressor pressure gage.

j. Interstage air pressure gages for each interstage.

k. Compressed air pressure downstream of aftercooler pressure gage.

l. Compressed air temperature downstream of aftercooler temperature gage.

m. Interstage air temperature after intercooler of each stage temperature gages.

n. Compressed air temperature at discharge of each stage of compression before cooling temperature gages.

o. Compressor inlet air temperature gage.

p. Cooling water to compressor temperature gage.

q. Cooling water outlet temperature at outlet of each intercooler and aftercooler temperature gages.

2.2.5.7 [Gages on Schematics

****

NOTE: Delete paragraphs if control schematics are not shown on project drawings.

****

Certain pressure and temperature gages are designed on schematic flow diagrams in the drawings. Where a monitor gage satisfies the required location on a schematic, no additional gage needs to be furnished.]

[2.2.5.8 Control Schematics

****

NOTE: Delete paragraphs if control schematics are not shown on project drawings.

****

The drawings show a generalized overall control system for compressor, auxiliaries, remote panel transmitting and receiving, and remote panel. The system is shown using relay symbology. Contractor and equipment suppliers may use standard panel features to accomplish the total requirements using other methods of signal, solid state devices, or revised lamping. All wiring diagrams and required devices must be approved by the Contracting Officer prior to installation.

]2.2.6 Control Air Supply

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NOTE: Revise paragraph and make provisions for control air if there is no existing air supply. Specify quantity of control air and maximum dew point.

****

[Extend existing][Provide new] control air system of dry and purified air for the compressor controls. Sizing must be based on not less than [_____] [425 L/s] [15 SCFM]. Filtration must be to 5 micrometers minimum and the air from the dryer must have a maximum system pressure dew point [4] [minus 18] degrees C [40] [0] degrees F.[The Contractor must obtain system air for the controls by piping from the existing system.]

2.2.7 Compressor Design Features

Compressor must be multistage centrifugal, with a minimum of 2 centrifugal compression stages, designed for optimum flow and speed requirements to produce highest space efficiencies at lowest compression ratio and temperature and lowest external noise level. Special attention must be given to energy saving features in design and arrangement such as radial damper intake valve, long radius interstage piping, and low air velocities. Equipment must be designed for economical and rapid maintenance. Casing components bearing housings and other major parts must be shouldered, dowelled, or designed with other provisions to facilitate accurate alignment or reassembly. Shaft seals and bearings must be accessible for inspection or replacement with a minimum of disassembly.

2.2.7.1 Casings

Casing must be cast iron, ductile iron, or cast steel. Casing stresses must be within the limits allowed by ASME BPVC SEC VIII D1. Casings, supports, and baseplates must be designed and fabricated to preclude excessive and injurious distortion from temperatures, pressures, and forces encountered in service conditions, including surge. Provide jackscrews, lifting lugs, eyebolts, guide dowels, and casing alignment dowels to facilitate disassembly and reassembly. When using jackscrews for parting contacting faces, relieve one of the faces by counterboring or recessing to prevent marring the face, which result in leaking or improper fit. Provide lifting lugs or eyebolts for removable portions of the casings. Flanged casing connections must conform to ASME B16.1 or ASME B16.5. Threaded connections must conform to ASME B1.20.1. Casing must be split in a manner permitting direct access to impellers, shafts, and bearings. Compressors must be axial flow inlet. Gear cases must be enclosed, accessible, force lubricated and designed with seals and slingers to keep oil out of air system.

2.2.7.2 Shafts

Shafts must be of forged or rolled alloy steel and must have a machined finish throughout their entire length. All rotating components must be positively secured to shafts by approved mechanical means or interference shrink fits.

2.2.7.3 Impellers

Impellers must be of 400 series or 17-4 PH stainless steel, open or closed design, with backward leaning vanes, and of welded, milled, or cast construction.

2.2.7.4 Gears

Gears must be of alloy steel, ANSI/AGMA 2009 and AGMA 2011 Quality Number 12 or better for both bull and pinion gears. Gears must be hardened to 275 Brinell for bull gear and 320 Brinell for pinion, unless otherwise approved. Gears must be ground to the required contours, checked for proper contact during assembly at the factory, and must not require a break-in period in the field for proper operation. All gears must be pressure lubricated.

2.2.7.5 Seals

Separate air and oil shaft seals must be provided to confine air in the casing and prevent contamination of the air stream by lubricating oil. Shafts seals must be labyrinth type, carbon ring type, or a combination of the two types. Provide an air space vented to the atmosphere between the air and oil seals. Seals must be suitable for all operating conditions including suction throttling, start-up, shutdown, and momentary surge.

2.2.7.6 Thrust Bearings

Axial impeller thrusts must be absorbed by thrust bearings on the pinion or transferred to the bull gear shaft by conical rider-ring thrust collars. Pinion thrust bearings must be hydrodynamic (fluid film), multiple-segment type, entitled pad type, or other approved type, and must be adequate to accommodate all operating conditions, including surging or stonewall operation. Bull gear thrust bearings must be sized for equal thrust in both directions and must be adequate for any axial loads transmitted through the driver coupling.

2.2.7.7 Radial Bearings

Radial bearings must be hydrodynamic (fluid film), precision bored sleeve or pad type, designed for easy replacement by a split design or axially removable arrangement. High speed pinion bearings must be anti-oil whip, tilting pad, tilted pad, or other approved type. Bearing design must provide low vibration and sufficient damping at rated speed and all operating modes, including rated capacity and unloading down to 15 to 20 percent of unloaded power.

2.2.7.8 Intercooler, Aftercoolers, and Oil Coolers

Intercoolers, aftercooler, and oil cooler must include admiralty brass [or copper] tubes conforming to ASTM B111/B111M in admiralty tube sheets conforming toASTM B171/B171M with plate fins and baffles for optimum cooling and fouling resistance using [fresh] [_____] water. Provide an intercooler between stages of compression factory assembled on unit base with piping. The aftercooler may be mounted separately. Intercoolers, aftercooler, and oil cooler must be factory tested at 1.5 times operating pressure. External intercoolers and aftercooler must be constructed in accordance with ASME BPVC SEC VIII D1, requirements and be ASME code stamped for 1207 kPa (gage) 175 psig working pressure. Intercoolers and aftercooler must be capable of one piece bundle removal. Each intercooler must be equipped with an integral or direct connected moisture separator with condensate trap or automatic drainer valve assembly. Piping to drainer and drainer assemble must be Class 300 stainless steel. Design intercoolers and aftercooler for 11 and 8 degrees C 20 and 15 degrees F approach, respectively, and a fouling factor of 0.001 for both sides of exchanger; however, the approach temperature used to size the coolers must be reduced if required to meet aftercooler maximum air outlet temperature specified. Nonstandard coolers must be provided if required to meet the aftercooler maximum air outlet temperature requirement. All coolers must be of counter-flow design.

2.2.7.9 Lubrication System

Include reservoir, shaft driven positive displacement pump, twin oil coolers, twin filter/strainer (readily replaceable cartridges while operating) and parallel piping and valving provisions to accommodate a separately driven prelube lubrication oil pump for start-up and standby. System must be factory assembled and tested. The oil reservoir must retain a minimum 3-minute oil supply. Lubricating oil must conform to MIL-PRF-17331, Lubricant No. 2190-TEP or as recommended by compressor manufacturer. Oil cooler must be designed for a fouling factor of 0.001 for both sides of exchanger. Pressure lubricate hydrodynamic bearings. Provide the oil sump with level indicator and drain and fill connections.

a. Prelubrication pump must be sized by air compressor manufacturer for the requirements of the system, but must meet the following requirements. Pump must be positive displacement gear pump separately mounted with motor on a common base plate with drip lip and drain.

   (1) Performance: Pump must have separate safety valve bypass set at [_____] [172 kPa] [25 psi] above peak expected pressure.

   (2) Materials must be hardened steel gears and shaft, cast iron case, bronze bearings, mechanical seal.

   (3) Flexible coupling with shaft guard must be provided, except that these items are not required for a close-coupled pump.

   (4) Motor must be NEMA MG 1, Design A, Class B insulation, of open drip-proof type. Furnish combination type starter for motor.

b. Lube Oil Heater: Provide thermostatically controlled electric heater in lubrication oil sump of sufficient capacity to heat up and maintain manufacturer's recommended oil temperature when unit is cold at [_____] [0 degrees C] [32 degrees F] ambient. Provide low oil level indicator with light for protection of heater.

2.2.8 Electric Motors

****

NOTE: Polyphase motors must be selected based on requirements of the driven equipment, service conditions, motor power factor, life cycle cost, and high efficiency in accordance with NEMA MG 10.

Use Motor Master software program to identify the most efficient and cost effective polyphase motor for a specific application. Motor Master is located in the "TOOLS" section of Construction Criteria Base (CCB). For additional guidance contact Charlie Mandeville of the NAVFAC Criteria Office at (757) 322-4208. Another source of information on energy efficiency is E-source, accessible to Navy users on the Naval Facilities Engineering Center (NFESC) home page http://energy.navy.mil/**.**

****

Efficiency and losses must be determined in accordance with IEEE 112. Unless otherwise specified horizontal polyphase squirrel cage motors rated one to 125 horsepower must be tested by dynamometer Method B as described in Section 6.4 of IEEE 112. Motor efficiency must be calculated using Form B of IEEE 112 calculation procedure.

Polyphase motors larger that 125 horsepower must be tested in accordance with IEEE 112 with stray load loss determined by direct measurement or indirect measurement (test loss minus conventional loss).

The efficiency must be identified on the motor nameplate by the caption NEMA Nominal efficiency or NEMA Nom eff.

2.2.8.1 Main Electric Drive Motor

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NOTE: Centrifugal compressors are normally provided with 3600 rpm induction motors. The specification will be considered restrictive by manufacturers if an 1800 rpm synchronous motor is specified because a special speed increasing gearbox will make them noncompetitive with nonlubricated rotary compressors.

****

The main drive motor for each compressor must be an induction motor, [_____] kW horsepower, with a continuous service factor of 1.0. Size the motor so that the nameplate kW horsepower rating is not exceeded under the entire range of operating conditions specified. Motor must be high efficiency type, rated not less than 95 percent based on IEEE 112 testing and labeling. Electrical service will be as specified. Motor must be designed for reduced voltage starting [at [50] [65] [80] percent of full voltage], allowing for characteristics of the connected load, and must start without undervoltage tripping. Provide resistance temperature detectors (RTD) attached to or imbedded in motor winding for control system. The motor must meet the requirements of NEMA MG 1 with Class F insulation. Motor design must include acoustical covering and reduced noise air intake housing and be rated for 84 dBA or less at 0.9 m 3 feet under full load. Provide space heaters for protection of windings during motor shutdowns.

2.2.8.2 Accessory and Related Equipment Motors

Motors less than 3/8 kW 1/2 horsepower must be single-phase induction motors and must conform to NEMA MG 1. Motors 3/8 through 3.75 kW 1/2 through 5 horsepower must be three-phase induction motors and must conform to NEMA MG 1. Single-phase and three-phase motors must have bimetallic disk thermostats attached to or imbedded in the motor winding. Motors must have NEMA MG 1 Class B insulation.

2.2.9 Control Panel

Control unit panel conforming to NEMA ICS 6, package or frame mounted, factory designed, assembled, and mounted must be provided complete with connections made to sensing points. The panel must be fabricated of formed stretcher leveled sheet steel, reinforced, and assembled into a rigid unit. Gasketed access doors must be provided as required. Panel must be factory finish painted. The panel must meet NEMA 12 requirements.

a. Panel must contain electric and safety control work required, including either alarm annunciator or individual labeled pilot lights arranged in a group. Panel must contain alarm device with light and silencing. Generalized arrangement in accordance with drawings.

b. Panel must contain start and stop buttons (the latter with lockout feature), vibration monitor subpanel, discharge air pressure gage, control test switch and lights, reset button, green unit running light, and control selector switch.

c. Oil pressure gages must be mounted separately from panel.

2.2.10 Accessories

Required accessories include:

2.2.10.1 Control Valves

Pneumatically controlled valves on suction inlet of compressor and on blowoff bypass line. Mount suction inlet control valve on unit.

2.2.10.2 Air Intake Devices

****

NOTE: Change compressor air inlet description to suit project if required.

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Compressor air inlet must be piped to the outside of the building and consist of the following:

a. Intake weather hood with rain hood and bird screen. Material must be galvanized steel or aluminum alloy, minimum 20 gage.

b. Intake pipe, ASTM A36/A36M steel galvanized, 12 gage or Schedule 5 minimum, from intake weather hood to filter housing flange, welded construction.

c. Filter housing by filter manufacturer to include filter frames, access door(s). Material for housing must be 1.65 mm 0.065 inch thickness, Class 5000 aluminum alloy. Unit must be rigid and free from distress with all seams sealed.

d. Intake Pipe from Filter Enclosure to Compressor: Aluminum alloy ASTM B209M ASTM B209, Alclad alloy 5052-H32 or equivalent, minimum 10 gage, flanged, welded with 5XXX welding rod using TIG method and including expansion bellows.

2.2.10.3 Compressor Air Outlet Connections

Compressor air outlet flexible connection of stainless steel bellows with braided steel cover jacket, with stainless steel liner sleeve, 460 mm 18 inch nominal length bellows, flanged ends, Class 150. If air bypass connects separately to the compressor from the outlet line, provide a second flexible connection of stainless steel bellows with braided jacket for the bypass.

2.2.11 Inlet Air Filters

Provide a three-stage filter system, complete with mounting racks (horizontal flow), interstage seals, and replaceable filters. Filter unit must be provided complete including enclosure or housing, and frames. Enclosure must be Class 5000 aluminum alloy with inlet and outlet flanges. Construction must be welded or, where welding is not practical, close riveted and caulked, weathertight, with access doors for filter replacement and cleaning. Access doors must be reinforced, fully gasketed with continuous flexible neoprene gaskets, corrosion-resistant continuous hinges and quarter-turn latches to ensure tightness. All internal ferrous surfaces, including galvanized, must receive a factory-applied epoxy prime and finish coat for corrosion resistance. Filters must consist of three separate stages and sized to fit the available space.

2.2.11.1   First-Stage

First-stage filter must be flat, 50 mm 2 inch thickness, replaceable media, and rated for the required air quantity at 2.54 m/s 500 FPM nominal face velocity, friction clean 62 Pa 0.25 inch water gage, efficiency 98 percent of 15 micrometers 0.60 microinches and 90 percent of 5 micrometers 0.20 microinches.

2.2.11.2   Second-Stage

Second-stage filter must be deep pleated type, 229 mm 9 inchesnominal depth and rated for the required air quantity at 1.78 m/s 350 FPM nominal face velocity, friction clean 50 Pa 0.20 inch watergage, efficiency 98 percent to 5 micrometers 0.20 microinches and 90 percent to 3 micrometers 0.12 microinches.

2.2.11.3   Third-Stage

Third-stage filter must be deep pleated type 305 mm 12 inchesminimum depth and rated for the required air quantity at 1.78 m/s 350 FPM nominal face velocity, friction clean 75 Pa 0.30 inch watergage, efficiency 99.9 percent to 0.5 micrometer 0.02 microinches.

2.2.11.4   Filter Media

Filter media must be rated and listed UL Class 2. Filter efficiencies must be based on National Bureau of Stands (NBS) type discoloration gravimetric test method using atmospheric dust.

2.2.12   Bypass Line Silencer

Provide a bypass line silencer with each compressor as selected by compressor manufacturer for sufficient noise attenuation to meet sound level criteria not greater than 84 dBA measured at an elevation of 1.50 meters 5 feet, and 3 meters 10 feet horizontally from silencer.

2.2.13   Isolating Pad

If specifically recommended by the compressor manufacturer, each compressor steel frame must be mounted on a neoprene waffle or rib type isolator pad which extends uniformly and continuously along the base mounting surface. The neoprene material must be of bridge bearing pad quality neoprene and must be formulated for 40 durometer hardness. The maximum bearing pressure on the isolating pad must be 345 kPa 50 psi. The pads must be composed of two layers or 8 mm 5/16 inch neoprene bonded to and sandwiching 16 gage galvanized steel. Compressor bolt down through the pad must be accomplished using 6 mm 1/4 inch thick neoprene impregnated duck washers. Neoprene bushings are not acceptable.

2.3   AIR FLOW RATE AND PRESSURE RECORDER AND MEASUREMENT

Provide a complete flow and pressure measurement and recording package. Provide orifice flanges with pressure taps, square edged stainless steel paddle orifice plate. The orifice plate must be concentric type, of 3 mm 0.125 inch thickness and must meet ASME Standards. Orifice must be sized for 10 kPa 40 inch water column differential at a full scale flow rate of [_____] L/s SCFM at compressor based on 827 kPa (gage) 120 psig upstream pressure. Static gage pressure measurement device of the recorder must have a range of zero to 1379 kPa (gage) 200 psig. Provide copper interconnecting tubing between the pressure taps and the recorder as part of this measurement and recording package. Provide a two-pen recorder for the measurement station. Pens must record pressure (0 to 1379 kPa (gage) 200 psig range) and air flow (0 to [_____] L/s SCFM). Recorder must be electric drive and housed in dust-tight steel cabinet. Charts must be 305 mm 12 inch diameter with evenly divided graduations. Drive must be 7 day circle. Provide continuous flow integration of a 7 digit counter type. Pens must be supplied with long-life cartridges and capillary supply. Chart case must be internally illuminated. Access to charts must be through front access window door. Calibrated overall accuracy of the recorded measurements must be within plus or minus 1.0 percent of full scale. Furnish a supply of 400 charts with the recorder.

2.4 CARBON MONOXIDE MONITOR

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NOTE: Include carbon monoxide monitor in systems which are used for breathing air per DM 3.5, Section 3.

****

The carbon monoxide (CO) monitor unit must be of the pressure type with attached sampling system. The unit must be solid state type operation, 2 to 50 ppm range, CO indicating, with provisions for milliamp signal to remote recorder, adjustable set point, and normally open/normally closed contacts for remote signal. Power must be 120 volt, single phase, 60 hertz with power cord and plug. Response time normally 2 minutes per sample/purge. Unit must be mounted in a gasketed enclosure with face gage indication CO readings.

2.4.1 Sampling System

Sampling system must include shutoff valve filter/regulator, pressure gage, manual drainer, and line humidifier set at 50 percent. Draw sample from compressor discharge.

2.4.2 Test System

Test system must include calibration gas (20 ppm CO) cylinder test gas (200 ppm CO) cylinder, and calibration connectors with quick disconnect.

2.5 SOURCE QUALITY CONTROL

2.5.1 Factory Test Procedures

The completely assembled air compressor package, including the actual contract drive motor, intercoolers, lubrication system, and control panel must be subjected to performance tests, balance tests, and sound level and run-in tests. Unit must comply with guarantee requirements applying engineering adjustments to guarantee conditions. Test must be certified by the manufacturer. Test must be run on the manufacturer's test stand using driver for this contract. Tests must be in accordance with ASME PTC 10 format. Full-range performance tests must indicate performance at maximum rated flow, rating point, and blowoff conditions. All accessory performance conditions must be reported, including intercoolers, aftercoolers, and lubrication and control systems. The complete unit must be factory tested with sound meters in accordance with ISO 2151. Location must be one horizontal meter from unit at 1.5 meters above the floor. Test must include readings at each octave band midpoint and the "A" scale, and must be 84 dBA or less and 90 decibels at any octave band. Results of test must be included in the factory test report on the ISO 2151 format. Factory test data may be corrected to the levels of an equivalent background noise level of 60 dBA showing calculations for reference use.

2.5.2 Supervision of Testing

System and components testing must be conducted or supervised by either a designated authorized and factory trained representative of the compressor manufacturer supplying the unit or a registered Mechanical Engineer experienced in such work.

2.5.3 System Test

Testing of system must conform to requirements outlined and must be witnessed by the Contracting Officer.

2.5.4 Approval of Testing Procedure

Proposed testing procedure must be approved by the Contracting Officer and the individual in charge of testing prior to conducting tests.

2.5.5 Certification of Performance Tests

The test supervisor must certify performance by test to be in compliance with specifications.

PART 3 EXECUTION

3.1 INSTALLATION

The Contractor must install the air compressors and accessories in accordance with manufacturer's recommendations and as indicated on the drawings. All equipment must be installed plumb and level and anchored to structure, matching holes provided.

3.1.1 Manufacturer's Supervision

Install the compressors under the direct supervision of an authorized representative of the manufacturer.

3.2 GENERAL REQUIREMENTS FOR INSTALLING AIR COMPRESSORS

****

NOTE: Delete or modify requirements on existing building and weight handling equipment to suit the project.

****

Air compressors with contract motor and accessories must be factory assembled, run in, and tested complete before shipment to job site. [The Contractor is advised that there are limitations to door opening sizes and available crane lifting capacity. Crane unit is specified to permit single lifts of complete compressor under special approval only.] Should the unit require disassembly for installation, reassembly must be under the direct supervision of the compressor manufacturer's authorized representative. Complete unit must be mounted on a rigid single or equivalent mechanically joined steel or iron base. Submit installation sequence plans to the Contracting Officer for approval prior to installation. [Any building materials removed to accomplish installation must be reinstalled if undamaged by removal procedures; or if damaged, must be replaced with new materials to match original configuration.]

3.2.1 Prompt Installation

The Contractor is advised that any compressor received must be installed and placed in operation promptly to prevent time deterioration when not installed. Should the Contractor sustain a delay exceeding 90 days prior to actual installation, the Contracting Officer must have the option of requiring breakdown and reassembly to inspect and clean prior to placing in operation. This work must be at no additional cost to the Government.

3.2.2 Start-Up Services

The Contractor must furnish the services of a compressor manufacturer's authorized representative to supervise prestart checkout, initial start-up, performance testing, and operator instruction. Time available must be as required to properly start up but not less than 3 consecutive days for the compressor.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Test Procedures

Complete field performance testing of the total system must be performed by the Contractor and witnessed by the Contracting Officer. Air compressor system tests must be conducted by either a compressor manufacturer's factory trained and authorized representative approved by the Contracting Officer or a qualified registered Mechanical Engineer. Tests may be run on individual components or on the system as a whole at Contractor option. Field tests require use of the actual compressor drive motor. Test must include operation at rated capacity for not less than 4 hours.

3.3.1.1 Air Compressor Performance Tests

Complete performance test must be run at maximum load, rated load, at point of unload but prior to unload, and unloaded condition. Data must be recorded listing:

a. Air flow, inlet pressure and temperature, humidity; discharge pressure and temperature.

b. Intercooler water flows, temperatures, and pressures.

c. Aftercooler water flow, temperatures, and pressures.

d. Lube oil cooling water flow, temperatures, and pressures.

e. Lube oil flow, pressures, and temperature.

f. Cooling water pump flow, pressures, and motor amperage.

g. [Cooling tower] [Closed circuit cooler] air flow, water and air temperatures, water pressure, and motor amperage.

h. Electrical load in volts and amperes for compressor motor, prelube oil pump motor, and compressor auxiliaries.

i. Intake filter pressure differential (clean).

j. Start-up sequence, alarm signals and automatic system shutdown.

k. Control sequence, either modulating or two step [in phase with the other air compressors and existing plant air].

l. Test compressor intake and discharge for conformance to CGA G-7.1. Compressor discharge must show no increase in contaminants.

3.3.1.2 Instrumentation Test

The Contractor may use instrumentation provided in the contract and instrumentation provided by the Contractor to conduct the test. The testing procedure and instrumentation must be submitted to the Contracting Officer for approval prior to conducting tests. The format of ASME PTC 10 is required. It is intended that a full field test be performed.However, in lieu of precise instrumentation, the Contractor may use certified cooling water pump curves [and [cooling tower] [closed circuit cooler] fan curves]. Shutdown signals must be caused by throttling selected fluids. Test data, such as air intake temperature and humidity, must be mathematically corrected to performance test requirement levels.

3.3.1.3 Sound Level Tests

Sound level tests must be conducted concurrently. Broad Band "A" scale readings and Octave Band readings must be taken and recorded at the same positions as on the factory testing. Maximum permissible level must be 84 decibels one horizontal meter from the compressor and 1.5 meters above the floor, with unit in operation and all other significant equipment not required for test within the same building bay shutdown at the same location previously described. A background noise correction to 60 decibels is permissible.

3.3.1.4 Deficiencies Discovered in Testing

Any operational deficiencies noted in the tests must be promptly corrected and affected portions of the test rerun.

3.3.1.5 Testing Tolerances

A tolerance of plus 2 percent minus zero on flow, plus or minus 4 percent on power, or plus or minus 5 percent on any other variable for each item of equipment or fluid with all others conforming is permissible on field test results when compared to factory test data and to guarantee performance data except that compressor air flow, discharge pressure, and motor power must be met.

3.3.2 Approval of Testing Procedure

Proposed testing procedure must be approved by the Contracting Officer and the individual in charge of testing prior to conducting tests.

3.4   TRAINING OF GOVERNMENT PERSONNEL

During start-up and field testing, train Government station personnel in the operation and maintenance of compressor, [cooling tower,] [closed circuit cooler,] associated equipment, and all control and safety devices. Training must not commence until equipment is operational and station personnel are in attendance. At least one day of classroom training and one day of field training must be furnished for each designated Government personnel. When factory training is required by the compressor manufacturer for proper maintenance and overhaul of the compressors, such training must be furnished by the compressor manufacturer at no additional cost to the Government. The Government will bear the cost of travel and living expenses for Government personnel as necessary for the factory training.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-22 31 00 (February 2009)**

Preparing Activity: USACE **Superseding**
UFGS-22 31 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 22 - PLUMBING

SECTION 22 31 00

WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE)

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PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-22 31 00 (February 2009)**

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SECTION 22 31 00

WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE)

02/09

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NOTE: This guide specification covers the requirements for fully automatic, semi-automatic, and manual water softening equipment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C701	(2019) Cold-Water Meters - Turbine Type for Customer Service
AWWA D102	(2024) Coating Steel Water-Storage Tanks

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2024b) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,

	Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D3299	(2010) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM E100	(2019; R 2024) Standard Specification for ASTM Hydrometers
ASTM E126	(2019; R 2024) Inspection and Verification of Hydrometers
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators

NSF INTERNATIONAL (NSF)

NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

SD-03 Product Data

Softening Equipment

Spare Parts

Field Instructions

SD-06 Test Reports

Softening Equipment

Piping

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

1.3 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.4 EXTRA MATERIALS

a. Submit spare parts data for each different item of material and equipment, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1] and [3] year(s) of service.

b. Provide, for each type of equipment furnished, special tools necessary for adjustment, operation, maintenance, and disassembly; a grease gun or other lubricating device for each type of grease required; and one or more steel cases mounted on the wall complete with flat key locks, two keys, and clips or hooks to hold each tool in a convenient location. Provide tools consisting of high-grade, smooth, forged, alloy, tool steel. Provide lever type greas guns. Deliver tools at the same time as the equipment and hand over on completion of the work.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

a. Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Furnish equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

b. Pumps and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.2 SOFTENING EQUIPMENT

****

NOTE: Insert the number of units in the battery.
If only one unit is to be furnished, delete the text
of paragraph, but maintain the title.

****

Provide softener battery consisting of [_____] water-softener units. Performance specified must refer to each unit and not to the battery as a whole. Submit a complete list of equipment and material, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions.

2.2.1 Equipment Capacity

Provide a [fully automatic] [semi-automatic] [manual] downflow pressure-type water softener, having a capacity to soften [_____] liters gallons of water with a maximum influent total hardness of [_____] milligrams per liter (mg/L) during the interval between successive regenerations, to a maximum effluent total hardness of [_____] mg/L. Intervals between successive generations must be [_____] hours.

2.2.2 Softener Tank

****

NOTE: For tanks less than 900 mm 36 inches in diameter, access openings 101.6 mm by 152.4 mm 4 inches by 6 inches or larger will be provided in upper head of tank; for tanks 900 mm 36 inches in diameter and larger, access opening 279.4 mm by 381.0 mm 11 inches by 15 inches will be provided.

****

Provide softener tank that is a minimum of [_____] mm inches in diameter by [_____] mm inches straight shell (tangent line to tangent line). Construct tank of buttwelded steel conforming to the ASME BPVC SEC VIII D1. Design shell for a working pressure of [_____] kPa psi. Line tank [and both sides of false bottom] with nontoxic epoxy or rubber conforming to [AWWA D102] [_____]. Furnish coatings for potable water tanks conforming to NSF/ANSI/CAN 61. Provide the upper head of each tank with an access opening [101.6] [279.4] mm [4] [11] inches by [152.4] [381.0] mm [6] [15] inches or larger. Provide lower side shell of each tank with an access opening 101.6 by 152.4 mm 4 by 6 inches or larger. Tank must have [angle leg] [skid] supports of cast-iron or steel.

2.2.3 Underdrain System

****

NOTE: Delete the inapplicable underdrain system and remove brackets. The header-lateral-distributor head type will be used in all tanks 900 mm 36 inches in diameter or larger. Tanks smaller than 900 mm 36 inches in diameter will be equipped with either deflector-plate or false-bottom type collector system.

****

Provide a system within the softener tank for collecting softened water and distributing backwash water. Provide [header-lateral-distributor head] [deflector-plate] [or] [false bottom] type system. Provide underdrain system that distributes the backwash water uniformly over the entire filter area, and at such velocities that prevents the channeling of the filter bed.

2.2.3.1 Header-Lateral-Distributor Head Type

****

NOTE: Delete entire paragraph for tanks smaller than

900 mm 36 inches in diameter.
****

Provide header-lateral-distributor head type consisting of a central manifold or header, connected to laterals provided with strainer heads or strainers with openings placed radially so as to discharge horizontally or downward. Support system by [a steel plate or steel angles conforming to ASTM A666 with [rubber] [or] [nontoxic epoxy] linings] [or by] [concrete fill] [or] [gravel bed] [or] [directly on the bottom of the tank]. Where the system will permit the loss of the exchange material during the filtering cycle, provide a gravel bed with the system. Provide stainless steel bolts and attaching hardware conforming with ASTM F593. Provide headers and laterals consisting of [all red brass, conforming to ASTM B43] [or] [polyvinyl chloride, conforming to ASTM D1785 or ASTM D2241]. Provide strainer heads and strainers manufactured of materials compatible with the header-lateral system, and [brass] [or] [stainless steel]. Laterals and strainer heads, after being placed, must not protrude into the header or laterals.

2.2.3.2 Deflector-Plate Type

****
NOTE: Delete this paragraph for tanks 900 mm 36 inches in diameter or more.
****

Provide deflector-plate type consisting of [cast-iron] [or] [steel], and [rubber] [or] [nontoxic epoxy] lined, fastened to the bottom of the tank, and arranged for discharge through radial slots. Provide pipe connection for softened water outlet or backwash inlet on the underside between the deflector and the tank bottom. Provide deflector-plate type collector system with a gravel bed.

2.2.3.3 False Bottom Type

****
NOTE: Delete this paragraph for tanks 900 mm 36 inches in diameter or more.
****

Furnish false bottom type consisting of a false bottom with attached strainers. Provide strainers and fasteners that are [brass] [or] [stainless steel]. Design system to eliminate the need for a supporting gravel bed.

2.2.4 Gravel Bed

****
NOTE: Delete this paragraph if a gravel supporting bed is not required.
****

Place supporting bed above the underdrain systems. Provide gravel that is free from clay, loam, dirt, and calcareous or other foreign materials and free of flat or elongated particles. Properly graduate gravel bed to distribute the backwash water, to prevent loss of exchange materials, and to prevent migration of the material in the gravel bed during operation and backwashing. Gravel bed less than 230 mm 9 inches in depth is not permitted. Where the void size of the top layer of gravel is greater than the smallest particle size of the exchange material, add a 75 mm 3 inch layer of ilmenite or garnet sand to the gravel bed.

2.2.5 Exchange Material

****

NOTE: The proper data will be inserted in all the blank spaces. In order to specify the type of exchange material required and thereby determine the size of the units of the softener system, an analysis of the water to be softened will be obtained giving the following information.

If the turbidity of the water exceeds 1 nethlometric turbidity unit, the water will be treated prior to softening. The following values are recommended for specifying the exchange material.

TABLE 1. PHYSICAL PROPERTIES STYRENE RESINS

Approximate shipping weight, kg/cu ft lb per cu ft	**Effective size (mm)**	**Maximum uniformity coefficient**	**Size screen not more than 1 percent must pass**
801-881 50-55	**0.45-0.60**	**2.0**	**50**

The maximum flow rate in liter per second per square meter gpm per square foot based on an application rate of 4.4 liter per second per cubic meter 2 gpm per cubic foot for various depths of bed are given in TABLE 2.

TABLE 2. MAXIMUM FLOW RATES

	Depth of bed in mm inches			
	762.0 30	**914.4 36**	**1066.8 42**	**1143.0 (45)**
Maximum flow rate, L/s per sq m gpm/square foot	**3.4 5**	**4.1 6**	**4.8 7**	**5.4 8**

In multiple-unit softening systems, the above flow rates may be increased by 40 percent for short periods of time to allow continuous operation while regenerating the individual softeners. The backwash rate of flow will be sufficient to give at least 25 percent bed expansion for all exchange materials. Rinse rates will not exceed the above flow rates. Minimum freeboard above exchanger bed will be 50 percent of bed depth.

Normally styrene resinous exchange materials that contain 8 to 8.5 percent divinylbenzene, by weight, are satisfactory for use in softening most waters. Since this type of resin is indicated to have

chemical stability over pH ranges from 0 to 14 and temperatures up to 121 degrees C 250 degrees F, pH and temperature will not usually be, by themselves, a factor in selecting the exchange material.

Iron and manganese can constitute a problem because they either deposit iron on the resins or reduce the capacity of the exchange material to soften the water. Iron in the ferrous state will be generally removed, while iron in the ferric state will be deposited on the grains. Ferric compounds are insoluble over a pH range of about 3 to 8, and since most water supplies lie within this pH range, they will deposit on ion exchange material. Manganese, on the other hand is insoluble at a pH of 9 or greater and, therefore, is not usually precipitated on the ion exchange material. To prevent the deposition of iron, the water may be prefiltered before softening, or where possible, the source of the oxidizing agent should be removed. Since this specification recommends a turbidity of one or less, in many cases prefiltration will be required, and this will also aid in reducing the iron deposition problem. Continuous application of iron bearing waters to the softening unit will foul the resins in time and require periodic cleaning. The cleaning process requires the removal of the resin from the softening tank. As an alternative, a cleaner additive may be added to the brine rinsing solution.

Where oxidizing agents such as chlorine or oxygen are present, the cross linking agent (divinylbenzene) may be broken down which results in an increase in pressure drop, a loss of volume capacity, and more frequent replacement of the resin material. The effect of oxidizing agents will be increased with higher temperatures. One method of correcting this problem is to select an exchange material that has a higher cross linkage. Where oxidizing agents are present, the exchange material supplier should be contacted for specific recommendations.

The sodium cycle softening process substitutes sodium for calcium and magnesium, and accordingly the sodium content of the finished water supply is increased. Regulations proposed by the United States Environmental Protection Agency limit the sodium content of water to be used for potable purposes to 20 mg/1. Many states have adopted this standard and some require notification to users, where the sodium concentration exceeds the allowable limit. Applicable State regulations should be confirmed. One method of controlling the sodium content of the water supply is to provide a side stream of unsoftened water, which may when mixed with the softened water, produce a water supply of acceptable hardness and sodium content.

To determine the working exchange capacity of a resin, the following information should be available:

a. The total dissolved solids in the influent water.

b. The acceptable hardness in the effluent water.

The first step is to determine the salt dosage required to obtain the desired level of hardness at the known total dissolved solids content in the influent water. The second step is to determine the working exchange capacity of a particular resin at the selected salt dosage and known total dissolved solids content in the influent water. Parameters for undertaking this analysis should be secured from the manufacturer of the particular resin under consideration.

Typical application hardness leakage rates, salt dosages, and resin working exchange capacities for softening water having 510 mg/1 of total dissolved solids (as calcium carbonate) are as follows:

Leakage	**Salt Dosage**		**Resin Working Exchange Capacity**
mg/L	**kg/cu ft lb/cu ft**	**kg/1,000 mg lb/1,000 gr**	**mg/cu m gr/cu ft**
0.6	**240 15**	**3.5 0.5**	**69 30,000**
1.4	**160 10**	**2.8 0.4**	**57 25,000**
4.0	**96 6**	**2.1 0.3**	**46 20,000**

Above working exchange capacities are for standard 8 percent to 10 percent divinylbenzene polystyrene resins used in water softeners.

****

Component	Concentration (mg/L)
Total Solids	[_____]
Total Dissolved Solids	[_____]
Calcium	[_____]
Sodium and Potassium	[_____]
Total Iron	[_____]
Ferric Iron	[_____]
Ferrous Iron	[_____]

Component	Concentration (mg/L)
Manganese	[_____]
Copper	[_____]
Silica	[_____]
Sulphate	[_____]
Chlorides	[_____]
Nitrates	[_____]
Alkalinity	[_____]
Methyl Orange as Calcium Carbonate	[_____]
Phenolphthalein as Calcium Carbonate	[_____]
Total Hardness as Calcium Carbonate	[_____]
Carbonate Hardness as Calcium Carbonate	[_____]
Noncarbonate Hardness as Calcium Carbonate	[_____]
Free Carbon Dioxide Calcium Carbonate	[_____]
Turbidity in Nethlometric Turbidity units	[_____]
Color by Platinum Standard Comparison	[_____]
Residual Chlorine	[_____]
Dissolved Oxygen	[_____]
Conductivity pH	[_____]

Provide styrene-resinous exchange material that is washed, processed, graded, and suitable for water softening purposes. Provide clean and hard granules, and provide material that is free from defects that affect the serviceability and appearance of the finished product. Do not dose or add any chemical mixture or solution to the water to be or to the water used for backwashing or regeneration other than sodium chloride, except for a cleaner additive recommended by the Exchange Material Manufacturer. Provide material conforming to the following:

a. Working exchange capacity not less than [_____] g/cubic meter grains pcf.

b. Approximate shipping weight of [_____] kg/cubic foot pcf, backwashed and drained volume.

c. Effective size not less than [_____] millimeters.

d. Uniformity coefficient not greater than 2.0.

e. Not more than 1 percent by weight to pass 50-mesh US standard screen.

Bed depth less than 750 mm 30 inches is not permitted. Do not exceed an application rate of 4.5 L per second/cubic meter 2 gpm per cubic foot of exchange material. Minimum freeboard above exchanger bed less than 50 percent of bed depth is not acceptable.

2.3 BRINE APPLICATION SYSTEM

Provide a brine application system, comprising one or two tanks, for each installation. Where two tanks are furnished, one tank must serve as a salt saturator tank, and the other as a brine tank. Single tank units must serve as a combined salt saturator and brine tank. Provide sufficient salt storage for three regeneration cycles or 24-hour operation, whichever is greater.

2.3.1 Tanks

Fabricate each saturator, brine or combined-purpose tank from steel conforming to ASTM A6/A6M not less than 4.8 mm 3/16 inch thick, lined with enamel, or of fiber glass filament-wound reinforced plastic construction, conforming to ASTM D3299. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Equip each tank with an underdrain system manufactured from [polyvinyl chloride conforming to ASTM D1785 or ASTM D2241] [or] [red brass conforming to ASTM B43] and provided with a layer of graded gravel or screens for filtering the brine. Furnish screens manufactured from [polyvinyl chloride,] [brass,] [or] [stainless steel]. Equip saturator tank or combined-purpose tank with a water inlet valve [float-operated] [or] [solenoid-operated. Activate solenoid-operated valve by a [probe] [or] [a float-operated switch] [or] [a timer together with a float switch to automatically shut off the incoming supply in the event of failure of the timing mechanism]]. Mount water inlet valves and switches externally. Floats and probes may be mounted internally or externally, in such a manner that the stored salt does not interfere with their operation. Fabricate all devices in contact with or subject to splashing of brine solution from [red brass] [bronze] [or] [polyvinyl chloride].

2.3.2 Hydraulic System

Provide a [hydraulic ejector] [or] [motor-driven centrifugal pump] of all bronze construction with valves, piping, and connections for lifting brine from the brine or combined tank. Provide [ejector] [and] [motor-driven pump] with sufficient capacity to permit a 2 to 1 variation in the concentrated brine rate of flow. [Equip hydraulic ejector system with a manual rate-set valve and a check valve on the suction side of the ejector. Where the brine tank or combination tank is emptied during each regeneration period, provide the suction side of the ejector system with a device to prevent the entrance of air into the system. Provide hydraulic ejector system capable of automatically flushing out the dilute brine piping system or completion of the brine cycle.] [Equip hydraulic pumping system with a manual rate-set valve, a check valve, and a brine measuring meter on the discharge of the pump. Provide brine measuring meter that is electrically interlocked with the pump starter so that after the discharge of a set quantity of brine, the pump motor shuts down. Set point must be infinitely adjustable over a 2 to 1 range. Use a mixing tee to mix dilution water with the concentrated brine. Control water inflow to the mixing tee by means of a manual rate-set valve. Automatically flush out the dilute brine piping system on completion of the brine regeneration cycle.] Protect the dilution water supply from inflow of brine by means of back flow prevention device.

2.4 CONTROLS

2.4.1 Valves

****

NOTE: The inapplicable types of operation will be deleted. The multiport valve and the package-type valve nest are suitable for all three types of operation.

****

Transfer water and brine solution to and from the water softener by a single-unit multiple-port valve or by a package-type valve nest for [automatic] [semiautomatic] [manual] operation. Design the valve mechanisms such that gradually increasing flows will be attained as ports are opened and initial surges and sudden inrushes of water or brine are avoided. Indicate each step of the operation using a dial pointer.

2.4.1.1 Multiple-Port Valve

Provide an assembly of nonsticking, nonleaking, water-lubricated valve ports that connect to the hard-water inlet, soft-water outlet, backwash inlet and outlet, and brine inlet, all enclosed in a single casing. Accomplish the various steps of operation service, backwash, brine flow, and rinse by the rotation of a shaft that drives the mechanism causing the opening and closing of ports in correct sequence.

2.4.1.2 Package-Type Valve

Provide package-type valve nest consisting of a pilot valve connected with fittings as may be required to each one of a nest of valves hydraulically or pneumatically operated. Provide connections to hard-water inlet, soft-water outlet, backwash inlet and outlet, and brine inlet.

2.4.2 Operation

Control of softener regeneration must be [fully automatic initiated by a control switch] [semiautomatic initiated manually by a pushbutton in response to an alarm with switch] [manual with operation initiated manually in response to an alarm with switch] connected to [a water meter] [an automatic hardness tester]. [Use [fully automatic] [semiautomatic] controls that permit regeneration to proceed automatically with no manual assistance other than replenishment of salt storage. Controls must be subject to convenient and accurate manual adjustment and must be designed for manual operation in the event of failure of the electrical equipment. Provide an interlocking system to prevent regeneration of more than one unit at a time.] [Control backwash, brine injection, displacement, rinsing, and return to service manually by turning the multiport valve or pilot valve. Provide a manual-reset electric alarm timer for timing the several regeneration cycles.]

2.5 ELECTRICAL WORK

[Provide electrical motor-driven equipment specified complete with motors [motor starters] and controls.] [Provide motor starters complete with properly sized thermal overload protection and other appurtenances necessary for the motor specified.] Perform electrical work as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices.

2.6 BOLTS, NUTS, AND FASTENERS

Furnish all bolts, anchor bolts, nuts, washers, plates, bolt sleeves, and all other types of supports necessary for the installation of the equipment with the equipment and galvanize unless otherwise indicated. Provide expansion bolts that have malleable-iron and lead composition elements. Unless otherwise specified, stud, tap, and machine bolts must be of refined bar iron. All threads must conform to ASME B1.1. Bolts, anchor bolts, nuts, and washers specified to be galvanized, must be zinc coated, after being threaded, by the hot-dip process in conformity with ASTM A123/A123M or ASTM A153/A153M. Provide Type 316 stainless steel bolts, anchor bolts, nuts, and washers specified to be stainless steel. Where indicated, specified, or required, provide anchor bolts with square plates at least 101.6 by 101.6 by 9.5 mm 4 by 4 by 3/8 inch or with square heads and washers and be set in the concrete forms with suitable pipe sleeves.

2.7 AUXILIARY EQUIPMENT

2.7.1 Water Meter

****

NOTE: If a control switch is not connected to the meter, the sentence in brackets will be removed.

****

Provide each softener with a displacement or turbine-type water meter reading in U.S. gallons, and conforming to AWWA C700 or AWWA C701 as appropriate. [Equip meter with necessary wiring and electric controls for automatic regeneration when the softener has delivered [_____] gallons of water.] Equip meter with necessary wiring and an alarm device to give notice when the unit has delivered [_____] gallons of water. Install meter in the soft-water line from the softener unit, and locate as to be readily accessible for reading and setting. Meter contacts must be infinitely adjustable over the range of the meter to permit setting to suit actual hardness of the water being treated.

2.7.2 Automatic Hardness Tester

****

NOTE: If an automatic hardness tester is not required, this paragraph will be deleted.

****

Install a hardness tester for automatically testing the hardness of the water in the soft-water line leading from each softener unit. Provide wall mounted automatic hardness tester that is capable of carrying out intermittent tests on the softened water and of giving visual warning that the residual hardness present exceeds a predetermined limit. Equip tester with necessary wiring and [electrical controls for automatic regeneration] [an alarm device to give notice] when the hardness of the water delivered by the softener unit exceeds [_____] mg/1.

2.7.3 Electric Motors

****

NOTE: Delete the entire paragraph if an electric motor is not required.

****

Furnish motors that are single-phase, suitable for operation on 115-volt, single-phase, 60 cycle, alternating current conforming to NEMA MG 1. Design each motor for operation in a 40-degree C ambient temperature. Provide motor controls conforming to NEMA ICS 1.

2.7.4 Piping

Pipe Fabricate pipesmaller than 100 mm 4 inches in diameter, excluding the underdrain and brine collection systems, from galvanized steel conforming to ASTM A53/A53M with malleable-iron fittings conforming to ASME B16.3. Pipe 100 mm 4 inches in diameter and larger must be flanged ductile-iron conforming to AWWA C115/A21.15 with ductile-iron fittings conforming to AWWA C110/A21.10 and AWWA C111/A21.11. Use pipe hangers and supports conforming to MSS SP-58 on all 40 mm 1-1/2 inch diameter or smaller pipe with runs longer than 2.14 m 7 feet, and on all 50 mm 2 inch diameter or larger pipe with runs longer than 2.74 m 9 feet. Fabricate pipe hanger and supports from steel and space no more than 2.14 to 2.74 m 7 to 9 feet as applicable.

2.7.5 Valves and Unions

Provide bronze gate valves smaller than 100 mm 4 inches with screwed ends, conforming to MSS SP-80 and valves 100 mm 4 inches or larger consisting of iron body with flanged ends, conforming to MSS SP-70. Valves must open counterclockwise, and the operating wheel must have an arrow, cast in the metal, indicating the direction of opening. Provide unions conforming to ASME B16.39.

2.7.6 Gauges and Cocks

Furnish pressure gauges and sampling cocks on each softener unit connected to the hard-water inlet and soft-water outlet to indicate the pressure loss through the softener and its pipe, valve, and fitting assembly, and to sample the hard and soft water. Provide a sampling cock on the brine system which will permit sampling of the dilute brine solution. Gauges must be precision type with bronze Bourdon tube and phenolic case and an accuracy of plus or minus 1/2 percent conforming to ASME B40.100. Sampling cocks must be of brass, ground key, lever handle, faucet type.

2.7.7 Water and Brine Testing Equipment

Provide a complete water-testing set recommended by the manufacturer with the softener. Include complete instructions for conducting tests for hardness in accordance with AWWA 10084. Provide two Baume hydrometers conforming to ASTM E100 and ASTM E126, and calibrated for the range necessary for testing saturated brine solution and three glass cylinders of heat-resistant glass to hold sufficient brine for testing.

2.8 FACTORY PAINTING

Provide factory painting conforming to manufacturer's standard factory finish for the intended service.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Submit drawings showing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Sshow proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

3.2.1 Softener and Brine Tanks

Anchor softener and brine tanks to a concrete mat. Provide anchor brackets, anchor rods or straps to hold the tank to the anchors in the mat. [Where concrete or gravel fill is provided for support of the header-lateral-distributor head, protect strainer heads and strainers while concrete or gravel fill is being placed.]

3.2.2 Valves

Install valves as nearly as possible in the position indicated consistent with convenience of operating the hand wheel. Carefully erect and support all valves in their respective position free from all distortion and strain on appurtenances during handling and installation. Carefully inspect all material for defects in workmanship and material, and debris and foreign material cleaned out of valve openings and seats, all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness. Repair or replace valves and other equipment which do not operate easily or are otherwise defective.

3.2.3 Pumps

Mount pump and motor on a common monoblock. Anchor the monoblock to a concrete mat. Provide anchor brackets, anchor rods, or straps to hold the monoblock to the anchors in the mat.

3.2.4 Piping

Install piping to accurate lines and grades and, where possible, parallel to building walls. Where temporary supports are used, they must be sufficiently rigid to prevent shifting or distortion of the pipe. Make provision for expansion where necessary. All piping must pitch toward low points, and make provision for draining these low points. Use a sufficient number of unions or flanges to allow for the dismantling of all water pipe, valves, and equipment. Peerform installation of piping including cleaning, cutting, threading and jointing, in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.3 MANUFACTURER'S SERVICES

3.3.1 Manufacturer's Representative

Provide services by a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Supervise the installing, adjusting, and testing of equipment.

3.3.2 Field Training

Conduct training course for operating staff as designated by the Contracting Officer. The training period, for a total of [_____] hours of normal working time, must start after the system is functionally completed but prior to final acceptance tests. Submit proposed diagrams, field instructions, and other sheets, prior to posting. Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, where directed. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, frame as specified above for the wiring and control diagrams and post beside the diagrams. Post the framed instructions before acceptance testing of the systems. Cover all of the items contained in the Operating and Maintenance Instructions. Submit [6] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operation features. Submit [6] [_____] complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include simplified wiring, layout, and control diagrams of the system as installed.

3.4 TESTING AND PERFORMANCE

After installation of the water softener, perform operating tests to assure that the water softener system operates properly. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

3.4.1 Softeners

****

NOTE: The approximate constant flow rate in liters per second gpm for operating capacity test will be inserted in the blank spaces provided. For some softener units, the tests may be modified if required by the type and operating conditions. This is particularly necessary where high capacity exchange materials are used and the hardness is such that complete tests would require abnormal extended periods of time. In such cases this paragraph will be suitably rewritten.

****

Run each softener to exhaustion and regenerate it to full capacity in accordance with manufacturer's instructions before test is started. Put softener through a complete cycle of operation at a constant flow rate of approximately [_____] L/second gpm for capacity test. During capacity test, the softened water must be wasted to the sewer if necessary to maintain the required flow rate. Determine the total grains of equivalent calcium carbonate removed by testing the hard water at such intervals that will give a representative calcium carbonate content.

a. After each run, regenerate the unit using salt brine delivered from the measuring tank in the amount called for by operating instructions. Near the end of the brine rinse and beginning of production of zero soft-water, take samples of the water every 2.5 minutes, read the meter, and record the reading. Titrate samples for chlorides, and consider zero soft-water production to begin when chlorides, as chloride radicals, are not in excess of 20 milligrams per liter above the chloride content of the hard-water. When the required number of liters gallons of hard water of specified hardness have been run through the softener, take a quart sample of the softened water and test.

b. Use the test results in determining the capacity and performance of the softener. Take a sample of hard-water and test in a similar manner. Make a complete log of each test run, giving the following data: date, time or readings, total water softened, and pounds of salt used per regeneration. Collect all samples in clean, glass-stoppered bottles. Thoroughly rinse bottles with water being sampled, and plainly mark all samples for identification.

c. Supply the salt required for regeneration of the exchange material after each of the above test runs. Under actual operating conditions the exchange material must not be washed out of the apparatus, the turbidity and color of the soft water must not exceed the turbidity and color of the hard water, and during any softening run, slugs of dirty or turbid water must not be delivered regardless of the change of demand rate up to the maximum on the apparatus. During the specified test of the softener, the soft-water sampling cock must remain open and a stream of softened water must be run through a rubber hose, discharging at the bottom of a wide mouth, 3 liter 1 gallon glass jar or bottle set against a white background so that the color and turbidity may be under observation at all times. Amount of salt used for regeneration exceeding [_____] kg pounds per 65 g 1,000 grains hardness of equivalent calcium carbonate removed is not permitted.

3.4.2 Piping

After installation, test all pipelines for watertightness. For these tests furnish testing plugs or caps, all necessary pressure pumps, pipe connections, gauges, other equipment, and all labor required. Indicate test pressures in the process pipe schedule shown. Test joints of air lines using a soapy water solution to detect leaks. The obtaining of water, electric power and other utility items as well as the disposal of water drainage are also the responsibilities of Contractor. Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report must indicate the final position of controls.

3.5 FIELD PAINTING

Paint equipment which did not receive a factory finish as specified in Section 09 90 00 PAINTS AND COATINGS. Thoroughly clean factory painted items requiring touching up in the field of all foreign material and prime and top-coat with the manufacturer's standard factory finish.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-22 33 30.00 10 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-22 33 30.00 10 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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08/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-22 33 30.00 10 (August 2020)**

Preparing Activity: USACE **Superseding**
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SECTION 22 33 30.00 10

SOLAR WATER HEATING EQUIPMENT

08/20

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NOTE: This guide specification covers the requirements for solar domestic and service water heating equipment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: In accordance with the design guidance presented in UFC 3-440-01, the system is designed around the properties of a particular collector. The designer should indicate the design methodology used on the drawings. This ensures that equipment shown on detail drawings (if different from the equipment assumed by the designer) is properly sized. It is particularly important for the designer to indicate on the drawings the collector parameters used in the design. Detail drawings returned should also be so noted, particularly if the collector chosen has properties different from those used in the original design. UFC 3-440-01 provides the designer, project manager, and quality

assurance personnel a checklist of required drawings and information called out by this guide specification to appear on the drawings.

Minimize the risk of legionellosis in building water system by following guidance in the U.S. Army Corps of Engineers (USACE) Engineer Manual (EM) 200-1-13, Environmental Quality: Minimizing the Risk of Legionellosis Associated with Building Water Systems on Army Installations.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 93	(2010; Errata 2013; Errata 2014) Methods of Testing to Determine the Thermal Performance of Solar Collectors

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)

ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

ASTM B828	(2023) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM F1199	(2021) Standard Specification for Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.2 SOLAR ENERGY SYSTEM

****

NOTE: For systems located in an area subject to freezing, a closed-loop antifreeze system may be used. This system requires the propylene-glycol based heat transfer fluid, pumps, heat exchanger, and an expansion tank. A drain back system with either potable water or a propylene-glycol based heat transfer fluid in a closed loop may also be used. For systems at locations in which freezing temperatures do not occur, a direct circulation system may be used. UFC 3-440-01 provides further information on these system types and their appropriate uses. The Solar Collectors Manufacturer's factory designed systems, applicable to the specific location and use, may be utilized.

****

a. Provide a solar energy system arranged for preheating of service (domestic and/or process) water using flat plate liquid solar collectors or evacuated tube collectors. Solar systems may be pressurized glycol systems[or drain back systems]. Include in the system components the solar collector array, storage tank[s], pump[s], automatic controls, instrumentation, interconnecting piping and fittings, [uninhibited food-grade propylene-glycol and water heat transfer fluid in a closed loop], [potable water heat transfer fluid in an open loop], [heat exchanger], [expansion tank], [drain back tank] and all accessories required for the fully functional operation of the system. Provide all appurtenances required by a manufacturer designed system for a full and functional operation.

b. Submit manufacturer's descriptive and technical literature; performance chart and curves; catalog cuts; installation instructions; proposed diagrams, instructions, and other sheets prior to posting. A copy of the posted instructions proposed to be used, including a system schematic, wiring and control diagrams, and a complete layout of the entire system. Include with the instructions, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system, methods of balancing and testing flow in the system, and methods of testing for control failure and proper system operation.

c. Submit drawings containing a system schematic; a collector layout and roof plan noting reverse-return piping for the collector array; a system elevation; an equipment room layout; a schedule of operation and installation instructions; and a schedule of design information including collector height and width, recommended flow rate and pressure drop at that flow rate, and number of collectors to be grouped per bank.

d. Include on the drawings complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work, including clearances for maintenance and operation.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Solar Energy System

As-Built Drawings

SD-03 Product Data

Spare Parts

Solar Energy System

Welder Qualifications

SD-06 Test Reports

Inspection and Testing

SD-10 Operation and Maintenance Data

Operation and Maintenance Procedures; G, [_____]

1.4 WELDER QUALIFICATIONS

Qualify procedures and welders in accordance with the code under which the welding is specified to be accomplished. Submit, prior to welding operations, [_____] copies of qualified procedures and lists of names and identification symbols of qualified welders and welding operators.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and excessive temperature variation, and dirt and dust or other contaminants.

1.6 WARRANTY

****

NOTE: Most flat plate collector manufacturers provide a minimum 10-year warranty. In the past, the solar energy field attracted a large number of disreputable manufacturers, many of whom were out of business long before their warranty expired. Any manufacturer that meets this collector specification should provide a quality collector that is capable of surviving the warranty.

****

Provide a minimum 10-year warranty against the following: failure of manifold or riser tubing, joints or fittings; degradation of absorber plate selective surface; rusting or discoloration of collector hardware; and embrittlement of header manifold seals. Include in the warranty full repair or replacement of defective materials or equipment.

1.7 SPARE PARTS

Submit data for each different item of material and equipment listed, including a complete list of parts and supplies, with current unit prices and source of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of equipment, or specified to be furnished as part of the contract; and a list of additional items recommended by the manufacturer to ensure efficient operation for a period of 120 days.

PART 2 PRODUCTS

****

NOTE: To comply with Public Law 109-58 (Energy Policy Act of 2005) design new federal buildings to achieve energy consumption levels that are at least 30 percent below the level required by ASHRAE 90.1-2004. As a minimum, all energy consuming products and systems must meet or exceed the requirements of ASHRAE 90.1.

****

2.1 GENERAL EQUIPMENT REQUIREMENTS

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 5 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

For each major item of equipment, secure a plate containing the manufacturer's name, address, type or style, model or serial number, and catalog number to the item of equipment.

2.1.3   Identical Items

Ensure items of the same classification are identical, including equipment, assemblies, parts, and components.

2.1.4   Equipment Guards [and Access]

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting set-screws, keys, and other rotating parts so located that any person may come in close proximity. Properly guard or cover high-temperature equipment and piping located so as to endanger personnel or where it creates a potential fire hazard with insulation of a type specified. [Provide catwalk, ladder, and guard rails where shown and in accordance with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.]

2.1.5   Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

2.2   PIPING SYSTEM

Provide complete piping system with pipe, pipe fittings, valves, strainers, expansion loops, hangers, inserts, supports, anchors, guides, sleeves, and accessories. Provide system materials conforming to the following:

2.2.1   Copper Tubing

ASTM B88M ASTM B88, Type K where buried, Type L otherwise. Collector risers Type L or M.

2.2.2   Solder

****

NOTE: The solders referenced are necessary for compatibility with the fluids and metals contained in solar energy systems and also required for piping containing potable water.

****

ASTM B32, Type Sb5, Sn94, Sn95, or Sn96. Lead solders are not allowed in any portion of the potable water system.

2.2.3   Joints and Fittings for Copper Tubing

Provide wrought copper and bronze solder-joint pressure fittings conforming to ASME B16.22 and ASTM B75/B75M. Provide cast copper alloy solder-joint pressure fittings conforming to ASME B16.18 and ASTM B828. Provide cast copper alloy fittings for flared copper tube conforming to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Provide ast bronze threaded fittings conforming to ASME B16.15. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Do not use grooved mechanical joints and fittings.

2.2.4   Dielectric Waterways and Flanges

****

NOTE: Since all wetted surfaces are required to be nonferrous, the only location for dielectric waterways to be considered is the penetrations to the storage tank.

****

Provide waterways and flanges conforming to the requirements of ASME B16.39. Provide dielectric waterways with metal connections at both ends suited to match connecting piping. Thread or solder ends to match adjacent piping. Line dielectric waterways internally with an insulator specifically designed to prevent current flow between dissimilar metals. Provide dielectric waterways and flanges suitable for the temperatures, pressures, and antifreeze encountered. Ensure dielectric flanges meet the performance requirements described herein for dielectric waterways.

2.2.5 Bronze Gate, Globe, Angle, and Check Valves

****

NOTE: MSS SP-80 shows standard practice for check valves. Of the check valves listed, only the metal to metal lift check valve (Type 1) may be used. However, spring loaded check valves (also called "nonslam" check valves) are available and are similar to the lift check valve referenced. These spring loaded check valves are preferred and should be used whenever practical.

****

MSS SP-80, Type 1 (or nonslam, spring type), Class 125 or 150.

2.2.6 Ball Valves

[MSS SP-72] [or] [MSS SP-110], Class 125 or 150.

2.2.7 Relief Valves, Pressure and Temperature

****

NOTE: The system should be used with 862 kPa 125 psig pressure relief and 99 degrees C 210 degree F temperature relief whenever possible. In the event of overpressure, the pressure relief valves located at the low points in the system (usually on the expansion tank in the equipment room) should open first due to the elevation head of the system. This prevents fluid release at the collector level and serves to alert maintenance personnel of a problem.

****

ANSI Z21.22/CSA 4.4. Locate pressure relief valves on the solar collector array upper manifold and on the expansion tank to open and discharge the collector fluid [into drain indicated] [into drain tank] when fluid pressure rises above 862 kPa 125 psig. Locate pressure and temperature relief valves on the solar storage tank to open and discharge water [into drain indicated] [into drain tank] when fluid pressure rises above [862] [_____] kPa [125] [_____] psig or when fluid temperature rises above [99] [_____] degrees C [210] [_____] degrees F.

2.2.8 Calibrating Balancing Valves

Provide calibrated balancing valves suitable for 862 kPa 125 psig and 121 degrees C 250 degrees F service, of bronze body/brass ball construction with seat rings compatible with system fluid, and with differential readout ports across valve seat area. Fit readout ports with internal insert of compatible material and check valve. Ensure calibrated balancing valves have memory stop feature to allow valve to be closed for service and reopened to set point without disturbing balance position and calibrated nameplate to assure specific valve settings.

2.2.9 Vacuum Breakers

Install atmospheric type anti-siphon vacuum breaker where indicated on the plans. Include lightweight disc float with silicone disc for tight seating. Construct the vacuum breaker of lead free materials.

2.2.10 Air Vents

[Provide manual air vents that are 10 mm 3/8 inch brass or bronze globe valves or cocks suitable for 862 kPa 125 psig service. Provide air vents with threaded plugs or caps.]

[Provide automatic air vents consisting of ball-float construction. Provide vent inlet no less than 12 mm 1/2-inch and outlet no less than 8 mm 1/4-inch. Provide corrosion-resistant steel. Ensure vent discharges air at any pressure up to 1034 kPa 150 psig.]

2.2.11 Strainers

ASTM F1199, removable basket and screen, Y pattern, cast iron strainer with pressures to 862 kPa 125 psig, simplex type; or a combination elbow-strainer with straightening vanes and strainer arranged for horizontal flow.

2.2.12 Pressure Gauges

ASME B40.100. Provide pressure gauges with throttling type needle valve or a pulsation dampener and shutoff valve. Provide minimum dial size of 90 mm 3-1/2 inch.

2.2.13 Thermometers

ASME PTC 19.3 TW, Type I, Class 3. Supply thermometers with wells and separable bronze sockets.

2.2.14 Pipe Threads

ASME B1.20.2MASME B1.20.1.

2.2.15 Pipe Supports

MSS SP-58. Provide stainless steel metal insulation shield.

2.2.16 Aluminum Sheets

ASTM B209M ASTM B209, Alloy 3003.

2.2.17 Copper Sheets Copper Alloy 110

ASTM B152/B152M.

2.3 ELECTRICAL WORK

Provide electric motor-driven equipment specified complete with motor, motor starters, and controls. Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Specify or indicate electrical characteristics. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Ensure each motor is of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices but are not shown. Ensure integral size motors are the premium efficiency type in accordance with NEMA MG 1.

2.4 COLLECTOR SUBSYSTEM

****

NOTE: As discussed in UFC 3-440-01, the design of a solar energy system is heavily dependent on the choice of a collector. It is important that the collector around which the system is designed be described as thoroughly as possible on the designer's drawings. Of particular interest are the length and width of the collector (for spacing and roof layout reasons), the recommended flow rate of the collector, and the rated pressure drop at that flow rate. The designer should verify that the values of the following parameters are indicated in schedules on the drawings:

1. Type of collectors
2. Number of collectors
3. Gross area and net aperture area
4. Collector height and width
5. Collector fluid volume
6. Collector filled weight
7. Collector manufacturer's warranty period
8. Recommended collector flow rate
9. Pressure drop across the collector at recommended flow rate.

Flat plate collectors should be utilized in ASHRAE Climate Zones 1-3. Evacuated tube collectors should be used in ASHRAE Climate Zones 4 and above or within zones 1-3 when water heating above 140 degrees F (60 degrees C) is required.

****

2.4.1 Flat Plate Collector Construction

Provide liquid, internally manifolded type flat plate solar collectors. Provide each collector with cover glazing, an absorber plate, heat transfer liquid flow tubes, internal headers, weep holes, insulation, and a casing. Collectors must be of weather-tight construction. Ensure solar collectors withstand a stagnation temperature of 177 degrees C 350 degrees F and a working pressure of 862 kPa 125 psig without degrading, out-gassing, or warping. Provide collector net aperture area as shown and is a minimum of 2.3 square meters 24.5 square feet. Provide collector length, width, and volume as shown on the drawings.

2.4.1.1 Absorber Plate and Flow Tubes

Provide copper absorber sheet or plate. Ensure top of absorber plate is coated with selective surface of black chrome and has an emissivity less than 0.2 and absorptivity greater than 0.9. Provide Type L or Type M copper flow tubes that are soldered, brazed, or mechanically bonded to the absorber plate. Install tubes on the absorber plate so that they drain by gravity.

2.4.1.2 Cover Glazing

Ensure each collector has a single layer of cover glazing made of clear float, water white or low iron type tempered glass. Provide glass meeting ASTM C1048. Provide cover glazing which is completely replaceable from the front of the collector without disturbing the piping or adjacent collectors. Ensure cover glazing is separated from the collector by a continuous gasket made of EPDM rubber.

2.4.1.3 Insulation

Insulate back and sides of the absorber plate. Fill space between absorber plate and casing with insulation that has an R value of 4 minimum. Use insulation conforming to EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING which is fibrous glass, polyisocyanurate, urethane foam, or other material suitable for the intended purpose, and capable of withstanding the moisture, sun exposure, and stagnation temperature limitations of the solar collector. Do not allow polyisocyanurate insulation to come in contact with the absorber plate.

2.4.1.4 Casing

Provide aluminum casing. Provide mill finish or factory applied baked enamel, embossed or bronze anodized aluminum. Separate cover glazing from the casing by an EPDM rubber gasket or equivalent material. Make allowance for thermal expansion between the cover and absorber plates and the casing, and for drainage of moisture through weep holes.

2.4.2 Evacuated Tube Collectors

****

NOTE: There are several types of solar collectors that utilize evacuated tubes. The most prominent being heat pipe collectors and direct flow collectors. Heat pipe collectors are highly efficient and recommended for use for domestic hot water. The tubes are easily removed and replaced without disabling the entire system. The tubes are suitable for cold climates. Correct Orientation of the pipes is imperative for proper operation. Direct flow collectors are wet systems, utilizing a "pipe within a pipe" design. The interior pipe has an integral heat absorber mechanically attached to the pipe. These tube collectors can be mounted

horizontal or vertical and are suitable for all weather conditions. The direct flow collectors are recommended for commercial and industrial applications. These collectors are very flexible and can be utilized when the ideal installation position is not available. For both types, the tubes are under a vacuum, providing excellent insulation.

****

Ensure evacuated tube collectors incorporate the use of borosilicate glass tubes. Utilize [heat pipe] [direct flow] collectors in the system design. Ensure tubes are resistant to thermal shock and designed to resist hail damage.

[Heat pipe systems are a dry system that does not utilize water within the collector tubes. Incorporate an inner sealed copper tube containing a non-toxic heat transfer medium into the system. The heat-pipe principle will transfer heat, via the heat pipe, from the evacuated glass tube to the receptor in the manifold. Design the system to allow the removal of the tubes without draining the system. Install systems that are extremely dependent on the correct mounting arrangements precisely as recommended by the manufacturer to insure correct operation.]

[Utilize direct flow systems, which are a fully pumped wet system, if ideal installation arrangements are not possible. Enclose a copper pipe, circulating water, within the evacuated tube. Connect the ends of the pipe to the cold or hot water header within the panel assembly. Direct flow systems are pressurized and can be mounted both horizontally and vertically. Manufacture the system to allow replacement of a single evacuated tube without draining the entire collector loop.]

2.4.2.1 Operating Conditions

[Provide direct flow collectors capable of withstanding a stagnation temperature of 300 degrees C 595 degrees F] [Provide heat pipe collectors capable of withstanding a stagnation temperature of 165 degrees C 330 degrees F]. Ensure evacuated tubes incorporate "plug and play" design where tubes can be removed or replaced without disabling the entire system.

2.4.3 Mounting and Assembly Hardware

Provide stainless steel mounting frame with stainless steel or aluminum mounting clips. Provide stainless steel assembly hardware including all bolts, washers, and nuts.

2.4.4 Solar Collector Performance

****

NOTE: The maximum number of collectors per bank allowed by the manufacturer should be investigated. This number is dependent on the header and riser diameters, flow rates, and thermal expansion characteristics of the collector. It is expected that most 1.2 m 4 foot wide collectors can be grouped into banks of at least seven, and this is the largest bank size allowed.

****

Plot thermal performance on the thermal efficiency curve in accordance with ASHRAE 93. Ensure the y-intercept is equal to or greater than 0.68, and the numerical value of the slope of the curve (FRUL) is between 0 and minus 5.7 watts per square meter per degree K (0 and minus 1.0 Btu per hour per square foot per degree F) 0 and minus 1.0 Btu per hour per square foot per degree F. Ensure manufacturer's recommended volumetric flow rate and the design pressure drop at the recommended flow rate is as shown. Ensure manufacturer's recommendations allow at least seven collectors to be joined per bank while providing for balanced flow and for thermal expansion considerations.

2.5 Solar Collector Array

2.5.1 Net Absorber Area and Array Layout

****

NOTE: The minimum array aperture area allowed for the project is that collector array area associated with the highest LCC savings by the SOLFEAS solar feasibility study computer program. The array layout should be completed according to the methods discussed in UFC 3-440-01. For flow balancing purposes, each bank must have the same number of collectors. Banks must contain between 4 and 7 collectors each. Generally, the array should follow building lines, but must keep within 20 degrees of due south. Care should be taken to distinguish between magnetic and due south for the project location. Row spacing is a function of the collector height and projection location; methodology for determining this spacing is given in UFC 3-440-01. It is imperative to proper construction of the system that the array layout be accurately shown on the drawings. Items to be shown on the drawings must include:

a. SOLFEAS result for minimum array size
b. Total array size to be installed
c. Bank size (4, 5, 6, or 7 collectors) and number of banks
d. Minimum row spacing in event of multiple rows of collection
e. Array orientation with respect to true south.

****

Provide array consisting of an assembly of solar collectors as shown with a minimum total array aperture area of [_____] square meters square feet. Assemble solar collectors as shown in banks of equal number of collectors. Banks consist of no less than 4 and no more than 7 collectors each. Orient collector array so that all collectors face the same direction and are oriented within 20 degrees of true south and with respect to true south as indicated. Space collectors arranged in multiple rows so that no shading from other collectors is evident between 1000 hours and 1400 hours solar time on December 21.

Use minimum spacing between rows as recommended by the manufacturer for the specific location.

2.5.2 Piping

****

NOTE: The reverse-return strategy is important to proper array operation. Because this strategy results in what may be initially perceived by the Contractor as excess piping, it is important that the array piping be shown and indicated on the drawing as satisfying this requirement. Rules, methodology, and examples of the reverse-return strategy are given in UFC 3-440-01. Collector loop flow rate should be determined by multiplying the recommended flow rate per collector by the number of collectors to be installed. Collector headers must be located such that there is no possibility of air pockets. Items to be shown on the drawings must include:

a. Flow rate through collector loop based on recommended flow per collector
b. Reverse-return piping shown and noted
c. Valves, strainers, automatic controls, and all accessories
d. Pipe pitch for draining.

****

The array piping includes interconnecting piping between solar collectors, and connect in a reverse-return configuration as indicated with approximately equal pipe length for any possible flow path. Provide flow rate through the collector array as indicated. Provide automatic pressure relief valves in the array piping system as indicated, and adjust to open when the pressure within the solar array rises above 862 kPa 125 psig. Ensure each collector bank is capable of being isolated by valves, and each bank capable of being separated has a pressure relief valve installed and is capable of being drained. Locate manually operated air vents at system high points, and pitch all array piping a minimum of 21 mm/meter 0.25 inch/foot as shown so that piping can be drained by gravity. Supply calibrated balancing valves at the outlet of each collector bank as indicated.

2.5.3 Supports for Solar Collector Array

****

NOTE: The support structure for the solar array is to be constructed from stainless steel to minimize cost and maintenance of painting a system. For the majority of solar projects, this structure will be constructed as a support rack on a flat roof. Design loads for solar arrays include the filled weight of the collectors, weight of filled piping, wind, seismic and snow loads, and the weight of the support structure itself. Of these, the wind imposed on solar collector arrays may require the most attention. Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19 must be

included in the contract documents. Support structures provided by the collector manufacturer may be used if they meet the stated specification.

****

Provide stainless steel support structure for collector array in accordance with Section [05 50 13 MISCELLANEOUS METAL FABRICATIONS][05 50 14STRUCTURAL METAL FABRICATIONS]. Use support structure to secure collector array at the tilt angle with respect to horizontal and orientation with respect to true south as shown. Ensure support structure withstands static weight of filled collectors and piping, wind, snow, seismic, and other loads as indicated. Ensure seismic details [conform to UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS] [be as shown on the drawings]. Ensure support structure allows access to all equipment for maintenance, repair, and replacement.

2.6 STORAGE TANK

****

NOTE: Storage tank volume should be between 61 to 81 liters per square meter 1.5 to 2 gallons per square foot of collector area. This range of acceptable values should be inserted in the blanks provided based on the array area inserted in paragraph Net Absorber Area and Array Layout. Storage volume outside of this range becomes undesirable from a system performance point of view. Items to be shown on the drawings must include:

a. Range of acceptable storage tank volumes
b. Number of liters gallons of storage provided per square meter square foot of collector area for given tank
c. Minimum R value of tank insulation
d. Type of lining in tank.

****

[Provide solar indirect water heater type storage tank, having integral coil heat exchanger for connection to the collector array (see Heat Exchanger in Transport Subsystem paragraph below).] Ensure solar system hot water storage tank has a storage volume between [_____] and [_____] liters gallons and is as shown. Provide solar system storage tank conforming to specifications for hot water storage tanks in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Provide insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except that insulation must have an R value of not less than 30. Design tank penetrations to allow for connections to copper piping without risk of corrosion due to dissimilar metals, and factory install as indicated.

2.7 TRANSPORT SUBSYSTEM

2.7.1 Heat Exchanger

****

NOTE: Although solar energy system performance is not strongly dependent on the effectiveness of the particular heat exchanger used, it is very important

to ensure that it is sized properly. Use of the approach and return temperatures stated in this paragraph ensures that the effectiveness of the heat exchanger is within acceptable limits. The hot side return temperature can be less than 49 degrees C 120 degrees F if the designer feels that the effectiveness should be greater than 0.5. When multi-plate heat exchangers are used, the effectiveness can be significantly increased above 0.5 for a small increase in heat exchanger cost. Both shell-and-tube and multi-plate or plate-and-frame heat exchangers are allowable for solar systems. Although the shell-and-tube exchangers are more common, multi-plate heat exchangers are becoming readily available from a variety of manufacturers. The multi-plate heat exchanger has the advantages over shell-and-tube of being more compact, more efficient, easier to clean, and it is commonly produced from superior materials. They can also be easily expanded to larger sizes if necessary, and many require little or no insulation. The designer should consider use of these exchangers whenever practical. Because of the wide variety of configurations used by these heat exchangers, they must often be sized by the individual manufacturers. In accordance with UFC 3-440-01, the flow rate on the storage side of the heat exchanger should be 1.25 times that on the collector side. Items to be shown on the drawings must include:

a. Type of heat exchanger and heat exchanger materials
b. Flow rates on both sides of heat exchanger
c. Plate or tube heat transfer area.

****

Perform heat exchanger construction and testing in accordance with ASME BPVC SEC VIII D1and list for use on potable water systems. Use minimum design pressure rating of 862 kPa 125 psig. Ensure heat exchanger is capable of returning a hot-side exit temperature of [49] [_____] degrees C [120] [_____] degrees F or less given a hot-side approach temperature of 60 degrees C 140 degrees F and a cold-side approach temperature of 38 degrees C 100 degrees F. Ensure heat exchanger is capable of withstanding temperatures of at least 116 degrees C 240 degrees F. Provide heat exchanger that is capable of operation at the flow rates as shown.

2.7.1.1 Plate Heat Exchanger

Construct heat exchanger of multiple plates of 316 stainless steel, titanium, copper, copper-nickel, or brass. Provide plates that are frame-mounted, mechanically bonded, welded, or brazed at edges. Ensure plate-type heat exchanger is able to be cleaned. Provide gaskets consisting of EPDM rubber or Viton. Ensure all plate heat exchanger characteristics are as indicated.

2.7.1.2 Tube-in-Shell Heat Exchanger

Provide [fixed] [removable] bundle, shell-and-tube type heat exchanger.

Construct shell, tube sheets, and end plates of nonferrous, brass, copper-nickel, or 316 stainless steel. Provide shell insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except that insulation must have a minimum R value of no less than 12. Provide tubes that are seamless copper or copper alloy and mechanically bonded, welded, or brazed to the end tube plates. Ensure tubes are straight and supported by tube sheets which maintain the tubes in alignment. [Arrange straight tube heat exchanger for mechanical cleaning.] Provide all tube-in-shell heat exchanger characteristics as indicated.

2.7.1.3 Coil Heat Exchanger

Ensure heat exchanger is integral to the storage tank. Construct heat exchanger of nonferrous, stainless steel, copper nickel, or copper. Provide all coil heat exchanger characteristics as shown. If a freeze protection fluid circulates in the heat exchanger, ensure heat exchanger piping consists of double wall construction.

2.7.2 Pumps

****

NOTE: In closed loop systems, the use of a standard base mounted or inline pump is acceptable. If the system utilizes an open loop or drain down tank where the pump may drain, incorporate a means to prime the pump or the use of a self-priming pump.

****

Provide circulating pumps that [are listed for use in a potable water system and]are the electrically-driven, single-stage, centrifugal, base mounted or inline type.[Provide self-priming pumps.] Support pumps [on a concrete foundation] [or] [by the piping on which installed]. Ensure pumps have a capacity no less than that indicated and are either integrally-mounted with the motor or direct-connected by a flexible-shaft coupling on a cast-iron or steel sub-base. Construct pump shaft of corrosion resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal. Provide pumps with bronze or stainless steel impellers and casings of cast iron or bronze. Ensure motors have sufficient power for the service required, are of a type approved by the manufacturer of the pump, are suitable for the available electric service and for the heat transfer fluid used, and conform to the requirements specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Control motors by suitable switches that can be activated by either the differential temperature controller or by manual override (Hand-Off-Automatic). Provide each pump suction and discharge connection with a pressure gauge as specified.

2.7.3 Pipe Insulation

Apply pipe insulation and coverings in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS as called out for steam piping to 103 kPa 15 psig. Provide array piping insulation capable of withstanding 121 degrees C 250 degrees F, except provide piping within 450 mm 1.5 feet of collector connections capable of withstanding 204 degrees C 400 degrees F.

2.7.4 Expansion Tank

****

NOTE: Care should be taken by the designer to properly size the expansion tank according to the guidance in UFC 3 440-01. This expansion tank sizing criteria requires the expansion tank to be able to accept an amount of fluid equal to the fluid volume of the collectors plus piping at the same height or above the collectors. This is in contrast to the conventional method of sizing the expansion tank to account for thermal expansion of the heat transfer fluid. The method described above allows for the large volume increase corresponding to the vaporization of fluid in the collectors during stagnation. This "oversizing" provides a fail-safe means of system pressure control during stagnation conditions, and prevents heat transfer fluid discharge by keeping the system pressure below the maximum 862 kPa 125 psig relief value. A bladder-type expansion tank is required to separate the heat transfer fluid from the metal tank material. Use of a precharged tank allows the overall tank size to be smaller. Care should be taken to ensure that the expansion tank precharge pressure is less than the fill pressure at the expansion tank. Items to be shown on the drawings must include:

a. Expansion tank acceptance and total volume
b. Expansion tank and bladder materials
c. Maximum relief, system cold fill, and precharge pressures.

****

Construct and test expansion tank in accordance with ASME BPVC SEC VIII D1 and as applicable for a working pressure of 862 kPa 125 psig. Provide tank with an elastomeric EPDM bladder which separates the system fluid from the tank walls and is suitable for a maximum operating temperature of 116 degrees C 240 degrees F. Size the expansion tank to accept a volume equal to the fluid volume of the collectors plus the associated piping. Ensure tank volume is a minimum of [_____] liters gallons as shown. If the system is modified from the construction documents, recalculate the system volume and modify the expansion tank volume as required. Provide total tank size and arrangement as shown. Provide tank with 862 kPa 125 psi pressure relief valve. Provide tank with precharge pressure of [_____] kPa psi as shown.

2.7.5 Heat Transfer Fluid

****

NOTE: Where freezing temperatures at the project location and the system design dictate, the use of an uninhibited propylene-glycol/water solution will be utilized. USP/food-grade uninhibited propylene-glycol is a nontoxic, noncorrosive fluid used by the food industry, and has been approved for use with single isolation heat exchangers in closed-loop military solar energy systems by the Office of the Surgeon General (DASG) in coordination with the Toxicology Division of the Army Environmental Hygiene Agency. The concentration to

be used is a function of the climate where the system is to be located. The concentration should be either 30 or 50 percent, with climates that commonly attain freezing temperatures (those above approximately 2,222 heating Kelvin days 4000 heating degree F days) receiving the 50 percent solution. Although inhibited propylene-glycol is often used in mechanical systems, uninhibited propylene-glycol is specified for solar systems to eliminate fluid maintenance requirements. Indicate in equipment schedules on drawings the heat transfer fluid used, the concentration, and the maximum operating temperature to assure proper equipment and materials compatibility. Items to be shown on the drawings regarding the heat transfer fluid must include, if applicable:

a. Use of uninhibited, food-grade propylene- glycol and distilled water solution
b. 30 or 50 percent concentration
c. Note of tamper resistant seal requirement.
****

[Ensure solar collector loop fluid is uninhibited USP/food-grade propylene-glycol and mixed with distilled or demineralized water to form a [30] [50] percent by volume propylene-glycol solution as shown]. [Solar collector loop fluid must be potable water.]

2.7.6 Drain Back Tank

Provide drain back tank that is constructed by one manufacturer, ASME stamped for working pressure, has ASME registration, and is sized in accordance with the requirements of the manufacturer. Construct tank of stainless steel type 304 alloy. Provide tank connection fittings that are 12 mm 1/2 inch female NPT type fittings. Ensure maximum operating pressure is no less than 50 PSI. Maximum temperature less than 95 degrees C 200 degrees F is unacceptable.

2.8 CONTROL AND INSTRUMENTATION SUBSYSTEM

2.8.1 Differential Temperature Control Equipment

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NOTE: The guidance contained in UFC 3-440-01 discusses desired control and diagnostic capabilities of control equipment.
****

Supply differential temperature control equipment as a system by a single manufacturer. Ensure controller is compatible with the building automation system (BAS). Provide solid-state electronic type controller complete with an integral transformer to supply low voltage, which allows a minimum adjustable temperature differential (on) of 4 to 11 degrees C 8 to 20 degrees F, a minimum adjustable temperature differential (off) of 2 to 3 degrees C 3 to 5 degrees F, and includes a switching relay or solid state output device for pump control. Thermostat must operate in the on-off mode. Controller accuracy must be plus or minus 0.5 degree C 1 degree F. Provide controller that is compatible with 10-kOhm thermistor temperature sensors. Use differential control to provide direct digital temperature readings of all temperatures sensed. Control must indicate visually when pumps are energized. Control ambient operating range must be a minimum of 0 to 49 degrees C 32 to 120 degrees F. At a minimum, system control points must include:

a. Collector temperature sensor

b. Storage tank temperature sensor

c. Heat exchanger temperatures inlet and outlet

d. Pump inlet and discharge pressure

e. Heat exchanger inlet and outlet pressure

f. Storage tank pressure

g. Flow indicator in the collector loop

h. Flow indicator in the storage loop

i. BTU meter to measure and record the thermal energy stored.

2.8.2 Thermistor Temperature Sensors

Provide 10-kOhm thermistor temperature sensors supplied by the differential temperature controller manufacturer, with an accuracy of plus or minus 1 percent at 25 degrees C 77 degrees F. Model supplied must have passed an accelerated life test conducted by subjecting thermistor assemblies to a constant temperature of 204 degrees C 400 degrees F or greater for a period of 1000 hours minimum. Maintain accuracy within plus or minus 1 percent as stated above. Provide hermetically sealed glass type thermistors. Use operating range of minus 22 to plus 204 degrees C minus 40 to plus 400 degrees F. Provide immersion wells or watertight threaded fittings for temperature sensors.

2.8.3 Sensor and Control Wiring

18 AWG minimum twisted and shielded 2, 3, or 4 conductor to match analog function hardware. Provide control wiring with 600 volt insulation. Provide multi-conductor wire with an outer jacket of PVC.

2.8.4 Flowmeters

****

NOTE: Venturi pressure differential is dependent on the flow rates to be measured. System flow rates are dependent on recommended collector flow rates. UFC 3 440-01 and paragraphs Piping and Heat Exchanger should be used to determine both the collector side and storage side flow rates.

****

Provide flowmeters consisting of a venturi, 150 mm 6 inch dial differential pressure meter, valved pressure taps, and bar stock needle valves. Provide venturi flow nozzle with threaded bronze ends for pipe sizes up to 50 mm 2 inches and flanged ends for pipe sizes 65 mm 2-1/2 inches and above. Ensure venturi length is not less than 1.6 times the pipe size. Select venturi to read differential pressure corresponding to 0.5 to 1.5 times the system flow rate. Provide venturi with an accuracy of plus or minus 1 percent of the range. Provide meter with an accuracy of plus or minus 2 percent of the full scale range.

2.8.5 Sight Flow Indicators

Provide sight flow indicators consisting of a clear glass window or cylinder and a nonferrous or 316 stainless steel body and impeller. Provide indicator with threaded ends for pipe sizes up to 50 mm 2 inches and flanged ends for pipe sizes 65 mm 2-1/2 inches and above. Ensure maximum operating pressure is no less than 862 kPa 125 psi. Ensure maximum operating temperature is no less than 121 degrees C 250 degrees F.

2.9 PAINTING AND FINISHING

Equipment and component items, when fabricated from ferrous metal and located inside the building, must be factory finished with the manufacturer's standard finish.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming thoroughly familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

3.2.1 Collector Subsystem

3.2.1.1 Collector Array

****

NOTE: UFC 3-440-01 discusses installation design guidelines for solar collector arrays. The tilt angle of the collectors off horizontal should be near the site latitude within plus or minus 10 degrees. Items to be shown on the drawings with regard to the installation of the array must include:

a. Tilt angle of collectors from horizontal
b. Elevation of bottom or back of collectors off of flat or pitched roof
c. Location and elevation of piping with regard to array supply and return.

****

Install solar collector array at the tilt angle, orientation, and elevation above roof as indicated. [Install collectors per the manufacturer's instructions.] [For installation on flat roofs with rack type collector mounting or for ground mounted collectors, bottom of collector must be a minimum of 450 mm 18 inches from roof or ground surface.] [For mounting on pitched roofs, install back of collectors a minimum of 50 mm 2 inches above roof surface.] Each solar collector must be removable for maintenance, repair, or replacement. Solar collector array must not impose additional loads on the structure beyond the loads scheduled on the structural drawings.

3.2.1.2 Array Piping

Install collector array piping in a reverse-return configuration so that path lengths of collector supply and return are of approximately equal length. All piping must be coded with fluid type and flow direction labels in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.1.3 Array Support

Install array support in accordance with the recommendations of the collector manufacturer. Weld structural members requiring welding in accordance with AWS D1.2/D1.2M for aluminum and welders should be qualified according to AWS B2.1/B2.1M.

3.2.2 Storage Subsystem

Install solar storage tank penetrations as shown so that cold water inlet to storage tank and outlet from storage tank to collector array are located near the bottom of the tank, and inlet from collector array and outlet to load are located near the top of the tank. Where practicable, install hot water storage tanks with access hatches in order to facilitate annual cleaning and inspections.

3.2.3 Transport Subsystem

3.2.3.1 Flow Rates

****

NOTE: The reverse-return strategy is important to proper array operation. Because this strategy results in what may be initially perceived by the Contractor as excess piping, it is important that the array piping be shown and indicated on the drawing as satisfying this requirement. Rules, methodology, and examples of the reverse-return strategy are given in UFC 3 440-01. Collector loop flow rate should be determined by multiplying the recommended flow rate per collector by the number of collectors to be installed. Collector headers must be located such that there is no possibility of air pockets. Items to be shown on the drawings must include:

a. Flow rate through collector loop based on recommended flow per collector
b. Reverse-return piping shown and noted
c. Valves, strainers, automatic controls, and all accessories
d. Pipe pitch for draining.

Although solar energy system performance is not strongly dependent on the effectiveness of the particular heat exchanger used, it is very important to ensure that it is sized properly. Use of the approach and return temperatures stated in this paragraph ensures that the effectiveness of the heat exchanger is within acceptable limits. The hot side return temperature can be less than 49 degrees C 120 degrees F if the designer feels that the

effectiveness should be greater than 0.5. When multi-plate heat exchangers are used, the effectiveness can be significantly increased above 0.5 for a small increase in heat exchanger cost. Both shell-and-tube and multi-plate or plate and frame heat exchangers are allowable for solar systems. The multi-plate heat exchanger has the advantages over shell-and-tube of being more compact, more efficient, easier to clean, and it is commonly produced from superior materials. They can also be easily expanded to larger sizes if necessary, and many require little or no insulation. The designer should consider use of these exchangers whenever practical. Because of the wide variety of configurations used by these heat exchangers, they must often be sized by the individual manufacturers. In accordance with UFC 3-440-01, the flow rate on the storage side of the heat exchanger should be 1.25 times that on the collector side. Items to be shown on the drawings must include:

a. Type of heat exchanger and heat exchanger materials
b. Flow rates on both sides of heat exchanger
c. Plate or tube heat transfer area.

****

[Base flow rate in the collector loop on recommended collector flow rate, and as shown. Ensure storage loop flow rate is 1.25 times the collector loop flow rate.] [Base system flow rate on recommended collector flow rate, and as indicated.] Ensure all flow rates are below 1.5 meters/second 5 feet/second.

3.2.3.2 Pumps

[Install pumps on foundations, leveled, grouted, and realigned before operation in accordance with manufacturers' instructions.] [Provide additional pipe supports for close-coupled in-line pumps.] [Provide a straight pipe between the suction side of the pump and the first elbow for all base mounted pumps. The length of this pipe must be a minimum of five times the diameter of the pipe on the suction side of the pump, or attach a suction diffuser of the proper size to the suction side of the pump.] [Provide straight pipe between the suction side of the pump and the first elbow for all in-line pumps. The length of this pipe must be a minimum of five times the diameter of the pipe size on the suction side of the pump.] Ensure drain line sizes from the pumps are not less than the drain trap or the pump dirt pocket, but in no case must the drain line be less than 13 mm 1/2 inch iron pipe size. Terminate drain lines to spill over the nearest floor or open sight drain.

3.2.3.3 Expansion Tank

Install expansion tank on suction side of pump.

3.2.3.4 Piping, Valves, and Accessories

****

NOTE: In freezing temperatures at the project , the

use of an uninhibited propylene-glycol/water solution may be required. USP/food-grade uninhibited propylene-glycol is a nontoxic, noncorrosive fluid used by the food industry, and has been approved for use with single isolation heat exchangers in closed-loop military solar energy systems by the Office of the Surgeon General (DASG) in coordination with the Toxicology Division of the Army Environmental Hygiene Agency. The concentration to be used is a function of the climate where the system is to be located. The concentration should be either 30 or 50 percent, with climates that commonly attain freezing temperatures (those above approximately 2,222 heating Kelvin days 4000 heating degree F days) receiving the 50 percent solution. Although inhibited propylene-glycol is often used in mechanical systems, uninhibited propylene-glycol is specified for solar systems to eliminate fluid maintenance requirements. Indicate in equipment schedules on drawings the heat transfer fluid used, the concentration, and the maximum operating temperature to assure proper equipment and materials compatibility. Water should only be used as a heat transfer fluid when the direct circulation system is specified, or when the system is designed with inherent freeze protection. Items to be shown on the drawings regarding the heat transfer fluid must include, if applicable:

a. Use of uninhibited, food-grade propylene- glycol and distilled water solution
b. 30 or 50 percent concentration
c. Note of tamper resistant seal requirements.

****

Install piping in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE, except where noted otherwise. Code piping with fluid type and flow direction labels in accordance with Section 09 90 00 PAINTS AND COATINGS. When a food-grade uninhibited propylene-glycol solution is used to heat potable service water, tamper resistant seals must be attached to all fill ports. All propylene-glycol circuits must be labeled "CONTAINS UNINHIBITED FOOD-GRADE PROPYLENE-GLYCOL: INTRODUCTION OF ANY NONAPPROVED FLUID MAY CONSTITUTE A HEALTH HAZARD." All tamper resistant seals must carry the name of the registered engineer or licensed plumber who certifies that only a [30] [50] percent food-grade uninhibited propylene-glycol and water solution has been installed in the system. Install air vents at the high points of the collector array and in the equipment room.

3.2.3.5 Pipe Expansion

Provide expansion of supply and return pipes for changes in the direction of the run of pipe or by expansion loops as indicated. Use expansion loops to provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. Provide cold-sprung loops and install where indicated. Provide pipe guides as indicated. Do not use expansion joints in system piping.

3.2.3.6 Valves

****

NOTE: Calibrated balancing valves are required at the outlet of each bank in addition to the ball valve required at this outlet. If the reverse-return piping strategy is properly adhered to, this valve may prove unnecessary. It is specified, however, to allow the array to be flow balanced in the event of improper construction or modification of the array at some later time. The ball valves are required to enable the array to be disconnected for maintenance or repair. Check valves at pump discharges are required to prevent back flow into pumps and are required on the collector loop to prevent fluid cooled in the collectors at night from migrating around the loop to the heat exchanger.

****

Install valves at the locations indicated and where required for the proper functioning of the system. Install valves with their stems horizontal or above. Install gate or ball valves at the inlet and outlet of each bank of internally manifolded collectors. Install calibrated balancing valves with integral pressure taps at the outlet of each bank and at the pump discharge. Mark final setting for each valve on each valve. Install ball valves with a union immediately adjacent. Install gate valves at the inlet and outlet of each pump and also at the inlet and outlet of each heat exchanger. Install a check valve at pump discharges. Pipe discharges of relief valves [where required for high temperature or pressure]to the nearest floor drain or as indicated on system drawings. Give consideration to the fluid temperature and pressure when locating the relief valve discharges. Additionally, evaluate the pipe material of the receiving pipe for high temperature fluids.

3.2.3.7 Foundations

Construct concrete foundations or pads for storage tanks, heat exchangers, pumps, and other equipment covered by this specification in accordance with manufacturer's recommendations and be a minimum of 150 mm 6 inches high with chamfered edges.

3.2.3.8 Grooved Mechanical Joints

Do not utilize grooved mechanical joints.

3.2.4 Control Subsystem

3.2.4.1 Differential Temperature Controller

Install automatic control equipment at the location shown in accordance with the manufacturer's instructions. Install control wiring and sensor wiring in conduit. [Mount collector temperature sensor in a temperature sensor well in the fluid stream along the top manifold of a bank between two adjacent collector units.] [Provide collector temperature sensor by differential temperature controller manufacturer and mount directly on the absorber plate by the manufacturer.] Unless otherwise indicated, provide operators, controllers, sensors, indicators, and like devices when installed on equipment casings and pipe lines with stand-off mounting brackets, bases, nipples, adapters, or extended tubes to provide clearance, not less than the thickness of the insulation, between the surface and the device. Ensure these stand-off mounting items are integral with the devices or standard accessories of the controls manufacturer unless otherwise approved. Clamp-on devices or instruments where direct contact with pipe surface is required are exempt from the use of the above mounting items. Color code and identify all control wiring with permanent numeric or alphabetic codes.

3.2.4.2 Sequence of Operation

****

NOTE: The following on/off set differentials are common for liquid systems:

Pump on = 7 to 11 degrees C 12 to 20 degrees F.
Pump off = 2 to 4 degrees C 3 to 8 degrees F.

****

The differential temperature controller sensing temperature difference between the fluid in a solar collector and water in the storage tank must start solar collector loop [and storage loop] pumps[s] when the temperature differential (Delta T - ON) rises above [8] [_____] degrees C [15] [_____] degrees F, and must stop the pump when the differential (Delta T - OFF) falls below [3] [_____] degrees C [5] [_____] degrees F.

3.3 INSPECTION AND TESTING

Submit an independent testing agency's certified reports of inspections and laboratory tests, including analysis, position of flow-balancing equipment, and interpretation of test results. Properly identify each report. Describe test methods used and compliance with recognized test standards.

3.3.1 Inspection

Make system available for inspection at all times.

3.3.2 Testing Prior to Concealment

3.3.2.1 Hydrostatic Test

Demonstrate to Contracting Officer that all piping has been hydrostatically tested, at a pressure of 862 kPa 125 psi for a period of time sufficient for inspection of every joint in the system and in no case less than 2 hours, prior to installation of insulation. Isolate expansion tank and relief valves from test pressure. Loss of pressure is not allowed. Repair leaks found during tests by replacing pipe or fittings and retest the system. Caulking of joints is not permitted.

3.3.2.2 Cleaning of Piping

Flush system piping with clean, fresh water prior to concealment of any individual section and prior to final operating tests. Prior to flushing piping, isolate or remove relief valves. Cover solar collectors to prevent heating of cleaning fluid, unless cleaning is performed during hours of darkness. Circulate the solution through the section to be cleaned at the design flow rate for a minimum of 2 hours.

3.3.3 Posting Framed Instructions

Post framed instructions under glass or in laminated plastic where directed. Include a system schematic, and wiring and control diagrams showing the complete layout of the entire system. Prepare condensed operating instructions explaining preventative maintenance procedures, balanced flow rates, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, frame as specified above, and post beside the diagrams. Submit proposed diagrams, instructions, and other sheets for approval prior to posting. Post framed instructions before acceptance testing of the system.

3.3.4 Acceptance Testing and Final Inspection

Notify the Contracting Officer 7 calendar days before the performance and acceptance tests are to be conducted. Perform tests in the presence of the Contracting Officer. Furnish all instruments and personnel required for the tests. Electricity and water will be furnished by the Government. Maintain a written record of the results of all acceptance tests to be submitted in booklet form. The tests are as follows:

3.3.4.1 As-Built Drawings

Submit, as a condition of final acceptance, a complete set of as-built system drawings. Clearly indicate the actual condition of the installed solar energy system at the time of the final test.

3.3.4.2 Final Hydrostatic Test

Demonstrate to Contracting Officer that all piping has been hydrostatically tested at a pressure of 862 kPa 125 pounds per square inch for a period of time sufficient for inspection of every joint in the system and in no case less than 2 hours. Isolate expansion tank and relief valves from test pressure. Use gauges in the test that have been calibrated within the 6-month period preceding the test. Test must be witnessed by Contracting Officer. Loss of pressure is not allowed. Repair leaks found during tests by replacing pipe or fittings and retest the system. Caulking of joints is not permitted.

3.3.4.3 System Flushing

For the final inspection, flush the system thoroughly, in no case for less than 2 hours, of all foreign matter until a white linen bag installed in a strainer basket shows no evidence of contamination. Keep the white linen bag in the strainer basket during the entire flushing operation prior to its being presented to the Contracting Officer for approval. The Contracting Officer will inspect the linen bag prior to completion of flushing and approve the flushing operation. Drain system prior to final filling.

3.3.4.4 System Filling

Fill system through indicated connections with [propylene-glycol solution. Mix solution consisting of [30] [50] percent propylene-glycol and [70] [50] percent distilled water by volume] [distilled water] externally to the solar system. Vent air from the system after filling. Ensure system pressure at the high point on the roof is 69 kPa 10 psig minimum.

3.3.4.5 Operational Test

Perform operational test over a period of 48 consecutive hours with sufficient solar insulation to cause activation of the solar energy system during daylight hours. With system fully charged so that pressure at the high point on the roof or the lowest system pressure is a minimum of 69 kPa 10 psig and with fluid and pump[s] energized, [sight flow indicator must indicate flow] [flowmeter must indicate flow as indicated]. Use calibrated balancing valves with pressure taps to indicate bank flow rate as shown.

3.3.4.6 Control Logic

****

NOTE: The following on/off set differentials are common for liquid systems:

Pump on = 7 to 11 degrees C 12 to 20 degrees F.
Pump off = 2 to 4 degrees C 3 to 8 degrees F.

****

By substituting variable resistors for collector and storage tank temperature sensors, demonstrate the differential temperature controller correctly energizes the system pump[s] when the collector sensor indicates a temperature of [8] [_____] degrees C [15] [_____] degrees F greater than the storage tank temperature, as indicated on the controller display panel. Provide differential temperature controller to de-energize the system pump[s] when the displayed temperature of the solar collectors is [3] [_____] degrees C [5] [_____] degrees F greater than the displayed temperature of the storage tank.

3.3.4.7 Temperature Sensor Diagnostics

Demonstrate that the controller will correctly identify open and short circuits on both the solar collector temperature sensor circuit and the storage tank sensor circuit.

3.3.4.8 Overall System Operations

Demonstrate that the solar energy system will operate properly while unattended for a period of at least 72 hours and that the controller will start pump[s] after being warmed by the sun, and that it will properly shut down during cloudy weather or in the evening over a minimum of three complete cycles. Contractor is permitted to manipulate the temperature of the storage tank by the introduction of cold water at local groundwater temperature.

3.4 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. Provide training for a minimum period of [_____] hours of normal working time and start after the system is functionally complete but prior to final acceptance tests. Include discussion of the system design and layout and demonstrations of routine operation and maintenance procedures. This training includes: normal system operation and control; flow balancing; detection of a nonfunctioning system due to sensor, controller, and/or mechanical failure; filling, draining, and venting of the collector array; replacement of sensors, collectors, and collector components; collector cleaning and inspection for leaks; and heat exchanger cleaning and expansion tank charging if applicable. Submit [6] [_____]

copies of operation and [6] [_____] copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Manuals must be approved prior to the field training course. Detail the step-by-step procedures required for system filling, startup, operation, and shutdown in the operating manuals. Include the manufacturer's name, model number, service manual, parts list, and brief descriptions of all equipment and their basic operating features. List routine maintenance procedures, possible breakdowns and repairs, troubleshooting guides, piping and equipment layout, balanced fluid flow rates, and simplified wiring and control diagrams of the system as installed in the maintenance manuals.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-22 60 70 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-22 60 70 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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05/20

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-22 60 70 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-22 60 70 (May 2009)

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SECTION 22 60 70

GAS AND VACUUM SYSTEMS FOR HEALTHCARE FACILITIES

05/20

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NOTE: This specification covers the requirements for medical and dental gas, support and vacuum systems for healthcare facilities.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification covers healthcare facility dental and medical gas, support gas, and vacuum systems. This specification essentially implements the requirements of NFPA 99.

Show the following information on project drawings:

1. Only drawings (not specifications) should indicate capacity, efficiency, dimensions, details, plan view, sections, elevations, locations of fixtures and equipment, and space required for maintenance of equipment.

2. Configuration, slope, and location of each

piping system such as: above or below floors, above or below ceilings, above or below roofs, above or below ground.

3. Location of each sectionalizing valve.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a reference ID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11	(1992; Reaffirmed 2005) Specifications for Interior Installation of Cementitious Backer Units

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.50	(2021) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 6000 SERIES	(2021) Professional Qualification Standard for Medical Gas Systems Installers, Inspectors and Verifiers

AMERICAN WELDING SOCIETY (AWS)

AWS C3.8M/C3.8	(2011) Specification for the Ultrasonic Pulse-Echo Examination of Brazed Joints

ASTM INTERNATIONAL (ASTM)

ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B819	(2000; R 2011) Standard Specification for Seamless Copper Tube for Medical Gas Systems
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM E2129	(2024) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM F437	(2024) Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F439	(2024) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441/F441M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F493	(2022) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-4.1	(2009) Cleaning Equipment for Oxygen Service; 6th Edition

CGA M-1	(2018) Standard for Medical Gas Supply Systems at Health Care Facilities; 4th Edition
CGA V-5	(2019) Diameter-Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications); 6th Edition

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2024) International Plumbing Code

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems- Requirements
ISO 11143	(2008) Dentistry - Amalgam Separators

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA Z535.1	(2022) Safety Colors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 55	(2023; TIA 22-1; TIA 22-2; TIA 23-3; TIA 23-4) Compressed Gases and Cryogenic Fluids Codes
NFPA 99	(2024) Health Care Facilities Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.144	Safety Color Code for Marking Physical Hazards

UL SOLUTIONS (UL)

UL 508A	(2018; Reprint Jul 2022) UL Standard for Safety Industrial Control Panels

1.2 SYSTEM DESCRIPTION

****

NOTE:
1. Choice of Category 1, Category 2, or Category 3 gas, support, and vacuum systems is determined by issues involving patient dependency on the system for life, effect of system failure on patient outcomes, and other criteria as defined in NFPA 99.
2. In general, dental facilities (or dental areas within combined medical/dental facilities) utilize

Category 2 or Category 3 systems as defined in NFPA 99.
3. In general, medical facilities (or medical areas within combined medical/dental facilities) utilize Category 1 systems in patient care areas and Category 3 systems in non-patient care areas (Category 3 systems, if used, must be entirely separate from Category 1 systems).
4. Determine choice of Category 2 or Category 3 systems by performing and documenting a Risk Assessment as required by NFPA 99, Section 4.2. A Risk Assessment is not required for Category 1 systems.
****

a. Provide the following gas, support, and vacuum systems conforming to NFPA 99 Category 1 criteria: [oxygen (O),] [nitrous oxide (NO),] [medical compressed air (MA),] [NF-nitrogen (N),] [instrument compressed air (IA),] [laboratory compressed air (LA) supplied from IA source,] [process compressed air (PA) supplied from IA source,] [carbon dioxide (CO2),] [medical-surgical vacuum (MV),] [waste anesthesia gas disposal (WAGD)].

b. Provide the following gas, support, and vacuum systems conforming to NFPA 99 Category 2 criteria: [oxygen (O),] [nitrous oxide (NO),] [medical compressed air (MA),] [carbon dioxide (CO2),] [medical-surgical vacuum (MV),] [waste anesthesia gas disposal (WAGD),] [dental compressed air (DA),] [laboratory compressed air (LA),] [process compressed air (PA),] [NF-nitrogen (N),] [dental surgical vacuum (DSV),] [oral evacuation (OE),] [high-volume laboratory dust evacuation (LE)].

c. Provide the following gas, support, and vacuum systems conforming to NFPA 99 Category 3 criteria: [oxygen (O),] [nitrous oxide (NO),] [dental compressed air (DA),] [laboratory compressed air (LA),] [process compressed air (PA),] [NF-nitrogen (N),] [dental surgical vacuum (DSV),] [oral evacuation (OE),] [high-volume laboratory dust evacuation (LE)].

1.2.1 Design Requirements

1.2.1.1 Patient Care Systems

Oxygen (O), Medical Compressed Air (MA), Nitrous Oxide (NO), and Carbon Dioxide (CO2) systems intended for patient care must not be supplied to or used for any purpose other than patient care applications.

1.2.1.2 Dental Surgical Vacuum (DSV), Medical-Surgical Vacuum (MV), and Waste Anesthesia Gas Disposal (WAGD)

Systems are dry vacuum systems and must not be supplied to or used for any purpose other than patient care applications.

1.2.1.3 Oral Evacuation (OE)

System is a wet vacuum system and must not be supplied to or used for any purpose other than patient care applications.

1.2.1.4 Support Utilities

Nitrogen (N), Dental Compressed Air (DA), Instrument Compressed Air (IA), Laboratory Compressed Air (LA), and Process Compressed Air (PA) systems are support utilities and must not be supplied to or used for patient respiration applications.

1.2.1.5 High-volume Laboratory Dust Evacuation (LE)

System is a dry vacuum system, support utility and must not be supplied to or used for patient care applications.

[1.2.2 Sustainable Design Requirements

1.2.2.1 Environmental Data

****

NOTE: ASTM E2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products. This is optional for Army projects.

****

Submit Table 1 of ASTM E2129 for products provided under work of this Section the following products: [_____].

]1.2.3 Performance Requirements

a. Provide all labor, equipment and services necessary for and incidental to the installation of piped [dental gas, support, and vacuum systems] [and] [medical gas, support, and vacuum systems]. [Provide oxygen systems complete to the source valve, ready for connection to the bulk gas supply system.] Provide all systems complete, started, tested and ready for use.

b. Government Furnished Materials provided to the Contractor for installation under this section include initial supply of gases in cylinders or containers as appropriate for cylinder sources [_____] [,and initial supply of liquid oxygen].

c. Provide system delivery pressure as follows:

****

NOTE: Process compressed air is generally supplied in the 827-862 kPa 120-125 psi range. However, a lower pressure may be required by the using facility. Modify range only if approved by the using facility.

****

d.

Oxygen, medical compressed air, nitrous oxide, carbon dioxide	379 kPa 55 psi
Dental compressed air	621 kPa 90 psi

Nitrogen, instrument compressed air	1276 kPa 185 psi
Laboratory compressed air	345-379 kPa 50-55 psi
Process compressed air	827-862 kPa 120-125 psi

e. Provide system vacuum as follows:
f.

Dental surgical vacuum, medical-surgical vacuum	37 kPa 19 inches Hg vacuum
Dental oral evacuation	73 kPa 8 inches Hg vacuum
Waste anesthesia gas disposal	60 kPa 12 inches Hg vacuum
High-volume laboratory dust evacuation	91 kPa 3 inches Hg vacuum at separator
kPa is absolute inches Hg vacuum is gauge	

1.2.4 Accessibility of Equipment

****

NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when there is some control over locations. However, designers should not rely on it since enforcing this requirement in the field would be difficult. Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, and equipment requiring access, in locations freely accessible through access doors.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer Qualifications

Installer Qualifications

Inspector Qualifications

Verifier Qualifications

Inspection, Testing, and Verification Agency

Environmental Data; G, [_____]

SD-02 Shop Drawings

Dental Gas, Support and Vacuum Systems; G, [_____]

Medical Gas, Support and Vacuum Systems; G, [_____]

SD-03 Product Data

Bulk Liquid Oxygen (LOX) Source; G, [_____]

Emergency Oxygen Supply Connection; G, [_____]

Cylinder Manifold Supply Source; G, [_____]

Dental Compressed Air (DA) Source; G, [_____]

Dental Surgical Vacuum (DSV) Source; G, [_____]

Dental Oral Evacuation (OE) Source; G, [_____]

High-Volume Laboratory Dust Evacuation (LE) Source; G, [_____]

Medical Compressed Air (MA) Source; G, [_____]

Lab Compressed Air (LA) [and Process Compressed Air (PA)] Source; G, [_____]

Medical-Surgical Vacuum (MV) Source; G, [_____]

Waste Anesthesia Gas Disposal Vacuum (WAGD) Source; G, [_____]

Instrument Compressed Air (IA) Source; G, [_____]

Pipe and Fittings; G, [_____]
Valves and Assemblies; G, [_____]

Nitrogen and Instrument Compressed Air Control Panels; G, [_____]

Hangers and Supports; G, [_____]

Dental Gas and Support Systems Outlets and Vacuum Systems Inlets; G, [_____]

Medical Gas and Support Systems Outlets and Vacuum Systems Inlets; G, [_____]

Warning Systems; G, [_____]

Vibration-Absorbing Features; G, [_____]

SD-06 Test Reports

Test Reports

SD-07 Certificates

Station Outlets/Inlets

SD-10 Operation and Maintenance Data

Dental Gas, Support, and Vacuum Systems; G, [_____]

Medical Gas, Support, and Vacuum Systems; G, [_____]

Maintenance Data Package; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Manufacturer Qualifications

Manufacturers must be regularly engaging in the manufacturing, supplying, and servicing of specified products and equipment, as well as, providing engineering services, for gas and vacuum systems for healthcare facilities. Provide evidence demonstrating compliance for a minimum of 5 years, and on 5 projects of similar complexity.

1.4.2 Installer Qualifications

a. [Dental gas, support, and vacuum systems] [and] [Medical gas, support, and vacuum systems] must be installed only by Certified Medical Gas Installers. Installer ASSE 6000 SERIES (Standard #6010 Medical Gas System Installer) certification card must be issued within the previous 36 months and Installers certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 32-hour training course including a written and a practical examination covering all facets of ASSE 6000 SERIES Standard #6010, NFPA 99, and NFPA 55. Course instruction must have been conducted by a Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Instructors). The installer must have a minimum of four (4) years of documented practical experience in the installation of medical gas and vacuum piping systems.

[b. Dental oral evacuation systems must be installed only by contractors/tradespersons who have at least 5 years experience installing central oral evacuation systems for dental operatories.]

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NOTE: Include following if bulk liquid oxygen source is included in project.

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[c. Bulk liquid oxygen systems must be installed only by Certified Bulk Medical Gas System Installer. Installer ASSE 6000 SERIES (Standard #6015 Bulk Medical gas Systems Installers) certification card must be issued within the previous 36 months and Installers certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 32-hour training course including a written and a practical examination covering their firm's standard operating procedures as they relate to bulk installations for medical gases, the FDA CGMP Regulation 21 CFR, Parts 210 and 211, CGA M-1, applicable sections of the ASSE 6000 SERIES Standard #6015), NFPA 99, and NFPA 55. Course instruction must be conducted by a Bulk Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Systems Instructors). The bulk system installer must have a minimum of four (4) years of documented practical experience in the installation of bulk systems.]

1.4.3 Agency Qualifications

Retained by the general contractor, but independent of the facility, installing contractor, and product manufacturer(s). [The Government will provide [Certified Medical Gas System Inspectors] [and] [Certified Medical Gas System Verifiers] [in addition to the [Certified Medical Gas System Inspectors] [and] [Certified Medical Gas System Verifiers] retained by the general contractor].]

1.4.3.1 Inspector qualifications

Systems must be inspected only by Certified Medical Gas System Inspectors. Inspector ASSE 6000 SERIES (Standard #6020 Medical Gas Systems Inspectors) certification card must be issued within the previous 36 months and Inspectors certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 24-hour training course including a written and a practical examination covering all facets of ASSE 6000 SERIES (Standard #6020), NFPA 99, NFPA 55. Course instruction must be conducted by a Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Systems Instructors). Certification to ASSE 6000 SERIES (Standard # 6030 Medical Gas Systems Verifier) meets the requirements of this section. The inspector must have a minimum of four (4) years of documented practical experience in the inspection of medical gas and vacuum systems. [Certified Medical Gas System Inspectors will be retained by the general contractor, independent of Certified Medical Gas System Verifiers.]

1.4.3.2 Verifier qualifications

Systems must be verified only by Certified Medical Gas System Verifiers. Verifier ASSE 6000 SERIES (Standard #6030 Medical Gas System Verifiers) certification card must be issued within the previous 36 months and verifiers certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 32-hour training course including a written and a practical examination covering all facets of ASSE 6000 SERIES Standard #6030, NFPA 99, NFPA 55 and CGA M-1. Course instruction must be conducted by a Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Systems Instructors). The verifier must have a minimum of four (4) years of documented practical experience in the verification of medical gas and vacuum systems. The verifier must have a current certificate of insurance, in the individual's name or employing verification company for general liability, and professional liability insurance. [Certified Medical Gas System Verifiers will be retained by the general contractor, independent of Certified Medical Gas System Inspectors.]

1.4.4 Certifying Agency Qualifications

Agency must be an American National Standards Institute accredited certifier. Agency is responsible for testing and certifying individuals in compliance with ASSE 6000 SERIES Standards. Provide installer, inspector, and verifier certifications by one of the following agencies or by an agency with comparable qualifications:

a. Medical Gas Professional Healthcare Organization (MGPHO).

b. National Inspection, Testing and Certification Corporation (NITC), Los Angeles, California.

1.4.5 Regulatory Requirements

1.4.5.1 Standards

The Standards for design, materials, installation, and testing of gas and vacuum systems for healthcare facilities:

a. National Fire Protection Association Standard for Health Care Facilities: NFPA 99.

[b. National Fire Protection Association Standard for Storage, use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks: NFPA 55.]

c. Interpret reference to the "Authority Having Jurisdiction" to mean the "Contracting Officer." For Government owned property, interpret references to the "owner" to mean the "Contracting Officer." For leased facilities, interpret references to the "owner" to mean the "lessor." Interpret references to the "permit holder" to mean the "Contractor."

d. The provisions of Chapter 1, "Administration" in NFPA 99 [and NFPA 55] do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project.

1.4.5.2 Referenced Publications

In each of the publications referred to herein, interpret references to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.5.3 Alternative Qualifications

Products having less than a three-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.5.4 Service Support

Provide equipment items supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract. Provide Maintenance Data Package [1] [2] [3] [4] [5]. Submit manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4.6 Shop Drawings

Submit detailed Shop Drawings for the complete systems including piping layouts and location of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams; and wiring diagrams or connection and interconnection diagrams. Indicate clearances required for maintenance and operation on detail drawings. Where piping and equipment are to be supported other than as indicated, include loadings and proposed support method. Draw all plans, elevations, views, and details to scale.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver equipment and parts to site factory cleaned and processed in their original factory sealed package ready for installation. Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

****

NOTE: Coordinate Article "Commissioning" and related paragraphs below with the project-specific requirements specified in Section 01 91 00.15 or , BUILDING COMMISSIONING; revise as required.

****

1.6 COMMISSIONING

Refer to Section 01 91 00.15 BUILDING COMMISSIONING for requirements

1.6.1 Inspection, Testing, and Verification Agency

****

NOTE: If project does not have a CxC, Commissioning Specialist, delete references to "Project CxC, Commissioning Specialist."

****

Commissioning must include retaining the Inspection, Testing, and Verification Agency prior to commencement of the installation of these systems. Coordinate scope of work with that of the [Project CxC, Commissioning Specialist] [and] [Project CxG, Government Commissioning Specialist] and function in coordination with, not in lieu of, the [Project CxC, Commissioning Specialist] [and] [Project CxG, Government Commissioning Specialist].

1.6.2 Responsibilities

The Inspection, Testing, and Verification Agencies responsibilities include:

a. Review of the project drawings and specifications and providing comments and additional clarification(s), as needed, to the Contracting Officer and the Designer of Record.

b. Witnessing by the Contracting Officer and a certified inspector or certified verifier of the brazing of a minimum of two joints (one vertical and one horizontal) by each brazer assigned to the project. Evaluation of adequacy of the brazed joints must be in accordance with NFPA 99 through observation of the brazing techniques, and by destructive methods (sectioning of the joint). This is required of all brazers utilized throughout the duration of the project. Brazing of project materials is not permitted until the brazer qualifications, and the adequacy of their joints have been determined to be acceptable.

c. Review and comment on the compliance of the project submittals required under "SUBMITTALS" and the specified items. Review must be concurrent with the review being performed by the designated representative of the Government.

d. Performing site observation visits prior to 1) backfilling exterior or interior below grade piping, 2) concealing above ceiling piping, and 3) concealing in wall piping. Conduct site observation visits by a certified inspector or certified verifier. Provide for each visit a written report stating progress of installation and any deficiencies needing corrective action.

e. Review of revisions/substitutions relating to the Contract Documents and/or the Project Commissioning Plan.

f. Coordination with the [Project CxC, Commissioning Specialist] [and] [Project CxG, Government Commissioning Specialist] in establishing a commissioning plan for components specific to the systems specified herein.

g. Coordination with the [Project CxC, Commissioning Specialist] [and]

[Project CxG, Government Commissioning Specialist] of the equipment start-up, and the system testing and verification procedures required by this specification.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products, essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening, and have been in satisfactory commercial or industrial use for 3 years prior to bid opening. The 3-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 3 year period. Submit manufacturer's catalog data with highlighting to show features such as model, size, and options that are intended for consideration. Provide adequate data to demonstrate compliance with contract requirements.

2.2 MANUFACTURER'S NAMEPLATE

Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

[2.3 BULK LIQUID OXYGEN (LOX) SOURCE

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NOTE: Bulk liquid oxygen systems are usually leased from a gas supplier by the user, and the tank, vaporizer(s), and associated appurtenances are not part of the project contract. Include the following and modify as required.

****

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with LOX tank, source shutoff, valves, vaporizer(s), and other components required by the Regulatory Requirements, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

]2.4 EMERGENCY OXYGEN SUPPLY CONNECTION

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NOTE: Emergency oxygen supply connection is required only on Category 1 systems where supply is remote from building. Coordinate location with building and site elements to assure accessibility.

****

Provide complete factory-packaged system including but not limited to enclosure, oxygen inlet, pressure gauge, 25 mm 1 inch shutoff valve, relief valve, and check valves. Provide lockable, weather tight enclosure for mounting on exterior of building. Provide [recessed] [surface mounted] enclosure. Provide check valves for main and emergency oxygen lines.

[2.5 CYLINDER MANIFOLD SUPPLY SOURCE

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NOTE: Coordinate manifold locations and power requirements with Division 26-Electrical.
****

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with control panel, source shutoff, isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system. Provide each source with the quantity of cylinder connections as indicated, but no less than two cylinders on each side of manifold.

a. Design the cylinder supply source so that when the switchover from the primary cylinders to the secondary cylinders occurs, there will be no drop or fluctuation in the line pressure. Provide control cabinet with a visual signal to indicate switchover from the primary to the secondary supply. Resetting of the control unit must be accomplished automatically. Provide with a bronze-bodied poppet-type pressure-relief adjusted to relieve at 50 percent above maximum working pressure. Equip with an approved pressure switch for actuating a warning signal when, or before, the secondary bank goes into operation. Locate control valve within a cabinet designed to prevent tampering by unauthorized personnel. One bank of cylinders must be in service while the other bank is in reserve. Equip each bank with a master regulator and a gauge for 28 MPa 4,000 psi or greater cylinder-contents pressure. Provide fully automatic switching from the empty bank of cylinders to the full bank of cylinders without resetting regulators.

b. Provide cylinder supply source as follows:

    (1) Oxygen (O): Provide for [_____] primary and [_____] secondary cylinders, Item a).

    (2) Nitrogen (N): Provide for [_____] primary and [_____] secondary cylinders. Item a).

****
NOTE: Locate nitrous oxide supply where it will not be exposed to freezing temperatures. Consult manufacturer's literature for details.
****

    (3) Nitrous oxide (NO)

        (a) Provide for [_____] primary and [_____] secondary cylinders.

****
NOTE: Coordinate requirements of heated supply with electrical engineer. Connect to emergency electrical power.
****

        (b) Provide heated supply to prevent ice build-up during high demand.

(4) [(4) Carbon dioxide (CO2)

(a) Provide for [_____] primary and [_____] secondary cylinders.

****

NOTE: Coordinate requirements of heated supply with electrical engineer. Connect to emergency electrical power.

****

(b) Provide heated supply to prevent ice build-up during high demand.]

][2.6 DENTAL COMPRESSED AIR (DA) SOURCE

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NOTE: Dental compressed air source can serve as dental laboratory compressed air source.

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a. Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with air compressors, receiver, dryers, filters, control panel, source shutoff, compressor isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

b. Provide air compressors manufactured to comply with UL listing requirements. Provide air compressors with manufacturer's name and address, together with trade name and catalog number, on a nameplate securely attached to the equipment. Provide guards to shield exposed moving parts. Provide an intake air filter and silencer with each compressor. Provide aftercooler and moisture separator between compressors and air receivers, to remove moisture before the air enters the receiver. Provide air cooled aftercoolers. The air must pass through a sufficient number of tubes to affect cooling. Provide tubes sized to give maximum heat transfer. Size cooling capacity of the aftercooler for the total capacity of the compressors.

2.6.1 Air Compressors

Provide [scroll type compressors] [reciprocating teflon-ring type compressors designed such that no oil is administered to the air cylinder, the portion of the piston rod that travels in the crankcase section does not travel in any portion of the air-cylinder section, and with provision to prevent the flow of lubrication oil along the piston rod into the air-cylinder section]. Provide a pressure gauge calibrated to 2068 kPa 300 psi, and equipped with a gauge cock and pulsation dampener for installation adjacent to the pressure switch. Provide motors and compressors directly connected or operated by V-belt drive. Provide compressors sequenced to start automatically when the pressure drops to a preset point. Provide air cooled compressors. Provide each compressor chamber with a high-temperature sensor to activate a local alarm. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 3600 RPM.

2.6.2 Air Receiver

Provide air receiver delivering air to dental operatories designed for 1034 kPa 150 psi working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to pressure gauge, sight glass, and automatic and manual drains. Provide receiver with galvanized or supplied with factory applied commercial enamel finish exterior. Provide the interior of the receiver with a factory applied vinyl lining. Provide a display of the ASME seal on the receiver, or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.6.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each compressor for selection of normal operation (automatic alternation) or manual selection of lead and lag compressors. Provide automatic alternation of compressors based on a first-on/first-off principle with provisions for simultaneous operation. The lag compressor must be able to start automatically if the lead compressor fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any compressor in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each compressor. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide pressure control switches or pressure transducer. Provide integral PLC controller for automatically switching operating sequence of compressors. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, pump maintenance intervals, compressor performance warnings, average system air demand, average dewpoint and CO levels on system, compressors on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag compressor In Use.

b. High discharge temperature.

c. High carbon monoxide levels.

2.6.4 Desiccant Air Dryers

Provide two identical twin-tower heatless desiccant air dryers. Provide dryers to achieve a pressure dewpoint minus 40 degrees C minus 40 degrees F at the maximum calculated NFPA system capacity. Provide lubricant free operation. Provide economizer cycle that reduces purge air requirements to match actual moisture loading. Provide solid-state cycle timer, OSHA purge exhaust mufflers, and a pressure gauge for each tower.

2.6.5 Filtration and Pressure Reducing Station

Provide two pre-filters rated 0.01 micron filtration with an efficiency of 99.9999 percent D.O.P. (Validated), two activated carbon filters, and two 1 micron final filters with an efficiency 99.9999 percent D.O.P. (Validated) installed downstream of the carbon filters. Provide all filters with a differential pressure gauge with color change indicator and automatic drain valve except the activated carbon filters. Provide downstream of the final filters a dual-line pressure regulating assembly consisting of two pressure regulators with pressure gauges, inlet and outlet isolation ball valves, and pressure relief valves. Arrange all filters/pressure regulators so that the isolation of one filter/ regulator will not affect the operation of the second filter/regulator.

2.6.6 Dew Point Monitor

Provide dew point monitor to continuously monitor the dew point of the dental compressed air. Provide ceramic type (aluminum oxide type is not acceptable) sensor with system accuracy of plus or minus 1 degree C 2 degrees F. Provide dew point alarm factory set at 2 degrees C 36 degrees F and be field adjustable. Provide activation of local alarm and all master alarms when the dew point at system pressure exceeds plus 4 degrees C 39 degrees F. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor in conformance with NFPA 99.

2.6.7 Carbon Monoxide Monitor

Provide carbon monoxide monitor to continuously monitor the dental compressed air for carbon monoxide and to actuate a local alarm if the carbon monoxide level is 10 ppm or higher. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor in conformance with NFPA 99.

][2.7 DENTAL SURGICAL VACUUM (DSV) SOURCE

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NOTE: Dental Surgical Vacuum was previously designated as Dental High Vacuum (DHV).

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Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, receiver, control panel, source shutoff, pump isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide sources with single-point connections to power wiring, warning system wiring, and piping system.

2.7.1 Vacuum Pumps

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NOTE: Water sealed liquid ring vacuum pumps should generally not be used. If used then they must fully meet the water conserving features outlined within.

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Provide [non-lubricated rotary] [non-contacting dry claw] [recirculating water sealed liquid ring] vacuum pumps. Mount each pump and its motor on modular skids in a horizontal or vertical configuration with coupling and guard. Provide tank mounted pumps and motors for small systems. Provide shutoff valve on each pump inlet. Provide vacuum gauge at each pump inlet.

[a. Provide completely dry non-lubricated rotary vane pumps equipped with self-lubricating carbon/graphite vanes. Provide lubricated and sealed bearings. No oil is permitted in any pump. Provide each pump completely air-cooled and having absolutely no water requirement. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.]

[b. Provide non-contacting dry claw style rotary pumps. Internal construction must be friction free and the rotors must be non-contacting. Provide oil free air end and requiring no sealants. Provide air cooled and continuous duty rated pumps. Provide each pump with a single lubricated gearbox requiring oil change not more often than 5,000 operating hours. Provide each pump with an exhaust silencer. Equip the pumps with high vacuum shutdown, high temperature shutdown, and alarm. Provide lubricants inert with oxygen. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, TEFC motor with 1.15 service factor, and maximum of 3500 RPM.]

[c. Provide oil-free, single-stage positive displacement, and non-pulsating recirculating water sealed liquid ring type pumps. Provide pumps with mechanical seals. Provide pumps of all iron construction with a bronze or stainless rotor and carbon steel shaft. Under normal operation, system must minimize fresh seal water required to 0.05 L/s 0.75 gpm. Provide system with reservoir of sufficient size for up to 48 hours operation without fresh water supply. Equip each pump with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide totally self contained system. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.]

2.7.2 Vacuum Receiver

Provide receiver designed for 1034 kPa 150 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to vacuum gauge, sight glass, and automatic and manual drains. Provide receiver with galvanized or factory applied commercial enamel finish exterior. Provide interior of the receiver with a factory applied vinyl lining. Provide a display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.7.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use

b. System Malfunction

][2.8 DENTAL ORAL EVACUATION (OE) SOURCE

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, separator(s), control panel, source shutoff, pump isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

2.8.1 Vacuum Pumps

Provide [turbine] [oil-lubricated rotary-vane] [regenerative blower] vacuum pumps. Connect pumps in parallel to the central wet separator tanks.

[2.8.1.1 Turbines

Provide self-governing, multistage, centrifugal type turbines of overhung or outboard design. The vacuum pumps must operate at a speed not to exceed 3,600 rpm and connected to its driving motor by a flexible coupling. Provide sealed or lubricatable type bearings. Provide a fan connected directly to the vacuum pump shaft adjacent to vacuum pump shaft bearings to create a flow of ambient air over the bearing carrier while the unit is operating. Provide a steel coupling guard encompassing the flexible coupling between the motor and vacuum pump. Cases must be cylindrical in design. Provide cases and end plates (inlet and exhaust heads included) constructed of either heavy-gauge sheet steel rigidly welded at seams and sections, or of cast grey iron. Provide either concave or convex sheet steel end plates. Inlet and exhaust connections must be tangential to the vacuum pump except the inlet connection can be axial to vacuum pump and sized to allow free air movement through the vacuum pump, without flow restriction and have class 150 flanges. Provide vacuum pump input with an adjustable volume control valve, a directional flow valve and antisurge valve. Provide vacuum pump output with an exhaust silencer. Connect plumbing to the vacuum pump through flexible sleeve connectors. Construct internal moving parts with not less than 3 mm 0.125 inch clearance throughout to prevent damage by transient particulates. Construct impellers of fabricated sheet metal or high-tensile aluminum alloy, smooth on all surfaces to prevent imbalance by uneven dust deposits. Provide impellers of the backward curved or radial design to provide optimal performance over a wide range of volume requirements. Securely attach impellers to the vacuum pump shaft by set screws or clamps of high-tensile material. Provide individually balanced impellers. The complete assembly, with motor, must not exceed 0.038 mm 1.5 mils of vibration when given a running test. Power to operate the vacuum pump must be in direct proportion to the volume of air exhausted and must not exceed the normal motor rating. The vacuum produced must be substantially constant throughout the operating range of the vacuum pump. Provide continuous duty NEMA MG 1, 3500 RPM maximum, T-frame, dripproof design motor with either sealed or lubricatable bearings. Operating temperature rise of the motor must not exceed 22 degrees C 72 degrees F. Mount each vacuum pump assembly on resilient isolator pads as recommended by the manufacturer. Do not fasten pads to the facility floor.

][2.8.1.2 Rotary-Vane Vacuum Pump

Provide low speed, positive displacement, oil lubricated rotary-vane vacuum pumps with separate, standard NEMA frame size, high efficiency motors. Provide automatic lubrication of moving pump parts by an oiling system not dependent on moving parts and operated only by gravity and vacuum. Provide vacuum pump constructed to provide protection against ingesting particulates larger than 15 µ into pump, operating with insufficient lubrication, and water contamination of oil. Provide electrical overload by thermal sensors built into single phase motors or thermal sensors built into three phase motor starters; three phase motor starters additionally protected against single phasing. Provide continuous duty, NEMA rated, C-face, TEFC motor with 1.15 service factor, and maximum of 1800 RPM.

][2.8.1.3 Regenerative Blower

Provide regenerative blower consisting of one impeller, mounted directly on the motor shaft. Provide precision cast aluminum impeller with multiple radial blades at its periphery. The impeller must be the only moving part, and must not require any lubrication. Dynamically balance the impeller to provide vibration-free operation without the need for vibration isolators. Install the impeller between the blower housing and cover. Provide housing and cover of cast aluminum and provided with multiple heat-dissipating fins. There must be no metal-to-metal contact within the blower housing. Oil lubrication must not be required, providing oil free discharge gas. The heat-dissipating fins must efficiently minimize heating of the compressed gas. Provide blower with a guaranteed ultimate vacuum of 60 kPa 12 inches Hg vacuum. Provide motor supported by outboard mounted, grease lubricated, anti-friction bearings. The bearings must be located outside of the compression chamber to maximize operating efficiency and bearing life. Provide bearing housing conservatively loaded and rated for an L(10) life of not less than 200,000 hours. Provide shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11. Provide a lip seal to minimize leakage where the motor shaft passes through the blower housing. Blower producing noise levels must not exceed 75 dBA. Additional silencers may be installed to further reduce the noise level. Provide continuous duty NEMA rated, TEFC motor with 1.15 service factor, and maximum of 3600 RPM. Provide direct driven blowers. Provide blower manufactured in accordance with ISO 9001 and UL listed. Provide each blower module with a separator with check valve, flex connector, isolation valve, and a relief valve. Provide control panel mounted vacuum pump control switches and set as follows:

a. Lead Pump: Continuous Operation

b. Lag Pump Start: 84 kPa 5 inches Hg vacuum

c. Lag Pump Stop: 73 kPa 8 inches Hg vacuum

]2.8.2 Pipe Isolators

Provide flexible, resilient band-sealed (clamped) sleeves furnished to isolate the vacuum pump from associated piping. Size sleeve couplings in accordance with the exhauster intake and output connections. Provide pipe isolators with steel coupling guards.

2.8.3 Valves

2.8.3.1 Volume Control Valve

Provide the input of each vacuum pump with an adjustable air volume control valve to prevent accidental vacuum pump overload and to provide a means of adjusting the upper design capacity limit. Provide volume control valve built in or immediately adjacent to the first or input stage of the vacuum pump and preset by the manufacturer during certification procedure. Provide butterfly type valve with cast iron body with corrosive resistant internals.

2.8.3.2 Antisurge Valve

Provide the input of each vacuum pump with an antisurge valve that will operate proportionally and automatically throughout the vacuum pump's designed range. This valve must continually sense the motor current and maintain a predetermined operational level of volume by proportionally bleeding air into the system. Equip valve with a silencer to attenuate air noise to 85 dBA or below. Install the valve in, on, or near the first stage of the vacuum pump mounted in conjunction with the directional flow valve.

2.8.3.3 Directional Flow Valve

Provide the input of each vacuum pump with a directional flow valve to prevent back flow of air through the shutdown. Provide cast iron directional flow valve with corrosive resistant internals.

2.8.4 Exhaust Silencer

Provide each vacuum pump exhaust with a separate air discharge silencer of the open-bore expansion type. No interior baffling or shrouding is permitted. Provide silencer to attenuate air noise to 85 dBA or less.

2.8.5 Control Panel

[Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation.

The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use

b. System Malfunction]

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NOTE: NOTE: Use control panel article below when basis of design product is similar to RAMVAC OWL Touch series.

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[Provide vacuum pump systems with microprocessor master control panel in a NEMA 250 Type 12 enclosure. Provide controls connections for vacuum pressure switch, oral evacuation remote control panel, and each individual vacuum pump controller to microprocessor. Microprocessor must provide for selection of normal operation (automatic alternation) or manual selection of lead, lag, and follow vacuum pumps. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide a magnetic motor starter with integral overload and short circuit protection, with lockable disconnecting means at each vacuum pump. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with a single point power feed connection to each vacuum pump. Provide control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide contacts to transmit system on/off status to the facility building management system to enable the separator tank liquid level control sequence. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel and the facility building management system if one or more local alarms are activated. Provide the master control panel with a remote control panel with visual indication of start/stop status located in the reception area adjacent to the master alarm and area alarm panels. Provide the master control panel with integrated controls for automatic actuation of the accumulator tank auto-wash system during off hours. For each vacuum pump system, provide the following alarms at the master alarm panel:

a. Lag vacuum pump In Use

b. System Malfunction]

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NOTE: Provide Central Wet Separators with automatic washdown feature in facilities with more than 10 dental chairs.

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2.8.6 Central Wet Separators

Provide the oral evacuation system with central wet separators. Provide separator tanks constructed of a nonmetallic, noncorrosive, inert material or composite such as glass-reinforced plastic (GRP). Provide freestanding tanks of one-piece construction, with smooth, interior walls. Tanks must be high-pressure vessels able to withstand a constant negative pressure of 51 kPa 15 inches Hg vacuum. Provide convex tank bottoms with drain at the apex of convexity. Provide separator tanks equipped with mechanical overflow protection. [Provide preplumbed with a 360 degree nozzle internal washdown system with timer. Provide washdown system with a 120 VAC automatic-flush, clock-controlled mechanism to provide a complete washdown of the interior of the separator at any predetermined time of day or night. Provide washdown time adjustable for up to at least 3 minutes. Locate timers in the main electric control panel. Equip the cold water supply to the automatic tank flush unit with an in-line filter with 40-mesh stainless steel screens. Filter must be supplied as part of the oral evacuation system.] Equip each separator tank with an electronic high-low liquid level sensor which must perform as the primary overfill protector. In multiple-tank installations, one tank must be adjusted to sense 90 percent of its capacity and the other tank 100 percent of its capacity via the liquid-level sensing devices. Each sensor must control a 120 volt ac electrically operated output air solenoid valve located to control the outgoing air from the tank to the vacuum pump. Equip each tank with a gate and swing type check valves at the bottom drain. With negative pressure in the tank, the check valve must remain closed to maintain vacuum. When negative pressure ceases, either by vacuum pump shutdown or by closure of the outgoing air solenoid control by the liquid level sensor, the check valve must open and the tank will undergo gravity drain.

2.8.7 Vacuum Relief Valve

Provide vacuum relief valve. The valve must operate automatically. Equip the valve with a silencer to attenuate air noise to 85 dBA or below.

2.8.8 Amalgam Separator

Provide amalgam separator consisting of a sedimentation collection chamber that is removable. Separation process must be sedimentation which may be supplemented with filtration, and/or ion exchange. Provide unit compatible for use on wet and dry vacuum systems. Provide wall or floor mounted assembly. Provide minimum 40 mm 1-1/2 inch inlet and outlet connection. Unit must be ISO 11143 Certified and have a minimum of 99 percent removal efficiency.

][2.9 HIGH-VOLUME LABORATORY DUST EVACUATION (LE) SOURCE

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NOTE: The high-volume laboratory dust evacuation system (LE) is an independent vacuum system specifically designed for scavenging, collecting, and filtering of grinding and polishing particulates generated in the dental/medical laboratory. This system was previously designated LDE.

****

a. Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, receiver, control panel, source shutoff, pump isolation valves and other components as indicated, required by the Standards, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

b. Provide laboratory dust evacuation systems of standard manufactured products, complete with devices normally furnished and devices required herein. Provide laboratory dust evacuation system by an established manufacturer of commercially available industrial quality vacuum system. Provide a dry system for collection of dust and grinding particulates. Provide one vacuum pump, except for area laboratory (ADL) application, and a dry, cyclonic, filtered separator.

2.9.1 Vacuum Pumps

Provide self-governing, multistage, centrifugal type turbines of overhung or outboard design. The vacuum pump must operate at a speed not to exceed 3600 RPM. Provide vacuum pump connected to its drive motor by multiple V-belts. The vacuum pump shaft must have a minimum of two radial bearings and at least one support bracket. Provide permanently-lubricated sealed or lubricatable type bearings. Fasten the vacuum pump/connector/drive motor assembly to a plate or frame structure. Power to operate the exhauster at the calculated design load must not exceed the normal motor rating. Power required must be in direct proportion to the volume of air exhausted. The vacuum produced must be substantially constant throughout the design operating range of the exhauster. Vacuum pump cases must be cylindrical in design. Provide cases and end plates constructed of either heavy-gauge sheet steel rigidly welded at seams or sections, or of cast grey iron. Provide either concave or convex sheet steel end plates for flex resistance. Inlet connections may be axially or tangentially placed. Exhaust connections may be tangential to the casing. Provide inlet and outlet connections sized to allow free air movement through the vacuum pump, without flow restrictions. Provide vacuum pump with an adjustable volume control device in, on, or adjacent to the first stage of the input and an exhaust silencer on the output. Provide flexible sleeve connectors for silencer and all plumbing connections to the vacuum. Internal moving parts of the vacuum pump must be constructed with not less than 3 mm 1/8 inch clearance throughout to prevent damage by transient particulates. Construct impellers of built-up sheet or high tensile composites. Impellers must be of the backward curved design. Securely attach impellers to the exhauster shaft by set screws or clamps of high-tensile material.

Provide individually balanced impellers. The complete assembly with motor, must not exceed 0.038 mm 1-1/2 mils of vibration when given a running test. The vacuum pump must be sized to produce the designated performance standards at the above-sea-level elevation of the proposed installation site, and be certified by the manufacturer by equipment tag or plate, or by letter of certification identifying the turbo-exhauster by serial number.

2.9.2 Motor

Provide continuous duty NEMA MG 1, 3500 RPM maximum, T-frame, dripproof design motor with either sealed or lubricatable bearings. Operating temperature rise of the motor must not exceed 22 degrees C 72 degrees F.

2.9.3 Isolation Pads

Mount vacuum pump assembly on resilient isolator pads as recommended by the manufacturer. Do not fasten pads to the facility floor. Vibration transmission must be limited to less than 5 percent of the lowest frequency of vibration.

2.9.4 Pipe Isolators

Provide flexible, resilient clamped sleeves furnished to isolate the vacuum pump from associated plumbing. Sleeve couplings must be sized in accordance with the exhauster intake and output connections. Provide pipe isolators with steel coupling guards.

2.9.5 Volume Control Device

Provide input of the vacuum pump with an adjustable air volume control device to prevent accidental overload and to provide a means of adjusting the upper design capacity limit. The volume control device may be built-in or immediately adjacent to the first or input stage of the exhauster and preset by the manufacturer during the certification procedure.

2.9.6 Exhaust Silencer

The vacuum pump must output to an air discharge silencer of the open-bore expansion type. No interior baffling or shrouding will be permitted. Provide silencer to attenuate air noise to 85 dBA or less.

2.9.7 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use.

2.9.8 Central Separator

Provide freestanding central separator of heavy-gauge steel and all-welded construction. Provide cyclonic type separator chamber and must effectively separate and trap all particulate matter contained in the vacuum input. The internal configuration of the separator must be such that air leaving the cyclonic chamber be directed upward through filter bags to effect final cleaning of the air before its entry into the vacuum pump. The lower part of the separator enclosure must contain an easily accessible and serviceable debris container. The container must lock into operating position to form a positive seal between the removable container and the separator enclosure. Provide removable debris container, reinstallable without the use of tools. Equip the container with casters to facilitate moving for emptying and reinstallation alignment and a pivoting handle to facilitate handling. Equip the separator with a filter-shaker mechanism actuated by an electric motor operating through mechanical linkage to the shaker mechanism. Provide an electrical switch to control the shaker motor on or adjacent to the separator. Provide the separator equipped with an easily removed screw- or bolt-fastened access panel to provide easy access for filter inspection and service.

2.9.9 Primary Separator

When necessary to satisfy specific design requirements, a primary separator must be used in addition to, and ahead of, the central separator. The primary separator must be of the cyclonic type and provide for initial separation of abrasive particulates before vacuum air and debris enter the central separator. Provide primary separator of heavy-gauge steel, all welded-seam construction, and may be freestanding or wall-mounted.

2.9.10 Air Volume Relief Valve

Provide mechanically operated air volume relief valve, requiring no electrical power. The valve must operate automatically, sensing negative pressure in the system and opening and closing proportionately to maintain designed air capacity to the vacuum pump regardless of the number of inlets online. Equip the valve with a silencer to attenuate air noise to 85 dBA or less.

2.9.11 Vacuum Inlets

User inlets for technicians' benches must be 32 mm 1-1/4 inches ID and for fixed-equipment locations, 40 mm 1-1/2 inches ID, with removable friction fit adapters sized to receive 80 mm 3 inch ID flexible hose. Adapters must provide an airtight seal when inserted into the vacuum inlet. Provide inlets with attached pivot or hinge-mounted doors. When closed, the doors must provide an airtight seal to close off the vacuum inlet; when open, they must not interfere with insertion of the adapters with 80 mm 3 inch ID hose attached.

]2.10 MEDICAL COMPRESSED AIR (MA) SOURCE

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with air compressors, receiver, dryers, filters, control panel, source shutoff, compressor isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system. Tank-mounted air compressors must be manufactured to comply with UL listing requirements. Provide air compressors with manufacturer's name and address, together with trade name and catalog number, on a nameplate securely attached to the equipment. Provide guards to shield exposed moving parts. Provide an intake air filter and silencer with each compressor. Provide aftercooler and moisture separator installed between compressors and air receivers, to remove moisture before the air enters the receiver. Provide air cooled aftercoolers. The air must pass through a sufficient number of tubes to affect cooling. Provide tubes sized to provide maximum heat transfer. Cooling capacity of the aftercooler must be sized for the total capacity of the compressors.

2.10.1 Air Compressors

Provide [scroll type compressors] [reciprocating teflon-ring type compressors designed such that no oil is administered to the air cylinder, the portion of the piston rod that travels in the crankcase section does not travel in any portion of the air-cylinder section, and with provision to prevent the flow of lubrication oil along the piston rod into the air-cylinder section]. Provide a pressure gauge calibrated to 2068 kPa 300 psi, and equipped with a gauge cock and pulsation dampener for installation adjacent to the pressure switch. Provide motors and compressors directly connected or operated by V-belt drive. Compressors must be sequenced to start automatically when the pressure drops to a preset point. Provide air cooled compressors. Provide each compressor chamber with a high-temperature sensor to activate a local alarm. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 3600 RPM.

2.10.2 Air Receiver

Provide receiver designed for 1034 kPa 150 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to pressure gauge, sight glass, and automatic and manual drains. Provide receiver with galvanized or factory applied commercial enamel exterior finish. Provide the receiver with factory applied vinyl lining interior. Provide a display of the ASME seal on the receiver, or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.10.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each compressor for selection of normal operation (automatic alternation) or manual selection of lead and lag compressors. Provide automatic alternation of compressors based on a first-on/first-off principle with provisions for simultaneous operation. The lag compressor must be able to start automatically if the lead compressor fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any compressor in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each compressor. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide pressure control switches or pressure transducer. Provide integral PLC controller for automatically switching operating sequence of compressors. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, pump maintenance intervals, compressor performance warnings, average system air demand, average dewpoint and CO levels on system, compressors on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag compressor In Use.

b. High discharge temperature.

c. High carbon monoxide levels.

d. High dewpoint level.

2.10.4 Desiccant Air Dryers

Provide two identical twin-tower heatless desiccant air dryers. Provide dryers sized to achieve a pressure dewpoint minus 40 degrees C minus 40 degrees F at the maximum calculated NFPA system capacity. Provide lubricant free operation. Provide economizer cycle that reduces purge air requirements to match actual moisture loading. Provide solid-state cycle timer, OSHA purge exhaust mufflers, and a pressure gauge for each tower.

2.10.5 Filtration and Pressure Reducing Station

Provide two pre-filters rated 0.01 micron filtration with an efficiency exceeding 99.9999 percent D.O.P. (Validated), two activated carbon filters, and two 1 micron filters with an efficiency exceeding 99.9999 percent D.O.P. (Validated) installed downstream of the carbon filters. Provide all filters with a differential pressure gauge with color change indicator and automatic drain valve except the activated carbon filters. Provide downstream of the final filters a dual-line pressure regulating assembly consisting of two pressure regulators with pressure gauges, inlet and outlet isolation ball valves, and pressure relief valves. Arrange all filters/pressure regulators so that the isolation of one filter/ regulator will not affect the operation of the second filter/regulator.

2.10.6 Dew Point Monitor

Provide dew point monitor to continuously monitor the dew point of the medical compressed air. Provide ceramic type (aluminum oxide type is not acceptable) sensor with system accuracy of plus or minus 1 degree C 2 degrees F. The dew point alarm must be factory set at 2 degrees C 36 degrees F and be field adjustable. Provide activation of local alarm and all master alarms when the dew point at system pressure exceeds plus 4 degrees C 39 degrees F. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor conforming to NFPA 99.

2.10.7 Carbon Monoxide Monitor

Provide carbon monoxide monitor to continuously monitor the medical compressed air for carbon monoxide, and to actuate a local alarm if the carbon monoxide level is 10 ppm or higher. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor conforming to NFPA 99.

2.11 MEDICAL-SURGICAL VACUUM (MV) SOURCE

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, receiver, control panel, source shutoff, pump isolation valves and other components as indicated, required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

2.11.1 Vacuum Pumps

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NOTE: Water sealed liquid ring vacuum pumps should generally not be used. If used, then they must fully meet the water conserving features outlined within.

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Provide [non-lubricated rotary] [non-contacting dry claw] [recirculating water sealed liquid ring] vacuum pumps. Mount each pump and its motor on modular skids in a horizontal or vertical configuration with coupling and guard. Pumps and motors for small systems may be tank mounted. Provide high efficiency motors. Provide shutoff valve on each pump inlet. Provide vacuum gauge at each pump inlet.

[a. Provide completely dry non-lubricated rotary vane pumps equipped with self-lubricating carbon/graphite vanes. Provide lubricated and sealed bearings. No oil is permitted in any pump. Each pump must be completely air-cooled and have absolutely no water requirement. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.]

[b. Provide non-contacting dry claw style rotary pumps. Internal construction must be friction free and the rotors must be non-contacting. The air end must be oil free and require no sealants. Provide air cooled and continuous duty rated pumps. Provide each pump with a single lubricated gearbox requiring oil change not more often than 5,000 operating hours. Provide each pump with an exhaust silencer. Equip pumps with high vacuum shutdown, high temperature shutdown, and alarm. The lubricant supplied must be inert with oxygen. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, TEFC motor with 1.15 service factor, and maximum of 3500 RPM.]

[c. Provide oil-free, single-stage positive displacement, and non-pulsating recirculating water sealed liquid ring type pumps. Provide pumps fitted with mechanical seals. Provide all iron pump construction with a bronze or stainless rotor and carbon steel shaft. Under normal operation, system must minimize fresh seal water required to 0.05 L/s 0.75 gpm. Provide system with reservoir of sufficient capacity for up to 48 hours operation without fresh water supply. Equip each pump with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide totally self contained system. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.]

2.11.2 Vacuum Receiver

Provide receiver designed for 1034 kPa 150 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to vacuum gauge, sight glass, and automatic and manual drains. Provide receiver with galvanized or factory applied commercial enamel exterior finish. Provide interior of receiver with a factory applied vinyl lining. Provide a display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.11.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use.

[2.12 WASTE ANESTHESIA GAS DISPOSAL VACUUM (WAGD) SOURCE

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, receiver, control panel, source shutoff, pump isolation valves and other components as indicated, required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

2.12.1 Vacuum Pumps

Provide [non-lubricated rotary] [non-contacting dry claw] [regenerative blower] [recirculating water sealed liquid ring] vacuum pumps. Mount each pump and its motor on modular skids in a horizontal or vertical configuration with coupling and guard. Provide tank mounted pumps and motors for small systems. Provide high efficiency motors. Provide shutoff valve on each pump inlet. Provide vacuum gauge at each pump inlet.

[a. Provide completely dry non-lubricated rotary vane pumps equipped with self-lubricating carbon/graphite vanes. Provide lubricated and sealed bearings. No oil is permitted in any pump. Each pump must be completely air-cooled and have absolutely no water requirement. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.]

[b. Provide non-contacting dry claw style rotary pumps. Internal construction must be friction free and the rotors must be non-contacting. The air end must be oil free and require no sealants. Provide air cooled and continuous duty rated pumps. Provide each pump with a single lubricated gearbox requiring oil change not more often than 5,000 operating hours. Provide each pump with an exhaust silencer. Equip the pumps with high vacuum shutdown, high temperature shutdown, and alarm. The lubricant supplied must be inert with oxygen. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, TEFC motor with 1.15 service factor, and maximum of 3500 RPM.]

[c. Provide regenerative blower vacuum pumps consisting of one impeller, mounted directly on the motor shaft. Provide precision cast aluminum impeller with multiple radial blades at its periphery. The impeller must be the only moving part, and not require any lubrication. Dynamically balance the impeller to provide vibration-free operation without the need for vibration isolators. Install the impeller between the blower housing and cover. Provide housing and cover of cast aluminum and provided with multiple heat-dissipating fins. There must be no metal-to-metal contact within the blower housing. Oil lubrication must not be required providing oil free discharge gas. The heat-dissipating fins must efficiently minimize heating of the compressed gas. Blower must have a guaranteed ultimate vacuum of 38 kPa 11 inches Hg vacuum. Provide motor supported by outboard mounted, grease lubricated, anti-friction bearings. The bearings must be located outside of the compression chamber to maximize operating efficiency and bearing life. Provide bearing housing conservatively loaded and rated for an L(10) life of not less than 200,000 hours. Provide shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11. Provide a lip seal to minimize leakage where the motor shaft passes through the blower housing. Blower producing noise levels must not exceed 75 dBA. Additional silencers may be installed to further reduce the noise level. Provide continuous duty NEMA rated, TEFC motor with 1.15 service factor, and maximum of 3600 RPM. Provide direct driven blower. Provide blower manufactured in accordance with ISO 9001, and UL listed. Provide each pump with a check valve, inlet filter, flex connector, isolation valve and a relief valve mounted at the pump inlet. Provide control panel mounted vacuum pump control switches set as follows:]

(1) Lead Pump: Continuous Operation

(2) Lag Pump Start: 88 kPa 4 inches Hg vacuum

(3) Lag Pump Stop: 81 kPa 6 inches Hg vacuum

[d. Provide oil-free, single-stage positive displacement, and non-pulsating recirculating water sealed liquid ring type pumps. The pumps must be fitted with mechanical seals. Provide pump of all iron construction with a bronze or stainless rotor and carbon steel shaft. Under normal operation, system must minimize fresh seal water required to 0.05 L/s 0.75 gpm. Provide system with reservoir of sufficient capacity for up to 48 hours of operation without fresh water supply. Equip each pump with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide totally self contained system. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.]

2.12.2 Vacuum Receiver

Provide receiver designed for 1034 kPa 150 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to vacuum gauge, sight glass, and automatic and manual drains. Provide exterior of receiver with galvanized or factory applied commercial enamel finish. Provide interior of the receiver with factory applied vinyl lining. Provide a display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.12.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use.

][2.13 INSTRUMENT COMPRESSED AIR (IA) SOURCE

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NOTE: Instrument compressed air may be used in lieu of nitrogen as a support gas in medical and dental facilities with prior approval by the using facility. If instrument compressed air is present in the facility, the source equipment can also supply the laboratory compressed air (LA) and/or the process compressed air (PA) systems. Pressure regulators are required.

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a. Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with air compressors, receiver, dryers, filters, control panel, source shutoff, compressor isolation valves and other components as indicated, required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

b. Manufacture tank-mounted air compressors to comply with UL listing requirements. Provide air compressors with manufacturer's name and address, together with trade name and catalog number, on a nameplate securely attached to the equipment. Provide guards to shield exposed moving parts. Provide an intake air filter and silencer with each compressor. Provide aftercooler and moisture separator installed between compressors and air receivers, to remove moisture before the air enters the receiver. Provide air cooled aftercoolers. The air must pass through a sufficient number of tubes to affect cooling. Provide tubes sized to give maximum heat transfer. Cooling capacity of the aftercooler must be sized for the total capacity of the compressors.

2.13.1 Air Compressors

Provide compressors with the scheduled capacity at a minimum of 1378 kPa 200 psi. Provide two stage, high pressure oil-lubricated continuous duty reciprocating type air compressors. A pressure gauge calibrated to 2068 kPa 300 psi, and equipped with a gauge cock and pulsation dampener must be provided for installation adjacent to the pressure switch. Connect motors and compressors by V-belt drive. Compressors must be sequenced to start automatically when the pressure drops to a preset point. Provide air cooled compressors. Provide each compressor chamber with a high-temperature sensor to activate a local alarm. Provide continuous duty NEMA rated, C-face, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.

2.13.2 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each compressor for selection of normal operation (automatic alternation) or manual selection of lead and lag compressors. Provide automatic alternation of compressors based on a first-on/first-off principle with provisions for simultaneous operation. The lag compressor must be able to start automatically if the lead compressor fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any compressor in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each compressor. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide pressure control switches or pressure transducer. Provide integral PLC controller for automatically switching operating sequence of compressors. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, pump maintenance intervals, compressor performance warnings, average system air demand, average dewpoint and CO levels on system, compressors on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag compressor In Use.

b. High discharge temperature.

c. High carbon monoxide levels.

d. High dewpoint level.

2.13.3 Air Receiver

Provide receiver designed for 1724 kPa 250 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to pressure gauge, sight glass, and automatic and manual drains. Provide exterior of receiver with galvanized or factory applied commercial enamel finish. Provide interior of the receiver with factory applied vinyl lining. Provide a display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.13.4 Desiccant Air Dryers

Provide two identical twin-tower heatless desiccant air dryers. Provide dryers sized to achieve a pressure dewpoint minus 40 degrees C minus 40 degrees F at the maximum calculated NFPA system capacity. Provide lubricant free operation. Provide economizer cycle that reduces purge air requirements to match actual moisture loading. Provide solid-state cycle timer, OSHA purge exhaust mufflers, and a pressure gauge for each tower.

2.13.5 Filtration and Pressure Reducing Station

Provide two separators with zero loss drain valve, two pre-filters rated 0.01 micron filtration with an efficiency exceeding 99.9999 percent D.O.P. (Validated), two activated carbon filters, and two final filters rated 0.01 micron filtration with an efficiency exceeding 99.9999 percent D.O.P. (Validated) installed downstream of the carbon filters. Provide all filters with a differential pressure gauge with color change indicator and automatic drain valve except the activated carbon filters. Provide downstream of the final filters with a dual-line pressure regulating assembly consisting of two pressure regulators with pressure gauges, inlet and outlet isolation ball valves, and pressure relief valves. Arrange all filters/pressure regulators so that the isolation of one filter/ regulator will not affect the operation of the second filter/regulator.

2.13.6 Dew Point Monitor

Provide dew point monitor to continuously monitor the dew point of the instrument compressed air. Provide ceramic type (aluminum oxide type is not acceptable) sensor with system accuracy of plus or minus 1 degree C 2 degrees F. The dew point alarm must be factory set at minus 30 degrees C minus 22 degrees F and be field adjustable. Provide activation of local alarm and all master alarms when the dew point at system pressure exceeds minus 30 degrees C minus 22 degrees F. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitors conforming to NFPA 99.

][2.14 LAB COMPRESSED AIR (LA) [AND PROCESS COMPRESSED AIR (PA)] SOURCE

a. Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with air compressors, receiver, dryers, filters, control panel, source shutoff, compressor isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

b. Manufacture tank-mounted air compressors to comply with UL listing requirements. Provide air compressors with manufacturer's name and address, together with trade name and catalog number, on a nameplate securely attached to the equipment. Provide guards to shield exposed moving parts. Provide an intake air filter and silencer with each compressor. Provide aftercooler and moisture separator between compressors and air receivers, to remove moisture before the air enters the receiver. Provide air cooled aftercoolers. The air must pass through a sufficient number of tubes to affect cooling. Provide tubes sized to give maximum heat transfer. Cooling capacity of the aftercooler must be sized for the total capacity of the compressors.

2.14.1 Air Compressors

Provide [scroll type compressors] [reciprocating teflon-ring type compressors designed such that no oil is administered to the air cylinder, the portion of the piston rod that travels in the crankcase section does not travel in any portion of the air-cylinder section, and with provision to prevent the flow of lubrication oil along the piston rod into the air-cylinder section]. Provide a pressure gauge calibrated to 2068 kPa 300 psi, and equipped with a gauge cock and pulsation dampener for installation adjacent to the pressure switch. Provide motors and compressors directly connected or operated by V-belt drive. Compressors must be sequenced to start automatically when the pressure drops to a preset point. Provide air cooled compressors. Provide each compressor chamber with a high-temperature sensor to activate a local alarm. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 3600 RPM.

2.14.2 Air Receiver

Provide air receiver delivering air to laboratories designed for 1034 kPa 150 psi working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to pressure gauge, sight glass, and automatic and manual drains. Provide exterior of receiver with galvanized or supplied with factory applied commercial enamel finish. Provide interior of the receiver with a factory applied vinyl lining. Provide a display of the ASME seal on the receiver, or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.14.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each compressor for selection of normal operation (automatic alternation) or manual selection of lead and lag compressors. Provide automatic alternation of compressors based on a first-on/first-off principle with provisions for simultaneous operation. The lag compressor must be able to start automatically if the lead compressor fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any compressor in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each compressor. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide pressure control switches or pressure transducer. Provide integral PLC controller for automatically switching operating sequence of compressors. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, pump maintenance intervals, compressor performance warnings, average system air demand, average dewpoint and CO levels on system, compressors on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag compressor In Use.

b. High discharge temperature.

2.14.4 Desiccant Air Dryers

Provide two identical twin-tower heatless desiccant air dryers. Provide dryers to achieve a pressure dewpoint minus 40 degrees C minus 40 degrees F at the maximum calculated NFPA system capacity. Provide lubricant free operation. Provide economizer cycle that reduces purge air requirements to match actual moisture loading. Provide solid-state cycle timer, OSHA purge exhaust mufflers, and a pressure gauge for each tower.

2.14.5 Filtration and Pressure Reducing Station

Provide two pre-filters rated 0.01 micron filtration with an efficiency of 99.9999 percent D.O.P. (Validated), two activated carbon filters, and two 1 micron final filters with an efficiency 99.9999 percent D.O.P. (Validated) installed downstream of the carbon filters. Filters without validation must not be used except the activated carbon filters. Provide all filters with a differential pressure gauge with color change indicator and automatic drain valve except the activated carbon filters. Provide downstream of the final filters a dual-line pressure regulating assembly consisting of two pressure regulators with pressure gauges, inlet and outlet isolation ball valves, and pressure relief valves. Arrange all filters/pressure regulators so that the isolation of one filter/ regulator will not affect the operation of the second filter/regulator.

2.14.6 Dew Point Monitor

Provide dew point monitor to continuously monitor the dew point of the laboratory compressed air. Provide ceramic type (aluminum oxide type is not acceptable) sensor with system accuracy of plus or minus 1 degree C 2 degrees F. Provide field adjustable dew point alarm factory set at 2 degrees C 36 degrees F. Provide activation of local alarm and all master alarms when the dew point at system pressure exceeds plus 4 degrees C 39 degrees F. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitors conforming to NFPA 99.

]2.15 PIPE AND FITTINGS

2.15.1 Service Entrance

Piping at service entrance (from 305 mm 12 inches inside building to 1525 mm 5 feet outside): Same as Indicated for outside utilities.

2.15.2 Positive pressure piping systems up to 1379 kPa 200 psi

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NOTE: The following applies to dental/medical compressed air, instrument compressed air, laboratory compressed air, process compressed air, oxygen, nitrogen, nitrous oxide, carbon dioxide. Fittings complying with ASME B16.50 are currently not manufactured.

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Hard-drawn seamless copper tubing (ASTM B819), Type K or L, bearing one of the following markings, OXY, MED, OXY/MED, and brazed solder-type wrought copper fittings (ASME B16.22), or brazed fittings (ASME B16.50) cleaned for oxygen service by the manufacturer in accordance with Pamphlet CGA G-4.1. Cast fittings must not be used. Minimum size must be 15 mm 1/2 inch. Install branch piping full size to each terminal device, including vertical drops, and provide reducer fitting at the device pigtail. Type L tubing is not acceptable for installation below grade. Provide with NF nitrogen purge and capped/plugged ends until prepared for installation. Tubing joining material must be ANSI/AWS-BCuP series filler material.

2.15.3 [Dental surgical] [Medical-Surgical] Waste Anesthesia Gas Disposal vacuum piping systems up to 34 kPa 20 inches Hg vacuum

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NOTE: The following applies to dental/medical vacuum, Waste Anesthesia Gas Disposal.

****

Hard-drawn seamless copper tubing (ASTM B819), Type K or L, bearing one of the following markings, OXY, MED, OXY/MED, and brazed solder-type wrought copper fittings (ASME B16.22), or brazed fittings (ASME B16.50) cleaned for oxygen service by the manufacturer in accordance with Pamphlet CGA G-4.1.. Cast fittings must not be used. Minimum size must be 20 mm 3/4 inch. Install branch piping full size to each terminal device, including vertical drops, and provide reducer fitting at the device pigtail. Tubing joining material must be ANSI/AWS-BCuP series filler material. Nitrogen purge not required. Labeled or otherwise identified prior to installation in order to preclude inadvertent inclusion into the pressurized systems. Labeling is not required if installation meets all requirements for pressurized piping including prohibition of flux on copper-to-copper joints and the use of a NF nitrogen purge during brazing.

2.15.4 Dental Oral Evacuation System

Provide polyvinyl chloride (PVC) solid-wall drainage, waste and vent (DWV) pipe and fittings conforming to ASTM D2665. Provide solvent cement for PVC pipe fittings conforming to ASTM D2564. Provide fittings, supports, and joint assembly complying with ICC IPC. Provide long-radius type fittings for turns and the wye type for branches. The most distant end of each trunk line from the separators may terminate with a vacuum relief valve.

2.15.5 High-Volume Laboratory Dust Evacuation System

Provide polyvinyl chloride (PVC) solid-wall drainage, waste and vent (DWV) pipe and fittings conforming to ASTM D2665. Provide solvent cement for PVC pipe fittings conforming to ASTM D2564. Provide fittings, supports and joint assembly complying with ICC IPC. The assembled piping system must be suitable for 84 kPa 5 inches Hg vacuum. Provide long-radius type fittings for turns and the wye type for branches. The most distant end of the main trunk line from the central filter-separator may terminate with an air volume relief valve.

2.15.6 Compressed Air Intake and Vacuum Pump Exhaust Line(s)

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NOTE: CPVC vacuum exhaust piping is permissible for Dental Oral Evacuation systems only.

****

Hard-drawn seamless copper tubing (ASTM B88 or ASTM B819), Type K or L, and solder-type wrought copper fittings (ASME B16.22). Cast fittings must not be used. Tubing joining material must be ANSI/AWS-BCuP series filler material. [For Dental Oral Evacuation systems only, provide ASTM F441/F441M Schedule 80 chlorinated polyvinyl chloride (CPVC) pipe, ASTM F439 Schedule

80 CPVC socket fittings and ASTM F437 Schedule 80 CPVC threaded fittings. Provide solvent cements for joining CPVC pipe conforming to ASTM F493.]

2.16 VALVES AND ASSEMBLIES

2.16.1 Valves

a. Positive pressure piping systems up to 1379 kPa 200 psi: Bronze, full port, quarter-turn ball type, three piece construction, 4137 kPa 600 psi WOG, blow-out proof stem, in-line repairable. Cleaned for oxygen service by manufacturer in accordance with Pamphlet CGA G-4.1. All sizes: 316 stainless steel ball and stem, glass reinforced polytetrafluoroethylene (RPTFE) seat seals and packings. Clean, cap and deliver to site in sealed package bearing manufacturer's identifying tag or stamp. Keep sealed until prepared for installation. Provide with valve manufacturer installed brazed Type K copper tube extensions a minimum of 150 mm 6 inch long on the inlet and outlet side of the valve for making connection to the pipeline(s). Provide a purge port on both the inlet and outlet tube extensions. Valves in locations other than zone valve boxes must be lockable.

b. Vacuum piping systems up to 34 kPa 20 inches Hg vacuum: Bronze full port, quarter-turn ball type, three piece construction, 3 kPa 29 inches Hg vacuum, blow out proof stem, in-line repairable. All sizes: 316 stainless steel ball and stem, glass reinforced polytetrafluoroethylene (RPTFE) seat seals and packings. Provide with valve manufacturer installed brazed Type K copper tube extensions a minimum of 152 mm 6 inch long on the inlet and outlet side of the valve for making connection to the pipeline(s). Provide a purge port on both the inlet and outlet tube extensions. Valves in locations other than zone valve boxes must be lockable.

2.16.2 Zone Valve Assemblies

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NOTE: Coordinate stud depth with architects. Provide minimum 152 mm 6-inch stud to allow for varying box depths.

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a. Recessed wall box, minimum 1.21 mm 18 GA sheet steel, baked enamel finish. Stainless steel or chrome front trim. Transparent plastic door with pull handle or ring for emergency access to valves. Service access to valves must be by removal and replacement of door, which must neither cause damage nor require special tools. Opaque plastic is not acceptable. Openings to box interior must be dust-tight. Provide each shutoff valve with pressure gauge and integral extension tubes for joining to piping system outside of box. Provide gauge port on each tubing extension. Lockable valves are not required..

b. Up to 5 shutoff valves of 25 mm 1 inch size or smaller may be installed in one box. Use single-valve boxes for 32 mm 1-1/4 inch valves and larger. Front trim with interlocking edges where single-valve boxes are jointed together for multiple valve installations. Provide custom-made boxes as specified above for those valves that are too large for pre-manufactured boxes.

c. Surface mounted wall box, same as recess mounted except provide with exposed surface finish primed for field painting and provide only where surface mounting is specifically indicated on drawings.

d. Arrange shutoff valves in following order from top to bottom: Oxygen, nitrous oxide, carbon dioxide, dental compressed air, medical compressed air, nitrogen, Waste Anesthesia Gas Disposal, dental surgical vacuum, and medical-surgical vacuum. If 2 or more valves for same service are located in common box, larger of valves must be lower.

2.17 NITROGEN AND INSTRUMENT COMPRESSED AIR CONTROL PANELS

Nitrogen and instrument compressed air control panels must be designed to deliver variable pressures to power pneumatic surgical tools. Provide the control panel with a 0-2070 kPa 0-300 psi pressure gauge, shutoff valve, pressure regulator, delivery pressure gauge and Diameter-Index Safety System (DISS) outlet. Provide quarter turn valves to obtain a fully "open" or "closed" position. Provide an adjustable self relieving type pressure regulator, with a operating range of 70 to 1725 kPa 10 to 250 psi. Control panels must be pre-piped internally requiring only external supply line connections. Additional outlets in the same room may be connected to the remote outlet pigtail furnished in the control panel. Remote outlets must be regulated by the adjustable pressure regulator within the panel and must match the nitrogen control panel outlet type. Provide control panels in horizontal or vertical orientation.

2.18 HANGERS AND SUPPORTS

Provide copper plated pipe hangers and supports when in direct contact with copper tubing. Tubing installed on trapeze hanger must be secured in place with appropriately sized clamp and be fully isolated from dissimilar metals.

2.19 GAUGES

a. Provide for line pressure use adjacent to source equipment, ASME B40.100 pressure gauges, 114 mm 4 1/2 inches in diameter with metal case for oxygen, nitrous oxide, carbon dioxide, dental compressed air, medical compressed air, laboratory compressed air, process compressed air, and nitrogen, accurate to within two percent. Range must be two times operating pressure. Dial graduations and figures must be black on a white background, or white on a black background. Provide gauges expressly made for and cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL". Provide bourdon tube and brass movement. Install with gauge cock. Gauges for all services downstream of main shutoff valve must be same as those adjacent to source equipment except diameter may be reduced to 40 mm 1-1/2 inches. Dial ranges must be 0 to 690 kPa 0 to 100 psi for pressurized gases and compressed air services except nitrogen and instrument compressed air; 0 to 2070 kPa 0 to 300 psi for nitrogen and instrument compressed air.

b. Provide for vacuum line use adjacent to source equipment, ASME B40.100 vacuum compound gauges, 114 mm 4 1/2 inches in diameter with metal case for dental surgical vacuum, medical-surgical vacuum, dental oral evacuation, Waste Anesthesia Gas Disposal, and laboratory dust evacuation, accurate to within two percent. Dial graduations and figures must be black on a white background, or white on a black background. Label for vacuum service. Provide with bourdon tube and brass movement. Install with gauge cock. Gauges for all services upstream of main shutoff valve must be same as those adjacent to source except diameter may be reduced to 40 mm 1 1/2 inches. Dial range must be 100 to 0 kPa 0 to 30 inches Hg vacuum.

2.20 DENTAL GAS AND SUPPORT SYSTEMS OUTLETS AND VACUUM SYSTEMS INLETS

2.20.1 Station Outlets/Inlets

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NOTE: The type of connectors at station outlets will be as specified by the using service. This is required to ensure that the connectors provided are compatible with those on Government-furnished mobile apparatus. Unless otherwise required by the using facility, provide DISS type outlets/inlets.

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Submit proof that outlets/inlets, as an assembly, are listed by Underwriters Laboratories, Inc., and are manufactured in accordance with applicable NFPA 99 and CGA standards. Provide station outlets/inlets (Oxygen, Nitrogen, Nitrous Oxide, Dental Surgical Vacuum, Waste Anesthesia Gas Disposal, Instrument Compressed Air) conforming to NFPA 99. Provide station outlets/inlets for concealed piping made of brass and having an adjustable valve mechanism to compensate for variation in wall thickness. Each unit must be securely mounted and self-sealing. Each unit as an assembly must conform to the requirements of the Underwriters Laboratories Inc.; submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, the Contractor may submit a written certificate from any approved nationally recognized testing organization adequately equipped and competent to perform such services, including the follow-up service, stating that the item has been tested and conforms to the requirements, including method of testing, of the specified agency. Provide station outlets/inlets equipped with threaded DISS connector per CGA standards [noninterchangeable quick disconnect coupler, except for nitrogen which must be equipped with DISS connections as assigned for gas and vacuum systems in CGA V-5, except that inlets for the Waste Anesthesia Gas Disposal system must be 22 mm 7/8 inch nonthreaded connections]. Provide DISS outlets for all dental vacuum and ceiling mount applications. Provide recessed wall type outlets/inlets unless specified otherwise. Provide station outlets cleaned for oxygen service in accordance with Pamphlet CGA G-4.1 and the assembly capped and the finished assembly poly bagged for shipment.

[2.20.1.1 Couplers

Where quick-disconnect couplers are furnished they must be of the noninterchangeable type. Connector must lock firmly into position and have a finger-type quick release. Coordinate quick-disconnect coupler type with the Contracting Officer.

]2.20.1.2 Faceplates

Provide polished chromium-plated metal or satin-finish stainless steel faceplates secured with chromium-plated countersunk screws. Provide service identification either cast into, or permanently etched by the manufacturer into each faceplate.

2.20.1.3 Rough-In Assembly

Provide rough in assembly of modular design and include a gas specific 16 gauge steel mounting plate designed to permit on-site ganging of multiple outlets, on 127 mm 5 inch center line spacing. Provide a machined brass outlet block permanently attached to the mounting bracket to permit the 15 mm 1/2 inch OD, type-K copper inlet to swivel 360 degrees for attachment to the piping system. The rough in assembly must contain a double seal to prevent gas leakage between the rough in and latch-valve assemblies after the wall is finished. A single o-ring seal is not acceptable. Provide latch-valve assembly which telescopes up to 19 mm 3/4 inches to allow for variation in finished wall thickness from 13 to 32 mm 1/2 to 1-1/4 inches.

2.20.1.4 Ceiling Applications/Hose Assemblies

Provide hose assemblies for all ceiling outlets for the finished ceiling height as indicated on drawings. Provide each hose with a heavy-duty chain type dual retractor for pressure gases and for vacuum. Retractions made of stainless cable are not acceptable. Allow an extra 457 mm 18 inches of hose length for retractors.

2.20.1.5 Vacuum Slides

Provide one vacuum slide of the same manufacturer of the vacuum inlet for each vacuum inlet. Coordinate location with room elevations.

2.20.2 Dental Compressed Air Outlets

Provide dental compressed air outlets as follows:

a. Provide dental treatment rooms (DTR) with a 15 mm 1/2 inch service pipe terminated with a 15 by 10 mm 1/2 by 3/8 inch compression angle stop valve.

b. Dental laboratory. Provide each of the following, and coordinate locations with the laboratory casework supplier.

    (1) 15 mm 1/2 inch service pipe terminated with a ball valve. 15 mm 1/2 inch service pipe terminated with a needle valve.

    (2) 15 mm 1/2 inch service pipe terminated with a quick disconnect brass body coupler and sleeve, 10 mm 3/8 inch NPT, 2070 kPa 300 psi maximum pressure rating, Buna-N seals, and complying with the dimensional requirements of military specification MIL-C-4109.

c. Provide dental instrument processing center with a 16 mm 5/8 inch OD service pipe terminated with a quick disconnect brass body coupler and sleeve, 10 mm 3/8 inch NPT, 2070 kPa 300 psi maximum pressure rating, Buna-N seals, and complying with the dimensional requirements of military specification MIL-C-4109.

2.20.3 Dental Oral Evacuation Inlets (Dental Treatment Room)

Provide dental51 mm 2 inches above bottom of floor box or above finished floor. Cover pipe end to prevent entrance of debris. Prepare end for continuation of service by another Division.

2.21 MEDICAL GAS AND SUPPORT SYSTEMS OUTLETS AND VACUUM SYSTEMS INLETS

2.21.1 Station Outlets/Inlets

****

NOTE: The type of connectors at station outlets

will be as specified by the using service. This is required to ensure that the connectors provided are compatible with those on Government-furnished mobile apparatus. Unless otherwise required by the using facility, provide DISS type outlets/inlets.
****

Provide station outlets/inlets (Oxygen, Nitrogen, Nitrous Oxide, Carbon Dioxide, Medical Compressed Air, Medical-Surgical Vacuum, Waste Anesthesia Gas Disposal, Instrument Compressed Air) conforming to NFPA 99. Provide station outlets/inlets for concealed piping made of brass and having an adjustable valve mechanism to compensate for variation in wall thickness. Each unit must be securely mounted and self-sealing. Each unit as an assembly must conform to the requirements of the Underwriters Laboratories Inc.; submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, the Contractor may submit a written certificate from any approved nationally recognized testing organization adequately equipped and competent to perform such services, including the follow-up service, stating that the item has been tested and conforms to the requirements, including method of testing, of the specified agency. Equip station outlets/inlets with threaded DISS connector per CGA standards [noninterchangeable quick disconnect coupler, except for nitrogen which must be equipped with DISS connections as assigned for gas and vacuum systems in CGA V-5, except that inlets for the Waste Anesthesia Gas Disposal system must be 22 mm 7/8 inch nonthreaded connections]. Provide DISS outlets for all ceiling mount applications. Provide recessed wall type outlets/inlets unless specified otherwise. Provide station outlets cleaned for oxygen service in accordance with Pamphlet CGA G-4.1 and the assembly be capped and the finished assembly poly bagged for shipment.

[2.21.1.1 Couplers

Where quick-disconnect couplers are furnished they must be of the noninterchangeable type. Connector must lock firmly into position and have a finger-type quick release. Coordinate quick-disconnect coupler type with the Contracting Officer.

]2.21.1.2 Faceplates

Provide polished chromium-plated metal or satin-finish stainless steel faceplates secured with chromium-plated countersunk screws. Provide service identification either cast into, or permanently etched by the manufacturer in to each faceplate.

2.21.1.3 Rough-In Assembly

Provide rough in assembly of modular design and include a gas specific 16 gauge steel mounting plate designed to permit on-site ganging of multiple outlets, on 127 mm 5 inch center line spacing. A machined brass outlet block must be permanently attached to the mounting bracket to permit the 15 mm 1/2 inch OD, type-K copper inlet to swivel 360 degrees for attachment to the piping system. Provide rough in assembly with a double seal to prevent gas leakage between the rough in and latch-valve assemblies after the wall is finished. A single o-ring seal is not acceptable. The latch-valve assembly must telescope up to 19 mm 3/4 inches to allow for variation in finished wall thickness from 13 to 32 mm 1/2 to 1-1/4 inches.

2.21.1.4 Ceiling Applications/Hose Assemblies

Provide hose assemblies for all ceiling outlets for the finished ceiling height as indicated on drawings. Provide each hose with a heavy-duty chain type dual retractor for pressure gases and for vacuum. Retractions made of stainless cable are not acceptable. Allow an extra 457 mm 18 inches of hose length for retractors.

2.21.1.5 Vacuum Slides

Provide one vacuum slide of the same manufacturer of the vacuum inlet for each vacuum inlet. Coordinate location with room elevations.

2.22 LABORATORY COMPRESSED AIR [AND PROCESS COMPRESSED AIR] TERMINATION

Provide 15 mm 1/2 inch tube at each location and terminate 102 mm 4 inches from finished face of wall/partition with 15 mm 1/2 inch ball valve and 152 mm 6 inch long capped extension.

2.23 WARNING SYSTEMS

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NOTE: Coordinate alarm panel locations and power requirements with Division 26.

****

Locate alarm panels for gas and vacuum systems as specified and indicated. Each signal and gauge must be appropriately labeled "OPERATING" and "EMERGENCY." Clearly identify each gauge and device by means of engraved plastic nameplates. Provide alarms and pressure gauges for each pressurized system. Provide alarms and vacuum gauges for each vacuum, Waste Anesthesia Gas Disposal, and oral evacuation system. Energize signal systems by the normal and emergency power systems.

2.23.1 Master Alarm Panels

****

NOTE: Coordinate locations with using facility. Recommended locations include emergency room, central information desk, and a connection to the UMCS (UFGS 23 09 00) as determined by the project.

****

a. Master alarm panel features:

   (1) Provide recessed panel, complete with all necessary displays, factory wiring, transformers, and circuitry requiring only [115] [230] VAC 60 Hz primary power connected to the Life Safety branch. Provide with metallic back (rough-in) box. Provide panel that is compliant with NFPA 99 and UL Listed as an assembly.

   (2) Provide one green Light Emitting Diode (LED) indicating that the panel is powered and operating normally, and one red LED indicating a fault in the panel power and/or microprocessor has been detected. The red LED must not be able to be reset until the fault has been repaired, and then the red LED must automatically reset to green. Muting of the audible alarm in "Abnormal" status must not cancel illumination of the red LED. Only correction of the abnormal condition must allow resetting of the LED to green.

(3) Provide each individual signal with one green and one red LED. Provide illuminated green LED for "Normal" status. Provide illuminated red LED for "Abnormal" status. Muting of the audible alarm in "Abnormal" status must not cancel illumination of the red LED. Only correction of the abnormal condition must allow resetting of the LED to green.

(4) Provide audible alarm upon actuation of any abnormal condition. Provide audible signal producing a minimum sound pressure level of 80 dBA measured at a distance of 914 mm 3 feet. Provide the audible alarm with a reset relay to shut off only the audible alarm and not affect the illuminated "Abnormal" LED, until the condition is corrected. The audible alarm must sound again upon actuation of any additional abnormal condition.

(5) Provide back (rough-in) box factory configured for internal sensor mounting. Provide gas specific sensors for periodic testing without interrupting pipeline pressures or vacuum. External sensors, when applicable, must be designed to function up to 1524 m 5,000 feet from the alarm panel.

(6) Provide front panel TEST button to initiate a self-test function to test the LED indicators, visual displays, audible alarm, and to view alarm set points.

(7) Provide contacts for connecting to UMCS (UFGS 23 09 00). Alarms requiring installation of additional circuit boards for PC-based monitoring are not acceptable.

b. Provide alarm points based on installed systems:

(1) Oxygen Liquid (Main Supply) Less Than One Day [Notify [_____]]

(2) Oxygen Changeover to Secondary Supply [Notify [_____]]

(3) Oxygen Reserve in Use [Notify [_____]]

(4) Oxygen Reserve Supply Less Than One Day [Notify [_____]]

(5) Oxygen Reserve Pressure Low [Notify [_____]]

(6) Oxygen Main Line Pressure High/Low

(7) Nitrous Oxide Main Supply Less Than One Day [Notify [_____]]

(8) Nitrous Oxide Changeover to Secondary Supply [Notify [_____]]

(9) Nitrous Oxide Reserve in Use [Notify [_____]]

(10) Nitrous Oxide Reserve Supply Less Than One Day [Notify [_____]]

(11) Nitrous Oxide Reserve Pressure Low [Notify [_____]]

(12) Nitrous Oxide Main Line Pressure High/Low

(13) Nitrogen Changeover to Secondary Supply [Notify [_____]]

(14) Nitrogen Main Line Pressure High/Low

(15) [(15) Carbon Dioxide Changeover to Secondary Supply [Notify [_____]]]

(16) [(16) Carbon Dioxide Main Line Pressure High/Low]

(17) Medical Compressed Air Main Line Pressure High/Low

(18) Medical Compressed Air Dew Point High

****

NOTE: Use following only if medical compressed air is provided by cylinder manifold.

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(19) [(19) Medical Compressed Air Changeover to Secondary Supply [Notify [_____]]]

(20) Medical-Surgical Vacuum Main Line Vacuum Low

(21) Waste Anesthesia Gas Disposal Main Line Vacuum Low

(22) Instrument Compressed Air Main Line Pressure High/Low

(23) Instrument Compressed Air Dew Point High

****

NOTE: Use following only if instrument compressed air is provided by cylinder manifold.

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[(24) Instrument Compressed Air Cylinder Reserve in Use [Notify [_____]]]

[(25) Instrument Compressed Air Cylinder Reserve Less Than One Hour Supply [Notify [_____]]]

(26) Dental Compressed Air Main Line Pressure High/Low

(27) Dental Surgical Vacuum Main Line Vacuum Low

(28) Dental Oral Evacuation Vacuum Low

(29) Medical Compressed Air Compressor(s) Local Alarm

(30) Instrument Compressed Air Compressor(s) Local Alarm

(31) Medical-Surgical Vacuum Pump(s) Local Alarm

(32) Waste Anesthesia Gas Disposal Vacuum Pump(s) Local Alarm

2.23.2 Area Alarm Panels

****

NOTE: Alarm panels are only required in areas designated in NFPA 99 unless otherwise required by using facility.

****

a. Area alarm panel features:

(1) Provide recessed panel, complete with all necessary displays, factory wiring, transformers, and circuitry requiring only [120] [230] VAC 60 Hz primary power connected to the Life Safety branch. Provide with metallic back (rough-in) box. Provide panel that is compliant with NFPA 99 and UL Listed as an assembly.

(2) Provide one green Light Emitting Diode (LED) indicating that the panel is powered and operating normally.

(3) Provide each individual signal with one green and one red LED. Provide illuminated green LED for "Normal" status. Provide illuminated red LED for "Abnormal" status. Muting of the audible alarm in "Abnormal" status must not cancel illumination of the red LED. Only correction of the abnormal condition must allow resetting of the LED to green.

(4) Provide audible alarm upon actuation of any abnormal condition. Provide audible signal producing a minimum sound pressure level of 80 dBA measured at a distance of 914 mm 3 feet. Provide the audible alarm with a reset relay to shut off only the audible alarm and not affect the illuminated "Abnormal" LED, until the condition is corrected. The audible alarm must sound again upon actuation of any additional abnormal condition.

(5) Provide back (rough-in) box factory configured for internal sensor mounting. Provide gas specific sensors for periodic testing without interrupting pipeline pressures or vacuum. External sensors are not permitted.

(6) Provide front panel TEST button to initiate a self-test function to test the LED indicators, visual displays, audible alarm, and to view alarm set points.

(7) [(7) Provide alarm panels in each nursing unit on a wing/ward basis as indicated, but these panels must not include nitrous oxide, nitrogen, nor Waste Anesthesia Gas Disposal and oral evacuation vacuum alarms, unless specifically indicated.]

b. Provide alarm points based on installed systems:

(1) High/Low Line Pressure (for each positive pressure system piped to the area). Actuation when the pressure in the line being monitored reaches approximately 20 percent above or below normal operating pressure.

(2) Low Line Vacuum (for each vacuum system piped to the area). Medical-surgical alarm must be actuated when the vacuum in the line being monitored reaches 60 kPa 12 inches Hg vacuum. [Waste Anesthesia Gas Disposal and oral evacuation alarm[s] must be actuated when the vacuum in the line being monitored reaches 80 kPa 6 inches Hg vacuum].

2.23.3 Local Alarm Panels

a. Provide alarm points based on installed systems:

****

NOTE: Use following for oil-less and oil-free

medical compressed air sources.
****

(1) Medical Compressed Air Source Backup (Lag) Compressor Operating

(2) Medical Compressed Air Source Carbon Monoxide High

(3) Medical Compressed Air Source High Discharge Air Temperature

(4) Medical Compressed Air Source High Water in Receiver

(5) Medical Compressed Air Source Dew Point High

****
NOTE: Use following for instrument compressed air sources.
****

(6) Instrument Compressed Air Source Backup (Lag) Compressor Operating

(7) Instrument Compressed Air Source Dew Point High

****
NOTE: Use following for medical-surgical vacuum sources.
****

(8) Medical-Surgical Vacuum Source Backup (Lag) Vacuum Pump Operating

****
NOTE: Use following for Waste Anesthesia Gas Disposal vacuum sources.
****

(9) Waste Anesthesia Gas Disposal Vacuum Source Backup (Lag) Vacuum Pump Operating

2.24 IDENTIFICATION MATERIALS

General: Provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.24.1 Plastic Pipe Markers

Provide snap-on or adhesive type pipe markers with nomenclature that closely matches Contract Drawings. Comply with designations indicated on Contract Drawings for piping system nomenclature and abbreviate only as necessary for each application length. Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

a. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A108.11ASME A13.1.

b. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ASME A13.1.

c. Application: For exterior diameters greater than 50 mm 2-inch (including insulation if any), provide continuous directional flow arrow tape around pipe circumference; two places, before and after pipe marker. Provide adhesive plastic pipe markers. For external diameters less than 50 mm 2 inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

   (1) Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

   (2) Adhesive lap joint in pipe marker overlap.

   (3) Laminated or bonded application of pipe marker to pipe (or insulation).

2.24.2 Valve Tags

Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 6 mm 1/4-inch high letters and sequenced valve numbers 13 mm 1/2-inch high, and with hole for fastener, or engraved plastic laminate valve tags, with piping system abbreviation in 6 mm 1/4-inch high letters and sequenced valve numbers 13 mm 1/2-inch high, and with hole for fastener. Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose. Compile valve schedule for each service. For each page of valve schedule, provide laminated plastic coated cardboard stock sheets.

a. Provide 38 mm 1 1/2-inch diameter tags, except as otherwise indicated.

b. Provide size and shape as specified or scheduled for each piping system.

c. Fill tag engraving with black enamel.

2.24.3 Engraved Plastic Laminate Signs

Provide manufacturer's standard laminated plastic, color coded equipment markers. Include terminology matching equipment schedules as closely as possible. Provide approximate 51 mm by 102 mm 2-inch by 4-inch markers for control devices, and 102 mm by 152 mm 4-inch by 6-inch for equipment. Identify equipment and electrical devices furnished under this section.

2.24.4 Plastic Equipment Markers

Provide manufacturer's standard laminated plastic, color coded equipment markers. Include terminology matching equipment schedules as closely as possible. Provide approximate 51 mm by 102 mm 2-inch by 4-inch markers for control devices, and 102 mm by 152 mm 4-inch by 6-inch for equipment. Identify equipment and electrical devices furnished under this section.

2.24.5 Plasticized Tags

Provide pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately, 51 mm by 152 mm 2-inch by 6-inch with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.24.6 Lettering and Graphics

Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Oral Evacuation Pump No. 2, Dental Air Compressor No. 1).

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

[3.2 BULK LIQUID OXYGEN SOURCE

****

NOTE: Include only if bulk liquid oxygen source exists.

****

Bulk liquid oxygen source: Connect oxygen gas supply line to bulk storage facility in accordance with the Regulatory Requirements.

][3.3 EMERGENCY OXYGEN SUPPLY CONNECTION

****

NOTE: Delete if no emergency oxygen supply connection exists.

****

Pipe relief valve discharge to exterior of building.

]3.4 CYLINDER MANIFOLD SUPPLY SOURCE

a. Provide complete set of full primary and secondary cylinders after successful completion of final tests. Coordinate source of cylinders with Owner.

b. Pipe system relief discharges to exterior of building.

c. Provide check valve between each cylinder head and the manifold header. Connect each header to the manifold controls with shutoff valves. Vent relief valve to the outside atmosphere if the total capacity of the system is more than 57 cubic meters 2,000 cubic feet of gas. Venting must be accomplished by piping the relief valve to the outside atmosphere or by approved ductwork having a minimum opening of 0.047 square meters 72 square inches. Install the manifold according to the manufacturer's recommendation and as required by NFPA 99.

3.5 COMPRESSED AIR AND VACUUM SOURCES

Installation must be in accordance with manufacturer's instructions and recommendations and NFPA 99. Align compressor and vacuum pump couplings in accordance with manufacturers' specifications. Provide factory service representative to supervise installation and to set pressure and vacuum switches. Perform system start-up by factory trained personnel and documented.

3.5.1 Central Dry Separator for High-Volume Laboratory Dust Evacuation

Locate the separator so that the lower canister can be removed easily and cleaned. Equip the separator with a cut-off valve to permit shutdown when the system is not in use.

3.5.2 Amalgam Separator for Dental Oral Evacuation

Install amalgam separator between the treatment rooms and the central wet separator in a location that is accessible from a standing position adjacent to the separator.

3.6 PIPING SYSTEMS

a. Piping must be cleaned, tested, and installed as specified in NFPA 99.

b. Provide Nitrogen NF gas purge to prevent oxide formation inside the copper tubing when brazing joints. Make joints with BCuP series brazing alloy, except as permitted otherwise by NFPA 99. Brazing alloy must fully penetrate joints to the depth of an ASME B16.50 fitting.

c. Make up threaded joints, as permitted by NFPA 99, with polytetrafluoroethylene tape, or other thread sealant approved for oxygen service. Apply thread sealant to male threads only.

d. Install pipe lines where they will not be subject to physical damage.

e. Install branch piping full size to each outlet/inlet, including vertical drops. Provide reducer at the outlet/inlet pigtail connection.

f. Provide protection of underground piping against frost, corrosion, and physical damage by installing piping in nonmetallic ducts or casings. Encase underground piping passing beneath load bearing surfaces and traffic areas in split PVC pipe sized to accommodate piping. Secure split PVC piping with galvanized steel draw bands. Support at regular intervals by insulating spacers providing complete circumferential clearance.

g. Install piping intended to contain cryogenic liquids such that the liquid does not come in contact with concrete in the event of a leak.

h. Connect piping near the top of receivers.

i. Extend compressed air intake pipe, and vacuum pump exhaust pipe to the outside of the building and turn their end down and screen against insects. Terminate compressed air intake piping a minimum of 36 inches above the roofing surface.

j. Provide vibration-absorbing couplings between the compressed air and vacuum source(s) and the system pipeline, and the compressed air and vacuum sources and the intake air/vacuum pump exhaust piping.

k. Provide laboratory and process air piping system(s) separate from the dental and medical compressed air system(s).

l. Install dental oral evacuation system piping with a minimum slope of 6 mm per 3.05 m 1/4 inch per 10 feet from the DTR utility box to the separator tanks.

m. Provide pipelines with appropriate system labeling conforming to NFPA 99.

n. Provide protective bushings on medical gas and vacuum piping passing through metal stud partitions.

o. Install vacuum exhaust piping with a minimum slope of 6 mm per 3.05 m 1/4-inch per 10 feet towards vacuum source equipment.

3.7 STATION OUTLETS/INLETS

3.7.1 Wall Outlets/Inlets

Locate wall outlets/inlets 1524 mm 60 inches from finished floor or as indicated. Permanently stamp back boxes with the gas or vacuum service identification and must be safety-keyed to accept only the appropriate gas or vacuum faceplate.

3.7.2 DISS Connections

Where threaded connections are furnished, DISS connections as described in CGA V-5 must be used to provide noninterchangeable connections. In order to facilitate connection making, the threads of the connection must engage before the check valve is depressed and pressure is allowed to enter the attached fitting. No leakage must occur when threads are fingertight.

3.7.3 Height of Hose-reel Type Outlets/Inlets

Termination must be a minimum of 2032 mm 80 inches above the finished floor.

3.8 VALVES AND ASSEMBLIES

Valve cabinets must be recess mounted on the corridor side of the partition. Cabinets must house alarm system sensors and zone control valves. The valves must be installed in the cabinet 1524 mm 5 feet above the floor at the center line of the box and provide complete shutoff of each of the piped services. Provide valves and exposed piping connecting the valves with appropriate system labeling conforming to NFPA 99. Valves and exposed piping connecting the valves must be labeled or identified in an approved manner with colors as follows:

System	Colors (Background/Text)
Dental Compressed Air	Yellow and White Diagonal Stripe/Black
Dental Surgical Vacuum	White and Black Diagonal Stripe/Black Boxed
Medical Compressed Air	Yellow/Black

System	Colors (Background/Text)
Dental Compressed Air	Yellow and White Diagonal Stripe/Black
Carbon Dioxide	Gray/Black or Gray/White
Instrument Air	Red/White
Laboratory Air	Yellow and White Checkerboard/Black
Laboratory Vacuum	Yellow and White Checkerboard/Black Boxed
Nitrogen	Black/White
Nitrous Oxide	Blue/White
Oral Evacuation	White and Black Checkerboard/Black Boxed
Oxygen	Green/White or White/Green
Medical Surgical Vacuum	White/Black
Waste Anesthetic Gas Disposal	Violet/White

Securely mount each valve in a fixed position by means of brackets. Position of each valve must allow for a firm grip to facilitate easy closing and opening. Each valve or valve box must be labeled in substance as follows:

> "Caution - (Name of applicable system) Valves. Do not close except in emergency. This valve controls (Name of applicable system) to [insert room name/number]."

3.9 GAUGES

a. Calibrate and zero gauges at job site.

b. Permanently label gauges with system name.

3.10 VIBRATION-ABSORBING FEATURES

****

NOTE: Designer will indicate on the drawings where equipment should be mounted resiliently. Details for proper mounting of equipment will be indicated on the drawings. Designer will insert required isolation efficiency in the blank space for installations where specific values for reduction of noise and vibration transmission are necessary; otherwise the sentence will be deleted. For areas where the maximum tolerable transmissibility in percent is considered necessary, the isolation efficiency will be given. Recommended transmissibility in percentages is as follows: 10 percent for equipment mounted in very critical

areas, 10 to 20 percent for critical areas, and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors or conditions surrounding the equipment, which are to be provided with vibration isolation units, favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values because of different equipment locations, the specification may be revised to indicate the appropriate values on the drawings.

Delete submittal of vibration-absorption features when not required.

****

Isolate mechanical equipment, including compressors and pumps, from the building structure by approved vibration-absorbing features unless otherwise shown. Each foundation must include standard isolation units as indicated. Each unit must consist of machine and floor or foundation fastening, together with intermediate isolation material, and be a standard product with printed loading rating. Provide piping connected to mechanical equipment with flexible connectors. Isolation unit installation must limit vibration to [_____] percent of the lowest equipment rpm. Submit details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

3.10.1 Tank or Skid Mounted Compressors

Provide floor attachments as recommended by compressor manufacturer. Mount compressors to resist seismic loads as specified in Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS.

3.10.2 Foundation Mounted Compressors

Provide foundation attachment as recommended by the compressor manufacturer. Mount compressors to resist seismic loads as specified in Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS.

3.11 TRAINING

a. Provide the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and be trained in operating theory as well as practical operation and maintenance work.

b. Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

c. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

3.12 IDENTIFICATION SYSTEMS

Identify piping and physical hazards in accordance with 29 CFR 1910.144, ASME A13.1, and NEMA Z535.1. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Identify each piping system and item of equipment indicated on Contract Drawings.

3.12.1 Piping System Identification

Install plastic pipe markers on each system, and include arrows to show normal direction of flow. Locate pipe markers and color bands wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, crawl spaces) and exterior non-concealed locations as follows.

a. Near each valve and control device.

b. Near each branch; mark each pipe at branch, where there could be question of flow pattern.

c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

d. At access doors, manholes and similar access points which permit view of concealed piping.

e. Near major equipment items and other points of origination and termination.

f. Spaced intermediately at maximum spacing of 6.1 meters20 feet along each piping run, except reduce spacing to 3 meters10 feet in congested areas of piping and equipment. Provide a minimum of one pipe label in each space where partitions extend to structure.

g. Align pipe labels and flow arrows on systems where parallel piping is installed.

3.12.2 Valves

Provide valve tag on every valve, cock and control device in each piping system. List each tagged valve in valve schedule for each piping system. .Mount laminated valve schedules under glass in mechanical equipment rooms. Coordinate location with the Contracting Officer. Provide 13 mm 1/2-inch red adhesive identification dots on ceiling tiles located immediately below balancing valves and shutoff valves.

3.12.3 Medical/Dental Source Equipment

Provide minimum 6 mm1/4-inch high lettering for name of unit where viewing distance is less than 13 mm 1/2-inch high for distances up to 1.8 meters 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering. In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.12.4 Pipe Color Code Marking

Specify color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS.

3.12.5 Color Coding Scheme for Locating Hidden Utility Components

Scheme must be provided in buildings having suspended grid ceilings. The color coding scheme must identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components must include valves. The color coding scheme must consist of a color code board and colored metal disks. Each colored metal disk must be approximately 10 mm 3/8-inch in diameter and secured to removable ceiling panels with fasteners. Insert fasteners into the ceiling panels so that the fasteners will be concealed from view. The fasteners must be manually removable without tools and must not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks must follow completion of the finished surface on which the disks are to be fastened. Provide the color code board with approximate dimensions of 3-foot width, 30-inch height, and 13 mm 1/2-inch thickness. Provide board made of wood fiberboard and framed under glass or 2 mm 1/16-inch transparent plastic cover. Unless otherwise directed, the color code symbols must be approximately 19 mm 3/4-inch in diameter and the related lettering in 13 mm 1/2-inch high capital letters. Mount and locate the color code board in the mechanical or equipment room.

3.13 GAS, SUPPORT, AND VACUUM SYSTEMS TESTING

3.13.1 Joint Validation

At its discretion, the Government reserves the right to validate joint fill through destructive and non-destructive methods. Non-destructive methods include, but are not limited to, Visual Examination and Ultrasonic Examination, in accordance with AWS C3.8M/C3.8. Validation of joint fill through destructive or non-destructive methods and extents of examinations will be as determined by the Contracting Officer.

[3.13.2 Camera Inspection

a. Prior to testing, perform camera (borescope) inspection of the interior of patient pressurized medical gas piping systems. The Contracting Officer will select [5 percent] [_____ percent] of each patient medical gas system for inspection. Prior to inspection, borescope probes must be free of dirt and debris. Any noted copper-oxide on the interior of joints will require replacement of the offending joints and affected piping to a point 12 inches beyond observed limits of copper-oxide. Locations where joints were replaced, camera re-inspection is required. Continue joint replacement and camera re-inspection until no evidence of copper-oxide is observed. Upon completion of camera inspection and replacement work, purge patient pressurized medical gas systems with NF nitrogen.

b. Provide the camera inspection report complete with log of locations inspected and re-inspected, copper-oxide observation pass/fail, joints replaced, photographs of the interior of each piping system at each inspection location, video of the interior of each piping system inspection, and floor plans indicating inspection locations. Provide video to the Government in Audio Video Interleave (AVI) format stored on Digital Video Disc (DVD). The use of Universal Serial Bus (USB) drives for video submission to the Government is not acceptable.

]3.13.3 Test Reports

a. Certified installers, inspectors, and verifiers must conduct, document tests in accordance with NFPA 99, furnish their own test equipment and supplies (including gases) for their respective tests. Reports must be certified with the signature of an officer of the company responsible for conducting the test.

b. Submit reports in booklet form, within two weeks of test date with separate copies of each report for Contractor Quality Control, and Contracting Officer. Submit reports of both failed and passed tests. Except as indicated under specific test description, reports may be subdivided by tested area to allow timely submission. Submit test reports showing all field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed systems. Each test report must indicate the final position of controls.

c. Document each report separately in an easy-to-follow manner, organized by areas and systems tested. (An area is typically a group of outlets downstream of a zone valve assembly.)

d. At the beginning of each report, document the following information:

(1) Name of project.

(2) Date of report.

(3) Name of company responsible for performing test.

(4) Name of person conducting test.

(5) Date of test.

(6) Area(s) tested.

(7) Name and address of facility.

e. Make pressure readings with calibrated gauges that have accuracies of plus or minus 7 kPa 1 psi.

f. Make temperature readings with calibrated thermometers that have accuracies of plus or minus 0.5 degrees C 1 degrees F.

3.13.4 Report Status

Project is acceptable only after systems have passed tests performed by the Inspection, Testing, and Verification Agency. Failure of test requires corrective action and retesting. Corrective actions taken to pass test and subsequent retesting must be provided at no extra cost.

3.13.5 Tests and Reports Prior to Start of Installation

****

NOTE: Delete this test and report when interconnections will not be made between new and existing systems.

****

Conduct test of existing medical gas/vacuum warning system to verify existing conditions and document.

3.13.6 Category 3 Systems Testing

3.13.6.1 General

a. Perform inspection and testing on all new piped systems, additions, renovations, temporary installations, or repaired systems, to ensure by a documented procedure, that all applicable provisions of NFPA 99 and the Contract Documents have been adhered to and system integrity has been achieved or maintained.

b. Inspection and testing to include all components of the system or portions thereof, including, but not limited to, medical gas source(s), compressed air sources (e.g., compressors, dryers, filters, regulators), alarms and monitoring safeguards, pipelines, isolation valves, and station inlets (vacuum) and outlets (positive pressure gases).

c. Inspect and test all systems that are breached and components that are subject to additions, renovations, or replacement (e.g., new medical gas sources, compressors, dryers, alarms). Systems are deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement, or addition. Breached portions of the systems subject to inspection and testing must be confined to only the specific altered zone and components in the immediate zone or area that is located upstream (inlet side) for vacuum systems and downstream (outlet side) for positive pressure gases at the point or area of intrusion.

d. Provide inspection, testing and verifier reports containing detailed findings and results directly to the Contracting Officer. Maintain all inspection, testing, and verification records on-site within the facility. The Contracting Officer must review the records prior to the use of all systems.

e. The Contracting Officer will accept the Verifier's Report as determining that the gas/vacuum delivered to the outlet/inlet is that shown on the outlet/inlet label and the proper connecting fittings are installed for the specific gas/vacuum service.

3.13.6.2 Initial Tests and Reports - All Category 3 Systems

The installing Contractor, a representative of the system supplier, or a representative of the system manufacturer is responsible for conducting and documenting these tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests.

a. Initial Blow Down Test.

b. Initial Pressure Test for Positive Pressure Gas Systems and Copper Vacuum Piping.

c. Initial Leak Test for PVC Vacuum Piping. Subject piping to a vacuum of not less than 60 kPa 12 inches Hg vacuum.

d. Initial Cross-Connection Test. Conduct this test only after completion of every system within test area.

e. Initial Piping Purge Test.

f. Initial Standing Pressure Test for Positive-Pressure Gas Piping.

g. Initial Standing Vacuum Test for Copper and PVC Vacuum Systems. Subject PVC piping to a vacuum of not less than 60 kPa 12 inches Hg which must not reduce to less than 73 kPa 8 inches Hg vacuum at the end of the 24 hour test period.

3.13.6.3 I,T&V Agency Tests and Reports

****

NOTE: Delete Final Tie-In Test Report when interconnections will not be made between new and existing systems.

****

The Inspection, Testing and Verification Agency is responsible for conducting and documenting gas and Nitrogen tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests.

[a. Verifier Final Tie-In Test.]

b. Verifier Standing Pressure Test.

c. Verifier Cross-Connection Test.

d. Verifier Warning System Test.

e. Verifier Piping Purge Test.

f. Verifier Piping Particulate Test.

g. Verifier Piping Purity Test.

h. Verifier Operational Pressure Test.

i. Verifier Gas Concentration Test.

j. Labeling.

k. Oxygen and Nitrous Oxide Source Equipment Operational Test.

3.13.6.4 Final Tests and Reports - All Category 3

****

NOTE: Delete Final Tie-In Test Report when interconnections will not be made between new and

existing systems.
****

The installing Contractor, a representative of the system supplier, a representative of the system manufacturer, or a certified system verifier is responsible for conducting and documenting Gas, Support, and Vacuum Systems (except Oxygen and Nitrous Oxide) tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests.

[a. Final Tie-In Test.]

b. Final Standing Pressure Test.

c. Final Standing Vacuum Test.

d. Final Cross-Connection Test.

e. Final Piping Purge Test.

f. Labeling.

g. Gas, Support Systems Source Equipment Operational Test.

h. Vacuum Systems Source Equipment Operational Test.

i. Dental Oral Evacuation (OE) System Test

Materials needed: Two vacuum gauges, accuracy of at least ±0.15 kPa at 79-73 kPa ±0.5" Hg at 6-8" Hg. Flow restrictors (quantity = 70 percent by number of dental treatment rooms). Flow restrictor components:

(1)

Part A	Hose, smooth bore OE tubing, 16 mm ID by 102 mm 5/8 inch ID by 4 inch long.
Part B	Hose adaptor, brass, 15 mm male pipe thread by 10 mm 1/2 inch male pipe thread by 3/8 inch hose barb.
Part C	Tubing, vinyl, 15 mm ID by 35 mm 1/2 inch ID by 1-3/8 inch long.
Part D	Tubing, vinyl, 15 mm OD, 5 mm ID by 25 mm 1/2 inch OD, 3/16 inch ID by 1 inch long.
Part E	Tubing, soft copper, 8 mm by 51 mm 5/16 inch by 2 inch long.

(2) Clear burrs on cut ends with 24 mm 15/16 inch drill bit.

Flow restrictor assembly:

a. Insert threaded end of the hose barb (Part B) completely into the 16 mm 5/8 inch OE hose (Part A).

b. Slip the 15 mm 1/2 inch ID tubing (Part C) completely over the hose barb (Part B).

c. Slip 15 mm 1/2 inch OD tubing (Part D) into the 15 mm 1/2 inch ID tubing (Part C) to butt against the hose barb (Part B).

d. Slip the copper tubing (Part E) into the 15 mm 1/2 inch OD tubing (Part D) approximately 19 mm 3/4 inch.

e. Flow restrictors as designed allow a flow of 3.5 L/s 7.4 SCFM when attached to plumbing under 79 kPa 6 inches Hg vacuum pressure.

****

NOTE: Show vacuum gauge No. 1 on the contract documents.

****

(1) Install vacuum gauge No. 1 on a pipe common to the power units close to the separating tanks. Install this gauge in a manner that will have minimal effect on airflow through the pipe.

(2) Install vacuum gauge No. 2 on the dental oral evacuation inlet in the floor box of the dental treatment room (DTR) farthest from the vacuum power units. Note that this inlet will be closed, with no flow passing through it.

(3) Place a flow restrictor over one dental oral evacuation inlet in 70 percent of the facility DTRs. DTRs fitted with flow restrictors should include a mix of DTRs most distant and DTRs nearest the vacuum source.

(4) Block off all other dental oral evacuation inlets and any other openings in the fixed pipe system.

****

NOTE: Dental oral evacuation systems utilize two or more vacuum pumps and are sized so that when one pump is inoperable the remaining pump(s) are capable of meeting the demand of 70 percent of the facility DTRs. For this reason, testing will be conducted with one pump inoperable. Utilization of flow restrictors simulates flow obtained through a functioning dental unit. Attaching flow restrictors to inlets in 70 percent of the DTRs (with other inlets blocked) verifies that an appropriate vacuum level can be obtained, with one pump inoperable, under flow conditions at a 70 percent system demand.

****

(5) Operate the vacuum system with one pump inoperable and note the readings on the two vacuum pressure gauges. Next, operate the vacuum system with a different pump inoperable and note the reading on both vacuum pressure gauges. Continue this process until a vacuum reading has been obtained with each of the system pumps taking a turn as the inoperable pump.

(6) An acceptable dental oral evacuation system must be able to maintain a minimum of 79 kPa 6 inches Hg vacuum as measured on the vacuum gauge on the furthest DTR inlet (gauge No. 2) under the conditions outlined above. The system piping pressure drop between the vacuum gauge near the power units (gauge No. 1) and the vacuum gauge at the farthest DTR (gauge No. 2) must be no more than 0.3 kPa 1 inch Hg vacuum.

3.13.7 Category 1 Systems Testing

3.13.7.1 General

a. Perform inspection and testing on all new piped systems, additions, renovations, temporary installations, or repaired systems, to assure by a documented procedure, that all applicable provisions of NFPA 99 and the Contract Documents have been adhered to and system integrity has been achieved or maintained.

b. Inspection and testing must include all components of the system or portions thereof, including, but not limited to, bulk source(s), cylinder manifolds, compressed air sources (e.g., compressors, dryers, filters, regulators), source alarms and monitoring safeguards, master alarms, pipelines, isolation valves, area alarms, zone valves, and station inlets (vacuum) and outlets (pressure gases).

c. All systems that are breached and components that are subject to additions, renovations, or replacement (e.g., new gas sources: bulk, manifolds, compressors, dryers, alarms) must be inspected and tested. Systems are deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement, or addition. Breached portions of the systems subject to inspection and testing must be confined to only the specific altered zone and components in the immediate zone or area that is located upstream for vacuum systems and downstream for pressure gases at the point or area of intrusion.

d. Provide inspection, testing, and verifier reports containing detailed findings and results directly to the Contracting Officer. Maintain all inspection, testing, and verification records on-site within the facility. The Contracting Officer or their appointed representative must review the records prior to the use of all systems.

e. Before piping systems are initially put into use the Contracting Officer must accept the Verifier's Report as determining that the gas/vacuum delivered to the outlet/inlet is that shown on the outlet/inlet label and the proper connecting fittings are installed for the specific gas/vacuum service.

3.13.7.2 Installer Performed Tests and Reports

****

NOTE: Delete Connection Report when interconnections will not be made between new and existing systems.

****

The installing Contractor is responsible for conducting and documenting these tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests. Tests apply to all Gas, Support, and Vacuum Systems.

[a. Connection Report.]

b. Initial Blow Down Test.

c. Initial Pressure Test.

d. Cross Connection Test.

e. Piping Purge Test.

f. Standing Pressure Test for Positive Pressure Piping.

g. Standing Vacuum Test for Vacuum Piping.

3.13.7.3 I,T&V Agency Tests and Reports

****

NOTE: Delete Final Tie-In Test Report when interconnections will not be made between new and existing systems.

Delete Initial Alarm Test Report when interconnections will not be made between new and existing systems.

****

The Inspection, Testing, and Verification Agency is responsible for conducting and documenting these tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests. Tests apply to all Gas, Support, and Vacuum Systems.

[a. Final Tie-In Test.]

[b. Initial Alarm Test. For each system, document operation of existing alarm systems prior to interconnecting new and existing systems.]

c. Standing Pressure Test.

d. Cross Connection Test.

e. Individual Pressurization Test.

f. Pressure Differential Test.

g. Valve Test.

h. Alarm Test. Master Alarms. Area Alarms.

i. Piping Purge Test.

j. Piping Particulate Test.

k. Piping Purity Test.

l. Operational Pressure Test.

m. Medical Gas Concentration Test.

n. Medical Compressed Air Purity Test.

o. Labeling.

p. Source Equipment Verification:

(1) Gas Cylinder Supply Sources.

(2) Medical Compressed Air Compressor Sources.

(3) Medical-Surgical Vacuum Sources.

3.14 WARNING SYSTEM

Provide wiring required for warning system except for power source at each alarm panel, which is provided by Electrical Specification Division contractor. Install wiring in conduit [including underground portion to the bulk oxygen site].

a. Label each alarm position on each alarm panel. Coordinate designations with using facility. Coordinate area designations with associated zone valve assembly designations.

b. Do not daisy-chain master alarm panels. Provide panel dedicated sensors and wiring from the alarm points to each installed master alarm panel.

c. Provide master alarm panels at the following locations:

(1)

Emergency Receiving Desk	Room [_____]
Central Information Desk	Room [_____]
Building Engineers Office	Room [_____]
Building Security Office	Room [_____]

d. Provide master alarm connection to UMCS (UFGS 23 09 00).

e. Do not daisy-chain area alarm panels.

[3.15 EXISTING PIPED DISTRIBUTION SYSTEMS

****

NOTE: Include existing piped distribution systems when remodels affect them. Edit to match project.

When bulk oxygen systems are leased to the Hospital, their upgrade is not part of these construction documents: Include the bracketed sentence.

****

Upgrade existing systems as indicated and as required to comply with the Regulatory Requirements.[Do not upgrade the bulk oxygen system, but do provide upgraded alarms at system site.]

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 01 30.41 (May 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 01 30.41 (February 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 01 30.41

HVAC SYSTEM CLEANING

05/22

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 01 30.41 (May 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 01 30.41 (February 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025

****

SECTION 23 01 30.41

HVAC SYSTEM CLEANING

05/22

****

NOTE: This guide specification covers the requirements for cleaning of HVAC systems, including applicable industry standards, qualifications of cleaning contractor, cleaning methodology, and performance verification.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality

INSTITUTE OF INSPECTION, CLEANING, AND RESTORATION CERTIFICATION (IICRC)

ANSI/IICRC S520	(2015) Standard and Reference Guide for Professional Mold Remediation

NATIONAL AIR DUCT CLEANERS ASSOCIATION (NADCA)

NADCA	(2005) Introduction to HVAC System Cleaning Services
NADCA ACR	(2013) Standard for Assessment, Cleaning, and Restoration of HVAC Systems
NADCA ASCS	(2013) Air Systems Cleaning Specialist to the NADCA Standard ACR
NADCA HVAC Inspection Manual	(2021) Procedures for Assessing the Cleanliness of Commercial HVAC Systems

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)

NAIMA AH112	(1993) Cleaning Fibrous Glass or Lined Sheet Metal Ducts
NAIMA AH122	(2006) Cleaning Fibrous Insulated Duct Systems - Recommended Practices
NAIMA AH127	(1999) Facts About the Impact of Duct Cleaning on Internal Duct Insulation

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 402-C-01-001	(2001) IAQ Building Education and Assessment Tool (I-BEAM)
EPA 402-F-91-102	(1991) Building Air Quality: A Guide for Building Owners and Facility Managers

UL SOLUTIONS (UL)

UL 181	(2013; Reprint Dec 2021) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 181A	(2013; Reprint Dec 2021) Standard for Safety Closure Systems for Use with Rigid Air Ducts
UL 181B	(2013; Reprint Dec 2021) UL Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors

1.2 DEFINITIONS

1.2.1 NADCA Standards

Perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA, NADCA ASCS,NADCA ACR and NADCA HVAC Inspection Manual).

a. All terms in this specification are defined as stated in the NADCA Standards.

b. Follow NADCA Standards without modification or deviation.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Record of Existing Conditions[; G, [_____]]

Coordination Plan[; G, [_____]]

NADCA Firm[; G, [_____]]

NADCA Team Assistants[; G, [_____]]

NADCA Air System Cleaning Specialist (ASCS)[; G, [_____]]

NADCA Supervisor Qualifications[; G, [_____]]

Records of Experience in the Field of HVAC System Cleaning[; G, [_____]]

NADCA Work Execution Schedule[; G, [_____]]

SD-03 Product Data

Safety Data Sheets (SDS)[; G, [_____]]

SD-06 Test Reports

Testing Procedures Summary[; G, [_____]]

[Gravimetric Analysis[; G, [_____]]

] Post-Project Report[; G, [_____]]

1.4 QUALITY CONTROL

1.4.1 NADCA Firm

Submit information certifying that the NADCA firm is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including furnishing equipment. Further, submit the following, for the firm, to Contracting Officer for approval:

a. Independent NADCA firm:

NADCA Firm: NADCA registration number and expiration date of current certification;

NADCA Supervisor Qualifications: Name and copy of NADCA supervisor certificate and expiration date of current certification.

NADCA Air System Cleaning Specialist (ASCS): Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of HVAC cleaning work in the field for not less than three years immediately preceding this contract's bid opening date.

NADCA Team Assistants: Names and documented evidence that each field technician has satisfactorily assisted a NADCA team field leader in performance of HVAC cleaning work in the field for not less than one year immediately preceding this contract's bid opening date.

Current Certificates: Ensure registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the HVAC cleaning work, in a timely manner so that there is no lapse in registration or certification. NADCA agency or NADCA team personnel without a current registration or current certification are not to perform HVAC cleaning work on this contract.

b. TAB Team Members: NADCA team approved to accomplish work on this contract are full-time employees of the NADCA firm. No other personnel is allowed to do HVAC cleaning work on this contract.

c. Replacement of NADCA Team Members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

1.4.2 Experience

Submit records of experience in the field of HVAC system cleaning. Bids will only be considered from firms which are regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.

1.4.3 Equipment, Materials and Labor

Possess and furnish all necessary equipment, materials and labor to adequately perform the specified services and comply with the applicable provisions of NADCA General Specifications for the Cleaning of Commercial HVAC Systems and ASHRAE 62.1.

a. Assure that all employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and Safety Data Sheets (SDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by this specification. For work performed in countries outside of the U.S.A., comply with applicable national safety codes and standards.

b. Maintain a copy of all current SDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs and this specification.

c. Submit all Safety Data Sheets (SDS) for all chemical products proposed used in the cleaning process, including all VOC ratings.

[1.4.4 Licensing

****

NOTE: If specific state or territorial licensing requirements are specified in Division 00, delete the following paragraph.

****

Provide proof of maintaining the proper license(s), if any, as required to do work in [_____] [the state of [_____]]. Comply with all Federal, State and local rules, regulations, and licensing requirements.

]1.4.5 Health And Safety

1.4.5.1 Safety Standards

Comply with all applicable Federal, State, and local requirements for protecting the safety of the contractors' employees, building occupants, and the environment. In particular, follow all applicable standards of the Occupational Safety and Health Administration (OSHA) when working in accordance with this specification[, and EM 385-1-1].

1.4.5.2 Occupant Safety

Employ no processes or materials in such a manner that introduce additional hazards into occupied spaces.

1.4.5.3 Disposal of Debris

Dispose of all debris removed from the HVAC System in accordance with applicable Federal, State and local requirements.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Mechanical Drawings

Obtain one copy of the following documents:

a. Project drawings and specifications

b. Approved construction revisions pertaining to the HVAC system

c. Any existing indoor air quality (IAQ) assessments or environmental reports prepared for the facility.

Submit a NADCA Work Execution Schedule to the Contracting Officer within [10] [_____] working days of the contract award.

1.5.2 Site Conditions

****

Note: Modify the following paragraph to succinctly and specifically define those systems and components requiring cleaning.

****

The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. The return air grilles, return air ducts (except ceiling plenums and mechanical room) to the air handling unit (AHU), the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, humidifiers and dehumidifiers, supply air ducts, fans, fan housing, fan blades, air wash systems, spray eliminators, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the HVAC system. The HVAC system may also include other components such as dedicated exhaust and ventilation components and make-up air systems.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA, NADCA ASCS,NADCA ACR and NADCA HVAC Inspection Manual).

a. All terms in this specification have their meaning defined as stated in the NADCA Standards.

b. Follow NADCA Standards with no modifications or deviations being allowed. Remove visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.

3.1 PREPARATION

3.1.1 HVAC System Inspections And Site Preparations

3.1.1.1 HVAC System Evaluation

Prior to the commencement of any cleaning work, perform a visual inspection of the HVAC system in the presence of the Contracting Officer to determine appropriate methods, tools, and equipment required to satisfactorily complete this project. Cleanliness inspection should include air handling units and representative areas of HVAC system components and ductwork. In HVAC systems that include multiple air handling units, a representative sample of units should be inspected. Notify the Contracting Officer [_____] [10] days prior to the planned inspection. As part of evaluation, record photographs and videos of each inspection location to document the "as found" condition prior to cleaning.

Document damaged system components found during the inspection and submit to the Contracting Officer, clearly labeled "Record of Existing Conditions."

3.1.1.2 Site Evaluation and Preparations

Conduct without negatively impacting indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, implement environmental engineering control measures.

Conduct a site evaluation, and establish a specific, coordination plan which details how each area of the building is protected during the various phases of the project.

3.2 APPLICATION

3.2.1 General HVAC System Cleaning Requirements

3.2.1.1 Containment

Collect debris removed during cleaning and take precautions to ensure that debris is not otherwise dispersed outside the HVAC system during the cleaning process.

3.2.1.2 Particulate Collection

Where the Particulate Collection Equipment (PCE) is exhausting inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or greater). When the PCE is exhausting outside the building, undertake mechanical cleaning operations only with PCE, including adequate filtration to contain debris removed from the HVAC system. When the PCE is exhausting outside the building, take precautions to locate the equipment down wind and away from all air intakes and other points of entry into the building.

3.2.1.3 Controlling Odors

Take all reasonable measures to control offensive odors and/or mist vapors during the cleaning process.

3.2.1.4 Component Cleaning

Employ cleaning methods such that all HVAC system components are Visibly Clean as defined in applicable standards. Upon completion, return all components to those settings recorded just prior to cleaning operations.

3.2.1.5 Air-Volume Control Devices

Mark the position of dampers and any air-directional mechanical devices inside the HVAC system prior to cleaning and, upon completion, restore to their marked position.

3.2.1.6 Service Openings

Utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection. Utilize the existing service openings already installed in the HVAC system where possible.

Create other openings where needed, created and resealed in conformance with NADCA Standard 05. Place closures so they do not significantly hinder, restrict, alter the air-flow within the system, or compromise the structural integrity of the system. Properly insulate closures to prevent heat loss/gain or condensation on surfaces within the system. Conform construction techniques used in the creation of openings to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards. Cutting service openings into flexible duct is not permitted. Disconnect flexible duct at the ends as needed for proper cleaning and inspection.

Reseal rigid fiber glass ductboard duct systems in accordance with NAIMA recommended practices; NAIMA AH112, NAIMA AH122, and NAIMA AH127. Only closure techniques which comply with UL 181, UL 181A, or UL 181B are suitable for fiber glass duct system closures.

Provide access doors for openings that need to be re-opened for future inspection or remediation. Refer to Section 23 30 00 HVAC AIR DISTRIBUTION for access doors. Clearly mark all service openings, capable of being re-opened for future inspection or remediation, and report their location in project report documents.

3.2.1.7 Ceiling Sections (Tile)

Carefully remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process. Replace any damaged ceiling sections caused by the removal at no cost to the Government.

3.2.1.8 Air Distribution Devices (Registers, Grilles and Diffusers)

Clean all air distribution devices.

3.2.1.9 Air Handling Units, Terminal Units, Blowers and Exhaust Fans

Ensure that supply, return, and exhaust fans and blowers are thoroughly cleaned. Areas for cleaning include blowers, fan housings, plenums (except ceiling supply and return plenums), scrolls, blades, or vanes, shafts, baffles, dampers and drive assemblies. Remove all visible surface contamination deposits in accordance with NADCA Standards.

a. Clean all air handling unit (AHU) internal surfaces, components and condensate collectors and drains.

b. Assure that a suitable operative drainage system is in place prior to beginning wash down procedures.

c. Clean all coils and related components, including evaporator fins.

3.2.1.10 Duct Systems

a. Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.

b. Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing NADCA Cleaning Verification Testings Standards.

c. Any exposed edges in internal duct lining within duct, including but not limited to interfaces with externally insulated duct, must be fully protected, sealed and encapsulated to prevent future erosion.

3.2.2 Mechanical Cleaning Methodology

3.2.2.1 Source Removal Cleaning Methods

Clean the HVAC system using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. Select Source Removal methods which will render the HVAC System Visibly Clean and capable of passing NADCA cleaning verification methods Standards and other specified standards and tests, in accordance with all general requirements. Use no cleaning method, or combination of methods, which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

Incorporate the use of vacuum collection devices that are operated continuously during cleaning for all methods used. Connect a vacuum device to the downstream end of the section being cleaned through a predetermined opening. Use a vacuum collection device of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment is assured.

Equip all vacuum devices exhausting air inside the building, including hand-held vacuums and wet-vacuums, with HEPA filters (minimum efficiency).

Equip all vacuum devices exhausting air outside the facility with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system, in a manner that does not allow contaminants to re-enter the facility. Release of debris outdoors which violates any outdoor environmental standards, codes or regulations is not allowed.

All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods include those which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

3.2.2.2 Methods of Cleaning Fibrous Glass Insulated Components

Thoroughly clean glass [thermal] [acoustical] insulation elements present in any equipment or ductwork with HEPA vacuuming equipment. Clean while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.

Do not use cleaning methods that cause damage to fibrous glass components or renders the system capable of passing Cleaning Verification Tests NADCA Standards.

Provide surface treatment for insulation for sections of internally-lined duct. Select and apply encapsulants, coatings, and insulation repair products to completely restore surface integrity of fibrous glass surfaces in accordance with applicable standards and manufacturer's installation instructions.

3.2.2.3 Damaged Fibrous Glass Material

If there is any evidence of damage, deterioration, delamination, friable material, mold or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating, identify them to the Contracting Officer for replacement.

When requested or specified, remediate exposed damaged insulation in air handlers and/or ductwork requiring replacement.

If insulation is damaged as a result of this work under this specification, notify Contracting Officer and initiate a meeting with same to determine options for repair or replacement of insulation.

3.2.2.4 Replacement Material

If replacement of fiber glass materials is required, conform all materials to applicable industry codes and standards, including those of UL and SMACNA 1966.

Replacement of damaged insulation is **not** covered by this specification. Refer to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.2.5 Cleaning of Coils

Use any cleaning method which renders the coil visibly clean and capable of passing NADCA Coil Cleaning Verification Standards. Coil drain pans are subject to Non-Porous Surfaces Cleaning Verification. Maintain operability of the drain for the condensate at all times. Do not damage, displace, inhibit heat transfer, or cause erosion of the coil surface or fins, and conform to coil manufacturer recommendations when available. Thoroughly rinse coils with clean water to remove any latent residues.

3.2.2.6 Antimicrobial Agents and Coatings

Perform application of antimicrobial agents used to control the growth of fungal or bacteriological contaminants after the removal of surface deposits and debris. Perform mold remediation in accordance with ANSI/IICRC S520.

Use only antimicrobial agents registered by the U.S. Environmental Protection Agency (EPA 402-F-91-102) (EPA 402-C-01-001) specifically for use within HVAC system.

Apply antimicrobial agents in strict accordance with manufacturer's instructions.

Use only antimicrobial coating products, for both porous and non-porous surfaces, which are EPA registered, water soluble solutions with supporting efficacy data and SDS records.

Apply antimicrobial coatings according to manufacturer's instructions. Spray coatings directly onto interior ductwork surfaces, rather than "fog" downstream onto surfaces. Achieve a continuous film on the surface treated by the coating application, and apply in strict accordance with manufacturer's minimum millage surface application rate standards for effectiveness.

3.3 FIELD QUALITY CONTROL

3.3.1 CLEANLINESS VERIFICATION

3.3.1.1 General

Verification of HVAC System cleanliness is determined after mechanical cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including antimicrobial agents and coatings.

3.3.1.2 Visual Inspection

Visually inspect the HVAC system to ensure that no visible contaminants are present.

If no contaminants are evident through visual inspection, consider the HVAC system clean; however, further verification of the system cleanliness through gravimetric or wipe testing analysis testing may be requested at the discretion of the Contracting Officer.

If visible contaminants are evident through visual inspection, re-clean those portions of the system where contaminants are visible, and subject to re-inspection for cleanliness.

As part of inspection, record photographs and videos of inspection locations to document post-cleaning condition.

[3.3.1.3 Gravimetric Analysis

At the expense of the **Contractor**, test sections of the HVAC system for cleanliness using the NADCA Vacuum Test (gravimetric analysis) as specified in applicable NADCA Standards. Ensure levels of debris collected are equal to or less than acceptable levels defined in applicable NADCA Standards.

If gravimetric analysis determines that levels of debris are equal to or lower than those levels specified, the system is considered clean and to have passed cleanliness verification.

If gravimetric analysis determines that levels of debris exceed those specified in applicable NADCA standards, the system will not be considered clean, and re-cleaning of those sections of the system which failed cleanliness verification will be required at the expense of the HVAC system cleaning contractor.

Perform cleanliness verification immediately after mechanical cleaning and before the HVAC system is restored to normal operation.

]3.3.1.4 Verification of Coil Cleaning

Cleaning is to restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed. If the original pressure drop is not known, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection (see NADCA HVAC Inspection Manual Standards).

3.3.2 Post-Project Report

At the conclusion of the project, provide a Testing Procedures Summary and

Post-Project Report indicating the following:

a. Success of the cleaning project, as verified through visual inspection [and][or] gravimetric analysis.

b. Areas of the system found to be damaged and/or in need of repair.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 03 00.00 20 (August 2010)**
Change 3 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-23 03 00.00 20 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 03 00.00 20

BASIC MECHANICAL MATERIALS AND METHODS

08/10, CHG 3: 08/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 03 00.00 20 (August 2010)**

Change 3 - 08/18

Preparing Activity: NAVFAC **Superseding**

UFGS-23 03 00.00 20 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 23 03 00.00 20

BASIC MECHANICAL MATERIALS AND METHODS

08/10, CHG 3: 08/18

****

NOTE: This guide specification covers the requirements for the mechanical general requirements for all sections of Divisions: 21, FIRE SUPPRESSION; 22, PLUMBING; and 23 HEATING, VENTILATING AND AIR CONDITIONING.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification can be applied to other divisions of the project specification.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 21, FIRE SUPPRESSION; 22, PLUMBING; and 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

1.3 QUALITY ASSURANCE

1.3.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.3 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.3.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

****

NOTE: Use this paragraph for other than NAVFAC SE projects.

****

[1.5 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

]

****

NOTE: Use this paragraph and its subparagraphs regarding electrical components and energy efficient motors for NAVFAC SE projects.

****

[1.6 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations must conform to IEEE C2, NFPA 70, and requirements specified herein.

1.6.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters [(except starters/controllers which are indicated as part of a motor control center)], control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not to be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, [the motor control equipment forming a part of motor control centers,] and the electrical power circuits must be provided under Division 26, except internal wiring for components of package equipment must be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.6.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

1.6.3 High Efficiency Motors

1.6.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors must be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.6.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors must be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings must meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

1.6.4 Three-Phase Motor Protection

Provide controllers for motors rated one 1.34 kilowatts 1 horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

]1.7 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.8 ACCESSIBILITY

****

NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when he has some control over locations. However, designer's should not rely on it at all since enforcing this requirement in the field would be difficult. Therefore, the system designer needs to layout and indicate the locations

of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

****

NOTE: For NAVFAC SE projects, delete all painting requirements and specify as follows: "PART 3 EXECUTION, Not used."

****

3.1 PAINTING OF NEW EQUIPMENT

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for the temperature service.

3.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm 1 mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm 1 mil per coat.

b. Temperatures Between 50 and 205 Degrees C 120 and 400 Degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F must receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 Degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F must receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 05 15 (May 2022)**
Change 2 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-23 05 15 (February 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 15

COMMON PIPING FOR HVAC

05/22, CHG 2: 08/24

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 05 15 (May 2022)**
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****

SECTION 23 05 15

COMMON PIPING FOR HVAC
05/22, CHG 2: 08/24

****

NOTE: This guide specification covers the requirements for standard basic mechanical work and should be supplemented by use of other mechanical sections as required.

Show on the drawings detailed upstream and downstream piping anchor provisions.

Install flexible metallic pipe vertically to keep dirt out of convolutions.

Coordinate design detail and specification for each installation with the manufacturer to ensure that length, stiffness of hose, and slack are suitable for the intended offset, travel, and imposed service under normal and shock conditions.

Indicate on the drawings use of flexible metal steam for main steamline dripping where amount of expansion and contraction is such that movement cannot be readily accommodated by piping configuration, with excessive stress on pressurized components or where there is a tendency to cause leaks at connections to mains. Tunnels, trenches, manholes, and above-ground steamlines are prime locations; ensure the pressure rating accounts for water-hammer shock. This specification is limited to 15 millimeter through 25 millimeter 1/2 inch through 1 inch. Use welded pipe, valve, and hole connections wherever possible. Provide a welded end steam strainer upstream of hose to prevent welding bead penetration of bellows upon start up. Wherever possible, install flexible metal steam hose vertically.

Show on the Drawings, or supplement the specifications to include, calculated movement of piping, operating pressure and temperature ranges, fluid velocity, piping anchor and guiding

provisions, limit stops, installation length, end connections, and special conditions such as angular displacement and vibration analysis in one or more planes.

This specification does not include slip-type expansion joints or ball joints.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.18.1/CSA B125.1	(2024) Plumbing Supply Fittings
ASME A112.19.2/CSA B45.1	(2024) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME B1.20.7	(1991; R 2013) Standard for Hose Coupling Screw Threads (Inch)
ASME B1.21M	(1997; R 2013; R 2018; R 2023) Standard for Metric Screw Threads - MJ Profile
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.25	(2022) Buttwelding Ends
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.3	(2022; Errata 2023) Process Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2024b) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A74	(2021) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A197/A197M	(2020; R 2023; E 2023) Standard Specification for Cupola Malleable Iron
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A278/A278M	(2001; R 2024) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A307	(2021) Standard Specification for Carbon

	Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A480/A480M	(2024a) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A888	(2024) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B749	(2020) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C67/C67M	(2024) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C404	(2024) Standard Specification for Aggregates for Masonry Grout
ASTM C476	(2023) Standard Specification for Grout for Masonry
ASTM C553	(2024) Standard Specification for Mineral

	Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C564	(2020a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2308	(2007; R 2013) Standard Specification for Thermoplastic Polyethylene Jacket for Electrical Wire and Cable
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E814	(2024) Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials
ASTM F568M	(2007) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners
ASTM F2389	(2024a) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 310	(2012) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

FLUID SEALING ASSOCIATION (FSA)

FSA-0017	(1995e6) Standard for Non-Metallic Expansion Joints and Flexible Pipe Connectors Technical Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 515	(2017) Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications

IEEE C2	(2023) National Electrical Safety Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2022) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-125	(2010) Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-18480	(1982; Rev B; Notice 2 2009; Notice 3 2022) Coating Compound, Bituminous, Solvent, Coal-Tar Base
MIL-DTL-17813	(2009; Rev H; Supp 1 2009; Notice 1 2013; Notice 2 2018; Notice 3 2023) Expansion Joints, Pipe, Metallic Bellows, General Specification for

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1922	(Rev A; Notice 1; Notice 2; Notice 3; Notice 4) Shield, Expansion (Caulking Anchors, Single Lead)
CID A-A-1923	(Rev A; Notice 1; Notice 2; Notice 3; Notice 4) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-1924	(Rev A; Notice 3) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors
CID A-A-1925	(Rev A; Notice 1; Notice 2; Notice 3; Notice 4) Shield Expansion (Nail Anchors)
CID A-A-55614	(Basic; Notice 2) Shield, Expansion (Non-Drilling Expansion Anchors)
CID A-A-55615	(Basic; Notice 1; Notice 2; Notice 3; Notice 4) Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors

UL SOLUTIONS (UL)

UL 1479	(2015; Reprint Apr 2024) Fire Tests of Through-Penetration Firestops

1.2 GENERAL REQUIREMENTS

****

NOTE: If Section 23 30 00 HVAC AIR DISTRIBUTION is not included in the project specification, applicable requirements thereof should be inserted and the first paragraph deleted. If Section 23 05 48.19 SEISMIC BRACING FOR HVAC is not included in the project specification, applicable requirements thereof should be inserted and the second paragraph deleted. If Section 40 05 13.96 WELDING PROCESS PIPING is not included in the project specification, applicable requirements thereof should be inserted and the third paragraph deleted.

****

[a. Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section

][b. Section 23 05 48.19 SEISMIC BRACING FOR HVAC applies to work specified in this section.

][c. Section 40 05 13.96 WELDING PROCESS PIPING applies to work specified in this section.

] d. Submit Records of Existing Conditions consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite.

Commencement of work constitutes acceptance of the existing conditions.

e. Include with Equipment Foundation Data for piping systems all plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

f. Submit Fabrication Drawings for pipes, valves and specialties consisting of fabrication and assembly details to be performed in the factory.

g. Submit Material, Equipment, and Fixture Lists for pipes, valves and specialties including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. Provide a complete list of construction equipment to be used.

h. Submit Manufacturer's Standard Color Charts for pipes, valves and specialties showing the manufacturer's recommended color and finish selections.

i. Include with Listing of Product Installations for piping systems identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Include in the list purchaser, address of installation, service organization, and date of installation.

j. Submit Record Drawings for pipes, valves and accessories providing current factual information including deviations and amendments to the drawings, and concealed and visible changes in the work.

k. Submit Connection Diagrams for pipes, valves and specialties indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

l. Submit Coordination Drawings for pipes, valves and specialties showing coordination of work between different trades and with the structural and architectural elements of work. Detail all drawings sufficiently to show overall dimensions of related items, clearances, and relative locations of work in allotted spaces. Indicate on drawings where conflicts or clearance problems exist between various trades.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists[; G, [_____]]

SD-02 Shop Drawings

Record Drawings[; G, [_____]]

Connection Diagrams[; G, [_____]]

Coordination Drawings[; G, [_____]]

Fabrication Drawings[; G, [_____]]

Installation Drawings[; G, [_____]]

SD-03 Product Data

Pipe and Fittings[; G, [_____]]

Piping Specialties[; G, [_____]]

Valves[; G, [_____]]

Miscellaneous Materials[; G, [_____]]

Supporting Elements[; G, [_____]]

Equipment Foundation Data[; G, [_____]]

SD-04 Samples

Manufacturer's Standard Color Charts[; G, [_____]]

SD-05 Design Data

Pipe and Fittings[; G, [_____]]

Piping Specialties[; G, [_____]]

Valves[; G, [_____]]

SD-06 Test Reports

Hydrostatic Tests[; G, [_____]]

Air Tests[; G, [_____]]

Valve-Operating Tests[; G, [_____]]

Drainage Tests[; G, [_____]]

Pneumatic Tests[; G, [_____]]

Non-Destructive Electric Tests[; G, [_____]]

System Operation Tests[; G, [_____]]

SD-07 Certificates

Record of Satisfactory Field Operation[; G, [_____]]

List of Qualified Permanent Service Organizations[; G, [_____]]

Listing of Product Installations[; G, [_____]]

Records of Existing Conditions[; G, [_____]]

Surface Resistance[; G, [_____]]

Shear and Tensile Strengths[; G, [_____]]

Temperature Ratings[; G, [_____]]

Bending Tests[; G, [_____]]

Flattening Tests[; G, [_____]]

Transverse Guided Weld Bend Tests[; G, [_____]]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals[; G, [_____]]

1.4 QUALITY ASSURANCE

1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Provide standard products in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.4.2 Alternative Qualifications

Products having less than a two-year field service record are acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.3 Service Support

Ensure the equipment items are supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. Select service organizations that are reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.4.4 Manufacturer's Nameplate

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

1.4.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer.

1.4.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions are considered mandatory, the word "should" is interpreted as "shall." Reference to the "code official" is interpreted to mean the "Contracting Officer." For Navy owned property, interpret references to the "owner" to mean the "Contracting Officer." For leased facilities, references to the "owner" is interpreted to mean the "lessor." References to the "permit holder" are interpreted to mean the "Contractor."

1.4.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, are applied as appropriate by the Contracting Officer and as authorized by his administrative cognizance and the FAR.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

[1.6 ELECTRICAL REQUIREMENTS

****

NOTE: Use this paragraph for other than SOUTHNAVFACENGCOM projects.

****

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Ensure motors, controllers, disconnects and contactors conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors is not permitted. Provide controllers and contactors with a maximum of 120 volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, include the cost of additional electrical service and related work under the section that specified that motor or equipment. Provide power wiring and conduit for field installed equipment under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

][1.7 ELECTRICAL INSTALLATION REQUIREMENTS

****

NOTE: Use this paragraph and its subparagraphs regarding electrical components and energy efficient motors for SOUTHNAVFACENGCOM projects.

****

Ensure electrical installations conform to IEEE C2, NFPA 70, and requirements specified herein.

1.7.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters [(except starters/controllers which are indicated as part of a motor control center)], control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not permitted. Provide under Division 26, the interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, [the motor control equipment forming a part of motor control centers,] and the electrical power circuits, except internal wiring for components of package equipment is provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.7.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

1.7.3 High Efficiency Motors

1.7.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, provide high efficiency single-phase fractional-horsepower alternating-current motors corresponding to the applications listed in NEMA MG 11.

1.7.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, select polyphase motors based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, ensure polyphase squirrel-cage medium induction motors with continuous ratings meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

1.7.4 Three-Phase Motor Protection

Provide controllers for motors rated one 1.34 kilowatts one horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

]1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Provide instructors thoroughly familiar with all parts of the installation and trained in operating theory as well as practical operation and maintenance work.

Give instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished is as specified in the individual section. When more than four man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY

****

NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when he has some control over locations. However, designers should not rely on it at all since enforcing this requirement in the field would be difficult. Therefore, the system designer needs to layout and indicate the locations of

equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 ELECTRICAL HEAT TRACING

Provide heat trace systems for pipes, valves, and fittings that are in accordance with IEEE 515 and be UL listed. System include all necessary components, including heaters and controls to prevent freezing.

Provide self-regulating heaters consisting of two 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature along its length. Ensure heater is able to be crossed over itself without overheating. Obtain approval before used directly on plastic pipe. Cover heater with a radiation cross-linked modified polyolefin dielectric jacket in accordance with ASTM D2308.

[For installation on plastic piping, apply the heater using aluminum tape. Provide heater with an outer braid of tinned-copper and an outer jacket of modified polyolefin in accordance with ASTM D2308, to provide a good ground path and to enhance the heater's ruggedness.

] **

NOTE: Self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 4 degrees C 40 degrees F pipe temperature operation to 66 degrees C 150 degrees F pipe temperature operation.

****

Provide heater with self-regulating factor of at least [90] [_____] percent, in order to provide energy conservation and to prevent overheating.

Operate heater on line voltages of [120] [208] [220] [240] [277] volts without the use of transformers.

****

NOTE: Required heater output rating is in watts per meter at 10 degrees C foot at 50 degrees F. Heater selection based on 25 millimeter one-inch fiberglass insulation on metal piping.

****

Size Heater according to the following table:

Pipe Size (DN)

(Millimeter Diameter)	Minus 23 degrees C	Minus 29 degrees C
80 or less	16 watts per meter (wpm)	16 watts per meter (wpm)
100	16 wpm	26 wpm
150	26 wpm	26 wpm
200	2 strips/16 wpm	2 strips/26 wpm
300 to 356	2 strips/26 wpm	2 strips/26 wpm

Pipe Size

(Inch, Diameter)	Minus 10 degrees F	Minus 20 degrees F
3 inches or less	5 watts per foot (wpf)	5 wpf
4 inch	5 wpf	8 wpf
6 inch	8 wpf	8 wpf
8 inch	2 strips/5 wpf	2 strips/8 wpf
12 inch	2 strips/8 wpf	2 strips/8 wpf

Control systems by an ambient sensing thermostat set at 4 degrees C 40 degrees F either directly or through an appropriate contactor.

2.2 PIPE AND FITTINGS

****

NOTE: Do not use press fittings on NAVFAC projects. Do not use grooved connections on NAVFAC projects.

****

Submit equipment and performance data for pipe and fittings consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis. Submit design analysis and calculations consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

2.2.1 Type BCS, Black Carbon Steel

****

NOTE: This pipe is applicable for chilled, hot, dual-temperature, and cooling-tower water. Refer to Specification Section 23 64 26 for system details.

****

Ensure pipe DN6 through DN300 1/8 through 12 inches is Schedule 40 black carbon steel, conforming to ASTM A53/A53M.

Ensure pipe DN6 through DN250 1/8 through 10 inches is Schedule 40 seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M, [Type E, Grade B (electric-resistance welded)] [Type S (seamless)]. Grade A should be used for permissible field bending, in both cases.

Ensure pipe DN300 through DN610 12 through 24 inches is 9.52 millimeter 0.375-inch wall seamless black carbon steel, conforming to ASTM A53/A53M, [Type E, Grade B (electric-resistance welded)] [Type S (seamless)].

Ensure fittings DN50 and under 2 inches and under are 1034 kilopascal 150-pounds per square inch, gage (psig) working steam pressure (wsp) banded black malleable iron screwed, conforming to ASTM A197/A197M and ASME B16.3.

Ensure unions DN50 and under 2 inches and under are 1724 kilopascal 250 pounds per square inch, wsp female, screwed, black malleable iron with brass-to-iron seat, and ground joint, conforming to ASME B16.39.

Ensure fittings DN65 and over 2-1/2 inches and over are Steel butt weld, conforming to ASTM A234/A234M and ASME B16.9 to match pipe wall thickness.

Ensure flanges DN65 and over 2-1/2 inches and over are 1034 kilopascal 150-pound forged-steel conforming to ASME B16.5, welding neck to match pipe wall thickness.

2.2.2 Type BCS-125, 862 kilopascal Service 125-psi Service

****

NOTE: This pipe is applicable for steam- and condensate-piping systems at pressures less than 862 kilopascal 125 pounds per square inch (psi). Avoid screwed-end connections in condensate piping wherever possible. See Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS for black carbon steel pipe for higher pressure ratings.

****

Ensure pipe DN6 through DN40 1/8 through 1-1/2 inches is Schedule 40 steam, Schedule 80 condensate, furnace butt weld, black carbon steel, conforming to ASTM A53/A53M, Type F (furnace butt welded, continuous welded) and ASME B36.10M.

Ensure pipe DN50 through DN250 2 through 10 inches is Schedule 40 steam, Schedule 80 condensate, seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M [Type E, Grade B (electric-resistance welded)] [Type S (seamless)] and ASME B36.10M.

****

NOTE: For condensate piping, modify following (for DN300 12 inches and over) to schedule 40 or schedule 80, if necessary.

****

Ensure pipe DN300 through DN610 12 through 24 inches is 9.52 millimeter 0.375-inch wall, [seamless] [electric-resistance] welded black carbon steel, conforming to ASTM A53/A53M [Type E, Grade B (electric-resistance welded)] [Type S (seamless) and ASME B36.10M].

[Ensure fittings DN50 and under 2 inches and under are 862 kilopascal 125-psig wsp, cast iron, screwed end, conforming to ASTM A126 Class A and ASME B16.4.

][Ensure fittings DN50 and under 2 inches and under are 1034 kilopascal 150-psig wsp banded black malleable iron screwed, conforming to ASTM A197/A197M and ASME B16.3.

][Ensure fittings DN25 through DN50 1 through 2 inches are 14 or 21 megapascal 2,000-or 3,000-psi water, oil, or gas (wog) to match pipe wall, forged carbon steel socket weld, conforming to ASTM A105/A105M and ASME B16.11.

][Ensure fittings DN50 and under 2 inches and under are 862 kilopascal 125-psig wsp, cast iron, screwed end, conforming to ASTM A126 Class A and ASME B16.4.

][Ensure fittings DN65 and over 2-1/2 inches and over are wall thickness to match pipe, long radius butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB and ASME B16.9.

][Ensure couplings DN50 and under 2 inches and under are commercial standard weight for Schedule 40 pipe and commercial extra heavy weight for Schedule 80 pipe, black carbon steel where threaded, and 14 or 21 megapascal 2,000-or 3,000-psi wog forged carbon steel, conforming to ASTM A105/A105M and ASME B16.11, where welded.

][Ensure flanges DN65 and over 2-1/2 inches and over are 1035 kilopascal, 150-pound, forged carbon-steel welding neck, with raised face or flat face and concentric serrated finish, conforming to ASTM A105/A105M and ASME B16.5.

][Conform grooved pipe couplings and fittings in accordance with paragraph GROOVED PIPE COUPLINGS AND FITTINGS.

]2.2.3   Type GCS, Galvanized Carbon Steel

****

NOTE: This pipe is applicable for potable water and rain water leader systems.

****

Ensure pipe DN15 through DN250, and where indicated 1/2 through 10 inches, and where indicated is Schedule 40 seamless or electric-resistance welded galvanized steel conforming to ASTM A53/A53M, Type E, Grade B (electric-resistance welded) or Type S (seamless).

Ensure pipe DN300 and over 12 inches and over is 9.52 millimeter 0.375-inch wall, seamless, galvanized steel, conforming to ASTM A53/A53M, Grade B.

Ensure fittings DN50 and under 2 inches and under are 1034 kilopascal 150-psig wsp banded galvanized malleable iron screwed, conforming to ASTM A197/A197M and ASME B16.3.

Ensure unions DN50 and under 2 inches and under are 1034 kilopascal 150-psig wsp female, screwed, galvanized malleable iron with brass-to-iron seat and ground joint.

Ensure fittings DN65 and over 2-1/2 inches and over are 862 kilopascal 125-psig wsp cast-iron flanges and flanged fittings, conforming to ASTM A126, Class A and ASME B16.1.

Conform grooved pipe couplings and fittings in accordance with paragraph GROOVED PIPE COUPLINGS AND FITTINGS.

As an option, use 1034 kilopascal 150-psig wsp banded galvanized malleable iron screwed fittings, conforming to ASTM A197/A197M and ASME B16.3.

2.2.4 Type GCS-DWV, Galvanized Steel Drain, Waste and Vent

****

NOTE: Nonferrous piping exposed to view in finished spaces and normally chrome plated is specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Select A53 pipe where bending and flattening tests are required.

****

Ensure pipe (all sizes) is Schedule 40 [seamless] [electric-resistance welded] galvanized carbon steel, conforming to ASTM A53/A53M, Grade A.

Furnace butt weld pipe is acceptable for sizes less than DN50 2 inches.

[Provide risers DN80 3 inches and larger are Type CISP-DWV.

][Ensure fittings are galvanized, [coated] [uncoated], screwed, cast iron, recessed pattern drainage fittings, conforming to ASTM A126.

][Use long radius fittings wherever space permits. Short-turn tees, branches, and ells may be used for vent piping and connections of branch lines to battery fixtures, except wall-hung water closets.

]2.2.5 Type CISP-DWV, Cast-Iron Drain, Waste and Vent

****

NOTE: When project requires risers DN80 3 inches and larger, include Type CISP-DWV materials specification.

****

[Provide soil pipe drain, waste, and vent bell-and-spigot type pipe cast iron, conforming to ASTM A74.[Joints shall be two-gasket system type neoprene, conforming to ASTM C564.][Caulk and lead all joints in lines to provide proper leaktight support and alignment.] Select the extra heavy (CISP-DWV-XH) pipe class.

][Provide soil pipe drain, waste, and vent hubless cast iron pipe and fittings, conforming to ASTM A888. Joints shall be heavyweight no-hub couplings with stainless steel clamps, conforming to CISPI 310.

]2.2.6 Type CPR, Copper

****

NOTE: Copper pipe above ground and below ground is acceptable for chilled, hot, dual-temperature, cooling-tower water, and potable-water systems. Refer to Sections 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS and 22 00 00 PLUMBING, GENERAL PURPOSE for system details.

****

2.2.6.1 Type CPR-A, Copper Above Ground

Ensure tubing DN50 and under 2 inches and under is seamless copper tubing, conforming to ASTM B88M, ASTM B88, Type L (hard-drawn for all horizontal and all exposed vertical lines, annealed for concealed vertical lines).

Ensure fittings DN50 and under 2 inches and under are 1034 kilopascal 150-psig wsp wrought-copper solder joint fittings conforming to ASME B16.22.

Ensure unions DN50 and under 2 inches and under are 1034 kilopascal 150-psig wsp wrought-copper solder joint, conforming to ASME B16.22.

[Provide brazing rod with Classification BCuP-5, conforming to AWS A5.8/A5.8M.

][Use solder, alloy Sb-5, conforming to ASTM B32.

]

2.2.6.2 Type CPR-U, Copper Under Ground

****

NOTE: For sizes under DN80 3 inches.

****

Provide Type K seamless copper tube piping, conforming to ASTM B88M ASTM B88. Use wrought copper socket-joint fittings, conforming to ASME B16.22. Ensure fittings for connection to corporation cocks are cast bronze, flared-type, conforming to ASME B16.26. Braze the joints.

2.2.6.3 Type CPR-INS, Copper Under Ground Insulated

****

NOTE: Type CPR-INS material is commercially available in sizes to and including DN105 4 inches OD.

Since pipe is protected from soil by insulation system, Type L copper tube may be used if suitable for water carried at a cost saving of 10 percent.

Type CPR-INS material may be used for hot water supply and return connected to tunnel mains.

****

Provide insulated Type K seamless copper tube piping conforming to ASTM B88M ASTM B88. Use wrought copper socket-joint fittings, conforming to ASME B16.22. Braze the joints.

Provide insulation not less than DN50 2 inches thick, suitable for continuous service temperatures of not less than 121 degrees C 250 degrees F. Use factory-molded, closed-cell polyurethane foam insulation of not less than 40 kilogram per cubic meter 2.5 pounds per cubic foot density. Waterproof insulation with an extruded rigid Type II virgin polyvinylchloride, with minimum wall thickness of 1.52 millimeter through 102 millimeter 60 mils through 4 inches outside diameter, 2.16 millimeter through 168.28 millimeter 85 mils through 6.625 inches and 2.79 millimeter through 273 millimeter 110 mils through 12.750 inches. Provide fitting covers fabricated from the same materials and thickness as adjacent pipe covering according to the manufacturer's directions.

2.2.7 Polypropylene Pipe

Pipe is manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F2389. Pipe is made in a three layer extrusion process. Piping contains a fiber layer (faser) to restrict thermal expansion. Pipe complies with the rated pressure requirements of ASTM F2389. Ensure layers are incorporated in the pipe wall to limit thermal expansion to 3.38 cm per degree C per meter 2 1/4-inches per 100 F per 100-ft. If the hydronic system includes ferrous components, an oxygen barrier is required in pipe wall.

Ensure pipe is certified by NSF International as complying with NSF/ANSI 14, and ASTM F2389.

Ensure pipe wrap or insulation meets the requirements of ASTM E84. Ensure the system has a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.

Where pipe is exposed to direct UV light for more than 30 days, provide a Factory applied, UV-resistant coating or alternative UV protection.

2.2.8 Grooved Pipe Couplings and Fittings

****

NOTE: Do not use grooved connections on NAVFAC projects.

****

Provide housing for all couplings, fabricated in two or more parts, of black, ungalvanized malleable iron castings. Ensure coupling gasket is molded synthetic rubber, conforming to ASTM D2000. Ensure coupling bolts are oval-neck, track-head type, with hexagonal heavy nuts conforming to ASTM A183.

Fabricate all pipe fittings used with couplings of black, ungalvanized malleable iron castings. Where a manufacturer's standard-size malleable iron fitting pattern is not available, approved fabricated fittings may be used.

Fabricate fittings from Schedule 40 or 19 millimeter 0.75-inch wall ASTM A53/A53M, Grade B seamless steel pipe; long radius seamless welding fittings with wall thickness to match pipe, conforming to ASTM A234/A234M and ASME B16.9.

2.3 PIPING SPECIALTIES

Submit equipment and performance data for piping specialties consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis. Submit design analysis and calculations consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

2.3.1 Air Separator

Air separated from converter discharge water is ejected by a reduced-velocity device vented to the compression tank.

[Provide a commercially constructed separator, designed and certified to separate not less than 80 percent of entrained air on the first passage of water and not less than 80 percent of residual on each successive pass. Provide shop drawings detailing all piping connections proposed for this work.

][Ensure the air separator is carbon steel, designed, fabricated, tested, and stamped in conformance with ASME BPVC SEC VIII D1 for service pressures not less than 862 kilopascal 125 psi.

]2.3.2 Air Vents

[Provide manual air vents using 10 millimeter 3/8-inch globe valves.

] **

NOTE: This size vent is suitable for most systems, and passes 9.40 liter per second of free air 20 cubic feet of free air per minute at a system pressure of 862 kilopascal 125 psi. Where a system is filled at a certain rate, larger vents or a multiple assembly with safety features should be used.

****

[Provide automatic air vents on pumps, mains, and where indicated using ball-float construction. Ensure the vent inlet is not less than DN20 3/4-inch ips and the outlet not less than 8 millimeter 1/4-inch ips. Orifice size is 3 millimeter 1/8 inch. Provide corrosion-resistant steel trim conforming to [ASTM A276/A276M] [ASTM A480/A480M]. Fit vent with try-cock. Ensure vent discharges air at any pressure up to 1034 kilopascal 150 psi. Ensure outlet is copper tube routed.

]2.3.3 Compression Tank

Provide compression tank designed, fabricated, tested, and stamped for a working pressure of not less than 862 kilopascal 125 psi in accordance with ASME BPVC SEC VIII D1. Ensure tank is hot-dip galvanized after fabrication to produce not less than 51 grams 1.5 ounces of zinc coating per square meter foot of single-side surface.

Tank accessories include red-lined gage-glass complete with glass protectors and shutoff valves, air charger and drainer, and manual vent.

2.3.4 Dielectric Connections

Electrically isolate dissimilar pipe metals from each other by couplings, unions, or flanges commercially manufactured for that purpose and rated for the service pressure and temperature.

2.3.5 Expansion Vibration Isolation Joints

****

NOTE: Drawings should show detailed piping anchor provisions where expansion vibration isolation joints are used.

This joint may also serve as a dielectric connector.

****

Construct single or multiple arch-flanged expansion vibration isolation joints of steel-ring reinforced chloroprene-impregnated cloth materials. Design joint to absorb the movement of the pipe sections in which installed with no detrimental effect on the pipe or connected equipment. Back flanges with ferrous-metal backing rings. Provide control rod assemblies to restrict joint movement. Coat all nonmetallic exterior surfaces of the joint with chlorosulphonated polyethylene. Provide grommets in limit bolt hole to absorb noise transmitted through the bolts.

****

NOTE: If other elastomers are substituted for chloroprene, temperature limits may be lowered to 82 degrees C 180 degrees F or less.

****

Ensure joints are suitable for continuous-duty working temperature of at least 121 degrees C 250 degrees F.

****

NOTE: Select the following paragraph where solids accumulating in arch would cause cutting of carcass. Note that all movements will be reduced by 50 percent.

****

Fill arches with soft chloroprene.

Ensure joint, single-arch, movement limitations and size-related, pressure characteristics conform to FSA-0017.

2.3.6 Flexible Pipe

****

NOTE: Drawings should show detailed upstream and downstream piping anchor provisions and location with respect to axis of motion where flexible pipe is used.

Grooved couplings and vibration-isolated pipe hangers should be considered.

Flexible pipe may also serve as a dielectric connector.

Select following paragraph for manufacturer's standard-service pipe.

****

Construct flexible pipe vibration and pipe-noise eliminators of wire-reinforced, rubber-impregnated cloth and cord materials and be flanged. Back the flanges with ferrous-metal backing rings. Ensure service pressure-rating is a minimum 1.5 times actual service, with surge pressure at 82 degrees C 180 degrees F.

****

NOTE: Anticipated life of chloroprene units at 121 degrees C 250 degrees F is 5 to 10 years.

****

Construct flexible pipe vibration and pipe noise eliminators of wire-reinforced chloroprene-impregnated cloth and cord materials. Ensure the pipe is flanged. Provide all flanges backed with ferrous-metal backing rings. Coat nonmetallic exterior surfaces of the flexible pipe with an acid- and oxidation-resistant chlorosulphonated polyethylene. Rate the flexible pipe for continuous duty at 896 kilopascal and 121 degrees C 130 psi and 250 degrees F.

Ensure unit pipe lengths, face-to-face, are not less than the following:

****

NOTE: The following lengths are basic recommendations: each application should be reviewed for optimum length.

****

INSIDE DIAMETER (DN)	UNIT PIPE LENGTH
[To 65, inclusive	305 millimeter
80 to 100, inclusive	450 millimeter
125 to 300, inclusive	600 millimeter]
[To 80, inclusive	450 millimeter
110 to 250, inclusive	600 millimeter
300 and larger	914 millimeter]

INSIDE DIAMETER	UNIT PIPE LENGTH
[To 2-1/2 inches, inclusive	12 inches
3 to 4 inches, inclusive	18 inches
5 to 12 inches, inclusive	24 inches]
[To 3 inches, inclusive	18 inches
4 to 10 inches, inclusive	24 inches
12 inches and larger	36 inches]

2.3.7 Flexible Metallic Pipe

Ensure flexible pipe is the bellows-type with wire braid cover and designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Minimum working pressure rating is [345] [690] kilopascal at 149 degrees C [50] [100] psi at 300 degrees F.

[Ensure minimum burst pressure is [four] [_____] times working pressure at 149 degrees C 300 degrees F. Bellows material is AISI Type 316L corrosion-resistant steel. Ensure braid is AISI 300 series corrosion-resistant steel wire.

][Ensure welded end connections are Schedule 80 carbon steel pipe, conforming to ASTM A106/A106M, Grade [B] [C].

][Provide threaded end connections; hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A312/A312M.

][Ensure flanged end connection rating and materials conform to specifications for system primary-pressure rating.

]2.3.8 Flexible Metal Steam Hose

Provide a bellows type hose with wire braid cover and designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Ensure the working steam pressure rating is 862 kilopascal at 260 degrees C 125 psi at 500 degrees F.

[Ensure minimum burst pressure is [four] [_____] times working steam pressure at 149 degrees C 300 degrees F.

] Ensure bellows material is AISI Type 316L corrosion-resistant steel. Braid is AISI Type 300-series corrosion-resistant steel wire.

[Provide welded end connections; Schedule 80 carbon steel pressure tube, conforming to ASTM A106/A106M, Grade [B] [C].

][Provide threaded end connections; hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A312/A312M.

][Ensure flanged end connection rating and materials conform to specifications for system primary-pressure rating.

]2.3.9 Metallic Expansion Joints

[Provide metallic-bellows expansion joints conforming to MIL-DTL-17813.

][Provide Type I expansion joints; (corrugated bellows, unreinforced), [Class 1 (single bellows, expansion joint)], [Class 2 (double bellows, expansion joint)].

] Design and construct joints to absorb all of the movements of the pipe sections in which installed, with no detrimental effect on pipe or supporting structure.

Rate, design, and construct joints for pressures to 862 kilopascal 125 psig and temperatures to 260 degrees C 500 degrees F.

Ensure joints have a designed bursting strength in excess of [four] [_____] times their rated pressure.

Ensure joints are capable of withstanding a hydrostatic test of 1.5 times their rated pressure while held at their uncompressed length without leakage or distortion that may adversely affect their life cycle.

Ensure life expectancy is not less than 10,000 cycles.

Ensure movement capability of each joint exceeds calculated movement of piping by [100] [_____] percent.

Provide bellows and internal sleeve material of AISI Type 304, 304L, or 321 corrosion-resistant steel.

End connections require no field preparation other than cleaning.

[Butt weld end preparation of expansion joints conform to the same codes and standards requirements as applicable to the piping system materials at the indicated joint location.

][Flanges of flanged-end expansion joints conforms to the same codes and standard requirements as are applicable to companion flanges specified for the given piping system at the indicated joint location.

] Provide joints, DN65 2-1/2 inches and smaller, with internal guides and limit stops.

Provide joints, DN80 3 inches and larger, with removable external covers, internal sleeves, and purging connection. Size sleeves to accommodate lateral clearance required, with minimum reduction of flow area, and with oversized bellows where necessary. When a sleeve requires a gasket as part of a locking arrangement, provide the gasket used by the manufacturer. Joints without purging connection may be provided; however, remove these from the line prior to, or not installed until, cleaning operations are complete.

[Provide the cylindrical end portion of the reinforced bellows element with a thrust sleeve of sufficient thickness to bring that portion within applicable code-allowable stress. Provide 360 degrees support for the element and end-reinforcing ring with the sleeve.

][Ensure expansion joints have four, equidistant, permanent tram points clearly marked on each joint end. Locate points to prevent obliteration during installation. Include distance between tram points indicating installed lengths in shop drawings. Overall dimension after joint installation is subject to approval from the Contracting Officer.

] Ensure each expansion joint has adjustable clamps or yokes provided at quarter points, straddling the bellows. Overall joint length is set by the manufacturer to maintain joints in manufacturer's recommended position during installation.

****

NOTE: Securely anchor pipe lines containing expansion joints to completely resist the thrust due to the pressure acting on the full internal area of the corrugations. Also, properly guide the pipe to prevent misalignment of the joint. Correlate details of anchors and guides for each application.

****

Permanently and legibly mark each joint with the manufacturer's name or trademark and serial number; the size, series, or catalog number; bellows material; and directional-flow arrow.

2.3.10 Hose Faucets

****

NOTE: Normally delete vacuum breaker when faucets

are installed in non-potable-water lines.
****

Construct hose faucets with 15 millimeter 1/2 inch male inlet threads, hexagon shoulder, and 20 millimeter 3/4 inch hose connection, conforming to ASME A112.18.1/CSA B125.1. Ensure hose-coupling screw threads conform to ASME B1.21M ASME B1.20.7.

Provide vandal proof, atmospheric-type vacuum breaker on the discharge of all potable water lines.

2.3.11 Pressure Gages

Ensure pressure gages conform to ASME B40.100 and to requirements specified herein. Pressure-gage size is 90 millimeter 3-1/2 inches nominal diameter. Ensure case is corrosion-resistant steel, conforming to any of the AISI 300 series of ASTM A6/A6M, with an ASM No. 4 standard commercial polish or better. Equip gages with adjustable red marking pointer and damper-screw adjustment in inlet connection. Align service-pressure reading at midpoint of gage range. Ensure all gages are Grade B or better and be equipped with gage isolators.

****
NOTE: Retain the following paragraph only if pressure gages are used on steam piping.
****

[Fit steam gages with black steel syphons and steam service pressure-rated gage cocks or valves.

]2.3.12 Sight-Flow Indicators

Construct sight-flow indicators for pressure service on 80 millimeter 3-inch ips and smaller of bronze with specially treated single- or double-glass sight windows and have a bronze, nylon, or tetrafluoroethylene rotating flow indicator mounted on an AISI Type [304] [316] corrosion-resistant steel shaft. Body may have screwed or flanged end. Provide pressure- and temperature-rated assembly for the applied service. Flapper flow-type indicators are not acceptable.

2.3.13 Sleeve Couplings

Sleeve couplings for plain-end pipe consist of one steel middle ring, two steel followers, two chloroprene or Buna-N elastomer gaskets, and the necessary steel bolts and nuts.

2.3.14 Thermometers

Ensure thermometers conform to ASTM E1, except for being filled with a red organic liquid. Provide an industrial pattern armored glass thermometer, (well-threaded and seal-welded). Ensure thermometers installed 1800 millimeter 6 feet or higher above the floor have an adjustable angle body. Ensure scale is not less than 180 millimeter 7 inches long and the case face is manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Thermometer range is [_____]. Provide thermometers with nonferrous separable wells. Provide lagging extension to accommodate insulation thickness.

2.3.15 Pump Suction Strainers

****

NOTE: To preclude cavitation, check the following conditions prior to specifying: NPSH, flow rate, open area, screen size, and pressure drop across strainer.

****

Provide a cast iron strainer body, rated for not less than 172 kilopascal at 38 degrees C 25 psig at 100 degrees F, with flanges conforming to ASME B16.1, Class 125. Strainer construction is such that there is a machined surface joint between body and basket that is normal to the centerline of the basket.

Ensure minimum ratio of open area of each basket to pipe area is 3 to 1. Provide a basket with AISI 300 series corrosion-resistant steel wire mesh with perforated backing.

Ensure mesh is capable of retaining all particles larger than 1,000 micrometer, with a pressure drop across the strainer body of not more than 5 kilopascal 0.5 psi when the basket is two-thirds dirty at maximum system flow rate. Provide reducing fittings from strainer-flange size to pipe size.

Provide a [differential-pressure gage][pressure gage with 2 kilopascal 0.25-pound graduations] fitted with a two-way brass cock across the strainer.

Provide manual air vent cocks in cap of each strainer.

2.3.16 Line Strainers, Water Service

Provide Y-type strainers with removable basket. Ensure strainers in sizes DN50 2-inch ips and smaller have screwed ends; in sizes DN65 2-1/2-inch ips and larger, strainers have flanged ends. Ensure body working-pressure rating exceeds maximum service pressure of installed system by at least 50 percent. Ensure body has cast-in arrows to indicate direction of flow. Ensure all strainer bodies fitted with screwed screen retainers have straight threads and gasketed with nonferrous metal. For strainer bodies DN65 2-1/2-inches and larger, fitted with bolted-on screen retainers, provide offset blowdown holes. Fit all strainers larger than DN65 2-1/2-inches with manufacturer's standard ball-type blowdown valve. Ensure body material is [cast bronze conforming to ASTM B62][cast iron conforming to Class 30 ASTM A278/A278M]. Where system material is nonferrous, use nonferrous metal for the metal strainer body material.

Ensure minimum free-hole area of strainer element is equal to not less than 3.4 times the internal area of connecting piping. Strainer screens perforation size is not to exceed 1.14 millimeter 0.045-inch. Ensure strainer screens have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material is[AISI Type [304] [316] corrosion-resistant steel][Monel metal].

2.3.17 Line Strainers, Steam Service

Provide Type Y strainers with removable strainer element.

Use flanged body end connections for all valves larger than DN50 2 inches, unless butt weld ends are specified. Use [screwed] [socket] weld for sizes DN50 2 inches and under to suit specified piping system end connection and maintenance requirements[or be welded].

For strainers located in tunnels, trenches, manholes, and valve pits, use welded end connections.

Body working steam pressure rating is the same as the primary valve rating for system in which strainer is installed, except where welded end materials requirements result in higher pressure ratings. Ensure body has integral cast or forged arrows to indicate direction of flow. Provide strainer bodies with blowdown valves that have discharge end plugged with a solid metal plug. Make closure assembly with tetrafluoroethylene tape. Ensure bodies fitted with bolted-on screen retainers have offset blowdown holes.

Body materials are [cast steel conforming to ASTM A216/A216M, Grade WCB] [forged carbon steel conforming to ASTM A105/A105M] [manufacturer's standard metallurgical equivalents for service pressures of 1035 kilopascal 150-psi wsp and greater, and for lower pressure ratings where welding is required] [cast iron conforming to ASTM A126, Class B, for service pressures 862 kilopascal 125-psi wsp and less].

Ensure minimum free-hole area of strainer element is equal to not less than 3.4 times the internal area of connecting piping. Strainer screens perforation size is not to exceed 0.51 millimeter 0.020 inch or equivalent wire mesh. Strainer screens have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material is AISI Type [304] [316] corrosion-resistant steel and fitted with backup screens where necessary to prevent collapse.

2.4 VALVES

****

NOTE: Figure 1A is a one piece body.

Figure 1B is a vertically split body with the split to one side of the ball.

Figure 1C is a top entry.

Figure 1D is a three piece body.

****

Submit equipment and performance data for valves consisting of corrosion resistance and life expectancy. Submit design analysis and calculations consisting of rates of flow, head losses, inlet and outlet design, and pressure calculations. Also include in data, pipe dimensions, as well as temperature ratings, vibration and thrust limitations, minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

Polypropylene valves will comply with the performance requirements of ASTM F2389. Valves shall conform to ASME B16.34.

2.4.1 Ball and Butterfly Valves

Ensure ball valves conform to MSS SP-72 for flanged valves and MSS SP-110 for screwed-end valves for Figure [1A] 1 piece body, [1B] vertically split body, [1C] top entry [1D] three piece body and are rated for service at not less than 1207 kilopascal at 93 degrees C 175 psig at 200 degrees F. For valve bodies in sizes DN50 2 inches and smaller, use screwed-end connection-type constructed of Class A copper alloy. For valve bodies in sizes [DN50] [DN65] 2-1/2 inches and larger, use flanged-end connection type, constructed of Class [D] [E] [F] material. Balls and stems of valves DN50 2 inches and smaller are manufacturer's standard with hard chrome plating finish. Balls and stems of valves DN65 2-1/2 inches and larger are manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome plating. Balls of valves DN150 6 inches and larger may be Class D with 900 Brinell hard chrome plating. Ensure valves are suitable for flow from either direction and seal equally tight in either direction. Valves with ball seals held in place by spring washers are not acceptable. Ensure all valves have adjustable packing glands. Seats and seals are fabricated from tetrafluoroethylene.

Ensure butterfly valves conform to MSS SP-67 and are the wafer type for mounting between specified flanges. Ensure valves are rated for 1034 kilopascal 150-psig shutoff and nonshock working pressure. Select bodies of cast ferrous metal conforming to ASTM A126, Class B, and to ASME B16.1 for body wall thickness. Seats and seals are fabricated from resilient elastomer designed for field removal and replacement.

2.4.2 Drain, Vent, and Gage Cocks

Provide [T-head] [lever handle] drain, vent, and gage cocks, ground key type, with washer and screw, constructed of polished ASTM B62 bronze, and rated 862 kilopascal 125-psi wsp. Ensure end connections are rated for specified service pressure.

Ensure pump vent cocks, and where spray control is required, are UL umbrella-hood type, constructed of manufacturer's standard polished brass. Ensure cocks are 15 millimeter 1/2-inch ips male, end threaded, and rated at not less than 862 kilopascal at 107 degrees C 125 psi at 225 degrees F.

2.4.3 Gate Valves (GAV)

Ensure gate valves DN50 2 inches and smaller conform to MSS SP-80. For valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated use union-ring bonnet, screwed-end type. Make packing of non-asbestos type materials. Use rising stem type valves.

Ensure gate valves DN65 2-1/2 inches and larger, are Type I, (solid wedge disc, tapered seats, steam rated); Class 125 (862 kilopascal 125-psig steam-working pressure at 178 degrees C 353 degrees F saturation); and 1379 kilopascal 200-psig, wog (nonshock), conforming to MSS SP-70 and to requirements specified herein. Select flanged valves, with bronze trim and outside screw and yoke (OS&Y) construction. Make packing of non-asbestos type materials.

2.4.4 Globe and Angle Valves (GLV-ANV)

Ensure globe and angle valves DN50 2 inches and smaller, are 862 kilopascal 125-pound, 125-psi conforming to MSS SP-80 and to requirements specified herein. For valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated, use union-ring bonnet, screwed-end type. Ensure disc is free to swivel on the stem in all valve sizes. Composition seating-surface disc construction may be substituted for all metal-disc construction. Make packing of non-asbestos type materials. Ensure disk and packing are suitable for pipe service installed.

Ensure globe and angle valves, DN65 2-1/2 inches and larger, are cast iron with bronze trim. Ensure valve bodies are cast iron conforming to ASTM A126, Class A, as specified for Class 1 valves under MSS SP-80. Select flanged valves in conformance with ASME B16.1. Valve construction is outside screw and yoke (OS&Y) type. Make packing of non-asbestos type materials.

2.4.5 Standard Check Valves (SCV)

Ensure standard check valves in sizes DN50 2 inches and smaller are 862 kilopascal 125-psi swing check valves except as otherwise specified. Provide lift checks where indicated. Ensure swing-check pins are nonferrous and suitably hard for the service. Select composition type discs. Ensure the swing-check angle of closure is manufacturer's standard unless a specific angle is needed.

Use cast iron, bronze trim, swing type check valves in sizes DN65 2-1/2 inches and larger. Ensure valve bodies are cast iron, conforming to ASTM A126, Class A and valve ends are flanged in conformance with ASME B16.1. Swing-check pin is AISI Type or approved equal corrosion-resistant steel. Angle of closure is manufacturer's standard unless a specific angle is needed. Ensure valves have bolted and gasketed covers.

Provide check valves with [external spring-loaded] [lever-weighted], positive-closure devices and valve ends are [mechanical joint] [push-on] [flanged].

2.4.6 Nonslam Check Valves (NSV)

****

NOTE: The following specification is adequate for most construction situations. Where unusual hydraulic conditions occur, review closing time and in-service adjustment capability of helical-coil valve construction versus other construction.

****

Provide check valves at pump discharges in sizes DN50 2 inches and larger with nonslam or silent-check operation conforming to MSS SP-125. Select a valve disc or plate that closes before line flow can reverse to eliminate slam and water-hammer due to check-valve closure. Ensure valve is Class 125 rated for 1379 kilopascal 200-psi maximum, nonshock pressure at 66 degrees C 150 degrees F in sizes to DN300 12 inches. Use valves that are [wafer type to fit between flanges conforming to ASME B16.1][fitted with flanges conforming to ASME B16.1]. Valve body may be cast iron, or equivalent strength ductile iron. Select disks using manufacturer's standard bronze, aluminum bronze, or corrosion-resistant steel. Ensure pins, springs, and miscellaneous trim are manufacturer's standard corrosion-resistant steel. Disk and shaft seals are Buna-N elastomer tetrafluoroethylene.

2.5 MISCELLANEOUS MATERIALS

Submit equipment and performance data for miscellaneous materials consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

2.5.1 Bituminous Coating

Ensure the bituminous coating is a solvent cutback, heavy-bodied material to produce not less than a 0.30 millimeter 12-mil dry-film thickness in one coat, and is recommended by the manufacturer to be compatible with factory-applied coating and rubber joints.

For previously coal-tar coated and uncoated ferrous surfaces underground, use bituminous coating solvent cutback coal-tar type, conforming to MIL-C-18480.

2.5.2 Bolting

Ensure flange and general purpose bolting is hex-head and conforms to ASTM F568M, Class 4.8 or above ASTM A307, Grade B (bolts, for flanged joints in piping systems where one or both flanges are cast iron). Heavy hex-nuts conform to ASTM A563M ASTM A563. Square-head bolts and nuts are not acceptable. Ensure threads are coarse-thread series.

2.5.3 Elastomer Caulk

Use two-component polysulfide- or polyurethane-base elastomer caulking material, conforming to ASTM C920.

2.5.4 Escutcheons

Manufacture escutcheons from nonferrous metals and chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Ensure metals and finish conforms to ASME A112.19.2/CSA B45.1.

Use one-piece escutcheons where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. Ensure all escutcheons have provisions consisting of [internal spring-tension devices] [setscrews] for maintaining a fixed position against a surface.

2.5.5 Flashing

Ensure sheetlead conforms to ASTM B749,[UNS Alloy Number L50049 (intended for use in laboratories and shops in general application)][UNS Alloy Number L51121 (for use where lead sheet of high purity and improved structural strength is indicated)].

Ensure sheet copper conforms to ASTM B370 and be not less than 4.88 kilogram per square meter 16 ounces per square foot weight.

2.5.6 Flange Gaskets

Provide compressed non-asbestos sheets, conforming to ASTM F104, coated on both sides with graphite or similar lubricant, with nitrile composition, binder rated to 399 degrees C 750 degrees F.

2.5.7 Grout

****

NOTE: When moisture or uncured concrete occurs, metallic grout may cause buildup of pressure that, under confinement, could be sufficient to misaligned equipment.

****

Provide shrink-resistant grout as a premixed and packaged metallic-aggregate, mortar-grouting compound conforming to ASTM C404 and ASTM C476.

****

NOTE: Specify epoxy grout, particularly where mild chemical resistance is necessary or where oil soaking may occur.

For service with acids, polyester grouts should be specified.

Where high anchor-bolt torques (2712 newton-meter) (2,000 ft-lb) are applied, epoxy polyamides will cold-flow.

****

Ensure shrink-resistant grout is a combination of pre-measured and packaged epoxy polyamide or amine resins and selected aggregate mortar grouting compound conforming to the following requirements:

Tensile strength		13.100 Megapascal, minimum
Compressive strength	ASTM C109/C109M	96.527 Megapascal, minimum
Shrinkage, linear		0.003 mm per millimeter, maximum
Water absorption	ASTM C67/C67M	0.1 percent, maximum
Bond strength to		6.895 Megapascal, minimum steel in shear minimum
Tensile strength		1,900 psi, minimum
Compressive strength	ASTM C109/C109M	14,000 psi, minimum
Shrinkage, linear		0.00012 inch per inch, maximum
Water absorption	ASTM C67/C67M	0.1 percent, maximum
Bond strength to		1,000 psi, minimum steel in shear minimum

2.5.8 Pipe Thread Compounds

Use polytetrafluoroethylene tape not less than 0.05 to 0.08 millimeter 2 to 3 mils thick in potable and process water and in chemical systems for pipe sizes to and including DN25 1-inch ips. Use polytetrafluoroethylene dispersions and other suitable compounds for all other applications upon approval by the Contracting Officer; however, do not use lead-containing compounds in potable water systems.

2.6 SUPPORTING ELEMENTS

Submit equipment and performance data for the supporting elements consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

Provide all necessary piping systems and equipment supporting elements, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable, or constant supports. Ensure supporting elements are suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.

Ensure supporting elements conform to requirements of ASME B31.3, and MSS SP-58, except as noted.

Ensure attachments welded to pipe are made of materials identical to that of pipe or materials accepted as permissible raw materials by referenced code or standard specification.

Ensure supporting elements exposed to weather are hot-dip galvanized or stainless steel. Select materials of such a nature that their apparent and latent-strength characteristics are not reduced due to galvanizing process. Electroplate supporting elements in contact with copper tubing with copper.

Type designations specified herein are based on MSS SP-58. Ensure masonry anchor group-, type-, and style-combination designations are in accordance with CID A-A-1922, CID A-A-1923, CID A-A-1924, CID A-A-1925 , CID A-A-55614, and CID A-A-55615. Provide support elements, except for supplementary steel, that are cataloged, load rated, commercially manufactured products.

2.6.1 Building Structure Attachments

****

NOTE: Review specific instructions relative to anchor devices in support elements installation paragraph prior to selection of following text.

****

2.6.1.1 Anchor Devices, Concrete and Masonry

Ensure anchor devices conform to CID A-A-1922, CID A-A-1923, CID A-A-1924, CID A-A-1925, CID A-A-55614, and CID A-A-55615

For cast-in, floor mounted, equipment anchor devices, provide adjustable positions.

[Provide built-in masonry anchor devices.

] Do not use powder-actuated anchoring devices to support any mechanical systems components.

2.6.1.2 Beam Clamps

Ensure beam clamps are center-loading MSS SP-58 Type [20] [21] [28] [29] [30] [_____].

[When it is not possible to use center-loading beam clamps, eccentric-loading beam clamps, MSS SP-58 Type [20] [25] [27] may be used for piping sizes DN50 2 inches and less and for piping sizes DN50 through DN250 2 through 10 inches provided two counterbalancing clamps are used per point of pipe support. Where more than one rod is used per point of pipe support, determine rod diameter in accordance with referenced standards.

]2.6.1.3 Type 19 and 23 C-Clamps

Torque Type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.

2.6.1.4 Inserts, Concrete

Use concrete MSS SP-58 Type [18] [_____] inserts When applied to piping in sizes DN50 2 inches ips and larger and where otherwise required by imposed loads, insert and wire a 305 millimeter 1-foot length of 13 millimeter 1/2-inch reinforcing rod through wing slots. Submit proprietary-type continuous inserts for approval.

2.6.2 Horizontal Pipe Attachments

2.6.2.1 Single Pipes

Support piping in sizes to and including DN50 2-inch ips by MSS SP-58 Type 6 solid malleable iron pipe rings, except that, use split-band-type rings in sizes up to DN25 1-inch ips.

Support piping in sizes through DN200 8-inch ips inclusive by MSS SP-58 Type [1] [3] [4] attachments.

Use MSS SP-58 Type 1 and Type 6 assemblies on vapor-sealed insulated piping and have an inside diameter larger than pipe being supported to provide adequate clearance during pipe movement.

Where thermal movement of a point in a piping system DN100 4 inches and larger would cause a hanger rod to deflect more than 4 degrees from the vertical or where a horizontal point movement exceeds 13 millimeter 1/2 inch, use MSS SP-58 Type [41] [44 through 46] [49] pipe rolls.

Support piping in sizes larger than DN200 8-inch ips with MSS SP-58 Type [41] [44 through 46] [49] pipe rolls.

Use MSS SP-58 Type 40 shields on all insulated piping. Ensure area of the supporting surface is such that compression deformation of insulated surfaces does not occur. Roll away longitudinal and transverse shield edges from the insulation.

Provide insulated piping without vapor barrier on roll supports with MSS SP-58 Type 39 saddles.

Provide spring supports as indicated.

2.6.2.2 Parallel Pipes

Use trapeze hangers fabricated from structural steel shapes, with U-bolts, in congested areas and where multiple pipe runs occur. Ensure structural steel shapes[conform to supplementary steel requirements][be of commercially available, proprietary design, rolled steel].

2.6.3 Vertical Pipe Attachments

Ensure vertical pipe attachments are MSS SP-58 Type 8.

Include complete fabrication and attachment details of any spring supports in shop drawings.

2.6.4 Hanger Rods and Fixtures

Use only circular cross section rod hangers to connect building structure attachments to pipe support devices. Use pipe, straps, or bars of equivalent strength for hangers only where approved by the Contracting Officer.

Provide turnbuckles, swing eyes, and clevises as required by support system to accommodate temperature change, pipe accessibility, and adjustment for load and pitch. Rod couplings are not acceptable.

2.6.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, design and fabricate such supplementary steel in accordance with AISC 325.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

Submit certificates for pipes, valves and specialties showing conformance with test requirements as contained in the reference standards contained in this section. Provide certificates verifying Surface Resistance, Shear and Tensile Strengths, Temperature Ratings, Bending Tests, Flattening Tests and Transverse Guided Weld Bend Tests.

Provide test reports for Hydrostatic Tests, Air Tests, Valve-Operating Tests, Drainage Tests, Pneumatic Tests, Non-Destructive Electric Tests and System Operation Tests, in compliance with referenced standards contained within this section.

Fabricate and install piping systems in accordance with ASME B31.3, MSS SP-58, and AWS WHB-2.9.

Submit Installation Drawings for pipes, valves and specialties. Drawings include the manufacturer's design and construction calculations, forces required to obtain rated axial, lateral, or angular movements, installation criteria, anchor and guide requirements for equipment, and equipment room layout and design. Ensure drawings specifically advise on procedures to be followed and provisions required to protect expansion joints during specified hydrostatic testing operations.

****

NOTE: Select one of the following two paragraphs. The first paragraph is the standard option that provides true electrical isolation. This is the preferred option. The second paragraph is a non-standard option intended to be used as a cost-saving option. This option also covers dielectric nipples that are often factory-installed on mechanical equipment. This option provides a level of electrical insulation between the two metals, but may still lead to galvanic corrosion

over time as metals are not truly isolated.
****

[Ensure connections between steel piping and copper piping are electrically isolated from each other. Dielectric pipe unions shall be installed to prevent galvanic corrosion. The dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. The metal parts of the union shall be separated so that the electrical current is below one percent of the galvanic current which would exist upon metal-to-metal contact. Gaskets, flanges, and unions shall be installed in accordance with manufacturer's recommendations.

][Provide dielectric nipples between steel piping and copper piping to reduce galvanic corrosion. Dielectric nipples shall be Schedule 40 galvanized steel conforming to ASTM A53/A53M with inert, non-corrosive thermoplastic lining. For pipe sizes DN50 2 inches ips smaller, a bronze ball valve can be used between dissimilar metals.

] Make final connections to equipment with [unions] [flanges] installed every 30480 millimeter 100 feet of straight run. Install unions in the line downstream of screwed- and welded-end valves.

Ream all pipe ends before joint connections are made.

Make screwed joints with specified joint compound with not more than three threads showing after joint is made up.

Apply joint compounds to the male thread only and exercise care to prevent compound from reaching the unthreaded interior of the pipe.

Install screwed unions, welded unions, or bolted flanges wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

Securely support piping systems with due allowance for thrust forces, thermal expansion and contraction. Do not subject the system to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.

Ensure field welded joints conform to the requirements of the AWS WHB-2.9, ASME B31.3, and ASME BPVC SEC IX.

[Make piping systems butt weld joints with backing rings. Use compatible backing ring materials with materials being joined. Ensure joint configuration conforms to ASME B16.25.

For polypropylene pipe, make fusion-weld joints in accordance with the pipe and fitting manufacturer's specifications and product standards. Use fusion-weld tooling, welding machines, and electrofusion devices specified by the pipe and fittings manufacturer. Prior to joining, prepare the pipe and fittings in accordance with ASTM F2389 and the manufacturer's specifications. Ensure joint preparation, setting and alignment, fusion process, cooling times and working pressure are in accordance with the pipe and fitting manufacturer's specifications.

] **

NOTE: Prior to selection of one of the following two paragraphs, review requirements of ASME B31.3 and ASME BPVC SEC IX to avoid conflict and redundancy. Also review PFI ES-19 and PFI ES-28 if

materials specifications have been rewritten or supplemented.
****

[Accomplish preheat and postheat treatment of welds in accordance with ASME BPVC SEC IX and ASME B31.3.

][Take all necessary precautions during installation of flexible pipe and hose including flushing and purging with water, steam, and compressed air to preclude bellows failure due to pipe line debris lodged in bellows. Ensure installation conforms to manufacturer's instructions.

]3.2 VALVES

Install valves in piping mains and all branches and at equipment where indicated and as specified.

Install valves to permit isolation of branch piping and each equipment item from the balance of the system.

Install riser and downcomer drains above piping shutoff valves in piping DN65 2-1/2 inches and larger. Tap and fit shutoff valve body with a DN15 1/2-inch plugged globe valve.

Install valves unavoidably located in furred or other normally inaccessible places with access panels adequately sized for the location and located so that concealed items may be serviced, maintained, or replaced.

3.3 SUPPORTING ELEMENTS INSTALLATION

Install supporting elements in accordance with the referenced codes and standards.

Support piping from building structure. Do not support piping from roof deck or from other pipe.

Run piping parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting may be removed between adjacent pipes and so that there is no less than DN15 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Arrange hangars on different adjacent service lines running parallel with each other in line with each other and parallel to the lines of the building.

Install piping support elements at intervals specified hereinafter, at locations not more than 900 millimeter 3 feet from the ends of each runout, and not over 300 millimeter 1 foot from each change in direction of piping.

Base load rating for all pipe-hanger supports on insulated weight of lines filled with water and forces imposed. Deflection per span is not exceed slope gradient of pipe. Ensure supports are in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, reduce the allowable span proportionately:

PIPE SIZE (DN) MILLIMETER	ROD SIZE MILLIMETER	STEEL PIPE MILLIMETER	COPPER PIPE MILLIMETER
25 and smaller	10	2500	1850

PIPE SIZE (DN) MILLIMETER	ROD SIZE MILLIMETER	STEEL PIPE MILLIMETER	COPPER PIPE MILLIMETER
32 to 40	10	3050	2500
50	10	3050	3050
65 to 90	13	3700	3700
100 to 125	16	5000	4300
150	20	5000	5000
200 to 300	22	6100	6100
356 to 457	25	6100	6100
508 and over	32	6100	6100

PIPE SIZE INCHES	ROD SIZE INCHES	STEEL PIPE FEET	COPPER PIPE FEET
1 and smaller	3/8	8	6
1-1/4 to 1-1/2	3/8	10	8
2	3/8	10	8
2-1/2 to 3-1/2	1/2	12	12
4 to 5	5/8	16	14
6	3/4	16	16
8 to 12	7/8	20	20
14 to 18	1	20	20
20 and over	1-1/4	20	20

Install vibration isolation supports where needed. Refer to Section 23 05 48.19 SEISMIC BRACING FOR HVAC where A/C equipment and piping is installed.

Support vertical risers independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Ensure risers have guides for lateral stability. For risers subject to expansion, install only one rigid support at a point approximately one-third down from the top. Place clamps under fittings unless otherwise specified. Support carbon-steel pipe at each floor and at not more than 4572 millimeter 15-foot intervals for pipe DN50 2 inches and smaller and at not more than 6096 millimeter 20-foot intervals for pipe DN65 2-1/2 inches and larger.

3.4   PENETRATIONS

Install effective sound stopping and adequate operating clearance to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces include space above ceilings where no special acoustic treatment of ceiling is provided. Finish penetrations to be compatible with surface being penetrated.

[Accomplish sound stopping and vapor-barrier sealing of pipe shafts and large floor and wall openings by packing to high density with properly supported fibrous-glass insulation or, where ambient or surface temperatures do not exceed 49 degrees C 120 degrees F, by foaming-in-place with self-extinguishing, 0.9 kilogram 2-pound density polyurethane foam to a depth not less than 152 millimeter 6 inches. Finish foam with a rasp. Ensure vapor barrier is not less than 3 millimeter 1/8-inch thick vinyl coating applied to visible and accessible surfaces. Where high temperatures and fire stopping are a consideration, use only mineral wool with openings covered by 1.6 millimeter 16-gage sheet metal.

]3.5 SLEEVES

Install sleeves where piping passes through roofs, masonry, concrete walls and floors.

Continuously [weld][braze] sleeves passing through steel decks to the deck.

Ensure sleeves that extend through floors, roofs, load bearing walls, and fire barriers are continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. Form all other sleeves by molded linear polyethylene liners or similar materials that are removable. Ensure diameter of sleeves is large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and provides a minimum 10 millimeter 3/8-inch clearance. Install a sleeve size to accommodate mechanical and thermal motion of pipe precluding transmission of vibration to walls and the generation of noise.

Pack the space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration solid with a mineral fiber conforming to ASTM C553 Type V (flexible blanket), to 538 degrees C to 1,000 degrees F. Install this packing wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration with an elastomer caulk to a depth of 13 millimeter 1/2 inch. Ensure all caulked surfaces are oil- and grease-free.

Ensure through-penetration fire stop materials and methods are in accordance with ASTM E814 and UL 1479.

Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed metal components.

****

NOTE: Review roof flooding provisions before revising the following paragraph.

****

[Ensure sleeve height above roof surface is a minimum of 305 12 and a maximum of 457 millimeter 18-inches.

]3.6 ESCUTCHEONS

Install escutcheons at all penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, install escutcheons on both sides of the partition. Where suspended ceilings are installed, install plates at the underside only of such ceilings. For insulated pipes, select plates large enough to fit around the insulation. Use chrome-plated escutcheons in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Firmly attach escutcheons with setscrews.

3.7 FLASHINGS

****

NOTE: Review roof flooding provisions.

****

[Install flashings at penetrations of building boundaries by mechanical systems and related work.

]3.8 UNDERGROUND PIPING INSTALLATION

Prior to being lowered into a trench, clean all piping, visually inspected for apparent defects, and tapped with a hammer to audibly detect hidden defects.

Further inspect suspect cast-ferrous piping by painting with kerosene on external surfaces to reveal cracks.

Distinctly mark defective materials found using a road-traffic quality yellow paint; promptly remove defective material from the site.

After conduit has been inspected, and not less than 48 hours prior to being lowered into a trench, coat all external surfaces of cast ferrous conduit with a compatible bituminous coating for protection against brackish ground water. Apply a single coat, in accordance with the manufacturer's instructions, to result in a dry-film thickness of not less than 0.30 millimeter 12 mils.

Ensure excavations are dry and clear of extraneous materials when pipe is being laid.

Use wheel cutters for cutting of piping or other machines designed specifically for that purpose. Electric-arc and oxyacetylene cutting is not permitted.

Begin laying of pipe at the low point of a system. When in final acceptance position, ensure it is true to the grades and alignment indicated, with unbroken continuity of invert. Blocking and wedging is not permitted.

[Point bell or grooved ends of piping upstream.

] Make changes in direction with long sweep fittings.

Install necessary socket clamping, piers, bases, anchors, and thrust blocking. Protect rods, clamps, and bolting with a coating of bitumen.

Support underground piping below supported or suspended slabs from the slab with a minimum of two supports per length of pipe. Protect supports with a coating of bitumen.

On excavations that occur near and below building footings, install backfilling material consisting of 13800 kilopascal 2,000-psi cured compressive-strength concrete poured or pressure-grouted up to the level of the footing.

Properly support vertical downspouts; soil, waste, and vent stacks; water risers; and similar work on approved piers at the base and provided with approved structural supports attached to building construction.

[Provide cleanout, flushing, and observation risers.

]3.9 HEAT TRACE CABLE INSTALLATION

Field apply heater tape and cut to fit as necessary, linearly along the length of pipe after piping has been pressure tested and approved by the Contracting Officer. Secure the heater to piping with [cable ties] [fiberglass tape]. Label thermal insulation on the outside, "Electrical Heat Trace."

Install power connection, end seals, splice kits and tee kit components in accordance with IEEE 515 to provide a complete workable system. Terminate connection to the thermostat and ends of the heat tape in a junction box. Ensure cable and conduit connections are raintight.

3.10 DISINFECTION

[Disinfect water piping, including all valves, fittings, and other devices, with a solution of chlorine and water. Ensure the solution contains not less than 50 parts per million (ppm) of available chlorine. Hold solution for a period of not less than 8 hours, after which the solution contains not less than 10 ppm of available chlorine or redisinfect the piping. After successful sterilization, thoroughly flush the piping before placing into service. Flushing is complete when the flush water contains less than 0.5 ppm of available chlorine. Water for disinfected will be furnished by the Government. Approve disposal of contaminated flush water in accordance with written instructions received from the Environmental authority having jurisdiction through the Contracting Officer and all local, State and Federal Regulations.

][Flush piping with potable water until visible grease, dirt and other contaminants are removed (visual inspection).

]3.11 HEAT TRACE CABLE TESTS

Test heat trace cable system in accordance with IEEE 515 after installation and before and after installation of the thermal insulation. Test heater cable using a [1000] [_____] vdc megger. Minimum insulation resistance is [20 to 1000] [_____] megohms regardless of cable length.

3.12 OPERATION AND MAINTENANCE

Provide Operation and Maintenance Manuals consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Submit test data that is clear and readily legible.

3.13 PAINTING OF NEW EQUIPMENT

****

NOTE: For SOUTHNAVFACENGCOM projects, delete all painting requirements and specify as follows: "PART 3 EXECUTION, Not used."

****

Factory or shop apply new equipment painting, as specified herein, and provided under each individual section.

3.13.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied withstands 125 hours in a salt-spray fog test, except that equipment located outdoors withstand 500 hours in a salt-spray fog test. Conduct salt-spray fog test is in accordance with ASTM B117, and for that test the acceptance criteria is as follows: immediately after completion of the test, the inspected paint shows no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shows no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

Ensure the film thickness of the factory painting system applied on the equipment is not less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, design the factory painting system for the temperature service.

3.13.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal, surfaces subject to temperatures in excess of 50 degrees C 120 degrees F.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Selected color of finish coat is aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F receives one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm one mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm one mil per coat.

b. Temperatures Between 50 and 205 Degrees C 120 and 400 Degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F Receives two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 Degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F receives two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 05 48.19 (February 2025)**

Preparing Activity: USACE **Superseding**

UFGS-23 05 48.19 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 48.19

SEISMIC BRACING FOR MECHANICAL SYSTEMS

02/25

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-23 05 48.19 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-23 05 48.19 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 23 05 48.19

SEISMIC BRACING FOR MECHANICAL SYSTEMS
02/25

****
NOTE: This guide specification covers the requirements for seismic protection of mechanical equipment, ductwork, building piping, and exterior utilities. Mechanical equipment seismic protection coverage within this specification is supplemental to the Equipment Bracing requirements with section 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: Refer to section 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS, PART 1 GENERAL editor note for the three options to provide seismic protection design for a project.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C105/A21.5	(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C116/A21.16	(2015) Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray Iron Fittings
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C213	(2022) Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings

ASTM INTERNATIONAL (ASTM)

ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120

ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM F891	(2024) Standard Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

FEMA P-414	(January 2004) Installing Seismic Restraints for Duct and Pipe

NSF INTERNATIONAL (NSF)

NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military Assets

VIBRATION ISOLATION AND SEISMIC CONTROL MANUFACTURERS ASSOCIATION (VISCMA)

VISCMA 412	(2014) Installing Seismic Restraints for Mechanical Equipment

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

****

NOTE: Designer should verify that specified details do not interfere with the performance of the cathodic protection system (when used) or of the vibration isolation systems.

For systems and equipment in RC V buildings that have a performance objective higher than non-mission critical (NMC), the designer should show a "G" classification for the items under SD-02 Shop Drawings in the SUBMITTALS paragraph. The Engineer of Record (EOR) should review the details of these essential systems and assess their impact on the structural supporting system of the essential building. This also includes Designated Seismic Systems that must remain operational after an

earthquake.

Design done by the Contractor must be in accordance with UFC 3-301-01 (UFC 3-301-02 for RC V facilities). Requirements for Contractor Designed Bracing are covered by specification section 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS which must be used in conjunction with this specification.

****

Apply the requirements for seismic protection measures described in this section, Section 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS, and on the drawings to the mechanical equipment and mechanical systems both inside and outside of the building along with exterior utilities and systems listed below. Where there is a conflict between the specifications and the drawings, the specifications will take precedence.

1.2.2 Mechanical Equipment

****

NOTE: The designer must ensure that the list below includes all mechanical items to be braced. Delete the items which are not part of the project and add items which are not included in the list.

The lists should be broken out as follows:

For mechanical equipment, components and systems in Risk Category V structures, the designer should provide three separate lists of equipment and systems; non-Mission Critical (NMC), Mission Critical Level 1 (MC-1 equipment and components must be fully operational immediately after a seismic event), or Mission Critical Level 2 (MC-2 equipment and components must be repairable and operable within 3 days after a seismic event).

For mechanical equipment, components, and systems in Risk Category I, II, III, or IV structures, two separate lists of nonstructural systems/components must be provided; components/systems with Ip = 1.0 and components/systems with Ip = 1.5 (Designated Seismic Systems).

The lists must be specific where more than one list is required.

****

Mechanical equipment restraints must be in accordance with the requirements for equipment restraints specified in section 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS. Mechanical equipment to be seismically protected must include the following items to the extent required on the drawings or in other sections of these specifications:

[Equipment/Components with Ip = 1.0]

Boilers and furnaces	Storage Tanks for Oil and Water
Water Heaters	
Expansion Air Separator Tanks	Valves and Fittings for Piping
Heat Exchangers	Steam-fed Kitchen Appliances
Water Chiller Units	Thermal Storage Units
Cooling Towers, Evaporative Coolers, and Fluid Coolers	Air and Refrigerant Compressors
Computer Room Air Conditioners	Air Handling Units
Pumps with Motors	Lab Scrubbers
Large Commercial Dryers	Pollution Control Equipment
Gas Dryers	Split System DX Units
Flash Tanks	Unit Heaters
Accumulator Tank	Exhaust, Return and Misc. Fans
Gas Cylinders	Solar Heating and Hot Water Units
Bridge Cranes and Monorails	Pumps
Air Terminal Units	Unitary HVAC Systems
Humidifiers	Fan Coil Units
Stacks	Instrumentation and Control for HVAC
Duct Mounted Coils	Duct Silencers

[Equipment/Components with Ip = 1.5 (Designated Seismic Systems)
Insert edited list here similar to one above for Ip = 1.0]
[Non-Mission Critical (NMC) Equipment/Components in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]
[Mission Critical Level 1 (MC-1) Equipment/Components in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]
[Mission Critical Level 2 (MC-2) Equipment/Components in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]

1.2.3 Mechanical Systems

****

NOTE: The designer must ensure that the list below includes all piping and mechanical systems which are to be installed or modified. Delete the items which are not part of the project and add items which are not included in the list.

****

Mechanical systems to be seismically protected must include the following items to the extent required on the drawings or in this or other sections of these specifications:

[Mechanical systems with Ip = 1.0]

a. All Piping and Ducts Inside the Building Except as Specifically Stated Below Under "Items Not Covered By This Section".

b. Chilled Water Distribution Systems Outside of Buildings.

c. Steam, Water, Oil, Gas and Fuel Piping Outside of Buildings.

d. All Water Supply Systems Outside of Buildings.

e. Storm and Sanitary Sewer Systems Outside of Buildings.

f. All Process Piping Outside of Buildings.

g. Heat Distribution Systems (Supply, Return, and Condensate Return) Outside of Buildings.

h. Condenser Water and Refrigerant Piping Outside the Building.

i. Pneumatic Tube Distribution System Outside of Buildings.

j. Cold Storage Refrigeration Systems Outside of Buildings.

k. Fuel Storage Tanks Outside of Buildings.

l. Water Storage Tanks Outside of Buildings.

m. Ductwork Outside of Buildings.

n. Stacks.

o. [_____]

[Mechanical systems with Ip = 1.5 (Designated Seismic Systems)
Insert edited list here similar to one above for Ip = 1.0]
[Non-Mission Critical (NMC) Mechanical Systems in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]
[Mission Critical Level 1 (MC-1) Mechanical Systems in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]
[Mission Critical Level 2 (MC-2) Mechanical Systems in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]

[1.2.4 Contractor Designed Supports and Attachments

****

NOTE: Retain this paragraph when the Contractor will design the bracing. The designer will refer and modify the listings above or will list below the equipment and systems to receive seismic bracing. Delete this paragraph when all bracing details and locations are indicated on the drawings and calculations are included in the Design Analysis.

****

The supports and attachments for the mechanical equipment designated in paragraph Mechanical Equipment must be developed by the Contractor complying with the requirements of 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS. Submit design calculations as required by 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS.

Design and provide seismic supports and attachments for mechanical systems listed in paragraph Mechanical Systems in accordance with ASCE 7-22 Chapter 13 and as modified by UFC 3-301-01[UFC 3-301-02]. Refer to 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS paragraph GENERAL REQUIREMENTS for Structural Design Criteria.

[Provide documentation of an independent design review for mission critical (MC) component or systems bracing design. Documentation must be signed by the independent reviewer who must also be a registered structural engineer.]

]1.2.5 Items Not Covered By This Section

1.2.5.1 Fire Protection Systems

Install seismic protection of piping for fire protection systems as specified in Sections 21 30 00 FIRE PUMPS, 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION, 21 13 16 DRY PIPE SPRINKLER SYSTEMS, FIRE PROTECTION, 21 13 18 PREACTION SPRINKLER SYSTEMS, FIRE PROTECTION, and 21 13 24.00 10 AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM.

1.2.5.2 Items Requiring No Seismic Restraints

Seismic restraints are not required where specifically identified as exempt based on Seismic Design Category (SDC), component Importance Factor (Ip), and other applicable factors indicated within ASCE 7-22, Chapter 13 section Mechanical and Electrical Components. Provide listing of mechanical equipment exempt from seismic restraint requirement within the Design Calculations submittal package submitted in accordance with specification 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Flexible Couplings or Joints

Coupling And Bracing

SD-03 Product Data

Flexible Couplings Or Joints; G, [_____]

Equipment Restraint; G, [_____]

PART 2   PRODUCTS

2.1   GENERAL DESIGN REQUIREMENTS

Submit detailed seismic restraint drawings for mechanical equipment, duct systems, piping systems and any other mechanical systems. Include calculations, catalog cuts, templates, and erection and installation details, as appropriate, for the items listed below. Indicate thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction. A registered professional engineer must stamp the calculations and verify the capability of structural members to which bracing is attached for carrying the load from the brace. Include drawing for [Mission Critical Equipment and] Designated Seismic System Equipment indicating the equipment location in the facility, sufficient to be used for the installation. Design must be based on actual equipment and system layout. Design must include calculated dead loads, static seismic loads and capacity of materials utilized for the connection of the equipment or system to the structure. Analysis must detail anchoring methods.

****

NOTE: Appropriate materials for structural supports must be used in corrosive environments. Dissimilar metals must be isolated.

****

2.2 EQUIPMENT RESTRAINT

****
NOTE: Seismic Bracing does not guarantee that the equipment itself is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, include paragraph Special Testing for Seismic Resisting Equipment. Roof mounted equipment is especially vulnerable due to building sway during seismic event.
****

Equipment must be rigidly or flexibly mounted as indicated on the drawings and in accordance with 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS depending on vibration isolation requirements.

Roof mounted equipment such as cooling towers and condensers, both vibration isolated and nonisolated, must have support members designed and anchored to building structural steel or concrete as required for seismic restraint and wind loads.

2.3 FLEXIBLE JOINTS

****
NOTE: Designer should include reference to other specification sections containing provisions for pipe pressure and temperature ratings, if deemed necessary.
****

Flexible joints must have same pressure and temperature ratings as adjoining pipe. Braided hoses must not be used where there is torsional or axial movement unless manufacturer allows it.

2.3.1 Braided Hose Expansion Joint

Braided hose expansion joint(s) must be installed in the locations indicated on the drawings and as required to accommodate any thermal expansion, contraction or seismic movement of the piping system. Joints must consist of two parallel sections of corrugated metal hose, compatible braid, and 180 degree return bend with inlet and outlet connections. Field fabricated loops are not acceptable. Braided hose expansion joint(s) must be installed in the locations indicated on the drawings and as required to accommodate any thermal expansion, contraction or seismic movement of the piping system. Joints must consist of two parallel sections of corrugated metal hose, compatible braid, and 180 degree return bend with inlet and outlet connections. Field fabricated loops must not be acceptable. Braided hose in a 60 degree flexible V loop arrangement must be used for small diameter pipe connections to coils in variable-air-volume (VAV)terminal units and fan coil units installed in suspended ductwork whether braced or unbraced.

All braided hose expansion joints must be manufactured in accordance with the documented manufacturers weld procedure specifications. The procedure qualification record must be used to document the execution of this procedure and must follow the general "guidelines" of ASME BPVC SEC IX. Each individual welder must conform to the in-house procedure qualification record and be qualified prior to each production lot. The testing of each individual welder must be documented in a welding procedure qualification record.

****

NOTE: Designer would typically select Type 304 stainless steel for most applications including chilled water, condenser water, heating hot water and steam. Bronze with applicable certifications would typically be selected for potable water and fuel oil service. Type 316 and 321 stainless steel would typically be selected for highly corrosive fluids or surrounding environment.

****

2.3.1.1 Corrugated Hose

Corrugated hose must be [Type [304] [321] [316] stainless steel] [bronze]. Braid must be [Type 304 stainless steel for any series 300 stainless steel hose] [bronze for any bronze hose]. Fittings materials of construction and end fitting type must be consistent with pipe material and equipment/ pipe connection fittings. Copper fittings must not be attached to stainless steel hose.

2.3.1.2 Flexible Hose Expansion Loops

Flexible hose expansion loops must have a factory supplied, hanger / support lug located at the bottom of the 180 degree return. [Flexible hose expansion loop(s) must be furnished with a plugged FPT to be used for a drain or air release vent.] Flexible hose expansion loop(s) must be rated with an operating pressure which is the same as the adjoining pipe. The operating pressure must be based on burst pressure with a 4 to 1 safety factor. [For steam service, the operating pressure must be based on burst pressure with a 8 to 1 safety factor.]

****

NOTE: Flexible expansion joint suitable for liquids under pressure compatible with material and pressure rating of joint.

****

2.3.2 Double Ball Flexible Expansion Joint

Install flexible expansion joints manufactured of ductile iron conforming to the material requirements of ASTM A536 and AWWA C153/A21.53 in the locations indicated on the drawings. Provide foundry certification of material upon request. Each flexible expansion joint must be pressure tested prior to shipment against its own restraint to a minimum of 350 psi (250 psi for flexible expansion joints 2 inch and 30 inches diameter and larger.) A minimum 2:1 safety factor, determined from the published pressure rating, must apply. Factory Mutual Approval for the 3 inch through 12 inch sizes is required. Each flexible expansion joint must consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20°, 2" - 12"; 15°, 14" - 36"; 12°, 42"-48" and 4-inches minimum expansion. Additional expansion sleeves must be available and easily added or removed at the factory or in the field. Both standardized mechanical joint and flange end connections must be available.

2.3.2.1 Internal Surfaces

Line all internal surfaces (wetted parts) with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213. Sealing gaskets must be constructed of EPDM. The coating must meet NSF/ANSI/CAN 61.

2.3.2.2 Exterior Surfaces

Coat exterior surfaces with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C116/A21.16. Include appropriately sized polyethylene sleeves, meeting AWWA C105/A21.5, for direct buried applications.

****

NOTE: Flexible expansion joint gravity drain (non-pressurized) suitable for sanitary drain, waste and vent applications.

****

2.3.3 Double Ball Flexible Expansion Joint Gravity Drain (Non-Pressurized)

Flexible expansion joints gravity drain must be installed in the locations indicated on the drawings and must be manufactured of pvc. All connections whether solvent weld or mechanical must be restrained to allow movement to be transferred to expansion joint. Each ball must allow up to 15 degrees deflection.

End connection outside diameters must be compatible with ASTM D1785, ASTM D2665 and ASTM F891 PVC pipe and are to be solvent welded.

2.4 SUPPORTS AND ATTACHMENTS

Sway bracing materials and associated fasteners and anchors must be as specified in 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS

PART 3 EXECUTION

3.1 COUPLING AND BRACING

****

NOTE: Unless otherwise determined by the Contracting Officer, A-E designs must include complete seismic details showing coupling requirements. Government designer should furnish coupling details for Contractor designed systems if required by the project.

****

a. Submit detail drawings, as specified here and throughout this specification, along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals must be complete in detail; must indicate thickness, type, grade, class of metal, and dimensions; and must show construction details, reinforcement, anchorage, and installation with relation to the building construction.

b. Provide coupling installation conforming to the details shown on the drawings. Provisions of this paragraph apply to all piping within a

1.5 m 5 foot line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers must be braced at the most frequent interval as determined by applying the requirements of this specification to each piping run on the common support.

c. Size bracing components as required for the total load carried by the common supports. Bracing rigidly attached to pipe flanges, or similar, must not be used where it would interfere with thermal expansion of piping.

d. Adjust isolators and restraints after piping systems has been filled and equipment is at its operating weight, following the manufacturer's written instructions.

e. Install cables at a 45-degree slope. Where interference is present, the slope may be minimum of 30 degrees or a maximum of 60 degrees per VISCMA 412.

3.2 BUILDING DRIFT

****

NOTE: Refer to Section 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS Structural Design Criteria under paragraph GENERAL REQUIREMENTS to determine the expected drift of the building. Insert the expected drift ratio (in terms of seismic drift per unit of story height) in the bracketed space below.

****

Provide joints capable of accommodating seismic displacements for vertical piping between floors of the building, where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators. Provide horizontal piping across expansion joints to accommodate the resultant of the drifts of each building unit in each orthogonal direction. For threaded piping, provide swing joints made of the same piping material. For piping with manufactured ball joints the seismic drift must be [_____] meters per meter feet per foot of height above the base where the seismic separation occurs; this drift value must be used in place of the expansion given in the manufacturer's selection table.

3.3 FLEXIBLE COUPLINGS OR JOINTS

3.3.1 Building Piping

Provide flexible couplings or joints in building piping at bottom of all pipe risers for pipe larger than 90 mm 3-1/2 inches in diameter. Laterally brace flexible couplings or joints without interfering with the action of the flexible coupling or joint. Cast iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to satisfy these requirements.

3.3.2 Underground Piping

****

NOTE: This paragraph may not be required for some

Seismic Design Category structures. The designer will coordinate the requirements for seismic isolation of piping with the structural and civil design drawings to locate flexible connections as required.

The amount of annular space will depend on the stiffness of the foundation assembly and of the surrounding soil, and the distance between the foundation wall and the point outside the building where the pipe is considered to be restrained. The geotechnical engineer will determine the pipe length necessary to provide fixity. As an approximation, a value of 76 mm 3 inches would be necessary for a pipe penetration in a one-story basement in soft soil.

****

Install flexible coupling in underground piping and 100 mm 4 inch or larger conduit, except heat distribution system, where the piping enters the building. Provide couplings that accommodate [_____] mm inches of relative movement between the pipe and the building in any direction. Provide additional flexible couplings where shown on the drawings.

3.4 PIPE SLEEVES

****

NOTE: The designer will determine the amount of differential movement of piping at pipe sleeves passing through non-fire rated walls and partitions and will indicate on the drawings the amount of clearance required between the pipe and the sleeve based on deflection of the pipe between sway braces on either side of the wall.

The designer should avoid pipe penetrations through fire rated assemblies.

****

Size pipe sleeves in interior non-fire rated walls to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve. Pipe sleeves in fire rated walls must conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.5 SPREADERS

****

NOTE: Refer to UFC 3-301-01 for guidance on separation between pipes and requirements for spreaders.

****

Provide spreaders between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than [100][_____] mm [4][_____] inches apart. Apply spreaders at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack. Apply spreaders to surface of bare pipe and over insulation on insulated pipes utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.6 SWAY BRACES FOR PIPING

Provide sway braces to prevent movement of the pipes under seismic loading. Provide braces in both the longitudinal and transverse directions, relative to the axis of the pipe. Provide sufficient braces for equipment to resist a horizontal force as specified in UFC 3-301-01[UFC 3-301-02] without exceeding safe working stress of bracing components. Provide bracing that does not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications. For seismic analysis of horizontal pipes, the equivalent static force should be considered to act concurrently with the full dead load of the pipe, including contents.

3.6.1 Transverse Sway Bracing

****

NOTE: Piping can be either rigid or flexible. Rigid piping has a period of vibration of 0.06 seconds or less. Piping systems with spacing between braces that exceeds allowable spacing for rigid piping will be deemed flexible and will be designed accordingly.

The designer should provide requirements for bracing PVC pipes.

****

Provide transverse sway bracing for steel and copper pipe at intervals not to exceed those shown on the drawings. All runs (length of pipe between end joints) must have a minimum of transverse bracing at each end. Provide transverse sway bracing for pipes of materials other than steel and copper at intervals not to exceed the hanger spacing as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.6.2 Longitudinal Sway Bracing

****

NOTE: Locate longitudinal sway braces on the drawings for systems subject to thermal expansion because indiscriminate placement of sway braces may interfere with expansion requirements.

****

Provide longitudinal sway bracing at 12 m 40 foot intervals unless otherwise indicated. All runs (length of pipe between end joints) must have one longitudinal brace minimum. Construct sway braces in accordance with the drawings. Do not use branch lines, walls, or floors as sway braces.

3.6.3 Vertical Runs

Run is defined as length of pipe between end joints. Do not brace vertical runs of piping at intervals greater than 3 meters 10 feet. Braces for vertical runs must be above the center of gravity of the segment being braced. Flexible couplings should be provided at the bottoms of risers for pipes larger than 3.5 in. (89 mm) in diameter. Flexible couplings and expansion joints should be braced laterally and longitudinally unless such bracing would interfere with the action of the couplings or joints. When pipes enter buildings, flexible couplings should be provided to allow for relative movement between the soil and building. Construct all sway braces in accordance with the drawings. Attach sway braces to the structural system. Do not connect to branch lines, walls, or floors.

3.6.4 Clamps and Hangers

Apply clamps or hangers on uninsulated pipes directly to pipe. Insulated piping must have clamps or hangers applied over insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

Hanger rod stiffener angle or strut bracing must be securely attached by a series of attachment clamps manufactured from a one piece metal stamping and must include all require attachment hardware and locking nuts. Attachment clamps made from aluminum or cast iron must not be used in seismic applications. Do not weld vertical braces to hanger rods.

3.7 SWAY BRACES FOR DUCTS

3.7.1 Braced Ducts

Provide bracing details and spacing for rectangular and round ducts in accordance with SMACNA 1981. However, the design seismic loadings for these items must not be less than loadings obtained using the procedures in UFC 3-301-01[UFC 3-301-02]. Bracing must not attach to duct joints. Use shortest screws possible when penetrating ductwork to minimize airflow noise inside duct.

3.7.2 Unbraced Ducts

Attach hangers for unbraced ducts to the duct within 50 mm 2 inches of the top of the duct with a minimum of two #10 sheet metal screws in accordance with FEMA P-414. Use shortest screws possible when penetrating ductwork to minimize airflow noise inside duct. Install unbraced ducts with a 150 mm 6 inch minimum clearance to vertical ceiling hanger wires.

3.8 EQUIPMENT

3.8.1 Equipment Support Requirements

Refer to 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS for requirements.

3.8.2 Controls

Ensure that controls for critical equipment that must remain operational after an earthquake are certified per 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS paragraph SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT and are served by emergency power as required.

3.9 ANCHORS

Refer to 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS for requirements.

3.10 SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT

Refer to 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS for requirements.

3.11 SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS AND EQUIPMENT

Refer to 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS for requirements.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 05 93 (November 2015)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 05 93 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

11/15

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-23 05 93 (November 2015)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 05 93 (August 2009)

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References are in agreement with UMRL dated January 2025

****

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

11/15

****

NOTE: This guide specification covers the requirements for testing, adjusting, and balancing (TAB) of heating, ventilating, and air-conditioning (HVAC) air and water distribution systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Show the following information on the project drawings:

1. A unique number or mark for each piece of equipment or terminal.

2. Air quantities at air terminals.

3. Air quantities and temperatures in air handling unit schedules.

4. Water quantities and temperatures in thermal energy transfer equipment schedules.

5. Water quantities and heads in pump schedules.

6. Water flow measurement fittings and balancing fittings.

7. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms and at the end of this section as Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING.

8. When applicable, provide notes on the drawings specifying and completely describing any special or out of the ordinary TAB work to be performed. If required, provide special coordinating paragraphs in this section to compliment the special TAB notes on the design drawings.

****

PART 1 GENERAL

****

NOTE: Use this specification for all projects which include new HVAC systems or modifications to existing HVAC systems.

The "Design Agent's Representative" must be a member of the HVAC design team, from the AE or Engineering Division and must actively participate in the process, including review of all submittals contained herein and participation in testing, adjusting, and balancing (TAB) verification. The planning and programming of either Title II services or in-house support is required as part of the participation of the "Design Agent's Representative".

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)
ASA S1.11 PART 1	(2014) American National Standard Electroacoustics – Octave-Band and Fractional-Octave-Band Filters – Part 1: Specifications

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 203	(1990; R 2011) Field Performance Measurements of Fan Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality
ASHRAE HVAC APP IP HDBK	(2023) HVAC Applications Handbook, I-P Edition
ASHRAE HVAC APP SI HDBK	(2023) HVAC Applications Handbook, SI Edition

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(2002; 6th ed) National Standards for Total System Balance
AABC MN-4	(1996) Test and Balance Procedures

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV	(2006) Procedural Standards for Measurements and Assessment of Sound and Vibration
NEBB PROCEDURAL STANDARDS	(2015) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	(2023) HVAC Systems - Testing, Adjusting

	and Balancing, 3rd Edition
SMACNA 1858	(2004) HVAC Sound And Vibration Manual - First Edition
SMACNA 1972 CD	(2012) HVAC Air Duct Leakage Test Manual - 2nd Edition

1.2 DEFINITIONS

a. AABC: Associated Air Balance Council

b. COTR: Contracting Officer's Technical Representative

c. DALT: Duct air leakage test

d. DALT'd: Duct air leakage tested

e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling

f. NEBB: National Environmental Balancing Bureau

g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means "a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction and sealant class.""a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING." When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."

h. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 17.5 degrees Celsius plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.

i. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 3 degrees Celsius plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.

j. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.

k. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

l. TAB: Testing, adjusting, and balancing (of HVAC systems)

m. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed

n. TAB Agency: TAB Firm

o. TAB team field leader: TAB team field leader

p. TAB team supervisor: TAB team engineer

q. TAB team technicians: TAB team assistants

r. TAB team field leader: TAB team field leader

s. TAB team supervisor: TAB team engineer

t. TAB team technicians: TAB team assistants

u. TABB: Testing Adjusting and Balancing Bureau

1.2.1 Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems	International Standards for Environmental Systems Balance
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures	Field Readiness Check & Prelim. Field Procedures

1.3 WORK DESCRIPTION

The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of [new][and existing] heating, ventilating, and cooling (HVAC) air[and water] distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings, including records of existing conditions.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

****

NOTE: When the measurement of existing conditions is desired, clearly indicate and/or specify all requirements.

****

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1972 CD, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

1.3.1 Air Distribution Systems

Test, adjust, and balance system[s] (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.2 Water Distribution Systems

TAB system[s] in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to water distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. At Contractor's option and with Contracting Officer's written approval, the piping systems may be insulated before systems are TAB'd.

Terminate piping insulation immediately adjacent to each flow control valve, automatic control valve, or device. Seal the ends of pipe insulation and the space between ends of pipe insulation and piping, with waterproof vapor barrier coating.

After completion of work under this section, insulate the flow control valves and devices as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.3 TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

(1) A unique number or mark for each piece of equipment or terminal.

(2) Air quantities at air terminals.

(3) Air quantities and temperatures in air handling unit schedules.

(4) Water quantities and temperatures in thermal energy transfer equipment schedules.

(5) Water quantities and heads in pump schedules.

(6) Water flow measurement fittings and balancing fittings.

(7) Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-

The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

Submit [three][_____] copies of the TAB Schematic Drawings and Report Forms to the Contracting Officer, no later than [21][_____] days prior to the start of TAB field measurements.

1.3.4 Related Requirements

Requirements for price breakdown of HVAC TAB work are specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

Requirements for construction scheduling related to HVAC TAB work are specified in Section 01 32 17.00 20 COST LOADED NETWORK ANALYSIS SCHEDULES (NAS).

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

If using this section for NAVFAC DALT and TAB projects, keep "G" for submittals.

****

****

NOTE: Refer to the paragraph above PHASING OF WORK. If this paragraph applies to the construction contract, modify the entire SUBMITTALS paragraph by phasing (maybe by repeating the various submittals for each phase) to facilitate the submittal process.

****

SD-01 Preconstruction Submittals

Records of Existing Conditions; G, [_____]

Independent TAB Agency and Personnel Qualifications; G, [_____]

TAB Design Review Report; G, [_____]

TAB Firm; G, [_____]

Designation of TAB Team Assistants; G, [_____]

Designation of TAB Team Engineer; G, [_____] or TAB Specialist; G, [_____]

Designation of TAB Team Field Leader; G, [_____]

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; G, [_____]

SD-03 Product Data

Equipment and Performance Data; G, [_____]

TAB Related HVAC Submittals; G, [_____]

A list of the TAB Related HVAC Submittals, no later than [7] [_____] days after the approval of the TAB team engineer [and assistant].

TAB Procedures; G, [_____]

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

Calibration; G, [_____]

Systems Readiness Check; G, [_____]

TAB Execution; G, [_____]

TAB Verification; G, [_____]

SD-06 Test Reports

Completed Pre-Final DALT Report; G, [_____]

Certified Final DALT Report; G, [_____]

Prerequisite HVAC Work Checkout List For Proportional Balancing; G, [_____]

Certified Final TAB Report for Proportional Balancing; G, [_____]

Prerequisite HVAC Work Checkout List For Season 1; G, [_____]

Certified Final TAB Report for Season 1; G, [_____]

Prerequisite HVAC Work Checkout List For Season 2; G, [_____]

Certified Final TAB Report for Season 2; G, [_____]
TAB Design Review Report; G, [_____]

TAB Report for Season 1; G, [_____]

TAB Report for Season 2; G, [_____]

SD-07 Certificates

Independent TAB Agency and Personnel Qualifications; G, [_____]

DALT and TAB Submittal and Work Schedule; G, [_____]

TAB Pre-Field Engineering Report; G, [_____]

Instrument Calibration Certificates; G, [_____]

DALT and TAB Procedures Summary; G, [_____]

Completed Pre-Final DALT Work Checklist; G, [_____]

Advance Notice of Pre-Final DALT Field Work; G, [_____]

Advance Notice of TAB Field Work for Proportional Balancing; G, [_____]

Advance Notice of TAB Field Work for Season 1; G, [_____]

Advance Notice of TAB Field Work for Season 2 G, [_____]

TAB Firm; G, [_____]

Design Review Report; G, [_____]

[Pre-field DALT Preliminary Notification; G, [_____]

] Advanced Notice for [Season 1] TAB Field Work; G, [_____]

Prerequisite HVAC Work Check Out List [For Season 1]; G, [_____]

[Advanced Notice for Season 2 TAB Field Work; G, [_____]

][Prerequisite HVAC Work Check Out List For Season 2; G, [_____]
]

1.5 QUALITY ASSURANCE

1.5.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:

a. Independent AABC or NEBB or TABB TAB agency:

(1) TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

(2) TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

(3) TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

(4) TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

(5) Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

1.5.1.1 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.1.2 Qualifications

a. TAB Firm

****

NOTE: Where the size or complexity of the HVAC system(s) warrant, include in the project specification the bracketed requirement specifying that the TAB firm be certified for "building systems commissioning".

****

b. The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including [TAB of environmental systems] [the performance of clean rooms and clean air devices] [building systems commissioning] [and] [the measuring of sound and vibration in environmental systems].

c. Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

d. These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

e. TAB Specialist

f. The TAB Specialist must be either a member of AABC,an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

g. TAB Specialist Responsiblities

h. TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process.

1.5.1.3 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.2 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

1.5.2.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

    (1) Contract drawings and specifications

    (2) Approved submittal data for equipment

    (3) Construction work schedule

    (4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.

e. Coordination of supporting personnel:

f. Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

g. Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

h. Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

i. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

j. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

k. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

    (1) HVAC system installations are fully complete.

    (2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and

approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

(3) DALT field checks for all systems are completed.

(4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

l. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

m. Insulation work: For required DALT work , ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

1.5.2.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

1.5.2.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Pre-DALT/TAB meeting: Attend meeting with Contractor.

c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.

e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.

f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.

g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

h. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

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NOTE: The number of workdays for the TAB supervisor's visit to the contract site for DALT work, is based on the size, number, type, and complexity of the HVAC system to be DALT'd.

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(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration.

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

****

NOTE: The number of workdays for the TAB supervisor's visits to the contract work site for TAB work, is based on the size, number, type, and complexity of the HVAC system to be TAB'd.

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NOTE: Choose one of the following options.

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NOTE: Option 1: Normally, use the following two subparagraphs, which requires two separate trips within a season to the contract site by the TAB field team (the first for the TAB field work, the second for the TAB quality assurance work) with the certified TAB report submitted between the trips. This is intended to give the design engineer time to review the certified TAB report before the field check of that report is conducted.

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[(1) TAB field visit: At the midpoint of the Season 1 and Season 2 TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration.

][(2) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration. Review the TAB final report data and certify the TAB final report.

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NOTE: Option 2: Use the following subparagraph when the contract site is remote, or the HVAC system is simple, and the specifier wants to reduce to one the number of trips to the contract site by the TAB field team within a season (TAB field work and TAB quality assurance accomplished in same trip).

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[(3) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration. Review the TAB final report data and certify the TAB final report.

] k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise [Season 1] [and Season 2] TAB field check.

1.5.2.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

[1.5.3 Project/Site Conditions

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NOTE: When the measurement of existing conditions is desired, clearly indicate and/or specify all requirements. If "existing conditions" does not apply, delete this paragraph.

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1.5.3.1 DALT and TAB Services to Obtain Existing Conditions

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct this DALT and TAB work in accordance with the requirements of this section.

]1.5.4 Sequencing and Scheduling

[1.5.4.1 Projects with Phased Construction

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NOTE: Ensure all aspects of the HVAC work, including DALT work and TAB work, are incorporated in the contract's construction phases and fully covered in the contract documents. Revise this paragraph accordingly based on your specific project.

****

This specification section is structured as though the HVAC construction, and thereby the TAB work, will be completed in a single phase. When the construction is completed in phases, the DALT work and TAB work must be planned, completed, and accepted for each construction phase.

a. Phasing of Work

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NOTE: In the following paragraph, DALT work is specified. If DALT work is not required for a given project, delete references to DALT throughout. This is facilitated by brackets locating these references to DALT work.

****

b. This specification section is structured as though the HVAC construction, and thereby the TAB work, is going to be completed in a single phase[in spite of the fact that there will be two seasons]. All elements of the TAB work are addressed on this premise. When a contract is to be completed in construction phases, including the TAB work, and the DALT work, the TAB work and DALT work must be planned for, completed and approved by the Contracting Officer with each phase. An example of this case would be one contract that requires the rehabilitation of the HVAC in each of several separated buildings. At the completion of the final phase, compile all approved reports and submit as one document.

]1.5.4.2 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.

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NOTE: The calendar day requirements specified should apply to many construction projects. However, the specifier, when preparing this paragraph for a specific contract, must review and modify this paragraph to suit the contract construction schedule. Season 1 may be the season of maximum heating load or maximum cooling load, depending upon construction schedule.

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Submit this schedule,and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

Qualify TAB Personnel: Within [45] [_____] calendar days after date of contract award, submit TAB agency and personnel qualifications.

Pre-DALT/TAB Meeting: Within [30] [_____] calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

Design Review Report: Within [60] [_____] calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Contracting Officer in writing within 5 days after completion.

Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Contracting Officer.

Submit Final DALT Report: Within [15] [_____] calendar days after completion of successful DALT Work Field Check, submit [Season 1] TAB report.

Pre-Field TAB Engineering Report: Within [_____] calendar days after approval of the TAB agency Personnel Qualifications, submit the

Pre-Field TAB Engineering Report.

Prerequisite HVAC Work Check Out List [For Season 1] and Advanced Notice For [Season 1] TAB Field Work: At a minimum of [115] [_____] calendar days prior to CCD, submit [Season 1] prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of [Season 1] TAB field work.

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NOTE: Choose one of the following options.

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NOTE: Option 1: Normally, use the following four paragraphs, which requires two separate trips within Season 1 to the contract site by the TAB field team (the first for the TAB field work, the second for the TAB quality assurance work) with the TAB report submitted between trips. This is intended to give the design engineer time to review the TAB report before the field check of that report is conducted.

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[[Season 1] TAB Field Work: At a minimum of [90] [_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1] TAB field work.

Submit [Season 1] TAB Report: Within [15] [_____] calendar days after completion of [Season 1] TAB field work, submit [Season 1] TAB report.

[Season 1] TAB Field Check: [30] [_____] calendar days after Season 1 TAB report is approved by the Contracting Officer, conduct [Season 1] field check.

Complete [Season 1] TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work].

]

****

NOTE: Option 2: Use the following two paragraphs when the contract site is remote or the HVAC system is simple, and the specifier wants to reduce to one the number of trips to the contract site by the TAB field team within Season 1 (TAB field work and TAB quality assurance accomplished in same trip). Renumber remaining paragraphs appropriately.

****

[[Season 1] TAB Field Work: At a minimum of [90] [_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1] TAB field work; submit [Season 1] TAB report; and conduct [Season 1] field check.

Complete [Season 1] TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work].

]

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NOTE: Include the remaining submittals and items of work only if there is a season 2 TAB Work

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[Prerequisite HVAC Work Check Out List For Season 2 and Advanced Notice For Season 2 TAB Field Work: Within [150] [_____] calendar days after date of the commencement of the Season 1 TAB field work, submit the Season 2 prerequisite HVAC work check out list certified as complete and submit advance notice of commencement of Season 2 TAB field work.

]

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NOTE: Choose one of the following options.

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NOTE: Option 1: Normally, use the following four paragraphs, which requires two separate trips within Season 2 to the contract site by the TAB field team (the first for the TAB field work, the second for the TAB quality assurance work) with the TAB report submitted between trips. This is intended to give the design engineer time to review the TAB report before the field check of that report is conducted.

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[Season 2 TAB Field Work: Within [180] [_____] calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within [15] [_____] calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 TAB Field Check: [30] [_____] calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

Complete Season 2 TAB Work: Within [15] [_____] calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

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NOTE: Option 2: Use the following two paragraphs when the contract site is remote, or the HVAC system is simple, and the specifier wants to reduce to one the number of trips to the contract site by the TAB field team within Season 2 (TAB field work and TAB quality assurance accomplished in same trip). Renumber remaining paragraphs appropriately.

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[Season 2 TAB Field Work: Within [180] [_____] calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish [Season 2] TAB field work; submit [Season 2] TAB report; and conduct Season 2 field check.

Complete Season 2 TAB Work: Within [15] [_____] calendar days after the completion of Season 2 field data check, complete TAB work.

] a. TAB Design Review Report

b. Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

c. Pre-Field DALT Preliminary Notification

d. Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.

1.5.4.3 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.

d. At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

1.5.5 Subcontractor Special Requirements

Perform all work in this section in accordance with the paragraph SUBCONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, stating that all contract requirements of this section must be accomplished directly by a first tier subcontractor. No work may be performed by a second tier subcontractor.

1.5.6 Instrument Calibration Certificates

It is the responsibility of the TAB firm to provide instrumentation that meets the minimum requirements of the standard under which the TAB Firm's qualifications are approved for use on a project. Instrumentation must be in proper operating condition and must be applied in accordance with the instrumentation's manufacturer recommendations.

All instrumentation must bear a valid NIST traceable calibration certificate during field work and during government acceptance testing. All instrumentation must be calibrated within no later than one year of the date of TAB work or government acceptance testing field work.

1.5.7 TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.8 Qualifications

1.5.8.1 TAB Firm

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NOTE: Where the size or complexity of the HVAC

system(s) warrant, include in the project specification the bracketed requirement specifying that the TAB firm be certified for "building systems commissioning".
****

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including [TAB of environmental systems] [the performance of clean rooms and clean air devices] [building systems commissioning] [and] [the measuring of sound and vibration in environmental systems].

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

1.5.8.2 TAB Specialist

The TAB Specialist must be either a member of AABC,an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

1.5.8.3 TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process[specified in Section 01 91 00.15 BUILDING COMMISSIONING].

1.5.8.4 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC

TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.9 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

1.5.9.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

   (1) Contract drawings and specifications

   (2) Approved submittal data for equipment

   (3) Construction work schedule

   (4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.

e. Coordination of supporting personnel:

f. Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

g. Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

h. Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

i. Deficiencies: Ensure that the TAB Agency supervisor submits all

Design/Construction deficiency notifications directly to the Contracting officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

j. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

k. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

    (1) HVAC system installations are fully complete.

    (2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

    (3) DALT field checks for all systems are completed.

    (4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

l. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

m. Insulation work: For required DALT work , ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

1.5.9.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

1.5.9.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Pre-DALT/TAB meeting: Attend meeting with Contractor.

c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.

e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.

f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.

g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

h. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

****

NOTE: The number of workdays for the TAB supervisor's visit to the contract site for DALT work, is based on the size, number, type, and complexity of the HVAC system to be DALT'd.

****

(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration.

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

****
NOTE: The number of workdays for the TAB supervisor's visits to the contract work site for TAB work, is based on the size, number, type, and complexity of the HVAC system to be TAB'd.
****

****
NOTE: Choose one of the following options.
****

****
NOTE: Option 1: Normally, use the following two subparagraphs, which requires two separate trips within a season to the contract site by the TAB field team (the first for the TAB field work, the second for the TAB quality assurance work) with the certified TAB report submitted between the trips. This is intended to give the design engineer time to review the certified TAB report before the field check of that report is conducted.
****

[(1) TAB field visit: At the midpoint of the Season 1 and Season 2 TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration.

][(2) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration. Review the TAB final report data and certify the TAB final report.

]

****
NOTE: Option 2: Use the following subparagraph when the contract site is remote, or the HVAC system is simple, and the specifier wants to reduce to one the number of trips to the contract site by the TAB field team within a season (TAB field work and TAB quality assurance accomplished in same trip).
****

[(3) TAB field visit: Near the end of the TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct site visit full-time for a minimum of [one] [two] [_____] 8 hour workday[s] duration. Review the TAB final report data and certify the TAB final report.

] k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise [Season 1] [and Season 2] TAB field check.

1.5.9.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

1.5.10 Test Reports

1.5.10.1 Data from DALT Field Work

Report the data for the Pre-final DALT Report and Certified Final DALT Report in compliance the following requirements:

a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.

b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition,provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.

c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.

d. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

1.5.10.2 Certified TAB Reports

Submit: TAB Report for Season 1 and TAB Report for Season 2 in the following manner:

a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.

b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

****

NOTE: The design engineer must list, in the paragraph below, those rooms, or zones, for which indoor dry bulb and wet bulb temperatures are compiled for the specified time duration. Include a sufficient number of rooms, or zones, in the listing to ensure correct evaluation of performance for the installed HVAC systems.

****

(1) [Specifier: List desired rooms and/or zones here]. Measure and compile data on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Measure and record data only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls must be fully operational a minimum of 24 hours in advance of commencing data compilation. Include the specified data in the [Season I TAB Report] [Season I and Season 2 TAB Report].

****

NOTE: Paragraphs c., d., and e., below apply to air distribution systems to be TAB'd. Delete all of these paragraphs if no air distribution systems are in the project, or delete the paragraphs not applicable and edit the terminology of the remaining paragraphs to agree with the drawings.

****

[c. System Diagrams: Provide updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations. Use a key numbering system on the diagram which identifies each outlet contained in the outlet airflow report sheets.

][d. Static Pressure Profiles: Report static pressure profiles for air duct systems including: [_____]. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. Include the following in the static pressure report data, in addition to AABC/NEBB/TABB required data:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

(5) Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(6) Report static pressure drop across outside air and relief/exhaust air louvers.

]

****

NOTE: Below, delete the period at the end of the sentence and delete the brackets for projects with large air moving systems, i.e., include in the specification the pressure readings in the additional listed duct locations for air moving systems 4720 L/S 10000 CFM and larger.

****

[(7) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.[and also at the following locations:

Main Duct: Take readings at four locations along the full length of the main duct, 25 percent, 50 percent, 75 percent, and 100 percent of the total duct length.

Floor Branch Mains: Take readings at floor branch mains served by a main duct vertical riser.

Branch Main Ducts: Take readings at branch main ducts.

VAV Terminals: Take readings at inlet static pressure at VAV terminal box primary air branch ducts.

VAV Terminals, Fan Powered: Take readings at fan discharge and inlet static pressures for series and parallel fan powered VAV terminal boxes.]

]

****

NOTE: Delete the brackets below for large air moving systems, i.e., include in the specification the duct traverses for the branch mains for air moving systems 4720 L/S 10000 CFM and larger.

****

e. Duct Traverses: Report duct traverses for main [and branch main] supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane."

f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

g. Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

h. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

i. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

j. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

[1.6 PROJECT/SITE CONDITIONS

****

NOTE: When the measurement of existing conditions is desired, clearly indicate and/or specify all requirements. If "existing conditions" does not apply, delete this paragraph.

****

1.6.1 DALT and TAB Services to Obtain Existing Conditions

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct this DALT and TAB work in accordance with the requirements of this section.

]1.7 SEQUENCING AND SCHEDULING

[1.7.1 Projects with Phased Construction

****

NOTE: Ensure all aspects of the HVAC work, including DALT work and TAB work, are incorporated in the contract's construction phases and fully covered in the contract documents. Revise this paragraph accordingly based on your specific project.

****

This specification section is structured as though the HVAC construction, and thereby the TAB work, will be completed in a single phase. When the construction is completed in phases, the DALT work and TAB work must be planned, completed, and accepted for each construction phase.

1.7.1.1 Phasing of Work

****

NOTE: In the following paragraph, DALT work is specified. If DALT work is not required for a given project, delete references to DALT throughout. This is facilitated by brackets locating these references to DALT work.

****

This specification section is structured as though the HVAC construction, and thereby the TAB work, is going to be completed in a single phase[in spite of the fact that there will be two seasons]. All elements of the TAB work are addressed on this premise. When a contract is to be completed in construction phases, including the TAB work, and the DALT work, the TAB work and DALT work must be planned for, completed and approved by the Contracting Officer with each phase. An example of this case would be one contract that requires the rehabilitation of the HVAC in each of several separated buildings. At the completion of the final phase, compile all approved reports and submit as one document.

]1.7.2 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.

****

NOTE: The calendar day requirements specified should apply to many construction projects. However, the specifier, when preparing this paragraph for a specific contract, must review and modify this paragraph to suit the contract construction schedule. Season 1 may be the season of maximum heating load or maximum cooling load, depending upon construction schedule.

****

Submit this schedule,and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer (CO) for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for CO approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

Qualify TAB Personnel: Within [45] [_____] calendar days after date of contract award, submit TAB agency and personnel qualifications.

Pre-DALT/TAB Meeting: Within [30] [_____] calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

Design Review Report: Within [60] [_____] calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Contracting Officer in writing within 5 days after completion.

Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Contracting Officer.

Submit Final DALT Report: Within [15] [_____] calendar days after completion of successful DALT Work Field Check, submit [Season 1] TAB report.

Pre-Field TAB Engineering Report: Within [_____] calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

Prerequisite HVAC Work Check Out List [For Season 1] and Advanced Notice For [Season 1] TAB Field Work: At a minimum of [115] [_____] calendar days prior to CCD, submit [Season 1] prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of [Season 1] TAB field work.

****

NOTE: Choose one of the following options.

****

****

NOTE: Option 1: Normally, use the following four paragraphs, which requires two separate trips within Season 1 to the contract site by the TAB field team (the first for the TAB field work, the second for the TAB quality assurance work) with the TAB report submitted between trips. This is intended to give the design engineer time to review the TAB report

before the field check of that report is conducted.
****

[[Season 1] TAB Field Work: At a minimum of [90] [_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1] TAB field work.

Submit [Season 1] TAB Report: Within [15] [_____] calendar days after completion of [Season 1] TAB field work, submit [Season 1] TAB report.

[Season 1] TAB Field Check: [30] [_____] calendar days after Season 1 TAB report is approved by the Contracting Officer, conduct [Season 1] field check.

Complete [Season 1] TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work].

]

****
NOTE: Option 2: Use the following two paragraphs when the contract site is remote or the HVAC system is simple, and the specifier wants to reduce to one the number of trips to the contract site by the TAB field team within Season 1 (TAB field work and TAB quality assurance accomplished in same trip). Renumber remaining paragraphs appropriately.
****

[[Season 1] TAB Field Work: At a minimum of [90] [_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1] TAB field work; submit [Season 1] TAB report; and conduct [Season 1] field check.

Complete [Season 1] TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work].

]

****
NOTE: Include the remaining submittals and items of work only if there is a season 2 TAB Work
****

[Prerequisite HVAC Work Check Out List For Season 2 and Advanced Notice For Season 2 TAB Field Work: Within [150] [_____] calendar days after date of the commencement of the Season 1 TAB field work, submit the Season 2 prerequisite HVAC work check out list certified as complete and submit advance notice of commencement of Season 2 TAB field work.

]

****
NOTE: Choose one of the following options.
****

****
NOTE: Option 1: Normally, use the following four paragraphs, which requires two separate trips within Season 2 to the contract site by the TAB field team (the first for the TAB field work, the second for the TAB quality assurance work) with the TAB report submitted between trips. This is intended to give the design engineer time to review the TAB report before the field check of that report is conducted.

****

[Season 2 TAB Field Work: Within [180] [_____] calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within [15] [_____] calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 TAB Field Check: [30] [_____] calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

Complete Season 2 TAB Work: Within [15] [_____] calendar days after the completion of Season 2 TAB field data check, complete all TAB work.
]

****

NOTE: Option 2: Use the following two paragraphs when the contract site is remote, or the HVAC system is simple, and the specifier wants to reduce to one the number of trips to the contract site by the TAB field team within Season 2 (TAB field work and TAB quality assurance accomplished in same trip). Renumber remaining paragraphs appropriately.

****

[Season 2 TAB Field Work: Within [180] [_____] calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish [Season 2] TAB field work; submit [Season 2] TAB report; and conduct Season 2 field check.

Complete Season 2 TAB Work: Within [15] [_____] calendar days after the completion of Season 2 field data check, complete TAB work.

]1.7.2.1 TAB Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

1.7.2.2 Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.

1.7.2.3 TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.

d. At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

1.8 WARRANTY

Furnish workmanship and performance warranty for the [DALT and] TAB system work performed for a period not less than [1] [2] [3] [5] [_____] years from the date of Government acceptance of the work; issued directly to the Government. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time constitutes grounds for having the corrective action and repairs performed by others and the cost billed to the TAB firm. The Contractor must also provide a [1] [2] [3] [5] [_____] year contractor installation warranty.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section as specified in Appendix A WORK DESCRIPTIONS OF PARTICIPANTS.

3.2 PRE-DALT/TAB MEETING

****

NOTE: Inclusion of this meeting requirement in the specification is based on the complexity of the HVAC systems and the location of the contract site.

****

Meet with the Contracting Officer's technical representative (COTR)[and the designing engineer of the HVAC systems] to develop a mutual understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

3.3 DALT PROCEDURES

****

NOTE: It is the designer's decision/responsibility to decide whether, or not, to require duct air leak testing in accordance with this section. Subjecting duct systems to acceptance testing likely results in higher quality ductwork. Only very simple duct systems, such as low velocity ductwork within a single room, do not justify DALT testing. Indicate on the drawings a duct construction schedule that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. Refer to SMACNA Leakage Test Mnl, Appendix B, "Sample Leakage Analysis" for guidance in determining leakage test pressures.Specify in Appendix D, the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, and duct leakage test pressure. Duct Seal Class shall be SMACNA Seal Class "A". Refer to SMACNA Leakage Test Mnl, Appendix B, "Sample Leakage Analysis" for guidance in determining leakage test pressures.

****

3.3.1 Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

3.3.2 Advance Notice of Pre-Final DALT Field WorkAdvance Notice of Pre-Final DALT Field Work

On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing prior to the COTR's duct selection field visit.

3.3.3 Ductwork To Be DALT'd

From each duct system indicated as subject to DALT, the COTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

[It is acceptable for an entire duct system to be DALT'd instead of disassembling that system in order to DALT only the 20 percent portion specified above.

]3.3.4 DALT Testing

Perform DALT on the HVAC duct sections of each system as selected by the COTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1972 CD.

In spite of specifications of SMACNA 1972 CD to the contrary, DALT ductwork of construction class of 746 Pa 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the COTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

3.3.5 Completed Pre-Final DALT Report

After completion of the DALT work, prepare a Pre-final DALT Report meeting the additional requirements specified in Appendix B REPORTS - DALT and TAB. Data required by those data report forms shall be furnished by the TAB team. Prepare the report neatly and legibly; the Pre-final DALT report shall provide the basis for the Final DALT Report.

TAB supervisor shall review, approve and sign the Pre-Final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-Final DALT Report data can commence.After completion of the DALT work, prepare a Pre-final DALT Report using the reporting forms specified. TAB team to furnish data required by those data report forms. Prepare the report neatly and legibly; the Pre-final DALT report is the basis for the Final DALT Report.

TAB supervisor must review and certify the Pre-final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-final DALT Report data can commence.

3.3.6 Quality Assurance - COTR DALT Field Acceptance Testing

In the presence of the COTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the COTR. For each duct system, this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.

Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the presence of the COTR.

3.3.7 Additional COTR Field Acceptance Testing

If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the COTR.

3.3.8 Certified Final DALT Report

On successful completion of all field checks of the Pre-final DALT Report data for all systems, the TAB Supervisor is to assemble, review, certify and submit the Final DALT Report to the Contracting Officer for approval.On successful completion of all field checks of the Pre-Final DALT Report data for all systems, the TAB Supervisor shall assemble, review, approve, sign and submit the Final DALT Report in compliance with Appendix B REPORTS - DALT and TAB to the Contracting Officer for approval.

3.3.9 Prerequisite for TAB Field Work

Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

3.4 TAB PROCEDURES

3.4.1 TAB Field Work

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

That is, comply with the the requirements of AABC MN-1 or SMACNA 1780 (TABB) and SMACNA 1858 (TABB),except as supplemented and modified by this section.

[Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.
]

****

NOTE: For those projects having only a single season TAB report, delete the last sentence of the following paragraph.
****

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section.[The only water flow and air flow reporting which can be deferred until the Season 2 is that data which would be affected in terms of accuracy due to outside ambient conditions.]

3.4.2 Preliminary Procedures

Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

3.4.3 TAB Air Distribution Systems

****
NOTE: Edit, delete, and add to the paragraphs below to ensure that air distribution systems indicated on project drawings are listed for TAB work. Explicitly identify new and existing systems and components which are to be TAB'd. Exercise particular care in defining existing systems and components. Specify the systems identically to labeling and terminology used on project drawings. Delete the subparts which do not apply to your project.
****

3.4.3.1 Units With Coils

Report heating and cooling performance capacity tests for hot water, chilled water, DX and steam coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For air handlers with capacities greater than 26,370 Watts 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."

b. Do not determine entering and leaving wet and dry bulb temperatures by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

c. Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

d. For units with capacities of 26370 Watts 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

e. Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.4.3.2 Air Handling Units

Air handling unit systems including fans (air handling unit fans, exhaust fans and winter ventilation fans), coils, ducts, plenums, mixing boxes, terminal units, variable air volume boxes, and air distribution devices for supply air, return air, outside air, mixed air relief air, and makeup air.

[3.4.3.3 Rooftop Air Conditioning

Rooftop air conditioning systems including fans, coils, ducts, plenums, and air distribution devices for supply air, return air, and outside air.

For refrigeration compressors/condensers/condensing units/evaporators, report data as required by NEBB, AABC, and TABB standard procedures, including refrigeration operational data.

][3.4.3.4 Heating and Ventilating Units

Heating and ventilating unit systems including fans, coils, ducts, plenums, roof vents, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.

][3.4.3.5 Makeup Air Units

Makeup air unit systems including fans, coils, ducts, plenums, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.

][3.4.3.6 Return Air Fans

Return air fan system including fan ducts, plenums, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.

][3.4.3.7 Fan Coils

Fan coil unit systems including fans, coils, ducts, plenums, and air distribution devices for supply air, return air, and outside air.

][3.4.3.8 Exhaust Fans

Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.

][3.4.4 TAB Water Distribution Systems

****

NOTE: Edit, delete, and add to the paragraphs below to ensure that water distribution systems indicated

on project drawings are listed for TAB work. Explicitly identify new and existing systems and components which are to be TAB'd. Exercise particular care in defining existing systems and components. Specify the systems identically to labeling and terminology used on project drawings.

****

3.4.4.1 Chilled Water

Chilled water systems including chillers, condensers, cooling towers, pumps, coils, system balance valves and flow measuring devices.

For water chillers, report data as required by AABC, NEBB and TABB standard procedures, including refrigeration operational data.

3.4.4.2 Heating Hot Water

Heating hot water systems including boilers, hot water converters (e.g., heat exchangers), pumps, coils, system balancing valves and flow measuring devices.

3.4.4.3 Dual Temperature Water

Dual temperature water systems including boilers, converters, chillers, condensers, cooling towers, pumps, coils, and system balancing valves, and flow measuring devices.

][3.4.5 Sound Measurement Work

3.4.5.1 Areas To Be Sound Measured

In the following spaces, measure and record the sound power level for each octave band listed in ASHRAE HVAC APP SI HDBK ASHRAE HVAC APP IP HDBK Noise Criteria:

a. All HVAC mechanical rooms, including machinery spaces and other spaces containing HVAC power drivers and power driven equipment.

b. All spaces sharing a common barrier with each mechanical room, including rooms overhead, rooms on the other side of side walls, and rooms beneath the mechanical room floor.

****

NOTE: Select representative non-mechanical rooms which are occupied by any personnel and are served by each type of primary HVAC air moving system and HVAC water moving systems. Include rooms served by like primary systems which have significantly different sound affecting configurations. List, in the subparagraphs below, the rooms to be sound measured that will accomplish the aforementioned sound assessment philosophy. List the rooms by terminology identical to labeling indicated on drawings.

****

[c. AHU No. 1 System: Rooms: [_____]

][d. [_____] System: Rooms: [_____]

][e. [_____] System: Rooms: [_____]

]3.4.5.2 Procedure

Measure sound levels in each room, when unoccupied except for the TAB team, with all HVAC systems that would cause sound readings in the room operating in their noisiest mode. Record the sound level in each octave band. Attempt to mitigate the sound level and bring the level to within the specified ASHRAE HVAC APP SI HDBK ASHRAE HVAC APP IP HDBK noise criteria goals, if such mitigation is within the TAB team's control. State in the report the ASHRAE HVAC APP SI HDBK ASHRAE HVAC APP IP HDBK noise criteria goals. If sound level cannot be brought into compliance, provide written notice of the deficiency to the Contractor for resolution or correction.

3.4.5.3 Timing

Measure sound levels at times prescribed by AABC or NEBB or TABB.

3.4.5.4 Meters

Measure sound levels with a sound meter complying with ASA S1.4, Type 1 or 2, and an octave band filter set complying with ASA S1.11 PART 1. Use measurement methods for overall sound levels and for octave band sound levels as prescribed by NEBB.

3.4.5.5 Calibration

Calibrate sound levels as prescribed by AABC or NEBB or TABB, except that calibrators emitting a sound pressure level tone of 94 dB at 1000 hertz (Hz) are also acceptable.

3.4.5.6 Background Noise Correction

Determine background noise component of room sound (noise) levels for each (of eight) octave bands as prescribed by AABC or NEBB or TABB.

][3.4.6 TAB Work on Performance Tests Without Seasonal Limitations

****

NOTE: Choose one of the following options: TAB without Seasonal Limitations, or TAB with Seasonal Limitations.

****

****

NOTE: Choose the text immediately below or the text in the paragraph TAB WORK ON PERFORMANCE TESTS WITH SEASONAL LIMITATIONS. Use the text immediately below in the case where the winter outdoor design dry bulb temperature and the summer outdoor design dry bulb temperature are within 19.4 degrees C 35 degrees F of each other. This will reduce the number of trips to the contract site from two (one per season) to one for performance testing by the TAB field team. Use the second option, in the other cases.

****

3.4.6.1 Performance Tests

In addition to the TAB proportionate balancing work on the air distribution systems and the water distribution systems, accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the [heating systems] [and] [cooling systems].

3.4.6.2 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

[3.4.6.3 Sound Measurements

Comply with the paragraph SOUND MEASUREMENT WORK, specifically, the requirement that a room must be operating in its noisiest mode at the time of sound measurements in the room. The maximum noise level measurements could depend on seasonally related heat or cooling transfer equipment.

][3.4.6.4 Water Chillers

For water chillers, report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

][3.4.6.5 Refrigeration Units

For refrigeration compressors/condensers/condensing units, report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

]3.4.6.6 Coils

Report heating and cooling performance capacity tests for [hot water], [chilled water], [DX] [and steam coils] for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

[a. For Central station air handlers with capacities greater than 26,370 Watts 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing".

b. Entering and leaving wet and dry bulb temperatures are not determined by single point measurement, but the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

c. Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

][d. For units with capacities of 26370 Watts 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

e. Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

]][3.4.7 TAB Work on Performance Tests With Seasonal Limitations

****

NOTE: Choose the text immediately below, or the text above in the paragraph TAB WORK ON PERFORMANCE TESTS WITHOUT SEASONAL LIMITATIONS. Refer to technical note immediately above. The text immediately below requires one trip each for Seasons 1 and 2.

****

3.4.7.1 Performance Tests

Accomplish proportional balancing TAB work on the air distribution systems and water distribution systems, in other words, accomplish adjusting and balancing of the air flows and water flows, any time during the duration of this contract, subject to the limitations specified elsewhere in this section. However, accomplish, within the following seasonal limitations, TAB work on HVAC systems which directly transfer thermal energy.Accomplish proportionate balancing TAB work on the air distribution systems and water distribution systems, in other words, accomplish adjusting and balancing of the air flows and water flows, any time during the duration of this contract, subject to the limitations specified elsewhere in this section. However, accomplish, within the following seasonal limitations, TAB work on HVAC systems which directly transfer thermal energy.

3.4.7.2 Season Of Maximum Load

Visit the contract site for at least two TAB work sessions for Season 1 and Season 2 field measures. [Visit the contract site during the season of maximum heating load] [and] [visit the contract site during the season of maximum cooling load], the goal being to TAB the operational performance of the [heating systems] [and] [cooling systems] under their respective maximum outdoor environment-caused loading. During the seasonal limitations, TAB the operational performance of the [heating systems] [and] [cooling systems].Visit the contract site for at least two TAB work sessions for TAB field measurements. [Visit the contract site during the season of maximum heating load] [and] [visit the contract site during the season of maximum cooling load], the goal being to TAB the operational performance of the [heating systems] [and] [cooling systems] under their respective maximum outdoor environment-caused loading. During the seasonal limitations, TAB the operational performance of the [heating systems] [and] [cooling systems].

3.4.7.3 Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3.4.7.4 Sound Measurements

Comply with the paragraph SOUND MEASUREMENT WORK, specifically, the requirement that a room must be operating in its noisiest mode at the time of sound measurements in the room. The maximum noise level measurements could depend on seasonally related heat or cooling transfer equipment.

[3.4.7.5 Water Chillers

Water chillers: For water chillers,report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

][3.4.7.6 Refrigeration Units

For refrigeration compressors/condensers/condensing units,report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

][3.4.7.7 Coils

Report heating and cooling performance capacity tests for [hot water], [chilled water], [DX] [and steam coils] for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For Central station air handlers with capacities greater than 26,370 Watts 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."

b. Entering and leaving wet and dry bulb temperatures are not determined by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

c. Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

d. For units with capacities of 26370 Watts 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

e. Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

]][3.4.8 Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Contracting Officer for direction.

]3.4.9 Deficiencies

Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph WORKMANSHIP, provide written notice as soon as possible to the Contractor and the Contracting Officer describing the deficiency and recommended correction.

Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

3.4.10 TAB Reports

Additional requirements for TAB Reports are specified in Appendix B REPORTS - DALT and TAB

****

NOTE: Choose one of the options below.

****

****

NOTE: Option 1: Normally, use the following paragraph, which requires two separate trips within a season to the contract site by the TAB field team (the first for the TAB field work, the second for the TAB quality assurance work) with the TAB report submitted between the trips. This is intended to give the design engineer time to review the TAB report before the quality assurance field check of that report is conducted.

****

[After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and certification, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP.
]

****

NOTE: Option 2: Use the following paragraph when the contract site is remote or the HVAC system is simple, and the specifier wants to reduce to one the number of trips to the contract site by the TAB field team within a season. (TAB field work and TAB quality assurance accomplished in same trip).

****

[After completion of the TAB work, prepare a pre-final TAB report using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP of this section.

Prepare the report neatly and legibly; the pre-final TAB report is the final TAB report minus the TAB supervisor's review and certification. Obtain, at the contract site, the TAB supervisor's review and certification of the TAB report.

Verbally notify the COTR that the field check of the TAB report data can commence; give this verbal notice 48 hours in advance of field check commencement. Do not schedule field check of the TAB report until the specified workmanship requirements have been met or written approval of the deviations from the requirements have been received from the Contracting Officer.

]

3.4.11 Quality Assurance - COTR TAB Field Acceptance Testing

3.4.11.1 TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR, random selections of data (water, air quantities, air motion, [sound level readings]) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the COTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

Group 1: All chillers, boilers, return fans, computer room units, and air handling units (rooftop and central stations).

Group 2: 25 percent of the VAV terminal boxes and associated diffusers and registers.

Group 3: 25 percent of the supply diffusers, registers, grilles associated with constant volume air handling units.

Group 4: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.

Group 5: 25 percent of the supply fans, exhaust fans, and pumps.

Further, if any data on the TAB Report for Groups 2 through 5 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

3.4.11.2 Additional COTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the COTR.

Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to to be found. This additional field testing is up and above the original 25 percent of the of reported data entries to be field tested.

If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.

3.4.11.3 Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Contracting Officer approval of the TAB Report submitted.

3.5 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

3.6 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

3.7 APPENDICES

Appendix A	WORK DESCRIPTIONS OF PARTICIPANTS
Appendix B	REPORTS - DALT and TAB
Appendix C	DALT AND TAB SUBMITTAL AND WORK SCHEDULE
Appendix D	REQUIREMENTS FOR DUCT AIR LEAK TESTING

Appendix A

WORK DESCRIPTIONS OF PARTICIPANTS

The Contractor is responsible for ensuring compliance with all requirements of this specification section. However, the following delineation of specific work items is provided to facilitate and co-ordinate execution of the various work efforts by personnel from separate organizations.

1. Contractor

a. HVAC documentation: Provide pertinent contract documentation to the TAB Firm, to include the following: the contract drawings and specifications; copies of the approved submittal data for all HVAC equipment, air distribution devices, and air/water measuring/balancing devices; the construction work schedule; and other applicable documents requested by the TAB Firm. Provide the TAB Firm copies of contract revisions and modifications as they occur.

b. Schedules: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Pre-DALT and TAB meeting: Arrange and conduct the Pre-DALT and TAB meeting. Ensure that a representative is present for the sheet metal contractor, the mechanical contractor, the electrical contractor, and the automatic temperature controls contractor.

d. Coordinate Support: Provide and coordinate support personnel required by the TAB Firm in order to accomplish the DALT and TAB field work. Support personnel may include factory representatives, HVAC controls installers, HVAC equipment mechanics, sheet metal workers, pipe fitters, and insulators. Ensure support personnel are present at the work site at the times required.

e. Correct Deficiencies: Ensure the notifications of Construction Deficiencies are provided as specified herein. Refer to the paragraph CONSTRUCTION DEFICIENCIES. Correct each deficiency as soon as practical with the Contracting Officer, and submit revised schedules and other required documentation.

f. Pre-TAB Work Checklists: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as pre-TAB work checklist items, the deficiencies pointed out by the TAB team supervisor in the design review report.

g. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's DALT and TAB Work Procedures Summary. Do not allow the TAB team to commence TAB field work until all of the following are completed.

h. Give Notice of Testing: Submit advance notice of proportional balancing, Season 1, and Season 2 TAB field work accompanied by completed prerequisite HVAC Work List

i. Insulation work: Ensure that no insulation is shall not be installed on ducts to be DALT'd until DALT work on the subject ducts is complete.

j. Ensure the duct and piping systems are properly insulated and vapor sealed upon the successful completion and acceptance of the DALT and TAB work.

2. TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Schedule: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Submittals: Provide the submittals specified herein.

d. Pre-DALT/TAB meeting: Attend meeting with Contractor. Ensure TAB personnel that will be involved in the TAB work under this contract attend the meeting.

e. Design Review Report: Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

f. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the DALT and TAB Procedures Summary, the during the DALT or TAB field work.

g. Ensure the Contractor is properly notified and aware of all support personnel needed to perform the TAB work. Maintain communication with the Contractor regarding support personnel throughout the duration of the TAB field work, including the TAB field acceptance testing checking.

h. Ensure all inspections and verifications for the Pre-Final DALT and Pre-TAB Checklists are completely and successfully conducted before DALT and TAB field work is performed.

i. Advance Notice: Monitor the completion of the duct system installations and provide the Advance Notice for Pre-Final DALT field work as specified herein.

j. Technical Assistance: Provide technical assistance to the DALT and TAB field work.

k. Deficiencies Notification: Ensure the notifications of Construction Deficiencies are provided as specified herein. Comply with requirements of the paragraph CONSTRUCTION DEFICIENCIES. Resolve each deficiency as soon as practical and submit revised schedules and other required documentation.

l. Procedures: Develop the required TAB procedures for systems or system components not covered in the TAB Standard.

3. TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC work list, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

Appendix B

REPORTS - DALT and TAB

All submitted documentation must be typed, neat, and organized. All reports must have a waterproof front and back cover, a title page, a certification page, sequentially numbered pages throughout, and a table of contents. Tables, lists, and diagrams must be titled. Generate and submit for approval the following documentation:

1. DALT and TAB Work Execution Schedule

Submit a detailed schedule indicating the anticipated calendar date for each submittal and each portion of work required under this section. For each work entry, indicate the support personnel (such as controls provider, HVAC mechanic, etc.) that are needed to accomplish the work. Arrange schedule entries chronologically.

2. DALT and TAB Procedures Summary

Submit a detailed narrative describing all aspects of the DALT and TAB field work to be performed. Clearly distinguish between DALT information and TAB information. Include the following:

a. A list of the intended procedural steps for the DALT and TAB field work from start to finish. Indicate how each type of data measurement will be obtained. Include what Contractor support personnel are required for each step, and the tasks they need to perform.

b. A list of the project's submittals that are needed by the TAB Firm in order to meet this Contract's requirements.

c. The schematic drawings to be used in the required reports, which may include building floor plans, mechanical room plans, duct system plans, and equipment elevations. Indicate intended TAB measurement locations, including where test ports need to be provided by the Contractor.

d. The data presentation forms to be used in the report, with the preliminary information and initial design values filled in.

e. A list of DALT and TAB instruments to be used, edited for this project, to include the instrument name and description, manufacturer, model number, scale range, published accuracy, most recent calibration date, and what the instrument will be used for on this project.

f. A thorough checklist of the work items and inspections that need to be accomplished before DALT field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Pre-Final DALT Work Checklist before DALT field work can be accomplished.

g. A thorough checklist of the work items and inspections that need to be accomplished before the [Season 1]TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed [Season 1]Pre-TAB Work Checklist before the [Season 1]TAB field work can be accomplished.

[h. A thorough checklist of the work items and inspections that need to be accomplished before the Season 2 TAB field work can be performed. The

Contractor must complete, submit, and receive approval of the Completed Season 2 Pre-TAB Work Checklist before the Season 2 TAB field work can be accomplished.

] i. The checklists specified above shall be individually developed and tailored specifically for the work under this contract. Refer to NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under the paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" for examples of items to include in the checklists.

3. Design Review Report

Submit report containing the following information:

a. Review the contract specifications and drawings to verify that the TAB work can be successfully accomplished in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

b. Submit a typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the DALT work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. If no deficiencies are evident, state so in the report.

4. Completed Pre-Final DALT Work Checklist

Report the data for the Pre-Final DALT Report meeting the following requirements:

a. Submit a copy of the approved DALT and TAB Procedures Summary: Provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit a comprehensive report for the DALT field work data using data presentation forms equivalent to the "Air Duct Leakage Test Summary Report Forms" located in the SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Node numbers shall be included in the completed report forms to identify each duct section.

c. Calculations: Include a copy of all calculations prepared in determining the duct surface area of each duct test section. Include in the DALT reports copy(s) of the calibration curve for each of the DALT test orifices used for testing.

d. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments are to be calibrated within one year of the date of use in the field; instrument calibration is to be traceable to the measuring standards of the National Institute of Standards and Technology.

e. TAB Supervisor Approval: Include on the submitted report the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

5. Final DALT Report

On successful completion of all COTR field checks of the Pre-final DALT Report data for all systems, the TABS Supervisor shall assemble, review, sign and submit the Final DALT Report to the Contracting Officer for approval.

6. TAB Reports: Submit TAB Report for Proportional Balancing, Season 1, and Season 2 in the following manner:

a. Procedure Summary: Submit a copy of the approved DALT and TAB Procedures Summary. When applicable, provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit the completed data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed, approved and signed by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data shall be typewritten. Handwritten report forms or report data are not acceptable.

c. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

****

NOTE: The design engineer shall list, in the paragraph below, those rooms, or zones, for which indoor dry bulb and wet bulb temperatures shall be compiled for the specified time duration. Include a sufficient number of rooms, or zones, in the listing to ensure correct evaluation of performance for the installed HVAC systems.

****

(1) [_____]

(2) Data shall be measured and compiled on a continuous basis for the period in which TAB work affecting those rooms is being done.

(3) Data shall be measured/recorded only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode. Provide a detailed explanation wherever a final measurement did not achieve the required value.

(4) Data may be compiled using direct digital controls trend logging where available. Otherwise, the Contractor shall temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls shall have been fully

operational a minimum of 24 hours in advance of commencing data compilation. The specified data shall be included in the [Season I TAB Report] [Season I and Season 2 TAB Report].

d. Air System Diagrams: Provided updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations.

e. Air Static Pressure Profiles: Report static pressure profiles for air duct systems including: [AHU-1][RTAC-1][MUA-1][_____]. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. The static pressure report data shall include, in addition to AABC or NEBB or TABB required data, the following:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

(5) Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(6) Report static pressure drop across outside air and relief/exhaust air louvers.

(7) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.

****

NOTE: Delete the brackets below for large air moving systems, i.e., include in the specification the duct traverses for the branch mains for air moving systems 4720 L/S 10000 CFM and larger.

****

[f. Duct Transverses: Report duct traverses for main [and branch main] supply, return[, exhaust, relief and outside air] ducts. [This shall include all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows.] The TAB Agency shall evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pitot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane".

] g. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

h. Instrumentation, used for taking wet bulb temperature readings shall provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

i. Performance Curves: The TAB Supervisor shall include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

j. Calibration Curves: The TAB Supervisor shall include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturis and flow orifices TAB'd on the job.

k. Data From TAB Field Work: After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and approval signature, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms shall be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report shall be considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP.

Appendix C

DALT AND TAB SUBMITTAL AND WORK SCHEDULE

****

NOTE: Modify this suggested number of calendar days to suit the contract construction schedule. Season 1 may be the season of maximum heating load or maximum cooling load, depending upon the construction schedule.

****

Perform the following items of work in the order listed adhering to the dates schedule specified below. Include the major items listed in this schedule in the project network analysis schedule required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS).

l. Submit TAB Agency and TAB Personnel Qualifications: Within [42] [_____] calendar days after date of contract award.

m. Submit the DALT and TAB Work Execution Schedule: within [14] [_____] days after receipt of the TAB agency and TAB personnel qualifications approval. Revise and re-submit this schedule 28 days prior to commencement of DALT work and 28 days prior to the commencement of TAB Season 1 work and TAB Season 2 work.

n. Submit the DALT and TAB Work Procedures Summary: within [14] [_____] days after receipt of the initial approved DALT and TAB Work Execution Schedule.

o. Meet with the COTR at the Pre-DALT/TAB Meeting: Within [28] [_____] calendar days after receipt of the approved initial DALT/TAB Execution Schedule.

p. Submit Design Review Report: Within [56] [_____] calendar days after the receipt of the approved initial DALT and TAB Work Execution Schedule.

****

NOTE: When the measurement of existing facility conditions is desired, delete the brackets from the paragraph below.

****

[q. Conduct measurements and submit the Record of Existing Facility Conditions: within [28] [_____] days after receipt of approved DALT and TAB Work Procedures Summary.

] r. Advance Notice of Pre-Final DALT Field Work: After the completed installation of the HVAC duct system to be DALT'd, submit to the Contracting Officer an Advance Notice of Pre-Final DALT Field Work accompanied by the completed Pre-Final DALT Work Checklist for the subject duct system.

s. Ductwork Selected for DALT: Within 14 calendar days after receiving an acceptable completed Pre-Final DALT Work Checklist, the Contracting Officer's technical representative (COTR) will select the project ductwork sections to be DALT'd.

t. DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected project ductwork.

u. Submit Pre-Final DALT Report: Within two working days after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow phased testing from system to system.

v. Quality Assurance - COTR DALT Field Checks: Upon approval of the Pre-final DALT Report, the COTR's DALT field check work shall be scheduled with the Contracting Officer.

w. Submit Final DALT Report: Within [14] [_____] calendar days after completion of successful DALT Work Field Check, submit [Season 1]TAB report.

x. Advance Notice of [Season 1]TAB Field Work: At a minimum of [14][_____] calendar days prior to [Season 1]TAB Field Work, submit advance notice of TAB field work accompanied by completed [Season 1]Pre-TAB Work Checklist.

****

NOTE: Use the following four paragraphs, which requires two separate trips within Season 1 to the contract site by the TAB field team (the first for the TAB field work, the second for the TAB quality assurance work) with the TAB report submitted between trips. This is intended to give the design engineer time to review the TAB report before the field check of that report is conducted.

****

y. [Season 1]TAB Field Work: At a minimum of [84][_____] calendar days prior to CCD, [and when the ambient temperature is within Season 1 limits,] accomplish [Season 1]TAB field work.

z. Submit [Season 1]TAB Report: Within [14] [_____] calendar days after completion of [Season 1]TAB field work, submit initial [Season 1]TAB report.

aa. [Season 1]Quality Assurance - COTR TAB Field Check: [30] [_____] calendar days after initial [Season 1]TAB report is approved by the Contracting Officer, conduct [Season 1]field check.

ab. Complete [Season 1]TAB Work: Prior to CCD, complete all TAB work [except Season 2 TAB work] and submit final.

ac. Receive the approved TAB report: Within 21 calendar days, receive the report from Contracting Officer approved TAB report.

****

NOTE: Include the remaining submittals and items of work only if there is a season 2 TAB Work

****

ad. Advance Notice of Season 2 TAB Field Work: At a minimum of [126] [_____]calendar days after CCD, submit advance notice of Season 2 TAB field work accompanied by completed Season 2 Pre-TAB Work Checklist.

****

NOTE: Use the following four paragraphs, which requires two separate trips within Season 2 to the contract site by the TAB field team (the first for the TAB field work, the second for the TAB quality assurance work) with the TAB report submitted between trips. This is intended to give the design engineer time to review the TAB report before the field check of that report is conducted.

****

ae. [Season 2 TAB Field Work: Within [14] [_____] calendar days after date of advance notice of Season 2 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

af. Submit Season 2 TAB Report: Within [14] [_____] calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

ag. Season 2 Quality Assurance - COTR TAB Field Checks: [28] [_____] calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

ah. Complete Season 2 TAB Work: Within [14] [_____] calendar days after the completion of Season 2 TAB field data check, complete all TAB work.]

ai. Receive the approved TAB report: Within calendar 21 days, receive the report from Contracting Officer.

****

NOTE: This appendix specifies certain parameters that are a part of DALT. The appendix is a template to be modified and edited by the specifier to adapt it to the design indicated on the design drawings.

Each piece of HVAC air-moving equipment indicated on the design drawings shall be scheduled in the table below. Specify the systems using the identical marks or terminology as indicated on the drawings and change the bracketed parameters to be identical to those indicated on the design drawings.

Specify the Duct Test Pressure in inches W.C. the same the Duct Static Pressure in inches W.C.

Specify the duct leak class as follows:

1. **For duct static pressure of less than 50 mm W.C., specify Class 12 for round duct and Class 24 for rectangular duct.**
2. **For duct static pressure of 50 inches to 75 mm W.C., specify Class 6 for round duct and Class 12 for rectangular duct.**
3. **For duct static pressure of higher than 75 mm W.C., specify Class 3 for round duct and Class 6 for rectangular duct.**

****

Appendix D					
REQUIREMENTS FOR DUCT AIR LEAK TESTING					
		SYSTEMS			
		[Package Rooftop w/VAV Unit No. [1] [_____]]	[Package Rooftop w/VAV Unit No. [2] [_____]]	[Package Rooftop w/CV Unit No. [1] [_____]]	[Package Rooftop w/CV Unit No. [2] [_____]]
Duct System Static Pressure, in millimeters W.C.	for Supply	[100] [_____]	[100] [_____]	[50] [_____]	[50] [_____]
	for Return	[50] [_____]	[50] [_____]	[25] [_____]	[25] [_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[50] [_____]	[50] [_____]	[25] [_____]	[25] [_____]
System Oval/Round Duct and Rectangular Duct SMACNA Seal Class	for Supply	A	A	A	A
	for Return	A	A	A	A
	for Exhaust	A	A	A	A
	for Outside Air	A	A	A	A
System Oval/Round Duct SMACNA Leak Class	for Supply	[3] [_____]	[3] [_____]	[6] [_____]	[6] [_____]
	for Return	[6] [_____]	[6] [_____]	[12] [_____]	[12] [_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[6] [_____]	[6] [_____]	[12] [_____]	[12] [_____]

Appendix D

REQUIREMENTS FOR DUCT AIR LEAK TESTING

		SYSTEMS			
		[Package Rooftop w/VAV Unit No. [1] [______]]	[Package Rooftop w/VAV Unit No. [2] [______]]	[Package Rooftop w/CV Unit No. [1] [______]]	[Package Rooftop w/CV Unit No. [2] [______]]
System Rectangular Duct SMACNA Leak Class	for Supply	[6] [______]	[6] [______]	[12] [______]	[12] [______]
	for Return	[12] [______]	[12] [______]	[24][______]	[24][______]
	for Exhaust	[______]	[______]	[______]	[______]
	for Outside Air	[12] [______]	[12] [______]	[24] [______]	[24] [______]
Duct Test Pressure, in millimeters W.C.	for Supply	[100] [______]	[100] [______]	[50] [______]	[50] [______]
	for Return	[50] [______]	[50] [______]	[25] [______]	[25] [______]
	for Exhaust	[______]	[______]	[______]	[______]
	for Outside Air	[50] [______]	[50] [______]	[25] [______]	[25] [______]

Appendix D

REQUIREMENTS FOR DUCT AIR LEAK TESTING

		SYSTEMS			
		[AHU w/ Economizer & CV Unit No. [1] [______]]	[AHU w/ Economizer & CV Unit No. [2] [______]]	[Series VAV Terminal Boxes Unit No. [1] [______]]	[Exhaust Systems Unit No. [1] [______]]
Duct System Static Pressure, in millimeters W.C.	for Supply	[50] [______]	[50] [______]	[13] [______]	n/a
	for Return	[25] [______]	[25] [______]	[13] [______]	n/a
	for Exhaust	[13] [______]	[13] [______]	n/a	[25] [______]
	for Outside Air	[25] [______]	[25] [______]	n/a	n/a
System Oval/Round Duct and Rectangular Duct SMACNA Seal Class	for Supply	A	A	A	A
	for Return	A	A	A	A
	for Exhaust	A	A	A	A
	for Outside Air	A	A	A	A
System Oval/Round Duct SMACNA Leak Class	for Supply	[6] [______]	[6] [______]	12	n/a
	for Return	[12] [______]	[12] [______]	12	n/a
	for Exhaust	[12] [______]	[12] [______]	n/a	[12] [______]
	for Outside Air	[12] [______]	[12] [______]	n/a	n/a

Appendix D					
REQUIREMENTS FOR DUCT AIR LEAK TESTING					
		SYSTEMS			
		[AHU w/ Economizer & CV Unit No. [1] [______]]	[AHU w/ Economizer & CV Unit No. [2] [______]]	[Series VAV Terminal Boxes Unit No. [1] [______]]	[Exhaust Systems Unit No. [1] [______]]
System Rectangular Duct SMACNA Leak Class	for Supply	[12] [______]	[12] [______]	24	n/a
	for Return	[24] [______]	[24] [______]	24	n/a
	for Exhaust	[24] [______]	[24] [______]	n/a	[24] [______]
	for Outside Air	[24] [______]	[24] [______]	n/a	n/a
Duct Test Pressure, in millimeters W.C.	for Supply	[50] [______]	[25] [______]	[13] [______]	n/a
	for Return	[25] [______]	[25] [______]	[13] [______]	n/a
	for Exhaust	[13] [______]	[13] [______]	n/a	[25] [______]
	for Outside Air	[25] [______]	[25] [______]	n/a	n/a

****

NOTE: This appendix specifies certain parameters that are a part of DALT. The appendix is a template to be modified and edited by the specifier to adapt it to the design indicated on the design drawings.

Each piece of HVAC air-moving equipment indicated on the design drawings shall be scheduled in the table below. Specify the systems using the identical marks or terminology as indicated on the drawings and change the bracketed parameters to be identical to those indicated on the design drawings.

Specify the Duct Test Pressure in inches W.C. the same the Duct Static Pressure in inches W.C.

Specify the duct leak class as follows:

1) For duct static pressure of less than 2 inches W.C., specify Class 12 for round duct and Class 24 for rectangular duct.
2) For duct static pressure of 2 inches to 3 inches W.C., specify Class 6 for round duct

and Class 12 for rectangular duct.
3) For duct static pressure of higher than 3 inches W.C., specify Class 3 for round duct and Class 6 for rectangular duct.

****

Appendix D

REQUIREMENTS FOR DUCT AIR LEAK TESTING

		SYSTEMS			
		[Package Rooftop w/VAV Unit No. [1] [_____]]	[Package Rooftop w/VAV Unit No. [2] [_____]]	[Package Rooftop w/CV Unit No. [1] [_____]]	[Package Rooftop w/CV Unit No. [2] [_____]]
Duct System Static Pressure, in inches W.C.	for Supply	[4] [_____]	[4] [_____]	[2] [_____]	[2] [_____]
	for Return	[2] [_____]	[2] [_____]	[1] [_____]	[1] [_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[2] [_____]	[2] [_____]	[1] [_____]	[1] [_____]
System Oval/Round Duct and Rectangular Duct SMACNA Seal Class	for Supply	A	A	A	A
	for Return	A	A	A	A
	for Exhaust	A	A	A	A
	for Outside Air	A	A	A	A

Appendix D

REQUIREMENTS FOR DUCT AIR LEAK TESTING

		SYSTEMS			
		[Package Rooftop w/VAV Unit No. [1] [_____]]	[Package Rooftop w/VAV Unit No. [2] [_____]]	[Package Rooftop w/CV Unit No. [1] [_____]]	[Package Rooftop w/CV Unit No. [2] [_____]]
System Oval/Round Duct SMACNA Leak Class	for Supply	[3] [_____]	[3] [_____]	[6] [_____]	[6] [_____]
	for Return	[6] [_____]	[6] [_____]	[12] [_____]	[12] [_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[6] [_____]	[6] [_____]	[12] [_____]	[12] [_____]
System Rectangular Duct SMACNA Leak Class	for Supply	[6] [_____]	[6] [_____]	[12] [_____]	[12] [_____]
	for Return	[12] [_____]	[12] [_____]	[24][_____]	[24][_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[12] [_____]	[12] [_____]	[24] [_____]	[24] [_____]
Duct Test Pressure, in inches W.C.	for Supply	[4] [_____]	[2] [_____]	[50] [_____]	[2] [_____]
	for Return	[2] [_____]	[2] [_____]	[1] [_____]	[1] [_____]
	for Exhaust	[_____]	[_____]	[_____]	[_____]
	for Outside Air	[2] [_____]	[2] [_____]	[1] [_____]	[1] [_____]

Appendix D

REQUIREMENTS FOR DUCT AIR LEAK TESTING

		SYSTEMS			
		[AHU w/ Economizer & CV Unit No. [1] [______]]	[AHU w/ Economizer & CV Unit No. [2] [______]]	[Series VAV Terminal Boxes Unit No. [1] [______]]	[Exhaust Systems Unit No. [1] [______]]
Duct System Static Pressure, in millimeters W.C.	for Supply	[2] [______]	[2] [______]	[0.5] [______]	n/a
	for Return	[1] [______]	[1] [______]	[0.5] [______]	n/a
	for Exhaust	[0.5] [______]	[0.5] [______]	n/a	[1] [______]
	for Outside Air	[1] [______]	[1] [______]	n/a	n/a
System Oval/Round Duct and Rectangular Duct SMACNA Seal Class	for Supply	A	A	A	A
	for Return	A	A	A	A
	for Exhaust	A	A	A	A
	for Outside Air	A	A	A	A
System Oval/Round Duct SMACNA Leak Class	for Supply	[6] [______]	[6] [______]	12	n/a
	for Return	[12] [______]	[12] [______]	12	n/a
	for Exhaust	[12] [______]	[12] [______]	n/a	[12] [______]
	for Outside Air	[12] [______]	[12] [______]	n/a	n/a

Appendix D

REQUIREMENTS FOR DUCT AIR LEAK TESTING

		SYSTEMS			
		[AHU w/ Economizer & CV Unit No. [1] [______]]	[AHU w/ Economizer & CV Unit No. [2] [______]]	[Series VAV Terminal Boxes Unit No. [1] [______]]	[Exhaust Systems Unit No. [1] [______]]
System Rectangular Duct SMACNA Leak Class	for Supply	[12] [______]	[12] [______]	24	n/a
	for Return	[24] [______]	[24] [______]	24	n/a
	for Exhaust	[24] [______]	[24] [______]	n/a	[24] [______]
	for Outside Air	[24] [______]	[24] [______]	n/a	n/a
Duct Test Pressure, in inches W.C.	for Supply	[2] [______]	[2] [______]	[0.5] [______]	n/a
	for Return	[1] [______]	[1] [______]	[0.5] [______]	n/a
	for Exhaust	[0.5] [______]	[0.5] [______]	n/a	[1] [______]
	for Outside Air	[1] [______]	[1] [______]	n/a	n/a

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 07 00 (August 2024)**

Preparing Activity: USACE **Superseding**
UFGS-23 07 00 (February 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS

08/24

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 07 00 (August 2024)**

Preparing Activity: USACE **Superseding**
UFGS-23 07 00 (February 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
08/24

****
NOTE: This guide specification covers the requirements for field applied thermal insulation on HVAC and plumbing systems located within, on, under, and adjacent to buildings; above and below ground.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: Show the following information on project drawings:

1. Areas where pipe insulation differs from the "Typical;"

2. Areas where ductwork is to be internally insulated;

3. Areas where metal jackets or 8-ply vapor barrier jacket are to be used on interior piping;

4. Pumps to be insulated and encased in 20 gauge

boxes; and

5. Heat exchange temperatures.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.2	(2018; Addenda A-B 2021; Addenda C-K 2023; Addenda L 2024) Energy-Efficient Design of Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM B209	(2014) Standard Specification for Aluminum

	and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C195	(2007; R 2024) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C450	(2008) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534/C534M	(2024) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C585	(2010) Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C592	(2024) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C610	(2017; R 2023) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C647	(2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C755	(2019b) Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation

ASTM C795	(2008; R 2023) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010; R 2015) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C1126	(2024) Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C1136	(2023) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1290	(2016; R 2021) Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
ASTM C1710	(2011) Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D2863	(2019) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D5590	(2017; R 2021) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E2231	(2021) Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics
ASTM E2336	(2020) Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2758	(2014) Paper - Determination of Bursting Strength

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(8th Ed) National Commercial & Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2024) Standard for the Installation of Warm Air Heating and Air Conditioning Systems
NFPA 96	(2024) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T403 OM	(2022) Bursting Strength of Paper

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation
MIL-A-24179	(1969; Rev A; Am 2 1980; Notice 1 1987; Notice 2 2020) Adhesive, Flexible Unicellular-Plastic Thermal Insulation
MIL-PRF-19565	(1988; Rev C) Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier

UL SOLUTIONS (UL)

UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SYSTEM DESCRIPTION

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NOTE: This guide specification is to be used for field applied insulation on mechanical systems; interior and exterior, above and below ground. Insulation for energy distribution systems covered by Sections 33 61 13 PRE-ENGINEERED UNDERGROUND HEAT DISTRIBUTION SYSTEM, 33 63 13.19 CONCRETE TRENCH HYDRONIC AND STEAM ENERGY DISTRIBUTION, 33 61 13.13 PREFABRICATED UNDERGROUND HYDRONIC ENERGY DISTRIBUTION, and 33 60 02 ABOVEGROUND HEAT DISTRIBUTION SYSTEM, are not within the scope of this guide specification. Heating, air conditioning, and evaporative cooling duct; equipment; and piping are included.

Pipe insulation covered in this specification is valid for between minus 34 and plus 204 degrees C minus 30 and plus 400 degrees F. Equipment insulation covered in this specification is valid for between minus 34 and plus 982 degrees C minus 30 and plus 1800 degrees F.

****

1.2.1 General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Provide insulation of heat distribution systems and chilled water systems outside of buildings as specified in

Section 33 61 13 PRE-ENGINEERED UNDERGROUND HEAT DISTRIBUTION SYSTEM, Section 33 63 13.19 CONCRETE TRENCH HYDRONIC AND STEAM ENERGY DISTRIBUTION, Section 33 60 02 ABOVEGROUND HEAT DISTRIBUTION SYSTEM, and Section 33 61 13.13 PREFABRICATED UNDERGROUND HYDRONIC ENERGY DISTRIBUTION. Provide field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

In SD-04, Designer will exclude ductwork insulation display samples for small, simple projects where the extent of duct insulation is not likely to cause a problem of enforcement with the requirements of the specification.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submit the three SD types, SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time for each system.

SD-02 Shop Drawings

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NOTE: For NAVFAC LANT projects, delete the requirement for this SD-02 Shop Drawing Submittal.

****

MICA Plates; G, [_____]

Pipe Insulation Systems and Associated Accessories

Duct Insulation Systems and Associated Accessories

Equipment Insulation Systems and Associated Accessories

Recycled content for insulation materials; S

SD-03 Product Data

Pipe Insulation Systems; G, [_____]

Duct Insulation Systems; G, [_____]

Equipment Insulation Systems; G, [_____]

SD-04 Samples

Thermal Insulation; G, [_____]

Display Samples; G, [_____]

SD-07 Certificates

Indoor air quality for adhesives; S

SD-08 Manufacturer's Instructions

Pipe Insulation Systems; G, [_____]

Duct Insulation Systems; G, [_____]

Equipment Insulation Systems; G, [_____]

1.4 CERTIFICATIONS

1.4.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualification

Qualified installers must have successfully completed three or more similar type jobs within the last 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the manufacturer's unopened containers. Protect materials delivered and placed in storage from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Attach manufacturer's stamp or label giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable) to packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval. Insulation packages and containers must be asbestos free.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening and is an acceptable product per this specification. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. Include the product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation. The product data must be copyrighted, have an identifying or publication number, and have been published prior to the issuance date of this solicitation. Submit materials furnished under this section together in a booklet and in conjunction with the MICA plates booklet (SD-02). Annotate the product data to indicate which MICA plate is applicable.

2.1.1 Insulation System

Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Provide CFC and HCFC free insulation.

2.1.2 Surface Burning Characteristics

Unless otherwise specified, insulation must have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Determine flame spread, and smoke developed indexes, by ASTM E84 or UL 723. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Prepare and mount test specimens according to ASTM E2231.

2.2 MATERIALS

****

NOTE: Tables 1, 2, 3, 4, and 5 are not inclusive of systems requiring insulation. Edit, modify, and add to the information contained in tables as required for your project requiring insulation. These tables must become a part of project specification.

For cryogenic equipment handling media between minus 34 and minus 18 degrees C minus30 and minus one degree F, use elastomeric closed cell or cellular glass.

Table 7 is primarily used for personnel safety where stacks or pipes are within reach, or if stacks or pipes run through conditioned spaces where heat losses may increase building energy usage.

ASHRAE 90.2 is for low-rise residential building. ASHRAE 90.1 is for all buildings except low-rise residential buildings. Low-rise building has one or two stories without elevators. High-rise building has multistory with elevators.

****

Provide insulation that meets or exceed the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP[ASHRAE 90.2]. Ensure insulation exterior is cleanable, grease resistant, non-flaking and non-peeling. Provide compatible materials that do not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Use materials on stainless steel surfaces meeting ASTM C795 requirements. Do not use calcium silicate on chilled or cold water systems. Use asbestos free materials. Provide product recognized under UL 94 (if containing plastic) and listed in FM APP GUIDE.

2.2.1 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants must meet limit requirements of "Other" category within SCAQMD Rule 1168 sealants table). Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for adhesives.

2.2.1.1 Acoustical Lining Insulation Adhesive

Provide a nonflammable, fire-resistant adhesive conforming to ASTM C916, Type I.

2.2.1.2 Mineral Fiber Insulation Cement

Provide cement in accordance with ASTM C195.

2.2.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. [To resist mold/mildew, use lagging adhesive meeting ASTM D5590 with 0 growth rating.]Provide nonflammable and fire-resistant lagging adhesives that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Ensure adhesive is MIL-A-3316, Class 1, pigmented [white] [red] and suitable, as listed by the manufacturer,for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Apply lagging adhesives in strict accordance with the manufacturer's recommendations for pipe and duct insulation.

2.2.1.4 Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Ensure adhesive does not adversely affect, initially or in service, the insulation to which it is applied, nor cause any corrosive effect on metal to which it is applied. Ensure that any solvent dispersing medium or volatile component of the adhesive has no objectionable odor and does not contain any benzene or carbon tetrachloride. Ensure dried adhesive does not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 100 degrees C 212 degrees F. The dried adhesive must be nonflammable and fire resistant. Flexible Elastomeric Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product listed in FM APP GUIDE.

2.2.2 Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

2.2.3 Corner Angles

Nominal 0.406 mm 0.016 inch aluminum 25 by 25 mm 1 by 1 inch with factory applied kraft backing. Aluminum must be ASTM B209M ASTM B209, Alloy 3003, 3105, or 5005.

2.2.4 Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with ASTM C1710. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, use properly installed protective vapor retarder/barriers and vapor stops on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

2.2.5 Finishing Cement

ASTM C450: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with ASTM C795.

2.2.6 Fibrous Glass Cloth and Glass Tape

Provide fibrous glass cloth, with 20X20 maximum mesh size, and glass tape with maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Provide tape consisting of 100 mm 4 inch wide rolls. Provide Class 3 tape that is 0.15 kg/square m 4.5 ounces/square yard. Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.

2.2.7 Staples

****

NOTE: For cold applications (cold water, chilled water, and brine systems), staples and tacks are not permitted to be installed on vapor retarder/barrier jackets or fitting covers.

Monel is a nickel rich alloy that has high strength, high ductility, and excellent resistance to corrosion.

****

Outward clinching type [monel] [Type 304 or 316 stainless steel].

2.2.8 Jackets

****

NOTE: The purpose of jacketing insulated pipes and vessels is to protect the vapor retarder system and the insulation. Protective jacketing is designed to be installed over the vapor retarder/vapor barrier and insulation to prevent weather and abrasion damage. The protective jacketing must be installed independently and in addition to any factory or field applied vapor retarder.

VAPOR BARRIER/VAPOR RETARDER. To determine which system is required, apply the following criteria: On ducts, piping and equipment operating below [select a temperature that is at least equal to the dry bulb temperature's median of extreme highs from the region's weather data] or located outside must be equipped with a vapor barrier. Whereas ducts, pipes and equipment that are located inside and that always operate above [use the same temperature selected earlier in this paragraph which is based on the region's median of extreme highs dry bulb temperature] must be installed with a vapor retarder where required as stated in "Vapor Retarder Required."

A vapor barrier should be installed where there is a possiblity of condensation. Therefore, the designer

must require a vapor barrier where the temperature in the system may be below the ambient temperature. If the application operates at times above the selected temperature and other times below the selected temperature, the application must be equipped with a vapor barrier.

****

2.2.8.1 Aluminum Jackets

Provide aluminum jackets consisting of corrugated, embossed or smooth sheet, 0.406 mm 0.016 inch nominal thickness; ASTM B209M ASTM B209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Do not use corrugated aluminum jacket outdoors. Aluminum jacket securing bands must be Type 304 stainless steel, 0.396 mm 0.015 inch thick, 13 mm 1/2 inch wide for pipe under 300 mm 12 inch diameter and 19 mm 3/4 inch wide for pipe over 300 mm 12 inch and larger diameter. Aluminum jacket circumferential seam bands must be 50.8 by 0.406 mm 2 by 0.016 inch aluminum matching jacket material. Ensure bands for insulation below ground are 19 by 0.508 mm 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, use bands at the circumferential joints that are designed by the manufacturer to seal the joints and hold the jacket in place.

2.2.8.2 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers must have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance. The minimum thickness for a Standard jacket is 0.508mm 0.020 inch and where high abuse resistance is required use Heavy Duty PVC jacket 0.762 mm0.030 inch. Standard PVC fittings will have an initial core thickness (before thermoforming) of 0.635 mm0.025 inch and heavy duty fittings will have an initial core thickness of 0.762 mm0.030 inch.

2.2.8.3 Vapor Barrier/Weatherproofing Jacket

****

NOTE: Do not provide this material on Navy projects. Only material greater than 8 ply is to be used for Army projects.

****

Provide laminated self-adhesive vapor barrier/weatherproofing jacket, greater than 3 plies standard grade, silver, white, black and embossed or greater than 8 ply (minimum 0.072 mm 2.9 mils adhesive); with less than 0.02 permeability when tested in accordance with ASTM E96/E96M, using the water transmission rate test method; heavy duty, white or natural; and UV resistant. Flexible Elastomeric exterior foam with factory applied, UV Jacket made with a cold weather acrylic adhesive. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and excellent Water Vapor Transmission (WVT) rate.

2.2.8.4 Vapor Barrier/Vapor Retarder

****

NOTE: Where there is a possibility of condensation install a vapor barrier. Therefore, the designer must require a vapor barrier where the temperature

in the system may be below the ambient temperature. If the application operates at times above the selected temperature and other times below the selected temperature, the application must be equipped with a vapor barrier.
****

Apply the following criteria to determine which system is required.

****
NOTE: Fill in the brackets a temperature that is at least equal to the dry bulb temperature's median of extreme highs from the region's weather data
****

a. On ducts, equip piping and equipment operating below [_____] degrees C degrees F or located outside with a vapor barrier.

****
NOTE: Use the same temperature selected earlier in this paragraph which is based on the region's median of extreme highs dry bulb temperature
****

b. Install ducts, pipes and equipment that are located inside and that always operate above [_____] degrees C degrees F with a vapor retarder where required as stated in paragraph VAPOR RETARDER REQUIRED.

2.2.9 Vapor Retarder Required

****
NOTE: The functions of a vapor retarder/vapor barrier are to keep out water, water vapor, and to prevent water vapor infiltration, in order to keep the insulation dry. Type I is a vapor barrier for use over insulation on pipes, ducts, or equipment operating at temperatures below ambient at least part of the time or wherever a vapor barrier is required. Type II vapor retarder is water vapor permeable and for use over pipes, ducts, or equipment operating above ambient temperatures or wherever a vapor barrier is not required.
****

ASTM C921, Type I, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 6.1 N/mm 35 pounds/inch width. ASTM C921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 3.5 N/mm 20 pounds/inch width. Use jackets on insulation exposed in finished areas that have white finish suitable for painting without sizing. Based on the application, insulation materials that require manufacturer or fabricator applied pipe insulation jackets are cellular glass, when all joints are sealed with a vapor barrier mastic, and mineral fiber. Ensure all non-metallic jackets have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible elastomerics require (in addition to vapor barrier skin) vapor retarder jacketing for high relative humidity and below ambient temperature applications.

2.2.9.1 White Vapor Retarder All Service Jacket (ASJ)

ASJ is for use on hot/cold pipes, ducts, or equipment indoors or outdoors if covered by a suitable protective jacket. Provide product which meets all physical property and performance requirements of ASTM C1136, Type I, except a minimum burst strength of 585 kPa 85 psi. ASTM D2863 Limited Oxygen Index (LOI) is a minimum of 31.

In addition, do not use paper or other moisture-sensitive material for the outer exposed surface or the inner-most surface contacting the insulation. Ensure the outer exposed surface is white and has an emittance no less than 0.80.

2.2.9.2 Vapor Retarder/Vapor Barrier Mastic Coatings

2.2.9.2.1 Vapor Barrier

The vapor barrier must be self adhesive (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) greater than 3 plies standard grade, silver, white, black and embossed white jacket for use on hot/cold pipes. Ensure permeability is less than 0.02 when tested in accordance with ASTM E96/E96M. Provide products meeting UL 723 or ASTM E84 flame and smoke requirements and that are UV resistant.

2.2.9.2.2 Vapor Retarder

Provide fire and water resistant vapor retarder coating appropriately selected for either outdoor or indoor service. Color must be white. Ensure the water vapor permeance of the compound is in accordance with ASTM C755. Provide nonflammable, fire resistant coating. [To resist mold/mildew, provide coating meeting ASTM D5590 with 0 growth rating.]Ensure coating meets MIL-PRF-19565 Type II (if selected for indoor service) and is Qualified Products Database listed. Determine all other application and service properties pursuant to ASTM C647.

2.2.9.3 Laminated Film Vapor Retarder

ASTM C1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork; where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable. Provide vapor retarder with a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible Elastomeric exterior foam with factory applied UV Jacket. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.2.9.4 Polyvinylidene Chloride (PVDC) Film Vapor Retarder

Provide PVDC film vapor retarder with a maximum moisture vapor transmission of 0.02 perms, minimum puncture resistance of 150 Beach units, a minimum tensile strength in any direction of 5.3 kN/m 30 lb/inch when tested in accordance with ASTM D882, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.9.5 Polyvinylidene Chloride Vapor Retarder Adhesive Tape

Requirements must meet the same as specified for Laminated Film Vapor Retarder above.

2.2.9.6 Vapor Barrier/Weather Barrier

Ensure the vapor barrier is greater than 3 ply self adhesive laminate -white vapor barrier jacket- superior performance (permeability less than 0.02 when tested in accordance with ASTM E96/E96M). Provide vapor barrier meeting UL 723 or ASTM E84 25 flame and 50 smoke requirements; and UV resistant. Minimum burst strength 1.3 MPa 185 psi in accordance with [TAPPI T403 OM] [ISO 2758]. Tensile strength 0.12 kg/m 68 lb/inch width (PSTC-1000). Provide tape as specified for laminated film vapor barrier above.

2.2.10 Vapor Retarder Not Required

ASTM C921, Type II, Class D, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable. Provide jacket with a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.11 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2.12 Insulation Bands

Provide 13 mm 1/2 inch wide; 26 gauge stainless steel insulation bands.

2.2.13 Sealants

Choose sealants from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Provide sealants with a maximum permeance of 0.02 perms based on Procedure B for ASTM E96/E96M, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3 PIPE INSULATION SYSTEMS

****

NOTE: Where the temperature of cold water entering a building is below the average dew point of the indoor ambient air or below 15 degrees C60 degrees F, and where condensate drip will cause damage or create a hazard, the piping should be insulated to limit or minimize condensation and a vapor barrier added per manufacturer's recommendations, if needed, whether piping is above or below ceilings. Insulation that may absorb moisture will see a reduction in effectiveness even with a slight amount of infiltration. Moisture on the interior of certain metal jackets may lead to corrosion and pitting.

Flexible elastomeric and cellular glass are very suitable for chilled water applications. Calcium silicate can not be used on chilled or cold water systems. Minimum thickness recommended for cellular glass insulation is 40 mm 1.5 inches. The reason is

that the breakage rate during shipment of 25 mm 1 inch thick cellular insulation is too high to be economical. Design the insulation thickness based on worst case ambient conditions, such as a humid environment. Vapor Barrier Jacket for elastomeric and cellular glass are very suitable for chilled water.

For NAVFAC LANT projects, delete the option of 13 mm 1/2 inch from line 4 of the following paragraph.

ASHRAE 90.2 is for low-rise residential building. ASHRAE 90.1 is for all buildings except low-rise residential buildings. Low-rise building has one or two stories without elevators. High-rise building has multistory with elevators.

****

Conform insulation materials to Table 1 and minimum insulation thickness as listed in Table 2 and meet or exceed the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP[ASHRAE 90.2]. Limit pipe insulation materials to those listed herein and meeting the following requirements:

2.3.1 Recycled Materials

Provide insulation materials containing the following minimum percentage of recycled material content by weight:

Rock Wool: 75 percent slag of weight
Fiberglass: 20 percent glass cullet
Rigid Foam: 9 percent recovered material
Phenolic Rigid Foam: 9 percent recovered material

Provide data identifying percentage of recycled content for insulation materials.

2.3.2 Aboveground Cold Pipeline (-34 to 16 deg. C -30 to 60 deg. F)

****

NOTE: When it is necessary to insulate existing cold water systems or systems that must remain in operation, the Designer may consider using a mineral fiber insulation that meets ASTM C547, with an integral wicking material designed to remove condensed water. The Designer should not consider using a mineral fiber integral wicking material when ambient conditions at the pipe location can be expected to be exposed to any high humidity conditions. High humidity areas are as identified in ASHRAE 90.1 as climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C. Follow manufacturer's recommendations for installation.

****

Provide insulation for outdoor, indoor, exposed or concealed applications, as follows:

2.3.2.1 Cellular Glass

ASTM C552, Type II, and Type III. Supply the insulation from the fabricator with (paragraph WHITE VAPOR RETARDER ALL SERVICE JACKET (ASJ)) ASJ vapor retarder and installed with all longitudinal overlaps sealed and all circumferential joints ASJ taped or supply the insulation unfaced from the fabricator and install with all longitudinal and circumferential joints sealed with vapor barrier mastic.

2.3.2.2 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II. Type I, Grade 1 for tubular materials. Type II, Grade 1, for sheet materials. Ensure Type I and II have vapor retarder/vapor barrier skin on one or both sides of the insulation, and require an additional exterior vapor retarder covering for high relative humidity and below ambient temperature applications.

2.3.2.3 Mineral Fiber Insulation with Integral Wicking Material (MFIWM)

ASTM C547. Install in accordance with manufacturer's instructions. Do not use in applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

2.3.2.4 Polyisocyanurate Insulation

ASTM C591, Type I. Polyisocyanurate insulation may only be used on systems operating at temperatures not to exceed 60 degrees C 140 degrees F. Supply the insulation with a factory applied vapor retarder/barrier that complies with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation and all covering must pass the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84.

2.3.3 Aboveground Hot Pipeline (Above 16 deg. C 60 deg. F)

Provide insulation for outdoor, indoor, exposed or concealed applications meeting the following requirements. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.1 Mineral Fiber

ASTM C547, Types I, II or III, supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.3.2 Calcium Silicate

ASTM C533, Type I indoor only, or outdoors above 121 degrees C 250 degrees F pipe temperature. Supply insulation with the manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.3 Cellular Glass

ASTM C552, Type II and Type III. Supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.3.4 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II to 105 degrees C 220 degrees F service. Type I for tubular materials. Type II for sheet materials.

2.3.3.5   Phenolic Insulation

ASTM C1126 Type III to 121 degrees C 250 degrees F service must comply with ASTM C795. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.3.6   Perlite Insulation

ASTM C610

2.3.3.7   Polyisocyanurate Insulation

ASTM C591, Type I. Supply the insulation with a factory applied vapor retarder/barrier that complies with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation and all covering must pass the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84.

2.3.4   Aboveground Dual Temperature Pipeline

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NOTE: The use of multiple layered systems, i.e., a flexible form of insulation, surrounded by a rigid form and sealed with mastics, sealants and vapor retarders/vapor barrier, may provide the most advantageous form of insulation system for this piping configuration. This is due to the pipe expansion and contraction associated with the change from hot to cold temperatures.

****

Select insulation for use over a dual temperature pipeline system (Outdoor, Indoor - Exposed or Concealed) in accordance with the most limiting/restrictive case. Find an allowable material from paragraph PIPE INSULATION MATERIALS and determine the required thickness from the most restrictive case. Use the thickness listed in paragraphs INSULATION THICKNESS for cold & hot pipe applications.

2.3.5   Below-ground Pipeline Insulation

For below-ground pipeline insulation, use cellular glass, ASTM C552, type II.

2.4   DUCT INSULATION SYSTEMS

****

NOTE: For NAVFAC ML projects, delete option of the following paragraph.

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2.4.1   Factory Applied Insulation

Provide factory-applied [ASTM C552, cellular glass thermal] [ASTM C534/C534M Grade 1, Type II, flexible elastomeric closed cell] insulation according to manufacturer's recommendations for insulation with insulation manufacturer's standard reinforced fire-retardant vapor barrier[, with identification of installed thermal resistance (R) value and out-of-package R value].

2.4.2 Field Applied Insulation

2.4.2.1 General

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NOTE: ASHRAE 90.2 is for low-rise residential building. ASHRAE 90.1 is for all buildings except low-rise residential buildings. Low-rise building has one or two stories without elevators. High-rise building has multistory with elevators.

****

Calculate the minimum thickness in accordance with [ASHRAE 90.2] ASHRAE 90.1 - SIASHRAE 90.1 - IP.

2.4.3 Rigid Insulation

Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB; 3.0 pcf. Provide insulation with [factory applied ASJ][and][factory-applied FSK] jacket. Minimum thickness in accordance with ASHRAE 90.1 - SIASHRAE 90.1 - IP[ASHRAE 90.2][Tables 3 and 4]

2.4.4 Blanket Insulation

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NOTE: For NAVFAC ML, delete this paragraph.

****

Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket; [3/4][1.5] pcf. Minimum thickness in accordance with ASHRAE 90.1 - SIASHRAE 90.1 - IP[ASHRAE 90.2][Tables 3 and 4].

2.4.5 Kitchen Exhaust Ductwork Insulation

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NOTE: If kitchen exhaust hood has outside air connection to cold outdoor, provide vapor barrier for outside air connection to prevent dissolution of calcium silicate.

****

Ensure insulation thickness is a minimum of 50 mm 2 inches, blocks or boards, either mineral fiber conforming to ASTM C612, Class 5, 320 kg/m3 20 pcf average [or calcium silicate conforming to ASTM C533, Type II. Provide vapor barrier for outside air connection to kitchen exhaust hood]. Provide enclosure materials and grease duct enclosure systems which meet testing requirements of ASTM E2336 for noncombustibility, fire resistance, durability, internal fire, and fire-engulfment with a through-penetration fire stop.

2.4.6 Acoustical Duct Lining

2.4.6.1 General

For ductwork indicated or specified in Section 23 30 00 HVAC AIR DISTRIBUTION to be acoustically lined, provide external insulation in accordance with this specification section and in addition to the acoustical duct lining if R-value would not be met as required in Table 3 and 4. The installation of internal acoustical duct insulation is prohibited.

2.4.6.2 Duct Liner

Flexible Elastomeric Acoustical and Conformable Duct Liner Materials: Flexible Elastomeric Thermal, Acoustical and Conformable Insulation Compliance with ASTM C534/C534M Grade 1, Type II; and NFPA 90A or NFPA 90B as applicable.

2.4.7 Duct Insulation Jackets

2.4.7.1 All-Purpose Jacket

Provide insulation with insulation manufacturer's standard reinforced fire-retardant jacket with or without integral vapor barrier as required by the service. In exposed locations, provide jacket with a white surface.

2.4.7.2 Metal Jackets

2.4.7.2.1 Aluminum Jackets

ASTM B209M ASTM B209, Temper H14, minimum thickness of 27 gauge (0.41 mm 0.016 inch), with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside dimension 200 mm 8 inches and larger. Provide corrugated surface jackets for jacket outside dimension 200 mm 8 inches and larger. Provide stainless steel bands, minimum width of 13 mm 1/2 inch.

2.4.7.2.2 Stainless Steel Jackets

ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.25 mm 0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 13 mm 1/2 inch.

2.4.7.3 Vapor Barrier/Weatherproofing Jacket

Provide vapor barrier/weatherproofing jacket that is laminated self-adhesive (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) less than 0.02 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 0.072 mm 2.9 mils adhesive), heavy duty white or natural).

2.4.8 Weatherproof Duct Insulation

Provide [ASTM C552, cellular glass thermal insulation] [ASTM C534/C534M Grade 1, Type II, flexible elastomeric cellular insulation], and weatherproofing as specified in manufacturer's instruction. Multi-ply, Polymeric Blend Laminate Jacketing: Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.5 EQUIPMENT INSULATION SYSTEMS

Insulate equipment and accessories as specified in Tables 5 and 6. In outside locations, provide insulation 13 mm 1/2 inch thicker than specified. Increase the specified insulation thickness for equipment where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface. Submit a booklet containing manufacturer's published installation instructions for the insulation systems in coordination with the submitted MICA Insulation Stds plates booklet. Annotate their installation instructions to indicate which product data and which MICA plate are applicable. The instructions must be copyrighted, have an identifying or publication number, and have been published prior to the issuance date of this solicitation. A booklet is also required by paragraphs titled: Pipe Insulation Systems and Duct Insulation Systems.

PART 3 EXECUTION

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NOTE: Project specifications will contain only the specific pipe or duct systems and equipment in a particular project that require insulation. Lists are not inclusive of systems requiring insulation. Edit, modify, and add to the information contained in the lists as required.

****

3.1 APPLICATION - GENERAL

Apply insulation to unheated and uncooled piping and equipment. Do not compress flexible elastomeric cellular insulation at joists, studs, columns, ducts, and hangers. The insulation must not pull apart after a one hour period; replace any insulation found to pull apart after one hour.

3.1.1 Display Samples

Submit and display, after approval of materials, actual sections of installed systems, properly insulated in accordance with the specification requirements. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Identify each material used by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. The Contracting Officer will inspect display sample sections at the jobsite. Keep approved display sample sections on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

3.1.1.1 Pipe Insulation Display Sections

Include as a minimum an elbow or tee, a valve, dielectric waterways and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

3.1.1.2 Duct Insulation Display Sections

Display sample sections for rigid and flexible duct insulation used on the job. Use a temporary covering to enclose and protect display sections for duct insulation exposed to weather

3.1.2 Installation

Except as otherwise specified, install material in accordance with the manufacturer's written instructions. Do not apply insulation materials until [tests] [tests and heat tracing] specified in other sections of this specification are completed. Remove material such as rust, scale, dirt and moisture from surfaces to receive insulation. Keep insulaton clean and dry. Do not remove insulation from its shipping containers until the day it is ready to use and return to like containers or equally protect from dirt and moisture at the end of each workday. Thoroughly clean insulation that becomes dirty prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, reject the insulation, and immediately remove from the jobsite. Stagger joints on multi layer insulation. Mix mineral fiber thermal insulating cement with demineralized water when used on stainless steel surfaces. Install insulation, jacketing and accessories in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

3.1.3 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING. The protection of ducts at point of passage through firewalls must be in accordance with NFPA 90A and NFPA 90B. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a NRTL.

3.1.4 Installation of Flexible Elastomeric Cellular Insulation

Install flexible elastomeric cellular insulation with seams and joints sealed with rubberized contact adhesive. Do not use flexible elastomeric cellular insulation on surfaces greater than 105 degrees C 220 degrees F. Stagger seams when applying multiple layers of insulation. Protect insulation exposed to weather with metal jacketing as recommended by the manufacturer after the adhesive is dry and cured.

3.1.4.1 Adhesive Application

Apply a brush coating of adhesive to both butt ends to be joined and to both slit surfaces to be sealed. Allow the adhesive to set until dry to touch but tacky under slight pressure before joining the surfaces. Ensure insulation seals at seams and joints are not capable of being pulled apart one hour after application. Replace insulation that can be pulled apart one hour after installation.

3.1.4.2 Adhesive Safety Precautions

Use natural cross-ventilation, local (mechanical) pickup, or general area (mechanical) ventilation to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices.

3.1.5 Welding

Welding is not permitted on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.6 Pipes/Ducts/Equipment That Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items as specified.

3.2 PIPE INSULATION SYSTEMS INSTALLATION

Install pipe insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

3.2.1 Pipe Insulation

3.2.1.1 General

Install pipe insulation on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder/barrier, including straight runs, fittings and appurtenances unless specified otherwise. Install full length units of insulation using a single cut piece to complete a run. Do not use cut pieces or scraps abutting each other. Omit pipe insulation on the following:

a. Air chambers.

b. Adjacent insulation.

c. ASME stamps.

d. Access plates of fan housings.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

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NOTE: Exterior wall and roof penetration details will be shown on the drawings. See Section 22 00 00 PLUMBING, GENERAL PURPOSE for additional information.

****

Provide continuous pipe insulation through the sleeve.

Provide an aluminum jacket or vapor barrier/weatherproofing self adhesive jacket (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) less than 0.0000 permeability, greater than 3 ply standard grade, silver, white, black and embossed with factory applied moisture retarder over the insulation wherever penetrations require sealing.

3.2.1.2.1 Penetrate Interior Walls

Provide aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) less than 0.02 permeability, greater than 3 plies standard grade, silver, white, black and embossed which extends 50 mm 2 inches beyond either side of the wall and secure on each end with a band.

3.2.1.2.2 Penetrating Floors

Extend the aluminum jacket from a point below the backup material to a point 250 mm 10 inches above the floor with one band at the floor and one not more than 25 mm 1 inch from the end of the aluminum jacket.

3.2.1.2.3 Penetrating Waterproofed Floors

Extend the aluminum jacket from below the backup material to a point 50 mm 2 inches above the flashing with a band 25 mm 1 inch from the end of the aluminum jacket.

3.2.1.2.4 Penetrating Exterior Walls

Continue the aluminum jacket required for pipe exposed to weather through the sleeve to a point 50 mm 2 inches beyond the interior surface of the wall.

3.2.1.2.5 Penetrating Roofs

Insulate pipe as required for interior service to a point flush with the top of the flashing and sealed with flashing sealant. Tightly butt the insulation for exterior application to the top of flashing and interior insulation. Extend the exterior aluminum jacket 50 mm 2 inches down beyond the end of the insulation to form a counter flashing. Seal the flashing and counter flashing underneath with metal jacketing/flashing sealant.

3.2.1.2.6 Hot Water Pipes Supplying Lavatories or Other Similar Heated Service

Terminate the insulation on the backside of the finished wall. Protect the insulation termination with two coats of vapor barrier coating with a minimum total thickness of 2.0 mm 1/16 inch applied with glass tape embedded between coats (if applicable). Extend the coating out onto the insulation 50 mm 2 inches and seal the end of the insulation. Overlap glass tape seams 25 mm 1 inch. Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. Ensure the escutcheon plate overlaps the wall penetration at least 10 mm 3/8 inches.

3.2.1.2.7 Domestic Cold Water Pipes Supplying Lavatories or Other Similar Cooling Service

Terminate the insulation on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). Protect the insulation with two coats of weather barrier mastic (breather emulsion type weatherproof mastic impermeable to water and permeable to air) with a minimum total thickness of 2 mm 1/16 inch. Extend the mastic out onto the insulation 50 mm 2 inches and seal the end of the insulation. Caulk the annular space between the outer surface of the pipe insulation and the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. Ensure the escutcheon plate overlaps the wall penetration by at least 10 mm 3/8 inches.

3.2.1.3 Pipes Passing Through Hangers

Ensure insulation, whether hot or cold application, is continuous through hangers. Support all horizontal pipes 50 mm 2 inches and smaller on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-58. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, install insulation inserts as specified below for piping larger than 50 mm 2 inches, or factory insulated hangers (designed with a load bearing core) can be used.

3.2.1.3.1 Horizontal Pipes Larger Than 50 mm 2 Inches at 16 Degrees C 60 Degrees F and Above

Supported on hangers in accordance with MSS SP-58, and Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2.1.3.2 Horizontal Pipes Larger Than 50 mm 2 Inches and Below 16 Degrees C 60 Degrees F

Supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-58. Install an insulation insert of cellular glass, prefabricated insulation pipe hangers, or perlite above 27 degrees C 80 degrees F above each shield. Ensure insert covers no less than the bottom 180-degree arc of the pipe. Provide inserts that are the same thickness as the insulation, and extend 50 mm 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 25 mm 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. Ensure the insulation jacket is continuous over the wooden dowel, wooden block, or insulation insert.

3.2.1.3.3 Vertical Pipes

Supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-58 covering the 360-degree arc of the insulation. Install an insulation insert of cellular glass or calcium silicate between each shield and the pipe. Ensure the insert covers the 360-degree arc of the pipe. Provide inserts that are the same thickness as the insulation, and extend 50 mm 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 25 mm 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. Ensure the insulation jacket is continuous over the wooden dowel, wooden block, or insulation insert. Support the vertical weight of the pipe with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 9 m 30 feet, support the weight of the pipe additionally with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. Use insulated hangers and seal the insulation jacket as indicated herein for anchors in a similar service.

3.2.1.3.4 Inserts

Covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, overlap the adjoining pipe jacket 38 mm

1-1/2 inches, and seal as required for the pipe jacket. Use jacket material to cover inserts in flexible elastomeric cellular insulation conforming to ASTM C1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Use tubular form flexible elastomeric cellular pipe insulation for pipe sizes 150 mm 6 inches and less. Grade 1, Do not stretch Type II sheet insulation used on pipes larger than 150 mm 6 inches around the pipe. On pipes larger than 300 mm 12 inches, adhere the insulation directly to the pipe on the lower 1/3 of the pipe. Stagger seams when applying multiple layers of insulation. Insulate sweat fittings with miter-cut pieces the same size as on adjacent piping. Insulate screwed fittings with sleeved fitting covers fabricated from miter-cut pieces and overlap and seal to the adjacent pipe insulation. Type II requires an additional exterior vapor retarder/barrier covering for high relative humidity and below ambient temperature applications.

3.2.1.5 Pipes in High Abuse Areas

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NOTE: In high abuse areas such as janitor closets and traffic areas in equipment rooms and kitchens, aluminum jackets will be shown. Normally, pipe insulation to the 2 m 6 feet level will be protected in high abuse areas. The designer will specifically indicate the high abuse areas.

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In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, utilize [welded PVC] [stainless steel], aluminum or flexible laminate cladding (comprised of elastomeric, plastic or metal foil laminate) laminated self-adhesive (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) vapor barrier/weatherproofing jacket, - less than 0.02 permeability; (greater than 3 ply, standard grade, silver, white, black and embossed) [aluminum] jackets. Protect pipe insulation to the 2 m 6 foot level. [Other areas that specifically require protection to the 2 m 6 foot level are [_____].]

3.2.1.6 Pipe Insulation Material and Thickness

****

NOTE: Where the temperature of cold water entering a building is below average dew point of the indoor ambient air and where condensate drip will cause damage or create a hazard, insulate piping with vapor barrier to prevent condensation, regardless to whether piping is above or below ceilings.

Flexible elastomeric and cellular glass are very suitable for chilled water applications. Minimum thickness recommended for cellular glass insulation is 40 mm 1.5 inches. The reason is that the breakage rate during shipment of 25 mm 1 inch thick cellular insulation is too high to be economical. Flexible elastomeric recommended minimum thickness is 25 mm 1 inch.

For cryogenic equipment handling media between minus 34 and minus 18 degrees C minus 30 and minus 1 degree F, use cellular glass insulation.

In Tables 1 and 3, state if a vapor barrier is required. Pipes and equipment with a temperature below 27 degrees C 80 degrees F should generally be provided with a vapor barrier jacket to prevent sweating. However, engineering judgment should be exercised to determine if a vapor barrier jacket is required. Reference paragraph ABOVEGROUND COLD PIPELINE (-34 TO 16 DEG. C -30 TO 60 DEG. F) for Vapor Retarder/Vapor Barrier requirements.

In Tables 1 and 2, when it is necessary to insulate existing cold water systems or systems that must remain in operation, the Designer may consider using a mineral fiber insulation that meets ASTM C547, with an integral wicking material designed to remove condensed water. The Designer should not consider using a mineral fiber integral wicking material when ambient conditions at the pipe location can be expected to be exposed to any high humidity conditions. High humidity areas are as identified in ASHRAE 90.1 as climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C. Follow manufacturer's recommendations for installation.

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NOTE: ASHRAE 90.2 is for low-rise residential building. ASHRAE 90.1 is for all buildings except low-rise residential buildings. Low-rise building has one or two stories without elevators. High-rise building has multistory with elevators.

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NOTE: In project locations with Environmental Severity Classification (ESC) of C3, C4 or C5, or high humidity areas as identified in ASHRAE 90.1 as climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C, use cellular glass in lieu of fiberglass materials to insulate all chilled water, refrigerant and condensate drain lines, including valves, strainers, and fittings when possible. Provide vapor barrier and coatings for all cold piping 60 degrees F and lower. See UFC 1-200-01 for determination of ESC for project locations.

****

Pipe insulation materials must be as listed in Table 1 and must meet or exceed the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP[ASHRAE 90.2].

TABLE 1

Insulation Material for Piping

Service	Material	Specification	Type	Class	VR/VB Req'd
Chilled Water (Supply & Return, Dual Temperature Piping, 4.44 C 40 F nominal)					
	Cellular Glass	ASTM C552	II	2	Yes
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		Yes
	[Mineral Fiber with Wicking Material][Do not use in applications exposed to outdoor ambient conditions in climatic zones 1 through 4.]	[ASTM C547]	[I]		[Yes]
	Polyisocyanurate	ASTM C591	I	2	Yes
Heating Hot Water Supply & Return, Heated Oil (Max 121 C 250 F)					
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Cellular Glass	ASTM C552	II	2	No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
	Polyisocyanurate Max temp 60C 140F	ASTM C591	I	2	Yes
Cold Domestic Water Piping, Makeup Water, and Condenser Water Piping					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Hot Domestic Water Supply & Recirculating Piping (Max 93 C 200 F)					
	Mineral Fiber	ASTM C547	I	1	No
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
Refrigerant Suction Piping (1.67 degrees C35 degrees F nominal)					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Cellular Glass	ASTM C552	II	1	Yes

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
Compressed Air Discharge, Steam and Condensate Return (94 to 121 Degrees C201 to 250 Degrees F					
	Cellular Glass	ASTM C552	II		No
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Condensate Drain Located Inside Building					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Medium Temperature Hot Water, Steam and Condensate (122 to 176 Degrees C 251 to 350 Degrees F)					
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Cellular Glass	ASTM C552	I or II		No
High Temperature Hot Water & Steam (177 to 371 Degrees C351 to 700 Degrees F)					
	Mineral Fiber	ASTM C547	I	2	No
	Calcium Silicate	ASTM C533	I		No
	Cellular Glass	ASTM C552			No
Brine Systems Cryogenics (-34 to -18 Degrees C-30 to 0 Degrees F)					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Brine Systems Cryogenics (-18 to 1.11 Degrees C0 to 34 Degrees F)					
	Cellular Glass	ASTM C552	II	2	No

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Note: VR/VB = Vapor Retarder/Vapor Barrier					

****

NOTE: Table 2 is not inclusive of all systems requiring insulation. Pipe insulation thicknesses must meet or exceed the requirements of ASHRAE 90.2 for low-rise residential buildings, and ASHRAE 90.1 for all other buildings except low-rise residential. Edit, modify, and add to the information contained in Tables 1 and 2 as required for the project. Use Table 6.8.3-1 and Table 6.8.3-2 in ASHRAE 90.1 for minimum thickness in buildings other than low-rise residential. Insulation thicknesses listed in Table 2 are calculated based on ASHRAE 90.1 using the referenced conductivity (K-value) shown for the insulation material (except as noted below for cellular glass) and the upper limit of the given temperature range. Insulation thicknesses may be reduced from listed table values based on engineering calclulations. Required insulation thickness should be similarly calculated for different materials if the K-value is outside the ranges listed in ASHRAE 90.1 Table 6.8.3-1 and 6.8.3-2. For low-rise residential buildings, refer to Table 6-4 of ASHRAE 90.2 for Minimum Pipe Insulation. These tables will become a part of the project specifications.

Where the temperature of cold water entering a building is below average dew point of the indoor ambient air and where condensate drip will cause damage or create a hazard, insulate piping with vapor barrier to prevent condensation, regardless to whether piping is above or below ceilings.

Flexible elastomeric and cellular glass are very suitable for chilled water applications. Minimum thickness recommended for cellular glass insulation is 40 mm 1.5 inches. The reason is that the breakage rate during shipment of 25 mm 1 inch thick cellular insulation is too high to be economical. Flexible elastomeric recommended minimum thickness is 25 mm 1 inch

For cryogenic equipment handling media between minus 34 and minus 18 degrees C 30 and minus 1 degree F, use cellular glass.

****

TABLE 2							
Piping Insulation Thickness (mminch) For flexible cellular foam the thickness should be 13mm instead of 15mm. Economic thickness or prevention of condensation is the basis of these tables. If prevention of condensation is the criterion, the ambient temperature and relative humidity must be stated. Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.							
Service							
	Material	Conductivity K-value (W/m^2-K) (Btu-in/ hr-ft^2-deg F)	Tube And Pipe Size (mm) (inch)				
			<25 <1	25-<40 1-<1.5	40-<100 1.5-<4	100-<20 4-<8	> or = 200 >8
[Chilled Water (Supply & Return, Dual Temperature Piping, 4.44 Degrees C 40 Degrees F nominal)]							
	Cellular Glass	0.043 0.30	40 1.5	401.5	401.5	401.5	502
	Flexible Elastomeric Cellular	0.034 0.235	251	251	251	N/A	N/A
	Mineral Fiber with Wicking Material	0.032 0.22	251	401.5	401.5	502	502
	Polyisocyanurate	0.026 0.18	13 0.5	25 1	25 1	25 1	40 1.5
Heating Hot Water Supply & Return, Heated Oil (Max 121 C 250 F)							
	Mineral Fiber	0.039 0.27	65 2.5	652.5	652.5	75 3	75 3
	Calcium Silicate	0.053 0.37	100 4	100 4	100 4	100 4	1004
	Cellular Glass		90 3.5	90 3.5	90 3.5	100 4	100 4
	Faced Phenolic Foam	0.035 0.24	65 2.5	65 2.5	65 2.5	75 3	75 3
	Polyisocyanurate Max temp 60C 140F	0.033 0.23	25 1	25 1	40 1.5	40 1.5	40 1.5
Cold Domestic Water Piping, Makeup Water, and Condenser Water							

TABLE 2

Piping Insulation Thickness (mminch)
For flexible cellular foam the thickness should be 13mm instead of 15mm. Economic thickness or prevention of condensation is the basis of these tables. If prevention of condensation is the criterion, the ambient temperature and relative humidity must be stated. Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service							
	Material	Conductivity K-value (W/m^2-K) (Btu-in/ hr-ft^2-deg F)	Tube And Pipe Size (mm) (inch)				
			<25 <1	25-<40 1-<1.5	40-<100 1.5-<4	00-<200 4-<8	> or = 200 >8
	Cellular Glass	0.043 0.30	40 1.5	401.5	401.5	401.5	401.5
	Flexible Elastomeric Cellular	0.034 0.235	251	251	251	N/A	N/A
Hot Domestic Water Supply & Recirculating Piping (Max 93 C 200 F)							
	Mineral Fiber	0.037 0.26	40 1.5	40 1.5	50 2	50 2	50 2
	Cellular Glass	0.049 0.34	50 2	50 2	65 2.5	65 2.5	65 2.5
	Flexible Elastomeric Cellular	0.043 0.30	40 1.5	40 1.5	50 2	N/A	N/A
Refrigerant Suction Piping (1.67 degrees C35 degrees F nominal)							
	Flexible Elastomeric Cellular	0.034 0.235	251	251	251	N/A	N/A
	Cellular Glass	0.042 0.29	40 1.5	401.5	401.5	401.5	401.5
Compressed Air Discharge, Steam and Condensate Return (94 to 121 Degrees C201 to 250 Degrees F							
	Mineral Fiber	0.039 0.27	65 2.5	65 2.5	65 2.5	75 3	75 3
	Calcium Silicate	0.053 0.37	65 2.5	803	1004	1004	1154.5
	Cellular Glass	0.050 0.35	502	652.5	803	803	803
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel							

TABLE 2

Piping Insulation Thickness (mminch)
For flexible cellular foam the thickness should be 13mm instead of 15mm. Economic thickness or prevention of condensation is the basis of these tables. If prevention of condensation is the criterion, the ambient temperature and relative humidity must be stated. Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service							
	Material	Conductivity K-value (W/m^2-K) (Btu-in/ hr-ft^2-deg F)	Tube And Pipe Size (mm) (inch)				
			<25 <1	25-<40 1-<1.5	40-<100 1.5-<4	00-<200 4-<8	> or = 200 >8
	Flexible Elastomeric Cellular		13 0.5	130.5	130.5	130.5	130.5
Condensate Drain Located Inside Building							
	Cellular Glass	0.043 0.30	40 1.5	401.5	401.5	401.5	401.5
	Flexible Elastomeric Cellular	0.034 0.235	251	251	251	N/A	N/A
Medium Temperature Hot Water, Steam and Condensate (122 to 176 Degrees C 251 to 350 Degrees F)							
	Mineral Fiber	0.042 0.29	65 2.5	90 3.5	100 4	115 4.5	115 4.5
	Calcium Silicate	0.056 0.39	125 5	165 6.5	165 6.5	165 6.5	165 6.5
High Temperature Hot Water & Steam (177 to 371 Degrees C351 to 700 Degrees F)							
	Mineral Fiber	0.046 0.32	115 4.5	125 5	125 5	125 5	125 5
	Calcium Silicate	0.059 0.41	115 4.5	125 5	1506	1506	1506
Brine Systems Cryogenics (-34 to -18 Degrees C-30 to 0 Degrees F)							
	Cellular Glass	0.036 0.25	65 2.5	652.5	803	803	903.5
	Flexible Elastomeric Cellular	0.35 0.24	251	251	N/A	N/A	N/A

TABLE 2

Piping Insulation Thickness (mminch)
For flexible cellular foam the thickness should be 13mm instead of 15mm. Economic thickness or prevention of condensation is the basis of these tables. If prevention of condensation is the criterion, the ambient temperature and relative humidity must be stated. Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service							
	Material	Conductivity K-value (W/m^2-K) (Btu-in/ hr-ft^2-deg F)	Tube And Pipe Size (mm) (inch)				
			<25 <1	25-<40 1-<1.5	40-<100 1.5-<4	00-<200 4-<8	> or = 200 >8
Brine Systems Cryogenics (-18 to 1.11 Degrees C0 to 34 Degrees F)							
	Cellular Glass	0.042 0.29	502	502	502	652.5	803
	Flexible Elastomeric Cellular	0.039 0.26	251	251	251	N/A	N/A

3.2.2 Aboveground Cold Pipelines

Insulate the following cold pipelines for minus 34 to plus 16 degrees C minus 30 to plus 60 degrees F in accordance with Table 2 except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted. This includes but is not limited to the following:

a. Make-up water.

b. Horizontal and vertical portions of interior roof drains.

c. Refrigerant suction lines.

d. Chilled water.

e. Dual temperature water, i.e. HVAC hot/chilled water.

f. Air conditioner condensate drains.

g. Brine system cryogenics.

h. Condenser water piping where pipe temperature may fall below ambient dew point.

i. Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap persons.

[
j. Domestic cold and chilled drinking water.]

3.2.2.1 Insulation Material and Thickness

****

NOTE: Table 1 is not all inclusive of service insulation requirements. Edit, modify, and add to the tables as required for your project. Consideration may be given to increasing or decreasing the thickness of insulation required if, in the judgment of the designer, the situation warrants. For example, hot water piping in conditioned spaces may not require the tabulated thickness; or extremely cold systems in a high humidity climate may require additional insulation.

The designer should take into consideration the dew point temperature of the area in which the system is to be built. This is separate from the design dry bulb and design wet bulb temperatures, and should not be confused with the information provided in UFC 3-400-02. When accounting for the dew point for design of the insulation thickness, consider using a relative humidity range of 80 to 90 percent unless you are in unusual circumstances. In very dry environments (Denver) consider using a relative humidity less than 80 percent, and remember to meet the requirements of the energy budget. In lower humidity environments, use the lower end of this range outdoors (80 to 85 percent). In high humidity environments use 90 percent. Indoors, where the humidity is to be controlled at 50 percent, it is more appropriate to design to 70 percent.

ASHRAE 90.1 insulation standard is a reference the designer should use to introduce a different material, or utilize an existing material type for an application that is not listed, or is outside the temperature range listed in Table 2. Table 2 may be modified for regions that meet one of the following conditions from UFC 3-410-01 or UFC 3-410-02. A wet bulb temperature of 19 degrees C 67 degrees F or higher and the outside design relative humidity is 50 percent or higher (dew point temperature greater than 16 C 60 F) for 3,000 hours or more. A wet bulb temperature of 22.8 degrees C 73 degrees F or higher and the outside design relative humidity is 50 percent or higher (dew point temperature greater than 19 C 67 F) for 1,500 hours or more. (Outside design relative humidity based on the 2.5 percent dry bulb and 5.0 percent wet bulb temperatures.) (Weather data obtained from UFC 3-400-02.)

Further references for recommended thickness includes the International Mechanical Code and manufacturers recommended thickness tables. The refrigerant suction piping thickness was determined for 1 degree C 35 degrees F service and the chilled water supply and return and dual temperature piping thickness was determined for 4 degrees C 40 degrees F

nominal service temperature.
****

Determine insulation thickness for cold pipelines using Table 2.

3.2.2.2 Factory or Field applied Jacket

****
NOTE: In high abuse areas such as janitor closets and traffic areas in equipment rooms and kitchens, aluminum jackets or PVC jackets and fittings will be shown. Normally, pipe insulation to the 2 m 6 foot level will be protected in high abuse areas. The designer will specifically indicate what pipes are to be provided with aluminum jackets, PVC jackets, and fittings (see paragraph 2.3.8.2 for PVC selection criteria). On overseas projects, designer to verify availability of labor at locale for insulation trade; if not available delete option for field applied jacket. If stateside, option for field applied jacket to remain.
****

Cover insulation with a factory applied vapor retarder jacket/vapor barrier or [field applied] seal welded PVC jacket or greater than 3 ply laminated self-adhesive (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.02 permeability, standard grade, sliver, white, black and embossed for use with Mineral Fiber, Cellular Glass, and Phenolic Foam Insulated Pipe. For insulation inside the building, to be protected with an aluminum jacket, PVC jacket or fittings (installed over a vapor retarder jacket), or greater than 3 ply vapor barrier/weatherproofing self-adhesive (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) product, less than 0.02 permeability, standard grade, Embossed Silver, White & Black, install the insulation and vapor retarder jacket as specified herein. Install the aluminum jacket, PVC jacket or fittings (installed over a vapor retarder jacket), or greater than 3 ply vapor barrier/weatherproofing self-adhesive (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) product, less than 0.02 permeability, standard grade, embossed silver, White & Black, as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, provide aluminum jackets, PVC jacket or fittings (installed over a vapor retarder jacket), or greater than 3 ply vapor barrier/weatherproofing self-adhesive (minimum0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) product, less than 0.02 permeability, standard grade, embossed silver, white & black, for pipe insulation to the 1.8 m 6 ft level. Other areas that specifically require protection to the 1.8 m 6 ft level are [_____].

3.2.2.3 Installing Insulation for Straight Runs Hot and Cold Pipe

Apply insulation to the pipe with tight butt joints. Seal all butted joints and ends with joint sealant and seal with a vapor retarder coating, greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or PVDC adhesive tape.

3.2.2.3.1 Longitudinal Laps of the Jacket Material

Overlap not less than 38 mm 1-1/2 inches. Provide butt strips 75 mm 3 inches wide for circumferential joints.

3.2.2.3.2 Laps and Butt Strips

Secure with adhesive and staple on 100 mm 4 inch centers if not factory self-sealing. If staples are used, seal in accordance with paragraph STAPLES below. Note that staples are not required with cellular glass systems.

3.2.2.3.3 Factory Self-Sealing Lap Systems

May be used when the ambient temperature is between 4 and 50 degrees C 40 and 120 degrees F during installation. Install the lap system in accordance with manufacturer's recommendations. Use a stapler only if specifically recommended by the manufacturer. Where gaps occur, replace the section or repair the gap by applying adhesive under the lap and then stapling.

3.2.2.3.4 Staples

Coat all staples, including those used to repair factory self-seal lap systems, with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - 0.0000 perm adhesive tape. Coat all seams, except those on factory self-seal systems, with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.5 Breaks and Punctures in the Jacket Material

Patch by wrapping a strip of jacket material around the pipe and secure it with adhesive, staple, and coat with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Extend the patch not less than 38 mm 1-1/2 inches past the break.

3.2.2.3.6 Penetrations Such as Thermometers

Fill the voids in the insulation and seal with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.7 Flexible Elastomeric Cellular Pipe Insulation

Install by slitting the tubular sections and applying them onto the piping or tubing. Alternately, whenever possible slide un-slit sections over the open ends of piping or tubing. Secure all seams and butt joints and seal with adhesive. When using self seal products, secure only the butt joints with adhesive. Push insulation on the pipe, never pulled. Stretching of insulation may result in open seams and joints. Clean cut all edges. Rough or jagged edges of the insulation are not be permitted. Use proper tools such as sharp knives. Do not stretch Grade 1, Type II sheet insulation around the pipe when used on pipe larger than 150 mm 6 inches. On pipes larger than 300 mm 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.2.4 Insulation for Fittings and Accessories

a. Butt pipe insulation tightly to the insulation of the fittings and accessories. Seal the butted joints and ends with joint sealant and seal with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

b. Place precut or preformed insulation around all fittings and accessories and conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation must be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Use insulation of the same thickness and conductivity as the adjoining pipe insulation. If nesting size insulation is used, overlap the insulation 50 mm 2 inches or one pipe diameter. Elbows insulated using segments must conform to MICA Tables 12.20 "Mitered Insulation Elbow'. Submit a booklet containing completed MICA Insulation Stds plates detailing each insulating system for each pipe, duct, or equipment insulating system, after approval of materials and prior to applying insulation.

(1) Ensure MICA plates detail the materials to be installed and the specific insulation application. Submit all MICA plates required showing the entire insulating system, including plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. Present all variations of insulation systems including locations, materials, vaporproofing, jackets and insulation accessories.

(2) If the Contractor elects to submit detailed drawings instead of edited MICA Plates, ensure the detail drawings are technically equivalent to the edited MICA Plate submittal.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers must be protected with PVDC or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 2 mm 1/16 inch, applied with glass tape embedded between coats. Overlap tap seams 25 mm 1 inch. Extend the coating out onto the adjoining pipe insulation 50 mm 2 inches. Protect fabricated insulation with a factory vapor retarder jacket with either greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape, standard grade, silver, white, black and embossed or PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 2 mm 1/16 inch and with a 50 mm 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, seal the joints with a vapor retarder coating and a 100 mm 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

d. Insulate anchors attached directly to the pipe for a sufficient distance to prevent condensation but no less than 150 mm 6 inches from the insulation surface.

e. Mark insulation to show the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape.

Factory precut insulation inserts or premolded insulation segments must be used under the fitting covers for elbows, tees and other miscellaneous configurations. Insulation inserts must be the same installed insulation thickness. One insert must be installed for each inch of pipe insulation. The installed and compressed insert must have the same thermal performance as the pipe insulation. Premolded insulation segments must be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. PVC fitting covers must be secured by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers. For above ambient pipe temperatures, secure PVC covers using tacks. As an option circumferential joints can be covered with PVC vapor retarder tape. For below ambient conditions seal system using PVC vapor retarder tape, and vapor retarder mastic with vapor dams. Longitudinal seams may be sealed with vapor retarder mastic, PVC vapor retarder tape or solvent weld adhesive to obtain a continuous vapor seal. For severe service conditions install PVC jackets over the existing ASJ jacket and seal using a solvent weld adhesive.

3.2.3 Aboveground Hot Pipelines

3.2.3.1 General Requirements

Insulate all hot pipe lines above 16 degrees C 60 degrees F, except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted, in accordance with Table 2. This includes but is not limited to the following:

a. Domestic hot water supply & re-circulating system.

b. Steam.

c. Condensate & compressed air discharge.

d. Hot water heating.

e. Heated oil.

f. Water defrost lines in refrigerated rooms.

Cover insulation, in accordance with manufacturer's recommendations, with a factory applied Type I jacket or field applied aluminum where required or seal welded PVC.

3.2.3.2 Insulation for Fittings and Accessories

Butt pipe insulation tightly to the insulation of the fittings and accessories. Seal butted joints and ends with joint sealant. Mark insulation to show the location of unions, strainers, check valves and other components that would otherwise be hidden from view by the insulation.

3.2.3.2.1 Precut or Preformed

Place precut insulation inserts or preformed insulation inserts around all fittings and accessories. Insulation inserts must be the same installed insulation thickness as the pipe insulation. One insert must be installed for each inch of pipe insulation thickness. The installed and compressed insert must have the same thermal performance as the pipe insulation. Preformed insulation inserts must be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity.

3.2.3.2.2 Rigid Preformed

Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Use insulation that is the same thickness and conductivity as the adjoining pipe insulation. If nesting size insulation is used, do not overlap insulation 50 mm 2 inches or one pipe diameter. Elbows insulated using segments must conform to MICA Tables 12.20 "Mitered Insulation Elbow".

3.2.4 Piping Exposed to Weather

****

NOTE: In project locations with Environmental Severity Classification (ESC) of C4 or C5 or high humid areas as identified in ASHRAE 90.1 as climate zones 0A, 0B, 1A, 1B, 2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, and 5C, provide aluminum or stainless steel jacket on piping exposed to weather. See UFC 1-200-01 for determination of ESC for project locations. Polymer jacketing is not recommended as it can experience degradation in UV light in any ASHRAE zone.

****

Insulate and jacket piping exposed to weather as specified for the applicable service inside the building. After this procedure, apply a laminated self-adhesive (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.02 permeability (greater than 3 ply, standard grade, silver, white, black and embossed aluminum jacket, stainless steel or PVC jacket.

PVC jacketing requires no factory-applied jacket beneath it, however apply an all service jacket if factory applied jacketing is not furnished.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. Overlap the jacket no less than 50 mm 2 inches at longitudinal and circumferential joints and secure with bands at no more than 300 mm 12 inch centers. Overlap longitudinal joints down to shed water and locate at 4 or 8 o'clock positions. Seal joints on piping 16 degrees C 60 degrees F and below with metal jacketing/flashing sealant while overlapping to prevent moisture penetration. Where jacketing on piping 16 degrees C 60 degrees F and below abuts an un-insulated surface, caulk joints to prevent moisture penetration. Seal joints on piping above 16 degrees C 60 degrees F with a moisture retarder.

3.2.4.2 Insulation for Fittings

Insulate and finish flanges, unions, valves, fittings, and accessories as specified for the applicable service. Apply two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer with glass tape embedded between coats. Overlap tap no less than 25 mm 1 inch and the adjoining aluminum jacket no less than 50 mm 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Provide molded PVC fitting covers when PVC jackets are used for straight runs of pipe.PVC fitting covers must be sealed based upon the pipe temperature in combination with ambient conditions and if the pipe insulation will be exposed to severe service conditions. For below ambient conditions, the pipe insulation and insulation fittings must be covered and sealed with a vapor barrier or weatherproofing jacket with a minimum 0.02 permeability as defined per ASTM C1136 before installing the PVC jacket and fitting cover. When in doubt as to the pipe temperature or service conditions, secure the PVC jacket using a weld adhesive using the manufacturer's recommended adhesive.

3.2.4.3 PVC Jacket

Provide ultraviolet resistant PVC jacket that is adhesive welded weather tight with manufacturer's recommended adhesive. Include provision for thermal expansion.

3.2.4.4 Stainless Steel Jackets

ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.25 mm0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 13 mm1/2 inch.

3.2.5 Below Ground Pipe Insulation

****

NOTE: Where significant amounts (approximately 8 meters 25 feet) of below grade piping is to be insulated, a separate specification section will be developed to allow factory pre-insulated systems as an alternate to field applied systems. Portions of the underground piping that are to be insulated using this paragraph will be indicated on the drawings.

****

Insulate below ground pipes in accordance with Table 2, except as precluded in paragraph PIPE INSULATION in PART 3. This includes, but is not limited to the following:

a. Heated oil.

b. Domestic hot water.

c. Heating hot water.

d. Dual temperature water.

e. Steam.

f. Condensate.

3.2.5.1 Type of Insulation

Insulate below ground pipe with Cellular Glass insulation, in accordance with manufacturer's instructions for application with thickness as determined from Table 2 (whichever is the most restrictive).

3.2.5.2 Installation of Below ground Pipe Insulation

a. Coat bore surfaces of the insulation with a thin coat of gypsum cement of a type recommended by the insulation manufacturer. Ensure coating thickness is sufficient to fill surface cells of insulation. Do not use mastic type materials for this coating. Note that unless this is for a cyclic application (i.e., one that fluctuates between high and low temperature on a daily process basis) there is no need to bore coat the material.

b. Use stainless steel bands, 19 mm 3/4 inch wide by 0.508 mm 0.020 inch thick to secure insulation in place. Apply a minimum of two bands per section of insulation. As an alternate, fiberglass reinforced tape may be used to secure insulation on piping up to 300 mm 12 inches in diameter. Apply a minimum of two bands per section of insulation.

c. Terminate insulation at anchor blocks but continue through sleeves and manholes.

d. At point of entry to buildings, terminate underground insulation 50 mm 2 inches inside the wall or floor, butt tightly against the aboveground insulation and seal the butt joint with high temperature silicone sealant and cover with fibrous glass tape.

e. Make provision for expansion and contraction of the insulation system in accordance with the insulation manufacturer's recommendations.

f. Insulate flanges, couplings, valves, and fittings with factory pre-molded, prefabricated, or field-fabricated sections of insulation of the same material and thickness as the adjoining pipe insulation. Secure insulation sections as recommended by the manufacturer.

g. Finish insulation, including fittings, with three coats of asphaltic mastic, with 6 by 5.5 mesh synthetic reinforcing fabric embedded between coats. Overlap fabric a minimum of 50 mm 2 inches at joints. Ensure total film thickness is a minimum of 4.7 mm 3/16 inch. As an alternate, apply a prefabricated bituminous laminated jacket, reinforced with internal reinforcement mesh, to the insulation. Use jacketing material and application procedures that match manufacturer's written instructions. Vapor barrier - less than 0.02 permeability self adhesive (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) jacket greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 0.072 2.9 mils adhesive), heavy duty, white or natural). Use application procedures that match the manufacturer's written instructions.

h. At termination points, other than building entrances, use mastic and cloth or tape to cover the ends of insulation and extend 50 mm 2 inches along the bare pipe.

3.3 DUCT INSULATION SYSTEMS INSTALLATION

****

NOTE: Insulation may be omitted on heating duct in heated spaces. Designer will determine if internally lined ducts are comparable in insulating value to those unlined ducts to be insulated. If not, field insulation will be added.

The designer must maintain conditioned space control under cooling and heating conditions - meet the energy budget, and not allow condensation

formation. The following do not require insulation: factory fabricated double wall internally insulated duct, glass fiber duct, site-erected air conditioning casings and plenums constructed of factory-insulated sheet metal panels, ducts internally lined with insulation or sound absorbing material, unless indicated otherwise, return ducts in ceiling spaces or as indicated, supply ducts in ceiling spaces which are used as return air plenums (or as indicated), factory pre-insulated flexible ducts, ducts within HVAC equipment, exhaust air ducts unless noted, and duct portions inside walls or floor-ceiling space in which both sides of the space are exposed to conditioned air and the space is not vented or exposed to unconditioned air.

In humid locations identified in ASHRAE 90.1 as Climate Zones 0A, 1A, 2A, 3A, 3C, 4C and 5C, exposed outdoor duct must be factory fabricated double wall internally insulated duct.

Ceiling spaces are defined as those spaces between the ceiling and bottom of floor deck or roof deck inside the air-conditioned space insulated envelope, and ceilings that form plenums.

ASHRAE 90.2 is for low-rise residential building. ASHRAE 90.1 is for all buildings except low-rise residential buildings. Low-rise building has one or two stories without elevators. High-rise building has multistory with elevators.

****

Install duct insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions. Duct insulation minimum thickness and insulation level must be as listed in Table 3 at the discretion of the designer and must meet or exceed the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP[ASHRAE 90.2].

Except for oven hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. [Omit duct insulation on exposed supply and return ducts in air conditioned spaces [where the difference between supply air temperature and room air temperature is less than 9 degrees C 15 degrees F] unless otherwise shown.] Air conditioned spaces are defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

3.3.1 Duct Insulation Minimum Thickness

****

NOTE: The following tables are adapted from ASHRAE 90.1. They may be used to modify the thicknesses listed in Table 4. The thicknesses listed are recommended, and may be changed at the discretion of

the designer. Duct insulation thicknesses must meet or exceed the requirements of ASHRAE 90.2 for low-rise residential buildings, and ASHRAE 90.1 for all other buildings except low-rise residential.

Use Table 6.8.2 Minimum Duct Insulation R-Value in ASHRAE 90.1 R-value for buildings other than low-rise residential. For low-rise residential buildings use minimum duct insulation requirements included in ASHRAE 90.2.

****

Table 3

Minimum Duct Insulation

	Cooling		Heating	
Duct Location	Annual Cooling Degree Days Base 18 C 65 F	Insulation R-Value (sm K)/W (h sf F)/Btu	Annual Heating Degree Days Base 18 C 65 F	Insulation R-Value (sm K)/W (h sf F)/Btu
Exterior of Building	<260 500	0.58 3.3	<816 1500	0.58 3.3
	260 - 621500 - 1150	0.88 5.0	816 - 2482 1500 - 4500	0.88 5.0
	622 - 1093 1151 - 2000	1.14 6.5	2483 - 4149 4501 - 7500	1.14 6.5
	>10932000	1.41 8.0	>41497500	1.41 8.0
	Temperature Difference	Insulation R-Value (sm K)/W (h sf F)/Btu	Temperature Difference degrees C degrees F	Insulation R-Value (sm K)/W (h sf F)/Btu
Inside building envelope or in unconditioned spaces	<815	None required	<815	None required
	8 <TD <2215 <TD <40	0.58 3.3	8 <TD <2215 <TD <40	0.58 3.3
	22 <TD40 <TD	0.88 5.0	22 <TD40 <TD	0.88 5.0

Table 3		
Minimum Duct Insulation		
	Cooling	**Heating**
These R-values do not include the film resistances. The required minimum thicknesses do not consider water vapor transmission and condensation. Additional insulation, vapor retarders, or both, may be required to limit vapor transmission and condensation. Where ducts are designed to convey both heated and cooled air, provide duct insulation as required by the most restrictive condition. Where exterior walls are used as plenum walls, provide wall insulation as required by the most restrictive condition of this section or the insulation for the building envelope. Cooling ducts are those designed to convey mechanically cooled air or return ducts in such systems. Heating ducts are those designed to convey mechanically heated air or return ducts in such systems. Thermal resistance will be measured in accordance with ASTM C518 at a mean temperature of 24 degrees C 75 degrees F. The Temperature difference is at design conditions between the space within which the duct is located and the design air temperature in the duct. Resistance for runouts to terminal devices less than 3 m 10 feet in length need not exceed 0.58 (sm K)/W 3.3 (h sf F)/Btu. Unconditioned spaces include crawlspaces and attics.		

Duct insulation minimum thickness in accordance with Table 4.

Table 4 - Minimum Duct Insulation (mm) (inches)	
Cold Air Ducts	50 2.0
Relief Ducts	40 1.5
Fresh Air Intake Ducts	40 1.5
Warm Air Ducts	50 2.0
Relief Ducts	40 1.5
Fresh Air Intake Ducts	40 1.5

3.3.2 Insulation and Vapor Retarder/Vapor Barrier for Cold Air Duct

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NOTE: Cold air ducts needing insulation are ducts that handle air at or below 16 degrees C 60 degrees F. Mixing boxes, relief air ducts, and filter boxes should not be insulated unless condensation is a problem. Insulation may be omitted on that portion of return air ducts installed in the ceiling spaces where condensation is not a problem, and on that portion of supply ducts installed in ceiling spaces used as a return air plenum where condensation is not a problem. The designer is required to provide

calculations to prove, if insulation is not provided for ducts or equipment, the space will be properly cooled and condensation will not form on ductwork or equipment. For ducts to be used for both heating and cooling, the requirements for cold ducts will govern.

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NOTE: Insulate all supply and return ductwork in humid locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1).

****

Provide insulation and vapor retarder/vapor barrier for the following cold air ducts and associated equipment.

a. Supply ducts.

b. Return air ducts.

c. Relief ducts.

d. Flexible run-outs (field-insulated).

e. Plenums.

f. Duct-mounted coil casings.

g. Coil headers and return bends.

h. Coil casings.

i. Fresh air intake ducts.

j. Filter boxes.

k. Mixing boxes (field-insulated).

l. Supply fans (field-insulated).

m. Site-erected air conditioner casings.

n. Ducts exposed to weather.

o. Combustion air intake ducts.

p. Exhaust ducts passing through concealed spaces, unconditioned spaces, or semi-heated spaces exhausting conditioned air.

Use insulation for rectangular ducts that is flexible type where concealed, minimum density 12 kg/cubic m 3/4 pcf, and rigid type where exposed, minimum density 48 kg/cubic m 3 pcf. Provide insulation for both concealed or exposed round/oval ducts that is flexible type, minimum density 12 kg/cubic m 3/4 pcf or a semi rigid board, minimum density 48 kg/cubic m 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Provide insulation for all exposed ducts with either a white, paint-able, factory-applied Type I jacket or a field applied vapor retarder/vapor barrier jacket coating finish as specified. Ensure the total field applied dry film thickness is approximately 2 mm 1/16 inch. Provide insulation on all concealed duct with a factory-applied Type I or II vapor retarder/vapor barrier jacket. Continue duct insulation through sleeves and prepare openings except firewall penetrations. Duct insulation terminating at fire dampers, must be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Provide duct insulation and vapor retarder/vapor barrier to cover the collar, neck, and un-insulated surfaces of diffusers, registers and grills. Apply vapor retarder/vapor barrier materials to form a complete unbroken vapor seal over the insulation. Seal sheet metal duct in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, attach flexible insulation by applying adhesive around the entire perimeter of the duct in 150 mm 6 inch wide strips on 300 mm 12 inch centers.

b. For rectangular and oval ducts, 600 mm 24 inches and larger, additionally secure insulation to bottom of ducts using mechanical fasteners. Space fasteners on 400 mm 16 inch centers and no more than 400 mm 16 inches from duct corners.

c. For rectangular, oval and round ducts, provide mechanical fasteners on sides of duct risers for all duct sizes. Space fasteners on 400 mm 16 inch centers and no more than 400 mm 16 inches from duct corners.

d. Impale insulation on the mechanical fasteners (self stick pins) where used and press thoroughly into the adhesive. Take care to ensure vapor retarder/vapor barrier jacket joints overlap 50 mm 2 inches. Do not compress insulation to a thickness less than that specified. Carry insulation over standing seams and trapeze-type duct hangers.

e. Where mechanical fasteners are used, install self-locking washers and trim and bend the pin over.

f. Secure jacket overlaps with staples and tape as necessary to ensure a secure seal. Coat staples, tape and seams with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 0.05 mm 2 mils adhesive, 0.075 3 mils embossed) - less than 0.0000 perm adhesive tape.

g. Cover breaks in the jacket material with patches of the same material as the vapor retarder jacket. Do not extend patches less than 50 mm 2 inches beyond the break or penetration in all directions and secure with tape and staples. Seal staples and tape joints with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) - less than 0.0000 perm adhesive tape.

h. At jacket penetrations such as hangers, thermometers, and damper operating rods, fill voids in the insulation and seal the penetration with a brush coat of vapor retarder coating or PVDC adhesive tape greater than 3 ply laminate (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) - less than 0.0000 perm adhesive tape.

i. Seal insulation terminations and pin punctures and flash with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. Ensure the coating overlaps the adjoining insulation and un-insulated surface 50 mm 2 inches. Extend pin puncture coatings 50 mm 2 inches from the puncture in all directions.

j. Where insulation standoff brackets occur, extend insulation under the bracket and terminate the jacket at the bracket.

3.3.2.2 Installation on Exposed Duct Work

a. For rectangular ducts, secure rigid insulation to the duct by mechanical fasteners on all four sides of the duct, space no more than 300 mm 12 inches apart and no more than 75 mm 3 inches from the edges of the insulation joints. Provide a minimum of two rows of fasteners for each side of duct 300 mm 12 inches and larger. Provide one row for each side of duct less than 300 mm 12 inches. Provide mechanical fasteners that are corrosion resistant as G60 coated galvanized steel, and indefinitely sustain a 22.7 kg 50 lb tensile dead load test perpendicular to the duct wall.

b. Form duct insulation with minimum jacket seams. Fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, bring insulation up to standing seams, reinforcing, and other vertical projections and do not carry over. Continue vapor retarder/barrier jacket across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, carry over insulation and jacket . Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors.

c. Impale insulation on the fasteners; install self-locking washers and trim and bend the pin over.

d. Seal joints in the insulation jacket with a 100 mm 4 inch wide strip of tape. Seal taped seams with a brush coat of vapor retarder coating.

e. Cover breaks and ribs or standing seam penetrations in the jacket material with a patch of the same material as the jacket. Do not extend patches less than 50 mm 2 inches beyond the break or penetration and secure with tape and staple. Seal staples and joints with a brush coat of vapor retarder coating.

f. At jacket penetrations such as hangers, thermometers, and damper operating rods, fill the voids in the insulation and seal the penetrations with a flashing sealant.

g. Seal and flash insulation terminations and pin punctures with a reinforced vapor retarder coating finish. Ensure coating overlaps the adjoining insulation and un-insulated surface 50 mm 2 inches. Extend pin puncture coatings 50 mm 2 inches from the puncture in all directions.

h. Insulation for both concealed or exposed round or oval ducts must be flexible type, minimum density 12 kg/cubic m 3/4 pcf or a semi rigid board, minimum density 48 kg/cubic m 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Insulation for all exposed ducts must be provided with either a white, factory-applied Type I jacket or a field applied vapor retarder or vapor barrier jacket coating finish as specified, the total field applied dry film thickness must be approximately 2 mm 1/16 inch.

i. Insulate oval and round ducts, flexible type, with factory Type I jacket insulation with minimum density of 12 kg per cubic meter 3/4 pcf, attach in accordance with MICA standards.

3.3.3 Insulation for Warm Air Duct

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NOTE: Warm air ducts needing insulation are ducts that handle air above 16 degrees C 60 degrees F. Mixing boxes, relief air ducts, and filter boxes should not be insulated unless condensation is a problem. Factory fabricated double-walled internally insulated duct exposed to the weather should be externally insulated on long runs of duct in cold climates. If insulation is required for unique building design, indicate on the drawings the locations the insulation is to be installed. Ducts for dual purposes will be as required for cold duct.

In humid locations, exhaust ducts passing through concealed spaces which exhaust conditioned air must be insulated and a vapor barrier provided. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Include item below relating to exhaust ducts where this condition occurs in project.

Delete items below as required.

****

Provide insulation and vapor barrier for the following warm air ducts and associated equipment:.

a. Supply ducts.

b. Return air ducts.

c. Relief air ducts

d. Flexible run-outs (field insulated).

e. Plenums.

f. Duct-mounted coil casings.

g. Coil-headers and return bends.

h. Coil casings.

i. Fresh air intake ducts.

j. Filter boxes.

k. Mixing boxes.

l. Supply fans.

m. Site-erected air conditioner casings.

n. Ducts exposed to weather.

o. Exhaust ducts passing through concealed spaces, unconditioned spaces, or semi-heated spaces exhausting conditioned air.

Provide insulation for rectangular ducts that is flexible type where concealed, and rigid type where exposed. Provide insulation on exposed ducts with a white, paint-able, factory-applied Type II jacket, or finish with adhesive finish. Use flexible type insulation for round ducts, with a factory-applied Type II jacket. Provide insulation on concealed duct with a factory-applied Type II jacket. Accomplish adhesive finish where indicated to be used by applying two coats of adhesive with a layer of glass cloth embedded between the coats. Ensure total dry film thickness is approximately 2.0 mm 1/16 inch. Continue duct insulation through sleeves and prepare openings. Terminate duct insulation at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

a. For rectangular, oval and round ducts, attach insulation by applying adhesive around the entire perimeter of the duct in 150 mm 6 inch wide strips on 300 mm 12 inch centers.

b. For rectangular and oval ducts 600 mm 24 inches and larger, secure insulation to the bottom of ducts using mechanical fasteners. Space fasteners on 450 mm 18 inch centers and no more than 450 mm 18 inches from duct corner.

c. For rectangular, oval and round ducts, provide mechanical fasteners on sides of duct risers for all duct sizes. Space fasteners on 450 mm 18 inch centers and no more than 450 mm 18 inches from duct corners.

d. Impale insulation on the mechanical fasteners where used. Do not compress insulation to a thickness less than that specified. Carry insulation over standing seams and trapeze-type hangers.

e. Install self-locking washers where mechanical fasteners are used and trim and bend the pin over.

f. Do not overlap insulatio jacket less than 50 mm 2 inches at joints and secure the lap and staple on 100 mm 4 inch centers.

3.3.3.2 Installation on Exposed Duct

a. For rectangular ducts, secure the rigid insulation to the duct using mechanical fasteners on all four sides of the duct, space no more than 400 mm 16 inches apart and no more than 150 mm 6 inches from the edges of the insulation joints. Provide a minimum of two rows of fasteners for each side of duct 300 mm 12 inches and larger and a minimum of one row for each side of duct less than 300 mm 12 inches.

b. Form duct insulation with factory-applied jacket with minimum jacket seams, and fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, bring insulation up to standing seams, reinforcing, and other vertical projections and do not carry over the projection. Continue jacket across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, carry insulation and jacket over the projection.

c. Impale insulation on the fasteners; install self-locking washers and trim and bend the pin over.

d. Seal joints on jacketed insulation with a 100 mm 4 inch wide strip of tape and brush with vapor retarder coating.

e. Cover breaks and penetrations in the jacket material with a patch of the same material as the jacket. Extend patches no less than 50 mm 2 inches beyond the break or penetration and secure with adhesive and staple.

f. Seal insulation terminations and pin punctures with tape and brush with vapor retarder coating.

g. Insulate oval and round ducts, flexible type, with factory Type I jacket insulation, minimum density of 12 kg per cubic meter 3/4 pcf attach by staples spaced no more than 400 mm 16 inches and no more than 150 mm 6 inches from the degrees of joints. Seal joints in accordance with item "d." above.

3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 16 degrees C 60 degrees F, insulate ducts as specified for cold air duct.

3.3.5 Insulation for Evaporative Cooling Duct

Insulate evaporative cooling supply duct located in spaces not evaporatively cooled. Use material and installation requirements as specified for duct insulation for warm air duct.

3.3.6 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, repair breaks in the insulation and jacket in accordance with the applicable section of this specification for the type of duct insulation to be repaired. After the insulation is repaired, identify on the outside of the insulation with marker, sticker, or other means "TAB test ports."

3.3.7 Duct Exposed to Weather

3.3.7.1 Installation

Insulate and finish ducts exposed to weather as specified for the applicable service for exposed duct inside the building. After the above is accomplished, further finish the insulation as detailed in the following subparagraphs.

3.3.7.2 Round Duct

Laminated self-adhesive (minimum 0.05 mm 2 mils adhesive, 0.075 mm 3 mils embossed) vapor barrier/weatherproofing jacket - Less than 0.02 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply, heavy duty, white and natural) membrane must be applied overlapping material by 75 mm 3 inches no bands or caulking needed - see manufacturer's recommended installation instructions.

Aluminum jacket with factory applied moisture retarder must be applied with the joints lapped no less than 75 mm 3 inches and secured with bands located at circumferential laps and at no more than 300 mm 12 inch intervals throughout. Lap horizontal joints down to shed water and located at 4 or 8 o'clock position. Seal joints with metal jacketing sealant to prevent moisture penetration. Where jacketing abuts an un-insulated surface, seal joints with metal jacketing sealant.

3.3.7.3 Fittings

Finish fittings and other irregular shapes as specified for rectangular ducts.

3.3.7.4 Rectangular Ducts

Apply two coats of weather barrier mastic reinforced with fabric or mesh for outdoor application to the entire surface. Ensure each coat of weatherproof mastic has a minimum thickness of 2 mm 1/16 inch. Ensure exterior is a metal jacketing applied for mechanical abuse and weather protection, and secure with screws or vapor barrier/weatherproofing jacket less than 0.02 permeability greater than 3 ply, standard grade, silver, white, black, and embossed or greater than 8 ply, heavy duty white and natural. Apply membrane overlapping material by 75 mm 3 inches. No bands or caulking needed-see manufacturing recommend installation instructions.

3.3.8 Kitchen Exhaust Duct Insulation

NFPA 96 for [ovens,] [griddles,] [deep fat fryers,] [steam kettles,] [vegetable steamers,] [high pressure cookers,] [and] [mobile serving units]. Provide insulation with 19 mm 3/4 inch wide, minimum 4 mm 0.15 inch thick galvanized steel bands spaced not over 305 mm 12 inches o.c.; or 16 gauge galvanized steel wire with corner clips under the wire; or with heavy welded pins spaced not over 305 mm 12 inches apart each way. Do not use adhesives.

3.4 EQUIPMENT INSULATION SYSTEMS INSTALLATION

Install equipment insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

3.4.1 General

Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Omit equipment insulation on the following:

a. Hand-holes.

b. Boiler manholes.

c. Cleanouts.

d. ASME stamps.

e. Manufacturer's nameplates.

f. Duct Test/Balance Test Holes.

3.4.2 Insulation for Cold Equipment

****

NOTE: Special cold equipment including Government-furnished equipment that requires field-applied insulation will be inserted in the appropriate paragraph.

****

Cold equipment below 16 degrees C 60 degrees F: Furnish insulation on equipment handling media below 16 degrees C 60 degrees F including the following:

a. Pumps.

b. Refrigeration equipment parts that are not factory insulated.

c. Drip pans under chilled equipment.

d. Cold water storage tanks.

e. Water softeners.

f. Duct mounted coils.

g. Cold and chilled water pumps.

h. Pneumatic water tanks.

i. Roof drain bodies.

j. Air handling equipment parts that are not factory insulated.

k. Expansion and air separation tanks.

3.4.2.1 Insulation Type

****

NOTE: Additional data on insulation thickness may be found in manufacturers catalogs and computer sizing programs and from individual calculations. Care should be taken in the selection of an insulating material for high temperature equipment. If the equipment rises to high operating temperature in a short period of time, thermal stresses may occur in rigid insulations that may lead to cracking and subsequent deterioration of the insulation.

****

Provide insulation suitable for the temperature encountered. Provide material and thicknesses as shown in Table 5:

TABLE 5		
Insulation Thickness for Cold Equipment (mm) (inches)		
Equipment handling media at indicated temperature		
	Material	Thickness (mm) (inches)
2 to 16 degrees C35 to 60 degrees F		
	Cellular Glass	401.5
	Flexible Elastomeric Cellular	251
Minus 18 to 1 degree C1 to 34 degrees F		
	Cellular Glass	753
	Flexible Elastomeric Cellular	401.5
Minus 34 to minus 17 degrees CMinus 30 to 0 degrees F		
	Cellular Glass	903.5
	Flexible Elastomeric Cellular	451.75

3.4.2.2 Pump Insulation

a. Insulate pumps by forming a box around the pump housing. Construct the box by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Join joints between sides and between sides and bottom by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. Ensure box conforms to the requirements of MICA Insulation Stds plate No. 49 when using flexible elastomeric cellular insulation. Ensure joints between top cover and sides fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.

b. Protect exposed insulation corners with corner angles.

c. Upon completion of installation of the insulation, including removable sections, apply two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish must be 2 mm 1/16 inch. Provide a parting line between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Apply flashing sealant to parting line, between equipment and removable section insulation, and at all penetrations.

3.4.2.3 Other Equipment

a. Form or fabricate insulation to fit the equipment. To ensure a tight fit on round equipment, bevel edges and tightly butt and stagger joints.

b. Secure insulation in place with bands or wires at intervals as recommended by the manufacturer but no more than 300 mm 12 inch centers except adhere flexible elastomeric cellular with contact adhesive. Protect insulation corners under wires and bands with suitable corner angles.

c. Install cellular glass in accordance with manufacturer's instructions. Seal joints and ends with joint sealant, and seal with a vapor retarder coating.

d. Use removable insulation on heads of heat exchangers. Fabricate removable section joints using a male-female shiplap type joint. Finish the entire surface of the removable section by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish must be 2 mm 1/16 inch.

e. Protect exposed insulation corners with corner angles.

f. Apply insulation on equipment with ribs over 150 by 150 mm 6 by 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot weld to the equipment over the ribs. Secure insulation to the fabric with J-hooks and 50 by 50 mm 2 by 2 inches washers or securely band or wire in place on 300 mm 12 inch centers.

3.4.2.4 Vapor Retarder/Vapor Barrier

Upon completion of installation of insulation, caulk penetrations. Apply two coats of vapor retarder coating or vapor barrier jacket over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. Ensure the total dry thickness of the finish is 2 mm 1/16 inch. Apply flasing sealant or vapor barrier tape to parting line between equipment and removable section insulation.

3.4.3 Insulation for Hot Equipment

****

NOTE: Special hot equipment such as sterilizers, expansion tanks for high temperature water systems, process equipment, and special Government-furnished equipment that requires field-applied insulation will be inserted in the appropriate subparagraphs. Expansion tanks on hot water heating systems will not normally be insulated.

****

Furnish insulation on equipment handling media above 16 degrees C 60 degrees F including the following:

a. Converters.

b. Heat exchangers.

c. Hot water generators.

d. Water heaters.

e. Pumps handling media above 54 degrees C 130 degrees F.

f. Fuel oil heaters.

g. Hot water storage tanks.

h. Air separation tanks.

i. Surge tanks.

j. Flash tanks.

k. Feed-water heaters.

l. Unjacketed boilers or parts of boilers.

m. Boiler flue gas connection from boiler to stack (if inside).

n. Induced draft fans.

o. Fly ash and soot collectors.

p. Condensate receivers.

3.4.3.1 Insulation

****

NOTE: Additional data on insulation thickness may be found in manufacturers catalogs and computer sizing programs and from individual calculations. Care should be taken in the selection of an insulating material for high temperature equipment. If the equipment rises to high operating temperature in a short period of time, thermal stresses may occur in rigid insulations that may lead to cracking and subsequent deterioration of the insulation.

****

Provide insulation suitable for the temperature encountered. Insulate shell and tube-type heat exchangers for the temperature of the shell medium.

Determine insulation thickness for hot equipment using Table 6:

TABLE 6		
Insulation Thickness for Hot Equipment (mm) (inches)		
Equipment handling steam or media at indicated pressure or temperature limit		
	Material	Thickness (mm) (inches)
103 kPa or 121 degrees C15 psig or 250 degrees F		
	Rigid Mineral Fiber	502
	Flexible Mineral Fiber	502
	Calcium Silicate/Perlite	1004
	Cellular Glass	753

TABLE 6

Insulation Thickness for Hot Equipment (mm) (inches)

Equipment handling steam or media at indicated pressure or temperature limit		
	Material	Thickness (mm) (inches)
	Faced Phenolic Foam	401.5
	Flexible Elastomeric Cellular (<93 C<200 F)	251
1380 kPa or 204 degree C200psig or 400 degrees F		
	Rigid Mineral Fiber	753
	Flexible Mineral Fiber	753
	Calcium Silicate/Perlite	1004
	Cellular Glass	1004
316 degrees C600 degrees F		
	Rigid Mineral Fiber	1255
	Flexible Mineral Fiber	1506
	Calcium Silicate/Perlite	1506
	Cellular Glass	1506
316 degrees C600 degrees F: Thickness necessary to limit the external temperature of the insulation to 50 C 120 F. Submit heat transfer calculations to substantiate insulation and thickness selection.		

3.4.3.2 Insulation of Boiler Stack and Diesel Engine Exhaust Pipe

Inside [boiler House] [mechanical Room], bevel insulation neatly around openings and provide sheet metal insulation stop strips around such openings. Apply a skim coat of hydraulic setting cement directly to insulation. Apply a flooding coat of adhesive over hydraulic setting cement, and while still wet, press a layer of glass cloth or tape into adhesive and seal laps and edges with adhesive. Coat glass cloth with adhesive. When dry, apply a finish coat of adhesive at can-consistency so that when dry no glass weave is observed. Provide metal jackets for [stacks] [and] [exhaust pipes] that are located above finished floor and spaces outside [boiler house] [mechanical room]. Apply metal jackets directly over insulation and secure with 19 mm 3/4 inch wide metal bands spaced on 457 mm 18 inch centers. Do not insulate name plates. Provide insulation type and thickness in accordance with the following Table 7.

****

NOTE: Table 7 is primarily used for personnel safety where stacks or pipes are within reach, or if stacks or pipes run through conditioned spaces where

heat losses may increase building energy usage.
****

TABLE 7						
Insulation and Thickness for Boiler Stack and Diesel Engine Exhaust Pipe						
Service & Surface Temperature Range (Degrees CF)						
	Material	Outside Diameter (mm) (Inches)				
		6 - 32 0.25 - 1.25	25 - 80 1 - 1.67	90-125 3.5-5	150 - 2506 - 10	> or = 280 - 90011 - 36
Boiler Stack (Up to 204 degrees C) (Up to 400 degrees F)						
	Mineral Fiber ASTM C585 Class B-3, ASTM C547 Class 1, or ASTM C612 Class 1	N/A	N/A	753	903.5	1004
	Calcium Silicate ASTM C533, Type 1	N/A	N/A	753	903.5	1004
	Cellular Glass ASTM C552, Type II	401.5	401.5	401.5	502	652.5
Boiler Stack (205 to 315 degrees C) (401 to 600 degrees F)						
	Mineral Fiber ASTM C547 Class 2, ASTM C592 Class 1, or ASTM C612 Class 3	N/A	N/A	1004	1004	1255
	Calcium Silicate ASTM C533, Type I or II	N/A	N/A	1004	1004	1004
	Mineral Fiber and Cellular Glass Assembly:					
	Mineral Fiber ASTM C547 Class 2, ASTM C592 Class 1, or ASTM C612 Class 3	251	251	251	251	502
	Cellular Glass ASTM C552, Type II	502	502	502	502	502

TABLE 7						
Insulation and Thickness for Boiler Stack and Diesel Engine Exhaust Pipe						
Service & Surface Temperature Range (Degrees CF)						
	Material	Outside Diameter (mm) (Inches)				
		6 - 32 0.25 - 1.25	25 - 80 1 - 1.67	90-125 3.5-5	150 - 2506 - 10	> or = 280 - 90011 - 36
Boiler Stack (316 to 427 degrees C) (601 to 800 degrees F)						
	Mineral Fiber ASTM C547 Class 3, ASTM C592 Class 1, or ASTM C612 Class 3	N/A	N/A	1004	1004	1506
	Calcium Silicate ASTM C533, Type I or II	N/A	N/A	1004	1004	1506
	Mineral Fiber and Cellular Glass Assembly:					
	Mineral Fiber ASTM C547 Class 2, ASTM C592 Class 1, or ASTM C612 Class 3	502	502	502	803	803
	Cellular Glass ASTM C552, Type II	502	502	502	502	502
Diesel Engine Exhaust (Up to 371 degrees C) (Up to 700 degrees F)						
	Calcium Silicate ASTM C533, Type I or II	803	903.5	1004	1004	1004
	Cellular Glass ASTM C552, Type II	652.5	903.5	1004	1154.5	1506
Diesel Engine Exhaust (371 to 649 degrees C) (700 to 1200 degrees F)						

TABLE 7						
Insulation and Thickness for Boiler Stack and Diesel Engine Exhaust Pipe						
Service & Surface Temperature Range (Degrees CF)						
	Material	Outside Diameter (mm) (Inches)				
		6 - 32 0.25 - 1.25	25 - 80 1 - 1.67	90-125 3.5-5	150 - 2506 - 10	> or = 280 - 90011 - 36
	Calcium Silicate ASTM C533, Type I or II	N/A	N/A	165 6.5	165 6.5	190 7.5

3.4.3.3 Insulation of Pumps

Insulate pumps by forming a box around the pump housing. Construct the box by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Band bottom and sides to form a rigid housing that does not rest on the pump. Ensure joints between top cover and sides fit tightly. The top cover must have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Apply two coats of Class I adhesive over insulation, including removable sections, with a layer of glass cloth embedded between the coats. Provide a parting line between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish must be 2 mm 1/16 inch. Apply caulking to parting line of the removable sections and penetrations.

3.4.3.4 Other Equipment

a. Form or fabricate insulation to fit the equipment. To ensure a tight fit on round equipment, bevel edges and tightly butt and stagger joints.

b. Secure insulation in place with bands or wires at intervals as recommended by the manufacturer but no greater than 300 mm 12 inch centers except adhere flexible elastomeric cellular. Protect insulation corners under wires and bands with suitable corner angles.

c. On high vibration equipment, set cellular glass insulation in a coating of bedding compound as recommended by the manufacturer, and seal joints with bedding compound. Fill mineral fiber joints with finishing cement.

d. Provide removable insulation on heads of heat exchangers. Fabricate the removable section joint using a male-female shiplap type joint. Finish the entire surface of the removable section as specified.

e. Protect exposed insulation corners with corner angles.

f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, apply insulation over 150 by 150 mm 6 by 6 inch by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot weld to the equipment over the ribs. Secure insulation to the fabric with J-hooks and 50 by 50 mm 2 by 2 inch washers or securely band or wire in place on 300 mm 12 inch (maximum) centers.

g. On equipment handling media above 316 degrees C 600 degrees F, apply insulation in two or more layers with staggered joints.

h. Upon completion of installation of insulation, caulk penetrations. Apply two coats of adhesive over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish must be 2 mm 1/16 inch. Apply caulking to parting line between equipment and removable section insulation.

3.4.4 Equipment Handling Dual Temperature Media

Below and above 16 degrees C 60 degrees F: insulate equipment handling dual temperature media as specified for cold equipment.

3.4.5 Equipment Exposed to Weather

3.4.5.1 Installation

Insulate equipment exposed to weather and finish in accordance with the requirements for ducts exposed to weather in paragraph DUCT INSULATION INSTALLATION.

3.4.5.2 Optional Panels

At the option of the Contractor, prefabricated metal insulation panels may be used in lieu of the insulation and finish previously specified. Thermal performance must be equal to or better than that specified for field applied insulation. Provide panels that are the standard catalog product of a manufacturer of metal insulation panels. Provide fastenings, flashing, and support system conforming to published recommendations of the manufacturer for weatherproof installation and that prevent moisture from entering the insulation. Design panels to accommodate thermal expansion and to support a 1112 N 250 pound walking load without permanent deformation or permanent damage to the insulation. Exterior metal cover sheet must be aluminum and exposed fastenings must be stainless steel or aluminum.

-- End of Section --

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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USACE / NAVFAC / AFCEC **UFGS-23 08 00 (May 2023)**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 23 08 00

COMMISSIONING OF MECHANICAL[AND PLUMBING] SYSTEMS

05/23, CHG 1: 08/24

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NOTE: This specification covers commissioning requirements for HVAC[and plumbing] systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: This section contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, GOVT HIRED COMMISSIONING PROVIDER, INTEGRATED SYSTEMS TESTS, DESIGN-BUILD, DESIGN-BID-BUILD, ARMY, and NAVY.

Select KTR HIRED COMMISSIONING PROVIDER tailoring for projects that require the Commissioning Provider to be provided by the Construction Contractor.

Select GOVT HIRED COMMISSIONING PROVIDER tailoring for projects where the Commissioning Provider is retained under a separate contract with the Government.

Select ARMY tailoring for projects that will be managed by the U.S. Army Corps of Engineers (USACE). Army managed projects will always have a

KTR HIRED COMMISSIONING PROVIDER in accordance with Engineering Regulations. Do NOT select GOVT HIRED COMMISSIONING PROVIDER tailoring for Army managed projects. Refer to Notes in Section 01 91 00.15 BUILDING COMMISSIONING and Engineering Regulations for further information.

Army Engineering Regulation (ER) 1110-345-723 describes Army project commissioning leadership structure. In all cases, the construction contractor will be required to provide a Contractor's Commissioning Specialist (CxC), herein referred to as the Lead Commissioning Specialist, to perform the duties listed. The Army will utilize a Government Commissioning Specialist (CxG) as described in the ER. Regardless of whether the CxG is provided by Army personnel or third party contract, all communication and coordination with the CxG will be managed through the Contracting Officer via processes established in other specification sections such as Quality Control, and Submittal Procedures.

Select NAVY tailoring for projects that will be managed by the Naval Facilities Engineering Systems Command (NAVFAC).

Select DESIGN-BUILD tailoring for Design-Build project execution.

Select DESIGN-BID-BUILD tailoring for Design-Bid-Build project execution.

Select INTEGRATED SYSTEMS TESTING tailoring for buildings with central control systems and interactive operation among different systems. (Examples include mission critical facilities such as hospitals, laboratories, mission operations, or other essential (RCIV) and strategic asset (RCV) facilities.)

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Building Commissioning is a systematic, quality-focused process for enhancing the delivery of a project that focuses on verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the project requirements. The purpose is to reduce the cost and performance risks associated with delivering facilities projects, and to increase value to owners, occupants, and users. Comply with specification Section 01 91 00.15 BUILDING COMMISSIONING.

1.1 SEQUENCING AND SCHEDULING

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NOTE: The following paragraph contains tailoring for ARMY and NAVY. Tailoring and deletions to this list will require renumbering the list items.

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Complete functional performance testing prior to performance verification testing required by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Complete the following prior to starting Functional Performance Tests of mechanical systems:

a. All equipment and systems completed, cleaned, flushed, disinfected, calibrated, tested, and operate in accordance with contract documents and construction plans and specifications

b. Final DALT Report submitted and approved in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

c. Pre-final Testing, Adjusting, and Balancing Report submitted in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

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NOTE: This item contains tailoring for ARMY.

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d. Performance Verification Tests of the controls systems have been completed and the Performance Verification Test Report has been submitted and approved in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

e. The Certificate of Readiness submitted and approved in accordance with Section 01 91 00.15 BUILDING COMMISSIONING

[f. Air Leakage Test Reports and Diagnostic Test Reports submitted and approved in accordance with Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING

][g. Tests, Flushing, and Disinfection in accordance with Section [22 00 00 PLUMBING, GENERAL PURPOSE][22 00 70 PLUMBING FOR HEALTHCARE FACILITIES]

][h. Inspection and Testing in accordance with Section 22 33 30.00 10 SOLAR WATER HEATING EQUIPMENT

]1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Test Equipment; G, [_____]

SD-06 Test Reports

Pipe Flushing, Testing, And Water Treatment Reports; G, [_____]

Completed Pre-Functional Checklists; G, [_____]

[Seasonal Test Report; G, [_____]

][Full-Load Test Report; G, [_____]

][Post-Construction Trend Log Report; G, [_____]

] SD-07 Certificates

Certificate Of Readiness; G, [_____]

1.3 ACCESSIBILITY REQUIREMENTS

Equipment, systems, and devices for commissioned systems must be accessible. Make necessary modifications if systems and devices are not accessible for inspections and testing.

Assist commissioning team in testing by removing equipment covers, opening access panels, and other required activities that assist with visual oversight. Furnish ladders, flashlights, meters, gauges, or other inspection equipment as necessary.

1.4 COORDINATION

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NOTE: This paragraph contains tailoring options for ARMY and NAVY.

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Refer to Section 01 91 00.15 BUILDING COMMISSIONING for requirements pertaining to coordination during the commissioning process. Coordinate with the Commissioning Provider Lead Commissioning Specialist in accordance with Section 01 91 00.15 and in accordance with the Commissioning Plan to schedule inspections as required to support the commissioning process. Furnish additional information requested by the Commissioning Provider Lead Commissioning Specialist. Coordinate scheduling of Functional Performance Testing with the commissioning team. Provide plans, reports, notes, and other documentation to the Commissioning Provider Lead Commissioning Specialist as specified in the commissioning plan, as it is completed.

1.5 PIPE FLUSHING, TESTING, AND WATER TREATMENT REPORTS

Test requirements are specified in Division [22 and]23 piping Sections. Prepare a pipe system cleaning, flushing, and hydrostatic testing log. Provide cleaning, flushing, testing, and water treatment log and final reports.

Include the following in the pipe system cleaning, flushing, and hydrostatic testing log:

a. Minimum flushing water velocity.

b. Water treatment reports.

c. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

1.6 CERTIFICATE OF READINESS

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NOTE: This paragraph contains tailoring options for ARMY and NAVY.

NOTE: Include the bracketed option Air Leakage Test Reports and Diagnostic Test Reports for Army projects that include this report in Section 01 91 19 BUILDING ENCLOSURE COMMISSIONING.

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Submit Certificate of Readiness documentation in accordance with Section 01 91 00.15 BUILDING COMMISSIONING for all equipment and systems including start-up reports; completed Pre-Functional Checklists; Testing, Adjusting, and Balancing (TAB) Report; Issues Log; HVAC Controls Start-Up Reports; Performance Verification Test Reports;[and the building envelope Air Leakage Test Reports and Diagnostic Test Reports]. Do not schedule Functional Performance Tests for the system until the Certificate of Readiness for that system receives approval by the Government. The CxC, Quality Control Manager, and the Mechanical, Electrical, Controls, and TAB subcontractor representatives must sign and date the Certificate of Readiness.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

Provide all testing equipment required to perform testing for the systems to be commissioned, except for equipment specific to and used by TAB as required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Provide a sufficient quantity of two-way radios for each subcontractor. Submit list of Test Equipment and instrumentation to be used for testing including equipment/instrument identification number, equipment application or planned use, manufacturer, make, model, and serial number, and calibration history with certificates. Also list special equipment and proprietary tools specific to a piece of equipment required for testing.

2.1.1 Proprietary Equipment

Provide manufacturer's proprietary test equipment and software required by any equipment manufacturer for programming and start-up, whether specified or not. Provide manufacturer test equipment, demonstrate its use, and assist in the commissioning process as needed. Provide data logging equipment and software required to test equipment.

2.1.2 Calibration and Accuracy

Comply with equipment manufacturer's test equipment calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to Contracting Officer upon request.

Provide all testing equipment of sufficient quality and accuracy to test and measure system performance with the tolerances specified. Unless otherwise noted, the following minimum requirements apply: Provide temperature sensors and digital thermometers with a certified calibration within the past year to an accuracy of 0.3 degrees C 0.5 degrees F and a resolution of plus or minus 0.1 degrees C 0.1 degrees F. Provide pressure sensors with an accuracy of plus or minus 2.0 percent of the value range being measured (not full range of meter) and calibrated within the last year.

PART 3 EXECUTION

3.1 MEETINGS

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NOTE: This paragraph contains tailoring options for ARMY and NAVY.

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Attend all meetings in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

Provide timely updates on construction schedule changes to allow the Commissioning Provider Lead Commissioning Specialist to execute commissioning process efficiently. Notify Contracting Officer of anticipated construction delays to commissioning activities not yet performed or not yet scheduled.

3.2 COMMISSIONING CONSTRUCTION OBSERVATION CHECKLISTS

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NOTE: This paragraph contains tailoring options for INTEGRATED SYSTEMS TESTS and ARMY.

****

Commissioning construction observation checklists include Pre-Functional Checklists, Integrated Systems Test Checklists, and Functional Performance Test Checklists. Provide commissioning construction observation checklists for the Interim and Final Construction Phase Commissioning Plan in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

Download example Pre-Functional Checklists, Integrated Systems Test Checklists, and Functional Performance Test Checklists for Section 01 91 00.15 BUILDING COMMISSIONING at the following location: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables. The checklists submitted in the Interim and Final Construction Phase Commissioning Plans must contain the same level of detail shown in the examples. The submitted checklists are not required to match the format of the examples.

3.2.1   Pre-Functional Checklists

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NOTE: This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, NAVY, and GOVT HIRED COMMISSIONING PROVIDER.

****

The Pre-Functional Checklists must include items for physical inspection or testing that demonstrate that installation and start-up of equipment and systems is complete. Refer to paragraph PRE-FUNCTIONAL CHECKS. Pre-functional checklists must be tailored to verify the specific installation requirements and details of the construction documents and manufacturer's instructions.

Use the Pre-Functional Checklists prepared by the CxC for physical inspection or testing to demonstrate that installation and start-up of equipment and systems is complete. Refer to paragraph PRE-FUNCTIONAL CHECKS.

3.2.2   Functional Performance Test Checklists

****

NOTE: This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, NAVY, GOVT HIRED COMMISSIONING PROVIDER, and INTEGRATED SYSTEMS TEST.

This paragraph contains tailoring for ARMY. Choose bracketed "and the Owner's Project Requirements" for projects that require one. Refer to specifier notes regarding the Owner's Project Requirements Document in Section 01 91 00.15 BUILDING COMMISSIONING.

****

Functional Performance Test Checklists must include procedures that explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the contract[and Owner's Project Requirements Document]. Refer to paragraph FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTING. Include the following sections and details appropriate to the systems being tested in the Functional Performance Test Checklists:

a. Notable system features including information about controls to facilitate understanding of system operation and maintenance

b. Conclusions and recommendations. Conclusions must clearly indicate if system does or does not perform in accordance with contract requirements and specifications[and Owner's Project Requirements Document]. Recommendation must clearly indicate that the system should or should not be approved by the Government.

c. Test conditions including date, beginning and ending time, and beginning and ending outdoor air conditions

d. Attendees

e. Identification of the equipment involved in the test

f. **System feature identification**

g. Point-to-point observations including demonstrating system flow meters and sensors have been calibrated and are correctly displayed on the Operator work station

h. Actuator operation observations demonstrating actuator responses to commands from the control system

i. As-found condition of the system operation

j. List of test items with step numbers along with the corresponding feature or control operation, intended test procedure, expected system response, and pass/fail indication.

k. Space for comments for each test item.

Use the Functional Performance Test Checklists prepared by the CxC that list, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the contract. Refer to paragraph FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTING.

3.2.3 Integrated Systems Test Checklists

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This paragraph is tailored for INTEGRATED SYSTEMS TEST and contains tailoring options for KTR HIRED COMMISSIONING PROVIDER and GOVT HIRED COMMISSIONING PROVIDER.

Choose bracketed "and the Owner's Project Requirements" for projects that require one. Refer to specifier notes regarding the Owner's Project Requirements Document in Section 01 91 00.15 BUILDING COMMISSIONING.

****

Integrated Systems Test Checklists must include test procedures that explain, step-by-step, the actions and expected results that will demonstrate that the interactive operations between systems performs in accordance with the contract[and Owner's Project Requirements Document]. Refer to paragraph FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTING. Include the following sections in the Integrated Systems Test Checklists:

a. Notable features of the interconnected systems organized by discipline including information to facilitate understanding of system operation

b. Conclusions and recommendations. Conclusions must clearly indicate if the systems do or do not perform in accordance with contract requirements and specifications[and the Owner's Project Requirements Document]. Recommendation must clearly indicate that the systems should or should not be approved by the Government

c. Test conditions including date and beginning and ending time

d. Identification of the equipment and systems involved in the test

e. List of test items with step numbers along with the corresponding feature or control operation, intended test procedure, expected system response, and pass/fail indication.

f. Space for comments for each test item.

Use the Integrated Systems Test Checklists prepared by the CxC that list, step-by-step, the actions and expected results that will demonstrate that the interactive operations between systems performs in accordance with the contract. Refer to paragraph FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTING.

3.3 PRE-FUNCTIONAL CHECKS

****

This paragraph contains tailoring for ARMY and NAVY. Choose bracketed "and the Owner's Project Requirements" for projects that require one. Refer to specifier notes regarding the Owner's Project Requirements Document in Section 01 91 00.15 BUILDING COMMISSIONING.

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Pre-Functional Checks are a type of Commissioning Inspection in accordance with Section 01 91 00.15 BUILDING COMMISSIONING. Complete one Pre-Functional Checklist for each individual item of equipment or system for each system required to be commissioned including, but not limited to, ductwork, piping, equipment, fixtures, and controls. Include manufacturer start-up checklists associated with equipment with the submission of the Pre-Functional Checklists. Provide manufacturer's installation manual for each type of unit. Indicate commissioning team member inspection and validation of each Pre-Functional Checklist item by initials. Validation of each Pre-Functional Checklist item by each team member indicates that item conforms to the contract documents and validated design in their area of responsibility. Validation of each item by each team member must occur immediately following completion of their respective duties related to the item. Commissioning Specialist validation of each Pre-Functional Checklist item indicates that each item has been installed correctly and in accordance with contract documents[and the Owner's Project Requirements Document]. Required commissioning team members for Pre-Functional Checks includes the CxC, Mechanical Commissioning Specialist, Quality Control Manager, sub-contractor representative for each trade responsible for construction/installation of the checklist item, and the TAB representative (for items impacting TAB). Submit the initialed and Completed Pre-Functional Checklists no later than 7 calendar days after completion of inspection of all checklists items for each system.

3.4 STARTUP AND INITIAL CHECKOUT

Document start-up and initial testing procedures, and include in the Completed Pre-Functional Checklists submittal, including:

a. Startup tests and factory testing reports.

b. Manufacturer's representative start-up, operating, troubleshooting and maintenance procedures.

[c. Additional documentation necessary for third party certification programs.

] d. Perform and clearly document system operational checks and quality control checks as they are completed, and providing a copy to the commissioning team.

e. Correct deficiencies and sign the Certificate of Readiness for each system before functional performance testing

3.5 DUCT AIR LEAKAGE TEST (DALT) REPORT REVIEW AND VERIFICATION

[3.5.1 Duct Air Leakage Test (DALT) Report Review

****

NOTE: Coordinate with project team to determine if CxC review of DALT report is necessary. For Navy projects, in-house personnel are responsible for technical oversight and final acceptance of DALT work. CxC may be leveraged to support DALT report review as necessary. This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, NAVY, and GOVT HIRED COMMISSIONING PROVIDER.

****

The Mechanical System Technical Commissioning Specialist must review the pre-final DALT Report required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. The Commissioning Specialist is responsible for reviewing the pre-final DALT Report required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel. All deficiencies must be resolved prior to DALT Report approval.

][3.5.2 Duct Air Leakage Test (DALT) Report Verification

****

NOTE: Coordinate with project team to determine if CxC witnessing DALT verification is necessary. For Navy projects, in-house personnel are responsible for technical oversight and final acceptance of DALT work. CxC may be leveraged to support DALT verification as necessary. This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, NAVY, and GOVT HIRED COMMISSIONING PROVIDER.

****

The Mechanical System Technical Commissioning Specialist must witness the DALT Field Acceptance Testing specified by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. The Commissioning Specialist is responsible for witnessing the DALT Field Acceptance Testing specified by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel. All deficiencies must be resolved prior to DALT Report approval.

][3.6 TESTING, ADJUSTING, AND BALANCING REPORT REVIEW AND VERIFICATION

[3.6.1 Testing, Adjusting, and Balancing (TAB) Report Review

****

NOTE: Coordinate with project team to determine if CxC review of TAB report is necessary. For Navy projects, in-house personnel are responsible for technical oversight and final acceptance of TAB work. CxC may be leveraged to support TAB report review as necessary. This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, NAVY, and GOVT HIRED COMMISSIONING PROVIDER.

****

The Mechanical System Technical Commissioning Specialist must review the pre-final TAB Report required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. The Commissioning Specialist is responsible for reviewing the pre-final TAB Report required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel. All deficiencies must be resolved prior to TAB Report approval.

][3.6.2 Testing, Adjusting, and Balancing (TAB) Report Verification

****

NOTE: Coordinate with project team to determine if CxC witnessing TAB verification is necessary. For Navy projects, in-house personnel are responsible for technical oversight and final acceptance of TAB work. CxC may be leveraged to support TAB verification as necessary. This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, NAVY, and GOVT HIRED COMMISSIONING PROVIDER.

****

The Mechanical System Technical Commissioning Specialist must witness the TAB Field Acceptance Testing specified by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. The Commissioning Specialist is responsible for witnessing the TAB Field Acceptance Testing specified by

Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel. All deficiencies must be resolved prior to TAB Report approval.

]][3.7 HVAC CONTROLS START-UP AND PERFORMANCE VERIFICATION TEST REVIEW

****

NOTE: Coordinate with project team to determine if CxC controls submittal review is necessary. For Navy projects, in-house personnel are responsible for technical oversight and final acceptance of HVAC controls work. CxC may be leveraged to support controls submittal review as necessary. This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, NAVY, and GOVT HIRED COMMISSIONING PROVIDER.

****

The Mechanical System Technical Commissioning Specialist must review the Start-Up Testing Report, PVT Procedures and PVT Reports, including endurance testing trend submittals, required by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC[and Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION]. The Mechanical System Technical Commissioning Specialist must review each submittal and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. The Commissioning Specialist is responsible for reviewing the Start-Up Testing Report, PVT Procedures and PVT Reports including endurance testing trend data required by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC[and Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION] and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel. All deficiencies must be resolved prior to final acceptance.

]3.8 FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTING

****

This paragraph contains tailoring for ARMY and INTEGRATED SYSTEMS TEST. Choose bracketed "and the Owner's Project Requirements" for projects that require one. Refer to specifier notes regarding the Owner's Project Requirements Document in Section 01 91 00.15 BUILDING COMMISSIONING.

****

Functional Performance and Integrated Systems Testing are a type of Commissioning Testing in accordance with Section 01 91 00.15 BUILDING COMMISSIONING. Conduct Functional Performance Testing in accordance with Section 01 91 00.15 BUILDING COMMISSIONING and requirements in this Section. Prior to Functional Performance Testing, complete all prerequisites in accordance with paragraph SEQUENCING AND SCHEDULING. Demonstrate that all system components have been installed, that each control device and item of equipment operates, and that the systems operate and perform, including interactive operation between systems, in accordance with contract documents[and the Owner's Project Requirements Document].

Perform Integrated Systems Tests only after the Functional Performance

Tests for each associated system are completed with all deficiencies resolved and after the related Functional Performance Test Checklists have been signed by each commissioning team member.

3.8.1 Test Scheduling and Coordination

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NOTE: The following paragraph contains tailoring for NAVY and INTEGRATED SYSTEMS TEST.
****

Schedule and conduct Initial Functional Performance Tests as soon as all contract work is completed, regardless of the season. Develop and implement means of artificial loading to demonstrate, to a reasonable level of confidence, the ability of the HVAC systems to handle peak seasonal loads. Schedule Functional Performance Tests for each system only after the Certificate of Readiness has been approved by the Government for the system. Correct all deficiencies identified through any prior review, inspection, or test activity before the start of Functional Performance Tests.

Functional Performance Tests and Integrated Systems Tests must be performed with the CxC present. Government reserves the right to witness all tests. Coordinate test schedule with Government representatives.

3.8.2 Preparation

Put equipment and systems into operation and continue operation during each working day of functional performance and integrated systems testing, as required. Verify temperature and pressure taps in accordance with Contract Documents. Provide a pressure/temperature plug at each water sensor which is an input point to control system.

Perform minor adjustments to equipment and systems during Functional Performance Tests as deemed necessary by the commissioning team. Where calibrated DDC sensors cannot be used to record test data, provide measuring instruments, logging devices, and data acquisition equipment to record data for the complete range of test data for the required test period.

3.8.3 Testing Procedures

Provide all necessary materials and system modifications to produce the necessary flows, pressures, temperatures, and other conditions necessary to execute the test according to the specified conditions. At completion of the test, return the affected building equipment and systems to their pre-test condition.

Follow the Functional Performance Test from the approved Final Construction Phase Commissioning Plan. Perform Functional Performance Tests for each item of equipment and each system required to be commissioned. Verify all sensor calibrations, control responses, safeties, interlocks, operating modes, sequences of operation, capacities, and all other performance requirements comply with contract, regardless of the specific items listed within the checklists provided. In general, testing must progress from equipment or components to subsystems to systems to interlocks and connections between systems. Commissioning Specialists are responsible for determining the order of components and systems to be tested.

Indicate validation of each item of equipment and systems tested by signature of each commissioning team member for each test. The Quality Control Representative, Commissioning Specialists, and Contracting Officer's Representative, if present, must indicate validation after the equipment and systems are free of deficiencies.

3.8.4 Simulating Conditions

Functional performance testing is conducted by simulating conditions at control devices to initiate a control system response. Before testing, calibrate all sensors, transducers and devices. Over-writing control input values through the control system is not acceptable unless approved by the Contracting Officer. Perform each test under conditions that simulate actual conditions as close as is practically possible. Specific examples of simulating conditions are provided below. Do not simulate conditions when damage to the system or building may result.

a. When varying static pressures inside ductwork cannot be simulated within the duct, and where a sensor signals the controls system to initiate sequences at various duct static pressures, it is acceptable to simulate the various pressures with a Pneumatic Squeeze-Bulb Type Signaling Device with gauge temporarily attached to the sensing tube leading to the transmitter. It is not acceptable to reset the various set-points, nor to simulate an electric analog signal (unless approved as noted above).

b. Dirty filter pressure drops can be simulated by partially blocking filter face.

c. Freeze-stat safeties can be simulated by packing portion of sensor with ice.

d. High outside air temperatures can be simulated with a hair blower.

e. Raising entering cooling coil temperatures by activating a heating/preheat coil can be used to simulate entering cooling coil conditions.

f. Do not use signal generators to simulate sensor signals unless approved by the Contracting Officer, as noted above, for special cases.

g. Control set points can be altered. For example, to see the air conditioning compressor lockout work at an outside air temperature below 12 degrees C 55 degrees F, when the outside air temperature is above12 degrees C 55 degrees F, temporarily change the lockout set point to be minus 17 degrees C 0 degrees F above the current outside air temperature. Caution: Set points are not to be raised or lowered to a point to cause damage to the components, systems, or the building structure and contents.

h. Test duct mounted smoke detectors in accordance with the manufacturer's recommendations. Perform the tests with air system at minimum airflow condition.

i. Test current sensing relays used for fan and pump status signals to control system to indicate unit failure and run status by resetting the set point on the relay to simulate a lost belt or unit failure while the unit is running. Confirm that the failure alarm was generated and received at the control system. After the test is conducted, return the set point to its original set-point or a set-point as indicated by the Contracting Officer.

3.8.5 Manufacturer's Representative

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NOTE: A factory trained representative is recommended for major equipment. Add equipment as required by scope of work and as determined necessary by the project delivery team.

Choose the bracketed paragraph below for systems with package controls.

****

Provide a factory trained representative authorized by the equipment manufacturer to perform Functional Performance Testing for the following equipment:

[Chillers

][Cooling towers and evaporatively cooled condensers

][Boilers

][Packaged Direct-Expansion Refrigeration Equipment, including variable refrigerant flow (VRF) systems

][Packaged Computer Room [Air Handlers (CRAH)] [Air Conditioners (CRAC)]

][Booster Pumps

][Packaged Air Compressors

][Water Quality and Chemical Treatment Systems

][Solar Water Heating Systems

] Ensure the test representative reviews, approves, and signs the completed field test report. Include person's name with signatures.

3.8.6 Integrated Systems Tests

****

NOTE: This paragraph is tailored for INTEGRATED SYSTEMS TEST.

****

Follow the Integrated Systems Test Checklists from the approved Final Construction Phase Commissioning Plan. Integrated Systems Tests must be performed for the interactive operation between HVAC systems and other systems such as fire protection systems, smoke control systems, or back-up electrical supply. Verify correct interactive operation, acceptable speed of response, and other contract requirements for both normal and failure modes. Examples of Integrated Systems Tests include the correct operation of HVAC systems during emergency system activation or correct operation of uninterruptible power supplies or energy generators and connected systems.

3.8.7 Sample Strategy

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NOTE: This paragraph contains tailoring options for DESIGN-BID-BUILD, DESIGN-BUILD, ARMY, and NAVY. For Design-Bid-Build, select the percentage sample size for large groups of identical equipment as determined by the project delivery team. Higher percentages may be appropriate for critical systems or projects or for small numbers of equipment.

****

Perform Functional Performance Tests using the following sample strategy. Perform Functional Performance Tests using the sample strategy identified herein. Test all central plant equipment, primary air handling units, and process cooling or heating equipment. Test all system-level equipment serving multiple zones. [Twenty-five] [Fifty] [_____] percent sample testing is allowed for large groups of identical equipment with identical controllers serving single zones such as air terminal units, fan coil units, unitary equipment, and plumbing fixtures. Sample size may be no less than three units. Refer to Section 01 91 00.15 BUILDING COMMISSIONING for sample strategy. Complete a Functional Performance Test Checklist for each item of equipment or system to be tested. During testing, Government representatives may select the specific equipment or system to be tested for sample sizes less than 100 percent. Equipment Identifiers are as indicated on the design drawings:

Equipment Identifier	Sample Size (Percent)
AHU	[_____]
VAV	[_____]
CUH	[_____]
CWP	[_____]
DWH	[_____]

Perform Integrated Systems Tests and complete an Integrated Systems Test Checklist for for all (100 percent) systems and equipment having interactive operation.

3.8.7.1 100 Percent Sample Procedures

Systems or equipment for which 100 percent sample size are tested fail if one or more of the test procedures results in discovery of a deficiency and the deficiency cannot be resolved within 5 minutes during the test.

Re-test to the extent necessary to confirm that the deficiencies have been corrected without negatively impacting the performance of the rest of the system.

3.8.7.2 Less than 100 Percent Sample Procedures

Randomly test each sample group of identical equipment. If 10 percent of the units in the first sample fail the functional performance tests, test a second sample group, the same size as the first sample group. The second sample must not include any units from the first sample group.

If 10 percent of the units in the second sample fail, test all remaining units. If at any point frequent failures occur the CxC may stop the testing and require the contractor to perform and document a checkout of the remaining units prior to continuing functional testing.

3.9 INTEGRATED SYSTEMS TEST

****

NOTE: The following paragraph is tailored for INTEGRATED SYSTEMS TEST.

****

Perform Integrated Systems Tests only after the Functional Performance Tests for each associated system are completed with all deficiencies resolved and after the related Functional Performance Test Checklists have been signed by each commissioning team member.

3.10 RETESTING REQUIREMENTS

Abort tests if any deficiency prevents successful completion of the test or if any required commissioning team member is not present for the test. Re-test only after all deficiencies identified during the original tests have been corrected.

Contracting Officer may withhold payment equivalent to lost time, re-testing, and aborted tests. These costs may include salary, travel costs, and per diem for Government team members. Correct deficiencies as identified by the commissioning team and retest the systems to be commissioned.

3.11 SYSTEM ACCEPTANCE

****

NOTE: Partial acceptance is acceptance of those parts of the system that could be tested and verified to function in conformance with the construction contract during initial Functional Performance Tests.

****

Systems may be partially accepted prior to seasonal testing if they comply with all construction contract and accepted design requirements that can be tested during initial Functional Performance Tests. All test procedures must be successful completed prior to full systems acceptance.

[3.12 SEASONAL TESTS

****

NOTE: Performing seasonal testing under maximum heating or cooling conditions is recommended for mission critical or humidity controlled facilities such as hospitals, laboratories, armories, mission operations, or other essential (RCIV) and strategic asset (RCV) facilities.

****

Perform Initial Functional Performance Tests as soon as all contract work is completed, but prior to facility turnover, regardless of the season.

In addition to the Initial Functional Performance Tests, perform Functional Performance Tests of HVAC systems during peak heating and cooling seasons during outdoor air condition design extremes. Schedule Seasonal Functional Performance Tests in coordination with the Contracting Officer. Submit Seasonal Test Report within 14 days of test completion. Include seasonal test report in the Updated Final Commissioning Report as specified in Section 01 91 00.15 BUILDING COMMISSIONING

Execute seasonal functional performance testing, witnessed by the Contracting Officer. Correct deficiencies and make adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

][3.13 FULL-LOAD TESTS

****

NOTE: Performing full-load testing for equipment serving process loads is recommended for facilities where tight environmental control is required such as simulators, electronic equipment facilities, and industrial process facilities.

When full-load testing cannot be performed under actual loading, retain the bracketed sentence to require artificial loading.

****

Perform Initial Functional Performance Tests as soon as all contract work is completed, but prior to facility turnover. In addition to the Initial Functional Performance Tests, perform Functional Performance Tests of HVAC systems under full-load conditions.[Develop and implement means of artificial loading to demonstrate the ability of the process cooling systems to handle peak process loads.] Schedule Full-Load Functional Performance Tests in coordination with the Contracting Officer. Submit Full-Load Test Report within 14 days of test completion.

Execute full-load functional performance testing, witnessed by the Contracting Officer. Correct deficiencies and make adjustments to O&M manuals and as-built drawings for applicable issues identified in any full load testing.

]3.14 TRAINING

****

NOTE: This paragraph contains tailoring options for KTR HIRED COMMISSIONING PROVIDER, NAVY, and GOVT HIRED COMMISSIONING PROVIDER.

****

The Mechanical Systems Technical Commissioning Specialist must review the training plan required by Section 01 78 00 OPERATION AND MAINTENANCE DATA and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.

The Commissioning Provider is responsible for overseeing and approving the training plan required by Section 01 78 00 OPERATION AND MAINTENANCE DATA and identifying any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.

Coordinate, schedule, and document all required training. At a minimum, include the following items in the training report for commissioned systems:

a. Complete commissioning documentation

b. Complete O&M data

c. Complete Training

d. Purpose of equipment.

e. Principle of how the equipment works.

f. Important parts and assemblies.

g. How the equipment achieves its purpose and necessary operating conditions.

h. Most likely failure modes, causes and corrections.

i. On site demonstration.

j. Provide updates to O&M manuals based on field modifications.

k. Provide training of the post-occupancy operations and maintenance staff.

3.15 COMMISSIONING REPORT

****

NOTE: This paragraph contains tailoring for INTEGRATED SYSTEMS TEST.

****

Include all completed Pre-Functional Checklists and Functional Performance and Integrated Systems Test Checklists in the Commissioning Report as specified in Section 01 91 00.15 BUILDING COMMISSIONING. Include the approved TAB Report.

[3.16 POST-CONSTRUCTION ENDURANCE TEST

****

NOTE: Post-Construction Endurance Tests evaluate HVAC system performance under actual operating load during normal operation. This activity is highly recommended. The Endurance Tests provide improved probability of identifying deficiencies prior to warranty expiration. If the building operators plan to monitor system performance closely or this activity is not funded, delete this paragraph.

NOTE: This paragraph contains tailoring options for ARMY, NAVY, and KTR HIRED COMMISSIONING PROVIDER.

Choose bracketed "and the Owner's Project Requirements" for projects that require one. Refer to specifier notes regarding the Owner's Project Requirements Document in Section 01 91 00.15 BUILDING COMMISSIONING.

****

Perform an Endurance Test in accordance with the paragraph ENDURANCE TEST ENDURANCE TESTING in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC once during the peak heating season and once during the peak cooling season during outdoor air condition extremes with the exception that network bandwidth usage measurement and recording is not required.[Use the Temporary Trending Hardware, if necessary, in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.]

The Mechanical System Commissioning Specialists must review the trend logs from the Endurance Tests to ensure that the systems have stable operation and operate as required by the construction contract, the accepted design[, and the Owner's Project Requirements Document]. The Commissioning Specialists must provide a Post-Construction Trend Log Report that identifies any deficiencies noted in operation, recommendations for correction, and includes a graphical representation of the trends. Provide one Trend Log Report for the peak cooling season and one Trend Log Report for the peak heating season. Submit the Post-Construction Trend Log Reports no later than 14 calendar days following receipt of the trend log data by the Commissioning Specialist. Provide a Post-Construction Trend Log Report meeting the same requirements as the Endurance Testing Results Format in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Provide one Trend Log Report for the peak cooling season and one Trend Log Report for the peak heating season. Submit the Post-Construction Trend Log Reports no later than 14 calendar days following download of the trended data. Include the Post-Construction Trend Log Reports in the Updated Final Commissioning Report as specified in Section 01 91 00.15 BUILDING COMMISSIONING

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 08 01.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15951N (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 08 01.00 20

TESTING INDUSTRIAL VENTILATION SYSTEMS

04/06

PART 1 GENERAL

PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 08 01.00 20 (April 2006)**

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****

SECTION 23 08 01.00 20

TESTING INDUSTRIAL VENTILATION SYSTEMS

04/06

****

NOTE: This guide specification covers the requirements for air flow testing of industrial ventilation systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: An industrial ventilation system is the mechanical equipment that provides the simultaneous exhaust and replacement of air to control contaminants generated from industrial operations. Test the following industrial ventilation system applications according to this specification:

1. Systems installed to control employee exposure to:

a. Hazardous airborne materials with a Permissible Exposure Limit (PEL) or Threshold Limit Value (TLV) of 0.1 milligram per cubic meter or the equivalent value in parts per million.

b. Isocyanate paints.

c. Lead.

d. Beryllium.

e. Otto Fuel II.

2. Permanently installed asbestos delagging facilities.

3. Metal cleaning or electroplating shops.

4. Foundries.

5. Fiberglass layup and sprayup operations.

6. Abrasive blasting operations.

7. Carpentry shops.

8. Advanced composite operations (e.g., graphite).

9. Indoor Firing Ranges.

Include this specification with the construction project and require the Contractor to hire an independent subcontractor. This specification encourages the use of the Commissioning Process. Modify this specification for an acceptance or performance test contract for any industrial ventilation system.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 201	(2002; R 2011) Fans and Systems

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH-2092S	(2004) Industrial Ventilation: A Manual of Recommended Practice

1.2 DEFINITIONS

a. Capture velocity: Air velocity at any point in front of the hood or at the hood opening necessary to overcome opposing air currents and to capture contaminated air at that point to cause it to flow into the hood.

b. Capture zone: Controlled space around an industrial process that provides a safe and healthy workspace.

c. Equilibrium performance point: The operating condition after sufficient start-up time that an air pollution control device reaches optimum efficiency. The manufacturer recommends the minimum start-up time for each device.

d. Facility: A building or portion of a building in which contaminated air is controlled by the industrial ventilation system. This includes the shop space, equipment room, offices, restrooms and locker rooms affected by the industrial process.

e. Full load condition: Condition in the facility where exhaust and replacement air systems operate simultaneously, as installed by the Contractor according to the design plans and specifications.

f. Heating and cooling equipment: Equipment used to temper air in the facility. Equipment includes, but is not limited to: condensers, chillers, pumps, heat exchangers, heating and cooling coils, heat pumps, cooling towers, and duct heaters.

g. Hood static pressure: Static pressure, in Pascals (Pa) inches of water gage (wg), taken at 3 duct diameters from a flanged or plain hood or 1 duct diameter from a tapered hood.

h. Manometer: An instrument for measuring pressure. Electronic or U-tube manometers with water or light oil are acceptable.

i. Replacement air system: The mechanical system supplying air to a facility to replace exhausted air.

j. Standard Temperature and Pressure: Air at standard conditions of 21.1 degrees Celsius and 101.3 kilopascals 70 degrees Fahrenheit and 1 atmosphere.

k. Static Pressure: The potential pressure exerted in all directions by a fluid at rest. For a fluid in motion, it is measured in a direction normal to the direction of flow. Usually expressed in Pa inches of wg.

l. System Effect: The estimated loss in fan performance from non-uniform air flow at the fan's inlet or outlet.

m. Test agency: A first tier subcontractor who is independent from the Contractor and the mechanical Sub-contractor except by the affiliation established by this contract.

n. Transport velocity: Minimum air velocity, in meter per second (m/s) feet per minute (fpm), required to prevent contaminants from settling, condensing, or pocketing in the ductwork.

o. Velocity pressure: The kinetic pressure in the direction of flow necessary to cause a fluid at rest to flow at a given velocity. Usually expressed in Pa inches of wg.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Preliminary review report; G, [_____]

Smoke tests report; G, [_____]

Fan operating points report; G, [_____]

Static pressure report; G, [_____]

Volume and velocity flow rates report; G, [_____]

Pitot traverse report; G, [_____]

Submit [6] [_____] copies of an organized report bound in a durable, 3-ring water-resistant binder. The report must contain a table of contents, an executive summary, an introduction, a results section and a discussion of the results. Include the reports specified in paragraphs entitled "Preliminary Review Report," "Smoke Test Reports,""Fan Operating Points Reports," "Static Pressure Report," "Volume and Velocity Flow Rates Report," and"Pitot Traverse Report" as appendices.

Submit field data and report forms in appendices separated by the fan system tested. Use the sample forms, "Replacement Air System Test Data" and "Exhaust Air System Test Data," to summarize the tests for the appropriate fan. Forms other than those listed may be used; however, include all information required by these forms.

Document deficiencies and unmet design requirements identified during testing. Notify the [Prime Contractor] [Contracting Officer] in writing, no later than [5] [_____] calendar days after encountering deficiency, describe the nature of the deficiency and a recommended course of action for resolution. Report daily temperature, humidity and barometric pressure readings. Note extreme weather and barometric pressure changes during the day.

SD-07 Certificates

Test agency Qualifications; G, [_____]

Record of Document Submittal to Testing Agency; G, [_____]

Work plan; G, [_____]

List of test instruments; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Modification of References

Test the industrial ventilation system according to the referenced publications listed in paragraph entitled "References" and as modified by this section. Consider the advisory or recommended provisions, of the referred references, as mandatory.

1.4.2 Certification

1.4.2.1 Test Agency Qualifications

Submit, no later than [15] [_____] calendar days after contract award, information certifying that the test agency is not affiliated with any other company participating in work on this contract. The work of the test agency must be limited to testing and making minor adjustments to the industrial ventilation system.

Use the sample form, "Test Agency Qualifications Sheet," to submit the following information:

a. Verification of [5] [10] years of experience as an agency in testing industrial ventilation systems or current member of either AABC or NEBB.

****

NOTE: There are two major certifying organizations for agencies testing, adjusting and balancing heating, cooling and ventilating equipment. The main difference between the two organizations, NEBB and AABC, is their affiliation. AABC certified agencies must be independent of any Contractor or equipment manufacturer. Many NEBB certified agencies are affiliated with a mechanical or sheet metal contractor, but many are independent. Other differences are listed below:

	AABC	**NEBB**
1. Minimum number of years:		
a. Agency in business	**3**	**1**
b. Individual: experience	**10**	**8-10**
c. Individual: test experience	**5**	
2. Licensed P.E. as Manager	**no**	**no**
3. Agency possesses own instruments	**yes**	**yes**
4. Job references required	**10**	**5**
5. Written exam required	**yes**	**yes**
6. Continuing education requirements	**2/cycle**	**annual**
7. Recertification cycle in years	**1**	**2**

****

b. References from five [Contracting Officers] [facility managers] of facilities with industrial ventilation systems that the agency has tested. A minimum of one facility must have processes and contaminants similar to those generated by the facility in this project.

c. Registration for Professional Engineer (PE) license or Certification for an Industrial Hygienist (CIH) or Test and Balance (TAB) Engineer for the lead test engineer. Submit PE license, CIH registration number, or TAB certification number. Include the discipline, date of issue, and expiration date. Engineers must include the state of issue.

d. Confirmation of 5 years of industrial ventilation test experience for the lead test engineer. References from five [Contracting Officers] [facility managers] for facilities where the lead engineer has supervised industrial ventilation systems tests in the last 5 years.

e. Verification of length of time lead engineer has been employed by a test and balance agency.

1.4.2.2 Record of Document Submittal to Testing Agency

Submit not later than [30] [_____] calendar days prior to the work plan submittal due date, a record of transmittal of the following documents to the approved independent testing agency. Information is required to develop a testing work plan and prepare for field testing.

a. Copy of working as-built project drawings and specifications, including marked design changes. Changes current as of the date of transmission.

b. Copies of all project submittals relating to the industrial ventilation system. Transmit copies of final record submittals including approval sheets.

1.4.2.3 Work Plan

Submit not later than [120] [_____] calendar days after contract award, but before start of work, steps to be taken by the lead engineer to accomplish the required testing. Submit the following:

a. Memorandum of test procedure.

    (1) Proposed dates for the preliminary review and test.

    (2) Plan view showing proposed test locations (i.e. static pressure locations).

    (3) Proposed pitot traverse reading locations.

b. Test equipment to be used.

c. Scaffolding and other Contractor's support equipment required to perform test.

d. Factory representatives and other Contractor's support personnel who will be on site for testing.

1.4.2.4 List of Test Instruments

Submit a signed and dated list of test instruments, their application, manufacturer, model, serial number, range of operation, accuracy and date of calibration.

1.4.3 Test Requirements

****

NOTE: This guide specification is not intended to give guidance on testing air pollution control devices. Refer to guide specifications specific to the air pollution device.

****

****

NOTE: This guide specification does not address testing the heating and cooling equipment in the industrial ventilation system. Refer to Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC, to test heating and cooling equipment. Coordinate the testing requirements with the following guide specifications, when used:

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS

Section 23 30 00 HVAC AIR DISTRIBUTION

Section 23 35 19.00 20 INDUSTRIAL VENTILATION AND EXHAUST

****

****

Note: This guide specification does not address noise and vibration testing. See Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS, NEBB publication, "Procedural Standards for the Calibration and Measurement of Sound and Vibration," and American Society of Heating Refrigerating and Air-Conditioning Engineers publication, "Handbook HVAC Systems and Applications," for noise and vibration testing details.

****

The Contractor must adjust and balance the industrial ventilation system according to Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. An independent test agency must test the industrial ventilation system according to ACGIH-2092S and this section under full load conditions. For tempered supply air repeat the industrial ventilation systems test for the following conditions: [plus or minus 20 percent minimum outdoor temperature design condition,] [plus or minus 10 percent maximum outdoor temperature design condition,] [[_____] percent loads on a variable air volume system,] [and] [_____].

1.4.4 Test Engineer

1.4.4.1 Field Work

The lead test engineer must be present at the project site while testing is performed and must be responsible for conducting, supervising, and managing of test work. Management includes health and safety of test agency employees.

1.4.4.2 Reporting Work

The lead test engineer must prepare, sign, and date the test agenda, equipment list, and certified report.

1.4.5 Test Report

1.4.5.1 Preliminary Review Report

Submit a preliminary review report, see paragraph entitled "Preliminary Review" [15] [_____] calendar days prior to beginning the test.

1.4.5.2 Smoke Tests Report

Describe turbulent air flow and dead air spaces in and around the hood capture zone. Describe air flow exiting from the replacement air distribution device and the effect of room air currents on smoke capture. Report leaks in the ductwork, access door, and duct connectors to fan. Report smoke behavior as it exits from the exhaust stack and describe entrainment around the tested facility, nearby structures and any geographical features.

1.4.5.3 Fan Operating Points Report

Determine the difference between measured and design volume flow rate. Compare measured fan static pressure to manufacturer's performance data. Show the design and measured operating point for each fan on the corresponding fan curve. Report fans that cannot operate at speeds 25 percent faster than the measured speed while remaining within the boundaries of the fan curve and fan class. Identify fan motors that are operating at or near full load amperage.

1.4.5.4 Static Pressure Report

Include the following:

a. Hood static pressures. Use tables to summarize test results by system.

b. Fan static pressure, as defined by ACGIH-2092S, for replacement and exhaust air systems.

c. Room static pressure, as compared to [atmosphere] [adjacent rooms], for each room in the facility.

d. Static pressures that are inconsistent and the probable reason. For example:

   (1) Inconsistent static pressure drop or increase in one or a series of hoods on the same branch;

   (2) Different static pressures for similar systems in the facility; and

   (3) Decreasing static pressures as the hoods get closer to the exhaust fan inlet.

e. [e. Differential pressure across air pollution control devices.]

1.4.5.5 Volume and Velocity Flow Rates Report

Report volume flow rates and velocities in standard cubic meters per second (cms) and meter per second (m/s) cubic feet per minute (cfm) and feet per minute (fpm), respectively, on the "Exhaust Air System Test Data" sample form or comparable form.

[Convert measured volume flow rates to standard volume flow rates for locations with operating conditions other than standard temperature and pressure. The conversion may be ignored if the volume flow rate changes less than plus or minus one percent. Show both the actual and standard value for test points. Show a sample conversion equation.]

Compare [measured] [converted] volume flow rates with the design value for each hood, the total exhaust air system, each replacement air distribution point and the total replacement air system. List the [measured] [converted] and design values in tabular form. Report the transport velocity for each branch [submain] and main duct in the exhaust air system.

Indicate if the test value is adequate or inadequate. Adequate hood volume flow rates and duct velocities are those with [measured] [converted] values within plus or minus 10 percent of design values. Adequate total system volume flow rates are those with [measured] [converted] values within plus or minus 10 percent of the design values.

1.4.5.6 Pitot Traverse Report

Use the "Pitot Traverse Data" sample form or comparable form to record pitot traverse readings. Submit the following data, as a minimum, for each test location:

a. Velocity pressure and their corresponding velocities;

b. Average velocity;

c. Duct dimensions and area;

d. Total measured volume flow rate; and

e. Static pressure reading.

1.4.5.7 Deadline

****

NOTE: Estimate the amount of time necessary for the Contractor to make corrections and for the test engineer to retest the system in the event that the system fails to pass the initial test.

****

Provide a simplified pass/fail report within [3] [_____] days after completion of testing. Provide a complete test report [15] [30] [_____] days after completion of testing. [The only exception is for the last seasonal work session which must be completed by [_____].]

1.5   SAMPLE FORMS

1.5.1   Test Agency Qualification Sheet

TEST AGENCY QUALIFICATION SHEET	
DATE:	COMPLETED BY:
A. Agency Qualifications	
Agency Name:	
Address:	
Telephone Number:	
Years of experience testing industrial ventilation systems:	
Industrial facilities tested (5 required). Include the following:	
Facility Name, Address, Point of contact with telephone number;	
Dates of test;	
Type of operation tested;	
List of Contaminants;	
Number of fans;	
Type of exhaust hoods;	
Air cleaning devices; and	
Personnel performing the test.	
Attach letters of recommendation for tests performed at these facilities. Three facilities must be of the type of operation to be tested.	
B. Lead Test Engineer Qualifications	
Name:	

TEST AGENCY QUALIFICATION SHEET
Length of time lead engineer has worked with Agency:
Years of experience testing industrial ventilation systems:
Professional Engineering Information:
discipline:
license number:
issue date:
recertification date:
state of registration:
Industrial facilities tested (5 required). Include the following:
Facility Name, Address, Point of contact with telephone number;
Dates of Test;
Type of Operation;
List of Contaminants;
Number of Fans;
Type of Exhaust Hoods; and
Air Cleaning Devices.

1.5.2 Pitot Traverse Data - Rectangular Duct

PITOT TRAVERSE DATA - Rectangular Duct		
Test Date:		
Readings By:		Traverse By:
Static Pressure:		
Room:		Air Temperature:
Traverse Location:		Inside/Outside Duct Width:
Distance to Resistance Component:	Causing Component Distance:	Inside/Outside Duct Height:
		Inside Duct Area:
before:	before:	Required Velocity:
after:	after:	Required Actual Volume Flow Rate:
Velocity Pressure Reported as [_____] Units		

Pitot Traverse Matrix											
Velocity | Pressure Readings (minimum center distance is 150 mm Velocity | Pressure Readings (minimum center distance is 6 inches											
Point Position	1	2	3	4	5	6	7	8	9	10	Confirm
A	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
B	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
C	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
D	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
E	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
F	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
G	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
H	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
I	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
J	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	

Pitot Traverse Matrix

Pressure Readings Converted to Velocity (m/s) (FPM)

Velocity Point Position	1	2	3	4	5	6	7	8	9	10	
A	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
B	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
C	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
D	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
E	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
F	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
G	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
H	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
I	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
J	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	
Subtotal:											

Total Velocity/# Readings = Avg. Velocity x Duct Area = Actual Volume Flow Rate:

______m/s / ________ = ________ m/s x _______ SQ. METER = _________ CMS
______FPM / ________ = ________ FPM x _______ SQ. FEET = _________ ACFM
* ACFM - actual cubic feet per minute

REMARKS

1.5.3 Pitot Traverse Data - Round Duct

PITOT TRAVERSE DATA - Round Duct		
Test Date:		
Readings By:		Traverse By:
Static Pressure:		
Room Number:		Air Temperature:
System/Unit:		Barometric Pressure:
Traverse Location:		Inside/Outside Duct DIA:
Distance to Resistance Component:	Causing Component Distance:	Inside Duct Area:
before:	before:	Required Velocity:
after:	after:	Required Actual Volume Flow Rate:
Velocity Pressure Reported as [_____] Units		

Pitot Traverse Matrix					
Duct Diameter	0-150 mm	150-1219 mm		>1219 mm or unstable velocity	
Readings	12 (6/traverse)	20 (10/traverse)		40 (20/traverse)	
TEST POINT	Velocity Pressure	Velocity	TEST POINT	Velocity Pressure	Velocity
1	[_____]	[_____]	21	[_____]	[_____]
2	[_____]	[_____]	22	[_____]	[_____]
2	[_____]	[_____]	22	[_____]	[_____]
3	[_____]	[_____]	23	[_____]	[_____]
4	[_____]	[_____]	24	[_____]	[_____]
5	[_____]	[_____]	25	[_____]	[_____]
6	[_____]	[_____]	26	[_____]	[_____]
7	[_____]	[_____]	27	[_____]	[_____]
8	[_____]	[_____]	28	[_____]	[_____]
9	[_____]	[_____]	29	[_____]	[_____]
10	[_____]	[_____]	30	[_____]	[_____]

Pitot Traverse Matrix					
11	[_____]	[_____]	31	[_____]	[_____]
12	[_____]	[_____]	32	[_____]	[_____]
13	[_____]	[_____]	33	[_____]	[_____]
14	[_____]	[_____]	34	[_____]	[_____]
15	[_____]	[_____]	35	[_____]	[_____]
16	[_____]	[_____]	36	[_____]	[_____]
17	[_____]	[_____]	37	[_____]	[_____]
18	[_____]	[_____]	38	[_____]	[_____]
19	[_____]	[_____]	39	[_____]	[_____]
20	[_____]	[_____]	40	[_____]	[_____]
Confirm 1:			Confirm 1:		
Confirm 2:			Confirm 2:		
Velocity Sum:					
(Without Confirm Value)					
Velocity Sum/# Readings = Average Velocity x Duct Area = Actual Volume Flow					
Rate [_____] m/s / [_____] = [_____] m/s x [_____] SQ. METER = [_____] CMS					
REMARKS					

Pitot Traverse Matrix					
Duct Diameter	0-6 in.	6-48 in.		>48 in. or unstable velocity	
Readings	12 (6/traverse)	20 (10/traverse)		40 (20/traverse)	
TEST POINT	Velocity Pressure	Velocity	TEST POINT	Velocity Pressure	Velocity
1	[_____]	[_____]	21	[_____]	[_____]
2	[_____]	[_____]	22	[_____]	[_____]
2	[_____]	[_____]	22	[_____]	[_____]
3	[_____]	[_____]	23	[_____]	[_____]
4	[_____]	[_____]	24	[_____]	[_____]
5	[_____]	[_____]	25	[_____]	[_____]
6	[_____]	[_____]	26	[_____]	[_____]
7	[_____]	[_____]	27	[_____]	[_____]
8	[_____]	[_____]	28	[_____]	[_____]

Pitot Traverse Matrix					
9	[______]	[______]	29	[______]	[______]
10	[______]	[______]	30	[______]	[______]
11	[______]	[______]	31	[______]	[______]
12	[______]	[______]	32	[______]	[______]
13	[______]	[______]	33	[______]	[______]
14	[______]	[______]	34	[______]	[______]
15	[______]	[______]	35	[______]	[______]
16	[______]	[______]	36	[______]	[______]
17	[______]	[______]	37	[______]	[______]
18	[______]	[______]	38	[______]	[______]
19	[______]	[______]	39	[______]	[______]
20	[______]	[______]	40	[______]	[______]
Confirm 1:			Confirm 1:		
Confirm 2:			Confirm 2:		
Velocity Sum:					
(Without Confirm Value)					
Velocity Sum/# Readings = Average Velocity x Duct Area = Actual Volume Flow					
Rate [_____] FPM / [_____] = [_____] FPM x [_____] SQ. Feet = [_____] ACFM					
REMARKS					

1.5.4 Exhaust Air System Test Data

EXHAUST AIR SYSTEM TEST DATA			
Test Dates:			
Readings By:			
Unit Number:		Pressures (Pa)	
Unit Location:		Fan Inlet Static:	
Make Model:		Fan Outlet Static:	
Model:		Fan Inlet Velocity:	
Serial Number:		Fan Static:	
		Fan Total:	
Damper Positions			
Hoods:		Differential Pressure across air cleaning device	
Submains:		Device	Delta P (Pa)
Total Volume Test Location		[_____]	[_____]
Duct dia. before fan	[_____]	[_____]	[_____]
Duct dia. after fan	[_____]		
		Fan Speed (RPM or RPS) [_____]	
		Motor Speed (RPM or RPS) [_____]	
Resistance Causing Elements			
Type	Relationship to Fan		Pulley - Center to Center Distance
	before/after	# Duct dia.	
elbow	[_____]	[_____]	
damper	[_____]	[_____]	
expansion	[_____]	[_____]	Amperage - T1, T2, T3 [_____]
contraction	[_____]	[_____]	Voltage - T1-2, T2-3,T3-1 [_____]
plenum	[_____]	[_____]	
[_____]	[_____]	[_____]	Temperature (W.B./D.B.)

EXHAUST AIR SYSTEM TEST DATA			
[_____]	[_____]	[_____]	Outside Air [_____]
[_____]	[_____]	[_____]	Replacement Air [_____]
* RPM - revolutions per minute			W.B. - wet bulb
RPS - radians per second			D.B. - dry bulb

EXHAUST AIR SYSTEM TEST DATA			
Test Dates:			
Readings By:			
Unit Number:		Pressures (inches of wg)	
Unit Location:		Fan Inlet Static:	
Make Model:		Fan Outlet Static:	
Model:		Fan Inlet Velocity:	
Serial Number:		Fan Static:	
		Fan Total:	
Damper Positions			
Hoods:		Differential Pressure across air cleaning device	
Submains:		Device	Delta P (in. wg)
Total Volume Test Location		[_____]	[_____]
Duct dia. before fan	[_____]	[_____]	[_____]
Duct dia. after fan	[_____]		
		Fan Speed (RPM or RPS) [_____]	
		Motor Speed (RPM or RPS) [_____]	
Resistance Causing Elements			
Type	Relationship to Fan		Pulley - Center to Center Distance
	before/after	# Duct dia.	
elbow	[_____]	[_____]	
damper	[_____]	[_____]	

EXHAUST AIR SYSTEM TEST DATA			
expansion	[_____]	[_____]	Amperage - T1, T2, T3 [_____]
contraction	[_____]	[_____]	Voltage - T1-2, T2-3,T3-1 [_____]
plenum	[_____]	[_____]	
[_____]	[_____]	[_____]	Temperature (W.B./D.B.)
[_____]	[_____]	[_____]	Outside Air [_____]
[_____]	[_____]	[_____]	Replacement Air [_____]
* RPM - revolutions per minute			W.B. - wet bulb
RPS - radians per second			D.B. - dry bulb

VOLUME FLOW RATES (Standard Cubic Meter per Second) VOLUME FLOW RATES				
SYSTEM	ACTUAL	DESIGN	ADEQUATE	INADEQUATE
Total Volume	[_____]	[_____]	[_____]	[_____]
SUBMAIN				
Submain name	[_____]	[_____]	[_____]	[_____]
Submain name	[_____]	[_____]	[_____]	[_____]
Submain name	[_____]	[_____]	[_____]	[_____]
HOODS				
Hood name	[_____]	[_____]	[_____]	[_____]
Hood name	[_____]	[_____]	[_____]	[_____]
Hood name	[_____]	[_____]	[_____]	[_____]
Hood name	[_____]	[_____]	[_____]	[_____]
Hood name	[_____]	[_____]	[_____]	[_____]
Hood name	[_____]	[_____]	[_____]	[_____]
Hood name	[_____]	[_____]	[_____]	[_____]
Hood name	[_____]	[_____]	[_____]	[_____]
Hood name	[_____]	[_____]	[_____]	[_____]
Hood name	[_____]	[_____]	[_____]	[_____]

1.5.5 Replacement Air System Test Data

REPLACEMENT AIR SYSTEM TEST DATA			
Test Dates:			
Readings By:			
Unit Number: [_____] [_____]		Pressures (PA) (inches of wg)	
Unit Location:		Fan Inlet Static:	
Make Model:		Fan Outlet Static:	
Model:		Fan Inlet Velocity:	
Serial Number:		Fan Static:	
		Fan Total:	
Damper Positions			
		Differential Pressure	
Terminals:		across Filters [_____]	
Submains:		across Reheat Coil[_____]	
across Cooling Coil [_____]			
across Preheat Coil [_____]			
Total Volume Test Location			[_____]
Total Volume Test Location			
Duct dia. before fan	[_____]	Fan Speed (RPM or RPS) [_____]	
Duct dia. after fan	[_____]	Motor Speed (RPM or RPS) [_____]	
Resistance Causing Elements			
Type	Relationship to Fan		Pulley - Center to Center Distance
	before/after	# Duct dia.	
elbow	[_____]	[_____]	
damper	[_____]	[_____]	
expansion	[_____]	[_____]	Amperage - T1, T2, T3 [_____]

REPLACEMENT AIR SYSTEM TEST DATA			
contraction	[_____]	[_____]	Voltage - T1-2, T2-3,T3-1 [_____]
plenum	[_____]	[_____]	
[_____]	[_____]	[_____]	Temperature (W.B./D.B.)
[_____]	[_____]	[_____]	Outside Air [_____]
[_____]	[_____]	[_____]	Replacement Air [_____]
[_____]	[_____]	[_____]	Mixed Air [_____]
* RPM - revolutions per minute			W.B. - wet bulb
RPS - radians per second			D.B. - dry bulb

VOLUME FLOW RATES (Standard Cubic Meter per Second) VOLUME FLOW RATES (Standard Cubic Feet per Minute)				
SYSTEM	ACTUAL	DESIGN	ADEQUATE	INADEQUATE
Total Volume	[_____]	[_____]	[_____]	[_____]
Outside Air Volume	[_____]	[_____]	[_____]	[_____]
Return Air	[_____]	[_____]	[_____]	[_____]
Ratio: Outside/Return	[_____]	[_____]	[_____]	[_____]
BRANCH				
Branch name	[_____]	[_____]	[_____]	[_____]
Branch name	[_____]	[_____]	[_____]	[_____]
Branch name	[_____]	[_____]	[_____]	[_____]
Branch name	[_____]	[_____]	[_____]	[_____]
Branch name	[_____]	[_____]	[_____]	[_____]
Branch name	[_____]	[_____]	[_____]	[_____]
Branch name	[_____]	[_____]	[_____]	[_____]

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 TEST PROCEDURE

****

NOTE: Facilities requiring industrial ventilation often contain offices, restrooms, locker rooms with showers and mechanical rooms. These rooms are affected by the industrial ventilation system for the facility. Contaminants from the work area must be prevented from migrating into these rooms. This is accomplished by providing a slightly negative pressure in the work area.

****

Determine the static pressure of the work area relative to [the outdoors and] the following rooms: [_____]. Report the results.

3.1.1 Preliminary Review

Conduct a preliminary review of the facility [45] [_____] calendar days prior to beginning the test. Perform the following tasks and report the results of each task in the Preliminary Review Report.

a. Locate industrial ventilation system components including hoods, hood transitions, ductwork, branch to main duct entries, elbows, expansions and contractions, fans, air pollution control devices, exhaust stacks, weather protection, replacement air plenums, and distribution devices. Show components on a single line drawing for each fan system.

b. Review design drawings, specifications, and shop drawings to verify that testing can be performed on the system. Record, on the single line drawings, locations of planned pitot traverses of mains and branches and design velocities. Report potential test problems, such as inadequate space, to the Contracting Officer.

c. Identify on the single line drawings the location of system fire protection components that may alter air flow, such as fire dampers.

d. Identify on the single line drawings the location of emergency and spill sensors.

e. Identify on the single line drawings the location of [pressure differential sensors] [static pressure sensors].

f. Use AMCA 201 to identify system effects that occur at the inlet and outlet of each replacement and exhaust air fan.

g. Verify that ductwork sizes, elbows and fittings, exhaust stacks and weather protection meet the design plans and specifications for both replacement and exhaust air systems.

h. Verify that fans are rotating in the proper direction.

i. Identify equipment such as fans, air pollution devices, heating coils, and controls, that do not meet the design plans and specifications.

j. Obtain fan performance data.

k. Verify that replacement air terminals including [diffusers] [louvers] [grilles] [perforated plate] [perforated ductwork] are installed according to design plans and specifications.

l. Obtain the differential pressure data and maximum operating pressures for air filtration devices including [dirty and clean replacement air filters] [high efficiency particulate air filters] [dust collectors] [mist eliminators] [wet scrubbers] [cyclone separators] [electrostatic precipitators] [_____].

m. Obtain the temperature and pressure control diagrams for the supply [and exhaust] industrial ventilation system.

n. Record the nameplate data from each fan, motor, [air cleaning device] [vacuum system] and [_____].

o. Record motor starter sizes and the type of thermal overload protection devices.

p. Verify the following requirements unless otherwise specified in the individual section:

    (1) Fan bearings have a minimum rated average life of 200,000 hours.

    (2) Fan bases are level.

    (3) Fan wheels are balanced and clear the housing.

    (4) Fan shafts are of uniform diameter [and there are no step down cuts at the bearings].

    (5) Access to fan grease fittings and other routine maintenance equipment.

    (6) Bearings are greased and the tube is full upon installation.

    (7) Safety equipment, such as fan belt guards, are in place.

    (8) [(8) Drive alignment and belt tension are correct for each fan.]

3.2 FIELD TESTS

3.2.1 Preliminary Procedures

Provide instruments and consumable equipment required to test the industrial ventilation system.

Before beginning the test:

a. Close all windows and doors in the facility.

b. Ensure that exhaust and replacement air ductwork and air intake sources are free from debris and dirt, through a visual inspection.

c. Load the replacement air prefilters to the manufacturer's recommended maximum load condition.

d. Run the exhaust air systems, containing air pollution control devices, for a sufficient time to obtain the manufacturer's recommended equilibrium performance point.

e. [e. Ensure that a duct leakage test is complete and accepted by the Contracting Officer.]

3.2.2 Test Method

Test the ventilation under full load conditions according to ACGIH-2092S, Chapter 9 and this section. Record quantitative readings on sample forms, "Pitot Traverse Data, [Rectangular Duct] [Round Duct]," "Exhaust Air System Test Data," and "Replacement Air System Test Data."

The test engineer is authorized to readjust and rebalance the system if minor adjustments will bring the system into compliance with the design. Minor adjustments include [adjusting the fan sheave] [correcting fan rotation] [resetting dampers] [adjusting blast gates] [_____].

3.2.2.1 Smoke Test

Test each hood with smoke generators to verify contaminant control in the capture zone, prior to performing quantitative tests on the industrial ventilation system. Smoke simulates the contaminant. [Videotape the air movement pattern at the worker's breathing zone for the [hoods] [booths] [indoor firing range] [_____] [and air currents].] Comply with restrictions on the use of incendiary devices. Inform the fire department or other responsible parties when large quantities of smoke are expected [or the ventilation system has internal smoke alarms].

3.2.2.2 Air Quantity Readings

****

NOTE: Straight duct prior to the test point is essential to obtain a realistic average duct velocity. The velocity profile becomes distorted after disturbances such as elbows, contractions, expansions, branch entries in the exhaust system and heating coils in the replacement air system. Look at the drawings and determine if there is enough straight duct to obtain 7.5 duct diameters of straight airflow before the test points. If not, specify the exact test points more explicitly, e.g., 3 meters 10 feet from the positive pressure side of the fan, or between the fan and the scrubber. Do not use the terms upstream or downstream. In exhaust systems the total volume flow rate test point may be located before or after the fan or pollution control device. In replacement air systems the test point is placed after the fan.

****

Use a pitot tube and manometer to measure the velocity pressures for the exhaust and replacement air systems. Determine the number and location of velocity pressure readings required for round and rectangular ducts according to ACGIH-2092S. Drill traverse access holes. [Round ducts require two traverse access holes positioned 90 degrees apart.]

[Rectangular ducts may require several traverse access holes.]

Take pitot traverses away from air disturbing devices (i.e. elbows, branch entries, duct expansions, and hood transitions). Minimum distances are:

a. Five (5) duct diameter of straight duct after the fan outlet; and

b. Seven and one-half (7.5) duct diameters of straight duct after an air disturbing device.

When these distances of straight duct are not available, use a schematic drawing to note the disturbance producing device, and distance between the pitot traverse and the device.

Confirm one velocity pressure reading for each access hole after completing a traverse. Accept traverse data when the difference between the original and confirmation measurement is plus or minus 10 percent; otherwise repeat the traverse. Plug holes with cap plugs immediately after each traverse.

Convert velocity pressure readings to velocity before averaging the duct velocity. Calculate average velocity from velocity pressure readings and volume flow rates for the following locations:

a. Replacement air fan outlet;

c. Replacement air duct branch;

d. Exhaust air duct branch, including hoods [and submains];

e. Exhaust fan inlet or outlet;

f. [e. Air pollution control device inlet; and]

g. [f. Outside and return air ducts in recirculating replacement air system.]

3.2.2.3 Air Velocity Meter Readings

A flow hood may be used for measuring office and restroom replacement air quantities. Do not substitute air velocity meter readings for manometer and pitot tube readings. Use air velocity meters to estimate the following:

a. Velocity exiting from replacement air systems without ductwork;

b. Crossdrafts in a room;

c. Hood capture velocity;

d. Duct velocities less than 3 m/s 600 fpm; and

e. [e. Slot velocities.]

3.2.2.4 Static Pressure Readings

****

NOTE: Static pressures are always required. If the system has no pollution control device, static pressure measurements are only required at the fan inlet and outlet. This is also true for the

replacement air fans. To properly evaluate the system, differential pressures are needed across the fan and each air pollution control device. Look at each system and determine the appropriate test points.

****

Take static pressure readings using a pitot tube and manometer. The following readings are required:

a. Hood static pressure. Take readings at a distance of one duct diameter from tapered hoods, and 3 diameters from plain or flanged hoods;

b. Replacement and exhaust fan inlet and outlet static pressure;

c. Room static pressure as compared to [outdoors] [outside the area controlled by industrial ventilation];

d. [d. Air cleaning device inlet and outlet static pressure; and]

e. [e. Branch static pressure in the replacement and exhaust air system submain ductwork.]

Verify test instrument readings correspond with attached static pressure gages

3.2.2.5 Control System Check-Out

Test warning system controls for the industrial ventilation system including the following:

a. Above and below range alarms for room static pressure.

b. Fan motor operating lights.

c. [c. Dampers operated by the control motor.]

d. [d. Hood static pressure.]

e. [e. Dislodged or ripped filtration equipment.]

f. [f. Overloaded air cleaning device.]

3.2.2.6 Other Readings

Take the following readings on each day testing is performed:

a. Temperature readings after the system has stabilized and has been running for at least 4 hours:

    (1) Wet bulb and dry bulb temperature of ancillary rooms, workspaces, replacement air, outside air, [return air,] [and] [mixed air].

    (2) External temperature for fan and motor bearings on ventilation equipment.

b. Record barometric pressure and altitude.

3.2.3 System Markings

Mark the settings and test ports to re-evaluate the industrial ventilation system during follow-up tests. Label test points before submitting the report. Use spray paint or another acceptable practice, i.e. permanent marker, to mark the airflow adjusting devices [such as valves, splitters, dampers, and blast gates], so the devices can be returned to their original position if an unauthorized adjustment is made.

3.2.4 Test Verification

Notify Contracting Officer [30] [_____] calendar days prior to conducting the Test Verification. In the presence of the Contracting Officer, the test engineer must repeat at least [10] [20] [_____] percent of the test for each replacement and exhaust air system to verify the results. As a minimum, re-test the following readings:

a. Total volume flow for each fan;

b. Inlet and outlet static pressure for each fan;

c. Volume flow and hood static pressure for the hood with the longest duct run from the exhaust fan; [and]

d. Hood volume flow rates and total system volume flow rates which disagree with the design value; [and]

e. [e. Differential pressure across each air pollution control device].

3.2.4.1 Test Result Disagreements

Static and velocity pressure test readings must be within plus or minus [10] [_____] percent of the verification readings. When the difference between test and verification readings are greater than these acceptable values, the test engineer must:

a. Recalculate the test and verification results.

b. Recalibrate test equipment.

c. Retest the entire system.

d. Verify the results.

3.2.5 Test Engineers Out-Brief

Provide a verbal summary for the Contracting Officer describing the condition of the industrial ventilation system. Report test data that does not meet the design criteria as defined in paragraph entitled "Field Test Reports."

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. [_____]	[_____]	[_____]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 09 00 (August 2024)**

Preparing Activity: USACE **Superseding**
UFGS-23 09 00 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

08/24

PART 1 GENERAL

ATTACHMENTS:

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-23 09 00 (August 2024)**

Preparing Activity: USACE

Superseding
UFGS-23 09 00 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

08/24

****

NOTE: This guide specification covers the requirements for HVAC control systems, including tailoring options for LNS-Based LonWorks, Niagara Framework-Based LonWorks, BACnet and Niagara Framework-Based BACnet systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR)**. CCRs for this specification can be submitted through the Whole Building Design Guide page for this section:**
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-

****

****

NOTE: The use of this UFGS, and the design of control systems, must be in accordance with UFC 3-410-02, DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. This specification MUST be used in conjunction with UFGS 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or UFGS 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS as well as UFGS 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC and UFGS 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL in order to specify a complete and functional system.

Verify the design is coordinated with the appropriate version of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.<

Except as otherwise indicated, edit this guide specification for project specific requirements ONLY by selecting appropriate tailoring options, choosing applicable items(s), or inserting appropriate information in bracketed items. Do not make edits outside of bracketed items except as noted without prior approval as indicated in UFC 3-410-02 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING SYSTEMS.

When used with UFGS 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, this specification covers installation of local (building-level) controls using LonWorks-based DDC using either LNS or the Niagara Framework.

When used with UFGS 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, this specification covers installation of local (building-level) controls using BACnet-based DDC, and may include the Niagara Framework.

This specification is primarily intended for building level control systems which are to be integrated into a Utility Monitoring and Control System (UMCS) as specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION (where Section 25 10 10 has also used the matching protocol tailoring option).

For projects that require the building system to provide UMCS functionality (without connection to a UMCS), include the necessary requirements from Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION in the project specifications.

Template drawings in electronic format for use with this section are available online at the Whole Building Design Guide page for this section:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-

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NOTE: This specification makes use of SpecsIntact Tailoring Options. This note describes these options and how to use them.

"TAILORING OPTION NOTES" Tailoring Option
Each time tailoring options are used there is an accompanying designer note describing the text that is tailored. As this Section makes heavy use of tailoring options there are many of these notes and they can distract from designer notes describing other decisions. The designer notes describing

tailoring options are all in a "TAILORING OPTION NOTES" tailoring option which can be hidden (in SpecsIntact select View-Tailoring Options and then deselect "TAILORING OPTION NOTES") once this section is tailored and the tailoring option notes are no longer needed.

Protocol Tailoring Options
This specification includes tailoring options for selection of protocol, and whether the Niagara Framework is required. There are four tailoring options, of which EXACTLY ONE must be used (the remaining three must be DESELECTED when managing tailoring options):

1) **BACNET: A (non-Niagara Framework) BACnet system: When this tailoring option is included this Section will reference Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Use UFGS 23 09 23.02 with the "NOT Niagara Framework" tailoring option selected (DESELECT the "Niagara Framework" tailoring option in UFGS 23 09 23.02).**

2) **LNS: A LonWorks system using LNS. When this tailoring option is included this Section will reference Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Use UFGS 23 09 23.01 with the "LNS" tailoring option selected (and DESELECT the "Niagara Framework" tailoring option in UFGS 23 09 23.01).**

3) **NIAGARA BACNET: A Niagara Framework system using BACnet controllers. When this tailoring option is included this Section will reference Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Use UFGS 23 09 23.02 with the "Niagara Framework" tailoring option selected (DESELECT the "NOT Niagara Framework" tailoring option in UFGS 23 09 23.02).**

4) **NIAGARA LONWORKS: A Niagara Framework system using LonWorks controllers. When this tailoring option is included this Section will reference Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Use UFGS 23 09 23.01 with the "Niagara Framework" tailoring option selected (DESELECT the "LNS" tailoring option in UFGS 23 09 23.01).**

You have currently included the following options:

NIAGARA BACNET
NIAGARA LONWORKS
BACNET
LNS

If you don't see any text between dashes above, you have DESELECTED all protocol tailoring options and this specification is not valid. SELECT ONE of the tailoring options.

If you see more than one line of text between the dashes above you have left multiple tailoring options related to protocol selected. DESELECT one or more tailoring options until a SINGLE protocol tailoring option is selected.

Service Tailoring Option
This specification also includes tailoring options for the Service (Air Force, Army, Navy) the specification is used for. There is a "Service Generic" tailoring option that can also be used when none of the other services tailoring options apply. Only ONE of the five tailoring options related to the services should be used. You have currently included the following options:

AIR FORCE
ARMY
NAVY
SERVICE GENERIC

If more than one item appears between the dashes above you have included more than one services tailoring option and need to DESELECT all but one of them. If there is no text between the dashes above you have not included any services tailoring options. Select ONE of the services tailoring options for inclusion.
****

PART 1 GENERAL

1.1 SUMMARY

****
NOTE: If sequences of operation are provided in Section 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL, keep the bracketed text referring to that section. If Section 23 09 93 is not provided remove the bracketed text.
****

****
NOTE: This subpart uses tailoring options:

1) Text referring to UFGS 23 09 23.01 will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.

2) Text referring to UFGS 23 09 23.02 will be included if the BACNET or NIAGARA BACNET tailoring options are selected.
****

****
NOTE: For Section 25 05 11, use the bracketed text in the Section number to add forth level numbering if used on the project as described in UFC 4-010-06. In the Section name, keep the bracketed text if the section was unnamed or use the empty brackets provided to change the Section name to match the project specifications.
****

Provide a complete Direct Digital Control (DDC) system, except for the Front End which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as indicated and shown and in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC,[Section 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL,] Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS, and other referenced Sections.

[1.1.1 Control System Vendor Requirement

****
NOTE: This subpart is within tailoring options and is included ONLY when the NAVY tailoring option is selected
****

****
NOTE: Keep this bracketed subpart ONLY for Navy projects where the installation has obtained a J&A to downselect to a particular vendor.

When keeping this subpart text:

1) fill in the control system manufacturer and product line information. For example: "ControlCo, BestSystem version 5".

2) Include the configuration setting requirements so the equipment can be installed, configured and programmed in accordance with the existing Risk Management Framework Authority to Operate. Obtain the equipment configuration settings from Public Works, the system owner, or local CIO office. Include these requirements as an attachment to this specification, as part of the contract drawings, or

in some other manner and select the appropriate bracketed text indicating where the settings are provided.

****

The control system provided under this Section must be [_____]. Configure the equipment as indicated in [attached configuration setting requirements][the configuration settings drawings][_____].

]1.1.2 Proprietary Systems

1.1.2.1 Proprietary Systems Exempted From Open Protocol Requirements

****

NOTE: UFC 3-410-02 defines specific circumstances in which a specific HVAC system can be excepted from the open protocol requirements and a proprietary network may be used instead.

When including/allowing proprietary networks in a design per UFC 3-410-02, the systems specifically permitted to use proprietary networks must be indicated in Table 1 below.

Review UFC 3-410-02 for the requirements related to this exception before permitting proprietary networks to ensure the exception is permitted, approved, and properly documented.

****

The following systems are specifically exempted from the open protocol requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS:

a. A simple split (DX) system consisting of a single indoor unit and a single outdoor unit from the same manufacturer.

b. Systems in Table I (previously approved by the designer in accordance with UFC 3-410-02).

TABLE I: Systems Approved to Use Proprietary Communications

System	Type (Multi-Split/VRF or Chiller/Boiler Plant)	Proprietary Multi-Split Engineering Tool Software Required (for Multi-Split/VRF only)

c. A system (not already shown Table I) of multiple boilers or multiple chillers communicating with a proprietary network for which an approved request has been obtained and for which: all units are from the same manufacturer, they are all co-located in the same room, the network connecting them is fully contained in that room, and the units are operating using a common "plant" sequence of operation which stages the units in a manner that requires operational parameters be shared between them and which cannot be accomplished with a single lead-lag command from a third-party controller.

1.1.2.2 Implementation of Proprietary Systems

For proprietary systems exempted from open protocol requirements, a proprietary network and DDC hardware communicating via a proprietary protocol are permitted. For these systems a building control network meeting the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS must also be provided, along with a gateway or interface to connect the proprietary system to the open building control network.

The proprietary system gateway or interface must provide the required functionality as shown on the points schedule. Scheduling, alarming, trending, overrides, network inputs, network outputs and other protocol related requirements must be met on the open protocol control system as specified in Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

1.1.2.3 Proprietary Multi-Split Engineering Tool Software

****

NOTE: Indicate in Table I for each permitted system whether the engineering tool software is required. Coordinate with the project site to determine if this software is needed.

****

For each permitted proprietary systems in Table 1 shown as requiring Proprietary Multi-Split Engineering Tool Software, provide the software needed to replace a unit and configure the replacement. Submit hard copies of the software user manuals with the software submittal.

Submit Proprietary Multi-Split Engineering Tool Software on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for each piece of software.

1.1.3 System Requirements

Provide systems meeting the requirements this Section and other Sections referenced by this Section, and which have the following characteristics:

****

NOTE: Select where sequences of operation are specified. UFGS 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL contains template sequences of operation.

****

a. The system implements the control sequences of operation [shown in the Contract Drawings][___] using DDC hardware to control mechanical and electrical equipment

b. The system meet the requirements of this specification as a stand-alone system and does not require connection to any other system.

****

NOTE: The requirement ", unless otherwise pre-approved by the Contracting Officer" in the following paragraph is required only for Air Force projects and is in AIR FORCE tailoring tags. (Deselect the AIR FORCE tailoring option if not specifying an Air Force owned system.)

****

c. Control sequences reside in DDC hardware in the building. The building control network is not dependent upon connection to a Utility Monitoring and Control System (UMCS) Front End or to any other system for performance of control sequences. To the greatest extent practical, the hardware performs control sequences without reliance on the building network, unless otherwise pre-approved by the Contracting Officer.

d. The hardware is installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

e. All necessary documentation, configuration information, programming tools, programs, drivers, and other software are licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

f. Sufficient documentation and data, including rights to documentation and data, are provided such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

g. Hardware is installed and configured such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor, Vendor or Manufacturer.

****

NOTE: The following list paragraph is included only when the NIAGARA BACNET or NIAGARA LONWORKS tailoring options are selected.

****

h. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license file:

```
accept.station.in="*"
accept.station.out="*"
accept.wb.in="*"
accept.wb.out="*"
```

1.1.4 End to End Accuracy

****
NOTE: This paragraph is referenced (by subpart title) elsewhere in the specification. If this paragraph is edited, removed, renamed, etc. make sure to verify that all references to it are updated as needed.
****

Select products, install and configure the system such that the maximum error of a measured value as read from the DDC Hardware over the network is less than the maximum allowable error specified for the sensor or instrumentation.

1.1.5 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.6 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

****
NOTE: Select whether Section 01 91 00.15 or , BUILDING COMMISSIONING, is used for commissioning or provide appropriate reference to the Commissioning specification.
****

****
NOTE: This subpart used tailoring options:
1) Text referring to UFGS 23 09 23.01 is included only when the LNS or NIAGARA LONWORKS tailoring option is selected.

2) Text referring to UFGS 23 09 23.02 is included only when the BACNET or NIAGARA BACNET tailoring option is selected.
****

****
NOTE:For Section 25 05 11, use the bracketed text in the Section number to add forth level numbering if used on the project as described in UFC 4-010-06. In the Section name, keep the bracketed text if the section was unnamed or use the empty brackets provided to change the Section name to match the project specifications.

Inlcude Section 23 81 00 and Section 23 81 29 only when these Sections are required for the project.

Keep the bracketed text referring to Section 01 91 00.15 OR use the empty brackets to indicate the appropriate commissioning specification.

****

Related work specified elsewhere:

a. Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LonWorks Systems using LNS or Niagara Framework or Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet systems with or without Niagara Framework.

b. Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

c. Section 23 09 93 SEQUENCES OF OPERATIONS FOR HVAC CONTROLS

d. Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEMS TESTING

e. Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS[

f. Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEMS (UMCS) FRONT END AND INTEGRATION][

g. Section 23 81 00 DECENTRALIZED UNITARY HVAC EQUIPMENT][

h. Section 23 81 29 VARIABLE REFRIGERANT FLOW HVAC SYSTEMS]

i. [Section 01 91 00.15 BUILDING COMMISSIONING][_____]

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks
ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition
ASHRAE FUN SI	(2021) Fundamentals Handbook, SI Edition

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification
CEA-709.3	(1999; R 2015) Free-Topology Twisted-Pair Channel Specification

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

TRIDIUM, INC (TRIDIUM)

Niagara Framework	(2021) NiagaraAX User's Guide
Tridium Open NiCS	(2021) Understanding the NiagaraAX Compatibility Statement (NiCS)

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-410-02	(2018; with Change 2, 2021) Direct Digital Control for HVAC and Other Building

Control Systems

UL SOLUTIONS (UL)

UL 5085-3	(2006; Reprint Jan 2022) UL Standard for Safety Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 DEFINITIONS

****

NOTE: Other sections (UFGS 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, UFGS 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, UFGS 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, UFGS 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL) reference this section for relevant definitions.

****

The following list of definitions includes terms used in Sections referenced by this Section and are included here for completeness. The definitions contained in this Section may disagree with how terms are defined or used in other documents, including documents referenced by this Section. The definitions included here are the authoritative definitions for this Section and all Sections referenced by this Section.

After each term the protocol related to that term is included in parenthesis.

****

NOTE: The following subparts use tailoring options to include or exclude terms based on the which tailoring options are selected. Each individual term does not have a designer note associated with it as this makes the list of definitions very difficult to read. The parenthesis after the subpart title will also indicate when the term is in tailoring option tags:

1) Subparts including "(LonWorks)" in the title are included when the LNS or NIAGARA LONWORKS tailoring options are selected.

2) Subparts including "(BACnet)" in the title are included when the BACNET or NIAGARA BACNET tailoring options are selected.

3) Subparts including "(Niagara Framework)" in the title are included when the NIAGARA BACNET or NIAGARA LONWORKS tailoring options are selected.

4) Subparts including "(All protocols)" are not in any tailoring options and are always included.

****

1.4.1 Alarm Generation (All protocols)

Alarm Generation is the monitoring of a value, comparison of the value to alarm conditions and the creation of an alarm when the conditions set for the alarm are met. Note that this does NOT include delivery of the alarm to the final destination (such as a user interface) - see paragraph ALARM ROUTING in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

1.4.2 Application Generic Controller (AGC) (LonWorks)

A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable Controller (GPPC).

1.4.3 Application Specific Controller (ASC) (LonWorks)

A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

1.4.4 Building Automation and Control Network (BACnet) (BACnet)

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall technology related to the ASHRAE 135 protocol.

1.4.5 BACnet Advanced Application Controller (B-AAC) (BACnet)

A hardware device BTL Listed as a B-AAC, which is required to support BACnet Interoperability Building Blocks (BIBBs) for scheduling and alarming, but is not required to support as many BIBBs as a B-BC.

1.4.6 BACnet Application Specific Controller (B-ASC) (BACnet)

A hardware device BTL Listed as a B-ASC, with fewer BIBB requirements than a B-AAC. It is intended for use in a specific application.

1.4.7 BACnet Building Controller (B-BC) (BACnet)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

1.4.8 BACnet Broadcast Management Device (BBMD) (BACnet)

A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Each IP subnet that is part of a BACnet/IP network must have at least one BBMD. Note there are additional restrictions when multiple BBMDs share an IP subnet.

1.4.9 BACnet/IP (BACnet)

An extension of BACnet, Annex J, defines the use of a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnets that share the same BACnet network number. See also paragraph BACNET BROADCAST MANAGEMENT DEVICE.

1.4.10 BACnet Internetwork (BACnet)

Two or more BACnet networks, connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

1.4.11 BACnet Interoperability Building Blocks (BIBBs) (BACnet)

A BIBB is a collection of one or more ASHRAE 135 Services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by a front-end, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

In the BIBB shorthand notation, -A is the client side and -B is the server side.

The following is a list of some BIBBs used by this or referenced Sections:	
DS-COV-A	Data Sharing-Change of Value (A side)
DS-COV-B	Data Sharing-Change of Value (B side)
NM-RC-B	Network Management-Router Configuration (B side)
DS-RP-A	Data Sharing-Read Property (A side)
DS-RP-B	Data Sharing-Read Property (B side)
DS-RPM-A	Data Sharing-Read Property Multiple (A Side)
DS-RPM-B	Data Sharing-Read Property Multiple (B Side)
DS-WP-A	Data Sharing-Write Property (A Side)
DM-TS-B	Device Management-Time Synchronization (B Side)

The following is a list of some BIBBs used by this or referenced Sections:	
DM-UTC-B	Device Management-UTC Time Synchronization (B Side)
DS-WP-B	Data Sharing-Write Property (B side)
SCHED-E-B	Scheduling-External (B side)
DM-OCD-B	Device Management-Object Creation and Deletion (B side)
AE-N-I-B	Alarm and Event-Notification Internal (B Side)
AE-N-E-B	Alarm and Event-Notification External (B Side)
T-VMT-I-B	Trending-Viewing and Modifying Trends Internal (B Side)
T-VMT-E-B	Trending-Viewing and Modifying Trends External (B Side)

1.4.12 BACnet Network (BACnet)

In BACnet, a portion of the control Internetwork consisting of one or more segments connected by repeaters. Networks are separated by routers.

1.4.13 BACnet Operator Display (B-OD) (BACnet)

A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. A B-OD profile could be used for LCD devices, displays affixed to BACnet devices, handheld terminals or other very simple user interfaces.

1.4.14 BACnet Segment (BACnet)

One or more physical segments interconnected by repeaters (ASHRAE 135).

1.4.15 BACnet Smart Actuator (B-SA) (BACnet)

A simple actuator device with limited resources intended for specific applications.

1.4.16 BACnet Smart Sensor (B-SS) (BACnet)

A simple sensing device with limited resources.

1.4.17 BACnet Testing Laboratories (BTL) (BACnet)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

1.4.18 BACnet Testing Laboratories (BTL) Listed (BACnet)

A device that has been listed by BACnet Testing Laboratory. Devices may be certified to a specific device profile, in which case the listing indicates that the device supports the required capabilities for that profile, or may be listed as "other".

1.4.19 Binary (All protocols)

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.4.20 Binding (LonWorks)

The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that information is automatically (and regularly) sent.

1.4.21 Broadcast (BACnet)

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.4.22 Building Control Network (BCN) (All protocols)

The network connecting all DDC Hardware within a building (or specific group of buildings).

1.4.23 Building Point of Connection (BPOC) (All protocols)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware.)

1.4.24 Channel (LonWorks)

A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

1.4.25 Commandable (All protocols)

See Overridable.

1.4.26 Commandable Objects (BACnet)

Commandable Objects have a Commandable Property, Priority_Array, and Relinquish_Default Property as defined in ASHRAE 135, Clause 19.2, Command Prioritization.

1.4.27 Configurable (All protocols)

****

NOTE: This subpart uses tailoring options:

1) Text referring to "Non-Niagara Framework BACnet system" is included only when the NIAGARA BACNET tailoring options is selected.

2) Text referring to "Niagara Framework BACnet system" is included only when the BACNET tailoring

options is selected.
****

A property, setting, or value is configurable if it can be changed via hardware settings on the device, via the use of engineering software or over the control network from the front end, and is retained through (after) loss of power.

a. In a non-Niagara Framework BACnet system, a property, setting, or value is configurable if it can be changed via one or more of:
   (1) via BACnet services (including proprietary BACnet services)
   (2) via hardware settings on the device

b. In a Niagara Framework BACnet system, a property, setting, or value is configurable if it can be changed via one or more of:
   (1) via BACnet services (including proprietary BACnet services)
   (2) via hardware settings on the device
   (3) via the Niagara Framework

Note this is more stringent than the ASHRAE 135 definition.

1.4.28 Configuration Property (LonWorks)

Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see paragraph STANDARD CONFIGURATION PROPERTY TYPE (SCPT).

1.4.29 Control Logic Diagram (All protocols)

A graphical representation of control logic for multiple processes that make up a system.

1.4.30 Device (BACnet)

A Digital Controller that contains a BACnet Device Object and uses BACnet to communicate with other devices.

1.4.31 Device Object (BACnet)

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

1.4.32 Device Profile (BACnet)

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE 135. Standard device profiles include BACnet Advanced Workstations (B-AWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS).

1.4.33 Digital Controller (All protocols)

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions.

1.4.34 Direct Digital Control (DDC) (All protocols)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

1.4.35 Domain (LonWorks)

A grouping of up to 32,385 nodes that can communicate directly with each other. (Devices in different domains cannot communicate directly with each other.) See also Node Address.

1.4.36 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received.

1.4.37 External Interface File (XIF) (LonWorks)

A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.

1.4.38 Field Point of Connection (FPOC) (All protocols)

The FPOC is the point of connection between the UMCS IP Network and the field control network (either an IP network, a non-IP network, or a combination of both). The hardware at this location which provides the connection is generally an IT device such as a switch, IP router, or firewall.

In general, the term "FPOC Location" means the place where this connection occurs, and "FPOC Hardware" means the device that provides the connection. Sometimes the term "FPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

1.4.39 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911.

1.4.40 Functional Profile (LonWorks)

A standard description, defined by LonMark, of one or more LonMark Objects used to classify and certify devices.

1.4.41 Gateway (All protocols)

****

NOTE: This subpart uses tailoring options: Text referring to Niagara Framework is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring options are selected.

****

A device that translates from one protocol application data format to another. Devices that change only the transport mechanism of the protocol - "translating" from TP/FT-10 to Ethernet/IP or from BACnet MS/TP to BACnet over IP for example - are not gateways as the underlying data format does not change. Gateways are also called Communications Bridges or Protocol Translators.

A Niagara Framework Supervisory Gateway is one type of Gateway.

1.4.42 General Purpose Programmable Controller (GPPC) (LonWorks)

Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.

1.4.43 IEEE 802.3 Ethernet (All protocols)

A family of local-area-network technologies providing high-speed networking features over various media, typically Cat 5, 5e or Cat 6 twisted pair copper or fiber optic cable.

1.4.44 Internet Protocol (IP, TCP/IP, UDP/IP) (All protocols)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes connections, also known as "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.4.45 Input/Output (I/O) (All protocols)

Physical inputs and outputs to and from a device, although the term sometimes describes network or "virtual" inputs or outputs. See also "Points".

1.4.46 I/O Expansion Unit (All protocols)

An I/O expansion unit provides additional point capacity to a digital controller

1.4.47 IP subnet (All protocols)

A group of devices which share a defined range IP addresses. Devices on a common IP subnet can share data (including broadcasts) directly without the need for the traffic to traverse an IP router.

1.4.48 JACE (Niagara Framework)

Java Application Control Engine. See paragraph NIAGARA FRAMEWORK SUPERVISORY GATEWAY

1.4.49 Local-Area Network (LAN) (All protocols)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.4.50 Local Display Panels (LDPs) (All protocols)

A DDC Hardware with a display and navigation buttons, and must provide display and adjustment of points as shown on the Points Schedule and as indicated.

1.4.51 LonMark (LonWorks)

See paragraph LONMARK INTERNATIONAL. Also, a certification issued by LonMark International to CEA-709.1-D devices.

1.4.52 LonMark International (LonWorks)

Standards committee consisting of numerous independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.

1.4.53 LonMark Interoperability Association (LonWorks)

See paragraph LONMARK INTERNATIONAL.

1.4.54 LonMark Object (LonWorks)

A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).

1.4.55 LonWorks (LonWorks)

The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.

1.4.56 LonWorks Network Services (LNS) (LonWorks)

A network management and database standard for CEA-709.1-D devices.

1.4.57 LonWorks Network Services (LNS) Plug-in (LonWorks)

Software which runs in an LNS compatible software tool, typically a network configuration tool. Device configuration plug-ins provide a user friendly method to edit a device's configuration properties.

1.4.58 MAC Address (All protocols)

Media Access Control address. The physical device address that identifies a device on a Local Area Network.

1.4.59 Master-Slave/Token-Passing (MS/TP) (BACnet)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

1.4.60 Monitoring and Control (M&C) Software (All protocols)

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.61 Network Number (BACnet)

A site-specific number assigned to each network. This network number must be unique throughout the BACnet Internetwork.

1.4.62 Network Variable (LonWorks)

See paragraph STANDARD NETWORK VARIABLE TYPE (SNVT).

1.4.63 Network Configuration Tool (LonWorks)

****

NOTE: This subpart uses tailoring options: The parenthetical referring to LNS is included only when the LNS tailoring option is selected.

****

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.4.64 Niagara Framework (Niagara Framework)

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.4.65 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include (but are not limited to)"EC-BOS", "FX-40", "TMN", "SLX" and "UNC".

1.4.66 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.4.67 Node Address (LonWorks)

The logical address of a node on the network, consisting of a Domain number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during installation and is unique within a subnet. This is not the factory-set unique Node ID (see Node ID).

1.4.68 Node ID (LonWorks)

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.

1.4.69 Object (BACnet)

An ASHRAE 135 Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

1.4.70 Object Identifier (BACnet)

A grouping of two Object properties: Object Type (e.g. Analog Value, Schedule, etc.) and Object Instance (in this case, a number). Object Identifiers must be unique within a device.

1.4.71 Object Instance (BACnet)

See paragraph OBJECT IDENTIFIER

1.4.72 Object Properties (BACnet)

Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

1.4.73 Operator Configurable (All protocols)

****

NOTE: This subpart uses tailoring options:

1) Text referring to Niagara Framework is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring options are selected.

2) Text referring to LNS is included only when the LNS tailoring option is included.

3) Text referring to non Niagara-based BACnet is only included when the BACNET tailoring option is selected.

****

Operator configurable values are values that can be changed from a single common front end user interface across multiple vendor systems.

For Niagara Framework Systems, a property, setting, or value is Operator Configurable when it is configurable from a Niagara Framework Front End.

For LNS LonWorks systems, Operator Configurable is defined the same as Configurable. See paragraph CONFIGURABLE.

For non Niagara-based BACnet systems, a property, setting, or value in a device is Operator Configurable when it is Configurable and is either:

a. a Writable Property of a Standard BACnet Object; or

b. a Property of a Standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.

1.4.74 Override (All protocols)

Changing the value of a point outside of the normal sequence of operation where the change has priority over the sequence and where there is a mechanism for releasing the change such that the point returns to the normal value. Overrides persist until released or overridden at the same or higher priority but are not required to persist through a loss of power. Overrides are often used by operators to change values, and generally originate at a user interface (workstation or local display panel).

1.4.75 Packaged Equipment (All protocols)

Packaged equipment is a single piece of equipment provided by a manufacturer in a substantially complete and operable condition, where the controls (DDC Hardware) are factory installed, and the equipment is sold and shipped from the manufacturer as a single entity. Disassembly and reassembly of a large piece of equipment for shipping does not prevent it from being packaged equipment. Package units may require field installation of remote sensors. Packaged equipment is also called a "packaged unit".

Note industry may use the term "Packaged System" to mean a collection of equipment that is designed to work together where each piece of equipment is packaged equipment and there is a network that connects the equipment together. A "packaged system" of this type is NOT packaged equipment; it is a collection of packaged equipment, and each piece of equipment must individually meet specification requirements.

1.4.76 Packaged Unit (All protocols)

See packaged equipment.

1.4.77 Performance Verification Test (PVT) (All protocols)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.4.78 Physical Segment (BACnet)

A single contiguous medium to which BACnet devices are attached (ASHRAE 135).

1.4.79 Polling (All protocols)

A device periodically requesting data from another device.

1.4.80 Points (All protocols)

Physical and virtual inputs and outputs. See also paragraph INPUT/OUTPUT (I/O).

1.4.81 Program ID (LonWorks)

An identifier (number) stored in the device that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage.

1.4.82 Proportional, Integral, and Derivative (PID) Control Loop (All protocols)

Three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.4.83 Proprietary (BACnet)

Within the context of BACnet, any extension of or addition to object types, properties, PrivateTransfer services, or enumerations specified in ASHRAE 135. Objects with Object_Type values of 128 and above are Proprietary Objects. Properties with Property_Identifier of 512 and above are proprietary Properties.

1.4.84 Protocol Implementation Conformance Statement (PICS) (BACnet)

A document, created by the manufacturer of a device, which describes which portions of the BACnet standard may be implemented by a given device. ASHRAE 135 requires that all ASHRAE 135 devices have a PICS, and also defines a minimum set of information that must be in it. A device as installed for a specific project may not implement everything in its PICS.

1.4.85 Repeater (All protocols)

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.86 Router (All protocols)

****

NOTE: This subpart uses tailoring options:

1) Text referring to LonWorks is included if the LNS or NIAGARA LONWORKS tailoring options are selected.

2) Text referring to BACnet is included if the BACNET or NIAGARA BACNET tailoring options are selected.

****

A device that connects two CEA-709.1-D channels (in a LonWorks system) or two ASHRAE 135 networks (in a BACnet system) and controls traffic between the two by retransmitting signals received from one side onto the other based on the signal destination. Routers are used to subdivide a LonWorks control network or a BACnet internetwork and to limit network traffic.

1.4.87 Segment (All protocols)

****

NOTE: This subpart uses tailoring options: The TP/FT-10 example is included only if the LNS or NIAGARA LONWORKS tailoring option is selected.

****

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, in a LonWorks system a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

1.4.88 Service Pin (LonWorks)

A hardware push-button on a device which causes the device to broadcast a message (over the control network) containing its Node ID and Program ID.

1.4.89 Standard BACnet Objects (BACnet)

Objects with Object_Type values below 128 and specifically enumerated in Clause 21 of ASHRAE 135. Objects which are not proprietary. See paragraph PROPRIETARY.

1.4.90 Standard BACnet Properties (BACnet)

Properties with Property_Identifier values below 512 and specifically enumerated in Clause 21 of ASHRAE 135. Properties which are not proprietary. See Proprietary.

1.4.91 Standard BACnet Services (BACnet)

ASHRAE 135 services other than ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer. See paragraph PROPRIETARY.

1.4.92 Standard Configuration Property Type (SCPT) (LonWorks)

Pronounced skip-it. A standard format type (maintained by LonMark International) for Configuration Properties.

1.4.93 Standard Network Variable Type (SNVT) (LonWorks)

Pronounced snivet. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

1.4.94 Subnet (LonWorks)

Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also paragraph NODE ADDRESS.

1.4.95 TP/FT-10 (LonWorks)

A Free Topology Twisted Pair network defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.

1.4.96 TP/XF-1250 (LonWorks)

A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10 networks.

1.4.97 User-defined Configuration Property Type (UCPT) (LonWorks)

Pronounced u-keep-it. A Configuration Property format type that is defined by the device manufacturer.

1.4.98 User-defined Network Variable Type (UNVT) (LonWorks)

A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.4.99 UMCS (All protocols)

UMCS stands for Utility Monitoring and Control System. The term refers to all components by which a project site monitors, manages, and controls real-time operation of HVAC and other building systems. These components include the UMCS "front-end" and all field building control systems connected to the front-end. The front-end consists of Monitoring and Control Software (user interface software), browser-based user interfaces and network infrastructure.

The network infrastructure (the "UMCS Network"), is an IP network connecting multiple building or facility control networks to the Monitoring and Control Software.

1.4.100 UMCS Network (All protocols)

The UMCS Network connects multiple building or facility control networks to the Monitoring and Control Software.

1.4.101 Writable Property (BACnet)

A Property is Writable when it can be changed through the use of one or more of the WriteProperty services defined in ASHRAE 135, Clause 15 regardless of the value of any other Property. Note that in the ASHRAE 135 standard, some Properties may be writable when the Out of Service Property is TRUE; for purposes of this Section, Properties that are only writable when the Out of Service Property is TRUE are not considered to be Writable.

1.5 PROJECT SEQUENCING

****

NOTE: Table II provides bracketed text in which the number of days between items may be specified. In many cases this information will be specified elsewhere. When project schedule is specified

elsewhere remove bracketed text and Table II will provide sequencing but not specific intervals. If time intervals are to be specified here keep the bracketed text and enter the number of days in the space provided.
****

TABLE II: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column). TABLE II does not specify overall project milestone and completion dates[; these dates are specified in the contract documents][_____].

a. Sequencing for Submittals: The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within [14][_____] days of notification that the submittal has been rejected. Upon resubmittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

b. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.

c. Abbreviations: In TABLE II the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

****
NOTE: The following table uses tailoring options:
1) Items referring to LNS are included only when the LNS tailoring option is selected.

2) XIF Files is included only when the LNS or NIAGARA FRAMEWORK tailoring option is selected

3) Items referring to Niagara Framework are included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring option is selected.
****

TABLE II. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE
1	S	Existing Conditions Report	
2	S	DDC Contractor Design Drawings	
3	S	Manufacturer's Product Data	
4	S	Pre-construction QC Checklist	

TABLE II. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE
5	E	Install Building Control System	AAO #1 thru #4
6	E	Start-Up and Start-Up Testing	ACO #5
7	S	Post-Construction QC Checklist	[[_____] days]ACO #6
8	S	Programming Software Configuration Software Niagara Framework Engineering Tool Niagara Framework Wizards XIF Files LNS Plug-Ins	[[_____] days]ACO #6
9	S	Draft As-Built Drawings Draft LNS Database	[[_____] days]ACO #6
10	S	Start-Up Testing Report	[[_____] days]ACO #6
11	S	PVT Procedures	[[_____] days]before schedule start of #12 and AAO #10
12	S,E	Execute PVT PVT Testing Activities	AAO #9 and #11As indicated in PART 3 of this Section
13	S	PVT Report	[[_____] days]ACO #12 As indicated in PART 3 of this Section
14	S	Controller Application Programs Controller Configuration Settings Niagara Framework Supervisory Gateway Backups Final LNS Database	[[_____] days]AAO #13
15	S	Final As-Built Drawings	[[_____] days]AAO #13
16	S	O&M Instructions	AAO #15

TABLE II. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE
17	S	Training Documentation	AAO #10 and [[_____] days]before scheduled start of #18
18	E	Training	AAO #16 and #17
19	S	Closeout QC Checklist	ACO #18

1.6 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

DDC Contractor Design Drawings; G, [_____]

Draft As-Built Drawings; G, [_____]

Final As-Built Drawings; G, [_____]

SD-03 Product Data

Programming Software; G, [_____]

Controller Application Programs; G, [_____]

Configuration Software; G, [_____]

****

NOTE: Controller Configuration Settings is only required for BACnet and is included only when BACNET or NIAGARA BACNET tailoring options are selected.

****

Controller Configuration Settings; G, [_____]

Proprietary Multi-Split Engineering Tool Software; G, [_____]

Manufacturer's Product Data; G, [_____]

****

NOTE: XIF files and the three LNS-related submittals are only required for LNS-based LonWorks systems and are included when the LNS tailoring option is selected.

****

XIF files; G, [_____]

Draft LNS Database; G, [_____]

Final LNS Database; G, [_____]

LNS Plug-ins; G, [_____]

****

NOTE: Niagara Framework Supervisory Gateway Backups, Niagara Framework Engineering Tool and Niagara Framework Wizards are only required for Niagara Framework systems and are included when the NIAGARA LONWORKS or NIAGARA BACNET

****

Niagara Framework Supervisory Gateway Backups; G, [_____]

****

NOTE: The Niagara Framework Engineering Tool is specified in Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL

SYSTEMS and Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, but is a designer option in these Sections. If the Niagara Framework Engineering Tool is not required for the project, remove the submittal requirements in this Section.
****

[Niagara Framework Engineering Tool; G, [_____]]

Niagara Framework Wizards; G, [_____]

SD-05 Design Data

Boiler Or Chiller Plant Gateway Request

SD-06 Test Reports

Existing Conditions Report

Pre-Construction Quality Control (QC) Checklist; G, [_____]

Post-Construction Quality Control (QC) Checklist; G, [_____]

Start-Up Testing Report; G, [_____]

****
NOTE: The following two submittals do not apply to Navy projects and are includeed only when the ARMY, AIR FORCE or SERVICE GENERIC tailoring option is selected..
****

PVT Procedures; G, [_____]

PVT Report; G, [_____]

****
NOTE: The following four submittals apply only to Navy projects and are included only when the NAVY tailoring option is selected.
****

Control Contractor’s Performance Verification Testing Plan; G

Equipment Supplier’s Performance Verification Testing Plan; G

Endurance Testing Results; G

Performance Verification Test Report; G

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, [_____]

Training Documentation; G, [_____]

SD-11 Closeout Submittals

****

NOTE: The Enclosure Keys are needed by the project site DPW.

****

Enclosure Keys; G, [_____]

****

NOTE: The Password Summary Report is needed by the project site DPW.

****

Password Summary Report; G, [_____]

Closeout Quality Control (QC) Checklist; G, [_____]

1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

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NOTE: The acquisition of all technical data, data bases and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Defense Acquisition Regulation Supplement (DFARS). Those regulations as well as the Services implementation thereof should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost. Specifically, DFARS 252.227-7013 Rights in Technical Data - Noncommercial Items, as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS.

In addition, the appropriate DD Form 1423 Contract Data Requirements List, will be filled out for each distinct deliverable data item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, will be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to ensure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government.

Include with the request for proposals a completed DD Form 1423, Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified with both description and quantity being required.

Coordinate the review of all submittals with the project site. The site may have a System Integrator

or other individual/office that should review all submittals before acceptance of the system.

Most of the submittals included in this Section are critical and require Government review. Any added submittals, normally, should be for information only and reviewed through the Contractor Quality Control system.

****

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.

1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS

Provide all software related to the programming and configuration of DDC Hardware and Gateways as indicated. License all Software to the project site. The term "controller" as used in these requirements means both DDC Hardware and Gateways.

1.8.1 Programming Software

****

NOTE: This subpart only applies to LonWorks systems and is only included when the LNS or NIAGARA LONWORKS tailoring option is selected.

In addition, the sentence referring to Application Generic Controllers and Wizards is included only when the NIAGARA LONWORKS tailoring option is selected.

****

For each type of General Purpose Programmable Controller (GPPC), provide the programming software in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each type of Application Generic Controller (AGC) provided as part of without a configuration and programming Wizard, provide the programming and configuration software in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of user manuals for each software with the software submittal.

Submit Programming Software on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for each piece of software.

1.8.2 Controller Application Programs

****

NOTE: This subpart only applies to LonWorks systems and is only included with the LNS and NIAGARA LONWORKS tailoring options.

In addition, "(LNS plug-in)" is only included when the LNS tailoring options is selected.

****

For each General Purpose Programmable Controller (GPPC), provide copies of the application program as source code compatible with the programming software for that GPPC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each Application Generic Controller (AGC), provide copies of the application program as source code compatible with the programming and configuration tool (LNS plug-in) for that AGC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit [2][_____] copies of the Controller Application Programs CD-ROM.

1.8.3 Configuration Software

****

NOTE: This subpart only applies to BACnet systems and is only included with the BACNET and NIAGARA BACNET tailoring options.

****

For each type of controller, provide the configuration tool software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of the software user manuals for each software with the software submittal.

Submit Configuration Software on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for each piece of software.

1.8.4 Controller Configuration Settings

****

NOTE: This subpart only applies to BACnet systems and is only included with the BACNET and NIAGARA BACNET tailoring options.

****

For each controller, provide copies of the installed configuration settings as source code compatible with the configuration tool software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Configuration Settings on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit [2][_____] copies of the Controller Configuration Settings CD-ROM.

1.8.5 Programming Software

****

NOTE: This subpart only applies to BACnet systems and is only included with the BACNET and NIAGARA BACNET tailoring options.

****

For each type of programmable controller, provide the programming software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of software user manuals for each software with the software submittal.

Submit Programming Software on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for each piece of software.

1.8.6 Controller Application Programs

****

NOTE: This subpart only applies to BACnet systems and is only included with the BACNET and NIAGARA BACNET tailoring options.

****

For each programmable controller, provide copies of the application program as source code compatible with the programming software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit [2][_____] copies of the Controller Application Programs CD-ROM.

1.8.7 LNS Plug-Ins (for LNS-based LonWorks systems)

****

NOTE: This subpart only applies to LNS-based LonWorks systems and and is only included with the LNS tailoring option.

****

Provide LNS Plug-ins in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for each Application Specific Controller and each Application Generic Controller. For LNS Plug-ins distributed under a license, license the Plug-In to the project site. Submit hard copy manuals, if available, for each plug-in provided as part of the LNS- Plug-Ins submittal.

Submit LNS Plug-ins on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device.

1.8.8 Niagara Framework Wizards (for Niagara LonWorks systems)

****

NOTE: This subpart only applies to Niagara Framework Based LonWorks systems and is only included with the NIAGARA LONWORKS tailoring option.

****

For each Application Generic Controller with a Niagara Framework Wizard and for each Application Specific Controller provide Niagara Framework Wizards in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copy manuals, if available, for each Wizard provided as part of the Niagara Framework Wizards submittal.

Submit Niagara Framework Wizards on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit [_____] hard copies of the software user manual, if available, for each Wizard.

1.8.9 Niagara Framework Supervisory Gateway Backups

****

NOTE: This subpart only applies to Niagara

Framework systems and is only included with the NIAGARA LONWORKS and NIAGARA BACNET tailoring options.

****

For each Niagara Framework Supervisory Gateway, provide a backup of all software within the Niagara Framework Supervisory Gateway, including configuration settings. This backup must be sufficient to allow the restoration of the Niagara Framework Supervisory Gateway or the replacement of the Niagara Framework Supervisory Gateway.

Submit backups for each Niagara Framework Supervisory Gateway on CD-ROM as a Technical Data Package. Mark each backup indicating clearly the source Niagara Framework Supervisory Gateway.

[1.8.10 Niagara Framework Engineering Tool(for all Niagara Framework system)

****

NOTE: This subpart only applies to Niagara Framework systems and is only included with the NIAGARA LONWORKS and NIAGARA BACNET tailoring options.

In addition, this subpart uses tailoring options:

1) Text referring to UFGS 23 09 23.01 will be included if the NIAGARA LONWORKS tailoring option is selected.

2) Text referring to UFGS 23 09 23.02 will be included if the NIAGARA BACNET tailoring option is selected.

****

****

NOTE: The Niagara Framework Engineering Tool is specified in Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, but is a designer option in these Sections. If the Niagara Framework Engineering Tool is not required for the project, remove the submittal requirements in this Section.

****

Provide a Niagara Framework Engineering Tool in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit software user manuals with the Niagara Framework Engineering Tool submittal.

Submit the Niagara Framework Engineering Tool on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for the Niagara Framework Engineering Tool.

]1.9 BOILER OR CHILLER PLANT GATEWAY REQUEST

****

NOTE: Before approving the use of a gateway to multiple chillers or boilers ensure that the

sequence of operation for the units requires information be shared between them and cannot be readily performed by a third-party controller.

****

****

NOTE: This subpart uses tailoring options:

1) Text referring to UFGS 23 09 23.01 and LonWorks will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.

2) Text referring to UFGS 23 09 23.02 and BACnet will be included if the BACNET or NIAGARA BACNET tailoring options are selected.

****

If requesting the use of a gateway to a boiler or chiller plant as indicated in paragraph Proprietary Systems Exempted From Open Protocol Requirements, submit a Boiler or Chiller Plant Gateway Request describing the configuration of the boilers or chillers including model numbers for equipment and controllers, the sequence of operation for the units, and a justification for the need to operate the units on a shared non-LonWorks non-BACnet network.

1.10 QUALITY CONTROL CHECKLISTS

****

NOTE: This subpart uses tailoring options. Each checklist is included only when appropriate tailoring option is selected.

****

The QC Checklist for LNS-Based LonWorks Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Checklist for Niagara Framework Based LonWorks Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Checklist for BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Checklist for Niagara Framework Based BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Representative must verify each item indicated and initial in the space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

1.10.1 Pre-Construction Quality Control (QC) Checklist

****

NOTE: Indicate the required number of Pre-Construction QC Checklists.

****

Complete items indicated as Pre-Construction QC Checklist items in the QC Checklist. Submit [four][_____] copies of the Pre-Construction QC Checklist.

1.10.2 Post-Construction Quality Control (QC) Checklist

****
NOTE: Indicate the required number of Post-Construction QC Checklists.
****

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist. Submit [four][_____] copies of the Post-Construction QC Checklist.

1.10.3 Closeout Quality Control (QC) Checklist

****
NOTE: Indicate the required number of Closeout QC Checklists.
****

Complete items indicated as Closeout QC Checklist items in the QC Checklist. Submit [four][_____] copies of the Closeout QC Checklist.

PART 2 PRODUCTS

****
NOTE: This subpart uses tailoring options:

1) Text referring to UFGS 23 09 23.01 will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.

2) Text referring to UFGS 23 09 23.02 will be included if the BACNET or NIAGARA BACNET tailoring options are selected.
****

Provide products meeting the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, other referenced Sections, and this Section.

2.1 GENERAL PRODUCT REQUIREMENTS

Units of the same type of equipment must be products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products must have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use must include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement is acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items must be supported by a service organization. Items of the same type and purpose must be identical, including equipment, assemblies, parts and components.

2.2 PRODUCT DATA

****

NOTE: This subpart uses tailoring options:

1) Text referring to UFGS 23 09 23.01 will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.

2) Text referring to UFGS 23 09 23.02 will be included if the BACNET or NIAGARA BACNET tailoring options are selected.

****

Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, or this Section. Provide product data for all products in a single indexed compendium, organized by product type.

For all LonWorks hardware: for each manufacturer, model and version (revision) of DDC Hardware indicate the type or types of DDC Hardware the product is being provided as in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

For all BACnet hardware: for each manufacturer, model and version (revision) of DDC Hardware provide the Protocol Implementation Conformance Statement (PICS) in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Manufacturer's Product Data on CD-ROM.

2.2.1 XIF Files

****

NOTE: This subpart only applies to LonWorks systems and is only included when the LNS or NIAGARA LONWORKS tailoring option is selected.

****

Provide External Interface Files (XIF Files) for DDC Hardware in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit external interface files (XIF files) as a technical data package for each model of DDC Hardware provided under this specification. Submit XIF files on CD-ROM.

2.3 OPERATION ENVIRONMENT

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

a. Pressure: Pressure conditions normally encountered in the installed location.

b. Vibration: Vibration conditions normally encountered in the installed location.

c. Temperature:

****

NOTE: Designer must decide if suggested outside air temperature range is sufficient, and provide a range if it's not.

****

(1) Products installed indoors: Ambient temperatures in the range of 0 to 50 degrees C 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

(2) Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of [-37 to +66 degrees C -35 to +151 degrees F] [_____] and temperature conditions outside this range normally encountered at the installed location.

d. Humidity: 10 to 95 percent relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

2.4 WIRELESS CAPABILITY

****

NOTE: For Section 25 05 11, use the bracketed text in the Section number to add forth level numbering if used on the project as described in UFC 4-010-06. In the Section name, keep the bracketed text if the section was unnamed or use the empty brackets provided to change the Section name to match the project specifications.

****

Wireless capabilities must comply with Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS

2.5 ENCLOSURES

****

NOTE: In outdoor applications specify Type 3 unless hosedown of the enclosure is anticipated, in which case specify Type 4.

For retrofit projects in older mechanical rooms or where hosedown of the enclosure is anticipated specify Type 4 enclosures. Type 4 provides a greater degree of protection in dirty and wet environments than does Type 2.

****

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

2.5.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 [Type 3][Type 4] requirements.

2.5.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 [Type 2][Type 4] requirements.

2.5.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.6.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.6.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG (1.02 mm diameter) 18 AWG copper or thicker wire rated for 300-volt service.

2.6.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG (1.02 mm diameter) 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 50 mm (2 inch) 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.6.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.6.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

PART 3 EXECUTION

[3.1 EXISTING CONDITIONS

****

NOTE: For renovation or retrofits keep this paragraph dealing with existing conditions. For new constructions existing conditions generally does not apply and this paragraph can be removed.

Indicate the required number of copies of the Existing Conditions Report.

****

3.1.1 Existing Conditions Survey

Perform a field survey, including testing and inspection of the equipment to be controlled and submit an Existing Conditions Report documenting the current status and its impact on the Contractor's ability to meet this specification. For those items considered nonfunctional, document the deficiency in the report including explanation of the deficiencies and estimated costs to correct the deficiencies. As part of the report, define the scheduled need date for connection to existing equipment. Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.

Submit [four][_____] copies of the Existing Conditions Report.

3.1.2 Existing Equipment Downtime

Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.

3.1.3 Existing Control System Devices

Inspect, calibrate, and adjust as necessary to place in proper working order all existing devices which are to be reused.

]3.2 INSTALLATION

****

NOTE: This subpart uses tailoring options:

1) Text referring to UFGS 23 09 23.01 will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.

2) Text referring to UFGS 23 09 23.02 will be included if the BACNET or NIAGARA BACNET tailoring options are selected.

****

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, and this Section.

3.2.1 Dielectric Isolation

Provide dielectric isolation where dissimilar metals are used for connection and support. Install control system in a matter that provides clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Install control system such that it does not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.2 Penetrations in Building Exterior

Make all penetrations through and mounting holes in the building exterior watertight.

3.2.3 Device Mounting Criteria

Install devices in accordance with the manufacturer's recommendations and as indicated and shown. Provide a weathershield for all devices installed outdoors. Provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Provide clearance for mechanical and electrical system maintenance; do not not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.4 Labels and Tags

Key all labels and tags to the unique identifiers shown on the As-Built drawings. For labels exterior to protective enclosures provide engraved plastic labels mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but must not be hand written. For tags, provide plastic or metal tags mechanically attached directly to each device or attached by a metal chain or wire.

a. Label all Enclosures and DDC Hardware.

b. Tag Airflow measurement arrays (AFMA) with flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient.

c. Tag duct static pressure taps at the location of the pressure tap

3.2.5 Surge Protection

3.2.5.1 Power-Line Surge Protection

Protect equipment connected to AC circuits to withstand power-line surges in accordance with IEEE C62.41. Do not use fuses for surge protection.

3.2.5.2 Surge Protection for Transmitter and Control Wiring

****

NOTE: Determine if any additional inputs or outputs require surge protection and show the requirement for them on the drawings.

****

Protect DDC hardware against or provided DDC hardware capable of withstanding surges induced on control and transmitter wiring installed outdoors and as shown. Protect equipment against the following two waveforms:

a. A waveform with a 10-microsecond rise time, a 1000-microsecond decay time and a peak current of 60 amps.

b. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

3.2.6 Basic Cybersecurity Requirements

****

NOTE: For each reference to Section 25 05 11, use the bracketed text in the Section number to add forth level numbering if used on the project as described in UFC 4-010-06. In the Section name, keep the bracketed text if the section was unnamed or use the empty brackets provided to change the Section name to match the project specifications.

****

3.2.6.1 Passwords

Password development and the Password Summary Report submittal must comply with Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS.

3.2.6.2 Wireless Capability

Wireless capabilities must comply with Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS..

3.2.6.3 IP Network Physical Security

IP network physical security must comply with Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS.

3.3 DRAWINGS AND CALCULATIONS

****

NOTE: Most contractor drawings are updated Contract Drawings. Therefore, it is important that the contract drawing package is complete.

Drawing package content is discussed in UFC 3-410-02 and UFC 3-410-07. Template drawings are available online at Whole Building Design Guide page for this section:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-

Many requirements in this specification refer to the Points Schedules so it is critical that complete Points Schedules are part of the Contract Drawings.

A Riser Diagram is not a required part of the Contract Drawings but you may wish to include a Riser Diagram in the contract drawings to show project specific requirements such as DDC Hardware locations etc.

Select a drawing size, (approx 279x432 mm 11x17 inch or 557x860 mm 22x34 inch) or to leave to leave it up to the Contractor.

Select an electronic submittal format in coordination with the project site. Be sure to require drawings in a format that is usable by the site maintenance staff. This may require including multiple format requirements here.

****

Provide drawings in the form and arrangement indicated and shown. Use the same abbreviations, symbols, nomenclature and identifiers shown. Assign a unique identifier as shown to each control system element on a drawing. When packaging drawings, group schedules by system. When space allows, it is permissible to include multiple schedules for the same system on a single sheet. Except for drawings covering all systems, do not put information for different systems on the same sheet.

Submit hardcopy drawings on [ISO A1 841 by 594 mm 34 by 22 inches][or][A3 420 by 297 mm 17 by 11 inches] sheets, and electronic drawings in PDF and in [AutoCAD][Microstation][Bentley BIM V8][Autodesk Revit 2013] format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

a. Submit DDC Contractor Design Drawings consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans. Submit DDC Contractor Design Drawings as a single complete package: [_____] hard copies and [_____] copies on CD-ROM.

b. Submit Draft As-Built Drawings consisting of each drawing indicated updated with as-built data for the system prior to PVT. Submit Draft As-Built Drawings as a single complete package: [_____] hard copies and [_____] copies on CD-ROM.

c. Submit Final As-Built Drawings consisting of each drawing indicated updated with all final as-built data. Final As-Built Drawings as a single complete package: [_____] hard copies and [_____] copies on CD-ROM.

3.3.1 Sample Drawings

Sample drawings in electronic format are available at the Whole Building Design Guide page for this section:

http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-23-09-00 These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. Note that these drawings do not meet the content requirements of this Section and must be completed to meet project requirements.

3.3.2 Drawing Index and Legend

Provide an HVAC Control System Drawing Index showing the name and number of the building, military site, State or other similar designation, and Country. In the Drawing Index, list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. In the Design Drawing Legend, show and describe all symbols, abbreviations and acronyms used on the Design Drawings. Provide a single Index and Legend for the entire drawing package.

3.3.3 Thermostat and Occupancy Sensor Schedule

Provide a thermostat and occupancy sensor schedule containing each thermostat's unique identifier, room identifier and control features and functions as shown. Provide a single thermostat and occupancy sensor schedule for the entire project.

3.3.4 Valve Schedule

Provide a valve schedule containing each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. In the valve schedule include actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. Provide a single valve schedule for the entire project.

3.3.5 Damper Schedule

Provide a damper schedule containing each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. Include the AMCA 511 maximum leakage rate at the operating static-pressure differential for each damper in the Damper Schedule. Provide a single damper schedule for the entire project.

3.3.6 Project Summary Equipment Schedule

Provide a project summary equipment schedule containing the manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a single project equipment schedule for the entire project.

3.3.7 Equipment Schedule

Provide system equipment schedules containing the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a separate equipment schedule for each HVAC system.

3.3.8 Occupancy Schedule

Provide an occupancy schedule drawing containing the same fields as the occupancy schedule Contract Drawing with Contractor updated information. Provide a single occupancy schedule for the entire project.

3.3.9 DDC Hardware Schedule

Provide a single DDC Hardware Schedule for the entire project and including following information for each device.

3.3.9.1 DDC Hardware Identifier

The Unique DDC Hardware Identifier for the device.

3.3.9.2 HVAC System

The system "name" used to identify a specific system (the name used on the system schematic drawing for that system).

3.3.9.3 LonWorks Device Information

****

NOTE: This subpart and its subparts are required only for LonWorks systems and are included only when the LNS or NIAGARA LONWORKS tailoring options are selected.

****

3.3.9.3.1 Network Address

The LonWorks Domain, Subnet and Node address for the device.

3.3.9.3.2 Unique Node ID

The Unique 48-bit Node ID associated with the device. (Also referred to as the Neuron ID for some devices)

3.3.9.4 BACnet Device Information

****

NOTE: This subpart and its subparts are required only for BACnet systems and are included only when the BACNET or NIAGARA BACNET tailoring options are selected.

****

3.3.9.4.1 Device Object Identifier

The Device Object Identifier: The Object_Identifier of the Device Object

3.3.9.4.2 Network Number

The Network Number for the device.

3.3.9.4.3 MAC Address

The MAC Address for the device

3.3.9.4.4 BTL Listing

The BTL Listing of the device. If the device is listed under multiple BTL Profiles, indicate the profile that matches the use and configuration of the device as installed.

3.3.9.4.5 Proprietary Services Information

If the device uses non-standard ASHRAE 135 services as defined and permitted in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, indicate that the device uses non-standard services and include a description of all non-standard services used. Describe usage and content such that a device from another vendor can interoperate with the device using the non-standard service. Provide descriptions with sufficient detail to allow a device from a different manufacturer to be programmed to both read and write the non-standard service request:

a. read: interpret the data contained in the non-standard service and;

b. write: given similar data, generate the appropriate non-standard service request.

3.3.9.4.6 Alarming Information

Indicate whether the device is used for alarm generation, and which types of alarm generation the device implements: intrinsic, local algorithmic, remote algorithmic.

3.3.9.4.7 Scheduling Information

Indicate whether the device is used for scheduling.

3.3.9.4.8 Trending Information

Indicate whether the device is used for trending, and indicate if the device is used to trend local values, remote values, or both.

3.3.9.5 Niagara Station ID

****

NOTE: This subpart is required only for Niagara Framework systems and is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring options are selected.

****

The Niagara Station ID for each Niagara Framework Supervisory Gateway

3.3.10 Points Schedule

Provide a Points Schedule in tabular form for each HVAC system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.

a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing with updated information in addition to the indicated fields.

b. When Point Schedules are included in the contract package, items requiring contractor verification or input have been shown in angle brackets ("<" and ">"), such as <___> for a required entry or <value> for a value requiring confirmation. Complete all items in brackets as well as any blank cells. Do not modify values which are not in brackets without approval.

Points Schedule Columns must include:

3.3.10.1 Point Name

The abbreviated name for the point using the indicated naming convention.

3.3.10.2 Description

A brief functional description of the point such as "Supply Air Temperature".

3.3.10.3 DDC Hardware Identifier

The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.

3.3.10.4 Settings

The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.

3.3.10.5 Range

The range of values, including units, associated with the point, including but not limited to a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety.

3.3.10.6 Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entries in this column:

a. AI: The value comes from a hardware (physical) Analog Input

b. AO: The value is output as a hardware (physical) Analog Output

c. BI: The value comes from a hardware (physical) Binary Input

d. BO: The value is output as a hardware (physical) Binary Output

e. PULSE: The value comes from a hardware (physical) Pulse Accumulator Input

f. NET-IN: The value is provided from the network (generally from another device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.

g. NET-OUT: The value is provided to another controller over the network. Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

3.3.10.7 Object and Property Information

****

NOTE: This subpart is required only for BACnet systems and is included only when the BACNET or NIAGARA BACNET tailoring options are selected.

****

The Object Type and Instance Number for the Object associated with the point. If the value of the point is not in the Present_Value Property, then also provide the Property ID for the Property containing the value of the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

3.3.10.8 Primary Point Information: SNVT Name

****

NOTE: This subpart is required only for LonWorks systems and is included only when the LNS or NIAGARA LONWORKS tailoring options are selected.

****

The name of the SNVT used for the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

3.3.10.9 Primary Point Information: SNVT Type

****

NOTE: This subpart is required only for LonWorks systems and is included only when the LNS or NIAGARA LONWORKS tailoring options are selected.

****

The SNVT type used by the point. Provide this information whenever SNVT Name is required.

3.3.10.10 Niagara Station ID

****

NOTE: This subpart is required only for Niagara Framework systems and is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring options are selected.

****

The Niagara Station ID of the Niagara Framework Supervisory Gateway the point is mapped into.

3.3.10.11 Network Data Exchange Information (Gets Data From, Sends Data To)

****

NOTE: This subpart is required only for BACnet systems and is included only when the BACNET or NIAGARA BACNET tailoring options are selected.

****

Provide the DDC Hardware Identifier of other DDC Hardware the point is shared with.

3.3.10.12 Override Information (Object Type and Instance Number)

****

NOTE: This subpart is required only for BACnet systems and is included only when the BACNET or NIAGARA BACNET tailoring options are selected.

In addition this subpart uses tailoring options: The text referring to Niagara Framework is only included when the NIAGARA BACNET tailoring option is selected.

****

For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate if the Object for the point is Commandable or, if the use of a separate Object was specifically approved by the Contracting Officer, provide the Object Type and Instance Number of the Object to be used in overriding the point.

3.3.10.13 Override Information (SNVT Name and Type)

****

NOTE: This subpart is required only for LonWorks systems and is included only when the LNS or NIAGARA LONWORKS tailoring options are selected.

In addition this subpart uses tailoring options: The text referring to Niagara Framework is only included when the NIAGARA LONWORKS tailoring option is selected.

****

For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate the SNVT Name and SNVT Type of the network variable used for the override.

3.3.10.14 Trend Object Information

****

NOTE: This subpart is required only for non Niagara Framework based BACnet systems and is included only when the NIAGARA BACNET tailoring option is selected.

****

For each point requiring a trend, indicate if the trend is Local or Remote, the trend Object type and the trend Object instance number. For remote trends provide the DDC Hardware Identifier for the device containing the trend Object in the Points Schedule notes.

3.3.10.15 Alarm Information

****

NOTE: This subpart is required only for BACnet systems and is included only when the BACNET or NIAGARA BACNET tailoring options are selected.

****

****

NOTE: The following paragraph is included only when the BACNET tailoring option is selected.

****

Indicate the Alarm Generation Type, Event Enrollment Object Instance Number, and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have Event Enrollment Objects.)

****

NOTE: The following paragraph is included only when the NIAGARA BACNET tailoring option is selects.

****

For Niagara BACnet systems: Indicate the Alarm Generation Type and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have a Notification Class Object.)

3.3.10.16 Configuration Information

****

NOTE: The next paragraph uses tailoring options. Text after the first sentence is included only when the NIAGARA BACNET or NIAGARA LONWORKS tailoring option is selected.

****

Indicate the means of configuration associated with each point. For points in a Niagara Framework Supervisory Gateway, indicate the point within the Niagara Framework Supervisory Gateway used to configure the value. For other points:

****

NOTE: The following TWO list paragraphs are included only when the BACNET or NIAGARA BACNET tailoring option is selected.

****

a. For Operator Configurable Points indicate BACnet Object and Property information (Name, Type, Identifiers) containing the configurable value. Indicate whether the property is writable always, or only when Out_Of_Service is TRUE.

b. For Configurable Points indicate the BACnet Object and Property information as for Operator Configurable points, or identification of the configurable settings from within the engineering software for the device or identification of the hardware settings on the device.

****

NOTE: The following TWO list paragraphs are included only when the LNS or NIAGARA LONWORKS tailoring option is selected. In addition:
1) References to LNS plug-ins are included only when the LNS tailoring option is selected.
2) References to Niagara Framework Wizards are included only when the NIAGARA LONWORKS tailoring option is selected.
****

a. Indicate "Plug-In" if the point is configurable via an LNS plug-in. Indicate "Niagara Framework Wizard" if the point is configurable via a Niagara Framework Wizard.

b. If the point is not configurable through an LNS plug-ina Niagara Framework Wizard, indicate the network variable or configuration property used to configure the value.

3.3.11 Riser Diagram

The Riser Diagram of the Building Control Network may be in tabular form, and must show all DDC Hardware and all Network Hardware, including network terminators. For each item, provide the unique identifier, common descriptive name, physical sequential order (previous and next device on the network), room identifier and location within room. A single riser diagram must be submitted for the entire system.

3.3.12 Control System Schematics

Provide control system schematics in the same form as the control system schematic Contract Drawing with Contractor updated information. Provide a control system schematic for each HVAC system.

3.3.13 Sequences of Operation[Including Control Logic Diagrams]

****
NOTE: Require Control Logic Diagrams if they have been included in the contract drawing or if the intent is to require the contractor to develop them. If requiring contractor to develop control logic diagrams provide at least one sample to establish format. If not requiring control logic diagrams remove bracketed text.
****

Provide HVAC control system sequence of operation and [control logic diagrams] in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation[and control logic diagrams] for each HVAC system

3.3.14 Controller, Motor Starter and Relay Wiring Diagram

Provide controller wiring diagrams as functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. Show necessary jumpers and ground connections and the labels of all conductors. Identify sources of power required for control systems and for packaged equipment control systems back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Show each power supply and transformer not integral to a controller, starter, or packaged equipment. Show the connected volt-ampere load and the power supply volt-ampere rating. Provide wiring diagrams for each HVAC system.

3.4 CONTROLLER TUNING

Tune each controller in a manner consistent with that described in the ASHRAE FUN SI ASHRAE FUN IP and in the manufacturer's instruction manual. Tuning must consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop must be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable must settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output must be steady. With the exception of naturally slow processes such as zone temperature control, the controller must settle out at the new setpoint within five (5) minutes. Set the controller to its correct setpoint and record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.5 START-UP

3.5.1 Start-Up Test

Perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

Adjust, calibrate, measure, program, configure, set the time schedules, and otherwise perform all necessary actions to ensure that the systems function as indicated and shown in the sequence of operation and other contract documents.

3.5.1.1 Systems Check

An item-by-item check must be performed for each HVAC system

3.5.1.1.1 Step 1 - System Inspection

****

NOTE: If the specification has been edited to include M&C Software (from Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION), include the requirement to inspect M&C Clients to make sure they display shutdown conditions. Otherwise, remove the bracketed text referring to M&C Client

****

With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, verify that power and main air are available where required and that all output devices are in their failsafe and normal positions. Inspect each local display panel [and each M&C Client] to verify that all displays indicate shutdown conditions.

3.5.1.1.2 Step 2 - Calibration Accuracy Check

Perform a two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter by comparing the value from the test instrument to the network value provided by the DDC Hardware. Use digital indicating test instruments, such as digital thermometers, motor-driven psychrometers, and tachometers. Use test instruments with accuracy at least twice as accurate as the specified sensor accuracy and with calibration traceable to National Institute of Standards and Technology standards. Check one the first check point in the bottom one-third of the sensor range, and the second in the top one-third of the sensor range. Verify that the sensing element-to-DDC readout accuracies at two points are within the specified product accuracy tolerances, and if not recalibrate or replace the device and repeat the calibration check.

3.5.1.1.3 Step 3 - Actuator Range Check

With the system running, apply a signal to each actuator through the DDC Hardware controller. Verify proper operation of the actuators and positioners for all actuated devices and record the signal levels for the extreme positions of each device. Vary the signal over its full range, and verify that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, verify that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. For valve actuators and damper actuators, perform the actuator range check under normal system pressures.

3.5.1.2 Weather Dependent Test

Perform weather dependent test procedures in the appropriate climatic season.

3.5.2 Start-Up Testing Report

Submit [4] [_____] copies of the Start-Up Testing Report. The report may be submitted as a Technical Data Package documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

3.5.3 Draft LNS Database

****

NOTE: This subpart is required only for LNS-based LonWorks systems and is included only when the LNS tailoring options is selected.

****

Upon completion of the Start-Up Test, submit the Draft LNS Database reflecting the system as installed and configured at the completion of the Start-Up and Start-Up-Testing. The Draft LNS Database must be a complete, fully commissioned LNS database for the complete control network provided under this specification. The Draft LNS database submittal must consist of the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, the provided LNS Database must include all device credits.

Submit two copies of the fully commissioned, valid draft LNS Database (including all LNS credits) as a Technical Data Package. Submit each copy on a CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

3.6 PERFORMANCE VERIFICATION TEST (PVT)

****

NOTE: This subpart does not apply to Navy projects, and is included only when the ARMY, AIR FORCE or SERVICE GENERIC tailoring option is selected.

****

3.6.1 PVT Procedures

****

NOTE: The designer must decide whether to require a one-point accuracy check and/or inlet and outlet air temperature measurements. Project specific requirements should be added, particularly for problematic controls based on designer and user experience.

****

Prepare PVT Procedures based on Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM TESTING explaining step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. Submit [4] [_____] copies of the PVT Procedures. The PVT Procedures may be submitted as a Technical Data Package.

3.6.1.1 Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

3.6.1.2 Temporary Trending Hardware

****

NOTE: This subpart is required only for LNS-based LonWorks systems and is included only when the LNS tailoring options is selected.

****

****

NOTE: For LNS-based LonWorks, trending is accomplished at the UMCS Front End, and the building control system will generally not be integrated into the UMCS during PVT. In this case additional hardware to perform trending will be required.

****

Unless trending capability exists within the building control system or the building control system is connected to a UMCS or other system which can perform trending, temporarily install hardware on the building control network to perform trending during the endurance test as indicated. Remove the temporary hardware at the completion of all commissioning activities.

3.6.1.3 Endurance Test

****
NOTE: Select the duration of the endurance test.
****

****
NOTE: This subpart uses tailoring options:
1) The paragraph requiring the use of BACnet Trend Log Objects is included only when the BACNET tailoring option is selected.

2) The paragraph requiring the use of a Niagara Trend Log Object is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring option is selected. The last sentence of the paragraph (which requires measuring TP/FT-10 bandwidth) is only included when the NIAGARA LONWORKS tailoring option is selected.

3) The paragraph referring to existing trend capabilities and temporary trending hardware is included only when the LNS tailoring option is selected.

4) The sentence requiring the measurement of bandwidth on TP/FT-10 is included only when the LNS or NIAGARA LONWORKS tailoring option is selected

****

Include a [one-week] [_____] endurance test as part of the PVT during which the system is operated continuously.

Use the building control system BACnet Trend Log or Trend Log Multiple Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost.

Use the building control system Niagara Trend Log Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.

Use the existing trending capabilities or the Temporary Trending Hardware as indicated to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.

3.6.1.4 PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment, include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

3.6.2 PVT Execution

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, software capable of reading and writing COV Notification Subscriptions, Notification Class Recipient List Properties, event enrollments, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. Do not start the performance verification test until after receipt of written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT, repair the system repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period.

3.6.3 PVT Report

****

NOTE: Indicate the required number of copies for the PVT Report.

****

Prepare and submit a PVT report documenting all tests performed during the PVT and their results. Include all tests in the PVT procedures and any additional tests performed during PVT. Document test failures and repairs conducted with the test results.

Submit [four][_____] copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

3.6.4 Final LNS Database

****

NOTE: This subpart is required only for LNS-based LonWorks systems and is included only when the LNS tailoring options is selected.

****

Submit a Final LNS Database consisting of the complete, fully commissioned LNS database for the complete control network provided under this specification. Provide the the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, include all device credits in the provided LNS Database.

Submit two copies of the fully commissioned, valid as-built LNS Database (including all LNS credits) for the complete control network provided under this specification as a Technical Data Package. Submit each copy on CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

3.7 PERFORMANCE VERIFICATION TESTING

****

NOTE: This subpart and its subparts are the PVT requirements for Navy projects and are included only when the NAVY tailoring option is selected.

****

3.7.1 General

****

NOTE: Indicate the number of days before installation for the pre-PVT meeting, and the meeting attendees.

****

PVT testing must demonstrate compliance of controls work with contract document requirements and must be performed by the Controls Contractor and Equipment Suppliers. No less than [14][__] calendar days prior to start of controls system installation, meet with the Contracting Office's technical representative (COTR) [and the designing engineer of the HVAC systems], the Contractor's QA representative, the Contractor's Controls Contractor representative,[and the control system Owner] to develop a mutual understanding relate to the details of the PVT work requirements, including required submittals, work schedule, and field quality control.

3.7.2 Performance Verification Testing and Commissioning

PVT testing is a Government quality assurance function that includes systems trending and field tests. Commissioning is a quality control function that is the Commissioning Team’s responsibility to the extent required by this contract.

3.7.3 Performance Verification Testing of Equipment with Packaged Controls

Controls Contractor and Equipment Supplier(s) must share and coordinate PVT testing responsibilities for equipment provided with on-board factory packaged controls such as boiler controllers, dedicated outside air systems (DOAS’s), and packaged pumping systems.

3.7.3.1 Controls Contractor Responsibilities

The Controls Contractor must provide a PVT Plan separate from Equipment Supplier’s performance verification testing plan, perform endurance testing, and perform PVT testing concurrent with Equipment Suppliers’ testing for equipment provided with on-board factory packaged controls to demonstrate the following:

a. Equipment enabling and disabling.

b. Equipment standard and optional control points necessary to accomplish functionality regardless if specified in contract documents or not.

c. Equipment standard and optional alarms critical to safe operation regardless if specified in contract documents or not.

d. All control points added by Controls Contractor in addition to onboard factory packaged controls regardless if specified in contract documents or not.

Refer to paragraphs titled “Performance Verification Test Plan” and “Endurance Testing” for additional information.

3.7.3.2 Equipment Supplier Responsibilities

Each Equipment Supplier must provide PVT Plans separate from Controls Contractor’s plans and perform PVT testing concurrent with Controls Contractor’s testing for their equipment provided with on-board factory packaged controls to demonstrate the following:

a. Equipment standard and optional control features necessary to accomplish functionality regardless if specified in contract documents or not.

b. Equipment standard and optional operation modes necessary to accomplish functionality regardless if specified in contract documents or not.

c. Equipment standard and optional alarm conditions for safe operation regardless if specified in contract documents or not.

Refer to all paragraphs under paragraph titled “Performance Verification Testing” except for section titled “Endurance Testing” for additional information.

3.7.4 Sequencing of Performance Verification Testing Activities

PVT activities must be sequenced with major activities listed below for Test and Balance (TAB) Contractor, Equipment Suppliers, Commissioning Specialists, and others to demonstrate fully functioning systems. Refer to Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS). Complete the items in TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES as schedule activities or milestones.

TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES

SEQUENCE	ITEM
1	Submission, review, and approval of Control Contractors PVT Plans.
2	Submission, review, and approval of Equipment Suppliers PVT Plans.
3	Submission, review, and approval of certified final Test and Balance Report.
4	Conduct commissioning functional performance tests.
5	Submission, review, and approval of all of the Commissioning Specialists completed functional performance tests.
6	Request Contracting Officer to allow beginning of Government-witnessed PVT testing.

TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES	
SEQUENCE	ITEM
7	Contracting Officers approval to begin PVT testing.
8	Conduct PVT field work.
9	Governments verbal approval of PVT field work for all systems.
10	Conduct Test and Balance verification field work.
11	Governments written approval of Test and Balance verification field work.
12	Submission, review, and approval of endurance testing.
13	Governments written approval of PVT field work for all systems.
14	Facility acceptance recommendation.
15	Submission, review, and approval of Control Contractors PVT Report.
16	Submission, review, and approval of Equipment Suppliers PVT Report.
17	Conduct applicable re-testing and seasonal testing within 10 months of beneficial occupancy.

3.7.4.1 PVT Testing for Multi-Phase Construction

For air moving systems except outside air systems serving multiple phases, all major activities listed in TABLE III through Government’s verbal approval of Test and Balance verification field work can be completed by phase if all ductwork construction is completed for that phase.

For primary systems such as chilled water systems, HVAC heating hot water systems, and outside air systems serving multiple phases, all major activities listed listed in TABLE III through Government’s verbal approval of Test and Balance verification field work for all air moving systems served by that primary system for that phase must be completed prior to conducting PVT field work for that primary system.

3.7.5 Control Contractor's Performance Verification Testing Plan

Submit a detailed PVT Plan of the proposed control systems testing in this contract for approval prior to its use. Develop and use a single PVT Plan for each system with a unique control sequence. Systems sharing an identical control sequence can be tested using copies of the PVT Plan intended for these systems.

PVT Plans must include system-based, step-by-step test methods demonstrating system performs in accordance with contract document requirements. The Government may provide sample PVT Plans upon request. PVT Plans must include the following:

a. Control sequences from contract documents segmented such that each control algorithm, operation mode, and alarm condition is immediately followed by numbered test methods required to initiate a response, expected response, space for comments, and “pass" or "fail” indication for each expected response.

b. PVT Plans with control sequences from contract documents that are not segmented into parts will not be accepted.

c. Indication where assisting personnel are required such as Mechanical Contractor.

d. Signature and date lines for the Contractor's PVT administrator, Contractor's quality assurance representative, and Contracting Officer's representative acknowledging completion of testing.

3.7.6 Performance Verification Testing Sample Size

PVT testing sample sizes will be as follows:

a. 100-Percent of the following systems:

  (1) primary systems including, but not limited to, chilled water and HVAC heating hot water systems

  (2) air handling unit systems including all associated fans except for remote exhaust air fans

  (3) DOAS’s including all associated fans except for remote exhaust air fans

b. 20-Percent of each set of systems with a shared identical control sequence for systems such as:

  (1) air terminal units

  (2) exhaust air fans

  (3) terminal equipment such as fan coil units and unit heaters

3.7.6.1 Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if previous testing results are inconsistent or demonstrate improper system control as follows:

a. An additional 25-percent after five-percent failure rate of first sample set.

b. 100-percent after any failures occurring in additional sample set.

3.7.7 Conducting Performance Verification Testing

At least 15 days prior to preferred test date, request the Contracting Officer to allow the beginning of Government-witnessed PVT testing. Provide an estimated time table required to perform testing of each system. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of testing. Testing personnel must be regularly employed in the testing and calibration of control systems. After receipt of Contracting Officer’s approval to begin testing, perform PVT testing using project's as-built (shop) control system drawings, project's design drawings, and approved PVT Plans.

During testing, identify deficiencies that do not meet contract document requirements. Deficiencies must be investigated, corrected with corrections documented, and re-tested at a later date following procedures for the initial PVT testing. The Government may require re-testing of any control system components affected by the original failed test.

3.7.8   Endurance Testing

3.7.8.1   General

Conduct endurance testing in conjunction with the PVT to demonstrate control loop stability and accuracy. For all control loops tested, record trend data of the control variables over time, demonstrating that the control loop responds to a sudden change of the control variable set point without excessive overshoot or undershoot. Conduct endurance testing for each system subject to PVT testing. Systems must be operating as normally anticipated during occupancy throughout endurance testing.

Endurance testing results must clearly demonstrate control loop stability and accuracy. Controlled loop outputs must be stable and accurately maintain each setpoint.

3.7.8.2   Hardware

****

NOTE: Select “Use hardware provided in this contract for testing.” only when a workstation is provided in this scope of work.

****

[Use hardware provided in this contract for testing.] [Use Government furnished hardware for testing if available when endurance testing begins. If unavailable, the Contractor must provide suitable hardware for required testing.]

If insufficient buffer capacity exists to trend the entire endurance test, upload trend data during the course of endurance testing to ensure all trend data is retained. Lost trend data will require retesting of all control points for affected system(s).

3.7.8.3   Endurance Testing Results Format

Submit endurance testing results for each tested system in a graphical format complete with clear indication of value(s) for y-axis, value for x-axis, and legend identifying each trended control point. The number of control points contained on a single graph must be such that all control points can be clearly visible. Control points must be logically grouped such that related points appear on a single graph. In addition, submit a separate comma separated value (CSV) file of raw trend data for each trended system. Each trended control point in CSV file must be clearly identified.

For control points recorded based on change of value, change of value for recording data must be clearly identified for each control point.

3.7.8.4 Endurance Testing Start, Duration, and Frequency

****

NOTE: Select duration and frequency of data collection.

****

Trending of all control points for a given system must start at an identical date and time regardless of the basis of data collection. Duration of all endurance tests must be at least [one-week][_____].

Unless specified otherwise for control points recorded based on time, frequency of data collection must be [15-minutes] [_____]. Frequency of data collection for specific types of control points is as follows:

3.7.8.4.1 Points Trended at One Minute Intervals

a. Temperature for supply air, return air, mixed air, supply water, and return water

b. Temperature for outside air, supply air, return air and exhaust air entering and leaving energy recovery device

c. Flow for supply air, return air, outside air, chilled water, and HVAC heating hot water

d. Flow for exhaust air associated with energy recovery

e. Relative humidity for outside air and return air

f. Relative humidity for outside air, supply air, return air and exhaust air entering and leaving energy recovery device

g. Command and status for control dampers and control valves

h. Speed for fans and pumps

i. Pressure for fans and pumps

3.7.8.4.2 Points Trended at 15 Minute Intervals

a. Temperature and relative humidity for zones

b. Temperature and relative humidity for outside air not associated with energy recovery

c. Command and status for equipment

d. Pressure relative to the outside for facility

3.7.8.5 Trended Control Points

Trended control points for each system must demonstrate each system performs in accordance with contract document requirements. Trended control points must include, but not be limited to, control points listed in contract document points list.

Minimum control points that are required to be trended for selected systems are listed below. These control points must be trended as applicable to this contract in addition to control points necessary to demonstrate systems perform in accordance with contract document requirements and those listed in contract document’s points list.

****

NOTE: Delete systems below if certain they are not in this project. If uncertain, then keep.

****

[3.7.8.5.1 Air-Cooled Chiller Chilled Water System.

a. Chiller(s) command and status

b. Chiller isolation valve(s) command and status

c. Chilled water pump(s) actual speed

d. Chilled water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system flow setpoint and actual flow

g. Chilled water supply setpoint and actual temperature

h. Chilled water return actual temperature

i. Chilled water actual flow

j. Outside air actual dry-bulb temperature

][3.7.8.5.2 HVAC Heating Hot Water System with Boiler.

a. Boiler(s) command and status

b. Boiler(s) isolation valve command and status

c. HVAC heating hot water pump(s) actual speed

d. HVAC heating hot water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system setpoint and actual flow

g. HVAC heating hot water supply setpoint and actual temperature

h. HVAC heating hot water return actual temperature

i. HVAC heating hot water actual flow

j. Outside air actual dry-bulb temperature

][3.7.8.5.3 HVAC Heating Hot Water System with Steam-to-Hot Water Heat Exchanger.

a. Steam control valve(s) command

b. Heat exchanger isolation valve(s) command and status

c. HVAC heating hot water pump(s) actual speed

d. HVAC heating hot water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system setpoint and actual flow

g. HVAC heating hot water supply setpoint and actual temperature

h. HVAC heating hot water return actual temperature

i. HVAC heating hot water actual flow

j. Outside air actual dry-bulb temperature

][3.7.8.5.4 Air Handling Unit with Relief Air Fan

a. Outside air actual dry-bulb temperature

b. Outside air actual relative humidity

c. Outside air setpoint and actual airflow

d. Minimum outside air control damper command

e. Economizer outside air control damper command

f. Facility setpoint and actual relative pressure

g. Return air actual dry-bulb temperature

h. Return air actual relative humidity

i. Return air control damper command

j. Relief air control damper command

k. Relief air fan actual speed

l. Mixed air setpoint and setpoint and actual temperature

m. Preheat coil leaving air setpoint and actual temperature

n. Preheat coil control actuator command

o. Cooling coil leaving air setpoint and actual temperature

p. Cooling coil control valve command

q. Supply air fan actual speed

r. Discharge air actual temperature

s. Supply air fan setpoint and actual static pressure

][3.7.8.5.5 Dedicated Outside Air System (DOAS)

a. Outside air actual dry-bulb temperature

b. Outside air actual relative humidity

c. Outside air isolation damper command and status

d. Outside air setpoint and actual airflow

e. Energy recovery wheel command, status, and actual speed

f. Energy recovery wheel’s OA bypass control damper command and status

g. Energy recovery wheel’s defrost cycle command and status

h. Energy recovery wheel’s OA discharge air actual dry-bulb temperature

i. Energy recovery wheel’s OA discharge air actual relative humidity

j. Preheat coil leaving air setpoint and actual temperature

k. Preheat coil control actuator command

l. Cooling coil leaving air setpoint and actual temperature

m. Cooling coil control valve command

n. Supply air fan actual speed

o. Reheat coil control valve command

p. Discharge air setpoint and actual temperature

q. Supply air fan setpoint and actual static pressure

r. Facility setpoint and actual relative pressure

s. Return air actual dry-bulb temperature

t. Return air actual relative humidity

u. Energy recovery wheel’s EA bypass control damper command and status

v. Energy recovery wheel’s EA discharge air actual dry-bulb temperature

w. Energy recovery wheel’s EA discharge air actual relative humidity

x. Exhaust air fan actual speed

y. Exhaust air isolation damper command and status

][3.7.8.5.6 Series Fan-Powered Supply Air Terminal Units

a. Zone setpoint and actual dry-bulb temperature

b. Zone actual relative humidity

c. Control damper command

d. Fan command and status

e. Heating coil valve command

f. Airflow actual value

g. Leaving air actual temperature

]3.7.8.6 Endurance Testing Sample Size

Endurance Testing sample sizes ware as follows:

a. 100-Percent of the following systems:

  (1) primary systems including, but not limited to, chilled water and HVAC heating hot water systems

  (2) air handling unit systems including all associated fans except for remote exhaust air fans

  (3) DOAS’s including all associated fans except for remote exhaust air fans

b. 20-Percent of each set of systems with a shared identical control sequence for systems such as:

  (1) air terminal units

  (2) exhaust air fans

  (3) terminal equipment such as fan coil units and unit heaters

3.7.8.6.1 Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if previous testing results are inconsistent or demonstrate improper system control as follows:

a. An additional 25-percent after five-percent failure rate of first sample set.

b. 100-percent after any failures occurring in additional sample set.

3.7.9 Performance Verification Test Report

Submit a PVT Report after receiving Government’s written approval of PVT field work that is intended to document test results and final control system sequences and settings prior to turnover. The PVT Report must contain the following:

a. Executive summary that briefly discusses results of each system’s endurance testing and PVT testing and conclusions for each system.

b. Endurance testing for each system.

c. Completed PVT Plan for each system used during testing that includes hand written field notes and participant signatures.

d. Blank PVT Plan for each system approved prior to testing that is edited to reflect changes occurring during testing. Edits must be typed and must reflect changes to control sequences from contract documents, must reflect changes to numbered test methods required to initiate a response, and must reflect changes to expected response. Only one blank PVT Plan is required for each set of systems sharing an identical control sequence, such as air terminal units, exhaust air fans, fan coil units and unit heaters.

e. Written certification that the installation and testing of all systems are complete and meet all contract document requirements.

3.8 FINAL LNS DATABASE

****

NOTE: This subpart is required only for LNS-based LonWorks systems and is included only when the LNS tailoring option is selected.

****

Submit a Final LNS Database consisting of the complete, fully commissioned LNS database for the complete control network provided under this specification. Provide the the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, include all device credits in the provided LNS Database.

Submit two copies of the fully commissioned, valid as-built LNS Database (including all LNS credits) for the complete control network provided under this specification as a Technical Data Package. Submit each copy on CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

3.9 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide HVAC control System Operation and Maintenance Instructions which include:

a. "Data Package 3" as indicated in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.

b. "Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.

c. HVAC control system sequences of operation formatted as indicated.

d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.

e. As-built HVAC control system detail drawings formatted as indicated.

f. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the frequency of the maintenance activity, and the fourth column is used for additional comments or reference.

g. Qualified service organization list, including at a minimum company name, contact name and phone number.

h. Start-Up Testing Report.

i. Performance Verification Test (PVT) Procedures and Report.

Submit [2] [_____] copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions may be submitted as a Technical Data Package.

[3.10 MAINTENANCE AND SERVICE

****

NOTE: The maintenance and service to be provided by the Contractor for the duration of the maintenance contract is specified in this paragraph. The Maintenance and Service may need to be a separate bid item funded by O&M funds.

Requirements should be coordinated with "WARRANTY MANAGEMENT" in Section 01 78 00 CLOSEOUT SUBMITTALS

If not requiring 1 year maintenance and service, delete this subpart. Most Navy projects will not use this requirement.

****

Provide services, materials and equipment as necessary to maintain the entire system in an operational state as indicated for a period of one year from the date of final acceptance of the project. Minimize impacts on facility operations.

a. The integration of the system specified in this section into a Utility Monitoring and Control System must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period. Integration into a UMCS includes but is not limited to establishing communication between devices in the control system and the front end or devices in another system.

b. The changing of configuration properties must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period.

3.10.1 Description of Work

Provide adjustment and repair of the system including the manufacturer's required sensor and actuator (including transducer) calibration, span and range adjustment.

3.10.2 Personnel

Use only service personnel qualified to accomplish work promptly and satisfactorily. Advise the Government in writing of the name of the designated service representative, and of any changes in personnel.

3.10.3 Scheduled Inspections

****

NOTE: Indicate when inspections are to be scheduled.

****

Perform two inspections at six-month intervals and provide work required. Perform inspections in [June and December][_____]. During each inspection perform the indicated tasks:

a. Perform visual checks and operational tests of equipment.

b. Clean control system equipment including interior and exterior surfaces.

c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all binary inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining binary inputs and outputs during the second inspection. If more than 20 percent of checked inputs or outputs failed the calibration check during any inspection, check and recalibrate all inputs and outputs during that inspection.

d. Run system software diagnostics and correct diagnosed problems.

e. Resolve any previous outstanding problems.

3.10.4 Scheduled Work

****

NOTE: Include bracketed text to accept default work times or indicate permissible work times in the space provided.

****

This work must be performed [during regular working hours, Monday through Friday, excluding Federal holidays][_____].

3.10.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel must be available to provide service to the system. A telephone number where the service supervisor can be reached at all times must be provided. Service personnel must be at the site within 24 hours after receiving a request for service. The control system must be restored to proper operating condition as required per Section 01 78 00 CLOSEOUT SUBMITTALS.

3.10.6 Operation

After performing scheduled adjustments and repairs, verify control system operation as demonstrated by the applicable tests of the performance verification test.

3.10.7 Records and Logs

Keep dated records and logs of each task, with cumulative records for each major component, and for the complete system chronologically. Maintain a continuous log for all devices, including initial analog span and zero calibration values and digital points. Keep complete logs and provide logs for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

3.10.8 Work Requests

Record each service call request as received and include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. Submit a record of the work performed within 5 days after work is accomplished.

3.10.9 System Modifications

Submit recommendations for system modification in writing. Do not make system modifications, including operating parameters and control settings, without prior approval of the Government.

]3.11 TRAINING

****

NOTE: Training requirements should be coordinated with the relevant shop organization at the project site. Extent of training should be based on the needs of the installation personnel.

****

Conduct a training course for [_____] operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. Conduct [32] [_____] hours of training at the project site within 30 days after successful completion of the performance verification test. The Government reserves the right to make audio and visual recordings (using Government supplied equipment)of the training sessions for later use. Provide audiovisual equipment and other training materials and supplies required to conduct training. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.11.1 Training Documentation

****

NOTE: Designer must choose appropriate shop supervisor(s) to coordinate training attendance.

****

Prepare training documentation consisting of:

a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the [Controls][HVAC][Electrical] shop supervisor.

b. Training Manuals: Provide training manuals which include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. When presenting portions of the course material by audiovisuals, deliver copies of those audiovisuals as a part of the printed training manuals.

3.11.2 Training Course Content

For guidance in planning the required instruction, assume that attendees will have a high school education, and are familiar with HVAC systems. During the training course, cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. Present the results of the performance verification test and the Start-Up Testing Report as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

3.11.3 Training Documentation Submittal Requirements

****

NOTE: Indicate number of additional copies of training material required.

****

Submit hardcopy training manuals and all training materials on CD-ROM. Provide one hardcopy manual for each trainee on the Course Attendee List and [2][_____] additional copies for archive at the project site. Provide [2][_____] copies of the Course Attendee List with the archival copies. Training Documentation may be submitted as a Technical Data Package.

APPENDIX A

QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS

This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.

Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.

This checklist is for (circle one:)

Pre-Construction QC Checklist Submittal

Post-Construction QC Checklist Submittal

Close-out QC Checklist Submittal

Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:

1	All DDC Hardware is numbered on Control System Schematic Drawings.	|____|
2	Signal lines on Control System Schematic are labeled with the signal type.	|____|
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	|____|

Items verified for Post-Construction and Closeout QC Checklist Submittals:

4	All sequences are performed as specified using DDC Hardware.	|____|
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	|____|
6	All DDC Hardware is installed on a TP/FT-10 Channel.	|____|
7	All Application Specific Controllers (ASCs) are LonMark certified.	|____|
8	Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used.	|____|
9	Explicit messaging has not been used.	|____|
10	Scheduling is performed in DDC Hardware meeting the Simple Schedule Functional Profile	|____|

Items verified for Closeout QC Checklist Submittal:

QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS

11	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	|____|
12	Programming software has been submitted for all programmable controllers.	|____|
13	All software has been licensed to the Government.	
14	O&M Instructions have been completed and submitted.	|____|
15	Training course has been completed.	|____|
16	LonWorks Network Services (LNS) Database is up-to-date and accurately represents the final installed system.	|____|
17	LNS Plug-ins have been submitted for all Application Specific Controllers (ASCs).	|____|
18	Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs).	|____|

____ ____________________

(QC Representative Signature) (Date)

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS

This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.

Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.

This checklist is for (circle one:)

Pre-Construction QC Checklist Submittal

Post-Construction QC Checklist Submittal

Close-out QC Checklist Submittal

Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:

1	All DDC Hardware is numbered on Control System Schematic Drawings.	|____|

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS

2	Signal lines on Control System Schematic are labeled with the signal type.	☐
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	☐
	Items verified for Post-Construction and Closeout QC Checklist Submittals:	
4	All sequences are performed as specified using DDC Hardware.	☐
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	☐
6	All DDC Hardware except Niagara Framework Supervisory Gateways is installed on a TP/FT-10 Channel.	☐
7	All Application Specific Controllers (ASCs) are LonMark certified.	☐
8	Except for communication between two Niagara Framework Supervisory Gateways, Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used. Communication between Niagara Framework Supervisory Gateways is via Fox Protocol.	☐
9	Explicit messaging has not been used.	☐
10	Scheduling, Alarming, and Trending have been implemented using Niagara Framework objects and services.	☐
	Items verified for Closeout QC Checklist Submittal:	
11	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	☐
12	Programming software has been submitted for all programmable controllers.	☐
13	All software has been licensed to the Government.	
14	O&M Instructions have been completed and submitted.	☐
15	Training course has been completed.	☐
16	The database in each Niagara Framework Supervisory Gateway is up-to-date and accurately represents the building control network beneath that Niagara Framework Supervisory Gateway.	☐
17	Niagara Wizards have been submitted for all Application Specific Controllers (ASCs) for which a Wizard is available and for all Application Generic Controllers (AGCs).	☐

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS		
18	Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs).	|____|
______________________________	______________	
	(QC Representative Signature)	(Date)

QC CHECKLIST FOR BACNET SYSTEMS		
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.		
This checklist is for (circle one:) Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal		
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:		
1	All DDC Hardware is numbered on Control System Schematic Drawings.	|____|
2	Signal lines on Control System Schematic are labeled with the signal type.	|____|
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	|____|
Items verified for Post-Construction and Closeout QC Checklist Submittals:		
4	All sequences are performed as specified using DDC Hardware.	|____|
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	|____|
Items verified for Closeout QC Checklist Submittal:		

QC CHECKLIST FOR BACNET SYSTEMS

6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	|____|
7	Programming software has been submitted for all programmable controllers.	|____|
8	All software has been licensed to the Government.	
9	O&M Instructions have been completed and submitted.	|____|
10	Training course has been completed.	|____|
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.	|____|
12	All DDC Hardware is BTL listed.	|____|
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.	|____|
14	Scheduling, Alarming, and Trending have been implemented using the standard BACnet Objects for these functions.	|____|
15	All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated	|____|

____ __________________

(QC Representative Signature) (Date)

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS

This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.

Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.

This checklist is for (circle one:)

Pre-Construction QC Checklist Submittal

Post-Construction QC Checklist Submittal

Close-out QC Checklist Submittal

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS

Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:

1	All DDC Hardware is numbered on Control System Schematic Drawings.	☐
2	Signal lines on Control System Schematic are labeled with the signal type.	☐
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	☐

Items verified for Post-Construction and Closeout QC Checklist Submittals:

4	All sequences are performed as specified using DDC Hardware.	☐
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	☐

Items verified for Closeout QC Checklist Submittal:

6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	☐
7	Programming software has been submitted for all programmable controllers.	☐
8	All software has been licensed to the Government.	
9	O&M Instructions have been completed and submitted.	☐
10	Training course has been completed.	☐
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.	☐
12	All DDC Hardware is BTL listed.	☐
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.	☐
14	Scheduling, Alarming, and Trending have been implemented using Niagara Framework objects and services, and BACnet Instrinsic Alarming as indicated.	☐
15	All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated	☐

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS	
	(QC Representative Signature) (Date)

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 09 13 (November 2015)**
Change 2 - 05/21

Preparing Activity: USACE **Superseding**
UFGS-23 09 23 (May 2011)
UFGS-23 09 23.13 20 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

11/15, CHG 2: 05/21

-- End of Section Table of Contents --

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

11/15, CHG 2: 05/21

****

NOTE: This guide specification covers the requirements for instrumentation and control devices for HVAC when combined with a companion DDC Network. Please refer to the respective specification sections for Direct Digital Control Devices and Utility Monitoring and Control Systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This section is for use on all USACE and AFCEC projects and for additions or retrofits to existing NAVFAC systems.

This specification covers installation of local control devices and instrumentation. It is primarily intended for building level control systems which are to be integrated into a Utility Monitoring and Control System (UMCS) Front End as specified in Section 25 10 10 UTILITY MONITORING AND

CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

The HVAC Control System design must be in accordance with UFC 3-410-02 Direct Digital Control for HVAC and Other Building Control Systems.
****

1.1 SUMMARY

****
NOTE: Designer is to add location and site specific requirements.
****

This section provides for the instrumentation control system components excluding direct digital controllers, network controllers, gateways etc. that are necessary for a completely functional automatic control system. When combined with a Direct Digital Control (DDC) system, the Instrumentation and Control Devices covered under this section must be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and indicated.

a. Install hardware to perform the control sequences as specified and indicated and to provide control of the equipment as specified and indicated.

b. Install hardware such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

c. Install and configure hardware such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the installing Contractor.

1.1.1 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.2 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere.

Section 01 30 00 ADMINISTRATIVE REQUIREMENTS

Section 23 30 00 HVAC AIR DISTRIBUTION

Section 23 05 15 COMMON PIPING FOR HVAC

Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating
AMCA 511	(2010; R 2016) Certified Ratings Program for Air Control Devices

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and

	Welding End
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1238	(2013) Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1693	(2015) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics

FLUID CONTROLS INSTITUTE (FCI)

FCI 70-2	(2021) Control Valve Seat Leakage

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 7.0.01	(1996) Quality Standard for Instrument Air

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.20	(2015; E 2018) Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

UL SOLUTIONS (UL)

UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 555	(2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers
UL 555S	(2014; Reprint Oct 2020) UL Standard for Safety Smoke Dampers
UL 1820	(2004; Reprint May 2013) UL Standard for Safety Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics
UL 5085-3	(2006; Reprint Jan 2022) UL Standard for Safety Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 SUBMITTALS

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NOTE: Submittals related to this section are specified in UFGS 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

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Submittal requirements are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.5 DELIVERY AND STORAGE

Store and protect products from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.6 INPUT MEASUREMENT ACCURACY

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NOTE: This paragraph is referenced elsewhere in the specification. If this paragraph is edited, removed, renamed etc make sure to verify that all references to it are updated as needed.

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Select, install and configure sensors, transmitters and DDC Hardware such that the maximum error of the measured value at the input of the DDC hardware is less than the maximum allowable error specified for the sensor or instrumentation.

1.7 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with the paragraph entitled CONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 General Requirements

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1.2 Operation Environment Requirements

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

2.1.2.1 Pressure

Pressure conditions normally encountered in the installed location.

2.1.2.2 Vibration

Vibration conditions normally encountered in the installed location.

2.1.2.3 Temperature

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NOTE: Designer must decide if suggested outside air temperature range is sufficient, and provide a range if it's not.

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a. Products installed indoors: Ambient temperatures in the range of 0 to 50 degrees C 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

b. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of [-37 to +66 degrees C-35 to +151 degrees F

] [_____] and temperature conditions outside this range normally encountered at the installed location.

2.1.2.4 Humidity

10 to 95 percent relative humidity, non-condensing and also humidity conditions outside this range normally encountered at the installed location.

2.2 WEATHERSHIELDS

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NOTE: Enclosures are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

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Provide weathershields constructed of galvanized steel painted white, unpainted aluminum, aluminum painted white, or white PVC.

[2.3 TUBING

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NOTE: Pneumatic sections included in the event pneumatic actuators are required for special circumstances (actuator response time or explosive environments). The Designer can include or delete as required by the project circumstances

Keep the bracketed text for pneumatic applications

****

2.3.1 Copper

Provide ASTM B75/B75M or ASTM B88 rated tubing meeting the following requirements:

a. For tubing 9 mm 0.375 inch outside diameter and larger provide tubing with minimum wall thickness equal to ASTM B88, Type M

b. For tubing less than9 mm 0.375 inch outside diameter provide tubing with minimum wall thickness of 0.6 mm 0.025 inch

c. For exposed tubing and tubing for working pressures greater than 207 kPa 30 psig provide hard copper tubing.

d. Provide fittings which are ASME B16.18 or ASME B16.22 solder type using ASTM B32 95-5 tin-antimony solder, or which are ASME B16.26 compression type.

2.3.2 Stainless Steel

For stainless steel tubing provide tubing conforming to ASTM A269/A269M

2.3.3 Plastic

Provide plastic tubing with the burning characteristics of linear low-density polyethylene tubing which is self-extinguishing when tested in accordance with ASTM D635, has UL 94 V-2 flammability classification or better, and which withstands stress cracking when tested in accordance with

ASTM D1693. Provide plastic-tubing bundles with Mylar barrier and flame-retardant polyethylene jacket.

2.3.4 Polyethylene Tubing

Provide flame-resistant, multiple polyethylene tubing in flame-resistant protective sheath with mylar barrier, or unsheathed polyethylene tubing in rigid metal, intermediate metal, or electrical metallic tubing conduit for areas where tubing is exposed. Single, unsheathed, flame-resistant polyethylene tubing may be used where concealed in walls or above ceilings and within control panels. Do not provide polyethylene tubing for [systems indicated as critical and] smoke removal systems, or for systems with working pressures over 206 kPa 30 psig. Provide compression or brass barbed push-on type fittings. Provide extruded seamless polyethylene tubing conforming to the following:

a. Minimum Burst Pressure Requirements: 690 kPa at 24 degrees C 100 psig at 75 degrees F to 172 kPa at 66 degrees C 25 psig at 150 degrees F.

b. Stress Crack Resistance: ASTM D1693, 200 hours minimum.

c. Tensile Strength (Minimum): ASTM D638, 7584 kPa 1100 psi.

d. Flow Rate (Average): ASTM D1238, 0.30 decigram per minute.

e. Density (Average): ASTM D792, 921 kg per cubic meter 57.5 pounds per cubic feet.

f. Burn rate: ASTM D635

g. Flame Propagation: UL 1820, less than 1.5 meters 5 feet ASTM D635

h. Average Optical Density: UL 1820, less than 0.15 ASTM D635

]2.4 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.4.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.4.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG (1.02 mm diameter) 18 AWG copper or thicker wire rated for 300-volt service.

2.4.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG (1.02 mm diameter) 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 50 mm (2 inch) 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.4.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.4.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

2.5 AUTOMATIC CONTROL VALVES

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NOTE: Ball valves are generally less expensive than globe valves, but because of potential cavitation problems should only be used in 2-position and chilled water applications. It is recommended that you coordinate their use with the local maintenance staff because unlike globe valves, maintenance is more likely to require complete removal of the valve.

Show each valve's Kv (m^3/hr) and/or Cv (gal/min) on the Valve Schedule. Kv = 0.857 x Cv. Modulating control valves should be sized for maximum full flow pressure drop between 50 percent and 100 percent (typically between 21 - 34 kPa 3 - 5 psig of the branch circuit it is controlling. Two position valves must be the same size as the connected piping.

Valves having class IV leakage ratings are typically used in process applications rather than HVAC. Class III leakage ratings are typical for HVAC applications unless strict environmental control is required.

****

Provide valves with stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Provide valves with bodies meeting ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Unless otherwise specified or indicated, provide valves meeting FCI 70-2 [Class III leakage rating][Class IV leakage rating]. Provide valves rated for modulating or two-position service as indicated, which close against a differential pressure indicated as the

Close-Off pressure and which are Normally-Open, Normally-Closed, or Fail-In-Last-Position as indicated.

2.5.1 Valve Type

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NOTE: Special attention must be paid to system pressure for hot water applications. Ball valves are more susceptible to cavitation than globe valves having the same pressure drop due to higher internal velocities in the ball valve. To prevent cavitation within the valve, the designer may need to increase the hydronic system pressure. Cavitation can occur when using ball valves for hot water service due to the increased internal velocity through the ball valve. The designer should take in to consideration the drop in system pressure through the valve to prevent cavitation at the outlet of the valve.

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2.5.1.1 Liquid Service 150 Degrees F or Less

Use either globe valves or ball valves except that butterfly valves may be used for sizes 100 mm 4 inch and larger.

2.5.1.2 Liquid Service Above 150 Degrees F

a. Two-position valves: Use either globe valves or ball valves except that butterfly valves may be used for sizes 100 mm 4 inch and larger.

b. Modulating valves: Use globe valves except that butterfly valves may be used for sizes 100 mm 4 inch and larger.

2.5.1.3 Steam Service

Use globe valves except that butterfly valves may be used for sizes 100 mm 4 inch and larger.

2.5.2 Valve Flow Coefficient and Flow Characteristic

2.5.2.1 Two-Way Modulating Valves

Provide the valve coefficient (Kv) (Cv) indicated. Provide equal-percentage flow characteristic for liquid service except for butterfly valves. Provide linear flow characteristic for steam service except for butterfly valves.

2.5.2.2 Three-Way Modulating Valves

Provide the valve coefficient (Kv) (Cv) indicated. Provide linear flow characteristic with constant total flow throughout full plug travel.

2.5.3 Two-Position Valves

Use full line size full port valves with maximum available (Kv) (Cv).

2.5.4 Globe Valves

2.5.4.1 Liquid Service Not Exceeding 66 Degrees C 150 Degrees F

a. Valve body and body connections:

  (1) valves 38 mm 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

  (2) valves from 51 mm to 76 mm 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 51 millimeters2 inch valves with threaded connections; 63 to 76 mm 2-1/2 to 3 inches valves with flanged connections

b. Internal valve trim: Brass or bronze.

c. Stems: Stainless steel.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.5.4.2 Liquid Service Not Exceeding 121 Degrees C 250 Degrees F

a. Valve body and body connections:

  (a) 1) valves 38 mm 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

  (b) 2) valves from 51 mm to 76 mm 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 51 millimeters2 inch valves with threaded connections; 63 to 76 mm 2-1/2 to 3 inches valves with flanged connections

b. Internal trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

c. Provide valves with non-metallic parts suitable for a minimum continuous operating temperature of 121 degrees C 250 degrees F or 28 degrees C 50 degrees F above the system design temperature, whichever is higher.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol

2.5.4.3 Hot water service 121 Degrees C 250 Degrees F and above

a. Provide valve bodies conforming to ASME B16.34 Class 300. For valves 25 mm 1 inch and larger provide valves with bodies which are carbon steel, globe type with welded ends. For valves smaller than 25 mm 1 inch provide valves with socket-weld ends. Provide valves with virgin polytetrafluoroethylene (PTFE) packing. Provide valve and actuator combinations which are normally closed.

b. Internal trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

2.5.4.4 Steam Service

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NOTE: For modulating valves at 103 kPa 15 psig or less inlet steam pressure, the design pressure drop should be 80 percent of the inlet gauge pressure. Higher than 103 kPa 15 psig inlet steam pressure, the pressure drop must be 42 percent of the inlet absolute pressure.
****

For steam service, provide valves meeting the following requirements:

a. Valve body and connections:

(a) 1) valves 38 mm 1-1/2 inches and smaller: complete body of brass or bronze, with threaded or union ends

(b) 2) valves from 51 mm to 76 mm 2 inches to 3 inches inclusive: body of brass, bronze, or carbon steel

(c) 3) valves 100 mm 4 inches and larger: body of carbon steel. 50 mm 2 inch valves with threaded connections; valves 63 mm 2-1/2 inches and larger with flanged connections.

b. Internal Trim: Type 316 stainless steel including seats, seat rings, modulation plugs, valve stems, and springs.

c. Valve sizing: sized for [103.4 kPa] [15 psig] [_____] inlet steam pressure with a maximum [83 kPa] [12 psi] [_____] differential through the valve at rated flow, except where indicated otherwise.

2.5.5 Ball Valves

2.5.5.1 Liquid Service Not Exceeding 66 Degrees C 150 Degrees F

a. Valve body and connections:

(a) 1) valves 38 mm 1-1/2 inches and smaller: bodies of brass or bronze, with threaded or union ends

(b) 2) valves from 51 mm to 76 mm 2 inches to 3 inches inclusive: bodies of brass, bronze, or iron. 50 mm 2 inch valves with threaded connections; valves from 63 to 76 mm 2-1/2 to 3 inches with flanged connections.

b. Ball: Stainless steel or nickel-plated brass or chrome-plated brass.

c. Seals: Reinforced Teflon seals and EPDM O-rings.

d. Stem: Stainless steel, blow-out proof.

e. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.5.6 Butterfly Valves

Provide butterfly valves which are threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies or with ductile iron bodies in accordance with ASTM A536. Provide butterfly valves with non-corrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from -28.9 to +121.1

degrees C -20 to +250 degrees F. Provide valves with rated Kv Cv of the Kv Cv at 70 percent (60 degrees) open position. Provide valves meeting FCI 70-2 Class VI leakage rating.

2.5.7 Pressure Independent Control Valves (PICV)

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NOTE: Pressure independent control valves minimize flow fluctuations due to changes in piping pressure. These valves are more expensive than other control valve options, but can provide more steady process control where fast changes in piping pressure are expected.

****

Provide pressure independent control valves which include a regulator valve which maintains the differential pressure across a flow control valve. Pressure independent control valves must accurately control the flow from 0-100 percent full rated flow regardless of changes in the piping pressure and not vary the flow more than plus or minus 5 percent at any given flow control valve position when the PICV differential pressure lies between the manufacturer's stated minimum and maximum. The rated minimum differential pressure for steady flow must not exceed 34.5 kPa 5 psid across the PICV. Provide either globe or ball type valves meeting the indicated requirements for globe and ball valves. Provide valves with a flow tag listing full rated flow and minimum required pressure drop. Provide valves with factory installed Pressure/Temperature ports ("Pete's Plugs") to measure the pressure drop to determine the valve flow rate.

2.5.8 Duct-Coil and Terminal-Unit-Coil Valves

For duct or terminal-unit coils provide control valves with either [flare-type][screw type] or solder-type ends. Provide flare nuts for each flare-type end valve.

2.6 DAMPERS

2.6.1 Damper Assembly

Provide single damper sections with blades no longer than 1.2 m 48 inches and which are no higher than 1.8 m 72 inches and damper blade width of 203 mm 8 inches or less. When larger sizes are required, combine damper sections. Provide dampers made of steel, or other materials where indicated and with assembly frames constructed of 2.8 mm 0.07 inch minimum thickness [galvanized][stainless] steel channels with mitered and welded corners. Steel channel frames constructed of 1.5 mm 0.06 inch minimum thickness are acceptable provided the corners are reinforced.

a. Flat blades must be made rigid by folding the edges. Blade-operating linkages must be within the frame so that blade-connecting devices within the same damper section must not be located directly in the air stream.

b. Damper axles must be 13 mm 1/2 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically must be supported by thrust bearings.

c. Provide dampers which do not exceed a pressure drop through the damper of 10 Pa 0.04 inches water gauge at 5 m/s 1000 ft/min in the wide-open position. Provide dampers with frames not less than 50 mm 2 inch in width. Provide dampers which have been tested in accordance with AMCA 500-D.

2.6.2 Operating Linkages

For operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, provide links able to withstand a load equal to at least 300 percent of the maximum required damper-operating force without deforming. Rod lengths must be adjustable. Links must be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises must be brass, bronze, or stainless steel. Adjustments of crank arms must control the open and closed positions of dampers.

2.6.3 Damper Types

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NOTE: As of July 2009, UFC 4-010-01 requires a maximum OA damper leakage of 15 L/s per square meter at 249 Pa 3 cfm per square foot at 1 iwc static, which is a Class 1A damper. If this UFC or a similar requirement for a low-leakage damper is applicable to the project select Class 1A.

Otherwise:
1) If the application is in a very cold climate or where the system runs continuously consider selecting Class 1.

2) In other flow control applications select Class 2

For reference only, AMCA 511 leakage classifications at 1017 Pa 4 iwc static are:
Class 1A: N/A.

Class 1: 41 L/s per square meter 8 cfm per square foot of damper area.

Class 2: 102 L/s per square meter 20 cfm per square foot of damper area.

Class 3: 406 L/s per square meter 80 cfm per square foot of damper area.

AMCA 511 leakage classifications at 256 Pa 1 iwc static are:
Class 1A: 15 L/s per square meter 3 cfm per square foot of damper area.

Class 1: 20 L/s per square meter 4 cfm per square foot of damper area.

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2.6.3.1 Flow Control Dampers

Provide parallel-blade or opposed blade type dampers for outside air, return air, relief air, exhaust, face and bypass dampers as indicated on the Damper Schedule. Blades must have interlocking edges. The channel frames of the dampers must be provided with jamb seals to minimize air leakage. Unless otherwise indicated, dampers must meet AMCA 511 [Class 1A][Class 1][Class 2] requirements. Outside air damper seals must be suitable for an operating temperature range of -40 to +75 degrees C -40 to +167 degrees F. Dampers must be rated at not less than 10 m/s 2000 ft/min air velocity.

2.6.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers

Provide utility space ventilation dampers as indicated. Unless otherwise indicated provide AMCA 511 class 3 dampers. Provide dampers rated at not less than 7.6 m/s 1500 ft/min air velocity.

2.6.3.3 Smoke Dampers

Provide smoke-damper and actuator assemblies which meet the current requirements of NFPA 90A, UL 555, and UL 555S. For combination fire and smoke dampers provide dampers rated for 121 degrees C 250 degrees F Class II leakage per UL 555S.

2.7 SENSORS AND INSTRUMENTATION

Unless otherwise specified, provide sensors and instrumentation which incorporate an integral transmitter. Sensors and instrumentation, including their transmitters, must meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion.

2.7.1 Analog and Binary Transmitters

Provide transmitters which match the characteristics of the sensor. Transmitters providing analog values must produce a linear 4-20 mAdc, 0-10 Vdc signal corresponding to the required operating range and must have zero and span adjustment. Transmitters providing binary values must have dry contacts rated at 1A at 24 Volts AC.

2.7.2 Network Transmitters

Sensors and Instrumentation incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS when used in a Lonworks network, or the requirements of 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS when used in a BACnet network.

2.7.3 Temperature Sensors

Provide the same sensor type throughout the project. Temperature sensors may be provided without transmitters. Where transmitters are used, the range must be the smallest available from the manufacturer and suitable for the application such that the range encompasses the expected range of temperatures to be measured. The end to end accuracy includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the end user interface (graphic presentation) including transmitters if used.

2.7.3.1 Sensor Accuracy and Stability of Control

2.7.3.1.1 Conditioned Space Temperature

Plus or minus 0.3 degrees C 0.5 degree F over the operating range.

2.7.3.1.2 Unconditioned Space Temperature

a. Plus or minus 0.6 degrees C 1 degree F over the range of -1 to +55 degrees C 30 to 131 degrees F AND

b. Plus or minus 2 degrees C 4 degrees F over the rest of the operating range.

2.7.3.1.3 Duct Temperature

Plus or minus 0.3 degrees C 0.5 degree F

2.7.3.1.4 Outside Air Temperature

a. Plus or minus 1 degree C 2 degrees F over the range of -35 to +55 degrees C -30 to +130 degrees F AND

b. Plus or minus 0.6 degrees C 1 degree F over the range of -1 to +40 degrees C 30 to 130 degrees F.

2.7.3.1.5 High Temperature Hot Water

Plus or minus 2 degrees C 3.6 degrees F.

2.7.3.1.6 Chilled Water

Plus or minus 0.4 degrees C 0.8 degrees F over the range of 2 to 18 degrees C 35 to 65 degrees F.

2.7.3.1.7 Dual Temperature Water

Plus or minus 1 degree C 2 degrees F.

2.7.3.1.8 Heating Hot Water

Plus or minus 1 degree C 2 degrees F.

2.7.3.1.9 Condenser Water

Plus or minus 1 degree C 2 degrees F.

2.7.3.2 Transmitter Drift

The maximum allowable transmitter drift: 0.1 degrees C 0.25 degrees F per year.

2.7.3.3 Point Temperature Sensors

Point Sensors must be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

2.7.3.4 Temperature Sensor Details

2.7.3.4.1 Room Type

Provide the sensing element components within a decorative protective cover suitable for surrounding decor.

2.7.3.4.2 Duct Probe Type

Ensure the probe is long enough to properly sense the air stream temperature.

2.7.3.4.3 Duct Averaging Type

Continuous averaging sensors must be one foot in length for each 0.1 square m 1 square foot of duct cross-sectional area, and a minimum length of 1.5 m 5 feet.

2.7.3.4.4 Pipe Immersion Type

For pipes with larger than 7.6 cm 3 inch diameter, provide minimum 7.6 cm 3 inch immersion. For pipes with less than 7.6 cm 3 inch diameter, provide immersion at least half the diameter of the pipe. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells must be stainless steel when used in steel piping, and brass when used in copper piping.

2.7.3.4.5 Outside Air Type

Provide the sensing element rated for outdoor use

2.7.4 Relative Humidity Sensor

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NOTE: 3 percent RH Accuracy may be sufficient for typical comfort cooling applications. For applications with more stringent requirements, a 2 percent RH accuracy may be desired.

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Relative humidity sensors must use bulk polymer resistive or thin film capacitive type non-saturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. The sensors must include removable protective membrane filters. Where required for exterior installation, sensors must be capable of surviving below freezing temperatures and direct contact with moisture without affecting sensor calibration. When used indoors, the sensor must be capable of being exposed to a condensing air stream (100 percent relative humidity) with no adverse effect to the sensor's calibration or other harm to the instrument. The sensor must be of the wall-mounted or duct-mounted type, as required by the application, and must be provided with any required accessories. Sensors used in duct high-limit applications must have a bulk polymer resistive sensing element. Duct-mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. Relative humidity (RH) sensors must measure relative humidity over a range of 0 percent to 100 percent with an accuracy of plus or minus [2][3] percent. RH sensors must function over a temperature range of 4.4 to 57.2 degrees C 40 to 135 degrees F and must not drift more than 1 percent per year.

2.7.5 Carbon Dioxide (CO2) Sensors

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NOTE: In applications where the expected outside air temperature range exceeds the listed values, the designer must make accommodations to place to OA CO Sensor in a conditioned 100 percent Outside Airstream.

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Provide photometric type CO2 sensors with integral transducers and linear output. Carbon dioxide (CO2) sensors must measure CO2 concentrations between 0 to 2000 parts per million (ppm) using non-dispersible infrared (NDIR) technology with an accuracy of plus or minus 50 ppm and a maximum response time of 1 minute. The sensor must be rated for operation at ambient air temperatures within the range of 0 to 50 degrees C 32 to 122 degrees F and relative humidity within the range of 20 to 95 percent (non-condensing). The sensor must have a maximum drift of 2 percent per year. The sensor chamber must be manufactured with a non-corrosive material that does not affect carbon dioxide sample concentration. Duct mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. The sensor must have a calibration interval no less than 5 years.

2.7.6 Differential Pressure Instrumentation

2.7.6.1 Differential Pressure Sensors

Provide Differential Pressure Sensors with ranges as indicated or as required for the application. Pressure sensor ranges must not exceed the high end range indicated on the Points Schedule by more than 50 percent. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The accuracy must be plus or minus 1 percent of full scale. The sensor must have a maximum drift of 2 percent per year

2.7.6.2 Differential Pressure Switch

Provide differential pressure switches with a user-adjustable setpoint which are sized for the application such that the setpoint is between 25 percent and 75 percent of the full range. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The switch must have two sets of contacts and each contact must have a rating greater than it's connected load. Contacts must open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as indicated.

2.7.7 Flow Sensors

2.7.7.1 Airflow Measurement Array (AFMA)

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NOTE: Care should be utilized in determining which technology is best suited for the application. While differential pressure measurement is usually the least expensive, it has limitations on the minimum velocities it can measure on a repeated basis. Due to the very small pressure differentials

at velocities below 400 fpm, outside influences (building pressure, wind velocities, etc.) have a greater effect on the repeatability. When sizing AFMS for applications where the minimum OA and economizer functions are combined into one AFMS (and associated damper), a review of the conditions at the minimum OA flow is prudent to make sure the desired AFMS can accurately read at this design point.

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2.7.7.1.1 Airflow Straightener

Provide AFMAs which contain an airflow straightener if required by the AFMA manufacturer's published installation instructions. The straightener must be contained inside a flanged sheet metal casing, with the AFMA located as specified according to the published recommendation of the AFMA manufacturer. In the absence of published documentation, provide airflow straighteners if there is any duct obstruction within 5 duct diameters upstream of the AFMA. Air-flow straighteners, where required, must be constructed of 3 mm 0.125 inch aluminum honeycomb and the depth of the straightener must not be less than 40 mm 1.5 inches.

2.7.7.1.2 Resistance to Airflow

The resistance to air flow through the AFMA, including the airflow straightener must not exceed 20 Pa 0.085 inch water gauge at an airflow of 10 m/s 2,000 fpm. AFMA construction must be suitable for operation at airflows of up to 25 m/s 5000 fpm over a temperature range of 4 to 49 degrees C 40 to 120 degrees F.

2.7.7.1.3 Outside Air Temperature

****

NOTE: Ensure that outside air temperature range is appropriate for the environment at the project site, and provide a range if it's not.

****

In outside air measurement or in low-temperature air delivery applications, provide an AFMA certified by the manufacturer to be accurate as specified over a temperature range of [-29 to +49 degrees C-20 to +120 degrees F] [_____].

2.7.7.1.4 Pitot Tube AFMA

Each Pitot Tube AFMA must contain an array of velocity sensing elements. The velocity sensing elements must be of the multiple pitot tube type with averaging manifolds. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published installation instructions of the AFMA manufacturer.

a. Pitot Tube AFMAs for use in airflows over 3.0 m/s 600 fpm must have an accuracy of plus or minus 5 percent over a range of 2.5 to 12.5 m/s 500 to 2500 fpm.

b. Pitot Tube AFMAs for use in airflows under 3.0 m/s 600 fpm must have an accuracy of plus or minus 5 percent over a range of 0.6 to 12.5 m/s 125 to 2500 fpm.

2.7.7.1.5 Electronic AFMA

Each electronic AFMA must consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published application data of the AFMA manufacturer. Electronic AFMAs must have an accuracy of plus or minus 5 percent over a range of 0.6 to 12.5 m/s 125 to 5,000 fpm and the output must be temperature compensated over a range of 0 to 100 degrees C 32 to 212 degrees F.

2.7.7.1.6 Fan Inlet Measurement Devices

Fan inlet measurement devices cannot be used unless indicated on the drawings or schedules.

2.7.7.2 Orifice Plate

Orifice plate must be made of an austenitic stainless steel sheet of 3. mm 0.125 inch nominal thickness with an accuracy of plus or minus 1 percent of full flow. The orifice plate must be flat within 0.1 mm 0.002 inches. The orifice surface roughness must not exceed 0.5 µm 20 micro-inches. The thickness of the cylindrical face of the orifice must not exceed 2 percent of the pipe inside diameter or 12.5 percent of the orifice diameter, whichever is smaller. The upstream edge of the orifice must be square and sharp. Where orifice plates are used, concentric orifice plates must be used in all applications except steam flow measurement in horizontal pipelines.

2.7.7.3 Flow Nozzle

Flow nozzle must be made of austenitic stainless steel with an accuracy of plus or minus 1 percent of full flow. The inlet nozzle form must be elliptical and the nozzle throat must be the quadrant of an ellipse. The thickness of the nozzle wall and flange must be such that distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline must not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing must be such that the nozzle throat must be centered accurately in the pipe.

2.7.7.4 Venturi Tube

Venturi tube must be made of cast iron or cast steel and must have an accuracy of plus or minus 1 percent of full flow. The throat section must be lined with austenitic stainless steel. Thermal expansion characteristics of the lining must be the same as that of the throat casting material. The surface of the throat lining must be machined to a plus or minus 1.2 µm 50 micro inch finish, including the short curvature leading from the converging entrance section into the throat.

2.7.7.5 Annular Pitot Tube

Annular pitot tube must be made of austenitic stainless steel with an accuracy of plus or minus 2 percent of full flow and a repeatability of plus or minus 0.5 percent of measured value. The unit must have at least one static port and no less than four total head pressure ports with an averaging manifold.

2.7.7.6 Insertion Turbine Flowmeter

Provide dual axial turbine flowmeter with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Insertion Turbine Flowmeter accuracy must be plus or minus 0.5 percent of rate at calibrated velocity., within plus or minus of rate over a 10:1 turndown and within plus or minus 2 percent of rate over a 50:1 turndown. Repeatability must be plus or minus 0.25 percent of reading. The meter flow sensing element must operate over a range suitable for the installed location with a pressure loss limited to 1 percent of operating pressure at maximum flow rate. The flowmeter ,must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs. The turbine rotor assembly must be constructed of Series 300 stainless steel and use Teflon seals.

2.7.7.7 Vortex Shedding Flowmeter

Vortex Shedding Flowmeter accuracy must be within plus or minus 0.8 percent of the actual reading over the range of the meter. Steam meters must contain density compensation by direct measurement of temperature. Mass flow inferred from specified steam pressure are not acceptable. The flow meter body must be made of austenitic stainless steel and include a weather tight NEMA 4X electronics enclosure. The vortex shedding flowmeter body must not require removal from the piping in order to replace the shedding sensor.

2.7.7.8 Ultrasonic Flow Meter

Provide Ultrasonic Flow Meters complete with matched transducers, self aligning installation hardware and transducer cables. Ultrasonic transducers must be optimized for the specific pipe and process conditions for the application. The flow meter accuracy must plus or minus 1 percent of rate from 0.3 to 12 meters/sec 0 to 40 ft/sec. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc output.

2.7.7.9 Insertion Magnetic Flow Meter

Provide insertion type magnetic flowmeters with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Flowmeter accuracy must be no greater than plus or minus 1 percent of rate from 0.6 to 6 meters/sec 2 to 20 feet/sec. Wetted material parts must be 300 series stainless steel. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs.

2.7.7.10 Positive Displacement Flow Meter

The flow meter must be a direct reading, gerotor, nutating disc or vane type displacement device rated for liquid service as indicated. A counter must be mounted on top of the meter, and must consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer must have a six digit register to indicate the volume passed through the meter in [liters] [gallons], and a sweep-hand dial to indicate down to 1 L 0.25 gallons. The pulse transmitter must have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter must have a bronze body with threaded or flanged connections as required for the application. Output accuracy must be plus or minus 2 percent of the flow range. The maximum pressure drop at full flow must be 34 kPa 5 psig.

2.7.7.11 Flow Meters, Paddle Type

Sensor must be non-magnetic, with forward curved impeller blades designed for water containing debris. Sensor accuracy must be plus or minus 1 percent of rate of flow, minimum operating flow velocity must be 0.3 meters/second 1 foot per second. Sensor repeatability and linearity must be plus or minus 1 percent. Materials which will be wetted must be made from non-corrosive materials and must not contaminate water. The sensor must be rated for installation in pipes of 76 mm to 1 m 3 to 40 inch diameters. The transmitter housing must be a NEMA 250 Type 4 enclosure.

2.7.7.12 Flow Switch

Flow switch must have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation must be adjustable over the operating flow range, and must be sized for the application such that the setpoint is between 25 percent and 75 percent of the full range.. The switch must have Form C snap-action contacts, rated for the application. The flow switch must have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system must be rated for use in corrosive environments encountered.

2.7.7.13 Gas Flow Meter

Gas flow meter must be diaphragm or bellows type (gas positive displacement meters) for flows up to 19.7 L/sec 2500 SCFH and axial flow turbine type for flows above 19.7 L/sec 2500 SCFH, designed specifically for natural gas supply metering, and rated for the pressure, temperature, and flow rates of the installation. Meter must have a minimum turndown ratio of 10 to 1 with an accuracy of plus or minus 1 percent of actual flow rate. The meter index must include a direct reading mechanical totalizing register and electrical impulse dry contact output for remote monitoring. The electrical impulse dry contact output must not require field adjustment or calibration. The electrical impulse dry contact output must have a minimum resolution of 3 cubic meters 100 cubic feet of gas per pulse and must not exceed 15 pulses per second at the design flow.

2.7.8 Electrical Instruments

Provide Electrical Instruments with an input range as indicated or sized for the application. Unless otherwise specified, AC instrumentation must be suitable for 60 Hz operation.

2.7.8.1 Current Transducers

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NOTE: Select the required accuracy for current transducers. Note that higher accuracy transducers will be more expensive and will likely require a more expensive/better quality controller.

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Current transducers must accept an AC current input and must have an accuracy of plus or minus [0.5] [2] percent of full scale. The device must have a means for calibration. Current transducers for variable frequency applications must be rated for variable frequency operation.

2.7.8.2 Current Sensing Relays (CSRs)

Current sensing relays (CSRs) must provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays must be of split-core design. The CSR must be rated for operation at 200 percent of the connected load. Voltage isolation must be a minimum of 600 volts. The CSR must auto-calibrate to the connected load or be adjustable and field calibrated. Current sensors for variable frequency applications must be rated for variable frequency operation.

2.7.8.3 Voltage Transducers

Voltage transducers must accept an AC voltage input and have an accuracy of plus or minus 0.25 percent of full scale. The device must have a means for calibration. Line side fuses for transducer protection must be provided.

2.7.8.4 Energy Metering

2.7.8.4.1 Watt or Watthour Transducers

Watt transducers must measure voltage and current and must output kW or kWh or both kW and kWh as indicated. kW outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1. kWh outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1.

2.7.8.4.2 Watthour Revenue Meter (with and without Demand Register)

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NOTE: The intent of including meters in this Section is for energy monitoring as may be required for interface to a UMCS. Meters are typically only required by this Section for retrofit applications. Coordination of meter installation and meter requirements with other specifications may be required.

Select the revenue meter accuracy as required for the application. For most applications, the 0.5 accuracy class should be suitable/sufficient. (Note the 0.5 accuracy class allows a 0.5 percent error, while the 0.2 class allows 0.2 percent).

****

All Watthour revenue meters must measure voltage and current and must be in accordance with ANSI C12.1 with an ANSI C12.20 Accuracy class of [0.5][0.2] and must have pulse initiators for remote monitoring of Watthour consumption. Pulse initiators must consist of form C contacts with a current rating not to exceed two amperes and voltage not to exceed 500 V, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations. Meter sockets must be in accordance with NEMA/ANSI C12.10. Watthour revenue meters with demand registers must output instantaneous demand in addition to the pulse initiators.

2.7.8.4.3 Steam Meters

Steam meters must be the vortex type, with pressure compensation, a minimum turndown ratio of 10 to 1, and an output signal compatible with the DDC system.

2.7.8.4.4 Hydronic BTU Meters

The BTU meter is to be supplied with wall mount hardware and be capable of being installed remote from the flow meter. The BTU meter must include an LCD display for local indication of energy rate and for display of parameters and settings during configuration. Each BTU meter must be factory configured for its specific application and be completely field configurable by the user via a front panel keypad (no special interface device or computer required). The unit must output Energy Rate, Energy Total, Flow Rate, Supply Temperature, and Return Temperature. An integral transmitter is to provide a linear analog or configurable pulse output signal representing the energy rate; and the signal must be compatible with building automation system DDC Hardware to which the output is connected.

2.7.9 pH Sensor

The sensor must be suitable for applications and chemicals encountered in water treatment systems of boilers, chillers and condenser water systems. Construction, wiring, fittings and accessories must be corrosion and chemical resistant with fittings for tank or suspension installation. Housing must be polyvinylidene fluoride with O-rings made of chemical resistant materials which do not corrode or deteriorate with extended exposure to chemicals. The sensor must be encapsulated. Periodic replacement must not be required for continued sensor operation. Sensors must use a ceramic junction and pH sensitive glass membrane capable of withstanding a pressure of 689 kPa at 66 degrees C 100 psig at 150 degrees F. The reference cell must be double junction configuration. Sensor range must be 0 to 12 pH, stability 0.05, sensitivity 0.02, and repeatability of plus or minus 0.05 pH value, response of 90 percent of full scale in one second and a linearity of 99 percent of theoretical electrode output measured at 24 degrees C 76 degrees F.

2.7.10 Oxygen Analyzer

Oxygen analyzer must consist of a zirconium oxide sensor for continuous sampling and an air-powered aspirator to draw flue gas samples. The analyzer must be equipped with filters to remove flue air particles. Sensor probe temperature rating must be 435 degrees C 815 degrees F. The sensor assembly must be equipped for flue flange mounting.

2.7.11 Carbon Monoxide Analyzer

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NOTE: Enter the range for the CO Analyzer

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Carbon monoxide analyzer must consist of an infrared light source in a weather proof steel enclosure for duct or stack mounting. An optical detector/analyzer in a similar enclosure, suitable for duct or stack mounting must be provided. Both assemblies must include internal blower systems to keep optical windows free of dust and ash at all times. The third component of the analyzer must be the electronics cabinet. Automatic flue gas temperature compensation and manual/automatic zeroing devices must be provided. Unit must read parts per million (ppm) of carbon monoxide in the range of [_____] to [_____] ppm and the response time must be less than 3 seconds to 90 percent value. Unit measurement range must not exceed specified range by more that 50 percent. Repeatability must be plus or minus 1 percent of full scale with an accuracy of plus or minus 1 percent of full scale.

2.7.12 Occupancy Sensors

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NOTE: Avoid using occupancy sensors with instant start fluorescent ballasts for instant start of lamps because they shorten the lamp life. Use only rapid start fluorescent ballasts.

Show which type of occupancy sensor to use drawings: Ultrasonic sensors are best suited for spaces with partitions or dividers; Infrared sensors are best suited in line-of-sight applications. Dual mode sensor are available for situations where only one mode will not adequately identify occupancy.

Show occupancy sensor mounting location on drawings. Office furniture is less likely to interfere with (block) ceiling mounted sensors. In retrofit applications, occupancy sensors can be installed in place of existing light switches.

Dual-technology sensors (one sensor incorporating both types) ordinarily turn lighting ON when both technologies sense occupancy. Then, detection by either technology will hold lighting ON.

****

Occupancy sensors must have occupancy-sensing sensitivity adjustment and an adjustable off-delay timer with a setpoint of 15 minutes. Adjustments accessible from the face of the unit are preferred. Occupancy sensors must be rated for operation in ambient air temperatures ranging from 5 to 35 degrees C 40 to 95 degrees F or temperatures normally encountered in the installed location. Sensors integral to wall mount on-off light switches must have an auto-off switch. Wall switch sensors must be decorator style and must fit behind a standard decorator type wall plate. All occupancy sensors, power packs, and slave packs must be UL listed. In addition to any outputs required for lighting control, the occupancy sensor must provide an output for the HVAC control system.

2.7.12.1 Passive Infrared (PIR) Occupancy Sensors

PIR occupancy sensors must have a multi-level, multi-segmented viewing lens and a conical field of view with a viewing angle of 180 degrees and a detection of at least 6 m 20 feet unless otherwise indicated or specified. PIR Sensors must provide field-adjustable background light-level adjustment with an adjustment range suitable to the light level in the sensed area, room or space. PIR sensors must be immune to false triggering from RFI and EMI.

2.7.12.2 Ultrasonic Occupancy Sensors

Ultrasonic sensors must operate at a minimum frequency 32 kHz and must be designed to not interfere with hearing aids.

2.7.12.3 Dual-Technology Occupancy Sensor (PIR and Ultrasonic)

Dual-Technology Occupancy Sensors must meet the requirements of both PIR and Ultrasonic Occupancy Sensors.

2.7.13 Vibration Switch

Vibration switch must be solid state, enclosed in a NEMA 250 Type 4 or Type 4X housing with sealed wire entry. Unit must have two independent sets of Form C switch contacts with one set to shutdown equipment upon excessive vibration and a second set for monitoring alarm level vibration. The vibration sensing range must be a true rms reading, suitable for the application. The unit must include either displacement response for low speed or velocity response for high speed application. The frequency range must be at least 3 Hz to 500 Hz. Contact time delay must be 3 seconds. The unit must have independent start-up and running delay on each switch contact. Alarm limits must be adjustable and setpoint accuracy must be plus or minus 10 percent of setting with repeatability of plus or minus 2 percent.

2.7.14 Conductivity Sensor

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NOTE: Remove the bracketed text for new construction (Contractor cannot meet this requirement). For retrofit projects, coordinate with the project site to determine need for this analysis.

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Sensor must include local indicating meter and must be suitable for measurement of conductivity of water in boilers, chilled water systems, condenser water systems, distillation systems, or potable water systems as indicated. Sensor must sense from 0 to 10 microSeimens per centimeter (µS/cm) for distillation systems, 0 to 100 µS/cm for boiler, chilled water, and potable water systems and 0 to 1000 µS/cm for condenser water systems. Contractor must field verify the ranges for particular applications and adjust the range as required. The output must be temperature compensated over a range of 0 to 100 degrees C 32 to 212 degrees F. The accuracy must be plus or minus 2 percent of the full scale reading. Sensor must have automatic zeroing and must require no periodic maintenance or recalibration.

2.7.15 Compressed Air Dew Point Sensor

Sensor must be suitable for measurement of dew point from -40 +27 degrees C -40 +80 degrees F over a pressure range of 0 to 1 MPa 0 to 150 psig. The transmitter must provide both dry bulb and dew point temperatures on separate outputs. The end to end accuracy of the dew point must be plus or minus 2.8 degrees C 5 degrees F and the dry bulb must be plus or minus 0.6 degrees C 1 degree F. Sensor must be automatic zeroing and must require no normal maintenance or periodic recalibration.

2.7.16 NOx Monitor

Monitor must continuously monitor and give local indication of boiler stack gas for NOx content. It must be a complete system designed to verify compliance with the Clean Air Act standards for NOx normalized to a 3 percent oxygen basis and must have a range of from 0 to 100 ppm. Sensor must be accurate to plus or minus 5 ppm. Sensor must output NOx and oxygen levels and binary output that changes state when the NOx level is above a locally adjustable NOx setpoint. Sensor must have normal, trouble and alarm lights. Sensor must have heat traced lines if the stack pickup is remote from the sensor. Sensor must be complete with automatic zero and span calibration using a timed calibration gas system, and must not require periodic maintenance or recalibration.

2.7.17 Turbidity Sensor

Sensor must include a local indicating meter and must be suitable for measurement of turbidity of water. Sensor must sense from 0 to 1000 Nephelometric Turbidity Units (NTU). Range must be field-verified for the particular application and adjusted as required. The output must be temperature compensated over a range of 0 to 100 degrees C 32 to 212 degrees F. The accuracy must be plus or minus 5 percent of full scale reading. Sensor must have automatic zeroing and must not require periodic maintenance or recalibration.

2.7.18 Chlorine Detector

The detector must measure concentrations of chlorine in water in the range 0 to 20 ppm with a repeatability of plus or minus 1 percent of full scale and an accuracy of plus or minus 2 percent of full scale. The Chlorine Detector transmitter must be housed in a non-corrosive NEMA 250 Type 4X enclosure. Detector must include a local panel with adjustable alarm trip level, local audio and visual alarm with silence function.

2.7.19 Floor Mounted Leak Detector

Leak detectors must use electrodes mounted at slab level with a minimum built-in-vertical adjustment of 3 mm 0.125 inches. Detector must have a binary output. The indicator must be manual reset type.

2.7.20 Temperature Switch

2.7.20.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) must be manual reset, low temperature safety switches at least 3 meters 1 foot long per square meter square foot of coverage which must respond to the coldest 450 mm 18 inch segment with an accuracy of plus or minus 2 degrees C 3.6 degrees F. The switch must have a field-adjustable setpoint with a range of at least -1 +10 degrees C 30 to 50 degrees F. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon drop of temperature below setpoint as indicated and must remain in this state until reset.

2.7.20.2 Pipe Mount Temperature Limit Switch (Aquastat)

Pipe mount temperature limit switches (aquastats) must have a field adjustable setpoint between 15 and 32 degrees C 60 and 90 degrees F, an accuracy of plus or minus 2 degrees C 3.6 degrees F and a 5 degrees C 10 degrees F fixed deadband. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon change of temperature above or below setpoint as indicated.

2.7.21 Damper End Switches

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NOTE: If the HVAC system design includes smoke dampers in the return air and fan discharge, or other dampers requiring end switches, show the end switches on drawings.

Dampers that have the potential to close off all airflow to/from a fan should have end switches providing an interlock with the fan control circuit. Interlock should be active in all modes (Hand, Automatic and Bypass).

****

Each end switch must be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure must be suitable for mounting on the duct exterior and must permit setting the position of the trip lever that actuates the switch. The trip lever must be aligned with the damper blade.

End switches integral to an electric damper actuator are allowed as long as at least one is adjustable over the travel of the actuator.

2.7.22 Air Quality Sensors

Provide full spectrum air quality sensors using a hot wire element based on the Taguchi principle. The sensor must monitor a wide range of gaseous volatile organic components common in indoor air contaminants like paint fumes, solvents, cigarette smoke, and vehicle exhaust. The sensor must automatically compensate for temperature and humidity, have span and calibration potentiometers, operate on 24 VDC power with output of 0-10 VDC, and have a service rating of 0 to 60 degrees C 32 to 140 degrees F and 5 to 95 percent relative humidity.

[2.8 INDICATING DEVICES

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NOTE: Indicating devices are typically provided by the Mechanical Contractor and the specifications of ancillary indicating devices is located in Sections 23 30 00 HVAC AIR DISTRIBUTION, 23 05 15 COMMON PIPING FOR HVAC. Both sections are listed in Subpart 1.2

With the re-organization of the indicating devices are specified in other sections are are included here to ensure they are included in the project specification. If the indicating devices are adequately listed on other sections, then remove all or part of the bracketed text.

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All indicating devices must display readings in [metric (SI)][English (inch-pound)] units.

2.8.1 Thermometers

Provide bi-metal type thermometers at locations indicated. Thermometers must have either 230 mm 9 inch long scales or 90 mm 3.5 inch diameter dials, with insertion, immersion, or averaging elements. Provide matching thermowells for pipe-mounted installations. Select scale ranges suitable for the intended service, with the normal operating temperature near the scale's midpoint. The thermometer's accuracy must be plus or minus 2 percent of the scale range.

2.8.1.1 Piping System Thermometers

Piping system thermometers must have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 230 mm 9 inch scale. Piping system thermometers must have an accuracy of plus or minus 1 percent of scale range. Thermometers for piping systems must have rigid stems with straight, angular, or inclined pattern. Thermometer stems must have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem must be filled with a heat-transfer medium.

2.8.1.2 Air-Duct Thermometers

Air-duct thermometers must have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

2.8.2 Pressure Gauges

Provide pipe-mounted pressure gauges at the locations indicated. Gauges must conform to ASME B40.100 and have a 100 mm 4 inch diameter dial and shutoff cock. Select scale ranges suitable for the intended service, with the normal operating pressure near the scale's midpoint. The gauge's accuracy must be plus or minus 2 percent of the scale range.

Gauges must be suitable for field or panel mounting as required, must have black legend on white background, and must have a pointer traveling through a 270-degree arc. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus 3 percent of scale range. Gauges must meet requirements of ASME B40.100.

2.8.3 Low Differential Pressure Gauges

Gauges for low differential pressure measurements must be a minimum of 90 mm 3.5 inch (nominal) size with two sets of pressure taps, and must have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus two percent of scale range.

[2.8.4 Pressure Gauges for Pneumatic Controls

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NOTE: Remove this paragraph if pneumatic devices are not required.

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Gauges must [have a 0 to 207 kPa 0 to 30 psi scale][sufficient scale to display the full range of expected pressures] with 5 kPa 1 psi graduations.

]]2.9 OUTPUT DEVICES

2.9.1 Actuators

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NOTE: Include the appropriate bracketed text if pneumatic actuators are used.

Edit the control Schematic drawing to show electric and/or pneumatic actuators along with their failsafe positions (NO, NC, or fail-in-last-position (FILP)). See the UFC for design guidance on choosing actuator fail-to positions.

Include the bracketed text if using electric actuator position feedback. This should be limited to primary equipment, such as built-up air handlers. Show this feedback signal on the control schematic drawings or specifically state where this requirement applies. Add the actuator position to the Points Schedule as a network variable available to be monitored by the UMCS (present or future).

****

Actuators must be electric (electronic) [or pneumatic as indicated]. All actuators must be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as indicated. Normally open and normally closed actuators must be of mechanical spring return type. Electric actuators must have an electronic cut off or other means to provide burnout protection if stalled. Actuators must have a visible position indicator. [Electric actuators must provide position feedback to the controller as indicated.] Actuators must smoothly and fully open or close the devices to which they are applied. Electric actuators must have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators must be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators must provide an output signal identical to its input signal to the additional devices. [Pneumatic actuators must be rated for 172 kPa 25 psi operating pressure except for high-pressure cylinder-type actuators.] All actuators must be rated for their operating environment. Actuators used outdoors must be designed and rated for outdoor use. Actuators under continuous exposure to water, such as those used in sumps, must be submersible.

Actuators incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section [23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

2.9.1.1 Valve Actuators

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NOTE: Indicate in the Valve Schedule a close-off pressure that is 150 percent of the pump dead head pressure for 2-way valves and 200 percent of the valve differential pressure for 3-way valves, or equivalent torque values.

****

Valve actuators must provide shutoff pressures and torques as indicated on the Valve Schedule.

2.9.1.2 Damper Actuators

Damper actuators must provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque must be at least 7.3 Nm/square m 6 inch-pounds/1 square foot of damper area for opposed blade dampers and 10.9 Nm/square m 9 inch-pounds/1 square foot of damper area for parallel blade dampers.

****

NOTE: Remove the bracketed text if pneumatic devices are not required.

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[2.9.1.3 Positive Positioners

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NOTE: Positive positioners may be required for larger valves and actuators or where high-speed actuation is needed. Edit the drawings to show positive positioners when they are required. The typical drawings do not show/require them due to maintenance requirements for these devices. See UFC 3-410-02 for more information.

****

Positive positioners must be a pneumatic relay with a mechanical position feedback mechanism and an adjustable operating range and starting point.

]2.9.1.4 Electric Actuators

Each actuator must have distinct markings indicating the full-open and full-closed position Each actuator must deliver the torque required for continuous uniform motion and must have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators must function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds..

a. Two-position actuators must be single direction, spring return, or reversing type. Two position actuator signals may either be the control power voltage or line voltage as needed for torque or appropriate interlock circuits.

b. Modulating actuators must be capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators must be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Modulating actuator input signals can either be a 4 to 20 mAdc or a 0-10 VDC signal.

****

NOTE: Non spring return (NSR) or Fail in Last Position Actuators (FILP) are both acceptable alternatives for non safety or equipment protection applications. They are not recommended for applications such as AHU mixing boxes, preheat coils, steam-water heat exchanges, etc..

Provide in the design valve and damper schedule a designation on the need for spring return and desired fail position for each valve and damper.

****

c. Floating or pulse width modulation actuators are acceptable for non-fail safe applications unless indicated otherwise provided that the floating point control (timed actuation) must have a scheduled re-calibration of span and position no more than once a day and no less than once a week. The schedule for the re-calibration should not affect occupied conditions and be staggered between equipment to prevent falsely loading or unloading central plant equipment.

[2.9.1.5 Pneumatic Actuators

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NOTE: Remove this paragraph if pneumatic devices are not required.

****

Provide piston or diaphragm type actuators with replaceable diaphragm/piston.

]2.9.2 Solenoid-Operated Electric to Pneumatic Switch (EPS)

Solenoid-Operated Electric to Pneumatic Switches (EPS) must accept a voltage input to actuate its air valve. Each valve must have three-port operation: common, normally open, and normally closed. Each valve must have an outer cast aluminum body and internal parts of brass, bronze, or stainless steel. The air connection must be a 10 mm 0.38 inch NPT threaded connection. Valves must be rated for 345 kPa 50 psig.

2.9.3 Electric to Pneumatic Transducers (EP)

****

NOTE: Depending on the application, the designer may choose to select an EP and actuator combination to operate over the full range in less than 90 seconds.

****

Electric to Pneumatic Transducers (EPs) must convert either a 4-20 mAdc input signal, a 0-10 Vdc input signal to a proportional 0 to 140 kPa 0 to 20 psig pneumatic output. The EP must withstand pressures at least 150 percent of the system supply air pressure (main air). EPs must include independent offset and span adjustment. Steady state air consumption must not be greater than 0.23 L/s 0.05 scfm. EPs must have a manual adjustable override for the EP pneumatic output. EPs must have sufficient output capacity to provide full range stroke of the actuated device in both directions within [90][_____] seconds.

2.9.4 Relays

****

NOTE: Panel mounted relays have historically be specified as 'socket type' for UMCS. Recent popularity of encapsulated types of relays under brand names such as 'RIB.' has increased which provides flexibility in mounting relays at the controlled device (i.e. Motor Starters) that allows for low voltage wiring be run to/from the panel to the device rather than medium voltage.

****

Relays must have contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light must be lit when the coil is energized and off when coil is not energized.

Control relay contacts must have utilization category and ratings selected for the application. Each set of contacts must incorporate a normally open (NO), normally closed (NC) and common contact. Relays must be rated for a minimum life of one million operations.

2.10 USER INPUT DEVICES

User Input Devices, including potentiometers, switches and momentary contact push-buttons. Potentiometers must be of the thumb wheel or sliding bar type. Momentary Contact Push-Buttons may include an adjustable timer for their output. User input devices must be labeled for their function.

2.11 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device must meet all requirements of each component device. Where the requirements for the component devices conflict, the multifunction device must meet the most stringent of the requirements.

2.11.1 Current Sensing Relay Command Switch

The Current Sensing Relay portion must meet all requirements of the Current Sensing Relay input device. The Command Switch portion must meet all requirements of the Relay output device except that it must have at least one normally-open (NO) contact.

Current Sensing Relays used for Variable Frequency Drives must be rated for Variable Frequency applications unless installed on the source side of the drive. If used in this situation, the threshold for showing status must be set to allow for the VFD's control power when the drive is not enabled and provide indication of operation when the drive is enabled at minimum speed.

2.11.2 Space Sensor Module

****

NOTE: Indicate requirements for each space sensor module on the Space Sensor Module and Occupancy Sensor drawing.

Space Sensor Modules may be commonly referred to as

Thermostats but should not be confused with devices that have contact outputs for control of heating/cooling equipment (fans, compressors, etc.).

Note that any device which includes control functionality (including a thermostat) is a DDC Controller and is specified in Sections 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

****

Space Sensor Modules must be multifunction devices incorporating a temperature sensor and one or more of the following as specified and indicated on the Space Sensor Module Schedule:

a. A temperature indicating device.

b. A User Input Device which must adjust a temperature setpoint output.

c. A User Input Momentary Contact Button and an output to the control system indicating zone occupancy.

d. A three position User Input Switch labeled to indicate heating, cooling and off positions ('HEAT-COOL-OFF' switch) and providing corresponding outputs to the control system.

e. A two position User Input Switch labeled with 'AUTO' and 'ON' positions and providing corresponding output to the control system..

f. A multi-position User Input Switch with 'OFF' and at least two fan speed positions and providing corresponding outputs to the control system.

Space Sensor Modules cannot contain mercury (Hg).

[2.12 COMPRESSED AIR STATIONS

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NOTE: Remove this bracketed paragraph if pneumatic devices are not required.

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NOTE: The designer will estimate the required control air consumption to calculate the required motor horsepower of the control air compressor and coordinate with the electrical designer.

For hospitals and critical installations, a standby compressor will be provided. For all other applications, the portion covering standby compressor will be deleted. For hospitals, delete the Contractor option permitting the use of polyethylene tubing in lieu of copper.

Indicate on the drawings the locations where

metallic raceway or electric metallic tubing is not required for protection of nonmetallic tubing.
****

2.12.1 Air Compressor Assembly

Air compressors for pneumatic control systems must be the tank-mounted, electric motor driven, air cooled, reciprocating type with integral [duplex motors and compressors][single motor and compressor], tank, controller, [alternator switch,]pressure switch, belt guard[s], pressure relief valve, automatic moisture drain valve and must be supported by a steel base mounted on an air storage tank. Compressor piston speeds must not exceed 2.28 meter/second 450 fpm. Provide compressors with a dry-type combination intake air filter and silencer with baked enamel steel housing. The filter must be 99 percent efficient at 10 µm 10 microns. The pressure switch must start the compressor[s] at 482 kPa 70 psig and stop the compressor[s] at 620 kPa 90 psig. The relief valve must be set for 69 to 172 kPa 10 to 25 psig above the control switch cut-off pressure. Provide compressor capacity suitable for not more than a [33] [50] percent run time, at full system control load. Compressors must have a combination type magnetic starter with undervoltage protection and thermal-overload protection for each phase and must automatically restart after a power outage. Motors 0.5 hp and larger must be three-phase.[

A second (duplex arrangement) compressor of capacity equal to the primary compressor must be provided, with interlocked control to provide automatic changeover upon malfunction or failure of either compressor. A manual selector switch must be provided to index the lead compressor including the automatic changeover.]

2.12.2 Compressed Air Station Specialties

2.12.2.1 Refrigerated Air Dryers

Provide each air compressor tank with a refrigerant air dryer sized for continuous operation at full delivery capacity of the compressor. The air must be dried at a pressure of not less than 483 kPa 70 psi to a temperature not greater than 2 degrees C 35 degrees F and an ambient air temperature between 13 and 35 degrees C 55 and 95 degrees F. The dryer must be provided with an automatic condensate drain trap with manual override feature with an adjustable cycle and drain time. Locate each dryer in the air piping between the tank and the pressure-reducing station. The refrigerant used in the dryer must be one of the fluorocarbon gases and have an Ozone Depletion Potential of not more than 0.05. A five micron pre-filter and coalescing-type 0.03 µm micron oil removal filter with shut-off valves must be provided in the dryer discharge.

2.12.2.2 Compressed Air Discharge Filters

Provide a disposable type in-line filter in the incoming pneumatic main at each pneumatic control panel. The filter must be capable of eliminating 99.99 percent of all liquid or solid contaminants 0.1 micron or larger. Provide the filter with fittings that allow easy removal/replacement. Each filter bowl must be rated for 1034 kPa 150 psi maximum working pressure. A pressure regulator, with high side and low side pressure gauges, and a safety valve must be provided downstream of the filter.

2.12.2.3 Air Pressure-Reducing Stations

Provide air compressors with a pressure-reducing valve (PRV) with a field adjustable range of 0 to 345 kPa 0 to 50 psig discharge pressure, at an inlet pressure of 482 to 620 kPa 70 to 90 psig. Provide a factory-set pressure relief valve downstream of the PRV to relieve over-pressure. Provide a pressure gage upstream of the PRV with range of 0 to 689 kPa 0 to 100 psig and downstream of the PRV with range of 0 to 207 kPa 0 to 30 psig. For two-pressure control systems, provide an additional PRV and downstream pressure gage. Pressure regulators of the relieving type must not be used.

2.12.2.4 Flexible Pipe Connections

The flexible pipe connections must be designed for 1034 kPa and 120 degrees C 150 psi and 250 degrees F service, and must be constructed of rubber or tetrafluoroethylene resin tubing with a reinforcing protective cover of braided corrosion-resistant steel, bronze, monel, or galvanized steel. The connectors must be suitable for the service intended and must have threaded or soldered ends. The length of the connectors must be as recommended by the manufacturer for the service intended.

2.12.2.5 Vibration Isolation Units

The vibration isolation units must be standard products with published loading ratings, and must be single rubber-in-shear, double rubber-in-shear, or spring type.

2.12.3 Compressed Air Tanks

The air storage tank must be fabricated for a working pressure of not less than 1380 kPa 200 psi and constructed and certified in accordance with ASME BPVC SEC VIII D1. The tank must be of sufficient volume so that no more than six compressor starts per hour are required with the starting pressure switch differential set at 140 kPa 20 psi. The tank must be provided with an automatic condensate drain trap with manual override feature. Provide drain valve and piping routing the drainage to a floor sink or other safe and visible drainage location.

]PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General Installation Requirements

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

3.1.1.1 Device Mounting Criteria

All devices must be installed in accordance with manufacturer's recommendations and as specified and indicated. Control devices to be installed in piping and ductwork must be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements must not be used except as specified. Spare thermowells must be installed adjacent to each thermowell containing a sensor and as indicated. Devices located outdoors must have a weathershield.

3.1.1.2 Labels and Tags

Match labels and tags to the unique identifiers indicated on the As-Built drawings. Label all enclosures and instrumentation. Tag all sensors and actuators in mechanical rooms. Tag airflow measurement arrays to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Tag duct static pressure taps at the location of the pressure tap. Provide plastic or metal tags, mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures must be engraved plastic and mechanically attached to the enclosure or instrumentation. Labels inside protective enclosures may attached using adhesive, but must not be hand written.

3.1.2 Weathershield

Provide weathershields for sensors located outdoors. Install weathershields such that they prevent the sun from directly striking the sensor and prevent rain from directly striking or dripping onto the sensor. Install weather shields with adequate ventilation so that the sensing element responds to the ambient conditions of the surroundings. When installing weathershields near outside air intake ducts, install them such that normal outside air flow does not cause rainwater to strike the sensor.

3.1.3 Room Instrument Mounting

****

NOTE: All facilities are required to follow ADA standards unless the building is for able-bodied military personnel with no handicapped visitors. Buildings must be constructed to ADA standards. For more information, please refer to the following website.
http://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm#pgfId-100828

****

Mount room instruments, including but not limited to wall mounted non-adjustable space sensor modules and sensors located in occupied spaces, [1.5][1.2] meters [60][48] inches above the floor unless otherwise indicated. Install adjustable devices to be ADA compliant unless otherwise indicated on the Room Sensor Schedule:

a. Space Sensor Modules for Fan Coil Units may be either unit or wall mounted but not mounted on an exterior wall.

b. Wall mount all other Space Sensor Modules.

3.1.4 Indication Devices Installed in Piping and Liquid Systems

****

NOTE: Coordinate with the project site for preference on the use of programmable controllers or multiple application specific controllers in cases where a single application specific controller for the application is not available.

****

Provide snubbers for gauges in piping systems subject to pulsation. For gauges for steam service use pigtail fittings with cock. Install thermometers and temperature sensing elements in liquid systems in thermowells. Provide spare Pressure/Temperature Ports (Pete's Plug) for all temperature and pressure sensing elements installed in liquid systems for calibration/testing.

3.1.5 Occupancy Sensors

****

NOTE: Choose the preferred location and type of for Occupancy Sensors (coordinate with the project site to determine preference of O&M Staff).

****

Provide a sufficient quantity of occupancy sensors to provide complete coverage of the area (room or space). Occupancy sensors are to be ceiling mounted. Install occupancy sensors in accordance with NFPA 70 requirements and the manufacturer's instructions. Do not locate occupancy sensors within 2 m 6 feet of HVAC outlets or heating ducts, or where they can "see" beyond any doorway. Installation above doorway(s) is preferred. Do not use ultrasonic sensors in spaces containing ceiling fans. Install sensors to detect motion to within 600 mm 2 feet of all room entrances and to not trigger due to motion outside the room. Set the off-delay timer to [15][_____] minutes unless otherwise indicated. Adjust sensors prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc. For each controlled area, provide one hundred percent coverage capable of detecting small hand-motion movements, accommodating all occupancy habits of single or multiple occupants at any location within the controlled room.

3.1.6 Switches

****

NOTE: Wall mounted thermostats and similar control system components containing user input devices in ADA compliant facilities and spaces are required to be mounted 1200 mm 48 inches above the floor for forward reach and 1300 mm54 inches for side reach. Note the mounting height and location for these system components on the drawings or revise the following paragraph accordingly.

****

3.1.6.1 Temperature Limit Switch

Provide a temperature limit switch (freezestat) to sense the temperature at the location indicated. Provide a sufficient number of temperature limit switches (freezestats) to provide complete coverage of the duct section but no less than 3 m 1 foot in length per square meter square foot of cross sectional area. Install manual reset limit switches in approved, accessible locations where they can be reset easily. Install temperature limit switch (freezestat) sensing elements in a side-to-side (not top-to-bottom) serpentine pattern with the relay section at the highest point and in accordance with the manufacturer's installation instructions.

3.1.6.2 Hand-Off Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.7 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate and install sensors according to manufacturer's instructions. Select sensors only for intended application as designated or recommended by manufacturer.

3.1.7.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of all user-adjustable sensors [1.5 m 5 feet above the finished floor][1220 mm 48 inches above the floor to meet ADA requirements][at the height[s] indicated]. Non user-adjustable sensors can be mounted as indicated in paragraph ROOM INSTRUMENT MOUNTING.

3.1.7.2 Duct Temperature Sensors

3.1.7.2.1 Probe Type

Place tip of the sensor in the middle of the airstream or in accordance with manufacturer's recommendations or instructions.Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. When installed in insulated duct, provide enclosure or stand off fitting to accommodate the thickness of duct insulation to allow for maintenance or replacement of the sensor and wiring terminations. Seal the duct insulation penetration vapor tight.

3.1.7.2.2 Averaging Type

Weave the sensing element in a serpentine fashion from side to side perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports in accordance with manufacturer's installation instructions. Avoid tight radius bends or kinking of the sensing element. Prevent contact between the sensing element and the duct or air handler internals. Provide a duct access door at the sensor location. The access door must be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors must be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.7.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. When installed on insulated piping, provide stand enclosure or stand off fitting to accommodate the thickness of the pipe insulation and allow for maintenance or replacement of the sensor or wiring terminations. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells must not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior ensuring contact between the sensor and the well.

3.1.7.4 Outside Air Temperature Sensors

Provide outside air temperature sensors on the building's north side with a protective weather shade that does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain. Location must not be near exhaust hoods and other areas such that it is not influenced by radiation or convection sources which may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.8 Air Flow Measurement Arrays (AFMA)

Locate Outside Air AFMAs downstream from the Outside Air filters.

Install AFMAs with the manufacturer's recommended minimum distances between upstream and downstream disturbances. Airflow straighteners may be used to reduce minimum distances as recommended by the AFMA manufacturer.

3.1.9 Duct Static Pressure Sensors

****

NOTE: Recommend that the designer of record determine the preferred location. It is desirable to have more than one terminal device downstream of the sensor to prevent a single device from having too much authority over the control loop.

****

Locate the duct static pressure sensing tap at 75 percent of the distance between the first and last air terminal units [as indicated on the design documents]. If the transmitter output is a 0-10Vdc signal, locate the transmitter in the same enclosure as the air handling unit (AHU) controller for the AHU serving the terminal units. If a remote duct static pressure sensor is to be used, run the signal wire back to the controller for the air handling unit.

3.1.10 Relative Humidity Sensors

Install relative humidity sensors in supply air ducts at least 3 m 10 feet downstream of humidity injection elements.

3.1.11 Meters

3.1.11.1 Flowmeters

Install flowmeters to ensure minimum straight unobstructed piping for at least 10 pipe diameters upstream and at least 5 pipe diameters downstream of the flowmeter, and in accordance with the manufacturer's installation instructions.

3.1.11.2 Energy Meters

Locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous demand/energy and other variables as indicated.

3.1.12 Dampers

3.1.12.1 Damper Actuators

Provide spring return actuators which fail to a position that protects the served equipment and space on all control dampers related to freeze protection or force protection. For all outside, makeup and relief dampers provide dampers which fail closed. Terminal fan coil units, terminal VAV units, convectors, and unit heaters nay be non-spring return unless indicated otherwise. Do not mount actuators in the air stream. Do not connect multiple actuators to a common drive shaft. Install actuators so that their action seal the damper to the extent required to maintain leakage at or below the specified rate and so that they move the blades smoothly throughout the full range of motion.

3.1.12.2 Damper Installation

Install dampers straight and true, level in all planes, and square in all dimensions. Dampers must move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. External linkages must operate smoothly over the entire range of motion, without deformation or slipping of any connecting rods, joints or brackets that will prevent a return to it's normal position. Blades must close completely and leakage must not exceed that specified at the rated static pressure. Provide structural support for multi-section dampers. Acceptable methods of structural support include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they must not sag due to lack of support. Do not use jackshafts to link more than three damper sections. Do not use blade to blade linkages. Install outside and return air dampers such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

3.1.13 Valves

****

NOTE: Three-way valve port markings vary from one manufacturer to another. Before installing a three-way valve, note the inlets and outlets, note which port is normally open, which is normally closed, and which is the common port. On butterfly valves, limit the valve travel to 70 percent (60 degrees) open position to achieve design flow.

****

Install the valves in accordance with the manufacturer's instructions.

3.1.13.1 Valve Actuators

Provide spring return actuators on all control valves where freeze protection is required. Spring return actuators for terminal fan coil units, terminal VAV units, convectors, and unit heaters are not required unless indicated otherwise.

3.1.14 Thermometers and Gauges

[3.1.14.1 Local Gauges for Actuators

****

NOTE: Remove this bracketed paragraph if pneumatic devices are not required.

****

Provide a pressure gauge at each pneumatic control input and output. Pneumatic actuators must have an accessible and visible pressure gauge installed in the tubing lines at the actuator as indicated.

]3.1.14.2 Thermometers

Mount devices to allow reading while standing on the floor or ground, as applicable.

3.1.15 Wire and Cable

****

NOTE: Coordinate with the project site and indicate whether all wiring needs to be in raceways or whether low-voltage wiring can be run without raceways.

Note that requiring all wiring to be run in raceways will increase the project cost.

****

Provide complete electrical wiring for the Control System, including wiring to transformer primaries. Wire and Cable must be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding must be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Test installed ground rods as specified in IEEE 142. Cables and conductor wires must be tagged at both ends, with the identifier indicated on the shop drawings. Electrical work must be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as indicated. Wiring external to enclosures must be run in raceways[, except low-voltage control and low-voltage network wiring may be installed as follows:

a. plenum rated cable in suspended ceilings over occupied spaces may be run without raceways

b. nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.]

Install control circuit wiring not in raceways in a neat and safe manner. Wiring must not use the suspended ceiling system (including tiles, frames or hangers) for support. Where conduit or raceways are required, control circuit wiring must not run in the same conduit/raceway as power wiring over 50 volts. Run all circuits over 50 volts in conduit, metallic tubing, covered metal raceways, or armored cable.

3.1.16 Copper Tubing

Provide hard-drawn copper tubing in exposed areas and either hard-drawn or annealed copper tubing in concealed areas. Use only tool-made bends. Use only brass or copper solder joint type fittings, except for connections to apparatus. For connections to apparatus use brass compression type fittings.

3.1.17 Plastic Tubing

Install plastic tubing within covered raceways or conduit except when otherwise specified. Do not use plastic tubing for applications where the tubing could be subjected to a temperature exceeding 55 degrees C 130 degrees F. For fittings, use brass or acetal resin of the compression or barbed push-on type for instrument service. Except in walls and exposed locations, plastic multitube instrument tubing bundle without conduit or raceway protection may be used where a number of air lines run to the same points, provided the multitube bundle is enclosed in a protective sheath, is run parallel to the building lines and is adequately supported as specified.

[3.1.18 Pneumatic Lines

****

NOTE: Remove this bracketed paragraph if pneumatic devices are not required.

****

Run tubing concealed in finished areas, run tubing exposed in unfinished areas like mechanical rooms. For tubing enclosed in concrete, provide rigid metal conduit. Run tubing parallel and perpendicular to building walls. Use1.5 m 5 foot maximum spacing between tubing supports. With the compressor turned off, test each tubing system pneumatically at 1.5 times the working pressure and prove it air tight, locating and correcting leaks as applicable. Caulking joints is not permitted. Do not run tubing and electrical power conductors in the same conduit.

a. Install pneumatic lines must such that they are not exposed to outside air temperatures. Conceal pneumatic lines except in mechanical rooms and other areas where other tubing and piping is exposed.

b. Install all tubes and tube bundles exposed to view in lines parallel to the lines of the building. Route tubing in mechanical/electrical so that the lines are easily traceable.

c. Purge air lines of dirt, impurities and moisture before connecting to the control equipment. Number-code or color-code air lines and key the coding in the As-Built Drawings for future identification and servicing the control system.

3.1.18.1 Pneumatic Lines In Mechanical/Electrical Spaces

In mechanical/electrical spaces, use plastic or copper tubing for pneumatic lines. Install horizontal and vertical runs of plastic tubing or soft copper tubing min raceways or rigid conduit dedicated to tubing. Support dedicated raceways, conduit, and hard copper tubing not installed in raceways every 2 m 6 feet for horizontal runs and every 2.4 m 8 feet for vertical runs.

3.1.18.2 Pneumatic Lines External to Mechanical/Electrical Spaces

External to mechanical/electrical spaces, use plastic tubing in raceways not containing power wiring or copper tubing with sweat fittings. Support raceways and tubing not in raceways every 2.4 m 8 feet. For pneumatic lines concealed in walls use hard-drawn copper tubing or plastic tubing in rigid conduit. Plastic tubing in a protective sheath, run parallel to the building lines and supported as specified, may be used above accessible ceilings and in other concealed but accessible locations.

3.1.18.3 Terminal Single Lines

For terminal single lines use hard-drawn copper tubing, except when the run is less than 300 mm 12 inches in length, flexible polyethylene may be used.

3.1.18.4 Connection to Liquid and Steam Lines

Use [copper][Series 300 stainless steel] with [brass compression][stainless-steel compression] fittings for connection of sensing elements and transmitters to liquid and steam lines.

3.1.18.5 Connection to Ductwork

Use plastic tubing for connections to sensing elements in ductwork.

3.1.18.6 Tubing in Concrete

Install tubing in concrete in rigid conduit. Install tubing in walls containing insulation, fill, or other packing materials in raceways dedicated to tubing.

3.1.18.7 Tubing Connection to Actuators

For final connections to actuators use plastic tubing no more than 300 mm 12 inches long and unsupported at the actuator.

]3.1.19 Compressed Air Stations

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NOTE: If possible, foundations and housekeeping pads should be specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

****

Mount the air compressor assembly on vibration eliminators, in accordance with ASME BPVC SEC VIII D1 for tank clearance. Connect the air line to the tank with a flexible pipe connector. Provide compressed air station specialties with required tubing, including condensate tubing to a floor drain. Compressed air stations must deliver control air meeting the requirements of ISA 7.0.01. Provide foundations and housekeeping pads for the HVAC control system air compressors [in accordance with the air compressor manufacturer's instructions][as specified in Section 23 30 00 HVAC AIR DISTRIBUTION].

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 09 23.01 (August 2024)**

Preparing Activity: USACE **Superseding**
UFGS-23 09 23.01 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 23.01

LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

08/24

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC UFGS-23 09 23.01 (August 2024)

Preparing Activity: USACE Superseding
UFGS-23 09 23.01 (February 2019)

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****

SECTION 23 09 23.01

LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
08/24

****
NOTE: This guide specification covers the requirements for LonWorks-based building control systems using the CEA-709.1-D-C communications protocol, including tailoring options for LNS-based and Niagara Framework-based LonWorks systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR)**. CCRs for this specification can be submitted through the Whole Building Design Guide page for this section:**
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-
****

****
The use of this UFGS, and the design of LonWorks Control Systems, must be in accordance with UFC 3-410-02, DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Use this specification in conjunction with UFGS 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and UFGS 25 05 11 CYBERSECUROTY FOR FACILITEY-RELATED CONTROL SYSTEMS in order to specify a complete and functional system.

Edit this guide specification for project specific requirements ONLY by selecting appropriate tailoring options, choosing applicable items(s), or inserting appropriate information in bracketed items. Do not make edits outside of bracketed items without prior

approval as specified in UFC 3-410-02.

This specification covers installation of local (building-level) controls using LonWorks-based DDC. It is primarily intended for building level control systems which are to be integrated into a Utility Monitoring and Control System (UMCS) as specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION (where Section 25 10 10 has also used the matching LonWorks or Niagara Framework tailoring option).

For projects that require the building system to provide UMCS functionality (without connection to a UMCS), the designer must include the necessary requirements from Section 25 10 10 in the project specification.

Template drawings in electronic format for use with this section are available online at the Whole Building Design Guide page for Section 23 09 00: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-
****

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NOTE: This specification makes use of SpecsIntact Tailoring Options. This note describes these options and how to use them.

"TAILORING OPTION NOTES" Tailoring Option
Each time tailoring options are used there is an accompanying designer note describing the text that is tailored. As this Section makes heavy use of tailoring options there are many of these notes and they can distract from designer notes describing other decisions. The designer notes describing tailoring options are all in a "TAILORING OPTION NOTES" tailoring option which can be hidden (in specsintact select View-Tailoring Options and then deselect "TAILORING OPTION NOTES") once this section is tailored and the tailoring option notes are no longer needed.

"NIAGARA FRAMEWORK" and "LNS" Tailoring Options
This specification includes tailoring options for "NIAGARA FRAMEWORK" and for "LNS". Exactly ONE of these tailoring options must be chosen. You have currently selected the following options:

NIAGARA FRAMEWORK
LNS

If you don't see either the words "NIAGARA FRAMEWORK" or "LNS" between the dashes above, you have not selected a tailoring option and this specification is not valid. Select ONE of the tailoring options.

If you see both "NIAGARA FRAMEWORK" and "LNS" you

have selected both tailoring options. Remove one of the tailoring options.

Service Tailoring Option
This specification also includes tailoring options for the Service (Air Force, Army, Navy) the specification is used for. There is a "Service Generic" tailoring option that can also be used. Only ONE of the four tailoring options related to the service should be use. You have currently selected the following options:

AIR FORCE
ARMY
NAVY
SERVICE GENERIC

If more than one item appears between the dashes above you have selected more than one services tailoring option and need to remove all but one of them.
****

****
WARNING - Both the NIAGARA FRAMEWORK and LNS Tailoring Options have been selected. This will result in a specification that contains conflicts and cannot be met. DESELECT one of these tailoring options. See UFC 3-410-02.
****

PART 1 GENERAL

1.1 SUMMARY

****
NOTE: Designer is to add location and site specific requirements.
****

Provide a complete Direct Digital Control (DDC) system, except for the Front End which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.1.1 System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

****
NOTE: The following list paragraph uses tailoring options:
1) The paragraph NOT referencing Niagara Framework is included only when the LNS tailoring option is

selected.
2) The paragraph referencing Niagara Framework is included only when the NIAGARA FRAMEWORK tailoring option is selected.
****

a. The control system must be an open implementation of LonWorks technology using CEA-709.1-D as the communications protocol. The system must use LonMark Standard Network Variable Types as defined in LonMark SNVT List exclusively for communication over the network.

The control system must be an open implementation of LonWorks technology using CEA-709.1-D and Fox as the communications protocols. Except for communication between Niagara Framework components (between Niagara Framework Supervisory Gateways or between a Niagara Framework Supervisory Gateway and a Niagara Framework Front End) which must use the Fox Protocol, the system must use LonMark Standard Network Variable Types as defined in LonMark SNVT List exclusively for communication over the network.

****
NOTE: The following list paragraph uses tailoring options:
1) The paragraph referring to LNS is included only when the LNS tailoring option is selected.
2) The paragraph referring to Niagara Framework is included only when the NIAGARA FRAMEWORK tailoring option is selected.
****

b. Use LonWorks Network Services (LNS) for all network management including addressing and binding of network variables. As specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, submit copies of the complete, fully-commissioned, valid, as-built Final LNS database, including all LNS credits, for the complete control system provided under this specification. All devices must be on-line and commissioned into the LNS database.

Use the Niagara Framework for all network management including addressing and binding of network variables. Each Niagara Framework Supervisory Gateway must contain a database for all controllers connected to its non-IP ports.

****
NOTE: The following list paragraph uses tailoring options for requirements specific to Niagara Framework systems. The requirements specific to Niagara Framework are included only when the NIAGARA FRAMEWORK tailoring option is selected
****

c. Install and configure control hardware, except as specified for Niagara Framework Supervisory Gateways, to provide all input and output Standard Network Variables (SNVTs) as indicated and as needed to meet the requirements of this specification. Points in Niagara Framework Supervisory Gateways which do not communicate with non-Niagara Framework DDC Hardware may be exposed via Fox instead.

****

NOTE: The following list paragraph uses tailoring options for requirements specific to Niagara Framework systems. The requirements specific to Niagara Framework are included only when the NIAGARA FRAMEWORK tailoring option is selected

****

d. All DDC hardware installed under this specification must communicate via CEA-709.1-D, and Niagara Framework Supervisory Gateways must also communicate over the IP network via Fox. Install the control system such that a SNVT output from any node on the network can be bound to any other node in the same domain.

****

NOTE: Select Web Pages if a local (in the building) web interface is required.

The following TWO list paragraphs apply only to Niagara Framework systems and are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

e. Use Niagara Framework hardware and software exclusively for alarming, scheduling, trending, and communication with a front end (UMCS). Use the Fox protocol for all communication between Niagara Framework Supervisory Gateways; use the CEA-709.1-D protocol for all other building communication. [Niagara Framework Supervisory Gateway must serve web pages as specified.]

****

NOTE: Select the required version of the Niagara Framework. This choice must be carefully coordinated with the project site. Niagara Framework is currently (2015) in a transition between two releases: "AX" and "Version 4". A Version 4 UMCS front end (e.g. as specified in Section 25 10 10) will work with either an AX or Version 4 Niagara Framework Supervisory Gateway, but an AX front end will ONLY work with an AX Niagara Framework Supervisory Gateway.

If the site has an AX front end, select "AX".
If the site has a Version 4 front end, or does not have a front end:
1) if there are multiple vendors servicing the project site that support Version 4, select "Version 4"

2) otherwise, select "either AX or Version 4"

****

f. Use Niagara Framework [AX][Version 4.0 or later][either AX or Version 4.0 or later].

1.1.2 Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any other Section referenced in this specification is not included in the project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification
CEA-709.3	(1999; R 2015) Free-Topology Twisted-Pair Channel Specification
CEA-852-C	(2014) Tunneling Device Area Network Protocols Over Internet Protocol Channels

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2022) Ethernet

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 4361	(2006) Node-specific Client Identifiers for Dynamic Host Configuration Protocol Version Four (DHCPv4)
IETF RFC 7465	(2015) Prohibiting RC4 Cipher Suites

LONMARK INTERNATIONAL (LonMark)

LonMark Interoperability Guide	(2005) LonMark Application-Layer

	Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4
LonMark SCPT List	(2014) LonMark SCPT Master List; Version 15
LonMark SNVT List	(2014) LonMark SNVT Master List; Version 15
LonMark XIF Guide	(2001) LonMark External Interface File Reference Guide; Revision 4.402

TRIDIUM, INC (TRIDIUM)

Niagara Framework	(2021) NiagaraAX User's Guide
Tridium Open NiCS	(2021) Understanding the NiagaraAX Compatibility Statement (NiCS)

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 916	(2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment

1.3 DEFINITIONS

For definitions related to this section, see Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.4 SUBMITTALS

****

NOTE: Submittals related to this section are specified in UFGS 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. UFGS 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC MUST be used with this specification to have a complete specification.

****

Submittals related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

****

NOTE: For Section 25 05 11, use the bracketed text in the Section number to add forth level numbering if used on the project as described in UFC 4-010-06. In the Section name, keep the bracketed text if the section was unnamed or use the empty brackets provided to change the Section name to match the project specifications.

****

All products used to meet this specification must meet the specified requirements, but not all products specified here will be required by every project. Provide products which meet the requirements of Section 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC, Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS, and this Section.

2.1 NETWORK HARDWARE

2.1.1 CEA-709.1-D Routers

CEA-709.1-D Routers must meet the requirements of CEA-709.1-D and must provide connection between two or more CEA-709.3 TP/FT-10 channels, or between one or more CEA-709.3 TP/FT-10 channels and a LonMark Interoperability Guide TP/XF-1250 channel.

2.1.2 CEA-709.1-D Repeaters

CEA-709.1-D Repeaters must be CEA-709.1-D Routers configured as repeaters. Physical layer repeaters are prohibited.

2.1.3 CEA-709.1-D Gateways

****

NOTE: This subpart uses tailoring options for requirements specific to Niagara Framework systems. The requirements specific to Niagara Framework are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

In addition to the requirements for DDC Hardware, CEA-709.1-D gateways must be a Niagara Framework Supervisory Gateway or must:

a. Allow bi-directional mapping of data between the non-CEA-709.1-D protocol and SNVTs

b. Incorporate a network connection to a TP/FT-10 network in accordance with CEA-709.3 and a separate connection appropriate for the a non-CEA-709.1-D network

Although Gateways must meet DDC Hardware requirements, except for Niagara Framework Supervisory Gateways, they are not DDC Hardware and must not be used when DDC Hardware is required. (Niagara Framework Supervisory Gateways are both Gateways and DDC Hardware.)

2.1.4 CEA-852-C Router

****

NOTE: This subpart applies only to LNS-based systems and is only included when the LNS tailoring option is selected.

****

CEA-852-C Routers must perform layer 3 routing of CEA-709.1-D packets over an IP network in accordance with CEA-852-C. The router must provide the appropriate connection to the IP network and connections to the CEA-709.3 TP/FT-10 or LonMark Interoperability Guide TP/XF-1250 network. CEA-852-C Routers must support the Dynamic Host Configuration Protocol (DHCP; IETF RFC 4361 for IP configuration and the use of an CEA-852-C Configuration Server (for CEA-852-C configuration), but must not rely on these services for configuration. CEA-852-C Routers must be capable of manual configuration via a console RS-232 or USB port.

2.1.5 Ethernet Switch

****
NOTE: For Section 25 05 11, use the bracketed text in the Section number to add forth level numbering if used on the project as described in UFC 4-010-06. In the Section name, keep the bracketed text if the section was unnamed or use the empty brackets provided to change the Section name to match the project specifications.
****

Ethernet Switches must be as specified in Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS.

2.2 CONTROL NETWORK WIRING

a. Provide TP/FT-10 control wiring in accordance with CEA-709.3.

b. Provide TP/XF-1250 control wiring in accordance with the LonMark Interoperability Guide.

****
NOTE: Although the controls contractor installs the building control system backbone, which is an IP network, this system will later be integrated into the basewide network via the FPOC. To ensure no issues arise during this later integration, obtain additional Ethernet media requirements (if any) from the project site NEC.
****

c. For the Building Control Network IP Network provide media that is CAT-5e Ethernet media at a minimum and meets all requirements of IEEE 802.3 [and [_____]].

2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

All DDC Hardware must meet the following general requirements:

****
NOTE: The following paragraph uses tailoring options. The phrase "Except for Niagara Framework Supervisory Gateways, it" is included only when the NIAGARA FRAMEWORK tailoring option is selected.
****

a. Except for Niagara Framework Supervisory Gateways, it It must incorporate a "service pin" which, when pressed will cause the DDC Hardware to broadcast its 48-bit NodeID and its ProgramID over the network. The service pin must be distinguishable and accessible.

b. It must incorporate a light to indicate the device is receiving power.

****
NOTE: The following paragraph uses tailoring options:

1) The phrase "Except for Niagara Framework Supervisory Gateways, it" is included only when the NIAGARA FRAMEWORK tailoring option is selected.

2) Transceiver requirements related to Niagara Framework Supervisory Gateways are included only when the NIAGARA FRAMEWORK tailoring option is selected.
****

c. Except for Niagara Framework Supervisory Gateways, it must It must incorporate a TP/FT-10 transceiver in accordance with CEA-709.3 and connections for TP/FT-10 control network wiring. Niagara Framework Supervisory Gateways must incorporate an IP connection and at least one other transceiver. These other transceivers must be either a TP/FT-10 transceiver in accordance with CEA-709.3 or a TP/XF-1250 transceiver in accordance with LonMark Interoperability Guide. Niagara Framework Supervisory gateways must have connection of the appropriate type for each transceiver.

****
NOTE: The following paragraph uses tailoring options - "or the Fox protocol" is included only when the NIAGARA FRAMEWORK tailoring option is selected.
****

d. It must communicate on the network using only the CEA-709.1-D protocol or the Fox protocol.

****
NOTE: The following paragraph uses tailoring options 1) "LNS" is only included when the LNS tailoring option is selected.

2) "the Niagara Framework" is included only when the NIAGARA FRAMEWORK tailoring option is selected.
****

e. It must be capable of having network communications configured via LNS the Niagara Framework.

****
NOTE: FYI, a link powered device gets it's power from the communication cable as opposed to from a separate power source.
****

f. It must be locally powered; link powered devices are not acceptable.

****
NOTE: The following paragraph uses tailoring options for requirements specific to Niagara Framework systems:
"except Niagara Framework Supervisory Gateways" is included only when the NIAGARA FRAMEWORK tailoring option is selected.
****

g. LonMark external interface files (XIF files), as defined in the LonMark XIF Guide, must be submitted for each type of DDC Hardware except Niagara Framework Supervisory Gateways.

h. Application programs and configuration settings must be stored in a manner such that a loss of power does not result in a loss of the application program or configuration settings:

(1) Loss of power must never result in the loss of application programs, regardless of the length of time power is lost.

(2) Loss of power for less than 2,500 hours must not result in the loss of configured settings.

i. It must have all functionality specified and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to:

****

NOTE: The following paragraph uses tailoring options for requirements specific to Niagara Framework systems. The phrases "or Niagara Framework Points", and "and Niagara Framework Points" are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

(1) It must provide input and output SNVTs or Niagara Framework Points as specified, as indicated on the Points Schedule, and as otherwise required to support the sequence and application in which it is used. All SNVTs and Niagara Framework Points must have meaningful names identifying the value represented by the SNVT or Niagara Framework Points . Unless a standard network variable type of an appropriate engineering type is not available, all network variables must be of a standard network variable type with engineering units appropriate to the value the variable represents.

****

NOTE: The following paragraph uses tailoring options for requirements specific to Niagara Framework systems. The sentence referring to Niagara Framework is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

(2) All settings and parameters used by the application in which the DDC hardware is used must be configurable via one of the following: standard configuration properties (SCPTs) as defined in the LonMark SCPT List, user-defined configuration properties (UCPTs), network configuration inputs (*ncis*) of a SNVT type as defined in the LonMark SNVT List, network configuration inputs (*ncis*) of a user defined network variable type, or hardware settings on the controller itself. Niagara Framework Supervisory Gateways may instead be configurable via the Niagara Framework.

j. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.

****

NOTE: FYI - The following requires that contractors with hardware that could be submitted under several categories to choose which requirements they must meet. This ensures that the device is evaluated according to its actual use.

****

****

NOTE: The following paragraph uses tailoring options for requirements specific to Niagara Framework systems. "Niagara Framework Supervisory Gateway" is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

k. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet the requirements of a Niagara Framework Supervisory Gateway, a Local Display Panel (LDP), Application Specific Controller (ASC), General Purpose Programmable Controller (GPPC), or an Application Generic Controller (AGC). All pieces of DDC Hardware must have their DDC Hardware Type identified as part of the Manufacturer's Product Data submittal as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Except for Local Display Panels provided as part of another controller, where a single device meets the requirements of multiple types, select a single type for that specific device based on it's use. Where a Local Display Panel is provided as part of another device, indicate both the controller type and local display panel. One model of DDC hardware may be submitted as different DDC Hardware types when used in multiple applications.

l. The user interface on all DDC Hardware with a user interface which allows for modification of a value must be password protected.

m. Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.

2.3.1 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

2.3.1.1 Analog Inputs

DDC Hardware analog inputs (AIs) must perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2.3.1.2 Analog Outputs

****

NOTE: PART 3 of this section and the Points Schedules may require that points have an H-O-A switch. For analog outputs these switches may be "full on, full off" overrides or may have a knob allowing for override to any value (0-100 percent). Unless the project site specifically requires that analog outputs be fully adjustable through the range 0-100 percent, keep the bracketed text allowing either option (i.e. keep "to 0 percent and to 100 percent". Requiring fully adjustable overrides (i.e. "through the range of 0 percent to 100 percent") will likely raise the cost of the system.

****

DDC Hardware analog outputs (AOs) must perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output [to 0 percent and to 100 percent][through the range of 0 percent to 100 percent]

2.3.1.3 Binary Inputs

DDC Hardware binary inputs (BIs) must accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient of 50 Vac must be provided.

2.3.1.4 Binary Outputs

DDC Hardware binary outputs (BOs) must provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the output open or closed.

2.3.1.4.1 Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.1.4.2 Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.1.5 Pulse Accumulator

DDC Hardware pulse accumulators must have the same characteristics as the BI. In addition, a buffer must be provided to totalize pulses. The pulse accumulator must accept rates of at least 20 pulses per second. The totalized value must be resettable via a configurable parameter.

[2.3.1.6 Integrated H-O-A Switches

****

NOTE: Even if H-O-A switches are implemented,

Requiring feedback of H-O-A status may seriously limit competition and raise project costs. Unless there is a specific project requirement for H-O-A feedback, remove the bracketed text.
****

****
NOTE: This subpart uses tailoring options for requirements specific to Niagara Framework systems. "Niagara Framework of via" is only included when the NIAGARA FRAMEWORK tailoring option is selected.
****

Where integrated H-O-A switches are provided on hardware outputs, controller must provide means of monitoring position or status of H-O-A switch. This feedback may be provided via the Niagara Framework or via network variable.

]2.3.2 Local Display Panel (LDP)

****
NOTE: This subpart uses tailoring options for requirements specific to Niagara Framework systems. "Niagara Framework points" is only included when the NIAGARA FRAMEWORK tailoring option is selected.
****

The Local Display Panels (LDPs) must be DDC Hardware with a display and navigation buttons or a touch screen display, and must provide display and adjustment of Niagara Framework points or network variables as indicated on the Points Schedule and as specified. LDPs must be provided as stand-alone DDC Hardware or as an integral part of another piece of DDC Hardware. LDPs must come factory installed with all applications necessary for the device to function as an LDP.

The adjustment of values using display and navigation buttons must be password protected.

2.3.3 Application Specific Controller (ASC)

Application Specific Controllers (ASCs) have a fixed factory-installed application program (i.e. ProgramID) with configurable settings and do not have the ability to be programmed for custom applications. ASCs must meet the following requirements in addition to the General DDC Hardware and DDC Hardware Input-Output (I/O) Function requirements:

a. ASCs must be LonMark Certified.

****
NOTE: The following list paragraph uses tailoring options:
1) The paragraph referring to Niagara Framework and Niagara Framework Wizards is included only when the NIAGARA FRAMEWORK tailoring option is selected.

2) The paragraph referring to LNS and LNS Plug-ins is included only when the NIAGARA FRAMEWORK tailoring option is selected.
****

b. Unless otherwise approved, all necessary Configuration Properties and network configuration inputs (*ncis*) for the sequence and application in which the ASC is used must be fully configurable through the Niagara Framework. Application Specific Controller configurable via a Niagara Framework Wizard is preferred. Wizards must be submitted for each type (manufacturer and model) of Application Specific Controller which has a Wizard available for configuration. Wizards distributed under a license must be licensed to the project site. (Note: configuration accomplished via hardware settings does not require configuration via Niagara Framework Wizard.)

Unless otherwise approved, all necessary Configuration Properties and network configuration inputs (*ncis*) for the sequence and application in which the ASC is used must be fully configurable through an LNS plug-in. LNS Plug-ins must be submitted for each type (manufacturer and model) of Application Specific Controller. LNS Plug-ins distributed under a license must be licensed to the project site. (Note: configuration accomplished via hardware settings does not require configuration via plug-in)

c. ASCs may include an integral or tethered Local Display Panel

2.3.4 General Purpose Programmable Controller (GPPC)

A General Purpose Programmable Controller (GPPC) must be programmed for the application. GPPCs must meet the following requirements in addition to the general DDC Hardware requirements and Hardware Input-Output (I/O) Functions:

a. The programmed GPPC must conform to the LonMark Interoperability Guide.

b. All programming software required to program the GPPC must be delivered to and licensed to the project site in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Submit the most recent version of the Programming software for each type (manufacturer and model) of General Purpose Programmable Controller (GPPC).

****

NOTE: The requirement to submit source code is vital to allow the Government to maintain the system and modify or reprogram devices if needed. The intent is that the Government can both:

1) modify the source code and re-download to the controller to change the sequence

2) buy an unprogrammed identical replacement controller and download the program into it in order to replace the controller

****

c. Submit copies of the installed GPPC application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted GPPC application program must be the complete application necessary for the GPPC to function as installed and be sufficient to allow replacement of the installed controller with a GPPC of the same type.

d. GPPCs may be include an integral or tethered Local Display Panel

2.3.5 Application Generic Controller (AGC)

An Application Generic Controller (AGC) has a fixed application program which includes the ability to be programmed for custom applications. AGCs must meet the following requirements in addition to the general DDC Hardware requirements and Hardware Input-Output (I/O) Functions:

a. The programmed AGC must conform to the LonMark Interoperability Guide.

b. The AGC must have a fixed ProgramID and fixed XIF file.

****

NOTE: The following TWO list paragraphs use tailoring options:
1) Requirements for LNS plug-ins are included only when the LNS tailoring option is selected.

2) Requirements for Niagara Framework Wizards are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

c. Unless otherwise approved, the ACG must be fully configurable and programmable for the application using one or more LNS plug-ins Niagara Framework Wizards, all of which must be submitted as specified for each type of AGC (manufacturer and model).

d. Submit copies of the installed AGC application programs as source code compatible with the supplied LNS plug-in Niagara Framework Wizard used for programming the device in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted AGC application program must be the complete application program necessary for the AGC to function as installed and be sufficient to allow replacement of the installed controller with an AGC of the same type.

****

NOTE: The requirement to submit source code is vital to allow the Government to maintain the system and modify or reprogram devices if needed. The intent is that the Government can both:

1) modify the source code and re-download to the controller to change the sequence

2) buy an unprogrammed identical replacement controller and download the program into it in order to replace the controller

****

e. AGCs may be include an integral or tethered Local Display Panel

2.3.6 Niagara Framework Supervisory Gateway

****

NOTE: This subpart applies only to Niagara Framework systems and is only included when the

NIAGARA FRAMEWORK tailoring option is selected.
****

****
NOTE: FYI - The Niagara Framework Supervisory Gateway is known by many names within industry, and this specification uses the name "Niagara Framework Supervisory Gateway" in order to remain vendor neutral. Probably the most common term used for this device in industry is a "Java Application Control Engine", or JACE.
****

Any device implementing the Niagara Framework is a Niagara Framework Supervisory Gateway and must meet these requirements. In addition to the general requirements for all DDC Hardware, Niagara Framework Supervisory Gateway Hardware must:

a. Be direct digital control hardware.

b. Have an unrestricted interoperability license and its Niagara Comparability Statement (NiCS) must follow the Tridium Open NiCS Specification.

c. Manage communications between a field control network and the Niagara Framework Monitoring and Control Software, and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components, regardless of the manufacturer of the other components.

d. Be fully programmable using the Niagara Framework Engineering Tool and must support the following:

    (1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects

    (2) Alarm generation and routing using the Niagara Alarm Service

    (3) Trending using the Niagara History Service and Niagara Trend Log Objects

    (4) Integration of field control networks using the Niagara Framework Engineering Tool

    (5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. Meet the following minimum hardware requirements:

    (1) [One][Two] 10/100/1000 Mbps Ethernet Port(s)

[(2) Central Processing Unit of 600 Mhz or higher.][

    (3) Embedded operating system.]

f. provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users.

Note: implementation of this capability may not be required on this project; see requirements in PART 3, EXECUTION of this Section.

g. Submit a backup of each Niagara Framework Supervisory Gateway as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The backup must be sufficient to restore a Niagara Framework Supervisory Gateway to the final as-built condition such that a new Niagara Framework Supervisory Gateway loaded with the backup is indistinguishable in functionality from the original.

2.4 NIAGARA FRAMEWORK ENGINEERING TOOL

****

NOTE: This subpart applies only to Niagara Framework systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

The Niagara Framework Engineering Tool must be Niagara Workbench or an equivalent Niagara Framework engineering tool software must:

a. have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.

b. be capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

c. be capable of programming and configuring of Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

d. be capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

Monitoring and Control Software is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION

3.1.1 Niagara Framework Engineering Tool

****

NOTE: This subpart applies only to Niagara Framework systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: If the installation has a Niagara Framework Engineering Tool keep the first bracketed text and provide the software name and version number in the space provided. If the installation does not have a Niagara Framework Engineering Tool keep the second

bracketed text.
****

[The project site currently has the [_____] Niagara Framework Engineering Tool. If this software is not adequate for programming the Niagara Framework Supervisory Gateways provided under this project, provide a Niagara Framework Engineering Tool as specified.][Provide a Niagara Framework Engineering Tool as specified.]

3.1.2 Building Control Network (BCN)

****
NOTE: This subpart uses tailoring options:
1) "Niagara Framework Supervisory Gateways" is included only when the NIAGARA FRAMEWORK tailoring option is selected.

2) "CEA-852-C Routers" is included only when the LNS tailoring option is selected.
****

Provide a Building Control Network (BCN) connecting all DDC hardware as specified. The Building Control Network (BCN) must consist of an IP Network, one or more Niagara Framework Supervisory Gateways CEA-852-C Routers, and one or more Non-IP Building Control Network Channels:

3.1.2.1 Building Control Network (BCN) Installation

****
NOTE: This subpart uses tailoring options:
1) "Niagara Framework Supervisory Gateways" is included throughout this subpart only when the NIAGARA FRAMEWORK tailoring option is selected.

2) "CEA-852-C Routers" is included throughout this subpart only when the LNS tailoring option is selected.
****

Provide building control networks meeting the following requirements:

a. Provide a Building Control Network IP Network, Non-IP Building Control Network Channels and Niagara Framework Supervisory Gateways CEA-852-C Routers to a create a single building control network connecting all DDC Hardware.

b. In addition to the connection to the Niagara Framework Supervisory Gateway CEA-852-C Router, each Non-IP Building Control Network (BCN) Channel directly connected to a Niagara Framework Supervisory Gateway CEA-852-C Router must be directly connected to either DDC Hardware or to CEA-709.1-D Routers, but not to both. A channel containing only CEA-709.1-D Routers is a backbone channel and a channel containing DDC Hardware is a non-backbone channel.

c. When only a single Niagara Framework Supervisory Gateway CEA-852-C Router is required, the IP network consists of only the Niagara Framework Supervisory Gateway CEA-852-C Router. When multiple Niagara Framework Supervisory Gateways CEA-852-C Routers are required, provide an IP Network connecting all Niagara Framework Supervisory Gateways

CEA-852-C Routers.

****

NOTE: The following list paragraph uses tailoring options. The text "other than Niagara Framework Supervisory Gateways" and the text "Connect all Niagara Framework Supervisory Gateways to the Building Control Network (BCN) IP Network." are only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

d. Connect all DDC Hardware other than Niagara Framework Supervisory Gateways to a non-backbone BCN Channel. Connect all Niagara Framework Supervisory Gateways to the Building Control Network (BCN) IP Network.

e. Install components such that there is no more than than one CEA-709.1-D Router between any DDC Hardware and a Niagara Framework Supervisory Gateway CEA-852-C Router

f. Install the network such that the peak expected bandwidth usage for each and every channel is less than 70 percent, including device-to-device traffic and traffic to the Utility Monitoring and Control System (UMCS) as indicated on the Points Schedule.

****

NOTE: The following list paragraph uses tailoring options. The text "other than a Niagara Framework Supervisory Gateway" is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

g. Where multiple pieces of DDC Hardware are used in the execution of a single sequence of operation, directly connect all DDC Hardware used to execute the sequence to the same channel and do not install other DDC Hardware, other than a Niagara Framework Supervisory Gateway, to that channel.

3.1.2.2 Non-IP Building Control Network (BCN) Channel

Provide Non-IP Building Control Network (BCN) Channels meeting the following requirements:

a. For each non-backbone channel, provide a TP/FT-10 channel in doubly terminated bus topology in accordance with CEA-709.3. For each backbone channel, provide either a TP/FT-10 channel in doubly terminated bus topology in accordance with CEA-709.3 or a TP/XF-1250 channel in accordance with the LonMark Interoperability Guide.

b. Connect no more than 2/3 the maximum number of devices permitted by CEA-709.3 to each TP/FT-10 channel. Connect no more than 2/3 the maximum number of devices permitted by LonMark Interoperability Guide to TP/XF-1250 channel.

c. Connect no more than 2/3 the maximum number of devices permitted by the manufacturer of the device transceivers to each channel. When more than one type of transceiver is used on the same channel, use the transceiver with the lowest maximum number of devices to calculate the 2/3 limit.

3.1.2.3 Building Control Network (BCN) IP Network

Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Network so that it is available at the Facility Point of Connection (FPOC) location [as specified][_____]. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Network can be extended to any location in the room.

3.1.3 DDC Hardware

****

NOTE: Select bracketed text for requirements when no Application Specific controller exists for the application. This selection must be made in coordination with the project site, as they may have a specific requirement related to their O&M capabilities or preferences.

One option for systems using the Niagara Framework is to require the use of a Niagara Framework Supervisory Gateway whenever an Application Specific Controller isn't available for the application (essentially allowing only Niagara Framework Supervisory Gateways and Application Specific Controllers and prohibiting Application Generic Controllers and General Purpose Programmable Controllers). Remove the bracketed text (from "or Application Generic " through the end of the paragraph) to require the use of Niagara Framework Supervisory Gateways when Application Specific Controllers aren't available for the application in question. Otherwise, keep this bracketed text and then select the appropriate bracketed text.

Select appropriate bracketed text to indicate requirement for programmable controllers or multiple application specific controllers in cases where a single application specific controller for the application is not available.

The first option ("Application Generic Controllers, General Purpose Programmable Controllers or multiple Application Specific Controllers") is most permissive and should be used when the project site does not have a specific requirement.

If the third option ("multiple Application Specific Controllers") is selected, requirements related only to General Purpose Programmable Controllers and Application Generic Controllers may be removed from this Section. Great caution must be exercised in removing these requirements to ensure that requirements related to Application Specific Controllers are not affected by the removal of text.

****

****
NOTE: This subpart uses tailoring options:
1) "Niagara Framework Supervisory Gateways","via the Niagara Framework" and "a Niagara Framework Supervisory Gateway [or " are included only when the NIAGARA FRAMEWORK tailoring option is selected.

2) "CEA-852-C Routers" and "via LNS using an LNS-based Network Configuration Tool" are included only when the LNS tailoring option is selected.
****

Install Niagara Framework Supervisory Gateways CEA-852-C Routers in lockable enclosures. Install other DDC Hardware which is not is suspended ceilings in [lockable]enclosures.

Configure and commission all DDC Hardware on the Building Control Network via the Niagara Frameworkvia LNS using an LNS-based Network Configuration Tool. Use Application Specific Controllers whenever an Application Specific Controller suitable for the application exists. When an Application Specific Controller suitable for the application does not exist use a Niagara Framework Supervisory Gateway [or [Application Generic Controllers, General Purpose Programmable Controllers or multiple Application Specific Controllers][Application Generic Controllers or General Purpose Programmable Controllers][multiple Application Specific Controllers]].

3.1.3.1 Hand-Off-Auto (H-O-A) Switches

****
NOTE: See also DDC Hardware in PART 2.

The bracketed text is a general requirement for H-O-A switches and should only be included if such a requirement is absolutely necessary. It is best practice to use overrides in lieu of H-O-A switches. If H-O-A switches are specifically required by the project site it is best to remove the bracketed text and indicate which points require H-O-A switches on the Points Schedules.

Note that many sequences already have H-O-A switch requirements for motors independent of any other H-O-A requirements.

Select the desired capability for external switches for analog outputs
****

Provide Hand-Off-Auto (H-O-A) switches [for all DDC Hardware analog outputs and binary outputs used for control of systems other than terminal units,]as specified and as indicated on the Points Schedule. H-O-A switches must be integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.

b. For external H-O-A switches for binary outputs, provide switches capable of overriding the output open or closed.

c. For external H-O-A switches for analog outputs, provide switches capable of overriding [to 0 percent or 100 percent][through the range of 0 percent to 100 percent].

3.1.3.2 Local Display Panels

****

NOTE: This subpart uses tailoring option: The text "points in a Niagara Framework Supervisory Gateway or" is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: Indicate on each Points Schedule which points, if any, are to be displayed or overridable from an LDP.

Coordinate with the project site to determine number and location of LDPs needed and show on them on the drawings.

****

Provide LDPs to display and override values of points in a Niagara Framework Supervisory Gateway or Network Variables as indicated on the Points Schedule. Install LDPs displaying points for anything other than a terminal unit in the same room as the equipment. Install LDPs displaying points for only terminal units [in a mechanical room central to the group of terminal units it serves][_____].

[3.1.3.3 Graphics and Web Pages

****

NOTE: This subpart applies only to Niagara Framework systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: Only include this requirement if requiring web pages served from the Niagara Framework Supervisory Gateway. Select options based on project requirements.

Note that serving web pages from the Niagara Framework Supervisory Gateway is normally not necessary as web pages will typically be served from a Niagara Framework front end.

The contractor will require a certificate for the Web Server (in order to use HTTPS as required here). Coordinate with the project site IT organization (NEC) to obtain this certificate.

****

Configure Niagara Framework Supervisory Gateways to use web pages to provide a graphical user interface including System Displays[using the project site sample displays], including overrides, as indicated on the Points Schedule and as specified. Label all points on displays with [full English language descriptions][the point name as indicated on the Points Schedule][the point description as indicated on the Points Schedule][_____]. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with [the [Controls] [HVAC] [Electrical] shop supervisor][_____]. Configure the web server to use HTTPS based on the Transport Layer Security (TLS) protocol in accordance with IETF RFC 7465 using a Government furnished certificate.

]3.1.3.4 Overrides for GPPCs and AGCs

****

NOTE: The following methods of implementing overrides are intended to be used for overriding setpoints and outputs. They will also work to override inputs, but the use of overrides on inputs is strongly discouraged since the operator loses all indication of the actual state of the system (e.g. The operator overrides zone temperature to 65 to force heating, zone heats up to 85 and operator has no indication that it's hot in the zone).

****

Provide the capability to override points for all General Purpose Programmable Controllers and Application Generic Controllers as specified and as indicated on the Points Schedule using one of the following methods:

a. Override SNVT of Same SNVT Type method:

(1) Use this method for all setpoint overrides and for overrides of inputs and outputs whenever practical.

(2) Provide a SNVT input to the DDC hardware containing the point to be overridden of the same SNVT type as the point to be overridden.

(3) Program and configure the DDC hardware such that:

(a) If the value of the SNVT on the override input is the *Invalid Value* defined for that SNVT by the LonMark SNVT List, then the point is not overridden (its value is determined from the sequence).

(b) If the value of the SNVT on the override input is not the *Invalid Value* defined for that SNVT by the LonMark SNVT List then set the value of the point to be overridden to the value of the SNVT on the override input.

b. HVAC Override SNVT method:

(1) Use this method for override of inputs and outputs when the "Override SNVT Shares SNVT Type" method is impractical.

(2) Provide a SNVT input to the DDC hardware containing the point to be overridden of SNVT type *SNVT_hvac_overid.* Show on the Points

Schedule how to perform the specified override using this SNVT.

3.1.3.5 Overrides for ASCs

Whenever possible use the methods specified for General Purpose Programmable Controllers and Application Generic Controllers to perform overrides for all Application Specific Controllers. If neither the "Override SNVT of Same SNVT Type" method or "HVAC Override SNVT" method are supported by the Application Specific Controller show this on the Points Schedule and perform overrides as follows:

a. Provide one or more SNVT input(s) to the DDC hardware containing the point to be overridden. Document the number and type of each SNVT provided on the Points Schedule.

b. Configure the Application Specific Controller such that:

    (1) For some specific combination or combinations of values at the SNVT override input(s) the point is not overridden, and its value is determined from the sequence as usual. Show on the Points Schedule the values required at the SNVT override input(s) to not override the point.

    (2) For other specific combinations of SNVT override input(s), the value of the point to be overridden is determined from the value of the override input(s). Show on the Points Schedule the correlation between the SNVT override input(s) and the resulting value of the overridden point.

3.1.4 Scheduling, Alarming, Trending and Overrides

3.1.4.1 Scheduling

****

NOTE: The following paragraph applies only to Niagara Framework systems and is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

Configure schedules in Niagara Framework Supervisory Gateway using Niagara Schedule Objects as indicated on the Points Schedule and as specified. When the schedule is controlling occupancy modes in DDC Hardware other than a Niagara Framework Supervisory Gateway use a network variable of type SNVT_Occupancy.

****

NOTE: The following paragraph applies only to LNS-based systems and is included only when the LNS tailoring option is selected.

****

Provide DDC Hardware with LonMark Objects meeting the Simple Scheduler Functional Profile and configure schedules as specified on the Points Schedule and as specified.

3.1.4.1.1 Schedule Groupings

****

NOTE: Indicate if a common schedule may be used for multiple Terminal Units (TUs).

If allowing a common schedule for multiple TUs: keep the 'group of' bracketed text, and decide if TU groupings will be included on the drawings (keep the 'as indicated' bracketed text) or if the Contractor should decide on groupings (remove the 'as indicated' bracketed text).

****

Provide a separate schedule for each AHU including it's associated Terminal Units and for each stand-alone Terminal Unit (those not dependent upon AHU service)[or group of stand-alone Terminal Units acting according to a common schedule[as indicated]].

3.1.4.1.2 Occupancy Mode Mapping to SNVT Values

Use the following mapping between SNVT_Occupancy enumerations and occupancy modes:

a. OCCUPIED mode: Enumeration value of OC_OCCUPIED
b. UNOCCUPIED mode: Enumeration value of OC_UNOCCUPIED
c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: Enumeration value of OC_STANDBY

3.1.4.2 Alarming

****

NOTE: The following paragraph applies only to LNS-based systems and is included only when the LNS tailoring option is selected.

****

For each point which is shown on the Points Schedule with an alarm condition, provide a SNVT output for the point to be used for alarm generation by the UMCS Front End

****

NOTE: The following paragraph applies only to Niagara Framework systems and is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

For each point not in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule with an alarm condition, provide a SNVT output for the point to be used for alarm generation. For each point which is shown on the Points Schedule with an alarm condition, configure alarms in Niagara Framework Supervisory Gateway using Niagara Alarm Extensions and Alarm Services.

3.1.4.3 Trending

****

NOTE: The following paragraph applies only to LNS-based systems and is included only when the LNS tailoring option is selected.

****

For each point which is shown on the Points Schedule as requiring a trend, provide a SNVT output for the point to be used for trending by the UMCS Front End.

****

NOTE: The following paragraph applies only to Niagara Framework systems and is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

For each point not in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule as requiring a trend, provide a SNVT output for the point to be used for trending. For each point which is shown on the Points Schedule as requiring a trend, configure a trend in a Niagara Framework Supervisory Gateway using Niagara Framework History Extensions and the Niagara Framework History Service.

3.1.4.4 Overrides

****

NOTE: The following paragraph applies only to LNS-based systems and is included only when the LNS tailoring option is selected.

****

For each point shown on the Points Schedule as requiring an override, provide an override as specified in paragraphs "Overrides for GPPCs and AGCs" and "Overrides for ASCs".

****

NOTE: The following paragraph applies only to Niagara Framework systems and is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

Provide overrides for points as indicated on the Points Schedule. For overrides to points in Niagara Framework Supervisory Gateways, use the Niagara Framework. For overrides to other points, provide an override to a point in a Niagara Framework Supervisory Gateway via the Niagara Framework where the Niagara Framework Supervisory Gateway overrides the other point as specified in paragraphs "Overrides for GPPCs and AGCs" and "Overrides for ASCs"

3.1.5 Gateways

****

NOTE: This subpart uses tailoring options for requirements specific to Niagara Framework systems. The phrases "or to Niagara Framework Points" and "(Note: A Niagara Framework Supervisory Gateway is CEA-709.1-D control hardware.)" are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: The intent of this is to allow the use of gateways to packaged equipment controllers not procured under the scope of the project this specification is used for and, to not allow the installation of a non-BACnet network connected to a BACnet network via a gateway.

****

The requirements in this paragraph do not themselves permit the installation of hardware not meeting the other requirements of this section. Except for proprietary systems specifically indicated in Section 23 09 00, all control hardware installed under this project must meet the requirements of this specification, including the control hardware providing the network interface for a package unit or split system specified under this Section or another Section. Only use gateways to connect to pre-existing control devices and to proprietary systems specifically permitted by Section 23 09 00.

Provide Gateways to connect non-CEA-709.1-D control hardware in accordance with the following:

a. Configure gateway to map writeable data points in the controlled equipment to Network Variable Inputs of Standard Network Variable Types as defined by the LonMark SNVT List, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

b. Configure gateway to map readable data points in the controlled equipment to Network Variable Outputs of Standard Network Variable Types as defined by the LonMark SNVT List, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

c. Do not use non-CEA-709.1-D control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. (Note: A Niagara Framework Supervisory Gateway is CEA-709.1-D control hardware.)

d. Do not use non-CEA-709.1-D control hardware for system scheduling functions.

e. Each gateway must communicate with and perform protocol translation for non-CEA-709.1-D control hardware controlling one and only one package unit or a single non-CEA-709.1-D system specifically permitted by Section 23 09 00.

f. Connect one network port on the gateway to the Building Control Network and the other port to the single piece of controlled equipment or the non-CEA-709.1-D network specifically permitted by Section 23 09 00.

g. For gateways to existing package units or simple split systems, non-CEA-709.1-D network wiring connecting the gateway to the package unit or split system interface must not exceed 3 m 10 feet in length and must connect to exactly two devices: the controlled equipment or split system interface and the gateway.

3.1.6 Network Interface Jack

****

NOTE: Choose the preferred location for network interface jacks by controllers with thermostats (coordinate with the project site to determine preference of O&M Staff).

Choose the number of interface cables to be furnished by the Contractor.

****

Provide standard network interface jacks such that each node on the control network is within 3 m 10 ft of an interface jack. For terminal unit controllers with hardwired thermostats this network interface jack may instead be located at the thermostat. Locating the interface jack [at the thermostat][near the controller] is preferred. If the network interface jack is other than a 3 mm 1/8 inch phone jack, provide an interface cable with a standard 3 mm 1/8 inch phone jack on one end and a connector suitable for mating with installed network interface jack on the other. No more than one type of interface cable must be required to access all network interface jacks. Furnish [one] [_____] interface cable(s).

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 09 23.02 (August 2024)**

Preparing Activity: USACE **Superseding**
UFGS-23 09 23.02 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

08/24

PART 3 EXECUTION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-23 09 23.02 (August 2024)**

Preparing Activity: USACE

Superseding
UFGS-23 09 23.02 (February 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

08/24

****

NOTE: This guide specification covers the requirements for protocol-specific requirements for a Direct Digital Control (DDC) building control system based on the ASHRAE 135 protocol, including a tailoring option to require the Niagara Framework.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR)**. CCRs for this specification can be submitted through the Whole Building Design Guide page for this section:**
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-

****

****

NOTE: The use of this UFGS, and the design of BACnet Control Systems, must be in accordance with UFC 3-410-02, DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. This specification MUST be used in conjunction with UFGS 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and UFGS 25 05 11 CYBERSECUROTY FOR FACILITEY-RELATED CONTROL SYSTEMS in order to specify a complete and functional system.

Edit this guide specification for project specific requirements ONLY by selecting appropriate tailoring options, choosing applicable items(s), or inserting appropriate information in bracketed items. Do not

make edits outside of bracketed items without prior approval as specified in UFC 3-410-02.

When used with UFGS 23 09 00, this specification covers installation of local (building-level) controls using BACnet-based DDC. It is primarily intended for building level control systems which are to be integrated into a Utility Monitoring and Control System (UMCS) as specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION (where Section 25 10 10 has also used the matching BACnet or Niagara Framework tailoring option).

For projects that require the building system to provide UMCS functionality (without connection to a UMCS), the designer must include the necessary requirements from Section 25 10 10 in the project specification.

Template drawings in electronic format for use with this section are available online at the Whole Building Design Guide page for Section 23 09 00:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-
****

****
NOTE: This specification makes use of SpecsIntact Tailoring Options. This note describes these options and how to use them.

"TAILORING OPTION NOTES" Tailoring Option
Each time tailoring options are used there is an accompanying designer note describing the text that is tailored. As this Section makes heavy use of tailoring options there are many of these notes and they can distract from designer notes describing other decisions. The designer notes describing tailoring options are all in a "TAILORING OPTION NOTES" tailoring option which can be hidden (in SpecsIntact select View-Tailoring Options and then deselect "TAILORING OPTION NOTES") once this section is tailored and the tailoring option notes are no longer needed.

"NIAGARA FRAMEWORK" and "NOT NIAGARA FRAMEWORK" Tailoring Options
This specification includes tailoring options for whether or not the Niagara Framework is required - "NIAGARA FRAMEWORK" and "NOT NIAGARA FRAMEWORK". Exactly ONE of these tailoring options must be chosen. You have currently selected the following options:

NIAGARA FRAMEWORK
NOT NIAGARA FRAMEWORK

If you don't see either the words "NIAGARA

FRAMEWORK" or "NOT NIAGARA FRAMEWORK" between the dashes above, you have not selected a tailoring option and this specification is not valid. Select ONE of the tailoring options.

If you see both "NIAGARA FRAMEWORK" and "NOT NIAGARA FRAMEWORK" you have selected both tailoring options. Remove one of the tailoring options.

Service Tailoring Option
This specification also includes tailoring options for the Service (Air Force, Army, Navy) the specification is used for. There is a "Service Generic" tailoring option that can also be used. Only ONE of the four tailoring options related to the service should be use. You have currently selected the following options:

AIR FORCE
ARMY
NAVY
SERVICE GENERIC

If more than one item appears between the dashes above you have selected more than one services tailoring option and need to remove all but one of them.

****

****

WARNING - Both the NIAGARA FRAMEWORK and NOT NIAGARA FRAMEWORK Tailoring Options have been selected. This will result in a specification that contains conflicts and cannot be met. DESELECT one of these tailoring options. See UFC 3-410-02.

****

PART 1 GENERAL

****

NOTE: IMPORTANT: You selected the NIAGARA FRAMEWORK Tailoring Option. Ensure that the front end (UMCS) uses the Niagara Framework, otherwise integration will fail.

****

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the front end which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.1.1 System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

****

NOTE: The following list paragraph uses tailoring options:
1) The paragraph referencing Niagara Framework is included only when the NIAGARA FRAMEWORK tailoring option is selected.
2) The paragraph NOT referencing Niagara Framework is included only when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

a. Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 and Fox as the communications protocols. The system must use standard ASHRAE 135 Objects and Properties and the Niagara Framework. The system must use standard ASHRAE 135 Services and the Niagara Framework exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 or the Fox protocol exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two ASHRAE 135 devices on the Internetwork can communicate using standard ASHRAE 135 Services.

Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 as the communications protocol. The system must use standard ASHRAE 135 Objects and Properties. The system must use standard ASHRAE 135 Services exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two devices on the Internetwork can communicate using standard ASHRAE 135 Services.

****

NOTE: The following list paragraph uses tailoring options: the text "or Niagara Framework Objects" is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

b. Install and configure control hardware to provide ASHRAE 135 Objects and Properties or Niagara Framework Objects as indicated and as needed to meet the requirements of this specification.

****

NOTE: The following TWO list paragraphs are only required for Niagara Framework systems and are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: Select Web Pages if a local (in the building) web interface is required.

****

c. Use Niagara Framework hardware and software exclusively for scheduling, trending, and communication with a front end (UMCS). Use Niagara Framework or standard BACnet Objects and services for alarming. Use the Fox protocol for all communication between Niagara Framework Supervisory Gateways; use the ASHRAE 135 protocol for all other building communication. [Niagara Framework Supervisory Gateway must serve web pages as specified.]

****

NOTE: Select the required version of the Niagara Framework. This choice must be carefully coordinated with the project site. Niagara Framework is currently (2015) in a transition between two releases: "AX" and "Version 4". A Version 4 UMCS front end (e.g. as specified in Section 25 10 10) UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION will work with either an AX or Version 4 Niagara Framework Supervisory Gateway, but an AX front end will ONLY work with an AX Niagara Framework Supervisory Gateway.

If the site has an AX front end, select "AX".
If the site has a Version 4 front end, or does not have a front end:
1) if there are multiple vendors servicing the project site that support Version 4, select "Version 4"

2) otherwise, select "either AX or Version 4"

****

d. Use Niagara Framework [AX][Version 4.0 or later][either AX or Version 4.0 or later].

1.1.2 Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any other Section referenced in this specification is not included in the project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks

BACNET TESTING LABORATORIES (BTL)

BTL Guide	(v.50; 2022) BACnet Testing Laboratory Implementation Guidelines

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2022) Ethernet

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-485	(1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

TRIDIUM, INC (TRIDIUM)

Niagara Framework	(2021) NiagaraAX User's Guide
Tridium Open NiCS	(2021) Understanding the NiagaraAX Compatibility Statement (NiCS)

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 916	(2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment

1.3 DEFINITIONS

For definitions related to this section, see Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.4 SUBMITTALS

****

NOTE: Submittals related to this section are specified in UFGS 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. UFGS 23 09 00 MUST be used with this specification to have a complete specification.

****

Submittal requirements related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

****

NOTE: For Section 25 05 11, use the bracketed text in the Section number to add forth level numbering if used on the project as described in UFC 4-010-06. In the Section name, keep the bracketed text if the section was unnamed or use the empty brackets provided to change the Section name to match the project specifications.

****

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements of Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS and this Section.

2.1 NETWORK HARDWARE

2.1.1 BACnet Router

****

NOTE: This subpart uses tailoring options: the text "except for Niagara Framework Supervisory Gateways, devices used as BACnet routers" is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

All BACnet Routers must be BACnet/IP Routers and must perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to one or more ASHRAE 135 MS/TP networks. Devices used as BACnet Routers must meet the requirements for DDC Hardware, and except for Niagara Framework Supervisory Gateways, devices used as BACnet routers must support the NM-RC-B BIBB.

2.1.2 BACnet Gateways

****

Gateways should be used only for the integration of a single piece of equipment. Gateways should not be used to permit the installation of new, non-ASHRAE 135 networks.

****

****

NOTE: This subpart uses tailoring options: the text "be a Niagara Framework Supervisory Gateway or must", "except for Niagara Framework Supervisory Gateways", and "(Niagara Framework Supervisory Gateways are both Gateways and DDC Hardware.)" are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

In addition to the requirements for DDC Hardware, the BACnet Gateway must be a Niagara Framework Supervisory Gateway or must meet the following requirements:

a. It must perform bi-directional protocol translation from one non-ASHRAE 135 protocol to ASHRAE 135. BACnet Gateways must incorporate a network connection to an ASHRAE 135 network (either BACnet over IP in accordance with Annex J or MS/TP) and a separate connection appropriate for the non-ASHRAE 135 protocol and media.

b. It must retain its configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.

c. It must allow bi-directional mapping of data between the non-ASHRAE 135 protocol and Standard Objects as defined in ASHRAE 135. It must support the DS-RP-B BIBB for Objects requiring read access and the DS-WP-B BIBB for Objects requiring write access.

d. It must support the DS-COV-B BIBB.

Although Gateways must meet DDC Hardware requirements , except for Niagara Framework Supervisory Gateways, they are not DDC Hardware and must not be used when DDC Hardware is required. (Niagara Framework Supervisory Gateways are both Gateways and DDC Hardware.)

2.1.3 Ethernet Switch

****

NOTE: For Section 25 05 11, use the bracketed text in the Section number to add forth level numbering if used on the project as described in UFC 4-010-06. In the Section name, keep the bracketed text if the section was unnamed or use the empty brackets provided to change the Section name to match the project specifications.

****

Ethernet Switches must be as specified in Section 25 05 11[._____] CYBERSECURITY FOR [FACILITY-RELATED CONTROL][_____] SYSTEMS

2.2 CONTROL NETWORK WIRING

a. BACnet MS/TP communications wiring must be in accordance with ASHRAE 135. The wiring must use shielded, three wire (twisted-pair with reference) cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors must be less than 100 pF per meter 30 pF per foot.

****

NOTE: Although the controls contractor installs the building control system backbone, which is an IP network, this system will later be integrated into the basewide network via the FPOC. To ensure no issues arise during this later integration, obtain additional Ethernet media requirements (if any) from the project site NEC.

****

b. Building Control Network Backbone IP Network must use Ethernet media. Ethernet cables must be CAT-5e at a minimum and meet all requirements of IEEE 802.3 [and [_____]].

2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

2.3.1 General Requirements

All DDC Hardware must meet the following requirements:

a. It must be locally powered and must incorporate a light to indicate the device is receiving power.

b. It must conform to the BTL Guide

c. It must be BACnet Testing Laboratory (BTL) Listed.

d. The Manufacturer's Product Data submittal for each piece of DDC Hardware must include the Protocol Implementation Conformance Statement (PICS) for that hardware as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

e. It must communicate and be interoperable in accordance with ASHRAE 135 and have connections for BACnet IP or MS/TP control network wiring.

f. Other than devices controlling terminal units or functioning solely as a BACnet Router, it must support DS-COV-B, DS-RPM-A and DS-RPM-B BIBBs.

g. Devices supporting the DS-RP-A BIBB must also support the DS-COV-A BIBB.

h. Application programs, configuration settings and communication information must be stored in a manner such that they persist through loss of power:

    (1) Application programs must persist regardless of the length of time power is lost.

    (2) Configured settings must persist for any loss of power less than 2,500 hours.

    (3) Communication information, including but not limited to COV subscriptions, event reporting destinations, Notification Class Object settings, and internal communication settings, must persist for any loss of power less than 2,500 hours.

i. Internal Clocks:

(1) Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.

(2) DDC Hardware incorporating a Clock must support the DM-TS-B or DM-UTC-B BIBB.

****

NOTE: The following list paragraph uses tailoring options: the text "or Niagara Framework Points" is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

j. It must have all functionality indicated and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to providing Objects or Niagara Framework Points as specified and as indicated on the Points Schedule.

k. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet any additional requirements for the application in which it is used (e.g. scheduling, alarming, trending, etc.).

l. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.

****

NOTE: The following list paragraph uses tailoring options: the text "Except for Niagara Framework Supervisory Gateways," is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

m. Except for Niagara Framework Supervisory Gateways, Device must support Commandable Objects to support Override requirements as detailed in PART 3 EXECUTION

n. User interfaces which allow for modification of Properties or settings must be password-protected.

****

NOTE: Select whether to allow devices using 2-wire (twisted pair with shield) media.

The use of devices using 3-wire (twisted pair with reference and shield) MS/TP media is generally preferable, particularly where long MS/TP runs are required, or in electrically noisy environments. However, many vendors do not offer devices supporting 3-wire media, and requiring use of 3 wire media will overly limit competition.

Unless the use of 3-wire devices is specifically required for the project, keep the bracketed text to allow the use of 2-wire devices.

****

o. Devices communicating BACnet MS/TP must meet the following requirements:

(1) Must have a configurable Max_Master Property.

(2) DDC Hardware other than hardware controlling a single terminal unit must have a configurable Max_Info_Frames Property.

(3) Must respond to any valid request within 50 msec with either the appropriate response or with a response of "Reply Postponed".

(4) Must use twisted pair with reference and shield (3-wire media) wiring[, or twisted pair with shield (2-wire media) wiring and use half-wave rectification].

p. Devices communicating BACnet/IP must use UDP Port 0xBAC0. Devices with configurable UDP Ports must default to 0xBAC0.

q. All Device IDs, Network Numbers, and BACnet MAC addresses of devices must be fully configurable without limitation, except MS/TP MAC addresses may be limited by ASHRAE 135 requirements.

****

NOTE: The following list paragraph uses tailoring options: the text "Except for Niagara Framework Supervisory Gateways," is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

r. Except for Niagara Framework Supervisory Gateways, DDC Hardware controlling a single terminal unit must have:

(1) Objects (including the Device Object) with an Object Name Property of at least 8 characters in length.

(2) A configurable Device Object Name.

(3) A configurable Device Object Description Property at least 16 characters in length.

****

NOTE: The following list paragraph uses tailoring options: the text "either Niagara Framework Supervisory Gateways or " is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

s. Except for Objects in either Niagara Framework Supervisory Gateways or DDC Hardware controlling a single terminal unit, all Objects (including Device Objects) must:

(1) Have a configurable Object Name Property of at least 12 characters in length.

(2) Have a configurable Object Description Property of at least 24 characters in length.

t. For programmable DDC Hardware, provide and license to the project site all programming software required to program the Hardware in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

u. For programmable DDC Hardware, provide copies of the installed application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted application program must be the complete application necessary for controller to function as installed and be sufficient to allow replacement of the installed controller with another controller of the same type.

2.3.2 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

2.3.2.1 Analog Inputs

DC Hardware analog inputs (AIs) must be implemented using ASHRAE 135 Analog Input Objects and perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2.3.2.2 Analog Outputs

****

NOTE: PART 3 of this section and the Points Schedules may require that points have an H-O-A switch. For analog outputs these switches may be "full on, full off" overrides or may have a knob allowing for override to any value (0-100 percent). Unless the project site specifically requires that analog outputs be fully adjustable through the range 0-100 percent, keep the bracketed text allowing either option (i.e. keep "to 0 percent and to 100 percent"). Requiring fully adjustable overrides (i.e. "through the range of 0 percent to 100 percent") will likely raise the cost of the system.

****

DDC Hardware analog outputs (AOs) must be implemented using ASHRAE 135 Analog Output Objects and perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output [to 0 percent and to 100 percent][through the range of 0 percent to 100 percent]

2.3.2.3 Binary Inputs

DDC Hardware binary inputs (BIs) must be implemented using ASHRAE 135 Binary Input Objects and accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient 50VAC must be provided.

2.3.2.4 Binary Outputs

DDC Hardware binary outputs (BOs) must be implemented using ASHRAE 135 Binary Output Objects and provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the output open or closed.

2.3.2.4.1 Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.4.2 Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.5 Pulse Accumulator

DDC Hardware pulse accumulators must be implemented using either an ASHRAE 135 Accumulator Object or an ASHRAE 135 Analog Value Object where the Present_Value is the totalized pulse count. Pulse accumulators must accept contact closures, ignore transients less than 5 msec duration, protect against
transients of 50 VAC, and accept rates of at least 20 pulses per second.

2.3.2.6 ASHRAE 135 Objects for Hardware Inputs and Outputs

The requirements for use of ASHRAE 135 objects for hardware input and outputs includes devices where the hardware sensor or actuator is integral to the controller (e.g. a VAV box with integral damper actuator, a smart sensor, a VFD, etc.)

[2.3.2.7 Integrated H-O-A Switches

****

NOTE: Even if H-O-A switches are implemented, Requiring feedback of H-O-A status may seriously limit competition and raise project costs. Unless there is a specific project requirement for H-O-A feedback, remove the bracketed text.

****

****

NOTE: This subpart uses tailoring options: the text "the Niagara Framework or via " is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

Where integrated H-O-A switches are provided on hardware outputs, controller must provide means of monitoring position or status of H-O-A switch. This feedback may be provided via the Niagara Framework or via any valid BACnet method, including the use of proprietary Objects, Properties, or Services.

]2.3.3 Local Display Panel (LDP)

****

NOTE: This subpart uses tailoring options: the text "Niagara Framework points or" is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

The Local Display Panels (LDPs) must be DDC Hardware with a display and navigation buttons or a touch screen display, and must provide display and adjustment of Niagara Framework points or ASHRAE 135 Properties as indicated on the Points Schedule and as specified. LDPs must be either BTL Listed as a B-OD, B-OWS, B-AWS, or be an integral part of another piece of DDC Hardware listed as a B-BC. For LDPs listed as B-OWS or B-AWS, the hardware must be BTL listed and the product must come factory installed with all applications necessary for the device to function as an LDP.

The adjustment of values using display and navigation buttons must be password protected.

2.3.4 Expansion Modules and Tethered Hardware

****

NOTE:
a. Covers the case where a base controller has add-on modules to provide I/O capability, where the modules "snap on" to the controller. This generally relies on a proprietary protocol between the base unit and the expansion modules, but as the module is essentially part of the base unit upon installation this is permitted.

b. covers a remotely tethered device and is primarily needed for remote "thermostats" connected to a controller, where the thermostat is essentially an extension of the controller.

****

A single piece of DDC Hardware may consist of a base unit and also:

a. An unlimited number of hardware expansion modules, where the individual hardware expansion modules are designed to directly connect, both mechanically and electrically, to the base unit hardware. The expansion modules must be commercially available as an optional add-on to the base unit.

b. A single piece of hardware connected (tethered) to a base unit by a single cable where the cable carries a proprietary protocol between the base unit and tethered hardware. The tethered hardware must not contain control logic and be commercially available as an optional add-on to the base unit as a single package.

   Note that this restriction on tethered hardware does not apply to sensors or actuators using standard binary or analog signals (not a communications protocol); sensors or actuators using standard binary or analog signals are not considered part of the DDC Hardware.

Hardware capable of being installed stand-alone, or without a separate base unit, is DDC Hardware and must not be used as expansion modules or tethered hardware.

2.3.5 Supervisory Control Requirements

2.3.5.1 Scheduling Hardware

****

NOTE: This subpart is only required for non-Niagara Framework based systems and is only included when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

DDC Hardware used for scheduling must meet the following requirements:

a. It must be BTL Listed as a B-BC and support the SCHED-E-B BIBB.

b. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Calendar and Schedule Objects, such that a front end BTL listed as a B-AWS may create or delete Calendar and Schedule Objects. It is also preferred but not required that devices supporting the DM-OCD-B BIBB accept any valid value for properties of Calendar and Schedule Objects. Note that there are additional requirements in the EXECUTION Part of this Section for Devices which do not support the DM-OCD-B BIBB as specified.

c. The Date_List property of all Calendar Objects must be writable.

d. The Present_Value Property of Schedule must support the following values: 1, 2, 3, 4.

2.3.5.2 Alarm Generation Hardware

****

NOTE: This subpart uses tailoring options: the text "Non-Niagara Framework " is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

Non-Niagara Framework DDC Hardware used for alarm generation must meet the following requirements:

a. Device must support the AE-N-I-B BIBB

b. The Recipient_List Property must be Writable for all Notification Class Objects used for alarm generation.

c. For all Objects implementing Intrinsic Alarming, the following Properties must be Writable:

    (1) Time_Delay
    (2) High_Limit
    (3) Low_Limit
    (4) Deadband
    (5) Event_Enable
    (6) If the issue date of this project specification is after 1 January

2016, Time_Delay_Normal must be writable.

****

NOTE: The following list paragraph is only required for Niagara Framework systems and is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

d. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects.

****

NOTE: The following THREE list paragraphs are only required for Non-Niagara Framework systems and are included only when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

e. For Event Enrollment Objects used for alarm generation, the following Properties must be Writable:

(1) Event_Parameters
(2) Event_Enable
(3) If the issue date of this project specification is after 1 January 2016, Time_Delay_Normal must be writable.

f. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects and Event Enrollment Objects, such that a front end BTL listed as a B-AWS may create or delete Notification Class Objects and Event Enrollment Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects and Event Enrollment Objects. Note that there are additional requirements in the EXECUTION Part of this Section for devices which do not support the DM-OCD-B BIBB as specified.

g. Devices provided to meet the the requirements indicated under "Support for Future Alarm Generation" in the EXECUTION part of this specification must support the AE-N-E-B BIBB.

2.3.5.3 Trending Hardware

****

NOTE: This subpart is only required for non-Niagara Framework based systems and is only included when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

DDC Hardware used for collecting trend data must meet the following requirements:

a. Device must support Trend Log or Trend Log Multiple Objects.

b. Device must support the T-VMT-I-B BIBB.

c. Devices provided to meet the EXECUTION requirement for support of Future Trending must support the T-VMT-E-B BIBB.

d. The following properties of all Trend Log or Trend Log Multiple Objects must be present and Writable:
    Start_Time
    Stop_Time
    Log_DeviceObjectProperty
    Log Interval Log interval must support an interval of at least 60 minutes duration.

e. Trend Log Objects must support using Intrinsic Reporting to send a BUFFER_FULL event.

f. The device must have a Notification Class Object for the BUFFER_FULL event. The Recipient_List Property must be Writable.

g. Devices must support values of at least 1,000 for Buffer_Size Properties.

h. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Trend Log Objects, such that a front end BTL listed as a A-AWS may create or delete Trend Log Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Trend Log Objects. Note that there are additional EXECUTION requirements for devices which do not support the DM-OCD-B BIBB as specified.

2.3.6 Niagara Framework Supervisory Gateway

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NOTE: This subpart is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

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NOTE: FYI - The Niagara Framework Supervisory Gateway is known by many names within industry, and this specification uses the name "Niagara Framework Supervisory Gateway" in order to remain vendor neutral. Probably the most common term used for this device in industry is a "Java Application Control Engine", or JACE.

****

Any device implementing the Niagara Framework is a Niagara Framework Supervisory Gateway and must meet these requirements. In addition to the general requirements for all DDC Hardware, Niagara Framework Supervisory Gateway Hardware must:

a. Be direct digital control hardware.

b. Have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.

c. Manage communications between a field control network and the Niagara Framework Monitoring and Control Software, and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other

Niagara Framework Components, regardless of the manufacturer of the other components.

d. Be fully programmable using the Niagara Framework Engineering Tool and must support the following:

  (1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects

  (2) Alarm generation and routing using the Niagara Alarm Service

  (3) Trending using the Niagara History Service and Niagara Trend Log Objects

  (4) Integration of field control networks using the Niagara Framework Engineering Tool

  (5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. Meet the following minimum hardware requirements:

  (1) [One][Two] 10/100/1000 Mbps Ethernet Port(s)

  (2) One or more MS/TP ports.[

  (3) Central Processing Unit of 600 Mhz or higher.][

  (4) Embedded operating system.]

f. Provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users. Note: implementation of this capability may not be required on all projects.

g. Submit a backup of each Niagara Framework Supervisory Gateway as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The backup must be sufficient to restore a Niagara Framework Supervisory Gateway to the final as-built condition such that a new Niagara Framework Supervisory Gateway loaded with the backup is indistinguishable in functionality from the original.

2.4 NIAGARA FRAMEWORK ENGINEERING TOOL

****

NOTE: This subpart is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

The Niagara Framework Engineering Tool must be Niagara Workbench or an equivalent Niagara Framework engineering tool software must:

a. Have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.

b. Be capable of performing network configuration for Niagara Framework

Supervisory Gateways and Niagara Framework Monitoring and Control Software.

c. Be capable of programming and configuring of Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

d. Be capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

Monitoring and Control Software is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

PART 3 EXECUTION

****

NOTE: Use the bracketed text for retrofit projects only. For new construction, the existing conditions survey may not be required and may be removed (be sure to remove the report from the submittals as well). Keeping it as a requirement, however, will ensure that the Contractor checks the mechanical equipment prior to beginning controls installation. This should allow problems to be caught and addressed earlier.

****

3.1 CONTROL SYSTEM INSTALLATION

3.1.1 Niagara Framework Engineering Tool

****

NOTE: This subpart is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: If the installation has a Niagara Framework Engineering Tool keep the first bracketed text and provide the software name and version number in the space provided. If the installation does not have a Niagara Framework Engineering Tool keep the seconded bracketed text.

****

[The project site currently has the [_____] Niagara Framework Engineering Tool. If this software is not adequate for programming the Niagara Framework Supervisory Gateways provided under this project, provide a Niagara Framework Engineering Tool.][Provide a Niagara Framework Engineering Tool.]

3.1.2 Building Control Network (BCN)

****

NOTE: Note that the term BCN is used across multiple specification including those using different protocols, and "network" is used in the generic sense to refer to the entire system. In

BACnet this is called the Internetwork but the term BCN is still used for consistency across specification.
****

****
NOTE: This subpart uses tailoring options: the phrase "for the IP network and" is only included when the NIAGARA FRAMEWORK tailoring option is selected.
****

Install the Building Control Network (BCN) as a single BACnet Internetwork consisting of a single IP network as the BCN Backbone and zero or more BACnet MS/TP networks. Note that in some cases there may only be a single device on the BCN Backbone.

Except for the IP Network and as permitted for the non-BACnet side of Gateways, use exclusively ASHRAE 135 networks.

3.1.2.1 Building Control Network IP Backbone

****
NOTE: Select the appropriate bracketed options to indicate whether the FPOC location is shown on a drawing or to specify the FPOC location here.

****

****
NOTE: This subpart uses tailoring options: the text "(Note that in a Niagara Framework system there may not be BACnet traffic on the IP Network)" is only included when the NIAGARA FRAMEWORK tailoring option is selected.
****

Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Backbone such that it is available at the Facility Point of Connection (FPOC) location [as indicated][_____]. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Backbone can be extended to any location in the room.

Use UDP port 0xBAC0 for all BACnet traffic on the IP network. (Note that in a Niagara Framework system there may not be BACnet traffic on the IP Network)

3.1.2.2 BACnet MS/TP Networks

When using MS/TP, provide MS/TP networks in accordance with ASHRAE 135 and in accordance with the ASHRAE 135 figure "Mixed Devices on 3-Conductor Cable with Shield" (Figure 9-1.4 in the 2020 version of ASHRAE 135). Ground the shield at the BACnet Router and at no other point. Ground the reference wire at the BACnet Router through a 100 ohm resistor and do not ground it at any other point. In addition:

a. Provide each segment in a doubly terminated bus topology in accordance with TIA-485.

b. Provide each segment with 2 sets of network bias resistors in accordance with ASHRAE 135, with one set of resistors at each end of the MS/TP network.

****

NOTE: 3-wire media (twisted pair with reference), which is required by this section, allows for both 2-wire and 3-wire MS/TP devices to co-exist on the same bus. Please refer to ASHRAE 135 (2020), subpart 9.2.2.1.1.4.

****

c. Use 3 wire (twisted pair and reference) with shield media for all MS/TP media installed inside. Use fiber optic isolation in accordance with ASHRAE 135 for all MS/TP media installed outside buildings, or between multiple buildings.

d. For 18 AWG cable, use segments with a maximum length of 1200 m4000 ft. When using greater distances or different wire gauges comply with the electrical specifications of TIA-485.

e. For each controller that does not use the reference wire provide transient suppression at the network connection of the controller if the controller itself does not incorporate transient suppression.

f. Install no more than 32 devices on each MS/TP segment. Do not use MS/TP to MS/TP routers.

****

NOTE: The following list paragraph uses tailoring options: the text "a Niagara Framework Supervisory Gateway configured as" is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

g. Connect each MS/TP network to the BCN backbone via a Niagara Framework Supervisory Gateway configured as a BACnet Router.

h. For BACnet Routers, configure the MS/TP MAC address to 0. Assign MAC Addresses to other devices consecutively beginning at 1, with no gaps.

i. Configure the Max_Master Property of all devices to be 31.

3.1.2.3 Building Control Network (BCN) Installation

Provide a building control network meeting the following requirements:

a. Install all DDC Hardware connected to the Building Control Network.

b. Where multiple pieces of DDC Hardware are used to execute one sequence, install all DDC Hardware executing that sequence on a single MS/TP network dedicated to that sequence.

c. Traffic between BACnet networks must be exclusively via BACnet routers.

****

NOTE: The following list paragraph is required only

for Niagara Framework systems and is included when the NIAGARA FRAMEWORK tailoring option is selected.
****

d. Use the Fox protocol for all traffic both originating and terminating at Niagara Framework components. Use the Fox protocol for all traffic originating or terminating at a Niagara Framework UMCS (including traffic to or from a future UMCS). All other traffic, including traffic between ASHRAE 135 devices and traffic between Niagara Framework Supervisory Gateways and ASHRAE 135 devices must be in accordance with ASHRAE 135.

3.1.3 DDC Hardware

****
NOTE: Indicate whether enclosures must be lockable.
****

Install all DDC Hardware that connects to an IP network in lockable enclosure. Install other DDC Hardware that is not in suspended ceilings in [lockable]enclosures. For all DDC hardware with a user interface, coordinate with site to determine proper passwords and configure passwords into device.

a. Except for zone sensors (thermostats), install all Tethered Hardware within 2 m 6 feet of its base unit.

b. Install and configure all BTL-Listed devices in a manner consistent with their BTL Listing such that the device as provided still meets all requirements necessary for its BTL Listing.

c. Install and configure all BTL-Listed devices in a manner consistent with the BTL Device Implementation Guidelines such that the device as provided meets all those Guidelines.

3.1.3.1 Device Identifiers, Network Addresses, and IP addresses

****
NOTE: Each device requires a unique DeviceID and each network requires a unique Network Number; a BACnet system will not operate if there are duplicates. While it is a simple matter to ensure unique IDs for a single project, there is no mechanism in BACnet to avoid duplicates when a project is later integrated into an existing basewide UMCS.
The installation must manually track and manage DeviceIDs and Network Numbers among all their BACnet systems, networks, and devices. The UFC has information on suggested strategies. Coordinate with the installation and either instruct the contractor to coordinate with the installation, or provide ranges for DeviceIDs and Network Numbers.
BACnet allows DeviceIDs in the range 0 - 4,194,302 and Network Numbers in the range 1 - 65,534.
Coordinate IP addresses with the installation NEC or instruct the contractor to do so.

****

a. Do not use any Device Identifier or Network Number already used by another BACnet system at the project site. [Coordinate Device IDs and Network Numbers with the installation. The installation POC is [_____]] [Use Device IDs within the range of [_____] to [_____] and Network Numbers in the range of [_____] to [_____]].

b. [Use IP addresses within the range of [_____] to [_____]] [Coordinate device IP addresses with installation. The installation POC is [_____]].

3.1.3.2 ASHRAE 135 Object Name Property and Object Description Property

Configure the Object_Names and Object_Descriptions properties of all ASHRAE 135 Objects (including Device Objects) as indicated on the Points Schedule (Point Name and Point Description) and as specified. At a minimum:

a. Except for DDC Hardware controlling a single terminal unit, configure the Object_Name and Object_Description properties of all Objects (including Device Objects) as indicated on the Points Schedule and as specified.

b. In DDC Hardware controlling a single terminal unit, configure the Device Object_Name and Device Object_Description as indicated on the Points Schedule and as specified.

****

NOTE: Indicate who is authorized to approve alternative object (point) names and descriptions.

****

When Points Schedule entries exceed the length limitations in the device, notify [_____] and provide recommended alternatives for approval.

3.1.3.3 Niagara Framework Point Names and Descriptions

****

NOTE: This subpart is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Configure the names and descriptions of all Points in Niagara Framework Supervisory Gateways as indicated on the Points Schedule and as specified.

3.1.3.4 Niagara Station IDs

****

NOTE: This subpart is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Ensure that Niagara Station IDs of new Niagara Framework Supervisory Gateways are maintained as unique within UMCS front-end, including ensuring they do not conflict with any existing Niagara Station ID.

3.1.3.5 Hand-Off-Auto (H-O-A) Switches

****

NOTE: See also DDC Hardware in PART 2.

The bracketed text is a general requirement for H-O-A switches and should only be included if such a requirement is absolutely necessary. It is best practice to use overrides in lieu of H-O-A switches. If H-O-A switches are specifically required by the project site it is best to remove the bracketed text and indicate which points require H-O-A switches on the Points Schedules.

Note that many sequences already have H-O-A switch requirements for motors independent of any other H-O-A requirements.

Select the desired capability for external switches for analog outputs

****

Provide Hand-Off-Auto (H-O-A) switches [for all DDC Hardware analog outputs and binary outputs used for control of systems other than terminal units,]as specified and as indicated on the Points Schedule. Provide H-O-A switches that are integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.

b. For external H-O-A switches used for binary outputs, provide for overriding the output open or closed.

c. For eternal H-O-A switches used for analog outputs, provide for overriding [to 0 percent or 100 percent][through the range of 0 percent to 100 percent].

3.1.3.6 Local Display Panels

****

NOTE: Designer must indicate on each Points Schedule which points, if any, are to be displayed or adjustable from an LDP.

Designer should coordinate with the project site to determine number and location of LDPs needed and show on them on the drawings.

****

****

NOTE: This subpart uses tailoring options: the text "points in a Niagara Framework Supervisory Gateway or " is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Provide LDPs to display and override values of points in a Niagara Framework Supervisory Gateway or ASHRAE 135 Object Properties as indicated on the Points Schedule. Install LDPs displaying points for anything other than a terminal unit in the same room as the equipment. Install LDPs displaying points for only terminal units [in a mechanical room central to the group of terminal units it serves][_____]. For LDPs using WriteProperty to commandable objects to implement an override, write values with priority 9.

3.1.3.7 MS/TP Slave Devices

Configure all MS/TP devices as Master devices. Do not configure any devices to act as slave devices.

3.1.3.8 Change of Value (COV) and Read Property

a. To the greatest extent possible, configure all devices to support the SubscribeCOV service (the DS-COV-B BIBB). At a minimum, all devices supporting the DS-RP-B BIBB, other than devices controlling only a single terminal unit, must be configured to support the DS-COV-B BIBB.

b. Whenever supported by the server side, configure client devices to use the DS-COV-A BIBB.

3.1.3.9 Engineering Units

****

NOTE: Coordinate with site and select either English or SI units for the building control system devices based on the standard used at the project site. Units must NOT be changed between BACnet projects at a site as units MUST be standardized across the entire UMCS. Also note that this choice affects how values are stored and/communicated in the system, not necessarily how they are displayed at the front end.

Keep the first section of bracketed text for SI (Metric) units, and the second for IP (English) units.

****

[Configure devices to use SI (Metric) units as follows:

a. Temperature in degrees C

b. Air or natural gas flows in Liters per Second (LPS)

c. Water flow in Liters per Second (LPS)

d. Steam flow in kilograms per second (kg/s)

e. Differential Air pressures in Pascals (Pa)

f. Water, steam and natural gas pressures in kiloPascals (kPa)

g. Enthalpy in kiloJoules per kilogram (kJ/kg)

h. Heating and Cooling Energy in kilowatt-hours (kWh)

i. Heating and Cooling load in kilowatts (kW)

j. Electrical Power: kilowatts (kW)

k. Electrical Energy: kilowatt-hours (kWh)][Configure devices to use English (Inch-Pound) engineering units as follows:

a. Temperature in degrees F

b. Air or natural gas flows in cubic feet per minute (CFM)

c. Water in gallons per minute (GPM)

d. Steam flow in pounds per hour (pph)

e. Differential Air pressures in inches of water column (IWC)

f. Water, steam, and natural gas pressures in PSI

g. Enthalpy in BTU/lb

h. Heating and cooling energy in MBTU (1MBTU = 1,000,000 BTU))

i. Cooling load in tons (1 ton = 12,000 BTU/hour)

j. Heating load in MBTU/hour (1MBTU = 1,000,000 BTU)

k. Electrical Power: kilowatts (kW)

l. Electrical Energy: kilowatt-hours (kWh)]

3.1.3.10 Occupancy Modes

****

NOTE: Intent is to standardize mode enumerations for operational modes. Sequences will be defined in Specification Section 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL

****

Use the following correspondence between value and occupancy mode whenever an occupancy state or value is required:

a. OCCUPIED mode: a value of one
b. UNOCCUPIED mode: a value of two
c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: a value of three

Note that elsewhere in this Section the Schedule Object is required to also support a value of four, which is reserved for future use. Also note that the behavior of a system in each of these occupancy modes is indicated in the sequence of operation for the system.

3.1.3.11 Use of BACnet Objects

****

NOTE: This subpart uses tailoring options: the text "Except as specifically indicated for Niagara

Framework Objects, " is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Except as specifically indicated for Niagara Framework Objects, Use only standard non-proprietary ASHRAE 135 Objects and services to accomplish the project scope of work as follows:

a. Use Analog Input or Analog Output Objects for all analog hardware I/O. Do not use Analog Value Object for analog hardware I/O) .

b. Use Binary Input or Binary Output Objects for all binary hardware I/O. Do not use Binary Value Objects for binary hardware I/O.

c. Use Analog Value Objects for analog setpoints.

d. Use Accumulator Objects or Analog Value Objects for pulse inputs.

e. For occupancy modes, use Multistate Value Objects and the correspondence between value and occupancy mode specified in paragraph OCCUPANCY MODES.

****

NOTE: The following list paragraph is required only for NON-Niagara Framework systems, and is included only when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

f. Use Schedule Objects and Calendar Objects for all scheduling. Use Trend Log Objects or Trend Log Multiple Objects for all trending and Notification Class Objects for trend log upload. Use a combination of Event Enrollment Objects,Intrinsic Alarming, and Notification Class Objects for alarm generation.

****

NOTE: The following list paragraph is required only for Niagara Framework systems, and is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

g. Use a combination of Niagara Framework Alarm Extensions and Alarm Services, Intrinsic Alarming, and Notification Class Objects for alarm generation.

h. For all other points shown on the Points Schedule as requiring an ASHRAE 135 Object, use the Object type shown on the Points Schedule or, if no Object Type is shown, use a standard Object appropriate to the point.

3.1.3.11.1 Niagara Framework Objects

****

NOTE: This subpart is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Points in the Niagara Framework Supervisory Gateway, even if used in a sequence or are shown on the Points Schedule, are not required to be exposed as BACnet Objects unless they are required to be available on the network by another device or sequence of operation (i.e. there is some other reason they are needed).

Use a Niagara Framework Supervisory Gateway as specified for all scheduling and trending. Use a Niagara Framework Supervisory Gateway as specified for all alarming except for intrinsic alarming.

3.1.3.12 Use of Standard BACnet Services

****

NOTE: This subpart uses tailoring options: the text "(including Niagara Frameworks Supervisory Gateways when communicating with non-Niagara Framework DDC Hardware)" is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Except as noted in this paragraph, for all DDC Hardware (including Niagara Frameworks Supervisory Gateways when communicating with non-Niagara Framework DDC Hardware) use Standard BACnet Services as defined in this specification (which excludes some ASHRAE 135 services) exclusively for application control functionality and communication.

DDC Hardware that cannot meet this requirement may use non-standard services provided they can provide identical functionality using Standard BACnet Services when communicating with BACnet devices from a different vendor. When implementing non-standard services, document all non-standard services in the DDC Hardware Schedule as specified and as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

3.1.3.13 Device Application Configuration

a. For every property, setting or value shown on the Points Schedule or otherwise indicated as Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

    (1) BACnet services (including proprietary services)

    (2) Hardware settings on the device

****

NOTE: The following item paragraph is required only for Niagara Framework systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

    (3) The Niagara Framework

****

NOTE: The following list paragraph uses tailoring options: the text "in non-Niagara Framework Hardware" is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

b. For every property, setting or value in non-Niagara Framework Hardware shown on the Points Schedule or otherwise indicated as Operator Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

(1) A Writable Property of a standard BACnet Object

(2) A Property of a standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.

****

NOTE: The following item paragraph is required only for Niagara Framework systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

(3) Using some other method supported by a Niagara Framework Supervisory Gateway

****

NOTE: The following TWO list paragraphs are required only for Niagara Framework systems and are only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

c. Configure Niagara Framework Supervisory Gateways such that the property, setting or value is configurable from a Niagara Framework Front End.

d. For every property, setting or value in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule or otherwise indicated as Operator Configurable, configure the value to be configurable from within the Niagara Framework such that it can be configured from a system graphic page at a Niagara Framework Front End.

3.1.3.14 Niagara Framework Engineering Tool

****

NOTE: This subpart is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Use the Niagara Framework Engineering Tool to fully discover the field control system and make all field control system information available to the Niagara Framework Supervisory Gateway. Ensure that all points on the points schedule are available to the front end via the Fox protocol.

[3.1.3.15 Graphics and Web Pages

****

NOTE: This subpart is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: Only include this requirement if requiring web pages served from the Niagara Framework

Supervisory Gateway. Select options based on project requirements.

Note that serving web pages from the Niagara Framework Supervisory Gateway is normally not necessary as web pages will typically be served from a Niagara Framework front end.

The contractor will require a certificate for the Web Server (in order to use HTTPS as required here). Coordinate with the project site IT organization (NEC) to obtain this certificate.

****

Configure Niagara Framework Supervisory Gateways to use web pages to provide a graphical user interface including System Displays[using the project site sample displays], including overrides, as indicated on the Points Schedule and as specified. Label all points on displays with [full English language descriptions][the point name as indicated on the Points Schedule][the point description as indicated on the Points Schedule][_____]. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with [the [Controls] [HVAC] [Electrical] shop supervisor][_____]. Configure the web server to use HTTPS based on the Transport Layer Security (TLS) protocol in accordance with RFC 5246 using a Government furnished certificate.

]3.1.4   Scheduling, Alarming, Trending, and Overrides

3.1.4.1   Scheduling

****

NOTE: The following designer note and paragraph text are only required for NON-Niagara Framework based systems and are only included when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: Indicate the number of blank schedule objects required for later use. In determining this number keep in mind that this is for future support (adding more schedules after the system is completed) and that one schedule can be used for multiple HVAC systems.

****

Configure schedules in BACnet Scheduling Objects to schedule systems as indicated on the Points Schedule and as specified using the indicated correspondence between value and occupancy mode. If no devices supports both the SCHED-E-B and DM-OCD-B BIBBS for Schedule Objects, provide [5][_____] blank Schedule Objects in DDC Hardware BTL listed as B-BCs and supporting the SCHED-E-B BIBB for later use by the site.

****

NOTE: This following paragraph is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****
Configure schedules in Niagara Framework Supervisory Gateway using Niagara Schedule Objects as indicated on the Points Schedule and as specified. When the schedule is controlling occupancy modes in DDC Hardware other than a Niagara Framework Supervisory Gateway use the indicated correspondence between value and occupancy mode.

****

NOTE: Indicate if a common schedule may be used for multiple Terminal Units (TUs). If allowing a common schedule for multiple TUs: keep the 'group of' bracketed text, and decide if TU groupings will be included on the drawings (keep the 'as indicated' bracketed text) or if the Contractor should decide on groupings (remove the 'as indicated' bracketed text).

****

Provide a separate schedule for each AHU including it's associated Terminal Units and for each stand-alone Terminal Unit (those not dependent upon AHU service)[or group of stand-alone Terminal Units acting according to a common schedule[as indicated]].

3.1.4.2 Alarm Configuration

****

NOTE: This subpart is only required for Niagara Framework based systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Configure alarm generation and management as indicated on the Points Schedule and as specified. Configure alarm generation in Niagara Framework Supervisory Gateways using Niagara Framework Alarm Extensions and Alarm Services or in other DDC Hardware (not Niagara Framework Supervisory Gateways) using ASHRAE 135 Intrinsic Alarming. Configure alarm management and routing for all alarms, including those generated via intrinsic alarming in other devices, in the Niagara Framework Supervisory Gateway such that the alarms are able to be accessed from the Niagara Framework Front End.

Where Intrinsic Alarming is used, configure intrinsic alarming as specified in paragraph "Configuration of ASHRAE 135 Intrinsic Alarm Generation". Configure a Niagara Framework Supervisory Gateway to provide a means to configure the intrinsic alarm parameters such that the Intrinsic Alarm is configurable from the front end via the Niagara Framework.

3.1.4.3 Configuration of ASHRAE 135 Intrinsic Alarm Generation

****

NOTE: This subpart uses tailoring options: The text "ASHRAE 135 Intrinsic" in the subpart title is only included when the NIAGARA FRAMEWORK tailoring option is selected.

The following sentence is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

Intrinsic alarm generation must meet the following requirements:

****

NOTE: The following paragraph (up to but not including the list items) is included only when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

Configure alarm generation as indicated on the Points Schedule and as specified using Intrinsic Alarming in accordance with ASHRAE 135 or Algorithmic Alarming in accordance with ASHRAE 135. Alarm generation must meet the following requirements:

a. Send alarm events as Alarms (not Events).

b. Use the ConfirmedNotification Service for alarm events.

c. For alarm generation, support two priority levels for alarms: critical and non-critical. Configure the Priority of Notification Class Objects to use Priority 112 for critical and 224 for non-critical alarms.

d. Number of Notification Class Objects for Alarm Generation:

    (1) If the device implements non-critical alarms, or if any Object in the device supports Intrinsic Alarms, then provide a single Notification Class Object specifically for (shared by) all non-critical alarms.

    (2) If the device implements critical alarms, provide a single Notification Class Object specifically for (shared by) all critical alarms.

    (3) If the device implements both critical and non-critical alarms, provide both Notification Class Objects (one for critical, one for non-critical).

    (4) If the device controls equipment other than a single terminal unit, provide both Notification Class Objects (one for critical, one for non-critical) even if no alarm generation is required at time of installation.

e. For all intrinsic alarms configure the Limit_Enable Property to set both HighLimitEnable and LowLimitEnable to TRUE. If the specified alarm conditions are for a single-sided alarm (only High_Limit used or only Low_Limit used) assign a value to the unused limit such that the unused alarm condition will not occur.

f. For all objects supporting intrinsic alarming, even if no alarm generation is required during installation, configure the following Properties as follows:

    (1) Notification_Class to point to the non-Critical Notification Class Object in that device.

    (2) Limit_Enable to enable both the HighLimitEnable and LowLimitEnable

    (3) Notify_Type to Alarm

****

NOTE: The following list paragraph (and the two item paragraphs below it) is required only for NON-Niagara Framework systems and are included only when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

g. Use of alarm generation types:

  (1) Only use algorithmic alarm generation when intrinsic alarm generation is not supported by the device or object, or when the specific alarm conditions cannot be implemented using intrinsic alarm generation.

  (2) Only use remote alarm generation when the alarm cannot be generated using intrinsic or local algorithmic alarm generation on the device containing the referenced property. If remote alarm generation is used, use the same DDC Hardware for all remote alarm generation within a single sequence.

****

NOTE: The following list paragraph is required only for Niagara Framework systems and are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

h. Configure the Recipient_List Property of the Notification Class Object to point to the Niagara Framework Supervisory Gateway managing the alarm.

3.1.4.4 Support for Future Alarm Generation

****

NOTE: This subpart is only required for NON-Niagara Framework systems and is included only when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

For every piece of DDC Hardware, support future alarm generation capabilities by supporting either intrinsic or additional algorithmic alarming. Provide one of the following:

a. Support intrinsic alarming for every Object used by the application in that device.

b. Support additional Event_Enrollment Objects. For DDC hardware controlling a single terminal unit, support at least one additional object. Otherwise, support at least [4][_____] additional Objects. Support additional Event_Enrollment Objects via one of the following:

  (1) Provide unused Event_Enrollment Objects on that device.

  (2) Support the DM-OCD-B BIBB and the creation of sufficient Event_Enrollment Objects on that device.

  (3) Provide one or more devices in the IP network that support the AE-N-E-B BIBB and have unused Event_Enrollment Objects.

(4) Provide one or more devices on the IP network that support the AE-N-E-B BIBB, the DM-OCD-B BIBB, and the creation of sufficient Event_Enrollment Objects.

The total number of Event_Enrollment Objects required by the project is the sum of the individual device requirements, and the distribution of Event_Enrollment Objects among devices is not further restricted. (Note this allows a single device to contain many Event_Enrollment Objects satisfying the requirements for multiple devices.)

3.1.4.5 Trend Log Configuration

****

NOTE: This subpart is only required for NON-Niagara Framework systems and is included only when the NOT NIAGARA FRAMEWORK tailoring option is selected.

****

a. Configure trends in Trend Log or Trend Log Multiple Objects as indicated on the Points Schedule and as specified.

b. Configure all trend logs (including any provided to support future trends) to save data on regular intervals using the BUFFER_FULL event to request trend upload from the front end.

c. Configure Trend Log Objects with a minimum Buffer_Size property value of 1,000 and Trend Log Multiple Objects with a minimum Buffer_Size property value of 1,000 per point trended (for example, a Trend Log Multiple Object used to trend 3 points must have a Buffer_Size Property value of at least 3,000).

d. Configure a Notification Class Object in devices doing trending (including devices supporting future trends) to handle the BUFFER_FULL event.

e. When possible, trend each point using an Object in the device containing the point. When it is necessary to trend using a an Object in another device, all trends not on the same Device as the Object being trended must be on a singe device (i.e. all Trend Log and Trend Log Multiple Objects used for remote trending within a sequence must be on the same device).

f. For each trend log, including any trend logs provided to support future trending, configure the following properties as specified:

(1) Logging_Type: Set to Polling

(2) Stop_When_Full: Set to Wrap Around

(3) Buffer_Size: Set to 400 or greater.

(4) Notification_Threshold: Set to 90 percent of full

(5) Notification_Class: Set to the Notification Class Object in that device

(6) Event_Enable: Set to TRUE

(7) Log_Interval: Set to 15 minutes.

g. Future Trending support. Provide support for future trending:

(1) Provide one or more devices on the Building Control Network Backbone IP network which support both the T-VMT-E-B and DM-OCD-B BIBBs for Trend Log Objects. Provide sufficient devices to support the creation of at least [[_____] additional Trend Log Objects][one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit].

(2) Provide [[_____] additional Trend Log Objects][one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit] in one or more devices on the Building Control Network Backbone IP network that support the T-VMT-E-B BIBB for later use by the site.

(3) A combination of these two methods is permitted provided the total required number of Trend Log Objects is met.

3.1.4.6 Trending

****

NOTE: This subpart is only required for Niagara Framework systems and is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

Perform all trending using a Niagara Framework Supervisory Gateway using Niagara Framework History Extensions and Niagara Framework History Service exclusively.

3.1.4.7 Overrides

****

NOTE: The strongly preferred method of Overrides is through Commandable Objects. Consider carefully before approving the other method specified here, and do not approve any other method of Overriding.

****

****

NOTE: This subpart uses tailoring options:
1) In the first paragraph, the requirements to use Niagara Framework for overrides is required only for Niagara Framework systems and is included only when the NIAGARA FRAMEWORK tailoring option is selected.

2) In the second paragraph, the text "in non-Niagara Framework Supervisory Gateway DDC Hardware" is required only for Niagara Framework systems and is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

Provide an override for each point shown on the Points Schedule as requiring an override. Use the Niagara Framework for all overrides to points in Niagara Framework Supervisory Gateways. For overrides to other points, provide an override to a point in a Niagara Framework Supervisory

Gateway via the Niagara Framework where the Niagara Framework Supervisory Gateway overrides the other point as specified.

Unless otherwise approved, provide Commandable Objects to support all Overrides in non-Niagara Framework Supervisory Gateway DDC Hardware. With specific approval from the Contracting Officer, Overrides for points which are not hardware outputs and which are in DDC hardware controlling a single terminal unit may support overrides via an additional Object provided for the override. No other means of implementing Overrides may be used.

a. Where Commandable Objects are used, ensure that WriteProperty service requests with a Priority of 10 or less take precedence over the SEQUENCE VALUE and that WriteProperty service request with a priority of 11 or more have a lower precedence than the SEQUENCE VALUE.

b. For devices implementing overrides via additional Objects, provide Objects which are NOT Written to as part of the normal Sequence of Operations and are Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable. Use this point as an Override of the normal value when Out_Of_Service is TRUE and the normal value otherwise. Note these Objects may be modified as part of the sequence via local processes, but must not be modified by local processes when Out_Of_Service is TRUE.

3.1.5 BACnet Gateways

****

NOTE: This subpart uses tailoring options for requirements specific to Niagara Framework systems. The phrases "or to Niagara Framework Points" and "(Note: A Niagara Framework Supervisory Gateway is BACnet control hardware.)" are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: The intent of this is to allow the use of gateways to packaged equipment controllers not procured under the scope of the project this specification is used for and not to allow the installation of a non-BACnet network connected to a BACnet network via a gateway except as noted for Boiler and Chiller Plants.

****

The requirements in this paragraph do not themselves permit the installation of hardware not meeting the other requirements of this section. Except for proprietary systems specifically indicated in Section 23 09 00, all control hardware installed under this project must meet the requirements of this specification, including the control hardware providing the network interface for a package unit or split system specified under another section. Only use gateways to connect to pre-existing control devices, and to proprietary systems specifically permitted by Section 23 09 00.

3.1.5.1 General Gateway Requirements

Provide BACnet Gateways to connect non-BACnet control hardware in accordance with the following:

a. Configure gateways to map writable data points in the controlled equipment to Writable Properties of Standard Objects, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

b. Configure gateway to map readable data points in the controlled equipment to Readable Properties of Standard Objects, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

c. Configure gateway to support the DS-COV-B BIBB for all points mapped to BACnet Objects.

d. Do not use non-BACnet control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. (Note: A Niagara Framework Supervisory Gateway is BACnet control hardware.)

e. Do not use non-BACnet control hardware for system scheduling functions.

f. Each gateway must communicate with and perform protocol translation for non-BACnet control hardware controlling one and only one package unit or a single non-BACnet system specifically permitted by Section 23 09 00.

g. Connect one network port on the gateway to the Building Control Backbone IP Network or to a BACnet MS/TP network and the other port to the single piece of controlled equipment or the non-BACnet system specifically permitted by Section 23 09 00..

h. For gateways to existing package units or simple split systems, non-BACnet network wiring connecting the gateway to the package unit must not exceed 3 meters 10 feet in length and must connect to exactly two devices: the controlled equipment (packaged unit) or split system interface and the gateway.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 09 53.00 20 (February 2010)**
Change 3 - 08/24

Preparing Activity: NAVFAC **Superseding**
UFGS-23 09 53.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 53.00 20

SPACE TEMPERATURE CONTROL SYSTEMS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 09 53.00 20 (February 2010)**
Change 3 - 08/24

Preparing Activity: NAVFAC **Superseding**
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References are in agreement with UMRL dated January 2025
****

SECTION 23 09 53.00 20

SPACE TEMPERATURE CONTROL SYSTEMS
02/10, CHG 3: 08/24

****
NOTE: This guide specification covers the requirements for space temperature control systems of the electric, analog electronic, and pneumatic type for heating, ventilating, and cooling systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: If there are questions concerning system design, The Engineering Field Division, Naval Facilities Engineering Systems Command, Mechanical Engineering and Design Branch, and Electrical Engineering and Design Branch should be consulted.
****

****
NOTE: This specification makes use of SpecsIntact tailoring option PNEUMATIC for pneumatic control devices. The pneumatic control devices should be tailored out, and electric, electronic, and analog control devices should be used, unless the installation desires continued pneumatic control for a specific piece of equipment or system.

****

****

NOTE: Show the following information on the project drawings:

1. Complete HVAC mechanical flow diagram depicting individual HVAC components being controlled. Relative position of sensors and actuators, including dampers, valves, thermostats, and wall mounted switches.

2. Complete ATC schematics including flow diagrams, connection diagrams, wiring interlock diagrams, setpoints, and sequences of operation. Indicate control and operating ranges to clarify control sequences. Indicate manual-off-auto local controls on the locally mounted motor starters and in control panel(s) for remote motor starters; wire all safety controls to protect during both local manual and auto operation. Indicate electric elementary diagrams of motor starters, control device actuators, and control sensors.

3. Location and types of automatic dampers, including smoke dampers, e.g., opposed or parallel blade.

4. Control valve nominal sizes, flow capacities, inlet pressures, controlled fluid, maximum and minimum pressure drops at the designed flow, and calculated Cv. Select valves for smallest Cv within available pressure constraints, pipe velocities, economy of design, and noise criteria.

5. Required controller parameters:

a. Throttling range, setpoint, and controller action, direct or reverse.

b. Differential for two-position controllers.

c. Specify the dead-band range for heating and cooling applications and the cascade control range or remote setpoint adjustment.

6. Special controller parameters:

a. Fixed setpoint and fixed differential controllers.

b. Adjustable damping and damping rate.

c. Proportional-integral-derivative mode constant settings.

7. Scale the range of temperature and pressure indicators. Location of temperature wells and pressure taps.

8. Initial time switch settings for each zone.

9. Smoke detection systems and location of key-operated override switches, when required, along with the zoning arrangements for these systems.

10. Define which indicators and gages are mounted on the panel face and which are located inside the panel. Provide a complete layout of the panel faces where a unique arrangement is necessary for efficient operation.

11. Location of room sensors and outdoor sensors.

12. Location of pneumatic compressors and refrigerated air dryers when required.

13. Write sequence of operation to include conventional control operations (e.g., temperature and pressure control loops), time clock operations, energy management functions (e.g., night setback and reset schedules), pushbutton overrides, safety devices, and emergency conditions.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition
ASHRAE FUN SI	(2021) Fundamentals Handbook, SI Edition

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B31.1	(2024) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC	(2010) Boiler and Pressure Vessels Code

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)

ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1238	(2013) Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1693	(2015) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ST 1	(1988; R 1994; R 1997) Specialty Transformers (Except General Purpose Type)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	(2023) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition
SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 555S	(2014; Reprint Oct 2020) UL Standard for Safety Smoke Dampers
UL 916	(2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment

1.2 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with the paragraph SUBCONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS. The paragraph specifies that all contract requirements of this section shall be accomplished directly by a first tier subcontractor. No work required shall be accomplished by a second tier subcontractor.

1.3 SYSTEM DESCRIPTION

Provide[new and modify existing] space temperature control systems complete and ready for operation.

1.4 SYSTEM REQUIREMENTS

****

NOTE: Indicate which control systems or control devices must be of a particular type for reasons of safety, control accuracy, or other technical reasons.

This paragraph contains a PNEUMATIC tailoring option.

****

Provide control systems composed of any combination of electric, electronic, pneumatic, or analog devices. Indicated control system devices of a particular type do not intend a requirement for the device unless the requirement is specifically indicated. Requirements apply to field installed control systems.

****

NOTE: Regarding the text below, indicate the manufacturer's name when there is an existing control system.

****

[Existing control system was manufactured by [_____]. Provide new equipment compatible with the existing control system to the extent that the direct interface uses the same control signal type and level over the same calibrated range as the existing equipment.

] **

NOTE: Regarding the text below, indicate portions of existing systems that are to be reused.

****

[Inspect and test reused portions of existing control systems, and furnish a report to the Government identifying all inoperative components or system deficiencies. The report shall include a cost estimate to correct deficiencies, scheduled need dates for equipment shutdown for repairs and connection to existing controls and systems. Proceed with repairs only after receipt of Government approval. Diagnose and report any malfunctions of existing control system device that occurs after the work commences. The Government is responsible for maintenance and repair of Government equipment. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Government equipment.

]1.5 CENTRALIZED DIRECT DIGITAL CONTROL (DDC) SYSTEMS

****

NOTE: If Direct Digital Control (DDC) is being used, use Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC in lieu of this section.
****

DDC systems are not permitted. Microprocessor-based single-loop controllers, unitary control system, variable-air-volume (VAV) boxes, and room thermostats may be used provided that the devices are manually configurable by the use of device firmware and require no software written by the Contractor for their application and use.

1.6 PERFORMANCE REQUIREMENTS

Provide control systems to maintain the required heating, ventilating, and cooling (HVAC) conditions by performing the functions and sequences of operations indicated. Control systems shall be complete, including all equipment and appurtenances, and ready for operation. Control systems shall be furnished, installed, tested, calibrated, and started up by, or under the supervision of trained technicians certified by the Contractor as qualified and regularly employed in such work. Control system equipment, valves, panels and dampers shall bear the manufacturer's nameplate.

1.7 DESIGN REQUIREMENTS

1.7.1 Control System Diagrams

For each system, indicate HVAC process flow and location of devices relative to flow and to the HVAC control panel, the connections of control devices in control loops, references of control device contacts and device operating coils to line numbers of a ladder diagram and sequencing diagrams showing the operation of valves, dampers, and contacts relative to controller output, and HVAC process variables.

1.7.2 Ladder Diagram

Indicate connections and interlocks to control system devices and other devices such as starters, drives, HVAC control system panels, and HVAC equipment panels. Coordinate diagram by line number and device number with each control system diagram.

1.7.3 Operating Parameters

Indicate operating parameters for devices shown on the control system diagram such as setpoints, ranges, limits, differentials, outside air temperature schedules, contact operating points, and HVAC equipment operating time schedules.

1.7.4 Automatic Control Valve Schedules

Indicate valve size, Cv, flow rate, pressure drop, top size, spring range, positioner range, operating signal characteristics, and power source.

1.7.5 Damper Schedules

Indicate damper sizes, quantities and sizes of actuators, spring ranges, positioner ranges, operating signal characteristics, and power source.

1.7.6 Wiring Diagram

Indicate terminal blocks, wire marker identification, connections to control system devices, external and internal power sources, and connections to external devices, starters, drives, control panels, jumpers, and ground connections.

1.7.7 Compressed Air Station Schematic

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Indicate compressors, motors and horsepower rating, voltage, starter, isolators, manual bypasses, tubing sizes, drain piping and drain traps, reducing valves, dryer, manufacturers' names and model numbers, mounting, access, and clearance requirements. Also include control panel schematics for pneumatic control.

1.7.8 Sequence of Operation

Sequence of operation for each HVAC control system coordinated with device identifiers on control system diagram and ladder diagram.

1.7.9 Arrangement Drawing

Arrangement diagram of each HVAC control system panel coordinated with device identifiers on the control system diagram and the ladder diagram.

1.8 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Control System Diagrams for each HVAC system; G, [_____]

Ladder Diagram; G, [_____]

Operating Parameters; G, [_____]

Automatic Control Valve Schedules; G, [_____]

Damper Schedules; G, [_____]

Sequence of Operation; G, [_____]

Arrangement Drawing; G, [_____]

Wiring Diagram; G, [_____]

Compressed Air Station Schematic; G, [_____]

Control Panel Schematics for pneumatic control; G, [_____]

SD-03 Product Data

Actuators; G, [_____]

Valves; G, [_____]

Dampers; G, [_____]

Fire Protection Devices; G, [_____]

Sensors; G, [_____]

Thermostats; G, [_____]

Sunshields; G, [_____]

Pressure Switches; G, [_____]

Indicating Devices; G, [_____]

Controllers; G, [_____]

Pressure Gages; G, [_____]

Control Panels; G, [_____]

Air Compressor; G, [_____]

Refrigerated Air Dryer; G, [_____]

Air Filtration System; G, [_____]

Compressed Air Station Specialties; G, [_____]

VAV Terminal Unit Controls; G, [_____]

SD-06 Test Reports

Commissioning Procedures; G, [_____]

Calibration Adjustment And Commissioning Reports; G, [_____]

Site Testing Procedures Identifying Each Item Tested and Describing Each Test; G, [_____]

Performance Verification Test plans and procedures; G, [_____]

SD-07 Certificates

Certification of Completion; G, [_____]

SD-08 Manufacturer's Instructions

Training Course Documentation; G, [_____]

SD-10 Operation and Maintenance Data

Space Temperature Control System, Data Package 3; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Qualified Service Organization List; G, [_____]

1.9 QUALITY ASSURANCE

1.9.1 Cybersecurity

Coordinate submittals with Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

1.9.2 Standard Products

a. Material and equipment shall be standard products of manufacturers regularly engaged in the manufacturing of such products, using similar materials, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of similarly sized equipment and materials used under similar circumstances.

b. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

c. The equipment items shall be supported by a service organization.

1.9.3 Nameplates and Tags

a. Provide nameplates bearing legends as shown and tags bearing device unique identifiers as shown shall have engraved or stamped characters. Nameplates shall be mechanically attached to HVAC control panel doors.

b. A plastic or metal tag shall be mechanically attached directly to each field-mounted device or attached by a metal chain or wire.

c. Each airflow measurement station shall have a tag showing flow rate range for signal output range, duct size, and device identifier where shown.

1.9.4 Verification of Dimensions

Contractor shall become familiar with details of work, shall verify dimensions in the field, and shall advise Contracting Officer of any discrepancy before performing work.

1.9.5 Modification of References

Accomplish work in accordance with ASME B31.1, ASME B31.5, NFPA 70, and NFPA 90A, except as modified herein or indicated otherwise for equipment, materials, installation, examination, inspection, and testing. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" had be substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to "authority having jurisdiction" and "owner" to mean the Contracting Officer.

1.9.6 Site Testing Procedures

Indicate test equipment to be used including manufacturers' names and model numbers, date of last calibration, and accuracy of calibration.

1.9.7 Commissioning Procedures

Define procedures specific to each control system including instructions on how to set control parameters and setpoints, proportional, integral and derivative mode constants, contact output settings, positioner range adjustments, and calibration checks of transmitters[Coordinate commissioning requirements with Section 01 91 00.15 BUILDING COMMISSIONING.]

1.9.8 Calibration Adjustment and Commissioning Reports

Submit specific to each HVAC control system, including settings adjustments and results of calibration checks

1.9.9 Space Temperature Control System

In addition to the requirements specified in the paragraph SUBMITTALS, meet the following requirements. Submit Operation and Maintenance Manuals for items of equipment listed under paragraph PRODUCT DATA. Manual shall contain full hardware support documentation, which shall include but not be limited to the following:

a. General description and specifications

b. Installation and initial checkout procedures

c. Detailed electrical and logical description

d. Troubleshooting procedures, diagrams, and guidelines

e. Alignment and calibration procedures for components

f. Preventive maintenance requirements and a maintenance checklist

g. Detailed schematics and assembly drawings

h. Spare parts list data, including required tool kits and suggested method of repairs such as field repair, factory repair, or item replacement

i. Signal identification and timing diagrams

j. Complete as-built control drawings, schedules, and sequence of operation

k. Controller configuration and parameter setting procedures

l. Step-by-step procedures required for each HVAC control systems startup, operation, shutdown, recovery, and fault diagnosis

m. Manufacturer supplied operator manuals for equipment

n. Qualified service organization list

PART 2 PRODUCTS

****

NOTE: In order to comply with UFC 1-200-02, designs must achieve energy consumption levels that are at least 30 percent below the baseline established in the 2019 publication of ASHRAE 90.1. The Designer of Record must design control systems that assist in achieving this requirement.

****

2.1 COMPONENTS

****

NOTE: Indicate control devices that must be in enclosures with more stringent requirements than that covered by NEMA 250 Type 1 and state the requirements.

****

Provide components factory ordered for this project. Rebuilt equipment, warehoused equipment, or earlier generation equipment shall not be acceptable. Electrical, electronic, and electropneumatic devices not located within control panels shall have a NEMA 250 Type 1 enclosure in accordance with NEMA 250 unless otherwise specified. Actuators and positive positioners, and transmitters shall operate within temperature limit ratings of plus 2 to 66 degrees C 35 to 150 degrees F. Panel mounted instruments shall operate within limit ratings of 2 to 49 degrees C 35 to 120 degrees F and 10 percent to 95 percent relative humidity, noncondensing. Devices installed outdoors shall operate within limit ratings of minus 2 to 66 degrees C 35 to 150 degrees F.

2.2 ACTUATORS

****

NOTE: This paragraph contains a PNEUMATIC tailoring option.

****

Provide pneumatic, electric, or electronic actuators. Actuators shall function as required within 85 to 110 percent of their power supply rating. Actuators shall fail to their spring return positions on signal or power failure unless indicated as timed, power return actuators. Actuators shall have visible position indicators. Where actuators do not have positive spring returns for fail-safe operation, provide[capacity tanks,] restrictors,[check valves,] and relays, or reserve power as required to achieve proper timed positioning for up to 4 minutes after primary power failure. Actuators shall open or close the devices to which they are applied within 60 seconds after a full scale signal input change. Pneumatic actuators shall be rated for 172 kPa (gage) 25 psig operating pressure except for high pressure cylinder type actuators.

2.2.1 Damper Actuators

Damper actuators shall be rated for at least 125 percent of the motive power necessary to operate the connected damper. The actuator stroke shall be limited by an adjustable stop in the direction of the return stroke. Actuators shall be provided with mounting and connecting hardware.

2.2.2 Valve Actuators

Valve actuators shall be rated for at least 125 percent of the motive power necessary to operate the valves over their full range of operation against the total and differential pressures.

2.2.3 Positive Positioners

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Positive positioners shall be pneumatic relays with mechanical feedback mechanisms, adjustable operating ranges, and starting points.

2.3 AUTOMATIC CONTROL VALVES

Provide automatic control valves.

****

NOTE: Avoid selection of oversized control valves. Select valve Cv so that maximum pressure drops are used within constraints of available pressures, pipe velocities, economy of design, and noise criteria. Select steam valves using critical pressure drop (.45 of absolute pressure) where available, and select connected equipment using resultant pressure on downstream side of valve. List calculated Cv and flow rate in schedules (not manufacturer's listed Cv) to allow bidders to personally select valves.

****

2.3.1 Valve Assembly

Valves shall have stainless steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall be designed for not less than 862 kPa (gage) 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Maximum rated shutoff pressure of the valve shall exceed the rated deadhead pressure of the pump that supplies it. Valve leakage rating shall be 0.01 percent of rated Cv for soft-seated valves and 0.05 percent for metal-to-metal seated valves. Class 125 copper alloy valve bodies and Class 150 steel or stainless steel valves shall conform to ASME B16.5 as a minimum. Components of cast iron valves shall conform to ASTM A126 Class B or C as a minimum.

2.3.2 Butterfly Valve Assembly

Butterfly valves shall be threaded lug type suitable for dead-end service, and for modulation to the fully closed position, with carbon steel bodies or cast iron Class 125 and noncorrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from minus 29 degrees to plus 121 degrees C.20 degrees to plus 250 degrees F. Valves shall have a manual means of operation independent of the actuator.

2.3.3 Two-Way Valves

Two-way modulating valves shall have equal percentage characteristics.

2.3.4 Three-Way Valves

Three-way valves shall provide constant total flow throughout full plug travel.

2.3.5 Duct-Coil and Terminal-Unit-Coil Valves

Control valves with either flare-type or solder-type ends shall be provided for duct or terminal-unit coils. Flare nuts shall be provided for each flare-type end valve.

2.3.6 Valves for Chilled Water, Condenser Water, and Glycol Service

ASME B16.1. Bodies for valves 50 mm 2 inches and smaller shall be brass or bronze, with threaded-end or union-end connections. Bodies for valves from 65 mm 2.5 inches and larger shall be cast iron. Bodies for valves 65 mm 2.5 inches and larger shall have flanged-end connections. Internal valve trim shall be brass or bronze except that valve stems may be Type 316 stainless steel. Water valves shall be sized for a [21 kPa] [3 psi]

[_____] differential through the valve at rated flow, except as indicated otherwise. Select valve flow coefficient (Cv) for an actual pressure drop not less than 50 percent or greater than 125 percent of the design pressure drop at design flow. Valves 100 mm 4 inches and larger shall be butterfly valves.

2.3.7 Valves for Hot Water Service

Valves for hot water service below 121 degrees C 250 Degrees F shall conform to ASME B16.1. Bodies for valves 50 mm 2 inches and smaller shall be brass or bronze, with threaded-end or union-end connections. Bodies for valves 65 mm 2.5 inches and larger shall be cast iron. Bodies for 65 mm 2.5 inches and larger shall have flanged-end connections. Water valves shall be sized for a [21 kPa] [3 psi] [_____] differential through the valve at rated flow, except as indicated otherwise. Select valve flow coefficient (Cv) for an actual pressure drop not less than 50 percent or greater than 125 percent of the design pressure drop at design flow. Internal trim, including seats, seat rings, modulating plugs, and springs, of valves controlling water hotter than 99 degrees C 210 degrees F shall be Type 316 stainless steel. Internal trim for valves controlling water 99 degrees C 210 degrees F or less shall be brass or bronze. Non-metallic parts of hot water control valves shall be suitable for a minimum continuous operating temperature of 121 degrees C or 10 degrees C 250 degrees F or 50 degrees F above the system design temperature, whichever is higher. Valves 100 mm 4 inches and larger shall be butterfly valves.

2.3.8 Valves for Steam Service

ASME B16.1. Bodies for valves 40 mm 1.5 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves 50 to 80 mm 2 to 3 inches inclusive shall be brass, bronze, or cast iron. Bodies for valves 100 mm 4 inches and larger shall be cast iron. Bodies for 50 mm 2 inch valves shall have threaded ends. Bodies for valves 65 mm 2.5 inches and larger shall be provided with flanged-end connections. Internal valve trim shall be Type 316 stainless steel. Steam valves shall be sized for [103 kPa (gage)] [15 psig] [_____] inlet steam pressure with a maximum [90 kPa] [13 psi] [_____] differential through the valve at rated flow, except as indicated otherwise.

2.3.9 Valves for High Temperature Hot Water Service

Valves for high temperature hot water service above 121 degrees C 250 degrees F. Valve bodies shall conform to ASME B16.34 Class 300. Valve and actuator combination shall be normally closed. Bodies shall be carbon steel, globe type with welded ends on valves 25 mm one inch and larger. Valves smaller than 25 mm one inch shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE). Internal valve trim shall be Type 316 stainless steel. Water valves shall be sized for a [21 kPa] [3 psi] [_____] differential pressure through the valve at rated flow, except as indicated otherwise. Select valve flow coefficient (Cv) for an actual pressure drop not less than 50 percent or greater than 125 percent of the design pressure drop at design flow.

2.3.10 Valves for Compressed Air Service

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Valves used for switching compressed air supplied to pneumatic systems shall be brass body, three-way valves which shall conform to ASME B16.15 Class 250.

2.4 DAMPERS

Provide dampers in air ducts.

****

NOTE: Use parallel blade dampers for mixing boxes and where two-position control is required. Use opposed blade dampers for modulating applications for face and bypass control.

****

2.4.1 Damper Assembly

Damper shall conform to SMACNA 1966. A single damper section shall have blades no longer than 1219 mm 48 inches and shall be no higher than 1829 mm 72 inches. Maximum damper blade width shall be 200 mm 8 inches. Larger sizes shall consist of a combination of sections. Dampers shall be steel or other materials where indicated. Flat blades shall be made rigid by folding the edges. Provide blades with compressible seals at points of contact. Provide channel frames of dampers with jamb seals to minimize air leakage. Dampers shall not leak in excess of 51 L/s per square meter 10 cfm per square foot at 996 Pa 4 inches water gage static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 degrees C to 93 degrees C 40 degrees F to 200 degrees F. Dampers shall be rated at not less than 10 m/s 2000 fpm air velocity. Moving parts of the operating linkage in contact with each other shall consist of dissimilar materials. Damper axles shall be 13 mm 0.5 inch minimum plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by a non-ferrous dissimilar thrust bearings. Pressure drop through dampers shall not exceed 12 Pa 0.05 inch water gage at 5 m/s 1,000 fpm in the wide-open position. Frames shall not be less than 51 mm 2 inches wide. Dampers shall be tested in accordance with AMCA 500-D.

2.4.2 Operating Links

Operating links external to dampers, such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Mating parts shall consist of dissimilar materials. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed position of dampers.

2.5 FIRE PROTECTION DEVICES

Provide smoke detectors in return and supply air ducts on the downstream side of the filters in accordance with NFPA 90A, except as otherwise indicated. Provide UL listed or FM approved detectors for duct installation.

2.5.1 Smoke Detectors

****

NOTE: Choose one of the following options.

****

****

NOTE: Regarding the text below, use this paragraph if project has[Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE].

****

[Provide in each air-handling system with supply air capacity greater than 944 L/s 2000 cfm in accordance with NFPA 90A. Locate downstream of the supply air filters and prior to any branch connection in accordance with NFPA 72. Provide in each air-handling system, serving more than one story, and having a return air capacity greater than 7079 L/s 15000 cfm in accordance with NFPA 90A. Locate at each story prior to connection to common return and at return connection to air handler prior to any fresh air inlet connection and prior to any recirculation connection in accordance with NFPA 72. Smoke control and exhaust systems shall have provision for automatic and manual operation by means of a key-operated switch to override any other shutdown features and shall be located[adjacent to the fire alarm system control panel][as indicated].

] **

NOTE: Regarding the text below: Use this paragraph if building has an existing fire evacuation alarm system. For connection to existing system, designer must determine if the existing fire alarm control panel is compatible with smoke detectors and has spare zone capacity. Edit accordingly. When in doubt leave choice of connection to fire alarm panel or a separate control unit in paragraph. For some antiquated alarm systems, it may be necessary to replace the control panel in which case[Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE] must be included in project and the first option should be used.

****

[Provide in each air-handling system with supply air capacity greater than 944 L/s 2000 cfm in accordance with NFPA 90A. Locate downstream of the supply air filters and prior to any branch connection in accordance with NFPA 72.

Provide in each air-handling system, serving more than one story, and having a return air capacity greater than 7079 L/s 15000 cfm in accordance with NFPA 90A. Locate at each story prior to connection to common return and at return connection to air handler prior to any fresh air inlet connection and prior to any recirculation connection in accordance with NFPA 72. Design for detection of abnormal smoke densities by the[ionization][or] photoelectric principle, responsive to both invisible and visible particles of combustion, and not susceptible to undesired operation by changes to relative humidity.

Provide UL listed or FM approved detectors for duct installation. Provide duct detectors with an approved duct housing, mounted exterior to the duct, and with perforated sampling tubes extending across the width of the duct. Provide permanent descriptive zone labels indicating in which air-handling units the detectors in alarm are located.

Provide detectors with a test port[, test switch] [and][or][, remote keyed test device]. Provide control and power modules required for operation of detectors[in their own control unit][or][integral with the main building fire alarm control panel]. A ground fault or single break or open condition in electrical circuitry to any detector or its control or power units shall cause activation of building fire alarm control panel trouble signals.

Electrical supervision of wiring used exclusively for air-handling unit shutdown is not required provided a break in wiring would cause shutdown of the associated unit. Equipment and devices shall be compatible and operable in all respects with, and shall in no way impair reliability or operational functions of, the existing building fire alarm system. The existing fire alarm control panel was manufactured by [_____].

Smoke control and exhaust systems shall have provisions for[automatic and] manual operation by means of a key-operated switch to override any other shutdown features and shall be located[adjacent to the fire alarm system control panel][as indicated].

] **

NOTE: Regarding the text below: Use this paragraph only with specific approval of the Engineering Field Division Fire Protection Engineer. Approval will normally be granted only if the building has no fire alarm system and none is required. When in doubt, contact the Fire Protection Engineer.

****

[Provide in each air-handling system with supply air capacity greater than 944 L/s 2000 cfm in accordance with NFPA 90A. Locate downstream of the supply air filters and prior to any branch connection in accordance with NFPA 72. Provide in each air-handling system, serving more than one story, and having a return air capacity greater than 7079 L/s 15000 cfm in accordance with NFPA 90A. Locate at each story prior to connection to common return and at return connection to air handler prior to any fresh air inlet connection and prior to any recirculation connection in accordance with NFPA 72.

Design for detection of abnormal smoke densities by the[ionization][or][photoelectric] principle, responsive to both invisible and visible particles of combustion, and not susceptible to undesired operation by changes in relative humidity. Provide UL listed or FM approved detectors for duct installation. Provide duct detectors with an approved duct housing, mounted exterior to the duct, and with perforated sampling tubes extending across the width of the duct.

Provide 115 Vac power supply unit integral with duct housing. Obtain power from[the source to the air-handling unit or air-handling unit controls][the location indicated]. Detectors shall have test port or test switch.[Provide remote alarm indicator[and keyed test] device at [_____][the location indicated].] Provide each detector with a visible indicator lamp that lights when the detector is activated.

Activation of duct detector shall cause shutdown of the associated air-handling unit[and closing of dampers][and shall sound an alarm bell, with minimum 152 mm 6 inch diameter, in a normally occupied area] located[as directed][as indicated].[Provide a separate bell with an engraved plastic or metal label indicating which unit each bell annunciates for each air-handling unit.]

]2.5.2 Smoke Dampers[and Combination Smoke/Fire Dampers]

****

NOTE: Use combination smoke/fire dampers only where required by NFPA and design manuals.

This paragraph contains a PNEUMATIC tailoring option.

****

Smoke dampers and actuator assemblies as required in accordance with NFPA 90A shall meet the Class II leakage requirements of UL 555S. Dampers shall be factory fabricated, galvanized steel or stainless steel with lubricated bearings, linkages, and seals to withstand temperatures from minus 29 to 121 degrees C 20 to 250 degrees F. Provide replaceable seals.[Combination smoke/fire dampers shall have a UL 1.5 hour rating and shall be equipped with electric/thermal links which close the damper at 74 degrees C 165 degrees F and then automatically reset after normal temperature is restored by cycling damper actuator.] Equip dampers with pneumatic or electric actuators which close smoke dampers tightly when activated. After the smoke has cleared, the dampers shall automatically reset.

2.6 SENSORS

****

NOTE: Use smallest span sufficient to cover the operating range. Use 0.06 degrees C 0.10 degree F allowable tolerance sensors where small temperature changes will have large impact on energy consumption; e.g., chilled water, where the span is nominally 4.44 to 6.67 degrees C 8 to 12 degrees F. The normal 0.28 degree C 0.5 degree F sensor would have an error of 3 to 6 percent: 0.28 degree C 0.5 degree F divided by 4.44 degree C 8 degrees F equals .06 or 6 percent.

****

****

NOTE: Indicate outside air sensors mounted on a north wall if possible; a fan-type air aspirator if necessary to avoid effects of wind, rain, solar radiation, and building outside air film; and also indicate a power source for the aspirator.

****

2.6.1 Spans and Ranges

****

NOTE: This paragraph contains a PNEUMATIC tailoring option.

****

Transmitters shall be calibrated to provide an electric or electronic output signal of 4 to 20 mA electric or electronic and 21 to 103 kPa 3 to 15 psi output for pneumatics over the indicated span or range.

[a. Conditioned space temperature, from 10 to 38 degrees C 50 to 100 degrees F.

][b. Duct temperature, from 4 to 60 degrees C 40 to 140 degrees F.

][c. High temperature hot-water temperature, from 93 to 260 degrees C 200 to 500 degrees F.

][d. Chilled water temperature, from minus one to 27 degrees C 30 to 80 degrees F.

][e. Dual temperature water, from minus one to 116 degrees C 30 to 240 degrees F.

][f. Heating hot water temperature, from 38 to 121 degrees C 100 to 250 degrees F.

][g. Condenser water temperature, from minus one to 54 degrees C 30 to 130 degrees F.

][h. Outside air temperature, from minus 34 to 54 degrees C 30 to 130 degrees F.

][i. Relative humidity, from 0 to 100 percent for high/low limit applications; from 20 to 80 percent for space applications.

][j. Differential pressure for VAV supply duct static pressure from 0 to 498 Pa 0 to 2.0 inches water gage.

][k. Pitot tube airflow measurement station and transmitter, from 0 to 25 Pa 0 to 0.1 inch water gage for flow velocities of 2.50 to 6 m/s, 0 to 62 Pa 500 to 1200 fpm, 0 to 0.25 inch water gage for velocities of 2.50 to 9 m/s, or 0 to 124 Pa 500 to 1800 fpm, or 0 to 0.5 inch water gage for velocities of 2.50 to 13 m/s, or 0 to 374 Pa 500 to 2500 fpm, or 0 to 1.5 inches water gage for velocities of 7.5 to 23 m/s, or 0 to 498 Pa 1500 to 4500 fpm, or 0 to 2 inches water gage for velocities of 15 to 30 m/s 3000 to 6000 fpm as required by the duct system.

][l. Electronic airflow measurement station and transmitter, from 0.64 to 13 m/s, 7.5 to 23 m/s, or 15 to 30 m/s 125 to 2500 fpm, 1500 to 4500 fpm, or 3000 to 6000 fpm as required by the duct system.

]2.6.2 Temperature Sensors

2.6.2.1 Resistance Temperature Detectors (RTD's)

RTD shall be platinum with a tolerance of plus or minus 0.25 percent at 0 degrees C 32 degrees F, and shall be encapsulated in epoxy, Series 300 stainless steel, anodized aluminum, or copper. RTD shall be furnished with RTD transmitter as specified, integrally-mounted unless otherwise indicated.

2.6.2.2 Continuous Averaging RTD's

Continuous averaging RTD's shall have a tolerance of plus or minus 0.55 degrees C 1.0 degrees F at the reference temperature, and shall be of sufficient length to ensure that the resistance represents an average over the cross section in which it is installed. Sensing element shall have a bendable copper sheath. Averaging RTD shall be furnished with RTD transmitter as specified, to match the resistance range of the averaging RTD. Element length shall be a minimum of 3280 mm per square meter one linear foot per square foot of coil face area.

2.6.2.3 RTD Transmitter

****

NOTE: Indicate where transmitters are required and not required.

****

RTD transmitter shall be selected to match the resistance range of the RTD. Transmitter shall be a two-wire, loop-powered device. Transmitter shall produce a linear 4 to 20 mA dc output corresponding to required temperature measurement. Output error shall not exceed 0.1 percent of the calibrated measurement. Transmitter shall include offset and span adjustments.

2.6.2.4 Pneumatic Temperature Transmitter

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

Use smallest span sufficient to cover operating range. This provides smallest allowable deviation, improving control accuracy.

****

Transmitting sensing elements shall be bi-metal, averaging element and capillary, rod and tube, or bulb and capillary. Transmitters shall operate within the range of 4 to 116 degrees C 40 to 240 degrees F. Provide the following spans and allowable deviations for applications listed.

a. Room sensors, minus 4 degrees C 25 degrees F, plus or minus 0.28 degrees C 0.5 degrees F

b. Room, chilled water, dew point, return air sensors, 10 degrees C 50 degrees F, plus or minus 0.42 degree C 0.75 degree F

c. Outside air, hot water, coil discharge sensors, 38 degrees C 100 degrees F, plus or minus 0.56 degree C 1.0 degree F

d. High temperature hot water, chilled hot water system sensors, 93 degrees C 200 degrees F, plus or minus 1.11 degrees C 2.0 degrees F.

2.6.3 Relative Humidity Instruments

2.6.3.1 Relative Humidity Sensor

****

NOTE:

1. Measuring dew point temperature and relative humidity with accuracy and repeatability using "commercial" controls is difficult. It is recommended that the designer plan the control system to eliminate the need to control dew point temperature or relative humidity including eliminating enthalpy control. Dry bulb temperatures should be used to control outside, return, and exhaust air dampers in economizer applications. Only use humidity control when the space has specific humidity requirements.

2. Indicate a fan powered type aspirating cabinet, an electronic relative humidity sensing element, a transmitter for outside air relative humidity sensing applications, and a power source for the cabinet.

****

Provide relative humidity sensor. Use nonsaturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. Sensing elements shall be bulk polymer or thin film polymer. Sensing elements shall have an accuracy of plus or minus 2 percent of full scale within the range of 20 to 80 percent relative humidity. Provide a two-wire, loop-powered transmitter located at the sensing elements to convert the sensing elements output to a linear 4 to 20 mA dc output corresponding to required humidity measurement. Output error shall not exceed 0.1 percent of calibrated measurement. Transmitter shall include offset and span adjustments. Transmitter shall have ability to be calibrated electronically by using a one-point, in-situ method which allows for error correction with a single potentiometer.

2.6.4 Dew Point Instruments

****

NOTE: Provide 2 degrees C 3 degree F dew point allowable deviation for normal control, as in commissary refrigerated display case, anti-sweat heater controls; provide a 0.55 degree C one degree F deviation for critical occupied space, as in computer rooms.

****

Provide analog salt-phase transition or dual chilled, mirror type sensor. Sensor shall have an allowable deviation of plus or minus [0.55] [2] degrees C [one] [3] degrees F dew point over the range of minus 12 to plus 27 degrees C 10 to 80 degrees F dew point.

2.6.5 Airflow Sensors

Provide airflow sensors.

****
NOTE: Use only where necessary. Airflow sensors are high maintenance items.
****

2.6.5.1 Electronic Airflow Measurement Stations and Transmitters

a. Stations shall contain an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. Velocity sensing elements shall be RTD or thermistor type, with linearizing means. Sensing elements shall be distributed across the duct cross section in the quantity and pattern set forth for measurements and instruments in accordance with ASHRAE FUN SI ASHRAE FUN IP and SMACNA 1780, for traversing of ducted airflows. Resistance to airflow through the airflow measurement station shall not exceed 20 Pa 0.08 inch water gage at airflow of 10 m/s 2000 fpm. Station construction shall be suitable for operation at airflows of up to 25.40 m/s 5000 fpm over a temperature range of 4 to 49 degrees C 40 to 120 degrees F, and accuracy shall be plus or minus 3 percent over a range of 0.64 to 12.70 m/s 125 to 2500 fpm scaled to air volume. Use stations if required velocity measurement is below 2.50 meters per second 500 feet per minute.

b. Transmitters shall produce a linear, temperature compensated 4 to 20 mA dc output corresponding to required velocity pressure measurement. Transmitters shall be a two-wire, loop-powered device. Output error of transmitters shall not exceed 0.5 percent of calibrated measurement. Transmitters shall have offset and span adjustments.

2.6.5.2 Pitot Tube Airflow Measurement Stations and Transmitters

a. Stations shall contain an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. Velocity sensing elements shall be multiple pitot tube type with averaging manifolds. Sensing elements shall be distributed across the duct cross section in the quantity and pattern set forth for measurements and instruments in accordance with ASHRAE FUN SI ASHRAE FUN IP or SMACNA 1780, for traversing of ducted airflows. Resistance to airflow through the airflow measurement station shall not exceed 20 Pa 0.08 inch water gage at airflow of 10 m/s 2000 fpm. Station construction shall be suitable for operation at airflows of up to 25.40 m/s 5000 fpm over a temperature range of 4 to 49 degrees C 40 to 120 degrees F, and accuracy shall be plus or minus 3 percent over a range of 2.5 to 12.7 m/s 500 to 2500 fpm scaled to air volume. Do not use stations if required velocity measurement is below 2.50 meters per second 500 feet per minute.

b. Transmitters shall produce a linear 4 to 20 mA dc output corresponding to the required velocity pressure measurement. Each transmitter shall have a low-range differential pressure sensing element and a square root extractor. The transmitter shall be a two-wire, loop powered device. Sensing element accuracy shall be plus or minus 1 percent of full scale, and overall transmitter accuracy shall be plus or minus 0.25 percent of the calibrated measurement. Each transmitter shall have offset and span adjustments.

2.6.6 Pressure Sensors

****
NOTE: Indicate spare pressure taps where in-piping

calibration is required.
****

Provide electronic pressure sensor and transmitter. Sensor shall be a pressure transmitter with an integral sensing element. Sensor over pressure rating shall be 172 kPa (gage) 25 psig above its normal operating range. Sensing element accuracy shall be plus or minus one percent of full scale. Transmitter accuracy shall be plus or minus 0.1 percent of the calibrated measurement. Transmitter shall be a two-wire, loop-powered device. Transmitter shall produce a linear 4 to 20 mA dc output corresponding to required pressure measurement. Transmitter shall have offset and span adjustments.

2.7 THERMOWELLS

Provide brass or Series 300 stainless steel thermowells with threaded brass plug and chain, 50 mm 2 inch lagging neck and extension type well, and inside diameter and insertion length as required for the application. Provide thermowells for immersion sensors with conducting material inside the well.

2.8 THERMOSTATS

Provide thermostats.

****
NOTE:

1. Use a recessed aspirating type mounting in public areas where it is necessary to make the thermostat less obvious to minimize vandalism. Do not use aspirating or concealed mountings in family housing. Use adjustable thermostats in family housing.

2. Locate room thermostats on interior walls where they will respond to average conditions in the rooms. Thermostats shall not be mounted on exterior walls if other locations are available. If mounted on exterior walls, thermostats shall be indicated with an insulating subbase. Thermostats for comfort cooling that are occupant controlled (indicate the limits) shall have fixed factory temperature limits. Indicate centerline of room thermostat at 1.50 meters 5 feet above finished floor.

3. Indicate switch differential for each contact and between each contact on multistage switches; also, indicate whether the differential is adjustable or fixed.
****

2.8.1 Ranges

Thermostat ranges shall be selected so that the setpoint is adjustable[without tools] between plus or minus 5 degrees C plus or minus 10 degrees F of the setpoint indicated.

2.8.2 Nonmodulating Electric Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be one degree C 2 degrees F. Thermostat covers shall consist of locking metal or heavy-duty plastic, and shall be capable of being locked by an Allen wrench or special tool. Thermostats shall have manual switches as required by the application and a minimum range of 13 to 32 degrees C 55 to 90 degrees F.

2.8.3 Microprocessor-Based Room Thermostats

****

NOTE: Use thermostats only for small split systems and packaged single-zone units.

****

Microprocessor-based room thermostats shall have built-in keypads for scheduling of day and night temperature settings.[Access to the scheduling mode shall be by password control code.] When out of the scheduling mode, thermostats shall have continuous 12-hour time display, with AM and PM indication, continuous display of day of the week, and either continuous display of room temperature with display of temperature setpoint on demand, or continuous display of temperature setpoint with display of room temperature on demand. In the programmable mode, use the display for setting and interrogating time program ON-OFF setpoints for each day of the week. The time program shall allow two separate temperature setback intervals per day. Thermostats shall have a means for temporary and manual override of program schedule, with automatic program restoration on the following day. Thermostats shall have a replaceable battery to maintain timing and to maintain the schedule in memory for one year in the event of a power outage. Maximum differential shall be one degree C 2 degrees F. Where used for heat pump applications, thermostat shall have an emergency heat switch.

2.8.4 Nonmodulating Capillary Thermostats and Aquastats

a. Thermostat shall have a capillary length of at least 1 1/2 meters 5 feet, adjustable direct reading scales for both setpoint and differential, and a differential adjustable from 3 to 9 degrees C 6 to 16 degrees F.

b. Aquastats shall be strap-on type, with 5.50 degrees C 10 degrees F fixed differential.

2.8.5 Low-Temperature Protection Thermostats (Freezestats)

****

NOTE: Indicate capillary serpentined in a plane perpendicular to airflow to uniformly sense entire airflow.

****

Low-temperature protection thermostats shall be manually reset low-temperature safety thermostats, with NO and NC contacts or a two-position pneumatic output signal and a 6 meters 20 foot element which shall respond to the coldest 456 mm 18 inch segment.

2.8.6 Modulating Capillary Thermostats

Thermostats shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Thermostats shall have adjustable throttling ranges of 2 to 4 degrees C 4 to 8 degrees F for each output.

2.8.7 Modulating Pneumatic Room Thermostats

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Two-temperature combination thermostats shall be adjustable proportioning type with dual setpoints containing two temperature sensing elements: one for heating control and one for cooling control; two for heating control or two for cooling control. Changeover for two-temperature combination thermostats shall be accomplished by a change in control air supply pressure which selects proper setpoint and proper controller action. Single-temperature thermostats shall be adjustable proportioning type with one temperature sensing element: one setpoint and proper controller action. "Dead-band" thermostats shall have one adjustable proportioning type controller with two setpoints, adjustable dead-band, and one controller output or two adjustable proportioning type controllers mounted on a common backplate with two setpoints, adjustable dead-band, and two controller outputs. Temperature sensing elements shall be selected for proper controller action. Individual temperature-sensing elements shall have a separate adjustable throttling range of one to 5.50 degrees C 2 to 10 degrees F; thermostat shall have a minimum range of 13 to 32 degrees C 55 to 90 degrees F and minimum safe air input pressure of 172 kPa (gage) 25 psig. Dead-band setting shall have a minimum adjustable range of 2 to 8 degrees C 4 to 15 degrees F. Room thermostat shall have concealed setpoint dial[, covers with Allen screws][, aspirator type wall box with flush plate and locking screws][, built-in concealed thermometers][, exposed adjustment covers with visible thermometers for family housing], and plug-in gage ports.

2.8.8 Modulating, Insertion, Immersion, and Averaging Pneumatic Thermostats

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

Indicate remote bulb return air thermostats in lieu of room thermostats where acceptable.

****

Thermostats shall be two-pipe, pilot-operated type with pneumatic feedback, proportional action and shall have an adjustable throttling range of one to 55 degrees C 2 to 100 degrees F with a minimum range of minus 12 to plus 121 degrees C 10 to 250 degrees F. Averaging elements shall be 825 mm 1 foot in length for each square meter 4 square feet of ductwork cross-sectional area with a minimum length of 2.44 meters 8 feet.

2.8.9 Nonmodulating Pneumatic Thermostats

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring

option is selected.
****

Thermostats shall have integral positive acting relays, zero or maximum output pressure. Remote element thermostats shall have standard or averaging bulbs. Averaging bulbs shall be 825 mm one foot in length for each square meter 4 square feet of ductwork cross-sectional area and a minimum length of 2.44 meters 8 feet. Differential ranges shall be field adjustable. Remote element thermostat differential range shall be one to 14 degrees C 2 to 25 degrees F with minimum control ranges of minus 23 to plus 121 degrees C minus 10 to plus 250 degrees F. Room thermostat differential range shall be one to 5.50 degrees C 2 to 10 degrees F with minimum control ranges of 13 to 32 degrees C 55 to 90 degrees F.

2.9 SUNSHIELDS

Provide sunshields for outside air temperature sensing elements to prevent the sun from directly striking temperature sensing elements. Provide sunshields with adequate ventilation so that the sensing element responds to the ambient temperature of surroundings. The top of each sunshield shall have galvanized metal or aluminum rainshield projecting over the face of the sunshield. Sunshields shall be painted white or shall be unpainted aluminum.

2.10 PRESSURE SWITCHES AND SOLENOID VALVES

Provide pressure switches and solenoid valves.

2.10.1 Pressure Switches

Switches shall have an adjustable setpoint with visible setpoint scale. Range shall be as indicated. Differential adjustment shall span 20 to 40 percent of the range of the device.

2.10.2 Differential Pressure Switches

Switches shall be an adjustable diaphragm-operated device with[two SPDT][one SPDT] contacts, with taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure. Fittings shall be angled-tip type with tips pointing into the airstream.[Range shall be 125 to 1494 Pa 0.5 to 6 inches water gage. Differential shall be a maximum of 37 Pa 0.15 inch water gage at the low end of the range and 87 Pa 0.35 inch water gage at the high end of the range.]

2.10.3 Pneumatic Electric (PE) Switches

****
NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.
****

Switches shall have an adjustable setpoint range of 21 to 138 kPa (gage) 3 to 20 psig, and differential adjustable from [14 to 41][7to 14][2 to 7] kPa [2 to 6][1 to 2][0.25 to 1] psi.

2.10.4 Solenoid Operated Pneumatic (EP) Valves

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Valves shall have three-port operation: common, normally open, and normally closed. Valves shall have an outer cast aluminum body. The air connection shall be a 6 mm 1/4 inch NPT threaded connection. Valves shall be rated for 345 kPa (gage) 50 psig where used in a control system which operates at 172 kPa (gage) 25 psig or less, or 1034 kpa (gage) 150 psig where used in a control system which operates in the range of 172 to 689 kPa (gage) 25 to 100 psig.

2.11 INDICATING DEVICES

Provide indicating devices.

2.11.1 Thermometers

a. Thermometers for insertion in ductwork and piping systems shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, and permanently stabilized glass tube with an indicating fluid column, white face, black numbers, and a 229 mm 9 inch scale.

b. Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern.

c. Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid stem thermometers, the space between bulb and stem shall be filled with a heat transfer medium.

d. Air duct thermometers shall have perforated stem guards and 45 degree adjustable duct flanges with locking mechanisms.

e. Averaging thermometers shall have 90 mm 3.5 inch (nominal) dial, with black legend on white background, and pointer traveling through a 270 degree arc.

f. Thermometers shall have an accuracy of plus or minus one percent of scale range. Thermometers shall have the following ranges:

   (1) Mixed air temperature: minus 18 to plus 38 degrees C in 1/2 degree C 0 to 100 degrees F in 1 degree F graduations.

   (2) Return air temperature: minus 18 to plus 38 degrees C in 1/2 degrees C 0 to 100 degrees F in 1 degree F graduations.

   (3) Cooling coil discharge temperature: minus 18 to plus 38 degrees C in 1/2 degree C 0 to 100 degrees F in 1 degree F graduations.

   (4) Heating coil discharge temperature: minus one to plus 82 degrees C in one degree C 30 to 180 degrees F in 2 degree F graduations.

   (5) Hydronic heating systems below 104 degrees C 220 degrees F: 4 to 116 degrees C in one degree 40 to 240 degrees F in 2 degree graduations.

   (6) Chilled water temperature: minus 18 to plus 38 degrees C in 1/2

degree C 0 to 100 degrees F in one degree F graduations.

(7) Condenser water temperature: 4 to 60 degrees C in 1/2 degree C 40 to 140 degrees in one degree F graduations.

(8) Glycol temperature: minus 18 to plus 38 degrees C 0 to 100 degrees Ffor cooling service in 1/2 degree C one degree F graduations, and 4 to 116 degrees C 40 to 240 degrees F for heating service in one degree C 2 degree F graduations.

(9) High temperature hot water: 38 to 288 degrees C in 3 degree C 100 to 550 degrees F in 5 degree F graduations.

2.11.2 Pressure Gages

****

NOTE: List item e. is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Provide pressure gages with gage cock, snubber, and syphon.

a. ASME B40.100. Gages shall be 65 mm 2 1/2 inch (nominal) size, back-connected, suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270 degree arc. Accuracy shall be plus or minus 3 percent of scale range.

b. Gages for indicating signal output to pneumatic actuators and main air gages shall have scale of 0 to 210 kPa (gage) in 10 kPa 0 to 30 psig in 1 psig graduations.

c. Gages for air storage tanks and for use before and after dirt and oil filters or dryers, shall have a scale of [0 to 1100][_____] kPa (gage) [0 to 160][_____] psig with 15 Kpa (gage) 2 psig graduations.

d. Gages for[hydronic][and][steam] system applications shall have ranges and graduations as indicated.

e. Pneumatic transmission receiver gages shall have a range to match the respective transmitters.

2.12 LOW-DIFFERENTIAL PRESSURE GAGES

Gages for low-differential pressure measurements shall be 115 mm 4 1/2 inch (nominal) size with two seats of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gages shall have ranges and graduations as indicated. Accuracy shall be plus or minus 2 percent of scale range.

2.13 CONTROLLERS

****

NOTE: Indicate which type of controller is required for each application.

****

2.13.1 Single-Loop Controllers

****

NOTE: Indicate single-loop controllers for applications where proportional-integral (PI) modes or proportional-integral-derivative (PID) modes are required or where the need for either mode is anticipated. Indicate single-loop controllers where one or two contact outputs are required to be operated in response to changes in process variable input signals for control application.

****

2.13.1.1 Controller Features

Controller shall be a microprocessor-based, single-loop device that does not require Contractor-generated software. Controller shall conform to FCC Part 15. Controller panel cutout shall be 92 by 92 mm 3.62 by 3.62 inches. Controller shall have field selectable range for process variables, a remote setpoint analog input and analog output with adjustable high and low end limits, and proportional control manual reset adjustment. Analog output shall result from PID control. Analog output shall be configurable as direct acting and reverse acting. Controller shall have keyboard, display, auto/manual selection for control of analog output, and remote setpoint adjustment/local setpoint adjustment selection. Controller shall have adjustable high-end and low-end limits, ratio, and bias adjustments on remote setpoint input; operator initiated self-tune/manual-tune selection, anti-reset wind-up feature, and two configurable independent SPDT with adjustable system contact closure outputs. Controller shall be configurable to power-up in manual with local setpoint control, in automatic with local setpoint control, and in automatic with remote setpoint control. Contact closures shall be activated by a process variable and by a process variable deviation from setpoint as configured. The range of hysteresis adjustment shall not be smaller than 1 percent to 5 percent of process variable input span. Controller shall power the analog output loop to 20 mA where connected to a load of 600 ohms. Controller shall have 5-year battery backup or shall have nonvolatile memory to store operating parameters.

2.13.1.2 Controller Parameter Input and Display

Control parameters shall be entered and displayed directly, in the correct engineering units, through a series of keystrokes on a front panel display with a 3-1/2-digit, seven-segment display, with decimal point and polarity indication. Use of the display shall allow manual interrogation of setpoint, mode constants, and values of process variables and outputs.

2.13.1.3 Controller Electrical Requirements

Controller shall be powered by 120 Vac. Controller shall provide electrical noise isolation, not less than 100 dB at 60 Hz common mode rejection ratio, and not less than 60 dB at 60 Hz normal mode rejection ratio between ac power line and process variable input, remote setpoint input, and output signals.

2.13.1.4 Controller Accuracy

Controller shall have an accuracy of plus or minus 0.30 percent of input span, plus or minus one digit.

2.13.1.5 Controller Self Tuning

Controller self-tuning operation shall apply proportional, integral, and derivative modes of control; mode constants shall be modified as required. Self tuning shall only operate when selected from the front panel.

2.13.1.6 Controller Manual Tuning

Controller manual tuning operation shall provide proportional, integral, and derivative control modes, or any combination thereof, by means of individual mode constant adjustments. Adjustments shall be set for the appropriate value if a particular control mode action is desired, or to zero for the particular mode not desired. The proportional mode constant shall be adjustable from 0 to 200 percent of input signal range; the integral mode constant shall be adjustable from 0 to 20 repetitions per minute; and the derivative mode constant shall be adjustable from 0 to 5 minutes.

2.13.2 Pneumatic Controllers

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

****

NOTE: Indicate on drawings in sequence of operation, the following controller characteristics:

1. Type of setpoint adjustment: local or remote. Specify "field selectable" where future provisions for remote setpoint may be foreseen, or where similar units, a portion of which requires remote adjustment, are to be used at remote job sites.

2. Type of input ports: single or dual.

3. Type of inputs: primary with single input ports, or primary and secondary with dual input ports.

****

Controllers shall be two-pipe devices which use main air supplied to controller and pneumatic relay to produce the controller output signal. Controllers shall have field selectable local and remote adjustable setpoints, and an adjustable proportional band for analog (proportional) control or an adjustable differential for binary (two-position or floating) control. Controllers shall have single- or dual-input ports as required for the application and field selectable direct or reverse action for inputs. Dual input controllers shall have adjustable secondary input authority. Controllers shall have integral gage or test connections for testing or indication of input and output signals.

2.13.3 Analog Electronic Controllers

Controllers shall be solid-state electronic devices which sense the difference between input sensor analog values (resistance or voltage) and setpoint adjustment analog values (resistance or voltage), and shall amplify the difference signal to provide the output signal. Controllers shall include the following:

a. Proportional band: 2.5 to 33 percent of input device span.

b. Authority: minimum of 33 to 200 percent.

c. Inputs: thermistor, resistance, transmitter, or output of other electronic controllers.

d. Outputs: within the range of minus 5 to 20 Vdc or a 4 to 20 mA dc current loop.

e. Remote setpoint adjustment (SPA): plus or minus 10 percent of input device span.

2.13.4 Unitary Control Systems

****

NOTE: Energy-efficient temperature control systems should be used for small systems as well as large systems. Systems that otherwise are not cost effective may use programmable controllers that are commercially available for HVAC applications. These are chiefly staging type controllers but some do incorporate modulating outdoor air damper control. Controllers are available to control cooling in two steps with either two or four heating steps, and in three cooling steps with three heating steps.

****

Unitary control systems shall be energy-efficient, micro-processor-based temperature controllers and associated devices that do not require Contractor-generated software. Provide control systems with[integral][or][remote] sensor as indicated. Controllers shall operate heating, cooling, and ventilating modes with independent occupied and unoccupied settings for each of 7 consecutive days. Cooling shall be controlled in[two][three] steps and heating shall be controlled in[two][three][four] steps with modulating control provided for the ventilation mode. Provide temperature changeover control to limit the ventilation mode when outdoor air temperature is not sufficiently low for "free-cooling." Provision shall be made for[automatic][manual] changeover between heating and cooling modes, providing a one minute minimum time delay between the start and stop operation of heating and cooling stages upon startup and after power failure to prevent short cycling and power surges. Provide an optimum startup program to minimize warm-up or cool-down periods prior to the occupied mode. Outside air dampers shall be closed during the optimum startup program unless outside air is beneficial for cool-down in lieu of mechanical cooling. Fan shall operate continuously during the occupied mode and shall cycle during the unoccupied mode for heating or cooling. Provide battery backup to retain programs and maintain clock operation for 48 hours minimum during power outages. Controller shall have a self-diagnostic program to indicate errors and locking covers to prevent unauthorized program entries. Provide a convenient means to restore the occupied mode of operation for a minimum 2-hour period without removing covers. An indexing switch shall allow operation in a continuous unoccupied mode during abnormal periods without changing normal programs.[Servicing tool required to place the unitary control system in use shall be a hand-held device used to adjust and monitor setpoints, controlled device positions, input sensor values, and other control system parameters.]

2.13.5 Pneumatic Low-Range Pressure Controllers for Ductwork Applications

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Controllers shall provide two-pipe, pilot-operated control with pneumatic feedback and proportional action. Sensing elements shall be differential type with pressure ranges appropriate for intended service. One element shall measure the variable while the other element measures the standard reference. Static pressure controllers shall have slack diaphragms with standard ranges between 0 to 1494 Pa 0 to 6 inches water gage and an adjustable throttling range of 5 to 125 Pa 0.02 to 0.5 inch water gage. Sensing element shall be mountable in ductwork and shall measure static pressure without pulsations.

2.13.6 Pneumatic Differential Pressure Controllers for Liquid Applications

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Differential pressure controllers shall have a minimum range of 0 to 345 kPa (gage) or 0 to 1724 kPa (gage) 0 to 50 psig or 0 to 250 psig as specified or required for the application and shall have an adjustable throttling range of 7 to 172 kPa (gage) 1 to 25 psig. Sensing element shall be filled diaphragm type with three-valve manifold for isolation and nulling. Provide syphons and pressure snubbers.

2.14 CONTROL DEVICES AND ACCESSORIES

Provide control devices and accessories.

2.14.1 Function Modules

Function modules shall accept mA dc analog input signals to produce analog output signals or contact output signals. Modules shall have zero and span adjustments for analog outputs, and setpoint adjustments for contact outputs.

2.14.1.1 Minimum Position Switches and Temperature Setpoint Devices

Minimum position switches and temperature setpoint devices shall accept manual input and shall produce steady analog output. Switches and devices shall be suitable for recessed wall mounting or panel mounting and shall have a graduated dial.

2.14.1.2 Signal Inverter Modules

Signal inverter modules shall accept analog input signal and produce analog output signal that linearly reverses the direction of signal change of input versus output.

2.14.1.3 High-Low Signal Selector Modules

High-low signal selector modules shall accept analog input signals and select either the highest or the lowest input signal as the output signal.

2.14.1.4 Sequencer Modules

Sequencer modules shall provide fixed time delayed sequencing of one or more contact transfers from an analog input signal. Sequencers shall return contacts to their zero input signal condition when power is interrupted.

2.14.2 Relays

Relays shall be two-pole, double-throw (DPDT) with a 10-ampere resistive rating at[120][24] Vac, and shall have an enclosed coil. Provide with a light indicator which is lit when the coil is energized and is not lit when the coil is not energized.

2.14.3 Time-Delay Relays

Time-delay relays shall be DPDT with octal connectors and dust covers. The adjustable timing range shall be[0 to 3 minutes] [_____].

2.14.4 Time Clocks

****

NOTE: Indicate time clock to automatically index to day or night thermostats; control system shall function on Saturday and Sunday as specified for night cooling and heating. The second clock circuit of the same clock that controls HVAC air delivery system timing shall be used to maintain outside air dampers closed from beginning of night period through the morning warm-up period.

****

Time clocks shall be a 24-hour, 365-day programmable timing device with two independently timed circuits. Clocks shall have a manual scheduling keypad and alphanumeric display of timing parameters. Timing parameters shall include Gregorian calendar date for month, day and day-of-month indication; and 24-hour time-of-day display, with one-minute resolution for programming the ON and OFF times for each circuit. Circuits shall have programmable timed override from 1 to 99 minutes. Clocks shall have capacity for programming four ON events and four OFF events for each circuit. Programmed events shall be assignable to a 365-day schedule. Clocks shall have automatic standard time and daylight saving time adjustments, keyed to input of appropriate dates. Provide clocks with 4-day battery backup.

2.14.5 Override Timer

****

NOTE: Mechanical override timer, when activated, shall bypass the time clock and activate the day heating or cooling and ventilation controls for assigned units. Upon expiration of timer operation, the control system shall return to normal mode.

****

Override timers shall be manually set, mechanically driven timers, or electronic timers, without a "hold" feature. Time intervals shall be selectable for up to 12 hours of operation and shall expire unless reset.

2.14.6 Current-to-Pneumatic (IP) Transducers

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Transducers shall be two-wire transmitters which convert an input signal to 21 to 103 kPa (gage) or 103 to 21 kPa (gage) 3 to 15 psig or 15 to 3 psig pneumatic output, with a conversion accuracy of plus or minus 2 percent of full scale, including linearity and hysteresis. Air consumption shall not be greater than 0.12 L/s 0.25 scfm.

2.14.7 Regulated Power Supplies

Power supplies shall provide a 24-Vdc linear supply at not less than 2 amperes, with regulation to 0.05 percent of output voltage. Power supplies shall have a fused input, and shall be protected from voltage surges and power-line transients. Power supply output shall be protected against overvoltage and short circuits. Power supply loading shall not be greater than 1.2 amperes.

2.14.8 Transformers

****

NOTE: Indicate a backup transformer connected to an alternate voltage supply for systems connected to critical areas where continuous operation is necessary.

****

UL 508 and NEMA ST 1 as applicable. Transformers, other than transformers in bridge circuits, shall have primaries wound for available voltage and secondaries wound for correct control circuit voltage. Transformers shall be sized so that connected loads equal 80 percent of rated capacity. Transformers shall be enclosed in rustproof, galvanized steel cabinets with conduit connections. Disconnect switch shall be provided on the primary side, and a fuse cutout on the secondary side.[For systems serving] [_____] [or] [as indicated], provide backup power supply including transformers connected to [the emergency power source] [_____].[Provide for automatic switchover and alarm upon failure of primary control circuit.]

2.14.9 Pilot Lights and Manual Switches

Device illumination shall be by light-emitting diode (LED) or neon lamp. Switches shall have operating levers and index plates showing switch positions and names of apparatus controlled or other appropriate designations.

2.15 HVAC SYSTEM CONTROL PANELS

Provide HVAC system control panels.

2.15.1 Panel Assembly

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NOTE: This paragraph contains PNEUMATIC tailoring options.
****

Panel shall be fabricated for bottom entry connection for control system electric power, control system main air source, control system wiring, pneumatic tubing, interconnection of control systems, interconnection of starters, and external shutdown devices. Panel shall have an operating temperature rise of not greater than 11 degrees C 20 degrees F above an ambient temperature of 38 degrees C 100 degrees F.

2.15.2 Panel Electrical Requirements

Control panel shall be powered by nominal 120 Vac terminating at panel on terminal blocks. Instrument cases shall be grounded. Interior and exterior panel enclosures shall be grounded.

2.15.3 Enclosures

****
NOTE: Indicate NEMA class for each panel.
****

Enclosures for each panel shall be a single door, wall-mounted box conforming to NEMA 250 with a continuous hinged and gasketed exterior door with a print pocket, key lock, and interior back panel. Inside finish shall be white enamel, and outside finish shall be gray primer over phosphatized surfaces.

2.15.4 Mounting and Labeling

Provide pilot lights, switches, panel-mounted control devices, and pressure gages shall be mounted on the door. Power conditioners, fuses, and duplex outlets shall be mounted on the interior of the cabinet. Other components housed in the panel shall be mounted on the interior back panel surface of the enclosure and shall be identified by plastic or metal nameplates which are mechanically attached to the panel. Lettering shall be cut or stamped into the nameplate to a depth of not less than 0.4 mm 1/64 inch, and shall have contrasting color, produced by filling with enamel or lacquer or by use of laminated material. Painting of lettering directly on the surface of the door or interior back panel is not permitted.

2.15.5 Wiring and Tubing

****
NOTE: This subpart title and list item a. contain PNEUMATIC tailoring options.
****

a. Pneumatic device inputs and outputs shall be piped to bulkhead fittings in the bottom of the panel with a 50 mm 2 inch loop to facilitate replacement. Electric, electronic, and electropneumatic device signals entering and leaving the panel shall be wired to identified terminal blocks.

b. Wiring shall be installed in wiring ducts so that devices can be added or replaced without disturbing existing wiring that is not affected by the change. Wiring to single-loop controllers shall have a 100 mm 4 inch wiring loop in the horizontal wiring duct at each wiring connection. There shall be no wiring splices within the control panel. Interconnections required for power or signals shall be made on device terminals, if available, or panel terminal blocks, with not more than two wires connected to each terminal.

c. Instrument signal grounds at the same reference level shall end at a grounding terminal connected to a common ground point for that level. Wiring shield grounds at the same reference level shall end at a grounding terminal connected to a common ground point for that level. Grounding terminal blocks shall be identified by reference level.

d. Wiring connected to controllers shall be identified by function and polarity, e.g., process variable input and remote setpoint input and output.

2.16 COMPRESSED AIR STATIONS

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Provide compressed air stations.

2.16.1 Air Compressor Assembly

****

NOTE: In that are additions to existing control systems, do not add additional loads or reuse existing control compressor unless it is verified by the designer that it has ample capacity and is dependable. If existing compressor is to be reused, so specify and indicate its location on drawings.

****

[a. Compressor shall be equipped with an electric motor with a totally enclosed belt guard, operating pressure switch, safety relief valves, gages, intake filter, and intake silencer. Compressor shall have combination type magnetic starter with undervoltage protection and thermal overload protection for each phase. Compressor shall be supported by a steel base mounted on an air storage tank. Air compressor shall be sized to supply compressed air required by the control system while operating not more than one-third of the time.

] **

NOTE: Regarding the text below, provide duplex air compressors for systems having greater than 50 control air users or greater than 0.71 L/s 1.5 cubic feet per minute of free air.

****

[b. Compressor shall be a duplex machine. Compressor shall be equipped with an electric motor with a totally enclosed belt guard, operating pressure switch, safety relief valve, cylinder unloader or solenoid unloader, intake filter, and intake silencer. Provide an alternator and two magnetic starters with undervoltage protection and thermal overload protection for each phase. Compressors shall be supported on a steel base mounted on an air storage tank. Compressor shall be sized to the control system compressed air requirement while operating not more than one-half of the time.

] c. Compressed air storage tank shall be fabricated for working pressure of not less than 1379 kPa (gage) 200 psig, and constructed and certified in accordance with ASME BPVC. Tank shall be of sufficient volume so that no more than six compressor starts per hour are required with the starting pressure switch differential set at 138 kPa 20 psi differential. Tank shall be provided with an automatic condensate drain trap with a manual override feature.

2.16.2 Compressed Air Station Specialties

a. Pressure regulator and refrigerated air dryer shall be provided in the air outlet line of the air storage tank. Dryer shall be sized for full air delivery capacity of compressor. Air shall be dried at a pressure of not less than 483 kPa (gage) 70 psig to a temperature not greater than 2 degrees C 35 degrees F. Dryer shall be provided with an automatic condensate drain trap with a manual override feature.

b. Two parallel combination dirt and coalescing type oil filters with shutoff valves and pressure regulators shall be provided in the dryer discharge. Air filtration system shall be rated for full delivery capacity of compressor. Filter shall be 100 percent efficient for particle diameters down to 0.3 microns. Filter bowl shall be rated for 1034 kPa (gage) 150 psig maximum working pressure. One of the filters shall serve as a standby. Pressure regulator and safety valve shall be provided downstream of the filter.

c. Flexible pipe connectors shall be designed for 1034 kPa (gage) and 121 degrees C 150 psi and 250 degrees F service, and shall be constructed of rubber, tetrafluoroethylene resin, or braided corrosion-resistant steel, bronze, monel, or galvanized steel. Connectors shall be suitable for service intended and may have threaded or soldered ends. Length of connectors shall be as recommended by the manufacturer for service intended.

d. Vibration isolation units shall be standard products with published loading ratings, and shall be single rubber-in-shear, double rubber-in-shear, or spring type.

2.17 ELECTRONIC VARIABLE AIR VOLUME VAV TERMINAL UNIT CONTROLS

Provide electronic VAV terminal unit controls.

2.17.1 VAV Terminal Units

****

NOTE: For NAVFAC LANT projects that use the regional specifications, refer to NAVFAC LANT regional specification NFGS 23 73 33.00 22 HEATING, VENTILATING AND COOLING SYSTEMS.

****

VAV terminal units shall be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.17.2 Terminal Unit Controls

a. UL 916 and FCC Part 15. Controls for pressure independent boxes shall consist of a velocity sensing device in the primary air entering box, a room temperature sensing element, a damper actuator, and an adjustable microprocessor-based VAV box controller. Controls shall operate a damper for cooling[and a duct coil for heating]. Actuator shall open or close the device to which it is applied within 6 minutes.

b. Controls for pressure independent boxes with recirculating fans shall consist of a velocity sensing device in the primary air entering the box, a room temperature sensing element, an adjustable microprocessor-based VAV box controller, a damper with actuator, and a duct pressure switch to operate the recirculation fan. Controller shall operate the damper for cooling and the recirculating fan[and duct coil] for heating.

c. One hand-held communication and programming device with an instruction manual, plus one additional hand-held communication device and instruction manual per 100 terminal units, shall be provided. Communication and programming device shall connect directly to the controller or to a jack at the room temperature sensing element location. Communication and programming device shall be used to read and set minimum velocity, maximum velocity, heating setpoint, and cooling setpoint, and to read air velocity and space temperature.

2.18 CONTROL TUBING AND WIRING

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NOTE: This article's title and subparts contain PNEUMATIC tailoring options.

****

Provide HVAC control tubing and wiring.

2.18.1 Tube and Fittings

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

Systems that are critical and required for smoke removal operation shall have tubing of noncombustible material only.

****

2.18.1.1 Copper Tubing

ASTM B75/B75M or ASTM B88M ASTM B88. Tubing 10 mm 0.375 inch outside diameter and larger shall have a minimum wall thickness equal to ASTM B88M ASTM B88, Type M. Tubing less than 10 mm 0.375 inch outside diameter shall have a minimum wall thickness of 0.64 mm 0.025 inch. Concealed tubing shall be hard or soft copper; multiple tubing shall be racked or bundled. Exposed tubing shall be hard copper; rack multiple tubing. Tubing for working pressures greater than 206 kPa (gage) 30 psig shall be hard copper. Bundled tubing shall have each tube numbered each 2.0 meters 6 feet minimum. Racked and individual tubes shall be permanently identified at each end. Fittings shall be solder type ASME B16.18 or ASME B16.22, using ASTM B32, Plumbing Code approved lead-free solder, or compression type ASME B16.26.

2.18.1.2 Polyethylene Tubing

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

If the building has crawl spaces or ceilings with openings to the outside, such as vent louvers, prohibit use of bare polyethylene tubing in these areas.

****

Polyethylene tubing shall be provided only for systems with working pressure of 206 kPa (gage) 30 psig or less. Provide flame-resistant, multiple polyethylene tubing in flame-resistant protective sheath with Mylar barrier, or unsheathed flame-resistant polyethylene tubing in rigid metal, intermediate metal, or electrical metallic tubing conduit for areas where tubing is exposed. Single, unsheathed, flame-resistant polyethylene tubing may be used where concealed in walls or above ceilings and within control panels, except prohibited in crawl spaces, attics, and above-ceiling spaces that are vented to the outdoors. Do not provide polyethylene tubing for[systems indicated as critical and] smoke removal systems. Number each tube in sheathing each 2 feet minimum. Permanently identify unsheathed tubing at each end. Provide compression or barbed push-on type fittings. Extruded seamless polyethylene tubing shall conform to the following:

a. Minimum burst pressure requirements: 690 kPa (gage) at 24 degrees C to 172 kPa (gage) at 66 degrees C 100 psig at 75 degrees F to 25 psig at 150 degrees F.

b. Stress crack resistance: ASTM D1693, 200 hours minimum.

c. Tensile strength (minimum): ASTM D638, 7583 kPa ASTM D638, 1100 psi.

d. Flow rate (average): ASTM D1238, 0.30 decigram per minute.

e. Density (average): ASTM D792, 920 kg/m3 57.5 pounds per cubic feet.

f. Burn rate: ASTM D635.

2.18.2 Wiring

a. Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanisms. Terminal blocks shall be rail mounted, and shall have end plates, partition plates or enclosed sides for separation.

b. Control wiring for 24-V circuits shall be 18 AWG minimum and shall be rated for 300-V service.

c. Wiring for circuits operating at more than 100 V shall be 14 AWG minimum and shall be rated for 600-V service.

d. Analog signal wiring circuits within control panels shall not be less than 20 AWG and shall be rated for 300-V service.

e. Instrumentation cable shall be 18 AWG, stranded copper, single or multiple twisted, minimum 2-inch lay of twist, 100 percent shielded pairs, and shall have 300-V insulation. Each pair shall have a 20-AWG tinned copper drain wire, individual pair, and overall insulation. Cables shall have an overall aluminum polyester or tinned overall copper cable shield tape, 20-AWG tinned-copper cable drain wire, and overall cable insulation.

f. Nonconducting wiring ducts in control panels shall have slotted side snap-on covers, fittings for connecting ducts, mounting clips for securing ducts, and wire retaining clips.

PART 3 EXECUTION

3.1 INSTALLATION

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NOTE: Indicate access doors where required for servicing mounted devices.

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Perform installation under the supervision of competent technicians regularly employed in the installation of control systems. Provide components for a complete and operational control system. Provide control system complete and ready for operation, as specified and indicated. Provide dielectric isolation where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be watertight. Control system installation shall provide adequate clearance for control system maintenance by maintaining access spaces between coils, to mixed-air plenums, and as required to calibrate, remove, repair, or replace control system devices. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance. Install devices mounted in or on piping or ductwork, on building surfaces, in mechanical and electrical spaces, or in occupied space ceilings in accordance with manufacturer's recommendations and as indicated on contract documents. Provide control devices to be installed in piping and ductwork with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Certify that installation of control system is complete and technical requirements of this section have been met.

3.1.1 Sensors

Provide sensors in locations to sense the appropriate condition. Install sensor and transmitter where easily accessible and serviceable without special tools. Sensors shall be calibrated to the accuracy specified in the contract, and operate correctly when installed. Do not install sensors designed for one application in the place of another application (e.g., replacing a duct sensor with a room sensor).

3.1.1.1 Room Sensors

Provide on interior walls to sense average room conditions. Avoid locations which may be covered by office furniture. Do not mount room sensors on exterior walls if other locations are available. Mount centerline of sensor 1-1/2 meters 5 feet above finished floor.

3.1.1.2 Duct Temperature Sensors

Provide sensors in ductwork in general locations as indicated. Select specific sensor location within duct to accurately sense appropriate air temperatures. Locate sensor connection boxes in position not obstructed by ducts or equipment. Install gaskets between sensor housing and duct wall. Seal duct and insulation penetrations. Install duct averaging sensors between two rigid supports in serpentine position to sense average conditions. Sensor shall have a total minimum length of 825 mm per square meter one linear foot per 4 square feet of duct area. Sensor shall be mounted a minimum of 80 mm 3 inches from outside wall surface. Thermally isolate temperature sensing elements from supports. Provide duct access doors to averaging sensors.

3.1.1.3 Immersion Temperature Sensors

****

NOTE: Indicate pipe size increases for thermowells in small diameter piping.

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Provide thermowells for sensors measuring temperatures in liquid applications or pressure vessels. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to effect proper flow across entire area of the well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Temperature sensors shall be installed in thermowells with thermal transmission material to speed the response of temperature measurement. Provide thermowells with sealing nuts to contain thermal transmission material.

3.1.1.4 Strap-on Temperature Sensors

Strap-on temperature sensors, using helical screw stainless steel clamps, shall be permitted on new hot water piping for on-off operation, and for existing hot water piping sizes not greater than 80 mm 3 inches. Clean the pipe to bright metal. Insulate strap-on bulb and pipe after installation. Provide other liquid temperature sensors with thermowells. Provide NEMA 250 Type 4 enclosures for outdoor installations. Provide brushed aluminum or brushed stainless steel enclosures for sensors located in finished spaces.

3.1.1.5 Outside Air Temperature Sensors

Provide outside air temperature sensor on north side of building, away from exhaust hoods, air intakes, and other areas which may affect temperature readings. Install sunshields to protect outside air temperature sensor from direct sunlight.

3.1.1.6 Low-Temperature Protection Thermostats (Freezestats)

Provide thermostat for each [7.5 square meter] [80 square feet] [_____] of coil-face area to sense the temperature at location indicated. Install thermostat sensing element in serpentine pattern.

3.1.2 Thermometers

Provide thermometers which are installed in liquid systems in thermowells with thermal transmitting materials within the well to speed the response of temperature measurement.

3.1.3 Pressure Sensors

3.1.3.1 Duct Static Pressure

Duct static pressure sensor shall be located where indicated on drawings. If no location is indicated, it should be located approximately two-thirds of distance from supply fan to the end of duct with greatest pressure drop.

3.1.3.2 Steam Pressure

Provide snubbers and isolation valves on steam pressure sensing applications.

3.1.4 Pressure Gages

Provide snubbers for gages in piping systems subject to pulsation. Gages for steam service shall have pigtail fittings with cocks. Install pressure gages at locations indicated. Pneumatic output lines shall have pressure gages mounted near the control panel.

3.1.5 Valves

Provide valve with stems upright where possible but with stems not lower than horizontal. Provide positioners where indicated and where necessary to prevent overlap of heating and cooling where one controller operates more than one pneumatic device and to maintain the proper dead band between heating and cooling.

3.1.6 Damper Actuators

Provide damper actuators so that the damper sealing action is smooth and sufficient to maintain leakage at or below specified leakage rate. Multiple actuators operating a common damper shall be connected to a common drive shaft. Provide positioners where indicated and where necessary to prevent overlap of heating and cooling where one controller operates more than one pneumatic device and to maintain the proper dead band between heating and cooling.

3.1.7 Access Doors

Provide access doors in ductwork to service airflow monitoring devices, devices with averaging elements, and low-temperature protection thermostats (freezestats).

3.1.8 Tubing

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NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

a. Provide control system so that pneumatic lines are not exposed to air temperatures below minus 4 degrees C 25 degrees F. Install tubes and tube bundles exposed to view neatly in lines parallel to lines of the building. Route tubing between panels and actuators in mechanical and electrical spaces so that lines are easily traceable. Tubes shall be permanently tagged on both ends with an identifier indicated on shop drawings. Install concealed tubing in finished areas, and install exposed tubing in unfinished areas such as mechanical equipment rooms.

b. Pneumatic lines in mechanical and electrical spaces shall be plastic tubing or copper tubing. Install horizontal and vertical runs of plastic tubes or soft copper tubing in raceways dedicated to tubing. Dedicated raceways shall be supported every 2 meters 6 feet of horizontal run and every 2.44 meter 8 feet for vertical runs. Tubing not installed in raceways shall be hard-drawn copper tubing with sweat fittings and valves, supported every 2 meter 6 feet of horizontal run and every 2.44 meters 8 feet for vertical runs.

c. Tubing for connecting sensing elements and transmitters to liquid and steam lines shall be[copper][Series 300 stainless steel] with[brass compression][stainless steel compression] fittings.

d. Tubing for final connection of sensing elements and transmitters to ductwork shall be plastic with a maximum length of 305 mm 12 inches.

e. Tubing external to mechanical and electrical spaces, where run in plenum ceilings, shall be soft copper with sweat fittings, supported every 2.44 meters 8 feet. Tubing not in plenum spaces shall be soft copper with sweat fittings supported every 2.44 meters 8 feet or shall be plastic tubing in raceways dedicated to tubing.

f. Provide tubing in concrete in rigid conduit. Install tubing in walls containing insulation, fill, or other packing materials in raceways dedicated to tubing.

g. Final connections to actuators shall be plastic tubing, a maximum of 305 mm 12 inches long and unsupported at the actuator.

h. Provide a manual valve at each HVAC control panel to allow shutoff of main air. Pneumatic connections to HVAC control panels shall be made using bulkhead fittings except where bundled tubing is being used.

i. Final connections to HVAC control panel bulkhead fittings shall be exposed tubing approximately 305 mm 12 inches long.

j. Tubing and two insulated copper phone wires for installation checkout may be run in the same conduit. Tubing and electrical power conductors shall not be run in the same conduit. Control circuit conductors, 24 V or less, may be run in the same conduit as polyethylene tubing.

3.1.9 Wiring

a. Provide wiring external to control panels, including low-voltage wiring, in metallic raceways. Install wiring without splices between sensors, transmitters, control devices, and HVAC control panels. Install instrumentation grounding as necessary to prevent ground loops, noise, and surges adversely affecting operation of the system. Tag cables, conductors, and wires at both ends, with identifiers indicated on shop drawings.

b. Other electrical work shall be specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide step-down transformers where control equipment operates at lower than line circuit voltages. Transformers serving individual heating, ventilating, and air-conditioning units shall be fed from fan motor leads, or fed from the nearest distribution panelboard or motor control center, using circuits provided for that purpose.

c. Ground control panels and cabinets as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Grounding of the green ac ground wire at the breaker panel alone is not adequate. Install ground wire from each control panel to adequate building ground.

3.1.10 Foundations and Housekeeping Pads

Provide 80 mm 3 inch high concrete foundations and housekeeping pads for the HVAC control system air compressors.

3.1.11 Compressed Air Stations

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Mount air compressor assembly on vibration eliminators, in accordance with ASME BPVC for tank clearance. Connect air line to the tank with a flexible pipe connector. Install compressed air station specialties with required tubing, including condensate tubing to a floor drain.

3.1.12 Control Drawings

Post laminated copies of as-built control system drawings in each mechanical room.

3.2 ADJUSTMENTS

Calibrate instrumentation and controls, and verify specified accuracy using test equipment traceable to National Institute for Science and Technology (NIST) standards. Adjust controls and equipment to maintain conditions indicated, to perform the functions indicated, and to operate in the sequence specified.

3.3 FIELD QUALITY CONTROL

****

NOTE: Include Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

****

a. Demonstrate compliance of HVAC control systems. Furnish personnel, equipment, instrumentation, and supplies necessary to perform calibration and site testing. Calibrate test equipment in accordance with NIST standards. Ensure that tests are performed or supervised by competent employees of the control system installer or the control system manufacturer regularly employed in testing and calibration of control systems.

b. Testing shall include field tests and the performance verification test. Field tests shall demonstrate proper calibration of instrumentation, input and output devices, and operation of specific equipment. The performance verification test shall ensure proper execution of sequence of operation and proper tuning of control loops.

c. The plan for each phase of field acceptance testing shall be approved in writing before beginning that phase of testing. Furnish written notification of planned testing to Contracting Officer at least 21 days prior to testing. Include proposed test procedures with notification. The Contractor will not be allowed to start testing without written Government approval of test procedures. Test procedures shall consist of detailed instructions for complete testing to prove the performance of heating, ventilating, and air-conditioning system and control system. Include the following tests in test procedures.

d. Submit original copies of data produced, including results of each test procedure, to the Government at the conclusion of each phase of testing. Tests are subject to supervision and approval by Contracting Officer. Do not perform testing during scheduled seasonal off-periods of heating and cooling systems.

3.3.1 Test Reporting

After completion or termination of field tests and again after the performance verification test, identify, determine causes, replace, repair, or calibrate equipment which fails to meet the specification; and deliver a written report to the Government. The report shall document test results, explain in detail the nature of each failure, and corrective action taken. After delivering the performance verification test report, the Contractor shall convene a test review meeting at the job site to present results and recommendations to the Government. As a part of the test review meeting, the Contractor shall demonstrate by performing appropriate portions of field tests or the performance verification test that failures have been corrected. Based on Contractor's report and test review meeting, the Government will determine either the restart point or successful completion of testing. Do not commence required retesting until after receipt of written notification by the Government. At the conclusion of retesting, repeat the assessment.

3.3.2 Contractor's Field Testing

Calibrate field equipment and verify equipment and system operation before system is placed on-line. Include the following tests in field testing.

3.3.2.1 Tubing and Wiring Integrity Tests

****

NOTE: This subpart is tailored for PNEUMATIC and will only be included when the PNEUMATIC tailoring option is selected.

****

Test tubing system pneumatically at 1.5 times the design working pressure for 24 hours. Allowable leakage rate is that which produces a pressure drop 7 kPa (gage) 1 psig in 24 hours with compressed air supply turned off. Test wiring for continuity, ground faults, and open and short circuits.

3.3.2.2 System Inspection

Observe HVAC control system in shutdown condition. Check dampers and valves for proper normal positions. Document positions for the performance verification test report.

3.3.2.3 Calibration Accuracy and Operation of Input Test

Verify correct calibration and operation of input instrument. For each sensor and transmitter, including for temperature, pressure, relative humidity, and dew point inputs, record the reading at the sensor or transmitter location using calibrated test equipment. Record the output reading provided by that sensor or transmitter. Document each of these location and output readings for the performance verification test report. The test equipment shall have been calibrated within one year of the date of use in the field. Test equipment calibration shall be traceable to the measurement standard of the National Institute of Standards and Technology.

3.3.2.4 Operation of Output Test

Check the operation of output to verify correct operation. Operate analog device to minimum range (e.g., 4 mA) and maximum range (e.g., 20 mA), and measure and record actual output values.

3.3.2.5 Actuator Range Adjustment

With the controller, apply a control signal to each actuator and verify that the actuator operates properly from its normal position through to the full range of stroke position. Record actual spring ranges and normal positions for modulating control valves and dampers.

3.3.3 Coordination with HVAC System Balancing

Tune the control system after air and hydronic systems have been balanced, minimum damper positions have been set, and a report has been issued.

3.3.4 Field Test Documentation

Before scheduling the performance verification test, provide field test documentation and written certification of completion to Contracting Officer and the Naval Energy and Environmental Support Activity (NEESA), that the installed system has been calibrated, tested, and is ready to begin the performance verification test. Do not start the performance verification test prior to receiving written permission from the Government.

3.3.5 Performance Verification Test

Conduct the performance verification tests to demonstrate that the control system maintains setpoints and that the control loops are tuned for the correct sequence of operation. Conduct the performance verification test during one week of continuous HVAC and control systems operation and before final acceptance of work. Specifically, the performance verification test shall demonstrate that the HVAC system operates properly through the complete sequence of operation (e.g., seasonal, occupied and unoccupied, warm up), for specified control sequences. Demonstrate proper control system response for abnormal conditions for which there is a specified system or controls response by simulating these conditions. Demonstrate that hardware interlocks and safety devices work as designed. Demonstrate that the control system performs the correct sequence of control.

3.3.6 Opposite Season Test

Repeat the performance verification test during an opposite season to the first performance verification test.

3.4 TRAINING

Provide a qualified instructor to conduct training courses for designated personnel in maintenance and operation of HVAC and control systems. Orientate training to the specific system being installed under the contract. Furnish audiovisual equipment and other training materials and supplies. A training day is defined as 8 hours of classroom or lab instruction, including two 15-minute breaks and excluding lunch time, Monday through Friday, during the daytime shift in effect at the training facility. For guidance, assume that the attendees have a high school education and are familiar with HVAC systems. Submit planned training schedule, agenda, and class materials to the Government at least 45 days prior to training.

3.4.1 Training Course Documentation

Training shall be based on the operation and maintenance manuals and control system training manual. Deliver manuals for each trainee with two additional sets for archiving at the project site. Include an agenda, defined objectives, and a detailed description of subject matter for each lesson.

3.4.2 Operator Training I

The first class shall be taught for a period of 5 consecutive training days at least one month prior to the scheduled performance verification test. The first course shall be taught in a Government-provided facility on base. Training shall be classroom instruction, but have hands-on operation of similar digital controllers. Maximum of [5][_____] personnel shall attend the course. Upon completion of course, each student, using appropriate documentation, shall be able to perform elementary operations, with guidance, and describe general hardware and functionality of the system. Course shall include but not be limited to description of hardware and operation of the system.

3.4.3 Operator Training II

The second course shall be taught in the field, using the operating equipment at project sites for a total of 16 hours of instruction per student, in blocks of 4 hours. Maximum of [5][_____] personnel shall attend the course. Include hands-on training under constant monitoring of instructor. Course content shall duplicate the Operator Training I course as applied to the installed system. Instructor shall determine the level of the password to be issued to each student before each session. Upon completion of the course, students shall be proficient in system operation. Prepare a written report describing the skill level of each student at the end of the course.

3.4.4 Operator Training III

The third course shall be taught in the field, at the project site, for a period of 3 training days no later than 6 months after completion of endurance test. Maximum of [5][_____] personnel shall attend the course.

Course shall be structured to address specific topics that the students need to discuss and to answer questions concerning operation of the system. Upon completion of the course, students shall be proficient in system operation and shall have no unanswered questions regarding operation of the installed system.

3.4.5 System Maintenance Training

Course shall be taught at the project site within one month after completion of endurance test for a period of 2 training days. Maximum of [_____] personnel shall attend the course. Course shall include but not be limited to the following:

a. Physical layout for each piece of hardware

b. Troubleshooting and diagnostics procedures

c. Repair instructions

d. Preventive maintenance procedures and schedule

e. Calibration procedures

3.5 QUALIFIED SERVICE ORGANIZATION LIST

The qualified service organization list shall include names and telephone numbers of organizations qualified to service HVAC control systems.

3.6 COMMISSIONING

****

NOTE: If commissioning procedures are required beyond the scope of those described in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC, include procedures in this paragraph.

****

Commissioning of control systems is specified in the pre-field TAB engineering report described in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 09 93 (November 2015)**

Preparing Activity: USACE **Superseding**
UFGS-23 09 23 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 93

SEQUENCES OF OPERATION FOR HVAC CONTROL

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USACE / NAVFAC / AFCEC **UFGS-23 09 93 (November 2015)**

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SECTION 23 09 93

SEQUENCES OF OPERATION FOR HVAC CONTROL

11/15

****

NOTE: This guide specification covers the requirements for sequences of operation for HVAC control.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: This Section contains only Sequences of Operation and cannot be used stand-alone (without the use of other Sections). This Section is intended to be used with Section 23 09 00.

Template drawings and Points Schedule in electronic format for use with this section are available in online at:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms

****

****

NOTE: The Sequences of Operation in this Section are being updated, and this Section will soon be revised to include the updated sequences.

****

PART 1 GENERAL

1.1 DEFINITIONS

For definitions related to this Section, see Section 23 09 00 INTRUMENTATION AND CONTROL FOR HVAC.

1.2 SUBMITTALS

Submittals related to this Section are specified in Section 23 09 00 INTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

Products related to this Section are specified in Section 23 09 00 INTRUMENTATION AND CONTROL FOR HVAC and related Sections 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC and 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

PART 3 EXECUTION

****

NOTE: These sequences are 'template' sequences. When editing this specification, the sequences should be put onto the drawings and these template sequences should be deleted. Note that the Alarm Handling and Scheduling sequences each need to be edited and placed onto their own drawing.

When removing the sequences, keep this subpart number and title intact, but replace the entire contents of the subpart with a note such as *"All Sequences of Operation are located on drawings"*.

****

3.1 SEQUENCES OF OPERATION FOR OCCUPANCY SCHEDULING

****

NOTE: FYI: Scheduling is normally performed by the Monitoring and Control (M&C) software (Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION. The UMCS (Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION) Contractor will set this up. In the absence of a UMCS or if communication with the UMCS is lost, a default schedule will be active.

The M&C software will have capabilities to perform scheduling according to day of week, holidays, etc and will have the capability to override system occupancy modes based on demand limiting programs or operator overrides.

****

3.1.1 System Mode

Operate air handling units (AHUs) in Occupied, Warm-Up-Cool-Down, or Unoccupied modes as specified. VAV boxes, Fan Coils, and operate other terminal equipment in Occupied or Unoccupied modes as specified. Chillers, boilers, and other sources of heating/cooling for hydronic loads do not require scheduling; these systems receive requests for heating/cooling from their loads.

3.1.2 System Scheduler Requirements

****

NOTE: Indicate if a common schedule may be used for multiple Terminal Units (TUs). If allowing a common schedule for multiple TUs: keep the 'group of' bracketed text, and decide if TU groupings will be included on the drawings (keep the 'as shown' bracketed text) or if the Contractor should decide on groupings (remove the 'as shown' bracketed text).

These sequences include details specific to the LonWorks protocol. When using other protocols, edit sequences accordingly.

****

The System Scheduler functionality must reside in either a piece of DDC Hardware dedicated to this functionality or in the DDC Hardware controlling the system AHU. A single piece of DDC Hardware dedicated to scheduling (performing no other control functionality) may contain multiple System Schedulers. Provide a unique System Scheduler for: each AHU including it's associated Terminal Units, and each stand-alone Terminal Unit (those not dependent upon AHU service)[or group of stand-alone Terminal Units acting according to a common schedule]. Each System Scheduler must provide the following functionality:

3.1.2.1 Scheduled Occupancy Input

Accept network variable of type SNVT_occupancy. Support the following possible values: OC_STANDBY, OC_OCCUPIED and OC_UNOCCUPIED.

3.1.2.2 Occupancy Override Input

Accept network variable of type SNVT_occupancy. Support the following possible values: OC_STANDBY, OC_OCCUPIED, OC_UNOCCUPIED, and OC_NUL.

3.1.2.3 Space Occupancy Inputs

For systems with multiple occupancy sensors, accept multiple inputs of network variable type SNVT_Occupancy. Support the following possible values: OC_OCCUPIED, OC_UNOCCUPIED, and OC_NUL. For systems with a single occupancy sensor, accept a network variable input of type SNVT_Occupancy or a hardware binary input (BI) indicating the space occupancy status as Occupied or Unoccupied.

3.1.2.4 Air Handler Occupancy Output

For a System Scheduler for a system containing an air handler, output one or more SNVTs indicating the desired occupancy status as one of the following possible values: Warm-Up-Cool-Down (when required by the AHU

Sequence of Operation), Occupied and Unoccupied.

3.1.2.5 Terminal Unit Occupancy Output

For a System Scheduler for a stand-alone terminal unit, [a group of stand-alone terminal units acting according to a common schedule,] or a group of terminal units served by a single air handler, output one or more SNVTs indicating the desired occupancy status as one of the following possible values: Occupied and Unoccupied.

3.1.2.6 Default Schedule

****

NOTE: Designer must provide the default (backup) 24-hour 7-day schedule on the Points Schedule (i.e. Occupied from 0600 - 2200 Monday through Friday, Unoccupied Saturday and Sunday).

****

Incorporate a 24-hour 7-day default schedule as shown on the drawings which may be activated and deactivated by the System Scheduler Logic.

3.1.2.7 Communication Determination

Determine the time elapsed between receipts of the scheduled occupancy input SNVT, and use this elapsed time to activate and deactivate the Default Schedule as specified. (This provides the capability for the system scheduler to use its Default Schedule if it loses communication with the UMCS).

3.1.3 System Scheduler Output Determination

For controlling an Air Handler, interpret a SNVT input of OC_STANDBY as Warm-Up-Cool-Down if the sequence of operation supports that mode, otherwise interpret OC_STANDBY as Occupied. For Terminal Units, interpret OC_STANDBY as Occupied.

3.1.3.1 Air Handler Occupancy Output

If more than 95 minutes have passed since the last receipt of the Scheduled Occupancy input, determine the Air Handler Occupancy Output by the default schedule and the Space Occupancy Inputs. Otherwise, determine the output as follows:

a. If the Override Occupancy Input is not OC_NUL, determine the Air Handler Occupancy Output from the Override Occupancy Input.

b. Otherwise, if at least the required number (as shown on the Occupancy Schedule Drawing) of Space Occupancy Inputs are OC_OCCUPIED or the hardware BI is Occupied the Air Handler Occupancy Output must be OC_OCCUPIED.

c. Otherwise, determine the Air Handler Occupancy Output from the Scheduled Occupancy Input SNVT.

3.1.3.2 Terminal Unit Occupancy Output

If more than 95 minutes have passed since the last receipt of the Scheduled Occupancy input, determine the Terminal Unit Occupancy Output by the default schedule. Otherwise, determine the output as follows:

a. If the Override Occupancy Input is not OC_NUL, determine the Terminal Unit Occupancy Output from the Override Occupancy Input SNVT:

b. Otherwise, determine the Terminal Unit Occupancy Output from the Scheduled Occupancy SNVT.

3.1.4 Air Handler System Scheduling

a. Bind the AHU Occupancy Output SNVT from the System Scheduler to the DDC Hardware that executes the Occupancy Mode Determination part of the Air Handler Sequence of Operation

b. For Air Handlers using occupancy sensors, bind the output SNVT (of type SNVT_Occupancy) of each occupancy sensor to a Space Occupancy Input of the System Scheduler.

c. Bind the Terminal Unit Occupancy Output SNVT from the System Scheduler to each AHU-Dependent Terminal Unit.

d. AHU-Dependent Terminal Units with occupancy sensors must have the Effective Occupancy SNVT (of type SNVT_Occupancy) of each Terminal Unit bound to a Space Occupancy Input of the System Scheduler.

3.1.5 Stand-Alone Terminal Unit Scheduling

Bind the Terminal Unit Occupancy Output from the System Scheduler to the DDC Hardware that executes the Occupancy Mode Determination part of the Terminal Unit Sequence of Operation.

3.2 SEQUENCES OF OPERATION FOR AIR HANDLING UNITS

****

NOTE:
1) The following sequences, with few exceptions, assume the use of a System Scheduler and space occupancy input(s) to switch between occupied and unoccupied mode setpoints.

2) Show occupied and unoccupied mode setpoints on the Points Schedule. A configured setpoint is operator adjustable over the control network, but resides in the local DDC Hardware. In these sequences it serves as the default occupied mode setpoint and (at a separate setting/value) as an unoccupied mode 'setback' setpoint.

3) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the 'Thermostat and Occupancy Sensor Schedule'. If a push-button is used, show the override time duration in the Schedule. Note that the occupancy sensor specification requires a delay that is adjustable between 30 seconds and 15 minute. If a delay outside of this range is needed edit the Occupancy Sensor Product specification in PART 2.

4) Occupancy sensor location is left up to the Contractor. If ceiling mount sensors are preferred, edit the sequences and/or indicate in the Thermostat and Occupancy Sensor Schedule.

5) For each unit, as applicable, indicate if the zone temperature setpoint will be occupant adjustable by placing an 'X' in the 'Thermostat and Occupancy Sensor Schedule'. For non-occupant-adjustable setpoints, show the setpoint in the Points Schedule. The intent is that the Contractor provides one or the other as shown. Non-occupant-adjustable setpoints are adjustable by a system operator using a local display panel (LDP) or an operator workstation (and appropriate software).

****

3.2.1 All-Air Small Package Unitary System

****

NOTE: For heating-only or cooling-only systems, edit the sequence as required. Where applicable, select 'Emerg Heat' for heat pump systems.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control must be proportional-integral (PI) control.

3.2.1.1 Fan ON-AUTO Switch

3.2.1.1.1 ON

With the thermostat fan ON-AUTO switch in the ON position, the DDC Hardware must start and continuously run the fan.

3.2.1.1.2 AUTO

With the thermostat fan ON-AUTO switch in the AUTO position, the DDC Hardware operates the fan according to HEAT-OFF-COOL[-EMERG HEAT] switch.

3.2.1.2 HEAT-OFF-COOL[-EMERG HEAT] Switch

3.2.1.2.1 HEAT-COOL[-EMERG HEAT]

With the thermostat switch in the HEAT or COOL [or EMERG HEAT] positions, use the DDC Hardware to operate the package unit according to the Occupancy Mode.

3.2.1.2.2 OFF

With the thermostat switch in the OFF position, de-energize the heating unit and cooling unit [and emergency supplemental heat] with the DDC Hardware.

3.2.1.3 Occupancy Modes

3.2.1.3.1 Occupied

The unit DDC Hardware must be in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

3.2.1.3.2 Unoccupied

The unit DDC Hardware must be in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

3.2.1.4 Safeties

Run the unit subject to the unit manufacturer's safeties.

3.2.1.5 Zone Temperature Control

a. In the Occupied Mode the zone temperature setpoint (ZN-T-SP) must be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as indicated.

b. In the Unoccupied Mode the zone temperature setpoint (ZN-T-SP-UNOCC) must be at the configured setpoint (ZN-T-SP-UNOCC) as indicated.

c. Cycle the fan, cooling unit, heating unit[, and emergency supplemental heat] with the DDC Hardware, in accordance with the HEAT-COOL[-EMERG HEAT] switch setting, to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP).

3.2.2 Heating and Ventilating Unit (or Unit Ventilator)

****

NOTE:
1) A special interlock control sequence for each fan system will be developed by the designer if required.

2) This system has a single outside air duct. Select either 2-position outside air dampers or modulating dampers.

3)Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from two different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

4) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule as required.

5) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

6) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

7) Smoke control is not addressed in this Section. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control must be proportional-integral (PI) control.

3.2.2.1   HAND-OFF-AUTO Switches

Provide supply fan motor starter to accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and starts the fan. Provide fan motor starter which accepts an occupant accessible emergency shutoff switch as indicated. Provide supply fan motor starter with an H-O-A switch:

3.2.2.1.1   HAND

With the H-O-A switch in HAND position, the supply fan starts and runs continuously, subject to Safeties.

3.2.2.1.2 OFF

With the H-O-A switch in OFF position, the supply fan stops.

3.2.2.1.3 AUTO

With the H-O-A switch in AUTO position, the supply fan runs subject to the Supply Fan Start/Stop (SF-SS) command and Safeties.

3.2.2.2 Occupancy Modes

Obtain the system's Occupancy Mode input from the System Scheduler as specified and indicated. Operate the system in one of the following modes:

3.2.2.2.1 Occupied

The Unit's DDC Hardware must be in the Occupied Mode when the input from the System Scheduler (SYS-OCC) is occupied [or when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied].

3.2.2.2.2 Unoccupied

The Unit's DDC Hardware must be in the Unoccupied Mode when the input from the System Scheduler (SYS-OCC) is unoccupied[and when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied].

3.2.2.3 System Enable and Loop Enable

3.2.2.3.1 Occupied Mode

****

NOTE: Include bracketed text (Mixed Air Damper Control) for systems with 2-position dampers.

****

Enabe the supply fan (SYS-ENA) and command to run (SF-SS). Enable the Zone Temperature Control loop [and Mixed Air Damper Control].

3.2.2.3.2 Unoccupied Mode

Disable all control loops. When BLDG-T drops below BLDG-T-LL-SP (with a 3 degrees C 5 degrees F deadband) enable the supply fan (SYS-ENA) and command to run (SF-SS) and enable the Zone Temperature Control loop.

3.2.2.4 Proofs and Safeties

Subject the supply fan and all DDC Hardware control loops to Proofs and Safeties. Direct-hardwire interlock safeties to the fan starter circuit as indicated. DDC Hardware must monitor all proofs and safeties and failure of any proof or activation of any safety must result in all control loops being disabled and the AHU fan being commanded off until reset.

3.2.2.4.1 Proofs

Supply fan status (proof) (SF-S)

3.2.2.4.2 Safeties

a. Heating Coil discharge air temperature low limit (freeze stat)

(HTG-DA-T-LL)

b. Supply air smoke (SA-SMK)

[c. Return air smoke (RA-SMK)]

3.2.2.4.3 DDC Hardware

DDC Hardware reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as indicated on the Points Schedule drawing.

3.2.2.5 Zone Temperature Control

****

NOTE: If the system has modulating dampers, select bracketed damper text in Zone Temperature Control paragraph. Otherwise, select Mixed Air Damper Control.

****

3.2.2.5.1 Enabled Loop

When this loop is enabled, the DDC Hardware must modulate the heating valve [and outside air, relief, and return air dampers in sequence] to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP). [Provide sequencing as indicated: Upon a rise in zone temperature above zone temperature setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as indicated, moculate the outside air, relief, and return air dampers to maintain zone temperature at setpoint. During occupied mode, ensure outside air damper minimum position (OA-D-MIN) is as indicated.] Upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as indicated, modulate the heating valve towards open to maintain zone temperature setpoint.

3.2.2.5.2 Disabled Loop

When this loop is disabled, close the heating valve[and close the outside air damper and relief damper and open the return damper].

[3.2.2.6 Mixed Air Damper Control

When this is enabled, open the outside air and relief air dampers and close the return air damper. When this is disabled, close the outside air and relief air dampers and open the return air damper.

]3.2.3 Single Zone with Heating and [DX]Cooling Coils

****

NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a preheat coil, economizer, and other project specific control loop requirements.

2) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant

volume system.

3) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

4) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from two different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

5) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

6) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

7) Smoke control is not addressed in this Section. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control must be proportional-integral (PI) control.

3.2.3.1 HAND-OFF-AUTO Switch

Provide supply fan motor starter to accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and starts the fan. Provide fan motor starter which accepts an occupant accessible emergency shutoff switch as indicated. Provide supply fan motor starter with an H-O-A switch:

3.2.3.1.1 HAND

With the H-O-A switch in HAND position, the supply fan starts and runs continuously, subject to Safeties.

3.2.3.1.2 OFF

With the H-O-A switch in OFF position, the supply fan stops.

3.2.3.1.3 AUTO

With the H-O-A switch in AUTO position, the supply fan runs subject to the Supply Fan Start/Stop (SF-SS) command and Safeties.

3.2.3.2 Occupancy Modes

Obtain the system's Occupancy Mode input from the System Scheduler as specified and indicated. Operate the system in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

3.2.3.3 System Enable and Loop Enable

3.2.3.3.1 Occupied Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS) and enable all control loops.

3.2.3.3.2 Unoccupied Mode

While the building temperature (BLDG-T) is above the low limit setpoint (BLDG-T-LL) disable all control loops and the supply fan does not run. When BLDG-T drops below BLDG-T-LL (with a 3 degrees C 5 degrees F deadband) enable the supply fan (SYS-ENA) and command to run (SF-SS) and enable the Heating Coil Temperature Control loop. Disable the Outside Air Flow Control, Economizer Damper Control, and [DX] Cooling Coil Control loops.

[3.2.3.3.3 Warm Up / Cool Down Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS) and disable the Minimum Outside Air Flow Control loop. Enable all other control loops.

]3.2.3.4 Proofs and Safeties

The supply fan and all DDC Hardware control loops are subject to Proofs and Safeties. Safeties must be direct-hardwire interlocked to the fan starter circuit as indicated. DDC Hardware must monitor all proofs and safeties and failure of any proof or activation of any safety result in all control loops being disabled and the AHU fan being commanded off until reset.

3.2.3.4.1 Proofs

Supply fan status (proof) (SF-S)

3.2.3.4.2 Safeties

a. Heating coil discharge air temperature low limit (freeze stat) (HTG-DA-T-LL)

b. Supply air smoke (SA-SMK)

c. Return air smoke (RA-SMK)

3.2.3.4.3 DDC Hardware

Provide DDC Hardware reset of all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.2.3.5 Minimum Outside Air Flow Control

When this loop is enabled, open the 2-position minimum outside air damper to introduce the minimum outside air flow quantity as shown. When this loop is disabled, the minimum outside air damper will be closed.

3.2.3.6 Economizer Damper Control

3.2.3.6.1 Enabled Loop

When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, the DDC Hardware will modulate the economizer outside air, relief, and return air dampers (Economizer dampers) in sequence with the [DX] cooling coil control and heating coil control valve as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown.

3.2.3.6.2 Disabled Loop

When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, the economizer outside air and relief air dampers will be closed, and the return air damper will be open.

3.2.3.6.3 Economizer Enable Logic

Ensure the economizer is ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. Otherwise the Economizer is OFF. Ensure ECO-HL-SP and ECO-LL-SP each have a 1 degree C 2 degrees F deadband.

3.2.3.7 Heating Coil Control

When this loop is enabled, modulate the heating coil control valve in sequence with the [DX staging control][cooling coil valve] and economizer dampers as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown. When this loop is disabled, the heating coil control valve is closed.

3.2.3.8 [DX]Cooling Coil Control

When this loop is enabled the DDC Hardware must [stage the DX Unit] [modulate the cooling coil control valve] in sequence with the heating coil valve and economizer dampers as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown. When this loop is disabled, the [DX unit is off] [cooling coil control valve is closed].

3.2.4 Single Zone with Dual-Temperature Coil

****

NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a preheat coil, economizer, and other project specific control loop requirements.

2) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant volume system.

3) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

4) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from two different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

5) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

6) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

7) Smoke control is not addressed in this Section. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control must be proportional-integral (PI) control.

3.2.4.1 HAND-OFF-AUTO Switch

Provide supply fan motor starter to accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and starts the fan. Provide fan motor starter which accepts an occupant accessible emergency shutoff switch as indicated. Provide supply fan motor starter with an H-O-A switch:

3.2.4.1.1 HAND

With the H-O-A switch in HAND position, the supply fan starts and runs continuously, subject to Safeties.

3.2.4.1.2 OFF

With the H-O-A switch in OFF position, the supply fan stops.

3.2.4.1.3 AUTO

With the H-O-A switch in AUTO position, the supply fan runs subject to the Supply Fan Start/Stop (SF-SS) command and Safeties.

3.2.4.2 Occupancy Modes

Obtain Occupancy Mode input from the System Scheduler as specified and shown. Operate the system in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

3.2.4.3 System Enable and Loop Enable

3.2.4.3.1 Occupied Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS) and enable all control loops.

3.2.4.3.2 Unoccupied Mode

While the building temperature (BLDG-T) is above the building low limit setpoint (BLDG-T-LL), disable all control loops and do not run the supply fan. When BLDG-T drops below BLDG-T-LL (with a 3 degrees C 5 degrees F deadband), enable the supply fan (SYS-ENA) and command to run (SF-SS) and enable the Dual Temperature Coil Temperature Control loop. Disable the Minimum Outside Air Flow Control and Economizer Damper Control loops.

[3.2.4.3.3 Warm Up / Cool Down Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Disable the Minimum Outside Air Flow Control loop and enable all other control loops.

]3.2.4.4 Proofs and Safeties

The supply fan and all DDC Hardware control loops are subject to Proofs and Safeties. Direct-hardwire interlock safeties to the fan starter circuit as shown. Monitor all proofs and safeties, and disable all control loops and command the AHU fan off until reset due to failure of any proof or activation of any safety.

3.2.4.4.1 Proofs

Supply fan status (proof) (SF-S)

3.2.4.4.2 Safeties

a. Dual Temperature coil discharge air temperature low limit (freeze stat) (DT-DA-T-LL)

b. Supply air smoke (SA-SMK)

c. Return air smoke (RA-SMK)

3.2.4.4.3 DDC Hardware

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.2.4.5 Minimum Outside Air Flow Control

When this loop is enabled, open the 2-position minimum outside air damper to introduce the minimum outside air flow quantity as shown. When this loop is disabled, close the minimum outside air damper.

3.2.4.6 Economizer Damper Control

3.2.4.6.1 Enabled Loop

When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, modulate the economizer outside air, relief, and return air dampers (Economizer dampers) in sequence with the dual temperature coil to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown.

3.2.4.6.2 Disabled Loop

When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, close the economizer outside air and relief air dampers, and open the return air damper.

3.2.4.6.3 Economizer Enable Logic

Ensure the economizer is ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. Otherwise the Economizer is OFF. Ensure ECO-HL-SP and ECO-LL-SP each have a 1 degree C 2 degrees F deadband.

3.2.4.7 Dual Temperature Coil Control

3.2.4.7.1 Enabled Loop

When this loop is enabled, select heating or cooling mode based on a pipe-mounted dual-temperature supply water sensor. A single sensor may be used for multiple instances of this sequence.

3.2.4.7.2 DDC Hardware

Modulate the coil control valve in sequence with the economizer dampers as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown.

3.2.4.7.3 Disabled Loop

When this loop is disabled, close the control valve.

3.2.5 Single Zone with Heating and Cooling Coils and Return Air Bypass

****

NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a preheat coil, economizer, and other project specific control loop requirements.

2) Coordinate the enable/disable of the cooling coil 2-position valve with the chilled water source. If it is from a local chiller define and share the enabling signal that turns on the chiller and opens the 2-position valve. Do not use a DX unit in place of the chilled water cooling coil.

3) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant volume system.

4) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

5) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from two different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

6) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

7) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

8) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control are proportional-integral (PI) control.

3.2.5.1 HAND-OFF-AUTO Switch

Provide supply fan motor starter to accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and starts the fan. Provide fan motor starter which accepts an occupant accessible emergency shutoff switch as indicated. Provide supply fan motor starter with an H-O-A switch:

3.2.5.1.1 HAND

With the H-O-A switch in HAND position, start the supply fan and run continuously, subject to Safeties.

3.2.5.1.2 OFF

With the H-O-A switch in OFF position, stop the supply fan.

3.2.5.1.3 AUTO

With the H-O-A switch in AUTO position, run the supply fan subject to the Supply Fan Start/Stop (SF-SS) command and Safeties.

3.2.5.2 Occupancy Modes

Obtain the Occupancy Mode input from the System Scheduler as specified and shown. Operate the system in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

3.2.5.3 System Enable and Loop Enable

3.2.5.3.1 Occupied Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS) and enable all control loops.

3.2.5.3.2 Unoccupied Mode

While the building temperature (BLDG-T) is above the low limit setpoint (BLDG-T-LL) disable all control loops and do not run the supply fan. When BLDG-T drops below BLDG-T-LL (with a 3 degrees C 5 degrees F deadband), enable the supply fan (SYS-ENA) and command to run (SF-SS) and enable the Heating Coil Temperature Control loop. Disable all other control loops.

[3.2.5.3.3 Warm Up / Cool Down Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Disable the Minimum Outside Air Flow Control loop and enable all other control loops.

]3.2.5.4 Proofs and Safeties

The supply fan and all DDC Hardware control loops are subject to Proofs and Safeties. Direct-hardwire interlock safeties to the fan starter circuit as shown. Monitor all proofs and safeties and disable all control loops and command the AHU fan off until reset due to failure of any proof or activation of any safety.

3.2.5.4.1 Proofs

Supply fan status (proof) (SF-S)

3.2.5.4.2 Safeties

a. Heating coil discharge air temperature low limit (freezestat)

(HTG-DA-T-LL)

b. Supply air smoke (SA-SMK)

c. Return air smoke (RA-SMK)

3.2.5.4.3 DDC Hardware

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.2.5.5 Minimum Outside Air Flow Control

When this loop is enabled the DDC Hardware, open the 2-position minimum outside air damper to introduce the minimum outside air flow quantity as shown. When this loop is disabled, close the minimum outside air damper.

3.2.5.6 Economizer Damper Control

3.2.5.6.1 Enabled Loop

When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, modulate the economizer outside air, return air, and relief air dampers (Economizer dampers) in sequence with the bypass and supply dampers and the heating coil control valve as shown to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown.

3.2.5.6.2 Disabled Loop

When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, close the economizer outside air and relief air dampers, and open the return air damper.

3.2.5.6.3 Economizer Enable Logic

Ensure the economizer is ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. Otherwise the Economizer is OFF. Ensure ECO-HL-SP and ECO-LL-SP each have a 1 degree C 2 degrees F deadband.

3.2.5.7 Temperature Control Loop Heating Coil Control

When this loop is enabled, modulate the heating coil control valve, modulate the economizer dampers if enabled, open and close the 2-position cooling coil valve and modulate the bypass and supply air dampers in sequence to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown. When this loop is disabled, close both valves and position the bypass and supply air dampers to bypass air.

3.2.6 Single Zone with Humidity Control

****

NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a preheat coil and other project specific control loop requirements.

2) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

3) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from 2 different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

3) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

4) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

5) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

****

Install DDC hardware to perform this Sequence of Operation and to provide

SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control are proportional-integral (PI) control.

3.2.6.1 HAND-OFF-AUTO Switch

Provide supply fan motor starter to accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and starts the fan. Provide fan motor starter which accepts an occupant accessible emergency shutoff switch as indicated. Provide supply fan motor starter with an H-O-A switch:

3.2.6.1.1 HAND

With the H-O-A switch in HAND position, start the supply fan and run continuously, subject to Safeties.

3.2.6.1.2 OFF

With the H-O-A switch in OFF position, stop the supply fan.

3.2.6.1.3 AUTO

With the H-O-A switch in AUTO position, run the supply fan subject to the Supply Fan Start/Stop (SF-SS)command and Safeties.

3.2.6.2 Occupancy Modes

Obtain Occupancy Mode input from the System Scheduler as specified and shown. Operate the system in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

3.2.6.3 System Enable and Loop Enable

3.2.6.3.1 Occupied Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS) and enable all control loops.

3.2.6.3.2 Unoccupied Mode

While the building temperature (BLDG-T) is above the low limit setpoint (BLDG-T-LL), disable all control loops and do not run the supply fan. When BLDG-T drops below BLDG-T-LL (with a 3 degrees C 5 degrees F deadband), enable the supply fan (SYS-ENA) and command to run (SF-SS), enable the Preheat Coil Control loop and Reheat Coil Control loop and disable all other loops.

[3.2.6.3.3 Warm Up / Cool Down Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Disable the Minimum Outside Air Flow Control loop and enable all other control loops.

]3.2.6.4 Proofs and Safeties

The supply fan and all DDC Hardware control loops are subject to Proofs and Safeties. Direct-hardwire interlock safeties to the fan starter circuit as shown. Monitor all proofs and safeties and disable all control loops and command the AHU fan off until reset due to failure of any proof or activation of any safety.

3.2.6.4.1 Proofs

Supply fan status (proof) (SF-S)

3.2.6.4.2 Safeties

a. Preheat coil discharge air temperature low limit (freezestat) (PH-DA-T-LL)

b. Supply air smoke (SA-SMK)

c. Return air smoke (RA-SMK)

3.2.6.4.3 DDC Hardware

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where both reset functions are provided and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.2.6.5 Minimum Outside Air Flow Control

When this loop is enabled, open the 2-position minimum outside air damper to introduce the minimum outside air flow quantity as shown. When this loop is disabled, close the minimum outside air damper.

3.2.6.6 Preheat Coil Control Loop

When this loop is enabled, modulate the preheat coil valve to maintain the preheat coil discharge air temperature (PH-DA-T) at setpoint (PH-DA-T-SP) as shown. When this loop is disabled, close the preheat coil valve.

3.2.6.7 Cooling-and-Dehumidification Coil Control

When this loop is enabled, modulate the cooling and dehumidification valve to maintain either the zone temperature (ZN-T) at setpoint (ZN-T-SP) or zone relative humidity (ZN-RH) at setpoint (ZN-RH-SP), whichever calls for more chilled water flow. Modulate the valve in sequence with the reheat valve and humidification valve as shown to avoid simultaneous cooling and reheating, and simultaneous dehumidification and humidification. When this loop is disabled, close the coil valve.

3.2.6.8 Reheat Coil Control

When this loop is enabled, modulate the reheat coil valve to maintain the zone temperature (ZN-T) at setpoint (ZN-T-SP) as shown. Modulate the valve in sequence with the cooling-and-dehumidification valve as shown to avoid simultaneous cooling and reheating. When this loop is disabled, close the coil valve.

3.2.6.9 Humidification Control

When this loop is enabled, modulate the humidifier valve to maintain zone relative humidity (ZN-RH) at setpoint (ZN-RH-SP). Modulate the valve in sequence with the cooling-and-dehumidification valve as shown to avoid simultaneous dehumidification and humidification. When the supply air duct humidity (SA-RH) rises above 80 percent relative humidity, begin modulating the humidifier valve towards closed and continue to gradually move towards closed until the supply air duct humidity reaches 90 percent relative humidity, at which point the humidifier valve is fully closed. When this loop is disabled, close the humidifier valve.

3.2.7 Multizone [Dual-Duct] [with][without] Return Fan

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NOTE:
1) The sequence is identical for a Dual-Duct system. You need only change hot/cold deck to hot/cold duct.

2) Edit the sequence and drawings as necessary for systems with/without a return fan, preheat coil, economizer, and other project specific control loop requirements.

3) Choose whether or not to require setpoint reset of the hot deck temperature setpoint, and whether the reset should be based on Outside Air Temperature or Coldest Zone Temperature. Edit the control schematic drawing to show the reset parameters.

4) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant volume system.

5) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

6) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from 2 different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

7) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

8) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

9) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

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Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control are proportional-integral (PI) control.

3.2.7.1 HAND-OFF-AUTO switches and Fire Alarm Panel (FAP) Signal:

Supply Fan VFD. Provide supply fan motor starter to accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and starts the fan. Provide fan motor starter which accepts an occupant accessible emergency shutoff switch as shown. Provide supply fan motor starter with an H-O-A switch:

3.2.7.1.1 HAND

With the H-O-A switch in HAND position, the supply fan starts and runs continuously, subject to Safeties.

3.2.7.1.2 OFF

With the H-O-A switch in OFF position, the supply fan stops.

3.2.7.1.3 AUTO

With the H-O-A switch in AUTO position, the supply fan runs subject to the Supply Fan Start/Stop (SF-SS)command and Safeties.

[3.2.7.2 Return Fan VFD

Incorporate an integral H-O-A switch, manual speed adjustment and also accept a Fire Alarm Panel (FAP) signal. Run the return fan according to the following inputs (in order of decreasing priority):

a. Use FAP signal to cause the RF to run at 100 percent

b. Connect SF-S (proof) to the RF VFD safety circuit such that if SF is not running, RF is off.

c. Use RF H-O-A switch to select RF mode as follows:

    (1) When switch is in Hand, run fan. Ensure fan speed is under manual control.

    (2) When switch is in Off, fan is off.

    (3) When switch is in Auto, run fan. Ensure fan speed is under control of the DDC Hardware.

]3.2.7.3 Occupancy Modes

Obtain Occupancy Mode input from the System Scheduler as specified and shown. Operate the system in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

3.2.7.4 System Enable and Loop Enable

3.2.7.4.1 Occupied Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Enable all control loops. Also enable the Zone Temperature Control loops serviced by the AHU.

3.2.7.4.2 Unoccupied Mode

While the building temperature (BLDG-T) is above the low limit setpoint (BLDG-T-LL), disable all control loops and do not run the supply fan. When BLDG-T drops below BLDG-T-LL (with a 3 degrees C 5 degrees F deadband), enable the supply fan (SYS-ENA) and command to run (SF-SS), enable the Hot Deck Coil Control loop and all Zone Temperature Control loops, and disable all other control loops.

[3.2.7.4.3 Warm Up / Cool Down Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Disable the Minimum Outside Air Flow Control loop and enable all other control loops. Also enable the Zone Temperature Control loops serviced by the AHU.

]3.2.7.5 Proofs and Safeties

The supply fan and all DDC Hardware control loops are subject to Proofs and Safeties. Direct-hardwire interlock safeties to the fan starter circuit as shown. Monitor all proofs and safeties and disable all control loops and command the AHU fan off until reset due to failure of any proof or activation of any safety.

3.2.7.5.1 Proofs

a. Supply fan status (proof) (SF-S)[

b. Return fan status (proof) (RF-S)]

3.2.7.5.2 Safeties

a. Mixed air temperature low limit (freeze stat) (MA-T-LL)[

b. Supply air smoke (SA-SMK)][

c. Return air smoke (RA-SMK)]

3.2.7.5.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.2.7.6 Minimum Outside Air Flow Control

When this loop is enabled, open the 2-position minimum outside air damper to introduce the minimum outside air follow quantity as shown. When this loop is disabled, close the minimum outside air damper.

3.2.7.7 Mixed Air Temperature Control With Economizer

3.2.7.7.1 Enabled Loop

When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, modulate the economizer outside air, relief, and return air dampers to maintain the mixed air temperature (MA-T) at setpoint (MA-T-SP) as shown.

3.2.7.7.2 Disabled Loop

When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, close the economizer outside air and relief air dampers, and open the return air damper.

3.2.7.7.3 Economizer Enable Logic

Ensure the economizer is ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. Otherwise the Economizer is OFF. Ensure ECO-HL-SP and ECO-LL-SP each have a 1 degree C 2 degrees F deadband.

3.2.7.8 Hot Deck Coil Control

3.2.7.8.1 Enabled Loop

When this loop is enabled, modulate the hot deck heating coil valve to maintain the hot deck temperature (HD-T) at setpoint (HD-T-SP) as shown. When this loop is disabled, close the hot deck coil valve.

[3.2.7.8.2 DDC Hardware Reset

Reset the hot deck temperature setpoint (HD-T-SP) using a linear reset schedule as shown. Base reset of the setpoint (HD-T-SP) on [Outside Air Temperature] [Coldest Zone Temperature].

]3.2.7.9 Cold Deck Coil Control

When this loop is enabled, modulate the cold deck cooling coil valve to maintain the cold deck temperature (CD-T) at setpoint (CD-T-SP) as shown. When this loop is disabled, close the cold deck cooling coil valve.

3.2.7.10 Zone Temperature Control

When this loop is enabled:

3.2.7.10.1 Zone Temperature Setpoint

Ensure zone temperature setpoint (ZN-T-SP) is at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

3.2.7.10.2 DDC Hardware Modulation

Modulate the hot deck and cold deck dampers to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP).

3.2.8 Multizone with Hot Deck Bypass [with][without] Return Fan

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NOTE:
1) NOTE: Edit the sequence and drawings as necessary for systems with/without a return fan, preheat coil, economizer, and other project specific control loop requirements.

2) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC, but don't use flow measurement in a constant volume system.

3) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

4) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from 2 different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

5) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be performed from a workstation (via SNVT) or local

display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

6) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

7) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer, based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

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Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and indicated on the Points Schedule. Unless otherwise specified, all modulating control must be proportional-integral (PI) control.

3.2.8.1 HAND-OFF-AUTO Switches

Supply fan motor starter must accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches and must start the fan. The fan motor starter must accept an occupant accessible emergency shutoff switch as shown. The supply fan motor starter must have an H-O-A switch:

3.2.8.1.1 HAND

With the H-O-A switch in HAND position, start and continuously run the supply fan, subject to Safeties.

3.2.8.1.2 OFF

With the H-O-A switch in OFF position, stop the supply fan.

3.2.8.1.3 AUTO

With the H-O-A switch in AUTO position, run the supply fan subject to the Supply Fan Start/Stop (SF-SS)command and Safeties.

[3.2.8.2 Return Fan Motor Starter

Return fan motor starter must accept a Fire Alarm Panel (FAP) signal that takes precedence over all other starter inputs and switches must start the fan. The return fan motor starter must have an H-O-A switch:

3.2.8.2.1 HAND

With the H-O-A switch in HAND position, run the return fan subject to Safeties.

3.2.8.2.2 OFF

With the H-O-A switch in OFF position, the return fan must be off.

3.2.8.2.3 AUTO

With the H-O-A switch in AUTO position, run the return fan subject to the supply fan running.

]3.2.8.3 Occupancy Modes

Obtain the system's Occupancy Mode input from the System Scheduler as specified and indicated. Operate the system in one of the following modes: Occupied, Unoccupied[, or WarmUp/CoolDown].

3.2.8.4 System Enable and Loop Enable

3.2.8.4.1 Occupied Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Enable all control loops. Also enable the Zone Temperature Control loops serviced by the AHU.

3.2.8.4.2 Unoccupied Mode

While the building temperature (BLDG-T) is above the low limit setpoint (BLDG-T-LL), disable all control loops and do not run the supply fan. When BLDG-T drops below BLDG-T-LL (with a 3 degrees C 5 degrees F deadband), enable the supply fan (SYS-ENA) and command to run (SF-SS), and enable all Zone Temperature Control loops. Disable the Minimum Outside Air Flow Control, Mixed Air Temperature Control With Economizer, and Cold Deck Coil Control loops.

[3.2.8.4.3 Warm Up / Cool Down Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Disable the Minimum Outside Air Flow Control loop and enable all other control loops. Also enable the Zone Temperature Control loops serviced by the AHU.

]3.2.8.5 Proofs and Safeties

The supply fan[, return fan,] and all DDC Hardware control loops are subject to Proofs and Safeties. Direct-hardwire interlocksafeties to the fan starter circuit as shown. Monitor all proofs and safeties and disable all control loops and command the AHU fan off until reset due to failure of any proof or activation of any safety.

3.2.8.5.1 Proofs

a. Supply fan status (proof) (SF-S)

[b. Return fan status (proof) (RF-S)]

3.2.8.5.2 Safeties

a. Mixed air temperature low limit (freeze stat) (MA-T-LL)

b. Supply air smoke (SA-SMK)

[c. Return air smoke (RA-SMK)]

3.2.8.5.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.2.8.6 Minimum Outside Air Flow Control

When this loop is enabled, open the 2-position minimum outside air damper to introduce the minimum outside air follow quantity as shown. When this loop is disabled, close the minimum outside air damper.

3.2.8.7 Mixed Air Temperature Control With Economizer

3.2.8.7.1 Enabled Loop

When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, modulate the economizer outside air, relief, and return air dampers to maintain the mixed air temperature (MA-T) at setpoint (MA-T-SP) as shown.

3.2.8.7.2 Disabled Loop

When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, close the economizer outside air and relief air dampers, and open the return air damper.

3.2.8.7.3 Economizer Enable Logic

Ensure the economizer is ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. Otherwise the Economizer is OFF. Ensure ECO-HL-SP and ECO-LL-SP each have a 1 degree C 2 degrees F deadband.

3.2.8.8 Cold Deck Coil Control

When this loop is enabled, modulate the cooling coil valve to maintain the cold deck supply air temperature (SA-T) at setpoint (SA-T-SP) as shown. When this loop is disabled, close the cooling coil valve.

3.2.8.9 Zone Temperature Control

a. Ensure the zone temperature setpoint (ZN-T-SP) is at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

b. Modulate the zone bypass and cold deck dampers, and the zone heating coil valve to maintain zone temperature (ZN-T) at setpoint (ZN-T-SP). Perform sequencing as shown: Upon a rise in zone temperature above zone temperature setpoint, subject to the zone temperature setpoint deadband as shown, modulate the zone cold deck damper towards open as the bypass deck damper modulates towards closed. Upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as shown, ensure the bypass damper is fully opened and the zone heating valve modulates towards open.

c. For systems with electric resistance heating elements, require proof of air flow before activating the heating elements.

3.2.9 Variable Air Volume System [with][without] Return Fan

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NOTE:
1) Edit the sequence and drawings as necessary for systems with/without a return fan, preheat coil, economizer, and other project specific control loop requirements.

2) Minimum outside air flow control can be accomplished several different ways. Refer to the UFC.

3) The inclusion of filter pressure switches should be coordinated with the local O&M staff. Pressure switches may not be desired/needed, particularly if filters are replaced on a regular schedule. Edit the Points Schedule and Control Schematic as required.

4) This spec does not include a variable frequency drive (VFD) specification. Specify a VFD that meets the requirements of the control sequence including the integral H-O-A and a safety shutdown input circuit that is separate from the start/stop input circuit and Fire Alarm Panel (FAP) override switch.

5) Indicate the System Scheduler and M&C Software Occupancy Schedule on the Occupancy Schedule drawing. The designer needs to coordinate System Scheduler (occupancy mode determination) with space occupancy sensor input and pushbutton override switch input use. As described in the System Scheduler sequence, 'occupied' inputs from 2 different spaces are required to help avoid needless turning on of the system (due to cleaning staff or security staff passing through after hours).

6) Absence of fan proof(s) or activation of any safety will result in system shutdown. The system remains shutdown until manually reset devices are reset and a manual reset button (RST-BUT), local to the DDC controller, is pressed. Reset could also be

performed from a workstation (via SNVT) or local display panel (LDP). It is recommended that you coordinate the decision with the local O&M staff. Edit the Control Logic Diagram and Points Schedule to indicate which reset method is to to be provided by the Contractor.

7) The hardware (product) specification requires that the low limit (freezestat) device include a manual reset at the device. In the event of shutdown due to freeze stat trip the system will remain shutdown until the device is reset and a separate DDC reset, as described above, is also used.

8) Smoke control is not addressed in this guide specification. Smoke control sequence of operation for each fan system, if beyond the requirements described, will be developed by the designer based on the requirements and parameters of the project. The designer will account for operation of dampers and fans for pressurization and manual override of interlocks to the fire alarm system. All automatic overrides of normal HVAC control sequences will be activated through the fire protection and smoke control interface panel that the designer will design for the project. With the present control sequence, in the event of shutdown due to smoke detector input the system will remain shutdown until the smoke detector is reset and a separate DDC reset, as described above, is also used. The Fire Alarm Panel (FAP) input takes precedence over any DDC input to force the fan(s) to run.

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Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.2.9.1   HAND-OFF-AUTO Switches

Provide supply fan variable frequency drive (VFD) unit to accept a Fire Alarm Panel (FAP) signal that takes precedence over all other VFD inputs and switches and causes the VFD to run at 100 percent speed. Provide VFD that accepts an occupant accessible emergency shutoff switch as shown. Provide supply fan variable frequency drive (VFD) unit with an integral H-O-A switch:

3.2.9.1.1   HAND

With the H-O-A switch in HAND position, start the supply fan and run continuously, subject to Safeties. Ensure fan speed is under manual-operator control.

3.2.9.1.2   OFF

With the H-O-A switch in OFF position, stop the supply fan.

3.2.9.1.3 AUTO

With the H-O-A switch in AUTO position, run the supply fan subject to the Supply Fan Start/Stop Signal (SF-SS) and Safeties. Ensure fan speed is under control of the DDC Hardware.

[3.2.9.2 Return Fan Variable Frequency Drive

Provide return fan variable frequency drive (VFD) unit that accepts a Fire Alarm Panel (FAP) signal that takes precedence over all other VFD inputs and switches and causes the VFD to run at 100 percent speed. Provide return fan variable frequency drive (VFD) unit with an integral H-O-A switch:

3.2.9.2.1 HAND

With the H-O-A switch in HAND position, run the return fan subject to Safeties. Ensure fan speed is under manual-operator control.

3.2.9.2.2 OFF

With the H-O-A switch in OFF position, the return fan is off.

3.2.9.2.3 AUTO

With the H-O-A switch in AUTO position, run the return fan subject to the supply fan running. Ensure fan speed is under control of the DDC Hardware.

]3.2.9.3 Occupancy Modes

Obtain Occupancy Mode input from the System Scheduler as specified and shown. Operate the system in one of the following modes: Occupied, Unoccupied[, or Warm Up/Cool Down].

3.2.9.4 Proofs and Safeties

The supply fan[, return fan,] and all DDC Hardware control loops are subject to Proofs and Safeties. Direct-hardwire interlock safeties to the VFD as shown. Monitor all proofs and safeties and disable all control loops and command the AHU fan off until reset due to failure of any proof or activation of any safety.

3.2.9.4.1 Proofs

a. Supply fan status (SF-S)

[b. Return fan status (RF-S)]

3.2.9.4.2 Safeties

a. Preheat coil discharge air temperature low limit (freezestat) (PH-DA-T-LL) for systems with a preheat coil. Cooling coil discharge air temperature low limit (freezestat) (CLG-DA-T-LL) for all other systems

b. Supply air duct pressure high limit (SA-P-HL)

c. Supply air smoke (SA-SMK)

d. Return air smoke (RA-SMK)

3.2.9.4.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.2.9.5 System Enable and Loop Enable

3.2.9.5.1 Occupied Mode

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Enable all control loops.

3.2.9.5.2 Unoccupied Mode

While the building temperature (BLDG-T) is above the low limit setpoint (BLDG-T-LL) disable all control loops and do not run the supply fan. When BLDG-T drops below BLDG-T-LL (with a 3 degrees C 5 degrees F deadband), enable the supply fan (SYS-ENA) and command to run (SF-SS), enable the Supply Duct Static Pressure Control[, Return Fan Volume Control][, Preheat Control] loops. Disable the Minimum Outside Air Flow Control, Mixed Air Temperature Control, and Cooling Coil Control loops.

[3.2.9.5.3 Warm Up/Cool Down

Enable the supply fan (SYS-ENA) and command to run (SF-SS). Disable the Minimum Outside Air Flow Control loop and enable all other control loops.

]3.2.9.6 Fan Capacity Control

3.2.9.6.1 Supply Duct Static Pressure Control

When this loop is enabled, modulate the supply fan variable frequency drive unit to maintain the duct static pressure (SA-P) at setpoint (SA-P-SP) as shown, as measured by the duct static pressure tap and sensor as shown. When this loop is disabled, ensure the DDC Hardware capacity modulation output to the VFD is zero percent.

[3.2.9.6.2 Return Fan Volume Control

When this loop is enabled, modulate the return fan variable frequency drive unit to maintain a constant volumetric airflow difference at setpoint (F-DIFF-SP) as shown, as measured by the airflow measurement arrays located in the supply and return ducts as shown. When this loop is disabled, ensure the output to the VFD is zero percent.

]3.2.9.7 Minimum Outside Air Flow Control

When this loop is enabled, modulate the minimum outside air damper to maintain the minimum OA volumetric flow (MINOA-F) at setpoint (MINOA-F-SP) as shown. When this loop is disabled, close the minimum outside air damper.

3.2.9.8 Mixed Air Temperature Control With Economizer

3.2.9.8.1 Enabled Loop

When this loop is enabled, and the Economizer is ON as determined by the Economizer Enable Logic, modulate the economizer outside air, relief, and return air dampers to maintain the mixed air temperature (MA-T) at setpoint (MA-T-SP) as shown.

3.2.9.8.2 Disabled Loop

When this loop is disabled, or the Economizer is OFF as determined by the Economizer Enable Logic, close the economizer outside air and relief air dampers, and open the return air damper.

3.2.9.8.3 Economizer Enable Logic

Ensure the economizer is ON when the outside air dry bulb temperature is between the high limit (ECO-HL-SP) and low limit (ECO-LL-SP) setpoints as shown. Otherwise the Economizer is OFF. Ensure ECO-HL-SP and ECO-LL-SP each have a 1 degree C 2 degrees F deadband.

3.2.9.9 Cooling Coil Control

When this loop is enabled, modulate the cooling coil valve to maintain the supply air temperature (SA-T) setpoint (SA-T-SP) as shown. When this loop is disabled, close the cooling coil valve.

[3.2.9.10 Preheat Coil Control

When this loop is enabled, modulate the preheat coil valve to maintain the preheat coil discharge air temperature (PH-DA-T) at setpoint (PH-DA-T-SP) as shown. When this loop is disabled, close the preheat coil valve.

]3.3 SEQUENCES OF OPERATION FOR TERMINAL UNITS

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NOTE: For the VAV Box Sequences:
1) Show the occupancy schedule (days/times) on the Occupancy Schedule drawing. For simplicity, it is recommended that all boxes, served by a common air handler, operate on the same schedule.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the 'Thermostat and Occupancy Sensor Schedule'. If a push-button is used, show the override time duration in the Schedule. Note that the occupancy sensor specification requires a delay that is adjustable between 30 seconds and 15 minutes. If a delay outside of this range is needed edit the Occupancy Sensor Product specification in PART 2

3) For each VAV box thermostat, indicate if the zone temperature setpoint will be occupant adjustable by placing an 'X' in the 'Thermostat and Occupancy Sensor Schedule'. For non-occupant-adjustable

setpoints, show the setpoint in the Points Schedule. The intent is that the Contractor provides one or the other as shown. Non-occupant-adjustable setpoints are adjustable by a system operator using a local display panel (LDP) or operator workstation (and appropriate software).
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3.3.1 Zone Temperature Control - Cooling-Only VAV Box

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.1.1 Occupancy Modes

3.3.1.1.1 Occupied

Ensure the VAV box DDC Hardware is in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

3.3.1.1.2 Unoccupied

The VAV box DDC Hardware must be in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

Safeties

This system has no safeties.

3.3.1.2 Zone Temperature Control

3.3.1.2.1 Occupied Mode

In the Occupied Mode the zone temperature setpoint (ZN-T-SP) must be at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown. The DDC Hardware must modulate the VAV box damper to maintain VAV box supply air flow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box. Sequenceas indicated: Upon a rise in zone temperature (ZN-T) above zone setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as indicated, adjust the airflow setpoint between minimum and maximum flow based on the difference between zone temperature and zone temperature setpoint as indicated.

3.3.1.2.2 Unoccupied Mode

In the Unoccupied Mode, ensure the VAV box damper is at its minimum position.

3.3.2 Zone Temperature Control - VAV Box with Reheat

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.2.1 Occupancy Modes

3.3.2.1.1 Occupied

Ensure the VAV box DDC Hardware is in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

3.3.2.1.2 Unoccupied

Ensure the VAV box DDC Hardware is in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

3.3.2.2 Safeties

For VAV boxes with electric resistance heating elements, require proof of air flow before activating the heating elements.

3.3.2.3 Zone Temperature Control

a. In the Occupied Mode, ensure the zone temperature setpoint (ZN-T-SP) is at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

b. In the Unoccupied Mode, ensure the zone temperature setpoint (ZN-T-SP) is at the configured setpoint as shown.

c. Modulate the VAV box damper to maintain VAV box supply air flow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box. Perform sequencing as shown: Upon a rise in zone temperature above zone temperature setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as shown, adjust the airflow setpointbetween minimum and maximum flow based on the difference between zone temperature and zone temperature setpoint as shown. Upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as shown, maintain the airflow at a fixed air flow setpoint (with a setting independent of the cooling minimum air flow), and modulate the heating valve towards open or cicle the staged electric resistance heating coil(s) on in sequence.

3.3.3 Zone Temperature Control - Fan Powered VAV Box

****

NOTE: This sequence is applicable to both Series and Parallel fan powered VAV boxes.

As specified in Section 23 30 00 HVAC AIR DISTRIBUTION, fans located in series fan-powered VAV boxes must start whenever the AHU fan that serves these boxes is started.

Select appropriate fan control text for series or parallel application. Note that since an unoccupied AHU cannot run except to provide heating, unoccupied zone temperature setpoint deadband should be large enough to prevent an unoccupied VAV from attempting to provide cooling.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.3.1 Occupancy Modes

3.3.3.1.1 Occupied

Ensure the VAV box DDC Hardware is in the Occupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is occupied or when the input from the System Scheduler (SYS-OCC) is occupied.

3.3.3.1.2 Unoccupied

Ensure the VAV box DDC Hardware is in the Unoccupied Mode when the local space occupancy input(s) (ZN-OCC) indicate that the space is unoccupied and the input from the System Scheduler (SYS-OCC) is unoccupied.

3.3.3.2 Safeties

For VAV boxes with electric resistance heating elements, require proof of air flow before activating the heating elements.

3.3.3.3 Fan Control

[Run series fans whenever the box is occupied or the Zone Temperature Control loop determines that the box is in heating mode. Prior to starting the fan, close the supply damper. Pause the controller after closing the damper before starting the fan to ensure that the fan is not spinning due to supply air delivered by the AHU. After the fan starts, control the supply damper by the Zone Temperature Control loop.][Run parallel fans whenever the Zone Temperature Control loop determines that the box is in heating mode.]

3.3.3.4 Zone Temperature Control

3.3.3.4.1 Occupied Mode

In the Occupied Mode, ensure the zone temperature setpoint (ZN-T-SP) is at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

3.3.3.4.2 Unoccupied Mode

In the Unoccupied Mode, ensure the zone temperature setpoint (ZN-T-SP)is at the configured setpoint as shown.

3.3.3.4.3 Sequencing

3.3.3.4.3.1 Cooling Mode

Upon a rise in zone temperature above zone temperature setpoint (ZN-T-SP), subject to the zone temperature setpoint deadband as shown, adjust the airflow setpoint between minimum and maximum based on the difference between zone temperature and zone temperature setpoint as shown. Modulate the VAV box damper to mix supply and plenum return air as it maintains VAV box supply airflow (VAV-SA-F) at setpoint as measured by a multi-point flow sensing element at the inlet to the VAV box.

3.3.3.4.3.2 Heating Mode

Upon a fall in zone temperature below zone temperature setpoint, subject to the deadband as shown, the DDC Hardware must[first turn on the parallel fan and then] modulate the VAV box damper to mix supply and plenum return air to maintain a fixed air flow setpoint (with a setting independent of the cooling minimum air flow), and modulate the heating valve towards open or cycle the staged electric resistance heating coil(s) on in sequence.

3.3.4 Perimeter Radiation Control Sequence

****

NOTE:
1) Show the occupancy schedule (days/times) on the Occupancy Schedule drawing. For simplicity, it is recommended that all units operate on the same schedule.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the Thermostat Schedule. If a push-button is used, show the override time duration in the Schedule. Note that the occupancy sensor specification requires a delay that is adjustable between 30 seconds and 15 minutes. If a delay outside of this range is needed edit the Occupancy Sensor Product specification in PART 2

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.4.1 Occupancy Modes

3.3.4.1.1 Occupied

Ensure the radiator DDC Hardware is in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

3.3.4.1.2 Unoccupied

Ensure the radiator DDC Hardware is in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

3.3.4.2 Safeties

This system has no safeties.

3.3.4.3 Space Temperature Control

3.3.4.3.1 Occupieed Mode

In the Occupied Mode, modulate the heating control valve to maintain space temperature at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

3.3.4.3.2 Unoccupied Mode

In the Unoccupied Mode, modulate the heating control valve to maintain space temperature at the configured setpoint as shown.

3.3.5 Unit Heater and Cabinet Unit Heater

****

NOTE:
1) Show the occupancy schedule (days/times) on the Occupancy Schedule drawing. For simplicity, it is recommended that all units operate on the same schedule.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the Thermostat Schedule. If a push-button is used, show the override time duration in the Schedule. Note that the occupancy sensor specification requires a delay that is adjustable between 30 seconds and 15 minute. If a delay outside of this range is needed edit the Occupancy Sensor Product specification in PART 2

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.5.1 Off-Auto Switch

3.3.5.1.1 OFF

With the thermostat OFF-AUTO switch in the OFF position, stop the fan and close the heating control valve.

3.3.5.1.2 AUTO

With the thermostat OFF-AUTO switch in the AUTO position, control the unit in accordance with its Occupancy Mode.

3.3.5.2 Occupancy Modes

3.3.5.2.1 Occupied

Ensure the unit heater DDC Hardware is in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

3.3.5.2.2 Unoccupied

Ensure the unit heater DDC Hardware is in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

3.3.5.3 Safeties

Run the unit subject to the unit manufacturer's safeties.

3.3.5.4 Space Temperature Control

3.3.5.4.1 Occupied Mode

In the Occupied Mode, modulate the heating control valve and cycle the multi-speed fan to maintain space temperature at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as shown.

3.3.5.4.2 Unoccupied Mode

In the Unoccupied Mode, modulate the heating control valve and cycle the multi-speed fan to maintain space temperature at the configured setpoint as shown.

3.3.6 Gas-Fired Infrared Heater

****

NOTE:
1) Use of a System Scheduler is likely not needed in this application. If it is, edit the sequence and the drawings.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the Thermostat Schedule. If a push-button is used, show the override time duration in the Schedule. Note that the occupancy sensor specification requires a delay that is adjustable between 30 seconds and 15 minute. If a delay outside of this range is needed edit the Occupancy Sensor Product specification in PART 2

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.6.1 On-Off-Auto Switch

3.3.6.1.1 ON

With the thermostat ON-OFF-AUTO switch in the ON position, energize the heater and run the heater continuously.

3.3.6.1.2 OFF

With the thermostat ON-OFF-AUTO switch in the OFF position, de-energize the heater.

3.3.6.1.3 AUTO

With the thermostat ON-OFF-AUTO switch in the AUTO position, control the heater in accordance with its Occupancy Mode.

3.3.6.2 Occupancy Modes

3.3.6.2.1 Occupied

Ensure the unit DDC Hardware is in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied.

3.3.6.2.2 Unoccupied

Ensure the unit DDC Hardware is in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied.

3.3.6.3 Safeties

Run the heater subject to the unit manufacturer's safeties.

3.3.6.4 Space Temperature Control

3.3.6.4.1 Occupied Mode

In the Occupied Mode, operate the heater to maintain space temperature at the configured setpoint or at the occupant-adjustable setpoint via the wall-mounted thermostat, as indicated.

3.3.6.4.2 Unoccupied Mode

In the Unoccupied Mode, operate the heater to maintain space setpoint at the configured unoccupied setpoint as indicated.

3.3.7 Dual Temperature Fan-Coil Unit

****

NOTE:
1) Show the occupancy schedule (days/times) on the Occupancy Schedule drawing. For simplicity, it is recommended that all units operate on the same schedule.

2) Space occupancy input(s) may consist of an occupancy sensor and/or a local push-button. Indicate the use of a sensor and/or push-button by placing an 'X' in the Thermostat Schedule. If a push-button is used, show the override time duration in the Schedule. Note that the occupancy sensor specification requires a delay that is adjustable between 30 seconds and 15 minute. If a delay outside of this range is needed edit the Occupancy Sensor Product specification in PART 2

3) Show 2-way and 3-way valve selections on the Valve Schedule.

4) Fan coil units typically have unit-mounted thermostats. Indicate if wall mounting is desired and/or show in the Thermostat Schedule for the individual fan coil units.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.3.7.1 Off-Auto Switch

3.3.7.1.1 OFF

With the thermostat OFF-AUTO switch in the OFF position, stop the fan and close the dual-temperature control valve.

3.3.7.1.2 AUTO

With the thermostat OFF-AUTO switch in the AUTO position, control the unit in accordance with its Occupancy Mode.

3.3.7.2 Occupancy Modes

3.3.7.2.1 Occupied

Ensure the unit DDC Hardware is in the Occupied Mode when the local space occupancy input(s) indicate that the space is occupied or when the input from the System Scheduler is occupied.

3.3.7.2.2 Unoccupied

Ensure the unit DDC Hardware is in the Unoccupied Mode when the local space occupancy input(s) indicate that the space is unoccupied and when the input from the System Scheduler is unoccupied.

3.3.7.3 Heat/Cool Modes

Automatically switch the fan coil unit DDC Hardware between the heating and cooling modes and the resultant control action, based on a pipe-mounted dual-temperature supply water temperature sensor.

3.3.7.4 Safeties

Run the unit subject to the unit manufacturer's safeties.

3.3.7.5 Space Temperature Control

3.3.7.5.1 Occupied Mode

In the Occupied Mode, modulate the dual-temperature control valve and modulate the multi-speed fan to maintain space temperature at the configured setpoint or at the occupant-adjustable setpoint via the [wall-mounted] thermostat, as indicated.

3.3.7.5.2 Unoccupied Mode

In the Unoccupied Mode, modulate the dual-temperature control valve and modulate the multi-speed fan to maintain space temperature at the configured setpoint as indicated.

3.4 SEQUENCES OF OPERATION FOR HYDRONIC SYSTEMS

3.4.1 Hydronic Heating Hot Water from Distributed [Steam][HTHW] Converter

****

NOTE:
1) Select Steam or High Temperature Hot Water as required.

2) The designer may want to consider other conditions under which this system is enabled, such as outside air temperature.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control must be proportional-integral (PI) control.

3.4.1.1 System Enable and Loop Enable

a. Monitor the enabled status of all systems served by this system. [If [one][two][___] or more systems served by this system are enabled, enable this system (SYS-ENA), otherwise disable this system][___].

b. When this system is enabled (SYS-ENA) command the hot water pump on via the Hot Water Pump Start/Stop (HW-PMP-SS) command.

c. When this system is enabled (SYS-ENA) and the hot water pump is proofed on, enable the Heat Exchanger Control loop.

3.4.1.2 HAND-OFF-AUTO Switch

Provide hot water pump motor starter with an H-O-A switch:

3.4.1.2.1 HAND

With the H-O-A switch in HAND position, the pump starts and runs continuously.

3.4.1.2.2 OFF

With the H-O-A switch in OFF position, the pump stops.

3.4.1.2.3 AUTO

With the H-O-A switch in AUTO position, the pump runs subject to the Hot Water Pump Start/Stop (HW-PMP-SS) command.

3.4.1.3 Proofs and Safeties

DDC Hardware must monitor all proofs and safeties.

3.4.1.3.1 Proofs

Hot water pump status (HW-PMP-S)

3.4.1.3.2 Safeties

None

3.4.1.3.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as indicated on the Points Schedule drawing.

3.4.1.4 Heat Exchanger Valve Control

****

NOTE: If a reset schedule is not required delete this option ([determined from a linear reset schedule]) from the sequence along with the reset schedule in the drawing. Where reset is used, edit the temperatures shown in the reset schedule on the drawing.

****

When this loop is enabled modulate the [steam][high temperature hot water] valve to maintain the Hot Water Supply Temperature (HWS-T) at setpoint (HWS-T-SP). The Hot Water Supply Temperature Setpoint (HW-T-SP) must be [determined from a linear reset schedule] as shown. When this loop is disabled, close the valve.

3.4.2 Hydronic Heating Hot Water From Single-Building Boiler

****

NOTE: The designer may want to consider other conditions under which this system is enabled, such as outside air temperature.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.4.2.1 System Enable and Loop Enable

a. Monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, enable this system (SYS-ENA). If no systems served by this system are enabled, disable this system.

b. When this system is enabled (SYS-ENA) and the hot water pump is proofed on, enable the boiler control and hot water temperature control loops.

3.4.2.2 HAND-OFF-AUTO Switch

Provide hot water pump motor starter with an H-O-A switch:

3.4.2.2.1 HAND

With the H-O-A switch in HAND position, start the pump and run continuously.

3.4.2.2.2 OFF

With the H-O-A switch in OFF position, stop the pump.

3.4.2.2.3 AUTO

With the H-O-A switch in AUTO position, run the pump subject to the Hot Water Pump Start/Stop (HW-PMP-SS) command.

3.4.2.3 Proofs and Safeties

DDC Hardware must monitor all proofs and safeties.

3.4.2.3.1 Proofs

Hot water pump

3.4.2.3.2 Safeties

None

3.4.2.3.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.4.2.4 Boiler Control

When this loop is enabled, turn the boiler on. When this loop is disabled, the boiler is turned off.

3.4.2.5 Hot Water Temperature Control

When this loop is enabled modulate the 3-way mixing valve to maintain hot water supply temperature (HWS-T) at setpoint (HWS-T-SP). The Hot Water Supply Temperature Setpoint (HWS-T-SP) must be [determined from a linear reset schedule] as shown. When this loop is disabled, the valve is in its normal (failsafe) position.

3.4.3 Hydronic Dual-Temperature System with [Steam][High Temperature Hot Water] Heat Exchanger and Chilled Water

****

NOTE:
1) Select Steam or High Temperature Hot Water as required.

3) The designer may want to consider other conditions under which this system is enabled, such as outside air temperature.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral (PI) control.

3.4.3.1 System Enable and Loop Enable

a. Monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, enable this system (SYS-ENA). If all systems served by this system are not enabled, do not enable this system.

b. When the system is enabled (SYS-ENA), run the pump.

c. When this system is enabled (SYS-ENA), and the HEATING/COOLING switch is in HEATING the Heat Exchanger Control loop is enabled.

****

NOTE: Chiller Enable (the following paragraph) is only required when there is a local chiller. In cases where chilled water is from a central plant delete the chiller enable requirement.

****

[d. When this system is enabled (SYS-ENA), and the HEATING/COOLING switch is in COOLING and the dual-temperature return water (DTWR-T) is below the dual-temperature return water high-limit temperature (DTWR-T-HL) setpoint of 29 degrees C 85 degrees F, enable the chiller.]

3.4.3.2 Switchover Valve Operation

Monitor the status of the DTWR-T-LL and DTWR-T-HL switches.

3.4.3.2.1 HEATING/COOLING Switch in the HEATING Position

With the HEATING/COOLING switch in the HEATING position, the switchover valve must open the heat-cool system piping to the heat exchanger and close the heat-cool system piping to the [central plant chilled water][single-building chiller].

3.4.3.2.2 HEATING/COOLING Switch in the COOLING Position

With the HEATING/COOLING switch in the COOLING position, the switchover valve must open the heat-cool system piping to the [central plant chilled water][single-building chiller] and close the heat-cool system piping to the heat exchanger whenever the dual-temperature return water temperature (DTWR-T) is below the dual-temperature return water high-limit temperature (DTWR-T-HL).

3.4.3.3 HAND-OFF-AUTO Switch

Provide Dual-Temperature water pump motor starter with an H-O-A switch:

3.4.3.3.1 HAND

With the H-O-A switch in HAND position, the pump starts and runs continuously.

3.4.3.3.2 OFF

With the H-O-A switch in OFF position, the pump stops.

3.4.3.3.3 AUTO

With the H-O-A switch in AUTO position, the pump runs subject to the Dual-Temperature Water Pump Start/Stop (DTW-PMP-SS) System Enable (SYS-ENA) command.

3.4.3.4 Proofs and Safeties

DDC Hardware must monitor all proofs and safeties.

3.4.3.4.1 Proofs

None

3.4.3.4.2 Safeties

Direct-hardwire interlock heat exchanger differential pressure switch (HX-P-LL) to the [steam][high temperature hot water] valve.

3.4.3.4.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

[3.4.3.5 [Heat Exchanger][Mixing] Valve Control

When this loop is enabled modulate the [steam][high temperature hot water] valve to maintain the Hot Water Supply Temperature (HWS-T) at setpoint (HWS-T-SP). The Hot Water Supply Temperature Setpoint (HWS-T-SP) must be [determined from a linear reset schedule] as shown. The DDC Hardware must monitor the status of the HX-P-LL safety. When this loop is disabled, close the valve.

]3.4.4 Hydronic Secondary with Variable Speed Pump

****

NOTE:
1) This spec does not include a variable frequency drive (VFD) specification. Specify a VFD that meets the requirements of the control sequence including the integral H-O-A.

2) The designer may want to consider other conditions under which this system is enabled, such as outside air temperature.

****

Install DDC hardware to perform this Sequence of Operation and to provide SNVT inputs and outputs as specified and shown on the Points Schedule. Unless otherwise specified, all modulating control is proportional-integral

(PI) control.

3.4.4.1 System Enable and Loop Enable:

a. Monitor the enabled status of all systems served by this system. If one or more systems served by this system are enabled, enable this system (SYS-ENA). If all systems served by this system are not enabled, do not enable this system.

b. When this system is enabled (SYS-ENA) the Pressure Control loop must be enabled.

3.4.4.2 HAND-OFF-AUTO Switch

Provide hot water pump variable frequency drive (VFD) unit with an integral H-O-A switch:

3.4.4.2.1 HAND

With the H-O-A switch in HAND position, the pump starts and runs continuously. Ensure pump speed is under manual-operator control.

3.4.4.2.2 OFF

With the H-O-A switch in OFF position, the pump stops.

3.4.4.2.3 AUTO

With the H-O-A switch in AUTO position, run the pump subject to the Hot Water Pump Start/Stop (HW-PMP-SS) command and ensure pump speed is under control of the DDC system.

3.4.4.3 Proofs and Safeties

DDC Hardware must monitor all proofs and safeties.

3.4.4.3.1 Proofs

None

3.4.4.3.2 Safeties

None

3.4.4.3.3 DDC Hardware Reset

Reset all proofs and safeties via a local binary push-button (RST-BUT) input to the DDC Hardware, via a remote command to the DDC Hardware via SNVT or both (where the Contractor provides both reset functions and the operator can use either one to perform the reset), as shown on the Points Schedule drawing.

3.4.4.4 Pressure Control

When this loop is enabled modulate the pump variable frequency drive unit to maintain the pipe system pressure at setpoint as shown, as measured by the differential pressure tap and sensor as shown. When this loop is disabled, ensure the DDC Hardware capacity modulation output to the VFD is zero percent.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 11 20 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-23 11 25 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 11 20

FACILITY GAS PIPING

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PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 11 20 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-23 11 25 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 23 11 20

FACILITY GAS PIPING

05/20

****
NOTE: This guide specification covers the requirements for low pressure facility gas piping systems conforming to NFPA 54 NFPA 58 for non-industrial uses.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This guide specification is intended for use when specifying the following facility gas distribution systems:

low pressure natural gas systems, 34 kPa 5 psi maximum, except for gas-air mixtures within the flammable range are limited to 69 kPa 10 psi maximum,

low pressure undiluted LPG systems, 140 kPa 20psi maximum,

aboveground steel piping both outside (up to 1.50 meters 5 feet beyond exterior walls) and within

buildings in compliance with [NFPA 54/ANSI Z223.1] , "National Fuel Gas Code" and [NFPA 58], "Liquefied Petroleum Gas Code",

thermoplastic gas pressure pipe, tubing, and fittings,

aluminum and aluminum-alloy drawn seamless tubes,

reinforced epoxy resin gas pressure pipe and fittings,

for non-industrial uses.

Use Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES for external utility (beyond 1.50 meters 5 feet from exterior walls) [natural gas distribution] [liquid petroleum gas (LPG)](includes tailoring for LPG systems).

Use Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES contains tailoring for utility metering systems. (The Energy Independence and Security Act (EISA 2007) requires equivalent metering of natural gas and steam in accordance with the guidelines established under the act prior to October 1, 2016.)

Define the gas meter, service regulator, and service line pipe, fittings, and appurtenances in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES when that specification is included in the project. Otherwise, use the definition of these components in this specification.

The gas meter, service regulator, and service line pipe, fittings, and appurtenances must meet the requirements of 49 CFR 192.

As a minimum, show the following information on the project drawings:

1. Layout and location of piping,

2. Location of appurtenances, valves, etc,

3. Details of method of mounting piping,

4. Capacity of pressure regulators

5. Meter location and emergency shut-offs.

6. Location and capacity of LP gas containers.

****

1.1 SUMMARY

This specification section applies to gas piping installed within buildings incidental underground piping under building, above ground steel piping and corrugated stainless steel tubing (CSST) both outside (up to 1.50 meters 5 feet beyond exterior walls) and within buildings in compliance with NFPA 54/ AGA Z223.1, "National Fuel Gas Code" NFPA 58, "Fuel Gas Piping".

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA ANSI B109.1	(2000) Diaphragm Type Gas Displacement Meters (Under 500 cubic ft./hour Capacity)
AGA ANSI B109.2	(2000) Diaphragm Type Gas Displacement Meters (500 cubic ft./hour Capacity and Over)
AGA ANSI B109.3	(2019) Rotary-Type Gas Displacement Meters
AGA ANSI B109.4	(2016) Self-Operated Diaphragm-Type Natural Gas Service Regulators for Nominal Pipe Size 1¼ inches (32 mm) and Smaller with Outlet Pressures of 2 psig (13.8 kPa) and Less
AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service
AGA Z223.1	(2012) National Fuel Gas Code

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.1/CSA 1.1	(2024) Household Cooking Gas Appliances
ANSI Z21.15/CSA 9.1	(2021) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and

	Hose End Valves
ANSI Z21.18/CSA 6.3	(2019; R 2024) Gas Appliance Pressure Regulators
ANSI Z21.21/CSA 6.5	(2023) Automatic Valves for Gas Appliances
ANSI Z21.24/CSA 6.10	(2022) Connectors for Gas Appliances
ANSI Z21.41/CSA 6.9	(2023) Quick-Disconnect Devices for Use with Gas Fuel Appliances
ANSI Z21.69/CSA 6.16	(2015; R 2020) Connectors for Movable Gas Appliances
ANSI Z21.78/CSA 6.20	(2010; R 2020) Standard Specification for Combination Gas Controls for Gas Appliances
ANSI Z21.80/CSA 6.22	(2019; R 2024) Line Pressure Regulators
ANSI Z21.93/CSA 6.30	(2017) Excess Flow Valves for Natural Gas and Propane Gas with Pressures up to 5 psig

AMERICAN PETROLEUM INSTITUTE (API)

API 570	(2016; Addendum 1 2017; Addendum 2 2018; ERTA 1 2018) Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems
API MPMS 2.2A	(1995; R 2017) Manual of Petroleum Measurement Standards Chapter 2-Tank Calibration Section 2A-Measurement and Calibration of Upright Cylindrical Tanks by the Manual Tank Strapping Method
API MPMS 2.2E	(2004; Errata 2009; R 2009) Petroleum and Liquid Petroleum Products - Calibration of Horizontal Cylindrical Tanks - Part 1: Manual Methods
API RP 1110	(2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API Spec 5CT	(2018) Casing and Tubing
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018;

	Errata 2 August 2018) Specification for Pipeline and Piping Valves
API Spec 15LR	(2001; R 2018) Specification for Low Pressure Fiberglass Line Pipe
API Std 598	(2009) Valve Inspecting and Testing
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 25-16	(2016) Earthquake-Activated Automatic Gas Shutoff Devices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.33	(2024) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 175 psi, (Sizes NPS 1/2 Through NPS 2)
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch

	Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.8	(2022; Supplement 2022) Gas Transmission and Distribution Piping Systems
ASME B31.9	(2020) Building Services Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASTM INTERNATIONAL (ASTM)

ASTM 01.01	(2019) Steel - Piping, Tubing, Fittings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A513/A513M	(2024) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A666	(2023) Standard Specification for Annealed

	or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B210/B210M	(2019a) Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B241/B241M	(2022) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B280	(2023) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM D2513	(2018a) Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
ASTM D2517	(2018) Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
ASTM F2015	(2000; R 2024) Standard Specification for Lap Joint Flange Pipe End Applications

CSA GROUP (CSA)

ANSI LC 1/CSA 6.26	(2023) Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)
CGA 3.11-M88	(2015) Lever Operated Pressure Lubricated Plug Type Gas Shut-Off Valves
CGA 3.16-M88	(2015) Lever Operated Non-Lubricated Gas Shut-Off Valves
CGA 9.2-M88	(1988; R 2009) Manually Operated Shut-Off Valves for Gas Piping Systems

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture,

	Selection, Application, and Installation
MSS SP-83	(2014) Class 3000 Steel Pipe Unions Socket Welding and Threaded
MSS SP-86	(2021) Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

UL SOLUTIONS (UL)

UL 125	(2020) UL Standard for Safety Flow Control Valves for Anhydrous Ammonia and LP-Gas
UL 842	(2015; Reprint Oct 2017) UL Standard for Safety Valves for Flammable Fluids
UL 860	(2014) Pipe Unions for Flammable and Combustible Fluids and Fire-Protection Service
UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.3 SYSTEM DESCRIPTION

The gas piping system includes [natural gas] [and] [liquid petroleum] piping and appurtenances from point of connection with supply system, as indicated, to gas operated equipment within the facility. Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, in three separate packages. Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section, with additions and modifications specified herein. [Provide cathodically protected insulating joints connecting aboveground piping from the meter to the building, with [lightning arrestors] [zinc grounding cells] conforming to API RP 2003, installed where indicated.]

1.3.1 Gas Facility System and Equipment Operation

Include shop drawings showing piping layout, locations of system valves, gas line markers[and cathodic protection system]; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system drawings); isolation procedures including valve operation to shutdown or isolate each section of the system (index valves to the system maps and provide separate procedures for normal operation and emergency shutdown if required to be different). Submit Data package No. 4.

1.3.2 Gas Facility System Maintenance

Include maintenance procedures and frequency for system and equipment; identification of pipe materials and manufacturer by locations, pipe repair procedures, and jointing procedures at transitions to other piping material or material from a different manufacturer. Submit Data Package No.4.

1.3.3 Gas Facility Equipment Maintenance

Include identification of valves, shut-offs, disconnects, and other equipment by materials, manufacturer, vendor identification and location; maintenance procedures and recommended tool kits for valves and equipment; recommended repair methods (i.e., field repair, factory repair, or replacement) for each valve and piece of equipment; and preventive maintenance procedures, possible failure modes and troubleshooting guide. Submit Data Package No. 3.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gas Piping System; G, [_____]

SD-03 Product Data

Pipe and Fittings; G, [_____]

Gas Equipment Connectors; G, [_____]

LPG Containers and Accessories; G, [_____]

Gas Piping System; G, [_____]

Pipe Coating Materials; G, [_____]

Pressure Regulators; G, [_____]

Risers; G, [_____]

Transition Fittings; G, [_____]

Valves; G, [_____]

Warning and Identification Tape; G, [_____]

SD-06 Test Reports

Testing; G, [_____]

Pressure Tests; G, [_____]

Pressure Tests for Liquified Petroleum Gas; G, [_____]

Test with Gas; G, [_____]

SD-07 Certificates

Welders Procedures and Qualifications; G, [_____]

Assigned Number, Letter, or Symbol; G, [_____]

SD-08 Manufacturer's Instructions

PE Pipe and Fittings; G, [_____]

Pipe Coating Materials; G, [_____]

SD-10 Operation and Maintenance Data

Gas Facility System and Equipment Operation; G, [_____]

Gas Facility System Maintenance; G, [_____]

Gas Facility Equipment Maintenance; G, [_____]

1.5 QUALITY ASSURANCE

Submit manufacturer's descriptive data and installation instructions for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Mark all valves, flanges and fittings in accordance with MSS SP-25.

1.5.1 Welding Qualifications

****

NOTE: When the need exists for more stringent welding requirements, the designer may develop an alternate paragraph from industry standards using the applicable portions of Section 40 05 13.96 WELDING PROCESS PIPING as a guide.

****

a. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators in accordance with API RP 2009, ASME BPVC SEC IX, and ASME B31.9. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.9. Notify the Contracting Officer at least 24 hours in advance of tests, and perform at the work site if practicable.

b. Submit a certified copy of welders procedures and qualifications metal and PE in conformance with ASME B31.9 for each welder and welding operator. Submit the assigned number, letter, or symbol that will be used in identifying the work of each welder to the Contracting Officer.[Weld all structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING, and in conformance with AWS A5.8/A5.8M, and AWS WHB-2.9.]

1.5.2 Jointing Thermoplastic and Fiberglass Piping

Perform all jointing of piping using qualified joiners and qualified procedures in accordance with AGA XR0603. Furnish the Contracting Officer with a copy of qualified procedures and list of and identification symbols of qualified joiners. Submit manufacturer's installation instructions and manufacturer's visual joint appearance chart, including all PE pipe and fittings.

1.5.3 Shop Drawings

Submit drawings for complete Gas Piping System, within [30] [_____] days of contract award, showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of gas equipment connectors and supports. Include LP storage tank, pad, and mounting details.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Plastic Pipe

Handle, transport, and store plastic pipe and fittings carefully. Plug or cap pipe and fittings ends during transportation or storage to minimize dirt and moisture entry. Do not subject piping to abrasion or concentrated external loads. Discard PE pipe sections and fittings that have been damaged.

1.6.2 CSST Tubing

Handle, transport and store CSST tubing on the wooden spool or shipping container provided by the manufacturer. Insure tubing ends are capped during transportation and storage to minimize dirt and moisture entry. Discard any tubing segment and fitting that has been damaged.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Submit catalog data and installation instructions for pipe, valves, all related system components, pipe coating materials and application procedures. Conform to NFPA 54NFPA 58 and with requirements specified herein. Provide supply piping to appliances or equipment at least as large as the inlets thereof.

2.2 GAS PIPING SYSTEM AND FITTINGS

****

NOTE: When acceptable to the serving gas supplier aluminum, thermoplastic or fiberglass pipe; copper, aluminum alloy, or steel tubing may be used with gases not corrosive to such materials. Before selecting aluminum, copper, thermoplastic or fiberglass materials, contact the gas supplier for a gas analysis to determine the types of chemicals which will be in the gas supply, and select suitable materials based on the gas analysis. In general, odorized gas is not suitable for aluminum or copper bearing materials.

****

[2.2.1 Steel Pipe, Joints, and Fittings

****
NOTE: For steam electric generation stations, industrial and institutional plants, and central heating plants, use Schedule 80 black steel piping in accordance with ANSI B31.1 for threaded joints.
****

a. Pipe: Black carbon steel in accordance with ASTM A53/A53M, Schedule [40] [80], threaded ends for sizes 50 mm 2 inches and smaller; otherwise, plain end beveled for butt welding.

b. Threaded Fittings: ASME B16.3, black malleable iron.

c. Socket-Welding Fittings: ASME B16.11, forged steel.

d. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.

e. Unions: MSS SP-83ASME B16.39, black malleable iron.

f. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1, with flange faces having integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

****
NOTE: Other materials, such as threaded ductile iron, copper or brass pipe in iron pipe sizes, may be used with gases noncorrosive to such materials. Designer may specify other approved materials and list proper reference publications based on those materials in this paragraph and reference paragraph. Designer also may delete materials or equipment listed if not desirable or applicable.
****

Provide steel pipe conforming to ASME B36.10M; and malleable-iron threaded fittings conforming to MSS SP-86 ASME B16.1 and ASME B16.3. Provide steel pipe flanges and flanged fittings, including bolts, nuts, and bolt pattern in accordance with ASME B16.5 and ASTM A105/A105M. Provide wrought steel buttwelding fittings conforming to ASME B16.9. Provide socket welding and threaded forged steel fittings conforming to MSS SP-83 ASME B16.11[and ASTM A181/A181M, Class 60].

][2.2.2 Aluminum Alloy Pipe and Tubing, Joints, and Fittings

Provide aluminum alloy pipe conforming to ASTM B241/B241M, except that alloy 5456 is not allowed. Mark the ends of each length of pipe indicating it conforms to NFPA 54 NFPA 58. Thread, flange, braze, or weld pipe joints. Provide aluminum alloy tubing conforming toASTM B210/B210M, Type A or B, or ASTM B241/B241M, Type A or equivalent, with joints made up with gas tubing fittings recommended by the tubing manufacturer.

][2.2.3 Copper Tubing, Joints and Fittings

Provide copper tubing conforming to ASTM B88M ASTM B88, Type K or L, or

ASTM B280, with tubing joints made up with tubing fittings recommended by the tubing manufacturer. Provide copper and copper alloy press fittings, with sealing elements of Hydrogenated Nitrile Butadiene Rubber (HNBR), factory installed, or an alternative supplied by the fitting manufacturer. Press fittings are not a permitted connection fitting for natural and LP gas on Army and Navy projects.

][2.2.4 Steel Tubing, Joints and Fittings

Provide steel tubing conforming to ASTM 01.01, and ASTM A513/A513M, with tubing joints made up with gas tubing fittings recommended by the tubing manufacturer.

][2.2.5 Thermoplastic Pipe, Tubing, Joints, and Fittings

****

NOTE: Use of thermoplastic pipe or components is not allowed under buildings. Use only for outdoor, underground installations only.

****

Provide thermoplastic pipe, tubing,casing and joints and fittings conforming to ASTM D2513 and API Spec 5CT.

][2.2.6 Fiberglass Pipe, Joints, and Fittings

Provide fiberglass piping systems conforming to ASTM D2517 and API Spec 15LR.

][2.2.7 Corrugated Stainless Steel Tubing, Fittings and Accessories

Provide corrugated stainless steel tubing conforming to ANSI LC 1/CSA 6.26 (austenitic stainless steel of series 300) with tubing joints made with special mechanical fittings as supplied by the tubing manufacturer.

2.2.7.1 Tubing

Austenitic stainless alloy of series 300 with polyethylene jacket/coating in accordance with ANSI LC 1/CSA 6.26 for sizes 9.4-mm 3/8-inch through 50-mm 2-inch

2.2.7.2 Mechanical Fittings

Copper alloy with one end matched to the corrugated tubing and one end with NPT threads in accordance with ASME B1.20.1

2.2.7.3 Striker Plates

Hardened steel designed to protect tubing from mechanical damage in accordance with ANSI LC 1/CSA 6.26

2.2.7.4 Manifolds

Malleable iron, steel or copper alloy with threaded connections/ports in accordance with ASME B1.20.1

][2.2.8 Sealants for Steel Pipe Threaded Joints

****

NOTE: Use this paragraph only if steel threaded

pipe is specified.
****

Provide joint sealing compound as listed in UL FLAMMABLE & COMBUSTIBLE, Class 20 or less. For taping, use tetrafluoroethylene tape conforming to UL FLAMMABLE & COMBUSTIBLE.

]2.2.9   Warning and Identification

Provide pipe flow markings, warning and identification tape, and metal tags as required.

2.2.10   Flange Gaskets

Provide gaskets of nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 316 degrees C 600 degree F service, to be used for hydrocarbon service.

2.2.11   Pipe Threads

Provide pipe threads conforming to ASME B1.20.2MASME B1.20.1.

2.2.12   Escutcheons

Provide chromium-plated steel or chromium-plated brass escutcheons, either one piece or split pattern, held in place by internal spring tension or set screw.

2.2.13   Gas Transition Fittings

****
NOTE: Choose the applicable options from the following:
****

[a. Provide steel to plastic (PE) designed for steel-to-plastic with tapping tee or sleeve conforming to AGA XR0603 requirements for transitions fittings.. Coat or wrap exposed steel pipe with heavy plastic coating.]

[b. Plastic to Plastic: [Manufacturer's standard bolt-on (PVC to PE) plastic tapping saddle tee, UL listed for gas service, rated for 690 kPa (gage) 100 psig, and O-ring seals.] [Manufacturer's standard slip-on PE mechanical coupling, molded, with stainless-steel ring support conforming to ASTM A666, O-ring seals, and rated for 1035 kPa (gage) 150 psig gas service.] [Manufacturer's standard fused tapping (PE-to-PE) tee assembly with shut-off feature.]]

[c. [Provide lever operated pressure lubricated plug type gas shut-off valve conforming to CGA 3.11-M88.][Provide lever operated non-lubricated gas shut-off valves conforming to CGA 3.16-M88][Provide manually operated shut-off valve conforming to CGA 9.2-M88]]

2.2.14 Insulating Pipe Joints

2.2.14.1 Insulating Joint Material

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.2.14.2 Threaded Pipe Joints

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

2.2.14.3 Flanged Pipe Joints

Provide joints for flanged pipe consisting of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts. [Provide lap joint flange pipe ends conforming to ASTM F2015.]

2.2.15 Flexible Connectors

a. Provide flexible connectors for connecting gas utilization equipment to building gas piping conforming to ANSI Z21.24/CSA 6.10 or ANSI Z21.41/CSA 6.9 for quick disconnect devices, and flexible connectors for movable food service equipment conforming to ANSI Z21.69/CSA 6.16.[Provide combination gas controls for gas appliances conforming to ANSI Z21.78/CSA 6.20.]

b. Do not install the flexible connector through the appliance cabinet face. Provide rigid metallic pipe and fittings to extend the final connection beyond the cabinet, except when appliance is provided with an external connection point.

2.3 VALVES

Provide lockable shutoff or service isolation valves [as indicated in the drawings]conforming to the following:

2.3.1 Valves 50 mm 2 Inches and Smaller

Provide valves 50 mm 2 inches and smaller conforming to ASME B16.33 of materials and manufacture compatible with system materials used.[Provide manually operated household cooking gas appliance valves conforming to ANSI Z21.1/CSA 1.1 and ANSI Z21.15/CSA 9.1.]

[2.3.2 Valves 65 mm 2-1/2 Inches and Larger

****

NOTE: Use the following for projects requiring larger volumes and pipe sizes over 65 mm 2-1/2 inches.

****

Provide valves 65 mm 2-1/2 inches and larger of carbon steel conforming to API Spec 6D, Class 150.

][2.3.3 Valve Support on PE Piping

Provide valve support assembly in accordance with the PE piping maufacturer's requirements at valve terminations points.

]2.4 RISERS

Provide manufacturer's standard riser, transition from plastic to steel pipe with 0.18 to 0.30 mm 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide [remote bolt-on or bracket][or][wall-mounted] riser supports [as indicated].

2.5 PIPE HANGERS AND SUPPORTS

Provide pipe hangers and supports conforming to MSS SP-58.

[2.6 LINE AND APPLIANCE REGULATORS AND SHUTOFF VALVES

****

NOTE: Regulators and shutoff valves specified herein are located downstream of the gas meter / service regulator, within the building gas supply system.

The customer's gas meter, service regulator, service line, and service line shutoff valve for gas fuel systems are specified in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES and must conform to 49 CFR 192 requirements. If that section is not a part of the contract specifications, select the applicable paragraphs included in this specification. Contact and validate with the installation's facility engineering the specific requirements for meters and regulators. Define on the drawings and in the specifications the requirements and division of responsibilities for providing both the meter and regulator.

****

Provide regulators conforming to [ANSI Z21.18/CSA 6.3 for appliances] [ANSI Z21.78/CSA 6.20 for combination gas controls for gas appliances] [, and ANSI Z21.80/CSA 6.22 for line pressure regulators]. Provide shutoff valves conforming to [ANSI Z21.15/CSA 9.1 for manually controlled gas shutoff valves] [and] [ANSI Z21.21/CSA 6.5 for automatic shutoff valves for gas appliances].

][2.7 NATURAL GAS SERVICE

****

NOTE: Paragraphs below specify the service regulator and gas meter that supply the building gas piping system. These components are specified in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES and must conform to 49 CFR 192 requirements.

If Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES is a part of the contract specifications, delete the paragraphs below.

If Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES is not a part of the contract specifications, include the paragraphs below.

Contact and validate with the installation's facility engineering the specific requirements for meters and regulators. Define on the drawings and in the specifications the requirements and division of responsibilities for providing both the meter and regulator.

****

2.7.1 Service Regulators

a. Provide ferrous bodied pressure regulators for individual service lines, capable of reducing distribution line pressure to pressures required for users. Provide service regulators conforming to AGA ANSI B109.4 CGA-6.18-M95 with full capacity internal relief [and overpressure shutoff]. Set pressure relief at a lower pressure than would cause unsafe operation of any connected user.

b. Adjust regulators for liquified petroleum gas to 2.5 to 3 kPa 10 to 12 inches of water column, with pressure relief set at 4 kPa 16 inches of water column.

c. Provide regulator(s) having a single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas flow rate at the regulator inlet pressure. Provide regulator valve vent of resilient materials designed to withstand flow conditions when pressed against the valve port, capable of regulating downstream pressure within limits of accuracy and limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Provide a self-contained service regulator, and pipe not exceeding exceed 50 mm 2 inch size.

2.7.2 Gas Meter

[AGA ANSI B109.1][AGA ANSI B109.2][AGA ANSI B109.3] [pipe][pedestal] mounted, [diaphragm] or [bellow][style], [cast-iron][enamel-coated steel][aluminum] case. [Provided with a strainer immediately upstream]. Provide [diaphragm-type meter conforming to AGA ANSI B109.1 for required flow rates less than 500 cfh, or AGA ANSI B109.2, for flow rates 500 cfh and above] [rotary-type displacement meter conforming to AGA ANSI B109.3] as required by local gas utility supplier. Provide combined [odometer-type] register totalizer index, UV-resistant index cover, water escape hole in housing, and means for sealing against tampering. Provide temperature-compensated type meters sized for the required volumetric flow rate and suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Provide meters with over-pressure protection as specified in 49 CFR 192 and ASME B31.8. Provide meters that are tamper-proof [with] [frost protection] [fungus protection][seismic protection]. Provide meters with a pulse switch initiator capable of operating up to speeds of 500 maximum pulses per minute with no false pulses and requiring no field adjustments. Provide not less than one pulse per 2.83 cubic meters 100 cubic feet of gas. Minimum service life must be 30,000,000 cycles.

2.7.2.1 Utility Monitoring and Control System (UMCS) / Energy Monitoring and Control (EMCS) or Automatic Meter Reading Interfaces

Provide gas meters capable of interfacing the output signal, equivalent to volumetric flow rate, with the existing UMCS / EMCS for data gathering in units of cubic meters cubic feet. Provide meters that do not require power to function and deliver data. Output signal must be either a voltage or amperage signal that can be converted to volumetric flow by using an appropriate scaling factor.

2.7.2.2 Measurement Configuration

For buildings that already have a gas meter with a pulse output, ensure that the pulse output is connected to a data gathering device (i.e. electric meter). For buildings where a natural gas meter already exists but does not have a pulse output, add a pulse kit to the existing meter and tie the output to a data gathering device. If the existing gas meter will not accept a pulse kit or if no meter exists a new natural gas meter must be installed, also requiring a pulse output to a data gathering device. Ensure the pulse frequency and electronic characteristics are compatible with the existing data gathering device, if any.

][2.8 SEISMIC PROVISIONS

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NOTE: Provide this earthquake protective feature primarily for seismic zones 3 and 4.

****

Provide earthquake automatic gas shutoff valve conforming to ASCE 25-16, SMACNA 1981 or excess flow valve (EFV) conforming with ANSI Z21.93/CSA 6.30 and UL listed or AGA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The earthquake valve may be either pendulum or ball construction with [remote [, pneumatic] [electronic] [or] [electric]] actuator. The EFV may be either a bypass (automatic reset) or a non-bypass type (manual reset).

]2.9 AUTOMATIC GAS SHUT-OFF

****

NOTE: This section has a corresponding graphic for attaching CSA US 3-92 called "IAS_3-92_Rev_020601.pdf"

NOTE: TO DOWNLOAD UFGS GRAPHICS

Go to http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms

****

[Provide low pressure automatic gas shutoff or excess flow valve (EFV) downstream of the point of delivery after the [meter/regulator] [propane tank] conforming to ANSI Z21.93/CSA 6.30 and UL listed or CSA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The EFV may be either a bypass (automatic reset) or a non-bypass type (manual reset).][Provide low pressure automatic gas shutoff or excess flow valve (EFV) at each branch to an appliance.]

2.10 LIQUIFIED PETROLEUM GAS - (LPG), LPG CONTAINERS AND ACCESSORIES

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NOTE: The maximum size permitted under DOT specifications is 0.50 cubic meter 1000 pounds) water capacity. Fuse plugs may be used in addition to the spring-loaded safety relief valves for aboveground ASME containers of 4.5 cubic meters 1200 gallons) water capacity or less.

****

Provide NFPA 58, [DOT] [or] [ASME] compliant containers with appurtenances, system working pressure, minimum design pressure, that is LPG vapor pressure at 38 degrees C 100 degrees F, and water capacity as indicated. Provide containers with piping and fittings,[fuse plugs,][hose and flexible hose connectors,][gas-air mixer,][strainer,] and marking conforming to NFPA 58, and[API MPMS 2.2A for upright cylindrical tanks] [API MPMS 2.2E for horizontal cylindrical tanks] Provide valves conforming to UL 125 and UL 842. Provide pipe unions conforming to UL 860.

2.11 BOLTING (BOLTS AND NUTS)

Stainless steel bolting; ASTM A193/A193M, Grade B8M or B8MA, Type 316, for bolts; and ASTM A194/A194M, Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts must conform with ASME B18.2.1 and ASME B18.2.2 with coarse threads conforming to ASME B1.1, with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs must extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts must have American Standard regular square or heavy hexagon heads; nuts must be American Standard heavy semifinished hexagonal.

2.12 GASKETS

Fluorinated elastomer, compatible with flange faces.

2.13 IDENTIFICATION FOR ABOVEGROUND PIPING

MIL-STD-101 for legends and type and size of characters. For pipes 19 mm 3/4 inch od and larger, provide printed legends to identify contents of pipes and arrows to show direction of flow. Color code label backgrounds to signify levels of hazard. Make labels of plastic sheet with pressure-sensitive adhesive suitable for the intended application. For pipes smaller than 19 mm 3/4 inch od, provide brass identification tags 40 mm 1 1/2 inches in diameter with legends in depressed black-filled characters.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy or areas of conflict before performing the work.

3.2 EXCAVATION AND BACKFILLING

Provide required excavation, backfilling, and compaction as specified in Section 31 00 00 EARTHWORK.

3.3 GAS PIPING SYSTEM

Provide a gas piping system from the point of delivery, defined as the outlet of the [meter set assembly] [service regulator] [shutoff valve], [as specified under "Gas Service" within this specification,][as specified in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES,] to the connections to each gas utilization device that is in compliance with NFPA 54[NFPA 58]..

3.3.1 Protection and Cleaning of Materials and Components

Protect equipment, pipe, and tube openings by closing with caps or plugs during installation. At the completion of all work, thoroughly clean the entire system.

3.3.2 Workmanship and Defects

Piping, tubing and fittings must be clear and free of cutting burrs and defects in structure or threading and must be thoroughly brushed and chip-and scale-blown. Repair of defects in piping, tubing or fittings is not allowed; replace defective items when found.

3.4 PROTECTIVE COVERING

3.4.1 Underground Metallic Pipe

Protect buried metallic piping and tubing from corrosion by either: (1) applying protective coatings as specified in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES; (2) encasement in a water tight plastic conduit; or (3) encasement in a protective system designed and listed by the manufacturer for this application. When dissimilar metals are joined underground, use gastight insulating fittings.

3.4.2 Aboveground Metallic Piping Systems

****

NOTE: This paragraph applies to normal interior and exterior conditions from the meter or main shut-off. Where severe corrosion is expected, edit this paragraph to provide for protection against corrosion.

****

3.4.2.1 Ferrous Surfaces

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed . Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances [by power wire brushing] [or] [commercial sand blasted conforming to SSPC SP 6/NACE No.3] and prime with [ferrous metal primer] [or] [vinyl type wash coat]. Finish primed surfaces with two coats of exterior [oil paint] [or] [vinyl paint].

3.4.2.2 Nonferrous Surfaces

Except for aluminum alloy pipe, do not paint nonferrous surfaces. Paint surfaces of aluminum alloy pipe and fittings to protect against external corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by such liquids as water, detergents or sewage. Solvent-clean the surfaces and treat with vinyl type wash coat. Apply a first coat of aluminum paint and a second coat of alkyd gloss enamel or silicone alkyd copolymer enamel.

3.5 INSTALLATION

****

NOTE: To assist the designer in selecting the proper documents for a specific project, the following scope in accordance with documents is provided:

1. NFPA 54 Scope: "1.1.1 Applicability: Coverage of piping systems extends from the point of delivery to the connections with each gas utilization device. For other than indicated liquified petroleum gas systems, the point of delivery is the outlet of the service meter assembly, or the outlet of the service regulator or service shutoff valve when no gas meter is provided. For undiluted liquified petroleum gas systems, the point of delivery is the outlet of the first stage pressure regulator."

If underground piping is subject to physical damage, specify deeper burial depths to protect piping.

****

Install the gas system in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54NFPA 58[and]AGA XR0603, and as indicated. Perform all pipe cutting without damage to the pipe, with an approved type of mechanical cutter, unless otherwise authorized. Use wheel cutters where practicable. On steel pipe 150 mm 6 inches and larger, an approved gas cutting and beveling machine may be used. Cut thermoplastic and fiberglass pipe in accordance with AGA XR0603.

3.5.1 Metallic Piping Installation

Bury underground piping a minimum of 450 mm 18 inches below grade. Make changes in direction of piping with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either tees or forged branch outlet fittings. Provide branch outlet fittings which are forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Do not use aluminum alloy pipe in exterior locations or underground.

3.5.2 Metallic Tubing Installation

Install metallic tubing using gas tubing fittings approved by the tubing manufacturer. CSST gas piping systems must be installed by contractors who have completed the manufacturer's training program as indicated on a certification card. Make branch connections with tees. Prepare all tubing ends with tools designed for that purpose. Do not use aluminum alloy tubing in exterior locations or underground. Maintain electrical continuity of gas piping system in accordance with NFPA 54 [NFPA 58], paragraph entitled 'Electrical Bonding and Grounding'.

3.5.3   Thermoplastic and Fiberglass Piping, Tubing, and Fittings

Installation of thermoplastic and fiberglass piping, tubing, and fittings is permitted only outside and underground. Bury piping a minimum of 450 mm 18 inches below grade. Install the piping to avoid excessive stresses due to thermal contraction, and use only where indicated. Installations must be made using qualified procedures, by qualified installers, and in compliance with AGA XR0603 and NFPA 54 [NFPA 58], and must be inspected by a qualified inspector.

3.5.4   Connections Between Metallic and Plastic Piping

Connections between metallic and plastic piping are only allowed outside, underground, and with approved transition fittings.

3.5.5   Piping and Tubing Buried Under Buildings

Run underground piping and tubing installed beneath buildings in a steel pipe casing protected from corrosion with protective coatings as specified in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES or installed within a water tight plastic conduit or as part of a listed encasement system. Extend casing or encasement system at least 100 mm 4 inches outside the building, and provide the pipe with spacers and end bushings to seal at both ends to prevent the entrance of water and/or the escape of gas. Extend a vent line from the annular space above grade outside to a point where gas will not be a hazard, and terminate in a rain/insect-resistant fitting.

3.5.6   Concealed Piping in Buildings

Do not use combinations of fittings (unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints) to conceal piping within buildings.

3.5.6.1   Piping and Tubing in Partitions

Locate concealed piping and tubing in hollow, rather than solid, partitions. Protect tubing passing through walls or partitions against physical damage both during and after construction, and provide appropriate safety markings and labels. Provide protection of concealed pipe and tubing in accordance with ANSI LC 1/CSA 6.26.

3.5.6.2   Piping in Floors

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NOTE: When acceptable to the serving gas supplier, gas piping may be embedded in portland cement concrete floor slabs. If acceptable, delete brackets.

****

Lay piping in solid floors [except where embedment in concrete is indicated] in channels suitably covered to permit access to the piping with minimum damage to the building. [Surround piping embedded in concrete by a minimum of 40 mm 1-1/2 inches of concrete and do not allow physical contact with other metallic items such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quickset additives or cinder aggregate.]

3.5.7 Aboveground Piping

Run aboveground piping as straight as practicable along the alignment and elevation indicated, with a minimum of joints, and separately supported from other piping system and equipment. Install exposed horizontal piping no farther than 150 mm 6 inches from nearest parallel wall and at an elevation which prevents standing, sitting, or placement of objects on the piping.

3.5.8 Final Gas Connections

****

NOTE: Only allow flexible connectors where they will not be vulnerable to physical abuse or will not be accessible to unqualified personnel. Acceptable locations would include locked equipment rooms, equipment suspended at least 3 m 10 feet above floor, and remote buildings with limited accessibility by unqualified personnel. If flexible connectors are allowed, include bracketed sentence prohibiting connectors from passing through the equipment cabinet.

****

Unless otherwise specified, make final connections with rigid metallic pipe and fittings. [Make final connections to kitchen ranges using flexible connectors not less than 1.02 m 40 inch long[, to afford access to coupling] [and][to permit movement of equipment for cleaning].][Flexible connectors may be used for final connections to residential dryers.] [Flexible connectors may be used for final connections to gas utilization equipment.] [In addition to cautions listed in instructions required by ANSI standards for flexible connectors, insure that flexible connectors do not pass through equipment cabinet.] Provide accessible gas shutoff valve and coupling for each gas equipment item.

3.5.9 Seismic Requirements

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NOTE: Provide seismic details and show on the drawings. Delete bracketed phrase if no seismic details are provided.

****

Support and brace piping and attached valves to resist seismic loads in conformance with ASCE 25-16[and][as specified in UFC 3-301-01, and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS][as indicated]. CSST tubing and fittings that are seismically qualified in accordance with the FM APP GUIDE: Flexible Piping Systems for Flammable Gases must meet the seismic requirements in accordance with the manufacturer's installation instructions.

3.6 PIPE JOINTS

Design and install pipe joints to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

3.6.1 Threaded Metallic Joints

Provide threaded joints in metallic pipe with tapered threads evenly cut and made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 40 mm 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 50 mm 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, ream pipe and remove all burrs. Caulking of threaded joints to stop or prevent leaks is not permitted.

3.6.2 Welded Metallic Joints

Conform beveling, alignment, heat treatment, and inspection of welds to NFPA 54. Remove weld defects and make repairs to the weld, or remove the weld joints entirely and reweld. After filler metal has been removed from its original package, protect and store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating.

3.6.3 Thermoplastic and Fiberglass Joints

3.6.3.1 Thermoplastic and Fiberglass

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NOTE: Thermoplastic and fiberglass pipe should not be installed where temperature will be below minus 29 degrees C 20 degrees F or above 38 degrees C 100 degrees F. Fiberglass pipe may be used at temperatures up to 66 degrees C 150 degrees F, providing the pipe is marked in accordance with ASTM D2513.

****

Conform jointing procedures to AGA XR0603. Do not make joints with solvent cement or heat of fusion between different kinds of plastics.

3.6.3.2 PE Fusion Welding Inspection

Visually inspect butt joints by comparing with, manufacturer's visual joint appearance chart. Inspect fusion joints for proper fused connection. Replace defective joints by cutting out defective joints or replacing fittings. Inspect, in conformance with API 570, 100 percent of all joints and re-inspect all corrections. Arrange with the pipe manufacturer's representative in the presence of the Contracting Officer to make first time inspection.

3.6.4 Flared Metallic Tubing Joints

Make flared joints in metallic tubing with special tools recommended by the tubing manufacturer. Use flared joints only in systems constructed from nonferrous pipe and tubing, when experience or tests have demonstrated that the joint is suitable for the conditions, and when adequate provisions are made in the design to prevent separation of the joints. Do not use metallic ball sleeve compression-type tubing fittings for tubing joints.

3.6.5 Solder or Brazed Joints

Make all joints in metallic tubing and fittings with materials and procedures recommended by the tubing supplier. Braze joints with material having a melting point above 538 degrees C 1000 degrees F, containing no phosphorous.

3.6.6 Joining Thermoplastic or Fiberglass to Metallic Piping or Tubing

When compression type mechanical joints are used, provide gasket material in the fittings compatible with the plastic piping and with the gas in the system. Use an internal tubular rigid stiffener in conjunction with the fitting, flush with end of the pipe or tubing, extending at least to the outside end of the compression fitting when installed. Remove all rough or sharp edges from stiffener. Do not force fit stiffener in the plastic. Split tubular stiffeners are not allowed.

3.6.7 Press Connections

Make press connections in accordance with manufacturer's installation instructions using tools approved by the manufacturer. Fully insert the tubing into the fitting and then mark at the shoulder of the fitting. Check the fitting alignment against the mark on the tubing to assure the tubing is fully inserted before the joint is pressed.

3.7 PIPE SLEEVES

Provide pipes passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make all rectangular and square openings as detailed. Extend each sleeve through its respective wall, floor or roof, and cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Extend sleeves in mechanical room floors above grade at least 100 mm 4 inches above finish floor. Unless otherwise indicated, use sleeves large enough to provide a minimum clearance of 6.4 mm 1/4 inch all around the pipe. Provide steel pipe for sleeves in bearing walls, waterproofing membrane floors, and wet areas . Provide sleeves in nonbearing walls, floors, or ceilings of steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, seal the annular space between the pipe and sleeve with fire-stopping material and sealant that meet the requirement of Section 07 84 00 FIRESTOPPINGG.

3.8 PIPES PENETRATING WATERPROOFING MEMBRANES

Install pipes penetrating waterproofing membranes as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.9 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors in accordance with Section 07 84 00 FIRESTOPPING.

3.10 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.11 SPECIAL REQUIREMENTS

Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of NFPA 54NFPA 58.

3.12 BUILDING STRUCTURE

Do not weaken any building structure by the installation of any gas piping. Do not cut or notch beams, joists or columns. Attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

3.13 PIPING SYSTEM SUPPORTS

Support gas piping systems in buildings with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Do not support any gas piping system by other piping. Conform spacing of supports in gas piping and tubing installations to the requirements of NFPA 54NFPA 58. Conform the selection and application of supports in gas piping and tubing installations to the requirements of MSS SP-58. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members is not to exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 3.2 mm 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.14 ELECTRICAL BONDING AND GROUNDING

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NOTE: Conventional flange joints allow sufficient current flow to satisfy this requirement.

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Provide a gas piping system within the building that is electrically continuous and bonded to a grounding electrode as required by NFPA 54, NFPA 58, and NFPA 70.

3.15 SHUTOFF VALVE

Install the main gas shutoff valve controlling the gas piping system to be easily accessible for operation, as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled. Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally.[Provide PE piping manufacturer bracket support assembly securely fastened to structure for valve connections to resist operating torque applied to PE pipes.] Provide stop valve on service branch at connection to main and shut-off valve on riser outside of building.

3.16 LINE AND APPLIANCE PRESSURE REGULATORS

Install line pressure regulators and appliance regulators in accordance with the manufacturer's requirements and in accordance with NFPA 54[NFPA 58]. Install each regulator in an accessible location and install shutoff valves ahead of each line and appliance regulator to allow for maintenance. Where vent limiting devices are not included in the regulators, install a vent pipe to the exterior of the building. Terminate all service regulator vents and relief vents in the outside air in rain and insect resistant fittings. Locate the open end of the vent where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

3.17 GAS SERVICE INSTALLATION

[Gas service line, service regulator and gas company meter must be installed in accordance with Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES.] Installations must be in accordance with 49 CFR 192 and ASME B31.8. Contractor must submit and use only tested and approved work procedures. Contractor must use only welders and jointers who have been recently qualified by training and test for joining and installing the gas pipe material used on this job. The finished product must be inspected by a person qualified to inspect joints made by the particular procedures used to make joints.

****

NOTE: This section specifies service line, service regulator, and gas company meter. These components must be installed in accordance with 49 CFR 192 and ASME B31.8 to allow gas systems to be accepted by Utility Privatization Contractors.

These installations are also specified is Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES. If that section is not included in the contract documents, delete the reference statement above and include the paragraphs below in this specification.

Where project documentation includes Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES, delete the paragraphs below and include the reference statement above.

****

[3.17.1 Service Line

Install service line, branch connection to the main, and riser in accordance with 49 CFR 192 and ASME B31.8. Provide a minimum of 460 mm 18 inches cover or encase the service line so that it is protected. Install service line so that no undue stress is applied to the pipe, connection, or riser. Install approved riser and terminate with an approved isolation valve, EFV and automatic shutoff device. After laying of pipe and testing, backfill the trench in accordance with Section 31 00 00 EARTHWORK.

Where steel pipe is used as service line, install corrosion prevention coating and cathodic protect for the steel service line. Where connected to an existing cathodically protected steel pipe, ensure electrical continuity from the riser to the branch connection to the main. Install a dielectric fitting on the riser to prevent electrical continuity to the above ground piping.

Where plastic pipe is used as the service line, make joints in accordance with procedures qualified by test. Personnel joining plastic pipe must be qualified by making a satisfactory specimen joint that passes the required inspection and test listed in 49 CFR 192.285. Inspection must be made by inspectors qualified in evaluating joints made under the specific joining procedure, as required by 49 CFR 192.287.

3.17.2 Service Regulator

Install service regulator in accordance with 49 CFR 192 and ASME B31.8 and this specification ensuring that the customer's piping is protected from over pressurization should the service regulator fail. A 3/8 inch tapped fitting equipped with a plug must be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. For inside installations, route the regulator vent pipe through the exterior wall to the atmosphere, and seal building penetrations for service line and vent. Terminate the regulator vent so that it is protected from precipitation and insect intrusion, so that it is not submerged during floods, and so that gas escaping will not create a hazard or enter the building through openings.

3.17.3 Gas Meter

Install shutoff valve, meter set assembly, and service regulator on the service line [outside the building] [inside the building, a minimum of 1 meter 3 feet from any potential ignition source], 18 inches above the [ground] [finished floor] on the riser. An insulating joint (dielectric connection) must be installed on the inlet side of the meter set assembly and service regulator and must be constructed to prevent flow of electrical current.

][3.18 CATHODIC PROTECTION

****

NOTE: Use this paragraph only for those projects requiring underground, or partially buried gas piping systems

Designs are required to have cathodic protection for underground ferrous gas piping regardless of soil condition. Other guidance is available in TM 5-811-7. Provide cathodic protection on additions to existing systems and stations for testing.

****

Provide cathodic protection for underground ferrous gas piping as specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [and] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

]3.19 TESTING

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Test entire gas piping system to ensure that it is gastight prior to putting into service. Prior to testing, purge the system, clean, and clear all foreign material. Test each joint with an approved gas detector, soap and water, or an equivalent nonflammable solution. Inspect and test each valve in conformance with API Std 598 and API Std 607. Complete testing before any work is covered, enclosed, or concealed, and perform with due regard for the safety of employees and the public during the test. Install bulkheads, anchorage and bracing suitably designed to resist test pressures if necessary, and as directed and or approved by the Contracting Officer. Do not use oxygen as a testing medium.

3.19.1 Pressure Tests

Submit test procedures and reports in booklet form tabulating test and measurements performed; dated after award of this contract, and stating the Contractor's name and address, the project name and location, and a list of the specific requirements which are being certified. Before appliances are connected, test by filling the piping systems with air or an inert gas to withstand a minimum pressure of 21 kPa 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54as specified in NFPA 58 without showing any drop in pressure. Do not use Oxygen for test. Measure pressure with a mercury manometer, slope gauge, or an equivalent device calibrated to be read in increments of not greater than 1 kPa 0.1 pound. Isolate the source of pressure before the pressure tests are made.

3.19.2 Pressure Tests for Liquified Petroleum Gas

Pressure test system as described above. When appliances are connected to the piping system, use fuel gas for testing appliances to withstand a pressure of not less than 2.5 kPa nor more than 3.5 kPa 10.0 inches nor more than 14.0 inches water column (0.36 nor more than 0.51 pounds per square inch) for a period of not less than 10 minutes without showing any drop in pressure. Measure pressure with a water manometer or an equivalent device calibrated to be read in increments of not greater than 20 Pa 0.1 inch water column. Isolate the source of pressure before the pressure tests are made.

3.19.3 Test With Gas

Before turning on gas under pressure into any piping, close all openings from which gas can escape. Immediately after turning on the gas, check the piping system for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. Conform all testing to the requirements of NFPA 54NFPA 58. If leakage is recorded, shut off the gas supply, repair the leak , and repeat the tests until all leaks have been stopped.

3.19.4 Purging

After testing is completed, and before connecting any appliances, fully purge all gas piping. LPG piping tested using fuel gas with appliances connected does not require purging. Conform testing procedures to API RP 1110. Do not purge piping into the combustion chamber of an appliance. Do not purge the open end of piping systems into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54NFPA 58 are followed.

3.19.5 Labor, Materials and Equipment

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

3.20 PIPE COLOR CODE MARKING

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NOTE: Coordinate color code marking with Section 09 90 00. Add color code marking for piping not listed in Table I of Section 09 90 00 to the table.
****

Provide color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS, conforming to ASME A13.1.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 21 13.00 20 (April 2006)**
Change 2 - 11/19

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15185N (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-23 21 13.00 20 (April 2006)**
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SECTION 23 21 13.00 20

LOW TEMPERATURE WATER (LTW) HEATING SYSTEM

04/06, CHG 2: 11/19

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NOTE: This guide specification covers the requirements for complete low temperature water heating system including hot water piping (supply and return) and terminal units used for heating.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This section does not include feedwater treatment equipment or process hot water terminal units. Piping as used in this specification includes pipe, tubes, flanges, bolting, gaskets, valves, relief devices, fittings, and pressure containing parts of other piping components, hangers and supports, and other equipment items necessary to prevent overstressing of the pressure containing parts.

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NOTE: The following information should be shown on the drawings:

1. Layout of heating system.

2. Location, size, and capacity of finned tube radiators, convectors, unit heaters, flow meters, pumps, and expansion tanks.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.36	(2020) Orifice Flanges
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.9	(2020) Building Services Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2023) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM F1007	(2018; R 2022) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2024) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR List	(continuously updated) List of Approved Backflow Prevention Assemblies

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2022) Butterfly Valves

MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	(2023) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-V-12003	(1980; Rev F; Am 1; CANC Notice 1) Valves, Plug, Cast-Iron or Steel, Manually Operated

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689	(Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film)
CID A-A-50543	(Basic; Notice 2; Notice 3) Heaters, Convection, Steam or Hot Water
CID A-A-50544	(Basic; Notice 2; Notice 3) Radiators, Heating, Steam and Hot Water, Cast Iron
CID A-A-50545	(Basic; Notice 2; Notice 3) Radiator, Heating, Baseboard Panel, Steam and Hot Water
CID A-A-50560	(Basic) Pumps, Centrifugal, Water Circulating, Electric-Motor-Driven
CID A-A-59617	(Basic, Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint

	Tube Connections
FS S-R-2834	(Basic; Notice 1; CANC Notice 1) Radiators: Heating, Steel, Multifin Type
FS WW-H-191	(Rev E; Notice 2) Heater, Fluid, Industrial (Instantaneous, Steam, Water Converter Type)
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
29 CFR 1910.219	Mechanical Power Transmission Apparatus

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

Except as specified otherwise, equipment and piping components must be suitable for use in low temperature water heating system. Except as modified herein, the pressure temperature limitations must be as specified in the referenced standards and specifications. Pressures in this specification are pressures in kilopascal (kPa) pounds per square inch above atmospheric pressure, and temperatures are in degrees Centigrade (C) Fahrenheit (F).

1.3.1 Hot Water Heating System

Submit plan, elevations, dimensions, capacities, and ratings. Include the following:

a. Unit heaters

b. Convectors

c. Finned tube radiators

d. Pumps

e. Valves

f. Expansion tanks

g. Flow measuring equipment

h. Backflow preventer

i. Air separating tank

j. [j. Boilers]

k. [k. Hot water heat exchangers]

l. [l. Converters]

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hot water heating system

SD-03 Product Data

Convectors

Finned tube radiators

Pumps

Include pump speed and characteristic curve for performance of impeller selected for each pump. Curves must indicate capacity vs head, efficiency, and brake power for full range, from shut-off to free delivery.

Expansion tanks

Flow measuring equipment

Backflow preventers

External air separation tanks

Hot water heating pipe

SD-06 Test Reports

Hydrostatic test of piping system

Auxiliary equipment and accessory tests

Submit test reports in accordance with the paragraph entitled "Field Quality Control."

SD-07 Certificates

Backflow preventer certification

Report of prior installations

Welding procedures

Welder's qualifications

SD-10 Operation and Maintenance Data

Convectors, Data Package 3; G, [_____]

Finned tube radiators, Data Package 3; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit a list of qualified service organizations which includes addresses and qualifications.

1.5 QUALITY ASSURANCE

1.5.1 Standard Commercial Product for Terminal Units

Terminal units provided must comply with features called out in this specification and must be the manufacturer's standard commercial product. Additional or better features which are not prohibited by this specification but which are a part of the manufacturer's standard commercial product, must be included in the terminal units being furnished. A standard commercial product is a product which has been sold or is currently being offered for sale, on the commercial market through advertisements or manufacturer's catalogs, or brochures. Provide Institute of Boiler and Radiator Manufacturer (IBR) or Steel Boiler Institute (SBI) rating for required capacity.

1.5.2 Welding

1.5.2.1 Report of Prior Installations

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project. Certificate must be from the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California, and must attest that this design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval is not acceptable in lieu of the above.

1.5.2.2 Welding Procedures

Before performing welding, submit three copies of welding procedure specification for all metals to be used in the work, together with proof of welder's qualification as outlines in ASME B31.9.

1.5.2.3 Welder's Qualifications

Before welder or operator performs welding, submit three copies of Welder's Performance Qualification Record in conformance with ASME B31.9showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition, submit each welder's assigned number, letter, or symbol used to identify the work of the welder.

1.5.2.4 Identification of Welder's Work

Ensure that each welder's assigned number, letter or symbol is affixed immediately upon completion of the weld. To welders making defective welds after passing a qualification test, give a requalification test. Upon failing to pass the test, do not permit welder to work in this contract.

1.5.2.5 Previous Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for this contract without requalification subject to the approval and provided that all the conditions specified in ASME B31.9 are met before a procedure can be used.

1.5.3 Brazing and Soldering

1.5.3.1 Brazing Procedure

ASME B31.9. Brazing procedure for joints must be as outlined in CDA A4015.

1.5.3.2 Soldering, Soldering Preparation, and Procedures for Joints

ASME B31.9 and as outlined in CDA A4015.

1.5.4 Backflow Preventer Certification

Submit a Certificate of Full Approval or a current Certificate of Approval for backflow preventers.

1.6 SAFETY STANDARDS

1.6.1 Welding

Safety in welding and cutting of pipe must conform to AWS Z49.1.

1.6.2 Guards

Couplings, motor shafts, gears and other moving parts must be guarded, in accordance with OSHA 29 CFR 1910.219. Guards must be cast iron or expanded metal. Guard parts must be rigid and removable without disassembling the guarded unit.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 Hot Water Heating Pipe (Supply and Return)

****

NOTE: Specify Schedule 40, 80, or 120 steel or Type K or L copper as required for temperature and pressure involved. Type M copper should only be specified for drain piping.

****

ASTM A53/A53M electric resistance welded or seamless Schedule [_____] steel pipe [or ASTM B88M ASTM B88 Type [_____] hard drawn Copper tubing].

2.1.2 Fittings

Provide fittings compatible with the pipe being provided and must conform to the following requirements.

2.1.2.1 Steel or Malleable Iron Pipe

Sizes 3 to 50 mm 1/8 to 2 inches. ASME B16.11 steel socket welding or screwed type or ASME B16.3 for screwed type malleable iron fittings.

2.1.2.2 Steel, Cast Iron, or Bronze

Sizes 65 mm 2 1/2 inches and above. Steel fitting butt welding type ASME B16.9 or ASME B16.5 flanged type. Cast iron fittings flanged type ASME B16.1. Bronze fittings up to 200 mm 8 inch size flanged type ASME B16.24.

2.1.2.3 Fittings for Copper Tubing

ASME B16.18 cast bronze solder joint type or ASME B16.22 wrought copper solder joint type. Fittings may be flared or compression joint type.

2.1.3 Unions

2.1.3.1 Steel Pipe

Provide ASME B16.39, malleable iron unions, threaded connections.

2.1.3.2 Copper Tubing

Provide CID A-A-59617, bronze unions, solder joint end.

2.1.3.3 Dielectric Union

Provide insulated union with galvanized steel female pipe-threaded end and a copper solder joint end conforming with ASME B16.39, Class 1, dimensional, strength and pressure requirements. Union must have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, insulation barrier must be able to withstand a 600-volt breakdown test.

2.1.4 Flanges

Remove raised faces when used with flanges having a flat face.

2.1.4.1 Steel Flanges

ASME B16.5 forged steel, welding type.

2.1.4.2 Cast Iron Screwed Flanges

ASME B16.1.

2.1.4.3 Bronze Screwed Flanges

ASME B16.24.

2.1.5 Drains and Overflows

2.1.5.1 Steel Pipe

ASTM A53/A53M, [Electric resistance welded] [Seamless] Schedule 40, Malleable iron or forged steel fittings, screwed or welded joints.

2.1.5.2 Copper Tubing

ASTM B88M ASTM B88, Type [K,] [L,] [M,] hard drawn, cast brass or wrought copper fittings, Grade Sb5 solder joints.

2.1.5.3 PVC Pipe

ASTM D1785, Schedule 40, [and Schedule 80 for sizes 200 mm 8 inch and larger,] solvent weld joints.

2.1.6 Valves

Valves must have rising stems and must open when turned counterclockwise.

2.1.6.1 Gate Valves

a. Bronze Gate Valves: MSS SP-80, 50 mm 2 inches and smaller, wedge disc, inside screw type not less than Class 150. Use solder joint ends with copper tubing.

b. Steel Gate Valves: ASME B16.34, provide with open stem and yoke type with solid wedge or flexible wedge disc and heat and corrosion-resistant steel trim.

c. Cast Iron Gate Valves: MSS SP-70, 65 mm 2 1/2 inches and larger, open stem and yoke type with bronze trim.

2.1.6.2 Globe and Angle Valves

a. Bronze Globe and Angle Valves: MSS SP-80, 50 mm 2 inches and smaller, Class 200, except use Class 150 with solder ends for copper tubing. Valves must have renewable seat and discs except solder end valves which must have integral seats.

b. Steel Globe and Angle Valves: ASME B16.34, provide with heat and corrosion-resistant trim.

c. Cast Iron Globe and Angle Valves: MSS SP-85, 65 mm 2 1/2 inches and larger, with bronze trim, tapped drains and brass plug.

2.1.6.3 Check Valves

a. Bronze Check Valves: MSS SP-80, 50 mm 2 inches and smaller, regrinding swing check type, Class 200.

b. Steel Swing Check Valves: [ASME B16.34], regrinding swing check type, Class 200.

   (1) Swing check valves must have bolted caps.

   (2) Steel Lift check valves 50 mm 2 inches and smaller must have bolted caps. Lift check valves 65 mm 2 1/2 inches and larger must have pressure seal caps.

c. Cast Iron Check Valves: ASME B16.34, 65 mm 2 1/2 inches and larger, bronze trim, non-slam, eccentric disc type for centrifugal pump discharge service.

2.1.6.4 Temperature Regulating Valves

Provide ASSE 1017 copper alloy body with adjustable range thermostat.

2.1.6.5 Water Pressure-Reducing Valves

ASSE 1003.

2.1.6.6 Plug Valves

MIL-V-12003, except that a replaceable valve seat will not be required. [Type I - lubricated, tapered plug] [Type II - non-lubricated, lift-plug] valves.

2.1.6.7 Ball Valves

Flanged or butt-welding ends ball valve must conform to MSS SP-72, [bronze] [steel]. Threaded, socket-welding, solder joint, grooved and flared ends must conform to MSS SP-110.

2.1.6.8 Radiator Valves

Radiator valves must be angle or straightway pattern, with packed or packless bonnet shutoff globe type, designed especially for hot water heating system. Valve must be constructed of brass or bronze or copper alloy conforming to ASTM specifications for materials with non-metallic renewable disc and plastic wheel handle for shutoff service.

2.1.6.9 Flow Control Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves must be suitable for 862 kPa (gage) 125 psig at 87.8 degrees C 190 degrees F hot water. Valve must function as a service valve when in fully closed position. Valve body must have factory-installed tappings for differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections must have positive check valves or shutoff valves. Each valve must have metal tag showing the liters per second gallons per minute flow for each differential pressure reading.

2.1.6.10 Butterfly Valves

Conform with MSS SP-67, Type I - Tight shut off valve, and [flanged] [screwed] [single flange] [flangeless] valve ends. Valve body material must be [cast iron] [steel] [bronze] and must be bubble tight for shutoff at 1034 kPa (gage) 150 psig. Flanged and flangeless type valves must have Type 300 series corrosion resistant steel stems and corrosion resistant or bronze discs with molded elastomer disc seals. Flow conditions must be for the regulation from maximum flow to complete shutoff by way of throttling effect. Valves must be provided in [closed] [open] system. Valves smaller than 200 mm 8 inches must have throttling handles. Valves 200 mm 8 inches and larger must have totally enclosed manual gear operators with adjustable balance return stops and indicators. Valves must have a minimum of 7 locking positions and must be suitable for water temperatures up to 93 degrees C 200 degrees F.

2.1.6.11 Butterfly Valves 2 Millimeters 2 Inches and Smaller

Valves must be one-piece and three-piece design with male or female threaded or soldered end connections and must be bubble tight for shutoff at 1034 kPa (gage) 150 psig. Stem and disc assembly must be of 300 series corrosion resistant steel. Disc seal assembly must be of 300 series corrosion resistant steel. Disc seal must be suitable for the liquid being used in the system in which the valve is to be installed. Valves must be suitable for water temperature up to 93 degrees C 200 degrees F and must be capable of operating at the rated pressure of [_____] kPa (gage) psig. Valves must be designed for throttling service use by valve lever and indicator adjustment.

2.1.6.12 Relief Valves

Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.1.6.13 Valve Operating Mechanisms

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NOTE: Show location of each floor stand, chainwheel or power operator required in the project. Delete paragraph entitled "Valve Operating Mechanisms" and its subparagraphs if these items are not required in

the project.
****

Provide [floor stands] [chainwheels] [power operators] [and extension stems] where indicated and as specified.

****
NOTE: Show floor stand details including distance from centerline of valve to top of floor, floor thickness, and handwheel height.
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a. Floor Stands: Construct for bolting to the floor and include an extension stem and an operating handwheel. Design an adequately supported and guided extension stems for connection to the valve stem by a sleeve coupling or universal joint. Floor stands must be cast iron or steel. Handwheel must identify rotation direction for closing the valve and must be of such diameter as to permit operation of the valve with a force of not more than 178 N 40 pounds.

b. Chainwheel Operator: Must be fabricated of cast iron or steel and must include a wheel, endless chain and a guide to keep the chain on the wheel. Provide galvanized steel endless chain extending to within one meter 3 feet of the floor.

c. Power Operators: Must be [electric] [pneumatic]. Power operated valves must open and close at rates no slower than 4 mm per second 10 inches per minute for gate valves and 1.70 mm per second 4 inches per minute for globe and angle valves. Valves must open fully or close tightly without requiring further attention when the actuating control is moved to the open or close position. A predetermined thrust exerted on the stem during operation resulting from an obstruction in the valve must cause the motor to automatically stop. Power operators must be complete with all gearing and controls necessary for the size of valve being provided. Power operators must be designed to operate on the [electric] [compressed air] power supply indicated.

d. Extension Stem: Corrosion resisting steel designed for rising and non-rising stems. Provide in length required to connect the valve stem and the [handwheel] [operating mechanism] and of sufficient cross section to transfer the torque required to operate the valve.

2.1.6.14 Balancing Valves

Balancing valves must be calibrated bronze body balancing valves with integral ball valve and venturi or valve orifice and valve body pressure taps for flow measurement based on differential pressure readings. Valve pressure taps and meter connections must have seals and built-in check valves with threaded connections for a portable meter. Meter must be provided by the same manufacturer and be capable of reading system pressures and must meet the requirements of the paragraph entitled "Flow Measuring Equipment." Valves must have internal seals to prevent leakage around rotating element and be suitable for full shut-off rated pressure. Valves must have an operator with integral pointer and memory stop. Balancing valves must be selected for the required flows as indicated on the plans.

2.1.7 End Connections

2.1.7.1 Flexible Connectors

Provide flexible pipe connectors on piping connected to equipment. Flexible section must consist of rubber, tetrafluoroethylene resin, corrosion-resistant steel, bronze, monel, or galvanized steel. Material provided and configuration must be suitable for [pressure,] [vacuum,] [temperature,] and circulating medium. Flexible section must have [threaded,] [welding,] [soldering,] [flanged] [or] [socket-weld] ends and must be suitable for service intended. Flexible section may be reinforced with metal retaining rings, with built-in braided wire reinforcement and restriction bolts or with wire braid cover suitable for service intended.

2.1.7.2 Steel Piping

Screwed or socket welded for 50 mm 2 inches and smaller and flanged or butt welded for 65 mm 2 1/2 inches and larger.

a. Screwed Joints With Taper Threads: ASME B1.20.1.

b. Flanged Joints: Bolting and gaskets must be as follows:

  (1) Bolting: Bolt and stud material ASTM A307, Grade B, and nut material ASTM A194/A194M, Grade 2. Bolt, stud, and nut dimensions ASME B18.2.2 threads ASME B1.1coarse type with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or bolt studs must extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Carbon steel bolts must have American Standard regular square or heavy hexagon heads and must have American Standard heavy semifinished hexagonal nuts conforming to ASME B18.2.2.

  (2) Gaskets: ASME B16.21, Nonasbestos compressed material 1 1/2 mm 1/16 inch thickness full face or self-centering flat ring type and suitable for pressure and temperature of the piping system.

c. Butt Weld Joints: ASME B31.9. Backing rings must conform to ASME B31.9. Ferrous rings must not exceed 0.05 percent sulfur; for alloy pipe, backing rings must be of material compatible with the chemical composition of the parts to be welded and preferably of the same composition. Provide continuous machined or split band backing rings.

d. Socket Weld Joints: ASME B31.9.

2.1.7.3 Joints for Copper Tubing

a. Solder conforming to ASTM B32 alloy grade Sb5 or Sn96. Solder and flux must be lead free (less than 0.2 percent of lead).

b. Copper Tube Extracted Joint: An extracted mechanical tee joint may be made in copper tube. Make joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints must not be permitted.

2.1.8 Expansion Joints

2.1.8.1 Packless Type

Provide ASTM F1120, Type III with fabricated corrosion-resistant steel bellows.

2.1.8.2 Guided Slip-Tube Type

Provide ASTM F1007, Type IV internally-externally guided, injected semiplastic type packing.

2.1.9 Instrumentation

2.1.9.1 Pressure and Vacuum Gauges

Provide ASME B40.100 with restrictor.

2.1.9.2 Indicating Thermometers

Thermometers must be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) must have a nominal scale diameter of 125 mm 5 inches. Construction must be stainless-steel case with molded glass cover, stainless-steel stem and bulb. Stem must be straight, length as required to fit well. Bimetal thermometers must have a scale diameter of 90 mm 3 1/2 inches. Case must be hermetic. Case and stem must be constructed of stainless steel. Bimetal stem must be straight and of a length as required to fit the well.

2.1.9.3 Pressure/Temperature Test Ports

Pressure/Temperature Test Ports must have brass body and EPDM and/or Neoprene valve seals. Ports must be rated for service between 2 and 135 degrees C 35 and 275 degrees F and up to 3447 kPa (gage) 500 psig. Ports must be provided in lengths appropriate for the insulation thickness specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and installed to allow a minimum of 305 mm 12 inches of access for probe insertion. Provide with screw-on cap attached with a strap or chain to prevent loss when removed. Ports must be 8 mm DN 1/4 inch NPT and accept 3 mm 1/8 inch diameter probes.

2.1.10 Miscellaneous Pipeline Components

2.1.10.1 Air Vent

Provide float type air vent in hydronic systems. Vent must be constructed of brass or semi-steel body, copper float, and stainless steel valve and valve seat. Design air vent to suit system operating temperature and pressure. Provide isolating valve to permit service without draining the system. Pipe discharge of vent to a drain.

2.1.10.2 Strainers

Strainers for classes 125 and 250 piping in IPS 15 to 200 mm 1/2 to 8 inches, inclusive, FS WW-S-2739 and locate as indicated.

2.1.10.3 Hangers and Supports

****

NOTE: In project locations with Environmental Severity Classification (ESC) of C4 or C5 or high humidity areas as identified in ASHRAE 90.1 as climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C,include bracketed sentence below to require hot-dipped galvanized hangers where ferrous metals are used. See UFC 1-200-01 for determination of ESC for project locations.

****

Design and fabrication of pipe hangers, supports, and welding attachments must conform to MSS SP-58 and ASME B31.9. Hanger types and supports for bare and covered pipe must conform to MSS SP-58 for the temperature range.[If ferrous materials are used, provide hot dipped galvanized hangers, inserts and supports.]

2.1.10.4 Pipe Sleeves

Sleeves in masonry and concrete walls, floors, and roof slabs must be ASTM A53/A53M, Schedule 40 or Standard Weight, hot-dip galvanized steel [ductile-iron or cast-iron] pipe. Sleeves in partitions must be zinc-coated sheet steel having a nominal weight of not less than 4.40 kilogram per square meter 0.906 pound per square foot.

2.1.10.5 Escutcheon Plates

Provide one piece or split hinge metal plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces and paint finish on metal plates in unfinished spaces.

2.2 CENTRAL MECHANICAL EQUIPMENT

2.2.1 [Boilers

Provide as specified in [Section 23 52 43.00 20 LOW PRESSURE WATER HEATING BOILERS UNDER 800,000 BTU/HR OUTPUT][Section 23 52 46.00 20 LOW PRESSURE WATER HEATING BOILERS OVER 800,000 BTU/HR OUTPUT].

]2.2.2 [Hot Water Heat Exchangers

Provide as specified in Section 23 21 13.23 20 [HIGH] [MEDIUM] TEMPERATURE WATER SYSTEM WITHIN BUILDINGS.

]2.2.3 [Converters

Steam to hot water converters must conform to FS WW-H-191 and must have capacity as indicated for the design conditions. The converters must be designed for support by separate pipe hangers, and [temperature regulator] [vent valve] must be provided.

]2.3 PIPING SYSTEM EQUIPMENT

2.3.1 Pumps

Provide hot water circulating pumps, CID A-A-50560, Service A. Pump casing and flange must be made of close-grained cast iron. Shaft must be carbon or alloy steel with lubricated bearings and impeller must be bronze. Select pumps so that the operating point on selected impeller-curve will lie at or to the left of shutoff side of, and not more than 5 percent below, point of maximum efficiency for impeller. Provide motors of [open] [splash proof] [totally enclosed] type conforming to NEMA MG 1 and suitable for electrical characteristic as indicated. Motor starters must conform to NEMA ICS 2 [manual] [across the line] [reduced-voltage-start] [part-wind] [wye-delta] type with NEMA ICS 6[general purpose] [weather-resistant] [watertight] enclosure.

2.3.2 Expansion Tanks

Provide welded steel, constructed and tested hydrostatically in accordance with ASME BPVC SEC VIII D1. Tank must be equipped with all necessary fittings. The tank and fittings must be pressure rated at least equal to the test pressure of the total system. Zinc coat the tank inside and out after fabrication by the hot dip process ASTM A123/A123M.

2.3.3 External Air Separation Tanks

Provide tank constructed of steel, designed for not less than 517 kPa (gage) 75 psig, and constructed and tested in accordance with the requirements of ASME BPVC SEC VIII D1. Provide tangential inlet and outlet connections, flanged for sizes 65 mm 2 1/2 inches and larger. Each unit must have an internal design suitable for creating the required vortex and subsequent air separation. Provide with automatic air release device and galvanized steel strainer. Provide a blow down connection with a gate valve and piped to nearest floor drain.

2.3.4 Backflow Preventers

****

NOTE: If contract specifications includes Section 22 00 00 PLUMBING, GENERAL PURPOSE in which backflow preventers are specified, delete this paragraph entitled "Backflow Preventers."

****

Reduced pressure principle type. Furnish proof that each make, model/design, and size of backflow preventer being furnished for the project is approved by and has a current "Certificate of Approval" from the [FCCCHR List] [or] [local code]. Listing of a particular make, model/design, and size in the current [FCCCHR List] [or] [local code] will be acceptable as the required proof.

2.3.5 Flow Measuring Equipment

Orifice or venturi type. Flow metering equipment including pitot tubes, venturis, orifice plates, flanges, and indicating meters must be the product of one and the same manufacturer. Provide flowmeters of [permanent type] [or] [portable type] [type indicated]. Flowmeters must be suitable for service in which they are to be installed. Primary elements of flowmeters must conform to ASME recommendations for flowmeters. Provide bronze, monel, or stainless steel materials for wetted parts of flow meters.

a. Orifices: Square-edge type, made of corrosion and erosion resistant metal and mounted between pipe flanges having factory-made pressure taps provided with shutoff valves. Orifice flanges must conform to

ASME B16.36.

b. Tubular Flowmeters: Flow measuring elements consisting of venturi tubes or pitot tubes where indicated. Locations and arrangement of piping, both upstream and downstream of flow measuring elements must conform to the manufacturer's published literature. Provide each flow measuring element with an integral tab, or a metal tag on a corrosion-resistant steel wire, extending outside pipe covering, and stamped or printed in a visible position with manufacturer's name and address; serial number of meter to which it is to be connected; name, number, or location of equipment served; specified rate of flow; and multiplier to be applied to meter reading. Provide taps with shutoff valves and quick connecting hose fittings for portable meters or double ferrule compression fittings for connection to tubing for permanently located meters or recorders. Tubes must be calibrated in accordance with ASME recommendations.

(1) Venturi Tubes: Certified by the manufacturer for the actual piping configuration and any necessary piping changes required for certification without additional cost to the Government. Throat diameter for each venturi tube must be designed so that at specified rate of flow the scale reading will fall between 50 percent and 80 percent of full scale value. Select venturi tube sizes from the manufacturer's latest published tables of flow versus differential pressure. Unrecovered head loss at maximum flow must not exceed 10 percent. Provide bronze or cast iron tubes with bronze-lined throats, with flanged, threaded, or welded ends to suit piping system. Provide bodies of fabricated steel and fittings of the same class as piping in which installed. Two integral meter taps must be provided in each venturi tube. Connections for attachment to portable flow meter hoses must be readily accessible and not over 1830 mm 6 feet above a floor or permanent platform.

(2) Pitot Tube Assemblies: Provide corrosion-resistant materials. Tubes must be capable of measuring liquid flow through tube elements providing an averaged, interpolated flow measurement from a single, fixed position. Provide self cleaning elements and impact tube designed to rotate when turned by the operator to protect pressure-sensing elements of tube when not in use. Location and total amount of pitot tubes required for system flow measurement must be as recommended by the manufacturer and as indicated.

c. Meters: Designed for a full scale pressure differential of 12 kPa 50 inches water gage for tubular type or 25 kPa 100 inches water gage for orifice type. Dials must have square root or linear scales with developed length of not less than 305 mm 12 inches. Provide flush mounted panel meters that read directly in liters per second gallons per minute. Dials of portable meters must have square root scales reading from 0 to 6 L/s 0 to 100 gpm for use with multiplier stamped on orifice or tubular type. Provide meters designed for not less than 1378 kPa 200 psi and protected against pressure surges. Meter bodies must have taps for venting and draining.

(1) Permanently Mounted Meters: Each meter must be connected completely [as indicated] [and] [as specified] and provided with the following: three valve manifold equalizer lines, two block valves, two vent and drain valves, and an integral pulsation

damper. Overall accuracy of meters must be plus or minus 2 percent of full scale flow over a range from 20 to 100 percent of full scale flow.

(2) Portable Meters: Provide meter with a factory-fabricated carrying case with carrying handle. Provide case fitted to hold meter securely and to accommodate the following accessories:

(a) Two 4.60 meters 15 foot lengths of connecting hose with suitable female connectors for connecting from meter to [venturi tube] [orifice flange] [pitot tube] pressure-tap nipples. Provide hose designed for a minimum service pressure of 861 kPa 125 psi or 150 percent of maximum system service pressure, whichever is greater.

(b) A completely assembled three-valve manifold with two block valves and vent and drain valves, piped and mounted on a base designed for use laying flat on a stationary surface.

(c) A bound set of descriptive bulletins, installation and operating instructions, parts list, and a set of curves showing flow versus pressure differential for each orifice, venturi tube, or pitot tube with which meter is to be used.

(d) A metal instruction plate, secured inside cover, illustrating use of meter.

(e) Provide meters with overall accuracy of plus or minus 5 percent of full scale flow over a range from 20 to 100 percent of full scale flow.

2.4 TERMINAL UNITS

2.4.1 Finned Tube Radiators

[Steel tube and steel fin type FS S-R-2834]. [Copper tube and aluminum fin type CID A-A-50545, [must have an adjustable damper].]

2.4.2 Convectors

CID A-A-50543 and CID A-A-50544, of design and capacity not less than that indicated.

2.4.3 Unit Heaters

Provide hot water unit heaters as specified in Section 23 82 00.00 20 TERMINAL HEATING UNITS.

2.4.4 Heating and Ventilating Units

Provide fan-coil units, induction units, unit ventilators, and gravity ventilators as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5 ELECTRICAL EQUIPMENT

Provide complete with motors, motor starters, thermal overload protection, and controls. Equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.6 CONTROLS

Provide controls as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.7 INSULATION

Provide shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 ASBESTOS PROHIBITION

Asbestos and asbestos containing products are prohibited.

PART 3 EXECUTION

3.1 PREPARATION

Provide storage for equipment and material at the project site. All parts must be readily accessible for inspection, repair, and renewal. Protect material and equipment from the weather.

3.2 INSTALLATION

Piping fabrication, assembly, welding, soldering, and brazing must conform to ASME B31.9. Piping must follow the general arrangement shown. Route piping and equipment within buildings out of the way of lighting fixtures and doors, windows, and other openings. Run overhead piping in buildings in inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit welding of joints and application of insulation. Make provision for expansion and contraction of pipe lines. Make changes in size of water lines with reducing fittings. Do not bury, conceal, or insulate until piping has been inspected, tested, and approved. Do not run piping concealed in walls, partitions, underground, or under the floor except as otherwise indicated. Where pipe passes through building structure, locate pipe joints and expansion joints where they may be inspected. Provide flanged joints where necessary for normal maintenance and where required to match valves and equipment. Furnish gaskets, packing, and thread compounds suitable for the service. Provide long radius ells where possible to reduce pressure drops. Pipe bends in lieu of welding fittings may be used where space permits. Pipe bends must have a uniform radius of at least five times the pipe diameter and must be free from appreciable flattening, wrinkling, or thinning of the pipe. Do not use mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction. Make branch connections over 50 mm 2 inches with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.9 may be used, provided the nominal diameter of the branch is at least one pipe size less than the nominal diameter of the run. Branch connections 50 mm 2 inches and under can be threaded or welded. Run vertical piping plumb and straight and parallel to walls. Provide sleeves for lines passing through building structure. Provide a fire seal where pipes pass through fire wall, fire partitions, fire rated pipe chase walls, or floors above grade. Install piping connected to equipment with flexibility for thermal stresses and for vibration, and support and anchor so that strain from weight and thermal movement of piping is not imposed on the equipment.

3.2.1 Hangers and Supports

Unless otherwise indicated, horizontal and vertical piping attachments must conform to MSS SP-58. Band and secure insulation protection shields without damaging pipe insulation. Continuous inserts and expansion bolts may be used.

3.2.2 Grading of Pipe Lines

Unless otherwise indicated, install horizontal lines of hot water piping to grade down in the direction of flow with a pitch of not less than 25 mm in 9 meters one inch in 30 feet, except in loop mains and main headers where the flow may be in either direction.

3.2.3 Pipe Sleeves

Provide sleeves where pipes and tubing pass through masonry or concrete walls, floors, roof, and partitions. Annular space between pipe, tubing, or insulation and the sleeve must not be less than 6 mm 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves must be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs must extend 50 mm 2 inches above finished floor. Firmly pack space between pipe or tubing and sleeve with oakum and caulk on both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a [mechanically adjustable] segmented elastomeric seal. Seal both ends of penetrations through fire walls and fire floors to maintain fire resistive integrity with UL listed fill, void, or cavity material.

3.2.4 Flashing for Buildings

Provide flashing where pipes pass through building roofs, and make outside walls tight and waterproof.

3.2.5 Unions and Flanges

Provide unions and flanges to permit easy disconnection of piping and apparatus. Each connection having a screwed-end valve must have a union. Place unions and flanges no farther apart than 30 meters 100 feet. Install unions downstream of valves and at equipment or apparatus connections. Provide unions on piping under 50 mm 2 inches in diameter, and provide flanges on piping 50 mm 2 inches and over in diameter. Provide dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous-to-non-ferrous connections.

3.2.6 Connections for Future Equipment

Locate capped or plugged outlets for connections to future equipment as indicated.

3.2.7 Changes in Pipe Size

Provide reducing fittings for changes in pipe size; reducing bushings are not permitted. In horizontal lines, provide eccentric reducing fittings to maintain the top of the lines in the same plane.

3.2.8 Cleaning of Pipe

Thoroughly clean each section of pipe, fittings, and valves free of foreign matter before erection. Prior to erection, hold each piece of pipe in an inclined position and tap along its full length to loosen sand, mill scale and other foreign matter. For pipe 50 mm 2 inches and larger, draw wire brush, of a diameter larger than that of the inside of the pipe, several times through the entire length of pipe. Before making final connections to apparatus, wash out interior of piping thoroughly with water. Plug or cap open ends of mains during shutdown periods. Do not leave lines open where foreign matter might enter the pipe.

3.2.9 Valves

Install valves in conformance with ASME B31.9. Provide gate valves unless otherwise directed. Install valves with stems horizontal or above. Locate or equip stop valves to permit operation from floor level, or provide with safe access in the form of walkways or ladders. Install valves in positions accessible for operation and repair.

3.2.9.1 Globe Valves

Install globe valves so that the pressure is below the disk and the stem horizontal.

3.2.9.2 Radiators Valves

Provide radiator valves on water inlet and balancing valves on water outlet of terminal heating units such as radiation, unit heaters, and fan coil unit.

3.2.9.3 Relief Valves

Provide valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks. Select system relief valve so that capacity is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment. Pipe relief valve outlet to the nearest floor drain.

3.2.10 Pressure Gage

Provide a shut-off valve or pet cock between pressure gages and the line.

3.2.11 Thermometers

Provide thermometers and thermal sensing elements of control valves with a separable socket. Install separable sockets in pipe lines in such a manner to sense the temperature of flowing the fluid and minimize obstruction to flow.

3.2.12 Strainers

Provide strainers, with meshes suitable for the services, where indicated, or where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.2.13 Pumps

Select pumps for specified fluid temperatures, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve. Support piping adjacent to pump such that no weight is carried on pump casings. Install close coupled and base mounted pumps on concrete base, with anchor bolts, set and level, and grout in place and provide supports under elbows on pump suction and discharge line sizes 100 mm 4 inches and over. Lubricate pump before start-up.

3.2.14 Equipment Foundations

Locate equipment foundations as shown on the drawings. Size, weight, and design must preclude shifting of equipment under operating conditions. Foundations must meet the requirements of the equipment manufacturer. Concrete must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE, and grout must be approved non-shrinking.

3.2.15 Equipment Installation

Install equipment in accordance with installation instructions of the manufacturers. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on the equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets.

3.2.16 Cleaning of Systems

As installation of the various system components is completed, fill, start, and vent prior to cleaning. Place terminal control valves in open position. Add cleaner to closed system at concentration as recommended by manufacturer. Apply heat while circulating, slowly raising temperature to 71 degrees C 160 degrees F and maintain for 12 hours minimum. Remove heat and circulate to 38 degrees C 100 degrees F or less; drain systems as quickly as possible and refill with clean water. Circulate for 6 hours at design temperatures, then drain. Refill with clean water and repeat until system cleaner is removed. Use neutralizer agents on recommendation of system cleaner supplier and approval of Contracting Officer. Remove, clean, and replace strainer screens. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required. Preliminary or final tests are not permitted until cleaning is approved.

3.2.17 Painting of Piping and Equipment

****

NOTE: When the project specification does not have a section on field painting, the requirements in Section 09 90 00 PAINTS AND COATINGS for cleaning and painting of pipe and equipment, and for painting and stenciling of piping must be included in this section.

****

Provide in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.18 Identification of Piping

****

NOTE: When the project specification does not have a section on field painting, the requirements in

Section 09 90 00 for cleaning and painting of pipe and equipment, and for painting and stenciling of piping must be included in this section.
****

Identify piping in accordance with OSHA 29 CFR 1910.144, except that labels or tapes may be used in lieu of painting or stenciling. Spacing of identification marking on runs must not exceed 15 meters 50 feet. Materials for labels and tapes must conform to CID A-A-1689, and must be general purpose type and color class. Painting and stenciling must conform to Section 09 90 00 PAINTS AND COATINGS.

3.3 FIELD QUALITY CONTROL

Perform inspections and tests as specified herein to demonstrate that piping and equipment, as installed, is in compliance with contract requirements. Start up and operate the system. During this time, periodically clean the various strainers until no further accumulation of foreign material occurs. Exercise care so that minimum loss of water occurs when strainers are cleaned. Adjust safety and automatic control instruments to place them in proper operation and sequence.

3.3.1 Hydrostatic Test of Piping System

****
NOTE: Test piping systems at one and one-half times system pressure or 345 kPa (gage) 50 psig whichever is greater.
****

Test piping system hydrostatically using water not exceeding 38 degrees C 100 degrees F. Conduct tests in accordance with the requirements of ASME B31.9 and as follows. Test piping system after all lines have been cleaned and before applying insulation covering. Remove or valve off from the system, gages, and other apparatus which may be damaged by the test before the tests are made. Install calibrated test pressure gage in the system to observe any loss in pressure. Maintain test pressure for a sufficient length of time to enable an inspection of each joint and connection. Perform tests after installation and prior to acceptance. Notify the Contracting Officer in writing [_____] days prior to the time scheduled for the tests.

3.3.2 Auxiliary Equipment and Accessory Tests

Observe and check pumps, accessories, and equipment during operational and capacity tests for leakage, malfunctions, defects, noncompliance with referenced standards, or overloading.

3.3.2.1 Backflow Preventers

Backflow preventers must be tested by locally approved and certified backflow assembly testers. A copy of the test report must be provided to the Contracting Officer prior to placing the domestic water system into operation, or no later than 5 days after the test.

3.4 TESTING, ADJUSTING, AND BALANCING

****
NOTE: Use the first sentence for simple hydronic

systems and where Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVACis not included in the specifications. Use the second sentence for all specifications with Section 15996.

****

[Except as specified herein, perform in accordance with SMACNA 1780, Chapter VIII "Hydronic System TAB Procedures," drawings and specifications; prepare complete report of final test results.] [Test, adjust, and balance the hydronic system in accordance with Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.]

3.4.1 Markings of Settings

Following final acceptance of the balancing report, the settings of all valves, splitters, dampers, and other adjustment devices must be permanently marked so that adjustment can be restored if disturbed at anytime.

3.4.2 Sound Level Tests

Upon completion of testing and balancing of hydronic systems, conduct sound level tests of conditioned spaces. Use sound level meter required by ASA S1.4, Type 2, calibrated in accordance with NBS standards and guidelines, and accompanied by a certificate of calibration. Record sound levels in dBA with heating systems off and with heating systems operating. Record the following data for each room and system:

a. Background sound level (systems off);

b. Total sound level corrected for background; and

c. Sound power rating by manufacturer of the respective outlet.

Test Locations: Take sound level reading at location 2 meters 6 feet from face of each outlet on a line at 45 degrees with face of outlet. Remedial Action: If sound level at any observation point exceeds [20] [45] [_____] dBA, take remedial action as directed.

3.5 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a.	[_____]	[_____]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 21 13.23 20 (July 2007)**
Change 1 - 11/19

Preparing Activity: NAVFAC **Superseding**
UFGS-15184N (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 21 13.23 20

[HIGH][MEDIUM]TEMPERATURE WATER SYSTEM WITHIN BUILDINGS

07/07, CHG 1: 11/19

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-23 21 13.23 20 (July 2007)**
Change 1 - 11/19

Preparing Activity: NAVFAC **Superseding**
UFGS-15184N (April 2006)

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****

SECTION 23 21 13.23 20

[HIGH][MEDIUM]TEMPERATURE WATER SYSTEM WITHIN BUILDINGS

07/07, CHG 1: 11/19

****

NOTE: This guide specification covers the requirements for high and medium temperature water piping systems inside of building mechanical rooms, including connections to interior existing piping and system terminal unit.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Project requirements may require addition of supplemental information to the paragraphs contained herein, however, designer is cautioned to verify additional references to ascertain applicability of materials to system design prior to inclusion.

****

****

NOTE: The following information must be shown on the project drawings:

1. Flow diagram of high or medium temperature water piping indicating connections to existing supply and return, pressure and temperature of existing supply

and return, (maximum and minimum or constant, applicable), valves and critical valve positions (including normally closed for bypass valve), any necessary flow rates, pressure drops not already in equipment schedule or specifications, and location of temperature and/or pressure sensors.

2. System Terminal Unit detail providing location of all piping including valves, strainers, flanges, fittings, connections, and supports (coordinate with Section 23 21 13.00 20 and Section 23 22 26.00 20).

3. Single line plan and any necessary sections indicating location, sizes, and routing of all associated piping.

4. Appropriate schedules for equipment, including any reset schedules.

5. Information necessary when asbestos material is involved (See second note in paragraph entitled "Description").

6. Detail of connections to existing high or medium temperature water piping, including air chambers and vents as required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications

ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA Z535.1	(2022) Safety Colors

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.144	Safety Color Code for Marking Physical Hazards

1.2 DEFINITIONS

1.2.1 Medium Temperature Water (MTW)

Heating hot water systems operating at 121 to 177 degrees C 250 to 350 degrees F.

1.2.2 High Temperature Water (HTW)

Heating hot water systems operating at greater than 177 degrees C but less than 232 degrees C 350 degrees F but less than 450 degrees F.

1.2.3 Terminal Unit

Heat exchanger or steam producer using [HTW][MTW] as the primary heating medium.

1.2.4 Steam Producer

Unfired steam generator.

1.3 GENERAL REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with additions and modifications specified herein.

1.3.1 Associated Work

****

NOTE: Edit, specifying all associated sections for the specific project.

****

Other work associated with this section including insulation, hot water piping, hot water distribution outside the building, steam, and painting is covered in other sections of this specification.

1.3.2 Description

****

NOTE: Work should be confined to inside of building mechanical rooms. Avoid running high or medium temperature water in occupied spaces or where hidden from access or view.

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NOTE: This section requires connections to existing high or medium temperature water piping that may contain asbestos insulation or associated material. Sampling and testing of suspicious material and subsequent inclusion of Section 02 82 00 ASBESTOS REMEDIATION or Section 02 83 00 LEAD REMEDIATION and appropriate plans for asbestos material removal and disposal must be verified by the designer and provided as necessary.

****

The work must include the furnishing, installing, and testing of high temperature water piping inside the building, as indicated, together with all fittings and appurtenances necessary for a complete and operable system. [The work also includes [modifications] [and] [[HTW][MTW] system connection] to the existing [HTW][MTW] piping.]

1.3.3 Classes and Maximum Working Pressures

Except as specified otherwise, piping components must be suitable for use under the maximum working pressures indicated. Except as modified herein, the pressure temperature limitations must be as specified in the referenced standards and specifications. All pressures in this specification are pressures in kilopascal (kPa) pounds per square inch (psi) above atmospheric pressure, and all temperatures are in degrees Celsius (C) degrees Fahrenheit (F).

1.3.4 Field Verification

The Contractor must become familiar with all details of the work, verify all dimensions in the field, verify the maximum operating temperature and pressure of the heating distribution system with the heating plant foreman, and advise the Contracting Officer of any discrepancy within 3 days and before performing any work.

1.3.5 Identification

Each major item of equipment must have the manufacturer's name, address, type or style, and model or serial number on a plate secured to the item of equipment.

1.3.6 Welding Safety

Safety in welding and cutting of pipe must conform to AWS Z49.1.

1.3.6.1 Procedures and Qualifications

Before any welding is performed, the Contractor must submit welding procedure specifications for all metals included in the work, together with proof of its qualification as outlined in ASME B31.1.

Before any welder or operator performs any welding, submit Welder's Performance Qualification Record in conformance with ASME B31.1showing that the welder was rated under the approved procedure specification submitted by the Contractor. In addition, submit each welder's assigned number, letter, or symbol used to identify the work of the welder, and affix immediately upon completion of the weld. To welders making defective welds after passing a qualification test, give a qualification test and upon failing to pass the test, do not permit to work this contract.

Welders and welding operators previous qualifications on welding procedures test may be accepted for the contract without requalification subject to the approval and provided that all the conditions specified in ASME B31.1 are met before a procedure can be used.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Valves

Packing

Gaskets

SD-02 Shop Drawings

[HTW][MTW] System connection diagrams (within building)

SD-03 Product Data

Valves

Strainers

Pipe

Pipe fittings

[Heat exchanger]

[Steam producer]

[Expansion joints]

Information must show details, dimensions, capacities, and ratings.

SD-07 Certificates

Welding procedure specifications

Performance qualification record

Previous qualifications

Valves

Gaskets

PART 2 PRODUCTS

2.1 PIPE AND PIPE SYSTEM

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NOTE: When individual branch loops require circulating pumps due to constant volume plant system design or insufficient available differential pressure for terminal unit control valve in a variable volume plant system design, designer must provide appropriate pump specifications herein.

Pumps must be carefully sized for the specific loop only such that operation of the main plant system and other branch loops is not affected.

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NOTE: If it is necessary to provide for additional thermal expansion of piping, designer may provide design and specification for either expansion loop(s) or mechanical expansion joints for the particular service, however, expansion loop(s) are preferred.

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2.1.1 High Pressure Piping System

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NOTE: Specify the maximum pressure and temperature leaving the central heating plant. Note that some operating pressures may be substantially higher than corresponding saturation pressures at the supply temperature, depending upon the method of plant generator pressurization (Booster pumps and compressed gas pressurization methods produce distribution pressures considerably higher than steam buffer type method). Select design pressure equal or greater than one and one half (1-1/2) times the maximum operating pressure.

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ASME B31.1; Maximum operating pressure of [_____] kPa psi at [_____] degrees C degrees F; design pressure of [2068] [2758] [4136] [_____] kPa [300] [400] [600] [_____] psi.

2.1.2 Pipe

Pipe 50 mm 2 inches in diameter and larger: schedule 80, black steel plain end beveled, ASTM A53/A53M, Grade B, Type E (electric resistance welded) or S (seamless), or ASTM A106/A106M, Grade B. Pipe sizes through 40 mm 1 1/2 inches in diameter: schedule 80, black steel, ASTM A106/A106M, Grade B.

2.1.3 Pipe Fittings

Fittings must be compatible in thickness with the pipe being used, must be used in conformance with ASME B31.1, and must conform to the following requirements. Steel welded fittings: ASTM A234/A234M. Flanges must be serrated or raised-faced type. In horizontal lines, reducing fittings must be the eccentric type and installed to ensure that the system can be thoroughly drained. Remove raised faces when used with existing flanges having a flat face.

2.1.3.1 Fittings for Steel Pipe Sizes 3 to 50 mm 1/8 to 2 inches

ASME B16.11, Class 300 steel socket welding type.

2.1.3.2 Fittings for Steel Sizes 65 mm 2 1/2 inches and Above

Steel fitting butt welding type ASME B16.9 or ASME B16.5flanged type, Class 300.

2.1.4 Gaskets

The Contractor must submit the manufacturers published temperature and pressure ratings and provide materials recommended by the manufacturer for the maximum operating temperature, system design pressure, and service specified herein.

2.1.5 Bolting

Bolt studs for flanged joints must be alloy steel studs, threaded on both ends and fitted with two hexagon nuts per stud. Bolt must be ASME B18.2.1 and material must conform to ASTM A193/A193M, Grade B-7, threads Class 7 fit. Nuts must be American Standard Heavy semi-finished hexagonal (ASME B18.2.2) and material must conform to ASTM A194/A194M, Grade 7.

2.1.6 Vents

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NOTE: Air chambers may be deleted if branch connections are made to bottom half of existing overhead supply and return mains. See paragraph entitled "Branch Connections" herein.

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Provide air chambers and manual air vent valves as indicated at all high points in the [HTW][MTW] system. Provide a 15 mm 1/2 inch vent line from each air vent to the nearest drain. Vent lines must be provided with two 15 mm 1/2 inch bar stock globe valves as indicated.

2.1.7 Valves; Gate, Globe, Ball, Check, Angle, and Control

All valve materials must conform to ASME B16.34. Valve bodies must be carbon or stainless steel (Type 304 or 316) with stainless steel trim. All valves must be Class 300. Ends must be butt welding or raised face flanged type conforming to ASME B16.34. Valve pressure and temperature design values must not be exceeded. The Contractor must submit the manufacturers recommended materials list for valves, packing, and gaskets with certification that all meet the system design pressure at maximum operating temperature and the service as specified herein.

2.1.7.1 Globe Valves

Globe type valves must have outside screw and yoke with bolt bonnets, and flat seats, but must not be of the reversed-cup type. The stuffing boxes must be large and deep. Valves 50 mm 2 inches and larger must have at least six U or V type [teflon-impregnated braided non-asbestos] [_____] packing rings, specifically designated as suitable for high-temperature water. Valves smaller than 50 mm 2 inches must have four or five rings. Spiral or continuous packing will not be acceptable. A metal insert must be provided having proper clearance around the stem at the bottom of the stuffing box and acting as a base for the packing materials. Packing glands must be furnished with liner of noncorrosive material and must be of one piece with not less than two bolts. Valves 32 mm 1 1/4 inches and smaller need not have yokes or bolted screws and deep stuffing boxes. Stems must be provided with bevel above the disk for cutoff and repacking valve under pressure when fully open. On the underside side of the bonnet a pack-under-pressure bushing of stainless steel must be provided. The bushing must be screwed into place.

2.1.7.2 Gate Valves

Gate valves, wedge gate type, outside screw and yoke, valve body with straight through ports without recesses except between seats to assure minimum turbulence, erosion, and resistance to flow. The bonnet must be equipped with a bonnet bushing. The valves must have a self-centering male and female joint equipped with a gasket.

2.1.7.3 Temperature Control Valves

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NOTE: Provide valve operating conditions based upon the type of control maintained at the central heating plant for the distribution system, and the arrangement of piping at the system terminal unit. Three-way valves and balancing valves are not recommended, nor any arrangement that may allow a drop in temperature/pressure sufficient to cause flash to steam. The delta P at design load should not be less than one half the available pressure drop across the valve in order for the equal-percentage type valve to function properly.

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Note: Control valve delta P at design load (valve full open) must not be less than 34 kPa 5 psi. If the control valve available differential pressure drop with valve full open is less than 34 kPa 5 psi, it is necessary to provide a pump sized for the specific branch (loop) only, which does not affect other system branches, to boost the available pressure.

****

Two-way, single seated, equal percentage-flow type, industrial quality flow regulating (control) valve conforming to the materials specified herein, and size selected by the valve manufacturer for the following conditions:

a. Maximum flow rate: [_____] L/s Gpm

b. Minimum flow rate: [_____] L/s Gpm

c. Internal pressure: [_____](maximum operating) kPa Psi

d. Pressure differential at design load: [_____](open) delta p, kPa Psi

e. Pressure Differential at minimum load: [_____] (closed) delta p, kPa Psi (Equal to pump head or controlled differential pressure in variable volume flow system)

Provide automatic operator with manual override (handwheel) and position indicator.

2.1.7.4 Emergency Shutoff Valve

[HTW] [MTW] automatic, quick closing, ball valve located between the manual [HTW] [MTW] supply shutoff valve and the system terminal unit inlet, with pressure/temperature sensor located on the shell side. Emergency valve must automatically close when the pressure/temperature setting of the shell side safety relief valve is reached. Emergency Valve must be normally open.

2.1.8 Strainers

Body materials must conform to ASME B16.34, Fine Mesh type strainer and trim must be Type 304 or 316 stainless steel, selected for the service specified herein.

2.1.9 Joints

2.1.9.1 Welded Joints

Joints between sections of pipe and between pipe and fittings must be welded. Joints between pipe and valves must be welded or flanged. The welding must conform to requirements of paragraph entitled "Responsibility of Contractor for Fusion Welding." Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitations. Branch outlet fittings where used must be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe-bursting strength.

2.1.9.2 Flanged Joints

Joints for connection to valves in high or medium temperature water system must be welded or flanged, faced true, provided with gaskets, and made perfectly square and tight. Flanges must be forged steel, raised face, weld-neck type. Slip-on flanges will not be allowed. Gaskets for [HTW] [MTW] systems must be [metallic non-asbestos] [_____].

2.1.10 Hangers and Supports

****

NOTE: In project locations with Environmental Severity Classification (ESC) of C4 or C5 or high humidity areas as identified in ASHRAE 90.1 as climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C, include bracketed sentence below to require hot-dipped galvanized hangers if ferrous materials are used. See UFC 1-200-01 for determination of ESC for project locations.

****

ASME B31.1, MSS SP-58, and as specified herein.[If ferrous materials are used, provide hot-dipped galvanized hangers, inserts and supports.]

2.1.11 Pipe Sleeves

Schedule 80 steel pipe, and as specified herein.

2.1.12 Caulking and Sealants

Materials as recommended by the manufacturer for the service specified herein.

2.1.13 Instrumentation

2.1.13.1 Pressure Gages

ASME B40.100, with corrosion resistant steel trim for high temperature water service. Dial range must be 0 kPa psi to the system design pressure specified herein. Provide stainless steel isolation petcock.

2.1.13.2 Indicating Thermometers

Thermometers must be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) must have a nominal scale diameter of 127 mm 5 inches. Construction must be stainless-steel case with molded glass cover, stainless-steel stem and bulb. Stem must be straight, length as required to fit well. Bimetal thermometers must have a scale diameter of 90 mm 3 1/2 inches. Case must be hermetic. Case and stem must be constructed of stainless steel. Bimetal stem must be straight and of a length as required to fit the well.

2.1.14 System Terminal Units

2.1.14.1 Heat Exchanger, [HTW][MTW]

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NOTE: Since the hot water heat exchanger and associated hot water piping is specified in Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEM and high or medium temperature water piping herein, coordination for the heat exchanger details indicating arrangement of piping is necessary. Avoid redundancy between Section 23 21 13.23 20 [HIGH] [MEDIUM] TEMPERATURE WATER SYSTEM WITHIN BUILDINGS, Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEM and other related specifications sections. When paragraph entitled "Pressure Gages" is used, provide auxiliary piping and accessories in other sections, including relief valve, thermal measuring element (sensor), and auxiliary piping and wiring, alarms, controllers, and flow switches.

****

Designed for an operating pressure of 2758 kPa 400 psi [_____] and a temperature of 204 degrees C 400 degrees F [_____]; factory tested hydraulically to 4136 kPa 600 psi [_____]; welded steel support brackets or flanges; Class 300 steel primary water flanges; stainless steel or seamless, stress relieved, cupro-nickel (90-10) U-tubes; steel head and flanged opening for easy tube bundle removal; tube sheets and baffles of [same material as tubes][steel]; steel shell designed for a pressure of 4136 [2758] [2068] kPa 600 [400] [300] psi; openings for ASME pressure relief valve, thermal measuring element (sensor), pressure gage, vent, thermometer, and drain, provided by welded fittings to shell; handholes provided where indicated or recommended by manufacturer. Arrangement of heat exchanger piping must be as indicated such that [HTW] [MTW] (primary heating medium) is connected to the U-tube side (with offset flanges) and secondary water to the shell side. The heat exchanger must be designed in accordance with ASME BPVC SEC VIII D1, and carry the code stamp.

2.1.14.2 Steam Producer, [HTW][MTW]

****

NOTE: When paragraph entitled "Indicating Thermometers" is used, coordination with Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS and other related sections is necessary. Designer must provide specifications for the following accessories:

1. Feedwater pump(s).

2. Condensate receiver.

3. Blowdown tank.

4. Chemical feed.

5. Makeup water.

6. Auxiliary piping & wiring.

7. Magnetrol water column pump controller/low water cutoff.

8. Proportional pressure controller with pressure sensing element for control valve.

****

Arranged with [HTW] [MTW] on the U-tube side and steam on the shell side, designed for an operating pressure of 2758 kPa 400 psi [_____] and a temperature of 204 degrees C 400 degrees F [_____], factory tested hydraulically to 4136 kPa 600 psi [_____]; welded steel support brackets or flanges; Class 300 steel water connections (offset); stainless steel or seamless, stress relieved, cupro-nickel (90-10) U-tubes; steel head and flanges opening for easy tube bundle removal; steel shell designed for a minimum pressure of 862 kPa 125 psi; openings for feedwater/makeup water, drain, blowdown, steam outlet, water level gage, water level control mechanism (pneumatic or electric), ASME safety relief valve [one] [two], pressure gage, [manhole] [handholes], chemical feed, and vent; internal water separator welded to shell at steam exit. The steam producer must be designed in accordance with ASME BPVC SEC VIII D1, and carry the code stamp.

PART 3 EXECUTION

3.1 INSTALLATION

Arrange work in a neat and orderly manner so that minimum storage of equipment and material is required at the project site. All parts must be readily accessible for inspection, repair, and renewal. Protect material and equipment from the weather.

3.2 PIPING

Unless specifically stated to the contrary, fabrication, assembly, welding, soldering, and brazing must conform to ASME B31.1 for all piping of the hot water system. All piping must follow the general arrangement shown; cut accurately to measurements established for the work by the Contractor, and work into place without springing or forcing, except where cold-springing is specified. Install piping within buildings entirely out of the way of lighting fixtures and doors, windows, and other openings. Run overhead piping in buildings in the most inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit the welding of joints; at least 150 mm 6 inches for pipe sizes 100 mm 4 inches and less, 254 mm 10 inches for pipe sizes over 100 mm 4 inches, and in corners provide sufficient clearance to permit the welder to work between the pipe and one wall. Make provision for expansion and contraction of pipe lines. Make changes in size of water lines with reducing fittings. Do not bury, conceal, or insulate piping until it has been inspected, tested, and approved. Protect materials and equipment from the weather. Do not run piping concealed in walls or partitions or underground or under the floor except as otherwise indicated. Where pipe passes through building structure, do not conceal pipe joints but locate where they may be readily inspected. Run all pipe to be insulated as shown and as required with sufficient clearance to permit application of insulation. Use flanged joints only where necessary for normal maintenance and where required to match valves. Provide gaskets, packing, and thread compounds suitable for the service. Use long radius ells wherever possible to reduce pressure drops. Pipe bends in lieu of welding fittings may be used where space permits. Pipe bends must have a uniform radius of at least five times the pipe diameter and must be free from any appreciable flattening, wrinkling, or thinning of the pipe. Changes in direction may be made by bending of pipe provided that a hydraulic pipe bender is used. Pipe to be bent must be steel conforming to ASTM A53/A53M, Class required to match adjoining pipe. Bent pipe showing kinks, wrinkles, or malformations will not be acceptable. Do not use mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction. Make all branch connections with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1. Open ends of pipe lines and equipment must be properly capped or plugged during installation to keep dirt and other foreign matter out of the system. Pipe not otherwise specified must be uncoated.

3.2.1 Branch Connections

Branches from supply and return mains must be taken off as indicated or as approved. Connections must be carefully made to ensure unrestricted circulation, eliminate air pockets, and permit the complete drainage of the system. Changes in horizontal piping sizes must be made through eccentric reducing fittings.

3.2.2 Cleaning of Piping (Pre-Erection)

Thoroughly clean each section of pipe, fittings, and valves of all foreign matter before erection as follows: hold each piece of pipe in an inclined position and thoroughly tap along its full length to loosen sand, mill scale and other foreign matter. Pipe 50 mm 2 inches and larger must have a wire brush of a diameter larger than that of the inside of the pipe drawn through its entire length several times. Before final connections are made to apparatus, wash out the interior of all piping thoroughly with water. Plug or cap open ends of mains during all shutdown periods. Do not leave lines open at any place where any foreign matter might accidentally enter pipe.

3.2.3 Cleaning of Piping (Post-Erection)

Prior to the hydrostatic, performance and operating tests, the interior of the heat-carrying piping must be flushed with water until the piping is free of all foreign materials to the satisfaction of the [Contractor Quality Control representative] [Contracting Officer].

3.2.4 Valves

3.2.4.1 General

Install valves in conformance with ASME B31.1 and as required herein at the locations indicated. Install valves with stems horizontal or above. Locate or equip stop valves to permit operation from floor level, or provide with safe access in the form of walkways or ladders. Install valves in positions accessible for operation and repair.

3.2.4.2 System Terminal Unit Piping

****

NOTE: Ascertain that the flow in the hot water side (shell) is continuous to preclude overheating, that the hot water supply side is provided with appropriate safety relief valve piped to drain, and that any necessary alarms and flow switches are provided on the hot water supply of the heat exchanger. Ascertain also that the high or medium temperature water is on the tube side of the heat exchanger and hot water on the shell side.

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NOTE: The following information must be shown on the project drawings:

1. Flow diagram of high or medium temperature water piping indicating connections to existing supply and return, pressure and temperature of existing supply and return, (maximum and minimum or constant, applicable), valves and critical valve positions (including normally closed for bypass valve), any necessary flow rates, pressure drops not already in equipment schedule or specifications, and location of temperature and/or pressure sensors.

2. System Terminal Unit detail providing location of all piping including valves, strainers, flanges, fittings, connections, and supports (coordinate with Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEM and Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS).

3. Single line plan and any necessary sections indicating location, sizes, and routing of all associated piping.

4. Appropriate schedules for equipment, including any reset schedules.

5. This section requires connections to existing high or medium temperature water piping that may contain asbestos insulation or associated material. Provide plans for removal and disposal of such material.

6. Detail of connections to existing high or medium temperature water piping, including air chambers and vents as required.

Since the hot water heat exchanger and associated hot water piping is specified in Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEM and high or medium temperature water piping herein, coordination for the heat exchanger details indicating arrangement of piping is necessary. Avoid redundancy between Section 23 21 13.23 20 [HIGH] [MEDIUM] TEMPERATURE WATER SYSTEM WITHIN BUILDINGS, Section 23 21 13.00 20 LOW TEMPERATURE WATER (LTW) HEATING SYSTEM and other related specifications sections. When paragraph entitled "Pressure Gages" is used, provide auxiliary piping and accessories in other sections, including relief valve, thermal measuring element (sensor), and auxiliary piping and wiring, alarms, controllers, and flow switches.

When paragraph entitled "Indicating Thermometers" is used, coordination with Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS and other related sections is necessary. Designer must provide specifications for the following accessories:

1. Feedwater pump(s).

2. Condensate receiver.

3. Blowdown tank.

4. Chemical feed.

5. Makeup water.

6. Auxiliary piping & wiring.

7. Magnetrol water column pump controller/low water cutoff.

8. Proportional pressure controller with pressure sensing element for control valve.

****

All associated [HTW] [MTW] piping must conform to the requirements specified herein and arrangement be as indicated and specified. Install control valve in the return side providing an upstream strainer, gate isolation valves, and a bypass with a globe or plug valve (Do not install control valve in supply with a check valve in the return). Install automatic emergency shutoff valve to provide quick [HTW] [MTW] shutoff in case of U-tube rupture and to protect the secondary piping. Install gate isolation valve in the supply. Provide a dirt leg with a gate isolation valve and capped end for the supply line drop. All valves must be installed in horizontal lines. Arrange connections to system terminal units with offset flanges such that adequate clearance is provided for pulling tubes and maintenance without requiring breaking of pipe.

3.2.5 Cleaning and Painting of Piping and Equipment

Clean and paint piping in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.6 Identification of Piping and Physical Hazards

Identify all piping & physical hazards in accordance with 29 CFR 1910.144, ASME A13.1, and NEMA Z535.1. Spacing of identification marks on runs must not exceed 15 meters 50 feet. Painting and stenciling must conform to Section 09 90 00 PAINTS AND COATINGS. Colors must conform to NEMA Z535.1.

3.2.7 Hangers and Supports

The design and fabrication of pipe hangers, supports, and welding attachments must conform to MSS SP-58 and ASME B31.1. Hanger types and supports for bare and covered pipe must conform to MSS SP-58for the temperature range. Unless otherwise indicated, horizontal and vertical piping attachments must conform to MSS SP-58. Continuous inserts and expansion joints may be used.

3.2.8 Pipe Sleeves

Provide sleeves where pipes pass through masonry or concrete walls. Sleeves in outside walls below and above grade, must be steel pipe, Schedule 80. Space between pipe or insulation and the sleeve must be not less than 6 mm 1/4 inch. Hold sleeves securely in proper position and location before and during construction. All sleeves must be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Firmly pack space between the pipe and the sleeve with oakum and caulk on both ends of the sleeve with elastic cement.

3.2.9 Instrumentation

Provide a thermometer and pressure gage, as specified herein, on both the high or medium temperature water supply and return piping located on the system terminal unit side of the isolation valves.

3.3 WELDING

3.3.1 Responsibility of Contractor for Fusion Welding

The Contractor is entirely responsible for the quality of the welding and must:

a. Conduct tests not only of the welding procedure used by his organization to determine the suitability of the procedure to insure welds that will meet the required tests, but also of the welding operators to determine the ability of the operators to make sound welds under standard conditions.

b. Be thoroughly familiar with ASME B31.1 and with AWS B2.1/B2.1M.

c. Be capable of performing all welding operations required for construction and installation of the heating system.

3.3.2 Qualifications of Welders

Rules of procedure for qualification of all welders and general requirements for fusion welding must conform with the applicable portions of ASME B31.1, or with AWS B2.1/B2.1M, and also as outlined below.

3.3.2.1 Examining Welders

Each welder must be examined at the jobsite by the Contractor in the presence of a representative of the Contracting Officer to determine the ability of the welder to meet the qualifications required. Welders for piping must be tested and qualified for all applicable positions. Each welder must be required to identify his weld with his specific code marking signifying his name and number assigned.

3.3.2.2 Examination Results

The Contracting Officer must be provided with a listing of names and corresponding code markings. Where a welder fails to meet the prescribed welding qualifications, that welder must be retested, and if he fails the second test, he must be disqualified for work on the project.

3.3.3 Beveling, Alignment, and Erection

Fabrication of welded pipe joints must be in accordance with ASME B31.1.

3.3.4 Weld Inspection

Welds must be inspected for defects in accordance with the following:

a. Cracks must not be acceptable regardless of length or location;

b. Undercut must not be deeper than 5 percent of the base-metal thickness or 0.79 mm 1/32 inch, whichever is less;

c. Overlap must not be permitted. The Contracting Officer reserves the right to further examine the welds by other means to establish the soundness of any weld. Weld defects must be removed and repairs made to the weld, or the weld joints must be entirely removed and repairs made to the weld at no additional cost to the Government. Repairing defective welds by adding weld material over the defect or by peening will not be permitted. Welders responsible for defective welds may be required to requalify under paragraph entitled "Qualifications of Welders."

3.3.5 Electrodes

Electrodes must be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating must not be used.

3.4 QUALITY CONTROL

3.4.1 General Test Requirements

Tests must be conducted before, during, and after the installation of the system. All instruments, equipment, facilities, and labor required to properly conduct the tests must be provided by the Contractor. Test pressure gages for a specific test must be approved by the Contracting Officer and must have dials indicating not less than 1 1/2 times nor more than 2 times the test pressure. Any deficiencies must be corrected at the Contractor's expense. Failure to correct any deficiencies will be cause for rejection of the system.

3.4.2 Field Tests

The following field tests must be conducted when applicable to the system involved. If any failures occur, the Contractor must make such adjustments or replacements as directed by the Contracting Officer, and the tests must be repeated at the Contractor's expense until satisfactory installation and operation are achieved.

3.4.2.1 Hydrostatic Tests of Service Piping

All service piping must be tested hydrostatically before insulation is applied at field joints, and must be proved tight at a pressure 1 1/2 times the maximum operating pressure or 1379 kPa 200 psi, whichever is greater, except hot water lines must not be tested at more than 4136 kPa 600 psi. Hydrostatic test pressures must be held for a minimum of 4 hours.

3.4.2.2 Operational Tests

After completion of the system, or testable portions thereof, operational tests must be conducted as in service to demonstrate satisfactory function and operating effectiveness. The tests on each system, or portion thereof, must last not less than 6 hours.

3.5 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Fluid Filled Thermometer: Nominal Scale Diameter	= 5 inches	= 127 mm
b. Bimetal Thermometer: Scale Diameter	= 3 1/2 inches	= 90 mm
c. Heat Exchanger: Operating Condition	= 400 psi	= 2758 kPa
	= 400 degrees F	= 204 degrees C

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 21 23 (August 2017)**

Preparing Activity: USACE **Superseding**
UFGS-43 21 13 (January 2008)
UFGS-43 21 39 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 23 21 23

HYDRONIC PUMPS

08/17

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NOTE: This guide specification covers the requirements for hydronic pumps primarily designed for chilled water, hot water and condenser water service in building HVAC systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B4.1	(1967; R 1994; R 2004; R 2009; R 2020) Preferred Limits and Fits for Cylindrical Parts
ASME B4.2	(1978; R 1994; R 2004, R 2009; R 2020) Preferred Metric Limits and Fits
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA E103	(2021) Horizontal and Vertical Line-Shaft Pumps

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A159	(1983; R 2024) Standard Specification for Automotive Gray Iron Castings
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A536	(2024) Standard Specification for Ductile Iron Castings

ASTM A582/A582M	(2022) Standard Specification for Free-Machining Stainless Steel Bars
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2014) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions
HI 1.3	(2013) Rotodynamic (Centrifugal) Pump Applications
HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 2.1-2.2	(2014) Rotodynamic Vertical Pumps of Radial, Mixed, and Axial Flow Types for Nomenclature and Definitions
HI ANSI/HI 9.6.3	(2024) Rotodynamic Pumps - Guideline for Operating Regions - B120
HI ANSI/HI 14.6	(2011) Rotodynamic Pumps for Hydraulic Performance Acceptance Tests - A136

INTERNATIONAL CODE COUNCIL (ICC)

ICC IgCC	(2018) International Green Construction Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA Z535.4	(2023) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF 372	(2022) Drinking Water System Components - Lead Content

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 21	(1982; E 2004) White or Colored Silicone Alkyd Paint (Type I, High Gloss and Type II, Medium Gloss)
SSPC Paint 25	(1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

UL SOLUTIONS (UL)

UL 778	(2016; Reprint Jul 2024) UL Standard for Safety Motor-Operated Water Pumps

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

System Coordination; G, [_____]

SD-03 Product Data

Instructions; G, [_____]

Equipment Data; G, [_____]

Training Period; G, [_____]

SD-06 Test Reports

Factory Tests

Field Quality Control

SD-07 Certificates

Manufacturer's Representative

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

Training; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer Services

Provide the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, testing of the equipment, and conduct training.

Submit the names and qualifications of the manufacturer's representative and training engineers and written certification from the manufacturer that the representative and trainers are technically qualified.

1.3.2 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate equipment that has been in satisfactory HVAC operation at least 2 years prior to issuance of this solicitation. Support equipment with a service organization that is reasonably convenient to the jobsite. Pumps [and] [motors] of the same types must each be the product of one manufacturer.

1.3.3 Conformance with Agency Requirements

Where materials or equipment are specified to be an approved type, attach the seal or label of approval from a nationally recognized testing agency, adequately equipped and competent to perform such services. A written certificate from the testing agency must accompany the materials or equipment and be submitted stating that the items have been tested and that they conform to the applicable requirements of the specifications and to the standards listed herein. The certificate must indicate the methods of testing used by the testing agency. In lieu of a certificate from a testing agency, published catalog specification data, accompanied by the manufacturer's certified statement to the effect that the items are in accordance with the applicable requirements of the specifications and the referenced standards, will be considered and may be acceptable as evidence that the items conform with agency requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect equipment, delivered and designated for storage, from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Hydronic pumps used for heating and air conditioning applications are defined by the type of impeller, number of impellers, type of casing, method of connection to the driver, and mounting position. Provide centrifugal water pumps of the types indicated and specified. Use an electric motor driving unit for each pump as indicated and specified.

2.1.1 Selection Criteria

Select pumps at a point within the maximum efficiency for a given impeller casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided the lesser efficiency is not less than the scheduled efficiency in the construction design documents. Pumps having impeller diameters larger or smaller than manufacturer's published maximum and minimum impeller diameters for a given impeller casing combination will be rejected. Pump performance data, as shown in performance curves, must be based on factory tests using precision instrumentation and exacting procedures as detailed in HI ANSI/HI 14.6.

2.1.2 System Coordination

Submit drawings containing complete wiring and piping schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show the proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation. Provide a complete listing of equipment, materials and miscellaneous components including mechanical seals, bearings, and couplings.

2.1.3 Safety Requirements

Fully enclose or guard couplings, projecting set-screws, keys, and other rotating parts, that pose an entangling hazards..

2.2 MATERIALS AND EQUIPMENT

2.2.1 Nameplates

Securely affix a standard nameplate to pumps and motors in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, for each pump show the capacity in L/second gpm at rated speed in rpm and total head in mm feet of water. For each electric motor show at least the minimum information required by NEMA MG 1. Show such other information as the manufacturer may consider necessary to complete identification on the nameplate. Pumps must be listed and labeled by UL, and comply with UL 778 for pumps not using universal motors rated more than 250 volts such as circulating pumps.

2.2.2 Framed Instructions

Submit proposed diagrams, instructions, and other sheets, prior to posting. Post approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping valves, and control sequence, framed under glass or in approved laminated plastic, where directed. Provide condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

2.2.3 Pump Characteristic

****

NOTE: Characteristics of each pump will normally be specified by a minimum of two points on the head-capacity curve. The blanks for liters per second gpm and total head in mm feet will be filled in appropriately. If two or more pumps are to operate in parallel or in series, and a system head curve is shown, the appropriate brackets will be removed indicating pumps will match the system curve.

****

Construct hydronic water pumps in accordance with HI 1.1-1.2 and HI ANSI/HI 2.1-2.2. The pumps must be capable of discharging quantities at total discharge heads measured at the discharge flange, between the following limits:

Operate pumps at optimum efficiencies to produce the most economical pumping system under the conditions encountered [and size to make optimum match with the system head curve as shown].[Suction lift on Pump No. [_____] must not be more than [_____] mm feet.] Pumps must furnish not less than 150 percent of rated capacity at a total discharge head of not less than 65 percent of total rated head.[The shutoff total head must not be greater than 120 percent of total rated head.] Operate pumps at specified system fluid temperatures without vapor binding and cavitation. Operate pumps to HI ANSI/HI 9.6.3 standard for Preferred Operationg Region (POR).

2.2.4 Pump Drivers

Provide electric motors as indicated for each pump and in compliance with Section [26 20 00 INTERIOR DISTRIBUTION SYSTEM][_____].

2.2.5 Equipment Data

Submit manufacturer's descriptive data and technical literature, performance charts and curves for all impeller sizes for a given casing, catalog cuts, and installation instructions. Provide spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and local source of supply with contact information.

Submit catalog information, certified pumps curves, rated capacities, final impeller dimensions, and accessories provided for the product indicated.

Indicate operating point of each pump on curves. Furnish pump curves for each pump and combination of pumps designed to operate in parallel. The pump curve must show as a minimum; bhp, flow, total dynamic head, efficiency, NPSH, impeller diameter and system curve (individually and in combination for each pump operating in a parallel application). Select pumps operating in parallel operation to cross the system curve when operating individually.

2.3 HYDRONIC PUMPS

****

NOTE: Enter the pump numbers shown on the drawings in the appropriate blanks. Delete inapplicable configurations.

****

Provide centrifugal, [single-stage type,][or][multi-stage type,] designed for HVAC service in the following configurations:

Configuration	Pump No.
Circulator	[_____]
Small In-Line	[_____]
Large In-Line	[_____]
Base-Mounted, Flexible Coupled, End Suction	[_____]
Base-Mounted, Close Coupled, End Suction	[_____]
Base-Mounted, Flexible Coupled, Double Suction, [Horizontally] [and] [Vertically] Split	[_____]
Vertical Lineshaft Turbine	[_____]
Automatic Cooling Coil Condensate Pump Units	[_____]

2.3.1 Circulator

****

NOTE: These pumps deliver up to 10 L per second 150 gpm and up to 10 m 35 feet head. They are most often used for low flow rates in small systems and are available in a wet rotor or three piece oil lubricated design. Wet rotor circulators use system fluid for cooling and lubrication. They do not require oiling and are less expensive; however, impeller can stick after a prolonged shutdown. Three piece circulators are oil lubricated with the potential for longer life if properly lubricated and can overcome a stuck impeller after a prolonged shutdown; however, there is potential maintenance of

mechanical seals and coupling assembly.
****

Provide pumps with capacities as indicated of a horizontal, [in-line, three piece oil lubricated] [wet rotor] circulator type specifically designed for quiet operation. Suitable for 107 degrees C 225 degrees F operation at [860][_____] kPa [125][_____] psig working pressure. The pump must be single stage with [flanged] [union] piping connections. The pump internals must be capable of being serviced without disturbing piping connections.

****
NOTE: Insert the following paragraph for three piece oil lubricated circulator pumps.
****

[a. The three piece pump must be composed of three separable components a motor, bearing assembly, and [cast iron] [lead free bronze certified in accordance with NSF 372 pump end (wet end). The motor shaft must be connected to the pump shaft via a replaceable flexible coupler.]
]

****
NOTE: Insert the following paragraph for wet rotor circulators used for potable water service.
****

[b. Wet rotor circulator for potable water service must be lead content certified in accordance with NSF 372.
]

2.3.1.1 Seal Assembly

****
NOTE: Retain this paragraph for wet rotor circulators used for potable water service.
****

Pump must be equipped with an internally flushed mechanical seal assembly. Seal assembly must have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

2.3.1.2 Motor Mount

****
NOTE: Include this paragraph for three piece oil lubricated circulators.
****

To ensure alignment, mount the motor to the bearing assembly via a bolted motor bracket assembly. Use a replaceable resilient rubber motor mount to assist in aligning the motor shaft with the pump shaft.

2.3.1.3 Motors

Motors must meet scheduled horsepower, speed, voltage, and enclosure design. Motors must be drip proof, maintenance free, premium efficiency and meet NEMA MG 1 specifications.

****
NOTE: Include the following paragraph for variable

speed pumps with ECM motors.

****

[Pump must be driven by an electrically commutated electrical motor (ECM) with permanent magnet rotor. The rotor magnets must be time stable, non-toxic ceramic magnets. Drive the electrically commuted electrical motor by a frequency converter with an integrated PFC filter.

]

2.3.2 Small In-Line

****

NOTE: These pumps deliver up to 12.5 L per second 200 gpm and 17 m 55 feet head. Pump motor shaft must stay horizontal, but pump body can be repositioned for horizontal or vertical discharge. These pumps are designed for 1750 rpm and indoor service using open drip proof enclosure electric motors.

****

Provide pumps with capacities as indicated,suitable for 107 degrees C 225 degrees F operation at [1204][_____] kPa [175][_____] psig working pressure. The pump must be single stage, in-line design, in cast iron bronze fitted construction. The pump internals must be capable of being serviced without disturbing piping connections.

2.3.2.1 Pump Shaft

The pump must have a solid steel shaft with a coupler between the pump and motor shafts. For non-stainless steel shafts, employ a non-ferrous shaft sleeve to completely cover the wetted area under the seal.

2.3.2.2 Bearing

The bearing assembly must house maintenance-free permanently lubricated bearings.

2.3.2.3 Seal Assembly

Equip the pump with an internal self-flushing mechanical seal assembly. Seal assembly must have Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

2.3.2.4 Impeller

Provide impeller of cast bronze or brass material. Impeller must be hydraulically and dynamically balanced to HI 9.6.4 balance grade G6.3, keyed to the shaft and secured by a locking capscrew or nut.

2.3.2.5 Volute

Pump volute must be of cast iron. The connection style on cast iron pumps must be flanged.

2.3.2.6 Motor Mount

To ensure alignment, mount the motor to the bearing assembly via a bolted motor bracket assembly. Use a replaceable resilient rubber motor mount to assist in aligning the motor shaft with the pump shaft.

2.3.2.7 Motors

NEMA MG 1; premium efficiency; non-overloading at any point on the pump curve; maintenance free with permanently lubricated bearings; and resilient mounted for smaller sizes, rigid mounted otherwise.

2.3.3 Large In-Line

****

NOTE: Large In-Line pumps can deliver up to 158 L per second 2500 gpm and 38 m 125 ft head at 1750 rpm. The use of large In-Line pumps is discouraged due to difficulty in providing routine servicing and repair. Large in-line pumps including motor can be more expensive than the preferred base-mounted, flexible coupled end suction pumps. In some cases floor space is limited so large in-line pumps may need to be used. Large In-Line pumps come in two basic configurations - split coupled and close coupled. Split coupled configuration allows mechanical seal maintenance without disturbing the pump or motor. However, split coupled pumps only allow the motor shaft to be oriented vertically with motor shaft down. Close coupled pumps may be mounted with the motor shaft vertical or horizontal but do not allow mechanical seal maintenance without disturbing the pump or motor. When mounted horizontally, it is critical that adequate support be provided to avoid strain on pump parts and piping.

****

Provide pumps with capacities as indicated; [split-coupled] [closed coupled], in-line, single stage, for installation in [vertical] [horizontal (where close coupled)] position, and. suitable for 107 degrees C 225 degrees F operation at [1204][_____] kPa [175][_____] psig working pressure. The pump internals must be capable of being serviced without disturbing piping connections.

2.3.3.1 Casing

Provide pump casing complying with ASTM A48/A48M Class 30 cast iron, suitable for [1204][_____] kPa [175][_____] psig working pressure with integral cast iron flanges drilled for ASME B16.1 [ANSI Class 125] [ANSI Class 250] flanges, with an integrally-cast support ring matching an Class 125 flange for pump support. The pump volute must include gauge tappings at suction and discharge nozzles along with vent and drain tappings at top and bottom.

2.3.3.2 Pump Shaft

Provide carbon or stainless steel pump shaft, guided by a carbon graphite lower throttle bushing. Carbon steel pump shaft must have a bronze shaft sleeve that completely covers the wetted area under the seal.

2.3.3.3 Seal Assembly

Equip the pump with a mechanical seal assembly consisting of a carbon seal rotating ring, stainless steel spring, ceramic seat and flexible bellows and gasket. The liquid cavity must have a tapped flush line with manual valve to remove air from the seal chamber to allow fast initial start-up and insure mechanical seal cooling.

2.3.3.4 Spacer Coupling

****

NOTE: Delete paragraph specifying spacer coupling below when close coupled pumps are used.

****

The axially split spacer coupling must be of high tensile aluminum, split to allow the servicing of the seal without disturbing the pump or motor. Pump coupler must be aligned by the manufacturer before shipment. The motor bracket must contain a carbon steel coupler guard conforming to 29 CFR 1910.219 standards for safety.

2.3.3.5 Impeller

****

NOTE: Bronze impellers should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.

****

Hydraulically and dynamically balance the impeller to HI 9.6.4 balance grade G6.3, closed, single suction, fabricated from cast bronze, keyed to the shaft and secured by a locking capscrew.

2.3.3.6 Motor

****

NOTE: Motor enclosure will usually be open drip proof where motor is located in dry, clean, well ventilated indoor area. Use totally enclosed fan cooled motor enclosure for outdoor service.

****

Electric motors must meet NEMA MG 1 and the horsepower, speed, voltage, indicated. Motor enclosure must be open drip proof[, totally enclosed fan cooled], with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide motor efficiencies as shown in the ICC IgCC standard. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.

Include one-piece combination motor bracket and volute coverplate in the assembly to ensure concentric alignment of the motor to the pump casing.

2.3.4 Base-Mounted, Flexible Coupled, End suction

Provide pumps with capacities as indicated; base mounted, separately-coupled, end suction designed with volute housing mounted to the frame to allow for pump service without relocating the motor or disturbing piping connections. Bearings and seals must be serviceable without disturbing piping. Pump must be factory hydrostatically tested in accordance with Hydraulic Institute standards and thoroughly cleaned.

2.3.4.1 Casing

****

NOTE: Cast iron casings should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.

****

Provide radially split pump casing ASTM A48/A48M Class 30 cast iron suitable for [1204][1720][_____] kPa [175][250][_____] psig working pressure with integral cast iron flanges drilled for ASME B16.1 [ANSI Class 125] [ANSI Class 250] flanges, with an integrally-cast pedestal support foot. The pump volute must include gauge tappings at suction and discharge nozzles along with vent and drain tappings at top and bottom.

2.3.4.2 Pump Shaft

****

NOTE: Carbon steel shaft should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.

****

Carbon steel pump shaft with a replaceable [bronze][stainless steel] shaft sleeve completely covering the wetted area of the shaft under the seal.

2.3.4.3 Bearing

****

NOTE: Regreasable ball bearings are discouraged. Studies have indicated that contamination and ineffective lubrication are responsible for approximately half of all bearing replacements. Concerns include the following; excessive grease will cause bearings to overheat, bearings are required to be regreased on a regular interval (2500 operating hours or every six months), impurities can be introduced when regreasing bearings, and grease added must be compatible with grease applied previously.

****

Incorporate maintenance free, permanently lubricated and sealed bearings in the pump bearing frame. [Regreasable ball bearing type with provision for purging or flushing through the bearing surface and greased while running after start-up.]

2.3.4.4 Seal Assembly

****

NOTE: When fluid used to internally flush seals exceeds 107 degrees C 225 degrees F, provide a heat exchanger to decrease the temperature of the seal flushing water to 107 degrees C 225 degrees F in order that the seal life does not get shortened.

****

Equip with an integrally flushed mechanical seal assembly or a positive pressure external seal flushing line. Provide a mechanical seal with ceramic seal seat and carbon seal ring. Seal assembly must be rated up to 107 degrees C 225 degrees F.

2.3.4.5 Baseplate

Baseplate must be of steel construction fully enclosed at sides and ends with welded cross members and fully open grouting area for field grouting. Minimum base plate stiffness must conform to HI 1.3 for horizontal baseplate design standards.

2.3.4.6 Coupler

Provide a flexible-type coupler between the pump and motor, capable of absorbing torsional vibration and variable speed operation between the pump and motor. The coupler must allow replacement with no need to move the hubs. Coupler must have natural rubber or neoprene type element materials with a maximum misalignment capability of 4 degrees angular and 3 mm 0.125 inches parallel. Provide donut shaped elastomer element with preassembled flanges mechanically clamped to reinforced element and preassembled spacer center assembly. Secure flexible donut shaped element of coupler in place with radial clamp ring screws. Couplers must be rated for required maximum rpm, amperage horsepower and torque. The coupler must be shielded by a coupler guard securely fastened to the base. Provide coupler guard in compliance with current national safety standards including 29 CFR 1910.219 and NEMA Z535.4. Guards cannot have gaps greater than 6 mm 0.250 inches, must be safety orange in color, and have an NEMA Z535.4 compliant warning label.

2.3.4.7 Impeller

****

NOTE: Cast bronze impellers should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.

****

Hydraulically and dynamically balance to HI 9.6.4 balance grade G6.3, closed, overhung, single suction, fabricate from cast bronze, key to shaft and secured by a locking capscrew.

2.3.4.8 Motor

****

NOTE: Motor enclosure will usually be open drip proof where motor is located in dry, clean, well ventilated indoor area. Use totally enclosed fan cooled motor enclosure for outdoor service.

****

Electric Motors must meet NEMA MG 1 and be the wattage horsepower, speed, and voltage indicated. Motor enclosure must be open drip proof [totally enclosed fan cooled]. Motor must have heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide motor efficiencies as shown in the ICC IgCC standard. [Totally enclosed fan cooled motor efficiencies must comply with

NEMA MG 1.]

2.3.5 Base-Mounted, Close Coupled, End Suction

****

NOTE: Use of base-mounted, close coupled, end suction pumps is discouraged. This type of pump takes up less floor space than base-mounted, flexible coupled, end suction pumps and should only be considered when floor space is extremely limited. Close coupled pumps do not have a pump shaft and pump bearing assembly. Motor bearings must be able to handle both motor rotating element and impeller forces. This requires a special motor with bearings designed to handle additional impeller loads and shaft that extends into the volute. This type of pump can be about the same cost as the preferred base-mounted, flexible coupled, end suction pump.

****

Provide pumps with capacities as indicated. Pump must be base mounted, close coupled, single stage, end suction design capable of being serviced without disturbing piping connections.

2.3.5.1 Casing

Provide pump volute of Class 30 cast iron suitable for [1204][_____] kPa [175][_____] psig working pressure. Include vent, drain and gauge tappings.

2.3.5.2 Seal Assembly

Seal off the liquid cavity at the motor shaft by an internally flushed mechanical seal or a positive pressure external seal flushing line with ceramic seal seat and carbon seal ring, suitable for continuous operation at 107 degrees C 225 degrees F. A replaceable shaft sleeve of bronze alloy must completely cover the wetted area under the seal.

2.3.5.3 Impeller

Provide cast bronze or 304 stainless steel impeller, enclosed type, hydraulically and dynamically balanced to HI 9.6.4 balance grade G6.3, keyed to shaft and secured by a locking capscrew.

2.3.5.4 Motor

****

NOTE: Motor enclosure will usually be open drip proof where motor is located in dry, clean, well ventilated indoor area. Use totally enclosed fan cooled motor enclosure for outdoor service.

****

Electric Motors must comply with NEMA MG 1 and be thewattage horsepower, and voltage indicated. Motor enclosure must be [open drip proof] [totally enclosed fan cooled]. provide with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor and pump impeller is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide motor efficiencies as shown in the ICC IgCC standard. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.

2.3.6 Base-Mounted, Flexible Coupled, Double Suction[,] [Horizontally Split][and][Vertically Split]

Provide pumps with capacities as indicated; base mounted, flexible coupled, double-suction, [horizontal] [and] [vertical] split case design, single stage centrifugal pump. Construction must be cast iron - bronze fitted, equipped with mechanical seals. Bearings and seals must be serviceable without disturbing piping or motor. Factory hydrostatically test the pump in accordance with Hydraulic Institute standards and thoroughly clean.

2.3.6.1 Casing

****

NOTE: Cast iron casings should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.

****

Provide ASTM A48/A48M Class 30 or ASTM A159 cast iron pump casing, suitable for [1204][_____] kPa [175][_____] psig working pressure, with integral cast iron flanges drilled for ASME B16.1 [ANSI Class 125] [ANSI Class 250] flanges. Supply the pump volute with plugged vent, drain, and gauge tappings.

2.3.6.2 Bearings

****

NOTE: The use of regreasable ball bearings are discouraged. Studies have indicated that contamination and ineffective lubrication are responsible for approximately half of all bearing replacements. Concerns include the following; excessive grease will cause bearings to overheat, bearings are required to be regreased on a regular interval (2500 operating hours or every six months), impurities can be introduced when regreasing bearings, and grease added must be compatible with grease applied previously.

****

Incorporate maintenance free, permanently lubricated and sealed bearings with an L10 life of 60,000 hours minimum in the pump bearing frame.[

Incorporate regreasable ball bearing type pump bearing frame with provision for purging or flushing through the bearing surface and greased while running after start-up.]

2.3.6.3 Seal Assembly

****

NOTE: When fluid used to internally flush seals exceeds 107 degrees C 225 degrees F, provide a heat exchanger to decrease the temperature of the seal flushing water to 107 degrees C 225 degrees F so that the seal life does not get shortened.

****

Seal off liquid cavity by an internally-flushed seal assembly. Seal assembly must have a brass housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon face rotating against a stationary silicon carbide seat. Provide replaceable mechanical seals without disturbing the upper casing half and system piping. Seals must be suitable for continuous operation at 107 degrees C 225 degrees F. Arrange to assure that seal leakage cannot enter the bearing housings.

2.3.6.4 Coupler

Provide a flexible-type coupler between the pump and motor capable of absorbing torsional vibration and variable speed operation. The coupler must allow replacement with no need to move the hubs. Coupler must have natural rubber or neoprene type element materials with a maximum misalignment capability of 4 degrees angular and 3 mm 0.125 inches parallel. Provide donut shaped elastomer element and with preassembled flanges mechanically clamped to reinforced element and preassembled spacer center assembly. Secure flexible donut shaped element of coupler in place with radial clamp ring screws. Couplers must be rated for required maximum rpm, wattage horsepower and torque. Shield the coupler by a coupler guard securely fastened to the base. Coupler guard must comply with current national safety standards including 29 CFR 1910.219, and NEMA Z535.4. Provide guards with gaps no greater than 6 mm 0.250 inches, of safety orange in color, and have an NEMA Z535.4 compliant warning label.

2.3.6.5 Base Plate

Provide baseplate of steel construction fully enclosed at sides and ends with welded cross members and fully open grouting area for field grouting. Minimum base plate stiffness must conform to HI 1.3 for horizontal baseplate design standards.

2.3.6.6 Impeller

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NOTE: Cast bronze impellers should not be used for pumping temperatures in excess of 120 degrees C 250 degrees F. Consult manufacturer for temperatures exceeding 120 degrees C 250 degrees F.

****

Bronze or brass enclosed double suction type, both hydraulically and dynamically balanced to HI 9.6.4 grade G6.3, keyed to shaft and fixed in an axial position. Hub must have sufficient metal thickness to allow machining for installation of impeller rings.

2.3.6.7 Motor

****

NOTE: Motor enclosure will usually be open drip proof where motor is located in dry, clean, well ventilated indoor area. Use totally enclosed fan cooled motor enclosure for outdoor service.

****

Provide electric motor conforming to NEMA MG 1 and of the wattage horsepower, and voltage indicated. Motor enclosure must be open drip proof [totally enclosed fan cooled]; with heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide motor efficiencies as shown in the ICC IgCC standard. Totally enclosed fan cooled motor efficiencies must be as shown in NEMA MG 1.

2.3.6.8 Pump Shaft

Provide pump shaft of solid 416 stainless steel shaft or solid carbon steel shaft with replaceable bronze or 304 stainless steel shaft sleeve covering wetted area of shaft.

2.3.7 Vertical Lineshaft Turbine

Provide pumps with capacities as indicated. Pump must be vertical lineshaft turbine manufactured for lubrication of the line-shaft bearings by the water being pumped. Design and manufacture the pumping unit in accordance with HI ANSI/HI 2.1-2.2 standards AWWA E103.

2.3.7.1 Bowl Assembly

Flange type construct the intermediate bowls, discharge cases and suction bowls from ASTM A48/A48M Class 30 close grain cast iron. They must be free of defects and accurately machined and fitted to ASME B4.2 ASME B4.1 close tolerances. Epoxy enamel coat the intermediate bowls waterways for maximum efficiency. Thread all threaded discharge cases for water lubricated column assembly. All assembly bolting must be stainless steel. Provide intermediate bowl bearings.

2.3.7.2 Pump Shaft

Construct the bowl shaft from ASTM A582/A582M type 416 stainless steel, precision ground and polished with surface finish better than 40 RMS.

2.3.7.3 Lineshaft

Vertical pump lineshaft must be open and constructed from ASTM A582/A582M type 416 stainless steel. Straighten lineshaft sections to 0.13 mm per 300 mm 0.0005inch/foot total runout. Lineshaft sections must not exceed 3 m 10 feet in length and must be coupled with threaded stainless steel couplings. Design the diameter of the lineshaft and coupling in accordance with AWWA E103.

2.3.7.4 Impeller

Provide impellers of ASTM B584 silicon bronze or stainless steel, the enclosed type. They must be free from defects, machined, and balanced to HI 9.6.4 balance grade G6.3 for optimum efficiency and performance. Securely fasten to the bowl shaft with stainless steel taper lock collets. The impellers must be adjustable by means of a top shaft adjusting nut or adjustable solid shaft coupling.

2.3.7.5 Discharge Head

Construct the discharge head, sized for pump capacity, of ASTM A48/A48M Class 30 high grade ductile iron or fabricated steel of the high profile type with an integral motor base which allows the head shaft to be coupled to the top shaft above the stuffing box. A separate motor stand is not acceptable. The discharge head must have an ASME B16.1 (for cast iron) or

Class 150 (for steel) discharge flange supplied with dual 6 mm 1/4 inch NPT ports at the top. Thread the head to accept the column pipe.

2.3.7.6 Stuffing Box

****

NOTE: Stuffing box is recommended over mechanical seals for vertical turbine pumps due to the many variables encountered in mechanical seal applications with this type of pump. Abrasives are commonly found in condenser water open loop systems, where this type of pump is used, that cause premature mechanical seal failure.

****

Provide stuffing box of cast or ductile iron, ASTM A536 class 65, and containing a minimum of five rings of packing; with an available fitting for pressure relief. The packing follower gland must be stainless steel and secured in place by stainless steel studs and nuts. The packing box bearing must be bronze. Provide a water slinger to operate on the top shaft, above the packing gland.

2.3.7.7 Mechanical Seal

Provide a mechanical seal.

2.3.7.8 Column Pipe

Provide column pipe of ASTM A53/A53M grade B steel pipe not less than Schedule 30. Machine the column ends with threads and faced parallel to the threads to ensure proper alignment. Connect the pipe with threaded sleeve type ductile iron couplings or flanges that will accept 20 mm 3/4 inch stainless steel or bonze bearing retainers. Lineshaft bearings must be fluted rubber retained in a centering spider retainer.

2.3.7.9 Basket Strainer

Provide and attach a stainless steel basket strainer of a suitable size to the pump suction with stainless steel fasteners. Strainer must have a net inlet area equal to at least three times the impeller inlet area. The maximum opening must not be more than 75 percent of the maximum opening of the water passage through the bowl or impeller.

2.3.7.10 Motor

Electric motor must meet NEMA MG 1 and be the size and voltage indicated. Provide [1800RPM] [_____] motor with NEMA Class B or Class F insulation. The motor must have a vertical hollow (or solid) shaft motor with space heaters and a non-reverse ratchet (or self-release coupling) to prevent reverse rotation. The motor must have an angular contact thrust bearing to meet the designed pump's hydraulic thrust load plus the weight of the rotating parts under operating conditions. Provide high efficiency motor with a weather protected WP-1 enclosure, [230/460] [_____] volt, [3] [1] phase, 60HZ, and a [1.15] [_____] service factor. Motor must be non-overloading at any point on the pump curve and premium efficiency. Provide motor with efficiencies in compliance with NEMA MG 1.

2.3.8 Cooling Coil Condensate Pump Units

Provide pumps with capacities as indicated. Cooling Coil Condensate Pump Unit must be a packaged unit including a corrosion-resistant pump, plastic tank with cover, and automatic controls. Include [factory] [field] installed check valve and a 1800 mm 72 inch minimum, electrical power cord with plug for 120V/1PH/60HZ electrical service.

2.3.8.1 Motor

Electric motor must comply with NEMA MG 1 and be the size, voltage and enclosure indicated. Provide heavy duty grease lubricated ball bearings completely adequate for the maximum load for which the motor is designed.

2.4 ELECTRICAL WORK

Provide electrical motor driven equipment specified herein complete with motors, motor starters, and controls. Provide electric equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics must be as indicated. Provide motor starters complete with properly sized thermal overload protection in each phase and other appurtenances necessary for the motor control specified. Each motor must be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage and frequency. Manual or automatic control and protective or signal devices required for the operation herein specified and any control wiring required for controls and devices but not indicated must be provided under this section of the specifications.

2.5 ELECTRICAL EQUIPMENT

Provide electrical equipment in conformance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical motor driven equipment herein specified complete with motors, motor starters, and controls. Motor controls, equipment, and wiring must be in accordance with NFPA 70.

2.5.1 Electric Motors

Drive each electric motor-driven pump by a continuous-duty electric motor with enclosure type for specific service as defined in paragraph HYDRONIC PUMPS. Motor must have a [1.5] [_____] service factor. Provide [squirrel-cage induction][synchronous] motors having normal-starting-torque and low-starting-current characteristics, and of sufficient size so that the nameplate wattage horsepower rating will not be exceeded throughout the entire published pump characteristic curve. Integral size motors must be the premium efficiency type in accordance with NEMA MG 1. Pump electric motor efficiencies must meet or exceed the requirements of the ICC IgCC standard. Motor bearings must provide smooth operations under the conditions encountered for the life of the motor. Provide adequate thrust bearing in the motor to carry the weight of all rotating parts plus the hydraulic thrust and be capable of withstanding upthrust imposed during pump starting[and under variable pumping head conditions specified]. Motors must be rated [_____] volts, [_____] phase, 60 Hz and such rating must be stamped on the nameplate. Provide motors in conformance with NEMA MG 1.

2.5.2 Control Equipment

[Manually controlled pumps must have START-STOP pushbutton in cover.][Automatically controlled pumps must have three-position "MANUAL-OFF-AUTOMATIC" selector switch in cover.] Provide additional controls or protective devices as indicated. [Install a pump low-water cutoff [in the well][on the suction pipe] and must shut the pump off when the water level in the well reaches the level shown.]

2.5.3 Variable Speed Control

****

NOTE: If any of the motors have a variable speed control, then include this paragraph.

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The variable speed motor controllers must meet the requirements of UFGS 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.

2.6 EQUIPMENT APPURTENANCES

2.6.1 Attachments

Furnish all necessary bolts, nuts, washers, bolt sleeves, and other types of attachments with the equipment for the installation of the equipment. Bolts conform to the requirements of ASTM A307 and hexagonal nuts of the same quality as the bolts used. Threads must be clean-cut and conform to ASME B1.1. Bolts, nuts, and washers specified to be galvanized or not otherwise indicated or specified, must be zinc coated after being threaded, by the hot-dip process conforming to [ASTM A123/A123M][ASTM A153/A153M] as appropriate. Bolts, nuts, and washers specified or indicated to be stainless steel must be Type 316.

2.6.2 Equipment Guards

Provide equipment driven by open shafts, belts, chains, or gears with all-metal guards enclosing the drive mechanism. Secure guards in position with steel braces or straps that permit easy removal for servicing the equipment. Coupler guards must comply with current national safety standards including 29 CFR 1910.219 and NEMA Z535.4. Provide guards with gaps no greater than 6 mm 0.250 inches, safety orange in color, and have an NEMA Z535.4 compliant warning label.

2.6.3 Tools

Furnish a complete set of all special tools which may be necessary for the adjustment, operation, maintenance, and disassembly of all equipment. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment. Special tools must be high-grade, smooth, forged, alloy, tool steel. Furnish one pressure grease gun for each type of grease required. Deliver all tools at the same time as the equipment to which they pertain. Properly store and safeguard such tools until completion of the work, at which time deliver them to the Contracting Officer.

2.7 FINISHES

All motors, pump casings, and similar parts of equipment must be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. Give ferrous surfaces not to be painted a shop coat of grease or other suitable rust-resistant coating.

[2.8 FACTORY TESTS

****

NOTE: Factory Tests for specific pumps shipped to construction site are not normally required unless the pumps are used for a critical application where precise performance is required. Manufacturers' performance data is based on factory tests using precision instrumentation and exacting procedures as detailed in Hydraulic Institute Standard ANSI/HI 1.6 Centrifugal Pump Tests for each typical pump model. Delete the following paragraph unless required.

****

Pumps must be tested by the manufacturer or a nationally recognized testing agency in compliance with HI 1.3. Submit certified test results.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

****

NOTE: Pump and driver shaft alignment on base mounted, long-coupled pumps is critical to reduce vibration, increase bearing life, increase coupler life, and increase mechanical seal life. Although shafts are typically aligned at factory, some misalignment will occur during shipping and lifting. Dial indicators or laser devices are called out to accurately perform final alignment of pump and driver shafts. Scales, straight edges and calipers provide less accurate alignment and are only suitable for initial alignment.

****

Install each pump and motor in accordance with the written instructions of the manufacturer[and under the direct supervision of the manufacturer's representative]. Provide access space around the device for servicing no less than the minimum recommended by the manufacturer.

[3.2.1 Base Mounted, Long-Coupled Pumps

Set the pump baseplate as follows.

a. Place two sets of shims or wedges for each foundation bolt. Lower baseplate onto foundation bolts and level baseplate both lengthwise and across by adding or removing shims or mount wedges. A maximum difference of 3 mm 0.125 inches lengthwise and 1.5 mm 0.059 inches across is allowable.

b. Mount pump and driver on baseplate if not already mounted at factory. Pump and driver shafts must have initial cold (pump and driver at ambient temperature) alignment check and final hot (pump and driver at operating temperature) alignment check. Perform cold alignment check before baseplate is grouted, after baseplate is grouted, and after piping is connected. Perform final alignment check when pump and driver are at operating temperature. Move or shim only the driver to make adjustments to prevent strain on the piping installations. Initial alignment may be performed with scales, straight edges and calipers. Final alignment must be done with dial gauges or laser alignment devices. Final alignment misalignment may not exceed coupling manufacturer's maximum parallel and angular misalignment values. When using variable frequency drives, reduce the manufacturer's misalignment values by 50 percent. Remove flexible coupling when performing alignment.

c. Support the connecting piping to ensure that there are no piping loads at the pump flange connections and connecting piping is not forced into position. [Use concrete for equipment foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide concrete foundations that are integral with and of the same class as that of the building floor unless otherwise indicated. Use concrete having a compressive strength of at least 17 MPa 2,500 psi in foundations that are entirely separated from the surrounding floor. Install a premolded filler strip between the foundation and floor slab as shown. Furnish foundation bolts, as required, for proper positioning during the placement of the concrete.]

]3.3 FIELD QUALITY CONTROL

After installation of the pumping units and appurtenances, including coupling guard, is complete, carry out operating tests to assure that the pumping installation operates properly.[Make arrangements to have the manufacturer's representatives present when field equipment tests are made.] Give each pumping unit a running field test in the presence of the Contracting Officer for a minimum of 2 hours. Operate each pumping unit at its rated capacity or such other point on its head-capacity curve selected by the Contracting Officer. Provide an accurate and acceptable method of measuring the discharge flow. Tests must assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report must indicate the final position of controls.

3.4 FIELD PAINTING

Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

3.4.1 Touch-up painting

Factory painted items requiring touching up in the field must be thoroughly cleaned of all foreign material, and primed and topcoated with the manufacturer's standard factory finish.

3.4.2 Exposed Ferrous Surfaces

Paint exposed ferrous surfaces with two coats of enamel paint conforming to SSPC Paint 21. Solvent clean factory primed surfaces before painting. Surfaces that have not been factory primed must be prepared and primed with one coat of SSPC Paint 25 or in accordance with the enamel paint manufacturer's recommendations.

3.5 CLOSEOUT ACTIVITIES

3.5.1 Operation and Maintenance Manuals

Submit one complete set at the time the tests procedure is submitted; remaining sets before the contract is completed. Permanently bind each in a hard cover. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the building, name of the Contractor, and contract number. Place flysheets before instructions covering each subject. Use 216 by 279 mm 8-1/2 by 11 inches paper for instruction sheets, with large sheets of drawings folded in.

Include, but do not limit to, the following in the Instructions:

a. System layout showing piping, valves, and controls.

b. Approved wiring and control diagrams[including variable frequency drives].

c. A control sequence describing startup, operation, and shutdown.

d. Operating and maintenance instructions for each piece of equipment, including task list for routine maintenance, routine inspections, intermediate inspections, and annual inspections; lubrication instructions; and troubleshooting guide.

e. Manufacturer's bulletins, cuts, and descriptive data; and parts list and recommended spare parts.

3.5.2 Training

Upon completion of the work, and at a time designated by the Contracting Officer, provide the services of one or more competent engineers for a training period of not less than [_____] hours to instruct a representative of the Government in the contents of the operation and maintenance manuals for the equipment furnished under these specifications. These field instructions must cover all the items contained in the bound instructions. Submit the training course curriculum and training instructions 14 days prior to the start of training.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 22 26.00 20 (February 2010)**
Change 1 - 05/15

Preparing Activity: NAVFAC **Superseding**
UFGS-23 22 26.00 20 (November 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 23 22 26.00 20

STEAM SYSTEM AND TERMINAL UNITS

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USACE / NAVFAC / AFCEC **UFGS-23 22 26.00 20 (February 2010)**
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SECTION 23 22 26.00 20

STEAM SYSTEM AND TERMINAL UNITS

02/10, CHG 1: 05/15

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NOTE: This guide specification covers the requirements for provision of a complete steam system within the building including steam, condensate, and terminal units for heating.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This guide specification does not include steam boilers, feedwater treatment equipment, or process steam terminal units, boiler feed, and blow-off piping.

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NOTE: The following information must be shown on the project drawings:

1. Extent of work including point of connection of new work to existing

2. General arrangement of the piping

3. Valve locations

4. Safety valve location, setting, pipe size, and method of termination

5. Valve clearances to permit proper valve operation in confined spaces

6. Floor stand, chainwheel operator, and power operator locations, when required

7. Floor stand details, when required

8. Electrical or compressed air power supply for power operators, when required

9. Expansion joints

10. Instrumentation

11. Condensate meters

12. Steam and air traps

13. Unit heaters, when required

14. Convertors, when required

15. Condensate return pumping units including pump capacity and electrical characteristics for the pump motor

16. Radiation units including size and capacity

17. Location where cold-springing is permitted

18. Connections for future equipment, when required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.20	(2023) Metallic Gaskets for Pipe Flanges
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC	(2010) Boiler and Pressure Vessels Code
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-45	(2020) Bypass and Drain Connections
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-17813	(2009; Rev H; Supp 1 2009; Notice 1 2013; Notice 2 2018; Notice 3 2023) Expansion Joints, Pipe, Metallic Bellows, General Specification for
MIL-DTL-18436	(2017; Rev G; Notice 1 2024) Valves, Check, Bronze, Cast Iron, and Steel Body
MIL-E-17814	(1992; Rev F; CANC Notice 1) Expansion Joints, Pipe, Slip-Type, Packed

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689	(Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film)
CID A-A-50494	(Basic; Notice 1) Exhaust Head, Steam
CID A-A-50543	(Basic; Notice 2; Notice 3) Heaters, Convection, Steam or Hot Water
CID A-A-50544	(Basic; Notice 2; Notice 3) Radiators, Heating, Steam and Hot Water, Cast Iron
CID A-A-50545	(Basic; Notice 2; Notice 3) Radiator, Heating, Baseboard Panel, Steam and Hot Water
CID A-A-50558	(Basic; Notice 1) Valves, Pressure Regulating, Steam

CID A-A-50559	(Basic; Notice 1) Valves, Temperature-Regulating (Thermostatically Controlled)
CID A-A-50568	(Basic; Notice 1) Gages, Liquid Level Measuring, Tank
CID A-A-59617	(Basic, Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections
CID A-A-60001	(Rev A) Traps, Steam
FS F-P-2908	(Basic; Notice 1) Pumping Units, Condensate, Return; and Boiler Feed Package
FS F-V-2906	(Basic; Notice 1) Valves, Air Venting, Steam
FS QQ-B-654	(Rev A; Notice 1; Notice 2) Brazing Alloys, Silver
FS S-R-2834	(Basic; Notice 1; CANC Notice 1) Radiators: Heating, Steel, Multifin Type
FS S-U-2833	(Basic; Notice 1) Unit Heater, Air-Circulating, Steam - Hot Water
FS WW-H-191	(Rev E; Notice 2) Heater, Fluid, Industrial (Instantaneous, Steam, Water Converter Type)
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

1.2 GENERAL REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein. This section includes steam and condensate piping, [unit heaters,] [convertors,] [condensate return units,] [radiation units,] [and steam coils] used for heating within the building. Steam boilers, feedwater treatment equipment, process steam terminal units, boiler feed piping, and blow-off piping are not covered in this section.

1.2.1 Classes and Maximum Working Pressures

Equipment, piping, and piping components must be suitable for use under the maximum working pressure indicated. Except as modified herein, the pressure temperature limitations must be as specified in the referenced standards and specifications.

1.2.2 Standard Commercial Product

The terminal units provided must, as a minimum, comply with the features specified herein and must be the manufacturer's standard commercial product. Additional or better features which are not specifically prohibited herein but which are a part of the manufacturer's standard commercial product, must be included in the terminal units being furnished. A standard commercial product is a product which has been sold or is currently being offered for sale, on the commercial market through advertisements or manufacturer's catalogs or brochures. Provide Institute of Boiler and Radiator Manufacturer (IBR) or Steel Boiler Institute (SBI) rating for required capacity.

1.2.3 Welding Safety

AWS Z49.1.

1.2.4 Definitions

1.2.4.1 High Pressure Piping System

A system whose pressure is greater than 103 kPa (gage) 15 psig and must conform to ASME B31.1.

1.2.4.2 Low Pressure Piping System

A system whose pressure is 103 kPa (gage) 15 psig or less.

1.2.4.3 Terminal Unit

An enclosed unit that provides heated air from a steam coil and includes natural convection units, radiation, and forced air units.

1.2.4.4 Piping and Piping System

Includes pipe, tubing, flanges, bolting, gaskets, valves, safety valves, fittings, and pressure containing parts of other piping components, hangers, supports, guides, expansion joints, anchors, and other equipment items necessary to prevent overstressing the pressure containing parts.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Unit Heaters

Convertors

Condensate Return Pumping Units

Finned Tube Radiation Units

Cast Iron Baseboard Radiation Units

Convectors

Steam to Air Heating Coils

Valves

Valve Operating Mechanism

Steam Meters

Traps

Strainers

Flash Tanks

Expansion Joints

Instrumentation

SD-06 Test Reports

Steam Piping tests

Copper Tubing test

Valves tests

Expansion Joints tests

Instrumentation tests

Pipe and Pipe System

Unit Heaters tests

Convertors tests

Condensate Return Pumping Units tests

Radiation Units tests

Steam to Air Heating Coils tests

Submit reports of tests required by the reference specification and standards.

SD-07 Certificates

Welding Procedure

Welder's Performance Qualification Record

List of Welders and Welder's Symbols

SD-08 Manufacturer's Instructions

Unit Heaters

Convertors

Condensate Return Pumping Units

Include manufacturer's recommendations for equipment foundations.

1.4 QUALITY ASSURANCE

1.4.1 Welding Procedure

Submit welding procedure specification for metals included in the work, together with proof of the procedure's qualifications as outlined in ASME B31.1.

1.4.2 Welder's Performance Qualification Record

Submit [to the Contracting Officer] the Welder's Performance Qualification Record in conformance with ASME B31.1 for each welder, showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition, the Contractor must submit list of welders and welder's symbols, assigned number, or letter which must be used to identify the work of the welder which must be affixed immediately upon completion of the weld. Welders making defective welds after passing a qualification test must be required to take a requalification test. Welders failing the requalification tests will not be permitted to work under this contract.

1.4.3 Previous Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for this contract without requalification subject to approval if the conditions specified in ASME B31.1 are met before a procedure can be used.

PART 2 PRODUCTS

2.1 PIPE AND PIPE SYSTEM

2.1.1 High Pressure Steam Piping System (Over 103 kPa (Gage)Over 15 psig)

****

NOTE: Specify the operating pressures and temperatures.

****

ASME B31.1 for a steam working pressure of [_____] kPa (gage) psig and a temperature of [_____] degrees C F, a condensate pressure f [_____] kPa (gage) psig, and a temperature of [_____] degrees C F.

2.1.1.1 High Pressure Steam Piping

****

NOTE: Specify Schedule 40 pipe for systems operating at 862 kPa 125 pounds or less steam pressure. For systems operating at pressures greater than 862 kPa 125 pounds or where piping will be subjected to high stress, determine pipe thickness required and specify the appropriate pipe schedule.

****

ASTM A106/A106M or ASTM A53/A53M, Grade B, Schedule [_____], black steel, [electric-resistance welded] [or] [seamless]. Use ASTM A53/A53M pipe for bending.

2.1.2 Low Pressure Steam Piping System

****

NOTE: Specify the operating pressures and temperatures.

****

ASME B31.1 for a steam working pressure of 103 kPa (gage) 15 psig or less, a condensate pressure of [_____] kPa (gage) psig, and a temperature of [_____] degrees C F.

2.1.2.1 Low Pressure Steam Piping

a. Steel Piping: ASTM A53/A53M, Schedule 40, black, [electric-resistance welded] [or] [seamless]. Use ASTM A53/A53Mpipe for bending.

b. Copper Tubing: ASTM B88M ASTM B88, Type K.

2.1.3 Condensate Return Piping (690 kPa (gage)100 psig or Less)

2.1.3.1 Steel Piping

ASTM A106/A106M or ASTM A53/A53M, Grade B, Schedule 80, black, [electric-resistance welded] [or] [seamless].

2.1.3.2 Copper Tubing (103 kPa (Gage)15 psig or Less)

ASTM B88MASTM B88, Type K.

2.1.4 Fittings

Provide fittings compatible in all respects (material, size, pressure, and temperature limitations) with the pipe being used and within any further limitations of ASME B31.1.

2.1.4.1 Fittings for Steel Pipe

a. Sizes 3 to 50 mm 1/8 to 2 inches:

   (1) Steel Fittings: ASME B16.11, socket welding or threaded. Where pressure exceeds 103 kPa (gage) 15 psig, provide socket-welding type only.

   (2) Malleable Iron Fittings: ASME B16.3, threaded.

b. Sizes 65 mm 2 1/2 inches and larger:

   (1) Steel Fittings: ASME B16.9, buttwelding or ASME B16.5, flanged.

   (2) Bronze Fittings: ASME B16.24, flanged. Sizes larger than 200 mm 8 inches are not permitted.

2.1.4.2 Fittings for Copper Tubing

ASME B16.18, cast copper alloy or ASME B16.22, wrought copper, solder joint type. Flared or compression joint type fittings for tube sizes not exceeding 50 mm 2 inches outside diameter (O.D.) may be provided as permitted in ASME B31.1.

2.1.5 Unions

2.1.5.1 Unions for Steel Pipe

ASME B16.39, threaded.

2.1.5.2 Unions for Copper Tubing

CID A-A-59617, solder joint end type.

2.1.6 Flanges

Remove the raised faces on flanges when used with flanges having a flat face.

2.1.6.1 Steel Flanges

ASME B16.5, forged steel, welding type.

2.1.6.2 Bronze Flanges

ASME B16.24, threaded.

2.1.7 Valves

Must conform to the following paragraphs. End connections must conform to paragraph END CONNECTIONS.

2.1.7.1 Gate Valves

a. Bronze Gate Valves: MSS SP-80, [Type 1 (solid wedge, non-rising stem)] [or] [Type 2 (solid wedge, inside screw, rising stem)], 80 mm 3 inches and smaller, threaded or solder joint ends, and not less than Class 150.

****

NOTE: When special trim material is required, revise latter portion of paragraph to identify the special trim material.

****

b. Steel Gate Valves: ASME B16.34. Provide outside screw and yoke type with solid wedge or flexible wedge disc, and with trim suitable for the service temperature and pressure.

2.1.7.2 Globe and Angle Valves

a. Bronze Globe and Angle Valves: MSS SP-80, Type 1 (metal disc, integral seat) or Type 3 (metal disc, renewable seat), 80 mm 3 inches and smaller, threaded or solder joint ends, Class 200 except that Class 150 with solder joint ends may be used for copper tubing. Valves must have renewable seats and discs, except solder joint end valves which must have integral seats.

****

NOTE: When special trim material is required, revise latter portion of paragraph to identify the special trim material.

****

b. Steel Globe and Angle Valves: ASME B16.34, with trim suitable for the service temperature and pressure.

2.1.7.3 Check Valves

a. Bronze Check Valves: MSS SP-80, Type 3 (swing check, metal disc to metal seat), 80 mm 3 inches and smaller, threaded or solder joint ends, Class 200, regrinding type.

****

NOTE: When special trim material is required, revise latter portion of paragraph to identify the special trim material.

****

b. Steel Check Valves: MIL-DTL-18436, with trim suitable for the service temperature and pressure.

(1) Swing Check Valves: Must have bolted caps.

(2) Lift Check Valves: Must have threaded or bolted caps.

2.1.7.4 Steam Pressure Reducing Valves

CID A-A-50558, Type [_____], Class [_____], Construction [_____], Load Characteristics [_____], cast iron prohibited.

2.1.7.5 Temperature Regulating Valves

CID A-A-50559, Type [_____], Style [_____], Class [_____], cast iron prohibited.

2.1.7.6 Air Vent Valves

FS F-V-2906, [with] [without] vacuum holding device, pressure rated for the intended service, and with a [capacity of [_____] liter per second cfm] [capacity based on manufacturer's standard for the connection size], cast iron prohibited.

2.1.7.7 Radiator Valves

Provide angle or straightway pattern with packed or packless bonnet shutoff globe type designed especially for steam heating system. Valve must be constructed of copper alloy conforming to ASTM specifications for materials with non-metallic renewable disc and plastic wheel handle for shutoff service.

2.1.7.8 Valve Operating Mechanism

****

NOTE: Show location of each floor stand, chainwheel, or power operator required in the project. Delete paragraph VALVE OPERATING MECHANISM and its subparagraphs if these items are not required in the project.

****

Provide [floor stands] [chainwheels] [power operators] [and extension stems] where indicated and as specified.

****

NOTE: Show floor stand details including distance from centerline of valve to top of floor, floor thickness, and handwheel height.

****

a. Floor Stands: Must be cast iron or steel, constructed for bolting to the floor and must include an extension stem, an operating handwheel, and a position indicator for non-rising stems. Floor stand must be not less than 762 mm 30 inches high. Handwheel must identify rotation direction for closing the valve and must be of such diameter as to permit operation of the valve with a force of not more than 178 Newton 40 pounds.

b. Chainwheel Operator: Must be fabricated of cast iron or steel and must include a wheel, an endless chain, and a guide to keep the chain on the wheel. Provide galvanized steel endless chain extending to within 914 mm 3 feet of the floor.

****

NOTE: Show electric or compressed air power supply required to operate the power operators.

****

c. Power Operators: Must be [electric] [pneumatic]. Power operated valves must open and close at rates no slower than 254 mm 10 inches per minute for gate valves and 100 mm 4 inches per minute for globe and angle valves. Valves must open fully or close tightly without requiring further attention when the actuating control is moved to the open or close position. A predetermined thrust exerted on the stem during operation resulting from an obstruction in the valve must cause the motor to automatically stop. Power operators must be complete with all gearing and controls necessary for the size of valve being provided. Power operators must be designed to operate on the [electric] [compressed air] power supply indicated.

d. Extension Stem: Must be corrosion resisting steel designed for rising and non-rising stems, as applicable, and for connection to the valve stem by a sleeve coupling or universal joint. Provide in length required to connect the valve stem and the [handwheel] [operating mechanism] and of sufficient cross section to transfer the torque required to operate the valve.

2.1.7.9 Safety Valves

****

NOTE: The designer must ensure that safety valves are installed for proper personnel protection. Vent piping must be sized to minimize back pressure. The pipe sizes and the method of termination must be shown on the drawings.

****

****

NOTE: Consult reference document to determine Type, Class, and Style as appropriate for the project.

****

MIL-DTL-18436, Type 1, Class [_____], Style [_____], and sized in accordance with ASME BPVC. Set point must be as indicated, cast iron prohibited.

2.1.8 End Connections

2.1.8.1 Steel Piping

Sizes 50 mm 2 inches and smaller threaded or socket welded; sizes 65 mm 2 1/2 inches and larger flanged or butt welded.

a. Threaded Joints: ASME B1.20.1.

b. Flanged Joints: Flanges must conform to paragraph entitled "Flanges." Bolting and gaskets must be as follows:

****

NOTE: For temperature limitations on the use of these bolts, consult ASME B31.1.

****

(1) Bolting: Material used for bolts and studs must conform to ASTM A307, Grade B; and material for nuts must conform to ASTM A194/A194M, Grade 2. Dimensions of bolts, studs, and nuts must conform to ASME B18.2.1 and ASME B18.2.2 with threads conforming to ASME B1.1coarse type, with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or bolt-studs must extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Carbon steel bolts must have American Standard regular square or heavy hexagon heads and must have American Standard heavy semifinished hexagonal nuts, conforming to ASME B18.2.1 and ASME B18.2.2.

(2) Gaskets: Gaskets must be as follows:

Working Conditions	Material
Saturation	
[_____] kPa (gage) [_____] degrees C	Composition or Copper
Superheated Steam, Less Than 400 degrees C	
[_____] kPa (gage) [_____] degrees C	Metal-Jacketed Composition, Monel, Steel, or Soft Steel

Working Conditions	Material
Saturation	
[_____] psig [_____] degrees F	Composition or Copper
Superheated Steam, Less Than 750 degrees F	
[_____] psig [_____] degrees F	Metal-Jacketed Composition, Monel, Steel, or Soft Steel

Gaskets must be as thin as the finish of surfaces will permit. Metal or metal-jacketed non-asbestos gaskets must be used with small male and female or small tongue-and-groove flanges or flanged fittings; they may be used with steel flanges with lapped, large male and female, large tongue-and-groove, or raised faces. Full faced gaskets must be used with flat-faced bronze flanges. Lapped steel flanges, or raised-face steel flanges must have ring gaskets with an outside diameter extending to the inside of the bolt holes. Widths of gaskets for small male and female and for tongue-and-groove joints must be equal to the widths of the male face or tongue. Gaskets must have an inside diameter equal to or larger than the port openings. Rings for ring joints must be in accordance with dimensions in ASME B16.20, suitable for the service conditions encountered, and must be softer than the flanges. Dimensions for non-metallic gaskets must be in accordance with ASME B16.21.

c. Butt Weld Joints: ASME B31.1. The use of backing rings must conform to ASME B31.1. Ferrous rings must be of good weldable quality and must not exceed 0.05 percent sulfur; for alloy pipe, backing rings must be of material compatible with the chemical composition of the parts to be welded and preferably of the same composition. Backing rings must be continuous machined or split band type.

d. Socket Weld Joints: ASME B31.1.

2.1.8.2 Joints for Copper Tubing

a. Solder Joints: ASTM B32, alloy grade Sb5 solder for steam pressure 103 kPa (gage) 15 psig or less.

b. Brazed Joints: FS QQ-B-654 for steam pressure 827 kPa (gage) 120 psig or less.

2.1.9 Expansion Joints

2.1.9.1 Packless Type

****

NOTE: Consult reference document to determine Type, Class, and Style as appropriate for the project.

****

MIL-DTL-17813, Type [_____], Class [_____], located as indicated. Bellows material must be [_____]. Expansion joint must be designed for [_____] cycles of movement.

2.1.9.2 Guided Slip-Tube Type

****

NOTE: Consult reference document to determine Type, Class, and Style as appropriate for the project.

****

MIL-E-17814, Type [_____], Style [_____], Class [_____], locate as indicated. Expansion joint material must be [_____].

2.1.10 Instrumentation

2.1.10.1 Pressure and Vacuum Gages

ASME B40.100 with restrictor, locate as indicated. Provide scale range for intended service. Scale range not to exceed two times (2X) the indicated pressure of piping.

2.1.10.2 Tank Gages

CID A-A-50568, locate as indicated.

2.1.10.3 Indicating Thermometers

Thermometers must be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) must have a nominal scale diameter of 125 mm 5 inches.

Construction must be stainless-steel case with molded glass cover, stainless-steel stem, and bulb. Stem must be straight, length as required to fit well. Bimetal thermometers must have a scale diameter of 90 mm 3 1/2 inches. Case must be hermetic. Case and stem must be constructed of stainless steel. Bimetal stem must be straight and of a length as required to fit the well.

2.1.11 Miscellaneous Pipeline Components

2.1.11.1 Steam Meters

[a. Rotary Axial-Turbine Steam Meter

(1) Provide rotary axial-turbine totalizing type designed for mounting directly in the steam line (for sizes up to 100 mm 4 inches inclusively) or in a bypass piping arrangement with orifice plate in the main line (for sizes 125 mm 5 inches and up). Bypass meter must be furnished for horizontal or vertical upward flow or vertical downward flow.

(2) The meter must be self-contained and self-operating requiring no mercury, pressure piping, compressed air, or electrical connections except for operation of accessory contacts where required or desired. The meter must include a dampened fan shaft assembly, fixed internal orifice, and magnetically driven counter of [dial and pointer type] [cyclometer type]. Stuffing box must not be allowed.

(3) Materials of construction must be [cast iron body with 113 kg 250 pounds flanged ends for pressures up to 1724 kPa 250 psig and temperatures up to 232 degrees C 450 degrees F] [cast steel body with 136 kg 300 pounds flanged ends for pressures up to 2070 kPa 300 psig and temperatures up to 400 degrees C 750 degrees F]. Wear parts must be of monel or stainless steel with graphite top bearing and jewelled bottom bearing.

(4) Meter must be direct reading in pounds of steam over a 10 to 1 range, with continuous overload capability up to 150 percent of rated capacity and temporary overload capability up to 200 percent of rated capacity.

(5) Accuracy must be within plus or minus 2 percent of actual flow over the entire 10 to 1 range at flow rates and pressures within the limits set forth in the capacity tables.

[(6) Meter must be equipped with pressure compensating counter for automatically and continuously correcting meter readings to compensate for line pressure variations. The counter must be self-contained and self-operating and require no connections other than a single tap to the steam main. Pressure compensation range must be [_____] to [_____] kPa psi.]

[(7) Meter counter must be equipped with electric contactor to operate a remote totalizer, or for providing impulses for interfacing with an energy monitoring system. Contacts or impulses to be proportional to pressure compensated steam flow.]]

[b. Variable Orifice Steam Meters

(1) Provide spring loaded variable orifice principle type steam meters, density compensated, to ensure accuracy within plus or minus 2 percent of actual flow rate independent of line pressure changes.

(2) Provide a computer to display totalized flow, flow rate, temperature, pressure, time, and date.

(3) The computer must be capable of providing high and low flow rate and temperature alarm set points, four independent timers to store peak flow rate and total flow, a 4 to 20 mA output and a communication port for energy management interface.]

2.1.11.2 Air Traps

CID A-A-60001 for float-operated steam traps (non-thermostatic), except that the valve mechanism must be inverted so as to be closed, not opened, by rising water. Arrange float-controlled valves to close promptly when water enters the traps. Locate traps as indicated.

2.1.11.3 Steam Traps

****

NOTE: Consult reference document to determine Type, Class, and Style as appropriate for the project.

****

CID A-A-60001, Type [_____], Style [_____], thermostatic and non-thermostatic steam traps. Provide traps with separate strainers and locate as indicated.

2.1.11.4 Strainers

FS WW-S-2739, Style Y (Y pattern) for Class 125 and 250 piping in sizes 15 to 200 mm 1/2 to 8 inches, inclusive, locate as indicated, cast iron prohibited.

2.1.11.5 Exhaust Heads

CID A-A-50494, for atmospheric discharge of exhaust steam.

2.1.11.6 Hangers, Supports, Spacing Requirements, and Attachments

MSS SP-58 and ASME B31.1 for materials, design, and manufacture. MSS SP-58 for selection and application.

2.1.11.7 Flash Tanks

Construct of steel for a minimum working pressure of 862 kPa 125 psig. Provide the tank with a vent and valved drain.

2.2 UNIT HEATERS

FS S-U-2833, [propeller] [centrifugal] fan type with [horizontal] [vertical] air delivery and with capacity as indicated for the design conditions. Fans must be dynamically balanced only.

2.3 CONVERTORS

FS WW-H-191, steam to hot water convertors, with capacity as indicated for the design conditions. Design convertor for support by [system piping] [separate pipe hangers], and provide [temperature regulator] [air vent valve] [air and steam trap].

2.4 CONDENSATE RETURN UNITS

****

NOTE: The discharge pressure limitations for condensate pumping unit with hexahedral or vertical receiver is 69 to 517 kPa (gage) 10 to 75 psig, for horizontal receiver, it is 69 to 1379 kPa (gage) 10 to 200 psig.

****

[2.4.1 Condensate Return Pumping Units

FS F-P-2908, with [hexahedral, floor-mounted receiver,] [horizontal, cylindrical, stand-mounted receiver,] [vertical, cylindrical, underground receiver], and a [single] [duplex] pump unit, with capacity as indicated.

]2.4.2 Pump Motors

NEMA MG 1, suitable for the electrical characteristics as indicated. Motors must be [open] [splash proof] [totally enclosed] type.

2.4.3 Motor Starters

****

NOTE: The motor control requirements should be coordinated with Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM and will depend on field conditions. The following types of motor starters should be used as a guide only. When electrical equipment is connected to heavily loaded power circuits, the starting current may cause an excessive voltage drop on the circuit.

Motor kW	**Voltage**	**Type Starter**
Up to 5.50	**208-230**	**Across-the-line-magnetic**
5.50 to 11	**208-230**	**Across-the-line-magnetic, part winding or wye-delta**

Motor h.p	**Voltage**	**Type Starter**
Up to 7 1/2	**208-230**	**Across-the-line-magnetic**
7 1/2 to 15	**208-230**	**Across-the-line-magnetic, part winding or wye-delta**

****

NEMA ICS 2, [manual] [across-the-line magnetic,] [reduced voltage-start] [part-winding] [wye-delta] type with NEMA ICS 6 [general purpose] [weather-resistant] [water tight] enclosure.

2.5 RADIATION UNITS

2.5.1 Finned Tube Radiation Units

[FS S-R-2834, steel tube with steel fins,] [CID A-A-50545, copper tube with aluminum fins,] [with an adjustable damper,] size and capacity not less than indicated.

2.5.2 Cast Iron Baseboard Radiation Units

CID A-A-50545, size and capacity not less than indicated.

2.5.3 Convectors

CID A-A-50543, CID A-A-50544, design and capacity not less than indicated.

2.6 STEAM TO AIR HEATING COILS

Heating and ventilating units for steam system must be as specified in [Section 23 30 00 HVAC AIR DISTRIBUTION,] except that steam coils must be provided in lieu of water coils. Coils for factory fabricated air handlers and reheat coils must be constructed as follows: Construct steam distribution (nonfreeze type) coils of cast semi-steel, welded-steel, or copper headers, red brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered or helically wound to tubes. Roll and bush, braze, or weld tubes into headers. Condensing tubes must be not less than 16 mm 5/8 inch outside diameter. Distributing tubes must be not less than 10 mm 3/8 inch outside diameter, with orifices to discharge steam to condenser tubes and must be held securely in position. The maximum length of a single coil must be limited to 120 times the outside diameter of the tube. Coil casings and tube support sheets, with collars of ample width, must be not lighter than 16 gage 1.6129 mm thick 0.0635 inch thick galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. The finned tube and header section must float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Factory test coils at 1724 kPa (gage) 250 psig hydrostatic test pressure or under water at 1724 kPa (gage) 250 psig air pressure. Coils must be suitable for 1379 kPa (gage) 200 psig steam working pressure. Test rate coils in accordance with AHRI 410.

PART 3 EXECUTION

3.1 INSTALLATION

Work material and equipment into a complete, convenient, and economical system or systems; and provide apparatus, parts, materials, and accessories which are necessary to accomplish this result.

3.1.1 Piping

Fabricate, assemble, weld, solder, braze, and install piping and pipe system in accordance with ASME B31.1 and as further qualified herein. Piping must follow the general arrangement shown. Cut piping accurately to measurements established, for the work shown, by the Contractor, and work into place without springing or forcing, except where cold-springing is indicated. Locate piping and equipment within buildings entirely out of the way of lighting fixtures, conduit, and doors, windows, and other openings. Run overhead piping in buildings in the most inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit the welding of joints; at least 150 mm 6 inches for pipe sizes 100 mm 4 inches and smaller, 250 mm 10 inches for pipe sizes larger than 100 mm 4 inches, and in corners provide sufficient clearance to permit the welder to work between the pipe and one wall. Make provision for expansion and contraction of pipe lines. Do not bury, conceal, or insulate piping until it has been inspected, tested, and approved. Do not conceal piping in walls, partitions, underground, or under the floor except as indicated. Where pipe passes through building structure, do not conceal pipe joints, but locate where they may be readily inspected and not weaken building structure. Run insulated pipe as shown and as required with sufficient clearance to permit application of insulation. Use flanged joints only where necessary for normal maintenance and where required to match valves and equipment. Gaskets, packing, and thread compounds must be suitable for the service. Apply joint compound or tape on male thread only. Use long radius ells wherever possible to reduce pressure drops. Pipe bends may be used in lieu of welding fittings where space permits. Pipe bends must have a uniform radius of at least five times the pipe diameter and must be free from any appreciable flattening, wrinkling, or thinning of the pipe. Mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction must not be used. Make branch connections with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1 may be used, provided the nominal diameter of the branch is at least one pipe size less than the nominal diameter of the run. Run piping as indicated, and avoid interference with other piping, conduit, or equipment. Run vertical piping plumb and straight and parallel to walls, except where specifically shown otherwise. Do not trap lines, except where indicated. Use reducing fittings for changes in pipe sizes. The use of bushings is prohibited. In horizontal lines 65 mm 2 1/2 inches and larger, use reducing fittings of the eccentric type to maintain the bottom of the lines in the same plane for steam lines and to maintain the top of the lines in the same plane for condensate lines except where a trap or pocket would result. Provide suitable size sleeves for lines passing through building structure. Install piping connected to equipment to provide flexibility for thermal stresses and for vibration. Support and anchor pipe so that strain from weight and thermal movement of piping is not imposed on the equipment. Thoroughly clean each section of pipe, fittings, and valves of foreign matter before erection. Before placing in position, clean the inside of black steel pipe by rapping along its full length to loosen sand, mill scale, and other foreign matter; pipe 50 mm 2 inches and larger must have a wire brush of a diameter larger than that of the inside of the pipe drawn through its entire length several times. Before final connections are made to the apparatus, thoroughly wash out the piping interior with water. Blow out steam piping with high-pressure steam, if available, or compressed air, removing rust, oil, chips, sand, and other material. Plug or cap open ends of mains during shutdown periods. Do not leave lines open at any place where any foreign matter might accidentally enter pipe.

3.1.1.1 Welding

a. Welding of Piping: Welding of joints in piping, butt welds, fillet welds, bends, loops, offsets, and preparation and cleaning of pipe must be in accordance with ASME B31.1. Welds must be visually examined and meet acceptance standards indicated in Chapter VI of ASME B31.1.

b. Quality of Welds: Quality of welds, correction of defects, stress relieving, and preheating must be in accordance with ASME B31.1.

c. Arc Welding and Gas Welding: In accordance with ASME BPVC SEC IX.

3.1.1.2 Brazing and Soldering

a. Brazing and soldering procedure qualification must conform to ASME B31.1. Brazing procedure for joints must be as outlined in the CDA A4015.

b. Soldering, soldering preparation, and procedures for joints must be in accordance with ASME B31.1 and as outlined in the CDA A4015.

c. Copper Tube Extracted Joint: An extracted mechanical tee joint may be made in copper tube. Make joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to ensure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints must not be permitted.

3.1.1.3 Hangers and Supports

Unless otherwise indicated, horizontal and vertical piping attachments must conform to MSS SP-58. Continuous inserts and expansion bolts may be used.

3.1.1.4 Grading and Venting of Pipe Lines

Unless otherwise indicated, install horizontal lines of steam and return piping to grade down in the direction of flow with a pitch of not less than 25 mm in 9 meters one inch in 30 feet, except in loop mains and main headers where the flow may be in either direction. When counterflow of condensate within the steam pipe occurs in a portion of a pipeline, pitch up in the direction of steam flow a minimum of 150 mm per 30 meters 6 inches per 100 feet and increase pipe diameters by one standard pipe size. Steam mains pitched away from the boiler must contain drip connection and air vent valves at the extreme end. Air vents must be provided at the highest point of any vertical riser. Drip connections must not be interconnected above the water line of the boiler.

3.1.1.5 Pipe Sleeves

****

NOTE: Specify flanges and clamping rings where waterproofed construction is required.

****

Provide pipe sleeves where pipes and tubing pass through masonry or concrete walls, floors, roofs, and partitions. Use Schedule 40 galvanized steel pipe sleeves in outside walls below and above grade, in floor, and in roof slabs. Sleeves in partitions must be zinc-coated sheet steel having a weight of not less than 4.43 kg per square meter 0.907 psf. Space between pipe, tubing, or insulation and the sleeve must be not less than 25 mm 1 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves must be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs must extend 50 mm 2 inches above the finished floor. Pack space between the pipe or tubing and the sleeve firmly with oakum and caulk both ends of the sleeve with elastic cement. [Furnish sleeves in waterproofed construction with flanges and clamping rings].

3.1.1.6 Floor, Wall, and Ceiling Plates

****

NOTE: Provide floor, wall, and ceiling plates for buildings other than power plants and heating plants.

****

Secure plates to the pipe with enough clearance for thermal expansion of pipe. Use chromium-plated steel or nickel-plated cast iron plates on pipes passing through floors and partitions of toilet rooms and where indicated; use painted cast iron, malleable iron, or steel for all other plates.

3.1.1.7 Flashing for Buildings

Provide tight waterproof flashing where pipes pass through building roofs and outside walls.

3.1.1.8 Unions and Flanges

Provide unions and flanges where necessary to permit easy disconnection of piping and apparatus, and as indicated. Provide a union for each threaded end valve. [Place unions or flanges no farther apart than 30 meters 100 feet.] [Place unions or flanges as indicated.] Use unions on piping smaller than 50 mm 2 inches in diameter, and use flanges on piping 50 mm 2 inches and larger in diameter. Provide dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous to non-ferrous connections. Dielectric fittings must utilize a non-metallic filler which will prevent current flow. The spacer must be suitable for the pressure and temperature of the service. The fittings must otherwise conform to the requirements of paragraph entitled "Fittings."

3.1.1.9 Traps and Connections

Traps must be of the type and capacity for the service and must be properly supported and connected. Except for thermostatic traps in pipe coils, radiators, and convectors, install traps with a dirt pocket and strainer between it and the piping or apparatus it drains. When necessary to maintain in continuous service apparatus or piping which is to be drained, provide a three-valve bypass so that the trap may be removed and repaired and condensate may drain through the throttled bypass valve. Provide a check valve on the discharge side of the trap whenever the trap is installed for lift or operating against a back pressure, or discharges into a common return line. When a thermodynamic trap is used, a check valve is not required or recommended. Provide test connections on the discharge side of the high and medium pressure traps when they are specifically required. The test connection must include a 15 mm 1/2 inch globe valve with uncapped nipple.

3.1.1.10 Connections for Future Equipment

Locate capped or plugged outlets for connections to future equipment as indicated.

3.1.2 Valves

3.1.2.1 General

Install valves in conformance with ASME B31.1, ASME BPVC SEC VIII D1, and as required herein, at the locations indicated and elsewhere as required for the proper functioning of the system. Use gate valves unless otherwise directed. Install stop valves in the supply lines equipped or located so as to permit operation from floor level, or provided with safe access in the form of walkways or ladders. Install valves in positions accessible for operation and repair. Provide gate valves 200 mm 8 inches and larger with globe-valved bypass in accordance with MSS SP-45.

3.1.2.2 Globe Valves

Install globe valves so that the pressure must be below the disk. Install globe valves with the stems horizontal on steam and exhaust lines.

3.1.2.3 Steam Pressure-Reducing Valves

****

NOTE: The designer must ensure that safety valves are installed for proper personnel protection. Vent piping must be sized to minimize back pressure. The pipe sizes and the method of termination must be shown on the drawings.

****

****

NOTE: The bypass valves must be located in bypass piping. The valve and piping must be sized to restrict the capacity to approximately that of the reducing valve and the sizes must be indicated on the drawings.

****

****

NOTE: Provide a drip trap upstream of the pressure reducing valve to preclude the build-up of condensate and potential water hammer through the valve and downstream piping.

****

Provide the steam line entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two cutout valves and with a globe or angle bypass valve and bypass piping. Provide each pressure-reducing valve unit with an indicating steam gage to show the reduced pressure, and a safety valve on the low pressure side with sufficient capacity to relieve the high pressure steam.

3.1.2.4 Valves for Radiators

Install a radiator valve on each radiator.

3.1.2.5 Safety Valves

Provide with drip pan elbows.

3.1.3 Pressure Gages

Install a shutoff valve or petcock between each pressure gage and the line, and gages on steam lines must have a syphon installed ahead of the gage.

3.1.4 Thermometers

Provide thermometers and thermal sensing elements of control valves with a separable socket. Install separable sockets in pipe lines in such a manner to sense the temperature of the flowing fluid and minimize obstruction to flow.

3.1.5 Steam Meters

Provide steam meters with a suitable three-valve bypass to permit dismantling and inspection without interference with the service.

3.1.6 Strainers

Provide strainers with meshes suitable for the services where indicated, and where dirt might interfere with the proper operation of valve parts, orifices, and moving parts of equipment.

3.1.7 Equipment Foundations

Design equipment foundations of sufficient size and weight to provide isolation and to preclude shifting of equipment under operating conditions. Foundations must meet the requirements of the equipment manufacturer. When required by the Contracting Officer, the equipment manufacturer's approval of the foundation design and construction for the equipment involved must be obtained.

3.1.8 Equipment Installation

Install equipment as specified and in accordance with the manufacturer's installation instructions. Grout equipment mounted on concrete foundations before piping is installed. Install piping in such a manner as not to place a strain on any of the equipment. Do not bolt flanged joints tight unless they match. Adequately extend expansion bends before installation. Grade, anchor, guide, and support piping without low pockets.

3.1.9 Cleaning of System

As installations of the various system components are completed, clean before final closing. Remove foreign matter from equipment and surrounding areas. Preliminary or final tests must not be performed until the cleaning is approved.

3.1.10 Cleaning and Painting of Piping and Equipment

****

NOTE: When the project specification does not have a section on field painting, the requirements for cleaning and painting of pipe and equipment, contained in Section 09 90 00, PAINTS AND COATINGS, must be included in this section.

****

Clean and paint piping and equipment in accordance with Section [09 90 00 PAINTS AND COATINGS].

3.1.11 Identification of Piping

Labels for pipes 20 mm 3/4 inch diameter and larger must bear printed legends to identify contents of pipes and arrows to shown direction of flow. Labels must have color coded background to signify levels of hazard in accordance with ASME A13.1. Legends and type and size of characters must also conform as ASME A13.1. Make labels of plastic sheet CID A-A-1689 with pressure sensitivity suitable for the intended applications, or they may be premolded of plastic to fit over pipe. For pipe smaller than 20 mm 3/4 inch diameter, provide brass identification tags 40 mm 1 1/2 inches in diameter with legends in depressed black filled characters.

3.2 FIELD TESTS AND INSPECTIONS

****

NOTE: For Contractor Quality Control projects, include field inspections.

****

****

NOTE: Coordinate with Division 1 concerning the availability of water and electric power.

****

Field [inspections, field] tests, and trial operations specified in this section must be performed by the Contractor. The Contractor must provide gas, oil, labor, equipment, and incidentals required for testing[, except that in accordance with Division 1 the Government will provide water or electric power required for tests]. The Contractor must give the Contracting Officer [_____] days' advance written notice of the dates and times scheduled for tests and trial operations.

3.2.1 Field Inspections

Inspect piping system prior to initial operation, for conformance to drawings, specifications, and ASME B31.1. Equipment, material, or work rejected because of defects or non-conformance with drawings, specifications, and ASME B31.1 must be replaced or corrected by the Contractor, as directed by the Contracting Officer.

3.2.2 Field Tests

Conduct the following tests after completion of the piping installation and prior to initial operation.

3.2.2.1 Piping System

Test piping system hydrostatically using water not exceeding 38 degrees C 100 degrees F. Conduct tests in accordance with the requirements of ASME B31.1 and as follows. Test the piping system after the lines have been cleaned as herein specified and before any insulation covering has been applied. Test piping system at 1 1/2 times the system pressure or 345 kPa (gage) 50 psig whichever is greater. Before performing tests, remove or valve off from the system, gages, traps, and other apparatus which may be damaged by the test pressure. Install a calibrated test pressure gage in the system to observe any loss in pressure. Maintain the required test pressure for a sufficient length of time to enable an inspection to be made of joints and connections. Perform tests after installation and prior to acceptance.

3.2.2.2 Start-Up and Operational Test

Start-up the system and initially operate with components operating. During the test, periodically clean the various strainers until no further accumulation of foreign material occurs. Exercise care so that minimum loss of [water] [steam] occur when strainers are cleaned. Adjust safety and automatic control instruments as necessary to place them in proper operation and sequence.

3.2.2.3 Extent of Field Tests

After installation and before acceptance, subject the work of this section to necessary field tests, including those herein specified, and in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 23 00 (August 2021)**

Preparing Activity: USACE **Superseding**
UFGS-23 23 00 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-23 23 00 (August 2021)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 23 23 00

REFRIGERANT PIPING
08/21

****

NOTE: This guide specification covers the requirements for refrigerant piping systems inside of buildings, or leading from equipment adjacent to buildings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 710 I-P	(2009) Performance Rating of Liquid-Line Driers
AHRI 711	(2009) Performance Rating of Liquid-Line Driers
AHRI 720	(2002) Refrigerant Access Valves and Hose Connectors
AHRI 750 I-P	(2016) Performance Rating of Thermostatic Refrigerant Expansion Valves
AHRI 751 SI	(2016) Performance Rating of Thermostatic Refrigerant Expansion Valves
AHRI 760 I-P	(2014) Performance Rating of Solenoid Valves for Use with Volatile Refrigerants
AHRI 1370 I-P	(2017) Performance Rating of Electronic Expansion Valves
AHRI 1371 SI	(2017) Performance Rating of Electronic Expansion Valves

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 17	(2022) Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	(2024) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B31.9	(2020) Building Services Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS A5.31/A5.31M	(2012) Specification for Fluxes for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A334/A334M	(2004a; R 2021) Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B280	(2023) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Refrigerant Piping System; G, [_____]

SD-03 Product Data

Refrigerant Piping System

Spare Parts

Qualifications

Refrigerant Piping Tests

Verification of Dimensions

SD-06 Test Reports

Refrigerant Piping Tests

SD-07 Certificates

Service Organization

SD-10 Operation and Maintenance Data

Maintenance; G, [_____]

Operation and Maintenance Manuals; G, [_____]

Demonstrations; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

****

NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement, otherwise delete the second. Regarding welding Section reference, use first bracketed statement for Army projects and delete the second option of the Navy Section; and vice versa.

****

Submit [_____] copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.[Weld piping in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests to be performed at the work site, if practical. The welder or welding operator must apply the personally assigned symbol near each weld made, as a permanent record. Weld structural members in accordance with Section [05 05 23.16 STRUCTURAL WELDING][05 12 00 STRUCTURAL STEEL].][Welding and nondestructive testing procedures are specified in Section [40 05 13.96 WELDING PROCESS PIPING][40 17 26.00 20 WELDING PROCESS PIPING].]

1.3.2 Contract Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation is the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

1.5 MAINTENANCE

1.5.1 General

Submit Data Package 2 plus operation and maintenance data complying with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

1.5.2 Extra Materials

****

NOTE: Remove this paragraph in Navy projects.

****

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis in the data.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

a. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

b. The 2 year use must include applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

c. Products must be supported by a service organization. System components must be environmentally suitable for the indicated locations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

d. Exposed equipment moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

e. Provide the manufacturer's standard catalog data, at least [5 weeks] [_____] prior to the purchase or installation of a particular component. Highlight the data to show information such as, but not limited to, material, size, options, performance charts, and curves in adequate detail to demonstrate compliance with contract requirements. Include the manufacturer's recommended installation instructions and procedures in the data provided. Provide data for the following components as a minimum:

(1) Piping and Fittings
(2) Valves
(3) Piping Accessories
(4) Pipe Hangers, Inserts, and Supports

2.2 ELECTRICAL WORK

****

NOTE: Use the first bracketed statement for Army projects or the second for Navy jobs; delete the non-applicable statement.

****

[Electrical equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Field wiring must be in accordance with manufacturer's instructions.] [Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided.]

2.3 REFRIGERANT PIPING SYSTEM

****

NOTE: This specification is written primarily for Group A1 refrigerants (i.e., R-134a, R-410A, and R-404A). For information on refrigerant classifications refer to ASHRAE 15 & 34. If the piping system is intended for other refrigerants such as R-123 (Group B1) or ammonia (Group B2), then the designer will have to research ASHRAE 15 & 34 and ASME B31.5 and modify the specification appropriately.

It is the responsibility of the engineer to select materials to resist deterioration for conditions of operation.

****

Provide refrigerant piping, valves, fittings, and accessories in accordance with ASHRAE 15 & 34 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories must be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service must be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant.

Submit drawings, at least [5] [_____] weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings must consist of:

a. Piping layouts which identify all valves and fittings.

b. Plans and elevations which identify clearances required for maintenance and operation.

2.4 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

2.4.1 Steel Pipe

****

NOTE: Due to the possibility of stress fractures resulting from repeated temperature related expansion and contraction, the designer of record is responsibile for determining whether to allow the use of 45-degree elbow fittings on each project.

****

Steel pipe for refrigerant service must conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

2.4.1.1 Welded Fittings and Connections

Butt-welded fittings must conform to ASME B16.9. Socket-welded fittings must conform to ASME B16.11. Identify welded fittings with the appropriate grade and marking symbol. Welded valves and pipe connections (both butt-welds and socket-welds types) must conform to ASME B31.9.

2.4.1.2 Threaded Fittings and Connections

Threaded fitting must conform to ASME B16.3. Threaded valves and pipe connections must conform to ASME B1.20.2MASME B1.20.1.

2.4.1.3 Flanged Fittings and Connections

Flanges must conform to ASME B16.5, Class 150. Gaskets must be non-asbestos compressed material in accordance with ASME B16.21, 1.59 mm 1/16 inch thickness, full face or self-centering flat ring type. Gaskets must contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Bolts, nuts, and bolt patterns must conform to ASME B16.5. Bolts must be high or intermediate strength material conforming to ASTM A193/A193M.

2.4.2 Steel Tubing

Tubing must be cold-rolled, electric-forged, welded-steel in accordance with ASTM A334/A334M, Grade 1. Joints and fittings must be socket type provided by the steel tubing manufacturer.

2.4.3 Copper Tubing

Provide copper tubing conforming to ASTM B280 annealed or hard drawn as required. Copper tubing must bear the product identification markings in accordance with ASTM B280, "ACR" must be present on copper tubing. Copper tubing must be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing must not be used in sizes larger than 35 mm 1-3/8 inches. Joints must be brazed except that joints on lines 22 mm 7/8 inchand smaller may be flared. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. Wrought copper and bronze solder-joint pressure fittings must conform to ASME B16.22 and ASTM B75/B75M. Joints and fittings for brazed joint must be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings are not allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

2.4.4 Solder

Solder must conform to ASTM B32, grade Sb5, tin-antimony alloy for service pressures up to 1034 kPa 150 psig. Solder flux must be liquid or paste form, non-corrosive and conform to ASTM B813.

2.4.5 Brazing Filler Metal

Filler metal must conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type FB3-A or Type FB3-C flux, except Type BCuP-3, BCuP-4, or BCuP-5 may be used for brazing copper-to-copper joints. BAlSi-4 with AWS Type FB1-A flux may be used when joining copper piping to aluminum components.

2.4.6 Brazing Flux

Brazing flux must conform to AWS A5.31/A5.31M, Type FB3-A or Type FB3-C when using Type BAg-5 filler metal. Type FB1-A is to be used with Type BAlSi-4 filler metal.

2.4.7 Press Fittings

Press fittings are not acceptable for use in refrigerant piping systems.

2.5 VALVES

Valves must be designed, manufactured, and tested specifically for refrigerant service. The valve material and all internal components must be compatible with the specific refrigerant and lubricant used. Valve bodies must be of brass, bronze, steel, or ductile iron construction. Valves 25 mm 1 inch and smaller must have brazed or socket welded connections. Valves larger than 25 mm 1 inch must have [tongue-and-groove flanged] [butt welded] end connections. Do not use threaded end connections, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts must be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere must be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow must be legibly and permanently indicated on the valve body. Control valve inlets must be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves must be of manufacturer's standard configuration.

2.5.1 Refrigerant Stop Valves

Valve must be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve packing must be replaceable under line pressure. Provide valve with a [handwheel] [or] [wrench] operator and a seal cap. Valve must be the straight or angle pattern design as indicated.

2.5.2 Check Valves

Valve must be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve must be provided with resilient seat.

2.5.3 Liquid Solenoid Valves

Provide valves that comply with AHRI 760 I-P and are suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves must be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions must be furnished. Provide solenoid coils that are moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves must have safe working pressure of 4206 kPa 610 psi and a maximum operating pressure differential of at least 1375 kPa 200 psi at 85 percent rated voltage. Valves must have an operating pressure differential suitable for the refrigerant used.

2.5.4 Expansion Valves

Provide valve conforming to AHRI 751 SI AHRI 750 I-P and ASHRAE 17. Valve must be the diaphragm and spring-loaded type with internal or external equalizers, and bulb and capillary tubing. Provide valve with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1 degree C 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge must be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Do not use gas limited liquid charged valves and other valve devices for limiting evaporator pressure without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves must have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. Provide an isolatable pressure gauge in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

2.5.5 Electronic Expansion Valves

Valve must conform to AHRI 1371 SIAHRI 1370 I-P and ASHRAE 17. The valve must prevent the return of liquid to the compressor in the event of power loss or low superheat.

2.5.6 Safety Relief Valves

Valve must be the two-way type, unless indicated otherwise. Valve must bear the ASME code symbol. Valve capacity must be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve must be of an automatically reseating design after activation.

2.5.7 Evaporator Pressure Regulators, Direct-Acting

Valve must include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve must maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load must not exceed the pressure difference corresponding to a 1 degree C 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring must be selected for indicated maximum allowable suction pressure range.

2.5.8 Refrigerant Access Valves

Provide refrigerant access valves and hose connections in accordance with AHRI 720.

2.6 PIPING ACCESSORIES

2.6.1 Filter Driers

Driers must conform to AHRI 711AHRI 710 I-P. Sizes 15 mm 5/8 inch and larger must be the full flow, replaceable core type. Sizes 13 mm 1/2 inch and smaller must be the sealed type. Cores must be of suitable desiccant that will not plug, cake, dust, channel, or break down, and must remove water, acid, and foreign material from the refrigerant. Constructfilter driers so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure must be 10.3 MPa 1,500 psi.

2.6.2 Sight Glass and Liquid Level Indicator

2.6.2.1 Assembly and Components

Assembly must be pressure- and temperature-rated and constructed of materials suitable for the service. Glass must be borosilicate type. Ferrous components subject to condensation must be electro-galvanized.

2.6.2.2 Gauge Glass

Gauge glass must include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

2.6.2.3 Bull's-Eye and Inline Sight Glass Reflex Lens

Provide bull's-eye and inline sight glass reflex lens for dead-end liquid service. For pipe line mounting, provide two plain lenses in one body suitable for backlighted viewing.

2.6.2.4 Moisture Indicator

Indicator must be a self-reversible action, moisture reactive, color changing media. Indicator must be furnished with full-color-printing tag containing color, moisture, and temperature criteria. Unless otherwise indicated, the moisture indicator must be an integral part of each corresponding sight glass.

2.6.3 Vibration Dampeners

Dampeners must be of the all-metallic bellows and woven-wire type.

2.6.4 Flexible Pipe Connectors

Connector must be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly must be constructed with a safety factor of not less than 4 at 150 degrees C300 degrees F. Unless otherwise indicated, the length of a flexible connector must be as recommended by the manufacturer for the service intended.

2.6.5 Strainers

Strainers used in refrigerant service must have brass or cast-iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens must be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.6.6 Pressure and Vacuum Gauges

Provide gauges conforming to ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge must be a minimum of 85 mm 3-1/2 inches in diameter with a range from 0 kPa 0 psig to approximately 1.5 times the maximum system working pressure. Select each gauge range so that at normal operating pressure, the needle is within the middle-third of the range.

2.6.7 Temperature Gauges

Provide industrial duty type temperature gauges for the required temperature range. Gauges must have Celsius scale in 1 degree Fahrenheit scale in 2 degrees graduations scale (black numbers) on a white face. The pointer must be adjustable. Provide rigid stem type temperature gauges in thermowells located within 1.5 m 5 feet of the finished floor. Provide universal adjustable angle type or remote element type temperature gauges in thermowells located 1.5 to 2.1 m 5 to 7 feet above the finished floor. Provide remote element type temperature gauges in thermowells located 2.1 m 7 feet above the finished floor.

2.6.7.1 Stem Cased-Glass

Provide stem cased-glass case composed of polished stainless steel or cast aluminum, 229 mm 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.6.7.2 Bimetallic Dial

Provide bimetallic dial type case that is greater than 89 mm 3-1/2 inches, stainless steel, and hermetically sealed with clear acrylic lens. Bimetallic element must be silicone dampened and unit fitted with external calibrator adjustment. Accuracy must be one percent of dial range.

2.6.7.3 Liquid-, Solid-, and Vapor-Filled Dial

Provide liquid-, solid-, and vapor-filled dial type cases that are greater than 89 mm 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill must be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing must be double-braided bronze.

2.6.7.4 Thermowell

Thermowell must be identical size, 13 or 19 mm 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 13 mm 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury must not be used in thermometers. Extended neck thermowells must be of sufficient length to clear insulation thickness by 25 mm 1 inch.

2.6.8 Pipe Hangers, Inserts, and Supports

Provide pipe hangers, inserts, guides, and supports conforming to MSS SP-58.

2.6.9 Escutcheons

Escutcheons must be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.7 FABRICATION

2.7.1 Factory Coating

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NOTE: For equipment to be installed outdoors, adequate protection will be specified. Manufacturers must submit evidence that unit specimen have passed the specified salt spray fog test. A 125-hour test will be specified in a noncorrosive environment and a 500 hour test will be specified in a corrosive environment.

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Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand [125] [500] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

2.7.2 Factory Applied Insulation

Factory installed insulation must be in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP. [Refrigerant suction lines between the cooler and each compressor [and cold gas inlet connections to gas cooled motors]]

[Refrigerant pumps and exposed chilled water lines on absorption chillers] must be insulated with not less than 13 mm 1/2 inch thick unicellular plastic foam. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Test material supplied by a manufacturer with a jacket as a composite material. Provide jackets, facings, and adhesives that have a flame spread index less than 25 and a smoke developed index less than 50 when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform a verification of dimensions in the field. Submit a letter, at least [2] [_____] weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found before performing any work.

3.2 INSTALLATION

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NOTE: Belowground refrigerant piping should be avoided if at all possible. Direct buried refrigerant piping will not be installed under any circumstances. In the event that belowground pipe routing is the only alternative, the piping will be routed through an accessible trench system (i.e. concrete, fiberglass, PVC, etc.) The designer will specifically detail the trench design as well as fully detail the piping techniques necessary to accommodate oil circulation at both full and part load conditions. Oil circulation is extremely critical to the successful operation of any refrigerant system. Designers will avoid creating any oil traps within a refrigerant piping system.

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Pipe and fitting installation must conform to the requirements of ASME B31.1. Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove by reaming, and permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

3.2.1 Directional Changes

Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

3.2.2 Functional Requirements

Install piping 4 mm/m 1/2 inch/10 feet of pipe in the direction of flow to ensure adequate oil drainage. Properly cap or plug open ends of refrigerant lines or equipment during installation to keep moisture, dirt, or other foreign material out of the system. Piping must remain capped until installation. Equipment piping must be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements must fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

3.2.3 Fittings and End Connections

3.2.3.1 Threaded Connections

Make threaded connections with tapered threads and make tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Do not show more than three threads after the joint is made.

3.2.3.2 Brazed Connections

Perform brazing in accordance with AWS BRH, except as modified herein. During brazing, fill the pipe and fittings with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, clean both the outside of the tube and the inside of the fitting with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux on copper-to-copper connections. Remove surplus brazing material at all joints. Make steel tubing joints in accordance with the manufacturer's recommendations. Paint joints in steel tubing with the same material as the baked-on coating within 8 hours after joints are made. Protect tubing against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Support piping prior to brazing and do not spring or force.

3.2.3.3 Welded Connections

Fusion-weld joints in steel refrigerant piping. Make branch connections with welding tees or forged welding branch outlets. Thoroughly clean pipe of all scale and foreign matter before the piping is assembled. During welding, fill the pipe and fittings with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld must conform to ASME B31.1. Remove and reweld weld defects at no additional cost to the Government. Store and dry electrodes in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Do not use electrodes that have been wetted or that have lost any of their coating

3.2.3.4 Flared Connections

When flared connections are used, use a suitable lubricant between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.2.3.5 Flanged Connections

When steel refrigerant piping is used, provide union or flange joints in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, chillers, control valves, and other similar items. Flanged joints must be assembled square end tight with matched flanges, gaskets, and bolts. Provide gaskets that are suitable for use with the refrigerants to be handled.

3.2.4 Valves

3.2.4.1 General

Install refrigerant stop valves on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Install stop valves with stems horizontal unless otherwise indicated. Install ball valves must be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches must be external to thermal insulation. Safety switches must not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves must be provided at all points of systems where accumulated non-condensable gases would prevent proper system operation. Valves must be furnished to match line size, unless otherwise indicated or approved.

3.2.4.2 Expansion Valves

Install expansion valves with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 54 mm 2-1/8 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 54 mm 2-1/8 inches. Fasten the bulb securely with two clamps. Insulate ehe bulb . Install the bulb in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing must be facing up.

3.2.4.3 Valve Identification

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NOTE: Delete last two sentences when identification tags are not considered necessary in small projects.

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Tag each system valve, including those which are part of a factory assembly. Tags must be in alphanumeric sequence, progressing in direction of fluid flow. Tags must be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately 34 mm 1-3/8 inch diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Attach tags with nonferrous, heavy duty, bead or link chain, 14 gauge 14 gauge annealed wire, nylon cable bands or as approved. Reference tag numbers in Operation and Maintenance Manuals and system diagrams.

3.2.5 Vibration Dampers

Provide vibration damper in the suction and discharge lines on spring mounted compressors. Install vibration dampers parallel with the shaft of the compressor and anchor firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.2.6 Strainers

Provide strainers immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

3.2.7 Filter Dryer

Provide a liquid line filter dryer on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Size dryers in accordance with the manufacturer's recommendations for the system in which it is installed. Install dryers such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Install dryers in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.2.8 Sight Glass

Install a moisture indicating sight glass in all refrigerant circuits down stream of all filter dryers and where indicated. Provide full line size sight glasses.

3.2.9 Discharge Line Oil Separator

Provide discharge line oil separator in the discharge line from each compressor. Connect the oil return line to the compressor as recommended by the compressor manufacturer.

3.2.10 Accumulator

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NOTE: Suction line accumulator should be included under certain split system applications, such as having extended refrigerant lines, 15 m 50 feet or longer. If accumulator is not used, then delete this paragraph.

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Provide accumulators in the suction line to each compressor.

3.2.11 Flexible Pipe Connectors

Install connectors perpendicular to line of motion being isolated. Fit piping for equipment with bidirectional motion with two flexible connectors, in perpendicular planes. Install reinforced elastomer flexible connectors in accordance with manufacturer's instructions. Provide piping guides and restraints related to flexible connectors as required.

3.2.12 Temperature Gauges

Locate temperature gauges specifically on, but not limited to the following: [the sensing element of each automatic temperature control device where a thermometer is not an integral part thereof] [the liquid line leaving a receiver] [and] [the suction line at each evaporator or liquid cooler]. Thermowells for insertion thermometers and thermostats must extend beyond thermal insulation surface not less than 25 mm 1 inch.

3.2.13 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to MSS SP-58, except as modified herein. Do not use pipe hanger types 5, 12, and 26. Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Support piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, by variable spring hangers and supports or by constant support hangers.

3.2.13.1 Hangers

Do not use Type 3 on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.2.13.2 Inserts

Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.2.13.3 C-Clamps

Torque Type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.2.13.4 Angle Attachments

Furnish Type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

3.2.13.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, must be used on all pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher. Use Type 40 shields on all piping less than 100 mm 4 inches and all piping 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F. Use a high-density insulation insert of cellular glass under the Type 40 shield for piping 50 mm 2 inches and larger.

3.2.13.6 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58 and install a support no more than 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Space pipe supports no more than 1.5 m 5 feet apart at valves. [Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 23 kg 50 pounds must have the excess hanger loads suspended from panel points.]

3.2.13.7 Vertical Pipe Supports

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m 15 feet not more than 2.4 m 8 feet from end of risers, and at vent terminations.

3.2.13.8 Pipe Guides

Provide Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Provide slide materials that are suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.2.13.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, usea Type 39 saddle. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.2.13.10 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 100 mm 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.2.13.11 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.2.13.12 Seismic Requirements

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NOTE: Provide seismic details, if a Government designer (either Corps office of A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase "as shown on the drawings" if no seismic details are provided. UFC 3-301-01 STRUCTURAL ENGINEERING and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS properly edited, must be included in the contract documents.

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Support and brace piping and attached valves to resist seismic loads as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and [23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS] [as shown on the drawings]. Provide structural steel required for reinforcement to properly support piping, headers, and equipment but not shown under this section. Specify material used for support under Section 05 12 00 STRUCTURAL STEEL.

3.2.13.13 Structural Attachments

Attachment to building structure concrete and masonry must be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors must be applied with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead applications of ferrous materials only. Provide structural steel brackets required to support piping, headers, and equipment, but not shown, under this section. Specify material used for support under Section 05 12 00 STRUCTURAL STEEL.

3.2.14 Pipe Alignment Guides

Provide pipe alignment guides where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1.5 m 5 feet on each side of each expansion joint, and in lines 100 mm 4 inches or smaller not more than 600 mm 2 feet on each side of the joint.

3.2.15 Pipe Anchors

Provide anchors wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Provide anchors consisting of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, immediately anchor these items adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Submit detailed drawings of pipe anchors for approval before installation.

3.2.16 Building Surface Penetrations

Do not install sleeves in structural members except where indicated or approved. Provide galvanized sheet metal sleeves in non-load bearing surfaces conforming to ASTM A653/A653M, Coating Class G-90, 1.0 mm (20 gauge) 20 gauge. Provide uncoated carbon steel pipe sleeves in load bearing surfaces conforming to ASTM A53/A53M, [Schedule 30] [Schedule 20] [Standard weight]. Apply sealants to moisture and oil-free surfaces and elastomers to not less than 13 mm 1/2 inch depth. Do not install sleeves in structural members.

3.2.16.1 Refrigerated Space

Fit refrigerated space building surface penetrations with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Construct sleeves with integral collar or fit cold side with a bonded slip-on flange or extended collar. In the case of masonry penetrations where sleeve is not cast-in, fill voids with latex mixed mortar cast to shape of sleeve and assemble flange/external collar type sleeve with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fastened to surface with masonry anchors. Flash integral cast-in collar type sleeve [as indicated.] [with not less than 100 mm 4 inches of cold side vapor barrier overlap of sleeve surface.] Normally seal noninsulated penetrating round surfaces to sleeve bore with mechanically expandable seals in vapor tight manner and insulate remaining warm and cold side sleeve depth with not less than [100] [_____] mm [4] [_____] inches of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer. Apply vapor barrier sealant to finish warm side insulation surface. Insulate warm side of penetrating surface beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Seal wires in refrigerated space surface penetrating conduit with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

3.2.16.2 General Service Areas

Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Provide pipes passing through concrete or masonry wall or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Provide sleeves that allow a minimum of 6 mm 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over-insulation and sleeve in accordance with Section 07 92 00 JOINT SEALANTS.

3.2.16.3 Waterproof Penetrations

Install pipes passing through roof or floor waterproofing membrane through a 5.17 kg/sq. m 17 ounce copper sleeve, or a 0.81 mm 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Form flashing sleeve, and extend skirt or flange greater than 200 mm 8 inches from the pipe and set over the roof or floor membrane in a troweled coating of bituminous cement. Extend the flashing sleeve up the pipe a minimum of 50 mm 2 inches above the roof or floor penetration. Seal the annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation as indicated. Seal penetrations by either one of the following methods.

3.2.16.3.1 Waterproofing Clamping Flange

Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.2.16.3.2 Modular Mechanical Type Sealing Assembly

In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Provide seals consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Loosely assemble links with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.2.16.4 Fire-Rated Penetrations

Seal penetration of fire-rated walls, partitions, and floors as specified in Section 07 84 00 FIRESTOPPING.

3.2.16.5 Escutcheons

Provide escutcheons for finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, use special deep-type escutcheons. Secure escutcheon to pipe or pipe covering.

3.2.17 Access Panels

Provide access panels for all concealed valves, vents, controls, and items requiring inspection or maintenance. Provide access panels of sufficient size and locate so that the concealed items may be serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.2.18 Field Applied Insulation

Field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2.19 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.2.19.1 Color Coding

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NOTE: Color coding for piping identification required by the using agency will be developed and inserted in the "Color Code Schedule" in Section 09 90 00 PAINTS AND COATINGS. For Air Force Installations, piping will be color-coded in accordance with Attachment 4 of AFM 88-15.

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Color coding for piping identification is specified in Section 09 90 00 PAINTS AND COATINGS.

3.2.19.2 Color Coding Scheme

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NOTE: Color Coding Scheme may be deleted if not required in the project. Use Sections with a 10 after the Section number and delete those with 20 for Army projects, and vice versa.

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Provide a color coding scheme for locating hidden piping in accordance with [Section 22 00 00 PLUMBING, GENERAL PURPOSE][Section 22 00 70 PLUMBING, HEALTHCARE FACILITIES].

3.2.20 Identification Tags

****

NOTE: Delete this paragraph when identification

tags are not considered necessary on small projects.
****

Provide identification tags made of brass, engraved laminated plastic or engraved anodized aluminum indicating service and item number on all valves and dampers. Tags must be 35 mm 1-3/8 inch minimum diameter and marking must be stamped or engraved. Indentations must be black for reading clarity. Attach tags to valves with No. 12 AWG copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.3 CLEANING AND ADJUSTING

Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant, or any foreign matter are considered contaminated systems. Restore contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, using currently approved refrigerant and refrigeration manufacturer's procedures. Restore contaminated systems at no additional cost to the Government as determined by the Contracting Officer. Do not use water in any procedure or test.

3.4 TRAINING COURSE

a. Submit a schedule, at least [2] [_____] weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training. Conduct a training course for [_____] members of the operating staff as designated by the Contracting Officer. The training period must consist of a total [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

b. Cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations in the field posted instructions..

c. Submit [6] [_____] complete copies of an operation manual in bound 216 by 279 8 1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least [4] [_____] weeks prior to the first training course. Include the manufacturer's name, model number, and parts list in the booklets. Include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features in the manuals.

d. Submit [6] [_____] complete copies of maintenance manual in bound 216 by 279 8 1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. Include piping layouts and simplified wiring and control diagrams of the system as installed in the manuals.

3.5 REFRIGERANT PIPING TESTS

****
NOTE: The following refrigerant system tests are for field fabricated refrigerant piping systems. The tests do not apply to packaged, unitary

equipment which is charged at the factory.

Equipment and piping will be capable of withstanding leak pressure tests at not less than the design pressure corresponding to the highest ambient temperature (refer to ASHRAE 15 & 34).

****

After all components of the refrigerant system have been installed and connected, subject the entire refrigeration system to pneumatic, evacuation, and startup tests as described herein. Submit a schedule, at least [2] [_____] weeks prior to the start of related testing, for each test. Identify the proposed date, time, and location for each test. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test. Provide the services of a qualified technician, as required, to perform all tests and procedures indicated herein. Coordinate field tests with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit [6] [_____] copies of the tests report in bound 216 by 279 mm 8 1/2 by 11 inch booklets documenting all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results in the report.

3.5.1 Preliminary Procedures

Prior to pneumatic testing, isolate equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, from the test pressure, or remove from the system. Remove safety relief valves and rupture discs that are not part of factory sealed systems, and cap or plug openings.

3.5.2 Pneumatic Test

Provide pressure control and excess pressure protection at the source of test pressure. Valves must be wide open, except those leading to the atmosphere. Test gas must be dry nitrogen, with minus 55 degrees C minus 70 degree F dewpoint and less than 5 ppm oil. Apply test pressure in two stages before any refrigerant pipe is insulated or covered. In accordance with ASME B31.5, a preliminary test not to exceed 170 kPa 25 psi must be applied as a means of locating major leaks. Every joint being tested must be coated with a thick soap or color indicating solution. The second stage test pressure must be at least 110 percent of the design pressure, but cannot exceed 130 percent of the design pressure of any component in the system. For large systems that are not completely visible, the pressure in the system must be gradually increased to one-half of the test pressure after which the pressure must be increased in steps of one-tenth of the test pressure, until the required test pressure has been reached. The test pressure must be continuously maintained for at leas 24 hours, after which it can be reduced to the leak test pressure. A correction factor of 2 kPa 0.3 psi will be allowed for each degree C F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. The leak test pressure must be the design pressure, or a pressure specified in the engineering design. To repair leaks, the joint must be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, re-melting, or back-welding/brazing are not acceptable. Following repair, the entire system must be retested using the pneumatic tests described above. Reassemble the entire system once the pneumatic tests are satisfactorily completed.

3.5.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, relieve the pressure and evacuate the entire system to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature must be higher than 2 degrees C 35 degrees F. Do not evacuate no more than one system at one time by one vacuum pump. Once the desired vacuum has been reached, close the vacuum line and allow the system to stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, evacuate the system again down to 300 micrometers and let set for another 1 hour period. Do not charge the system until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure rises above 500 micrometers, continue to repeat the evacuation procedures until all residual moisture has been removed. During evacuation, record pressures by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

3.5.4 System Charging and Startup Test

Following satisfactory completion of the evacuation tests, charge the system with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system must operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. Test the entire system tested for leaks. Test fluorocarbon systems with halide torch or electronic leak detectors.

3.5.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must be immediatelyisolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. The refrigerant must not be discharged into the atmosphere.

3.5.6 Contractor's Responsibility

At all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time will the allowable leak rate exceed the leak rates allowed in Section 608 of the Clean Air Act: 30 percent of the full charge per year for industrial refrigeration, 20 percent of the full charge per year for commercial refrigeration, and 10 percent of the full charge per year for comfort cooling. Any system leaks within the first year must be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 25 00 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-23 25 00 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS

05/21

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS
05/21

****
NOTE: This guide specification covers the requirements for chemical treatment of water for mechanical systems.

Adher to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM D596	(2001; R 2018) Standard Guide for Reporting Results of Analysis of Water
ASTM D1384	(2005; R 2019) Corrosion Test for Engine Coolants in Glassware
ASTM D2688	(2015; E 2016) Standard Test Method for Corrosivity of Water in the Absence of Heat Transfer (Weight Loss Methods)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 200-1-13	(2016) Environmental Quality -- Minimizing the Risk of Legionellosis Associated with Building Water Systems on Army Installation
PWTB 420-49-5	(1998) Industrial Water Treatment Procedures

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-430-08N	(2004) Central Heating Plants

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Water Treatment System; G, [_____]

Water Analysis; G, [_____]

Spare Parts

Field Instructions

Tests; G, [_____]

Training Course; G, [_____]

SD-06 Test Reports

Condenser Water QA Tests

Steam Boiler Water QA Tests

SD-10 Operation and Maintenance Data

Water Treatment System

1.3 MAINTENANCE MATERIAL SUBMITTALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings, not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with source of supply, with the data.

1.4 QUALITY CONTROL

1.4.1 Safety

****

NOTE: Catwalk, ladder and guardrail may be required. If so, select the applicable item and delete the others and indicate on drawings the selected item. If not applicable, delete the entire sentence within the brackets.

****

Ensure exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel are insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired. Provide [catwalk,] [ladder,] [and guardrail] where indicated and in accordance with Section [05 50 13 MISCELLANEOUS METAL FABRICATIONS] [05 51 33 METAL LADDERS].

1.4.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Summary

This section covers the provisions and installation procedures necessary for a complete and totally functional water system(s) chemical treatment. Provide and install the system with all necessary System Components, Accessories, Piping Components, and Supplemental Components/Services. Minimize to risk of Legionellosis by following the guidance in EM 200-1-13.

2.1.2 Standard Products

a. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for two years' prior to bid opening.

b. Include in the two-year use all applications of equipment and materials under similar circumstances and of similar size. Ensure the two years' experience has been satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a two-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

c. All products are required to be supported by a service organization. Submit a certified list of qualified permanent service organizations for support of the equipment, including their addresses and qualifications. These service organizations are required to be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

d. The selected service organization provides the chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company provides all chemicals required for the [condenser] [condenser and chilled] water systems and fills the systems with chemicals to the levels specified. The chemical is required to meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and cooling tower. Acid treatment chemicals are not allowed to be used.

2.1.3 Water Analysis

****

NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.

Cooling towers with a capacity greater than 176 kW 50 tons will be provided with automatic chemical feed and blow down systems. Smaller towers will be provided with continuously activated systems. Indicate the location of the entire water treatment system.

****

Conditions of make-up water to be supplied to the boilers, cooling towers and chilled water systems reported in accordance with ASTM D596 are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees C
Silica (SiO 2)	[_____] ppm (mg/L)
Insoluble	[_____] ppm (mg/L)
Iron, total (Fe)	[_____] ppm (mg/L)

Aluminum (Al)	[_____] ppm (mg/L)
Calcium (Ca)	[_____] ppm (mg/L)
Magnesium (Mg)	[_____] ppm (mg/L)
Carbonate (HCO 3)	[_____] ppm (mg/L)
Sulfate (SO 4)	[_____] ppm (mg/L)
Chloride (Cl)	[_____] ppm (mg/L)
Nitrate (NO 3)	[_____] ppm (mg/L)
Turbidity	[_____] ntu
pH	[_____]
Residual Chlorine	[_____] ppm (mg/L)
Total Alkalinity	[_____] ppm (mg/L)
Non-Carbonate Hardness	[_____] ppm (mg/L)
Total Hardness	[_____] ppm (mg/L)
Dissolved Solids	[_____] ppm (mg/L)
Conductivity	[_____] Micromho/cm

2.2 EQUIPMENT

2.2.1 Nameplates

Provide a nameplate for each major component of equipment that includes the manufacturer's name, address, type or style, and catalog or serial number securely attached to the item of equipment. Provide nameplates for:

a. Pump(s)

b. Pump Motor(s)

c. Water Treatment Controller(s)

2.2.2 Electrical Work

****

NOTE: Where motor starters for mechanical equipment are provided in motor-control centers, the references to motor starters will be deleted. Mechanical designer must ensure that the electrical designer is provided with electrical requirements for chemical feed pumps.

****

Ensure all electrical equipment, motors, motor efficiencies, and wiring complies with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical motor driven equipment specified complete with motors, motor starters, and controls. Provide electrical characteristics and enclosure types as shown, and unless otherwise indicated, provide all motors of 745 W 1 horsepower and above with open, drip-proof, or totally enclosed fan cooled enclosures, high efficiency type. Perform field wiring in accordance with manufacturer's instructions. Each motor is required to conform to NEMA MG 1 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide continuous duty motors with the enclosure specified. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Furnish motors with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Furnish motor starters with [NEMA 1] [NEMA 3R] [NEMA [_____]] enclosures. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown.

2.2.3 Gauges

Provide gauges that conform to ASME B40.100, Class 1, 2, or 3, Style X, Type I or III as required, 115 mm 4-1/2 inches in diameter with phenolic or metal case.

2.3 COMPONENTS

2.3.1 Condenser Water Treatment Systems

The use of chemical-treatment products containing hexavalent chromium (Cr) is prohibited. Treat the water to be used in the condenser water systems to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals are required to meet all required federal, state, and local environmental regulations for the treatment of condenser-side heat exchangers, cooling towers and direct discharge to the sanitary sewer.

Provisions should be made to effectively dose, monitor and control a water treatment program to include (1) inhibitor and biocide injection (2) water sampling, (3) corrosion coupon sampling, and (4) effective bleed and control points.

2.3.1.1 Condenser Water Limits

Meet the following condenser water limits, unless dictated differently by the cooling tower or chiller manufacturer's recommendations:

Treatment type	Phosphonate/Polymer
Puckorius Index	4 minimum
Langelier Index	4 maximum
Total Dissolved Solids	5000 ppm maximum
Calcium Hardness	1200 ppm maximum
Silica	150 ppm maximum

pH	7.5 - 8.5

For treated condenser/cooling tower water, minimize blowdown until the first of one of the top 5 limits is reached. Specific requirements for treatment chemicals and levels are listed below in paragraphs dealing with small and large systems.

2.3.1.2 Glycol Solution

****

NOTE: If freeze protection for condenser water is not required or addressed using a different method, this paragraph should be deleted. When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient or operating temperature.

****

Coordinate minimum glycol concentration with manufacturer to avoid corrosion inhibitor degradation. Test the glycol in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. Provide glycol that contains corrosion inhibitors. Silicate based inhibitors are not acceptable. Ensure the solution is compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

2.3.1.3 Chemical Treatment for Small Systems

For cooling systems with a capacity of 175.8 kW 50 tons or less, provide the following chemical treatment. For corrosion control provide 6.8 to 9.1 kg 15 to 20 pounds polyphosphate in nylon mesh bag in cooling tower sump. If biocide is needed, use either 1-bromo-3-chloro-5.5-dimethylhydantoin or gluteraldehyde as recommended by manufacturer.

2.3.1.4 Chemical Treatment for Large Systems

For cooling systems with capacities greater than 175.8 kW 50 tons provide one of the three following chemical treatments with the limits indicated. The zinc and molybdate in the last two treatments help to meet the maximum corrosion requirements in waters that tend to be more corrosive. Maintain biocides to control bacteria below 10,000 colony forming units per milliliter.

a. Phosphonate Type Treatment

(1)

Phosphate	3-5 ppm

Polymer	3-4 ppm
TT	1-2 ppm
Biocides	as required

b. Zinc-Phosphonate Type Treatment
(1)

Phosphate	3-5 ppm
Polymer	3-4 ppm
Zinc	1-2 ppm
TT	1-2 ppm
Biocides	as required

c. Zinc-Molybdate Type Treatment
(1)

Phosphate	3-5 ppm
Polymer	3-4 ppm
Molybdate	10-15 ppm
Zinc	2-3 ppm
TT	1-2 ppm
Biocides	as required

2.3.1.4.1 General Requirements

Provide a water treatment system capable of automatically feeding chemicals and bleeding the system to prevent corrosion, scale, and biological formations. Submit [6] [_____] complete copies, at least 5 weeks prior to the purchase of the water treatment system, of the proposed water treatment plan including a layout; control scheme; a list of existing make-up water chemistry, including the items listed in paragraph Water Analysis; a list of treatment chemicals to be added; the proportion of chemicals to be added; the final treated water control levels; and a description of health, safety and environmental concerns for handling the chemicals plus any special ventilation requirements. Automatic chemical feed systems automatically feed chemicals into the condenser water based on makeup water rate. Use electrical signals from a water meter on the makeup water line to control the output of chemical feed pumps. Set the system initially manually based on the water analysis of the make-up water. Submit [6] [_____] complete copies of operating and maintenance manuals for the step-by-step water treatment procedures. Include in the manuals all testing procedures used in determining water quality.

2.3.1.4.2 Chemical Feed Pumps and Tanks

****

NOTE: The required maximum pump flow rate will be shown on the drawings. The flow rate will depend upon the makeup water flow rate, the chemical composition of the makeup water and the concentration of the chemical supplied. A water treatment company should be consulted for determining the proper maximum pump flow rate.

A water treatment company will be consulted to determine the number of tanks required and must be shown on plans. The number will depend on the size of the boiler, makeup water flow rate, and makeup water composition. A potable water line will be provided near the tanks for the mixing of chemicals.

****

a. Furnish chemical feed pumps and tanks as a package with the pumps mounted on and piping connected to the tank. Furnish chemical feed pumps of the positive displacement diaphragm type. Furnish all pump cylinders, plungers, ball check valves, and check valve bodies made of corrosion resistant materials suitable for the chemicals being pumped. Ensure the cylinders of the provided pumps are replaceable for increased or reduced pressure or capacity ranges.

b. Provide pumps with a flow rate adjustable from 0 to 100 percent while in operation. The volumetric accuracy of the pumps is required to be within one percent over the range indicated. Ensure pump capacities are adjustable by positioning crank pin with micrometer setscrews. Divide stroke length scale in percentage graduations engraved on scale. Ensure the discharge pressure of pumps is not less than 1.5 times the line pressure at the point of connection. Provide the pumps with a pressure relief valve and a check valve mounted in the pump discharge. Control the pump by an external controller/timer receiving signals from the makeup water meter.

c. Provide drive motors rated at 110 volt, single phase with drip-proof enclosures. Provide two chemical tanks constructed of [materials compatible with the chemicals to be stored in the tank] [high density polyethylene] [stainless steel] [fiber reinforced plastic] with a hinged cover and mounted on legs. Ensure tanks have filling and drain connections and gauge glasses. Furnish each tank with one pump, mounted and piped with pipe materials and fittings suitable for working pressure and compatible with the chemicals in the tank it is in contact with, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Provide a tank bottom that is dished concave to a radius equal to the diameter of the tank. Provide motor-driven agitator. Size the tanks to have sufficient capacity to require recharging only once per [7] [14] [21] [_____] days during normal operation.

2.3.1.4.3 Chemical Injection Assembly

Provide an injection assembly at each chemical feed point. Locate the injection assembly downstream of recirculating pumps and upstream of the condenser. Construct the injection assemblies of stainless steel. Locate the discharge of the assemblies in the condenser water piping as recommended by the manufacturer. Include with each assembly a shutoff valve and check valve at the point of entrance into the condenser water line.

2.3.1.4.4 Water Meter

Provide water meters with an electric contacting register and remote accumulative counter. Install the meter within the make-up water line, as indicated.

2.3.1.4.5 Timers

Provide timers which are of the automatic reset, adjustable type, and are electrically operated. Ensure the timers are designed to work with the contacting head water meters. Include the water meter cable with the timer. Ensure timers control operation of the chemical feed pumps and are suitable for a 120 volt current. Locate the timers within the water treatment control panel.

2.3.1.4.6 Bleed (Blowdown) Line

Control the flow through the bleed line by a conductivity meter and probe installed to measure the conductivity of the condenser water. Provide a high and low set point on the conductivity meter above which the meter opens a solenoid valve on the bleed line. Locate the bleed line attachment to the condenser water piping downstream of the recirculating pumps and upstream of the chemical injection point. Extend the bleed line to the nearest drain for continuous discharge.

2.3.1.4.7 Control Panel

****

NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems. In areas where a panel could come in contact with the water treatment chemical, choose the stainless steel construction.

****

Provide a NEMA 12 control panel enclosure suitable for surface mounting. Construct the panel of [stainless steel] [coated steel] with a hinged door and lock. Include a laminated plastic nameplate identifying each of the following functions:

(1) Main power switch and indicating light
(2) MAN-OFF-AUTO selector switch
(3) Indicating lamp for bleed-off valve
(4) Indicating lamp for each chemical feed pump
(5) Set point reading for each timer

2.3.1.4.8 Chemical Piping

Construct the piping and fittings of [schedule 80 PVC] [stainless steel] suitable for the water treatment chemicals.

2.3.1.4.9 Sequence of Operation

Add chemicals based upon sensing the make-up water flow rate and activating appropriate timers. Provide a separate timer for each chemical. Control the blow down based upon the conductivity of the condenser water. Control the injection of the chemical required for biological control manually set for proper chemical feed. The water treatment company is required to determine and set a timer set points, blow down rates, and chemical pump flow rates.

2.3.1.4.10 Test Kits

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals.

2.3.2 Chilled Water System

****

NOTE: The services of a company regularly engaged in water treatment for mechanical systems to treat a chilled water system should only be required if the makeup water available is of very poor quality.

For dual temperature systems (chilled and heated water), coordinate the compatibility of the separate water treatment systems.

****

Provide a [7.57] [18.92] [_____] L [2] [5] [_____] gallon shot feeder on the chilled water piping as indicated. Furnish the feeder with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.3.2.1 Requirements for Glycol Solution

****

NOTE: If freeze protection for chilled water is not required, this paragraph should be deleted. When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient or operating temperature. Consult with a water treatment company to determine the exact treatment levels for chilled water treatment.

****

Coordinate minimum [ethylene][propylene] glycol concentration with manufacturer to avoid corrosion inhibitor degradation. Test the glycol in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. Ensure the glycol contains corrosion inhibitors. Silicate based inhibitors are not acceptable. Ensure the solution is compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

2.3.2.2 Chilled Water Treatment

Treat chilled water with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment are acceptable for use with glycol. Maintain borax/nitrite treatment at the limits of [ ] ppm nitrite, [ ] ppm copper corrosion inhibitor (TT or MBT), and pH of 8.5 to 9.5. Maintain molybdate treatment at the limits of [ ] ppm molybdate, [ ] ppm copper corrosion inhibitor (TT or MBT), and pH of 8.0 to 9.0.

2.3.2.3 Dual Temperature Systems

Dual hot/chilled water systems that are treated with borax/nitrite are also to be treated with a biocide.

2.3.2.4 Chilled Water Test Kits

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals (e.g. pH and nitrite or molybdate).

2.3.3 Low and Medium Temperature Hot Water Boilers and Heat Exchangers

Low and medium temperature hot water boilers are defined as those operating below 177 degrees C 350 degrees F, (122 degrees C 250 degrees F for Low Temperature).

2.3.3.1 Chemical Feeder

Provide a [7.57] [18.92] [_____] L [2] [5] [_____] gallon shot feeder on the hot water piping as indicated. Base the size and capacity of feeder upon local requirements and water analysis. Furnish the feeder with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.3.3.2 Water Softening System

****

NOTE: The makeup water analysis and the boiler manufacturer's recommended feed water conditions will be used to determine the need for a water softener. Softening of makeup water for hot water boilers is required if the makeup water hardness is above 200 ppm or the makeup rate is above 1 percent.

****

Provide a water softening system as specified in Section 22 31 00 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.3.3.3 Low and Medium Temperature Hot Water Treatment

Treat hot water with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment are acceptable to use with glycol. Maintain borax/nitrite treatment at the limits of 600 to 1000 ppm nitrite, 40 - 50 ppm copper corrosion inhibitor (TT or MBT) and pH of 8.5 to 9.5. Maintain molybdate treatment at the limits of 100 to 125 ppm molybdate, 40 - 50 ppm copper corrosion inhibitor (TT or MBT) and pH of 8.0 to 9.0.

2.3.3.4 Dual Temperature Systems

Dual hot/chilled water systems treated with borax/nitrite are required to also be treated with a biocide.

2.3.3.5 Test Kit Requirements

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals (e.g. pH and nitrite or molybdate).

2.3.4 High Temperature Hot Water Boilers

****

High Temperature Hot Water Boilers are defined as those operating above 177 degrees C 350 deg F. The chemical treatment requires more attention (daily), the makeup water requires softening and the chemicals and limits differ from the low and medium temperature hot water boilers.

****

2.3.4.1 Chemical Feeder Unit

****

NOTE: The required maximum pump flow rate will be shown on the drawings. The flow rate will depend upon the makeup water flow rate, the chemical composition of the makeup water and the concentration of the chemical supplied. A water treatment company should be consulted for determining the proper maximum pump flow rate.

A company regularly engaged in water treatment for mechanical systems will be consulted to determine the number of tanks required to be shown on the drawings. The number will depend on the size of the boiler, makeup water flow rate, and makeup water composition. A potable water line will be provided near the tanks for the mixing of chemicals.

****

Provide a feeder unit for each boiler. Ensure chemical feeder provided is automatic proportioning, shot type, or pump type. Provide all appurtenances necessary to ensure the system performs in compliance with the requirements outlined herein. Base the size and capacity of feeder upon local requirements and water analysis.

2.3.4.2 Pumps and Tanks

a. Furnish chemical feed pumps and tanks as a package with the pumps mounted on and piping connected to the tank. The chemical feed pumps are required to be positive displacement diaphragm type. Furnish the pump cylinders, plungers, ball check valves, and check valve bodies fabricated from corrosion resistant materials suitable for the chemicals being pumped. Ensure cylinders used are replaceable for increased or reduced pressure or capacity ranges.

b. Provide for a flow rate of the pumps that is adjustable from 0 to 100 percent while in operation. Ensure volumetric accuracy of the pumps is within one percent over the range indicated. Ensure pump capacities are adjustable by positioning crank pin with micrometer setscrews. Divide stroke length scale in percentage graduations engraved on scale. Ensure the discharge pressure of pumps is not less than 1.5

times the line pressure at the point of connection. Design the pumps to feed the chemical solutions into the HTW return line to the system circulating pumps with a capacity to feed a maximum of [5.3] [_____] mL/second [5] [_____] gph. Provide the pumps with a pressure relief valve and a check valve mounted in the pump discharge. Control the pumps by an external controller/timer receiving signals from the makeup water meter.

c. Provide drive motors that are 110 volt, single phase and have drip-proof enclosures. Provide the tanks constructed of [materials compatible with the chemicals to be stored in the tank] [high density polyethylene] [stainless steel] [fiber reinforced plastic] with a hinged cover and mounted on legs. Ensure tanks have both filling and drain connections and gauge glass. Furnish each tank with one pump, mounted and piped with black iron pipe and fittings suitable for working pressures and compatible with the chemicals in the tank it is in contact with, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Provide tank with a dished concave bottom to a radius equal to the diameter of the tank. Provide units suitable for phosphate, caustic feed and sulfite feeding. Provide sulfite tank with a floating cover to completely cover the surface of the solution. Include a motor-driven agitator. Size tanks to have sufficient capacity to require recharging only once per [7] [14] [21] [_____] days during normal operation.

d. For auto proportioning systems, provide controllers designed to be used with selected system specifically for the purpose of injecting chemicals into boiler systems.

e. Mount system components on metal buses or supports instead of mounting directly to the floor.

2.3.4.3 Water Softening System

****

NOTE: The makeup water analysis and the boiler manufacturer's recommended feed water conditions will be used to determine the need for a water softener. Hardness must be maintained below 2 ppm.

****

Provide water softening system as specified in Section 22 31 00 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.3.4.4 Treated Water Limits

Consult with the boiler manufacturer for the determination of the boiler water chemical composition limits. Provide for the following recirculating hot water chemical limits unless dictated differently by the boiler manufacturer's recommendations:

pH	9.3-9.9
Sulfite	30-60 ppm
Hardness	Less than 2.0 ppm

2.3.5 Test Kit

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals (e.g. pH, hardness and sulfite).

2.3.6 Steam Boiler Water Treatment

****

NOTE: The chemical piping will be indicated on the drawing. Piping for feeding sulfite will be connected to the storage section of the deaerator or feedwater heater or to the feedwater line. Piping for other treatment chemicals will be connected to the boiler drum. The chemical shot feeder will not be required for larger steam boilers.

If steam is used for cooking or humidification, a separate heat exchanger will be required due to environmental constraints with the use of amines (AR 420-49, 6-5b).

****

Provide a water treatment system capable of feeding chemicals and blowdown of the system to prevent corrosion and scale within the boiler and piping distribution system. Treat the water to maintain the conditions recommended by the boiler manufacturer or UFC 3-430-08N (Central Heating Plants) and PWTB 420-49-5 (Industrial Water Treatment Procedures). Provide chemicals that meet all required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. Engage the services of a company regularly engaged in the treatment of boilers to determine the correct concentrations required for water treatment. The company is required to maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Do not use filming amines, hydrazine and chelants. Ensure the water treatment chemicals remain stable throughout the operating temperature range of the system and are compatible with pump seals and other elements of the system.

2.3.6.1 Boiler Water Limits

Provide for boiler water limits as follows unless dictated differently by the boiler manufacturer's recommendations:

Causticity (OH)	20-200 ppm
Total Alkalinity (CaCO3)	200-800 ppm
Phosphate (PO4)	30-60 ppm
Polymer (dispersant) or Tannin	5-10 ppm or medium color, respectively
Dissolved Solids (water tube boilers)	3000-3500 ppm
Dissolved Solids (fire tube boilers)	3500-5000 ppm

Suspended Solids	15 ppm Maximum
Sodium Sulfite	20-40 ppm
Silica	Less than 200 ppm
Dissolved Oxygen	Less than 7 ppb
Iron	Less than 10 ppm
pH (Condensate)	7.5 - 8
Conductivity (Condensate)	Less than 35 micromhos
Hardness (Condensate and makeup)	Less than 2 ppm

The above limits apply to boilers operating above 100 kPa 15 psi up 2070 kPa 300 psi. Above 2070 kPa 300 psi these limits decrease. Use ABMA or chemical vendor recommended limits above 2070 kPa 300 psi.

2.3.6.2 Water Softening System

****

NOTE: The makeup water analysis and the boiler manufacturer's recommended feed water conditions will be used to determine the need for a water softener. Generally, all boilers operating above 100 kPa 15 psi require softened water.

****

Provide the water softening system as specified in Section 22 31 00 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.3.6.3 Boiler Water Treatment System

Provide water treatment system capable of automatically feeding chemicals to prevent corrosion and scale within the boiler and condensate system. Ensure automatic chemical feed systems feed chemicals into the boiler based on makeup water rate. Use electrical signals from a water meter on the makeup water line to control the output of chemical feed pumps.

2.3.6.4 Steam Boiler Chemical Feed Pumps and Tanks

****

NOTE: The required maximum pump flow rate will be shown on the drawings. The flow rate will depend upon the makeup water flow rate, the chemical composition of the makeup water and the concentration of the chemical supplied. A water treatment company should be consulted for determining the proper maximum pump flow rate.

A company regularly engaged in water treatment for mechanical systems will be consulted to determine the number of tanks required to be shown on the drawings. The number will depend on the size of the boiler, makeup water flow rate, and makeup water

composition. A potable water line will be provided near the tanks for the mixing of chemicals.

****

a. Furnish chemical feed pumps and tanks as a package with the pumps mounted on and piping connected to the tank. Use chemical feed pumps that are positive displacement diaphragm type. Ensure the pump cylinders, plungers, ball check valves, and check valve bodies are fabricated of corrosion resistant materials suitable for the chemicals being pumped. Ensure cylinders are replaceable for increased or reduced pressure or capacity ranges. Ensure the flow rate of the pumps is adjustable from 0 to 100 percent while in operation. Ensure volumetric accuracy of the pumps is within one percent over the range indicated. Pump capacities are required to be adjustable by positioning crank pin with micrometer setscrews. Divide stroke length scale in percentage graduations engraved on scale.

b. Ensure the discharge pressure of pumps is not less than 1.5 times the line pressure at the point of connection. Provide pumps with a pressure relief valve and a check valve mounted in the pump discharge. Control the pumps by an external controller/timer receiving signals from the makeup water meter.

c. Provide drive motors rated for 110 volt, single phase and are equipped with drip-proof enclosures. Provide tanks constructed of [materials compatible with the chemicals to be stored in the tank] [high density polyethylene] [stainless steel] [fiber reinforced plastic] with a hinged cover and mounted on legs. Ensure tanks have filling and drain connections and gauge glass. Furnish each tank with one pump, mounted and piped with pipe and fittings suitable for working pressures and compatible with the chemicals in the tank it is in contact with, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Shape tank bottom to be dished concave to a radius equal to the diameter of the tank. Ensure the tank for sodium sulfite is equipped with a floating cover to minimize contact with air. Provide a motor-driven agitator. Size the tanks to have sufficient capacity to require recharging only once per [7] [14] [21] [_____] days during normal operation.

2.3.6.5 Steam Boiler Chemical Injection Assemblies

Provide an injection assembly at each chemical injection point located along the boiler piping as indicated. Provide injection assemblies that are constructed of stainless steel. Extend the discharge of the assemblies to the centerline of the piping. Include a shutoff valve and check valve with each assembly at the point of entrance into the water line.

2.3.6.6 Steam Boiler Water Meter

Provide the water meter with an electric contacting register and remote accumulative counter. Install the meter within the makeup water line, as indicated.

2.3.6.7 Steam Boiler Timers

Provide timers that are automatic reset, adjustable type, and electrically operated. Design timers to work with the contacting head water meters. Include the water meter cable with the timer. Ensure timers control operation of the chemical feed pumps. Ensure timers are suitable for a 120 volt current. Use timers to control the electrical signals from the water meters to the chemical feed pumps.

2.3.6.8 Steam Boiler Control Panel

****

NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems.

****

Provide control panel constructed of a NEMA 12, single door, wall-mounted box conforming with NEMA 250. Ensure the panel is constructed of [coated steel] [stainless steel] with a hinged door and lock. Ensure the panel contains, as a minimum, the following functions identified with a laminated plastic nameplate:

a. Main power switch and indicating light
b. MAN-OFF-AUTO selector switch
c. Indicating lamp for each chemical feed pump
d. Indicating lamp for the water softener

2.3.6.9 Boiler Blowdown

****

NOTE: Typically, automatic blowdown will be economical for boilers with capacities greater than 2.9 MW 10,000,000 Btuh.

****

Provide the boiler with [continuous blowdown] [automatic blowdown based upon conductivity or boiler load]. Provide a bottom blowdown connection and valve to allow removal of solids and water from the bottom of the boiler.

2.3.6.10 Boiler Chemical Piping

****

NOTE: If steel piping is selected, an interior coating may be required depending upon the chemicals used.

****

Fabricate the piping and fittings of [steel] [stainless steel].

2.3.6.11 Boiler Test Kits

Provide one test kit of each type required to determine the water quality as outlined in paragraph Boiler Water Limits above and within the operation and maintenance manuals.

2.3.7 Supplemental Components/Services

****

NOTE: All drain and makeup water piping should be indicated on the drawings.

****

Ensure drain and makeup water piping complies with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE. Connect drains to sanitary sewer systems by means of an indirect waste connection.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy, before performing any work.

3.2 INSTALLATION

Provide all chemicals, equipment and labor necessary to bring all system waters in conformance with the specified requirements. Perform all work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.

3.2.1 Piping

Fabricate all connections between dissimilar metals using dielectric unions.

3.3 FIELD QUALITY CONTROL

3.3.1 Tests

If the waters of the mechanical systems are not in conformance with the specified requirements or in accordance with manufacturer's recommendations, the contractor is required to direct the water treatment company to take corrective action to achieve compliance. Perform daily operational tests in the directed frequencies to maintain required control to prevent corrosion, scaling and damage to equipment during operation. Submit test schedules, at least 2 weeks prior to the start of related testing, for the condenser/chilled/boiler/condensate/feedwater water quality tests. Identify the date, time, frequency and collection location for each test within the schedules.

3.3.2 Condenser Water Quality Tests

3.3.2.1 Small Systems (weekly)

Once a week, for cooling systems with a capacity of 175.8 kW 50 tons or less, ensuring the following items are recorded.

pH	[_____]
Total Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm

3.3.2.2 Tests for Large Systems (daily)

Daily, for cooling systems with a capacity larger than 175.8 kW 50 tons, ensuring the following items are recorded.

pH	[_____]
Total Alkalinity (as CaCO3)	[_____] ppm (mg/L)

Conductivity	[_____] micromho/cm
Phosphate	[_____] ppm (mg/L)
Zinc, if used (Zn)	[_____] ppm (mg/L)
Molybdate, if used (Mo)	[_____] ppm (mg/L)

3.3.3 Chilled Water Testing (monthly)

Perform the following tests on chilled water on a monthly basis.

pH	[_____]
Nitrite or Molybdate	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm

3.3.4 Hot Water Boiler Water Quality Testing

3.3.4.1 Low and Medium Temperature Systems (monthly)

Complete and record monthly testing for the following parameters.

pH	[_____]
Nitrite or Molybdate	[_____] ppm (mg/L)

3.3.4.2 High Temperature Hot Water Systems (daily)

Complete and record daily testing for the following parameters.

pH	[_____]
Sulfite	[_____] ppm (mg/L)
Hardness	[_____] ppm (mg/L)

3.3.5 Steam Boiler Water Testing

3.3.5.1 Small Steam Systems

The type of treatment required for small steam systems (below 0.25 MW 25 hp) varies greatly depending on local water and system conditions. Base the determination of the type of treatment and frequency of testing on the recommendations of by the water treatment chemical vendor.

3.3.5.2 Medium Steam Systems (twice weekly)

Record the following items twice a week for steam boiler systems operating between 0.25 MW 25 hp and 1 MW 100 hp and utilize data for operation purposes.

pH	[_____]
P Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Total Dissolved Solids	[_____] ppm (mg/L)
Phosphate (PO4)	[_____] ppm (mg/L)
Sulfite (NaSO3)	[_____] ppm (mg/L)

3.3.5.3 Large Steam Systems (daily)

Record the following items daily for steam boiler systems operating above 100 kPa 15 psi and 1 MW 100 hp and utilize data for operational purposes.

Sulfite (NaSO3)	[_____] ppm (mg/L)
P Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Neutralized Conductivity	[_____] micromho/cm
Total Dissolved Solids	[_____] ppm (mg/L)
Phosphate (PO4)	[_____] ppm (mg/L)
Condensate pH	[_____]
Condensate Conductivity	[_____] micromho/cm
Condensate Hardness (as CaCO3)	[_____] ppm (mg/L)
Makeup Water Hardness (as CaCO3)	[_____] ppm (mg/L)

3.3.6 Quality Assurance Testing

****

NOTE: It is important to require Quality Assurance (QA) testing performed by an independent industrial water treatment laboratory/consultant to sustain good water chemistry control. Systems without good chemistry control will experience higher equipment replacement costs, energy and operating costs, higher water usage, more plant shutdowns, higher and decreased safety.

****

Conduct QA testing periodically by an independent water treatment lab/consultant to verify to managers that the mechanical and water treatment systems are being maintained properly. Provide the QA evaluation reports to the government COR.

3.3.6.1 Condenser Water QA Tests

Submit test reports in bound 216 by 279 mm 8-1/2 by 11 inch booklets. Within the reports, identify the chemical composition of the condenser water. Also include in the reports a comparison of the manufacturer's or chemical vendor's recommended operating conditions for the cooling tower and condenser in relation to the actual condition of the condenser water. Document any required corrective actions undertaken within the report.

a. For cooling systems with a capacity of 175.8 kW 50 ton or less, the perform following tests

b.

Presence of scale/corrosion	[_____]
Polyphosphate	[_____] ppm (mg/L)
Biocide	[_____] ppm (mg/L)
pH	[_____]
Total Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Calcium Hardness (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Written evaluation summary	

c. For cooling systems with capacities greater than 175.8 kW 50 ton), analyze the condenser water a minimum of once a month for a period of one year by the water treatment company. Ensure the analysis includes the following information recorded in accordance with ASTM D596.

d.

Date of Sample	[_____]
Temperatures (before & after condenser)	[_____] & [_____] degrees C
pH	[_____]
Silica (SiO2)	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Copper (Cu)	[_____] ppm (mg/L)
Calcium Hardness(CaCO3)	[_____] ppm (mg/L)
Total Hardness (as CaCO3)	[_____] ppm (mg/L)
Chloride (Cl)	[_____] ppm (mg/L)

Total Alkalinity (as $CaCO_3$)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Total Dissolved Solids	[_____] ppm (mg/L)
Phosphonate (as PO_4)	[_____] ppm (mg/L)
Zinc (if used) (Zn)	[_____] ppm (mg/L)
Molybdate (if used) (Mo)	[_____] ppm (mg/L)
Tolyltriazole (TT)	[_____] ppm (mg/L)
Biocide	[_____] ppm (mg/L)
Bacteria colony count	[_____] colonies/mL
Makeup water pH	[_____] ppm (mg/L)
Makeup water Iron	[_____] ppm (mg/L)
Makeup water Silica	[_____] ppm (mg/L)
Makeup water Calcium Hardness	[_____] ppm (mg/L)
Makeup water Total Hardness	[_____] ppm (mg/L)
Makeup water Total Alkalinity	[_____] ppm (mg/L)
Makeup water Chloride (Cl)	[_____] ppm (mg/L)
Makeup water Conductivity	[_____] micromho/cm
Written evaluation summary	

3.3.6.2 Chilled Water Quality Assurance Testing (quarterly)

Perform the following tests quarterly on chilled water.

pH	[_____]
Nitrite or Molybdate	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Written evaluation summary	

3.3.6.3 Hot Water Boiler Water Quality Assurance Testing

a. Complete quarterly testing of Low and Medium Temperature Systems and record the following parameters.

b.

pH	[_____]
Nitrite or Molybdate	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Written evaluation summary	

c. Have an independent consultant analyze the hot water boiler water once a month for a period of 1 year. Include the following information recorded in accordance with ASTM D596 in the monthly report.

d.

pH	[_____]
Sulfite (Na2SO3)	[_____] ppm (mg/L)
Hardness(as CaCO3)	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Written evaluation summary	

3.3.6.4 Steam Boiler Water QA Tests

Submit the water quality test report identifying the chemical composition of the boiler, feedwater and condensate water. Include in the report a comparison of the condition of the boiler water with the manufacturer's or chemical vendor's recommended conditions. Document any required corrective action within the report.

a. Small and Medium Steam Boiler Systems (quarterly)are systems operating between 0.25 MW 25 hp and 1 MW 100 hp. Perform the following tests quarterly.

b.

pH	[_____]
Sulfite, if used, (NaSO3)	[_____] ppm (mg/L)
P Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Total Dissolved Solids	[_____] ppm (mg/L)
Phosphate, if used, (PO4)	[_____] ppm (mg/L)
Polymer, if used	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Condensate pH	[_____]
Condensate Conductivity	[_____] micromho/cm

Condensate Hardness (as CaCO3)	[_____] ppm (mg/L)
Condensate Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Makeup Water Hardness (as CaCO3)	[_____] ppm (mg/L)
Written evaluation summary	

c. Large steam boilers are those operating above 100 kPa 15 psi and 1 MW 100 hp. Retain an independent consultant to analyze the boiler water a minimum of once a month for a period of 1 year. Include the following information recorded in accordance with ASTM D596 in the monthly report.

d.

Date of Sample	[_____]
pH	[_____]
Sulfite (NaSO3)	[_____] ppm (mg/L)
P Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Neutralized Conductivity	[_____] micromho/cm
Total Dissolved Solids	[_____] ppm (mg/L)
Phosphate (PO4)	[_____] ppm (mg/L)
Polymer, if used	[_____] ppm (mg/L)
Silica (SiO2)	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Condensate pH	[_____]
Condensate Conductivity	[_____] micromho/cm
Condensate Hardness (as CaCO3)	[_____] ppm (mg/L)
Condensate Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Makeup Water Hardness (as CaCO3)	[_____] ppm (mg/L)
Written evaluation summary	

3.3.7 Corrosion Testers

****

NOTE: Choose from the systems below to be monitored with corrosion testers.

****

Install corrosion coupon and rack systems to verify corrosion control in the systems. Install testers or coupons in flowing system water through a sidestream or rack system. Test both mild steel and copper metal samples in the corrosion testers in accordance with ASTM D2688. Replace and analyze samples every 3 months. Rates of corrosion less than 3 mpy for steel and 0.2 mpy for copper are acceptable. Install corrosion testers on the piping systems of the following systems.

Condenser loop
Chilled water system
Hot water loop
Condensate

3.4 CLOSEOUT ACTIVITIES

3.4.1 Training Course

Submit a schedule, at least 2 weeks prior to the date of the proposed training course that identifies the date, time, and location for the training. Conduct a training course for the operating staff as designated by the Contracting Officer. Conduct the training to include a total of [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. Submit field instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. Include within the condensed operation instructions all preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. Frame the posted instructions under glass or laminated plastic and post where indicated by the Contracting Officer. Ensure the field instructions cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

3.5 INSPECTIONS

3.5.1 Inspection General Requirements

Thirty days after project completion, inspect the cooling tower and condenser for problems due to corrosion, scale, and biological growth. If the cooling tower and condenser are found not to conform to the manufacturer's recommended conditions, and the water treatment company recommendations have been followed; instruct the water treatment company to provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

3.5.2 Boiler/Piping Test

****
NOTE: If a steam boiler is not used, delete the reference to condensate piping.
****

Thirty days after project completion, inspect the boiler and condensate piping for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, instruct the water treatment company to provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations. If corrosion is found within the condensate piping, proper repairs are required to be made by the water treatment company at no additional cost.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 30 00 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-23 00 00 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 30 00

HVAC AIR DISTRIBUTION

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USACE / NAVFAC / AFCEC **UFGS-23 30 00 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-23 00 00 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 23 30 00

HVAC AIR DISTRIBUTION

02/25

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NOTE: This guide specification covers the requirements for air supply, distribution, ventilation, and exhaust portions of an HVAC system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: Coordinate the use of this specification with other sections, as appropriate, in order to specify a complete HVAC built-up system.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 220	(2005;R 2012) Test Methods for Air Curtain Units
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating
AMCA 511	(2010; R 2016) Certified Ratings Program for Air Control Devices

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 260 I-P	(2012) Sound Rating of Ducted Air Moving and Conditioning Equipment
AHRI 350	(2015) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
AHRI 430	(2009) Central-Station Air-Handling Units
AHRI 440	(2008) Performance Rating of Room Fan-Coils
AHRI 880 I-P	(2011) Performance Rating of Air Terminals

AHRI 885	(2008; Addendum 2011) Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets
AHRI DCAACP	(Online) Directory of Certified Applied Air-Conditioning Products

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality
ASHRAE 70	(2023) Method of Testing the Performance of Air Outlets and Inlets
ASHRAE 84	(2024) Method of Testing Air-to-Air Heat/Energy Exchangers
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B75/B75M	(2020) Standard Specification for Seamless

	Copper Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B280	(2023) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C534/C534M	(2024) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2855	(2020) Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets

ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E2016	(2022) Standard Specification for Industrial Woven Wire Cloth

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GERMAN INSTITUTE FOR STANDARDIZATION (DIN)

DIN EN 14037	(2016) Free Hanging Heating and Cooling Surfaces for Water with a Temperature Below 120 Degrees C - Part 1: Pre-Fabricated Ceiling Mounted Radiant Panels for Space Heating
DIN EN 14240	(2004) Ventilation for Buildings

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST RP-CC-001	(2016; Rev 6) HEPA and ULPA Filters

INTERNATIONAL CODE COUNCIL (ICC)

ICC IMC	(2024) International Mechanical Code

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60034-30-1	(2014) Rotating Electrical Machines – Part 30-1: Efficiency Classes of Line Operated AC Motors (IE Code)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 21940-11	(2016) Mechanical vibration -- Rotor balancing -- Part 11: Procedures and Tolerances for Rotors with Rigid Behavior

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors

NEMA MG 10009	(2022) Energy Management Guide for Selection and Use of Single-Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2024) Standard for the Installation of Warm Air Heating and Air Conditioning Systems
NFPA 96	(2024) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1819	(2002) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 5th Edition
SMACNA 1884	(2003) Fibrous Glass Duct Construction Standards, 7th Edition
SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

U.S. DEPARTMENT OF ENERGY FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)

PL-109-58	(1992; R 2005) Energy Efiicient Procument Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 94	(2023; Reprint Jan 2024) UL Standard for

	Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 181	(2013; Reprint Dec 2021) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 555	(2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers
UL 555S	(2014; Reprint Oct 2020) UL Standard for Safety Smoke Dampers
UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 705	(2017; Reprint Sep 2024) UL Standard for Safety Power Ventilators
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment
UL 2021	(2015; Reprint Dec 2016) UL Standard for Safety Fixed and Location-Dedicated Electric Room Heaters
UL Bld Mat Dir	(updated continuously online) Building Materials Directory
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.2.1 Mechanical Equipment Identification

The number of charts and diagrams must be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.2.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

[1.2.1.2 Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. provide neat mechanical drawings provided with extruded aluminum frame under 3 mm 1/8-inch glass or laminated plastic, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.

]1.2.2 Service Labeling

****

NOTE: Edit table below to include equipment types and tagging nomenclature matching the design.

****

1.2.2.1 Equipment Labeling

Label equipment as indicated below with labels made of self-sticking, plastic film designed for permanent installation. Provide labels in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Air handling unit Number	AHU - [_____]
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF - [_____]
VAV Box Number	VAV - [_____]
Fan Coil Unit Number	FC - [_____]
Terminal Box Number	TB - [_____]
Unit Ventilator Number	UV - [_____]

1.2.2.2 Pipe Labeling

****

NOTE: The MIL-STD-101 system is for ground based piping systems and compressed gas cylinders. The color coding is not compatible with ASME A13.1 which is commonly used for facilities work

****

Identify similar services with different temperatures or pressures. Where pressures could exceed 860 kilopascal 125 pounds per square inch, gage, include the maximum system pressure in the label. Color coding of all piping systems must be in accordance with [ASME A13.1] [MIL-STD-101]. Label and arrow piping in accordance with the following:

a. Each point of entry and exit of pipe passing through walls.

b. Each change in direction, i.e., elbows, tees.

c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 22 meter 75 feet. All labels must be visible and legible from the primary service and operating area.

e.

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
13 thru [_____] mm1/2 thru 1-3/8 inch	13 mm1/2 inch
40 thru [_____] mm1-1/2 thru 2-3/8 inch	[_____] mm3/4 inch
65 mm and larger2-1/2 inch and larger	[_____] mm1-1/4 inch

1.2.2.3 Ductwork Labeling

Label ductwork with 2 inch lettering indicating the type of ductwork, associated air handling device and arrow indiccating direction of airflow. Coordinate ductwork labeling with any duct insulation and painting requirements to assure labeling is visible on final installation. Duct labels are to be black text on white background, produced by either paint/stenciling or made of self-sticking, plastic film designed for permanent installation. Locations of ductwork labels are to be in accordance with the following:

a. Each point of entry and exit of ductwork passing through walls.

b. In congested or hidden areas and at all access panels at each point required to clarify service.

c. In long straight runs, locate labels at distances within eyesight of each other not to exceed 22 meter 75 feet.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Metallic Flexible Duct

Insulated Nonmetallic Flexible Duct Runouts

Pre Manufactured Double Wall Ductwork

Fabric Ductwork

Duct Connectors

Duct Access Doors; G, [_____]

Fire Dampers; G, [_____]

Manual Balancing Dampers; G, [_____]

Gravity Backdraft and Relief Dampers; G, [_____]

Automatic Smoke-Fire Dampers; G

Automatic Smoke Dampers; G, [_____]

Sound Attenuation Equipment

Acoustical Duct Liner

Diffusers

Registers and Grilles

Louvers

Air Vents, Penthouses, and Goosenecks

Centrifugal Fans

In-Line Centrifugal Fans

Axial Flow Fans

Propeller Type Sidewall Fans

Centrifugal Type Power Wall Ventilators

Centrifugal Type Power Roof Ventilators

Propeller Type Power Roof Ventilators

Air-Curtain Fans

Ceiling Exhaust Fans

PL-109-58 label for ceiling exhaust fan product; S

Air Handling Units; G, [_____]

Room Fan-Coil Units; G, [_____]

Constant Volume, Single Duct Terminal Units; G, [_____]

Variable Volume, Single Duct Terminal Units; G, [_____]

Variable Volume, Single Duct, Fan-Powered Terminal Units; G, [_____]

Dual Duct Terminal Units; G, [_____]

Reheat Units; G, [_____]

Unit Ventilators

Energy Recovery Devices; G, [_____]

Hydronic Modular Panels; G, [_____]

Prefabricated Radiant-Heating Electric Panels; G, [_____]

Test Procedures

Diagrams; G, [_____]

Indoor Air Quality for Duct Sealants; S

SD-06 Test Reports

Performance Tests; G, [_____]

Damper Acceptance Test; G, [_____]

SD-07 Certificates

Bolts

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

Fire Dampers; G, [_____]

Manual Balancing Dampers; G, [_____]

Automatic Smoke-Fire Dampers; G, [_____]

Automatic Smoke Dampers; G, [_____]

Centrifugal Fans; G, [_____]

In-Line Centrifugal Fans; G, [_____]

Axial Flow Fans; G, [_____]

Propeller Type Sidewall Fans; G[, [_____]]

Centrifugal Type Power Wall Ventilators; G, [_____]

Centrifugal Type Power Roof Ventilators; G, [_____]

Propeller Type Power Roof Ventilators; G, [_____]

Air-Curtain Fans; G, [_____]

Ceiling Exhaust Fans; G, [_____]

Air Handling Units; G, [_____]

Room Fan-Coil Units; G, [_____]

Constant Volume, Single Duct Terminal Units; G, [_____]

Variable Volume, Single Duct Terminal Units; G, [_____]

Variable Volume, Single Duct, Fan-Powered Terminal Units; G, [_____]

Dual Duct Terminal Units; G, [_____]

Reheat Units; G, [_____]

Unit Ventilators; G, [_____]

Energy Recovery Devices; G, [_____]

Hydronic Modular Panels; G, [_____]

Prefabricated Radiant-Heating Electric Panels; G, [_____]

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.4 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

a. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.

b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.

c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or ENERGY STAR covered product categories, equipment selected must have as a minimum the efficiency rating identified under "Energy-Efficient Products" at http://femp.energy.gov/procurement.[Equipment having a lower efficiency may be specified if the designer determines such equipment to be more life-cycle cost effective.]

1.4.1 Prevention of Corrosion

****

NOTE: Refer to sub-section titled "Painting" for painting requirements.

****

Protect metallic materials against corrosion. Provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Provide hot-dip galvanized ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations.[Provide written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, and the number of each type of bolt to be furnished in the certification.]

1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.4.3 Ozone Depleting Substances Technician Certification

****

NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants, such as R-123, into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

****

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4.4 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

1.4.5 Test Procedures

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

****
NOTE: Use this paragraph for Air Force and Army projects.

****

Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.2 STANDARD PRODUCTS

****
NOTE: Use this paragraph for Navy projects.
****

Except for the fabricated duct, plenums and casings specified in paragraphs "Metal Ductwork" and "Plenums and Casings for Field-Fabricated Units", provide components and equipment that are standard products of manufacturers regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. This requirement applies to all equipment, including diffusers, registers, fire dampers, and balancing dampers.

a. Standard products are defined as components and equipment that have been in satisfactory commercial or industrial use in similar applications of similar size for at least two years before bid opening.

b. Prior to this two year period, these standard products must have been sold on the commercial market using advertisements in manufacturers' catalogs or brochures. These manufacturers' catalogs, or brochures must have been copyrighted documents or have been identified with a manufacturer's document number.

c. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.3 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Provide identification plates that are layers, black-white-black, engraved to show white letters on black background. Letters must be upper case. Identification plates 40 mm 1-1/2-inches high and smaller must be 1.6 mm 1/16-inch thick, with engraved lettering 3 mm 1/8-inch high; identification plates larger than 40 mm 1-1/2-inches high must be 3 mm 1/8-inch thick, with engraved lettering of suitable height. Identification plates 40 mm 1-1/2-inches high and larger must have beveled edges. Install identification plates using a compatible adhesive.

2.4 EQUIPMENT GUARDS AND ACCESS

****

NOTE: Catwalks, ladders, and guardrails could be required. If so, select the applicable item and indicate on drawings. If not applicable, delete the entire last sentence.

****

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard. The requirements for catwalks, operating platforms, ladders, and guardrails are specified in Section 08 31 00 ACCESS DOORS AND PANELS.

2.5 ELECTRICAL WORK

****

NOTE: Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm on the drawings in the equipment schedules.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting interferes with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (SD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01 INTERIOR ELECTRICAL SYSTEMS.

****

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

****

NOTE: Specification paragraph b, below no longer limits to alternating current motors - allowing the use of ECMs.

****

b. For single-phase motors, provide high-efficiency type, including motors that are part of a system, in accordance with NEMA MG 10009 and NEMA MG 1. Provide premium efficiency type for alternating current motors in accordance with NEMA MG 1.

c. For polyphase motors, provide either ECM or squirrel-cage medium induction motors. Utilize the best equipment for the given mechanical equipment characteristics, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1 or NEMA MG 10009. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

e. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.

2.5.1 Electronically Commutated Motors

Provide ECM Motors of a sufficient size for the duty to be performed while not exceeding the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions.

2.5.1.1 Design Requirements

****

NOTE: Do not switch ECM motor's AC power to turn ECM motor on and off. Instead control the 24VAC signal or BAS signal to turn the ECM motor on and off. The ECM motor has large capacitors that charge quickly on mains power up. Switching on several motors frequently could reduce building power quality and is not recommended.

****

a. Provide Electronically Commutated Motors (ECM) designed as a DC brushless motor for variable speed or constant speed motor control. ECM design must allow for factory setting of the unit's fan flow. ECM must maintain respective constant fan speed at all set points regardless of external pressures that are within design ranges. Motor must be permanently lubricated with ball bearings with an L-10 rated life of not less than standards in accordance with ABMA 9 or ABMA 11.

b. ECM will be complete with and be operated by a single-phase or three-phase integrated controller/inverter. AC power will be rectified, filtered and then converted to DC power. This will ensure variable speed operation at DC power.

c. ECM controller must be capable of accepting a 0-10VDC or a 4-20mA signal for manual/automatic control.

d. Ensure efficiency is a minimum of 70 percent over the motors entire operating range.

2.5.1.2 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, make adjustments to the motor size, wiring and conduit systems, disconnect devices, and circuit protection to accommodate the equipment installed, at no additional cost to the Government. Provide control and protective devices in accordance with NFPA 70 requirements.

2.5.1.3 Voltage Ratings

Provide at a minimum, motors with the following voltage ratings:

MOTOR SIZE		FED FROM POWER SOURCE	MOTOR VOLTAGE RATING
MOTOR TYPE	HORSE POWER		
Fractional horsepower, single-phase	3/4 and smaller	120/208-volt, 120/240-volt, 480/277-volt, 3-phase, 4-wire	115-volt, 200-volt, 230-volt, 277-volt 1-phase 50/60-hertz
Integer horsepower, single-phase	1	120/208-volt, 120/240-volt, 277/480-volt, 3-phase, 4-wire	115-volt, 200-volt, 230-volt, 277-volt 1-phase 50/60-hertz
Integer horsepower, single-phase	2 and 3	120/208-volt, 120/240-volt, 3-phase, 4-wire	200-volt, 230-volt, 1-phase 50/60-hertz
Integer horsepower, three-phase	1 thru 5	120/208-volt, 120/240-volt, 277/480-volt, 3-phase, 4-wire	200-volt, 230-volt, 460-volt, 3-phase 50/60-hertz

MOTOR SIZE		FED FROM POWER SOURCE	MOTOR VOLTAGE RATING
MOTOR TYPE	HORSE POWER		
Integer horsepower, three-phase	7.5 and above	277/480-volt, 3-phase, 4-wire	460-volt, 3-phase 50/60-hertz

2.5.1.4 Temperature Rating and Insulation

Provide motors designed for continuous operation at the rated full load in an ambient temperature of 40 degrees C, 104 degrees F, with an insulation level of at least Class B.

2.5.1.5 Motor Enclosures

2.5.1.5.1 Indoor Type Enclosures

a. For motors installed in indoor, clean, dry, non-hazardous locations, provide the following: Open-type drip-proof enclosures.

b. For motors installed in indoor, wet, non-hazardous locations, provide the following: Open splash-proof enclosures.

c. For motors installed in indoor, non-hazardous locations where it is necessary to protect the motor from dirt, moisture, chemical fumes, or other harmful ingredients in the surrounding atmosphere, provide either of the following type of enclosure: Totally enclosed fan-cooled enclosures for exterior cooling by means of a fan or fans integral with the machine.

2.6 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts must not degrade the surrounding concrete.

2.7 SEISMIC ANCHORAGE

****

NOTE: Retain this paragraph only when equipment is to be installed in areas of seismic activity. Where project requires seismic bracing of HVAC systems, specification section 23 05 48.19 is to be included with the project specifications.

****

Provide seismic bracing for HVAC systems components in accordance with 23 05 48.19SEISMIC BRACING FOR MECHANICAL SYSTEMS

2.8 PAINTING

****

NOTE: Use upgraded materials/coatings in humid locations or project locations with Environmental

Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. For projects in these locations, include the sentence below to paint in accordance with Section 09 96 00 HIGH PERFORMANCE COATINGS; designer to edit and include Section 09 96 00.

****

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing. Paint in accordance with Section 09 96 00 HIGH-PEFORMANCE COATINGS.

2.9 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM D1654, and ASTM D3359. Submit evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors [and 500 hours for units to be installed outdoors][, refer to paragraph Corrosion Protection for Coastal Installations for equipment installed within [16 kilometers 10 miles][8 kilometers 5 miles] of a sea (salt) water coastline]. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 3 mm 1/8 inch. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to ASTM D520 Type I.

Field paint factory painting that has been damaged prior to acceptance by the Contracting Officer in compliance with the requirements of paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

2.10 CORROSION PROTECTION FOR COASTAL INSTALLATIONS

****

NOTE: Use this paragraph for projects located within a coastal environment.

Specify corrosion protection for exterior HVAC equipment, including air handling units, heat exchanger coil surfaces, equipment casings, air-cooled water chiller coils, heat pumps, and air conditioning units, that is exposed to the weather within 16 km (10 miles) of a sea (salt) water coast.

At these coastal locations, this corrosion protection is also required on HVAC equipment within buildings that are subject to the outside weather conditions. Specifically, equipment requiring protection is defined as the first HVAC equipment (excluding louvers) met by the outside air in the supply air ductwork system.

For packaged equipment (outdoor heat pumps, AC units, AHU's) less than 10 tons capacity, Specifier the manufacturer's standard off-the-shelve anti-corrosion options for "coastal" or "sea coast" installations are required/provided. (This approach is generally less costly than specifying custom corrosion protection.

****

Provide air handling coils with aluminum fins on copper tubes or micro channel coils or otherwise custom treated for corrosion protection. Coils on all outdoor equipment of [35 kW 10 ton][18 kW 5 ton] capacity or greater must pass ASTM B117 3000 hour salt spray test as installed. For equipment installed within 300 meters 1000 feet of the ocean corrosion resistance mush pass ASTM B117 6000 hour salt spray test as installed

For packaged equipment (outdoor heat pumps, air conditioning units, air handling units) less than [35 kW 10 ton][18 kW 5 ton] capacity, such equipment must be provided with the manufacturer's seacoast/coastal anti-corrosion options.

Heat transfer ratings of equipment must be indicated within the equipment submittals with consideration for the deratings associated with the corrosion protection systems as installed.

2.11 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.12 DUCT SYSTEMS

****

NOTE: Identify all pressure classification for all ductwork in accordance with SMACNA 1966, including points of changes in pressure classification, on the drawings. Indicate pitch of ductwork, low spots in ductwork, and means of disposing of condensate, where required. Size outdoor air intakes so that rain and snow are not drawn into the ductwork. Slope watertight intakes to a drain line and provide means to dispose of the water. The requirement that outdoor air intake ducts and plenums be fabricated watertight with soldered or brazed joints and seams can be eliminated where rain or snow does not get drawn into the outdoor air intake.

Provide Ductwork Construction and Leakage Testing Table provided on the drawings in accordance with UFC 3-410-01.

Limit the use of flexible duct (due to the inordinate pressure drop and corresponding fan energy consumption that it causes). Show the extent of flexible duct on the drawings. Ensure that the restrictions in these standards pertaining to the use of non-metallic materials in air distribution

plenums are adhered to.

The flammability and combustibility of non-metallic duct materials is controlled by NFPA 90A, 90B, and 91. Show the extent of non-metallic duct on the drawings when these standards limit its use.

All ductwork must meet the requirements of Seal Class A.

****

2.12.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification .

a. Construct ductwork meeting the requirements for the duct system static pressure as indicated on the Ductwork Construction and Leakage Testing Table provided on the drawings.

b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.

c. Provide branch duct supply take-offs and return connections to main ductwork using 45 degree branch connections or conical tap connections [as indicated on the drawings].

d. Provide ductwork that meets the requirements of Seal Class A.

e. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant. Provide duct sealant products that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or Volatile Organic Compounds (VOC) content requirements of SCAQMD Rule 1168 (HVAC duct sealants are classified as "Other" within the SCAQMD Rule 1168 sealants table). The VOC emittance must be 420 g/l or less. Provide validation of indoor air quality for duct sealants.

f. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 50 mm 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable.

****

NOTE: Include option below to slope duct connection to louver in locations where snowfall is prevalent and likely to be pulled in through the louver.

****

g. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams. [Slope bottom of [outdoor air intake plenums][final[meter][3 feet] of duct run connecting to louver] at[85mm per meter][1/2 inch per foot]].

2.12.1.1 Metallic Flexible Duct

a. Provide duct that conforms to UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Provide duct assembly that does not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of 497 Pa 2 inches water gauge positive pressure and 373 Pa 1.5 inches water gauge negative pressure. Provide flexible round duct length that does not exceed 1525 mm 5 feet. Secure connections by applying adhesive for 51 mm 2 inches over rigid duct, apply flexible duct 51 mm 2 inches over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.

b. Inner duct core: Provide interlocking spiral or helically corrugated flexible core constructed of zinc-coated steel, aluminum, or stainless steel; or constructed of inner liner of continuous galvanized spring steel wire helix fused to continuous, fire-retardant, flexible vapor barrier film, inner duct core.

c. Insulation: Provide inner duct core that is insulated with mineral fiber blanket type flexible insulation, minimum of 25 mm 1 inch thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

2.12.1.2 Insulated Nonmetallic Flexible Duct Runouts

****

NOTE: Select the glass fabric density. Higher density flexible duct provides better attenuation and isolation of vibration excitation by fan motors.

****

Use flexible duct runouts only where indicated. Runout length is indicated on the drawings, and is not to exceed 1.5 m 5 feet. Provide runouts that are preinsulated, factory fabricated, and that comply with NFPA 90A and UL 181. Provide either field or factory applied vapor barrier. Provide not less than[0.60 kg/square meter 20 ounce/square yard][1 kg/square meter 30 ounce/square yard] glass fabric duct connectors coated on both sides with neoprene. Where high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Do not expose the insulation material surface to the air stream.

2.12.1.3 General Service Duct Connectors

Provide a flexible duct connector approximately 150 mm 6 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardant fabrics" in UL Bld Mat Dir.

2.12.1.4 High Temperature Service Duct Connections

Provide material that is approximately 2.38 mm 3/32 inch thick, 1.2 to 1.36 kg per square meter 35 to 40-ounce per square yard weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 650 degrees C 1200 degrees F.

2.12.1.5 Aluminum Ducts

ASTM B209/B209M, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.12.1.6 Copper Sheets

ASTM B152/B152M, light cold rolled temper.

2.12.1.7 Corrosion Resisting (Stainless) Steel Sheets

ASTM A240/A240M

2.12.2 Duct Access Doors

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NOTE: Provide duct access doors at regular intervals to facilitate the cleaning of duct systems for applications requiring clean air supplies, such as hospitals, laboratories, electronics servicing and similar activities.

****

Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 375 by 450 mm 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 600 by 600 mm 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.12.3 Fire Dampers

****

NOTE: Indicate the location of each fire damper and details of the damper installations according to NFPA 90A. Three-hour rated fire dampers must be specifically identified on the drawings. Indicate locations of pressure relief doors on plans. Pressure relief doors are to be provided in locations where rapid closure of a fire damper will result in exploding or imploding ductwork due to contained air volumes between the fan and the fire damper (no pathway for relief via grilles /

registers / diffusers or other openings). Provide information on plans regarding the pressure relief door opening direction (positive or negative pressure type door) as well as specified pressure setting of the door)

****

Use 1.5 hour rated fire dampers unless otherwise indicated. Provide fire dampers that conform to the requirements of NFPA 90A and UL 555. Perform the fire damper test as outlined in NFPA 90A. [Provide pressure relief doors where indicated on plans to prevent duct damage upon rapid closure of fire dampers to the duct system.] Provide automatic operating fire dampers with a dynamic rating suitable for the maximum air velocity and pressure differential to which it is subjected. Provide fire dampers approved for the specific application, and install according to their listing. Equip fire dampers with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, does not impair the operation of the damper. Equip sleeves or frames with perimeter mounting angles attached on both sides of the wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies in conformance with UL Fire Resistance. Provide [curtain type with damper blades] [in the air stream] [out of the air stream][or][single blade type][or][multi-blade type] fire dampers. Install dampers that do not reduce the duct or the air transfer opening cross-sectional area. Install dampers so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, comply with the installation details given in SMACNA 1819 and in manufacturer's instructions for fire dampers. Perform acceptance testing of fire dampers according to paragraph DAMPER ACCEPTANCE TEST and NFPA 80.

2.12.4 Manual Balancing Dampers

****

NOTE: Show all manual volume dampers on the drawings. Do not rely upon diffuser and register volume dampers for balancing.

****

a. Furnish factory manufactured and assembled manual balancing dampers with accessible locking-type quadrant operators. Manufacturer must publish damper data sheets and dampers must be sold on the open market. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building where ductwork is exposed.

b. Furnish stand-off mounting brackets, bases, or adapters, not less than the thickness of the insulation, to provide clearance between the duct surface and the operator. Stand-off mounting items are to be integral with the operator or standard accessory of the damper manufacturer. For duct widths greater than 750mm30 inches, provide locking regulator at each end of the damper shaft.

c. Dampers installed in ductwork with an air velocity over 7.5 meters per second1500 feet per minute, or pressure class greater than 500 pascals2 inches must be rated for the design velocity and pressure class indicated.

2.12.4.1 Single Blade Round Dampers

a. May be furnished up to 500mm20 inches in diameter.

b. Provide a minimum 10mm3/8 inch square continuous full length galvanized or plated steel axle shaft that supports the entire blade diameter and extends through the standoff bracket and quadrant operator. Firmly affix the axle shaft to the blade. Spring-loaded positioners are not permitted.

c. Must be factory fabricated in a frame with a minimum length of 150mm6 inches made of galvanized steel with straightening ribs; minimum of 22 gage up to 200mm8 inch diameter, and 20 gage above 200mm8 inch diameter. Damper frames are to be mounted end to end with round duct. Supple the axle shaft on both ends with a pressed in elastomeric bearing/seal, for low infiltration/exfiltration air leakage.

d. Provide galvanized steel damper blade; minimum of 22 gage up to 200mm8 inch diameter, and 20 gage above 200mm8 inch diameter.

2.12.4.2 Single Blade Rectangular Dampers

a. May be furnished up to 300mm12 inches in height for rectangular ducts.

b. Provide square galvanized or plated steel axle shaft(s) that support the blade at both ends and extends through the standoff bracket and quadrant operator; minimum 10mm3/8 inch up to 475mm19 inch blade length, and 13mm1/2 inch over 475mm19 inch blade length. Firmly affix the axle shaft(s) to the blade. Spring-loaded positioners are not permitted. Provide, at the duct wall shaft penetration, an elastomeric seal for low infiltration/exfiltration air leakage.

c. Must be factory fabricated in a frame with a minimum length 75mm3 inches made of galvanized steel; minimum of 24 gage up to 475mm19 inch blade length, and 22 gage over 475mm19 inch blade length. Damper frames are to be mounted inside the duct. Support axle shaft on both ends with a bearing in the frame.

d. Provide damper blades made of galvanized steel with roll formed or broke stiffener(s); minimum of 20 gage up to 475mm19 inch blade length, and 18 gage over 475mm19 inch blade length.

2.12.4.3 Multi-blade Rectangular Dampers

a. Furnish for round ducts larger than 500mm20 inch and rectangular duct greater than 300mm12 inches in height, except flanged duct system. Furnish square to round transitions for application in round duct.

b. Provide 13mm1/2 inch galvanized or plated steel axle shafts that support each blade at both ends. Extend the operator shaft through the standoff bracket and quadrant operator. An elastomeric seal for low infiltration/exfiltration air leakage must be at the duct wall shaft penetration.

c. Must be factory fabricated in a frame with a minimum length of 125mm5 inches made of minimum 16 gage galvanized steel. Damper frames are to be mounted inside the duct. Support axle shafts on both end with a bearing in the frame. Blade linkage must be galvanized or plated steel and concealed in the frame, out of the air stream.

d. Provide opposed blades made of galvanized steel with roll formed or broke stiffeners(s); minimum of 16 gage.

2.12.4.4 Rectangular Dampers for Flanged Duct

a. Provide for flanged duct systems.

b. Must be multi-blade rectangular.

c. Provide 13mm1/2 inch galvanized or plated steel axle shafts that support each blade at both ends. Extend the operator shaft through the standoff bracket and quadrant operator.

d. Must be factory fabricated in a frame with a minimum length of 75mm3 inches made galvanized steel with a thickness to match the duct and at least 16 gage, or 20 gage with additional reinforcing such as a C channel. Mount damper frames end to end with the duct. Support axle shafts on both ends with a pressed in elastomeric bearing/seal for low infiltration/exfiltration air leakage. Provide galvanized or plated steel blade linkage, concealed in a frame, out of the air stream.

e. Provide opposed blades made of galvanized steel with roll formed or broker stiffeners(s); minimum of 16 gage.

2.12.5 Automatic Balancing Dampers

Provide pressure independent automatic balancing dampers at locations as shown on the plans or in accordance with drawing schedules. Automatic balancing dampers must operate without a required power supply and be field adjustable to design airflows without the use of tools using a slide setpoint indicator on the face of the damper. Automatic balancing dampers must be rated for operation with air temperatures ranging from -4 degrees to 60 degrees C25 degrees to 140 degrees F. Automatic air balancing dampers must provide airflow within 10 percent of setpoint at air pressures from 50 to 300 pascal0.2 inch to 1.2 inch water column when tested in accordance with AMCA 500-D.

2.12.6 Automatic Smoke-Fire Dampers

****

NOTE: Use this paragraph for Navy projects only. When this paragraph is not used, delete "Automatic Smoke-Fire Dampers" from the submittal list.

For smoke-fire dampers, use UL 555S Class III, unless the particular building and application such as hospital dictates the use of UL 555S Class II instead.

****

Multiple blade type with airfoil type blades, 82 degrees C 180 degrees F fusible fire damper link; smoke damper assembly to include [pneumatically powered][electric] damper operator. UL 555 as a 1.5 hour rated fire damper; further qualified under UL 555S as a leakage rated damper. Provide a leakage rating under UL 555S that is no higher than Class [II][or][III] at an elevated temperature Category B (121 degrees C 250 degrees F for 30 minutes).

2.12.7 Automatic Smoke Dampers

****

NOTE: Use this paragraph for Navy projects only. When this paragraph is not used, delete "Automatic Smoke Dampers" from the submittal list.

For smoke-fire dampers, use UL 555S Class III, unless the particular building and application such as hospital dictates the use of UL 555S Class II instead.

****

UL listed multiple blade type with airfoil type blades, supplied by smoke damper manufacturer, with pneumatic electric damper operator as part of assembly. Qualified under UL 555S with a leakage rating no higher than Class II or III at an elevated temperature Category B (121 degrees C 250 degrees F for 30 minutes).

2.12.8 Air Supply And Exhaust Air Dampers

****

NOTE: Use this paragraph for Air Force and Army projects.

****

Provide outdoor air supply and exhaust air dampers that have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - SI ASHRAE 90.1 - IP, including maximum Damper Leakage for:

a. Climate Zones 1,2,6,7,8 the maximum damper leakage at 250 Pa 1.0 inch w.g. for motorized dampers is 20 L/s per square m 4 cfm per square foot of damper area and non-motorized dampers are not allowed.

b. All other Climate Zones the maximum damper leakage at 250 Pa 1.0 inch w.g. is 50 L/s per square m 10 cfm per square foot and for non-motorized dampers is 100 L/s per square m 20 cfm per square foot of damper area.

Dampers smaller than 600 mm 24 inches in either direction may have leakage of 200 L/s per square m 40 cfm per square foot.

2.12.9 Gravity Backdraft and Relief Dampers

Provide gravity balanced backdraft dampers where indicated on plans or as required on equipment schedules. Backdraft dampers must be constructed for horizontal or vertical mounting as required for the application. Backdraft dampers must be testing and rated for the required application in accordance with AMCA 500-D.

Damper blades are to be equipped with [neoprene][vinyl] blade seals mechanically locked into the blade edge.

Equip with adjustable counterbalancing weights to allow operation of the blades such that "start to open" occurs at 5 pascals 0.02 inch w.g. and the damper achieves fully open position at 12.5 pascals 0.05" w.g.

Where backdraft dampers are provided as an accessory option to a fan, such backdraft dampers must be installed meeting all manufacturer's recommendations. The installer must demonstrate that the damper closes once the fan ceases operation.

2.12.10 Plenums and Casings for Field-Fabricated Units

****

NOTE: If field-fabricated air handling units are not used, delete this paragraph entirely. Delete inapplicable sentences or items. Delete the push-button station if not required.

****

2.12.10.1 Plenum and Casings

Fabricate and erect plenums and casings as shown in SMACNA 1966, as applicable. Construct system casing of not less than 1.6 mm 16 gauge galvanized sheet steel. Furnish cooling coil drain pans with 25 mm 1 inch threaded outlet to collect condensation from the cooling coils. Fabricate drain pans from not lighter than 1.6 mm 16 gauge steel, galvanized after fabrication or of 1.3 mm 18 gauge corrosion-resisting sheet steel conforming to ASTM A240/A240M, Type 304, welded and stiffened. Thermally insulate drain pans exposed to the atmosphere to prevent condensation. Coat insulation with a flame resistant waterproofing material. Provide separate drain pans for each vertical coil section, and a separate drain line for each pan. Size pans to ensure capture of entrained moisture on the downstream-air side of the coil. Seal openings in the casing, such as for piping connections, to prevent air leakage. Size the water seal for the drain to maintain a pressure of at least 500 Pa 2 inch water gauge greater than the maximum negative pressure in the coil space.

2.12.10.2 Casing

Terminate casings at the curb line and bolt each to the curb using galvanized angle, as indicated in SMACNA 1966.

2.12.10.3 Access Doors

****

NOTE: Determine whether an electrical push-button to stop the fan by a person inside the casing is required. If required, check the drawings to ensure that the item is shown, and properly coordinated with electrical drawings. Use push-button stations for Army and Air Force projects only.

****

Provide access doors in each section of the casing. Weld doorframes in place, gasket each door with neoprene, hinge with minimum of two brass hinges, and fasten with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, make doors 900 by 450 mm 36 by 18 inches and locate them 450 mm 18 inches above the floor. Where the space available does not accommodate doors of this size, use doors as large as the space accommodates. Swing doors so that fan suction or pressure holds doors in closed position, airtight. Provide a push-button station, located inside the casing, to stop the supply.

2.12.10.4 Factory-Fabricated Insulated Sheet Metal Panels

Factory-fabricated components are allowed for field-assembled units, provided all requirements specified for field-fabricated plenums and casings are met. Provide panels of modular design, pretested for structural strength, thermal control, condensation control, and acoustical control. Seal and insulate panel joints. Provide and gasket access doors to prevent air leakage. Provide panel construction that is not less than one mm 20 gauge galvanized sheet steel, assembled with fasteners treated against corrosion. Provide standard length panels that deflect not more than 13 mm 1/2 inch under operation. Construct details, including joint sealing, not specifically covered, as indicated in SMACNA 1966. Construct the plenums and casings to withstand the specified internal pressure of the air systems.

2.12.10.5 Duct Liner

****

NOTE: If duct liner is used, remove this paragraph.

****

Unless otherwise specified, duct liner is not permitted.

2.12.11 Sound Attenuation Equipment

****

NOTE: Use sound attenuators or acoustical duct liner only where acoustical treatment is required and there are no other suitable alternatives. Do not use acoustical duct liner in medical facilities.

Refer to UFC 3-450-02, Power Plant Acoustics , for noise criteria. Include sound power levels required in the appropriate schedule on the drawings.

****

2.12.11.1 Systems with total pressure above 1 kPa 4 Inches Water Gauge

Provide sound attenuators on the discharge duct of each fan operating at a total pressure above 1 kPa 4 inch water gauge, and, when indicated, at the intake of each fan system. Provide sound attenuators elsewhere as indicated. Provide factory fabricated sound attenuators, tested by an independent laboratory for sound and performance characteristics. Provide a net sound reduction as indicated. Maximum permissible pressure drop is not to exceed 157 Pa 0.63 inch water gauge. Construct traps to be airtight when operating under an internal static pressure of 2.5 kPa 10 inch water gauge. Provide air-side surface capable of withstanding air velocity of 50 m/s 10,000 fpm. Certify that the equipment can obtain the sound reduction values specified after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Provide sound absorbing material conforming to ASTM C1071, Type I or II. Provide sound absorbing material that meets the fire hazard rating requirements for insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. For connection to ductwork, provide a duct transition section. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system can be provided if complying with requirements specified for factory fabricated sound attenuators, in lieu of factory fabricated sound attenuators. Construct the double-walled duct and fittings from an outer metal pressure shell of zinc-coated steel sheet, 25 mm 1 inch thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Provide a sufficient length of run to obtain the noise reduction coefficient specified. Certify that the sound reduction value specified can be obtained within the length of duct run provided. Provide welded or spiral lock seams on the outer sheet metal of the double-walled duct to prevent water vapor penetration. Provide duct and fittings with an outer sheet that conforms to the metal thickness of high-pressure spiral and round ducts and fittings shown in SMACNA 1966. Provide acoustical insulation with a thermal conductivity "k" of not more than 0.0389 W/m-K 0.27 Btu/inch/square foot/hour/degree F at 24 degrees C 75 degrees F mean temperature. Provide an internal perforated zinc-coated metal liner that is not less than 0.7 mm 24 gauge with perforations not larger than 6.35 mm 1/4 inch in diameter providing a net open area not less than 10 percent of the surface.

2.12.11.2 System with total pressure of 1 kPa 4 Inch Water Gauge and Lower

Use sound attenuators only where indicated. Provide factory fabricated sound attenuators that are constructed of galvanized steel sheets. Provide attenuator with outer casing that is not less than 0.85 mm 22 gauge. Provide fibrous glass acoustical fill. Provide net sound reduction indicated. Obtain values on a test unit not less than 600 by 600 mm 24 by 24 inches outside dimensions made by a certified nationally recognized independent acoustical laboratory. Provide air flow capacity as indicated or required. Provide pressure drop through the attenuator that does not exceed the value indicated, or that is not in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Acoustically test attenuators with metal duct inlet and outlet sections while under the rated air flow conditions. Include with the noise reduction data the effects of flanking paths and vibration transmission. Construct sound attenuators to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 500 Pa 2 inch water gauge.

[2.12.11.3 Acoustical Duct Liner

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NOTE: In accordance with UFC 3-410-01, acoustical duct liner is prohibited and should not be used. The following paragraph for Acoustical Duct Lining should be deleted unless specifically approved for use when no other acceptable alternatives exist. Acoustical duct liner must not be used as a means of duct insulation, only for acoustical attenuation as required where sound attenuation cannot be achieved by other methods. If necessary to provide acoustical duct as a means of attenuation, factory fabricated double wall ductwork with mylar barrier material between the perforated inner liner should be used where it can achieve the attenuation requirements.

****

Use fibrous glass designed or flexible elastomeric duct liner for lining ductwork and conforming to the requirements of ASTM C1071, Type I and II. Provide uniform density, graduated density, or dual density liner composition, as standard with the manufacturer. Provide not less than 25 mm 1 inch thick coated lining. Where acoustical duct liner is used, provide the thermal equivalent of the insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS for liner or combination of liner and insulation applied to the exterior of the ductwork. Increase duct sizes shown to compensate for the thickness of the lining used. In lieu of sheet metal duct with field-applied acoustical lining, provide acoustically equivalent lengths of fibrous glass duct, elastomeric duct liner or factory fabricated double-walled internally insulated duct with perforated liner [with mylar barrier material installed between the insulation and perforated liner].

]2.12.12 Diffusers, Registers, and Grilles

****

NOTE: Coordinate with paragraph Sound Attenuation Equipment.

If diffusers or registers or grilles are not required, delete reference to the omitted items. Delete specified performance characteristics peculiar to the omitted items. If any one or two of the three types of units are omitted, delete the corresponding subparagraph.

The specification below provides general criteria applicable to all Diffusers, Registers and grilles. Provide an air device equipment schedule (diffuser, register & grilles) on the project drawings that defines the specific parameters of each type of device to be used on the project. Schedule must include all pertinent information to fully define the devices intended to be used including but not limited to: Maximum airflow or acceptable airflow range through device, service of device (supply, return, exhaust, transfer air), device size (face size, neck/connection size), maximum permissible NC (Noise Criteria).

****

Provide factory-fabricated units of [steel][corrosion-resistant steel][or][aluminum] that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 0.25 m/s 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. Provide units with sound ratings at design conditions not exceeding the ASHRAE Applications Handbook, Noise and Vibration Control Chapter - table "Design Guidelines for HVAC-Related Background Sound in Rooms"[refer to drawing air device schedule for maximum permissible sound rating by device]. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. [Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers.] Where the inlet and outlet openings are located less than 2 m 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.

2.12.12.1 Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Install ceiling mounted units with rims tight against ceiling.

Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2.12.12.2 Perforated Plate Diffusers

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NOTE: Use this paragraph for Navy projects only.

****

Provide adjustable [one-way,] [two-way,] [three-way,][or][four-way] air pattern controls[as indicated on the drawings]. Provide diffuser faceplates that do not sag or deflect when operating under design conditions.

2.12.12.3 Linear Diffusers

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NOTE: Use this paragraph for Navy projects only.

****

Make joints between diffuser sections that appear as hairline cracks. Provide alignment slots for insertion of key strips or other concealed means to align exposed butt edges of diffusers.[Equip with plaster frames when mounted in plaster ceiling.] Do not use screws and bolts in exposed face of frames or flanges. Metal-fill and ground smooth frames and flanges exposed below ceiling. Furnish separate pivoted or hinged adjustable air-volume-damper and separate air-deflection blades.

2.12.12.4 Security Ceiling Diffusers

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NOTE: Use this paragraph for brig facilities only.

****

Provide diffusers that are steel with faceplate, fixed diffusion louvers, with flat surface margin, and an opposed blade damper. Provide faceplate that is 1.9 mm 14 gage minimum with 13 by 13 mm holes on 5 mm 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.

2.12.12.5 Registers and Grilles

Provide registers and grilles of the types indicated on the drawings. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 150 mm 6 inches below the ceiling unless otherwise indicated. Locate return and exhaust registers 150 mm 6 inches above the floor unless otherwise indicated. Provide grilles as specified for registers, without volume control damper.

2.12.12.6 Registers

****

NOTE: Use this paragraph for Navy projects only. Delete paragraph, "Registers and Grilles," when this paragraph is used.

****

Double-deflection supply registers.[Provide manufacturer-furnished volume dampers. Provide volume dampers of the group-operated, opposed-blade type and key adjustable by inserting key through face of register. Operating mechanism must not project through any part of the register face. Automatic volume control devices are acceptable.][Provide exhaust and return registers as specified for supply registers, except provide exhaust and return registers that have a single set of nondirectional face bars or vanes having the same appearance as the supply registers.][Set face bars or vanes at [_____] degrees.]

2.12.12.7   Security Supply Air Registers Except in Cells

****
NOTE: Use this paragraph for brig facilities only.
****

Provide supply air registers, except in prisoner cells and prisoner holding cells, that are steel with individually adjustable horizontal and vertical vanes, perforated faceplate, flat surface margin and opposed blade damper. Put vertical vanes in front; with 19 mm 3/4 inch o.c. vane spacing. Provide a 1.9 mm 14 gage (minimum) perforated faceplate with 13 by 13 mm holes on 5 mm 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.

2.12.12.8   Security Return and Other Air Registers Except in Cells

****
NOTE: Use this paragraph for brig facilities only.
****

Provide return, exhaust, transfer and relief air registers, except in prisoner cells and prisoner holding cells, that are steel with perforated faceplate, flat surface margin, opposed blade damper, and duct mounting sleeve. Provide 14 gage (minimum) faceplate with 13 by 13 mm holes on 5 mm 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent.

2.12.12.9   Security Supply Air Registers in Cells

****
NOTE: Use this paragraph for brig facilities only.
****

Provide supply air registers in prisoner cells and prisoner holding cells that are steel with perforated faceplate, flat surface margin, extension sleeve, opposed blade damper, and back mounting flanges. Provide a 1.9 mm 14 gage (minimum) faceplate with 13 by 13 mm holes on 5 mm 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum) wall sleeve.

2.12.12.10   Security Return and Other Type Air Registers in Cells

****
NOTE: Use this paragraph for brig facilities only.
****

Provide steel return, exhaust, transfer and relief air registers in prisoner cells and prisoner holding cells with perforated faceplate, flat surface margin, wall sleeve, opposed blade damper, and back mounting flanges. Provide 1.9 mm 14 gage (minimum) faceplate with 13 by 13 mm holes on 5 mm 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum)wall sleeve.

2.12.13 Louvers

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NOTE: Ensure that louver selection includes consideration of parameters such as pressure drop and water penetration.

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Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section [07 60 00 FLASHING AND SHEET METAL] [08 91 00 METAL [WALL][AND][DOOR] LOUVERS].

2.12.14 Air Vents, Penthouses, and Goosenecks

Fabricate air vents, penthouses, and goosenecks from galvanized steel [or aluminum] sheets with galvanized[or aluminum] structural shapes. Provide sheet metal thickness, reinforcement, and fabrication that conform to SMACNA 1966. Accurately fit and secure louver blades to frames. Fold or bead edges of louver blades for rigidity and baffle these edges to exclude driving rain. Provide air vents, penthouses, and goosenecks with bird screen.

2.12.15 Bird Screens and Frames

Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.12.16 Radon Exhaust Ductwork

Fabricate radon exhaust ductwork installed in or beneath slabs from Schedule 40 PVC pipe that conforms to ASTM D1785. Provide fittings that conform to ASTM D2466. Use solvent cement conforming to ASTM D2564 to make joints. Otherwise provide metal radon exhaust ductwork as specified herein.

2.12.17 Pre Manufactured Double Wall Ductwork

For all interior exposed ductwork in finished/occupied spaces[as indicated on plans] provide double wall pre-insulated ductwork with minimum 24 gauge solid galvanized inner wall. Double wall ductwork and fittings are to be from a single manufacturer. Provide ducts with clear internal dimensions of the inner duct equal to the duct dimensions indicated on the plans. Construct the outer duct of galvanized sheet steel, unless otherwise indicated. Double wall duct must comply with SMACNA 1966 based on static pressure class[as indicated on the drawings], and be sealed in accordance to SMACNA Seal Class A requirements.

2.12.17.1 Double Wall Duct Insulation

Insulation thickness as installed must meet or exceed the thermal performance requirements of ASHRAE 90.1 - SIASHRAE 90.1 - IP. Interstitial insulation may be one of the following:

a) Fibrous glass duct liner complying with ASTM C1071 and NFPA 90A or

NFPA 90B. Fibrous glass duct liner insulation must be installed in the interstitial space with spacers that position the inner duct at a uniform distance from the outer duct without compressing the insulation. Provide with antimicrobial coating and cover with polyester film complying with UL 181 Class 1.

b) Flexible elastomeric duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

2.12.18 Clothes Dryer Exhaust Ductwork

Ductwork serving clothes dryer exhaust must be constructed of materials in accordance with ICC IMC

2.12.19 Fabric Ductwork

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NOTE: Designer to indicate specific requirements on the drawings including total design airflow for given length-diameter at design static pressure. This will define/determine the specific selection of fabric, hole, and hole pattern.

****

Continuous tubular diffuser materials are to be listed and labeled as complying with UL 723, NFPA 90A and NFPA 90B. Air outlet configuration is to be a combination of permeable fabric or circumferential hole pattern as[required for airflow at design static pressure][indicated on the drawings]. Fabric duct connection to rigid ductwork must be made in accordance to fabric duct manufacturer's installation requirements. Accessories for installation of the fabric duct system (quick connect joint, cleanout zipper, support hoops, and all other required appurtenances) must be in accordance with manufacturer's installation requirements. Submit fabric ductwork product data and installation and maintenance data.

2.13 AIR SYSTEMS EQUIPMENT

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NOTE: Required items in this paragraph are determined by whether field-fabricated air handling units apply or whether equipment external to air handling units are used in the distribution system.

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2.13.1 Fans

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NOTE: Coordinate with paragraph Sound Attenuation Equipment. Include any applicable noise criteria in appropriate equipment schedule on the drawings.

Refer to UFC 3-450-02, Power Plant Acoustic, for vibration criteria. Detail vibration isolation required on the drawings and include it in the appropriate schedule.

Design and detail ductwork near air moving devices to minimize system effect on the fans in accordance with AMCA 201. Add system effect to the duct friction loss and indicate fan static pressure on

drawings for the designed ductwork configuration.

Indicate the location of each duct smoke detector in the HVAC system and include the detectors on the schematic and associated ladder diagram. Provide duct smoke detectors according to NFPA 90A. Duct detectors are intended to shut associated air distribution fans and smoke dampers, if provided. Duct smoke detectors are not for use inside ducts where ambient temperatures exceeds 38 degrees C 100 degrees F.

When the building is equipped with a fire alarm system, connect the duct smoke detectors to the fire alarm control panel (FACP) for alarm initiation. Show wiring to the FACP for either new or existing fire alarm systems.

Fans with motors greater than 0.5 kW 3/4 hp must have automatic controls capable of shutting off fans when not required.

HVAC systems having a total fan system power exceeding 3.7 kW 5 hp must meet the provisions of ASHRAE 90.1. These include ASHRAE 90.1, Table 6.5.3.1, Fan Power Limitation:

For supply air volumes less than 9,400 L/s 20,000 cfm the allowable nameplate motor power for a constant volume fan is 1.9 kW/1000 L/s 1.2 hp/1000 cfm and for a variable volume fan is 2.7 kW/1000 L/s 1.7 hp/1000 cfm.

For supply air volumes of 9,400 L/s 20,000 cfm and greater the allowable nameplate motor power for a constant volume fan is 1.7 kW/1000 L/s 1.1 hp/1000 cfm and for a variable volume fan is 2.4 kW/1000 L/s 1.5 hp/1000 cfm.

****

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than [150] [140] [120] percent of the connected driving capacity. Provide belt driven fans less than 3.75 kW 5 hp with adjustable pitch motor sheaves selected such that the pitch adjustment is at the middle of the adjustment range at fan design condition. Provide fixed pitch motor sheaves for motors 3.75 kW 5 hp and above sized to produce fan design condition. Provide replacement sheaves as needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as[indicated on the drawings][required by ASHRAE Applications Handbook - Table "Selection Guide for Vibration Isolation]. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide units with sound ratings at design conditions that will not result in objectional background noise in accordance with the ASHRAE Applications Handbook, chapter Noise and Vibration Control, table "Design Guidelines for HVAC-Related Background Sound in Rooms"[refer to drawing fan schedule for maximum permissible sound rating by device]. Obtain the sound power level values according to AMCA 300. Provide power ventilators that conform to UL 705 and have a UL label.

2.13.1.1 Centrifugal Fans

Provide fully enclosed, single-width single-inlet, or double-width double-inlet centrifugal fans, with AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Provide impeller wheels that are rigidly constructed and accurately balanced both statically and dynamically. [Provide forward curved or backward-inclined airfoil design fan blades in wheel sizes up to 750 mm 30 inches. Provide backward-inclined airfoil design fan blades for wheels over 750 mm 30 inches in diameter]. [Provide open-wheel radial type booster fans for exhaust dryer systems, and fans suitable for conveying lint and the temperatures encountered. Equip the fan shaft with a heat slinger to dissipate heat buildup along the shaft. Install an access (service) door to facilitate maintenance to these fans.] Provide fan wheels over 900 mm 36 inches in diameter with overhung pulleys and a bearing on each side of the wheel. Provide fan wheels 900 mm 36 inches or less in diameter that have one or more extra long bearings between the fan wheel and the drive. Provide sleeve type, self-aligning and self-oiling bearings with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Connect grease fittings to tubing for serviceability from a single accessible point. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide steel, accurately finished fan shafts, with key seats and keys for impeller hubs and fan pulleys. Provide fan outlets of ample proportions, designed for the attachment of angles and bolts for attaching flexible connections. Provide[[manually] [automatically] operated inlet vanes on suction inlets. Provide [manually] [automatically] operated outlet dampers.] Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have [open] [drip-proof] [totally enclosed] [explosion-proof] enclosures. [Provide [manual] [magnetic] [across-the-line] [reduced-voltage-start] type motor starters with [general-purpose] [weather-resistant] [watertight] enclosure.] [Provide remote manual switch with pilot indicating light where indicated.]

2.13.1.2 In-Line Centrifugal Fans

Provide in-line fans with centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Mount fans in a welded tubular casing. Provide a fan that axially flows the air in and out. Streamline inlets with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Enclose and isolate fan bearings and drive shafts from the air stream. Provide precision, self aligning ball or roller type fan bearings that are sealed against dust and dirt and are permanently lubricated.

Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11.[Provide motors with [open][drip-proof][totally enclosed] [explosion-proof] enclosure.] [Provide [manual] [magnetic] motor starters across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosures.][Provide remote manual switch with pilot indicating light where indicated.]

2.13.1.3   Axial Flow Fans

Provide axial flow fans complete with drive components and belt guard, with steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Provide fan wheels that are dynamically balanced and keyed to the fan shaft, with radially projecting blades of airfoil cross-section. Enclose and isolate fan bearings and drive shafts from the air stream. Permanently lubricate fan bearings or provide them with accessible grease fittings. Provide precision self-aligning ball or roller type fan bearings that are sealed against dust and dirt. Provide fan bearings that have a L50 rated bearing life at not less than 200,000 hours of operation as defined by ABMA 9 and ABMA 11. Provide fan inlets with an aerodynamically shaped bell and an inlet cone. Install diffuser or straightening vanes at the fan discharge to minimize turbulence and provide smooth discharge air flow. Furnish fan unit with [inlet and outlet flanges,] [inlet screen,] [duct equalizer section,] and [manual] [automatic] operation adjustable inlet vanes. Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have [open] [drip-proof] [totally enclosed] [explosion-proof] enclosure. [Provide [manual] [magnetic] motor starters across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosure.] [Provide remote manual switch with pilot indicating light where indicated.]

2.13.1.4   Propeller Type Sidewall Fans

Provide propeller type fans, assembled on a reinforced metal panel with venturi opening spun into panel. Provide direct or V-belt driven fans with wheels less than 600 mm 24 inches in diameter and provide V-belt driven fans with wheels 600 mm 24 inches in diameter and larger. Provide fans with wall mounting collar. Provide lubricated bearings. Equip fans with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Provide [drip-proof][totally enclosed fan cooled][explosion-proof] type motor enclosure. Install [gravity][motor operated] backdraft dampers where indicated.

2.13.1.5   Centrifugal Type Power Wall Ventilators

Provide [direct][or][V-belt] driven centrifugal type fans with backward inclined, non-overloading wheel. Provide removable and weatherproof motor housing. Provide unit housing that is designed for sealing to building surface and for discharge and condensate drippage away from building surface. Construct housing of heavy gauge aluminum. Equip unit with an [aluminum or plated steel wire discharge bird screen,] [disconnect switch,] [[anodized aluminum][stainless steel] wall grille,] [manufacturer's standard [gravity][motor-operated] damper,] an airtight and liquid-tight metallic wall sleeve. Provide [totally enclosed fan cooled] [drip-proof] [explosion-proof] type motor enclosure. Use only lubricated bearings.

2.13.1.6   Centrifugal Type Power Roof Ventilators

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NOTE: Delete kitchen exhaust fan when not required.

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Provide [direct][or][V-belt] driven centrifugal type fans with backward inclined, non-overloading wheel. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge aluminum. Provide fans with [birdscreen,] [disconnect switch,] [[gravity][motorized] dampers,] [sound curb,] [roof curb,] and [extended base]. Provide [drip-proof] [explosion-proof] type motor enclosure. Provide centrifugal type kitchen exhaust fans according to UL 705 and NFPA 96, fitted with V-belt drive, round hood, and windband upblast discharge configuration, integral residue trough and collection device, with motor and power transmission components located in outside positively air ventilated compartment. Use only lubricated bearings. If there is a conflict between NFPA 96 and UL 705 the most stringent wording must be adhered to.

2.13.1.7 Propeller Type Power Roof Ventilators

Provide [direct][or][V-belt] driven fans. Provide hinged or removable weathertight fan housing, fitted with framed rectangular base constructed of aluminum or galvanized steel. Provide [totally enclosed fan cooled] [explosion-proof] type motors. Furnish motors with nonfusible, horsepower rated, manual disconnect mount on unit. Furnish fans with [gravity] [motor operated] dampers, [birdscreen][sound curb][roof curb]. Use only lubricated bearings.

2.13.1.8 Air-Curtain Fans

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NOTE: Provide air curtains designed as fly fans on all exterior entranceways to food preparation areas, except where the entranceway is to be used only as an emergency exit. Include air curtains for service windows and service entries whenever feasible on the exterior of the entranceway. When air curtains are mounted in locations significantly above normal door heights, verify curtain air velocities and noise levels.

****

Provide fans that conform to AMCA 220 with AMCA seal. Furnish air curtains with a weatherproof housing constructed of high impact plastic or minimum 1.3 mm 18 gauge rigid welded steel. Provide backward curved, non-overloading, centrifugal type fan wheels, accurately balanced statically and dynamically. Provide motors with totally enclosed fan cooled enclosures. Provide remote manual type motor starters with weather-resistant enclosure actuated when the doorway served is open. Provide air curtains that attain the air velocities specified within 2 seconds following activation. Provide bird screens at air intake and discharge openings. Provide air curtain unit or a multiple unit installation that is at least as wide as the opening to be protected. Provide the air discharge openings to permit outward adjustment of the discharge air. Place installation and adjust according to the manufacturer's written recommendation. Furnish directional controls on air curtains for service windows for easy clean or convenient removal. Design air curtains to prevent the adjustment of the air velocities specified. Make the interior surfaces of the air curtain units accessible for cleaning. Provide certified test data indicating that the fan can provide the air velocities required[when fan is mounted as indicated]. Provide air curtains designed as fly fans unless otherwise indicated. [Provide air curtains designed for use in service entranceways that develop an air curtain not less than 75 mm 3 inches thick at the discharge nozzle. Provide air velocity that is not less than 8 m/s 1600 fpm across the entire entryway when measured 900 mm 3 feet above the floor.] [Provide air curtains designed for use on customer entranceways that develop an air curtain not less than 200 mm 8 inches thick at the discharge opening. Provide velocity that is not less than 3 m/s 600 fpm across the entire entryway when measured 900 mm 3 feet above the floor. Equip recirculating type air curtains with readily removable filters, or design the filters for in-position cleaning. Provide readily accessible and easily cleanable air capture compartment or design for in-position cleaning.] [Provide air curtains designed for use on service windows that develop an air curtain not less than 200 mm 8 inches thick at the discharge opening. Provide air velocity that is not less than 3 m/s 600 fpm across the entire opening of the service window measured 900 mm 3 feet below the air discharge opening.]

2.13.1.9 Ceiling Exhaust Fans

Provide centrifugal type, direct driven suspended cabinet-type ceiling exhaust fans. Provide fans with acoustically insulated housing. Provide chatter-proof backdraft damper. Provide egg-crate design or louver design integral face grille. Mount fan motors on vibration isolators. Furnish unit with mounting flange for hanging unit from above. Provide U.L. listed fans. Provide PL-109-58 labeled ceiling exhaust fan product. Provide proof of PL-109-58 label for ceiling exhaust fan product.

2.13.1.10 High Volume Low Velocity (HVLS) Fans

Provide High Volume Low Speed (HVLS) or LVF (Low Velocity Fan) fans as indicated on the drawings. HVLS fans are to be factory-assembled and tested horizontal, non-ducted fan unit, consisting of large diameter aluminum airfoil blade set and either a direct drive electric motor with variable speed motor controller or a speed reducing gearbox. HVLS Fans must be designed for operating in space temperatures up to 50 degree C 122 degree F. Provide with manufacturer's wall mounted controller[with integration capability to the building DDC control system]. Manufacturer's controller must at a minimum provide on/off, direction (forward/reverse) and variable speed control of the fan(s). Obtain the fan mounting system from the fan manufacturer and install it on members specific to the type designated by the manufacturer.

2.13.2 Coils

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NOTE: Research local conditions to determine the effect of corrosive atmosphere on dissimilar metals. Where condenser or evaporator coils are to be installed in corrosive atmospheres, rewrite the specification for coils and fins for these specific conditions. Consider the following coil and fin combinations based on past experience with the suitability of these materials in dealing with the local conditions.

a. Copper coil and aluminum fins, coated.

b. Copper coil and copper fins, coated.

c. Aluminum coil and aluminum fins, coated.

d. Aluminum coil and aluminum fins, uncoated.

e. Copper coil and copper fins, uncoated.

Provide either phenolic, vinyl or epoxy/electrodeposition coating. For coils with relatively close fin spacing such as those found in most unitary equipment, the phenolic or epoxy/electrodeposition coating is preferred, as these have less tendency to bridge across the fins than vinyl, better thermal conductivity than vinyl and in many conditions weathers better than vinyl.
****

Provide fin-and-tube type coils constructed of seamless [copper][red brass] tubes and [aluminum][or][copper] fins mechanically bonded or soldered to the tubes.[Provide copper tube wall thickness that is a minimum of [0.406][0.508][0.6096] mm [0.016][0.020][0.024] inches].[Provide red brass tube wall thickness that is a minimum of [0.89][1.24] mm [0.035][0.049] inches]. [Provide aluminum fins that are [0.14][0.19] mm [0.0055][0.0075] inch minimum thickness.][Provide copper fins that are 0.114 mm 0.0045 inch minimum thickness.] Provide casing and tube support sheets that are not lighter than 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Mount coils for counterflow service. Rate and certify coils to meet the requirements of AHRI 410.[Provide factory applied phenolic, vinyl or epoxy/electrodeposition coating.]

2.13.2.1 Direct-Expansion Coils

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NOTE: Use this paragraph for Army and Air Force projects only.
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Provide suitable direct-expansion coils for the refrigerant involved. Provide refrigerant piping that conforms to ASTM B280 and clean, dehydrate and seal. Provide seamless copper tubing suction headers or seamless or resistance welded steel tube suction headers with copper connections. Provide supply headers that consist of a distributor which distributes the refrigerant through seamless copper tubing equally to all circuits in the coil. Provide circuited tubes to ensure minimum pressure drop and maximum heat transfer. Provide circuiting that permits refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Provide field installed coils which are completely dehydrated and sealed at the factory upon completion of pressure tests. Pressure test coils in accordance with UL 1995.

2.13.2.2 Water Coils

Install water coils with a pitch of not less than 10 mm/m 1/8 inch/foot of the tube length toward the drain end. Use headers constructed of cast iron, welded steel or copper. Furnish each coil with a plugged vent and drain connection extending through the unit casing. Provide removable water coils with drain pans. Pressure test coils in accordance with UL 1995.

2.13.2.3 Steam Heating Coils

Construct steam coils from cast semisteel, welded steel or copper headers, and [red brass][copper] tubes. Construct headers from cast iron, welded steel or copper. Provide fin tube and header section that float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide each coil with a field or factory installed vacuum breaker. Provide single-tube type coils with tubes not less than 13 mm 1/2 inch outside diameter, except for steam preheat coils. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure test coils in accordance with UL 1995.

2.13.2.4 Steam Preheat (Nonfreeze) Coils

Provide steam-distribution-tube type steam (nonfreeze) coils with condensing tubes not less than 25 mm 1 inch outside diameter for tube lengths 1.5 m 60 inches and over and 13 mm 1/2 inch outside diameter for tube lengths under 1.5 m 60 inches. Construct headers from cast iron, welded steel, or copper. Provide distribution tubes that are not less than 15 mm 5/8 inch outside diameter for tube lengths 1.5 m 60 inches and over and 10 mm 3/8 inch outside diameter for tube lengths under 1.5 m 60 inches with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes and hold securely in alignment. Limit maximum length of a single coil to 3.66 m 144 inches. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure test coils in accordance with UL 1995.

2.13.2.5 Electric Heating Coil

Provide an electric duct heater coil in accordance with UL 1995 and NFPA 70. Provide duct- or unit-mounted coil. Provide [nickel chromium resistor, single stage, strip] [nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type coil. Provide coil with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Provide galvanized steel or aluminum coil casing and support brackets. Mount coil to eliminate noise from expansion and contraction and for complete accessibility for service.

2.13.2.6 Eliminators

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NOTE: Use this paragraph for Navy projects only.

****

Equip each cooling coil having an air velocity of over 2 m/s 400 fpm through the net face area with moisture eliminators, unless the coil manufacturer guarantees, over the signature of a responsible company official, that no moisture can be carried beyond the drip pans under actual conditions of operation. Construct of minimum 24 gage [zinc-coated steel] [copper] [copper nickel] [or] [stainless steel], removable through the nearest access door in the casing or ductwork. Provide eliminators that have not less than two bends at 45 degrees and are spaced not more than 63 mm 2-1/2 inches center-to-center on face. Provide each bend with an integrally formed hook as indicated in the SMACNA 1884.

2.13.2.7 Sprayed Coil Dehumidifiers

****
NOTE: Use this paragraph for Navy projects only.
****

Provide assembly with reinforced, braced, and externally insulated galvanized steel casing, vertical in-line spray pump, bronze self-cleaning spray nozzles, galvanized steel pipe spray headers, adjustable float valve with replaceable neoprene seat, manufacturer's standard cooling coil, and welded black steel drain tank. Provide overflow drain, make-up, and bleed connection.

2.13.3 Air Filters

****
NOTE: Select filters based on the functional needs of the area served, including indoor air quality. The combination of the extended surface pleated panel filters and the extended surface nonsupported pocket filters or the cartridge filter of the same efficiency are intended to fulfill the filtration requirements in UFC 3-410-01, Heating, Ventilating, and Air-Conditioning Systems for areas where indoor air quality is of primary concern. Consider limiting the variety of filter sizes required to minimize inventory requirements for system maintenance.

In the event the retention of efficiency values in the specification becomes too cumbersome, revise the requirements by referring to the efficiencies indicated on the drawings, to show for each air handling unit or system the efficiency of the air filters required, and the maximum initial resistance.
****

List air filters according to requirements of UL 900, except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of UL 586.

2.13.3.1 Extended Surface Pleated Panel Filters

Provide 50 mm 2 inch depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to ASHRAE 52.2. Provide initial resistance at 2.54 m/s 500 fpm that does not exceed 0.09 kPa 0.36 inches water gauge. Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.13.3.2 Extended Surface Nonsupported Pocket Filters

Provide [750][_____] mm [30][_____] inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [2.54][_____] m/s

[500][_____] fpm that does not exceed [0.1125][_____] kPa [0.45][_____] inches water gauge. Provide UL Class 1 filters. Provide fibrous glass media, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Provide pockets that do not sag or flap at anticipated air flows. Install each filter [with an extended surface pleated panel filter as a prefilter] in a factory preassembled, side access housing or a factory-made sectional frame bank[, as indicated].

2.13.3.3 Cartridge Type Filters

Provide 305 mm 12 inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [2.54][_____] m/s [500][_____] fpm that does not exceed [0.14][_____] kPa [0.56][_____] inches, water gauge. Provide UL class 1 filters, and pleated microglass paper media with corrugated aluminum separators, sealed inside the filter cell to form a totally rigid filter assembly. Fluctuations in filter face velocity or turbulent airflow have no effect on filter integrity or performance. Install each filter [with an extended surface pleated media panel filter as a prefilter] in a factory preassembled side access housing, or a factory-made sectional frame bank[, as indicated].

2.13.3.4 Sectional Cleanable Filters

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NOTE: Delete washing and charging racks when not required.

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Provide [25][50] mm [1][2] inch thick cleanable filters. Provide viscous adhesive in 20 L 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than one L one quart for each filter section. Provide one washing and charging tank for every 100 filter sections or fraction thereof; with each washing and charging unit consisting of a tank and [single][double] drain rack mounted on legs and drain rack with dividers and partitions to properly support the filters in the draining position.

2.13.3.5 Replaceable Media Filters

Provide the [dry-media][viscous adhesive] type replaceable media filters, of the size required to suit the application. Provide filtering media that is not less than 50 mm 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Enclose pad in a holding frame of not less than 1.6 mm 16 gauge galvanized steel, equipped with quick-opening mechanism for changing filter media. Base the air flow capacity of the filter on net filter face velocity not exceeding [1.5][_____] m/s [300][_____] fpm, with initial resistance of [32][_____] Pa [0.13][_____] inches water gauge. Provide MERV that is not less than [_____] when tested according to ASHRAE 52.2.

2.13.3.6 Automatic Renewable Media Filters

Provide the following:

a. Automatic, renewable media filters consisting of a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass supplied in convenient roll form, and filter that does not require water supply, sewer connections, adhesive reservoir, or sprinkler equipment as part of the operation and maintenance requirements.

b. Basic frame that is fabricated of not less than 2 mm 14 gauge galvanized steel, and sectional design filters with each section of each filter fully factory assembled, requiring no field assembly other than setting in place next to any adjacent sections and the installation of media in roll form.

c. Each filter complete with initial loading of filter media drive motor adequate to handle the number of sections involved, and [painted steel] [stainless steel] control box containing a warning light to indicate media runout, a runout switch, and a Hand-Off-Auto selector switch.

d. Media feed across the filter face in [full-face increments] [increments] automatically controlled as determined by [filter pressure differential] [time interval control] [time interval control with pressure override] [photo electric control] to provide substantially constant operating resistance to airflow and varying not more than plus or minus 10 percent. Roll or enclose media in such a way that collected particulates can not re-entrain.

e. Rolls of clean media, no less than 19.8 m 65 feet long, rerolled on disposable spools in the rewind section of the filter after the media has accumulated its design dirt load. Equip rewind section with a compression panel to tightly rewind used media for ease of handling. Provide media made of continuous, bonded fibrous glass material, UL Class 2, that does not compress more than 6 mm 1/4 inch when subjected to air flow at 2.54 m/s 500 fpm. Factory charge media with an odorless and flame retardant adhesive which does not flow while in storage nor when subjected to temperatures up to 79.4 degrees C 175 degrees F. Support media on both the leaving and entering air faces. Clean media must have initial resistance that does not exceed 45 Pa 0.18 inch water gauge at its rated velocity of 2.54 m/s 500 fpm. Set control so that the resistance to air flow is between 100 and 125 Pa 0.40-and 0.50 inch water gauge unless otherwise indicated.

f. Dust holding capacity, of 80 percent average arrestance under these operating conditions, when operating at a steady state with an upper operating resistance of 125 Pa 0.50 inch water gauge, that is at least 592 (55) grams of ASHRAE Standard Test Dust per square meter foot of media area, when tested according to the dynamic testing provisions of ASHRAE 52.2.

g. The horizontal type automatic renewable media filters, when used in conjunction with factory fabricated air handling units, that are dimensionally compatible with the connecting air handling units, and horizontal type filter housings with all exposed surfaces factory insulated internally with 25 mm 1 inch, 24 kg/cubic meter 1-1/2 pound density neoprene coated fibrous glass with thermal conductivity not greater than 0.04 W/m-K 0.27 Btu/hour/degree F/square foot/inch of thickness.

h. Access doors for horizontal filters with double wall construction as specified for plenums and casings for field-fabricated units in paragraph DUCT SYSTEMS.

2.13.3.7 Electrostatic Filters

Provide the following:

a. The combination dry agglomerator/extended surface, nonsupported pocket electrostatic filters or the combination dry agglomerator/automatic renewable, media (roll) type electrostatic filters, as indicated (except as modified). Supply each dry agglomerator electrostatic air filter with the correct quantity of fully housed power packs and equip with silicon rectifiers, manual reset circuit breakers, low voltage safety cutout, relays for field wiring to remote indication of primary and secondary voltages, with lamps mounted in the cover to indicate these functions locally. Equip power pack enclosure with external mounting brackets, and low and high voltage terminals fully exposed with access cover removed for ease of installation. Furnish interlock safety switches for each access door and access panel that permits access to either side of the filter, so that the filter is de-energized in the event that a door or panel is opened.

b. Ozone generation within the filter that does not exceed five parts per one hundred million parts of air. Locate high voltage insulators in a serviceable location outside the moving air stream or on the clean air side of the unit. Fully expose ionizer wire supports and furnish ionizer wires precut to size and with formed loops at each end to facilitate ionizer wire replacement.

c. Agglomerator cell plates that allow proper air stream entrainment of agglomerates and prevent excessive residual dust build-up, with cells that are open at the top and bottom to prevent accumulation of agglomerates which settle by gravity. Where the dry agglomerator electrostatic filter is indicated to be the automatic renewable media type, provide a storage section that utilizes a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass for dry agglomerator storage section service supplied in 19.8 m 65 foot lengths in convenient roll form. Otherwise, provide section construction and roll media characteristics as specified for automatic renewable media filters. Also a dry agglomerator/renewable media combination with an initial air flow resistance, after installation of clean media, that does not exceed 62.3 Pa 0.25 inch water gauge at 2.54 m/s 500 fpm face velocity.

d. A MERV of the combination that is not less than 15 when tested according to ASHRAE 52.2 at an average operating resistance of 125 Pa 0.50 inch water gauge. Where the dry agglomerator electrostatic filter is indicated to be of the extended surface nonsupported pocket filter type, provide a storage section as specified for extended surface non-supported pocket filters, with sectional holding frames or side access housings[as indicated]
.

e. A dry agglomerator/extended surface nonsupported pocket filter section combination with initial air flow resistance, after installation of clean filters, that does not exceed 162 Pa 0.65 inch water gauge at 2.54 m/s 500 fpm face velocity, with a MERV of the combination not less than 16 when tested according to ASHRAE 52.2. Furnish front access filters with full height air distribution baffles and upper and lower mounting tracks to permit the baffles to be moved for agglomerator cell inspection and service. When used in conjunction with factory fabricated air handling units, supply side access housings which have dimensional compatibility.

2.13.3.8   High-Efficiency Particulate Air (HEPA) Filters

****

NOTE: Use high-efficiency particulate air filters in CLEAN ROOMS (White Rooms or Dust Controlled Facilities), clean work stations, and for critical areas of hospitals. Show the efficiency of the prefilter on the drawings. Provide efficiency that is sufficient for the anticipated contamination load and the degree of prefiltration required. Reference ASME AG-1 either all or in part when extreme temperature or humidity requirements exist. Ensure that requirements added to text from ASME AG-1 are essential to customer's needs to prevent unnecessary expenses from being added to the project, as this standard is not intended for routine commercial applications. When used, add ASME AG-1 to paragraph REFERENCES.

****

Provide HEPA filters that meet the requirements of IEST RP-CC-001 and are individually tested and certified to have an efficiency of not less than [95] [99.97] percent, and an initial resistance at [_____] m/s fpm that does not exceed [_____] Pa inches water gauge. Provide filters that are constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by corrugated aluminum or mineral-fiber inserts, strips of filter medium, or by honeycomb construction of the pleated filter medium. Provide interlocking, dovetailed, molded neoprene rubber gaskets of 5-10 durometer that are cemented to the perimeter of the [upstream] [downstream] face of the filter cell sides. Provide self-extinguishing rubber-base type adhesive or other materials conforming to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide filter cell sides that are [19 mm 3/4 inch thick exterior grade fire-retardant plywood] [cadmium plated steel] [galvanized steel] assembled in a rigid manner. Provide overall cell side dimensions that are correct to 2 mm 1/16 inch, and squareness that is maintained to within 3.2 mm 1/8 inch. Provide holding frames that use spring loaded fasteners or other devices to seal the filter tightly within it and that prevent any bypass leakage around the filter during its installed life. Provide air capacity and the nominal depth of the filter[as required by associated fan capability][as indicated]. Install each filter in a factory preassembled side access housing or a factory-made sectional supporting frame[as indicated]. Provide prefilters of the type, construction and efficiency indicated.

2.13.3.9   Return Air Filter Grilles

****

NOTE: Designer to select filter grille size and depth to achieve pressure losses across loaded filters within acceptable fan limitations of the equipment served. Filter grilles are to be selected to accommodate readily available standard filter sizes, and oversized where feasible to reduce velocity/pressure drop across filter and maximize loading time. Note that filter grilles are generally available to accommodate either 1" or 2" deep filters, with the deeper 2" filters offering

lower resistance and longer loading periods at the same face size. Include required information for filter grilles on the drawing air distribution device schedule.

****

Provide return air filter grilles as indicated on the drawing schedule. Return air filter grilles are to be pleated panel filters,[25 mm][50 mm][1 inch][2 inch] depth with a minimum MERV rating of [8][11][13][____] .

2.13.3.10 Holding Frames

Fabricate frames from not lighter than 1.6 mm 16 gauge sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.13.3.11 Filter Gauges

Provide dial type filter gauges, diaphragm actuated draft for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Provide gauges that are at least 98 mm 3-7/8 inches in diameter, with white dials with black figures, and [graduations] [graduated in 0.0025 kPa 0.01 inch of water,] with a minimum range of 0.25 kPa 1 inch of water beyond the specified final resistance for the filter bank on which each gauge is applied. Provide each gauge with a screw operated zero adjustment and two static pressure tips with integral compression fittings, two molded plastic vent valves, two 1.5 m 5 foot minimum lengths of 6.35 mm 1/4 inch diameter [aluminum] [vinyl] tubing, and all hardware and accessories for gauge mounting.

2.14 AIR HANDLING UNITS

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NOTE: To prevent condensate overflow, calculate the size of condensate drain pans for air handling units where abnormally high latent loads are encountered such as high humidity locations or units operating with 100 percent outside air. Where the potential exists for a manufacturer's standard condensate pan to be smaller than the size calculated, include the size required in the equipment schedule on the drawings.

For AHU's intended for outdoor installation, note on equipment schedule that AHU roof (used for Army projects only) must slope a minimum of 6 mm/300 mm 1/4 in per ft and overhang wall panels by a minimum of 50 mm 2 inches.

****

2.14.1 Field-Fabricated Air Handling Units

Provide built-up units as specified in paragraph DUCT SYSTEMS. Provide fans, coils spray-coil dehumidifiers, and air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types indicated.

2.14.2 Factory-Fabricated Air Handling Units

****

NOTE: Coordinate with paragraph Fans and paragraph Coils.

****

Provide [single-zone draw-through type][or][single-zone blow-through type][or][multizone blow-through type][blow-through double-deck type][blow-through triple deck type] units[as indicated]. Units must include fans, coils, airtight insulated casing, [prefilters,] [secondary filter sections,][and][diffuser sections where indicated,] [air blender] adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, [mixing box] [combination sectional filter-mixing box,] [[pan][drysteam][spray type] humidifier,] vibration-isolators, and appurtenances required for specified operation. Provide fan and motor assemblies with vibration-isolation supports or mountings as[indicated on the drawings][required by ASHRAE Applications Handboook - Table "Selection Guide for Vibration Isolation]. Physical dimensions of each air handling unit must be suitable to fit space allotted to the unit with the capacity indicated. Provide air handling unit that is rated in accordance with AHRI 430 and AHRI certified for cooling.

2.14.2.1 Casings

Provide the following:

a. Casing sections 50 mm 2 inch double wall type, constructed of a minimum [22 gauge] galvanized steel, [0.040 inch] aluminum, or [22 gauge] stainless steel conforming to ASTM A240/A240M, Type 304. Make the inner casing of double wall units a minimum [20 gauge] solid galvanized steel [for all applications except for medical facilities (hospitals or clinics) or specially identified facilities].[For medical facilities (hospitals or clinics) or specially identified facilities, inner casing to be stainless steel conforming to ASTM A240/A240M, Type 304.] Design and construct casing with an integral insulated structural galvanized steel or aluminum frame such that exterior panels are non-load bearing.

   Incorporate a standing seam or thermoplastic polyolefin (TPO) on the exterior of outdoor unit roofs to ensure a rigid roof construction and prevent water infiltration. Roof assembly must be sloped not less than 1:100 for drainage and is to overhang all walls by 40mm 1.5 inch minimum to prevent sheeting from roof to side panels. Rain gutters are to also be provided over all doors shorter than total unit height to direct rain away from door assembly. Where outdoor units are shipped in multiple sections, provide standing-seam joiners at each split with adhesive, hardware, and cover strips for field joining by the installing contractor.[All outdoor unit base frames must be welded construction.]

   Unit casing (wall/floor/roof panels and doors) must be able to withstand up to 1.5 times design static pressure, or 2000 pascals 8-inch water gauge and not exceed 0.0042 per inch of panel span (L/240) when measured at the panel midpoint. Air leakage to be guaranteed at no more than [1/2 percent] [1 percent] of the design volume at 1.5 times the design operating pressure or 50 cubic feet per minute, whichever is greater. Specified air leakage accomplished without the use of caulk. Total estimated air leakage reported for each unit in liters per second cubic feet per minute or as a percentage of supply air.

b. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break is provided for [all unit casing panels] [all unit casing panels downstream of the cooling coil]. Individually removable exterior panel sections are removable with standard tools. Removal must not affect the structural integrity of the unit. Furnish casings with access sections, according to paragraph AIR HANDLING UNITS, inspection doors, and access doors must be capable of opening a minimum of 90 degrees.

****

NOTE: Provide stainless steel option for medical facilities (hospitals and clinics) or specially identified facilities.

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c. Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum [22 gauge] galvanized steel, [0.040 inch] aluminum, or [22 gauge] stainless steel conforming to ASTM A240/A240M. Provide rigid doors with heavy duty hinges and latches. Inspection doors must be a minimum 300 mm 12 inches wide by 300 mm 12 inches high. Access doors must be a minimum 600 mm 24 inches wide, the full height of the unit casing or a minimum of 1800 mm 6 foot, whichever is less. [Install a minimum 200 by 200 mm 8 by 8 inches sealed glass window suitable for the intended application in all access doors.]

d. Double-wall insulated type drain pan (thickness equal to exterior casing) constructed of 0.95 mm 20 gauge stainless steel conforming to ASTM A240/A240M, Type 304, conforming to ASHRAE 62.1. Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils must not flow across the face of lower coils. Provide intermediate drain pans or condensate collection channels and downspouts, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Construct drain pan to allow for easy visual inspection, including underneath the coil without removal of the coil and to allow complete and easy physical cleaning of the pan underneath the coil without removal of the coil. Provide coils that are individually removable from the casing. Drain connections must be of the same material as the primary drain pan and extend a minimum of 60mm 2-1/2 inch beyond the base to ensure adequate room for field piping of condensate traps.

e. Casing insulation that conforms to NFPA 90A. Insulate double-wall casing sections handling conditioned air with not less than 50 mm 2 inches of the same insulation specified for single-wall casings. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Seal double wall insulation completely by inner and outer panels.

f. Factory applied fibrous glass insulation that conforms to ASTM C1071, except that the minimum thickness and density requirements do not apply, and that meets the requirements of NFPA 90A. Make air handling unit casing insulation uniform over the entire casing. Foil-faced insulation is not an acceptable substitute for use on double-wall access doors and inspection doors [and casing sections].

g. Duct liner material, coating, and adhesive that conforms to fire-hazard requirements specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Protect exposed insulation edges and joints where insulation panels are butted with a metal nosing strip or coat to meet erosion resistance requirements of ASTM C1071.

h. A latched and hinged inspection door, in the fan and coil sections. Plus additional inspection doors, access doors and access sections [_____][where indicated].

2.14.2.2 Heating and Cooling Coils

Provide coils as specified in paragraph AIR SYSTEMS EQUIPMENT.

2.14.2.3 Air Filters

Provide air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.14.2.4 Fans

****

NOTE: Coordinate with paragraph Sound Attenuation Equipment.

Refer to UFC 3-450-02, Power Plant Acoustics, for vibration criteria. Detail vibration isolation required and include it in the appropriate schedule on the drawings.

****

Provide the following:

a. Fans that are double-inlet, centrifugal type with each fan in a separate scroll. Dynamically balance fans and shafts prior to installation into air handling unit, then after it has been installed in the air handling unit, statically and dynamically balance the entire fan assembly. Mount fans on steel shafts, accurately ground and finished.

b. Fan bearings that are sealed against dust and dirt and are precision self-aligning ball or roller type, with L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide bearings that are permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Support bearings by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Do not fasten bearings directly to the unit sheet metal casing. Furnish fans and scrolls with coating indicated.

c. Fans that are driven by a unit-mounted, or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Furnish belt guards that are the three-sided enclosed type with solid or expanded metal face. Design belt drives for not less than a 1.3 service factor based on motor nameplate rating.

d. [Motor sheaves that are variable pitch for motors below 4 kW 5 hp and fixed pitch at or above 4 kW 5 hp.] Where fixed sheaves are required, the use of variable pitch sheaves is allowed during air balance, but replace them with an appropriate fixed sheave after air balance is completed. Select variable pitch sheaves to drive the fan at a speed that produces the specified capacity when set at the approximate midpoint of the sheave adjustment. Furnish motors for V-belt drives with adjustable bases, and with [open][splashproof][totally enclosed] enclosures.

****

NOTE: Where air handling unit sound criteria is critical, indicate acoustical performance information on the drawings and retain bracketed sentences below to assure factory fabricated AHU's are provided meeting the required acoustical performance.

****

e. Motor starters of [manual][magnetic][across-the-line][reduced-voltage-start] type with [general-purpose][weather-resistant][watertight] enclosure. [Select unit fan or fans to produce the required capacity at the fan static pressure with sound power level as indicated. Obtain the sound power level values according to AMCA 300 or AHRI 260 I-P.]

2.14.2.5 Fan Arrays

****

NOTE: Retain paragraph below for projects where Fan Arrays are utilized/required (otherwise delete). Air handling units requiring the use of Fan Arrays must be indicated on the drawings.

Redundancy paragraph (d) below to be selected/included at the discretion of the designer dependent upon if the design requirements of the served spaces warrant inclusion.

Optional paragraphs (e) for Backflow Device: Blank-Off Plate and Backdraft Dampers are mutually exclusive. Backdraft dampers at each fan offer automatic redundancy/operation in event of a fan failure preventing reverse airflow an preserving system efficiency reducing need for immediate manual intervention and downtime.

****

Air handling units utilizing fan arrays are to comply with the following requirements:

a. Fans require Class II (minimum) construction with single inlet, direct drive ACMA Arrangement 4 fans installed either in a modular fashion in the field or pre-assembled on a prefabricated frame. Fans must be dynamically balanced and internally isolated to minimize vibration. Fan performance rated in accordance with AMCA 210.

b. Fan array plenum type fans driven by variable speed drives unless otherwise indicated; where indicated fans are driven by brushless DC electronically commutated motor (ECM) with external rotor and integrated maintenance free, permanently lubricated ball bearings and statically and dynamically balanced in accordance with ISO 21940-11. The ECM must be closed, protection level IP 54, thermal class 155; motor efficiency class complies with IEC 60034-30-1 IE3 Premium efficiency.

c. Fan array controller provided by the air handling unit manufacturer to control the fan array modulating individual fan speed and number of active fans to provide the required airflows with minimum energy consumption.

[d. Ensure the fan quantity allows achieving design airflow even with at least one fan out of operation. .]

[e. Ensure that each fan in fan systems with more than one fan is equipped with a backdraft damper. This safety measure helps protect against individual fan failure. .]

[f. Fan systems having more than one fan, and which do not include backdraft dampers require one blank-off plate, which may be used in the case of failure of a single fan to then replace the fan and prevent backflow through that location.]

2.14.2.6 Access Sections and Filter/Mixing Boxes

Provide access sections where indicated and furnish with access doors[as shown]. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

2.14.2.7 Diffuser Sections

Furnish diffuser sections between the discharge of all housed supply fans [and cooling coils of blow-through single zone units][and][filter sections of those units with high efficiency filters located immediately downstream of the air handling unit fan section]. Provide diffuser sections that are fabricated by the unit manufacturer in a manner identical to the remainder of the unit casing, designed to be airtight under positive static pressures up to [2][_____] kPa [8][_____] inches water gauge and with an access door on each side for inspection purposes. Provide a diffuser section that contains a perforated diffusion plate, fabricated of galvanized steel, Type 316 stainless steel, aluminum, or steel treated for corrosion with manufacturer's standard corrosion-resisting finish, and designed to accomplish uniform air flow across the down-stream [coil][filters] while reducing the higher fan outlet velocity to within plus or minus 5 percent of the required face velocity of the downstream component.

2.14.2.8 Dampers

Provide dampers integral to factory fabricated air handling units constructed in accordance with 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC. Dampers connecting the air handling unit to the outdoors (outdoor air, exhaust air, relief Air) must be AMCA 511 leakage classification 1A.

2.15 TERMINAL UNITS

****
NOTE: Coordinate with paragraph Sound Attenuation Equipment.
****

2.15.1 Room Fan-Coil Units

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NOTE: Provide required acoustical performance on the drawings. Where not provided on the drawings include maximum permissible sound power information within paragraph below.
****

Provide base units that include galvanized coil casing, coil assembly drain pan [valve and piping package,] [outside air damper,] [wall intake box,] air filter, fans, motor, fan drive, motor switch, an enclosure for cabinet models and casing for concealed models, leveling devices integral with the unit for vertical type units, and sound power levels[not to exceed[ ]][as indicated]. Obtain sound power level data or values for these units according to test procedures based on AHRI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. Values obtained for the standard cabinet models are acceptable for concealed models without separate test provided there is no variation between models as to the coil configuration, blowers, motor speeds, or relative arrangement of parts. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Fasten each unit securely to the building structure. Provide units with capacity indicated. Provide room fan-coil units that are certified as complying with AHRI 440, and meet the requirements of UL 1995.

2.15.1.1 Enclosures

Fabricate enclosures from not lighter than 1.3 mm 18 gauge steel, reinforced and braced. Provide enclosures with front panels that are removable and have 7 mm 1/4 inch closed cell insulation or 13 mm 1/2 inch thick dual density foil faced fibrous glass insulation. Make the exposed side of a high density, erosion-proof material suitable for use in air streams with velocities up to 23 m/s 4,500 fpm. Provide a discharge grille that is [adjustable] [fixed] and that is of such design as to properly distribute air throughout the conditioned space. Plastic discharge and return grilles are acceptable provided the plastic material is certified by the manufacturer to be classified as flame resistant according to UL 94 and the material complies with the heat deflection criteria specified in UL 1995. Provide galvanized or factory finished ferrous metal surfaces with corrosion resistant enamel, and access doors or removable panels for piping and control compartments, plus easy access for filter replacement. Provide duct discharge collar for concealed models.

2.15.1.2 Fans

Provide steel or aluminum, multiblade, centrifugal type fans. In lieu of metal, fans and scrolls could be of non-metallic materials of suitably reinforced compounds with smooth surfaces. Dynamically and statically balance the fans. Provide accessible assemblies for maintenance. Disassemble and re-assemble by means of mechanical fastening devices and not by epoxies or cements.

2.15.1.3 Coils

Fabricate coils from not less than 10 mm 3/8 inch outside diameter seamless copper tubing, with copper or aluminum fins mechanically bonded or soldered to the tubes. Provide coils with not less than 13 mm 1/2 inch outside diameter flare or sweat connectors, accessory piping package with thermal connections suitable for connection to the type of control valve supplied, and manual air vent. Test coils hydrostatically at 2000 kPa 300 psi or under water at 1700 kPa 250 psi air pressure. Provide coils suitable for 1400 kPa 200 psi working pressure. Make provisions for coil removal.

2.15.1.4 Drain Pans

Size and locate drain and drip pans to collect all water condensed on and dripping from any item within the unit enclosure or casing. Provide condensate drain pans designed for self-drainage to preclude the buildup of microbial slime and thermally insulated to prevent condensation and constructed of not lighter than 0.9 mm 21 gauge type 304 stainless steel or noncorrosive ABS plastic. Provide insulation with a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and of a waterproof type or coated with a waterproofing material. Design drain pans so as to allow no standing water and pitch to drain. Provide minimum 19 mm 3/4 inch NPT or 15 mm 5/8 inch OD drain connection in drain pan. Provide plastic or metal auxiliary drain pans to catch drips from control and piping packages, eliminating insulation of the packages; if metal, provide auxiliary pans that comply with the requirements specified above. Extend insulation at control and piping connections 25 mm 1 inch minimum over the auxiliary drain pan.

2.15.1.5 Manually Operated Outside Air Dampers

Provide manually operated outside air dampers according to the arrangement indicated, and parallel airfoil type dampers of galvanized construction. Provide blades that rotate on stainless steel or nylon sleeve bearings.

2.15.1.6 Filters

Provide disposable type filter that complies with ASHRAE 52.2. Provide filters in each unit that are removable without the use of tools.

2.15.1.7 Motors

****

NOTE: Edit depending on whether the units are freestanding, built-in or both. Values for high static motors cover 115V, 230V, and 277V.

****

Provide motors of either the permanent split-capacitor type with built-in thermal overload protection or ECM type, directly connected to unit fans. Provide motor switch with two or three speeds and off, manually operated, and mounted on an identified plate [inside the unit below or behind an access door][or][adjacent to the room thermostat][as indicated]. In lieu of the above multiple fan speed control, a solid-state variable-speed controller having a minimum speed reduction of 50 percent is allowed or alternatively, if an ECM motor is provided, occupant interface to the vary the airflow via the ECM may be utilized. Provide motors with permanently-lubricated or oilable sleeve-type or combination ball and sleeve-type bearings with vibration isolating mountings suitable for continuous duty. Provide a motor power consumption, shown in watts, at the fan operating speed selected to meet the specified capacity that does not exceed the following values:

Free Discharge Motors			
Unit Capacity (L/S) (cfm)	Maximum Power Consumption (Watts)		
	115V	230V	277V
94200	70	110	90
142300	100	110	110
189400	170	150	150
283600	180	210	220
378800	240	240	230
4721000	310	250	270
5661200	440	400	440

High Static Motors	
Unit Capacity (L/S) (cfm)	Maximum Power Consumption (Watts)
94200	145
142300	145
189400	210
283600	320
378800	320
4721000	530
5661200	530

2.15.2 Variable Air Volume (VAV) and Dual Duct Terminal Units

****

NOTE: Delete reheat coils when not required.

****

a. Provide VAV and dual duct terminal units that are the type, size, and capacity shown, mounted in the ceiling or wall cavity, plus units that are suitable for single or dual duct system applications. Provide actuators and controls as specified in paragraph SUPPLEMENTAL

COMPONENTS/SERVICES, subparagraph CONTROLS. For each VAV terminal unit, provide a temperature sensor in the unit discharge ductwork.

b. Provide unit enclosures that are constructed of galvanized steel not lighter than 0.85 mm 22 gauge or aluminum sheet not lighter than 1.3 mm 18 gauge. Provide single or multiple discharge outlets as required. Units with flow limiters are not acceptable. Provide unit air volume that is factory preset and readily field adjustable without special tools. [Provide reheat coils as indicated.]

****

NOTE: Provide required acoustical performance on the drawings. Where not provided on the drawings include maximum permissible sound power information within paragraph below.

****

c. Attach a flow chart to each unit. Base acoustic performance of the terminal units upon units tested according to AHRI 880 I-P with the calculations prepared in accordance with AHRI 885. Provide sound power levels[not to exceed [ ]][as indicated]. Show discharge sound power for minimum and [375][_____] Pa [1-1/2][_____] inches water gauge inlet static pressure. Provide with double wall construction for acoustical attenuation. Solid metal liner must completely isolate insulation from airstream within the unit. Acoustical duct lining is not permitted.

d. For VAV terminal units provided with heating coils provide a manufacturer's access door to facilitate with the cleaning of the coil and servicing internal components without disturbing duct connections.

2.15.2.1 Constant Volume, Single Duct Terminal Units

Provide constant volume, single duct, terminal units that contain within the casing, a constant volume regulator. Provide volume regulators that control air delivery to within plus or minus 5 percent of specified air flow subjected to inlet pressure from 200 to 1500 Pa 3/4 to 6 inch water gauge.

2.15.2.2 Variable Volume, Single Duct Terminal Units

Provide variable volume, single duct, terminal units with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays. Provide units that control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 200 to 1500 Pa 3/4 to 6 inch water gauge. Provide units with an internal resistance not exceeding 100 Pa 0.4 inch water gauge at maximum flow range. Provide external differential pressure taps separate from the control pressure taps for air flow measurement with a 0 to 250 Pa 0 to 1 inch water gauge range.

2.15.2.3 Variable Volume, Single Duct, Fan-Powered Terminal Units

Provide variable volume, single duct, fan-powered terminal units with a calibrated air volume sensing device, air valve or damper, actuator, fan and motor, and accessory relays. Provide units that control primary air volume to within plus or minus 5 percent of each air set point as determined by the thermostat with variations in inlet pressure from 200 to 1500 Pa 3/4 to 6 inch water gauge. Provide unit fan that is centrifugal, direct-driven, double-inlet type with forward curved blades. Provide either single speed with speed controller, ECM motor with electronic speed control or three-speed, permanently lubricated, permanent split-capacitor type fan motor. Isolate fan/motor assembly from the casing to minimize vibration transmission. Provide factory furnished fan control that is wired into the unit control system. Provide a factory-mounted pressure switch to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.

2.15.2.4 Dual Duct Terminal Units

Provide dual duct terminal units with hot and cold inlet valve or dampers that are controlled in unison by single or dual actuators. Provide actuator as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Provide unit that controls delivered air volumes within plus or minus 5 percent with inlet air variations from 250 to 2000 Pa 1 to 8 inch water gauge in either duct. Include mixing baffles with the unit casing. Provide cabinet and closed duct leakage that does not exceed 2 percent of maximum rated air volume. Provide units with an internal resistance that does not exceed [_____] Pa inch water gauge at maximum flow range.

2.15.2.5 Series Fan Powered Variable Air Volume (VAV) Terminals

****

NOTE: For evaporator variable airflow applications such as VAV or multizone, provisions for capacity control and minimum capacity must be indicated. Provide capacity control by compressor unloading or multiple compressors. For minimum capacity control, provide these applications with factory installed hot-gas bypass.

****

Provide units factory assembled, designed, tested, rated in accordance with AHRI 880 I-P, that are AHRI certified, listed in the AHRI DCAACP and that produce a supply air discharge mix by modulation of conditioned primary air and recirculating of return air. Provide units that include casing, centrifugal fan and motor, primary VAV damper or valve, electronic volume regulator, discharge air damper, primary air inlet cone with high and low pressure flow sensors, recirculating air filter frames, filter, and electrical disconnect. [Provide hot water heating coils integral to the terminal, or provide insulated hot water coil section attached to the discharge of the terminal.]

2.15.2.5.1 Casing

Provide removable full bottom access panels for servicing internal components without disturbing duct connections. Insulate inside of casing with manufacturer's standard insulation. Provide units that have recirculating air inlet equipped with filter frame, round primary damper or valve, and unit mounting brackets.

2.15.2.5.2 Fans and Motors

Provide centrifugal, forward curved, multiblade, fan wheels with direct-drive motors. Provide motors that are the high efficiency permanent-split capacitor type with thermal overload protection, permanently lubricated bearings, and have three speeds or are equipped with solid state speed controllers, or ECM motors with electronic speed control capacity may be provided.. Provide isolation between fan motor assembly and unit casing. Provide fan and motor that is removable through casing access panel.

2.15.2.5.3 Flow Sensor

Provide ring or cross type sensor with minimum of two pickup points which average the velocity across the inlet. Obtain flow measurement within plus or minus 5 percent of rated airflow with 1.5 diameters of straight duct upstream of unit and inlet static variation of 124 to 1240 Pa 0.5 to 5.0 inches water gauge. Supply flow measuring taps and calibration flowchart with each unit for field balancing airflows.

2.15.2.5.4 Primary VAV Damper or Valve

Provide galvanized steel damper blade that closes against gasket inside unit. Connect damper to operating shaft with a positive mechanical connection. Provide nylon bearing for damper shaft. Cylindrical die cast aluminum valve inlet tapered to fit round flexible ducts with integral flow diffuser and beveled self-centering disc. Provide damper or valve leakage at shutoff that does not exceed 2 percent of capacity at 250 Pa 1 inch water gauge pressure.

2.15.2.5.5 Regulator

Provide electronic volume regulator. Electronic controls contained in NEMA ICS 6, Type 1 enclosure sealed from airflow. Provide unit with controls mounted on side or on air valve. System powered regulators are not permitted. Provide volume regulator that resets primary air volume as determined by thermostat, within upstream static pressure variation noted in paragraph titled "Flow Sensor." Provide volume regulators that are field adjustable, factory set and calibrated to indicated maximum and minimum primary airflows, direct acting and normally [open] [closed] upon loss of pneumatic pressure.

2.15.2.5.6 Electrical

Provide unit that incorporates single point electrical connection with electrical disconnect. Provide electrical components that are UL or ETL listed, installed in accordance with NFPA 70 and mounted in control box. Units UL or ETL listed as an assembly do not require airflow switch interlock with electric heating coil, when factory assembled.

2.15.2.5.7 Filters

Provide UL listed throwaway 25 mm one inch thick fiberglass filters, standard dust-holding capacity.

2.15.2.6 Reheat Units

2.15.2.6.1 Hot Water Coils

Provide fin-and-tube type hot-water coils constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Provide headers that are constructed of cast iron, welded steel or copper. Provide casing and tube support sheets that are 1.6 mm 16 gauge, galvanized steel, formed to provide structural strength. Provide tubes that are correctly circuited for proper water velocity without excessive pressure drop and are drainable where required or indicated. At the factory, test each coil at not less than 1700 kPa 250 psi air pressure and provide coils suitable for 1400 kPa 200 psi working pressure. Install drainable coils in the air handling units with a pitch of not less than 10 mm per m 1/8 inch per foot of tube length toward the drain end. Coils must conform to the provisions of AHRI 410.

2.15.2.6.2 Steam Coils

Provide steam coils constructed of cast semisteel, welded steel, or copper headers, red-brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered to the tubes. Roll and bush, braze or weld tubes into headers. Provide coil casings and tube support sheets, with collars of ample width, that are not lighter than 1.6 mm 16 gauge galvanized steel formed to provide structural strength. When required, furnish multiple tube supports to prevent tube sag. Float the fin tube and header section within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide coils that are factory pressure tested and capable of withstanding 1700 kPa 250 psi hydrostatic test pressure or 1400 kPa 250 psi air pressure, and are for [700] [1400] kPa [100] [200] psi steam working pressure. Provide steam-distribution tube type preheat coils with condensing tubes having not less than 15 mm 5/8 inch outside diameters. Provide distribution tubes that have not less than 10 mm 3/8 inch outside diameter, with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes held securely in alignment. Limit the maximum length of a single coil to 120 times the diameter of the outside tube. Other heating coils must be single tube type with an outside diameter not less than 13 mm 1/2 inch. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Provide coils that conform to the provisions of AHRI 410.

2.15.2.6.3 Electric Resistance Heaters

Provide the duct-mounting type electric resistance heaters consisting of a nickel-chromium resistor mounted on refractory material and a steel or aluminum frame for attachment to ductwork. Provide electric duct heater that meets the requirement of Underwriters Laboratories and NFPA 70 and is provided with a built-in or surface-mounted high-limit thermostat. Interlock electric duct heaters electrically so that they cannot be energized unless the fan is running.

2.15.3 Unit Ventilators

****

NOTE: Provide required acoustical performance on the drawings. Where not provided on the drawings include maximum permissible sound power information within paragraph below.

****

Provide unit ventilators that include an enclosure, [galvanized casing,] [cold-rolled steel casing with corrosion resistant coating,] coil assembly, [resistance heating coil assembly,] [valve and piping package,] drain pan, air filters, fan assembly, fan drive, motor, motor controller, dampers, damper operators, and sound power level[not to exceed [   ]][as indicated]. Obtain sound power level data or values for these units according to test procedures based on AHRI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles, when handling standard flow for which the unit air capacity is rated. Secure each unit to the building structure. Provide the unit ventilators with capacity indicated. Provide the year-round classroom type unit ventilator with automatic controls arranged to properly heat, cool, and ventilate the room. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Make the sequence of control any one of the standard ANSI cycles specified in paragraph CONTROLS.

2.15.3.1 Enclosures

Fabricate enclosures from not lighter than 1.6 mm 16 gauge galvanized steel, reinforced and braced, or all welded framework with panels to provide equivalent strength. Provide casing that is acoustically and thermally insulated internally with not less than 13 mm 1/2 inch thick dual density fibrous glass insulation. Make the exposed side a high density, erosion-proof material suitable for use in air streams with velocities up to 246 m/s 4500 fpm. Fasten the insulation with waterproof, fire-resistant adhesive. Design front panel for easy removal by one person. Provide discharge grilles that [have adjustable grilles or grilles with adjustable vanes and] properly distribute air throughout the conditioned space. Provide return grilles that are removable where front panel does not provide access to interior components. Plastic discharge or return grilles are not acceptable. Furnish removable panels or access doors for all piping and control compartments. Provide fan switch that is key operated or accessible through a locked access panel. Install gaskets at the back and bottom of the unit for effective air seal, as required.

2.15.3.2 Electric Resistance Heating Elements

****

NOTE: Provide heating element requirements on the drawings.

****

Provide electric resistance heating elements that are of the sheathed, finned, tubular type, or of the open resistance type designed for direct exposure to the air stream. Provide heating element electrical characteristics as indicated. Where fan motor or control voltage is lower than required for the electric-resistance heating element, install a fused factory mounted and wired transformer.

2.15.3.3 Fans

Provide fans that meet the requirements as specified in paragraph AIR SYSTEMS EQUIPMENT. Provide galvanized steel or aluminum, multiblade, centrifugal type fans, dynamically and statically balanced. Equip fan housings with resilient mounted, self-aligning permanently lubricated ball bearings, sleeve bearings, or combination ball and sleeve bearings, capable of not less than 2000 hours of operation on one oiling. Provide direct-connected fans.

2.15.3.4 Coils

Provide coils that are circuited for a maximum water velocity of 2.4 m/s 8 fps without excessive pressure drop and are otherwise as specified for hot water coils in paragraph TERMINAL UNITS.

2.15.3.5 Drain Pans

Size and locate drain and drip pans to collect all condensed water dripping from any item within the unit enclosure. Provide drain pans constructed of not lighter than 1.2 mm 18 gauge steel, galvanized after fabrication, and thermally insulated to prevent condensation. Provide insulation that is coated with a fire-resistant waterproofing material. In lieu of the above, drain pans constructed of die-formed 1.0 mm 20 gauge steel is allowed, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 1.3 mm 18 gauge steel material, or of die-formed 1.3 mm 18 gauge type 304 stainless steel insulated as specified above. Pitch drain pans to drain. Furnish drain connection unless otherwise indicated. Make the minimum connection 19 mm 3/4 inch NDT or 18 mm 5/8 inch OD.

2.15.3.6 Filters

Disposable type rated in accordance with ASHRAE 52.2, installed upstream of coil.

2.15.3.7 Dampers

Provide an outside air proportioning damper on each unit. In addition, provide a vane to prevent excessive outside air from entering unit and to prevent blow-through of outside air through the return air grille under high wind pressures. Where outside air and recirculated air proportioning dampers are provided on the unit, an additional vane is not required. Provide face and bypass dampers for each unit to ensure constant air volume at all positions of the dampers. Furnish each unit with a factory installed control cam assembly, pneumatic motor, or electric motor to operate the face and bypass dampers and outside air damper or outside air and recirculated air dampers in the sequence as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.15.3.8 Motors

****

NOTE: Edit based on whether the units are freestanding, built-in, or both.

****

Provide permanent split-capacitor type motors with built-in thermal overload protection and automatic reset or ECM type motors. Mount motor on a resilient mounting, isolated from the casing and suitable for operation on electric service available. Provide a manually operated motor switch that provides for 2 or 3 speeds and off, mounted on an identified plate [inside the unit below or behind an access door][or][adjacent to the room thermostat][as indicated]. In lieu of speed control, provide a solid state variable speed controller having minimum speed reduction of 50 percent, or if ECM motors are provided, electronic speed controller for the ECM motor..

2.15.3.9 Outside Air Intakes

Provide the manufacturer's standard design outside air intakes furnished with 13 mm 1/2 inch mesh bird screen or louvers on 13 mm 1/2 inch centers.

2.16 ENERGY RECOVERY DEVICES

2.16.1 Rotary Wheel

****

NOTE: Show energy recovery device supply/exhaust filters, preheat coils, backdraft dampers, exhaust dampers, recirculation dampers, face and bypass dampers, drainage provisions, controls and like ancillaries on the drawings and supplement by the specifications as necessary. Select minimum acceptable energy transfer effectiveness and maximum acceptable cross-contamination.

Delete moisture resistance and chain drive if not required.

****

Provide unit that is a factory fabricated and tested assembly for air-to-air energy recovery by transfer of sensible heat from exhaust air to supply air stream, with device performance according to ASHRAE 84 and that delivers an energy transfer effectiveness of not less than [70][85][_____] percent with cross-contamination not in excess of [0.1][1.0][_____] percent of exhaust airflow rate at system design differential pressure, including purging sector if provided with wheel. Provide exchange media that is chemically inert, moisture-resistant, fire-retardant, laminated, nonmetallic material which complies with NFPA 90A. Isolate exhaust and supply streams by seals which are static, field adjustable, and replaceable. Equip chain drive mechanisms with ratcheting torque limiter or slip-clutch protective device. Fabricate enclosure from galvanized steel and include provisions for maintenance access. Provide recovery control and rotation failure provisions[as indicated].

2.16.2 Run-Around-Coil

****

NOTE: Delete "factory fabricated and tested" if not required.

Coordinate with paragraph Glycol Solution in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS. Glycol is considered a hazardous waste. If the base does not have a used glycol waste program, using glycol can be an expensive maintenance item.

****

Provide assembly that is factory fabricated and tested air-to-liquid-to-air energy recovery system for transfer of sensible heat from exhaust air to supply air stream and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination with maximum energy recovery at minimum life cycle cost. Computer optimize components for capacity, effectiveness, number of coil fins per inch, number of coil rows, flow rate, heat transfer rate of [_____] percent by volume of [ethylene][propylene] glycol solution, and frost control. Provide coils that conform to paragraph AIR HANDLING UNITS. Provide related pumps, and piping specialties that conform to requirements of [Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS][_____].

2.16.3 Heat Pipe

****

NOTE: Include face air velocity, static pressure drop, temperature requirements for entering and leaving air or exhaust streams, fins per unit length and number of tube rows on the equipment schedule for heat pipes.

Delete flexible connectors if not required.

****

Provide a device that is a factory fabricated, assembled and tested, counterflow arrangement, air-to-air heat exchanger for transfer of sensible heat between exhaust and supply streams and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination. Provide heat exchanger tube core that is [15][18][25] mm [1/2][5/8][1] inch nominal diameter, seamless aluminum or copper tube with extended surfaces, utilizing wrought aluminum Alloy 3003 or Alloy 5052, temper to suit. Provide maximum fins per unit length and number of tube rows as indicated. Provide tubes that are fitted with internal capillary wick, filled with a refrigerant complying with ANSI/ASHRAE 15 & 34, selected for system design temperature range, and hermetically sealed. Refrigerants containing chlorofluorocarbons (CFC) are prohibited. Provide heat exchanger frame that is constructed of not less than 1.6 mm 16 gauge galvanized steel and fitted with intermediate tube supports, and flange connections. Provide tube end-covers and a partition of galvanized steel to separate exhaust and supply air streams without cross-contamination and in required area ratio.[Provide a drain pan constructed of welded Type 300 series stainless steel.] Provide heat recovery regulation by [system face and bypass dampers and related control system[as indicated]][interfacing with manufacturer's standard tilt-control mechanism for summer/winter operation, regulating the supply air temperature and frost prevention on weather face of exhaust side at temperature indicated]. Coil must be fitted with pleated flexible connectors.

2.16.4 Desiccant Wheel

Provide counterflow supply, regeneration airstreams, a rotary type dehumidifier designed for continuous operation, and extended surface type wheel structure in the axial flow direction with a geometry that allows for laminar flow over the operating range for minimum air pressure differentials. Provide the dehumidifier complete with a drive system utilizing a fractional-horsepower electric motor and speed reducer assembly driving the rotor. Include a slack-side tensioner for automatic take-up for belt-driven wheels. Provide an adsorbing type desiccant material. Apply the desiccant material to the wheel such that the entire surface is active as a desiccant and the desiccant material does not degrade or detach from the surface of the wheel which is fitted with full-face, low-friction contact seals on both sides to prevent cross leakage. Provide rotary structure that has underheat, overheat and rotation fault circuitry. Provide wheel assembly with a warranty for a minimum of five years.

2.16.5 Plate Heat Exchanger

Provide energy recovery ventilator unit that is factory-fabricated for indoor installation, consisting of a flat plate cross-flow heat exchanger, cooling coil, supply air fan and motor and exhaust air fan and motor. The casing must be 1 mm 20 gauge G90, galvanized steel, double wall construction with 25 mm one inch insulation. Provide fibrous desiccant cross-flow type heat exchanger core capable of easy removal from the unit.

2.17 SUPPLEMENTAL COMPONENTS/SERVICES

2.17.1 Chilled, Condenser, or Dual Service Water Piping

The requirements for chilled, condenser, or dual service water piping and accessories are specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

2.17.2 Refrigerant Piping

The requirements for refrigerant piping are specified in Section 23 23 00 REFRIGERANT PIPING.

2.17.3 Water or Steam Heating System Accessories

The requirements for water or steam heating accessories such as expansion tanks and steam traps are specified in Section [23 52 00 HEATING BOILERS][23 21 13.00 20 LOW TEMPERATURE WATER (LTW) HEATING SYSTEM][23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS][_____].

2.17.4 Condensate Drain Lines

[Provide and install condensate drainage for each item of equipment that generates cooling coil condensate in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE][Provide and install condensate drainage for steam condensate in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS except as modified herein].

2.17.5 Backflow Preventers

The requirements for backflow preventers are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.17.6 Insulation

The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.17.7 Controls

The requirements for controls are specified in [Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS][and][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][and][Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS][_____].

2.18 RADIANT PANELS

****

NOTE: There are currently no performance certification requirements or standards in the US for radiant ceiling panels. Until those performance certification procedures are developed, accepted and published, the European Standards DIN EN 14037 and DIN EN 14240 will be utilized.

****

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NOTE: For radiant cooling panels, special care must be taken to avoid condensation on the panels. The design must include a sequence of operation to circulate chilled water to the panels at a temperature slightly above the room dew point temperature and must be able to adjust the chilled water temperature as required based on changes in the room relative humidity.

****

2.18.1 Hydronic Modular Panels

2.18.1.1 Panels

Modular radiant panels will fit into a standard 600 mm x 600 mm24 inch x 24 inch or 600 mm x 1200 mm24 inch x 48 inch suspended T-Bar ceiling grid or flush mounted on a drywall ceiling. For flush mounted ceiling applications, the manufacturer will provide a one piece extruded aluminum frame. Panels must be supported from the T-bar assembly. Panels must be [14 gauge] or [16 gauge] extruded aluminum or sheet steel.

2.18.1.2 Heat Sink

The modular panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face.

2.18.1.3 Water Tubes

Tubes must consist of ASTM B75/B75M [13 mm] [1/2 inch] [16 mm] [5/8 inch] O.D. nominal copper tubing. Water connections will be suitable for solder or compression fittings. Heat pads will be used between the soldered fitting and the panel to protect the panel surface. The manufacturer will provide water pressure drop data as well as heating and cooling output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling). The panels will have the capacity to have multiple passes with connections either on the [same end] or [opposite ends], dependent on the number of passes.

2.18.1.4 Finish

All visible components must be powder coated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Standard finish color must be white.

2.18.1.5 Performance

Manufacturer will provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.18.1.6 Capacity

****

NOTE: Include the last bracketed sentence if it is deemed necessary to confirm heating and/or cooling capacity after the panels are installed.

****

Modular radiant panel capacity will be tested and certified by manufacturer in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling) to meet the required performance. [The manufacturer will have factory testing facility available to perform performance test of units in accordance with said standard.]

2.18.1.7 Water Connections

Connections will be shipped sealed to limit the introduction of dust and dirt during shipping and construction.

2.18.1.8 Installation

Panels will be installed as recommended by the manufacturer.

2.18.1.9 Accessories

Stainless steel braided hoses, 300 mm12 inches or 450 mm18 inches long will be supplied with the panels.

The top of the heating and cooling panels must be covered with 38 mm1-1/2 inches thick 16kg/m31 lb/cu ft formaldehyde-free fiber glass insulation with a minimum R = 0.79 m2 deg C/W4.5 (hr ft2 deg F)/BTU. The insulation must be covered with a foil scrim kraft vapor barrier facing.

2.18.2 Hydronic Linear Panels

2.18.2.1 Panels

Linear radiant panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face. The linear radiant panel is to radiate or absorb heat from or to the zone below. Panels must be [14 gauge] or [16 gauge] extruded aluminum.

2.18.2.2 Heat Sink

The modular panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face.

2.18.2.3 Water Tubes

Tubes must consist of ASTM B75/B75M 13 mm1/2 inch or 16mm5/8 inch O.D. nominal copper tubing. Water connections will be suitable for solder or compression fittings. The manufacturer will provide water pressure drop data as well as heating and cooling output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.18.2.4 Mounting

Units must be provided with mounting hardware as required for mounting in T-Bar applications or ceiling flush mounting. The manufacturer's standard hardware for mounting panels abutting each other must be submitted for approval.

2.18.2.5 Finish

All visible components must be powder coated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Standard finish color must be white.

2.18.2.6 Performance

Manufacturer must provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.18.2.7 Capacity

****

NOTE: Include the last bracketed sentence if it is deemed necessary to confirm heating and/or cooling capacity after the panels are installed.

****

Modular radiant panel capacity must be tested and certified by manufacturer in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling) to meet the required performance. [The manufacturer must have factory testing facility available to perform performance test of units in accordance with said standard.]

2.18.2.8 Water Connections

Connections will be shipped sealed to limit the introduction of dust and dirt during shipping and construction.

2.18.2.9 Accessories

Stainless steel braided hoses, 300 mm12 inches or 450 mm18 inches long will be supplied with the panels.

The top of the heating and cooling panels must be covered with 38 mm1-1/2 inches thick 16kg/m31 lb/cu ft formaldehyde-free fiber glass insulation with a minimum R = 0.79 m2 deg C/W4.5 (hr ft2 deg F)/BTU. The insulation must be covered with a foil scrim kraft vapor barrier facing.

2.18.3 Prefabricated Radiant-Heating Electric Panels

2.18.3.1 Description

Sheet metal enclosed panel with heating element suitable for [lay-in installation flush with T-bar ceiling grid] [surface mounting] [recessed mounting]. Comply with UL 2021

2.18.3.2 Panel

Minimum 0.7 mm0.027 inch thick, galvanized steel sheet back panel riveted to minimum 1.0 mm0.040 inch thick, galvanized steel sheet front panel with fused-on crystalline surface.

2.18.3.3 Heating Element

Powdered graphite sandwiched between sheets of electric insulation.

2.18.3.4 Electrical Connections

Nonheating, high-temperature, insulated-copper leads, factory connected to heating element.

2.18.3.5 Exposed-Side Panel Finish

[Apply silk-screened finish to match appearance of Architect selected acoustical ceiling tiles.] [Baked-enamel finish in color as selected by Architect.]

2.18.3.6 Surface-Mounting Trim

Sheet metal with baked-enamel finish in color as selected by Architect.

2.18.3.7 Wall Thermostat

Bimetal, sensing elements; with contacts suitable for [low] [line]-voltage circuit, and manually operated on-off switch with contactors, relays, and control transformers.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of [910][_____] mm [3][_____] feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices)and an additional [910][_____] mm [3][_____] feet.

c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

3.2.1 Condensate Drain Lines

Provide water seals in the condensate drain from all [units] [units except room [fan-coil units]]. Provide a depth of each seal of 50 mm 2 inches plus 0.1 mm for each Pa the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 150 mm 6 inch concrete pads or curbs doweled in place unless otherwise indicated assuring mounting height accommodates depth of condensate drain water seal (trap) where applicable. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.2.4 Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

3.2.5 Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

3.2.5.1 Underground Ductwork

****

NOTE: Due to potential contaminants of air-stream, such as pesticides and corrosion, use underground ductwork only for exhaust air.

****

Provide Polyvinyl Duct Spiral Pipe (PVS) for underground systems. PVS must consist of prime, hot-dipped, G-90 galvanized steel, cleaned and fire treated with epoxy primer bonded to both sizes of the metal, with final 4-mil polyvinyl coating heat fused to both sides (4x4). Install ductwork[as indicated] following all manufacturer's instructions. All underground ducts are to be PVS formed in spiral tubes. All couplings and fittings must be factory fabricated of PVS. All joints and connections must be screw fastened and taped in accordance with manufacturer's installation requirements to assure an air-tight system. All ducts and fittings are to be installed and back-filled according to manufacturer's recommendations. Maximum burial depth is 2 m 6 feet.

3.2.5.2 Radon Exhaust Ductwork

****

NOTE: Design subslab ventilation for radon mitigation as prescribed in TM 5-810-1.

****

Perforate subslab suction piping where indicated. Install PVC joints as specified in ASTM D2855.

3.2.5.3 Light Duty Corrosive Exhaust Ductwork

For light duty corrosive exhaust ductwork, use PVC plastisol coated galvanized steel with PVC coating on interior [surfaces][and exterior surfaces][and epoxy wash primer coating on exterior surfaces].

3.2.6 FRP Ductwork

****

NOTE: Study characteristics of exhaust stream constituents and contaminant materials to determine service life and safety controlling parameters. Consider that constituents concentrate upon evaporation of carrier. Some concentrates detonate upon impact. Design to preclude concentrate high-allow for out water washing. Review fire protection provisions, and the need for fire stops. The manufacturer cannot be held responsible for performance of his product, unless the specification delineates product exposure. Modify or supplement specification criteria as necessary.

****

Provide fibrous glass reinforced plastic ducting and related structures that conform to SMACNA 1884. Provide flanged joints where indicated. Crevice-free butt lay-up joints are acceptable where flanged joints are not indicated. When ambient temperatures are lower than 10 degrees C 50 degrees F, heat cure joints by exothermic reaction heat packs.

3.2.7 Kitchen Exhaust Ductwork

****

NOTE: Show on the drawings the requirements in NFPA 96 pertaining to enclosures around kitchen exhaust ducts.

The referenced SMACNA HVAC Duct Construction Manual does not cover negative pressures in excess of 747 Pa

3 inches water gauge. If the static pressure within the duct can exceed 75 mm 3 inches negative, then the spacing and duct thickness must be indicated on the drawings and the paragraph accordingly.

Specify stainless steel duct for projects in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

3.2.7.1 Ducts Conveying Smoke and Grease Laden Vapors

Provide ducts conveying smoke and grease laden vapors that conform to requirements of NFPA 96. Make seams, joints, penetrations, and duct-to-hood collar connections with a liquid tight continuous external weld. Provide duct material that is a [minimum 1.3 mm 18 gauge, Type 304L or 316L, stainless steel] [minimum 1.6 mm 16 gauge carbon steel]. [Include with duct construction an external perimeter angle sized in accordance with SMACNA 1966, except place welded joint reinforcement on maximum of 600 mm 24 inch centers; continuously welded companion angle bolted flanged joints with flexible ceramic cloth gaskets where indicated; pitched to drain at low points; welded pipe coupling-plug drains at low points; welded fire protection and detergent cleaning penetration; steel framed, stud bolted, and flexible ceramic cloth gasketed cleaning access provisions where indicated. Make angles, pipe couplings, frames, bolts, and other required appurtenances from the same material as that specified for the duct unless indicated otherwise.]

3.2.7.2 Exposed Ductwork

Provide exposed ductwork that is fabricated from minimum 1.3 mm 18 gauge, Type 304L or 316L, stainless steel with continuously welded joints and seams. Pitch ducts to drain at hoods and low points indicated. Match surface finish to hoods.

3.2.7.3 Concealed Ducts Conveying Moisture Laden Air

Fabricate concealed ducts conveying moisture laden air from minimum [1.3 mm 18 gauge, Type 300 series, stainless steel] [1.6 mm 16 gauge, galvanized steel] [0.55 mm 16 ounce, tempered copper sheet]. Continuously weld, braze, or solder joints to be liquid tight. Pitch ducts to drain at points indicated. Make transitions to other metals liquid tight, companion angle bolted and gasketed.

3.2.8 Clothes Dryer Exhaust Ductwork

Clothes dryer exhaust duct work to be installed in accordance with ICC IMC and the dryer manufacturer's installation requirements. For single domestic/residential clothes dryer ducts, dryer duct to be supported at 1 meter 4 foot intervals and secured in place. The insert end of the duct is to extend into the adjoining duct or fitting in the direction of airflow. Ducts are not be joined with screws or fasteners that protrude more than 3 mm 1/8 inch into the inside of the duct. For multiple clothes dryers refer to ICC IMC for installation requirements.

[3.2.9 Acoustical Duct Lining

****

NOTE: In accordance with UFC 3-410-01, acoustical duct liner is prohibited and should not be used. The following paragraph for Acoustical Duct Lining should be deleted unless specifically approved for use when no other acceptable alternatives exist. Acoustical duct liner must not be used as a means of duct insulation, only for acoustical attenuation as required where sound attenuation cannot be achieved by other methods.

****

Apply lining in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C916, Type I, NFPA 90A, UL 723, and ASTM E84. Provide top and bottom pieces that lap the side pieces and are secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA 1966. Provide welded pins, cup-head pins, or adhered clips that do not distort the duct, burn through, nor mar the finish or the surface of the duct. Make pins and washers flush with the surfaces of the duct liner and seal all breaks and punctures of the duct liner coating with the nonflammable, fire resistant adhesive. Coat exposed edges of the liner at the duct ends and at other joints where the lining is subject to erosion with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Apply duct liner to flat sheet metal prior to forming duct through the sheet metal brake. Additionally secure lining at the top and bottom surfaces of the duct by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA 1966 to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, are acceptable.

]3.2.10 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

3.2.11 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums [up to the point where the outdoor air reaches the conditioning unit][or][up to the point where the outdoor air mixes with the return air stream].

3.2.12 Duct Test Holes

****

NOTE: Show the location of duct test holes on the drawings. Locate holes so as to implement the requirements of Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

****

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

3.2.13 Power Roof Ventilator Mounting

Provide foamed 13 mm 1/2 inch thick, closed-cell, flexible elastomer insulation to cover width of roof curb mounting flange. Where wood nailers are used, predrill holes for fasteners.

3.2.14 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 75 mm 3-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of [28][14][_____] calendar days before being loaded.

3.4 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.5 CLEANING

****

NOTE: Cover general cleaning and rubbish removal requirements in Division 01.

****

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse [_____] protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 PENETRATIONS

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NOTE: Where sleeves are installed in the bearing walls, the designer must provide design details in drawings of the structural steel sleeves. Consult with structural engineers for the design details.

****

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 380 mm 15 inches and smaller. Build framed, prepared openings for round duct larger than 380 mm 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide 25 mm one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

3.6.1 Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from 1 mm 20 gauge thick mill galvanized sheet metal. Refer to design details on the drawings for sleeves in bearing walls or partitions.

3.6.2 Framed Prepared Openings

Fabricate framed prepared openings from 1 mm 20 gauge galvanized steel, unless otherwise indicated.

3.6.3 Insulation

Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 16 degrees C 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

3.6.4 Closure Collars

Provide closure collars of a minimum 100 mm 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 380 mm 15 inches in diameter or less from 1 mm 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 380 mm 15 inches from 1.40 mm 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 380 mm 15 inches or less from 1 mm 20 gauge galvanized steel. Install collars with fasteners a maximum of 150 mm 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 300 mm 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 500 mm 20 inches in diameter or less.

3.6.5 Firestopping

Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.

3.7.1 Temperatures less than 50 degrees C 120 degrees F

Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm one mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm one mil per coat to metal surfaces subject to temperatures less than 50 degrees C 120 degrees F.

3.7.2 Temperatures between 50 and 205 degrees C 120 and 400 degrees F

Apply two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm two mils to metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F.

3.7.3 Temperatures greater than 205 degrees C 400 degrees F

Apply two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm two mils to metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F.

3.7.4 Finish Painting

The requirements for finish painting of items only primed at the factory, and surfaces not specifically noted otherwise, are specified in Section 09 90 00 PAINTS AND COATINGS.

3.8 IDENTIFICATION SYSTEMS

****

NOTE: There is a similar requirement for identification in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Ensure that color coding for all mechanical systems is coordinated.

NOTE: Delete when identification tags are not considered necessary on small projects.

****

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 35 mm 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 2 mm 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.8.1 Identification of Hidden Utility Components

****

NOTE: Complete the final sentence of this paragraph to indicate appropriate above ceiling equipment included within the project design.

****

Provide labeling for equipment installed above the ceiling that requires periodic inspection or servicing. The labeling must be stick-on adhesive type with black lettering on white or clear background with lettering a minimum of 1/2" in height. For lay-in ceiling applications, locate stick-on on ceiling grid T-Bars closest to equipment such that recommended ceiling tile to be removed for servicing/access is direction [above][below] the label. For equipment located above hard ceilings, labeling is to be provided on the provided access door. The operable equipment requiring identification include, valves, dampers, [VAV terminal boxes], [fans], and [_____].

3.9 DUCTWORK LEAK TESTS

The requirements for ductwork leak tests are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

3.10 DAMPER ACCEPTANCE TEST

Submit the proposed schedule, at least 2 weeks prior to the start of test. Perform the damper acceptance test in accordance with NFPA 80. Operate all fire dampers and smoke dampers with the air handling and distribution system operating at maximum air flow conditions, prior to the occupancy of the building to verify that they function properly. Test each fire damper with a fusible link by manually releasing the damper. Visually inspect the mechanism. Reset all fire dampers after acceptance testing.

3.11 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.12 PERFORMANCE TESTS

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

3.13 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of [room fan-coil units][air terminal units,] [unit ventilators,] thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Temporary filters must be provided and used when any air distribution system is in operation during construction. Provide new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Perform and document that proper "Indoor Air Quality During Construction" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.14 RADIANT PANELS

3.14.1 Installation

Install radiant panels level and plumb, maintaining sufficient clearance for normal services and maintenance.

3.14.2 Soldering

When soldering copper fittings at the panel, a heat pad will be used to protect the panel finish.

3.14.3 Connections

Install piping adjacent to radiant panels to allow for service and maintenance.

3.15 OPERATION AND MAINTENANCE

3.15.1 Operation and Maintenance Manuals

Submit [six] [_____] manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.15.2 Operation And Maintenance Training

****

NOTE: Determine the number of hours of instruction based on the number and complexity of the systems specified.

****

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of [_____] hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 35 16 (February 2025)**

Preparing Activity: USACE **Superseding**
UFGS-23 35 16.17 10 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 35 16

MECHANICAL ENGINE[AND WELDING FUME] EXHAUST SYSTEMS

02/25

-- End of Section Table of Contents --

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SECTION 23 35 16

MECHANICAL ENGINE[AND WELDING FUME] EXHAUST SYSTEMS

02/25

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NOTE: This guide specification covers the requirements for exposed flexible tubing, vehicle tailpipe and welding fume exhaust systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: The designer should be familiar with the current American Conference of Governmental Industrial Hygienists' "Industrial Ventilation: A Manual of Recommended Practice" and the applicable requirements in the most current editions of AHSRAE Handbooks before preparing the design.

The exhaust system layout, including all ductwork, ductwork components (including supports, hangars and anchors), flexible connections, cleanouts and test ports will be shown on the drawings.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM E2016	(2022) Standard Specification for Industrial Woven Wire Cloth

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1520	(1999) Round Industrial Duct Construction Standards, 3rd Edition
SMACNA 1922	(2004) Rectangular Industrial Duct Construction Standards, 2nd Edition

1.2 SYSTEM DESCRIPTION

Construct, complete and operational, an exhaust system as specified herein. Provide adequate air exhaust quantities and velocities. Properly size all duct for pressure loss and adequate velocity including locating intakes, ductwork size, layout, equipment and controls. Base construction of the exhaust system on the referenced publications, and other provisions as specified herein. Furnish ductwork offsets, fittings, and any other accessories required, as specified, to provide a complete exhaust system installation and to eliminate interference with other construction. Provide controls as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Related Submittals

Ductwork Components; G, [_____]

Materials and Equipment

Spare Parts

Field Instructions

Onsite Training; G, [_____]

Exhaust System Specialist; G, [_____]

SD-06 Test Reports

Final Acceptance Tests

SD-07 Certificates

Inspection; G, [_____]

SD-10 Operation and Maintenance Data

Exhaust System

Operation and Maintenance Manuals

1.4 QUALITY ASSURANCE

1.4.1 Detail Drawings

Submit [3] [_____] copies of the Exhaust System Drawings, no later than [21] [_____] days prior to the start of exhaust system installation. Include a complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, installation instructions, complete duct, wiring, and schematic diagrams and any other details to demonstrate that the system has been coordinated and will properly function as a unit. Also show proposed layout and anchorage of equipment and appurtenances, and equipment in relation to other parts of the work including clearances required for maintenance and operation.

1.4.2 Exhaust System Specialist

Submit the name and documentation of experience of the proposed Exhaust System Specialists, no later than [14] [_____] days after the Notice to Proceed and prior to the submittal of the exhaust system drawings and hydraulic calculations. Documentation of experience for the Exhaust System Specialist must include a listing of [3][5][_____] projects, project locations and dates of completion. Prepare a list of the submittals from the Contract Submittal Register that relate to the successful installation of the exhaust systems(s). Submit the list no later than [7] [_____] days after the approval of the Exhaust System Specialist. The related submittals identified on this list must be accompanied by a letter of approval signed and dated by the Exhaust System Specialist when submitted to the Government. The Exhaust System Specialist must be regularly engaged in the installation of the type and complexity of system specified in the Contract documents, and will have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.5 DELIVERY, STORAGE, AND HANDLING

House all equipment delivered and placed in storage in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all ductwork, flexible connections and pipes until installed.

1.6 EXTRA MATERIALS

Submit spare parts data for each item of equipment and material specified. Include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

a. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacture of the product and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit manufacturer's catalog data included with the Exhaust System Drawings for all items specified herein. Highlight data to show model, size, and all options that are intended for consideration. Demonstrate compliance with all contract requirements. In addition, provide a complete equipment list that includes equipment description, model number and quantity.

b. Where an integrated, packaged exhaust system is furnished, all items will be the product of the system manufacturer. System component parts may be by other manufacturers. Provide equipment by a service organization that is capable of responding to service calls within [four hours] [_____].

c. Asbestos and asbestos-containing products are not acceptable.

2.2 NAMEPLATES

Furnish a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number on all equipment.

2.3 EQUIPMENT GUARDS AND ACCESS

****

NOTE: Catwalks, ladders, and guardrails may be required. If so, select the applicable item and indicate on drawings. If not applicable, delete the entire last sentence.

****

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard with insulation of a type specified. Provide [catwalks,] [operating platforms,] [ladders,] [and] [guardrails] where shown and construct according to Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.4 DUCTWORK COMPONENTS

****
NOTE: Provide duct access doors at regular intervals to facilitate the cleaning of duct systems for applications requiring clean air supplies, such as hospitals, laboratories, electronics servicing and similar activities.
****

2.4.1 General

Provide duct constructed of [galvanized] [stainless steel] sheets of the minimum gauge thickness for ducts as required in [SMACNA 1922] [SMACNA 1520]. Construct and seal ducts in accordance with [SMACNA 1922] [SMACNA 1520] for a negative pressure of [_____] Pa inch water gauge static pressure. Unless otherwise approved, provide ducts that are round with longitudinal lock seam and conform to the dimensions indicated. Provide ducts that are straight and smooth on the inside with airtight joints. Where ducts with crimped ends are used to make up joints, the joints must have crimp and bead. The bead must provide a rigid stop for the mating open end to seat against. Steel spiral wound duct is not acceptable.

2.4.2 Fittings

Furnish reducing fittings that have a minimum of 1 mm increase in diameter per 8 mm 1 inch increase in diameter per 8 inches in length. Elbows that have a centerline radius less than 1.5 times the diameter are not permitted. Stub branches into mains at main expansion points at an angle of not more than 30 degrees with the centerline of the main duct in the direction of air flow, unless otherwise indicated or approved. Where riser ducts with single or multiple inlets are indicated, connect the riser duct into the bottom of the main duct at an angle as specified for branches. Where flexible connections connect to the main duct, brace the duct branch takeoff or stub with approved metal straps or members.

2.4.3 Cleanout

Provide cleanout on the end of the main ductwork opposite the end of the fan suction connection. Size the cleanout opening to the approximate inside area of the duct. Provide removable airtight caps or flange type covers of minimum gauge thickness as the main duct. Provide other cleanout openings where indicated.

2.4.4 Apparatus Connections

Where sheet metal connections are made to fan suction and discharge, or where ducts of dissimilar metals are connected, install an approved noncombustible flexible connection approximately 150 mm 6 inches and securely fasten by zinc-coated steel clinch-type draw bands for round ducts. For rectangular ducts, install the flexible connections locked to metal collars using normal duct construction methods.

2.4.5 Duct Test Holes

Provide test holes with covers where indicated, directed, or where necessary in ducts and plenums for using Pitot tubes for taking air measurements to balance the air systems.

2.4.6 Duct Sleeves and Framed Openings

Provide duct sleeves for all round ducts 375 mm 15 inch diameter or less passing through floors, walls, ceilings, or roofs. Provide sleeves in non-load bearing walls fabricated of 1.0 mm 20 gauge steel sheets conforming to ASTM A924/A924M. Provide sleeves in load-bearing walls fabricated of standard-weight galvanized steel pipe conforming to ASTM A53/A53M. Install round ducts larger than 375 mm 15 inch diameter and all square and rectangular ducts passing through floors, walls, ceilings, or roofs through framed openings. Furnish structural steel members for framed openings conforming to ASTM A36/A36M. Provide 25 mm 1 inch clearance between the duct and the opening. Provide closure collars of galvanized steel no less than 100 mm 4 inches wide on each side of walls or floors where sleeves or framed openings are provided. Fabricate collars for round ducts 375 mm 15 inch diameter or less from 1.0 mm 20 gauge galvanized steel. Fabricate collars for round, square or rectangular ducts with minimum dimension over 375 mm 15 inches from 1.2 mm 18 gauge galvanized steel.

2.5 EXHAUST HOSE SYSTEM

****

NOTE: The following may be used as a guide in selecting materials based on maximum temperature for exhaust hose. A variety of hose is available that can handle various temperature as suitable for the application.

a. Galvanized steel, 315 degrees C 600 degrees F (for 0.3 mm 0.012 thickness).

b. Stainless steel, (for 0.3 mm 0.012 inch thickness) 540 degrees C 1000 degrees F.

c. Heat-resistant wire reinforced glass fiber and neoprene, 120 degrees C 250 degrees F.

d. Heat-resistant wire reinforced glass fiber and silicone, 315 degrees C 600 degrees F.

e. Heat resistant thermoplastic, reinforced with a layer of polyester rated for 149 degrees C 300 degrees F.

f. Double layered, chemically treated, woven glass fabric mechanically joined to an outer steel coil. Temperature resistance is to 815.5 degrees C 1500 degrees F.

Also of importance is that the design incorporate adjustment or shut-off dampers at each adapter or receptor.

****

2.5.1 Tailpipe Adapters

Provide tapered-cone adapters with spring clips or other suitable devices for exhaust pipe attachment. The adapter must fit [_____] mm inch nominal diameter exhaust pipe.

2.5.2 Welding Fume Receptors

Construct welding fume receptors of minimum 1.0 mm 20 gauge thick aluminum and equip with 13 mm 1/2 inch mesh receptor screens; with swivel connections, and magnets on receptor base.

2.5.3 Flexible Exhaust Hose

Flexible exhaust hose must be [0.30 mm 0.012 inch minimum strip thickness of stainless steel] [0.30 mm 0.012 inch minimum strip thickness of galvanized steel] [approved heat-resistant wire-reinforced glass fiber and neoprene tubing] [approved heat-resistant wire reinforced glass fiber and silicone tubing]. [Provide wye connectors where shown]. Provide flexible tubing inside diameter and length as shown. Connect the tubing to the bottom of the ductwork. Provide a flanged connection where the flexible tubing and overhead ductwork are joined. The flanged connection must consist of steel flanges not less than 200 mm 0.078 inch thick, 3.175 mm 1/8 inch gasket. Provide gasket suitable for the system design temperature shown, in accordance with ASME B16.21, full face or self-centering flat ring type. It must contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Size or design the flange to suit the hose as approved. [The connection of the neoprene hose may be installed with an approved hose clamp or as recommended by the manufacturer.]

2.5.4 Exhaust Hose Suspension System

Suspend the flexible tubing overhead when not in use; allowing it to be lowered to the operating level, when required. Furnish the suspension system complete with cable, and operating mechanism. The suspension system must be [counter-weighted type]or [manually operated balancer type with safety ratchet lock or automatic brake having slip resistant hand grip].

2.6 DAMPERS

****

NOTE: Indicate the location of dampers and the types required. Details of the dampers will be shown on the drawings. Shutoff dampers may be shown on the drawings to be provided at each individual tailpipe exhaust adapter. The use of these dampers at inactive stations will reduce infiltration and may reduce the energy required for heating. When shutoff dampers are provided in the individual branch tailpipe adapters, adjust the exhaust fan capacity for systems which have four stations. Systems having more than four branches provided with shutoff dampers must have a fan capacity equal to four branches plus 50 percent of the capacity of the number of branches over four.

****

Provide dampers of the type indicated and install where shown. Provide circular disk dampers with quadrant locking device or blast gate type. Damper blades less than 1.6 mm 16 gauge thickness of stainless steel are not permitted. Provide blast gate dampers consisting of two piece construction with adjustable sliding gate and setscrew.

2.7 MATERIALS

Provide materials conforming to the following requirements.

2.7.1 Screen

ASTM E2016, type and class as required for the application.

2.7.2 Iron and Steel Sheets

2.7.2.1 Galvanized Iron and Steel

ASTM A924/A924M, Coating Designation G90.

2.7.2.2 Uncoated Steel

ASTM A1011/A1011M, condition, and type best suited to intended use.

2.7.2.3 Stainless Steel

ASTM A240/A240M, Type 304.

2.7.3 Steel Structural Shapes

ASTM A36/A36M.

2.7.4 Solder Silver

AWS A5.8/A5.8M, brazing alloy; grade to suit application.

2.7.5 Solder

ASTM B32, composition to suit application.

2.7.6 Bolts and Nuts

Furnish bolts and nuts, except as required for high temperature exhaust applications, in accordance with ASTM A307. Use bolts and nuts for exhaust applications where the temperature of the bolt may rise above 200 degrees C 400 degrees F or use as flange bolts in corrosion resistant material in accordance with ASTM A193/A193M Class 2. Mark the bolt head to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307 or ASTM A193/A193M as applicable.

2.8 ELECTRICAL WORK

****

NOTE: Electrical characteristics, motor starter type, enclosure type, and maximum rpm should be shown on the drawings in the equipment schedules.

****

Provide specified electrical motor-driven equipment complete with motor,

motor starter, and controls. Unless otherwise specified, provide electric equipment, including wiring and motor efficiencies, according to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical characteristics and enclosure type as shown. Unless otherwise indicated, motors of 745 W 1 hp and above must be high efficiency type. Provide motor starters complete with thermal overload protection and other appurtenances necessary. Provide each motor according to NEMA MG 1 and of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, must be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Utilize solid-state variable-speed controllers for motors rated 7.45 kW 10 hp or less. Use adjustable frequency drives for larger motors.

2.9 AIR MOVING DEVICES

****

NOTE: Drawings will indicate fan capacity, CFM total static pressure, sound/power level, arrangement, rotation, discharge and motor horsepower. Details for weather hoods and flashing and locations for bird screens and location of remote manual switches will be indicated on the drawings.

****

2.9.1 General

Test and rate fans in accordance with the standards of AMCA 210, Type "D" Ducted Inlet, Ducted Outlet Configuration. [Fans having a capacity of less than 200 L/s 400 cubic feet/minute will be directly connected to the motor shaft] [Where V-belt drives are used, design such drives for no less than 150 percent of the connected driving capacity, and adjust motor sheaves to provide no less than an overall 20 percent speed variation. Select sheaves to drive the fan at such speed as to produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Provide motors for V-belt drives with adjustable rails or bases]. Provide fans with personnel screens or guards on both suction and supply ends except where ducts or dampers are connected to the fan. Provide fans and motors with vibration isolation supports or mountings. Vibration isolation units must be standard products with published load ratings, and must be single rubber-in-shear, neoprene coated fiberglass, double rubber-in-shear springs, or springs under inertia base. Select each fan to produce the capacity required at the fan total pressure indicated. Provide standard AMCA arrangements unless otherwise indicated and provide the rotation and discharge as indicated. Provide fans with nonoverloading characteristics. Construct fan housing with no less than 1.5 mm 16 gauge thick steel. Construct fan impellers to meet AMCA Spark Resistance "B" Classification and accurately balance both statically and dynamically when installed in the assembled fan unit. Coat impellar and housing in the air stream with neoprene, epoxy, phenolic resins, or otherwise be suitable to resist the corrosive gases and temperatures produced. Fans must be free of objectionable vibration or noise. Certified performance curves indicating that the fan supplied will operate in its most efficient operating range will be provided. In addition, furnish "sound power" ratings with each fan. Provide fans indicated to be mounted on exterior of building with weatherproof covers for the motor drive unit or other weatherproofing as recommended by the manufacturer. Select each fan to produce the capacity required at the fan total pressure indicated. Provide weather hoods, flashing, and bird screens where indicated.

2.9.2 Fans

****

NOTE: Refer to UFC 3-450-01, Noise and Vibration Control for Mechanical Equipment, for vibration criteria. Vibration isolation required should be shown and included in the appropriate schedule on the drawings. Provide fan power level on drawings where fan location and operation may incur sound levels approaching OSHA permissible noise exposure limits and retain first bracketed sentence below to require fans meet scheduled fan sound criteria.

****

[Provide sound power level as indicated and obtain values according to AMCA 300.]Indicate Standard AMCA arrangement, rotation, and discharge. Test and rate fans according to AMCA 210. Select each fan to produce the capacity required at the fan static pressure indicated. Fans may be connected to the motors either directly or indirectly with V-belt drive. Design V-belt drives for no less than [150] [140] [120] percent of the connected driving capacity. Provide belt driven fans less than ?? kW 5 hp with adjustable pitch motor sheaves selected such that the pitch adjustment is at the middle of the adjustment range at fan design condition. Provide fixed pitch motor sheaves for motors ?? kW 5 hp and above sized to produce fan design condition (provide replacement sheave as needed to achieve system air balance).

2.9.2.1 Protective Devices

Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Vibration-isolation units must be standard products with published loading ratings.

2.9.2.2 Centrifugal Fans

Centrifugal fans must be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Provide rigidly constructed impellar wheels, accurately balance both statically and dynamically. [Fan blades may be forward curved, backward-inclined or airfoil design in wheel sizes up to 750 mm 30 inches. Fan blades for wheels over 750 mm 30 inches in diameter must be backward-inclined or airfoil design]. These fans must be suitable for the temperatures encountered. Provide fan shaft with a heat slinger to dissipate heat buildup along the shaft. Supply an access (service) door to facilitate maintenance with these fans. Fan wheels over 900 mm 36 inches in diameter must have overhung pulleys and a bearing on each side of the wheel. Indirect drive fan wheels 900 mm 36 inches or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Provide bearings that are sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Connect grease fittings to tubing and service from a single accessible point. Bearing life must be L50 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide steel fan shafts, accurately finish, and provide key seats and keys for impeller hubs and fan pulleys. Provide each fan outlet of ample proportions and design for the attachment of angles and bolts for attaching flexible connections. Provide motors, unless otherwise indicated, that do not exceed 1800 rpm and have [open] [dripproof] [totally enclosed] [explosion-proof] enclosures. [Provide motor starters that are [manual] [magnetic] [across-the-line] [reduced-voltage-start] type with [general-purpose] [weather-resistant] [watertight] enclosure.] [Provide remote manual switch with pilot indicating light where indicated.]

2.9.3 In-Line Centrifugal Fans

Provide in-line centrifugal fans consisting of welded tubular casings, centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Air must enter and leave the fan axially. Inlets must be streamline with conversion vanes to eliminate turbulence and discharge air flow smoothly. Enclose fan bearings and drive shafts and isolate from air stream. Provide fan bearings that are sealed against dust and dirt and permanently lubricated or lubricative type with grease lines extending to the exterior of the housing. Bearing life must be L50 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide motors that have [open] [dripproof] [totally enclosed] [explosion-proof] enclosure. Provide motor starters that are [manual] [magnetic] across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosure. [Provide remote manual switch with pilot indicating light where indicated.]

2.10 FACTORY COATING

****

NOTE: Select ASTM B117 testing of 3000 hours for installations in a sea coastal environment (within 10 miles of coast); 500 hours for all other outdoor installations.

****

Provide factory finished equipment and component items, when fabricated from ferrous metal as defined by ASTM (or similar) standard, with the manufacturers standard finish except provide weather-resistant finishes that will withstand [500][3000] hours exposure to the salt spray test specified in ASTM B117 to items located outside of building.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install work as shown and according to the manufacturer's diagrams and recommendations.

3.3 INSPECTION

The Exhaust System Specialist must (1) Inspect the exhaust system periodically during the installation. (2) Witness the final tests, and sign approval of the test results. (3) Certify in writing that the system has been installed in accordance with the contract requirements. Bring any discrepancy to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

3.4 EXHAUST SYSTEM INSTALLATION

3.4.1 General Requirements

Perform welding and brazing conforming to ASME BPVC SEC IX. Install horizontal sections of the main duct with the longitudinal lock seam on the top. Seal slip joints in accordance with [SMACNA 1922] [SMACNA 1520]. Support and anchor riser duct to the structure[as indicated]. Attach main duct to the structural members of the building as recommended by [SMACNA 1922] [SMACNA 1520].

3.4.2 Building Surface Penetrations

****

NOTE: Indicate penetration and sleeve and packing details on the drawings in accordance with TM-5-812-2, Section 07 84 00 FIRESTOPPING.

****

Utilize sleeves or framed openings where duct penetrates building surfaces. Penetrations must be sealed[, and fireproofed in accordance with Section 07 84 00 FIRESTOPPING]. Pack the space between the sleeve or framed opening and the duct with mineral wool or other approved material. Install closure collars around the duct on both sides of the penetrated surface. Collars must fit tight against the building surfaces and snugly around the duct.

3.5 PIPE COLOR CODE MARKING

****

NOTE: Designer will coordinate color code marking with Section 09 90 00 PAINTS AND COATINGS.

****

Provide color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6 ONSITE TRAINING

Submit proposed Onsite Training schedule, at least [14] [_____] days prior to the start of related training for the operating staff as designated by the Contracting Officer. The training period must consist of a total [8] [_____] hours of normal working time and must start after the system is functionally completed but prior to final acceptance tests. The field instructions must cover all of the items contained in the approved operation and maintenance manuals, as well as demonstrations of routine maintenance operations. Submit [6] [_____] manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days [_____] prior to on-site training. Include the manufacturer's name, model number, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. [Each service organization submitted must be capable of providing [4] [_____] hour on-site response to a service call on an emergency basis.] Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.7 FINAL ACCEPTANCE TESTS

Balance each exhaust system and inlet to produce the indicated air quantities within 10 percent at the conditions shown. Set control devices to control at the points indicated or directed. Lubricate bearings, and check the speed, direction or rotation of each fan. Check the running current of each motor. Upon completion, and prior to acceptance of the installation, test the exhaust system at operating conditions to demonstrate satisfactory functional and operating efficiency.

a. Operating tests must cover a period of not less than 2 hours for each system, and conduct all tests in the presence of the Contracting Officer. If tests do not demonstrate satisfactory operation of the exhaust system, correct deficiencies and retest. Provide all instruments, facilities, and labor required to properly conduct the tests. The electricity required for testing will be furnished by the Government.

b. Submit [3] [_____] copies of the completed Final Acceptance Tests Reports, no later that [7] [_____] days after the completion of the Tests. Sign all items in the Final Acceptance Report. Submit proposed diagrams, instructions, and other sheets, concurrent with the Final Acceptance Test Procedures. Post framed instructions under glass or in laminated plastic where directed, including wiring and control diagrams showing the complete layout of the entire system. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, frame as specified above for the wiring and control diagrams and post beside the diagrams. Post the framed instructions before acceptance testing of the systems.

c. Submit proposed procedures for Final Acceptance Tests, no later than [14] [_____] days prior to the proposed start of the tests.

d. Submit proposed date and time to begin Final Acceptance Tests, with the Final Acceptance Test Procedures. Provide notification at least [14] [_____] days prior to the proposed start of the test.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 35 19.00 20 (February 2010)**
Change 3 - 11/24

Preparing Activity: NAVFAC **Superseding**
UFGS-23 35 19.00 20 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 35 19.00 20

INDUSTRIAL VENTILATION AND EXHAUST

02/10, CHG 3: 11/24

PART 3 EXECUTION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC | **UFGS-23 35 19.00 20 (February 2010)**
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Preparing Activity: NAVFAC | **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 23 35 19.00 20

INDUSTRIAL VENTILATION AND EXHAUST

02/10, CHG 3: 11/24

****

NOTE: This guide specification covers the requirements for blower and exhaust systems for removal of flammable vapors including paint spraying residue, corrosive fumes, dust, and stock conveying.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification also includes plastic duct systems for removal of nonflammable corrosive fumes and vapors. Materials must be selected by the designer to suit project requirements. The system must be designed in accordance with NFPA 91. Ventilation and exhaust systems and components for removal of smoke and grease laden vapors from commercial type cooking equipment are covered in Section 11 05 40 COMMON WORK RESULTS FOR FOODSERVICE EQUIPMENTand 23 30 00 HVAC AIR DISTRIBUTION. Laboratory fume hoods are covered in Section 11 53 00 LABORATORY EQUIPMENT AND FUME HOODS. The design agency (EFD, OICC, PWC, etc.) must ensure review of the ventilation system design by the appropriate Naval Medical Command

(NAVMEDCOM) activity in accordance with NAVOSH requirements. For high temperature applications, the designer must specify special fans and duct material as required for the particular application.

****

****

NOTE: The following information must be shown on the project drawings:

1. Arrangement plan and details for fans, ducts, and accessories.

2. Duct pressure classes or duct operating pressures. Design duct for maximum negative pressure practical to accommodate improper operation or poor maintenance.

3. Equipment schedules.

4. Equipment foundations and supports.

5. Structural supports for ducts where required.

6. The design of industrial ventilation systems and the editing of this section should be performed by professional engineers or industrial hygienists with a sound knowledge of industrial ventilation. Design should conform to the ACGIH-2092S Industrial Ventilation: A Manual Of Recommended Practice; ASSE Z9.2, Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems; AIHA Z9.3, Spray Finishing Operations - Safety Code for Design, Construction and Ventilation; UFC 3-410-04N, "Industrial Ventilation"; and other references as applicable. Fan arrangements should be selected to eliminate system effects identified in ANSI/AMCA 201.

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 99-0401	(1986) Classifications for Spark Resistant Construction
AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 211	(2013; Rev 2017) Certified Ratings Program Product Rating Manual for Fan Air Performance
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating
AMCA CRP	(Online) Directory of Products Licensed Under the AMCA International Certified Ratings Program

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 1060 I-P	(2014) Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Heat Equipment

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH-2092S	(2004) Industrial Ventilation: A Manual of Recommended Practice

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM C582	(2023) Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D1330	(2004; R 2010) Rubber Sheet Gaskets
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive

	Environments
ASTM D1927	(1981; R 1988) Rigid Poly(Vinyl Chloride) Plastic Sheet
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D4167	(2015) Fiber-Reinforced Plastic Fans and Blowers

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 65	(1993) Processing and Finishing of Aluminum
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 91	(2020) Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids
NFPA 664	(2020) Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

RUBBER MANUFACTURERS ASSOCIATION (RMA)

RMA IP-20	(2007) Specifications for Drives Using

	Classical V-Belts and Sheaves. Specifications for A, B, C, and D Cross Sections
RMA IP-22	(2007) Specifications for Drives Using Narrow V-Belts and Sheaves (Joint RMA/MPTA), 4th Edition

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1378	(1995) Thermoplastic Duct (PVC) Construction Manual, 2nd Edition
SMACNA 1403	(2008) Accepted Industry Practice for Industrial Duct Construction, 2nd Edition
SMACNA 1520	(1999) Round Industrial Duct Construction Standards, 3rd Edition
SMACNA 1922	(2004) Rectangular Industrial Duct Construction Standards, 2nd Edition
SMACNA 1972 CD	(2012) HVAC Air Duct Leakage Test Manual - 2nd Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 11	(1992; E 2000) Paint Specification No. 11Red Iron Oxide, Zinc Chromate, Raw Linseed Oil and Alkyd Primer
SSPC Paint 20	(2019) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic)
SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2022) Adhesive and Sealant Applications

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-12276	(2006; Rev E; Notice 1 2011; Notice 2 2016; Notice 3 2021) Varnish, Phenolic, Baking
MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for
MIL-P-21035	(1991; Rev B; Notice 2 2003; Notice 3 2021) Paint, High Zinc Dust Content, Galvanizing Repair (Metric)
MIL-PRF-23236	(2009; Rev D; Notice 1 2023) Coating Systems for Ship Structures

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-272	(Rev B; Notice 1) Caulking Compounds
FS TT-S-001543	(Rev B; Notice 1) Sealing Compound: Silicone Rubber Base (For Calking, Sealing, and Glazing in Buildings and Other Structures)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

UL SOLUTIONS (UL)

UL 33	(2010; Reprint Apr 2020) Heat Responsive Links for Fire-Protection Service
UL 181	(2013; Reprint Dec 2021) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 214	(1997; Rev thru Aug 2001) Tests for Flame-Propagation of Fabrics and Films
UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 GENERAL REQUIREMENTS

1.2.1 SMACNA Duct Construction Manuals

The recommendations in the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) duct construction manuals must be considered mandatory requirements. Substitute the word "must" for "should" in these manuals.

1.2.2 Fan Data

[For fans include fan curves or rating tables and derating factors.]Provide certified performance curves showing total pressure, power, and mechanical efficiency versus flow rate of the operating density and fan speed. All areas of unstable operation must be indicated. For fans equipped with adjustable capacity controls such as variable inlet or vaneaxial fans with adjustable blade settings, minimum and maximum performance must be indicated along with performance for fire intermediate settings.

1.2.3 Natural Ventilation

Evaluate natural ventilation for appropriate spaces, and design air distribution systems to operate in the same direction as natural ventilation to reduce energy cost of pumping outdoor air.

1.2.4 Industrial Ventilation and Exhaust Systems

Submit drawings including fan installation drawings; duct systems[, including welding and vehicle exhaust]; supports and anchor location and load imposed.

1.2.5 Start-Up Tests

Submit start-up tests reports in accordance with the paragraph TESTING, ADJUSTING, AND BALANCING. Submit final test report for [the] system[s] tested, describing all test apparatus, instrumentation calculations, factors, flow coefficients, sound levels, and equipment data based on ACGIH-2092S recommended forms or reasonable facsimiles thereof to suit project conditions. Adjustment and setting data must be included in test report. Submit sound level test reports for high noise level equipment.

1.2.6 Related Requirements

Conform to Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS as well as additional requirements specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Industrial Ventilation and Exhaust Systems; G, [_____]

SD-03 Product Data

Fans; G, [_____]

Dampers; G, [_____]

Flexible Connectors

Flexible Duct; G, [_____]

Gaskets

Protective Coating Materials

Sealants

Access Ports; G, [_____]

Damper Regulators; G, [_____]

Blast Gates; G, [_____]

Vibration Isolators; G, [_____]

Ductwork, Dust [and Fume] Collection

Steel Ducts; G, [_____]

Fiberglass Ductwork; G, [_____]

Thermoplastic Ductwork; G, [_____]

Vehicle Tail Pipe Exhaust System; G, [_____]

Welding Fume Exhaust System; G, [_____]

Recycled Content of Ductwork Steel Components; S

Recycled Content of Protectively Coated Steel Ducts; S

Indoor Air Quality for Duct Sealants; S

SD-06 Test Reports

Fan Tests, including Sound Power Level Tests; G, [_____]

Ventilation and Exhaust System Start-Up Tests; G, [_____]

Sound Level Tests; G, [_____]

SD-07 Certificates

Welding Procedures; G, [_____]

Welding Test Agenda; G, [_____]

Welding Test Procedures; G, [_____]

Welders' Identification; G, [_____]

Fiberglass Fan Servicer Experience Information; G, [_____]

SD-10 Operation and Maintenance Data

Fans, Data Package 2; G, [_____]

Vehicle Tail Pipe Exhaust System, Data Package 2; G, [_____]

Welding Fume Exhaust System, Data Package 2; G, [_____]

Industrial Ventilation and Exhaust Systems, Data Package 2; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions

Submit text of posted operating instructions for ventilation and exhaust systems.

1.4 QUALITY ASSURANCE

1.4.1 Welders' Identification

Submit a listing of the names and identification symbols to be used to identify the work performed by the welder or welding operator who after completing a welded joint must identify it as his work by applying his assigned symbol for a permanent record.

1.4.2 Fiberglass Fan Servicer Experience Information

Submit text.

1.4.3 Qualified Personnel

Operations involving joining thermoplastic ductwork by solvent or hot gas and joining fiberglass ductwork by laminating must be performed by personnel certified by the manufacturer as qualified for the work.

1.4.4 Qualification of Welders

Qualify each welder or welding operator by tests using equipment, welding procedures and a base metal and electrode or filler wire from the same compatible group number that will be encountered in the applicable welding test procedures. Welders or welding operators who make acceptable procedure qualification test welds will be considered performance qualified for the welding procedure used. Determine performance qualification in accordance with AWS D1.1/D1.1M. Notify the Contracting Officer 24 hours in advance as to the time and place of tests[and wherever practical perform the tests at the work site].

1.4.5 TAB Requirements

Requirements are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING and Section 23 08 01.00 20 TESTING INDUSTRIAL VENTILATION SYSTEMS.

1.5 POSTED OPERATING INSTRUCTIONS

Provide for ventilation and exhaust system. In addition, permanently mark, drill, and pin as an integral part of device, final adjustment and settings pursuant to testing, adjusting, and balancing.

1.6 SAFETY PRECAUTIONS

1.6.1 Guards and Screens

Provide metal personnel safety guards for normally accessible unducted fan inlets and discharges and moving power transmission components in accordance with OSHA 29 CFR 1910.219.

1.6.2 Welding

Conform to AWS Z49.1 for safety in welding and cutting.

PART 2 PRODUCTS

2.1 FANS, GENERAL REQUIREMENTS FOR

2.1.1 General Performance, Component, and Other Requirements

Fans must have certified performance ratings as evidenced by conformance to the requirements of AMCA 211, and must be listed in AMCA CRP, or must be currently eligible for such listing. Fans must generally be in accordance with AMCA 99 unless superseded by other requirements stated elsewhere herein. Determine performance data for fans in accordance with AMCA 210. Select fans to minimize the exposure of personnel working in or occupying the immediate installation area. The total sound power level of the fan tests must not exceed 90 dBA when tested per AMCA 300 and rated per AMCA 301, or it must be provided with an appropriate attenuation device or devices. Scheduled fan performance is the performance required under specified or indicated installation conditions with specified or indicated accessories. The net installed air performance of the fan, with accessories/appurtenances in place, must be sufficient to meet the scheduled performance within the limits of the fan rating certification tolerance. Affix the manufacturer's product identification nameplate to each unit. Apply additional requirements for specific service or generic type or class of fan. If nonuniform air flow conditions are likely to be encountered, contact the fan manufacturer to ensure that the fan is rated for the additional fan inlet and outlet effect. Install fans to minimize fan system effect in accordance with AMCA 201. Fans must be listed in the Directory of Products licensed to use AMCA seal.

2.1.2 Bearings and Lubrication

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NOTE: Sleeve type bearings should be specified or indicated on drawings where low noise levels are required.

****

Precision anti-friction or sleeve type with provisions for self-alignment and for radial and thrust loads imposed by the service. Provide water-cooled bearings where required for the service or recommended by the manufacturer.

2.1.2.1 Anti-friction Bearings

****

NOTE:

Continuous 8-hour service	**20,000**
Continuous 24-hour service	**40,000**
Continuous 24-hour service (extreme reliability)	**80,000**

****

Constructed of steel alloys with a certified L-10 minimum rated life of [20,000] [40,000] [80,000] hours under load conditions imposed by the service. Rated and selected in accordance with ABMA 9 and ABMA 11. Provide with dust-tight seals suitable for environment and lubricant pressures encountered; cast ferrous metal housing, bolted-split pillow block type where located within fan casings; grease lubricated with provisions to prevent overheating due to excess lubricant; surface ball check type grease supply fittings. Provide manual or automatic grease pressure relief fittings visible from normal maintenance locations. Include lubrication extension tubes where necessary to facilitate safe maintenance during operation and fill tubes with lubricant prior to equipment operation. Prelubricated, sealed, anti-friction bearings, which conform to above specified materials and L-10 life requirements, may be provided for fans requiring less than 0.37 kW 1/2 horsepower.

2.1.2.2 Sleeve Bearings

Premounted, self-aligning, continuous oil supply, single or double ring lubricated, insert type, with suitable provisions for shaft expansion and such thrust as may be imposed by service loads. Provide water cooling for shaft surface speed exceeding 6.1 meters per second 1200 feet per minute. Provide each sleeve bearing with approximately 473 mL 16 ounce capacity constant level oiler and oil level gage. Include on sleeve bearing submittal data: Bearing manufacturing source, type, lubricant, clearances, "L/D" ratio, antifriction metal, belt angle, shaft speed, shaft critical speed, Brinell hardness at journal, and shaft surface finish at journal in micro-inches.

2.1.3 Motors and Motor Starters

****

NOTE: The motor control requirements should be coordinated with the Electrical Section and will depend on field conditions. The following types of motor starters should be used as a guide only. When electrical power circuits to which ventilation and exhaust equipment are connected are heavily loaded, the full voltage across the line starting may result in excessive voltage drop on the circuits.

Power (kW)	Voltage	Type Starter
Up to 5 1/2	208-230	Across-the-line magnetic
5 1/2 to 11	208-230	Across-the-line magnetic part winding or wye delta
11 to 22 3/8	460	Across-the-line magnetic part winding or wye delta
Above 11	208-230	Part winding or wye delta
Above 22 1/2	460	Part winding or wye delta

Motor H.P.	Voltage	Type Starter
Up to 7 1/2	208-230	Across-the-line magnetic
7 1/2 to 15	208-230	Across-the-line magnetic part winding or wye delta
15 to 30	460	Across-the-line magnetic part winding or wye delta
Above 15	208-230	Part winding or wye delta
Above 30	460	Part winding or wye delta

****

Conform to NEMA MG 1 and NEMA ICS 1 and NEMA ICS 2. Motors less than 3/4 kW one hp must meet NEMA High Efficiency requirements. Motors 3/4 kW one hp and larger must meet NEMA Premium Efficiency requirements. Motors must not exceed 1800 rpm, unless otherwise indicated, and must be variable-speed, [[open] [dripproof] enclosure] [totally enclosed fan cooled] [explosion proof] type. Provide [manual] [magnetic-across-the-line] [reduced voltage] [part-winding] [wye-delta] type motor starters with [general-purpose NEMA 1] [weather resistant NEMA 3R] [watertight NEMA 4] [moisture and dusttight NEMA 12] enclosure in accordance with NEMA ICS 6. Provide single-phase motors with inherent thermal overload protection with manual reset. Provide three-phase motors with thermal overload protection in the control panel. Provide permanently lubricated or grease-lubricated ball or roller bearings; auxiliary lubrication and relief fittings on outside of fan casing; arrange grease lines to minimize pressure on bearing seals. Motor power must not be less than brake power required with blades set at maximum pitch angle at any air delivery from the indicated amount down to 50 percent thereof.

2.1.4 Guards and Screens

Construct guards and screens to provide, as applicable: required strength and clearance with minimal reduction in free area at fan inlets and discharges; cooling; access panels for tachometer readings; ease of sectional disassembly for maintenance and inspection functions where guard total weight exceeds 22.70 kg 50 pounds; weather protection where components are weather exposed. Installed guards and screens must not negate noise control and vibration isolation provisions.[For burn protection, insulate surfaces when service temperatures exceed 60 degrees C 140 degrees F as part of work under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.]

2.1.5 Power Transmission Components

2.1.5.1 Fan Drives

[Direct] [or] [V-belt] type as indicated. V-belt drives must conform to RMA IP-20 and RMA IP-22. Drives must be applied in accordance with the manufacturer's published recommendations, unless specified otherwise. Base power rating of a V-belt drive on maximum pitch diameter of sheaves. Provide classical belt section adjustable sheave type, with a minimum service factor of 1.5 for drives with motors rated up to and including 22 kW 30 hp.[Provide classical section or narrow section, fixed sheave or adjustable sheave type with a minimum 1.5 service factor for drives with motors rated over 22 kW 30 hp.][Provide at least two belts for drives with motors rated one hp and above.]

2.1.5.2 Sheaves

Statically and dynamically balanced, machined cast ferrous metal or machined carbon steel, bushing type, secured by key and keyway. Pitch diameter or fixed sheaves and adjustable sheaves, when adjusted to specified limits, must not be less than that recommended by NEMA MG 1. Select adjustable sheaves that provide the required operating speed with the sheave set at midpoint of its adjustment range. The adjustment range for various size and type belts must be: 16 percent, minimum for Classical section belts; 12 percent, minimum for Narrow section belts. [Belt deflection in adjustable sheave drives must not exceed 1 1/2 degrees.] Provide companion sheaves for adjustable sheave drives with wide groove spacing to match driving sheaves, except that standard fixed pitch spacing may be used for all two-through-four groove drives whose center-to-center dimensions exceed the following: "A" and "B" Section 406 mm 16 inches; "C" Section 635 mm 25 inches; "D" Section 914 mm 36 inches. Furnish endless, static dissipating, oil-resistant, synthetic cloth or filament reinforced elastomer construction belts.

2.1.6 Special Construction for Hazardous Areas

2.1.6.1 Spark-Resistant

Construct [_____] [specified or indicated] units in accordance with AMCA 99-0401; Type [A] [B] [C]. Provide [Type B] [or] [Type C] construction and electrical grounding of fan parts and grounding to building structure where fume or vapor handling systems conforming to NFPA 91 are specified. Do not place bearings in the air stream.

2.1.6.2 Explosion Proof

Construct fans to AMCA 99-0401, Type [A] [B] [C] spark-resistant requirements where explosion-proof electrical components are specified or indicated to conform to NFPA 70, Class [_____], Group [_____], Division [_____] requirements.

2.1.7 Protective Coating for Fans

Prepare and coat fans as follows: Replace bolts required to provide access or adjustment and normally threaded into the coated surface with studs or bolts having heads continuously welded inside. Omit sharp edges, self-tapping screws, and permanent threads protruding into the coated surface. Eliminate hairline cracks and sharp inside corners by continuous welding, brazing, or filling with high melting point solder. Seal impeller hub to the shaft. Construct housing split to use external throughbolts. Flange inlet and outlet and consider as fan interior. Peen or grind welds smooth, and grind outside corners to approximately 1.60 mm 1/16 inch radius. Sandblast metal surfaces to white metal in accordance with SSPC SP 5/NACE No. 1. Coat interior surfaces of housing in contact with airstream, including inlet, impeller and shaft, flange faces, shaft seal, [exterior surfaces of housing] [, and bearing and motor pedestal]. Do not coat bearings, coupling, motor, drive, or other auxiliaries.[Prepare and coat stainless steel shaft.][Finish fan in accordance with the manufacturer's standard practice.][Coat fan with [phenolic] [epoxy] [_____].][Coat fan as indicated.] Statically and dynamically balance the fan in two planes after coating and finishing, and where material has been removed, refinish and rebalance the fan as specified herein.

2.2 CENTRIFUGAL FANS

2.2.1 General Requirements for Centrifugal Fans

****

NOTE: See Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS for guidance given in guide specification technical notes. Definite requirements should be specified in contract specification for bidders' information.

****

Provide fan of [forward-curved] [radial] [backward inclined] [airfoil] type blades with [manual] [or] [automatic inlet vanes [as indicated]]. Arrange fans for indicated service, and construct for the applicable AMCA 99Class pressure ratings as indicated for system design pressure and temperature. Fan shaft must be solid steel, ground and finished as required for the service, with first critical speed a minimum 25 percent higher than cataloged fan speed. Select fan for maximum efficiency, minimum noise, and stability during all modes of system operation. [Vibration isolation mountings must be spring type and limit vibration transmissibility to a maximum [_____] [5] percent of the unbalanced force at lowest equipment speed, unless otherwise specified or indicated.] Arrangement and drives must be as indicated.

2.2.2 Industrial Exhauster[s]

****

NOTE: Use industrial exhausters for high particulate loading applications.

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Single-width, single-inlet type arranged for indicated service and constructed for duty at indicated system design pressure and temperature not to exceed [66] [93] [177] [260] [371] degrees C [150] [200] [350] [500] [700] degrees F. Continuously welded [carbon] [alloy] [copper bearing alloy] [Type [_____] [304L] [316L] stainless] [steel] [[_____] alloy aluminum] scroll with required reinforcement, flanged inlet and outlet connections, [cone] inlet [bolted] [welded] to scroll side sheet, threaded and plugged scroll drain, [quick] [or] [bolted] access door with gasket; [Carbon] [alloy] [Type [_____] stainless] steel shaft, [fitted with] [heat slinger] [shaft seal] [grease lubricated stuffing box]; continuously welded [carbon] [alloy] [copper bearing alloy] [Type [_____] [304L] [316L] stainless] [steel] [_____ alloy aluminum] impeller assembly. [_____] [radial] [paddle type (open radial)] [backplated paddle] type impeller blades [with inlet shroud].[Provide protective coating of [_____].] on fan surfaces exposed to [air] [fume] [vapor] stream; [Motor must be totally enclosed type.] Mount complete assembly including motor, power transmission components, and guards on a common vibration isolation base with spring mountings [conforming to requirements indicated].

2.2.3   Utility Set[s]

Single-width, single-inlet, nonoverloading scroll type. Scroll must be [intermittently] [or] [continuously] welded [carbon] [Type [304L] [316L] stainless] [steel] [_____ alloy aluminum] with required reinforcement, [flanged inlet and outlet connections], streamline orifice inlet bolted [and gasketed] to scroll side sheet, [threaded and] [plugged] [piped] [scroll drain,] [access door with gasket].[Carbon] [Type [304] [316] stainless] [steel] [monel] shaft finished as required [and fitted with] [heat slinger] [shaft seal] [grease lubricated stuffing box]; welded [carbon] [Type [304L] [316L] stainless] [steel] [_____ alloy aluminum] impeller assembly; [backward inclined] flat or single thickness airfoil type impeller blades. Provide protective coating of [_____] for [fan surfaces exposed to [air] [fume] [vapor] stream and weather.] Motor and power transmission components must be enclosed in ventilated weathertight hood. [Discharge must be fitted with an automatic gravity shutter constructed from [specified stainless steel] [aluminum].][Mount complete assembly from individual points of support on rails and vibration isolated by double-rubber-in-shear mountings] [conforming to requirements indicated].

2.2.4   In-line Centrifugal Fans

Welded steel casings, centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards and adjustable motor mounts. Inlet and outlet connections for fan casings to duct work and equipment casings, may be of the slip fit or flanged type. [Provide guards for discharges. Rate fans with guards in place.] Air must enter and leave the fan axially. Inlet must be streamlined and conversion vanes must eliminate turbulence and provide smooth discharge air flow. Enclose fan bearings and drive shafts, and isolate from the air stream. Fan bearings must be mechanically sealed against dust and dirt and must be self-aligning, pillow block ball or roller type. Motor and drive must be provided by fan manufacturer.

2.2.5   Fiberglass Centrifugal Fans

****

NOTE: Show intended service on drawing fan schedule or specify here. Revise paragraph if special chemical or corrosion resistance is required in accordance with manufacturer's recommendations.

****

ASTM D4167. Construct of fire retardant fiberglass with a flame spread rating at least equal to or less than that of the duct system. Housing and fan impeller must be fiberglass. Shaft and fan support stand must be steel with protective coating. Provide exterior gel coat, coating, or paint with ultraviolet light inhibiting properties for fans exposed to sunlight. Fiberglass fans must be suitable for [the intended service.] [use in

[_____]]. Provide with flanged outlet [and inlet] connections, [threaded [and plugged]] scroll drain, bolted access and inspection doors, and epoxy coated steel fan base and motor mount.

2.3 [VANEAXIAL] [TUBEAXIAL] FANS

Direct-connected with adjustable blade impeller or V-belt driven. When direct connected, fans must be driven by totally-enclosed, air-over (TEAO), flanged or end mounted motors. When belt-driven, provide internal and external belt guards and adjustable motor mounts.

2.3.1 Fan Impeller Blades

Air-foil type [with stationary guide vanes], designed to provide the efficiency [and sound level] indicated. In fan selection, consider and account for any losses due to the size of the motor in relation to the fan hub diameter. Impeller blades of direct-driven fans must be adjustable to permit varying performance over a range of volume and pressure. Index the hub to facilitate setting the angle of the blades uniformly and accurately from minimum to maximum angle; provide stops to avoid overloading motor. Furnish motor with the factory blade maximum setting included in the fan nameplate data.

2.3.2 Fan Casings

Cylindrical, or welded steel construction, with flanged inlets and outlets. Assemble motor support [and guide vanes] by welding. Provide casings with bolted or hinged access plates adequate for inspection and servicing of internal parts.

2.4 BATHROOM AND KITCHEN FANS

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NOTE: Quiet operation will increase the likelihood that occupants will use fans.

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Power used must be a maximum of 13 watts for 50 cfm fans; 15 watts for 70 cfm fans; 17 watts for 90 cfm fans; and 20 watts for 100 cfm fans. Noise levels must not exceed 0.5 sones for 50 to 70 cfm fans; 1.0 sones for 90 cfm fans; and 1.5 sones for 100 cfm fans. Fan lights must be compact fluorescent.

2.5 BASIC MATERIALS

2.5.1 Coated and Uncoated Carbon Steel Sheets, Plates, and Shapes

2.5.1.1 Mill Galvanized Steel Sheet

ASTM A653/A653M, lock forming quality, Coating G-90[, 204 degrees C 400 degrees F, maximum].

2.5.1.2 Mill Galvanized Steel Shapes

ASTM A36/A36M galvanized in accordance with [ASTM A123/A123M] [ASTM A653/A653M].

2.5.1.3 Uncoated (Black) Carbon Steel Sheet

ASTM A1011/A1011M.

2.5.1.4 Uncoated (Black) Carbon Steel Plates and Shapes

ASTM A36/A36M.

2.5.2 Corrosion Resistant (Stainless) Steel

ASTM A167, Type 304L or Type 316L with mill finish, except as otherwise specified.

2.5.3 Corrosion Protection

Treat equipment fabricated from ferrous metals that do not have a zinc coating conforming to [ASTM A123/A123M] [ASTM A653/A653M] for prevention of corrosion with a factory coating or paint system that will withstand 125 hours in a salt-spray fog test except that equipment located outdoors must withstand 500 hours. Perform salt-spray fog test in accordance with ASTM B117. Each specimen must have a standard scribe mark as defined in ASTM D1654. Upon completion of exposure, evaluate and rate the coating or paint system in accordance with procedures A and B of ASTM D1654. The rating of failure at the scribe mark must be not less than six (average creepage not greater than 3 mm 1/8 inch). The rating of the unscribed area must be less than ten (no failure). Thickness of coating or paint system on the actual equipment must be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness.

2.6 HEAT RECOVERY SYSTEMS

Heat recovery systems must be utilized in ventilation units (100 percent outside air units) where the temperature differentials between supply air and exhaust air is significant. Heat recovery systems must operate at a minimum of 70 percent efficiency. The heat recovery systems must have factory-installed microprocessor controller that in turn can be connected to a Direct Digital Control (DDC) Building Automation System to monitor temperatures, [wheel operation,] filter cleanliness, defrost control, and other critical conditions. Prefilters must be provided in all heat recovery systems before the heat recovery equipment.

2.6.1 Unit Casing

****

NOTE: Include bracketed sentences unless condensate drain is not needed or cross contamination is prevented by other methods.

****

Provide a self supporting unit casing constructed of minimum 1.1 mm 0.04 inches thick extruded aluminum profiles and aluminum zinc sheet steel that create a double wall.[The base of the casing must be constructed as a continuous condensate drain with a total of four connection possibilities.] The casing bottom, top, and sides must be insulated with 50 mm 2 inch thick fibrous glass insulation with a minimum density of 96 kg per cubic meter 6 lb per cubic foot or another material with equivalent insulating value.[Provide a partition to isolate the exhaust and supply airstreams from each other to avoid cross contamination.] Partition must be a minimum of [1.9][_____] mm [0.075][_____] inches [galvanized steel] [aluminum]. Provide stainless steel casing for corrosive air streams. The casing must be designed for diagonal mounting of the heat exchanger access from the side for maintenance and cleaning. The casing must be designed with an integral defrost control damper on the heat exchanger section for defrost control. Provide full size access doors for checking the heat exchanger section.

2.6.2 Heat Exchanger Section

[2.6.2.1 Enthalpy Wheel

A desiccant-impregnated enthalpy wheel with variable speed rotary wheel must be used in the supply and exhaust systems. Wheels must contain media made of a lightweight polymer that is coated with a corrosion-resistant finish. Etched or oxidized surfaces are not acceptable. Heat transfer surfaces must be coated with a non-migrating (permanently bonded) absorbent.[Desiccant must be silica gel for maximum latent energy transfer.] Wheel must allow laminar flow but not radial, and prevent leakage, bypassing, and cross contamination by cross flow within wheel. The wheel must have rotor seals specifically designed to limit cross-contamination, and a rotation detector. Should rotation stop, the rotation detector must alarm the HVAC control system. Wheel must not condense water directly or require a condensate drain for summer or winter operation. Performance rating must be in accordance with AHRI 1060 I-P.

][2.6.2.2 Heat Pipe

For sensible heat recovery a run-around type heat pipe must use refrigerant to absorb heat from the air stream at the air intake and reject the heat back into the air stream at the discharge of the air-handling unit. The heat transfer between air streams must take place in a counterflow arrangement. The unit must have no moving parts and must be one piece construction. Tube core must be [18][25][_____] mm [5/8][1][_____] inch OD seamless aluminum tubing permanently expanded into the fins to form a firm, rigid and complete metal pressure contact between the tube and fin collar of all operating conditions. Provide copper tubes and copper fins for corrosive air streams. Secondary surfaces must be of continuous plate type aluminum fins, [0.18][_____] mm [0.007][_____] inch thick, and of corrugated design to produce maximum heat transfer efficiencies. System must have solenoid valve control to operate under partial load conditions.

][2.6.2.3 Run-around Coil

The run-around coils must be used at the exhaust discharge from the building and at the fresh air intake into the building.[A glycol run-around coil must be used with control valves and a pump for part load conditions.]

][2.6.2.4 Sensible Heat Recovery Unit

[A cross-flow, air-to-air (z-duct) heat exchanger must recover the heat in the exhaust and supply air streams. Z-ducts must be constructed entirely of sheet metal.] [Heat wheels must be used for sensible heat recovery. Unit must have variable speed drive for controlling the temperature leaving the unit. Wheels must contain media made of a lightweight polymer that is coated with a corrosion-resistant finish. Etched or oxidized surfaces are not acceptable. Wheel must allow laminar flow but not radial, and prevent leakage, bypassing, and cross contamination by cross flow within wheel.

The wheel must have rotor seals specifically designed to limit cross-contamination, and a rotation detector. Should rotation stop, the rotation detector must alarm the HVAC control system. Wheel must not condense water directly or require a condensate drain for summer or winter operation. Performance rating must be in accordance with AHRI 1060 I-P.]

]2.6.3 Defrost Control Damper Section

Provide an integral defrost control damper section with electric damper motor for defrost control of the heat exchanger section. The defrost control dampers must be mounted upstream of the heat exchanger section and must be capable of preventing frost build-up on the plates of the heat exchanger. Drain pan must be stainless steel. The damper motor must be located outside of both airstreams.

2.6.4 Angle Filter Box

Provide a side access, galvanized steel duct mounted filter box assembly with integral holding frames suitable for accommodating [50 mm2 inch][_____] thick filters with a minimum efficiency reporting value of 13. Provide filter box constructed of minimum 1.3 mm 0.05 inch thick galvanized steel with extruded aluminum tracks and individual universal holding frames with polyurethane foam gaskets and positive sealing clips designed to accommodate various standard size filters in various efficiency ranges. Provide access doors with positive sealing, heavy duty quick opening half-twist latches and sponge neoprene gasketing on each side of filter box for removal and replacement of filters. For each filter box provide one magnehelic gauge or inclined manometer with static pressure taps, shut-off and vent cocks, and aluminum tubing with range 50 to 1470 Pa 0.0073 to 0.21 psi.

2.7 FIRE DAMPERS

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NOTE: Use 1 1/2 hour rated damper for up to 2 hour fire walls. Use 3 hour rated damper only for 3 hour or 4 hour fire walls.

****

Provide [_____] [single leaf] [guillotine] [recessed] [hinged] [type] [curtain type with interlocking blades] [with frame and operating mechanism housed out-of-[air] [fume] [vapor] stream,] constructed and rated in accordance with AMCA 500-D. Furnish dampers for indicated stream flow, to equal or exceed fire resistance rating of [1 1/2 hours] [3 hours]. Fire damper must be rattle-free and must cause a minimum [5] [10] percent increase in stream velocity or system static pressure.[For [_____] system[s], stream exposed materials of construction must be [_____].] Provide building penetration collars in accordance with AMCA 500-D [and NFPA 91], [unless otherwise indicated]. Provide one spare fusible link for testing of each fire damper operation and one spare fusible link for each [10] fire dampers, but not less than two.

2.8 MISCELLANEOUS MATERIALS

2.8.1 Filler Metal, Welding

AWS filler metal specification and grade compatible with base materials to develop full joint strength.

2.8.2 Flashing Materials

[Mill galvanized, phosphatized, steel sheet with minimum spangle, conforming to ASTM A653/A653M, Coating G90, 24 gage minimum thickness. Mill No. 1 or 2D finished, stainless steel, fully annealed, soft temper, conforming to ASTM A167, Type 304, 0.38 mm 0.015 inch minimum thickness. Mill finished copper, conforming to ASTM B152/B152M, minimum 1487 gram per square meter 16 ounces per square foot.][As specified in Section [07 60 00] FLASHING AND SHEET METAL.]

2.8.3 Flexible Connectors

2.8.3.1 General Service

Airtight, fire-retardant, fume and vapor resistant, chloroprene or chlorosulfonated polyethylene impregnated, woven fibrous glass fabric, rated for continuous service at 121 degrees C 250 degrees F, conforming to UL 214, with 678 gram per square meter 20 ounce per square yard weight for service at 498 Pa 2 inches water gage and under and 1017 gram per square meter 30 ounce per square yard weight for service over 498 Pa 2 inches water gage. Provide with or without integral 24 gage mill galvanized sheet metal connectors.

2.8.3.2 Acoustic Service

Provide as second layer for nonpressure service to 60 degrees C 140 degrees F, leaded sheet vinyl, a minimum 1.40 mm 0.055 inches thick, weighing a minimum 20.60 kg per square meter 0.87 pounds per square foot, capable of 10 dBA attenuation in 10 to 10,000 Hz range, suitable for solvent seam or overlap joining and banding.

2.8.3.3 [Fume] [Dust Collection] Service

[3 mm][1/8 inch] [_____] thick, single-ply, synthetic fabric reinforced chloroprene suitable for 107 degrees C 225 degrees F.

2.8.3.4 High Temperature Service

a. Bellows type metal expansion joints, temperature range minus 29 degrees C to [427] [538] degrees C 20 degrees F to [800] [1000] degrees F, plus or minus 25 kPa 100 inches water gage [with interior liner [and exterior cover]].

b. Fabric reinforced, insulated, elastomeric cover expansion joint for operating temperature up to [204 degrees C] [400 degrees F][_____] [belt] [or] [flange] type for [10 kPa gage] [40 inches water gage] [_____] positive or negative pressure [, with interior liner or baffle].

2.8.4 Flexible Duct

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NOTE: The designer must indicate on the drawings the types of flexible duct required.

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2.8.4.1 Metallic Type

Single-ply [zinc-coated carbon steel] [mill galvanized carbon steel] [Type 316 stainless steel] [two-ply aluminum], [self-supporting to 2.50 meters 8 foot spans] with corrugated and interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius approximately 10 times the duct diameter, airtight, rated for positive or negative working pressure of 3735 Pa 15 inches water gage at [177 degrees C350 degrees F for aluminum] [343 degrees C650 degrees F for galvanized steel and stainless steel] UL 181, Class 1 rated, conforming to NFPA 91.

2.8.4.2 Wire Reinforced Fabric Type

Elastomer impregnated woven synthetic fabric, bonded to and supported by corrosion protected or corrosion resistant spring steel helix, rated for positive or negative working pressure of [3735 Pa gage at 121 degrees C] [15 inches water gage at 250 degrees F] [_____] UL 181, Class 1 labeled. Provide with manufacturer's standard metallic connection collar and clamping fastener assembly [fitted with] [dampers] [and] [extractors] [as indicated].

2.8.4.3 Ball Joints

Fabricated from cast iron or formed sheet metal with outer sections secured with bolts. Provide each half of the ball joint with tubular stubs for connecting ducts.

2.8.4.4 Slip Joints

Fabricated from tubular sheet metal sections. Provide outer tube with formed steel flat bar clamps. Where required or indicated, provide a chain or other means to fix relative longitudinal position of outer and inner joint sections.

2.8.5 Gaskets

2.8.5.1 Elastomer Buna N

Sheet, 3 mm 1/8 inch thick, conforming to ASTM D2000, Type 2BG410B14.

2.8.5.2 Elastomer Chloroprene

Sheet, 3 mm 1/8 inch thick, conforming to ASTM D2000, Type 2BE410B14.

2.8.5.3 Rubber

Sheet, 3 mm 1/8 inch thick red or black, natural, reclaimed, synthetic rubber or mixture thereof, conforming to ASTM D1330.

2.8.6 Protective Coating Materials

2.8.6.1 Baked Unmodified Phenolic

MIL-DTL-12276, Type II.

2.8.6.2 Epoxy Coating

Conform to MIL-PRF-23236, Type I, Class 1 or MIL-DTL-24441 system, Formula 150 green primer 0.076 mm 3 mils, Formula 151 haze gray 0.076 mm 3 mils, and Formula 152 white 0.076 mm 3 mils.

2.8.6.3 Inorganic Zinc Coating

SSPC Paint 20, Type I-C (Self-cure type).

2.8.6.4 Galvanizing Repair Paint

Conform to MIL-P-21035.

2.8.7 Sealants

2.8.7.1 Elastomeric

Sealant specified in these specifications or referenced standards as elastomeric or without further qualification, must be silicone, polyurethane, polysulfide, polyisobutylene, or acrylic terpolymer suitable for the service. For sealing of nongasketed duct joints during fabrication or assembly, sealant must be polyurethane, acrylic terpolymer or polysulfide. Sealants must conform to the following:

a. Silicone: Conforming to FS TT-S-001543, single component type, not requiring primed substrate, with manufacturer published estimated life of 30 years and a maximum 5 percent shrinkage when cured.

b. Polyurethane: Conforming to ASTM C920, Type 2, Class A, single component type, not requiring primed substrate, with manufacturer published estimated life of 20 years and a maximum 10 percent shrinkage when cured.

c. Polysulfide: Conforming to ASTM C920, Type 2, Class A, single component type, not requiring primed substrate, with manufacturer published estimated life of 20 years and a maximum 10 percent shrinkage when cured.

d. Polyisobutylene/Butyl: Conforming to CID A-A-272, Type 1, single component type, not requiring primed substrate, with manufacturer published estimated life of 10 years and a maximum 15 percent shrinkage when cured.

e. Acrylic Terpolymer: Conforming to ASTM C920, single component type, not requiring primed substrate, with manufacturer's published estimated life of 20 years and a maximum 10 percent shrinkage when cured.

f. Provide sealants and non-aerosol adhesive products meeting either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants must be classified in the "Other" category within the SCAQMD Rule 1160 sealants table). Provide validation of indoor air quality for duct sealants.

2.8.7.2 Heat Shrinking over Round Exterior Duct

High molecular weight, irradiated polyethylene band with interior heat activated epoxy adhesive coating for heat shrinking and epoxy extrusion over round, exterior, duct joints.

2.8.7.3 Hard Cast Caulking for Exterior Ducts

Mineral and adhesive impregnated woven fiber tape with adhesive activator for exterior round or rectangular duct joints.

2.8.7.4 Caulking of Building Surface Penetration

Foamed silicones, two-component, fire-resistant, [gamma radiation resistant], low-exotherm, room temperature vulcanizing silicone.

2.9 SPECIALTIES

Steel, cast iron, stainless steel, nonferrous metal, or plastic to match duct construction, or as indicated.

2.9.1 Access Ports, Test

With gasketed screw cap and flange, to suit exhaust service[, 25 mm one inch nominal pipe size].

2.9.2 Damper Regulators

Incremental position indicating and locking type, with satin finish chrome plated, flush surface mounting cover and regulator box where concealment is required in finished spaces. For splitter dampers, provide splitter tip mounted trunnion brackets with self-locking screw regulator or rods with external swivel joint brackets.

2.9.3 Blast Gates

Provide means for locking in adjusted position with bolt and nut.

2.9.4 Cast Iron Access Door

Cast iron frame, [hinged and] gasketed cast iron door, quick closing clamps for watertight sealing[, size as indicated][, 152 by 229 mm 6 by 9 inches minimum size].

2.10 SUPPORTS AND HANGERS

****

NOTE: The designer must design all supports, including wind bracing for stacks, and show all important details on the drawings. SMACNA Accepted Industry Practice for Industrial Duct Construction is illustrative and does not fix sizes of supports or allowable loads. Refer to SMACNA round and rectangular duct construction standards for design tables and other information.

****

2.10.1 General Requirements for Supporting Elements

Provide ducting systems and equipment supporting elements including but not limited to building structure attachments; supplementary steel; hanger rods, stanchions and fixtures; vertical duct attachments; horizontal duct attachments; anchors; supports. Design supporting elements for stresses imposed by systems, with a minimum safety factor of 4.0 based on duct being 50 percent full of particulate conveyed. Supporting elements must conform to SMACNA 1403, SMACNA 1922, SMACNA 1520, [SMACNA 1378,] and NFPA 91, as applicable, and modified and supplementary requirements specified herein. Do not use weld studs and powder actuated anchoring devices to support mechanical systems components without prior approval.

2.10.2 Vertical Attachments

Provide in accordance with SMACNA Standards, except mill galvanized iron straps must be a minimum of 25 mm one inch wide, 16 gage thick.

2.10.3 Horizontal Attachments

Provide as indicated in accordance with SMACNA Standards.

2.10.4 Supplementary Steel

Provide where required to frame structural members between existing members or where structural members are used in lieu of commercially rated supports. Such supplementary steel must be fabricated in accordance with the AISC 360.

2.10.5 Vibration Isolators

****

NOTE: See Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS for guidance given in guide specification technical notes. Definite requirements should be specified in contract specification for bidders' information.

****

[Provide vibration isolators with in-series, contained, steel springs, chloroprene elastomer elements, and fasteners for connecting to building structure attachments. Devices must be loaded by support system in operating condition to produce required static spring deflection without exceeding 75 percent of device maximum load rating.][Conform to Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS.]

2.11 DUCTWORK, DUST [AND FUME] COLLECTION

2.11.1 General Requirements for Dust[and Fume] Collection Ductwork

****

NOTE: Delete all welded seams and flanged joints when not required. However, factors such as water intrusion under negative pressure in weather exposure should be considered when construction which is not leak-tight is permitted for the project. Duct conveying fumes subject to condensation should be leak-tight.

****

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research has shown that products are available meeting the recycled content requirements stated below.

****

[Where specified or indicated] [_____] fabricate system ductwork from black carbon steel [, with welded seams and flanged and gasketed joints]. Provide steel with a minimum of 70 percent recycled content. Provide data identifying percentage of recycled content of ductwork steel components. Construct duct to handle [_____] [wood dust] particulate with an influent loading of [15,000 grains per [standard liter per second (L/s)] [actual L/s]] [7,000 grains per [standard cubic feet per minute (scfm)] [actual cubic feet per minute (acfm)] [_____]]. Provide ductwork in accordance with best practice recommendations and requirements of SMACNA 1922 and SMACNA 1520, for [Class I] [Class II] [Class III] [Class IV] duct and requirements specified or indicated.

2.11.2 Fabrication of Dust [and Fume] Collection Ductwork

****

NOTE: Delete all welded seams and flanged joints when not required. However, factors such as water intrusion under negative pressure in weather exposure should be considered when construction which is not leak-tight is permitted for the project. Duct conveying fumes subject to condensation should be leak-tight.

****

Provide indicated sizes, lengths and configuration without deviation unless otherwise approved. Assemble ductwork airtight [as defined under paragraph DUCTWORK STRUCTURAL INTEGRITY AND LEAKAGE TESTING in this section] and include necessary reinforcements, bracing, supports, framing, gasketing and fastening to guarantee rigid construction and freedom from vibration, airflow induced motion, and excessive deflection. For [_____] system, provide SMACNA Class 1 construction with any of the reference standard seams and connections being acceptable [, except [_____]]. For [_____] system, provide SMACNA Class [2] [3] [4] construction with welded duct and fitting seams and welded companion angle or Van-Stone flanges. Welding must conform to requirements specified herein. Provide flanges at [branches] [hoods,] [equipment] [and] [enclosure connections,] where necessary for ease of access to equipment or maintenance disassembly, and where indicated. Provide elbows and fittings a minimum 2 gages heavier than straight ducts of equal diameter.

2.11.3 Radius Elbows

Fabricated from butt welded specified piece gore sections or from formed welded or seamless tubing to a minimum centerline radius of [2.0] [2.5] [_____] diameters. Assemble, weld, and finish ground gore sections to eliminate internal projections. Construct gored elbow in accordance with the following:

400 mm diameter and less 16 inches diameter and less	Over 400 mm diameter Over 16 inches diameter
90 degree - 5 piece minimum	90 degree - 7 piece minimum
60 degree - 4 piece minimum	60 degree - 6 piece minimum
45 degree - 3 piece minimum	45 degree - 5 piece minimum

400 mm diameter and less 16 inches diameter and less	Over 400 mm diameter Over 16 inches diameter
30 degree - 3 piece minimum	30 degree - 4 piece minimum
15 degree - 2 piece minimum	15 degree - 3 piece minimum

2.11.4 Flanged Joints

Gasketed with full face gaskets 3 mm 1/8 inch thick red or black rubber as specified under paragraph MISCELLANEOUS MATERIALS in this section.

2.11.5 Access Doors

Provide hinged, gasketed, and fitted with snap-action closures access doors. Equip access door with gaskets of common weather stripping type, foamed, closed-cell, elastomer with pressure sensitive adhesive back. Provide cleanout adjacent to every bend and vertical riser. In horizontal duct runs, locate cleanout door with maximum of spacing of 4 meters 12 feet for ducts 300 mm 12 inches or less in diameter and 6 meters 20 feet for larger ducts.

2.11.6 Flexible Connectors

[Provide drawband secured flexible connectors, conforming to requirements specified under paragraph MISCELLANEOUS MATERIALS in this section, utilizing 3 mm 1/8 inch thick reinforced elastomer, fabricated into a cylindrical shape by vulcanizing or otherwise bonding longitudinal seam.] [Provide flange secured flexible connectors, conforming to requirements specified under paragraph MISCELLANEOUS MATERIALS in this section, utilizing bellows type metal expansion joint. Where service temperature exceeds 149 degrees C 300 degrees F, insert 25 mm one inch thickness of mineral wool.]

2.12 PROTECTIVELY COATED STEEL DUCTS

Ductwork, Protectively Coated Steel, For Corrosive Fume and Vapor Exhaust:

2.12.1 General Requirements for Protectively Coated Steel Ductwork

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NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Research has shown that products are available meeting the recycled content requirements stated below.

****

Fabricate [_____] system ductwork from black carbon steel with welded seams, flanged and gasketed joints and protectively coated interior surfaces including flange faces, provide steel with a minimum of 70 percent recycled content. Provide data identifying percentage of recycled content of protectively coated steel ducts. Construct ductwork to handle [_____] [fumes] [condensing] [noncondensing] [vapors] containing [_____]. Spiral welded duct is prohibited. Provided ductwork in accordance with best practice recommendations and requirements of SMACNA 1922 and SMACNA 1520, for Class [IV] [_____] duct.

2.12.2 Protective Coating

Provide [_____] [and] [_____] protective coatings as specified under PROTECTIVE COATING MATERIALS, a subparagraph of MISCELLANEOUS MATERIALS in this section. Provide [_____] coating to interior of duct [and related fan] surfaces. Coat exterior duct [and related fan] surfaces with same protective coating as specified for exterior surfaces [primed with] [inorganic zinc coating] [_____].[Exterior fan surfaces must be finished [protectively coated] [primed] [as specified under paragraph, "_____".]][Field finish exterior surfaces which have only been primed, as specified in Section 09 90 00 PAINTS AND COATINGS.]

2.12.3 Fabrication of Protectively Coated Ductwork

Construct protectively coated ductwork for corrosive fume and vapor exhaust in accordance with SMACNA 1922 and SMACNA 1520 and as specified herein. Provide indicated sizes, lengths and configuration without deviation, unless otherwise approved. Spiral welded duct is prohibited. Install ductwork to be water washable, watertight, self-draining, and airtight [as defined under paragraph DUCTWORK STRUCTURAL INTEGRITY AND LEAKAGE TESTING in this section]. Provide necessary reinforcements, bracing supports, framing, gasketing, and drainage provisions, and fastening to guarantee rigid construction and freedom from vibration, airflow induced motion, and excessive deflection. Rigid construction is required to prevent damage to or failure of protective coating during construction, transport, erection, and on-off system operation. Only companion angle flanged joints must be permitted. Weld ducting and fittings seams. Avoid seams in bottom 80 mm 3 inchesof ducting and in corners wherever practical by bending of corners and arranging seams high in the side sheets or top sheet. Cracks, laps, sharp inside corners, sharp sheared edges, weld "icicles," flux, pits, weld spatter, burrs, and similar defects which contribute to coating discontinuities must be eliminated by the following: a) welding continuously, b) grinding of metal flush with surface or to 0.8 mm 1/32 inch radius or to maximum radius permitted by thinner metals, c) Utilizing other fabrication techniques and subsequent surface preparation abrasive blasting. Removed from the job site for repair rejected ducting not conforming to these requirements and which exhibit coating thickness deficiency. Welding must conform to requirements specified herein. Continuously weld companion flange angles to the inside of the duct and intermittently weld with 25 mm one inch welds every 100 mm 4 inches on outside of duct. Intermittently weld girth and transverse reinforcements to duct surface for 25 mm one inch on 152 mm 6 inch centers or spot welded on 100 mm 4 inch centers. Weld and grind flange and reinforcement angles at corners or ends to form continuous frames. Provide flanges at [branches,] [hoods,] [equipment] [and] [enclosure connections,] where necessary for ease of access to equipment or maintenance disassembly, and where indicated. Limit duct lengths in accordance with size, to permit complete and ready access for welding, grinding, blasting, coating, coating continuity checking and testing, and visual inspection during fabrication and immediately prior to erection.

2.12.4 Radius Elbows

Fabricated radius elbows from butt welded specified piece gore sections or from formed welded or seamless tubing to a minimum centerline radius of [2.0] [_____] diameters and preferably 2.5 times the duct diameter.

Assemble, weld, and finish ground gore sections to prevent internal crevices and projections. Construct gored elbow in accordance with the following:

400 mm diameter and less 16 inches diameter and less	Over 400 mm diameter Over 16 inches diameter
90 degree - 5 piece minimum	90 degree - 6 piece minimum
60 degree - 4 piece minimum	60 degree - 5 piece minimum
45 degree - 3 piece minimum	45 degree - 4 piece minimum
30 degree - 3 piece minimum	30 degree - 3 piece minimum
15 degree - 2 piece minimum	15 degree - 2 piece minimum

2.12.5 Flanged Joints

Gasketed with full-face gaskets which are one-piece, heat, adhesive or solvent vulcanized, or bonded and assembled to prevent drainage and limit extrusion or cavity at joint.

2.12.6 Access and Cleanout Door Openings

Provide access plates upstream and downstream of equipment installed in ductwork, at locations to facilitate duct cleaning (such as in horizontal runs, near elbow junctions, and vertical runs), and where indicated. For ducts 300 mm 12 inches diameter or less, locate cleanout or access openings a minimum of 3.70 meters 12 feet apart. Provide 250 by 300 mm 10 by 12 inches minimum size access opening; unless otherwise indicated or prevented by duct dimension. Locate opening a minimum of 80 mm 3 inches from bottom of duct. Frame access openings by welded and ground miter joint 5 mm 3/16 inch thick strap iron, or angle iron, with 6 mm 1/4 inch stainless steel bolt or stud assembly to duct on 100 mm 4 inch centers. Fabricate plates out of 300 series corrosion-resistant steel or polyvinyl chloride faced sheet backed by 16 gage sheet metal, reinforced as required for larger sizes, or constructed of heavier gage metal. Ensure only corrosion resistant materials are expose to duct interior. Provide one "U" handle on access plates through 250 by 300 mm 10 by 12 inches and two "U" handles on larger sizes. Locate access openings at points which will permit ready access to duct internals with no duct cutting. Where access through equipment or access doors specified herein is not available at a specific point, provide 200 mm 8 inch diameter gasketed access plates spaced on maximum 3 meters 10 foot centers. Where penetration of duct surfaces is approved or specified, provide 300 series corrosion resistant steel fastener assemblies. Provide hex type, cadmium plated flange fastener bolts and nuts and [3 mm1/8 inch thick acid resistant chloroprene] [3 mm1/8 inch thick Buna N] joint gaskets.

2.13 THERMOPLASTIC DUCTWORK

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NOTE: Duct systems of plastic material may be used to handle only nonflammable corrosive fumes and vapor when conventional metal duct systems will not be adequate.

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NOTE: SMACNA Thermoplastic Duct (PVC) Construction Manual is applicable to fume exhaust systems construction and installation requirements for round and rectangular PVC ductwork for positive and negative pressure systems operating in environments up to 27 degrees C at 498 Pa, 1493 Pa, and 2488 Pa 80 degrees F at 2 inches, 6 inches, and 10 inches water gage. The requirements of this standard are applicable specifically to Classes 12454-B and 12454-C PVC compounds as defined in ASTM D1784, Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds. The designer must indicate on the drawings the static pressure classification (498 Pa, 1493 Pa, or 2488 Pa2 inches, 6 inches, or 10 inches water gage positive or negative) to which each duct system (or each portion of a duct system) is to be constructed.

****

2.13.1 Ductwork

Construct ductwork, fittings, hoods, and accessories in accordance with SMACNA 1378 and NFPA 91. Fabricate supplementary steel in accordance with the AISC 360.

2.13.2 Product Requirements

Provide duct system from a manufacturer recognized in the field of fabrication of PVC material. Fabricating personnel must be certified by the manufacturer as qualified to perform the work in accordance with the specified requirements.

2.13.3 Basic Ductwork Materials

Fabricate ducts, hoods, accessories and components in sheet form from materials conforming to ASTM D1927, [Type I, Grade 1] [Type I, Grade 2]. Utilize extrusions of the same compounds as specified for duct. Solvent cement must conform to ASTM D2564. Construct metal components, when permitted to be located interior to the duct, of [Type] [304 or 304L] [316 or 316L] [_____] [corrosion resistant steel] [_____].

2.13.4 Fasteners

Where penetration of duct surfaces is approved or specified, provide Type 316 corrosion resistant steel fastener assemblies encapsulated with polyester on duct interior, unless total disassembly is intended. Provide flange fastener bolts and nuts of hex type only, cadmium plated, unless exposed to corrosive fumes; in which case provide Type 316 stainless steel. Equip bolted assemblies with two oversized washers, except where assembled with metallic reinforcement contact. Plastic bolting is prohibited.

2.13.5 Joint Gaskets

Provide [3 mm1/8 inch thick acid resistant chloroprene.] [3 mm1/8 inch thick Buna N.]

2.13.6 Fabrication

Construct water washable, watertight, self-draining, and airtight ductwork as specified or indicated. Provide required reinforcements, bracing, supports, framing, gasketing, sealing, resilient mounting, drainage provisions, and fastening to guarantee rigid construction and freedom from vibration, airflow induced motion and noise, and excessive deflection at specified maximum system pressure and velocity.

2.13.6.1 Flanges

Provide flanges at all branches on maximum 6 meters 20 foot centers in ducting sized 400 mm 16 inches and under, on maximum 2.40 meters 8 foot centers in duct sized over 400 mm 16 inches, where required for ease of access to equipment, at hoods, enclosure connections and where indicated. Furnish one piece, heat, adhesive, or solvent vulcanized or bonded full face gaskets at flange joints.

2.13.6.2 Access Plates

Provide access plates upstream and downstream of equipment in ducts at locations to facilitate duct cleaning, and where indicated. Locate access openings a minimum of 50 mm 2 inches above bottom of duct and externally frame with welded and ground miter joint steel which is isolated from duct interior. Construct access plate with PVC on interior side, backed with steel on exterior side. Provide stainless steel access plate fasteners. For ductwork cleaning access, provide 200 mm 8 inch diameter gasketed access plates on maximum 3 meters 10 foot on centers, except where access is available through an air terminal device or other required access.

2.14 FIBERGLASS DUCTWORK

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NOTE: Duct systems of plastic material may be used to handle only nonflammable corrosive fumes and vapor when conventional metal duct systems will not be adequate.

****

Ductwork, Fiberglass for Nonflammable [Corrosive] [Fume] [Vapor] Exhaust:

2.14.1 Fiberglass Ductwork

Construct ductwork, fittings, accessories, and material of construction in accordance with NFPA 91, and ASTM C582. Fabricate supplementary steel in accordance with the AISC 360.

2.14.2 Basic Ductwork Materials

****

NOTE: Fill in resin characteristics from ASTM C582 if necessary. Verify suitability of Type 316 stainless steel for the specific chemical exposure; for example, chromic acid attacks Type 316 stainless steel. Revise as required.

****

****

NOTE: Designer must verify that products meeting

the indicated minimum recycled content are available, preferably from at least three sources, to ensure adequate competition. If not, write in suitable recycled content values that reflect availability and competition.

****

Fabricate ducts, accessories and components in sheet form from materials conforming to ASTM C582 [, RTP [_____]]. Provide exterior gel coat, coating or paint with ultraviolet light inhibiting properties for ducts exposed to sunlight. Construct metal components, when permitted to be located interior to the duct, of Type 316 corrosion resistant steel.

2.14.3 Fasteners

Where penetration of duct surfaces is approved or specified, provide Type 316 corrosion resistant steel fastener assemblies encapsulated with polyester on duct interior, unless total disassembly is intended. Provide flange fastener bolts and nuts of hex type only, cadmium plated, unless exposed to corrosive fumes; in which case provide Type 316 stainless steel. Equip bolted assemblies with two oversized washers, except where assembled with metallic reinforcement contact. Plastic bolting is prohibited.

2.14.4 Joint Gaskets

Provide [3 mm1/8 inch thick acid resistant chloroprene.] [3 mm1/8 inch thick Buna N.]

2.14.5 Fabrication

Construct water washable, watertight, self-draining, and airtight ductwork as specified or indicated. Provide required reinforcements, bracing, supports, framing, gasketing, sealing, resilient mounting, drainage provisions, and fastening to guarantee rigid construction and freedom from vibration, airflow induced motion and noise, and excessive deflection at specified maximum system pressure and velocity.

2.14.5.1 Flanges

Provide flanges at all branches on maximum 6 meters 20 foot centers in ducting sized 400 mm 16 inches and under, on maximum 2.40 meters 8 foot centers in duct sized over 400 mm 16 inches, where required for ease of access to equipment, at hoods, enclosure connections and where indicated. Furnish one piece, heat, adhesive, or solvent vulcanized or bonded full face gaskets at flange joints. Provide flanges at dissimilar material joints, such as between fiberglass reinforced plastic (FRP) and PVC.

2.14.5.2 Access Plates

Provide access plates upstream and downstream of equipment in ducts at locations to facilitate duct cleaning, and where indicated. Locate access openings at least 50 mm 2 inches above bottom of duct and externally frame with welded and ground miter joint steel which is isolated from duct interior. Construct access plate with fiberglass on interior side, backed with steel on exterior side. Provide Type 316 stainless steel access plate fasteners. For ductwork cleaning access, provide 200 mm 8 inch diameter gasketed access plates on not more than 3 meters 10 foot centers, except where access is available through an air terminal device or other required access provision.

2.15 VEHICLE TAIL PIPE EXHAUST SYSTEM

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NOTE: Specifications included are for maintenance work. Dynamometer applications require revised specifications with special considerations for high temperatures involved. Following are kW/cms horsepower/cfm of exhaust gas recommendations for sizing system and hoses for maintenance work applications.

Maintenance-gasoline: 223 (kW/0.07 m3/s; 261/0.09; 373/0.19 299 (HP)/150 (CFM); 350/200; 500/400

Maintenance-diesel: 224/0.19; 373/0.28; 522/0.47 300/400; 500/600; 700/1000

Turbo-charged diesel: to 373/0.66 500/1400

****

2.15.1 General Requirements for Vehicle Tail Pipe Exhaust System

Provide a hanging [exposed overhead] [disappearing overhead] [disappearing underfloor] [nondisappearing (plug-in underfloor)] type vehicle tail pipe exhaust system. Construct and install in accordance with applicable requirements of NFPA 91.

2.15.2 Ductwork

Construct ducts and miter or stamped fittings with galvanized steel. Duct sheet metal gages must conform to Class I in SMACNA 1922 and SMACNA 1520.

2.15.2.1 Suction Side Ductwork

Construct suction side ductwork with lock groove seam longitudinal joints. Connect circumferential joints between sections with push-on or bead and crimp type, secured with a minimum 4 rivets or screws on ducts up to and including 100 mm 4 inches diameter, and with screws or rivets a minimum 80 mm 3 inches on center on larger sizes of duct. Lap joints in the direction of air flow. On disappearing overhead systems, assemble roller duct sections using pop rivets. Solder all joints or construct ductwork leak-tight as for discharge side ductwork below.

2.15.2.2 Discharge Side Ductwork

Construct ductwork on the discharge side of the fan leak-tight with joints and seams welded, brazed, or soldered. Provide flanges with suitable gaskets, where required. Repair damaged galvanizing with galvanizing repair compound.

2.15.3 Fan

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NOTE: The criteria for special AMCA construction for protective coating can be further delineated here or incorporated into referenced paragraph, if this is the only fan. Specify welded Class II construction only where required.

****

****

NOTE: See Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS for guidance given in guide specification technical notes. Definite requirements should be specified in contract specification for bidders' information.

****

Comply with paragraph CENTRIFUGAL FANS in this section [, subparagraph UTILITY SET,] and special requirements for protective coatings.[Provide unit of all welded construction, utilizing minimum 14-gage carbon steel in AMCA Class II construction.] [Internal and external protective coating must be manufacturer's standard, engineered quality type, with properties comparable to [air-dry or baked phenolic,] [or] [epoxy] applied in multiple coats of 0.10 to 0.15 mm 4 to 6 mil dry film thickness.] [Mount entire assembly for vibration isolation on structural steel base and spring or elastomer type isolators with minimum transmissibility of [10] [5] percent.][Provide split sleeve or flexible connection at fan inlet.]

2.15.4 Flexible Tail Pipe Exhaust Tubing and Connectors

Provide interlocking helical seam metallic type construction of 0.3 mm 0.012 inch minimum thickness up to and including 150 mm 6 inch diameter and 0.51 mm 0.020 inch minimum thickness over 150 mm 6 inches diameter Type 302, 304, or 321 corrosion-resistant steel [with inside diameter] [and length as shown.] [of] [80] [100] [125] [150] [200]mm and [_____] meters in length [3] [4] [5] [6] [8] [inches] and [_____] feet in length. Connect to duct by welding or with screws or flanged joint with gasket [and fit with tail pipe adapters constructed of minimum 20 gage Type 300 or 400 Series stainless steel, and which include provisions for secure tail pipe attachment]. Secure hose terminal connections by screws, clamps, or flanged connections.[Provide winch operated hose assembly.]

2.15.5 Supporting Elements

Support ducting [as indicated] with anti-sway bracing to resist perceptible movement in response to forces imposed by flexible tubing location on handling. Suspend tubing from overhead location and provide means to raise and lower for use. Assemble suspension system with rigid pulley restraint, 3 mm 1/8 inch diameter aircraft cable, pulleys, and manually operated winch fitted with safety ratchet lock and slip resistant hand grip.

2.16 WELDING FUME EXHAUST SYSTEM

2.16.1 General Requirements for Welding Fume Exhaust System

Provide a [hanging] [long reach type] welding fume exhaust system as specified and indicated. Construct and install in accordance with applicable requirements of NFPA 91.

2.16.2 Ductwork

Construct ducts and stamped fittings with galvanized steel. Duct sheet metal gages must conform to Class I in SMACNA 1922 and SMACNA 1520.

2.16.2.1 Suction Side Ductwork

Construct suction side ductwork with lock groove seam longitudinal joints. Connect circumferential joints between sections with push-on or crimp and bead type, secured with a minimum 4 rivets or screws up to and including 100 mm 4 inches diameter, and with screws or rivets a maximum 80 mm 3 inches on center on larger sizes of duct. Lap joints in the direction of air flow.

2.16.2.2 Discharge Side Ductwork

Construct ductwork on the discharge side of the fan leak-tight with joints and seams welded, brazed, or soldered. Provide flanges with suitable gaskets, where required. Repair damaged galvanizing with galvanizing repair compound.

2.16.3 Fan

****

NOTE: The criteria for special AMCA construction for protective coating can be further delineated here or incorporated into referenced paragraph, if this is the only fan. Specify welded Class II construction only where required.

****

****

NOTE: See Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS for guidance given in guide specification technical notes. Definite requirements should be specified in contract specification for bidders' information.

****

Comply with paragraph CENTRIFUGAL FANS [, subparagraph UTILITY SET,] in this Section and special requirements for protective coatings.[Provide unit of all welded construction, utilizing a minimum 14-gage carbon steel in AMCA Class II construction.][Internal and external protective coating must be manufacturer's standard, engineered quality type, with properties comparable to [air-dry or baked phenolic,] [or] [epoxy] applied in multiple coats of 0.10 to 0.15 mm 4 to 6 mil dry film thickness.] [Mount entire assembly for vibration isolation on structural steel base and spring or elastomer type isolators with a minimum transmissibility of [10] [5] percent.][Provide split sleeve or flexible connection at fan inlet.]

2.16.4 Flexible Welding Fume Exhaust Tubing and Connectors

Provide corrosion protected, spring steel helix reinforced, neoprene impregnated, woven fibrous glass fabric laminate, flexible tubing with cuffed ends or equivalent construction, and with an inside diameter [and length as shown.] of [100] [125] [150] mm [and [_____] meters in length] [4] [5] [6] inches [and [_____] feet in length]. Connect to duct with clamp or gasketed flange [and fit with swivel connected conical fume hood, constructed of minimum 20 gage aluminum [or 26 gage galvanized steel] [or ABS plastic] and fitted with 13 mm 1/2 inch mesh intake screen and magnets for holding receptor in fixed location]. Secure tubing to terminal devices by clamping.[Provide spring or weight counterbalanced supporting arms for flexible hose section of long reach system.]

2.16.5 Supporting Elements

Support ducting [as indicated] with anti-sway bracing to resist perceptible movement in response to forces imposed by flexible tubing location on handling. Suspend tubing from overhead location [and provide means to raise and lower for use].[Assemble suspension system with rigid pulley restraint, 3 mm 1/8 inch diameter aircraft cable, pulleys, and manually operated winch fitted with safety ratchet lock and slip resistant hand grip.] [Support movable portion of long reach system with brackets.] Observe that hood remain in a fixed position after manual adjustment.

2.17 STACKHEADS

Provide SMACNA 1403 no loss type stackheads for vertical discharge to the atmosphere unless indicated otherwise. Weather caps are prohibited. Provide bracing or guy wires for wind loads on stacks as indicated. Discharge stacks should be vertical and terminate at a point where height or velocity prevents reentry of exhaust air.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Installation Requirements

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NOTE: Ductwork for Class 2, 3, and 4 service and supporting elements must be able to sustain working live loads imposed by ducting 50 percent filled with particulate material being conveyed. Provide supplementary structural steel for the support of system components.

****

Install in accordance to NFPA 91, and SMACNA 1922, and SMACNA 1520. Provide mounting and supports for equipment, ductwork, and accessories, including structural supports, hangers, vibration isolators, stands, clamps and brackets, access doors, blast gates, and dampers. Install accessories in accordance with the manufacturer's instructions. Construct positive pressure duct inside buildings airtight.

3.1.1.1 Wood Facilities

****

NOTE: Include paragraphs when appropriate. For other projects, edit as required and include appropriate references.

****

For [wood processing] [and] [woodworking] facilities, conform to NFPA 664.

3.1.1.2 Aluminum Facilities

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NOTE: Include paragraphs when appropriate. For other projects, edit as required and include appropriate references.

****

For aluminum [processing] [and] finishing facilities, conform to NFPA 65.

3.1.2 Electrical Ground Continuity

Where electrical ground continuity is required, provide brazed connection insulated, multi-strand, copper wire jumpers across points of discontinuity. Provide connection to ground and continuity testing as part of the work of Division 26.

3.1.3 Special Installation Requirements

Special installation requirements for protectively coated steel ductwork for corrosive fume and vapor exhaust: Slope horizontal ducts [25] [_____] mm in [12] [_____] meters [one] [_____] inch in [40] [_____] feet in the direction of air flow or [25] [_____] in [3] [_____] meters [one] [_____] inch in [10] [_____] feet in the direction opposite to airflow. Where necessary, slope duct to common drainage point. Provide drains at low points, at internal duct restrictions, at base of risers and where indicated. Provide drain connections of 25 mm one inch pipe size corrosion resistant steel couplings welded to duct and provided with polytetrafluoroethylene paste lubricated PVC plug where drainage piping is not indicated. Provide drain lines with a trap of 25 mm one inch greater depth than the positive or negative pressure in the duct but not less than 50 mm 2 inches. Provide duct support system to include additional weight due to collection or [condensate] [and] washing water in nondrainable deflected surface and other areas. Provide duct supports and building structure attachments in accordance with SMACNA 1922 and SMACNA 1520.

3.1.4 Special Requirements for Installation of Thermoplastic Ductwork

Requirements for installation of thermoplastic ductwork for nonflammable corrosive fume and vapor exhaust:

3.1.4.1 Slope

Slope horizontal ducts [25] [_____] mm in [12] [_____] meters [one] [_____] inch in [40] feet in the direction of airflow or [25] [_____] in [3] [_____] meters [one] [_____] inch in [10] [_____] feet in opposite to the direction of airflow. Where necessary, slope duct to common drainage point.

3.1.4.2 Drains

Provide drains at all low points, at internal to duct drainage restrictions, at base of risers, and where indicated. Provide drain connections of 25 mm one inch IPS couplings with polytetrafluoroethylene paste lubricated plug where drainage piping is not indicated, and where piping is indicated, provide PVC Type DWV piping conforming to ASTM D2665 to points indicated. Provide trap of 25 mm one inch greater depth than the positive or negative pressure in the duct but not less than 50 mm 2 inches.

3.1.4.3 Duct Supports

Isolate duct support contact surfaces from supporting steel by 6 mm 1/4 inch thick closed-cell foamed cellular elastomer insulation material of a width greater than support. Provide duct support system to include additional weight due to collection of condensate and washing water in nondrainable, deflected surface and other areas.

3.1.5 Special Requirements for Installation of Fiberglass Ductwork

Requirements for installation of fiberglass ductwork for nonflammable corrosive fume and vapor exhaust:

3.1.5.1 Slope

Slope horizontal ducts [25] [_____] mm in [12] [_____] meters [one] [_____] inch in [40] [_____] feet in the direction of airflow or [25] [_____] mm in [3] [_____] meters [one] [_____] inch in [10] [_____] feet in opposite to the direction of airflow. Where necessary, slope duct to common drainage point.

3.1.5.2 Drains

Provide drains at all low points, at internal drainage restrictions, at base of risers, and where indicated. Provide drain connections of 25 mm one inch IPS couplings with polytetrafluoroethylene paste lubricated plug where drainage piping is not indicated, and where piping is indicated, provide PVC Type DWV piping conforming to ASTM D2665 to points indicated. Provide a trap of one inch greater depth than the positive or negative pressure in the duct but not less than 50 mm 2 inches.

3.1.5.3 Duct Supports

Isolate duct support contact surfaces from supporting steel by 6 mm 1/4 inch thick closed-cell foamed cellular elastomer insulation material of a width greater than support. Design duct supporting system to include additional weight due to collection of condensate and washing water in nondrainable, deflected surface and other areas.

3.1.6 Miscellaneous Sheet Metal Work

Provide [_____] and [_____], fabricated from [mill galvanized steel] [black steel and protectively coated] [aluminum] [_____], as indicated. Sheet metal thickness, reinforcement and fabrication, where not indicated, must conform to SMACNA 1403.

3.1.7 Building Penetrations

3.1.7.1 General Penetration Requirements

Provide properly sized, fabricated, located, and trade coordinated sleeves and prepared openings, for duct mains, branches, and other item penetrations, during the construction of the surface to be penetrated. Provide sleeves for round duct 380 mm 15 inches and smaller and prepared openings for round duct larger than 380 mm 15 inches and square or rectangular duct. Fabricate sleeves, except as otherwise specified or indicated, from 20 gage, 1.00 mm 0.0396 inch thick mill galvanized sheet metal. Sleeves penetrating load bearing surfaces must be standard weight galvanized steel pipe. Provide roof penetrations as shown in SMACNA 1403.

3.1.7.2 Framed Opening

Provide framed openings in accordance with approved shop drawings. Refer to paragraph FIRE DAMPERS in this section, for related work.

3.1.7.3 Clearances

Provide a minimum 25 mm one inch clearance between penetrating and penetrated surfaces. Fill clearance space with bulk fibrous glass or mineral wood [or foamed silicone] and seal and close.

3.1.7.4 Tightness

Penetration must be [weathertight] [fireproof where fire rated surfaces are penetrated] [vaportight to prevent vapor transmission to conditioned spaces] [sound tight to prevent sound transmission to or between normally occupied or finished spaces] [deleterious or hazardous substance-tight where] [toxic] [flammable] [_____] [substances or gases could migrate].

3.1.7.5 Sealants

Provide sealant of [_____] [elastomeric] type [or foamed silicone type], as specified under paragraph SEALANTS in this section. Apply to oil free surfaces to a minimum 10 mm 3/8 inch depth.

3.1.7.6 Closure Collars

Provide a minimum 100 mm 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around penetrating item without contact. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 380 mm 15 inches in diameter or less from 20 gage, 1.00 mm 0.0396 inch nominal thickness, mill galvanized steel. Attach collars a minimum of 4 fasteners to where the opening is 300 mm 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 500 mm 20 inches in diameter or less. Fabricate collars for square and rectangular ducts with a maximum side of 380 mm 15 inches or less from 20 gage, 1.00 mm 0.0396 inch nominal thickness, mill galvanized steel. Fabricate collars for round, square, and rectangular ducts with minimum dimension over 380 mm 15 inches from 18 gage, 1.40 mm 0.0516 inch in nominal thickness, mill galvanized steel. Install collars with fasteners a maximum of 150 mm 6 incheson center.[Where penetrating items are irregularly shaped and where approved, smoothly finished, fire-retardant, foamed silicone elastomer may be utilized without closure collar.]

3.1.8 Installation of Fire Dampers

Install fire dampers at locations indicated. Provide units and connecting ductwork in accordance with applicable provisions of [NFPA 91,] [UL Bld Mat Dir,] AMCA 500-D [and UL 33], [and as indicated]. Install retaining angles, sleeves, break-away connections, and duct access doors at each damper, as required. Minimum thickness of sleeves must be 14 gage [, except as otherwise indicated]. Duct access doors must be hinged [and fitted with UL listed glass viewing port assembly]. Prior to acceptance, simulate conditions to cause each unit to function automatically. Apply safe, nonflame, heat source to fusible links and replace test activated fusible links.

3.1.9 Installation of Flexible Connectors

Flexibly connect duct connected and vibration isolated fans [, ducts crossing building expansion joints] and specified or indicated components [, except where direct connections are specified or indicated]. When fans are started, stopped, or operating, flexible connector surfaces must be curvilinear, free of stress induced by misalignment or fan reaction forces, and must not transmit vibration. Leakage must not be perceptible to the hand when placed within 150 mm 6 inches of the flexible connector surface or joint. Provide a minimum of 150 mm 6 inches and a maximum of 610 mm 2 feet active length with a minimum of 25 mm one inch of slack, secured at each end by folding in to 24 gage sheet metal or by metal collar frames.

3.1.10 Installation of Supports

3.1.10.1 Selection

Select duct and equipment support system taking into account the best practice recommendations and requirements of SMACNA 1922, SMACNA 1520, and NFPA 91; location and precedence of work under other sections; interferences of various piping and electrical work; facility equipment; building configuration; structural and safety factor requirements; vibration and imposed loads under normal and abnormal service conditions. Indicated support sizes, configurations, and spacings are the minimal type of supporting component required for normal loads. Where installed loads are excessive for the normal support spacings, provide heavier duty components or reduce the element spacing. After system start-up, replace or correct support elements which vibrate and cause noise or possible fatigue failure. Exercise special care to prevent cascading failure.

3.1.10.2 General Requirement for Supports

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NOTE: See Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS for guidance given in guide specification technical notes. Definite requirements should be specified in contract specification for bidders' information.

****

Securely attach supporting elements to building structural steel or structural slabs. Where supports are required between building structural members provide supplementary structural steel as specified for work under this section. On submittals show location of supports and anchors and loads imposed on each point of support or anchor. Do not hang ductwork or equipment from piping, or other ducts or equipment. Attach supports to structural framing member and concrete slab. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required, between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips. A maximum span of 3 meters 10 feet must exist between any two points, with lesser spans as specified or as required by duct assemblies, interferences, and loads imposed or permitted. Provide a minimum one set of two vertical support elements for each point of support and each length of duct, except as otherwise specified. Install supports on both sides of all duct turns, branch fittings, and transitions. Cross-brace hangers sufficiently to eliminate sway. Perforated strap hangers are prohibited. Where ductwork system contains heavy equipment, hang such equipment independently of the ductwork.[Duct supports must be vibration isolated from structure at points indicated.][Provide vibration isolators in indicated discharge ducting system for a minimum distance of [15 meters] [50 feet] [_____] beyond the fan. Coordinate deflection of duct and equipment mountings and conform to Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS.][

The location of supporting elements must be limited by the allowable load on the purlin which must be limited to that no greater than the moment produced by 4450 Newton one Kip load at mid-span of purlin. When the hanger load exceeds these limits, provide reinforcing of purlin[s] or additional support beam[s]. When an additional beam is used, the beam must bear on the top chord of the roof trusses and bearing must be over gusset plates of top chord. Stabilize beam by connection to roof purlin along bottom flange.]

3.1.10.3 Methods of Attachment

Clamp, or weld when approved, attachment to building structural steel in accordance with AWS D1.1/D1.1M. Construct masonry anchors selected for overhead applications of ferrous materials only. Install masonry anchors in rotary, non-percussion, electric drilled holes. Self-drilling anchors may be used provided masonry drilling is performed with electric hammers selected and applied in such a manner as to prevent concrete spalling or cracking. Pneumatic tools are prohibited.

3.1.11 Welding

Welding test agenda must be done in accordance with the applicable provisions of AWS D1.1/D1.1M and AWS D1.3/D1.3M.

3.1.12 Test Ports

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NOTE: The designer must indicate on the drawings the location of test ports required for proper testing, including static pressure, velocity pressure, and test openings for sampling discharge stack or duct. See ACGIH-2092S Industrial Ventilation: A Manual Of Recommended Practice for recommendations in the chapter on testing.

****

Provide test access ports at points required for work under paragraph TESTING, ADJUSTING, AND BALANCING in this section. Locate test ports in straight duct as far as practical downstream of fans, change of direction fittings, takeoffs, interior to duct accessories, and like turbulent flow areas.

3.1.13 Ductwork Cleaning

Protect duct openings from construction debris using temporary caps, flanges, or other approved means. Clean ductwork in accordance with manufacturer's recommendations [and the North American Insulation Manufacturers Association (NAIMA) Guide on Cleaning of Duct Board Materials].[Clean dirty duct interior with high velocity water and oil-free air streams or by vacuum cleaning as required by project conditions.][Test watertight duct work for proper support, leakage, and unacceptable drainage provisions by intermittently spraying interior with garden hose nozzle, at a rate of 0.2 liter per second 3 gallons per minute, exercising care to prevent excessive water accumulation.] After construction is complete but accessible and prior to acceptance, remove all construction debris from exterior surfaces. Do not close duct inspection ports until inspected by the Contracting Officer.

3.1.14 Protective Coating Work

3.1.14.1 General Requirements for Protective Coating Work

Provide protective coating on interior [and exterior] surfaces of [_____] [and] [interior] [and] [exterior] surfaces of [_____] with [_____] system as specified hereafter. Prime coat exterior surfaces of [_____] [and] [_____] with [_____] [inorganic zinc coating as part of work under this section] [.] [, for field finishing of exterior surfaces as part of work under Section [09 90 00] PAINTS AND COATINGS.] Brush primer, or protective coating where no primer is specified, onto corners and into crevices and welds, working the material into irregular surfaces for a holiday free finish.

3.1.14.2 Baked, Unmodified Phenolic System

a. General: The following must govern for a protective coating system based on unmodified phenol-formaldehyde resin intended for shop application to [black carbon steel] [_____] surfaces in [fume] [vapor] exhaust service with possibility of materials concentration by condensation and subsequent evaporation. Shop apply coating by an applicator approved or licensed by the coating manufacturer.

b. Surface Preparation: Clean and blast surfaces with dry abrasive to "White Metal" and critical profile and anchor pattern in accordance with SSPC SP 5/NACE No. 1, and requirements and recommendations of the coating manufacturer.

c. Application: The complete system must include the application of two coats of red pigmented base followed by not less than one coat of the clear finish, to provide a total minimum dry film thickness of [0.15 mm] [6 mils] [_____]. Apply coating materials by conventional industrial pressure spray equipment. Use only those thinners and cleaners in amounts recommended by the manufacturer. Heat-cure each coat between coats and bake surfaces after the last coat in accordance with manufacturer's applicable published instructions and specific instructions for the specified application. Baking time between coats must be a minimum 1 1/2 to 2 hours at 93 to 121 degrees C 200 to 250 degrees F. Baking after top coat must be one hour at 93 to 177 degrees C 200 to 350 degrees F, plus 2 hours final bake at a temperature of [177] [204] degrees C [350] [400] degrees F. Other baking schedules to achieve required quality coating may be proposed.

d. Repair: Return damaged surfaces to the applicator's shop for repair, unless otherwise approved by the Contracting Officer.

3.1.14.3 Inorganic Zinc Coating System

a. General Requirements, Inorganic Zinc Coating System: The following must govern for a protective coating system primer based on inorganic zinc coating intended for shop application to [_____] [specified] black carbon steel surfaces with subsequent field finishing with compatible tie coat and [epoxy] [acrylic latex] [modified acrylic] [chlorinated rubber] top coat [applied as part of work under Section 09 90 00 PAINTS AND COATINGS.]

b. Surface Preparation: SSPC SP 5/NACE No. 1.

c. Application: Apply one coat at [0.05 to 0.10] [0.10 to 0.13] mm [2 to

3] [3 to 5] mils dry film thickness by airless or conventional spray equipment. Use only those thinners and cleaners in amounts recommended by the manufacturer.

d. Repair: Field repair damaged surfaces in accordance with manufacturer's instructions.

3.1.14.4 Field Inspection of Protective Coating Work

Visually inspect coated surfaces from a maximum distance of 1.5 meters 5 feet with special attention given to corners and crevices. Check coating thickness in accordance with SSPC Paint 11. Perform inspection immediately prior to erection of ductwork and equipment and in the presence of the Contracting Officer. Repair coating as required. Apply additional coating if thickness is not sufficient.

3.1.15 Factory and Field Painting and Finishing

3.1.15.1 Factory Work

Factory finish interior ferrous metal and other specified metallic equipment and component surfaces with manufacturer's standard surface preparation, primer, and finish coating. Factory finish exterior to building space ferrous metal surfaces and other exterior to building and interior to building metallic or nonmetallic surfaces with specified protective coating system in accordance with the paragraph PROTECTIVE COATING MATERIAL in this section and otherwise with manufacturer's standard surface preparation, primer and finish which meet the requirements of paragraph CORROSION PREVENTION.

3.1.15.2 Field Work

Touch-up or if necessary, repaint factory applied finishes which are marred, damaged, or degraded during shipping, storage, handling, or installation to match the original finish. Clean and prime field or shop fabricated ferrous metals required for the installation specified under this section in accordance with the applicable provisions of Section [09 90 00] PAINTS AND COATINGS. Painting of surfaces not otherwise specified and finish painting of items only primed at the factory or elsewhere, are specified as part of the work under Section [09 90 00] PAINTS AND COATINGS.

3.2 TESTING, ADJUSTING, AND BALANCING

3.2.1 Ductwork Structural Integrity and Leakage Testing

****

NOTE: In addition to significant energy losses, air leakage from HVAC ducts and air handling units can cause significant IAQ problems due to unexpected airflow between indoors and outdoors, and between areas within the building. Air leakage from supply or return duct work contributes to the condensation of humid air in building cavities and/or on the neighboring surfaces. Air leakage can be especially problematic for ducts or AHUs that are located outside the conditioned spaces.

****

Inspect and test systems pressure rated higher than 498 Pa 2 inches water gage for structural integrity and leakage as systems or sections during construction but after erection, as work progresses, in system or section lengths not exceeding 30 meters 100 feet. Test for structural integrity at [_____] percent in excess of system fan positive or negative total pressure. Test for leakage at [_____] percent in excess of system fan positive or negative total pressure.[Leakage test procedure and apparatus must be in accordance with SMACNA 1972 CD. Total leakage, prorated to length of duct under test, must not exceed one percent of system capacity.] [Confirm that duct leakage is less than three percent of coil airflow for new systems and less than six percent for existing systems.] Do not permit leakage in positive pressure ducts in buildings carrying flammable or toxic materials.

3.2.2 Power Transmission Components Adjustment

Test and adjust V-belts and sheaves for proper alignment and tension preliminary to operation and after 72 hours of operation at final speed, in the presence of the Contracting Officer. Belts on drive side must be uniformly loaded, not bouncing.[Align direct-drive couplings to less than half of manufacturer's allowable range of misalignment.]

3.2.3 Preliminary Tests

Conduct an operational test on the entire exhaust duct systems, components, and equipment for a period of not less than 6 hours after power transmission components are adjusted. Replace filters, if any, after preliminary tests and prior to conducting final acceptance tests.

3.2.4 Testing, Adjusting, and Balancing Work

Perform work in accordance with the applicable and recommended procedures of: ACGIH-2092S. Provide apparatus, certified, calibrated, instrumentation including that to measure sound levels, motor current, and power factor. Unless approved otherwise, instruments must be limited to manometers and approved aneroid type gages (such as a Magnehelic). Velometers may be used for low velocity measurements if approved by the Contracting Officer.

3.2.5 Systems Volume Acceptance Criteria

Systems final volume must be within the following limits:

Fan: Plus 10 percent, minus zero percent of design volume at design temperature

Hood or Equipment: Plus or minus [5] [10] percent of design volume at design temperature

Note: Tolerances must be taken on clean or dirty conditions as indicated on the drawings.

3.2.6 Sound Level Tests

Report to the Contracting Officer in writing, sound levels higher than 84 dBA at hoods or at workers' normal operating positions at equipment in addition to being included in the required test reports.

3.3 SYSTEM[S] OPERATION DEMONSTRATION

After systems and equipment testing, adjusting, and balancing has been completed and accepted, demonstrate the complete and correct functioning of systems equipment and controls by operation through normal ranges and sequences, and by simulation of abnormal conditions, [including the manual tripping of fire dampers]. Manually and automatically cause every device to function as intended. Readjust, as necessary, any settings and after sufficient operating time, but not less than [6] [_____] hours, verify ability of equipment and controls to establish and maintain stable and accurate operation and required system performance. Note any abnormal deviations, such as excessive vibration, noise, and heat, binding damper mechanisms, and incorrect fan rotation. Make any necessary repairs, replacements or adjustments.

3.4 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Motors: Capacity	= 7 1/2 hp	= 5 1/2 kW
	= 15 hp	= 11 kW
	= 30 hp	= 22 3/8 kW
b. Gaskets: Thickness	= 1/8 inch	= 3 mm

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 44 00.00 10 (February 2016)**

Preparing Activity: USACE **Superseding**
UFGS-23 40 00.00 10 (October 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

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CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) AIR FILTRATION SYSTEM

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PART 3   EXECUTION

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USACE / NAVFAC / AFCEC **UFGS-23 44 00.00 10 (February 2016)**

Preparing Activity: USACE **Superseding**
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SECTION 23 44 00.00 10

CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) AIR FILTRATION SYSTEM

02/16

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NOTE: This guide specification covers the requirements for chemical, biological, and radiological air filtration systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME AG-1	(2023) Code on Nuclear Air and Gas Treatment
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME N509	(2002; R 2008) Nuclear Power Plant Air-Cleaning Units and Components
ASME NQA-1	(2024) Quality Assurance Requirements for Nuclear Facility Applications

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D2867	(2009; R 2014) Moisture in Activated Carbon
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST RP-CC-001	(2016; Rev 6) HEPA and ULPA Filters

IEST RP-CC-008	(2007; Rev 2) Gas-Phase Adsorber Cells

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-32101	(2019; Rev B; Notice 1 - Controlled Distribution Document) Carbon, Activated, Impregnated, Copper-Silver-Zinc-Molybdenum-Triethylenediamine (ASZM-TEDA)
MIL-PRF-32016	(2002; Rev A; Notice 1 2024) Cell, Gas Phase, Adsorber
MIL-STD-282	(2015; Rev B; Notice 1 2020) Filter Units, Protective Clothing, Gas-Mask Components and Related Products: Performance Test Methods

U.S. DEPARTMENT OF ENERGY (DOE)

DOE HDBK-1169	(2003) Nuclear Air Cleaning Handbook

UL SOLUTIONS (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

CBR Air Filtration System; G, [_____]

Installation and Erection; G, [_____]

SD-03 Product Data

Standard Products

Welding

Acceptance Tests

Factory Tests

Field Training

SD-06 Test Reports

Acceptance Tests

SD-07 Certificates

Field Acceptance Test

Protective Shipping

Carbon Adsorber

SD-10 Operation and Maintenance Data

Filtration Unit Manuals; G, [_____]

Operating and Maintenance Instructions; G, [_____]

1.3 QUALITY ASSURANCE

****

NOTE: Review ASME NQA-1 and include or exclude requirements as necessary. ASME NQA-1 is used for safety class filtration systems that perform a fail-safe function, typically for containment of highly toxic materials.

****

1.3.1 General

Manufacture the filtration units and stand-alone isolation dampers under a quality assurance program that meets the requirements stated in ASME NQA-1.

1.3.2 Welding

Qualify welding procedures, welders, and welding operators in accordance with ASME BPVC SEC IX. Submit a copy of qualified welding procedures, and a list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations. Perform all welding in accordance with the requirements specified in ASME BPVC SEC IX and as required by ASME N509. Pressure retaining weld joints must comply with the requirements of ASME BPVC SEC IX.

1.4 DELIVERY, STORAGE, AND HANDLING

Mount the filtration system with protective shipping skids, crated or covered, blocked, braced, and cushioned as necessary to prevent physical damage during shipping. Submit certification of compliance, including a certified list of materials. Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

2.1.1 General

a. Provide ductwork, fittings, and accessories as required to provide a complete installation and to eliminate interference with other construction. The CBR Air Filtration System must include ASTM A240/A240M Type 304 stainless steel bag-in/bag-out housing, isolation dampers located where indicated, roughing filter, pre-filter, HEPA filters, carbon adsorbers, [post-filter], in-place test sections, and a [blow-through] [draw-through] fan unit mounted on a structural steel equipment skid as indicated. Provide the filtration system with filtration element removal trays, removable access doors, [filtration element banding kits,] pressure ports, pressure gauges, duct transitions, flexible connections, test blanks, and other appurtenances required for the specified operation.

b. The filtration system physical dimensions must be suitable to fit the space allotted. Join together sections of the filtration system in series to make a system that meets the required capacity. Mechanically test the filtration system for leaks while in the factory.

c. The filtration system must be suitable for continuous operation with an air stream temperature of up to 57.2 degrees C 135 degrees F and suitable for radioactive and chemical warfare service. The system must also meet the applicable requirements of ASME AG-1, ASME N509, and UL 586. Systems located in temperature controlled areas that filter conditioned air or low temperature ambient air must be [externally or internally insulated as indicated] [of double walled construction with thermal insulation in the interstitial space].

d. The filtration system must meet the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

2.1.2 Structural Design

****

NOTE: Seismic protection is required for filtration systems that perform a safety function during and after a seismic event. Manufacturer's standard equipment is normally considered qualified for the requirements specified below. Review ASME AG-1, Section AA-4000, and provide specific additional requirements for the design application.

Coordinate seismic protection requirements with UFC 3-301-01.

****

Structurally design and test the filtration system, components, and accessories and submit appropriate documentation and certification as required by ASME AG-1 Section AA. The service condition of the filtration system must meet level [A] [B] [C] [D] service limits with the design loads indicated. Verify the structural design of the filtration system, components, and accessories by analysis, testing, or a combination of analysis and testing. The filtration system must be subjected to [5] [_____] operating based earthquakes (OBE) and one safe shutdown earthquake (SSE) as indicated by the required response spectrum. Each OBE and SSE must have a minimum test duration of [30] [_____] seconds. Ensure the seismic protection requirements of the filtration system, components, and accessories comply with Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT.

2.2 STANDARD PRODUCTS

Provide components and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design, and workmanship and have been in satisfactory commercial or industrial use for 5 years before bid opening. Submit a statement demonstrating successful completion of similar services on at least five projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section. Include manufacturer's catalog data for the specified items. Highlight the data to show model, size, options, etc., that are intended for consideration.

a. Include the 5-year experience applications of components and equipment under similar circumstances and of similar size. The 5 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 5-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 15,000 hours exclusive of the manufacturer's factory tests, can be shown. Submit proposed schedule for factory tests, at least 2 weeks prior to the start of related tests.

b. The equipment items must be supported by a service organization. Asbestos and asbestos-containing products are not acceptable.

c. Demonstrate compliance with contract requirements for the following:

  (1) Filtration System

  (2) Filtration Elements including Roughing Filter, Pre-filter, HEPA Filter, Carbon Adsorber,[Post-Filter], Gasket Seal, Fluid Seal and Bag-In/Bag-Out Assembly and Banding Kits

  (3) Isolation Dampers and Damper Operators

  (4) Fan Units

  (5) Flexible Connection

  (6) Pressure Gauge

  (7) Manufacturer's Quality Assurance Program

  (8) Testing Agency Qualifications

2.3 NAMEPLATES

Provide equipment with a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number. Provide each filtration element access door with a metal nameplate of the same material as the filter housing, fastened to the exterior which states the critical replacement components and part numbers for the equipment contained inside. Include filtration element model number, filtration element efficiency, and size on the nameplate. Provide each filtration element housing with an external metal pocket, for holding the operation and maintenance instruction manual, which must be provided with the housing. If housing is exposed to the weather, provide metal pocket that is weather resistant and equipped with weep holes. Provide instructions which are complete and detailed for the actual filtration system provided.

2.4 FILTRATION SYSTEM HOUSING

****

NOTE: A bag-in/bag-out housing is primarily used for filtration systems that continuously filter contaminants. For filtration systems in standby mode or that will not likely filter contaminants, a bag-in/bag-out housing is not required. A blow-through filtration system will be used when located in a contaminated environment and a draw-through filtration system arrangement will be used when located in a clean environment.

****

Provide housings of [single] [50 mm 2 inch double] [100 mm 4 inch double] wall construction, fabricated of a minimum 2 and 3 mm 12 and 14 gauge ASTM A240/A240M Type 304 stainless steel, with all pressure boundary joints, seams, and penetrations welded airtight. The housing must conform to ASME N509. Provide housings of a [single] [dual] side servicing bank type arrangement. Equip a housing two or more filtration elements wide with a filtration element removal rod. Design and construct the housing for a pressure of 5,000 Pa 20 inches wg and with an integral structural steel frame. Provide lifting lugs with a minimum of 50 mm 2 inch diameter eyeholes, made of the same material as the housing, on the top of each filtration unit. All portions of the filtration system housing must be free of sharp edges and burrs.

2.4.1 Filtration Element Access Door

Provide each filtration element location with an access door to remove the filtration element and replace it with another. Provide [single-wall] [double-wall insulated] type access doors, fully gasketed to the filtration system housing. Provide each rigid access door with at least four tie-down latches [with locking hasps] [with tamper-proof fasteners]. Design the access door such that, when removed, no sharp projections remain [and access to the bag-out port is not impeded]. [When the access door is closed, it must not press against the bag-out port or the PVC bag.]

2.4.2 Filtration Element Sealing Mechanism

[Filtration elements provided with gasket seals must have a sealing mechanism that is a replaceable unit, constructed of series 300 stainless steel, providing a total clamping force of 6200 N 1400 lbs per filtration element in accordance with DOE HDBK-1169.] [Filtration elements provided with fluid seals must have a series 300 stainless steel replaceable sealing mechanism that engages and disengages the element on the housing mounting frame's knife edge.]

2.4.3 Casings and Insulation

Field insulate casings as specified in Section 23 30 00 HVAC AIR DISTRIBUTION, paragraph: Casings. Place all of the required insulation for double wall type casing sections inside the cavity area.

2.4.4 Housing Man-Entry Doors

Provide [single wall] [50 mm 2 inch] [100 mm 4 inch thick double wall type access doors injected with a minimum of 0.028 kg/cubic meter 2.2 pounds/cubic foot of polyurethane foam]. Finish each door with the same material as the housing front and back. [Bond interior and exterior panels to create a seamless rigid panel with a minimum insulating value of] [R-13] [_____]. Door panels must [use a high density polyurethane thermal break and] incorporate an extruded gasket and be impervious to virtually all chemicals and be highly flexible in extreme heat or cold. Provide heavy duty stainless steel hinges and a minimum 200 by 200 mm 8 by 8 inch [single] [double] pane safety glass view windows with integral wire mesh reinforcing. Using test method ASTM E283 confirm zero total CFM air leakage at 1250 Pa 5.0 inches wg static pressure for a 600 by 1500 mm 24 by 60 inch [out] [in] swing door with two hinges and two latch points operable from inside and outside the housing.

2.4.5 Housing Leak and Pressure Test

****

NOTE: Use housing leakage rate of 0.20 percent of housing volume for all-welded man-entry steel housings and 0.05 percent for small single-filter housings.

****

Factory leak test the filtration system housing in accordance with ASME AG-1, Section 6, using the pressure decay method. The maximum housing leakage rate acceptance criteria is in accordance with DOE HDBK-1169 table 4.5, which is [0.05] [0.20] percent of housing volume at 2480 Pa 10 inches wg pressure differential. Test the housing both positively and negatively to the design pressure of [5,000] [_____] Pa [20] [_____] inches wg before performing the DOE HDBK-1169 housing leak acceptance criteria test.

2.5 FILTRATION ELEMENTS

Provide air filtration elements listed in accordance with UL 900. High-efficiency particulate air filters and carbon adsorbers must meet the requirements indicated.

2.5.1 Roughing Filter

Provide [50] [100] mm [2] [4] inch deep UL 586 Class II roughing filter, rigid pleat panel filter, consisting of cotton and synthetic media, heavy gauge expanded metal support grid, and rigid board enclosing frame. Provide roughing filter having a particle size removal efficiency (PSE) of 25 to 30 percent based on ASHRAE 52.2. Initial resistance at [_____] m/s feet/second must not exceed [_____] Pa inches wg.

2.5.2 Pre-filter and Post-filter

****

NOTE: Post filters are required by ASME N 509, are located downstream of adsorbers for carbon fines collection, and used for non-military applications.

****

Provide extended, dry media type [pre-filter] [pre-filter and post-filter], [100] [150] [300] mm [4] [6] [12] inch deep, with a particle size removal efficiency (PSE) of 95 percent based on ASHRAE 52.2. Initial resistance at [_____] m/s feet/second must not exceed [_____] Pa inches wg.

2.5.3 High-Efficiency Particulate Air (HEPA) Filter

****

NOTE: Frames constructed of plywood are usually used in applications where disposal of filters is by incineration.

****

Provide HEPA filters and frames meeting the materials, design, inspection, fabrication, quality assurance, and nameplate marked as specified in ASME AG-1, Section FC, and having a 99.97 percent efficiency with a 0.3 µm micron diameter particle size as determined by the dioctyl phthalate (DOP) test method in accordance with IEST RP-CC-001. Qualify and label HEPA filters in accordance with UL 586. HEPA filters must have the indicated capacity and pressure drop for clean filters. Provide [Type II - stainless steel sheet, Type 304] [Type IV plywood] construction filter frames as defined in ASME AG-1, Section FC. Manufacture the HEPA filter media in accordance with ASME AG-1, Section FC. Provide filtration media frames with an integral perimeter gasket seal. Initial resistance at [_____] m/s feet/second of filter face area must not exceed [_____] Pa inch wg.

2.5.4 Carbon Adsorber

****

NOTE: To remove all chemical warfare agents (included in FM 3-9) from an air stream use impregnated ASZM-TEDA carbon media. To remove chemical agents that only have low volatility (vapor pressure less than 1,000 Pa 4 inches wg) use activated carbon conforming to ASME AG-1. Many toxic industrial chemical vapors are not effectively removed by ASZM-TEDA carbon.

Commercial carbon adsorbers are typically designed for 235 sL/s 500 scfm when configured as a single stage system; however, designs for various air flow capacities 165 to 354 sL/s 350 to 750 scfm are available as indicated in the table below.

Adsorber Air Flow Rate		
Nominal Adsorber Depth, mm inches	**Single Stage, L/s cfm**	**Dual Stage, L/s cfm**
35514	**177375**	**354750**
40516	**236500**	**4721000**
45518	**295625**	**5901250**
51024	**354750**	**7081500**

The air flow rates listed above are at 0.25 seconds residence time.

Care should be taken to maintain residence time of air passing through the carbon adsorber. For example, placing two adsorbers in series maintains the residence time while doubling the airflow capacity.

At 472 sL/s 1000 scfm the ASZM-TEDA adsorber uses a 12 x 30 mesh of carbon media that has a pressure drop of approximately 1,500 Pa 6 inches wg per carbon adsorber stage. Activated carbon adsorbers, conforming to ASME AG-1 and using 8 x 16 mesh carbon, have a pressure drop of approximately 682 Pa at 472 sL/s 2.75 inches wg at 1000 scfm per carbon adsorber stage.

****

Provide carbon adsorbers consisting of six 50 mm 2 inch thick panels configured as a V-bed similar to the shape of a Type I cell in accordance with IEST RP-CC-008. The adsorber consists of [ASZM-TEDA carbon conforming to MIL-DTL-32101] [non-impregnated highly activated carbon conforming to ASME AG-1, Section FF]. Provide carbon adsorber meeting the requirements for airflow resistance, refrigerant leak test, dimethylmethylphosphonate (DMMP) breakthrough life test, moisture content, cyanogen chloride (CK) gas life, and gas life capacity testing. Provide carbon adsorber having an airflow rate capacity as indicated and designed to adsorb chemical vapor with an overall system minimum residence time of [0.25] [______] seconds. Use ASTM A240/A240M Type 304 stainless steel for all inner and outer case materials.[Design the adsorber to include a means to obtain samples of the adsorbent. The preferred method incorporates a set of sample canisters. Other methods or designs are acceptable if it can be shown that a representative sample of the total bed thickness is produced without voids or that result in a bypass condition.] Provide carbon adsorber frames with an integral perimeter [gasket seal] [fluid seal]. Submit documentation, including table and/or schematic, identifying outline or significant interface dimensions, certified list of materials, adsorbent type and its certified test reports, welder qualifications, certified test reports for all performance requirements specified, certification of compliance with specified packaging and shipping requirements.

2.5.4.1 Airflow Resistance

The airflow resistance must be [750 Pa 3.0 IWG +/- 10 percent] [1,500 Pascal 6.0 IWG] [[_____] Pascal IWG +/- 10 percent] at the rated air flow with an air stream temperature of 21 degrees C 70 degrees F and a barometric pressure of 760 mm 29.92 inches Hg. Test each cell to be delivered to the Purchaser at the manufacturer's location prior to packaging. Mark airflow resistance and certification on each cell. Reject any cell not meeting the airflow resistance requirement. Install the cell in the test tunnel in its service orientation and the airflow through the cell adjusted to [236 L/s 500 SCFM +/- 5 percent] [472 L/s 1,000 SCFM +/- 5 percent] [[_____] L/s SCFM +/- 5 percent]. Perform the following: 1) Record the barometric pressure. 2) Measure and record the air stream temperature. 3) Determine and record the difference in the static pressure head upstream of the cell to that downstream of the cell. Subtract the test fixture resistance so that the recorded resistance is that of the cell. If testing occurs at nonstandard conditions, calculate and record the airflow resistance, and correct the test measurements to standard conditions.

2.5.4.2 Refrigerant Leak Test

Each cell to be delivered to the Purchaser must have been tested by the manufacturer prior to packaging. During the test, the downstream concentration of the refrigerant gas cannot exceed 0.0005 times the upstream concentration. Reject cells that do not meet this requirement. Install the cell in the test tunnel in its service orientation and the airflow to [236 L/s +/- 12 L/s 500 SCFM +/- 25 SCFM] [472 L/s +/- 24 L/s 1,000 SCFM +/- 50 SCFM]. Challenge the cell with a refrigerant vapor (R-134a or equivalent) at a concentration equivalent to at least 20,000 times the minimum sensitivity of the monitor used to measure filter leakage. Locate the challenge-gas injection port in such a manner to ensure uniform mixing of the tracer gas. Locate the downstream test port to ensure a representative sample. Qualification data to verify test port selection must be on file for inspection upon request. Inject the leak tracer chemical (refrigerant) continuously into the filter influent over an interval sufficient to ensure the effluent monitor is capable of accurately measuring the required leakage level.

2.5.4.3 Dimethylmethylphosphonate (DMMP) Breakthrough Life Test

****

NOTE: For production lots consisting of a large number of filters, less than 10 percent of the filters can be tested to obtain a high level of confidence of acceptable performance.

****

The adsorber cell being destructively tested for DMMP gas life value as specified for a minimum of [50] [_____] minutes when subjected to the rated air flow at 52 degrees C 125 degrees F, at less than 40 percent relative humidity and having an inlet concentration indicated. Test cells which are filled with an adsorbent meeting the specified requirements will be randomly selected by the Contracting Officer from the lot. The number of cells required for DMMP testing is 10 percent, rounded down for the total number of adsorbers in the lot, but not less than one. Therefore, the required number of deliverables is equal to the number required for the system plus the number of cells to undergo this destructive testing. Hard-mount each test cell to a rough handling machine in its service orientation and vibrate for 10 minutes at a frequency of 200 cycles per minute at an amplitude of 19.1 mm +/- 0.32 mm 3/4 inch +/- 1/8 inch in accordance with MIL-STD-282, Test Method 105.11. Immediately following the rough handling, DMMP breakthrough life test the cells at the same test facility the cells were rough handled in order to minimize carbon redistribution. If at least one cell fails to meet the criteria, reject the lot. Adjust the filling procedure and submit another lot for DMMP breakthrough life test. Just prior to running the DMMP test, measure and record airflow resistance data for the sample cell and the airflow resistance calculated at standard conditions as indicated. Install cell in the test tunnel in its service orientation. Adjust airflow to [236 L/s 500 SCFM +/- 5 percent] [472 L/s 1,000 SCFM +/- 5 percent]. Run the test to cell life. Test the cell for DMMP breakthrough life at the following test parameters:

Challenge Concentration	5,000 (400 mg/m3 1050 ppm +/- 80 ppm)
Breakthrough Concentration	0.02 mg/m3 0.004 ppm
Relative Humidity	less than 40 percent
Temperature	45 degrees C +/- 5 degrees C 113 degrees F +/- 9 degrees F

a. For the adsorber cell to be acceptable, the breakthrough time for the DMMP concentration of the filter effluent to increase to 0.02 mg/m3 0.004 ppm must be as indicated. While the challenge concentration is permitted to vary within the stated range during the course of the test, normalize the breakthrough time measured to the 5000 mg/m3 1050 ppm concentration by the following calculation:

b. Corrected breakthrough time = Measured breakthrough time x Average concentration during test x 5000 mg/m3 1050 ppm.

c. The DMMP vapor in air challenge concentration must be created to ensure uniform mixing of the DMMP vapor with the air once it reaches the test cell. Have qualification testing to verify the DMMP vapor concentration is uniform across the cell face on file and available for inspection. Operate the test tunnel at the rated flow. Challenge the inlet face of the cell as specified above. Record the total time from the start of the cell challenge until the breakthrough concentration is reached (i.e. the life of the cell) as the breakthrough time. This testing will be performed by the Government at the following location:

Quality Evaluation Laboratory,Engineering Directorate,
U.S. Army Edgewood Research, Development and Engineering Center
Aberdeen Proving Ground, MD 21010-5423
(410) 436-2284
(410) 436-4804 (FAX)

2.5.4.4 Moisture Content/Cyanogen Chloride (CK) Gas Life Sampling

Obtain a minimum 0.45 kg one pound specimen of carbon during filling of the first cell, the middle cell, and the last cell of the day. Place each carbon specimen in an open container or in a cloth bag and accompany its cell through the assembly line. Do not expose the specimen to refrigerant. Label the carbon specimen to match it to its adsorber cell. Upon completion of the lot, choose a sample from the specimens in each quarter of the lot. Ship these 4 samples for testing by the Government at the location indicated above.

2.5.4.5 Moisture Content

Sample carbon as indicated and moisture content of each carbon adsorbing cell cannot exceed 3 percent by weight when tested. Determine the moisture content of the carbon samples in accordance with ASTM D2867, except the oven temperature is 103 to 107 degrees C 217 to 225 degrees F and the drying time is 3 hours. Should any sample fail to meet the moisture requirements, remove all cells fabricated following the last cell represented by a sample carbon which did meet the requirement and before the carbon represented by the next carbon sample which does meet the requirement from the production lot. These cells may be dried at a temperature not to exceed 66 degrees C 150 degrees F by blowing air less than 10 percent relative humidity at rated flow for 3 hours, immediately before packaging.

2.5.4.6 CK Gas Life Test

After completion of all manufactures steps, the adsorber cell's carbon must comply with the CK gas sorption requirement of MIL-DTL-32101 for unaged carbon. Determine the CK Gas Life of the carbon samples in accordance with MIL-DTL-32101. Reject the production lot of cells if any sample fails to meet the CK gas life requirements as indicated.

2.5.5 Gasket Seal

Mount and seal an interlocking dovetailed gasket to the perimeter of the upstream face of the filtration element frame in accordance with ASME AG-1, Section FC. Provide oil resistant expanded cellular elastomer gasket conforming to ASTM D1056 Grade 2C2, and able to withstand the specified applied clamping force without loss of seal resilient memory.

2.5.6 Fluid Seal

****

NOTE: Fluid seals are limited to low-temperature filtration applications.
****

Provide filtration element frames having an integral channel filled with a fluid seal. The fluid seal must engage a continuous knife-edge on the housing mounting frame. The fluid seal must be highly viscous, odorless, biostatic, self-healing, non-evaporating, non-Newtonian, radiation and chemical resistant, insoluble in water, silicone compound, and suitable for a temperature range of -50 to 202 degrees C -58 to 396 degrees F. Seal the channel before the fluid seal is placed into the channel. The fluid seal cannot pull out of the groove or leave a residue on the housing mounting frame knife-edge.

2.6 BAG-IN/BAG-OUT ASSEMBLY AND BANDING KITS

Provide each filtration element access location with a bag-in/bag-out assembly and 0.20 mm 8 mil transparent PVC bag sized to completely enclose the element and suitable for 57.2 degrees C 135 degrees F ambient environment. Locate the assembly inside the access door. Provide the bag with an elastic shock cord hemmed into its mouth and secured by a strap to the assembly to prevent bag slippage during the filtration element bagging procedure. Test the bag at the factory to ensure it has no leaks. Provide an additional quantity of [one complete set of] [_____] spare bags to the Contracting Officer. Provide one complete banding kit with each filtration unit equipped with a bag-in/bag-out assembly. The banding kit must provide a secure clamping off of the bag between the housing and the spent filtration element. Provide with each kit a banding tool, a bag-cutting tool, and two sets of plastic ties, stainless steel bands, and replacement bags. Also provide additional tools required to complete the bag-in/bag-out procedure.

2.7 IN-PLACE DOP/GAS AEROSOL TEST SECTION

****
NOTE: Test sections are necessary to perform leakage tests and to locate leaks in multiple filter arrays. Filters or adsorbers placed in series will require a test and sample combination section between stages.

A swing-away mixing device is only used in leakage testing. The device swings out of the way in normal filtration operation.

Upstream injection and downstream sampling sections are required if particulate is to be filtered from the air stream.
****

Provide the test sections as an injection, sampling, and/or injection and sampling combination as indicated, constructed in a manner identical to the remainder of the filtration system housing and meeting the applicable design parameters of ASME N509. Where a second stage of [HEPA filters] [or] [carbon adsorbers] is required, use an injection and sampling combination test section between the first and second stages. Construct the test sections such that adjoining parallel test sections are isolated from each other. This will permit [individual efficiency and mechanical seal test of each HEPA filter] [and] [mechanical seal tests of the carbon adsorber] and supporting framework in accordance with ASME AG-1. The pressure drop across each test section must be no greater than 62 Pa at 472 L/s 0.25 inches wg at 1000 cfm during the test. Stationary baffle type test sections are not acceptable. Furnish the test section with swing-away mixing devices. Provide injection and sample ports and apparatus to form an integral part of the test section.

2.8 IN-PLACE TEST PORTS

****

NOTE: If only gas adsorption is to be performed by the filtration system in lieu of upstream and downstream sampling sections, aerosol injection and sample ports may be used.

****

[Provide upstream challenge aerosol inlet and sample ports for each [HEPA filter] [or] [carbon adsorber] section. Provide a 13 mm 1/2 inch NPT Type 304 stainless steel coupling with plug test port, used for upstream sampling, located upstream of the HEPA filter and welded to the top side of the filtration system housing.] [Provide three additional test ports shipped loose for field installation into the ductwork; one used for injection upstream, one used for sampling before the filter housing, and one used for downstream sampling of the filtration system housing. Locate upstream inlet and sample port and downstream sample port to provide uniform mixing during field-testing as required by ASME N509 and ASME AG-1.]

2.9 WEATHER COVER

Protect filtration systems located in unsheltered areas by using an integral weather cover. Construct the weather cover of the same material as the filter housing and mechanically fasten,including gasket, to the filter housing.

2.10 ISOLATION DAMPERS

****

NOTE: Depending on system design requirements, isolation dampers may or may not be part of the filtration system design. The gasket material must be butyl rubber for Class 0, zero leakage dampers, and EPDM for Class 1 low leakage dampers.

****

Provide isolation dampers as an integral part of the filtration system. [Provide an individual damper to isolate the filtration system.] [Provide multiple dampers to isolate individual sections of the filtration system.] Classify, construct, inspect, and test dampers in accordance with ASME N509 construction Class B as a single blade damper or a combination of single blade dampers. The leakage of the isolation dampers must conform to ASME AG-1, Section DA, Class [0, zero leakage] [1, low leakage]. Construct the blade/disk, frame, shafts, and linkages of Type 304 stainless steel. Provide the dampers with Type 304 stainless steel disk with a [butyl rubber] [EPDM] gasket. The isolation damper disk gasket (seal) and shaft seal must be replaceable. Operate each isolation damper by an independent electrically-actuated drive mechanism [with manual backup]. Provide isolation dampers of all welded design. [Factory drill in isolation damper flanges 11 mm 7/16 inch holes, located on the filtration unit [as indicated] and no more than 100 mm 4 inches apart as described in

DOE HDBK-1169]. Reinforce the flanges with flat stock of the same material to provide a combined minimum thickness of 6 mm 1/4 inch.

2.10.1 Electrically and Manually Actuated Isolation Damper Operators

Operate damper operators in an automatic mode [with manual backup]. Provide an electric/manual operator of sufficient capacity to operate the damper under all conditions, and to guarantee tight close-off of the damper against all system pressures encountered. The maximum force required to manually actuate the damper is 11.3 kg 25 pounds. Provide controls as specified in [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

2.10.2 Fan Unit

Provide fans, airflow control dampers, and actuators as specified in Section 23 30 00 HVAC AIR DISTRIBUTION. Provide single-inlet, centrifugal type fans, with the fan [inlet] [outlet] connected to the filtration unit with a flexible duct connector and duct transition to the filtration unit housing. Control the fan by [a manually] [an automatic electrically] actuated, [inlet vortex] [outlet opposed blade] damper suitable for the specified static pressure.

2.10.3 Flexible Duct Connectors

Provide a flexible duct connector approximately 152 mm 6 inches in width where sheet metal connections are made to the fan unit. Lock the flexible material, chemically resistant butyl rubber, to metal collars and install using normal duct construction methods. The flexible material must withstand the indicated system pressures. Provide composite connector system in compliance with NFPA 701 and classified as flame-retarded fabrics in UL 723.

2.11 DUCTWORK AND DUCT TRANSITIONS

Provide ductwork and duct transitions of stainless steel, and as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.12 THERMAL INSULATION

Provide thermal insulation for ductwork and equipment as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.13 PRESSURE GAUGE

Provide dial type pressure gauges, diaphragm operated, with two pressure relay switches for low and high limit relay control. Incorporate adjustable switch point indicators for continuous indication of switch settings into the gauges. Provide gauges for roughing filter, pre-filter, HEPA filter banks, post filter, and total filter system pressure drop. Provide gauges that are at least 98 mm 3-7/8 inches in diameter, have white dials with black figures with graduations, and a minimum range of 250 Pa 1 inch wg beyond the specified final resistance for the individual filter served. Incorporate a screw operated zero adjustment into each gauge and furnish complete with stainless steel compression fittings and tubing. Mount all hardware in one location and test at the factory. All gauges must have a dual dial scale readout in units of pascals and inches water gauge.

2.14 PRESSURE PORTS

****

NOTE: Pressure ports are not needed for carbon adsorber elements.

****

Locate static pressure ports on the filtration unit upstream and downstream of each roughing filter, pre-filter, HEPA filter bank, and post filter. Use 6 mm 1/4 inch 300 series stainless steel pipe nipples and caps for port connections.

PART 3 EXECUTION

3.1 INSTALLATION AND ERECTION

Install and erect CBR Air filtration systems in accordance with ASME N509, as indicated on the drawings, and in accordance with the manufacturer's diagrams and recommendations.

Submit drawings consisting of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports, typical support details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and pressure gage tubing layout showing the location of all gages. Include in the drawings a table and/or schematic identifying outline or significant interface dimensions and any information required to demonstrate that the system has been coordinated and properly functions as a unit, and shows equipment relationship to other parts of the work, including clearances required for operation and maintenance.

3.2 ACCEPTANCE TESTS

Conduct all acceptance tests in accordance with the procedures in ASME AG-1 and as required by MIL-PRF-32016.

a. Submit proposed test schedules for adjusting and balancing, housing leak and pressure, air-aerosol mixing uniformity, damper operation and leakage, system bypass, performance tests of systems and test procedures, at least 2 weeks prior to the start of related testing.

b. Submit certified test report for adsorbent filtration type, for filtration unit factory acceptance test, filtration unit field test, isolation damper acceptance test, air-aerosol mixing uniformity test, damper operation and leakage test, housing leak and pressure test, system bypass test, and performance tests in booklet form, upon completion of testing. Document, in the report, phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

3.2.1 Visual Inspection

Perform visual inspection in accordance with ASME AG-1.

3.2.2 Airflow Capacity and Distribution Test

Measure the airflow across each filtration element bank to verify that it meets the designed flow rate under actual field conditions. Also verify that the airflow is distributed evenly across each filtration element bank as required by ASME AG-1 which is +/- 20 percent of the average airflow through each filter bank. Perform all tests in accordance with ASME AG-1.

3.2.3 Air-Aerosol Mixing Uniformity Test

Introduce a challenge gas into the air system to verify that it has uniformly mixed before entering the filtration element bank. Follow and comply with the test procedure in ASME AG-1.

3.2.4 Damper Operation and Leakage Test

Test the damper to verify that it operates as specified. Measure and record the air leakage rate through the isolation dampers. Functionally test the damper as required in ASME AG-1. [Apply the pressure decay or bubble test method leakage test for Class 0 dampers as specified in ASME AG-1.] [Perform the leakage test for Class 1 dampers in accordance with ASME AG-1.]

3.2.5 System Bypass Test (Filter and Adsorber Mounting Frame)

Remove and replace the filtration elements at each [HEPA] [HEPA and Carbon Adsorber] mounting frame housing location with a test blank. Test the filtration element housing and housing seal in accordance with ASME AG-1. Measure and record the air that bypasses the test blank as an air leakage rate, repair by seal welding and retest. Caulking or other temporary sealing measures are not allowed. The acceptable leakage rate is zero percent. After testing is completed, remove the blank and reinstall the filtration elements. Turn over the test blank to the Contracting Officer.

3.3 FIELD TRAINING

****

NOTE: The number of hours of instruction should be determined based on the number and complexity of the systems specified.

****

Submit proposed schedule for field training, at least 2 weeks prior to the start of related field training. Conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Provide training for a period of [_____] hours of normal working time. Starttraining after the system is functionally complete but prior to the performance tests. The field instruction must cover all of the items contained in the approved Operating and Maintenance Instructions and the Filtration Unit Manuals.

Submit [6] [_____] manuals in [hard copy form] [in electronic form (PDF) on DVD] listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals must include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted must be capable of providing [4][_____] -hour on-site response to a service call on an emergency basis.

3.4 FIELD ACCEPTANCE TEST

****

NOTE: A number of factors will determine the efficiency of a carbon adsorber system; generally, 8 x 16 mesh carbon granules provide at least 99.9 percent efficiency. Select the appropriate concentration reduction value for the field tests.

****

After installation, field test the filtration system for leaks using a mechanical test method. Also test the system for leaks between the filter element and its housing. Perform testing after installation by an independent testing agency in accordance with ASME AG-1. Submit testing agency certification prior to in-place filtration element testing in accordance with ASME NQA-1 or provide documentation demonstrating previous experience with similar systems as approved by the Contracting Officer. [Challenge the carbon adsorber system housing and carbon adsorber with refrigerant vapor R-134a or equivalent with the downstream concentration not to exceed [0.001] [0.0001] times the upstream concentration.] [The HEPA filter DOP aerosol penetration must be less than 0.03 percent.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 50 52.00 10 (February 2016)**

Preparing Activity: USACE **Superseding**
UFGS-33 60 00.00 10 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

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CENTRAL HIGH TEMPERATURE WATER (HTW) GENERATING PLANT AND AUXILIARIES

02/16

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 50 52.00 10 (February 2016)**

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UFGS-33 60 00.00 10 (April 2008)

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SECTION 23 50 52.00 10

CENTRAL HIGH TEMPERATURE WATER (HTW) GENERATING PLANT AND AUXILIARIES

02/16

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NOTE: This guide specification covers the requirements for high temperature water plants of capacities over 2,930 kW 10,000,000 Btuh, producing water at temperatures of 115 to 227 degrees C 240 to 440 degrees F at pressures up to 2.8 MPa 400 psig.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)

ABMA Boiler 203	(2002) A Guide to Clean and Efficient Operation of Coal-Stoker-Fired Boilers

AMERICAN GAS ASSOCIATION (AGA)

AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6013	(2006A; R2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems
ANSI Z83.19/CSA 2.35	(2017; R 2022) Gas-Fired High-Intensity Infrared Heaters

AMERICAN PETROLEUM INSTITUTE (API)

API STD 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2023) Manual for Railway Engineering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VII	(2017) BPVC Section VII-Recommended Guidelines for the Care of Power Boilers
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers

ASME PTC 4	(2013; R 2023) Fired Steam Generators
ASME PTC 10	(2022) Performance Test Code on Compressors and Exhausters

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C213	(2022) Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A514/A514M	(2022) Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B68/B68M	(2011) Standard Specification for Seamless Copper Tube, Bright Annealed (Metric)
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube

ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C27	(1998; R 2022) Fireclay and High-Alumina Refractory Brick
ASTM C34	(2023) Standard Specification for Structural Clay Loadbearing Wall Tile
ASTM C62	(2023) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C401	(2012; R 2022) Alumina and Alumina-Silicate Castable Refractories
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

CAGI B19.1	(2010) Safety Standard for Compressor Systems

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION (CEMA)

CEMA B105.1	(2015) Welded Steel Conveyor Pulleys
CEMA Belt Book	(2014; Errata 2016; Tech Statement 1 2016) Belt Conveyors for Bulk Materials

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NACE INTERNATIONAL (NACE)

NACE SP0185	(2024) Extruded Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

RUBBER MANUFACTURERS ASSOCIATION (RMA)

RMA IP-1	(2011) Conveyor and Elevator Belt Handbook; 3rd Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 16	(2023) Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

TUBULAR EXCHANGER MANUFACTURERS ASSOCIATION (TEMA)

TEMA Stds	(2007) Standards of the Tubular Exchange Manufacturers Association (TEMA)

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

30 CFR 1	Mine Safety and Health Administration;

	Establishment and Use of Official Emblem

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

High Temperature Water Generators

SD-03 Product Data

Calculations

Spare Parts

Support of the Equipment

Manufacturer's Instructions

Tests

Welding Qualifications

Field Training

SD-06 Test Reports

Tests

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Welding Qualifications

****

NOTE: Where pipeline, structural, or other welding is required on the same project, tests will be required accordingly. Testing may be by the coupon method as prescribed in the welding code or by special radiographic methods. If the need exists for more stringent requirements for weldments, delete the first bracketed statement and the welding submittal.

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[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Submit a copy of qualified welding procedures and a list of names and identification symbols of qualified welders and welding operators. Qualifiy procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform the tests at the work site if practicable. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.3.2 Calculations

Submit manufacturer's design data and structural computations, calculations for walls, roof, foundations, and other features for specialty type of construction, along with design data for lateral forces that may be encountered due to wind loads and seismic forces.

1.4 DELIVERY, STORAGE, AND HANDLING

Store all equipment delivered and placed in storage with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of the drawings and not later than [_____] months before the date of beneficial occupancy. Include a complete list of spare parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1] [and] [3] year[s] of service

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 5 years prior to bid opening.

Equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.1.2 Nameplates

Secure to each major item of equipment a plate with the manufacturer's name, address, type or style, model or serial number, thermal output or flow rate, and catalog number.

2.1.3 Prevention of Rust

Unless otherwise specified, factory prime paint surfaces of ferrous metal subject to corrosion with a rust inhibiting coating and subsequently factory finish paint in accordance with the manufacturer's standard practice. Prime and paint equipment exposed to high temperature when in service with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil.

2.1.4 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact. Provide guard or specified insulation cover for high temperature equipment and piping exposed to contact by personnel or where it creates a fire hazard. Provide items such as catwalks, operating platforms, ladders, and guardrails where shown, and constructed in accordance with Section [08 31 00

ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.1.5 Use of Asbestos Products

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NOTE: The first clause in brackets should be used when it is known that substitutes are available for any asbestos products which might be included with the equipment. The second clause in brackets should be used when it is possible or definitely known that asbestos products for which no technically acceptable substitute exists may be included with the equipment.

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[Products which contain asbestos are prohibited. This prohibition includes items such as packings or gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material.] [Except as provided below, products which contain asbestos are prohibited. This prohibition includes items such as packings and gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material. Asbestos products are acceptable only in exceptional cases where the Contractor states in writing that no suitable substitute material exists, and, in addition, the Contractor furnishes to the Contracting Officer a copy of U.S. Department of Labor, Occupational Safety and Health Administration "Material Safety Sheet" (Form OSHA-20), completed by the asbestos manufacturer, stating that the product is not an asbestos health hazard.]

2.2 HIGH TEMPERATURE WATER GENERATORS

Submit detail drawings consisting of schedules, performance charts, brochures, diagrams, drawings, and instructions necessary for installation of the HTW generating units and associated equipment, and for piping, wiring, devices, trenches, and related foundations. Complete setting plans certified by the HTW generator and burner manufacturers. Detail drawings for HTW generators and appurtenances, including coal and ash handling equipment indicating clearances required for maintenance and operation containing complete wiring and schematic diagrams, equipment layout and anchorage, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Include manufacturer's written instructions indicating optimum pressure at all manometer connectors. Provide, for each HTW generator (boiler), with a label indicating the capacity when operating at [_____] degrees C degrees F entering water temperature and [_____] degrees C degrees F outlet temperature with a water flow of [_____] kg/second pounds/hour. Design the HTW generators for a maximum allowable working pressure of [_____] kPa psig at [_____] degrees C degrees F. Provide in the design, equipment layout and accessory locations permitting accessibility for maintenance and service with the following design conditions:

a. Site elevation, [_____] m feet.

b. Ambient air temperatures, [_____] degrees C degrees F to [_____] degrees C degrees F.

c. Reference air temperature, 27 degrees C 80 degrees F.

Provide HTW generators capable of operating continuously at maximum specified capacity without damage or deterioration to the generator, its setting, or firing equipment or auxiliaries with automatic operation while burning the fuel specified. Provide HTW generators to operate on [coal meeting the requirement of paragraph FUEL BURNING EQUIPMENT][fuel oil conforming to grade number of ASTM D396][a combination of coal and fuel oil conforming to ASTM D396][natural gas].

2.2.1 Capacity

Provide HTW generators which operate at rated capacity continuously without exceeding the furnace heat release, volumetric and radiant, furnace exit temperature, and gas exit temperature specified. Include generator fans, motors, drives, and similar equipment with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork.

2.2.2 Electrical Equipment

Provide electric motor-driven equipment complete with motors and necessary motor control devices, specifying motors and motor control devices in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM including requirements for hazardous area locations with electrical characteristics and enclosure type indicated. Provide integral size premium efficiency type motors in accordance with NEMA MG 1.

2.2.2.1 Motor Ratings

Provide motors suitable for the voltage and frequency required. Provide three phase for 373 W 1/2 horsepower motor and larger unless otherwise indicated with ratings adequate for the duty imposed, but not less than indicated.

2.2.2.2 Motor Starters

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

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Provide motor starters where a motor starters are not indicated, in a motor control center on the electrical drawings, under this section of the specifications with complete with properly sized thermal overload protection and other equipment at the specified capacity including an allowable service factor, and other appurtenances necessary. Provide, whether indicated or not, manual or automatic control and protective or signal devices required for the operation specified, and any wiring required to such devices. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function.

2.2.3 Heating Plant Requirements

Provide plant fired [package type][field-erected type], [coal-][fuel oil-][combination coal/fuel oil-], controlled circulation, HTW generators; expansion vessels; nitrogen pressurization system; makeup water equipment; fuel systems; pumps; and all controls, piping, insulation, miscellaneous plant equipment and other accessories indicated or necessary to provide a complete and operable system.

2.2.4 HTW Generator Design Requirements

2.2.4.1 Radiant Heat Input

Limit the radiant heat input for the effective radiant heating surface of controlled circulation watertube HTW generators to a maximum of 394 kW/square meter 125,000 Btuh/square foot.

2.2.4.2 Maximum Heat Input

Limit the maximum heat input per cubic meter cubic foot of furnace volume to 931 MJ/cubic meter 25,000 Btu/cubic foot with spreader stokers and watertube boilers and 1,677 MJ/cubic meter 45,000 Btuh/cubic foot with underfeed stokers.

2.2.4.3 Combustion Gas Temperature

Provide the combustion gas temperature at the furnace exit with [minimum of 56 degrees C 100 degrees F less than the ash fusion softening temperature (reducing atmosphere) of the coal specified] [or] [maximum of 1150 degrees C 2100 degrees F when furnace is oil-fired].

2.2.4.4 Design Requirements

Provide manufacturer certification for the HTW generator controlled, forced-circulation, watertube, once-through type designed and constructed for high temperature water service conforming to, unless modified, the applicable construction and performance requirements of ASME BPVC SEC I and ASME BPVC SEC VII with the following additional requirements:

a. Water pressure drop not exceeding 105 kPa 15 psi based on a water temperature differential of 83 degrees C 150 degrees F, generator inlet to outlet.

b. The generator with no steam space or other spaces where steam can be trapped, with vented headers at high points as required.

c. Provide design for horizontal flow or upflow of water tubes and headers located in any radiant heat transfer zone.

d. Tubes and headers located outside the primary radiant heat transfer zones may be designed for downflow of water.

e. Provide generator designed for equalization of water flow through the tube circuits with radiant and convective heating surfaces arranged for series water flow to insure uniform flow distribution and temperature rise with proportioned flow to the heat input to prevent formation of steam in any tubes or headers to the extent that flow distribution becomes unbalanced. Distribution of flow may be controlled by limiting the number of flow paths in parallel, or by using restrictors (orifices), when required, in each group of parallel flow paths to increase pressure drop and to insure that all groups have the same pressure drop.

2.2.4.5 Spreader Stoker Units

Provide a maximum loading of 2206 kW/square meter 700,000 Btuh/square foot of grate area for spreader stoker units with continuous or intermittent automatic mechanical ash discharge grates, with a maximum loading of 1,419 kW/square meter 450,000 Btuh/square foot of grate area for the traveling grate type.

2.2.4.6 Underfeed Dumping Grate Units

Provide for underfeed dumping grate units, excluding side dumping areas, a maximum loading per square meter square foot of grate of 1,419 kW 450,000 Btuh, assuming a 10 percent maximum ash content and 1200 degrees C 2200 degrees F minimum ash softening temperature.

2.2.4.7 Effective Radiant Heating Surface

Effective radiant heating surface side receiving heat, excluding refractory lined surfaces, is defined as the heat exchange surface within the furnace boundaries which is directly exposed to radiant heat of the flame on one side and to the medium being heated on the other. This surface includes plain or finned tubes and headers and plain surfaces which may be bare, metal covered, or metallic core covered. Base computations of effective radiant heating surfaces on the following:

2.2.4.7.1 Bare, Metal Covered, or Metallic Core Covered Tubes and Headers

The projected area, external diameter times length, of the tube or header.

2.2.4.7.2 Extended Surfaces, Metal and Metallic Surfaces Extending from the Tubes or Headers

80 percent of the flat projected area, except metal blocks not integral with tubes or headers; extended surfaces less than 6.4 mm 1/4 inch thick or more than 32 mm 1-1/4 inches long; that portion of the extended surface which is more than one tube or header radius from the tube or header from which it extends, are not included.

2.2.4.7.3 Furnace Exit Tubes

The projected area of those portions of the first two rows of exit tubes receiving radiant heat from the fire.

2.2.4.8 Furnace Volume

Furnace volume is defined as the cubical volume between the top of the grate and the first plane of entry into, or between, the tubes. If screen tubes are utilized, they constitute the plane of entry.

2.2.4.9 Burners

Conform burners to requirements of NFPA 85, UL 296, and UL 726, except as otherwise specified. Equip flame safeguard controls with repetitive self-checking circuits.

2.2.4.10 Generator

Provide HTW generator with continuous capacity within the specified range at the specified pressure with boiler feed water at approximately [_____] degrees C degrees F, with flue gas outlet temperature [_____] degrees C degrees F, based on excess air of [_____] percent and carbon loss of [_____] percent, at all loads above 50 percent of maximum continuous capacity. Base output capacity on tests of the HTW generator [and burner] as a unit.

2.2.4.11 Nameplates

Provide each HTW generator with nameplates stamped with:

a. Maximum continuous capacity in Watts Btuh.

b. Radiant heating surface in square meters square feet.

c. Total heating surface in square meters square feet.

d. Design pressure in Pa psig.

2.3 HIGH TEMPERATURE WATER GENERATOR DETAILS

Mercury is prohibited for use in thermometers.

2.3.1 HTW Generators and Components

Provide HTW generators [site assembled] [shop assembled] type and arranged to suit firing equipment as specified, designed for continuous operation at the capacity indicated and designed to burn [fuel oil specified] [and] [coal of size and analysis specified]. For watertube, waterwall type HTW generating units provide complete with [oil burners] [and] [stokers for coal firing], forced and induced draft fans, control and instrument panel with limit and automatic controls, soot blowers, [over fire air system,] feedwater regulator, low water flow cutoff and alarm, feed piping, and all other fittings, auxiliaries, and appurtenances necessary for safe and efficient operation, with matched firing equipment and boiler adjusted in accordance with the boiler manufacturer's requirements. [Provide factory-fabricated HTW generator assembled on a steel foundation or foundations, or shipped in not more than three complete subunits to minimize field erection.] Provide combustion controls.

2.3.1.1 Headers

Provide header-and-tube boiler construction with header diameter limited to accommodate the water flow and required distribution with a reasonable pressure drop. The use of drums or excessive header sizes is not acceptable. Provide seamless steel ASTM A106/A106M, Grade B headers which are not in primary radiant furnace section with uninsulated bottom portion of header at tube connection. Attach tube to headers by strength welding or by rolling, seal welding, and rerolling in accordance with ASME BPVC SEC I. Rolling of tubes into headers only is not acceptable.

2.3.1.2 Tubes

Provide electric welded or seamless steel tubes with boilers having water-cooled furnace walls of a design suitable for the application. Design tubes located in the primary furnace for horizontal or upflow of water. Distribute the water to the heating surface in proportion to the heat absorbing capacities of these surfaces. Locate tube heat absorbing surfaces so that radiant and convection sections provide for series flow of water, from generator inlet to outlet, to ensure uniform water distribution and uniform temperature rise from inlet to outlet. Provide flow orifices where required with each orifice protected from clogging by individual strainers or by the master strainer located in the HTW generator return line. Provide individual access opening for individual strainers with machined surfaced shoulder type a. Provide individual access openings with stainless steel filled gaskets with all header gasket surfaces machined to provide proper seating of gasket.

2.3.1.3 Baffles

Arrange either water-cooled or a refractory material or metal suitable for temperatures encountered baffles to bring the products of combustion into contact with the heating surfaces. If used, provide steel plate or refractory baffles with water cooling on the radiant heat (furnace) side and the generator's convection section having counterflow, water-to-gas, to provide an integral economizer arrangement for optimum heat absorption, gas-to-water, with draft loss held to a minimum.

2.3.1.4 Furnace

Provide water-cooled furnace with the combustion space provided with water cooling on sidewalls, rear wall, roof, and front, except the portion of the front wall section required for [stoker installation] [and] [burner installation]. For stoker-fired generators, provide water-cooled furnace side walls and rear wall with vertical tubes with center-to-center spacing not to exceed twice the tube diameter, and furnished with cast-iron, water-cooled armor block at the grate line to a height of not less than 380 mm 15 inches above the grate line. Provide readily replaceable (without the use of special tools required) keyed armor block held in place without the use of bolts, pins, or mastic.

2.3.1.5 Supports

Support HTW generators and firing equipment from the foundations with structural steel independent of all brickwork, with HTW generator supports permitting free expansion and contraction of each portion of the HTW generator without placing undue stress on any part of the HTW generator or setting.

2.3.1.6 Access Doors

Provide access doors in sufficient number, of adequate size, and properly located for cleaning, inspection, and repair of all areas in the complete assembly with gas-tight doors, and with interior surfaces exposed to direct radiation and high temperature provided with approved lining refractory material to prevent excessive heat losses and warping of doors. Provide hinged doors for those too large or bulky for hand removal. Provide at least one observation port with cast-iron cover on the front and rear wall of the furnace.

2.3.1.7 Miscellaneous

Provide pipe connections for water inlet and drain outlet, with drain valves, relief valves, blowoff, air supply to soot blowers, gauge and vent, chemical feed, and instruments. Provide HTW generators with necessary jets for furnace turbulence, the number and arrangement as recommended by the HTW generator manufacturer. Provide soot blowers, if required by the manufacturer, and a suitable smoke outlet with steel frame, damper, and damper shaft, with damper having a high temperature roller or ball bearings at both ends of the shaft and with suitable operating arm and rod.

2.3.2 HTW Generator Setting Materials

Provide materials conforming to the following:

a. Firebrick: ASTM C27, class as recommended by the HTW generator manufacturer.

b. Insulating Brick: ASTM C155, Class A.

c. Castable Refractory: ASTM C401. The minimum modulus of rupture for transverse strength must not be less than 4137 kPa 600 psi after being heat-soaked for 5 hours or more at a temperature in excess of 1370 degrees C 2500 degrees F.

d. Mortar, Air-Setting, Refractory: As recommended by the HTW generator manufacturer.

e. Brick, Common: ASTM C62.

f. Tile, Load-Bearing, Hollow: ASTM C34, Grade LBX.

g. Iron and Steel Sheets: Galvanized, ASTM A653/A653M; gauge numbers specified refer to United States Standard gauge. Uncoated, black: ASTM A568/A568M, or ASTM A36/A36M.

2.3.2.1 HTW Generator Casing

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NOTE: On water tube type HTW generators that will be used intermittently, welded wall construction is recommended to minimize corrosion. In other applications, or with fuels containing not more than 0.5 percent sulfur, a casing type enclosure is suitable.

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[Provide HTW generator with steel-encased wall construction with fabrication details as recommended by the HTW generator manufacturer, and with wall and roof lining consisting of a continuous screen of closely spaced water tubes. Provide double wall construction for HTW generators with reinforced, welded, gas-tight inner casing constructed of not lighter than 3.416 mm 10 gauge black steel sheets, and outer casing constructed of not less than 1.897 mm 14 gauge steel sheets. Outer casing may be either bolted or welded. Reinforce inner casing with structural steel to provide rigidity and prevent buckling. Abut inner casing in furnace section with furnace tubes containing no foreign sealer between the tube steel and the casing steel, and with casing not attached to tubes. Support each horizontal tube independently of casing at intervals not exceeding 1.8 m 6 feet with inner casing applied so as to form expansion joints at the point of tube support. Where refractory is installed at access doors, provide the double casing constructed to form a gas-tight seal with combustion gases unable to enter between inner and outer casing. Check all welded joints and openings by a pressure test. Repair any casing leakage and make pressure-tight. Provide reinforced panels that do not exceed the maximum deflection of 1/360 of the length of the maximum span. Apply block insulation between the inner and outer casings and hold securely with insulating pins. Provide the casing, when tested, capable of holding a pressure of 1.5 times the predicted maximum furnace operating pressure.] [Provide HTW generator walls of welded-wall construction with fin width limited to 19 mm 3/4 inch to prevent overheating of the fins under all operating conditions. Designs exceeding 19 mm 3/4 inch may only be used when provided with supporting calculations and are subject to Contracting Officer review for approval. Provide seamless type tubes with continuous fin-to-tube weld and on both the front (fireside) and back side of the fin. Provide a minimum of 6.4 mm 1/4 inch thick fins. Pressure test all welded joints and openings repairing any casing leakage making it pressure tight. Limit the maximum deflection of the reinforced panels to 1/360 of the length of the maximum span with the unit capable of holding a pressure of 1.5 times the predicted maximum furnace operating pressure.]

2.3.2.2 Walls

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NOTE: For personnel safety, the design temperature of the casing surface should not exceed 65 degrees C 150 degrees F. Should the designer wish to use a design surface temperature between 55 and 65 degrees C 130 and 150 degrees F, an economic evaluation must be performed. The evaluation must determine if the additional capital costs for insulation outweigh the cost savings due to reduced boiler radiation losses.

****

[Provide high-duty refractory behind the waterwall tubes of not less than 65 mm 2-1/2 inches thick conforming to manufacturer's requirements.] Provide high temperature block and mineral wool blanket between the refractory backup and steel casing or between an inner and outer casing with thickness of insulation such that an average casing temperature in the furnace area does not exceed [55] [_____] degrees C [130] [_____] degrees F with a surface air velocity of 508 mm/second 100 fpm, and an ambient air temperature of 25 degrees C 80 degrees F when operating at full capacity.

2.3.2.3 HTW Generator Roof

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NOTE: For personnel safety, the design temperature of the casing surface should not exceed 65 degrees C 150 degrees F. Should the designer wish to use a design surface temperature between 55 and 65 degrees C 130 and 150 degrees F, an economic evaluation must be performed. The evaluation must determine if the additional capital costs for insulation outweigh the cost savings due to reduced boiler radiation losses.

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Provide refractory lining conforming to manufacturer's requirements consisting of not less than 65 mm 2-1/2 inches of high-duty refractory backup behind the roof tubes and sufficient thickness of high temperature block insulation or mineral-wool blanket suitable for the temperature encountered to limit casing temperature in the furnace area to [55] [_____] degrees C [130] [_____] degrees F, with a surface air velocity of 508 mm/second 100 fpm and an ambient air temperature of 25 degrees C 80 degrees F when operating at full capacity. Provide insulation neatly against a metal ring for manholes and other inspection and access openings, and identification plates and stamps.

2.3.2.4 Bridge Walls

Provide for bridge walls exposed on all sides to radiant heat and the products of combustion constructed of super-duty refractory not less than 457 mm 18 inches thick, conforming to manufacturer's requirements. Provide for walls having only the front side exposed to radiant heat and the products of combustion, a front facing and cap constructed of 225 mm 9 inches of super-duty refractory and back facing of not less than 225 mm 9 inches of low-duty firebrick with the base of the wall constructed of common brick.

2.3.2.5 Settling Chamber

Provide settling chamber for the removal of fly ash below the last pass of each HTW generator with easy means for frequent cleaning without shutting down the HTW generators.

2.3.2.6 Expansion Joints

Provide expansion joints as required and where indicated to permit all brickwork to expand freely without interference with the boiler, with joints of adequate width, tightly sealed against leakage and free from mortar, with the outer 100 mm 4 inches sealed with resilient mineral wool suitable for 925 to 1095 degrees C 1700 to 2000 degrees F. Provide a series of 3 mm 1/8 inch wide vertical openings, spaced 1.8 m 6 feet apart, on the furnace side of the wall. Make provision for expansion and contraction between boiler foundation and floor as specified.

2.3.2.7 Firebrick

Lay up firebrick in air-setting mortar with each brick dipped in mortar, rubbed, shoved into its final place, and then tapped with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel is not permitted. Provide a maximum mortar joint thickness not exceeding 3 mm 1/8 inch and an average joint thickness not exceeding 1.6 mm 1/16 inch.

2.3.2.8 Plastic Refractory

Install plastic refractory in accordance with the manufacturer's recommendation and by workmen skilled in its application.

2.3.3 Boiler Fittings and Appurtenances

Provide HTW generator fittings and appurtenances suitable for a HTW working pressure of [_____] Pa psig and [_____] degrees C degrees F for each HTW generator in accordance with ASME BPVC SEC I.

2.3.3.1 Thermometer

Provide thermometer for HTW generator inlet water and outlet water for each HTW generator in a visible location on the HTW generator.

2.3.3.2 Pressure Gauge

Provide pressure gauge for each HTW generator in a visible location on the HTW generator.

2.3.3.3 Relief Safety Valves

Provide HTW generator relief safety valves such that the discharge is through piping extended to the plant blowoff tank with relief valves sized, and constructed, with set pressures as determined in accordance with ASME BPVC SEC I.

2.3.3.4 Drain Valves

Provide drain valves in tandem at each drain point of blowdown as recommended by the HTW generator manufacturer. Provide piping conforming to the requirements of ASME BPVC SEC I and extra strong weight black steel pipe conforming to ASTM A53/A53M. Provide drain valves conforming to ASME BPVC SEC I, the balanced seatless type unless otherwise approved.

2.3.4 Soot Blowers

When required, provide HTW generator with air powered, automatic sequencing and intermittent puff type soot blower system, with a soot blower control unit suitable for mounting on the generator control panels. Provide controllers that automatically rotate the soot blower units in successive steps, each step involving no more than a 69 kPa 10 psi drop in air pressure at the receiver. After one unit is operated in successive steps through its cycle, the controller shifts the operation to the second soot blower unit, and so on, until all units on that generator have been operated, after which the controller shuts down automatically by the sequence controls. Provide the soot blower heads with elements of suitable chrome alloy material for the temperatures encountered in the HTW generator, and with a sequence timer provisioned for manual selection of the soot blower units to be used.

2.4 FUEL BURNING EQUIPMENT

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NOTE: The designer must include all the required data for proper design of the boiler. Delete all references to coal and stokers where oil is the only fuel to be utilized.

Delete paragraphs describing stoker equipment that are not required. Stokers and stoking equipment selected will be based on the following:

Boilers having output capacities of 3,517 kW 12,000,000 Btuh or more will be equipped with mechanically-driven grates operating continuously or intermittently. Dump grates will not be permitted in boilers in this size range. Spreader stokers will be specified when bituminous coal with ash content on a dry basis in excess of eight percent or ash fusion temperature lower than 1200 degrees C 2,200 degrees F is to be used. Pulsating grate units will be water-cooled and complete with automatic coal feed and continuous ash removal. Conveyor stokers may be specified if suitable for the type of coal available. Chain or traveling grate may be specified by deletion of one type of grate, or the choice between the two types may be left to the Contractor by including both types in

the description. The following is a general guide in determining which type of grates to investigate:

MW Output **MBtuh Output**	**(Size) Type of Grate and Stoker**
735 - 5860 **2,500 - 20,000**	**Single retort, stationary grate, underfeed stokers**
5860 - 8800 **20,000 - 30,000**	**Single retort, moving grate, underfeed stoker**
1465 - 22000 **5,000 - 75,000**	**Reciprocating grate, front continuous ash discharge stoker**
1465 - 29500 **5,000 - 100,000**	**Vibrating conveyor grate, front continuous ash discharge stoker**
5860 - 36500 **20,000 - 125,000**	**Water-cooled, incline grate, hopper fed vibrating grate stoker**
8800 - 120,000 **30,000 - 400,000**	**Spreader stoker, continuous front ash discharge**

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Provide manufacturer certification for the HTW generator that the stoker selected is satisfactory for the HTW generator design. Provide stokers and HTW generator capable of efficiently burning coal with fuel sizing conforming to ABMA Boiler 203 for Stoker Firing of Bituminous Coals, approximately [_____] mm inches in size with an approximate moisture content of [_____] percent and having the following analyses:

Proximate Analysis	Percent, Dry
Moisture	[_____]
Volatile matter	[_____]
Fixed carbon	[_____]
Ash	[_____]

Ultimate	Analysis Percent, Dry
Carbon	[_____]
Hydrogen	[_____]
Nitrogen (Calc)	[_____]
Sulfur	[_____]
Chlorine	[_____]
Ash	[_____]

Ultimate	Analysis Percent, Dry
Oxygen (Diff)	[_____]
kJ/kgBtu/lb. as received	[_____]
kJ/kgBtu/lb. - dry	[_____]
Grindability	[_____]
Raw Fuel Size	[_____]
Ash Analysis	Percent
SiO(2)	[_____]
Al(2)O(3)	[_____]
TiO(2)	[_____]
Fe(2)O(3)	[_____]
CaO	[_____]
MgO	[_____]
Na(2)O	[_____]
K(2)O	[_____]
SO(3)	[_____]
Ash Fusion Temperatures	Degrees CDegrees F
Initial deformation temperature	[_____]
Softening temperature	[_____]
Fluid temperature	[_____]

2.4.1 Spreader Stokers

Provide overfeed self-feeding type spreader stokers suitable for burning a portion of the coal in suspension, but sized assuming 100 percent combustion on the grate. [Coal must be evenly distributed across the full width of the grate by not less than [_____] feeder units. Provide unit designed for operation of any feeder independently of the others, or possible to operate all feeders simultaneously.] Provide feeders capable of handling and uniformly distributing coal over the grate area. Provide mechanical-rotating type feeders with no moving parts within the combustion chamber, and where moving parts are exposed to excessive heat, protect bearings with suitable water jackets. Provide grease or oil lubrication for all bearings. Provide stoker designed for readily adjustable feed distribution of coal on the grates.

2.4.1.1 Grates

Provide high air resistant type grates for stoker spreader firing, arranged for powered mechanical or compressed air actuated dumping in sections. Provide openings for proper distribution of air under the fuel bed. [Provide grates in sections to match the feeders with provisions for shutting off the forced draft to each section so that any section of the grate can be cleaned while the others remain in service.] Provide heavy-duty, heat-resisting cast-iron grates. Provide mechanical dumping with [air-] [water-] actuated power cylinders connected to the grates, and furnish grates complete with cylinders, linkages, valves, and piping as required, with each section dumping independently of other sections. Provide necessary over fire air jets complete with fans, ducts, and air control valves as required for proper turbulence and combustion. Provide grate drives that operate independent of feeder drives to provide independent speed variation of feeders and grates.

2.4.1.2 Traveling Grates

Provide high air resistant type traveling grates especially designed for spreader stoker firing and for continuous ash discharge. Provide openings for proper distribution of air under the fuel bed with generator grates being heavy-duty, heat-resisting cast-iron, and individual replaceable sections without taking the grate out of service. Hold leakage to a minimum with air seals around grate. Furnish moving grates complete with supporting steel, shafts, sprockets, chain, gears, skid bars, and bearings as required, with the front end of the grates where the ash is discharged enclosed with a dust-tight enclosure made of heavy cast-iron plates not less than 16 mm 5/8 inch thick and properly protected with firebrick where exposed to the furnace or of refractory lined steel plate. Fit the vertical fronts of the enclosure with refractory lined inspection and access doors, one for each feeder. Seal the roof of the enclosure with refractory to protect the metal parts from the furnace temperature. Enclose the underside of the grates to form a chamber. Provide hopper for receiving the ashes constructed as indicated or as recommended by the manufacturer. Provide over-fire air jets as required for proper turbulence and combustion.

2.4.1.3 Vibrating Grate

Provide high air resistant type vibrating grate especially designed for spreader stoker firing and for continuous ash discharge, with either air- or water-cooled with openings to provide proper distribution of air under the fuel bed. Provide heavy-duty, heat-resisting cast-iron grates with individual replaceable sections. Provide a manual adjustment to regulate the ash bed thickness, with ashes automatically discharged to the ash pit. Enclose the front of the grates where the ash is discharged with a dust-tight enclosure of heavy cast-iron plates not less than 16 mm 5/8 inch thick and properly protected with firebrick where exposed to the furnace, or of refractory-lined steel plate. Fit the vertical fronts of this enclosure with refractory-lined inspection and access doors, one to each feeder. Seal the roof of this enclosure with refractory for protecting the metal parts from the furnace temperature. Enclose the underside of the grates to form a chamber with a hopper for receiving the ashes with over-fire air jets provided for turbulence and combustion.

2.4.1.4 Controls

Provide stoker controls that accurately regulate the coal feed rate, of the type required for connection to the combustion control system with a manual setting of the coal feed rate with variation of stoker feed as required to maintain any desired capacity between 50 and 110 percent of boiler capacity without disconnecting linkage. Provide separate feeder and grate drives, with grate driven through a variable speed transmission with devices for changing speed interlocked with fuel feed regulation. Provide manual adjustment of grate speed for allowing synchronization with fuel feed. Provide all gears and chains of the variable speed transmission and gear reduction units, as required, run in a bath of oil and enclosed in a dust-tight and oil-tight case.

Provide a forced lubrication system with fittings located outside the setting. Provide antifriction bearings with hardened inner and outer races fitted with dust seals and easily accessible forced lubrication fittings for front and rear shafts of the grates with safety release devices to protect the mechanism from foreign materials or obstructions. Provide electric motor driven stoker with electric motor [totally enclosed, fan-cooled] [totally enclosed fan-cooled for installation in Class II, Division 1, Group F hazardous location in accordance with NFPA 70], and motor starter magnetic [across-the-line] [reduced voltage start] type with [general-purpose] [dust-tight] [explosion-proof] enclosure.

2.4.1.5 Hoppers

Construct hoppers of steel plates not less than 6.4 mm 1/4 inch thick and capacity of not less than [_____] kg pounds per feeder, provided with cleanout doors in the front of each feeder. Fit coal feed to the hoppers with concave type transitions to ensure the proper distribution of coal and coal fines across the width of the hoppers. Provide stoker front plate forming the front of the boiler for the full width of the boiler and from the firing floor to some point above the stoker where it connects to the boiler structural framing. Provide a front of cast-iron or steel plate refractory lined with [auxiliary firing doors and] cleanout doors of refractory lined cast-iron. Structurally frame as required to support the stoker and its components from the boiler foundation or boiler room floor. Divide the area under the grates into not less than four air-tight zones for supply of forced draft having zone control dampers with external indicating operating and locking devices with all pressure parts for water-cooled grates including watertubes, headers, and valves furnished by the stoker manufacturer for boiler pressure specified and constructed in accordance with ASME BPVC SEC I.

2.4.1.6 Air Systems

Provide spreader stokers with over-fire turbulence and cinder and dust reinjection systems. Use [air][or][steam] as the transport medium. Provide systems with operating air by a single, low volume high-pressure fan driven by a splash-proof electric motor. Provide reinjection system ejectors properly designed, located, and sized for maximum fly ash pickup from all points. Equip nozzles for each system with manometer connections and heavy-duty adjustable dampers fitted with locking devices and position indicators and with nozzles providing maximum combustion efficiency and furnace turbulence. Provide a manometer connection and a permanent manometer immediately downstream from the main reinjection air supply damper. Provide a portable manometer.

2.4.2 Underfeed Stokers

2.4.2.1 Ram-Type Stokers

For single retort, provide electric motor drive, with all necessary auxiliary equipment, heavy-duty ram-type stokers equipped with stationary or moving grates and side dump plates, with compressed air actuated dumping power cylinders, and stokers capable of handling the coal specified. Provide hopper feed into the retort by means of a that evenly distributes along the full length of the retort with auxiliary pusher blocks on a pusher rod located at the bottom of the retort actuated by the coal ram. Provide dampers between ash pits and main air chamber under stoker to permit control of air distribution to the grate surface arranged for operation from the front plate of the boiler. Provide a design where the air distribution is such that the air pressure is greatest where the fuel bed is the thickest with air quantity varying in direct proportion to the coal feed rate controlled automatically.

2.4.2.2 Grate Surface

Provide a grate surface with an underfeed retort area, air admitting tuyeres, side combustion grates, and the side dumping plates, with retorts being sectional construction of large capacity and proper shape to distribute coal uniformly over the entire grate surface with a minimum of moving parts within the furnace. Provide stokers having total grate width of more than 2.1 m 7 feet with movable grates providing positive lateral feeding of the coal from the retort toward the dump plates. Provide retort and grate sections constructed of heavy-duty, heat-resisting cast-iron, and cored for proper air distribution, being designed for easy replacement of individual sections. Provide ash dump plates with necessary levers and linkage for hand operation from the front of the boiler.

2.4.2.3 Ram Feed

Provide mechanical, pneumatic, or hydraulic driven by an electric motor connected through an efficient gear reduction unit, crank shaft, and connecting rod for ram feed. Provide [totally enclosed fan-cooled type] [totally enclosed fan-cooled type for installation in a Class II, Division 1, Group F hazardous location motors in accordance with NFPA 70]. [Provide motor starter with magnetic [across-the-line] [reduced voltage start] type with [general-purpose] [dust-tight] [explosion-proof] enclosure.] Provide stoker controls for connection to the combustion control system to accurately regulate the coal feed rate with manual setting of the coal feed rate possible without disconnecting linkage, with variation of stoker feed as required to maintain any desired capacity between 25 and 110 percent of boiler capacity in 10 or more equal increments. Regulate the coal feed rate by varying the time increments between strokes of the ram. Provide a throw-out release protecting the coal feeding mechanism from injury in case foreign materials obstruct normal operation.

2.4.2.4 Hoppers

Provide hoppers constructed of steel plates not less than 6.4 mm 1/4 inch thick and capacity of not less than [_____] kg pounds, with cleanout doors. Provide stoker front plate to form the front of the boiler for the full width of the boiler and extend from the firing floor to some point above the stoker where it connects to the boiler structural framing. Provide cast-iron or steel plate front, refractory lined with [auxiliary firing doors and] cleanout doors of refractory-lined cast-iron. Provide structural framing as required to support the stoker and its components from the boiler foundation or boiler room floor. Provide water spray pipes and nozzles for quenching the ashes in the ash pit.

2.4.3 Conveyor Stokers

Provide grate level feed, forced draft [chain grate] [traveling grate] type conveyor stokers complete with hoppers, feed gate, drive shaft, sprocket wheels, grate, drive, and all necessary auxiliary equipment. Provide stokers capable of handling the coal specified. Feed coal automatically at a constant rate from the hopper onto the moving grate and evenly distribute across the full width of the grate. Provide stoker frame with no less than four air-tight zones for supply of forced draft and have suitable zone control dampers with external indicating, operating, and locking devices.

2.4.3.1 Grates

Provide grates with individual sections constructed of heavy-duty, heat-resisting cast-iron, fitted or cored for proper air distribution, and designed for easy replacement of individual sections. [Provide chain grates with staggered links connected by pins to form a continuous flat chain the full width of the furnace.] [Provide traveling grates with grate blocks mounted on carrier bars which, in turn, are fastened to two or more drive chains to form a continuous flat grate surface the full width of the furnace.] Support continuous grates at the ends by suitable sprockets and at intermediate points on suitable tracks or skids.

2.4.3.2 Conveyor Grate

Drive conveyor grate by [electric motor connected through a suitable speed-reduction unit] [hydraulically-operated variable speed drive] with all gears and chains required for the drive enclosed in a dust-tight and oil-tight housing. Provide main shafts for the grates with a forced system of lubrication [with fittings located outside the casing] [having self-lubricating bearings]. [Provide a forced lubrication system with bearings fitted with dust seals and easily accessible forced lubrication fittings.] Provide stoker controls suitable for connection to the combustion control system to accurately regulate the coal feed rate with manual setting of the coal feed rate by varying stoker feed as required to maintain any desired capacity between 25 to 125 percent of boiler capacity possible without disconnecting linkage. Change feed rate by varying the speed of the grate. Automatically vary air volume in direct proportion with the feed rate with feed rate varying in not less than 10 equal increments. Provide [totally enclosed fan-cooled type] [totally enclosed fan-cooled type electric motor suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [dust-tight] [explosion-proof] enclosure.]

2.4.3.3 Hoppers

Construct hoppers of steel plates not less than 6.4 mm 1/4 inch thick, having a capacity of not less than [_____] kg pounds, and provided with suitable cleanout doors. Fit coal feed to the hoppers with concave type transitions to insure the proper distribution of coal and coal fines across the width of the hoppers. Construct stoker frame of cast-iron, cast steel, or forgings, with all parts of the stoker, except the grates, properly cooled or otherwise protected from the furnace heat to prevent damage by warping or undue expansion. Provide stoker front plate to form the front of the boiler for the full width of the boiler and extend from the firing floor to some point above the stoker where it connects to the boiler structural framing. Provide cast-iron or steel plate, refractory-lined with cleanout doors of refractory-lined cast iron front with structural framing as required to support the stoker and its components from the boiler foundation or boiler room floor. Discharge ash at the end of the grate into a [bunker] [pit] as indicated. [Provide a bunker with a dust-tight enclosure made of steel plates not less than 6.4 mm 1/4 inch thick, properly protected with firebrick where exposed to the furnace, and fitted with cast-iron, refractory-lined inspection and access doors, and have provisions for ash removal.]

2.4.4 Vibrating Grate Stokers

Provide grate level feed, forced draft type vibrating grate stokers with the vibrating action of the grate used to feed the coal from the hopper through the furnace and to discharge the ashes into the ash pit. Provide stokers capable of handling the specified coal, complete with hopper, feed gate, grate, drive mechanism, and all necessary auxiliary equipment. Automatically feed coal from the hopper onto the grate and evenly distribute across the full width of the grate. Provide a manual adjustment to regulate the fuel bed thickness. Ashes must be automatically and continuously discharged to the ash pit. Divide the area under the grates into not less than four air-tight zones for forced draft supply with suitable zone control dampers with external indicating, operating, and locking devices.

2.4.4.1 Grates

Provide grates that are either air-cooled or water-cooled with grate bars in intimate contact with the water tubes and with individually replaceable sections of iron or steel suitable for the temperatures encountered. Provide all pressure parts including water tubes, headers, and valves suitable for boiler pressure specified and constructed in accordance with ASME BPVC SEC I, with grate sections properly designed for even air distribution over the entire grate area.

2.4.4.2 Controls

Provide stoker controls designed for connection to the combustion control system accurately regulating the coal feed rate and arranged for manual operation, independent of the combustion control system. Change the length of time of vibrations to vary the coal feed rate with a vibration generator belt-connected or gear-connected to the electric motor. Provide a unit free of any vibration that may damage other parts of the boiler or the building structure. Provide bearings requiring lubrication with easily accessible lubrication fittings. Automatically vary combustion air volume in direct proportion with the coal feed rate. Drive stoker by electric motor that are high starting torque [totally enclosed, nonventilated] [totally enclosed, fan-cooled] totally enclosed, fan-cooled suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70, with magnetic, reversing [across-the-line] [reduced voltage start] type motor starter and [general-purpose] [dust-tight] [explosion-proof] enclosure.

2.4.4.3 Hoppers

Construct hoppers of steel plates not less than 6.4 mm 1/4 inch thick, having a capacity not less than [_____] kg pounds, and provided with a suitable method of cleanout. Provide furnace arches of a design suitable for the intended use and a type that will insure proper combustion of the fuel. Inclue the lower furnace sidewall headers in a waterwall boiler to accommodate the inclined grate arrangement. Provide stoker front that forms the front of the boiler for the full width of the boiler and extends from the firing floor to some point above the stoker where it connects to the boiler structural framing. Provide cast-iron or steel plate refractory lined front with cleanout and access doors of refractory-lined cast-iron and structural framing as required supporting the stoker and its components from the boiler foundation or boiler room floor. Discharge the ash at the end of the grate the ash into a [bunker] [pit] as indicated. Provide dust tight enclosure for the bunker constructed of steel plates not less than 15.9 mm 5/8 inch thick, protected with firebrick where exposed to the furnace and fitted with cast-iron, refractory-lined inspection and access doors, and provisions for ash removal.

2.4.5 Burners

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NOTE: The designer must include all the required data for proper design of the boiler. Delete all references to coal and stokers where oil is the only fuel to be utilized.

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Provide each HTW generator with oil-fired burner or burners with burner assembly and control systems conforming to NFPA 85, UL 296, and UL 726, except as otherwise specified, and with supervised manual, semiautomatic, and fully automatic combustion safety controls conforming to NFPA 85 and ASME CSD-1.

2.4.6 Fuel Oil Pumping and Heating Sets

Provide a duplex integrated, shop-fabricated oil pumping and heating set, assuring 100 percent standby with the oil heated by medium temperature water. Provide two positive displacement oil meters, include with each set an electric oil heater of sufficient capacity to heat the specified fuel oil to ignition temperature at low generator load until enough HTW is generated to operate the high temperature water-to-low temperature water (LTW) heat exchanger and the LTW-to-oil heater. Control electric heater by a magnetic starter with a manually-operated ON-OFF switch in series with a thermostatic control. When oil temperature is raised to proper level and maintained by the LTW heater, automatically disconnect the electric heater by the thermostatic control. Provide electric-motor driven fuel pumps with each pump having the capacity of not less than [_____] L/second gpm at a discharge pressure of [_____] kPa psig and a suction lift of 3 m 10 feet.

2.5 COMBUSTION CONTROL EQUIPMENT

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NOTE: Paragraphs describing inapplicable types of combustion control equipment will be deleted. The type of combustion control system specified for a project will depend largely on the boiler capacity, the fuel, initial cost, and cost of operation. Basically, the types should be as follows (the boiler capacities are expressed inMW Btuh):

Type of Control	**Coal**	**Oil**
Positioning	**0.879-15 MW 3-50 million Btuh**	**0.870 - 12 MW 3-40 million Btuh**
Semimetering	**7-21 MW 25-72 million Btuh**	**7-19 MW25-66 million Btuh**
Metering	**7 MW 25 million Btuh and above**	**7-19 MW 25 million Btuh and above**
Metering with Oxygen Compensation	**20 MW 68 million Btuh and above**	**20 MW 68 million Btuh and above**

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Use a single manufacturer for the automatic combustion control equipment system to be installed for each boiler in accordance with the manufacturer's recommendations. Locate controllers on the designated heating plant master control center panel. Provide equipment capable of operating either pneumatically, electrically, or electronically. Pneumatic control systems must conform to CAGI B19.1. Install air filter regulator sets at each control valve and transmitter in the system with the master air filter regulator set on the control panel being the dual type where one side can be cleaned and repaired while the other is operating. Protect exterior control air piping and devices from freezing by use of regenerative desiccant dryers. Provide each system with a selector switch or other means of manual control of the firing rate when required. Provide electrical control devices rated at 115 volts and connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wire operating and limit controls to interrupt the ungrounded circuit conductor. Conform controls and instruments to the requirements of ASME CSD-1, NFPA 85, UL 296, and UL 726, except as otherwise specified. Provide individual control for each boiler. For multiple boiler installations, provide a means to base load on individual boilers while on automatic control.

2.5.1 Combustion Controls

Provide [positioning] [semi-metering] [metering] [metering with oxygen compensation] type combustion controls. Provide a plant master controller sensitive to temperature transmitter in return water header to provide anticipatory signals to all generator master controllers with generator master or submaster controllers reacting to anticipatory signals from plant master and then adjust firing rate as necessary in response to generator outlet temperature indication to maintain preset temperature at each generator outlet. Plus or minus 3 percent is the limit for precision of pressure or temperature control of the set point of the boiler pressure in kPa psig, or the temperature in degrees C degrees F during any load swings of up to 10 percent of the boiler capacity per minute over the entire turndown range.

2.5.2 Stoker Controls

Interlock the combustion control system with the grate drive to balance the ash discharge with the firing rate. The coal feed flow rate may be used as the index of fuel feed. Provide stoker controls to as outlined for the stoker specified.

2.5.3 Positioning Type Combustion Control Equipment

Provide separate parallel type positioning controllers for fuel feed and air flow, and both are modulated by the boiler load. Provide manual means for readily adjusting the fuel-to-air ratio for the most efficient combustion and an adjustable compensating device to maintain the proper ratio of fuel and air over the entire range of operation to provide combustion efficiency within the range specified. Provide a furnace draft controller, when required. Flush-mount all controllers on the control and instrument panel; all adjustments and calibrations of fuel feed, air flow and furnace draft, on the front of the panel.

2.5.4 Semi-Metering Type Combustion Control Equipment

Provide two controllers per boiler, one for fuel feed and one for air flow, with the first of these positioned in proportion to the boiler load to deliver a proportionate impulse to the second controller which functions in direct relation to that impulse; the second controller then measuring the fuel feed or air flow provided and automatically making necessary adjustments to maintain the fuel-to-air ratio for which it is set over the entire range of operation. Provide furnace draft or pressure controllers where required. Flush-mount all controllers on the control and instrument panel; make all adjustments and calibrations of fuel feed, air flow, and furnace draft or pressure, at the front of the panel, and provide indicators to show the amount of adjustment and the results obtained.

2.5.5 Metering Type Combustion Control Equipment

Provide metering controls with adequate means for automatically adjusting both fuel feed and air flow in strict relation to the load requirements, in addition to measuring the rates of fuel feed and air flow and maintaining the required ratios over the full range of boiler operation. In addition to the master controller, provide separate controllers for fuel feed and air flow responding either in parallel or series. Include air flow-fuel flow cross limiting devices. [If required by a particular system, a separate fuel-to-air ratio controller may be provided.] Measure the actual rate of fuel flow in the fuel line to the burner, and measure the actual air flow by a differential orifice in the forced draft duct. Operation of either controller for both functions is not acceptable. In addition, provide a separate controller to control the draft or pressure in the boiler furnace. Flush-mount controllers on the control and instrument panel; make all adjustments and calibrations of fuel feed, air flow, fuel-to-air ratio, and furnace draft or pressure, at the front of the panel and provide indicators to show the degree of adjustment.

2.5.6 Combustion Control with Oxygen Trim

Flue gas oxygen trim may be provided as an adjunct to the metering system of control. Determine the oxygen content in combustion gases; from this, send an impulse to the oxygen controller, which readjusts the air flow to maintain the required oxygen content. Provide the oxygen set point as a function of generator load with operator biasing capability limiting the amount of oxygen controller trim to prevent potentially hazardous conditions created by equipment failure or faulty operation.

2.5.7 HTW Generator Limit Controls

Provide low generator water flow and high generator temperature controls with the limit controls interlocked with the combustion control system to provide for generator alarm and shutdown.

2.5.8 Burner Control/Fuel Safety System

2.5.8.1 Design Requirements

Provide a microprocessor-based (distributed digital or programmable controller) or relay type control system with a dedicated hardwired insert panel furnished for monitoring and operator interface with the burner control/fuel safety system with the panel also providing the operator with direct fuel tripping capability in emergency situations. Subdivide the burner control system to permit inservice checkout and maintenance without impairing the reliability of the overall control system. Provide logic cabinets that include status indicating lights for all logic inputs and outputs and for monitoring availability of control power to all subsystems as required to facilitate troubleshooting. Provide indication of equipment status and system permissives at the operator interfaces. Include, where common power supplies internal to the system are furnished, a full-capacity on-line backup supply. Provide alarm for failure of either power supply.

2.5.8.1.1 Maintenance and Reliability Requirements

In general, maintenance is accomplished on-line and without imposing any special restrictions on overall plant operation. Provide diagnostic routines, interchangeable electronic cards or boards, and clear written procedures as a minimum requirement of this specification. For reliability, incorporate both software and hardware into the system design, including redundancy, loop distribution, component specifications and testing, and quality control to assure the highest level of system reliability.

2.5.8.1.2 Adverse Electrical Conditions

Provide equipment capable of operating as specified and without damage within the electrical environment of the plant, including, but not necessarily limited to, high-voltage, high-frequency surges caused by electro-mechanical equipment, energy coupled between conductors by capacitance and mutual inductance, and imperfect grounds. Provide input and output isolation, shielding, separation of circuits, surge suppression, or other measures which may be required to meet these provisions. Inputs, outputs, and other connections must meet the surge to withstand requirements of IEEE C37.90.

2.5.8.2 System Design

Provide a compatible burner control system in all respects with the HTW generator and auxiliary equipment. The system design must meet the requirements specified in NFPA 85. Provide a burner control system incorporating a continuous purge of the furnace to insure that the HTW Generator is free of any accumulation of combustibles; in addition, provide a burner control that supervises the operation of the fuel-air equipment associated with fuel oil burners, accepts operator commands and, if the required permissives are met, perform the required operation. Provide continuously monitored equipment and alarm any deviation while the system either corrects the deviation of shuts down equipment as necessary to avoid hazardous furnace conditions or equipment damage. Provide a system that monitors the operation of the fuel equipment and if the equipment fails to respond to command from the burner control system, initiates the equipment trip sequence. Provide system indications to allow the operator to determine the equipment that initiated a trip of fuel equipment, shutting down the tripped equipment reset of the trip is permitted. Include a fuel safety subsystem in the burner control system that includes a master fuel trip (MFT) system, ignition oil trip system, and main fuel oil trip system; including a hardwired relay in each system which may directly operate from the operator insert panel. Include inputs to the MFT, in addition to those associated with the burner control system, those that are required to provide overall HTW generator protection. Provide a system that interfaces with the combustion control system to position and monitor devices for startup and shutdown which are normally modulated during on-line operation. Design the burner control system to operate reliably, minimizing the number of false trips.

2.5.8.3 System Functional Requirements

2.5.8.3.1 Operating Modes

It is the operator's responsibility to initiate the start and stop sequences listed below. Once initiated the burner control system must automatically place the oil burner in service or remove it from service. The steps each of which require operator initiation are:

a. Purge

b. Igniter control

c. Feeder control

d. Main oil burner

2.5.8.3.2 Furnace Purge and Boiler Monitor

Provide a furnace purge control to incorporate prelight off and post purges of the furnace to insure that the HTW generator is free of any accumulation of combustibles, which indicates to the operator, after which the operator will reset the master fuel trip relay. Provide a furnace purge on any master fuel trip. Provide the HTW generator monitor that prevents starting any fuel equipment if the furnace firing permissives are not met, with the furnace purge control providing indications to the operator of the status and the progress of the furnace purge, extinguishing permissive indications when the MFT relay is reset.

2.5.8.3.3 Igniter Control

An igniter group consists of all the igniters associated with a main oil burner. Igniters associated with a burner group will be controlled from a separate electropneumatic igniter control package. Provide sequential starting of igniters between burner groups to be started and stopped from the insert panel and local pushbuttons. An igniter fuel trip (IFT) first out indication will be provided to indicate the initiating cause of the IFT and extinguished only when the IFT relay is reset.

2.5.8.3.4 Main Oil Burner Control

Starting and stopping of each main oil burner may be accomplished either locally or from the insert panel. Proven igniter groups is one of the permissives required for starting. Provide fuel oil trip first out indications and a main fuel oil trip (FOT) relay.

2.5.8.3.5 Fuel Safety Subsystem

The fuel safety subsystem comprises the MFT system, main FOT system, and IFT system. Each fuel safety system provides the protection for its respective fuel and includes a dedicated hardwired relay which may be directly operated from operator insert panel. The MFT system provides overall HTW generator protection, also includes a dedicated hardwired relay, and directly trips all other fuel safety system relays. Design the system to de-energize to trip.

2.5.8.3.6 Flame Monitoring

Individual self-checking flame scanners are required for each burner. Igniter flame safety devices must discriminate individually from any flame that may exist at other burner locations. Discriminate burner flame individually from the associated igniter flame and any other flame that may exist in the furnace. Igniter and burner flame discrimination must cover the range from startup to full load operation. Blocking interlocks from closed valves in flame discrimination circuits to avoid false flame indication are not acceptable. If required to obtain satisfactory flame discrimination, include extended tube scanners. Individual flame detector output level indicators are required. If required, provide provisions for cooling and cleaning.

2.5.8.3.7 Enclosures

The system logic cabinets contain all control devices, power supplies, circuit protective devices, cable plugs, and terminal blocks. Provide spare space to accommodate a minimum of 20 percent additional devices. Make the cabinets accessible from both front and back, each having gasketed hinged doors with latches. Do not exceed door with of 610 mm 24 inches. Natural draft cooling of the control system cabinets is preferred. If cabinet cooling fans are furnished, alarm the loss of any fan.

2.5.8.3.8 Local Termination Boxes

Include local junction boxes, one at each burner level containing separate pushbuttons and indicating lights for local control of each igniter group. In addition, include terminals for field wiring, internal wiring, cable connectors for intersystem wiring, circuit breakers, and if required by the system, relays and reversing starters in the terminal boxes. Configure terminal boards for field wiring to allow 20 percent spare connections.

2.5.8.3.9 Interconnecting Cable Requirements

Interconnect cables between the logic cabinet, insert panel, and local burner junction boxes via prefabricated plug-in cables, including connectors. Also, provide flame scanner cables.

2.5.8.3.10 Buffered Output Signals

Fully isolate output signals required for tripping, control, and monitoring from each other. Isolate such that an open or short circuit in the related equipment does not affect other control systems.

2.6 HEATING PLANT PANELS AND INSTRUMENTS

Do not use Mercury in thermometers.

2.6.1 HTW Generator Instrument and Control Panel

Size the HTW generator instrument and control panel to contain all controls, instruments, gauges, and meters. Provide free-standing panel with faceplate of not less than 4.8 mm 3/16 inch steel, reinforced, and finished with the manufacturer's standard finish coating. Mount the units flush on the panel as far as practicable. Enclose the back of the panel with sheet metal and with adequate removable access panels or doors for maintenance and removal of any unit without interfering with other units. Provide latching equipment and hardware. Indentify each recorder, indicator, and control unit with engraved metal or laminated plastic nameplates securely fastened to the panel. Provide the panel with continuous, rapid-start, fluorescent light fixtures mounted with reflectors providing suitable shielding to illuminate all controls, instruments, gauges, and meters. Terminate all field piping connections in one bulkhead-mounted manifold located to conform with the installation requirements of the system. Terminal all field electrical wiring in a mounted color-coded terminal strip so located as to conform with the installation requirements of the system. If a pneumatic control system is provided, include duplex air supply filter and regulator set, mounted on the rear of the panel with properly identified pneumatic terminal blocks and low-point drain in the panel. No high-pressure lines are allowed to enter the panel. Provide control equipment with the necessary operating switches, indicating lights, gauges, alarms, the combustion control system, and the generator and fuel safety interlock systems. If the package type boiler burner units with integral controls are furnished, the control equipment for each boiler may be mounted on a separate free-standing panel in accordance with the requirements above for instrument and control panel. Ppanel-mount and test at the factory controllers and indicators specified or required, complete with relays, transformers, switches, wiring, valves, and piping. Color-code or otherwise identify all wiring and piping within the panel.

2.6.2 Indicators

Provide flush mounted indicators with a vertical scale from 100 to 150 mm 4 to 6 inch length with scales in engineering units with an accuracy of plus or minus 1 percent of full scale. Indicators may be either electronic or pneumatic with zero adjustments, receiving standard signals from locally mounted transmitters.

2.6.3 Recorders

Provide servo mechanism type, multiple pen type, [circular] [strip chart] type recorders with minimum chart width of 100 mm 4 inches, accuracy of plus or minus 1/2 percent of full scale, and each pen having a separate scale calibrated in engineering units. Provide 120 volts ac chart drive and 1 year's supply of chart paper.

2.6.4 Panel Display

As a minimum, display the following parameters on the panel:

	Indicator	Recorder Point
Pressure		

		Indicator	Recorder Point
	Main hot water header	x	x
	Boiler drum	x	
	Feedwater	x	x
	Instrument air	x	
Draft			
	Windbox	x	x
	Furnace	x	
	Gas outlet	x	
	ID fan inlet	x	
Temperature			
	Hot water outlet		x
	Boiler gas outlet		x
	Windbox		x
	Feedwater		x
	HTW differential temperature		x
	HTW zone inlet and outlet (each zone)		x
Level			
	Bunker or silo		x
Flow			
	Hot water outlet (including totalizer)		x
	Feedwater		x
	Air		x
	Fuel		x
	HTW (each zone)		x
Analyzers			
	Flue gas opacity		x

		Indicator	Recorder Point
	Flue gas oxygen		x

2.6.5 Hot Water and Feedwater Flow Measurement

Provide square edge, concentric, paddle type, designed for flange taps orifice plates to measure hot water and feedwater flow to each generator with nozzles and orifice plates flange-mounted type, made of stainless steel. Minimum straight pipe runs in accordance with AGA XR0603.

2.6.6 Pressure Gauges

Provide heavy-duty industrial type pressure gauges with phenolic case, solid front, rear blowout, threaded ring, shatterproof glass, and 13 mm 1/2 inch NPT bottom connection installed for proper operation with stainless steel Bourdon spring-type having 114 mm 4-1/2 inch dial sizes installed where it is clearly visible from the operating level, and all requisite piping and gauge cocks described, or required above. Provide pressure gauges on high temperature service with pigtail siphons. Provide pump discharge gauges located on pump discharge lines with pulsation dampeners or snubbers with gauge ranges selected so that at normal operation the pointer is at approximately 50 percent of range. Provide gauges for the following services:

Expansion Tank
Dump Tank
Master Control Center
Circulation Pump Panel
Distribution System Mains
Master Control Panel
Makeup Pumps
Emergency Feed Pump
Water Main
Chemical Feed Pumps
Air Compressors
Fuel Oil Supply Header
Generator Pressure
HTW Water Inlet and
Outlet Duplex

2.6.7 Dial Indicating Thermometers

Provide bimetallic type with stainless steel case and stem, with thermowells and having a 127.0 mm 5 inch dial and plus or minus 1 percent accuracy.

2.6.7.1 Expansion Tank and Dump Tank Thermometers

Provide three thermometers on each tank; at the drum centerline, at the top 1/3 point, and at the lower 1/3 point of the drum.

2.6.7.2 Inlet and Outlet Gauges of HTW Generators

Provide inlet and outlet gauges of HTW generators as above, as applicable.

2.6.8 Remote Reading Temperature Indicators

2.6.8.1 Pump Thermometers

Provide HTW generator and distribution system circulation pump panel dial type, liquid filled, surface panel mounting, back-connected thermometers in 150 mm 6 inch turret type phenolic case, with range 35 to 260 degrees C 100 to 500 degrees F, with self-compensating stainless steel 3 m 10 foot long capillary having a stainless steel separable socket with a 65 mm 2-1/2 inch extension neck, 150 mm 6 inch bulb length, 19 mm 3/4 inch IPS connection.

2.6.8.2 Pipeline Thermometers

Provide pipeline thermometers similar to above, with 65 mm 2-1/2 inch extension neck separable sockets, where accessible, and with required capillary length where not accessible, for direct reading.

2.6.8.3 Flue Gas and Fuel Oil (if Oil-Fired) Thermometers

Provide vertical scale, moving pointer type temperature indicators, in semiflush mounting dust-tight case, with curved translucent scales, internally illuminated, with instrument scale graduations, figures, and range suited for the indicated service, employing a diaphragm measuring element with linkage actuation of the indication pointer. Provide gas-filled bulb type thermal sensing element with spirally wound, bronze armored flexible copper connection tubing to the instrument, and instrument accuracy of 2 percent of full scale range with a sensitivity of 0.2 percent of full scale range.

2.6.8.4 Separable Sockets

At all points of recording, controlling, or integrating instrument temperature bulb insertion, install a stainless steel separable socket having a screwed cover and attachment chain adjacent to a temperature bulb for insertion of a test thermometer.

2.6.9 Oxygen Analyzer

If oxygen compensation controls are furnished, provide an oxygen analyzer to indicate, record, and control the percentage of net excess oxygen in, and the average temperature of the flue gas leaving, the boiler. Provide a direct probe type oxygen analyzer utilizing an in situ zirconium sensing element inserted directly into the process flue gas stream and in direct contact with the process gases. Provide a sensing element contained within a protective shield mounted to the ductwork by an adapter plate. Provide analyzer equipped to allow daily automatic calibration check without removing the analyzer from the process, where as sample gases may be injected directly on the sensing element while the analyzer is in the process. Include any temperature compensation of control required with the output signal range from 4 to 20 mA dc and representing 0 to 10 percent as a linear function.

2.6.10 Flue Gas Opacity Monitor

Provide a flue gas monitoring system with continuous measurement, indication, and recording of smoke opacity from each boiler, and with the stack units including a light source and a light detecting or receiving unit mounted in the stack or main breeching, as recommended by the manufacturer. Provide a control or transmitter unit with electronic solid-state circuitry and meter or digital type indicator, and provide an output signal for 0 to 100 percent opacity. In addition, provide the control unit with calibration and alarm adjustments for compliance with Federal, State, and local environmental regulations, and a control or transmitter unit and recorder with a dust-tight metal enclosure. Provide a purging air system to clean light source lens and light detector lens. Provide the control unit with adjustable alarm output contacts for various smoke densities.

2.6.11 Fuel Flow Meter

Provide a volumetric measurement type flow meter incorporating a rotary, positive displacement piston body with gear train driven generator and totalizing register, a panel-mounting meter to indicate fuel oil rate of flow in gallons per minute, and a transmitter output signal of 4 to 20 mA dc to be used for combustion control, with a bronze with hard-cast bronze measuring piston. Provide a totally enclosed generator with grease-packed ball bearings, silver commutator, and brushes. Mount the totalizing register on top of the generator housing and calibrate in liters U.S. gallons.

2.6.12 Water Flow Meter

Provide a water flow recorder with totalizer for each generator and a recorder conforming to the requirements specified for the HTW temperature recorder except that flow rates are to be recorded in L/sec gpm.

2.6.13 Btu Recorder

Provide a recording totalizer which integrates temperature difference and water flow to provide the net J Btu output of the generator for each HTW generator.

2.6.14 Makeup Water Meter

Provide a makeup, positive displacement type water meter in the treated water line suitable for operation with water at 21 degrees C 70 degrees F and 450 kPa 65 psig with the complete meter assembly to include meter isolation valves and a valved bypass and strainer on the inlet side of the meter, and 254.0 mm 10 inch diameter vertical type dial calibrated in L gallons having two hands; 380 L 100 gallons indicated on one hand and 7570 L 2000 gallons on the other hand. Provide the hands with a manual reset device. Provide a totalizing register with all bearings self-lubricating if submerged. Provide a meter capacity of [_____] L/sec gpm.

2.6.15 Master Control Center

Provide a centrally located master control center to serve as the central control and recording station for the plant, also serving as a central point for miscellaneous functions including the various alarm circuits with their annunciators and audible signals, and the controls for the system. The units to be installed on the panel are specified under the various paragraphs of this specification. Install all necessary electric wiring for instruments, panel lighting, and equipment requiring electrical connections. Install all necessary transformers, separate relays, switches, and fuses in a fully enclosed junction box with a safety switch with fuses serving the 120-volt power supply to the plug-in strip and any other power supply as required for control circuits. Provide all wire suitable for boiler room requirements and install according to NFPA 70.

Install and support in place on the rear of the panel and test at the factory all necessary interconnecting piping, terminal block, valves, and fittings required for the control equipment.

2.6.15.1 Panel Board

Provide a free-standing master panel board, floor-mounted on a 100 mm 4 inch concrete curb and provided with vibration isolators between panel and anchor bolts. Construct the control panel of specially leveled steel sheet not less than 4.8 mm 3/16 inch thick with adequate structural steel framework to provide a rigid unit, and with the panel gaskets and other seals necessary to form a dust-tight enclosure of the controls conforming to NEMA ICS 1 standards. Identify all controls and instruments using nameplates. Match the panelboard with the boiler control units and distribution panel in appearance, unless it is a console type. Provide each panel with a suitable plug-in strip on the rear of the panel for any required plug-in electrical connections of the instruments with all necessary piping or electrical connections and all necessary devices for a complete operating installation. Provide suitable single strip, rapid start fluorescent lighting with a panel-mounted toggle switch for a panel hood, with a single, pull chain, ceiling light receptacle installed in the interior of the panel enclosure and wired to the common point of electrical supply.

2.6.15.2 Distribution Zone Valve Controls

Provide a manual valve control for each zone control valve on the master panel, with instruments to indicate the position of each valve operator.

2.6.15.3 Expansion Tank Water Level Indicator

On the master control panel provide a remote reading, liquid level indicator type water level indicator, with the indicating scale showing uniform divisions for all level changes, and requiring no liquids for calibration other than the expansion drum water, suitable for 2,758 kPa 400 psig operating pressure, and connected and calibrated to show indicated levels of [_____] mm inches to [_____] mm inches above the outside bottom of the expansion tank. Locate the primary or transmitting elements at the liquid level control station, so located and calibrated that the center point of the indicator shows the normal water level in the tank at [_____] mm inches above the tank bottom.

2.6.15.4 Annunciator

Provide an annunciator system with a semiflush mounted panel which indicates and alarms on the following:

a. Expansion Tank:

Overflow level
Normal level
Combustion cutout level
High pressure
Low pressure

b. Dump tank:

Overflow level
High pressure

Low pressure

c. HTW generator (each) - safety shutdown

d. Fuel (to suit firing system):

Low fuel oil header pressure
Low fuel oil storage level
Low stoker hopper level
Low coal bunker level

e. Air:

Low service air pressure
Low instrument air pressure if pneumatic controls are used

f. Distribution zones (each) - low return pressure

Provide the annunciator with lamp test and acknowledge push buttons, with the operational sequence as follows:

Condition normal	Light off, horn off
Alarm	Light flashing, horn on
Alarm acknowledged	Light on, horn off
Return to normal	Light off, horn off

Provide the system with devices to actuate the annunciator from the above sources, unless otherwise specified.

2.6.15.5 Liquid Level Control Stations

Provide liquid level control stations at the expansion tank and dump tank, and include adequate detection, sensing, and actuating devices to provide signals for the annunciator system and to control the overflow system. The levels for carrying out the above functions are as indicated.

2.6.15.5.1 Expansion Tank Overflow Controller

Provide overflow control system from the expansion tank. Provide the expansion tank that overflows on control signal from the control station specified above which actuates a motorized normally-closed valve allowing water to relieve to the dump tank.

2.6.15.5.2 Dump Tank Overflow Controller

Provide an overflow control system from the dump tank with the dump tank overflowing on a control signal from the controller which actuates a motorized normally-closed valve allowing water to relieve to the blowdown tank.

2.6.15.6 Distribution Zones Control Station

Provide a control station for distribution zones valve control with one manual valve control for each zone. Provide the instrument that indicates the position of the valve operator with remote control and adjustment of the valve. Provide a motorized gate valve for the controlled valve in the distribution zone supply line for emergency shutoff and flow modulation, with the motorization of the valve being such that any partial opening of the valve may be held positively without drift or consumption of a power means. Conform the valve body to the requirements for valves specified in paragraph PIPING.

2.6.15.7 Plant Master Controller

Provide a plant master controller for nitrogen pressurized systems that reacts in response to temperature transmitter signals from a temperature sensing element in the return water header and provides the necessary signals to the HTW generator master controllers with a manual selector station for selecting either automatic control or manual control and a means for adjusting the set point return water temperature control.

2.6.15.8 Clock

Provide an electric synchronous motor type clock, except as modified herein. Provide a surface mounted, suitable for operation on 115-volt, 60 Hz single-phase electric service with a white dial, 380 mm 15 inch size, easy-to-read black numerals, black hands, red sweep second hand, and external manual reset knob at bottom of case. Provide a motor gear train sealed in a permanent oil bath.

2.6.16 Panel Piping and Wiring

Pneumatically or electrically, or both, transmit high-pressure and high-temperature values to the panel. Transmit pneumatic signal at 0.69 to 104 kPa 3 to 15 psig and include piping connectors to indicators with 6.4 mm 1/4 inch OD copper tubing conforming to ASTM B68/B68M. Transmit flow signals either pneumatically or electrically to the panel-mounted receiver. Run copper tubing connections and electric wiring to a terminal block located on the inside of the panel front near the bottom with wiring terminated at an identified terminal strip. Provide wiring suitable for boiler room requirements and install according to NFPA 70.

2.6.17 Pilot Lights

Provide factory-built cabinet with assembled pilot lights, suitable for flush mounting in cutouts in boiler control panel, complete with extruded trim, clamps, and sheet metal rear housing, and finished in baked black enamel. Provide white plastic and engraved in black ink lens with lettering 19 mm 3/4 inch high and black. Provide two 6 watts, 24 volts dc, S-6 incandescent type lamps, supplied with color caps, one red and one green per pilot light, independently wired lamps per pilot, with black lens bezels unless otherwise indicated.

2.6.18 Continuous Emissions Monitoring

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NOTE: A continuous emissions monitoring system (CEMS) is required by the Clean Air Act Amendment (CAAA) of 1990 if the fuel utilized is oil or coal and the heat input is 3 megawatts 1 million BTU/HR or greater. A CEMS may also be required by state or local laws. If a CEMS is necessary, review the CAAA and the relevant state or local law early in the

project to allow time to incorporate the required CEMS specification and to determine which fine gas emissions will be included in the required reports. Before acceptance of the installation, furnish the Contracting Officer with a written test report which provides documentation that the CEMS equipment has passed factory and field certification tests required by federal, state and local regulations. The investigation will determine if the reported values may be calculated or should be direct measurements. Fill in the data to state what method of measurement or calculation will be utilized for the determination of the report variable.

Emerging flue gas flow monitor technologies are available. The traditional differential pressure technique specified uses familiar equipment that can be maintained by plant personnel. This type of measurement device has reliably satisfied regulatory requirements. The possible use of other technologies should include a thorough investigation of flue gas flow monitor regulatory requirements and in-house maintenance capabilities.

****

a. Provide continuous emissions monitoring system (CEMS) equipment as a system by a single manufacturer, meeting the requirements of applicable federal regulations, State of [_____] and local regulations, for each boiler in accordance with manufacturer's recommendations and under the direct supervision of the CEMS equipment manufacturer.

b. Include in the reported data [sulfur dioxide (SO2)] [oxides of nitrogen (NOx)] [carbon dioxide (CO2)] [particulate matter (PM)] and other information required by federal, state, and local regulations. Base SO2 reporting on [analyzer measurement] [fuel flow and percent sulfur calculation] [daily heat input calculation]. Base nitrous oxides, carbon dioxide and particulate matter reporting on analyzers.

c. Provide the CEMS equipment with the central processing unit, printer, hard disk drive, and optical disc drive, with the optical disc drive functioning as a recorder. Provide the manufacturer's software to generate the required reports in a format acceptable to the federal, state and local regulatory agencies. Provide a CRT screen as the operator interface to the CEMS equipment.

2.7 NITROGEN PRESSURIZATION SYSTEM

Provide a complete system of nitrogen pressurization, including necessary equipment, parts, pressure vessels, piping, valves, devices, and accessories allowing proper HTW expansion and contraction, and control of makeup water with a minimum loss of nitrogen and HTW while maintaining the system pressures corresponding to the operating range of the combustion control of 5.5 degrees C 10 degrees F above or below the boiler-outlet water temperature, without steaming in the system.

2.7.1 Expansion Tank

Provide one expansion tank constructed, hydrostatically tested at the factory, stamped, and certified in accordance with ASME BPVC SEC VIII D1 for an operating pressure of [_____] kPa psig and temperature of [_____] degrees C degrees F, with connections and piping inserts adequately supported structurally as required for the service. Provide a standard manhole, actuating device for feed water control, alarm devices, gauge glasses, floats, and controls as required, for the proper functioning of the expansion tank.

2.7.2 Dump Tank

Provide dump tank, hydrostatically tested at the factory, constructed, stamped, and certified in accordance with ASME BPVC SEC VIII D1 for an operating pressure of [_____] kPa psig and [_____] degrees C degrees F, with connections and piping inserts adequately supported structurally as required for the service, also with a standard manhole, actuating services for makeup water control, alarm devices, gauge glasses with shields, floats, and controls as required, for the proper functioning of the dump tank.

2.7.3 Expansion Tank and Dump Tank Fittings

Tank fittings conforming to ASME BPVC SEC VIII D1 and including the following:

a. Pressure gauge.

b. Water level gauge.

c. Level controls.

d. Thermometer.

e. Drain valves; hard seat, seatless pattern; rating 400 to 600 pound class.

f. Vent valves; Class 600 600 pound steel bar stock, OS&Y.

g. Safety relief valves conforming to ASME B16.34, and suitable for a HTW expansion drum at working pressure of [_____] kPa psig, with all internal parts are of steel or stainless steel with hard facing allowable.

2.8 BLOWOFF SYSTEM

2.8.1 Sample Cooler

Provide a water-cooled, shell-and-tube type heat exchanger with stainless steel tubes suitable for cooling the blowoff (before sampling) sample cooler. Connect the cooler to a header and valved so that the operator can obtain a sample of properly cooled blowoff from any boiler as desired. Support the cooler and provide a steel sampling cock with a sampling glass container suitable for handling the water temperature to be encountered and a hydrometer or equivalent device suitable for measuring the concentration of solids in the boiler blowoff and reading in parts per million.

2.8.2 Blowoff Tank

Provide a concrete blowoff tank with bolted manhole cover, cover plate with disappearing lifts, inlet blowoff connection equipped with mixing nozzle, vent, overflow and drain connection.

2.9 WASTE HEAT RECOVERY EQUIPMENT

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NOTE: For the efficiencies specified, waste heat recovery will be required. Designer must consult with HTW generator manufacturers to select the most appropriate unit for the size of HTW generator being designed.

****

Equip each boiler with [an economizer] [an air preheater], which may be separate from or integral with the boiler and complete with insulation and jackets, casings, supports, and access doors, and with provisions for tube or tube bundle removal and for cleaning.

2.9.1 Economizers

Provide economizers of a type normally provided by the boiler manufacturer and including [finned tubes] [bare tubes] baffles and headers, and provisions for cleaning and tube bundle removal, constructed of materials capable of withstanding the maximum boiler exit gas temperature plus 28 degrees C 50 degrees F. Use tubes conforming to ASME BPVC SEC I. Design and install as to preclude cold-end corrosion under any load condition, with economizer tube metal temperature being above the maximum flue gas dewpoint for the fuel being fired under all load conditions.

2.9.2 Air Preheaters

Provide air preheaters normally provided by the boiler manufacturer and being the recuperative tube plate or regenerative type constructed of materials adequate to withstand the corrosion effects of the flue gases with the overall installation precluding cold-end corrosion of the air preheater under any load condition. Temperatures of all metals in contact with flue gas must be above the flue gas maximum dewpoint temperature for the fuel being fired under all load conditions. Provide air-preheat or automatic bypass control integrated with the combustion control system.

2.10 DRAFT FANS

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NOTE: Induced draft fan outlet dampers may not be required in single fan/single boiler installations, except to eliminate the stack effect during outages.

****

Provide [backward curved blades] [radial tip blades] or axial flow type centrifugal fans conforming to AMCA 801 [Type I] [Type II] furnished as an integral part of boiler design. Size each fan for an output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner or grate, leakages, temperature, and elevation corrections for a dirty boiler with worst ambient conditions, all at full combustion to meet net rated output at normal firing condition, with fan sizing including minimum margins of 10 percent volume and 21 percent static pressure, plus margins of 5 degrees C 10 degrees F for forced-draft fans and 22 degrees C 40 degrees F for induced-draft fans. Design induced-draft fans for handling hot flue gas at the maximum outlet temperature adjusted for surface fouling. [Provide induced-draft fans with outlet dampers.] Noise levels for fans must not exceed 85 decibels at 914 mm 3 foot station, with [air cooled] [or] [water-cooled] fan bearings, and backward curved fan blade type with bearings not requiring water cooling may be of the self-aligning antifriction type. [Provide scroll sheets and rotor blades with liners.]

2.10.1 Draft Fan Control

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NOTE: Variable speed control, inlet vane control and inlet damper control are, in descending order of efficiency, capable of control draft fan conditions. The choice is based on economics. However, in erosive services, inlet vane control is not desirable.

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Provide forced-draft centrifugal fans with [inlet vane controls] [variable speed control]. Provide induced-draft centrifugal fans with [inlet vane control] [inlet damper control] [variable speed control] and [axial propeller fans having variable propeller pitch control.] Provide inlet vanes or dampers suitable for use with combustion control equipment.

2.10.2 Draft Fan Drives

****

NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

****

Provide electric motor driven fans with electric motor being [drip-proof] [totally enclosed nonventilated] [totally enclosed fan-cooled] [totally enclosed fan-cooled, suitable for installation in a Class II, Division 1, Group F, hazardous location conforming to NFPA 70]. [Provide magnetic [across-the-line] [reduced voltage start] type motor starters with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure and furnished with four auxiliary interlock contacts.]

2.11 AIR DUCTS

Design air ducts connecting the forced-draft fan units with the stoker plenum chamber to convey air with a minimum of pressure loss due to friction. Provide galvanized sheet metal ductwork conforming to , with ducts straight and smooth on the inside with laps made in direction of air flow, and externally braced, installed and anchored as to be completely free from vibration. Provide access and inspection doors as required. Construct ducts with long radius elbows having a centerline radius 1.5 times the duct width, or where the space does not permit the use of long radius elbows, short radius or square elbows with factory-fabricated turning vanes may be used. Provide substantially air-tight duct joints of adequate strength for the service, with 38 x 38 x 3.2 mm 1-1/2 x 1-1/2 x 1/8 inch structural steel angles used where required for strength or rigidity. Duct walls thickness as follows:

Duct, Maximum Dimension	Galvanized Steel Sheet, Minimum Thickness
Up through 1525 mmUp through 60 inches	1.613 mm16 gauge
1526 m and larger61 inches and larger	2.753 mm12 gauge

2.12 BREECHING

Construct breeching of not less than 3.416 mm 10 gauge steel sheets conforming to ASTM A36/A36M and with adequate reinforcement and bracing with structural steel angles not smaller than 50 x 50 x 6.4 mm 2 x 2 x 1/4 inches, and all welded joints, longitudinal seams and angles. Provide expansion joints as required to suit the installation, being flexible type requiring no packing. Providing breeching with angle flanges and gaskets for connection to boilers, fans, equipment, or stacks. Provide gas-tightbreeching connections, caulked-tight all around and sealed with cement to form an air-tight joint. Provide clean-out openings of suitable size and at approved locations for access to all sections of the breeching with tight-fitting, hinged, cast-iron doors with cast-iron frames. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping for combustion gases.

2.13 STACKS

Provide self-supporting, double-wall insulated type stacks for individual boilers. Provide for each stack, unless otherwise indicated, complete with structural steel base, base plates, anchor bolts and nuts, cleanout door, [induced-draft fan] [boiler] connection and a thermometer well. Stub stacks for packaged boiler units may be supported directly on the boiler providing the boiler structure is designed to accommodate such an arrangement. Provide insulation suitable for sustained flue gas temperature of 485 degrees C 900 degrees F with intermittent temperatures up to 650 degrees C 1200 degrees F and the wall section "U" factor of approximately 0.26. Fabricate stacks of high-strength, low alloy, structural steel resistant to atmospheric corrosion and conforming to ASTM A242/A242M for both inner and outer shell. Provide inner shells of each section with an air-sealed and concealed expansion and contraction device to allow for differential expansion of inner and outer shells. Extend stacks above the roof to the height indicated. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping for combustion gases.

2.14 ELECTRIC MOTOR-DRIVEN PUMPS

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

****

Provide electric motor-driven pumps with motors that are [splash-proof] [totally enclosed, nonventilated] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type, suitable for installation in a Class

II, Division 1, Group F hazardous location in accordance with NFPA 70]. Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.

2.14.1 HTW Circulating Pumps

Design and size HTW circulating pumps for specific applications. Provide pumps having a combined rating of flow and head that results in a power rating less than 185 kW 250 bhp to meet the design requirements of API STD 610, being end-suction, top discharge, and supported at its centerline. Provide horizontal-split case, multi-stage centrifugal pumps for sizes above 185 kW 250 bhp. Provide volute or diffuser design casing construction, supported at its casing centerline. Provide all pumps nominally rated for excess capacity of 10 percent above the maximum continuous rating of the service. Provide the required Net Positive Suction Head (NPSH) at the pump design flow, head, and speed not exceeding 80 percent of the available system NPSH at the same flow, assuming a low level in the storage tank. Provide the pump's suction specific speed not to exceed 9000 at the pump's best efficiency point (BEP) reflecting a guaranteed NPSH requirement of 3 percent breakdown criteria. Select a pump based on a constantly rising to shutoff with no point of inflection, and with no restriction to operation at any point from minimum continuous flow to design flow.

2.14.1.1 Suction and Discharge Flanges

Provide pumps with integrally cast suction and discharge flanges drilled to meet the design pressure of the application. Provide feed pumps designed for an operating temperature of not less than 205 degrees C 400 degree F, with casings drilled, tapped, and provided with vent and drain connections. Pumps designed for this service do not require cooling at ratings below 375 kW 500 bhp for both frame cooling and seal cooling. For pumps below 375 kW 500 bhp, provide antifriction radial and thrust bearings, lubricated by flinger rings in a sealed housing with mechanical seals, and with air-cooled flush piping conforming to API STD 610, Plan 23. For pumps above 375 kW 500 bhp, provide a single cooling circuit for both cooling the oil being delivered by a forced oil system to sleeve radial bearings and a floating shoe thrust bearing, coupled with the seal coolers for both stuffing boxes and mechanical seals. In both cases, provide site-convertible stuffing to a packed box. Provide for maximum leakage no more than 0.025 L/hour 25 cc/hr for a seal life of no less than 25,000 hours, and bearing rating not less than 100,000 hours (L-10 life) at the point of maximum load, as defined by ABMA 9.

2.14.1.2 Structural Steel Bases

Support pumps on structural steel bases that do not require grouting in order to impart strength to the pump for static and dynamic loading from the piping system, with bases pitched to a low point drain. Shop align complete pump and motor assembly using shims on both the pump and the motor.

2.14.1.3 Pump Coupling and Guard

Provide pumps with nonlubricated flexible-disc couplings and a coupling guard. Provide spacer-type couplings to permit removal of the mechanical seals and limited-end-float-type for pumps with sleeve bearings.

2.14.1.4 Recirculation Control Valve

Provide pumps with a self-contained automatic recirculation control valve sized for nominally 25 percent of the pump's BEP flow.

2.14.1.5 Pump Testing

Subject pumps to shop hydrostatic testing. Subject one pump in each service to complete shop performance tests to demonstrate that, at rated capacity, head is within a margin of plus 3 percent and minus 0 percent of design; efficiency is within a tolerance of minus 0 percent; NPSH at the pump's BEP and at the rated condition is within a margin of plus 0 percent and minus 10 percent. Conduct performance tests in accordance with API STD 610. Procedures and results are subject to the approval of the Contracting Officer.

2.14.1.6 Instrument Panel

Provide each HTW circulation pump with an instrument panel, with construction and arrangement of the gauge panel as indicated. Provide nameplates having letters 6 mm 1/4 inch high designating the pump number and service. Provide surface panel mounted gauges. Provide the instruments specified above and include one single-element pressure gauge for the pump suction, one duplex pressure gauge with two elements to indicate flow pressure on each side of the pump discharge regulating valve, and one dial type thermometer to indicate the discharge temperature. Provide identification letterings located either on the gauge dial or on a nameplate adjacent to the gauge identifying the service of the gauge, with a stainless steel socket with cover for a separable socket-type test thermometer installed in the pump discharge piping at each circulation pump for future insertion of a test thermometer. PProvide pressure gauges with a gauge valve and a pigtail siphon as specified installed at the point of connection with the main piping. Provide pulsation dampeners or snubbers for pressure gauges connected to the pump discharge.

2.14.2 Emergency Makeup Water Pump

Provide centrifugal type emergency makeup water pump; split case, 2 stage type with closed impellers and radial or mixed flow. Design the pump to handle high temperature water at 122 degrees C 250 degrees F, specific gravity of 0.942, pH of 9.5 to 10.5, and the capacity and head indicated.

2.14.3 Makeup Water Pumps

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NOTE: If inadequate NPSH is available, give consideration to substituting either a double suction or positive displacement pump.

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Provide horizontal, end-suction, single-stage, centrifugal, motor-driven makeup water pumps. Provide pumps having stainless steel shafts, bronze impellers, and stuffing boxes. Lubricate by splash oil with oil level sight glass provided. Subject pumps to the same tests specified for the HTW circulating pumps.

2.14.4 LTW Circulation Pump

Provide centrifugal type, end suction, single stage type with closed, open, or semi-open impellers, radial or mixed flow, designed to handle low temperature water at 110 degrees C 225 degrees F, and the capacity and head indicated.

2.15 LTW EXPANSION TANK

Provide LTW expansion tank in connection with the LTW water heater constructed in accordance with ASME BPVC SEC VIII D1 and with a protected gauge glass and manual air vent. Hydrostitically test the tank at 1-1/2 times the working pressure or at 690 kPa 100 psig, whichever is greater.

2.16 HEAT EXCHANGERS

2.16.1 Water Heaters

Provide water heaters of the types scheduled and with thermostatic control valves, valved bypasses, strainers, and temperature/pressure relief valves. Provide thermometers where indicted, and temperature and pressure relief valves conforming to the requirements of ANSI Z21.22/CSA 4.4. Provide separate valves if input exceeds 29.3 kW 100,000 BTU/H or storage capacity exceeds 454 L 120 gallons. Provide thermostatic control valves installed in the HTW return line from each water heater coil, installed to operate in conjunction with a remote bulb temperature controller, and conforming to the requirements of paragraph THERMOSTATIC REGULATING VALVE. Provide flanged valves, minimum Class 300 300 pound class, and sized for the service by the manufacturer. Provide shell-and-tube design instantaneous water heaters conforming to the applicable requirements of TEMA Stds, Class C with the heater shell being steel and designed for [_____] kPa psi and [_____] degrees C degrees F temperature, and U-tube type coil designed for high temperature water at [_____] kPa psi pressure. Provide 16 mm 5/8 inch or 19 mm 3/4 inch size, constructed of No. 16 AWG cupronickel (90 percent/10 percent) coil tubing.

2.16.2 LTW Heat Exchanger for Fuel Oil Heating

Provide instantaneous shell-and-tube type heater conforming to the applicable requirements of TEMA Stds, Class C, with a steel shell and designed for [_____] kPa psi pressure and [_____] degrees C degrees F temperature. Provide with U-tube type coil designed for HTW at [_____] kPa psi pressure, constructed of No. 16 AWG 16 mm 5/8 inch or 19 mm 3/4 inch cupronickel (90 percent - 10 percent) tubing.

2.17 CHEMICAL TREATMENT AND WATER SOFTENING EQUIPMENT

2.17.1 Chemical Feeder

Provide an automatic proportioning, shot type, or pump type chemical feeder unit for each boiler, including all appurtenances necessary for satisfactory operation, with size and capacity of feeder based on local requirements and water analysis.

2.17.2 Chemical Feed Pumps and Tanks

Provide chemical feed pumps with pump cylinders, plungers, ball check valves, and check valve bodies of corrosion resistant materials suitable for the chemicals being pumped and tanks as a complete package assembly with the pumps mounted on and piping connected to the tank. Volumetric accuracy of the pumps must be within one percent over the range indicated. Provide with adjustable pump capacities by positioning crank pin with micrometer setscrews. Provide stroke length scale divided in percentage graduations engraved on scale. Provide replaceable cylinders for increased or reduced pressure or capacity ranges. Provide drive motors suitable for the electrical power available and having drip-proof enclosures. Provide tanks made of polypropylene and mounted on legs with filling and drain connections, gauge glass and hinged cover. Provide each tank with one pump, mounted and piped with black iron pipe and fittings, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Provide tank with bottom dished concave to a radius equal to the diameter of the tank. Provide tanks suitable for phosphate or caustic feed and sulfite feeding. provide a motor-driven agitator. Design the pump to feed the chemical solutions into the HTW return line to the system circulating pumps and have the capacity to feed a maximum of 5.3 mL/sec 5 gph.

2.17.3 Water Softening Equipment

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NOTE: If softening equipment for makeup water is not required, as determined in accordance with UFC 3-410-01, entire paragraph should be deleted. If water softening equipment is required, list desired water treatment conditions; e.g., pH level, hardness, chemical concentrations.

****

Provide a [single] [double] unit automatic water softener system as indicated, designed for a working pressure of [_____] Pa psig, complete with raw and regenerate water distribution; under drain; inlet and outlet connection in upper and lower header respectively; resin removal connecting pipe legs; control valve for service, backwash, regenerate, and rinse; water meters, pressure gauges, brine storage, and measuring tank and controls for automatic operation. Provide either hot-dipped galvanized after fabrication or polypropylene brine tank[s], brine piping either all copper pipe and fittings or Schedule 80 PVC and fittings. Provide equipment having a total capacity between regenerations of not less than [_____] liters gallons of water of [_____] g grains hardness when operating at a sustained softening rate of [_____] L/sec gpm, and based on the data below. Provide test sets for pH comparator for the range [_____] to [_____] sulfide comparator, and phosphate comparator.

2.17.3.1 Water Analysis

The source of the raw water is [_____]. The analysis of the water is approximately as follows:

Constituents*	
Sodium as (Na)	[_____] ppm
Silica as (SiO(2))	[_____] ppm
Calcium as (Ca)	[_____] ppm
Magnesium as (Mg)	[_____] ppm

Constituents*	
Iron and aluminum oxides as (Fe(2)O(3)), (Al(2)O(3))	[_____] ppm
Bicarbonates as (HCO(3))	[_____] ppm
Bicarbonates as (HCO(3))	[_____] ppm
Hydroxides as (OH)	[_____] ppm
Sulphates as (SO(4))	[_____] ppm
Chlorides as (Cl)	[_____] ppm
Phosphates as (PO(4))	[_____] ppm
Carbon dioxide (free CO(2))	[_____] ppm
Total hardness as (CaCO(3))	[_____] ppm
Total solids in solution	[_____] ppm
Volatile and organic matter	[_____] ppm
Suspended matter	[_____] ppm
Free acid	[_____] ppm
Color	[_____]
pH	[_____]
*Numbers in parentheses are subscripts.	

2.17.3.2 Zeolite

Provide high capacity polystyrene base sulphonic synthetic type zeolite, with not less than [_____] cubic meters cubic feet of zeolite with each reactor tank.

2.17.3.3 Reactor Tank

Provide reactor tank sized on allowing a freeboard above the zeolite bed of not less than 50 percent of the zeolite bed depth, and a maximum flow rate of 0.679 L/square meter per second one gallon/square foot per minute for each 111 mm 4-3/8 inches of zeolite bed depth.

2.17.3.4 Softening System

Provide the softening system complete with all piping, control, and power wiring, and a complete initial charge of rock salt installed in the brine tank as recommended by the softener manufacturer.

2.17.3.5 Water Test Kit

Provide a water test kit in a strong carrying case, complete with test containers, reagents, and instructions for testing the raw and effluent water.

2.17.3.6 Treated Water Storage Tank

Provide a treated water storage tank as indicated, having a capacity of not less than [_____] liters gallons, fabricated from steel plates not less than 4.76 mm 0.1875 inch thick for shell and heads, constructed in accordance with ASME BPVC SEC VIII D1 for a design working pressure of 520 kPa 75 psig, with dished or concave heads to a radius equal to the diameter of the tank, and hydrostatically tested at the factory at not less than 690 kPa 100 psig. Provide the tank with the connections indicated, an 200 mm 8 inch copper ball float, lever-operated control valve, valve bypass and accessories, and a protected gauge glass.

2.18 HTW SPECIALTIES

2.18.1 Sediment Trap and Blender

Provide a hydrostatically tested sediment trap constructed, stamped, and certified in accordance with ASME BPVC SEC VIII D1 for an operating pressure of [_____] Pa psig and [_____] degrees C degrees F, with the receiver sized for maximum plant flow condition of [_____] L/second gpm and maximum flow velocity of 150 mm/second 0.5 fps. Flange and dish receiver heads and flange all tank nozzles 50 mm 2 inches and larger Class 300 300 pound class. Provide an inspection handhole.

2.18.2 Line Mixer

Fabricate the line mixer as indicated using seamless steel welding pipe fittings with the area of holes drilled in the HTW injector pipe equal or exceed 1.5 times the cross-sectional area of the injector pipe.

2.18.3 Liquid Level Control Column

Provide the column fabricated as indicated of seamless steel pipe and standard welding fittings, using forged steel pipe weldolets for gauge glass piping connections and float switch connections.

2.19 AIR COMPRESSORS

Provide the air compressor units conforming to ASME PTC 10, with compressor speeds not to exceed 900 rpm and motor speed not to exceed 1750 rpm, except as specified otherwise.

2.19.1 Service Air Compressors

Provide the service air requirements as indicated with receivers sized as indicated. Provide units suitable for heavy-duty service (soot blowing), with simplex type compressors, single-stage, double-acting, with water-jacketed cylinder; fitted with intake and discharge valves of the lightweight feather, disc or plate type; and provided with all necessary controls, water-cooled aftercooler, moisture separator, drive, receiver, relief valves, and cooling water controls as indicated or required. Provide the compressor air intake with a low drop type air suction filter/silencer suitable for outdoor installation. Provide shell-and-tube type after cooler designed for air flow through the tubes with steel shell internal baffle plates and Admiralty metal tubes expanded into Muntz metal tube sheets. Provide moisture separator with an automatic water discharge trap and level gauge. Provide vertical type air receiver constructed in accordance with ASME BPVC SEC VIII D1 and equipped with flanged inlet and outlet connections, valved drain connection, 150 mm 6 inch dial pressure gauge, pop safety valves, and regulator connections. Provide cooling water controls for regulating compressor cylinder water temperature and after cooler water temperature of the thermostatic valve type and being installed with a three-valve bypass in the water outlet lines ahead of open sight drain funnels. Equip the compressor with adjustable, pressure type unloader controls suitable for continuous compressor operation.

2.19.2 Instrument Air Compressors

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NOTE: The designer should determine if two redundant full size instrument air compressors will be required as loss of air will cause unit shutdown unless other provisions are made, such as crossties to the soot blower/service air system. Delete paragraph if not required.

****

Provide an electric motor-driven oil-free automatic air compressor unit and a refrigerating drying unit, with he air compressor capable of delivering at a pressure of [_____] kPa psig not less than 0.00472 cubic meter/sec 10 scfm dry air at an atmospheric dew point of -18 degrees C 10 degrees F with entering air at 35 degrees C 95 degrees F, saturated, and the air compressor unit sized to run not more than 60 percent of the time when all controls are in service. Provide the air compressor unit complete with all necessary accessories including automatic pressure control equipment, relief valves, check valves, air filters, moisture traps, and a receiver with ample capacity for emergency operation of the controls for 15 minutes after compressor shutdown. Provide a vertical constructed receiver in accordance with ASME BPVC SEC VIII D1, with relief valve and drain fittings. Provide a self-contained, refrigerated type air dryer, complete with refrigeration compressor, heat exchanger, automatic controls, and moisture removal trap or a regenerative desiccant type dryer, as required. Provide a hermetically-sealed type refrigeration unit capable of continuous operation at maximum load conditions.

2.20 PIPING

Unless otherwise specified herein, provide pipe and fittings conforming to the requirements of ASME B31.1.

2.20.1 Pipe

Pipe material as specified in TABLE I, except fuel oil pipe material must comply with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.20.2 Fittings

Pipe fittings as specified in TABLE II, except fuel oil fittings must comply with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.20.3 Nipples

Nipples conforming to ASTM A733, Type I or II, as required to match adjacent piping.

2.20.4 Unions

Unions conforming to ASME B16.39, type as required to match adjacent piping.

2.20.5 Pipe Threads

Pipe threads conforming to ASME B1.20.2MASME B1.20.1, right- or left-hand tapered thread as required.

2.20.6 Pipe Expansion

2.20.6.1 Expansion Joints

Design expansion joints for a HTW working pressure not less than [_____] kPa psig and in accordance with applicable requirements of ASME B31.1 and EJMA Stds. Provide flanges for end connections. [Provide service outlets where indicated or required.] Provide Type II joints suitable for repacking under full line pressure.

2.20.6.2 Flexible Ball Joints

Construct flexible ball joints of [stainless steel] [carbon steel] or other alloys as appropriate for the service intended, complete with flanged joints or welded end as required and capable of absorbing the normal operating axial, lateral, or angular movements or combination thereof. Design and construct the ball-type joint in accordance with ASME B31.1 and ASME BPVC SEC VIII D1 where applicable. Conform flanges to the diameter and drilling of ASME B16.5. Provide molded gaskets suitable for the service intended.

2.20.7 Valves

Install valves at all indicated locations, where specified, and where required for proper functioning and servicing of the system. Provide motor-operated valves capable of closing speeds of 2.5 to 5.1 mm/sec 6 to 12 inches/minute, with motor operators equipped with position indicators, valve stem protectors above the motor operating units, and auxiliary handwheels for manual operation of the valves in the event of power failure, and motors suitable for operation on the electric current characteristics indicated.

2.20.7.1 Check Valves

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NOTE: The designer will indicate the type of valves, vertical lift or horizontal, on the drawings.

****

a. Valves for Class 125 125 pound class steel piping conforming to the following:

    (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 3 or 4, Class 125.

    (2) Sizes 80 mm 3 inches through 600 mm 24 inches, cast-iron: MSS SP-71, Type III or IV, Class 125.

b. Valves for Class 150 150 poundclass steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Class 150 minimum.

(2) Sizes 80 mm 3 inches through 600 mm 24 inches, steel: ASME B16.34, Class 150 minimum, flanged ends, swing disc.

c. Valves for Class 300 300 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Class 300 minimum.

(2) Sizes 80 mm 3 inches through 600 mm 24 inches, steel: ASME B16.34, Class 300 minimum flanged ends, swing disc.

2.20.7.2 Gate Valves

Unless otherwise indicated or specified, gate valves used as shutoff valves at main headers and elsewhere, as indicated, provide chain-operated type with sufficient chain for easy operation from the operating floor or walkway for gate valves 200 mm 8 inches and larger provide a globe valve bypass. Provide wedge disc type gate valves with outside screw and yoke and bonnet bushings. Provide valve bodies with straight-through ports without recesses except between seats to assure minimum turbulence, erosion, and resistance to flow. Provide motor-operated gate valves installed in the HTW supply and return mains, where indicated, to isolate the distribution zones from the plant in case of a line break. Provide valves that close by a pressure switch operated by return main water pressure with Bourdon tube, actuated mercury switch type pressure switch and with an adjustable operating range of 345 to 2413 kPa 50 to 350 psi. Provide a three-position selector switch for automatic or manual operation of the valve position.

a. Valves for Class 125 125 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 125.

(2) Sizes 80 mm 3 inches through 1200 mm 48 inches, cast-iron: MSS SP-70, Type I, Class 125, Design OT or OF (OS&Y), bronze trim.

b. Valves for Class 150 150 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 150 minimum.

(2) Sizes 80 mm 3 inches through 610 mm 24 inches, steel: ASME B16.34, Class 150 minimum, flanged ends.

c. Valves for Class 300 300 pound class steel piping conforming to the following:

(1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 300 minimum.

(2) Sizes 80 mm 3 inches through 610 mm 24 inches, steel: ASME B16.34,

Class 300 minimum, flanged ends.

2.20.7.3 Globe Valves and Angle Valves

Provide globe type valves having outside screw and yoke with bolted bonnets, stainless steel trim, and flat seats, and large and deep boxes, but not the reversed cup type. Install valves with the stem horizontal or above. Provide a distribution system bypass motor-operated globe-valved piping connection between the supply and return mains, where required, installed to ensure uninterrupted water flow to the HTW generator in case of low return pressure. While in operation, valve must modulate to the open position on low return main pressure signal. Provide a three position selector switch for automatic or manual selection of valve position. Install for each distribution zone, a manually-operated handwheel or chainwheel globe valve in each high temperature return main to control the flow and the resultant differential temperature drop through each system.

a. Valves for Class 125 125 pound class steel piping conforming to the following:

   (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 125.

   (2) Sizes 80 mm 3 inches through 300 mm 12 inches, cast-iron: MSS SP-85, Type III and Type IV, Class 125.

b. Valves for Class 150 150 pound class steel piping conforming to the following:

   (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 150 minimum.

   (2) Sizes 80 mm 3 inches through 610 mm 24 inches, steel: ASME B16.34, Class 150 minimum, flanged ends.

c. Valves for Class 300 300 pound class steel piping conforming to the following:

   (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 300 minimum.

   (2) Sizes 80 mm 3 inches through 610 mm 24 inches, steel: ASME B16.34, Class 300 minimum, flanged ends.

2.20.7.4 Thermostatic Regulating Valve

2.20.7.4.1 Cooling Water Control Valves

Install a thermostatically-operated flow control valve in the cooling water piping from each HTW circulating pump, each air compressor, and each aftercooler to control the flow of the cooling water automatically, to prevent the waste of water, and provide proper operating temperature for the bearings. Provide a valve matching the piping size to which it is connected, suitable for operation on 1,034 kPa 150 psi water pressure, with threaded ends, and direct-acting to open on temperature increase. Provide the valve body to have a 3.2 mm 1/8 inch hole drilled through the wall separating the inlet and outlet ports so that water circulation is not completely shut off. Provide the valve with a nonmetallic disc and means for preventing the water from coming in contact with the range spring and sliding parts, with a manual adjustment of the setting of 29 to 51 degrees C 85 to 125 degrees F and factory set for 38 degrees C 100 degrees F. Provide a temperature bulb for closed tank immersion with 13 mm 1/2 inch NPT connector.

2.20.7.4.2 Makeup Water Heater Control Valve

Install a temperature controller in the high temperature return water line from the feedwater heater coil. Provide a motor-operated valve and operate in conjunction with the remote bulb temperature controller, with both valve and controller the reverse-acting type failing in the closed position. Provide the normal operating range fully open at 79 degrees C 175 degrees F and fully closed at 100 degrees C 210 degrees F feedwater temperature with the controller modulating the flow between these points. Provide a valve with a cast steel body, stainless steel trim, and lubricated deep-type stuffing box with packing suitable for the conditions, and with the valve disc top-and-bottom guided of the equal percentage type. Provide a single seated valve for tight closing, [_____] mm inch body size, flanged, passing [_____] kg/sec pounds/hour of HTW at a maximum pressure drop of 15 m 50 foot head.

2.20.7.4.3 LTW Heater Control Valve

Install a thermostatic control valve to operate in conjunction with a remote bulb temperature controller with the valve operating range of 93 to 110 degrees C 200 to 225 degrees F and with valve modulating the flow of HTW to maintain LTW between these temperatures. Provide valve with a cast steel body with stainless steel trim, and lubricated deep-type stuffing box with packing suitable for the temperature and pressure conditions and be single-seated, [_____] body size, to pass [_____] kg/sec pounds/hour of HTW at a maximum pressure drop of 15 m 50 foot head. Provide the temperature bulb for pipeline insertion with 19 mm 3/4 inch NPT connector with all necessary appurtenances including bypass valve and combination temperature-pressure relief valve

2.20.7.4.4 Domestic Water Heater Control Valve

Install a thermostatic control valve to operate in conjunction with a remote bulb temperature controller with the valve operating range of 38 to 70 degrees C 100 to 160 degrees F, adjustable and modulating the flow of HTW to the heater between these temperatures. Provide valve with a cast steel body with stainless steel trim and lubricated deep-type stuffing box with packing suitable for the temperature and pressure conditions, and be single-seated, [_____] body to pass [_____] kg/sec pounds/hour of HTW at a maximum pressure drop of 15 m 50 foot head. Provide temperature bulb for pipeline insertion with 19 mm 3/4 inch NPT connector with all necessary appurtenances including bypass valve, strainer, and combination temperature-pressure relief valve.

2.20.8 Back Pressure Relief Valves

Provide back pressure relief valves with steel bodies and equipped with corrosion resistant trim and valve seats, which are guided and provide positive closing so that no leakage can result, with adjustment of the desired back pressure covering the range between 13 to 70 kPa 2 to 10 psig. Provide external adjustment with adjustable stuffing boxes having renewable packing for any shafts extending through the valve body.

2.20.9 Exhaust Heads

Provide exhaust heads for the discharge of flash steam to atmosphere, constructed of one-piece steel plate, semisteel, or cast-iron with suitable baffle arrangement for the removal of entrained condensate and oil, and with drain connection, and with flow area through unit being larger than connecting pipe.

2.20.10 Strainers

Provide strainer body connections of the same size as the pipelines in which the connections are installed. Provide heavy and durable cast steel strainer bodies that have arrows clearly cast on the sides to indicate the direction of flow. Equip each strainer with an easily removable cover and sediment basket, with the basket not less than 0.063 mm 0.0025 inch thick stainless steel, with enough small perforations to provide a net free area through the basket of at least 3.30 times that of the entering pipe, and with the flow into the basket and out through the perforations.

2.20.11 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports conforming to MSS SP-58, except as modified herein.

2.20.11.1 Types 5, 12, and 26

Do not use Types 5, 12, and 26.

2.20.11.2 Type 3

Do not use Type 3 on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.

2.20.11.3 Type 18

Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

2.20.11.4 Types 19 and 23

Torque Types 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

2.20.11.5 Type 20

Provide Type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

2.20.11.6 Type 24

Type 24 may be used only on trapeze hanger systems or on fabricated frames.

2.20.11.7 Type 39 Saddle or Type 40 Shield

Where Type 39 saddle or Type 40 shield is permitted for a particular pipe attachment application, use the Type 39 saddle on all pipe 100 mm 4 inches and larger.

2.20.11.8 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58 and install a support not over 300 mm 1 foot from the pipe fitting joint at each changes in direction of the piping. Do not space pipe support over 1.5 m 5 feet apart at valves. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. For spacing of the base support members, do not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Rigidly connect the clips or clamps to the common base member. Provide a clearance of 3 mm 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

2.20.11.9 Vertical Pipe Supports

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m 15 feet not more than 2.4 m 8 feet from end of risers, and at vent terminations.

2.20.11.10 Type 35 Guides with Slides

Provide Type 35 guides of steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides, where required, to allow longitudinal pipe movement. Provide lateral restraints as required. Use slide materials suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

a. Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

b. Where there are high system temperatures and welding to piping is not desirable, then include a pipe cradle with , welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 100 mm 4 inches, or by an amount adequate for the insulation, whichever is greater.

2.20.11.11 Pipe Hangers on Horizontal Insulated Pipes

Size pipe hangers on horizontal insulated pipes, except Type 3, based on the outside diameter of the insulation.

2.20.11.12 Piping in Trenches

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NOTE: Detail of piping supported in trenches will be shown on the drawings.

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Support piping in trenches as indicated.

2.21 INSULATION

Shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.22 TOOLS

Furnish special tools and all uncommon tools necessary for the operation and maintenance of boilers, stokers, pumps, fans, controls, meters, special piping systems, and other equipment. Provide a cabinet for small hand tools, mounted where directed.

2.22.1 Smoke Pipe Cleaner

Provide jointed handle cleaner of sufficient length to clean breeching and smoke connections without dismantling.

2.22.2 Firing Tools

Provide firing tools including hoe, poker, and slice bar for each boiler.

2.22.3 Wrenches and Gaskets

Provide wrenches as required for opening boiler manholes, handholes, and cleanouts. Also provide one set of extra gaskets, packaged and identified, for boiler manholes and handholes, for pump barrels, and other similar items of equipment.

2.23 FUEL OIL TANKS

2.23.1 Fuel-Oil Storage Tanks

Provide in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.23.2 Hot-Water Coil

Provide coil constructed of 25 mm 1 inch seamless steel tubing in each tank for No. 6 fuel oil and install around the suction end of the oil line. Provide coil in each tank with the capacity to heat from [_____] to [_____] degrees C degrees F the maximum demand of all oil burners connected to the tank when supplied at 115 degrees C 240 degrees F. Provide heater with automatic temperature-control valve, with strainer and three-valve by-pass in heated water supply line, and with check valve and cutoff valve in return line. Provide an additional manhole located above the heater for removal of the heater as a unit.

2.23.3 Tank Accessories

Provide accessories in compliance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.24 COAL HANDLING EQUIPMENT

2.24.1 Screw Conveyor

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NOTE: Where motor starters for mechanical equipment

are provided in motor control centers, delete the description of motor starters.

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provide screw conveyor for the lateral distribution of coal, consisting of steel screw conveyor with capacity of not less than [_____] cubic meters/sec cubic feet/hour when handling coal of the specified maximum lump size. Base the maximum capacity of the conveyor on the screws carrying not more than 30 percent of their cross section (except feeder conveyors), and the maximum speed of conveyor at 60 rpm. Assemble conveyor and housing in sections, with the sectional flights mounted on steel pipe and connected by coupling shafts. A feeder conveyor may be installed to assume the proper distribution of the load. Mount both the feeder screw and the extended screw flights on the same pipe. Provide conveyor with sectional supporting hanger bearings of the babbitted type. Do not exceed 3.6 m 12 feet conveyor length between bearings. Provide trough ends fabricated of cast-iron type with feet and fitted with babbitted bearings, with the drive located at the discharge end of the conveyor, and consisting of an electric gear motor and chain drive. Provide the chain drive from the motor to the reducer enclosed in an oil-tight casing. Absorb the thrust in either direction by the thrust bearings. The motor may be mounted on top of the trough. Provide a dust-proof trough conveyor housing of not less than 4.8 mm 3/16 inch steel with a 1.897 mm (14 gauge) 14 gauge steel cover. Provide discharge spout and coal gate as indicated. Also provide an approved type of supporting saddle. Space supports at not more than 3 m 10 foot intervals. Provide [totally enclosed, nonventilated] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in conformance with NFPA 70] motor enclosure. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [weather-resistant] [dust-tight] [explosion-proof] enclosure.] Provide dust controlling covers and inlet and discharge enclosures for each conveyor.

2.24.2 Belt Conveyor

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

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Provide belt trough type conveyor, as indicated, with the belt conveyor on a maximum incline not exceeding 15 degrees. Provide conveyor support frame of sufficient rigidity to maintain belt alignment, at least 75 mm 3 inches clearance to prevent damage to the edge of the belt on its return run, and adjustments for aligning shafts. Provide decking placed on top of the stringers to protect the return belt from coal sifting and to provide lateral stiffness. Provide idlers as a rigid framework that maintains permanent alignment of well-balanced, smooth-running, easy turning idler rolls in accordance with CEMA Belt Book. Pressure lubricate ball or roller bearings. Provide 20-degree or 35-degree three-roll type idlers spaced on 1200 mm 4 foot centers, except under loading points and skirts. Space return idlers on 3 m 10 foot centers. Provide Grade 2 belting with field-vulcanized splices as defined in RMA Conveyor and Elevator Belt Technical Information. Design pulleys in accordance with CEMA B105.1, constructed of heavy welded steel, true to diameter and accurately bored, key seated and tightly fitted to the shafts. Provide pulley face width for belts 1.1 m 42 inches wide and smaller, that are 150 m 500 feet or more in length, to belt width plus 100 mm 4 inches; less than 150 m 500 feet in length, to belt width plus 75 mm 3 inches. Pulley face width for belts 1200 mm 48 inches and larger must be belt width plus 150 mm 6 inches. Provide drive pulleys with 19 mm 3/4 inch thick vulcanized and grooved lagging. Provide snub pulleys with 9.5 mm 3/8 inch vulcanized smooth lagging. Support all conveyor pulley shaft assemblies by two heavy-duty antifriction bearings having a minimum life expectancy of 50,000 hours for 90 percent of bearings in accordance with ABMA 11 for roller bearings. The pulley diameter must be sufficiently large to meet the requirements of the duck weight and ply of the belt to permit flexing of the belt around the pulley circumference without damaging the belt or shortening the belt life. Drive the conveyor by a [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in Class II, Division 1, Group F hazardous location in conformance with NFPA 70] electric motor connected to a drive-shaft-mounted speed reducer unit by a [roller chain drive] [V-belt drive] [flexible coupling]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Provide belt conveyors with belt misalignment switches, emergency stop pull cords and pull switches, galvanized expanded metal shields over tail pulley, zero speed switches, loading skirts, plugged chute switches, walkways, supports, belt takeups, belt cleaners, skirt boards, and pulley scrapers. Provide dust controlling covers and inlet and discharge enclosures for each conveyor.

2.24.3 Flight Conveyor

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

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Provide [scraper] [shoe-suspended] flight conveyor arranged generally as indicated and of the single-strand type having capacity not less than [_____] metric tons/hour tons/hour when handling coal with approximate weight of 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches diameter. Base the capacity on a maximum speed of 508 mm/sec 100 fpm with conveyor operating up a [_____] degree incline. Provide drop-forged steel type chain with flights made of either steel or malleable-iron, spaced at least three times the largest lump size. Protect foot shaft screw takeup with adjustment of not less than 300 mm 12 inches. Make trough of 4.8 mm 3/16 inch steel plate, minimum. Line all sliding surfaces in contact with the chain or flights with 19 mm 3/4 inch thick, removable, ultra high molecular weight polyethylene liners. Provide each side of trough with a warning sign, visible on each floor level and at frequent intervals; "DANGER - DO NOT WELD - FLAMMABLE PLASTIC LINER." Provide conveyor with discharge openings as indicated, each of which provided with rack-and-pinion-operated gates with handwheels. Provide motor to drive conveyor through a speed reduction unit which is either direct-connected or roller-chain-connected to the drive shaft. Provide [totally enclosed, nonventilated type motor] [totally enclosed, fan-cooled type motor] [totally enclosed, fan-cooled type motor suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] motor starter type with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Construct conveyor frame essentially as indicated, with additional bracing as required for rigidity, and with dust controlling covers and inlet and discharge enclosures.

2.24.4 Bucket Elevators

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

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Provide dust tight vertical bucket elevators complete with continuous chain and attached buckets, upper and lower sprockets, gears, shafts, bearings, casing with flanged connections including top hood and discharge spout, bottom boot, access doors, electric motor drive, and all accessories. Provide [vertical spaced centrifugal discharge] [positive discharge] [continuous bucket type] bucket elevators with capacity of not less than [_____] metric tons/hour tons/hour when handling coal weighing approximately 800 kg/cubic meter 50 pcf, and with linear velocity as indicated below:

Type of Bucket Elevator	Linear Velocity (meters per second) (feet per minute)
Centrifugal discharge	1.1-1.6225-305
Continuous bucket	0.51-0.69100-135
Positive discharge	0.61 120 Max

Construct the head shaft and foot shaft of cold-rolled steel with the shaft diameters in accordance with manufacturer's standards, and with both shafts mounted in roller bearings with forced-type lubricating fittings. Provide screw takeup with adjustment of not less than 229 mm 9 inches for the foot shaft. Install an automatic backstop on the head shaft to prevent any backward motion of the chain. Provide boot plates [, loading legs of continuous bucket elevator,] and bottom plate of stub discharge chute a minimum of 4.8 mm 3/16 inch thick steel, and other flat casing members a minimum of 2.657 mm (12 gauge) 12 gauge thick steel. Provide corner angles and stiffeners to make the elevator self-supporting. In addition, tie the elevator to the adjoining structure at close enough spacing to increase the rigidity of the elevator. Provide the boot section with clean-out doors, as well as front and back removable panels. Also provide an inspection door in the intermediate section at operating level large enough to remove a bucket from either run of the chain. Drive the elevator by an electric motor installed in a housing at the top of the flight. Provide [totally enclosed, nonventilated motors] [totally enclosed, fan-cooled type motors] [totally enclosed, fan-cooled type motors suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Install a platform and a compliant safety access ladder adjacent to the motor for servicing the motor and equipment mounted in the hood. Locate controls for the operation of the elevator as indicated. Provide dust control covers and inlet and discharge enclosures for each conveyor.

2.24.5 Vibrating Conveyor

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NOTE: Where motor starters for mechanical equipment

are provided in motor control centers, delete the description of motor starters.
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Provide electric-motor driven, mechanical vibrating type vibrating conveyor with a capacity of [_____] metric tons/hour tons/hour when handling coal weighing approximately 800 kg/cubic meters 50 pcf, with maximum lump size of [_____] mm inches in diameter, and with conveying length as indicated. Fabricate the conveyor trough of [_____] mm gauge steel, [_____] mm inches in width and [_____] mm inches deep [and provided with dust-tight cover]. Provide conveyor pans of 9.5 mm 3/8 inch thick, Type 304L solid stainless steel plate. Mount the trough on vibrator bars, torsion bars, or coil springs attached to yoker legs of rigid cross brace construction and fabricated of corrosion-resistant material with hardened steel encased rubber bushings at articulation points. Fabricate the base of steel channels or angles bolted directly to [building support] [concrete foundations]. Drive through an eccentric shaft supported by a double row of self-aligning ball-or roller-bearing pillow blocks. Impart positive action motion to the trough by a cast steel connecting rod attached to the trough by rubber-bushed wristpin and securely locked by taper lock bushings. Provide [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type suitable for installation in Class II, Division 1, Group F hazardous location in accordance with NFPA 70] electric motor connected to the eccentric shaft by V-belt drive. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.]

2.24.6 Gravimetric Weigh Feeder

Provide metering belt type weigh feeder device designed to operate at a variable rate ranging from 10 percent of maximum capacity to [_____] metric tons/hour tons/hour with an automatic flow rate. Provide a silicon-controlled, rectifier dc drive to automatically adjust the belt speed to maintain the rate of material flow, as set on the controller. The weight feeders conforming to or exceeding the requirements of NIST HB 44, [Southern] [Eastern] [Western] Weighing and Inspection Bureau. Provide the weigh feeders with an accuracy of 1/2 of 1 percent of flow rates over their total variable rated capacity. Provide the feeder with a flexible boot for connecting the gate to the feeder inlet chute which, in turn, is flared to produce a feed opening tapering from [_____] wide to [_____] wide with the direction of flow of material. The belts for feeders conforming to the RMA IP-1, fire-resistant type conforming to the standards of 30 CFR 1 Schedule 28, Part 34 of the MSHA. Provide top belt cover thickness of 6 mm 1/4 inch with bottom cover 3 mm 1/8 inch thick. Provide belt edges with a minimum 25 mm 1 inch flanges and sealed by carrying the cover around the carcass edges during manufacture. Provide cover and skim coat material comparable to those meeting the requirements of RMA IP-1, Grade 2 for impact and abrasion resistance. Provide the weight sensor constructed of heavy-duty, industrial, electronic force transducer flexure-mounted to the force collection system. Provide remote indicating meter and a six-digit totalizing counter located, installed, and connected in the boiler control panel. Provide unit frame of rigid support for the material load, belt, and idlers. Shop assemble the unit complete with drive and all appurtenances, being dust-tight in operation.

2.24.7 Track Hoppers

Provide standard double hopper design with a belt or vibrating-type feeder as indicated, having a capacity of approximately [_____] metric tons tons and constructed of not less than 9.5 mm 3/8 inch thick, Type 304L stainless steel plates, with slopes of not less than 55 degrees and stiffened with angles. The hoppers may also be of ASTM A36/A36M mild steel, minimum 6 mm 1/4 inch thick with replaceable liners 6 mm 1/4 inch thick, ASTM A167, Type 304L, stainless steel. Provide flat heads on all rivets and field bolts inside the hopper. Suspend the hopper from the track girders by heavy bolts and cast washers, or carry the sides to the bottom of the track and support by flanges fastened to concrete ledge continuously around the hopper with the concrete forming the top portion of hopper sides. Provide track girders consisting of wide flange beams conforming to AREMA Eng Man for loading plus impact, complete with bearing plates, WF cross struts, and rail clips. Fit the top of hopper with sections of grating made with steel bars sized [_____] by [_____] mm inches, and cross rods [_____] mm inches in diameter, to form openings [_____] mm inches square.

2.24.7.1 Rack-and-Pinion Gate

Provide a self-cleaning type rack-and-pinion gate at each hopper outlet. Provide [hand] [motor]-operated sliding plate of 9.5 mm 3/8 inch thick carbon steel, formed into the shape of a winged U with the gate plate surface completely protected by an overlapping liner of 3 mm 1/8 inch thick, ASTM A167, Type 304L stainless steel. Use 4.8 mm 3/16 inch thick ASTM A167, Type 304L stainless steel where in contact with coal flow for gate body material, except for the dust cover.

2.24.7.2 Vibrating or Belt Feeders

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

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provide vibrating or belt feeders of manufacturer's standard design for the service required. Provide [totally enclosed, nonventilated] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70] motor. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starters with [weather-resistant] [dust-tight] [explosion-proof] enclosure.]

2.24.8 Truck Hoppers

Provide standard double hopper design with a belt or vibrating type feeder as indicated having the capacity of approximately [_____] metric tons tons and constructed of 9.5 mm 3/8 inch thick Type 304L stainless steel plates, minimum, with slopes of at least 55 degrees, and stiffened with 6.4 mm 1/4 inch angles, minimum. The hopper may also be of ASTM A36/A36M mild steel, minimum 6.4 mm 1/4 inch thick with replaceable liners 6.4 mm 1/4 inch thick, ASTM A167, Type 304L stainless steel. Use flat head type rivets and field bolts inside the hopper. Support the hopper by a flange fastened to the concrete ledge continuously around the hopper, with the concrete forming the top portion of hopper sides. Fit the top of hopper with section of bar grating made with [_____] by [_____] mm inch mild steel bars and [_____] mm inch diameter cross rods to form openings [_____] mm inches square. Provide a supporting beam not less than [_____] mm inches deep, [_____] kg/meter pounds/foot, in a wide flange member, under the grating.

2.24.8.1 Rack-and-Pinion Gate

Provide a self-cleaning type rack-and-pinion gate at each hopper outlet. Provide a [hand] [motor]-operated sliding plate of 9.5 mm 3/8 inch thick carbon steel, formed into the shape of a winged U with the gate plate surface completely protected by an overlapping liner of 3.2 mm 1/8 inch thick, ASTM A167, Type 304L stainless steel. Provide the gate body material, except for the dust cover, of 4.8 mm 3/16 inch thick ASTM A167, Type 304L stainless steel where in contact with coal flow.

2.24.8.2 Vibrating or Belt Feeders

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

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Provide vibrating or belt feeders complete with control of manufacturer's standard design for the service required. Provide [totally enclosed, nonventilated] [totally enclosed, fan-cooled] [totally enclosed, fan-cooled type, suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70] motors. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [weather-resistant] [dust-tight] [explosion-proof] enclosure.]

2.24.9 Vibrator

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

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Provide electromagnetic type vibrator with variable power control that produces mechanical pulsating motion, with the net weight of the vibrator [_____] kg pounds and power input [_____] watts, [_____] amperes at [_____] volts ac, and provide 3600 vibrations per minute or 7200 vibrations for heavy duty applications. Provide semi noiseless vibrator with mounting plates for welding to hoppers as indicated, each complete with an eye bolt for attaching a safety chain. Provide vibrator electric control suitable for separate wall mounting complete with an electronic valve for changing alternating current to mechanical pulsating waves and a dial switch or rheostat to vary the power of vibration. Provide vibrators with Division I, Class II, Group F rating in the areas where coal dust is present, in accordance with NFPA 70.

2.24.10 Car Heaters

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NOTE: The designer will determine if electrical facilities are sufficient to provide the power requirements of electric car heaters or if gas-fired heaters must be used. The designer will determine if the location and climatic conditions will require sidecar panels or undercar heaters, or a combination of both types of heaters.

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2.24.10.1 Gas-Fired Heaters

Provide infrared radiant type gas-fired heaters located between rails and along the walls of the shed with heater input capacity of approximately 90 kW 300,000 Btuh. Provide perforated, heavy-gauge stainless steel cover for the heater, that is not affected by water or coal falling from the car, with windproof burner pilot, main gas solenoid valve, safety switch to interrupt gas supply to burner if pilot is not burning, furnished with manual cutoff valves and pressure regulator, with electric blower for furnishing combustion air to the burner, and with all other controls and accessories as recommended by the heater manufacturer for a complete installation, in compliance with ANSI Z83.19/CSA 2.35 and UL 795.

2.24.10.2 Electric Infrared Radiant Heaters

Provide electric infrared radiant heaters as weatherproof car thawing equipment, with radiating surfaces of alloy tubing enclosing electrically insulated conductors, designed for hazardous area locations. Provide equipment in modular lengths suitable for both 45 and 90 metric tons 50 and 100 ton capacity cars and designed for not requiring [manual] [automatic] disconnection of units during thawing operations. Provide heaters for sidecar or undercar heating banks, or both, capable of operating as independent units designed for maintaining a balanced three-phase distribution system with heating conductor units, including factory assembled connections for attachment to water-tight terminal boxes, supported on corrosion-resistant metal framing and having rust-resistant steel reflectors with an approved coating. Provide heaters connections wired using NEMA 4 enclosures, in accordance with NEMA ICS 1, suitable for cleaning by hosing down with water.

2.24.11 Coal Spouts, Chutes, Inlet Boxes, and Outlet Hoppers

Construct coal spouts, chutes, inlet boxes, and outlet hoppers of ASTM A36/A36M steel members not lighter than 3.416 mm (10 gauge) 10 gauge, adequately reinforced and braced with angle frames, and with all joints dust tight. Slope as steep as possible, but not less than 55 degrees off horizontal. Provide stainless steel or ultra-high molecular weight polyethylene (UHMWP) liners. If UHMWP liners are used, provide each side of chute at each floor level with a warning sign "DANGER - DO NOT WELD - FLAMMABLE PLASTIC LINER." Provide impact liners. Provide access openings and inspection openings with cover plates as indicated and required. [Provide silo frames constructed of heavy channel frames the full size of the silo opening and with concealed steam pipe and coil around opening.] [Provide outlet hoppers with rack-and-pinion type gates and lined with austenitic stainless steel [_____] mm inches thick, conforming to ASTM A167, Type 304L]. Use rack-and-pinion type gates for track hoppers.

2.24.12 Car Spotter

Provide electric-motor driven car spotter having a capstan mounted vertically on a rigid housing that completely encloses the gears, including helical gears and worm gear; fabricate the helical gears of high grade steel accurately finished and splash-lubricated, and fabricate the worm gear of bronze. Mount all of the mechanism on a steel base rigidly welded to maintain alignment. Provide the unit coupled to, and driven by, a separate, [_____] W hp, totally enclosed, nonventilated, hoist-type motor with a full-load speed of 1720 rpm. Provide roller-chain flexible type coupling enclosed in a revolving casing and protected by a heavy steel guard. Provide a unit with a starting pull of 23 kN 5000 pounds, a running pull of 11 kN 2500 pounds, and an average rope speed not in excess of 230 mm/sec 45 fpm, complete with [_____] m feet of [32 mm 1-1/4 inch diameter manila rope with a breaking strength of 60 kN 13,500 pounds, minimum,] [19 mm 3/4 inch diameter marline-covered standard steel wire rope with a breaking strength of 170 kN 37,600 pounds, minimum,] and a steel car pulling hook with an allowable rope pull of 45 kN 10,000 pounds, so fabricated as to be readily attachable to, and removable from, the car frames.

2.24.13 Coal Bunkers

Provide suspension coal bunkers of size and capacity indicated, constructed of ASTM A36/A36M steel plate, reinforced and braced as required, and installed dust-tight, of a design optimized for coal flow, not susceptible to rat-holing or hangups. Provide cylindrical or silo type bunkers to reduce stagnation for each boiler, each with conical discharge hoppers and slopes not less than 70 degrees, with the outlet cone manufactured of, or lined with, ASTM A167, Type 304L stainless steel. Provide rack and pinion type coal shutoff valves, self-cleaning, and dust tight for bunkers. Use corrosion resistant steel for valve materials exposed to flowing coal. Provide an emergency diverter for emptying the bunker.

2.24.14 Coal Storage Silos

2.24.14.1 Silo Walls

Silo walls may be slip-formed, cast-in-place reinforced concrete, precast concrete, or other approved construction materials. use concrete having a 28-day compressive strength in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide silo roof of reinforced concrete complete with 600 mm 24 inch square, weatherproof, hinged access door, and handrail and steel toe-board all around roof of the silo. Provide live storage shelf for the silo of reinforced concrete sloped not less than 60 degrees from horizontal and supported by steel beams corbelled from the inside walls of the silo. Provide live storage outlet hopper to chute and feeders constructed of not lighter than 9.5 mm 3/8 inch steel with a silo reserve storage floor constructed of reinforced concrete, sloped not less than 60 degrees and laid on well-tamped fill material. Provide reclaim outlet hopper to the chute feeding the flight feeder constructed of of not lighter than 9.5 mm 3/8 inch steel.

2.24.14.2 Concrete Stave Silo

Finish the interior finish with a three-coat concrete parget, consisting of a brush coat, scratch coat, and a finish trowel coat applied, one after the other, to produce a smooth monolithic finish. Work the parget into the vertical and horizontal grooves to permanently interlock the concrete staves.

2.24.14.3 Exteriors of Stave And Concrete Silos

Cover the exteriors of stave and concrete silos with a brush coat of gray cement applied over all hoops, lugs, and staves to produce a homogeneous finish.

2.24.14.4 High- and Low-Level Switch

Mount a normal high-level and emergency high-level control switch at the top of the silo to shut off the feeding system when the silo is full of coal. Provide a low-level switch at the low level of the silo's live storage shelf, as indicated, to signal by light that coal is at a low level in the live storage compartment and also provide switches near the bottom of the silo, as indicated, to signal by light that coal is at a low level in the reserve storage compartment. provide switches for Class II, Division 1, Group F hazardous location in accordance with NFPA 70.

2.24.15 Coal Crusher

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

Select the appropriate type of crusher, based on the throughput requirements and an economic analysis.

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Provide [roll crusher] [hammermill] coal crusher for maximum lump size of [_____] mm inches with a minimum capacity of [_____] metric tons/hour tons/hour when handling average size bituminous coal. Provide a heavy-duty cast or welded heavy steel plate housing with the interior of the housing fitted with replaceable liners, constructed of abrasion resistant steel. Provide replaceable breaker plate, grates, rolling rings, swing hammers, and other parts of the unit subject to excessive wearing. Fit the crusher with provisions to trap and reject hard foreign objects without damaging the crusher. Provide shafts constructed of forged, heat-treated alloy steel with bearings mounted in dust-tight housings. Provide [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70] motor. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.]

2.24.16 Vibrating Feeders

Provide [electro-magnetic] [electro-mechanical] [single input (Brute Force)] type vibrating feeders with a capacity of 0 to [_____] metric tons/hour tons/hour when handling coal weighing approximately 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches in diameter, and fitted with replaceable feeder pans and skirts [6.4] [9.5] [12.7] mm [1/4] [3/8] [1/2] inch thick, Type 304 solid stainless steel plate without liners. Fabricate the feeder pan to [_____] mm inches in width, [_____] mm inches in length, and [_____] mm inches deep. Provide dust control covers of 3.416 mm (No. 10 gauge) No. 10 gauge thick steel for each unit. Provide [two] [four] rectangular poke holes ([one] [two] each side) with 6.4 mm 1/4 inch thick Type 304L stainless steel sliding covers. Fabricate all feeder parts coming in contact with coal of, or lined with, Type 304 stainless steel. All feeders must automatically compensate for material headloads and weight effect to maintain a constant feed and must not damper out when operating under full silos or bins. Do not exceed 10 degrees slope on pan. Provide the vibratory feeders with [foot] [suspension] mounted supports. Provide suspended feeders with safety cables with their drives located [above] [below] trough. Provide [totally enclosed, nonventilated type motors] [totally enclosed, fan-cooled type motors suitable for installation in Class II, Division I, Group F hazardous location in accordance with NFPA 70].

2.24.17 Tripper

Provide the tripper of steel construction, motor propelled, automatically reversible, or manually controlled; equipped with antifriction bearings throughout, rolled or forged steel wheels, hand-operated rail clamps for optional operation in a fixed location, scraper, and crossover walk with handrail and with the traversing speed not exceeding 127 mm/second 25 fpm, and include a motor brake. Provide the chute one way toward the center of the silo sloping at not less than 55 degrees. Provide a plow type seal with all necessary components for installation to suit the bunker/silo slot. Provide the tripper with [_____] W hp motor, all reversing and end travel limit switches, cable reel, and 14 No. 12 AWG conductor cable (13 slip rings) and supports for the starter,with two push-button stations mounted, one on each side of the tripper. Provide both stations with forward-reverse and tripper stop-run push buttons. Provide the conveyor frame with a ladder type cable tray to contain the cable from the reel. Mount reversing switches on the tripper and actuate by track dogs to permit reversal of the tripper over each extreme silo. Mount limit switches on the tripper to operate immediately beyond both extreme limits of tripper reversal. Provide a plugged chute switch. Provide all tripper controls, including limit switches and reversing switches, in explosion-proof enclosures approved for Class II, Division 1, Group F service, in accordance with NFPA 70. Include pulley assemblies, shafts, bearings, carrying and return idlers, tripper framing and supports.

2.24.18 Trackmobile

Provide trackmobile with a [_____] liter cubic inch industrial gasoline engine for moving/switching [_____] rail cars on the track and hauling carts and other portable vehicles while traveling on its road wheels. Design the trackmobile to ride on [_____] mm inch gauge track with heat treated, cast steel, rail wheels keyed on tapered axles, and solidly mounted suspension system. Provide heavy duty, [_____] ply, [_____] by [_____] tires, roller-bearing mounted road wheels, with retractable suspension. Provide heavy-duty, cast steel coupler, remotely controlled from cab. Do not exceed maximum speed on rail of (km/hour) (mph) low [_____], high [_____]; on road, low [_____], high [_____]. The trackmobile must be able to operate on a maximum grade of [_____] percent and minimum curve of [_____] foot radius and be equipped with [air brakes] [self-energizing drum and shoe type, hydraulic service], cab heater and defroster, sanders, [electric horn] [air horn] strobe light, front and rear lights, back-up alarm, [enclosed cab] [open cab] with windshield wipers [,radio remote control,] and power steering.

2.24.19 En-Masse Chain Conveyors

These conveyors move materials horizontally and/or vertically, with multiple discharge points and in a dust-tight and completely enclosed unit. Provide conveyors at length indicated but do not exceed 75 m 250 feet, and capacity of [_____] metric tons/hour tons/hour when handling coal with approximate weight of 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches diameter. Base the maximum capacity on a chain speed not to exceed 800 mm/sec 160 fpm. provide a drop-forged, case hardened, steel alloy of the single-strand type chain with flights welded to the chain links, or integral chain and flights type, with link hardness at 500-600 BHN. Provide a dust tight conveyor casing of 6.4 mm 1/4 inch thick ASTM A242/A242M high strength, low alloy steel with 3.416 mm (No. 10 gauge) No. 10 gauge cover of the same material. Provide the casing with T-1 steel (ASTM A514/A514M, Type B) removable liners, with liners being 19 mm

3/4 inch thick on the bottom, and 13 mm 1/2 inch thick on the sides, 19 mm 3/4 inch T-1 steel wear bars provided for the empty run of the conveyor. Attach liners and wear bars to the casing using countersunk stainless steel bolts with stainless steel nuts and washers. Provide heat treated, induction hardened to a minimum depth of 6.4 mm 1/4 inchdrive sprocket with heat treated drive shaft designed and sized based on ANSI/AGMA 6113AGMA 6013 requirements. Provide spherical double roller bearings with a dust seal where the drive shaft ends go through the casing. Provide the conveyor with inlet and outlet spouts, inspection doors giving access to the drive sprocket, cleaner and wear surfaces, with chain tension controlled by a screw take-up. Provide each discharge opening with rack-and-pinion-operated gates with [handwheels] [motor operated] [air operated]. Drive conveyor through a speed reduction motor unit which is either direct-connected or roller-chain-connected to the drive shaft with motor being [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled] type suitable for installation in a Class II, Division 1, Group F Hazardous location in accordance with NFPA 70. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Construct conveyor frame as indicated, with supports and additional bracing as required for rigidity.

2.25 ASH HANDLING SYSTEM

2.25.1 Boiler Room Ash Handling System

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NOTE: When specifying boilers with capacity of 4.1 MW 14 million Btuh or less per boiler, paragraph Ash Hopper and subsequent paragraphs will be deleted, except applicable portions of paragraph Ash Silo through paragraph Rotary, Dustless Unloader will be retained.

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Provide dry pneumatic type ash handling system in stoker fired boilers, which gathers ash from the boiler forward ash discharge grate hopper and from [economizer] [air preheater] ash discharge hopper and other filtration systems and discharges to the ash storage silo located outside of the building. Coordinate the entire system to fit the equipment supplied. Include ash dust control conditioners to reduce fugitive dust emissions during discharge of ash from the storage silo.

2.25.1.1 Ash Hopper

Construct the ash removal hopper for each boiler of 6.4 mm 1/4 inch thick steel plate, minimum, with suitable external structural steel supports for connection to boiler ash hopper and necessary internal anchors for holding refractory lining in place, with refractory lining 225 mm 9 inches thick on vertical walls and 150 mm 6 inches thick on feed plates. Provide each hopper with a sliding ash gate and dach boiler sliding gate unit with an access compartment to allow gathering and cooling of ash. provide a cast-iron grate along with a manually-operated air-tight inlet valve for feeding ash into the pneumatic gathering line. Provide a hinged, steel access gate at each compartment. Provide spring loaded air intakes at the end of each header. Base the structural integrity of the hopper on the ash weight of 1120 kg/cubic m 70 pcf.

2.25.1.2 Clinker Grinder

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NOTE: Delete this paragraph if coal analysis indicates no possibility of slag formation.

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Provide the clinker grinder unit with [_____] mm inch wide double roll for each hopper outlet gate housing, with grinders having manganese steel rolls and cast-iron housings and with grinder shafts mounted on outboard bearings protected by a stuffing box and gland assembly. Provide grinder shafts through stuffing boxes equipped with packing rings and lantern rings for seal water flow. Provide a reversing mechanism to reverse direction of the clinker grinder rolls should an obstruction stall the grinder. Provide a 9.5 mm 3/8 inch steel plate ejector feed hopper below each clinker grinder to feed the inlet of the pneumatic ash gathering system, with fixed passages in the clinker grinders preventing discharge of particles too large to be handled by the pneumatic conveying system. Drive each clinker grinder with a totally enclosed type motor and provide with a reversing starter, pressure switch for seal water control, diaphragm-operated seal water valve, and a solenoid valve. Design units for the characteristics of the coal specified and provide capability of handling bottom ash at a rate exceeding the conveying system capacity.

2.25.1.3 Conveyor Piping

Make conveyor pipe and fittings of an abrasive-resisting alloy metal cast by the sand-spun process, having a minimum Brinell hardness of 280, with wall thickness not less than 13 mm 1/2 inch and pipe lengths not exceeding 5.5 m 18 feet. Make joints air tight with flanges or sleeve pipe couplings. Provide fittings to have a Brinell hardness number of approximately 400 and with removable wearbacks, where applicable, or of the integral wearback type. Design ash inlet fittings so that the ash cannot overload or clog the conveyor pipeline. Provide adjustable supports or hangers. Provide vacuum hose connections as indicated and include 4.6 m 15 foot lengths of vacuum hose with quick connectors and four floor sweep-up nozzles.

2.25.1.4 Vacuum and Combination Vacuum/Pressure Systems

2.25.1.4.1 Vacuum System

Provide pneumatic suction type ash conveying equipment, complete with vacuum pumps and all component parts necessary for complete and successful operation, sized approximately twice the predicted accumulation rate. The system must have the capacity to convey and empty not less than [_____] metric tons/hour tons/hour of ash weighing approximately [_____] kg/cubic meter pcf. Base the tonnage on average handling rate and not on the instantaneous rate.

2.25.1.4.2 Combination Vacuum/Pressure Systems

Provide vacuum/pressure equipment that is commercially produced for this particular type of service and including a pressure vessel equipped with a filter section at the top and an aeration ring at the bottom. Draw material into the unit by vacuum, with the air separated from the material in the top filter section and exhausted through a silencer. Provide a high level indicator within the vessel that can through a silencer and filter unit and discharging the pressurized air into the vessel. Utilize part of the air to clean the filter and pass part of the air through the aeration ring of the vessel to pick up material and convey it under pressure to the storage silo. Furnish the unit complete with all automatic air control valves to control air flow to and from the vessel continuously through the two modes of the operating cycle continuing automatically until switched off at the control cabinet. Provide skid mounts for all automatic valves, interconnecting piping, and the vacuum/pressure vessel must be skid-mounted with vacuum/pressure pump mounted separately. The control cabinet may be mounted separately or skid-mounted on the vacuum/pressure vessel skid. Provide unit capacity to be approximately [_____] metric tons/hour tons/hour of ash weighing approximately [_____] kg/cubic meter pcf. Provide piping sizes for ash collection system designed to fit the unit supplied. Use a vacuum/pressure system where storage silo is more than 150 m 500 feet from the boiler plant. Provide a vacuum system should be used for capacities of less than 45 metric tons/hour 50 tons/hour per system.

2.25.1.4.3 Pump Unit

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NOTE: Where characteristics of the fly ash require additional treatment, incorporate a water spray in the filtering unit. If not required, delete the portion included in the brackets. Air discharged to the atmosphere must meet the local air pollution standards.

****

Size the vacuum or vacuum/pressure pump unit to match system design requirements with pump unit being liquid-ring type having round rotor with curved blades rotating in an elliptical casing. Provide the required pumping action with water alternately entering and leaving the chambers within the rotor vanes. Provide water within the casing that does not act as an air cleansing agent with the operation and maintenance of the unit not being affected by dust-laden air. Provide base-mounted unit with electric motor drive and all required heat exchangers, separators, and control valves. Provide the vacuum pump inlet piping with a vacuum filter unit to remove the fly ash obtained from the economizer ash hopper. Provide a filter unit in a metal housing that contains filter bags removing all fly ash before discharge to the atmosphere and an automatic air purge back-washing system. [Incorporate a water spray into the filtering unit.]

2.25.1.4.4 Control Cabinet

Provide a control cabinet for the complete operation of the system and include all running indicating lights as required. Provide a push-button switch conveniently located in the boiler house to start and stop the system. Provide a vacuum breaker, operating automatically from a timer, in the bottom ash conveyor line to break the system vacuum.

2.25.1.4.5 Controls

Provide a selector switch set to automatic position to start the unit in the vacuum cycle with the controls for the combination vacuum/pressure system . Provide a high-level indicator in vacuum/pressure vessel to actuate necessary controls to cut off the vacuum gathering system and pressurize the vessel for pressure discharge of collected material. Provide a low-pressure switch in the control panel that senses the pressure drop in conveying pressure and returns the unit to vacuum operation. Provide a unit that operates continuously in this manner until manually shut down. Provide a selector switch that in the manual position shuts the unit down after filling. Discharge is then accomplished by pressing the manual discharge button. Provide a high vacuum switch with time delay to shut the system down automatically in the event none of the inlet valves are actuated. Provide heavy duty switches and controls in accordance with NEMA ICS 1.

2.25.1.4.6 Automatic Air Valve

Provide an automatic air valve at economizer or air preheater ash inlet hopper discharge slide gate to allow air into system without causing a vacuum within the boiler ash hopper. Provide slide gate as part of the ash system to be manually-operated and interlocked to actuate the automatic air inlet valve.

2.25.1.5 Ash Silo

Provide an ash storage silo with a capacity of not less than [_____] metric tons tons of ash and fly ash considered to have an average weight of [_____] kg/cubic meter pcf with the capacity based on a minimum of 24 hours [60 hours if ash cannot be removed on weekends]. Construct the silo of welded steel with a cone bottom for truck filling and supported on a structural steel tower with all elements exposed to the exterior designed for wind loads of [_____] kg/square meter psf. Provide a 4.3 m 14 foot clearance under the hopper outlet fitting or appurtenance. Provide silo with steel ladder and safety cage from the ground level to roof, steel ladder inside storage bin, and an angle railing around the roof perimeter, with a minimum plate thickness of 6.4 mm 1/4 inch. Provide silo complete with all accessories required for an operable installation including, but not limited to, high ash level detector, roof manhole, pressure and relief valve, and other roof openings, as necessary. Finish the interior coating with coal-tar epoxy conforming to SSPC Paint 16.

2.25.1.5.1 Ash Storage Silo

Provide an ash storage silo for vacuum system with two stage separators [and a tertiary bag filter], with the primary receiver being cylindrical and constructed entirely of sectional steel or cast plates suitable for this special service. Provide a receiver not less than 900 mm 3 feetin diameter. Provide flanges and bolts on the outside, and the impact of ash directed against heavy iron wear plates of abrasive-resistant alloy. Provide the receiver with an air-tight discharge passage not less than 450 mm 18 inches in diameter for free flow of clinkers and include a means for positive, periodic, and automatic operation in dumping its entire contents into the silo. Design the system so that all suction is positively shut off from the receiver during its dumping period so that no dust can be sucked out through the exhaust while the discharge of the receiver is open or opening with the air from the primary receiver entering an external secondary separator removing 90 percent of the dust not collected by the primary receiver. Provide a combined efficiency of the primary and external secondary separators [and tertiary bag filter] of not less than 98 percent. Provide the secondary separator similar to the primary receiver in construction but of smaller and of lighter material. Do not allow any part of the discharger to extend into the main storage bin. Construct the housing of 6.4 mm 1/4 inch steel plate with a tight-closing access door provided as an enclosure for the discharger.

2.25.1.5.2   Silo Vent Filter

Mount the silo vent filter unit on top of the silo, acting as an air release unit to separate the air from the ash, with the ash dropping into the silo. Provide automatic back cleaning of the bag filters utilizing plant air at approximately 690 to 860 kPa 100 to 125 psig that is actuated whenever the ash handling system is in use, and with dust released from the filter bags in the back cleaning operation falling into the storage silo. Provide housing to allow the unit to operate exposed to the weather in ambient temperatures ranging from -40 degrees C to plus 55 degrees C -40 to plus 130 degrees F.

2.25.1.5.3   Rotary, Dustless Unloader

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

****

Provide a rotary, dustless unloader to eliminate all dust in unloading ash and dust from the ash storage silo. Do not add water to the ashes in the conveyor or in the storage bin. Provide a dustless unloader to add water to the ash in controlled quantities so that no surplus water runs or drips from the ash after discharge with the discharged ash being muddy but loose and free flowing. Water valve must open only when drive motor is running. Provide an unloader with capacity of not less than 27 metric tons 30 tons of conditioned ash per hour. Design the rotating unit so that all bearings are located on the outside and not in contact with the material handled. Provide a platform for access to unit, with a handrail and a safety ladder to grade. Provide a totally enclosed type motor for outdoor operation. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starter with [weather-resistant] [water-tight] [dust-tight] enclosure.]

2.25.1.6   Conveyor Type Ash Handling System

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NOTE: When specifying boilers with capacity greater than 4.1 MW 14 million Btuh per boiler, this paragraph through paragraph Elevator Conveyor will be deleted.

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Provide funnel shaped ash pits, constructed of 6.4 mm 1/4 inch steel plate, minimum, and covered with a heavy grating with openings approximately 50 mm 2 inches square to receive ashes and clinkers discharged from the boiler ash hoppers into ash pits located directly below the ash hopper doors. Arrange combination drag chain conveyor for horizontal conveying and an elevator conveyor for vertical conveying of ashes as indicated to take ashes from the bottom of the ash pits for discharge into the ash silo. Provide conveyors to have a capacity of not less than [_____] metric tons/hour tons/hour when handling ashes weighing approximately [_____] kg/m pcf at a maximum speed of 508 mm/second 100 fpm. Provide doors for access to all parts, as required. Provide [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type motors] [totally enclosed, fan-cooled type motors suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Provide [manual] [[magnetic] [across-the-line] [reduced voltage start]] type motor starters with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.]

2.25.1.6.1 Drag Chain Conveyor

Provide a drag chain conveyor of a single strand of wide, heat treated, high alloy, drop forged rivetless drag chain with a [_____] mm inch pitch, [_____] mm inch overall width, and [_____] kg pounds working strength, and having a hardness of 460-510 Brinell, with the upper strand of the chain conveying the ash in a trough constructed of 9.5 mm 3/8 inch cast-iron extending from [_____] mm inches in front of the foot shaft to [_____] mm inches behind the head shaft and set flush with the floor. Carry the return strand of chain in angle runways set flush with the trench floor. Drive the drag chain conveyor by a [_____] mm inch pitch roller chain and [_____] mm inch pitch diameter, [_____] tooth sprocket on the drive shaft, and a [_____] mm inch pitch diameter, [_____] -tooth sprocket on the elevator foot shaft.

2.25.1.6.2 Elevator Conveyor

Provide elevator conveyor of a single strand chain positive discharge type with head and takeup with the casing constructed of 2.657 mm (12 gauge) 12 gauge steel, minimum, with 9.5 mm 3/8 inch thick boot plates. Provide the head-end drive to include a gear motor and steel roller chain complete with drive brackets, guards, and backstop. Equip the elevator with head-end platform and ladder.

2.25.2 Ash Handling Controls

Provide a control panel for the ash handling system control containing all necessary instrumentation, including selector switches, annunciators, push buttons, and ammeters required for monitoring and operation of the ash handling system, with graphically display of the system. In addition, provide a panel containing all necessary timers, relays, and terminal blocks that are required for the control system with control and monitoring of the ash removal system from a single panel having pushbuttons to start automatic operation of each system and also pushbuttons for individual control of each component. Provide the panel with sufficient instrumentation to observe the removal operations and controls to permit effective emergency control, with local control stations at each ash removal point for local manual operation. Provide local selector switches so that equipment may be operated manually for test and maintenance purposes. Control the operation of the bottom ash system by a microprocessor-based control system, a solid-state programmable controller, or an electro-mechanical system. Provide for controls and instrumentation located indoors with NEMA 12 rating, in accordance with NEMA ICS 1. Provide NEMA 4 rating for all outdoor components in accordance with NEMA ICS 1. Factory mount ,major equipment components, including control panels and devices, prewired, tubed, and tested to the maximum practical extent with the controls for fully automatic and sequential operation of the ash handling system. Design these controls so that manual steps, such as continuous monitoring and regulation are not required. Incorporate safety interlocks to assure that proper permissive conditions have been met prior to changing the operating status of major system components. Provide automatic shutdown of the ash handling system, or portion thereof, with alarms, should unsafe conditions arise during operation of the system. Provide facilities for monitoring and control of the ash handling system for the following functions:

a. Manual start of the automatic control operations.

b. Selection of operating components.

c. Override of the automatic control sequences, both at the ash handling control panel and locally.

d. Manual operation, either remotely from the control center or locally.

e. Emergency shutdown on a unit or system basis.

f. Status monitoring at the ash handling control panel of the operation of the ash handling system and its components.

The automatic controls for bottom ash collection transport must operate as specified. When a start command has been manually initiated, the automatic ash collection and transport sequences for the unit progress through their complete cycles, shutting down the after completion of the cycles. Include an annunciator system, complete with audio and visual alarms, as part of the ash handling control panel, with the annunciator system receiving inputs from devices and system logic, indicating any out-of-specification or trip condition. Provide recorders to provide a permanent record of selected variables that relate to the ash handling system's performance and operation. Provide control stations supplied with analog control loops that provide bumpless transfer between the manual and automatic modes of operation, with the manual mode of operation providing direct control of the end device with no intervening analog control components unless those components are powered by the same source as the end device.

2.25.3 Submerged Drag Chain Conveyor (SDCC)

Design submerged drag chain conveyor to extract ash at normal capacity [_____] metric tons/hour TPH and maximum capacity [_____] metric tons/hour TPH, based on a dry ash density of approximately [_____] kg/cubic meter pcf with the maximum chain speed of 76 mm/sec 15 fpm. Design the SDCC for continuous operation having a storage capacity of [_____] cubic meters cubic feet accumulation with the SDCC having an upper compartment filled with water and a dry lower compartment, and with the equipment maintaining water temperature at approximately 60 degrees C 140 degrees F. Provide a dewatering slope an angle of [_____] degrees with the horizontal and a top trough of not less than 9.5 mm 3/8 inch thick carbon steel plate, welded construction, lined with renewable abrasion resistant steel wear plates, with a minimum thickness of 13 mm 1/2 inch and 380 BHN. Grind all welds smooth. Provide the necessary track guide angles, hold-down angles, and carbon steel chain protectors. Provide the minimum depth of water in the upper trough [_____] meters feet. The return chain bottom trough must be dry, constructed of 9.5 mm 3/8 inch thick steel plate, stiffened and braced with structural shapes and water-tight. Provide chain track angles with a minimum 13 mm 1/2 inch thick steel replaceable wear flats with a minimum 300 BHN and include wear strips under the return flights, minimum 13 mm 1/2 inch thick and 50 mm 2 inches wide. Provide a double strand round-link or ship-type conveyor chain, case hardened, corrosion and abrasion resistant, chrome-nickel-alloy, annealed and carburized with surface hardness between 500-630 BHN, with design strength and pitch based on operating conditions. Provide conveyor flights [_____] mm inches deep by [_____] mm inches thick T-1 steel plates attached on both ends to the chain with each flight provided with top wear pads and bottom wear strips of abrasion resistant steel plate of 300 BHN minimum. Provide a chain tensioner at the tail end of SDCC for maintaining proper tension in both strands of the chain. Include cast-iron idler wheel, bearings, shaft, guide block and bearing housing for the assembly. Fabricate the idler assemblies for both troughs to include heavy duty spherical roller type bearings with external lubrication fittings. Iinclude cast iron wheels with removable, surface hardened, toothed segments, drive shaft, bearings for the chain drive assembly. Provide a hydrostatic driven unit coupled with a low speed, high torque hydraulic motor, built-in torque limiting valves for preventing damage to load train or electric motor for the conveyor, with speed regulation, self-lubrication, internal cooling, and dynamic braking provided with the drive, and include inching capability. Provide hinged inspection doors, windows, and removable panels along the conveyor to permit access and observation at critical points. Construct inspection doors, windows, and removable panels in mild steel with stainless steel hardware and make completely water-tight. Provide water cooling and drainage connections through flanged connections to the conveyor trough with provision for continuous water flow into the top trough of the conveyor including two overflow connections, one for normal level and one high level, including high level alarm and an overflow weir box to prevent drain clogging. Provide chain cleaning sprays.

2.25.4 Dense Phase Ash Handling

Provide a pneumatic dense phase type, complete with transfer vessels, solenoid valves, air receiver tank, air producer and ash conveying piping for the ash conveying system. Design the ash handling system to handle [_____] metric tons/hour tons/hour of ash weighing approximately [_____] kg/cubic meter pcf with each transport vessel bolted to the hopper discharge flange where ash flows into vessel by gravity until a level indicator indicates the vessel is full. The transport vessel inlet valve then closes, and transport air between 170 to 345 kPa 25 to 50 psi enters the vessel through a fluidizing unit located at the bottom of the vessel. When the vessel has been brought to transport air pressure, the transport line valve opens and a "slug" of fly ash is transported to the storage silo. Provide Schedule 40 transporting pipe, standard black iron pipe [_____] mm inches diameter. Base design on the material velocities in the transportation pipe of [_____] meters/sec fpm but not in excess of 5 meters/sec 1000 fpm utilizing 210 to 415 kPa 30 to 60 psi compressed air to fluidize the transmit ash.

2.25.5 Fly Ash Collectors

Fly ash collectors are as specified in Section 44 10 00 AIR POLLUTION CONTROL. Provide and size ash collectors to handle total flue gas at maximum boiler load and stack temperature, and include induced draft equipment. Coordinate fly ash collector requirements with boiler draft and control requirements.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

Install boiler and auxiliary equipment as indicated and in accordance with manufacturers' instructions.

3.3 EARTHWORK

Perform excavation and backfilling for tanks and piping as specified in Section 31 00 00 EARTHWORK, except conform backfill for fiberglass reinforced fuel tanks to the manufacturer's installation instructions.

3.4 STORAGE TANK INSTALLATION

Install storage tank installation in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.5 PIPING INSTALLATION

Cut pipe accurately to measurements established at the jobsite, install without cold springing, and clear windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted. Free piping of burrs, oil, grease, and other foreign matter and install to permit free expansion and contraction without damaging building structure, pipe, joints, or hangers. Use fittings to make changes in direction, except that bending of pipe 100 mm 4 inches and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Carbon steel piping to be bent conforming to ASTM A53/A53M, Grade A, standard, or Grade B extra-heavy weight. Carry vent pipes through the roof and properly flash. Unless otherwise indicated, pitch down horizontal supply mains in the direction of flow with a grade of not less than 25 mm in 12 m 1 inch in 40 feet. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the systems. Undercoat pipe not otherwise specified. Unless otherwise specified or shown, make connections to equipment with malleable-iron unions for steel pipe 65 mm 2-1/2 inches or less in diameter and with flanges for pipe 80 mm 3 inches or more in diameter, with unions for copper pipe or tubing made of brass or bronze. Provide cathodic protection for connections between ferrous piping and copper piping, electrically isolated from each other with dielectric couplings or other approved methods. Use reducing fittings for changes in pipe sizes. For horizontal HTW lines, provide eccentric type reducing fittings to maintain the top of the lines at the same level.

3.5.1 Pipe Sleeves

Provide pipe sleeves fitted into place at the time of construction for pipes and tubes passing through concrete or masonry walls or concrete floors or roofs. Install a waterproofing clamping flange as indicated. Do not install sleeves in structural members except where indicated or approved. Provide details for rectangular and square openings. Extend each sleeve through its specified wall, floor, or roof, and cut flush with each surface, except extend sleeves through floors and roofs above the top surface at least 150 mm 6 inchesfor proper flashing or finishing. Provide membrane clamping rings where membranes are penetrated. Unless otherwise indicated, size sleeves to provide a minimum clearance of 6 mm 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Provide galvanized steel pipe sleeves in bearing walls, waterproofing membrane floors, and wet areas. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls, partitions, and floors as indicated and specified in Section 07 92 00 JOINT SEALANTS and in fire rated walls, partitions, and floors seal as indicated and specified in Section 07 84 00 FIRESTOPPING. Provide metal jackets over insulation passing through exterior walls, fire walls, fire partitions, floors, or roofs, no thinner than 152.4 micrometers 0.006 inch thick aluminum, if corrugated, and 0.4064 mm 0.016 inch thick aluminum, if smooth, and secured with aluminum or stainless steel bands not less than 10 mm 3/8 inch wide and not more than 200 mm 8 inches apart. When penetrating roofs, before fitting the metal jacket into place, run a 13 mm 1/2 inch wide strip of sealant vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 900 mm 36 inches above the roof. If the pipe turns from vertical to horizontal, run the sealant strip to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, extend the metal jacket must extend from a point below the backup material to a minimum distance of 50 mm 2 inches above the flashing. For other areas, the metal jacket from a point below the backup material to a point 300 mm 12 inches above floor; or when passing through walls above grade, extend jacket a minimum of 100 mm 4 inches beyond each side of the wall.

3.5.1.1 Pipes Passing through Waterproofing Membranes

In addition to the pipe sleeves referred to above, provide for pipes passing through roof or floor waterproofing membranes with a 1.8 kg 4 pound lead flashing or a 453 g 16 ounce copper flashing, each within an integral skirt or flange, with flashing formed, and the skirt or flange extending not less than 200 mm 8 inches from the pipe and must set over the roof or floor membrane in a troweled coating of bituminous cement. Extend the flashing up the pipe a minimum of 250 mm 10 inches above the roof or floor. Seal the annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation as indicated. Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a galvanized steel sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical-type sealing assembly may be installed. Provide seals consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates, with the links loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolts to cause the rubber sealing elements to expand and provide a water-tight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. If the use modular mechanical-type seals is elected, provide sleeves of the proper diameters.

3.5.1.2 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing standard roof coupling for threaded pipe up to 150 mm 6 inches in diameter; lead flashing sleeve for dry vents and turning the sleeve down into the pipe to form a waterproof joint; tack-welded or banded-metal rain shield around the pipe and sealing as indicated.

3.5.2 Pipe Joints

Provide welded or flanged joints between sections of pipe and fittings on all HTW piping. On auxiliary piping, except as otherwise specified, provide threaded fittings 25 mm 1 inch and smaller. Provide threaded or welded fittings 32 mm 1-1/4 inches up to, but not including, 65 mm 2-1/2 inches Provide flanged or welded fittings 65 mm 2-1/2 inches and larger. Weld pipe and fittings 32 mm 1-1/4 inches and larger installed in inaccessible conduits or trenches beneath concrete floor slabs. Provide black malleable-iron unions for pipe 50 mm 2 inches or smaller in diameter, and with flanges for pipe 65 mm 2-1/2 inches or larger in diameter for connections to equipment.

3.5.2.1 Threaded Joints

Make threaded joints with tapered threads properly cut and made perfectly tight with a stiff mixture of graphite and oil, or polytetrafluoroethylene tape or equal, applied to the male threads only, and in no case to the fittings.

3.5.2.2 Welded Joints

Fusion weld joints in accordance with ASME B31.1, unless otherwise required. Provide only weld fittings for changes in direction of piping; mitering or notching pipe to form elbows and tees or other similar type construction is not acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Provide forged and flared branch outlet fittings, where used, for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.

3.5.2.2.1 Beveling

Field and shop bevels in accordance with the recognized standards and done by mechanical means or flame cutting. Where beveling is done by flame cutting, clean surfaces of scale and oxidation before welding.

3.5.2.2.2 Alignment

Before welding, align the component parts to be welded so that no strain is placed on the weld when finally positioned. Align height so that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Set flanges and branches true, preserving the alignment during the welding operation. Provide welds of the same quality for tack welds, made by the same procedure as the completed weld; otherwise, remove tack welds during the final welding operation.

3.5.2.2.3 Erection

Where the temperature of the component parts being welded reaches 0 degrees C 32 degrees F or lower, heat the material to approximately 38 degrees C 100 degrees F for a distance of 900 mm 3 feet on each side of the weld before welding, finishing the weld before the materials cool to 0 degrees C 32 degrees F.

3.5.2.2.4 Defective Welding

Remove and replace defective welds, repairing defective welds in accordance with ASME B31.1.

3.5.2.2.5 Electrodes

After filler metal has been removed from its original package, protect or store so that its characteristics or welding properties are not affected. Do not use electrodes that have been wetted or that have lost any of their coating.

3.5.2.3 Flanges and Unions

Face flanges and unions true, and make square and tight. Provide gaskets of nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, full-face or self-centering flat ring type. Provide gaskets with aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) using NBR binder for hydrocarbon service. Provide union or flange joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.5.3 Supports

3.5.3.1 General

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NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 23 kg 50 pounds must have the excess hanger loads suspended from panel points.

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Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support by variable spring hangers and supports or by constant support hangers, piping subjected to vertical movement, when operating temperatures exceed ambient temperatures. [Do not exceed 23 kg 50 pounds for pipe hanger loads suspended from steel joist between panel points. Suspend pipe loads exceeding 23 kg 50 pounds from panel points.]

3.5.3.2 Seismic Requirements

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NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

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Support and brace piping and attached valves to resist seismic loads [as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR

MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS] [as indicated]. Provide structural steel required for reinforcement to support piping, headers, and equipment as specified under Section 05 12 00 STRUCTURAL STEEL.

3.5.3.3 Structural Reinforcements

Provide structural steel reinforcements required to support piping, headers, and equipment, but not shown, as specified under Section 05 12 00 STRUCTURAL STEEL.

3.5.4 Anchors

Provide anchors wherever necessary, or indicated, to localize expansion or prevent undue strain on piping. Provide anchors of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results, using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.5.5 Pipe Expansion

3.5.5.1 Expansion Loop

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NOTE: Wherever possible, provisions for expansion of supply-and-return pipes will be made by changes in the direction of the run of the pipe or by field fabricated expansion bends. Where restrictions in space prevent such provisions for expansion, expansion joints will be installed and blank will filled as appropriate. Bracketed portion will be deleted if inapplicable.

****

Provide expansion loop to ensure adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. Cold spring loops and install where indicated. Provide pipe guides as indicated. Except where otherwise indicated, utilize expansion loops and bends to absorb and compensate for expansion and contraction instead of expansion joints.

3.5.5.2 Expansion Joints

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NOTE: If expansion joints are required, this paragraph will be deleted. Where restrictions in space prevent such provisions for expansion, expansion joints will be installed and blank will be filled as appropriate. Bracketed portion will be deleted if inapplicable.

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Provide expansion joints for either single or double slip of the connected pipes, as required and indicated, and for not less than the traverse indicated. Provide anchor bases or support bases as indicated or required. Make initial setting in accordance with the manufacturer's recommendation to allow for an ambient temperature at time of installation. Install pipe alignment guides as recommended by the joint manufacturer, but in any case not more than 1.5 m 5 feet from expansion joint, except that in lines 100 mm 4 inches or smaller install guides no more than 600 mm 2 feet from the joint.

3.5.6 Valves

Install gate valves and globe valves with the stem horizontal or above. Install swing check valves in horizontal piping with the cap or bonnet up, or in vertical piping with the flow upward. Always install lift or piston check valves in horizontal piping with the cap or bonnet up.

3.6 BURIED PIPING INSTALLATION

3.6.1 Protective Coating for Underground Steel Pipe

Provide steel pipe installed underground with a protective covering, mechanically applied in a factory or field plant especially equipped for the purpose. Apply for specials and other fittings which cannot be coated and wrapped mechanically with a protective covering applied by hand, preferably at the plant applying the covering to the pipe. Do not field apply coatings until the piping has satisfactorily passed the leak or hydrostatic test. Coat and wrap field joints by hand in a manner and with materials that will produce a covering equal in effectiveness to that of the mechanically-applied covering.

3.6.2 Cleaning of Surfaces to be Coated

Solvent wash steel surfaces to assure an oil-and-grease-free surface, and blast-clean to bare metal as specified in SSPC SP 6/NACE No.3. For areas that cannot be cleaned by blasting, clean to bare metal by powered wire brushing or other mechanical means. Provide an air supply for blasting that is free from oil and moisture. Following cleaning, wipe the surfaces with coal-tar solvent naphtha and allow to dry. Ensure the surfaces to be coated are free of all mill scale and foreign matter such as rust, dirt, grease, oil, and other deleterious substances. Apply coating to surfaces as soon as practicable after the cleaning operation.

3.6.3 Coating

Coat buried steel piping with one of the following methods:

3.6.3.1 Epoxy Coating System

The epoxy coating system, conforming to the AWWA C213. Factory coat fittings, valves, and joints with materials identical to those used on the pipe, or may be field-coated with a 2-part epoxy system recommended by the manufacturer of the pipe coating system. Field protection may also be provided for joints and fittings with a coal tar tape hot applied over a compatible primer.

3.6.3.2 Bituminous Pipe Coating

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NOTE: If coating system similar to coal tar coating and wrapping is required using different materials, rewrite this paragraph. Where excessively corrosive soils are encountered, give the piping a second

coating of coal-tar enamel and a second wrapper of felt.

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Provide bituminous protective system of coal-tar enamel and primer coating system, consisting of a coal-tar priming coat, a coal-tar enamel coat, a wrapper of coal tar saturated felt, and a wrapper of kraft paper, or a coat of water-resistant white-wash, applied in the order named and conforming to the requirements of AWWA C203 in all respects as to materials, methods of application, tests, and handling, except do not apply an interior lining. Coat and wrap joints and fittings.

3.6.3.3   Polyethylene Pipe Coating

Provide factory-applied system, with continuous extruded polyethylene coating and adhesive undercoat application procedure, including surface preparation, conforming to NACE SP0185, Type A. Provide tape wrapped joints, valves, flanges, and other irregular surfaces as outlined under the tape wrapping system, except apply the tape half-lapped, and prime all extruded polyethylene coating and adhesive undercoat surfaces to be tape-wrapped with a compatible primer before application of tape. Use the primer recommended by the tape manufacturer and approved by the applicator of the extruded polyethylene coating. Repair damaged areas of extruded polyethylene coating by tape-wrapping as described under the tape-wrapping system, except press any residual material from the extruded polyethylene coating into the break or trim off. Prime all areas to be taped and apply the tape half-lapped.

3.6.3.4   Tape-Wrap Pipe Coating

Prime cleaned surfaces before applying tape as recommended by the manufacturer of the tape. Provide approved, pressure-sensitive, organic plastic tape with a minimum nominal thickness of 0.51 mm 0.020 inch, conforming to ASTM G21 for fungus resistance. Apply tape to clean, dry, grease-free, and dust-free surfaces only. Wire brush all weld beads and remove all burrs and weld spatter. Cover weld beads with one wrap of tape before spiral wrapping. At each end of straight runs, apply a double wrap of one full width of tape at right angles to the axis of the spiral wrapping. Remove any kraft paper protective wrapping from the pipe before the tape is applied. Provide wrap protection for material which is wrapped before it is placed in its final position at sling points with roofing felt or other approved heavy shielding material, or handle with canvas slings. Repair damaged wrapping as specified. Wrap pipe in straight runs spirally, half-lapping the tape as it is applied. For pipe smaller than 100 mm 4 inches, apply one layer half-lapped. For pipe 100 mm 4 inches and larger, apply two layers half-lapped with the second layer wrapped opposite-hand to the first. Spirally wrap joints, coupling fittings, and similar units and damaged areas of wrapping, beginning with one complete wrap 75 mm 3 inches back from each edge of the corresponding size of straight pipe. On irregular surfaces such as valves and other accessories, apply one layer half-lapped and stretched to conform to the surface, followed by a second layer half-lapped and applied with tension as it comes off the roll.

3.6.3.5   Coating Inspection and Testing

After field coating of the pipe joints, inspect the entire pipe with an electric holiday detector having an operating crest voltage of from 12,000 to 15,000 volts when using a full-ring, spring-type coil electrode. Provide a holiday detector equipped with a bell, buzzer, or other audible signal which operates when a holiday is detected. Repair detected holidays in the protective covering. Occasional checks of holiday detector potential will be made by the Contracting Officer to determine suitability of the detector. Perform the inspection for holidays just before covering the pipe with backfill and take every precaution during backfill to prevent damage to the protective covering. Furnish all equipment and labor necessary for inspection.

3.6.4 Installing Buried Piping

Carefully handle pipe and accessories to assure a sound, undamaged condition with special care taken to not damage coating when lowering pipe into a trench and when backfilling. Install nonmetallic pipe in accordance with pipe manufacturer's instructions.

a. Submit Proposed diagrams, instructions, and other sheets, before posting. Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, where directed. Prepare in typed form, and frame as specified, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system above, including the wiring and control diagrams posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

b. Lay underground pipelines with a minimum pitch of 25 mm/15 m 1 inch/50 feet. Provide minimal coverage for horizontal pipe sections of 450 mm 18 inches, laying piping free of traps and draining toward tank. Solidly rest the full length of each section of underground pipe on the pipe bed with piping connections to equipment as indicated, or as required, by the equipment manufacturer.

c. Provide two swing elbows [or flexible connectors] at each tank connections to allow for differential settlement. Thoroughly clean the interior of the pipe of all foreign matter before being lowered into the trench and keep clean during installation. Do not lay the pipe in water or when the trench or weather conditions are unsuitable.

d. Securely close open ends of pipe and fittings so that water, earth, or other substances cannot enter the pipe or fittings when work is not in progress. Replace any pipe, fittings, or appurtenances found defective after installation. Make threaded joints with tapered threads perfectly tight with joint compound applied to the male threads only. This requirement does not apply for the gauging hatch or similar connections directly over the tank where the line terminates in a fitting within a cast-iron manhole designed to allow for differential settling.

e. Weld pipe to structural steel where steel piping is to be anchored to the structural steel member of the anchor and patch the abraded area with protective coating or covering as specified. Fit piping passing through concrete or masonry construction with sleeves of sufficient length to pass through the entire thickness of the associated structural member and large enough to provide a minimum clear distance of 13 mm 1/2 inch between the pipe and sleeve, except where otherwise indicated. Sleeves through concrete may be 0.912 mm (20 gauge) 20 gauge metal, fiber, or other approved material. Accurately locate sleeves on center with the piping and securely fasten in place. Caulk and fill the space between the sleeves and the pipe with bituminous plastic cement or mechanical caulking units designed for such use.

3.7 FIELD PAINTING AND COATING

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NOTE: Where identification of piping is required by the using service, this paragraph will be amplified to include appropriate requirements either directly or by reference to a separate section. Air Force requirements are covered in AFM 88-15.

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Except as otherwise specified, prepare, clean and paint ferrous metal as specified in Section 09 90 00 PAINTS AND COATINGS. Apply protective coating to buried steel as specified. Paint exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum sheath over insulation.

3.8 MANUFACTURER'S SERVICES

3.8.1 Manufacturer's Representative

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified, to supervise the installing, adjusting, and testing of the equipment.

3.8.2 Field Training

Conduct a field training course for designated operating staff members. Submit proposed schedule for field training, at least 2 weeks prior to the start of related training. Provide training for a total period of [_____] hours of normal working time, starting after the system is functionally complete, but prior to final acceptance tests. Provide field training to cover all of the items contained in the approved operating and maintenance instructions. Submit operating instructions, prior to the field training course and [6] [_____] copies of operating instructions outlining the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features in the instructions. Submit maintenance instructions, prior to the field training course; [6] [_____] complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed in the instructions.

3.9 TESTS

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NOTE: Before occupancy of a facility inspect the boilers in accordance with the Code of Boiler and Pressure Vessel Inspectors (BPVI) and the American Society of Mechanical Engineers (ASME). Inspectors must be certified in accordance with BPVI standards.

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Submit the proposed performance test procedure for required tests, 30 days prior to the proposed test date, containing a complete description of the proposed test, along with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. Do not commence the testing until the procedure has been approved. Submit the complete plan for water treatment, including proposed chemicals to be used and nationally recognized testing codes applicable to the system, prior to system startup. Submit all test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate for each test report, the final position of controls. Include the action settings for all automatic controls in the form of a typed, tabulated list indicating the type of control, location setting, and function. Provide a written statement from the manufacturer's representative certifying that combustion control equipment has been properly installed and is in proper operating condition, upon completion of the installation.

3.9.1 Hydrostatic Tests

Following erection, hydrostatically test each HTW generator proving tight under a gauge pressure of 1.5 times the specified working pressure. Following the installation of all piping and boiler house equipment, but before the application of any insulation, perform hydrostatic tests to prove the system tight under gauge pressures of 1.5 times the specified working pressure. Conduct tests under the direction of, and subject to, the approval of the Contracting Officer. Adjust all equipment and controls before the scheduled operational test. Submit the testing schedule least 15 days before scheduled test.

3.9.1.1 Water Sides Including Fittings and Accessories

Hydrostatically test water sides in accordance with the requirements of ASME BPVC SEC I and ASME BPVC SEC VIII D1 as applicable. The ASME stamp will be accepted as evidence of this test.

3.9.1.2 Generator Casing, Air Casings, and Ducts

Pneumatically test air casing and ducts exterior to the generators at the maximum working pressure using the soap bubble or smoke bomb method to verify tightness. Test the gas sides of the generators normally operated under pressure for tightness at 1-1/2 times the predicted operating pressure in the furnace at maximum predicted output. Tightly seal, by suitable means blanking off all generator openings, prior to testing. Admit air to the generator until the test pressure is reached and then hold. If in a 10-minute period the pressure drop does not exceed 1.2 kPa 5 inches water gauge, the casing is regarded as tight and accepted. Use air pressure and smoke bomb or comparative CO(2) readings for induced draft generators.

3.9.1.3 Fuel Oil Test

After the system has been flushed and operationally tested, leak test the underground portion of the system in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.9.1.4 Fuel Systems for Oil-Fired HTW Generators

Hydrostatically test the part of the preassembled fuel oil system that is furnished integrally with the generator at 1.5 times the maximum operating pressure. Pneumatically test the part of the preassembled gas system that is furnished integrally with the generator at operating pressure using the soap bubble test method to verify tightness of the gas system.

3.9.2 Fire Safety for Oil-Fired HTW Generators

Conduct test as necessary to determine compliance with the applicable UL safety standards. The presence of the UL label may be accepted as evidence of compliance in this respect.

3.9.2.1 Oil-Fired Generators

Oil-fired generators must meet the test requirements of UL 726.

3.9.2.2 Oil Burners

Oil burners must meet the test requirements of UL 296.

3.9.3 Capacity and Efficiency Tests

Determine the capacity and efficiency at the specified capacity of the generator in accordance with the ASME PTC 4 for steam generating units. Determine the efficiency by the direct input-output method and check with the loss method computation. Make test runs at the maximum capacity for 4 hours; at the minimum capacity and at 50 percent capacity for 2 hours each, respectively. Submit est reports and performance curves. Balance the system within 5 percent of that indicated before any operational tests are conducted. Make corrections and adjustments as necessary to produce the required conditions. Use approved methods to measure all rates of flow. Provide a qualified test engineer, observed by a representative of the Contracting Officer, to conduct efficiency and general performance tests on the boilers. Set up, calibrate, test, and ready test apparatus for testing the boiler before the arrival of the Contracting Officer's representative. Furnish calibration curves or test results furnished by an independent testing laboratory for each instrument, meter, gauge, and thermometer to be used in efficiency and capacity test before the test. Provide a test report including logs, heat balance calculations, and tabulated results together with conclusions, [delivered in quadruplicate,] including an analysis of the fuel being burned on the test. Include in the analysis all pertinent data tabulated in the ASME PTC 4 abbreviated efficiency test. Provide and install all necessary temporary piping valves, controls, heat exchanger, and cooling water provisions to provide a load for testing each HTW generator. If any system load is available, the Contracting Officer will provide for loading the heating system for the test, but full-load capability will probably require a supplementary heat exchanger for the test.

3.9.4 Operating Tests

After adjustment and achievement of stable operation of the HTW generators, test each continuously for 12 hours, minimum, to demonstrate control and operational conformance to the requirements of this specification under varying load conditions ranging from the specified capacity to the minimum burner or stoker turndown ratio without on-off cycling. In each case, cover the periods for the capacities tabulated below:

Waterwall Watertube Boilers	
Time (minimum)	Percent of Capacity
First 2 hours	50
Next 2 hours	75
Next 6 hours*	100
Next 2 hours	110
* The efficiency tests may be conducted either concurrently with the operating tests or separately at the option of the Contractor. Efficiency may be no less than that specified.	

3.9.5 Test of Fuel Burning Equipment

Test automatic oil burners for capability to provide high temperature water in accordance with demand when on-off cycling is required. Fuel burning equipment that exhibits excessive or unexplained loss of ignition, nuisance shutdown due to faulty burner, stoker, or control operation, improper flame, excessive carbon deposits or slag, or necessity for difficult or frequent adjustments must be rejected. Include the following as applicable to the type of HTW generator.

3.9.5.1 Sequencing

[Start, operate] [Operate,] and stop the HTW generator in accordance with the specified operating sequence.

3.9.5.2 Flame Safeguard

Verify the operation of the flame safeguard control on oil- or gas-fired generators by simulated flame and ignition failures. Test burners having continuous or intermittent pilots by simulating main flame failure while the pilot is burning. Use a stop watch for the trial-for-pilot ignition, trial-for-main-flame ignition, combustion control reaction, and valve closing verified times.

3.9.5.2.1 Immunity to Hot Refractory

Operate the burner at high fire until the combustion chamber refractory reaches maximum temperature, then close the main fuel valve manually dropping out the combustion safeguard immediately causing the safety shutoff valves to close within the specified control reaction and valve closing times.

3.9.5.2.2 Pilot Intensity Required

Gradually reduce the fuel supply to the pilot flame to the point where the combustion safeguard begins to drop out (sense "no flame") but holds in until the main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame must be capable of safely igniting the main burner. If the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, reject the generator.

3.9.5.2.3 Turndown Ratio

Verify the specified turndown ratio by firing at the minimum firing rate.

3.9.5.2.4 HTW Generator Limit and Fuel Safety Interlocks

Simulate the interlock actuating conditions for each generator limit and fuel and safety interlock for the safety shutdown. Specify specific manner in which the safety shutdowns occur.

3.9.5.2.5 Combustion Controls

Demonstrate the accuracy range and smoothness of operation of the combustion controls by varying the demand throughout the entire firing range required by the turndown ratio specified for the [burner] [and] [stoker] and in the case of automatic sequenced burners by further varying the firing rate to require on-off cycling. Note the control accuracy as specified.

3.9.5.2.6 Safety Valves

Do not test safety valves on HTW generators under operating conditions.

3.9.5.2.7 Blowdown Valves and Try Cocks

Test blowdown valves and try cocks for proper operation.

3.9.5.2.8 Fans, Heaters, Pumps, and Motors

Test draft fans, fuel oil heaters, fuel pumps, and electric motors when necessary to determine compliance with the referenced standards. Closely observe the operation of fans, [fuel oil heaters] [stokers] [fuel pumps] and electric motors for possible defects or nonconformance.

3.9.6 Test of Water Treatment Equipment

Test of water treatment equipment must meet the requirements specified for capacity and quality of effluent. Tests for ion-exchange units must cover at least two complete regenerations and capacity runs.

3.9.7 System Balancing

During operating tests, observe the preliminary system balancing results and log the flow rates. Where an auxiliary heat exchanger is not required for the test load, perform final system balancing during the operating test. Where the auxiliary heat exchanger is required, provide sufficient temporary piping to shunt the water flow through the various system control valves to allow an approximate flow balance of the system.

3.10 CLEANING OF HTW GENERATORS AND PIPING

3.10.1 HTW Generator Cleaning

After the hydrostatic tests have been made, and before performance of the operating tests, thoroughly and effectively clean the boilers of foreign materials. Wherever possible, wire brush surfaces in contact with water to remove loose material. The following procedure may be used or an alternate standard procedure may be submitted for review and approval. Fill HTW generators with a solution consisting of the following proportional ingredients for every 3785 L 1000 gallons of water, and operated at approximately 210 to 345 kPa 30 to 50 psig for a period of 24 to 48 hours:

a. Use 11 kg caustic soda 24 lb. caustic soda; 3.6 kg sodium nitrate 8 lb. sodium nitrate; 11 kg disodium phosphate, anhydrous 24 lb. disodium phosphate, anhydrous; and 230 g approved wetting agent 1/2 lb. approved wetting agent.

b. Thoroughly dissolve chemicals in the above proportions, or as otherwise approved, in the water before being placed in the HTW generator. After the specified boiling period, allow the boilers to cool, and then drain and thoroughly flush. Clean piping by operating the HTW generators for a period of approximately 48 hours.

3.10.2 HTW Generator Water Conditioning

Provide HTW generator water conditioning including chemicals, chemical treatment, and blowdown during periods of boiler operation to prevent scale and corrosion in HTW generators and in supply and return distribution systems from the initial startup of the system, through the testing period, and to final acceptance of the completed work, but for at least 30 days of operation. Use approved chemicals and method of treatment.

3.11 SCHEDULES

TABLE I. PIPE

Service	Pressure	Material	Specification	Type
Boiler feed, drain lines & HTW lines	0-4150 0-600	Black steel (2)	ASTM A53/A53M	Type E Grade A
Feedwater piping	0-8600-125	Std. wt. black steel	ASTM A53/A53M	Type E Grade A
Cold water piping	0-8600-125	Std. wt. zinc-coated	ASTM A53/A53M	Type E Grade A
Water column (1)	0-4150 0-600	Std. wt. black steel	ASTM A53/A53M	Type E Grade A
Vent and exhaust	0-1750-25	Std. wt. black pipe steel	ASTM A53/A53M	Type E Grade A
Compressed air	0-8600-125	Std. wt. black steel	ASTM A53/A53M	Type E Grade A
Gauge piping	0-1750-25	Copper tubing	ASTM B88MASTM B88	Type K or L
	0-4150 0-600	Black steel (2)	ASTM A53/A53M	Type E Grade A
Fuel oil (Nos. 4, 5 & 6	0-1050 0-150	Std. wt. black steel	ASTM A53/A53M	Type E Grade A

TABLE I. PIPE

Service	Pressure	Material	Specification	Type
Control air	0-1050 0-150	Copper tubing	ASTM B68/B68M	[_____]
		Std. wt. black steel	ASTM A53/A53M	Type E Grade A
Note 1: No bending of pipe will be permitted. Provide crosses with pipe plugs at connection.				
Note 2: Extra Strong (XS) minimum weight. Conform to ASME B31.1 for wall thickness.				

TABLE II. FITTINGS

Service	Size	Title	Materials	Specification
Vent pipe	Under 80 mm 3-inches	Threaded	Malleable-iron	ASME B16.3
	80 mm3-inches & larger	Buttwelded	Steel	ASME B16.9
Compressed air	Under 80 mm 3-inches	Threaded	Zinc-coated Malleable-iron	ASME B16.3
Exhaust pipe	Under 80 mm 3-inches	Threaded	Zinc-coated Malleable-iron	ASME B16.3
	80 mm3-inches & larger	Buttwelded	Steel	ASME B16.9
Boiler feed (1)	Under 80 mm 3-inches	Threaded	Malleable-iron	ASME B16.3
	80 mm3-inches & larger	Buttwelded	Steel	ASME B16.9
Feedwater pipe	Under 80 mm 3-inches	Threaded	Malleable-iron	ASME B16.3
	80 mm3-inches & larger	Buttwelded	Steel	ASME B16.9
Drain lines (1) & HTW lines	All	Buttwelded	Steel	ASME B16.9
		Socket Welded	Steel	ASME B16.11
		Flanged with long radius elbows	Steel	ASME B16.5
Water column piping (1)	Under 80 mm 3-inches	Threaded	Malleable-iron	ASME B16.3
Gauge pipe	All	Flared or or soldered	Cast or wrought bronze	ASME B16.18 ASME B16.26

TABLE II. FITTINGS				
Service	Size	Title	Materials	Specification
Note 1: Conform to ASME B31.1 for wall thickness except minimum being extra strong pipe. Match piping requirements.				
Note 2: Fuel oil piping and fittings, complying with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.				

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 51 43.00 20 (February 2010)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 51 43.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-23 51 43.00 20 (February 2010)**

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SECTION 23 51 43.00 20

DUST AND GAS COLLECTOR, DRY SCRUBBER AND FABRIC FILTER TYPE

02/10

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NOTE: This guide specification covers the requirements for furnishing, installing, adjusting, and testing of a dry flue gas desulfurization (FGD) scrubber(s) and fabric filter baghouse(s) system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: The dry FGD scrubber(s) is intended to be used for flue gas sulfur dioxide removal and collection associated with coal-fired boilers. Coal-fired boilers applicable to this specification are those designed with capacities ranging between 6.30 and 31.50 kg of steam per second 50,000 and 250,000 pounds of steam per hour. The design shall be as a system where one manufacturer is responsible for the fabric filter baghouse and the dry FGD scrubber. There are probably no manufacturers that can meet all the specifications. Discretion must be exercised to determine which deviations are acceptable. Removing either the dry FGD or the fabric filter baghouse out as a separate design or purchase is not acceptable.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S12.54	(2011; R 2016) Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Engineering Method in an Essentially Free Field over a Reflecting Plane

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating
AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines
AMCA 802	(2019) Industrial Process/Power Generation Fans: Establishing Performance Using Laboratory Models

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B31.1	(2024) Power Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME BPVC	(2010) Boiler and Pressure Vessels Code
ASME HST-4	(2021) Performance Standard for Overhead Electric Wire Rope Hoists

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2024) Standard Specification for Zinc

	(Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A490M	(2014a) Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings

ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B103/B103M	(2023) Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar
ASTM B443	(2019) Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625)and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219)* Plate, Sheet, and Strip
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM C25	(2024) Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
ASTM C110	(2024) Standard Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM D578/D578M	(2005; E 2011; R 2011) Glass Fiber Strands
ASTM D737	(2018) Standard Test Method for Air Permeability of Textile Fabrics
ASTM D1682	(1964; R 1975e1) Test for Breaking Load and Elongation of Textile Fabrics
ASTM D1777	(1996; E 2011; R 2011) Thickness of Textile Materials
ASTM D2176	(1997a; R 2007) Folding Endurance of Paper by the M.I.T. Tester
ASTM D3775	(2017; E 2018) Standard Test Method for End (Warp) and Pick (Filling) Count of Woven Fabrics
ASTM D3776/D3776M	(2009a; R 2017) Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
ASTM D3887	(1996; R 2008) Standard Specification for Tolerances for Knitted Fabrics
ASTM E515	(2011; R 2022) Standard Practice for Leaks Using Bubble Emission Techniques

HYDRAULIC INSTITUTE (HI)

HI M100	(2009) HI Pump Standards Set

INSTITUTE OF CLEAN AIR COMPANIES (ICAC)

ICAC EP-7	(2004) Electrostatic Precipitator Gas Flow Model Studies
ICAC F-2	(1972) Fundamentals of Fabric Collectors and Glossary of Terms
ICAC F-3	(2002) Operation and Maintenance of Fabric Filters
ICAC F-5	(1991) Types of Fabric Filters

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 85	(1973; R 1986) Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery
IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators
IEEE 114	(2001) Test Procedure for Single-Phase Induction Motors
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MATERIAL HANDLING INDUSTRY OF AMERICA (MHI)

MHI MH27.1	(2016) Specifications for Underhung Cranes and Monorail Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA C50.41	(2012; R 2021) Polyphase Induction Motors for Power Generating Stations
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National

	Electrical Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 12.01	(2002; E 2004) One Coat Zinc-Rich Painting System
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS W-C-375	(Rev E; Supp 1; Am 1; Am 2) Circuit Breakers, Molded Case, Branch Circuit and Service

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60	Standards of Performance for New Stationary Sources

UL SOLUTIONS (UL)

UL 67	(2018; Reprint Aug 2023) UL Standard for Safety Panelboards
UL 845	(2021) UL Standard for Safety Motor Control Centers

1.2 GENERAL REQUIREMENTS

1.2.1 Mechanical General Requirements

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section.

1.2.2 Electrical General Requirements

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, applies to this section.

1.2.3 General Application of Reference Specifications

In regard to referenced Federal Specifications and Military Specifications, the following exceptions apply:

a. Preproduction samples are not required.

b. Certified test reports are not required.

c. The preservation and packing requirements shall be the manufacturer's standard method.

1.2.4 Steam Generators

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NOTE: Use fuel oil that is available at activity and that can be burned in the steam generators. A similar fuel oil should be used in all steam generators. The maximum steam demand shall be determined by the activity and the number of steam generators shall reflect turn down ratios, low steam demand, and swing conditions.

****

The steam generators will be [stoker] [pulverizer] coal-fired and will also be capable of 100 percent oil firing. Boilout and start-up of the boilers will be with No. [_____] fuel oil. The steam generators will be used to supply steam to [a steam distribution system serving process and space heating loads][a cogeneration system]. Consequently, the units will operate with a wide load range and rapid load changes. The maximum steam demand can be met by operation of [_____] steam generators. A steam generator will be available for emergency or standby service.

1.3 DEFINITIONS

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NOTE: Refer to ICAC FGD1 for additional flue gas desulfurization terminology.

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a. Adiabatic Saturation Temperature: The temperature resulting when water is evaporated into the flue gases, in adiabatic process, until the flue gases are saturated. The adiabatic saturation temperature is equal to the wet-bulb temperature.

b. Approach Temperature: The temperature difference between the actual temperature of a given gas-vapor mixture and the adiabatic saturation temperature of that gas-vapor mixture.

c. Spray/Dryer: An apparatus in which flue gas is contacted with a slurry or solution such that the flue gas is adiabatically humidified and the slurry or solution is evaporated to apparent dryness.

d. Stoichiometry: The moles of slaked sorbent introduced to the system divided by the moles of sorbent theoretically required for complete reaction with all of the sulfur dioxide entering the system whether or not it is all removed.

1.4 DESIGN REQUIREMENTS

1.4.1 Detail Drawing

1.4.1.1 Dust Collector System

Submit drawings and diagrams necessary to erect, install, startup, and place the FGD system into regular operation. Indicate the kind, size, arrangement, weight of each component, and breakdown for shipment; the external connections, location of local controls, remote control panels, anchorages, and support required; the dimensions needed for installation and correlation with other materials and equipment; and structural steel and foundations. Submit fabrication details including reinforcing and embedded items cutouts, holes, welds, and attachments, and identify components with piece mark numbers. Include the erection, assembly, and installation sequences, and the tolerances to be maintained in erection, assembly, and installation.

1.4.1.2 Dust Collector Components

Submit drawings for each component showing design and assembly. Include the arrangement of internal apparatus and components, and the location of internal piping, tubing, valves, wireways, busses, and terminal blocks, and flow diagrams with flow rates, pressures, temperatures, valving, and instrumentation. Submit drawings for each gage board, instrument rack, mounting plate, and transmitter bracket showing at least the construction features, bracing, brackets, device mounting holes, and dimensions required for fabrication. Submit schematic drawings of processing sensing lines for each type of installation, instrument, or special case including water level columns and draft lines. Submit layout drawings of control boards and system cabinets showing component arrangement. Submit drawings for each graphic subpanel, to include symbols, flow lines, indicating lights, switches and other devices. Damper submittals shall indicate information for the general arrangement and outline, insulation, instrumentation, erection, electric motors, details of seal air systems, and design flows and pressures for transmittal to damper manufacturers. For instrument and control devices, submit outline drawings and listing of tag numbers for each type of device furnished. One drawing may be used for devices of the same type, but the drawing shall be marked to list the tag number of devices to which it applies. Indicate tag numbers on device drawings, instrument lists, functional diagrams, and logics. Include drawings that apply to each item listed below.

a. Spray dryer sulfur dioxide absorbers

b. Lime system

c. Dampers

d. Instruments and control devices

e. Control panels

f. Electric motors

g. Atomizers

h. Fabric filter baghouse

i. Ductwork

j. Expansion joints

k. Fans

l. Pumps

m. Access systems

1.4.1.3 Piping Drawings

Submit general arrangement and outline, piping fabrication, erection, piping connection, valves, pipe hangers, insulation, and instrumentation. Contractor shall submit complete drawings for piping furnished in plan and elevation. Submit dimensions required for fabrication and assembly of piping components and location of field joints and identify components with piece mark numbers, location of hangers and supports, and the location of instrument, vent, and drain connections. Submit drawings showing approximate field routing for instrument control tubing bundles. Include details of engineered hanger assemblies showing plan location, elevations of piping and support steel in the design, cold and hot positions, design loads, and a complete bill of materials.

1.4.1.4 Wiring Diagrams

Include a wiring diagram with each wire or wire bundle shown by a line, or a point-to-point type wiring diagram with individual wire designations listed at the location of each termination and identify device and equipment terminals, and internal and external connection terminal blocks.

1.4.1.5 Schematic Control Diagrams

Submit elementary diagrams of control and alarm functions, both internal and external to the equipment, wire colors, ANSI symbols circuit designations, and identify external connection terminals and terminal blocks. Submit process and piping instrumentation diagrams, analog control system functional diagrams and associated logic, logic diagrams of digital systems, flow charts or word logic of software systems, description of operation of each control system, electrical interconnection drawings showing external terminal blocks for each input, output, and power cable connection and destination of other end of cable, analog and digital signal input and output lists, and nameplate lists.

1.4.1.6 Printed Circuitboards Information

Include a schematic diagram and board photographs or component layout drawings, with parts labeled, for each type of board and as a parts list containing complete description of discrete components and integrated circuits.

1.4.2 Calculations

Submit hangar load calculations and equipment foundation design loading requirements for conditions of testing and operation including a loading plan showing design base loads for each piece of equipment and equipment support. Submit FGD system panelboard heat load for use in design of control room air-conditioning system.

1.4.3 Additional Product Data

For resistance temperature detectors, submit calibration curve showing predicted resistance versus temperature for the range of 0 C to 1,000 degrees C 32 to 1832 degrees F. For vanes and dampers requiring control drives, submit the maximum allowable torque and forces to avoid damage to the damper or vane components. For insulation, include a tabulation including manufacturer, manufacturer's designation, and complete specifications including density, thermal conductivity, sound transmission loss, flexural strength, compressive strength, temperature rating, and dimensional stability. Submit detailed specifications of any rubber hose and rubber-lined pipe proposed for use. For electric motors, submit nameplate data for motors including the manufacturer's name, model, serial number, type and frame designation, power horsepower rating, and time rating. For fans, provide octave band sound pressure levels, fan performance curves, class, air flow, pressure, power horsepower, and efficiency. For draft equipment, submit certified performance data including performance curves showing flow vs. head, efficiency and brake power horsepower from zero flow to at least 120 percent of maximum design flow.

1.5 QUALITY ASSURANCE

1.5.1 Manufacturer Experience

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NOTE: Contractor equipment used for experience requirements shall be at least as efficient as local or state percent sulfur dioxide removal regulations.

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The Contractor shall have successfully met air pollution emission requirements on two coal-fired boilers each with a minimum of 4719 L/s 10,000-actual cubic feet per minute (acfm) or larger similar spray dryer sulfur dioxide absorber and fabric filter baghouse systems. The completed system shall have utilized lime slurry as the absorbent material. Slurry atomization shall have been by rotary atomization or by two-fluid nozzle atomization. The completed system spray dryer sulfur dioxide absorber shall have been designed for and operated at inlet flue gas temperatures of 177 degrees C 350 degrees F or less, and shall have achieved at least [_____] percent sulfur dioxide removal including sulfur dioxide removal in the baghouse during performance testing. The Contractor shall have also successfully met air pollution emission requirements at least five fabric filter baghouse installations of a size comparable to or larger than that [proposed][bid]. At least two of the five installations shall have been a fly ash application and at least two of the five shall have utilized the pulse jet cleaning method. The Contractor shall also have provided at least one dry FGD system on a coal-fired boiler that has been utilizing a spray dryer sulfur dioxide absorber and a fabric filter baghouse is in operation at least 24 months prior to the close of bid date for the proposed system. The previous commercial system shall have the following design features in common with the system to be provided under this contract:

a. Lime slurry preparation system including storage bin and lime slaker;

b. Rotary atomization, or two-fluid nozzle atomization using compressed air;

c. Spray dryer design inlet temperature of 177 degrees C 350 degrees F or lower; and

****

NOTE: 80 to 85 percent sulfur dioxide removal is possible with most commercial units. Negotiate with most commercial units. Negotiate with state and local air pollution authorities prior to bidding emission trading should be utilized. Emission trading includes trading, off-sets, and banking. Ensure that any reductions in emissions are banked for future use or sale.

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d. Minimum [_____] percent sulfur dioxide removal over a gas flow range of 30 percent to 100 percent of design gas flow. Process control system used and instrumentation provided shall be the same as those in applications at pilot plant or commercial installations use for qualifying experience.

1.5.1.1 Auxiliary Manufacturer Experience

The lime slurry individual equipment may be the manufacturer's standard, but the particular combination of that equipment into a lime slurry preparation system shall have a history of successful and reliable operation for a period of at least three years. Mechanical draft equipment and appurtenances and ductwork and expansion joint equipment and materials shall have an acceptable history of satisfactory reliable operation in industrial steam plant use for a period of at least three years at comparable temperature, pressure, voltage, and design stress levels. The Contractor shall provide information necessary to demonstrate history of operation.

1.5.2 Certificates

1.5.2.1 Pipe Welding Procedures

Submit the welding procedures and the heat treatment records for pipe fabrication.

1.5.2.2 Weld Testing Procedures

Describe procedures for nondestructive testing which shall be performed on the welds or base material of the fans.

1.5.2.3 Welding Shops

Submit certification that welding shops are qualified as specified.

1.5.2.4 Qualifying Experience Certification

Submit proof that the dust collector manufacturer has installed the following systems:

a. Spray dryer system

b. Lime slurry system

c. Mechanical draft equipment

d. Fabric filter baghouse

e. Dry FGD systems

Manufacturer shall certify that no failures have occurred on this type collector built by the manufacturer within 5 years preceding contract award date, as required by paragraph QUALITY ASSURANCE.

1.5.2.5 Factory Test Certification

Submit certificates of completion of factory tests of mechanical draft equipment.

1.5.2.6 Dry FGD System Experience Certification

Indicate compliance with paragraph QUALITY ASSURANCE. Submit a listing of other applications of the [proposed] [bid] dry scrubber system within the range of 4719 to 47,190 L/s 10,000 to 100,000 acfm and shall have demonstrated operation for 8,000 hours. Include a narrative description of the specific design changes which must be made to apply application experience to dry flue gas desulfurization (FGD) systems. Specifically note the use of the completed dry FGD system test results to verify the feasibility of the design changes. Information to be contained in the certificate shall include:

a. List of at least two installations meeting the requirements set forth in the paragraph MANUFACTURER EXPERIENCE.

b. Owner and location of each such installation including name of contact, address, and telephone number.

c. Design inlet gas volume, actual liter per second cubic feet per minute; inlet gas temperature, degrees C degrees F; inlet dust loading, grams per liter grains per acf; outlet dust loading; grams per liter grains per acf; and dry FGD system model number.

d. Type of coal-fired boiler.

e. Description of fabric filter bag material and cleaning mechanism.

f. Completed bid forms for dry FGD systems.

1.5.3 Test Reports

1.5.3.1 Pump Tests Reports

Include certified curves showing pump performances.

1.5.3.2 Damper Tests Reports

In each damper factory test report, report, discuss the test conditions, results, defects found and corrective action taken. In lieu of factory tests on poppet dampers, include the results of field tests performed on similar installations.

1.5.3.3 Dust Collector Model Tests Report

Submit model test reports within 30 days of test completion. The test reports shall include a scale drawing of the model showing actual dimensions and a scale drawing of the full-size installation showing modifications made and devices added to the ductwork and transitions as a result of the model study. The test report shall also include uniform gas velocity diagrams and histograms, indicating the root mean square velocity deviation, standard deviations, and mean velocity, at strategic locations which shall include, but not be limited to the following:

a. Inlet to spray dryer sulfur dioxide absorbers.

b. Inlet to baghouse.

c. Inlet to each fabric filter baghouse module.

d. Inlets to induced draft fans.

e. Stack inlet.

f. Two stack diameters located downstream of the stack inlet.

Submit a complete explanation of the test procedures including flow rates, pressures, sample calculations and assumptions prior to testing. Deviations in dynamic or geometric similitude by the model from the full-size installation shall be listed and justified. Conclusions that show type and location of devices required for proper gas distribution and modifications necessary to the proposed ductwork, that result from model testing, shall be incorporated into the Contractor's final ductwork design. The report should recommend the location of test ports, the location and type of flow distribution devices in stack, and the location of gas flow instrumentation points and monitors. Provide a complete listing of pressure drop data taken at each pressure tap during each test run and also include data from runs before and after the addition of supplemental flow distribution devices that correct distribution problems identified by initial runs. Pressure taps shall be located as required to accurately determine the pressure drop across critical ductwork components and the effect of the additional distribution devices on the pressure drop. Submit with the report a complete set of photographs and videotapes recordings of model during air flow test.

1.5.3.4 Instrument Calibration and Testing

For instrument calibration and testing, certify that instruments were calibrated and testing readings indicated are true, that computations required for testing are accurate, that acceptable methods were used, and that the equipment satisfactorily performed in accordance with the requirements.

1.5.4 Records

Submit text of each required posted operating instructions. For device purchase information, submit data or specification sheets for each device furnished by this contract. These sheets shall be the actual sheets used for ordering and fabrication, and shall include the final vendor's own sheets, where applicable, in addition to the Contractor's purchase order forms. Provide an index for the data sheets. These sheets shall include technical data for the devices including tag number, manufacturer, complete catalog or model number, scale range, complete electrical information including current voltage ratings, contact action (SPST, DPDT, etc.), data or specification sheet number, scheduling information showing dates for ordering, fabrication, shipment, etc., manufacturer's data for tubing, fittings, valves and accessories, and material.

1.5.5 Model Test

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NOTE: Contracting Officer shall have authority to select an experienced modeller from list supplied by contractor.

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NOTE: Test model system scale shall meet good

engineering practices. In no case shall scale be less than 1:100 1/8 scale.

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NOTE: Dust used for testing shall be sifted, bleached wheat flour or approved vendor selection.

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Conduct a three-dimensional model study as defined in ICAC EP-7 to verify air flow design of the spray dryer sulfur dioxide absorbers, ductwork, fabric filter baghouse, and inlet transition to stack and to determine the flow distribution and requirements for distribution devices to provide adequate operating conditions in all of the equipment. The model study shall be used by the Contractor to determine flow distribution and pressure drop through out the system. Make necessary modifications to the model to minimize pressure drop in ductwork. The scope of the model study shall begin at the [economizer][air heater] outlets and end in the inlet transition to the stack. Model shall represent the complete system, as specified, reduced to not less than 1:100 1/8 scale. Test model shall have dimensional tolerance of plus or minus 1 1/2 mm 1/16 inch. Dynamic and geometric similitude shall be observed in all phases of the model study. Flow conditions in the spray dryer sulfur dioxide absorbers, fabric filter baghouse, ductwork, and inlet transition to the stack shall be tested and the results submitted to the Contracting Officer. Flow and dust distribution tests shall be performed at 30 percent, 50 percent, 75 percent, 100 percent, and 125 percent of maximum continuous flow rating. The Contractor shall notify the Contracting Officer no less than 15 working days before the tests are scheduled to be made so that Contracting Officer may witness test. Dust used for testing shall be [_____].

1.5.6 Tabulations

Submit a tabulation of piping connections with each assigned a unique designation including size and type of each connection in all views. Submit a tabulation of valves furnished, with each assigned a unique designation including manufacturer, pressure and temperature rating, body material, trim material, and manufacturer's model or figure number, and a detailed cross section of each different model or figure number, and valve. Submit a tabulation of instruments and instrument connections furnished in spray dryer sulfur dioxide absorbers, fabric filter baghouse, ductwork, and auxiliary equipment. Assign a unique alphanumeric designation and show type, location, and quantity for each connection.

1.6 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Tabulation of Piping Connections

Tabulation of Valves

Instruments and Instrument Connections

SD-02 Shop Drawings

Dust Collector System

Dust Collector Components

Piping Drawings

Wiring Diagrams

Schematic control Diagrams

Printed Circuitboards

Model testing shall be completed and approved prior to submittal of drawings. Drawings of typical installations will be acceptable provided that the individual applications are noted.

SD-03 Product Data

Vanes and Dampers

Insulation

Mechanical Draft Equipment

Pumps

Atomizers

Motors

Lime System Component Equipment

Instrumentation and Control Devices

Piping

Ductwork

Fabric filter baghouse

Fans

Expansion Joints

Bag Material

Fabric Filter

Valves

Spray Dryer Sulfur Dioxide Absorbers

Control Panels

Monorail and Hoist

Resistance Temperature Detectors

Rubber Hose and Rubber-Lined Pipe

SD-05 Design Data

Equipment Foundation Design Loading Requirements

Hangar Load Calculations

FGD System Panelboard Heat Load

Guillotine Dampers design pressures and flows

SD-06 Test Reports

Lime System Component Equipment

Instrumentation and Control Devices

Atomizers

Piping

Pump Tests

Bag Material

Fans

Motors

Damper Tests

Mechanical Draft Equipment

Instrumentation and Control Devices

Dust Collector Model Tests

Smoke Tests

System Stoichiometry Tests

System Power Consumption Tests

Instrument Calibration and Testing

Include field data sheets and show the calculation of stoichiometry with stoichiometry field test report. Include an explanation of the method used for the system power consumption determination.

SD-07 Certificates

Pipe Welding Procedures

Weld Testing Procedures

Welding Shops

Qualifying Experience Certification

Dry FGD System Experience Certification

Factory Test Certification

SD-10 Operation and Maintenance Data

Atomizers, Data Package 3

Fans, Data Package 2

Lime System Component Equipment, Data Package 2

Pumps, Data Package 2

Valves, Data Package 2

Dampers, Data Package 2

Motors, Data Package 2

Fabric Filter Baghouse, Data Package 2

Instrumentation and Control Devices, Data Package 3

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include the manufacturer's recommended supply list for each type of instrumentation recorder furnished. The lists shall include as minimum information, the chart paper type, size, and order number, ink type (cartridge or pen) order number, capillary tube order number, and pen point order number.

SD-11 Closeout Submittals

Device Purchase Information

Posted Operating Instructions

1.7 DELIVERY AND STORAGE

Equipment shall be shipped factory assembled, except when the physical size, arrangement, or configuration of the equipment, or shipping limitations, makes the shipment of assembled equipment impracticable.

1.8 AMBIENT ENVIRONMENTAL REQUIREMENTS

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NOTE: Insert extreme temperatures experienced at site. Do not use heating or cooling design conditions.

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The dry FGD system design shall be such that the electrical equipment shall perform satisfactorily in the ambient environment of [_____] to [_____] degrees C degrees F and [_____] to [_____] percent relative humidity.

1.9 EXPERIENCE CLAUSE

1.9.1 Certificate

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NOTE: Select air flows, temperatures, and dust loadings similar to design conditions.

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Units which have been replaced within 3 years of start-up, have had retrofit, overhaul, or repair cost exceeding 10 percent of the original price of the collector (excluding transportation and erection), have failed to meet specified removal efficiency, or have allowed emissions to exceed specified limits shall be considered failures. Off-line time exceeding five percent of the planned annual operation or 300 hours per annum, whichever is less, within the first 3 years of operation due to collector or component failure shall be considered a failure. System failure due to natural disaster or a result of damage from fire or explosion in appurtenant structures will not be considered failure. Pilot or research projects will be excluded from failure analysis. The certificate must certify that the manufacturer has constructed not less than two dry FGD systems of the same design as proposed for this project treating flue gas from a boiler with [automatic][manual] combustion control [and a mechanical cyclone-type dust collector]. Each dry FGD system shall have performed satisfactorily, normal maintenance or downtime of the associated [boiler][dust collector] included, for a period of not less than 2 years treating at least [_____] L/s acfm of inlet gas at a temperature of at least [_____] degrees C degrees F, with inlet dust loading of at least [_____] grams per liter grains per acf and outlet dust loading of at most [_____] grams per actual liter grains per actual cubic feet. In determining this experience:

a. Only collection of fly ash as produced by [pulverized coal-fired boilers] [stroker coal-fired boilers] is considered as equivalent experience.

b. Only experience at the maximum continuous flow rate, plus or minus 40 percent, maximum continuous inlet flue gas temperature, plus or minus 46 degrees C 50 degrees F, and maximum continuous inlet dust loading, plus or minus 50 percent, is acceptable.

1.10 OPERATOR TRAINING PROGRAM

Provide an organized training program for the Government's operating personnel including the system specified herein. The purpose of the training program is to familiarize personnel with the operation and maintenance of the flue gas cleaning system and the individual equipment components. The training program shall be designed to provide the operators with a working knowledge of the theory and principles of operation of the system, the activities required for operation and control of the system and the tools and techniques required for maintenance of the system. The training program shall provide classroom instruction, testing, and hands-on training to ensure that operators who complete the organized program will be able to operate and maintain the flue gas cleaning system for the Government. Furthermore, the training manuals and testing materials shall provide information so that, in conjunction with the operation and maintenance manuals furnished under this contract, future training of new operators can be accomplished without the assistance of the Contractor.

1.10.1 Training Manuals

Provide training manuals covering the complete FGD system and including separate sections devoted to each major equipment item including spray dryer sulfur dioxide absorbers, fabric filter baghouses, lime system, induced draft fans, and system control panel. Each section shall include equipment description, principles of operation, control philosophy, control hardware, and relation to other equipment. Furnish [_____] copies and an original of the complete training manual.

1.10.2 Testing Program

Furnish a written testing program designed to objectively determine the individual level of comprehension of the material presented in the training program to the participants. Use the testing program in conjunction with the classroom instruction. Provide [_____] copies of the complete testing program.

1.10.3 Classroom Instruction

Develop and present 40-hour course of organized classroom instruction by experienced engineers. The classroom instruction shall cover theory and principle of operation and shall utilize and augment the information provided in the training manuals. Administrate the testing program at the conclusion of the course. Present the course at least twice in order to accommodate Government operating personnel. The Contractor shall arrange with the Contracting Officer for classroom space and times for the classes to be given.

1.10.4 Field Instructions

Service engineer shall provide 8-hour per day supervision of the system for a period of 30 days after start-up to assist and instruct Government's operations. Instruction shall include, but not be limited to the following:

a. Actual start-up and shutdown of the FGD system for each boiler.

b. Indoctrination to the lime handling system, stressing safety.

c. Remove and install one atomizer.

d. Disassemble and assemble one atomizer to the extent required for normal maintenance.

e. Review of instrument, gage, and control functions in the control room.

f. Deliberate upset of FGD system and instruction on making necessary corrections.

g. Simulation of induced fan failure.

h. Review of fabric filter baghouse maintenance including removal and replacement of bags.

1.10.5 Video Recording

Furnish color video tapes made during field instruction or prepared color video tapes covering the field instruction material. Video tapes instruction and hands-on-training, along with prepared video instruction tapes, shall become the property of the Government.

1.11 MODEL DELIVERY

The model shall remain the property of the Government, and shall be delivered to the Government upon request by the Contracting Officer within one year of start-up. The model shall include a support table as part of the deliverable items.

1.12 POSTED OPERATING INSTRUCTIONS

Provide for the following:

a. Atomizers

b. Lime feeders

c. Baghouse

d. Lime slakers

e. Lime unloading

PART 2 PRODUCTS

2.1 APPLICATION

****

NOTE: Refer to ICAC FGD1 for additional flue gas desulfurzation terminology.

****

The Flue Gas Cleaning System and induced draft fans shall be used to control emissions of sulfur dioxide and particulate matter and furnace draft from steam generators. The steam generators will be [stoker][pulverized] coal-fired and will also be capable of 100 percent oil firing. Boilout and start-up of the boilers will be with No. [_____] fuel oil. The steam generators will be used to supply steam to [a steam distribution system serving process and space heating loads][a congeneration system]. Consequently, the units will operate with a wide load range and with rapid load changes. The maximum steam demand can be met by operation of [_____] steam generators. A steam generator will be available for emergency or standby service. A separate FGD system for each steam generator as indicated. Also, provide facilities for reagent storage, preparation, and feed. The system shall be designed to use lime as the alkali material.

2.2 EQUIPMENT AND MATERIALS PROVIDED UNDER THIS CONTRACT

****

NOTE: It is not the intent of this specification to require a reagent recycle system. Life cycle cost analyses indicate that the reasonably expected lime savings do not justify the additional capital and operating costs for a recycle system. Proposers or bidders including a recycle system as an essential portion of their process must include in their scope of supply equipment and material required for a complete and operational recycle system including all necessary instrumentation and controls. The proposer's or bidder's scope of supply must include all ash handling and conveying equipment associated with the recycle system.

****

Equipment to be provided under this contract includes the items listed below and other equipment required for a complete and operable FGD system although not specifically mentioned in these specifications. The following items are listed for the convenience of the Contractor in understanding the scope of supply.

2.2.1 Spray Dryer Sulfur Dioxide Absorbers

****

NOTE: Air compressor is specified in paragraph TWO-FLUID NOZZLE ATOMIZERS.

****

Provide spray dryer sulfur dioxide absorbers, complete with slurry atomizers, inlet gas dispersers, conveying system for continuous removal of absorber products, absorber product holding bin(s), frames for penthouse and hopper enclosures, mechanism for atomizer removal, and spare atomizers.

For systems utilizing two-fluid nozzle atomizers, provide a dedicated air compressor system to provide air for slurry atomization.

2.2.2 Fabric Filter Baghouse

Provide fabric filter baghouses, complete with inlet and outlet manifolds, pulse jet or reverse gas cleaning systems, bags, bag attachment and support hardware, and frames for penthouse and hopper level enclosures.

2.2.3 Lime Slurry Preparation System

Provide lime slurry preparation system including lime feed bin, fill pipe and truck unloading connection, bin vent filter, bin vibrators, lime feeders, slakers, grit removal equipment, slaker product tank, agitators, and drives. Provide accessory equipment and control panels to control lime slurry preparation system. Provide tanks as required by specific system design including slurry mixing tanks, feed tanks, and head tanks.

2.2.4 Pumps, Valves, and Motors

Provide pumps including slurry feed pumps and process water pumps. Provide sump pumps as required as a result of the specific system design. Provide water, slurry and air piping (excluding field-installed instrument air tubing), piping support systems, valves, and expansion joints required for the FGD system within the battery limits indicated. Provide electric motors for induced draft fans, pumps, and other equipment included in this system. Provide motor control centers as required for motors furnished under this contract rated at 480 volts and less. Provide separate motor control centers for each spray dryer absorber-baghouse unit, and for the lime slurry preparation system, complete with internal controls wired and interlocked together and brought out to terminal blocks for remote field connection by the Contractor.

2.2.5 Ductwork and Draft Equipment

Provide induced draft fans including inlet boxes, dampers, and drives. Provide ductwork between [economizer][air heater] outlet interfaces and stack inlet including spray dryer absorber bypass reheat ducts, as necessary. Provide test ports. Provide expansion joints, turning vanes, dampers, damper operators, and seal air systems including fabric filter baghouse dampers. Provide gas distribution devices in ductwork ahead of baghouse to assure even flow of gases into baghouse.

2.2.6 Instrumentation and Control Devices

Provide system controls and instrumentation including local control panels and a remote control panel to be located in the main plant control room.

2.2.7 Structural and Miscellaneous Steel

Provide structural and miscellaneous steel including structural steel for support of equipment, ductwork, platforms, walkways and stairs, and miscellaneous framing. Provide stairs, walkways and access platforms, and as required for normal operation and maintenance.

2.3 SITE FABRICATED AUXILIARY CONSTRUCTION

****

NOTE: Penthouse and hopper enclosures shall be

specified. Enclosed areas improve maintenance and lower heating requirements.

****

Provide concrete foundations with anchor bolts conforming to ASTM A307for structural steel columns and equipment. Also, provide metal siding and roofing, insulation, doors, windows, and heating and ventilating equipment for spray dryer sulfur dioxide absorber, for fabric filter baghouse penthouse and hopper enclosures, and for the lime slurry preparation system enclosure. Provide insulation and lagging including necessary subgirts for spray dryer sulfur dioxide absorbers, baghouses, and ductwork. Also, provide insulation and heat tracing for piping, as necessary, and in accordance with the equipment specification requirements. Provide a remote bulk lime storage silo, conveying system, and piping for connection to Contractor's lime feed bin fill piping. Provide ash conveying equipment from hopper flanges on the fabric filter baghouses and the absorber product holding bins. Also, water storage tanks along with potable (non-process) water piping, fire protection water piping, and field-installed instrument air tubing. Provide electrical field wiring and conduit, lighting, and motor control centers for 4,000-volt motors.

2.4 SITE CONDITIONS

****

NOTE: Dry and Wet Bulb Temperature and Duration:

Parameter	**Season**	**Temperature (Degrees C)**	**Frequency of Occurrence of Higher Temperatures**
Dry Bulb	**Dec-Feb**	**[_____]**	**[_____]**
Dry Bulb and Mean Coincident Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**
Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**

Parameter	**Season**	**Temperature (Degrees F)**	**Frequency of Occurrence of Higher Temperatures**
Dry Bulb	**Dec-Feb**	**[_____]**	**[_____]**
Dry Bulb and Mean Coincident Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**
Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**

****

Contractor shall use site conditions of elevation, design ambient temperature, and design dry and wet bulb temperature, and duration (differentiate for different seasons including frequency of occurrence of higher temperatures) specified.

2.5 OPERATING INSTRUCTIONS

2.5.1 Steam Generators

****

NOTE: Insert appropriate Section number and title in the blanks below using format per UFC 1-300-02.

****

The system shall be designed for operation with [the boiler(s) specified in [_____]] [boiler(s) manufactured by [_____], Type [_____], Model No. [_____]]. The steam generator is [a new] [an existing] [pulverized coal-fired] [spreader stoker-fired] [underfeed stoker-fired] boiler. Operating conditions for each steam generator at its maximum rating are:

a. Type firing [_____]

b. Steam flow, kg/s lb/hr [_____]

c. Steam pressure, kPa (gage) psig [_____]

d. Steam temperature, degrees C degrees F [_____]

e. Gross heat input, kW 106 Btu/hr [_____]

f. Excess air leaving boiler, percent [_____]

g. Grade elevation, meters feet above mean sea level [_____]

For purposes of the proposal, the Contractor shall assume that the gross heat input at any fractional load rating is that same fraction of the maximum rated heat input given above.

2.5.2 Fuels

The steam generator shall utilize a fuel with following properties:

Coal:

****

NOTE: Coal sources vary year to year when purchased by Defense Fuel Supply Agency (DFSA). Request a contract for a longer period of time. Specified coal properties shall be maintained throughout length of contract.

****

a. Source:	
State	[_____]
Seam	[_____]
Area	[_____]

b. Proximate Analysis-- Percent (as received)	Average	Range
Moisture		
Volatile Matter		
Fixed Carbon		
Ash		
Higher Heating Value, kJ/kg Btu/lb		
c. Ultimate Analysis--Percent (as received)		
Moisture		
Carbon		
Hydrogen		
Nitrogen		
Chlorine		
Sulfur		
Ash		
Oxygen (by Difference)		
Total		
d. Mineral Analysis of Ash-- Percent		
Phosphorus Pentoxide, P205		
Silica, Si02		
Ferric Oxide Fe203		
Alumina, A1203		
Titania, Ti02		
Lime, Ca0		
Magnesia, Mg0		
Sulfur Trioxide, S03		
Potassium Oxide, K20		

Sodium Oxide, Na202

Oil burned in the steam generators will be grade [_____] fuel oil conforming to ASTM D396. Boiler combustion is controlled [manually] [automatically]. The standby fuel is [_____].

2.5.3 Lime

****

NOTE: Contract for lime shall be for a period longer than one year. Ca0 content and amount of grit shall be maintained throughout length of contract.

****

The lime to be used in the system will be high-calcium pebble quicklime (20 mm by 0) (3/4 inch by 0). The high-calcium pebble quicklime will have a "high" reactivity as defined and as determined by ASTM C110. The expected chemical analysis based on ASTM C25 is as follows:

Typical, Percent	Range, Percent
Ca0 (Available)	92.0
Ca0 (Total)	96.0
Mg0	0.4
Si0	0.7
Fe203	0.09
A1203	0.07

2.5.4 Slaking Water

The water to be used for lime slaking will be boiler blowdown which has been diluted with city water for cooling to a temperature of 38 degrees C 100 degrees F. The following water quality criteria will be maintained:

Constituent	Concentration
Combined sulfate, sulfite and bisulfate ions	Less than 500 mg/1
Total dissolved solids	Less than 1,000 mg/1
Total suspended solids	Less than 100 mg/1

2.5.5 Process Water

****

NOTE: Due to the variable proportioning of the plant wastewater streams which will make up the process water, the quality of this water is expected to be more variable than that of the slaking water.

****

FGD system processes other than lime slurry preparation and slurry line flushing will utilize plant wastewater. Plant wastewater will consist of a mixture of variable proportions of boiler blowdown, cooling tower blowdown, process wastewater and potable water.

2.5.6 Compressed Air

****

NOTE: When retrofitting an existing power plant specify increased volume for compressed air system. Insulate system where applicable. Compressed air supplies will be as follows.

1. Service Air: [_____] kPa (gage) psig, dew point up to [_____] degrees C degrees F at [_____] kPa (gage) psig.

2. Instrument Air: [_____] kPa (gage) psig, dew point [_____] degrees C degrees F at [_____] kPa (gage) psig.

3. Instrument Air (for outdoor use): [_____] kPa (gage) psig, dew point [_____] degrees C degrees F at [_____] kPa (gage) psig.

****

The FGD system utilizes compressed air supplies for service air and indoor and outdoor instrument air.

2.6 DESIGN PARAMETERS

2.6.1 Expected Flue Gas Conditions

****

NOTE: Pressures, rates, and duration of sootblowing will depend on site conditions and acceptable operating procedures.

****

Flue gas conditions leaving each steam generator are expected to be as follows: (at [economizer][air heater] outlet, except as noted).

	Design	Range
a. Gas flow, L/s		
b. Gas temperature, degrees C (before [economizer][air heater])		
c. Specific volume, L/kg		
d. Dust loading, gram/L		
e. Absolute humidity, kg H20/kg dry gas		

	Design	Range
Normal operation		
During sootblowing		
f. S02, kg/s (full load)		

	Design	Range
a. Gas flow, acfm		
b. Gas temperature, degrees F (before [economizer][air heater])		
c. Specific volume, acf/lb		
d. Dust loading, gr/acf		
e. Absolute humidity, lb H20/lb dry gas		
Normal operation		
During sootblowing		
f. S02, lb/hr (full load)		

Conditions during sootblowing are based on the injection of steam [_____] kPa (gage) psigat a rate of [_____] kg/s lbs/min during the sootblowing cycle. The cycle is expected to last approximately [_____] minutes.

2.6.2 Spray Dryer Absorbers

****

NOTE: Specified percent sulfur dioxide removal must be identical to paragraph QUALITY ASSURANCE.

****

Each spray dryer absorber shall be designed in conjunction with its associated fabric filter baghouse to remove a minimum of [_____] percent of the sulfur dioxide present in the flue gas leaving the steam generator for any flue gas condition specified and burning any coal within the range specified.

2.6.3 Fabric Filter Baghouses

****

NOTE: Emission rates will depend upon local or state air pollution regulations. Negotiations with the agencies may be necessary.

****

****

NOTE: Typical fly ash densities are 560 kg/m 335 lbs/ft3 for hopper design capacity and 1440 kg/m3 90 lbs/ft3 for hopper design load.

****

****

NOTE: Dry and Wet Bulb Temperature and Duration:

Parameter	**Season**	**Temperature (Degrees C)**	**Frequency of Occurrence of Higher Temperatures**
Dry Bulb	**Dec-Feb**	**[_____]**	**[_____]**
Dry Bulb and Mean Coincident Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**
Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**

Parameter	**Season**	**Temperature (Degrees F)**	**Frequency of Occurrence of Higher Temperatures**
Dry Bulb	**Dec-Feb**	**[_____]**	**[_____]**
Dry Bulb and Mean Coincident Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**
Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**

****

Each fabric filter baghouse shall be designed to reduce maximum particulate emissions leaving the baghouse to not more than [_____] kg/106 kJ lbs/106 Btu of heat input to the boiler for any gas flow conditions specified and burning any coal within the specified range. Each fabric filter baghouse shall be divided into a minimum of flue modules. The maximum air-to-cloth ratio excluding one module for cleaning and one module for maintenance shall be 4.0 for pulse-jet units or 2.25 including the reverse gas volume, for reverse gas units with the spray dryer operating at the design gas flow specified in paragraph EXPECTED FLUE GAS CONDITIONS. Calculation of air-to-cloth ratio for reverse gas fabric filter baghouses shall exclude thimble, ring, and cuff area covered by bags. Pulse-jet fabric filter baghouses, if provided, shall be designed for off-line cleaning during normal operation with the capability for on-line cleaning when required. Reverse gas fabric filter baghouses shall provide a maximum of three-bag reach. Reverse gas bag cleaning systems shall provide a minimum of 9 liter per second per square meter 1.75 cubic feet per minute per square foot of fabric to be cleaned. Hopper capacity shall allow for a minimum of ten hours storage at maximum fly ash and absorber product material loading. Hopper design capacity shall be based on a fly ash density of [_____] kilogram per cubic meter pounds per cubic feet. Hopper design strength shall be based on fly ash density of [_____] kg per cubic meter pound per cubic feet plus the support of 454 kg 1,000 pounds of ash handling equipment per hopper. Structural design shall be based on the assumption that the hopper is full of ash up to the bottom of the bags for pulse-jet units or up to the tube sheet for reverse gas units. Fabric filter baghouse structural design temperature range: [_____] to [_____] degrees C degrees F.

2.6.4 Lime Slurry Preparation System

****

NOTE: Design slaker enclosure with adequate access area around feeders, slakers, and grit removal equipment to perform required maintenance.

****

A single lime slurry preparation system shall serve all spray dryer absorbers. The lime feed bin shall be sized to store at least the quantity of lime required for 72 hours operation of two steam generators at the maximum sulfur dioxide rate specified and at the guaranteed stoichiometry. The minimum storage volume shall be [_____] cubic meter feet. Provide the bin with two conical hoppers. The lime feed bin shall be capable of receiving lime either directly from self-unloading blower trucks or from a remote silo and pneumatic conveying system to be provided by the Contractor. Lime shall be slaked with detention or paste-type slakers. Two full-capacity lime feeders and slakers shall be provided. Each lime feeder and slaker shall be sized to provide 110 percent of the slurry quantity required during operation of 2 steam generators at the maximum sulfur dioxide rate specified. The turndown capability from this design capacity shall be at least 10 to one. The lime slurry preparation system shall provide 100 percent installed spare capacity feeders, slakers, and grit removal equipment. The lime slurry system will operate with one equipment train in operation and one as backup. The FGD system control panel in the steam plant control room shall provide complete operational monitoring of and alarm annunciation for each equipment train. Capability for emergency shutdown of the lime slurry preparation system shall be provided at the FGD system control panel. Failure of the operating equipment train to respond to the automatic start signal from the low tank level switch shall be alarmed in the control room. The slurry tank storage capacity between the low and low-low levels shall be sufficient to allow time for the control room operator to dispatch operations personnel to the lime slurry preparation system to start-up the backup train and to provide slurry to the tank before the low-low level is reached. Enclosed feeders shall include equipment to protect the lime from moisture. Slakers shall discharge slurry by gravity flow into product tank. Slurry preparation system shall include positive means of removing sufficient grit from the slurry to assure proper operation of the slurry feed system and the spray atomizers. Grit shall be conveyed to a disposal bin provided by the Government. Provide emergency eyewash stations at each level in the lime slurry preparation system enclosure. Provide piping to exterior of enclosure for connection to potable water piping system provided by the Contractor.

2.6.5 Ductwork

****

NOTE: Ductwork velocities shall be such to maintain self-cleaning conditions.

****

Ductwork upstream of the fabric filter baghouse outlets shall be designed for a velocity of [_____] meter per second feet per minute at the design flue gas flow, specified in paragraph EXPECTED FLUE GAS CONDITIONS. Ductwork downstream of the fabric filter baghouse outlets shall be designed for a velocity of [_____] m/s fpm at the design flue gas flow, specified in paragraph EXPECTED FLUE GAS CONDITIONS. Ductwork from the fabric filter baghouse outlet to the stack inlet shall be designed to withstand a transient internal pressure (80 percent of yield strength) range of minus 2490 Pa to plus 7470 Pa 10 inches Water Column (WC) to plus 30 inches WC without permanent deformation of any structural member at yield or in buckling.

2.6.6 Induced Draft Fans

****

NOTE: Pressures and air flows will be site specific and will require system analysis.

****

****

NOTE: Dry and Wet Bulb Temperature and Duration:

Parameter	Season	Temperature (Degrees C)	Frequency of Occurrence of Higher Temperatures
Dry Bulb	**Dec-Feb**	**[_____]**	**[_____]**
Dry Bulb and Mean Coincident Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**
Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**

Parameter	Season	Temperature (Degrees F)	Frequency of Occurrence of Higher Temperatures
Dry Bulb	**Dec-Feb**	**[_____]**	**[_____]**
Dry Bulb and Mean Coincident Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**
Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**

****

Test block flow capacity shall be [_____] actual liter per second cubic feet per minute. Test block static pressure shall be 140 percent of the static pressure required to withdraw [_____] L/s cfm from the [economizer][air heater] outlet interface through the FGD system and to provide [_____] Pa inches WC at the stack inlet plus [_____] Pa inches WC which is equal to 140 percent of the static pressure required to withdraw the design flow from the steam generator to the [economizer] [air heater] outlet. The static pressure requirement shall be based upon normal operation of the FGD system, except that the fan inlet temperature shall be assumed to have the value specified in paragraph SULFUR DIOXIDE REMOVAL PERFORMANCE GUARANTEES. The design and construction of the fan shall be capable of withstanding operation at the maximum gas flow and temperatures which would result, if the spray dryer was not in operation. Test block capacity and static pressure shall be calculated assuming inlet gas temperature to be 93 degrees C 200 degrees F. Design ambient temperature for lubrication system shall be [_____] degree C degree F to [_____] degree C degree F. Induced draft fan speed shall not exceed [_____] rpm.

2.6.7 Sulfur Dioxide Removal Performance Guarantees

****

NOTE: Stoichiometry for dry scrubbing is defined as the moles of fresh slaked sorbent introduced to the system divided by the moles theoretically required for complete reaction with all of the sulfur dioxide entering the system whether or not it is all removed. This is opposed to wet scrubbing where stoichiometry is generally based on moles of sulfur dioxide removed by the system. Absorbent stoichiometry directly affects sulfur dioxide removal in the spray dryer. For example, a reported stoichiometric ratio of 1.2 for a dry system achieving 80 percent sulfur dioxide removal would be equivalent to 1.5 for a wet scrubbing system. The absorbent stoichiometry may be raised by an increase in the amount of absorbent fed to the spray dryer. A higher absorbent stoichiometry enhances removal of sulfur dioxide.

****

****

NOTE: The compensatory damages for exceeding the guaranteed stoichiometry will be determined on the basis of $_____ for each 45 g mole CaO/g mole 0.10 lb mole CaO/lb mole sulfur dioxide increase above the guaranteed stoichiometric ratio. Deduction of compensatory damages, if any, shall be included in the processing of the final payment. The compensatory damages exceeding guarantees power consumption will be determined on the basis of $_____ /kW. Deduction of compensatory damages, if any, shall be included in the processing of the final payment. The total power consumption will be measured at the Government's power input to the FGD system during the final acceptance tests.

****

The guaranteed sulfur dioxide removal efficiency of the Flue Gas Cleaning System shall not be less than [_____] percent and the outlet sulfur dioxide emission shall not exceed [_____] kg/106 kJ lb/106 Btu for any load on the steam generators down to 30 percent of maximum rating while in any normal operating mode (excluding sootblowing) and burning any coal within the range specified, when the Government provides lime, water, compressed air, and other utilities to the interface points in accordance with the Contractor's process flow diagrams, material balances, and these specifications. Contractor shall guarantee the removal efficiency specified with any two boilers and their associated flue gas cleaning equipment in operation at full load. For [_____] percent sulfur dioxide removal efficiency, the Contractor shall guarantee the maximum system stoichiometry (lb-mole of Ca0 per lb-mole of S02 entering the system) at both 100 percent and 50 percent of the maximum rating of the steam generator and burning any coal within the range specified. The guarantee at 50 percent rating shall be based on 50 percent of the design gas flow by weight and an inlet gas temperature of 121 degrees C 250 degrees F. Contractor shall specify minimum quality of lime on which stoichiometry calculations are based as 90 percent available CaO by weight. Any increase in the guaranteed stoichiometry at 50 percent rating and firing the average coal will reduce the contract price. The operating stoichiometry will be measured during the final acceptance tests. The measurements will be made under normal operation and no special cleaning, adjustments or other preparations will be allowed. Contractor shall include in the design of the FGD system the necessary provisions for accurate determination of operating stoichiometry. The proposal shall include a description of the method by which stoichiometry may be determined. Contractor shall guarantee that an atomizer can be changed out while the steam generator which it serves is operating.

2.6.8 Particulate Removal Performance Guarantees

****

NOTE: Emission rates will depend upon local or state air pollution regulations. Negotiations with the agencies may be necessary.

****

The maximum particulate emission leaving the fabric filter baghouses shall not exceed [_____] kg/106 kJ lb/106 Btu for any flue gas conditions as specified while in any operating condition and burning any coal within the ranges specified. The maximum particulate emission shall be defined as the average of three complete test runs which shall include a proportional part of the boiler sootblowing cycle. Bag life shall be guaranteed for a minimum of two years after date of first flue gas passage through the bags. Fabric filter baghouse will normally be bypassed during 100 percent oil firing due to plugging of bags, bag guarantee shall be based upon coal/oil and soot combination firing only. Soot blowing, with fabric filter baghouse in operation, shall not void guarantee. If 10 percent or more of the bags in any given compartment fail within the guarantee period, the Contractor shall replace and install all bags in that compartment at his own expense. Replacement of bags on a one-by-one as-fails basis will not normally be allowed. However, the Contractor will be granted the opportunity to locate and replace bags which fail within 30 days of initial start-up of each baghouse due to deficiencies in manufacture or improper installation.

2.6.9 Lime Slurry System Performance Guarantees

The Contractor guarantees that the Gas Cleaning System shall meet the above specified performance, based on the process material balances submitted. The guaranteed process material balances shall be based on the following: (a) Lime analysis and coal analysis as specified, (b) slaking water analysis and temperature as specified, and (c) specified gas flows and operating conditions. The Contractor shall guarantee the capacity of each lime slaker at 110 percent of lime quantity required at maximum sulfur dioxide rate.

2.6.10 Draft Equipment Performance Guarantees

The Contractor shall guarantee that dampers have no leakage of flue gas to the atmosphere. The Contractor shall guarantee the maximum leakage across each damper when the dampers are in the closed position and are operating at the design conditions.

2.6.11 FGD System Operational Performance Guarantees

****

NOTE: The compensatory damages for exceeding the guaranteed stoichiometry will be determined on the basis of $_____ for each 45 g mole CaO/g mole 0.10 lb mole CaO/lb mole sulfur dioxide increase above the guaranteed stoichiometric ratio. Deduction of compensatory damages, if any, shall be included in the processing of the final payment. The compensatory damages exceeding guarantees power consumption will be determined on the basis of $_____ /kW. Deduction of compensatory damages, if any, shall be included in the processing of the final payment. The total power consumption will be measured at the Government's power input to the FGD system during the final acceptance tests.

****

The Contractor shall guarantee the maximum FGD system power consumption with one boiler unit in operation at the maximum rating and burning any coal within the range specified. The guaranteed maximum power consumption shall include the power consumption for equipment of the FGD system provided under this contract which would be in use when one boiler is in operation. Any increase in this total guaranteed power consumption will reduce the contract price. The total power consumption will be measured at the Government's power input to the FGD system during the final acceptance tests. Specifically, watt-hour meters accurate to within one percent will be used to measure average power consumption at the motor control centers, the induced draft fan drive motor and the atomization air compressor drive motor (if applicable) during the period of the performance tests. The measurements will be made under normal operation and no special cleaning, adjustments or other preparations will be allowed. Design and operation of the FGD system shall be based upon the requirement that stack inlet temperature differential above acid dew point shall not drop below minus 7 degrees C below 20 degrees F and that fabric filter baghouse inlet temperature differential above acid dew point shall not drop below 17 degrees C 30 degrees F. Operating temperatures will be maintained at or above these levels during performance testing. The Contractor shall guarantee the maximum pressure drop across the entire system at design flue gas flow rate. The Contractor shall guarantee that the sound levels specified for the baghouses, pumps, motors, and valves will not be exceeded.

2.7 SPRAY DRYER ABSORBERS

****

NOTE: Dry and Wet Bulb Temperature and Duration:

Parameter	**Season**	**Temperature (Degrees C)**	**Frequency of Occurrence of Higher Temperatures**
Dry Bulb	**Dec-Feb**	**[_____]**	**[_____]**

Parameter	**Season**	**Temperature (Degrees C)**	**Frequency of Occurrence of Higher Temperatures**
Dry Bulb and Mean Coincident Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**
Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**

Parameter	**Season**	**Temperature (Degrees F)**	**Frequency of Occurrence of Higher Temperatures**
Dry Bulb	**Dec-Feb**	**[_____]**	**[_____]**
Dry Bulb and Mean Coincident Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**
Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**

****

Furnish and deliver [_____] spray dryer absorbers, complete with slurry atomizer units and accessories for a complete and operable installation. Each spray dryer absorber shall meet the performance criteria specified in paragraph SULFUR DIOXIDE REMOVAL PERFORMANCE GUARANTEES. The absorbers shall be constructed of steel plate of 6 mm 1/4 inchminimum thickness, conforming to ASTM A36/A36M. Structural steel design shall be as specified in paragraph STRUCTURAL AND MISCELLANEOUS STEEL. Structural design temperature range shall be [_____] to 204 degrees C 400 degrees F. External stiffening ribs shall be spaced as required to provide support for the vessel shell, equipment, walkways, penthouse, monorail, and hoist. Stiffeners shall be sized and positioned to provide a uniformly curved surface for the installation of insulation and lagging. Structural welded seams shall be seal welded. Joints shall be provided so that they can be assembled airtight. Each spray dryer absorber shall be provided with the necessary framing for a penthouse to provide shelter of atomizers, motors, lubrication systems, control devices and other equipment located above the spray chamber. Emergency eyewash stations shall be provided in each penthouse. Potable water piping to eyewash stations will be provided by the Contractor. The penthouse design shall be such that the overall cylindrical appearance of the absorber shall be maintained. The rotating assembly of each atomizer unit shall be tested for dynamic and static balance using the actual driver. Complete test reports shall be submitted to the Contracting Officer. Notify the Contracting Officer, in writing, at least 20 days in advance of the tests so that he or his representative can be present. The motor drivers shall be tested as specified in paragraph PUMPS, VALVES, MOTORS. Two-fluid nozzle atomizer assemblies shall be tested for proper atomization performance, plugging resistance and wear resistance during actual flow of lime slurry and compressed air through the nozzle, as required during operation. Submit information on the categories general arrangement, foundation design, structural fabrication, piping, erection, insulation, instrumentation, wiring, and electric motors. Exterior ferrous metal surfaces of the spray dryer absorber systems including, but not limited to, absorber vessels, holding bins, support steel, manifolds, handrails and kickplate shall be properly cleaned and shop primed, as specified. Mechanical and electrical component equipment, such as atomizer machinery and control panels shall be provided with the manufacturer's standard finishes. Ferrous surfaces which should not be painted and are subject to corrosion shall be protected for the period during shipment and storage with a suitable rust-preventative compound as recommended by manufacturer.

2.7.1 Spray Dryer Absorber Vessel

The spray dryer vessel shall be cylindrical with a 60-degree conical bottom section or with a trough-shaped bottom section with a minimum sideslope of 60 degrees above the horizontal. Provide replaceable wear plates, where necessary. The absorber vessel shall be gas-tight and designed for a transient condition (80 percent of yield strength) at internal pressures of at least plus 4980 and minus 7470 Pa 20 and minus 30 inches water gage. Stiffeners shall be of equal depth to provide a uniform surface to receive insulation. The bottom section of the vessel shall be provided with hopper heaters as specified in paragraph FABRIC FILTER BAGHOUSE. Heaters shall cover the bottom one-third of the hopper surface area. Provide the hopper with poke holes, flanged discharge opening, mechanical vibrators, strike plate and nuclear level switches, as specified in paragraph HOPPERS. A minimum of one access door on side of vessel, as specified in paragraph ACCESS, shall be provided for access to the vessel interior for maintenance. Provide access doors with external latches and tightening devices which will allow for gasket shrinkage and yet produce a gas-tight seal. Doors shall be provided with means for padlocking in the open position. Access shall be sufficient to allow inspection of the vessel interior and removal and replacement of any internal parts subject to erosion or corrosion.

2.7.2 Spray Dryer Atomizers

Each spray dryer sulfur dioxide absorber shall be provided with slurry atomizers of the rotary or two-fluid nozzle type, as specified in the following sections. Equip the spray dryer sulfur dioxide absorbers with vanes, dampers, dispersers, and distributors required to ensure proper contact of the flue gas with the atomized lime slurry. These devices shall be designed to prevent maldistribution and short circuiting of flue gas and localized abrasive impingement of fly ash on absorber internals. The gas dispersers shall be designed to prevent the atomizer spray from impinging on or wetting the vessel wall. Design the gas distribution devices to provide contact between the gas and the atomized slurry as necessary to maintain system performance throughout the gas flow range. Materials of construction shall be suitable for use in the flue gas environment.

2.7.2.1 Rotary Atomizers

Provide a single slurry atomizer for each spray dryer absorber, complete with electric motor drive, power transmission assembly, lubrication system, atomizer wheel, and operational monitoring and control system. Atomizers supplied under this paragraph shall be of the rotary design and shall have a proven record of efficient and reliable service in previous lime slurry applications. Provide atomizers with quick disconnects on the atomizer motor and feed system to allow rapid changeout of atomizers while the steam generators are on-line. The atomizers motor drive shall be as specified in paragraph PUMPS, VALVES, MOTORS. The transmission connecting the drive motor to the atomizer shall be of the belt or gear-box type. The transmission assembly shall be designed to produce the wheel tip speed required for proper slurry atomization over the range of operating conditions, and shall be provided with a simple means of changing the wheel tip speed, so that the design value can be changed if operational experience indicates the need for adjustment. The wheel tip speed shall be a minimum of 137 meters per second 450 feet per second. Gear units shall comply with all applicable AGMA standards. Bearings shall be the manufacturer's standard design for this application. Bearings shall have an operating life of at least 6,000 hours. Provide a complete lubrication system for each installed atomizer including necessary pumps, reservoirs, filters, heat exchangers, piping, valves, instrumentation and controls, and other accessories, as required, to circulate, clean, and cool the lubricating oil for the atomizer drive and transmission bearings. The lubrication system shall be designed with redundant features and controls required to provide safe and reliable operation of the atomizer and to prevent damage to the atomizer motor or transmission assembly due to loss of lubrication. The atomizer wheel shall be designed so that parts exposed to abrasion from the slurry are wear resistant and replaceable. The wheel body shall be constructed of stainless steel. The orifices in the wheel shall be provided with silicon carbide inserts. The wheel shall be dynamically balanced to minimize vibration of the atomizer unit. Provide instrumentation and controls as specified in Section INSTRUMENTATION AND CONTROLS. Include as a minimum the monitoring of the following atomizer operating conditions: motor amperage, lubricating oil pressure, oil temperature, oil reservoir level, motor temperature, atomizer vibration, slurry feed rate, and water feed rate. One complete, ready to run, spare atomizer including motor and drive shall be provided for the Flue Gas Cleaning System. Provide two stands for storing one spare atomizer in an upright position. Provide a stand to hold one atomizer for maintenance. Provide two complete, ready to install, spare atomizer wheels. Two complete sets of tools, as required to disassemble and assemble the entire atomizer, shall be provided. Atomizers shall be designed so that normal maintenance can be performed by plant maintenance personnel who have been trained, as specified in paragraph OPERATOR TRAINING PROGRAM.

2.7.2.2 Two-Fluid Nozzle Atomizers

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NOTE: Alternate arrangement applicable only when plant design includes idle boiler at plant maximum demand load.

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Provide multiple-slurry atomizers for each spray dryer absorber, each with its own flue gas plenum to ensure adequate contact of the flue gas with the atomized slurry. Atomizers supplied under this paragraph shall be of the two-fluid nozzle design using compressed air as the atomizing fluid and shall have a proven record of efficient and reliable service in previous lime slurry applications. Atomizers shall be provided with quick disconnects on the compressed air and lime slurry feed lines to allow rapid changeout of atomizers while the steam generators are on-line. Air compressors shall be as specified in this paragraph. Nozzles shall be the internal mixing type so that the compressed air and the lime slurry are mixed internally to the nozzle orifice, resulting in the atomization of the slurry. Internal surfaces of the nozzle which are subject to wear shall be made of a suitable abrasion-resistant material and shall be easily replaceable. Atomizer operation shall be monitored remotely in the steam plant control room and locally in the absorber penthouse. Provide instrumentation, controls, and alarms, as necessary, to ensure proper operation of the atomizers. Slurry flow and pressure and air flow and pressure in each atomizer feed line shall be monitored continuously. Provide flow and pressure switches to indicate nozzle flow malfunction. Control system shall automatically isolate any malfunctioning atomizer and provide alarm annunciation in steam plant control room. Sufficient control interlocks shall be furnished to assure that air flow to nozzle commences first and terminates last relative to slurry flow during atomizer start-up and shutdown. Atomizers shall be designed so that normal maintenance can be performed by plant maintenance personnel who have been trained, as specified in paragraph OPERATOR TRAINING PROGRAM. The dedicated air compressor system provided with FGD systems utilizing two fluid-nozzle atomization shall be complete with two air compressors, one operating and one backup, and necessary controls and accessories required for automatic operation. Each compressor shall be sized to provide at least 120 percent of the maximum atomization air flow and pressure required. [As an alternative to the preceding specified arrangement, individual air compressors may be provided for each spray dryer absorber. Each unit shall be sized to provide at least 120 percent of the maximum atomization air flow and pressure required for operation of one spray dryer, and with all [_____] units connected together, so that the unit normally dedicated to the spray dryer for the idle boiler provides the required backup.] [For either arrangement], [the] following features shall be provided: The air compressors and all controls and accessories specified herein shall be located inside an enclosure to provide an environment suitable for compressor operation. Provide the structural and miscellaneous steel for framing of the enclosure. Instrumentation and controls shall provide both, local and remote monitoring, alarm annunciation, and automatic transfer to backup unit in the event of failure of the operating unit.

2.7.2.3 Spare Equipment

One complete spare atomizer assembly shall be provided for every two installed assemblies. Spare atomizer assemblies shall require only the connection of lime slurry and air feed lines to allow insertion and operation in place of a malfunctioning assembly. In addition, provide spare nozzle wearing surface component parts, and other atomizer component parts as required for one year's operation. Provide two complete sets of tools required for disassembly and assembly of atomizer units.

2.7.3 Monorail and Hoist

Provide permanent hoist and monorail system for each spray dryer absorber, as required, to install and remove atomizers. Monorail and hoist system shall conform to NFPA 70. Monorail shall extend beyond edge of absorber with sufficient clearance to allow lowering of atomizer assembly to ground level and raising from ground level. Hoisting system shall be designed in accordance with MHI MH27.1 and ASME HST-4. Provide wire rope electric hoist with motor-operated trolley. Rope drum shall be sized for full lift from ground level. Hoist capacity shall be 150 percent of heaviest piece of equipment to be lifted during atomizer installation or removal or 908 kilograms 2,000 pounds, whichever is heavier. Capacity shall be clearly indicated on hoisting equipment. Factor of safety for hoisting equipment shall be not less than five on load-sustaining parts based on ultimate strength. Hoist shall be provided with automatic mechanical load brake and electric motor brake, either of which will sustain rated load in any position. Monorail shall have minimum capacity of 150 percent of heaviest piece of equipment to be lifted or 908 kg 2,000 pounds, whichever is heavier. Provide angle stops on the monorail at each end to prevent trolley over-travel. Provide 460 volt, 3-phase, 60-hertz, totally-enclosed, roller ball-bearing type motor rated on 30-minute, 55-degree C rise-duty basis, specifically designed for NEMA Class 2--Light Duty Industrial Service for cranes. Monorail and hoist control shall be by push button station suspended from hoist on pendant cord of sufficient length to allow operation from penthouse floor or walkway level. Push buttons shall control all hoist and trolley motions and shall provide "dead-man" control action. Enclosed reversing-type magnetic starters shall be mounted on hoist. Upper and lower limit switches shall be provided to prevent hood over-travel. Provide double-acting limit switch to prevent trolley over-travel in either direction. Conductor system shall be rigid enclosed safety-type runway conductor, supported and insulated to conform to NFPA 70.

2.7.4 Absorber Product Removal System

Provide necessary equipment, structural support steel, instrumentation, and controls required for continuous removal, transfer, and short-term storage of absorber product material and fly ash from the bottom hopper section of each spray dryer absorber vessel. The design capacity of the conveying equipment provided shall be at least 120 percent of the maximum expected rate of accumulation of fly ash and absorber product in the vessel based on the specified maximum inlet loadings of sulfur dioxide and particulate. The Contractor's conveying system shall continuously transfer the collected material to a holding bin or bins from which the ash handling system will intermittently convey it to an ash silo. The total capacity of the holding bins provided shall be not less than that required to store the quantity of fly ash and absorber product material representing ten hours of operation of the conveying system at design capacity. The holding bin or bins shall be provided with auxiliary equipment, controls and instrumentation required to keep the control room operator informed as to the system status, minimize fugitive dust emissions and maintain the flow of material to the ash handling system when needed. Structural design requirements shall be as specified. Structural design shall be based on a density of 47 kg per cubic meter 100 pounds per cubic feet. Capacity shall be based on a density of 16.5 kg per cubic meter 35 pounds per cubic feet. Provide a flanged outlet connection for interface with the ash handling system to be provided by the Contractor.

2.8 FABRIC FILTER BAGHOUSES

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NOTE: The use of an electrostatic precipitator (ESP) with the dry scrubber instead of a fabric filter baghouse is not acceptable.

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Provide [_____] fabric filter baghouses, complete with flue gas bypass, inlet and outlet flue gas manifolds, dampers, bags and bag attachment with support hardware, ash collection hoppers, pulse jet or reverse gas cleaning systems, and accessories required for a complete and operable installation. Each fabric filter baghouse shall meet the performance criteria specified in paragraph PARTICULATE REMOVAL PERFORMANCE GUARANTEES. The fabric filter baghouses will be operated on the suction side of the induced draft fans, as indicated. Each fabric filter baghouse shall have a minimum of four lighted modules. The modules shall be arranged in two rows with the inlet and outlet flue gas manifolds located between the rows of modules. The design and arrangement of the fabric filter baghouses shall complement the spray dryer absorbers, fans and ductwork such that the complete Flue Gas Cleaning System installation meets the space requirements indicated. Each fabric filter baghouse shall be provided with framing for a penthouse area as required to allow bag replacement, [damper and damper operator maintenance] [and] [pulse valve maintenance] in a protected environment. Structural design requirements shall be as specified in the paragraphs FABRIC FILTER BAGHOUSES, MISCELLANEOUS STEEL, and in this paragraph. Submit information on the categories general arrangement, foundation design, structural fabrication, piping, erection, insulation, instrumentation, internal arrangement, and valves. Exterior ferrous metal surfaces of the baghouse system including, but not limited to, fabric filter baghouse modules, hoppers, support structures, manifolds, handrails, and kickplate shall be properly cleaned and shop primed, as specified. Surfaces that will be exposed to the flue gas flow need not be painted, but shall be protected during shipment and storage with a suitable rust-preventative coating, as recommended by manufacturer. The fabric filter baghouses shall conform to ICAC F-2, ICAC F-3, and ICAC F-5.

2.8.1 Pulse Jet Cleaning Systems

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NOTE: Air compressor is specified in paragraph TWO-FLUID NOZZLE ATOMIZERS.

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NOTE: Factors involved in selecting fabric filter bag materials include:

1. **Duration of cleaning.**

2. **Type of cleaning arrangements.**

3. **System temperature level.**

4. **Coal type.**

5. **Sulfur dioxide removal efficiency.**

NEEDLED felts are most commonly specified for pulse-jet units. Precoat bags with fly ash prior to operation. Fabric specifications are dependent upon material.

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NOTE: Insert appropriate Section number in the blanks below.

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The fabric filter baghouse assembly shall be of modular construction. The inner housing casing and tube sheet of each module shall be fabricated from carbon steel plate of 5 mm 3/16 inch minimum thickness, conforming to ASTM A36/A36M. The inner casing shall be of welded construction, gastight and watertight, designed for a transient condition (80 percent of yield strength) at internal pressures of at least plus 4980 and minus 7470 Pa plus 20 and minus 30 inches water gage. Joints shall be sealed by continuous fillet or continuous complete penetration groove welds, as applicable. The tube sheet opening arrangement and bag clearance shall limit gas velocity between the bags at any point within the module to not more than 1.27 m/s 250 ft/min at design conditions. Bag to wall clearance used in calculating gas velocity shall not exceed bag to bag clearance.

Minimum bag clearance shall be 50 mm 2 inches. Additional space shall be provided between rows of bags, as necessary, to clear access door supports crossing the tube sheet. Tube sheet shall be continuous fillet or continuous complete penetration groove welded gastight so that all flue gas must pass through the bags. No caulking or sealing materials shall be used. Tube sheet shall be arranged for individual top bag and cage removal and reinforced, as required for pedestrian traffic (minimum support shall be 488 kg per square meter 100 pounds per square foot). Modules shall have shop insulated, double-cased lift-off doors with quick-opening handles for access to the tube sheet. Doors shall have high-temperature gaskets to prevent air infiltration. Multiple tube sheet access doors shall be provided such that each door shall be easily removable by two men. The doors shall be provided with lifting handles. Top surface of access doors shall be 6 mm 1/4 inch thick ASTM A36/A36M four-way raised pattern floor plate. The manufacturer's standard tube sheet access door arrangement and design will be considered provided the design provides adequate insulation and protection against infiltration. The bag cleaning system shall be designed to ensure efficient cleaning operation with a minimum pressure drop across the system and with the gentlest possible cleaning mechanism to ensure long bag life. Source of compressed air is specified under Section [_____] COMPRESSED AIR SYSTEMS. Compressed air used in the cleaning system shall pass through a dryer/filter system. The dryer shall be provided to remove moisture from compressed air used in system. Dryer shall remove sufficient moisture to provide a maximum dewpoint of [_____] degree C at 690 kpa (gage) degree F at 100 psig. A filter system shall be provided to clean compressed air used in system. Filter system shall remove a minimum of 90 percent to 95 percent of particles greater than 0.6 microns in diameter. Filters shall be sized to operate for 90 days without service under normal operating conditions and shall be easily accessible for inspection and service. Dryer/filter system shall be sized service. Dryer/filter system shall be sized for 120 percent of design air flow. Dewpoint should be 6 degrees C 10 degree F lower than design minimum temperature. In no case should a dewpoint be greater than 2 degrees C 35 degrees F. Each module shall have a factory-installed compressed air header, pulse valves, and distribution piping. Valves and wiring shall be located in a weather protected enclosure with forced air ventilation to prevent freezing or overheating. The enclosure shall be readily accessible through hinged doors. Diaphragm valves shall be factory prewired to a junction box. Entire pulsing system shall be removed with top door or other provisions shall be made such that piping does not interfere with bag replacement. Connections to compressed air headers and distribution pipes shall be made with flexible hose with automatic shutoff quick connect fittings for ease of removal during maintenance. Each row of bags shall be serviced by its own pulse valve and distribution pipe so that only one row of bags shall be cleaned per each compressed air pulse. The pulse valves shall be heavy-duty diaphragm type with solenoid actuators and stainless-steel internals. Pulse valves shall be designed to limit noise from pulse valve operation to not more than 84 dBA measured 1 1/2 meters five feet from the valves. Compressed air and instrument air piping for each fabric filter baghouse shall be piped back to a single point within the battery limits of the collector(s) as indicated for connection with the steam plant piping system to be provided by the Contractor. Contractor's piping shall include shut off valves, pressure gages, pressure regulating stations, filters, surge tanks, and other equipment required for complete operation of the cleaning system. For off-line cleaning modules shall be sequentially isolated by closing the outlet valve. Manufacturer to recommend off-line times. When the module is off-line, each row of bags shall be individually pulsed with 483 to 690 kPa (gage) 70 to 100 psig compressed air through a solenoid-piloted, heavy duty diaphragm valve.

Each bag support cage shall be fitted with a diffuser element. After bags are cleaned, the module shall be held off-line for a period of time sufficient to allow the dust to settle into the hopper. The bags to be furnished shall be of a fabric type, weight, finish, and construction suitable for the intended service. Bags shall be suitable for continuous exposure to the flue gas temperature conditions at the economizer outlet. Bags and cages shall be provided with coatings as necessary to minimize abrasion and to resist acid or alkali attack. Bags shall not be more than 150 mm 6 inches in diameter and not more than 4 1/2 meters 15 feet in length. Bag cage design and construction shall be suitable for the intended service. Bags shall be clamped at top between cage and tube sheet in such a manner that bags will not sway, but can be readily removed without special tools. The manufacturer's standard cage design will be considered, provided that it has a proven record of reliable services with the bag material proposed. The method of attachment of bags and cages to the tube sheet shall provide proper air seal, bag tension, and cage alignment. If venturis are provided, they shall be the manufacturer's standard type for this application. Special care shall be taken to assure there are no rough spots on cages to cause bag abrasion. Provide equipment and materials necessary for bag leak detection. Leak detection system provided shall utilize a fluorescent powder for detection with ultraviolet light. Furnish portable light and sufficient powder for one year of normal inspections. Furnish sufficient bag capping devices for 5 percent of the total installed number of bags. The Contractor shall precoat the bags for initial start-up on oil.

2.8.1.1 Spare Equipment

Ten percent extra bags and two percent extra cages shall be furnished.

2.8.2 Reverse Gas Cleaning System

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NOTE: Factors involved in selecting fabric filter bag materials include:

1. Duration of cleaning.

2. Type of cleaning arrangements.

3. System temperature level.

4. Coal type.

5. Sulfur dioxide removal efficiency.

NEEDLED felts are most commonly specified for pulse-jet units. Precoat bags with fly ash prior to operation. Fabric specifications are dependent upon material.

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NOTE: Specify air pressure available for pneumatic operators or electrical characteristics available for electric operators.

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The baghouse assembly shall be of modular construction. The inner housing casing and tube sheet of each module shall be fabricated from carbon-steel plate of 6 mm 1/4 inch minimum thickness, conforming to ASTM A36/A36M. The inner casing shall be of all-welded construction, gastight and watertight designed for a transient condition (80 percent of yield strength) at internal pressures of at least plus 498 and minus 7470 Pa 20 and minus 30 inches WC. Joints shall be sealed by continuous fillet or continuous complete penetration groove welds as applicable. Tube sheets shall be continuous fillet or complete penetration groove welded gastight so that flue gas must exit through the thimbles. Thimbles shall be fabricated of carbon-steel plate with a minimum thickness of 12 gage and minimum length of one nominal bag diameter and shall be spaced on not less than 241 mm 9 1/2 inch centers for 200 mm 8 inch diameter bags and not less than 356 mm 14 inch centers for 300 mm 12 inch diameter bags. Thimbles shall be inline and not staggered. Tubesheet/baghanger alignment shall be within 3 mm 1/8 inch for plumb and centering hanger adjustment shall be provided to allow maintenance of bag alignment. Internal walkways with kickplates shall be provided to access both upper and lower bag supports. Upper access walkways shall be at least 457 mm 18 inches wide. Lower access walkways shall be at least 610 mm 24 inches wide. If the upper walkways are located between upper support frames, upper walkways shall be one meter 3 feet below the upper support frame and a crawl space at least 1.22 meters 4 feet high shall be provided above the support frames. Each reverse gas fabric filter baghouse shall be provided with a bag cleaning system including two 100 percent capacity reverse gas fans, connecting ductwork, dampers, and automatic controls. Each fan shall be provided with automatic operated inlet louver dampers for control and shutoff. Automatic-operated dampers shall also be provided to isolate the "standby" fan and the modules not being cleaned. The reverse gas-cleaning system shall provide for gradual reinflation of the bags after cleaning. The reverse gas for cleaning shall be taken from the outlet plenum. Reverse gas fans shall be specified in paragraph DUCTWORK AND DRAFT EQUIPMENT. Motor drives shall be as specified in PUMPS, VALVES, MOTORS Louver dampers for reverse gas fans shall be as specified in paragraph DUCTWORK AND DRAFT EQUIPMENT. The collector manufacturer shall furnish valves necessary for each module to cause effective reverse air cleaning of each module. The clean gas outlet valve and the reverse air inlet valve for each module shall be of the [air cylinder] [electric motor] operated, poppet-type arranged for manual lockout capability with position indicating switches at both ends of the travel. The clean gas outlet valves shall be the adjustable slow opening type arranged for manual lockout capability with position indicating switches at both ends of the travel. The clean gas outlet valve shall be arranged to fail-safe in the closed position. The dirty gas inlet valve for each module shall be of the manually operated, poppet-type or butterfly-type suitable for isolating each module for maintenance. The manual operator shall be of a type that is readily accessible. Bags shall be suitable for continuous exposure to the flue gas temperature conditions at the economizer outlet. Bags shall be provided with coatings, as necessary, to minimize abrasion and to resist acid and alkali attack. Bags shall be 300 mm 12 inches in diameter and a maximum of 10 meters 35 feet in length or 200 mm 8 inches in diameter and a maximum of 7.32 meters 24 feet in length. Each bag shall have at least eight for 300 mm 12 inch bags or five for 200 mm 8 inch bags sewn-in rings of welded steel, galvanized or cadmium plated, or welded stainless steel after fabrication. Bags shall attach to the thimbles by means of quick release clamps. Clamps shall not require tools for adjustments or installation. Upper bag suspensions shall provide for ease of adjustment, tensiding, and bag replacement. The suspension shall not use threaded members such as bolts and nuts for adjustment or attachment of bags. Bag caps and other suspension hardware that comes in direct contact with the bag fabric shall be cadmium-plated steel or stainless steel. The method of attaching the bags to the cap and thimble shall provide a leakproof seal. The Contractor shall supply insert materials necessary to precoat the bags for initial start-up on oil.

2.8.2.1 Spare Equipment

Furnish ten percent extra bags and ten percent extra clamps.

2.8.3 Bag Guarantee

Bags and cages, or bags and sliprings, as applicable, shall be guaranteed for 2 calendar years from startup. In case of failure during that period, Contractor shall supply a replacement without cost to Government. Contractor shall provide the number of spare bags, and cages, if applicable, required to replace the bags in baghouse. These bags, and cages if applicable, shall not be used as replacement during startup and testing. If bag, and cage, if applicable, replacement exceeds 10 percent in any compartment during the first 2 years, replacement of all bags, and cages, if applicable, in that compartment shall be provided by the Contractor at no cost to the Government. The replacement bags, and cages, if applicable, shall be guaranteed for an additional 2 years. Bags shall be inspected for creases, folds, abrasions, holes, and tears prior to installation. Any bag with one or more of the preceding imperfections shall be rejected. Cages or rings, as applicable, shall be inspected for corrosions, sharp edges, bends, bad or broken welds, eccentricity, or burrs prior to installation. Any cage or ring with one or more of the preceding imperfections shall be rejected.

2.8.4 Bag Quality Assurance

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NOTE F: Factors involved in selecting fabric filter bag materials include:

1. **Duration of cleaning.**

2. **Type of cleaning arrangements.**

3. **System temperature level.**

4. **Coal type.**

5. **Sulfur dioxide removal efficiency.**

NEEDLED felts are most commonly specified for pulse-jet units. Precoat bags with fly ash prior to operation. Fabric specifications are dependent upon material.

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Bag manufacturer shall furnish following actual test data for each bag material lot used:

Permeability (ASTM D737)
MIT Flex (ASTM D2176)
Tensile Strength (ASTM D1682--Method IR-T)
    Mullen Burst (ASTM D3887)
    Weight (ASTM D3776/D3776M)
    Thickness (ASTM D1777)

Count (ASTM D3775)
Yarn Weight (ASTM D578/D578M)
Fabric Treatment Content

The fabric shall meet the following specifications.

Permeability	[_____]
MIT Flex	[_____]
Tensile Strength	[_____]
Mullen Burst	[_____]
Weight	[_____]
Thickness	[_____]
Weave Thread Count (warp x fill)	[_____]
Yarn Weight	[_____]
Type of Finish	[_____]
Weight of Finish	[_____]
(Percent of fabric weight)	[_____]

Provide material lot analyses prior to manufacture of bags. Prior to processing, the yarn shall be inspected for cleanliness, binder content, broken filaments, denier and tensile strength. Substandard yarns shall be rejected. Sizing applied to yarns shall be removed from the fabric prior to applying the finish. Stitching used in filter bag fabrication shall be made using [_____] thread. Filter bags shall be packaged and protected as necessary to prevent damage during shipping and outdoor storage at the job site. Material not meeting the requirements of this specification shall be rejected and replaced with materials of the specified type and quality at no additional expense to the Government. The Contracting Officer or his representative shall have uninhibited access to areas in which the fabrication of materials governed by the specifications takes place.

2.8.5 Hoppers

Hoppers shall be pyramidal-type fabricated from ASTM A240/A240M, type 317L cold-rolled steel plate having a minimum thickness of 6 mm 1/4 inch. Hoppers shall be properly stiffened, from the outside only, and shall be constructed with a minimum valley angle of 60 degrees from the horizontal. Hoppers shall be of welded construction and shall be welded to the modules to form a gas-tight unit. Welded joints shall be sealed by continuous fillet or continuous complete penetration groove welds as applicable. Hoppers shall span no more than one module. Steel reinforcements not in contact with the gas or ash may be either type 317L stainless steel or ASTM A242/A242M structural steel. If the latter is used, welding rods shall be specifically selected for the service. Provide protection of rods against moisture whether for factory or field assembly. Provide key interlocked access doors on each hopper on both sides of any hopper baffle. Hopper access doors shall be interlocked to fly ash level detectors to prevent access when the nuclear level detectors are operational. Doors shall be in accordance with the requirements specified in paragraph STRUCTURAL AND MISCELLANEOUS STEEL. Each hopper shall be furnished with provisions for attachment of vibrators. Hoppers shall have adequate flexibility for vibrating. Each hopper shall be provided with two 100 mm 4 inch poke holes with a tee wash connection and screw caps. Poke holes shall be positioned to permit downward thrusts into the hopper. A special plate reinforced "pounding area" shall be furnished on each hopper face for external manual vibrating. Each pounding plate shall be 300 by 300 by 25 mm 12 by 12 inches by 1 inch thick plate steel ASTM A36/A36M. A work platform with stairs shall be provided to each pounding area for units with pounding areas more than 1 1/2 meters five feet above ground. Approve location and arrangement of poke holes and pounding areas by the Contracting Officer. Pounding plate shall not be insulated. Insulation shall be neatly finished at this discontinuity. Each hopper shall include a 300 mm 12 inch diameter 57 kg 125 pound flat face flanged outlet connection to match ash conveying system to be provided by the Contractor. Provide access hatch not less than 200 by 200 mm 8 by 8 inch for cleanout within 200 mm 8 inches above the flange. Ash valve shall be a minimum of 150 mm 6 inch diameter. Bolt-down type hatch is acceptable for clean-out hatch. Provide each hopper with two mechanical vibrators, to be located at mid-height on opposite sides. Vibrator controls shall be interfaced with ash collection system to provide vibrator operation only at the inception and during an evacuation cycle. Operation shall be automatic. Manual override control for hopper vibrators and evacuation system shall be provided in hopper area and shall be enclosed in cases to prevent accidental energization of systems. A warning shall be placed over the vibrator manual control with the following inscription: "Warning: Vibrator Control. Do not activate unless hopper evacuation system is operating." Provide nuclear hopper level switches as specified in paragraph INSTRUMENTATION AND CONTROLS. Provide a hopper heater system for each fabric filter baghouse. Each system shall be as specified herein. Hopper heaters for each hopper shall be furnished by the collector manufacturer and shall include material required for mounting. The system shall be designed to provide a 93 degrees C 200 degrees F rise in temperature in the hopper, in the vicinity of the heaters, during offline and startup conditions. The system shall be designed to provide maximum heater coverage between hopper stiffeners. The system shall be designed with a minimum heating safety factor of 1.1 and a minimum wind heat loss factor of 1.12. The system shall include a flexible throat heater for each hopper. Heaters shall be of modular design except for throat heaters. Flexible electric heating blankets or tapes, capable of withstanding 454 degrees C 850 degrees F, shall be used for areas where modular equipment will not fit. Heater modules shall be designed for easy installation. Heater modules shall cover at least 20 percent of the hopper area (covered hopper area not to include exposed areas of poke holes, level detectors, strike plates, stiffeners, access doors, etc.), shall cover the bottom portion of the hopper to the maximum extent possible, and shall extend at least 50 percent up the hopper height. Hopper throats shall be heated with blanket or tape heaters. Equipment furnished shall be designed and tested to withstand natural and induced vibrations including manual rapping of the strike plates. The hopper heater system shall be individually thermostatically controlled with adjustable setpoint between 66 to 121 degrees C 150 to 250 degrees F internal skin temperature, the minimum specified ambient temperature, and shall be furnished and installed complete including power, control, and alarm components. Heater voltage shall be [_____] volts AC. Control voltage shall be 120 volts AC. Modular heaters shall be furnished complete. Heater modules shall be self-contained. The modules shall have a flexible heating face to conform to the irregularities of the hopper surface, providing intimate contact between the heaters and the hopper, and providing maximum heat transfer. Hopper heaters shall be of low watt density design (maximum of three watts per 645 square mm square inch of resistance element) with a minimum of six parallel resistance paths per heater (continuous blanket type elements shall be deemed to meet the multipath requirement). Each heating element in the module shall be capable of being operated at 2152 watts per square meter 200 watts per square foot. Heating elements shall be made of 600 series stainless steel alloy or nichrome encased in a 20 gage minimum aluminum or aluminized steel mounting pan or casing. Cold lead wires and interconnecting wires shall be multistrand copper wire with high temperature (454 degrees C) (850 degrees F) insulation. Cold leads shall be furnished with strain relief constructed in such a manner as to prevent damage to the heater modules due to rough handling. Leads shall be of sufficient length to reach the terminal box. Splices shall not be permitted in leads from modules, tapes, or blankets to the terminal box. Each module, blanket, or tape shall be tested for electrical integrity at 1,000 volts prior to installation. Individual modules shall be designed to fit between the hopper stiffeners and other hopper well obstructions to provide the maximum coverage possible. Heating units supplied shall have metal labels firmly attached to the unit listing the wattage and voltage of the unit. Heating units and mounting hardware shall be constructed of high temperature materials capable of withstanding 454 degrees C 850 degrees F. Heating units shall be insulated with high temperature woven glass cloth or mineral fiber. Mica or magnesium oxide insulated heaters shall not be provided. Cold leads from each heater shall be provided for external circuit connection. The cold leads shall be contained in hot-dip galvanized NEMA Type 4, as defined in NEMA ICS 6, cast iron fitting for connection to field installed solid conduit or waterproof raceway. NEMA 4 as defined in NEMA ICS 6 hopper heater terminal boxes with terminal blocks for connection to heater leads and thermostat leads shall be provided. Terminal blocks in each terminal box shall contain a sufficient number of terminals to connect the heaters for each hopper, one control thermostat, and one low temperature alarm thermostat. The thermostats for monitoring hopper temperature shall be 120 volts AC adjustable type in NEMA 4 enclosures. Each hopper heater terminal box, fed from a panel, shall include one 3-pole fused main switch, magnetic contractor and alarm relay with two normally open contacts, terminal blocks for power, control and alarm circuits, a fused control transformer having a 120-volt secondary, and auxiliary relays for automatic operation of the heater system. The cover shall have the following devices mounted, for each contractor: "HAND," "OFF," "AUTO" selector switch.

a. 120 volt red light--"ON" with integral transformer.

b. 120 volt white light--"LO TEMP" alarm with integral transformer.

c. Device and enclosure nameplates.

The following components shall be provided for each fabric filter baghouse for thermostatic control of the hopper heater system:

a. A master hopper heater control panel.

b. Hopper heater terminal panels at each hopper. The contractor shall furnish materials, tools, and labor required for connections of circuits and wiring between local hopper heater control panels and the master heater control panel.

This panel shall contain relays, contractors (fused switches or circuit breakers), control transformers, and other devices required for complete control of the heater system. Master heater control panel shall be located as indicated. Panel components shall be factory installed and wired in a NEMA 4 enclosure and shall include the following.

a. A main-fused switch or circuit breaker.

b. A fused switch or circuit breaker, contractor alarm relay, with two normally open contacts. A selector switch, "HAND," "OFF," "AUTO," red "ON" light, and white "LOW TEMP" alarm light for each local heater panel. The contractor shall have a 120-volt operating coil.

c. Device and enclosure nameplates.

d. Auxiliary relays and equipment required for operation of the heating and alarm systems.

2.8.6 Manifolds and Draft Equipment

Furnish inlet an outlet manifold ducts as part of each fabric filter baghouse. Manifolds shall be sealed by continuous fillet or complete penetration groove welds to provide gas-tight construction, fabricated from minimum 6 mm 1/4 inch thick ASTM A36/A36M steel plate, and properly stiffened. Manifolds shall have necessary expansion joints conforming to the requirements of the paragraph DUCTWORK AND DRAFT EQUIPMENT and access doors and shall be supported from the fabric filter baghouse structure. Structural design shall be based on assumption the ducts may be 30 percent full of fly ash. Taper inlet manifolds to maintain a uniform gas velocity to all modules. Size manifolds to minimize pressure drop, but also so that velocities shall be between 28 to 30 meters per second 5,500 to 6,000 feet per minute at 100 percent of boiler load capacity to minimize ash drop out of the gas stream. Inlet manifold take-offs to each module shall be located in or near the bottom of the duct to assist in sweeping the dust into the modules. A replaceable, abrasion resistant baffle plate shall be furnished at the inlet to each module to prevent abrasion of the bags. Each module shall be provided with inlet and outlet dampers. Inlet and outlet dampers shall be the manufacturer's standard type. Each fabric filter baghouse shall be provided with bypass dampers to bypass the fabric filter baghouse during start-up and shutdown, during oil firing, and in the event of excessive flue gas moisture conditions due to spray dryer absorber malfunction Bypass dampers shall be as specified in paragraph DUCTWORK AND DRAFT EQUIPMENT.

2.9 LIME SLURRY PREPARATION SYSTEM

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NOTE: Pressures, rates, and duration of sootblowing will depend on site conditions and acceptable operating procedures.

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Provide a single lime slurry preparation system to serve [_____] spray dryer absorbers. Provide the lime slurry preparation system with equipment for receiving, storing, feeding, and slaking pebble quicklime, and for storing and pumping lime slurry of sufficient quantity and quality as required for use in the FGD system. Lime system component equipmentand controls shall be as specified in paragraph LIME SLURRY PREPARATION SYSTEM, and herein. Motors shall be as specified in paragraph PUMPS, VALVES, MOTORS. Provide structural and miscellaneous steel as required for support of equipment, framing of the equipment enclosure, and access to equipment, as specified. Structural design shall be as specified in paragraph STRUCTURAL AND MISCELLANEOUS STEEL. Equipment shall be arranged within the lime system enclosure to allow easy access for operation and maintenance. Arrange equipment on multiple levels as follows: Slurry storage tank and pumps shall be located on the lower level; lime feeders, slakers, and grit screens shall be located on a level above the tanks so that slurry flows by gravity into the tank. Headroom between each level and the structural supports for the level above shall be 3 meters 10 feet minimum. The lime system enclosure shall be located in the area between spray dryer absorbers. The plan area of the enclosure shall be not less than 37 square meters 400 square feet. The length and width of the enclosure shall be selected to be compatible with the Contractor's general arrangement to minimize displacement of the spray dryer absorbers. The length and width of the enclosure shall be selected to be compatible with the Contractor's general arrangement to minimize displacement of the spray dryer absorbers and fabric filter baghouses from the boiler centerlines. To provide for adequate lime system equipment layout the Contractor's structural framing arrangement may provide for connection of the enclosure for the lime system and that for one or both of the hopper enclosures for spray dryer absorbers and fabric filter baghouses from the boiler centerlines. Provide interior access to each lime system equipment level to provide Class one personnel access as specified in the paragraph STRUCTURAL AND MISCELLANEOUS STEEL. The enclosure framing shall allow for the location of an 2440 mm 8 foot wide roll-up door (to be provided by the Contractor) to provide access to the Government's grit disposal bin by forklift truck. Components shall be tested at the factory to verify proper operation of controls, motors, and equipment components. Notify the Contracting Officer, in writing, at least 30 days in advance of the final complete system factory tests, so that he may have a representative observe the tests. Provide information necessary to determine the structural design requirements of the concrete foundation pad. Provide necessary erection drawings and installation instructions. Include submittal information on the categories general arrangement, foundation design, piping, erection, instrumentation, internal arrangement, wiring, valves, and electric motors. The exterior of the lime storage and feed bin shall be cleaned and primed as specified in the paragraph STRUCTURAL AND MISCELLANEOUS STEEL. Other lime slurry preparation system component equipment shall be provided with the manufacturer's standard finish.

2.9.1 Lime Storage and Feed Bin

The lime preparation system shall have an integral storage and feed bin for pebble lime. The bin shall be shop fabricated, all welded construction of carbon steel plate with a minimum thickness of 6 mm 1/4 inch, conforming to ASTM A36/A36M. The bin shall be structurally supported as necessary to provide for enclosed areas for equipment levels directly beneath the bin cone hoppers. The lime preparation system structure shall be designed for wind, snow, seismic and other loads, as specified in paragraph STRUCTURAL AND MISCELLANEOUS STEEL. Structural design shall be based on a bulk density for pebble lime of 1040 kg per cubic meter 65 pounds per cubic foot. Bin diameter shall be 3.70 meters 12 feet. Bin height shall be based on pebble lime bulk density of 880 kg per cubic meter 55 pounds per cubic foot and angle or repose of 55 degrees. Bin shall be cylindrical with twin, 60 degree minimum conical bottom hoppers. Roof shall be sloped 1:12 for drainage. The roof shall have an inlet target box located at the center and provisions for mounting the bin vent filter, pressure relief valve and high-level switch. Provide for access to the interior of the bin from the roof through a hinged manway. Access, handrails, and kickplate for the roof shall be provided as specified in paragraph STRUCTURAL AND MISCELLANEOUS STEEL. A fill pipe shall be provided for transporting pebble lime from self-unloading trucks to the storage and feed bin. The fill pipe shall extend from the truck fill connection point, approximately 1.22 meters 4 feet above grade, to the center fill collar. The fill pipe shall be 100 mm 4 inch O.D. Schedule 40 carbon steel pipe. A 1219 mm 4 inch centerline radius bend shall be used for the direction change at the top of the fill tube riser. The fill tube shall be complete with a quick coupling hose connection with security chain, dust cap and limit switch at the truck connection point and a clean-out cap at the inlet target box. The inlet target box shall be provided with two openings for fill piping connections: One for use with the 100 mm 4 inch fill pipe to be provided under this contract and one for use with the pneumatic conveying system piping to be provided by the Contractor. The opening for use by the pneumatic conveying system piping shall be 150 mm 6 inches in diameter and shall be suitable for attachment of a reducer for compatibility with the conveying line size selected later for use with the pneumatic conveying system. Provide a bin vent filter for mounting on top of the bin, with retained dust discharge directly into storage bin. This unit shall have a venting capacity of at least 472 L/s 1,000 scfm. Filter bags must be readily removable for inspection or replacement without tools. Construction of filter manifold shall prevent filter bags from falling into storage bin. Operation of the filter shall be such that there will be no escape of dust during truck unloading. Filter unit shall be fabricated weatherproof and dripproof construction, with self-contained bag cleaning system and fan assemblies. Weather and dripproof gasketed access doors to bag compartment shall be provided. Parts of unit subject to service or maintenance shall be not more than 1 1/2 meters 5 feet above the bin roof and shall be accessible by a person standing on top of the bin without use of ladders or platforms. The bin filter exhaust fan shall be the squirrel-cage type, operating at less than 3,500 rpm, with mounting on the bin vent filter. This unit shall have air handling capacity of at least 472 L/s 1,000 scfm. It shall provide a negative pressure within the bin during unloading operations. The fan outlet shall be provided with a louvered damper which automatically opens during operation and closes when the bin is not being filled and shall be fitted with a removable bird and insect screen. Electric connections shall be NEMA 3R, rainproof. A disconnect switch in NEMA 3R steel enclosure shall be provided and mounted on the vent filter unit to allow local shutoff of power supply to electrical devices located at the bin roof level. Wiring connections to these units shall be made by the Contractor. Two bin level switches shall be mounted at a high and at a low level on the bin. These switches are to be of the stainless steel, rotating-paddle type, electrically operated. Indicating lights coincident with these switches shall be provided in both the truck unloading panel and the main control panel. Top-mounted units must have extension shafts and guards. Side-mounted units shall be provided with inside shields and all units must be mounted adjacent to ladders or on top of storage bin. The lower bin switch shall be located to represent capacity in terms of complete truck loads of material, based on truck load capacity of 18.82 cubic meter 665 cubic feet per load of quicklime density at approximately 960 kg per cubic meter 60 pounds per cubic foot. One heavy-duty vibrator shall be connected to the outside of each bin cone and provided with suitable controllers and timers to allow pacing from the quicklime feeder. Each vibrator shall be interconnected with the associated feeder, in order that it operates in proportion to feed rate only when the bin gate is open and the feeder operates. Live bottom type bin dischargers may be provided in lieu of the outside vibrators. A manually-operated, dust-tight slide gate shall be mounted at the termination of each bin cone to allow isolation of the equipment below for maintenance.

2.9.2 Lime Slakers

The lime slakers shall be of the detention or paste type. The slakers shall be designed for continuous operation at the required capacity. Slaking temperature and slaking performance shall be automatically maintained, so that at least 90 percent of the calcium hydroxide particles formed are smaller that 2 microns in size, when lime quality is as specified. Slakers shall be capable of slaking all grades of 20 mm 3/4 inch pebble quicklime at a controlled temperature. Automatic controls shall be provided to inject excess water into the slaking chamber should the temperature exceed a preset limit. Slakers shall be provided with an exhaust system to prevent water vapor from rising into the feeder mechanism. The slakers shall be of all welded steel construction and shall be completely dust-tight. Access covers for all compartments shall be provided. Slakers shall be designed for ease of maintenance and shall be capable of shutdown for up to 24 hours without requiring cleanout prior to restart. Provide a hose connection at each slaker level for use by maintenance personnel. Lime feeders shall be of the gravimetric or volumetric type as required for compatibility with the lime slakers. Feeders shall be designed to prevent flooding of the slakers with lime. Feeders shall be capable of handling pebble quicklime, including fines. Feeders shall be dust-tight and shall be provided with dust-tight, stainless-steel inspection doors on the discharge side of the feeders. Flexible connections shall be provided between the bin cone outlets and the feeders. Feeders shall be provided with adjustable rate setters and totalizers. Each lime slaker shall be provided with a positive means of removing grit from the lime slurry prior to discharging the slurry to the tank. The grit removal system shall include classifiers or screens or both as required to remove any grit which could produce operational problems in the slurry pumps, piping, valves, or atomizers. The grit removal system shall include a means of rinsing the grit with water to minimize lime carryover to the grit disposal bin. The degritted slurry shall flow by gravity to the slurry tank. The grit shall be conveyed to a disposal bin (bin provided by the Government) located on the lower level within the lime system enclosure at a point accessible to a forklift truck. The Contractor shall provide conveyors and chutes as necessary to discharge grit to the disposal from a point not more than 1.83 meters 6 feet above the lower level floor. A slurry storage tank shall be located beneath the slakers in the lime system enclosure. The tank shall be constructed of 6 mm 1/4 inch carbon steel. The slurry tank shall be designed with a minimum storage capacity of one hour at the maximum slurry use rate. The tank shall be covered to minimize contact of the slurry with air. The tank shall be provided with heavy-duty, top-mounted turbine agitators of a quantity and design as necessary to keep the slurry particles in uniform suspension without vortex formation. Tank shall have internal baffles to promote agitation. Agitators shall be interlocked with pump controls so that pumps cannot start unless at least one agitator is on. The tank shall be provided with level monitors required for proper system operation. Level switches shall be electrode probe type. Bubbler-type level switches are not acceptable. The tank shall be provided with all necessary inlet, outlet, and overflow connections. The bottom of the tank shall be pitched for drainage and provided with a cleanout easily accessible by maintenance personnel. The Contractor shall provide additional slurry tanks as required for his specific system design. Tanks furnished under this contract shall be shop fabricated, all-welded construction of carbon steel with a minimum shall thickness of 6 mm 1/4 inch. Structural design requirements of paragraph STRUCTURAL AND MISCELLANEOUS STEEL, including seismic design, are applicable to tanks furnished.

2.10 PUMPS, VALVES, MOTORS

Centrifugal pumps shall be used for applications for which unique flow and head requirements necessitate the use of positive displacement pumps. The general requirements specified in this paragraph shall be applicable to pumps furnished except as specifically noted. Positive displacement pumps furnished for use with lime slurry shall have a history of reliable operation for that application at pilot plant or commercial installations. Positive displacement slurry pumps for which shaft seals are necessary shall be provided with mechanical seals which do not require the use of seal water which could infiltrate into the slurry. Provide piping, valves, and fittings required to connect the spray dryer absorbers, lime slurry preparation system, fabric filter baghouses, pumps, and tanks complete with hangers and connection for instruments, vents, flushing, and drains as required. Provide properly sized bypasses for equipment and control valves. Instrumentation and controls shall be as specified in paragraph INSTRUMENTATION AND CONTROLS. Piping materials and fabrication shall conform to ASME B31.1 (Power Piping Code). Furnish alternating current high efficiency electric motors required to drive the equipment furnished under this Contract. Provide each pump assembly with the manufacturer's standard finish. Protect exposed machine surfaces with a rust-preventative compound. Cover flanged openings with plywood covers held by a minimum of four bolts. Plug or cap screwed connections with standard fittings.

2.10.1 Pumps

Furnish the pumps required or specified complete with motor drives, accessories, and field service. Provide 100 percent installed spare capacity for pumps. Provide water pumps for slaking water and cooling water supply as shown on the process flow diagram. These locate pumps at the water storage tanks to be provided by the Contractor. For purposes of the proposal, these tanks shall be assumed to be located at grade at a distance of 18.30 meters 60 feet from the piping interface point indicated. Contractor shall provide piping from these tanks to the points of application within his system. Each pump assembly shall include pump, driving motor, baseplate, drive coupling or multiple V-belt drive, and coupling guard, as applicable. Include dowelling of pumps to baseplate. Each pump shall be of a design and construction for service intended. Overhead motor mounting structure shall have provision for drive belt tension adjustment. Structure shall be such that motor and mounting are supported independently of the pump bearing assembly. Provide structure to allow for removal of pump bearing assembly without disturbing the motor. Structure shall be of fabricated steel, and shall provide support for V-belt drive guard. Drive couplings and matched multiple V-belt drive (MVD) sets shall be rated at not less than 140 percent of the motor power. Guard for matched MVD sets shall have solid metal cover on pump side and expanded metal mesh on outboard end. Flexible drive coupling guards shall comply with applicable safety requirements. Flexible coupling guards shall be arranged for ease in disassembly or removal for access to couplings. Coupling guards shall be rigidly fastened to baseplate. Prevent any external thrust from being transmitted to the motor shaft under any operating conditions. Provide double-screw adjustment bases on nonadjustable horizontal arrangements. Suction and discharge connections shall be standard Class 150 ANSI flat-faced flanges, rubber lined, if pump is rubber lined. Furnish drawings and data as specified in paragraph SUBMITTALS. Include in submittals information for the general arrangement and outline, instrumentation, piping connection, electric motors sound pressure ratings, description of flushing system for slurry pumps, and performance curves.

2.10.1.1 Centrifugal Pumps

Pump speed shall be such that the upper limits of specific speed, as defined by the applicable figure of the HI M100 are not exceeded at any pump operating condition. Total dynamic head of pumps shall be maximum at zero flow and continuously decreasing from zero flow to design flow. Head capacity characteristics shall permit stable operation when pump is operating alone or in parallel with other pumps of the same designation. Pump shut-off head shall be more than 110 percent of design point head and less than 150 percent of design point head. Pump shaft critical speeds shall not occur from 10 percent of design point head. Pump shaft critical speeds shall not occur from 10 percent to 120 percent of design rpm. Pump shaft shall be free from excessive vibration at discharge rates from 10 percent to 120 percent of design delivery. Impeller shall not be maximum or minimum size for pump casing furnished to allow for possible future modification of head capacity furnished to allow for possible future modification of head capacity characteristic by changing impeller size. The maximum allowable sound pressure level shall be 84 dB for each pump-motor unit. Slurry pumps shall be vertically split-case, rubber-lined single-stage pumps designed for indoor service. Water pumps shall be vertically split-case single-stage pumps designed for outdoor service. Slurry pumps shall be provided with shaft seals which do not require water flushing. Provide water pumps with mechanical shaft seals which do not require an external source of seal water. Pumps shall be provided with flexible inlet and outlet connections.

2.10.1.2 Vertically Split-Case Rubber-Lined Pumps

Vertically split-case rubber-lined pumps shall be end suction, single-stage, single-suction centrifugal, of the volute type. Pump trim shall be stainless steel suitable for the service and designed for continuous operation at specified operating conditions. Pumps shall be frame mounted with pump shaft carried on its own bearings with multiple V-belt drive between pump and motor. Pumps shall have bottom horizontal discharge. Pump casing shall be split vertically into suction inlet assembly and pump assembly designed for ease of disassembly. Casing shall have replaceable secured rubber liner, minimum 10 mm 3/8 inchthick designed for long life under operating conditions specified. Pump impeller shall be enclosed type, of soft natural rubber on steel skeleton. Pump shaft shall be provided with ceramic faced shaft sleeves designed to prevent water leakage between shaft and sleeve. Sleeve shall be adequately anchored to the shaft to prevent any rotation of the sleeve relative to the shaft. Shaft shall be keyed on the driven end for easy removal of the coupling half. Shaft shall be completely encased along its entire length within the wetted area by the impeller and shaft sleeves. Provide adequate fillets for changes in diameter. Pump bearings shall consist of two bearing assemblies, ball or tapered type roller type, mounted in an oil-filled or grease-lubricated housing. Provide adequate seals to prevent leakage of lubricant to outside and dust entry to inside of housing. Bearings shall have 60,000-hour minimum B-10 life under design conditions in accordance with ABMA 9 and ABMA 11. Design to limit maximum shaft deflection to 0.05 mm 0.002 inch. Provide with lubrication system consisting of a constant-level oiler with level indicator or easily accessible grease nipples as appropriate to the bearing design. Provide mechanical or centrifugal shaft seals conforming to paragraph CENTRIFUGAL PUMPS. Furnish one spare set of shaft seals for each pump. Support frames for all vertically split pumps shall be fabricated of structural steel and heavy plate extending the full length of pump and driver. Design to adequately support equipment under operating conditions without grout fill inside the frame. Frame shall not be covered with a thin steel plate which requires grouting under the plate, but the frame may be filled with concrete as required for drainage. Grout shall be required under the basic frame only. Contractor to provide minimum 25 mm one inch pipe drain in the perimeter of the frame. Drawings shall indicate the required concrete fill lines for proper drainage. The pump shall be dowelled shall be dowelled to the frame in the shop; the driver shall be dowelled in the field. Furnish bolts or screws for attaching pumps and motor drives to the support frame. Frames shall have grouting holes, 100 mm 4 inch minimum size, to facilitate proper grouting, if area is covered. Materials of construction shall be as specified below.

Part Name	Material
Casing	Cast iron or steel, ASTM A48/A48M with replaceable rubber liners
Impeller	Soft rubber on steel skeleton
Shaft	Heat-treated carbon, or stainless steel, ASTM A276/A276M, Type 410
Shaft Sleeve	Ceramic faced
Baseplate Steel	ASTM A36/A36M

2.10.1.3 Vertically Split-Case Pumps

Vertically split case pumps shall be end suction, single-stage, single-suction centrifugal, of the volute type. Pumps shall be bronze trimmed, and designed for continuous operation at specified operating conditions. Pumps shall be frame-mounted with pump shaft carried on its own bearings with flexible coupling between pump and motor. Pump orientation to fit piping arrangement. Pump casing shall be split into suction inlet assembly and pump assembly. Design for ease of disassembly, allowing the rotating assembly and bearing housing to be removed without disconnecting pipe or moving the motor. Provide renewable casing rings locked against rotation, with one ring mounted in suction inlet assembly and the other ring mounted in pump assembly. Provide with casing vent and drain connections. Pump casing shall be back pull out design. Pump impeller shall be enclosed type, fully machines throughout. Axial balance shall be obtained by balancing ports and rear sealing rings. Casing and impeller wear rings shall be of different hardness designed for long wearing qualities. Pump shaft shall be provided with shaft sleeve designed to prevent water leakage between shaft and sleeve. Sleeve shall be anchored to the shaft to prevent any rotation of the sleeve relative to the shaft. Shaft shall be keyed on the driven end for easy removal of the coupling half. Shaft shall be completely encased along its entire length within the wetted area by the impeller and shaft sleeves. Provide adequate fillets for changes in diameter. Design to limit the maximum shaft deflection at the stuffing box to 0.05 mm 0.002 inch. Pump bearings shall consist of two bearing assemblies, tapered-roller type, mounted in an oil-filled housing. Provide adequate seals to prevent leakage of oil to outside and dust entry to the inside. Bearings shall have 60,000 hour minimum B10 life under design head conditions. Bearing loading for thrust determination shall be at the most adverse operating condition of the pump. Provide with oil lubrication system including oil level indicator. Seals shall be single, mechanical type of the inside, balanced design. Seal face materials shall be selected to provide long life in the service intended. Factory-installed seal water piping shall be provided from pump discharge to inlet connection on seal housing as required to cool and lubricate the seal faces. Seal water loop shall include a valve or orifice to control flow. Provide a spare seal for each pump. Support frames for vertically split pumps shall be fabricated of structural steel and heavy plate extending the length of pump and driver, rigid enough to maintain alignment of machinery, and designed to adequately support equipment under all operating conditions without grout fill inside of the frame. Frame shall not be covered with a thin steel plate which requires grouting under the plate, but the frame may be filled with concrete as required for drainage. Grout shall be required under the basic frame only. Contractor to provide one inch minimum drain in the perimeter of the frame. Drawings shall indicate the required concrete fill lines for drainage. The pump shall be dowelled to the frame in the shop, the driver will be dowelled in the field by others. Furnish bolts or screws for attaching pumps and motor drives to the support frame. Frames shall have grouting holes, 100 mm 4 inch minimum size, to facilitate proper grouting. Materials of construction shall be as specified.

Part Name	Material
Casing	Cast iron or steel, ASTM A48/A48M with replaceable rubber liners
Impeller	Bronze, ASTM B584
Shaft	Heat-treated carbon, or stainless steel, ASTM A276/A276M, Type 410
Shaft Sleeve	11-13 percent chrome steel, 450 minimum Brinell hardness, ASTM A743/A743M
Casing rings	Bronze, ASTM B103/B103M
Impeller rings	Bronze, ASTM B103/B103M
Baseplate Steel	ASTM A36/A36M

2.10.1.4 Vertical Wet Pit Pumps

Vertical wet pit pumps shall be end suction, single-stage, single-suction centrifugal of the volute type. Pump trim shall be 316L stainless steel designed for continuous operation at specified operating conditions. Pumps shall be frame mounted with pump shaft carried on its own bearings with multiple V-belt drive between pump and motor. Provide suitable connections on the frame for lifting and lowering of the pump. Pump casing, pipe shaft column, discharge piping, and submerged materials, shall be rubber-coated a minimum of 6 mm 1/4 inch thick. Pump casing shall be split perpendicular to shaft. Provide renewable impeller wear rings locked against rotation. Casing shall have replaceable rubber liner, minimum 10 mm 3/8 inch thick designed for long life under operating conditions specified. Casing shall be rubber covered. Pump impeller shall be enclosed type of soft natural rubber on steel skeleton. Pump shaft shall be provided with hardened (minimum 450 BHN) stainless-steel shaft sleeves designed to prevent water leakage between shaft and sleeve. Sleeve shall be adequately anchored to the shaft to prevent any rotation of the sleeve relative to the shaft.

Shaft shall be keyed on the driven end for easy removal of the coupling half. Shaft shall be completely encased along its entire length by the impeller and shaft sleeves. Shaft shall have fillets for changes in diameter. Shaft shall be designed to carry torsional and axial thrust loads. Shaft shall be one-piece construction. Shaft support column shall be rubber covered. Upper bearing assembly shall be ball or tapered-roller type, mounted in an oil-filled or grease-filled housing. Include adequate seals to prevent leakage of lubricant to outside and dust entry to the inside. Bearings shall have 60,000-hour minimum B10 life under design head conditions. Provide with adequate lubrication system. Provide with dust and oiltight seals. Pump shall have no submerged bearings. Provide shaft seals as specified in paragraph VERTICALLY SPLIT-CASE RUBBER-LINED PUMPS. Pump baseplate shall be of fabricated steel, of adequate size and thickness to prevent excessive vibration and deflection. Provide holes for mounting of the pump and necessary piping as required. Baseplate shall be rubber-coated on the bottom side. Provide with shims, bolts, and other devices required for proper alignment and anchorage. Anchor bolts required in foundation will be furnished by the Contractor. Materials of construction shall be as specified below.

Part Name	Material
Casing	Cast iron or steel, ASTM A48/A48M rubber covered with replaceable rubber liner
Impeller	Soft rubber on steel skeleton
Shaft	Heat-treated carbon, or stainless steel, ASTM A276/A276M, Type 410
Shaft Sleeve	Stainless Steel, 450 minimum Brinell hardness, or ceramic
Baseplate Steel	ASTM A36/A36M

2.10.1.5 Factory Test and Reports

Pumps shall be tested for static and dynamic balance of rotating assemblies, for normal functioning in conformance with the "Standards of the Hydraulic Institute," and for performance at design conditions. The pump casing shall be hydrostatically tested at 150 percent of shutoff head. After completion of shop tests, install new gaskets and tighten all bolts so that pumps are ready for operation and so that no field disassembly, cleaning, or flushing is required. Notify the Contracting Officer at least 30 days in advance of tests so that a representative can be present.

2.10.2 Valves and Piping

Piping, valves, and pumps in slurry service shall include provisions for automatic and manual flushing, complete drainage and cleanout. Pipe drains shall drain back into a tank. Control and isolating valves and controls required for flushing operations shall be furnished. Furnish parallel piping systems to allow for flushing of one pipeline system with continued operation of the FGD system using the other. A description of provisions for flushing the piping systems shall be included as part of the system description. Slurry piping shall utilize flanged joints and long-radius (600 mm 24 inch minimum) bends. Piping shall be designed for the maximum operating and start-up pressure and temperature requirements of the service. Vent and bypass lines or other lines in intermittent service shall be sized for the available pressure drop. Bypass (recirculation) lines with control valves sized for the available pressure drop shall be provided on systems with varying demands as required to protect the pump. Piping for emergency service only shall be sized as required by the applicable code or based upon the available pressure drop. Piping systems shall be arranged to prevent plugging and settling out in lines and valves. Pipe hangers shall be corrosion-resistant as specified herein. Forces placed on equipment by piping shall not exceed the manufacturer's allowable levels. Piping materials and systems shall be compatible with the fluids handled. Fluid systems shall be designed so that circulation is has a low sound level and there is no water hammer and so that vibration from equipment is not transmitted through the piping systems. The fluid systems shall be designed and constructed to produce less than 85 dBA sound level, free field, at one meter 3 feet distance from any part of the system in accordance with ASA S12.54. Velocities maintained in slurry systems shall be not less than 1.22 meters 4 feet per second nor more than 3.35 meters 11 feet per second under all conditions in line including low and high flow. Piping systems shall have high-point vents and low-point drains. Valves shall be located no higher than 1 1/2 meters 5 feet above maintenance platforms and a minimum of 2.13 m 7 foot headroom shall be maintained over walkways. Provide expansion devices and appurtenances to allow for expansion of the piping system. Piping shall be arranged and routed to be readily accessible for maintenance. Field connections shall be located to allow access for disconnection as required for maintenance. On-off control valves shall be provided in the suction and discharge piping of pumps.

2.10.2.1 Valves

Air and water valves shall be as follows: Valves 50 mm 2 inchesand smaller shall be Class 200 bronze gate, globe or angle valves conforming to ASTM B61, valves larger than 50 mm 2 inchesshall be Class 125 cast-iron gate, globe, or angle valves conforming to ASTM A126. Slurry valves shall be Class 150 polyfluorotetraethylene (PTFE) sleeve plug valves, rubber-lined diaphragm valves with a minimum rating of Class 150, Class 150 semisteel rubber-lined eccentric plug valves, Class 150 knife gate valves or rubber sleeve pinch valves. Pinch valves or rubber-lined diaphragm valves shall be used to modulate slurry flow. The pinch valve elastomers shall be neoprene reinforced with polyester. Elastomer sleeve diameter-to-length ratio shall be 1.3 minimum. Pinch valve closure mechanism shall close the valve from opposite sides of the sleeve simultaneously, with complete valve closure at the centerline of the pipe, and shall be provided with positive opening feature. Valves shall be provided with lever or handwheel operators with adjustable position stop. As used in this specification, the term "control valve" refers to an assembly, consisting of a valve body and an actuator, which is used for on-off or modulating opening and closing of the valve, regulating fluid flow, or pressure in response to signal(s) from a control system. Control valve bodies shall be as specified. Provide control valves as required to enable the FGD system to be operated from the steam plant control room. Control valves shall have indicators showing position of valve. Control valves shall have manual override to ensure immediate local control. Manual override shall override coil without damage to coil. Control valves shall be provided with isolating valves as necessary to allow for maintenance. Actuators shall be spring-and-cylinder double-acting cylinder or spring-and-diaphragm type actuators and shall have long-stroke design or special linkages, adapters as required for rotary-type valves. Actuators shall be sized as required for stable operation under maximum pressure drop conditions with 414 kPa (gage) 60 psig maximum air supply pressure available to actuator. Stable operation is defined as the ability of the actuator to position and hold the valve plug, elastomer sleeve or diaphragm accurately without pulsation, vibration, or sticking. Actuators shall be provided with stem travel indicator on yoke. Solenoid valves shall conform to the requirements as specified in paragraph SOLENOID VALVES. Provide with each open-closed control valve a limit switch assembly consisting of two DPDT switches, one to actuate in the open position and one to actuate in the closed position. Provide each modulating control valve with a position transmitter. Limit switches shall conform to the requirements of paragraph LIMIT SWITCHES. Limit switches shall be furnished factory mounted to their respective control valves. Control valves shall be furnished with manual overrides on solenoid valves for local manual operation of the control valve.

2.10.2.2 Piping

Pipe furnished shall conform to the ASTM material specification specified and meet the dimension standards set forth in ASME B36.10M. Piping furnished shall be provided with the manufacturer's standard exterior surface preparation and coating as necessary to prevent rusting during shipping and storage. Random length pipe shipped to the jobsite shall be identified continuously along its length indicating schedule number and material. If this identification is in the form of a color code or colored stripe, copies of the color code shall be submitted for approval. Each piece of pipe shall be identifiable as to grade and schedule after erection. Water pipe shall be carbon steel, conforming to ASTM A53/A53M, Grade A or B. Pipe sizes 50 mm 2 inches and smaller shall be Schedule 80. Pipe sizes larger than 50 mm 2 inches shall be standard weight. Lime slurry piping shall be Schedule 80 carbon steel, ASTM A53/A53M, Revision B. Rubber hose or rubber-lined pipe may be used for lime slurry where approved by the Contracting Officer. Rubber hose and rubber-lined pipe shall be provided complete with flanges. Except for tubing as specified, air pipe shall be carbon steel, conforming to ASTM A53/A53M, Grade A or B. Pipe 50 mm 2 inches and smaller shall be Schedule 80. Pipe larger than 50 mm 2 inches shall be standard weight. Instrumentation and air tubing shall be seamless, fully annealed and suitable for bending. Steel tubing shall be 316 stainless steel conforming to ASTM A269/A269M, Grade TP 316. Copper tubing shall conform to ASTM B75/B75M. Minimum wall thickness of tubing shall be as follows:

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NOTE: Wall thickness selection depends on fluid, media, and pressure.

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Material	Diameter (mm)	Wall Thickness (mm)	Fluid
Steel	6	0.889	
	10	1.245	
	15	1.651	
	16	2.108	

Material	Diameter (mm)	Wall Thickness (mm)	Fluid
Copper	6	0.711	
	10	0.889	
	15	1.245	

Material	Diameter (inch)	Wall Thickness (inch)	Fluid
Steel	1/4	0.035	
	3/8	0.049	
	1/2	0.065	
	5/8	0.083	
Copper	1/4	0.028	
	3/8	0.035	
	1/2	0.049	

2.10.2.3 Fittings

Screwed fittings shall be Class 300 malleable iron conforming to ASME B16.3. Fittings shall be galvanized when used with galvanized pipe. Flanges shall conform to ASME B16.5. Steel pipe flanges shall be forged steel. Flanged fittings shall be cast steel. Steel flanges and fittings shall be of the same material and schedule as the pipe to which they connect. Flanges shall be provided with carbon steel bolts and nuts conforming to ASTM A307, Grade B. Bolts and nuts shall have hexagonal heads. Gaskets shall be heavy-duty Buna-N 1.59 mm 1/16 inch thick, full-faced, punched for bolts and pipe opening as required. Fittings shall conform to ASME B16.9 except that cast fittings are not acceptable. Butt-welded fittings shall be of the same material and schedule as the pipe to which they connect. Fittings shall be clean and free of all oxides, slag, and other impurities or foreign matter. Backing rings shall be split-ring type with knock-off spacer nubs.

2.10.2.4 Pipe Hangers

Pipe hanger assemblies, anchors and sway braces shall be designed by the hanger manufacturer and the Contractor in accordance with ASME B31.1, MSS SP-58, and as follows: (a) Make weight and moment balance calculations to determine the required supporting force on each hanger and the reaction on equipment, (b) design supports so that the spacing does not exceed that given in Table 121.1.4, ASME B31.1 Power Piping Code, except in the center spans of straight runs where the spacing may be increased 20 percent, (c) design the first rigid hanger in a system so that the restraining action of the hanger produces a bending stress no greater than 1/4th of the allowable stress listed in Appendix A of the Power Piping Code, (d) design supports at concentrated load so as to prevent excessive bending moments in system, (e) design in accordance with Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS, (f) design supports and hanger such that the resultant reactions imposed on the equipment connections due to the weight of the piping system does not exceed a resultant force of plus or minus 45.4 kg 100 lbs or a resultant moment of plus or minus 671 meters per kg 1,000 feet per pound, and (f) provide spring supports in accordance with the following:

Maximum Vertical Movement	MSS SP-58 Type
6.35 mm	51SS, 52SS, 53SS
12.70 mm	51S, 52S, 53S
25.40 mm	51LS, 52LS, 53LS
Over 25.40 mm	54, 55, 56

Maximum Vertical Movement	MSS SP-58 Type
1/4 inch	51SS, 52SS, 53SS
1/2 inch	51S, 52S, 53S
1 inch	51LS, 52LS, 53LS
Over 1 inch	54, 55, 56

Hanger assemblies shall use the following materials in construction:

a. Hanger rods shall be hot-rolled carbon steel cut to length and threaded in the factory. (Continuous threaded rods are not acceptable).

b. Pipe clamps shall be carbon steel.

c. Clevises, turnbuckles, and eye nuts shall be forged steel.

d. Eye rods shall be welded type.

e. Protection saddles shall be carbon steel.

f. Hanger rod components located outdoors shall be galvanized with the exception of lugs and clips welded directly to pipes or structural members.

Pipe hanger assemblies, anchors, and sway braces shall utilize only acceptable type of components as outline in MSS SP-58. Upper supports shall utilize types 22, 28, 29, and 33. Intermediate supports shall utilize types 13, 14, 16, 17, 51, 52, 53, 54, 55, and 56. Lower supports shall utilize types 2, 3, 4, 8, 24, 33, 35, 36, 37, 38, 39A, 39B, 40, 41, 44, 45, 46, 47, and steel plate lugs shop welded to the pipe.

2.10.2.5 Shipping and Handling

Materials for piping systems shall be prepared and marked for shipment and storage as specified. Each piece of piping fabrication shall be identified with a piece mark number which is repeated on each end of section and on each branch. Ship gaskets to the jobsite tagged with size, material, and pressure rating. Loose parts such as nuts, bolts, and gaskets shall be packaged for outdoor storage. Protect flanges with plywood or tempered hard fiberboard covers sealed and bolted to the flange with not less than four bolts. Protect threaded connections with thread protectors. Protect small connections with plastic inserts pressed into the connection and sealed with waterproof tape. Ship hangers to the jobsite with each hanger assembly individually bundled and tagged with the hanger assembly number. Coat-threaded connections with a suitable rust-preventative compound. Ship valves to the jobsite tagged with the appropriate valve number corresponding to the valve list. Ship valves with suitable covers to prevent entrance of foreign material into valve body. Protect valve threads, stems, and handwheels from damage.

2.10.3 Electric Motor Drives and Motor Control Center

Alternating current electric motors required to drive the equipment shall be continuous-duty type suitable for a steam plant environment where moderately abrasive conductive dusts and high humidity are present. Motors shall be self-ventilated. Motors shall be designed for full-voltage starting. Indoor motors shall be suitable for continuous operation at an ambient temperature of 50 degrees C 122 degrees F. Outdoor motors shall be suitable for continuous operation at any ambient temperature from minus 10 degrees C to plus 40 degrees C 14 degrees F to 104 degrees F. Motors shall have squirrel-cage rotors. The nameplate power rating of each motor at 1.0 service factor shall equal or exceed the power required to drive the connected equipment under the design conditions specified and within normal operating ranges. For each motor furnished, the nameplate power rating multiplied by the service factor shall equal or exceed the power required to drive the connected equipment under any operating condition. Motors shall be of high efficiency type.

2.10.3.1 Motors Rated 3/8 kW 1/2 Horsepower and Smaller

Motors shall be rated at 115 volts, single-phase, 60 hertz, and have a service factor of 1.0. The torque characteristics of each motor at voltages from 90 to 110 percent rated voltage shall be as required to accelerate the motor and driven equipment to full speed without damage to the motor or the driven equipment. Insulation shall be Class B or Class F, with Class B temperature rise in accordance with NEMA MG 1. Enclosures shall be fabricated of steel. Horizontal motors shall be mounted on a common baseplate with the driven equipment. Manual reset thermal overload protection shall be furnished integral to each motor. Enclosures shall be totally enclosed nonventilated.

2.10.3.2 Motors Rated 1/2 Through 149 kW 3/4 Through 199 H.P.

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NOTE: The efficiency of each motor shall not be less than that indicated in the following table:

Efficiency						
Nameplate	**3600 rpm**		**1800 rpm**		**1200 rpm**	
Kilowatt	**Nominal**	**Minimum**	**Nominal**	**Minimum**	**Nominal**	**Minimum**
0.746	**81.5**	**78.5**	**84.0**	**81.5**	**78.5**	**75.5**

Efficiency						
Nameplate	3600 rpm		1800 rpm		1200 rpm	
1.21	81.5	78.5	84.0	81.5	84.0	81.5
1.49	84.0	81.5	84.0	81.5	86.5	84.0
2.24	86.5	84.0	88.5	86.5	88.5	86.5
3.73	88.5	86.5	90.2	88.5	88.5	86.5
5.60	88.5	86.5	90.2	88.5	88.5	86.5
7.46	88.5	86.5	90.2	88.5	90.2	88.5
11.19	90.2	88.5	91.7	90.2	90.2	88.5
14.92	91.7	90.2	91.7	90.2	91.7	90.2
18.65	91.7	90.2	93.0	91.7	91.7	90.2
22.38	91.7	90.2	93.0	91.7	91.7	90.2
29.84	91.7	90.2	93.0	91.7	93.0	91.7
37.30	91.7	90.2	94.1	93.0	93.0	91.7
44.76	93.0	91.7	94.1	93.0	93.0	91.7
55.95	94.1	93.0	94.1	93.0	94.1	93.0
74.60	94.1	93.0	95.0	94.1	94.1	93.0
93.25	94.1	93.0	95.0	94.1	94.1	93.0
111.90	94.1	93.0	95.0	94.1	95.0	94.1

Efficiency						
Nameplate	3600 rpm		1800 rpm		1200 rpm	
Horsepower	Nominal	Minimum	Nominal	Minimum	Nominal	Minimum
1	81.5	78.5	84.0	81.5	78.5	75.5
1.5	81.5	78.5	84.0	81.5	84.0	81.5
2	84.0	81.5	84.0	81.5	86.5	84.0
3	86.5	84.0	88.5	86.5	88.5	86.5
5	88.5	86.5	90.2	88.5	88.5	86.5

Efficiency						
Nameplate	**3600 rpm**		**1800 rpm**		**1200 rpm**	
7.5	**88.5**	**86.5**	**90.2**	**88.5**	**88.5**	**86.5**
10	**88.5**	**86.5**	**90.2**	**88.5**	**90.2**	**88.5**
15	**90.2**	**88.5**	**91.7**	**90.2**	**90.2**	**88.5**
20	**91.7**	**90.2**	**91.7**	**90.2**	**91.7**	**90.2**
25	**91.7**	**90.2**	**93.0**	**91.7**	**91.7**	**90.2**
30	**91.7**	**90.2**	**93.0**	**91.7**	**91.7**	**90.2**
40	**91.7**	**90.2**	**93.0**	**91.7**	**93.0**	**91.7**
50	**91.7**	**90.2**	**94.1**	**93.0**	**93.0**	**91.7**
60	**93.0**	**91.7**	**94.1**	**93.0**	**93.0**	**91.7**
75	**94.1**	**93.0**	**94.1**	**93.0**	**94.1**	**93.0**
100	**94.1**	**93.0**	**95.0**	**94.1**	**94.1**	**93.0**
125	**94.1**	**93.0**	**95.0**	**94.1**	**94.1**	**93.0**
150	**94.1**	**93.0**	**95.0**	**94.1**	**95.0**	**94.1**

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Motors shall be rated at 460 volts, 3 phase, 60 hertz, and have service factor of 1.15 for open dripproof enclosures, and a service factor of 1.0 for all other enclosure types. Enclosures shall be fabricated of cast iron or aluminum. Enclosures for indoor service other than in the lime slurry preparation area shall be open dripproof, fully guarded. Enclosures for the lime slurry preparation area, and for outdoor service shall be totally enclosed nonventilated or totally enclosed fan cooled. Bearings shall be antifriction type, and shall have an ABMA-L10 rating life of not less than 80,000 hours at rated speed, and under the thrust loadings encountered within normal operating ranges. The thrust loading corresponding to an ABMA-L10 rating life of 5,000 hours at rated speed shall not be exceeded under any operating condition of the motor or the driven equipment. Bearings shall be insulated when required to prevent bearing or shaft damage due to stray shaft currents. Each horizontal motor shall be mounted on a common baseplate with the driven equipment, or shall be furnished with separate sole plates and subsole plates to permit removal of the motor without disturbing the alignment of the driven equipment. Furnish space heaters for motors rated 19 kW 25 horsepower and above. Space heaters shall be rated 120 volts, single-phase, 60 hertz. The torque characteristics of each motor at voltages from 90 to 110 percent rated voltage shall be as required to accelerate the motor and driven equipment to full speed without damage to the motor or the driven equipment. Insulation shall be Class B or Class F, with Class B temperature rise in accordance with NEMA MG 1. The motor "A" weighted sound level shall not exceed 84 dBA when measured to conform to IEEE 85 at a reference distance of one meter. Motors shall be of special high-efficiency and high-power factor design including the following design features: Low-loss lamination steel, increased stator and rotor length, increased winding cross section, high-efficiency cooling fan design, and optimized slot configuration and air gap. Information submitted with the compliance submittals shall include minimum guaranteed efficiency based on tests performed in accordance with IEEE 112, Method B, with accuracy improvement by segregated loss determination including stray load loss measurement. Information submitted shall include percent efficiency and percent power factor at full load, 3/4 load, and 1/2 load. Provide motor bearing thermocouples and motor winding resistance temperature detectors (RTDs) for motors 15 kW 20 horsepower and larger. Thermocouples and RTD's shall be as specified in paragraph TEMPERATURE MONITOR.

2.10.3.3 Motors Rated 150 Kilowatt 200 Horsepower and Larger

Motors shall be rated 4,000 volts, 3-phase, 60 hertz, have a service factor of 1.0 and conform to NEMA C50.41. The torque characteristics of each motor at voltages from 85 to 110 percent rated voltage shall be as required to accelerate the motor and driven equipment to full speed without damage to the motor or the driven equipment. Insulation shall be Class B or Class F, with Class B temperature rise in accordance with NEMA C50.41. Insulation systems shall be mica based. Each motor shall be furnished with not less than two resistance temperature detectors per phase, embedded in the stator windings. Detectors shall be rated 10 ohms at 25 degrees C as specified in paragraph TEMPERATURE MONITOR. The acceleration times for each motor at voltages within the starting voltage specified, when connected to the driven equipment, shall not exceed the allowable locked-rotor times at those voltages. In addition to the starting capabilities specified in NEMA C50.41, following one start with the motor initially at a temperature equal to the rated-load operating temperature, each motor shall be capable of making additional starts with a cooling period at standstill between starts not greater than 45 minutes. Enclosures shall be fabricated of cast iron or steel, and shall be furnished with corrosion-resistant hardware. Enclosures shall be weather-protected NEMA Type II. Horizontal motors shall be furnished with sleeve type bearings. Bearings, bearing brackets, and end shields shall be split type when available for the frame size and enclosure furnished. For motors, furnish oil rings; oil reservoirs; sight glasses located to be readily observable, and marked with the proper oil level when running and at standstill; and drain and fill piping to a location where each bearing and reservoir can be flushed, drained, and refilled. At least one bearing shall be insulated when required to prevent bearing or shaft damage due to stray shaft currents. Each horizontal motor shall be mounted on a common baseplate with the driven equipment, or shall be furnished with separate sole plates and subsole plates to permit removal of the motor without disturbing the alignment of the driven equipment. Thermostatically controlled heaters shall be furnished in each bearing oil reservoir of outdoor motors. Heaters rated 1,200 watts and less shall be rated 120 volts, single phase; heaters rated above 1,200 watts shall be rated 240 volts, single phase. One thermocouple type temperature detector shall be furnished for each sliding type bearing as specified in paragraph SLIDE BEARINGS. A vibration transducer mounting pad shall be furnished on the output shaft bearing housing of each motor connected to equipment specified with a bearing vibration system. Space heaters shall be furnished on each motor. Space heaters rated 1,200 watts and less shall be rated 120 volts, single phase; space heaters rated above 1,200 watts shall be rated 240 volts, single phase. Each motor power lead terminal box shall be Type II as defined in NEMA C50.41. Each box shall be sized to enclose connections to synthetic-insulated shielded power cables including preformed stress cones. Removable molded insulating boots shall be furnished for factory and field connections in each box. Accessory leads including temperature detector leads, space heater leads, and current transformer secondary leads shall be wired to the accessory terminal box. The motor "A" weighted sound level shall not exceed 84 dBA when measured to conform to IEEE 85 at a reference distance of one meter.

2.10.3.4 Motor Control Centers

Contractor shall furnish motor control centers with starters and controls for 3 phase motors rated less than 150 kW 200 hp. Separate motor control centers shall be provided for each of the spray dry absorber-fabric filter baghouse units and the lime slurry preparation system. The lime system motor control center shall be located within the system enclosure. Motor control centers shall be totally enclosed dead-front type suitable for use on 480-volt, 3-phase, 4-wire, 60-hertz system. Motor control centers shall conform to NEMA ICS 6 and UL 845. Motor control centers shall consist of individual vertical self-supporting sections, nominally 508 mm wide, 508 mm deep, 2286 mm high 20 inches wide, 20 inches deep, and 90 inches high, bolted together on floor sills. Sections shall be divided into compartments for control equipment and arranged for future additions at the ends. Structures shall be rigid and sufficiently braced to prevent movement of control centers when inserting or withdrawing removable units. Compartment doors shall be hinged full length and equipped with quick captive screws and neoprene gasket on each compartment door. Guide rails shall be provided for alignment of plug-in units. Plug-in units and doors shall be accurately constructed and aligned to prevent binding. Control centers shall be arranged for front mounting of equipment and control units shall be plug-in type with wiring accessible from the front. Plug-in units shall be draw-out or tilt-out type with provisions for padlocking in the disconnected position. Disconnecting stabs shall be pressure type of silverplated high-strength copper alloy. Control center disconnecting devices shall be provided with external operating handles arranged for padlocking in the "off" position and the compartment doors shall be interlocked to permit opening only when the disconnect device is in the "off" position. Control center enclosure shall be NEMA 1 and wiring shall be NEMA Class II, Type B. Control center main horizontal buses shall be rated as required for the connected loads, but not less than 600 amperes, and vertical buses for each section shall be rated as required for connected load, but not less than 300 amperes, both at a continuous rating at 50 degrees C 122 degrees F rise. Buses shall withstand stresses of short-circuit currents of 42,000 amperes rms. A ground bus shall be provided at the bottom for the full length of the motor control centers. Furnish each vertical section with continuously energized space heaters as required to prevent condensation during construction. Space heaters shall be applied at one-half rated voltage. Space heaters in a shipping section shall be wired together and connected to a terminal block that is accessible before the motor control center is uncrated. Control center motor starters shall be circuit-breaker combination type and shall be rated at 460 volts, 3-phase, and shall be the NEMA size classifications required for motors furnished. Motor starter shall be magnetic, across-the-line, single speed, two speed or reversing as required. Each starter shall be provided with a control transformer rated 480/120 volts having a volt-ampere capacity to suit the control load including control devices, but not less than 100 VA. A fuse shall be provided in the 120-volt control circuit for each starter. Control connections shall be as required. Each starter shall be equipped with three thermal overload relays. Short-circuit rating of combination starter shall be 42,000 amperes rms symmetrical. Starters shall be wired to the terminal block for a remote auxiliary contact to be provided by the Contractor. The auxiliary contact will be wired in series with the stop push button, selector switch or control device to open the control circuit to the starter contractor when the auxiliary contact is opened. Each motor control center shall be equipped with two NEMA Size 1, two NEMA Size 2, and one NEMA Size C complete, spare, full-voltage, nonreversing motor starters. Control center circuit breakers shall be rated 600 volts ac, manually operated, trip free from the handle, and with a molded case. Breakers shall be 3 pole unless otherwise specified. Breakers used in combination motor starters shall be adjustable instantaneous only, coordinated to provide short-circuit protection for both the motor circuit and the thermal overload relays in the magnetic starter. Breakers shall contain inverse-time thermal overload protection and instantaneous magnetic short-circuit protection. Combination motor starter circuit breakers shall have a symmetrical interrupting capacity at 480 volts not less than the motor control center short-circuit ratings. If current-limiting fuses are used to achieve the specified short-circuit rating, a positive acting anti-single-phase trip mechanism must be furnished. Each motor control center shall be equipped with two 100 A, 3-pole, and one 225A, 3-pole, spare feeder circuit breakers. Include external handle which clearly indicates when breaker is "on," "off," or "tripped." Handle shall be lockable in the "off" position. Control centers shall be ambient compensated to 50 degrees C 122 degrees F. Control centers that utilize frame sizes 225 ampere and larger shall be furnished with interchangeable trip units. Circuit breakers shall conform to NEMA AB 1 and shall meet the appropriate classification of FS W-C-375.

2.10.3.5 Factory Tests

<TESTPerform factory tests on each motor rated 460 volts and below in conformance with NEMA MG 1, and IEEE 112 or IEEE 114. Tests shall include:

a. No-load current and speed tests at normal voltage and frequency,

b. high potential test, and

c. standard factory tests.

Perform factory tests on each motor rated above 460 volts in accordance with NEMA C50.41 and IEEE 112. Tests shall include:

a. Measurement of winding resistance,

b. no-load test with readings of current, power, and nominal speed at rated voltage and frequency,

c. mechanical vibration test,

d. direction of rotation versus phase sequence test,

e. insulation resistance test, and

f. high-potential test.

2.11 DUCTWORK AND DRAFT EQUIPMENT

Provide self cleaning ductwork for the Flue Gas Cleaning System from the economizer outlet to the stack inlet as indicated, including fabric filter baghouse reverse gas ducts, if required, complete with necessary expansion joints, transitions, structural slide bearings, dampers, turning vanes, and support steel. Provide 100 mm 4 inch pipe coupling test ports upstream and downstream of each spray dryer absorber and upstream of each guillotine system isolation damper. Test ports in horizontal ductwork shall be located in the side of the ductwork and test ports shall be of sufficient length to extend 102 mm 4 inches beyond the insulation and lagging to be provided by the Contractor. Test ports shall be Schedule 40 316 stainless steel, pipe conforming to ASTM A167 with screw plugs. Coat each plug with antiseize lubricant suitable for service at the design temperature extremes. Exact locations and number and arrangement of ports at each location shall be determined by the Contractor following the model test. Except for the ductwork between the spray dryer absorber and the fabric filter baghouse, duct runs in which the Contractor intends to locate test ports shall be arranged to conform to at least the minimum requirements of U.S. EPA Regulation 40 CFR 60, Method 1, relative to the spacing between test port locations and flow disturbances in the upstream and downstream directions. Final location and arrangement is subject to approval of the Contracting Officer. Structural design temperature range for ductwork shall be [_____] to [_____] degrees C degrees F. Long ductwork sections shall contain hoppers, clean-out doors, and structural support due to dust drop out. Ductwork and support steel shall be designed such that no loads will be applied to the ductwork provided by the Contractor at the interface points. The expansion joints, bolts, nuts, backing bars and gasketing at interface connections shall be by the Contractor. Carbon steel ductwork, support steel, access ways and access doors shall be designed as specified and as noted on the drawings. External and internal walls and partitions of the ductwork shall be of fully sealed by continuous fillet or continuous complete penetration groove welds, as applicable. Provide control instruments and required penetrations as specified in paragraph INSTRUMENTATION AND CONTROLS. Expansion joints shall be provided at interface points of ductwork included in this contract and as required to ensure that no stresses in ductwork and supports are transmitted to equipment to be provided by the Contractor. Contracting Officer will supply exact location, sizing and bolt hole patterns for connections at the economizer outlet ductwork and chimney inlet. Furnish and deliver dampers as indicated and as required for operation of FGD system including, but not limited to, fabric filter baghouse module inlet and outlet dampers, fabric filter baghouse bypass isolation dampers, induced draft fan inlet control dampers, and guillotine system isolation system dampers. Furnish damper units complete with operators and accessories and field service, as specified. Dampers and louvers shall conform to AMCA 500-D, AMCA 801, and AMCA 802. Provide mechanical draft equipment required for proper operation of the flue gas cleaning systems and boilers including, but not limited to, induced draft fans. Fans shall be complete with accessories and auxiliaries specified. Provide fan inlet dampers as specified in paragraph DAMPERS. Ductwork submittals shall include general arrangement and outline information, foundation design information, structural fabrication information, internal arrangement and erection information, insulation and instrumentation information, and design calculations for stiffener requirements for internal pressure ratings. Drawings shall show details of ductwork connections, and layout and details as required for access platforms, ladders, and handrails, details of each expansion joint, details of slide bearing plates, and the expansion joint locations, the movements to be absorbed in each joint, construction details and flange-to-flange dimensions.

2.11.1 Ductwork

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NOTE: Dimension interface of ductwork and the chimney to reduce pressure drop. Use maximum dimensions.

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Ductwork shall be constructed with a minimum thickness of 6 mm 1/4 inch. Ductwork shall be designed for a transient condition (80 percent of yield strength) at internal pressure of at least plus 4980 and minus 7470 Pa 20 and minus 30 inches WC except as specified otherwise. Joints and seams shall be welded gas-tight by continuous fillet or continuous complete penetration groove welds. Provide with access doors, as specified, to provide access to each run of duct including both sides of dampers and gas distribution devices. Ductwork shall be designed to withstand a fallout particulate weight of 976 kg/square meter 200 lbs/square feet. Provide 10 mm 3/8 inch thick-turning vanes for turns 45 degrees and greater and where indicated by the model study. Properly brace and support with pipes and angles. Bracing with rods is not permitted. Turning vanes are not required in fabric filter baghouse manifold inlet and outlet transitions to and from modules. Gas velocity of the main flue gas stream shall be as specified in paragraph DUCTWORK. Provide gasket material bolts and nuts for flanged connections. Gaskets shall be of ethylene propylene terpolymer (EPDM) material. Provide flanges and expansion joints at ends of scope to match equipment to be provided by the Contractor. Bolt hole tolerance in flanges to be connected at interface points and to dampers shall be 3/4 mm 1/32 inch between adjacent holes and 1 1/2 mm 1/16 inch between any two holes on a side in the flange pattern after fabrications of the complete ductwork section. After fabrication of the ductwork section, measurement shall be made between holes across diagonals and bracing shall be installed to maintain flange bolt tolerance. Provide connections for temperature and pressure measurements as specified and as required of the control of the FGD system. Instrument connections shall be 50 mm 2 inch Schedule 40 pipe with screw caps and shall extend 150 mm 6 inches beyond the insulation and lagging on the ductwork. Instrument connections shall be provided with rod-out caps or plugs. Maximum plan width inside dimension of the breeching at interface with the chimney shall be [_____].

2.11.1.1 Reverse Air Ductwork

Reverse air ductwork shall be constructed of sheet steel and all seams and connections shall be airtight. Means shall be provided to maintain the temperature in the reverse air ductwork above the dewpoint by circulation of clean flue gas.

2.11.2 Expansion Joints

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NOTE: Dry and Wet Bulb Temperature and Duration:

Parameter	**Season**	**Temperature (Degrees C)**	**Frequency of Occurrence of Higher Temperatures**
Dry Bulb	**Dec-Feb**	**[_____]**	**[_____]**
Dry Bulb and Mean Coincident Wet Bulb	**Jun-Sep**	**[_____]**	**[_____]**

Parameter	Season	Temperature (Degrees C)	Frequency of Occurrence of Higher Temperatures
Wet Bulb	Jun-Sep	[_____]	[_____]

Parameter	Season	Temperature (Degrees F)	Frequency of Occurrence of Higher Temperatures
Dry Bulb	Dec-Feb	[_____]	[_____]
Dry Bulb and Mean Coincident Wet Bulb	Jun-Sep	[_____]	[_____]
Wet Bulb	Jun-Sep	[_____]	[_____]

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Expansion joints shall be nonmetallic belt-type joints. Expansion joints shall be suitable for maximum expected or specified working pressures and for operation at design gas-flow velocities. Expansion joints shall include baffles able to withstand a fallout ash weight of 976 kg/sq m 200 lbs/sq ft and remain completely workable. Expansion joints shall be designed for temperature from [_____] to [_____] degrees C degrees F. Provide access to four sides of expansion joints, both interior and exterior to the ductwork. Each expansion joint shall include: minimum 80 by 80 by 6 mm 3 by 3 by 1/4 inch carbon steel angle flanges drilled for mounting to ductwork for joints where belt does not have molded flanges, a carbon steel backing bar, and internal baffle around full circumference of expansion joint; minimum of 3 mm 1/8 inch thick to prevent fly ash erosion and buildup in web of joint and not restrict the movement of the joint, and nuts and bolts required to attach the fabric to the flanges and the expansion joints to the ductwork. Bolt holes on maximum of 100 mm 4 inch centers. Belt materials shall be minimum 6 mm 1/4 inch thick, two-ply, aramid-or fiberglass-reinforced, solid fluoroelastomer polymer specially compounded for the intended service. Material shall be factory spliced to form endless belt without sewn joints. Bolt holes shall be factory punched.

2.11.3 Dampers

Dampers shall be designed for a Zone [_____] seismic risk area and a wind loading and additional loads as specified. The dampers shall be designed to be operated without manual assistance under temperatures and pressures specified and with normal accumulations of flue products. Dampers shall have provision for periodic lubrication with appropriate grease, if not permanently lubricated and sealed. Dampers shall be supplied with limit switches which shall give positive indication of the damper position (open/close). Dampers except guillotine dampers shall have pneumatic operators. Guillotine dampers shall be provided with the manufacturer's standard motor operators as required for the service intended. Dampers shall fail in failsafe position upon loss of power or air. Fabric filter baghouse bypass dampers shall be a double tight seal damper to provide for essentially zero leakage at maximum fabric filter baghouse design differential pressure. Bypass dampers shall be provided with an air reservoir of sufficient capacity as to activate damper upon loss of plant air. Inlet and outlet dampers shall be a minimum of 99 percent gas tight. Fabric filter baghouse module inlet and outlet damper operators shall be located outside of the gas stream and shall be accessible for maintenance with the unit in operation. Induced draft fan inlet control dampers shall be louver dampers in accordance with induced draft fan manufacturer's recommendations. Guillotine isolation dampers at stack inlet breeching shall be provided with control interlocks to prevent dampers from closing when the associated induced draft fan is operating. Provide positive means of preventing accidental closure of guillotine dampers. These dampers will be used to isolate the equipment upstream for maintenance. They shall be equipped with an external, locally-mounted audible alarm to signal loss of seal air for personnel safety. Each damper frame shall be of a rigid structural design to eliminate distortion or warpage which may interfere with the damper operation. Frames shall be flanged for bolting to connecting ductwork. Frames shall be designed to support a fly ash load of 1464 kg/sq m 300 lbs/sq ft on the bottom of the frame. Design frames to support a 908 kg 2,000 pound concentrated load due to uneven fly ash distribution, at a point that causes maximum deflection of the frame. Frames shall be designed to support the seal air fan system, related controls, motors, and drive mechanisms, and the entire damper unit with only one flange bolted to the ductwork. Include lifting lugs to ensure proper handling of the damper during transportation and erection. Frames on louver dampers shall be of a length greater by one inch than the width of the louver blades. Control drive units shall be as specified and shall provide a direct position readout at the damper by means of a mechanical position indicator showing percent of damper opening on flow control dampers. Control drives other than poppet damper actuators shall be equipped with a permanently mounted handwheel that is disengaged under conditions of pneumatic or motor operation.

2.11.3.1 Seal Air Systems

Each guillotine damper shall be provided with a seal air system. Each seal air system shall include two full-capacity seal air fans, one operating and one standby. Each fan shall be capable of supplying two times the guaranteed cfm leakage rate through the dampers at design conditions. Fans shall be as specified. Each fan shall be capable of maintaining a pressure between the seal chamber and the gas stream of at least 747 Pa 3 inches W.C. at the design conditions. Provide zero leakage isolation valves at the discharge of each fan. Valves shall be mild steel gate or butterfly valves. Provide check valves at the discharge of each fan to prevent backflow through the idle fan. Check valves shall have a replaceable soft fluoroelastomer seat, and shall be designed to prevent "flutter" when in the open position. Provide a manual control damper or valve in the seal air duct to permit seal chamber pressure to be controlled. Control damper or valve shall be mild steel, and shall have an easily visible position indicator. Provide an automatic isolation valve in the seal air duct to permit seal chamber pressure to be controlled. Control damper or valve shall be mild steel, and shall have an easily visible position indicator. Provide an automatic isolation valve at the connection of the seal air duct to the seal air chamber. Valve shall be gate or butterfly type constructed of nickel-chromium alloy containing a minimum of 55 percent nickel, 20 percent chromium and 8 percent molybdenum and shall be suitable for corrosive environments. Provide pneumatic piston operator on the valve to operate on 552 to 862 kPa (gage) 80 to 125 psig instrument air. Tube and mount a four-way dual-coil solenoid valve, with Class H coils rated for 120-VAC service. Provide two dual-pole-dual-throw limit switches, one to actuate in the open position, one to actuate in the closed position. Limit switch housing shall meet NEMA 4 requirements. Piston actuator shall remain in last position if air supply fails. Provide three 50 mm 2 inch pipe nipples with caps and rod-out on the seal chamber of the damper, preferably on top of the damper, for attachment of seal chamber pressure instrumentation. Provide necessary instrumentation to monitor operation of seal air system and initiate alarm as specified for maintenance personnel protection. Provide 50 mm 2 inch port with rod-out on seal chamber and 50 mm 2 inch port with rod-out on ductwork to test seal air pressure differential. Port on ductwork shall extend 150 mm 6 inchesbeyond stiffeners to clear insulation and lagging. Provide caps or plugs. Seal air systems, where possible, shall be mounted on the damper frame. Installation shall be such that the system is easily accessible and instrumentation can be easily observed. Install such that there is complete access to linkages, drive units, bearings, and stuffing boxes. Isolation valve and blower shall be mounted such that condensation occurring between the damper and the isolation valve flows into the ductwork. If installation on the damper frame is not possible, a platform shall be provided to support the equipment.

2.11.3.2 Louver Dampers

Damper blade/shaft assembly shall be designed not only for the maximum allowed stress, but to limit the deflection under the maximum conditions at which the damper is to seal to L/14.4 or 6 mm L/360 or 1/4 inch, (whichever is less)(L = blade length in mm inches). Blade shall be of a rigid structural design, capable of handling thermal stresses and warping due to differential temperatures and pressures, without affecting damper operation. Stub shafts shall be pinned or bolted to the through shaft or blade in such a manner that individual damper blades can be easily removed. Pins or bolting materials shall be of carbon steel, with a design such that the connections are self-locking. Shafts shall be sized to deliver the full operator torque to any one blade, without exceeding one-third of the shaft yield stress when operating at the worst-case design conditions. Provide dust-tight stuffing boxes sealed with fluoroplastic packing material to seal the shaft openings. Stuffing boxes shall be designed such that the packing can be adjusted or removed from the outside of the duct, without removing or disturbing the bearings or the linkage. Adjusting nuts, washers, and bolts shall be 316 stainless steel conforming to UNS S31600 (.03 to .08C) and shall incorporate a self-locking design, such that vibrations in the damper unit will not cause backing out of the bolts. Bearings shall be permanently lubricated, self-aligning type. Bearings shall be mounted outboard of the damper unit and any insulation and lagging, in such a manner that leaking packing will not cause the bearing to become contaminated with fly ash. Each bearing and bearing mount shall be designed to withstand three times the stress transmitted from the load on the blades plus the operator output torque. Linkage system shall be located outside of the damper unit. Linkage system shall be fully adjustable to compensate for thermal expansion of the frame. Parts with threaded connections for adjustment shall be carbon steel. Provide lock nuts on the adjustable linkage to positively hold the linkage after adjustment. Design shall be such that each individual blade can be adjusted. Clevis arms shall be pinned or bolted to the stub shaft. Arms shall be keyed to the shaft for easy removal. Clevis arm shall be carbon steel and linkage pins or bolts shall be 304 stainless steel conforming to UNS S30400 (.03 to .08C). Pins or bolts shall incorporate a self-locking design, such that operation or vibration of the unit will not cause loosening of the connections. Linkage system, including connections, shall be designed to withstand three times the stress transmitted from the load on the blades plus the operator output torque. Linkage system shall have provisions for locking with a heavy-duty padlock in such a manner that the damper cannot be operated until the padlock is removed. Sealing strips shall conform to ASTM B443. Strips shall be bolted into place with bolts and nuts fabricated of the same alloy as the strips. Connection shall be self-locking to prevent loosening of the connection. Seal strips shall be of a suitable length to enable easy replacement in the event of damage or failure. Sealing strips are not required for induced draft fan dampers. Louver dampers shall be either parallel or opposed blade. Blades shall be air-foil type, of rigid structural design. Blade skin and through shaft shall be compatible material for expansion and contraction. Blade shall be connected to through shaft with self-locking bolts or pins. Louver dampers except the induced draft fan inlet control dampers and dampers in vertical ducts shall be designed for staged closing. Operation of the blade shall be such that blades close, except the bottom blade. When the upper blades have closed, then the bottom blade will close. Provide two operators on the linkage system, one to operate the top blades, and one to operate the bottom blade. Design of the linkage shall be such that the number of blades operated by each operator may be changed with relative ease. To prevent ash buildup at bottom of hopper, install purge air system.

2.11.3.3 Poppet Dampers

Poppet dampers shall be vertically operating, with pneumatic operators, adjustable speed and stroke, shaft packing glands, replaceable seal plates, and machined steel seating cylinder and guide shaft. The dampers shall be equipped so they can be mechanically locked in a closed position to protect service personnel. Poppet damper shafts shall be out of the dirty gas stream wherever possible. Shafts exposed to the flue gases shall be provided with shaft seals. Poppet dampers shall be a minimum of 99.5 percent gas tight.

2.11.3.4 Guillotine Dampers

Guillotine dampers shall be bottom-entering dampers in paragraph DAMPERS. Guillotine dampers shall have bonnets over the top frame if required to prevent flue gas leakage to the atmosphere. Bonnet assembly shall be of carbon steel and shall have easily removable side plates for inspection of the damper drive assembly. Bonnet shall be designed for continuous-seal air purge. Guillotine dampers shall have a removable plate for access to the bottom frame seal. Damper blade shall be fabricated of plate, and shall be as rigid as necessary to withstand the maximum differential pressures specified. Provide blade with sealing strips around the periphery of the blade and on the seating surfaces of the frame. Local seals on both the upstream and downstream sides of the blade. Sealing strips, seal strip bolting materials and backing strips shall be as specified for louver dampers. Blade shall be designed to include provisions for thermal expansion such that the blade will not bind. Bearings shall be permanently lubricated, self-aligning type. Design shall be such that thermal gradients and long periods of time between damper operation will not cause bearings to bind or seize. Damper drive shall be designed to lift the damper blade evenly on both sides. Each drive, tie rod, and bearing, shall be designed to withstand three times the load caused by the damper blade plus the operator output torque, at worst-case pressure and flow conditions. Upper frame shall be designed to support the blade, drive mechanisms, and attachments. Frame shall not sway and cause binding of the blade when operating at worst-case flow and pressure conditions. Pressures and flows provided to the damper manufacturers shall be approved by the Contracting Officer in advance. Damper shall include a mechanical crank for manual operation.

2.11.4 Mechanical Draft Equipment

Mechanical draft equipment and appurtenances shall have an acceptable history of satisfactory reliable service in industrial steam plant use for a period of a least three years at comparable temperature, pressure, voltage, and design stress levels. Newly developed equipment with less than three years actual service may be considered from established manufacturers, only if it has been adequately tested, at an approved lab meeting AMCA standards, meets the requirements of this Contract, and is approved by the Contracting Officer. Prior to shipment, the manufacturer shall thoroughly inspect parts of the equipment furnished to ensure sound material and first class workmanship. Rivets shall be tight and welds shall be full thickness and without undercutting. Keys shall fit snugly and rotors shall be secured firmly to the shafts. Welding on rotors for fans shall be examined by magnetic particle inspection. Magnetic particle inspection shall be performed on the root pass and the finished surfaces of all welds. On full-penetration welds, the backside of the root base shall be examined by magnetic particle inspection before depositing weld from the backside. Welds shall be free from undercutting in excess of 0.40 mm 1/64 inch in depth and free of cracks and fissures in excess of 6 mm 1/4 inch in length. Inspection of the fans for compliance may be made by the Contracting Officer. Notify the Contracting Officer, in writing, at least 45 days prior to start of assembly and welding of fan rotors so that he may have a representative present to inspect fan rotors during fabrication, if desired. This inspection of the fan rotors will include an examination of the weld grooves preparations on the material being joined in the assembly of the fan wheels, witnessing the actual welding being performed on the fan wheels, a visitation to the manufacturer's nondestructive testing facility, witnessing the nondestructive testing being performed on welds and base material of the fan wheel, and verifying that subassemblies are fabricated properly and in accordance with the manufacturer's drawings and specifications. Fans shall be designed and constructed to ensure reliability with a minimum number of scheduled outages for repairs and maintenance. Fans shall be suitable for continuous operation at full or part load. The fans and their ducts, flow-regulating devices and dampers shall be coordinated to give an installation which will be capable of operation without excessive vibration, fan noise, or air or gas vibrations. This satisfactory performance shall be maintained throughout the entire load range of the fans including operation at minimum flow settings with cold air. Fans over 19 kW 25 hp shall be two-bearing design with rotor suspended between bearings with no overhung wheels.

2.11.4.1 Fan Housing

Provide split housing so the rotor is accessible and removable for normal maintenance without disconnecting the housing from the inlet or outlet ducts or foundation and without moving the motor. Shape the housing for maximum streamline flow from inlet to outlet. Construct from mild steel plate. Brace with structural steel welded to the housing and designed for sufficient strength to prevent warping and excessive vibration under operating conditions. Provide with gas-tight inspection doors. Provide with inlet and outlet connections of structural angle flanges for welding to similar flanges on the ductwork with bolts provided and used for alignment only, or for connections to similar flanges on the ductwork by means of gaskets and bolts. Bolts shall be spaced not more than 65 mm 2 1/2 inches apart. Provide with a 50 mm 2 inch drain pipe connection welded to the lowest point of the fan scroll. Provide nipple and cap. Housing will be supported from a concrete base. Housing shall be designed so a minimum distance of 600 mm 24 inches will exist between the bottom of the housing and the foundation to permit application of insulation and access to the housing drain connection. Shop paint fan housings in accordance with the specifications for painting of the ductwork to which they connect.

2.11.4.2 Fan Rotors and Shafts

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NOTE: Rotors shall be balanced statically and dynamically so that vibration displacement at the bearings measured on the shaft at full load and full speed with a clean rotor will not exceed the following.

Maximum Vibration	
Rotor Speed, rpm	**Displacement, mm**
Up to 600	**0.051**
600 to 900	**0.038**
Above 900	**0.025**

Maximum Vibration	
Rotor Speed, rpm	**Displacement, inches**
Up to 600	**0.0020**
600 to 900	**0.0015**
Above 900	**0.0010**

Weight adjustment for balancing shall be by either the addition or the removal of metal.

****

Fan rotors shall be designed and constructed to keep stresses from rotation or temperature differential at a safe and conservative level. Fan rotors shall be designed so the maximum calculated stress at any point on the rotor, under any normal condition such as continuous operation or starting acceleration, will not exceed 50 percent of the yield strength of the rotor material at the maximum operating temperature. Fan rotors shall have center plates and shroud plates of mild or alloy steel. Tie rods between plates or blades will not be permitted. Construct so that while the rotor is turning, the run-out of similar points on the rotor structure will not deviate from the median path by more than 0.375 percent of the wheel diameter. Rotors shall be designed and constructed so that the first critical speed of the rotor is not less than 33 percent above the normal operating speed for fans operating at temperatures up to 93 degrees C 200 degrees F and not less than 50 percent above the normal operating speed for fans operating at temperatures of 93 degrees C 200 degrees F and above. Fan shafts shall be forged and heat-treated steel, accurately machined, with ground and polished journal and thrust bearing surfaces. Shafts shall be provided with seals to minimize leakage where the shaft penetrates the housing.

2.11.4.3 Bearings

Bearings shall be suitable for continuous heavy-duty service and shall be self-aligning, sleeve-type journal bearings designed with adequate lubrication for coast down without an external oil supply. Install bearings in a horizontal split housing or pedestal of structural steel or cast iron. Pedestals shall allow removal of bearings without removing rotor and shall be suitable for shimming. Bearings shall be located external to the inlet boxes. Bearings on double-inlet fans shall be designed to withstand the thrust unbalance resulting from the shutoff of one inlet while the other inlet is open. Protect bearings from the weather on outdoor installations with a suitable rain hood and sun shield as recommended by the manufacturer. Each bearing shall have bearing temperature thermocouple as specified in paragraph INSTRUMENTATION AND CONTROLS. Bearing lubrication systems shall be specifically designed for air cooling except as noted below. Provide cooling air by inlet box suction. Inlet air filters shall be provided. Where the bearing surface rubbing speed exceeds 7.62 m/s 18,000 inches/minute bearings designed for water cooling shall be furnished. Each bearing shall be equipped with at least two machined oiling rings and an adequately sized integral lube oil reservoir with oil level gage. Reservoirs shall be equipped with immersion heaters designed to continuously maintain the lube oil in the bearing at starting temperature over the range of ambient temperature specified in paragraph DESIGN PARAMETERS. Immersion heaters shall be 120-volt AC single-phase and shall be complete with a thermostat located to accurately control lube oil temperature. Furnish bearing pedestals, mounting plates, and soleplates as required to mount the equipment on the concrete foundation. Contractor shall furnish the torque requirements of the foundation bolts for fans.

2.11.4.4 Motor Drive

Each fan shall be furnished with a single-speed motor drive. Each fan shall be equipped with a flexible coupling between the fan and motor drive. Coupling shall be rated at not less than 150 percent of the motor power at design fan speed. Design coupling to prevent any axial thrust from being transmitted to the driver under any normal operating condition.

2.11.4.5 Induced Draft Fan

Performance of the induced draft fan shall be as specified in paragraph DESIGN PARAMETERS. Induced draft fans shall be double inlet, double width. Provide one induced draft fan for each steam generator and its associated gas cleaning equipment as indicated. Each induced draft fan shall be equipped with dampers as specified in paragraph MECHANICAL DRAFT EQUIPMENT. Provide inlet control dampers for regulating the fan output. Inlet dampers shall be arranged for operation from one control drive at each fan. Control drive shall be as specified in paragraph ANALOG CONTROL SYSTEM. Provide control signal from combustion controls. Induced draft fans shall have housing constructed of 10 mm 3/8 inch minimum thick mild steel. Housing shall be provided with wear-resistant liners of not less than 12.70 mm 1/2 inchthickness at all points of wear. Liners shall be easily replaceable. Interior bolt heads shall be protected from fly ash erosion. Fabricate housing of 19 mm 3/4 inch minimum thick, mild steel plate instead of separate liner plates, if desired. Induced draft fan rotors shall have radial blades with replaceable wearing surfaces over at least two-thirds of the blade width, at least equal to the thickness of the skin of the blade.

2.11.4.6   Reverse Air Fan

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NOTE: Insert appropriate Section number in the blanks below.
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The reverse air fans shall be heavy duty industrial type fans having single flanged inlets and outlets. Type of bearings and bearing lubrication shall be suitable for the temperatures encountered. Provide heat slingers. A quick-release gasketed inspection door shall be furnished on the housing. Fans shall be V-belt driven by a constant speed motor through adjustable speed sheaves. Mount motor on slide motor bases designed to adjust belt tension from a screw mechanism; furnish suitable belt guards. The fan shall be rated for flow, pressure, power, speed of rotation, and efficiency in accordance with AMCA 210 and the fan shall comply with AMCA 201 and the fan shall comply with AMCA 99. Motors shall be as specified in Section [_____] ELECTRICAL, for the service intended. Minimum reversing air flow shall be with 10 L/s per square meter 2 acfm per square foot of net cloth area under cleaning action.

2.11.5   Painting

Surfaces of ductwork and metal parts of expansion joints which will be exposed after installation of insulation and lagging shall be painted as specified in paragraph DUCTWORK AND DRAFT EQUIPMENT. Areas that will not be exposed shall be painted as specified, except that a dry film thickness of 0.051 mm 2 mils shall be applied. Apply primer to steel surfaces, except the areas within 50 mm 2 inches adjacent to field welds. Surfaces that will be exposed to the flue gas flow need not be painted, but shall be protected during shipment and storage with a suitable rust-preventative coating. Damper frames, support steel and seal air ductwork not directly in the gas stream shall be shop-cleaned and painted as specified in paragraph STRUCTURAL AND MISCELLANEOUS STEEL. Damper operators, seal air valve operators, motors, seal air fans and limit switches shall be primed and painted per the equipment manufacturer's standard practice. Protect exposed machined surfaces with a suitable rust-preventative compound.

2.11.6   Factory Tests

Perform manufacturer's standard factory tests on mechanical draft equipment and material. Perform tests required by the applicable codes and these specifications. Notify the Contracting Officer in writing at least 45 days prior to factory tests so that he may have a representative witness the tests.

2.11.6.1   Damper Tests

Perform factory tests on dampers, except poppet dampers. Each damper which is provided with an integral frame shall be operated five times to test for smooth and trouble-free operation, at both ambient and design pressures. Each damper will then be checked to assure that no damage has been sustained to the frame, blades, or seals. Each damper which is provided with an integral frame shall be tested in an airtight chamber at design temperature and pressure to determine the amount of gas leakage across the damper and through the frame. Provide instruments to determine the amount of leakage and the static pressure against the damper. Each damper equipped with a seal system shall be tested for air leakage across the damper with the seal air system operating at design temperature and at the design differential pressure across the damper. Each seal air unit shall be tested to assure that design flow, temperature and pressures are being met. These tests shall be run independently from the damper tests, and prior to the damper tests.

2.11.6.2 Mechanical Draft Equipment Tests

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NOTE: Overspeed test is as follows. If the operating temperature of the fan is less than 93 degrees C 200 degrees F, the wheel shall be Spun at 10 percent above the maximum operating speed for a period of not less than three minutes. If the operating temperature of the fan is 93 degrees C 200 degrees F or more, the wheel shall be spun for a period of not less than three minutes at the speed calculated from the following formula.

$$\text{Test speed} = 1.10\,(\text{max oper spd})\;\frac{(\text{allowable stress at 38 C})}{(\text{allowable stress at oper temp})}$$

$$\text{Test speed} = 1.10\,(\text{max oper spd})\;\frac{(\text{allowable stress at 100 F})}{(\text{allowable stress at oper temp})}$$

There shall be no permanent deformation of any part of the wheel as a result of overspeeding. After the test, welds shall be examined for cracks by magnetic particle testing or dye check.

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Perform manufacturer's standard factory tests on mechanical draft equipment and material. Perform tests required by the applicable codes and these specifications. Fan wheels with tip speeds exceeding 127 meter per second 25,000 feet per minute, and which are not identical to fan wheels in successful commercial operation, shall be given an overspeed test. Factory test shall include mechanical balancing of rotating parts.

2.12 INSTRUMENTATION AND CONTROLS

Furnish a control system to provide safe, reliable, and efficient operation of the Flue Gas Cleaning System through integrated control of system processes and equipment. The control system shall perform safe boiler start-up and shutdown and shall respond to dynamic variations in boiler operating conditions including steam sootblowing while maintaining required emission levels. The control system shall include a vertical control and graphic system panelboard located in the Steam Plant control room and system cabinets located in the control equipment room. The Control system shall integrate local controls provided with the lime slurry preparation equipment, and other equipment, as specified, so that complete system operation can be remotely monitored and controlled from the Steam Plant control room. The Contractor shall provide instrumentation and control equipment, as specified and as required for a complete and operational system. Furnish instrumentation required to monitor the process variables. Furnish flow, pressure, and temperature instrumentation for each pump, to monitor operating conditions and indicated performance. Furnish flow, level, pressure, and temperature switches for alarm actuation in process lines, tanks, vessels, and heat exchangers. Furnish transmitters required to transmit the process variable to the control systems. Furnish instrumentation required to transmit the status of the process and equipment to control room panels. Furnish analyzers and sensors required to monitor and to control process reagents, flue gas influent and effluent, and waste products. Furnish supports, hardware, enclosures, and accessories required to mount, protect, and operate the instrumentation. Furnish instruments, meters, gages, switches, controllers, thermometers, thermocouples, transmitters, analyzers, panels, and gage boards as required. Furnish metal instrument identification tags on field devices. Furnish tubing, piping, and fittings required for a complete instrumentation and control system. Furnish electronic control systems to control and monitor continuous time-varying processes using either split architecture analog controllers or direct-digital control techniques to emulate analog controllers. Furnish electronic digital control systems to control and monitor sequential processes. Provide necessary control program software and hardware. Furnish control drives and control valve operators required for control of the FGD system including induced draft fan inlet damper control drives. Furnish control boards for at least the following areas or functions: FGD system control panelboard in Steam Plant control room, lime slurry preparation equipment, lime unloading, and at each spray dryer penthouse. Control panels in each area shall include the necessary control devices and instruments required to operate and monitor the equipment specified for control from that panel. Equipment which is specified to have both local control and control from the main system panelboard in the control room shall be provided with control mode selector switches at the main panelboard. Panelboards shall conform to UL 67. Analog loops shall be controlled from the main system panelboard only. Tag each field-mounted device and panel-mounted device using the following tag numbering scheme. Instruments shall be tagged according to contract number and type of device using standard device abbreviations. Tag numbers shall be prefixed with the number [_____] to signify this contract. Instruments furnished in multiples for multiple equipment shall have identical tag numbers suffixed by the letters A, B, C, etc., to correspond to the multiple equipment. Tag each device prior to shipment. Device tags shall be permanently attached (not with string or tape) to the stem or case of each device. Tags shall be fabricated of solid brass or aluminum with correct tag number stamped clearly on into the metal. Each tag shall be inscribed with a unique tag number assigned using the specified scheme. Submit drawings of mounting locations for devices to be mounted.

2.12.1 System Operation

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NOTE: Failure Analysis. Provide a complete control system failure analysis demonstrating and explaining the effects of various system component failure on the system. The failure analysis shall specifically identify the control system features which will be provided to minimize the effect of component failures and protect the equipment, especially the fabric filter bags.

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Operation and control of the Flue Gas Cleaning System shall be accomplished by a full-time operator from the steam plant control room. The control system shall be designed to allow operation of FGD system in either of two modes; remote manual or semi-automatic. In the remote manual mode the various dampers, control valves, pumps and associated equipment will be opened or closed, started or stopped from individual switches or push buttons located on the main control panel. In the semi-automatic mode the FGD system components for each boiler will automatically placed in or taken out of service in the proper sequence when the start or stop push button is activated. In both modes sufficient interlocks shall be provided to assure that proper sequencing is followed and to allow equipment to be automatically tripped when required. The control system shall be designed to ensure that in the event of a power failure of FGD system equipment failure, the necessary corrective action to prevent damage to the equipment will automatically be initiated. Contractor shall provide a complete system failure analysis. Process variable indicators and alarms required for proper monitoring of system performance shall be located on the main control panel. Furnish necessary instrumentation to provide positive indication of operational status of equipment; such as, flow or pressure switches to verify operation of pumps and limit switches to indicate position of dampers and valves. Local controls shall be provided for valves, dampers, and motors. A complete system graphic display shall be provided.

2.12.1.1 Lime Slurry Preparation

Provide a control panel adjacent to the truck unloading fill pipe connection. Provide a NEMA 4 enclosure for panel. Panel shall include bin vent filter fan indicating light, low bin level indicator light, high bin level indicator light and audible alarm with alarm silencer button. When truck unloading tube is connected to the fill pipes, a limit switch mounted on the fill pipe shall be actuated. Limit switch actuation shall activate bin vent filter exhaust fan. Disconnection of truck pipe shall return limit switch to normal and operate bag cleaning mechanism for a preset period of time. Reaching high bin level during truck unloading shall sound alarm. Level switches for high and low feed bin level shall be provided, as specified in paragraph INSTRUMENTATION AND CONTROLS. Provide local and remote monitoring of feed bin levels. Provide signal from low and high bin level indicators as required for input to control of pneumatic lime conveying system from bulk lime storage silo. Silo, conveying system, and controls for bulk lime storage will be provided by the Contractor. Provide space for additional level monitors on FGD system panelboard for use with bulk storage silo. Primary control of the lime slurry preparation operation shall be from the local control panels as specified herein. Main FGD system control panelboard shall interface with local controls as specified paragraph INSTRUMENTATION AND CONTROLS. Once a feeder/slaker has been selected for operation from the local control panel, the lime slurry preparation equipment shall function automatically. A low level signal from the slurry tank level switch shall start water feed, lime feed, bin vibrator and other equipment as required including slaker agitator and grit removal equipment. A high-level signal from the slurry tank shall stop line feed and bin vibrator immediately and provide continued operation of water feed, slaker agitator and grit removal equipment for adjustable time periods. Provide control panels at the time slurry preparation area enclosure preparation area enclosure and shall include complete controls for equipment in the slurry preparation system. In addition to selector switches or push buttons for all equipment, the local controls shall provide full instrumentation to annunciate any component failures and automatically trip equipment. Local annunciator shall be provided for component faults including high slaker temperature, slaker overflow, slaker fail-to-start grit remover zero speed, slurry agitator zero speed, and low-low slurry tank level. Any local alarm shall register at the main FGD system panelboard in steam plant. Flushing of the slurry pumps and piping systems shall be controlled from a panel at the slurry tank level in the lime system enclosure.

2.12.1.2 Spray Dryer Absorbers

The following paragraphs provide a typical functional description of the control of sulfur dioxide concentration and flue gas temperature leaving the spray dryer absorbers. It is recognized that individual differences between control schemes may exist to the extent that not all of the control details specified are applicable to a given system. The [proposal] [bid] shall clearly indicate such differences and shall include a detailed description of the control system features provided to attain the control objectives specified in these paragraphs. The degree of sulfur dioxide control achieved in the spray dryer absorber and fabric filter baghouse is directly related to the rate of lime feed to the atomizer. The lime slurry feed rate to the atomizer shall be regulated by a control valve which is modulated by a signal from the analog control system utilizing an input from an sulfur dioxide analyzer located at the fabric filter baghouse outlet. The control valve shall fail closed on loss of air, power, or control signal and the control system shall be provided with sufficient interlocks so that FGD system upsets cannot result in excessive liquid feed and subsequent moisture carryover to the fabric filter baghouse. The control system shall be designed to automatically control the sulfur dioxide concentration leaving the fabric filter baghouse at a level set by the operator from an operating station in the control room. Provide continuous indication of the inlet and outlet sulfur dioxide concentration, control valve status and slurry feed rate on the main control panelboard. The temperature of the flue gas leaving the absorber shall be controlled to an operator-adjustable setpoint by automatic regulation of water feed to the atomizer. The water feed rate to the atomizer shall be regulated by a control valve which is modulated by a signal from the analog control system utilizing an input from a temperature transmitter located at the spray dryer outlet. The control system shall provide a means of assuring that the outlet temperature remains above the moisture dewpoint with an adequate margin of safety as required to prevent condensation at any point downstream in the FGD system. A control signal will be available to indicate the initiation and termination of the steam sootblowing cycle. The temperature control system shall make use of this signal to automatically compensate for the additional moisture input with the flue gas. The water control valve shall fail closed on loss of air, power, or control signal. Absorber inlet and outlet temperature, water control valve status, and water feed rate shall be indicated at the main control panelboard. Each atomizer shall be provided with a local control panel mounted in the penthouse enclosure. Complete local controls, indicating lights and alarms shall be provided. Controls for the two-fluid nozzle atomizers shall be as follows: interlocks and automatic trips shall be provided to automatically stop the atomizer due to low oil pressure, high oil temperature, high motor temperature or high vibration level. Remote indication of atomizer operating conditions and alarms shall be provided on the main control panelboard. Atomizer start switches shall be provided both locally and remote.

2.12.1.3 Baghouses

Primary control of the fabric filter baghouses shall be from the FGD system panelboard located in the steam plant control room. Design the control system for automatic control of each fabric filter baghouse as required to ensure stable and reliable operation. Monitor status and position of motors, dampers, valves, etc. at the main control board by a graphic presentation. Design for automatic or manual start-up and automatic verification of the operation of each component of the fabric filter baghouse in sequence as required for proper operation of the system. The automatic start-up sequence will be manually initiated. Design for automatic or manual shutdown and automatic verification of the shutdown of each component of the fabric filter baghouse in sequence as required for proper shutdown of the system. Design for automatic and safe shutdown of any malfunctioning part of the system without disrupting boiler operation capabilities. Any effect on the steam plant due to system control changes will be avoided or minimized. The cleaning cycle will be initiated by measurement of pressure drop across total fabric filter baghouse, by timer, or by manual switch. Initiation mode shall be switch selectable. A manual selector switch will allow manual operation of the cleaning function for any module for the purpose of extra cleaning of any module or in the event of automatic sequence failure. Off-line cleaning of pulse-jet fabric filter baghouse modules (normal) or on-line cleaning shall be available at the selection of the operator. The automatic timer and manual selector switch will be interlocked with an isolation switch located at the tube sheet access doors to ensure isolation of the module for maintenance. The automatic timer will bypass any module not in service. This bypass will be accomplished without timing through the cleaning cycle for the module just bypassed (no dead time). The cleaning timer will allow for adjustment of the frequency and duration of cleaning cycles to obtain optimum bag cleaning. The bypass mode selector for each fabric filter baghouse will be functional for either automatic control and for manual control. The system shall automatically bypass the fabric filter baghouse as required to prevent moisture carryover from spray dryer. Monitor status of process and equipment for abnormal operation, failure, trip, etc. and provide visual and audible alarms. Alarm indication shall include, but not be limited to, high temperature drop across the fabric filter baghouse, high-pressure drop across fabric filter baghouse, cleaning system malfunction, high ash level (with indication of which hopper is alarming) and low hopper temperature (with indication of which hopper is alarming).

Graphic display shall include at a minimum the following indicating lights (color of lens in parentheses):

a. Inlet damper--OPEN (green).

b. Inlet damper--CLOSED (red).

c. Outlet poppet--OPEN (green).

d. Outlet poppet--CLOSED (red).

e. Module--ACTIVE (green).

f. Module--INACTIVE (red).

g. High ash level (red)*.

h. High inlet gas temperature (red)*.

i. Low compressed air pressure (red)*.

j. High system differential pressure (red)*.

k. Power--ON (red).

l. SYSTEM START (green).

m. SYSTEM STOP (red).

n. Cleaning mode OFF-LINE selected (white).

o. Cleaning mode ON-LINE selected (white).

p. *These items shall activate an audible alarm.

Two position selector switches shall be provided for the following.

a. Power--ON/OFF.

b. Module--ACTIVE/INACTIVE.

c. Cleaning mode--OFF-LINE/ON-LINE.

Momentary contact push buttons shall be provided for the following.

a. System--START (green head).

b. System--STOP (red head).

c. Alarm--ACKNOWLEDGE.

Provide auxiliary devices required for the control functions indicated including the following.

a. Position indication switches on isolation valves.

b. Hopper level alarms.

c. Temperature indicator and thermocouple.

d. Pressure switch.

e. Audible alarm.

f. Differential pressure gage (baghouse module and panel board).

g. Fan current.

h. Fan inlet static pressure.

i. Fan outlet static pressure.

j. Opacity.

Provide suitable laminated plastic nameplates for devices on panel face. Temperature controller and differential pressure gage shall be mounted on face of panel. In addition, provide a two pen, 250 mm 10 inch diameter circular chart recorder to record inlet gas temperature and pressure drop across baghouse system for each module. Differential pressure gage for each module shall be indicating type with diaphragm magnetically coupled to pointer mechanism.

Units shall include a programmable controller which shall be completely solid state and shall be preprogrammed to control the following.

a. Pulse duration (pulse-jet only).

b. Pulse sequencing (pulse-jet only).

c. Cleaning cycle time.

d. Settling time.

e. Module isolation valve control.

The system shall sense differential pressure between inlet and outlet of each baghouse. When the differential pressure reaches the setpoint, controller shall initiate cleaning of all modules. In addition, an overriding timer shall be provided so that the bags can be cleaned on a preset interval independent of pressure differential. (Pulse interval and duration), cleaning cycle time, setting time and time for valve operation shall all be adjustable. Differential pressure setpoint shall also be adjustable.

2.12.2 Analog Control Systems

Furnish an analog control system complete with transmitters, flow-measuring elements, control modules, control system cabinets and panelboard, control operating stations, prefabricated plug-in cables, signal converters, control drives and accessories as required to allow control of the FGD system from the central steam plant control room. The control systems and instruments shall be electronic and be designed for continuous operation. The control system shall be of the "split architecture" design where computing and logic modules are mounted in system cabinets. Operating stations shall be mounted in the panelboard and connected to the system control module racks, mounted in the system cabinets, using prefabricated cables.

2.12.2.1 Electronic Control Modules

Analog computing and logic modules shall use proven solid-state electronic design. Circuits shall be constructed with high-quality, pretested components making maximum use of integrated circuits. Components shall be readily available from known suppliers. Analog computing and logic modules shall be designed for plug-in rack mounting in the system cabinets. Module pins and mating connectors shall be gold plated on nickel to withstand chemical attack by ambient atmospheric chemicals. Modules of the same type shall be interchangeable to facilitate maintenance and trouble-shooting by substitution. Pretest and age each module before installing in the module racks. Factory assemble, wire, and test the system using the operating stations and actual plug-in cables for the system. Provide input and output test jacks on each module for tests. Controllers and analog computing circuits shall perform as follows unless specifically noted otherwise for a particular system or control loop: Provide calibrated, front-mounted controls on appropriate modules, to adjust proportional, integral and derivative action. Adjustments shall be possible while operating in automatic without causing undesirable upsets such as a proportional step. Prevent reset windup action and design to develop response to demand without the system first performing internal controller balancing. Provide means to automatically balance each loop that has a manual-automatic operating station so that bumpless transfer may be made from manual to automatic and from automatic to manual without any intermediate manual balancing. Where both master stations and individual final control element stations are employed in a loop, the master, as well as individual stations shall transfer bumplessly and without balancing, and be tied together, as appropriate. Bumpless transfer is effected if the output signal to the final control element does not vary more than 2 percent of the full-scale output signal range when transferring from automatic to manual and from manual to automatic. Provide for all interlocks and contact inputs and outputs and all digital logic functions necessary to control or interface the analog circuits throughout the system. Provide signal monitor modules to track analog signals where required to produce contact outputs for alarm or interlock with other logic when the signal exceeds a predetermined level. Signal monitor units shall be equipped with independently adjustable high and low set points. Provide suitable isolating devices such as relays or optical couplers to protect the control system from external outputs or inputs. Provide indicating lights on the modules to show the status of all logic, transfer relays, and signal monitors. Lights shall be visible without removing or withdrawing the modules from the racks.

2.12.2.2 Input and Output Signals

Input signals from field transmitters shall be 4-20 mA dc "two-wire." Provide output signals to panel recorders and indicators. Provide square root extraction for flow signals outputs to devices furnished. Output signals shall be 4-20 mA dc. Transmitters required to provide multiple outputs to recorders, and indicators as well as providing an input to the control system shall be buffered so that disconnecting, shorting or grounding of the input at the recorder or indicator shall not cause an upset or failure in the control system. Output control signals to final control elements shall be 4-20 mA dc. The final control elements shall be provided with the proper signal converter.

2.12.2.3 System Electrical Power and Power Supplies

The following power sources will be provided by the Government: Source "A" 120-V ac from station inverter. Source "B" 120-V ac from station service. The Contractor shall furnish fuses or circuit breakers for each source to protect against faults or overloads at the system modules. System computing and logic power, transmitter power, or other power used for control or indication, used either remotely or internally, shall originate from within the system. Such power users shall be properly fused or furnished with circuit breakers to protect power sources and supplies from overloads or faults. Power sources and power supplies shall be distributed into functional groups and protected from overloads or faults such that a power failure in one group does not cause power failure to the remainder of the control system. The system shall take appropriate control action and initiate an alarm contact upon partial power failure. Tripout of a circuit breaker or opening of a fuse due to control equipment failure or wiring fault in a control loop shall disable the loop in which the failure occurred and place the final drive in the manual mode and initiate an alarm contact. Fuses, breakers, and fuse or breaker panels shall be readily accessible and clearly identified. Provide input filters for noise suppression, as required. Where internal dc power supply buses are utilized, furnish two full-capacity power supplies for each bus voltage and auctioneer their outputs to ensure no control upsets if one supply or its source fails. Power one supply from source "A" or "B" is distributed internally to individual circuit cards or individual transmitters or converters which have separate dc power supplies, provide an automatic transfer switch to switch to the backup source upon primary source failure. Furnish manual reset feature and provide an alarm contact on transfer. Provide circuit isolation and monitoring to permit removal of faulty supplies during operation.

2.12.2.4 Operating Stations

Operating stations will be remote mounted on the control panelboard in the central steam plant control room. Furnish operating station with an individual mounting rack to permit simple and quick removal from the panel. Wiring to the system cabinets shall be by a prefabricated plug-in cable. Operating stations shall contain dials, switches, lights, and indicators necessary to operate the system by either manual or automatic mode. Stations shall not contain computing or logic elements which are a part of the control loop except for operator-system interface. Station shall have the following features, as applicable, depending upon their purpose in the control system:

a. Manual-automatic selector switch or push buttons.

b. Dedicated indicating meters displaying only one variable, and marked in appropriate engineering units where applicable. Indicating lights displaying manual or automatic status of the control loop. Lights displaying status of the switch are not acceptable.

c. Set point dials calibrated and marked in appropriate engineering units.

d. Deviation meter.

e. Position meter indicating the actual final drive element position over its full range, and not the loading signal.

f. Raise and lower control for manual operation.

Manual, set point, or indicator stations which have specified functions shall have no extraneous or ineffectual indicators, switches, or lights. The station shall be tailored to its purpose. Tag operating stations with a unique number, as specified. Provide an engraved nameplate on each operating station identifying the service such as spray dryer outlet temperature.

2.12.2.5 Control Drive

Control drives shall be pneumatic type. The term "control drive" refers to a power actuator which is primarily used for positioning another device such as a damper, in response to signals from a control system. Select each control drive size as required to provide adequate capacity for the existing loads and conditions. Each control drive used for modulating service shall positively position its controlled device accurately and without fluctuations with the existing load conditions and at any position. The time required for full-stroke travel in either direction shall be 15 seconds. Provide speed control to allow adjustment of full-stroke time from ten seconds to one minute. Provide couplings, adapters, linkages, clevises, ball joints, drive arms and damper arms required. Furnish control drives and handwheels, dual-pole-dual-throw limit switches for open and closed indication, on open-close drives, and 4-20 mA dc position outputs on modulating drives. Position shall be sensed electronically without the use of a slide wire. Provide control drives except the induced draft fan inlet damper drives with current-to-pneumatic positioners to accept a 4-20 mA dc control signal. The induced draft fan inlet damper drives shall be furnished with a pneumatic positioner to accept a 3-15 psi signal from a current-to-pneumatic signal converter furnished by the Contractor.

2.12.3 Digital Control Systems

Digital controls shall be relay logic, solid-state programmable logic. Baghouse sequence control shall be wired solid-state logic or solid-state programmable logic. Digital logic associated with analog process controls shall be as specified in paragraph ELECTRONIC CONTROL MODULES. Control circuits shall be 120 VAC maximum. Higher voltage power shall not be brought into a control system cabinet or control panelboard.

2.12.3.1 Wired Solid-State Logic

Components shall be highest quality industrial grade devices. Logic elements shall be integrated circuits. Components shall be subjected to a rigorous quality assurance inspection. Circuit cards shall be burned-in and tested in the completed system a minimum of 170 hours continuous operation. Logic elements shall be assembled on circuit cards to perform specific operational functions. Different types of circuit cards shall be minimized to reduce stocking of spares and to facilitate maintenance by card substitution. Logic cards shall be arranged in functional groupings for individual pumps or sequences. Failure of a single logic circuit or compartment shall not affect more than one pump or separate functional sequence. Power supplies shall be as specified for Analog Control Systems. System electronics shall be buffered and protected from external power sources by optical couplers or reed relays. Logic shall be documented by logic diagrams.

2.12.3.2 Solid-State Programmable Logic

Components shall be highest quality industrial grade devices. Components shall be subjected to a rigorous quality assurance inspection. Circuit cards shall be burned-in and tested in the completed system a minimum of 170 hours continuous operation. Small systems requiring a minimum of memory elements may use nonvolatile programmable memory. Larger systems shall use software programmable memory with nonvolatile memory for program and executive storage. Logic functions shall be performed by software engineer. Logic shall be documented by flow charts or word logic, and by program listings. Memory shall be static. Programming aids shall be provided to permit easy field reprogramming. Battery power back-up may be approved by the Contracting Officer. System electronics shall be buffered and protected from external power sources by optical couplers or reed relays. Software shall be factory tested and debugged including simulating inputs and outputs and checking resulting logic sequences.

2.12.4 Flue Gas Cleaning System Panelboard and System Cabinets

Provide one common vertical panelboard and system cabinet sections, as specified, to control the flue gas cleaning equipment for boilers. Panelboard dimensions shall be 0.762 m deep by 2.44 m wide by 2.44 m high 30 inches deep by 96 inches wide by 96 inches high. No process fluids or pneumatic signal lines shall be brought into any panelboard or system cabinet.

2.12.4.1 Construction

Construct of 3 mm 1/8 inch hot-rolled steel panels reinforced with angles and channels in the interior to form a single, rigid, freestanding unit in compliance with NEMA 12. Panelboards shall be completely enclosed floor-mounted units, except with bottom open. Panelboards shall be constructed with no bolt heads or fastenings visible from the exterior. Construct with 6 mm 1/4 inch radius corners. Edges shall be filled and ground to conform to a 6 mm 1/4 inch radius. Provide interior innerpanels for mounting auxiliary equipment and terminal blocks, as required. Make provisions for anchoring to floor or foundation. Provide hinged doors on the rear of the panelboard with key locks to allow access to equipment. Provide lifting eyes and shipping pallet on the panelboard to facilitate moving into the steam plant. Provide ventilation grills, exhaust fans, ductwork, and filters, as required. Provide cutouts and removable cover plates for items designated as future. Paint cover plates to match panels. Prime and paint panelboard as specified. System cabinets shall conform to the following requirements: Steel frame and sides, freestanding, and fully enclosed. Front and rear access doors with key locks to allow access to racks. Cabinets shall be maintained at positive pressure using a fan powered by a 120-volt, single-phase motor with a minimum power output of 0.09 kW 1/8 hp. Maintain cabinet pressure at least at 125 Pa 0.5 inch water gage. Provide ventilation louvers as required. Size ventilation system to ensure adequate heat dissipation and to maintain continuous operation without loss of function or cause reduced life. Pressurizing air shall be filtered with a 98.5 percent minimum efficiency for dust particles one micron or larger. Control cabinet shall be equipped with a safety key interlock (and shall be located as indicated). Assemble cabinets in sections in sizes convenient for handling and moving into the steam plant, but with lifting eyes and shipping pallet for each separate section. Design cabinets to allow sections to be installed side-by-side. Provide side openings at the bottom of the sections as required to permit interconnection of the sections by prefabricated cables without routing the cables outside of the cabinets. Provide work light and one 120 VAC, duplex, 3-wire-polarized-grounding type, specification grade, convenience outlet in each cabinet.

2.12.4.2 Finish

Smooth, fill, and apply one coat of primer and two coats of finish paint to exterior surfaces. Apply one coat of primer and one coat of white paint to interior surfaces. Contractor shall furnish finish paint of type and color specified by the Contracting Officer.

2.12.4.3 Nameplates

Fabricate nameplates from laminated white phenolic plastic with black engraved letters. Size of nameplates shall be 40 mm high and 150 mm long 1 1/2 inches high and 6 inches long for "Master" nameplates, with 10 mm 3/8 inch letters. Individual device nameplates shall be 20 mm high and 80 mm long with 3 mm 3/4 inch high and 3 inches long with 1/8 inch broad letters. Engrave designations as required later by the Contracting Officer. Nameplates shall be attached by permanent adhesive or screws. Self-adhesive, embossed plastic label tape is not acceptable. Fabricated bezels shall be laminated phenolic plastic with beveled edges, brushed aluminum or as approved by the Contracting Officer.

2.12.4.4 Graphics

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NOTE: Refer to paragraph SPRAY DRYER ABSORBERS.
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Provide the FGD system panelboard with a graphic subpanel to pictorially describe the flue gas cleaning system process to the operator. Graphic shall include pipelines, pumps, fans, equipment, tanks, vessels, valves, and dampers that are part of the process, with indicating lights and control switches located adjacent to the corresponding graphic equipment symbols. The graphic shall include the flue gas flow path for each of the [_____] spray dryer absorber and fabric filter baghouse systems. The graphic subpanel shall be provided with switches, indicating lights and other devices as required to control and display the status of the equipment. Indications provided shall include at least the operating status of the equipment. Indications provided shall include at least the operating status (running or stopped) of each pump, fan and other driven equipment and the position (open and closed) of each valve and damper. Graphic laminated acrylic symbols on a base of solid acrylic sheeting or panels shall be constructed of laminated phenolic. Acrylic sheeting shall be supported by the metal panel surface continuously. Laminated phenolic may be used as a subpanel. Base sheet shall be 6 mm 1/4 inch thick for phenolic, 5 mm 3/16 inch for acrylic. Color will be selected later from manufacturer's standard colors. Provide smoothly finished openings accurately sized for indicating lights, switches, meters, and oversized openings in panel metal behind acrylic sheeting. Attach base sheet with mechanical fasteners which allow for expansion and contraction of the base. Finish the edge between graphic base sheet and panel surfaces with a brushed stainless-steel trim. Graphic symbols, flow lines, nameplates shall be:

a. Material: Laminated acrylic sheeting.

b. Thickness: Equipment symbols, flow arrows, and nameplates (10 mm (0.40 inch; flow lines: 0.51 mm 0.020 inch).

c. Color: Solid white core with colored satin finish overlay. Colors will be selected later from manufacturer's standard colors.

d. Engraving: Engrave through colored overlay to expose solid core. Cut laminate with beveled edges (except flow lines) to expose solid core on perimeter of all symbols, nameplates, etc.

e. Mounting: Attach to front face sheet by means of contact cement that may be loosened by a solvent that will not damage face sheet or symbols. Use of double-faced adhesive tape is not acceptable.

2.12.4.5 Wiring

Interconnecting wiring between the system cabinets and panelboard-mounted operating stations or subpanels and between separate sections of the system cabinets shall be prefabricated cables with plug-in connectors at both ends. Cable connectors shall incorporate a mechanical restraint between the mating halves to assure that each connecting pin-pair maintains electrical contact and that the connector does not separate due to mechanical vibration or cable sag. The male connector shall be of a design which protects the pins from damage during cable pulling and aligns the two halves accurately during mating. The connector shall be approved by the Contracting Officer. Prefabricated cables shall be rated 600 volt, 90 degree C conductor temperature, 18-gage minimum size copper conductors, overall neoprene or polychlorosulphonate jacket, and shielding if required. Prefabricated cable length between the panelboard and system cabinets shall be [_____] meters feet. Provide field terminal blocks in the Flue Gas Cleaning System panelboard or system cabinets as appropriate for analog and digital connections of remote devices. Transmitters furnished by this contract will be wired to terminals in the system cabinets and powered by the Contractor's power supplies. Field terminal blocks shall be grouped and wired into the system according to the function or site of the input or output signals to simplify termination of multiconductor field cables. Wiring shall be insulated switchboard wire rated for 600 volt ac, 60 hertz, 90 degree C conditions. Size shall be No. 14 AWG or larger for 120-volt ac control and indicating circuits, No. 20 AWG for low voltage (28 volts or less) devices, and No. 10 AWG or larger for 120-volt ac main power supplies and tap circuits. Use heavy-duty terminal blocks rated at least 20 amperes, 600 volts with not less than 15 mm 1/2 inch spacing between terminals. Terminal blocks for main power supply circuits and control bus termination shall be rated at least 40 amperes. Terminals shall be sliding-link type to allow individual circuit isolation for testing without disconnecting field or cabinet wiring. Terminal shall be designed to receive ring-tongue cable connectors on the field side. Terminal blocks for current transformer circuits shall be 2 or 4 point, as required, short-circuiting type with one shorting screw for each terminal. Identify each terminal on all blocks by stamping or permanently marking the terminal designation on the marking strip. Self-adhesive embossed plastic label tape is not acceptable. Mount terminal blocks vertically in rows on interpanels within the panelboard and system cabinets with provisions for cleating external cables entering from the bottom. Location of the terminal blocks shall be subject to approval by the Contracting Officer. No terminal blocks shall be mounted at a height less than 300 mm 12 inches. Provide a quantity of terminals sufficient for both signal and power circuits required to implement the system plus 10 percent spare for future modifications. Provide grouping of the following terminals: (1) Analog, (2) Annunciator, (3) Control. Provide a ground bus running the full length of the panelboard and system cabinet sections with No. 4-250 MCM lugs for ground cable connection at each end. The internal copper ground bus shall be at least 25 by 6 mm 1 by 1/4 inch. Connect internal grounds required to the ground bus. Furnish one two-tube, 40-watt, 120-volt fluorescent light fixture with a protective metal grill for the panelboard. Furnish 120-VAC, duplex, 3-wire polarized-grounding type, specification grade, convenience outlets in the panelboard. Furnish single-pole and three-pole fuse blocks with fuses for each set of relaying and metering potential circuits. Provide 20A molded-case circuit breakers for connections from control buses to miscellaneous equipment installed in or served from the panelboard or system cabinet. Provide plug-in strips for connection of 120 VAC supplies to meters and recording equipment where required.

2.12.4.6 Power Supplies and Switches

Furnish a circuit breaker panelboard in the FGD system panelboard. Furnish mechanically interlocked, main circuit breakers mounted in the panelboard for switching or primary and backup power services. Furnish quantity as required. Furnish molded-case circuit breaker for each tap from the control bus to serve items requiring separate AC circuits. Provide one AC alarm relay connected to each AC bus with two sets of contacts to close after 2-second delay on loss of AC. Provide a 120-volt AC control bus and a 120-volt utility bus. Provide 24 VAC or VDC power supplies for low voltage indicating lights, meters, and transmitters, as required. Control switches shall be heavy-duty oiltight momentary contact, spring return unless otherwise specified, with normally open and normally closed contacts of adequate quantity. Switch handle types, colors, and retaining rings will be as required. Metal nameplates shall be used for position marking, but plastic nameplates shall be used for identification, as specified, unless otherwise noted.

2.12.4.7 Lights and Indicators

Indicating light size shall be nominal 15 mm 1/2 inch diameter and rating shall be 120 volts ac. Lens shall be transparent, color to be indicated later by the Contracting Officer, unless otherwise specified. Indicators shall be of the high-accuracy D'Arsenvol type. Provide indicators in groups, as required, with mounting hardware and frame. Meter movement shall be suitable for 4-20 mA dc input signal. Scale markings and colors shall be as required. Scales shall be illuminated.

2.12.4.8 Counters and Meters

Six-digit pulse counters to interface with 4-20 mA dc input shall be provided, as required. Meters shall be semi-flush mounting, 70 mm 2.7 inches square. Accuracy shall be rated at plus or minus 2 percent. Meter movement shall be 0-5 ampere AC, 0-1 milliampere DC signal. Scales shall be as specified with overload red lines. Pushbuttons shall be heavy-duty oiltight construction. Contacts shall be momentary, one normally open and one normally closed, unless otherwise specified. Button type and color shall be specified later by the Contracting Officer.

2.12.4.9 Recorders

Multipoint printing strip chart size shall be 254 mm 10 inchesnominal width. Chart speed shall be 50 mm 2 inches per hour, nominal. Printing period shall be 5 seconds per point or multi-speed using numbered dots or plus signs with color selected later by the Contracting Officer. Provide engraved legend plate and rubber legend stamp. Provide a 12 month supply of charts and ink for each instrument. Recorders shall be designed for 120 volt AC power. Supply one complete set of manufacturer's tools and accessories. Provide internal fluorescent illumination. Furnish input circuitry for thermocouple, RTD, voltage and current input signals. Provide three separately adjustable alarm points with latching relay for wiring to the annunciator. Miniature pen strip chart size shall be 100 mm 4 inch nominal width. Chart speed shall be 25 mm one inch per hour. Provide indicating scale for each pen and scale legend markings. Provide a 12 month supply of charts and ink for each instrument miniature pen strip chart recorder.

2.12.4.10 Annunciators

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NOTE: Alarm sequence shall be the following.

Status	**Visual**	**Audible**
Normal	**Off**	**Off**
Alert	**Fast Flash**	**On**

Status	**Visual**	**Audible**
Acknowledge	**On**	**Off**
Return to Normal	**Slow Flash**	**Off**
Return before Acknowledge	**Slow Flash**	**Off**
Acknowledge (Reset)	**Off**	**Off**
Test	**On**	**Off**

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Annunciator shall consist of remote logic rack and separate lamp box assemblies for control room applications, and integral logic, terminal blocks, and lamp box assemblies for local control panels. Mount the remote logic racks for the system panelboard annunciator in the system cabinets. Provide prefabricated display cables to connect the remote logic with lamp box assemblies mounted in the panelboard. Equipment shall be constructed of the highest quality solid-state electronics, factory-tested and burned in. Trouble contact circuitry shall meet IEEE C37.90.1 Surge Withstand Capability Test. Provide repeat contacts for each window wired to terminals. Equipment shall be powered from the Government's 120-volt AC station service source. Arrange power supplies, circuit breakers, and input terminal blocks in groups to permit servicing single sections of the annunciator system without disabling the entire system. Alarm windows shall be full 50 by 80 mm 2 by 3 inch nominal size. Cable connectors to lamp box assemblies shall be right-angle type to allow rear connection and cable routing from below. Terminal blocks in equipment cabinets shall be slide-link type. Provide terminal marking strips. Alarm audibles for the annunciator systems shall be electronic tone generators with variable pitch and volume controls.

2.12.5 Temperature Monitor

Temperature monitor shall scan thermocouple inputs, monitor critical process conditions, and record temperature in degrees C degrees F and point number upon alarm or operator demand. Scanning shall be continuous; recording shall be automatic for each alarm detected. Input point number, process value, and alarm condition shall be printed on a strip recorder. Front panel controls shall enable the operator to select scanning rate, continuous scanning, single point or group scanning, and print-on-alarm or print-on-demand. A digital display shall present point number and value for visual monitoring of any or all selected points. In addition to critical process temperatures such as spray dryer and fabric filter baghouse inlet and outlet temperatures, inputs shall include bearing thermocouples and motor RTDs (one per motor). Instrument calibration accuracy shall be one half degree C one degree F, or better, throughout the temperature range of 18 to 149 degrees C zero to 300 degrees F and one percent full scale for process variables. Calibration stability shall be within one half degree C one degree F for six months with no adjustment, and equivalent value for process variables. Scanning rate of 6 points per second, continuous shall be used. Print speed shall be 6 lines per second. Provide five separate high-temperature alarm comparators with dual field adjustable set points wired for assignment to groups of inputs. Provide one isolated lock-in type alarm contact for each alarm set point for wiring to external annunciator, and wired for manual reset from a remote push button. Monitor output printer shall be numeric strip chart, nonimpact ribbonless, roll-type with take-up reel. Provide extra supply of paper for printing at least 10,000 lines. Provide for flush panel mounting with printer, indicators, and operator's controls accessible from the front. Alarm set-point modules, input modules, and auxiliary chassis shall be mounted behind panel or adjacent to operator's controls. Controller sensing element shall be stainless-steel armored bulb and capillary, 7.62 meter 25 feet in length. Controller shall include the following features:

a. Reset and rate as specified.

b. Set point, proportional ban, reset and rate adjustment.

c. Pressure gages for supply and control pressure.

d. Indicator for process temperature.

e. Supply air pressure regulator.

Provide thermowell sized for the bulb in accordance with the thermowell specification. Temperature switch elements shall be dry contact (mercury switch contacts not acceptable) single-pole-dual-throw, rated for at least 120 volt AC, 4 amp or 125 volt DC, 0.5-amp. Switch enclosure shall be NEMA 12. Sensing element shall be stainless-steel armored bulb and capillary, or direct-mounted bulb, as specified. Provide thermowell sized for the bulb in accordance with the paragraph THERMOWELLS. Factory adjust each switch to the proper setting before shipment to the jobsite. Indicate the factory setting on the device tag.

2.12.5.1 Thermometers

Thermometers shall be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) shall have a nominal scale diameter of 125 mm 5 inches. Construction shall be stainless-steel case with molded glass cover, stainless-steel stem and bulb. Stem shall be straight, length as required to fit well. Bimetal thermometers shall have a scale diameter of 90 mm 3 1/2 inches. Case shall be hermetic. Case and stem shall be constructed of stainless steel. Bimetal stem shall be straight and of a length as required to fit the well.

2.12.5.2 Thermocouples

Pipe thermocouples shall be Type J, iron-constantan element, ungrounded, for pipeline mounting in a thermowell. Provide protective sheath, screw terminal head, and the thermowell sized for the service specified. Element shall be at least 20 gage wire, with 2 hole insulators, 304 stainless-steel sleeve, silver plug tip, spring loaded. Head shall be universal type with screwed cover and chain and terminal connector. Provide stainless-steel nipple as required for head to clear insulation by at least 50 mm 2 inches. Well shall be sized for each thermocouple in accordance with the thermowell specification. Duct thermocouples shall have Type J ungrounded element with 20 AWG iron-constantan wires 2 hole insulators and universal head as specified for pipe thermocouples. Protecting tube shall be as specified under thermowells. Bearing thermocouples shall have Type J ungrounded element with 20 AWG iron-constantan wires and 25 mm one inch insulator cemented over measuring junction. Element shall be mounted in 5 mm 3/16 inch spun and welded copper tube, sealed at open end. Head shall be as specified for pipe thermocouples. Surface thermocouples shall have ungrounded Type K element (chromel-alumel) at least 20 AWG suitably protected from high temperatures using fiberglass insulating jacket.

2.12.5.3 Resistance Temperature Detectors (RTDs)

Detector shall be three lead resistance sensor with protective sheath and screw terminal head for pipeline mounting in a thermowell. Accuracy shall be plus or minus 1/2 degree C 1 degree F or plus or minus 0.5 percent of reading, whichever is greater. Element material and nominal resistance shall be 10 ohm copper. Head shall be universal type with screwed cover, chain, and terminal connector. Provide stainless-steel nipple as required for head to clear insulation by at least 50 mm 2 inches. Element length shall be as required for the insertion depth and insulation thickness specified. Provide thermowell sized for the element in accordance with the thermowell specification.

2.12.5.4 Thermowells

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NOTE: General. Provide thermowell for each temperature sensing element (thermometer, thermocouple, remote bulb, etc.) unless otherwise noted.

Insertion:

Piping: 65 mm minimum, 150 mm 2 1/2 inch minimum, 6 inchmaximum unless otherwise noted.

Ductwork: At least 1/2 duct depth but not over 910 mm 36 inch unless otherwise noted.

Lagging extension neck: As required to keep well wrench flats clear of insulation.

Protection: Provide cardboard inserts in each well to prevent internal damage prior to installing thermometer in installed well.

Pipeline Wells:

Bore: Straight or tapered bore sized to fit sensor.

Material: 316 stainless steel unless otherwise noted.

Ratings: Submit pressure vs. temperature and velocity vs. insertion length ratings for each type of well furnished. Submit calculations (to verify that wells are safe for the specified conditions) for special wells for which ratings are not available.

Duct Protecting Tubes:

Type	**Material (unless otherwise noted)**
25 mm Schedule 80 pipe, closed end	**Wrought iron**
25 mm standard weight pipe, closed end	**Type 446 stainless steel**
Adapter: Furnish adjustable flange type collar with companion flange to provide airtight seal on a 50 mm pipe nipple fastened on the duct or casing. The adapter must completely support the tube; no intermediate supports will be provided.	

Type	**Material (unless otherwise noted)**
1 inch Schedule 80 pipe, closed end	**Wrought iron**
1 inch standard weight pipe, closed end	**Type 446 stainless steel**
Adapter: Furnish adjustable flange type collar with companion flange to provide airtight seal on a 2 inch pipe nipple fastened on the duct or casing. The adapter must completely support the tube; no intermediate supports will be provided.	

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Provide a well for each temperature sensing element (thermometer, thermocouple, remote bulb) unless otherwise noted. Include specifications of insertion length, shipping protection, bore, material, and any necessary adapters.

2.12.6 Pressure Gages

Gage connections shall be bottom for flush, surface or line mounting. Furnish scale ranges to produce a reading 60 to 70 percent of full scale during normal operating conditions. Service legends shall be printed on the gage face by the manufacturer. Include adjustments for set point and proportional band of pressure controllers. Provide pressure gages indicating supply and control pressures. Provide cleanout push button for cleaning restricted feed orifice without dismantling. Case shall be dust-tight with air bleed hole. Pressure switch elements shall be dry contact (mercury switch contacts not acceptable) rated for at least 120-volt AC, 4 amperes or 125-volt DC, 0.5-amperes. Contacts shall be single-pole-dual-throw, or as specified. Switch enclosure shall be NEMA 12. Sensing element shall be type and material suitable for the service. Factory adjust each switch to the proper setting before shipment to jobsite. Indicate the factory setting on the device tag. Provide brass pulsation dampeners and liquid fill with high viscosity silicon oil for all gages used for steam, water, air, or liquid service. Diaphragm seal materials shall be 316 stainless-steel diaphragm and bottom housing with a carbon steel top housing. Provide tip bleed feature for bourdon tube in pressure sensing element. Provide pigtail siphons for pressure gages in steam service. Fabricate siphons from 6 mm 1/4 inch seamless carbon-steel pipe, ASTM A106/A106M Grade A, Schedule 40.

2.12.6.1 Panel Gages

Panel gages shall be provided with 150 mm 6 inch diameter face. Accuracy shall be 1/2 of one percent of scale range. Case shall be aluminum or high-impact polypropylene reinforced with glass fiber; solid front face; blowout back. Dial shall be white laminated plastic with black markings.

2.12.6.2 Header Gages

Header gage face shall be 113 mm 4 1/2 inch diameter. Accuracy shall be one percent of scale range. Bourdon tube shall be bronze, brazed. Movement shall be stainless-steel geared. Case shall be polished stainless-steel. Dial shall be fabricated of aluminum.

2.12.6.3 Differential Gages

Differential gage accuracy shall be 1/2 percent of scale range. Pressure unit shall be rupture-proof, stainless-steel bellows. Body shall be 316 stainless steel with 6894 kpa (gage) 1000 psig safe working pressure. Dial shall be 150 mm 6 inch diameter.

2.12.7 Level Elements

Level controllers shall be electrode probe type and shall feature remote electronic enclosure rated NEMA 4 with integral level indicator. Zero and span adjustments shall be noninteracting. Proportional band adjustment shall be provided. Electronic output as required. Power input: 115-volt AC. Prefabricate cable to connect probe to transmitter with quick disconnect connectors. Probe and electronic circuitry shall be designed to provide reliable level control unaffected by coating or material buildup on probe. Liquid level switch elements shall be dry contact (mercury switch contacts not acceptable), single-pole-dual-throw, rated for at least 120 volt AC, 4 amperes or 125-volt DC, 0.5-amperes, unless noted otherwise. Switch enclosure shall be NEMA 12 unless noted otherwise. The float actuated cage shall be external type with temperature and pressure rating equal to or greater than the design rating of the vessel to which it is attached. The float and trim materials shall be stainless steel. Float-type switches shall not be used for slurry tanks. Differential-pressure type shall be indicating type switch. Electrode probe types shall be provided with remote NEMA 4 electronic enclosure with integral level indicator, and noninteracting zero and span adjustments. Power input: 115-volt AC, single phase 60 hertz. Probe to transmitter prefabricated cable with quick disconnect connectors. Level indication shall be unaffected by material buildup on probe.

2.12.8 Flow Elements

Flanged orifice plates shall be 3 mm 1/8 inch thick, 304 stainless steel, sized for the service. Furnish a calculated calibration curve based upon design flow conditions plotting flow versus differential pressure. Insertion flow elements shall be Pitot-tube type using 304 stainless steel as material. Provide pipe connections. Application shall be for water only. Provide inline-magnetic type with liner material and thickness to match the piping. Accuracy shall be plus or minus one percent of rate. Power supply shall be 110 volt AC, 60 hertz. Furnish prefabricated cable from primary element to transmitter. Provide integral indication of flow. Flow switch elements shall be dry contact (mercury switch contacts not acceptable) single-pole-dual-throw rated for at least 120-volt AC, 4 amperes or 125-volt DC, 0.5-amperes. Switch enclosure shall be NEMA 12, except as noted. Materials and pressure ratings shall be compatible with the service. Flow switch shall be paddle, plunger, differential-pressure, or ultrasonic type. Ultrasonic flow switches shall be provided with one flow setpoint, unless otherwise noted. Provide individual adjustment of setpoint and time response delay. Power input: 115-volt AC, single phase, 60 hertz. Provide NEMA 4 enclosure for electronics and encapsulated sensor probes. Use only when other types are not recommended for the service. Flow controllers shall include adjustments for set point, proportional band, rate, reset, and specific gravity. Provide pressure gages indicating supply and control pressures. Provide cleanout push button for cleaning restricted feed orifice without dismantling. Design shall utilize high-temperature diaphragms and gaskets, and shall provide dust-tight case, and cooling fins.

2.12.9 Density Elements and Transmitters

Shall be nuclear type and shall be accurate within 0.001-SGU maximum. Signal shall be linearized. Response of measurement system shall provide adequate response time when tied to mass flow. Power supply shall be 115-volt AC, single phase 60-hertz. Furnish prefabricated cable as required from primary element to transmitter.

2.12.10 Fly Ash Level Alarms

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NOTE: Alarm sequence shall be the following.

Status	**Visual**	**Audible**
Normal	**Off**	**Off**
Alert	**Fast Flash**	**On**
Acknowledge	**On**	**Off**
Return to Normal	**Slow Flash**	**Off**
Return before Acknowledge	**Slow Flash**	**Off**
Acknowledge (Reset)	**Off**	**Off**
Test	**On**	**Off**

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Each fabric filter baghouse hopper shall be provided with a fly ash level alarm utilizing nuclear type detectors. The detectors shall be single-point gamma source and detection units. The detectors shall be complete with separately mounted electronic units which shall include a local high level indicating light and relays for use with annunciation system specified in paragraph ANNUNCIATORS. Relays shall be rated 10 amperes, 120 volts AC. Switch housings shall be dustproof and shall be mounted as one easily accessible location. Detector and source electronics shall be located at the hopper control panel. Detector shall be explosion proof and have waterjacketing. Alarm shall be able to withstand vibration and temperatures up to 260 degrees C 500 degrees F. The source shall have a lockable shutter mechanism operated by an external handle to totally isolate the beam when in the closed position. Electrical wiring schematic shall be furnished. Electrical supply shall be 115 volts AC, single phase, 60 hertz. Alarm level shall be located at the 50 percent hopper capacity level. Each hopper shall have two sensors; one at the alarm level and one at the empty level. Level reproducibility shall be within one inch.

Outdoor components shall operate between [_____] degrees C and 93 degrees C degrees F and 200 degrees F. Source for each hopper level sensor shall be Cesium 137. Source head shall be designed with a spring return off system in the event of remote cable actuator failure. Source shall be interlocked with hopper access doors to prevent entry into hopper unless source has been secured. Hopper access door key shall only be able to open one pair of hopper doors.

2.12.10.1 Hopper Level Signals

Hopper level signals based on hopper status indicator system shall report to a microprocessor through a coaxial cable system. Each hopper shall have two indicators, one for full and one for empty. A flashing light shall indicate a wall buildup. Loss of power for any period of time shall not require a recalibration. Enclosure for microprocessor shall be [NEMA 4] [12] and shall be located in [_____]. Each group of detector units for a single fabric filter baghouse shall be incorporated into the unit alarm system for its respective baghouse so that a high level in any hopper shall indicate as part of the unit alarm system.

2.12.11 Transmitters

Each transmitter shall be selected and adjusted for the service and operating conditions required and shall be designed to operate at the maximum condition expected. Transmitters shall be electronic, two-wire type with 4-20 mA current signal output powered by 24-volt DC source unless specified otherwise. Enclosures shall have NEMA 4 rating as a minimum. Devices shall be designed to operate continuously under the ambient conditions specified. Furnish condensing pots for flow and level transmitters when required by the conditions of the measured fluid. Furnish seal pots or diaphragm seals where required for the fluid being measured. Furnish transmitter mounting brackets suitable for either surface or piping mounting. Furnish any power supply, transformer, rectifier, or other device required to interface the equipment with the system. Magnetic flowmeter transmitters (signal converters) shall be compatible with the primary elements. Ultrasonic level transmitters shall be protected from process fluid corrosion by resistant coating or material. Temperature compensation shall be within accuracy requirements. Integral output indication shall be graduated in engineering units. Accuracy shall be at least plus or minus 2 percent of measured range. Provide with coaxial cable from each probe to each transmitter. Provide with recommended installation hardware for flange mounting. Transmitter shall use doppler effect to filter out moving fill material during measurement.

2.12.12 Limit Switches

Limit switches shall be provided with DPDT contacts. Limit switches shall be provided with housing conforming to NEMA 4 requirements.

2.12.13 Gage Glasses

Glass shall be 20 mm 3/4 inch borosilicate type class red line tubular. Length shall be a maximum of 915 mm 36 inches per section. Use multiple overlapping sections for more than 915 mm 36 inches length allowing one inch visible overlap between sections. Gage valves shall be offset with 20 mm 3/4 inch union tank connection. Provide four guard rods with holders. Drain valve shall be 15 mm 1/2 inch globe-type needle valve.

2.12.14 Solenoid Valves

Valve body shall be brass of 316 stainless-steel as required by the operating conditions. Coil shall be rated for continuous operation in ambient temperatures up to 50C. Voltage shall be 120 volts AC, single phase, 60 hertz. Provide design features as required that include 15 mm 1/2 inch threaded conduit hub, explosion-proof construction, metal-to-metal seats, and manual operation.

2.12.15 Sulfur Dioxide Analyzers

Analyzers shall have a history of successful application in coal-fired boiler flue gas analysis. Performance shall be unaffected by high moisture content and high grain loading. Analyzers shall meet or exceed the applicable requirements of U.S. EPA Regulation 40 CFR 60, Appendix B. Provide control units, calibration gas, signal cable, mounting flanges, accessories, and appurtenances required for integration of the analyzers into the process control system.

2.12.16 Factory Tests

Notify Contracting Officer, in writing, 45 days prior to factory tests. Conduct standard tests required by the applicable codes and standards.The Contracting Officer's representative may be present as an observer during functional factory testing to assure correct operation of circuits. Perform factory control systems tests with control system components and prefabricated cables connected together, except transmitters and control drive units. Provide an open loop test of each control system to check for circuit continuity. Provide a completely closed loop simulation for each analog control system to verify function and response, and to check direction of response. Provide a completely closed loop simulation for each digital control system to verify sequence operation, timing, and software integrity. Test control boards as follows: Supply control boards with 115-volt AC, 60 hertz, and operate each control switch and selector switch in all positions to verify that control circuits operate ash shown on the schematic diagrams. Simulate remote contacts and switches with jumpers at the appropriate external terminal blocks to verify proper circuit operation. Test annunciator systems to verify that annunciator points operate correctly by jumpering or operating alarm initiating device or jumpering external terminals for remote alarm inputs.

2.12.17 Nameplates

Provide plastic, engraved nameplates for remote mounted devices. Fabricate nameplates from laminated white phenolic plastic with black engraved letters. Size shall be 19 mm high and 80 mm long 3/4 inch high and 3 inches long. Attach nameplates with permanent adhesive or screws.

2.13 STRUCTURAL AND MISCELLANEOUS STEEL

Provide structural and miscellaneous steel required to frame and support the spray dryer absorbers, fabric filter baghouses, ductwork, lime slurry preparation system, and component parts and equipment. Provide steel supports, access platforms, grating walkways and stairs for access to spray dryer absorbers, fabric filter baghouses, and other equipment, as specified in paragraph ACCESS. Structural-steel supports shall be designed to support equipment from the top of concrete foundations set at elevation [_____] (150 mm 6 inches abovegrade). All concrete foundations, anchor bolts and grouting will be provided by the Contractor. The Contractor shall allow 50 mm 2 inches for grout, so that the bottom of the baseplates provided under this contract shall be at elevation [_____]. Provide steel girts, purlins, braces and framing required for enclosures. Compliance submittals shall include general arrangement and outline information, foundation design information, structural fabrication information, and erection information. Unless otherwise specified, all structural steel shall conform to ASTM A36/A36M, as designated in the AISC 360, Part I. High-strength structural steel as listed in AISC may be used if it conform to the appropriate ASTM specification and subject to approval of the Contracting Officer. Structural steel includes columns, beams, trusses, baseplates, girts, secondary bracings, purlins, girders and hangers of structural steel. Miscellaneous steel includes steel other than structural steel such as edge plates, handrails, stairs, grating, ladders, and plate. Structural and miscellaneous steel shall be designed to resist not less than the minimum loadings. Design, fabrication, and erection of structural steel shall conform to the AISC 360 Manual of Steel Construction. Structural components shall be designed for wind loads with a minimum wind velocity of [_____] km/s mph. Design for seismic loads in accordance with Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS. The entire structure along with components shall be designed in accordance with earthquake regulations for structures located in Zone [_____]. The site periods shall be between 0.8 and 1.2 seconds, whichever results in the highest lateral force. The term "W" as used in the calculations for seismic loading shall be interpreted as the normal operating weight of the unit including dead loads. Platform live loads may be excluded. The structural components shall be designed for a snow loading of [_____] kg per square meter pounds per square foot. The structural components shall be designed for dust loading of 98 kg per square meter 20 pounds per square foot. The structural components shall be designed for dust loading where appropriate based on 1600 kg per cubic meter 100 pounds per cubic foot minimum. Use a higher load where applicable. Walkways, platforms, and stairs shall be designed for live loads of 488 kg per square meter 100 pounds per square footplus concentrated equipment loads. Stair live load shall be 610 kg per square meter 125 pounds per square foot and shall be designed to carry the live load or a moving concentrated load of 454 kg 1000 pounds, whichever is greater. Roof purlins shall be spaced so that the metal roof deck span will not exceed 2.13 meters 7 foot. Design for a roof dead load of 98 kg per square meter 20 pounds per square foot and a live load of 148 kg per square meter 30 pounds per square foot.

2.13.1 Girts and Opening Frames

Provide girts for support of metal-wall panels with maximum spacing of 2.13 meters 7 foot center-to-center and supported on the outside face of the columns. Girts shall have a girt line or outside edge distance of 560 mm 1 foot 10 inches from the supporting column centerline. Lowest girt on spray dryer absorbers, fabric filter baghouses, and lime slurry preparation system enclosure to be located abovegrade (Elevation [_____]) with support at base of wall by Contractor. Provide closed ends or miter-cut girts at corners. Provide structural subframing for doors and ventilators located more than [_____] above grade. Contractor will provide doors, door frames, and ventilators and will also provide necessary structural subframing from these items up to [_____] above grade.

2.13.2 Slide Bearings

Provide structural slide bearings for spray dryer absorbers, ductwork, and fabric filter baghouse to ensure correct alignment, prevent equipment damage, ensure that stresses in the ductwork, fabric filter baghouse duct, and supports are not excessive, and to allow efficient system operation at conditions. Provide ductwork and fabric filter baghouse supports, except at totally laterally restrained points, with structural slide bearings. Construct slide bearings with slide bars or other methods to prevent possible accumulation of ash, dirt, and other materials on the bearing area. Slide bearings shall have fluoroplastic self-lubricating bearing elements.

2.13.3 Miscellaneous Steel

Handrail shall be 40 mm 1 1/2 inch round black standard weight pipe conforming to ASTM A53/A53M Type E or S, Grade B, with two horizontal pipe runs at 584 mm and 1067 mm1 foot 11 inches and 3 feet 6 inches above top of walking grating. Handrail, accessories, and kickplates shall be hot-dipped galvanized after fabrication in accordance with ASTM A123/A123M. Kickplates shall be 6 mm 1/4 inch thick steel plate. Steel floor grating shall be one-piece, resistance-welded steel construction without notching of bearing or crossbars before welding. Main bars shall be 5 mm 3/16 inch thick, spaced not more than 30 mm 1 3/16 inches on centers. Serrate main bars for outdoor use. Crossbars shall be spaced at four inches on centers and shall be one of the following shapes: hexagon with 8 mm 5/16 inch diameter of inscribed circle; rectangular 13 by 5 mm 1/2 by 3/16 inch; square 6 mm 1/4 inch with spiral twist; round 8.33 mm 21/64 inch diameter. Grating materials shall be of welding quality and conform to the following standards: (1) Crossbar - ASTM A108 - Grade 1010. (2) Main Bars - ASTM A108 - Grade 1015. Grating finish shall be hot-dip galvanized after fabrication in accordance with ASTM A123/A123M. Stairs shall be open-riser type with grating treads and grating landings conforming to "Steel Floor Grating" an with main bars 25 by 5 mm 1 by 3/16 inch(Serrate main bars for outdoor use). Stair treads and landings shall be hot-dip galvanized after fabrication in accordance with ASTM A123/A123M. Stairs shall be supported with carrier plates 65 by 5 mm 2 1/2 by 3/16 inch by tread width tack welded to all bearing bars and with 5 mm 3/16 inch fillet welds (one side only) to the front two and the rear bearing bars, or supported with 35 by 22 by 3 mm 1 3/8 by 7/8 by 1/8 inch minimum size angle welded to the front and rear bearing bar (one side only). Provide subframing so grating span on landings does not exceed 1067 mm 3 feet 6 inches. Provide nosing on all treads and at the head of all stairs. Raised pattern floor plate shall be 6 mm 1/4 inch minimum thickness with surface deformation of the four-way type. Hot-dip galvanize raised pattern floor plate and straighten warped plate after galvanizing so that warpage does not exceed one inch for every 3 meters 10 feet in any direction.

2.13.4 Fabrication

Shop fabrication and assembly of steel structures shall be done in conformance with AISC Specifications, Codes, and Standards. Field welding shall be shielded metal arc or submerged arc. Shop welding shall be shielded-metal arc, submerged arc, flux-core arc, or gas metal arc. Welding shall be done in conformance with the requirements of the AWS D1.1/D1.1M and AISC Specifications. Field welds shall be shown on erection drawings in conformance to the applicable standards. Shop connections shall be welded, riveted, or bolted with high-strength bolts at the Contractor's option and as allowed by the seismic code. Unless restricted by consideration of clearance or seismic design criteria, field connections shall be shown as bolted friction type using ASTM A325M ASTM A325 or ASTM A490M ASTM A490 bolts and shall be designed to conform to AISC specification for "Structural Joints Using ASTM A325M ASTM A325 or ASTM A490M ASTM A490Bolts." Form and weld handrails and do not exceed 1.83

meters 6 feet from center-to-center of posts. Grind welds smooth and even with the surface of the pipe, remove weld splatter. Carefully form transitions at corners where change of direction or elevation occurs as required to provide continuous handrail. Clear columns or other vertical or horizontal projections by at least 80 mm 3 inches. Furnish plates and additional items as required for fastening to supporting members. Extend kickplates 100 mm 4 inches above top of grating and install at the edge of uncovered openings and at the edge of walkways and platforms. Kickplates shall be constructed to allow water run-off. Shop fabrication shall be as complete as possible and within standard industry practice. Large pieces shall be left unassembled only to the extent necessary for shipment.

2.13.4.1 Grating

Fabricate grating main bars vertical within a tolerance of 2.5 mm per 25 mm 0.1 inch per inch of depth with the longitudinal bow before fastening to supports shall be less than 1/200 of the length and the traverse bow before fastening to supports shall be less than 10.41 mm in one meter 3/8 inch in 3 feet. Crossbars shall not deviate from a straight line perpendicular to the main bars by more than 5.21 mm in one meter 3/16 inch in 3 feet. Crossbars shall match crossbars of adjacent sections to form a continuous pattern of straight lines. Grating panels shall be cut to size and piece marked. Panel width and length tolerances shall be plus or minus 6 mm 1/4 inch. Provide openings in grating as required for installation of piping and equipment furnished under this Contract. Band openings 100 mm 4 inches and larger with a metal bar same size as main bearing bar. Weld to each bearing bar with 4.76 mm 3/16 inch fillet weld 19 mm 3/4 inch long. Tack weld to crossbars. Trim band open end of grating at head of ladder, manway opening, hinged sections, and grating panels with four crossbars or less. Grating shall be removable. Fasten raised pattern floor plate in place with countersunk stainless-steel screw at each corner of each piece or plug weld where permanent fastening is required. Screws shall be flathead, 6 mm 1/4 inch, national coarse thread stainless steel, and shall be countersunk.

2.13.4.2 Stairs

Construction of stringers of channel sections shall be adequate to carry the specified design loads without excessive deflection. Construct cross brace stringers to provide lateral stability where the horizontal run exceeds 3.66 meters 12 feet. Provide struts and hangers where required to suit specified live load with minimum size as specified. Bolt tread to stringers with a minimum of two 9.53 mm 3/8 inch, national coarse thread, stainless steel bolts.

2.13.5 Access

Provide access walkways across top of ductwork from boiler enclosures to spray dryer absorbers as indicated. Extend walkways to fabric filter baghouses as indicated. Stair access and platforms shall be supplied to fabric filter baghouse hopper accessories. Provide stair access and walkways for access to the tube sheet level of the fabric filter baghouses with connecting walkways. Internal and external access walkways, lights, and platforms shall be provided to access doors, inspection or maintenance points, and other areas where access is required for operation, inspection, testing, and maintenance. Walkways and platforms at each level shall be interconnected by walkways at the same level. Walkways including roof, shall be connected by stairs. Caged ladders shall be provided at each level for secondary egress. Provide stair access and platforms to lime system equipment levels. Access shall be provided for dust valves, manholes, poke holes, hopper vibrators, conveyors, expansion joints, dampers, portion of the ductwork subject to dust accumulation, gas sampling points and all parts of equipment requiring routine maintenance, repair or replacement. Handholds shall be provided inside and outside directly above each access door. Access doors, and mechanical and electrical components shall be accessible from a walkway or platform. Complete layout of access system shall be subject to approval of the Contracting Officer.Provide supporting steel, grating, handrails, and kickplates electrical lights and outlets for walkways, stairs and platforms. Arrangement, design, and fabrication of access systems shall conform to OSHA regulations. Headroom shall be 2.13 meters 7 foot clear. Provide adequate allowance for installation of piping, conduit, electrical outlets, and lighting fixtures. Design exterior walkways and platforms which will be located above ductwork or other areas requiring insulation and lagging to allow a minimum of 150 mm 6 inches clearance between lagging and bottom of walkway structural steel assuming that insulation and lagging will be placed on top of ductwork stiffeners. Stairs, walkways, platforms, and ladders and their vertical support steel shall be located a minimum dimension of 0.91 m 3 foot from the outside column row centerline of structures for which the Contractor will be supplying and installing metal wall panel. Walkways width shall be 0.91 m 3 foot, minimum. Include handrail and kickplates around platforms. Design access stairs, as specified. Access stairs width shall be 0.91 m 3 foot, minimum. Include handrail along both sides, top rail to be 762 to 813 mm 2 foot 6 inches to 2 foot 8 inches above edge of tread. Stairs shall be open-riser type. Stair treads shall be as specified. Stairs shall have a minimum of 229 mm 9 inch tread and a maximum of 203 mm 8 inches rise. Minimum width of ladders shall be 457 mm 1 foot 6 inches. Rung diameter shall be 19 mm 3/4 inch. Rungs shall be spaced at 300 mm 12 inch on centers. Side rails shall be a minimum of 9.53 by 63.50 mm 3/8 by 2 1/2 inch. Exterior ladders and cages shall be hot-dip galvanized after fabrication in conformance with ASTM A123/A123M. Provide gas-tight and liquid-tight access doors to facilitate entry to parts of the flue gas cleaning system. Access doors shall be 610 mm 24 inch minimum diameter and the quick opening type. Access doors shall have ethylene propylene terpolymer (EPDM) gaskets. Provide access doors with hinges to support door when open. Provide access doors with external latches and tightening devices which allow for gasket shrinkage without loss of gas-tight seal. Provide safety chains on access doors to allow door to be cracked open slightly before opening completely. Provide a means of padlocking access doors in the open position. Provide inside and outside handholds directly above each access door.

2.13.6 Personnel Access Requirements

2.13.6.1 Class 1

Regularly attended areas shall have access operating platforms which are fully accessible by stairs. No ladder or ships ladders for access will be permitted. Areas included: Lubricated equipment, bearings, instruments, valve operators, damper operators, damper linkages and drives, test ports, instrument connections, and equipment requiring access during operation and for normal day-by-day inspection and maintenance. Platforms at same elevation on each side of equipment or building shall have a walkway connecting the two sides.

2.13.6.2 Class 2

Maintenance access areas such as expansion joints, duct access doors, safety valves, valve packing, and other areas requiring access every two years or more, shall have access platforms of adequate size to permit two people to work, 1.12 meter 12 square feet minimum, with access ladders and maintenance access walkways for reaching the platforms in accordance with the following: Maintenance access walkways shall be not less than 610 mm 2 foot in width. Ladders shall be as specified in paragraph ACCESS. Headroom shall be 2.13 meters 7 footclear except 2 meters 6 foot 6 inches will be allowed in tight locations. Provide adequate allowance for installation of Government's piping, conduit, and lighting fixtures. Provide at least two avenues of escape from safety valves or other hazardous equipment.

2.13.6.3   Class 3

Maintenance access areas, where access is only required for painting, reinsulation, or replacement of components which have a service life of 10 years or more, shall be met by providing facilities to enable the erection of patent scaffolding, temporary ladders, platforms and safety nets to safely perform the work involved.

2.13.6.4   Maintenance Access Requirements

Provide rotating machinery and mechanical equipment components weighing in excess of 91 kg 200 pounds with monorails and eyebolts to permit the equipment to be removed and lowered to grade in a single lift.

2.13.7   Painting

The steel surfaces must be dry and clean in accordance with the following requirements. Remove grease, oils, and contaminants as outlined in SSPC SP 1. Remove weld spatter and grind burrs on cut edges and rough welds smooth. Blast-clean surfaces after fabrication, in accordance with SSPC SP 6/NACE No.3 and profile depth from 0.038 to 0.064 mm 1.5 to 2.5 mils. Apply first coat before any rust bloom forms. Apply one coat, dry film thickness of 0.076 mm three mils, of any of the organic zinc-rich primers meeting the requirements of SSPC PS 12.01, with a minimum of 82 percent zinc in the dry film. Apply primer in accordance with manufacturer's recommendations. Apply primer to steel surfaces except the areas within 50 mm 2 inches adjacent to field welds and surfaces specified to be hot-dip galvanized.

PART 3   EXECUTION

3.1   INSPECTION

As equipment is delivered to the jobsite, it shall receive a preliminary inspection by Contractor Quality Control Representative and the Contracting Officer. The inspection will be continued during the installation after installation, and during testing. The right is reserved to inspect equipment at the plant of the manufacturer, during or after manufacture, and to require reasonable witness tests before shipments are made. Government and Contractor Quality Control Representatives shall be allowed unrestricted access to manufacturing and fabrication facilities. Any equipment rejected shall be either corrected or replaced before installation. The Contractor shall provide field representatives for technical direction of the erection, startup, and testing of the FGD system by the Contractor and for training of the Government's operating personnel.

3.1.1 Contractor Construction Representatives

The Contractor shall furnish experienced, competent, contractor construction representatives including travel and living expenses, to advise and consult the Contractor regarding erection procedures and quality standards for the equipment furnished. These inspection services shall be furnished from receipt of materials at the jobsite until the equipment and material furnished under this contract is ready for operation by the Government. The contractor construction Representative shall be responsible for the inventory and inspection of equipment and material furnished under this contract at delivery to determine if the equipment and material meets the requirements of the specifications for the Contractor's purpose of recovering, at the Contractor's option, the cost of new equipment and materials or the cost of corrections or modifications to the equipment, and materials from the Contractor's, subcontractors, or suppliers.

3.1.2 Contractor Construction Representative Areas of Work

The contractor construction representative shall advise and consult with the Contractor regarding the proper removal of equipment from rail cars, trucks, and other means of shipment, and the movement of material to and from storage facilities. Contractor shall advise Contracting Officer regarding the need for various classes of storage facilities. The Contractor shall advise the Contracting Officer regarding the protection of equipment while in storage. Contractor shall review the status of stored equipment and advise the Contracting Officer of any condition not in conformance with the Contractor's storage requirements. Contractor shall review the storage facilities to ensure the following:

a. Protection of motors, electrical equipment, and machinery of all kinds against corrosion, moisture deterioration including temporary wiring of motors space heaters while in storage, mechanical injury, and accumulation of dirt or other foreign matter.

b. Protection of exposed machined surfaces and unpainted iron and steel as necessary with suitable rust-preventive compounds.

c. Protection of bearings and similar items with grease packing or oil lubrication.

d. Handling and storing of steel plate, breeching sections, dampers, expansion joints, and similar items, in a manner to prevent deformation.

e. Blocking equipment and material stored outdoors, at least 6 inches above the ground and arranging for natural drainage with equipment drain connection open, but protected.

Contractor Construction Representative shall advise and consult with the Contractor regarding the erection of structural and miscellaneous steel, installation, and retightening of valves, welding of piping, installation of instruments and controls, installation of insulation and lagging, erection of bracing and scaffolding, grouting, retouching paint surfaces, protection of equipment from freezing, and alignment of equipment.

3.1.3 Field Service Engineer Representatives

Contractor shall include in his bid the cost of the services of competent, qualified field service engineers from the manufacturers of purchased equipment. Field service engineers shall provide consulting and advising services required for placing equipment into successful operation. Field service engineers shall be provided for the spray dryer, fabric filter baghouse, hopper heaters, fly ash level detectors, induced draft fans, pumps, dampers, control valves, air pollution monitors, FGD system panelboard, and analog control systems. Field service engineers shall perform an inspection prior to startup to verify that the unit is installed in conformance with the manufacturer's recommendations. A written report of the inspection, performed by the field service engineer, shall be submitted to the Contracting Officer stating his findings including the acceptability of the FGD system for field performance tests within 15 calendar days after his inspection. Field service engineer shall be on call for 30 days after start-up.

3.2 INSULATION INSTALLATION

3.2.1 General

Insulation shall be applied with interruptions to permit access doors, inspection doors, flanges, and other special features to be opened or removed for inspection or maintenance without disturbing the insulation. Boxouts around code stamping symbols and nameplates shall be provided. Double thickness insulation shall be installed with the joints of the two layers staggered. Cracks, voids, and depressions in layers of insulation shall be filled with suitable insulating cements before application of another layer of insulation as required to allow for thermal expansion movements which might cause cracks or tears in the insulation. Insulation shall be installed between stiffeners or over stiffeners in such a manner that stiffeners are completely insulated. Additional insulation or casing spacers shall be installed between stiffeners so that a uniform level surface is achieved. The intent of this insulating procedure is to prevent a direct metal path between inside the dry FGD system and ambient air. Insulation shall be securely wired and laced in place using No. 14 dead soft type 302 stainless steel wire, conforming to ASTM A580/A580M.

3.2.2 Block and Mineral Fiberboard Insulation Installation

Block and mineral fiberboard insulation shall be held in place with insulation lugs spaced on not greater than 300 by 450 mm 12 by 18 inch center. The lugs shall be stud type welded in place. Blocks shall be reinforced on the exterior face with expanded metal, if necessary, to prevent sagging or cutting of the insulation by the lacing wire. Block and mineral fiberboard insulation of the specified thickness shall be securely wired in place over the entire surface by means of wire threaded through the lugs both ways, pulled tight with the ends of the wire loops twisted together with pliers, bent over, and carefully pressed into the surface of the insulation.

3.2.3 Mineral Fiber Blanket Insulation Installation

Mineral fiber blanket insulation shall be held in place with speed washers and impaling pins spaced on centers not exceeding 300 mm 12 inches. Mineral fiber blanket insulation shall be provided with expanded metal reinforcement on the outer surface and wire mesh or expanded metal on the inner surface. Sections of the blankets shall be tightly butted and jammed together, and securely tied for maximum sealing at joints. The blanket shall be secured at joints to prevent peeling or bulging away from blanket edges. Care shall be taken in applying speed washers so that the designed thickness of insulation is not reduced when washers are installed.

3.2.4 Protection From Insulation Materials

Equipment and structures shall be adequately protected from damage from insulation materials. After completion of the work, equipment and structures shall be cleaned, repaired, and restored to their original state. Casings which become corroded, discolored, or otherwise damaged shall be repaired by replacement of casing or other means acceptable to the Contracting Officer.

3.3 CASING INSTALLATION

3.3.1 Structural Steel Grid System

Casing shall be installed on aluminized structural steel grid system of subgirts designed, furnished, and installed by the Contractor. The subgirts shall be of sufficient size, gage, and depth to provide adequate support and a smooth exterior surface and shall be welded to the equipment and structural support surfaces. Subgirts shall be of sufficient depth to provide for application of the full thickness of insulation over the stiffeners, access doors, flanges, ribs, and other surfaces having uneven contours to provide a smooth finished surface. Subgirts on vertical and bottom surfaces shall be at a maximum spacing of 1220 mm four feeton centers. Subgirts on roof surfaces shall be at a maximum spacing of 600 mm two feet on centers. The walking surfaces shall be such as to transmit an external 114 kg 250 pound walking load from the casing to the structural steel grid system without compression of the insulation material.

3.3.2 Access Openings

Access doors and other penetrations through the insulation shall have insulation fitted closely to the fittings and shall be neatly framed and flashed to make weathertight and to create a pleasing appearance. Hinged or lift-off doors designed for convenient opening or removal shall be provided with nameplates, code stampings, and nonprojecting connections at all access openings. Access openings shall be pitched for water runoff and have flashing at door head as shown in SMACNA 1793.

3.3.3 Weatherproofing

Install casing with proper overlap to make the installation weathertight. The casing shall be carefully fabricated and fitted to ensure a neat appearance. Provide closures, flashings, and seals. The open ends of fluted sections shall be provided with tightfitting closure pieces. Flashing shall be suitably formed and installed so that water cannot enter and wet the insulation. The flashing shall be designed and installed to readily drain any water that might enter. Joints or openings in casing which cannot be effectively sealed from entry of moisture by flashings or laps shall be weatherproofed by application of an aluminum-pigmented sealer manufactured for this type of service.

3.3.4 Convection Stops

Furnish and install convection stops on vertical surfaces over 3.70 meters 12 feet tall. The maximum interval between convection stops shall be 3.70 meters 12 feet. The convection stops shall consist of steel channels or Z girts.

3.3.5 Casing Attachment

Attach aluminum casing to the steel structural members by means of No. 14 stainless steel series 300 self-tapping screws on 300 mm 12 inch centers. Fasten vertical laps and flashing by means of 10 mm 3/4 inch No. 14 stainless steel series 300 sheet metal screws on 300 mm 12 inch centers. Exposed screws shall have aluminum or stainless steel backed neoprene washers preassembled to screws. Installation shall be such that the insulation is not compressed below nominal thickness.

3.4 FIELD INSPECTIONS AND TESTS

3.4.1 General

Field testing of the equipment provided under this contract shall include the tests specified herein. Field testing will be performed by the Contractor and observed by the Contractor's field representatives as indicated in Section 01 45 00 QUALITY CONTROL. If the equipment fails to perform as required by this specification during any of these tests due to any deficiency in the Contractor's work, the cost of any repairs and any retesting required as a result of such deficiency shall be borne by the Contractor.

3.4.2 Hydrostatic Tests

After erection, piping systems shall be given a hydrostatic test 50 percent in excess of the design working pressure in accordance with the ASME BPVC Boiler and Pressure Vessel Codes (Sections I, II, V, VIII, and IX) and the applicable portions of ASME B31.1. Hydrostatic tests shall be conducted before any piping systems are encased by jacketing or insulation. Contractor shall provide cold water for the tests and suitable disposal facilities for wastewater after tests are complete. Contracting Officer has option to provide or not provide cold water or disposal facilities. Contractor shall furnish necessary equipment and materials required for testing including pumps, gages, temporary blank-off plates, gaskets, anchors, and bracing required to conduct tests. Contractor shall furnish and install an accurate pressure recorder and continuously record the pressure during the complete hydrostatic test. Contractor will furnish and install adequate relief valves to limit the maximum pressure that can be developed during the hydrostatic test to the specified test pressure. Tanks will by hydrostatically tested with clear water by filling to not less than 150 mm six inches from the tank top. Welds at tank bottom will be tested using a bubble technique, as specified in ASTM E515.

3.4.3 Smoke Tests

Spray dryer absorber vessels, fabric filter baghouse modules and breeching will be given a smoke test with smoke bombs producing a larger volume than available in the FGD system. The purpose of this test is to detect leaks due to shop and field welding and at expansion joints around seals. Test will be made by sealing gas inlets, outlets, and other openings. Pressure will be produced with a special pressure fan or with compressed air. Testing equipment and materials will be provided by the Contractor. Perform testing prior to the placement of insulation and lagging. Leaks found during the test will be repaired and the equipment will be retested until complete system is acceptable. Conduct tests at a pressure of 1245 Pa 5 inches W.C. Measure pressure with a suitable water manometer. High-intensity white smoke bombs shall be used to provide the means for leak detection. Contractor shall provide equipment and materials required for the tests including fans, compressor, blank-off plates, gaskets, and smoke bombs. Notify the Contracting Officer 48 hours in advance prior to conducting any smoke tests. Tests will be witnessed by the Government's Field Representative.

3.4.4 Acceptance Tests

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NOTE: Method 17 of 40 CFR 60 may be used as an alternative to Method 5. Specify that testing shall include sootblowing where applicable in certain states. If necessary provide for steam venting. Test with fuel close to design parameters. Operate boiler close to design parameters.

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NOTE: Since most Navy facilities are not base loaded determine turn down capabilities of system.

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After a period of initial operation, a performance test will be conducted on the [entire steam plant] [dry FGD system]. Conduct tests to determine if, according to the Contracting Officer, equipment and systems provided under this contract appear to be operating in a reliable and satisfactory manner. Tests will be conducted to determine if the equipment is performing as specified. Conduct final acceptance tests for gas cleaning performance in accordance with the test procedures outlined in U.S. EPA regulation 40 CFR 60. Performance testing for the fabric filter baghouses shall conform to methods 1, 3, 5, 6, 7, and 9. [For the purpose of determining fabric filter baghouse performance, the term "particulate" shall not include material collected in the impingers of the Method 5 sampling train.] Performance simultaneously testing for sulfur dioxide removal efficiency will be based on testing upstream of the spray dryer sulfur dioxide absorber and downstream of the fabric filter baghouse utilizing Method 6. Three contiguous one-hour runs shall constitute one test. Tests shall be conducted on the flue gas cleaning equipment for each of the units. Conduct tests at both 50 and 100 percent of rated boiler capacity. The operating temperature limits specified will be maintained during the acceptance tests. [Sootblowers will [not] be operated during the performance test for sulfur dioxide removal or fabric filter baghouse performance]. Perform field performance tests by an independent testing organization approved by the Contracting Officer. The Contractor shall give written notice to the Contracting Officer, at least 45 calendar days before scheduled test date, stating that equipment is being scheduled for test. Perform a trial run of 30 days minimum before actual test to ensure that associated systems required for the test are ready. Contractor and the manufacturer's field service engineer shall witness the test. Tests shall be performed at design conditions herein specified. Conduct the efficiency tests after the gas cleaning system has been in continuous service for at least 45 days.

3.4.5 System Stoichiometry Tests

Contractor shall conduct system stoichometry tests for the flue gas cleaning systems. Measure system stoichiometry as the ratio of moles of sorbent entering the spray absorber per mole of sulfur dioxide entering the spray absorber. Sulfur dioxide entering the spray absorber shall be determined by Method 6 of 40 CFR 60, Appendix A. Sorbent entering the spray absorber shall be calculated from the lime slurry feed rate and the calcium hydroxide content of the lime slurry as determined by ASTM C25. Conduct separate tests for each spray absorber. Tests shall be performed at both 50 and 100 percent of rated boiler capacity. Contractor shall consult with the Contracting Officer and with the Government's operators to coordinate schedules and operating conditions for the tests.

3.4.6 System Power Consumption Tests

Contractor shall measure the total power consumption of the flue gas cleaning system with boiler unit in operation at 100 percent of rated capacity. Power consumption shall be determined through the use of watt-hour meters provided by the Contractor for the purpose. Watt-hour meters shall be used at the power supply inputs to the motor control center for the lime slurry preparation equipment, the motor control center for the spray absorber-baghouse combination in operation, and the operating induced draft fan motor. The watt-hour meters used shall be accurate to within 1.0 percent. Coordinate test schedule and operating requirements with the Contracting Officer and the Government's operators.

3.4.7 Test Failures

In case any of the equipment furnished under this contract fails to operate as required, or in case of failure to meet any of the provided for in this contract, the Government shall have the right to operate the equipment until such defects have been remedied, and guarantees complied with as specified in paragraph QUALITY ASSURANCE, without cost to the Government. Failure to meet guarantees for which a schedule of compensatory damages has been specified may be resolved, at the Government's Option, by deduction of compensatory damages from the final payment. Removal of rejected equipment shall be scheduled at the convenience and discretion of the Government. In the event that serious defects necessitate the rejection of equipment, the Government will have the right to operate the equipment until such time as new equipment is provided to replace the rejected equipment.

3.5 PAINTING

Provide field painting of those surfaces of the following equipment not in contact with the flue gas stream; cyclones, fabric filter baghouse, fans, dry scrubber, and ductwork. Field painting shall meet the requirements specified in Section 09 90 00 PAINTS AND COATINGS. Other equipment provided in this section shall be painted; either field-painted with systems conforming to the requirements specified in Section 09 90 00 PAINTS AND COATINGS or painted with factory or shop painting systems conforming to the requirements specified in Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.

3.5.1 Galvanic Corrosion Prevention

To prevent galvanic corrosion, care shall be used to prevent permanent contact of aluminum casing with copper, copper alloy, tin, lead, nickel alloy including Monel Metal. Where it is necessary to attach the casing to carbon steel or low alloy steel, the steel shall first be prime painted with zinc chromate, and then painted with aluminum paint suitable for surface temperatures encountered. The use of lead base paint is not acceptable.

3.6 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. [_____]	[_____]	[_____]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 51 43.01 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15861N (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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04/06

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USACE / NAVFAC / AFCEC **UFGS-23 51 43.01 20 (April 2006)**

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SECTION 23 51 43.01 20

MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES

04/06

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NOTE: This guide specification covers the requirements for furnishing, installing, adjusting, and testing of mechanical cyclone-type dust collector(s).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: The dust collectors are intended to be used for flue gas particulate removal and collection associated with coal-fired or oil-fired boilers and refuse-fired waste disposal incinerators. Coal-fired boilers applicable to this specification are those designed for pulverized coal firing, spreader stoker firing, or underfeed stoker firing with capacities ranging between 3.78 and 44 kilogram of steam per second 30,000 and 350,000 pounds of steam per hour. The incinerators applicable to this specification are those designed for burning municipal-type waste having firing capacities between 454 kilogram per hour 1,000 pounds per hour and 182 Mg 200 tons per day.

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NOTE: The following information must be shown on the project drawings:

1. The physical geometry of the cyclone relative to the plant.

2. The manner in which the cyclone is connected to the ductwork.

3. The means of physical support of the cyclone.

4. The amount of clearance between the hopper and floor.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A139/A139M	(2022) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A532/A532M	(2010; R 2023) Standard Specification for Abrasion-Resistant Cast Irons
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM A667/A667M	(1987; R 2022) Standard Specification for Centrifugally Cast Dual Metal (Gray and White Cast Iron) Cylinders
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C401	(2012; R 2022) Alumina and Alumina-Silicate Castable Refractories
ASTM C592	(2024) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation

INSTITUTE OF CLEAN AIR COMPANIES (ICAC)

ICAC M-2	(1969) Cyclonic Mechanical Dust Collector Criteria
ICAC M-4	(1973) Information Required for the Preparation of Bidding Specifications for Large Diameter Cyclones and Tubular Centrifugal Collectors
ICAC M-5	(1975) Standardized Method of Particle Size Determination and Collection Efficiency
ICAC M-6	(1981) Simplified Method of Efficiency Calculations from Fractional Efficiency Curves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1403	(2008) Accepted Industry Practice for Industrial Duct Construction, 2nd Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SSPM	(2010) SSPC Painting Manual, Volume 2, Systems and Specifications

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-28	(Rev H) Paint, Aluminum, Heat Resisting (1200 Degrees F.)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces
40 CFR 60	Standards of Performance for New Stationary Sources

1.2 SYSTEM DESCRIPTION

****

NOTE: Select the applicable paragraph(s) from the following:

****

****

NOTE: Use these paragraphs for multitube collectors 150 mm 6 inch diameter collecting tubes may cause a plugging problem. Designer must investigate flue gas particulate size, distribution and tendency of particulates to adhere to each other for the specific project before selecting diameter of collector tubes.

****

****

NOTE: The third sentence of this paragraph must be used only when dust collector is used with spreader stoker-fired boiler.

****

[Dust collector(s) must be multitube, mechanical cyclone type, having collector tubes in accordance with ICAC M-2, ICAC M-4, ICAC M-5, and ICAC M-6. Collector(s) must remove fly-ash from flue gas produced by a [pulverized coal-fired boiler] [spreader stoker-fired boiler] [underfeed stoker-fired boiler] [No. 6 fuel oil fired boiler] [refuse fired waste disposal incinerator of water wall furnace design]. [There must not be any reinjection from dust collector hopper(s) into spreader stoker-fired boiler.] Collector(s) must be designed for [indoor] [outdoor] installation and located in the flue-gas system between [_____] outlet and [_____] inlet [existing] locations. Provide necessary gas distribution devices in the ductwork ahead of and at the entrance of the dust collector(s) to ensure even gas flow into the dust collector(s).]

****

NOTE: Use this paragraph for 600 mm 24 inch or larger diameter cyclone collectors. A choice of diameter is dependent upon design parameters that must be analyzed.

****

[Dust collector(s) must be high-efficiency, mechanical cyclone-type, [600 mm] [24 inch] [_____] diameter centrifugal cyclone body with tangential entry having arrangements of one, two, four, or more parallel unit combinations in accordance with ICAC M-2, ICAC M-4, ICAC M-5, and ICAC M-6. Collector(s) must remove fly ash from flue gas produced by a refuse fired waste disposal incinerator of the no-boiler furnace design. Collector(s) must be designed for [indoor] [outdoor] installation and located in the flue gas system between [_____] outlet and [_____] inlet [existing] locations. Provide necessary gas distribution devices in the ductwork ahead of and at the entrance of the dust collector(s) to ensure even gas flow into the dust collector(s).]

1.3 PERFORMANCE

****

NOTE:

1. The stack emission or efficiency requirement must comply with either (a) weight emission standards: (b) opacity regulations; or (c) community standards for visible emissions. Compliance with existing emission codes may not satisfy the opacity regulation. Similarly opacity regulations may not be as demanding as community standards. A specific quantitative emission rate must be selected on the basis of the goals established.

2. Stack opacity is influenced by particle size makeup. For example, with pulverized coal-fired boilers, about 45 percent of ash particles are below 10 microns in size; for a cyclone-fired boiler, about 70 percent are below 10 microns; for a stoker-fired boiler, about 25 percent are below 10 microns. A visually acceptable stack for these three options might require residuals of 0.046 g/m3 0.02 gr per cf, 0.023 g/m3 0.01 gr per cf, and 0.0929 g/m3 0.04 gr per cf, respectively.

3. A 90 percent overall collection efficiency may be attainable with most coals burned in underfeed or gravity feed stoker-fired boilers. Mechanical cyclones must be viewed as a part of an air pollution system on boilers or incinerators. When used as precleaners in conjunction with electrostatic precipitators (ESP) or baghouses, a

high efficiency cyclone is not necessary and may even adversely affect the high efficiencies of the ESP or baghouse. In addition, 90 percent efficiency is dependent upon particle size, distribution and concentration as well as the collector being or not being used in conjunction with higher efficiency ESP or baghouse collectors. The large diameter cyclones do have a low pressure drop, but the high efficient multitube collectors operate in a range from 747 to 1992 Pa 3 to 8 inches water gage.

****

[Multitube] [Centrifugal cyclone] collector must operate with a minimum overall collection efficiency of [_____] percent at a maximum draft loss of [1992] [249] Pa [8] [1] [_____] inch water gage when operating at maximum [continuous] [peak] rating of flue gas flow conditions, dust loading, and dust particle size distribution specified in paragraph INLET GAS CONDITIONS.

1.4 DESIGN REQUIREMENTS

1.4.1 Mechanical Cyclone Dust Collector System

Indicate the kind, size, collector arrangement with duct gas distribution devices, duct transitions, hopper access, walkways, housing access, damper and damper controls, draft gage and sample portal connections, weight of each component, and breakdown for shipment. When detail drawings are submitted without statements describing sectional shipments, it will be understood that no field assembly of the equipment will be required. Indicate the arrangement of platforms, walkways, stairways, and fixed ladders that are required for operation, examination, testing and maintenance of each dust collector. Indicate the external connections, location of local controls and remote control panels, anchorages, and supports required; the dimensions needed for installation and correlation with other materials and equipment; and foundation and loading information. Submit the layout drawings for each component showing design and assembly. Layout drawings must show each hopper face with all arrangement including control zones. Submit wiring diagrams and control schematics of all electrical and pneumatic circuits used.

1.5 OPERATING EXPERIENCE REQUIREMENTS

1.5.1 Equipment

Provide only [a] dust collector[s] which meet[s] all of the operating experience requirements listed below.

1.5.2 Operating Experience

Manufacturer must certify that the manufacturer has constructed not less than three mechanical cyclone type dust collectors of the [multitube mechanical type] [high-efficiency; large-diameter centrifugal cyclone type] treating flue gas from [an incinerator] [a boiler] with [automatic] [manual] combustion control. Each collector must have performed satisfactorily, normal maintenance or downtime of the associated [boiler] [incinerator] included, for a period of not less than 2 years treating at least [_____] L/s acfm of inlet gas at a temperature of at least [_____] degrees C F, with inlet dust loading of at least [_____] grams per liter grains per acf and outlet dust loading of at most [_____] grams per liter grains per acf. In determining this experience:

a. Only collection of fly ash as produced by [coal-fired boilers] [oil-fired boilers] [refuse-fired waste disposal incinerator] is considered as equivalent experience.

b. Only experience at the approximate flow gas volume, flue gas temperature and inlet dust loading is acceptable.

1.6 MANUFACTURER'S FIELD REPRESENTATIVE

Furnish the services of [a] field representative(s) specifically trained by the manufacturer to assist installers of their equipment. Field representative(s) must be at the erection site during all phases of the installation including unloading, hauling, storing, cleaning, erecting, and testing. It is the responsibility of the field representative(s) to assist the installer during the erection of [the] dust collector(s) and to assure both parties that dust collector(s) [is] [are] being installed in accordance with the dust collector manufacturer's recommendations. The field representative(s) must certify in writing to the Contracting Officer that dust collector(s) [has] [have] been installed as recommended by the manufacturer. The field representative(s) must supervise the adjustment of all controls, control devices, and components supplied with dust collector(s) as necessary to place dust collector(s) in successful operation. Field representative(s) must instruct plant operators in operation, care, and maintenance of the dust collector(s). Written notice from the Contracting Officer must be received prior to scheduling these instructions. The field representative[s] services will be required for approximately [3] [_____] days and will include [2] [_____] round trips to the job site.

1.7 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, must apply.

1.8 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

[Centrifugal Cyclone Collector]

[Multitube Collector]

Submit performance curves consisting of particle size distribution and fractional efficiency curves.

SD-02 Shop Drawings

Mechanical Cyclone Dust Collector System

SD-07 Certificates

Lists of Prior Installations

Certification of Testing Capability

SD-06 Test Reports

Voltage Testing Certificate

Post-installation Inspection of Dust Collectors

Performance Test of Dust Collectors

Particulate Tests of Dust Collectors

Submit post installation inspection report within 15 calendar days after inspection stating the findings including a statement that [the] mechanical dust collector(s) [are] [are not] acceptable for field performance tests. Perform dust collector tests in conjunction with boiler or incinerator. For each performance test, including cycling test and 100 percent load testing, submit data specified in paragraph INLET GAS CONDITIONS and paragraph DUST COLLECTOR DATA. Depict deficiencies and failures of components in test reports. Test reports for particulators tests must certify that instruments were calibrated and readings indicated are true, that computations required for testing are accurate, that acceptable methods were used, and that the equipment performed in accordance with the requirements or performed with depicted failures or deficiencies. Results of additional tests must be recorded and submitted in a written report to the Contracting Officer.

SD-10 Operation and Maintenance Data

Centrifugal Cyclone Collector, Data Package 3

Multitube Collector, Data Package 3

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include complete installation, operation and maintenance instructions and data including models and serial numbers and part lists for the equipment.

1.9 QUALITY ASSURANCE

1.9.1 Lists of Prior Installations

Submit within 30 days after award and prior to commencement of installation, a certificate containing the following information:

a. A list of at least three installations meeting requirements set forth in paragraph OPERATING EXPERIENCE.

b. Owner and location of each installation.

c. Date of owner acceptance of each installation.

d. Collector model number.

e. Design inlet gas volume, L/s acfm.

f. Design inlet gas temperature, degrees C F.

g. Design inlet dust loading, grams per liter grains per acf.

h. Design outlet dust loading grams per liter grains per acf.

i. Type of [coal-fired] [oil-fired] [boiler] [refuse-fired waste disposal incinerator].

1.9.2 Certification of Testing Capability

Certify that the factory is capable of performing electrical integrity tests of 1000 volts for hopper heater modules, blanket or tape.

1.9.3 Voltage Testing Certificate

Submit test.

1.10 BID FORMS

ICAC M-4 evaluation bid forms.

1.11 DELIVERY AND ASSEMBLY

Ship equipment completely factory-assembled, except when physical size, arrangement, or configuration of the equipment, or shipping limitations, makes the shipment of completely assembled equipment impracticable, in which case assemble equipment and ship as shown on the approved shop drawings. The Contractor is responsible for all costs encountered in the field for assembly of sections, accessories, or appurtenances not listed in the proposal as requiring field assembly.

1.11.1 Coordination

Contractor must ensure that design parameters of collector are coordinated by dust collector manufacturer with manufacturers of system equipment and installing contractor of ductwork with gas distribution devices which will interface with, and optimize system operation.

1.12 DATA AND CONDITIONS

1.12.1 Boiler Data

****

NOTE: Select the applicable paragraph(s) from the following:

****

****

NOTE: Depending on air pollution emission regulations, mechanical cyclone-type dust collectors should not be used alone on pulverized coal-fired boilers. They should be used with, and ahead of, electrostatic precipitators. Specify range of properties for coal. If other air pollution equipment exists or is proposed, list: description, type, rating, performance, condition, expected life and how to be used with new equipment.

****

****

NOTE: Insert appropriate Section number and title in the blanks below using format per UFC 1-300-02.

****

Design mechanical cyclone-type dust collectors for operation with [the boiler(s) specified in [_____]] [boiler(s) manufactured by [_____], Type [_____], Model No. [_____]]. The boiler is a [new] [existing] [pulverized coal-fired] [spreader stoker-fired] [underfeed stoker-fired] [No. 6 fuel oil fired] boiler rated [_____] kilogram per second of steam at [_____] kPa pounds per hour of steam at [_____] psi, having a gross heat input of [_____] kilowatt million Btu per hour, and utilizing coal with the following approximate properties:

a. Proximate analysis, as received, percent by weight:

Range	
Moisture	[_____]
Ash	[_____]

Range	
Volatile Matter	[_____]
Fixed Carbon	[_____]
Sulfur, percent by weight	[_____]
Heating Value, Btu per pound	[_____]

b. Ultimate analysis, as received, percent by weight

Range	
Moisture	[_____]
Carbon	[_____]
Hydrogen	[_____]
Sulfur	[_____]
Nitrogen	[_____]
Oxygen	[_____]
Ash	[_____]

Expected range of boiler steam output will be between [_____] and [_____] pounds per hour with peak loads only between [_____] and [_____] hours. Proposed or other existing gas cleaning equipment includes [_____]. Boiler combustion is controlled [manually] [automatically]. The standby fuel is [_____].

[Incinerator Data

****

NOTE:

1. The standard classification of wastes is as follows:

CLASSIFICATION

Type	Description	Principle Components	Noncombustibl Solids (Max. Percent by Weight	Moisture Content (Max. Percent)	Heating Value (kJ per kg)
0	Trash	Highly combustible waste, paper, wood, cardboard cartons, including up to 10 percent treated paper, plastic or rubber scrap, commercial and industrial sources	5	10	19,805
1	Rubbish	Combustible waste paper, cartons, rags, wood scraps, combustible floor sweepings, domestic, commercial, and industrial sources	10	25	15,145
2	Refuse	Rubbish and garbage; residential sources	7	50	10,019
3	Garbage	Animal and vegetable waste, restaurants, hotels, markets; institutional, commercial, and industrial sources	5	70	5825
4	Animal solids and organic wastes	Carcasses, organs, solid organic wastes; hospital, laboratory, abattoirs, animal pounds, and similar sources	5	85	2330
Loose Paper			-	-	23,300
Loose Wood			-	-	23,300
Classified Material		Highly-combustible waste, paper, cardboard cartons including up to 10	-	-	16,310 to 23,300

CLASSIFICATION					
Type	Description	Principle Components	Noncombusti Solids (Max. Percent by Weight	Moisture Content (Max. Percent)	Heating Value (Btu per Pound)
0	Trash	Highly combustible waste, paper, wood, cardboard cartons, including up to 10 percent treated	5	10	8,500
1	Rubbish	Combustible waste paper, cartons, rags, wood scraps, combustible floor sweepings, domestic,	10	25	6,500
2	Refuse	Rubbish and garbage; residential sources	7	50	4,300
3	Garbage	Animal and vegetable waste, restaurants, hotels, markets; institutional, commercial, and	5	70	2,500
4	Animal solids and organic wastes	Carcasses, organs, solid organic wastes; hospital, laboratory, abattoirs, animal pounds, and similar	5	85	1,000
Loose Paper			-	-	10,000
Loose Wood			-	-	10,000
Classified Material		Highly-combustible waste, paper, cardboard cartons including up to 10 percent plastics and treated paper	-	-	7,000 to 10,000

2. Include ash analysis if available. Classified

material contents description may change as plastic use increases. Check Incinerator Institute of America for latest information.

****

****

NOTE: Insert appropriate Section number and title in the blanks below using format per UFC 1-300-02.

****

Design mechanical cyclone-type dust collector(s) for operation with [the incinerator(s) specified in [_____]] [incinerator(s) manufactured by [_____], Type [_____], Model No. [_____]]. The incinerator is a [new] [existing] installation capable of burning [_____] [kilogram pounds] per hour [Mg tons per day] of type [0], [1], [2], [3], [4], [loose paper] [loose wood] [classified material] wastes. The expected range of incinerator operation will be between [_____] and [_____] [kilogram pounds] per hour [Mg tons per day] of wastes. Incinerator combustion is controlled [manually] [automatically]. Auxiliary fuel is [_____]. Proposed or other existing gas cleaning equipment includes [_____].]

1.12.2 Inlet Gas Conditions

****

NOTE:

1. To properly apply their equipment, the dust collector manufacturer must know the expected inlet gas conditions. This information can best be supplied by the boiler or incinerator manufacturer.

2. In determining the inlet gas conditions for existing installations, source testing should be performed to determine the gas flow and contents. Gas volume determinations should be made using a Pitot tube in accordance with ICAC "Test Procedure," Bulletin 101. This publication incorporates ASME techniques as called for in ASME PTC 38 "Determining the Concentration of Particulate Matter in a Gas Stream." For particulate loading an actual sample should be taken and analyzed in accordance with ASME PTC 28, "Determining the Properties of Fine Particulate Matter" or in accordance with EPA 40 CFR 60, Appendix A, Method 5 or Method 17 or applicable local standard.

3. If off-design conditions exist, the following relationships are available for estimation purposes:

For Variable Gas Flow Rate:

$$\frac{100 - Eff\ (1)}{100 - Eff\ (2)} = \frac{[Q(2)]\ 0.5}{[Q(1)]\ 0.5}$$

For Constant Gas Flow Rate:

$$\frac{100 - Eff\ (1)}{100 - Eff\ (2)} = \frac{[U(2)]\ 0.5}{[U(1)]\ 0.5}$$

For Variations in Gas Density:

$$\frac{100 - Eff\ (1)}{100 - Eff\ (2)} = \frac{[Pp-Pg(2)]\ 0.5}{[Pp-Pg(1)]\ 0.5}$$

For Moderate Changes In Gas Particulate Loadings:

$$\frac{100 - Eff\ (1)}{100 - Eff\ (2)} = \frac{[C(2)]\ 0.183}{[C(1)]\ 0.183}$$

Eff: Collector Efficiency
Pp: Particulate Density
Q: Volume Flow Rate
Pg: Gas Density
U: Gas Viscosity
C: Particulate Concentration
1,2: Operating Conditions (Mass Per Unit Volume)

4. Mechanical cyclone type dust collectors should be able to handle up to 120 percent of inlet flue gas volume.

5. For new installations, the inlet gas conditions should be obtained from the boiler or incinerator manufacturer. If this is not possible, the gas contents must be estimated. When estimates are made, the emission factors and handbook data should be taken from U.S. Environmental Protection Agency publication No. AP-42, "Compilation of Air Pollutant Emission Factors" with the latest supplements.
****

****
NOTE: Supply excess air percentage for incinerator applications.
****

Design mechanical cyclone-type dust collector(s) for inlet gas conditions from the [boiler(s)] [incinerator(s)] specified above. Dust collector manufacturer must coordinate the application of his equipment with the [boiler] [incinerator] manufacturer to assure that the collection efficiency specified herein is attained. The inlet gas conditions are:

Design Data	Percent of Boiler Load			
	25	50	75	100
a. Inlet gas volume, L/s:	[_____]	[_____]	[_____]	[_____]
b. Inlet gas temperature, degrees C:	[_____]	[_____]	[_____]	[_____]
c. Inlet gas density, kilogram per cubic meter:	[_____]	[_____]	[_____]	[_____]
d. Inlet gas moisture, percent by weight:	[_____]	[_____]	[_____]	[_____]

Design Data	Percent of Boiler Load			
	25	50	75	100
e. Inlet dust loading, grams per liter (kg per kJ):	[_____]	[_____]	[_____]	[_____]
f. Altitude above sea level, m:	[_____]	[_____]	[_____]	[_____]
g. Particle size distribution:				

Design Data	Percent of Boiler Load			
	25	50	75	100
a. Inlet gas volume, acfm:	[_____]	[_____]	[_____]	[_____]
b. Inlet gas temperature, degrees F:	[_____]	[_____]	[_____]	[_____]
c. Inlet gas density, pounds per acf:	[_____]	[_____]	[_____]	[_____]
d. Inlet gas moisture, percent by weight:	[_____]	[_____]	[_____]	[_____]
e. Inlet dust loading, grains per acf (lbs per MMBTU:	[_____]	[_____]	[_____]	[_____]
f. Altitude above sea level, ft:	[_____]	[_____]	[_____]	[_____]
g. Particle size distribution:				

Size, Microns (Diameter)	Maximum Percent by Weight Less Than Particle Size
60 and Over	[_____]
40	[_____]
30	[_____]
20	[_____]
15	[_____]
10	[_____]
7.5	[_____]

Size, Microns (Diameter)	Maximum Percent by Weight Less Than Particle Size
60 and Over	[_____]
1.0	[_____]
0 to 1.0	[_____]
Total	100.0

h. Fly ash density for hopper volume design kilogram per cubic meter pounds per cubic foot: [640] [40] [_____]

i. Fly ash density for weight determination, kilogram per cubic meter pounds per cubic foot: [1440] [90] [_____]

j. Fly ash specific gravity: [_____]

k. Excess air (range): [_____]

Contractor must verify data in the field and must design the dust collector(s) to operate efficiently over the possible range of inlet gas conditions.

1.12.3 Dust Collector Data

The following design criteria must apply to [each of] the dust collector(s). Applicable criteria must be based on flow conditions at maximum continuous rating.

a. Minimum collection efficiency, percent [_____].

b. Gas velocity range through dust collector, m/s fps[_____].

c. Maximum pressure drop through dust collector at design condition of flue gas flow and inlet dust loading, Pa inches water gage [_____].

d. Maximum hopper storage capacity, each hopper, hours [_____].

e. Minimum hopper storage capacity, each hopper, cubic meter feet [_____].

f. Minimum hopper valley angle degrees from horizontal, [57] [_____].

g. Minimum hopper side slope angle degrees from horizontal, [60] [_____].

h. Minimum casing design pressure at [260 degrees C] [500 degrees F] [_____], Pa inches water gage [plus 3735 plus 15] [_____].

i. Minimum casing design vacuum at [21 degrees C] [70 degrees C] [_____], Pa inches water gage [minus 6225 minus 25] [_____].

j. Minimum casing design temperature, degrees C F [_____].

PART 2 PRODUCTS

2.1 MATERIALS

****
NOTE: Select the applicable paragraph(s) from the following:
****

****
NOTE: Use these paragraphs for multitube collectors 150 mm 6 inch diameter collecting tubes may cause a plugging problem. Designer must investigate flue gas particulate size, distribution and tendency of particulates to adhere to each other for the specific project before selecting diameter of collector tubes.
****

Multitube collector parts exposed to flue gas must have a multilayer internal lining having physical characteristics suitable for the service and able to withstand abrasive and chemical action of flue gas and fly ash. Insulating properties of lining must be such that metal skin temperature must not exceed 343 degrees C 650 degrees F. All parts subject to deterioration must be accessible for inspection, maintenance or replacement. Materials used must conform to the following requirements:

****
NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.
****

a. Exterior shell: [ASTM A242/A242M Type 1] [or] [ASTM A36/A36M] 6 mm 1/4 inch minimum thickness.

b. Hoppers: [ASTM A240/A240M] 6 mm 1/4 inch minimum thickness.

****
NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.
****

c. Collecting and outlet tube sheets: [ASTM A242/A242M Type 1] [or] [ASTM A36/A36M].

d. Outlet tube: [ASTM A139/A139M Steel] [or] [ASTM A667/A667M Centrifugally Cast Iron] [or] [ASTM A532/A532M, Abrasion Resistant Cast Iron].

e. Collecting tube: [ASTM A667/A667M Centrifugally Cast Iron] [or] [ASTM A532/A532M, Abrasion Resistant Cast Iron].

f. Inlet vanes: [ASTM A667/A667M Centrifugally Cast Iron] [or] [ASTM A532/A532M, Abrasion Resistant Cast Iron].

g. Gaskets: Type E, fiberglass suitable for service temperatures up to 371 degrees C 700 degrees F.

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

h. Inlet manifold: [ASTM A242/A242M Type 1] [or] [ASTM A36/A36M] 6 mm 1/4 inch minimum thickness.

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

i. Structural and miscellaneous steel: [ASTM A242/A242M Type 1] [or] [ASTM A36/A36M].

****

NOTE: Use these paragraphs for 600 mm 24 inch or larger diameter cyclone collectors. A choice of diameter is dependent upon design parameters that must be analyzed (See SD-10 Operation and Maintenance Data) and satisfied for each specific project.

****

[Centrifugal cyclone collector parts exposed to flue gas must be of materials having physical characteristics suitable for the service and able to withstand abrasive and chemical action of flue gas and fly ash. Materials used must conform to the following requirements:

a. Cone: ASTM A36/A36M, 6 mm 1/4 inch minimum thickness.

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

b. Body: [ASTM A242/A242M Type 1] [or] [ASTM A36/A36M] 6 mm 1/4 inch minimum thickness.

c. Hoppers: [ASTM A240/A240M] 6 mm 1/4 inch minimum thickness.

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

d. Inlet manifold: [ASTM A242/A242M Type 1] [or] [ASTM A36/A36M].

e. Dense castable abrasion resistant lining: ASTM C401, Class B.

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C

400 degrees F or higher.
****

f. Structural and miscellaneous steel: [ASTM A242/A242M Type 1] [or] [ASTM A36/A36M].]

2.2 FABRICATION

****
NOTE: Select the applicable paragraph(s) from the following:
****

****
NOTE: Use these paragraphs for multitube collectors. 150 mm 6 inch diameter collecting tubes may cause a plugging problem. Designer must investigate flue gas particulate size, distribution and tendency of particulates to adhere to each other for the specific project before selecting diameter of collector tubes.
****

[Fabricate multitube type mechanical dust collector(s) of welded and flanged steel with structural steel supporting framework. Arrange internal inlet tubes so that no tube is more than one row away from alleyway with a minimum width of 460 mm 18 inches that will allow total accessibility for inspection and cleaning of tubes. Recovery vanes are not required and must not be provided on dust collectors that receive the gases from oil burning [boilers] [incinerators]. Stresses due to draft differential and thermal expansion must not cause excessive deflection of plates or members. Joints between tubes and tube sheets must be gas tight; dust collector housings must be gas tight and dust tight. Flange flue gas inlet and outlet connections and arrange to accommodate connecting breeching as shown on drawings. Arrange tubes in outlet and hopper sections so that no tube is more than two rows from physical access from an alleyway with a minimum width of 600 mm 24 inches.]

****
NOTE: Use this and associated paragraphs for 600 mm 24 inch or larger diameter cyclone collectors. A choice of diameter is dependent upon design parameters that must be analyzed (See SD-10 Operation and Maintenance Data) and satisfied for each specific project.
****

[Fabricate [600 mm] [24 inch] [_____] diameter centrifugal dust cyclone collector(s) of welded steel. Provide all portions of collector(s) subjected to high temperature flue gas flow with a multilayer internal lining having specified insulating and abrasion resistant properties suitable for service intended. In addition, provide inside surfaces of outlet manifold with ASTM C401, Class B abrasion resistant lining. Lining must be suitable for maximum 343 degrees C 650 degrees Fof metal skin temperatures. Apply and reinforce lining in accordance with lining manufacturer's recommendations to resist cracking, spalling, and blistering. Provide each hopper with a flanged fly ash outlet connection to accept fly ash transportation system valves. Flange flue gas inlet and outlet connections and arrange to accommodate connecting breeching as shown on drawings.]

2.2.1   Structural Supports

****

NOTE: Delete 1st sentence if project is not located in seismic Zone 3 and 4 of the Uniform Building Code. Use 6 mm 1/4 inch thick steel for temperatures over 260 degrees C 500 degrees F. Detail structural supports on the drawings. Obtain from manufacturer and provide collector operating pressure and design pressure (PaWC negative-positive) and design temperature (degrees C F) on drawings.

****

[Support duct collector(s) in accordance with Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS.]Design dust collector(s) to support its own dead weight plus insulation, maximum weight of accumulated fly ash, and the following external loads based upon flue gas flow at maximum continuous[boiler][incinerator] load rating and maximum pressure drop across the dust collector.

a. Snow load, kilogram per square meter pounds per square foot[_____]

b. Wind load, kilogram per square meter pounds per square foot[_____]

c. Live load, kilogram per square meter pounds per square foot[_____]

2.2.2   Hoppers

****

NOTE: Specify access door for clean gas side of collector(s) if such access door is not provided in the clean gas ductwork.

****

Provide dust hopper(s) with dust collector(s). Provide a minimum of one pyramid hopper for each collector. Fabricate all hopper plates of 6 mm 1/4 inch thick ASTM A240/A240M, Type 316 stainless steel. Provide hopper(s) with untapered fillet sheets, fabricated of cold rolled 10 gage ASTM A167 Type 316 stainless steel in each corner. Extend fillet sheets the full length of the corner. Seal weld the fillet sheets to the hopper walls. Provide closure sheets at the top of the hopper at each corner to prevent flow into the area between the fillet sheet and the hopper corner. Steel reinforcements not in contact with the gas or ash may be either [ASTM A167][ASTM A240/A240M] Type 316 stainless steel or ASTM A242/A242M Type 1 structural steel. Welding rods must be specifically selected to be compatible with the base metal and must be submitted to the Contracting Officer for approval. Provide protection of rods against moisture whether for factory or field assembly.

2.2.2.1   Hopper Accessories

Provide at least one key interlocked hinged inspection cleanout and access door on each hopper with gas tight seals. Each lock must have a key unique for this installation. Keys must not be able to be removed from the locks when access doors are opened. Access doors must be a minimum opening size of 460 by 600 mm 18 by 24 inches for rectangular openings and 600 mm 24 inches inside diameter for round openings. Hoppers with gas baffles must have access doors on both sides of the hopper. Provide each hopper with provisions for attachment of vibrators. Hoppers must have adequate flexibility for vibrating. Provide each hopper with two 100 mm 4 inch poke holes with a tee wash connection and screwed caps. Position poke holes to permit only downward thrusts into the hopper. A special reinforced "pounding area" plate must be provided on each hopper face for external manual vibrating. Each pounding plate must be 300 by 300 by 25 mm 12 by 12 by 1 inch thick ASTM A36/A36Mplate steel. Provide a work platform with fixed stairs and railing and toe board to each pounding area for units with pounding areas more than 1.50 meters five feet above ground. Pounding plate must not be insulated. Insulation must be neatly finished at this discontinuity. Provide a flanged fly ash outlet connection on each hopper to accept the fly ash transportation system equipment. Provide access hatch not less than 200 by 200 mm 8 by 8 inches for cleanout within 200 mm 8 inches above flange on opposite sides. Bolt down type hatches are acceptable for the cleanout hatch.

2.2.2.2 Hopper Vibrators

Provide each hopper with 2 vibrators set at the mid-height and on opposite sides. Vibrator controls must be interfaced with ash collection system to provide vibrator operation only at the inception and during an evacuation cycle. Operation must be automatic. Provide manual override control for hopper vibrators and evacuation system in the hopper area. Enclose override control(s) in [a] case(s) to prevent accidental energization of systems. Place a warning over the vibrator manual control with the following inscription: "WARNING: VIBRATOR CONTROL. DO NOT ACTIVATE UNLESS HOPPER EVACUATION SYSTEM IS OPERATING."

2.2.3 Multitube Collector Collecting and Outlet Tubes

****

NOTE: Use these paragraphs for multitube collectors. 150 mm 6 inch diameter collecting tubes may cause a plugging problem. Designer must investigate flue gas particulate size, distribution and tendency of particulates to adhere to each other for the specific project before selecting diameter of collector tubes.

****

Fabricate multitube collector collecting tubes of material specified in paragraph MATERIALS. Material must have a Brinell hardness of not less than 400. Attach collecting tubes to tube sheet so that tubes may be readily removable and replaceable. Collecting tube diameter must be not less than [150 mm] [6 inches] [_____]. Fabricate multitube collector outlet tubes, to convey clean gases out of collector, of material specified in paragraph MATERIALS, and vary length with longest row at flue gas inlet to collector. Provide steel wear angles not less than 100 by 100 by 10 mm 4 by 4 by 3/8 inch vertically tack welded in 5 or 6 places onto the exterior surface of the inlet row of the outlet tubes. Locate each angle so that each leg faces the inlet flue gas and deflects the flue gas by protecting the exterior surfaces of each outlet tube along the inlet row from abrasive particles contained in the incoming flue gas. These vertical wear angles must extend between the top of the bottom header sheet and the bottom of the top header sheet on the inlet row of the outlet tubes.

2.2.4 Hopper Heating Systems

****

NOTE: Use this paragraph when units are operated where incoming gases may be cooled below dew point.

****

Provide a hopper heating system for each cyclone hopper as specified herein.

2.2.4.1 Hopper Heater System Design

The system must be furnished by the collector manufacturer with all material required for mounting and must be designed to provide a 66 degrees C 150 degree F rise in temperature in the hopper, in the vicinity of the heaters, during offline and startup conditions. The system must be sized to provide a hopper skin temperature of not less than 121 degrees C 250 degrees F when insulation specified herein is in place during minimum equipment operating temperatures. Design system with a minimum heating safety factor of 1.1 and a minimum wind heat loss factor of 1.12. Provide system with maximum heater coverage between hopper stiffeners utilizing modular heaters and flexible blanket or tape heaters for the hopper throat heating. Heater modules must cover at least 33 percent of the hopper area, must cover the bottom portion of the hopper to the maximum extent possible, and must extend at least 70 percent up the hopper height. Use flexible electric heating blankets or tapes, capable of withstanding 427 degrees C 800 degrees F, where modular equipment will not fit. Design all equipment to withstand natural and induced vibrations, plus shock loadings normally experienced during operation of the dust collector and ancillary equipment including manual rapping of the strike plates. The hopper heater system must be individually, thermostatically controlled with adjustable setpoint and must be furnished and installed complete including all power, control, and alarm components. Locate the low temperature and control thermocouples in the lower portion of each heater zone. Heater power voltage must be 480 volts AC. Heater control voltage must be 120 volts AC.

Hopper Heater Module Design: Heater modules must be self-contained and each modular heater must be furnished complete. The modules must have a flexible heating face to conform to the irregularities of the hopper surface, providing intimate contact between the heaters and the hopper, and providing maximum heat transfer. Hopper heater modules must be of low watt density design (maximum of 0.0047 watts per square mm 3 watts per square inch of resistance element) with a minimum of 6 parallel resistance paths per heater (continuous blanket type elements must be deemed to meet the multipath requirement). Heating element in the module must be capable of being operated at and must be rated at 2690 watts per square meter 250 watts per square foot, but must be designed to operate at 2152 watts per square meter 200 watts per square foot. Size all wiring, circuits, and controls for 2690 watts per square meter 250 watts per square foot. Total power density must not be less than 4304 watts per square meter 400 watts per square foot of heater module surface. Provide hopper throat blanket heater with a single heating element. Blanket element must remain on during startup, offline, and online operating conditions. Heating elements must be made of 600 series stainless steel alloy or nickel-chrome alloy encased in a minimum 20 gage aluminum or aluminized-steel mounting pan or casing. Two sets of heater pigtails must exit each module, one set of pigtail for each element and circuit. Heater pigtail wires and interconnecting wires must be multi-strand copper wire with high temperature (454 degrees C 850 degrees F) insulation. Provide heater pigtails with strain relief fabricated in such a manner as to prevent damage to the heater modules due to rough handling. Pigtails must be of sufficient length to reach the terminal box. Splices must not be permitted in pigtails from modules, tapes, or blankets to the terminal box. Test each module, blanket, or tape for electrical integrity at 1,000 volts prior to installation. Heating units supplied must have metal labels firmly attached to the unit listing the wattage and voltage of the unit. Heating units and mounting hardware must be fabricated of high temperature materials capable of withstanding 454 degrees C 850 degrees F. Insulate heating units with high temperature woven glass cloth or mineral fiber. Mica or magnesium oxide insulated heaters must not be provided.

2.2.4.2 Hopper Heater Controls

Each hopper heater must be thermostatically controlled with adjustable set point and must be furnished and installed complete including all power, control, and alarm components. The thermostats for monitoring temperature must be 120 volt AC adjustable type mounted in NEMA ICS 6, Type 4 enclosures. For thermostatic control of the hopper heater system, the Contractor must provide a Master Hopper Heater Control Panel for the Plant, a Local Hopper Heater Control Panel for the [boiler] [incinerator], and a Local Hopper Heater Terminal Box at the hopper(s). The Contractor must furnish all materials, tools, and labor required for connections of circuits and wiring between local hopper heater terminal boxes, local hopper heater control panel(s), and the master hopper heater control panel(s).

a. Local Hopper Heater Terminal Box: On each hopper, provide hot-dipped galvanized NEMA ICS 6 Type 4 hopper heater terminal boxes with terminal blocks for connection of heater pigtails and thermostat leads. Terminal blocks in each terminal box must contain a sufficient number of terminals to connect heater pigtails and thermocouples.

b. Local Hopper Heater Control Panel: Provide each [boiler] [incinerator] with a local hopper heater control panel located in the control room. Each local hopper heater control panel must contain: terminal blocks for power, control, and alarm circuits, one control temperature thermostat, one low temperature alarm thermostat, magnetic contactor and alarm relay with two normally open contacts, and auxiliary relays for automatic operation of the heater system. Provide a 3-pole fused switched main disconnect device and a fused control transformer having a 120-volt AC secondary for connection to the [boiler] [incinerator] local hopper heater control panel. Provide thermostats with a set point range of 38 to 260 degrees C 100 to 500 degrees F. Thermostats must measure hopper skin temperature using ungrounded, Type J thermocouples. The local hopper heater control panel cover must contain the following devices.

    (1) "START UP," "ON LINE," "OFF," "AUTO" selector switch.

    (2) 120 V "ON" red light with integral transformer.

    (3) 120 V "LO TEMP" alarm white light with integral transformer.

    (4) Device and enclosure nameplates.

    (5) Wire the selector switch for the following system operation:

        (a) 1) "START UP": All elements on (includes throat heater).

(b) 2) "ON LINE": All elements on (includes throat heater).

(c) 3) "OFF": All elements off.

(d) 4) "AUTO": Control functions transfer to Master Hopper Heater Control Panel.

c. Master Hopper Heater Control Panel: Provide panel(s) containing relays, contactors, circuit breakers, control transformers, and other devices required for complete control of [each] hopper heater system. Locate Master Hopper Heater Control Panel(s) in the control room. Panel components must be factory installed and wired in a NEMA ICS 6, type 4 enclosure and must include the following:

(1) A main circuit breaker.

(2) A circuit breaker and contactor alarm relay with two normally open contacts. The contactor must have a 120-volt operating coil.

(3) "START UP," "ON LINE," "OFF," selector switch for each hopper.

(4) 120 V red "ON" light and 120 V white "LO TEMP" alarm light with integral transformers.

(5) Auxiliary relays and equipment required for operation of the heating alarm systems.

(6) Device and enclosure nameplates.

(7) Fused control transformer having a 120 volt AC secondary.

2.2.5 Fly Ash Level Alarms

****

NOTE: The nuclear detector radiation should not exceed 6x10-7 sievert per hour 0.06 mR/Hr. The designer must contact the safety department of the using activity to coordinate the limit of the surface radiation and edit into this paragraph that limit for the specific project.

****

Provide each hopper with a fly ash level alarm utilizing factory installed lead shielded nuclear type detectors. The detectors must be single-point gamma source and detection units. Provide lead shielding to cover the detector and surrounding mounting surfaces and additional lead shielding required around the source housing to limit the maximum measured surface radiation at any surface accessible to personnel during normal operation to [6x10-7 sievert/hr] [0.06 mR/hr] [_____] above ground radiation. Provide manufacturer's standard nuclear warning sign. Provide detectors complete with separately mounted electronic units which must include a local high level indicating light and relays for use with annunciation system herein specified. Relays must be rated 10 amperes, 120 volts AC, or 125 volts DC continuous duty. Switch housing for all hoppers must be dustproof and must be mounted at one easily accessible location. Locate all detector and source electronics at the hopper control panel. Detector must be explosion proof and have waterjacketing. Alarm must be able to withstand vibration and temperatures up to 427 degrees C 800 degrees F. Provide the source with a lockable shutter mechanism operated by an external handle to totally isolate the beam when in the closed position. Electrical supply must be 120 volts, single phase, 60 hertz. Locate alarm at the 50 percent hopper capacity level. Provide each hopper with two sensors--one at the alarm level, and one at the empty level. Level reproductivity must be within one inch. All outdoor components must operate between minus 40 and 93 degrees C 40 and 200 degrees F.

2.2.5.1 Hopper Source and Access Door

Source for each hopper must be Cesium 137. Design source head with a spring return off system in the event of remote cable actuator failure. Interlock source with hopper access door(s) to prevent entry into hopper unless source has been secured. Hopper access door key must only be able to open one pair of hopper doors.

2.2.5.2 Hopper Level Signals

Hopper level signals, based on hopper level status indicator system, must report to a microprocessor through a coaxial cable system. Provide each hopper with two indicators, one for full and one for empty. A flashing light must indicate a wall buildup. Loss of power for any period of time must not require a recalibration. Provide microprocessor with a NEMA ICS 6, Type 4 enclosure.

2.2.6 Ductwork

Section 23 35 19.00 20 INDUSTRIAL VENTILATION AND EXHAUST, and SMACNA 1403, for [Class III] [Class IV] duct construction suitable for system operating pressures and temperatures indicated. Provide duct materials, fittings, hangers, supports, flanges, gaskets, expansion joints, connections, relief vents, reinforcements, [and corrosion protection] for the [existing] flue gases [to be] encountered in accordance with SMACNA 1403.

2.2.6.1 Ductwork to Cyclones

Design all ductwork between [boilers] [incinerator(s)] and cyclone(s) to be self-cleaning. Ductwork meeting the following requirements will be considered to be self-cleaning.

a. A duct at an angle greater than 45 degrees to the horizontal plane with gas flowing downward.

b. A duct at an angle greater than 60 degrees to the horizontal plane with gas flowing upward.

c. A duct with hopper-shaped bottom and a conveyor[specified in Section 23 51 43.03 20 FABRIC FILTER DUST COLLECTOR OF FLY ASH PARTICLES IN FLUE GAS to remove the settled dust].

2.2.6.2 Flue Gas Velocity

Flue gas design velocities in ductwork must be calculated at the design flow range specified in paragraph, "Dust Collector Data." The design velocities in self-cleaning ducts must be between 1372 and 1524 m/s 4,500 and 5,000 fpm. Where a possibility of dust settling exists, the design velocity must be 1676 to 1829 m/s 5,500 to 6,000 fpm. The design velocity of clean gas must be greater than 1219 m/s 4,000 fpm.

2.2.7 Draft Connections

Provide a 25 mm one inch capped connection in flue gas inlet and outlet breech of dust collector(s) for determining differential pressure across collector(s). Orient these connections so as to be accessible from access platform or walkway specified herein.

2.2.8 Inlet Manifold and Dampers

****

NOTE: Specify or indicate air pressure available for pneumatic operators or electrical characteristics available for electric operators.

****

Provide, specially made for the dust collector, a steel plate flue gas inlet manifold to provide single, flanged inlet connection. Furnish this manifold with sectionalizing dampers with [pneumatic] [electric motor] operators suitable for remote-manual operation. Dampers must be guillotine type not louver type.

2.2.9 Access

2.2.9.1 Access Structures and Fixtures

Platforms, Walkways, Stairways, Handrails, Kickplates and Fixed Ladders: that are required for operation, examination, testing and maintenance of each dust collector and must be provided with each dust collector. Platforms, walkways, stairways, handrails, kickplates and fixed ladders must be factory or shop fabricated, must provide suitable access to all openings in the hopper, and must meet OSHA 29 CFR 1910-SUBPART D for safety of maintenance and operating personnel. Walkways must be provided for maintenance and inspection of maintenance points. Walkways must be located not more than 1.22 meters 4 feet directly below the centerline of collector striker plates and the centerline of [the] [each] access door to [the] [each] hopper. Walkways and platforms must be connected by stairways or fixed ladders. Supporting steel for platforms, fixed ladders and walkways must be designed for the live load specified herein. Platforms must be designed to support a 488 kilogram per square meter 100 pound per square foot live load. Walking surfaces of walkways and platforms must be fabricated of ASTM A242/A242M raised pattern floor plate minimum 5 mm 3/16 inch thickness. Platforms, walkways, stairways, fixed ladders, handrails and kickplates must be hot dipped galvanized after fabrication in accordance with ASTM A123/A123M. Minimum galvanized coating weight per surface must be not less than 0.70 kilogram per square meter 2.3 ounces per square foot.

2.2.9.2 Access Doors

Access doors to hoppers and mechanical or electrical components must be accessible from walkways or be provided with a permanent steel ladder or stairway to facilitate maintenance. Provide internal and external handholes at all access doors to facilitate entry. Provide access doors to hoppers and to inlet plenums and to outlet plenums. Provide fixed industrial stairs or fixed ladders that meet OSHA 29 CFR 1910-SUBPART Dto connect access doors. Access doors must be permanently hinged or be completely removable by guide-action fastening devices. Key interlocks are required only on hinged doors.

2.2.10 Insulation and Casing

Insulate and case the collector shell [including flue gas inlet manifold] and hoppers. Insulation must be asbestos free. Provide a walking surface on all top surfaces hereinafter specified, where periodic equipment maintenance or inspection of equipment located in that area is required.

2.2.10.1 Insulation Material

****

NOTE:

1. For multitube collector(s) use minimum thickness of 65 mm 2 1/2 inches for operating temperature range of 94 to 260 degrees C 201 to 500 degrees F, and minimum thickness of 140 mm 5 1/2 inches for operating temperatures above 261 degrees C 501 degrees F.

2. For 300 mm 12 inch or larger diameter centrifugal cyclone collector(s) use minimum thickness of 140 mm 5 1/2 inches.

3. For ductwork with an operating temperatures 94 to 260 degrees C 201 to 250 degrees F, use minimum insulation thickness of 65 mm 2 1/2 inches; for operating temperatures 261 to 190 degrees C 251 to 375 degrees F, use minimum insulation thickness of 100 mm 4 inches; for operating temperature range 191 to 260 degrees C 376 to 500 degrees F, use minimum insulation thickness of 125 mm 5 inches for operating temperatures above 260 degrees C 500 degrees F, use minimum insulation thickness of 140 mm 5 1/2 inches.

****

Externally insulate shell, hoppers, and ductwork. Mineral fiber block and board insulation must conform to ASTM C612 and mineral fiber blanket insulation must conform to ASTM C592. Minimum insulation thicknesses must be as follows:

a. Shell: [_____] mm inches

b. Hoppers: [_____] mm inches

c. Ductwork: [_____] mm inches.

2.2.10.2 Casing Materials

ASTM B209M ASTM B209 aluminum. Casing, except the top surface which might serve as personnel walking surface, must be 1.27 mm 0.050 inch thick stucco embossed, 100 mm 4 inch rib unpainted aluminum panel. Top surface ductwork casing must be flat aluminum sheet having a minimum thickness of 2.03 mm 0.080 inch and be suitably reinforced to support a 122 kilogram per square meter 25 pound per square foot live load.

2.3 SAMPLING PORTALS

Provide minimum 100 mm 4 inch inside diameter x minimum 6 mm 1/4 inch thick wall sampling portals for fly ash particulate sample testing on inlet breech and outlet breech of dust collector. Sampling portal material must conform to ASTM A36/A36M and must be insulated as specified elsewhere in this section. Locate sampling portals in accordance with EPA 40 CFR 60, Appendix A, Method 1 - "Sample and Velocity Traverses for Stationary Sources." Provide two portals 90 degrees apart on round inlet breech and two portals 90 degrees apart on round outlet breech. For rectangular breeching apply EPA 40 CFR 60, Appendix A, Method 1. Portals must extend above the exterior surface of breech insulation at least 150 mm 6 inches. Exposed end of each portal outside of breech insulation must be NPT threaded and closed with a NPT threaded, removable screw cap or plug. ASTM A36/A36M exterior surface areas of portal and cap or plug must be painted as specified in paragraph PAINTING. Cap or plug when detached from portal must be secured to portal by a galvanized or stainless steel chain welded at one end to the top of the cap or plug and welded to the side of the portal. Portal must be continuously welded where it contacts breech and not extend inside the breech more than 15 mm 1/2 inch. In EPA 40 CFR 60, Appendix A, Method 1 the term "administrator" and "stack" or the word "duct" must mean "Contracting Officer" and "breech" in that order, respectively.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Revise this paragraph as necessary when it is desired to have the collector manufacturer install the equipment furnished.

****

Install equipment specified herein on foundations or structural-steel framework shown on the drawings, or as specified herein. Install in accordance with manufacturer's recommendations as shown on manufacturer's detailed drawings. Furnish the services of [a] field representative(s) of the dust collector manufacturer as hereinafter specified.

3.2 INSULATION INSTALLATION

Apply insulation in order to permit access doors, inspection doors, flanges, sampling portals and other special features to be opened, or removed for inspection or maintenance, without disturbing insulation. Provide boxouts around code stamping symbols and nameplates. Install double thickness insulation with joints of the two layers staggered. Fill cracks, voids, and depressions in layers of insulation with suitable insulating cements before application of another layer of insulation or jacket application. Provide expansion joints in insulation as required to allow for thermal expansion movements which might cause cracks or tears in the insulation. Install insulation between and over stiffeners in such a manner that stiffeners are completely insulated. Install additional insulation or casing spacers between stiffeners so that a level surface is achieved. The intent of this insulating procedure is to prevent a direct metal path between the collector inside and ambient air. Securely wire insulation and lace in place using No. 14 dead soft Type 302 stainless steel wire conforming to ASTM A580/A580M.

3.2.1 Block and Mineral Fiberboard Insulation Installation

Hold block and mineral fiberboard insulation in place with insulation lugs spaced on not greater than 300 to 460 mm 12 to 18 inch centers. Lugs must be stud-type welded in place. Reinforce blocks on exterior face with expanded metal, if necessary, to prevent sagging or cutting of insulation by lacing wire. Securely wire block and mineral fiberboard insulation of specified thickness in place over entire surface by means of wire threaded through lugs both ways, pulled tight with ends of wire loops twisted together with pliers, bent over, and carefully pressed into surface of insulation.

3.2.2 Mineral Fiber Blanket Insulation

Hold mineral fiber blanket insulation in place with speed washers and impaling pins spaced on centers not exceeding 300 mm 12 inches. Provide mineral fiber blanket insulation with expanded metal reinforcement on the outer surface and wire mesh or expanded metal on the inner surface. Tightly butt sections of blankets, jam together, and securely tie for maximum sealing at joints and edges. Take care in applying speed washers so that designed thickness of insulation is not reduced when washers are installed.

3.3 CASING INSTALLATION

3.3.1 Structural Steel Grid System

Install casings on an aluminized structural steel grid system of subgirts. Provide subgirts of sufficient size, gage, and depth to provide adequate support and a smooth exterior surface. Subgirts must be welded to equipment and structural support surfaces. Subgirts must be of sufficient depth to provide for application of full thickness of insulation over the stiffeners, access doors, flanges, ribs, and other surfaces having uneven contours to provide a smooth finished surface. Subgirts on vertical and bottom surfaces must be at a maximum spacing of 1.22 meters 4 feeton centers. Subgirts on top surfaces must be at a maximum spacing of 610 mm 2 feet on centers. Design so as to transmit an external 114 kg 250 pound walking load from aluminum casing to structural steel grid system without compression of insulation material.

3.3.2 Access Openings

Access doors and other penetrations through the insulation must have insulation fitted closely to the hinges and fasteners and must be neatly framed and flashed to be weather tight and create a pleasing appearance. Provide hinged or lift off doors designed for convenient opening at nameplates, code stampings, non-projecting connections, and access openings. Flash and weatherproof openings. Pitch all horizontal access openings for water runoff. Provide all vertical access doors with flashing above door head and flash to prevent wind driven rain from seeping under the aluminum casing.

3.3.3 Weatherproofing

Install casings with proper overlap to make the installation weather tight. Carefully fabricate and fit casing to ensure a neat appearance; furnish required closures, flashings, and seals. Provide open ends of fluted sections with tight-fitting closure pieces. Form and install flashing so that water cannot enter and wet the insulation, and design and install flashing to readily drain any water that might enter. Weatherproof joints or openings in casing, which cannot be effectively sealed from entry of moisture by flashings or laps by application of an aluminum pigmented sealer manufactured for this type of service.

3.3.4 Convection Stops

Furnish and install convection stops on vertical surfaces over 3.66 meters 12 feet tall; maximum interval between convection stops must be 3.66 meters 12 feet. Convection stops must consist of steel channel of Z-girt, covered with 80 mm 3 inch thickness of insulation.

3.3.5 Casing Attachment

****

NOTE: If a separate insulation section is part of this specification, add note to that section to indicate that insulation of the collector is covered by this section.

****

Attach aluminum casing to structural steel grid system by means of No. 14 stainless steel, Series 300, self-tapping screws on 300 mm 12 inchcenters. Fasten vertical laps and flashings by means of 20 mm 3/4 inch No. 14 stainless steel, Series 300, sheet-metal screws on 300 mm 12 inch centers. Exposed screws must have aluminum or stainless-steel backed neoprene washers preassembled to screws. Install insulation so that it is not compressed below nominal thickness.

3.4 HOPPER HEATER SYSTEM

Deliver system components to the job site in containers designed to protect the components from adverse handling, weather, and storage conditions. Store components in their original shipping containers, unless the containers are damaged, or under protective weatherproof covering until installation. Clean hopper surfaces of dust, grease, oil and rust thoroughly prior to installation of any heater. Heater modules must be installed to provide maximum contact between the heaters and the hopper wall. Furnish heaters with mounting hardware, channels, and brackets. Throat heaters must not overlap and must be held in place with high temperature (454 degrees C 850 degrees F) glass tape or other means approved by the Contracting Officer. Cover the throat heater with insulation material prior to application of jacketing.

3.5 GALVANIC CORROSION

To prevent galvanic corrosion, avoid permanent contact of aluminum casing with copper, copper alloy, tin, lead, nickel, or nickel alloy including monel metal. Where it is necessary to attach casing to carbon steel or low alloy steel, first prime steel with zinc chromate, and then paint with aluminum paint conforming to FS TT-P-28 suitable for surface temperatures encountered. Use of lead base paint is prohibited.

3.6 PROTECTION FROM INSULATION MATERIALS

Protect equipment and structures from damage from insulation materials. After completion of work, clean, repair, and restore equipment and structure to their original state. Repair any casing that becomes corroded, discolored, or damaged or replace casing if beyond repair as determined by the Contracting Officer.

3.7 INSPECTIONS AND TESTS

3.7.1 Factory Inspection

The right is reserved by the Government to inspect the equipment at the manufacturer's plant, during or after manufacture. Acceptance at the factory must not constitute final acceptance.

3.7.2 Field Inspection and Tests

3.7.2.1 Delivery Inspection

Upon delivery to the jobsite, materials and equipment will be inspected to assure that equipment and installation comply with local and Government requirements for equipment and safety.

3.7.2.2 Post-Installation Inspection of Dust Collectors

Dust collector manufacturer's field representative must inspect mechanical dust collector after installation is completed and prior to start of testing to verify that the unit is installed in conformance with the manufacturer's recommendations.

3.7.2.3 Performance Test of Dust Collectors

****

NOTE:

1. If provision for operation at partial loads is included, specify that test must also be conducted at the desired part-load conditions.

2. If Government operating personnel are available for operation of the associated equipment required to perform the tests, revise this paragraph accordingly. For installation in which a new boiler or incinerator is being installed, the Government operating personnel should be under the supervision of the Contractor.

3. Specifying inlet and outlet tests to determine efficiency or performance guarantees for cyclones can cause problems in retrofits and some new units. Cyclones with very short or angled inlet and outlet ducts can cause inaccurate test data to be collected. Therefore, specifying cyclone outlet grain loading requirements may be more appropriate than an efficiency requirement.

****

Field performance tests must be performed by a testing laboratory with experience in EPA's test methods and approved by the Contracting Officer. Furnish a schedule of tests in writing to the Contracting Officer at least 10 calendar days before scheduled test(s) start date. Dust collector(s) field performance test must be conducted with [its] [their] respective [boiler] [incinerator]. Operate each dust collector and its [boiler] [incinerator] for at least 45 calendar days at approximately 25, 50, 75 and 100 percent loads and cycle [boiler] [incinerator] not less than two complete cycles between 100 percent load and each partial load and back to

100 percent load. A trial run of 7 days minimum witnessed by the Government, must be performed before the 45 day test to ensure that all associated systems required for the test are ready. The Contractor and the dust collector manufacturer's field representative must witness the trial run and all tests. The testing laboratory must furnish equipment, tools and personnel necessary for testing, data gathering, and recording test results.

a. Particulate Tests of Dust Collectors: Simultaneous inlet and outlet particulate tests on all mechanical dust collector(s) must be performed in accordance with EPA 40 CFR 60, Appendix A, methods 1 through 5 and 17. Method 17, in stack filtration, may be performed as an alternate test to Method 5. Tests must be performed at maximum and partial load conditions herein specifiedand report submitted to the Contracting Officer.

b. Additional Tests: In the event that the mechanical dust collector(s) do not meet performance requirements, failures and deficiencies must be resolved and additional tests must be performed by the testing laboratory as required to demonstrate that the resolutions used permitted acceptable performance of the mechanical dust collectors.

3.8 IDENTIFICATION

Provide an aluminum, brass, or type 304 or 316 stainless steel nameplate and fasten to equipment in a visible location by means of rivets or sheet metal screws of the same material as the nameplate material. Nameplate must contain data that consists of the manufacturer's name, model or series number, and serial number. Indent or emboss the information in the metal. Offset the nameplate a sufficient amount to avoid being covered by insulation.

3.9 PAINTING

Clean the non-insulated exterior surfaces of equipment being furnished to base metal in accordance with SSPC SP 6/NACE No.3 and paint at the factory with two coats of paint conforming to FS TT-P-28. Performed painting in accordance with SSPC SSPM. Power clean to bare material and touch up exterior surfaces damaged during field installation or during shipment with two coats of FS TT-P-28 high temperature (up to 650 degrees C 1200 degrees F) heat resistant paint.

3.10 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. [_____]	[_____]	[_____]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 51 43.02 20 (April 2006)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15862N (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 51 43.02 20

ELECTROSTATIC DUST COLLECTOR OF FLUE GAS PARTICULATES

04/06, CHG 1: 11/24

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 51 43.02 20 (April 2006)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Replacing without change**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 23 51 43.02 20

ELECTROSTATIC DUST COLLECTOR OF FLUE GAS PARTICULATES

04/06, CHG 1: 11/24

****

NOTE: This guide specification covers the requirements for furnishing, installing, adjusting, and testing of electrostatic precipitator(s).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The precipitator(s) is intended to be used for flue gas particulate removal and collection associated with coal-fired boilers and refuse-fired waste disposal incinerators. Coal-fired boilers applicable to this specification are those designed with capacities ranging between 3.78 and 31.5 kilogram of steam per second 30,000 and 250,000 pounds of steam per hour. The incinerators applicable to this specification are those designed for burning municipal-type waste having firing capacities between 454 kilogram per hour 1,000 pounds per hour and 182 Mg 200 tons per day. For engineering and design assistance on precipitators applied close to or outside these capacities, contact:

Commanding Officer (ESC Code 433)
NAVFAC Engineering Service Center
560 Center Drive
Port Hueneme, CA 93043-4340
Telephone: (805) 982-4984

There are probably no precipitator manufacturers that can meet all the specifications. Discretion must be exercised to determine which deviations are acceptable.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A490M	(2014a) Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C592	(2024) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM D877/D877M	(2019) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D923	(2007) Standard Practice for Sampling Electrical Insulating Liquids

INSTITUTE OF CLEAN AIR COMPANIES (ICAC)

ICAC EP-1	(2000) Terminology for Electrostatic Precipitators
ICAC EP-6	(1968) Pilot Electrostatic Precipitators

ICAC EP-7	(2004) Electrostatic Precipitator Gas Flow Model Studies
ICAC EP-8	(1993) Structural Design Criteria for Electrostatic Precipitator Casings
ICAC EP-10W	(2008) Bid Specification Information Requirements and Bid Evaluation Form for Electrostatic Precipitators

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60309-3	Pin and Sleeve Devices

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 12.01	(2002; E 2004) One Coat Zinc-Rich Painting System
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60	Standards of Performance for New Stationary Sources

1.2 DEFINITIONS

Electrostatic precipitator terminology must be in accordance with ICAC EP-1 except for the following:

a. Aspect Ratio: Effective treatment length divided by effective collection plate height.

b. Collection Surface Area: Area of vertical grounded plates parallel to the gas flow. The area of components in walkways, hoppers, discharge electrical surfaces, inlet plenums, and outlet plenums must be excluded. Exclude area of plates above or below the uniform gas flow.

c. Effective Collection Plate Height: Vertical height of the grounded collection plate in contact with the flue gas.

d. Effective Treatment Length: Horizontal length of the grounded collection plates parallel to the gas flow in a single passage in the direction of gas flow. Exclude walkways, inlet plenums, and outlet plenums.

e. Specific Collection Area: Total grounded collection surface area, in square meter feet, divided by maximum gas flow rate.

f. Rigid Frame Type: Typical design in which the discharge electrodes are fastened in a support frame of welded horizontal and vertical masts suspended from four support insulators.

g. Hot Roof: Top section of the precipitator casing between the penthouse and the gas stream.

h. Penthouse Roof: The walking surface on top of the penthouse; that is, the raised pattern plate that covers the top of the penthouse casing insulation.

i. Plate Spacing: Center to center spacing of the grounded collecting electrode surfaces.

1.3 DESCRIPTION

****

NOTE:

1. If fly ash conditioning or removal prior to the precipitator is included in the design, the system should be described.

2. If it is anticipated that the efficiency of the precipitator will be increased by the addition of field(s) in the future, this should be described.

3. If it is desired that the inlet and outlet breeching be furnished and/or designed by the collector manufacturer, it should be described.

4. Specify the ESP location and breeching tie points.

****

Provide electrostatic precipitator(s) of the rigid frame type designed in accordance with ICAC EP-1, ICAC EP-10W , ICAC EP-6, ICAC EP-7, and ICAC EP-8 to remove fly ash from flue gas produced by a [pulverized coal-fired boiler] [spreader stoker-fired boiler] [underfeed stoker-fired boiler] [refuse-fired waste disposal incinerator]. Provide precipitator(s) suitable for [indoor] [outdoor] installation. Locate the precipitator(s) in the flue gas system between the [_____] and the [_____].

1.3.1 Electrostatic Dust Collector Layout and Component Drawings

Drawings must indicate the kind, size, arrangement, weight of each component, and breakdown for shipment; the external connections, location of local controls, remote control panels, anchorages, and supports required; the dimensions needed for installation and correlation with other materials and equipment; seismic structural calculations; and foundation and loading information. Supply drawings for each component showing design and assembly. Provide schematics of all electrical and pneumatic circuits used. Submission must include, but must not be limited to the following details:

a. Transformer-rectifier equipment.

b. High voltage switches and disconnects.

c. High voltage fuses and circuit breakers.

d. Control systems.

e. Ground lugs.

f. Protection against electrolysis.

g. Graphic display panel indicating power components.

h. Lubrication locations.

i. Electrodes and collecting surfaces.

j. Platforms, walkways, stairways, and ladders which will be required for operation, inspection, testing, and maintenance, and furnished with the precipitator.

k. Location of field welds, in conformance to AWS D1.1/D1.1M.

1.3.2 Hopper Heater Drawings

Provide layout drawings, wiring diagrams, and control schematics diagrams. Layout drawings must show each hopper face including control zones.

1.3.3 Dust Collection System

Submit a full description of the system proposed, including arrangement, operation, and maintenance of the discharge electrodes and collecting surfaces. Indicate planned rapping cycle and performance test details and sampling location. Describe electrodes and collecting surfaces.

1.4 PERFORMANCE

****

NOTE:

1. Select either a collection efficiency or outlet dust loading condition, whichever is more stringent.

2. The stack emission or efficiency requirements must comply with (a) weight emission standards; (b)

opacity regulations; and (c) community standards for visible emissions. Compliance with existing emission codes may not satisfy the opacity regulation. Similarly, opacity regulations may not be as demanding as community standards. A specific quantitative emission rate must be selected on the basis of the goals established.

3. Stack opacity is influenced by particle size makeup. For example, with pulverized coal-fired boilers, about 45 percent of the ash particles are below 10 microns in size; for a cyclone-fired boiler, about 70 percent are below 10 microns; for a stoker-fired boiler, about 25 percent are below 10 microns. A visually acceptable stack for these three options might require residuals of 0.046 g/m3 0.02 gr per acf, 0.023 g/m3 0.01 gr per acf, and 0.092 g/m3 0.04 gr per acf, respectively.

4. If it is determined that a spare or additional precipitator section is desirable to increase reliability, the specification should be modified so that the performance can be met with any one section out of service.

****

The precipitator must operate at a [dust collection efficiency of not less than [_____] percent] [dust loading at the precipitator outlet of not more than [_____] grams per liter grains per standard cubic foot], as measured using EPA method 5, when operating continuously at the maximum continuous rating of flue gas flow conditions and dust loading specified in paragraph entitled "Inlet Gas Conditions." The collection efficiency must not be limited because of variations in dust resistivity levels. Flue gas conditioning by injection of sulfur-trioxide, ammonia, or other substance must not be an acceptable method of achieving performance.

1.5 OPERATING EXPERIENCE REQUIREMENTS

1.5.1 Equipment

Provide dust collectors which meets all of the operating experience requirements listed below.

1.5.2 Experience Required

****

NOTE: Allow only operating experience treating flue gas from the equipment specified in paragraph entitled "Design Criteria" and of the approximate L/s acfm, temperature and inlet grain loading as that specified in paragraph entitled "Inlet Gas Conditions."

****

The manufacturer has constructed not less than three electrostatic precipitators each at a separate facility, treating flue gas from [a refuse-fired waste disposal incinerator] [a coal-fired boiler] with [automatic] [manual] combustion control. Each precipitator must have performed satisfactorily, normal maintenance or downtime of the associated [boiler] [incinerator] [dust collector] included, for a period of not less than 2 years treating at least [_____] L/s acfm of inlet gas at a temperature of at least [_____] degrees C F, with inlet dust loading of at least [_____] grams per liter grains per acf and outlet dust loading of at most [_____] grams per liter grains per acf.

1.5.3 List of Prior Installations Contents

Submit a certificate from the manufacturer containing the information outlined below within 30 days after award and prior to commencement of installation. Information to be contained in the certificate must include:

a. A list of at least three installations at separate facilities meeting the requirements set forth above.

b. Owner, location, point of contact, and phone number of each such installation.

c. Date of owner acceptance of each such installation.

d. Design inlet gas volume, L/s acfm; inlet gas temperature, degrees C F; inlet dust loading, grams per liters grains per acf; and outlet dust loading, grams per liter grains per acf.

e. Type of [coal-fired boiler] [refuse-fired waste disposal incinerator].

1.6 MODEL TEST

****

NOTE: Generally, the complete gas system is included in the model test.

****

The precipitator manufacturer or a Contracting Officer approved independent modeling and testing lab must perform a three dimensional model test of not less than 1:100 1/8 scale. Hold all model dimensions to within plus or minus 1.50 mm 1/16 inch. The precipitator manufacturer or testing lab must have at least five years experience in conducting electrostatic precipitator model tests. (The five years of experience is required prior to proposal submittal.) The test must determine the gas flow patterns in accordance with ICAC EP-7procedures, the potential areas of dust accumulation using sifted bleached wheat flour and neutral buoyancy bubbles, velocity distribution, and potential pressure drop reductions through the precipitator, nozzles, and breeching. Model breeching and particulate control equipment from [_____] to [_____]. Include precipitator hoppers, collection plates, distribution devices, turning vanes, anti-sneak baffles and internal bracing and supports. Simulate the cyclones to represent the adversely affected gas flow distribution from the cyclones. Perform flow and dust distribution tests at 30, 50, 75, 100, and 125 percent of maximum continuous flow rating. Notify the Contracting Officer of test dates in writing not less than 14 calendar days before tests are to begin.

1.6.1 Precipitator Model Tests Reports

****

NOTE: Include other test locations of concern based on the preliminary breeching design. These may include inlets to induced draft fans and stacks as

well as bypass breeching.
****

Complete model testing and have approved by the Contracting Officer prior to submittal of drawings. Provide reports within 30 days of test completion. Include a scale drawing of the model showing actual dimensions and a scale drawing of the full-size installation showing modifications made and devices added to the breeching and transitions as a result of the model study. Include uniform gas velocity diagrams and histograms, indicating the root mean square velocity deviation, standard deviation, and mean velocity, at strategic locations which must include, but not be limited to, the following:

a. Inlet to electrostatic precipitator.

b. Outlet of electrostatic precipitator.

Provide a complete explanation of the test procedures including flow rates, pressures, sample calculations and assumptions prior to testing. List and justify deviations in dynamic or geometric similitude by the model from the full-size installation. The test report must recommend breeching configuration changes, gas flow vaning, straightening or other gas distribution devices in the system required to meet ICAC EP-7 requirements and gas distribution specified in paragraph entitled "Gas Distribution Devices." Incorporate devices required for specified gas distribution and modifications necessary to the proposed breeching, that result from model testing, into the final breeching design. Recommend the location of test ports, the location and type of flow distribution devices in stack, and the location of gas flow instrumentation points and monitors. Provide a complete listing of pressure drop data taken at each pressure tap during each test run and also include data from runs before and after the addition of supplemental flow distribution devices that correct distribution problems identified by initial runs. Locate pressure tap as required to accurately determine the pressure drop across critical breeching components and the effect of the additional distribution devices on the pressure drop. Submit with the report a complete set of photographs and videotape recordings of model during air flow test.

1.6.2 Reports

For precipitator inspection, submit report of the factory service engineer's inspection within 15 calendar days after the inspection stating his findings including the acceptability of the precipitator for field performance tests. Submit air load test report with the precipitator inspection report. With performance test reports, certify that instruments were calibrated and readings indicated are true. Include certification that computations required for testing are accurate, that acceptable methods were used, and that the equipment performed in accordance with the requirements. For precipitator calibration, include certification that computations required for testing are accurate, and that acceptable methods were used.

1.7 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Electrostatic dust collector

Hopper heater

SD-03 Product Data

Warning signs

SD-05 Design Data

Dust collection system

SD-06 Test Reports

Precipitator model tests

Hopper heater module voltage tests

Precipitator inspection

Air load test

Performance tests

Precipitator calibration

SD-07 Certificates

List of prior installations

SD-10 Operation and Maintenance Data

Electrostatic dust collector system, Data Package 3

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.8 DELIVERY AND STORAGE

Ship equipment completely factory assembled, except when the physical size, arrangement, or configuration of the equipment, or shipping limitations, makes the shipment of completely assembled equipment impracticable, in which case assemble the equipment and ship as stated in the Contractor's proposal. Provide storage and protection of delivered equipment in accordance with manufacturer's recommendations.

1.9 DESIGN CRITERIA

1.9.1 [Boiler Data

****

NOTE: Select the applicable paragraph(s) from the following:

****

****

NOTE: Include ash analysis if available. Specify range of properties for coal.

****

****

NOTE: Insert appropriate Section number and title in the blanks below using format per UFC 1-300-02.

****

Provide electrostatic precipitator(s) for operation with [the boiler(s) specified in [_____]] [boiler(s) manufactured by [_____], Type [_____], Model No. [_____]]. The boiler is a [new] [existing] [pulverized coal-fired] [spreader stoker-fired] [underfeed stoker-fired] boiler rated [_____] kilogram per second pounds per hour of steam at [_____] kPa psi, having a gross heat input of [_____] kilowatt millions Btu per hour, and utilizing coal with the following properties:

a. Proximate analysis, as received, percent by weight:

Range	
Moisture	[_____]

Range	
Ash	[_____]
Volatile Matter	[_____]
Fixed Carbon	[_____]
Sulfur, percent by weight	[_____]
Heating Value, Btu per pound	[_____]

b. Ultimate analysis, as received, percent by weight:

Range	
Moisture	[_____]
Carbon	[_____]
Hydrogen	[_____]
Sulfur	[_____]
Nitrogen	[_____]
Oxygen	[_____]
Ash	[_____]

The expected range of boiler steam output will be between [_____] and [_____] kilogram per second pounds per hour. Boiler combustion is controlled [manually] [automatically]. The standby fuel is [_____].]

[Incinerator Data

****

NOTE: The standard classifications of wastes are as follows:

CLASSIFICATION

Type	Description	Principle Components	Noncombustibl Solids (Max. Percent by Weight	Moistur Content (Max. Percent	Heating Value (kJ per kg)
0	Trash	Highly combustible waste, paper, wood, cardboard cartons, including up to 10 percent treated paper, plastic or rubber scrap, commercial and industrial sources	5	10	19,805
1	Rubbish	Combustible waste paper, cartons, rags, wood scraps, combustible floor sweepings, domestic, commercial, and industrial sources	10	25	15,145
2	Refuse	Rubbish and garbage; residential sources	7	50	10,019
3	Garbage	Animal and vegetable waste, restaurants, hotels, markets; institutional, commercial, and industrial sources	5	70	5825
4	Animal solids and organic wastes	Carcasses, organs, solid organic wastes; hospital, laboratory, abattoirs, animal pounds, and similar sources	5	85	2330
Loose Paper			-	-	23,300
Loose Wood			-	-	23,300
Classified Material		Highly-combustible waste, paper, cardboard cartons	-	-	16,310 to 23,300

CLASSIFICATION					
Type	Description	Principle Components	Noncombusti Solids (Max. Percent by Weight	Moisture Content (Max. Percent)	Heating Value (Btu per Pound)
0	Trash	Highly combustible waste, paper, wood, cardboard cartons, including up to 10 percent treated	5	10	8,500
1	Rubbish	Combustible waste paper, cartons, rags, wood scraps, combustible floor sweepings, domestic,	10	25	6,500
2	Refuse	Rubbish and garbage; residential sources	7	50	4,300
3	Garbage	Animal and vegetable waste, restaurants, hotels, markets; institutional, commercial, and	5	70	2,500
4	Animal solids and organic wastes	Carcasses, organs, solid organic wastes; hospital, laboratory, abattoirs, animal pounds, and similar	5	85	1,000
Loose Paper			-	-	10,000
Loose Wood			-	-	10,000
Classified Material		Highly-combustible waste, paper, cardboard cartons including up to 10 percent plastics and treated paper	-	-	7,000 to 10,000

Include ash analysis if available. Classified material contents description may change as plastic use increases. Check incinerator Institute of America for latest information.

****

****

NOTE: Insert appropriate Section number and title in the blanks below using format per UFC 1-300-02.

****

Provide electrostatic precipitator(s) for operation with [the incinerator(s) specified in [_____]] [incinerator(s) manufactured by [_____]]. The incinerator is a [new] [existing] installation capable of burning [_____] [kilogram per second pounds per hour] [Mg tons per day] of Type [0], [1], [2], [3], [4], [loose paper] [loose wood] [classified material] wastes. The expected range of incinerator operation will be between [[_____] and [_____]] [kilogram per second pounds per hour] [Mg tons per day] of wastes. Incinerator combustion is controlled [manually] [automatically]. The auxiliary fuel is [_____].

]1.9.2 Mechanical Collector Data

****

NOTE: Use this paragraph only when a combination of mechanical cyclone-type dust collector and electrostatic precipitator is selected. An assumed efficiency range of 35 percent to 70 percent is typical. For existing cyclones testing may be necessary to determine efficiency.

****

Provide the electrostatic precipitator(s) with [the mechanical cyclone-type dust collector(s) specified in Section 23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES [mechanical cyclone-type dust collector(s) manufactured by [_____], Type [_____], Model No. [_____]].] The mechanical cyclone-type dust collector [is specified to have] [was designed for] an overall collection efficiency of [_____] percent. The contractor must assume that the cyclone may be operating at any point in the efficiency range of [_____] to [_____] percent.

1.9.3 Inlet Gas Conditions

****

NOTE:

1. To properly apply their equipment, the precipitator manufacturer must know the expected inlet gas conditions. For new equipment this information can be best supplied by the boiler manufacturer, incinerator manufacturer, and mechanical cyclone-type dust collector manufacturer.

2. In determining the inlet gas conditions for existing installations, source testing should be performed to determine the gas flow and contents. Gas volume determinations should be made EPA Methods 1-4 in 40 CFR, Part 60, Appendix A. For particulate size distribution an actual sample should be taken and analyzed in accordance with ASME PTC 28, "Determining the Properties of Fine Particulate Matter." For particulate loading only, use EPA Method 5 or 17.

3. For new installations, the inlet gas conditions should be obtained from the manufacturer. If this is not possible, the gas contents must be estimated. When estimates are made, the emission factors and handbook data should be taken from U.S. Environmental Protection Agency Publication no. AP-42, entitled "Compilation of Air Pollutant Emission Factors," with the latest supplements. Correction for expected combustible content should be made. Source testing should be conducted in accordance with the applicable portion of EPA 40 CFR 60, Appendix A or applicable local standard.

****

****

NOTE: Supply excess air percentage for incinerator applications.

****

Provide electrostatic precipitator(s) for entire operating range of gas conditions from the [boiler(s)] [incinerator(s)] [mechanical cyclone-type dust collector] specified above. The electrostatic precipitator inlet gas conditions must be:

	Maximum	Minimum	Peak
a. Inlet gas volume, L/s:	[_____]	[_____]	[_____]
b. Inlet gas temperature, degrees C:	[_____]	[_____]	[_____]
c. Inlet gas density, kg per cubic meter:	[_____]	[_____]	[_____]
d. Inlet gas moisture, percent by weight:	[_____]	[_____]	[_____]
e. Inlet dust loading, grams per liter:	[_____]	[_____]	[_____]
f. Altitude above sea level, meter:		[_____]	
g. Particle size distribution:			

Size, Microns	Maximum Percent by Weight Less Than Particle Size
60	[_____]
40	[_____]
30	[_____]
20	[_____]
15	[_____]
10	[_____]
7.5	[_____]
1.0	[_____]
1.0	[_____]

	Maximum	Minimum
h. Fly ash density, for hopper volume design, kg per cubic meter	[_____]	[_____]
i. Fly ash density for weight determination, kg per cubic meter (compacted)	[_____]	[_____]
j. Excess Air (range)	[_____]	[_____]

	Maximum	Minimum	Peak
a. Inlet gas volume, acfm:	[_____]	[_____]	[_____]
b. Inlet gas temperature, degrees F:	[_____]	[_____]	[_____]
c. Inlet gas density, pounds per acf:	[_____]	[_____]	[_____]
d. Inlet gas moisture, percent by weight:	[_____]	[_____]	[_____]
e. Inlet dust loading, grains per acf:	[_____]	[_____]	[_____]
f. Altitude above sea level, ft:		[_____]	

	Maximum	Minimum	Peak
a. Inlet gas volume, acfm:	[_____]	[_____]	[_____]
g. Particle size distribution:			

Size, Microns	Maximum Percent by Weight Less Than Particle Size
60	[_____]
40	[_____]
30	[_____]
20	[_____]
15	[_____]
10	[_____]
7.5	[_____]
1.0	[_____]

	Maximum	Minimum
h. Fly ash density, for hopper volume design, pounds per cubic foot	[_____]	[_____]
i. Fly ash density for weight determination, pounds per cubic foot (compacted)	[_____]	[_____]
j. Excess Air (range)	[_____]	[_____]

Verify data in the field and design the precipitator(s) to operate efficiently over the entire range of inlet gas conditions.

1.9.4 Precipitator Data

****

NOTE:

1. If a spare or additional precipitator section is included, the following should be added to the collection efficiency: "with one section out of service."

2. As a general rule, use four fields.

3. Usually a minimum of two electrically isolatable bus section per field is used.

4. Maximum velocity through precipitator is in the range of 1.22-2.13 m/s 4-7 fps.

5. Minimum specific collecting area is in the range of 69 to 98 square meter per 1000 L/s 350 to 500 square feet per 1000 acfm.

6. Minimum aspect ratio should be at least 1.5.

7. Minimum hopper storage should be at least 12 hours.

8. Usually a 55 degree hopper valley angle is used. If the ash is "sticky" as for western coal, or if moisture content is high, a 65 degree angle should be used.

9. Minimum casing design pressure and vacuum is usually 3735 Pa 15 inches WC.

10. Minimum design for dust on plates should be based on 6 mm 1/4 inch of dust on all internal surfaces assuming a dust weight of 640-1600 kg/m3 40-100 lb/ft 3.

****

Apply the following construction criteria to each of the electrostaticprecipitator(s). Base applicable criteria on flow conditions at maximum continuous rating specified in paragraph entitled "Inlet Gas Conditions."

a. Minimum required collection efficiency, percent [_____]

b. Minimum number of fields in direction of gas flow [_____]

c. Minimum effective treatment time, seconds [_____]

d. Minimum effective treatment length, meter feet [_____]

e. Minimum number of electrically isolatable bus sections per mechanical field [_____]

f. Maximum collection area per electrically separate bus sections, square meter feet [_____]

g. Maximum number of electrically separate bus sections per transformer-rectifier [_____]

h. Maximum number of gas passages per bus section [_____]

i. Minimum number of transformer-rectifier sets per mechanical field [_____]

j. Gas velocity minimum through precipitator, m/s fps[_____]

k. Minimum specific collecting area, square meter per 305 cubic meter feet per 1000 acfm [_____]

l. Maximum vertical height of discharge electrodes, meter feet[_____]

m. Maximum vertical height of collecting electrodes, meter feet [_____]

n. Range of plate spacing, mm inches [_____] to [_____]

o. Minimum discharge electrode cross-sectional area, square mm inches [_____]

p. Maximum horizontal length of each electrical field, meter feet [_____]

q. Minimum aspect ratio [_____]

r. Maximum pressure from [_____] to [_____] Pa inches watergage [_____]

s. Minimum hopper storage capacity, each hopper, hours [_____]

t. Minimum hopper storage capacity, each hopper, cubic meter feet [_____]

u. Minimum hopper valley angle, degrees from horizontal [_____]

v. Minimum number of hoppers for each electrical field [_____]

w. Minimum casing design pressure at [_____] degrees C F, Pa inches water gage [_____]

x. Minimum casing design vacuum at [_____] degrees C F, Pa inches Hg [_____]

y. Minimum casing design temperature, degrees C F [_____]

z. Minimum insulator design temperature, degrees C F [_____]

aa. Minimum design wind load, kg per square meter pounds per square foot [_____]

ab. Minimum design snow load, kg per square meter pounds per square foot [_____]

ac. Minimum design live load, kg per square meter pounds per square foot [_____]

ad. Minimum design load for dust on internal surfaces, kg pounds [_____]

1.9.5 Breeching

Provide breeching, stiffeners, bracing, supports, hangers, supporting steel, expansion joints and heat insulation between the [_____] and [_____]. Design the breeching to withstand internal pressures between plus 3735 to minus 6225 Pa 15 to minus 25 inch water gage. Include turning vanes in breeching as recommended by the report on model test. Provide self-cleaning type breeching to prevent dust accumulation. Provide expansion joints to give the breeching sufficient flexibility under thermal changes. Provide suitable supports and guides to eliminate transverse loading of flexible expansion joints.

1.9.6 Coordination

Coordinate design parameters and controls of precipitator between precipitator manufacturer and manufacturers of equipment which will interface with, or affect, system operation. Design the precipitator for operation with the [boiler] [incinerator] [and the mechanical cyclone type dust collection] specified to assure that the collection efficiency specified is attained.

1.9.7 Electrostatic Dust Collector System

Submit operation and maintenance data for electrostatic dust collector system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.10 AMBIENT ENVIRONMENT IN VICINITY OF ELECTRICAL EQUIPMENT

Guarantee that electrical equipment mounted external to the precipitator housing must perform satisfactorily during normal operation of the [boiler] [incinerator] at loads within its rated limits and during start-up and shutdown, with an ambient environment of [[_____] to [_____]] degrees C F and [[_____] to [_____]] percent relative humidity, and exposure, including solar effects. Electrical equipment must include the following:

a. Motors, motor starters, controllers, and controls

b. Transformer-rectifiers

c. Rapper coils

d. Insulators

e. High voltage bus

f. Raceway and conductors interconnecting precipitator electrical equipment

g. Pressure switches

h. Heater contactors.

1.11 MISCELLANEOUS

Provide installation complete in accordance with this specification and as shown and include the following:

a. Wiring, conduits, fittings, supports, and grounding of electrical equipment in accordance with Division 26, "Electrical."

b. Special tools and devices required for operating, adjusting, repairing, and maintaining the air pollution control with their accessories.

c. Warning signs, of an approved permanent type, where required for the safety of operating personnel.

d. Bronze grounding lugs outside each access door into the precipitator.

1.12 DELIVERY OF MODEL

The model used for testing must remain the property of the Government. Deliver the model including a support table to the Contracting Officer within six months after Government acceptance of the full size units.

PART 2 PRODUCTS

2.1 MATERIALS

Parts exposed to the flue gas of materials having physical suitable for the service and able to withstand the abrasive and chemical action of the flue gas and fly ash. Make parts subject to deterioration easily accessible for inspection, maintenance, or replacement. The materials used must conform to the following:

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

a. Housing plate and stiffeners: [ASTM A242/A242M, Type 1]

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

b. Hoppers: [ASTM A242/A242M, Type 1] [ASTM A276/A276M]

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

c. Discharge electrodes: [ASTM A242/A242M, Type 1]

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

d. Collecting surfaces: [ASTM A242/A242M, Type 1]

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

e. Gas distribution devices: [ASTM A242/A242M, Type 1]

****

NOTE: Use ASTM A242/A242M steel when material is subjected to continuous temperatures of 204 degrees C 400 degrees F or higher.

****

f. Structural and miscellaneous steel: [ASTM A242/A242M, Type 1]

2.2 STRUCTURAL SUPPORTS

****

NOTE: Use 6 mm 1/4 inch thick steel for temperatures over 260 degrees C 500 degrees F. Detail structural supports on drawings.

****

Provide steel support structures for the precipitator as [indicated] [specified herein]. Provide the precipitator with column extensions or stubs to project from the precipitator internal support system to the support structure. Provide column extensions or stubs of adequate length to provide clearance between the precipitator casing and hoppers and the support frame beams. Provide sufficient clearance to permit the insulation and casing to be installed and to accommodate the extremes of displacement caused by thermal expansion. Support precipitator components from the precipitator internal support system. Provide additional grid steel required at the unit for support of precipitator components. Anchor the precipitator on its centerlines and allow to expand in both directions. Provide slide plates for installation between the precipitator free support points and the support structure.[Design the precipitator supports in accordance with Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS.] Fabrication and erection of structural steel must conform to AISC 360.

2.3 ELECTRICAL REQUIREMENTS

2.3.1 Electrical Scope of Work

The work covered by this section consists of providing, adjusting, testing, and placing in operation electrical equipment and materials which are an integral part of the electrostatic precipitator provided under this section.

2.3.1.1 Material and Workmanship

Material and workmanship in factory assembled equipment, unless indicated or specified otherwise, must conform to Division 26, "Electrical." Include interconnecting conduit and wire, grounding, and the electrical connection of the mechanical equipment to the electrical power circuit under Division 26, "Electrical."

2.3.1.2 Electrical Supply Voltage

Provide supply voltage of [_____] volt, three phase and [_____] volt, single phase, 60 hertz. Balance single phase loads on three phase systems. Except as specified herein, design all equipment for energization from a [_____] volt, single phase, 60 hertz electrical supply.

2.3.1.3 Transformers

Supply transformers and accessory equipment as required to convert the [[_____] volt, three phase] [[_____] volt, single phase], 60 hertz electrical supply to those voltages required.

2.3.2 Equipment Enclosure Heaters

Provide outdoor equipment enclosures with space heaters to prevent condensation of moisture within the equipment enclosures. Space the heaters away and thermally insulate from close painted surfaces. Control the heaters by an adjustable thermostat set to deenergize the heaters when the temperature rises to 35 degrees C 95 degrees F, and to energize the heaters when the temperature decreases to 29 degrees C 85 degrees F. The space heaters must not interfere with normal entrance of cables into the enclosures or equipment within the enclosure.

2.3.2.1 Equipment Enclosure Nameplates

Provide equipment enclosures and associated switches, indicating lights, meters, and devices with nameplates.

2.3.2.2 Equipment Enclosure Grounding

Provide equipment enclosures with a ground bus and connectors in accordance with National Electrical Code. Connect electrical equipment to the grounding system specified in Division 26, "Electrical."

2.3.2.3 Insulation and Weatherproofing

****

NOTE: Use this paragraph only when equipment is exposed to the atmosphere.

****

Insulate and weatherproof electrical enclosures exposed to the atmosphere. The enclosures must conform to specification for insulation and enclosure for roof housing in paragraph entitled "Housing."

2.3.2.4 Wiring

Wiring design and installation must be in accordance with NFPA 70 and as specified.

2.3.3 Transformer-Rectifier (T-R) Set

****

NOTE: T-R voltage should be 50 KV DC average as a minimum. Sump must be covered and piped to an oil-water separator if penthouse is not covered by a weather enclosure.

****

Enclose the high voltage rectifying equipment in the sealed transformer case to form a single enclosure. The enclosure must meet the requirements of NEMA Type 3R construction as described in NEMA ICS 6. Provide oil-filled, air-cooled type transformer designed and shielded for precipitator service. Equip the transformer case with, at a minimum, the following items: connection box, grounding connection, filling connection, drain and sampling valves, thermometer, oil and vacuum gages, and high temperature alarm. Provide sump to contain the oil which may leak from the transformer. Provide rectifier with concentric pipe and guard conductors between power supply and precipitator. Voltage supply must be rated for [_____] volts. T-R capacity must be [_____] KVA maximum. T-R output voltage rating must be [_____] kV minimum. T-R must operate at 60 percent to 100 percent of its current rating at normal operating conditions.

2.3.3.1 Rectifier

Provide oil immersed, solid state silicone type rectifier. Mount within the transformer case and equip with necessary surge equalizers and suppressors. Arrange interior parts to facilitate circulation of oil for adequate cooling.

2.3.3.2 Grounding Switches

Provide each transformer-rectifier set with a five-position grounding switch to permit grounding of both bushings; full-wave power to one bushing, grounding of the other bushing and vice versa; half-wave power to both bushings. Provide a bus duct between the power supply and the precipitator. Do not connect more than two bus sections to a single transformer-rectifier set; connect each bus section to a single bushing and connect each bushing to only one bus section.

2.3.3.3 Transformer Oil

Provide insulating mineral oil, PCB free, kV rated with required dielectric rating. Sample the oil after installation and test in accordance with ASTM D923 and ASTM D877/D877M. If the oil does not meet the ASTM specification, dry and filter until it meets or exceeds the requirements.

2.3.4 Control Cabinet

Provide controls for the high voltage precipitator supply in control cabinets and include all regulating devices. Provide control cabinets that are completely wired, self-ventilated, free standing, and enclosed in a grounded casing. Maintain cabinet at positive pressure using a fan powered by a 120 volt, single-phase motor with a power output of not less than [0.093 kW] [1/8 hp] [_____]. Filter pressurizing air with a filter that is not less than 98.5 percent efficient for dust particles one micron or larger. Equip control cabinet and T-R with a safety key interlock. Construct the control cabinet in accordance with NEMA Type 12 as defined in NEMA ICS 6. Each controller must conform to NEMA ICS 1 and NEMA ICS 2 and contain, but not be limited to, the following:

a. Completely automatic solid state controller which will maintain a preset spark rate, maximum current, and maximum voltage; silicon controlled rectifiers driven by transistorized automatic controls with auxiliary manual capability. Provide the reactor in conjunction with the T-R set with a nominal impedance of 40 percent and additional taps at 50 percent and 60 percent impedance. Provide easily accessible taps to facilitate changing of tap position. The reactor must hold inductance within 5 percent at 2.5 times rated current at 40 percent impedance.

b. Full range control on both manual and automatic. Field adjustments to the automatic control must be maximum current, maximum voltage, and spark rate set point.

c. Indicators, meters, and protection.

d. High voltage start and stop pushbuttons.

e. Thermal line breaker with undervoltage coil and adjustable magnetic trip.

f. Transformer primary AC voltmeter.

g. Transformer primary AC ammeter.

h. Precipitator DC milliammeter.

i. Precipitator DC voltmeter.

j. Precipitator spark rate meter.

k. High temperature alarm indicator for T-R oil temperatures.

l. Auxiliary contacts for the attachment of a partable oscilloscope in order to observe both voltage and current wave forms on the high tension electrodes.

m. Inverse time over current relay for units rated higher than 300 milliamperes.

n. Static regulator to limit precipitator current during automatic control.

o. Alarm circuit interlock which opens when transformer primary circuit is energized.

p. Fused control disconnect for circuit breaker undervoltage coil and automatic control.

q. Manual automatic control select switch.

r. Thyristors with heat sink sized for operation without thyristor fan.

s. Automatic voltage control unit.

t. Three position selector switch with indicating lights; "LOCAL-MANUAL," "LOCAL-AUTO," and "REMOTE-AUTO" positions.

u. Adjustable memory.

v. Visual annunicator for each of the following conditions:

    (1) T-R overload, one each transformer-rectifier.

    (2) T-R undervoltage, one each transformer-rectifier.

    (3) T-R high voltage short circuit and open circuit, one each transformer-rectifier.

    (4) T-R open circuit, one each transformer-rectifier.

    (5) High temperature indicator for T-R oil temperatures.

2.3.4.1 Arc Suppression Within the Precipitator

Controls must prevent or minimize sparking. The device must suppress an arc within 1/2 cycle and recover within two cycles to initial voltage before arc. Recovery rate must be adjustable.

2.3.4.2 Auxiliary Alarm

Wire the control enclosure so that an isolated contact will close and alarm the local annunciator when any of the white indicating lights are illuminated for any of the T-R controls specified in paragraph entitled

"Control Cabinet." Similarly provide an isolated contact to close and to alarm the local annunciator when any T-R control is not in the "REMOVE-AUTO" position.

2.3.4.3 Pushbutton Stations

****

NOTE: Require these indicator lights if remote indication is required.

****

Wire the start pushbuttons to function only when the three position selector switch is in the "LOCAL-MANUAL" or "LOCAL-AUTO" positions. In addition to shutting down the T-R, the stop pushbutton must clear all alarm outputs, except the output indicating that T-R control is not remote. Startup, whether by local pushbutton or remote control, must arm the alarm system. Provide remote control so that all T-R sets which have their three-position selector switches in the "REMOTE-AUTO" position may be stopped by pushbutton station on the main control panel. Provide output contacts for remote indication of the status of T-R which are in the "REMOTE-AUTO" mode. Provide indicating lights for each precipitator on the auxiliary boiler control panel as follows:

a. Green -- all units off.

b. Red -- all units on.

****

NOTE: Require amber light if sequential startup is required.

****

c. Amber - startup in progress.

2.3.4.4 Redundant Protective Devices

Provide redundant protective devices on controller connections to the transformer unit secondary circuit.

2.3.5 High Voltage System Wiring and Support Insulators

****

NOTE: Use this paragraph for "bus-duct" wiring.

****

Provide wiring materials and insulators, including insulators for discharge electrode supports, required to electrically connect the T-R to the discharge electrodes. The high voltage lead from the rectifier to the discharge electrodes must consist of a conductor in metal enclosed weatherproof bus duct. Furnish the bus duct complete with necessary insulators, duct supports and fittings, and supply formed to exact length ready for bolting to the equipment.

2.3.6 High-Voltage Leads

****

NOTE: Use this paragraph for "pipe" wiring.

****

Completely enclose high voltage leads to the precipitator in a grounded 16 gage minimum thickness sheet metal guard. The conductor must be 20 mm 3/4 inch diameter, Schedule 40 iron pipe. Include equipment for the introduction of clean purging air in and around the support bushings to prevent dust buildup on the insulators. The high voltage conductor pipe must have a union immediately connected to the T-R set so the T-R can be easily isolated from the precipitator. Connect the conductor pipe to the high voltage electrode frame by a removable wire lead.

2.3.7 High Voltage Insulators

Provide a minimum of four insulating support bushings for each electrical bus section. Compression-load the high tension insulators and install outside of the contaminated gas stream. Provide insulators of materials suitable for the temperature. Provide best process electrical glazed ceramic high density 85 percent alumina for temperatures below 454 degrees C 850 degrees F. Provide adequate access for removal and reinstallation of high voltage insulators. Provide four pad-eyes above each high voltage bus frame to facilitate lifting of the frame for precipitator maintenance. Attach pad-eyes to support beams. Each pad-eye and support beam must be capable of supporting the entire weight of its respective high voltage bus frame. Provide other means for lifting high voltage bus frames if acceptable to Contracting Officer.

2.3.8 High Voltage Insulator and Pressurizing System Heaters

Provide a heating and pressurizing/purging system for the high voltage bus duct insulators and the discharge electrode support insulators. Furnish control devices to automatically energize the heaters, as required, when the temperature of the insulating support bushings falls below [107 degrees C] [225 degrees F] [_____] and deenergize the heaters when the temperature reaches [121 degrees C] [250 degrees F] [_____]. The system must maintain an insulator temperature of 107 degrees C 225 degrees F when the precipitator is off line. Provide sufficient pressure to prevent the infiltration of dust and moisture laden air into the penthouse and to keep the inside of the high voltage insulators free from the flue gas. Supply a minimum of 47.20 L/s 100 acfm of heated, filtered air for each insulator. Direct the purge air downward in swirl pattern across the inside surface of each insulator. Provide a purge air filter of the disposable or cleanable type with a filter efficiency of not less than 98.5 percent for dust particles of one micron or larger. Provide remote annunciation for malfunctions of the heating and pressurizing system as specified in paragraph entitled "Annunication and Indication." Provide pressurizing fans, complete with electric motor, automatic backflow prevention dampers, inlet filters, and a relief device for filter bypass in case of blocked filters. Furnish a minimum of two fans for each pressurizing system. Provide pressurizing fans of equal capacity and requiring the same size motors. Upon less of any one fan, the remaining fans must automatically pressurize the system as required to ensure continued normal operation of the precipitator. Provide a control system consisting of necessary relays, pressure switches, flow switches, and control devices. Factory mount control devices, except those requiring local mounting, and wire in an indoor NEMA ICS 6, Type 12 floor-mounted control enclosure. Provide each fan discharge duct with an airflow switch for use in fan control. Furnish locally mounted NEMA ICS 6, Type 4 combination starters for the fans. Mount an "AUTO-ON" selector switch for each fan on the door of its associated local combination starter. Mount indicating lights for system status on the starter door. Provide each fan control circuit with a two-position, "AUTO-ON," selector switch. Provide a single normally open contact, which will close upon start up of the induced draft fans, when the selector switch is in the "AUTO" position. Provide relays as required to multiply this signal. Electrically isolate output contacts for controls motor starters.

2.3.9 Discharge Electrodes and Collecting Surfaces

Provide rigid frame type discharge electrodes. Rigid electrode, or weighted wire design precipitators are not acceptable. The discharge electrodes in each passageway must run in a vertical direction and must be supported by a welded pipe, tube, or channel frame. Provide the frame with vertical pipe, tube, or channel supports spaced at a maximum interval of 1.22 meters four feet. Also provide the frame with horizontal pipe, tube, or channel supports spaced at a maximum interval of 1.22 meters four feet. The electrodes must have a cross-sectional area of not less than 16 square mm 0.025 square inches and not more than 64.52 square mm 0.10 square inches. Fabricate collecting surface from rolled seamless sheet of not less than 16 gage thickness. Collecting surface plate spacing must be not less than 280 mm 11 inches or greater than 330 mm 13 inches. Support discharge electrodes and collecting surfaces as required to maintain proper alignment during operation. Support each main discharge electrode bus section support frame by four alumina support insulators. Design collecting surfaces so that deflection from a plane surface will not exceed plus or minus 6 mm 1/4 inch about any axis. Design and construct discharge electrodes and collecting surfaces to be readily located and aligned within plus or minus 6 mm 1/4 inch of the normal design position. Assemble the collecting surfaces at the factory. Factory assembled modules which can be shipped to the field for erection may be provided. Provide high voltage frames with sway braces or other devices as required to prevent swaying. Incorporate gas baffles into the collecting plates to provide a gas flow quiescent zone and to provide stiffening.

2.3.10 Rappers

Provide falling hammer collecting surface and discharge electrode rappers with individual hammers for each plate and frame. Design plate rappers for sequential rapping to prevent simultaneous rapping of plates and provide a minimum of 27 N.m 20 foot pounds of rapping force per plate. Design discharge electrode rappers for sequential rapping to prevent simultaneous rapping of frames and provide a minimum of 12.24 N.m 9 foot pounds of rapping force per frame. Provide solid steel rapper drive shafts with a minimum diameter of 50 mm 2 inches. Provide magnetic impulse gravity return gas distribution plate rappers with individual rappers for each plate or screen.

2.3.10.1 Rapper Controls

Rapper controls must have adjustments for independent field repeat intervals and for independent field rest time.

2.3.10.2 Rapper Control System

Provide a rapper control system conforming to NEMA ICS 1 and NEMA ICS 2 consisting of necessary devices for the complete control of each rapper system. Factory install and wire the system for [indoor] [outdoor] installation in a NEMA [12] [3R] cabinet as described in NEMA ICS 6 and locate in [control house] [control room] [roof]. Provide outdoor mounted units finish painted for outdoor service, wind braced for [_____] km miles per hour wind and completely weatherproofed.

2.3.10.3 Rapper Disconnects

Provide disconnecting switches for individual rapper groups to deenergize for servicing.

2.3.10.4 Rapper High Voltage Spikes

Provide the rapper system with surge suppressors and other devices as required to eliminate high voltage spikes.

2.3.10.5 Rapper Annunciation

Provide remote annunciation for malfunctions of the rapping system as follows:

"White" light for rappers not operating (power failure).

2.3.11 Annunciation and Indication

2.3.11.1 Off-Limit Conditions

Provide annunciator and indication equipment for individual annunciation and indication of the following off-limit conditions:

a. T-R control trouble.

b. T-R overload, one each transformer-rectifier.

c. T-R undervoltage, one each transformer-rectifier.

d. T-R open circuit, one each transformer-rectifier.

e. T-R not in remote, one each transformer-rectifier.

f. Penthouse or insulator compartment air pressure low.

g. Loss of penthouse pressurizing airflow.

h. Rapper control failure, one each rapper control enclosure.

i. Low hopper temperature.

j. Insulator temperature below [107 degrees C] [225 degrees F][_____].

k. Purge air filter clogged.

2.3.11.2 Annunciator

Provide annunciator with a station for each alarm input plus a minimum of 25 percent spare stations. Provide sufficient stations for annunciation such that the items of equipment that failed can be easily identified. Provide a backlighted window for each station with an engraved legend that will be readable by a [standing] [sitting] operator at the operating station. The unit must be complete with test, audible silence, flasher reset, and lamp reset pushbuttons and audible device. Incorporate an adjustable time delay relay in the annunciator audible device circuit to cause automatic silencing of the device after a manually selected time period. The annunciator stations must, however, remain lighted until the trouble is cleared. Provide solid-state type annunciator, suitable for 120 volts AC power supply with not less than 125 volts DC applied to the trouble contacts. Include one electrically isolated contact per window for remote annunciation. Provide positive oriented logic, 120 volts AC or 125 volts DC power supply for trouble contacts, and two lamps wired in parallel circuit per indicating window. Design annunciator alarm contacts to accept field contacts which close on alarm condition. Do not use contacts which open on alarm condition. Provide an auxiliary isolated contact for each station. The auxiliary contact action must follow that of the field contact. Provide cover-mounted annunciator, test, audible silence, flasher reset, lamp reset, and acknowledge pushbuttons on a NEMA ICS 6, Type 12 enclosure. Mount and wire the following devices inside the enclosure:

a. Annunciator audible device.

b. Fuse and fuse holder for annunciator power supply.

c. Fuse and fuse holder for the audible device.

d. Terminal blocks for connections to all external circuits.

2.3.12 Electrical Service Outlets

Provide a 20 amp, 110 VAC duplex ground fault NEMA 5 20R terminal duplex interrupter receptacle within 2.44 meters 8 feet of access doors except doors in the hot-roof and gas distribution plates. The receptacles on each precipitor level must be on a separate circuit. Ground fault interrupters must test and reset at the receptacle. Wire receptacles to provide individual receptacle protection such that no other receptacles are interrupted by an individual receptacle trip. The receptacle must interrupt at 5 plus or minus 1 milliamp ground fault current. Provide specification grade or better receptacles and protect by weather tight covers. Provide a CS 6369 (Alpha Configuration) 50 amp, 3 pole, 4 wire , 120/250 VAC twist type receptacle in a FS box with a weatherproof cover (Hubbell SR-50 or approved equal - item may be provided as an integral assembly or as individual components) inside each weather enclosure on separate circuits. Provide a weatherproof 100 amp, 3 pole, 4 wire, 120/250 VAC, pin ad sleeve receptacle conforming to IEC 60309-3 within 15 meters 50 feet of each stack base and each precipitator base. Provide each of the 50 amp receptacles with an individual 50 amp, 208 VAC service. Provide each of the 100 amp receptacles with an individual 100 amp 208 VAC service.

2.4 HOUSING

Construct the precipitator housing, including inlet and outlet nozzles, of minimum 6 mm 1/4 inch thick steel plate and attach to appropriate structural steel supporting members. Plumb the housing within 10 mm 3/8 inch measured at top, bottom, and tie points, side to side, and front to rear. The top of the precipitator support must be flat within 1.50 mm 1/16 inch for area of support foot and at elevation within 3.18 mm 1/8 inch. Make provisions, including expansion joints if required, to allow for any expansion, differential expansion, and contraction that may occur. Design the expansion provisions to prevent escape of gas or inflow of ambient air. Provide a minimum of 1.50 meters 5 feet of vertical clearance inside the housing above the discharge electrodes and collecting surface frames to afford access for inspection and maintenance. Locate walkways internal to the housing between electrical fields, at the inlet to the first field, at the outlet to the last field, and as otherwise required to provide access to equipment located within the housing which may require inspection or maintenance. Provide access to internal walkways by two access openings located on opposite sides of the precipitator for each internal walkway. Access openings must align directly with internal walkways and must be unobstructed. The walkways must provide a minimum passageway clearance of 762 mm 30 inches. Provide the housing with insulated, hinged, quick opening, access, inspection, and cleanout doors with gastight seals as required for proper operation and maintenance. Provide a minimum of one door above each bus section. The minimum access opening size must be 460 by 600 mm 18 by 24 inches for rectangular openings and 600 mm 24 inches diameter for round openings. Provide key interlocks for openings through which personnel may come in contact with high voltage equipment to prevent opening before the electrical supply is deenergized. The housing must be of all welded construction. Minimize the use of flanged or bolted joints. Use only where bolted assembly is required for adjustment or removal. Prevent structural members from acting as radiators, thereby reducing internal corrosion. The difference between the inside wall temperature at any point and the inlet gas temperature must be less than 22 degrees C 40 degrees F.

2.4.1 Penthouse

Provide a penthouse to enclose the high voltage system support insulators. Enclose the entire top of the housing. Design the penthouse to withstand the effects of differential thermal expansion between the precipitator housing and the penthouse. Design the expansion provisions to assure an airtight penthouse. Weld gas tight. Check for leaks using smoke candles or other method approved by the Contracting Officer. Repair leaks by welding or repair of mechanical seals. Do not use caulking. Provide a minimum of 2 insulated, hinged, quick-opening access doors on the penthouse roof; one at each end of the roof. Provide penetrations, openings and hatches in or on the penthouse roof with mechanical seals or weld to provide a gas tight and watertight seal. Install calcium silicate insulation conforming to ASTM C533 over 12 gage steel pines stud welded on 610 mm 2 foot centers on the penthouse roof. Hold in place by 65 mm 2 1/2 inch square speed washers and closely fit around penetrations. Construct top surface of 6 mm 1/4 inch thick raised pattern plate conforming to ASTM A242/A242M, Type I to form a continuous walking surface. Provide support to bear not less than 488 kg per square meter 100 pounds per square foot live load. Provide additional support for equipment placed on the roof. Seal joints by continuous fillet or complete penetration groove welds as applicable. Weld appurtenances similarly to the plate. Provide top penetrations with a 50 mm two inch minimum extension above the plate and similarly weld to the plate. Slope the top surface to allow water runoff and to prevent pooling. Extend top surface at least 25 mm one inch beyond side insulation. Provide a 80 mm 3 inch fascia of 6 mm 1/4 inch steel conforming to ASTM A242/A242M plate as a rain barrier. Provide a 80 mm 3 inch kickplate of 6 mm 1/4 inch steel conforming to ASTM A242/A242M plate around the perimeter of the top surface and provide adequate drain holes to permit water runoff. Provide a safety rail on the top perimeter. Manufacture top surfaces of appurtenant structures with 6 mm 1/4 inch steel conforming to ASTM A242/A242M raised pattern floor plate in a manner similar to that specified herein including soffit and fascia dimensions. Aluminum casing materials must conform to ASTM B209M ASTM B209.

2.4.2 Insulation Materials

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NOTE: For operating temperature range of 94 to 260 degrees C 201 to 500 degrees F use minimum thickness

of 115 mm 4 1/2 inches. For operating temperatures 261 degrees C 501 degrees F and above use minimum thickness of 140 mm 5 1/2 inches.

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Insulate the precipitator housing, penthouse, and hoppers with ASTM C612 mineral fiber block or ASTM C592 mineral fiber blanket insulation. Insulate the roof with ASTM C533 calcium silicate block. Minimum insulation thicknesses must be as follows:

a. Housing [_____] mm inches

b. Hoppers [_____] mm inches

c. Hot Roof [_____] mm inches

d. Penthouse [_____] mm inches.

2.4.3 Casing Materials

Casing except top surface casing, which might serve as personnel walking surface, must be 1.27 mm 0.050 inch thick stucco embossed, 100 mm 4 inch rib, unpainted aluminum panel. Aluminum casing must be ASTM B209M ASTM B209.

2.5 HOPPERS

Construct hopper plate of [Type 316 stainless steel conforming to ASTM A276/A276M] [structural steel conforming to ASTM A242/A242M Type 1] and a minimum 6 mm 1/4 inch thick. Provide hoppers with ASTM A242/A242M baffles to prevent flue gas from bypassing the electrostatic field. Hoppers must span no more than one electrical field. Provide hoppers with untapered fillet plates, constructed of cold rolled minimum 10-gage ASTM A276/A276M Type 316 stainless steel, in each corner. Extend the fillet plates the full length of the corner. Seal weld the fillet plates to the hopper walls. Provide closure plates at the top of the hopper at each corner to prevent flow into the area between the fillet plate and the hopper corner. Steel reinforcements not in contact with the gas or ash may be either ASTM A276/A276M Type 316 stainless steel or ASTM A242/A242M structural steel. If the latter is used, select welding rods specifically for the service and submit to the Contracting Officer for approval. Provide protection of rods against moisture.

2.5.1 Hopper Accessories

Provide key interlocked access doors on each hopper on both sides of any hopper baffle. Doors must be in accordance with the requirements specified herein. Hoppers must have adequate flexibility for vibrators. Provide each hopper with two 100 mm 4 inch poke holes with a tee wash connection and screwed caps. Position poke holes to permit downward thrusts into the hopper. Provide a special plate reinforced "pounding area" on each hopper face for external manual vibrating. Each pounding plate must be 300 by 300 by 25 mm 12 by 12 by 1 inch thick ASTM A36/A36M plate steel. Provide a work platform with stairs to each pounding area for units with pounding areas more than 1.50 meters five feet above ground. Do not insulate pounding plate. Finish insulation at this discontinuity. Provide a minimum 200 mm 8 inchdiameter flanged fly ash outlet connection on each hopper to accept the fly ash transportation system equipment. Provide access hatch not less than 200 by 200 mm 8 by 8 inches for cleanout within 200 mm 8 inches above flange.

2.5.2 Hopper Vibrators

Provide each hopper with two vibrators set at the mid-height and on opposite sides. Interface vibrator controls with ash collection system to provide automatic vibrator operation only at the inception and during an evacuation cycle. Provide manual override control for hopper vibrators and evacuation system in hopper area and enclose in (a) case(s) to prevent accidental energization of systems. Place a warning over the vibrator manual control with the following inscription:

"WARNING: VIBRATOR CONTROL. DO NOT ACTIVATE UNLESS HOPPER EVACUATION SYSTEM IS OPERATING."

2.5.3 Hopper Heater System

Provide a hopper heater system for each precipitator.

2.5.3.1 Hopper Heater System Design

Provide the system complete with all material required for mounting. The system must provide a 139 degrees C 250 degree F rise in temperature in the hopper, in the vicinity of the heaters, during offline and startup conditions. Size the system to provide a hopper skin temperature of not less than 177 degrees C 350 degree F when the insulation is in place during minimum ambient temperatures specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Design the system with a minimum heating safety factor of 1.1 and a minimum wind heat loss factor of 1.12. Design the system to provide maximum heater coverage between hopper stiffeners utilizing modular heaters and flexible blanket or tape heaters for the hopper throat heating. Heater modules must cover not less than 33 percent of the hopper area. Cover the bottom portion of the hopper to the maximum extent possible, and extend at least 70 percent up the hopper height. Provide a two zone system. Comprise the lower zone of heaters located on the bottom one-third of hopper height including the throat heater; the upper zone must include the remaining hopper heaters. Use flexible electric heating blankets or tapes, capable of withstanding 427 degrees C 800 degree F, where modular equipment will not fit. Provide only equipment designed to withstand natural and induced vibrations, plus shock loadings normally experienced during operation of the precipitator and ancillary equipment including manual rapping of the strike plates. Provide an individually, thermostatically controlled hopper heater system with adjustable setpoint and include power, control, and alarm components. Locate the low temperature and control thermocouples in the lower portion of each heater zone. Heater voltage must be 480 volts AC. Control voltage must be 120 volts AC.

a. Hopper Heater Module Design: Provide self-contained, modular heaters. Provide hopper heater modules which have a flexible heating face to conform to the irregularities of the hopper surface, providing contact between the heaters and the hopper, and providing maximum heat transfer. Provide low watt density design modules with a maximum of 0.0047 watts per square mm 3 watts per square inch of resistance element and with a minimum of six parallel resistance paths per heater. Continuous blanket type elements must be deemed to meet the multipath requirement. Each module must have dual heating elements. Both elements must function during startup and offline conditions. To reduce power consumption and cycling while maintaining the hopper temperature during online operating conditions, controls must automatically switch off one element in the lower zone and both elements in the upper zone without affecting the remaining element's operation. The hopper throat blanket heater must have a single heating element and must remain on during startup, offline, and online operating conditions. Each heating element in the module must be capable of being operated at and must be rated at 2690 watts per square meter 250 watts per square foot, but must be designed to operate at 2152 watts per square meter 200 watts per square foot. Size wiring, circuits, and controls for 2690 watts per square meter 250 watts per square foot. Total power density must be not less than 4303 watts per square meter 400 watts per square foot of heater module surface. Construct heating elements of 600 series stainless steel alloy or ni-chrome encased in a 20 gage minimum thickness aluminum or aluminized-steel mounting pan or casing. Provide two sets of heater pigtails for each module, one set of pigtails for each element and circuit. Provide multistrand copper pigtail and interconnecting wires with high temperature (454 degrees C 850 degree F) insulation. Furnish heater pigtails with strain relief constructed to prevent damage to the heater modules due to rough handling. Provide pigtails of sufficient length to reach the terminal box. Splices are not permitted in pigtails from modules, tapes, or blankets to the terminal box. Perform hopper heater module voltage tests for each module, blanket, or tape for electrical integrity at 1,000 volts. Provide heating modules with metal labels firmly attached to the module listing the wattage and voltage of the module. Construct heating modules and mounting hardware of high temperature materials capable of withstanding 454 degrees C 850 degrees F. Insulate heating modules with high temperature woven glass cloth or mineral fiber. Mica or magnesium oxide insulated heaters are not acceptable.

b. Hopper Heater Installation: Heater modules must provide maximum contact between the heaters and the hopper wall.

2.5.3.2 Hopper Heater Controls

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NOTE: Use these paragraphs for local control only.

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NOTE: Use these paragraphs for master control only.

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Control each hopper heater zone thermostatically with adjustable setpoint and provide complete including power, control and alarm components. Provide 120 volt AC adjustable type thermostats for monitoring hopper temperature and locate in NEMA ICS 6, Type 4 enclosures. For thermostatic control of the hopper heater system, provide a Master Hopper Heater Control Panel for each precipitator, a Local Hopper Heater Control Panel for each hopper, and a Local Hopper Heater Zone Terminal Box for each zone. Provide materials, tools, and labor required for connections of circuits and wiring between local hopper heater zone terminal boxes, local hopper heater control panels, and the master hopper heater control panels.

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NOTE: Use these paragraphs for local control only.

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a. Local Hopper Heater Zone Terminal Box: Provide hot-dipped galvanized NEMA ICS 6, Type 4 hopper heater terminal boxes with terminal blocks for connection of heater pigtails and thermostat leads on each hopper for each hopper zone. Provide a sufficient number of terminals to connect the heater pigtails and thermocouples for each hopper zone.

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NOTE: Use these paragraphs for local control only.

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b. Local Hopper Heater Control Panel: Provide each precipitator with a local hopper heater control panel at each hopper. Locate at a regularly accessed area near each hopper. For each zone, provide each local hopper heater control panel with: terminal blocks for power, control, and alarm circuits, one control temperature thermostat, one low temperature alarm thermostat, magnetic contactor and alarm relay with two normally open contacts, and auxiliary relays for automatic operation of the heater system. Provide a 3-pole fused switched main disconnect device and a fused control transformer having a 120-volt AC secondary for each local hopper heater control panel. Provide thermostats with a set point range of 38 to 260 degrees C 100 to 500 degrees F. Measure hopper skin temperature using ungrounded, type J thermocouples. Provide each local hopper heater control panel cover with the following devices:

(1) "START UP," "ON LINE," "OFF," "AUTO" selector switch.

(2) 120 V "ON" red light with integral transformers, one each zone.

(3) 120 V "LO TEMP" alarm white light with integral transformer, one each zone.

(4) Device and enclosure nameplates.

(5) Wire the selector switch for the following system operation:

(6) "START UP": Upper and lower zones all elements on (includes throat heater).

(7) "ON LINE": Single element lower zone on (includes throat heater).

(8) "OFF": All elements off.

(9) "AUTO": Control functions transfer to Master Hopper Heater Control Panel.

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NOTE: Use these paragraphs for master control only

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c. Master Hopper Heater Control Panel: Provide panels containing relays, contactors, circuit breakers, control transformers, and other devices required for complete control of each precipitator hopper heater system. Locate Master Hopper Heater Control Panels with precipitator controls in the control room. Factory install and wire the panel components in a NEMA ICS 6, Type 12 enclosure and include the following:

(1) A main circuit breaker.

(2) A circuit breaker and contactor alarm relay with two normally open contacts for each hopper zone. The contactor must have a 120-volt operating coil.

(3) "START UP," "ON LINE," "OFF," selector switch for each hopper.

(4) 120 V red "ON" light and 120 V white "LO TEMP alarm light with integral transformers for each hopper zone.

(5) Auxiliary relays and equipment required for operation of the heating and alarm systems.

(6) Device and enclosure nameplates.

(7) Fused control transformer having a 120 volt AC secondary.

2.5.4 Fly Ash Level Alarms

Provide each hopper with a fly ash level alarm utilizing nuclear type detectors. The detectors must be single point gamma source and detection units. Provide the detectors complete with separately mounted electronic units including local high level indicating light and relays for use with annunciation system herein specified. Provide relays rated at 10 amperes, 120 volts AC, or 125 volts DC continuous duty. Provide dustproof switch housing for hoppers and mount at one easily accessible location. Locate alarm indicators and detector and source electronics at the hopper control panel. Provide detector that is explosion proof, waterjacketed, and able to withstand vibration and temperatures up to 427 degrees C 800 degrees F. Provide the source with a lockable shutter mechanism operated by an external handle to totally isolate the beam when in the closed position. Furnish electrical wiring schematics. Electrical supply must be 120 volts, single phase, 60 hertz. Provide two sensors for each hopper--one at the alarm level and one at the empty level. Locate alarm level at the 50 percent hopper capacity level.

2.5.4.1 Temperature Range Requirement

Level reproducibility must be within one inch. Outdoor components must operate between minus 40 and 93 degrees C 40 and 200 degrees F.

2.5.4.2 Cesium Source Safety Systems

Provide Cesium 137 source for each hopper. Design source head with a spring return off system in the event of remote cable actuator failure. Interlock source with hopper access doors to prevent entry into hopper unless source has been secured. Hopper access door key must only open one pair of hopper doors.

2.5.4.3 Hopper Level Indicator

Hopper level signals, based on hopper level status indicator system, must report to a microprocessor through a coaxial cable system. Provide each hopper with two indicators, one for full and one for empty. A flashing light must indicate a wall buildup. Loss of power for any period of time must not require a recalibration. Provide NEMA ICS 6, Type 4 enclosure for microprocessor.

2.5.4.4 Alarm System

Incorporate each group of detector units for a single electrostatic precipitator into the unit alarm system for its respective precipitator so that a high level in any hopper must indicate as part of the unit alarm system.

2.6 ACCESS

2.6.1 Walkways

Provide walkways for inspection and maintenance of discharge electrode hanger points. Access doors and external walkways must make routine inspection tours readily performable. Connect walkways, including roof, by stairways. Interconnect walkways at each level by walkways at the same level. Provide caged ladders as a means of secondary egress connecting all levels.

2.6.2 Doors

Provide every access door with a corresponding exterior walkway connected to the general system of platforms and walkways. Provide insulated, hinged, quick opening access, inspection, and clean out doors with gastight seals. Access doors, including hopper doors, and mechanical and electrical components must be easily accessible from the walkway or provide with a permanent steel ladder or stairway to facilitate maintenance. Provide internal and external handholds at all access doors to facilitate entry.

2.6.3 Platforms, Walkways, and Ladders

Shop fabricate walkways, stairways, and ladders. Provide access to openings in both the precipitator and hoppers. Provide walkways in the casing interior as specified in paragraph entitled "Housing." Provide walkways, platforms, stairways, ladders, handrails, and kickplates on the penthouse roof and housing roof, as applicable, and as specified in paragraph entitled "Penthouse." Design platforms, ladders, and walkways support steel for live load specified herein. Design platforms to support a 488 kg per square meter 100 pound per square foot live load. Construct external walkways and platforms of steel conforming to ASTM A242/A242M raised pattern floor plate.

2.6.4 Maintenance

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NOTE: Provide 227 kg 500 pound crane unless T/R sets are to be replaced with the crane. If used for T/R replacement, size for T/R weight.

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Provide jib crane as required to remove roof-mounted equipment. Load limits must be [_____] kg pounds and the jib crane must be properly signed for safety showing maximum load permitted.

2.6.5 Hot Dip Galvanizing

Hot dip galvanize platforms, walkways, stairways, ladders, handrails, and kickplates after fabrication in accordance with ASTM A123/A123M. Minimum galvanized coating per surface must not be less than [_____] kg per square meter ounces/square foot.

2.6.6 Gas Distribution Devices

Provide the precipitator with inlet and outlet screens or baffles required to obtain proper gas distribution across the face of the precipitator as determined by model test study. Gas distribution devices must contain removable 915 by 610 mm 3 by 2 feet panels on each screen or baffle for access between screens. Provide the precipitator with internal gas baffles as required to prevent gases from bypassing the treatment zone. Gas distribution velocities across the inlet to the precipitator must have a root-mean-square deviation of no more than 15 percent and no flow must exceed 125 percent of average flow velocity.

2.6.7 Interlocks

Provide a key type safety interlock system with sequential key arrangement on the precipitator housing and penthouse access doors, inlet and outlet nozzle access doors, rectifier enclosure access doors, transformer-rectifier grounding switch, hopper level indicator sources, hopper access doors, and control unit circuit breakers. No high voltage equipment must be accessible without properly locking out the power supply and grounding the high voltage equipment. Keys must not be able to be removed from the locks when access doors are open.

2.7 FABRICATION

Perform shop fabrication and assembly of steel structures in conformance with AISC Specifications, Codes and Standards. Field welding must be shielded metal arc or submerged arc. Shop welding must be shielded-metal arc, submerged arc, flux-core arc, or gas metal arc. Perform welding in conformance with the requirements of the AWS D1.1/D1.1M and AISC Specifications. Shop connections must be welded, riveted, or bolted with high-strength bolts at the Contractor's option and as allowed by the seismic code. Unless restricted by consideration of clearance or seismic design criteria, show field connections as bolted friction type using ASTM A325M ASTM A325 or ASTM A490M ASTM A490 bolts and design to conform to AISC specification for "Structural Joints Using ASTM A325M ASTM A325 or ASTM A490M ASTM A490 Bolts." Form and weld handrails and do not exceed 6 feet from center-to-center of posts. Grind welds smooth and even with the surface of the pipe, remove weld splatter. Carefully form transitions at corners where change of direction of elevation occurs as required to provide continuous handrail. Clear columns or other vertical or horizontal projections by at least 80 mm 3 inches. Furnish plates and additional items as required for fastening to supporting members. Extend kickplates 100 mm 4 inches above top of grating and install at the edge of uncovered openings and at the edge of walkways and platforms. Construct kickplates to allow water run-off. Shop fabricate as complete as possible and within standard industry practice. Leave large pieces unassembled only to the extent necessary for shipment.

2.8 PAINTING

Steel surfaces must be dry and clean before painting. Remove grease, oils, and contaminants as outlined in SSPC SP 1. Remove weld spatter and grind burrs smooth on cut edges and rough welds. Blast-clean surfaces after fabrication, in accordance with SSPC SP 6/NACE No.3 and profile depth of 0.038 to 0.051 mm 1.5 to 2.5 mils. Before any rust bloom forms, apply one coat, dry film thickness of 0.076 mm 3 mils, of any of the organic zinc-rich primers meeting the requirements of SSPC PS 12.01, with a minimum of 82 percent zinc in the dry film. Apply primer in accordance with manufacturer's recommendations. Apply primer to steel surfaces except the areas within 50 mm two inches adjacent to field welds and surfaces specified to be hot-dip galvanized.

PART 3 EXECUTION

3.1 FACTORY INSPECTION

Any material or equipment used in the manufacture of the precipitator and found to be defective during inspection at the manufacturer's plant must be either corrected or replaced as approved by the Contracting Officer before shipment. Acceptance at the factory must not constitute final acceptance.

3.2 INSTALLATION

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NOTE: Revise this paragraph as necessary when it is desired to have the precipitator manufacturer install the equipment furnished.

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The contractor must install the equipment specified herein on foundations or structural-steel framework shown on the drawings or as specified elsewhere herein. Installation must be in accordance with the manufacturer's recommendations.

3.3 MANUFACTURER'S FIELD REPRESENTATIVE

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NOTE: The period of instruction should be reduced only if the operating personnel have significant experience on identical equipment.

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The contractor must provide the services of a field representative(s) specifically trained by the manufacturer to assist installers of their equipment. The field representative(s) must be at the erection site during installation including unloading, hauling, storing, cleaning, erecting, and testing. The field representative(s) must supervise the adjustment of all controls, control devices, and components supplied with the precipitator as necessary to place the precipitator in successful operation. The field representative(s) must instruct the plant operators in the operation, care, and maintenance of the equipment. Provide a minimum of 10 working days advance notice to the Contracting Officer prior to scheduling these instructions. Provide a total of [20] [_____] days instruction including [6] [_____] round trips to the jobsite. Provide training by field representative in precipitator theory and design, start-up, shut-down, operation, performance monitoring, performance evaluation, problem diagnosis, maintenance, inspection methods, safety, operations and maintenance plans.

3.4 FIELD TESTS AND INSPECTIONS

3.4.1 Delivery Inspection

Materials and equipment must be inspected in accordance with the Contract Clauses. Inspections may be made to assure that equipment and installation comply with local and government requirements for equipment and safety as well as applicable specifications.

3.4.2 Post Installation Inspection

A factory service engineer employed by the precipitator manufacturer must inspect the precipitator after installation is completed and prior to startup to verify that the unit is installed in conformance with the manufacturer's recommendations. Perform an air load test with precipitator readings recorded.

3.4.3 Performance Tests

Perform field performance tests by an independent testing organization acceptable to the Contracting Officer. Provide written notice to the Contracting Officer, at least 20 calendar days before scheduled test date, stating that equipment is being scheduled for test. Perform a trial run of 30 days minimum before actual test (operate boiler at least 60 to 90 percent load) to ensure that associated systems required for the test are ready. Perform boiler tune-up to optimum efficiency prior to performance test. The Contractor and the manufacturer's factory service engineer must witness the test. Perform tests in accordance with applicable state or local methods. If no such methods or adaptations are required, then perform the tests in accordance with EPA 40 CFR 60, Appendix A, Methods 1-5, 9 and 17. Perform tests at the maximum continuous rating for the inlet gas conditions specified in paragraph entitled "Inlet Gas Conditions" and, if applicable, at other operating conditions that are required for approval by the appropriate regulatory agency. Test the precipitator for efficiency by simultaneous testing of precipitator inlet and outlet emissions. Conduct the efficiency tests after the precipitator has been in operation for at least 45 days.

3.5 IDENTIFICATION

Fasten an aluminum, brass, or corrosion-resistant steel nameplate to the equipment in a readily visible location by means of stainless steel Series 300 rivets or sheet metal screws. The nameplate must contain data such as the manufacturer's name, and model or series number. Indent or emboss the information in the metal. Offset the nameplate a sufficient amount to avoid being covered by insulation.

3.6 INSULATION INSTALLATION

3.6.1 General Insulation Requirements

Apply insulation with interruptions to permit access doors, inspection doors, flanges, and other special features to be opened or removed for inspection or maintenance without disturbing the insulation. Provide boxouts around code stamping symbols and nameplates. Install double thickness insulation with the joints of the two layers staggered. Fill cracks, voids, and depressions in layers of insulation with suitable insulating cements before application of another layer of insulation or jacket application. Provide expansion joints in the insulation as required to allow for thermal expansion movements which might cause cracks or tears in the insulation. Install insulation between stiffeners and over stiffeners so that stiffeners are completely insulated. Install additional insulation or casing spacers between stiffeners so that a level surface is achieved. The intent of this insulating procedure is to prevent a direct metal path between the precipitator inside and ambient air. Securely wire and lace in place insulation using number 14 dead soft Type 302 stainless steel wire, conforming to ASTM A580/A580M.

3.6.2 Block and Mineral Fiberboard Insulation Installation

Secure block and mineral fiberboard insulation in place with insulation lugs spaces on not greater than 300 by 460 mm 12 by 18 inch centers. Provide stud type lugs welded in place. Reinforce blocks on the exterior face with expanded metal if necessary to prevent sagging or cutting of the insulation by the lacing wire. Securely wire block and mineral fiberboard insulation of the specified thickness in place over the entire surface by means of wire threaded through the lugs both ways, pulled tight with the ends of the wire loops twisted together with pliers, bent over, and carefully pressed into the surface of the insulation.

3.6.3 Mineral Fiber Blanket Insulation Installation

Secure mineral fiber blanket insulation in place with speed washers and impaling pins spaced on centers not exceeding 300 mm 12 inches. Provide mineral fiber blanket insulation with expanded metal reinforcement on the outer surface and wire mesh or expanded metal on the inner surface. Tightly butt sections of the blankets together and securely tie for maximum sealing at joints. Secure the blanket at joints to prevent peeling or bulging away from blanket edges. Do not reduce the design thickness of insulation when applying speed washers.

3.6.4 Housing Hot Roof

Install calcium silicate insulation conforming to ASTM C533 over 12 gage steel pins stud welded on 610 mm two foot centers to the surface to be insulated. Hold the insulation in place by 65 mm 2 1/2 inch square speed washers and closely fit around penetrations. Construct top surfaces of steel conforming to ASTM A242/A242M raised pattern plate not less than 6 mm 1/4 inch thick and suitably support to bear 488 kg per square meter 100 pounds per square foot live load. Seal joints by continuous fillet or complete penetration groove welds as applicable. Weld appurtenances similarly to the plate. Provide top penetrations with a 50 mm 2 inch minimum extension above the plate and similarly weld to the plate.

3.7 PROTECTION FROM INSULATION MATERIALS

Protect equipment and structures from damage from insulation materials. After completion of the work, clean, repair, and restore equipment and structures to their original state. Repair any casing which becomes corroded, discolored, or otherwise damaged by replacing of casing or other means acceptable to the Contracting Officer.

3.8 CASING INSTALLATION

3.8.1 Structural Steel Grid System

Install casing over exterior insulated surfaces on an aluminized structural steel grid system of subgirts designed, furnished, and installed by the contractor. Provide subgirts of sufficient size, gage, and depth to provide adequate support and a smooth exterior surface and weld to the equipment and structural support surfaces. Provide subgirts of sufficient depth to provide for application of the full thickness of insulation over the stiffeners, access doors, flanges, ribs, and other surfaces having uneven contours to provide a smooth finished surface. Provide subgirts on vertical and bottom surfaces at a maximum spacing of 1.22 meters 4 feet on centers. Provide subgirts on roof surfaces at a maximum spacing of 610 mm two feet on centers. Provide a roof surface system that will transmit an external 114 kg 250 pound walking load from the casing to the structural steel grid system without compression of the insulation material.

3.8.2 Access Openings

Closely fit insulation to fittings around access doors and other penetrations through the insulation. Neatly frame and flash to make weathertight and to create a pleasing appearance. Provide insulated hinged or lift-off doors designed for convenient opening or removal at nameplates, code stampings, nonprojecting connections, and access openings. Pitch access openings for water runoff and have flashing at door head as shown in SMACNA 1793.

3.8.3 Weatherproofing

Install casing with proper overlap to make the installation weathertight. Fabricate and fit the casing to ensure a neat appearance. Provide closures, flashings, and seals required. Provide the open ends of fluted sections with tightfitting closure pieces. Suitably form and install flashing so that water cannot enter and wet the insulation. Design and install flashing to readily drain any water that might enter. Weatherproof joints or openings in casing which cannot be effectively sealed from entry of moisture by application of an aluminum-pigmented sealer manufactured for this type of service.

3.8.4 Convection Stops

Provide steel channel or Z-girt convection stops on all vertical surfaces over 3.66 meters 12 feet tall. The maximum interval between convection stops must be 3.66 meters 12 feet.

3.8.5 Casing Attachment

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NOTE: If a separate insulation section is part of this specification, add a note to that section to indicate that insulation of the precipitator is covered by this section.

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Attach aluminum casing to the steel structural members by means of Number 14 stainless steel Series 300 self-tapping screws on 305 mm 12 inch centers. Fasten vertical laps and flashing by means of 20 mm 3/4 inch Number 14 stainless steel Series 300 sheet metal screws on 305 mm 12 inch centers. Provide exposed screws with aluminum of stainless steel backed neoprene washers preassembled to screws. Do not compress insulation below nominal thickness when installing screws.

3.9 HEATER INSTALLATION

Thoroughly clean hopper surfaces prior to heater module, tape, or blanket installation. Install the heater module so the module surface contacts the hopper wall to the maximum extent possible. Provide heaters with necessary mounting hardware, channels, and brackets. Install throat heaters so the heater conforms to the surface of the throat and contacts the throat to the maximum extent possible. Do not overlap throat heaters. Hold throat heaters in place with high temperature (454 degrees C 850 degrees F) glass tape or other means acceptable to the Contracting Officer. Completely cover the throat heater with the glass tape prior to lagging.

3.10 WIRE NUMBERS

Provide wire numbers on both ends of each wire appearing on the elementary diagram. Use space terminals for terminations. Markers must be white plastic sleeves with black letters.

3.11 GALVANIC CORROSION PREVENTION

To prevent galvanic corrosion, prevent permanent contact of aluminum casing with copper, copper alloy, tin, lead, nickel, or nickel alloy including Monel metal. Where it is necessary to attach the casing to carbon steel or low alloy steel, paint the steel with zinc chromate primer. Then paint with aluminum paint suitable for surface temperatures encountered. Do not use lead base paint.

3.12 PAINTING

Provide field painting of those surfaces of the following equipment not in contact with the flue gas stream: precipitators, cyclones, fans, and breeching. Field paint as specified in Section 09 90 00 PAINTS AND COATINGS. Paint other equipment provided in this section; either field paint with paint systems conforming to Section 09 90 00 PAINTS AND COATINGS or paint with factory or shop painting systems conforming to the requirements specified in Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.

3.13 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. [_____]	[_____]	[_____]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 51 43.03 20 (February 2010)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Superseding**
UFGS-23 51 43.03 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 51 43.03 20

FABRIC FILTER DUST COLLECTOR OF FLY ASH PARTICLES IN FLUE GAS

02/10, CHG 1: 11/24

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 51 43.03 20 (February 2010)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 23 51 43.03 20

FABRIC FILTER DUST COLLECTOR OF FLY ASH PARTICLES IN FLUE GAS
02/10, CHG 1: 11/24

****

NOTE: This guide specification covers the requirements for providing, installing, adjusting, and testing of fabric filter type dust collectors (baghouses).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The baghouse is intended to be used for flue gas particulate removal and collection associated with coal fire boilers or incinerators. Coal fired boilers applicable to this specification are those designed for pulverized coal firing, spreader traveling grate stoker firing, chain traveling grate stoker firing or underfeed stoker firing with capacities ranging between 3.78 and 31.50 kilogram 30,000 and 250,000 pounds of steam per second hour. Incinerators applicable to this specification are those designed for burning wastes having firing capacities between 454 kilograms 1,000 pounds per hour and 182 Mg 200 tons per day. For engineering and design assistance on baghouses applied close to or outside these capacities, contact:

Commanding Officer (ESC Code 43)
NAVFAC Engineering Service Center
560 Center Drive
Port Hueneme, CA 93043-4340
Telephone: (805) 982-4984

Indicate on drawings who supplies compressed air cleaning and control system components, piping, valves, and fittings.

****

PART 1   GENERAL

1.1   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating
AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines
AMCA 802	(2019) Industrial Process/Power Generation Fans: Establishing Performance Using Laboratory Models

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B443	(2019) Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625)and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219)* Plate, Sheet, and Strip
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C592	(2024) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM D578/D578M	(2005; E 2011; R 2011) Glass Fiber Strands
ASTM D737	(2018) Standard Test Method for Air Permeability of Textile Fabrics
ASTM D1682	(1964; R 1975e1) Test for Breaking Load

	and Elongation of Textile Fabrics
ASTM D1777	(1996; E 2011; R 2011) Thickness of Textile Materials
ASTM D2176	(1997a; R 2007) Folding Endurance of Paper by the M.I.T. Tester
ASTM D3775	(2017; E 2018) Standard Test Method for End (Warp) and Pick (Filling) Count of Woven Fabrics
ASTM D3776/D3776M	(2009a; R 2017) Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
ASTM D3887	(1996; R 2008) Standard Specification for Tolerances for Knitted Fabrics

INSTITUTE OF CLEAN AIR COMPANIES (ICAC)

ICAC F-2	(1972) Fundamentals of Fabric Collectors and Glossary of Terms
ICAC F-3	(2002) Operation and Maintenance of Fabric Filters
ICAC F-5	(1991) Types of Fabric Filters

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2017) Metal Bar Grating Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-I-24092	(1993; Rev D; Supp 1993; NOtice 1 2021) Insulating Varnishes and Solventless Resins for Applications by the Dip Process

MIL-T-152	(1961; Rev B; Am 2 1966; Notice 2 2000; Notice 3 2006; Notice 4 2011; Notice 5 2019) Treatment, Moisture and Fungus Resistant, of Communications, Electronic, and Associated Electrical Equipment
MIL-V-173	(1969; Rev C; Am 2; CANC Notice 3) Varnish, Moisture and Fungus Resistant (For Treatment of Communications, Electronic, and Associated Equipment)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA AP-42	(1995) Compilation of Air Pollution Emission Factors

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-28	(Rev H) Paint, Aluminum, Heat Resisting (1200 Degrees F.)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60	Standards of Performance for New Stationary Sources

1.2 QUALITY ASSURANCE

Section 01 45 00 QUALITY CONTROL, applies to this section.

1.2.1 Experience

Manufacturers and contractors must have constructed not less than three fabric filter type dust collectors (baghouses) of the type to be provided in this contract collecting flyash produced by [pulverized coal fired boilers][[_____] stoker fired boilers] [incinerators] and operating under the following conditions:

****

NOTE: Use plus or minus 30 percent for inlet gas volumes up to and including 23,595 L/s 50,000 acfm and plus or minus 10 percent for gas volumes over 23,595 L/s 50,000 acfm.

****

a. Treating an inlet gas volume within plus or minus [_____] percent of the inlet gas volume specified in paragraph entitled "Design Criteria."

b. Operating in continuous duty, normal maintenance downtime included, for not less than two years at a minimum efficiency of 98 percent.

1.2.2 Model Study

****

NOTE: Choose model dust which will follow trajectories and depositions geometrically similar to those of the flyash characteristics as specified in paragraph entitled "Design Criteria." Proper

scaling must include centrifugal and gravity force effects. Refer to Electric Power Research Institute Report C5-2427, Development of Guidelines for Optimum Baghouse Fluid Dynamic System Design, June 1982. In this report, EPRI determined that finely ground cork dust (200/0 mesh) with a mass mean diameter of 38.3 um effectively simulates flyash with a 24.4 um mass mean diameter.

****

Conduct a three-dimensional model study to analyze and optimize pressure losses, velocity profiles, and dust flow distribution through the baghouse system. Model must represent the system from the [air heater] [economizer] [_____] outlet to the stack inlet, reduced to not less than 1:100 1/8 scale. Construct model from transparent thermoplastic; dimensional tolerances must be plus or minus 1.50 mm 1/16 inch. Perform tests at 30, 50, 75, 100, and 125 percent of maximum continuous flow rating using [_____]. Modify the model to minimize system pressure losses and to provide uniform, within plus or minus 10 percent of the mean, gas flow and dust flow distribution at baghouse inlet flange, inlet manifold, outlet manifold, hoppers, and the inlet and outlet of each compartment including the bag region. Retest to prove minimum system pressure losses, and uniform gas flow and dust flow distribution. Notify Contracting Officer or designated Government representative of test dates in writing no less than 15 working days prior tests so that Contracting Officer or designated Government representative may witness both tests.Incorporate modifications into final design.

1.2.3 Bag Fabric Guarantee

Prior to manufacturing bags, test finished material lots to ensure fabric meets paragraph entitled "Design Criteria." Material lot tests must include:

a. Yarn weight: ASTM D578/D578M

b. Permeability: ASTM D737

c. Tensile strength: ASTM D1682

d. Thickness: ASTM D1777

e. M.I.T. flex: ASTM D2176

f. Count: ASTM D3775

g. Fabric weight: ASTM D3776/D3776M

h. Bursting strength: ASTM D3887

1.2.4 Bag Guarantee

Bags and hardware must as specified in paragraph entitled "Design Criteria" and paragraph entitled "Bags and Hardware," and must be guaranteed for two calendar years from startup during which time bags which have abrasions, holes or tears, and hardware which have corrosion, sharp edges, bends, bad welds, or burrs must be replaced free of charge to the Government. Damage to bags and hardware due to obvious operator negligence is not covered by this guarantee. Do not use spare bags and hardware as replacements. Should replacements exceed 10 percent in any compartment during the two year period, replace bags and hardware in that compartment free of charge to the Government. Guarantee replacement bags and hardware for an additional two years.

1.2.5 Certificate

1.2.5.1 Certificate of Experience

Include:

a. List of not less than three baghouses at separate facilities meeting the conditions as specified in paragraph entitled "Quality Assurance."

b. Each installation owner's name, location, point of contact for operation and maintenance, address, and telephone number.

c. Date of owner's acceptance and startup of each installation.

d. Baghouse design conditions at each installation: Inlet gas volume, L/s acfm; inlet gas temperature, degrees C degrees F; inlet dust loading, grams per liter grains per acf; efficiency, percent; and net gas to cloth ratio, m/s fpm.

e. Baghouse actual operating conditions at each installation: Inlet gas volume, L/s acfm; inlet gas temperature, degrees C degrees F; inlet dust loading, grams per liter grains per acf; efficiency, percent; and net gas to cloth ratio, m/s fpm.

f. Type of [incinerator] [coal fire boiler] at each installation.

1.2.5.2 Factory Test Completion Certification

Submit certificate of completion for factory tests on control circuits, mechanical draft equipment, materials, and dampers except poppet dampers, as required in paragraph entitled "Source Quality Control."

1.2.5.3 Baghouse Installation

Submit certification from the field representative that the baghouse has been installed as recommended by the manufacturer.

1.2.6 Smoke Test

Prior to installing insulation, perform smoke tests on installed baghouse [including pulse jet weather enclosure] to identify leaks. Use forced draft fan to pressurize baghouse. Notify Contracting Officer or designated Government representative of test date in writing not less than 15 working days prior test so that Contracting Officer or designated Government representative may witness test. Repair leaks before installing insulation.

1.2.7 Particulate Emissions Test

****

NOTE:

1. Emissions must comply with local, state, and federal standards for particulate and visible emissions. Note that compliance with particulate emission standards does not guarantee compliance

with opacity standards; nor does compliance with federal or state standards guarantee compliance with local standards.

2. Opacity is influenced by particulate size distribution. For example, approximately 25 percent of the emissions from stoker fired boilers are below 10 microns, thus a visually acceptable stack may result in a particulate emissions loading of 0.09s g/m3 0.04 grains per cu ft. However, approximately 45 percent of the emissions from pulverized coal fired boilers are below 10 microns, thus a visually acceptable stack may result in an emissions loading of 0.046 g/m2 0.02 grains per cu ft.

****

Prior to baghouse acceptance, provide simultaneous particulate emissions tests at the baghouse inlet and at the baghouse outlet. Test to ensure particulate emissions loadings does not exceed [_____] gram per dry std cubic meter grains per dry std cu ft when operating at maximum continuous flow rating and to ensure accuracy of inlet grain loading estimate. Perform three tests using procedures and equipment as in 40 CFR 60, EPA AP-42, Appendix A and local regulations. Operate the system in automatic without system failure or tripout, for 30 days prior to performing tests. Notify Contracting Officer or designated Government representative of test date in writing not less than 15 working days prior test so that Contracting Officer or designated Government representative may witness test. Should particulate emissions loading exceed [_____] gram per dry std cu meter grains per dry std cu ft, Contractor must modify baghouse to meet emission limits. Retest baghouse, free of charge to the government, to provide compliance with emission limits.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Dust Collector System Components

Dust Collector System Layout

Electrical and Pneumatic Circuit Diagrams

SD-06 Test Reports

Dust Collector Model Tests

Bag Tests

Baghouse Controls Tests

Particulate Emissions Tests

Mechanical Draft Equipment Tests

Damper Tests

Baghouse Inspection

SD-07 Certificates

Certificate of Experience

Dust Collector Model Study Procedures

Particulate Emissions Test Procedures

Factory Test Completion Certification

Baghouse installation

SD-10 Operation and Maintenance Data

Baghouse, Data Package 3

Instrumentation and Control Systems, Data Package 3

Bypass System, Data Package 3

Dampers, Data Package 2

Fans, Data Package 3

Valves, Data Package 2

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include procedures for:

a. Bag precoating.

b. Baghouse startup; initial and routine.

c. Baghouse shutdown; short duration, long duration, and emergencies.

1.4 DELIVERY AND STORAGE

Ship equipment as shop welded, factory assembled modules, except when physical size, arrangement, equipment configuration, or shipping limitations, make the shipment of assembled equipment impracticable. Do not ship modules with bags installed. Package bags separately to prevent damage during shipping, handling, and during outdoor storage at the job site. Handle, store, and protect equipment and materials to prevent damage before and during installation as recommended by the manufacturer. Replace damaged or defective items free of charge to the Government. Describe sectional shipments in proposal, otherwise it must be understood that equipment must not require field assembly. The manufacturer must pay field assembly costs of sections, accessories, or appurtenances not listed in the proposal as requiring field assembly.

1.5 DESIGN CRITERIA

1.5.1 Detail Drawings

Obtain approval of dust collector model tests prior drawing submittal. Submit drawings for dust collector system components, dust collector system layout, and electrical and pneumatic circuit diagrams. For each component, indicate kind, size, design, arrangement, assembly, breakdown for shipment, and weight. Include locations for external connections, controls, remote control panels, anchorages, and supports. Indicate dimensions for installation and correlation with other materials and equipment. Include foundation and loading information.

[1.5.2 Boiler Data

****

NOTE: Select this paragraph or the paragraph below entitled "Incinerator Data."

****

****

NOTE: Insert appropriate Section number and title in the blanks below using format per UFC 1-300-02.

****

Design baghouse(s) for operation with [manually] [automatically] controlled [boiler(s) specified in [_____]] [boiler(s) manufactured by [_____], Type

[_____], Model Number [_____]]. The boiler is a [new] [existing] [pulverized coal fired boiler] [[_____] grate spreader stoker fired boiler] [[_____] retort underfeed stoker fired boiler] rated [_____] kg/s lbs/hr steam at [_____] kPa psi. Boiler gross heat input is expected to be [_____] kW MBtu/hr and boiler steam output is expected to be between [[_____] and [_____]] kg/s lb/hr. Boiler must burn coal meeting the following criteria. The standby fuel is [_____].

a. Proximate analysis, as received, percent by weight:

	Range
Moisture	[_____]
Ash	[_____]
Volatile Matter	[_____]
Fixed Carbon	[_____]
Total	100.00
Sulfur	[_____]
Heating Value, Btu/hr	[_____]

b. Ultimate analysis, as received, percent by weight:

	Range
Moisture	[_____]
Carbon	[_____]
Hydrogen	[_____]
Sulfur	[_____]
Nitrogen	[_____]
Oxygen	[_____]
Ash	[_____]
Total	100.00

][1.5.3 Incinerator Data

****

NOTE: Waste standard classifications are as follows:

Type	Description	Principle Components	Noncombustibl Solids (Max. Percent	Moisture Content (Max. Percent)	Heating Value (kJ per kg)
0	(Trash)	Highly combustible waste, wood, cardboard cartons, paper, rubber and plastic scrap, commercial and industrial sources	5	10	19,805
1	(Rubbish)	Combustible waste, wood scraps, cardboard cartons, paper, rags, and combustible floor sweepings. Domestic, commercial, and industrial sources.	10	25	15,145
*2	(Refuse)	Rubbish and garbage	7	50	10,019
*3	(Garbage)	Animal and vegetable waste, restaurants, hotels, markets,institutional commercial, and industrial sources	5	70	5825
*4	(Animal solids and organic wastes)	Carcasses, organs, solid organic wastes; hospital, laboratory, abattoirs, animal pounds, and similar sources	5	85	2330
Loose Paper			-	-	23,300
Loose Wood			-	-	23,300

Type	Description	Principle Components	Noncombustibl Solids (Max. Percent	Moisture Content (Max. Percent)	Heating Value (kJ per kg)
0	(Trash)	Highly combustible waste, wood, cardboard cartons, paper, rubber and plastic scrap, commercial and industrial sources	5	10	19,805
Classified Material		Highly-combustible waste, paper, cardboard cartons including up to 10 percent plastics and treated paper	-	-	23,300
* Types 2, 3 and 4 are not suitable for baghouse applications. Include ash analysis if available.					

Type	Description	Principle Components	Noncombustibl Solids (Max. Percent	Moisture Content (Max. Percent)	Heating Value (Btu/lb)
0	(Trash)	Highly combustible waste, wood, cardboard cartons, paper, rubber and plastic scrap, commercial and industrial sources	5	10	8,500
1	(Rubbish)	Combustible waste, wood scraps, cardboard cartons, paper, rags, and combustible floor sweepings. Domestic, commercial, and industrial sources.	10	25	6,500

Type	Description	Principle Components	Noncombustible Solids (Max. Percent	Moisture Content (Max. Percent)	Heating Value (Btu/lb)
0	(Trash)	Highly combustible waste, wood, cardboard cartons, paper, rubber and plastic scrap, commercial and industrial sources	5	10	8,500
*2	(Refuse)	Rubbish and garbage	7	50	4,300
*3	(Garbage)	Animal and vegetable waste, restaurants, hotels, markets,institutional commercial, and industrial sources	5	70	2,500
*4	(Animal solids and organic wastes)	Carcasses, organs, solid organic wastes; hospital, laboratory, abattoirs, animal pounds, and similar sources	5	85	1,000
Loose Paper			-	-	10,000
Loose Wood			-	-	10,000
Classified Material		Highly-combustible waste, paper, cardboard cartons including up to 10 percent plastics and treated paper	-	-	10,000
* Types 2, 3 and 4 are not suitable for baghouse applications. Include ash analysis if available.					

****

****

NOTE: Insert appropriate Section number and title

in the blanks below using format per UFC 1-300-02.

****

Design baghouse(s) for operation with [manually] [automatically] controlled [incinerator(s) specified in [_____]] [incinerator(s) manufactured by [_____], Type [_____]] capable of burning [_____] [kg/slb/hr] [Mgtons per day] of Type [0], [1], [2], [3], [4], [loose paper] [loose wood] [classified material] wastes. Operation is expected to be between [_____] and [_____] [kg/slb/hr] [Mgtons per day] of wastes. The auxiliary fuel is [_____].

]1.5.4 Mechanical Collector Data

****

NOTE: Avoid using a mechanical collector upstream of a baghouse. Since mechanical collectors are most effective on particulate greater than 5 microns, baghouse inlet gas conditions would be skewed towards a finer particulate size distribution. However, an excess of fine particulates tends to cause baghouse pressure drop and bag life problems. Not only is there an increased pressure drop in the baghouse due to the finer particulates but the mechanical collector will add 498 to 747 Pa 2 to 3 inches WC to the overall system pressure drop. Use a mechanical collector upstream of a baghouse only if necessary to prevent glowing embers (from incinerators) from burning bags.

****

Design baghouse(s) for operation with [Section 23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES] [mechanical cyclone dust collector(s) manufactured by [_____], Type [_____], Model Number [_____]]. The mechanical dust collector [is specified to have] [was designed for] an outlet particulate emissions loading no greater than [_____] grams per dry std cu meter grains per dry std cu ft.

1.5.5 Inlet Gas Conditions

****

NOTE:

1. Baghouse manufacturer must know the expected range of inlet gas conditions. For operation sensitive at reduced load applications, eg. stokers and incinerators, include upset partial load conditions. This information can best be supplied by the boiler or incinerator manufacturer; compensate for system component effects between the baghouse inlet and boiler, or incinerator, outlet.

2. For existing installations, conduct source testing to determine baghouse inlet gas conditions. Use EPA, 40 CFR 60, Appendix A, Method 1 through Method 4, to determine gas volume flowrates. Use ASME PTC 28 to determine particulate size distribution. For particulate loading only, use EPA, 40 CFR 60, Appendix A, Method 5, or Method 17.

3. For new installations, obtain inlet gas conditions from the manufacturer. If this is not possible, estimate using EPA AP-42 emission factors. Make corrections for expected combustible content.
****

Baghouse inlet gas conditions, at [_____] meter feet above sea level, are:

	Maximum	Minimum	Peak
a. Inlet gas volume, L/s:	[_____]	[_____]	[_____]
b. Inlet gas temperature, degrees C:	[_____]	[_____]	[_____]
c. Gas temperature, degrees C	[_____]	[_____]	[_____]
d. Gas density, kg/m3	[_____]	[_____]	[_____]
e. Gas moisture, percent by weight	[_____]	[_____]	[_____]
f. Particulate size distribution:			

	Maximum	Minimum	Peak
a. Inlet gas volume, acfm:	[_____]	[_____]	[_____]
b. Inlet gas temperature, degrees F:	[_____]	[_____]	[_____]
c. Gas temperature, degrees F	[_____]	[_____]	[_____]
d. Gas density, lb/ft3	[_____]	[_____]	[_____]
e. Gas moisture, percent by weight	[_____]	[_____]	[_____]
f. Particulate size distribution:			

Size, Microns	Maximum Percent by Weight Less Than Particle Size
60	[_____]
40	[_____]

30	[_____]
20	[_____]
15	[_____]
10	[_____]
7.5	[_____]
1.0	[_____]
Total	[_____]

	Maximum	Minimum
g. Particulate loading, grams per liter		
h. Flyash specific volume (loose) for hopper volume design, m3/kg	[_____]	[_____]
i. Flyash density (compacted) for hopper weight design, kg/m3	[_____]	[_____]
j. Excess air, percent	[_____]	[_____]

	Maximum	Minimum
g. Particulate loading, grains per acf		
h. Flyash specific volume (loose) for hopper volume design, ft3/lb	[_____]	[_____]
i. Flyash density (compacted) for hopper weight design, lb/ft3	[_____]	[_____]
j. Excess air, percent	[_____]	[_____]

1.5.6 Fabric Filter Type Dust Collector (Baghouse)

****

NOTE:

1. Review projects to determine feasibility of purchasing an additional compartment for out-of-service maintenance.

2. Provide a manual flue gas bypass system for oil firing startup and provide also an automatic flue gas bypass system for use during operational upsets, should flue gas temperature exceed the bag material temperature limit or should baghouse pressure drop exceed paragraph entitled "Design Criteria" by 10 percent. This is particularly important if the standby fuel is oil. Local environmental

regulations may require a waiver to permit this necessary feature.

3. The air-to-cloth ratio effects the baghouse pressure drop, bag failure rate, and bag life. It is dependent upon the bag cleaning system, frequency of cleaning, and dust loading. Most reverse air baghouses have a net air-to-cloth ratio of 2-2.5 to 1. The Navy recommends use 2 to 1. Most pulse jet baghouses will have a net air-to-cloth ratio of 4-4.5 to 1, based on a continuous cleaning cycle. The Navy recommends use 4 to 1.

4. Pressure drop across the baghouse, measured after the bags have had time to season in service, is a function of the air-to-cloth ratio, inlet dust loading, and dust particulate characteristics. For a 2 to 1 air-to-cloth ratio and 4.60 g/m3 2 grains per acf inlet dust loading, the flange to flange pressure drop should be approximately 1245 Pa 5 inches WC.

5. Use a 55 degree hopper valley angle unless the ash is "sticky" as for Western coal, or if moisture content is high; then use a 60 degree angle. Ash hopper collection capacity should be approximately 8 to 10 hours using 1/3 of the hopper volume.

****

Design baghouse(s) complete with structural supports, weather enclosure, manifolds, ductwork, dampers, bags, bag cleaning system, hoppers, and accessories to meet OSHA regulations, ICAC F-2, ICAC F-3, ICAC F-5, and the following criteria. Base applicable criteria on maximum flow conditions specified in the above paragraph with two compartments out of service; one out of service for cleaning and one out of service for maintenance.

a. Maximum outlet particulate emissions loading, grams per dry std cu meter grains per dry std cu ft [_____]

b. Maximum gas velocity, m/s fps [_____]

c. Minimum number of online compartments ____4____

d. Maximum net air-to-cloth ratio, L/s per sq meter acfm per sq ft (at maximum continuous rating, including volume used for reverse air) [_____]

e. Minimum system pressure drop, Pa inches WC (from inlet flange to outlet flange) [_____]

f. Maximum system pressure drop, Pa inches WC (from inlet flange to outlet flange) [_____]

g. Minimum individual hopper storage capacity, hours [_____]

h. Minimum individual hopper storage capacity, cu m cu ft[_____]

i. Minimum hopper valley angle, degrees from horizontal ___55___

j. Maximum negative pressure, Pa inches WC [_____]

k. Maximum snow load, kg/m2 psf [_____]

l. Maximum wind load, kg/m2 psf [_____]

m. Maximum live load, kg/m2 psf [_____]

[1.5.7 Bags--Reverse Air Cleaning System

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NOTE: Select this paragraph or the following paragraph entitled "Bags--Pulse Jet Cleaning System."

****

a. Maximum bag diameter, 305 mm 12 inches

b. Maximum bag length, 10.70 m 35 feet

c. Minimum tensile strength (warp direction), kPa psi [_____]

d. Minimum tensile strength (fill direction), kPa psi [_____]

e. Minimum yarn weight, g per sq m oz per sq yd [_____]

f. Minimum permeability, L/s per sq m cfm per sq ft (clean at 125 Pa 1/2 inch WC) [_____]

g. Minimum thickness, mm mil [_____]

h. Minimum M.I.T. flex (warp direction), cycles [_____]

i. Minimum M.I.T. flex (fill direction), cycles [_____]

j. Minimum count, ends per 25 mm inch by picks per 25 mm inch [_____]

k. Minimum fabric weight, 2894 g per sq m 9.5 oz per sq ft

l. Minimum bursting strength, kPa psi [_____]

][1.5.8 Bags--Pulse Jet Cleaning System

a. Maximum bag diameter, 152 mm 6 inches

b. Maximum bag length, 4.25 m 14 feet

c. Minimum tensile strength (warp direction), kPa psi [_____]

d. Minimum tensile strength (fill direction), kPa psi [_____]

e. Minimum yarn weight, g per sq m oz per sq yd [_____]

f. Minimum permeability, L/s per sq m cfm per sq ft (clean at 125 Pa 1/2 inch WC) [_____]

g. Minimum thickness, mm mil [_____]

h. Minimum M.I.T. flex (warp direction), cycles [_____]

i. Minimum M.I.T. flex (fill direction), cycles [_____]

j. Minimum count, ends per 25 mm inch by picks per 25 mm inch [_____]

k. Minimum fabric weight, 4874 g per sq m 16 oz per sq ft

l. Minimum bursting strength, kPa psi [_____]

]1.5.9 Test

1.5.9.1 Particulate Emissions Test Procedures

Include:

a. Name, address, and telephone number of testing organization.

b. Procedures and equipment description.

c. Analytical techniques.

1.5.9.2 Dust Collector Model Tests Report

Submit the model study report within 45 days of test completion. Model study report must include:

a. Scale drawing of the model showing actual dimensions and modifications, and devices required as a result of the model study.

b. Photographs and videotape recordings of model during air flow tests.

c. Uniform gas velocity diagrams and histograms indicating the root mean square deviation, standard deviation, and mean velocity, at locations including the inlet and outlet to the baghouse, and the inlet and outlet to each baghouse compartment.

d. Test procedures including flow rates, pressures, calculations, and assumptions.

e. List of and justifications for dynamic or geometric similitude deviations in the model from the full size unit.

f. Pressure drop data at each pressure tap during each test run, including data from initial runs used for identifying gas flow distribution problems and test data from runs made after the addition of supplemental gas flow distribution devices.

g. Recommendations for test port locations, instrumentation monitor locations, and for providing uniform gas flow; breeching configuration changes, gas flow vaning, straightening, or gas distribution devices.

h. Name and resumes of test personnel.

1.5.9.3 Bag Tests Data

Submit test certification and sample for each finished material lot. Test certification data must include, for each material lot analysis:

a. Yarn weight.

b. Permeability.

c. Tensile strength.

d. Thickness.

e. M.I.T. flex.

f. Count.

g. Fabric weight.

h. Bursting strength.

1.5.9.4 Particulate Emissions Tests Report

Submit the particulate emission test report within 45 days of test completion. Test report must include:

a. Process description.

b. Schematic drawings.

c. Test procedures including chain of custody and analytical techniques.

d. Test results including inlet loading, emission rates, and isokinetic sampling rates.

e. Raw data for each test run, including calculations, load sheets, and calibration data.

f. Name and resumes of test personnel.

1.5.9.5 Damper Tests Reports

Submit test reports in accordance with the paragraph entitled "Dampers." In lieu of poppet damper factory tests include field testing results for poppet dampers at similar installations.

1.5.9.6 Baghouse Inspection

Submit a written inspection report from the baghouse manufacturer's service engineers within 15 days after inspection.

1.6 EXTRA STOCK

Provide ten percent of total bags and two percent of total cages as spares. Provide fluorescent powder for one year of normal inspections and provide a portable ultraviolet light to leak test the bags.

1.7 MODEL

1.7.1 Dust Collector Model Study Procedures

Include:

a. Name, address, and telephone number of testing organization.

b. Procedures and equipment to be used.

c. Model design and construction.

d. Model dust use justification.

1.7.2 Delivery

Deliver model used during model study, including a support table, [to the Contracting Officer] within one year of startup of the full size unit.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: This guide specification presents nonpropriety materials and equipment. When the guide specification is edited or supplemented to suit project requirements, exercise care to present a project specification section which contains no proprietary materials or equipment.

****

Provide materials suited for the intended service. The material of parts exposed to the flue gas must withstand chemical action of flue gas and flyash.

2.1.1 General

Provide the following materials and minimum thicknesses:

a. Ductwork (6 mm 1/4 inch): ASTM A36/A36M

b. Hoppers (6 mm 1/4 inch): ASTM A36/A36M

c. Housing (6 mm 1/4 inch): ASTM A36/A36M

d. Structural steel (6 mm 1/4 inch): ASTM A36/A36M

e. Tube sheet (6 mm 1/4 inch): ASTM A36/A36M

f. Weather enclosure (6 mm 1/4 inch): ASTM A36/A36M

g. Floor grating: NAAMM MBG 531

h. Stair tread grating: NAAMM MBG 531

i. Weather enclosure roof and top surface of appurtenant structures (6.40 mm 1/4 inch): ASTM A242/A242M, Type I, raised pattern plate.

2.1.2 Insulation

Insulate baghouse ductwork including [reverse air ductwork,] inlet manifold ductwork, and outlet manifold ductwork, hoppers, housing, and weather enclosure. Do not use materials containing asbestos, magnesium oxide, or Mica. Provide the following materials and minimum thicknesses:

a. Ductwork (80 mm 3 inches): ASTM C592, mineral fiber blanket; or ASTM C612, mineral fiber block.

b. Hoppers (100 mm 4 inches) (with 50 mm 2 inchair gap): ASTM C533, calcium silicate block; ASTM C592, mineral fiber blanket; or ASTM C612, mineral fiber block.

c. Housing (100 mm 4 inches): ASTM C533, calcium silicate block; ASTM C592, mineral fiber blanket; or ASTM C612, mineral fiber block.

d. Weather enclosure (80 mm 3 inches): ASTM C533, calcium silicate.

2.1.3 Casing

Case baghouse ductwork including [reverse air ductwork,] inlet manifold ductwork, and outlet manifold ductwork, hoppers, housing, and weather enclosure. Provide the following materials and minimum casing thicknesses:

a. Top ductwork surface and weather enclosure roof (2 mm 0.080 inch): ASTM B209M ASTM B209, flat aluminum sheet supported to permit use as a walking surface without causing distortion or damage.

b. All other surfaces (100 mm 4 inch rib) (1.25 mm 0.050 inch): ASTM B209M ASTM B209, unpainted aluminum panel and stucco embossed.

2.2 BAGS AND HARDWARE

[2.2.1 Bags and Hardware, Reverse Air Cleaning System

****

NOTE: Select this paragraph or the paragraph below entitled "Bags and Hardware, Pulse Jet Cleaning System."

****

Provide glass fiber bags, 3 kg per sq m 9.5 oz per sq ft, 3 by 1 twill weave, as specified in paragraph entitled "Design Criteria." Coat bags with 100 percent Teflon B lubricant for 10 percent add on weight. Bags 305 mm 12 inches in diameter and maximum 10.70 meters 35 feet in length must have not less than eight 3 mm 1/8 inchsewn-in cadmium plated welded steel anti-collapse rings. Bags 200 mm 8 inches in diameter and maximum 7.30 meters 24 feet in length must have not less than five 3 mm 1/8 inch sewn-in cadmium plated welded steel anti-collapse rings. Provide leakproof quick release Type 301 stainless steel clamps to attach the lower portion of the bags to the caps and thimbles. Provide an adjustable suspension system without using nuts and bolts to attach the upper portion of the bags. Cadmium plate bag caps and suspension hardware which come into contact with the bag fabric. Provide ten percent of total bags as spare bags. Stitch bags using [_____] thread. Provide fluorescent powder for one year of normal inspections and provide a portable ultraviolet light to leak test the bags.

][2.2.2 Bags and Hardware, Pulse Jet Cleaning System

Provide glass fiber bags, 4874 gram per sq m 16 oz per sq ft, 3 by 1 twill weave, as specified in paragraph entitled "Design Criteria." Coat bags with 100 percent Teflon B lubricant for 10 percent add on weight. Provide the manufacturer's standard cage design including venturis, provided it has a reliable service record with the bags proposed. Attach bags and cages to the tub sheet to provide proper air seal, bag tension, and cage alignment. Clamp bags at top between the cage and tube sheet so that the bags may be readily removed without special tools yet not sway.

]2.3 STRUCTURAL SUPPORTS

Provide structural and miscellaneous steel to frame and support the baghouse, ductwork, weather enclosure, component parts, and equipment. Structural steel includes columns, beams, trusses, baseplates, girts, bracing, purlins, girders, and hangers. Miscellaneous steel includes edge plates, handrails, stairs, grating, and ladders. Provide steel supports for paragraph entitled "Access Provisions." Provide concrete foundations, anchor bolts, and grouting. Allow 50 mm 2 inches for grout so that bottom of baseplates are at an elevation of [_____] meters feet. Design structural steel support of baghouse to withstand differential thermal expansion and to support its own dead weight plus insulation, the maximum weight of accumulated flyash, and the maximum loads as specified in paragraph entitled "Design Criteria," or 4.8 kPa 100 psf, whichever is greater. Design to support equipment from the top of concrete foundations set an elevation of [[_____] metersfeet] [150 mm6 inches above grade]. Platform live loads may be excluded. Design for a roof dead load of one kPa 20 psf and a live load of 1.50 kPa 30 psf. Design supports in accordance with Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS and earthquake regulations. Use site periods between [[_____] and [_____]] [0.8 and 1.2] seconds for Zone [_____] structures, whichever results in the highest lateral force. Use the normal operating weight of the unit including dead loads as "W."

2.3.1 Girts and Opening Frames

Provide doors, door frames, and ventilators. Provide structural subframing for doors and ventilators located above grade [_____] meters feet. Provide girts to support outside face of metal wall panel, spaced at maximum 2.10 meters 7 feet center-to-center. Locate lowest girt above grade [[_____] meters feet] with support at the wall base. Design girt line or outside edge distance from the supporting column centerline for 0.56 meter one foot 10 inches. Provide closed ends or miter cut girts at corners.

2.3.2 Slide Bearings

Provide structural slide bearings using fluoroplastic self-lubricating bearing elements to ensure correct alignment and to prevent equipment damage and stress. Use slide bars to prevent ash and dirt from accumulating on the bearings.

2.4 DUCTWORK SYSTEM

Provide insulated weather-tight ductwork system from the [economizer] [air heater] [_____] outlet to the stack inlet including [reverse air ductwork,] bypass ductwork, and manifolds complete with transitions, structural steel, structural slide bearings, turning vanes, expansion joints, dampers, test ports, and mechanical draft equipment. Weld by continuous fillet or complete penetration groove welds. Design ductwork system for temperatures of minus 12 to plus 204 degrees C 10 to 400 degrees F, internal pressures of positive 5 kPa to negative 7.60 kPa 20 to negative 30 inches Water Column (WC), velocities of [_____] m/s fps, and for flyash fallout of 1171 kg/m2 240 lb/sq ft. Provide penetrations for control instruments.

2.4.1 General Ductwork

Provide insulated weather-tight ductwork. For ductwork sections greater than [_____] meters feet in length, provide hoppers, clean-out doors, and additional structural support. Do not apply loads at interface points. Provide 9.50 mm 3/8 inch thick turning vanes for turns greater than 45 degrees and where indicated by the model study. Brace turning vanes with pipes and angles but do not brace with rods. Brace ductwork maintaining bolt hold tolerances of 0.8 mm 1/32 inchbetween adjacent holes and 1 .50 mm 1/16 inch between two holes on the same side. Provide bolts, nuts, and ethylene propylene terpolymer (EPDM) gaskets for flanged connections.

2.4.2 Manifolds

Provide insulated weather-tight inlet and outlet manifolds supported from the baghouse structure. Include expansion joints. Locate manifolds, minimum 6 mm 1/4 inch stiffened ASTM A36/A36M of welded construction, between two rows of compartments and design to minimize pressure drop yet avoid low velocities which may allow flyash fallout. Base structural design on the assumption that manifolds are 30 percent full of flyash. Taper inlet manifold and provide take-offs to each compartments at or near the manifold bottom to assist flyash into the compartments. Provide a replaceable, abrasion resistant baffle plate at each compartment inlet.

2.4.3 Expansion Joints

Provide nonmetallic belt expansion joints with minimum 80 by 80 by 6 mm 3 by 3 by 1/4 inch carbon steel angle flanges. Belt material must be minimum 6 mm 1/4 inch thick, two-ply, aramid or fiberglass reinforced, solid fluoroelastomer polymer, spliced to form an endless belt without sewn joints. Provide nuts and bolts to attach fabric to the flanges and to attach expansion joints to the ductwork. Flange bolt holes must be factory punched and located at maximum 100 mm 4 inchcenters.

2.4.4 Dampers

****

NOTE: Provide items in brackets for reverse air cleaning system baghouses only.

****

Provide automatically controlled damper units, including framing, operators, and accessories, for the induced draft fan inlet, [the reverse air fan inlet,] the inlet manifold, the outlet manifold, the inlet of each compartment, [the outlet of each compartment,] [the inlet reverse air ductwork,] and the bypass ductwork. Dampers must conform to AMCA 500-D, AMCA 801, and AMCA 802 and must withstand, without affecting damper operation, differential thermal expansion, 1464 kg/m2 300 lb/sq ft flyash load at the bottom of the damper frame, 908 kg 2,000 pound concentrated load at the maximum frame deflection point, and maximum loads specified in paragraph entitled "Design Criteria."Damper frame must support the damper unit including controls, motors, drive mechanisms, and seal air system, with only one flange bolted to the ductwork without swaying or without causing the blade to blind. Bearings, bearing mount, and linkage system including connections must withstand three times the damper blade load plus the operator output torque, at worst case design conditions. Damper units must include:

a. Pneumatic operators; except guillotine dampers which must have the manufacturer's standard motor operators. Locate outside of the gas stream and within access for maintenance during baghouse operation.

b. Control drive units with permanently mounted handwheels which may be disengaged during pneumatic or motor operation; exclude poppet damper actuators.

c. Limit switches to show damper position (opened or closed).

d. Mechanical position indicator, at the damper, to show percent of damper opening.

e. Flanged frames for bolting to connecting ductwork.

f. Lifting lugs for transportation and installation handling.

g. External, locally mounted audible alarms to signal loss of seal air. Upon loss of power or air, dampers must fail in [failshut] [failopen] position.

h. Bearings. Permanently lubricated, self-aligning bearings located outside of the damper unit, insulation, and lagging, so that leaking packing must not contaminate the bearing with flyash.

i. Sealing strips, bolting materials and backing strips: ASTM B443. Not required for induced draft fan dampers.

j. Nuts, bolts, and washers. Use self-locking Type 316 stainless steel, Unified Numbering System Number S31600 (0.03 to 0.08 percent carbon) bolts, so that damper unit vibrations do not cause bolts to back out.

2.4.4.1 Louver Dampers

Provide the induced draft fan inlet [and the reverse air fan inlet] with parallel or opposed airfoil louver damper units. Frame length must be 25 mm one inch greater than the blade width; blade width must be maximum 610 mm 24 inches. Provide a minimum of two blades. Dampers having an open area of 3.72 to 7.43 sq meter 40 to 80 sfmust have a minimum of three blades. Dampers having an open area over 7.43 sq meter 80 sf must have a minimum of four blades. Allowable bending stresses must not exceed 60 percent of yield at design conditions. Provide louver damper units with the following:

a. Damper blade shaft assembly. Limit deflections at maximum damper seal conditions to L/360 (L = blade length in mm inches) or 6 mm 1/4 inch, whichever is less, and to deliver the full operator torque to a blade without exceeding one-third of the shaft yield stress when operating at the worst case design conditions.

b. Stuffing boxes. Provide dust-tight stuffing boxes, to seal shaft openings, so that fluoroplastic packing may be adjusted or removed from the outside of the duct without removing bearings or linkage.

c. Linkage system. Provide fully adjustable self-locking linkage system outside of the damper unit. Key arms to the shaft for easy removal. Pin or bolt stub shafts to the through shaft or blade so that individual damper blades may be adjusted or removed. Use Type 304 stainless steel, Unified Numbering System Number S30400 (0.03 to 0.08 percent carbon), linkage pins or bolts to connect carbon steel clevis arm to the stub shaft. Provide two operators on the linkage system, one to operate the top blade, and one to operate the bottom blade. The upper blades must closed first, then the bottom blade must close. Design linkage so that the number of blades operated by each operator may be changed.

d. Lock system. Provide a lock system using heavy-duty padlocks so the damper system can not be operated until the padlocks are removed.

2.4.4.2 Poppet and Butterfly Dampers

Provide each compartment with an inlet [, an outlet, and an inlet reverse air] damper having a maximum air leakage rate of 0.5 percent to provide for essentially zero leakage at maximum baghouse design differential pressure. Dampers must be either poppet dampers or butterfly dampers with adjustable speed and stroke operators, shaft packing glands, replaceable seal plates, and machined steel seating cylinder and guide shaft. Provide a lock system to lock dampers closed to protect service personnel. Locate shafts out of the dirty gas stream, otherwise provide shaft seals.

2.4.4.3 Double Guillotine Dampers

****

NOTE: An outlet manifold damper is not required for single baghouse installations. Where two or more baghouses share a single stack, provide dampers at each baghouse outlet manifold to prevent flue gas from exiting one baghouse and entering another.

****

Provide the inlet manifold, [the outlet manifold,] and the inlet bypass, with double plate steel guillotine dampers having a maximum air leakage rate of 0.5 percent to provide for essentially zero leakage at maximum baghouse design differential pressure. One damper must be open while the other damper is closed. Include a mechanical crank for manual operation. Provide dampers with carbon steel bonnets over the top frame, removable side plates for inspection of the damper drive assembly, and a removable bottom plate for access to the frame seal. Design bonnet for continuous seal air purge and provide an air reservoir to activate the damper upon loss of plant air. Design damper drive to lift the damper blade evenly on both sides. Provide damper units with the following:

a. Sealing strips, bolting materials and backing strips: ASTM B443. Provide both the upstream and downstream side of blade with sealing strips around the periphery of the blade and on the seating surfaces of the frame.

b. Control interlocks: Provide control interlocks to prevent dampers from simultaneously closing when the induced draft fan is operating.

2.4.4.4 Seal Air Systems

Provide each guillotine damper with a seal air system, consisting of an isolation damper or valve and a fan system, mounted onto the frame and located within access for maintenance. Mount so that condensation between the dampers flows into the ductwork. If installation on the damper frame is not possible, provide a platform to support the equipment. Fan, at design conditions, must supply two times the guaranteed L/s cfmleakage rate through the dampers and must maintain not less than 747 Pa 3 inches WC between the seal chamber and the flue gas. Control the seal chamber pressure using a mild steel manual control damper or a minimum 55 percent nickel, 20 percent chromium and 8 percent molybdenum gate or butterfly valve. Valve must operate on 552 to 862 kPa (gage) 80 to 125 psig instrument air using a pneumatic piston operator. Should the air supply fail, the piston actuator must remain in the last position. Provide instrumentation to monitor seal air system operation; tube and mount a 4-way dual-coil solenoid valve, with Class H coils rated for 120 VAC service. Provide two dual-pole dual-throw limit switches, one to actuate in the open position, one to actuate in the closed position, and house within a NEMA ICS 6, Type 4 enclosure.

2.4.5 Test Ports

ASTM A167, Type 316 stainless steel pipe, Schedule 40. Provide three 50 mm 2 inch pipe nipples with caps and rod-out on the topside of each guillotine damper seal chamber and provide one 50 mm 2 inch port with rod-out on the ductwork adjacent to each guillotine seal chamber, to attach seal chamber pressure measurement tubing. Provide 150 mm 6 inch diameter test ports on the horizontal side of the ductwork for air pollution sampling; locate the test ports upstream baghouse and downstream baghouse. Ports on ductwork must extend 150 mm 6 inches beyond stiffeners to clear insulation and lagging. Provide a screw plug for each test port. Coat each plug with an antiseize lubricant appropriate for the design inlet temperatures. Determine number, arrangement, and location of air pollution sampling test ports using 40 CFR 60, EPA AP-42, Appendix A, Method 1. Final number, location, and arrangement of test ports is subject to Contracting Officer approval.

2.4.6 Mechanical Draft Equipment

Provide mechanical draft equipment complete with operators, accessories, and field service.

2.5 HOPPERS

Provide insulated gas tight pyramidal hoppers as specified in paragraph entitled "Design Criteria." Design to withstand vibration due to vibrators and differential thermal expansion. Hoppers must span no more than one compartment. Weld hoppers to the baghouse compartments using continuous fillet or complete penetration groove welds. Provide a minimum 300 mm 12 inch diameter flanged flyash outlet connection on each hopper.

2.5.1 Poke Hole

Provide each hopper with a 100 mm 4 inch diameter poke hole extending a minimum of 150 mm 6 inches beyond the stiffeners and the hopper side, to clear insulation and lagging. Include a screwed cap. Locate the poke hole near the hopper outlet flange, orient to be accessible from the platform, and position to permit downward thrusts into hopper throat.

2.5.2 Vibrators

Provide each hopper with both mechanical and manual vibrators. Mechanical vibrators must consist of two automatically controlled vibrators, with manual override control, set at mid height and on opposite sides of the hopper. Interface vibrator controls with the ash evacuation system so that vibrators operate at the inception of and during an ash evacuation cycle. Enclose controls in cases to prevent accidental energizing of system. Place a warning over the vibrator manual override control, "WARNING; VIBRATOR CONTROL. DO NOT ACTIVATE UNLESS HOPPER EVACUATION SYSTEM IS OPERATING." Manual vibrators must consist of two uninsulated reinforced strike plates set at mid height and on opposite sides of the hopper. Provide strike plates, 300 by 300 by 25 mm 12 by 12 by one inchASTM A36/A36M steel, within hinged insulated panels. Provide space around strike plate to swing a small sledge hammer. Provide a work platform with stairs for strike plates greater than 1.50 meters 5 feet above ground.

2.5.3 Flyash Level Alarm System

Provide each hopper with a flyash level alarm system consisting of a nuclear flyash level detector and alarm relays to indicate the 50 percent hopper capacity level and the empty level. The nuclear detector must be an explosion proof, Cesium 137 single point gamma source detector having a lockable shutter mechanism operated by an external handle. Reproducibility must be within one inch. Design to withstand vibration and temperatures up to 427 degrees C 800 degrees F. Interlock with hopper access doors to prevent entry into the hopper when the source is activated. Provide one access key per hopper door. The alarm relays must be rated at 10 A, 120 VAC, or 125 VDC continuous duty. House flyash level detector controls in a [explosion proof] [dustproof] enclosure and mount in an easily accessible location. System must be operational at outdoor temperatures between minus 40 and 93 degrees C 40 F and 200 degrees F.

2.5.4 Hopper Heater System

Provide each hopper with an automatically controlled hopper and hopper throat heater system able to withstand 454 degrees C 850 degrees F, the maximum expected mechanical (normal operation) vibrations, and manual (strike plate use) vibrations. Design using a minimum 1.1 heating safety factor and a minimum 1.12 wind loss. Hopper and hopper throat heaters with insulation in place, at minimum ambient temperature of [_____] degrees C F, must maintain an internal skin temperature of 121 degrees C 250 degrees F while offline and during startup, and must maintain an internal skin temperature of 177 degrees C 350 degrees F or acid dew point temperature while online.

2.5.4.1 Hopper Heaters

Hopper heaters must cover not less than 33 percent of the total hopper area and must extend not less than 70 percent up the hopper height. Provide modular hopper heaters having a flexible heating face to conform to the irregularities of the hopper surface to provide maximum heat transfer. Where modular heaters do not fit, provide tape heaters or flexible blanket heaters. Heaters must be maximum 0.0046 W/mm2 3 W/in2 of resistance element, with a minimum 6 parallel resistance path, rated at 2.7 kw/m2 250 W/ft2 but designed to operate at 2.2 kW/m2 200 W/ft2. Use Series 600 stainless steel alloy or nickel-chrome heating elements and encase in a minimum 20 Gage aluminum or aluminized-steel mounting pan or casing. Provide heaters with attached metal labels listing the heater's wattage and voltage.

2.5.4.2 Throat Heaters

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NOTE: The hopper throats are normally part of the ash evacuation valve connected to the hopper outlet flange. This cast iron valve housing creates a restrictive outlet, a common area for pluggage unless the flyash is heated; thus the hopper throat heaters are intended for the inlet of the ash evacuation valve housing. Insulate the hopper

throats with a 50 mm 2 inch air gap with 80 mm 3 inches of insulation.

****

Provide tape heaters or flexible blanket heaters having a single Series 600 stainless steel alloy or nickel-chrome heating element, rated at 2.7 kW/m2 250 W/ft2. Design heaters to operate at 2.2 kW/m2 200 W/ft2 and to remain on during startup, offline, and online operating conditions. Encase in a minimum 20 Gage aluminum or aluminized-steel mounting pan or casing. Provide attached metal labels listing the heater's wattage and voltage.

2.6 WEATHER ENCLOSURES--REVERSE AIR CLEANING SYSTEM

****

NOTE: Select the applicable paragraph(s) from the following:

****

[Provide a weather-tight enclosure, including lighting, to enclose the top and the bottom of the baghouse. Enclose hoppers within the bottom weather enclosure. Conform to SMACNA 1793. Seal joints by continuous fillet or complete penetration groove welds. Do not use caulking. Design enclosures to withstand differential thermal expansion between housing and weather enclosures. Design weather enclosure roof to support minimum 4.8 kPa 100 psf. Space roof purlins so that roof deck span will not exceed 2.12 m 7 feet. Provide additional support for equipment placed on the roof. Slope and extend top surface and top surfaces of appurtenant structures, but not less than 25 mm one inch beyond side insulation, to allow water runoff and to prevent pooling. Provide a safety rail around the top perimeter surface, a 80 mm 3 inch fascia rain barrier of 6 mm 1/4 inch ASTM A242/A242M steel plate, a 80 mm 3 inch kickplate of 6 mm 1/4 inch ASTM A242/A242M steel plate, and drain holes to permit water runoff.

][WEATHER ENCLOSURE--PULSE JET CLEANING SYSTEM

Provide an insulated clean gas outlet plenum directly above the bags. Since the outlet plenum must enclose the entire top of the baghouse, do not provide a weather enclosure above the outlet plenum. However, enclose hoppers within a bottom weather enclosure. Plenum height must be \7[minimum\^ 305 mm^\\~ one foot~\ greater in height than bags] [minimum 4.50 meters 15 feet when using 4.30 meters 14 feet bags] to provide an indoor bag replacement area. Conform to SMACNA 1793. Include lighting. Seal joints by continuous fillet or complete penetration groove welds. Do not use caulking. Design enclosure to withstand differential thermal expansion between housing and weather enclosure. Design plenum to support minimum 4.8 kPa 100 psf. Space roof purlins so that roof deck span will not exceed 2.13 meters 7 feet. Provide additional support for equipment placed on the roof. Slope and extend top surface and top surfaces of appurtenant structures, by not less than 25 mm one inch beyond side insulation, to allow water runoff and to prevent pooling. Provide a safety rail around the top perimeter surface, a 80 mm 3 inch fascia rain barrier of 6 mm 1/4 inch ASTM A242/A242M steel plate, a 80 mm 3 inch kickplate of 6 mm 1/4 inch ASTM A242/A242M steel plate, and drain holes to permit water runoff.

]2.7 BAG CLEANING SYSTEM

2.7.1 General

Clean bags by [reverse air] [pulse jet]. Clean one compartment at a time on a predetermined adjustable programmed cycle or when the differential pressure across the bags reaches a set point. Provide 50 mm 2 inch capped pressure taps with rod-outs on each side of the tube sheet, accessible from the access platforms, to measure differential pressure. Connect pressure taps to remote indicators in the control room using minimum 10 mm 3/8 inch stainless steel tubing. Provide tubing with three-way valves, adjacent to the pressure indicators within the control room panel, to allow cleaning of the pressure lines with compressed air.

[2.7.2 Reverse Air Cleaning System

Provide each baghouse with a reverse air cleaning system including two reverse air fans, connecting ductwork, dampers, valves, and automatic controls. Bags must gradually reinflate after cleaning. Use air from the outlet manifold for reverse air cleaning and to maintain the reverse air ductwork temperature above the dewpoint temperature. Thimbles for 200 mm 8 inch diameter bags must be of 12 Gage carbon-steel plate, one nominal bag diameter in length, and spaced not less than 241 mm 9 1/2 inch on centers. Thimbles for 300 mm 12 inch diameter bags must be of 12 Gage carbon-steel plate, one nominal bag diameter in length, and spaced not less than 356 mm 14 inch on centers. Thimbles must be inline, not staggered. Tubesheet and bag alignment must be within 3 mm 1/8 inch for plumb.

2.7.2.1 Reverse Air Fans

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NOTE: One fan is sufficient for most applications. However, two fans, each rated at 100 percent of required capacity, may be required where increased reliability, logistics, or service dictate.

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Provide two heavy duty 100 percent capacity industrial reverse air fans; one fan must be placed on standby while the other fan is operational. Each fan must have a single flanged inlet, a single flanged outlet, and an automatically operated louver damper. Louver dampers must be as specified in paragraph entitled "Ductwork System" and must be designed for staged closing. Minimum reversing air flow must be 10 L/s per sq m 2 acfm per sf of net cloth area in a single compartment. Fan must be V-belt driven by a constant speed motor through an adjustable speed sheave, rated for flow, pressure, power, speed of rotation, and efficiency as in AMCA 210, AMCA 201, and AMCA 99. Mount the motor, Section 16, Electrical, on a slide motor base designed to allow belt tension adjustment from a screw mechanism. Provide motor with a belt guard. Provide a heat slinger for temperatures above 177 degrees C 350 degrees F.

2.7.2.2 Reverse Air Dampers

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NOTE: Specify air pressure available for pneumatic installation and location. Include control wiring installation as part of this section or as part of Division 26, Electrical. If included in this section, it must comply with Division 26,

Electrical. A duplicate control timer may be specified if increased reliability is desired.
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Provide each compartment with dampers for the dirty gas inlet, the clean gas outlet, and the reverse air inlet, as specified in paragraph entitled "Ductwork System." The dirty gas inlet damper must be a manually operated poppet or butterfly damper with the operator located within access for maintenance. The clean gas outlet damper and the reverse air inlet damper must be [air cylinder] [electrical motor] operated, adjustable speed poppet or butterfly dampers arranged for manual lockout capability with position indicating switches at both ends of travel. The clean gas outlet damper must fail-safe in the open position and the reverse air damper must fail-safe in the closed position.

Pulse Jet Cleaning System

Provide each compartment with a pulse jet cleaning system including compressed air dryer and filter system, isolation valves, pulse valves, and piping. Provide tube sheet arrangement and bag clearance to limit gas velocity between bags to a maximum 1.27 m/s 250 fpm at design conditions. Bag to bag clearance and bag to wall clearance must be minimum 50 mm 2 inches. Provide additional space between rows of bags, if necessary, to clear access door supports crossing the tube sheet. Arrange tube sheet for individual top bag and cage removal, and reinforce for minimum 488 kg/m2 100 psf pedestrian traffic.

Dryer and Filter System

Provide a dryer and filter system to remove moisture and particulate from compressed air for pulse jet cleaning. Size dryer and filter system for maximum 2 degrees C 35 degrees F dewpoint temperature at 690 kPa (gage) 100 psig, 120 percent of design air flow, and for 90 days of operation without service under normal operating conditions. Locate filters to be easily accessible for inspection and service.

Valves and Piping

Provide each compartment with an isolation valve to isolate the compartments for offline cleaning. When offline, individually pulse each row of bags with 483 to 690 kPa (gage) 70 to 100 psig dry, filtered compressed air. Provide each row with a compressed air header including heavy duty, stainless steel, internal, diaphragm pulse valves and solenoid actuators to distribute the compressed air to the bags. Diaphragm valves must be factory wired to a junction box and must be no louder than 84 dBA, 1.50 meters 5 feet from the valve. After the bags are cleaned, the compartment must remain offline for [_____] seconds to allow the dust to settle into the hoppers. Provide the distribution piping with couplings to allow removal of piping for bag replacement.

]2.8 BAGHOUSE CONTROLS

2.8.1 Control Functions

Provide main baghouse control from the boiler plant control room panel board. The main control system must include the following operational and monitoring functions:

a. Automatic and manual startup and shutdown. Provide manually initiated automatic startup sequence.

b. Automatic baghouse control.

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NOTE: For pulse jet cleaning systems both off line cleaning (normal) and on-line cleaning are available.

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c. Automatic bag cleaning. Provide an automatic timer to initiate compartment cleaning when differential pressure across the bags reaches a set point.

d. Programmed bag cleaning. Provide an overriding timer to initiate compartment cleaning on a predetermined adjustable programmed cycle independent of pressure differential. Provide for [adjustable pulse jet duration time,] [adjustable pulse jet sequencing,] adjustable cleaning cycle time, adjustable settling time, and adjustable isolation valve operation.

e. Manual bag cleaning. Provide a manual selector switch to allow manual compartment cleaning.

f. Operations monitoring. Provide graphics and audible alarms to monitor equipment status for abnormal operation, malfunction, failure, or trip.

g. Automatic shutdown of malfunctioning components. Provide automatic and safe shutdown of malfunctioning components with minimal disruption to boiler operational capabilities.

h. Automatic and manual bypass. Provide automatic and manual bypass for out of service compartments or for system upset conditions. Design controls to bypass the baghouse when the inlet temperature is below [_____] degrees C F or above [_____] degrees C F. When a compartment is bypassed, exclude from the automatic cleaning cycle.

i. Compartment lockout. Interlock the automatic timer, overriding timer, and manual selector switch of each compartment with an isolation switch located at the tube sheet access door to isolate the compartment for maintenance.

Provide two position selector switches for the following:

a. Power--ON/OFF

b. Module--ACTIVE/INACTIVE

c. Cleaning Mode--OFFLINE/ONLINE

Provide momentary contact push buttons for the following:

a. System--START (green head)

b. Hopper level alarms

c. Alarm--ACKNOWLEDGE

Provide auxiliary devices for the following:

a. Position indication switches on isolation valves.

b. Hopper level alarms.

c. Temperature indicators, thermocouple alarm, and switch, to initiate bypass, at the baghouse inlet.

d. Temperature indicators and thermocouples at the baghouse outlet.

e. Temperature indicators and thermocouples for each hopper throat.

f. Differential pressure gages with pressure switch and audible alarm for each compartment.

g. Differential pressure gages with pressure switch and audible alarm for the baghouse inlet and outlet.

h. Opacity at baghouse outlet.

2.8.2 Instrumentation and Control Systems

Use solid-state analog circuitry. Assemble circuits using readily available pretested components making maximum use of integrated circuits. Gold plate pins and mating connectors on nickel to withstand chemical attack by ambient atmospheric chemicals. Arrange logic elements on circuit cards in functional groups so that failure of a single logic circuit or compartment must not affect more than one separate functional sequence. Memory must be static. Factory assemble, wire, test, and debug circuit cards using the operating stations and actual plug-in cables for the system. Test circuit card logic in the completed system for a minimum of 170 hours continuous operation. Provide programming aids to permit easy field reprogramming of adjustable parameters. Battery power backup may be approved by the Contracting Officer.

2.8.3 System Electrical Power and Power Supplies

The Government must furnish one 120 VAC power source from the station service. Provide fuses or circuit breakers to protect each source against faults, overloads, and power failures. Fuses, fuse panels, breakers, and breaker panels must be readily accessible and clearly identified. Provide input filters for noise suppression. Provide a full-capacity internal DC power supply for each bus.

2.8.4 Control Drive

Provide adjustable speed pneumatic control drives including handwheels, couplings, adapters, linkage system, drive arms, and damper arms, to respond to signals from the control system. Provide dual-pole dual-throw limit switches to electronically sense open and closed damper positions without using a slide mechanism. The full-stroke travel time of the damper drive piston in either direction must be adjustable from one second to one minute.

2.8.5 Main Baghouse Control Panel

Provide an enclosed control panel cabinet for each baghouse. Baghouse controls and indicators must include meters, recorders, thermocouples, pressure gages, graphics, annunciators, power supplies, power switches, and wiring. The cabinets, 3 mm 1/8 inch hot-rolled steel paneled NEMA ICS 6, Type 12 enclosures, reinforced inside with angles and channels, must have lifting lugs for shipping and handling. Provide a shipping pallet for each control panel cabinet. Cabinets must also include one two-tube 40 W, 120 V fluorescent light fixture, one 120 VAC duplex 3 wire polarized grounded outlet, terminal blocks, interior panels for mounting auxiliary equipment, front and rear hinged access doors with key locks, cutouts with removeable cover plates for items designated as future, and floor anchoring or a floor foundation. Install cabinet sections side by side and provide bottom side openings to interconnect the cables without routing the cables outside of the cabinets. Do not bring power greater than 120 V into the cabinet. Fill and grind cabinet edges to a 6 mm 1/4 inch radius. Maintain cabinets at minimum 125 Pa 0.5 inch WC using a fan powered by a 120 V, single-phase minimum 0.09 kW 1/8 hp motor. Provide a ventilation system including ventilation louvers, grills, exhaust fans, ductwork, and filters to ensure heat is dissipated. Filter pressurizing air for particulates greater than one micron at a minimum 98.5 percent efficiency.

2.8.5.1 Recorders

Provide each miniature pen strip chart recorder with an engraved scaled legend plate, a rubber legend stamp, internal fluorescent lighting, a set of tools and accessories, and a 12 month supply of charts and ink. Design recorders for 120 VAC power. Miniature pen strip chart recorders must be 100 mm 4 inches in width having a 25 mm one inch per hour chart speed.

2.8.5.2 Thermocouples

Provide Type K ungrounded thermocouples with AWG Size 20 iron-constantan wires for measuring ductwork, and surface temperatures. Provide universal thermocouple heads with screwed covers, chains, terminal connectors, and stainless steel nipples so that head clears insulation by 50 mm 2 inches. Ductwork thermocouples must be spring loaded with two hole insulators, Type 304 stainless steel sleeve sheath, and silver plug tip. Insulate surface thermocouples using a glass fiber insulating jacket to protect thermocouples from high temperatures.

2.8.5.3 Pressure Gages

Provide pressure gages indicating pressures from zero to 2490 Pa 10 inches WC, with high and low pressure rip set points. Pressure gages must withstand up to 172 kPa (gage) 25 psig. Enclose pressure switch elements, 120 VAC, dual-pole dual-throw relays, in a NEMA ICS 6enclosure.

2.8.5.4 Graphics

Provide a graphic subpanel to pictorially describe the flue gas flow path through each baghouse, including through the ductwork, bypass, dampers, fans, and valves, to display the operating status of each fan, and to display the position of each valve and damper. Provide control switches, indicating lights, and meters adjacent to the corresponding graphic equipment symbol. Provide smooth finished display openings for the switches, lights, and meters, in the panel metal behind acrylic sheeting. The graphic symbols, flow lines, nameplates must be:

a. Base material: 6 mm 1/4 inch phenolic or 4.76 mm 3/16 inch solid acrylic sheeting.

b. Letters and symbol material: Laminated phenolic or acrylic sheeting.

c. Equipment symbols, flow arrows, and nameplates thickness: one mm 0.040 inch.

d. Flow line thickness: 0.50 mm 0.020 inch.

e. Color: Solid white core with colored satin finish overlay.

f. Engraving: Engrave through colored overlay to expose solid core. Cut laminate with beveled edges, except flow lines, to expose solid core on perimeter.

g. Mounting: Mount to front face sheet with contact cement. Cement must be removeable using a solvent that will not damage face sheet or symbols. Do not use double-faced adhesive tapes.

Indicating lights must be nominal 15 mm 1/2 inch diameter and rated for 120 VAC. Provide the following indicating lights; lens colors are in parentheses, * indicates items activating an audible alarm:

a. Inlet damper--OPEN (green)

b. Inlet damper--CLOSED (red)

c. Outlet poppet--OPEN (green)

d. Outlet poppet--CLOSED (red)

e. Module--ACTIVE (green)

f. Module--INACTIVE (red)

g. Hopper throat heater--ON (green)

h. Hopper throat heater--OFF (red)

i. High ash level (red)*, one per hopper

j. High inlet gas temperature (red)*

k. High temperature drop across baghouse (red)*

l. Low hopper temperature (red)*, one per hopper

m. Low compressed air pressure (red)*

n. High pressure drop across baghouse (red)*

o. Power--ON (red)

p. SYSTEM START (green)

q. SYSTEM STOP (red)

r. Cleaning mode OFFLINE selected (white)

s. Cleaning mode ONLINE selected (white)

t. Cleaning mode MALFUNCTION (red)*

2.8.5.5 Annunciators

Construct annunciators using factory-tested, burned in solid state electronics. Contact circuitry must meet IEEE C37.90.1. Power equipment from the Government's 120 VAC station service source. Arrange power supplies, circuit breakers, and input terminal blocks in groups to permit servicing single section of the annunciator system without disabling the entire system. Alarm window must be 50 to 80 mm 2 by 3 inch. Use electronic tone generators with variable pitch and volume controls.

2.8.5.6 Power Supplies and Switches

Provide mechanically interlocked, main circuit breakers mounted in the baghouse panelboard for switching, and for primary and backup power services. Provide a 20 A molded case circuit breaker for each tap from the control bus. Provide one AC alarm relay connected to each AC bus with two sets of contacts to close after a 2 second delay on loss of AC. Provide a 120 VAC control bus and a 120 V utility bus. Provide a 24 VAC power supply for low voltage indicating lights and meters. Use metal position marking nameplates and plastic identification nameplates.

2.8.5.7 Wiring

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NOTE: Include control wiring installation and amperage ratings as part of this section or as part of Division 26, Electrical. If included in this section, it must comply with Division 26, Electrical. Amperage ratings must comply with load requirements. Provide an automatic transfer switch to switch to the backup source upon primary source failure. Provide a manual reset and provide an alarm contact on transfer.

****

Provide cables, terminal blocks, grounding buses, and fuse boxes as follows:

a. Cables: Prefabricated cables, [_____] meters feet in length, with plug-in connectors at both ends of the interconnecting wire. Provide a mechanical restraint between the cable connector mating halves so that the connecting pin-pair does not separate due to mechanical vibration or cable sag. Design the male connector to protect the pins from cable pulling and to align the two halves during mating. The connector must be rated for 600 V and 90 degree C 194 degrees F conductor temperature, with minimum 18 Gage copper conductors, neoprene or polychlorosulphonate jackets, and shielding.

b. Terminal Blocks: Heavy-duty, sliding-link rated not less than 20 A, 600 V with not less than 13 mm 1/2 inch spacing between terminals. Provide 10 percent spares. Main power supply circuit terminal blocks and control bus termination terminal blocks must be rated not less than 40 A. Design to allow individual circuit testing without disconnecting cabinet wiring. Design terminal to receive ring-tongue cable connectors on the field side. Mount terminal blocks in rows within the panel cabinets at heights greater than 305 mm 12 inches, for connections of remote devices. Group and wire terminal blocks by function. Wire using insulated switchboard wire rated for 600 VAC, 60 Hz, 90 degree C conditions. Use American Wire Gage (AWG) Size 14 or larger for 120 VAC control and indicating circuits, AWG Size 10 or larger for 120 VAC main power supplies and tap circuits, and AWG Size 20 for devices not greater than 28 V. Permanently stamp or mark the marking strip with the terminal designation. Do not use self-adhesive embossed plastic label tape.

c. Grounding Buses: Minimum 25 by 6 mm one inch by 1/4 inchgrounding bus running the full length of the panel cabinet sections. Provide with Number 4, 250 thousand circular mil (MCM) lugs for ground cable connection at each end. Connect internal grounds to the ground bus.

d. Fuse boxes: Provide single-pole and three-pole fuse boxes with fuses for each set of relaying and metering potential circuits. Provide plug-in strips to connect 120 VAC supplies to meters and recording equipment.

2.8.6 Local Hopper Heater Control Panels

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NOTE: Specify parallel alarm contacts within the control panel and connect to a terminal block within the panel to a remote alarm system.

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Provide each hopper with a factory wired local hopper heater control panel containing relays, contactors, circuit breakers, and control transformers. Use non-spliced interconnecting multistrand copper wire with high temperature (454 degrees C 850 degrees F) insulation, from the hopper heater and from the hopper throat heater, to the local hopper heater control panel. Locate local hopper heater control panels near the corresponding hopper. Provide each hopper heater with individual automatic heater controls having adjustable setpoints and proportional bands. Heaters must not operate when access doors are open. Heater voltage must be [_____] VAC. Control voltage must be 120 VAC. Size wiring, circuits, and controls for 2690 W/m2 250 W/ft2. Arrange heater wiring and connections to provide a balanced load on a [_____] V, 3-phase power supply system. Enclose in a NEMA ICS 6 [Type 12] [Type 4] [floor] [wall] mounted enclosure and include the following:

a. One control temperature thermostat (with bulbs and 1524 mm 60 inch flexible cable capillaries).

b. One low temperature alarm thermostat (with bulbs and 1524 mm 60 inch flexible cable capillaries).

c. One high temperature alarm thermostat (with bulbs and 1524 mm 60 inch flexible cable capillaries).

d. One main 3 pole [_____] V circuit breaker.

e. One individual fuse circuit protector for the [_____] V power circuit to each local hopper heater terminal box.

f. One [_____] V/120 V dry control transformer with one secondary lead fused and the other secondary lead grounded.

g. One 600 V contactor with a 120 V operating coil for each thermostatically controlled heater circuit.

h. Magnetic contactor and alarm relay with two normally open contacts.

i. Terminal blocks for termination of control and alarm circuits including 10 percent spares on each block.

j. Auxiliary relays for automatic operation of the heater system terminal blocks for power, control, and alarm circuits.

k. Throat heater surface thermocouples, one thermocouple per hopper heater.

Provide each local hopper heater control panel cover with the following:

a. "ONLINE," "OFF," "AUTO" selector switch.

b. 120 V "HIGH LEVEL" red light with integral transformer, one each zone.

c. 120 V "ON" green light with integral transformers, one each zone.

d. 120 V "LO TEMP" white light with integral transformer, one each zone.

e. Device and enclosure nameplates screwed or riveted to panel.

Wire the selector switch for the following system operation:

a. "ONLINE": Heaters operating (includes throat heater).

b. "OFF": All elements off.

c. "AUTO": Control functions transfer to Master Hopper Heater Control Panel.

2.8.7 Master Hopper Heater Control Panel

Provide a factory wired master hopper heater control panel containing relays, contactors, circuit breakers, control transformers, and devices for complete control of each hopper heater system, in the control room. Enclosed in a NEMA ICS 6 [Type 12] [Type 4] [floor] [wall] mounted enclosure and include the following:

a. One main circuit breaker.

b. One circuit breaker and contactor alarm relay with two normally open contacts for each hopper zone. The contactor must have a 120 V operating coil.

c. "ONLINE," "OFF," "AUTO" selector switch for each hopper.

d. 120 V "HIGH LEVEL" red light with integral transformer for each hopper.

e. 120 V "ON" green light with integral transformers for each hopper.

f. 120 V "LO TEMP" white light with integral transformer for each hopper.

g. Device and enclosure nameplates screwed or riveted to panel.

h. Auxiliary relays and equipment required for operation of the heating and alarm systems.

i. Fused control transformer having a 120 VAC secondary.

2.9 ACCESS PROVISIONS

2.9.1 Access Requirements

Provide access stairs, walkways, and platforms from boiler to baghouse. Baghouse access must include interior and exterior access, including access to manifolds, bags, tube sheet, weather enclosure, hoppers, valves, conveyors, expansion joints, dampers, gas sampling ports, poke holes, and equipment requiring routine maintenance, repair, or replacement. Access provisions must comply with OSHA regulations. Interconnect walkways and platforms on each side of the baghouse or each side of equipment, at the same elevation, by walkways. Connect walkways, including roof, by stairs. Provide caged ladders at each level for secondary egress. Provide allowance for installing piping, conduit, electrical outlets, and lighting fixtures. Provide 7 feet headroom clearance above walkways, platforms, and stairs. Provide manholes, inspection doors, and access doors with internal and external access walkways, lights, and platforms, at areas requiring access for operation and maintenance. Operation and maintenance access requirements are listed, by Class, below:

2.9.1.1 Class 1

Regularly attended areas including: lubricated equipment, bearings, instruments, valve operators, damper operators, damper linkages, damper drives, test ports, instrument connections, and equipment requiring daily inspection, maintenance, and operation. Provide platforms accessible by stairs. Do not use a ladder or ship ladders.

2.9.1.2 Class 2

Periodic maintenance access areas including expansion joints, ductwork inspection doors, safety valves, valve packing, and equipment requiring access every two years or more. Provide platforms accessible by ladders. Provide not less than two avenues of escape from safety valves or other hazardous equipment.

2.9.1.3 Class 3

Infrequent maintenance access areas, where access is required for painting, reinsulation, or replacement of components which have a service life of 10 years or more. Provide area to erect temporary scaffolding, ladders, platforms, and safety nets. Provide rotating machinery and mechanical equipment components weighing greater than 91 kg 200 pounds with lifting lugs and provide monorails to remove and lower the equipment to grade in a single lift.

2.9.2 Interior Access Provisions

Provide minimum 5 mm 3/16 inch ASTM A36/A36M manholes, inspection doors, and access doors to allow interior access to the hoppers, manifolds, ductwork, bags, and tube sheet. Access openings must have gas-tight, insulated, externally hinged, ethylene propylene terpolymer (EPDM) gasketed doors with 13 mm 1/2 inch diameter smooth hand holds above the inside and outside of each door. Hinges must support the doors when open. Provide safety chains to allow doors to be cracked slightly open before opening completely and padlocks to allow padlocking doors in the open position. Additional requirements are as follows:

2.9.2.1 Access to Hoppers

Provide each hopper with one quick-opening, minimum 610 mm 24 inchdiameter manhole having an access door as specified in the above paragraph. Interlock hopper access doors to level detectors to prevent access when the nuclear level detectors are operational. Provide 13 mm 1/2 inchdiameter smooth hand holds inside each hopper, every 460 mm 18 inches down the side of the hopper to the bottom, to serve as a ladder.

2.9.2.2 Access to Manifolds and Ductwork

Provide at least one quick-opening, minimum 610 mm 24 inch diameter manhole or one quick-opening minimum 460 by 610 mm 18 by 24 inchinspection door at the inlet manifold, the outlet manifold, and at ductwork areas greater than [_____] meters feet in length. Provide either a quick-opening, minimum 610 mm 24 inch diameter manhole or a quick-opening minimum 460 by 610 mm 18 by 24 inch inspection door at both sides of dampers, expansion joints, and both sides of gas distribution devices. The doors must be as specified in the above paragraph.

2.9.2.3 Access to Reverse Air System Bags

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NOTE: Select the applicable paragraph(s) from the following:

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[Provide each compartment with interior walkways and access doors to allow access to the bags and both upper and lower bag supports. Interior walkways must be minimum 610 mm 24 inches wide with kickplates. Access doors must be minimum 508 by 1118 mm 20 by 44 inch with external bolt-down lugs and safety interlocks, and as specified in the above paragraph. Space lugs evenly around the door perimeter including the hinged side, minimum one lug per 305 mm foot of door perimeter, to assure uniform gasket pressure around the entire door periphery. Provide permanently attached caution signs and opening instructions at each door for operating personnel. Locate walkways between rows of bags maintaining minimum 13 mm 1/2 inch clearance with the bags inflated, to prevent bags from coming into contact with the walkways and wearing out, and maintaining a maximum three-bag reach. Provide upper access walkways one meter 3 feet below the upper support frame. Provide a minimum 1 .22 meters 4 feet crawl space above the upper support frame.

][Access to Pulse Jet System Bags

Provide each compartment with interior walkways and access doors to allow access to the bags and bag support. Interior walkways must be minimum 610 mm 24 inches wide with kickplates. Access doors must be minimum 508 by 1118 mm 20 by 44 inch with external bolt-down lugs and safety interlocks, and as specified in the above paragraph. Space lugs evenly around the door perimeter including the hinged side, minimum one lug per foot of door perimeter, to assure uniform gasket pressure around the entire door periphery. Provide permanently attached caution signs and opening instructions at each door for operating personnel. Locate lower walkways between rows of bags to maintain a maximum three-bag reach. Locate the lower walkways 152 mm 6 inches below the lower end of the bags to prevent bags from coming into contact with the walkways and wearing out. Provide upper access walkways along the floor of the outlet plenum.

]2.9.3 Exterior Access Provisions

Provide ladders, stairs, walkways, and platforms, including supporting steel, handrails, kickplates, electrical lights, and electrical outlets, to manholes, inspection doors, and access doors. Design ladders, stairs, walkways, and platforms for live loads, as specified in paragraph entitled "Design Criteria." Provide walking surfaces on the roof for periodic equipment maintenance or inspection areas. Provide a 1829 by 2109 mm 72 by 83 inches uninsulated double utility door to each weather enclosure.

2.9.3.1 Ladders

Ladders must be minimum 457 mm 1 foot 6 inches wide with 20 mm 3/4 inch diameter rungs spaced at 305 mm 12 inch on centers and minimum 10 by 65 mm 3/8 by 2 1/2 inch side rails.

2.9.3.2 Stairs

Stairs must be open risers with a minimum 229 mm 9 inch grate tread, minimum 0.91 m 3 foot width, and a maximum 203 mm 8 inch rise. Design for 610 km/m2 125 psf live load or 454 kg 1,000 pound moving concentrated load, whichever is greater. Provide 40 mm 1 1/2 inch diameter black standard weight pipe, ASTM A53/A53M, Type E or Type S, handrails along both sides of stairs. Top handrail must be 762 to 813 mm 2 feet 6 inches to 2 feet 8 inches above edge of tread. Main bars must be 25 by 5 mm 1 by 3/16 inch. Use serrate main bars for outdoor use. Support stairs at bearing bars with tack welded 65 by 5 mm 2 1/2 by 3/16 inch carrier plates.

2.9.3.3 Walkways

Provide minimum 610 mm 2 feet walkways in Class 2 areas. Other walkways must be minimum 0.91 m 3 feet. Design for 488 kg/m2 100 psf live loads plus concentrated equipment loads. Design walkways which are above ductwork or other surfaces, so that the underside of the walkway is a minimum of 150 mm 6 inches above the upper surface of the ductwork including insulation and lagging. Provide 40 mm 1 1/2 inch diameter black standard weight pipe, ASTM A53/A53M, Type E or Type S handrails. Pipe runs must be horizontal at 584 mm and 1.07 m 1 foot 11 inches and 3 feet 6 inches above walk grating.

2.9.3.4 Platforms

Provide minimum 1.11 sq meters 12 sq feet platforms. Design platforms for live loads of 488 kg/m2 100 psf plus concentrated equipment loads. Design platforms which are above ductwork or other surfaces, so that the underside of the platform is a minimum of 150 mm 6 inches above the upper surface of the ductwork including insulation and lagging. Provide minimum 6 mm 1/4 inch thick raised steel floor plate grating of one piece, resistance-welded with 5 mm 3/16 inch diameter main bars, ASTM A108, Grade 1015, spaced at no more than 30 mm 1 3/16 inches on corners. Use serrate main bars for outdoor use. Provide subframing so grating span is no greater than 1.07 m 3 feet 6 inches. Space crossbars, ASTM A108, Grade 1010, at 102 mm 4 inches on centers. Crossbars must be hexagonal of 8 mm 5/16 inch diameter of inscribed circle, 13 by 5 mm 1/2 by 3/16 inch rectangular, 6 mm 1/4 inch square with spiral twist, or 8.33 mm 21/64 inch diameter round. Provide 40 mm 1 1/2 inch diameter black standard weight pipe, ASTM A53/A53M, Type E or Type S handrails and 6 mm 1/4 inch thick steel kickplates. Pipe runs must be horizontal at 584 mm 1 feet 11 inches and 1.07 m 3 feet 6 inches above grating.

2.10 SOURCE QUALITY CONTROL

Conduct standard factory tests and performance tests required by the applicable codes on control circuits, mechanical draft equipment and materials, and dampers, except poppet dampers. Notify Contracting Officer of test dates in writing not less than 45 days before factory tests so that Contracting Officer may witness test.

2.10.1 Baghouse Controls Tests

Perform control system factory tests with control system components connected together. To test, provide control boards with 115 VAC, 60 Hz, and operate each control switch and selector switch to verify that each control circuit operates as shown on the schematic diagrams. Simulate remote contacts and switches with jumpers at the appropriate external terminal blocks to verify proper circuit operation. Test annunciator systems to verify that annunciator points operate correctly by jumpering or operating alarm initiating device or jumpering external terminals for remote alarm inputs.

2.10.2 Mechanical Draft Equipment Tests and Materials

Factory tests must include mechanical balancing of rotary parts.

2.10.3 Dampers

Test each damper following AMCA 500-D, including frame, except poppet dampers, five times in an airtight chamber at design flowrate temperature and pressure to determine gas leakage across the damper and the frame. Provide instruments to determine the amount of leakage and the static pressure against the damper. If a damper is equipped with a seal air system, test the damper both independently and with the seal air system. Operate system at design flowrate, temperature, and pressure.

PART 3 EXECUTION

3.1 COORDINATION

Coordinate design parameters and baghouse collection system controls with manufacturers whose equipment will interface with, or affect, the system operation.

3.2 INSPECTION

The Contractor Quality Control Representative and the Contracting Officer must inspect equipment and materials before, during and after installation at the job site. Correct or replace defective material and equipment as approved by the Contracting Officer.

3.3 INSTALLATION

****

NOTE: Revise this paragraph as necessary when baghouse manufacturer is to install the equipment provided.

****

Install equipment on foundations or structural steel framework as shown on the drawings, or as specified elsewhere herein.

3.3.1 Insulation

****

NOTE: If a separate insulation section is part of this specification, add a note to that section to indicate that baghouse insulation is covered by this section.

****

Insulate housing, hopper, and ductwork. Provide insulation with interruptions to permit access to the following openings without damaging the insulation system: manholes, inspection doors, access doors, and flanged openings. Provide boxouts around nameplates and code stamping symbols. Install a double layer of insulation with the joints of the two layers staggered. Fill cracks, voids, and depressions of insulation with insulating cements before applying another layer of insulation or jacket application. Provide insulation with expansion joints to withstand differential thermal expansion movements which may cause cracks or tears in the insulation. Install insulation between stiffeners and over stiffeners so that the stiffeners are completely insulated. Install additional insulation or casing spacers between stiffeners so that the surface is level. Securely wire and lace insulation in place using a soft ASTM A580/A580M, Number 14, Type 302 stainless steel wire.

3.3.1.1 Mineral Fiber Block and Board Insulation

Secure mineral fiber and block and board insulation with stud insulation lugs spaced not greater than 432 mm 17 inches on center. Weld lugs in place. Reinforce blocks on the exterior face with expanded metal to prevent sagging or cutting of the insulation by the lacing wire. Secure entire surface of mineral fiber block and board insulation in place using wire threaded lugs. Thread lugs with wire both ways, pull tight, twist ends together with pliers, bend over, and carefully press into the surface of the insulation.

3.3.1.2 Mineral Fiber Blanket Insulation

Secure mineral fiber blanket insulation with speed washers and impaling pins spaced not greater than 305 mm 12 inches on centers. When applying speed washers, do not compress the insulation below the design insulation thickness. Reinforce mineral fiber blanket insulation with expanded metal on the outer surface and wire mesh or expanded metal on the inner surface. Tightly butt blanket sections together and tie at joints to prevent the blanket edges from peeling or bulging, and to provide maximum sealing.

3.3.1.3 Calcium Silicate Insulation

Provide calcium silicate insulation over 12 Gage steel pins studwelded on 610 mm 2 feet centers. Do not place calcium silicate insulation directly in contact with the aluminum casing. Closely fit insulation around penetrations. Hold insulation in place by 65 mm 2 1/2 inchsquare speed washers. Protect calcium silicate on horizontal surfaces by 16 Gage sheet steel coated with a non-slip paint. On other areas, apply 13 mm 1/2 inch thick insulating concrete or cover using 16 Gage sheet steel. Provide access panels with removable insulation panels.

3.3.2 Casing

3.3.2.1 Structural Steel Grid System

Design the structural steel grid system to provide a smooth finished surface of insulation over the stiffeners, access doors, flanges, ribs, and uneven surfaces. Weld the grid system onto the equipment and structural support surfaces. Install aluminum casing onto grid system. Design the roof to transmit an external 114 kg 250 pound walking load from the casing to the structural grid system without compression of the insulation material.

3.3.2.2 Access Openings

Closely fit insulation to manholes, inspection doors, access doors, and flanged openings. Frame and flash to make weather-tight. Provide hinged or lift-off doors with nameplates, code stamping symbols, and non-projecting connections.

3.3.2.3 Weatherproofing

Fabricate and overlap casing to make weather-tight. Provide closures, flashings, and seals. Provide the open ends of fluted sections with tight-fitting closure pieces. Form and install flashing so that water cannot enter and wet the installation. Design and install flashing to readily drain any water that might enter. Weatherproof joints or casing openings which cannot be sealed by flashings or laps with an aluminum pigmented sealer.

3.3.2.4 Convection Stops

Provide convection stop on vertical surfaces over 3.67 meters 12 feet tall. The maximum interval between convection stops must be 3.67 meters 12 feet.

3.3.2.5 Casing Attachment

Attach aluminum casing to the structural steel grid system using Number 14 stainless steel, Series 300, self-tapping screws on 305 mm 12 inchcenters. Fasten vertical laps and flashings using 20 mm 3/4 inchNumber 14 stainless steel, Series 300, sheet metal screws on 305 mm 12 inch centers. Provide exposed screws with aluminum or stainless steel backed neoprene washers preassembled to screws. Do not compress insulation below nominal thickness.

3.4 FIELD QUALITY CONTROL

3.4.1 Manufacturer's Field Representative

Furnish the services of a baghouse manufacturer field representatives trained by the manufacturer to assist baghouse installers to ensure that the baghouse is installed in accordance with the manufacturer's recommendations. The field representatives must be at the erection site during installation phases including unloading, hauling, storing, cleaning, erecting, startup, and testing, until the system has been brought online and stabilized. The field representatives must supervise the adjustment of controls, control devices, and components supplied with the baghouse and must instruct the plant operators in the operation, care, and maintenance of the equipment. The field representatives must certify in writing to the Contracting Officer that the baghouse has been installed as recommended by the manufacturer.

3.4.2 Post-Installation Inspection

The baghouse manufacturer's service engineer must inspect the complete baghouse prior to startup to verify that the unit is installed as the manufacturer recommends.

3.5 IDENTIFICATION

Securely fasten an aluminum, brass, or corrosion resistant steel nameplate to the equipment in a readily visible location using rivet or sheet metal screws. The nameplate must contain the manufacturer's name, model or series number, serial number, design gas inlet volume and temperature, and air-to-cloth ratio. Indent or emboss the information into the metal to avoid nameplate being covered by insulation. Provide plastic engraved nameplates for remote mounted devices. Fabricate nameplates from laminated white phenolic plastic with black engraved letters, 20 mm high and 76 mm long 3/4 inch high and 3 inches long. Attach nameplates with permanent adhesive or screws.

3.6 TRAINING PROGRAM OF OPERATING AND MAINTENANCE PERSONNEL

****

NOTE: CAUTION: There are restrictions on the type and extent of training which can be paid for with various categories of construction funds. The training routinely acceptable under construction contracts is the one- to two-day type where factory representatives or others instruct facility maintenance and operating personnel in the basics of operating and maintaining the equipment, generally on-site. If more extensive types of training are required, particularly where the student is required to travel and where special consultants are required to teach government personnel for extended amounts of time, consult the PA Director, Contact Division and the Head, Comptroller Department, for assistance in determining how to accomplish the training within the regulations. Anything over two- to three-days offsite should be highly suspect.

****

Provide classroom instruction, field instruction, and testing to the Government's operating personnel to ensure that operators will be qualified to properly and safely operate and maintain the baghouse system, including individual equipment components. Provide training at job site within 30 days of startup. Provide the operators with a working knowledge of operation theory and principles, operation and control requirements, and technical requirements for maintenance. Provide training manuals and testing materials so that, with the operating and maintenance manuals, the Government may train new operators without Contractor assistance.

3.6.1 Classroom Instruction

Develop and present 40 hours of organized classroom instruction on operation theory and principles, operation and control requirements, and technical requirements for maintenance. Administrate tests at the conclusion of the course.

3.6.2 Field Instruction

After startup, a service engineer must provide supervision of the system for not less than 8 hours per day for 30 days to assist and instruct Government operators. Instruction must include, but not be limited to the following:

a. Precoating of bags.

b. Actual startup and shutdown.

c. Instrument, gage, and control functions.

d. Deliberate upset of the system and correction instructions.

e. Simulation of induced fan failure.

f. Baghouse maintenance including removal and replacement of bags.

g. Bypass system. When and how to use bypass system.

3.6.3 Testing Program

Provide a written test program to determine individual comprehension levels. Use the testing program in conjunction with the classroom instruction.

3.6.4 Video Recording

Provide color video tapes of field instruction or provide prepared color video tapes covering the field instruction material.

3.7 PAINTING

At the factory, blast clean exterior surfaces of the baghouse system to base metal, SSPC SP 6/NACE No.3, including ductwork, manifolds, hoppers, support structures, and access provisions, and prime and apply two coats of paint, FS TT-P-28. Surfaces exposed to the flue gas flow need not be painted but must be protected during shipment and storage with a rust-protective coating.

3.8 PROTECTION FROM GALVANIC CORROSION

To prevent against galvanic corrosion, prevent permanent contact of aluminum casing with copper, copper alloy, tin, lead, nickel, nickel alloy, and Monel metal. Where it is necessary to attach the casing to carbon steel or to a low alloy steel, first prime the steel with zinc chromate, and then paint with aluminum paint, FS TT-P-28. Do not use lead based paints. Hot-dip galvanize, ASTM A123/A123M, external floor plates, ladders, grating, stairs, platforms, walkways cages, handrails, kickplates, and accessories. Floor plate warpage must not exceed 25 mm one inch for every 3.05 meters 10 feet in any direction.

3.9 PROTECTION FROM INSULATION MATERIALS

Protect equipment and structures from insulation materials. Clean, repair, and restore equipment and structures to their original state after work is completed. Replace corroded, discolored, or damaged casing.

[3.10 FUNGUS TREATMENT (TROPICAL AREAS ONLY)

****

NOTE: Use this paragraph only for projects in tropical areas with considerable moisture.

****

Do not treat components and elements inert to fungi, hermetically sealed, or of operations adversely affected by the application of varnish, for moisture and fungus resistance. Treat the electrical connections including terminals, as follows:

a. Starter and solenoid coils, except potted coils: MIL-T-152.

b. Motor coils which rise in temperature 40 degrees C 104 degrees F or less: MIL-V-173.

c. Motor coils which rise in temperatures over 40 degrees C 104 degrees F: Two coats Type AN, Class 105, MIL-I-24092.

Apply coats by the vacuum-pressure, immersion, centrifugal, pulsating pressure, or buildup method to fill coil interstices and to prevent entrapped air or moisture. The sealer coat may be applied by brushing or spraying.

]3.11 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. [_____]	[_____]	[_____]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 52 00 (April 2008)**
Change 5 - 11/19

Preparing Activity: USACE **Superseding**
UFGS-23 52 00.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 52 00

HEATING BOILERS

04/08, CHG 5: 11/19

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 52 00 (April 2008)**

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SECTION 23 52 00

HEATING BOILERS

04/08, CHG 5: 11/19

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NOTE: This guide specification covers the requirements for packaged hot water and steam boiler systems (oil, gas or combination oil/gas fired) of up to 6000 kW 20,000,000 Btuh output capacity. The hot water boiler systems operate at water temperatures below 120 degrees C 250 degrees F and water working pressures less than 1100 kPa 160 psi. The steam heating systems operate up to 100 kPa 15 psig.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13/CSA 4.9	(2022) Gas-Fired Low Pressure Steam and Hot Water Boilers

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings

	Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.20	(2023) Metallic Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers
ASME PTC 10	(2022) Performance Test Code on Compressors and Exhausters

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2022) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2/B2.2M	(2016) Specification for Brazing Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe,

	Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube

ASTM B828	(2023) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C27	(1998; R 2022) Fireclay and High-Alumina Refractory Brick
ASTM C34	(2023) Standard Specification for Structural Clay Loadbearing Wall Tile
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C401	(2012; R 2022) Alumina and Alumina-Silicate Castable Refractories
ASTM D596	(2001; R 2018) Standard Guide for Reporting Results of Analysis of Water
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM F876	(2024b) Standard Specification for Crosslinked Polyethylene (PEX) Tubing
ASTM F1097	(2017; R 2022) Standard Specification for Mortar, Refractory (High-Temperature, Air-Setting)
ASTM F1139	(1988; R 2024) Steam Traps and Drains

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

CAGI B19.1	(2010) Safety Standard for Compressor Systems

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

HYDRONICS INSTITUTE DIVISION OF AHRI (HYI)

HI-004	(1995) Radiant Floor Heating
HYI-005	(2008) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment
UL 1738	(2023) UL Standard for SafetyVenting Systems for Gas-Burning Appliances, Categories II, III and IV
UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Materials and Equipment

[Energy Star label for residential gas fired hot water boiler product; S

][Energy Star label for residential oil fired hot water boiler product; S

] Spare Parts

Water Treatment System

Boiler Water Treatment

Heating System Tests

Fuel System Tests

Unit Heaters

Welding

Qualifications

Field Instructions

Tests

SD-06 Test Reports

Heating System Tests

Fuel System Tests

Water Treatment Testing

SD-07 Certificates

Bolts

Continuous Emissions Monitoring

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions; G, [_____]

Water Treatment System; G, [_____]

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.3 QUALITY ASSURANCE

****

NOTE: Where pipeline, structural, or other welding is required on the same project, tests will be required accordingly. Testing may be by the coupon method as prescribed in the welding code or by special radiographic methods. If the need exists for more stringent pipe welding requirements, delete the sentences in the first set of brackets.

****

Submit a copy of qualified welding procedures and a list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations. [Weld and braze boilers and piping in accordance with qualified procedures using performance-qualified welders and welding operators. Use procedures and welders that are qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests, and perform the tests at the work site if practical. The welder or welding operator must apply the personally assigned symbol near each weld made as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures for piping are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.4 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and no later than 2 months prior to the date of beneficial occupancy. Submit Detail Drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of guides and anchors, the load imposed on each support or anchor (not required for radiant floor tubing), and typical support details. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function as a unit and to show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

PART 2 PRODUCTS

****

NOTE: In order to comply with UFC 1-200-02, designs

must achieve energy consumption levels that are at least 30 percent below the ASHRAE 90.1 baseline. In accordance with P.L. 109-58 (Energy Policy Act of 2005), Executive Order 13423, and Federal Acquisition Regulation (FAR) Section 23.203 energy consuming products and systems must meet or exceed the performance criteria for ENERGY STAR®-qualified products as long as these requirements are nonproprietary. The ENERGY STAR product requirements are available on the web at www.energystar.gov/products**. Where ENERGY STAR products are not applicable, energy consuming products and systems must meet or exceed the requirements of ASHRAE 90.1.**

ENERGY STAR Eligibility Criteria Version 3.0 requires that residential boilers of less than 90 kW 300,000 Btuh energy input supplying low pressure steam or hot water for space heating applications have a minimum AFUE of 90 percent for gas-fired type or 87 percent for oil-fired type. Boilers intended only for commercial applications and/or with an input rating of 90 kW 300,000 Btuh or higher are not eligible for Energy Star.

If a FEMP efficiency is not stated for a particular boiler capacity, this document includes boiler efficiency requirements in conformance with ASHRAE 90.1. ASHRAE 90.1 requires that low and medium pressure boilers used primarily in commercial space heating applications meet the following thermal (Et) or combustion (Ec) efficiencies:

Natural Gas-fired Hot Water rated at 88 - 732 kW 300,000 - 2,500,000 Btuh capacity, Et = 80 percent.

Natural Gas-fired Hot Water rated greater than 732 kW 2,500,000 Btuh capacity, Ec = 82 percent.

Natural Gas-fired Steam (excluding natural draft) rated at 90 kW 300,000 Btuh capacity and larger, Et = 79 percent.
Natural Gas-fired - Natural Draft Steam rated at 90 kW 300,000 Btuh capacity and larger, Et = 77 percent.

#2 Oil-fired Water rated at 88 - 732 kW 300,000 - 2,500,000 Btuh capacity, Et = 82 percent.

#2 Oil-fired Water rated greater than 732 kW 2,500,000 Btuh capacity, Ec = 84 percent.

#2 Oil-fired Steam rated greater than 90 kW 300,000 Btuh capacity and larger, Et = 81 percent.

Include all equipment efficiencies on the equipment schedules on the drawings.

****

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Submit manufacturer's catalog data included with the detail drawings for the following:

a. Radiant floor heating system including tubing, joints, and manifold for radiant floor heating systems.

b. Data showing model, size, options, etc., that are intended for consideration. Ensure data submitted is adequate to demonstrate compliance with contract requirements. Include manufacturer's written installation instructions and manufacturer's recommendations for operation and maintenance clearances for the following:

    (1) Boilers
    (2) Unit Heaters
    (3) Fuel Burning Equipment
    (4) Combustion Control Equipment
    (5) Pumps
    (6) Fittings and Accessories
    (7) Fuel Oil Storage System
    (8) Water Treatment System

2.1.2 Asbestos Prohibition

Asbestos and asbestos-containing products will not be allowed.

2.1.3 Nameplates

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number. Also, display an Energy Star label as applicable. Provide an approved ASME stamp for each pressure vessel.

2.1.4 Equipment Guards

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact in accordance with OSHA requirements. Properly guard high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard or cover with insulation of a type specified. Provide catwalks, operating platforms, ladders, and guardrails where shown and construct in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.2 BOILERS

****

NOTE: A selection will be made between hot water and steam service. Also select between firetube, water tube, cast iron, and condensing type boilers. Condensing type boilers should only be considered

for hot water service. Natural draft/atmospheric burners will not be used for any boiler exceeding 300 kW 1,000,000 Btuh output. Delete inapplicable references. A Life Cycle Cost Analysis should be performed to determine the appropriate type of boiler.

****

Provide each boiler with the output capacity in kilowatts (kW) British thermal units per hour (Btuh) as indicated when fired with the specified fuels. Furnish boiler complete with the [oil] [gas] [combination oil/gas] burning equipment, boiler fittings and trim, automatic controls, [[forced] [induced] draft fan,] [natural draft/atmospheric burner,] electrical wiring, insulation, piping connections, and protective jacket. Assemble boiler completely and test at the manufacturer's plant. Provide boiler auxiliaries including fans, motors, drives, and similar equipment with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, do not size the boiler safety devices for a 10 percent excess capacity. Design and install the boiler and its accessories to permit ready accessibility for operation, maintenance, and service. Design, construct, and equip boilers in accordance with ASME BPVC SEC IV. Each boiler must be of the [firetube] [watertube] [cast iron] [condensing] type and designed for [water] [steam] service as specified herein. Base boiler capacity on the ratings shown in HYI-005 or as certified by the American Boiler Manufacturers Association, or American Gas Association.

2.2.1 Firetube Boiler

Provide self-contained, multipass, packaged type boiler, complete with all accessories, mounted on a structural steel base. When the boilers are operating at maximum output, the heat input rates must not be greater than 21 Kw/square meter 6,700 Btuh per square ft of fireside heating surface.

2.2.2 Watertube Boiler

****

NOTE: Select between standard, finned, or bent/flexible tube boiler. If bent or flexible tube boilers are not selected, remove all references to bent or flexible tube boilers. Standard water tube boilers are steel tube boilers that have historically been used for most heating applications. Finned tube boilers are typically small boilers (residential type) that utilize a finned tube arrangement. Bent or flexible tube boilers are steel tube boilers with bent tubes that experience multiple water tube passes. Bent/Flexible tube boilers typically require less space than standard water tube boilers. The bent or flexible tubes are also easier to replace than the standard water tubes; however, the interior surface of the tubes cannot be cleaned mechanically; they can only be chemically cleaned. Bent or flexible tube boilers also have a higher ratio of heat output to heating surface area.

****

Provide a [standard] [finned] [bent or flexible] type of water tube boiler. Provide a self-contained, packaged type boiler, complete with all accessories, mounted on a structural steel base. [The boiler heating surface area for bent or flexible tube boilers must be at least 0.03 square meters/kW 4 square feet/boiler horse power. [The heat input rate for finned tube steam boiler or hot water generator must not be greater than3.5 kW 12,000 Btuh based on internal heating area.]Provide bent or flexible tube boilers with single or multiple downcomers for circulation without the need for exterior pumping. Design the tubes for bent or flexible tube boilers for replacement without requiring welding or rolling of tubes. Provide any special tools required for bent or flexible tube removal or installation with the boiler.]

2.2.3 Cast Iron Boiler

Provide rectangular, sectional type, self-contained, packaged type boiler, complete with accessories, mounted on a structural steel base. Use cast iron sections that are free of leaks under all operating conditions. Provide access to permit cleaning of internal tube surfaces.

2.2.4 Condensing Boiler

****

NOTE: Due to the sulfur content of fuel oil, condensing boilers should only be considered if natural gas is used.

The lower the return temperature of water entering the boiler the higher the resulting boiler efficiency. (See ASHRAE HVAC Equipment and Applications Handbook). The return water temperature should be at or below the dew point of the flue gas to result in the formation of condensate. This condition may not occur within a steam heating system. Therefore, condensing boilers should only be used for hot water service. In addition, the water distribution system and heating coils should be designed for higher temperature differentials.

Condensing boilers may be in the form of fire tube boilers with pulse combustion, copper fire tube boilers, or multiple heat exchanger boilers. The military specifications listed in the preceding paragraphs concerning fire tube and water tube boilers do not apply to condensing boilers.

****

Provide a self-contained packaged type boiler, complete with accessories, mounted on a structural steel base or a steel base which is integral to the boiler shell. Each boiler must conform to the commercial design used by the manufacturer and permit free thermal expansion without placing undue stress on any part of the boiler. Design each boiler which experiences the formation of condensate within the flue gas specifically for condensing application. Each boiler must withstand the corrosive effects of condensate for each part which may be in contact with the condensate at all possible operating conditions. Provide each boiler with a separate air intake, exhaust, and condensate drain. Design each boiler to withstand the water temperature differentials anticipated at the required operating conditions without experiencing any damage due to thermal shock.

2.2.5 Modular Configuration

****

NOTE: A modular configuration is a series of small cast iron type and/or condensing type boilers. The smaller boilers are manifolded together to provide heating for larger loads. This arrangement may be economical when heating load variances are expected. Delete this paragraph if a modular configuration is not desired.

****

Provide [cast iron] [and] [condensing] type modular boilers with the capability of independent operation. Upon failure of any module, ensure the remaining modules are capable of operating at their designed capacity. Use size of the individual modules as indicated.

2.2.6 Hot Water Heating Boilers

****

NOTE: Hot water heating boilers will operate at pressures not over 1100 kPa 160 psi and at temperatures not above 120 degrees C 250 degrees F at or near the boiler outlet. If a pressure above 200 kPa 30 psi is selected, the boiler may be required to be manned 24 hours a day. Consult AR 420-49 for boiler attendance requirements. Fill in blank spaces to define operating conditions, under the listed subparagraphs which are not applicable to the design. Indicate the elevation of the project site and outdoor ambient air temperature range expected at the project site. Site conditions affect fan selection, boiler design, and stack design. Select appropriate boiler types. Allow adequate space around each boiler to permit accessibility for operation, maintenance, and service (including space for tube removal). A minimum clearance of 1200 mm 4 feet around the boiler will be required unless modular boilers are specified. Some modular boilers installations require little or no room between the individual boilers.

****

Provide hot water heating boiler capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity is the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. The boiler design conditions are as follows:

a. Boiler design pressure [200] [_____] kPa [30] [_____] psig.

b. Operating pressure at boiler outlet [_____] kPa psig.

c. Hot water temperature [70] [80] [_____] degrees C [160] [180] [_____] degrees F.

d. Temperature differential between boiler discharge and system return [_____] degrees C degrees F.

e. Water pressure drop [70] [_____] kPa [10] [_____] psig.

f. Outdoor ambient air temperature [_____] degrees C degrees F (max), [_____] degrees C degrees F (min).

g. Site elevation [_____] m feet.

h. Maximum continuous capacity [_____] kW Btuh.

i. Rated capacity [_____] kW Btuh.

j. Maximum exhaust stack temperature [_____] degrees C degrees F.

****

NOTE: Energy efficiency data for residential boilers provided in item "k" below is from Energy Star Program Requirements Product Specification for Boilers, Eligibility Criteria Version 3.0. Energy efficiency data for commercial boilers provided in item "k" below is from ASHRAE 90.1 Table 6.8.1F.

****

k. [Residential gas fired hot water boilers with a capacity less than 90 kW 300,000 Btu must have an Annual Fuel Utilization Efficiency of at least 90 percent, and must be Energy Star Labeled. Provide proof of Energy Star label for residential gas fired hot water boiler product.][Residential oil fired hot water boilers with a capacity less than 90 kW 300,000 Btu must have an Annual Fuel Utilization Efficiency of at least 87 percent, and must be Energy Star Labeled. Provide proof of Energy Star label for residential oil fired hot water boiler product.][Hot water boilers with a capacity less than 90 kW 300,000 Btuh must have an Annual Fuel Utilization Efficiency of at least 80 percent.][Gas fired boilers with a capacity of greater than or equal to 90 kW 300,000 Btuh and less than or equal to 733 kW 2,500,000 Btuh must have a thermal efficiency of at least 80 percent when fired at the maximum and minimum ratings allowed by the controls.][Gas fired boilers with a capacity of greater than 733 kW 2,500,000 Btuh must have a combustion efficiency of at least 82 percent when fired at the maximum and minimum ratings allowed by the controls][Oil fired boilers with a capacity of greater than or equal to 90 kW 300,000 Btuh and less than or equal to 733 kW 2,500,000 Btuh must have a thermal efficiency of at least 82 percent when fired at the maximum and minimum ratings allowed by the controls.][Oil fired boilers with a capacity of greater than 733 kW 2,500,000 Btuh must have a combustion efficiency of at least 84 percent when fired at the maximum and minimum ratings allowed by the controls.]

****

NOTE: Minimum boiler efficiencies will either be presented in this specification or on the design drawings. Delete boiler efficiencies in the specification if efficiencies are shown on the drawings. If the efficiencies are shown on the drawings, reference the applicable standard.

****

2.2.7 Steam Heating Boilers

****

NOTE: Steam boilers will operate at pressures below 100 kPa 15 psi. In case of installation of a small boiler where the omission of the water column is standard in some manufacturers, the water column requirement and other inapplicable words will be deleted. However, if the water column requirement is deleted from the specification, include a visible water column in the external piping arrangement to the boiler. The boiler feed water piping must contain a loop or trap. The bottom portion of the trap must be below the anticipated water level within the boiler. All piping arrangements will be shown on the drawings. Delete those subparagraphs which are not applicable to the design. Indicate the elevation of the project site and the outdoor ambient air temperature range expected at the project site. Site conditions affect fan selection, boiler design, and stack design. Select the feed water temperature to avoid thermal shock. Typical ranges are between 10 degrees C 20 degrees F and 20 degrees C 40 degrees F below the boiler outlet temperature. The boiler manufacturer should be consulted for proper selection. Select appropriate boiler types. Allow adequate space around each boiler to permit accessibility for operation, maintenance, and service (including space for tube removal). A minimum of 1200 mm 4 feet around the boiler will be required.

****

Provide boiler with a water column with gauge glass and fittings including water column and gauge glass drain valves of the straight through type. Provide steam heating boiler that is capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity is the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. Design conditions are as follows:

a. Boiler design pressure 200 kPa 30 psig.

b. Operating pressure at boiler outlet [_____] kPa psig.

c. Steam temperature 120 degrees C 250 degrees F.

d. Feedwater temperature [_____] degrees C degrees F.

e. Outdoor ambient air temperature [_____] degrees C degrees F (max), [_____] degrees C degrees F (min).

f. Site elevation [_____] m feet.

g. Maximum continuous capacity [_____] kg pounds of steam per hour.

h. Rated capacity [_____] kg pounds of steam per hour.

i. Maximum exhaust stack temperature [_____] degrees C degrees F.

****

NOTE: Energy efficiency data for commercial boilers provided in item "j" below is from ASHRAE 90.1 Table 6.8.1F.

****

j. [Gas fired boilers with a capacity less than 90 kW 300,000 Btuh must have an Annual Fuel Utilization Efficiency of at least 75 percent.][Oil fired boilers with a capacity less than 90 kW 300,000 Btuh must have an Annual Fuel Utilization Efficiency of at least 80 percent.][Gas fired boilers (all, except natural draft) with a capacity of greater than or equal to 90 kW 300,000 Btuh must have a thermal efficiency of at least 79 percent.][Gas fired natural draft boilers with a capacity greater than or equal to 733 90 kW 300,000 Btuh must have a thermal efficiency of at least 77 percent.][Oil fired boilers with a capacity greater than or equal to 90 kW 300,000 Btuh must have a thermal efficiency of at least 81 percent when fired at the maximum and minimum ratings allowed by the controls.]

****

NOTE: Minimum boiler efficiencies will either be presented in this specification or on the design drawings. Delete boiler efficiencies in the speciication if efficiencies aare shown on the drawing. If the efficiencies are shown on the drawings, reference the applicable standard.

****

2.3 FUEL BURNING EQUIPMENT

****

NOTE: Include all the required data for proper design of the boiler. Delete all references to fuels which will not be used. When firing fuel oil, include nitrogen and sulfur content of fuel for emission requirements.

Review the Clean Air Act Amendment of 1990 (CAAA) and other applicable Federal, state, and local regulations early in the design phase to determine the appropriate emission limitations and monitoring requirements.

The CAAA does not require the application of low NOx burner (LNB) technology for boilers within the size range of this specification. The CAAA limits SO2 emissions for fuel oil fired boilers over 10.55 gJ 10,000,000 Btu to 215 kg/nJ 0.5 lb per million Btu input or to firing oil with less than 0.5 weight percent sulfur. However, state implementation plans may place limits on NOx and particulates and more stringent requirements on SO2.

Many options are available to reduce NOx emissions.

The nitrogen and sulfur content of fuel oil should be specified in the fuel purchase contract. Restrictions on the nitrogen content will limit fuel flexibility. A careful analysis of proposed NOx reduction technologies must be performed to account for any required changes to auxiliary equipment and to identify future increase in O&M costs. Important questions that should be answered and be a part of the evaluation include the performance of NOx reduction over the entire load range, performance during backup fuel firing, and performance over the lifetime of the unit.

The majority of NOx control techniques can be defined as combustion modifications. The goals of combustion modification include redistribution of air and fuel to slow mixing, reduction of O2 in NOx formation zones, and reduction of the amount of fuel burned at peak flame temperatures.

Combustion modifications primarily deal with the control of fuel and air. Vertical staging includes overfire air (OFA) ports above the main combustion zone. Horizontal staging use registers or other devices to introduce air at different points along the flame. Fuel staging establishes a fuel rich zone above an air lean main combustion zone. Burner Out of Service (BOOS) techniques direct fuel to lower burner levels, while operating upper burners with air only. Flue Gas Recirculation (FGR) reduces O2 available to react with nitrogen and cools the flame. In addition to low NOx burners (LNB), OFA and BOOS other combustion modification techniques include fuel biasing, low excess air (LEA) and fuel reburning. Oil fired burners have successfully used advanced oil atomizers to reduce NOx without increasing opacity. Oil/water emulsion is a technique to reduce NOx on smaller industrial boilers.

Consideration will be given to the unique installation and space requirements of various NOx reduction systems. LNB may or may not require pressure port modifications. FGR involves routing large ductwork. OFA is very effective and involves modification to pressure parts. Fuel staging requires pressure port modifications for reburn fuel injection and/or OFA ports.

****

Design boiler to burn [gas] [oil] [combination gas and oil]. Each boiler must comply with Federal, state, and local emission regulations. As a minimum, meet the following emission requirements:

NOx - [[_____] kg/joule lb/million Btu input] [parts per million (ppm) corrected to 3 percent Oxygen by volume].

SO2 - [[_____] kg/joule lb/million Btu input] [parts per million (ppm) corrected to 3 percent Oxygen by volume].

Particulate - [[_____] kg/joule lb/million Btu input] [parts per million (ppm) corrected to 3 percent Oxygen by volume].

2.3.1 Burners

****

NOTE: If No. 4, 5, or 6 oil will be one of the fuels, requirements for burners and accessories for these heavy oils will be inserted in the project specification.

****

2.3.1.1 Gas and Combination Gas-Oil Fired Burners and Controls

Burners must be UL approved [mechanical draft burners with all air necessary for combustion supplied by a blower where the operation is coordinated with the burner] [natural draft/atmospheric burners]. Provide burner complete with fuel supply system in conformance with the following safety codes or standards:

a. Provide gas-fired units with inputs greater than 0.117 MW 400,000 Btuh per combustion chamber conforming to UL 795. [Provid gas fired units less than 3.66 MW 12,500,000 Btuh input conforming to ANSI Z21.13/CSA 4.9.] [Provide single and multiple burner gas-fired units greater than or equal to 3.66 MW 12,500,000 Btuh input conforming to NFPA 85.]

b. Provide combination gas and oil-fired units conforming to UL 296. [Provide combination gas and oil-fired units less than 3.66 MW 12,500,000 Btuh input conforming to ASME CSD-1.] [Provide single and multiple burner combination gas and oil-fired units equal to or greater than 3.66 MW 12,500,000 Btuh input conforming to NFPA 85.]

2.3.1.2 Oil-Fired Burners and Controls

Oil-fired burners and controls for oil-fired units firing No. [_____] oil must be atomizing, forced-draft type in conformance with UL 726. [Provide oil-fired units less than 3.66 MW 12,500,000 Btuh input conforming to ASME CSD-1.] [Provide oil-fired units greater than or equal to 3.66 MW 12,500,000 Btuh input conforming to NFPA 85.]

2.3.1.3 Steam or Air Atomizer

****

NOTE: Delete this paragraph if steam or air atomization is not used.

****

Provide [steam] [or] [air] atomizer of the inside mix type utilizing [steam] [or] [air] mixing with the oil inside the nozzle. No moving parts are required within the atomizer assembly. Provide unit that is capable of completely atomizing the oil through a minimum capacity range of 4 to 1 without changing nozzles or sprayer plates and when supplied with [steam] [or] [air] at a maximum pressure of [100] [_____] kPa [15] [_____] psig. Provide unit with adjustable capacity. Furnish unit with a blowout valve so that [steam] [or] [air] may be blown through the oil passages to clear them of any accumulation. Mount a diffuser designed to stabilize the flame near the furnace end of the atomizer in such a position that oil will not strike it.

2.3.1.4 Mechanical pressure atomizer

****

NOTE: If mechanical pressure atomization is not used delete this paragraph.

****

Operate mechanical pressure atomizer solely by the use of oil pressure and have no moving parts within the atomizer. Unit must be capable of completely atomizing the oil through a minimum capacity range of 4 to 1 without changing nozzles or sprayer plates and when furnished with oil at a constant pressure of [_____]. Supply a constant volume of oil to the atomizer. Obtain variable capacity by adjusting control valve. Mount a diffuser provided to stabilize the flame near the furnace end of the atomizer, but in such a position that oil will not strike it.

2.3.2 Draft Fans

****

NOTE: If natural draft/atmospheric burners are utilized, all draft fan paragraphs will be deleted. Select between forced draft and induced draft fan or a combination of both. In most applications, a forced draft fan will be adequate. Fan bearings on induced draft fans must have adequate means to prevent overheating and provision for lubrication. Choice of type of cooling will depend on availability of water for the particular site. Water-cooled bearings are generally used for induced draft fans but air-cooled, sealed-type bearings are available; however, their use must be approved by the fan manufacturer for the application if specified. Forced draft fans are typically air cooled.

****

Furnish fans conforming to AMCA 801 [forced-draft] [and] [induced-draft] as an integral part of boiler design. Provide centrifugal fans with [backward-curved blades] [radial-tip blades] or axial flow type. Size each fan for output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner, leakages, temperature, and elevation corrections for worst ambient conditions, all at full combustion to meet net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against a 20 percent static overpressure. Do not exceed noise levels of 85 decibels for fans in any octave band at a 0.914 m 3 foot station. [Air cool draft fan bearings.] [Design induced-draft fans for handling hot flue gas at the maximum outlet temperature in the boiler. Provide induced draft fan housings with drain holes to accommodate the drainage of condensation. [Air-cool] [Water-cool] induced draft fan bearings. Provide induced draft fan scroll sheets and rotor blades with protective liners.]

2.3.2.1 Draft Fan Control

[Provide forced-draft centrifugal fans with inlet vane controls or variable speed control where indicated. Provide inlet vanes suitable for use with combustion control equipment.] [Provide induced-draft centrifugal fans with outlet dampers and variable speed control.] [Provide induced-draft fans with inlet vane controls.] Provide axial propeller fans with variable propeller pitch control.

2.3.2.2 Draft Fan Drives

****

NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the description of motor starters.

****

Drive fans by electric motors. Electric motor must be [drip proof] [totally enclosed nonventilated] [totally enclosed fan cooled] [totally enclosed fan-cooled, suitable for installation in a Class II, Division 1, Group F, hazardous location conforming to NFPA 70]. [Motor starter must be [magnetic across-the-line] [reduced voltage start] type with [general purpose] [weather-resistant] [watertight] [dust-tight] [explosion-proof] enclosure and furnished with four auxiliary interlock contacts.]

2.3.3 Draft Damper

****

NOTE: Select between manual and automatic dampers. Normally, manual dampers are adequate for single boilers less than 600 kW 2,000,000 Btuh capacity. Select automatic dampers for modular boilers.

****

Provide boilers with [manual] [automatic] dampers, draft hoods, or barometric dampers as recommended by the boiler manufacturer to maintain proper draft in the boiler. Provide draft damper in a convenient and accessible location in the flue gas outlet from the boiler. Arrange automatic damper for automatic operation by means of a [damper regulator] [furnace draft regulator] [damper motor].

2.3.4 Ductwork

****

NOTE: In colder climates, tempering of combustion air may be required. Add an appropriate paragraph for tempering combustion air, if required. Delete this paragraph, if a plenum chamber is not needed.

****

Design air ducts connecting the forced-draft fan units with the plenum chamber to convey air with a minimum of pressure loss due to friction. Provide ductwork consisting of galvanized sheet metal conforming to ASTM A653/A653M. Ducts must be straight and smooth on the inside with laps made in direction of air flow. Ducts must have cross-break with enough center height to assure rigidity in the duct section, angle iron braced, and completely free of vibration. Provide access and inspection doors as indicated and required, with a minimum of one in each section between dampers or items of equipment. Construct ducts with long radius elbows having a centerline radius 1-1/2 times the duct width, or where the space does not permit the use of long radius elbows, short radius or square elbows with factory-fabricated turning vanes may be used. Duct joints must be substantially airtight and have adequate strength for the service, with 38 x 38 x 3 mm 1-1/2 x 1-1/2 x 1/8 inch angles used where required for strength or rigidity. Provide duct wall thickness of 16 gauge (1.5 mm 0.0598 inch) for ducts 1500 mm 60 inches or less and 12 gauge (2.66 mm 0.1046 inch) for ducts larger than 1500 mm 60 inches in maximum dimension. Additional ductwork must be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4 COMBUSTION CONTROL EQUIPMENT

****

NOTE: If steam boilers are not utilized, delete all references to steam pressure controllers. If hot water boilers are not utilized, delete all references to water temperature controllers.

Controls for facilities with operating Energy Monitoring and Control Systems (EMCS) will be specified to be compatible with existing EMCS controls. Delete reference to multiple boilers if a single boiler is used.

Delete "pneumatic controls" for new systems. Use only pneumatic controls for existing pneumatic controls systems that require new parts be purchased.

****

Provide combustion control equipment as a system by a single manufacturer. Field install automatic combustion control system in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer. [Control the boiler water temperature by a water temperature controller.] [Control the boiler pressure by a steam pressure controller.] Operate the equipment [electronically] [either electrically or pneumatically as applicable]. On multiple boiler installations, provide each boiler unit with a completely independent system of controls responding to the load and to a plant master controller. If recording instruments are provided, furnish a 1 year supply of ink and 400 blank charts for each recorder.

2.4.1 Pneumatic Controls

If pneumatic operation is provided, provide a regenerant desiccant air dryer unit. Shut down boiler on loss of control air pressure. Provide pneumatic control systems conforming to CAGI B19.1. Install air filter regulator sets at each control valve and transmitter in the system. Provide dual type master air filter regulator set where one side can be cleaned and repaired while the other is operating. Protect exterior control air piping and devices from freezing.

2.4.1.1 Air Compressor Unit

Provide electric-motor driven, polytetrafluoroethylene or carbon ring type automatic air compressor unit. Size the compressor unit to run no more than 60 percent of the time when all controls are in service. Provide air compressor unit complete with necessary accessories including automatic pressure control equipment, relief valves, check valves, air filters, moisture traps, and a receiver with ample capacity for emergency operation of the controls for 15 minutes after compressor shutdown. Do not exceed compressor speed of 900 rpm. Do not exceed motor speed of 1750 rpm. Provide compressor air intake with a low drop type air suction filter/silencer suitable for outdoor installation.

2.4.1.2 Air Receiver

****

NOTE: The condensate drain line will be located in such a manner as to prevent freezing.

****

Construct the air receiver in accordance with ASME BPVC SEC VIII D1for unfired pressure vessels for 1379 kPa 200 psi working pressure, and equipd with inlet and outlet connections, valved drain connection, minimum 150 mm 6 inch dial pressure gauge, pop safety valves, and regulator connections.

2.4.2 Electrical controls

Provide electrical control devices rated at [120] [24] volts and connect as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.4.3 Water Temperature Controller

****

NOTE: If hot water boilers are not utilized, the following paragraph will be deleted. Consideration will be given to the utilization of outside air reset controls. Outside air reset control is typically used for boilers whose primary loads are due to space heating applications. Information on outdoor air reset controls for space heating application is located in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and UFC 3-410-02 or inactive UFC 3-540-02N (http://www.wbdg.org/ccb/DOD/UFC/INACTIVE/ufc_3_540_02n.pdf **). Consideration will be given to the use of control based on return water temperature rather than supply water temperature.**

****

Provide controller made of sturdy construction and protect against dust and dampness. Insert the thermostatic element in a separable socket installed [in the upper part of the boiler near the water outlet] [in the boiler return piping]. [Operate fixed position (on-off) and three position (high-low-off) controller on a 5.56 degree C 10 degree F differential over an adjustable temperature range of approximately 60 to 104.4 degrees C 140 to 220 degrees F.] [Provide modulating controllers to control the fuel burning equipment to maintain set boiler water temperature within 2 percent.] [Furnish controller with necessary equipment to automatically adjust the setting to suit the outside weather conditions. Operate the outside air reset controller in such a manner that the operating temperatures required by the boiler manufacturer are not compromised.]

2.4.4 Steam Pressure Controller

****

NOTE: If steam boilers are not utilized the following paragraph will be deleted.

****

Provide controller made of sturdy construction and protect against dust and dampness. Ensure sensing elements of the steam controller are in direct contact with the steam. [Operate fixed position (on-off) and three position (high-low-off) type controllers on a 6.9 kPa 1 pound differential over a pressure range of 0 to 103.4 kPa 0 to 15 psig.] [Modulating controllers must automatically maintain, within 2 percent, the desired steam pressure by regulating the burner.]

2.4.5 Boiler Plant Master Controller

****

NOTE: If only one boiler is utilized, the following paragraph will be deleted. A master controller will be provided for applications involving multiple boilers and for boilers arranged in a modular configuration.

****

Furnish a boiler plant master controller, sensitive to a [temperature transmitter in the return water header for the boiler] [steam pressure transmitter in the boiler steam discharge header] to provide anticipatory signals to all boiler controllers. Boiler controllers must react to anticipatory signals from the plant master controller as necessary in response to the boiler [temperature] [pressure] indication to maintain the preset [temperature] [pressure]. Provide an automatic-manual switch to allow the sequence of boiler loading to be varied to distribute equal firing time on all boilers in the plant. The plant master controller must load the boilers one at a time as the plant load increases.

2.4.6 Boiler Combustion Controls and Positioners

****

NOTE: A pilot is required for all oil fired boilers over 875 kW 3,000,000 Btuh. However, a pilot is recommended for all fired boilers.

Select between fixed rate (on-off), three position (high-low-off), and modulating controls. Combustion controls will be fixed-rate, on-off for gross outputs up to 200 kW 700,000 Btuh; high-low-off or fixed-rate on-off, depending on anticipated load profile, for gross output from 200 to 600 kW 700,000 to 2,000,000 Btuh; high-low-off or modulating, depending on anticipated load profile, for gross output from 600 to 1200 kW 2,000,000 to 4,000,000 Btuh; modulating for gross outputs above 1200 kW 4,000,000 Btuh. Modular boilers will be fixed-rate on-off for each module. Delete inappropriate paragraphs.

****

a. Provide [gas] [combination gas-oil fired] boiler units with [fixed rate (on-off)] [three position (high-low-off)] [modulating] combustion controls with gas pilot or spark ignition. Provide modulating controls with a means for manually controlling the firing rate.

b. Provide oil fired boiler units with [on-off] [high-low-off] [modulating] combustion controls with [direct electric spark ignition system] [spark ignited [No. 2 oil] [natural gas] [liquified petroleum gas] pilot]. Provide modulating controls with a means for manually controlling the firing rate.

c. Accomplish modulating control function positioning type controls. Control air flow ratio and fuel control valve relative positions of operative levers on a jackshaft responding to a [water temperature controller] [steam pressure controller]. Provide positioning type combustion control equipment including draft controls with synchronized fuel feed and combustion air supply controls that maintain the proper air/fuel ratio. Maintain the desired furnace draft within 0.25 mm 0.01 inch of water column.

d. [Fixed rate on-off] [High-low-off] controls for boilers with capacities up to 600 kW 2,000,000 Btuh must use a [water temperature controller in a temperature well in direct contact with the water] [steam pressure controller in direct contact with the steam].

2.4.7 Combustion Safety Controls and Equipment

****

NOTE: Provide feed water regulator with low-water cutoff on close coupled boilers (i.e. short supply and return lines with low pick-up losses) under 1200 kW 4,000,000 Btuh gross output with no process loads. Provide pump controller with low-water cutoff for all other boilers. Low-water cutoff will require a manual reset unless a supplementary low-water cutoff is provided. A supplementary low-water cutoff is required for boilers utilizing a pumped condensate return system. State and local codes may also require supplementary low-water cutoffs. When a supplementary low-water cutoff is provided, it will require manual reset and the initial low-water cutoff will not require manual reset.

Include the manually operated shutoff switch in the controls drawings, set point schedules and plans.

****

Provide combustion safety controls and equipment that are UL listed, microprocessor-based distributed process controller. Include mounting hardware, wiring and cables, and associated equipment. Mount completely wired, programmed, debugged controller, and test to perform all of its functions. Process the signals for complete control and monitoring of the boiler. This includes maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. Document the program and include cross references in description of coils and contacts. Provide microprecessor to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Mount controllers for each boiler on a separate, free standing panel adjacent to the boiler or for packaged boilers on the boiler supporting structure. Provide control systems and safety devices for automatically fired boilers conforming to ASME CSD-1. Provide electrical combustion and safety controls rated at 120 volts, single phase, 60 Hz and connect as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide a 100 mm 4 inch diameter alarm bell and locate where indicated or directed. The alarm bell must ring when the boiler is shut down by any safety control or interlock. Provide indicating lights on the control panel. Use a red light to indicate flame failure, and a green light to indicate that the main fuel valve is open. The following shutdown conditions require a manual reset before the boiler can automatically recycle:

a. Flame failure.

b. Failure to establish pilot flame.

c. Failure to establish main flame.

d. [Low-water] [supplementary low-water] cutoff.

e. [High temperature cutoff] [High pressure cutoff].

2.4.7.1 Low-water Cutoff

****

NOTE: If state or local codes or regulations require a second cutoff, a separate supplementary low-water cutoff of the float type or electrode type may be provided. Delete supplementary low-water cutoff, if second cutoff is not required. Delete feedwater regulator and pump controller for water heating systems.

****

Provide float actuated switch or electrically actuated probe type low-water cutoff. Provide float chamber with a blow-down connection. Cutoff must cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum level. A safety shutdown due to low water must require manual reset before operation can be resumed and prevent recycling of the burner. The cutoff must be in strict accordance to ASME CSD-1.

2.4.7.1.1 Feedwater Regulator with Low-Water Cutoff

Provide regulator of an approved design sized for the application. Provide a regulator for each boiler. Arrange the feeder so that water will be fed to the boiler automatically when the water level in the boiler drops below a preset point and will actuate the alarm bell when the water level reaches the low danger point. Arrange the boiler feeder so that the burner and forced-draft fan will stop whenever the water level drops below a preset danger point. Construct the boiler feeder so that the feedwater valve and seat are isolated from the float chamber to prevent overheating of the feed water and precipitation of scale on either the valve or seat. Construct each float mechanism, valve, and seat of an approved, durable, corrosion-resistant steel alloy. Provide removable and renewable valve seats. Equip regulator with a large, self-cleaning strainer. Use gate or other straight-through type drain valve on the regulator.

2.4.7.1.2 Pump Controller with Low-Water Cutoff

Provide controller of a design approved by the boiler manufacturer. Provide a pump controller for each boiler which is used for space heating and process steam loads or long distribution lines. Control the operation of the burner, forced-draft fan, and pump. Provide pump controller and low-water cutoff with a float-operated mercury switch arranged to start and stop the pump at preset boiler water levels. If the water level in the boiler reaches the low danger point, provide a second mercury switch to shut down the burner and actuate the alarm bell.

2.4.7.1.3 Supplementary Low-Water Cutoff

Provide supplementary low-water cutoff of the [electrically operated probe type] [float activated type] in addition to the low-water cutoff required above on each boiler. Mount supplementary low-water cutoff directly in the boiler shell and set below the low-water cutoff required above.

2.4.7.2 Water Flow Interlock

****

NOTE: Delete this paragraph if a hot water boiler is not utilized.

****

Provide hot water boiler limit controls to include protection for low boiler water flow and high boiler water temperature. Interlock the limit controls with the combustion control system to effect boiler alarm and shutdown. Do not allow boiler startup unless hot water flow is proven.

2.5 PUMPS

2.5.1 Fuel Oil Pumping and Heating Sets

****

NOTE: This paragraph may not be needed if the fuel does not require heating. This paragraph should be coordinated with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS and any burner mounted pump. Select type I: simplex unit or type II duplex unit. Indicate the design requirements of filter/basket strainer located ahead of electric oil heater in order to match characteristics of fuel oil to be utilized. Select single filter/basket strainer for boilers below 60 kW 200,000 Btuh.

****

Provide [simplex] [duplex] and UL approved integrated, shop-fabricated oil pumping and heating set. Provide two positive displacement oil meters. Locate one meter on the fuel supply line. Locate the other meter on the fuel return line. Include an electric oil heater of adequate capacity to heat the specified fuel oil to ignition temperature at low boiler load until enough [hot water] [steam] is generated to operate the heat exchanger in each set. Control the electric heater by magnetic starter with a manually-operated On-Off switch in series with a thermostatic control. When oil temperature is raised to proper level and maintained by the [hot water] [steam] heater, disconnect the electric heater automatically by the thermostatic control. Provide electric-motor-driven fuel pumps. Each pump must have a capacity of no less than [_____] L/s gpm at a discharge pressure of [_____] kPa psig with a suction lift of 3.74 kPa 15 feet. Install a [duplex] [single] filter/basket strainer system ahead of the electric oil heater and final discharge filter/strainer system.

2.5.2 Hot Water and Boiler Circulating Pumps

****

NOTE: Boiler and hot water circulating pumps must be selected at the most efficient point of the pump curve which will generally lie on the sloped portion of the curve.

If separate pumps are not needed to provide water flow to the boilers, delete the requirement for boiler circulating pumps. The flow switch or pressure switch will only be needed for the pump which provides flow through the boiler. Pipe supported pumps are typically available up to 1.5 kw 2HP. Closed-coupled pumps are typically available up to 3.7 kw 5HP.

****

Provide circulating pumps for hot water that are electrically driven single-stage centrifugal type and have a capacity no less than indicated. [Support boiler circulating pumps [on a concrete foundation with a cast iron or structural steel base] [or] [by the piping on which installed] and must be [closed-coupled shaft] [or] [flexible-coupled shaft]. The boiler circulating pumps must be [horizontal split case] [vertical split case] type]. [Support hot water circulating pumps [on a concrete foundation with a cast iron or structural steel base] [or] [by the piping on which installed] and with a [closed-coupled shaft] [or] [flexible-coupled shaft]. The hot water circulating pumps must be [horizontal split case] [vertical split case] type]. Construct pump shaft of corrosion-resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal, and the housing of close-grained cast iron. Use pump seals capable of withstanding 115 degrees C 240 degrees F temperature without external cooling. Provide motor with sufficient power for the service required, of a type approved by the manufacturer of the pump, suitable for the available electric service, and conforming to the requirements of paragraph ELECTRICAL EQUIPMENT. Provide each pump suction and discharge connection with a pressure gauge as specified. Provide the [boiler] [hot water] circulating pump discharge heater with a [flow switch] [pressure switch]. [Use a self-contained swinging vane type flow switch unit to indicate fluid flow.] [Use a self-contained snap action type pressure switch unit to indicate fluid pressure.] Provide switch that is a SPDT with 120-volt, 15-ampere rating.

2.5.3 Condensate Pumping Unit

****

NOTE: If steam is utilized, only one type of condensate return unit will be required; delete either the condensate pumping unit or the vacuum pumping unit. Delete this paragraph if hot water is utilized.

****

Each pump must have a capacity no less than that indicated when discharging against the specified pressure. The minimum capacity of the tank is as indicated. The condensate pumping unit must be the [single] [duplex] [horizontal shaft] [vertical shaft] type as indicated. Provide unit consisting of [one pump] [two pumps] with electric motor drive, and a single receiver, all mounted on a suitable cast-iron or steel base. The motor may be mounted on the top of the receiving tank. Provide centrifugal or turbine type pump, bronze-fitted throughout, with impellers of bronze or other approved corrosion-resisting metal. Ensure pump is free from air binding when handling condensate of temperatures up to 93 degrees C 200 degrees F. Connect pump directly to suitable drip-proof enclosed motors. Receiver must be cast iron or not less than 4.75 mm 3/16 inch thick black iron or steel and provide with all the necessary reinforced threaded openings, including condensate return, vent, overflow, and pump suction connections. Provide inlet strainer either integral in the tank or separate in the inlet line to the tank. Provide galvanized steel vent pipe, and galvanized malleable iron fittings. Extend vent pipe through the roof and properly flash. The pump, motor, and receiving tank may be mounted on a single base with the receiver piped to the pump suctions. Provide a gate valve and check valve in the discharge connection from each pump and provide a strainer and gate valve in the suction line to each pump except where pumps are directly mounted on top of the receiver.

2.5.3.1 Controls for Space Heating Steam Loads Only

****

NOTE: For loads where space heating is only part of the steam load, delete this paragraph.

****

Install an enclosed float switch complete with float mechanisms in the head of the receiver. Control each condensate pump by a float switch which automatically starts the motor when the water in the receiving tank reaches the high level and stops the motor when the water reaches the low level. Provide motors with magnetic across-the-line starters equipped with general-purpose enclosures and three-position, "Manual-Off-Automatic" selector switches in the cover. Provide automatic alternator for duplex units.

2.5.3.2 Space Heating and Steam Loads or Distribution Lines

****

NOTE: For space heating loads only, delete this paragraph.

****

Provide condensate pump with an approved float-actuated valve or water feeder in the cold-water makeup connection either external to or integral with the receiver. Where a de-aerating feedwater heater is not included, control the condensate pumping unit automatically by a pump controller with low-water cutout on each boiler. Provide pump controller and low-water cutout with two float-operated mercury switches arranged to start and stop the condensate pump at preset boiler water levels. Use one switch to control the operation of the condensate pump by starting the pump when the water in the boiler reaches a preset low level and by stopping the pump when the water in the boiler rises to a preset high level. Use the second switch to ring an alarm bell and simultaneously shut down the burner. Provide relays if necessary. Install a minimum 100 mm 4 inch alarm bell with bell-ringing transformer where directed. Install a gate valve and a check valve or a stop-check (nonreturn) valve in the feed line between the boiler and the pump adjacent to the boiler connection. Provide condensate pump motor with a magnetic, across-the-line starter equipped with thermal-overload protection conforming to the requirements of paragraph ELECTRICAL EQUIPMENT. Where two or more boilers are provided, install a pump controller and low-water cutout at the normal waterline of each boiler. Install an automatic feed valve in the feed line to each boiler. When any boiler requires water, the pump controller must open the feed valve by actuating an end switch which, in turn, operates the condensate pump. When the normal water level is restored, the pump controller must close the feed valve, and the end switch of the valve must stop the condensate pump.

2.5.3.3 Rating and Testing

Submit a certified test report covering the actual test of the unit and certifying that the equipment complies with the indicated requirements.

2.5.4 Vacuum Pumping Unit

****

NOTE: Delete this paragraph if hot water is utilized.

****

Provide vacuum pumping unit which is a combination air removal and condensate return unit consisting of [a single pump, electric motor, and receiving tank] [pumps, electric motors, and other functioning parts in duplicate and a single receiving tank] as indicated. Two interconnected single units will be acceptable in place of a duplex unit. Arrange the unit for automatic operation. Where duplicate pumps are used, one pump will serve as a standby. Where it is standard with the manufacturer, separate pumps may be used for air removal and condensate return if both pumps are mounted on a common receiver. Construcy the receiver of cast iron, or of no less than 4.75 mm 3/16 inch thick black iron or steel. Provide bronze pumping unit fitted throughout with bronze shafts or with shafts protected by bronze sleeves. Mount pumps, motors, and receiver on a single base and make provision for catching the drip from the stuffing boxes. Provide accessories consisting of a compound gauge, a pressure gauge inlet strainer, thermometer, water level gauge with stopcocks, adjustable vacuum relief valve, air discharge and condensate discharge check valves, and companion flanges for all flanged connections. Provide discharge line from each pump with a nonslam check valve and a globe valve. Provide each motor with a dripproof-type enclosure. Provide fully automatic controls for each pump motor. Provide controls consisting of a float in the receiving tank, a float switch, an adjustable vacuum switch, an automatic, magnetic, across-the-line type starter with general-purpose enclosure, and a three-position selector switch in the cover. The selector switch must provide for ["Automatic," "Float," "Vacuum,"] ["Automatic," "Float,"] and "Continuous" operation of the pump.

2.6 COLD WATER CONNECTIONS

Provide connections which include consecutively in line a strainer, reduced pressure principle backflow preventers, and water pressure regulator in that order in the direction of the flow. Provide reduced pressure principle backflow preventers as indicated and in compliance with Section 22 00 00 PLUMBING, GENERAL PURPOSE. Make cold water fill connections to the water supply system as indicated. Provide necessary pipe, fittings, and valves required for water connections between the boiler and cold water main as shown. Provide pressure regulating valve of a type that will not stick or allow pressure to build up on the low side. Set the valve to maintain a terminal pressure of approximately 35 kPa 5 psi in excess of the static head on the system and operate within a 15 kPa 2 psi tolerance regardless of cold water supply piping pressure and without objectionable noise under any condition of operation.

2.7 RADIATORS AND CONVECTORS

Provide radiators, convectors and associated equipment in accordance with Section [23 57 10.00 10 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS] [23 58 00.00 10 CENTRAL STEAM HEATING AND UTILITIES

SYSTEMS].

2.8 RADIANT FLOOR HEATING SYSTEMS

****

NOTE: Delete this paragraph if radiant floor heating systems are not required.

Although this specification deals with heating water produced by boilers, other sources of heat such as solar, domestic water heaters, waste heat, or heat pumps may also be used for radiant floor heating.

The radiant floor heating system should be designed in accordance with the latest edition of the ASHRAE Systems and Equipment Handbook, HI-004, and the Radiant Panel Association's (RPA) Standard Guidelines for the Design and Installation of Residential Radiant Panel Heating Systems.

All pipe layouts, zones, pipe sizes, and pump sizes should be clearly shown on the drawings. The designer should provide a cross sectional detail of the integrated floor and piping system that clearly shows the floor design. Floor insulation, floor coverings, floor load bearing characteristics, and manifold access panel should be coordinated with the architect and structural engineer. The method of insulating the floor is different from typical construction. If the insulation is not properly designed, the system will not work.

The drawings should also address the desired control sequence for the radiant heating system. The drawings should indicate which loops will require temperature control, in order for the manufacturer to provide a proper manifold. Various control strategies can be found in HYI 400 and the RPA standard guideline for the Design and Installation of Residential Radiant Panel Heating Systems. The control sequence should consider the required circulation of water through the boiler. High mass radiant floor heating systems do not typically respond quickly to a change in load due to the thermal mass of the floor. Therefore, night setback control is not feasible for high mass floor radiant heating systems, unless long durations of unoccupied spaces occur such as in a chapel.

Radiant floor heating systems use lower water temperatures than standard convection heating. Therefore, the boiler may experience a water temperature that is lower than recommended by the boiler manufacturer. If this occurs due to the design and selection of boiler, a mixing valve or other control devices should be provided to maintain the recommended water temperature for the boiler.

Several floor designs can be used for radiant

heating. The following examples indicate a few possibilities:

Slab-on-grade: typical concrete floor system with tubing imbedded in concrete.

Thin-slab system: tubing imbedded in a thin light weight concrete on top of a wooden sub-floor.

Above floor plate system: tubing installed in channels with reflective metal barriers above a wooden sub-floor. The tubing is then covered with thin sheets of plywood.

Below floor plate system: the tubing is installed below the wooden sub-floor using reflective metal barriers.

Below floor suspended tube system: the tubing is suspended within the interstitial space between a wooden sub-floor and insulation. (Seldom used due to higher water temperature requirements).

Below floor staple-up system: the tubing is stapled to the underside of a wooden sub-floor. This system is available; however, the below floor plate system is more energy efficient.

If outdoor air is required for ventilation, a separate make-up air system should be installed.

In accordance with the Standard Mechanical Code, the temperature of these heating systems should not exceed an operating temperature of 60 degrees C (125 degrees F), when the piping is used in gypsum assemblies.

****

Provide radiant floor heating system including all piping, manifolds, valves, pumps, expansion tank, pressure relief valves, and controls to provide a complete and operational heating system.

2.8.1 Tubing

Use tubing material in compliance with ASTM F876. Provide piping with a factory applied oxygen barrier with a diffusion rate that does not exceed 0.1 grams per cubic meter per day. The piping must be rated at 689 kPa 100 psi and 82.5 degrees C 180 degrees F.

2.8.2 Joints

Consult the manifold manufacturer to determine the proper joint for connection of tubing to the manifold. For joints required to connect the tubing to the manifold, provide compression type fittings using crimp rings, a combination of inserts and O-rings, gripper type fittings using a retainer ring and O-rings, or as otherwise recommended by the manifold and tubing manufacturer.

2.8.3 Manifold

Provide design and construction of the manifold that is compatible with the tubing manufacture's requirements. Provide piping manifold material that is compatible with the piping material. The manifold must be capable of providing the number of circuits as indicated on the drawings. The manifold must be suitable for an operating pressure of 689 kPa 100 psi and 82.5 degrees C 180 degrees F. Provide balancing valves for each circuit. Provide isolation valves for each supply and return connection. Provide each manifold with an air vent. Allow for the measurement of temperature for each circuit. Provide manifold with all required mounting hardware.

2.9 UNIT HEATERS

****

NOTE: Indicate capacity of unit heaters and heating and ventilating units on drawings. Show typical piping details on drawings for these units.

In critical areas where maximum noise level limits are required, the sentence in brackets will be retained and the brackets deleted. The maximum acceptable noise limits for these critical areas will be determined in NC level or dbA and should be indicated on the drawings. The sentence in brackets will be deleted for noncritical areas. Sound values will be selected by the designer based on a study of the design goal. The ASHRAE Handbook, Fundamentals, shows the range of sound pressure values for speech communications as being 50 dB for fair, 44 dB for very good, and 38 dB for perfect speech intelligibility.

****

Provide heaters as specified below, and with a heating capacity not in excess of 125 percent of the capacity indicated. [Noise level of each unit heater for areas noted must not exceed the criteria indicated.]

2.9.1 Propeller Fan Heaters

Design heaters for suspension and arrange for [horizontal] [vertical] discharge of air as indicated. Provide casings consisting of no less than 0.912 mm 20 gauge black steel and finished with lacquer or enamel. Provide suitable [stationary] [rotating air] deflectors to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. [Operate fans for vertical discharge type heaters at speeds not in excess of 1,200 rpm, except that units with 84.4 MJ 80,000 Btu output capacity or less may operate at speeds up to 1,800 rpm.] [Provide horizontal discharge type unit heaters with discharge or face velocities not in excess of the following]:

Unit Capacity, L/s cfm	Face Velocity, m/s fpm
Up to 472 1000	4.06 800
473 to 1416 1,001 to 3,000	4.57 900

Unit Capacity, L/s cfm	Face Velocity, m/s fpm
1417 3001 and over	5.08 1,000

2.9.2 Centrifugal Fan Heaters

Arrange heaters for floor or ceiling mounting as indicated. House heating elements and fans in steel cabinets of sectionalized steel plates or reinforced with angle-iron frames. Construct cabinets of black steel no lighter than 1.27 mm 18 gauge. Provide each unit heater with a means of diffusing and distributing the air. Mount fans on a common shaft, with one fan to each air outlet. Equip fan shaft with self-aligning ball, roller, or sleeve bearings and accessible means of lubrication. Fan shaft may be either directly connected to the driving motor or indirectly connected by adjustable V-belt drive rated at 150 percent of motor capacity. All fans in any one unit heater must be the same size.

2.9.3 Heating Elements

****

NOTE: For project designs requiring air-supply and distribution systems, consider using the optional choice of referencing Section 23 30 00 HVAC AIR DISTRIBUTION for the equipment in this paragraph.

****

[Provide heating coils and radiating fins consisting of suitable nonferrous alloy with [threaded] [brazed] fittings at each end for connecting to external piping. Provide heating elements that are free to expand or contract without developing leaks and properly pitch for drainage. Test elements under a hydrostatic pressure of 1.38 MPa 200 psig and submit a certified report of the test to the Contracting Officer.] [Provide heating coils as specified in Section 23 30 00 HVAC AIR DISTRIBUTION for types indicated.] Ensure coils are suitable for use with water up to 121 degrees C 250 degrees F.

2.9.4 Motors

Provide motors with NEMA MG 1 open drip proof (ODP) [TEFC][_____] enclosure. Motors and motor controls must otherwise be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.9.5 Motor Switches

Provide motors with manual selection switches with "Off," and "Automatic" positions and equip with thermal overload protection.

2.9.6 Controls

Provide controls as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.10 HEATING AND VENTILATING UNITS

Provide heating and ventilating units and associated equipment in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.11 AIR HANDLING UNITS

Provide air handling units and associated equipment in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.12 FITTINGS AND ACCESSORIES

Install boiler fittings and accessories with each boiler in accordance with ASME BPVC SEC IV, unless otherwise specified.

2.12.1 Soot Blowers

****

NOTE: Soot blowers will normally be required on large water tube units burning No. 5 or 6 fuel oil. Manufacturers of boilers should be consulted to determine if soot blowers are applicable for the design contemplated. Small units are usually manually cleaned.

****

Where indicated, provideeach boiler with soot blowers using [compressed air] [steam] as the blowing medium. Provide automatic sequencing and intermittent puff type soot blower system. Sequence the soot blower units automatically using successive steps by their controller, each step involving no more than a 70 kPa 10 psi drop in air pressure at the receiver. After one unit is operated in successive steps through its cycle, the controller must shift the operation to the second soot blower unit, and so on, until all units on that boiler have been operated, after which the controller must be shut down automatically by the sequence controls. Provide soot blower heads with elements of suitable material for the highest temperatures encountered in the boiler. The sequence timer must have provision for manual selection of the soot blower units to be used. Provide soot blower system for oil fired boilers conforming to NFPA 85.

2.12.1.1 Air Compressor Unit

Provide air compressor unit conforming to ASME PTC 10 except as specified otherwise. Do not exceed compressor speed of900 rpm. Do not exceed motor speed of 1750 rpm. Provide service air requirements as indicated with receivers sized as indicated. Provide units that are suitable for heavy-duty service (soot blowing). Use simplex type, single-stage, double-acting compressors, with water-jacketed cylinder, fitted with intake and discharge valves of the lightweight feather, disc or plate type, and provide with necessary controls, water-cooled aftercooler, moisture separator, drive, receiver, relief valves, and cooling water controls as required. Provide compressor air intake with an air suction filter/silencer suitable for outdoor installation. The filter must have a collection efficiency of 99 percent of particles larger than 10 microns. The filter body and media must withstand a pressure of 850 kPa 125 psi. Provide shell-and-tube type aftercooler designed for air flow through the tubes with steel shell internal baffle plates. Size the cooling capacity of the after cooler for the total capacity of the compressor. Provide moisture separator with an automatic water discharge trap and level gauge. Provide thermostatic valve type cooling water controls for regulating compressor cylinder water temperature and after-cooler water temperature and install with a three-valve bypass in the water outlet lines ahead of open sight drain funnels. Equip compressor with adjustable, pressure type unloader controls suitable for continuous compressor operation.

2.12.1.2 Air Receiver

Provide a vertical type air receiver constructed in accordance with ASME BPVC SEC VIII D1 for unfired pressure vessels for 1379 kPa 200 psi working pressure, and equipd with flanged inlet and outlet connections, valved drain connection, minimum 150 mm 6 inch dial pressure gauge, pop safety valves, and regulator connections.

2.12.2 Continuous Emissions Monitoring

****

Emerging flue gas flow monitor technologies are available. The traditional differential pressure technique specified used familiar equipment that can be maintained by plant personnel. This type of measurement device has reliably satisfied regulatory requirements. The possible use of other technologies should include a thorough investigation of flue gas flow monitor regulatory requirements and inhouse maintenance capabilities.

****

a. Provide Continuous Emissions Monitoring System (CEMS) equipment as a system by a single manufacturer. Provide a CEMS, meeting the requirements of applicable federal, State of [_____] and local regulations, for each boiler in accordance with manufacturer's recommendations and under the direct supervision of the CEMS equipment manufacturer. Before acceptance of the installation, furnish the Contracting Officer a written test report which provides documentation that the CEMS equipment passed factory and field certification test required by federal, state, and local regulations. Submit written certification by the boiler manufacturer that each boiler furnished complies with Federal, state, and local regulations for emissions. Also include a description of applicable emission regulations. If any boiler is exempt from the emission regulations, indicate the reason for the exemption in the certification.

b. Include [sulfur dioxide (SO2)] [oxides of nitrogen (NOX)] [carbon dioxide (CO2)] [and] [particulate matter (PM)] and other information required by Federal, state, and local regulations in the reported data. Base SO2 reporting on [analyzer measurement] [fuel flow and percent sulfur calculation]. Base nitrous oxides, carbon dioxide and particulate matter reporting on analyzers.

c. The CEMS equipment includes the central processing unit, printer, hard disk drive, and floppy disk drive. The floppy disk drive must function as a recorder. The manufacturer must provide the software to generate the required reports in a format acceptable to the Federal, state and local regulatory agencies. Provide operator interface to the CEMS equipment via CRT screen.

2.12.2.1 Gaseous Emission Monitors

Provide extractive or in situ gaseous monitors. A combination of extractive and in situ monitors is not acceptable. Include automatic calibration checks for gas monitors. Provide an alarm horn and annunciator to alarm when any monitor parameter is out of range or a gaseous monitor malfunctions. Construct surfaces that are exposed to the corrosive gas of the boiler of noncorrosive materials such as 316 SS, teflon or hastelloy.

a. Mount in situ monitor on the ductwork at the location [shown on the plans] [recommended by the manufacturer]. The situ system must not be affected by the presence of particulate matter in the flue gas.

b. Provide [wet] [dry] [diluted] extractive systems. Locate analyzing equipment for the extractive system in a walk-in cabinet. Arrange the equipment to provide access for maintenance. Heat trace extractive system sampling between the probes and the analyzers to maintain the temperature recommended by the manufacturer when the ambient temperature is [_____] degrees C F. Mount probes on the ductwork at the location [shown on the plans] [recommended by the manufacturer].

2.12.2.2 Flue Gas Flow Monitor

Flue gas flow monitor must utilize the pitot tube principle to measure the flow. Provide an across-the-duct-average pitot tube probe and design and locate to obtain representative measurement. Use differential pressure transmitters to sense the difference between the static and total pressure of the flowing gas steam. Ensure calibrations are stable. Arrange lines to prevent collection of condensate. Provide a purge system as required to keep the pitot pressure taps clear.

2.12.2.3 Particulate Matter Monitor

Provide particulate matter (opacity) monitor based on the principle of transmissometry. Provide transmissometer with automatic simulation of zero opacity and upscale check of calibration while the boiler is in service without dismounting the unit. Include analyzer internal circuitry and electronic circuitry in calibration check. Provide an alarm horn and annunciator to annunciate excess opacity and any system malfunction. Provide units with fans to keep the sending and receiving lenses pressurized and blown clean at all times.

2.12.2.4 Wiring

Provide CEMS equipment with plug-in prefabricated cable for interconnection between components. Provide 2-wire, 120 volt nominal or less, 60 Hz, power supply to the equipment with one side grounded. Connect electrical devices as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.12.3 Tankless Water Heater

****

NOTE: If the system will not be used to heat domestic hot water delete this paragraph.

****

Install a seamless copper immersion type tankless water heater of the specified capacity in the boiler. Equip the heater with an approved water-tempering valve which is set to supply hot water at approximately 60 degrees C 140 degrees F. Instead of the immersion type coil, an approved external shell and tube type or plate type heat exchanger may be installed as specified in Section 23 57 10.00 10 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS.

2.12.4 Conventional Breeching and Stacks

****

NOTE: Delete this paragraph for condensing boilers.

****

2.12.4.1 Breeching

Connect each boiler to the stack or flue by breeching constructed of black steel sheets no less than 1.2 mm 0.0478 inch thick nor less than thickness of stack, whichever is larger. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. The clear distance between any portion of the breeching surface and any combustible material must not be less than that specified in NFPA 211. Fasten joints and seams securely and make airtight. Provide suitable hinged and gasketed cleanouts, which will permit cleaning the entire smoke connection without dismantling. Provide flexible-type expansion joints as required and do not require packing.

2.12.4.2 Stacks

****

NOTE: Frequently boiler outlets are designed to support no more than the weight of a 6 m 20 foot stack section, when installed directly above the boiler outlet. Ensure that the stack is properly supported.

****

[Extend individual stub stacks above the roof to the heights indicated. Use individual stub stacks that are [6] [_____] m [20] [_____] feet in height when assembled on the boiler and measured from the ground line. Provide sheet steel stack section having a thickness of no less than 2.47 mm 0.0972 inch.] [Extend prefabricated double wall stacks system above the roof to the height indicated. Provide stacks that are [6] [_____] m [20] [_____] feet in height when assembled on the boiler and measured from the ground line. Provide inner stack consisting of [304 stainless steel] [316 stainless steel] having a thickness of no less than 0.89 mm 0.035 inch. Provide outer stack consisting of sheet steel having a thickness of no less than 0.635 mm 0.025 inch. Incorporate a method of maintaining concentricity between the inner and outer stacks. Seal the joints between the stack sections to prevent flue gas leakage.] Provide a 7.92 mm 0.3125 inch diameter hole in the stack no greater than 150 mm 6 inches from the furnace flue outlet for sampling of the exit gases. Provide a method to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Provide each stack complete with rain hood. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.12.5 Direct Vents

****

NOTE: Delete this paragraph if condensing boilers are not used. A conventional stack is not needed for condensing boilers due to the low exhaust air temperature. Precautions should be taken due to the acidic condition of the condensate. The location and size of the vents should be shown on the drawings. Consult NFPA 54, UL 1738, and available

vendor data to design the vents. The vents can be mounted on the roof or exterior wall with proper separation. The vents should be extended above the typical snow level. Vents should be located in such a manner as to prevent vandalism and to prevent discharge of condensate across walkways.

****

Use direct venting for condensing type boilers. Size and locate the air intake and exhaust vents as indicated on the drawings and as recommended by the boiler manufacturer. Provide a separate combustion air intake vent and exhaust vent for each boiler.

2.12.5.1 Combustion Air Intake Vent

Construct the combustion air intake piping of Schedule 40 PVC in accordance with ASTM D1784. Provide vent that is suitable for the temperature at the boiler combustion air intake connection point. Provide each intake complete with bird screen.

2.12.5.2 Exhaust Vent

Construct the exhaust vent piping of Schedule 40 CPVC or stainless steel conforming to UL 1738 and the boiler manufacturer's recommendations. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. Provide exhaust vent that is suitable for the maximum anticipated boiler exhaust temperature and withstands the corrosive effects of the condensate. Provide a 8 mm 0.3125 inch diameter hole in the stack no greater than 152 mm 6 inches from the boiler flue outlet for sampling of the exit gases. Provide a method to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Provide each exhaust stack complete with bird screen.

2.12.6 Expansion Tank

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NOTE: If a hot water heating system is not utilized delete this paragraph.

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Provide hot water pressurization system including a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system will be the permanent sealed-in air cushion contained in the diaphragm-type tank. Provide sizes as indicated. Provide welded steel expansion tank, constructed, tested, and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of [850] [_____] kPa [125] [_____] psi and precharged to the minimum operating pressure. Fit the tank's air chamber with an air charging valve and pressure gauge. Support the tank by steel legs or bases for vertical installation or steel saddles for horizontal installations. Provide lifting rings and a drain connection for the tank. All components must be suitable for a maximum operating temperature of 120 degrees C 250 degrees F.

2.12.7 Air Separator

Provide steel external air separation tank, constructed, tested and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of [850] [_____] kPa [125] [_____] psi. The capacity of the air separation tank indicated is minimum.

2.12.8 Filters

Provide filters conforming to ASHRAE 52.2.

2.12.9 Foundation (Setting) Materials

2.12.9.1 Firebrick

Provide ASTM C27 class firebrick as recommended by boiler manufacturer.

2.12.9.2 Tile

Provide ASTM C34, Grade LBX tile.

2.12.9.3 Insulating Brick

Provide insulating brick complying with ASTM C155.

2.12.9.4 Refractory Mortar

Provide refractory mortar complying with ASTM F1097.

2.12.9.5 Castable Refractories

Castable refractories must be ASTM C401. The minimum modulus of rupture for transverse strength must be no less than 4136 kPa 600 psi after being heat soaked for 5 hours or more at a temperature in excess of 1371 degrees C 2500 degrees F.

2.12.10 Steel Sheets

2.12.10.1 Galvanized Steel

Galvanized steel must be ASTM A653/A653M.

2.12.10.2 Uncoated Steel

Use uncoated steel which is composition, condition, and finish best suited to the intended use.

2.12.11 Gaskets

Provide gaskets consisting of nonasbestos material in accordance with ASME B16.20, full face or self-centering type. Provide gaskets spiral wound type gaskets with graphite filler material.

2.12.12 Steel Pipe and Fittings

2.12.12.1 Steel Pipe

Steel pipe must be ASTM A53/A53M, Type E or S, Grade A or B, black steel, standard weight.

2.12.12.2 Steel Pipe Fittings

Affix the manufacturer's trademark to fittings in accordance with MSS SP-25 to permanently identify the manufacturer.

2.12.12.3 Steel Flanges

Provide flanged fittings including items such as flanges, bolts, nuts, bolt patterns, in accordance with ASME B16.5 class 150 and have the manufacturer's trademark affixed in accordance with MSS SP-25. Provide flange material conforming to ASTM A105/A105M. Use serrated or raised-face type flanges for high temperature water systems. Provide blind flange material conforming to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Provide high strength or intermediate strength bolts with material conforming to ASTM A193/A193M. Submit written certification by the bolt manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

2.12.12.4 Welded Fittings

Provide welded fittings conforming to ASTM A234/A234M with WPA marking. Provide buttwelded fittings conforming to ASME B16.9, and socket-welded fittings conforming to ASME B16.11.

2.12.12.5 Cast-Iron Fittings

Provide ASME B16.4, Class 125, type fittings required to match connecting piping.

2.12.12.6 Malleable-Iron Fittings

Provide ASME B16.3, type fittings as required to match connecting piping.

2.12.12.7 Unions

Provide ASME B16.39, Class 150 unions.

2.12.12.8 Threads

Provide pipe threads conforming to ASME B1.20.2MASME B1.20.1.

2.12.12.9 Grooved Mechanical fittings

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NOTE: Grooved mechanical fittings will not be allowed for steam piping or condensate piping or hot water piping above 110 degrees C 230 degrees F.

****

Design joints and fittings for no less than[862 kPa 125 psig] [_____] service, and ensure joints and fittings are the products of the same manufacturer. Provide ductile iron fitting and coupling houses conforming to ASTM A536. Provide molded synthetic rubber gaskets with central cavity, pressure responsive configuration and conforming to ASTM D2000 for circulating medium up to 110 degrees C 230 degrees F. Provide grooved joints conforming to AWWA C606. Provide steel coupling nuts and bolts conforming to ASTM A183.

2.12.13 Copper Tubing and Fittings

2.12.13.1 Copper Tubing

Provide ASTM B88M ASTM B88, Type K or L tubing. Use brass or bronze adapters for copper tubing for brazed fittings.

2.12.13.2 Solder-Joint Pressure Fittings

Provide wrought copper and bronze solder-joint pressure fittings conforming to ASME B16.22 and ASTM B75/B75M. Provide cast copper alloy solder-joint pressure fittings conforming to ASME B16.18 and ASTM B828.

2.12.13.3 Flared Fittings

Provide cast copper alloy fittings for flared copper tube conforming to ASME B16.26 and ASTM B62.

2.12.13.4 Adapters

Adapters may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.12.13.5 Threaded Fittings

Provide cast bronze threaded fittings conforming to ASME B16.15.

2.12.13.6 Brazing Material

Use brazing material conforming to AWS A5.8/A5.8M.

2.12.13.7 Brazing Flux

Provide paste or liquid form flux appropriate for use with brazing material. Flux must be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides, and contain fluorides. Use silver brazing materials in accordance with AWS A5.8/A5.8M.

2.12.13.8 Solder Material

Provide solder metal conformig to ASTM B32 95-5 tin-antimony.

2.12.13.9 Solder Flux

Flux must be either liquid or paste form, non-corrosive and conform to ASTM B813.

2.12.13.10 Grooved Mechanical Fittings

****

NOTE: Grooved mechanical fittings will not be allowed for steam piping or condensate piping or hot water piping above 110 degrees C 230 degrees F.

****

Design joints and fittings for no less than [862 kPa 125 psig] [_____] service, and ensure joints and fittings are the products of the same manufacturer. Provide ductile iron fitting and coupling houses conforming to ASTM A536. Provide molded synthetic rubber gaskets with central cavity, pressure responsible configuration and conforming to ASTM D2000, for circulating medium up to 110 degrees C 230 degrees F. Provide grooved joints conforming to AWWA C606. Provide steel coupling nuts and bolts conforming to ASTM A183.

2.12.14 Dielectric Waterways and Flanges

Provide dielectric waterways that have temperature and pressure rating equal to or greater than that specified for the connecting piping. Provide waterways with metal connections on both ends suited to match connecting piping. Include dielectric unions to prevent current flow between dissimilar metals. Use dielectric flanges meeting the performance requirements described herein for dielectric waterways.

2.12.15 Flexible Pipe Connectors

Design flexible pipe connectors for 861.8 kPa 125 psi or 1034.2 kPa 150 psi service. Install connectors where indicated. Construct the flexible section of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Use materials and configuration suitable for the pressure, vacuum, and temperature medium. The flexible section must be suitable for service intended and may have threaded, welded, soldered, flanged, or socket ends. Equip flanged assemblies with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors must be as recommended by the manufacturer for the service intended. Provide internal sleeves or liners, compatible with circulating medium, when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.12.16 Pipe Supports

Provide pipe supports conforming to MSS SP-58.

2.12.17 Pipe Expansion

2.12.17.1 Expansion Loops

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NOTE: Whenever possible, utilize expansion loops, offsets, and bends instead of expansion joints to absorb and to compensate for expansion and contraction. Coordination will be made with seismic bracing. Seismic bracing should not interfere with thermal expansion.

****

Expansion loops and offsets must provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. Provide cold-sprung loops and offsets and install where indicated. Provide pipe guides and anchors as indicated.

2.12.17.2 Expansion Joints

Expansion joints must provide for either single or double slip of the connected pipes, as required or indicated, and for no less than the transverse indicated. Design joints for a [hot water] [steam] working pressure no less than [_____] kPa psig and in accordance with applicable requirements of EJMA Stds and ASME B31.1. Provide flanged end connection. Providee anchor bases or support bases as indicated or required. Sliding surfaces and water wetted surfaces must be chromium plated or fabricated of corrosion resistant steel. Make initial setting in accordance with the manufacturer's recommendations to compensate for an ambient temperature at time of installation. Install pipe alignment guides as recommended by the joint manufacturer, but in any case do not install pipe alignment guides more than 1.5 m 5 feet from expansion joint, except in lines 100 mm 4 inches or do not install smaller guides more than 600 mm 2 feet from the joint. Provide service outlets where indicated.

2.12.17.2.1 Bellows-Type joint

Provide bellows-type joints that are flexible, guided expansion joints. Provide expansion element consisting of stabilized corrosion resistant steel. Provide bellows-type expansion joints conforming to the applicable requirements of EJMA Stds and ASME B31.1 with internal lines. Guiding of piping on both sides of expansion joint must be in accordance with the published recommendations of the manufacturer of the expansion joint. Design joints for the working temperature and pressure suitable for the application but no less than 1135 kPa 150 psig.

2.12.17.2.2 Flexible Ball Joint

Construct flexible ball joints of alloys as appropriate for the service intended. Provide threaded, grooved, flanged, or welded end joints as required that are capable of absorbing the normal operating axial, lateral, or angular movements or combination thereof. Provide polished, chromium-plated balls and sockets when materials are not of corrosion-resistant steel. Design and construct ball type joint in accordance with ASME B31.1 and EJMA Stds. Provide flanges conforming to the diameter and drilling of ASME B16.5. Provide molded gaskets suitable for the service intended.

2.12.17.2.3 Slip Type Expansion Joint

Provide EJMA Stds and ASME B31.1, Class 1 or 2 slip type expansion joints. Provide Type II joints which are suitable for repacking under full line pressure.

2.12.18 Valves

Provide Class 125 valves that are suitable for the application. Grooved ends in accordance with AWWA C606 may be used for water service only. Provide valves in nonboiler external piping meeting the material, fabrication and operating requirements of ASME B31.1. The connection type of all valves must match the same type of connection required for the piping on which installed.

2.12.18.1 Gate Valves

Provide gate valves 65 mm 2-1/2 inches and smaller conforming to MSS SP-80 bronze rising stem, threaded, solder, or flanged ends. Provide gate valves

80 mm 3 inches and larger conforming to MSS SP-70 cast iron bronze trim, outside screw and yoke, flanged, or threaded ends.

2.12.18.2 Globe Valves

Provide globe valves 65 mm 2-1/2 inches and smaller conforming to MSS SP-80, bronze, threaded, soldered, or flanged ends. Provide globe valves 80 mm 3 inches and larger conforming to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.12.18.3 Check Valves

Provide check valves 65 mm 2-1/2 inches and smaller conforming to MSS SP-80, bronze, threaded, soldered, or flanged ends. Provide check valves 80 mm 3 inches and larger conforming to MSS SP-71, cast iron, bronze trim, flanged, or threaded ends.

2.12.18.4 Angle Valves

Provide angle valves 65 mm 2-1/2 inches and smaller conforming to MSS SP-80 bronze, threaded, soldered, or flanged ends. Provide angle valves 80 mm 3 inches and larger conforming to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.12.18.5 Ball Valves

Provide ball valves 15 mm 1/2 inch and larger conforming to [MSS SP-72] [or] [MSS SP-110], ductile iron or bronze, threaded, soldered, or flanged ends.

2.12.18.6 Plug Valves

Provide plug valves 51 mm 2 inch and larger conforming to MSS SP-78. Provide plug valves smaller than 51 mm 2 inch conforming to ASME B16.34.

2.12.18.7 Grooved End Valves

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NOTE: Grooved end valves will not be allowed for steam piping.

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Valves with grooved ends in accordance with AWWA C606 may be used if the valve manufacturer certifies that their performance meets the requirements of the standards indicated for each type of valve.

2.12.18.8 Balancing Valves

Provide balancing valves that have meter connections with positive shutoff valves. Provide an integral pointer to register the degree of valve opening. Calibrate valves so that flow rate can be determined when valve opening in degrees and pressure differential across valve is known. Construct each balancing valve with internal seals to prevent leakage and supply with preformed insulation. Provide valves that are suitable for 120 degrees C 250 degrees F temperature and working pressure of the pipe in which installed. Provide valve bodies with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. Provide pipe extensions with quick connecting hose fittings for a portable meter to measure the pressure differential. Furnish one portable differential meter. Provide meter suitable for the operating pressure specified complete with hoses, vent, and shutoff valves, and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.

2.12.18.9 Automatic Flow Control Valves

****

NOTE: In any facility where technological and occupancy requirements indicate that load imbalances cannot be tolerated and there is a need for automatic control ensuring constant hydronic flow, the design will incorporate automatic flow-control valves indicating their location and capacity on the drawings. The required pump head will be shown on the drawings.

Utilize electric motor controls for new systems; thus, delete bracketed selection "or pneumatic type as applicable" for projects involving new systems.

****

In lieu of the specified balancing valves, automatic flow control valves may be provided to maintain constant flow and designed to be sensitive to pressure differential across the valve to provide the required opening. Select valves for the flow required and provide with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Control the flow within 5 percent of the tag rating. Ensure valves are suitable for the maximum operating pressure of 850 kPa 125 psi or 150 percent of the system operating pressure, whichever is greater. Where the available system pressure is not adequate to provide the minimum pressure differential that still allows flow control, increase the system pump head capability. Ensure alves are suitable for 120 degrees C 250 degrees F temperature service. Use vavlve materials that are the same as specified for the heating system check, globe, angle, and gate valves. Provide electric motor type[or pneumatic type as applicable] valve operator. Provide valve operator that is capable of positive shutoff against the system pump head. Provide valve bodies with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. Provide pipe extensions with quick connecting hose fittings for a portable meter to measure the pressure differential across the automatic flow control valve. Provide a portable meter with accessory kit as recommended for the project by the automatic valve manufacturer.

2.12.18.10 Butterfly Valves

Provide 2-flange type or lug wafer type butterfly valves, and make bubbletight at 1135 kPa 150 psig. Provide valve bodies consisting of cast iron, malleable iron, or steel. Provide ASTM A167, Type 404 or Type 316, corrosion resisting steel stems, bronze, or corrosion resisting steel discs, and synthetic rubber seats. Valves smaller than 200 mm 8 inches must have throttling handles with a minimum of seven locking positions. Valves 200 mm 8 inches and larger must have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Provide valves in insulated lines with extended neck to accommodate insulation thickness.

2.12.18.11 Drain valves

Provide drain valves at each drain point of blowdown as recommended by the boiler manufacturer. Provide piping conforming to ASME BPVC SEC IV and ASTM A53/A53M.

2.12.18.12 Safety Valves

Provide safety valves with steel bodies and equip with corrosion-resistant trim and valve seats. The valves must be properly guided and positive closing so that no leakage can occur. Adjustment of the desired back-pressure must cover the range between 15 and 70 kPa 2 and 10 psig. Make the adjustment externally, and provide any shafts extending through the valve body with adjustable stuffing boxes having renewable packing. Install boiler safety valves of proper size and of the required number, in accordance with ASME BPVC SEC IV, so that the discharge will be through piping extended [to the blowoff tank] [to a location as indicated]. [Provide each discharge pipe for steam service with a drip pan elbow to prevent accumulation of water on the valve. Provide a slip joint between drip pan elbow and riser.] [Pitch each discharge pipe for hot water service away from the valve seat.]

2.12.19 Strainers

Provide basket and "Y" type strainers which are the same size as the pipelines in which they are installed. Provide strainer bodies that are heavy and durable, fabricated of cast iron, and drill and tap bottoms with a gate valve attached for blowdown purposes. Design strainers for [_____] kPa psig service and [_____] degrees C degrees F. Clearly cast arrows on the sides of bodies indicating the direction of flow. Equip each strainer with an easily removable cover and sediment screen. Make the screen of 0.795 mm 22 gauge thick [brass sheet] [monel] [corrosion-resistant steel] with small perforations numbering not less than 6,150/square m 400/square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow must be into the screen and out through the perforations.

2.12.20 Pressure Gauges

Provide gauges conforming to ASME B40.100 with throttling type needle valve or a pulsation dampener and shutoff valve. Provide minimum dial sizeof 90 mm 3-1/2 inches. Provide a pressure gauge for each boiler in a visible location on the boiler. Provide pressure gauges with readings in kPa psi. Provide pressure gauges with an indicating pressure range that is related to the operating pressure of the fluid in accordance with the following table:

Operating Pressure (kPa) (psi)	Pressure Range (kPa) (psi)
519-1030 76-150	0-1400 0-200
105-518 16-75	0-690 0-100
14-104 2-15	0-210 0-30 (retard)

2.12.21 Thermometers

Provide thermometers with wells and separable corrosion-resistant steel sockets. Do not use mercury in thermometers. Provide thermometers for [inlet water and outlet water for each hot water boiler] [the feedwater for each steam boiler] in a visible location on the boiler. Provide thermometers with brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a minimum 225 mm 9 inch scale. The operating range of the thermometers must be 0-100 degrees C 32-212 degrees F. Provide thermometers with readings in degrees C F.

2.12.22 Air Vents

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NOTE: Air vent locations will be indicated on drawings; distinguish between manual and automatic air vents.

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2.12.22.1 Manual Air Vents

Manual air vents must be brass or bronze valves or cocks suitable for the pressure rating of the piping system and furnished with threaded plugs or caps.

2.12.22.2 Automatic Air Vents

Automatic air vents must be 19 mm 3/4 inch quick-venting float and vacuum air valves. Provide each air vent valve with a large port permitting the expulsion of the air without developing excessive back pressure, a noncollapsible metal float which will close the valve and prevent the loss of water from the system, an air seal that will effectively close and prevent the re-entry of air into the system when subatmospheric pressures prevail therein, and a thermostatic member that will close the port against the passage of steam from the system. Clearly stamp the name of the manufacturer on the outside of each valve. Ensure the air vent valve is suitable for the pressure rating of the piping system.

2.12.23 Steam Traps

****

NOTE: The design engineer, when designating steam using equipment or special steam applications, will indicate the type of steam trap required in accordance with the following data:

a. Inverted Bucket Traps: This type of trap continuously vents air and carbon dioxide at steam temperature and is recommended for modulating loads. The bucket floats on steam to close the outlet and sinks into condensate to open the condensate outlet. Any trapped air is discharged first into the condensate return line and is followed by condensate discharge. This type of trap has the longest life on systems under modulated control. When large amounts of air are anticipated, an external thermostatic air vent should be installed on a line bypassing the trap to bleed air

from the steam line and discharge it to the condensate return line. This system will give optimum performance at low steam pressures with maximum dependability. These traps will handle condensate from fan coil units where condensate must be lifted to return lines located above the equipment. They operate best at near full load conditions where loads do not vary over a wide range. Before operation, traps must be primed by filling them with water.

b. Vertical Open-Top Bucket Trap: Trap construction is more complex than inverted bucket type but is suitable for applications having wide variation of load and pressure and is recommended for constant pressure systems. Bucket sinks into condensate when condensate reaches top of trap and the discharge port opens. After discharge, the bucket floats on incoming condensate keeping the discharge port closed.

c. Impact-Operated Traps: These traps depend on steam velocity to keep the disc closed. As steam velocity decreases, the disc lifts off the seat and allows flow of condensate. These traps allow some steam leakage and do not vent air at low pressure. They are not recommended for service lower than 69 kPa (10 psig) or where back pressure may exceed 50 percent of inlet pressure. These traps are less expensive and have poor performance in the presence of dirt.

d. Thermostatic Traps: These traps are bellows-actuated and contraction of bellows at a few degrees below saturated steam pressure allows condensate air and noncondensable gases to be discharged. As steam reaches the bellows the expansion of the bellows closes the discharge port. These traps can also be utilized to vent air from a steam system and can be used in conjunction with an inverted bucket steam trap previously described.

e. Float and Thermostatic Trap: These traps provide optimum performance on modulating systems at lowest first cost. Where steam pressures modulate down to zero, large amounts of air may be liberated. They are ideal for dripping ends of steam risers, heels of up-feed steam risers, bottoms of down-feed stem risers. These traps are also ideal for fan coil units and unit heaters.

f. Any trap selected must be sized for the expected condensate load with an applicable safety factor applied for the particular type of equipment serviced. Manufacturer's application manuals should be consulted to assist in sizing traps. Safety factors vary from 2:1 to 10:1. An average 3:1 safety factor value will cover most applications.

g. Service life between repairs or replacement of traps may be a determining factor in the choice of traps. One manufacturer of all types of traps offers the following experience record:

Type of Trap	**Average Service Life Between Replacement or Repairs (months)**
Inverted bucket traps	**42**
Float and thermostatic traps	**24**
Thermostatic traps	**24**
Impact-operated traps	**19**

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2.12.23.1 Thermostatic Traps

Provide thermostatic traps conforming to the requirements of ASTM F1139 and install in the return connection from each radiator and elsewhere as indicated. Install drip traps for mains, risers, and similar lines with a cooling leg of 1.50 m 5 feet of uncovered 19 mm 3/4 inch pipe. Base capacity of traps a pressure differential of 15 kPa 2 psi. Design traps for a steam working pressure of 100 kPa 15 psig but operate with a supply pressure of approximately 15 kPa 2 psig. The traps must be angle or straight-through pattern with union inlet connections as indicated. Provide brass trap bodies and covers. Valve mechanisms and seats must be monel, stainless steel or hard bronze and removable for servicing or replacement.

2.12.23.2 Float-and-Thermostatic Traps

Provide float-and-thermostatic traps conforming to the requirements of ASTM F1139 and design for a steam working pressure of 100 kPa 15 psig but operate with a supply pressure of approximately 34 kPa 5 psig. Base trap capacity on a pressure differential of 15 kPa 2 psig. Provide each float-and-thermostatic trap with a cast iron body and provide with a hard bronze, monel, or corrosion-resisting steel valve seat and mechanism, an open- or closed-type float of brass or equally corrosion-resistant metal, and a corrosion-resisting steel thermostatic air vent, all of which can be easily removed for inspection or replacement without disturbing the piping connections. The inlet to each trap must have a brass or stainless steel strainer, either as an integral part of the trap or as a separate item of equipment.

2.12.23.3 Inverted Bucket Traps

Provide inverted bucket traps conforming to the requirements of ASTM F1139 and design for a steam working pressure of 100 kPa 15 psig but operate with a supply pressure of approximately 35 kPa 5 psig. Provide each trap with a cast iron body and a corrosion-resistant steel valve and seat and a brass or corrosion-resistant steel bucket, all of which can be easily removed for inspection or replacement without disturbing the piping connections. The inlet to each trap must have a brass or stainless steel strainer, either as an integral part of the trap or as a separate item of equipment.

2.13 ELECTRICAL EQUIPMENT

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NOTE: Select standard efficiency for motors used less than 750 hours per year and high efficiency for motors used over 750 hours per year. The efficiency of each motor will be indicated in the equipment schedules.

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Provide electric motor-driven equipment complete with motors, motor starters, and necessary control devices. Provide electrical equipment, motor control devices, motor efficiencies and wiring as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ensure motors which are not an integral part of a packaged boiler and which are integral in size are the premium efficiency type in accordance with NEMA MG 1. Ensure motors which are an integral part of the packaged boiler are the highest efficiency available by the manufacturer of the packaged boiler. Provide motor starters complete with properly sized thermal overload protections and other appurtenances necessary for the motor control specified. Furnish starters in [general purpose][watertight][explosion-proof, Class I, division I] enclosures. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices that are not shown.

2.13.1 Motor Ratings

Motors must be suitable for the voltage and frequency provided. Motors 375 W 1/2 hp and larger must be three-phase, unless otherwise indicated. Provide motors of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating on the motor.

2.13.2 Motor Controls

****

NOTE: Coordinate motor controls properly with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Coordinate with the electrical designer for power factors, service factors, and desired type of control.

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Provide motor controllers complete with properly sized thermal overload protection. Provide manual or automatic control and protective or signal devices required for the operation specified and any wiring required to such devices. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Utilize solid state variable speed controllers for fractional through 7.46 kW 10 hp ratings. Use adjustable frequency drives for larger motors.

2.14 INSULATION

Use shop and field-applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15 TOOLS

Furnish special tools. Include uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems, and other equipment. Furnish small hand tools within a suitable cabinet, mounted where directed.

2.15.1 Breeching Cleaner

Provide a cleaner to clean the breeching. The cleaner must have a jointed handle of sufficient length to clean the breeching without dismantling.

2.15.2 Tube Cleaner

If a watertube boiler is being furnished, provide a water-driven tube cleaner with three rotary cutters and rotary wire brush complete with the necessary length of armored water hose, valves, and other appurtenances necessary for operation. Provide tube cleaner and rotary brush for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Provide necessary valves and fittings to permit ready connection of the cleaner hose to a high-pressure pump for cold water supply to operate the cleaner.

2.15.3 Tube Brush

If a firetube boiler is being furnished, provide a tube brush, with steel bristles and jointed handle of sufficient length to clean full length of firetubes.

2.15.4 Wrenches

Provide wrenches as required for specialty fittings such as manholes, handholes, and cleanouts. Provide one set of extra gaskets for all manholes and handholes, for pump barrels, and other similar items of equipment. Package and properly identify gaskets.

2.16 FUEL OIL STORAGE SYSTEM

Provide fuel oil storage system as specified in Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS unless noted otherwise. Provide a [helical wound coil constructed of 25 mm 1 inch seamless steel tubing] [platecoil suction bell heater constructed of carbon steel no lighter than 1.9 mm (14 gauge) 14 gauge] in each tank for No. 6 fuel oil and install around the suction end of the oil line. Provide coil in each tank with capacity to heat the fuel oil from [_____] to [_____] degrees C degrees F, during the maximum demand of all oil burners connected to the tank. The coil must utilize [steam at [_____] kPa psig] [hot water at [_____] degrees C degrees F] as the heating medium. Attach the heating coil inlet and outlet connections and the fuel-oil suction and return piping connections to the same tank manway cover. Provide an additional manhole located above the heater for removal of the heater as a unit.

2.17 BOILER WATER TREATMENT

****

NOTE: The chemical piping will be indicated on the drawing. Piping for external chemicals will be connected to the boiler feedwater. Piping for internal chemicals will be connected to the boiler drum. If steam is used for cooking or humidification, a separate heat exchanger will be required due to environmental constraints with the

use of amines. The following items will not be required for hot water boilers: water softening system, chemical feed pumps, tanks, injection assemblies, water meters, water treatment control panel, and sequence of operation. The chemical shot feeder will not be required for steam boilers.

****

Submit [six] [_____] complete copies of the proposed water treatment plan. Include a layout, control scheme, a list of the existing water conditions including the items listed in this paragraph, a list of all chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals. The water treatment system must be capable of feeding chemicals and bleeding the system to prevent corrosion and scale within the boiler and piping distribution system. Submit [6] [_____] complete copies of operating and maintenance manuals for the step-by-step water treatment procedures, including procedures for testing the water quality. Treat the water to maintain the conditions recommended by the boiler manufacturer. Provide chemicals meeting required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. Use the services of a company regularly engaged in the treatment of boilers to determine the correct chemicals and concentrations required for water treatment. The company must maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Do not use filming amines and proprietary chemicals. The water treatment chemicals must remain stable throughout the operating temperature range of the system and must be compatible with pump seals and other elements of the system.

2.17.1 MakeUp Water Analysis

****

NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.

****

The makeup water conditions reported as prescribed in ASTM D596 are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees C degrees F
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)

Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (C1)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] ntu
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] epm (meq/1)
Noncarbonate Hardness	[_____] epm (meq/1)
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] micro-mho/cm

2.17.2 Boiler Water Limits

****

NOTE: The material contained within the first set of brackets will be used for steam boilers. The material contained within the second set of brackets will be used for hot water boilers.

****

Consult the boiler manufacturer for the determination of the boiler water chemical composition limits. The boiler water limits are as follows unless dictated differently by the boiler manufacturer's recommendations:

[

Causticity	20-200 ppm
Total Alkalinity (CACO3)	900-1200 ppm
Phosphate	30-60 ppm
Tanin	Medium
Dissolved Solids	3000-5000 ppm
Suspended Solids	300 ppm Max

Sodium Sulfite	20-40 ppm Max
Silica	Less than 150 ppm
Dissolved Oxygen	Less than 7 ppm
Iron	10 ppm
pH (Condensate)	7 - 8

][

Sodium Sulfite	20-40 ppm
Hardness	Less than 2 ppm
pH	9.3 - 9.9

]

2.17.3 Water Softening System

****

NOTE: The makeup water analysis and the boiler manufacturer's recommended feed water conditions will be used to determine the need for a water softener. UFC 3-230-03 contains general guidance for the selection.

****

Provide water softening system as specified in Section 22 31 00 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.17.4 Chemical Feed Pumps

****

NOTE: The required maximum pump flow rate will be shown on the drawings. The flow rate will depend upon the makeup water flow rate and the chemical composition of the makeup water. A water treatment company should be consulted for determining the proper maximum pump flow rate.

****

Provide one pump for each chemical feed tank. Provide positive displacement diaphragm type chemical feed pumps. The capacity of the pumps must be adjustable from 0 to 100 percent while in operation. The discharge pressure of the pumps must not be less than 1.5 times the pressure at the point of connection. Provide pumps with a pressure relief valve and a check valve mounted in the pump discharge.

2.17.5 Tanks

****

NOTE: A water treatment company will be consulted to determine the number of tanks required. The number will depend on the size of the boiler, makeup water flow rate, and makeup water composition. A water line will be provided near the tanks for the

mixing of chemicals.
****

Construct tanks of [high density polyethylene] [stainless steel] with a hinged cover. Provide tanks with sufficient capacity to require recharging only once per 7 days during normal operation. Incude a level indicating device with each tank. Provide an electric agitator for each tank.

2.17.6   Injection Assemblies

Provide an injection assembly at each chemical injection point located along the boiler piping as indicated. Construct the injection assemblies of stainless steel. Extend the discharge of the assemblies to the centerline of the piping. Include a shutoff valve and check valve at the point of entrance into the water line with each assembly.

2.17.7   Water Meter

Provide water meter with an electric contacting register and remote accumulative counter. Install the meter within the makeup water line, as indicated.

2.17.8   Water Treatment Control Panel

****
NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems.
****

Provide a NEMA 12, single door, wall-mounted box conforming with NEMA 250 control panel. Construct the panel of [steel] [stainless steel] with a hinged door and lock. The panel must contain, as a minimum, the following functions identified with a laminated plastic nameplate:

a. Main power switch and indicating light

b. MAN-OFF-AUTO selector switch

c. Indicating lamp for blow down

d. Indicating lamp for each chemical feed pump

e. Indicating lamp for the water softener

2.17.9   Sequence of Operation

****
NOTE: Manually set flow rates should only be used when fluctuations in steam demand and makeup water are not expected. Typically, automatic blowdown will be economical for boilers with capacities greater than 2.9 MW 10,000,000 Btuh.
****

Base the flow rate of chemical addition upon [metering the makeup water.] [a manual setting.] Provide the boiler with [continuous blowdown.] [automatic blowdown based upon conductivity or boiler load.] Determine the required rate of chemical feed and boiler blowdown by the water treatment company.

2.17.10 Chemical Shot Feeder

Provide a shot feeder as indicated. Base size and capacity of feeder upon local requirements and water analysis. Furnish the feeder with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.17.11 Chemical Piping

****

NOTE: If steel piping is selected, an interior coating may be required depending upon the chemicals used.

****

Construct piping and fittings of [schedule 80 PVC] [steel] [stainless steel].

2.17.12 Test Kits

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals.

2.17.13 Glycol Feed System

Design the Glycol feed system to automatically maintain the desired glycol content of the closed water recirculation system(s). Each system must consist of the following components:

2.17.13.1 Supply Tank and Stand

Include a 200 liter50 gallon cross lined polyethylene tank and steel support stand. Provide tank with a cover and bottom outlet fitting for pump suction. Equip the tank stand with a pump mounting platform and support for the control panel and level switch.

2.17.13.2 Glycol Pump

Rotary gear type of bronze construction with a capacity of 0.114 liter/sec 1.8 gpm at 275.8 kPa40 psi. Provide pump with a 0.35 kw1/3 horsepower, 1/115V/60hz motor and internal pressure relief. Provide the pump with a discharge check valve and shutoff valve.

2.17.13.3 Pressure Switch

Provide pressure switch that is adjustable over the range of 20.7 - 103.4 kPa3 - 15 psi with a 42.4 kPa6 psi differential and have contacts rated for 115V.

2.17.13.4 Level Switch

Equipped with N/O and N/C contacts to activate upon sensing a low level condition.

2.17.13.5 Control Panel

Install the control panel in a NEMA 1 enclosure with terminal strip and include a red low level alarm light, low level alarm bell and silence button, full voltage motor starter for the glycol pump, and a Hand-Off-Auto selector switch.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

3.2 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

****

NOTE: Consult boiler manufacturers for foundation requirements. Delete the requirement for packing the joint between the boiler and floor with nonasbestos rope, if not required. This packing is typically not required for smaller units.

****

Install boiler and auxiliary equipment in accordance with manufacturer's written instructions. Make proper provision for expansion and contraction between boiler foundation and floor. Pack this joint with suitable nonasbestos rope and fill with suitable compound that will not become soft at a temperature of 40 degrees C 100 degrees F. Support boilers and firing equipment from the foundations by structural steel completely independent of all brickwork. Boiler supports must permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. Boiler breeching must be as indicated with full provision for expansion and contraction between all interconnected components.

3.3 PIPING INSTALLATION

Unless otherwise specified, provide nonboiler external pipe and fittings conforming to the requirements of ASME B31.1. Cut pipe accurately to suit field conditions, install without springing or forcing, and properly clearing windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Provide pipes that are free of burrs, oil, grease and other foreign material and install to permit free expansion and contraction without damaging the building structure, pipe, pipe joints, or pipe supports. Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Carry vent pipes through the roof as directed and flash properly. Unless otherwise indicated, pitch horizontal supply mains down in the direction of flow with a grade of no less than 0.2 percent 1 inch in 40 feet. Properly cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified must be uncoated. Unless otherwise specified or shown, make final connections to equipment with malleable-iron unions for steel pipe 65 mm 2-1/2 inches or less in diameter and with flanges for pipe 80 mm 3 inches or more in diameter. Provide brass or bronze unions for copper pipe or tubing. Use reducing fittings for changes in pipe sizes. In horizontal hot water lines, use eccentric type reducing fittings to maintain the top of the lines at the same level to prevent air binding.

3.3.1 Hot Water Piping and Fittings

Pipe must be black steel or copper tubing. Fittings for steel piping must be black malleable iron or cast iron to suit piping. Fittings adjacent to valves must suit valve material. Grooved mechanical fittings will not be allowed for water temperatures above 110 degrees C 230 degrees F.

3.3.2 Vent Piping and Fittings

Provide black steel vent piping. Fittings must be black malleable iron or cast iron to suit piping.

3.3.3 Gauge Piping

Piping must be copper tubing.

3.3.4 Steam Piping and Fittings

Provide black steel piping. Provide black, malleable iron, cast iron or steel fittings. Fittings adjacent to valves must suit valves specified. Grooved mechanical fittings will not be allowed for steam piping.

3.3.5 Condensate Return Pipe and Fittings

Provide black steel piping. Provide malleable iron, cast iron, or steel fittings. Grooved mechanical fittings will not be allowed for condensate piping.

3.3.6 Joints

Provide threaded, grooved, flanged or welded joints between sections of steel pipe and between steel pipe and fittings as indicated or specified. Except as otherwise specified, fittings 25 mm 1 inch and smaller must be threaded; fittings 32 mm 1-1/4 inches and up to but not including 80 mm 3 inches must be either threaded, grooved, or welded; and fittings 80 mm 3 inches and larger must be either flanged, grooved, or welded. Weld pipe and fittings 32 mm 1-1/4 inches and larger installed in inaccessible conduit or trenches beneath concrete floor slabs. Make connections to equipment with black malleable-iron unions for pipe 65 mm 2-1/2 inches or smaller in diameter and with flanges for pipe 80 mm 3 inchesor larger in diameter. Provide flared, soldered, or brazed joints between sections of copper tubing or pipe.

3.3.6.1 Threaded Joints

Make threaded joints with tapered threads properly cut and make perfectly tight with a stiff mixture of graphite and oil or with polytetrafluoroethylene tape applied to the male threads only and in no case to the fittings.

3.3.6.2 Welded Joints

Weld joints in accordance with paragraph GENERAL REQUIREMENTS unless otherwise specified. Make changes in direction of piping with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, must be forged, flared for improved flow characteristics where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Assemble socket weld joints so that the space between the end of the pipe and the bottom of the socket is no less than 1.5 mm 1/16 inch and no more than 3 mm 1/8 inch.

3.3.6.3 Grooved Mechanical Joints

Grooved mechanical joints may be provided for hot water systems in lieu of unions, welded, flanged, or screwed piping connections in low temperature hot water systems where the temperature of the circulating medium does not exceed 110 degrees C 230 degrees F. Prepare grooves according to the coupling manufacturer's instructions. Use pipe and groove dimensions in compliance with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer or other method specifically approved by the coupling manufacturer for the intended application. Measure and record groove width and dimension of groove from end of pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Do not use grooved joints in concealed locations. Mechanical joints must use rigid mechanical pipe couplings, except at equipment connections. At equipment connections, flexible couplings may be used. Provide bolted type coupling for use with grooved end pipes, fittings, valves, and strainers. Provide self-centering couplings that engage in a watertight couple.

3.3.6.4 Flared and Brazed Copper Pipe and Tubing

Cut tubing square, and remove burrs. Clean both inside of fittings and outside of tubing thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing must not occur when making connections. Install in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Make brazed joints in conformance with AWS B2.2/B2.2M and CDA A4015 with flux. Copper-to-copper joints must include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) must include the use of flux with either a copper-phosphorous, copper-phosphorous-silver or a silver brazing filler metal. Joints for flared fittings must be of the compression pattern. Provide swing joints or offsets in all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Provide flared or brazed copper tubing to pipe adapters where necessary for joining threaded pipe to copper tubing.

3.3.6.5 Soldered Joints

Make soldered joints with flux and are only acceptable for lines 50 mm 2 inches and smaller. Provide soldered joints conforming to ASME B31.5 and CDA A4015.

3.3.6.6 Copper Tube Extracted Joint

An extruded mechanical tee joint may be made in copper tube. Produce joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops.

Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

3.3.7 Flanges and Unions

Provide faced true flanges with 1.6 mm 1/16 inch thick gaskets, and make square and tight. Where steel flanges mate with cast-iron flanged fittings, valves, or equipment, provide flanges with flat faces and full face gaskets. Provide union or flange joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Provide dielectric pipe unions between ferrous and nonferrous piping to prevent galvanic corrosion. Use dielectric unions with metal connections on both ends. The ends must be threaded, flanged, or brazed to match adjacent piping. Separate the metal parts of the union so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Install gaskets, flanges, and unions in accordance with manufacturer's recommendations.

3.3.8 Branch Connections

****

NOTE: Select the appropriate type of branch connections and delete those which are not required.

****

3.3.8.1 Branch Connections for Hot Water Systems

Pitch branches from the main up or down as shown to prevent air entrapment. Connections must ensure unrestricted circulation, eliminate air pockets, and permit complete drainage of the system. Pitch branches with a grade of no less than 8 mm in 1 m 1 inch in 10 feet. When indicated, install special flow fittings on the mains to bypass portions of the water through each radiator. Use special flow fittings that are standard catalog products and install as recommended by the manufacturer.

3.3.8.2 Branch Connections for Steam Systems

Take branches from the supply mains at an angle of 45 degrees above the horizontal, unless otherwise indicated. Take branches from return mains from the top or sides, unless indicated otherwise. Pitch branches up from the mains toward the undripped risers or radiator connections with a grade of no less than 8 mm in 1 m 1 inch in 10 feet. Connections must ensure unrestricted circulation, eliminate air pockets, and permit the complete drainage of the system.

3.3.9 Steam Connections to Equipment

****

NOTE: Delete this paragraph if steam connections are not required.

****

Provide steam supply and return connections as shown. Make connections with malleable-iron unions or with steel flanges, to match equipment. Install valves and traps in accordance with the manufacturer's recommendations. The size of the supply and return pipes to each piece of equipment must not be smaller than the outlets on the equipment.

3.3.10 Steam Risers

****

NOTE: Delete this paragraph if steam risers are not required.

****

The location of risers is approximate. The exact locations of the risers must be approved. Terminate downfeed risers in a dirt pocket and drip through a trap to the return line.

3.3.11 Air Vents for Steam Systems

****

NOTE: Delete this paragraph if a steam system is not utilized.

****

Install automatic balanced pressure thermostatic air vents at the ends of the steam lines and where shown on the drawings. Use vents that are rated for 862 kPa 125 psi steam service. Route the outlet of the vent to a point designated by the Contracting Officer's Representative. Provide inlet line with a gate valve or ball valve.

3.3.12 Flared, Brazed, and Soldered Copper Pipe and Tubing

Provide flared, brazed, or soldered copper tubing. Cut tubing square, and remove burrs. Clean both inside of fittings and outside of tubing thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing must not occur when making connections. Install in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for flared fittings must be of the compression pattern. Provide swing joints or offsets on branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Provide pipe adapters where necessary for joining threaded pipe to copper tubing. Make brazed joints in conformance with CDA A4015. Copper-to-copper joints must include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) must include the use of flux with either a copper-phosphorous, copper-phosphorous-silver, or a silver brazing filler metal. Make soldered joints with flux and are only acceptable for lines 50 mm 2 inches or smaller. Provide soldered joints conforming to ASME B31.5 and in accordance with CDA A4015.

3.3.13 Copper Tube Extracted Joint

An extracted mechanical tee joint may be made in copper tube. Produce joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

3.3.14 Supports

Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support piping subjected to vertical movement when operating temperatures exceed ambient temperatures by variable spring hangers and supports or by constant support hangers. Do not use formed or bent threaded rods for support. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

3.3.14.1 Seismic Requirements for Supports and Structural Bracing

****

NOTE: Provide seismic requirements, if a Government designer (either Corps Office of A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if no seismic requirements are provided. Section 13 48 73, properly edited, must be included in the contract documents.

****

Support and brace piping and attached valves to resist seismic loads as specified in Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT [and][as shown on the drawings]. Provide structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, in this section. Use material for supports as specified in Section 05 12 00 STRUCTURAL STEEL.

3.3.14.2 Pipe Hangers, Inserts, and Supports

****

NOTE: Details of pipe supports in trenches will be shown on the drawings. Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 225 N 50 pounds must have the excess hanger loads suspended from panel points.

****

Provide pipe hangers, inserts, and supports conforming to MSS SP-58, except as modified herein.

3.3.14.2.1 Types 5, 12, and 26

Use of Types 5, 12, and 26 is prohibited.

3.3.14.2.2 Type 3

Do not use Type 3 on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe, if the clamp bottom does not extend through the insulation, and if the top clamp attachment does not contact the insulation during pipe movement.

3.3.14.2.3 Type 18

Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

3.3.14.2.4 Type 19 and 23 C-Clamps

Torque Type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.

3.3.14.2.5 Type 20 Attachments

Furnish Type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

3.3.14.2.6 Type 24

Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.3.14.2.7 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58 and do not install a support over 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Do not space pipe supports over 1500 mm 5 feet apart at valves.

3.3.14.2.8 Vertical Pipe Support

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of no more than 4500 mm 15 feet, no more than 2400 mm 8 feet from end of risers, and at vent terminations.

3.3.14.2.9 Type 35 Guides

Provide Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Provide slide materials suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

a. Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rested on a steel plate. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rested on a steel slide plate.

b. Where there are high system temperatures and welding to piping is not desirable, include a pipe cradle welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 100 mm 4 inches or by an amount adequate for the insulation, whichever is greater.

3.3.14.2.10 Horizontal Insulated Pipe

Except for Type 3, pipe hangers on horizontal insulated pipe must be the size of the outside diameter of the insulation.

3.3.14.2.11 Piping in Trenches

Support piping in trenches as indicated.

3.3.14.2.12 Structural Steel Attachments

Provide structural steel attachments and brackets required to support piping, headers, and equipment, but not shown, under this section. Provide material and installation as specified under Section 05 12 00 STRUCTURAL STEEL. Do not exceed 22 kg 50 pounds for pipe hanger loads suspended from steel joist between panel points. Suspend loads exceeding 22 kg 50 pounds from panel points.

3.3.14.3 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support member must not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run. Attach the clips or clamps rigidly to the common base member. Provide a clearance of 3 mm 1/8 inch between the pipe insulation and the clip or clamp for piping which may be subjected to thermal expansion.

3.3.15 Anchors

****

NOTE: Anchors will be coordinated with seismic bracing. Seismic bracing should not interfere with the thermal expansion design.

****

Provide anchors where necessary to localize expansion or to prevent undue strain on piping. Provide anchors consisting of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results, using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.3.16 Valves

Install valves where indicated, specified, and required for functioning and servicing of the systems. Ensure valves are safely accessible. Install swing check valves upright in horizontal lines and in vertical lines only when flow is in the upward direction. Install gate and globe valves with stems horizontal or above. Disassemble valves to be brazed prior to brazing and remove all packing. After brazing, allow the valves to cool before reassembling.

3.3.17 Pipe Sleeves

Provide pipe passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Install a waterproofing clamping flange as indicated where membranes are involved. Do not install sleeves in structural members except where indicated or approved. Provide rectangular and square openings as detailed. Extend each sleeve through its respective wall, floor, or roof.

Cut sleeves through walls flush with wall surface. Sleeves through floors must [be cut flush with floor surface] [extend above top surface of floor a sufficient distance to allow proper flashing or finishing]. Extend sleeves through roofs above the top surface of roof at least 150 mm 6 inches for proper flashing or finishing. Unless otherwise indicated, size sleeves to provide a minimum clearance of 6 mm 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Use galvanized steel pipe or cast-iron pipe sleeves in waterproofing membrane floors, bearing walls, and wet areas. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe, cast-iron pipe, or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls as indicated and specified in Section 07 92 00 JOINT SEALANTS. Provide metal jackets over insulation passing through exterior walls, firewalls, fire partitions, floors, or roofs.

a. Metal jackets must not be thinner than 0.1524 mm 0.006 inch thick aluminum, if corrugated, and 0.4 mm 0.016 inch thick aluminum, if smooth.

b. Secure metal jackets with aluminum or stainless steel bands not less than 9 mm 3/8 inch wide and not more than 200 mm 8 inches apart. When penetrating roofs and before fitting the metal jacket into place, run a 13 mm 1/2 inch wide strip of sealant vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 1000 mm 36 inches above the roof. If the pipe turns from vertical to horizontal, run the sealant strip to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, extend the metal jacket from a point below the back-up material to a minimum distance of 50 mm 2 inches above the flashing. For other areas, extend the metal jacket from a point below the backup material to a point 300 mm 12 inches above material to a minimum distance of 50 mm 2 inches above the flashing. For other areas, extend the metal jacket from a point below the backup material to a point 300 mm 12 inches above the floor; when passing through walls above grade, extend the jacket at least 100 mm 4 inches beyond each side of the wall.

3.3.17.1 Pipes Passing Through Waterproofing Membranes

In addition to the pipe sleeves referred to above, provide pipes passing through waterproofing membranes with a 1.6 mm 4 pound lead flashing or a 0.55 mm 16 ounce copper flashing, each within an integral skirt or flange. Suitably form flashing, and extend the skirt or flange no less than 200 mm 8 inches from the pipe and set over the membrane in a troweled coating of bituminous cement. Extend the flashing above the roof or floor a minimum of 250 mm 10 inches. Seal the annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation as indicated. Pipes up to and including 250 mm 10 inches in diameter which pass through waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.3.17.2 Optional Modular Mechanical Sealing Assembly

At the option of the Contractor, a modular mechanical type sealing assembly may be installed in the annular space between the sleeve and conduit or pipe in lieu of a waterproofing clamping flange and caulking and sealing specified above. Provide seals with interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. Assemble the links loosely with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.3.17.3 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may consist of standard roof coupling for threaded pipe up to 150 mm 6 inches in diameter, lead flashing sleeve for dry vents with the sleeve turned down into the pipe to form a waterproof joint, or a tack-welded or banded-metal rain shield around the pipe, sealed as indicated.

3.3.17.4 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, provide a fire seal as specified in Section 07 84 00 FIRESTOPPING.

3.3.18 Balancing Valves

Install balancing valves as indicated.

3.3.19 Thermometer Wells

Provide a thermometer well in each return line for each circuit in multicircuit systems.

3.3.20 Air Vents

Install air vents in piping at all system high points. Keep the vent open until water rises in the tank or pipe to a predetermined level at which time it must close tight. Run an overflow pipe from the vent to a point designated by the Contracting Officer's representative. Provide inlet to the air vent with a gate valve or ball valve.

3.3.21 Escutcheons

Provide escutcheons at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Fasten chromium-plated iron or chromium-plated brass, either one-piece or split pattern, escutcheons securely to pipe or pipe covering and hold in place by internal spring tension or setscrews.

3.3.22 Drains

Install a drain connection with a 25 mm 1 inch gate valve or 19 mm 3/4 inch hose bib at the lowest point in the return main near the boiler. In addition, install threaded drain connections with threaded cap or plug on the heat exchanger coil on each unit heater or unit ventilator and wherever required for thorough draining of the system.

3.3.23 Strainer Blow-Down Piping

Fit strainer blow-down connections with a black steel blow-down pipeline routed to an accessible location and provided with a blow-down valve.

3.3.24 Direct Venting for Combustion Intake Air and Exhaust Air

****

NOTE: Delete this paragraph if condensing boilers are not used.

****

Install intake air and exhaust vents in accordance with NFPA 54 and boiler manufacturer's recommendations. Slope exhaust vent 20.8 mm/m 1/4 inch/ft toward the boiler's flue gas condensate collection point.

3.4 GAS FUEL SYSTEM

Provide gas piping, fittings, valves, regulators, tests, cleaning, and adjustments in accordance with the Section 23 11 20 FACILITY GAS PIPING. Submit proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing. Comply with NFPA 54 unless otherwise specified. Provide burners, pilots, and all accessories that are listed in UL FLAMMABLE & COMBUSTIBLE. Provide fuel system with a gas tight, manually operated, UL listed stop valve at the gas-supply connections, a gas strainer, a pressure regulator, pressure gauges, a burner-control valve, a safety shutoff valve suitable for size of burner and sequence of operation, and other components required for safe, efficient, and reliable operation as specified. Provide approved permanent and ready facilities to permit periodic valve leakage tests on the safety shutoff valve or valves.

3.5 FUEL OIL SYSTEM

Install fuel oil system in accordance with NFPA 31, unless otherwise indicated.

3.5.1 Piping and Storage Tank

Istall fuel oil piping and storage tanks in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS, unless indicated otherwise.

3.5.2 Fuel-Oil Storage Tank Heating-Coil Piping

Install supply and return piping and fittings for the heating coil in accordance with paragraph PIPING INSTALLATION. Provide [hot water] [steam] supply line to the heating coil with an automatic temperature-control valve, a strainer and a three-valve bypass. Provide return line from the coil with a [check valve] [steam trap] and a block valve.

3.5.3 Automatic Safety Shutoff Valve

Equip oil supply line to each oil burner with an automatically operated valve designed to shut off the oil supply in case of fire in the immediate vicinity of the burner. Provide thermoelectrically actuated or thermomechanically actuated type valve and locate immediately downstream of the manual shutoff valve at the day tank inside of the building. If a day tank is not used, locate the automatic safety valve immediately downstream of the building shutoff devices where oil supply line enters the building. Locate a thermoelectrical or thermomechanical detection device over the oil burner to activate the valve. A fire shutoff valve may be combined with other automatic shutoff devices if listed in UL FLAMMABLE & COMBUSTIBLE.

3.5.4 Earthwork

Perform excavation and backfilling for tanks and piping as specified in Section 31 00 00 EARTHWORK.

3.6 RADIANT FLOOR HEATING SYSTEM

Install radiant floor heating system in accordance with HI-004, unless otherwise indicated by the tubing manufacturer's installation instructions. During the installation, plug all tubing on each end to prevent foreign materials from entering the tubing. Check all tubing for abrasions prior to installation. Tubing with excessive abrasions that damage the oxygen barrier coating will not be acceptable. Tubing with any abrasion that is greater than 10 percent of the minimum wall thickness will not be acceptable. Install all tubing embedded or concealed by the floor without joints. The bending radius of the tubing must not exceed the values recommended by the tubing manufacturer. Install tubing in such a manner as to evenly distribute the heat across the floor. Do not place tubing near heat sensitive materials such as water closet seals. Install isolation valves on each side of each tubing manifold. The manifold and fittings must be accessible for maintenance. After the system is filled with water or glycol, vent all air from the system. After the system is allowed to stabilize at the operating temperatures of the heating fluid, vent the system again.

3.6.1 Concrete Slab construction

****

NOTE: Delete this paragraph if slab construction is not required. The type of installation under the slab should be coordinated with the architect and structural engineer.

****

In areas where tubing must cross expansion joints, control joints, or other crack control measures, install the tubing below the joints. Fasten the tubing to the reinforcing steel in accordance with the tubing manufacturer's recommendations. Pressurize tubing prior to and during the concrete pour to ensure system integrity.

3.6.2 Wooden Floor Construction

****

NOTE: Delete this paragraph if a wooden floor construction is not required.

****

Fasten tubing to the wood subflooring in accordance with the drawings and the tubing manufacturer's recommendations. Attach the tubing to the flooring without causing abrasions on the tubing.

3.6.3 Penetrations to Fire Rated Assemblies

Where pipe pass through firewalls, fire partitions, or floors, provide a fire seal as specified in Section 07 84 00 FIRESTOPPING.

3.7 COLOR CODE MARKING AND FIELD PAINTING

****

NOTE: Designer will coordinate color code marking with Section 09 90 00. Color code marking for piping not listed in Table 1 of Section 09 90 00 will be added to the table.

****

Color code marking of piping must be as specified in Section 09 90 00 PAINTS AND COATINGS. Clean, prepare, and paint ferrous metal not specified to be coated at the factory as specified in Section 09 90 00 PAINTS AND COATINGS. Paint exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum sheath over insulation.

3.8 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified to supervise the installing, adjusting, and testing of the equipment.

3.9 TEST OF BACKFLOW PREVENTION ASSEMBLIES

Test backflow prevention assemblies in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.10 HEATING SYSTEM TESTS

****

NOTE: Whenever possible, the testing of heating systems will be done under adverse winter conditions and low outside temperatures. The test data included will be modified as required to suit the particular heating system.

Select a 4 hour hydrostatic test for radiant floor heating systems in accordance with HYI 400. All other systems should be tested for 2 hours.

****

Submit the Qualifications of the firms in charge of installation and testing as specified. Submit a statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section. Before any covering is installed on pipe or heating equipment, hydrostatically test and prove tight the entire heating system's piping, fittings, and terminal heating units at a pressure of 1.5 times the design working pressure, but no less than 689 kPa 100 psi. Submit proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

a. Before pressurizing system for test, blank off items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure or replace with spool pieces.

b. Before balancing and final operating test, remove test blanks and spool pieces; and reconnect protected instruments and equipment. With equipment items protected, pressurize the system to test pressure. Hold pressure for a period of time sufficient to inspect all welds, joints, and connections for leaks, but no less than 2 hours. No loss of pressure will be allowed. Repair leaks and retest repaired joint.

c. Repair joints are not allowed under the floor for floor radiant heating systems. If a leak occurs in tubing located under the floor in radiant heating systems, replace the entire zone that is leaking. If any repair is made above the floor for floor radiant heating systems, provide access for the installed joint. Caulking of joints is not permitted.

d. Drain system and after instruments and equipment are reconnected, refill the system with service medium and maximum operating pressure applied. Hold the pressure while inspecting these joints and connections for leaks. Repair the leaks and retest the repaired joints.

Upon completion of hydrostatic tests and before acceptance of the installation, submit test reports for the heating system tests. Upon completion of testing complete with results, balance the heating system in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS and operating tests required to demonstrate satisfactory functional and operational efficiency. Cover a period of at least 24 hours for each system, and include, as a minimum, the following specific information in a report, together with conclusions as to the adequacy of the system:

a. Certification of balancing.

b. Time, date, and duration of test.

c. Outside and inside dry bulb temperatures.

d. [Temperature of hot water supply leaving boiler] [Steam pressure].

e. Temperature of [heating return water from system at] [condensate feed to] boiler inlet.

f. Quantity of water feed to boiler.

g. Boiler make, type, serial number, design pressure, and rated capacity.

h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.

i. [Circulating] [Condensate] [Vacuum] pump make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.

j. Flue-gas temperature at boiler outlet.

k. Percent carbon dioxide in flue-gas.

l. Grade or type and calorific value of fuel.

m. Draft at boiler flue-gas exit.

n. Draft or pressure in furnace.

o. Quantity of water circulated.

p. Quantity of fuel consumed.

q. Stack emission pollutants concentration.

Read indicating instruments at half-hour intervals unless otherwise directed. Furnish all instruments, equipment, and personnel required for the tests and balancing. Obtain necessary natural gas, water and electricity as specified in the [SPECIAL CONTRACT REQUIREMENTS][Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS] Provide necessary quantities of propane gas or No. [_____] fuel oil when propane gas or fuel oil is require for testing. Demonstrate that fuel burners and combustion and safety controls meet the requirements of [ASME CSD-1] [ANSI Z21.13/CSA 4.9] [NFPA 85]

3.10.1 Water Treatment Testing

Analyze the boiler water [prior to the acceptance of the facility] [a minimum of once a month for a period of 1 year] by the water treatment company. Submit a water quality test report identifying the chemical composition of the boiler water. Include a comparison of the condition of the boiler water with the manufacturer's recommended conditions. Document any required corrective action within the report. Identify the condition of the boiler at the completion of 1 year of service. Include a comparison of the condition of the boiler with the manufacturer's recommended operating conditions. Include the following information recorded in accordance with ASTM D596 in the analysis.

Date of Sample	[_____]
Temperature	[_____] degrees C degrees F
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (C1)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] ntu

pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] epm (meq/1)
Noncarbonate Hardness	[_____] epm (meq/1)
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] micro-mho/cm

If the boiler water is not in conformance with the boiler manufacturer's recommendations, the water treatment company must take corrective action.

3.10.2 Boiler/Piping Test

****

NOTE: If a steam boiler is not used, delete the reference to condensate piping.

****

At the conclusion of the 1 year period, inspect the boiler and condensate piping for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company must provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations. If corrosion is found within the condensate piping, make proper repairs.

3.11 CLEANING

3.11.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, thoroughly clean the boilers and piping by filling the system with a solution consisting of either 0.5 kg 1 pound of caustic soda or 0.5 kg 1 pound of trisodium phosphate per 190 L 50 gallons of water. Observe proper safety precautions in the handling and use of these chemicals. Heat the water to approximately 65 degrees C 150 degrees F and circulate the solution in the system for a period of 48 hours. Then drain the system and thoroughly flush out with fresh water. Thoroughly clean strainers and valves. Prior to operating tests, remove air from all water systems by operating the air vents.

3.11.2 Heating Units

Thoroughly clean inside space heating equipment, ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with all traces of oil, dust, dirt, or paint spots removed. Provide temporary filters for fans that are operated during construction, and provide new filters after construction dirt has been removed from the building, and the ducts, plenum, casings, and other items specified have been vacuum cleaned. Perform and document that proper "Indoor Air Quality During Construction" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition until final acceptance. Lubricate bearings properly with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions.

3.12 FIELD TRAINING

****

NOTE: The number of hours required for giving instructions for operation and maintenance will depend on the complexity of the system specified. The blank will be filled with the appropriate number. When the system is to be installed at a location where experienced Government engineers are on duty, delete the entire paragraph.

****

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period consists of a total of [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

a. Cover all of the items contained in the approved operation and maintenance manuals, as well as demonstrations of routine maintenance operations and boiler safety devices, in the field instructions.

b. Submit system layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, post these items where directed.

c. Submit [six] [_____] complete operation and maintenance instructions listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. Include the manufacturer's name, model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization must be capable of providing [4] [_____] hour onsite response to a service call on an emergency basis.

d. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.13 FUEL SYSTEM TESTS

Submit test reports for the fuel system tests, upon completion of testing complete with results.

3.13.1 Fuel Oil System Test

Test fuel oil system in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.13.2 Gas System Test

Test gas fuel system accordance with the test procedures outlined in NFPA 54.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 52 30.00 10 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-23 52 43.00 10 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-23 52 30.00 10 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-23 52 43.00 10 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 23 52 30.00 10

HEAT RECOVERY BOILERS
05/20

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NOTE: This guide specification covers the requirements for both fire-tube and water-tube heat recovery, steam generating boilers with individual capacities from 907 to 136,000 kg 2,000 to 300,000 pounds of steam per hour.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)

ABMA Boiler 402	(2012) Boiler Water Quality Requirements and Associated Steam Quality for Industrial/Commercial and Institutional Boilers

AMERICAN PETROLEUM INSTITUTE (API)

API STD 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for

	Construction of Power Boilers
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers
ASME MFC-3M	(2022) Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi
ASME PTC 4	(2013; R 2023) Fired Steam Generators
ASME PTC 10	(2022) Performance Test Code on Compressors and Exhausters
ASME PTC 12.3	(1997; R 2004; R 2009; R 2014; R 2019; R 2024) Performance Test Code on Deaerators
ASME PTC 19.2	(2010; R 2015; R 2020; R 2024) Pressure Measurement
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes
ASME PTC 19.10	(1981) Flue and Exhaust Gas Analyses
ASME PTC 19.11	(2008; R 2013) Steam and Water Sampling, Conditioning, and Analysis in the Power Cycle

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc

	Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A179/A179M	(2024) Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes
ASTM A192/A192M	(2024) Standard Specification for Seamless Carbon Steel Boiler Tubes for High-Pressure Service
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A249/A249M	(2024a) Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes
ASTM A278/A278M	(2001; R 2024) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A285/A285M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
ASTM A297/A297M	(2021a) Standard Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A319	(1971; R 2024) Standard Specification for Gray Iron Castings for Elevated Temperatures for Non-Pressure Containing Parts
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A350/A350M	(2024b) Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A688/A688M	(2024) Standard Specification for Welded Austenitic Stainless Steel Feedwater Heater Tubes
ASTM B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings
ASTM B68/B68M	(2011) Standard Specification for Seamless Copper Tube, Bright Annealed (Metric)
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C27	(1998; R 2022) Fireclay and High-Alumina Refractory Brick
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C401	(2012; R 2022) Alumina and Alumina-Silicate Castable Refractories
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM D888	(2012; E 2013) Dissolved Oxygen in Water
ASTM D1066	(2018; E 2018) Standard Practice for Sampling Steam
ASTM D2186	(2005; R 2009) Deposit-Forming Impurities in Steam
ASTM E230/E230M	(2012) Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples

ASTM F1097	(2017; R 2022) Standard Specification for Mortar, Refractory (High-Temperature, Air-Setting)

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

CAGI B19.1	(2010) Safety Standard for Compressor Systems

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

HEAT EXCHANGE INSTITUTE (HEI)

HEI 2622	(2009) Standards for Closed Feedwater Heaters; 8th Edition
HEI 2623	(2004) Standards for Power Plant Heat Exchangers

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 7.0.01	(1996) Quality Standard for Instrument Air

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J534	(2021) Lubrication Fittings

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 353	(1994; Reprint Nov 2011) Standard for Limit Controls

1.2 SUMMARY

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NOTE: Steam operating pressures will cover a range up to 3.45 MPa 500 psig. However, fire-tube boilers are not generally available above 2.07 MPa 300 psig. This specification is intended to be used primarily with heat recovery incinerators (Section 11 82 19 PACKAGED INCINERATORS), but may be used in other waste heat applications.

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Provide a facility consisting of [_____] complete steam generation systems (unit systems) with connections to the steam distribution and condensate return systems and auxiliary equipment. Combustion equipment (heat source) is described in Section [23 52 49.00 20 STEAM BOILERS AND EQUIPMENT (500,000 - 18,000,000 BTU/HR)][23 52 53.00 20 STEAM BOILERS AND EQUIPMENT (18,000,000 - 60,000,000 BTU/HR)]. Each steam boiler must be capable of fully independent or simultaneous operation. The normal mode of operation must be the same as for the heat source. Vary combination of unit systems to optimize running times; therefore each unit system must provide identical features to provide redundancy and capability for maintaining continuous operation of the facility at full rated capacity.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Drawings

Boiler Setting

SD-03 Product Data

Support Steel

Spare Parts

Welding

Framed Instructions

Performance Tests; G, [_____]

SD-06 Test Reports

Testing

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Welding

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NOTE: Where pipeline, structural, or other welding is required on the same project, tests will be required accordingly. Testing may be by the coupon method as prescribed in the welding code or by special radiographic methods.

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Perform all welding in accordance with qualified procedures using performance-qualified welders and welding operators. Use qualified procedures and welders in accordance with AWS B2.1/B2.1M or ASME BPVC SEC IX as applicable. Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests to be performed at the work site if practicable. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record. The welders mark must not deform or remove metal. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

1.4.2 Conformance with Agency Requirements

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NOTE: In lieu of the label or listing, the Contractor may submit a written certificate from any nationally recognized testing organization adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the requirements, including methods of testing, of the specified agency.

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Where materials or equipment are specified to conform to the requirements of, or listed in rating publications of national agencies, submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence. Where equipment is specified to conform to the requirements of the ASME Boiler and Pressure Vessel Code, provide design, fabrication, testing, and installation conforming to the code in every subject.

1.4.3 Detailed Drawings

Submit detailed drawings, for the specific equipment being proposed, consisting of schedules, performance charts, brochures, diagrams, drawings (including illustrations and equipment placement elevations), instructions, a complete list of equipment and materials, and other information necessary for installation of the steam-generating units and associated equipment, and for piping, wiring devices, trenches, and related foundations. Indicate on the drawings clearances required for maintenance and operation and show complete wiring and schematic diagrams, equipment layout and anchorage, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Support list of materials and equipment by descriptive material, such as catalog cuts, detailing conformance with the specification requirements. Catalog numbers alone will not be acceptable. Include the name and address of the nearest service and maintenance organization. Include on the detail drawings equipment connections, complete control wiring, connection diagrams, the proposed plan, elevations, cross section arrangements, and dimensions of the boiler systems. Show on the drawings proposed layout of equipment and appurtenances, and their relationship to other parts of the work to establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. If departures from the contract drawings are deemed necessary by the Contractor, include details of such departures, including changes in related portions of the project and the reasons therefore, with the drawings.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of the detail drawings and not later than [_____] months before the date of beneficial occupancy. Include in the data a complete list of spare parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be maintained in inventory for [_____] months of facility operation.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide material, equipment, and controls which are the standard products of a manufacturer regularly engaged in the manufacture of the product and that essentially duplicate items that have been in satisfactory use on at least [three] [_____] jobs for at least 2 years prior to bid opening. To meet the 2 year experience criteria, couple the heat recovery boiler with the same type of combustion equipment as stated in the bid package. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the plant site. Provide controls of a type that has given satisfactory field performance under normal operating conditions for no less than 2 years or 6000 hours before the award of the contract. Types that have been shown to have operated satisfactorily for these periods may have modifications, provided it can be shown that the modifications will not increase maintenance and operating costs and will not decrease the life of the equipment.

2.1.1 Nameplates

Secure a plate to each major item of equipment containing the manufacturer's name, address, type or style, model number, serial number, and applicable equipment rating. Also affix the ENERGY STAR label to the equipment as applicable. Conform nameplates for electrical apparatus to the applicable NEMA Standards.

2.1.2 Equipment Guards and Access

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NOTE: Catwalk, ladder, and guardrail requirements will be indicated on the drawings.

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Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact. Guard or cover high-temperature equipment and piping over 66 degrees C 150 degrees F exposed to contact by personnel or where it creates a fire hazard properly with insulation of a type specified. Provide items such as catwalks, operating platforms, ladders, and guardrails where shown, constructed in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.1.3 Prevention of Rust

Unless otherwise specified, factory prime paint surfaces of ferrous metal subject to corrosion with a rust inhibiting coating and subsequently factory finish painted in accordance with the manufacturer's standard practice. Prime and finish paint equipment exposed to high temperature when in service with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil. Use a light color finish paint.

2.1.4 Use of Asbestos Products

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NOTE: The first clause in brackets should be used when it is known that substitutes are available for any asbestos products which might be included with the equipment. The second clause in brackets should be used when it is possible or definitely known that asbestos products for which no technically acceptable substitute exists may be included with the equipment.

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[Products which contain asbestos are prohibited. This prohibition includes items such as packings and gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material.] [Except as provided below, asbestos products are acceptable only in exceptional cases where the Contractor states in writing that no suitable substitute material exists, and in addition, the Contractor furnishes to the Contracting Officer a copy of U.S. Department of Labor, Occupational Safety and Health Administration, "Safety Data Sheet" (Form OSHA-20), completed by the asbestos manufacturer stating that the product is not an asbestos health hazard.]

2.2 BOILERS

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NOTE: Select the appropriate ASME Standard for the desired pressure class and service specified.

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Provide each boiler system with the capacity described herein and as shown on the contract drawings. The equipment design and accessory installations must permit accessibility for maintenance and service. Design boilers for a maximum allowable working pressure of [_____] kPa psig with an operating pressure of [_____] kPa psig. Design conditions are as follows:

Rated capacity	[_____] kg/hour pounds/hour
Steam outlet temperature	[_____] degrees C degrees F
Site elevation	[_____] meters feet
Ambient air temperatures	[_____] to [_____] degrees C [_____] to [_____] degrees F
Reference air temperature	27 degrees C 80 degrees F

Provide boiler that is capable of operating continuously at maximum specified capacity without damage or deterioration to the boiler, setting, heat source equipment, or auxiliaries. The boiler must be capable of automatically controlled operation while coupled to the heat source. Design the equipment in accordance with the latest ASME Standards; ASME BPVC SEC I, ASME BPVC SEC IV, and ASME BPVC SEC VIII D1. Certification of such compliance must be evidenced by applicable "P" forms before acceptance of the facility by the Government. Provide boiler piping under ASME B31.1. Equip each boiler with an [economizer] [air preheater]. Boiler unit or heat recovery section must be a standard part of a steam generation system package closely coupled to the combustion equipment.

2.2.1 Capacity

Rated capacity is the capacity at which the boilers will operate continuously without exceeding the specified boiler heat transfer rates, and boiler exit temperature. Provide boiler auxiliaries including fans, motors, drives, and similar equipment with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork.

2.2.2 Electrical Equipment

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NOTE: Indicate the type and class of motor enclosure depending on the environment in which the motor is to be used.

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Provide electric motor-driven equipment specified complete with motors and necessary motor control devices. Provide motors, motor control devices, and power supply wiring conforming to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM including requirements for hazardous area locations. Use premium efficiency type integral size motors in accordance with NEMA MG 1. Submit a complete electrical connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device for approval before installation. Provide motors with enclosures as indicated.

2.2.2.1 Motor Ratings

Use motors that are suitable for the voltage and frequency provided. Motors 373 W 1/2 horsepower and larger must be three phase, unless otherwise indicated. Ensure ratings are adequate for the duty imposed, but are not less than indicated. Provide motors conforming to NEMA MG 1 with enclosure as specified. Motors smaller than 746 W Fractional horsepower motors must be Type I, Class 1B or Class 2A or 2B, Continuous Duty. Motors larger than 746 W Integral horsepower motors must be Type I or II, Class 2 Continuous Duty, Design L or M.

2.2.2.2 Motor Starters

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the reference to motor starters.

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Where a motor starter is not shown in a motor control center on the electrical drawings, provide a motor starter. Where required, provide motor starters complete with properly sized thermal overload protection and other equipment at the specified capacity, including an allowable service factor and other appurtenances necessary for the motor control specified. Provide manual or automatic control and protective or signal devices required for operation specified and any wiring required to such devices not shown on the electrical drawings. Where two-speed or variable-speed motors are indicated, solid state variable-speed controllers may be provided to accomplish the same function.

2.2.3 Boiler Design Requirements

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NOTE: Indicate whether the boiler should be fire-tube, water-tube, or can be either one.

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Ensure each boiler is suitable for indoor installation and include a heat recovery [fire] [water]-tube section and a steam separator. Design tube section so the tubes are installed in an arrangement that will permit ease of access and replacement. Fire boilers with the hot gases generated by the associated combustion equipment. Draw hot gases [through] [over] the tube banks by an induced draft fan. Control gas flow by a system of automatically actuated dampers that will route the hot gases through the tube section and out the stack as required to satisfy the operational procedures. Provide boilers that are [either] [fire-tube] [or] [single or multiple drum, bare-tube, water-tube, natural circulation]. Provide sootblowing systems with coordinated controls.

2.2.3.1 Radiant Heating

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NOTE: The following is a guide to determine maximum radiant heat release:

Boiler Type	**Maximum kW/square meter Btuh/sq ft**
Controlled circulation	**water-tube boilers 394.3 125,000**
Natural circulation	**water-tube boilers 315.5 100,000**
	Fire-tube boilers 315.5 100,000

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Limit the maximum effective radiant heating surface to [_____] kW/square meter Btu input per square foot/hour.

2.2.3.2 Combustion Gas

The combustion gas temperature at the furnace exit (boiler entrance) must be a minimum of 56 degrees C 100 degrees F less than the ash fusion softening temperature (reducing atmosphere) of any ash contained in the fuel. For boilers attached to waste incinerators, do not exceed 1093 degrees C 2000 degrees F.

2.2.3.3 Radiant Heating Surface

Effective radiant heating surface for water-tube boilers must include the flat projected area of bare, metal covered or metallic ore covered tubes and headers, 90 percent of the flat projected area of extended metal or metallic surfaces from the tubes, and the flat projected area of those portions of the first two rows of exit tubes receiving radiant heat from the fire. The flat projected area is defined as the external diameter times the length of the tube. The flat projected area of the extended surfaces must not include the metal blocks not integral with tubes, extended surfaces less than [_____] mm inch thick or more than [_____] mm inch in length, and the portion of the extended surface which is more than one tube radius from the tube from which it extends. For fire-tube steel firebox boilers it must be the total water-backed area within the furnace boundaries exposed to the flame. Use the mean circumference for corrugated crown sheets.

2.2.3.4 Boiler Operating Capacity

The boiler must maintain continuous capacity within the specified range while operating on [1][2][3] shifts per day, [_____] days per week schedule at the specified pressure with boiler feedwater at a temperature of approximately [_____] degrees C degrees F. Ensure the hot gas entrance temperature is [_____] degrees C degrees F and the flue gas outlet temperature is [_____] degrees C degrees F, based on a flow of [_____] actual cubic meters/second ACFM. Ensure moisture in the steam and boiler water concentrations is in accordance with ABMA Boiler 402.

2.2.3.5 Boiler Output Capacity

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NOTE: In order to comply with Executive Order 13423 and Public Law 109-58 (Energy Policy Act of 2005), designs must achieve energy consumption levels that are at least 30 percent below the level required by the 2004 publication of ASHRAE 90.1. In accordance with P.L. 109-58 (Energy Policy Act of 2005), Executive Order 13423, and Federal Acquisition Regulation (FAR) 23.203 Energy-efficient Products, meet or exceed the performance criteria for ENERGY STAR®-qualified or FEMP-designated products as long as these requirements are nonproprietary. The FEMP and ENERGY STAR product requirements are available on the web at www.eere.energy.gov/femp/procurement **and** www.energystar.gov/products**. Where ENERGY STAR or FEMP products are not applicable, provide energy consuming products and systems that meet or exceed the requirements of ASHRAE 90.1.**

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Base output capacity of the boilers on tests of the boilers and combustion equipment as a unit. Provide a minimum efficiency of [80][_____] percent at maximum continuous capacity.

2.2.3.6 Boiler Markings

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NOTE: Delete brackets if the boiler does not include a superheater.

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Furnish each boiler with a metal nameplate including the following information:

a. Maximum continuous capacity in Watts and Btu/hour Btu/hour.

b. Radiant heating surface in square meters square feet.

c. Total heating surface in square meters square feet.

d. Boiler maximum allowable working pressure.

e. Boiler system ASME Code Stamp and Certification.

f. Maximum steam flow of boiler in kg/hour pounds/hour.

g. Manufacturer's Model Number.

h. Serial Number.

i. Year manufactured.

[j. Superheater final steam temperature in degrees C degrees F.]

[k. Superheater heating surface in square meters square feet.]

2.2.3.7 Noise

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NOTE: Indicate the noise level required by the location of the equipment. Equipment in remote areas can be allowed to produce noise at a level slightly higher than the normal 85 decibel-A scale (dBA). Occupational Safety and Health Administration (OSHA) regulations and Corps of Engineers safety regulations should be consulted for the most current 8-hour exposure limits.

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The noise level 304.8 mm 1 foot from a boiler must not exceed 85 dBA. This includes the boiler, blowers, compressor, and any other noise-producing items related to the boiler.

2.3 BOILER DETAILS

2.3.1 Materials

Provide materials exposed to the internal environment of the boiler that are compatible with the temperature and atmospheric conditions which they will encounter. Do not use dissimilar metals that, when in contact or otherwise electrically connected to each other in a conductive solution, generate an electric current, in intimate contact.

2.3.2 Lubrication

Provide all sliding, moving, or rotating parts normally requiring lubrication, except those provided with "sealed-for-life" lubrication, with suitable means for lubricating. Ensure lubrication points are readily accessible and identified by a permanent instruction plate mounted in a convenient location on the boiler. Design equipment to operate efficiently and satisfactorily when lubricated using standard military lubricants.

2.3.2.1 Lubrication Fittings

Locate lubrication fittings in accessible protected positions. Paint a bright red circle around each point. Provide carbon steel balls, bodies and tips of fittings. Threads of fittings must be 1/4 - 28 taper, straight or 1/8 pipe threads. Incorporate a surface ball-check valve located at the surface of the inlet tip into fittings. Use cadmium plated carbon steel fittings in accordance with ASTM B766, Type I, Class 5 or zinc coated in accordance with ASTM B633, Type I, Class 1 except that the salt spray test period for red rust corrosion is a minimum of 50 hours.

2.3.2.2 Caution Plates

When the use of high-pressure lubrication equipment, 6.89 MPa 1,000 psi and higher, will damage grease seals or other parts, affix a suitable warning or caution plate to the equipment in a conspicuous location.

2.3.3 Lifting Attachments

Equip each unit with lifting attachments designed and installed to enable the equipment to be lifted in its normal position without undue stress on the unit.

2.3.4 Accessibility

Make all parts subject to wear, breakage, or distortion, and all parts that require periodic maintenance readily accessible for adjustment or replacement.

2.3.5 Interchangeability

Manufacture all parts to standards that will permit replacement without modification to parts or equipment.

2.3.6 Surfaces

Finish or paint all surfaces as specified in paragraph PAINTING AND FINISHING.

2.3.7 Fastening Devices

Provide bolts and nuts that are suitable and conforming to ASME B18.2.1 and ASME B18.2.2 respectively. Ensure all screw threads conform to the requirements of ASME B1.1. Install all screws, pins, bolts, hydraulic fittings, and similar parts with a means to prevent loss of tightness. Ensure such parts subject to removal or adjustment are not swagged, peened, staked, or otherwise permanently deformed.

2.3.8 Electrical

Bring all wiring to a single location. Provide factory wired equipment complete with all necessary accessory devices, so as to require only a source of power at [_____] volts, [_____] phase, 60 hertz, to make the equipment operable. Make wiring neat and secure.

2.3.9 Castings and Forgings

Ensure all castings and forgings are free from defects such as scale, mismatching, blowholes, or any other defect that will affect life or function of the part. Use cast gray iron conforming to [ASTM A278/A278M] [ASTM A48/A48M], cast iron conforming to ASTM A319, and heat resistant alloy conforming to ASTM A297/A297M Grade HF.

2.3.10 Welding, Brazing, Soldering, Riveting, or Wiring

Employ welding, brazing, soldering, riveting, or wiring only where these operations are required in the original design.

2.3.11 Refractory and Insulation

Use manufacturer's proven standard design for refractory and insulation systems. Submit temperature estimates, material quality information, and description of installation methods in sufficient detail to permit evaluation of the materials and methods used. Construction materials and methods must be approved before manufacture. Install plastic refractory in accordance with the manufacturer's recommendations and by workmen skilled in its application. Provide insulation systems consisting of the manufacturer's proven standard materials and methods and submit with data as to adequacy of material. Field repair hot spots exceeding requirements as directed. Field install exposed areas as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.3.11.1 Insulation

Where specified or indicated, insulation must be insulating block containing no asbestos material, designed to prevent damage to foundation and boiler exterior due to excessive heat. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Provide Class 5 mineral fiber block insulation conforming to ASTM C612. Lay insulating block in approved mortar specifically manufactured for this purpose or recommended by the insulating material manufacturer. Provide firebrick conforming to ASTM C27 and ASTM C155. Interpret firebrick to include straight brick, radial brick, wedge brick, skew-type brick, cupola blocks, and other similar shapes. Lay firebrick up in air-setting mortar. Dip each brick in mortar, rub, push into place, and then tap with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel will not be permitted. Use mortar conforming to ASTM F1097. Do not exceed maximum mortar joint thickness of 3.2 mm 1/8 inch and average joint thickness of 2.0 mm 1/16 inch. Insulate main arches of the boiler and flue connection above the firebrick and, where exposed to the weather, protect with a suitable concrete or brick slab. Insulate firebrick floors from the supporting floors with insulating brick except that if the supporting floor has full bearing on earth, a 75 mm 3 inch layer of contained dry sand may be used in lieu of insulating brick. Minimum thickness for walls is [_____] mm inches to limit the temperature of the outer casing to 49 degrees C 120 degrees F in an ambient temperature of 21 degrees C 70 degrees F when the unit is operating at full rated capacity, and as determined by a surface pyrometer.

2.3.11.2 Expansion Joints

Provide joints in the firebrick masonry at [approximately the locations shown] [spacings of approximately 2.44 meters 8 feet]. Provide joints that are 12.7 mm 1/2 inch wide and completely separate the sections without any interlocking of the bricks. [The locations may be changed from those indicated by as much as 300 mm 12 inches in either direction for convenience of construction and changed as necessary, by offset or otherwise, to avoid weakening the arch over an opening.] Expansion joints closer than 300 mm 12 inches to the vertical side of an arched opening or to the top of the brick forming the arch over the opening are not permitted. When joints are offset, do not bond the horizontal faces between the two courses of brick along the offset. In addition, to allow for expansion of the inner face, provide a series of 3.2 mm 1/8 inch wide vertical openings spaced 1.8 m 6 feet apart on the furnace side of the wall. Make proper provision for expansion and contraction between boiler foundation and floor.

2.3.12 Boiler Setting

Construct boiler to comply with ASME BPVC SEC VIII D1 and provide with insulation, steel base, water column with gauge, automatic feed water pump control and low water cutoff, steam pressure gauge, relief valve, automatic steam pressure control and blowoff, and soot-blower. Submit complete setting plans, certified by the boiler manufacturer.

2.3.12.1 Boiler Foundation

Provide foundation structure and install in accordance with manufacturer's recommendations and as indicated. Use structural systems supporting pressure parts, tubes, and refractory with a safety factor to permit delivery of boiler, jacking, and rigging.

2.3.12.2 Supports

Provide boilers and separator drums with support lugs and saddles to provide an adequate and firm installation to the foundation structure. Supports are to provide for free expansion and contraction of each part of the boiler without placing undue stress on any part of the boiler or setting.

2.3.12.3 Shell

Construct casing or shell sides of carbon steel materials no lighter than 3.416 mm 0.1345 inch thick, either bolted or welded. Provide gas-tight casing and reinforce with steel ribs or stiffeners to provide rigidity and prevent buckling. Insulate boiler casing fully with sufficient thickness to limit the casing temperature as specified. Equip boiler shell with all necessary connections including outlet nozzles, return connections, and connections for pressure relief valves, water level controls, and other required trim. Provide manholes, handholes, and observation ports in accordance with ASME BPVC SEC I. Equip boilers with gas-tight observation ports.

2.3.12.4 Expansion and Contraction

Make adequate provisions for expansion and contraction of the boiler unit and associated breaching to prevent damage to the support structure or the equipment and associated ductwork. Make provisions for expansion and contraction between boiler foundation and floor. Pack joints with oakum and fill with a suitable compound that will not become soft at temperatures of 49 degrees C 120 degrees F.

2.3.13 Water-Tube Boiler

Provide a shop fabricated and field erected boiler or a packaged unit. Include water walls, soot-blowers, [economizer,] [super heater,] and steam drums to withstand temperatures existing under maximum load conditions to ensure production of the steam as specified. Include setting refractory, insulation to maintain a casing temperature of no greater than 55 degrees C 130 degrees F with a surface air velocity at 5.4 km/hour 5 feet/second and an ambient temperature of 26 degrees C 80 degrees F while boiler is operating at maximum capacity (do not use asbestos material), and welded or doubled wall casing. Provide hinged access opening covers.

2.3.13.1 Drums or Dome Space

For water-tube boilers, each drum or dome space must be steel plate, fusion welded in conformance with ASME BPVC SEC I, including stress relieving and x-raying of welded seams. Provide main steam drums of sufficient size to accommodate steam separators and drum internals with provisions and space for accomplishment of maintenance. Provide baffling to separate the steam from the water in the drum and to maintain a stable water level under a fluctuating load. Do not exceed 50 mm 2 inches of variations in normal water level with an increasing load change of 20 percent of rated capacity per minute. Provide steam separators to deliver saturated steam with a maximum specified moisture content. Provide each drum with two 300 by 400 mm 12 by 16 inch elliptical manholes, with the exception of the mud drum which has at least one 300 by 400 mm 12 by 16 inch elliptical manhole. Provide a cover, yoke, and gaskets for each manhole.

2.3.13.2 Drum Outlets

Apply drum outlets in approved manner and of approved strength in accordance with ASME BPVC SEC I. Outlets include but are not limited to:

a. Steam nozzle of 2.07 MPa 300 pounds, flanged to receive specified nonreturn stop and check valve, and able to withstand forces and moments imposed by connected piping. Studdery will not be permitted.

b. Boiler vent on shell or steam drum as approved by ASME BPVC SEC I, to be equipped with 2.07 MPa 300 pound steel steam gate valve, nipples, and ells to vent away from operator.

c. Safety valve outlets in required number and size, located approximately as indicated, or as necessary to permit straight run of vent through roof.

d. Water column and low water cutoff connections with outside screw and yoke (OS & Y) valves, [lockable,] [and with locks and keys furnished].

e. Connections for boiler water feed, chemical admission, continuous blowdown and water sampling combined, located as indicated on plans.

f. Intermittent blowdown connections.

g. Water level sensor connections (for level control).

h. Pressure gauge and pressure switch connections.

2.3.13.3 Tubes

Provide tubes of the diameter and arrangement that best suits the manufacturer's recommendation to meet the specified design criteria. Provide electric-welded or seamless steel tubes, and connect to the drums and header by expanding into bored tube seats (standard fit) or by welding in accordance with ASME BPVC SEC IX. Tube wall thickness must be at least the minimum recommended by the manufacturer. Allow finned tubes only when the fuel is gas or oil and provide a continuously welded bond between the tube surface and the helically wound fin. Use tube materials complying with ASTM A192/A192M and provide optimum life expectancy and corrosion resistance. Ensure tube headers, channels, and manifold pipes provide sufficient volume to ensure no part of the boiler will become water-starved. Make radii of all bends in tubes such that standard turbine type cleaners can easily pass through for cleaning of full length of tubes.

2.3.13.4 Baffles

Arrange baffles to bring the products of combustion into contact with the heating surfaces without excessive loss of draft. Ensure baffles are gas-tight and are either a refractory material or metal suitable for temperatures encountered.

2.3.14 Fire-Tube Boiler

Provide packaged type boiler and include programming control system with capacity as indicated. Provide hinged access opening covers.

2.3.15 Boiler Internals

2.3.15.1 Internal Fittings

Use securely mounted and demountable internal fittings for boiler access and cleaning. Internal fittings include, but are not limited to:

a. Boiler feedwater admission system to properly distribute feedwater.

b. Chemical feed piping to permit infusion of caustic, phosphate, and water mixture by continuous feed system.

c. Continuous blowdown and water sampling system as combined unit.

d. Intermittent blowoff system to properly collect mud from bottom and permit drainage of boiler without water accumulation.

2.3.15.2 Outlet Fittings

Provide flanged outlet fittings above 50 mm 2 inches, but may be threaded for 50 mm 2 inches and smaller. [Note that all boiler systems (steam, feedwater, and intermittent blowdown) operate into common headers serving more than one generator.] Provide all devices, designs, and piping methods in full accordance with applicable provisions of ASME BPVC SEC I for pressure piping and evidence by proper certificates of work performance and inspection.

2.3.15.3 Openings

Flash or seal steam outlets, safety valves, and other valve openings in outer casing at top of boiler in a manner to prevent water leaking into the casing insulation.

2.3.15.4 Settling Chamber

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NOTE: Requirement for Settling Chamber is an option depending on the fuel at the heat source.
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Provide settling chamber for removal of fly ash, equipped with suitable means for frequent cleaning without shutting down the boilers, below the last pass of each boiler.

2.3.16 Access Doors

Provide access doors in sufficient number, of adequate size, and properly located for cleaning, inspection, and repair of all areas in the complete assembly. Provide gas-tight doors and line interior surfaces exposed to direct radiant heat and high temperatures with approved refractory material to prevent excessive heat losses and warping of doors. Hinge doors too large or bulky for hand removal. Provide at least one observation port with cast-iron cover on each door of the boiler. Provide an electrical interlock to prevent the tube cleaning system from operating unless the doors are closed and latched. Provide door casing of the same material and thickness as the adjoining boiler casing. Provide door lining consisting of 50 mm 2 inches of block insulation and 102 mm 4 inches of heavy castable refractory conforming to ASTM C401, Class R. Equip doors with high temperature gaskets and door latches.

2.3.17 Miscellaneous Pipe Connections

Provide miscellaneous pipe connections for steam outlet, safety valves, feedwater, feedwater regulator, water column, blowoff, steam supply to soot blowers, steam gauge and vent, continuous blowdown, continuous chemical feed, and instrument connections. Provide soot blowers if the combustion source utilizes solid fuel. Provide a suitable smoke outlet with steel frame, damper, and damper shaft. Provide damper with external high temperature roller or ball bearings at both ends of the shaft, and with a suitable operating arm and rod.

2.3.18 Observation Ports

****
NOTE: Requirements for observation ports and test holes depend upon the specific project, including competence and availability of operating and maintenance personnel, type of fuel to be burned, etc. The number and location of the test holes will conform to the requirements of the regulatory authority. In addition, test holes for monitoring operating efficiency will be provided as shown.
****

Provide [one] [two] observation port[s] 80 mm 3 inches in diameter on each access door and consisting of no less than 2.657 mm 12 gauge black steel or cast iron tube or duct with a heat resistant glass cover or an angular steel frame and closure plate with handle for operation without gloves or other protective devices. Extend tube or duct from the exterior of the casing to no less than one-half the thickness of the refractory opening and make gas-tight. Make provision for air purging of the port when solid fuels are used at the heat source.

2.3.19 Test Holes

****
NOTE: Coordinate with paragraph Observation Ports.
****

Provide test holes as indicated and fit with standard weight, 50 mm 2 inch diameter, black steel pipe. Extend sleeve from the exterior of the casing to no less than one-half the thickness of the refractory lining. Form refractory opening from the end of the pipe sleeve to the interior wall surface to shield the end of the sleeve from reflected heat. Fit sleeve with a brass screw cap and security chain. Weld two or more sturdy lugs in approximately the middle of the length of each test pipe to prevent the pipe from turning when the cap is being removed.

2.3.20 Safety Devices

Use boilers with safety devices providing automatic overheat shutdown and manual shutoff of the combustion equipment or flue gas dampers to bypass the boiler.

2.3.21 Freeze Protection

Equip low points of all piping and tubing with drains for freeze protection.

2.3.22 Fire Protection

Provide boilers meeting the requirements of NFPA 85.

2.4 BOILER AUXILIARY EQUIPMENT

2.4.1 Boiler Fittings and Appurtenances

Provide boiler fittings, and all other boiler appurtenances complying with ASME BPVC SEC I. Provide boilers with a continuous blowdown connection from an internal pipe running the length of the steam drum at the point of the highest concentration of dissolved solids. Make blowoff provisions from the mud drum or lower part of a fire-tube boiler. Provide pressure gauges for high-pressure steam units which include a siphon, gauge cock, and test connection. Ensure trim and appurtenances include a 150 mm 6 inch minimum pressure gauge and a safety valve. Provide a chemical feed connection with internal distribution pipe.

2.4.1.1 Water Column

Provide water column with straight-through type drain valve. Provide water column complete with gauge glass, high- and low-water alarm, and three quick-closing gauge valves and try cocks fitted with the necessary chains and handles for operation from the boiler room floor. Also include a test valve, blowdown valve, and a straight-through type drain valve. Do not combine water column with the low water cutoff. [Provide water column lighting for ease of reading at all times.]

2.4.1.2 Low Water Cutoff

****

NOTE: When the boiler is used as a "heat recovery unit," an alternate path is usually provided to vent or bypass the hot gases in the event the boiler is unable to perform its function. In all other cases, activation of the low-water cutoff will cause the loss of all support to the combustion process including loss of combustion air and fuel.
****

Provide a low-water cutoff, with alarm located on instrument panel, and include either a float-actuated switch as a means of making electrical contact or an electrically-actuated probe type low water cutoff. Provide float chamber with a blowdown connection. The cutoff must cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum level [and route hot gases from the combustion equipment to the bypass stack]. [Install two low-water cutoffs on each boiler. Pipe low-water cutoffs for the boilers separately with separate drum connections. Provide a separate housing for each low-water cutoff. Two elements in one housing will not be permitted.] A safety shutdown due to low-water cutoff must require a manual reset before operation can be resumed and must prevent recycling of the combustion equipment. The cutoff must be in strict accordance to the latest version of code, ASME CSD-1, Controls and Safety Devices for Automatically Fired Boilers.

2.4.1.3 Feed and Check Valves

Provide feed and check valves adjacent to each boiler feed nozzle.

2.4.1.4 Continuous Blowdown Valve

****
NOTE: Continuous blowdown equipment will be provided as required by UFC 3-410-01 or UFC 3-410-02. If a fire-tube boiler is specified, these paragraphs will be deleted.
****

Provide manual proportioning continuous blowdown valves, fabricated of corrosion-resistant steel. Provide valves with a micrometer dial setting and a chart listing the capacities through the complete range of micrometer settings at the boiler pressure. Provide valves conforming to ASME BPVC SEC I. Provide blowoff valves in tandem at each point of blowdown as recommended by the boiler manufacturer. Provide piping consisting of extra-heavy weight, minimum, steel pipe conforming to ASTM A106/A106M Grade B. Use balanced, seatless type slow opening valves unless otherwise approved. Provide both surface and bottom blowdown connection points with required accessories. Provide valves with a capacity equal to the capacity of the boiler and forged steel bodies with socket weld connections. Provide valve with a solid Stellite disk with stainless steel seat sleeves. Design the bodies for a minimum working pressure of 2.07 MPa 300 psig. Quick opening valves must be lever operated, flat seat sliding disks with sealing bushing on the inlet side, and double tightening on both sides of the disk. Provide gear operated quick opening valves. All blowoff valves must be suitable for safe blowdown through the piping system installed. Supply all pipe, valves, and fittings as necessary to allow tie-in to a central point for surface and bottom blowdown.

2.4.1.5 Safety Valves

Provide safety valves of proper size and of the required number and construction and set pressures in accordance with ASME BPVC SEC I and install so that the exhaust steam will discharge through pipes extending through the roof. Provide a drip-pan elbow for each exhaust riser to prevent the accumulation of water on the valve. Provide a suitable slip joint between the drip-pan elbow and the riser. Each exhaust head must be one-piece construction of plate steel, semisteel, or cast iron, equipped with suitable baffle arrangement and drain connection for removing entrained condensate and oil. Flow area through the valve must be larger than through the connecting pipe. Set valves to discharge at 10 percent above the operating pressure of the system.

2.4.1.6 Steam Nonreturn Valves

Install steam nonreturn valves of size and pressure rating shown in the steam supply line from each boiler. Arrange valves to close automatically when there is a pressure differential of 35 kPa 5 psi between the boilers and steam headers, and arrange to operate as stop valves. Set rising stem type valves with stem up, either inclined or vertical. Provide angle or straight-way type valves and operate without chattering, hammering, or sticking. Valves must be cast steel.

2.4.1.7 Feedwater Regulator

Connect feedwater regulator, sized for the application, complete with all necessary piping and accessories for automatic operation. Provide valved bypass around the control valve. Provide units with a device to lock the regulator in existing position in case of power failure. Provide unit with a manual/automatic selector panel located on the instrument panel in the control room. Provide feedwater control element with a drain valve. Fit feed-water line with a thermometer well. Mechanical linkages and chains to position the valve are not allowed. Provide feed-water piping conforming to the requirements of ASME BPVC SEC I. Provide a hand wheel or a manual jacking device to permit manual operation of the regulator valve.

2.4.1.8 Soot Blowers

****

NOTE: Soot blowers should be required for all boilers when solid fuel is burned, and are advisable when burning No. 6 fuel oil. If only gas or No. 2 fuel oil is being burned, this paragraph may be deleted. Soot blowers are available for fire-tube boilers.

****

Provide soot blowers in conjunction with the heat recovery or boiler section of each solid fuel fired steam generation system. Furnish soot blower or cleaning nozzles in sufficient numbers, permanently mounted, and so arranged or spaced to effectively clean all tube surfaces. Each soot blowing system must be an automatic sequencing, flexible operation using air or steam as the blowing medium. Construct elements within the boiler of heat-resisting alloys suitable for the flue gas temperature encountered and are removable without disturbing the boiler tubes. If the soot blowers are air operated, provide air compressors with sufficient capacity to accommodate the additional load of the soot blowers. [Provide each boiler unit with a cyclone separator installed in conjunction with the boiler stack to capture particulate matter emitted during tube cleaning operations.] Control frequency of the cleaning operation automatically by timers that are interlocked with the inspection doors to prevent cleaning when the doors are open. Furnish each blower unit complete with all necessary auxiliaries, controls, and equipment and connect according to the manufacturer's recommendations.

2.4.1.9 Drains

Install drains consisting of a 20 mm 3/4 inch hose bib or a 25 mm 1 inch hose gate valve at the lowest point in the return main near the boiler and at locations shown or as required for the convenient and thorough draining of the system.

2.4.2 Economizers

****

NOTE: The economizer or air preheater will be selected to be compatible with any pollution control equipment being utilized. Finned tubes will not be used for solid fuels.

****

Use economizers of a type normally provided by the boiler manufacturer and include [finned tubes,] [bare tubes,] baffles and headers and have provision for cleaning and tube bundle removal. At maximum load, economizer exit water must not be within 17 degrees C 30 degrees F lower than saturation temperature. Provide materials capable of withstanding the maximum boiler exit gas temperature plus 28 degrees C 50 degrees F. Provide tubes conforming to ASME BPVC SEC I. Overall design and installation must preclude cold-end corrosion under any load condition. Economizer exit flue gas temperature must be no less than 177 degrees C 350 degrees F and the tube metal temperature must be above the maximum flue gas dew point for the fuel being fired under all load conditions.

2.4.3 Air Preheaters

****

NOTE: The economizer or air preheater will be selected to be compatible with any pollution control equipment being used.

****

Use air preheaters of a type normally provided by the boiler manufacturer which are recuperative, tube plate, or regenerative type constructed of materials adequate to withstand the corrosion effects of the flue gases. Overall design must preclude cold-end corrosion of the air preheater under any load condition. Temperatures of all metals in contact with flue gas must be above the flue gas maximum dew point temperature for the fuel being fired under all load conditions. Control by steam preheat or by automatic bypass and integrate with the combustion control system.

2.4.4 Draft Fans

****

NOTE: Where induced draft fans are installed directly after the heat recovery boiler, it may be necessary to provide liners for scroll sheets and rotor blades if the gases contain particulates in

excess of 229 mg per dry standard cubic meter (0.10 gr/DSCF). The fan design and construction will be strongly influenced by the type of particulate control device used and its location relative to that device.
****

Furnish induced draft centrifugal fans, as specified, as an integral part of the boiler design. Provide unit consisting of an electrical motor driven centrifugal fan, a housing (scroll and side plates), controls, guards and accessories. Attach all components to a common base which includes provisions for fastening to a foundation. Provide completely assembled unit, ready for installation and operation.

a. Provide fan assemblies suitable for continuous boiler draft operation to handle flue gases having temperatures up to 800 degrees F. Provide fans complying with AMCA 99 standard applicable to centrifugal furnace fans and that are rated for flow rate, pressure, power, speed of rotation and efficiency in accordance with AMCA 210 and ASME PTC 10. Submit to the Contracting Officer satisfactory evidence that the fan furnished meets the requirements of AMCA 210. Acceptable evidence of meeting the requirements of this standard will be the AMCA Certified Rating Seal or a certified inspection report from an independent testing laboratory indicating that the fan conforms to the requirements of AMCA 210.

b. Provide centrifugal fans with backward curved blades or radial tip blades. Size each fan for operation at an elevation of [_____] meters feet, with an output volume and equipment, leaks, and temperature and elevation corrections for a dirty boiler with worst ambient conditions, all at full combustion. In addition, include margins of 10 percent excess volume against a 21 percent static pressure and air temperature 22 degrees C 40 degrees F above operating temperature.

c. Design induced draft fans for handling hot flue gas at the maximum boiler outlet temperature adjusted for boiler surface fouling. Provide [single] [or] [double] width centrifugal type fans. [When the fan is a double-width centrifugal type, it must have a double inlet.] Ensure the direction of fan rotation is [clockwise] [or] [counterclockwise] as determined from the drive side of the fan. Ensure the direction of discharge is [top horizontal] [top angular down] [down blast] [bottom angular down] [top angular up] [up blast] [bottom angular up] [or] [bottom horizontal]. The position of inlet box must be [45] [90] [135] [180] [225] [270] [315] [or] [360]. Provide fans with a static efficiency of no less than 0 percent in standard air at best efficiency point. Construct fan wheel of [steel] [or] [aluminum]. Turn, grind, and polish the shaft. Balance the fan wheel and shaft assembly statically and dynamically. Balance the complete rotating assembly of the fan dynamically within the limits of the following formula:

$$\frac{\text{Vibration displacement}}{\text{mills-peak-to-peak}} - \frac{1.620}{\text{revolutions per minute}}$$

Noise levels for fans must not exceed 85 dBA at a 914.4 mm 3 foot station. Provide fan housing consisting of carbon steel of a nominal thickness no less than that selected in Table I.

TABLE I HOUSING GAUGES

Nominal fan diameter (mm) (inches)	Sides	Scroll
up to 584 23	3.42 mm (10 gauge) 10 gauge	3.42 mm (10 gauge) 10 gauge
600-68524-27	4.55 mm (7 gauge) 7 gauge	4.55 mm (7 gauge) 7 gauge
1855 73 and over	6.35 mm 1/4 inch	6.35 mm 1/4 inch

Provide continuously welded scroll and sideplate joints. Reinforce housing with steel member to provide a rigid structure and to minimize vibration. [Locate a threaded drain connection to accommodate a 25 mm 1 inch standard pipe at the lowest point in the scroll. Include a flush-type access door in the scroll and hold by quick-release clamps and locate as specified. Provide flanged inlet and outlet duct connections].[Equip the inlet of the fan with an inlet box of the same steel thickness as the housing.] Provide seals to minimize leakage where the shaft passes through the housing or inlet box. [Provide scroll sheets and rotor blades with liners.]

a. Insulate induced draft fans as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Factory paint fans with the manufacturer's standard finish. If drawings so indicate, design the induced-draft fan housing to support the portion of the boiler stack that is resting on the housing. Provide fans with [inlet vane control] [inlet damper control] [variable speed control]. Provide inlet vanes or dampers that are suitable for use with combustion control equipment. Equip fan with [precision anti-friction bearings that meet the requirements for a minimum rating life of 100,00 hours] [the self-aligning sleeve type] [or] [roller bearings mounted in suitable pillow blocks]. Fans with backward curved blades may have self-aligning anti-friction bearings.

b. Provide air cooled fan bearings. Provide air balanced pillow blocks or auxiliary seals to prevent the aspiration of oil from oil slinger type bearings. Provide oil reservoir with heat slingers for control of air movement over the bearing housing in order to prevent a buildup of ambient temperature. Provide means for lubrication in accordance with the manufacturer's standard practice. Locate parts requiring lubrications to make the lubricating points easily visible and accessible. Provide hydraulic lubrication fittings in accordance with SAE J534. Where use of high-pressure lubricating equipment, 1000 pound-force per square inch or higher, will damage grease seals or other parts, affix a suitable warning to the equipment in a conspicuous location. Properly lubricate all parts requiring lubrication before delivery.

c. Drive fans by electric motors. Provide electric motor which is [drip proof] [totally enclosed, nonventilated] [totally enclosed, fan-cooled] [totally enclosed, fan-cooled, suitable for installation in a Class 1, Division 1, Group F, hazardous location conforming to NFPA 70]. Motor starter must be magnetic [across-the-line] [reduced voltage start] with [general-purpose] [weather resistant] [watertight] [dust-tight] [explosion-proof] enclosure and furnished with four auxiliary interlock contacts. Connect fans directly or indirectly to the driving motor. If the fan is indirectly connected, provide a V-belt designed for 50 percent overload capacity, and mount the motor on the base in a manner that will permit tightening of the belt.

2.4.5 Flue Ducting

Connect each boiler to the stack or flue by means of a smoke connection constructed of black iron or steel sheet no less than 1.214 mm 0.0478 inch, nominal thickness. Ensure clear distance between any portion of the smoke connection surface and any combustible material is not less than that specified in NFPA 211. Fasten joints and seams securely and make airtight. Provide suitable clean-outs to permit cleaning the entire smoke connections without dismantling. Construct duct conforming to SMACNA 1966. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.4.6 Breaching

Construct breaching of no less than 3.416 mm 10 gauge steel sheets conforming to ASTM A36/A36M. Reinforce and brace breaching adequately with structural steel angles no smaller than 50.8 by 50.8 by 6.4 mm 2 by 2 by 1/4 inch and weld all joints and seams in the sheets and angles. Install flexible type expansion joints that require no packing as indicated and required to suit the installation. Provide breaching with angle flanges and gaskets for connection to boilers, fans, equipment, or stacks with breaching to be the full size of the opening. Line breaching with a minimum of 76.2 mm 3 inch thick refractory. Make gas-tight breaching connections, caulk tight all around and seal with cement to form an air-tight joint. Provide clean-out openings consisting of tight-fitting hinged doors with frames, of suitable size, and at approved locations for access to all sections of the breaching. Locate one 400 by 400 mm 16 by 16 inch inspection door in the side of the breaching just preceding the boiler unit. Locate a similar inspection door just following the boiler unit. Breaching may be supplied in bolted or welded sections for ease of handling and erection and constructed in accordance with SMACNA 1966. Provide connectors in accordance with NFPA 211. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.4.7 Flue Gas Inlet Damper

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NOTE: Optional wording is applicable to guillotine-type dampers.

****

Install a [guillotine] [butterfly] [shutter] damper [of the thickness indicated] [at least 63 mm 2-1/2 inches thick] and consisting of refractory material enclosed in a steel frame at the entrance of the waste heat recovery boiler to isolate it from the combustion equipment during emergency boiler repairs. Furnish a [chain hoist] [manual lever] [electrical control] for raising and lowering the damper and must be of a size and design to ensure free movement by the damper. [Secure the hoist cable to the damper frame by shackles and bolts. Provide damper slot with a steel plate cover 6.4 mm 1/4 inch thick and of the proper length and width. Provide cover with a slot to permit passage of the damper cable, and for easy removal of the damper. Provide hoist that is a product of a manufacturer regularly engaged in the manufacture of hoists. Provide spur geared hoist. Design unit for high-speed lifting, have high mechanical efficiency, an automatic load brake, and a built-in load limit.] The operator must be able to move the required load freely and maintain the damper in any desired position within the limits of the flue opening. Do not exceed a maximum pull of 310 Newtons 70 pounds to operate the unit.

2.4.8 Flue Gas Discharge Dampers

Install a controller-actuated, refractory-lined damper at the boiler exit. Install another damper in the dump stack and open if any of the following conditions occur:

a. Excess boiler steam pressure.

b. Induced draft fan failure.

c. Boiler is shut off.

Operate boiler dampers by a controller-actuated motor based on the [boiler steam pressure] [boiler water temperature]. Provide reverse acting boiler and dump stack dampers, i.e., when the boiler damper is open, the dump stack damper will be closed.

2.4.9 Blowoff Tank

[Construct blowoff tank of 4000 psi reinforced concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE, and fit with a bolted steel manhole cover and frame. Install blowoff pipe, vent pipe, and drain pipe to sewer in pipe sleeves built into the concrete. Fill and caulk space between the pipe and sleeves with lead wool or similar material to make a water-tight connection. Divide tank into two sections by a baffle to form a sediment chamber] [Construct blowoff tank of steel].

2.4.10 Boiler Feed Pumps

Size and design boiler feed pumps for the specific application. Furnish pumps having a combined rating of flow and head that results in a horsepower rating less than 186 kW 250 bhp to meet the design requirements of API STD 610. Provide either end-suction or top suction, top-discharge pump and support at the center line. Pump size with higher ratings than the above must be horizontal-split case, multistage centrifugal pumps. All pump ratings must have, nominally, an excess capacity of 10 percent above the maximum continuous rating of the service. The required net positive suction head (NPSH) at the pump design flow, head, and speed must not exceed 80 percent of the available system NPSH at the same flow, assuming a low level in the storage tank. Ensure guaranteed NPSH requirements reflect 3 percent breakdown criteria. Ensure the pump's head-capacity (H-Q) curve is constantly rising to shutoff with no point of inflection. There must be no restriction to operation at any point from continuous flow to design flow. Provide turbine type pumps, bronze fitted throughout, with impellers of bronze or other corrosion-resistant metal as approved. Fit pump barrel assemblies with lifting rings. Use capacities and characteristics as indicated.

2.4.10.1 Casings

Construct casing using either volute or diffuser design and support at its centerline. Provide pumps with integrally cast suction and discharge flanges that are drilled to meet the design pressure of the application. Use a maximum operating temperature, for design purposes, of any feedpump that is no less than 204 degrees C 400 degrees F. Drill and tap casings. Provide casings with vent, gauge, and drain connections. Pumps designed for this service must not require cooling at ratings below 370 kW 500 bhp.

This applies to both frame cooling or seal cooling. Below 370 kW 500 bhp, employ antifriction radial and thrust bearings lubricated by flinger rings in a sealed housing. Provide seals consisting of mechanical and air-cooled flush piping conforming to API STD 610, Plan 23. Above 370 kW 500 bhp, employ a single cooling circuit for both cooling and delivering the oil by a forced-oil system to sleeve radial bearings, and a floating shoe thrust bearing, coupled with the seal coolers for both stuffing boxes. Provide mechanical seals and an extra seal replacement kit for each pump. In both cases, stuffing boxes must be site-convertible to a packed box. Ensure leakage is no more than 25 cc/hr for a seal life of not less than 25,000 hours. Ensure bearing rating is not less than 100,000 hours (L-10 life) at the point of maximum load, as defined by ABMA 9. Cool sump by indirect coil. Design pump casing to allow the pump barrel assembly to be removed as a unit, from the drive shaft end to the impeller, without disturbing the main piping or the drive [motor] [or] [turbine].

2.4.10.2 Pump Base

Support pumps on structural steel bases that do not require grouting in order to impart strength to the pump for static and dynamic loading from the piping system. Provide bases for pump and drive assembly and support complete with drain lip and pitch to a low-point drain. Shop align the complete pump and motor assembly using shims on both the pump and motor. Install pumps on their concrete foundations where shown on the drawings.

2.4.10.3 Pump Couplings

Furnish all pumps with nonlubricated flexible-disk couplings and a coupling guard. Provide spacer type couplings to permit removal of the mechanical seals and limited-end-float-type for pumps with sleeve bearings.

2.4.10.4 Pump Relief Valve

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NOTE: If automatic recirculation valve is utilized, delete this paragraph.

****

Where an automatic boiler feedwater recirculation valve is not used, arrange each boilerfeed pump for continuous operation and furnish with a suitable relief valve for bypassing the boiler feed to the deaerating feedwater tank to maintain a minimum flow of 5 percent under shutoff conditions. Use feedwater regulating valve to maintain a constant feed-pump discharge pressure. Provide an internal-pilot-operated piston valve, single-seated, V port or tapered plug, and adjust to maintain within 7 kPa 1 pound of the desired terminal pressure, regardless of fluctuations in the initial pressure or fluctuations in the rate of flow. Construct valve body of bronze with renewable disks and seats of hardened stainless steel and design for a working pressure of not less than [1.72] [_____] MPa [250] [_____] psig. Provide a position indicator with the valve.

2.4.10.5 Pump Shutoff Valve

Fit each pump with a shutoff valve on the suction inlet line and with a nonslam check valve and a shutoff valve on the discharge line. On pump sizes over 3 L/second 50 gpm, provide an automatic recirculating bypass valve unit on each pump discharge to prevent the pump from overheating and consequent damage at low flows. Where the automatic recirculating valve is so designed, it may be used as a combination check valve and recirculating valve and the separate nonslam check valve may be omitted.

2.4.10.6 Steam Turbines

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NOTE: Steam driven boiler auxiliaries will not be used unless the exhaust steam can be used completely. It is recommended that a life cycle cost study be performed to determine if this section is applicable. Reference to steam drives will be deleted if inapplicable for the equipment specified.

****

Provide steam turbines for boilerfeed pump to operate the pump properly in a steam pressure range of [_____] kPa psig with steam back-pressure of [_____] kPa psig. Turbines must have horizontally-split, two-piece, centerline supported casings, water-cooled bearing cases with ring-oiled, babbitt lined, bronze packed sleeve bearings. Equip turbines with a mechanical shaft speed governor and valve, independent over-speed emergency governor and trip valve, reed tachometer, constant pressure type governor, insulation with removable metal jacket, oil-sight glasses with guards, stainless steel steam strainer that is removable without disconnecting piping, any special wrenches and tools required for servicing the turbine, and a sentinel warning on the exhaust casings. Provide turbines conforming to NEMA SM 23.

2.4.10.7 Electric Motor Drives

Select electric motors for continuous duty and nonoverloading characteristics suitable for the power characteristics available. Provide [splashproof] [totally enclosed, nonventilated] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type, suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70] motors. Provide magnetic, reduced voltage start type motor starter with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.

2.4.10.8 Shop Hydrostatic Testing

Subject all pumps to shop hydrostatic testing. Subject one pump in each service to a complete shop performance test to demonstrate that, at rated capacity, head is within a margin of plus 3 percent and minus 0 percent of design; efficiency is within a tolerance of minus 0 percent; NPSH at the pump's BEP and at the rated condition is within a margin of plus 0 percent and minus 10 percent. Make performance tests in accordance with API STD 610. Procedures and results are subject to the approval of the Contracting Officer.

2.4.10.9 Control Location

Start boiler feedwater pumps through the combustion equipment/boiler panel, manual/automatic switch.

2.4.11 Condensate Pumps

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NOTE: If inadequate NPSH is available, give consideration to substituting either a double suction or positive displacement pump.

****

Condensate pumps must be horizontal, end-suction, single-stage, centrifugal, motor-driven pumps. Provide casing of proper material for the pressure involved, and provide bronze or Monel trimmed pumps, with stainless steel shafts or shaft sleeves, and bronze impellers. Provide pumps with stuffing boxes. Lubricate by splash oil with oil level sightglass provided. Pumps are subject to the same tests specified for the boiler feedpumps. Install condensate pumps on suitable concrete foundations. Provide each pump with the capacity to pump 100 percent of the design load continuously. Pumps will pump a mixture of condensate and sodium zeolite softened water from the condensate tank to the deaerator. The NPSH required for all pumps must not exceed [_____] meters feet, and the pumps must be capable of handling water up to 99 degrees C 210 degrees F under these conditions without cavitating. Ball bearings amply sized for any and all thrust loads expected must be water-or oil-cooled and self-aligning. All necessary vents, drains, petcocks, oil sight glasses, etc., and the proper packing materials for mixed condensate and makeup water service must be of the manufacturer's highest standards. Provide factory assembled horizontal pumps to the motor drives on a rigid structural steel or cast iron baseplate. Connect each pump directly to a motor through a flexible coupling with approved coupling guards.

2.4.11.1 Design Conditions

The design conditions are:

a. [_____] L/second gpm.

b. [_____] head.

c. Water pumped at 16 to 99 degrees C 60 to 210 degrees F.

2.4.11.2 Condensate Pump Drives

Provide amply sized condensate pump motor drives to handle the pump power with low discharge heads and do not exceed 1750 revolutions per minute (rpm). Supply ball bearing motors of totally enclosed fan-cooled construction for the power characteristics available. Provide condensate pump motors with a magnetic across-the-line starter equipped with thermal overload protection. Locate starters in the motor control center.

2.4.11.3 Condensate Pump Auxiliaries

Provide condensate tank and pumps complete with all piping, suction strainers, suction and discharge valves, check valves, and fittings required for an integrated unit. Make provisions in the pump suction and discharge lines for thermal expansion and vibration isolation. Use factory assembled piping. Furnish all pumps with isolating valves on suction and discharge, suction strainers, startup strainers, silent check valves, and recirculating piping. Arrange pumps with bypass line and orifice in accordance with manufacturer's specifications to recirculate pumped fluid. Provide all controllers, alarms, gauges, sight glasses, control valves, etc., with shutoff and/or bypass valves as required for maintenance of the system while in operation.

2.4.12 Emergency Interlock

Provide emergency interlocks to bypass the flue gas or shut down the combustion source, in case of low water, high or low pressure, power failure, or control failure. The system must act automatically.

2.4.13 Calorimeter

Provide a calorimeter connection in the steam main and provide a flange nozzle between the stop gate and the nonreturn valve to permit release to atmosphere when testing the boiler at maximum capacity. Equip the flanged nozzle with blind flange and gaskets.

2.5 CONDENSATE TANK AND ACCESSORIES

2.5.1 Condensate Tank

Design condensate tank for a working pressure of 103 kPa 15 psig and conform to ASME BPVC SEC VIII D1. Provide tank with a storage capacity equal to or greater than indicated and install complete with all piping and accessories. Factory prime condensate tank with the manufacturer's standard paint.

2.5.2 Feedwater Makeup Valve

Provide a float-controlled valve for emergency feedwater makeup to the tank. Operate valve by a float-control mechanism connected to the surge tank and maintain a suitable minimum water level in the tank. Locate float box outside the tank and ensure connections are properly valved to permit blowdown and servicing.

2.5.3 Overflow Trap

Install an overflow trap designed for the service with the condensate tank. Operate the trap to prevent the water level in the surge tank from rising above a predetermined point by automatically discharging the excess water and design to prevent the escape of steam and air.

2.5.4 Tank Connection and Controls

Provide tank with all necessary threaded and flanged openings for condensate return, 300 by 400 mm 12 by 16 inch (minimum) access manhole, overflow, drain, pump suction, gauge glass with cocks and drains, and other openings as required. Provide tank with a low-level alarm and pump shutoff and high-level alarm. Provide alarms consisting of an alarm horn and warning lights mounted on the control panel as specified.

2.5.5 Design Conditions

The design conditions are:

Tank Capacity (Normal-1/2 capacity)	[_____] liters gallons
Tank Capacity (Design to overflow)	[_____] liters gallons
Condensate Temperature	16 to 99 degrees C60 to 210 degrees F
Tank Operating Pressure	Atmospheric
Tank Outlet Capacity (operating)	[_____] kg lb per hour

Tank Outlet Capacity (design)	[_____] kg lb per hour

2.5.6 Detail Specifications

Provide tank consisting of butt fusion welded steel plate with a maximum diameter of [_____] and a maximum straight side length of [_____]. Test tank under pressure to assure no leaks. Make provisions in the tank for all connections. After fabrication, clean the interior of the tank of all mill scale, oil, and weld splatter and then coat with a baked-on phenolic lining or approved equivalent material that is suitable and guaranteed for continuous immersion in condensate and softened water from a sodium zeolite softener at 99 degrees C 210 degrees F. Provide shop assembled condensate tank and check for proper fit of accessories. Determine what items should be removed and ship loose for field assembly. Erect condensate tank in a horizontal position.

2.5.7 Condensate Tank Trim

Provide condensate tank with the following trim:

a. Water gauge glasses with shutoff valves to cover the full water level travel.

b. Thermometer.

c. Makeup water control valve with inlet, outlet, and bypass valves. Mechanical linkage control will not be acceptable.

d. Pneumatic level controller.

e. Level switches with provisions to attach an alarm or 120 volt control signal.

f. Drain valve.

g. Insulation clips for 25 mm 1 inch block insulation.

h. Provide all controllers, alarms, gauges, sight glasses, control valves, etc., with shut off and/or bypass valves as required for maintenance of the system while in operation.

2.5.8 Additional Requirements

Provide all required foundations, anchor bolts, concrete work, and grouting shown in the manufacturer's load diagram and anchor bolt plan. Provide insulation and covering conforming to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide all wiring incidental to the operation of controls and instrumentation. Provide all piping to connect to the tank for accessories.

2.6 HEAT EXCHANGERS

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NOTE: If the bulk of the condensate return is at a high temperature, as from a laundry, a heat exchanger will be used. If the bulk of the condensate is returned to a heating pump unit, a

heat exchanger will not be required for that application. Heat exchangers can be used for either heating or cooling the condensate.
****

a. Design, fabricate, test, and stamp heat exchangers in accordance with ASME BPVC SEC VIII D1. Additionally, meet the requirements of HEI 2623. Ensure closed feedwater heater designs meet the requirements of HEI 2622. Provide all heat exchangers with relief valves as required by ASME BPVC SEC VIII D1 and HEI 2623 and design for a working steam pressure of [586] [_____] kPa [85] [_____] psig. [Design heat exchangers using service water to have the service water inside the tubes.] [The exchangers must be of straight tube design with bolted full diameter access channel covers to facilitate tube maintenance as required.] Return bonnets are acceptable when there are no tubeside connections at the far end.

b. Use carbon steel materials of construction, except use service water side materials that reflect the service water available. When the water quality permits, provide stainless steel tubes in accordance with ASTM A249/A249M, Grade TP 304; provide all carbon steel for the remainder of the tube side. When the service water is known to contain chloride levels harmful to stainless steels, provide 90-10 Copper-Nickel tubes in accordance with ASTM B111/B111MAlloy 706; provide the following for the remainder of the service water side: tubesheets, Monel-clad steel; channel covers, carbon steel lined with Monel; channels and bonnets, Monel.

c. Fixed tubesheet designs are preferred when operating conditions do not impose a large differential movement that cannot be readily accommodated with a simple thin-wall metal bellows expansion joint. For larger differentials, a packed floating tubesheet with lantern ring is acceptable up to 1.03 MPa 150 psig design pressure. For pressures above 1.03 MPa 150 psig, use a split-ring floating-head design.

d. Provide heat exchangers, steam-to-heat domestic water or other fluids such as glycol-water mixtures or fuel oil with the steam in the shell side. Provide exchangers of U-tube designs with bolted full-diameter channel covers to facilitate tube maintenance as required. Ensure the tubesheet is the full diameter to match the shell flange and has sufficient threaded holes so that a shell hydro test may be applied without the channel in place. Materials of construction must be all carbon steel with the exception of the tubes which should typically be specified as stainless steel in accordance with ASTM A688/A688M, Grade TP 304, stress relief annealed temper with the U-bends stress relieved after bending. Provide fuel oil heaters with carbon steel tubes in accordance with ASTM A179/A179M and furnish in the stress relief annealed temper with the U-bends stress relieved after bending.

e. Use feedwater heaters consisting of all-welded construction with bolted full diameter channel covers to facilitate tube maintenance as required. Ensure the channel barrel is integral with the tubesheet and has an internal pass partition bolted cover design that is readily removable when the channel cover is removed. Pass partitions that are sealed with a gasketed groove in the channel cover are prohibited. Use carbon steel for all materials of construction except the tubes. Provide pressure boundary material in accordance with ASTM A516/A516M, Grade C, when plate material is required, or ASTM A350/A350M when forging material is required. Provide shroud plate material for desuperheating and subcooling zones in accordance with ASTM A285/A285M, Grade C. Provide stainless steel tubes in accordance with ASTM A688/A688M, Grade TP 304, stress relief annealed temper with U-bends stress relieved after bending. Coat shell on the outer surfaces with an approved rust-inhibiting paint. Design coils for a working pressure of [_____] kPa psig. [Employ a heat exchanger to reduce the temperature of high-pressure condensate by heating domestic or boiler feedwater, to prevent excessive flashing in the condensate tank.]

2.7 DEAERATING FEEDWATER HEATER

Install deaerating feedwater heater, of the size and capacity indicated, where indicated. Provide steel plate shell. [Provide a corrosion-resistant steel tray system for a Type I unit.] Provide [copper] [corrosion-resistant steel] floats. Provide a [loop seal] [float-controlled overflow trap] overflow control. Provide a heater with a pressure relief valve, thermometers, pressure gauge, and oil separator. Install a combination temperature-pressure recorder for each feedwater heater. Take steam pressure readings from the shell, and the temperature bulb must [indicate] [record] the temperature of the feedwater after it passes over the trays and sprays. Provide an alarm to turn on a red pilot signal lamp and to sound a bell in the event that the water level in the feedwater heater storage tank falls to 300 mm 12 inches above the bottom of the tank. Operate system by an approved type of external electric float switch connected to the tank. Mount signal lamp and bell where directed. Provide float operator for the deaerator level control valve of the externally connected cage type of semisteel construction and noncorrodible float, both designed for 858 kPa 125 psig working pressure, piped with shut-off and drain valves.

2.7.1 Design Conditions

The design conditions are:

Outlet Capacity Design	[_____] kg lb per hour
Outlet Capacity - Operating	[_____] kg lb per hour
Operating Pressure	[_____] kPa psig
Design Pressure	[_____] kPa psig
Storage Tank Capacity	[_____] L gal (Normal Level) at centerline
Operating Temperature	[_____] degrees C F
Pumped Condensate - Operating	[_____] kg/hour at degrees C lb/hour at degrees F liq
Pumped Condensate - Design	[_____] kg/hour at degrees C lb/hour at degrees F liq (min temp)
Makeup steam - Operating	[_____] kg/hour kPa (2.79 MJ/kg) lb/hour psig (1200 Btu/lb)
Makeup steam - Design	[_____] kg/hour kPa (2.79 MJ/kg) lb/hour psig (1200 Btu/lb)

2.7.2 Detail Specifications

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NOTE: In general, use tray system for fluctuating loads and the spray system for steady loads.

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Provide spray type heater with spray valve vent condenser in accordance with ASME BPVC SEC I and design for [_____] kPa psig working pressure. Deaerator must be ASME stamped. All steel plate used in construction of the heater and storage tank shells must be ASTM A285/A285M Grade C. Where thickness makes it desirable, ASTM A515/A515M or ASTM A516/A516M steel may be used as appropriate. Include at least 2.0 mm 1/16 inch corrosion allowance over the calculated ASME Code thickness. Test heater and storage tank at a pressure 50 percent in excess of the design pressure. Design heater so that corrosive gases do not come in contact with the outer shell or heads of the unit. However, units not complying with this provision will be accepted providing the upper head and the heater shell sections in contact with gases are clad with 304 stainless steel, 2.0 mm 1/16 inch minimum thickness. Provide heater with adequate supports, manholes, gauge glasses denoting full water travel in the storage section, and all other connections as necessary for a complete working unit, along with those called out as accessories. Provide heater with an internal vent condenser fabricated entirely of stainless steel which includes a vent hood and vent orifice or separate vent valve. Heater section must contain spring-loaded spray valves mounted in a stainless steel water box and a stainless steel vent condenser. Construct spray valves of 18/8 stainless steel and provide a constant angle of spray at ranges from 10 to 150 percent of capacity. Provide hydraulically balanced valves, thus requiring no guides that might bind, scale, or otherwise clog. Locate spray valves to allow their servicing, inspection, and removal. Maximum tank dimensions are [_____] outside diameter. Construct internal parts of the deaerating heater, including baffles, distributing nozzles, vent pipe, and vent collecting hood of heavy gauge stainless steel. Provide a drawing showing the "internal" construction of the heater with each bid. Include an internal sparger tube for chemical treatment injection with the deaerator. Provide boiler feedwater pump suction nozzle incliding a vortex breaker. Provide deaerator with all of the connections shown on the drawings, as a minimum.

2.7.3 Deaerator Trim

Provide deaerator with the following trim:

a. Safety relief valve set to open at 83 kPa 12 psig, and of sufficient capacity to protect the deaerator from excessive steam pressure with the steam regulating valve in fully open position.

b. Vacuum breaker valve.

c. Water gauge glasses with shutoff valves to cover the full water level range.

d. Provide pressure gauges conforming to ASME B40.100 complete with siphon and isolation valve.

e. Makeup steam control valve with strainer, bypass, inlet and outlet valves. Valves to reduce steam pressure from [_____] kPa psig to [_____] kPa psig, with capability to operate at up to [2.07] [3.45] MPa [300] [500] psig inlet pressure. Adjust reducing valve to maintain the desired terminal pressure, regardless of fluctuations in the initial pressure. Provide single-seated, spring loaded valves that are quiet in operation, and guaranteed not to stick. Valve body 65 mm 2-1/2 inches and larger must be cast steel; 50 mm 2 inches and smaller must be of bronze. Provide valve trim consisting of stainless steel, Monel metal, or approved corrosion-resisting material. Ensure all parts subject to wear are readily replaceable. Provide valves with seats and plugs faced with cobalt tungsten carbide mixture, or made of heat treated stainless steel or high chromium steel guaranteed to resist erosion. Provide seal and plug facing with a Brinell hardness of no less than 450. Install valve with a strainer, a bypass, [safety valve on deaerator] as indicated. Connect sensing line to the steam space in the deaerator. Size control valve for a minimum capacity of [_____] kg/hour lb/hour at design conditions, but do not exceed a capacity greater than [_____] kg/hour lb/hour for the same conditions. Select valve trim to result in a noise level not to exceed 85 dBA, measured 914 mm 3 feet from valve.

f. Makeup water control valve with bypass and inlet and outlet valves. Valve to operate at an inlet pressure of up to 552 kPa 80 psig.

g. Pneumatic level controller. Mechanical linkage control of makeup will not be acceptable.

h. Overflow trap or valve with float control.

i. Insulation clips for 38 mm 1-1/2 inch block insulation.

j. Lifting lugs as required.

k. Multiport relief valve with exhaust head for mounting in piping supplied by others.

l. Manual air vent valve.

m. Drain valve.

n. Chemical injection valve.

o. Sample valve.

p. High and low level switches.

q. All support steel.

2.7.4 Additional Requirements

All required foundations, anchor bolts, concrete work, and grouting, will be in accordance with Manufacturer's Load Diagram and Anchor Bolt Plan. Installation and covering must conform to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. All wiring incidental to the operation of controls and instrumentation will be provided. All steam and water piping to connect to the deaerator will be provided. Provide testing outfit conforming to ASTM D888, complete with chemicals for 100 tests. Provide all controllers, alarms, gauges, sight glass, control valves, etc., with shutoff and/or bypass valves as required for maintenance of the system while in operation.

2.7.5 Performance Guarantee

Provide that the deaerator:

a. Is of sufficient design to reduce the oxygen content of the feedwater to [_____] cc/liter when tested by the accepted modified Winkler or ASTM method.

b. Is of sufficient design to reduce free carbon dioxide to zero.

c. Is of sufficient design to ensure essentially noiseless operation at all rates up to and including maximum capacity.

d. Meets all performance requirements at all loads from 3 to 100 percent of capacity.

e. Admits makeup water only after giving preference to available condensate.

2.8 PIPING

Unless otherwise specified, provide pipe and fittings conforming to Section 33 63 23 EXTERIOR ABOVEGROUND STEAM DISTRIBUTION.

2.9 CHEMICAL TREATMENT AND WATER SOFTENING EQUIPMENT

2.9.1 Chemical Feeder

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NOTE: Conform to requirements of UFC 3-410-01 or UFC 3-410-02.

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Provide a feeder unit for each boiler. Provide automatic proportioning, shot, or pump type chemical feeders. Provide all appurtenances necessary for satisfactory operation. Base size and capacity of feeder upon local requirements and water analysis. Install feed piping to feed chemicals directly to each boiler, as shown on the drawings or as required for the equipment supplied.

2.9.2 Pumps and Tanks

Furnish chemical feed pumps and tanks as a package with the pumps mounted on and piping connected to the tank. Provide pump cylinders, plungers, ball check valves, and check valve bodies consisting of corrosion-resistant materials suitable for the chemicals being pumped. Ensure volumetric accuracy of the pumps is within one percent over the range indicated. Adjust pump capacities by positioning the crankpin with micrometer setscrews. Stroke length scale must be divided in percentage graduations engraved on the scale. Cylinders must be replaceable for increased or reduced pressure or capacity ranges. Provide drive motors that are suitable for the electric power available and that have drip-proof enclosures. Drive each pump by a separate motor. Make tanks of polypropylene and mount on legs. Provide tanks with filling and drain connections, and gauge glass. Furnish each tank with one pump, mounted and piped with black iron pipe and fittings, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Each tank must have a hinged cover. Tank bottom must be dished concave to a radius equal to the diameter of the tank. Units must be for phosphate or caustic feed and sulfate feeding. Provide motor-driven agitator. Design the pump to feed the chemical solutions into the boiler feedwater system.

2.9.3 Water Softening Equipment

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NOTE: Need for softening equipment for makeup water will be as determined in accordance with UFC 3-410-01 or UFC 3-410-02. If water softening is not required, delete the paragraph.

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Provide a complete sodium zeolite cycle water softening system as specified in Section 22 31 00 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE). Size equipment to run 24 hours before regeneration when operating at a sustained softening rate of [_____] L/second gpm. Provide tanks complete with cover and design to eliminate the need for a gravel supporting bed.

2.10 BOILER CONTROL EQUIPMENT

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NOTE: Positioning type control equipment will be specified for boilers with capacities of 13 MW 45 MBtuh or less. Metering type equipment will be used for larger boilers. Positioning type controls may be furnished for boilers with capacity of 13 MW 45 MBtuh or more in lieu of metering type.

A continuous emmissions monitoring system (CEMS) is required by the Clean Air Act Amendment (CAAA) of 1990 if the fuel utilized is oil or coal and the heat input is 3 MW 10 million BTU/HR or greater. A CEMS may also be required by state or local laws. If a CEMS is necessary the designer should review the CAAA and the relevant state or local law early in the project to allow time to incorporate the requires CEMS specifications and to determine which flue gas emmissions will be included in the required reports.

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a. Install an automatic control system for each boiler in accordance with the manufacturer's recommendations. Provide all locally indicating instrumentation and controls and install complete, as required to suit equipment furnished and as shown. All remote instrumentation, controls, and their connection points will also be provided and installed as indicated. If the controls are manufactured by a manufacturer other than the boiler manufacturer, install controls in accordance with the control manufacturer's instructions. Locate automatic controllers on the control room panel as specified.

b. Operate equipment either pneumatically, electrically, or electronically. Provide pneumatic control systems conforming to CAGI B19.1. Install air filter regulator sets at each control valve and transmitter in the system. Provide dual type master air filter regulator set on the control panel where one side can be cleaned and repaired while the other is in operation. Protect exterior control air piping and devices from freezing by use of a regenerative desiccant dryer. Provide each system with a selector switch or other means to permit manual control of the firing rate when required. Electrical control devices must be rated at 120 volts and connected as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wire operating and limit controls to interrupt the ungrounded circuit conductor.

c. [Steam and energy generating equipment must include instrumentation and sufficient metering for accountability interface with a future Energy Monitoring and Control System (EMCS).] If pneumatic controls are provided, use duplex air compressors with a drier between the compressors and tank. Size air compressor units to run no more than 60 percent of the time when all controls are in service.

2.10.1 Positioning Type

Provide positioning type control equipment capable of maintaining boiler steam pressure within plus or minus 2 percent of the set pressure over the complete range of boiler operation. Set point controllers may be used for on/off functions only. Maintain combustion efficiency without appreciable manual adjustment. Provide system capable of maintaining the specified pressure provided that the load does not exceed a 15 percent per minute change in capacity at any one time. Connect master transmitter to the main steam header where the steam pressure is to be controlled. The signal transmitted from this point to the master controller must be a function of steam pressure. On multiple boiler installations, provide a means to base load on individual boilers while on automatic, and control each boiler unit individually. Make provision on the control system for adding on other boilers to the system with only minor wiring or piping changes on the panel. Provide a manual-to-automatic station and indicator on the control panel for each automatic controller that will provide for selecting either automatic control or manual control and also will provide for manual operation. Arrange manual controls to allow any one or more of the functions of the control system to be controlled manually while the other functions remain on automatic control. Provide manual control station complete with all necessary indicators to facilitate changing from automatic control to manual control and vice versa. Mount controllers on the instrument panel which indicate and control measurement in the areas shown, and have a manual adjustment on the front of the instrument. Install controllers complete with wiring or piping between the controller, transmitter, and the final control device.

2.10.2 Equipment

Provide control equipment and instruments including fan controls, time clocks, relays, operating switches, indicating lights, gauges, motor starters, fuses, alarms, and circuit elements of the control system, and other controls and instruments necessary for unit operation. Provide control system in accordance with FM APP GUIDE. Mount operating controls and instruments on one or more free-standing control panels conveniently located and place so that operating personnel may effectively monitor boiler operations but not in a position that would interfere with those operations. Indicating and recording instruments will be provided for pressure, flow of air and liquids, and alarm circuitry. Interlock automatic-control circuit systems and manual switches to prevent hazardous conditions or the discharge of excessive amounts of air pollutants.

2.10.3 Boiler System Operation

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NOTE: If the fuel being burned contains any significant pollutants, some states may not allow the flue gases to be vented to the atmosphere without going through an air pollution control device.

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When steam is demanded, direct gases through the boiler. As long as maximum energy is required, make this the mode of operation. If less than full energy production is required, modulate gas flow to reduce steam production by the boiler. Maintain specified steam pressure within plus or minus 1 pound by means of a pressurestat and a boiler-draft regulator. Provide pressurestat with necessary relays to stop and start the flow of gases by means of the induced draft fan so as to maintain the desired steam pressure.

2.10.4 Damper Control

Size power units for the movement of dampers to operate the device to be positioned, and mount so that a rigid mechanical connection to the device being operated can be used. Ensure units automatically close in the event of failure of the operating medium. Manual operation of the controller must not necessitate disconnecting the linkages during power failure or other emergency. Include position switches on fuel and air-drive units for interlock with safety systems. Place retransmitting devices on all power units for remote indication on the control panel of the position of the mechanism at any time. If electric operators are utilized, use oil immersed gear trains on the units.

2.10.5 Draft Fan Control

Provide induced draft centrifugal fans with outlet dampers [and variable speed control]. [Provide axial propeller fans with variable propeller pitch control.] Provide means for operating the induced draft fan for 15 minutes after the combustion equipment has ceased operation.

2.10.6 Soot Blower

Mount all controls, lights, switches, and indicators provided for operation of soot blower on the control cabinet.

2.10.7 Boiler Limit Controls

Provide limit controls and interlock switches conforming to UL 353.

2.10.7.1 Low-Water Cutoffs

Provide two low-water cutoffs to prevent startup and to shut down the combustion equipment if the boiler water level is below the preset safe level. Primary interlock may be automatic or manual reset type. Provide manual reset type secondary interlock.

2.10.7.2 High-Pressure Limit Switch

Provide a high-pressure limit switch to shut down the combustion equipment when steam pressure exceeds the preset safe limit. Provide this equipment in addition to the operating controls.

2.10.7.3 Draft Loss Interlock

Provide a draft loss interlock and an airflow switch or a suction switch to prevent startup and to shut down or bypass the combustion equipment when air is inadequate to safely support combustion. Provide limit and operating controls for operation on a two-wire grounded branch circuit.

2.10.8 Instrument Control Panel

Provide a NEMA ICS 6 Type 4 unit prewired panel, of steel, weathertight, and conforming to UL 50. Unless enclosed in a booth or separate room, also construct the panel to protect the instruments and controls from dust. Locate boiler control panel next to the control panel for the combustion equipment, or one panel may be used for both. Wire all instrument connectors and cable termination connectors in the factory by the instrumentation fabricator. Flush mount all controls, instruments, and other equipment at the factory and assembly-test before shipment. Furnish a lock and two keys . Identify all controls and instruments with nameplates. [Provide a thermostatically controlled heater to prevent condensation.]

2.10.8.1 Panel Details

a. Size instrument and control panel to contain all controls, instruments, gauges, and meters. Provide freestanding panels with a faceplate of no less than 7 mm 3/16 inch steel, properly reinforced, and finish with the manufacturer's standard finish coating. Mount units flush on the panel as far as practicable. Flush mount all controls, instruments, and other equipment, fit each neatly into a cutout, and completely cover the cutout and any mounting screws or bolts.

b. Enclose back of the panel with sheet metal and with adequate removable access panels or doors for maintenance and removal of any unit without interfering with other units. Provide proper latching equipment and hardware. Identify each recorder, indicator, and control unit with nameplates securely fastened to the panel. Provide nameplates consisting of black over white laminated plastic with the lettering penetrating the black surface to expose the white. Provide panel with continuous rapid-start fluorescent light fixtures mounted with reflectors providing suitable shielding to illuminate all controls, instruments, gauges, and meters.

c. Terminate all field piping connections in one bulkhead-mounted manifold, located to conform with the installation requirements of the system. Terminate all field electrical wiring in a color-coded terminal strip to conform with the installation requirements of the system. Ensure all electrical tubing or piping connections to controls, instruments, or other devices on the panel are inside the panel and not visible from the panel front. Provide a suitable plug-in strip in the rear of the panel for any required plug-in electrical connections of the instruments. Install all necessary transformers, separate relays, switches, and fuses in a fully enclosed junction box. Use a fused safety switch to serve the 120-volt power supply required for control circuits.

d. If a pneumatic control system is provided, include duplex air supply filter and regulator set mounted on the rear of the panel with properly identified pneumatic terminal blocks and low point drain. High pressure lines will not be allowed to enter the panel. [If packaged burner units with integral controls are furnished, the control equipment may be mounted on a separate panel for each unit. Provide panel mounted controllers and indicators specified or required and test at the factory complete with relays, transformers, switches, wiring, valves, piping, and other appurtenances. Color-code all wiring and piping within the panel or identify otherwise.] Isolate thermocouple and low energy signal conductors completely from power and alarm conductors, subject to approval by the Contracting Officer. Provide visual and audible alarms to protect personnel and equipment.

2.10.8.2 Recorders

Provide servo-mechanism type or multiple-pen type recorders. Provide [circular] [strip] chart. Minimum chart width is 100 mm 4 inches. Accuracy must be plus or minus 1/2 percent. Provide each pen with a separate scale calibrated in engineering units. Chart drive must be 120 volts ac. Provide one year's supply of chart paper. Make record in ink on a [24-hour] [31-day] chart driven by an electric clock mechanism. Make each recorder point with a different color ink. Install recorders complete with all necessary wiring or pipe between the recorder and the transmitter in the boiler room. Ensure recorders mounted on the instrument panel record and indicate measurement in the areas shown.

2.10.8.3 Panel Display

Include visual indication of the various modes of the main system components (i.e., damper positions, I.D. fans). As a minimum, display the following parameters on the panel:

a. Temperature recorder (boiler inlet exit).

b. Steam flow and pressure recorder (pressure immediately after second block valve, steam flow totalizer).

c. Clock with minimum 200 mm 8 inch diameter face (one panel only).

d. Steam gauge conforming to ASME B40.100 to indicate boiler shell or drum pressure.

2.10.8.4 Identification

Furnish all field items with a permanent metal tag suitable for tag number or service identification; include back of panel items in this category. Install wires and cables without joints or splices except at terminal points. Identify wires at both ends by labels.

2.10.8.5 System Diagram

Furnish laminated, color-coded system diagram mounted on the control panel indicating all system components and location of all sensors and alarm points.

2.10.9 Pilot Lights

Assemble pilot lights in a factory-built cabinet, suitable for flush mounting in cutouts in the control cabinet, complete with extruded trim, clamps, and sheet metal rear housing, and finished in baked black enamel. Integrate components through appropriate electro-mechanical devices with push-to-test indicating lights. Provide industrial oil-tight construction in the following colors for the indication functions:

a. Amber for power on the system.

b. Green for boiler purge completion (one per boiler).

c. White or manufacturer's standard color for energizing main fuel valves.

d. Red for alarms.

    (1) High temperature in combustion chamber.

    (2) High temperature at induced draft fan inlet.

    (3) System operation.

    (4) Emergency damper closed.

2.10.10 Clock

Provide electric synchronous motor type clock. Provide clock for surface mounting and suitable for operation on 115-volt, 60-Hz single-phase electric service. Provide clock with a shatterproof, crystal-covered white dial, easy-to-read black Arabic numerals, black hour and minute hands, red sweep second hand, and external manual reset knob at bottom of case. Seal the motor gear train in a permanent oil bath.

2.10.11 Alarm Annunciator Panel

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NOTE: Edit to indicate the number of points desired and specific items in the list.

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Mount an annunciator system on each control panel. Visual signals must be backlighted nameplates for each point. Provide a common audible alarm signal and a common acknowledge push button for each control panel. Include a common alarm-silencing relay in the alarm circuit which will permit the boiler operator to silence the audible horn while retaining visual indication until the malfunction or abnormal condition has been cleared. Nameplate size of alarm modules must be nominal 70 mm 2-3/4 inches high by 75 mm 3 inches wide in translucent white acrylic plexiglass and engrave all nomenclature on front surface in black lettering. Mount flasher module and prewire with silence and test pushbuttons. Ensure alarm points and window engraving are as shown below.

ALARM POINT	WINDOW ENGRAVING
LSL-[_____]	High condensate tank level
LSL-[_____]	Level low, condensate storage tank
LSL-[_____]	Pump cut-out, condensate storage tank
PSL-[_____]	Pressure-low condensate
PSL-[_____]	Pressure-low feedwater

ALARM POINT	WINDOW ENGRAVING
PSH-[_____]	Pressure-high steam drum
LSH-[_____]	Level-high steam drum
LSL-[_____]	Low water level with cutoff
LSL-[_____]	Second low water level cutoff
LSH-[_____]	Level-high deaerator
LSL-[_____]	Level-low, deaerator
PSL-[_____]	Induced draft fan failure
PSL-[_____]	Boiler tube cleaning failure

2.10.12 Steam Flowmeters

Provide steam flowmeters to measure the steam flow from each boiler and each main steam header outlet. Also provide flow meters to measure feedwater flow to each boiler. Provide flange-mounting type nozzles and orifice plates made of stainless steel. Provide orifice plates of the square edge, concentric, paddle type designed for flange taps. Provide condensate pots for steam service. Design meters to accurately measure saturated steam at a gauge pressure of [_____] kPa psi. Provide direct connected meters of the indicating, recording, and integrating type with electric chart drives. Provide dust-tight metallic or plastic instrument cases, finished in manufacturer's standard black, and arranged for flush-panel mounting. Ensure flow recordsare in thousands of kg pounds per hour on an ink chart recorder. Totalize steam flow in kg pounds by an integrator having no less than a six-digit counter. The installation of stainless steel orifice plates must include shutoff valves, equalizing valves, and blowdown valves. Provide each meter with a guaranteed accuracy of plus or minus 1/2 of 1 percent while operating at 20 to 100 percent of capacity. Install steam-flow orifices and associated steam piping in accordance with the manufacturer's recommendations and label with the following tags:

Tag Number	Service
FR-[_____]	Unit Number 1, Steam Flow
FR-[_____]	Unit Number 2, Steam Flow
FR-[_____]	Unit Number 3, Steam Flow
[FR-[_____]]	[Export Steam, Steam Flow]
[FR-[_____]]	[Domestic Steam, Steam Flow]

2.10.12.1 Orifice Plate

Size orifice plate to produce a 25.42 kPa 100 inch W.G. pressure differential at the rated flow of the meter as shown on the drawings. Provide orifice plates that are 3.2 mm 1/8 inch thick 316 or 304 SS, chambered with the sharp edge orifice facing upstream, fitted with a tab extending beyond flanges showing bore size, differential, and maximum flow. Calculation of flow must be made by the manufacturer under ASME MFC-3M, or equivalent by Spink or American Gas Association. Drill a weep hole in plates for steam or condensibles service when installed in horizontal meter runs.

2.10.12.2 Flow Transmitters

Provide pressure differential and transmitting components with an accuracy of plus or minus 1 percent, 0.15 percent repeatability, 4-20 milliamp dc signal into 0-500 ohms, (if electronic) internal square root extractor, adjustable zero and span, and equalizing valves. Ensure span range, and working pressure are as shown on the drawings. Install transmitters with condensate reservoirs where required to protect transmitter from excessive temperature.

2.10.13 Boiler Feedwater Flow Meters

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NOTE: For boilers having less than 4500 kg/hour 10,000 lb/hour steaming capacity, a mechanical feedwater meter may be provided. Plants having metered zeolite softeners used exclusively for boiler makeup will not require an additional cold water makeup water meter. Boilers over 4500 kg/hour 10,000 lb/hour capacity will have indicating-recording meters and they will be integrating type where indicated.

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Provide differential pressure type, Venturi style flow meters for boiler feedwater measurement. Provide pound-ratedVenturi flow tubes with a series of nozzles around the inner surface to sense and average the velocity head. Ensure tubes 150 mm 6 inches and larger are flanged and install smaller tubes between welded neck flanges. Provide smaller flow tubes consisting of corrosion-resistant steel and flanged tubes with corrosion-resistant steel throat inserts. Metering must be for water flow [and feedwater temperature]. Mount receiver for each boiler on the boiler instrument panel. Equipment must be complete with differential pressure transmitter, shutoff valves, equalizing valves, and blowdown valves as required for a complete installation.

2.10.13.1 Indicating Feedwater Meter Receivers

Meter receivers must match other panel components in appearance and must indicate water flow in [_____]. Where indicating feedwater meter only is utilized, provide a companion indicating feedwater temperature receiver.

2.10.13.2 Indicating, Recording, and Integrating Receivers

Provide indicating, recording, [and integrating] meter receivers. Furnish in a dust-tight metallic or plastic case finished in manufacturer's standard black finish and arrange for flush panel mounting. The indicator must show with a pointer the rate of water flow. Record the flow, in thousands of kg pounds per hour, in ink on a 24 hour, 300 mm 12 inch diameter, equally graduated circular chart driven by an electric clock mechanism. Provide sufficient blank charts and ink for 400 days of operation. Also record boiler feedwater temperature in degrees C and degrees F degrees F on the same chart. [Totalize water in kg pounds by an integrator having no less than a six-digit counter.]

2.10.14 Blowoff Sample Cooler

Provide a water-cooled, shell-and-tube or shell-and-coil type heat exchanger with stainless steel tubes and cast-iron or steel shell suitable for cooling the blowoff before sampling. Connect cooler to a header and valve so the operator can obtain a sample of properly cooled blowoff from any boiler as desired. Properly support cooler and provide a brass or bronze sampling cock with lever or compression handle. Provide a sampling glass container suitable for handling the water temperature to be encountered and a hydrometer or equivalent device suitable for measuring the concentration of solids in the water and reading in parts per million.

2.10.15 Temperature Indicators

The Contractor may install any of the following temperature measuring devices as indicated. Ensure gauges match pressure gauges in appearance and match requirements of the transmitters supplied. Remote temperature indicators include condensate and steam temperature.

2.10.15.1 Thermometers

Provide thermometers conforming to ASME PTC 19.3 TW, Type 1, Class 3, dial with wells and separable corrosion-resistant steel sockets, and temperature range suitable for the use encountered. Do not use Mercury in thermometers. Provide thermometer consisting of a dial, 90 mm 3-1/2 inch diameter chromium-plated case, remote bulb or direct bulb as required, with plus or minus 1 degree C 2 degree F accuracy, and white face with black digits graduated in 2 degree increments. Install thermometers so as to be easily read from the operating floor.

2.10.15.2 Thermocouples

Use thermocouples suitable for continuous operation and control at temperatures up to 1260 degrees C 2300 degrees F, accurate to 0.75 percent, and long enough to be inserted 150 mm 6 inches into the boiler. Provide thermocouples conforming to ASTM E230/E230M, Type K with an adjustable flange and with a high-temperature metal alloy closed-end protection tube suitable for inserting into the furnace without support of the projecting end. Supply one hundred feet of 16-gauge compensating lead wire with a weatherproof braid for connecting the thermocouple to the instrument. Installed unit must indicate gas passage temperatures and control combustion equipment operation. Transmit temperature to the instrument in the control panel as shown.

2.10.15.3 Indicating, Recording Pyrometers

The instrument must have a temperature range from minus 18 to plus 1316 degrees C 0 to 2400 degrees F, and must be accurate to within plus or minus 1/4 of 1 percent of the range. Indicate temperature on a large scale with prominent black letters on a white background and record by chart recorder. The instrument must have automatic cold-junction compensation.

Provide a simple means of pyrometer standardization. Instrument must not be affected by vibration, dust, or air currents when the door of the instrument is open. Lighting circuit for 110 volts ac must be available.

2.10.16 Draft Indicator and Control

Provide an indicator continuously showing pressure in the boiler. Also provide a separate draft-controlling instrument maintaining a constant balanced (atmospheric) pressure in the boiler. Provide gauges conforming to ASME B40.100, Style 1 with a diaphragm or bellows actuating system and a circular scale. Provide gauges with a zero adjustment screw and a connection to atmosphere. Provide suitable shutoff cocks. Gauges must be remote reading to the control panel and install complete with all necessary piping between the gauges and the points at which the drafts are measured. Gauge piping must be copper tubing conforming to ASTM B68/B68M, Type K or L.

2.10.17 Pressure Gauges

Provide heavy-duty industrial type gauges conforming to ASME B40.100, Type I, Class 1 or 2, as applicable, style as required, suitable for specified pressure or vacuum with minimum 115 mm 4-1/2 inch diameter dial, except as otherwise specified. Install pressure gauges on the low-pressure side of each pressure-reducing valve, on the suction and discharge side of each pump, on inlets and outlets of heat exchangers, on the feedwater heater, and where shown or required for proper operation. Install pressure gauge with a [250 mm 10 inch] [300 mm 12 inch] dial face on each boiler. Install gauges to be accessible and easily read from the operating floor. Equip gauges with integral or separate siphons, and pulsation dampeners and connect by brass pipe and fittings with shutoff cocks. Where pressure reducing valves are used, place upstream and downstream gauges close to the pressure reducing assembly, but connect approximately 3 m 10 feet therefrom. Operating ranges of the gauges must be approximately twice the normal operating pressure.

2.10.17.1 Pressure Gauges (Panel)

Furnish and install[three] [_____] 150 mm 6 inch dial size, phenol or brass, black enamel finished case, gauges to indicate main steam, boiler feedwater, and deaerator makeup. Provide Bourdon tube style gauges with back connections and white dials with black lettering. Equip steam gauges with siphons and ensureall gauges have shutoff valves at the panel. Make panel entry through bulk-head connectors located in the upper part of the panel. Gauge accuracy must be at least 1/2 of 1 percent and normal readings must be approximately 50 to 75 percent of full scale reading. Label gaugesas follows:

Tag Number	Service	Pressure Range, kPa psig
PI-[_____]	Condensate, Supply Pressure	-69 to 345 -10 to 50
PI-[_____]	Feedwater, Supply Pressure	0 to 2068 0 to 300
PI-[_____]	Main Steam, Steam Pressure	0 to 2068 0 to 300

2.10.17.2 Pressure Gauges (Local)

Furnish and install [_____] 115 mm 4-1/2 inch dial size, phenol or brass, black enamel finished case, gauges for the services shown below. Provide Bourdon-tube style gauges with bottom connections and white dials with black lettering. Equip steam gauges with siphons and install all with shutoff valves. Gauge accuracy must be at least 1/2 of 1 percent and normal readings must be approximately 50 to 75 percent of full scale reading.

Tag Number	Service
PI-[_____]	Condensate Pump Number 1, Discharge Pressure
PI-[_____]	Condensate Pump Number 2, Discharge Pressure
PI-[_____]	Potable Water Supply Pressure
PI-[_____]	B.F. Pump Number 1, Suction Pressure
PI-[_____]	B.F. Pump Number 1, Discharge Pressure
PI-[_____]	B.F. Pump Number 2, Suction Pressure
PI-[_____]	B.F. Pump Number 2, Discharge Pressure
PI-[_____]	Main Steam, Steam Pressure
PI-[_____]	B.F. Pumps, Strainer Pressure
PI-[_____]	Condensate Pump No. 1, Suction Pressure
PI-[_____]	Condensate Pump No. 2, Suction Pressure

Provide gauges conforming to ASME B40.100, of pressure detecting class, single, Bourdon tube style, and suitable for detecting air pressure. Ensure gauges are remote reading to the control panel.

2.10.18 Feedwater Temperature and Pressure Recorder

Install feedwater temperature and pressure recorder on the boiler plant central metering panel to record the deaerated feedwater temperature and the pressure of steam space in the deaerating heater. Provide recorder as specified. Provide unit with interconnecting tubing and separable sockets for elements located in the feedwater heater. Totally enclose electrical connections. Provide accuracy within plus or minus 1 percent of the chart range.

2.10.19 Condensate Flowmeter

Furnish and install a 40 mm 1-1/2 inch in-line disk meter in the makeup line to the deaerator. Provide meter consisting of a bronze housing, stainless steel trim, and disk suitable for an operating temperature of 105 degrees C 220 degrees F. Equip meter with a register of at least six digits and have a capacity of at least 3 L/second 50 gallons per minute.

Tag Number	Service
FQI-[_____]	Condensate Flow

2.11 TOOLS

Furnish special tools only and include all uncommon tools necessary for the operation, cleanout, and maintenance of the boilers, pumps, fans, controls, meters, special piping systems, and other auxiliary equipment. Furnish small hand tools with a suitable cabinet, mount where directed. Also furnish the following tools.

2.11.1 Tube Cleaner

For water-tube boiler installations, provide a water-driven cleaner with three rotary cutters, the necessary length of armored water hose, valves, and all other appurtenances necessary for operation. Provide tube cleaner for each size of watertube in the boiler, with one extra set of cutters for each size cleaner. Provide necessary valves and fittings to permit convenient connection of the cleaner hose to one of the boiler feed pumps to supply cold raw water for operation of the cleaner. Arrange piping such that one boiler feed pump may be used to operate the cleaner without interfering with normal operation.

2.11.2 Tube Brush

Provide tube brush (for fire-tube boiler installations) with steel bristles and jointed handle of sufficient length to clean full length of fire-tubes.

2.11.3 Smoke Pipe Cleaner

Provide cleaner to clean the breaching and smoke connections. Cleaner must have jointed handle of sufficient length to clean breeching and smoke connections without dismantling.

2.11.4 Wrenches and Gaskets

Provide wrenches as required for opening boiler manholes, handholes, and cleanouts. Provide one set of extra gaskets for all boiler manholes and handholes, for pump barrels, and other similar items of equipment. Package and properly identify all gaskets.

2.12 PAINTING AND FINISHING

2.12.1 Preventing Corrosion

Unless otherwise specified, factory paint surfaces of ferrous metal subject to corrosion in accordance with the manufacturer's standard practice. Paint all exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum sheath over insulation. Protect all metallic materials against corrosion. Where connected to dissimilar metal, protect aluminum by approved fittings and treatment. Zinc coat all parts such as boxes, bodies, fittings, guards, etc., made of ferrous metals, but not of corrosion-resistant steel, in accordance with ASTM A123/A123M or ASTM A153/A153M, except where other equivalent protective treatment is specifically approved in writing by the Contracting Officer. Where a rust-inhibiting coating or hot-dip galvanizing is specified, any protective treatment system that will pass the salt-spray fog test is acceptable.

2.12.2 Treatment

Clean all surfaces of castings, forgings, molded parts, stampings, welded parts, exterior surfaces of the boiler, before application of the insulation, and all interior surfaces of the sheet jacket, before assembly, to bare metal to remove oil, rust, sand, dirt, fins, spurs, scale, slag, flux, etc., before primer is applied at the factory. External surfaces must be smooth and all edges rounded or beveled, unless sharpness is required to perform a necessary function.

2.12.3 Boiler Coating

Finish boiler with one coat of silicone aluminum heat-resisting (up to 648 degrees C 1200 degrees F) paint. Apply paint directly to clean bare metal surfaces and attain a minimum dry film thickness of 1 mil. After assembly, clean all exposed surfaces of the equipment normally painted in good commercial practice to bare metal and finish with two coats of silicone aluminum heat-resisting paint, with each coat being a minimum dry film thickness of 0.025 mm 1 mil. Component parts procured factory finished need not be repainted. Mechanical cleaning need not be performed on the sheet steel jacket if the surfaces are free of all mill scale and rust. However, clean the surfaces to remove all grease and other foreign matter. Do not apply paint when the temperature is below 10 degrees C 50 degrees F or above 32 degrees C 90 degrees F.

2.12.4 Equipment Coating

Factory finish equipment and component items, when fabricated from ferrous metal, with the manufacturer's standard finish if located within buildings. Items located outside must have weather-resistant finishes that will withstand 500 hours of exposure to the salt-spray test specified in ASTM B117, using a 20 percent sodium chloride solution. This test may be performed on test specimens coated and finished in the same manner as the actual equipment. Immediately after the test, the specimens must show no sign of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust beyond 3 mm 1/8 inch on either side of the scratch mark.

2.13 FACTORY TESTS

Conduct initial capacity and performance tests of factory-assembled boiler components at the manufacturer's plant. Repair or replace any rejected material or equipment before installation.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work. Because of the small scale of the drawings, it is not possible to detail all runs and indicate all required offsets, fittings, and accessories. Investigate structural and finish conditions affecting the work, arrange the work accordingly as required, and furnish the fittings and accessories required to meet such conditions. The plans are generally diagrammatic and coordinate the work of the different trades so interference between conduit, piping, equipment, architectural, and structural work will be avoided. Building design modifications necessitated by the proposed equipment are the responsibility of the Contractor and must be approved before proceeding with the work.

3.2 INSTALLATION

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NOTE: All pertinent piping and related equipment supports will be designed for seismic forces as specified in subparagraph Support Steel below.

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Install equipment and material as indicated and in accordance with manufacturer's instructions. A manufacturer's representative experienced in installation of this type of boiler, must supervise the erection of the boiler and associated equipment.

3.2.1 Piping

Unless otherwise specified, provide pipe and fittings conforming to Section 33 63 23 EXTERIOR ABOVEGROUND STEAM DISTRIBUTION.

3.2.2 Field Painting

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NOTE: Where identification of piping is required by the using service, this paragraph will be amplified to include appropriate requirements either directly or by reference to a separate section. Air Force requirements are covered in AFM 88-15.

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Clean, prepare, and paint all ferrous metals not specified to be coated at the factory as specified in Section 09 90 00 PAINTS AND COATINGS. Paint all exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum sheath over insulation.

3.2.3 Insulation

Provide shop- and field-applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS unless otherwise specified. Insulate breaching, unjacketed boilers, [dust collectors,] and induced draft fan housings with magnesia, mineral wool, calcium silicate, or approved mineral insulation. Insulation may be either block or blanket. Fill joints in the insulation with magnesia, mineral wool, or a suitable cement.

3.2.4 Foundation

Construct boiler foundation of [21] [_____] MPa [3000] [_____] psi concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Set anchor bolts of adequate length to install the boiler accurately. When embedded in concrete, provide anchor bolts with plates welded on the head and protect against damage until the equipment is installed. Provide plates conforming to ASTM A36/A36M.

3.2.5 Equipment Structural Support

3.2.5.1 Structural Steel

Design structural steel equipment supports in accordance with Section 05 12 00 STRUCTURAL STEEL.

3.2.5.2 Support Steel

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NOTE: Provide seismic requirements, if a Government designer (Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not included. UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

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Design support steel to resist all applicable dead and live loads. Design seismic loads as specified in UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS [as indicated]. Show a complete loading and support diagram on the detail drawings. Equipment supports shown on the contract drawings are for a general equipment layout and may not conform to the system furnished. Piers and footings may be relocated to suit equipment furnished if no interference with other footings is encountered. Provide support steel complying with ASTM A242/A242M and fabricate in accordance with the provisions of Section 05 05 23.16 STRUCTURAL WELDING or field bolted using ASTM A325M ASTM A325 high strength bolts. Submit manufacturer's design data and structural computations for walls, roof, foundations, and other features for specialty type of construction, with design data for lateral forces that may be encountered due to wind loads and seismic forces. Include in the design data manufacturer's equipment design data.

3.2.5.3 Column Base Plates

Design column base plates to bear on a [21] [_____] MPa [3000] [_____] psi concrete floor slab.

3.2.5.4 Anchor Bolts

Provide ASTM A307 anchor bolts. Provide anchor bolt sizes and locations as shown on the detail drawings.

3.2.6 Stack Support

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NOTE: Indicate wind force the stack design will have to withstand. Structural design will also include seismic resistance as specified in subparagraph Support Steel above.

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Provide stack support in accordance with NFPA 211, as applicable. Ensure vertical and lateral supports for exterior chimneys withstand wind forces of [130] [_____] km/hour [80] [_____] mph.

3.2.7 Catwalks and Access Platforms

Furnish and install all necessary platforms, ladders, handrails, and stairs needed for safe and efficient operation and maintenance of the equipment. They may be relocated from the wall openings and passageways shown in order to suit the boiler equipment provided. All railings must have 100 mm 4 inch wide toe-board located no more than 6 mm 1/4 inch above the floor level. Construction must conform as close as practical to items indicated. Provide fabrication, materials, and coatings that conform to Section 05 12 00 STRUCTURAL STEEL.

3.2.8 Control System Installation

Install equipment in accordance with the manufacturer's instructions and approval by the Contracting Officer. Furnish and install all control conduit, wiring and/or tubing not specified elsewhere, but required to provide a complete and operable system under this section of the specifications. This includes material and items required to arrange the system to compensate for the actual field conditions encountered. Copper, stainless steel, or nonmetallic tubing may be used as appropriate. Provide ASTM B88M ASTM B88, Type K copper with flared cast brass or wrought copper fittings. Provide pneumatic tubing with 6.4 mm 1/4 inch OD with a minimum wall thickness of 0.762 mm 0.030 inch unless otherwise indicated. Where 9.5 mm 3/8 inch or 12.7 mm 1/2 inch OD tubing is used, the wall thickness must be a minimum of 1.245 mm 0.049 inch. The extent, general location, and arrangement of the system must be as indicated. Locate control panels as indicated and place so that operating personnel may effectively monitor boiler operations, but are not in a position that would interfere with those operations. Fit equipment, instruments, piping, wiring, and tubing into the space allotted and allow adequate clearances for entry, servicing, and maintenance. Install locally mounted instruments in such a manner as to prevent interference with mechanical installations and to ensure readability from the front aisles or operating area of the equipment. Coordinate installation of the instrumentation system carefully with the work of other trades.

3.2.9 Field Tubing

Provide compression type tube fittings compatible with tubing material (e.g., brass for copper tubing, stainless steel for stainless steel tubing, and nonmetallic for nonmetallic tubing). Check each connection for proper tightness and installation. All piping between primary connections and instruments must be a minimum of 9.5 mm 3/8 inch OD tubing. Provide all copper instrument single connecting lines with brass, ASTM B61, 20.7 MPa 3000 psi rating, forged body screws or tube ends.

3.2.9.1 Tubing Supports

Use PVC-coated expansion metal troughs or epoxy-coated vertical unistrut racks as tubing supports. Do not use elbows, tees, or crosses. Where the trough branches or changes direction, a suitable gap for the transition will be acceptable. Do not support the tubing over the gap.

3.2.9.2 Air Supply

Provide instrument air supply headers as shown. Distribute instrument air through the area at nominally 620 kPa 90 psig. Reduce pressure to that required at the instrument by a local regulator. Furnish and install an air set unit for each instrument that has a pneumatic output signal (e.g., transmitter, transducer, controllers, positioner, and relay). Provide air set units with a filter regulator with integral drip-well and drain cock and output gauge.

3.2.10 Electrical

Perform instrumentation and power-interconnecting wiring as [shown] [recommended by the manufacturer] and as specified in NFPA 70. Terminate all external wiring to the control panels on terminal boards or on devices in the panels. Carry all cable wire and cable runs in conduit or wireways. Run all signal wiring used for alarm or measurement of control circuits in conduit separate from power circuits. Direct current signals used for electronic transmission may be run in multiconductor cables. Wiring for control, shutdown, or interlock circuits may be run in the same conduit with power wiring as shown. Do not feed instruments from lighting branch circuits. Make termination of all wires on instrument binding screws with solderless insulated shoulder ring-tongue lugs of the proper size for the wire and binding screw. Properly and securely crimp lugs to the wire using the tool recommended by the lug manufacturer. Cut off any termination that is made improperly and install a new lug. Strip all wire with an approved stripping tool or in such a manner as not to damage the conductor.

3.2.10.1 Cable Conductor Identification

Permanently attach identification to each wire terminating on a terminal board or binding screw to facilitate maintenance. Identify by means of plastic sleeving with printed markings, permanently attached stamped foil markers, or other approved means. Wire numbers must correspond to wire numbers shown.

3.2.10.2 Relays

Provide industrial relays for interlocking circuits. Ensure contacts and coils are accessible for cleaning and replacement.

3.2.11 Steam Flowmeter Installation

Mount transmitters at the orifice flanges. Slope impulse lines to eliminate liquid or gas pockets. Provide three-valved meter manifolds, except use a five-valve manifold when the meter is sealed or purged.

3.3 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Supervise the installing, adjusting, and testing of the equipment. Ensure that sufficient lead time is given to prevent installation delay resulting from late delivery of equipment and materials.

3.4 TESTING

3.4.1 General

Before requesting the performance and acceptance test, conduct final checking of systems installations and preliminary operation testing and adjustments of all systems in accordance with the manufacturer's recommendations and the requirements of the specifications. Schedule all tests in advance and conduct at times approved. Perform testing in the presence of the Contracting Officer. Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate the final position of controls in each test report. Submit a written statement from the manufacturer's representative certifying that control equipment has been properly installed and is in proper operating condition, upon completion of the installation. Provide the action settings for all automatic controls in the form of a typed, tabulated list indicating the type of control, location, setting, and function. Include logs, thermal efficiency calculations, tabulated results, and conclusions.

3.4.1.1 Schedule for Testing

Notify the Contracting Officer in writing at least [20] [_____] days in advance of the intent to test the boilers, and submit a testing schedule. The Contracting Officer will notify the appropriate authorities.

3.4.1.2 Visual Inspection

Examine each boiler for defects outlined below:

a. Parts of components missing.

b. Improper assembly.

c. Parts or components not functioning properly.

d. Workmanship not as specified.

e. Exposed edges of metal not smooth.

f. Materials not as specified.

3.4.1.3 Repairs

Replace all defective parts furnished and installed by the Contractor and complete all repairs identified during capacity and operating tests.

3.4.2 Instrumentation Tests

Test all instrument systems after completing the following activities:

a. Inspect complete work and make any nonoperating checks required to assure operability in the manner required for the process application.

b. Check instrument air lines and wiring for proper hookup.

c. Test air lines for tightness according to the requirement of the Instrument Society of America Recommended Practice ISA 7.0.01.

d. Commission instruments, controls, interlocks, alarms, and related items. Include operating checks, provision and installation of seals as required, checking and adjusting settings, standardizing and calibration, and proof tests.

e. Install relief valves and filter regulator sets.

f. Insulate and winterize instruments.

If all of the above cannot be completed before startup, advise the Contracting Officer in writing 2 weeks before testing.

3.4.3 Dielectric Tests

Test electrical system for dielectric strength. Electrical system, excluding control and recording instruments, are subject to a voltage of twice its rated voltage, plus [500] [_____] volts, for a period of not less than [1] [_____] minute. Before testing, disconnect all instruments and operating mechanisms that could be damaged. After the test, the circuit must still register a resistance of not less than 1 megohm at [600] [_____] volts dc. This test applies between all insulated circuits and external metal parts.

3.4.4 Control Tests

Ttest boiler under actual firing conditions. Verify with the tests that all controls function within the maximum and minimum limits for temperature or timing. Simulate unsafe conditions, such as high temperatures, during the tests by reducing the settings for activation of limit and safety controls.

3.4.5 Necessary Temporary Piping

Furnish necessary temporary test piping no less than [100] [_____] mm [4] [_____] inches in diameter. Provide a steam silencer to exhaust excess steam to the atmosphere in the event the boiler load is insufficient to meet the capacity specified. Provide a control valve for exhausting excess steam to atmosphere in a convenient location inside the boiler room.

3.4.6 Test of Deaerating Feedwater Heater

Test the deaerating feedwater heater in compliance with ASME PTC 12.3 and demonstrate that the equipment installed meets the requirements specified as to performance, capacity, and quality of effluent. During the operating test of the boilers, conduct tests to determine oxygen content in accordance with ASTM D888, Method A. Operate boilers at varying loads up to maximum heater capacity while oxygen tests are being made.

3.4.7 Test of Water Treatment Equipment

Test water treatment equipment meeting the requirements specified as to capacity and quality of effluent. Tests for ion exchange units must cover at least two complete regenerations and capacity runs. Boiler water conditioning includes chemical treatment and blowdown periods to prevent scale and corrosion in boilers and in supply and return distribution systems from the initial start of the system, through the testing period, and to final acceptance of the completed work. Use approved chemicals and method of treatment.

3.4.8 Hydrostatic Tests

Following erection, test each boiler hydrostatically and prove tight under a gauge pressure of 1-1/2 times the working pressure specified. Following the installation of all piping and boiler house equipment, but before the application of any insulation, make hydrostatic tests and prove the system tight under gauge pressures of 1-1/2 times the specified working pressure. Test boilers and inspect the piping connections by an NBBI-commissioned boiler inspector for determining compliance with all requirements in ASME BPVC SEC VIII D1, and supply the Contracting Officer with a certificate of approval for each boiler. Apply shop foam to all seams to detect leaks. Boiler must not lose more than [1.27] [_____] kPa [5] [_____] inches water gauge in [10] [_____] minutes.

3.4.9 Test for Steam Purity and Water Level Stability

Perform test for steam purity, in accordance with ASTM D1066, and water level stability simultaneously under the operating conditions specified.

3.4.9.1 Steam Tests

Make steam tests for boiler over [2.07] [_____] MPa [300] [_____] psig, without superheaters, not used for power generation or large turbine drive, on steam sampled in accordance with ASTM D1066, using the conductivity method in ASTM D2186. Do not exceed 30 microhms at 18 degrees C conductivity of the steam corrected for carbon dioxide and ammonia content. Sample steam for boilers less than [2.07] [_____] MPa [300] [_____] psig, with or without superheat, used for power generation or turbine drive for air-conditioning equipment in accordance with ASTM D1066 and test in accordance with the conductivity method in ASTM D2186. Do not exceed 4.0 microhms at 18 degrees C 60 degrees F conductivity of the steam corrected for carbon dioxide and ammonia content. Test steam for moisture in accordance with calorimetric method outlined in Part II of ASME PTC 19.11.

3.4.9.2 Water Level Stability Test

Conduct water level stability test first by use of the manual bypass around the feedwater regulator. Then repeat test using the automatic feedwater regulator. Ensure boiler maintaina specified water level stability under both conditions.

3.4.10 Performance Tests

Submit a proposed performance test procedure for the operating [and environmental] tests, 30 days prior to the proposed test date. Include a complete description of the proposed test with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. Do not commence test until the procedure has been approved. The Contractor's complete plan for water treatment, including proposed chemicals to be used and nationally recognized testing codes applicable to the system, must be included and approved prior to system startup.

a. Upon completion of installation, subject the boiler and associated equipment and instrumentation to such operating tests as may be required to demonstrate satisfactory functional operation.[Stack sampling for compliance with applicable emission limits is covered under Section 23 52 00 HEATING BOILERS.] Perform testing in accordance with the test procedures indicated below and in accordance with the requirements of ASME PTC 19.10. All pressure measurements are to be taken in accordance with ASME PTC 19.2, and all temperature measurements are to be taken in accordance with ASME PTC 19.3 TW. Furnish all instruments, equipment, and personnel required for the tests. The Government will supply water, electric power, and fuel. Ensure two instruction manuals are available at all times during the tests.

b. Run an efficiency and capacity test on one boiler of each size installed, conducted in strict accordance with ASME PTC 4, abbreviated efficiency test, utilizing the input-output method, except for use of alternate measuring or metering devices properly calibrated before the test, for the purpose of metering the water used and change in the temperature of flue gas. Analyze and record combustion gases entering the heat recovery boiler. Record CO, CO2, H2O, O2, N2, HCl, SO2 and temperature. Use water meter in the test suitable for hot water. Ensure efficiency is not less than specified. Ensure maximum moisture content of saturated steam leaving the boiler is as specified. Conduct efficiency and general performance tests on the boilers by a qualified test engineer. Provide calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in efficiency and capacity tests before the test. Read all indicating instruments at 1/2-hour intervals unless otherwise directed. Instruments required for conducting the boiler tests are contained in ASME PTC 4 and ASME PTC 19.11.

3.5 CLEANING OF BOILERS AND PIPING

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NOTE: Local guidelines may dictate the maximum discharge rate for cleaning chemicals into the sanitary sewer system.

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After the hydrostatic tests, but before the operating tests, clean the boilers of foreign materials. Wherever possible, wire brush surfaces in contact with water to remove loose material.

a. The following procedure may be used or submit other standard procedure for review and approval by the Contracting Officer. Fill boilers with a solution consisting of the following proportional ingredients for every 1000 liters gallons of water and operated at approximately 200 to 350 kPa 30 to 50 psig for a period of 24 to 48 hours, exhausting steam to the atmosphere:

   (1) 2875 g 24 pounds caustic soda.

   (2) 2875 g 24 pounds disodium phosphate (anhydrous).

   (3) 960 g 8 pounds sodium nitrate.

   (4) 60 g 1/2 pound approved wetting agent.

b. Dissolve chemicals in the above proportions or as otherwise approved thoroughly in the water before placing in the boilers. After the specified boiling period, allow the boilers to cool, then drain and thoroughly flush. Clean piping by operating the boiler for approximately 48 hours, wasting the condensate.

c. Provide boiler water conditioning, including chemical treatment and blowdown during periods of boiler operation to prevent scale and corrosion in boilers and in supply and return distribution systems from the initial startup of the system, through the testing period and to final acceptance of the completed work. Use approved chemicals and method of treatment.

3.6 FRAMED INSTRUCTIONS

Provide framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, equipment, piping, valves, and control sequence. Post the instructions where directed. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, frame and post beside the wiring and control diagrams. Submit posted diagrams, instructions, and other sheets, before posting. Post framed instructions before acceptance testing of the systems.

3.7 FIELD TRAINING

****

NOTE: Consult equipment manufacturers for recommended time required to train personnel for the proper operation of the unit and insert number of hours.

****

Provide a training course for designated operating, maintenance, and supervising staff members. Provide training for a total period of [_____] hours of normal working time, starting after the system is functionally complete, but prior to final acceptance tests. Cover all of the items contained in the approved operating and maintenance instructions as well as demonstrations of routine maintenance operations. Submit [6] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation, and emergency shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Submit [6] [_____] complete copies of maintenance instruction listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include piping layout, equipment layout, and simplified wiring and control diagrams for the system as installed, and other information necessary for equipment maintenance. Also include recommendations for total staffing and job descriptions in the field training. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.8 OPERATING TEST

Perform test at full-scale for 24 hours, or longer if required by the combustion equipment specifications. During this period, the boilers must supply the rated amount of steam at the temperature, pressure, and thermal efficiency specified when the unit is supplied with the rated amount of hot gases at the specified temperature. The entire unit must maintain this efficiency during the entire test period. After [4] [_____] hours, temperature readings of the outer shell, taken at not less than five random locations, must not exceed the temperature limitation specified. Boilers must also demonstrate the ability to operate well with the combustion equipment and to follow changing load demands while maintaining specified steam temperature and pressure based upon the limitations of the equipment. At the conclusion of testing, inspect the boilers for deterioration such as slagged or spalling refractory, warping of parts, and discolored exterior paint.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 52 30.01 10 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-23 70 01.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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CENTRAL COAL-FIRED STEAM-GENERATING SYSTEM

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 52 30.01 10 (May 2020)**

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SECTION 23 52 30.01 10

CENTRAL COAL-FIRED STEAM-GENERATING SYSTEM
05/20

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NOTE: This guide specification covers the requirements for coal-fired central steam-generating systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.13	(2005; R 2010) Methods for the Measurement of Sound Pressure Levels in Air (ASA 118)

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)

ABMA Boiler 203	(2002) A Guide to Clean and Efficient Operation of Coal-Stoker-Fired Boilers
ABMA Boiler 402	(2012) Boiler Water Quality Requirements and Associated Steam Quality for Industrial/Commercial and Institutional Boilers

AMERICAN GAS ASSOCIATION (AGA)

AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6013	(2006A; R2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z83.19/CSA 2.35	(2017; R 2022) Gas-Fired High-Intensity Infrared Heaters

AMERICAN PETROLEUM INSTITUTE (API)

API STD 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries
API Spec 15LR	(2001; R 2018) Specification for Low Pressure Fiberglass Line Pipe

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2023) Manual for Railway Engineering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME BPVC SEC I	(2017) BPVC Section I-Rules for

	Construction of Power Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers
ASME PTC 4	(2013; R 2023) Fired Steam Generators
ASME PTC 10	(2022) Performance Test Code on Compressors and Exhausters
ASME PTC 19.11	(2008; R 2013) Steam and Water Sampling, Conditioning, and Analysis in the Power Cycle

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C213	(2022) Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A179/A179M	(2024) Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A249/A249M	(2024a) Standard Specification for Welded

	Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes
ASTM A285/A285M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
ASTM A350/A350M	(2024b) Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components
ASTM A514/A514M	(2022) Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A659/A659M	(2012; R 2017) Standard Specification for Commercial Steel (CS), Sheet and Strip, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled
ASTM A688/A688M	(2024) Standard Specification for Welded Austenitic Stainless Steel Feedwater Heater Tubes
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B68/B68M	(2011) Standard Specification for Seamless Copper Tube, Bright Annealed (Metric)
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock

ASTM C27	(1998; R 2022) Fireclay and High-Alumina Refractory Brick
ASTM C62	(2023) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C401	(2012; R 2022) Alumina and Alumina-Silicate Castable Refractories
ASTM D888	(2012; E 2013) Dissolved Oxygen in Water
ASTM D1066	(2018; E 2018) Standard Practice for Sampling Steam
ASTM F1139	(1988; R 2024) Steam Traps and Drains
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

CAGI B19.1	(2010) Safety Standard for Compressor Systems

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION (CEMA)

CEMA B105.1	(2015) Welded Steel Conveyor Pulleys
CEMA Belt Book	(2014; Errata 2016; Tech Statement 1 2016) Belt Conveyors for Bulk Materials

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

HEAT EXCHANGE INSTITUTE (HEI)

HEI 2622	(2009) Standards for Closed Feedwater Heaters; 8th Edition
HEI 2623	(2004) Standards for Power Plant Heat Exchangers

HYDRONICS INSTITUTE DIVISION OF AHRI (HYI)

HYI-005	(2008) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NACE INTERNATIONAL (NACE)

NACE SP0185	(2024) Extruded Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-23 PART 1	(2013) National Board Inspection Code - Part 1 Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code
NFPA 329	(2025) Recommended Practice for Handling Releases of Flammable and Combustible Liquids and Gases

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

RUBBER MANUFACTURERS ASSOCIATION (RMA)

RMA IP-1	(2011) Conveyor and Elevator Belt Handbook; 3rd Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 16	(2023) Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

30 CFR 1	Mine Safety and Health Administration; Establishment and Use of Official Emblem

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Steam-Generating Units; G, [_____]

Equipment Erection; G, [_____]

SD-03 Product Data

Steam-Generating Units

Spare Parts

Framed Instructions

Welding

SD-06 Test Reports

Tests

SD-10 Operation and Maintenance Data

Steam-Generating Units; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Welding

****

NOTE: Where pipeline, structural, or other welding is required on the same project, tests will be required accordingly. Testing may be by the coupon method as prescribed in the welding code or by special radiographic methods. If the need exists for more stringent requirements for weldments, delete the first bracketed statement and delete the welding submittal.

****

[Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators, and a proposed performance test procedure, 30 days prior to the proposed test date, containing a complete description of the proposed test along with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. No test will commence until the procedure has been approved. Submit complete plan for water treatment, including proposed chemicals to be used and nationally recognized testing codes applicable to the system, prior to system startup. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders are to be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform the tests at the work site if practicable. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record.] [Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING. Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING, PRESSURE PIPING.]

1.3.2 Use of Asbestos Products

****

NOTE: The first clause in brackets should be used when it is known that substitutes are available for any asbestos products which might be included with the equipment. The second clause in brackets should be used when it is possible or definitely known that asbestos products for which no technically acceptable substitute exists may be included with the equipment.

****

[Products which contain asbestos are prohibited. This prohibition includes items such as packings or gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material.] [Except as provided below, products which contain asbestos are prohibited. This prohibition includes items such as packings and gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material. Asbestos products are acceptable only in exceptional cases where the Contractor states in writing that no suitable substitute material exists, and, in addition, the Contractor furnishes to the Contracting Officer a copy of U.S. Department of Labor, Occupational Safety and Health Administration, "Safety Data Sheet" (Form OSHA-20), completed by the asbestos manufacturer stating that the product is not an asbestos health hazard.]

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each item of equipment specified, after approval of the detail drawings and not later than [_____] months before the date of beneficial occupancy. Include in the data a complete list of spare parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1] and [3] years of service.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each major item of equipment must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.3 Prevention of Rust

Unless otherwise specified, surfaces of ferrous metal subject to corrosion will be factory prime painted with a rust inhibiting coating and subsequently factory finish painted in accordance with the manufacturer's standard practice. Equipment exposed to high temperature when in service will be prime and finish painted with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil.

2.1.4 Equipment Guards and Access

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact must be fully enclosed or guarded. High temperature equipment and piping exposed to contact by personnel or where it creates a fire hazard must be properly guarded or covered with insulation of a type specified. Items such as catwalks, operating platforms, ladders, and guardrails are to be provided where shown and be constructed in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.2 BOILERS

****

NOTE: Specify steam outlet temperature in cases where the boiler includes a superheater.

****

Each boiler must have the capacity indicated. The equipment design and accessory installations will permit accessibility for maintenance and service. Design boilers for a maximum allowable working pressure of [_____] Pa psig with an operating pressure of [_____] Pa psig. Design conditions are follows:

Rated capacity	[_____] kg/hour pounds/hour
Steam outlet temperature	[_____] degrees C degrees F

Site elevation	[_____] m feet
Ambient air temperatures	[_____] to [_____] degrees C degrees F
Reference air temperature	27 degrees C 80 degrees F

The boiler must be capable of operating continuously at maximum specified capacity without damage or deterioration to the boiler, setting, firing equipment, or auxiliaries. The boiler must be capable of automatically controlled operation while burning the fuel specified.

2.2.1 Capacity

Rated capacity must be the capacity at which the boilers will operate continuously without exceeding the specified furnace heat release and transfer rates, furnace exit temperature, and gas exit temperature. Boiler auxiliaries including fans, motors, drives, and similar equipment must be provided with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. [Stoker and grate capacities are to also be provided with 10 percent excess capacity to allow for variations in coal analysis.]

2.2.2 Electrical Equipment

Provide electric motor-driven equipment specified complete with motors and necessary motor control devices. Motors and motor control devices will be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM including requirements for hazardous area locations. Integral size motors must be premium efficiency type in accordance with NEMA MG 1.

2.2.2.1 Motor Ratings

Motors must be suitable for the voltage and frequency provided. Motors 373 W 1/2 horsepower and larger are to be three phase, unless otherwise indicated. Ratings must be adequate for the duty imposed, but not be less than indicated.

2.2.2.2 Motor Starters

****

NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the reference to motor starters.

****

Where a motor starter is not shown in a motor control center on the electrical drawings, provide a motor starter. Where required, provide motor starters complete with properly sized thermal overload protection and other equipment at the specified capacity, including an allowable service factor and other appurtenances necessary for the motor starter specified. Manual or automatic control and protective or signal devices required for operation specified and any wiring required to such devices not shown on the electrical drawings must be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function.

2.2.3 Boiler Design Requirements

2.2.3.1 Radiant Heating

****

NOTE: The following is a guide to determine maximum radiant heat release:

Boiler Type	**Maximum kJ/sq meter Btuh/sq ft**
Controlled circulation watertube boilers	**1,419,500 125,000**
Natural circulation watertube boilers	**1,135,650 100,000**
Firetube boilers	**1,135,650 100,000**

****

The maximum effective radiant heating surface is limited to [_____] watt per square meter input Btu input per square foot per hour.

2.2.3.2 Heat Input

The maximum heat input per cubic meter cubic foot of furnace volume must be [931.5 Megajoules/cubic meter 25,000 Btu/cubic foot with spreader stokers] [1.7 Gigajoules/cubic meter 45,000 Btu/cubic foot with underfeed stokers].

2.2.3.3 Combustion Gas

The combustion gas temperature at the furnace exit will be a minimum of 38 degrees C 100 degrees F less than the ash fusion softening temperature (reducing atmosphere) of the coal specified.

2.2.3.4 Ash Discharge

[Spreader stoker units with continuous or intermittent automatic mechanical ash discharge grates, or one of the traveling grate type, will have a maximum loading of 2.2 Mega watts/square meter 700,000 Btuh/square foot of grate area.] [Underfeed dumping grate units will have a maximum loading 1.4 Mega watts/square meter 450,000 Btuh/square foot of grate, assuming a 10 percent maximum ash content and 1205 degrees C 2,200 degrees F minimum ash softening temperature. Do not include side dumping areas in the area.]

2.2.3.5 Radiant Heating Surface

Effective radiant heating surface will be as specified in ASME BPVC SEC I. For firetube steel firebox boilers it must be the total water backed area within the furnace boundaries exposed to the flame. The mean circumference must be used for corrugated crown sheets.

2.2.3.6 Furnace Volume

Furnace volume for watertube or firetube boilers is defined as the cubical volume between the top of the grate and the first plane of entry into, or between, the tubes. If screen tubes are utilized, they constitute the plane of entry.

2.2.3.7 Boiler Operating Capacity

The boiler must maintain continuous capacity within the specified range at the specified pressure with boiler feedwater at a temperature of approximately [_____] degrees C degrees F. The flue gas outlet temperature will be [_____] degrees C degrees F, based on excess air of [_____] percent and carbon loss of [_____] percent at maximum continuous capacity. Moisture in steam and boiler water concentrations will be in accordance with ABMA Boiler 402.

2.2.3.8 Boiler Output Capacity

Output capacity of the boiler will be based on tests of the boiler as a unit.

2.2.3.9 Boiler Markings

****

NOTE: Delete brackets if the boiler does not include a superheater.

****

Each boiler must be stamped with:

a. Maximum continuous capacity in Watts Btuh.

b. Radiant heating surface in square meters feet.

c. Total heating surface in square meters feet.

d. Furnace volume in cubic meters feet.

e. Boiler unit design maximum allowable working pressure.

[f. Superheater final steam temperature in degrees C degrees F.]

[g. Superheater heating surface in square meters feet.]

2.3 BOILER DETAILS

2.3.1 Packaged Steam-Generating Units

Submit manufacturer's design data and structural computations for walls, roof, foundations, and other features, for specialty type of construction. Include design data for lateral forces that may be encountered due to wind loads and seismic forces.

Submit [6] [_____] complete copies of operating instructions, prior to the training course, outlining the step-by-step procedures required for system startup, operation, and shutdown. Include in the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Submit [6] [_____] complete copies of maintenance instructions, prior to the training course listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions will include piping layout, equipment layout, and simplified wiring, and control diagrams of the system as installed.

2.3.1.1 Firebox Type (for Boiler Capacities Less Than 2.9 Mega watts 10,000,000 Btuh)

Units must be furnished complete with coal burning equipment, [fly ash collector,] brickwork, insulation with steel jacket, safety and operating controls, forced- and induced-draft fans, low water cutoff and alarm, and other required appurtenances. The unit will be complete, self-contained, fully automatic, and ready for service upon completion of utility connections except that firing equipment, safety and operating controls may be packaged separately from the boiler, fully assembled, factory wired, and completely ready for field mounting. The firebox boiler will be of the watertube or firetube type in conformance with ASME BPVC SEC I. Control panel must be prewired and totally enclosed. Provide over-fire air jets for furnace turbulence. Provide positioning controls. [Equip the boiler with soot blowers.]

2.3.1.2 Watertube, Waterwall Type (Boiler Capacities Over 2.9 Mega watts 10,000,000 Btuh)

Except as modified, the steam-generating unit will comply with the requirements of ASME BPVC SEC I. Steam generating unit must be furnished complete with stoker, [fly ash collector,] forced- and induced-draft fans, control and instrument panel with limit and automatic controls, soot blowers, over-fire air system feedwater regulator, low water cutoff and alarm, feed piping and all other fittings, auxiliaries, and appurtenances necessary for safe and efficient operation. The steam generator must be factory fabricated and [assembled on a steel foundation or foundations] [top supported].

2.3.2 Watertube Boilers

Watertube type boilers will be of the [site assembled] [shop assembled] type with either two or three drums and arranged to suit the fuel burning equipment specified. Provide boilers capable of continuous operation at the indicated capacity.

2.3.2.1 Drums

Drums are to be steel plate, fusion welded in conformance with ASME BPVC SEC I, including stress relieving and x-raying of welded seams. The main steam drums will be of sufficient size to accommodate steam separators and drum internals with provisions and space for accomplishment of maintenance. Provide baffling to separate the steam from the water in the drum and to maintain a stable water level under a fluctuating load. Variations in normal water level are not to exceed 50 mm 2 inches, with an increasing load change of 20 percent of rated capacity per minute. Provide steam separators to deliver saturated steam with maximum specified moisture content. Each drum will have two 304.8 x 406.4 mm 12 x 16 inch elliptical manholes, with the exception of the mud drum which will have at least one 304.8 x 406.4 mm 12 x 16 inch elliptical manhole. Each manhole will have cover, yoke, and gaskets.

2.3.2.2 Tubes

Tubes will be no less than 50 mm 2 inches in diameter, electric welded or seamless steel, and be connected to the drums and headers by expanding into bored tube seats. Boilers will have water-cooled furnace walls of a design suitable for the application. Lower header of sidewalls will be round design with tubes welded to header stubs. Each waterwall header must have enough supply and riser tubes to ensure that no portion of the waterwalls will become water starved at maximum capacity.

2.3.2.3 Baffles

Arrange baffles to bring the products of combustion into contact with the heating surfaces without excessive loss of draft. Baffles will be gas-tight and be either a refractory material or metal suitable for temperatures encountered.

2.3.2.4 Access Doors

Access doors in sufficient number, of adequate size, and properly located must be provided for cleaning, inspection, and repair of all areas in the complete assembly. Doors must be gas-tight and interior surfaces exposed to direct radiation and high temperatures must be lined with approved refractory material to prevent excessive heat losses and warping of doors. Doors too large or bulky for hand removal are to be hinged. At least one observation port with cast-iron cover must be provided on the front and rear wall of the furnace.

2.3.2.5 Miscellaneous Pipe Connections

Miscellaneous pipe connections must be provided for steam outlet, safety valves, feedwater, feedwater regulator, water column, blowoff, steam supply to soot blowers, steam gauge and vent, continuous blowdown, continuous chemical feed, and instrument connections. Provide boilers with necessary jets for furnace turbulence, the number and arrangement of as recommended by the boiler manufacturer. Provide soot blowers , if required by the manufacturer. Provide a suitable smoke outlet with steel frame, damper, and damper shaft. Damper must have external high temperature roller or ball bearings at both ends of the shaft, and have a suitable operating arm and rod.

2.3.2.6 Superheater Design

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NOTE: Delete if the boiler does not include a superheater.

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The design of the superheater will be such that at any given load, and to the extent feasible, all elements have the same outlet temperature. The superheater tube and support materials must be chosen so that with any reasonably expectable excess air and the worst expected unbalance in air, steam, and fuel distribution, there is an ample and conservative margin of safety to prevent damage by overheating or corrosion to the components. Pad-type permanent thermocouples must be installed on superheater tubes in sufficient number and so located as to indicate the variation in, and maximum value of, the tube temperature across the furnace width. Locate the thermocouples outside of the gas stream. The superheater outlet header must be capable of absorbing the reactions from the main steam piping. Extend the superheater terminals to sufficiently clear the boiler walls to facilitate connecting thereto. Any superheater piping must be extended beyond the boiler front wall line, 900 mm 3 feet beyond casing. Minimize header penetrations through the casing. Provide adequate superheater piping to mount the safety valves. The design must minimize external corrosion on the superheater and reheater due to molten slag or fouling. Minimize the location of headers in the gas stream. Spray desuperheaters must be complete with thermal sleeves of sufficient length to prevent droplets of water from coming in contact with the hot wall of the pipe. Arrange the sleeves so they attach securely to the pipe, but in a manner that will permit differential expansion.

2.3.2.7 Boilers and Firing Equipment

Support boilers and firing equipment from the foundations with structural steel independent of all brickwork. Boiler supports must permit free expansion and contraction of each portion of the boiler without placing undue stress of any part of the boiler or setting.

2.3.3 Boiler Settings

2.3.3.1 Boiler Material

Conform materials to the following:

2.3.3.1.1 Firebrick

ASTM C27, class as recommended by the boiler manufacturer.

2.3.3.1.2 Insulating Brick

ASTM C155

2.3.3.1.3 Castable Refractory

ASTM C401. The minimum modulus of rupture for transverse strength will be no less than 4.1 MPa 600 psi after being heat-soaked for 5 hours or more at a temperature in excess of 1371 degrees C 2,500 degrees F.

2.3.3.1.4 Mortar, Air-Setting, Refractory

As recommended by the boiler manufacturer.

2.3.3.1.5 Brick, Common

ASTM C62

2.3.3.1.6 Galvanized Steel Sheets

ASTM A659/A659M, ASTM A653/A653M. Gauges specified are manufacturer's standard gauge.

2.3.3.1.7 Uncoated Steel Sheets and Strips, Low Carbon

ASTM A36/A36M. Gauges specified are manufacturer's standard gauge.

2.3.3.2 Firebox, Packaged Type

Install boiler refractories and insulation to permit free expansion without placing undue stress on the boiler or refractory. Insulation and jacket must provide a casing temperature not exceeding 77 degrees C 170 degrees F in an ambient temperature of 38 degrees C 100 degrees F with a surface wind velocity not exceeding 254.0 mm/second 50 fpm while operating at full load.

2.3.3.3 Watertube, Waterwall Type

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NOTE: On watertube type boilers that will be used intermittently, welded wall construction is recommended to minimize corrosion. In other applications or with fuels containing not more than 0.5 percent sulfur, a casing type enclosure is suitable.

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Boiler walls must be [steel-encased wall construction with fabrication details as recommended by the boiler manufacturer. Boiler wall and boiler roof lining must consist of a continuous screen of closely spaced finned, tangent, or intermittent watertubes. Steel-encased walls will have casing constructed of not thinner than 3.416 mm 10 gauge black steel sheets, either bolted or welded. Casing are to be gas-tight and be reinforced with structural steel to provide rigidity and prevent buckling. Make provisions for expansion and contraction. [Refractory behind the waterwall tubes are to be high-duty refractory, not less than 63.5 mm 2-1/2 inches thick.] High temperature block and mineral wool blanket insulation must be provided between the refractory backup and steel casing, or between an inner and outer casing, and be of sufficient thickness to limit the maximum casing temperature in the furnace area to [54] [_____] degrees C [130] [_____] degrees F with a surface air velocity of 508.0 mm/second 100 fpm and an ambient air temperature of 27 degrees C 80 degrees F when operating at full capacity. When boilers are provided with double casings, the inner casing will be constructed of not thinner than 1.897 mm 14 gauge steel sheets. Alloy steel conforming to ASTM A568/A568M will be used where temperatures over 370 degrees C 700 degrees F occur.] [of welded wall construction. The width of the fins are limited to 19 mm 3/4 inch to prevent overheating of the fins under all operating conditions. Designs exceeding 19 mm 3/4 inch may only be used when provided with supporting calculations and subject to the approval of the Contracting Officer. Tubes must be seamless type. The fin-to-tube weld must be continuous and on both the front (fireside) and back side of the fin. The fin will not be less than 6.4 mm 1/4 inch thick. The construction must form a pressure-tight structure capable of transferring a maximum amount of heat to the tube. Check all welded joints and openings by a pressure test. Repair any casing leakage and make pressure-tight. The maximum deflection of the reinforced panels are to not exceed 1/360 of the length of the maximum span. The structure tested must be capable of holding a pressure of 1.5 times the predicted maximum furnace operating pressure.]

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NOTE: For personnel safety, the design temperature of the casing surface should not exceed 66 degrees C 150 degrees F. Should the designer wish to use a design surface temperature between 54 and 66 degrees C 130 and 150 degrees F, an economic evaluation must be performed. The evaluation must determine if the additional capital costs for insulation outweigh the cost savings due to reduced boiler radiation losses.

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2.3.3.3.1 Boiler Roof

Boiler roof will have a casing constructed no thinner than 3.416 mm 10 gauge black steel sheet. Refractory lining will consist of 63.5 mm 2-1/2 inches, minimum, of high-duty refractory backup behind the roof tubes and sufficient thickness of high temperature block insulation or mineral wool blanket to limit the maximum casing temperature in the furnace area to [54] [_____] degrees C [130] [_____] degrees F with a surface air velocity of 508.0 mm/second 100 fpm and an ambient air-temperature of 27 degrees C 80 degrees F when operating at full capacity. Exposed portions of the boiler drums must be insulated with 75 mm 3 inches of suitable mineral wool blanket or block insulation. Manholes and other inspection and access openings, identification plates, and stamps will have insulation finished neatly against a metal ring provided for this purpose.

2.3.3.3.2   Bridge Walls

Bridge walls exposed on all sides to radiant heat and to the products of combustion are to be constructed of super-duty refractory not less than 450 mm 18 inches thick, conforming to the boiler manufacturer's requirements; walls having only the front side exposed to radiant heat and to the products of combustion will have front facing and cap constructed of 225 mm 9 inches of super-duty refractory and a back facing of not less than 225 mm 9 inches of low-duty firebrick. Base of the wall will be common brick.

2.3.3.3.3   Settling Chamber

Provide settling chamber [, equipped with suitable means for frequent cleaning without shutting down the boilers,] below the last pass of each boiler for the removal of fly ash.

2.3.3.3.4   Expansion Joints

Provide expansion joints where indicated and else-where as required to permit all brickwork to expand freely without interference with the boiler. Joints will be of adequate width, tightly sealed against leakage, and free from mortar, with the outer 100 mm 4 inches sealed with resilient mineral wool suitable for 930 to 1095 degrees C 1,700 to 2,000 degrees F. In addition, to allow for expansion of the inner face, a series of 3.2 mm 1/8 inch wide vertical openings spaced 1.8 m 6 feet apart must be provided on the furnace side of the wall. Make proper provision for expansion and contraction between boiler foundation and floor.

2.3.3.3.5   Firebrick

Lay up firebrick in air-setting mortar. Each brick must be dipped in mortar, rubbed, shoved into its final place, and then tapped with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel will not be permitted. Maximum mortar joint thickness is not to exceed 3.2 mm 1/8 inch and average joint thickness is not to exceed 1.6 mm 1/16 inch.

2.3.3.3.6   Plastic Refractory

Install plastic refractory in accordance with the manufacturer's recommendations and by workmen skilled in its application.

2.3.3.4   Watertube, Waterwall (Packaged Type) Unit

Boiler setting, refractory, insulation, and casing will be in accordance with ASME BPVC SEC I.

2.3.4 Boiler Fittings and Appurtenances

Boiler fittings and appurtenances suitable for a steam working pressure of [_____] Pa psig and [_____] degrees C degrees F will be installed with each boiler in accordance with ASME BPVC SEC I.

2.3.4.1 Water column

Provide water column with straight-through type drain valve. Water column will be complete with gauge glass, high- and low-water alarm, and three quick-closing gauge valves and try cocks fitted with the necessary chains and handles for operation from the boiler room floor. [Provide water column lighting for ease of reading at all times.]

2.3.4.2 Water Gauge

Provide water gauge drain valve of the straight-through type.

2.3.4.3 Low Water Cutoff

Low water cutoff with alarm located on instrument panel must include either a float-actuated switch as a means of making electrical contact or an electrically-actuated probe type low water cutoff. Provide the float chamber with a blowdown connection. The cutoff must cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum level. A safety shutdown due to low water cutoff must require a manual reset before operation can be resumed and prevent recycling of the [burner] [stoker].

2.3.4.4 Bypass Button

Provide a spring-loaded shunt bypass button to prevent nuisance shutdowns during sightglass blowdown.

2.3.4.5 Steam Gauge

Provide steam gauge for each boiler in a visible location on the boiler.

2.3.4.6 Feed and Check Valves

Provide feed and check valves adjacent to each boiler feed nozzle.

2.3.4.7 Continuous Blowdown Valve

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NOTE: Continuous blowdown equipment will be provided if required by UFC 3-410-01 or UFC 3-410-02. If a firetube boiler is specified, these paragraphs will be deleted.

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Continuous blowdown valve must be manual proportioning type fabricated of corrosion-resistant steel. Equip the valve with a micrometer dial and pointer to indicate the proportional setting.

2.3.4.8 Safety Valves

Safety valves of proper size and of the required number and construction and set pressures will be in accordance with of the ASME BPVC SEC I and be installed so that the exhaust steam will discharge through pipes extending through the roof. Each exhaust riser must have a drip-pan elbow to prevent the accumulation of water on the valve. A suitable slip joint must be provided between the drip-pan elbow and the riser.

2.3.4.9 Blowoff Valves

Provide blowoff valves in tandem at each point of blowdown as recommended by the boiler manufacturer. Piping must be extra-heavy weight, minimum, steel pipe conforming to ASTM A106/A106M Grade B. Blowoff valves will be the balanced seatless type unless otherwise approved.

2.3.4.10 Steam Nonreturn Valve

Install steam nonreturn valve of size and pressure rating shown in the steam supply line from each boiler. Arrange valves to close automatically when there is a pressure differential of 34.5 kPa 5 psi between the boilers and steam headers and also arrange to operate as stop valves. Set rising stem type valves with the stem up, either inclined or vertical. Provide angle or straight-way type, cast steel valves and operate without chattering, hammering, or sticking.

2.3.4.11 Feedwater Regulator

Connect feedwater regulator, sized for the application, complete with all necessary piping and accessories for automatic operation. Provide valved bypass around control valve. [Provide units with device to lock regulator in existing position in case of power failure.] [Provide units with manual/automatic selector panel located on instrument panel.] Provide feedwater control element with a drain valve. Fit the feedwater line with a thermometer well.

2.3.4.12 Soot Blowers

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NOTE: Manually operated rotary soot blowers are normally supplied on boilers up to 6 Megawatts 20 million Btuh. Delete the inappropriate type of soot blower.

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Furnish soot blowers as required to effectively clean all tube surfaces within the boiler. Use adjustable steam blowing pressure. Construct elements within the boiler of heat-resisting alloys suitable for the flue gas temperature encountered and are removable without disturbing the boiler tubes. Furnish soot blowers complete with necessary auxiliaries and connect in accordance with the manufacturer's recommendations. Provide soot blowers that are [permanently-mounted, rotary type manually-operated by a single chain. Provide quick-opening, positive-closing type valve located in the blower head, external to the boiler, with the working parts protected from the furnace gases, and operate by the same chain that rotates the element. Provide continuous chains that extend within easy reach of the operating floors. Furnish blowers complete with necessary auxiliaries and connect in accordance with the manufacturer's recommendations.] [electrically-operated rotary or retractable type, except that soot blowers exposed to flue gas temperatures over 815 degrees C 1,500 degrees F must be retractable type only. Provide rotary type soot blowers with a quick-opening, positive closing type valve located in the blower head, external to the boiler, with the working parts protected from the furnace gases, and operate valve by the same motor that rotates the element. Provide electrically-operated retractable type soot blowers with either single motor-driven, totally-enclosed drive carriage with dual rack-and-pinion drives or dual-motor electric drive enclosed in a protective steel housing. Include starters and pushbutton stations for electrically-operated soot blowers.]

2.4 STOKER EQUIPMENT

Certify that the stoker selected will be satisfactory for the boiler design. Provide stokers that are capable of efficiently burning coal with fuel sizing conforming to ABMA Boiler 203, approximately [_____] mm inches in size with an approximate moisture content of [_____] percent and having the following analyses:

Proximate Analysis	Percent, Dry
Moisture	[_____]
Volatile Matter	[_____]
Fixed Carbon	[_____]
Ash	[_____]
Ultimate Analysis	Percent, Dry
Carbon	[_____]
Hydrogen	[_____]
Nitrogen (Calc)	[_____]
Sulfer	[_____]
Chlorine	[_____]
Ash	[_____]
Oxygen (Diff)	[_____]
Btu/lb as received	[_____]
Btu/lb - dry	[_____]
Grindability	[_____]
Raw Fuel Size	[_____]
Ash Analysis	Percent
SiO(2)	[_____]
Al(2)O(3)	[_____]

TiO(2)	[_____]
Fe(2)O(3)	[_____]
CaO	[_____]
MgO	[_____]
Na(2)O	[_____]
K(2)O	[_____]
SO(3)	[_____]
Ash Fusion Temperatures	Degrees C F
Initial deformation temperature	[_____]
Softening temperature	[_____]
Fluid temperature	[_____]

2.4.1 Spreader Stokers

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NOTE: Any paragraphs describing stoker equipment not necessary for the system specified will be deleted. Stokers and stoking equipment selected will be based on the following:

Boilers having output capacities of 3.5 Megawatts 12,000,000 Btuh or more will be equipped with mechanically-driven grates operating continuously or intermittently. Dump grates will not be permitted in boilers in this size range. Spreader stokers will be specified for watertube boilers using bituminous coal with ash content on a dry basis in excess of 8 percent or ash fusion temperature lower than 1204 degrees C 2200 degrees F.

Underfeed or pulsating grate stokers may be specified for firebox packaged boilers when bituminous coal of any composition is used. Underfeed stokers will be the screw-feed type for boilers with capacity of less than 1635 kg (3600 pounds) of steam per hour, and the ram type for larger boilers. Pulsating grate units will be water-cooled and complete with automatic coal feed and continuous ash removal. Conveyor stokers may be specified for watertube boilers if suitable for the type of coal available. Chain or traveling grate may be specified by deletion of the inapplicable type of grate, or the choice between the two types may be left to the Contractor by including both types in the description. If steam drives are specified, plant must have an auxiliary boiler or an

alternate source of steam for startup. The following is a general guide in determining which type of grates to investigate:

Size Steam rate of boiler kg/hr lb/hr	**Type of Grate and Stoker**
1,135 - 9,070 **2,500 - 20,000**	**Single retort, stationary grate, underfeed stoker**
9,070 - 13,600 **20,000 - 30,000**	**Single retort, moving grate, underfeed stoker**
2,270 - 34,020 **5,000 - 75,000**	**Reciprocating grate, front continuous ash discharge stoker**
2,270 - 45,360 **5,000 - 100,000**	**Vibrating conveyor grate, front continuous ash discharge stoker**

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Provide overfeed self-feeding typespreader stokers suitable for burning a portion of the coal in suspension, but sized assuming 100 percent combustion on the grate. [Distribute coal evenly across the full width of the grate by no less than [_____] feeder units. Design unit for operation of any feeder independently of the others, or make it possible to operate all feeders simultaneously.] Provide mechanical-rotating type feeders that are capable of handling and uniformly distributing coal over the grate area and have no moving parts within the combustion chamber. Where moving parts are exposed to excessive heat, protect all bearings by suitable water jackets. Provide grease or oil lubrication for all bearings. Design stoker for readily adjustable feed distribution of coal on the grates.

2.4.1.1 Spreader Stoker Grates

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NOTE: Steam driven boiler auxiliaries will not be used unless the exhaust steam can be utilized completely. Reference to steam drives will be deleted if inapplicable for the equipment specified.

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Ensure grates for spreader stoker firing are the high air-resistant type especially designed and arranged for powered mechanical or compressed air actuated dumping in sections. Ensure openings provide proper distribution of air under the fuel bed. [Provide grates in sections to match the feeders with provisions for shutting off the forced draft to each section so that any section of the grate can be cleaned while the others remain in service.] Provide heavy-duty, heat-resisting cast-iron grates. Perform mechanical dumping with [steam-] [air-] [water-]actuated power cylinders connected to the grates, and furnish grates complete with cylinders, linkages, valves, and piping as required. Ensure each section dumps independently of other sections. Provide necessary over-fire air jets complete with fans, ducts, and air control valves as required for proper turbulence and combustion. Ensure grate drives are independent of feeder drives to provide independent speed variation of feeders and grates.

2.4.1.2 Traveling Grates

Provide high air-resistant type traveling grates especially designed for spreader stoker firing and for continuous ash discharge. Ensure openings provide proper distribution of air under the fuel bed. Provide heavy-duty, heat-resisting cast-iron grates, and ensure individual sections are replaceable without taking the grate out of service. Place air seals around grate to hold air leakage to a minimum. Furnish moving grates complete with supporting steel, shafts, sprockets, chain, gears, skid bars, and bearings as required. Enclose the front end of the grates where the ash is discharged with a dust-tight enclosure made of heavy cast-iron plates no less than 15.9 mm 5/8 inch thick and properly protect with firebrick where exposed to the furnace, or use a refractory-lined steel plate. Fit the vertical fronts of the enclosure with refractory-lined inspection and access doors, one for each feeder. Seal the roof of the enclosure with refractory to protect the metal parts from the furnace temperature. Enclose the underside of the grates to form a chamber. Construct hopper for receiving the ashes as indicated or as recommended by the manufacturer. Privude over-fire air jets as required for proper turbulence and combustion.

2.4.1.3 Vibrating Grate

Design high air-resistant type vibrating grate especially for spreader stoker firing and for continuous ash discharge. Provide grates that are either air- or water-cooled with openings to provide proper distribution of air under the fuel bed. Ensure grates are heavy-duty, heat-resisting cast iron and individual sections are replaceable. Provide a manual adjustment to regulate the ash bed thickness and automatically discharge ashes to the ash pit. Enclose the front of the grates where the ash is discharged with a dust-tight enclosure of heavy cast-iron plates no less than 15.9 mm 5/8 inch thick and properly protect with firebrick where exposed to the furnace, or use a refractory-lined steel plate. Fit the vertical fronts of this enclosure with refractory-lined inspection and access doors, one to each feeder. Seal roof of this enclosure with refractory for protecting the metal parts from the furnace temperature. Enclose the underside of the grates to form a chamber with a hopper for receiving the ashes. Provide over-fire air jets for turbulence and combustion.

2.4.1.4 Stoker Controls

Provide stoker controls toaccurately regulate the coal feed rate and that are the type required for connection to the combustion control system. Ensure manual setting of the coal feed rate with variation of stoker feed, as required to maintain any desired capacity between 50 and 110 percent of boiler capacity, is possible without disconnecting linkage. Provide separate feeder and grate drives Drive grate through a variable speed transmission with devices for changing speed interlocked with fuel feed regulation. Adjust grate speed manually to allow synchronization with fuel feed. Run all gears and chains of the variable speed transmission and gear reduction units, as required, in a bath of oil and enclose in a dust-tight and oil-tight case. Fit front and rear shafts of the grates with a forced lubrication system with fittings located outside the setting. Provide antifriction type bearings with hardened inner and outer races fitted with dust seals and easily accessible forced lubrication fittings. Provide stoker [and grate] with safety release devices to protect the mechanism from foreign materials or obstructions. Drive stoker by [electric motor] [steam turbine]. [Provide totally enclosed fan-cooled electric motor for installation in Class II, Division 1, Group F hazardous location in accordance with NFPA 70. Provide magnetic [across-the-line] [reduced voltage start] type motor starter with [general-purpose] [dust-tight] [explosion-proof] enclosure.] [Provide steam turbines utilized for stoker drives conforming to NEMA SM 23.]

2.4.1.5 Hoppers

Construct hoppers of steel plates no less than 6.4 mm 1/4 inch thick and with a capacity of no less than [_____] kg pounds per feeder. Provide hoppers with clean-out doors in the front of each feeder. Fit coal feed to the hoppers with concave type transitions to ensure the proper distribution of coal and coal fines across the width of the hoppers. Use stoker front plate to form the front of the boiler for the full width of the boiler and from the firing floor to some point above the stoker where it connects to the boiler structural framing. Front must be cast-iron or steel plate refractory lined with [auxiliary firing doors and] clean-out doors of refractory lined cast-iron. Provide structural framing as required to support the stoker and its components from the boiler foundation or boiler room floor. Divide the area under the grates into no less than four airtight zones for supply of forced draft having zone control dampers with external indicating operating and locking devices. Ensure all pressure parts for water-cooled grates including watertubes, headers, and valves furnished by the stoker manufacturer are for boiler pressure specified and constructed in conformance with ASME BPVC SEC I.

2.4.1.6 Over-Fire Turbulence and Cinder and Dust Reinjection System

Provide spreader stokers with over-fire turbulence and cinder-and-dust reinjection systems. Either air or steam may be used as the transport medium. Provide air systems with operating air by a single, low volume, high-pressure fan, driven by a splashproof electric motor. Design, locate, and size reinjection system ejectors for maximum fly ash pickup from all points. Equip nozzles for each system with manometer connections and heavy-duty adjustable dampers fitted with locking devices and position indicators. Ensure nozzles provide maximum combustion efficiency and furnace turbulence. Provide a manometer connection and a permanent manometer immediately downstream from the main reinjection air supply damper. Provide a portable manometer.

2.4.2 Underfeed Stokers

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NOTE: Any paragraphs describing stoker equipment not necessary for the system specified will be deleted.

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2.4.2.1 Single Retort, Heavy-Duty Ram-Type Stokers

Equip single retort, heavy-duty ram-type stokers with stationary or moving grates and side dump plates, and provide with [steam] [electric motor] drive and all necessary auxiliary equipment. Provide compressed air actuated dumping power cylinders. Feed coal from the hopper into the retort by means of a ram and distribute evenly along the full length of the retort with auxiliary pusher blocks on a pusher rod located at the bottom of the retort and actuated by the coal ram. Provide dampers between ash pits and main air chamber under stoker to permit control of air distribution to the grate surface. Arrange dampers for operation from the front plate of the boiler. Air distribution must be such that the air pressure is greatest where the fuel bed is the thickest. Air quantity must vary in direct proportion with coal feed rate and controlled automatically.

2.4.2.1.1 Grate Surface

Include the underfeed retort area, air admitting tuyeres, side combustion grates, and the side dumping plates. Provide retorts consisting of sectional construction of large capacity and proper shape to distribute coal uniformly over the entire grate surface with a minimum of moving parts within the furnace. Ensure stokers having total grate width of more than 2.1 m 7 feet have movable grates providing positive lateral feeding of the coal from the retort toward the dump plates. Construct retort and grate sections of heavy-duty, heat-resisting cast iron, core for proper air distribution, and design for easy replacement of individual sections. Provide ash dump plates with necessary levers and linkage for hand operation from the front of the boiler.

2.4.2.1.2 Ram Feed

Provide mechanical [steam] [pneumatic or hydraulic] [driven by an electric motor connected through an efficient gear reduction unit, crankshaft, and connecting rod] ram feed. [Provide totally enclosed fan-cooled type motors [for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]]. [Provide magnetic [across-the-line] [reduced voltage start] type motor starter with [general-purpose] [dust-tight] [explosion-proof] enclosure.] Provide stoker controls for connection to the combustion control system to accurately regulate the coal feed rate. Ensure manual setting of the coal feed rate is possible without disconnecting linkage, with variation of stoker feed as required to maintain any desired capacity between 25 and 110 percent of boiler capacity in 10 or more equal increments. Regulate the coal feed rate by varying the time increments between strokes of the ram. Protect the coal feeding mechanism from injury in case foreign materials obstruct normal operation using a throw-out release.

2.4.2.1.3 Hoppers

Construct hoppers of steel plates no less than 6.4 mm 1/4 inch thick and with a capacity of no less than [_____] kg pounds. Provide hoppers with clean-out doors. Use stoker front plate to form the front of the boiler for the full width of the boiler and extend from the firing floor to some point above the stoker where it connects to the boiler structural framing. Provide cast-iron or steel plate, refractory lined front with [auxiliary firing doors and] clean-out doors of refractory lined cast-iron. Provide structural framing, as required, to support the stoker and its components from the boiler foundation or boiler room floor. Provide water spray pipes and nozzles for quenching the ashes in the ash pit.

2.4.2.2 Single Retort Screw Type Stokers

Equip single retort, heavy-duty, screw feed stokers with rectangular firepot, side dump grates, forced-draft fan, electric-motor drive, and all necessary auxiliary equipment. Feed coal from the hopper into the retort with a spiral worm conveyor designed to feed a constant amount of coal and to prevent coal from packing in the worm. [Provide dampers between ash pits and main air chamber under stoker to permit control of air distribution to the grate surface. Arrange dampers to operate manually from the front plate of the boiler.] Provide stoker with an integral, forced-draft fan driven by the stoker motor. Air quantity must vary in direct proportion with the coal feed rate and controlled automatically. Construct retorts and grates of heavy-duty, heat-resisting cast-iron, core for proper air distribution, and design for easy replacement of individual sections. Provide retorts of proper size and shape to distribute coal uniformly over the entire grate surface. Provide stationary grates on all sides of the retort as required to suit the firebox. [Provide ash dump grates on each side of the retort complete with necessary levers and linkages for hand operation from the front of the boiler.] Electric motor must be belt-connected to an efficient gear reduction unit which drives the feed screw and forced-draft fan. Immerse gear reduction unit in oil in a dustproof housing. Provide stoker controls that are suitable for connection to the combustion control system to accurately regulate the coal feed rate. Control feed rate to allow manual setting for no less than three speeds and neutral, in equal increments, with speed changes possible while stoker is running. Protect the coal feeding mechanism from injury in case foreign materials obstruct normal operation using a suitable release. Provide totally enclosed fan-cooled type motors [for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. Provide [manual] [[magnetic] [across-the-line] [reduced voltage start] type motor with [general-purpose] [dust-tight] [explosion-proof] enclosure.] Construct reinforced hoppers of 6.4 mm 1/4 inch steel sheet, minimum, and with a capacity of no less than [_____] kg pounds. Provide hoppers with suitable cleanout. Provide removable feed screw and conveyor compartment with cleanout. Do not rest stoker on boiler room floor.

2.4.3 Conveyor Stokers

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NOTE: Any paragraphs describing stoker equipment not necessary for the system specified will be deleted.

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Provide conveyor stokers that are the grate level feed, forced-draft [chain grate] [traveling grate] type with hoppers, feed gate, drive shaft, sprocket wheels, grate, [electric motor] [steam] drive, and all necessary auxiliary equipment. Feed coal automatically at a constant rate from the hopper onto the moving grate and distribute evenly across the full width of the grate. Provide stoker frame with no less than four air-tight zones for supply of forced draft and suitable zone control dampers with external indicating, operating, and locking devices.

2.4.3.1 Grates

Provide grates with individual sections constructed of heavy-duty, heat-resisting cast-iron, fit or core for proper air distribution, and design for easy replacement of individual sections. [Provide chain grates with staggered links connected by pins to form a continuous flat chain the full width of the furnace.] [Provide traveling grateswith grate blocks mounted on carrier bars which, in turn, are fastened to two or more drive chains to form a continuous flat grate surface the full width of the furnace.] Support continuous grates at the ends by suitable sprockets and at intermediate points on suitable tracks or skids.

2.4.3.2 Grate Operation

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NOTE: Steam driven boiler auxiliaries will not be used unless the exhaust steam can be utilized completely. Reference to steam drives will be deleted if inapplicable for the equipment specified.

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Drive conveyor grate by [electric motor connected through a suitable speed reduction unit] [steam] [hydraulically operated variable speed drive]. Enclose gears and chains required for the drive in a dustproof and oil-tight housing. Ensure main shafts for the grates have a forced system of lubrication with fittings located outside the casing or have self lubricating bearings. If the forced lubrication system is supplied, fit bearings with dust seals and easily accessible forced lubrication fittings. Provide stoker controls that are suitable for connection to the combustion control system to accurately regulate the coal feed rate. Manually set the coal feed rate by varying stoker feed, as required to maintain any desired capacity between 25 to 125 percent of boiler capacity without disconnecting linkage. Change feed rate by varying the speed of the grate. Air volume must automatically vary in direct proportion with the feed rate. Vary possible feed rate in no less than 10 equal increments. [Provide totally enclosed fan-cooled type electric motor [for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70.]] [Provide [manual] [magnetic] [across-the-line] [reduced voltage start] type motor starter with [general-purpose] [dust-tight] [explosion-proof] enclosure.]

2.4.3.3 Hoppers

Construct hoppers of steel plates no less than 6.4 mm 1/4 inch thick, with a capacity of no less than [_____] kg pounds, and provide with suitable cleanout doors. Fit coal feed to the hoppers with concave type transitions to ensure the proper distribution of coal and coal fines across the width of the hoppers. Construct stoker frame of cast-iron, cast steel, or forgings, and properly cool or otherwise protect all parts of the stoker, except the grates, from the furnace heat to prevent damage by warping or undue expansion. Use furnace arrangement and shape as recommended by the stoker manufacturer to ensure proper combustion of the fuel. Stoker front plate must form the front of the boiler for the full width of the boiler and extend from the firing floor to some point above the stoker where it connects to the boiler structural framing. Front must be cast-iron or steel plate, refractory lined with cleanout doors of refractory lined cast iron. Use structural framing, as required, to support the stoker and its components from the boiler foundation or boiler room floor. At the end of the grate, discharge the ash into a bunker or pit as indicated. Provide bunker with a dust-tight enclosure made of steel plates no less than 15.9 mm 5/8 inch thick, properly protected with firebrick where exposed to the furnace; that is fitted with cast-iron, refractory lined inspection and access doors; and with provisions for ash removal.

2.4.4 Vibrating Grate Stokers

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NOTE: Any paragraphs describing stoker equipment not necessary for the system specified will be deleted.

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Provide grate level feed, forced-draft type virbrating grate stokers with the vibrating action of the grate used to feed the coal from the hopper through the furnace and discharge the ashes into the ash pit. Ensure stokers are complete with hopper, feed gate, grate, drive mechanism, and all necessary auxiliary equipment. Feed coal automatically from the hopper onto the grate and distribute evenly across the full width of the grate. Provide a manual adjustment to regulate the fuel bed thickness. Discharge ashes automatically and continuously to the ash pit. Divide the area under the grates into no less than four airtight zones for forced draft supply containing suitable zone control dampers with external indicating, operating, and locking devices.

2.4.4.1 Grates

Provide grates that are either air cooled or water cooled with grate bars in intimate contact with the watertubes. Provide grates with individually replaceable sections of iron or steel suitable for the temperatures encountered. Ensure pressure parts, including watertubes, headers, and valves are suitable for boiler pressure specified and constructed in accordance with ASME BPVC SEC I. Properly design grate sections for even air distribution over the entire grate area.

2.4.4.2 Stoker Controls

Design stoker controls for connection to the combustion control system to accurately regulate the coal feed rate and arrange for manual operation independent of the combustion control system. Vary the coal feed rate by changing the length of time of vibrations. Vibration generator must be belt connected or gear connected to the electric motor. Ensure unit is free of any vibration that may damage other parts of the boiler or the building structure. Provide bearings requiring lubrication with easily accessible lubrication fittings. Combustion air volume must automatically vary in direct proportion with the coal feed rate. Drive stoker by [electric motor] [steam turbine]. [Provide high-starting torque [totally enclosed, nonventilated] [totally enclosed, fan-cooled] [totally enclosed, fan-cooled motor suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with the NFPA 70].] [Provide magnetic, reversing, [across-the-line] [reduced voltage start] type motor starter with [general-purpose] [dust-tight] [explosion-proof] enclosure.]

2.4.4.3 Hoppers

Construct hoppers of steel plates no less than 6.4 mm 1/4 inch thick, with a capacity no less than [_____] kg pounds, and provide with a suitable method of cleanout. Ensure furnace arches are designed for the intended use and that proper combustion of the fuel is provided. Incline lower furnace sidewall headers in a waterwall boiler to accommodate the inclined grate arrangement. Use stoker front to form the front of the boiler for the full width of the boiler and extend from the firing floor to some point above the stoker where it connects to the boiler structural framing. Front must be cast-iron or steel plate refractory lined with cleanout and access doors of refractory lined cast-iron. Provide structural framing, as required, to support the stoker and its components from the boiler foundation or boiler room floor. At the end of the grate, dscharge the ash into a bunker or pit as indicated. Provide bunker with a dust-tight enclosure made of steel plates no less than 15.9 mm 5/8 inch thick properly protected with firebrick where exposed to the furnace and fitted with cast-iron, refractory lined inspection and access doors, and provisions for ash removal as indicated.

2.5 PULVERIZED COAL BOILERS

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NOTE: Pulverized coal boilers require special consideration since they are usually designed to operate on one specific type of coal and usually are

utilized for large units where a steady minimum load of 68,040 to 90,720 kg per hour 150,000 to 200,000 pounds per hour is assured.

Small horizontal type units down to 36,290 kg per hour 80,000 pounds per hour of steam are available, but horizontal units also will range up to 113,400 kg per hour 250,000 pounds per hour of steam. Larger units are usually the vertical type.

The type of pulverizer will be determined from the coal analysis and the boiler manufacturer's requirements. The pulverizer selected also affects the control system requirements. The furnace ash disposal system components will depend on the ash characteristics and EPA requirements. Volumetric heat release should be 745.2 Megajoules/cubic meter 20,000 Btu/per cubic foot of furnace volume. Coal is crushed in a central plant and stored in bunkers. Each boiler has two pulverizers, fed by a drag type coal feeder, and in turn feed the burners. This system requires room within the plant to accommodate the coal pulverizers. Fineness of pulverized coal may vary with different designs, and fine pulverized coal will significantly affect the selection of ash handling and pollution control equipment and will require special consideration for erosion control on induced-draft fan. Where pulverized coal boilers are specified, reference to stoker fired boilers will be deleted.

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Where indicated, provide pulverized coal boilers. Design boiler and boiler accessories specifically to operate on the fuel specified. Ensure boilers are complete with coal feeders, crushers, dryers, burners, ignition system, air preheater, economizer, soot blowers, controls, and complete furnace ash handling facilities. Fly ash collection and pollution control equipment is specified in Section 44 10 00 AIR POLLUTION CONTROL. Provide [horizontal] [vertical] type boilers that are [top] [bottom] supported. Provide ash hoppers which are dry, refractory-lined type divided into compartments, each containing a hydraulically-operated clean-out door. Support the hopper from the boiler and use a dry seal to provide gastight connection. Furnish forced draft and induced draft fans with the boiler.

2.5.1 Coal Pulverizers

Provide each boiler with a minimum of two pulverizers arranged to allow operation of boiler at reduced capacity when one pulverizer is taken out of service either for maintenance or for operation of low loads. Provide coal pulverizer complete with all required accessories such as rotary drum feeder unit, air preheater, fans for drying coal by either the primary air or suction system, coal classifier distributor unit, and shut off coal valves to allow isolation of individual burners. Provide drum feeder unit with a tramp metal rejection device incorporated in the unit.

2.5.2 Burners

Design pulverized coal burners specifically for the boiler provided. Include an ignition system designed for ignition of pulverized coal.

2.5.3 Furnace Ash System

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NOTE: Detail of piping supported in trenches will appear on the drawings.

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Ensure boiler is the dry bottom type, discharging ash to the hopper compartments. Handle pulverized coal boiler ash hydraulically rather than pneumatically. Provide facilities for pulverized coal boiler ash handling as indicated. Do not mix fly ash with furnace ash but economizer ash can be combined with furnace ash as indicated. Provide dual ash dewatering bins to allow recirculation of ash conveying water as indicated. Provide each bin with automatic controls and hydraulically operated gate for ash unloading to trucks or railroad cars. Mainain hopper in flooded condition and hydraulically operate sluice gates to allow for periodic removal of ash. Fit each ash hopper compartment with double-roll, electric motor driven clinker grinders fitted with manganese steel crusher rolls and teeth. Provide discharge from the grinders to an adaptor or to a sump for feed to the centrifugal pump. Provide centrifugal pump for each hopper compartment and incorporate special abrasive resistant metals and special seals for abrasive slurry handling. Ensure drives are totally enclosed electric motors as indicated. Make ash slurry conveying pipelines of abrasive resistant alloy metal with a Brinell hardness number of approximately 280. Ensure wall thickness is no less than 13 mm 1/2 inch and pipe lengths do not exceed 5.5 m 18 feet. Provide tangent end type fittings with a Brinell hardness number of approximately 400 and with removable wearbacks, where applicable, or the integral wearback type. Provide loading facilities for ash removal of dewatering bins as indicated.

2.5.4 Pulverizer Rejects

Collect pulverizer rejects such as tramp iron or pyrites in hoppers adjacent to each mill discharge spout. Provide high-level hopper indicators to initiate reject removal, in sequence, from each hopper to the central holding bin by properly sized jet pumps. Provide mill discharge control gates and interlock the control system with the furnace ash removal system to provide a completely automatic disposal system. Discharge of mill rejects into the ash hopper is not acceptable. Provide central holding bin and loading facilities as indicated.

2.5.5 Control Systems

Provide pulverized coal plant control systems in accordance with NFPA 85 and interlock to provide for a completely automatic boiler operation. Coordinate automatic controls for coal feed, pulverizer operation, combustion, and ash disposal systems.

2.5.5.1 Coal Master Control System

Regulate the total coal feed from the coal [bunkers] [silos] to the pulverizers in response to changing demand. Provide a parallel metering combustion control system that limits the firing rate to the actual total air flow available. Arrange the cross limiting of air and fuel so the air leads the fuel on load increase and trails the fuel on a load decrease. Provide a gain changer to compensate the fuel system for the number of pulverizers in service. Depending on the requirements of the pulverizer, actuate the coal master control system by the coal feeder speed or by the coal/air mixture. Ensure the total fuel controller is a standard, proportional plus integral controller with a derivative or rate term on the master demand only. Multiply change in master demand by the derivative circuit to assist in overfiring on load increase and underfiring on a load decrease. Make provision for taking any one of the pulverizers for each boiler out of service with firing continuing at reduced rates for extended periods during maintenance or during low demand intervals. Provide alarms and interlocks of the fuel master control as required by the boiler but include, as a minimum, a unit trip to run the fuel master to zero and alarm contacts for "fuel master at maximum," "fuel master at minimum," "fuel greater than air," and "air demand limiting fuel."

2.5.5.2 Primary Air

Provide primary air fan or suction air fan control for each system with all required damper operating and sensing control devices. Ensure primary air system fans exhaust into a duct common with individual pulverizer primary air flow dampers in order to control the flow required by each pulverizer. Maintain common duct pressure at a given set point by modulating fan inlet dampers. Provide gain compensation to maintain system response with a different number of fans in operation. Provide biasing between fans.

2.5.5.3 Air Temperature Control

For pulverizer coal air temperature control, assume the maximum safe mixture temperature required to increase the firing efficiency at the furnace and to remove additional residual moisture that may be present in the coal for each pulverizer coal air exit. Provide tempering air inlet with controls to prevent combustion in the pulverizer.

2.5.5.4 Flame Safety System

Provide a burner control/flame safety system with the boiler. Meet the requirements specified in NFPA 85 as a minimum. Provide an interface between the analog control system and the flame safety system or burner control system. As a minimum, position coal feeders and pulverizer air dampers to respond to "unit tripped" and "pulverizer tripped" signals. Incorporate a pulverized coal ignition system. Incorporate boiler shutdown as well as normal monitoring of startup sequencing and normal operation. Ensure each burner has a scanner for the lighting system as well as a scanner for the main flame.

2.6 FLUIDIZED BED COMBUSTION BOILERS

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NOTE: The designer will perform an economic analysis to compare the installation and operating costs of a fluidized bed combustion boiler against the use of a conventional boiler and its associated air pollution control equipment.

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Where indicated, provide fluidized bed combustion boilers. The Contractor may provide either bubbling bed (AFB) or circulating bed (CFB) boilers. Use fluidizing velocities ranging from 1.2 to 3.7 m/second 4 to 12 fps for AFB boilers and ranging from 4.3 to 9.1 m/second 14 to 30 fps for CFB boilers. Ensure each boiler is in compliance with sulfur dioxide, nitrogen oxides, particulate, carbon monoxide, and all other emission regulations, as specified. Control the bed temperature within the appropriate range, normally 815 to 900 degrees C 1500 to 1650 degrees F to enhance sulfur capture, inhibit the formation of nitrogen oxides, enhance combustion efficiency, and limit carbon monoxide formation. In AFBs, generally introduce all the air required for combustion through the nozzles in the distribution plate in order to reduce the potential of forming reducing conditions within the bed that could cause severe corrosion of in-bed surfaces. The use of over-fire air in applications where it is needed to complete the burnout of carbon monoxide and the combustion of fines in the freeboard requires the approval of the Contracting Officer who will be satisfied that reducing conditions will not exist. CFB boilers may introduce as much as 40 to 50 percent of the combustion air as secondary air in one or more stages at various locations above the distribution plate. Design the boiler and boiler accessories specifically to operate with the specified fuel and sorbent. Provide boilers complete with the required crushers, dryers, coal and sorbent handling systems, burners, ignitors, air preheater, economizer, soot blowers, boiler controls and instrumentation, furnace ash handling system, draft systems, and superheater, where required.

2.6.1 General

Furnish the design, materials, and construction of equipment conforming to the applicable requirements of ASME BPVC SEC I and NFPA 85. Furnish the Manufacturer's Data Report required by ASME BPVC SEC I certified by the Authorized Inspector located in the manufacturer's shop. Make full provision so that each component can expand and contract under the operating cycle of temperatures without damage to itself or to any adjoining component, and without the leakage of any contained fluid outwards, or of air either inwards or outwards. Design the unit to accommodate thermal movement without side effects such as tearing, buckling, distortion, or vibration. Design the unit to prevent destructive vibration during normal operation. Provide balanced draft type furnace. Design the ducts and equipment from the forced draft fan, including the fluidized bed plenums, for pressures in accordance with NFPA 85. Provide access and observation doors to permit access to compartments and the observation of critical portions of the furnace and fluid bed. Anchor door frames securely. Provide doors with a suitable durable gasket, a device which when closed will force the door to an air-or gas-tight seal, and an interior design which will minimize erosion or deterioration of the inner surface from exposure to the internal conditions at that point. Ensure refractory is an integral part of the door. Use manufacturer's standard access doors that approaches in size 450 mm 18 inch wide by 400 mm 16 inch high. Provide all observation ports and lance doors with sealing and aspirating air facilities. Convection pass velocity greater than 15.2 m/second 50 fps is not permitted. Base the convection pass velocity on maximum guaranteed excess air at Maximum Continuous Rating (MCR) plus five percentage points (i.e., if excess air is 20 percent, base the convection pass velocity on 25 percent excess air). In CFB designs where convection surface exists in the high solids circulation passes, a velocity not greater than 4.6 m/second 15 fps is permitted between the tubes, based on 25 percent excess air. Design equipment such that the interior surfaces of all water-filled pressure parts and superheater sections are capable of being chemically cleaned. Furnish, as required, fill and drain connections. Ensure each header is drainable. Provide the secondary air and flue gas system resistance curves.

2.6.2 Furnace and Boiler

Provide water-tube welded-wall type boiler, having in-bed tube surface for

AFB offerings with natural and/or forced circulation. Use seamless tubes and weld all connections. Identify tubes of the electric resistance welding process, where used, and ultrasonically test along their entire length. Provide permanent thermocouples, as required, run to a terminal box outside the boiler casing. As a minimum, these thermocouples indicate:

a. Water wall temperature in critical locations (risers, etc.).

b. Heat absorption rates (cordial type t/c).

c. Air and gas temperatures.

d. Water and steam temperatures.

Fusion weld drums throughout and fit with manholes and hinged covers at both ends. Monitor the hydrostatic test temperature carefully, as indicated in paragraph "TESTS," to avoid brittle failure. Furnish boiler drains sufficient in size and number to completely drain the water from the entire unit in not more than 1 hour at 0 kPa psig pressure. Equip the drum with internals for steam separation.

2.6.3 Forced Circulation System

Provide boiler designs utilizing horizontal in-bed evaporating surfaces with a forced circulation system. Install number and capacity of the pumps such that with one pump out of service, the maximum rating of the boiler can be carried with complete safety. In addition, loss of all pumps, with the unit at MCR, must allow for a safe and orderly shutdown (without fans) without damage to the boiler. Ensure pumps are single stage, centrifugal, driven by constant speed motors. Provide pumps complete with all necessary accessories, including welded suction and discharge connections, lubrication system, casing drain valves in duplicate, and any necessary auxiliary pumps, heat exchangers, or other equipment. The pumps must withstand the boiler test pressure and all operating pressures and temperatures without distortion, binding, or other effects. Ensure casings withstand the forces and moments imposed upon them by the connecting piping without disturbing the alignment or successful operation of the pumping units. Ensure construction is such as to permit inspection of the rotating parts without dismantling the suction and discharge piping. Operate pumps satisfactorily at all loads, either by themselves or in parallel with the other pumps furnished. Provide motor operated pump suction valves. Furnish bypasses with valves around the pump isolating valves to maintain operating temperature in the idle pumps and piping. Provide discharge valves with impactor handwheels and lugs for air motor drive. Provide orifices, with protecting strainers as required, to assure adequate circulation to all parts of the boiler circuits. All materials that may come in contact therewith must be suitable to withstand acid and caustic boiler cleaning solutions. Provide connecting lines with stop valves between the main distributing header and the economizer inlet header for use as a circulating line to the economizer when the boiler is acid cleaned.

2.6.4 In-Bed Tube Surface (AFB Designs)

Provide in-bed tube surface as required to achieve steam generation or superheat temperature as defined in the data sheets. Ensure in-bed tubes are completely clear of bed material when the fluid bed (at the bed weight specified by the manufacturer at boiler MCR) is slumped. Alternatively, the manufacturer must ensure that the tubes are protected from overheating due to contact with a slumped bed and/or maintenance problems due to moisture in a slumped bed.

2.6.5 Coal and Sorbent Feed Systems

Furnish all equipment required to provide a boiler feed system to convey coal and sorbent to the boiler injection inlets. Size all components of these systems to provide flow of fuel and sorbent based on MCR condition in the boiler and the design coal and sorbent specified. Design the system to minimize the segregation or generation of fines.

2.6.5.1 AFB Coal Feed System

Coal feed systems for AFB may be either pneumatic under bed or spreader stoker over-bed. For pneumatic under-bed feed systems, provide a feed point every 1.7 to 2.3 square meters 18 to 24 square feet. The system must consist of a complete integrated system including weigh belt feeder, lock hoppers, and/or other components necessary for the pneumatic fuel injection system. Do not use rotary type feeders as the primary pressure sealing device. Consider the conveying air as part of the combustion air. Crush coal feed to approximately 6.4 mm 1/4 inch and use with fluidizing velocities ranging from 1.2 to 3.7 m/second 4 to 12 fps. For these systems, sorbent may be mixed with the coal in the appropriate proportion and fed with the fuel. However, a separate sorbent feed system is acceptable. Design over-bed feed systems to provide even distribution over the entire bed. Provide heavy duty standard production spreader/injector/feeders for dispersing the specified fuels into the boiler. Provide chain type spreader/feeders or equal, as approved by the Contracting Officer. Provide chain type feeder portion with infinitely adjustable feed rate from 0 to 100 percent of rated capacity. Provide spreaders consisting of adjustable rotating paddles on a shaft designed to disperse the specified coals into the boiler at the required locations and to minimize side throw into adjacent bed compartments which may not be in operation. The spreaders must be capable of rotating at variable rates of speed. The spreader/feeders must have overfire capability to the extent required by the design for use in compensating for a spreader/feeder out of service. For spreader stoker coal feed systems, sorbent feed must be by separate systems. These systems must consist of a method to feed the correct proportion of sorbent over the load range to keep the sulfur oxides emission in compliance. These systems must feed over-bed or in-bed and may be gravity, pneumatic, or a combination. Provide under-bed coal feed systems with coal dryers unless approved.

2.6.5.2 CFB Coal Feed Systems

For CFB systems, provide feed systems capable of providing the appropriate coal feed over the load range. Include weigh belt feeders, rotary feeders, screw conveyors or air swept feeders, or gravity-feed metered by weigh belt. Do not use rotary type feeders as the primary pressure sealing device. The fluidizing velocity in systems ranges from 4.3 to 9.1 m/second 14 to 30 fps. Permit maintenance of full load with loss of a single feed point. Design screw conveyors to operate continuously. Provide sorbent feed for CFB systems capable of providing the required proportion of sorbent over the load range. These systems must consist of a sorbent metering device weigh belt feeder and be fed by gravity, pneumatic injection, or air swept feeder. The sorbent must be fed in-bed, under-bed, or over-bed, and separately from the fuel.

2.6.6 Fluidized Bed Combustion Area

Ensure parts subject to severe wear or deterioration are replaceable with a minimum of dismantling. Design the fluid bed combustor to insure that no combustion air entering the bed is allowed to bypass contact with bed solids. Air distribution to the fluid bed will be through a number of nozzles located in the bed support plate. Average superficial velocity above the bed at the point of fuel and limestone feed must be between 1.2 to 3.7 m/second 4 to 12 fps at bed temperature and mix zone pressure. The pressure drop through the air distributor plate must be 3.7 kPa 15 inches water gauge minimum. Construct the walls of the fluid bed combustor of water-cooled tubes which form a part of the steam water circuit of the boiler. These walls must be of membrane wall type of construction. Designate distributor to assist with removal of large tramp material, where expected.

2.6.7 Bed Material Letdown System

Provide bed material letdown system that is capable of removing and cooling solids from the bed including spent sorbent, unfired fuel, bottom ash, rocks, and debris. Design the system to operate continuously and to cool all the solids going to disposal to 135 degrees C 275 degrees F or less. Size the system to continuously remove at least 80 percent of the total solids generated from the boiler, unless otherwise approved. Design the bed letdown system to include personnel safety considerations such as prevention of spillage of hot bed material from the unit.

2.6.8 Burners and Fuel Piping

Provide burners and burner equipment suitable for continuous service. Ensure parts subject to severe wear or deterioration are replaceable with a minimum of dismantling. Mount all valves or controls outside the boiler front and air housing. Ensure burner design provides positive and uniform mixing of the air and fuel at all loads, and produces sufficient turbulence to preclude stratification. The burner design must permit the firing of No. 2 fuel oil. Provide air atomizing type in-duct/over-bed burners. Ensure burners and/or ignitors have an aggregate capacity capable of bringing a cold unit up to ignition temperature using either precalcined limestone or spent bed material in 4 hours for AFBs, and 8 to 12 hours for CFBs, depending upon refractory limitations. Furnish equipment for remote positioning, if required, of each burner gun at either the fully retracted or fully inserted position. Provide air operated positioning equipment including limit switches to indicate the position of the gun and all necessary drives, linkages, and mechanisms; and that automatically purges the fuel from the guns before retracting.

2.6.9 Air Distribution System

Provide uniform air distribution to the fluid bed under any mode of operation. The system must also meet the mechanical and structural requirements of the boiler such as bed material dead load support, effective seal with the enclosure wall, and nonsifting air nozzles.

2.6.10 Mechanical Collector and Solids Recycle System for AFB Boilers

Provide a mechanical cyclone dust collector at the outlet of the boiler. Ensure mechanical dust collector is the high efficiency multicyclone type designed for maximum operating temperatures encountered under all operating conditions. Design collectors to resist erosion and minimize plugging, that are gas-tight, and with a collection efficiency of 85 to 95 percent on particles greater than 20 microns aerodynamic diameter, depending upon the recycle rate selected by the manufacturer. No refractory lining will be acceptable in the mechanical dust collector. The collection hopper must have a valley angle of at least 60 degrees below the horizontal. Fabricate the line carrying recycle solids back to the bed of carbon steel with an allowance for wear and install at an angle of no less than 60 degrees below the horizontal. Provide solids collection hopper and dipleg with pressure differential measurement to indicate pluggage. Include provisions for sampling of recycle solids hopper contents. Fabricate hopper of material capable of enduring the conditions imposed by a flue gas atmosphere. Provide for continuous disposal of ash from the recycle hoppers.

2.7 IGNITION OIL SYSTEM

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NOTE: Wherever light oil is required as a support and/or ignition fuel, a complete ignition oil system must be provided. The system should include two full-size rail/truck unloading pumps, capable of unloading a rail shipment in one 8 hour shift or a truck shipment in 1 hour; one ignition oil storage tank capable of storing either 88 hours continuous plant ignition fuel demand or one rail shipment, whichever is larger; two full size ignition oil supply pumps per boiler unit, each capable of supplying the maximum ignition oil demand for each boiler unit; and one ignition oil day tank per boiler unit capable of storing 8 hours of continuous boiler ignition oil demand. Both the ignition oil transfer and boiler ignition supply pumps should be centrifugal type, where allowed by suction conditions and discharge flow/pressure requirements; otherwise, use positive displacement pumps.

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2.7.1 Ignition Oil Pumps

Furnish ignition oil pumps as duplex types assuring 100 percent standby. Provide pumps complete with coupling, coupling guard, and electric motor shop-mounted and aligned on a common skid.

2.7.2 Burners

Where indicated and specified, provide each boiler with oil-fired burner or burners. The burner assembly and control systems must conform to UL 296, UL 726 and NFPA 85, except as otherwise specified. Ensure supervised manual semiautomatic and fully automatic combustion safety controls conform to NFPA 85 and ASME CSD-1.

2.7.3 Aboveground Oil Storage Tanks

Provide aboveground oil storage tanks and associated piping systems in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.7.4 Underground Oil Storage Tanks

Provide underground oil storage tanks and associated piping in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.8 COMBUSTION CONTROL EQUIPMENT

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NOTE: Subparagraphs describing inapplicable types of combustion control equipment will be deleted. Positioning type combustion control equipment will be specified for boilers with capacity of 13.2 MW 45,000,000 Btuh or less. Metering type equipment will be used for larger boilers. Positioning type controls with oxygen compensation may be furnished for boilers with capacity of 13.2 MW 45,000,000 Btuh or more in lieu of metering type. Oxygen compensated controls may be specified for boilers having output capacities of 7.3 MW 25,000,000 Btuh and greater if a life cycle cost analysis indicates it to be favorable.

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Provide combustion control equipment as a system by a single manufacturer. Install an automatic combustion control system for each boiler in accordance with the manufacturer's recommendations. Locate the controllers on the boiler room panel specified in paragraph BOILER ROOM PANELS AND INSTRUMENTS. Operate equipment either pneumatically, electrically, or electronically. Provide pneumatic control systems conforming to CAGI B19.1. Install air filter regulator sets at each control valve and transmitter in the system. Provide dual type master air filter regulator set on the control panel where one side can be cleaned and repaired while the other is in operation. Protect exterior control air piping and devices from freezing by use of a regenerative desiccant dryer. Provide each system with a selector switch or other means of manual control of the firing rate when required. Use electrical control devices that are rated at 120 volts and connect as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wire operating and limit controls to interrupt the ungrounded circuit conductor. [Steam and energy generating equipment must include instrumentation and sufficient metering for accountability interface with a future Energy Monitoring and Control System (EMCS).]

2.8.1 Positioning Type

Provide positioning type combustion control equipment that is capable of maintaining boiler steam pressure within plus or minus 2 percent of the set pressure over the complete range of boiler operation. Maintain excess air within plus or minus 10 percent of the original control setting. The efficiency will be maintained without appreciable manual adjustment. Provide system that is capable of maintaining the specified pressure provided that the load does not exceed a 15 percent per minute change in capacity at any one time. Connect the master transmitter to the main steam header where the steam pressure is to be controlled. Ensure the signal transmitted from this point to the master controller is a function of steam pressure. On multiple boiler installations, provide a means to base load on individual boilers while on automatic, and control each boiler unit individually. Make provision on the control system for adding on other boilers to the system with only minor wiring or piping changes on the panel. Ensure the fuel-to-air ratio on this system is adjustable from one knob that indicates increase and decrease of air in proportion to fuel. Limit the range of this adjustment to prevent operation below safe combustion limits.

2.8.2 Metering Type Combustion Control Equipment

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NOTE: This paragraph will be deleted if controls with oxygen compensation specified in paragraph COMBUSTION CONTROLS WITH OXYGEN TRIM are used.

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2.8.2.1 Fuel-Flow, Air-Flow Type Combustion Control

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NOTE: This paragraph will be used for spreader stokers.

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[Provide fuel-flow, air-flow type combustion control equipment that is the proportioning and reset type, and position the fuel feed or air flow and then adjust one to the other by a ratio controller operating from air flow and fuel feed. Include fuel-flow measuring elements and air-flow measuring elements. Panel-mount separate fuel feed and air-flow controllers along with a fuel-to-air ratio controller. Set the air-flow index by a measuring element in the air stream. Systems controlling fuel and air by line shafting and mechanical connections will not be acceptable.]

2.8.2.2 Two Element (Steam Pressure, Steam Flow)

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NOTE: If underfeed, traveling grate, or vibrating grate stokers are specified, use this paragraph.

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[Provide two element (steam pressure, steam flow) combustion control equipment that is the proportioning and reset type, and control the fuel feed or air flow either in parallel or series. Include measuring elements for steam flow, fuel feed, and air flow. Panel-mount separate steam pressure, fuel flow, and air flow controllers along with a fuel-to-air ratio controller. Measure the actual steam flow an orifice or other flow measuring device in the steam line. Set air-flow by a measuring element in the combustion air stream. Systems controlling fuel and air by line shafting and mechanical connections will not be acceptable.]

2.8.2.2.1 Master Pressure Transmitter

Provide a master pressure transmitter and connect to the main steam header at a point where the steam pressure is to be controlled. Using the master controller, which is located on the panel, load the various individual boiler controllers according to steam pressure changes. On multiple boiler installations, provide an operator station to base load or bias each individual boiler while keeping its fuel and air controllers on automatic. Mount this boiler master station on the control panel between the master controller and the remainder of the control system. Provide indicators to show the loading impulse from the master controller to the boiler master station and each boiler master station output.

2.8.2.2.2 [Fuel Feed] [Steam-Flow] Transmitter

Provide a [fuel feed] [steam-flow] transmitter for each boiler and feed a signal to a fuel feed controller. Load each fuel feed controller using the master controller for the rate of [fuel feed] [steam-flow] corresponding to the rating of the respective boiler. Operate the fuel device controlling the rate of fuel feed. Incorporate proportional plus reset control features.

2.8.2.2.3 Air-Flow Transmitter

Provide air-flow transmitter for each boiler. The air-flow controller must control from this signal or in such other manner as to maintain a predetermined ratio of air to fuel. Provide an indicator showing the amount of any manual adjustment to the air-to-fuel ratio. Provide controller with proportional plus reset modes of control.

2.8.2.2.4 Automatic Controller

Each automatic controller must have a manual-to-automatic station and indicator on the control panel that will provide for selecting either automatic control or manual control and also will provide for manual operation. Arrange the manual controls to allow any one or more of the functions of the control system to be controlled manually while the other functions remain on automatic control. Provide manual control station complete with all necessary indicators and provide bumpless balanceless transfer from automatic control to manual control and vice versa.

2.8.2.2.5 Power Units

Size power units for the movement of dampers and fuel feed levers to operate the device to be positioned and mount so that a rigid mechanical connection to the device being operated can be used. Allow units to remain in the last position to which they moved in event of failure of the operating medium. Manual operation of the controller does not necessitate disconnecting the linkages during power failure or other emergency. Include position switches on fuel and air-drive units for interlock with safety systems. Place retransmitting devices on all power units for remote indication on the boiler panel of the position of the operator at any time. If electric operators are utilized, provide oil-immersed gear trains on the units.

2.8.2.2.6 Furnace Draft Controller

Provide furnace draft controller of the modulating type with each boiler. Design the draft controller to maintain automatically within 2.5 Pa 0.01 inch water column the desired furnace draft for which it has been set manually. Fix the position of the boiler outlet damper through a power operator. Provide an indicator to show the amount of any manual adjustment that might be made. Equip the draft regulator with a manual-automatic switch.

[2.8.3 Combustion Controls with Oxygen Trim

Flue gas oxygen trim may be furnished with combustion controls specified. Provide an oxygen analyzer and oxygen controller. Provide oxygen controller of the proportional band and reset type which feeds its signal in a biasing fashion into the fuel-to-air ratio system. Ensure the oxygen setpoint is a function of boiler load with operator biasing capability. Limit the amount of oxygen controller trim prevent potentially hazardous conditions caused by equipment failure or misoperation.

]2.8.4 Boiler Limit Controls

a. Provide two low-water cutoffs to prevent startup and to shutdown the fuel if the boiler water level is below the preset safe level. The primary interlock may be automatic or manual reset type. The secondary interlock must be the manual reset type.

b. Provide a high-pressure limit switch to shutdown the fuel when steam pressure exceeds the preset safe limit. This equipment is additional to the operating controls.

c. Provide a draft loss interlock and air-flow switch or a suction switch to prevent startup and to shutdown fuel supply when air is inadequate to safely support combustion. Provide limit and operating controls for operation on a two-wire grounded branch circuit.

d. Provide safety interlocks required by the applicable NFPA standard.

2.8.5 Burner Control/Fuel Safety System

2.8.5.1 Design Requirements

Provide control system of the microprocessor-based (distributed digital or programmable controller) or relay type. Furnish a dedicated hardwired insert panel for monitoring and operator interface with the burner control/fuel safety system, which also provides the operator with direct fuel tripping capability in emergency situations. Ensure the burner control system is sufficiently subdivided to permit inservice checkout and maintenance without impairing the reliability of the overall control system. Provide logic cabinets including status indicating lights for logic inputs and outputs, and for monitoring availability of control power to subsystems as required to facilitate troubleshooting. Provide indication of equipment status and system permissives at the operator interfaces. Where common power supplies internal to the system are furnished, include a full-capacity on-line backup supply. Failure of either power supply must be alarmed.

2.8.5.1.1 Maintenance and Reliability Requirements

In general, accomplish maintenance on-line and without imposing any special restrictions on overall plant operation. Provide diagnostic routines, interchangeable electronic cards or boards, and clear written procedures. Incorporate reliability, both software and hardware, into the system design. Include redundancy, loop distribution, component specifications and testing, and quality control to assure the highest level of system reliability.

2.8.5.1.2 Adverse Electrical Conditions

Equipment must be capable of operating as specified and without damage within the electrical environment of the plant. This environment includes high-voltage, high-frequency surges caused by electromechanical equipment, energy coupled between conductors by capacitance and mutual inductance, and imperfect grounds. Provide input and output isolation, shielding, separation of circuits, surge suppression, or other measures which may be required to meet these provisions. Ensure inputs, outputs, and other connections meet the surge to withstand requirements of IEEE C37.90.

2.8.5.2 System Design

Provide burner control system that is compatible in all respects with the boiler and auxiliary equipment. Design the system to meet the requirements specified in NFPA 85. Incorporate a continuous purge of the furnace to insure that the boiler is free of any accumulation of combustibles. Also supervise the operation of the fuel-air equipment associated with the pulverizer and fuel oil burners. The system must accept operator commands and, if the required permissives are met, perform the required operation. Monitor equipment continuously, and any deviation must be alarmed while the system either corrects the deviation or shuts down equipment as necessary to avoid hazardous furnace conditions or equipment damage. The system must monitor the operation of the fuel equipment and, if the equipment fails to respond to commands from the burner control system, initiate the equipment trip sequence. Provide indications to allow the operator to determine the equipment which initiated a trip of fuel equipment. Shut down tripped equipment successfully before reset of the trip is permitted. Provide burner control system including a fuel safety subsystem which includes a master fuel trip (MFT) system, ignitor fuel trip system, and pulverizer mill trip systems. Include a hardwired relay which may be directly operated from the operator insert panel for each systen. Inputs to the MFT include, in addition to those associated with the burner control, those that are required to provide overall boiler protection. Also, interface the system with the combustion control system to position and monitor devices for startup and shutdown which are normally modulated during on-line operation. Design the burner control system to operate reliably and to minimize the number of false trips.

2.8.5.3 System Functional Requirements

2.8.5.3.1 Operating Modes

The operator is responsible for initiating the start and stop sequence listed below. Once initiated, the burner control system must automatically place the mill or oil burner in service or remove it from service. The steps, each of which requires operator initiation, are:

(1) Purge

(2) Igniter control

(3) Pulverizer control

(4) Feeder control

2.8.5.3.2 Furnace Purge and Boiler Monitor

Iincorporate prelight off and post purges of the furnace to ensure that the boiler is free of any accumulation of combustibles. Indicate completion of the furnace purge to the operator, after which the operator will reset the master fuel trip relay. A furnace purge is required on any master fuel trip. Ensure boiler monitor prevents starting any fuel equipment if the furnace firing permissives are not met. Provide indications to the operator of the status and the progress of the furnace purge. Ensure permissive indications are extinguished when the MFT is reset.

2.8.5.3.3 Mill Start-Stop Sequences

Start and stop the mill in three steps (ignitor, pulverizer, feeder) following fixed sequences. Provide system capable of transferring between the startup and shutdown sequences at any time. Monitor each mill and should any unsafe conditions occur, trip that mill. Provide a mill first out indication to indicate the initiating cause of trip. Delete the first out indication only upon reset of the mill trip relay. Provide startup and shutdown sequence indications to allow the operator to follow the progress of the mill startup or shutdown sequences. These indications must show the next step to be performed, as well as the progress through the sequences.

2.8.5.3.4 Ignitor Control

An ignitor group consists of the ignitors associated with a pulverizer burner group. Control ignitors associated with a burner group from a separate electropneumatic ignitor control package. Provide sequential starting of ignitors between burner groups. Start and stop the ignitors associated with a burner group from the insert panel and local push buttons. Provide an ignitor fuel trip (IFT) first out indication to indicate the initiating cause of the IFT. Ensure this indication is extinguished only when the IFT relay is reset.

2.8.5.3.5 Fuel Safety Subsystem

The fuel safety subsystem comprises the MFT system, IFT system, and pulverizer mill trip (MT) systems. Provide a mill trip system for each mill. Ensure each fuel safety system provides the protection for its respective fuel and includes a dedicated hardwired relay which may be directly operated from the operator insert panel. Ensure the master fuel trip system provides overall boiler protection, also includes a dedicated hardwired relay, and directly trips all other fuel safety system relays. Design the system to deenergize to trip.

2.8.5.3.6 Flame Monitoring

Individual self-checking flame scanners are required for each burner. Use ignitor flame safety devices that discriminate individually from any flame that may exist at other burner locations. Ensure burner flame is discriminated individually from the associated ignitor flame and any other flame that may exist in the furnace. Ensure ignitor and burner flame discrimination covers the range from startup to full load operation. Blocking interlocks from closed valves in flame discrimination circuits to avoid false flame indication are not acceptable. If required to obtain satisfactory flame discrimination, include extended tube scanners. Individual flame detector output level indicators are required. Make provisions for cooling and cleaning, if required.

2.8.5.3.7 Enclosures

The system logic cabinets must contain control devices, power supplies, circuit protective devices, cable plugs, and terminal blocks. Provide spare space to accommodate a minimum of 20 percent additional devices. Provide cabinets that are accessible from both front and back, and have gasketed hinged doors with latches. Do not exceed 600 mm 24 inches in width for each door. Natural draft cooling of the control system cabinets is preferred. If cabinet cooling fans are furnished, alarm the loss of any fan.

2.8.5.3.8 Local Termination Boxes

Include local junction boxes, one at each burner level and one at each pulverizer. Provide burner level junction boxes that contain separate push buttons and indicating lights for local control of each ignitor group. In addition, provide terminal boxes that contain terminals for field wiring, internal wiring, cable connectors for intersystem wiring, circuit breakers and, if required by the system, relays and reversing starters. Ensure terminal boards for field wiring include 20 percent spare connections. Also, include local pulverizer junction boxes for terminating field wiring associated with each mill in the system. These junction boxes must meet the requirements described above, except local control is not required.

2.8.5.3.9 Interconnecting Cable Requirements

Interconnecting cables between the logic cabinet, insert panel, local burner junction boxes, and local mill junction boxes must be via prefabricated plug-in cables, including connectors. Also, furnish flame scanner cables.

2.8.5.3.10 Buffered Output Signals

Fully isolate output signals required for tripping, control, and monitoring from each other. Ensure isolation is such that an open or short circuit in the related equipment does not affect other control systems.

2.9 BOILER ROOM PANELS AND INSTRUMENTS

2.9.1 Instrument Control Panel

Size instrument and control panel to contain all controls, instruments, gauges, and meters. Provide free-standing panel with faceplate of no less than 4.8 mm 3/16 inch steel, properly reinforced, and finished with the manufacturer's standard finish coating. Mount units flush on the panel as far as practicable. Flush mount controls, instruments, and other equipment, each fitting neatly into a cutout, and completely covering the cutout and any mounting screws or bolts. Enclose the back of the panel with sheet metal and with adequate removable access panels or doors for maintenance and removal of any unit without interfering with other units. Provide proper latching equipment and hardware. Identify each recorder, indicator, and control unit with nameplates securely fastened to the panel. Provide nameplates that are black over white laminated plastic with the lettering penetrating the black surface to expose the white. Mount nameplates no more than 25 mm 1 inch below the instrument or gauge, on the centerline. Use panel consisting of continuous, rapid-start, fluorescent light fixtures mounted with reflectors providing suitable shielding to illuminate controls, instruments, gauges, and meters. Terminate field piping connections in one bulkhead-mounted manifold, located to conform with the installation requirements of the system. Terminate field electrical wiring in a color-coded terminal strip so located as to conform with the installation requirements of the system. Ensure electrical tubing or piping connections to controls, instruments, or other devices on the panel are inside the panel and not visible from the panel front. Provide a suitable plug-in strip in the rear of the panel for any required plug-in electrical connections of the instruments. Install necessary transformers, separate relays, switches, and fuses in a fully enclosed junction box. Use a fused safety switch to serve the 120-volt power supply required for control circuits. If a pneumatic control system is provided, include duplex air supply filter and regulator set mounted on the rear of the panel with properly identified pneumatic terminal blocks and low point drain. No high-pressure lines will be allowed to enter the panel. [If packaged boiler burner units with integral controls are furnished, the control equipment may be mounted on a separate free-standing panel for each boiler. Ensure controllers and indicators specified or required are panel-mounted and tested at the factory complete with relays, transformers, switches, wiring, valves, piping, and other appurtenances. Ensure wiring and piping within the panel is color-coded or otherwise identified.]

2.9.2 Indicators

Flush mount indicator with a vertical scale of 100 to 150 mm 4 to 6 inch length. Indicators may be either electronic or pneumatic with zero adjustment, receiving standard signals form locally mounted transmitters. Ensure scales are in engineering units with an accuracy of plus or minus 1 percent.

2.9.3 Recorders

Provide servo mechanism type or multiple pen type recorders. Provide [circular] [strip] chart type. Minimum chart width is 100 mm 4 inches. Accuracy must be plus or minus 0.5 percent. Provide a separate scale calibrated in engineering units for each scale. Chart drive must be 120 volts ac. Provide one year's supply of chart paper.

2.9.4 Panel Display

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NOTE: Steam flow meters will be specified for boilers having a continuous steam capacity of 4,540 kg 10,000 pounds or more per hour and must be integrating type where indicated. Feedwater meter will be provided on individual boilers not having steam flow meter.

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As a minimum, display the following parameters on the panel:

Pressure	Indicator	Recorder Point
Main steam header	X	X
Boiler drum	X	
Feedwater	X	X
Instrument air	X	

Draft	Indicator	Recorder Point
Windbox	X	
Furnace	X	
Boiler gas outlet	X	
ID fan inlet	X	

Temperature	Indicator	Recorder Point
Main steam		X

Temperature	Indicator	Recorder Point
Boiler gas outlet		X
Windbox		X
Feedwater		X

Level	Indicator	Recorder Point
Boiler drum		X
Bunker or silo	X	

Flow	Indicator	Recorder Point
Main steam (including totalizer		X
Feedwater		X
Air		X
Fuel		X

Analyzers	Indicator	Recorder Point
Flue gas opacity		X
Flue gas oxygen		X

2.9.5 Panel Piping and Wiring

Transmit high-pressure and high temperature values pneumatically or electrically, or both, to the panel. Pneumatic signals must be 21 to 103 kPa 3 to 15 psig. Piping connectors to indicators must be 6 mm 1/4 inch OD copper tubing conforming to ASTM B68/B68M. Transmit flow signals either pneumatically or electrically to the panel-mounted receiver. Run copper tubing connections and electric wiring to a terminal block located on the inside of the panel front near the bottom. Terminate wiring at an identified terminal strip. Provide wiring suitable for boiler room requirements and install according to NFPA 70.

2.9.6 Pilot Lights

Assemble pilot lights in a factory-built cabinet, suitable for flush mounting in cutouts in boiler control panel, complete with extruded trim, clamps, and sheet metal rear housing, and finish in baked black enamel. Provide white plastic lens engraved in black ink. Lettering must be 19 mm 3/4 inch high and black. Provide two lamps per pilot and wire independently. Ensure lamps are 6 watts, 24 volts dc, S-6 incandescent type, supplied with color caps, one red and one green per pilot light. Use black lens bezels unless otherwise indicated.

2.9.7 Clock

Provide electric synchronous motor type clock. The clock must be for surface mounting and suitable for operation on 115-volt, 60 Hz single-phase electric service. Provide clock with a white dial, easy-to-read black numerals, black hands, red sweep second hand, and external manual reset knob at bottom of case. Seal motor gear train in a permanent oil bath. The clock dial must be 381.0 mm 15 inch size.

2.9.8 Alarm Annunciator Panel

Provide layout of annunciator panel as shown. Provide panel consisting of a flush-mounted cabinet, mounting trim with clamps, removable rear cover, and alarm modules. Finish cabinet with black baked enamel, aluminum trim, and black alarm bezels. Ensure nameplate size of alarm modules is nominal 70 mm 2-3/4 inches high by 75 mm 3 inches wide in translucent white acrylic plexiglass and engrave all nomenclature on front surface in black lettering. Provide plug-in alarm module that includes epoxy circuit board, one reversible plug-in relay, one general-purpose plug-in relay, relays with dust covers, two selector switches for relay contact selection, and two lamps wired in parallel at 24 volts dc, 6 watts. Mount flasher module and prewire with silence and test pushbuttons. Provide alarm horn of general-purpose construction and mount remotely. Input voltage must be 120 volts ac, 60 cycle. Provide power supply of 120 volts to 24 volts dc output of volt-ampere capacity to suit load. Alarm sequences of panel must provide for "first alert" sequence, with manual reset and ringback sequences. Prewire annunciator panel internally to a rear terminal strip.

2.9.9 Combustion Control Components

Provide components conforming to the requirements of paragraph COMBUSTION CONTROL EQUIPMENT.

2.9.10 Steam and Feedwater Flow Measurement

Provide flow nozzles to measure the steam flow from each boiler and each main steam header outlet. Provide orifice plates to measure feedwater flow to each boiler. Use flange-mounting type nozzles and orifice plates made of stainless steel. Ensure orifice plates are the square edge, concentric, paddle type designed for flange taps. Make minimum straight pipe runs in accordance with AGA XR0603. Provide condensate pots for steam service.

2.9.11 Flue Gas Opacity Monitor

Provide a flue gas monitoring system to provide continuous measurement, indication, and recording of smoke opacity from each boiler. Include a light source and a light detecting or receiving unit mounted in the stack or main breeching as recommended by the manufacturer for stack units. Provide control or transmitter unit with electronic solid-state circuitry and meter or digital type indicator, and provide an output signal of 4 to 20 mA dc for 0 to 100 percent opacity. In addition, provide control unit with calibration and alarm adjustments for compliance with Federal, State, and local environmental regulations. Ensure control or transmitter unit and recorder has dust-tight metal enclosure. Provide a purging air system to clean light source lens and light detector lens. Ensure control unit has adjustable alarm output contacts for various smoke densities.

2.9.12 Sample Cooler

Provide a water cooled shell and tube or shell and coil type heat exchanger with stainless steel tubes and cast-iron or steel shell suitable for cooling the blowoff before sampling. Connect the cooler to a header and valved so that the operator can obtain a sample of properly cooled blowoff from any boiler as desired. Ensure the cooler is properly supported and has a brass or bronze sampling cock with lever or compression handle. Provide a sampling glass container suitable for handling the water temperature to be encountered and a hydrometer or equivalent device suitable for measuring the concentration of solids in the water and reading in parts per million.

2.9.13 Oxygen Analyzer

If oxygen compensation controls are furnished, provide an oxygen analyzer to indicate, record, and control the percentage of net excess oxygen in, and the average temperature of the flue gas leaving, the boiler. Provide direct probe type oxygen analyzer utilizing an in situ zirconium sensing element. Insert the element directly into the process flue gas stream and directly contact the process gases. Contain sensing element within a protective shield mounted to the ductwork by an adapter plate, furnished by the manufacturer. Equip the analyzer to allow daily automatic calibration check without removing the analyzer from the process. That is, sample gases may be injected directly on the sensing element while the analyzer is in the process. Include any temperature compensation of control required. The output signal range must be 4 to 20 mA dc and must represent 0 to 10 percent as a linear function.

2.9.14 Continuous Blowdown

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NOTE: Continuous blowdown equipment will be provided if required by UFC 3-410-01 or UFC 3-410-02. If a firetube boiler is specified, these paragraphs will be deleted.

Blowdown system will be deleted if not required for the project.

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Provide package type blowdown system that is rated as indicated. The system must automatically proportion blowdown to amount of makeup. Include [the heat exchanger's flow control valve,] strainer, sample cooler (if required), solenoid valve, and surge tank in the unit. [Provide an extra-heavy blowdown heat exchanger. Tubes must be of stainless steel. Provide a removable tube bundle with U-tubes having bends twice the thickness of the tubing. Use a rear baffle to support all tubes at the return bend.] Install a sample cooler so that shell and tubing can be removed without disturbing piping or mounting. Continuous blowdown valve must be the manual proportioning type fabricated of corrosion-resistant steel. Equip the valve with a micrometer dial and pointer to indicate the proportional setting.

2.9.15 Continuous Emissions Monitoring

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NOTE: A continuous emissions monitoring system (CEMS) is required by the Clean Air Act Amendment (CAAA) of 1990 if the fuel utilized is oil or coal and the heat input is 3 megawatts 10 million BTU/HR or greater. A CEMS may also be required by state or local laws. If a CEMS is necessary the designer will review the CAAA and the relevant state or local

law early in the project to allow time to incorporate the required CEMS specification and to determine which flue gas emissions will be included in the required reports. Before acceptance of the installation, furnish a written test report which provides documentation that the CEMS equipment has passed factory and field certification tests required by federal, state and local regulations to the Contracting Officer. The investigation will determine if the reported values may be calculated or should be direct measurements. Fill in the data to state what method of measurement or calculation will be utilized for the determination of the report variable.

Emerging flue gas flow monitor technologies are available. The traditional differential pressure technique specified uses familiar equipment that can be maintained by plant personnel. This type of measurement device has reliably satisfied regulatory requirements. The possible use of other technologies should include a thorough investigation of flue gas flow monitor regulatory requirements and in-house maintenance capabilities.

****

a. Provide continuous emissions monitoring system (CEMS) equipment as a system by a single manufacturer. Provide a CEMS, meeting the requirements of applicable federal regulations, State of [_____] and local regulations, for each boiler in accordance with manufacturer's recommendations and under the direct supervision of the CEMS equipment manufacturer.

b. Include [sulfur dioxide (SO2)] [oxides of nitrogen (NOx)] [carbon dioxide (CO2)] [particulate matter (PM)] and other information required by federal, state, and local regulations in the reported data. Base SO2 reporting on [analyzer measurement] [fuel flow and percent sulfur calculation] [daily heat input calculation]. Base nitrous oxides, carbon dioxide and particulate matter reporting on analyzers.

c. Include the central processing unit, printer, hard disk drive, and floppy disk drive in CEMS equipment. The floppy disk drive must function as a recorder. TProvide the software to generate the required reports in a format acceptable to the federal, state and local regulatory agencies. The operator interface to the CEMS equipment must be via CRT screen.

2.10 WASTE HEAT RECOVERY EQUIPMENT

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NOTE: Economizer or preheater will be selected to be compatible with pollution control equipment being utilized.

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Equip each boiler with [an economizer] [an air preheater]. Units may be separate from or integral with the boiler and complete with insulation and jackets, casings, supports and access doors, and have provision for tube or tube bundle removal and for cleaning. Provide soot blowers as specified in paragraph BOILERS.

2.10.1 Economizers

Provide economizers which are a type normally provided by the boiler manufacturer and that include [finned tubes] [bare tubes] baffles and headers and have provision for cleaning and tube bundle removal. At maximum load, economizer exit water must not be within 17 degrees C 30 degrees F lower than saturation temperature. Provide materials that are capable of withstanding the maximum boiler exit gas temperature plus 28 degrees C 50 degrees F. Provide tubes conforming to ASME BPVC SEC I. The overall design and installation must preclude cold-end corrosion under any load condition. Economizer tube metal temperature must be above the maximum flue gas dewpoint for the fuel being fired under all load conditions.

2.10.2 Air Preheaters

Provide air preheaters which are a type normally provided by the boiler manufacturer and are the recuperative tube plate or regenerative type constructed of materials adequate to withstand the corrosion effects of the flue gases. The overall installation must preclude cold-end corrosion of the air preheater under any load condition. Ensure temperatures of metals in contact with flue gas are above the flue gas maximum dewpoint temperature for the fuel being fired under all load conditions. Control by steam-preheat or by automatic bypass and integrate with the combustion control system.

2.11 DRAFT FANS

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NOTE: Where fans are not protected by electrostatic precipitators or baghouse filters on boilers of 4540 kg per hour 10,000 pounds per hour and larger, provide liners for scroll sheets and rotor blades.

Induced draft fan outlet dampers may not be required in single fan/single boiler installations, except to eliminate the stack effect during outages.

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Furnish centrifugal fans conforming to AMCA 801 [Type I] [Type II] [forced-draft] [and] [induced-draft] as an integral part of boiler design. Provide centrifugal fans with [backward curved blades] [radial tip blades] [or] [axial flow type]. Size each fan for an output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner or grate, leakages, temperature and elevation corrections for a dirty boiler with worst ambient conditions, all at full combustion to meet net rated output at normal firing condition. In addition, fan sizing must include margins of 10 percent volume and 21 percent static pressure, plus margins of 5 degrees C 10 degrees F for forced draft fans and 22 degrees C 40 degrees F for induced draft fans. Design induced-draft fans for handling hot flue gas at the maximum boiler outlet temperature adjusted for boiler surface fouling. [Provide induced draft fans with outlet dampers.] Noise levels for fans exceeding 85 decibels at 914.4 mm 3 foot station are not acceptable. Provide [air-cooled] [or] [water-cooled] fan bearings, and backward curved fan blade type with bearings not requiring water cooling may be of the self-aligning antifriction type. [Provide scroll sheets and rotor blades that have liners.]

2.11.1 Draft Fan Control

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NOTE: Variable speed control, inlet vane control, and inlet damper control are, in descending order of efficiency, capable of control draft fan conditions. The choice is based on economics. However, in erosive services, inlet vane control is not desirable.

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Provide forced-draft centrifugal fans with [inlet vane controls] [variable speed control] where indicated. Provide induced-draft centrifugal fans with [inlet vane control] [inlet damper control] [variable speed control]. [Provide axial propeller fans that have variable propeller pitch control.] Provide inlet vanes or dampers suitable for use with combustion control equipment.

2.11.2 Draft Fan Drives

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the reference to motor starters.

Steam driven boiler auxiliaries will not be used unless the exhaust steam can be utilized completely. Reference to steam drives will be deleted if inapplicable for the equipment specified.

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Provide fan that is driven by [an electric motor] [or] [a steam turbine]. [Provide [drip-proof] [totally enclosed nonventilated] [totally enclosed fan-cooled] [totally enclosed fan-cooled, suitable for installation in a Class II, Division 1, Group F, hazardous location conforming to NFPA 70] electric motor.] [Provide motor starter which is magnetic [across-the-line] [reduced voltage start] type with [general-purpose] [weather-resistant] [watertight] [dust-tight] [explosion-proof] enclosure and furnish with four auxiliary interlock contacts.] [Operate steam turbines properly in a steam pressure range of [_____] Pa psig with steam back pressure of [_____] Pa psig. Ensure turbines have horizontally-split, centerline supported casings, water-cooled bearing housings with ring-oiled, babbitt-lined, bronze packed sleeve bearings. Also equip turbines with a mechanical shaft speed governor and valve, and independent emergency overspeed governor and trip valve, reed tachometer, constant pressure type governor, insulation with removable metal jacket, oil-sight glasses with guards, removable stainless steel steam strainer [without disconnecting piping], any special wrenches and tools required for servicing turbine, and a sentinel warning on the exhaust casings. Provide turbines conforming to NEMA SM 23.]

2.12 AIR DUCTS

Design air ducts connecting the forced-draft fan units with the plenum chamber to convey air with a minimum of pressure loss due to friction. Provide galvanized sheet metal ductwork conforming to ASTM A653/A653M. Make ducts straight and smooth on the inside with laps made in direction of air flow. Brace ducts externally and install and anchor to be free of vibration. Provide access and inspection doors as indicated and required. Construct ducts with long radius elbows having a centerline radius 1-1/2 times the duct width, or where the space does not permit the use of long radius elbows, short radius or square elbows with factory-fabricated turning vanes may be used. Make duct joints substantially air-tight and have adequate strength for the service, with 38.1 x 38.1 x 3.2 mm 1-1/2 x 1-1/2 x 1/8 inch structural steel angles used where required for strength or rigidity. Ensure duct walls thickness is as follows:

Ducts, Maximum Dimension	Steel Sheet, Minimum Thickness
Up thru 1.5 m (60 inches) Up through 60 inches	1.519 mm (16 gauge)16 gauge
1.6 m (60 inches) 61 inches and larger	2.657 mm (12 gauge)12 gauge

2.13 BREECHING

Construct breeching of no less than 3.416 mm 10 gauge steel sheets conforming to ASTM A36/A36M. Reinforce and brace breeching adequately with structural steel angles no smaller than 50 x 50 x 6.4 mm 2 x 2 x 1/4 inches, and weld all joints and seams in the sheets and angles. Install expansion joints as indicated and as required to suit the installation. Ensure expansion joint are the flexible type requiring no packing. Provide breeching consisting of angle flanges and gaskets for connection to boilers, fans, equipment, or stacks. Ensure breeching connections are gas-tight and are caulked tight all around and sealed with cement to form an air-tight joint. Provide clean-out openings of suitable size at approved locations for access to all sections of the breeching and consisting of tight-fitting, hinged, cast-iron doors with cast-iron frames. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping for combustion gases.

2.14 STACKS

Provide self-supporting double-wall insulated type stacks for individual boilers. Unless otherwise indicated, provide each stack complete with structural steel base, base plates, anchor bolts and nuts, clean-out door, [induced-draft fan] [boiler] connection and a thermometer well. Stub stacks for packaged boiler units may be supported directly on the boiler providing the boiler structure is designed to accommodate such an arrangement. Provide insulation suitable for sustained flue gas temperature of 480 degrees C 900 degrees F with intermittent temperatures up to 650 degrees C 1200 degrees F and the wall section must provide a "U" factor of approximately 0.26. Fabricate stacks of steel conforming to ASTM A242/A242M for both inner and outer shell. Provide inner shells of each section with an air-sealed and concealed expansion and contraction device to allow for differential expansion of inner and outer shells. Extend stacks above the roof to the height indicated. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping for combustion gases.

2.15 BLOWOFF TANK

[Construct blowoff tank of 28 MPa 4000 psi reinforced concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE, and fit with a bolted steel manhole cover and frame. Install blowoff pipe, vent pipe, and drain pipe to sewer in pipe sleeves built into the concrete. Fill and caulk the space between the pipe and sleeves with lead wool or similar material to make a water-tight connection. Divide the tank into two sections by a baffle to form a sediment chamber.] [Construct blowoff tank of steel in accordance with NBBI NB-23 PART 1.]

2.16 PUMPS

2.16.1 Boiler Feed Pumps

Size and design boiler feed pumps for the specific application. Furnish pumps having a combined rating of flow and head that results in a wattage horsepower rating less than 185 kW 250 bhp to meet the design requirements of API STD 610. Provide pump that is end-suction, top discharge and support at its centerline. Ensure pump sizes with higher ratings than the above are horizontal-split case, multistage centrifugal pumps. Provide casing construction that is either volute or diffuser design and also support at its casing centerline. All pump ratings must have, nominally, an excess in capacity of 10 percent above the maximum continuous rating of the service. The required net positive suction head (NPSH) at the pump design flow, head, and speed must not exceed 80 percent of the available system NPSH at the same flow, assuming a low level in the storage tank. The pump's suction specific speed must not exceed 9000 at the pump's best efficiency point (BEP). The guaranteed NPSH requirements must reflect 3 percent breakdown criteria. The pump's head-capacity (H-Q) curve must be constantly rising to shutoff with no point of inflection. There will be no restriction to operation at any point from minimum continuous flow to design flow.

2.16.1.1 Casings

Pumps must have integrally cast suction and discharge flanges that must be drilled to meet the design pressure of the application. The maximum operating temperature, for design purposes, of any feedpump less than 204 degrees C 400 degrees F is not acceptable. Drill and tap casings. Provide casings with vent and drain connections. Do not require cooling at ratings below 375 kW 500 bhp for pumps designed for this service. This applies to both frame cooling or seal cooling. Below 375 kW 500 bhp, employ antifriction radial and thrust bearings lubricated by flinger rings in a sealed housing. Use mechanical and air-cooled flush piping seals conforming to API STD 610, Plan 23. Above 375 kW 500 bhp, employ a single cooling circuit for both cooling the oil being delivered by a forced oil system to sleeve radial bearings and a floating shoe thrust bearing, coupled with the seal coolers for both stuffing boxes. Also provide mechanical seals.. In both cases, ensurestuffing boxes are site-convertible to a packed box. Ensure leakage is no more than 25 mm/hour 25 cc/hr for a seal life of no less than 25,000 hours. Bearing rating must be no less than 100,000 hours (L-10 life) at the point of maximum load, as defined by ABMA 9.

2.16.1.2 Base

Support pumps on structural steel bases that do not require grouting in order to impart strength to the pump for static and dynamic loading from the piping system. Pitch bases to a low point drain. The complete pump and motor assembly must be shop-aligned using shims on both the pump and the motor.

2.16.1.3 Couplings

Furnish all pumps with nonlubricated flexible-disc couplings and a coupling guard furnished to OSHA requirements. Use spacer-type couplings to permit removal of the mechanical seals and limited-end-float-type for pumps with sleeve bearings.

2.16.1.4 Automatic Recirculation

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NOTE: If automatic recirculation valve is utilized, delete this paragraph.

****

Furnish all pumps with a self-contained automatic recirculation control valve that is sized for nominally 25 percent of the pump's BEP flow.

2.16.1.5 Turbines

Use steam turbines for boiler feed pump to operate the pump properly in a steam pressure range of [_____] Pa psig with steam backpressure of [_____] Pa psig. Provide turbines consisting of horizontally-split, two-piece, centerline supported casings, water-cooled bearing cases with ring-oiled, babitt-lined, bronze packed sleeve bearings. Also equip turbines with a mechanical shaft speed governor and valve, independent overspeed emergency governor and trip valve, reed tachometer, constant pressure type governor, insulation with removable metal jacket, oil-sight glasses with guards, stainless steel steam strainer that is removable without disconnecting piping, any special wrenches and tools required for servicing the turbine, and a sentinel warning on the exhaust casings. Provide turbines conforming to NEMA SM 23.

2.16.1.6 Electric Motors

Select electric motors for continuous duty and non-overloading characteristics suitable for the power characteristics available. Provide motors that are [splashproof][totally enclosed, nonventilated][totally enclosed, fan-cooled type][totally enclosed, fan-cooled type, suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with the NFPA 70]. [Provide motor starter that is [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [general-purpose][weather-resistant][water-tight][dust-tight][explosion-proof] enclosure.] Ensure integral size motors are the premium efficiency type in accordance with NEMA MG 1.

2.16.1.7 Shop Hydrostatic Testing

Subject all pumps to shop hydrostatic testing. Subject one pump in each service to a complete shop performance test to demonstrate that, at rated capacity, head is within a margin of plus 3 percent and minus 0 percent of design; efficiency is within a tolerance of minus 0 percent; NPSH at the pump's BEP and at the rated condition is within a margin of plus 0 percent and minus 10 percent. Performance tests must be in accordance with API STD 610. Procedures and results are subject to the approval of the Contracting Officer.

2.16.2 Condensate Pumps

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NOTE: If inadequate NPSH is available, the designer will give consideration to substituting either a double suction or positive displacement pump.
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Provide horizontal, end suction, single stage, centrifugal, motor-driven condensate pumps with stainless steel shafts and bronze impellers. Provide pumps with stuffing boxes. Lubricate by splash oil with oil level sightglass provided. Subject pumps to the same tests specified for the Boiler Feedpumps.

2.17 CONDENSATE TANK AND ACCESSORIES

2.17.1 Condensate Tank

Design condensate tank for a working pressure of 103 kPa 15 psig and conforming to ASME BPVC SEC VIII D1. Ensure tank has a storage capacity equal to or greater than indicated and install complete with piping and accessories.

2.17.2 Feedwater Makeup Valve

Provide float-controlled valve for emergency feedwater makeup to the tank. Operate valve by a float-control mechanism connected to the surge tank and maintain a suitable minimum water level in the tank. Locate the float box outside the tank and valve the connections properly to permit blowdown and servicing.

2.18 HEAT EXCHANGERS

Design, fabricate, test, and stamp heat exchangers in accordance with ASME BPVC SEC VIII D1. Additionally, ensure heat exchanger designs meet the requirements of HEI 2623. Closed feedwater heater designs must meet the requirements of HEI 2622. Provide heat exchangers with relief valves as required by ASME BPVC SEC VIII D1 and the HEI Standards. Design heat exchangers using service water to have the service water inside the tubes. Provide exchangers of straight tube designs with bolted full diameter access channel covers to facilitate tube maintenance as required. Return bonnets are acceptable when there are no tubeside nozzle connections at the far end. Provide materials of construction that are all carbon steel, except the service water side which reflects the service water available. When the water quality permits, use stainless steel tubes in accordance with ASTM A249/A249M, Grade TP 304, the remainder of the tube side must be all carbon steel. When the service water is known to contain chloride levels harmful to stainless steels, the tubes must be 90-10 Copper-Nickel in accordance with ASTM B111/B111M Alloy 706; the remainder of the service water side must be as follows: tubesheets, monel-clad steel; channel covers, carbon steel lined with monel; channels and bonnets, monel. Fixed tubesheet designs are preferred when operating conditions do not impose a large differential movement that cannot be readily accommodated with a simple thin-wall metal bellows expansion joint. For larger differentials, a packed floating tubesheet with lantern ring is acceptable up to 1.03 MPa 150 psig design pressure. For pressures above 1.03 MPa 150 psig, use a split ring floating head design. Heat exchangers using steam to heat domestic water or other fluids such as glycol-water mixtures or fuel oil must have the steam in the shell side. Provide exchangers of U-tube designs with bolted full diameter channel covers to facilitate tube maintenance as required. The tubesheet must be the full diameter to match the shell flange and have sufficient threaded bolt holes so that a shell hydro test may be applied without the channel in place. Use materials of construction that are all carbon steel with the exception of the tubes which should typically be specified as stainless steel in accordance with ASTM A688/A688M, Grade TP 304, stress relief annealed temper with the U-bends stress relieved after bending. Fuel oil heaters must have carbon steel tubes in accordance with ASTM A179/A179M and be furnished in the stress relief annealed temper with the U-bends stress relieved after bending. Provide feedwater heaters consisting of all welded construction with bolted full diameter channel covers to facilitate tube maintenance as required. The channel barrel must be integral with the tubesheet and have an internal pass partition bolted cover design that is readily removable when the channel cover is removed. Pass partitions that are sealed with a gasketed groove in the channel cover are prohibited. Ensure materials of construction are all carbon steel except the tubes. Provide pressure boundary material in accordance with ASTM A516/A516M, Grade C, when plate material is required, or ASTM A350/A350M when forging material is required. Provide shroud plate material for desuperheating and subcooling zones in accordance with ASTM A285/A285M, Grade C. Provide stainless steel tubes in accordance with ASTM A688/A688M, Grade TP 304, stress relief annealed temper with the U-bends stress relieved after bending.

2.19 DEAERATING FEEDWATER HEATER

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NOTE: Economizer or preheater will be selected to be compatible with pollution control equipment being utilized.

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Install deaerating feedwater heater where indicated and that is the size and capacity indicated. Provide [cast iron] [steel plate] shell. [Tray system for unit must be [cast-iron] [corrosion-resistant steel.] Floats must be of [copper] controlled overflow-trap] type. Provide heater with [a pressure relief valve,] [thermometers,] [pressure gauge,] [and] [oil separator]. [Install a combination temperature-pressure recorder for each feedwater heater.] [Take steam pressure readings from the shell, and place the temperature bulb to [indicate] [record] the temperature of the feedwater after it passes over the trays and sprays.] Provide an alarm to turn on a red pilot signal lamp and to sound a bell gong in the event that water level in the feedwater heater storage tank falls to 300 mm 12 inches above the bottom of the tank. Operate the system by an approved type of external electric float switch connected to the tank. Mount the signal lamp and bell where directed. The deaerating feedwater heater must have a capacity of [_____] pounds of water per hour at a discharge temperature of [_____] degrees F at the following inlet conditions:

	Pressure (kPa) (psig)	Temperature range (deg C) (deg F)	Flow rate (kg/hr) (lb/hr)
Condensate return	[_____]	[_____]	[_____]
High-pressure trap returns	[_____]	[_____]	[_____]
Makeup water	[_____]	[_____]	[_____]
Heating steam	[_____]	[_____]	[_____]

2.20 STEAM TRAPS

****

NOTE: The design engineer, when designating steam-using equipment or special steam applications, will indicate the type of steam trap required in accordance with the following data:

a. Inverted Bucket Traps: This type of trap continuously vents air and carbon dioxide at steam temperature and is recommended for modulating loads. The bucket floats on steam to close the outlet and sinks into condensate to open the condensate outlet. Any trapped air is discharged first into the condensate return line and is followed by condensate discharge. This type of trap has the longest life on systems under modulated control. When large amounts of air are anticipated, an external thermostatic air vent should be installed on a line bypassing the trap to bleed air from the steam line and discharge it to the condensate return line. This system will give optimum performance at low steam pressures with maximum dependability. These traps will handle condensate from fan coil units where condensate must be lifted to return lines located above the equipment. They operate best at near full load conditions where loads do not vary over a wide range. Before operation, traps must be primed by filling them with water.

b. Vertical Open-Top Bucket Trap: Trap construction is more complex than inverted bucket type but is suitable for applications having wide variation of load and pressure, and is recommended for constant pressure systems. Bucket sinks into condensate when condensate reaches top of trap and the discharge port opens. After discharge, the bucket floats on incoming condensate keeping the discharge port closed.

c. Impact-Operated Traps: These traps depend on steam velocity to keep the disc closed. As steam velocity decreases, the disc lifts off the seat and allows flow of condensate. These traps allow some steam leakage and do not vent air at low pressure. They are not recommended for service lower than 70 kPa 10 psig or where back pressure may exceed 50 percent of inlet pressure. These traps are less expensive and have poor performance in the presence of dirt.

d. Thermostatic Traps: These traps are bellows-actuated and contraction of bellows at a few degrees below saturated steam pressure allows condensate air and noncondensable gases to be discharged. As steam reaches the bellows, the expansion of the bellows closes the discharge port. These traps can also be utilized to vent air from a

steam system and can be used in conjunction with an inverted bucket type steam trap previously described.

e. Float and Thermostatic Trap: These traps provide optimum performance on modulating systems at lowest first cost. Where steam pressures modulate down to zero, large amounts of air may be liberated. They are ideal for dripping ends of steam risers, heels of up-feed steam risers, bottoms of down-feed steam risers. These traps are also ideal for fan coil units and unit heaters.

f. Any trap selected must be sized for the expected condensate load with an applicable safety factor applied for the particular type of equipment serviced. Manufacturer's application manuals should be consulted to assist in sizing traps. Safety factors vary from 2:1 to 10:1. An average 3:1 safety factor value will cover most applications.

g. Service life between repairs or replacement of traps may be a determining factor in the choice of traps. One manufacturer of all types of traps offers the following experience record:

Type of Trap	**Average Service Life Between Replacement or Repairs**
Inverted bucket traps	**42 months**
Float and thermostatic traps	**24 months**
Thermostatic traps	**24 months**
Impact-operated traps	**19 months**

****

Provide steam traps in accordance with ASTM F1139, type, style, and class as applicable.

2.20.1 Bucket Traps

Provide either the inverted bucket type or the vertical bucket type bucket traps with automatic air discharge. Design traps for a working pressure of 1.03 MPa 150 psig, but in the correct pressure class to operate properly at the actual steam supply pressure indicated for the system. Construct valve and seat of stainless steel. Construct all other interior parts of corrosion-resistant metal and the traps may be sealed type with corrosion-resistant steel bodies. Ensure traps discharge the condensate to the return line and are connected as indicated. Install a suitable strainer with blow-off valve in the intake connection to each trap. Ensure capacity of traps is no less than that indicated.

2.20.2 Impact-Operated Traps

Impact-operated traps, impulse-operated traps, or thermodynamic traps with continuous discharge may be installed in lieu of bucket traps if applicable, subject to approval of the Contracting Officer.

2.20.3 Thermostatic Traps

Thermostatic traps designed for a steam working pressure suitable for the application may be furnished in lieu of the traps specified above if applicable. Base thermostatic trap capacities on a pressure differential not in excess of the following:

Steam working pressure	Differential pressure
275-350 kPa40-50 psig	240 kPa35 psig
620-690 kPa90-100 psig	550 kPa80 psig

2.20.4 Float and Thermostatic Traps

Design float and thermostatic traps for a steam working pressure of 103 kPa 15 psig which operates with the supply pressure indicated for the system. Base trap capacity on a pressure differential of 15 kPa 2 psi. Provide inlet to each trap with a brass or stainless steel strainer either separately or as an integral part of the trap.

2.21 PRESSURE GAUGES

Provide heavy-duty industrial type pressure gauges with phenolic case, solid front, rear blowout, threaded ring, shatterproof glass, and 13 mm 1/2 inch NPT bottom connection suitable for specified pressure or vacuum with minimum 114.3 mm 4-1/2 inch diameter dial, except as otherwise specified. Install pressure gauges on the low-pressure side of each pressure reducing valve, on the suction and discharge side of each pump, on inlets and outlets of heat exchangers, on the feedwater heater, and where shown or required for proper operation. Install pressure gauge with a [254.0 mm 10 inch dial] [304.8 mm 12 inch dial] face on each boiler. Install gauges to be accessible and easily read from the operating floor. Equip gauges with integral or separate siphons, and pulsation dampeners and connect by brass pipe and fittings with shutoff cocks. Where pressure reducing valves are used, place upstream and downstream gauges close to the pressure reducing assembly, but connect approximately 3 m 10 feet therefrom. The operating ranges of the gauges must be approximately twice the normal operating pressure.

2.22 THERMOMETERS

Provide bimetallic type thermometerswith stainless steel case and stem, separable stem, separable thermowells, and temperature range suitable for the use encountered. Install thermometers in the feedwater heater storage and steam areas, boiler feed pump; in the main condensate return line before entering the surge tank; in the combustion air inlets and outlets of air preheaters, water inlets, and outlets of economizers; in the suction and discharge of boiler feed pumps; in air inlets to forced and induced draft fans; in the flue gas inlets and outlets of economizers and air preheaters; and elsewhere as indicated or specified. Provide thermometers with a universal joint and that are easily read from the operating floor. Ensure thermometers have 127.0 mm 5 inch scales except where 304.8 mm 12 inch scales are required for remote reading and plus or minus 1 percent accuracy.

2.23 WATER METER

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NOTE: For boilers having less than 4,540 kg 10,000 lbs per hour steaming capacity, a mechanical type feedwater meter may be provided in accordance with this paragraph. Plants having metered zeolite softeners used exclusively for boiler makeup purposes will not require an additional cold water makeup water meter. Boilers over 4,540 kg 10,000 lbs per hour capacity will have indicating-recording meters and they must be integrating type where indicated.

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Provide water meter, including the three-valve bypass and connections, in the cold water makeup line [and in each boiler feedwater line]. Provide disk type water meters with reinforced disk for hot water above 65 degrees C 150 degrees F and rubber or synthetic polymer disk for cold water, that are constructed of bronze composition and cast-iron protected by noncorrosive coating. Ensure moving parts subject to wear are easily removable. Provide meters conforming to the requirements of AWWA C700.

2.24 CHEMICAL TREATMENT AND WATER SOFTENING EQUIPMENT

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NOTE: Inapplicable type of chemical feeder will be deleted in accordance with the requirements of UFC 3-410-01 or UFC 3-410-02.

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2.24.1 Chemical Feeder

Provide a feeder unit for each boiler. Chemical feeder must be automatic proportioning, shot, or pump type. Provide all appurtenances necessary for satisfactory operation. Base size and capacity of feeder upon local requirements and water analysis. Furnish chemical feed pumps and tanks as a package with the pumps mounted on and piping connected to the tank. Provide pump cylinders, plungers, ball check valves, and check valve bodies consisting of corrosion-resistant materials suitable for the chemicals being pumped. Volumetric accuracy of the pumps must be within one percent over the range indicated. Adjust pump capacities by positioning crank pin with micrometer setscrews. Ensure stroke length scale is divided in percentage graduations engraved on scale. Provide replaceable cylinders for increased or reduced pressure or capacity ranges. Provide drive motors suitable for the electrical power available with drip-proof enclosures. Provide polypropylene tanks and mount on legs. Provide tanks with filling and drain connections and gauge glass. Furnish each tank with one pump, mounted and piped with black iron pipe and fittings, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Provide hinged cover for each tank. Tank bottom must be dished concave to a radius equal to the diameter of the tank. Units must be for phosphate or caustic feed and sulfite feeding. Provide motor-driven agitator. Design the pump to feed the chemical solutions into the boiler feedwater system.

2.24.2 Water Softening Equipment

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NOTE: Need for softening equipment for makeup water will be as determined in accordance with UFC 3-410-01 or UFC 3-410-02. If water softening is not required, delete the paragraph.

****

Provide a [single] [double] unit automatic water softener system as indicated. Design the system for a working pressure of [_____] Pa psig. The system must be complete with raw and regenerate water distribution; under drain; inlet and outlet connection in upper and lower header respectively; resin removal connecting pipe legs; control valve for service, backwash, regenerate, and rinse; water meters, pressure gauges, brine storage, and measuring tank and controls for automatic operation. Brine tank must be either hot-dipped galvanized after fabrication or polypropylene. Brine piping must be either all copper pipe and fittings or Schedule 80 PVC. Provide equipment with a total capacity between regenerations of no less than [_____] liters gallons of water of [_____] grams grains hardness when operating at a sustained softening rate of [_____] L/second gpm. Base the system on the data below. Provide test sets for pH comparator for the range [_____] to [_____] sulfite comparator, and phosphate comparator.

2.24.2.1 Water Analysis

The source of the raw water is [_____]. The analysis of the water is approximately as follows:

Constituents*	
Sodium as (Na)	[_____] ppm
Silica as (SiO(2))	[_____] ppm
Calcium as (Ca)	[_____] ppm
Magnesium as (Mg)	[_____] ppm
Iron and aluminum oxides as (Fe(2)O(3)), (Al(2)O(3))	[_____] ppm
Bicarbonates as (HCO(3))	[_____] ppm
Carbonates as (CO(3))	[_____] ppm
Hydroxides as (OH)	[_____] ppm
Sulphates as (SO(4))	[_____] ppm
Chlorides as (Cl)	[_____] ppm
Phosphates as (PO(4))	[_____] ppm
Carbon Dioxide (free CO(2))	[_____] ppm
Total hardness as (CaCO(3))	[_____] ppm

Constituents*	
Total solids in solution	[_____] ppm
Volatile and organic matter	[_____] ppm
Suspended matter	[_____] ppm
Free acid	[_____] ppm
Color	[_____]
pH	[_____]
*Numbers in parentheses are subscripts.	

2.24.2.2 Zeolite

Provide the high capacity polystyrene base sulphonic synthetic type zeolite. Provide no less than [_____] cubic meter feet of zeolite with each reactor tank.

2.24.2.3 Reactor Tank

Base reactor tank sizes on allowing a freeboard above the zeolite bed of no less than 50 percent of the zeolite bed depth, and a maximum flow rate of 11.3 mL/square meters per second one gallon/square foot per minute for each 111 mm 4-3/8 inches of zeolite bed depth.

2.24.2.4 Softening System

Provide softening system complete with all piping, control, and power wiring. Install a complete initial charge of rock salt in the brine tank as recommended by the softener manufacturer.

2.24.2.5 Water Test Kit

Provide a kit complete with test containers, reagents, and instructions for testing the raw and effluent water in a strong carrying case.

2.24.2.6 Treated Water Storage Tank

Fabricate treated water storage tank from steel plates no less than 4.7625 mm 0.1875 inch thick for shell and heads, and construct in accordance with ASME BPVC SEC VIII D1 for unfired pressure vessels for a design working pressure of 517 kPa 75 psig. Heads must be dished concave to pressure to a radius equal to the diameter of the tank. Provide tank with the connections indicated, an 203.2 mm 8 inch copper ball float, level-operated control valve, valve bypass and accessories, and a protected gauge glass. The tank must be the diameter shown and have a capacity no less than [_____] liters gallons. Hydrostatically test the tank at the factory at no less than 690 kPa 100 psig.

2.25 BUILDING HEATING EQUIPMENT

2.25.1 Unit Heaters

2.25.1.1 General

Do not select individual heaters with a capacity in excess of 125 percent of the value specified for the heater. Provide orifice plates to reduce the joule Btu output where required. The noise level of each unit heater must be appropriate for the space in which the heater is installed. The sound power level [_____] decibels reference must not exceed the following values in each octave band at the midfrequency, cycles per second:

Octave Bands	3	4	5	6	7
Midfrequency (in Hz)	250	500	1000	2000	4000
	Sound Power Level				
Office Space	54	50	47	45	43
Conference Rooms, Communication Facilities	51	46	45	42	38
Shops, Factories	69	62	61	58	57

Base sound power level data for these units on tests conducted in accordance with ASA S1.13.

2.25.1.2 Propeller Type Unit Heater

Design heater for suspension and arrange for horizontal or vertical discharge of air as indicated. The casings must be no lighter than 0.912 mm 20 gauge steel. Provide suitable stationary or rotating air deflectors to assure proper air and heat penetration at floor level. Suspension from heating pipes will not be permitted. Operate vertical discharge heaters at speeds not in excess of 1200 rpm, except that units with 53 Megajoules 50,000 Btu output capacity or less may operate at speeds up to 1,800 rpm. Provide horizontal discharge unit heaters with discharge or face velocities no greater than the following:

Unit Capacity	Face Velocity
Up to 0.472 cu m/second 1,000 cuf/minute	4.0 m per second800 feet per minute
0.472 to 1.4 cu m/second1.001 to 3,000 cu f/minute	4.6 m per second900 feet per minute
1.4 and over cu m/second3.001 and over cu f/minute	5.1 m per second1,000 feet per minute

2.25.1.3 Cabinet Unit Heaters

Provide centrifugal fan type heaters arranged for floor or ceiling mounting as indicated. House heating elements and fans in steel cabinets with angle iron frames. The cabinets must be of no lighter than 0.912 mm 20 gauge steel. Provide each unit heater fan discharge with an approved adjustment for air diffusion and distribution. Mount the fans on a common shaft with one fan to each air outlet. Equip the fan shaft with self-aligning ball or roller bearings accessible for lubrication. Connect the fan shaft directly to the driving motor or connect indirectly by adjustable V-belt drive rated at 150 percent of motor capacity. Provide guards for all exposed moving parts. Ensure all fans in any one unit heater are the same size.

2.25.1.4 Heating Elements

Heating coils must be copper, and radiating fins may be copper, aluminum, or suitable ferrous alloy. Ensure heating elements are free to expand or contract without developing leaks and are properly pitched for drainage. Test elements under a hydrostatic pressure of 1.4 MPa 200 psi and submit a certified report of the test to the Contracting Officer.

2.25.1.5 Manual Selection Switches

Provide motors with manual selection switches for [on, off, and automatic] [on-off] operation and equip with thermal-overload protection.

2.25.1.6 Automatic Operation

2.25.1.6.1 Thermostatic Control by Fan Regulation

Control unit heaters automatically by thermostats located where indicated. Provide adjustable thermostats and fit with thermometers. Operate each thermostat on no more than a 2 degrees C 3 degrees F differential over a temperature range of approximately 13 to 24 degrees C 55 to 75 degrees F. The thermostat must start or stop the respective unit heater fan motor when the room temperature falls below or rises above the thermostat set point. Provide summer-winter switches for fan operation adjacent to the thermostat for each unit heater.

2.25.1.6.2 Thermostatic Control by Steam Valve Regulation

Control cabinet type unit heaters automatically by proportioning type thermostats and modulating steam valves located where indicated. Provide on-off switches for fan operation adjacent to the thermostat for each fan unit. The thermostats and valves must maintain the desired room temperature within 1 degree C 2 degrees F of the thermostat set point by regulating the steam supplied to the coil.

2.25.2 Radiator and Convector

Provide each [radiator] [convector] unit with a top supply connection with a control valve and a bottom return connection with a thermostatic trap. Test each unit hydrostatically at the factory and prove tight at a pressure of no less than 690 kPa 100 pounds. Provide extended surface tube-type radiators consisting of suitable metal fins permanently bonded to copper or steel pipe cores threaded at each end for connecting to external piping. Determine radiator capacities in accordance with the HYI-005 Rating Code. Equip radiators with [expanded metal cover grilles fabricated from steel sheets no lighter than 1.519 mm 16 gauge, secured either directly to radiators or to independent brackets] [solid front, slotted, horizontal top grilles fabricated from steel sheets no lighter than 1.214 mm 0.0478 inch thick, secured either directly to radiators or to independent brackets] [solid front, slotted, sloping, top cover grilles fabricated from steel sheets no lighter than 1.214 mm 0.0478 inch thick independently secured to masonry with brackets]. [Test nonferrous convectors hydrostatically at the factory and prove tight under a pressure of no less than 585 kPa 85 psig.]

2.26 AIR COMPRESSOR UNITS

Provide air compressor conforming to ASME PTC 10, except as specified otherwise. Do not exceed 900 rpm compressor speed. Do not exceed 1750 rpm motor speed.

2.26.1 Service Air Compressors

Meet service air requirements as indicated with receivers sized as indicated. Provide units suitable for heavy-duty service (soot blowing). Provide compressors that are simplex type, single-stage, double-acting, with water-jacketed cylinder; fitted with intake and discharge valves of the lightweight feather, disc, or plate type; and provide with necessary controls, water-cooled aftercooler, moisture separator, drive, receiver, relief valves, and cooling water controls as indicated or required. Provide compressor air intake with a low drop-type air suction filter/silencer suitable for outdoor installation. The aftercooler must be the shell-and-tube type designed for air flow through the tubes with steel shell internal baffle plates and Admiralty metal tubes expanded into Muntz metal tube sheets. Provide moisture separator with an automatic water discharge trap and level gauge. Provide vertical type air receiver, constructed in accordance ASME BPVC SEC VIII D1 for unfired pressure vessels for 1.4 MPa 200 psi working pressure, and equip with flanged inlet and outlet connections, valved drain connection, 152 mm 6 inch dial pressure gauge, pop safety valves, and regulator connections. Cooling water controls for regulating compressor cylinder water temperature and aftercooler water temperature must be thermostatic valve type and install with a three-valve bypass in the water outlet lines ahead of open sight drain funnels. Equip compressor with adjustable, pressure-type unloader controls suitable for continuous compressor operation.

2.26.2 Instrument Air Compressors

****

NOTE: The designer should determine if two redundant full-size instrument air compressors will be required as loss of air will cause unit shutdown unless other provisions are made, such as crossties to the soot blower/service air system. Delete paragraph if not required.

****

Provide an electric motor-driven oil-free automatic air compressor unit and a refrigerating drying unit. The air compressor must be capable of delivering, at a pressure of [_____] Pa psig, not less than 0.00472 standard cubic meters/second 10 scfm dry air at an atmospheric dew point of -23 degrees C -10 degrees F with entering air at 35 degrees C 95 degrees F, saturated. Size air compressor unit to run no more than 60 percent of the time when all controls are in service. Provide complete air compressor unit with all necessary accessories including automatic pressure control equipment, relief valves, check valves, air filters, moisture traps, and a receiver with ample capacity for emergency operation of the controls for 15 minutes after compressor shutdown. The receiver must be of vertical construction, in accordance, ASME BPVC SEC VIII D1 with relief valve and drain fittings. Provide a self-contained, refrigerated type air dryer, complete with refrigeration compressor, heat exchanger, automatic controls, and moisture removal trap, or a regenerative desiccant type dryer, as required. Ensure refrigeration unit is the hermetically-sealed type capable of continuous operation at maximum load conditions.

2.27 PIPING

Unless otherwise specified herein, provide pipe and fittings conforming to ASME B31.1.

2.27.1 Pipe

Provide pipe material as specified in TABLE I.

2.27.2 Fittings

Provide pipe fittings as specified in TABLE II.

2.27.3 Nipples

Provide nipples conforming to ASTM A733, Type I or II, as required to match adjacent piping.

2.27.4 Unions

Provide unions conforming to ASME B16.39, type as required to match adjacent piping.

2.27.5 Pipe Threads

Provide pipe threads conforming to ASME B1.20.2MASME B1.20.1, right- or left-hand tapered thread as required.

2.27.6 Expansion Joints

2.27.6.1 Guided, Slip-Tube Type Expansion Joints

****

NOTE: Wherever possible, provision for expansion of steam supply and return pipes will be made by changes in the direction of the run of the pipe or by field-fabricated expansion bends. If expansion joints are not required, applicable paragraphs will be deleted. Where space limitations prevent such provisions for expansion, expansion joints will be installed.

****

Guided, slip-tube expansion joints must conform to EJMA Stds and ASME B31.1. End connections must be flanged. Provide anchor bases or support bases as indicated or required. Design joints for a steam working pressure no less than [_____] Pa psig. Joints must provide for either single or double slip of the connected pipes, as indicated, and for not less than the traverse indicated. [Provide service outlets where indicated or required.]

2.27.6.2 Bellows Type Expansion Joints

Bellows type joints must be flexible, guided expansion joints conforming to EJMA Stds and ASME B31.1. The expansion element must be stainless steel. Guiding of piping on both sides of expansion joint must be in accordance with the published recommendations of the manufacturer of the expansion joint. Design joints for the working temperature and pressure suitable for the application, but design pressure less than 1.03 MPa 150 psig is not permitted.

2.27.6.3 Flexible Ball Type Expansion Joints

Provide flexible ball joints that are [stainless steel] [malleable-iron] [ductile iron] [carbon steel] [bronze] or other alloys as appropriate for the service intended. The joints may be threaded, flanged, or welded end, as required, and must be capable of absorbing the normal operating axial, lateral, or angular movements or combination thereof. Design and construct ball-type joint in accordance with ASME B31.1 and EJMA Stds, where applicable. Provide flanges conforming to the diameter and drilling provisions of ASME B16.5. Furnish molded gaskets suitable for the service intended.

2.27.7 Valves

Install valves at indicated locations, where specified, and where required for proper functioning and servicing of the system. Valves must be of the pressure class shown. Provide motor-operated valves capable of closing speeds of 2.5 to 5.1 mm/sec 6 to 12 inches/minute. Equip motor operators with position indicators, valve stem protectors above the motor operating units, and auxiliary handwheels for manual operation of the valves in the event of power failure. Ensure motors are suitable for operation on the electrical current characteristics indicated.

2.27.7.1 Check Valves

****

NOTE: The designer will indicate the type of valves, vertical lift or horizontal, on the drawings.

****

a. Provide valves for 125 pound class steel piping conforming to the following:

    (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 3 or 4, Class 125.

    (2) Sizes 80 mm 3 inches through 600 mm 24 inches, cast-iron: MSS SP-71, Type III or IV, Class 125.

b. Provide valves for 150 pound class steel piping conforming to the following:

    (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Class 150 minimum.

    (2) Sizes 80 mm 3 inches through 600 mm 24 inches, steel: ASME B16.34, Class 150 minimum, flanged ends, swing disc.

c. Valves for system operating pressure greater than 1.4 MPa 200 psi must be swing check or lift check valves having a steel body and suitable for specified operating pressure, but not less than Class 300 300 pound class. Valves 40 mm 1-1/2 inches and smaller must be cast or forged steel with socket welded ends. Valves 50 mm 2 inch and larger must be steel with butt welded ends. Check valves must have renewable composition discs or metallic discs of the regrindable type which permits regrinding without removing valve from the line.

2.27.7.2 Gate Valves

Gate valves used as shutoff valves in the boiler leads to the steam headers, and elsewhere as indicated, must be of the chain-operated type, with enough chain for easy operation from the operating floor or walkway. Provide gate valves 200 mm 8 inches and larger used on high-pressure steam lines, and elsewhere as indicated with a globe valve bypass.

a. Provide valves for 125 pound class steel piping conforming to the following:

    (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 125.

    (2) Sizes 80 mm 3 inches through 1200 mm 48 inches, cast-iron: MSS SP-70, Type I, Class 125, Design OT or OF (OS&Y), bronze trim.

b. Provide valves for 150 pound class steel piping conforming to the following:

    (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 150 minimum.

    (2) Sizes 80 mm 3 inches through 600 mm 24 inches, steel: ASME B16.34, Class 150 minimum, flanged ends.

c. Valves for system operating pressure greater than 1.4 MPa 200 psi must be split wedge disc type, outside screw and yoke, steel and suitable for specified operating steam pressure, but no less than Class 300 300 pound class. Valves 50 mm 2 inch and smaller must be forged steel with socket welded ends. Valves 65 mm 2-1/2 inches and larger must be steel with butt welded ends.

2.27.7.3 Globe Valves and Angle Valves

Provide globe type valves with outside screw and yoke with bolted bonnets, stainless steel trim, and flat seats, but not the reversed cup type. Provide large and deep stuffing boxes. Install valves with the stem horizontal or above.

a. Provide valves for 125 pound class steel piping conforming to the following:

    (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 125.

    (2) Sizes 80 mm 3 inches through 300 mm 12 inches, cast-iron: MSS SP-85, Type III and Type IV, Class 125.

b. Provide valves for 150 pound class steel piping conforming to the following:

    (1) Sizes 65 mm 2-1/2 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 150 minimum.

    (2) Sizes 80 mm 3 inches through 600 mm 24 inches, steel: ASME B16.34, Class 150 minimum, flanged ends.

c. Valves for system operating pressure greater than 1.4 MPa 200 psi must be suitable for specified operating conditions, but no less than 300 pound class. Valves 50 mm 2 inch and smaller must be forged steel with socket welded ends. Valves 65 mm 2-1/2 inches and larger steel withbutt welded ends. Valves must have renewable flat metal seats.

2.27.7.4 Steam Pressure Reducing Valves

****

NOTE: Single-seated valves should be used when a dead-end shutoff of the steam is required. When a thermostatically-controlled valve is installed after and near the reducing valve in a manner to cut off the passage of steam, the single-seated valve should be used. Double-seated valves may be used where the low (reduced) pressure lines will condense enough steam to offset normal leakage through the valve. Under conditions of widely varying initial pressure, double-seated valves usually give closer control of reduced pressure.

****

Provide reducing valves designed for the working pressure shown, but not for less than 1.4 MPa 200 psig, wherever indicated or required. Adjust each reducing valve to maintain the desired terminal pressure, regardless of fluctuations in the initial pressure. The valves must be [single seated] [doubled seated], spring-loaded, quiet in operation, and must not stick internally. Provide pilot-operated valves or other controllers using steam or compressed air for operating medium. Valves 65 mm 2-1/2 inches and larger must be cast steel, cast-iron, or semisteel as required for the steam pressure. Valves 50 mm 2 inches and smaller must be bronze. Valve trim for iron body valves must be stainless steel, nickel copper, or other approved corrosion-resisting material. All parts subject to wear must be readily renewable. Provide valves with seats and plugs faced with a cobalt-tungsten carbide mixture, or made of heat-treated stainless steel or a high chromium steel designed to resist erosion. Provide seat and plug facing with a Brinell hardness of no less than 450. Install each valve with a strainer, a three-valve bypass, and a safety relief valve as indicated. Where pressure reducing valves are used for reducing the steam pressure to the deaerating heater, use single seated type valves. Connect sensing lines to the steam space in the deaerator or at least 3 m 10 feet downstream of the pressure reducing valve.

2.27.7.5 Thermostatic Regulating Valves

****

NOTE: If a hot water generator is not installed, this subparagraph will be deleted.

****

Install valves of the self-contained type to control water temperature within the domestic hot water generator by regulating the steam supplied to the heating coil in the steam supply line to each generator. Design thermostatic regulating valves for a steam working pressure of 1.4 MPa 200 psig and operate at the pressure shown. The valves must be adjustable within an operating range of approximately 38 to 71 degrees C 100 to 160 degrees F and maintain the desired water temperature within plus or minus 3 degrees C 5 degrees F.

2.27.7.6 Back Pressure Relief Valves

Provide valves with cast-iron or steel bodies and equip with corrosion-resistant trim and valve seats. The valves must be properly guided and must be positive closing to prevent leakage. Adjustment of the desired back pressure must cover a range between 34 to 103 kPa 5 to 15 psig. The adjustment must be effected externally, and provide any shafts extending through the valve body with adjustable stuffing boxes having renewable packing.

2.27.7.7 Boiler Automatic Feedwater Recirculating Control Valve

****

NOTE: If automatic recirculation valve is not utilized, delete this paragraph.

****

Provide self-contained self-powered type valve. Automatically program the recirculation flow when required and assume all functions for prevention of the backflow of the main feedwater flow, for detection of low flow, for cycling of the control valve, and for the pressure reduction for liquid delivery to the low-pressure feedwater heater. Provide flanged type valve assembly with flanged spools provided in both the main line and recirculation line for ease of disassembly.

2.27.8 Exhaust Heads

Exhaust heads for the discharge of steam to atmosphere must be one-piece plate steel, semisteel, or cast-iron construction with internal baffle arrangement for the removal of entrained condensate and oil, and with provision for drain connection. Flow area through unit must be larger than connecting pipe.

2.27.9 Strainers

Make strainer body connections the same size as the pipelines in which the connections are installed. Provide strainer bodies consisting of heavy and durable cast steel [or gray cast-iron]. Clearly cast arrows on the sides of bodies to indicate the direction of flow. Equip each strainer with an easily removable cover and sediment basket. The basket must be no less than 0.63 mm 0.025 inch thick corrosion-resistant steel [or sheet brass] with enough small perforations to provide a net free area through the basket of at least 3.30 times that of the diameter of the entering pipe.

2.27.10 Pipe Hangers, Inserts, and Supports

Provide pipe hangers, inserts and supports conforming to MSS SP-58, except as modified herein:

a. Do not use Types 5, 12, and 32.

b. Do not use Type 3 on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.

c. SecureType 18 inserts to concrete forms before concrete is placed.

Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

d. Torque Type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Furnish Type 20 attachments used on angles and channels with an added malleable-iron heel plate or adaptor.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Where Type 39 saddle or Type 40 shield is permitted for a particular pipe attachment application, use the Type 39 saddle on all pipe 100 mm 4 inches and larger.

h. Space horizontal pipe supports as specified in MSS SP-58 and do not install a support over 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Do not space pipe supports over 1.5 m 5 feet apart at valves. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Ridgidly connect the clips or clamps to the common base member. Provide a clearance of 3 mm 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

i. Supportvertical pipe at each floor, except at slab-on-grade, and at intervals of no more than 4.5 m 15 feet, no more than 2.4 m 8 feet from end of risers, and at vent terminations.

j. Provide Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides, where required, to allow longitudinal pipe movement. Provide lateral restraints as required. Provide slide materials suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

  (1) Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

  (2) Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 100 mm 4 inches, or by an amount adequate for the insulation, whichever is greater.

k. Pipe hangers on horizontal insulated pipes, except for Type 3, must be the size of the outside diameter of the insulation.

l. Support piping in trenches as indicated.

2.28 INSULATION

Provide shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.29 TOOLS

Furnish special tools only and include all uncommon tools necessary for the operation and maintenance of boilers, stokers, pumps, fans, controls, meters, special piping systems, and other equipment. Furnish small hand tools with a suitable cabinet, mount where directed. Also furnish the following tools.

2.29.1 Tube Brush

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NOTE: Applies to firetube boilers.

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Provide tube brush, with steel bristles and jointed handle of sufficient length to clean full length of firetubes.

2.29.2 Smoke Pipe Cleaner

Provide cleaner to clean the breeching and smoke connections. Provide cleaner with jointed handle of sufficient length to clean breeching and smoke connections without dismantling.

2.29.3 Firing Tools

Provide firing tools including hoe, poker, and slice bar for each boiler.

2.29.4 Wrenches and Gaskets

Provide wrenches as required for opening boiler manholes, handholes, and cleanouts. Provide one set of extra gaskets for all boiler manholes and handholes, for pump barrels, and other similar items of equipment. Package and properly identify all gaskets.

2.30 COAL HANDLING EQUIPMENT

2.30.1 Screw Conveyor

****

NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the reference to motor starters.

****

Provide screw conveyor for the lateral distribution of coal consisting of steel screw conveyor with capacity of no less than [_____] cubic meters/second cubic feet/hour when handling coal of the specified maximum lump size. Base maximum capacity of the conveyor on the screws carrying no more than 30 percent of their cross section (except feeder conveyors), and the maximum speed of conveyor must be 60 rpm. Assemble conveyor and housing in sections. Mount sectional flightson steel pipe and connect by coupling shafts. A feeder conveyor may be installed to assume the proper distribution of the load. Mount flights of both the feeder screw and the extended screw on the same pipe. Provide conveyor with sectional supporting hanger bearings of the babbitted type. Do not exceed a conveyor length between bearings of 3.7 m 12 feet. Provide fabricated cast-iron trough ends with feet and fit with babbitted bearings. Locate drive consisting of an electric gear motor and chain driveat the discharge end of the conveyor. Enclosethe chain drive from the motor to the reducer in an oil-tight casing. Thrust in either direction must be absorbed by the thrust bearings. The motor may be mounted on top of the trough. The trough conveyor housing must be no less than 4.8 mm 3/16 inch steel with a 1.897 mm 14 gauge steel, dust-proof cover. Furnish discharge spout and coal gate as indicated. Provide an approved type of supporting saddle. Space supports at no more than 3 m 10 foot intervals. Motor enclosure must be [totally enclosed, nonventilated] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in conformance with NFPA 70]. [Motor starter must be [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [weather-resistant] [dust-tight] [explosion-proof] enclosure.] Provide dust controlling covers and inlet and discharge enclosures for each conveyor.

2.30.2 Belt Conveyor

Belt conveyor must be of the trough type, as shown. Maximum incline of the belt conveyor must not exceed 15 degrees. Provide conveyor support frame with sufficient rigidity to maintain belt alignment, at least 75 mm 3 inches clearance to prevent damage to the edge of the belt on its return run, and adjustments for aligning shafts. Place decking to protect the return belt from coal sifting and to provide lateral stiffness on top of the stringers. Make idlers accurately to provide a rigid framework that will maintain permanent alignment of well balanced, smooth-running, easy turning idler rolls. All idlers and return rolls must be CEMA Belt Book, Series C5. Provide pressure lubrication to ball or roller bearings. Space 20-degree or 35-degree three-roll type idlers on 1.2 m 4 foot centers, except under loading points and skirts. Spce return idlers on 3 m 10 foot centers. Provide Grade 2 belting as defined in RMA IP-1. The belting must have field-vulcanized splices. Design pulleys in accordance with CEMA B105.1, of heavy welded steel, true to diameter and accurately bored, key seated and tightly fitted to the shafts. Pulley face width for belts 1067 mm 42-inches wide and smaller, that are 150 m 500 feet or more in length, must be belt width plus 100 mm 4 inches; less than 150 m 500 feet in length, must be belt width plus 75 mm 3 inches. Pulley face width for belts 1.2 m 48 inches and larger must be belt width plus 150 mm 6 inches. Provide drive pulleys with 19 mm 3/4 inch thick vulcanized and grooved lagging. Provide snub pulleys with 9.5 mm 3/8 inch vulcanized smooth lagging. Support all conveyor pulley shaft assemblies by two heavy-duty antifriction bearings having a minimum life expectancy of 50,000 hours for 90 percent of bearings in accordance with ABMA 11 for roller bearings. The pulley diameter must be sufficiently large to meet the requirements of the duck weight and ply of the belt to permit flexing of the belt around the pulley circumference without damaging the belt or shortening the belt life. Drive conveyor by a [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in Class II, Division 1, Group F hazardous location in conformance with NFPA 70] electric motor connected to a drive-shaft-mounted speed reducer unit by a [roller chain drive] [V-belt drive] [flexible coupling]. [The motor starter must be [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [general-purpose] [weather-resistant] [watertight] [dust-tight] [explosion-proof] enclosure.] Provide all belt conveyors with belt misalignment switches, emergency stop pull cords and pull switches, galvanized expanded metal shields over tail pulley, zero speed switches, loading skirts, plugged chute switches, walkways, supports, belt take-ups, belt cleaners, skirt boards, and pulley scrapers. Provide dust controlling covers and inlet and discharge enclosures for each conveyor.

2.30.3 Flight Conveyor

[Scraper] [Shoe-suspended] flight conveyor arranged generally as shown and of the single-strand type must have capacity no less than [_____] metric tons/hour tons/hour when handling coal with approximate weight of 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches diameter. Base capacity on a maximum speed of 0.508 m/sec 100 fpm with conveyor operating up a [_____] degree incline. Chain must be drop-forged steel type with flights made of either steel or malleable-iron, spaced at least three times the largest lump size. Foot shaft must have protected screw take-up with adjustment of no less than 300 mm 12 inches. Make trough of 4.8 mm 3/16 inch steel plate, minimum. Line all sliding surfaces in contact with the chain or flights with 19 mm 3/4 inch thick, removable, ultra high molecular weight polyethylene liners. Provide both sides of trough with a warning sign "DANGER - DO NOT WELD - FLAMMABLE PLASTIC LINER." Make signs visible on each floor level and at frequent intervals. Provide conveyor with discharge openings as indicated. Provide each with rack-and-pinion-operated gates with handwheels. Motor must drive conveyor through a speed reduction unit which is either direct-connected or roller-chain-connected to the drive shaft. Motor must be [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Motor starter must be [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Construct conveyor frame essentially as indicated, with additional bracing as required for rigidity. Provide dust controlling covers and inlet and discharge enclosures for each conveyor.

2.30.4 Bucket Elevators

Furnish dust tight vertical bucket elevators complete with continuous chain and attached buckets, upper and lower sprockets, gears, shafts, bearings, casing with flanged connections including top hood and discharge spout, bottom boot, access doors, electric motor drive, and all accessories. Bucket elevators must be [vertical spaced centrifugal discharge] [positive discharge] [continuous bucket type]. The capacity of the elevator must be no less than [_____] metric tons/hour tons/hour when handling coal weighing approximately 800 kg/cubic meter 50 pcf. Linear velocity must be as indicated below:

Type of Bucket Elevator	Linear Velocity (meters per second)
Centrifugal discharge	1.1-1.6225-305
Continuous bucket	0.508-0.686100-135
Positive discharge	0.610 120 Max

Construct head shaft and foot shaft of cold-rolled steel with the shaft diameters in accordance with manufacturers' standards. Mount both shafts in roller bearings with forced-type lubricating fittings. Foot shaft must have screw take-up with adjustment of no less than 225 mm 9 inches. Install an automatic backstop on the head shaft to prevent any backward motion of the chain. Boot plates [, loading legs of continuous bucket elevator,] and bottom plate of stub discharge chute must be 4.8 mm 3/16 inch thick, minimum. All other flat casing members must be 2.657 mm 12 gauge steel thick, minimum. Provide corner angles and stiffeners to make the elevator self-supporting. In addition, tie the elevator to the adjoining structure at close enough spacing to increase the rigidity of the elevator. Provide boot section with clean-out doors, as well as front and back removable panels. Provide an inspection door large enough to remove a bucket from either run of the chain in the intermediate section at operating level. Drive elevator by an electric motor installed in a suitable housing at the top of the flight. Motors must be [totally enclosed, nonventilated] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Motor starter must be [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [general-purpose] [weather resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.] Install a platform adjacent to the motor for servicing the motor and equipment mounted in the hood. Provide access to the platform by an approved type of safety ladder. Locate controls for the operation of the elevator as indicated. Provide dust control covers and inlet and discharge enclosures for each conveyor.

2.30.5 Vibrating Conveyor

Vibrating conveyor must be the electric-motor driven mechanical vibrating type with a capacity of [_____] metric tons/hour tons/hour when handling coal weighing approximately 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches in diameter. Conveyor must have a conveying length as shown. Fabricate conveyor trough of [_____] mm gauge steel, [_____] mm inches in width and [_____] mm inches deep [and provide with dust-tight cover]. Provide conveyor pans of 9.5 mm 3/8 inch thick, Type 304L solid stainless steel plate. Mount trough on vibrator bars, torsion bars, or coil springs attached to yoker legs of rigid cross brace construction and fabricate of corrosion-resistant material with hardened steel encased rubber bushings at articulation points. Fabricate base of steel channels or angles bolted directly to [building support] [concrete foundations]. The drive must be through an eccentric shaft supported by a double row of self-aligning ball-or roller-bearing pillow blocks. Impart positive action motion to the trough by a cast steel connecting rod attached to the trough by rubber-bushed wristpin and securely locked by taper lock bushings. Drive conveyor by a [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type suitable for installation in Class II, Division 1, Group F hazardous location in accordance with NFPA 70] electric motor connected to the eccentric shaft by V-belt drive. [The motor starter must be [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [general-purpose] [weather-resistant] [water-tight] [dust-tight] [explosion-proof] enclosure.]

2.30.6 Gravimetric Weigh Feeder

The weigh feeder must be a metering belt type device designed to operate at a variable rate ranging from 10 percent of maximum capacity to [_____] metric tons/hour tons/hour. Flow rate must be automatic. Use a silicon-controlled, rectifier dc drive to automatically adjust the belt speed to maintain the rate of material flow, as set on the controller. Provide weigh feeders meeting or exceeding the requirements of NIST HB 44 [Southern] [Eastern] [Western] Weighing and Inspection Bureau. They must have an accuracy of 1/2 of 1 percent of flow rates over their total variable rated capacity. Provide feeder with a flexible boot for connecting the gate to the feeder inlet chute, which in turn must be flared to produce a feed opening tapering from [_____] wide to [_____] wide with the direction of flow of material. Use belts for feeders that meet RMA IP-1 requirements, conforming to the Conveyor and Elevator Belt Handbook, fire-resistant type conforming to the standards of Part 18.65, of the 30 CFR 1. Top belt cover thickness must be 6.4 mm 1/4 inch with bottom cover 3.2 mm 1/8 inch thick. Belt edges must have minimum 25 mm 1 inch flanges and seal by carrying the cover around the carcass edges during manufacture. Provide cover and skim coat material comparable to those meeting the requirements of the RMA IP-1 for impact and abrasion resistance. The weight sensor must be a heavy-duty, industrial, electronic force transducer flexure-mounted to the force collection system. Provide each sensor with a remote indicating meter and a six-digit totalizing counter located, installed, and connected in the boiler control panel. Use unit frame to provide rigid support for the material load, belt, and idlers. Provide shop assembled unit complete with drive and all appurtenances, which is dust-tight in operation.

2.30.7 Track Hoppers

Provide track hoppers that are standard double hopper design with a belt or vibrating-type feeder as indicated. The hoppers must have a capacity of approximately [_____] metric tons tons and constructed of no less than 9.5 mm 3/8 inch thick, Type 304L stainless steel plates, with slopes no less than 55 degrees, and stiffened with angles. The hoppers may also be of ASTM A36/A36M mild steel, minimum 6.4 mm 1/4 inch thick with replaceable liners 6.4 mm 1/4 inch thick, ASTM A167, Type 304L stainless steel. Use flat head rivets and field bolts inside the hopper. Suspend hopper from the track girders by heavy bolts and cast washers, or carry the sides to the bottom of the track and support by flanges fastened to concrete ledge continuously around the hopper with the concrete forming the top portion of hopper sides. Provide track girders consisting of wide flange beams conforming to the AREMA Eng Man for loading plus impact, complete with bearing plates, WF cross struts, and rail clips. Fit top of hopper with properly sized sections of grating made with steel bars sized [_____] by [_____] mm inches, and cross rods [_____] mm inches in diameter, to form openings [_____] mm inches square.

2.30.7.1 Hopper Gates

Provide a self-cleaning rack-and-pinion gate at each hopper outlet. [Hand-] [Motor-] operated sliding plate must be 9.5 mm 3/8 inch thick carbon steel, formed into the shape of a winged U. Protect gate plate surface completely by an overlapping liner of 3.2 mm 1/8 inch thick ASTM A167, Type 304 stainless steel. The gate body material, except for the dust cover, must be of 4.5 mm 3/16 inch thick ASTM A167, Type 304L stainless steel where in contact with coal flow.

2.30.7.2 Hopper Feeders

Provide vibrating or belt feeders of manufacturer's standard design for the service required. Motor must be [totally enclosed, nonventilated] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Motor starter must be [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [weather-resistant] [dust-tight] [explosion-proof] enclosure.]

2.30.8 Truck Hoppers

Provide truck hoppers that are standard double hopper design with a belt or vibrating type feeder as indicated. The hoppers must have a capacity of approximately [_____] metric tons tons and constructed of 9.5 mm 3/8 inch thick Type 304L stainless steel plates, minimum, with slopes of at least 55 degrees, and stiffened with 6.4 mm 1/4 inch angles, minimum. The hopper may also be of ASTM A36/A36M mild steel, minimum 6.4 mm 1/4 inch thick, with replaceable liners 6.4 mm 1/4 inch thick, ASTM A167, Type 304L stainless steel. Use flat head rivets and field bolts inside the hopper. Support hopper by a flange fastened to the concrete ledge continuously around the hopper, with the concrete forming the top portion of hopper sides. Fit top of hopper with properly sized section of bar grating made with [_____] by [_____] mm inch mild steel bars and [_____] mm inch diameter cross rods to form openings [_____] mm inches square. Provide a supporting beam no less than [_____] mm inches deep, [_____] kg/meter pounds/foot, in a wide flange member, under the grating.

2.30.8.1 Hopper Gates

Provide a self-cleaning rack-and-pinion gate at each hopper outlet. [Hand-] [Motor-] operated sliding plate must be 9.5 mm 3/8 inch thick carbon steel, formed into the shape of a winged U. Protect gate plate surface completely by an overlapping liner of 3.2 mm 1/8 inch thick ASTM A167, Type 304 stainless steel. Provide gate body material, except for the dust cover, consisting of 4.5 mm 3/16 inch thick ASTM A167, Type 304L stainless steel where in contact with coal flow.

2.30.8.2 Hopper Feeders

Provide vibrating or belt feeders, complete with control of manufacturer's standard design for the service required. Motor must be [totally enclosed, nonventilated] [totally enclosed, fan-cooled] [totally enclosed, fan-cooled type, suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Motor starter must be [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [weather-resistant] [dust-tight] [explosion-proof] enclosure.]

2.30.9 Vibrator

Provide electromagnetic type vibrator with variable power control that produces mechanical pulsating motion. The net weight of the vibrator must be [_____] kg pounds and power input must be [_____] watts, [_____] amperes at [_____] volts ac. Provide 3600 vibrations per minute or 7200 vibrations for heavy duty applications. Provide semi-noiseless vibrator with mounting plates for welding to hoppers, as indicated, each complete with an eye bolt for attaching a safety chain. Provide electric control suitable for separate wall mounting complete with an electronic valve for changing alternating current to mechanical pulsating waves and a dial switch or rheostat to vary the power of vibration. Provide vibrators with Division I, Class II, Group F rating in the areas where coal dust is present, in accordance with NFPA 70.

2.30.10 Car Heaters

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NOTE: The designer will determine if electrical facilities are sufficient to provide the power

requirements of electric car heaters or if gas-fired heaters must be used. The designer will determine if the location and climatic conditions will require sidecar panels or undercar heaters, or a combination of both types of heaters.

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2.30.10.1 Gas-Fired Heaters

Provide infrared radiant type gas-fired heaters located between rails and along the walls of the shed. Heater must have an input of approximately 90 kW 300,000 Btuh. Provide heater with perforated, heavy-gauge stainless steel cover that is not affected by water or coal falling from the car. Provide burner with windproof pilot, main gas solenoid valve, and safety switch to interrupt gas supply to burner if pilot is not burning, and furnish with manual cutoff valves and pressure regulator. Supply heater with electric blower for furnishing combustion air to the burner and with all other controls and accessories as recommended by the heater manufacturer for a complete installation, and in compliance with ANSI Z83.19/CSA 2.35 and UL 795.

2.30.10.2 Electric Infrared Radiant Heaters

Electric infrared radiant heaters must be weatherproof car thawing equipment with radiating surfaces of alloy tubing enclosing electrically insulated conductors. Provide equipment in modular lengths suitable for both 45 and 90 metric tons 50 and 100 tons capacity cars and designed for [manual] [automatic] disconnection of units not required during thawing operations. Include sidecar or undercar heating banks, or both, capable of operating as independent units designed for maintaining a balanced three-phase distribution system. Provide heating conductor units, including factory assembled connections for attachment to water-tight terminal boxes, supported on corrosion-resistant metal framing and have rust-resistant steel reflectors with an approved coating. Wire heaters and connections using NEMA 4 enclosures, in accordance with NEMA ICS 1, suitable for cleaning by hosing down with water.

2.30.11 Coal Spouts, Chutes, Inlet Boxes, and Outlet Hoppers

Construct coal spouts, chutes, inlet boxes, and outlet hoppers of ASTM A36/A36M steel members no lighter than 3.416 mm 10 gauge, adequately reinforced and braced with angle frames, and with all joints dust tight. Make slopes as steep as possible, but no less than 55 degrees off horizontal. Provide stainless steel or ultra-high molecular weight polyethylene (UHMWP) liners. If UHMWP liners are used, provide each side of chute at each floor level with a warning sign "DANGER DO NOT WELD - FLAMMABLE PLASTIC LINER." Also use impact liners. Provide access openings and inspection openings with cover plates as indicated and required. [Construct silo frames of heavy channel frames the full size of the silo opening and provide with concealed steam pipe and coil around opening.] [Provide outlet hoppers with rack-and-pinion type gates and line with austenitic stainless steel [_____] mm inches thick, conforming to ASTM A167, Type 304L]. Rack-and-pinion gates must be of the type specified for track hoppers.

2.30.12 Car Spotter

Provide electric-motor driven car spotter having a capstan mounted vertically on a rigid housing that completely encloses the gears. Include helical gears and worm gear; fabricate helical gears of high grade steel accurately finished and splash-lubricated, and fabricate worm gear of bronze. Mount all of the mechanism on a steel base rigidly welded to maintain alignment. Couple unit to, and drive by, a separate, [_____] W hp, totally enclosed, nonventilated, hoist-type motor with a full-load speed of 1720 rpm. Use a roller-chain flexible type coupling enclosed in a revolving casing and protect by a heavy steel guard. The unit must have a starting pull of 22 kN 5000 pounds, a running pull of 11 kN 2500 pounds, and an average rope speed not in excess of 230 mm/sec 45 fpm. Provide unit complete with [_____] m feet of [32 mm 1-1/4 inch diameter manila rope with a breaking strength of 60 kN 13,500 pounds, minimum,] [19 mm 3/4 inch diameter marline-covered standard steel wire rope with a breaking strength of 170 kN 37,600 pounds, minimum,] and a steel car pulling hook with an allowable rope pull of 45 kN 10,000 pounds, so fabricated as to be readily attachable to, and removable from, the car frames.

2.30.13 Coal Bunkers

Construct suspension coal bunkers of size and capacity indicated of ASTM A36/A36M steel plate reinforced and braced as required and install dust-tight. Provide bunkers designed for optimized coal flow, not susceptible to rat-holing or hangups. Provide cylindrical or silo type bunkers to reduce stagnation for each boiler, each with conical discharge hoppers and slopes no less than 70 degrees. Manufacture outlet cone of, or line with, ASTM A167, Type 304 stainless steel. Provide bunkers with rack and pinion type coal shutoff valves, self-cleaning, and dust tight. Valve materials exposed to flowing-coal must be of corrosion resistant steel. Provide an emergency diverter for emptying the bunker.

2.30.14 Coal Storage Silos

2.30.14.1 Silo Design

Silo walls may be slip-formed, cast-in-place reinforced concrete, precast concrete, or other approved construction materials. Concrete must have a 28-day compressive strength in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Silo roof must be reinforced concrete complete with 600 mm 24 inch square, weatherproof, hinged access door. Provide handrail and steel toe-board all around the roof of the silo. Live storage shelf for the silo must be reinforced concrete, sloped no less than 60 degrees from horizontal and supported by steel beams corbelled from the inside walls of the silo. Build live storage outlet hopper to chute and feeders of steel no lighter than 9.5 mm 3/8 inch. Silo reserve storage floor must be reinforced concrete, sloped no less than 60 degrees and laid on well-tamped fill material. Build reclaim outlet hopper to the chute feeding the flight feeder of steel no lighter than 9.5 mm 3/8 inch.

2.30.14.2 Silo Interior Finish

In a concrete stave silo, provide interior finish consisting of a three-coat concrete parget. Apply a brush coat, scratch coat, and a finish trowel coat, one after the other, to produce a smooth monolithic finish. Work parget into the vertical and horizontal grooves to permanently interlock the concrete staves.

2.30.14.3 Silo Exterior Finish

Cover exteriors of stave and concrete silos with a brush coat of gray cement. Apply this coating over all hoops, lugs, and staves to produce a homogeneous finish.

2.30.14.4 Silo Level Controls

Mount a normal high-level and emergency high-level control switch at the top of the silo to shut off the feeding system when the silo is full of coal. Furnish a low-level switch at the low level of the silo's live storage shelf, as indicated, to signal by light that coal is at a low level in the live storage compartment. Also furnish switches near the bottom of the silo, as indicated, to signal by light that coal is at a low level in the reserve storage compartment. Provide switches for Class II, Division 1, Group F hazardous location in accordance with NFPA 70.

2.30.15 Coal Crusher

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NOTE: The designer will select the appropriate type of crusher based on the throughput requirements and an economic analysis.

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Provide [roll crusher][hammermill][granulator][impactor] coal crusher designed to reduce run-of-mine or lump coal to a maximum lump size of [_____] mm inches. Crusher must have a minimum capacity of [_____] metric tons/hour tons/hour when handling average size bituminous coal. Make housings of heavy castings or welded heavy steel plate. Interior of the housing must have replaceable liners, constructed of abrasion resistant steel. Provide replaceable breaker plate, grates, rolling rings, swing hammers, and other parts of the unit subject to excessive wearing. Crusher must have provisions to trap and reject hard foreign objects without damaging the crusher. Provide shafts consisting of forged, heat-treated alloy steel with bearings mounted in dust-tight housings. Motor must be [totally enclosed, nonventilated type][totally enclosed, fan-cooled type][totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Motor starter must be [manual][[magnetic][across-the-line][reduced voltage start]] type with [general-purpose][weather-resistant][water-tight][dust-tight][explosion-proof] enclosure.] Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

2.30.16 Vibrating Feeders

Vibrating feeders must be the [electromagnetic][electromechanical] [single input (Brute Force)] type with a capacity of 0 to [_____] metric tons/hour tons/hour when handling coal weighing approximately 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches in diameter. Feeder pans and skirts must be replaceable [6.4][9.5][12.7] mm [1/4][3/8][1/2] inch thick, Type 304 solid stainless steel plate without liners. The feeder pan must be fabricated [_____] mm inches in width, [_____] mm inches in length and [_____] mm inches deep. Provide dust control covers of 3.416 mm No. 10 gauge thick steel for each unit. Provide [two][four] rectangular poke holes ([one][two] each side) with 6.4 mm 1/4 inch thick No. 304 stainless steel sliding covers. Make all feeder parts coming in contact with coal of, or line with, Type 304 stainless steel. Automatically compensate for material headloads and weight effect to maintain a constant feed and must not damper out when operating under full silos or bins. Slopes on pan must not exceed 10 degrees. The vibratory feeders must be [foot][suspension] mounted and completed with supports. Provide suspended feeders with safety cables. Locate feeder drives [above][below] trough.

The motors must be [totally enclosed, nonventilated type][totally enclosed, fan-cooled type suitable for installation in Class II, Division I, Group F hazardous location in accordance with NFPA 70]. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

2.30.17 Tripper

The tripper must be of steel construction, motor-propelled, automatically reversible, or manually controlled. Equip tripper with antifriction bearings throughout, rolled or forged steel wheels, hand-operated rail clamps for optional operation in a fixed location, scraper, and crossover walk with handrail. Do not exceed traversing speed of 127 mm/sec 25 fpm, and include a motor brake. Make chute one way toward the center of the silo and lope at no less than 55 degrees. Provide its seal with all necessary components for installation to suit the bunker/silo slot. Provide plow type seal. Provide tripper with [_____] W hp motor, all reversing and end travel limit switches, cable reel, and 14 No. 12 AWG conductor cable (13 slip rings) and supports for the starter. Mount two pushbutton stations, one on each side of the tripper. Include forward-reverse and tripper stop-run pushbuttons on both stations. Provide conveyor frame including a ladder type cable tray to contain the cable from the reel. Mount reversing switches on the tripper and actuate by track dogs to permit reversal of the tripper over each extreme silo. Mount limit switches on the tripper to operate immediately beyond both extreme limits of tripper reversal. Also furnish a plugged chute switch. Furnish all tripper controls, including limit switches and reversing switches in explosion-proof enclosures approved for Class II, Division 1, Group F service, in accordance with NFPA 70. Also include pulley assemblies, shafts, bearings, carrying and return idlers, tripper framing, and supports.

2.30.18 Trackmobile

Provide trackmobile with a [_____] liter cubic inch industrial gasoline engine for moving/switching [_____] rail cars on the track and hauling carts and other portable vehicles while traveling on its road wheels. Design trackmobile to ride on [_____] mm inch gauge track. Provide rail wheels that are heat treated, cast steel, keyed on tapered axles, solidly mounted suspension system. Provide road wheels that are, heavy duty, [_____] ply, [_____] by [_____] tires, roller-bearing mounted wheels, with retractable suspension. The coupler must be heavy-duty, cast steel, remotely controlled from cab. Maximum speed must be provided on rail km/hour mph low [_____], high [_____]; on road, low [_____], high [_____]. Operate trackmobile on a maximum grade of [_____] percent and minimum curve of [_____] m foot radius. Equip trackmobile with [air brakes] [self-energizing drum and shoe type, hydraulic service], cab heater and defroster, sanders, [electric horn] [air horn] strobe light, front and rear lights, backup alarm, [enclosed cab] [open cab] with windshield wipers [, radio remote control,] and power steering.

2.30.19 En-Masse Chain Conveyors

These conveyors must move materials horizontally and/or vertically, with multiple discharge points and in a dust-tight and completely enclosed unit. Conveyors must have a length as shown but not to exceed 75 m 250 feet. Conveyor capacity must be [_____] metric tons/hour tons/hour when handling coal with approximate weight of 800 kg/cubic meter 50 pcf and with maximum lump size of [_____] mm inches diameter. Base maximum capacity on a chain speed not to exceed 813 mm/second 160 fpm. Chain must be drop-forged, case hardened, steel alloy of the single-strand type with flights welded to the chain links or integral chain and flights type. The hardness of the links must be 500-600 BHN. The conveyor casing must be dust tight and of 6.4 mm 1/4 inch thick ASTM A242/A242M high strength, low alloy steel with 3.416 mm No. 10 gauge cover of the same material. Provide casing with T-1 steel (ASTM A514/A514M Type B) removable liners. The liners must be 19 mm 3/4 inch thick on the bottom and 13 mm 1/2 inch thick on the sides. Provide 19 mm 3/4 inch T-1 steel wear bars for the empty run of the conveyor. Attach liners and wear bars to the casing using countersunk stainless steel bolts with stainless steel nuts and washers. Drive sprocket must be heat treated, induction hardened to a minimum depth of 6.4 mm 1/4 inch. Drive shaft must be heat treated, designed, and sized based on ANSI/AGMA 6113 AGMA 6013 requirements. Use spherical double roller bearings. Provide a dust seal where the drive shaft ends go through the casing. Provide inlet and outlet spouts, inspection doors giving access to the drive sprocket, cleaner, and wear surfaces. Chain tension is achieved by a screw take-up. Provide each discharge opening with rack-and-pinion-operated gates with [hand wheels][motor operated][air operated]. Motor must drive conveyor through a speed reduction unit which is either direct connected or roller chain connected to the drive shaft. Motor must be [totally enclosed, nonventilated type][totally enclosed, fan cooled type][totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Motor starter must be [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [general-purpose][weather resistant] [water-tight][dust-tight][explosion-proof] enclosure.] Conveyor frame must be constructed essentially as indicated, with support and additional bracing as required for rigidity. Integral size motors must be the premium efficiency type in accordance with NEMA MG 1.

2.31 ASH HANDLING SYSTEM

2.31.1 Boiler Room Ash Handling System

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NOTE: When specifying boilers with capacity of 4.1 MW 14,000,000 Btuh per boiler or less, this paragraph and subsequent paragraphs will be deleted, except applicable portions.

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The ash handling system must be the dry pneumatic type in stoker fired boilers. Gather ash from the boiler forward ash discharge grate hopper and from [economizer] [air preheater] ash discharge hopper and other filtration systems and discharge to the ash storage silo located outside of the building. Coordinate entire system to fit the equipment supplied. Use ash dust control conditioners to reduce fugitive dust emissions during discharge of ash from the storage silo.

2.31.1.1 Ash Hopper

Construct ash removal hopper for each boiler of 6.4 mm 1/4 inch thick steel plate, minimum, with suitable external structural steel supports for connection to boiler ash hopper and necessary internal anchors for holding refractory lining in place. Refractory lining must be 225 mm 9 inches thick on vertical walls and 150 mm 6 inches thick on feed plates. Furnish each hopper with a sliding ash gate. Provide each boiler sliding gate unit with an access compartment to allow gathering and cooling of ash. Provide a cast-iron grate along with a manually-operated air-tight inlet valve for feeding ash into the pneumatic gathering line. Provide a hinged, steel access gate at each compartment. Provide spring loaded air intakes at the end of each header. Base the structural integrity of the hopper on the ash weight of 1120 kg/cubic meter 70 pcf.

2.31.1.2 Clinker Grinder

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NOTE: Delete this paragraph if coal analysis indicates no possibility of slag formation.

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Provide clinker grinder unit with [_____] mm inch wide double roll for each hopper outlet gate housing. Provide grinders that have manganese steel rolls and cast-iron housings with grinder shafts mounted on outboard bearings protected by a stuffing box and gland assembly. Pass grinder shafts through stuffing boxes equipped with packing rings and lantern rings for seal water flow. Provide clinker grinder with a reversing mechanism to reverse direction of the grinder rolls should an obstruction stall the grinder. Furnish a 9.5 mm 3/8 inch steel plate ejector feed hopper below each clinker grinder to feed the inlet of the pneumatic ash gathering system. Provide fixed passages in the clinker grinders to prevent discharge of particles too large to be handled by the pneumatic conveying system. Drive each clinker grinder by a totally enclosed type motor and provide with a reversing starter, pressure switch for seal water control, diaphragm-operated seal water valve, and a solenoid valve. Design units for the characteristics of the coal specified that are capable of handling bottom ash at a rate exceeding the conveying system capacity.

2.31.1.3 Conveyor Piping

Make conveyor pipe and fittings of an abrasive-resisting alloy metal cast by the sand-spun process, having a minimum Brinell hardness of 280. Wall thickness less than 13 mm 1/2 inch is not acceptable, and do not exceed pipe lengths of 5.5 m 18 feet. Make joints with flanges or sleeve pipe couplings and make airtight. Provide fittings with a Brinell hardness number of approximately 400 and provide with removable wearbacks, where applicable, or provide the integral wearback type. Design ash inlet fittings so that the ash cannot overload or clog the conveyor pipeline. Provide suitable adjustable supports or hangers. Provide vacuum hose connections as indicated. Provide 4.6 meters 15 foot lengths of vacuum hose with quick connectors and four floor sweep-up nozzles.

2.31.1.4 Vacuum and Combination Vacuum/Pressure Systems

2.31.1.4.1 Vacuum System

Provide pneumatic suction type ash conveying equipment, complete with vacuum pumps and all component parts necessary for complete and successful operation. Size ash conveying equipment approximately twice the predicted accumulation rate. Provide system with the capacity to convey and empty no less than [_____] metric tons/hour tons/hour of ash weighing approximately [_____] kg/cubic meter pcf. Base tonnage on average handling rate and not on the instantaneous rate.

2.31.1.4.2 Combination Vacuum/Pressure Systems

Provide commercially produced vacuum/pressure equipment for this particular type of service and include a pressure vessel equipped with a filter section at the top and an aeration ring at the bottom. Draw material into the unit by vacuum, with the air separated from the material in the top filter section and exhausted through a silencer. A high level indicator within the vessel must then reverse the action of the vacuum/pressure pump by aspirating air through a silencer and filter unit and discharging the pressurized air into the vessel. Utilize part of the air to clean the filter and pass part of the air through the aeration ring of the vessel to pick up material and convey it under pressure to the storage silo. Furnish unit complete with all automatic air control valves to control air flow to and from the vessel continuously through the two modes of the operating cycle. Control unit operation automatically until switched off at the control cabinet. Skid-mount all automatic valves, interconnecting piping, and the vacuum/pressure vessel. Mount vacuum/pressure pump separately. The control cabinet may be mounted separately or skid-mounted on the vacuum/pressure vessel skid. Capacity of the unit must be approximately [_____] metric tons/hour tons/hour of ash weighing approximately [_____] kg/cubic meter pcf. Design piping sizes for ash collection system to fit the unit supplied. Use vacuum/pressure system where storage silo is more than 150 m 500 feet from the boiler plant. A vacuum system should be used for capacities of less than 45 metric tons/hour 50 tons/hour per system.

2.31.1.4.3 Pump Unit

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NOTE: Where characteristics of the fly ash require additional treatment, incorporate a water spray in the filtering unit. If not required, delete the portion included in the brackets. Air discharged to the atmosphere must meet the local air pollution standards.

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Size vacuum or vacuum/pressure pump unit to match system design requirements. Provide liquid-ring type pump unit having round rotor with curved blades rotating in an elliptical casing. Use water alternately entering and leaving the chambers within the rotor vanes to provide the required pumping action. Water within the casing must act as an air cleansing agent and the operation and maintenance of the unit must not be affected by dust-laden air. Base-mount unit with electric motor drive and all required heat exchangers, separators, and control valves. Provide vacuum pump inlet piping with a vacuum filter unit to remove the fly ash obtained from the economizer ash hopper. Include a metal housing containing filter bags and an automatic air purge back-washing system.[Incorporate a water spray into the filtering unit.] The filtering unit must remove all fly ash before discharge to the atmosphere.

2.31.1.4.4 Control Cabinet

Supply control cabinet for the complete operation of the system and include all running indicating lights as required. Locate a push-button switch conveniently in the boiler house to start and stop the system. Provide a vacuum breaker, operating automatically from a timer, in the bottom ash conveyor line to break the system vacuum.

2.31.1.4.5 Controls

Provide controls for a combination vacuum/pressure system with a selector switch set to automatic position to start the unit in the vacuum cycle. Provide high-level indicator in vacuum/pressure vessel to actuate necessary controls to cut off the vacuum gathering system and pressurize the vessel for pressure discharge of collected material. Provide a low-pressure switch in the control panel to sense the pressure drop in conveying pressure and to return the unit to vacuum operation. Operate unit continuously in this manner until manually shut down. Set selector switch in manual position to shut the unit down after filling. Then accomplish discharge by pressing the manual discharge button. Provide a high vacuum switch with time delay to shut the system down automatically in the event none of the inlet valves are actuated. Provide heavy-duty switches and controls in accordance with NEMA ICS 1.

2.31.1.4.6 Automatic Air Valve

Provide automatic air valve at economizer or air preheater ash inlet hopper discharge slide gate to allow air into system without causing a vacuum within the boiler ash hopper. Provide slide gate as part of the ash system that is manually-operated and interlocked to actuate the automatic air inlet valve.

2.31.1.5 Ash Silo

Provide ash storage silo with a capacity of no less than [_____] metric tons tons of ash and fly ash considered to have an average weight of [_____] kg/cubic meter pcf. Base this capacity on a minimum of 24 hours[60 hours if ash cannot be removed on weekends]. Make silo of welded steel with a cone bottom for truck filling and support on a structural steel tower. Design all elements exposed to the exterior for wind loads of [_____] kg/square meter psf. Provide a 4.3 m 14 foot clearance under the hopper outlet fitting or appurtenance. Provide silo with steel ladder and safety cage from the ground level to roof, steel ladder inside storage bin, and an angle railing around the roof perimeter. Provide minimum plate thickness of 6.4 mm 1/4 inch. Provide silo complete with all accessories required for an operable installation including, but not limited to, high ash level detector, roof manhole, pressure and relief valve, and other roof openings, as necessary. Interior coating must be coal-tar epoxy conforming to SSPC Paint 16.

a. Provide ash storage silo for vacuum system with two stage separators[and a tertiary bag filter]. The primary receiver must be cylindrical and constructed entirely of sectional steel or cast plates suitable for this special service. The receiver must be no less than 900 mm 3 feet in diameter. Locate flanges and bolts on the outside, and direct the impact of ash against heavy iron wear plates of abrasive-resistant alloy. Provide receiver with an air-tight discharge passage no less than 450 mm 18 inches in diameter for free flow of clinkers. Provide means for positive, periodic, and automatic operation in dumping its entire contents into the silo; in addition, design the system so that all suction is positively shut off from the receiver during its dumping period so that no dust can be sucked out through the exhaust while the discharge of the receiver is open or opening. The air from the primary receiver must enter an external secondary separator which must remove 90 percent of the dust not collected by the primary receiver. The combined efficiency of the primary and external secondary separators[and tertiary bag filter] must be no less than 98 percent. Provide secondary separator that is similar to the primary receiver in construction, but may be smaller and of lighter material. Do not extend part of the discharger into the main storage bin. Provide a housing constructed of 6.2 mm 1/4 inch steel plate with a tight-closing access door as an enclosure for the discharger.

b. Mount silo vent filter unit on top of the silo to act as an air release unit to separate the air from the ash. Drop ash into the silo. Back cleaning of the bag filters must be automatic, utilizing plant air at approximately 690 to 860 kPa 100 to 125 psig. Actuate back cleaning unit whenever the ash handling system is in use. Dust released from the filter bags in the back cleaning operation must fall into the storage silo. Provide housing to allow the unit to operate exposed to the weather in ambient temperatures ranging from minus 40 to plus 55 degrees C minus 40 to plus 130 degrees F.

c. Provide a rotary, dustless unloader to eliminate all dust in unloading ash and dust from the ash storage silo. Do not add water to the ashes in the conveyor or in the storage bin. Use dustless unloader to add water to the ash in controlled quantities so that no surplus water runs or drips from the ash after discharge. The discharged ash must be muddy but loose and free flowing. Open water valve only when drive motor is running. Provide unloader with a capacity of no less than 27 metric tons 30 tons of conditioned ash per hour. Design rotating unit so that all bearings are located on the outside and not in contact with the material handled. Provide platform for access to unit with a handrail and a safety ladder to grade. Motor must be totally enclosed type for outdoor operation. [Motor starter must be [manual][[magnetic][across-the-line][reduced voltage start]] type with [weather-resistant][water-tight][dust-tight] enclosure.]

2.31.1.6 Conveyor Type Ash Handling System

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NOTE: When specifying boilers with capacity greater than 4.1 Megawatts 14 million Btuh per boiler, the following paragraphs will be edited.

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Provide funnel shaped ash pits, constructed of 6.2 mm 1/4 inch steel plate, minimum, and covered with a heavy grating with openings approximately 50 mm 2 inches square. Discharge ashes and clinkers from the boiler ash hoppers into ash pits located directly below the ash hopper doors. Arrange a combination drag chain conveyor for horizontal conveying and an elevator conveyor for vertical conveying of ashes, as indicated, to take ashes from the bottom of the ash pits for discharge into the ash silo. Provide conveyors with a capacity of no less than [_____] metric tons/hour tons/hour when handling ashes weighing approximately [_____] kg/cubic meter pcf at a maximum speed of 508 mm/sec 100 fpm. Provide doors for access to all parts, as required. Motor must be [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Motor starter must be [manual][[magnetic] [across-the-line][reduced voltage start]] type with [general-purpose][weather-resistant][water-tight][dust-tight][explosion-proof] enclosure.]

2.31.1.6.1 Drag Chain Conveyor

Drag chain conveyor must be of a single strand of wide, heat treated, high alloy, drop forged, rivetless drag chain with a [_____] mm inch pitch, [_____] mm inch overall width, and [_____] kg pounds working strength, and a hardness of 460-510 Brinell. Using the upper strand of the chain, convey the ash in a trough constructed of 9.5 mm 3/8 inch cast-iron extending from [_____] mm inches in front of the foot shaft to [_____] mm inches behind the head shaft and set flush with the floor. Carry the return strand of chain in angle runways set flush with the trench floor. Drive drag chain conveyor by a [_____] mm inch pitch roller chain and [_____] mm inch pitch diameter, [_____] tooth sprocket on the drive shaft, and a [_____] mm inch pitch diameter, [_____] tooth sprocket on the elevator foot shaft.

2.31.1.6.2 Casing

Construct casing of 2.656 mm 12-gauge thick steel, minimum, with 9.5 mm 3/8 inch thick boot plates. Include a gear motor and steel roller chain complete with drive brackets, guards, and backstop in the head end drive. Equip elevator with head-end platform and ladder.

2.31.2 Ash Handling Controls

The ash handling system control panel must contain all necessary instrumentation, including selector switches, annunciators, push buttons, and ammeters required for monitoring and operation of the ash handling system. The panel must graphically display the system. In addition, the panel must contain all necessary timers, relays, and terminal blocks that are required for the control system. Control and monitor the ash removal system from a single panel. Provide panel with push buttons to start automatic operation of each system and also push buttons for individual control of each component. Provide panel with sufficient instrumentation to observe the removal operations and controls to permit effective emergency control. Also provide local control stations at each ash removal point for local manual operation. Provide local selector switches so that equipment may be operated manually for test and maintenance purposes. Control operation of the bottom ash system by a microprocessor-based control system, a solid-state programmable controller or an electromechanical system. All controls and instrumentation for location indoors must have NEMA 12 rating in accordance with NEMA ICS 1. All outdoor components must have NEMA 4 rating, in accordance with NEMA ICS 1. All major equipment components, including control panels and devices, must be factory-mounted, prewired, tubed, and tested to the maximum practical extent. Include controls for fully automatic and sequential operation of the ash handling system. Design these controls so that manual steps, such as continuous monitoring and regulation, will not be required. Incorporate suitable safety interlocks to assure that proper permissive conditions have been met prior to changing the operating status of major system components. Initiate shutdown of the ash handling system, or portion thereof, automatically with alarms, should unsafe conditions arise during operation of the system. Provide facilities for monitoring and control of the ash handling system for the following functions:

a. Manual start of the automatic control operations.

b. Selection of operating components.

c. Override of the automatic control sequences, both at the ash handling control panel and locally.

d. Manual operation, either remotely from the control center or locally.

e. Emergency shutdown on a unit or system basis.

f. Status monitoring at the ash handling control panel of the operation of the ash handling system and its components.

Operate automatic controls for bottom ash collection transport as specified. When a start command has been manually initiated, the automatic ash collection and transport sequences for the unit must progress through their complete cycles, and after completion of the cycles, automatically shut down the system. Include an annunciator system, complete with audio and visual alarms, as part of the ash handling control panel. The annunciator system must receive inputs from devices and system logic which indicate any out of specification or trip condition. Furnish recorders to provide a permanent record of selected variables that relate to the ash handling system's performance and operation. Supply control stations with analog control loops to provide bumpless transfer between the manual and automatic modes of operation. Use manual mode of operation to provide direct control of the end device with no intervening analog control components unless those components are powered by the same source as the end device.

2.31.3 Submerged Drag Chain Conveyor (SDCC)

Design submerged drag chain conveyor to extract ash at normal capacity [_____] metric tons/hour TPH and maximum capacity [_____] metric tons/hour TPH, based on a dry ash density of approximately [_____] kg/cubic meter pcf. The maximum chain speed must be 76 mm/second 15 fpm. Design SDCC for continuous operation and a storage capacity of [_____] cubic meter cu ft accumulation. The SDCC must have an upper compartment filled with water and a dry lower compartment. Provide equipment to maintain water temperature at approximately 60 degrees C 140 degrees F. The dewatering slope must be at an angle of [_____] degrees with the horizontal. The top trough must be no less than 9.5 mm 3/8 inch thick carbon steel plate, welded construction, lined with renewable abrasion resistant steel wear plates, with a minimum thickness of 13 mm 1/2 inch and 300 BHN. Grind all welds smooth. Provide necessary track guide angles, hold-down angles, and carbon steel chain protectors. The minimum depth of water in the upper trough must be [_____] m feet. Provide dry return chain bottom trough constructed of 9.5 mm 3/8 inch thick steel plate, stiffen and brace with structural shapes and make water-tight. Provide chain track angles with a minimum 13 mm 1/2 inch thick steel replaceable wear flats with a minimum 300 BHN. Also provide wear strips under the return flights, minimum 13 mm 1/2 inch thick and 50 mm 2 inch wide. The conveyor chain must be a double strand round-link or ship-type chain, case hardened, corrosion and abrasion resistant, chrome-nickle-alloy, annealed and carburized with surface hardness between 500-600 BHN. Base design strength and pitch on operating conditions. The conveyor flights must be [_____] mm inches deep by [_____] mm inches thick T-1 steel plates attached on both ends to the chain. Provide flight with top wear pads and bottom wear strips of abrasion resistant steel plate of 300 BHN minimum. Provide a chain tensioner at the tail end of SDCC for maintaining proper tension in both strands of the chain. The assembly must include cast-iron idler wheel, bearings, shaft, guide block and bearing housing. Idler assemblies for both troughs must include heavy duty spherical roller type bearings with external lubrication fittings. The chain drive assembly must include cast-iron wheels with removable, surface hardened, toothed segments, drive shaft, bearings. Drive conveyor by a hydrostatic drive unit coupled with a low speed, high torque hydraulic motor, built-in torque limiting valves for preventing damage to load train or electric motor. Provide speed regulation, self-lubrication, internal cooling, and dynamic braking with this drive. Provide inching capability. Provide hinged inspection doors, windows, and removable panels along the conveyor to permit access and observation at critical points. Provide all inspection doors, windows, and removable panels in mild steel with stainless steel hardware and must be made completely water-tight. Provide water cooling and drainage connections through flanged connections to the conveyor trough. Make provision for continuous water flow into the top trough of the conveyor including two overflow connections, one for normal level and one high level; including high level alarm and an overflow weir box to prevent drain clogging. Also provide chain cleaning spray.

2.31.4 Dense Phase Ash Handling

Provide pneumatic dense phase type ash conveying system, complete with transfer vessels, solenoid valves, air receiver tank, air producer, and ash conveying piping. Design ash handling system to handle [_____] metric tons/hour tons/hour of ash weighing approximately [_____] kg/cubic meter pcf. Bolt each transport vessel to the hopper discharge flange where ash flows into the vessel by gravity until a level indicator indicates the vessel is full. The transport vessel inlet valve then closes, and transport air between 175 to 350 kPa 25 to 50 psi enters the vessel through a fluidizing unit located at the bottom of the vessel. When the vessel has been brought to transport air pressure, the transport line valve opens and a "slug" of fly ash is transported to the storage silo. The transporting pipe must be Schedule 40 standard black iron pipe [_____] mm inches diameter. The material velocities in the transportation pipe must be [_____] meters/second fpm. Provide system with 210 to 410 kPa 30 to 60 psi compressed air to fluidize and transmit ash. Do not exceed conveying velocity of 5.1 meters/second 1000 fpm.

2.31.5 Fly Ash Collectors

Specify fly ash collectors as specified in Section 44 10 00 AIR POLLUTION CONTROL. Size fly ash collectors to handle total flue gas at maximum boiler load and stack temperature, and provide along with induced draft equipment. Coordinate fly ash collector requirements with boiler draft and control requirements.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 EARTHWORK

Perform excavation and backfilling for tanks and piping as specified in Section 31 00 00 EARTHWORK, except conform to the manufacturer's installation instructions for backfilling of fiberglass reinforced fuel tanks.

3.3 EQUIPMENT ERECTION

Install boiler and auxiliary equipment as indicated and in accordance with manufacturers' instructions. Submit detail drawings, consisting of schedules, performance charts, brochures, diagrams, drawings, and instructions necessary for installation of the steam-generating units and associated equipment. Include drawings for piping, pipe anchors, wiring devices, trenches and related foundations, and setting plans certified by the boiler manufacturer and burner manufacturer including coal and ash handling equipment. Indicate clearances required for maintenance and operation and also contain complete wiring and schematic diagrams, equipment layout and anchorage, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Include manufacturer's written instructions indicating optimum pressures at all manometer connectors.

3.4 STORAGE TANK INSTALLATION

Install storage tank in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.5 PIPING INSTALLATION

Cut pipe accurately to measurements established at the jobsite, install without cold springing, and properly clear windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Pipes must be free of burrs, oil, grease, and other foreign matter. Install pipes to permit free expansion and contraction without damaging building structure, pipe, joints, or hangers. Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Carbon steel piping to be bent must conform to ASTM A53/A53M, Grade A, standard, or Grade B extra-heavy weight. Carry vent pipes through the roof as directed and properly flash. Unless otherwise indicated, pitch horizontal supply mains down in the direction of flow, with a grade of no less than 25 mm in 12 m 1 inch in 40 feet. Properly cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified must be uncoated. Unless otherwise specified or shown, make connections to equipment with malleable-iron unions for steel pipe 65 mm 2-1/2 inches or less in diameter and with flanges for pipe 80 mm 3 inches or more in diameter. Use brass or bronze unions for copper pipe or tubing. Electrically isolate connections between ferrous piping and copper piping from each other with dielectric couplings or other approved methods. Use reducing fittings for changes in pipe sizes. In horizontal steam lines, use eccentric type reducing fittings to maintain the top of the lines at the same level.

3.5.1 Pipe Sleeves

Provide pipe passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Install a waterproofing clamping flange as indicated. Do not install sleeves in structural members except where indicated or approved. Provide all rectangular and square openings as detailed. Extend each sleeve through its specified wall, floor, or roof, and cut flush with each surface, except extend sleeves through floors and roofs above the top surface at least 150 mm 6 inches for proper flashing or finishing. Provide membrane clamping rings where membranes are penetrated. Unless otherwise indicated, size sleeves to provide a minimum clearance of 6 mm 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas must be galvanized steel pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe, or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls and floors as indicated and specified in Section 07 92 00 JOINT SEALANTS, and seal fire rated walls and floors as indicated and specified in Section 07 84 00 FIRESTOPPING. Provide metal jackets for insulated pipes passing through exterior walls, firewalls, fire partitions, floors, and roofs that are no thinner than 0.15 mm 0.006 inch thick aluminum if corrugated, and 0.41 mm 0.016 inch thick aluminum if smooth, and secure with aluminum or stainless steel bands no less than 9.5 mm 3/8 inch wide and no more than 200 mm 8 inches apart. Where penetrating roofs, before fitting the metal jacket into place, run a 13 mm 1/2 inch wide strip of sealant vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum of 900 mm 36 inches above the roof. If the pipe turns from vertical to horizontal, run the sealant strip to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, extend the metal jacket from a point below the backup material to a minimum distance of 50 mm 2 inches above the flashing. For other areas, extend the metal jacket from a point below the backup material to a point 300 mm 12 inches above floor; or when passing through walls above grade, extend jacket at least 100 mm 4 inches beyond each side of the wall.

3.5.1.1 Pipes Passing Through Waterproofing Membranes

In addition to the pipe sleeves referred to above, provide pipes passing through roof or floor waterproofing membrane with a 1.8 kg 4 poundlead flashing or a 448 g 16 ounce copper flashing, each within an integral skirt or flange. Suitably form flashing, and do not extend the skirt or flange no less than 200 mm 8 inches from the pipe and set over the roof or floor membrane in a troweled coating of bituminous cement. Extend flashing up the pipe a minimum of 250 mm 10 inches above the roof or floor. Seal annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation as indicated. Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a galvanized steel sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical-type sealing assembly may be installed. Provide seals consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Assemble links loosely with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolts to cause the rubber sealing elements to expand and provide a water-tight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.5.1.2 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by one of the following methods:

a. Standard roof coupling for threaded pipe up to 150 mm 6 inches in diameter.

b. Lead flashing sleeve for dry vents and turning the sleeve down into the pipe to form a waterproof joint.

c. A tack-welded or banded-metal rain shield around the pipe and sealing as indicated.

3.5.2 Pipe Joints

Use welded or flanged joints between sections of pipe and fittings. Except as otherwise specified, fittings 25 mm 1 inch and smaller must be threaded; fittings 32 mm 1-1/4 inches up to, but not including, 65 mm 2-1/2 inches may be either threaded or welded; and fittings 65 mm 2-1/2 inches and larger must be either flanged or welded. Use welded pipe and fittings 32 mm 1-1/4 inches and larger installed in inaccessible conduits or trenches beneath concrete floor slabs. Make connections to equipment with black malleable-iron unions for pipe 50 mm 2 inches or smaller in diameter, and with flanges for pipe 65 mm 2-1/2 inches or larger in diameter.

3.5.2.1 Threaded Joints

Make threaded joints with tapered threads properly cut and make perfectly tight with a stiff mixture of graphite and oil, or polytetrafluoroethylene tape or equal, applied to the male threads only, and in no case to the fittings.

3.5.2.2 Welded Joints

Provide fusion welded joints in accordance with ASME B31.1, unless otherwise required. Make changes in direction of piping with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Forge, flare branch outlet fittings, where used, for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.

3.5.2.2.1 Beveling

Provide field and shop bevels in accordance with the recognized standards and must be done by mechanical means or flame cutting. Where beveling is done by flame cutting, claen surfaces of scale and oxidation before welding.

3.5.2.2.2 Alignment

Align parts to be welded so that no strain is placed on the weld when finally positioned. Align height so that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Flanges and branches must be set true. Preserve this alignment during the welding operation. Provide tack welds of the same quality and make by the same procedure as the completed weld; otherwise, remove tack welds during the final welding operation.

3.5.2.2.3 Erection

Where the temperature of the component parts being welded reaches 0 degrees C 32 degrees F or lower, heat the material to approximately 38 degrees C 100 degrees F for a distance of 900 mm 3 feet on each side of the weld before welding, and finish the weld before the materials cool to 0 degrees

C 32 degrees F.

3.5.2.2.4 Defective Welding

Remove and replace defective welds. Repair defective welds in accordance with ASME B31.1.

3.5.2.2.5 Electrodes

After filler metal has been removed from its original package, protect or store it so that its characteristics or welding properties are not affected. Do not use electrodes that have been wetted or that have lost any of their coating.

3.5.2.3 Flanges and Unions

Flanges and unions must be faced true and made square and tight. Provide gaskets consisting of nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, full face or self-centering flat ring type. Ensure gaskets contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Use NBR binder for hydrocarbon service. Provide union or flange joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance, such as coils, pumps, control valves, and other similar items.

3.5.3 Supports

3.5.3.1 General

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NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 23 kg 50 pounds must have the excess hanger loads suspended from panel points.

****

Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Supportall piping subjected to vertical movement when operating temperatures exceed ambient temperatures by variable spring hangers and supports or by constant support hangers. [Pipe hanger loads suspended from steel joist between panel points must not exceed 23 kg 50 pounds. Suspend loads exceeding 23 kg 50 pounds from panel points.]

3.5.3.2 Seismic Requirements

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NOTE: Provide seismic requirements if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not included. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

****

Seismic Requirements for Pipe Supports and Structural Bracing: Support and brace all piping and attached valves to resist seismic loads as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS[as shown.] Provide structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, as specified under this section. Provide material used for supports as specified under Section 05 12 00 STRUCTURAL STEEL.

3.5.3.3 Structural Attachments

Provide structural steel brackets required to support piping, headers, and equipment, but not shown, as specified under this section. Provide material used for supports as specified under Section 05 12 00 STRUCTURAL STEEL.

3.5.4 Anchors

Provide anchors wherever necessary or indicated to localize expansion or prevent undue strain on piping. Provide anchors consisting of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results, using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.5.5 Pipe Expansion

3.5.5.1 Expansion Loops

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NOTE: Wherever possible, provision for expansion of steam supply and return pipes will be made by changes in the direction of the run of the pipe or by field-fabricated expansion bends.

****

Use expansion loops to provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loop must be cold-sprung and installed where indicated. Provide pipe guides as indicated. Except where otherwise indicated, utilize expansion loops and bends to absorb and compensate for expansion and contraction instead of expansion joints.

3.5.5.2 Expansion Joints

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NOTE: If expansion joints are not required, this paragraphs will be deleted. Where space limitations prevent such provisions for expansion, expansion joints will be installed, and blanks will be filled as appropriate.

****

Use expansion joints to provide for either single or double slip of the connected pipes, as required and indicated. Make initial setting in accordance with the manufacturer's recommendations to allow for ambient temperature at time of installation. Install pipe alignment guides as recommended by the joint manufacturer, but in any case no more than 1.5 m 5 feet from expansion joint, except in lines 100 mm 4 inches or smaller install guides no more than 600 mm 2 feet from the joint.

3.5.6 Valves

Install gate or globe valves with stems horizontal or upright. Install swing check valves in horizontal piping with the cap or bonnet up, or in vertical piping with the flow upward. Install lift or piston check valves in horizontal piping with the cap or bonnet up.

3.6 BURIED PIPING INSTALLATION

3.6.1 Protective Coating for Underground Steel Pipe

Give all steel pipe installed underground a protective covering, mechanically applied in a factory or field plant especially equipped for the purpose. Specials and other fittings which cannot be coated and wrapped mechanically must have the protective covering applied by hand, preferably at the plant, applying the covering to the pipe. Do not field apply coatings until the piping has satisfactorily passed the leak or hydrostatic test. Coat and wrap all field joints by hand. Perform all hand coating and wrapping in a manner and with materials that will produce a covering equal in effectiveness to that of the mechanically-applied covering.

3.6.2 Cleaning of Surfaces to be Coated

Solvent-wash steel surfaces to assure an oil-and-grease-free surface and blast-cleaned to bare metal as specified in SSPC SP 6/NACE No.3. Clean areas that cannot be cleaned by blasting to bare metal by powered wire brushing or other mechanical means. Ensure air supply for blasting is free from oil and moisture. Following cleaning, wipe surfaces with coal-tar solvent naphtha and allow to dry. The surfaces to be coated must be free of all mill scale and foreign matter such as rust, dirt, grease, oil, and other deleterious substances. Coat surfaces as soon as practicable after the cleaning operation.

3.6.3 Coating Materials

Coat buried steel piping with one of the following methods:

3.6.3.1 Bituminous Pipe Coating

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NOTE: If coating system similar to coal tar coating and wrapping is required using different materials, rewrite this paragraph. If double wrap system is required, the designer will remove the brackets.

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Provide bituminous protective system that is a coal-tar enamel and primer coating system, consisting of a coal-tar priming coat, a coal-tar enamel coat, a wrapper of coal tar saturated felt, and a wrapper of kraft paper, or a coat of water-resistant whitewash, applied in the order named and conforming to the requirements of AWWA C203 in all respects as to materials, methods of application, tests, and handling, except do not apply an interior lining.[In addition, where excessively corrosive soils are encountered, give the piping a second coating of coal-tar enamel and a second wrapper of felt.] Coat and wrap joints and fittings.

3.6.3.2 Polyethylene Pipe Coating

Continuous extruded polyethylene coating and adhesive undercoat application procedure, including surface preparation, must be a factory-applied system conforming to NACE SP0185, Type A. Tape-wrap joints, valves, flanges, and other irregular surfaces as outlined under the tape-wrapping system, except apply the tape half-lapped, and prime all extruded polyethylene coating and adhesive undercoat surfaces to be tape-wrapped with a compatible primer before application of tape. Use primer as recommended by the tape manufacturer and approved by the applicator of the extruded polyethylene coating. Repair damaged areas of extruded polyethylene coating by tape-wrapping as described under the tape-wrapping system, except press any residual material from the extruded polyethylene coating into the break or trim off. Prime all areas to be taped and apply the tape half-lapped.

3.6.3.3 Tape-Wrap Pipe Coating

Prime cleaned surfaces before applying tape as recommended by the manufacturer of the tape. Provide tape which is an approved, pressure-sensitive, organic plastic tape with a minimum nominal thickness of 0.51 mm 0.020 inch. The tape must conform to ASTM G21 for fungus resistance. Apply tape to clean, dry, grease-free, and dust-free surfaces only. Weld beads must be wire-brushed. Remove all burrs and weld spatter. Cover weld beads with one wrap of tape before spiral wrapping. At each end of straight runs, apply a double wrap of one full width of tape at right angles to the axis of the spiral wrapping. Remove kraft paper protective wrapping, if any, from the pipe before the tape is applied. For material which is wrapped before it is placed in its final position, protect the wrapping at sling points with roofing felt or other approved heavy shielding material, or handle with canvas slings. Repair damaged wrapping as specified. Wrap pipe in straight runs spirally, half-lapping the tape as it is applied. For pipe smaller than 100 mm 4 inches, use one layer half-lapped. For pipe 100 mm 4 inches and larger, use two layers half-lapped with the second layer wrapped opposite-hand to the first. Wrap joints, coupling fittings, and similar units, and damaged areas of wrapping, spirally beginning with one complete wrap 75 mm 3 inches back from each edge of the corresponding size of straight pipe. On irregular surfaces such as valves and other accessories, apply one layer half-lapped and stretched sufficiently to conform to the surface, followed by a second layer half-lapped and applied with tension as it comes off the roll.

3.6.3.4 Epoxy Coating System

Provide epoxy coating system conforming to AWWA C213, Type II. Fittings, valves, and joints must be factory coated with materials identical to those used on the pipe, or may be field coated with a two-part epoxy system recommended by the manufacturer of the pipe coating system. Field protection may also be provided for joints and fittings with a coal tar tape hot-applied over a compatible primer.

3.6.3.5 Coating Inspection and Testing

After field coating of the pipe joints, inspect the entire pipe with an electric holiday detector having an operating crest voltage of from 12,000 to 15,000 volts when using a full-ring, spring-type coil electrode. Equip holiday detector with a bell, buzzer, or other audible signal which operates when a holiday is detected. Repair all detected holidays in the protective covering. Occasional checks of holiday detector potential will be made by the Contracting Officer to determine suitability of the detector. Perform inspection for holidays just before covering the pipe with backfill and take every precaution during backfill to prevent damage to the protective covering. Furnish equipment and labor necessary for inspection.

3.6.4 Installing Buried Piping

Handle pipe and accessories carefully to assure a sound, undamaged condition. Take care not to damage coating when lowering pipe into a trench and when backfilling. Install nonmetallic pipe in accordance with pipe manufacturer's instructions. Lay underground pipelines with a minimum pitch of 25 mm per 15 m 1 inch per 50 feet. Horizontal sections must have a minimum coverage of 450 mm 18 inches. Piping must be free of traps and drain toward tank. Rest full length of each section of underground pipe solidly on the pipe bed. Make piping connections to equipment as indicated, or as required, by the equipment manufacturer. Make tank connections with two elbow swing joints [or flexible connectors] to allow for differential settlement. Clean interior of the pipe thoroughly of all foreign matter before being lowered into the trench and keep clean during installation. Do not lay pipe in water or when the trench or weather conditions are unsuitable. When work is not in progress, securely close open ends of pipe and fittings so that water, earth, or other substances cannot enter the pipe or fittings. Replace any pipe, fittings, or appurtenances found defective after installation. Make threaded joints with tapered threads and make perfectly tight with joint compound applied to the male threads only. This requirement does not apply for the gauging hatch or similar connections directly over the tank where the line terminates in a fitting within a cast-iron manhole designed to allow for differential setting. Where steel piping is to be anchored, weld the pipe to the structural steel member of the anchor and patch the abraded area with protective coating or covering as specified. Fit piping passing through concrete or masonry construction with sleeves. Make each sleeve sufficient length to pass through the entire thickness of the associated structural member and large enough to provide a minimum clear distance of 13 mm 1/2 inch between the pipe and sleeve, except where otherwise indicated. Sleeves through concrete may be 0.912 mm 20 gauge metal, fiber, or other approved material. Locate sleeves accurately on center with the piping and fasten securely in place. Caulk and fill space between the sleeves and the pipe with bituminous plastic cement or mechanical caulking units designed for such use.

3.6.5 Fiberglass Reinforced Plastic (FRP) Pipe

Field assemble pipe in conformance with the manufacturer's written instructions and installation procedures. Several pipe joints having interference-fit type couplings may be field-bonded and cured simultaneously. However, do not move pipe nor make additional joints until the previously laid joints are completely cured. Fit joints not having interference-fit type couplings with a clamp which holds the joint rigidly in place until the joint cement has completely cured. The clamps must have a protective material on the inner surface to prevent damage to the plastic pipe when the clamp is tightened in place. Provide pipe with a device or method to determine when the joint is pulled against the pipe stop. Use a gauge provided by the pipe manufacturer to measure the diameter of the spigot ends to insure the diameter conforms to the tolerances specified by the manufacturer. Gauge all pipe ends. Utilize FRP pipe for buried piping only. No aboveground FRP pipe is allowed. Cut with a hacksaw or circular saw with an abrasive cutting wheel.

3.6.5.1 Installation

Bury pipe to the elevation shown on the profiles, except do not bury pipe under roadways less than 900 mm 36 inches. Backfill must not include large or sharp-edged rocks of any size in direct contact with the pipe surfaces. Compact to avoid damage to the pipeline. Provide conduits or sleeves of steel pipe at least 50 mm 2 inches in diameter larger than the FRP pipe size under heavy traffic roadways. Limit bending of pipe to follow ditch contours to long trench curvatures and do not permit for abrupt changes in pipe direction. Bend radii must not be less than shown in the manufacturer's installation procedures.

3.6.5.2 Thrust Blocks

Provide concrete thrust blocks at all tees, valves, blind flanges, reducers, or whenever the pipe alignment changes direction. Size them in accordance with the pipe manufacturer's instructions to suit local soil conditions, operating pressures, test pressures, pipe size, and thermal conditions. In case of a conflict, the most stringent requirements govern.

3.6.5.3 Curing of Field-Bonded Joints

Cure all field-bonded epoxy-cemented joints, regardless of ambient temperatures, with a self-regulating, thermostatically controlled electrical heating blanket for the time and temperature recommended by the manufacturer for the applicable size and type of joint, or by an alternate approved heating method. Do not move joined sections during heating or before the joint has cooled to 27 degrees C 80 degrees F or to ambient temperature, whichever is higher.

3.6.5.4 Metal to FRP Connections

Make metal to FRP connections with flanged connections. Use flat-faced steel flanges for bolting to FRP flanges. Where raised-face steel flanges are used, utilize spacer rings to provide a flat-face seat for FRP flanges. Use a full-face Buna-N gasket, 3.2 mm 1/8 inch thick with a shore hardness of 50 to 60, between all flanged connections. The FRP flange must have raised sealing rings. Use flat washers under all nuts and bolts on FRP flanges. Provide bolts and nuts consisting of noncorrosive metal and torque to no more than 135 newton meters 100 ft-lbs. Do not bury flanges. Provide a concrete pit for all flanged connections.

3.6.6 Buried Fuel Piping

Buried fuel piping must be in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.7 CATHODIC PROTECTION

Cathodic protection must be in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.8 FIELD PAINTING

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NOTE: Where identification of piping is required by

the using service, this paragraph will be amplified to include appropriate requirements either directly or by reference to a separate section. Air Force requirements are covered in AFM 88-15.
****

Clean, prepare, and paint all ferrous metals not specified to be coated at the factory as specified in Section 09 90 00 PAINTS AND COATINGS. Paint exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum sheath over insulation.

3.9 CLEANING OF BOILERS AND PIPING FOR TESTING

3.9.1 Boiler Cleaning

After the hydrostatic tests but before the operating tests, clean boilers of foreign materials. Wherever possible, wire-brush surfaces in contact with water to remove loose material. The Contractor may use the following procedure or may submit his own standard procedure for review and approval by the Contracting Officer. Fill boilers with a solution consisting of the following proportional ingredients for every 3785 liters 1000 gallons of water and operated at approximately 207 to 350 kPa 30 to 50 psig for a period of 24 to 48 hours, exhausting steam to the atmosphere:

11 kg 24 pounds caustic soda	3.6 kg 8 pounds sodium nitrate
11 kg 24 pounds disodium phosphate,	230 mg 1/2 pound approved wetting

Thoroughly dissolve hemicals in the above proportions or as otherwise approved in the water before placing in the boilers. After the specified boiling period, allow the boilers to cool and then drain and thoroughly flush. Clean piping by operating the boilers for a period of approximately 48 hours, wasting the condensate.

3.9.2 Boiler Water Conditioning

Provide boiler water conditioning including chemical treatment and blowdown during periods of boiler operation to prevent scale and corrosion in boilers and in supply and return distribution systems from the initial startup of the system, through the testing period, and to final acceptance of the completed work but for at least 30 days of operation. Use approved chemicals and method of treatment.

TABLE I. PIPE

Service	Pressure, kPa psig	Material	Specification	Type
Steam	0-35000-500	Std. wt. black steel	ASTM A53/A53M	Type E, Grade A
Condensate return	0-17000-250	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
		Copper pipe	ASTM B42	[_____]
Boiler feed & blowoff lines	0-41000-600	Extra strong black steel (2)	ASTM A53/A53M	Type E, Grade A

TABLE I. PIPE

Service	Pressure, kPa psig	Material	Specification	Type
Feedwater piping	0-8600-125	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Water column (1)	0-41000-600	Std weight black steel (2)	ASTM A53/A53M	Type E, Grade A
Vent & exhaust pipe	0-1700-25	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Compressed air	0-8600-125	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Gauge piping	0-1700-25	Copper tubing	ASTM B88M ASTM B88	Type K or L
		Blask steel (2)	ASTM A53/A53M	Type E, Grade A
Fuel oil (No. 2)	0-10000-150	Copper tubing	ASTM B88M ASTM B88	Type K or L
		Fiber reinforced plastic (FRP) (buried	API Spec 15LR	[_____]
Fuel oil (Nos. 4, 5 & 6)	0-10000-150	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Control air	0-10000-150	Copper tubing	ASTM B68/B68M	[_____]
		Std weight black steel	ASTM A53/A53M	Type E, Grade A
Note 1: No bending of pipe will be permitted. Provide crosses with pipe plugs at connections.				
Note 2: Extra strong (XS) minimum weight. Conform to ASME B31.1 for wall thickness.				

TABLE II. FITTINGS

Service	Size, mm inches	Title	Materials	Specification
Steam (1)	Under 80 mm 3 inches	Threaded	Malleable-iron	ASME B16.3
	Under 80 mm 3 inches	Threaded	Steel	ASME B16.11
	80 mm 3 inches and	Flanged	Steel	ASME B16.5
	80 mm or larger	Buttwelded	Steel	ASME B16.9

TABLE II. FITTINGS

Service	Size, mm inches	Title	Materials	Specification
Condensate return	Under 80 mm 3 inches	Threaded	Cast-iron	ASME B16.4 Black, Class 250
	Under 80 mm 3 inches	Threaded	Malleable-iron	ASME B16.3, Class 300
	Under 80 mm 3 inches	Threaded	Bronze	ASME B16.15
	80 mm 3 inches and	Buttwelded	Steel	ASME B16.9
Vent pipe	Under 80 mm 3 inches	Threaded	Malleable-iron	ASME B16.3
	80 mm or larger	Buttwelded	Steel	ASME B16.9
Exhaust pipe	Under 80 mm 3 inches	Threaded	Zinc-coated malleable-iron	ASME B16.3
	80 mm 3 inches and	Buttwelded	Steel	ASME B16.9
Boiler feed (2)	Under 80 mm 3 inches	Threaded	Malleable-iron	ASME B16.3
	80 mm 3 inches and	Buttwelded	Steel	ASME B16.9
Feedwater pipe	Under 80 mm 3 inches	Threaded	Malleable-iron	ASME B16.3
	80 mm 3 inches and	Buttwelded	Steel	ASME B16.9
Blowoff lines (2)	All	Buttwelded	Steel	ASME B16.9
		Socket welded	Steel	ASME B16.11
		Flanged with long radius elbows	Steel	ASME B16.5
Water column piping (2)	Under 80 mm 3 inches	Threaded	Malleable-iron	ASME B16.3
Fuel oil	All	Threaded	Malleable-iron	ASME B16.3
		Flared or brazed	Cast or wrought bronze	ASME B16.18 ASME B16.26
		Plastic	FRP	Compatible with pipe API Spec 15LR
Gauge pipe	All	Flared or soldered	Cast or wrought bronze	ASME B16.18 ASME B16.26

Note 1: Conform to ASME B31.1 for wall thickness. Match requirements for steam piping.

Note 2: Conform to ASME B31.1 for wall thickness, except minimum must be extra strong pipe. Match piping requirements.

3.10 MANUFACTURERS' FIELD SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Supervise the installing, adjusting, and testing of the equipment.

3.11 FIELD TRAINING

Provide a field training course for designated operating staff members. Provide training for a total period of [_____] hours of normal working time and start after the system is functionally complete, but prior to final acceptance tests. Cover all of the items contained in the approved operating and maintenance instructions as well as demonstrations of routine maintenance operations. Notify Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.12 FRAMED INSTRUCTIONS

Submit proposed diagrams, instructions, and other sheets, before posting. Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, where directed. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, frame as specified above for the wiring and control diagrams, and post beside the diagrams. Post framed instructions before acceptance testing of the systems.

3.13 TESTS

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NOTE: Before occupancy of a facility, inspect the boilers in accordance with the Code of Boiler and Pressure Vessel Inspectors (BPVI) and the American Society of Mechanical Engineers (ASME). Inspectors must be certified in accordance with BPVI standards.

References to inapplicable types of boilers will be deleted.

****

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate the final position of controls in each test report. Submit a written statement from the manufacturer's representative certifying that combustion control equipment has been properly installed and is in proper operating condition, upon completion of the installation. The action settings for all automatic controls in the form of a typed, tabulated list indicating the type of control, location, setting, and function.

3.13.1 Hydrostatic Tests

Following erection, test each boiler hydrostatically and prove tight under a gauge pressure of 1-1/2 times the working pressure specified. Following the installation of piping and boiler house equipment, but before the application of any insulation, make hydrostatic tests and the prove system tight under gauge pressures of 1-1/2 times the specified working pressure. Test the boilers and inspect the piping connections by a NBBI-commissioned boiler inspector for determining compliance with all requirements in ASME BPVC SEC VIII D1 and supply the Contracting Officer with a certificate of approval for each boiler. After flushing and operationally testing, leak test underground portions of oil containing piping systems. The test must be the [standpipe method][buoyancy device] type and conform to the requirements in NFPA 329. Do not involve pressurization of the system in any way which could increase the rate of product escape through an established leak in the test method.

3.13.2 Efficiency and Operating Tests

Upon completion of installation, subject the boiler plant to operating tests required to demonstrate satisfactory functional operation. Adjust equipment and controls before the scheduled operating test. Submit a testing schedule to the Contracting Officer at least 15 days before the scheduled test. Conduct each operating test as directed by Contracting Officer.

a. Run an efficiency and capacity test on one boiler of each size installed, conducted in accordance with ASME PTC 4 abbreviated efficiency test utilizing the heat loss method, except for use of measuring or metering devices properly calibrated before the test, for the purpose of metering the water used and weighing the amount of fuel burned. Use water meter in the test suitable for hot water. Provide instruments, test equipment, and test personnel required to properly conduct tests. The necessary fuel, water, and electricity will be furnished by the Government.

b. The performance tests must, in each case, cover the periods for the capacities tabulated below:

c.

	Percent of Capacity	
Time (Minimum)	Waterwall and Watertube Boilers	Firetube and Boilers
First 1 hour	50	50
Next 1 hour	75	75
Next 4 hours*	100	100
Next 2 hours	110	
*The efficiency tests may be conducted either concurrently with the operating tests or separately, at the option of the Contractor. Efficiency must be not less than specified. Maximum moisture content of saturated steam leaving the boiler must be as specified.		

d. Conduct efficiency and general performance tests on the boilers by a qualified test engineer, and observed by the Contracting Officer. Set up all testing apparatus, calibrate, test, and be ready for testing the boiler before the arrival of the Contracting Officer.

e. Furnish calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in efficiency and capacity tests before the test. Deliver a test report including logs, heat-balance calculations, and tabulated results together with conclusions in quadruplicate. Submit an analysis of the fuel being burned on the test to the Contracting Officer.

f. Include all pertinent data tabulated in the ASME PTC 4 abbreviated efficiency test. Provide necessary temporary test piping no less than 100 mm 4 inches in diameter and steam silencer to exhaust excess steam to atmosphere in the event the boiler load is insufficient to meet the capacity specified. Provide control valve for exhausting excess steam to atmosphere in a convenient location inside the boiler room. Instruments required for conducting the boiler tests are contained in ASME PTC 19.11.

3.13.3 Test of Fuel Burning Equipment

Test of fuel burning equipment must demonstrate that equipment installed will meet the requirements of the specifications. Oil burners must meet the test requirements of UL 296. Demonstrate accuracy range and smoothness of operation of the combustion controls by varying the demand throughout the entire firing range required by the turndown ratio specified for the [burner][and][stoker] and, in the case of automatic sequenced burners, by further varying the firing rate to require on-off cycling. The control accuracy must be as specified. Verify specified turndown ratio by firing at the minimum firing rate. Verify operation of the flame safeguard control by simulated flame and ignition failures.

3.13.4 Test of Deaerating Feedwater Heater

Test of deaerating feedwater heater must demonstrate that the equipment installed meets the requirements specified as to performance, capacity, and quality of effluent. During the operating test of the boilers, conduct tests to determine oxygen content in accordance with ASTM D888, Method A. Operate boilers at varying loads up to maximum heater capacity while oxygen tests are being made.

3.13.5 Test of Water Treatment Equipment

Test of water treatment equipment must meet the requirements specified as to capacity and quality of effluent. Tests for ion-exchange units must cover at least two complete regenerations and capacity runs.

3.13.6 Test for Steam Purity and Water Level Stability

Perform test for steam purity, in accordance with ASTM D1066, and water level stability simultaneously under the operating conditions specified.

[3.13.6.1 Conductivity Tests for Boilers without Superheaters

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NOTE: Delete the inapplicable paragraph.

****

Make steam tests for boilers without superheaters, not used for power generation or large turbine drive, on steam sampled in accordance with ASTM D1066. Do not exceed 30 microhms at 18 degrees C65 degrees F conductivity of the steam corrected for carbon dioxide and ammonia content.

]3.13.6.2 Conductivity Test, Boilers with or without Superheaters

Sample steam for boilers, with or without superheat, used for power generation or turbine drive for air-conditioning equipment in accordance with ASTM D1066 with the conductivity of the steam corrected for carbon dioxide and ammonia content not to exceed 4.0 microhms at 18 degrees C65 degrees F.

3.13.6.3 Water Level Stability Test

[Conduct water level stability test first by use of the manual bypass around the feedwater regulator. Then repeat test using the automatic feedwater regulator. Boiler must maintain specified water level stability under both conditions.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 52 30.02 10 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-23 70 02.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-23 52 30.02 10 (May 2020)**

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SECTION 23 52 30.02 10

CENTRAL STEAM GENERATING SYSTEM - COMBINATION GAS AND OIL FIRED

05/20

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NOTE: This guide specification covers the requirements for steam generation plants based on operating pressure above 200 kPa 30 psig to a maximum of 1030 kPa 150 psig.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: Sustainable design factors which should be considered during design of steam generating systems include, but are not limited to, the following: use of cleaner burning fuels (natural gas, low sulfur No. 2 oil); design for minimal air emissions; specification of boilers and ancillary equipment in the upper 25 percent of available efficiency for the capacity range used; proper insulation of piping, fittings, and other heated surfaces; returning condensate to the steam plant for reuse; blowdown heat recovery; appropriate use of water treatment systems and chemicals; use of electric rather than steam turbine motor drives; recycling of dismantled

or demolished material and equipment; and for new plants, building on a previously developed or "brownfield" site if possible. These factors are generally subject to life-cycle cost analysis.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 15LR	(2001; R 2018) Specification for Low Pressure Fiberglass Line Pipe

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded

ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers
ASME PTC 4	(2013; R 2023) Fired Steam Generators
ASME PTC 12.3	(1997; R 2004; R 2009; R 2014; R 2019; R 2024) Performance Test Code on Deaerators
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes
ASME PTC 19.11	(2008; R 2013) Steam and Water Sampling, Conditioning, and Analysis in the Power Cycle
ASME PTC 25	(2023) Pressure Relief Devices

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A278/A278M	(2001; R 2024) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A290/A290M	(2016; R 2021) Standard Specification for Carbon and Alloy Steel Forgings for Rings for Reduction Gears
ASTM A395/A395M	(1999; R 2022) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	(2024) Standard Specification for Ductile

	Iron Castings
ASTM A582/A582M	(2022) Standard Specification for Free-Machining Stainless Steel Bars
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM B68/B68M	(2011) Standard Specification for Seamless Copper Tube, Bright Annealed (Metric)
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C34	(2023) Standard Specification for Structural Clay Loadbearing Wall Tile
ASTM C62	(2023) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C700	(2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D888	(2012; E 2013) Dissolved Oxygen in Water
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D5543	(2009) Standard Test Methods for Low-Level Dissolved Oxygen in Water
ASTM F1139	(1988; R 2024) Steam Traps and Drains

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide

	https://www.approvalguide.com/

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 5.2	(1976; R1992) Binary Logic Diagrams for Process Operations
ISA 5.3	(1983) Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems
ISA 51.1	(1979; R1993) Process Instrumentation Terminology

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-232	(1997f; R 2012) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

TIA-485	(1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 567	(2021) UL Standard for Safety Emergency Breakaway Fittings, Swivel Connectors and Pipe-Connection Fittings for Petroleum Products and LP-Gas
UL 574	(2003; Reprint Oct 2024) UL Standard for Safety Electric Oil Heaters
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

1.2 DEFINITIONS

The definitions of the terms relating to process control instrumentation technology are those given in ISA 51.1. Use logic symbols in accordance with ISA 5.2. Use graphic symbols for distributed control in accordance with ISA 5.3.

1.3 SYSTEM DESCRIPTION

1.3.1 Design Analysis and Calculations

Submit manufacturer's design data and structural computations,and design analyses and calculations for walls, roofs, foundations, and other features, for specialty type of construction, with design data for lateral forces that may be encountered due to wind loads and seismic forces. Mount instrumentation on equipment in accordance with paragraph Supports in PART 3.

1.3.2 Electrical Environment

Provide electrical and electronic equipment that operate satisfactorily, both independently and in conjunction with other equipment. The operation of electrical and electronic equipment must not be adversely affected by interference voltages and fields from external sources, and that equipment provided must not be a source of interference that might adversely affect the operation of other equipment. Ensure the basic design of equipment, components, and assemblies limits the effects of radio frequency interference and electromagnetic interference.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Variable Spring Hangers

Pipe Anchors

Setting Plans

Graphics Screen Format

SD-03 Product Data

Materials

Safety Data Sheets

Design Analysis and Calculations.

Welding; G, [_____]

Water Treatment Plan

Cleaning of Boiler and Piping.

Testing of Piping Systems; G, [_____]

Spare Parts

Framed Instructions; G, [_____]

SD-06 Test Reports

Test Schedule

Proposed Test Procedure

Boiler Emissions Report

Adjusting, Inspecting, and Cleaning

Fuel oil analysis; G, [_____]

Startup Test Hardcopy Printout; G, [_____]

SD-07 Certificates

Environmental Permit Compliance; G, [_____]

Experience; G, [_____]

Factory Testing

Certificate of Compliance

Performance Test Report

Certificates of Inspection, Test, and Calibration

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Experience

Submit evidence of the Contractor's prior experience in installing similar equipment, including a list of 5 combustion control installations on boilers of equal or larger size that have been in satisfactory operation for 2 years prior to bid opening; also, the location of the combustion control installations.

1.5.2 Welding

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NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement regarding welds and the welding submittal, and use the second bracketed sentence. Non return valves are only required on multiple boiler installations.

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Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Furnish this information regarding welds, internal to packaged boilers, if requested by the Government.

a. Weld and stamp steam piping between the boiler [steam nozzle] [nonreturn valve] and the second stop valve in accordance with ASME BPVC SEC I. [Weld other piping in accordance with qualified procedures using performance qualified welders and welding operators. Use qualified procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1.

b. Notify the Contracting Officer 24 hours in advance of tests. The welder or welding operator must apply the personally assigned symbol near each weld made as a permanent record.

c. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING].

1.5.3 Use of Asbestos Products

Products that contain asbestos are prohibited. This prohibition includes items such as packings or gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material.

1.5.4 Detail Drawings

Submit detail drawings consisting of schedules, performance charts, brochures, diagrams, drawings, and instructions necessary for installation of the steam-generating units and associated equipment, and for piping, wiring devices, trenches and related foundations. Detail drawings for steam generators and appurtenances, including the fuel system. Indicate clearances required for maintenance and operation and also contain complete wiring and schematic diagrams, equipment layout and anchorage, and other details required to demonstrate that the system has been coordinated and will function properly as a unit. Manufacturers' confidential information concerning manufacturing techniques and proprietary data such as detailed fabrication shop drawings are not required.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.7 PROJECT/SITE CONDITIONS

Design instruments located in furnace rooms for 79 degrees C 175 degrees F ambient temperature operation. Design other instruments for 40 degrees C 104 degrees F ambient temperature operation.

1.8 EXTRA MATERIALS

Submit spare parts data for each item of equipment provided, after acceptance of the detail drawings and not later than [_____] months before the date of beneficial occupancy. Include in the data a complete list of spare parts and supplies, with current unit prices and sources of supply. Include special tools necessary for the operation and maintenance of boilers, burners, pumps, fans, and other equipment. Furnish small hand tools with a suitable hardwood cabinet mounted where directed. Provide special wrenches for opening boiler manholes, handholes, and cleanouts.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

For each major item of equipment, secure a plate with the manufacturer's name, address, type or style, model or serial number, and catalog number to the item of equipment.

2.1.3 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personal contact. Properly guard or cover high temperature equipment and piping exposed to contact by personnel or where they create a fire hazard with insulation of the type specified. Provide items such as catwalks, operating platforms, ladders, and guardrails where shown and construct in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.2 MATERIALS

Submit outline drawings, data sheets, parts lists, schedules, performance charts, installation instructions, brochures, diagrams, and other information to illustrate equipment, wiring related components, and material. Ensure performance charts provide information necessary to determine compliance to the specified and indicated requirements and include minimum capacity for stable operation of the equipment. Submit manufacturer's installation recommendations for each item of instrumentation. Provide product data including catalogs, and characteristic curves; and manufacturer recommended cleaning procedure, interior and exterior, for applicable items. Provide materials complying with the following:

2.2.1 Brick, Common

ASTM C62.

2.2.2 Bricks, Refractory

ASTM A653/A653M, class as recommended by the boiler manufacturer.

2.2.3 Bricks, Refractory, Insulating

ASTM C155.

2.2.4 Coal-Tar Primer and Enamel

AWWA C203.

2.2.5 Draft Gauge

ASME B40.100, Style 1. Mount draft gauges for the windbox, combustion chamber, and last boiler pass in the panel front. Field-verify operating range for the draft gauges with normal reading in the middle of the scale range. Ensure draft gauges include piping between the gauges and the boiler.

2.2.6 Exhaust Head

One piece construction of plate steel, semisteel, or cast iron equipped with suitable baffle arrangement and drain connection for the removal of entrained condensate and oil. Flow area through unit must be larger than connecting pipe.

2.2.7 Expansion Joint

EJMA Stds Book of Standards and ASME B31.1. Provide packless, leak proof, externally pressurized bellows type expansion joint. Include integral guide rings, full thickness cover designed to contain full system pressure, and self-draining convolutions. Provide expansion jointthat is insensitive to flow direction. Provide expansion joint with a drain connection for condensate removal. Provide expansion joint consisting of welded construction with ASTM A240/A240M T-304 stainless steel bellows, ASTM A106/A106M GR B cover and ASTM A106/A106M GR B standard wall pipe with flanged ends. For pumped condensate, use Schedule 80 pipe. Use expansion joint that is rated for 1.03 MPa 150 psig and 425 degrees C 800 degrees F and has maximum axial movement rating of 100 or 200 mm 4 or 8 inches with a rated cycle life of 1,000 for the full rated movement.

2.2.8 Gauge, Pressure and Vacuum

ASME B40.100, Type I, Class 1 or 2, as applicable, style as required, suitable for pressure or vacuum specified, with 150 mm 6 inch minimum diameter dial except as otherwise specified.

2.2.9 Low Water Cutoff

Provide float actuated low water cutoff switch or electrically actuated probe type. Provide float chamber with a blowdown connection. Low water cutoff must cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum. A safety shutdown due to low water must require manual reset before operation can be resumed and must prevent recycling of the burner. Perform low water cutoff in strict accordance with the ASME CSD-1.

2.2.10 Mortar, Refractory

As recommended by the boiler manufacturer.

2.2.11 Pipe and Fittings

2.2.11.1 Clay Pipe

ASTM C700, Class 1, Type I, Style a.

2.2.11.2 Nipple

ASTM A733, standard or extra strong weight to match adjacent piping.

2.2.11.3 Pipe

As specified in TABLE I for service use and size. Provide underground fuel piping in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.2.11.4 Flanges

As specified in TABLE II for service use and size. Convoluted steel flanges conforming to ASME BPVC SEC VIII D1 may be provided in lieu of flanges conforming to ASME B16.5. Provide convoluted flanges consisting of cold-formed steel conforming to ASTM A516/A516M. Mate flanges with ASME B16.5, Class 150 flanges.

2.2.11.5 Flange Gasket

Provide gasket consisting of nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, of self centering flat ring type. Provide gasket containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Use NBR binder for hydrocarbon service. Use metallic spiral wound nonasbestos gaskets for steam lines.

2.2.11.6 Flexible Connector

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NOTE: Listed flexible connectors may be used when allowed by NFPA 30 and when approved by local codes as an alternative for swing joints.

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Provide flexible metal hose, corrugated type with braided wire sheath covering, close pitch annular corrugations, rated for a working pressure of at least 1.03 MPa 150 psig, 300 mm 12 inch minimum live length, threaded end connections and conforming to requirements of UL 567. Ensure metal for hose and braided wire sheath is stainless steel, any type of AISI series.

2.2.11.7 Union

ASME B16.39, limited to 690 kPa 100 psig, type to match adjacent piping. For higher pressure, use ground joint cast steel or forged steel union.

Use unions with appropriate pressure and temperature ratings.

2.2.12 Pipe Support

MSS SP-58.

2.2.13 Pipe Threads

ASME B1.20.2MASME B1.20.1.

2.2.14 Steel Sheet

Carbon, zinc-coated (galvanized) by the hot-dip process: ASTM A653/A653M. Gauges specified are Manufacturer's Standard Gauge.

2.2.15 Strainer

Unless otherwise specified, provide strainer with screwed ends to 50 mm 2 inches, flanged for 65 mm 2-1/2 inches and larger.

2.2.15.1 Body

For systems up to 1.03 MPa 150 psi, Class 150 150 pound WSP class, cast steel; and for higher pressure, 2.06 MPa 300 psi, Class 300 300 pound use WSP class forged steel or cast steel.

2.2.15.2 Screen

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NOTE: Specify screen size for the needs of the equipment.

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Provide Type 304 stainless steel screen with free area no less than 2.5 times inlet area. For water system, ensure perforation is 6.4 mm 1/8 inch for strainer size up to 200 mm 8 inches, and 4 mm 5/32 inch for strainer 250 mm 10 inches and larger. For steam and condensate system, ensure perforation is 0.4 mm 1/64 inch for strainer size up to 50 mm 2 inches, 0.8 mm 1/32 inch for strainer 65 mm 2-1/2 inches through 100 mm 4 inches, and 1.2 mm 3/64 inch for strainers 125 mm 5 inches and larger. Provide reinforced wire gauge screen, with continuous magnetic field around entire circumference of screen and magnets with stainless steel retaining lugs and threaded rods.

2.2.15.3 Y-Type Strainer

Provide Y-type strainer as shown. Provide Y-type strainer that is full line size of connecting piping, with ends matching piping system materials. Provide Y-type strainers with a globe valve blowdown.

2.2.15.4 Tee Strainer

Provide tee strainer as shown. Provide tee strainer that is the full line size of the connecting piping with ends matching the piping system materials. Provide tee strainer with a swing bolt closure.

2.2.15.5 Basket Strainer, including Duplex Basket Strainer

Provide basket strainer as shown. Provide basket strainer with bolted covers to allow removal of the basket for cleaning. Provide duplex basket strainer including a multiport plug valve to allow the operator to switch active strainer baskets without interrupting system operation.

2.2.16 Tape

2.2.16.1 Threaded Pipe Joint

ASTM D3308.

2.2.16.2 Pipe Joint Coating

AWWA C203.

2.2.17 Tile, Load Bearing, Hollow

ASTM C34, Grade LPX.

2.2.18 Traps, Steam and Air

ASTM F1139.

2.2.19 Thermometer

Unless otherwise specified, provide dial type thermometer, 90 mm 3-1/2 inch diameter, chromium plated case for indoor use and stainless steel for outdoor use, remote or direct type bulb as required, with plus or minus 0.5 Degrees C 1 degree F accuracy and white face with black digits in 2 degree increments. Use well and temperature range for use encountered. Install thermometer so as to be easily read from the operating floor. Do not use Mercury in thermometers.

2.2.20 Valve

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NOTE: Valves operating above 170 kPa/130 degrees C 25 psig/267 degrees F will be minimum Class 150. Pressure class will be suitable for intended service.

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2.2.20.1 Reference Standards

ASTM A126 and ASTM A278/A278M as applicable.

2.2.20.2 Check, Globe, Angle, and Gate

a. Sizes 40 mm 1-1/2 inches and smaller that are operating at or below 170 kPa 25 psig and also operating at or below 130 degrees C 267 degrees F, saturation temperature at 170 kPa 25 psig must be bronze, MSS SP-80, Class 125 with threaded connections.

b. Sizes 40 mm 1-1/2 inches and smaller operating above either 170 kPa 25 psig or 130 degrees C 267 degrees F, saturation temperature at 170 kPa 25 psig, must be [forged] [cast] steel, stainless steel trim, rising stem, Class [_____] with handwheels. Ensure connections are [socket weld] [threaded] end connections.

c. Sizes 50 mm 2 inches and larger must be cast steel, stainless steel trim, rising stem, outside screw and yoke, Class 150 with handwheels.

Provide either butt weld or flanged connections.

2.2.20.3 Back Pressure Relief

Provide ASME PTC 25 back pressure relief valve with stainless steel or cast steel body with valve internals and seats constructed of stainless steel. Provide positive closing back pressure relief valve with guides. Adjust the desired back pressure to cover a range between 14 and 70 kPa 2 and 10 psig. Effect the adjustment externally and provide any shafts extending through the valve body with adjustable stuffing boxes having renewable packing. Provide self contained, internal pilot piston operated back pressure relief valve. Provide an external positioner on each valve.

2.2.20.4 Blowoff and Quick Opening

Provide blowoff and quick opening valves as required in ASME BPVC SEC I. Provide balanced seatless type or double seated rotating disk type valve. Ensure quick opening valve is the straightway type. Design blowoff and quick opening valves for a working pressure of 2.06 MPa 300 psig and suitable for safe blowdown through the installed piping system.

2.2.20.5 Pressure Reducing

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NOTE: Valves requiring tight shutoff for steam service will be ANSI Class IV. Where a thermostatically controlled valve is installed after and near the reducing valve in a manner to cut off the passage of steam, valves with ANSI Class IV shutoff will be used. Where valves are used for reducing pressure to the deaerating heater, valves will have ANSI Class IV shutoff.

Consider silencers in pressure reducing valve trains where acoustics to adjacent spaces or maximum noise level in mechanical room is an issue.

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Design pressure reducing valve for a working pressure of no less than 1.03 MPa 150 psig, and ensure valve is quiet and nonsticking in operation. Provide spring loaded, internal pilot piston operated type pressure reducing valve with an external position indicator. Pressure reducing valve body 65 mm 2-1/2 inches and larger must be cast steel. Provide pressure reducing valve with raised face flanges to match the raised face flanges on connecting piping. Pressure reducing valve 38 mm 1-1/2 inches and smaller must be bronze with screwed connections. Ensure pressure reducing valve trim is stainless steel or monel metal. Parts subject to wear must be renewable. Provide pressure reducing valve with seat and plug faced with cobalt tungsten carbide mixture, or made of heat treated stainless steel or high chromium steel. Provide seat and plug facing with a Brinell hardness of no less than 450. Design pressure reducing valve for dead-end service. Do not exceed a resulting noise level of [_____] dBA.

2.2.20.6 Plug

Provide tapered plug, lubricated type plug valve. Use lubricant that is suitable for the intended application. Provide cast steel body. Provide carbon steel plug. Pressure class must be minimum ANSI Class 150. Plug valve 38 mm1-1/2 inches and smaller must be screwed. Plug valve 50 mm 2 inches and larger must be flanged.

2.2.20.7 Safety Relief

Size and construct safety relief valve in compliance with requirements set forth in ASME BPVC SEC I. Provide safety relief valve with a manual lifting device for testing.

2.2.20.8 Steam Nonreturn

Provide either angle type or straight type steam nonreturn valve with rising stem as shown. Operate steam nonreturn without chattering, hammering, or sticking over the entire operating range of the boiler. Provide valve complying with ASME BPVC SEC I. Provide steam nonreturn valve with Class 300 ASTM A216/A216M cast steel body. Provide steam nonreturn consisting of bronze trim, rising stem, bolted bonnet, outside screw and yoke and flanged ends.

2.2.20.9 Thermostatic Regulating

Design thermostatic regulating valve for a steam working pressure of 1.03 MPa 150 psig. Provide adjustable thermostatic regulating valve with an operating range of approximately 54 to 88 degrees C 130 to 190 degrees F and maintain the desired fluid temperature within plus or minus 2.5 degrees C 5 degrees F. Provide [bronze] or [cast] [forged] steel or stainless steel body.

2.2.20.10 Ball

Provide Teflon seated and packed ball valve. Ball valve must provide bubble tight shutoff. Provide [bronze] or [cast] [forged] steel or stainless steel body. Ball valve must be two-piece full-port design.

2.2.20.11 Feedwater Control

Provide feedwater control valve with the boiler. Supply feedwater control valve with filter, regulator, supply and control pressure gauges, [metric] converter and positioner with charactering cam. Control system must provide 4 to 20 mAdc control signal.

2.2.21 Water Column

Construct water column valve in accordance with ASME BPVC SEC I, fit with gauge glass and quick-closing gauge valves with chains and handles for operation from the boiler room floor. [Provide mirror and illuminating light to allow water levels to be read from the boiler room floor] [Provide gauge glass with illuminating light].

2.2.22 Meters

2.2.22.1 Natural Gas Flow

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NOTE: Ensure the turndown ratio (TDR) of the natural gas flow meter is wider than that of the boiler burner TDR firing on natural gas.

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Provide positive displacement type natural gas flow meter with an aluminum body and a pressure correcting device that will correct flow readings to atmospheric pressure. Use a minimum meter design pressure of 690 kPa 100 psig. Ensure accuracy is plus or minus 1 percent of calibrated span minimum. Turndown must be [_____]. Provide threaded connections for sizes 38 mm 1-1/2 inches and smaller. Provide flanged connections for sizes 50 mm 2 inches and larger.

2.2.22.2 Water Flow

Provide disk type water flow meter with reinforced disk for hot water above 65 degrees C 150 degrees F, and rubber or carbon disk for cold water, and constructed of bronze composition and cast iron protected by noncorrosive coating. Ensure moving parts subject to wear are easily replaceable. Provide waterflow meters conforming to the requirements of AWWA C700.

2.2.22.3 Fuel Oil Flow

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NOTE: Ensure the turndown ratio (TDR) of the oil flow meter is wider than that of the boiler burner TDR firing on fuel oil.

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Provide nutating disc, positive displacement fuel oil flow meter with direct mechanical shaft drive from meter to register. Use construction materials consisting of cast iron housing, bronze internals, aluminum ball and web disc, and Type 316 stainless steel diaphragm. Provide totalizing register as specified. Use floe oil meter suitable for maximum oil temperature.

2.2.23 Natural Gas Pressure Regulator

Provide pilot operated type natural gas pressure regulator. Use nitrile diaphragms. Natural gas pressure regulator valve body must be steel. Use minimum pressure rating of 1.03 MPa 150 psig. Make vent connection in accordance with NFPA. Provide natural gas pressure regulator with an external position indicator.

2.2.24 Fractional and Integral Horsepower Motors

Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

2.3 ELECTRICAL WORK

Provide specified electric motor driven equipment complete with motor, motor starter, and controls. Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ensure electrical characteristics are as specified or indicated. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Use motor of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified.

2.4 BOILER AND APPURTENANCES

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NOTE: Delete types of boilers that are not used.

Select appropriate fuels and fill in pressure and temperature requirements. Select efficiency in the upper 25 percent of the competitive range. Specify efficiencies that correlate to the fuel(s) required. Select applicable burner type and combustion control system. To accommodate shipping limitations or installation access requirements in existing boiler plants,the boiler may be specified to be knocked down and field assembled.

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2.4.1 Boiler

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NOTE: Coordinate turndown ratio with subparagraph "Fuel Oil Burner" and subparagraph "Natural Gas Burner" in paragraph FUEL BURNING EQUIPMENT.

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Provide boiler as complete boiler-burner package, including integral forced draft burner, boiler trim, refractory, controls, fuel train and accessory components. Provide boiler-burner package [fully assembled] [field assembled] ready for floor mounting and connection to steam, feedwater, electrical, [fuel oil], [natural gas], vent, chemical feed, blowdown and control lines in accordance with the Setting Plans. Submit complete setting plans certified by the boiler manufacturer and burner manufacturer. Provide boiler with the capacity indicated. Ensure equipment design and accessory installations permit accessibility for maintenance and service. Provide boiler complying with NFPA 85. Design boiler for working pressure of [_____] kPa psig and operating pressure of [_____] kPa psig. Each boiler must be capable of continuously producing [_____] kg pounds per hour saturated steam [_____] degrees C degrees F while being supplied with [_____] degrees C degrees F feedwater. Boiler operation must be stable at a turndown ratio of [_____]. Provide [natural gas] [fuel oil] [combination natural gas fuel oil] burners of type, size and so located and arranged such that the flame in no case impinges on any surface in the boiler nor extends beyond the limits of the furnace.

2.4.2 Performance

Provide boiler with the specified capacity at the operating pressure, feedwater temperature and boiler site elevation specified. Base capacity on the evaporation rate in kg pounds per hour at boiler specified outlet steam temperature and pressure while firing [No.[_____] fuel oil] [natural gas] [No. [_____] fuel oil or natural gas]. [Use fuel oil supply temperature and pressure of [_____] degrees C degrees F and [_____] kPa psig]. [Use natural gas supply pressure of [_____] kPa psig]. Boiler must be capable of continuous operation at full rated capacity. Ensure minimum efficiency is no less than [_____] percent when fired continuously at full rated capacity with [natural gas] [fuel oil] [natural gas or fuel oil]. Maintain both stable firing and efficiency over the entire firing range required by the turndown ratio. Base output capacity of the boiler on tests of the boiler and burner as a unit. Moisture in the steam must not exceed 0.5 percent at maximum continuous rated boiler capacity and during a load swing of 10 percent of boiler capacity per minute with boiler water dissolved solids concentration at approximately 3,500 ppm and total alkalinity not in excess of 700 ppm.

2.4.3 Construction

Build and stamp boiler in accordance with ASME BPVC SEC I and as specified.

2.4.4 Identification

Stamp boiler as follows:

a. Maximum capacity in MW Btu/Hr.

b. Maximum allowable working pressure.

c. Radiant heating area.

d. Total heating surface area.

e. Furnace volume.

2.4.5 Watertube, Packaged Type Steam Boiler

Provide shop assembled type boiler with either 2 or 3 drums and water cooled furnace roof, floor, front, rear and side walls. Ensure the furnace side and rear walls are completely suitable for pressurized firing. Arrange boiler faces to give maximum cooling effect to furnace refractories. Furnace waterwall tubes must enter steam drum below the normal operating drum level. Provide tube inspection ports in furnace to boiler division wall, along both the steam and lower drums. Size furnace for complete combustion of fuel in the furnace with no flame impingement on the water-cooled surfaces and no combustion in the convection area. Do not exceed furnace heat release rate, based on fuel analysis and required fuel input, of [_____] gigajoules/hr per cubic meter Btu/hr per cubic foot of furnace volume. Ensure furnace heating surface is no less than [_____] square meters square feet on a flat protected area.

2.4.5.1 Drum

a. Extend drums beyond the entire length of furnace setting. Fabricate drum of steel plate, weld in accordance with ASME BPVC SEC I, including stress relieving and X-raying of welded seams. Provide steam drum with steam separators and drum internals required to maintain the specified steam moisture content, and provisions for maintenance. Provide necessary baffling to separate steam from water in the drum and to maintain stable water level under a fluctuating load. Ensure variations in normal water level do not exceed boiler manufacturer's recommendations as approved during the shop drawing submittal stage with an increasing load change of 10 percent of boiler capacity per minute. The steam drum diameter must not be less than the following:

   (1) . 915 mm 36 inch (steam flow of 5,455 to 31,800 kg/hr 12,000 to 70,000 pounds/hr).

   (2) . 1,070 mm 42 inch (steam flow of 31,800 to 45,450 kg/hr 70,000 to 100,000 pounds/hr).

   (3) . 1,220 mm 48 inch (steam flow of 45,450 to 68,180 kg/hr 100,000 to 150,000 pounds/hr).

   (4) . 1,370 mm 54 inch (steam flow of 68,180 to 81,800 kg/hr 150,000 to 180,000 pounds/hr).

b. Lower drum must not be less than 610 mm 24 inches in diameter.

c. Provide drum with two 300 by 400 mm 12 by 16 inch elliptical manholes with double clamps, studs and gaskets.

d. Provide boiler with connections as shown.

2.4.5.2 Tubes

2.4.5.2.1 Furnace and Boiler

Provide furnace and boiler tubes no less than 50 mm 2 inches in diameter and thickness conforming to that given in ASME BPVC SEC I for the pressure specified. Bend tubes to a true radius. Tubes that are distorted in bending, flattened or ridged are not acceptable. Drill, ream and serrate tube holes in the drum. Design tubes to permit drums and tubes to drain by gravity.

2.4.5.2.2 Furnace Waterwall

Provide furnace waterwall that extend the entire length of furnace setting and consists of 50 mm 2 inch tangential electric resistance welded steel tubes or welded furnace membrane wall. Expand tubes connected to the drums and/or lower headers into bored tube seats. If headers are provided, use lower headers of sidewalls that are round or square design. Provide lower header with gasketed handhole covers for easy access to each wall tube. Size tube bend radii for standard turbine type cleaners for easy pass through for cleaning of the full length of the tubes.

2.4.5.2.3 Convection Tubes

Provide convection tubes consisting of electric resistance welded construction in accordance with ASME BPVC SEC I. Arrange convection tubes to ensure proper and effective soot blowing. Expand convection tubes in the boiler section into the upper and lower drums.

2.4.5.3 Baffles

Arrange baffles to direct products of combustion into contact with heating surfaces without short circuit of flue gas at the outlet or excessive loss of draft. Provide baffles that are either a refractory material, tangent tubes or a metal suitable for the temperature encountered.

2.4.5.4 Supports

Support boiler and firing equipment from the foundation with structural steel independent of brickwork. Boiler supports must permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. For lifting and handling of the boiler, weld lifting lugs to the steam drum. Reinforce boiler skid and provide with space beneath the end of the beam for jacking the unit during installation. Provide holes in the main beam for use by a rigger to drag or lift the unit by its base frame for final positioning, if this method is recommended by boiler manufacturer.

2.4.5.5 Boiler Casing and Insulation

Encase boiler completely in a double casing and fill with blanket insulation. Construct casing of welded black steel sheets no lighter than 3.4 mm 10 gauge. Provide gastight casing and reinforce with structural steel to provide rigidity and prevent buckling. Provide refractory or insulation behind the waterwall tubes that is no less than 65 mm 2 1/2 inches thick. Provide insulation of sufficient thickness to ensure an average casing temperature in the furnace area not in excess of 60 degrees C 140 degrees F with a surface air velocity of 0.25 meters per second 50 fpm and an ambient air temperature of 38 degrees C 100 degrees F when operating at full capacity. Provide insulation material and installation as recommended by the boiler manufacturer. Insulate exposed portion of the boiler drum with mineral wool block and enclose in a welded 3.4 mm 10 gauge steel casing, field installed. Use factory installed refractory and insulation.

2.4.5.6 Access Door and Observation Port

Provide boiler with access doors in sufficient number, size and location for cleaning, inspection and repair. Ensure access door is gastight and interior surfaces exposed to direct radiation and high temperature are lined with approved refractory material to prevent excessive heat loss. Access doors that are large or weigh more than 23 kg 50 pounds must be hinged. In addition, provide at least two observation ports with cast iron covers, one on the front and one on the rear wall of the furnace, so that the entire inner surface of the furnace is visible from one or more ports.

2.4.5.7 Settling Chamber

****

NOTE: Specify for No. 4 and No. 6 fuel oil.

****

Provide settling chamber for the removal of fly ash below the last pass of the boiler with suitable means for frequent cleaning without shutting down the boiler.

2.4.5.8 Soot Blower

****

NOTE: Specify for No. 4 and No. 6 fuel oil.

****

Provide boiler with soot blower for convection bank cleaning. Provide steam operated soot blower, valve-in-head type and furnish complete with wall sleeve, clamps, hangers, supports, manual operating chains and other appurtenances required for a complete installation. Arrange blower elements so that all parts of the heating surfaces are cleaned of soot deposits when rotated by electric motor actuated by [automatic sequence from boiler control panel] [manual switch from boiler control panel]. Use soot blower elements of such length, diameter and total nozzle area such that for the operating pressure involved there will be no significant difference in the cleaning effect between the nozzle nearest the inlet and those farthest from the inlet of the element. Make soot blower of a material that will satisfactorily withstand the temperature in the zone where it is installed.

2.4.5.9 Economizer

a. Furnish boiler with a rectangular, package extended surface economizer. Provide shop assembled economizer and ship complete with structural steel frame, inner casing, shop applied insulation and [_____] mm gauge box ribbed metal lagging. Design and fabricate economizer in accordance with ASME BPVC SEC I. Flue gas flow through economizer must be vertical with orientation of economizer as shown.

b. Provide economizer of continuous tube, loop tube design and completely drainable by gravity after installation. Design and arrange economizer such that there will be no steaming in the economizer under any load or operating condition. Ensure minimum design temperature of the economizer is 370 degrees C 700 degrees F. Hydrostatically factory test economizer at 1.5 times the tube side design pressure or at least 2.07 MPa 300 psi in the presence of a Code Inspector. Provide ASME code stamped unit including nameplate and code documentation.

c. Extended surface must be of solid continuous, resistance welded carbon steel fins. Use maximum fin spacing of [_____] fins per meter foot. Fins must be no less than 1.9 mm 0.075 inches thick.

d. Provide SA-106-B headers with minimum Schedule 40 wall thickness and equip with minimum ANSI Class [_____] raised face weld neck flanged connections. Use header wall thickness and flange rating which is dependent on tube side design pressure in accordance with ASME BPVC SEC I requirements. Tube arrangement must be of the open lattice design. Drilled tube sheets are not acceptable.

e. Hot structure design must be gastight and designed for a minimum of 250 mm 10 inches wc gas side pressure.

f. Ensure pressure parts are not in contact with tube sheets.

g. Provide inner casing that is a minimum of 3.4 mm 10 gauge carbon steel.

h. Design the economizer for the maximum operating conditions of the boiler and capable of reducing boiler stack exit flue gas temperature to 148 degrees C 300 degrees F when the boiler is being fired with natural gas or oil and being supplied with feedwater at [107] [_____]degrees C [225] [_____] degrees F at all boiler loads.

i. The boiler feedwater head loss through the economizer must not exceed 103 Pa 15 psi at maximum boiler load.

j. Insulate economizer with a minimum 50 mm 2 inch thick blanket type mineral wool or approved equal.

k. Provide weatherproofouter casing with a minimum 7.5 mm 22 gauge corrugated galvanized carbon steel lagging. Paint exposed surfaces not enclosed by outer casing with high temperature aluminum paint.

l. Provide minimum 19 mm 3/4 inch vent and drain connections on feedwater headers.

m. Provide economizer with electrically operated soot blowers. Use quantity of soot blowers as recommended by the manufacturer. Install soot blowers transversely to provide maximum cleaning capabilities.

n. Provide access door of carbon steel construction in the economizer design. Insulate access door.

o. Design the economizer to accept piping reactions without distortion or creating overstressed conditions in the piping.

2.4.6 Firetube, Package Type Steam Boiler

Construct and stamp boiler pressure vessel in accordance with the rules of Section 1 of the ASME BPVC SEC I. Excute ASME manufacturer's data reports by the manufacturer and an authorized inspector who holds a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors prior to shipment. Furnish ASME manufacturer's data to the Contracting Officer, the inspection agency and the state and local authorities at the place of installation. Stamp pressure vessel for 1030 kPa 150 psig design pressure.

2.4.6.1 Heating Surface

Provide boiler furnace tube with its centerline below the boiler centerline for maximum water coverage. Provide boiler with a minimum of 0.465 square meters 5 square feet of fireside heating surface per rated BHP. Provide furnace large enough for complete combustion of fuel at maximum capacity without flame impingement. Ensure heating surface is fully accessible for inspection and cleaning without disturbing the burner equipment. Locate observation and sight ports at each end of the boiler to allow inspection of flame conditions. Provide a rear access opening with observation port. Provide handholes and manholes in accordance with ASME BPVC SEC I.

2.4.6.2 Boiler Firetubes

Provide boiler firetubes which are no less than 50 mm 2 inches in diameter, seamless steel tubing expanded to the tube sheets. Welded welded firetubes are not acceptable.

2.4.6.3 Flue Gas Exhaust

Locate flue gas exhaust connection and stack thermometer on the top centerline. Furnish boiler flue outlet with a manual cast iron locking damper.

2.4.6.4 Boiler Supports

Support boiler and firing equipment from the foundation. Provide boiler supports consisting of heavy duty structural steel base with lifting lugs and rigging holes in the skid to facilitate installation. Locate two or more lifting lugs on top of pressure vessel.

2.4.6.5 Refractory

Provide either hinged or davited front boiler door, as required, to provide access to firetubes without disconnecting the burner or fuel train. Configure front boiler door such that front tube sheets are fully accessible for inspection and cleaning when open. Rear door must be davited. "Dry back" boilers having rear door refractory are not acceptable. Seal doors with ceramic fiber rope gaskets and fasten securely using lugs and nuts threaded onto studs welded into the vessel. Insulate rear door with blanket insulation with a steel covering. Contain front door refractory and insulation in the formed door which must swing open for inspection of brick work. Submit Safety Data Sheets detailing refractory materials contained within the boiler.

2.4.6.6 Boiler Insulation

Provide boiler insulation consisting of minimum 50 mm 2 inch fiberglass blanket covering entire circumference of pressure vessel and protect by preformed sheet metal lagging. Cover insulation with minimum 0.8 mm 22 gauge preformed sheet metal and factory paint before shipment using a hard finish enamel coating.

2.4.7 Boiler Trim

Provide boiler complete with the following trim:

a. Water column consisting of gauge glass set, gauge glass and water column blowdown valve.

b. Low water cutoff, as an integral part of the boiler feedwater control. Cutoff must be factory wired into the burner control circuit to prevent burner operation if the boiler water level falls below the safe operating level.

c. Mount an auxiliary low water cutoff below the primary unit, wire in series with the primary unit, and provide with a manual reset device.

d. Provide steam pressure gauge, range to suit operating pressure, on the boiler front, including siphon, cock and test connection.

e. Steam safety valve of type and size to comply with ASME Code requirements.

f. Two bottom blowdown connections, one at the bottom front and one at the bottom rear of the vessel.

g. A minimum of [_____] surface blowdown connection[s].

2.4.8 Prevention of Rust

Unless otherwise specified, factory prime paint surfaces of ferrous metal subject to corrosion with a rust-inhibiting coating and subsequently factory finish paint in accordance with the manufacturer's standard practice. Prime and finish paint equipment exposed to high temperature when in service with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil. Do not paint internal surfaces of tubes and piping that will not be in storage more than three months prior to being placed in service, but coat with a water soluble pipe oil for rust protection. Do not coat surfaces which will be exposed directly to the flue gases (fireside furnace surfaces, OD surface of convection pass surfaces, inside of flues and ducts) with a high temperature heat resistant paint, but protect with a suitable coat of the manufacturer's standard primer. Paint surfaces that will be covered by insulation and lagging with a high temperature heat resistant paint.

2.4.9 Factory Coating

Factory finish equipment and component items, when fabricated from ferrous metal, with the manufacturer's standard finish unless otherwise specified.

2.5 FUEL BURNING EQUIPMENT

****

NOTE: Determine the boiler emissions NO_x requirements. Boiler emissions must comply with local environmental permits. State regulations may be more stringent than Federal Regulations. Delete flue gas recirculation (FGR) if not required.
****

Provide fuel burning equipment complete with flame safeguard system, forced draft low NO_x burner, combustion air windbox, piping, fuel trains and instrumentation supplied as a factory assembled and mounted package on the boiler front. Provide packaged burner capable of firing the boiler at a continuous rating as scheduled, using [natural gas at 69 Pa 10 psi] [No. [2] [4] [6] fuel oil] as an [integral] [combination] unit[.] [suitable for firing either fuel separately, designed to permit a quick changeover without modification of equipment]. Incorporate provisions for withdrawing, shielding or otherwise preventing the oil burner from cooking while firing gas. Apply emissions guarantees through specified turndown range. Utilize flue gas recirculation to lower emissions, but limit to 15 percent and induce by the combustion air fan. Provide burner with a stable flame over the turndown range. Ensure primary air spinner zone, zone divider and main burner are removable without removing the entire register or windbox. Provide register front plate with a swivel scanner and observation port. Submit an Environmental Permit Compliance certificate regarding the boiler emissions.

2.5.1 Pilot

****
NOTE: Select one type of pilot (natural gas, liquified petroleum gas or fuel oil) and remove the others.
****

a. Provide natural gas-electric type pilot burner with the capacity required to reliably light off the boiler. Supply a 6,000 volt secondary side ignition transformer and mount backside of the windbox.

b. Provide liquefied petroleum gas (LPG) type pilot. Locate two 18 kg 40 lb cylinders on concrete pads outside of the building as shown. Include manifold and valves for cylinders to allow removal and filling of one tank without interrupting service to pilot. Provide regulators and gauges with adequate capacity to serve pilot.

c. Provide straight mechanical or atomizing type pilot as specified for the burner. Design pilot system to fire No. 2 oil and provide complete with fuel oil pump, safety shut-off valve, integral metallic screen strainers and a cartridge type filter. Provide ignition transformer rated at no less than 10,000 volts on the secondary side.

d. Make provision in the burner housing for inspection of the pilot flame.

e. Provide pilot with individual manual shut-off valve, pressure gauge, pressure regulation separate from the main burner, self closing solenoid valve and vent valve in accordance with FM APP GUIDE and UL 795. Provide pilot and valving in accordance with NFPA 85.

2.5.2 Burner Refractory Throat

Make burner refractory throat of high quality castable refractory suitable for 1650 degrees C 3000 degrees F. Ship the precast refractory in a steel retaining ring with stainless steel anchors separately for field mounting on the boiler. Burner refractory throat must be concentric with the burner, contoured to ensure complete mixing of [air and natural gas] [air and oil] [air and natural gas and air and oil], and designed to assist in complete combustion by radiating heat to the fuel. Position burner so that the flame parallels the contour of the burner refractory throat but avoids striking the refractory.

2.5.3 Windbox

****

NOTE: Intent is to provide capability for flue gas recirculation (FGR) on all boilers specified, either for present use or future installation.

****

Windbox must provide even airflow. Windbox must not interfere with boiler smoke box door operation and have a flange bottom for easy firm mounting on a support structure. Provide windbox with an induced flue gas recirculation (FGR) inlet adaptor assembly.

2.5.4 Combustion Air Fan

Use centrifugal type combustion air fan with backwardly inclined air foil bladed wheel. Provide combustion air-fan wheel which is directly driven by a TEFC NEMA frame motor and complete with inlet cone and screen and flange outlet. Mount bottom flanged combustion air fan on same structural member as windbox. Size combustion air-fan to provide sufficient static pressure to overcome system losses when providing 15 percent excess air at maximum firing rate, plus the amount of flue gas induced to comply with the NO_x emission requirements.

2.5.5 Combustion Air Damper

Provide flanged combustion air damper and locate between combustion air fan and windbox. Provide combustion air damper suitable for specified turndown and provide same turndown performance when up to 15 percent flue gas is induced and mixed in the airstream.

2.5.6 Fuel Oil Burner

Provide [mechanical pressure atomizing] [steam atomizing][air atomizing] type fuel oil burner conforming to UL 296, UL 726 and NFPA 85, capable of burning [heated] [unheated] [No. 6] [No. 4] [No. 2] fuel oil. Ensure fuel oil burner is capable of firing boiler to maximum capacity with turndown range of [eight (8) to one (1) for boiler above 2452 kW 250 horsepower] [four (4) to one (1) for boiler 2452 kW 250 horsepower or less]. Provide fuel oil burner that is quiet in operation without blowtorch effect or tendency to localize heat at any one part of combustion chamber and without depositing unburned oil on any part of combustion chamber or boiler. Ensure fuel oil burner is easily moved out of firing position for cleaning, inspection, adjustment and maintenance.

2.5.7 Natural Gas Burner

Natural gas burner must be a multi-spud burner with gas feed pipe in center of air register for easy removal. Provide forced draft type natural gas burner suitable for efficiently burning natural gas having a calorific value of [_____] Joules per cubic meter Btu per cubic foot when supplied at a pressure of approximately [_____] kPa psig. Discharge natural gas in burner throat area. Natural gas-air premix or natural gas discharged outside of burner throat are not acceptable. Main natural gas burner must be capable of firing the boiler to maximum capacity with a turndown of [ten (10) to one (1) for boilers above 2452 kW 250 horsepower] [four (4) to one (1) for boilers 2452 kW 250 horsepower or less].

2.5.8 Flame Safeguard System

****

NOTE: Edit for fuel choice and select appropriate options.

****

a. Provide flame safeguard system that is manufactured by burner manufacturer and mount in boiler control panel as a panel insert. Provide UL listed flame safeguard system components. Provide complete and automatic flame safeguard system in accordance with NFPA requirements safe start-up, on-line operation and shut-down of package burner.

b. Provide micro-processor based flame safequard system including, but not limited to, automatic burner sequencing, flame supervision, status indication, fire-out annunciation and self diagnostics.

c. House overcurrent protective devices, and motor starters for the combustion air fan motor, burner damper motor and electric oil heater. Also include control transformers and an RS-232C serial communication port.

d. Flame scanner must not require a separate purge air supply. Connect flame scanner output signal to flame amplifier module in microprocessor based unit. Within four seconds after loss of flame, flame safeguard controller must shut the automatic safety shut-off fuel valve[s] [and open the gas automatic vent valve]. Display flame failure signal on flame safeguard display or burner control panel.

e. Provide logic with flame safeguard system to:

   (1) Prevent introduction of igniter flame (pilot) or main fuel flame to furnace until furnace, boiler passes, breeching and stack have been purged of combustible gases.

   (2) Prevent opening of automatic fuel shut-off valves in main fuel line until igniter flame is proven.

   (3) Limit trial for main fuel ignition to ten (10) seconds from time igniter flame is proven.

   (4) In event of burner failure, require operator intervention to manually reset flame safeguard controller prior to restart.

f. Provide first-out annunciation by an expansion module. Annunciate alarms and flame-outs individually at panel front and transmit along with other process points monitored by the panel to [Central Monitoring System (CMS)] [Supervisory Computer Workstation[s]] for graphic display. At a minimum, annunciate the following points individually by flame safeguard system:

(1) Low water level.

(2) Low water cutoff.

(3) High water level.

(4) High steam pressure.

(5) Low atomizing [steam pressure] [or] [air pressure].

(6) Low fuel oil pressure.

(7) Low fuel oil temperature.

(8) High natural gas pressure.

(9) Low oxygen concentration.

g. Provide flame safeguard system cabinet with [natural gas] [No. 6] [No. 4] [and] [No. 2] oil fuel selector. Integrate selector into controls such that when No. 2 oil is selected, low oil temperature switch [and electric heater] [is] [are] taken off line from oil train.

h. Also provide indicating lights for the following:

(1) Limits satisfied.

(2) Purging.

(3) Pilot ON.

(4) Main flame ON.

(5) Flame failure.

(6) Fuel oil ON.

(7) Natural gas ON.

i. Provide industrial, oil-tight construction indicating pilot lights with push-to-test feature or "All-Pilot Lights" test button.

2.5.9 Boiler Piping Trains

****

NOTE: Delete oil heater, oil temperature switches and oil temperature gauge for plants which will not burn oil heavier than No. 2 fuel oil now or in the near future. When heavy oil is burned, steam is typically used to heat it nearly to burning temperature and electric heat is used for trimming (approx. 11 to 17 degrees C 20 to 30 degrees F). However, full capacity electric oil heating (approx. 56 degrees C 100 degrees F rise) or other independent heat source is needed to cold-start the plant. Cold start capability should be provided for at least two boilers for multiple boiler plants. If the plant is operable on emergency power,

consideration should be given to supplying the full capacity electric oil heaters from the emergency source.

****

Provide completely prepiped piping train, wire and mount on boiler. Provide [fuel oil and [steam] [air] atomizing systems] [and] [natural gas] train in accordance with NFPA and FM standards and requirements and including, but not limited, to the following items:

2.5.9.1 Fuel Oil Train

a. NFPA 31.

b. Adjustable fuel oil pressure regulating and relief device.

c. Fuel oil flow control valve with characterizing adjustments to match airflow.

d. Dual (NC) motorized oil shut-off valve with proof of closure.

e. Low fuel oil pressure switch.

f. Fuel oil flow transmitter.

g. Fuel oil pressure gauge for fuel oil supply and burner pressure.

h. Manual shut-off valves at connections to supply and return headers.

i. "Y" type strainer.

j. Fuel oil check valve.

k. High fuel oil temperature switch.

l. Low fuel oil temperature switch.

m. Fuel oil temperature gauge.

n. Electric fuel oil preheater capable of raising oil temperature 56 degrees C 100 degrees F at rated firing rate and comply with UL 574.

2.5.9.2 Steam Atomizing Train

a. Manual shut-off valve at connection to atomizing supply.

b. Y-type strainer in atomizing steam line.

c. Automatic shut-off solenoid and check valve in atomizing steam branch line to allow automatic purging of burner.

d. Check valve to prevent backflow in steam line.

e. Pressure gauge with isolating valve for servicing in atomizing steam supply and at burner.

f. Solenoid shut-off valve to close when burner shuts down.

g. One self-contained pressure regulating valve to maintain atomizing steam pressure.

h. Low atomization steam pressure switch.

i. Steam trap.

2.5.9.3 Air Atomizing Train

a. Manual shutoff valve at connection to atomizing supply.

b. Y-Type strainer in atomizing air line.

c. Automatic shutoff solenoid and check valve in atomizing air line to allow automatic purging of burner.

d. Check valve to prevent backflow in air line.

e. Pressure gauge with isolation valve for servicing in atomizing air supply and at burner.

f. Solenoid shutoff valve to close when the burner shuts off.

g. One self-contained pressure regulating valve to maintain atomizing air pressure.

h. Low atomization air pressure switch.

2.5.9.4 Natural Gas Trains

a. NFPA 54.

b. Natural gas flow control valve with characterizing adjustments to match airflow.

c. Manual shut-off valve (NO) at supply and discharge of vent and drain valves.

d. Manual shut-off valve (NO) at igniter natural gas supply and discharge of vent and drain valve.

e. Y-type strainer supplied in igniter natural gas and main natural gas lines.

f. Two (NC) solenoid safety shut-off valves, in series, in igniter line with one (NO) solenoid vent valve located between safety shut-off valves, piped to atmosphere through the roof.

g. Two shut-off valves with proof of closure, piped in series in main gas line with one (NO) solenoid vent valve located between safety shut-off valves, piped to atmosphere through the roof.

h. One pressure regulating valve in igniter natural gas line to regulate natural gas pressure to igniter.

i. One pressure regulating valve to regulate main natural gas pressure at natural gas train inlet.

j. Natural gas meter.

k. Natural gas flow transmitter for main natural gas to burner.

l. Pressure gauge, with shut-off valve for main natural gas supply.

m. Pressure gauge, with shut-off valve for main natural gas at burner.

n. Pressure gauge, with shut-off valve for natural gas supply to igniter.

o. Pressure gauge, with shut-off valve for natural gas igniter.

p. Low natural gas pressure switch.

q. High natural gas pressure switch.

2.6 CONTROLS

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NOTE: This paragraph specifies several levels of available control systems. Bracketed text or section denotes designer's options. The base level of required controls is an integrated system of local control and monitoring panels. An upgrade to this system would include a remote supervisory workstation to monitor and alarm functions of the boiler plant via a network controller LAN.

****

a. Provide boiler controller and plant master controller systems, and other sub-control systems specified herein by a single control manufacturer.

b. For multiple boiler installation, boiler No. 1 control panel must act as the plant master control and contain controls common to all boilers. Provide interfaces between flame safeguard, combustion control and burners.

c. Provide electronic, solid state, microprocessor type system components. Operate control components on 120 VAC power.

d. Provide 4-20 mA DC analog signals to and from field-mounted devices. Provide [4-20 mA] [1-5V] DC analog signals between rack or panel-mounted devices.

2.6.1 Instrument System

Power instrument systems by 120 volts alternating current, 60 Hertz or 24 volts direct current 2-wire system. The 24 volts direct current powered systems must receive power from the central control system. Provide instrument enclosures conforming to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Transmitter output signals must be 4 to 20 mADC.

2.6.2 Indicating Instruments

Provide indicating instruments that have the normal operating point marked in green on instrument. Provide transmitters which include output meters in integrally mounted housings. Ensure calibration is set by manufacturer, and adjustment access is internal only.

2.6.3 Factory Tests

Inspect, calibrate, and test instruments, units, and other accessories. Calibrate to manufacturer's standard for accuracy of input versus output. Submit Certificates of inspection, test, and calibration tags of instrumentation to be used during boiler acceptance test ensuring compliance with standards; certificate of compliance with applicable codes after boiler installation and one certificate for each boiler. Control system manufacturer must configure, program, stage, and burn-in the control system prior to shipment to construction site. Perform programming of configuration and constants data at this time, and store on disks. Perform burn-in for a minimum of 10 days of continuous operation. The Government reserves right to witness factory tests. Give a thirty-day advance notice to the Government prior to commencing any factory tests.

2.6.4 Sequence of Operation

a. Using plant master controller vary firing rate of [all] boiler[s] [in parallel]. Plant master controller must receive a pressure signal from main steam header and generate a signal to drive boiler master controller[s].

b. Boiler master controller must increase or decrease firing rate based on comparison to setpoint.

   c. Provide steam pressure control including proportional plus reset control modes.

c. Integrate combustion controls fully with flame safeguard system to assure low-fire startup and complete purge regardless of boiler master output signal.

d. Ensure combustion control strategy is single point positioning with oxygen trim.

e. Control boiler firing rate by actuating burner jackshaft drive motor to move jackshaft that mechanically links fuel and combustion airflow.

f. Accomplish boiler oxygen trim by modulating combustion air damper to alter fuel-air ratio based on input from oxygen analyzer.

g. Ensure control loops include manual-automatic stations to provide for control of system. Provide each manual-automatic station with a built in indicator to graphically depict variable being controlled.

h. Arrange control system so that failure of control system for one boiler does not affect automatic and manual operation of other boilers. Electrically isolate common electrical signals in each boiler section.

2.6.5 Enclosures

a. Provide free-standing or boiler-mounted factory-assembled steel enclosure with indicators, control switches, flame safeguard cabinet and indicating lights on cabinet front and relays and other components mounted on interior subbases for each boiler. For multiple boiler installations, the boiler No. 1 panel must contain controls common to all boilers. Provide enclosure with locking doors and complying with NEMA ICS 6.

b. Provide NEMA 12, 11 gage steel enclosure, consisting of all welded construction with minimum radius corners, stiffened as required and framed with angles. Construct door of 14 gage steel with key-locking vault handle and three (3)point latches. Ensure doors are fully gasketed.

c. Clean, phosphatize, prime and finish metal surfaces. Interior must be glass white enamel. Exterior must be gray texture polyurethane enamel to provide resistance to fuel oil, solvents and abrasion. Provide engraved plastic laminated nameplates for devices on the front of the cabinet except where devices themselves are provided with a service engraving. Provide nameplates with white letters on a black background and minimum height of 6.5 mm 0.25 inch, mount with screws or epoxy or secure by pilot light or switch. List equipment title and identification number. Abbreviations are not acceptable.

d. Support enclosure mounted devices properly, front and rear and must occupy the upper portion of the enclosure front.

e. Provide enclosure wiring in compliance with acceptable standard panel practice.

f. The 120 volt, 60 Hz circuit wiring must be number 16 AWG minimum, THWN 600 volt insulation, color coded. Signal circuits, less than 50 volts, must be number 18 AWG minimum or number 20 AWG in multi-conductor cable.

g. Wire devices requiring power so that when wires are removed from one device, power will not be interrupted to other devices. Wire enclosure-mounted devices to numbered lug and screw terminals so that field wiring can easily be terminated in the panel.

h. Supply signal common and power common buses. Connect signal common to earth ground at one point.

2.6.6 Controllers

****

NOTE: Single loop controllers are specified. Consider programmable logic controllers (PLCs) as an option.

****

a. Provide microprocessor-based controller of single loop design. Flush-mount controller with splash-proof mylar faces in control cabinet. Provide membrane type operator pushbuttons with tactile feedback. Provide a 4-1/2 digit numeric display on front of controller.

b. Provide two bar graphs on the front of controller to give an analog interpretation of process variables, setpoints or deviation. Ensure these are of the 100 segment LED type. Provide a dedicated 20 segment LED bar graph for the controller main output.

c. Provide each controller that drives a final control device (damper, valve or other) with a hard manual backup station to ensure operator control in the event of a memory failure or service requirement.

d. Provide controller output logic including proportional, plus integral, plus derivative (PID) modes.

e. Multiple loops on single controller are not acceptable. During integral hard manual backup mode, ensure operator has control of output via up-down pushbutton and output indication.

f. Should the controller or memory fail, controller must deenergize a dead-man relay and alert operator to use backup station.

g. Backup station may be separate station or may be integral to main controller. If Integral, backup circuitry must function when controller is removed for servicing.

h. Provide controller capable of being configured in field without use of external computers, hand-held terminals, EPROM programmers or other devices.

i. Accomplish configuration changes and tuning adjustments y means of key pad on controller front. Protect controller digital circuitry from power surges and spikes by optical isolation or by uninterruptible power supply.

j. Maintain configuration in (2) removable battery backed RAM chips. Failure in primary memory must cause backup memory to be downloaded automatically.

k. Equipment Controller Self-Tuning PID Loop Routine

(1) Self-Tuning PID Loops: Three methods of tuning PID Loops must be available: Manual, Automatic, and Adaptive. Provide tuning utility allowing collection of data and process tuning in real time.

(2) The tuning utility must display following information on display upon operator request: Control loop being tuned, Input process variable, Output control variable, setpoint of loop, Integral reset interval, and Proportional band, Derivative rate interval.

(3) Display above information on supervisory workstation in graphic format with automatic scaling such that the input and output variable are superimposed on a graph of time versus variable. Ensure program allows operator to affect output variable by modifying setpoint, and tuning parameters, and view results on display.

(4) Automatic Tuning: Provide controller with on-line or manual utility to disturb process. Monitor the results and calculate new parameters for sample interval, Proportional band, Integral gain, and Derivative gain. Ensure utility is usable during commissioning process to establish reasonable values, then turned off.

(5) Adaptive Tuning: Provide controller with on-line utility which may run continuously.

(6) Initiate adaptive tuning automatically whenever operator-defined change in the process input variable is detected. Utility must monitor process (control loop) after natural disturbance, and automatically recalculate Proportional gain, Integral gain, and Derivative gain. Use this utility to keep a system tuned, as the equipment ages and occupancy and loads change, after commissioning.

l. The tuning utility must display following information on the CRT upon operator request:

  (1) Adaptive control is enabled or disabled.

  (2) Maximum bump: output step change required to produce a change in input, greater than noise level, but not so great as to damage equipment.

  (3) Setting time: time it takes PID output process variable to settle down after a process disturbance. For automatic tuning, time interval between setting PID output to control point and beginning of tuning cycle. For adaptive tuning, minimum time that will be observed between parameter calculations.

  (4) Maximum overshoot: percent allowed.

  (5) Target damping: desired reduction in process variable overshoot from first overshoot (maximum overshoot) to second, in percent.

  (6) Noise band: minimum process variable perturbation that will initiate adaptive calculation of PID parameters, in percent of input range.

m. Provide controller with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controller [and to supervisory computer workstation].

2.6.7 Plant Master Controller

a. Plant master controller [must match individual boiler master controller[s] and] must provide for proportional, integral, and derivative (PID) control of firing rate demand based on steam header pressure. [Locate plant master controller in the boiler No.1 cabinet.] The output of the plant master controller must go to the boiler master plant master controller. Provide digital display of the following:

  (1) Controller output.

  (2) Steam pressure.

  (3) Steam pressure setpoint.

  (4) Outdoor temperature.

  (5) Total plant steam flow.

b. Provide inputs as follows:

  (1) Steam pressure (Analog).

  (2) Steam flow signal from individual boiler (Analog.)

  (3) Outdoor temperature (Analog).

[(4) Fuel oil temperature (Analog).]

[(5) Fuel oil pressure (Analog).]

[(6) Natural Gas pressure (Analog).]

c. Provide outputs as follows:

(1) Boiler master signal (Analog).

(2) Total plant steam flow.

(3) Totalized steam flow pulse.

d. Provide controller with protocol converter/gateway with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory computer workstation.]

2.6.8 Boiler Master Controller

a. Provide each boiler with a boiler master controller. Control jackshaft in response to plant master demand signal or in response to boiler pressure and local setpoint. Use primary analog output to modulate jackshaft actuator of boiler. Logic required to ensure that prepurge, postpurge, lightoff and burner modulate cycles are handled correctly and according to local regulation is the burner manufacturer's responsibility. Controller digital display must include the following in their respective engineering units:

(1) Controller output.

(2) Natural Gas flow.

(3) Fuel Oil flow.

(4) Local setpoint.

b. Controller inputs are:

(1) Plant master signal.

(2) Steam flow.

(3) Steam pressure (Analog).

(4) Natural gas flow (Analog).

(5) Fuel oil flow (Analog).

(6) Firing rate hold (Contact).

(7) Purge from flame safeguard system (Contact).

(8) Auto from flame safeguard system (Contact).

(9) Remote alarm silence (Contact).

c. Controller outputs are:

(1) Jackshaft drive (Analog).

(2) Remote audible alarm (Contact).

(3) Flow pulse for natural gas flow totalizer (Contact).

(4) Pulse for fuel oil flow totalizer (Contact).

d. Provide controllers with protocol converter/gateways with an TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory computer workstation.]

2.6.9 Feedwater Controller

****

NOTE: Specify two-element boiler water level control for smaller capacity plants with relatively stable loads, such as space heating. Specify three-element control for larger capacity plants and unstable loads, such as industrial process and Navy pier facilities.

****

a. Feedwater controller must match other controllers in system and provide [two] [three] element PID control of boiler water level in response to changing boiler level and feed forward signal of steam flow. Automatically switch to single element feedwater control strategy during cold startup when steam and feedwater flow signals are not active. Ensure controller digital displays are as follows in their respective engineering units:

(1) Controller output.

(2) Water level.

(3) Steam flow.

(4) Feed water flow.

b. Controller inputs are:

(1) Water level.

(2) Steam flow.

(3) Feed water flow.

(4) Remote alarm silence (Contact).

c. Controller outputs are:

(1) Feedwater control valve (Analog).

(2) Remote audible alarm (Contact).

(3) Steam flow (Analog).

d. Provide controllers with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory computer workstation.]

2.6.10 Draft Controller

a. Draft controller must match other controllers in system and have capability of PI control of furnace draft in response to changing furnace pressure and feed forward signal of boiler load.

b. Control system includes logic required to interface with flame safeguard system so as to insure that prepurge, postpurge, lightoff and burner modulate cycles are handled correctly and in accordance with local regulations.

c. Provide controller with characterizable setpoint curves for feed forward signal based on load.

d. Ensure controller digital displays are as follows in their respective engineering units:

  (1) . Controller output.

  (2) Furnace draft.

  (3) Furnace draft setpoint.

e. Controller inputs are:

  (1) Jackshaft output (Analog)

  (2) Furnace draft (Analog).

  (3) Purge from flame safeguard system (Contact).

  (4) Auto from flame safeguard system (Contact).

  (5) Remote alarm silence (Contact).

f. Controller outputs are:

  (1) Flue gas damper actuator (Analog).

  (2) Remote audible alarm (Contact).

g. Provide controller with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory computer workstation.].

2.6.11 Oxygen Trim Controller

a. Oxygen trim controllers must match other controllers in the system and have the capability of PID control of fuel/air ratio in response to flue gas oxygen content.

b. Provide controller capable of calculating and displaying boiler efficiency using ASME "By Losses" method.

c. Control system includes logic required to interface with flame safeguard system so as to ensure the prepurge, postpurge, lightoff and burner modulation cycles are handled correctly and in accordance with local regulations.

d. Ensure controller digital displays are as follows in their respective engineering units:

  (1) Controller output.

  (2) Flue gas temperature.

  (3) Combustion air temperature.

  (4) Boiler efficiency.

  (5) Flue gas oxygen percentage.

  (6) Jackshaft position.

e. Controller inputs are:

  (1) Fuel flow (oil or natural gas) (Analog).

  (2) Flue gas temperature (Analog).

  (3) Flue gas oxygen (Analog).

  (4) Combustion air temperature (Analog).

  (5) Fuel selection (Contact).

  (6) Remote alarm silence (Contact).

  (7) Jackshaft position (Analog).

f. Controller outputs are:

  (1) Oxygen trim actuator (Analog).

  (2) Boiler efficiency.

  (3) Remote audible alarm (Contact).

g. Provide controllers with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory workstation.]

2.6.12 Alarm Annunciator

a. Provide each boiler master panel with single horn and single alarm silencing pushbutton. Provide first out alarm annunciation for following alarm points to activate alarm horn:

  (1) Low steam pressure.

  (2) High steam pressure.

(3) Low water level.

(4) Low oxygen.

(5) Low draft.

(6) Low efficiency.

(7) High flue gas temperature.

(8) High opacity.

b. Each alarm condition must activate separate visual indication to allow operator to locate cause of alarm. This may be accomplished with first out annunciator having labeled windows and individual clearly labeled lights or with microprocessor based English language alarm message display. Sound horn for every new alarm, even if previously silenced.

c. Provide controllers with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory workstation.]

2.6.13 Opacity Monitor

a. Provide double pass system to provide continuous stack opacity indication.

b. Provide system consisting of transceiver and retro-reflector module mounted on opposite sides of the stack, and electronic monitor.

c. Use bi-directional digital communications link to connect electronics processor and transceiver module.

d. Provide transceiver with backlit pushbutton for calibration offline.

e. Provide light source and receiver with air purge system for use with plant air.

f. Ensure electronics withstand air failures and maintain on-line service without shutdown. Provide field-mounted device in NEMA 4 enclosure.

g. Ensure system is suitable for operation on 120 volt single-phase power.

h. Provide system in compliance with latest requirements of [_____] City air pollution control code, [_____] City engineering criteria for fuel burning equipment and [_____] State Department of Environmental Protection Opacity Monitoring Requirements.

i. When performing on-stack calibration, check each component of opacity system including: light, source, receiver, optics on stack and associated electronics.

j. Provide a minimum of two (2) months unattended operation. At selected intervals the system must perform fully automatic, on-stack calibration including zero and span. Automatically and continuously correct the measurement for variations in temperature, line voltage, lamp aging and component drift. Provide dirty lens detection system with alarm and four independently selectable optical density filters with range switches. System must sample and mold control output during calibration.

k. The output from the system includes:

    (1) 4-20 mADC output.

    (2) Digital display of opacity.

    (3) Two digital violation occurrence meters, one for total elapsed time and one for number of occurrences.

l. Program is as follows: When opacity exceeds setpoint, instant flashing alert light signals; at 20 seconds, alarm light lights and contacts close. At 60 seconds, lights and contacts lock and require manual reset.

2.6.14 Vertical Scale Indicators

Provide vertical scale indicators that are 150 mm 6 inches high for steam header pressure, outdoor air temperature and combustion air temperature.

2.6.15 Digital Indicators

Provide oversized digital indicators for fuel oil flow and gas flow. [At manufacturer option, controller displays may be used if they show each value in engineering units, include 16 character alphanumeric display describing what is displayed and include dedicated bar graph that can be used for each value.]

2.6.16 Draft Gauge

Mount draft gauges for wind box, combustion chamber and last boiler pass on panel front. Field verify operating ranges for draft gauges with normal reading in middle of scale range. Include piping between gauge and boiler with three (3) way cocks for shutoff and zero check.

2.6.17 Recorder

a. Provide circular chart type recorder with direct reading having evenly divided graduation. Drive charts by 120 volt, 60 Hz motors. Provide pens with different color ink and arrange to pass each other without interference. Each chart must show 24 hours.

b. Record up to four points. Ensure recorder unit is fully programmable in order that each channel can be configured to accept 4-20 mA DC voltage, thermocouple and RTD inputs. Ensure nonlinear inputs are linearized and make provisions for special linearizations.

c. In addition to recording, make provisions for individual 16 character tags and messages per channel and provide up to four integrators which are selectable either as reset or non-reset type. Fit each channel with two alarms selectable as absolute, rate of change or deviation.

d. Measure the following points:

    (1) Steam flow.

    (2) Percent oxygen.

(3) Flue gas temperature.

(4) Opacity.

e. Provide recorder with protocol converter/gateways with TIA-485 multi-drop communications port for controller LAN network interconnection to field panel controllers [and to supervisory workstation.]

2.6.18 Totalizer

Provide eight-digit, non-resettable totalizers for: natural gas, fuel oil and steam flow flush-mounted in each boiler control panel. Display directly in engineering units. Only powers of ten (10) are allowable as scale factors. Back up power by a lithium battery with a life span of no less than 8 years. [Smart transmitters may be used to communicate to associated controllers on a device level network LAN. Smart transmitters are not allowed to reside on controller LAN]

2.7 FIELD DEVICES

Furnish and install the following field devices to provide a complete working system.

2.7.1 Oxygen Analyzer

****

NOTE: Consider specifying a reference and calibration gas system for plants having two or more boilers at 11,700 kW 40,000 lb/hr or greater capacity. Otherwise, delete.

****

a. Provide oxygen analyzer for each boiler. Stack-mount oxygen analyzer and utilize zirconium sensing element. Insert sensing element directly in flue gas stream and in direct contact with process gases. Contain sensing element within a protective housing mounted to flue gas outlet by means of adapter plate, both furnished by manufacturer.

b. Equip oxygen analyzer to allow daily calibration check without removing analyzer from process.

c. Sample gases may be injected directly on sensing element while analyzer is in process.

d. In order to eliminate temperature effect of flue gases, provide externally-mounted temperature controller. Provide isolated 4-20 mA DC temperature controller output representing 0-10 percent oxygen content as linear function.

e. Provide reference and calibration gas system for each boiler consisting of gas supply, regulator with relief valve, gauge and necessary valving and piping. Provide electrical power connections and piping for distribution to calibration gas connection on each analyzer.

2.7.2 Fuel Oil Flow Transmitter

a. Provide fuel oil flow transmitter for each fuel oil flow meter. Ensure transmitter output is isolated 4-20 mA dc.

b. Connect panel-mounted totalizer to transmitter. Provide necessary signal conditioning devices to integrate fuel oil flow transmitter with control and recording instrument panels.

c. Smart transmitters may be used to communicate to associated controllers on device level network LAN. Smart transmitters are not allowed to reside on controller LAN.

2.7.3 Natural Gas Flow Transmitter

Provide natural gas flow transmitter for each natural gas meter. Smart transmitters may be used to communicate to associated controllers on device level network LAN. Smart transmitters are not allowed to reside on controller LAN.

2.7.4 Steam Flow Meter-Transmitter

a. Provide steam flow meter-transmitter consisting of a Vortex-Bar meter probe designed for pipe insertion type installation by means of hot tap or other non-disruptive method. Measure media flow by means of a vortex shedding flow element located in flow stream.

b. Provide steam flow meter-transmitter with sliding-type stem passing through two pressure seals allowing proper positioning of sensor in flow stream and isolation valve so that transmitter can be completely removed from pipeline without disruption of process. Supply steam flow meter with a two-wire preamplifier with analog 4 to 20 mA dc output signal.

c. Meet the following performance criteria:

(1) Pressure Rating: To [950 kPa 125 psig] [205 degrees C 400 degrees F][_____].

(2) Seals: Teflon.

(3) Wetted Parts: Type 316 stainless steel with 304 stainless steel body.

(4) Flow Rangeability: 10:1.

(5) Linearity: Plus or minus 1.0 percent (to 24 mA output).

(6) Repeatability: Plus or minus 0.25 percent at maximum.

(7) Current Limit: To approximately 30 mA.

d. Meet the following materials of construction criteria:

(1) Sensor: Type 316 stainless steel.

(2) Sensor Support: Type 304 stainless steel.

(3) Bushings: Stellite or stainless steel hardened with stellite.

(4) Stem: 300 Series stainless steel.

e. Provide with steam flow meter-transmitter a full port gate valve with proper flanged connection that allows steam flow sensor to be inserted and removed from pipe under full pressure. Provide both valve and pipe tap with a minimum [48 mm 1.875 inches] [_____] internal diameter clearance.

f. Provide NEMA [4] [4X] electronics enclosure.

g. Smart transmitters may be used to communicate to associated controllers on device level network LAN. Smart transmitters are not allowed to reside on controller LAN.

2.7.5 Temperature Transmitter

a. Provide platinum resistance temperature detector (RTD) temperature transmitter. Ensure resistance is 100 ohms at [0 degrees C 32 degrees F] [_____] with tolerances in accordance with BS 101-4 and DIN 43760.

b. Make connections to control cabinet via three identical copper conductors of No. 14 AWG minimum.

c. Insert RTD in protective sheath or well suitable for the environment.

d. Utolize platinum RTD input to provide 4-20 mA dc output to control cabinet. Ensure transmitter is plus/minus 0.2 percent accuracy of calibration span, to include combined effects of transmitter repeatability, hysteresis, linearity and adjustment resolution.

e. [Smart transmitters may be used to communicate to associated controllers on device level network LAN. Smart transmitters are not allowed to reside on controller LAN.]

f. Monitor the following temperatures.

    (1) [Fuel oil (each boiler)].

    (2) Flue gas (each boiler).

    (3) Combustion air (each boiler).

    (4) Outdoor air (one (1) per plant).

2.7.6 Electric Drive

a. Provide electric drive for jackshaft and flue gas dampers. Accept signal input from control system and provide feedback of actuator position by means of integral potentiometer. Include four adjustable end switches.

b. Provide electric drive with 90 degree rotation in 15 seconds and capable of [_____] Newton Meter ft-lbs of torque under continuous duty.

2.7.7 Pressure Transmitter

Provide pressure transmitter with 0.25 percent of full scale accuracy, process fluid isolating diaphragms, 5:1 field calibration adjustability, NEMA 4 housing and 4-20 mA dc output. Provide pressure transmitter with a calibration valve manifold. Include an isolating siphon with pressure transmitter for steam service. Provide the following transmitters:

a. Steam pressure (one per plant).

[b. Fuel oil pressure.]

[c. Natural gas pressure.]

d. Furnace draft.

2.7.8 Differential Pressure Water Level Transmitter

a. Provide boiler with differential pressure type water level transmitter.

b. Provide differential pressure type water level transmitter with 0.25 of full scale accuracy, process fluid isolating diaphragms, 5:1 field calibration adjustability, NEMA 4 housing and 4-20 mA dc output.

[c. Smart transmitters may be used to communicate to associated controllers on a device level network LAN. Smart transmitters are not allowed to reside on the controller LAN.]

2.7.9 Pressure Switch

Provide pressure switch with repetitive accuracy of plus or minus 1 percent of the operating range. Adjust pressure switch actuation over the operating range. Provide pressure switch with snap-action Form C contacts rated for the application.

2.7.10 Temperature Switch

Provide temperature switch with repetitive accuracy of plus or minus 1 percent of the operating range. Adjust temperature switch actuation over operating temperature range. Provide temperature switch with a snap-action Form C contacts rated for the application.

2.7.11 Oxygen Trim Drive

Provide oxygen trim drive that is the in-line piston type actuator in linkage from jackshaft to combustion air damper. Use oxygen trim drive to position combustion air damper based on signal from oxygen trim controller.

2.7.12 Supervisory Computer Workstation

****

NOTE: For new central steam plants or as an upgrade of existing central steam plants consider the following section to provide remote monitoring capability trend logging and graphical system interface.

****

a. Provide dedicated monitoring and data collection system supervisory computer workstation, complete with custom software as specified. Collect and store data transmitted from system controllers and other sensing and monitoring devices, and log alarms. Use software described to generate periodic reports. Data collection function takes priority over report generation function and do not interrupt by generation of reports.

b. Log data at five (5) second interval that is adjustable as required. In event of alarm condition or unusual plant operating condition, immediately initiate data logging.

c. Design supervisory computer workstation computer such that a failure of the CPU, the storage disk, or any other device does not result in the loss of any previously stored data.

d. Include the computer, keyboard, printer, monitor, and other peripherals and locate as shown. Provide cabling between the work station and the system controllers. Provide all prefabricated cabling required between the work station and peripheral devices.

e. Ensure authorized personnel is capable of editing and modifying programs with access code. Provide password protection for all levels of access. Ensure multiple level password protection system is acceptable to the Owner.

f. Ensure supervisory computer workstation computer is a microprocessor based personal computer. Provide computer with eight expansion slots. Ensure computer is Microsoft Windows $^{(R)}$ compatible, each with a floppy disk drive, 17 inch high resolution SVGA color monitor for graphic displays. Provide hard disk drive with sufficient capacity to perform required data substitution routines without accessing other data storage media. [Provide a 650 MB CD-RW reader-writer-rewriter drive with minimum of 8X write, 4X rewrite and 24X read speeds and 25 preformatted rewritable and 100 preformatted writable CD media disks or archival and routine backup.] Include the following minimum equipment as part of the supervisory computer workstation:

(1) Intel Pentium III Class 633 Mhz Micro Processor or approved equal.

(2) 128 MB RAM.

(3) 4 MB RAM video adapter.

(4) [20] [_____] GB hard disk.

(5) 2 Parallel Ports.

(6) 2 Universal Serial Bus (USB) Ports.

(7) 56,600 Baud Modem.

(8) Synchronous adapter with dual port compatible with supervisory computer workstation interface hardware.

(9) Equip the keyboard with thirty-two function keys with custom legends for each key, to allow report generation, graphic display selection, alarm silencing, and data retrieval with single key strokes. Provide keyboard with a high resolution track ball.

g. Provide the following additional peripheral equipment as shown:

(1) Inkjet printer, 1200 dpi by 1200 dpi, tri-color and black ink cartridges or four ink cartridges (red, blue, yellow and black).

(2) Inkjet printer, 1200 dpi by 1200 dpi, dual ink cartridges (tri-color and black) or red, blue, yellow and black ink

cartridges or color laser printer.

2.7.12.1 Software

****
NOTE: Text within brackets denotes the designer's options.
****

a. Provide software required for efficient operation of automatic system functions required by this specification. Software must be modular in design.

b. Provide available supervisory computer workstation application and system software with system, which resides in supervisory computer workstation computer. Unbundled software packages for which vendor can charge user extra fees, require dedicated work stations or require system rebooting for access, are unacceptable.

c. Provide licensing agreement from PC manufacturer for each software program or package specified to ensure customer support from PC manufacturer for each copy of software program or package provided at supervisory computer workstations.

d. Provide software in system consisting of both firmware, resident in the controller, and software resident in the supervisory computer workstation computer. Distribute architecture of system, application software and firmware with no single system component responsible for a control function for entire LAN. Provide each controller with the necessary firmware, control software and I/O capability to function independently in case of network failure. Ensure controller is able to stage, rotate and fully control the equipment during a communication failure with network LAN. Active control sequences are prohibited in supervisory computer workstation or central control unit. Provide workstation and controllers that are removable from system without loss of control function. Only alarm monitoring, long-term history collection and operator monitor, command, and edit functions may be lost.

e. Provide software upgrades while maintaining full operational control of loss of any operating features for five years after Government acceptance of system at no additional cost. Software upgrades include new versions, releases, upgrades and wholesale revisions in software. This does not include labor required to update graphic pages or revise control sequences, except as caused by revisions in software.

f. Provide necessary hardware, software and programming to allow remote access to system via the Internet. Access will allow user located off-site to view and monitor current conditions at site. Acceptable configurations are software program making the host PC accessible through the Internet or development of Internet web pages specifically for site.

2.7.12.2 Software Capabilities

[a. Provide primary operator interface to system through graphical, object oriented, and interactive presentation using mouse and cursor for object selection and commands. Use Microsoft Windows based plant management software.]

[b. Support pop-up windows for point commands. On selecting object with cursor, open up a window to present operator with choices corresponding to operator's password authorizations. These point commands include state changes, manual override of application software, test mode activation and test value entry. This window includes the point descriptor (name), the point hardware address and alarm status.]

[c. Support pop-up windows for point editing. On selecting object with cursor, open up a window to present operator with a list of active point data base editors, if permitted by the operator's password level. Allow operator to modify basic parameters associated with a point, as well as access to programs assigned to the point such as time schedules, calculations, and events by selecting one of these editors.]

[d. Base system on interactive prompts and choices, using dialogue boxes as opposed to memorization of commands, syntax or exact spellings. Use interactive prompt and choices approach in monitoring, issuing commands, and editing. Use command choices which entail clicking cursor to select correct work choice prompts, for example: ON-OFF, without typing in letters. Provide editing mode choices that prompt ranges or options, for example: 16 CHARACTERS for point name, or DIRECT-REVERSE for control action).]

[e. Zoom: Make it possible for operator to locate system point to monitor status, issue commands, or edit associated database without knowledge of the point name, address, or associated controller, and without having to refer to a tree directory. Ensure operator is able to locate control points by, for example, zooming in on a floor in a building graphic or zooming in on a system in a floor plan graphic.]

f. Compile system software for faster execution speeds and offer the following features and capabilities.

(1) Input/Output Capabilities: From the connected supervisory computer workstation, the system operator must have ability to:

(2) Request displays of current values or status using a tabular [or graphic format.] [Use a global data base sorting utility which allows an expanded tabular display of only points on current graphic display.] This [expanded tabular] display must list point name, hardware address, dynamic state or value, alarm status, override and test mode status.

(3) Initiate logs and reports.

(4) Change analog limits.

(5) Change point input and output descriptors, status, alarm descriptors and engineering unit descriptors while system is on-line.

(6) Modify and set up maintenance scheduling parameters.

(7) Develop, modify, delete or display full range of color graphic displays. Ensure development, editing and display work is possible with system fully on-line and in full communications with the Controller LAN without disruption of system function.

(8) Select discrete or analog sample data from the field to be automatically archived in the assigned workstation. This archiving must occur even if workstation is running third party software such as word processing or electronic spreadsheets.

(9) Comprehensive report writer capability to sort and extract data from archived files and to generate finished custom reports. Initiate reports manually or print automatically. Provide system with capability to print reports on daily, weekly, monthly, yearly or scheduled basis. Provide capability for statistical data manipulation and extraction. As a minimum, the custom report writer must provide capability to generate following types of reports:

(a) Statistical detail reports

(b) Summary reports.

(c) Trend graphic plots.

[(d) X-Y graphic plots.]

(10) Ensure report function is on-line for both development and printout, and does not require export to a third party spreadsheet program for execution.

(11) [In addition to on-line function, ensure historical database is capable of being converted to Data Interchange Format (DIF) for use in spreadsheet for off-line manipulation. Ensure transmission to DIF files is manual or automatic based on operator selectable parameters including: time of day, frequency (daily, weekly, monthly, yearly), scheduled days (32 days minimum).]

(12) File transfer must support appending new data to existing file data.

(13) Print alarm annunciations and normal operator acknowledgments, action messages, system alarms, operator sign-on and sign-off. Operator control activities include the operator's initials in the printed and disk record. The data printer will be reserved for printing reports, page prints, and data base prints.

(14) Provide operator the option of selecting daily, weekly or monthly scheduled frequency to synchronize time and data in controllers from the supervisory computer workstation. Perform synchronization for dialup as well as direct connected locations. Accommodate automatic daylight savings time adjustments.

(15) Provide a feature to indicate audibly [and visually,] when Off-Normal conditions and messages exist.

[(16) Ensure operator is able to request a summary of points on controller LAN currently in test mode or in off-normal condition.]

g. Supervisory Computer Workstation: The supervisory computer workstation must:

(1) Accept data from Controller LAN on an as needed basis without having to scan entire network for updated point data.

(2) Interrogate Controller LAN for updated point data as requested by operator.

(3) Allow operator command of equipment connected to controllers.

(4) Store duplicate data base on file for every controller and allow database to be downloaded to remote panel while system is on-line.

(5) Develop, store and modify dynamic color graphics utilizing system supplied mouse and mouse supported software.

(6) Provide data archiving of assigned points throughout system [and to support overlaid graphing of utilizing up to four (4) variables.]

h. Alarm Processing: Provide the following alarm processing features, all of which are definable through the input keyboard:

(1) Each OFF-NORMAL condition must cause an alarm and appropriate message, including time and date of alarm, system and point descriptor and alarm condition. Ensure operator has the ability to select, at any time, which state or value are considered alarms and which alarms cause automatic dial-out to occur.

(2) Display each critical alarm or change-of-state message . Store controller LAN network alarm messages on disk which may be reviewed on the display printed on operator selected printer at any time. Ensure it is possible to sort this alarm and change-of-state database by date, time or item fields.

(3) Provide automatic user defined time delay of alarms during equipment start-up or shut-down.

(4) Unacknowledged alarms will continue to blink even if alarm condition has returned to normal.

(5) Only operator acknowledgment can remove the blinking alarm indication.

(6) Operator workstation will notify an operator of an alarm condition in one or more points or controllers anywhere in the system.

(7) Provide alarm notification consisting of an automatic print of the alarm condition.

i. Prepared Historical Report: Provide an on-line, historical, data base sort report utility with: Prompts to select data base sort by time, by date, by point or range of points with system supplied default values of 24 hours, today, all Controller LAN points, respectively. Prompts for activating "conditional" sorts, including: changes-of-state, alarms, returns to normal, operator sign on/off, operator acknowledgements, command errors, program control of a point, test on/off, manual on/off, program control (Demand, Event) override, power restore, LAN reconfiguration, controller off line, time/data modifications and archive disk memory 90 percent full, 95 percent full and full. Single keystroke retrieval resulting in a report listing the most recent condition first, along with the time, date, address, name, condition type, and value. The supervisory computer workstation must provide functions listed below.

2.7.12.3 Graphics Screen Format

Submit graphics screen format showing process variable in engineering units, such as process variable setpoints, analog or digital input or output conditions, and to meet requirements of the Centralized Monitoring System of this specification. Include the proposed input conditions shown on flow diagrams created by the Contractor based on Drawings, including process and instrumentation drawings and shop drawings from boiler manufacturer.

2.7.12.4 Graphic Display

At a minimum, make the following screens available:

a. Plant overview.

b. Individual Boilers.

c. Individual controllers.

d. Display of all measured variables and setpoint s.

2.7.12.5 Historical Trending

Provide system capable of storing values from transmitters as well as system computed values, such as efficiency and compensated flow rates, at selected intervals for archival storage and future analysis.

2.7.12.6 Totalization of Data

a. Provide system capable of totalizing the following data:

   (1) Steam Utilization.

   (2) Total Feedwater Flow.

   (3) Total Natural Gas Consumption.

   (4) Run Time for monitored motors.

   (5) Total Fuel Oil Consumption.

b. Run time logged for each motor driven equipment must enable the plant maintenance to schedule regular maintenance for each motor driven device. Once a motor driven device has been serviced or repaired as a part of regular maintenance or due to emergency, plant maintenance must be able to log servicing or repair data in the supervisory computer. Plant maintenance must also be capable of logging servicing or repair data for equipment monitored in the steam plant.

2.7.13 Centralized Monitoring System (CMS)

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NOTE: The CMS paragraphs apply to existing plants without a supervisory computer workstation.

****

a. Use CMS for centralized monitoring and data acquisition of various plant variables.

b. Provide services required for installation, programming, testing and startup of system.

c. Employ industrial grade equipment in CMS that is Underwriter Laboratories (UL) listed.

d. Provide CMS to include, but not be limited to, the following functions:

    (1) System engineering.

    (2) System hardware.

    (3) System programming and configuring.

    (4) System documentation.

    (5) System installation.

    (6) System testing.

    (7) Packing and shipping.

    (8) Maintenance training program.

    (9) Operator training program.

    (10) System startup.

    (11) Scheduled system maintenance.

    (12) Attend construction review meetings and provide progress reports.

2.7.13.1 System Controller

a. Monitor various plant variables, log data and generate summary reports as required by plant operations. Provide system controller capable of data reduction and backup data logging. Perform data and alarm interfaces between CMS equipment and Government equipment at system controller.

b. Provide an industry standard programmable logic controller (PLC), or direct digital controller (DDC), rack mounted in NEMA 12 CMS equipment cabinets. Use compatible interconnecting cabling and fittings and clearly label as to the equipment and termination points they are to interconnect.

c. Provide backup digital storage of CMS data. Provide backup data storage device with sufficient memory to store at least seventy two (72) hours of CMS data in event of failure of monitoring and data acquisition system computer or communications hardware. Upon restoration of communications with monitoring and data acquisition system computer, transfer data logged during communications failure period automatically to monitoring and data acquisition system computer. Provide battery backup for backup data storage device if required to preserve data in event of a power supply failure.

d. Provide system controller consisting of solid-state control system which has a user programmable memory for storage of instructions to implement specific instructions such as input-output control, Boolean logic, timing, counting, arithmetic, and data manipulation. Provide system controller consisting of central processors, input-output interfaces, memory, power supplies, a programming device, and tape or disk drive for storing and rapidly loading programs. Make provision for portable operator interface panel with CMS system to provide the capability of viewing access to data stored in the CPU and input of constants required by system controller.

e. Provide central processing unit consisting of solid-state design on modular printed circuit boards. Provide hardware, source code, and programming parameters required for internal programming of controller.

2.7.13.2 Interface Requirements

a. Ensure system controller is capable of interfacing with plant controllers, computers, or printers in accordance with TIA-232 or another communications interface common to all plant microprocessor-based control equipment.

b. Electrically isolate inputs and outputs from other input-output and from all cabinet wiring.

2.7.13.3 Alarm Interface

Provide CMS with 2 annunciator cabinets, each equipped with one (1) white indicating light, one (1) flashing red indicating light, 1 audible horn, 1 Acknowledge pushbutton and 1 Test pushbutton as shown. Locate one of these annunciator cabinets [_____] and locate the other in the plant control room. Provide momentary Acknowledge and Test pushbuttons. Connect equipment in these cabinets directly to the CMS input-output ports as shown. When alarm condition is detected, sound horn at both annunciator cabinets and flash the red indicating lights. When Acknowledge button is pressed in any one of the annunciator cabinets, or when the alarm is acknowledged at either of the work stations, silence horn, stop red flashing lights, and turn on the white indicating light. At this point the system is ready to annunciate new alarm condition detected. The white indicating light must stay on until the alarm condition is removed. If the Test pushbutton is pressed, the horn must sound and the red indicating light must flash. Pressing the Acknowledge button must silence horn and reset alarm system. Provide lamptest pushbutton to allow verification that all indicating lights are operational.

2.7.14 Monitoring Requirements

2.7.14.1 Monitoring of Boilers

Boiler may be supplied from manufacturer with stand-alone controller. System controller must receive output signals from stand-alone boiler controller by means of data communication link. Send other variables requiring monitoring to CMS as analog or discrete contact closure signals. If existing boiler control system is utilized, make provision to acquire data from these controllers, preferably by means of serial communication links. If it is not feasible to establish serial communication links, send variables to be monitored to CMS as appropriate analog or discrete signals. Apply calibration factors to analog inputs accessed from recorders, controllers and transmitter as required.

2.7.14.2 Variables to be Accessed from Boiler Control systems

At a minimum, access data for the following variables from boiler control system:

a. Steam pressure in kPa psig.

b. Steam pressure setpoint in kPa psig.

c. Steam flow in thousands of kg/hr lb/hr.

d. Flue gas temperature in degrees C degrees F.

e. Flue gas oxygen in percent.

f. Opacity in percent.

g. Fuel oil flow in R/sec GPH.

h. Fuel oil supply pressure in kPa psig.

i. Fuel oil supply temperature in degrees C degrees F.

j. Natural gas flow in thousand standard cubic meters.

k. Natural gas supply pressure in psig.

l. Boiler control system power ON or OFF.

m. Fuel selected: GAS, OFF or OIL.

n. Purging.

o. Ready.

p. Pilot ON.

q. Fuel oil ON.

r. Natural gas ON.

s. Emergency trip.

t. Boiler efficiency.

2.7.14.3 Alarms to be Accessed from Boiler Control Systems

At a minimum, access the following alarms from boiler control system:

a. High steam pressure.

b. High water level alarm.

c. Low water level alarm.

d. Low water cutoff.

e. High natural gas pressure.

f. Low natural gas pressure.

g. Low atomizing steam pressure.

h. Low fuel oil pressure.

i. Low fuel oil temperature.

j. Low oxygen level.

k. Flame failure.

l. High opacity.

2.7.15 Balance of Plant (BOP) Variables

a. Monitor status of equipment common to all boilers and any other plant variables not part of any boiler control system directly by the CMS controller via input-output interface modules. Input-output modules must be analog, discrete or communication ports as required. Provide isolated or nonisolated discrete inputs-outputs as required by prevailing conditions. Apply calibration factors to raw analog transmitter output as required.

b. Controller inputs-outputs include, but are not limited to, those indicated.

2.7.15.1 BOP Variables to be Monitored:

Access the following balance of plant variables from dedicated instruments or controllers:

a. Outside air temperature in degrees C.

b. Steam header pressure in [KPA] [MPA].

c. Boiler feedwater temperature in degrees C.

d. Boiler feedwater flow in litersgallons per minute.

e. Boiler feedwater pressure in [KPA] [MPA]PSI.

f. Boiler water makeup flow in litersgallons per minute.

g. Air Compressor status (one per compressor).

h. Boiler Feed Pump status (one per pump).

i. Condensate Transfer Pump status (one per pump).

j. City water supply valve status ("OPEN" or "CLOSE").

k. Fuel Oil Pump status (one per pump).

2.7.15.2 BOP Alarms

Access the following alarms from dedicated instruments or controllers:

a. Air Compressor Low Pressure (one per compressor).

b. Condensate Transfer Pump Trip (one per pump).

c. Fuel Oil Pump Trip (one per pump).

d. Deaerator Tank Level High.

e. Deaerator Tank Level Low.

f. Atmospheric Condensate Receiver Level High.

g. Atmospheric Condensate Receiver Level Low.

h. Heating Plant Pressure Receiver Trouble.

i. Water Softener Trouble.

j. Blow Off Separator High Level.

2.7.16 Uninterruptible Power Supply (UPS)

Provide a [_____] kVA UPS, with a minimum run time of thirty five (35) minutes at full load to power work stations and their peripherals, controllers and input-output systems.

2.7.17 Monitoring and Communication Cables and Associated Raceways

Provide monitoring and communication cables, wiring, and associated raceways, including conduit, junction boxes, and fittings in accordance with applicable sections of specifications. Contractor is responsible for providing cables required as indicated in these specifications and to provide a complete and working system. Provide cables as required for connection between CMS equipment, boiler controllers and field devices.

2.7.18 Remote Communication Interface Modem

Provide system with auto dial-auto answer modem suitable for use with voice grade telephone lines. Provide communications in English language and limit to ASCII character codes. Ensure system is capable of automatically dialing up in both pulse and tone dial mode.

2.7.19 Instrument Power Supply

Provide instrument power supplies, as necessary, to power panel and field mounted instruments, including instruments within instrument cabinets and back-of-panel components. Provide regulated plus-minus 24 V dc or as required for transmitter and transducer power requirements. Select power supply current rating based on loop burden. Meet the following requirements:

a. Provide 120 V ac, 60 Hz, single-phase input power to the instrument power supply. Wire power supply as a tap circuit through a separate pull-out type fusible block rated 300 V ac minimum at rated amperes, and wire to the same branch circuit as CMS controller.

b. Provide power supply with output current protection.

c. Supply power supply with brackets for installation on mounting panels within the CMS cabinet.

2.7.20 System Architecture

Design system in modular fashion. Provide spare capacity of the following:

a. Input, digital- 25 percent.

b. Input, analog - 25 percent.

c. Controller memory - 25 percent spare.

d. Output digital - 10 percent.

e. Output analog - 10 percent.

2.7.20.1 Inputs

CMS controller must be capable of accepting inputs as described below:

a. Analog Inputs (AI): Monitor analog inputs originating from sensing elements and buffer as AI, except that automatic conversion to proper engineering units must occur without any additional signal conditioning as follows:

 (1) Convert temperature inputs from thermistors or RTDs or temperature transmitters to degree C,

  (a) 2) Convert flow inputs from flow transmitters to liter per minute, cubic meter per minute or as specified in process and instrumentation diagram.

  (b) 3) Convert valve or damper position from potentiometer or similar device to percent open.

  (c) 4) Convert pressure input from pressure transmitter to mm of water kPa as specified in process and instrumentation diagram.

b. Discrete Inputs: CMS controller must accept discrete signal from device such as contactor, relay, limit switch, pressure switch, and temperature switch. Provide input device capable of withstanding continuous shorting to 120 V ac or to 1500 volts for fifty (50) microseconds.

2.7.20.2 Outputs

Provide controllers that are capable of directing outputs as follows:

2.7.20.2.1 Analog Outputs (AO)

Analog outputs as direct or reverse function of associated analog inputs must modulate final elements in response to controller algorithms. Final element actuators must be industrial grade capable of accepting a modulated [electronic] [pneumatic] signal from the controller [via a signal converter, current to pneumatic]. Electronic signal must be 4-20 mA dc with a minimum of 16 [_____] bit resolution. [The pneumatic signal must be 21 to 34 kPa 3 to 15 psi. Each pneumatic output must have feedback for monitoring of the actual pneumatic signal.]

2.7.20.2.2 Digital Outputs (DO)

Command equipment to the selected position via schedules and programs. Provide contact closure with contacts rated at a minimum of 1 ampere at 24 volts. The output signals include, but are not limited to:

a. Enable-Disable.

b. Start-Stop.

c. On-Off.

d. Open-Close.

e. Demand Limit

f. Temperature Reset.

g. Boiler Selection

h. Floating Control.

2.7.20.3 Program Storage

CMS controller must be able to store programs on a solid state memory PC card, a hard disk drive, or a CD-RW reader-writer-rewriter disk drive requiring no front end computer for the data conversion.

2.7.21 System Software

Document CMS controller program code sufficiently that operator can modify controller logic and setpoints. Software provided includes, but is not limited to, operating systems, communication control, definition of process, operator interface, and system services. Provide Read Only Memory [ROM] and Programmable Read Only Memory [PROM]as required, as resident operating system. Application software must be RAM resident. Do not use bulk storage devices, such as magnetic disks, in an interactive on-line mode, but may be added for extended data storage.

2.7.21.1 Trend Logging.

Initiate a custom log for any variable value in the control program. Select type of log, number of values log contains, and time interval between values. Assign trend log activation period from keypad by day, month, year, and time span desired for each log.

2.7.21.2 Alarm Reporting.

Provide control capable of analyzing any variable in the program and evaluate for alarm condition. Alarm can be generated based on analog value out of limits or based on a programmed sequence of events. Store alarms in log upon each occurrence and report them immediately.

2.7.21.3 Alarm Lockout Routine.

Provide alarm lockout routine to inhibit nuisance alarms.

2.7.22 Documentation

Provide the following documentation:

2.7.22.1 List of Hardware

Complete list of hardware required to provide a complete and fully functional CMS.

2.7.22.2 Input and Output Point List.

Complete input and output point list.

2.7.22.3 Operating and Maintenance Manuals.

Provide functional description of proposed equipment, and descriptions of maintenance on system components. Ensure operating and maintenance manuals cover inspection, periodic preventive maintenance, fault diagnosis, replacement and repair of defective components.

2.7.22.4 Equipment Installation Details.

Submit detail drawings showing installation requirements for each component of the CMS.

2.7.22.5 System Interconnection Block Diagram.

Show the interconnection of components in the CMS network.

2.7.22.6 Software Manual

Provide software manuals describing programming and testing for CMS controller and containing system overview with detailed description of software features. Instruct operator on programming CMS controller, including control programs, algorithms, mathematical equations, variable, setpoints, time periods, messages, and other information necessary to load, alter, test, and execute system operation. Include the following in the software manual:

a. Complete description of programming language, including commands, algorithms, printouts and logs, mathematical calculations, and passwords.

b. Instructions on modifying any algorithm or parameter, verifying errors, status, changing passwords, and initiating or disabling control programs.

c. Software documentation providing easy reference from summary sheets which compare pertinent information about hardware, and wiring information in the field. Include the following documentation:

    (1) Complete point identification, including terminal number, symbol, engineering units, control program reference number, and logic printout.

    (2) setpoint s for various analog input loops.

    (3) Field information including location, device, device type and functions

(4) Location identification of the CMS hardware.

2.7.23 Equipment Cabinet Factory Wiring

Factory install internal equipment cabinet wiring, color code and bundle neatly or route via wiring duct. Install cables and wiring as specified.

2.7.23.1 Termination

Make terminations with pressure type connectors or lugs. Do not wrap stranded conductors around screw type terminals. Connect incoming cables to CMS controller via terminal blocks. Terminate internal wiring at one side of the terminal blocks.

2.7.23.2 Nameplate for Device Inside Equipment Cabinets.

Stamp nameplate for device mounted inside equipment cabinet with the device number only. Provide nameplate consisting of 10 mm 3/8 inches wide stainless steel tape. Attach to the device with stainless steel wire.

2.7.24 Continuous Emissions Monitoring

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NOTE: A continuous emissions monitoring system (CEMS) is required by the Clean Air Act Amendment (CAAA) of 1990 if the fuel utilized is oil or coal and the heat input is 3 megawatt 10 million BTU/HR or greater. A CEMS may also be required by state or local laws. If a CEMS is necessary the designer must review the CAAA and the relevant state or local law early in the project to allow time to incorporate the required CEMS specification and to determine which flue gas emissions will be included in the required reports. Before acceptance of the installation, furnish a written test report which provides documentation that the CEMS equipment has passed factory and field certification tests required by federal, state and local regulations to the Contracting Officer. The investigation will determine if the reported values may be calculated or should be direct measurements. The CAAA includes measurement options for gas/oil fired units depending upon the particular category of unit as defined by the regulations. Fill in the data to state what method of measurement or calculation will be utilized for the determination of the report variable.

Emerging flue gas flow monitor technologies are available. The traditional differential pressure technique specified uses familiar equipment that can be maintained by plant personnel. This type of measurement device has reliably satisfied regulatory requirements. The possible use of other technologies should include a thorough investigation of flue gas flow monitor regulatory requirements and in-house maintenance capabilities.

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a. Provide continuous emissions monitoring system (CEMS) equipment as a system by a single manufacturer. Provide CEMS, meeting requirements of applicable federal regulations, State of [_____] and local regulations for boiler in accordance with manufacturer's recommendations and under direct supervision of CEMS equipment manufacturer.

b. Reported data includes [sulfur dioxide ($S0_2$)] [oxides of nitrogen (NO_x)] [carbon monoxide (CO)] [carbon dioxide ($C0_2$)] [particulate matter (PM)] and other information required by federal, state, and local regulations. Base SO_2 reporting on [analyzer measurement] [fuel flow and percent sulfur calculation] [daily heat input calculation]. Base nitrous oxides, carbon oxides and particulate matter reporting on analyzers.

c. Include central processing unit, printer, hard disk drive, and floppy disk drive. Provide floppy disk drive to function as recorder. Provide software to generate required reports in format acceptable to federal, state and local regulatory agencies. Provide operator interface to CEMS equipment by means of CRT display.

2.7.24.1 Gaseous Emissions Monitor

Provide dxtractive or in-situ gaseous emissions monitors. Combination of extractive and in-situ monitors is not acceptable. Gaseous emissions monitors include automatic calibration checks. Provide alarm horn and annunciator to alarm when any monitored parameter is out of range or gaseous emissions monitor malfunctions. Construct surfaces exposed to corrosive gas of boiler of noncorrosive materials such as 316 SS, Teflon or Hastelloy.

Provide [wet][dry][diluted] extractive systems. [Provide rack-mounted analyzing equipment for extractive system.][Locate analyzing equipment for extractive system in a walk-in cabinet].

2.7.24.2 Flue Gas Flow Monitor

Utilize the pitot tube principle to measure flue gas flow. Provide flue gas flow monitor base which is across-the-duct average pitot tube and properly design and locate to obtain representative measurement. Use differential pressure transmitters to sense the difference between the static and total pressure of the flowing flue gas stream. Ensure calibrations are stable.

2.7.24.3 Particulate Matter Opacity Monitor

Base particulate matter opacity monitor on principle of transmissometry. Include automatic simulation of zero opacity and up scale check of calibration while boiler is in service without dismounting monitor. Include analyzer internal circuitry and electronic circuitry in calibration check. Provide alarm horn and annunciator to annunciate excess opacity and system malfunction. Provide monitor with fans to keep sending and receiving lenses pressurized and blown clean at all times.

2.7.24.4 Wiring

Provide CEMS equipment with plug in prefabricated cable for interconnection between components. Use 2 wire, 120 volt nominal or less, 60 Hz, power supply to the equipment with one side grounded. Connect electrical devices as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.8 BOILER FEEDWATER SYSTEM

2.8.1 Deaerators

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NOTE: Deaerator manufacturers should be consulted regarding specific features of construction for a particular application. Specifications are included for atomizing spray-type, tray-type, and atomizing spray, two tank type deaerators. Careful consideration will be given to the type of deaerator selected. Tray type is preferred however it requires more space than the other types. To satisfy shipping requirements or where access is limited, the deaerator may be knocked down and field assembled. Select applicable pump type and control.

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2.8.1.1 Components

Provide deaerator as a complete package by one manufacturer including receiver with deaerating section, pumps, electrical control and accessories. Deaerator components include but are not limited to the following:

a. Storage tank.

b. Deaerator [spraymaster][or][column.] ASME PTC 12.3.

c. Water inlet atomizing valve.

d. Steam inlet atomizing valve.

e. Deaerator manual and automatic vents.

f. Gauge glass.

g. Steam pressure gauge.

h. Feedwater thermometer.

i. Tappings.

j. Water level controller with makeup valve.

k. Three valve by-pass and strainers for control devices.

l. Steam relief valve.

m. High water level alarm.

n. Low water level alarm.

o. High temperature condensate diffuser.

p. Boiler feed pump and motor sets.

q. Recirculation orifice.

r. Pump suction shutoff valve.

s. Suction strainer.

t. Suction flexible fitting.

u. Pump discharge shutoff valve.

v. Pump discharge pressure gauge.

w. Pump discharge manifold.

x. Overflow drain connection.

y. Control panel.

z. Chemical feed quill.

aa. Vacuum breaker.

ab. Sentinel relief valve.

ac. Tank drain valve.

2.8.1.2 Deaerator, General Requirements

Provide deaerator water storage tank with a [_____] mm inches diameter, and [_____] mm inches long.

a. Provide storage tank section with [_____] minutes of storage and a capacity of [_____] liters gallons measured to overflow. Provide an 280 by 380 mm 11 by 15 inch elliptical manhole for access. Provide deaerator rated at [_____] kg pounds of steam per hour.

b. Design deaerator to remove dissolved oxygen in boiler feedwater to 0.005 cc/liter or less and eliminate carbon dioxide at any load between 5 and 100 percent of rated capacity.

c. Provide tank consisting of welded steel construction built in accordance with Section VIII of the ASME pressure vessel code for 345 kPa 50 psig at [_____] degrees C degrees F and stamped accordingly. Construct internal surfaces which come in contact with underaerated water of Type 316 stainless steel.

d. Provide deaerator with manual and automatic vent valves. Control automatic vent valve thermostatically to provide fast venting of sudden buildup of gases. Provide manual vent valve with an orifice for continuous minimum venting. Do not exceed a manual minimum venting rate of 0.1 percent of rated deaerator capacity. Provide deaerator that is suitable to operate from 13.6 to 102 kPa 2 to 15 psig.

e. Provide steel fabricated deaerator stand of appropriate height for the feed pump-motor set, and mount on a solid base. Reinforce base to prevent vibration.

f. Nozzles 100 mm 4 inches and under must be 1350 kg 3000 pounds forged steel couplings. Nozzles 63.5 mm 2-1/2 inches and over must be 1.03 MPa

150 psig rated flat face flanges.

g. Mount pump-motor set on individual base before mounting on the stand base. Provide individual suction piping, including strainer, shutoff valve and flexible connector, for pump. Provide pump suction nozzle with vortex breakers to eliminate loss in NPSH and cavitation. Make connections as shown.

h. Provide factory-lined tank interior with high quality baked epoxy lining. Apply lining to white metal surface in accordance SSPC SP 5/NACE No. 1. Apply four to six coats with each dry coat being approximately 0.38 mm 1.5 mils dry, for a total thickness of 0.152 mm 6 mils dry minimum. Holiday spark test lining using low voltage and a wet sponge to ensure uniform coating free of pin holes.

i. Prime exterior with a high heat silicone acrylic primer, 0.05 mm 2 mil minimum DFT.

2.8.1.3 Deaerator, Atomizing Spray-Type

Provide atomizing spray-type, pressurized horizontal type deaerator. Provode ASME torispherical type heads constructed of ASTM A516/A516M GR 70 carbon steel with a minimum thickness of 6.35 mm 0.25 inch. Fabricate shell plate of ASTM A36/A36M carbon steel with minimum thickness of 6.35 mm 0.25 inch. Provide main deaerating portion, located internally, consisting of water collector and steam atomizing valve. Build spring loaded water spray nozzle which includes automatic and manual vent valves into a flange on top of the tank.

2.8.1.4 Deaerator, Tray-Type

Provide tray-type deaerator with spray manifold in a 300 Series stainless steel deaeration dome with integral cascade trays, pressurized horizontal type. Flange mount deaeration dome with integral cascade trays containing a spray manifold with stainless steel spray nozzles to the boiler feed receiver. Flange mount manifold to the dome. Make flange opening large enough to permit the manifold to be easily withdrawn for servicing. Install direct injection steam heating assembly in the receiver. Provide heating assembly consisting of double flange mounted injection pipe, steam control valve, pressure-temperature regulator, wye strainer and pressure gauge.

2.8.1.5 Deaerator, Atomizing Spray Two-Tank Type

a. Provide atomizing spray-type two-tank deaerator, divided into two separate sections. Divide deaerator water storage and condensate surge sections by a double inner head. Pack air space between 2 inner spaces with fiberglass insulation and provide a breather and drain connections. Fabricate shell plate of ASTM A36/A36M carbon steel with minimum thickness of 6.35 mm 0.25 inch. Provide ASME torospherical type heads constructed of ASTM A516/A516M GR 70 carbon steel with a minimum thickness of 6.35 mm 0.25 inch.

b. Provide surge tank section with [_____] minutes of storage and a capacity of [_____] liters gallons flooded. Provide a 280 by 380 mm 11 by 15 inch elliptical manhole for access. ASME stamp is not required for the surge tank.

c. Surge tank must receive returning condensate and be supplemented by makeup by water to maintain desired operating level. Vent surge tank to the atmosphere. Transfer collected water to deaerator. Locate main deaerating portion, consisting of water collector and steam atomizing valve, in deaerator storage tank. Build a spring loaded water spray nozzle which includes an automatic and manual vent valve into a flange on top of deaerator storage tank.

d. Provide deaerator and surge tank support of appropriate height to meet the NPSH requirements of the transfer pumps and feedwater pump/motor set.

e. Height of deaerator support must not exceed 1220 mm 48 inches.

2.8.1.6 Chemical Feed Quill

Locate chemical feed quill beneath the normal tank water level. Use stainless steel chemical feed quill material. Provide even distribution and bleeding of chemicals.

2.8.2 Boiler Feed Pump

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NOTE: Pump manufacturers should be consulted regarding specific features of construction for a particular application. In general, for lower pressure and flow applications vertical in-line pumps with stainless steel shafts and impellers can be applied. Cast iron or cast steel casings could also be used for these applications. Horizontally split pump casing specifications should require nozzles on the suction and discharge and feet on the lower half of the casing so the top half of the casing can be removed without disturbing the main piping. Designer is required to determine the upper temperature limit for pumps based on the project requirements. Delete design conditions if pump schedule is shown on the drawings.

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For installations including more than one boiler feed pump, each boiler feed pump must be identical [_____] L/hour gpm, [vertical in-line] [horizontally split case, multi-volute or diffuser], centrifugal, self-contained, multistage pump. The nomenclature used in these specifications pertaining to pumps and hydraulic conditions is as used by the Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps.

2.8.2.1 Design Conditions

Number of pumps	[_____]	
Rated capacity of each pump	[_____]	L gpm
Total dynamic head at rated capacity	[_____]	L gpm
Net positive suction head available	[_____]	m Feet

Maximum allowable shutoff head	[_____]	m Feet
Minimum allowable shutoff head	[_____]	m Feet
Type of fluid pumped	Boiler Feedwater	
Max. expected temp. of fluid	[_____]	degrees C degrees F
Maximum speed of pump	3600	rpm

2.8.2.2 Construction Materials

Provide pump with [_____] Class [_____] suction flange and [_____]Class [_____] discharge flange. Provide stainless steel shaft, impeller, and internals including sleeves and wearing rings containing no less than 11 percent chromium. [Provide closed type horizontal pump impellers, cast in one piece.] Ensure casing is 11 to 13 percent chromium steel. [Provide cast iron suction and discharge chamber.] [Design horizontal pump to pump water at any temperature from 10 to [_____] degrees C 50 to [_____] degrees F without undue temperature strains within pump. Properly balance rotating parts. Dynamically balance assembled rotor. Stagger casing volutes to ensure radial balance of the assembled rotor under operating conditions. On volute pumps, mount impeller on the shaft half facing in one direction and the other half facing in the opposite direction to give axial balance to the motor.]

2.8.2.3 Cooling Water Piping

Furnish pump with complete cooling water system which connects jacket cooler to common header. Factory assemble piping as completely as possible on the pump. Provide Type 316 stainless steel seal flush piping. Provide Type 304 stainless steel seal flush cooler tubing. Provide flow regulating valve and 6.35 mm 1/4 inch bypass needle-valve on each supply branch.

2.8.2.4 Bearings

[Provide horizontal pump including a double row ball type thrust bearing on the outboard end and a single row deep groove radial bearing on the inboard end. Provide splash type bearing lubrication .]

[Provide vertical type pump bearings that are water lubricated sleeve type constructed of babbitted graph alloy with Type 304 stainless steel shaft sleeves.] Design bearings for L-10 bearing life of [_____].

2.8.2.5 Shaft Sealing System

[Equip vertical pump with an effective mechanical shaft seal to seal.] [Fit horizontal pump with balanced mechanical seals, pressurized type, tungsten carbide and carbon sealing faces especially designed for high temperature, high pressure boiler feed pump service. Provide mechanical seals with pumping rings. Provide complete field flush piping from each mechanical seal to its respective seal cooler with a temperature alarm thermometer, adjustment for silencing, range of 10 to 204 degrees C 50 to 400 degrees F with contacts suitable for 100 milliamperes at 125 V dc, closing on rise of temperature.]

2.8.2.6 Shaft Coupling

[Provide direct coupled type shaft coupling between vertical pump and drive.] [Connect horizontal pump directly to its motor by means of a spacer disc type coupling. Provide spacer piece between motor and pump to facilitate removal of coupling flanges and mechanical seals without disturbing the pump or motor hold-down bolts. Disc coupling must be limited and float. Use stainless steel disc. Furnish suitable coupling guards.]

2.8.2.7 Special Tools

Furnish complete set of special tools as required for assembly, disassembly or maintenance of pumps.

2.8.2.8 Pump Characteristics

a. Provide pump discharge head such that the maximum discharge head occurs at shutoff and continually decreases as pump delivery increases. Ensure head capacity characteristics permit stable operation when pump is operating alone or in parallel with another pump.

b. Provide pump with shutoff head of no greater than 150 percent and no less than 115 percent of design head. Ensure design point capacity on the selected pump curve is within 25 percent of the capacity at the best efficiency point for the impeller selected. Ensure minimum flow required for continuous pump operation is no greater than 30 percent of the specified design flow for each pump.

c. Provide pump with an efficiency of 60 percent or greater at rated capacity.

2.8.2.9 Horizontal Pump Accessory Equipment

Provide the following as package from pump manufacturer:

a. Pump and drive, mounted on a suitable, full length baseplate.

b. Suitable vent valves for the pump.

c. Stainless steel orifice plate for minimum flow across the pump.

d. Standard accessories and integral piping required for complete unit.

e. One flanged end suction tee type strainer of corrosion resistant materials, of size compatible with suction piping. Use tee type strainer with fine mesh screen fitted over it for use during startup period. Remove fine mesh screen after condensate system is clean.

f. One set of spare pump gaskets and "O" rings.

g. Renewal parts for mechanical pump seal.

2.8.3 Deaerator Control

Furnish completely wired control cabinet, mounted on pump unit or free-standing. Provide cabinet with hinged door and include the following:.

a. Combination magnetic starters having 3 overload relays, with circuit breakers and cover interlocks.

b. Auto Lead-Lag-Off-Continuous selector switches.

c. Pilot lights indicating pump operation.

d. Control circuit disconnect switch.

e. Terminal block.

f. Control circuit transformer, fused.

g. Momentary contact Test pushbuttons.

h. Deaerator Control Panel meeting the following requirements:

(1) Construction: Properly size deaerator control panel to contain control devices, instrument gauges and meters. Provide unit mounted or free-standing deaerator control panel with face-plate of no less than 4.7 mm 3/16 inch reinforced steel plate. Ensure control cabinet is factory-assembled steel enclosure with locking door. Provide panel consisting of NEMA 4 construction, 12 gauge steel all welded construction with minimum radius corners, stiffened as required and framed with angles. Construct the door of 12 gauge steel with door clamps and continuous hinge. Ensure door is fully gasketed.

(2) Wiring: Wire deaerator control panel in accordance with NFPA 70 and provide individual motor starter with 120 volt holding coil and fuse protection. Provide individual green oil-tight pump run lights. Provide NEMA 4 rated switches and light with nameplate identification. Paralleling of individual control power transformers will not be permitted. Provide panel with main disconnect device, consisting of nonfused disconnect or nonautomatic circuit breaker. Equip disconnect with mechanical door interlock preventing door opening the disconnect in closed position. Provide cartridge type fusing. Provide multiple horsepower rated, heavy duty type dual element, current limiting, time delay safety switches. Provide NEMA type, full voltage, non-reversing magnetic motor starter for motor assembly , which isoverload protected for each phase, and with auxiliary contacts. Ensure overload relay is trip-free, thermal bimetallic, manual reset with trip heaters based on actual full load current of motor. Provide spare NO and NC auxiliary contacts wired to the terminal block. Provide control power transformer with primary fuse disconnect and secondary fusing. Provide factory mounted and wired control, arrange to receive a signal from the boiler plant master controller and water regulating valve assembly. Match quantity of deaerator feedwater pumps to the quantity of boilers. Provide panel mounted Lead-Lag-Off-Continuous switch for each feedwater pump.

(3) Sequence of Operation: From cold start of plant, when plant master controller indicates one boiler to start, start lead pump. When second boiler is indicated to start, start lag pump and continue this process for additional boiler starts. Run feedwater pumps continuously. When one boiler shuts down, shut down one feedwater pump. When all boilers are off, all pumps must be off. Should there be a failure of any pump, operate the next pump in

sequence automatically. Provide audible and visual high and low water level alarms by bell or horn with silence switch and individual red oil tight lights. Use a low-low water level signal to cut off feedwater pumps. Deaerator water level control system must provide a 4-20 mA dc signal to the condensate receiver control panel to start transfer pumps.

2.9 CONDENSATE RETURN SYSTEM

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NOTE: Coordinate the components of this system with the deaerator selection. Some components are specified with the two tank-type deaerator.

****

Provide condensate return system that is a factory assembled package system including condensate surge tank, transfer pumps, controls, auxiliary equipment and piping as shown.

2.9.1 Condensate Surge Tank

Provide condensate surge tank with a [_____] mm inch diameter by [_____] mm inch long with 280 by 380 mm 11 by 15 inch elliptical manhole. Provide condensate surge tank with [_____] minutes of storage and capacity of [_____] liters gallons flooded. Provide condensate surge tank, base, piping nozzle construction as specified. Include the following:

a. Required tappings and manway.

b. Thermometer.

c. Gauge glass.

d. Water level controller with make-up valve.

e. Three-valve bypass and strainer for control devices.

f. Suction shutoff valve.

g. Suction strainer.

h. Suction flexible fitting.

i. Pump discharge check valve.

j. Discharge shutoff valve.

k. Pump suction and discharge gauge.

l. Discharge manifold.

m. Chemical feed quill.

n. Sparge tube.

o. High water level alarm.

p. Low water level alarm.

q. Low water pump cut-off.

r. Recirculation orifice.

s. Insulation and lagging.

t. Transfer pump and motor.

u. Control panel.

2.9.1.1 Gauge Glass

Provide surge tank with gauge glass assembly that covers entire tank diameter. Provide quartz gauge glass with 16 mm 5/8 inch diameter by 610 mm 24 inch maximum length. Furnish gauge glass with bronze gauge cock set and protector rods.

2.9.1.2 Makeup Valve and Controller

a. Provide motorized makeup valve with steel body and threaded connections. Provide gear type makeup valve directly coupled to the valve stem and control electronically by solid state controller with internally mounted capacitance probes. Maintain water level setpoint. Provide controller with hand selector for automatic and manual operation. Ensure makeup valve does not exceed 69 kPa 10 psig pressure drop and is rated for 150 degrees C 300 degrees F.

b. Provide makeup valve rated for [_____] kPa psi 1/hr. inlet pressure and ensure valve C_v does not exceed [_____]. Include two additional probes for high and low water level alarms.

2.9.1.3 Sparge Tube

Locate sparge tube beneath normal tank water level. Construct sparge tube of 50 mm 2 inch pipe. Provide even distribution of high pressure condensate return.

2.9.2 Condensate Pump

****

NOTE: Pump manufacturers should be consulted regarding specific features of construction for a particular application. Specifications are included for horizontal end suction and vertical type pumps. Careful consideration will be given to the type of pump selected. The Pump Column paragraph applies only to vertical type pumps and should be deleted if horizontal type pumps are selected. Delete design conditions if pump schedule is shown on drawings.

****

Condensate pumps must be [_____] identical [_____] L/hour gpm, [horizontal end suction ANSI size A70 type pumps][vertical type pumps with suction barrels] type. Nomenclature used in this specification pertaining to pumps and hydraulic conditions is that used by the Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps.

2.9.2.1 Design Conditions

Number of pumps	[_____]	
Rated capacity of each pump	[_____]	L gpm
Total dynamic head at rated capacity	[_____]	L gpm
Net positive suction head available	[_____]	m Feet
Maximum allowable shutoff head	[_____]	m Feet
Type of fluid pumped	Boiler Feedwater	
Maximum expected temperature of fluid	[_____]	degrees C degrees F
Maximum speed of pump	1800	rpm

2.9.2.2 Construction and Materials

Provide [centrifugal, horizontal end suction, top discharge type] [vertical, multistage, self contained type with suction barrel] pump. Include [_____] Class [_____] suction flange and [_____] Class [_____] discharge.

2.9.2.3 Casing and Casing Bowls

Flange pump [casing] [casing bowls] and bolt with jacketing top bolt. [Construct casing of ductile iron ASTM A395/A395M, Grade 60-40-18.] Provide flanged casing bowls, constructed of ASTM A48/A48M Class 30 cast iron equipped with pinned, replaceable wearing rings constructed of ASTM A276/A276M Type 316 stainless steel with 11 to 13 percent chrome hardened to 450 BHN. Provide unlined bowls. Design bowl assemblies to withstand an operating pressure of 4.3 MPa 630 psi. [Use minimum casing thickness for horizontal pumps of 12.7 mm 1/2 inch with an additional 3.2 mm 1/8 inch corrosion allowance.]

2.9.2.4 Impeller

[Impeller for horizontal type pump must be totally open type, screw mounted directly to shaft with an O-ring seal and constructed of ductile iron ASTM A536, Grade 60-40-18. Balance impeller dynamically to the maximum rated speed.] [Provide enclosed, split ring, key mounted type impeller for vertical can type pumps constructed of 11 to 13 percent chrome steel in accordance with ASTM A743/A743M or 316 SS ASTM A290/A290M GR CF-8M. Provide impeller with replaceable wearing rings constructed of 11 to 13 percent chrome hardened to 300 BHN. Statically and dynamically balance impeller to maximum rated speed. Ensure impeller is 95 percent of maximum allowable impeller diameter.]

2.9.2.5 Pump Shaft

[Construct pump shaft and shaft sleeve for horizontal pumps of Type 316 stainless steel. Ensure shaft diameter and design is sufficient to transmit at least 2.5 times rated motor power of the pump.] [Provide one piece pump shaft for vertical type pumps constructed of ASTM A582/A582M

Type 416 stainless steel. Supply largest diameter shaft available for use with selected impeller that is able to transmit at least 2.5 times rated motor power.]

2.9.2.6 Pump Construction

[Construct pump and bearing frame and housing of cast iron, ASTM A48/A48M.] [Provide discharge head and suction barrel with mounting flange constructed of carbon steel, designed in accordance with ASME BPVC SEC VIII D1 with a 7.6 mm 300 mil corrosion allowance. Also provide sole plate constructed of a minimum of 25 mm 1 inch thick carbon steel plate with a minimum of four 19 mm 3/4 inch anchor bolts. Ensure welds on the pressure containing section of the pump are the full penetration type with welders and welding procedures in accordance with ASME BPVC SEC IX. Size suction barrel so that the velocity in the barrel does not exceed 915 mm 3 feet per second at 150 percent of design flow. Discharge head and can type must be the "T" type configuration so that discharge and suction are above baseplate. Provide suction barrel of sufficient length to accommodate installation of 2 additional turbine stages.]

2.9.2.7 Pump Column

Provide flanged pump column constructed of carbon steel. Design pump column assembly to withstand 4.1 MPa 600 psig and incorporate 7.6 mm 300 mil corrosion allowance. Construct bearing retainers located in the pump column in a manner that will assure concentric alignment of the shaft within 0.13 mm 0.005 inches.

2.9.2.8 Miscellaneous Hardware

Provide Type 316 stainless steel bolts, lock washers, nuts and miscellaneous hardware used with casing, pump frame and gland.

2.9.2.9 Shaft Sealing System

Equip pump with effective mechanical shaft seal to seal against discharge pressure when pump is operating. Provide cartridge type seals with Hastalloy "C" bellows mounted on Type 316 stainless steel shaft sleeve. Use tungsten carbide seal faces versus silicon carbide. Provide one spare mechanical seal. Provide flush vent and drain type gland constructed of ASTM A276/A276M Type 316 stainless steel. Also provide bypass line, constructed of ASTM A269/A269M Type 316 stainless steel, from the stuffing box to the suction side of the pump.

2.9.2.10 Pump Bearings

[Provide anti-friction type horizontal end suction pump bearings and operate in oil bath. Design pump bearings for radial and unbalanced axial loads imposed by the pump.] [Provide vertical type pump bearings that are water lubricated sleeve type constructed of babbitted graph alloy with Type 304 stainless steel shaft sleeves.] Design bearings for L-10 bearing life of [_____] hours.

2.9.2.11 Shaft Coupling

Provide shaft coupling between the pumps and motors of the flanged, adjustable, rigid, spacer type with OSHA approved coupling guard. [On horizontal end suction type pump, this coupling must facilitate removal of the mechanical seal without removing the driver.] Also design shaft coupling to transmit at least 2 1/2 times the motor power rating.

2.9.2.12 Painting and Corrosion Protection

Protect pumps, motors and accessories prior to initial startup. Thoroughly clean and smooth unfinished work. Factory paint surfaces which will not be in contact with the pumping fluid with a finish coat. Coat internal surfaces with a water soluble rust preventative material.

2.9.2.13 Special Tools

Provide complete set of special tools, if required for assembly, disassembly or maintenance of pump.

2.9.2.14 Bedplate

Provide horizontal type pump which includes single bedplate long enough to accommodate pump, motor drive and cooler. Provide bedplate in accordance with API and of heavy rigid construction, made of suitably structural steel members and plate to provide a stable platform for pump, drive and accessories. Suitably reinforce and brace bedplate to minimize deflection or bending during shipment and erection. Provide sufficient grout holes, minimum 75 mm 3 inch diameter, and grouting area vent holes in each corner of each grout space. Provide bedplate including horizontal jacking screws and vertical leveling screws along the length and width. Make provisions on the bedplate to collect drainage from the unit at one point. Locate and drill hold down bolts and dowel holes in field. Mount pump on bedplate at factory and ship as unit with bedplate mounted on a suitable skid to prevent deformation of the bedplate during shipment and erection.

2.9.2.15 Alignment

Precision align pump unit. Mount and matchmark pump coupling, mechanical seal and motor prior to shipment. Maximum allowable shaft runout must be 0.05 mm 0.002 inch as measured at impeller end.

2.9.2.16 Pump Characteristics

a. Pump discharge head must be such that maximum discharge head occurs at shutoff and continually decreases as the capacity increases. Ensure head capacity characteristics permit stable operation when pump is operating alone or in parallel with another pump.

b. Pump must have a shutoff head of no greater than 150 percent and no less than 115 percent of design head. Design point capacity on the selected pump curve must be within 25 percent of capacity at best efficiency point for impeller diameter selected to meet design point conditions. Minimum flow required for continuous pump operation must not be greater than 30 percent of specified design flow for each pump.

c. Provide pump with efficiency of 50 percent or greater at rated capacity.

2.9.3 Sump Pump

Provide sump pump for sump pit shown. Provide heavy duty, upright type sump pump, certified by the Sump and Sewage Pump Manufacturers' Association.

2.9.3.1 Design Conditions

Motor Power	[_____]	kW
Minimum capacity (including suction and friction losses)	[_____] L/hr at head of [_____] m [_____] gph at head of [_____] feet	
Shutoff head	[_____]	m feet
Maximum fluid temperature	[_____]	degrees C degrees F

2.9.3.2 Construction

Bronze fitted cast iron volute with non-clogging cast bronze impeller and stainless steel sediment screen. Use brass upright column. Discharge connection must be ISO NPT. Furnish high efficiency non-clogging impeller with stainless steel shaft journal and bearing suitably designed for intended service.

2.9.3.3 Backwater Valve

Provide a backwater valve in the pump discharge.

2.9.3.4 Float Switch

Actuate float switch by an adjustable copper float mounted on stainless steel rod.

2.9.4 Pump Drive

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NOTE: Delete the Steam Turbine Drives paragraph if all-electric motor drives are used and the Electric Drives paragraph if all-steam turbine drives are used.

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2.9.4.1 Steam Turbine Drive

Provide steam turbine drive rated for the specified operating conditions and designed in accordance with NEMA SM 23. Provide turbine of the single or multiple valve design and utilize impulse type blading. Provide flexible support for thermal expansion at governor end of turbine. Ensure turbine is horizontally or vertically split case with metal to metal joints without the use of gaskets. Properly lubricate journal bearings as recommended by turbine manufacturer for operating conditions. Provide anti-friction bearings that have L-10 bearing life of [_____] hours. Use thrust bearings of [ball] [tilting pad] design. Do not weld turbine blading. Ensure turbine blading issecurely anchored and renewable. Provide blading material consisting of minimum stainless steel and suitable for steam quality and purity. Seal steam glands [interstage diaphragms] with carbon rings or labyrinths. Finish turbine shaft with hard chrome in gland sealing zones. Provide turbine with single governor to control valve(s). Ensure governor is NEMA SM 23 Class [_____]. Furnish hand valves in cases where operating conditions will be substantially different than design or where future operating conditions will change. Provide overspeed trip set at 110 percent of the normal operating speed. Ensure overspeed trip is NEMA SM 23 Class [_____]. Include manual trip lever. Factory test turbine to check operation.

2.9.4.2 Electric Drive

Motor must be [splashproof] [totally enclosed, nonventilated] [totally enclosed, fan cooled] [totally enclosed, fan cooled suitable for installation in a class II, division 1, group G hazardous location as defined in NFPA 70]. Motor starter must be [manual] [magnetic] [across the line] [reduced voltage] type with [general purpose] [weather resistant] [watertight] [dust tight] [explosion proof] enclosure.

2.9.5 Condensate Return System Control

Furnish completely wired control cabinet, mounted on condensate return equipment or free-standing. Provide cabinet with hinged door and include the following:

a. Auto Lead-Lag-Off-Continuous selector switch.

b. Pump running Pilot light.

c. Control circuit disconnect switch.

d. Terminal block.

e. Control circuit transformer, fused.

f. Momentary contact Test pushbutton.

g. Control Panel meeting the following requirements:

    (1) Construction: Size the condensate return surge tank control panel properly to contain all control devices, instrument gauges and meters. Ensure control cabinet is factory assembled steel enclosure with locking door. Provide panel consisting of NEMA 12 construction, 11 gauge steel with key-locking vault handle, three (3) point latches, and continuous hinge. Provide fully gasketed door.

    (2) Wiring: Wire control panel in accordance with NFPA 70 and include individual motor starter with 120 volt holding coil and fuse protection. Provide individual green oil-tight pump run lights. Provide switches and lights with nameplate identification. Paralleling of individual control power transformers is not permitted. Provide panel with a non-fuse disconnect or non-automatic circuit breaker main disconnect device . Equip disconnect with mechanical door interlock preventing door opening with the disconnect in the closed position. Use cartridge type fusing. Use dual element, current limiting, time delay safety switches which are multiple horsepower rated, heavy duty type. Provide magnetic motor starter for each motor assembly that is NEMA type, full voltage, non reversing, overload protected for each phase, with auxiliary contacts. Ensure overload relay is trip-free, thermal bimetallic, manual reset with trip heaters based on actual full load current of motor. Provide spare NO and NC auxiliary contacts wired to the terminal block. Provide control power transformer with primary fuse disconnect and secondary fusing. Provide factory mounted and wired control,

arrange to receive a signal from the deaerator water level assembly. Provide a panel mounted Lead-Lag-Off-Continuous switch for feedwater pump.

(3) Sequence of Operation: From a cold start, when the plant master controller indicates one boiler to start, start the lead pump and operate continuously. When all boilers are off, all pumps must be off. Should there be a failure of any pump, operate the next pump in sequence automatically.

2.10 BOILER BOTTOM BLOWDOWN TANK

Provide blowdown tank with [_____] mm inches diameter by [_____] mm inches high. Provide supports, associated accessories and appurtenances as specified and shown. Provide blowdown tank consisting of welded steel construction built in accordance with ASME BPVC SEC VIII D1 and stamped for a 1.03 MPa 150 psig rating. Include a tangential inlet, size to match boiler blowdown pipe, stainless steel striking plate at point of inlet impingement, internal stainless steel flow restrictor plates, waterleg type drain vent, gauge glass opening, inspection opening and clean-out connections. Use materials in fabrication of boiler blowdown tank equipment in compliance with ASME BPVC SEC II-C. Provide inspection openings on tank as required in paragraphs UG-45 and 46 of ASME BPVC SEC VIII D1 and as shown. Provide connections as shown. Ensure interior surface preparation is in accordance with SSPC SP 5/NACE No. 1 and the coating manufacturer's recommendations. Coat interior with a suitable baked epoxy phenolic coating, minimum 0.13 mm 5 mil DFT. Ensure exterior surface preparation is in accordance with SSPC SP 6/NACE No.3 and the coating manufacturer's recommendations. Prime exterior with a high heat silicone acrylic primer, minimum 0.05 mm 2.0 mil DFT. Supply the blowdown tank with drain aftercooler and temperature regulating valve. Provide aftercooler with cold water inlet, flanged body for easy removal, 6.35 mm 1/4 inch NPTF connection for temperature regulating valve sensing bulb. Use valve adjustable range of 43 to 65 degrees C 110 to 150 degrees F. Provide a thermostatic regulating valve to inject potable water to maintain acceptable discharge temperature to the sewer.

2.11 BOILER SURFACE BLOWDOWN HEAT RECOVERY SYSTEM

2.11.1 General Requirements

Provide blowdown flush separator that is [_____] mm inches in diameter by [_____] mm inches high. Provide supports, associated accessories and appurtenances in accordance with these specifications and as shown. Provide steel tank consisting of welded construction in accordance with ASME BPVC SEC VIII D1 and stamped for a 1.0 MPa 150 psig rating. Provide tank with a tangential inlet connection sized to match the boiler blowdown pipe, stainless steel striking plate at the point of inlet impingement, internal stainless steel flow restrictor plates, float level control, gauge glass openings, inspection opening and clean-out connection. Provide thermostatic regulating valve to inject potable water to maintain acceptable discharge temperature to sewer.

2.11.2 Materials

Use materials in fabrication of boiler blowdown equipment in compliance with ASME BPVC SEC II-C. Provide inspection openings on tank as required in Paragraphs UG-45 and 46 of ASME BPVC SEC VIII D1 and as shown. Provide connections as shown. Ensure interior surface preparation is in accordance with SSPC SP 5/NACE No. 1 and the coating manufacturer's recommendation. Coat interior with a suitable baked epoxy phenolic coating, minimum 0.13 mm 5 mil DFT. Ensure exterior surface is in accordance with SSPC SP 6/NACE No.3 and coating manufacturer's recommendations Prime exterior with high heat silicone acrylic primer, minimum 0.05 mm 2.0 mil DPT. Pipe flash separator to heat exchanger. Provide heat exchanger consisting of horizontal U-tube with removable tube bundle and of self-draining type. Blowdown water must pass through shell and cooling water must pass through tubes. Provide stainless steel tubes with rear supporting baffle. Provide steel side welded shell with anti-vibration hold-down clamps, ASME Code stamping for 1.03 MPa 150 psig rated for 208 degrees C 400 degrees F and supporting structural steel stand. Supply heat exchanger with drain aftercooler and temperature regulating valve. Provide aftercooler with cold water inlet, flanged body for easy removal, 6.35 mm 1/4 inch NPT connection bimetallic thermometer, and 25.4 mm 1 inch NPTE connection for temperature regulating valve sensing bulb. Use valve adjustable range of 43 to 65 degrees C 110 to 150 degrees F.

2.11.3 Monitor-Controller

Provide one electronic monitor-controller for use in boiler surface blowdown line for each boiler, consisting of:

a. Control concentration of total dissolved solids (TDS). House monitor-controller in a painted steel NEMA 12 enclosure. Interlock boiler surface blowdown control with boiler operation.

b. Ensure panel display includes the following:

    (1) Long-life LED indicators on front panel and labeled power and control.

    (2) Manually-operated two position switch to allow operator to turn monitor-controller on or off. Manually-operated two position switch to allow operator to test the output circuits.

    (3) Manually operated two position switch to allow the operator to select either a low or high scale of conductivity.

    (4) A manually operated two position switch to allow the operator to continuously read system conductivity level or to set or read the front panel operator adjustable trip point.

    (5) Calibration adjustment.

    (6) Timer for adjustment of intervals between sampling periods.

c. Provide one prepiped blowdown piping assembly installed in each boiler surface blowdown line. Provide assembly consisting of:

    (1) Shut-off valve 19 mm 3/4 inch rated for system operating pressure and temperature.

    (2) Conductivity probe.

    (3) Normally closed motorized flow control valve [[19 mm 3/4 inch] rated for system operating pressure of [1150 kPa 150 psig] and temperature up to [200 degrees C 400 degrees F]] [_____].

(4) Throttling valve [19 mm 3/4 inch] [_____] rated for system operating pressure and temperature.

(5) Temperature compensation probe.

2.12 CHEMICAL FEED SYSTEM

Provide chemical feed system for steam and condensate chemical treatment consisting of introduction of chemical solutions into deaerator, boiler and boiler feedwater lines. Ensure chemical feed system is the automatic proportioning pump type for single or multiple boiler installation and consists of pumps, tank, piping, control and accessories. Provide chemical feed system consisting of a completely preassembled package, factory tested, hydraulically and electrically, and furnish with required special tools, lubricants, and installation instructions. Provide chemical feeding and control equipment for the following:

a. For each boiler:

  (1) Boiler scale inhibitor and antifoaming chemical treatment.

  (2) Alkalinity supplement.

  (3) Neutralizing amines.

b. For deaerator feedwater condensate return systems: chemical treatment consisting of oxygen scavenger such as sodium sulfite.

Provide a 1 year supply of chemicals. Ensure chemical products are compatible with system materials of construction and operating conditions and comply with all applicable regulatory agencies. Interlock the chemical feeder with boiler and deaerator operation.

2.12.1 Chemical Feed Pump and Tank

Provide chemical feed pump and tank as indicated. Ensure chemical feed pump and tank is a package with pump mounted and piping connected to the tank. Provide chemical feed pump capacity as indicated. Provide positive displacement metering type chemical feed pump. Provide chemical feed pump with micrometer capacity adjustment from 0-100 percent while the chemical feed pump is running and metering accuracy within plus or minus one (1) percent. Provide chemical feed pump components constructed of materials suitable for the chemicals being pumped. Provide 120 volts ac, 60 Hz, single phase drive motors, with general purpose dripproof enclosure. Fabricate chemical feed tank of materials suitable for chemicals used and provide with fill and chemical feed drain connections and gauge glass. Furnish chemical feed tank with one chemical feed pump, mounted and piped with piping and fittings constructed of materials suitable for the chemicals being pumped, and include a suction strainer and 13 mm 1/2 inch relief valve. Provide chemical feed tank with hinged cover. Ensure chemical feed tank bottom is dished concave to radius equal to diameter of tank.

2.12.2 Agitator

Equip chemical feed tank with agitator. Provide motor driven agitator with Type 316 stainless steel impeller and drive shaft. Maximum speed is 1750 rpm. Mount agitator and support on chemical feed tank.

2.12.3 Boiler Chemical Treatment System

****

NOTE: For steam boiler plant with more than one boiler select a bulk storage system 800 liters 200 gallons for each chemical or dedicated feeder system for each chemical with individual drums 200 liters 50 gallons for the chemical treatment for boilers listed above.

****

Provide the following for each boiler:

a. Three chemical feed pumps. Provide each pump with a pressure relief valve piped on discharge side of the pump to divert overpressurized chemical solution back to the storage tank. Ensure chemical feed pumps have the capability of accepting 4 to 20 mA dc signal.

[b. One 800 liter 200 gallon bulk storage tank.]

[c. Three 200 liter 50 gallon drums.]

d. One connecting head water meter. Use maximum operating pressure of 1650 kPa 225 psig and maximum temperature of 120 degrees C 250 degrees F. Provide turbine type water meters with cast iron Maine cases.

e. Proportional chemical feed controller and electronic pulse timer. Control proportional feed of treatment chemicals based on feedwater as measured by a contacting head water meter. Provide controller with the following features:

    (1) Painted steel NEMA 12 enclosure.

    (2) Panel display including: proportional pulse timer, automatic-off-manual switch, push-to-test momentary switch which simulates a water meter pulse and runs the timer for one cycle, 12-volt signal to water meter, and pulse accumulator.

2.12.4 Deaerator Condensate Return System Chemical Treatment System

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NOTE: Select 200 liters 50 gallons drum for boiler plant up to 22,650 kg/hr

****

Provide one feedwater chemical treatment system for deaerator including the following:

a. One chemical feed pump. Provide chemical feed pump with pressure relief valve piped on discharge side of chemical feed pump to divert overpressurized chemical solution back to the storage tank. Ensure chemical feed pump is capable of accepting 4 to 20 mA dc signal.

    b. [One 8000 liter 200 gallon tank.][or][One 200 liter 50 gallon tank.]

b. Provide one contacting head water meter. Use maximum operating pressure of 1650 kPa 225 psigand maximum temperature of 120 degrees C 250 degrees F. Provide turbine type meter with cast iron Maine case.

c. Proportional chemical feed controller and electronic pulse timer. Control proportional feed of treatment chemicals based on makeup water as measured by contacting head water meter. Provide controller with the following features:

  (1) Painted steel NEMA 12 enclosure

  (2) Panel display including one proportional pulse timer, Automatic-Off-Manual switch. Test momentary switch which simulates a water meter pulse and runs timer for one cycle, and pulse accumulator.

2.12.5 Testing Equipment

Provide testing equipment, including carrying case and spare reagent, for maintaining control of a program of water treatment standards in steam boiler system in accordance with the water treatment plan. Submit a plan for water treatment, including proposed chemicals to be used and nationally recognized testing codes applicable to the system, prior to system startup. Provide testing equipment consisting of the following:

a. Reagents and apparatus for determination of phosphate and sulfite levels in the boiler water.

b. Reagents and apparatus for determination of PH, P and M alkalinity and chloride.

c. Reagents and apparatus for determination of neutralizing amine level in the steam and condensate return lines.

d. One conductivity meter with temperature compensation and multiple measurements ranges of 0-10, 0-100, and 0-10,000 micromhos.

e. Wall mounting test equipment cabinet for storage of testing glassware and reagents. Provide cabinet with one shelf, keylock door and fluorescent light. Construct cabinet of 1 mm No. 18 gauge thick cold-rolled steel, primed and painted with white polyurethane enamel for corrosion protection.

f. Prefabricated steel corrosion nipple bypass assembly to monitor program effectiveness. Include inlet and outlet shut-off valve, wye strainer, and two corrosion nipples.

2.13 WATER SOFTENING EQUIPMENT

****

NOTE: Insert water analysis specific to the site. Insert desired water treatment conditions, e.g. pH level, hardness, chemical concentrations.

****

a. Provide a [single] [double] unit automatic water softener system as indicated. Design water softener system for working pressure of [_____] MPa psi. Provide water softener system complete with raw and regenerate water distribution; under drain, inlet and outlet connections in upper and lower header respectively; resin removed connecting pipe legs; control valve for service, backwash, regenerate, and rinse; water meters, pressure gauges, brine storage, measuring tank and controls. Provide test sets for pH comparator for range [_____] to [_____], sulfide comparator, and phosphate comparator.

b. Influent water analysis for which system must be designed is [_____].

c. Treatment conditions to be maintained in circulation water are [_____].

2.14 MAINTENANCE EQUIPMENT

2.14.1 Tube Cleaner

Provide water turbine driven tube cleaner that includes three rotary cutters, complete with necessary length of armored water hose, valves, and other appurtenances necessary for operation. Provide tube cleaner for each size of watertube in boiler, with one extra set of cutters for each size cleaner. Provide necessary valves and fittings to permit convenient connection of tube cleaner hose boiler feed pump to supply cold raw water for operation of tube cleaner. Arrange piping such that one boiler feed pump may be used to operate tube cleaner without interfering with normal operation.

2.14.2 Tube Brush

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NOTE: The tube brush applies only to firetube boilers and will be deleted if not applicable.

****

Provide brush with steel bristles and jointed handle of sufficient length to clean full length of fire tubes.

2.15 FACTORY COATING

Factory finish equipment and component items, when fabricated from ferrous metal, with the manufacturer's standard finish unless otherwise specified.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION, EXCEPT FUEL SYSTEM

Install work as indicated and in accordance with manufacturer's diagrams and recommendations and applicable requirements of FM and NFPA.

3.2.1 Piping

a. Unless otherwise specified, use pipe and fittings conforming to requirements of ASME B31.1. Cut pipe to measurements established at the jobsite and work into place without springing or forcing, completely clearing windows, doors, and other openings.

b. Install pipes a minimum of 2.4 m 8 feet above walkway elevations.

c. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval.

d. Remove burrs from pipes by reaming and install to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Wipe filings, dust, or dirt from interior of pipe or tubing before connections are made.

e. Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. Ensure centerline radius of bends is no less than 6 diameters of pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Carry vent pipes through the roof as directed and flash.

f. Unless otherwise indicated, pitch horizontal supply mains down in direction of flow with a grade of no less than 25 mm in 12 meters 1 inch in 40 feet.

g. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

h. Pipe not otherwise specified must be uncoated. Provide brass or bronze unions for copper pipe or tubing.

i. Electrically isolate connections between ferrous piping and copper piping from each other with dielectric couplings or other approved methods.

j. Provide pipe and fittings of the types indicated in TABLES I and II for the applicable service and pressure.

3.2.2 Joints

Provide threaded, flanged, or welded joints between sections of pipe and between pipe and fittings as specified. Except as otherwise specified, ensure fittings 38 mm 1-1/2 inches and smaller are either threaded or socket welded, and fittings 50 mm 2 inches and larger are either flanged or butt welded. Weld pipe and fittings 32 mm 1-1/4 inches and larger installed in inaccessible conduits or trenches under concrete floor slabs. Unless otherwise specified or indicated, make connections to equipment with black malleable iron unions for pipe 38 mm 1-1/2 inches or smaller in diameter, and with flanges for pipe 50 mm 2 inches or larger in diameter.

3.2.2.1 Threaded Joints

Make threaded joints with tapered threads properly cut, and make tight with PTFE tape, or equivalent joint compound material applied to the male threads only. Do not apply joint compound to fittings.

3.2.2.2 Welded Joints

a. Make welded joints as specified. Make changes in direction of piping with welding fittings only.

b. Branch connection may be made with either welding tees or branch outlet fittings. Provide forged branch outlet fittings, flared for improvement of flow where attached to the run, and reinforced against external strains.

c. Bevel, align, heat treat, and inspect weld conforming to ASME B31.1.

d. Remove weld defects and make repairs to the weld, or remove weld joints entirely and reweld.

e. Store and dry electrodes in accordance with AWS D1.1/D1.1M or as recommended by manufacturer. Do not use electrodes that have been wetted or that have lost any of their coating.

3.2.2.3 Expansion Joints

Perform guiding of piping on both sides of expansion joint in accordance with published recommendations of manufacturer.

3.2.2.4 Flanges and Unions

Ensure flanges are faced true, provided with metallic spiral wound nonasbestos gaskets, and made square and tight. Provide union or flange joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.2.3 Supports

3.2.3.1 General

****

NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions will contain notes indicating that hanger loads between panel points in excess of 22.7 kg 50 lbs steel joist must have the excess hanger loads suspended from panel points.

Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase in item a. if no seismic details are provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, will be included in the contract documents.

Support for steam piping from boiler nozzle to steam header and steam lines 150 mm 6 inches and larger will be detailed on the drawings as excessive stress and movement can occur in these piping systems due to thermal expansion. Each spring hanger location will be clearly indicated. They will be assigned a number in a schedule on the drawings that lists hanger details, load, and movement.

****

Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while supporting the load. Install pipe guides and anchors to prevent buckling, swaying, and undue strain. Support piping subjected to vertical movement when operating temperatures exceed ambient temperatures by variable spring hangers and supports or by constant support hangers. Submit detailed drawings of spring type pipe hangers, before installation. Ensure pipe hanger loads suspended from steel joists between panel points do not exceed 23 kg 50 pounds. Suspend loads exceeding 23 kg 50 pounds from panel points.

a. Seismic Requirements for Pipe Supports and Structural Bracing: Support and brace piping and attached valves to resist seismic loads as specified in UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS. Provide structural steel required for reinforcement to properly support piping, headers, and equipment but not shown under this section. Use material for supports as specified under Section 05 12 00 STRUCTURAL STEEL.

b. Structural Attachments: Provide structural steel brackets required to support piping, headers, and equipment, but not shown, under this section. Provide material and installation as specified under Section 05 12 00 STRUCTURAL STEEL.

3.2.3.2 Pipe Hangers, Inserts, and Supports

Provide pipe hangers, inserts and supports conforming to MSS SP-58 except as otherwise specified.

a. Do not use Types 5, 12, and 26.

b. Do not use Type 3 on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.

c. Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Torque Type 19 and 23 in accordance with MSS SP-58 and have both locknuts and retaining devices furnished by the manufacturer. Do not construct C-clamp body from bent plate.

e. Furnish Type 20 attachments used on angles and channels with an added malleable iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Where type 39 saddle or type 40 shield is permitted for a particular pipe attachment application, use the type 39 saddle on pipe 100 mm 4 inches and larger.

h. Space horizontal pipe supports as specified in the tables in MSS SP-58 and do not install a support over 300 m 1 foot from the pipe fitting joint at each change in direction of the piping. Space pipe support as required for specified hydrostatic tests. Do not space pipe supports over 1.5 m 5 feet apart at valves. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Ensure spacing of the base support members does not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Connect clips or clamps rigidly to the common base member. Provide a clearance of 3.2 mm 1/8 inch between the pipe and clip or clamp for piping which may be subjected to thermal expansion.

i. Support vertical pipe at each floor, except at slab on grade, and at intervals of no more than 4.5 meters 15 feet, nor more than 2.4 m 8 feet from ends of risers, and at vent terminations.

j. Type 35 guides using steel, provide reinforced PTFE or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Provide slide materials suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

  (1) Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, a type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm 4 inches, a type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

  (2) Where there are high system temperatures and welding to piping is not desirable, use type 35 guide including a pipe cradle, welded to the guide structure and strapped securely to the pipe. Separate pipe from the slide material by at least 100 mm 4 inches, or by an amount adequate for the insulation, whichever is greater.

  (3) Insulated pipes: Except for type 3, use pipe hangers on horizontal insulated pipe that are the size of the outside diameter of the insulation.

3.2.3.3 Piping in Trenches

****

NOTE: Detail pipe in trenches on the drawings. Show exact locations of pipe supports. Include individual hanger identification. Provide schedule of data to include, but not be limited to identification number, detail references, load, and movement.

****

Support piping as indicated.

3.2.4 Pipe Anchors

Provide anchors wherever necessary or indicated to localize expansion or prevent undue strain on piping. Provide anchors consisting of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results, using turnbuckles where required. Do not attach supports, anchors, or stays in places where they will injure the construction during installation, or by the weight of expansion of the pipeline. Submit detailed drawings of pipe anchors for approval before installation.

3.2.5 Pipe Sleeves

Provide pipe passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Provide rectangular and square openings as indicated. Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Unless otherwise indicated, use sleeves of a size that will provide a minimum of 6.35 mm 1/4 inch all around clearance between bare pipe or insulation jacket and sleeves. Ensure sleeves in bearing walls, waterproofing membrane floors, and wet areas are steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, or galvanized sheet metal with lock type longitudinal seam and of the metal thickness indicated. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over insulation and sleeve in non-fire rated walls and floors as indicated and specified in Section 07 92 00 JOINT SEALANTS, and in fire rated walls and floors seal as indicated and specified in Section 07 84 00 FIRESTOPPING. Sleeve pipes passing through wall waterproofing membrane as described above. In addition, install a waterproofing clamping flange as indicated.

3.2.5.1 Pipes Passing Through Roof or Floor Waterproofing Membrane

Install pipes through a 1.8 kg 4 pound lead flashing sleeve, a 0.450 kg 16 ounce copper sleeve, or a 0.8 mm 0.032 inch thick aluminum sleeve, each having an integral skirt or flange. Form flashing sleeve suitably, and extend the skirt or flange no less than 200 mm 8 inches from the pipe and set over the roof or floor membrane in a troweled coating of bituminous cement. Extend flashing sleeve up the pipe a minimum of 50 mm 2 inches above the highest flood level of the roof or a minimum of 250 mm 10 inches above the roof, whichever is greater, or 250 mm 10 inches above the floor. Seal the annular space between the flashing sleeve and the bare pipe or metal jacket covered insulation as indicated. Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.2.5.2 Counterflashing

As an alternate to caulking and sealing the annular space between the pipe and flashing sleeve or metal jacket covered insulation and flashing sleeve, counterflashing may be by standard roof coupling for threaded pipe up to 150 mm 6 inches in diameter; lead flashing sleeve for dry vents and turning the sleeve down into the pipe to form a waterproof joint; or tack welded or banded metal rain shield round the pipe and sealing as indicated.

3.2.5.3 Sealing Uninsulated Pipes or Conduits

A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing, as specified, of annular space between pipe and sleeve or conduit and sleeve. Provide seals consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Assemble links loosely with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.2.6 Escutcheons

Povide escutcheons at finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, use special deep type escutcheons. Fasten chromium plated iron or chromium plated brass, either one piece or split pattern, escutcheons securely to pipe or pipe covering and hold in place by internal spring tension or setscrew.

3.2.7 Clay Sewer Pipe

Install pipe where indicated for housing steam supply and condensate return lines. Install sewer pipe on properly graded and well tamped earth or gravel base. Pack joints with twisted jute packing and seal with bituminous sealing compound or portland cement mortar.

3.2.8 Pipe Expansion

****

NOTE: Detail expansion loops on the drawings.

****

Install expansion loops and pipe guides where indicated.

3.2.9 Valves

Install valves at locations indicated and where specified. Use gate valves for isolation service unless otherwise indicated or specified. Use globe valves for throttling service unless otherwise specified. Install valves with stems horizontal or vertical, except install steam nonreturn valves as specified. Use chain operated type gate valves as shutoff valves in the boiler lines to and from steam headers, and elsewhere as indicated, if walkways are not provided for their operation. Ensure chain operated valves have sufficient chain for easy reach of the operating personnel from the operating floor or walkway. Provide gate valves 200 mm 8 inches and larger used on high pressure steam lines, and elsewhere as indicated, with a valve bypass integral with the valve body.

3.2.9.1 Back Pressure Relief

Set backpressure valve to exhaust at the pressure indicated.

3.2.9.2 Steam Pressure Reducing

Adjust steam pressure reducing valve to maintain desired terminal pressure, regardless of fluctuations in the inlet steam pressure. Steam pressure reducing valves must fail closed. Provide pilot, or auxiliary operated valves using steam for operating medium, or sliding gate and plate valves. Install steam pressure reducing valve with strainer, 3 valve bypass, and safety valve as indicated. Where steam pressure reducing valves is used for reducing steam pressure to deaerating heater, provide pneumatic pilot operated type valve. Connect sensing line to the steam space in the deaerator.

3.2.9.3 Thermostatic Regulating

Provide thermostatic regulating valve to control temperature of water within hot water generator, by regulating steam supplied to the heating coil, in the steam supply line to each generator.

3.2.10 Flow Meter

****

NOTE: Specify which meters should receive 3-way bypass to maintain service during a meter service or replacement (suggest that fuel oil flow meters have a 3-way valve bypass if service is critical.)

****

Install flow meter in straight line pipe of at least [_____] pipe diameters to maintain accuracy. [Provide a 3-way valve bypass for [_____] flow meters.]

3.3 FUEL OIL SYSTEM INSTALLATION

3.3.1 Fuel Storage Tank Installation

Install fuel storage tank in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.3.2 Underground Ferrous Metallic Piping

Provide underground ferrous metallic piping in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.4 FIELD PAINTING AND FINISHING

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00 PAINTS AND COATINGS.

3.5 ELECTRICAL

3.5.1 General

Perform field run conduit, wiring and terminations in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.5.2 Splice

Splice stranded conductors by solder or pressure type connectors. Do not use wirenut connectors on stranded conductors. Cover splices with electrical insulation equivalent to, or of higher rating than, insulation of conductors being spliced. Splices will not be allowed in control or signal wiring, except where sensors or controlled devices are provided with pigtails for connecting to incoming cable

3.5.3 Identification

Label both ends of wires.

3.5.4 Grounding of Drain Wire of Shielded Cable.

Ground shield cable drain wire at the source end, terminate at a copper bus ground bar 3.175, 12.7, by 100 mm 1/8, 1/2, by 4 inches minimum.

3.5.5 Analog Signal Cable Connections

Connect analog signal cables to controller by means of terminal blocks with knife isolation switches with test plugs to enable isolation of each instrument without disconnecting common instrument power supply. Ensure these terminal blocks are double level terminal blocks with knife disconnect point with test plugs at the upper level and feed through terminal at lower level. Provide minimum of thirty percent (30 percent) spare terminal points.

3.5.6 Digital Input-Output

Connect digital input-output cables to controller by means of terminal blocks. Provide minimum of thirty percent (30 percent) spare terminal points.

3.6 INSULATION

Use thickness of insulation materials for piping and equipment and application in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.7 BOILERS AND AUXILIARY EQUIPMENT

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NOTE: Before occupancy of a facility, inspect the boilers in accordance with the Code of Boiler and Pressure Vessel Inspectors (BPV I) and American Society of Mechanical Engineers (ASME). Inspectors must be certified in accordance with BPV I standards.

****

3.7.1 Inspection

Inspect areas and conditions under which boiler and auxiliary equipment are to be installed. Field verify location of connections to piping, equipment and supports and make connection to said items utilizing field-verified dimensions. Notify Contracting Officer of discrepancies and ensure that unsatisfactory conditions have been corrected in an acceptable manner.

3.7.2 Preparation

a. Coordinate the installation of equipment and appurtenances prior to installation with other work.

b. Provide work required to correct situations resulting from the Contractor's failure to coordinate with the work of other trades, at no additional cost.

c. Take into consideration priority needs for location and space of work of all trades. Failure to do so will require the Contractor to remove and relocate the work at no additional cost.

3.7.3 Installation

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NOTE: Delete reference to local city and state codes if not applicable.

****

3.7.3.1 Boiler

Install boiler in accordance with the manufacturer's written instructions, [in accordance with boiler installation requirements of local, city, state codes] and in accordance with applicable provisions of NFPA and ASME code standards. Locate boiler and associated components where indicated. Install boiler level to a tolerance of 3 mm in 3 m 1/8 inch in 10 feet in all directions. Make electrical connections in accordance with Section [_____].

3.7.3.2 Protection

It is the Contractor's responsibility to protect boiler and components from damage after installation, until Government takes custody. After installation, provide touchup paint to damaged areas on shop and finish-coated surfaces of the equipment. Ensure surfaces are free of rust, scale and foreign substances before application of touchup paint. Use touchup paint that is equivalent to the shop and/or finish paint.

3.7.3.3 Adjusting, Inspecting, and Cleaning

Submit test reports, in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completing and testing the installed system. Indicate the final position of controls in each test report. A written statement from the manufacturer's representative certifying that combustion control equipment has been properly installed and is in proper operating condition, upon completion of the installation. Include action settings for automatic controls in the form of a typed, tabulated list indicating the type of control, location, setting, and function.

a. Thoroughly clean inside of boiler by performing boil-out, flushing and cleaning in accordance with manufacturer's instruction prior to startup.

b. Make final adjustment to boiler in accordance with manufacturer's recommendations, but no less than following:

    (1) Verify lubrication of moving parts.

    (2) Verify fan rotation direction.

    (3) Adjust water level control for proper operating level.

    (4) Adjust firing rate control.

    (5) Confirm operation of safety devices.

    (6) Adjust controls and verify operation.

3.7.3.4 Field Quality Control.

a. Provide trained field representative to supervise installation of boiler and its components. Inspect alignment and balancing of rotating and moving parts. After completion of installation, provide services of factory-trained field representative to start and adjust boiler.

b. Provide trained field representative for final inspection of boiler for proper installation, alignment and leveling prior to boiler startup.

c. Coordinate with other representatives on startup of other items and building services as required.

d. Contractor's representative must be available to instruct and train Government personnel for not less than two (2)days after boilers are operational.

3.7.4 Gaseous Emissions Monitor

Provide extractive or in-situ gaseous emissions monitor. Combination of extractive and in-situ monitors is not acceptable. Include automatic calibration checks. Alarm horn and provide annunciator to alarm when any monitored parameter is out of range or gaseous emission monitor malfunctions. Construct surfaces exposed to corrosive gas of boiler of noncorrosive materials such as 316 SS, Teflon or Hastalloy.

a. Mount in-situ gaseous emissions monitor on ductwork at location [shown on plans] [recommended by the manufacturer]. Do not affect in-situ system by presence of particulate matter in flue gas.

b. Provide [wet] [dry] [diluted] extractive systems. [Provide rack-mounted analyzing equipment for extractive system.] [Locate analyzing equipment for extractive system in a walk-in cabinet.]

c. Arrange equipment to provide access for maintenance. Heat trace extractive system sampling between probes and analyzers to maintain temperature recommended by manufacturer when ambient temperature is [_____]. Mount probes on ductwork at the location [shown on the plans] [recommended by manufacturer].

d. Submit a Boiler Emissions Report of air pollutants showing compliance with the limits established in the environmental permit.

3.7.5 Flue Gas Flow Monitor

Utilize pitot tube principle to measure flow. Ensure flue gas flow monitor probe is across-the-duct average pitot tube and properly designed and located to obtain representative measurement. Use differential pressure transmitters to sense the difference between the static and total pressure of the flowing flue gas stream. Arrange lines to prevent collection of condensate. Provide purge system to keep pitot pressure taps clear.

3.7.6 Testing

ASME PTC 19.3 TW.

3.7.6.1 Factory Testing

Provide boilers guaranteed to perform in accordance with stated operating conditions. Complete packaged boiler must be hydrostatically and fire tested at boiler manufacturer's factory to check construction, operation and function of all controls. Submit certification of factory tests. Tests may be witnessed by Contracting Officer or Representative of Contracting Officer. Notify Contracting Officer two weeks prior to factory testing.

3.7.6.2 Field Testing

a. Furnish personnel, equipment, instrumentation, and supplies necessary to perform field testing. Upon completion, and prior to acceptance of the work, subject boiler plant to such operating tests as may be required to demonstrate satisfactory functional operation of the plant, including safety devices. Conduct operating tests at such times as the Contracting Officer may direct.

b. Submit proposed test procedure to Contracting Officer, 30 days prior to the proposed test date, for approval. Include a complete description of the proposed test with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. Do not commence test until the procedure has been approved. The Government will witness the field tests. Obtain written permission from the Contracting Officer before proceeding with testing. Tests must be supervised by respective manufacturers.

c. Turn over original copies of data produced, including results of each test procedure during field testing, to the Government at the conclusion of testing prior to Government approval of the test.

d. Do not schedule testing during seasonal off-periods of heating systems. Perform testing in accordance with approved test procedures. Cover actual equipment and functions specified for the project.

3.7.6.3 Hydrostatic Test

****

NOTE: Delete boiler isolation valve test for single-boiler plants. This test is critical for multiple-boiler plants as it verifies that individual boilers can be isolated for maintenance or replacement while the steam system is in operation.

****

a. General: Submit a written field hydrostatic test schedule [7] [_____] days in advance to Contracting Officer for approval. Schedule will be approved by the Contracting Officer.

b. After installation is completed and prior to startup, furnish the services of local boiler and pressure vessel inspector to observe field hydrostatic test, inspect installation and piping and certify that installation is in accordance with ASME code.

c. Following installation of piping and boiler plant equipment, but before application of piping and boiler insulation, complete a hydrostatic test, including boiler and associated piping within boiler plant. Prove system tight for at least two hours under gauge pressure of 1.5 times the working pressure specified and no less than the following:

[(1) Low pressure lines up to 448 kPa 65 psig working - Test pressure 590 kPa 100 psig.]

[(2) Medium pressure from 448 to 690 kPa 65 to 100 psig, working - test pressure 1.03 MPa 150 psig.]

[(3) High pressure 1.03 MPa 150 psig working - Test pressure 1.55 MPa 225 psig.]

d. Test boiler isolation valves individually to isolate against the specified hydrostatic test pressure. At the conclusion of the system hydrostatic test, close each boiler's isolation valves (steam discharge, boiler feedwater, etc.); drain down the boiler; and monitor pressure on both sides of each isolation valve for a minimum of two hours to verify that the valves isolate each boiler.

e. Test boilers and inspect piping connections by a certified boiler inspector for compliance with ASME BPVC SEC I.

f. Submit certificate of compliance with ASME BPVC SEC I for each boiler to Contracting Officer.

3.7.6.4 Inner Casing Air Tests for Packaged Force Draft Boilers

Following installation, air test each packaged forced draft boiler up to 2.5 kPa 10 inches water gauge. Apply soap foam to seams to detect leaks. Ensure boiler does not lose more than 1.3 kPa 5 inches water gauge in 10 minutes. Perform this test prior to installing insulation.

3.7.6.5 Efficiency and Capacity Test

a. Run efficiency and capacity test on one boiler of each size installed, conduct in strict accordance with ASME PTC 4, abbreviated efficiency test.

b. Properly calibrate measuring devices used for measuring feedwater evaporated and amount of fuel burned prior to test. Use water flow meter suitable for hot water. Furnish instruments, test equipment, test personnel, and fuel oil required to properly conduct tests. Submit a fuel oil analysis report of Independent Agency for fuel oil used during efficiency testing.

c. Calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and furnish thermometer to be used in the efficiency and capacity test prior to test.

d. Obtain necessary natural gas, water and electricity as specified in the [SPECIAL CONTRACT REQUIREMENTS][Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS] Provide necessary quantities of propane gas or No. [_____] fuel oil when propane gas or fuel oil is require for testing.

e. Conduct efficiency and general performance tests on boiler by a qualified test engineer furnished by Contractor.

f.

TESTING AND PERFORMANCE		
Percent of Capacity		
Time	Waterwall Watertube Boilers	Cylindrical Furnace Firetube Goilers
First 1 hour	50	50
Next 2 hours	75	75
Next 4 hours	100	100

g. Efficiency tests may be conducted concurrently with operating tests, or separately. Ensure thermal efficiency is no less than specified. Ensure maximum moisture content of saturated steam leaving boiler is as specified.

h. Submit Performance Test report including logs, heat balance calculations, and tabulated results together with conclusions to Contracting Officer in quadruplicate.

i. Submit an analysis by an independent testing laboratory of fuel being burned during test to the Contracting Officer. Include pertinent data tabulated in ASME PTC 4, abbreviated efficiency test.

j. Contracting Officer will observe and approve tests.

3.7.6.6 Control System Operational Testing

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NOTE: For operational functional testing, consider adding project specific equipment and sequences of operation, alarms and other critical interface points between contracts (such as mechanical and instrumentation) for field operational tests. Consider integrating these tests into a larger project commissioning plan and specification.

****

a. Conduct full operational test of boiler plant control system to demonstrate compliance with sequences of operation, safety interlocks and control functions of the specification.

b. Field Installation Test: Following the installation of the control system, align and adjust all hardware, and record all test readings in accordance with the manufacturer and installer recommended tests and maintenance procedures. Include in the associated test report a list of all hardware or components replaced or changed between the completion of factory tests and the start of field installation test. Demonstrate all hardware to be operational by running off-line diagnostics. Include electrical continuity, complete exercising of each Input and Output point, and simulation of each control loop. Consider field installation test complete only after all variances generated during installation are resolved and tested.

c. Startup Test and Punchout: Prior to on-line operation, conduct a complete demonstration and readout of the control system scope of surveillance and control. Include simulation of analog inputs and observation of the action of system final control elements. Generate a hardcopy printout and perform punchout of all Input and Output points. Submit startup test hardcopy printout to Contracting Officer two (2) weeks prior to demonstrating the control system. Conduct full functional test in accordance with the control system sequences of operation. Conduct startup test and punchout in the presence of the Contracting Officer. Notify the Contracting Officer no later than ten days prior to scheduled startup testing.

d. Operational Acceptance Test: After all previous testing has been successfully completed, operate control system for thirty (30) days to the complete satisfaction of the Contracting Officer. Submit to Contracting Officer a bound log reporting all control system failures that occur red during operational acceptance test. Show the point name and number, time and date of failure, and time and date of return to service. During the 30-day acceptance test, any operational failures due to malfunction of the control panels, wiring, or Control Room Equipment must require that the 30 day test begin again when repairs are completed. Correct any failures between field-sensing equipment and the control panels, and continue the testing from the day of failure. During the last seven calendar days of testing, no failures of any kind will be accepted or repeat the last seven days. If the season of the year prevents complete testing of any individual component of the control system, acceptance will be conditional upon the successful demonstration of the specific component at the appropriate season.

e. Final Acceptance: The control system will not be considered accepted by the Government until all tests are successfully completed. Beneficial use of the system by the Government will not be considered as acceptance. The Government will deem the control system to be fully accepted when:

   (1) Structured, unstructured and availability tests have been successfully completed, and all incidents and variances have been resolved to the Government's satisfaction.

   (2) Documentation and training requirements have been completed and are satisfactory to the Government.

   (3) Maintenance and related contracts and releases of subcontractors have been duly executed and submitted to the Government.

   (4) Identified defects have been corrected to the Government's satisfaction.

3.7.6.7 Boiler Room Panels and Instruments

After inspections of installation and calibration of instruments, and after boiler test, provide a certificate of compliance to Contracting Officer stating that controls and instrumentation operate satisfactorily and within the operating parameters as specified for each fuel. If units fail to operate satisfactorily or fail to achieve specified performance, make adjustments, modifications, repairs, or replacements as necessary at no additional cost until specified performance has been achieved and certified by Contracting Officer.

3.7.6.8 Temporary Piping for Testing

Furnish necessary temporary piping, of no less than 100 mm 4 inches in diameter, and provide a muffler to exhaust excess steam to atmosphere in event boiler load is insufficient to meet capacity specified. Provide control valve for exhausting excess steam to atmosphere in a convenient location inside the boiler room. Provide instruments required for conducting boiler tests as described in ASME PTC 4 and ASME PTC 19.11. Provide temporary piping, valves, pipe hangers, mufflers and test equipment at no additional cost. Muffler must have level of noise of exhaust steam within requirements as set forth by Occupational Safety and Health Act.

3.7.6.9 Fuel Burning Equipment Testing

a. Test fuel burning equipment to demonstrate that equipment installed will meet requirements of specifications, and that overall efficiency is as specified, with not over 15 percent excess air, can be obtained with boiler operating at 100 percent capacity without flame impingement on any combustion chamber wall, floor, baffle or watertube.

b. Include all boiler and burner interlocks, safety interlocks, combustion controls, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. prior to combustion testing. Replace all malfunctioning components. Submit an itemized data record sheet of this component testing.

c. Calibrate each boiler control system and all boiler appurtenances and set to ensure the specified performance. Ensure the fuel burner, forced-draft fan, controls, and other such items are fully coordinated, manually capable, and automatically controllable to hold the required settings. Ensure boiler fuel burning system is continuously variable throughout the specified operating range without manual adjustment of burner, register or nozzle, and achieve turndown without manual adjustment. Ensure testing apparatus is set up, calibrated, tested and ready for use prior to final combustion testing. Furnish calibration certificates for all test instruments with test data.

3.7.6.10 Deaerating Feedwater Heater Testing

Test deaerating feedwater heater to demonstrate that equipment installed meets specified requirements as to performance, capacity, and quality of effluent. During operating test of boiler, conduct tests to determine oxygen content in accordance with ASTM D888, Method B or C, or ASTM D5543. Operate boilers at varying loads, up to maximum heater capacity, while oxygen tests are being made. Furnish means and equipment to perform this test.

3.7.6.11 Water Treatment Testing

Test water treatment equipment meeting requirements specified as to capacity and quality of effluent. Tests for ion exchange units must cover at least 2 complete regenerations and capacity runs. Test for hot process or other precipitation type softeners must cover a minimum continuous period of 48 hours with samples being taken at 2 hour intervals.

3.7.6.12 Steam Quality Testing

Test for steam quality and water level stability must be simultaneous under operating conditions specified.

3.7.6.13 Water Level Stability Testing

Boiler water level stability must be specified by boiler manufacturer in writing to Contracting Officer prior to test. Conduct test first by use of manual bypass around feedwater regulator. Repeat test using automatic feedwater regulator. To be acceptable, boiler must maintain specified water level stability as specified by boiler manufacturer under both conditions.

3.7.6.14 Testing of Piping Systems

a. General: Submit a written schedule 7 days in advance of test to Contracting Officer for approval, and a detailed manufacturer's acceptance testing plan, for approval, for each item of instrumentation; including procedures for pressure testing and repair of piping and tubing materials failing pressure tests.

b. Hydrostatically test piping before piping insulation is applied. Ensure hydrostatic test pressure at any point in piping system is no less than 1.5 times the design pressure, but does not exceed the maximum allowable test pressure of nonisolated components.

c. Test underground lines in pressure service prior to backfilling, as specified, with pressure to be maintained for 12 hours without drop. Furnish accessories required for test.

d. When particular circumstances prohibit hydrostatic tests, Contracting Officer may exercise option to have Contractor perform air pressure and soap solution test. If this type of test is approved by Contracting Officer, perform air pressure and soap solution test at weld and flange joints. Ensure pneumatic test pressure is no less than 1.2 nor more than 1.5 times the design pressure of piping system. Do not exceed maximum allowable test pressure of non-isolated components. Correct leaks discovered during test and perform successive tests. Repeat test until leaks are sealed. Conduct test before insulation is applied. Use a portable sprayer to spray soap solution on joints to detect leaks. Provide temporary pumps and air compressors required to pressurize system prior to and during tests. Perform tests in accordance with ASME B31.1.

3.7.7 Cleaning of Boiler and Piping

After hydrostatic tests have been made, and prior to performance of operating tests, thoroughly and effectively clean boiler of foreign materials by mechanical cleaning, initial chemical cleaning, a chemical boiling period and finally by operating steam system at 100 percent (100 percent) makeup water and wasting the condensate. Submit procedure for cleaning, prior to connecting tubing and piping to instruments and prior to pressure testing, test equipment use, and cleaning after completion of testing and installation. Wherever possible, wire brush water contacted surfaces to remove loose material, then fill boiler with solution consisting of following proportional ingredients and circulate at approximately 207 to 344 kPa 30 to 50 psig for period of 24 to 48 hours:

Caustic soda	10.9 kg 24 lbs

Disodium phosphate, anhydrous	10.9 kg 24 lbs
Sodium nitrate	3.6 kg 8 lbs
Approved wetting agent	0.23 kg 1/2 lb
Water	3,785 liters 1,000 gallons

Dissolve chemicals in proportions above, or as approved by Contracting Officer, thoroughly in water before placing in boiler. After this initial chemical cleaning, drain boiler and refill with the above chemical solution and boil in accordance with the manufacturer's instructions. After specified boiling period, allow boiler to cool, after which drain boiler and thoroughly flush. Finally, clean piping by operating boiler for period of approximately 48 hours with 100 percent (100 percent) makeup water, wasting the steam and condensate.

3.7.8 Boiler Water Conditioning

Provide boiler water conditioning by chemical treatment and blowdown during periods of boiler operation from the initial starting of system, through testing period, and to final acceptance of completed work by the Government. Use chemicals and treatment method approved by Contracting Officer.

3.7.9 Fuel Oil Leak Test

Conduct fuel oil leak tests for the underground portion of the system in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.8 MANUFACTURER'S SERVICES

Provide services of a manufacturer's representative who is experienced in installation, adjustment, and operation of equipment specified. Supervise installing, adjusting, and testing of equipment. Contractor personnel will not be allowed to render specified services. Manufacturer's test representatives must be on manufacturer's payroll on a continuing eight hour pay basis, especially trained, and regularly rendering such services.

3.9 FIELD TRAINING

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NOTE: Consult equipment manufacturer for hours required to train plant personnel for equipment operation and then insert the hours.

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a. Provide field training course for designated operating staff members. Provide training for a total period of [_____] hours of normal working time and start after system is functionally complete, but prior to final acceptance tests. Cover items contained in approved operation and maintenance instructions as well as demonstrations of routine maintenance operations. Notify Contractiin writing at least 14 days prior to start of training.

b. Submit [6] [_____] complete copies of operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. Include the manufacturer's name, model number, service manual and a brief description of equipment and their basic operating features.

c. Submit [6] [_____] complete copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, preventative maintenance schedule, and troubleshooting guides. Include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. Also include equipment lubrication requirements and schedules, recommended spare parts list, index, instruction book binders with hard back covers and printing to identify the name of the facility, Government entity operating the facility, Contractor, shop order, equipment, and volume number if required. Obtain approval of operation and maintenance manuals prior to the training course.

d. Provide a minimum of [_____] days of training for [_____] of Government's representatives at [plant site] [factory]. Training includes, but is not limited by the following:

  (1) Use of operating console display; their interface with process; their aid in system diagnostics; all with hands on experience with equipment for trainees.

  (2) Training to emphasize process control techniques, with demonstrations to show variations that can be implemented with algorithms and system configuration instructions.

  (3) Training to acquaint the operators with specifics of this process, and how system operates.

  (4) Training to include theory of operation, maintenance, and troubleshooting techniques, using flow charts and diagnostics with equipment in operation, and framed instructions containing wiring and control diagrams under glass or in laminated plastic, to be posted where directed. Frame condensed operating instructions, prepared in typed form, as specified above and post beside the diagrams. Post framed instructions before acceptance testing of the systems.

e. Video tape field training. Provide reproducible copies of each training session video tape, printed training materials for each designated operating staff member, and two spare copies for file.

TABLE I. PIPE

Service	Pressure, kPa psig	Material	Specification	Type
Steam	0-10300-150	Std. wt. black steel	ASTM A53/A53M	Type E or S, Grade A
Condensate return	0-17000-250	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Boiler feed & blowoff lines	0-10300-150	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Feedwater piping	0-10300-150	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Water column (a)	0-10300-150	Extra strong black steel	ASTM A53/A53M	Type E, Grade A
Vent & pipe	0-1700-25	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Compressed air	0-8600-125	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Gauge piping	0-1700-25	Copper tubing	ASTM B88M ASTM B88	Type K or L
Draft gauge & Oxygen recorder	0-1700-25	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Aboveground Fuel oil (No. 2)	0-10300-150	Copper tubing	ASTM B88M ASTM B88	Type K or L
		Fiberglass (b)	API Spec 15LR or UL approved	[_____]
		Std weight black steel	ASTM A53/A53M	Type E or S Grade A or B
		Sched 40 seamless or Elec. welded steel	API Spec 5L	Grade A or B
Aboveground Fuel oil (Nos. 4, 5 & 6)	0-10300-150	Std weight black steel	ASTM A53/A53M	Type E, Grade A
Control air	0-10300-150	Copper tubing	ASTM B68/B68M	[_____]
		Std weight black steel	ASTM A53/A53M	Type E, Grade A
Natural gas	0-1050-75	Std weight black steel	ASTM A53/A53M	Type E, Grade A

Note a: No bending of pipe will be permitted.

Note b: For buried service only.

TABLE II. FITTINGS

Service	Size	Title	Materials	Specification
Steam	38 mm 1.5 inches and under	Screwed or Socket welded	Steel	ASME B16.11
	50 mm 2 inches and larger	Flanged or Butt welded	Steel	ASME B16.5, ASME B16.9
Condensate return	38 mm 1.5 inches and under	Screwed or Socket welded	Steel	ASME B16.11 extra strong
	50 mm 2 inches and larger	Butt welded	Steel	ASME B16.9 extra strong
Vent pipe	38 mm 1.5 inches and under	Screwed	Steel	ASME B16.9
	50 mm 2 inches and	Butt welded	Steel	ASME B16.9
Compressed air	38 mm 1.5 inches and under	Screwed	Zinc-coated malleable iron	ASME B16.3
	50 mm 2	Butt welded	Steel	ASME B16.9
Boiler feed	38 mm 1.5 inches and under	Screwed or Socket welded	Steel	ASME B16.11 extra strong
	38 mm 1.5 inches and under	Butt welded	Steel	ASME B16.9 extra strong
Feedwater pipe	38 mm 1.5 inches and under	Screwed	Steel	ASME B16.9
	50 mm 2	Butt welded	Steel	ASME B16.9
Blowoff lines	38 mm 1.5 inches and under	Butt welded	Steel	ASME B16.9 extra strong
	50 mm 2 inches and larger	Socket welded	Steel	ASME B16.11 extra strong
		Flanged with long radius elbows	Steel	ASME B16.5
Water column piping	38 mm 1.5 inches and under	Screwed		extra strong
Draft gauge and O^2 recorder	All	Screwed		
Fuel oil (a)	All	Screwed, Flared or brazed	Cast or wrought bronze	ASME B16.18 ASME B16.26
Gauge pipe	All	Flared or soldered	Cast or wrought bronze	ASME B16.18 ASME B16.26

TABLE II. FITTINGS				
Service	Size	Title	Materials	Specification
Natural gas	38 mm 1.5 inches and under	Socket welded		ASME B16.11
	50 mm 2 inches and	Butt welded		ASME B16.9
Note a: Conform to ASME B31.1 for wall thickness. Match requirements for steam piping.				

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 52 33.01 20 (November 2008)**
Change 3 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-23 52 33.01 20 (July 2007))

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 52 33.01 20

STEAM HEATING PLANT WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL

11/08, CHG 3: 02/22

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 52 33.01 20 (November 2008)**
Change 3 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-23 52 33.01 20 (July 2007))

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 23 52 33.01 20

STEAM HEATING PLANT WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL
11/08, CHG 3: 02/22

****
NOTE: This guide specification covers the requirements for equipment for a steam heating plant which will generate from 2 1/2 to 9 1/2 kg per second 20,000 to 75,000 pounds per hour of steam.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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NOTE: This specification is intended to be used in the procurement and installation of heating plant equipment. Requirements for materials and procedures for special or unusual design shall be added to and modifications made to this specification as necessary to fit specific projects. This guide specification shall be used in conjunction with the following NAVFAC definitive drawings and UFC 3-410-06N, "Central Heating Plants Operation and Maintenance".

NAVFAC NO./DRAWING TITLE

1429327 - STEAM HEATING PLANT NO. 4 2 1/2 to 9 1/2 KG PER SECOND 20,000 to 75,000 POUNDS PER HOUR

WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL SITE PLAN AND SECTIONS

1429328 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL FLOOR PLAN

1429329 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL LONGITUDINAL SECTION

1429330 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL TRANSVERSE SECTION

1429331 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL PIPING SCHEMATIC

1429332 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL PIPING SCHEMATIC

1429333 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL CONTROL SCHEMATICS

1429334 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL COAL HANDLING CONTROLS

1429335 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL DETAILS

1429337 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL FUEL OIL UNLOADING

1429338 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL FUEL OIL STORAGE

1429339 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL SITE DETAILS COAL HANDLING

1429340 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR

WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL RESERVE COAL STORAGE

1429341 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL SITE PLAN - ELECTRICAL

1429342 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL FLOOR PLAN - ELECTRICAL

1429343 - STEAM HEATING PLANT NO. 4 2 1/2 TO 9 1/2 KG PER SECOND 20,000 TO 75,000 POUNDS PER HOUR WATERTUBE (SHOP ASSEMBLED) COAL/OIL OR COAL ONE-LINE DIAGRAM - ELECTRICAL

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NOTE: The following information shall be shown on the project drawings:

1. Dimensions of construction

2. Relationship of materials

3. Quantities, location and capacity of equipment.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 118	(1979) Coal-Tar Bitumen Used in Roofing, Damp-Proofing, and Waterproofing

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)

ABMA Boiler 103	(2001) Selected Codes and Standards of the Boiler Industry

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN PETROLEUM INSTITUTE (API)

API MPMS 2.2A	(1995; R 2017) Manual of Petroleum Measurement Standards Chapter 2-Tank Calibration Section 2A-Measurement and Calibration of Upright Cylindrical Tanks by the Manual Tank Strapping Method
API MPMS 2.2B	(1989; R 2019) Manual of Petroleum Measurement Standards Chapter 2: Tank Calibration - Section 2B: Calibration of Upright Cylindrical Tanks Using the Optical Reference Line Method
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats
API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B29.100	(2011) Precision Power Transmission, Dbl-P-Power Transmission, Dbl-P-conveyor Roller Chains, Attachments and Sprockets
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC VII	(2017) BPVC Section VII-Recommended Guidelines for the Care of Power Boilers
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 4	(2013; R 2023) Fired Steam Generators

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C510	(2017; R 2021) Double Check Valve Backflow Prevention Assembly
AWWA C511	(2017; R 2021) Reduced-Pressure Principle Backflow Prevention Assembly
AWWA C651	(2023) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A211	(1975; R 1985) Specification for Spiral-Welded Steel or Iron Pipe
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM D1047	(2016) Poly(Vinyl Chloride) Jacket for Wire and Cable
ASTM F1007	(2018; R 2022) Standard Specification for Pipeline Expansion Joints of the Packed

	Slip Type for Marine Application
ASTM F1120	(1987; R 2024) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications

FM GLOBAL (FM)

FM DS 12-17	(2001) Watertube Boilers

INTERNATIONAL CODE COUNCIL (ICC)

ICC UBC	(1997; Erratas Vol 1, 2 & 3 01/2001; Vol 1 & 2 03/2001; Vol 2 10/2001) Uniform Building Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-27	(1991) National Board Rules and Recommendations for the Design and Construction of Boiler Blowoff Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 11.01	(1982; E 2004) Black (or Dark Red) Coal Tar Epoxy Polyamide Painting System

SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
MIL-T-19646	(1990; Rev A; Notice 1 2021) Thermometer, Gas Actuated, Remote Reading

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 150/5345-43	(2019; Rev J) Specification for Obstruction Lighting Equipment

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50555	(Basic) Pumping Units, Sewage, Duplex, Centrifugal, Automatic Wet-Pit Type
CID A-A-50558	(Basic; Notice 1) Valves, Pressure Regulating, Steam
CID A-A-50562	(Basic) Pump Units, Centrifugal, Water, Horizontal; General Service and Boiler-Feed: Electric-Motor or Steam-Turbine-Driven
CID A-A-59222	(Basic; Notice 1; CANC Notice 1 2021) Fans, Centrifugal, Draft, Forced and Induced
CID A-A-59224	(Basic; Notice 2) Meters, Fluid Quantity Volumetric
CID A-A-60001	(Rev A) Traps, Steam
FS F-B-2902	(Basic; Notice 1) Boilers, Steam Watertube (Bent Tube, Multi-Drum and Cross Drum) Packaged Type (10,000,000 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-B-2910	(Basic) Burners, Single Oil, Gas, and Gas-Oil Combination for Packaged Boilers (320,001 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-F-351	(2019; Rev G; Notice 1) Filters and Filter Elements, Fluid Pressure: Lubricating Oil, Bypass and Full Flow
FS W-H-2904	(Basic; Notice 1) Heaters, Fluid, Deaerating (For Water Only) 1,000 to 1,600,000 Pounds Per Hour Capacity
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

FS XX-C-2816	(Rev A) Compressor, Air, Reciprocating or Rotary, Electric Motor Driven, Stationary, 10 HP and Larger

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910-SUBPART Q	Welding, Cutting, and Brazing

U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

NAVFAC MO 324	(1992) Inspection and Certification of Boilers and Unfired Pressure Vessels

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

WATER QUALITY ASSOCIATION (WQA)

WQA S-100	(2000) Household, Commercial, and Portable Exchange Cation Exchange Water Softeners

1.2 RELATED REQUIREMENTS

The following guide specification sections apply to this section with the additions and modifications as stated in the paragraph cited:

01 78 23 OPERATION AND MAINTENANCE DATA

03 30 00 CAST-IN-PLACE CONCRETE

05 12 00 STRUCTURAL STEEL

09 97 13.28 PROTECTION OF BURIED STEEL PIPING AND BULKHEAD TIE RODS

09 90 00 PAINTS AND COATINGS

21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION

41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING

23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS

23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS

23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS

40 17 26.00 20 WELDED PRESSURE PIPING

22 00 00 PLUMBING SYSTEMS

23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES

23 51 43.03 20 FABRIC FILTER DUST COLLECTOR OF FLYASH PARTICULATES IN FLUE GAS

UFC 3-430-11 BOILER PLANT INSTRUMENTATION AND CONTROL SYSTEMS

1.3 DEFINITIONS

a. Standard Commercial Product: A product which has been sold or is being currently offered for sale on the commercial market through advertisements or manufacturer's catalogs, or brochures, and represents the latest production model.

b. System Supplier: A manufacturer, fabricator, erector, corporation or firm that regularly is employed in the design, fabrication, erection, or erection supervision, testing and startup of systems comparable in size and type to those specified and indicated. The system supplier shall arrange the equipment selected, design the equipment interconnections, produce related shop drawings, supervise the erection, and start up and test the equipment.

1.4 SYSTEM DESCRIPTION

1.4.1 Design Requirements

1.4.1.1 Boiler

Boiler design and service conditions:

a. Design pressure: [_____] kPa (gage) psig

b. Operating pressure: [_____] kPa (gage) psig

c. Steam temperature: [_____] degrees C F

d. Feedwater temperature: [_____] degrees C F

e. Site elevation: [_____] meters feet

f. Ambient air temperatures:

  (1) Minimum: [_____] degrees C F

  (2) Maximum: [_____] degrees C F

g. Maximum continuous output (steam): [_____] kg/sec lb/hr

h. Minimum continuous output (steam): [_____] kg/sec lb/hr (without smoking)

i. Continuous blowdown: [_____] percent

****

NOTE: Regarding the text below, the specified

efficiency for the boiler at maximum continuous load shall be not less than 80 percent for coal and 82 percent for oil. If an economizer is used, use 82 and 84 percent respectively for coal and oil firing. Depending on the particular application and fuel used, these efficiencies could be higher.
****

j. Efficiency at maximum continuous rating [includes economizer]

(1) Coal: [_____] percent

(2) [Oil]: [_____] percent

1.4.1.2 Economizer

****
NOTE: Economizers shall be specified for all boilers with operating pressure greater than 345 kPa (gage) 50 psig and a capacity of 2 1/4 kg/sec 18,000 pounds per hour and larger. For boilers from 1/2 to 2/14 kg/sec 4,000 to 18,000 pounds per hour the designer shall make the decision based upon a specific economic analysis. This paragraph shall be included as applicable.
****

****
NOTE: Unless a coal or a fuel oil to be burned has an uncommon tendency to foul tubes, finned tube economizers should be suitable for both fuels. Feedwater temperatures should be 110 degrees C 230 degrees F when sulphur (S) content of oil is 0.5 percent; 116 degrees C 240 degrees F, S=1.5 percent - 2 percent; 121 degrees C 250 degrees F, S=2.0 percent - 2.7 percent. Where fuels having more than 1.5 percent sulfur content are to be fired, finned tubes shall not be used unless they are steel tubes covered with cast iron finned casing.
****

a. Design pressure: [_____] kPa (gage) psig

b. Operating pressure: [_____] kPa (gage) psig

c. Fuel: Coal [and No.: [_____] fuel oil]

d. Specific heat of the flue gas: [_____] kJ/kg - degrees C Btu/lb - degrees F

e. Feedwater flow: [_____] L/s gpm

f. Flue gas temperature entering economizer: [_____] degrees C F

g. Flue gas temperature leaving economizer: [_____] degrees C F

h. Feedwater temperature entering economizer: [_____] degrees C F

i. Maximum pressure drop, economizer gas side: [_____] Pa inches water

j. Maximum pressure drop, economizer water side: [_____] kPa psi

k. Fouling factor on feedwater side: [_____]

l. Fouling factor on gas side: [_____]

1.4.1.3 Forced Draft Fan (Coal Firing)

Design fan to handle air at temperatures from [_____] to [_____] degrees C F. Fan shall be [single] [double] width inlet, [single] [double] width outlet, with [clockwise] [counter clockwise] rotation when viewed from the motor end.

1.4.1.4 Induced Draft Fan Design

Design fan of materials which will withstand flue gas temperatures up to 316 degrees C 600 degrees F without damage. Fan shall be [single] [double] width inlet, [single] [double] width outlet, with [clockwise] [counterclockwise] rotation when viewed from the motor end.

1.4.1.5 Expansion Joints

a. Stacks (for installation without flue gas scrubbers):

(1) Temperature:

Maximum ambient: [_____] degrees C F

Minimum ambient: [_____] degrees C F

Inlet gas at maximum gas flow (coal): [_____] degrees C F

Inlet gas at maximum gas flow (oil): [_____] degrees C F

Inlet gas at minimum gas flow (coal): [_____] degrees C F

Inlet gas at minimum gas flow (oil): [_____] degrees C F

(2) Gas flow at inlet

Maximum: [_____] kg/sec lb/hr

Minimum: [_____] kg/sec lb/hr

(3) Required net available draft at stack inlet

At maximum gas flow: [_____] Pa inches water

(4) Gas exit velocity (cone exit)

Maximum at maximum conditions: [_____] m/sec ft/sec

(5) Flue gas acid dew point

Coal: [_____] degrees C F

Fuel oil: [_____] degrees C F

(6) Test pressures

Shop test: [_____] Pa inches water

(7) Thermal efficiency of stack: 96 to 98 percent

(8) Stack friction, max. at design condition: [_____] Pa inches water

(9) Stack height

Ground elevation: [_____] m ft

Roof elevation: [_____] m ft

Stack height: [_____] m ft

Foundation or footing elevation: [_____] m ft

(10) Wind pressure: [_____] kg/m2 psf

(11) Wind velocity, gusting: [_____] km/hr mph

(12) Stack Diameter, min. (below exit cone): [_____] mm inches

(13) Max. stack deflection (from vertical center line): [_____] mm inches

(14) Soil bearing stress, maximum: [_____] kg/m2 psf

(15) Seismic zone: [_____]

1.4.1.6 Fuel Oil Pump

****

NOTE: The values enclosed in brackets are for No. 6 low sulfur fuel oil. Adjust values to suit fuel oil used if other than No. 6.

Tabulated pump data is included in the specifications but it is preferred that such information to be shown on the drawings instead.

****

a. Transfer pumps (for fuel oil tank truck or railroad tank car unloading and transfer to tanks):

(1) Number of assemblies: [_____]

(2) Tag numbers: As indicated

(3) Capacity each: [_____] L/s gpm at 450 ssu

(4) Suction lift required: [_____] kPa ft of water

(5) Discharge pressure: [_____] kPa (gage) psig

(6) Operating temperature: [27 to 54] [_____] to [_____] degrees C [80 to 130] [_____] to [_____] degrees F

(7) Viscosity range: [450 to 5000] [_____ to ____] ssu

(8) Specific gravity: [.92 to .99] [_____ to ____]

(9) Viscosity at brake power selection point: [9000] [_____] ssu

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, low sulfur] [_____]

b. Transfer pumps (for fuel oil transfer from tanks to heating plant):

(1) Number of assemblies: [_____]

(2) Tag numbers: As indicated

(3) Capacity: [_____] L/s gpm at 450 ssu

(4) Suction lift required: [_____] kPa ft of water

(5) Discharge pressure: [_____] kPa (gage) psig

(6) Operating temperature: [49] [_____] degrees C [120] [_____] degrees F

(7) Viscosity range: [450 to 3000] [_____] to [_____] ssu

(8) Specific gravity: [.92 to .99] [_____] to [_____]

(9) Viscosity at brake power selection point: [5000] [_____] ssu

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, low sulfur] [_____]

c. Fuel oil recirculation pump sets (at remote storage):

(1) Number of assemblies: [_____]

(2) Tag numbers: As Indicated

(3) Capacity: 1.60 L/s 25 gpm at 450 ssu

(4) Suction lift required: [_____] kPa ft of water

(5) Discharge pressure: [_____] kPa (gage) psig

(6) Operating temperature: [49] [_____] degrees C [120] [_____] degrees F

(7) Viscosity range: [450 to 3000] [_____] to [_____] ssu

(8) Specific gravity: [.92 to .99] [_____] to [_____]

(9) Viscosity at brake power selection point: [5000] [_____] ssu

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, low sulfur] [_____]

[1.4.1.7 Fuel Oil Pump and Heater Set

a. Capacity each pump and each steam heater: [_____] L/s gpm

b. Suction lift: [_____] kPa ft of water

c. Discharge pressure at outlet of heater: [_____] kPa (gage) psig

d. Maximum pump speed: 1750 rpm

e. Specific gravity range: [.92 to .99] [_____] to [_____]

f. Viscosity at brake power selection point: 5000 ssu

g. Viscosity range: [500 to 5000] [_____] to [_____] ssu

h. Oil temperature at inlet of heater: [_____] degrees C F

i. Oil temperature at outlet of heater: [_____] degrees C F

j. Maximum oil pressure drop through heater: [_____] kPa psi

k. Heating medium: Steam

l. Steam pressure available: [_____] kPa (gage) psig

m. Steam temperature: [_____] degrees C F

n. Heater type: [Bare Tube] [Extended Surface]

]1.4.1.8 Electric Startup Heater

a. Oil temperature at inlet of heater: [_____] degrees C F

b. Oil temperature at outlet of heater: [_____] degrees C F

c. Maximum oil pressure drop through heater: [_____] kPa psi

d. Capacity of heater: [_____] L/s gpm

e. Heating power supply at three phase, 60 Hz: [_____] volts

f. Control power supply 120 volts, single phase, 60 Hz

1.4.1.9 Ash Handling System (Pneumatic)

a. Capacity:

(1) Ash Handling System: Estimated capacities at maximum plant output are listed below; ash handling system capacity shall be sized for twice the amounts listed.

[_____] Mg tons per hour for fly ash

[_____] Mg tons per hour for bottom ash at the farthest ash intake from the exhauster

[_____] Mg tons per hour in main ash line leaving the boiler house (minimum).

(2) Ash silo: Storage capacity of ash silo is specified in the paragraph ASH STORAGE SILO.

(3) Rotary unloader: [_____] Mg tons per hour

b. General Data

(1) Available water pressure: [_____] kPa (gage) psig

(2) Available air pressure: [_____] kPa (gage) psig

(3) Seismic Zone: [_____]

(4) Wind Velocity (Gusts): [_____] km/hr mph

(5) Altitude of plant: [_____] m ft

(6) Steam rating of plant: [_____] kg/sec lb/hr

(a) Maximum continuous rating of boiler No. 1 [_____] kg/sec lb/hr

(b) Maximum continuous rating of boiler No. 2 [_____] kg/sec lb/hr

[(c) Maximum continuous rating of boiler No. 3 [_____] kg/sec lb/hr

][(d) Maximum continuous rating of boiler No. 4 [_____] kg/sec lb/hr

] (7) Coal Analysis

(a) Ash: [_____] percent

(b) Carbon: [_____] percent

(c) Hydrogen: [_____] percent

(d) Sulfur: [_____] percent

(e) Moisture: [_____] percent

(f) Nitrogen: [_____] percent

(g) Oxygen: [_____] percent

(8) Ash Analysis

(a) Carbon: [_____] percent

(b) Calcium: [_____] percent

(9) Minimum velocities required for materials

(a) Fly Ash: 19.30 meters per second (m/s) 3800 feet per minute (fpm)

(b) Bottom Ash [Single Retort Underfeed] 28.40 m/s 5600 fpm [Traveling Grate] stoker

1.4.1.10 Ash Handling System (Mechanical)

a. Capacity:

(1) Ash Handling System: Estimated capacities at maximum plant output are listed below; ash handling system capacity shall be sized for twice the amounts listed.

[_____] Mg tons per hour for fly ash

[_____] Mg tons per hour for bottom ash

[_____] Mg tons per hour in bucket elevator leaving the boiler house (minimum).

(2) Ash Silo: Storage capacity of ash silo is specified in the paragraph ASH STORAGE SILO.

(3) Rotary unloader: [_____] Mg tons per hour

b. General Data:

(1) Available water pressure: [_____] kPa (gage) psig

(2) Available air pressure: [_____] kPa (gage) psig

(3) Seismic Zone: [_____]

(4) Wind Velocity (Gusts): [_____] km/hr mph

(5) Altitude of plant: [_____] m ft

(6) Steam rating of plant: [_____] kg/sec lb/hr

(a) Maximum continuous rating of boiler No. 1 [_____] kg/sec lb/hr

(b) Maximum continuous rating of boiler No. 2 [_____] kg/sec lb/hr

[(c) Maximum continuous rating of boiler No. 3 [_____] kg/sec lb/hr

][(d) Maximum continuous rating of boiler No. 4 [_____] kg/sec lb/hr

] (7) Coal Analysis

(a) Ash: [_____] percent

(b) Carbon: [_____] percent

(c) Hydrogen: [_____] percent

(d) Sulfur: [_____] percent

(e) Moisture: [_____] percent

(f) Nitrogen: [_____] percent

(g) Oxygen: [_____] percent

(8) Ash Analysis

(a) Carbon: [_____] percent

(b) Calcium: [_____] percent

1.4.1.11 Deaerating Heater

a. Design pressure: 207 kPa (gage) 30 psig

b. Normal steam operating pressure: [_____] kPa (gage) psig

c. Maximum steam operating pressure: [_____] kPa (gage) psig

d. Capacity (minimum): [_____] kg/sec lb/hr of feedwater

e. Inlet Conditions at Heater:

	Maximum Pressure kPa(gage)	Temperature Range Degrees C	Flow Rate kg/sec
(1) Condensate return	[_____]	[_____] to [_____]	[_____]
(2) High pressure trap returns	[_____]	[_____] to [_____]	[_____]
(3) Makeup water (softened)	[_____]	[_____] to [_____]	[_____]

	Maximum Pressure psig	Temperature Range Degrees F	Flow Rate lb/hr
(1) Condensate return	[_____]	[_____] to [_____]	[_____]
(2) High pressure trap returns	[_____]	[_____] to [_____]	[_____]
(3) Makeup water (softened)	[_____]	[_____] to [_____]	[_____]

f. Outlet temperature of feedwater from heater at design capacity: [_____] degrees C F

g. Heating steam pressure: [_____] kPa (gage) psig

h. Heating steam enthalpy: [_____] kJ/kg Btu/lb

i. Storage capacity to overflow of storage tank: [_____] liters gallons

1.4.1.12 Water Softening System

Base the water softening system on the following:

****

NOTE: Analysis of the water available for makeup shall govern the softener system selected. A competent water treating consultant shall be obtained to formulate specific system recommendations if the makeup water analysis indicates any of the following:

1. Iron in excess of 0.1 ppm as Fe.

2. Mg Alkalinity in excess of 50 ppm as CaCO3.

3. Silica in excess of 6 ppm as Si02.

****

a. Raw Water Analysis: Source of raw water is [_____]. Raw water is available at pressures of [_____] to [_____] kPa (gage) psig. Analysis of water available for makeup is approximately as follows:

TABLE 1: MAKEUP WATER ANALYSIS

	Constituent	Analysis	Parts Per Million
Cations	Calcium (Ca++)	as CaCO3	[_____]
	Magnesium (Mg++)	as CaCO3	[_____]
	Sodium (Na+)	as CaCO3	[_____]
	Hydrogen (H+)	as CaCO3	[_____]
TOTAL CATIONS		as CaCO3	[_____]
Anions	Bicarbonate (HCO3 -)	as CaCO3	[_____]
	Carbonate (CO3 --)	as CaCO3	[_____]
	Hydroxide (OH -)	as CaCO3	[_____]
	Sulfate (SO4 --)	as CaCO3	[_____]
	Chloride (Cl -)	as CaCO3	[_____]
	Phosphate PO4 ---)	as CaCO3	[_____]
	Nitrate (NO3 -)	as CaCO3	[_____]
TOTAL ANIONS		as CaCO3	[_____]

TABLE 1: MAKEUP WATER ANALYSIS

	Total hardness	as CaCO3	[_____]
	Methyl orange alkalinity	as CaCO3	[_____]
	Phenolphthalein alkalinity	as CaCO3	[_____]
	Iron, total	as Fe	[_____]
	Carbon dioxide	as Free CO2	[_____]
	Silica	as SiO2	[_____]
	Suspended solids (Turbidity)		[_____]
	Total dissolved solids (TDS)		[_____]
	Free acids		[_____]
	Color		[_____]
	pH		[_____]
	Specific Conductance Microhms/cm		[_____]

b. Softener Effluent Analysis:

****

NOTE: Total solids of 175 ppm in the feedwater concentrated 20 times give 3,500 ppm in the boiler water.

****

(1) Hardness: Maintain hardness of softened feedwater near zero and in no case allow it to exceed 1.0 part per million (ppm) as CaCO3.

(2) Total Solids: Maintain total solids in softened feedwater at a level to ensure a total solids concentration in the boiler water of less than 3,500 ppm without excessive blowdown.

1.4.2 Detail Drawings

1.4.2.1 Steam Generating Unit

Submit steam generating unit (boiler) manufacturer's drawing for the following:

a. Refractory details, expansion joints;

b. Certified outline, general arrangement (setting plan), and anchor bolt detail drawings including foundation loading diagrams;

c. Plans and elevations detailing piping connections;

d. Detailed dimensional drawings of auxiliaries furnished with unit;

e. Piping schematics for auxiliaries, such as sootblowers or hydraulic stoker drives (when used);

f. Shop fabrication details of boiler/furnace: Including details showing tubing, spacing, radii, dimensions, and gage; sections through walls and expansion joints showing refractory construction and replacement details; internal and external dimensions of boiler;

g. Wiring diagrams for subsystems;

h. Economizer and economizer inlet breeching;

i. Sootblowers;

j. Auxiliaries furnished with boilers;

k. Forced draft fan, drives and ductwork;

l. Induced draft fan, drives and ductwork;

m. Structural steel and loading diagrams; and

n. Overfire air fan system.

1.4.2.2 Boiler Room Auxiliary Equipment

Include equipment arrangements, wiring diagrams, piping diagrams and details of valves and piping. Submit descriptive information for each item on the drawings.

a. Water softening equipment;

b. Brine storage tank;

c. Condensate receiver;

d. Condensate transfer pumps including certified performance curves;

e. Deaerator;

f. Boiler feed pumps including certified performance curves;

g. Steam turbines;

h. Continuous blowdown system;

i. Chemical feed units;

j. Air compressors;

k. Air dryers;

l. Cranes and hoists; and

m. Plant heating and ventilating equipment showing related ductwork.

1.4.2.3 Stokers

Include the following:

a. General arrangement drawings;

b. Foundation drawings;

c. Front plates;

d. Ash hoppers;

e. Fuel gate mechanism;

f. Grate details;

g. Zone dampers;

h. Air seal details;

i. Overfire air nozzle arrangement;

j. Coal feeder details;

k. Fuel feeder drives;

l. Piping schematics;

m. Wiring schematics; and

n. Access doors.

1.4.2.4 Ash Handling System

Include the following:

a. General arrangement;

b. Construction details of ash storage silo complete with loading diagrams;

c. Control panel arrangement and schematics;

d. Wiring and control diagrams;

e. Ash piping arrangement drawings and schematic drawings;

f. Wear back fitting details;

g. Piping and fittings;

h. Details of [steam] [motor driven mechanical] exhauster [and air washer - steam condenser];

i. Details of separators, tertiary bag filter, and ash silo vent bag filter; and

j. Silo fluidizing system and rotary ash conditioner.

1.4.2.5 Burners

Include the following:

a. General arrangement;

b. Piping details;

c. Burner control schematics;

d. Flame safety schematics;

e. Component details; and

f. Throat tile details.

1.4.2.6 Stacks, Dampers, and Breechings

Include the following:

a. General arrangement;

b. Breeching, reinforcing details;

c. Breeching hangers and support details;

d. Dampers and operators;

e. Access doors and frames;

f. Expansion joints; and

g. Stack details including anchor bolt and foundation details, stack sampling ports, platforms, and accessories.

1.4.2.7 Coal Handling Equipment Drawings

Include the following:

a. Certified outline and general arrangement drawings for complete coal handling system;

b. Dimensional equipment and fabrication drawings, including equipment weights, equipment locations, support details, and anchor bolt arrangements for items and equipment specified under the paragraph COAL HANDLING EQUIPMENT;

c. Control panel, coal presence indicators, and equipment response switch details; and

d. Control schematic diagrams and complete wiring diagrams.

1.4.2.8 Fuel Oil Equipment

Manufacturer's standard size for pumps, pump curves, valves, strainers and pump wiring and include the following:

a. Certified outline and general arrangement drawings;

b. Certified pump curves;

c. Equipment detail sheets including viscosity controller, heater and valves;

d. Electrical wiring diagrams; and

e. Oil tanks, foundations, tank heaters, appurtenances, water drawoff and level indication.

1.4.2.9 Piping and Specialty Items

Manufacturer's standard size and include the following:

a. Details of valves and fittings;

b. Feedwater regulator details and schematics;

c. Details and schematics of feedwater automatic recirculation; and

d. Installation details for ball expansion joints for saturated steam piping including allowable angular flex and minimum offset dimensions.

1.4.2.10 Furnishing Approved Drawings

Furnish one reproducible mylar shop drawing of each approved drawing sheet to the Contracting Officer for the following items:

a. Boiler layout, foundations, construction and details including economizers, and auxiliaries;

b. Breeching layout, construction and details;

c. Burner control and flame safety schematics;

d. Burner details;

e. Wiring diagrams;

f. Fuel tanks, foundations and appurtenances;

g. Feedwater automatic recirculation system;

h. Piping schematics;

i. Control diagram schematics including control panel construction and layouts;

j. Coal handling system;

k. Stoker details; and

l. Ash handling system.

1.4.3 Posted Operating Instructions

Provide posted operating instructions for each piece of equipment installed.

1.4.4 Performance Requirements

1.4.4.1 Boiler

Efficiency listed for coal burning shall be based on stoker firing with [_____] percent excess air.[Efficiency for fuel oil firing shall be based on [_____] percent excess air.] Efficiency shall allow for [_____] percent continuous blowdown and 1.5 percent unaccounted losses and manufacturer's margin. Base boiler performance on burning fuels in accordance with the Coal Analysis [and Fuel Oil Analysis] listed below.

a. Coal Analysis

(1) Ultimate Analysis (percent by weight)

Carbon	[_____]
Hydrogen	[_____]
Oxygen	[_____]
Nitrogen	[_____]
Sulfur	[_____]
Ash	[_____]
Moisture	[_____]
TOTAL	[_____]

(2) Proximate Analysis (percent by weight)

Moisture	[_____]
Volatile Matter	[_____]
Fixed Carbon	[_____]
Ash	[_____]
TOTAL	[_____]

(3) Coal Characteristics:

Heating Value: [_____] kJ/kg Btu per pound

Ash Softening Temperature Reducing: [_____] degrees C F, Oxidizing: [_____] Degrees C F

Free Swelling Index (Coke Button):
Size: 32 by 19 mm (percent): [_____]; 19 by 6.35 mm (percent): [_____]; 6.35 by zero mm (percent): [_____]Size: 1 1/4 by 3/4 inch (percent): [_____]; 3/4 by 1/4 inch (percent): [_____]; 1/4 by zero inch (percent): [_____]

(4) Coal Variations: Due to periodic changes in coal suppliers, boiler and stoker combination shall be designed to burn coal within the following limits (percent by weight unless indicated otherwise):

	Minimum	Maximum
Ash	[_____]	[_____]
Sulfur	[_____]	[_____]
Hydrogen	[_____]	[_____]
Carbon	[_____]	[_____]
Moisture	[_____]	[_____]
Nitrogen	[_____]	[_____]
Oxygen	[_____]	[_____]
kJ per kg Btu per pound	[_____]	[_____]
Ash softening temperature	[_____]	[_____]
Volatile matter	[_____]	[_____]
Fixed carbon	[_____]	[_____]

[b. Fuel Oil Analysis

****

NOTE: Use Fuel Oil Analysis Schedule only if fuel oil burners are used.

****

(1) Grade of Fuel Oil:
(2) Ultimate Analysis (percent by weight)

Carbon	[_____]
Hydrogen	[_____]
Oxygen	[_____]
Nitrogen	[_____]
Sulfur	[_____]
Ash	[_____]
Moisture	[_____]

TOTAL	[______]

(3) Heating Valve: [_____] kJ/kg Btu per pound
(4) Specific Gravity: [_____] degrees API
(5) Viscosity at burner
(6) [_____] (SSF at 50 degrees C 122 degrees F
(7) [_____] Water and Sediment (percent by volume)
(8) [_____] Flash Point degrees C F

] Submit predicted economizer performance along with and as a part of the boiler predicted performance.

1.4.4.2 Economizer

Increase in efficiency due to the economizer shall be not less than [_____] percent at full load. Fully coordinate economizer with the boiler to which it is to be applied.

1.4.4.3 Oil Burner/Windbox Package

Burner turndown ratio on specified fuel oil shall be not less than eight to one, with excess air not over 15 percent at full steam load, and excess air not over 22 percent at 20 percent steam load.[Air flow shall be modulated through a single set of register louvers.]

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Make submittals within [60] [75] [90] days after award of the contract.

SD-02 Shop Drawings

Steam Generating Unit

Boiler Room Auxiliary Equipment

Stokers

Ash Handling System

Burners

Stacks, Dampers, and Breechings

Coal Handling Equipment

Fuel Oil Equipment

Piping and Specialty Items

Each drawing size shall be A1 841 by 594 mm 34 by 22 inches, unless otherwise noted.

SD-03 Product Data

Steam Generating Unit (Boiler)

Coal Handling System

Insulation

Fans

Pumps

SD-04 Samples

Insulation

Submit samples of each type of insulation with indications of its intended application and manufacturer's stamp or label attached giving name of manufacturer, brand and description of material.

SD-05 Design Data

Stack Manufacturer's Calculations

Submit as specified under the paragraph MANUFACTURER'S CALCULATIONS REQUIRED.

SD-06 Test Reports

Boiler Predicted Performance

Economizer Performance

Instrument Air Compressor Package

Variable Speed Motor Controller

Submit certified copies of variable speed motor controller design, production and conformance tests for approval before delivery of the equipment.

Heating Plant

Submit for tests and inspections specified under the paragraph FIELD QUALITY CONTROL.

SD-07 Certificates

List of Equipment Manufacturers

Proof of Experience; G, [_____]

Manufacturer's Installation Approval

Boiler Inspector's Report

System and Equipment Installation

[Vertical Fuel Oil Tank Calibration

] Backflow Preventer

SD-10 Operation and Maintenance Data

Heating Plant, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions

Submit text for each piece of equipment.

1.6 QUALITY ASSURANCE

Equipment shall be factory assembled except for steam generators, coal handling equipment and ash handling equipment which shall utilize shop assembled components to the maximum extent to facilitate erection and minimize field labor.

1.6.1 Standard Commercial Product

Boilers and equipment shall, as a minimum, be in accordance with requirements of this specification and shall be the manufacturer's standard commercial product. Include additional or higher quality features which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product, in the boilers and equipment being provided.

1.6.2 Equipment Furnished

Equipment furnished by the Contractor shall be furnished by the manufacturers listed in the submittal letter listing equipment manufacturers.

1.6.3 Responsibility

The contract drawings show the required general arrangement configuration and location of equipment items. However, the contract allows for selection of any vendor's equipment at the option of the Contractor, provided the vendor's experience and equipment meet the requirements of these specifications and drawings. Because there may be significant variation between the drawings and the individual vendor's equipment as to foundations, physical dimensions and detailed arrangement of equipment items, the Contractor shall furnish detailed design and shop drawings and calculations for the systems selected. Show foundation arrangements, walkways and other information as required for a completely coordinated, useable and properly functional system. A single system supplier shall be responsible for a complete system including erection or erection supervision for each of the following systems:

a. Boiler system, including but not limited to the following: Boiler, stoker, oil burners, [economizer,] refractories, insulation, induced draft fan, sootblowers, steam separator, forced draft fan, overfire air fan, boiler trim, blowdown valves, safety valves and trim, and breeching. Ensure that the system manufacturer coordinates the required instrumentation and control logic with the controls and instrumentation supplier. Controls and instrumentation are specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

b. Coal handling system, including but not limited to the following: Track and reclaim hoppers, belt feeders, belt conveyors and tube galleries, telescoping chute, flight conveyor, coal bunker, under bunker conveyor and triple valves, coal scale, controls, coal chutes and gates.

c. Ash handling system including ash piping, fittings, intakes, ash silo, separators, tertiary filter, [mechanical exhauster] [steam exhauster, air washer-condenser], and rotary unloader.

d. Stack system including steel stack, internal acid resistant lining and external coating.

1.6.4 Certification of Backflow Preventer

Certificate of Full Approval or current Certificate of Approval for each backflow preventer being provided for the project shall be from the Foundation for Cross-Connection Control Research, University of Southern California and shall attest that the design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval will not be acceptable in lieu of the above.

1.6.5 Modification of References

In the API publications referred to in this specification, the advisory provisions shall be considered mandatory, as though the word "shall" had been substituted for "should" and "suggested" wherever they appear.

1.6.6 Certificates

1.6.6.1 List of Equipment Manufacturers

Submit to the Contracting Officer a letter listing the equipment manufacturers for the following equipment:

a. Boilers and stokers;

b. Boiler feedwater pumps;

c. Coal car handling equipment;

d. Induced draft fans;

e. Coal handling equipment; and

f. Ash handling equipment.

When the Contracting Officer determines that a manufacturer does not meet the qualification or experience requirements of the specifications, the Contractor shall submit, to the Contracting Officer, the name of another manufacturer within 15 days of notification.

1.6.6.2 Proof of Experience

Submit proof of experience of manufacturers, system suppliers and installers as follows.

a. Experience, Responsibility and Certification: Submit to the Contracting Officer, the required information and experience certificates within 30 days after award and prior to commencing work on the site.

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NOTE: Regarding the text below, verify number of manufacturers' installations operating and years of operation for boiler, coal handling systems, ash handling systems, forced draft fan, burner/windbox package and control systems to avoid an unnecessarily restrictive experience requirement.

****

b. Experience Requirements: Boilers and equipment installed within or as a part of the heating plant shall be of proven designs. Each manufacturer or system supplier shall be regularly engaged in designing, fabricating, erecting or erection supervision, testing and starting up of the equipment or system. Within 30 days after contract award, or at any time during performance of the contract, if the Contractor is required to use a different manufacturer or system supplier from one that was designated previously, through no fault of the Contractor, the Contractor shall submit certification and other evidence of acceptable experience from each replacement manufacturer or system supplier. Such certification shall show that equipment and systems made or furnished by the manufacturers or system suppliers have operating characteristics which are substantially similar to the equipment or systems specified. The certification shall also state that essentially equivalent equipment or systems supplied by the manufacturer or system supplier have been successfully installed and reliably operated in at least [one] [two] [three] installation[s] under comparable operating conditions for a period of not less than two years.

c. Information Required: Submit to the Contracting Officer, evidence or proof of experience required from the equipment manufacturer or system supplier containing the following information:

(1) List of installations meeting requirements of the paragraph EXPERIENCE REQUIREMENTS including detailed description of equipment furnished for each one;

(2) Owner and location of each installation;

(3) Name and phone number of supervisory person at each installation; and

(4) Date of Owner acceptance of such installation.

[d. Vertical Fuel Oil Tank Calibration Experience: Submit to the Contracting Officer evidence or proof that the tank calibration organization has at least 2 years of prior successful and accurate experience in calibrating tanks of comparable type and size.

]1.6.6.3 Manufacturer's Installation Approval

Submit manufacturer's installation approval for the following systems and equipment as specified under the paragraph SYSTEM AND EQUIPMENT INSTALLATION:

a. Steam generating units (boilers) and auxiliary equipment;

b. Coal handling system;

c. Ash handling system;

d. Plant air compressors;

e. Steam turbines;

f. Variable speed motor controller; and

g. [_____].

1.6.6.4 Boiler Inspector's Report

Submit as specified under the paragraph BOILER INSPECTION.

1.6.6.5 System and Equipment Installation

Submit from each system supplier and each manufacturer of the equipment, written certification that the system and equipment installation is in accordance with the system supplier's and equipment manufacturer's instructions and recommendations, that the unit or system has been run, rotating parts have been dynamically balanced, fluid (including air) flows have been balanced, instrumentation and controls are properly functioning, adjusted and have been calibrated, and the equipment or system is ready for final testing. Certificates shall be submitted before the entire boiler plant may be given an acceptance test.

[1.6.6.6 Vertical Fuel Oil Tank Calibration

Submit four copies of the certified record.

]1.6.6.7 Backflow Preventer

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project.

1.7 ENVIRONMENTAL REQUIREMENTS

Boiler plant shall comply with all applicable Federal, State, and local environmental regulations.

1.7.1 Air Permits

Permits for construction and operation of the boiler plant must be obtained from and/or submitted to the local environmental regulatory agency prior to the start of construction.

1.7.2 Burner Emission Requirements

The emission requirements shall be met at the maximum required continuous output. The burner shall meet all applicable environmental rules and regulations. Emission requirements to be considered are oxides of nitrogen (NOx), opacity, particulate, sulfur dioxide, and carbon monoxide. Other emission requirements may be imposed.

1.7.2.1 NOx Emission Regulations

Compliance shall be met using [one] [a combination] of the following:

a. Low NOx burners

b. Flue gas recirculation equipment which conforms to UL 795

c. Other NOx reduction techniques. See Nitrogen oxide control for stationary combustion sources.

1.8 DELIVERY, STORAGE, AND HANDLING

Each assembly of components packaged as a unit shall be of a size that can be transported by common carrier without disassembly insofar as shipping clearances are concerned.

1.9 EXTRA MATERIALS

Furnish a spare set of refractory bricks for each railroad hopper car thawing system.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials free of defects which would adversely affect the performance or maintainability of individual components or of the overall assembly. Materials not specified shall be of the same quality used for the intended purpose in commercial practice. Unless otherwise specified, equipment, material, and articles incorporated in the work covered by this specification shall be new.

2.1.1 Identical Items

Provide physically and mechanically identical boilers and equipment of the same classification, size or capacity to permit the interchangeability of replacement parts. This requirement includes parts, assemblies, components, and accessories. Parts provided on the same type unit regardless of size and identifiable by identical part numbers shall be functionally and dimensionally interchangeable. No deviation is acceptable without prior written approval of the Contracting Officer.

2.2 BOILER

[Coal/Oil] [Coal] Fired. Submit steam generating unit (boiler) data for the following:

a. Safety valve calculation sheets;

b. Boiler predicated performance data, and

c. Economizer predicted efficiency calculations.

2.2.1 Packaged Watertube Boiler

Provide Type I boiler conforming to FS F-B-2902 except as modified below. Provide lifting attachments.

2.2.2 Operational Requirements

Boiler shall be capable of operating continuously at the maximum specified conditions without damage or deterioration to the boiler, settings, firing equipment or auxiliaries. Boiler shall be capable of automatically controlled operation while burning the specified fuel[s].

2.2.3 Tubes

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NOTE: Use this paragraph if tube diameters larger than specified in FS F-B-2902 are desired and insert minimum acceptable diameter.

****

Boiler and furnace tubes shall be not less than [_____] mm inches in outside diameter. Furnace tubes and first two rows of main boiler bank shall be one gage heavier than other tubes.

2.2.4 Boiler Trim

Fitting, drain valves, drain piping, feed piping, pressure gages, feed valves, stop valves, check valves, safety valves, and remaining appurtenances shall comply with applicable requirements of the ASME Boiler and Pressure Vessel Code. Components shall conform to the following:

2.2.4.1 Boiler Blowoff Valves

Provide flanged [Class 250 cast iron] [Class 300 cast steel] body, seatless, sliding plunger type valves mounted in tandem at each boiler blowoff connection.

2.2.4.2 Steel Gate, Globe and Angle Valves

ASME B16.34.

2.2.4.3 Safety, Relief, and Safety Relief Valves

ASME BPVC SEC I.

2.2.4.4 Steam Gage

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NOTE: Select gage scale to operate within the middle third of range.

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Provide a 300 mm 12 inch diameter indicating steam gage with chromium plated trim and zero to [_____] kPa (gage) psig scale. Gage shall be complete with syphon, valve, piping, and fittings to properly connect same. Gage shall be flush mounted on a 368 mm square by 5 mm 14 1/2 inch square by 3/16 inch thick steel plate. Provide plugged tee connection for connection to remote steam gage.

2.2.4.5 Water Column

Provide a safety water column with high and low water alarm suitable for the design pressure of the boiler. Column shall be complete with three-chain-operated gage cocks, heavy duty inclined gage glass, and quick-closing water gage valves having cross leavers and chains operated from floor. Gage glass shall be readable from any point directly below unit. Make connections to water column from boiler with extra strong steel pipe and forged steel fittings. Provide crosses instead of tees or elbows, with screwed plugs in open ends. Terminate bottom of water column and water column gage glass with plug-type valves accessible from operating floor. Provide screwed plugged connections in water column piping for remote level indicator. Provide gate valves immediately below water column and gage glass. Provide a suitable lamp fixture to illuminate water column.

2.2.4.6 Safety Valves

Provide not less than [_____] cast steel or cast iron body high capacity safety valves to give a total steam relieving capacity in accordance with the ASME BPVC SEC I requirements as to total boiler and water wall heating surface. Valves shall be set with a set pressure of [_____] kPa (gage) psig, [[_____] kPa (gage) psig] [, [_____] kPa (gage) psig] [and [_____] kPa (gage) psig] respectively. Valves shall have flanged inlet and outlet connections.

2.2.4.7 Non-Return Valve

Provide a non-return valve on each boiler steam outlet. Valve shall be a stop check angle body valve, flanged, [Class 250 cast iron] [Class 300 steel] body with handwheel shutoff, pressure operated disc and external equalizer. Assembly for manual operation shall be outside screw and yoke type.

2.2.4.8 Blowoff Connections

Bottom drum blowoff connection on boiler shall be [_____] mm inch diameter and extended to outside of setting terminating with tandem flanged blowoff valves as specified above. Boiler water wall blowoff connections and economizer inlet pipe blowoff shall be 40 mm 1 1/2 inch diameter and extended to outside of setting and equipped with same type valves. Provide stop valves for water column blowoff connections. Boiler blowoff connections shall conform to the applicable requirements of ASME BPVC SEC I, Part PG-59.

2.2.4.9 Miscellaneous Stop Valves

Provide stop valves near boiler for each connection to boiler; include valves for soot blowers, chemical feed, vent, continuous blowoff, and required drains.

2.2.4.10 Tube Cleaner

Provide one tube cleaner suitable for cleaning boiler tubes. Tube cleaner shall operate on water at 1034 kPa (gage) 150 psig pressure. Tube cleaner shall be complete with one motor, one wrench, one cutter head assembled, one universal coupling for cutter head, two sets of cutters, two sets of cutter pins, one set of arm pins, one set of keeper pins, one brush with a set of refills, one tool box, and two 15 meters 50 foot lengths of heavy duty hose with 20 mm 3/4 inch diameter pipe connections.

2.2.4.11 Wrenches

Provide special wrenches required for proper maintenance of equipment.

2.2.5 Boiler Limit Interlocks

Provide applicable boiler limit interlocks required by FS F-B-2910 and connect to effect safety shutdown of the stoker[and oil burners]. Interlocks shall be compatible with and integrated into the control and instrumentation system.

2.2.6 Sootblowers

Provide boiler [and economizer] with a sootblowing system using [steam] [compressed air] for removing deposits of soot and fly ash from heat transfer surfaces. Sootblower elements shall be of a sufficient number and in a proper location to clean every heat transfer surface susceptible to soot or fly ash deposition. Fixed position, multi-nozzle rotating elements may be used in applications where flue gas temperatures do not exceed 982 degrees C 1800 degrees F. Retractable soot blowers shall be provided where flue gas temperatures exceed 982 degrees C 1800 degrees F.

[2.2.6.1 Fixed Position Soot Blowers (Steam)

****
NOTE: Choose this paragraph or the paragraph below, FIXED POSITION SOOTBLOWERS (AIR PUFF).
****

Steam, fixed position, multi-nozzled, rotating, valve-in-head type with electric motor operation to permit proper cleaning of heat transfer surfaces with cam operated valves arranged to automatically open steam valve through proper arc of rotation. Cams shall be adjustable to give proper operating arc or shall be specially designed for each location. Furnish and install soot blowers complete, including valve-in-head blower heads, wall sleeve bushings, high temperature elements, low temperature elements, [_____] volt, [_____] Hz, [_____] kW hp motor operators, hand operated drain valve, with drilled orifice and disc to prevent tight shutoff, element supports, clamps, bolts, and other required hardware. Furnish necessary piping and valves including drain lines, shutoff valves, piping supports and insulation. Weld sootblower piping and fittings. No screwed piping or fittings will be permitted. Install sootblower elements with care so that they do not rub on tubes and cause eventual tube failure. Provide scavenging air connections from forced draft fan where required to protect blower in non-blowing position. Provide a single control station containing start and stop pushbuttons and necessary relays to control motor operators.

][2.2.6.2 Fixed Position Sootblowers (Air Puff)

****
NOTE: Choose this subparagraph or the subparagraph above FIXED POSITION SOOTBLOWERS (STEAM).
****

Air puff type, fixed position, multi-nozzled rotating element type complete with air master controller for each boiler, entirely air-operated and designed for controlled automatic sequential operation. Units shall be operated in such a manner that air issues from the element in a series of sustained high pressure puffs of approximately one second duration each. During each puff, element shall be rotated through a predetermined and measured short arc (17 degrees) by means of a ratchet mechanism in the sootblower head. Between each puff, no air shall flow through blowers and there shall be sufficient time for system to be restored to full pressure. When each blowing cycle is complete, the controller shall automatically stop its operating sequence. Provide sootblowers complete, with wall sleeve bushings, element supports, clamps, bolts, and other required hardware. Provide necessary piping and valves, including shutoff valves, piping, and supports. Sootblower piping and fittings shall have welded connections. No threaded piping or fittings will be permitted. Install sootblower elements with care so that they do not rub on tubes and cause eventual tube failure.

]2.2.6.3 Retractable Sootblowers

Provide in lieu of fixed position type and use where flue gas temperatures exceed 982 degrees C 1800 degrees F. Sootblowers shall be [air] [electric] motor operated. Rotation of sootblower shall be continuous from the moment the lance or element begins to extend. Rotational and translational speeds shall be independently adjustable by changing sprockets. Sootblowers shall be complete with heavy steel housing, outside adjustment of nozzle pressure, alloy element or lance, wall sleeve, supports, and necessary hardware required for a completely workable system.

2.2.6.4 Sootblower Elements

Provide sootblowers with elements specially designed for use with [steam] [air]. Elements subjected to temperatures of 482 to 816 degrees C 900 to 1500 degrees F shall be chromium covered extra heavy carbon steel tubing or a chrome alloy as specified for high temperatures; between 817 to 927 degrees C 1501 to 1700 degrees F, elements shall contain not less than 20 to 23 percent chrome; from 928 to 982 degrees C 1701 to 1800 degrees F, not less than 24 to 27 percent chrome. Provide a flexible connection between each head and element.

2.2.6.5 Pushbutton

On the operating floor provide a pushbutton for each boiler for starting and stopping sootblower system.

2.2.6.6 Control for Sootblowing System

Provide sootblowing system with an automatic programmable control system which will automatically start and stop each soot blower in programmable sequence and monitor and display operation of soot blowers. Provide an override control which will permit manual start-stop operation of sootblowers.

2.2.7 Combustion Controls

As specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.3 ECONOMIZER

****

NOTE: Economizers shall be specified for all boilers with operating pressures greater than 345 kPa (gage) 50 psig and a capacity of 2 1/4 kg/sec 18,000 pounds per hour and larger. For boilers from 1/2 to 2 1/4 kg/sec 4,000 to 18,000 pounds per hour the designer shall make the decision based upon a specific economic analysis. This paragraph shall be included as applicable.

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NOTE: Unless a coal or a fuel oil to be burned has an uncommon tendency to foul tubes, finned tube economizers should be suitable for both fuels. Feedwater temperatures should be 110 degrees C 230 degrees F when sulphur (S) content of oil is 0.5 percent; 116 degrees C 240 degrees F, S=1.5 percent - 2 percent; 121 degrees C 250 degrees F, S=2.0 percent - 2.7 percent. Where fuels having more than 1.5 percent sulfur content are to be fired, finned tubes shall not be used unless they are steel tubes covered with cast iron finned casing.

****

Provide a modular [bare tube] [cast iron finned, steel tube] unit constructed in accordance with the ASME BPVC SEC I. Water flow shall be parallel to flue gas flow (incoming water shall enter at the same end that the flue gasses enter the economizer).

2.3.1 Construction

Provide manufacturer's standard economizer design for the operating conditions and the fuel(s) specified. Coordinate the amount of heating surface with the flue gas conditions exiting the boiler or boilers on which the economizer is to be applied to preclude reaching the "acid dew point" for specified fuels. When necessary (sulfur is present in the specified fuel and the designed inlet temperature could fall below the "acid dew point"), provide a feedwater temperature control system. Provide casing of not less than 12 gage steel plate reinforced with steel support lugs and breeching flanges. Provide building framing steel to properly support the economizer.[Provide built-in rotary chain operated soot blowers for each economizer to thoroughly clean surfaces exposed to flue gas.] Economizer shall be designed so that internal construction can be easily cleaned and inspected.

2.3.2 Equipment

Provide the following equipment for each unit:

a. Relief valve

b. Shutoff gate valve on feedwater outlet and shutoff globe valve on inlet with globe valve bypass. Size valves as shown in economizer piping detail

c. Temperature indicator on feedwater outlet

d. Temperature indicator on feedwater inlet

e. Temperature indicator on flue gas outlet

f. Temperature indicator on flue gas inlet

g. Temperature alarm switches for high and low flue gas temperatures

h. Alarm with trouble light and silencing switch

i. Panel with annunciator and temperature indicators for feedwater inlet, feedwater outlet, flue gas inlet, flue gas outlet of each economizer

j. A drain valve downstream of the economizer before the shutoff valve

k. A stack flue gas temperature control system to control and limit flue gas temperature to not less than 149 degrees C 300 degrees F by modulating a motorized feedwater control valve in a bypass around the economizer. Provide a shutoff valve on each side of the control valve with a strainer upstream of each valve. Provide this system parallel to the manual shutoff and bypass described above

l. Differential pressure indicator on water side

m. Differential pressure indicator on gas side

n. Pressure gages on feedwater inlet and outlet

2.3.3 Insulation

Submit manufacturer's literature of each insulation type and installation, adhesives, coating mastic and accessories. Make reference to specification paragraph numbers where they apply. Insulate economizer with not less than the equivalent of 50 mm 2 inches of mineral wool insulation and lag with not less than 27 gage galvanized, weatherproof lagging.

2.4 COAL STOKERS

****

NOTE: The single retort underfeed stoker can be used for up to a maximum continuous rating of approximately 3 kilogram per second (kg/s) 25,000 pounds per hour steam flowrate and a two hour peak rating of 3.75 kg/s 30,000 pounds per hour depending upon the manufacturer.

****

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NOTE: If the boiler is not part of this project insert Coal Analysis at end of this paragraph and delete the last sentence.

****

Provide for each boiler a single retort underfeed stoker with moving grates arranged for side dump ash discharge. Stoker shall be capable of continuous operation at such rate as required for continuous output of not less than that specified for the boiler and shall satisfactorily provide for automatic operation, by means of a combustion control system, within the range given when burning specified coal and operated in accordance with manufacturer supplied instructions. Satisfactory operating conditions shall be obtained throughout the full operating range of the stoker. Stoker shall be considered as an integral part of the steam generator and shall be subject to applicable provisions of the boiler design and service conditions together with requirements of tests, performance guarantees and other warranties specified for the boiler. Coal analysis shall be as specified in the Coal Analysis Schedule for the boiler.

2.4.1 Stoker Grate Area and Heat Release Rate

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NOTE: The designer shall refer to the graph of Stoker Allowable Rating - Percent Of Full Load Rating Versus Ash Fusion Temperature shown in NAVFAC DM-3.6, NAVFAC Design Manual, Figure 11 and select the appropriate combustion rate.

****

Provide a grate with area sufficient to give specified steam output when burning specified coal. Grate shall fit between furnace side wall headers and between the inside face of the front wall and face of the bridge wall. Maximum stoker heat release rate shall be not greater than [_____] watt per square meter Btu per square foot per hour at the specified maximum continuous rating for the boiler.

2.4.2 Construction

2.4.2.1 Coal Fuel Feed Control

Provide a stoker ram with a constant stroke for feeding fuel to the central retort and necessary auxiliary rams or pushers to secure an even distribution of fuel throughout the entire length of the retort and over the grate surface. Determine rate of coal feed by the length of the rest period between full strokes. Provide for control by adjustment at a single point. Design stoker controls for connection to a combustion control system.

2.4.2.2 Coal Hopper

Provide a [_____] mm inch thick Type 316 stainless steel coal hopper having a capacity of not less than [_____] kg pounds at the front of each stoker.

2.4.2.3 Stoker Front Enclosure

Provide stoker front with dusttight enclosure of cast iron, or not less than 10 gage steel plate, of height and width to match boiler front to eliminate dust from the boiler room and prevent air infiltration to grate.

2.4.2.4 Stoker Grates

Grate surface shall consist of air cooled lateral firebars or grates inclined downward from the central retort toward side walls of furnace. Provide for agitation of fuel bed by either an alternating arrangement of moving and stationary grate bars or an undulating grate bar motion. Moving grates shall be adjustable to obtain the degree of movement necessary to suit characteristics of the fuel. Adjustments shall be capable of being made while unit is in operation. Design firebars or grates to prevent sifting of coal through spaces provided for air admission to the fuel bed. As a minimum, construct stoker grates of alloyed cast iron.

2.4.2.5 Stoker Drive

Stoker may be hydraulically or mechanically driven through cranks and machine cut, double reduction worms and gears, fully enclosed in an oiltight case and running in a bath of oil. Bearings shall be antifriction type, with hardened inner and outer races and fitted with forced lubrication fittings.

2.4.2.6 Stoker Drive Electric Motor

[_____] volt, [_____] phase, 60 Hz, [_____] rpm, totally enclosed, fan cooled not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES.

2.4.2.7 Air Distribution Control

Divide stoker plenum chamber into high and low pressure zones. High pressure zone shall be adjacent to retort where fuel bed is normally heaviest. Low pressure zone shall be under end of grate furthest from retort and shall compensate for thinner fuel bed normally carried in that area. Make provisions to admit air under pressure through the dump grates by manually operated blast gates.

2.4.2.8 Overfire Air System

Overfire air system shall consist of a blower, damper, manifold with properly sized nozzles and connecting air piping to ensure full penetration and proper turbulence. Blower volume shall not be less than 15 percent of total volume of combustion air. Blower pressure shall be sufficient for penetration of the full length of the furnace. Nozzles shall be located in rear of furnace wall and nozzle spacing shall be approximately 150 to 230 mm 6 to 9 inches o.c. Utilizing air from forced draft fan for overfire air system is not acceptable. Design shall conform to requirements of the stoker manufacturer to suit the boiler furnished.

2.4.2.9 Ash Discharge System

Provide each stoker with power operated dump grates extending from front wall to bridge wall on both sides adjacent to side walls and of sufficient area to handle ash resulting from burning of coal specified at the maximum capacity specified. Stoker dump cylinders shall be [steam] [air] [hydraulically] operated. Perforate dump grates for admission of air to burn out combustibles before refuse is discharged to ash pit. Provide ash spray pipes with manually operated valves on front of stoker beneath each dump grate.

2.4.2.10 Doors

Provide stoker front with not less than two lined furnace access doors not less than 460 mm wide by 400 mm high 18 inches wide by 16 inches high with observation ports, two ash pit doors not less than 350 mm wide by 300 mm high 14 inches wide by 12 inches high, and two air plenum cleanout doors.

2.4.2.11 Lubrication

Provide stoker drive mechanism with grease cups, oil cups, or splash pans to provide proper lubrication.

2.5 OIL BURNER/WINDBOX PACKAGE

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NOTE: The designer shall fill in the appropriate information as defined in FS F-B-2910.

****

Provide a fully modulating, oil burner conforming to FS F-B-2910, Class [_____], except as modified below. Provide burner with windbox, burner blower fan, dampers, fuel train and associated controls to comprise a complete factory assembled package. Total heat input to the boiler furnace shall be provided by [_____] burners. Burner package shall be considered an integral part of the steam generator and shall be subject to applicable provisions of the boiler design and service together with the requirements of tests, performance guarantees and other warranties specified for the boiler.

2.5.1 Burner

2.5.1.1 Burner Characteristics

Burner shall be quiet in operation and shall operate with a balanced flame so as not to localize heat in any part of the combustion chamber. Burner shall be capable of completely atomizing and effectively mixing oil with air so as to ensure complete combustion. Air admitted shall be of sufficient quantity for complete combustion, but not of such quantity as to produce an undue percentage of excess air with attendant high stack loss. Oil burner shall operate without clogging or failure, and shall have sufficient capacity to develop not less than the specified capacity. Burner unit shall be easily removed from firing position and readily accessible for inspection, cleaning, and other purposes. Provide adequate observation ports on burner. Burner manufacturer shall guarantee that there will be no flame impingement on sidewalls, top, bottom, or rear walls of furnace. Install burner manufacturer furnished refractory throat tiles or other items required for proper installation of burner.

2.5.1.2 Atomization

****

NOTE: For boilers below 7100 kW 25,000 pounds per hour the designer shall select either compressed air or steam atomization after performing an economic analysis. For 7100 kW 25,000 pounds per hour and above, atomization shall be by compressed air unless steam pressure is required for greater turndown.

****

Burner shall be [steam atomizing; steam pressure at header is [_____] kPa (gage) psig; steam temperature at header is [_____] degree C F] [air atomizing; filtered compressed air shall be available for burner atomization and the maximum requirement for each burner shall not exceed [_____] L/s scfm of air at [_____] kPa (gage) psig]. Provide pressure reducing valve and controls as required.

2.5.1.3 Electric Ignition System

****

NOTE: Natural gas pilot ignition system may be considered only when natural gas is available at the site.

****

****

NOTE: Choose this subparagraph or the subparagraph below, NATURAL GAS PILOT IGNITION SYSTEM.

****

Burner shall be equipped with an electric ignition system. System shall be either high energy ignition or glow rod type. Gas ignition system is not acceptable. High energy ignition system shall use stored energy to develop 2000 Vdc pulses. Glow rod system shall use a low voltage, carbon rod electrode which develops a tip temperature of 1427 degrees C 2600 degrees F. Provide ignition system complete.

2.5.1.4 Natural Gas Pilot Ignition System

****

NOTE: Natural gas pilot ignition system may be considered only when natural gas is available at the site.

****

****

NOTE: Choose this subparagraph or the subparagraph above, ELECTRIC IGNITION SYSTEM.

****

Provide a complete interrupted type natural gas-fired, spark ignited pilot system for the burner assembly. Combustion air supply shall be from the burner windbox. Lighting system shall have capacity to stabilize firing during startup periods. Lighter shall be arranged for easy removal and servicing while boiler is in operation. Furnish igniter complete with spark rod and power pack. Power pack shall operate on 120 volt, 60 cycle, single phase power. Provide gas piping, to one point of supply, including necessary gas pressure regulators. Igniter system shall include controls, gages, flame safety systems, interlocks and accessories to comply with Industrial Risk Insurers' (I.R.I.) (formerly F.I.A.) requirements and applicable codes and regulations.

2.5.1.5 Windbox

Construct of carbon steel plate not less than 10 gage thickness with 6 mm 1/4 inch thick front plate. Design windbox to provide even and uniform air entrance into the burner register and seal weld to the boiler front wall. Provide windbox with support legs.

2.5.1.6 Purge Connection

Provide [steam] [air] purge connection, properly valved, for purging oil from gun prior to removal from burner.

2.5.1.7 Aspirating System

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NOTE: Provide aspirating system only for boilers in which the expected furnace pressure exceeds 1245 Pa 5 inches water.

****

Provide an air aspirating system for fuel oil atomizer guide pipes to prevent blowback of hot furnace gases. Aspirating system shall use approximately [_____] L/s scfm of [_____] kPa (gage) psig compressed air.

2.5.1.8 Piping

Provide piping and flexible hoses for guide pipe purge[and aspirating] system[s]. Air from forced draft fan shall be used for guide pipe purging during normal operation.

2.5.1.9 Metal Parts

Metal parts exposed to radiant heat, including atomizer shield, shall be of stainless steel or other approved alloy.

2.5.1.10 Fuel Oil Control Valve

Fuel oil will be supplied at [_____] kPa (gage) psig and [_____] degrees C F at the inlet of the fuel piping train. Size fuel oil automatic control valve for 103 kPa 15 psi differential pressure.

2.5.1.11 Fuel

ASTM D396, Grade No. [_____].

2.5.1.12 Burner Blower Fan For Oil Fired Burner

Provide fan fully integrated with and mounted on windbox. Provide an inlet silencer, when required, to ensure operation at noise level below 85 dBA.

2.5.1.13 Electric Motor

Motor shall be [two speed,] [_____] volt, [_____] phase, 60 Hz, [totally enclosed, non-ventilated] [totally enclosed, fan cooled], not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES.

2.5.2 Flame Safeguard Controls

Provide a complete system of valves, interlocks and controls in accordance with NFPA 85 and as approved by Factory Mutual Engineering and Research.

2.5.2.1 Fuel Oil Train

Provide fuel oil train consisting of [steam] [air] atomizing oil gun, auxiliary [steam] [air] atomizing oil gun for changing guns without a shutdown, fuel oil control valve, two safety shutoff valves, recirculation valve, strainer, and flexible hose connections to oil burner. Provide low oil pressure and low atomizing air pressure switches, and all other safety interlocks and devices as required. Provide in panel mounted on burner package the following gages. Gages shall be 150 mm 6 inch with white coated dials and black figures:

a. Fuel oil supply pressure (0 to 1034 kPa (gage) 150 psig)

b. Fuel oil pressure at burner (0 to 1034 kPa (gage) 150 psig)

[c. Atomizing air pressure at burner (0 to 1034 kPa (gage) 150 psig)

][d. Atomizing steam pressure at burner (0 to 1034 kPa (gage) 150 psig).

]2.5.2.2 Control Sequencing

Flame safeguard system shall be designed to ensure safe purge, light-off and shutdown procedures, and to monitor light-off, main flame and boiler operating conditions.

[a. Flame safeguard system shall be automatically sequenced type with programming timed and sequenced by a heavy duty, industrial type timer. Timer shall be tamper-proof and shall be designed so that advancement of timer to shorten purge will shut down unit.

] b. Provide system with [ultraviolet] [infrared] scanner and electronic relay located in the front wall which will shut down the fuel within 2 to 4 seconds of loss of flame.

c. Provide scanner output meter in panel for indication of scanner signal strength.

d. Safety system shall include the following limit devices incorporated into a limit circuit:

(1) Flame failure

(2) High boiler outlet pressure

(3) Low fuel oil pressure

(4) Low water level cutout

(5) Low combustion air flow

(6) Low atomizing [air] [steam] pressure

(7) Any additional as required by FM or NFPA

[(8) Low fuel oil temperature

] e. Safety System Limits: Safety system limits specified above shall be displayed on a first out annunciator mounted in the burner panel.[Provide a common alarm contact to be wired to the operator control console.]

2.5.2.3 Light Off

Failure shall require a manual restart of the programmer. Safety system shall provide a mandatory purge with forced draft fan vanes proven open, and a return to proven low fire position before light off. Main fuel valve shall open for a timed period of 10 seconds during trial for ignition.

2.5.2.4 Circuit Analyzer

Provide a circuit analyzer system, which, by means of 12 or more lights, will indicate which circuits are energized at any specific time, and will thereby indicate improperly operating circuits.

2.5.2.5 Control Panel

Programmer, limit control, relays, annunciator, shall be mounted in a [NEMA MG 1 control panel, modified with fully gasketed doors and panels mounted on burner package] [control panel as specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS].

2.6 FANS

Submit fans and blowers characteristic curves.

2.6.1 Forced Draft Fan (Coal Firing)

****

NOTE: The designer shall make a technical evaluation to determine if the coal forced draft fan should be integrated with the stoker front or mounted separately on the floor.

****

CID A-A-59222, Type [_____], Class 1, except as specified otherwise.

2.6.1.1 Fan Size

Size fans for complete combustion of fuel at maximum firing rate taking into account design allowances, corrections for burner pressure drop, furnace pressure, combustion air temperature, plant elevation, and other design factors[including allowance for economizer]. After fans have been sized in accordance with the above, add the following allowances for momentary overloads and normal deterioration of fans, firing equipment and boilers to obtain the required test block rating:

a. Excess volume: 20 percent

b. Excess pressure: 32 percent

2.6.1.2 Fan Construction

Construct fan wheel of steel. Direction of fan discharge shall be easily changed at angles of 45 degrees. Provide fan with roller bearings mounted in pillow blocks. Provide one coat manufacturer's shop prime paint over interior and exterior of fan and wheel.

2.6.1.3 Electric Motor

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the fan drive motor shall be provided with variable speed control. Generally variable speed drives for fans over 7 1/2 kW 10 hp will be cost effective.

****

Motor for driving forced draft fan shall be [variable speed] [two speed], [_____] volt, three phase, 60 Hz, [open drip-proof] [totally enclosed, fan cooled] not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES, and shall not overload at the specified capacity with unheated cold air. Provide [_____] mm inch thick steel soleplate for motor. Soleplate shall be common for all four motor mounting bolts. Separate parallel soleplate bars are not acceptable.

2.6.1.4 Noise Level for Forced Draft Fan

Not to exceed 85 dBA sound pressure level at 1 1/2 meters 5 feet above floor and 1 1/2 meters 5 feet from fan in any direction. Provide heavy duty sound attenuator with screen on fan inlet when required to meet sound pressure level requirements.

2.6.2 Induced Draft Fan

CID A-A-59222, Type [_____], Class 2 except as specified otherwise.

2.6.2.1 Fan Size

Size fans to handle combustion gases at maximum firing rate. Maximum fan speed shall not exceed [_____] rpm at test block rating. Design allowances and corrections for furnace, economizer, [scrubber,] [baghouse,] [dust collector,] breeching pressure drop when operating at [10] [20] [40] percent excess air, flue gas temperature, plant elevation and other design factors shall be made. Add the following allowances for momentary overloads and normal deterioration of fans, firing equipment and boilers after sizing in accordance with the above, to obtain the required test block rating:

	Excess Volume	Excess Pressure
Coal Fired		
Induced draft	20 percent	32 percent
Oil Fired		
Induced draft	10 percent	20 percent

2.6.2.2 Fan Construction

Fan wheel shall be radial tip design constructed of steel. Balance fan wheel both statically and dynamically at factory. Direction of fan discharge shall be easily changed at angles of 45 degrees. Provide fan with [air] [water] cooled sleeve type or roller bearings mounted in pillow blocks.

2.6.2.3 Dampers

Provide inlet dampers with multi-parallel-stream flow blades with anti-friction bearings with 80 mm 3 inch minimum spacers and stuffing boxes to keep bearings cool. Dampers shall be mounted in 200 mm 8 inch channel frames and interconnected with one extended, ball bearing mounted control level for connection to control actuator.

2.6.2.4 Painting

Interior of fan, including wheel, shall be coated with protective coatings suitable for flue gas conditions expected to be encountered by this fan. Exterior surface of fan shall have coatings of quality weather and heat resistant paint. Fan shall be shop assembled and match-marked by manufacturer before dismantling for shipment. Surface cleaning and painting shall be in accordance with manufacturer's standards for service expected.

2.6.2.5 Electric Motor

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the fan drive motor shall be provided with variable speed control. Generally variable speed drives for fans over 7 1/2 kW 10 hp will be cost effective.

****

Motor for driving induced draft fan shall be [variable speed] [two speed], [_____] volt, three phase, 60 Hz, [open drip-proof,] [totally enclosed fan cooled,] not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES, and shall not overload over the range of the fan with unheated air. Provide [_____] mm inch thick steel soleplate for motor. Soleplate shall be common for all four motor mounting bolts. Separate parallel soleplate bars are not acceptable.

2.6.2.6 Noise Level for Induced Draft Fan

Noise level shall not exceed 85 dBA sound pressure level at 1 1/2 meters 5 feet above floor and 1 1/2 meters 5 feet from the fan in any direction. Provide sound attenuation to meet sound pressure level requirements.

2.7 COMPRESSED AIR SYSTEM

****
NOTE: Refer to utilities schedule on definitive drawings for suggested plant air requirements.
****

2.7.1 Plant Compressed Air System

Provide two packaged units conforming to FS XX-C-2816, Type [_____], except as modified below. Each compressor capacity shall be not less than [_____] standard L/s scfm of air, at 20 degrees C 68 degrees F and [_____] kPa (gage) psig (equivalent to pressure at an elevation of [_____] meters feet), compressed to 1379 kPa (gage) 200 psig at the discharge. Compressor speed shall not exceed [_____] rpm. Number of stages shall be [_____].[Compressor shall have water cooled cylinders and heads.][Oil free delivery is required.] Provide a safety valve between each compressor discharge and its shutoff valve. Provide a shutoff valve on the discharge piping of each compressor. Provide an electric thermostatically controlled immersion heater. Provide compressor with [[air] [water] cooled intercooler and] aftercooler.[Compressor and motor shall be tank mounted.] Provide lifting lugs and tie down attachments.

2.7.1.1 Air Filter

Air Filter on inlet shall act as a muffler. Provide filter of the [oil wetted type] [dry type] readily removable for cleaning.

2.7.1.2 Oil Filter

Provide full flow type filter for positive forced feed lubrication conforming to FS F-F-351.

2.7.1.3 Air Receiver

Receiver shall be [_____] liter cubic feet minimum volume designed in conformance with FS XX-C-2816 except that working pressure shall be 1724 kPa (gage) 250 psig. Provide the receiver, with a safety valve set for 1792 kPa (gage) 260 psig, a drain valve and an air trap with shutoff valve.[Provide a stand for mounting the receiver.] Provide a dial gage, not less than 114 mm 4 1/2 inches diameter, range zero to 2068 kPa (gage) 300 psig, on the receiver.

2.7.1.4 Electric Motor

Motor shall be [_____] volt, [_____] phase, 60 Hz, totally enclosed, fan cooled not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES. Control circuits for motors shall be nominal 120 volts.

2.7.1.5 Controls

Provide [constant speed] [dual control] regulation and the "optional safety controls" as specified in Table I of FS XX-C-2816 for the compressor system. In addition, provide a lead-lag control system with alternating lead-lag cycles.

2.7.2 Instrument Compressed Air System

Provide air compressor package with two compressors, two electric motors, one horizontal receiver, and control panel, [mounted on one supporting steel base with skids] [mounted separately].

2.7.2.1 Air Compressor

Each shall be a single stage, cross head type, vertical, double acting, water cooled, nonlubricated head type. Compressor shall be specially designed for non-lubricated service, with a honed cylinder, piston rod packing, piston rings and piston wear rings. Valve guide inserts and wear rings shall be TFE. Valves shall be reversible and hardened, with stainless steel seat plates for nonlubricated service. Provide necessary sleeves, baffles, and collars to prevent oil carryover. Provide air operated, piston type, free air unloaders for capacity reduction and starting. Mount filter-silencer directly on air inlet to cylinder.

Design and Performance: Each compressor shall deliver not less than [_____] standard L/s scfm of free air at a discharge pressure of 690 kPa (gage) 100 psig.

2.7.2.2 Air Receiver

Horizontal tank with a volume not less than [_____] liters cubic feet. Design unit for 1034 kPa (gage) 150 psig working pressure in accordance with the ASME BPVC SEC VIII D1. A receiver bearing the ASME Code Symbol stamp will be accepted as meeting these requirements. Provide an automatic condensate trap, safety valve, and outlet connection.

2.7.2.3 Aftercooler

Aftercoolers shall be water cooled, with counter current flow, and shall be installed directly between each compressor cylinder and the air receiver. Design cooler to cool total output air flow of compressor to within 9 degrees C 15 degrees F of inlet cooling water temperature. Tube bundle shall be removable for cleaning and inspection.

2.7.2.4 Electric Motor

Each compressor shall be V-belt driven by a [_____] volt, [_____] phase, 60 Hz motor not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Provide a removable, totally enclosed belt guard.

2.7.2.5 Controls

Provide controls and shutdowns necessary for automatic operation of compressor package. House controls in NEMA 12 control cabinet. Controls shall include two, full voltage, automatic across-the-line starters; alternator to switch compressors from lead to lag and to run both compressors when needed; 120 volt control transformer; air discharge pressure gage; selector switches for constant speed or automatic dual control, along with necessary time delay and control relays. Provide automatic solenoid operated cooling water valve in the cooling water line to the compressors and aftercoolers. Factory wire control cabinet and mount as part of package.

2.7.2.6 Accessories

Factory assemble compressors, electric motors, controls, air receiver, aftercoolers, and miscellaneous hardware and mount on steel supporting base. Provide lifting lugs and tiedown attachments. Provide air, water, and condensate piping and terminate them at the edge of the supporting base.

[2.7.2.7 Desiccant Air Dryer

****

NOTE: Choose this subparagraphs or the subparagraph below, REFRIGERATED AIR DRYER.

****

Provide for systems exposed to freezing temperatures a compressed air desiccant dryer with noncorrosive desiccant housed in twin pressure vessels, capable of drying [_____] standard L/s scfm of air to [_____] degrees C F pressure dewpoint. Unit shall be field adjustable to maintain pressure dewpoint of dried air at any preselected value below operating temperature, to minus 40 degrees C F. As an integral part of the unit, provide an indicator showing the water content of the dry air and a calibrated adjustment control to change water content to any preselected level.

a. Design: Design unit for maximum temperature of not less than 49 degrees C 120 degrees F and maximum operating pressure of not less than 1034 kPa (gage) 150 psig. Pressure drop through unit operating at full rated flow shall not exceed 27 kPa 4 psi.

b. Controls: Provide continuous supply of dry air by automatically cycling operation of desiccant beds. Dryer shall be complete with panel mounted gages showing pressure in each drying tower and spark suppressor to protect microswitch in timer circuit. Total electrical power requirements shall not exceed 75 watts at 110 Vac.

c. Filters: Provide prefilter upstream of dryer to remove oil vapor, liquid water, and solid particles. It shall have greater than 99 percent efficiency in removing both 0.5 micron diameter solid particles and 0.5 micron diameter oil aerosol. Filter shall have replaceable oil absorbing filter element which turns red to indicate saturation with oil and which shall be mounted in a transparent cast methyl methacrylate tube for visibility and inspection while on stream. Protect transparent acrylic tube by a safety shield. Provide afterfilter for removal of solid particles down to 5 microns size.

][2.7.2.8 Refrigerated Air Dryer

****

NOTE: Choose this subparagraph or the subparagraph above, DESICCANT AIR DRYER.

****

Provide for systems not exposed to freezing temperatures a compressed air dryer of the self contained refrigerated type complete with heat exchanger, a commercial quality refrigeration system, a moisture separator and condensate trap, and internal wiring and piping. Install dryer between receiver and distribution line.

a. Heat Exchanger: Provide air and refrigerant coils surrounded by aluminum granules of sufficient mass to ensure adequate cooling capacity for varying air flow loads without causing excessive refrigeration cycling. Provide an automatic control system, for heat exchanger with a sensing element located in the aluminum granules, to shut down refrigeration system on low or no-load conditions. Provide means to determine exchanger temperature.

b. Moisture Separator: Provide a centrifuge type located within the heat exchanger to provide for moisture separation at point of minimum air temperature.

c. Refrigeration Unit: Provide hermetically sealed type which operates intermittently at all but maximum load conditions. Unit shall be capable of drying [_____] standard L/s scfm of air to an atmospheric dew point of not less than minus 23 degrees C 10 degrees F with entering air at 38 degrees C 100 degrees F, saturated. Maximum operating pressure of dryer shall be [_____] kPa (gage) psig. House entire unit in a steel cabinet. Provide cabinet with access door and panel for easy access to parts for maintenance and inspection.

]2.7.3 Pressure Reducing Regulator

Provide self-operating type designed for not less than a 1724 kPa (gage) 250 psig operating pressure, and a normal operating temperature range of minus 29 degrees C 20 degrees F to plus 65 degrees C 150 degrees F. Regulator shall have an adjustable outlet pressure range not less than 34 to 690 kPa (gage) 5 to 100 psig with not less than four ranges. Provide external adjusting screw for adjustment throughout each spring range. Provide internal pressure tap for outlet pressure regulation.

2.8 BREECHING, EXPANSION JOINTS, STACKS, DAMPERS, AND ACCESSORIES

2.8.1 Breeching

Provide with rectangular cross section stiffened on sides, top and bottom and fabricated of not less than 5 mm 3/16 inch thick black steel plate unless otherwise noted. Stiffeners shall be not less than 65 by 50 by 6 mm 2 1/2 by 2 by 1/4 inch steel angles welded to exterior with 50 mm 2 inch leg outstanding. Stiffeners shall not exceed one meter 3 feet on center. Breeching shall connect to [each boiler flue gas outlet,] [intermediate heat recovery equipment,] [air pollution control equipment,] [and to stack as required].

2.8.1.1 Breeching Connections and Joints

Weld or bolt breeching joints unless indicated otherwise. Welding shall conform to AWS D1.1/D1.1M and AWS D1.3/D1.3M. Bolts for bolted connections shall be not less than 15 mm 1/2 inch diameter and spaced not more than 80 mm 3 inches apart, with bolts, lockwashers and nuts being hot-dipped galvanized. Provide bolted joints with a minimum of 3 mm 1/8 inch thick non-asbestos gaskets, suitable for the intended use. Bolt breeching connections to all boilers, equipment items, dampers, expansion joints, and breeching accessories. Flanged breeching connections to equipment shall be drilled to match flanges on equipment. Seal weld flanged joints to make connection gas-tight.

2.8.1.2 Uninsulated Breeching

Thoroughly wire brush breeching which is not to be insulated and clean by degreasing with nonflammable solvent such as trichloroethylene prior to painting.

2.8.1.3 Breeching Access Doors

Provide where indicated. Construct access doors with frame and hinged door of cast iron or reinforced steel plate. Frame shall be not less than 635 by 940 mm 25 by 37 inches with access opening of 457 by 762 mm 18 by 30 inches. Connection to breeching shall be gasketed and made with minimum 15 mm 1/2 inch diameter hot-dipped galvanized bolts, lockwashers, and nuts spaced not more than 125 mm 5 inches on center. Each side of access door shall have not less than two quick-clamp positive closing latches, with long side opposite hinges containing three clamps to give a gastight seal. Side of access door opposite hinges shall contain a minimum 80 by 125 mm 3 by 5 inch size handle. Provide a gasket consisting of 10 mm 3/8 inch diameter fire resistant resilient rope seal and mastic compound between access door and access door frame.

2.8.1.4 Breeching Cleanout Doors

Provide where indicated. Construct cleanout doors of not less than 5 mm 3/16 inch thick steel plate. Secure cleanout doors to a 32 by 32 by 5 mm 1 1/4 by 1 1/4 by 3/16 inch thick angle frame with 10 mm 3/8 inch hot-dipped galvanized mounting bolts welded to the angle frame and spaced not more than 150 mm 6 inches on center. Weld frame to breeching and provide a 1.60 mm 1/16 inch non-asbestos gasket suitable for the intended service between frame and cleanout door. Cleanout doors shall be not less than 610 mm 24 inches square except where breeching dimensions are smaller, in which case cleanout door shall be full height of the breeching and not less than 305 mm 12 inches in length.

2.8.1.5 Breeching Structural Materials

****

NOTE: The designer shall detail breeching supports and breeching stiffening. Breeching hangers shall be designed to carry not less than 5 times the breeching weight, or the breeching weight plus 136 kg 300 pounds whichever is greater. Hangers for rectangular breeching shall be of the trapeze type with angle or channel support members and hanger rods. Breeching shall be stiffened with angle or channel members as required to withstand internal breeching static pressure.

****

Structural and support materials shall be steel and shall comply with applicable sections of the AISC 360.[Support and stiffen breeching as indicated.]

2.8.2 Expansion Joints

2.8.2.1 Metallic Breeching Expansion Joints

Provide factory fabricated metallic breeching expansion joints[where indicated]. Expansion joints shall be guided metal bellows type capable of a minimum of [_____] mm inches of axial travel. Form metal bellows from not less than 1.60 mm 1/16 inch thick type 321 stainless steel plate. Cover plates shall be not less than 3 mm 1/8 inch thick steel plate.

2.8.2.2 Non-Metallic Expansion Joints

Provide factory fabricated non-metallic breeching expansion joints 3 mm 1/8 inch minimum thickness[where indicated]. Expansion joints shall be constructed of a fluoroelastomer vulcanized to two plies of knitted wire mesh capable of a minimum of [_____] mm inches of axial compression, [_____] mm inches of axial extension and [_____] mm inches of lateral offset [unless indicated otherwise]. Joints shall have a continuous operatingtemperature rating of 204 degrees C 400 degrees F, with excursion design standards up to 400 degrees C 750 degrees F. Operating pressure range shall be minus 34 kPa (gage) 5 psig to plus 34 kPa (gage) 5 psig. Expansion joints shall be preformed with integrally molded corners, suitable for mounting against a 150 mm 6 inch flange. Provide carbon steel backup bars with slotted holes, bolts, and nuts.

2.8.3 Stacks (For Installation Without Flue Gas Scrubbers)

Free standing, dual wall with insulated annular space, self supporting, steel construction. Provide stack manufacturer's calculations for supporting steel and concrete foundations, that suit specified design conditions. Provide each stack complete with accessories and appurtenances, including test ports, sampling platforms, caged safety ladders, anchors, sleeves, insulation, base and chair rings, and cleanout door.

2.8.3.1 Manufacturer's Calculations Required

a. Foundation (including bearing and moment forces) and anchor bolts

b. Stack (Static and Dynamic Analysis)

    (1) Stresses due to various loading conditions including wind and seismic loads

    (2) Damping of vortex shedding and seismic response

    (3) Vibration and damping

    (4) Heat transfer at various design and ambient conditions

    (5) Expansion profiles

    (6) Shipping and erection stress analysis

2.8.3.2 Construction

a. Provide in annular air space between the two steel shells insulation with sealing means to accommodate thermal expansion differentials and lateral deflections or sway of inner and outer shells.

b. Provide openings with adequate reinforcement to minimize stress concentrations.

c. Design wall thickness of inner shell to be 1.60 mm 1/16 inch thicker than that required by dynamic and static structural design but not less than 5 mm 3/16 inch.

d. Construct outer shell of ASTM A242/A242M steel with a plate thickness not less than [_____] mm inch.

e. Construct expansion devices of corrosion resistant stainless steel suitable for the temperatures and flue gas combinations to be experienced by stacks.

f. Base construction of stack shall transmit forces and moments in the shell to the [foundation] [supporting steel] without local stresses of appreciable magnitude being induced in the shell or exceeding allowable stresses of the supporting [concrete] [steel].

g. Provide openings in breeching and stack for test equipment for sampling flue gas and for monitoring devices. Openings shall be properly reinforced and designed for differential expansion. Breeching opening shall be of double wall construction. Penetrations through inside shell of stack shall be completely welded to provide proper sealing between the stack and the opening.

h. Provide top 1.22 meters 4 feet cone section of stack of corrosion resistant steel.

i. Provide suitable anchor bolts furnished by the stack manufacturer.

j. Accessories to be provided.

    (1) Provide double wall insulated steel plate door cleanout complete with 25 mm one inch round hinge pin, gasket and not less than 18 swing bolts.

    (2) Provide a ring of Type 304 Corrosion Resistant Steel (CRES) to support an inspection or painter's trolley. Weld ring and support from stack plates with not less than three brackets 10 by 65 by 381 mm 3/8 by 2 1/2 by 15 inches. Space brackets at not more than 610 mm 2 feet on center around circumference of stack.

    (3) Provide a three wheel CRES flat rail trolley of 227 kg 500 lbs capacity. Trolley shall have guides to prevent it from leaving the track [_____] meters of 8 mm feet of 1/4 inch CRES plow steel cable.

    (4) Provide each stack with an external ladder with cage for full height of stack. Construct ladder and cage of corrosion resistant steel.

    (5) Provide a flue gas sensing thermocouple well with thermocouple one meter 3 feet above breeching opening and 1 1/2 meters 5 feet below top of stack. Wells shall be CRES and shall extend about halfway into stack.

2.8.3.3 Finish

Stacks shall be shop coated prior to shipping from factory.

2.8.3.4 Obstruction Lighting

****

NOTE: Stack obstruction lighting requirements are dependent on a number of factors including the location and height of the stack. The designer shall refer to NAVFAC DM-23.1, NAVFAC DM-23.2, and FAA AC 150/5345 to determine if obstruction lighting is required.
****

Provide an obstruction lighting system for each heating plant stack, consisting of one red, flashing, 300 millimeter hazard beacon atop each stack, two steady burning, red obstruction marker lights halfway up each stack, photoelectric and flasher controls, weather-tight terminal boxes, cable, and conduit.

a. Hazard Beacons: FAA AC 150/5345-43 Type L-866.

b. Obstruction Lights: FAA AC 150/5345-43 Type L-810.

[2.8.3.5 Stack Sampling Platform

****
NOTE: Designer shall detail a stack sampling platform if required. If not required delete this paragraph. If required the platform will have to be located at a point as approved by air pollution control agency having jurisdiction. Many local and state codes incorporate Title 40 Code of Federal Regulations, Part 60. Depending upon final air pollution control equipment arrangement this location may be on the stack or possibly on a long length of horizontal breeching. Stack sampling platform should have the following features:

1. Sampling ports located according to 40 CFR 60 Appendix A, Method.

2. Platform should be 914 mm 36 inches wide but at ports location it should project away from breeching or stack a minimum of 610 mm 2 feet plus the diameter of the breeching or stack for up to 3 meters 10 feet in diameter stack.

3. If any type of continuous air pollution monitoring devices are located at stack sampling point or anywhere else on breeching, a non-vertical access (stairs or catwalk) is required. For stack sampling purposes a non vertical ladder is preferred but is not required. Platform with grating shall be designed for a live loading of 1464 kg/m2 300 lbs/sq. ft; platform should have railing with two intermediate railings and 100 mm 4 inch toeplate. Four 30 amp weatherproof receptacles and adequate lighting including lights over the test ports should be provided.
****

Provide stack sampling platform conforming to requirements of 29 CFR 1910-SUBPART D, Walking and Working Surfaces.

]2.8.4 Dampers

2.8.4.1 Multilouver Dampers

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NOTE: Opposed blade dampers shall be used for throttling service and parallel blade dampers shall be used for two-position service.

****

Provide factory fabricated multilouver dampers with [parallel][or][opposed] blade type operation. Construct damper frame of distortion resistant welded steel channels with raised seat to ensure free nonbinding operation of blades and to keep blades square in the frame. Construct blades of 6 mm 1/4 inch thick steel plate in a stressed skin airfoil-shape with fully welded seams containing no external ribs. Blade shafts shall be stainless steel. Blades shall be pinned to blade shafts. Louver shaft bearings shall be outboard type and shall be self-lubricating and self-cleaning. Bearing seals shall be gas-tight.

a. Multilouver damper linkage shall be adjustable and of pinned construction for easy removal and shall be designed to handle full operation torque. Linkage on dampers in clean flue gas areas shall operate from a single connection point. Design linkage on dampers in dirty flue gas areas, between boiler outlet and inlet to air pollution equipment, so that bottom blade linkage arm is not connected to above linkage, to allow this blade to operate separately. Remaining linkage for this damper shall be constructed to operate from a single operating point.

b. Provide control damper operators as noted. Operators may be either electrically or pneumatically operated with positive positioning, manual override, and hydraulic or oil immersed gear trains. Each operator shall be full-proportioning type, with spring return to position indicated in case of loss of power. Damper operating speeds shall be selected or adjusted so that operators will remain in step with controller. Operators acting in sequence with other operators shall have adjustment of control sequence as required by operating characteristics of system.

c. Two-position damper operators shall be pneumatically operated with air cylinder, four way valve, and solenoid valve arrangement.

2.8.4.2 Guillotine Dampers

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NOTE: Guillotine dampers shall be used for open-shut service where tight shutoff is required; for example, for air pollution control equipment bypass dampers.

****

Provide factory fabricated guillotine dampers with heavy structural frame rigid enough to support extended blade and external loads through the breeching flange. Damper shall be capable of operating without precleaning or manual assistance under normal operating conditions. Enclosed bonnets will only be required where indicated. Provide 80 mm 3 inch diameter cleanout ports on both sides for cleaning bottom sections.

a. Provide stress-relieved flat plate guillotine damper blades. Damper blade shall be nonwarping. Intermediate blade supports are acceptable to limit blade deflection. Leading edge of damper blade shall be beveled and capable of guiding damper blade into frame seat. Blade guides shall be continuous and self-cleaning and capable of preventing binding from deposits and damage from misalignment. Bonnet guides shall be removable. Design damper so that a damper blade can be replaced without opening the frame.

b. Provide guillotine damper bonnet seal to effectively seal against atmospheric leakage under normal operating conditions.

c. Guillotine damper drive shall be a positive dual endless chain drive capable of driving damper in both directions. Chain drive headshaft shall have sufficient torsional rigidity to prevent binding of blade when blade is stalled. Damper shall be motor operated with manual override. Design drive mechanism to prevent back driving of motor. Entire drive mechanism shall be of a simple design and require no routine maintenance other than inspection. Chain shall be capable of operating up to the stall torque of the damper drive motor.

d. Electric motor shall be [_____] volt, [_____] phase, 60 Hz, [totally enclosed, fan cooled] [open drip-proof], not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES. Provide removable, totally enclosed chain guard.

2.9 COAL HANDLING EQUIPMENT

Submit coal handling system manufacturer's data for the following:

a. Railroad hopper car thawing system;

b. Railroad hopper car shaker;

c. Railroad hopper car puller;

d. Coal scale;

e. Belt scraper; and

f. Coal dust suppression system.

2.9.1 Railroad Hopper Car Thawing System

****

NOTE: Pit type railcar thawing system is capable of operating on natural gas, liquified petroleum gas or No. 2 fuel oil. The radiant heat (infrared) type railcar thawing system can only burn natural gas or liquified petroleum gas or use electric resistance heaters. The radiant heat (infrared) type provides a slower method of thawing but causes less damage to the railroad car finish and is preferred provided natural gas or liquified petroleum gas or electrical power is economically available and permitted by current DoD policy.

****

[Pit-type] [Prefabricated surface mounted enclosed type] [or electric radiant type] hopper car thawing unit including burners, controls, combustion air blowers, fuel storage and handling, and related work. Design system to thaw 56 Mg, 71 Mg and 102 Mg 55 ton, 70 ton and 100 ton capacity coal cars. System shall be capable of thawing [_____] bottom hopper unloading coal cars simultaneously. Railroad hopper car thawing system shall utilize [No. 2 fuel oil] [natural gas] [liquified petroleum gas] as a fuel. Provide a sufficient number of heaters to have a minimum heat input of 2198 kW 7,500,000 Btu/hr per car station, with heaters distributed under hopper car, or under and beside hopper car, such that entire car is heated. Locate [burner pits] [heater units] for even heating of hopper cars without subjecting air hoses, air brake equipment, and bearings to excessive heat.

[2.9.1.1 Pit-Type Railroad Hopper Car Thawing System

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NOTE: Choose this subparagraph or the subparagraph below SURFACE MOUNTED ENCLOSED RAILROAD HOPPER CAR THAWING SYSTEM.

****

a. Pit-Type Thawing Unit: Pit-type hopper car thawing unit shall be complete with a refractory lined steel box, burner assemblies, steel burner enclosure with cover, valves, piping, and hinged main pit protective covers. Each pit shall have the capacity to generate 366 kW 1,250,000 Btu/hr when burning [No. 2 fuel oil] [natural gas] [liquified petroleum gas]. Burners shall fire horizontally and tangentially into pit from opposite sides to heat refractory lined pit up to radiant temperature. Heat shall be transferred to hopper car by radiation from hot refractory surfaces and by convection from exhaust gases and evaporated moisture to rail car bottom and sides. Construct pit outer shell of not less than 6 mm 1/4 inch thick corrosion resistant steel plate, with end plates of 10 gage (3.42 mm 0.1345 inch) steel. Provide supporting flanges and handling loops on both ends and provide cap strips on top of both sides. Place cast iron heat deflecting plates with overlapping edges on pit sides and bottom supported off ledge on outer shell. Provide a minimum 25 mm one inch air space between plates and outer shell. Pit side walls and bottom shall have a minimum 65 mm 2 1/2 inch thickness of standard firebrick with one course of standard end skew brick along top of side walls. Firebrick shall be easily replaceable. End section shall have not less than 114 mm 4 1/2 inch thick precast high temperature refractory panels. Provide burner refractory ignition tiles with steel jacket casings having mounting lugs for bolting to end plates of pit. Provide concrete railroad ties adjacent to each thawing pit. Deliver combustion air to burners by means of pressure blowers which take fresh air from outside thawing area. Factory wire and assemble heaters, control panels, blowers, and zone controls. Shop fabricate burner piping and control valve assemblies.

****

NOTE: Designer shall make selections in the text below based on fuel to be used in thawing system.

****

b. Fuel System:[Provide complete fuel system for operation with, [natural] [liquified petroleum] gas including piping, regulators, low and high pressure limit switches interlocked with combustion controls, gages, solenoid valves, shutoff valves, and accessories which may be required for each manufacturer's particular system.][Provide complete fuel system for operation with duplex fuel oil pump set with [_____] liters gallon horizontal [below] [above] ground fuel tank and accessories which may be required for each manufacturer's particular system. Provide fuel oil system in accordance with the requirements specified under the paragraph FUEL OIL SYSTEM.]

c. Burner controls shall meet Industrial Risk Insurers' (I.R.I.) (formerly F.I.A.) requirements. Connect fuel system piping to fuel supply piping as indicated. Burners shall be controlled (modulate) to regulate heat output to suit the operating requirements. Provide a manual light-off, low pressure [gas] [oil] pilot for automatic light-off of each thawing unit.

d. Air System: Provide complete air systems for operation with blowers, inlet silencers, gages, shutoff valves, low pressure limit switches interlocked with combustion controls, and accessories which may be required for each manufacturer's particular system.

e. Control Panel: Provide centrally located control panel, with panel front consisting of a graphic display of the thawing system. Display shall be approximately to scale and coordinated with control and light indication for combustion air blowers and on-off control of convenient groups of heaters. Provide on-off control with indicating light for each thawing pit. Panel shall have a NEMA [12] [3R-8], dust-tight enclosure with internal equipment and wiring accessible from panel front. Provide nameplates on panel front to designate function of switches and indicating lights. Controls shall be suitable for [_____] volt, [_____] phase, 60 Hz operation. Provide and mark terminals for connections with the exception of the neutral. Terminal blocks shall be 600 volt rated. Control relays shall have convertible contacts and shall have rating suitable for intended services but not less than 10 amp, 600 volt rating. Components shall be oiltight type. Connections to panel shall be watertight. Motor starters for combustion air blowers shall be installed in each respective blower cabinet.

][2.9.1.2 Surface Mounted Enclosed Railroad Hopper Car Thawing System

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NOTE: Choose this subparagraph or the subparagraph above PIT-TYPE RAILROAD HOPPER CAR THAWING SYSTEM.

****

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NOTE: Choose item a. or item b. that follows.

****

[a. Surface Mounted Enclosed Thawing Unit (Gas): Burner shall be of multiport cast iron construction and provide for even heating of radiant elements. Heater design shall be essentially the same for undercar and sidecar heaters, with heat transmitted to hopper car by both radiation and convection. Design burner and radiant element for radiation being the primary mode of heat transfer. Radiant element over burner shall be of a heavy corrosion-resistant metal material. Design burner to operate on [natural gas] [liquified petroleum gas], and such that open flame from combustion will not extend beyond emitter surface either during normal operation or in the event of emitter deterioration or burnout. Provide shields where necessary to direct radiation and hot exhaust gases to hopper car surface. Provide means for shielding car air hoses, air brake equipment, and bearings from excessive heat. Provide each heater with individual heater control boxes constructed as to provide positive air pressure inside control box. Control boxes shall contain mixing valve for maintaining proper gas-air ratio for satisfactory combustion. Locate gas and air piping connections for easy removal of individual burners. Deliver combustion air to heaters by means of pressure blowers which take fresh air from outside thawing area to ensure continued satisfactory combustion of gaseous fuels. Factory wire and assemble thawing units, control panels, blowers, and zone controls.

]

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NOTE: Choose item b. or item a. above.

****

[b. Surface Mounted Enclosed Thawing Unit (Electric): Thawing unit may be an electric radiant heat thawing unit which includes self-contained heater banks such as under-car heater sections, outside the rail heater sections, lower side car heater sections and vertical side car heater sections, with reflectors, hinged cover, waterproof and weatherproof wired terminal blocks and zone controls for flexibility of operation.

] c. Burner Controls (for Gas Fired Units): Burners shall be electrically ignited with controls meeting Industrial Risk Insurers' requirements. Provide a gas pressure regulator for serving not more than eight individual burners. Regulator shall reduce gas pressure in supply line to pressure required for burners. Provide each burner with an air regulating valve for fuel-air ratio adjustment. Regulating valve shall contain positive vibration-proof locking device for maintaining critical adjustment.

d. Control Panel: Provide centrally located control panel with panel front having a graphic display of the thawing system. Display shall be approximately to scale and coordinated with control and light indication for combustion air blowers and on-off control of individual heaters. Provide a modulating control for each heater to regulate heat output to suit the operating requirements. Panel shall be NEMA [12] [3R-8], dust-tight enclosure with internal equipment and wiring accessible from the panel front. Provide nameplates on panel front to designate function of switches and indicating lights. Controls shall be suitable for [_____] volt, [_____] phase, 60 Hz operation. Provide and mark terminals for connections, with the exception of the neutral. Terminal blocks shall be 600 volt rated. Control relays shall have convertible contacts and shall have rating suitable for intended service but not less than 10 amp, 600 volt rating. Components shall be an industrial design of the oiltight type. Connections to the panel shall be watertight. Motor starters for combustion air blowers shall be installed in each respective blower cabinet.

]2.9.1.3 Shed

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NOTE: Shed should be used in the severe climate areas.

****

Provide shed of pre-engineered metal space frame construction with corrugated siding as indicated. Provide ventilation with roof vents and openings along bottom of sides.

2.9.2 Top-Mounted Railroad Hopper Car Shaker (Unloader)

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NOTE: If noise is a major factor of concern, design a shaker enclosure with acoustical treatment which will be capable of reducing the noise to a tolerable level.

****

Provide top-mounted rail car shaker complete with shaker, frame, vibrator, motors, hoists, hoist frame, [enclosure,] and controls. Design unit for operation under all weather conditions.

2.9.2.1 Shaker

Shaker shall operate with a nominal 4 mm 5/32 inch stroke at 1200 rpm. Stroke shall be generated by large eccentric SAE 1045 steel shaft mounted in high capacity, self-aligning, spherical roller bearings. Seal bearings with a double piston ring labyrinth seal and dust and water slinger to retain lubricant and prevent entry of contaminants. Shaker frame shall be stress-relieved, all welded steel construction. Fabricate frame of heavy steel plate, with bearing housing seats machined after stress relieving. Provide four lifting eyebolts of heat-treated forged alloy steel for connecting to hoist chains.

Shaker Electric Motor and Drive:

Motor shall be totally enclosed, fan cooled, 1800 rpm, [_____] volt, three phase, 60 Hz, not less than 15 kW 20 hp, as specified in the paragraph MOTORS AND DRIVES. Motor shall be mounted on heavy spring isolated supporting frame with adjustable motor base. Shaker shall be belt driven with special deep groove sheaves, taper locking type hubs, and constant belt tensioning spring.

2.9.2.2 Shaker Hoist

Twin hook type having a rated capacity exceeding the weight of the shaker unit. Hoist shall have a lift of not less than 7.50 meters 25 feet with a hoist speed of not less than 0.08 m/sec 16 fpm. Hoist shall have not less than 460 mm 18 inch long sling chains for connecting hoist to shaker lifting eyes, and hooks shall have U-bolt safety latches. Hoist shall be mounted on an electrified trolley as specified in Section 41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING.

Shaker Hoist Electric Motor:

Totally enclosed, [fan cooled,] [non ventilated,] 1800 rpm, [_____] volt, three phase, 60 Hz, not less than 5 1/2 kW 7 1/2 hp as specified in the paragraph MOTORS AND DRIVES. Motors shall be high slip type with thermal overload protection embedded in the windings.

2.9.2.3 Controls

Provide [remote] [pendant] pushbutton station for both shaker and hoist operation. Provide automatic controls with upper and lower screw type limit switches to limit hook travel, slack cable limit switch to stop lowering of hooks when car shaker has been lowered on top of car, electrical interlock to prevent operation of car shaker motor until shaker is lowered on car, and electrical interlock to prevent operation of hoist motor while car shaker is running. Mount electrical equipment in NEMA 4 enclosures.

2.9.2.4 Frame [and Enclosure]

****

NOTE: If noise is a major factor of concern, design a shaker enclosure with acoustical treatment which will be capable of reducing the noise to a tolerable level.

****

Provide frame [and enclosure] as indicated for support of hoist and shaker unit[and for attenuation of noise].

[2.9.3 Capstan Car Puller

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NOTE: Designer shall select either a capstan type or drum type car puller. A capstan type puller is satisfactory for handling rail cars on level grade provided the pulling capacity is not exceeded. For high pulling capacities and locations where rails are not on level grade, the drum type puller should be used. Designer shall detail required footings and foundations based on the selected puller and soil conditions at each plant site.

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NOTE: Choose this paragraph and subparagraphs or the paragraph REVERSIBLE DRUM TYPE CAR PULLER, and its subparagraphs below.

****

Capstan-type designed with capacity of not less than 4540 kg 10,000 pounds of starting pull and an average rope speed of approximately 0.23 m/sec 45 fpm. Assembly shall be totally enclosed, weatherproof, and suitable for exterior installation with vertical capstan. Capstan shall be semisteel alloy construction designed for use with marlin-covered wire rope.

2.9.3.1 Accessories

Provide capstan complete with accessories, including controls, rope, rope storage reel, car hooks, sheaves, snatch blocks, anchors, and ratchet holdback.

2.9.3.2 Rope

Capstan rope shall be not less than 25 mm one inch o.d. marlin clad wire rope with a breaking strength of not less than 13,620 kg 30,000 pounds.

2.9.3.3 Rope Storage Reel

Construct of metal, hand operated with the drum not less than 300 mm 12 inches in diameter and the reel faces not less than one meter 3 feet in diameter. Drum shall have not less than [_____] mm inches face width and store not less than [_____] meters of 25 mm feet of one inch diameter marlin clad wire rope.

2.9.3.4 Electric Motor

Totally enclosed, [fan cooled,] high starting torque, reversing type, [_____] volt, three phase, 60 Hz, not less than 7 1/2 kW 10 hp as specified in the paragraph MOTORS AND DRIVES.

][2.9.4 Reversible Drum Type Car Puller

****

NOTE: Designer shall select either a capstan type or drum type car puller. A capstan type puller is satisfactory for handling rail cars on level grade provided the pulling capacity is not exceeded. For high pulling capacities and locations where rails are not on level grade, the drum type puller should be used. Designer shall detail required footings and foundations based on the selected puller and soil conditions at each plant site.

****

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NOTE: Choose this paragraph and subparagraphs or the paragraph CAPSTAN CAR PULLER, and its subparagraphs above.

****

[Single drum reversing] [Double drum] type designed with a capacity of not less than [_____] kg pounds of running rope pull. Starting pull capacity shall be not less than twice the running pull capacity. Provide assembly on one-piece heavy steel base with weatherproof motor and gear reducers suitable for exterior location.

2.9.4.1 Puller

Unit shall consist of a [_____] mm inch pitch diameter by [_____] mm inch face, spirally grooved for [_____] mm inch diameter wire rope with sealed anti-friction bearings, alloy steel ring mounted spur gear and SAE 1045 steel shaft. Provide an SAE 1045 steel countershaft with anti-friction pillow blocks and heat-treated alloy steel spur pinion roller chain drive with steel sprockets and enclosed guard. Speed shall be a minimum of [_____] m/sec fpm.

a. Electric Motor: [Totally enclosed,] [fan cooled,] high starting torque, reversing type, [_____] volt, [_____] phase, 60 Hz, not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES. Provide clutch for engaging and disengaging power to drum.

b. Reduction Gears: AGMA Class I sized for the motor power with motor base and coupling. Motor shall include motor mounted disc brake in dust and watertight enclosure. Provide rope overwind switch assembly and rotary type limit assembly.

2.9.4.2 Accessories

a. Rope Sheaves: Provide four stationary type, 762 mm 30 inch pitch diameter single sheaves and one 762 mm 30 inch takeup sheave assembly. Sheave shall be cast steel, grooved for [_____] mm inch diameter rope and shall be oriented horizontally and mounted in a welded steel frame with self-lubricating bronze bushings. Provide removable steel rope guards over sheaves.

b. Wire Rope: Not less than [_____] mm inch in diameter with a breaking strength of not less than [_____] kg pounds. Rope shall consist of six 19 wire strands of improved plow steel rope with hemp center.

c. Safety Warning System: Provide a safety warning system, including an audible horn and three flashing lights to indicate cars in motion. System shall activate 30 seconds before puller motor is energized and shall not deactivate until puller motor is de-energized. Provide a permanent warning sign at each light indicating "Railcar in Motion."

d. Miscellaneous: Provide reversing controls, car hooks, snatch blocks, and anchors.

]2.9.5 Track Hopper

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NOTE: Determine if a track hopper will be required.
****

Welded construction of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate not less than 4.50 meters wide and 8.50 meters long 14 feet wide and 28 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.5.1 Track Girders

Two wide flanged beams designed for Cooper's E-[_____] loading with 50 percent impact allowance and sized at W [_____] by [_____]. Provide beams with cross struts for rigidity and bearing plates for mounting on pit wall as indicated.

2.9.5.2 Grating

Hopper grating between the rails of [_____] by 10 mm 3/8 inch steel bars and [_____] by 10 mm 3/8 inch steel cross bars with openings [100] [150] by [100] [150] mm [4] [6] by [4] [6] inches. Grating outside rails shall have openings 100 by 100 mm 4 by 4 inches and be constructed of same size steel bars as specified above. Construct grating in removable panels and support from concrete pit walls and by steel angle supports resting on track girders.

2.9.5.3 Cover

Structurally reinforced 5 mm 3/16 inch thick raised pattern floor plate. Cover for portions of hopper outside rails shall be hinged with edges turned down. Construct cover between rails in easily removable sections with handles.

2.9.5.4 Hopper Outlet

Flanged not less than [_____] by [_____] mm inches. Outlet shall contain a water-collecting reclaim hopper type coal gate not less than [_____] by [_____] mm inches in size along with a dusttight all metal slip joint, constructed of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate. Slip joint shall be of split construction to allow for disassembly and replacement. Design slip joint to allow for necessary flexibility to take care of deflection of the hopper outlet due to varying coal loads and temperature variations without imposing load on the feeder enclosure. Provide rope packing or other resilient gasket material to make the slip joint completely dusttight.

2.9.6 Truck Hopper

****

NOTE: Determine if a track hopper will be required.

****

Welded construction of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate not less than 3 meters wide and 3 meters long 10 feet wide and 10 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.6.1 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches. Construct grating of 125 by 13 mm 5 by 1/2 inch steel bars and 25 by 10 mm one by 3/8 inch steel cross bars. Weld grating and make in sections for ease of removal. Provide two intermediate support beams sized not less than W8 by 31 arranged for a maximum grating span of 1016 mm 3 feet 4 inches.

2.9.6.2 Hopper Outlet

Flanged not less than [_____] by [_____] mm inches. Outlet shall contain a water-collecting reclaim hopper type coal gate not less than [_____] by [_____] mm inches size.

[2.9.6.3 Cover

Structurally reinforced 5 mm 3/16 inch thick raised pattern floor plate. Construct cover in sections with handles for ease of removal.

]2.9.7 Reclaim Hoppers

Welded construction of not less than 6 mm 1/4 inch thick structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel plate not less than 3 meters wide and 3 meters long 10 feet wide and 10 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.7.1 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches. Construct grating of 125 by 13 mm 5 by 1/2 inch steel bars and 25 by 10 mm one by 3/8 inch steel cross bars. Weld grating and make in sections for ease of removal. Provide two intermediate support beams sized not less than W8 by 31 arranged for a maximum grating span of 1016 mm 3 feet 4 inches.

2.9.7.2 Hopper Outlet

Flanged not less than [_____] by [_____] mm inches. Outlet shall contain a special reclaim hopper gate not less than [_____] by [_____] mm inches.

2.9.7.3 Cover

Structurally reinforced 5 mm 3/16 inch thick raised pattern floor plate. Construct cover in sections with handles for ease of removal.

2.9.8 Belt Feeder

Totally enclosed, dusttight, approximately [_____] meters feet between pulley centers, designed to operate at a speed not to exceed [_____] m/sec fpm, and having a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide belt feeder complete with continuous belt, shafts, pulleys, idlers, belt cleaner, frame, enclosure, reduction gear, and drive motor.

2.9.8.1 Head and Foot Shafts

Cold rolled steel, not less than [_____] and [_____] mm [_____] and [_____] inches in diameter respectively. Mount shafts in antifriction roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than a [_____] mm inch adjustment. Shafts shall fit tight in pulley hubs.

2.9.8.2 Pulleys

Welded steel type with detachable compression grip-type hubs, steel plate ends, and crown faces 50 mm 2 inches wider than the belt width. [Provide an adjustable spring loaded or counter weighted type rubber bladed belt wiper beneath the head pulleys.]

2.9.8.3 Belt

Mine Safety and Health Administration (MSHA) approved fire resistant construction, belt not less than [_____] mm inches wide, [_____] ply, [_____] kg per square meter ounces per square foot, with 3 mm 1/8 inch thick oil and chemical resistant cover on carrying side, 0.79 mm 1/32 inch thick oil and chemical resistant rubber cover on under side. Cover shall be fire resistant. Belt shall have a cover tensile strength of not less than [_____] kPa pounds per square inch (psi) and friction between plies of not less than [_____] kPa pounds per inch. Belt shall have vulcanized splice.

2.9.8.4 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, [_____] phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Motor shall be direct connected by means of flexible coupling with guard to a reduction gear.

2.9.8.5 Reduction Gear

Alloy steel helical gear type enclosed in oiltight housing. Provide an adjustable base for motor and reducer unit. Drive from the output shaft of the speed reducer to the conveyor head shaft shall be by means of finished steel roller chain conforming to ASME B16.39 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall also conform to ASME B29.100. Properly tension drive chain.

2.9.8.6 Backstop

Differential band brake type, cam type, or internal type to prevent reversal of belt.

2.9.8.7 Idlers

Flat type with 125 mm 5 inch diameter steel shells, malleable iron end brackets, grease sealed roller-type antifriction bearings, and self-cleaning angle bases. Idler spacing shall be not greater than 1372 mm 4 feet 6 inches. Return idler shall be of the flat single-pulley type having 125 mm 5 inch diameter steel shells, grease sealed roller-type antifriction bearings spaced on not more than [_____] meters feet on center. Provide self-aligning training type idlers, as required, to ensure proper training of the belt. Provide additional idlers, as required, beneath track or truck hopper for support of belt and coal and to properly protect belt from impact caused by coal. Extend grease pipes to one side for four point lubrication from tunnel walkway.

2.9.8.8 Load Skirts

Steel plate 6.35 mm 1/4 inch thick supported by structural brackets from conveyor frame. Skirts shall have rubber strips along bottom edge to seal the belt. Strips shall be easily adjustable by means of a clamp bar arrangement not requiring slotted bolt holes.

2.9.8.9 Frame, Supports, and Enclosure

Construct frame of either structural steel channel side stringers properly tied and braced for support of head and foot shafts with 12 gage (2.66 mm 0.1046 inch) steel deck plate full length of feeder, or integrally formed plate conveyor and deck frame. Support idlers from conveyor frame. Support frame from floor of tunnel [by steel channel legs] [as indicated]. Completely enclose feeder in a dust-tight enclosure constructed of not less than 10 gage (3.42 mm 0.1345 inch) steel plate with easily removable gasketed side panels containing handles at each panel end.

2.9.8.10 Loading Hopper

Constructed of not less than 10 mm 3/8 inch thick steel plate connected to bottom flange of the track or truck hopper. Provide an adjustable regulating gate adjacent to loading hopper for regulating height of coal on the belt.

2.9.8.11 Vibrating Feeder

Flat pan type vibrating feeder to convey coal from day hopper to belt conveyor. Pan shall be [_____] mm inches wide by [_____] mm inches long, with 150 mm 6 inch sides, constructed of 6 mm 1/4 inch thick stainless steel. Provide feeder with integral electromechanical drive and a remote controller. Controller shall contain operating switches and rate of flow adjustment and the power source for the feeder drive. Controller shall be designed for 460 volt, 60 Hz. supply voltage. Support feeder from hopper.

[2.9.9 Shallow-In-Built Bar Flight Feeder and Receiving Hopper

****

NOTE: Determine by an economic analysis and a technical evaluation if shallow-in-built bar flight feeders and receiving hoppers might be used instead of track or truck hoppers with belt feeders.

****

Bar flight feeder shall be totally enclosed, dusttight type with shallow-in-built [track] [truck] hopper. Bar flight feeder shall have a horizontal length of [_____] meters feet [_____] mm inchesbetween sprocket centers, operate at not greater than [_____] m/s fpm, and have a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide feeder complete with continuous chains and attached bars, terminal sprockets, gears, shafts, bearings, troughs, enclosure, frames, [truck] [track] hopper, grating, regulating gate, hinged inspection doors, discharge chute, electric motor, reduction gear, and supports.

2.9.9.1 Head and Foot Shafts

Head and foot shafts shall be not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively. Construct shafts of cold rolled steel and mount in antifriction roller bearings. Mount head shaft in fixed pillow blocks and foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.9.9.2 Terminal Sprockets

Cast iron with chilled rims not less than 380 mm 15 inches in diameter. Foot shaft sprockets shall be split type in two 180 degree sections to facilitate removal in shallow pit.

2.9.9.3 Chains and Flights

Chains shall be bar link type each having a pitch of not greater than 150 mm 6 inches and an ultimate strength of not less than 20,430 kg 45,000 pounds. Construct chain of heat treated carbon steel components with not less than a 22 by 38 mm 7/8 by 1 1/2 inch wide center link, 10 mm wide by 38 mm 3/8 inch wide by 1 1/2 inch thick side bars, fastened with 18 mm 5/8 inch diameter pins. Construct bar flights of 10 mm 3/8 inch thick steel bars not less than 50 mm 2 inches high with flight width of not less than [_____] mm inches. Flight spacing shall be such that feeder shall move the required coal with a head shaft speed not greater than [_____] rpm.

2.9.9.4 Frame and Enclosure

Construct feeder frame of structural steel properly tied and braced, complete with guides and track for both carrying and return runs, of not less than 80 by 80 by 10 mm 3 by 3 by 3/8 inch steel angles with not less than 6 mm 1/4 inch high renewable carbon steel wear bars. Enclosure shall be dusttight of not less than 10 gage (3.42 mm 0.1345 inch) commercial hot rolled steel plate. Enclosure shall be removable in sections. Top and side panels at head and foot sections shall be hinged and removable for access to chain sprockets.

2.9.9.5 Trough

Construct with flat bottom of not less than 10 mm 3/8 inch thick steel plate. Trough shall be removable and constructed with flanged discharge opening.

2.9.9.6 Hopper

Construct not less than 2 1/2 meters long and 3 meters wide 8 feet long and 10 feet wide of structurally reinforced 10 mm 3/8 inchthick steel plate lined with 10 gage (3.42 mm 0.1345 inch) 410 stainless steel plate. Hopper sides shall not slope less than 55 degrees from the horizontal. Construct hopper with a shield over return run so that coal is fed directly to bottom conveying run.

2.9.9.7 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches. Construct grating of 65 by 10 mm 2 1/2 by 3/8 inch steel bars and 20 mm 3/4 inch diameter steel rods. Weld grating and make in sections for ease of removal. Provide intermediate beams to support grating.

2.9.9.8 Flight Feeder Drive

Flight feeder shall be driven by an electric motor direct connected by means of flexible coupling to a reduction gear unit having alloy steel helical or herringbone gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and gear. Drive from output speed shaft of the reduction gear to the conveyor head shaft shall be by means of standard finished steel roller chain running over cut tooth sprockets, both conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall also conform to ASME B29.100. Properly tension drive chain.

2.9.9.9 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES.

]2.9.10 Bucket Elevator

Dusttight [centrifugal discharge] [continuous bucket] type having approximately [_____] meters feet [_____] mm inch sprocket centers, vertical chain and bucket, operating at a speed not to exceed [_____] m/s fpm, and having a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide bucket elevator complete with continuous double chains and attached buckets, upper and lower sprockets, gears, shafts, bearings, casing, top hood, discharge spout, bottom boot, access doors, electric motor drive, reduction gear, service platform, and accessories.

2.9.10.1 Head and Foot Shafts

Cold rolled steel not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively. Mount shafts in antifriction roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than a [_____] mm inch adjustment. Shafts shall fit tight in sprocket hubs.

2.9.10.2 Terminal Sprockets

Cast iron with chilled rims. Head sprockets shall be not less than [_____] mm inches in diameter and foot sprockets not less than [_____] mm inches in diameter.

2.9.10.3 Buckets and Chain

Construct buckets of [malleable iron] [not less than [_____] mm inch steel plate] not less than [_____] mm inches long, [_____] mm inches wide, and [_____] mm inches deep. Buckets shall be mounted by not less than four bolt attachments to double strand of steel bushed chain each having an ultimate strength of not less than [_____] kg pounds and pitch of [_____] mm inches. Bucket spacing shall not be greater than [_____] mm inches.

2.9.10.4 Backstop

Differential band brake type, cam type or internal type to prevent reversal of chain and buckets in case of power failure.

2.9.10.5 Elevator Casing

Not less than [_____] by [_____] mm inches inside of not less than [_____] [gage] [mm inch thick] commercial hot rolled mild steel plate with 50 by 50 by 6 mm 2 by 2 by 1/4 inch corner angles for full height of elevator casing. Construct casing in standard sections from 3048 to 3658 mm 10 to 12 feet high with 50 by 50 by 6 mm 2 by 2 by 1/4 inch angle flanges at the end of each section. Provide a hinged inspection door not less than 610 by 760 mm 24 by 30 inches in the section immediately above the boot section [and where indicated]. Casing and inspection doors shall be of dust-tight construction with flange angles continuously welded and gasketed. No makeshift repairs or field patching to overcome leakage shall be permitted. Casing interior shall be given a 1.60 mm 1/16 inch thick coating of coal tar primer and enamel in accordance with SSPC PS 11.01.

2.9.10.6 Head Section

Not less than [_____] mm inch thick commercial hot rolled mild steel plate in heavy angle frame with split, hinged, and removable top cover hood. Construct hood of not less than [_____] mm inch thick commercial hot rolled mild steel plate with flanged discharge throat built of not less than [_____] mm inch thick commercial hot rolled mild steel plate. Design head section to support drive machinery and head bearings. Provide maintenance access ladder and platform conforming to applicable OSHA regulations [as indicated].

2.9.10.7 Boot Section

Not less than [_____] mm inch thick commercial hot rolled mild steel plate in heavy rolled mild steel plate in heavy angle frame with curved and renewable bottom plate built of not less than [_____] mm inch thick commercial hot rolled mild steel plate, and flanged inlet. Mount take up and foot terminal bearing on one side of boot in a bolted removable side panel so foot shaft and [sprocket] [sprockets] may be removed through side of door. Bolt end panels so they are removable for cleanout and inspection.

2.9.10.8 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES. Motor shall be direct connected by means of flexible coupling to a reduction gear.

2.9.10.9 Reduction Gear

Alloy steel herringbone or helical gear type enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear unit. Drive from the output shaft of the reduction gear to the elevator head shaft shall be by means of standard finished steel roller chain running over cut tooth sprockets, both conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall also conform to ASME B29.100. Properly tension drive chain.

2.9.10.10 Anchoring Brackets

Provide steel brackets at intervals [as indicated] at [not less than [_____] meters feet over centers] for anchoring elevator and to increase rigidity.

2.9.11 Flight Conveyor

Dusttight double strand chain-type with [_____] meters feet sprocket centers, operating speed not greater than [_____] m/s fpm, and having a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide flight conveyor complete with continuous chain and attached flights, terminal sprockets, gears, shafts, bearings, trough, casing, frame, hinged inspection doors, electric motor drive, reduction gear, and supports. [Design flight conveyor for future length of [_____] meters feet for future plant expansion.]

2.9.11.1 Head and Foot Shafts

SAE 1045 steel not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively, mounted in antifriction tapered roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.9.11.2 Terminal Sprockets

Cast iron with chilled rims and not less than 8 teeth. One sprocket shall be keyed on shaft and the other shall be free to turn.

2.9.11.3 Flights and Chain

Construct flights not less than [457] [508] [610] [762] mm [18] [20] [24] [30] inches long and [200] [250] mm [8] [10] inches high of not less than 6 mm 1/4 inch thick abrasion resistant steel. Mount flights at not greater than [457] [508] [610] [914] mm [18] [20] [24] [36] inch intervals between two matched strands of steel bushed roller chain having [_____] mm inch pitch and an ultimate strength of not less than [_____] kg pounds per each strand. Chain shall have [_____] by [_____] mm inch high carbon steel side bars, high carbon steel, heat-treated pins, carbon steel case-hardened bushings, and [_____] mm inch diameter single flange chilled gray iron or chrome iron rollers. Support chain so that chain does not lie or run in coal.

2.9.11.4 Frame and Enclosure

Construct conveyor frame of structural steel properly tied and braced, complete with track for both the carrying and return run of chain of not less than 80 by 80 by 10 mm 3 by 3 by 3/8 inch steel angles with not less than 6 mm 1/4 inch high renewable molybdenum steel wear bars. Enclosure shall be dust-tight of not less than 10 gage (3.42 mm 0.1345 inch) hot rolled steel plate with easily removable side panels containing handles at each panel end. Enclosure shall have hinged inspection doors 600 mm 24 inches wide and full height of the enclosure opposite loading hopper and at each discharge chute. End panels shall be hinged and removable for access to the chain sprockets.

2.9.11.5 Trough

Not less than 6 mm 1/4 inch thick corrosion resistant steel plate made in boxlike U-shape. Trough shall be removable in not more than 2.44 meters 8 foot long sections and constructed with flanged discharge openings where indicated.

2.9.11.6 Loading Hopper

Steel plate not less than 6 mm 1/4 inch thick sloped at not less than 60 degrees.

2.9.11.7 Outlets

Bottom of trough shall have [_____] outlets not less than [457] [508] [610] [762] mm [18] [20] [24] [30] inches long with gates to discharge coal into cylindrical bunkers. Provide outlets with deflection plate type baffle designed to make coal drop straight down into bunker.

2.9.11.8 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Motor shall be directly connected by means of flexible coupling to a reduction gear.

2.9.11.9 Gates

Provide coal gates on bottom trough of flight conveyor, immediately under outlets. Opening shall be [_____] mm inch square with motor operated slide gates for controlling discharge to each bunker. Provide double rack and pinion type gates driven by not less than 0.56 kW 3/4 hp motor. Provide limit switches for signal lights, control and interlocking. Provide outlets from gates with a 6 mm 1/4 inch abrasion resistant steel plate discharge chute.

2.9.11.10 Reduction Gear

Alloy steel helical or herringbone gear type with antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear. Drive from output shaft of motor reducer to conveyor head shaft shall be by means of standard finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100. Provide means to properly tension drive chain.

2.9.12 Belt Conveyor

Inclined and approximately [_____] meters feet between pulley centers, operated at a speed not to exceed [_____] m/s fpm, and have a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide belt conveyor complete with continuous belt, shafts, pulleys, idlers, takeups, belt cleaner, frame with conveyor cover and walkway, transfer chute, hopper, emergency stop cord and switch, alignment switch, reduction gear, electric motor, bin high level limit switch and alarm.

2.9.12.1 Head and Foot Shafts

Construct shafts of turned and polished cold rolled steel not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively. Mount shafts in antifriction roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.9.12.2 Takeups

[Three pulley guided vertical counter weighted type] [Screw type] to maintain proper belt tension. Shafts shall be as specified above and not less than [_____] mm inches in diameter. Provide a safety device to prevent free fall of takeup pulley. Takeups shall provide a minimum adjustment of 1.5 percent of total belt length.

2.9.12.3 Pulleys

Welded steel type with detachable compression grip-type hubs, steel plate ends, and crown faces 50 mm 2 inches wider than the belt width. Provide a multiple belt scraper at each head pulley.

2.9.12.4 Magnetic Pulley

Drive pulley of [_____] conveyor shall be a nonelectric permanent magnet type designed to remove tramp iron. Provide a removable pan to collect tramp iron.

2.9.12.5 Belt

Synthetic fabric, not less than [_____] mm inches wide, a minimum of [_____] ply, with 3 mm 1/8 inch thick oil and chemical resistant cover on carrying side, [1.59] [0.79] mm [1/16] [1/32] inch thick oil and chemical resistant rubber cover on under side. Cover shall be fire resistant. Belt shall have a tension pull strength of not less than [_____] N per mm pounds per inch of belt width. Belt shall have vulcanized splice.

2.9.12.6 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Motor shall be direct connected by means of flexible coupling with guard to a reduction gear.

2.9.12.7 Reduction Gear

Alloy steel helical gear type enclosed in an oiltight housing. Provide an adjustable base for mounting motor and reducing unit. Drive from output shaft of speed reducer to conveyor head shaft shall be by means of finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100. Provide means to properly tension drive chain.

2.9.12.8 Backstop

Differential band brake type, cam type, or internal type to prevent reversal of belt.

2.9.12.9 Emergency Stop Cord and Switch

Provide emergency stop cord the length of the conveyor to actuate a switch for stopping the conveyor. Switch shall have flag to indicate actuated switch and shall have positive safety lock that cannot be accidentally reset. Cord shall be not less than 2.38 mm 3/32 inch galvanized aircraft cable with a minimum 1.19 mm 3/64 inch vinyl or nylon protective coating. Provide sufficient number of switches to prevent cable weight from actuating switch.

2.9.12.10 Belt Alignment Switch

Provide belt alignment switches on each side of the belt mounted off conveyor frame or discharge chute to stop conveyor under belt misalignment or runoff conditions. Mount switches on breakaway mounts to prevent damage from runaway belt.

2.9.12.11 Idlers

Troughing idlers shall be [20] [35] degree three-pulley type with 125 mm 5 inch diameter steel shells, malleable iron end brackets, grease sealed roller type antifriction bearings, and self-cleaning angle bases. Troughing idler spacing shall be not greater than 1.37 meters 4 feet 6 inches, with additional idlers at the loading point. Return idler shall be flat single-pulley type having 125 mm 5 inch diameter steel shells, grease sealed roller type antifriction bearings and spaced not more than 3 meters 10 feet on center. Provide self-aligning training type trough and return idlers at not greater than 15.24 meters 50 foot intervals to ensure proper training of belt. Extend grease pipes to one side for four point lubrication from walkway.

2.9.12.12 Load Skirts

Not less than 6 mm 1/4 inch thick steel plate and supported by structural brackets from conveyor frame. Skirts shall have rubber strips along bottom edge to seal belt. Strips shall be easily adjustable by means of a clamp bar arrangement not requiring slotted bolt holes.

2.9.12.13 Frame, Supports, and Walkway

Frame shall be structural steel truss type with head and foot terminals framed of structural steel. Support frame from grade on structural A-frames set on concrete footings as indicated. Support idlers on not less than 150 mm 6 inch channel stringers braced and tied to structural steel truss frame. Provide a 12 gage (2.66 mm 0.1046 inch) steel deck plate for full length of conveyor. Provide a curved belt cover constructed of not less than 16 gage (1.52 mm 0.0598 inch) corrugated galvanized metal having removable panels on walkway side for access to idlers. Provide walkway not less than 914 mm 36 incheswide, supported from structural steel framing for entire length of conveyor. Walkway shall be complete with handrails and metal nonslip grating meeting requirements of 29 CFR 1910-SUBPART D, Walking and Working Surfaces.

2.9.12.14 Discharge Hopper

Construct of not less than 6 mm 1/4 inch thick steel plate to discharge on a discharge chute. Provide a discharge hood built of 10 gage (3.42 mm 0.1345 inch) steel plate enclosing top, front, and sides above discharge hopper.

2.9.13 Coal Scales

Stationary, automatic, dust-proof, belt-fed, batch type with rated capacity of not less than [_____] Mg tons per hour and a hopper capacity of 91 kg 200 pounds. Coal scales shall be complete units, including body, belt feeder, feeder drive, bypass, weighing mechanism, weigh hopper, controls, counters, and remaining items required to make a completely automatic coal scale.

2.9.13.1 Body

Dusttight, of welded heavy steel plate construction with base angles not less than 6 mm 1/4 inch thick. Top plate, bypass plate, and reducer mounting plate shall be not less than 6 mm 1/4 inch thick, with other plates of not less than 11 gage (3.04 mm 0.1196 inch) steel plate. Provide large, gasketed, dusttight doors with adjustable pre-set compression type latches and forged steel hinges for inspection and maintenance purposes. Door openings shall be sufficient to allow removal of feeder and hopper without removal of screws or bolts.

2.9.13.2 Feeder

A self-contained unit with an endless belt which is capable of being removed from one end or side. Construct feeder of heavy rigid steel frame with an 11 gage (3.04 mm 0.1196 inch) stainless steel plate to support the belt on the carrying run. Head and takeup shafts shall be cold rolled steel carried on self-aligning ball bearings equipped with dust seals and fitted for pressure lubrications. Bearings shall be capable of being lubricated during scale operation. Takeup shaft shall have screw-type takeup bearings and pulleys shall be crown faced steel for proper belt tracking.

2.9.13.3 Feed Belt

Channel type and of endless construction without splice. Belt shall be not less than 7.94 mm 5/16 inch thick of three ply heavy fabric core construction with chemical and abrasion resistant rubber coating. Feeder skirts and leveling plate shall be stainless steel and shall be arranged to provide a continuous stream of constant width and depth coal on the feed belt.

2.9.13.4 Electric Motor And Drive

Totally enclosed [_____] volt, [_____] phase, 60 Hz, with heavy duty reduction gear not less than 0.56 kW 3/4 hp as specified in the paragraph MOTORS AND DRIVES. Scale shall be capable of bypassing coal without disconnection of drive. Drive disconnection shall not be required for feeder removal unless special provisions are made for a quick and simple drive disconnection.

2.9.13.5 Coal Bypass

Provide a quick-operating coal bypass with an easily operable lever located on the outside of scale body. Operating lever operation shall instantly bypass coal around the feeder section and weighing mechanism without release of belt tension to prevent entry of coal between belt and pulley or support plates. Bypass construction shall not restrict inlet opening size for normal scale operation.

2.9.13.6 Weighing Mechanism

Enclose in a dusttight compartment. Construct of cold rolled steel for minimum deflection, warp, and twist. Pivot points shall be self-aligning with hardened double bearing surfaces. Weighing mechanism shall be complete with weight lever, tare adjustment, and compensator [, with design subject to approval by the Contracting Officer] and scale shall be guaranteed to weigh coal accurately within 0.25 percent.

2.9.13.7 Scale Weigh Hopper

Construct scale weigh hopper and discharge gate of not less than 14 gage stainless steel plate, continuously welded and stiffened with angle irons. Weigh hopper shall be of such design and construction to ensure clean discharge.

2.9.13.8 Controls

Provide controls, except those required for weigh hopper discharge, prewired and located in a NEMA [12] [3] dusttight enclosure. Provide circuit breaker interlocked with electrical panel door. Control circuits shall be two wire nominal 120 volt systems obtained by using an isolation transformer with one side grounded and wired to a single terminal block which shall be included in the electrical panel. Segregate circuits of different voltage levels. Controls shall include large, oiltight, industrial type pushbuttons for use as "start-stop," "test," and "dump" switches mounted on the scale body adjacent to the electrical panel.

2.9.13.9 Counters

Mount a mechanical type coal counter on the scale body. Counter shall be rugged, reliable, with heavy duty register and designed so that double counting is impossible.[A remote motor operated counter shall be furnished located on the coal handling control panel in the control room. Counter shall be designed so that double counting is impossible.][Provide a contact closure for sending a pulse signal of each weigh hopper discharge to the operator control console.]

2.9.13.10 Scale Inlet

Scale inlet shall contain coal gate with opening not less than 457 by 457 mm or 406 by 508 mm 18 by 18 inches or 16 by 20 inches along with a dusttight all metal slip joint constructed of not less than 4.76 mm 3/16 inch thick steel plate. Slip joint shall be of split construction to allow for installation after coal scale is in place. Design slip joint to allow necessary flexibility to take care of deflection of [bunker] [silo] outlet due to varying load and temperature variations without imposing load on the scale. Provide rope packing or other resilient gasket material to make slip joint completely dusttight.

2.9.13.11 Scale Outlet Hopper

Not less than 6 mm 1/4 inch thick 410 stainless steel plate of capacity not less than 227 kg 500 pounds and 13 mm 1/2 inch thick steel plate flanges.

2.9.14 Stoker Hopper Extension

Dusttight and bolted to hopper furnished with stokers. Construct hopper extensions as indicated of 6 mm 1/4 inch thick 410 stainless steel plate with structural stiffeners. Hopper extension shall hold not less than [_____] Mg tons of coal at a density of 800 kg per cubic meter 50 pounds per cubic foot. Hopper extensions shall have bolted emergency firing doors of not less than 610 by 610 mm 24 by 24 inches which shall contain a 152 by 152 mm 6 by 6 inch glass observation window. Connections shall be dusttight.

2.9.15 Coal Valve

Dusttight and dripproof of the double ladder rack-and-pinion type sized as indicated for each valve. Valve shall be capable of closing through a standing coal column. Valve opening shall be full size with no bridges, internal braces, or other barriers.

2.9.15.1 Valve Body

Not less than 6 mm 1/4 inch thick formed 410 stainless steel with heavy 19 mm 3/4 inch thick flanges. Continuously weld joints in contact with coal both inside and out and grind smooth. Valve body shall have dusttight steel gate assembly cover with molded gasket for removal of gate without removing coal valve. Provide a minimum of two dusttight poke holes with rigid covers and molded gaskets.

2.9.15.2 Valve Gate

Dripproof and siftproof of 10 mm 3/8 inch thick steel plate with an 11 gage (3.04 mm 0.1196 inch) 410 stainless steel liner. Support gate by ball bearing rollers with 16 gage (1.52 mm 0.0598 inch) stainless steel shells equipped with felt grease seals and stainless steel grease retainers. Provide rollers with grease fittings extended through valve body for pressure lubrication. Design gate so that supporting rollers, racks, and pinions are located completely out of the coal stream. Provide cold formed, self cleaning racks, with stainless steel self cleaning pinions located over racks for positive tooth engagement.

2.9.15.3 Operating Shaft

Mount operating shaft in ball bearings with felt seals, stainless steel shells, stainless steel grease retainers, and grease fittings. Provide handwheels with proper finger clearance or pocket sheaves with heavy hot-dipped galvanized chain and chain guard as indicated. Handwheels and sheaves shall be not less than 457 mm 18 inches in diameter. Provide valves with mechanical type position indicator consisting of large pointer and legend to indicate position of valve gate.

2.9.15.4 Electric Motor Operators

Provide motor operators where indicated and capable of remote operation from the coal handling control panel. Operator shall consist of totally enclosed, fan cooled, high torque, [_____] volt, [_____] phase, 60 Hz motor as specified in the paragraph MOTORS AND DRIVES with reduction gear, clutch and limit switches. Motor horsepower shall be as recommended by the manufacturer. Provide motorized valves that have manual operators, with fail-safe interlocks that make manual operation impossible while motor is operating.

2.9.16 Track and Reclaim Hopper Valves

Dusttight, double rack and pinion type, with water collecting trough. Valve shall have inlet opening not less than [_____] by [_____] mm inches in direction of gate travel with a larger outlet opening. Inlet and outlet shall be flanged and constructed of mild steel.

2.9.16.1 Valve Body

Not less than 10 mm 3/8 inch thick mild steel continuously welded both internally and externally and lined with 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate where body comes in direct contact with coal. Construct inlet skirt of not less than 6 mm 1/4 inch thick 410 stainless steel with outlet body plates constructed of 10 mm 3/8 inch thick mild steel lined with 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate. Construct water collecting trough of not less than 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate and containing water sprays for flushing. Valve body shall have dust-tight steel gate assembly cover with molded gasket for removal of gate without removing the coal valve. Provide a hinged access panel not less than [_____] by [_____] mm inches in the direction of gate travel with compression-type latches over water collecting trough for removing obstructions.

2.9.16.2 Valve Gate

Slope gate plate toward water collecting trough and mount it on large ball bearing rollers with 16 gage (1.52 mm 0.0598 inch) stainless steel shells equipped with felt grease seals and stainless steel grease retainers. Provide rollers with grease fittings extended through valve body for pressure lubrication. Gate shall be U-shaped with ladder racks on both sides and shall be constructed of not less than 15.90 mm 5/8 inch thick mild steel lined with 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate. Gate design shall be such that supporting rollers, racks, and pinions are located completely out of coal stream. Racks shall be cold formed and self-cleaning, with stainless steel, self cleaning pinions over racks.

2.9.16.3 Operating Shaft

Mount operating shaft in ball bearings with felt seals, stainless steel shells, stainless steel grease retainers, and grease fittings. Mount a reduction gear on the gate shaft and provide an ample gate clearance pocket in the body to ensure ease of operation through a standing column of coal. Handwheel for operating valve shall be not less than 457 mm 18 inches in diameter.

2.9.17 Chutes

Construct coal chutes dusttight as indicated of not less than 6 mm 1/4 inch thick 410 stainless steel plate. Weld chutes with flanges located as indicated to facilitate equipment and chute section removal. Flanges shall be not less than 10 mm 3/8 inch thick steel and gasketed to maintain dust-tight seal. Provide poke holes and access panels where indicated.

2.9.18 Coal Presence Indicators and Equipment Response Switches

May be of the following types and shall be interlocked with coal handling controls to indicate equipment failures, coal stoppages, and provide for a semi-automatic system. Enclosures for components shall meet requirements of NEMA Type 7, Class I, Division I, Groups C and D, and NEMA Type 9, Class II, Division I, Groups E, F, and G.

2.9.18.1 Type A - Diaphragm Type Presence Indicator

Pressure-sensitive to presence of coal consisting of housing, diaphragm, limit switches, wiring, and mounting bracket flanges. Housing shall be either cast iron, stainless steel, or protected cast aluminum, with synthetic diaphragm as recommended for coarse slightly abrasive materials. Diaphragm deflection shall actuate a limit switch to indicate coal presence. Design unit so that maintenance, diaphragm replacement and sensitivity adjustment can be made from outside the bin. Type and number of contacts and voltages shall be as indicated on control diagrams.

2.9.18.2 Type B - Paddle Type Presence Indicator

Paddle mounted on a counterweighted horizontal shaft so that deflection of paddle rotates a cam which actuates a limit switch in a control box mounted on the shaft. Unit shall consist of paddle, shaft, enclosure, limit switches, wiring, and mounting brackets. Shaft shall be cold rolled steel and paddle shall be stainless steel with control enclosure of cast iron, stainless steel, or suitably protected cast aluminum. Type and number of contacts and voltages shall be as indicated on control diagram. Mount shaft in ball bearings equipped with suitable dust seals and fittings for pressure grease lubrication.

2.9.18.3 Type C - Tilt Type Presence Indicator

Conical steel float that shall be tilted by presence of coal. Unit shall consist of housing, conical float, universal pivot-collar, pendant mechanism, dust seal, limit switches, wiring, and mounting brackets. Unit shall operate so that tilting of float actuates a limit switch in enclosed housing above. Provide a hood constructed according to manufacturer's recommendations for the indicator's location of not less than 5 mm 3/16 inch thick steel plate. Provide access panel for servicing the unit. Tilt type indicator may be a totally enclosed type in which tilting causes a ball to roll off the center actuating a limit switch. Design unit to be cable hung and to tilt on presence of coal. Type and number of contacts and voltages shall be as indicated on control diagram.

2.9.18.4 Type D - Rotating Type Presence Indicator

Rotating paddle where presence of coal stalls motor and actuates a limit switch. Unit shall have either cast iron or cast aluminum housing, stainless steel paddle, couplings, and flexible shaft. Shaft seal shall be spring loaded and shall prevent buildup of fines between shaft and hub. Operation shall be such that when paddle stalls motor continues to operate until limit switch is actuated, which in turn shuts off current to motor. Vane and baffle arrangements shall be according to manufacturer's recommendations for each indicator location. Type and number of contacts and voltages shall be as indicated on control diagrams.

2.9.18.5 Type E - Vibrating Type Presence Indicator

Vibrating sensing rod so that presence of coal dampens vibrations actuating a control signal. Sensing rod shall be stainless steel not less than 10 mm 3/8 inch in diameter. Control unit shall be solid state, with type and number of contacts and voltages as indicated on control diagrams.

2.9.18.6 Equipment Speed Response Switch

Actuates a control signal when preset abnormal equipment operating conditions are encountered. Switch shall be adjustable so that it may be used as an underspeed switch, overspeed switch, or zero speed switch. Switch shall consist of input shaft from which the equipment speed is measured and compared to a preset point. Enclosure shall be cast iron or suitably protected cast aluminum. Mount speed response switches as indicated. Type of switch adjustment, type and number of contacts, and voltages shall be as indicated on control diagrams.

2.9.18.7 Presence Indicators and Response Switches

Provide at hoppers and conveyor discharges located and protected according to manufacturer's recommendations to ensure safe and reliable operation. Mount presence indicators in such a manner that they will not be damaged by occasional large lumps or falsely operated by stray lumps or collected amounts of coal.

2.9.19 Control Panel and Controls

Provide a semi-automatic control system for coal handling system as indicated.

2.9.19.1 Control Panel

NEMA 12 construction, centrally located in main plant control room. Panel front shall include a system graphic display as indicated. Display shall be approximately to scale and painted with an industrial acrylic enamel. Outline each item with 3 mm 1/8 inch wide black lines. Lettering shall be on engraved plastic screwed to front of panel, with white letters on a black background. Provide controls for operation on [_____] volt, [_____] phase, 60 Hz ac. Panel shall be complete with an annunciator and interlocks, relays, switches, running and safety lights, and auxiliary parts necessary to safely control and operate the system. Items located in door shall be dust-tight and oil tight with push-to-test transformer type indicating lights. Control relays shall be 10 amp, 600 volt class with convertible contacts. Provide and mark terminals for connections with the exception of the neutral. Panel shall contain [_____] percent spare terminals. Wiring shall be No. 14 AWG type THHN stranded. Neutral wire shall be white. Color code and label wiring of 120 volts or less. Provide plastic wire duct of sufficient size to provide [_____] percent cross sectional spare. Wiring shall be in accordance with requirements of NFPA 70.

a. Panel Devices: Control panel shall include the following indicating lights and color:

(1) Power - ON	red
(2) System Run (3 required)	

Rail unloading hopper to boiler plant	green
Rail unloading hopper to storage yard	green
Reclaim hopper to boiler plant	green
(3) Rail unloading hopper surfactant sprays - ON	green
(4) Reclaim hopper surfactant sprays - ON	green
(5) Belt feeders - ON (one required for each feeder)	green
(6) Reversible belt conveyor to stackout conveyor - ON	green
(7) Reversible belt conveyor to transfer belt conveyor - ON	green
(8) Transfer belt conveyor - ON	green
(9) Stackout tube belt conveyor - ON	green
(10) Reclaim belt conveyor - ON	green
(11) Bucket elevator belt conveyor - ON	green
(12) Bucket elevator - ON	green
(13) Bunker - HIGH LEVEL	green
(14) Bunker - LOW LEVEL	red
(15) Underbunker conveyor to emergency discharge - ON	green
(16) Coal scale - ON	green
(17) Stoker hopper - HIGH LEVEL (one required for each hopper)	
(18) Stoker hopper - LOW LEVEL (one required for each hopper)	

b. Provide momentary contact pushbuttons or selector switches for the following:

(1) System START (3 required)
Rail unloading hopper to boiler plant
Rail unloading hopper to storage yard
Reclaim hopper to boiler plant

(2) System - STOP (red head)

(3) Rail unloading surfactant spray system - ON-OFF

(4) Rail unloading hopper surfactant spray - START/STOP

(5) Reclaim surfactant spray system - ON-OFF

(6) Reclaim hopper surfactant spray - START/STOP

   (7) Coal to stackout tube (SELECT)
   (8) Alarm - ACKNOWLEDGE

c. Annunciator panel shall include the following:

   (1) Bunker - HIGH LEVEL
   (2) Bunker - LOW LEVEL
   (3) Stoker hopper (one required for each hopper) - HIGH LEVEL
   (4) Stoker hopper (one required for each hopper) - LOW LEVEL
   (5) EMERGENCY SHUTDOWN (Auxiliary contacts for remote alarm)
   (6) Blank (3 required)

d. Size panel to accommodate future addition of one stoker hopper and associated equipment.

e. Provide auxiliary devices required for control functions indicated above.

f. Provide laminated plastic name plates for devices on panel face.

2.9.19.2 Remote Controls

Provide controls for the following items in the main plant control room as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS:

a. Conveyor system - EMERGENCY STOP

b. Bunker - HIGH LEVEL ALARM

c. Bunker - LOW LEVEL ALARM

d. Stoker hopper (one required for each hopper) - HIGH LEVEL

e. Stoker hopper (one required for each hopper) - LOW LEVEL

f. Under Bunker conveyor system - START/STOP

g. Coal scale - START/STOP

2.9.19.3 Control Sequence

To ensure that coal does not back up during system startup or shutdown, design controls so that on startup, the last piece of equipment to handle coal starts first and on shutdown, stops last.

2.9.19.4 Additional Controls

Provide as shown. These controls include local START and STOP pushbuttons or three-position selector switches for the following:

a. Belt feeders

b. Belt conveyors (at head pulley)

c. Flight conveyor

d. Coal scale

e. EMERGENCY STOP pushbuttons which stop the entire system shall be provided where indicated.

2.9.20 Multiple Belt Scrapers

Equip conveyor belts at the head pulley, with multiple belt scrapers. Provide adequate room and service access in head chute design for multiple cleaners. Provide a doctor blade on face of head pulley to remove most of the carryback material and a torsion arm type multiple blade cleaner to scrape and remove material that bypasses primary cleaner. Provide tail pulley takeups with a plow to protect against material being carried back between belt and pulleys. Both cleaners and plows shall have features that enable the operator to safely inspect and adjust the blades. Dribble chutes shall be designed to resist material buildup and shall be plastic lined. Provide a convenient dust tight door for clean out and inspection purposes on each side of the dribble chute.

2.9.21 Steel Coal Bunker

Cylindrical shaped type having a storage capacity of not less than [_____] Mg tons of coal having a density of 800 kg per cubic meter 50 pounds per cubic foot.

2.9.21.1 Construction

All welded construction, not less than [_____] meters feet in diameter with a vertical cylindrical section [_____] meters feet [_____] mm inches high. Construct vertical cylindrical section of not less than 7.90 mm 5/16 inch thick steel plate. Slope bottom cone shaped hopper section at not less than 55 degrees and fabricate from not less than 10 mm 3/8 inch thick 410 stainless steel plate. Top of bunker shall be conical 35 degree sloped structurally reinforced 6 mm 1/4 inch thick steel plate. Provide ladder inside bunker. Provide dusttight, weather tight access hatch of not less than 610 by 610 mm 24 by 24 inches in bunker top immediately above ladder. Shell and bottom plates shall be beveled for full penetration butt weld on inside of bunker and a finish weld on outside of bunker. Provide bunker with flanged outlet drilled to match inlet of gate.

a. Responsibility: Ensure that full responsibility for final design and details of construction of steel coal bunker is assumed by the manufacturer.

b. Supports: Bunker shall be self supporting from four stub columns which shall be supported from on top horizontal structural steel framing. Structural steel framing for supporting the stub columns is specified in Section 05 12 00 STRUCTURAL STEEL.

c. Liner: Surface blast vertical inside surfaces of the bunker to a near white metal, and then coat with 6 mm 1/4 inch thick troweled-on heavy duty three compound corrosion resistant liner consisting of a resin, a hardener and graphite aggregate. Liner shall have an operating temperature limitation of not less than 66 degrees C 150 degrees F.

2.9.21.2 Accessories:

a. Alarm Switches: Provide bunker with two automatic bin level indicators with neoprene rubber diaphragm and a single pole, double throw switch mounted in explosion proof aluminum housing to signal high and low level alarms. Provide mounting plates on bunker shell and holes for installation of indicator housing on outside of bunker. Wiring shall be as specified in Division 26.

b. Vibrators: Provide on cone bottom of coal bunker a heavy duty pulsating magnet electric vibrator, semi-noiseless type, complete with mounting plate. Provide one vibrator controller panel arranged for mounting in wall mounted control panel. Panel shall contain an "ON-OFF" switch, power control dial, fuses and rectifier. Power supply to panel shall be 460 volt, single phase, 60 Hz current.

2.9.22 Stackout Tube

Provide a stackout type discharge tube not less than 10 mm 3/8 inch thick, reinforced, stainless steel plate for discharging coal from stackout conveyor to coal storage yard. Tube shall be 1220 mm 4 feet in diameter, and designed as the structural support for a portion of the stackout conveyor and support steel as indicated. Tube shall be a window chute designed to discharge coal at not more than 1829 meters 6 feet above coal pile.

2.10 FUEL OIL SYSTEM

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NOTE: In reference to the following text, choose either Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS, for below ground tanks, or Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION), for above ground tanks. The rest of the fuel oil system is covered in Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).

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The fuel oil system shall be designed and built in accordance with Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION)[.][, except for below grade level fuel tanks, which shall be constructed to Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.]

2.11 ASH HANDLING SYSTEM (PNEUMATIC)

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NOTE: Designer shall select type of ash handling system most suited for each project. For plants over 4 kg per second 31,500 pounds per hour steam ultimate capacity use a pneumatic ash handling system. For plants under 4 kg per second 31,500 pounds per hour steam ultimate capacity use a mechanical system. Refer to NAVFAC DM-3.6, Section 5, paragraph 4d for design criteria.

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NOTE: Choose this article (and the paragraphs and subparagraphs following) or the article, (paragraphs

and subparagraphs) below, ASH HANDLING SYSTEM (MECHANICAL).
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2.11.1 System Requirements

Provide a complete integrated, pneumatic, semi-automatic sequencing, ash handling system with air intakes, material intakes,[ash doors and enclosures,] iron alloy conveyor line, fittings, rotary slide gates, primary and secondary material separators, tertiary bag filter, [steam exhauster,] [electric motor driven positive displacement blower (mechanical exhauster),] [air washer,] silo vent filter, ash silo, rotary ash conditioner, and equipment that may be necessary for a complete pneumatic ash handling system. Provide related electrical work required to operate the ash handling system. Design system so that the ash silo is never placed under a partial vacuum.

2.11.2 Type

System shall be the intermittent vacuum type, whereby the vacuum is interrupted permitting periodic discharge of collected materials into the silo on a programmed time cycle. System shall have sufficient air velocity to pick up ash that may be deposited in the pipe.

2.11.3 Ash Silo

System shall receive, and on a sequenced basis convey to the ash silo, ash from the stoker fired boiler [ash storage hoppers,] [ash storage pits,] [siftings hoppers,] [soot hoppers,] [economizer hoppers,] [baghouse hoppers,] and other pollution control equipment hoppers. Convey ash from only one pickup point at a time.

2.11.4 Ash

Discharge ash into the ash storage silo in a dry condition. Arrange silo equipment for disposal of conditioned ash to trucks. The operation shall be as nearly dustless as possible.

2.11.5 Maximum Noise Level

The noise level of the operation shall not exceed 85 decibels sound pressure level 1.50 meters 5 feet from the equipment in any direction.

2.11.6 Dry Ash Storage Hopper

Provide for each boiler to receive and store bottom ash as it is discharged from the traveling grate. Hopper shall be compatible with the grate ash discharge enclosure and shall have a net volume to receive and to store material for an 8 hour period at maximum boiler output. Size hopper for mean ash level for one meters 3 feet below the stoker floor with ash density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing.

2.11.6.1 Construction

Not less than 6 mm 1/4 inch thick, ASTM A36/A36M, steel plate, dusttight, floor supported steel structure with refractory lining. Provide required steel columns, beams stiffeners and cross bracing. Bolt top section of hopper to stoker support steel. Base design load of hopper on 1120 kg per cubic meter 70 pounds per cubic foot. Slope sides at not less than 45 degrees from horizontal to maintain positive feed to outlet.

2.11.6.2 Refractory Materials

As recommended by the manufacturer; minimum total thickness of refractory and insulating block lining shall not be less than 178 mm 7 inches. Refractory shall be minimum of 114 mm 4 1/2 inches thick.

2.11.6.3 Discharge Doors or Gates

Provide each hopper with refractory lined, dusttight, water cooled, vertical lift doors, of an opening size not less than 560 by 560 mm 22 by 22 inches. Each door shall be [air-cylinder operated] [chain wheel operated].[Provide intermediate positioning capability with air cylinder operators.] Provide each door with guide rollers and support arms to ensure smooth operation without binding. When doors are vertical, minimum number of guide rollers shall be 4; for a sloping surface, minimum number of guide rollers shall be 6.

2.11.6.4 Hopper Lift Door Enclosure

Provide not less than 6 mm 1/4 inch thick steel, dusttight, enclosure, for each vertical lift door. Match enclosure to housing of clinker crusher and make enclosure large enough to enclose the outlet and the vertical lift door. Provide hinged inspection and cleanout door on enclosure front.

2.11.6.5 Hinged Hopper Access Door

Provide on one side wall of each hopper. Door shall be cast iron, air tight swingaway locking type with refractory lining. Install door so that it is conveniently accessible and easy to use.

2.11.7 Clinker Crusher

Provide mounted below each hopper discharge outlet, under vertical lift door enclosure, capable of reducing clinkers from bottom ash to a maximum size of 50 mm 2 inches at a rate not less than conveyor system capacity.

2.11.7.1 Construction

Single roller crusher unit with extra heavy housing, outboard bearings sealed against grit infiltration, motor and drive. Housing shall be 15 mm 1/2 inch thick. Crusher rollers shall have replaceable cam segments (teeth) with a minimum Brinell hardness of 450. Each cam tooth shall be designed to permit resurfacing with hard material. Stationary heavy cast iron or manganese steel abrasion resistant wear plates, of a Brinell hardness not less than 350, shall be mounted about the crusher rollers. Cam shaft rotational speed shall not exceed 20 rpm.

2.11.7.2 Fluid Gear Drive

Crushers shall be driven by a fluid gear drive including a totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz electric motor not less than 3.75 kW 5 hp, as specified in the paragraph MOTORS AND DRIVES, fluid coupling and reduction gear, integrally mounted in dust and oil tight enclosures. Fluid drive shall protect unit from excessive shock. Drive shall automatically reverse when stalled; crusher shall reverse and move forward three times and, after third time, shut down and alarm when still stalled.

2.11.8 System Valving

2.11.8.1 Side Intake Valves for Fly Ash Collection

Provide at each hopper, including dust collection hoppers and rear pass hoppers, and other collection points. Side intake valve shall be pneumatically opened, spring closed, totally enclosed disc valve of cast iron construction with wearing surfaces of Brinell hardness not less than 350. Provide valve complete with flanged inlet hopper, handhole with gasketed cover and clamp and couplings. Side intake valve shall feed ash to conveyor line on an angle, thus permitting air to mingle with ash in the proper proportion to eliminate clogging. Valves shall provide positive and automatic air tight shutoff and dust tight pickup. Valve shall close on failure of operating air and before discharge cycle of intermittent conveyor operation. A full load regulating switch shall control each valve to prevent overloading of conveyor system.

[2.11.8.2 Manual Valve Intakes for Bottom Ash

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NOTE: Choose this subparagraph or the subparagraph ROTARY VALVE INTAKE FOR BOTTOM ASH.

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Provide in front of stoker ash pit doors, a 610 by 610 mm 24 by 24 inch cast iron grid and hopper complete with a self-feeding bottom ash intake, seal plug and pull-out rod that may be lifted to permit ash to enter system.

][2.11.8.3 Rotary Valve Intakes for Bottom Ash

Provide a rotary valve, designed for regulating bottom ash to the a conveyor pipeline, under each crusher. Valve shall provide intake isolation and prevent overfilling or plugging of the conveyor line. Construction of valve shall be of cast iron with wearing surfaces of Brinell hardness not less than 350. Valve shall be pneumatically operated.

]2.11.8.4 Air Intake

Provide spring loaded, swing disc, check valve type air intake, designed for air induction, at the end of each conveyor branch. When intake is located exposed to weather, provide a rain hood.

2.11.8.5 Isolating Valves (Line Valves)

Provide an air operated, totally enclosed rotary slide gate isolating valve at each branch pipe line connection to prevent air flow through an unused branch line. Construct valve of abrasion resistant metal, machined and fitted to ensure a vacuum tight fit and guard against leakage and excessive maintenance. Provide purge air connection and a solenoid valve in the valve housing or cavity for purging the gate cavity of ash.

2.11.8.6 Silo Discharge Valve

Provide a rotary feeder for discharging bottom ash and fly ash from the ash silo. Feeders shall be of ductile iron or cast steel and shall be complete with motor, motor support, chain drive, and necessary guards. Chain shall be driven through a torque limiting clutch on the driven sprocket equipped with electric cutout switch and alarm.[Feeder shall have spring-loaded hinged bypass plate to permit passage of clinkers.] Inlet and outlet flanges shall be standard drilled pipe flange. Rotor blades and sealing arrangement shall be the manufacturer's standard for the intended service. When rotors are equipped with adjustable tips, provide a service door in the valve body for tip adjustment. Provide packing gland type shaft seals with suitable packing materials. Shaft bearings shall be outboard sealed ball bearings. Periphery seals shall be such that a complete seal is accomplished at a differential of [_____] Pa inches of water static pressure.

2.11.9 Ash Conveyor Pipe and Fittings

Abrasion resistant cast iron alloy free of blowholes and other defects and suitable for use in ash conveying systems.

2.11.9.1 Conveyor Piping

Centrifugally cast, abrasion resistant cast iron alloy pipe with a Brinell hardness of not less than 280.

2.11.9.2 Elbows and Fittings

Cast iron alloy with a Brinell hardness of not less than 350 and shall have renewable wearbacks not less than 25 mm one inch thick.

2.11.9.3 Hangers and Supports

Provide adjustable roller supports and pipe hangers to properly support the pipe. System supplier shall design support system and furnish supports.

2.11.9.4 Contractor's Option

At the Contractor's option, conveyor pipe handling only fly ash may be Schedule 80 black steel pipe in lieu of the iron alloy pipe; however outlet fitting, elbows, tees and laterals shall be iron alloy with wearbacks. Pipe for a distance of one meter 3 feet after the cast iron alloy fittings shall be cast iron alloy pipe. Provide pipe with couplings or split flanges, bolts and gaskets all rated not less than 538 degrees C 1000 degrees F.

2.11.9.5 Expansion Joints

Stainless steel bellows type with abrasion resistant liners of a Brinell hardness not less than 350 or slip tube expansion joints fabricated of cast iron alloy, of Brinell hardness not less than 280, machined for smooth sliding fit with its mating part to absorb system thermal movement and shock loads.

2.11.10 Vacuum Air Piping

Provide from the secondary separator to the tertiary bag filter and from the tertiary bag filter to the [steam exhauster] [mechanical exhauster] not less than 10 gage, ASTM A211, spiral welded, vacuum air piping with ASTM A1011/A1011M, standard radius, mitered 10 gage elbows.

2.11.11 Compressed Air Piping and Accessories

Provide pressure reducing valves, safety valves, pressure gages, manual plug or ball valves, compressed air piping, as specified under the paragraph PIPING and other items required for a complete, operable, pneumatic system.

2.11.12 Primary Ash Receiver-Separator and Secondary Ash Separator

Provide on top of ash silo two stages of receiving and separating, with each stage a complete self-contained unit with efficient dust and air separation and gravity dump bottom gates to open with interruption of vacuum and discharge into a silo. Design system so that suction is positively shut off from receiver during its dumping period, so that no dust can be sucked out through exhaust while discharge of the receiver is open or opening. Air from the primary receiver shall enter the external secondary separator which shall remove approximately 85 percent of the dust not collected by the primary receiver. Combined efficiency of primary and external secondary separators shall be not less than 95 percent. Provide completely contained gate assemblies in a dust-tight enclosure fitted with access doors large enough to remove the entire gate assembly. Provide receivers of hard abrasion-resistant cast alloy iron with a Brinell hardness of not less than 500 constructed as specified below:

2.11.12.1 Primary Receiver-Separator

Not less than [914] [1219] mm [36] [48] inches inside diameter with cast sections 19 mm 3/4 inch thick and 50 mm 2 inch thick impingement section. Cylinder, along with discharge hopper shall be of segmental bolted construction. Construct receiver to ensure dropping of maximum quantity of solids from transporting air. Provide carbon steel outlet pipe and discharge gate. Receiver-separator shall have an internal baffle assembly to prevent reentrainment of ash.

2.11.12.2 Secondary Separator

Not less than [406] [508] [610] mm [16] [20] [24] inches inside diameter of not less than 8 mm 5/16 inch thick one piece construction with at least 13 mm 1/2 inch thick inlet wear section. Design receiver to minimize carryover of fly ash into the [air washer] [tertiary bag filter]. Separator shall have an internal baffle assembly to prevent reentrainment of ash once it has fallen into the collection hopper of the separator.

2.11.12.3 Dusttight Enclosure

Support primary and secondary receivers on not less than 6 mm 1/4 inch thick, dust tight, carbon steel support boxes with hinged access doors or removable panels on each side for servicing the receiver swing gates. Provide support box with airtight roller bearings, hinged, counterweighted swing gates with removable neoprene seals. Gates may as an option, be air cylinder operated gates in lieu of the counterweighted gates.

2.11.13 Mechanical Exhausters

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NOTE: When environmental restraints, availability of steam or water or economics preclude the use of steam exhausters, use a mechanical (electrical driven) exhauster with a pulse jet bag filter to produce the required system air flow.

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Provide two, V-belt drive, positive displacement, blowers with electric motors and accessories with each capable of producing a vacuum of at least 41 kPa 12 inches of mercury and with air flow necessary for handling ashes through the system. One blower (exhauster) shall be used as a prime mover and the other as a standby unit.

2.11.13.1 Isolation Gates

Each exhauster shall include a manual bolt-up type gate for isolation and crossover. Gates shall include limit switches for status indication.

2.11.13.2 Accessories

Exhauster shall be complete with belt guard, air inlet silencer, air discharge snubber, support stand, expansion joint on inlet and outlet, belt and shaft guards, high temperature safety switch and vacuum relief valve.

2.11.13.3 Electric Motor

Totally enclosed, fan cooled, [_____] volts, three phase, 60 Hz as specified in the paragraph MOTORS AND DRIVES.

2.11.13.4 Noise Level

Not to exceed 85 dBA sound pressure level at 1.50 meters 5 feet above the floor and 1.50 meters 5 feet from blower in any direction.

2.11.14 Pulse Jet Self-Cleaning Bag Filter Assembly

Provide as a tertiary means of removing fine ash particles from the conveying air system. Installation of the assembly shall be on the silo roof, downstream of the two-stage cyclone type mechanical separator so as to permit a combined minimum separating efficiency of 99.5 percent (by weight), with a guaranteed outlet emission less than 0.005 grains particulate per dry standard cubic foot of exhaust air. Filter assembly shall include a main housing, bag assemblies, bag cleaning mechanism, discharge gate and control panel. Equipment shall be integrated with cyclone type separators, vacuum breakers, vacuum switches and conveying system controls as specified elsewhere. Bag filter shall be capable of operating at 25 percent above the system design vacuum. Filter housing shall be capable of withstanding a vacuum of 96 kPa 28.5 inches of mercury.

2.11.14.1 Cloth Area

Size filter on the basis of not greater than 25.40 L/s 5 acfm of air per square meter foot of cloth area. The acfm shall be calculated on the maximum system air flow.

2.11.14.2 Filter Construction

All welded construction housing or body of, ASTM A36/A36M plate with an upper clean gas plenum, bag compartment, hopper bottom, internal access platform and support structure. Plate thickness shall be a minimum of 6 mm 1/4 inch with exception of plenum tube sheet, which shall be a minimum of 13 mm 1/2 inch thick. Housing shall be cylindrical, having a minimum diameter of [_____] meters feet [_____] mm inches.

a. Upper Gas Plenum: Dished head, with flanged inlet and discharge connections, tube sheet, venturis and blow tubes. These appurtenances shall be welded airtight. Venturis shall be fabricated from carbon steel having a minimum thickness of 16 gage. Minimum centerline spacing between venturis shall be 191 mm 7 1/2 inches. A series of blow tubes shall be employed over the venturis. Each tube shall extend through dished housing wall and be manifolded externally. Include support of external manifold.

b. Bag Compartment: Of sufficient height to allow internal access by maintenance personnel. Base of compartment shall include metal platform supported by steel angle cross bracing. Platform shall extend over entire base area of compartment. Sidewall of compartment shall include a hinged access door with locking handle. Door shall be gasketed and opening shall be a minimum of 762 mm high by 406 mm wide 30 inches high by 16 inches wide.

c. Hopper Bottom: Conical having a slope angle of not greater than 45 degrees with a flanged outlet.

d. Access Platform: With [stairs] [ladder] and safety handrail for external mounting to filter housing. Mount platform at a height to allow convenient access through hinged door located on bag compartment sidewall. Platform floor area shall be not less than 1.40 square meter 15 square feet.

e. Provide filter housing with required columns and cross bracing to support structure from silo roof to discharge directly into silo. This support shall be of sufficient height to allow convenient installation of filter discharge gate.

2.11.14.3 Discharge Gate

Air cylinder operated swing disc type. A rotary feeder type gate is not acceptable. When in the open position, gate disc shall swing out of the path of material being discharged. Both gate disc and seal shall be replaceable. Include handhole on gate housing for easy access to both disc and seat.

2.11.14.4 Bag Cleaning Mechanism

Provide venturis, blow tubes, manifold, solenoid air valves, diaphragm valves and differential pressure switch conveniently located at the filter unit. Operation of these devices shall be on a sequential basis (adjustable setting) to allow periodic surges of compressed air through the filter venturi sections. Compressed air requirement for bag cleaning shall not be greater than 7.08 standard L/s at 690 kPa (gage) 15 scfm at 100 psig.

2.11.14.5 Filter Bag Assemblies

Each shall include the filtering media, wire retainer and stainless steel clamping device. Filter bag shall slide over retainer and both shall be clamped to the venturi by a stainless steel common band clamp. Top portion of retainer shall have the inside dimension equal to the mating venturi to ensure a tight fit.

a. Retainers: Cage type construction, fabricated from No. 1018 rounds or equal, using minimum of 3 mm 1/8 inch diameter rounds on vertical strands and 5 mm 3/16 inch diameter rounds on horizontal strands. Coat retainer with nickel and zinc after completion of fabrication.

b. Filter Bags: Not less than 474 g per square meter 14 ounces per square yard felted material. Provide felted polyester or dacron bags when operating temperatures are below 135 degrees C 275 degrees F. Provide Nomex bags or bags of similar abrasion and temperature resistant qualities when temperatures are above 135 degrees C 275 degrees F but not greater than 218 degrees C 425 degrees F. Bags shall have an exterior finish to aid in dust release.

2.11.14.6 Control Panel

NEMA 4, wall mounted control panel to sequentially control bag cleaning and dump operations of the filter unit. Locate panel near filter unit to permit easy field adjustment of sequence timers. Panel overall dimensions shall be not less than 610 mm wide by 762 mm high by 200 mm deep 24 inches wide by 30 inches high by 8 inches deep. As a minimum, panel instrumentation shall include a dump cycle timer, pulse valve sequence timer, two high differential pressure delay relays, alarm relay, time delay relay, manual/auto selector switch, pulse valve "ON" indicating light, high differential indicating light, terminal blocks and internal wiring. Welds and scratches of panel enclosure shall be polished smooth and thoroughly cleaned before painting. Surface finish shall be free from blemishes. Paint panel exterior with manufacturer's standard enamel. Interior of panel shall be white enamel. Shop inspect panel and test prior to shipment.

2.11.14.7 Vacuum Breakers

Provide two air cylinder operated vacuum breakers. One shall be a pop-up or single ported type for installation in the air line between the secondary separator and tertiary bag filter. Second breaker shall be a three-ported type for locations in the air line between the tertiary bag filter and the exhauster. Each breaker shall use a disc type gate or equivalent to ensure full closure of the gate against its mating seat.

2.11.15 Steam Exhauster

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NOTE: The steam exhauster system requires 0.32 kg os stream per second 2500 pounds of steam per hour for a 150 mm 6 inch system (8 to 23 Mg 9 to 25 tons per hour) and 0.44 kg of steam per second 3500 pounds of steam per hour for an 200 mm 8 inch system (13.60 to 31.75 Mg 15 to 35 tons per hour) and approximately 1.89 L/s 30 gpm of water to the air washer. A steam condenser, air washer and silencer should be used when the steam exhauster is used and should not be used when a mechanical exhauster is specified.

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Provide a steam jet exhauster of cast iron construction with venturi throat of the high efficiency type for producing the vacuum necessary for handling ashes through the system. Make inlet air connection on the steam jet exhauster through a special spiral fitting so that air enters the exhauster unit tangentially, avoiding direct impingement on the nozzle. Provide a unit capable of producing a vacuum of at least 40.56 kPa 12 inches of mercury column at shutoff and not requiring more than [0.32] [0.44] kg of steam per second at 690 kPa (gage) [2,500] [3,500] pounds of steam per hour at 100 psig.

2.11.15.1 Steam Condenser, Air Washer and Silencer

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NOTE: The steam exhauster system requires 0.32 kg of steam per second 2500 pounds of steam per hour for a 150 mm 6 inch system (8 to 23 Mg 9 to 25 tons per hour) and 0.44 kg of steam per second 3500 pounds of steam per hourfor an 200 mm 8 inch system (13.60 to 31.75 Mg 15 to 35 tons per hour) and approximately 1.89 L/s 30 gpm of water to the air washer. A steam condenser, air washer and silencer should be used when the steam exhauster is used and should not be used when a mechanical exhauster is specified.

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Provide a double stage cyclone type steam condenser, which also extracts the remaining solids from the steam-air system. Construct steam condenser body of hard metal castings not less than 16 mm 5/8 inch thick suitable for this special service except that inlet connector shall be not less than 19 mm 3/4 inch thick. Castings shall have a Brinell hardness of not less than 250. Remaining metal used in the condenser shall be at least 6 mm 1/4 inch thick steel with the top not less than 13 mm 1/2 inch thick steel plate. Provide drain connection not less than 76 mm 3 inches and water connection not less than 38 mm 1 1/2 inches. Provide silencer as required for quiet operation.

2.11.16 Ash Storage Silo

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NOTE: Use enclosure for silo roof and unloader level in climates where protection of equipment and personnel from the weather is desired.

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[_____] meters feet in diameter with [_____] meters feet high walls with a live bottom and flyash storage capacity of not less than [_____] Mg tons, based on ash bulk density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing. Structural joints shall be dusttight and watertight. Provide columns, beams, bracing, and other structural members as required for complete erection of silo and accessories. Live storage capacity shall allow for 20 degree angle of repose from silo outlet. Height of silo storage shall not be more than twice the diameter. Provide a minimum of one meter 3 feet of freeboard above the ash level. Design of support steel shall be approved by the ash system supplier. Design silo in accordance with the ICC UBC. Design shall take into account seismic load, wind load, snow load, equipment loads and an ash bulk density of 1120 kg per cubic meter 70 pounds per cubic foot. Ash silo support shall be free standing and shall be of sufficient height to allow gravity discharge of ash through the rotary ash conditioner to a [truck] [railroad car]. Provide access stair tower with intermediate platforms at 3.66 meters 12 feet intervals for access to ash conditioner level, silo floor level and silo roof level. Platforms from adjacent structures with stair access may be provided in lieu of the stair tower, but ladders with safety cages and access platforms must then be also provided. Provide ladder with stainless steel fall prevention device on inside of silo from manhole in top of silo to bottom of silo.[Provide silo roof enclosure and unloader room enclosure each with single one by two meters 3 by 7 feet access door, [_____] by [_____] meters feet double door, two windows, ventilator, [heater,] insulated metal panel siding to match boiler plant walls and electrical lighting and convenience receptacles. Unloader room enclosure shall have reinforced concrete floor.]

2.11.16.1 Construction

Construct silo of steel with refractory lining or of concrete staves with steel hoops and concrete roof. Roof accessories shall include manhole, relief valve and vent filter. Bottom of silo shall be [conical, sloped a minimum of 45 degrees] [flat with a steel plate feeding hopper in bottom of silo to funnel the ash into the inlet of the rotary vane feeder]. Provide hopper with expansion joints and sufficient poke holes with cover or cap.

2.11.16.2 Concrete Stave Silo

Construct of either lightweight solid or hollow precast concrete staves with post-tensioned steel reinforcing hoops around the exterior. Mechanically measure and mix materials in concrete staves. Vibrate and shape staves under pressure and steam or air cure.

a. Wall Coating: Coat interior surface with a three-step process of a brush coat, scratch coat, and finish trowel coat of a mixture of fine sand and portland cement in accordance with silo manufacturer's recommendations. Apply each coat successively to produce a smooth interior surface. Work mixture into the formed horizontal and vertical grooves to permanently interlock the concrete staves. Brush coat the exterior surface with a double application of waterproof mixture. Mixture shall include a chemical agent for waterproofing and portland cement, sand, and water. Work coating into joints and over the steel reinforcing hoops to form a weatherproof protective coating.

b. Steel Reinforcing Hoops: Galvanized steel rods not less than 14 mm 9/16 inch in diameter with not less than 16 mm 5/8 inch rolled threads. Join hoop ends together with nuts and heavy malleable galvanized iron lugs or heavy duty galvanized steel lugs to a close tolerance for a tight fit. Electrogalvanize rods, nuts, and lugs to ensure adequate protection against corrosion. Rods shall be high quality, metallurgically sound steel with tensile strength not less than 448 MPa 65,000 pounds per square inch, yield point not less than 276 MPa 40,000 pounds per square inch, and a minimum elongation of 14 percent in 229 mm 9 inches. Reinforcing shall be sufficient to resist maximum lateral pressure and loads imposed by ash pressure within the silo. Structurally connect together hoop rods that pass through silo outlets on inspection frames.

c. Hollow Concrete Stave Silos: Construct silo of precast concrete staves with lateral air spaces. Cast staves from a well proportioned mix of portland cement and an expanded clay light weight aggregate. Minimum compressive strength of concrete at 28 days shall be 34.50 MPa 5,000 psi. Hollow staves shall be 92 mm thick by 250 mm wide by 762 mm long 3 5/8 inches thick by 10 inches wide by 30 inches long with five lateral air cores per stave, except that shorter starter staves may be used to permit horizontal joints to be staggered.

d. Solid Concrete Stave Silos: Construct silo of solid lightweight precast concrete staves. Solid staves shall be not less than 92 mm thick and 250 mm wide by 762 mm long 3 5/8 inches thick and 10 inches wide by 30 inches long, except starter staves may be shorter. Solid staves shall be constructed from a well proportioned mix of portland cement, washed sand and gravel which is free from injurious organic impurities and contains less than 5 percent of deleterious substances. Grade aggregate from coarse to fine. Compressive strength of solid concrete staves at 28 days shall be 34.50 MPa 5,000 psi.

2.11.17 Bag Filter Vent

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NOTE: Consult the manufacturer of ash handling equipment for venting requirements.

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Provide pulse jet bag filter vent for silo constructed of 10 gage steel plate, fitted with rain hood. Bag material shall be sateen cotton capable of withstanding not less than 91 degrees C 195 degrees F, weighing 0.33 kg per square meter 9.75 ounces per square yard, having thread count of 4 by 2 per square mm 96 by 60 per square inch and permeability of 76 to 102 L/s per square meter at 249 Pa 15 to 20 cfm per square foot at one inch water column. Vent shall have not less than [_____] square meter feet effective cloth filtering area, with each bag having a maximum effective cloth filtering area of 0.56 square meter 6 square feet.

2.11.18 Rotary Ash Conditioner (Unloader)

Provide a complete dustless horizontal, floor mounted unloading device to discharge ashes from silo to a [truck] [railroad car]. Unloader (ash conditioner) shall include a 762 mm 30 inch diameter revolving drum which rotates about fixed spray nozzles, and shall be complete with conditioner and discharge compartments, scrapers, and other accessories as required. Unloader drum shall be constructed of steel plate not less than 10 mm 3/8 inch thick and shall be roller chain driven by a totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz electric motor not less than 3.75 kW 5 hp as specified in the paragraph MOTORS AND DRIVES. Unloader shall discharge conditioned ashes to a truck through a 6 mm 1/4 inch thick steel plate chute. Unloader shall be designed to eliminate most dust in unloading ash from the ash silo. Unloaders that utilize screws as a means of mixing are not acceptable. Dustless unloader shall add water to ash, but not to the extent that there is free or surplus water running or dripping from the ash after discharge. Discharge ash shall be in a semi-fluid, loose, free flowing condition.

2.11.19 Fluidizing System

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NOTE: Delete fluidizing system if not necessary.

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Provide a fluidizing system on the silo floor to ensure a constant and uniform feed of ash through silo discharge outlet. System shall consist of a series of diffuser modules, a conical diffuser hood, designed to support the total weight of ash when the silo is full, and compressed air piping. Each diffuser module shall be mounted on the silo floor using sloped concrete pads. System shall operate from plant air system. Provide pressure reducing valves, safety valves, and controls for a complete system.

2.11.20 Control Panel and Controls

Provide a semi-automatic control system for the ash handling system[as indicated].

2.11.20.1 General

Provide a centrally controlled operation, with auxiliary local operation, and a monitoring control system with graphic display for the ash conveying system. Provide local control stop-start pushbuttons and indication stations for [clinker crusher and ash hopper vertical lift door at each bottom ash hopper] [mechanical exhausters] and rotary ash conditioner. Ash handling system manufacturer shall provide measuring devices, status switches, solenoid vales, and auxiliary parts necessary to safely control and operate the system. Provide related electrical work required to operate the ash handling system.[Provide detailed control logic diagrams from ash handling system manufacturer to the manufacturer of the digital process control and data acquisition system.]

2.11.20.2 Control Panel

Provide a [separate control panel] [subpanel mounted in the main plant control panel] of NEMA 12 construction, centrally located in the main plant control room. Panel front shall include a system graphic display as indicated. Display shall be approximately to scale and painted with an industrial acrylic enamel. Outline items with 3 mm 1/8 inch wide black lines. Lettering shall be on engraved plastic screwed to front of panel, with white letters on a black background. Provide controls for operation on [_____] volt, [_____] phase, 60 Hz ac. Panel shall be complete with an annunciator and interlocks, relays, switches, running and safety lights, and auxiliary parts necessary to safely control and operate the system. Items located in the door shall be dusttight and oil tight with push-to-test transformer type indicating lights. Control relays shall be 10 amp, 600 volt class with convertible contacts. Provide and mark terminals for connections with the exception of the neutral. Panel shall contain [_____] percent spare terminals. Wiring shall be No. 14 AWG type THHN stranded. Neutral wire shall be white and remaining wiring of 120 volts or less shall be color coded and labeled. Provide a plastic wire duct of sufficient size to provide [_____] percent cross sectional spare. Wiring shall be in accordance with requirements of NFPA 70.

a. Provide capability to perform the following functions from the ash handling system control panel[operator interface console].

    (1) System Start

    (2) System Stop

    (3) Auto/Manual/Index Mode of Operation Selection

    (4) Selection of Bypass of any Boiler [Bottom Ash,] [Siftings,] [Economizer] Hoppers

    (5) Manual Index to any Intake

    (6) Selection of Ash Silo for Baghouse Ash

b. Provide sensors or contact closures for status indication on the ash handling system control panel annunciator[operator interface console].

    (1) Conveyor On

    (2) Unit on (one required for each unit)

(3) Final Line Purge On/Complete

(4) Baghouse Ash to Ash Silo

c. Provide sensors such that the following items can be alarmed on the ash handling system control panel annunciator[operator interface console].

[(1) Blower Failure

][(2) Blower High Temperature

] (3) Bag Filter Failure

(4) Bag Filter High Differential

(5) Bag Filter Off

(6) Plugged Hopper

(7) Conveying Complete

[(8) Clinker Crusher Abnormal Shutdown
(a) 1 required for each boiler)

] (9) Low Conveying Air

(10) High Conveying Vacuum

d. Vacuum Transmitter: To measure conveying system vacuum. Range shall be zero to 101 kPa 30 inches mercury with 4 to 20 mA dc linear transmitter output. Display vacuum on the ash handling system control panel[operator interface console].

2.11.20.3 Operation

a. Normally operated in the automatic mode. Automatically sequence through the automatic intakes except [clinker crusher] [bottom ash intake] for each boiler after system is started. When a unit is not in operation, selecting the "bypass mode" shall cause intakes on that unit to be skipped. For manual operation, "index" is used to select the desired intake. As conveying system shuts down automatically, main conveyor line shall be purged for approximately one minute to remove ash remaining in it.

b. Sequence system under control of vacuum switches and timers. Maximum vacuum will be when system is conveying material. When a hopper is empty, vacuum will drop and a "no load" vacuum switch shall cause system to shift to the next intake. Prevent premature sequencing due to momentary low vacuum with a timer. When a plugged hopper occurs, vacuum will be between "no load" and normal value. Provide a timer to allow packed or arched material to break loose before alarming the condition.

c. Provide solenoid air valves for each air operated device, timers, contactors, relays and devices and equipment required for system control, measuring and operation. Identify each device with an engraved plastic identification plate[in accordance with a system graphic display] to be provided by the ash handling system supplier.

d. Bottom Ash Hopper Local Control Stations: Provide a wall mounted, NEMA [_____], control station at each bottom ash hopper with front access door, lock, circuit breakers, selector switches, lights and pushbuttons.

(1) Selector Switches:

(a) Crusher: three position switch, "Reverse (momentary)-Off-Forward"

(b) Rotary Valve Intake: two position switch "Open-Close"

(c) Vertical Lift Door: position switch "Open-Intermediate-Close"

(2) Emergency "Stop" Pushbutton, for clinker crusher, with manual reset.

(3) Indicating Lights:

(a) "On-Manual"

(b) "Crusher Stalled"

[2.12 ASH HANDLING SYSTEM (MECHANICAL)

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NOTE: Designer shall select type of ash handling system most suited for each project. For plants over 4 kg per second 31,500 pounds per hour steam ultimate capacity use a pneumatic ash handling system. For plants under 4 kg per second 31,500 pounds per hour steam ultimate capacity use a mechanical system. Refer to NAVFAC Design Manual DM-3.6, Section 5, paragraph 4d for design criteria.

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NOTE: Choose this article, paragraphs and subparagraphs or the article, paragraphs and subparagraphs above ASH HANDLING SYSTEM (PNEUMATIC).

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NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine the degree of sophistication of the mechanical ash handling system. Preference should be given to keeping the system as simple as possible. An example of this would be an arrangement where the plant would not require an ash silo and ash is simply removed by the operators raking the ash pits and shoveling the ash into wheeled dumpsters for removal. Mechanical collector hoppers would have ash removed by means of rotary airlock valves dumping through chutes into additional wheeled covered dumpsters. For greater ash removal rates screw conveyors could be used for removing ash from the stoker ash pits. These could convey ash to wheeled ash dumpsters or into a drag

conveyor, bucket elevator, ash silo system.
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Provide a complete integrated, mechanical, semi-automatic, ash handling system with chain drag conveyor, screw conveyors, bucket elevator, material intakes, rotary valves,[ash doors and enclosures,] silo vent filter, ash silo, rotary ash conditioner, and other equipment that may be necessary for a complete mechanical ash handling system. Provide related electrical work required to operate the ash handling system.

2.12.1 Ash Silo

The system shall receive, and convey to the ash silo, ash from the stoker fired boiler ash storage pits, [economizer hoppers,] [baghouse hoppers,] and other pollution control equipment hoppers.

2.12.2 Ash

Discharge ash into the ash storage silo in a dry condition. Arrange silo equipment for disposal of conditioned ash to trucks. Operation shall be as dustless as possible.

2.12.3 Maximum Noise Level

Noise level of operation shall not exceed 85 decibels sound pressure level 1.50 meters 5 feet from the equipment in any direction.

2.12.4 System Valving

2.12.4.1 Rotary Valves

Provide rotary valve feeders of carbon steel construction complete with drive, guard, motor mount and gaskets, carbon steel adjustable blade tips, adjustable shoe type air seal and right angle gearhead drive motor. Rotor blade tips and shoes shall have a minimum Brinell hardness of 500. Valves requiring part of the housing to form an airlock seal are not acceptable. The electric motor for the rotary valve feeders shall be totally enclosed, fan cooled, [_____] volt, [_____] phase, 60 Hz., and not less than [_____] kW hp, as specified in the paragraph MOTORS AND DRIVES.

2.12.4.2 Manual Valve Intakes for Bottom Ash

Provide in front of stoker ash pit doors, a 610 by 610 mm 24 by 24 inch cast iron grid and hopper with opening approximately sized for the conveyor. Provide intake with dusttight, removable 6 mm 1/4 inch thick checkered steel plate cover.

2.12.4.3 Silo Discharge Valve

Provide a rotary feeder for discharging bottom ash and fly ash from the ash silo. Feeders shall be of ductile iron or cast steel and shall be complete with motor, motor support, chain drive, and necessary guards. Chain shall be driven through a torque limiting clutch on the driven sprocket equipped with electric cutout switch and alarm.[Feeder shall have spring-loaded hinged bypass plate to permit passage of clinkers.] Inlet and outlet flanges shall be standard drilled pipe flange. Rotor blades and sealing arrangement shall be manufacturer's standard for the intended service. When rotors are equipped with adjustable tips, provide a service door in body of valve for tip adjustment. Provide packing gland type shaft seals with suitable packing materials. Shaft bearings shall be outboard sealed ball bearings. Periphery seals shall be such that a complete seal is accomplished at a differential of [_____] Pa inches of water static/pressure.

2.12.5 Conveyors

2.12.5.1 Chain Drag Conveyor

Provide with endless chain for dragging coal ashes from front of boilers along a recessed trough to the inlet chute of a bucket elevator. Conveyor shall have [_____] meter feet sprocket centers, operate at speed not greater than 35 mm/sec 7 fpm, and have a capacity of not less than [_____] Mg tons per hour of 640 kg per cubic meter 40 pounds per cubic foot ash. Provide conveyor complete with continuous chain, drive, and take up terminals, gears, shafts, bearings, return rolls, hard white iron trough, ash intake gratings, floor plates, discharge chute, electric motor, reduction gear, and supports.[Chain drag conveyor shall be designed for future length of [_____] meters feet.]

a. Head and Foot Shafts: Provide SAE-1045, steel head and foot shafts not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively, mounted in anti-friction roller bearings in pillow blocks. Foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

b. Terminal Sprockets: Gray iron chilled rim not less than [_____] mm inches in diameter with solid web and not less than eight teeth each.

c. Chain: Combination drag type of riveted construction. Design chain symmetrically so that it can be turned over after one side is worn. Chain shall be [_____] mm inches wide with a pitch not greater than 200 mm 8 inches and an ultimate strength of not less than [187] [249] kN [42,000] [56,000] pounds. Construct chain of promal, a pearlitic malleable iron, center links not less than [_____] mm inches high, and heavy [_____] mm inch thick heat treated carbon steel side bars. Steel pins shall be cold rolled steel not less than [_____] mm inch in diameter, press-fitted into sidebars, and machined flat on one side to prevent rotation. Center section shall be rugged block type forming a rigid rectangle for maximum resistance to distortion with broad wearing shoes contoured to prevent snagging and damage to chain or trough. Barrels of center section shall be chambered to provide lubricant reservoir and still provide maximum bearing area for pins. Shape barrel with pushing surface on one side and for contact with sprocket on the other side.

d. Trough: Concrete lined with not less than [_____] mm inch thick hard white iron approximately as indicated. Trough shall be [_____] mm inches wide with hinged 6 mm 1/4 inch thick checkered steel plate covers. Covers shall be installed to be dusttight. Coordinate concrete work with conveyor manufacturer's requirements.

e. Return Rollers: Chilled rim, single flange, enclosed-oiling type on [_____] mm inch diameter carbon steel shafts spaced at not more than 3 meters 10 feet apart.

f. Discharge Chute: Construct of not less than 10 mm 3/8 inch steel plate and slope at not less than 60 degrees.

g. Electric Motor and Drive: Totally enclosed, fan cooled, high torque, [_____] volt, [_____] phase, 60 Hz not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES, in this section, direct connected by means of flexible coupling to a reduction gear unit having alloy steel helical or herringbone gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear. Drive, from output shaft of reduction gear to conveyor head shaft, shall be by means of finished steel roller chain running over cut tooth sprockets complete with steel plate chain guard. Roller chain, sprockets and roller chain attachments shall conform to ASME B29.100.

2.12.5.2 Screw Conveyors

Provide each screw conveyor dusttight and furnished complete, with trough, screw, inlet and discharge spouts, discharge gates, bearings, bearing hangers, dust cover, electric motor, reduction gear,[service platform,] and supports. Each screw conveyor shall meet the following minimum design and performance specifications when handling dry flyash of density not greater than [_____] kg per cubic meter pounds per cubic foot:

	CONVEYOR NO. 1	CONVEYOR NO. 2
Capacity	[_____] Mg/hr	[_____] Mg/hr
Screw diameter	[_____] mm	[_____] mm
Length	[_____] meters	[_____] meters
Coupling diameter	[_____] mm	[_____] mm
Motor horsepower	[_____] kW	[_____] kW
Screw flight thickness	[_____] mm	[_____] mm
Trough thickness	[_____] mm	[_____] mm
Trough cover thickness	[_____] mm	[_____] mm
Trough end plate thickness	[_____] mm	[_____] mm
Maximum speed	[_____] rpm	[_____] rpm

	CONVEYOR NO. 1	CONVEYOR NO. 2
Capacity	[_____] tons/hr	[_____] tons/hr
Screw diameter	[_____] inches	[_____] inches
Length	[_____] feet	[_____] feet
Coupling diameter	[_____] inches	[_____] inches
Motor horsepower	[_____] hp	[_____] hp

	CONVEYOR NO. 1	CONVEYOR NO. 2
Screw flight thickness	[_____] inches	[_____] inches
Trough thickness	[_____] inches	[_____] inches
Trough cover thickness	[_____] inches	[_____] inches
Trough end plate thickness	[_____] inches	[_____] inches
Maximum speed	[_____] rpm	[_____] rpm

a. Inlet and Discharge Spouts: Arrange as indicated. Spouts shall be flanged and square with opening dimensions equal to inside diameter of trough.

b. Screw Trough: Provide dusttight screw trough with trough covers. Support trough by 6 mm 1/4 inch thick steel plate feet at not less than 3 meter 10 foot intervals. Individual trough sections shall not be greater than 3 meters 10 feet long with steel angle end flanged connections.

c. Bearings and Hangers: Provide thrust bearings and trough end dust seals for both drive and tail bearings. Thrust bearings shall be bronze in antifriction pillow blocks. Screw hanger bearings shall be babitted-type, with cast iron hangers having removable bearing caps held in place by a U-bolt. Design hangers to fit inside the conveyor trough and equip bearings for grease lubrication with grease fittings penetrating dust cover to allow bearings to be greased without removing dust cover. Hangers shall not be located at trough joints, feed, or discharge openings. Locate hangers at not less than [3.66 meter 12 foot intervals for screw diameters larger than 250 mm 10 inches][and][3 meter 10 foot intervals for screw diameters 250 mm 10 inchesin diameter and smaller].

d. Conveyor Screws and Couplings: Construct conveyor screws of helocoid-type flights and connect with cold rolled steel couplings. Assemble conveyor screws so that at the hangers there is 180 degrees rotation between flight ends of each adjacent screw section. Screw flight shall end over last discharge spout so bare pipe extends across this area to prevent material carry-over.

e. Electric Motor: Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES. Install motor at discharge end of conveyor. Motor shall be supported by a unit bracket attached to the screw conveyor trough end plate and connected to reduction gear through a V-belt drive. Reduction gear shall be shaft mounted, double reduction type mounted directly on the conveyor shaft. Provide tie rods, when required, to prevent reduction gear rotation and for adjusting belt tension.

f. Service Platforms: Conform to OSHA regulations as indicated to properly maintain and service conveyor drive unit.

2.12.6 Bucket Elevator

Provide a dusttight bucket elevator centrifugal discharge type, having approximately [_____] meters feet [_____] mm inch sprocket centers, vertical chain and bucket, operating at a speed not to exceed [_____] m/s fpm, and having a capacity of not less than [_____] Mg tons per hour of 640 kg per cubic meter 40 pounds per cubic foot ash. Provide bucket elevator complete with continuous chain and attached buckets, sprockets, gears, shafts, bearings, casing, top hood, discharge spout, bottom boot, access doors, electric motor, reduction gear, service platform, and accessories.

2.12.6.1 Head and Foot Shafts

Not less than [_____] and [_____] mm [_____] and [_____] inches in diameter, respectively. Construct shafts of cold rolled steel and mount in antifriction roller bearings with forced lubricating type fittings. Mount foot shaft in fixed pillow blocks. Head shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.12.6.2 Terminal Sprockets

Cast iron with chilled rims. Head sprocket shall be not less than [_____] mm inches in diameter and foot sprocket not less than [_____] mm inches in diameter.

2.12.6.3 Buckets ands Chain

Construct buckets of malleable iron not less than 200 mm long, 127 mm wide, and 140 mm deep 8 inches long, 5 inches wide, and 5 1/2 inches deep. Buckets shall be mounted by not less than four bolt attachments to a single strand of steel bushed chain having an ultimate strength of not less than 178 kN 40,000 pounds and pitch of 100 mm 4 inches. Bucket spacing shall not be greater than 406 mm 16 inches.

2.12.6.4 Backstop

Differential band brake type to prevent reversal of chain and buckets in case of power failure.

2.12.6.5 Elevator Casing

Not less than 298 by 991 mm 11 3/4 by 39 inch internal dimension and constructed of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate with 50 by 50 by 6 mm 2 by 2 by 1/4 inch corner angles for full height of elevator casing. Fabricate casing in standard sections from 3 to 3.66 meters 10 to 12 feet high with 50 by 50 by 6 mm 2 by 2 by 1/4 inch angle flanges at the end of each section. Provide a hinged inspection door not less than 610 by 762 mm 24 by 30 inches in the section immediately above the boot section and where indicated. Casing and inspection doors shall be of dusttight construction with flange angles continuously welded and gasketed. No makeshift repairs or field patching to overcome leakage shall be permitted. Coat casing interior with not less than 1.60 mm 1/16 inch thick coal tar primer and enamel conforming to SSPC PS 11.01.

2.12.6.6 Head Section

Construct of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate in heavy angle frame with split, hinged, and removable top cover hood built of not less than 10 gage (3.42 mm 0.1345 inch) commercial hot rolled mild steel plate and flanged discharge throat built of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate. Design head section to support the drive machinery and head bearings. Provide access ladder and service platform conforming to applicable OSHA regulations as indicated for providing proper service and maintenance of elevator.

2.12.6.7 Boot Section

Construct of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate in heavy angle frame with curved and renewable bottom plate and renewable internal loading leg, both built of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate, and flanged inlet. Mount take-up and foot terminal bearing on one side of boot in a bolted removable side panel so foot shaft and sprocket may be removed through side of the door. Bolt end panels so they are removable for cleanout and inspection.

2.12.6.8 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified in the paragraph MOTORS AND DRIVES, direct connected by means of flexible coupling to a reduction gear unit having alloy steel herringbone or helical gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear unit. Drive, from the output speed shaft of the reduction gear to the elevator head shaft, shall be by means of finished steel roller chain running over cut tooth sprockets, complete with steel plate chain guard. Roller chain, sprockets, and roller chain attachments shall conform to ASME B29.100.

2.12.6.9 Anchoring Brackets

Provide steel brackets as indicated at intervals for anchoring elevator to increase rigidity.

2.12.6.10 Discharge Chute

Construct of not less than 10 mm 3/8 inch thick steel plate and attach to ash silo.

2.12.7 Ash Storage Silo

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NOTE: Use enclosures for silo roof and unloader level in climates where protection of equipment and personnel from the weather is desired.

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[_____] meters feet in diameter with [_____] meters feet high walls with a live bottom and flyash storage capacity of not less than [_____] Mg tons, based on ash bulk density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing. Structural joints shall be dusttight and watertight. Provide columns, beams, bracing, and other structural members as required for complete erection of silo and accessories. Live storage capacity shall allow for 20 degree angle of repose from silo outlet. Height of silo storage shall not be more than twice the diameter. Provide a minimum of one meter 3 feet of freeboard above the ash level. Provide support steel design approved by the ash system supplier. Design silo in accordance with ICC UBC. Design shall take into account seismic load, wind load, snow load, equipment loads and an ash bulk density of 1120 kg per cubic meter 70 pounds per cubic foot. Ash silo support shall be free standing and of sufficient height to allow gravity discharge of ash through the rotary ash conditioner to a [truck] [railroad car]. Provide access stair tower with intermediate platforms at 3.66 meters 12 feet intervals for access to ash conditioner level, silo floor level and silo roof level. Platforms from adjacent structures with stair access may be provided in lieu of the stair tower, but ladders with safety cages and access platforms shall then be also provided. Provide ladder with stainless steel fall prevention device on inside of silo from manhole in top of silo to bottom of silo.[Provide silo roof enclosure and unloader room enclosure each with single one by 2 meters 3 by 7 feet access door, [_____] by [_____] meter [_____] by [_____] feet double door, two windows, ventilator, [heater,] insulated metal panel siding to match boiler plant walls and electrical lighting and convenience receptacles. Unloader room enclosure shall have reinforced concrete floor.]

2.12.7.1 Construction

Construct silo of steel with refractory lining or of concrete staves with steel hoops and concrete roof. Roof accessories shall include manhole, relief valve and vent filter. Bottom of silo shall be [conical, sloped a minimum of 45 degrees] [flat with a steel plate feeding hopper in bottom of silo to funnel the ash into the inlet of the rotary vane feeder]. Provide hopper with expansion joints and sufficient poke holes with cover or cap.

2.12.7.2 Concrete Stave Silo

Construct of either lightweight solid or hollow precast concrete staves with post-tensioned steel reinforcing hoops around the exterior. Mechanically measure and mix materials in concrete staves. Vibrate and shape staves under pressure and steam or air cure.

a. Wall Coating: Coat interior surface with a three-step process of a brush coat, scratch coat, and finish trowel coat of a mixture of fine sand and portland cement in accordance with silo manufacturer's recommendations. Apply each coat successively to produce a smooth interior surface. Work mixture into the formed horizontal and vertical grooves to permanently interlock the concrete staves. Brush coat exterior surface with a double application of waterproof mixture. Mixture shall include a chemical agent for waterproofing and portland cement, sand, and water. Work coating into joints and over steel reinforcing hoops to form a weatherproof protective coating.

b. Steel Reinforcing Hoops: Galvanized steel rods not less than 14 mm 9/16 inch in diameter with not less than 16 mm 5/8 inch rolled threads. Join hoop ends together with nuts and heavy malleable galvanized iron lugs or heavy duty galvanized steel lugs to a close tolerance for a tight fit. Electrogalvanize rods, nuts, and lugs to ensure adequate protection against corrosion. Rods shall be high quality, metallurgically sound steel with tensile strength not less than 488 MPa 65,000 pounds per square inch, yield point not less than 276 MPa 40,000 pounds per square inch, and a minimum elongation of 14 percent in 229 mm 9 inches. Reinforcing shall be sufficient to resist the maximum lateral pressure and loads imposed by the ash pressure within the silo. Structurally connect together hoop rods that pass through silo outlets on inspection frames.

c. Hollow Concrete Stave Silos: Construct silo of precast concrete staves with lateral air spaces. Cast staves from a well proportioned mix of portland cement and an expanded clay light weight aggregate. Minimum compressive strength of the concrete at 28 days shall be 34.50 MPa 5,000 psi. Hollow staves shall be 92 mm thick by 250 mm wide by 762 mm long 3 5/8 inches thick by 10 inches wide by 30 inches long with five lateral air cores per stave, except that shorter starter staves may be used to permit the horizontal joints to be staggered.

d. Solid Concrete Stave Silos: Construct silo of solid lightweight precast concrete staves. Solid staves shall be not less than 92 mm thick by 250 mm wide by 762 mm long 3 5/8 inches thick and 10 inches wide by 30 inches long, except starter staves may be shorter. Solid staves shall be constructed from a well proportioned mix of portland cement, washed sand and gravel which is free from injurious organic impurities and contains less than 5 percent of deleterious substances. Grade the fine aggregate from coarse to fine. Compressive strength of the solid concrete staves at 28 days shall be 34.50 MPa 5,000 psi.

2.12.8 Pulse Jet Bag Filter Vent

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NOTE: Consult the manufacturer of ash handling equipment for venting requirements.

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Provide for the silo constructed of 10 gage steel plate, fitted with rain hood. Bag material shall be sateen cotton capable of withstanding not less than 91 degrees C 195 degrees F, weighing 0.33 kg per square meter 9.75 ounces per square yard, having thread count of 4 by 2 per square mm 96 by 60 per square inch and permeability of 76 to 102 L/s 15 to 20 cfm per square meter foot at 249 Pa one inch water column. Vent shall have not less than [_____] square meter feet effective cloth filtering area, with each bag having a maximum effective cloth filtering area of 0.56 square meter 6 square feet.

2.12.9 Rotary Ash Conditioner (Unloader)

Provide a complete dustless horizontal, floor mounted unloading device to discharge ashes from silo to a [truck] [railroad car]. Unloader (ash conditioner) shall include a 762 mm 30 inch diameter revolving drum which rotates about fixed spray nozzles, and be complete with conditioner and discharge compartments, scrapers, and other accessories as required. Unloader drum shall be constructed of steel plate not less than 10 mm 3/8 inch thick and shall be roller chain driven by a totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz electric motor not less than 3.75 kW 5 hp as specified in the paragraph MOTORS AND DRIVES. Unloader shall discharge conditioned ashes to a truck through a 6 mm 1/4 inch thick steel plate chute. Unloader shall be designed to eliminate most dust when in operation. Unloader may utilize screws as a means of mixing. Dustless unloader shall add water to ash, but not to the extent that free or surplus water is running or dripping from ash after discharge. Discharge ash shall be in a semi-fluid, loose, free flowing condition.

2.12.10 Fluidizing System

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NOTE: Delete fluidizing system if not necessary.

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Provide a fluidizing system on silo floor to ensure a constant and uniform feed of ash through the silo discharge outlet. System shall consist of a series of diffuser modules, a conical diffuser hood, designed to support the total weight of ash when silo is full, and compressed air piping. Each diffuser module shall be mounted on the silo floor using sloped concrete pads. System shall operate from the plant air system. Provide pressure reducing valves, safety valves, and controls for a complete system.

2.12.11 Control Panel and Controls

Provide a semi-automatic control system for the ash handling system[as indicated]. Provide a centrally controlled operation, with auxiliary local operation, and a monitoring control system with graphic display for the ash conveying system. Provide local control stop-start pushbuttons and indication stations for chain drag conveyor, screw conveyors, bucket elevator, and rotary ash conditioner. Ash handling system manufacturer shall provide measuring devices, status switches, solenoid valves, and auxiliary parts necessary to safely control and operate the system. Provide related electrical work required to operate the ash handling system.[Provide detailed control logic diagrams from ash handling system manufacturer to manufacturer of the digital process control and data acquisition system.]

2.12.11.1 Control Panel

Provide a [separate control panel] [subpanel mounted in the main plant control panel] of NEMA 12 construction, centrally located in the main plant control room. Panel front shall include a system graphic display as indicated. Display shall be approximately to scale and painted with an industrial acrylic enamel. Outline items with 3 mm 1/8 inch wide black lines. Lettering shall be on engraved plastic screwed to front of panel, with white letters on a black background. Provide controls for operation on [_____] volt, [_____] phase, 60 Hz ac. Panel shall be complete with an annunciator and interlocks, relays, switches, running and safety lights, and auxiliary parts necessary to safely control and operate the system. Items located in the door shall be dusttight and oil tight with push-to-test transformer type indicating lights. Control relays shall be 10 amp, 600 volt class with convertible contacts. Provide and mark terminals for connections with the exception of the neutral. Panel shall contain [_____] percent spare terminals. Wiring shall be No. 14 AWG type THHN stranded. Neutral wire shall be white and remaining wiring of 120 volts or less shall be color coded and labeled. Provide a plastic wire duct of sufficient size to provide [_____] percent cross sectional spare. Wiring shall be in accordance with requirements of NFPA 70.

a. Panel Devices: Control panel shall include the following indicating lights and color:

(1) Power - ON	red
(2) System Run (3 required)	
Chain drag conveyor to elevator	green
Screw conveyors to drag conveyor	green
Bucket elevator to silo	green
(3) Ash Silo - HI LEVEL	red

(4) Ash Silo - LOW LEVEL	red
(5) Silo Vent Filter - ON	green

b. Provide momentary contact pushbuttons or selector switches for the following:

   (1) System - START (3 required)
   Bucket elevator
   Chain drag conveyor
   Screw conveyors

   (2) System - STOP (red head)

c. Provide sensors such that the following items can be alarmed on an ash handling system control panel annunciator.

   (1) Ash silo - HIGH LEVEL

   (2) Bucket elevator - EMERGENCY SHUTDOWN

   (3) Screw conveyor - EMERGENCY SHUTDOWN

   (4) Chain drag conveyor - EMERGENCY SHUTDOWN

   (5) Silo vent filter - OFF

   (6) Plugged Hopper

d. Provide auxiliary devices required for the control functions above and laminated plastic name plates for devices on the panel front.

e. Provide local control panel for operating and indication of the rotary ash conditioner with the following functions:

   (1) Power - ON (red)

   (2) Water - ON/OFF

   (3) Ash feeder - ON/OFF

   (4) Rotary ash conditioner - START/STOP/JOG

   (5) Normal Stop

   (6) Wash out - START/STOP

   (7) Emergency Stop: Provide control panel mounted at grade level for remote operation of the rotary ash conditioner with the following functions:

      (a) Rotary ash conditioner - START/STOP

      (b) Normal stop

      (c) Emergency stop

]2.13 AIR POLLUTION CONTROL EQUIPMENT

****

NOTE: Mechanical cyclone collectors should be used for soot blowing and as a prefilter on baghouse fabric filters or electrostatic precipitators. The fabric filter should be used where necessary to meet local, state or federal regulations or statutes for particulate emissions, when sulfur emissions are within regional limits through the burning of low sulfur "compliance coal." When coal containing more than 2 percent sulfur is burned, an electrostatic precipitator is generally more economical for control of particulates than the fabric filters, if sulfur emissions will meet regional limitations. When sulfur emissions are not within the regional limits, a scrubber with a prefilter mechanical cyclone and possibly a baghouse filter may be required to meet the emission limitations.

****

2.13.1 Mechanical Cyclone Collectors

As specified in Section 23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES.

2.13.2 Fabric Filter Baghouse

As specified in Section 23 51 43.03 20 FABRIC FILTER DUST COLLECTOR OF FLYASH PARTICULATES IN FLUE GAS.

2.13.3 Electrostatic Precipitator Filters

As specified in Section 23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES.

2.13.4 Scrubbers

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

As specified in [_____].

2.14 MISCELLANEOUS EQUIPMENT

2.14.1 Condensate Receiver

Provide a [horizontal] [vertical] type tank not less than [_____] meters feet [_____] mm inches in diameter by [_____] meters feet [_____] mm inches [long] [high] overall with a storage capacity of not less than [_____] liters gallons. Tank shall be constructed of welded steel plate not less than 10 mm 3/8 inch thick. Provide condensate tank with a 610 mm 24 inch diameter manway, dual gage glasses with protective guards, saddles, and other connections as indicated.

2.14.1.1 Coating

Surface blast interior of tank to bare metal and coat with a bake-on phenolic lining or corrosion resistant liner consisting of a resin and hardener suitable for immersion in water at not less than 121 degrees C 250 degrees F. Coat exterior of tank with one shop coat of manufacturer's standard primer rated for service of not less than 121 degrees C 250 degrees F.

2.14.1.2 Accessories

Provide condensate receiver with the following:

a. Connections for condensate pumped return, vent, water outlet, drain, sampling outlet, level transmitter and controls.

b. [_____] mm inch vent.

c. Reflex type water gage glasses with shutoff valves and guards.

d. One, 125 mm 5 inch dial, thermometer, 10 to 149 degrees C 50 to 300 degree F range, with lagging extension type wells, for steam and water space.

e. [_____] mm inch overflow trap.

f. One high water alarm switch with stainless steel float and trim. Circuit shall close as liquid level rises. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of receiver.

g. One low water alarm switch with stainless steel float and trim. Circuit shall close as liquid level falls. Locate switch to close circuit when water level drops to 25 percent of the storage capacity of the storage tank.

h. Install switches on a single column with valved connections to tank. Provide unions in pipe on each side of each float switch.

i. Furnish pipe, fittings, controls, specialties, bolts, gaskets, drains, valves, necessary for a complete unit and install at jobsite.

j. Provide automatic control system to control level in condensate tank by modulating discharge from condensate pumps.

2.14.2 Deaerating Heater

Provide a deaerating feedwater heater with storage tank conforming to FS W-H-2904, except as modified below and to ASME BPVC SEC VIII D1. Tank shall be ASME Code stamped. Provide stainless steel trays. No test model will be required.

a. Model A - Pressurized operation.

b. Type I - Tray-type heating and deaerating element.

c. Class 3 - 10 minute water storage capacity (minimum).

d. Grade A - Guaranteed removal from water of all dissolved oxygen in excess of 0.005 cubic centimeters (cc) per liter 0.0012 cubic inches per gallon, over a ten to one load swing.

2.14.2.1 Heater Capacity

Provide deaerating heater capable of heating and deaerating makeup water consisting of [_____] kg per second pounds per hour of softened makeup water from [_____] to [_____] degrees C F (outlet temperature).

2.14.2.2 Inlet Water Characteristics

Softened makeup water:

a. Ph: [_____]

b. Total hardness (as CaC03): [_____]

2.14.2.3 Storage Tank

Horizontal design with steel supports[drilled for bolting] of approved design. Provide storage tank with not less than a 410 by 510 mm 16 by 20 inch minimum size manhole and cover and provide heater section with not less than a 300 by 460 mm 12 by 18 inch minimum size tray access handhole and door.

2.14.2.4 Vent Condensing Arrangement

Provide deaerating heater with a vent condenser which shall condense vented steam when heater is operating at full capacity with inlet water mixture at a temperature not exceeding 82 degrees C 180 degrees F. Construct vent condenser, when of the direct contact type, with stainless steel baffling.

2.14.2.5 Materials

Construct trays, tray supports, water distributors, and all other parts coming in contact with underaerated water or air laden steam of 430 stainless steel.

2.14.2.6 Accessories

Provide the deaerating heater with the following accessories:

a. Pressure Relief Valve: Sized in accordance with FS W-H-2904.

b. Thermometers: Two, 125 mm 5 inch dial thermometers, 10 to 149 degrees C 50 to 300 degrees F, with lagging extension type wells for the storage tank and heater section. Provide a thermometer similar to above but with range of minus [_____] degrees C F to plus [_____] degrees C F for the makeup water connection.

c. Lifting attachments for tray section and storage tank.

d. Water Gage Glasses: Reflex type with shutoff valve and guards.

e. Pressure Gages: One 150 mm 6 inch dial compound pressure gage for the heater section with range from [_____] kPa inches of mercury (vacuum) to [_____] kPa (gage) psig.

f. Float Controllers:

(1) Inlet condensate controller

(2) Makeup water controller

(3) Overflow controller

g. Overflow Control Valve: With pneumatic controller arranged for local automatic operation.

h. Storage Tank Gage Glass: Full height, shielded, for storage tank including shutoff valve and drain cocks.

i. Makeup Water Inlet Control Valve: With pneumatic controller.

j. Switches: For low water level alarm in the storage tank, high water level alarm, condensate pump shutdown in the storage tank, and low steam pressure alarm. Install switches on a single column with connections valved and unions provided in pipe on each side of each float switch.

k. Special Tools: One set for maintenance.

l. Condensate Pump Reset: With stainless steel float and trim to reset pump shutdown switch on fall of liquid level in tank to [_____] mm inches below level of overflow level of storage tank.

m. Furnish pipe, fittings, controls, specialties, bolts, gaskets, drains, and valves, necessary for proper attachment of accessories and trimmings and install.

[n. Oil separator

]2.14.2.7 Connections

Provide necessary connections for condensate, steam, makeup water, removal of vented gases, vacuum breakers, discharge of deaerated water, and instruments and controls.

a. Provide heater connections as follows:

(1) [_____] mm inch steam inlet

(2) [_____] mm inch makeup water inlet

(3) [_____] mm inch condensate

(4) [_____] mm inch high pressure trap return

(5) [_____] relief valves sized as required

(6) [_____] mm inch vent

(7) [_____] mm inch for thermometer well

(8) [_____] mm inch for pressure gage

(9) Vacuum Breakers: As required

(10) [_____] mm inch heater drain

(11) [_____] mm inch spare [capped] [flanged]

(12) [_____] mm inch spare [capped] [flanged]

(13) Handholes And Manhole: With covers

b. Tank connections shall include:

(1) [_____] mm inch drain

(2) [_____] mm inch boiler feed recirculation ([_____] required)

(3) 25 mm One inch sampling

(4) 25 mm One inch chemical feed

(5) [_____] mm inch for sight glass ([_____] sets required)

(6) [_____] mm inch for high and low level alarm switches

(7) [_____] mm inch thermometer well

(8) Vacuum Breakers: As required

(9) [_____] mm inch spare (capped)

(10) [_____] mm inch spare (flanged)

(11) [_____] mm inch level transmitter and controller ([_____] sets required)

(12) Downcomer And Equalizer: As required

(13) [_____] mm inch feedwater outlet

(14) [_____] mm inch overflow outlet with internal water seal

2.14.2.8 Level Control

Provide an automatic control system to control the water level in the storage tank, by modulating valves in the makeup water lines. Output of condensate pump shall be controlled by level in condensate storage tank.

a. Controllers: Provide external cage type air operated level controllers for both the condensate and makeup water lines complete with 40 mm 1 1/2 inch screwed connections, external cage, and controller. Cage body shall be Class 125 cast iron construction. Internal components including displacer, torque tube, displacer rod, displacer rod driver and bearings shall be 316 stainless steel. Displacer shall be 356 mm 14 inches long. Controller shall be direct acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band adjustment. Locate controller to maintain an operating level at 2/3 full point of storage tank. Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

b. Air Operated Regulating Valves: Provide air operated control valves for both the condensate and makeup water lines. Valves shall have Class 125 or Class 150 rating with iron or semi-steel bodies and 316 stainless steel internals. Provide condensate valve which fails open on loss of air and makeup water valve with an air lock mounted on valve diaphragm to hold valve in last position on loss of air. Design valves for the following conditions:

	Condensate	Makeup Water
Valve size	[_____] mm	[_____] mm
Capacity	[_____] L/s	[_____] L/s
Maximum pressure drop at above capacity	[_____] kPa (gage)	[_____] kPa (gage)
Available pressure	[_____] kPa (gage)	[_____] kPa (gage)
Minimum Cv at 100 percent open	[_____]	[_____]

	Condensate	Makeup Water
Valve size	[_____] inch	[_____] inch
Capacity	[_____] gpm	[_____] gpm
Maximum pressure drop at above capacity	[_____] psig	[_____] psig
Available pressure	[_____] psig	[_____] psig
Minimum Cv at 100 percent open	[_____]	[_____]

2.14.2.9 Low Pressure Steam Control

Provide an automatic control system to control steam to the deaerating heater. Maintain steam pressure in the heater by modulating a pressure reducing valve in the steam supply line. Control shall be local and remote from the control panel.

a. Controller: Adjustable proportional band, 0 to 103 kPa (gage) 15 psig brass bellows for input signal, and 20 to 103 kPa (gage) 3 to 15 psig output air pressure range, pilot controller complete with air set (valve, filter, drier and pressure regulator) mounted on control valve yoke.

b. Pressure Reducing Station Control Valve: Provide a [_____] mm inch air operated pressure reducing valve with proper internals to pass a flow of [_____] kg per second pounds per hour of steam. Steam at the valve inlet shall be [_____] kPa (gage) psig saturated, and outlet shall be controlled at [_____] kPa (gage) psig. Minimum steam flow shall be approximately [_____] kg per second pounds per hour. Minimum valve Cv shall be [_____] at 100 percent open. Valve shall be Class 250 or Class 300 flanged, iron or semi-steel body with stainless steel internals equal percentage flow characteristics and a full size port. Provide valve actuator including travel indicator, hand jack, valve positioner, and air supply filter-reducer set. Valve shall move to open position in case of failure.

2.14.2.10 Gage Glasses

Provide to cover the entire range of water level in the storage section. Gage glasses shall not be greater than 610 mm 24 inches center-to-center. Provide gage glasses complete with[chain operated] ball check shutoff and drain cock valves and safety shield.

2.14.2.11 Alarms

Provide high and low water level alarms for storage tank as follows:

a. High Water Level Alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of storage tank.

b. Low Water Level Alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level falls to [_____] meters feet [_____] mm inches above bottom of storage tank.

c. Coordinate alarms with annunciator panel as indicated.

2.14.2.12 Multiport Back Pressure Relief Valve

****

NOTE: Use multiport valve on systems where deaerating heater will be subject to occasional overpressuring.

****

Provide valve capable of relieving not less than [_____] kg per second pounds per hour of steam with not more than a [_____] kPa (gage) psig pressure rise when set at [_____] kPa (gage) psig initial operating pressure. Set pressure shall be fully adjustable by means of an external handwheel or chain operator for a range of zero to 172 kPa (gage) 25 psig. Locate on low pressure steam header manifold for the deaerating heater. Valve shall be multiport vapor cushion type rated for operating temperatures up to but not greater than 149 degrees C 300 degrees F with Class 125 cast iron body, bronze trim and carbon steel springs.

2.14.2.13 Exhaust Head

Type [I (cast iron)] [II (fabricated steel plate)] of [_____] mm inch size with [_____] mm inch diameter drain, and a capacity of [_____] kg per second pounds per hour of steam at [_____] kPa (gage) psig.

2.14.3 Boiler Feed Pumps

****

NOTE: Use this paragraph for centrifugal boiler feed pumps. If regenerative type turbine pumps are required for the smaller capacities, they must be specified. Use Style 1, horizontal split case pumps in all sizes where available. Pump service requirements shall include pump capacity of a minimum of 135 percent of boiler requirements at maximum load for modulating service and 200 percent for on-off service. Discharge head must include all change in elevation, friction losses through pipe,

valves and fittings and be sufficient to deliver water to the boiler at a pressure 6 percent higher than the setting of the lowest set boiler safety valve.

****

CID A-A-50562, Type II (boiler feed), Style 1 (horizontal split case), Class [1 single] [2 multi-] stage except as modified below.Submit pump characteristic curves superimposed on system curves at various pumping rates, 20, 40, 60, 80, 100 percent capacity.

2.14.3.1 Pump Service Requirements

a. Capacity: [_____] L/s gpm

b. Pumping temperature: [_____] degrees C F

c. Liquid pH: [_____]

d. Discharge head: [_____] meters feet

e. Available NPSH: [_____] meters feet

f. In addition to the operating point established above, pump curve shall run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

2.14.3.2 Construction

Bronze fitted including bronze impeller and impeller wear rings, and ASTM A48/A48M, Class 30, cast iron casing. Provide casing with suction and discharge gages in tapped openings. Mount each pump and prime mover on a fabricated steel bed plate having a drip collection chamber with tapped drain openings. Provide lifting attachments to enable equipment to be set into its normal position and to enable pumps to be easily dismantled in place.

2.14.3.3 Drives

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the boiler feed or condensate pump motors shall be provided with variable speed control. Generally variable speed drives for pumps over 5 1/2 kW 7 1/2 hp will be cost effective.

****

[Variable speed] electric motors [or turbines] direct connected to respective pumps with a gear type, forged steel, flexible coupling. Provide a shaft and coupling guard.

a. Electric Motors: [Variable speed,] [open dripproof,] [totally enclosed,] [fan cooled,] [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified in paragraph[s] MOTORS AND DRIVES[and VARIABLE SPEED MOTOR CONTROL].

[b. Steam Turbines: Single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F and normal exhaust back pressure of 34 kPa (gage) 5 psig or a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg per BkW per second pounds per BHP per hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve.

(1) Turbine Construction: Turbine casing split on the horizontal centerline constructed ofASTM A48/A48Mcast iron, with a design pressure rating of 1724 kPa (gage) at 232 degrees C 250 psig at 450 degrees F at inlet, and 379 kPa (gage) at 232 degrees C 55 psig at 450 degrees F at the outlet.

(2) Turbine Bearings and Shaft: Horizontal split, ring oiled, sleeve type, water cooled. Shaft shall be stainless steel or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

(3) Speed Governor: Variable speed oil relay, NEMA SM 23, Class D governor for speed control and pneumatic operator to maintain an adjustable, preset pump discharge header pressure by variation of turbine speed. Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the control acquisition system.

(4) Emergency Overspeed Governor: Completely independent of the speed governor and shall operate a separate trip valve.

(5) Insulation: Turbine shall be insulated and lagged by the manufacturer as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

]2.14.3.4 Minimum Flow Protection for Boiler Feed Water Pumps

a. Automatic Flow Control Valve: Provide with each pump an automatic bypass valve. Valve shall automatically program recirculation flow, detection of low flow, cycling of control valve and pressure letdown for high pressure boiler feedwater return to the feedwater heater. Bypass valve shall be cast steel with stainless steel internals, and shall have a rating of not less than 2068 kPa (gage) at 204 degrees C 300 psig at 400 degrees F. Valve shall have a line size body with a 25 mm one inch recirculation connection.

b. Boiler Feedwater Automatic Recirculation System: (Option to Automatic Valve). Provide to protect feedwater pumps at low flow conditions.

System shall be capable of recirculating the minimum flow recommended by the pump manufacturer. System shall be an engineered system consisting of various functional components specified or shall be a self-contained and self-powered mechanical system. Components of the engineered system shall include a flow transmitter with orifice in feedwater line, bypass flow controller with bypass flow control valve, and a bypass pressure reducing orifice.

(1) System Bypass Flow Controller: Include detection of low flow and modulation of a control valve in a bypass line returning to a low pressure sink. Incorporate a pressure let-down feature or device to reduce pressure from boiler feedwater pump discharge pressure to that of the low pressure sink.

(2) System Bypass Control Valve: Modulate to provide minimum flow recommended by the pump manufacturer and to provide shutoff or recirculation flow when feedwater flow to boilers exceeds minimum flow required for pump protection.

2.14.3.5 Feedwater Stop and Check Valves

Provide a Class 300, flanged, cast steel feedwater stop gate valve and check valve on the feedwater outlet of each pump. Provide piping from valves to economizer inlet, and from economizer to flanged connection on boiler drum. Provide connection on pipe at economizer outlet for remote recording thermometer.

2.14.4 Condensate Pumps

****

NOTE: Use this paragraph for centrifugal condensate pumps. If regenerative type turbines are required for the smaller capacities, they must be specified. Use Style 1, horizontal split case pumps in all sizes where available. Pump service requirements shall include pump capacity of a minimum of 135 percent of boiler requirements at maximum load for modulating service to the deaerator and 200 percent for on-off service. Discharge head must include all change in elevation and friction loses through pipe, valves and fittings.

****

CID A-A-50562, Type I (general service), Style [1 (horizontally split case)] [2 (end suction)], Class 1 (single stage) unless modified below.

2.14.4.1 Pump Service Requirements

a. Capacity: [_____] L/s gpm

b. Pumping temperature range: [_____] to [_____] degrees C F

c. Liquid pH: [_____]

d. Discharge head: [_____] meters feet

e. Available NPSH: [_____] meters feet

f. In addition to the operating point established above, pump curve shall also run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

2.14.4.2 Construction

Bronze impellers and impeller wear rings. [Cast iron] [ductile iron] pump casing designed for the specified conditions. Bearings shall be oil lubricated. Equip casing with tapped openings for suction and discharge gages. Provide gages in openings. Mount pump and driver on a fabricated steel bed plate having a drip collection chamber with tapped drain openings. Provide lifting attachments for installation and maintenance.

2.14.4.3 Drives

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the boiler feed or condensate pump motors shall be provided with variable speed control. Generally variable speed drives for pumps over 5 1/2 kW 7 1/2 hp will be cost effective.

****

[Variable speed] electric motors or [turbines] direct connected to respective pumps with a gear type flexible coupling. Provide shaft and coupling guards.

a. Electric Motors: [Variable speed,] [open dripproof,] [totally enclosed,] [fan cooled,] [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified in paragraph[s] MOTORS AND DRIVES [and VARIABLE SPEED CONTROL FOR MOTORS].

[b. Steam Turbines: Single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F, normal exhaust back pressure of 34 kPa (gage) 5 psig and a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg per BkW per second pounds per BHP per hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve.

(1) Turbine Construction: Turbine casing split on the horizontal or vertical centerline constructed ofASTM A48/A48M cast iron, with a design pressure rating of 1724 kPa (gage) at 232 degrees C 250 psig at 450 degrees F at inlet, and 379 kPa (gage) at 232 degrees C 55 psig at 450 degrees F at the outlet.

(2) Turbine Bearings Shaft: Ring oiled, anti-friction type. Shaft shall be stainless steel or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

(3) Speed Governor: Variable speed governor for speed limiting and pneumatic operator to maintain an adjustable preset level in [deaerator tank] [condensate receiver] by variation of turbine speed. Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal and vary the turbine speed from minimum to full speed in a linear response. Maximum and minimum speed shall be adjustable. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the controller.

(4) Emergency Overspeed Governor: Completely independent of the speed governor and shall operate a separate trip valve.

(5) Insulation: Turbine shall be insulated and lagged as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

]2.14.5 Variable Speed Motor Control

Remotely installed cabinet housed units with solid state rectification and inverter equipment to vary frequency of electrical power to drive motors.

2.14.5.1 Housing

House controller in a [wall] [floor] mounted, NEMA [_____] enclosure finished with manufacturers standard painted finish. Provide control panel complete with fused disconnect switches, magnetic [across the line] [part winding] starters with thermal overload protection, transformer, hand-off-automatic selector switches, hand potentiometer for manual speed control, fuses and running lights.

a. Provide the manual switch within the control panel so that in the event failure of a component, motor can be put across the line at full voltage to maintain air or pump pressure. Provide a mechanical door interlock that allows panel to open only when fused disconnect is in the off position.

b. Variable Frequency Controllers: Variable frequency controllers shall use solid-state semiconductor power conversion equipment. Provide controllers as integrated and assembled products. Controllers shall be furnished by the same manufacturer.

(1) Each controller shall be rated for a supply of [_____] volts, three phase, 60 Hz. Output shall be [_____] volts, three phase with frequency variable between zero and 60 Hz. Controllers shall be rated to operate motors continuously at their rated horsepower and frequency. Speed regulation shall be three percent or better without tachometer feedback. Electrical supply system has an available short circuit rating of [_____] amperes symmetrical.

(2) Each controller shall be capable of driving motor continuously at a lower speed no greater than 20 percent of full rated motor speed with stable operation and without overheating the motor under rated ambient conditions. Provide estimate of minimum speed at which motor can be operated continuously without overheating or

problems of instability due to overhauling of load.

c. Provide controller fault protection so that a single or three phase short circuit at the controller terminals or inverter commutation failure will not result in damage to power circuit components. Provide overload protection so that motor and controller are protected against operating overloads.

d. Provide adjustable time delay undervoltage protection so that motors will continue to operate during momentary voltage fluctuation or loss of voltage. Time adjustment shall be zero to 5 seconds. Provide for orderly shutdown on undervoltage conditions exceeding the time delay interval.

e. Provide adjustable timed linear acceleration and deceleration.

f. Provide volts/Hz control to prevent motor overheating throughout the speed range.

g. Provide door interlocks to prevent opening of enclosure doors unless power is disconnected.

h. Controllers shall be self protecting and shall provide orderly shutdown for, but not limited to, the following conditions:

    (1) Loss of input power

    (2) Undervoltage

    (3) Sustained gradual overload

    (4) Fault or large instantaneous overload

    (5) Overtemperature

    (6) Failure of ventilating system

    (7) Overvoltage

    (8) Control circuit failure

Provide contacts for remote annunciation of shutdown or abnormal condition.

i. Electrical Bypass: Provide each controller with manual isolation and bypass switching. Switch shall be manually operated with controller deenergized. Switch shall be two position with provisions for locking switch in either position.

    (1) Normal Position: Bypass shall be open and controller shall be connected to supply circuit and load.

    (2) Bypass Position: Bypass shall be closed and controller shall be electronically isolated from supply and load. Isolating contacts shall be located so that it is possible to verify by visual inspection that contacts are open and controller is electrically isolated. In the bypass position the motor shall be operated at constant speed and controlled from the air circuit breaker. Provide auxiliary contacts that close in the bypass position. Auxiliary contacts shall be used to activate the damper control to

provide fan load control in the bypass position.

2.14.5.2 Controller Environmental Protection

a. Ventilation: Design controllers enclosed and ventilated for installation in a moderately dusty area. Provide forced filtered ventilation including fans, filters, controls and accessories required for operation. Enclosures shall be operated under positive pressure at all times. Provide filtered ventilating openings and gasketed doors to prevent infiltration of dust.

b. Heating: Provide electric heaters to prevent condensation in the enclosure and to prevent low ingoing air temperatures that exceed the equipment rating. Provide a low temperature alarm to sound when enclosure temperature falls below required minimum temperature. Provide contacts for remote annunciation of alarm condition.

2.14.5.3 Method of Control

Supply each controller from an electrically operated air circuit breaker or motor starter. Controller ventilation and heating shall be from another circuit.

a. Start Signal: Closes the electrically operated air circuit breaker or motor starter to energize the controller. Controller shall accelerate fan to operating speed. Fan speed shall be controlled from the load control signal.

b. Stop Signal: Opens electrically operated air circuit breaker or motor starter to deenergize the controller. Upon deenergization, controller control system shall revert to stop condition.

c. Boiler Feedwater Pump Speed Control System: Matches pump discharge to system demand and maintains a system header pressure controlled to the set point values. Provide Manual/Automatic control stations for master pressure and for each boiler feed pump. Provide indicators for feedwater header pressure and individual boiler feedwater pump flow.

2.14.5.4 Variable Speed Motor Controller

Conduct burn-in tests for at least 50 hours at rated conditions. If a component fails during burn-in test, replace it, and run test again on entire assembly for another 50 hours. Burn-in test shall not be complete until entire assembly has operated for 50 hours without failure.

2.14.6 Valve Actuators

[Electrically][or][pneumatically] operated and designed so that valve may be manually operated by removing drive pins. Actuators shall be operated by push button control. Locate one push button at a position adjacent to the valve. Locate a second push button within the boiler control room. Provide a valve position indicator utilizing indicating lights. A green light shall indicate valve is fully open and an amber light shall indicate valve is fully closed. Both lights on shall indicate when valve is partially open.[Provide torque limit controls to protect valve during opening and closing for electrically operated valves.] Actuator electric motor shall be totally enclosed, [_____] volts, [_____] phase, 60 Hz as specified in the paragraph MOTORS AND DRIVES. Provide NEMA 4 control enclosures.

2.14.7 Sump Pumps

CID A-A-50555 with automatic float switch and disconnect switch in NEMA 6 enclosure.

2.14.8 Water Softening System

****

NOTE: One hundred percent makeup shall be assumed in calculating the sustained softening rate.

****

Ion exchange resin type conforming to WQA S-100 except as modified below. [Manual] [Push button automatic] [Fully automatic] in operation with operating controls housed in a NEMA 12 enclosure having a minimum total capacity between regenerations of [_____] liters gallons of water of [_____] grams grains hardness when operated at a sustained softening rate of [_____] L/s gpm. Maximum effluent water temperature shall be [_____] degrees C F.

2.14.8.1 Softener Equipment

Including but not limited to the following:

a. Water Hardness Monitor: Provide with an alarm point at 1.0 ppm to ensure compliance for boilers rated above 3150 grams/sec 25,000 lb/hr.

b. Total Solids Monitor and Controller: Provide a continuous monitor and controller (when required) to control concentration of dissolved solids and treatment chemicals in water for boilers rated above 3150 grams/sec 25,000 lb/hr.

c. Water Meter: Provide a [_____] mm inch cold water meter on each softener unit.

d. Ion Exchange Resin: High capacity, polystyrene base, sulfonated synthetic type except that exchange capacity shall be not less than 68.70 kg per cubic meter 30 kilograins per cubic foot at a salt dosage of 240 kg per cubic meter 15 pounds per cubic foot.

e. Tank Sizing: Minimum acceptable bed depth of 762 mm 30 inches; maximum acceptable bed depth of 1829 mm 72 inches. Base reactor tank sizes on allowing a freeboard above the resin bed of not less than 75 percent of resin bed depth, and flow rate between 1.11 and 7.13 L/s per cubic meter 0.5 and 3.2 gpm per cubic foot of resin.

2.14.8.2 Brine Storage System

Provide complete, including fiberglass storage tank, sight level gage, bulk salt delivery tube, internal distribution system, level control system, tank vent with dust collection system, top and side manholes, access ladder, and other required appurtenances.

a. Storage Tank: Filament wound fiberglass with flat bottom and domed top as recommended by the manufacturer for brine storage. Tank shall be [_____] meters feet [_____] mm inch in diameter by [_____] meters feet [_____] mm inch wall height with a nominal capacity of [_____] liters gallons and a dry salt storage capacity of [_____] Mg tons. Design water distribution system, internal piping distributors, and brine collection system so that system shall be capable of dissolving [_____] kg pounds of rock salt per second minute to produce [_____] L/s gpm of brine. System shall be able to dissolve [_____] Mg tons of salt before cleanout.

b. Accessories: Provide the following accessories:

(1) Steel holddown lugs securely bonded to tank in adequate number to properly anchor tank to concrete base;

(2) Side bottom flanged drain not less than 100 mm 4 inches in diameter;

(3) Side and top manholes not less than 559 mm 22 inches in diameter;

(4) Flanged top connections for delivery pipe and vent;

(5) Ladder for access to top manhole;

(6) Water inlet connection;

(7) Brine outlet connection;

(8) Level control system; and

(9) Sight level gage

c. Pneumatic Delivery Pipe: Not less than 100 mm 4 inches in diameter.

d. Dust Collection Vent System and Safety Relief Valve: Provide storage tank with dust collection vent system and safety relief valve.

e. Access Ladder: Of steel construction to be bolted to tank by means of FRP (fiberglass reinforced plastic) mounting lugs complete with safety cage. Platform shall connect ladder to tank for safe access to the manhole.

f. Tank Internals: Construct tank internals including water distribution piping and brine collectors of FRP or polyvinyl chloride (PVC).

g. Tank Nozzles: ASME B16.5, Class 150, FRP or PVC flanges.

h. Level Control System: Electrode holder and electrodes mounted in a standpipe exterior to the tank. Position electrodes so that a solenoid operated water makeup valve will be opened or closed to maintain liquid level to within plus or minus 25 mm one inch of the set level. Provide tank with a high water alarm. Electrodes shall be easily removable for cleaning and constructed of materials, that will allow continual immersion in brine.

2.14.9 Chemical Feed Systems

Provide systems complete with storage tank, supporting framework, hinged cover, mixer, strainers, level indicators, proportioning pumps, relief valves and interconnecting piping for a complete chemical feed packaged unit.

2.14.9.1 Storage Tank

Capacity of 190 liters 50 gallons constructed of FRP. Provide removable, hinged cover.

2.14.9.2 Exterior Gage Glass

Protected, full height of tank complete with gage cocks.

2.14.9.3 Low Level Alarm

Provide tank with a low level switch to sound alarm and shut down pumps should level drop to preset minimum.

2.14.9.4 Dissolving Baskets

****

NOTE: The chemical feed solution to be used shall be inserted here.

****

Construct baskets of a corrosion resistant material suitable for continuous immersion in a [_____] solution.

2.14.9.5 Tank Strainer

In suction line to pump.

2.14.9.6 Supporting Steelwork

Provide to adequately support tank, mixer, and the number of proportioning pumps specified.

2.14.9.7 Agitator

Provide with mounting bracket to mount to storage tank. Agitator shaft and propeller shall be of stainless steel.

2.14.9.8 Proportioning Pumps

Provide [two] [three] [_____] [simplex] [duplex] proportioning pump[s]. Each pump shall have a minimum capacity of [_____] L/s gallons per hour at a [_____] kPa (gage) psig discharge pressure. Capacity shall be adjustable from zero to 100 percent by a convenient screw adjustment of stroke length. Provide pump with integral check valves. Electric motors shall be [totally enclosed,] [fan cooled,] [_____] volts, [_____] phase, 60 Hz as specified in the paragraph MOTORS AND DRIVES.

2.14.9.9 Safety Relief Valve

Provide for each pump to discharge back into the tank in event of excessive line pressure.

2.14.10 All Welded Blowdown Tank

Provide in accordance with the NBBI NB-27 (supplemental to the National Board Inspection Code) latest edition published by the National Board of Boiler and Pressure Vessel Inspectors, Columbus, Ohio.

2.14.10.1 Construction

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NOTE: The volume of the blowdown tank shall be calculated to be twice the volume of water removed from one boiler when the normal water level is reduced not less than 100 mm 4 inches.

****

Construct equipment and accessories in accordance with requirements of ASME BPVC SEC VIII D1 for a working pressure of at least the maximum allowable working pressure of the boiler but in no case shall plate thickness be less than 10 mm 3/8 inch. Provide corrosion allowance of [2.54] [_____] mm [0.1] [_____] inch. Tank dimensions shall be [_____] meters feet [_____] mm inches o.d. by [_____] meters feet [_____] mm inches long over the heads (overall). Provide tank with wear plate not less than 10 mm 3/8 inch thick and [279 by 381 mm] [457 by 508 mm] [11 by 15 inch] [18 by 20 inch] manhole.

a. Provide the following tank connections:

    (1) Blowdown inlet for bottom blowdown: [20] [25] mm [3/4] [one] inch;

    (2) Tangential blowdown inlet: [_____] mm inch;

    (3) Steam vent, flanged: [_____] mm inch;

    (4) Discharge water outlet, flanged: [_____] mm inch with internal water seal and 20 mm 3/4 inch siphon breaker;

    (5) Drain: 50 mm 2 inch;

    (6) Thermometer connection: 20 mm 3/4 inch;

    (7) Pressure gage connection: 6 mm 1/4 inch;

    (8) Cold water inlet: [_____] mm inch with temperature regulating valve and backflow preventer; and

    (9) Two gage glass connections: 15 mm 1/2 inch.

b. Angle Supports and Coating: Provide tank with steel angle support legs extending [_____] meters feet below bottom of tank. Coat tank with one coat of manufacturer's standard high temperature primer.

2.14.10.2 Accessories

a. Gage Glass: 300 mm 12 inch reflex type with shutoff valves and guard.

b. Thermometer: Bi-metal dial type with separable socket, 125 mm 5 inch dial, 10 to 149 degrees C 50 to 300 degrees F range.

c. Pressure Gage: Zero to 172 kPa (gage) 25 psig range.

d. Internal Baffles and Pipes: As detailed.

2.14.10.3 Controls

Provide a self operating regulator to control the flow of cooling water to the tank. Regulator shall include a 20 mm 3/4 inch screwed bronze body with stainless steel trim, reverse acting actuator (for cooling), capillary tubing and a union connection bulb with a stainless steel well. Control setting shall be 60 degrees C 140 degrees F with a minimum Cv of [_____].

2.14.11 Continuous Blowdown System

Provide a complete automatic continuous boiler blowdown system which shall include a controller/programmer unit and flow assembly for each boiler, plus a continuous blowoff heat exchanger, flash tank and boiler water sample cooler.

2.14.11.1 Automatic Blowdown Controller

Intermittent type boiler blowdown system rated for not less than 1724 kPa (gage) 250 psig steam pressure.

a. Flow Assembly: Include a 25 mm one inch ball valve with 316 stainless steel ball and stem and stainless steel electrode assembly.

b. Controller/Programmer: Include a conductivity meter with zero to 6000 microhms range, valve open/closed indicators and manual/auto control switch. Cycle interval and sample duration shall both be adjustable over a wide range. Mount units at the operating floor near the boiler front.

c. Accessories and Connections:

    (1) Continuous Blowdown Connection: At each boiler, provide a gate valve and extend piping to header at flash tank.

    (2) Header Connections: Provide with a tee with valved sampling connection. Provide a 20 mm 3/4 inch, three globe valve bypass around each flow assembly.

    (3) Common Header: Provide from valved outlet connections on flow assembly units to connection on flash tank.

2.14.11.2 Flash Tank

Designed for [_____] kPa (gage) psig and constructed in accordance with ASME BPVC SEC VIII D1. Tank shall be [_____] mm inches in diameter by [_____] mm inches long including heads and shall be ASME Code stamped.

a. Provide tank with blowdown inlet, steam outlet, gage glass, float operated outlet valve, relief valve, and inspection openings. Tank shall have steel angle legs with plate feet for bolting to floor. Legs shall be of sufficient length so that bottom of lower head of tank will be not less than 457 mm 18 inches above floor.

b. Automatic Control System: Control level in the flash tank, by modulating a valve in the water outlet line.

    (1) Level Controller: External cage type air operated level controller, complete with 40 mm 1 1/2 inch screwed connection, 350 mm 14 inch stainless steel float and Class 125 cast iron body. Controller shall be direct acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band. Locate controller to maintain an operating level at center line of storage tank.

Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

(2) Outlet Water Valve: [_____] mm inch air operated control valve with a capacity to pass [_____] L/s gpm at a pressure drop of [_____] kPa (gage) psig. Cv shall not be less than [_____] at 100 percent open. Valve shall be Class [_____], flanged, iron or semi-steel body with stainless steel internals. Valve shall have equal percentage flow characteristics with a full size port. Provide an air lock mounted on valve diaphragm and piped to hold valve in last position on air failure.

2.14.11.3 Sample Cooler

Water cooled shell and tube type with valves and accessories required to safely withdraw a water sample from the boiler drum. Provide drain under sampling valve terminating with a 20 mm 3/4 inch splash proof funnel, 229 mm 9 inches below outlet of valve.

2.14.11.4 Heat Exchanger

Provide an ASME code stamped continuous blowoff heat exchanger designed and constructed in accordance with ASME BPVC SEC VIII D1, to transfer heat from the continuous blowoff water leaving continuous blowoff flash tank to treated makeup water entering the feedwater heater. Heat exchanger shall be a bare tube, helical coiled bundle, installed in a one piece casing with removable front plate. Bundle shall be removable. Tube diameter shall be not less than 20 mm 3/4 inch. Tubes shall be ASTM B111/B111M copper alloy with cast iron shell. Design tube side for not less than [_____] kPa (gage) psig pressure at [_____] degrees C F. Design shell side for not less than [_____] kPa (gage) psig pressure at [_____] degrees C F.

2.15 PIPING

Piping work shall include the provision of piping systems, including valving and specialty items, for steam plant and related external auxiliary equipment. Piping shall be in accordance with ASME B31.1 except as modified below or indicated otherwise.

2.15.1 Expansion

Compute expansion of pipe with operating temperatures above minus 19 degrees C zero degrees F with minus 19 degrees C zero degrees F in lieu of 21 degrees C 70 degrees F specified in ASME B31.1.

2.15.2 Steam Heating and Distribution and Hot Water

Requirements of ASME B31.1 apply to building steam heating and steam distribution piping designed for 103 kPa (gage) 15 psig or lower and hot water heating systems 207 kPa (gage) 30 psig or lower.

2.15.3 Materials

Suitable for the maximum pressure at the maximum temperature at which equipment must operate.

2.15.3.1 Pipe Materials

a. Steel Pipe:

   (1) Steam Pipe, Boiler Feedwater Pipe, Relief Pipe and Steam Tracer Pipe: Black, ASTM A53/A53M or ASTM A106/A106M seamless steel pipe, Grade A or B. Wall thickness not less than Schedule 40. Steam tracer pipe, with steam up to 103 kPa (gage) 15 psig, may be ASTM B88M ASTM B88, Type K copper tubing.

   (2) Condensate Pipe and Boiler Blowdown Pipe: Black, welded or seamless ASTM A53/A53M or ASTM A106/A106M, steel pipe, Grade A or B. Wall thickness not less than extra strong (XS or Schedule 80).

   (3) Chemical Feed Pipe: ASTM A312/A312M austenitic stainless steel.

   (4) Fuel Oil Pipe: ASTM A53/A53M or ASTM A106/A106M, seamless black steel pipe, Grade A or B.

   (5) Treated Water, Hot Water Heating, High Temperature Water, Drains (Other Than Sanitary), and Overflow Pipe: ASTM A53/A53M or ASTM A106/A106M, Grade A or B.

   (6) Gas Pipe and Compressed Air Pipe: ASTM A53/A53M or ASTM A106/A106M, Grade A or B.

b. Copper Tubing:

   (1) Instrument Air Pipe: ASTM B88M ASTM B88hard copper tubing, Type K or L; except in a corrosive atmosphere or outside pipe shall be copper tubing, Type K or L, with ASTM D1047 PVC jacketing.

   (2) Steam Tracer Pipe: Contractor may provide ASTM B88M ASTM B88, Type K, copper tubing for steam up 103 kPa (gage) 15 psig.

   (3) Potable Water, Sanitary Drains and Storm Drains: As specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE unless otherwise specified. Chlorinated polyvinyl chloride (CPVC) and other plastic tubing and fittings shall not be used in the steam heating plant.

2.15.3.2 Fittings

a. Fittings for Steel Pipe:

   (1) Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.3 malleable iron, screwed end fittings, for working pressures not greater than 2068 kPa (gage) 300 psig at temperatures not greater than 232 degrees C 450 degrees F or ASME B16.11 forged steel.

   (2) Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.11 steel, socket welded end fittings.

   (3) Sizes 6 to 65 mm 1/8 to 2 1/2 inches: ASME B16.9 steel, butt welding fittings.

   (4) Sizes 65 to 600 mm 2 1/2 to 24 inches: ASME B16.5 forged steel, flanged fittings.

b. Welded Outlets and Welding Saddles: Make branch connections of 45 and 90 degrees either with ASME B16.9 forged steel welded outlet fittings or welding saddles. Welding outlets and saddles shall not be smaller than two pipe sizes less than main pipe sizes.

c. Fittings For Copper Tubing: ASME B16.18 cast bronze solder joint or ASME B16.22 wrought copper solder joint. For instrument air, fittings may be ASME B16.26 compression joint type.

d. Unions:

  (1) Unions For Steel Pipe: ASME B16.11, ASME B16.39 threaded. Unions for zinc coated pipe shall be zinc coated.

  (2) Unions For Copper Tubing: ASME B16.22. For instrument air, unions may be compression joint type.

2.15.3.3 Flanges

ASME B16.5, forged steel, welding type. Remove raised faces on flanges when used with flanges having a flat face. Unless specified otherwise, pressure and temperature limitations shall be as specified in ASME B16.5 for the proper class and service, and type face specified.

2.15.3.4 Valves

a. Valves for maximum working pressure of 1034 kPa (gage) 150 psig saturated steam or 1550 kPa (gage) 225 psig W.O.G. (Water, Oil, Gas) at 93 degrees C 200 degrees F (non-shock service). For working pressures not exceeding 862 kPa (gage) 125 psig saturated steam or 1379 kPa (gage) 200 psig water at 93 degrees C 200 degrees F non shock service, Class 125 may be used in lieu of Class 150 or Class 250.

  (1) Valve Sizes 50 mm 2 Inches and Smaller:

    (a) Non Throttling Valves: Gate valves, bronze, wedge disc, rising stem, Class 150, MSS SP-80 or ball valves, bronze, double stem seals, stainless steel ball and shaft, tight shutoff.

    (b) Globe Valves and Angle Valves: Bronze, Class 150, MSS SP-80.

    (c) Check Valves: Bronze, Type [IV, swing check] [III, lift check], Class 150, MSS SP-80.

  (2) Valve sizes 65 mm 2 1/2 inches and larger.

    (a) Gate Valves: Flanged, cast iron, Class 250, MSS SP-70 or steel, Class 150, ASME B16.34. Valves shall have wedge disc, outside screw and yoke (OS&Y), rising stem; valves 200 mm 8 inches and larger shall have globe valved bypass.

    (b) Globe Valves and Angle Valves: Flanged, cast iron, Class 250, MSS SP-85 or steel, Class 150, ASME B16.34.

    (c) Check Valves: Flanged, cast iron, Class 250 or steel, Class 150, Type [_____], [lift] [swing] check, style [_____], ASME B16.34.

b. Valves for maximum working pressure of 1724 kPa (gage) 250 psig steam at a maximum temperature of 232 degrees C 450 degrees F or 3447 kPa (gage) 500 psig W.O.G. at 93 degrees C 200 degrees F (non-shock).

    (1) Valve sizes 65 mm 2 1/2 inches and larger.

        (a) Gate Valves: Flanged or butt welded, cast iron, Class 250, MSS SP-70 (Maximum size 300 mm 12 inches) or steel, Class 300, ASME B16.34. Valves shall have wedge disc, OS&Y, rising stem; each valve 200 mm 8 inches and larger shall have globe valved bypass.

        (b) Gate Valves, Globe Valves and Angle Valves: Flanged or butt welded, cast iron, Class 250, MSS SP-85 or steel, Class 300, ASME B16.34.

        (c) Check Valves: Flanged or butt welded, iron body, Class 250 or steel, Class 300, Type [_____] [lift] [swing] check, style [_____], ASME B16.34.

c. Valves for maximum working pressure of 2068 kPa (gage) 300 psig steam at a maximum temperature of 454 degrees C 850 degrees F or a maximum W.O.G. pressure of 4653 kPa (gage) at 149 degrees C 675 psig at 300 degrees F (non shock).

    (1) Valve sizes 65 mm 2 1/2 inches and larger:

        (a) Gate Valves, Globe Valves, and Angle Valves: Flanged or butt welded, ASME B16.34, steel, Class 300, rising stem, OS&Y. Gate valves 200 mm 8 inches and larger shall have globe valved bypass.

        (b) Check Valves: Flanged or butt welded, steel, Class 300, Type [_____], [lift] [swing] check, style [_____], ASME B16.34.

d. Ball Valves: ASME B16.5 and API Std 607 double stem seal type for bubble tight shutoff. Seats and seals shall be TFE material. Ball and shaft shall be stainless steel. Provide mechanical stops to prevent cycling valve in wrong direction and self-aligning stem seal.

e. Valve Accessories: Valve operating mechanisms include chain wheels, gear operators, floor stands, electric motors, air motors and cylinder-type actuating devices. Provide accessories as follows and as indicated.

    (1) Power Operators: [Electric] [Pneumatic]. Power operated valves shall open and close at rates no slower than 254 mm 10 inches per minute for gate valves and 100 mm 4 inches per minute for globe and angle valves. Valves shall open fully or close tightly without requiring further attention when actuating control is moved to the open or closed position. A predetermined thrust exerted on the stem during operation resulting from an obstruction in the valve shall cause motor to automatically stop. Power operators shall be complete with gearing and controls necessary for size of valve being provided. Power operators shall be designed to operate on the [electric] [compressed air] power supply indicated. Provide power operators with remote position indicators on the following valves: soot blowers, [_____], [_____].

(2) Floor Stands and Extension Stems: Floor stands shall be cast iron or steel, constructed for bolting to floor and shall include an extension stem, an operating handwheel and a position indicator for non-rising stems. Floor stand shall be not less than 762 mm 30 inches high. Handwheel shall identify rotation direction for closing valve and shall be of such diameter as to permit operation of valve with a force of not more than 18 kg 40 pounds. Extension stems shall be corrosion resisting steel designed for rising and non-rising stems, as applicable, and for connection to valve stem by a sleeve coupling or universal joint. Provide in length required to connect valve stem and [handwheel] [operating mechanism] and of sufficient cross section to transfer torque required to operate valve. Provide floor stands and valve extensions on floors and platforms for the following valves: deaerator drain valves, [_____] [_____].

(3) Provide motorized actuators or chain wheels with chain and guides on valves with handwheel centerline higher than 2 meters 7 feet above floor or platform except where specified otherwise. Chainwheel operator shall be fabricated of cast iron or steel and shall include a wheel, endless chain and a guide to keep the chain on the wheel. Provide galvanized steel endless chain extending from valve to within one meter 3 feet of floor or platform. Provide impact chain wheels on steam headers and other locations where the valve has a tendency to stick. When a valve is motorized, provide hand operation for emergency.

(4) Provide gear operators on ball valves larger than 80 mm 3 inches and on gate valves 200 mm 8 inches and larger.

f. Steam Pressure Regulating Valves: CID A-A-50558, minimum of Class [125] [150] [250] [300], except as specified otherwise. [Cast iron], [cast steel] valve body with valve seats and disc of replaceable heat treated stainless steel. Valves shall be single seated, shall seat tight under dead end conditions, and shall go to the closed position in the event of pressure failure of the operating medium. Valves shall be spring loaded diaphragm operated type, except valves exposed to ambient temperature of less than 2 degrees C 35 degrees F or exposed to the weather shall be piston operated type. Capacity of valves shall be not less than that indicated. Pilot valves shall have strainer at inlet from external feeder piping:

(1) Spring Loaded Diaphragm Operated Valves: Fabricate main spring of stainless steel, and it shall not be in the path of steam flow through the valve. Control valve by pilot valve through external feeder piping.

(2) Piston Operated Valves: Control valve by integral pilot valve through external feeder piping.

g. Safety Relief Valves: ASME BPVC SEC I, with Class [150] [300] inlet flange, with test lever, designed for the intended service.

2.15.3.5 Bolts and Nuts

a. Bolts: ASTM A193/A193M, Grade B8. Lengths of bolts shall be such that not less than two full threads will extend beyond nut with bolts tightened to the required tensions and washers seated.

b. Nuts: ASTM A194/A194M, Grade 8.

2.15.3.6 Gaskets

ASME B31.1 and as specified below, except provide spiral wound metal covered non-asbestos gaskets in lieu of compressed sheet non-asbestos. Gaskets shall be as thin as the finish of surfaces will permit. Do not use paper, vegetable fiber, rubber, or rubber inserted gaskets for temperatures greater than 121 degrees C 250 degrees F. Provide metal or metal jacketed non-asbestos gaskets with small male and female and small tongue-and-groove flanges and flanged fittings; they may be used with steel flanges with lapped, large male and female, large tongue-and-groove, and raised facings. Provide fullface gaskets with flat-faced flanges. Raised face cast iron flanges, lapped steel flanges, and raised faced steel flanges shall have ring gaskets with an outside diameter extending to inside of bolt holes. Widths of gaskets for small male and female and for tongue-and-groove joints shall be equal to widths of male face and tongue. Gaskets shall have an inside diameter equal to or larger than port opening. Dimensions for nonmetallic gaskets shall be in accordance with ASME B16.21. Materials for flanged gaskets shall be as listed below for service specified:

a. Steam, Boiler Blowdown, Exhaust Steam: Spiral wound metal composition or copper

b. Boiler Feed Water: Metal jacketed non-asbestos, copper or monel

c. Hot Water, (above 38 degrees C 100 degrees F): Spiral wound metal non-asbestos

d. Cold Water: Red rubber or neoprene rubber

e. Heavy Fuel Oil (No. 6): Spiral wound metal non-asbestos, soft steel, or monel

f. Diesel Fuel (No. 2): ASME B16.21 metallic

g. Compressed Air: Spiral wound metal non-asbestos

2.15.3.7 Expansion Joints

a. Slip Tube Expansion Joints: ASTM F1007, single or double slip tube as indicated, designed for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Expansion joints shall be of the type which permits injection of semi plastic type packing while joint is in service under full line pressure. Slip tube shall be of chromium plated, wrought steel construction, guided by internal and external guides integral with joint body. Fit slip tube ends with forged steel pipe flanges or bevel for welding into pipe line where indicated. Deliver joints complete with packing and ready for installation.

b. Ball Expansion Joints: Capable of 360 degrees rotation plus 15 degrees angular flex movement. Ball joints shall have steel bodies and polished steel balls. Provide end connections to suit class of piping hereinbefore specified. Seals shall be of pressure molded composition designed for the working pressure. Design joints for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Cold set joints as necessary to compensate for temperature at time of installation. Do not use ball joints on superheated steam or on joints subject to frequent flexure. Ball joints shall be installed in strict accordance with recommendations of the manufacturer.

c. Bellows Expansion Joints: ASTM F1120 flexible guided type with stainless steel expansion element, internal sleeves and external covers. Joints shall be designed for a working pressure of [_____] kPa (gage) psig and a temperature of [_____] degrees C F.

2.15.3.8 Pipe Hangers and Supports

MSS SP-58, Type [_____] or Type [_____] of the adjustable type, except as specified or indicated otherwise. Suspended steam and condensate piping shall have pipe hangers Type [_____] with insulation protection saddles Type [_____]. Provide insulated piping, except steam and condensate piping, with insulation protection shields Type 40. Provide bronze or copper plated collars on uninsulated copper piping. Support rods shall be steel. Rods, hangers and supports shall be zinc plated, except for uninsulated copper piping which shall be copper plated; cast iron rollers, bases and saddles may be painted with two coats of heat resisting aluminum paint in lieu of zinc plating. Axles for cast iron rollers shall be stainless steel. Size hanger rods with a 150 percent safety factor for a seismic design.

2.15.3.9 Instrumentation

a. Pressure and Vacuum Gages: Conform to applicable requirements of ASME B40.100.

b. Indicating Thermometers: Liquid-in-glass or MIL-T-19646 dial type. Thermometer shall include a separable immersion well.

2.15.3.10 Miscellaneous Pipeline Components

a. Cold and Hot Water Meters: CID A-A-59224 for maximum flow of [_____] L/s at 38 degrees C gpm at 100 degrees F and reduced flow of up to [_____] L/s at 121 degrees C gpm at 250 degrees F.

b. Air Traps: Float controlled valves arranged to close properly when water enters traps. Air traps shall conform to requirements for float operated steam traps (non-thermostatic), CID A-A-60001, except that valve mechanism shall be inverted so as to be closed, not opened, by rising water.

c. Steam Traps: CID A-A-60001. Inverted bucket high pressure steam traps designed for use at [_____] kPa (gage) psig at [_____] degrees C F. Low pressure steam traps shall be float and thermostatic type for pressures up to 103 kPa (gage) 15 psig. Provide traps with separate strainers unless specified otherwise.

d. Strainers: FS WW-S-2739, Style Y for Class [125] [250] with blow off outlet. Construct strainers for Class 300 of cast carbon steel in accordance with ASME B16.5 for minimum of 2068 kPa (gage) 300 psig saturated steam pressure. Provide blow off outlet with pipe nipple and gate valve.

2.15.3.11 Backflow Preventers

Reduced pressure principle type conforming to applicable requirements of [AWWA C510 and AWWA C511] [Section 22 00 00 PLUMBING, GENERAL PURPOSE].

2.15.3.12 Insulation

Materials and application shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15.3.13 Pipe Sleeves

a. Floor Slabs, Roof Slabs, and Outside Walls Above and Below Grade: Galvanized steel pipe having an inside diameter at least 15 mm 1/2 inch larger than outside diameter of pipe passing through it. Provide sufficient sleeve length to extend completely through floors, roofs, and walls, so that sleeve ends are flush with finished surfaces except that ends of sleeves for floor slabs shall extend 13 mm 1/2 inch above finished floor surface. Sleeves located in waterproofed construction shall include flange and clamping ring.

b. Partitions: Galvanized sheet steel, 26 gage or heavier, of sufficient length to completely extend through partition thickness with sleeve ends flush with partition finished surface.

2.15.3.14 Piping Identification

Conform to MIL-STD-101 and place in clearly visible locations; except paint piping in the boiler room the primary color of the color code. Provide labels and tapes conforming to ASME A13.1 in lieu of band painting or stenciling. Labels shall be outdoor grade acrylic plastic. Markings on labels shall indicate direction of flow, flowing media, and media design pressure and temperature. Spacing of identification marking shall not exceed 3 meters 10 feet. Provide two copies of complete color and stencil codes used. Frame codes under glass and install where directed.

2.16 FIRE PROTECTION SYSTEM

Provide fuel oil room with a wet sprinkler system as specified in Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION.

2.17 MARKING

Identify equipment, valves, switches, motor controllers, and controls or indicating elements by printed, stamped or manufactured identification plates or tags of rigid plastic or non-ferrous material. Lettering for identification plates or tags shall be not less than 5 mm 3/16 inch high. Nomenclature and identification symbols used on the identification plates or tags shall correspond to those used in maintenance manuals, operating instructions, and schematic diagrams. Rigidly affix identification plates or tags to the equipment or devices without impairing functions or, when this is not possible, attach using a non-ferrous wire or chain. In addition to identification plate or tag, each major component of equipment shall have a nameplate listing manufacturer's name, model number, and when applicable, electrical rating and other information required by pertinent standards or codes.

2.18 TOOLS AND TESTING EQUIPMENT

Provide special tools and wrenches required for installation, maintenance, and operation of equipment. Testing equipment to be provided shall include necessary equipment to perform routine tests:

a. On lubricating oil for acidity (pH-potentiometer), viscosity (saybolt test), and dirt (gravimetric).

b. On softened water for hardness (soap test or colorimetric test), and boiler blowdown water for pH (colorimetric) and conductivity (potentiometer).

c. For water (distillation) and sediment (gravimetric) in fuel oil.

2.19 WELDING MATERIALS

Comply with ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

2.20 MOTORS AND DRIVES

Alternating current electric motors shall meet requirements of NEMA MG 1. Motors shall be designed for continuous operation at rated load under usual service conditions as defined by NEMA. Unless specifically noted otherwise, motors less than 3/8 kW 1/2 hp shall be 115 volt, 60 Hz, single phase, capacitor-start, or permanent split capacitor, with Class B insulation for 40 degrees C 104 degrees F ambient. Unless specifically noted otherwise, motors 3/8 kW 1/2 hp and larger shall be 460 volt, 60 Hz, three phase, Design B, squirrel cage induction with a minimum insulation of Class F for 40 degrees C 104 degrees F ambient. Size motors to meet power requirements of driven unit at design conditions, including drive and coupling losses which are incurred, without loading motor beyond its nameplate horsepower rating. Minimum service factor for open drip-proof motors shall be 1.15 and for totally enclosed, fan cooled motors 1.0. Motor shall be quiet operating. Bearings shall be heavy duty, grease lubricated, anti-friction, single shielded, regreasable type and shall have approved lubricating fittings extended to an easily accessible location for field servicing. Provide sole plates for motors installed on concrete pads. Motor shall have copper windings.

2.20.1 Motors

Motors used to drive equipment specified under "Coal Handling Equipment" shall be designed to operate in Class II, Division II, Group F atmosphere.

2.20.2 SOURCE QUALITY CONTROL

2.20.3 Instrument Air Compressor Package

Factory test air compressor package at full load for not less than 2 hours. Check capacity, smoothness of operation, alternation of units, and proper operation of air unloaders during test.

PART 3 EXECUTION

3.1 INSTALLATION

Install materials and equipment as indicated and in accordance with manufacturer's recommendations.

3.1.1 Boiler and Equipment Installation

Boiler and equipment installation shall be strictly in accordance with this specification, and installation instructions of the manufacturers. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on equipment. Do not bolt flanged joints tight unless they match adequately. Expansion bends shall be adequately extended before installation. Grade, anchor, guide and support piping, without low pockets.

3.1.1.1 Boiler and Equipment Foundations

Of sufficient size and weight, and proper design to preclude shifting of equipment under operating conditions, and under abnormal conditions which could be imposed upon equipment. Design boiler foundation to accommodate and support stoker and incorporate stoker ash pits. Limit equipment vibration to within acceptable limits, and isolate. Foundations shall be adequate for soil conditions of the site and shall meet requirements of the equipment manufacturer. Trowel exposed foundation surfaces smooth except properly roughen surfaces to receive grout.

3.1.1.2 Installing Stoker Ash Pit Firebrick

Lay up in air-setting mortar. Dip each brick in mortar, rub, place into its final position, and then tap with a wooden mallet until it touches adjacent bricks. Mortar thick enough to lay with a trowel will not be permitted. Maximum mortar joint thickness shall not exceed 3 mm 1/8 inch and average joint thickness shall not exceed 1.60 mm 1/16 inch.

3.1.1.3 Forced and Induced Draft Fans

Set, shim level, anchor and grout each fan assembly into place prior to setting driver. Properly shim driver on base plate using steel shim stock. Shims shall be full size of feet and shall have slotted hole for installation. After drive has been properly aligned and shimmed, by an approved millwright, millwright shall drill and ream foot and base plate and install taper pins with nut on top for pullout removal. One front foot and diagonally opposite rear foot shall be pinned to base plate. Equipment shall be adequately bolted in place in an approved manner. Level and grout fan and bearing pedestal sole plates in place.

3.1.1.4 Stack

Install level and plumb. Erected stack shall be no more than 25 mm one inch out of plumb per 15 meters 50 feet. Remove roughness, marks, and lifting lugs, from stack and grind surfaces smooth and flush with surrounding surfaces.

[3.1.1.5 Horizontal Fuel Oil Tanks (Below Ground)

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NOTE: Choose this subparagraph or the subparagraph below, HORIZONTAL FUEL OIL TANKS (ABOVE GROUND), or the following subparagraph VERTICAL FUEL OIL TANK.

****

Provide concrete ballast slabs for tanks and concrete protective ground level slabs for FPR tanks. Ballast slabs shall be full length and width of tanks and protective slabs shall extend 610 mm 2 feet beyond tanks.

Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

a. Install and backfill fiberglass reinforced tanks as recommended by the manufacturer; backfill adjacent to tanks shall be pea gravel unless otherwise recommended by the manufacturer. Backfill for steel tanks shall be sand.

b. Set steel tanks on a bed of sand not less than 152 mm 6 inches deep over the concrete slab and strap in place with stainless steel hold-down straps with stainless steel turnbuckles. Set FRP tanks on a bed of pea gravel not less than 305 mm 12 inches thick and pre-shape for tank contours for FRP tanks. Fabricate straps for FRP tanks from FRP resins reinforced with stainless steel to prevent breaking of straps and floating of empty tanks.

c. Slope tank toward sump not less than 25 mm one inch in each 1 1/2 meters 5 feet.

][3.1.1.6 Horizontal Fuel Oil Tanks (Above Ground)

Continuously support steel tank saddles along the full length of the base and level and grout to ensure full bearing.

][3.1.1.7 Vertical Fuel Oil Tank

Provide [sand, crushed stone or fine gravel cushion] [concrete base].

a. Sand, Crushed Stone or Fine Gravel Cushion: Cover area beneath tank with a fuel resistant plastic membrane with a thickness of not less than 0.51 mm 20 mils. Carefully fuse or cement plastic membrane seams. Lay plastic over a thoroughly compacted select subgrade free from rocks that could puncture the plastic. Over plastic, provide a bed of sand, crushed stone or fine gravel not less than 152 mm 6 inches thick. Stabilize bed with an approved material and shape to tank bottom. Slope bed down to center sump approximately 152 mm 6 inches for each 3 meters 10 feet of tank radius. When in place, tank shell shall be plumb.

b. Concrete base shall be as indicated and in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

c. Mastic Seal: Place mastic seal between tank and concrete ring to the cross section indicated. Compact mastic thoroughly. Immediately before placing mastic, coat tank surfaces to be in contact with concrete ring with a coat of AASHTO M 118bituminous material.

]3.1.2 Piping

Unless specified otherwise, erection, welding, brazing, testing and inspection of piping shall be in accordance with ASME B31.1 and Section 40 17 26.00 20 WELDING PRESSURE PIPING. Piping shall follow the general arrangement shown. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing, except where cold-springing is specified. Piping and equipment within buildings shall be entirely out of the way of lighting fixtures and doors, windows, and other openings. Locate overhead piping in buildings in the most inconspicuous positions. Do not bury or conceal piping until piping has been inspected, tested, and approved. Where pipe passes through building structure, conceal pipe joints but locate where they may be readily inspected and building structure not be weakened. Avoid interference with other piping, conduit, or equipment. Except where specifically shown otherwise, run vertical piping plumb and straight and parallel to walls. Install piping connected to equipment to provide flexibility for vibration. Support and anchor piping so that strain from weight of piping is not imposed on equipment.

3.1.2.1 Fittings

Provide long radius ells on welded piping to reduce pressure drops. Mitering of pipe to form elbows, notching straight runs to form full sized tees, or similar construction shall not be used. Make branch connections with welding tees, except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1 may be provided.

3.1.2.2 Grading of Pipe Lines

Unless indicated otherwise, install horizontal lines of steam and return piping to grade down in the direction of flow with a pitch of not less than 25 mm in 9 meters one inch in 30 feet, except in loop mains and main headers where flow may be either direction. Pitch air lines to source of supply, and make provisions for draining off condensate. Install water lines to drain to a shutoff valve.

3.1.2.3 Anchoring, Guiding, and Supporting Piping

Anchor and support piping in a manner such that expansion and contraction will take place in the direction desired, prevent vibration by use of vibration dampeners, and prevent undue strains on boilers and equipment served. Fabricate hangers used for the support of piping of 50 mm 2 inch nominal pipe size and larger to permit adequate adjustment after erection while still supporting the load. Provide wall brackets where pipes are adjacent to walls or other vertical surfaces which may be used for supports. Provide supports to adequately carry weight of the lines and maintain proper alignment. Provide inserts and sleeves for supports in concrete where necessary and place in new construction before pouring concrete. Provide insulated piping with a pipe covering protection saddle at each support. Provide pipe guides and anchors of approved type at points where necessary to keep pipes in accurate alignment, to direct expansion movement, and to prevent buckling and swaying and undue strain. Provide pipe guides for alignment of pipe connected to free unanchored end of each expansion joint. Support pipe rollers in concrete conduits and trenches by extra strong steel pipe with ends inserted in slots provided in concrete walls. Set pipe supports for rollers at correct elevations either by metal shims or by cutting away of concrete and after pipe lines have been placed in alignment, grout ends of pipe supports and fix in place. Space pipe supports to provide adequate support for pipes. Pipe shall not have pockets formed in the span due to sagging of pipe between supports, caused by weight of pipe, medium in the pipe, insulation, valves, and fittings. Maximum spacing for pipe supports for steel pipe shall be in accordance with ASME B31.1; maximum spacing for supports for copper tubing shall be in accordance with MSS SP-58.

3.1.2.4 Copper Tubing

Copper tubing shall have solder joints with solder suitable for pressure-temperature ratings of piping system. Tubing 20 mm 3/4 inch and smaller for instrument air may be compression joint in lieu of soldered joint. Tin-antimony (95/5) solder is suitable for saturated steam up to 103 kPa (gage) 15 psig but tin lead (50/50) solder is not acceptable for steam service. Flux shall be non corrosive. Wipe excess solder from the joints.

3.1.2.5 Sleeves

Provide pipe sleeves where pipes and tubing pass through masonry and concrete walls, floors, and partitions. Space between pipe, tubing, or insulation and the sleeve shall be not less than 6 mm 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, and slabs. Sleeves in floor slabs shall extend 13 mm 1/2 inch above the finished floor. Firmly pack space between pipe or tubing and the sleeve with oakum and caulk on both ends of sleeve with elastic cement.

3.1.2.6 Flashing for Buildings

Where pipes pass through building roofs and outside walls, provide proper flashing and counter flashing and make tight and waterproof.

3.1.2.7 Outlets for Future Connections

Locate as directed capped or plugged outlets for connections to future equipment, when not located exactly by project drawings.

3.1.2.8 Screwed Joints in Piping

Use teflon tape or suitable pipe joint compound applied to male threads only for making up screwed joints. Piping shall be free from fins and burrs. Ream or file out pipe ends to size of bore, and remove chips.

3.1.2.9 Welded Joints

Weld joints in piping by the metal-arc or gas welding processes in accordance with ASME B31.1 and as specified in Section 40 17 26.00 20 WELDING PRESSURE PIPING. Number or mark each weld to identify the work of each welder on welds on which stress relieving or radiographic inspection is required.

a. Contracting Officer reserves the right to require the Contractor to provide re-examination and recertification of welders.

b. Radiographic testing of circumferential butt welded joints of pipe with operating temperature of 177 degrees C 350 degrees F and above shall be required on ten percent of the joints, the location of which will be determined by the Contracting Officer; when more than ten percent of the radiographically tested joints show unacceptable defects radiographically test every joint of this type piping.

c. Equipment and Protection: Items of equipment for welding shall be so designed and manufactured, and shall be in such condition as to enable qualified operators to follow procedures and to attain results specified. Protect welders and gas cutters from the light of the arc and flame by approved goggles, shields, helmets, and gloves. Replace cover glasses in helmets and shields when they become sufficiently marred to impair the operator's vision. Take care to avoid risk of explosion and fire when welding and gas cutting near explosive or flammable materials. Ventilate welding and gas cutting operations in accordance with paragraph 1910.252 (f) of 29 CFR 1910-SUBPART Q.

d. Surface Conditions: Do not weld when atmospheric temperature is less than minus 18 degrees C zero degrees F, when surfaces are wet, when rain or snow is falling or moisture is condensing on surfaces to be welded, nor during periods of high wind, unless welder and work are protected properly. At temperatures between 0 degrees C and minus 18 degrees C 32 degrees F and zero degrees F, heat with a torch the surface for an area within 80 mm 3 inches of the joint to be welded to a temperature warm to the hand before welding. Free surfaces to be welded from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces shall be smooth, uniform and free from fins, tears, and other defects which might affect proper welding. Remove slag from flame-cut edges to be welded by grinding, but temper color need not be removed. Thoroughly clean each layer of weld metal by wire brushing prior to inspection or deposition of additional weld metal.

3.1.2.10 Cleaning of Piping

Before installing pipe, thoroughly clean pipe of sand, mill scale and other foreign material. After erection but before making final connections to apparatus, thoroughly clean interior of piping. Flush piping with water except air and fuel lines. In addition, blow out steam lines with intermittent high pressure steam blows to promote shedding of internal scale. Blow compressed air and fuel oil lines clean with 552 to 690 kPa (gage) 80 to 100 psig air dried to a 2 degrees C 35 degree Fdew point at 552 kPa (gage) 80 psig. Sterilize potable water piping by means of liquid chlorine or hypochlorite in accordance with AWWA C651 before placing water system in service. Take care during fabrication and installation, to keep piping, valves, fittings and specialties free of loose welding metal chips of metal or slag, welding rods and foreign matter. Blowing or flushing shall in no case be channeled through equipment, pump, control valve, regulating valve, instrument gage or specialty in the system. Provide temporary screens, strainers, connections, spool pieces and bypasses consisting of piping or hoses, pumps and other required equipment temporarily installed for the purpose of cleaning and flushing piping. Drain flushing water and test water to the sanitary sewer system.

3.1.2.11 Reduction in Pipe Size

Provide reducing fittings for changes in pipe size; bushings will not be permitted. In horizontal steam lines, reducing fittings shall be the eccentric type to maintain bottom of lines in the same plane. In horizontal water mains, reducers shall be set to maintain top of lines in the same plane.

3.1.2.12 Expansion Control

Provide bends, loops, and offsets wherever practical to relieve overstressed piping systems due to thermal expansion and to provide adequate flexibility. Cold spring piping system as indicated but not more than 50 percent of the total linear expansion.

3.1.2.13 Connection to Equipment

Provide unions or flanges where necessary to permit easy disconnection of piping and apparatus. Provide unions and gate valves at each connection to threaded end control valves, strainers and equipment.

3.1.2.14 Valve Installation

Install valves in positions accessible for operation and repair. Install stems in a vertical position with handwheels or operators on top or in a horizontal position. Do not install handwheels on stop valves below the valve. When centerline of valve is more than 2 meters 7 feet above floor or platform, provide valve with a chain-operated handwheel. When valve is motorized, provide hand operation for emergency use.

a. Gate Valves: Arrange back outlet gate valves for turbine exhaust for hand operation and provide with a floor stand.

b. Globe Valves: Pressure shall be below the disc. Install globe valves with stems horizontal on steam and exhaust lines, when better drainage is required or desired.

c. Steam Pressure-Reducing Valves: Provide steam line entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two shutoff valves and with a globe or angle bypass valve and bypass pipe. A bypass around a reducing valve shall be of reduced size to restrict its capacity to approximately that of the reducing valve. Provide each pressure-reducing valve unit with indicating steam gages to show reduced pressure and upstream pressure and an adequately sized safety valve on low pressure side.

d. Valve Tags and Charts: Permanently tag each valve with a black and white engraved laminated plastic tag showing valve number, valve function and piping system and whether another valve must be opened or closed in conjunction with this valve. Furnish a typed chart which will show required valve tagging plus the location of each valve. Frame valve charts under glass and install as directed.

3.1.2.15 Traps and Connections

Traps shall be of the type and capacity for the service required, and shall be properly supported and connected. Except for thermostatic traps in pipe coils, radiators, and convectors, install traps with a dirt pocket and strainer between trap and piping or apparatus it drains. When it is necessary to maintain in continuous service, apparatus or piping which is to be drained, provide a three valve bypass so that trap may be removed and repaired and condensate drained through the throttled bypass valve. Provide a check valve on the discharge side of the trap when trap is installed for lift or operating against a back pressure, or trap discharges into a common return line. Provide test connections on the discharge side of the high and medium pressure traps when specifically required. Test connection shall include a 1/2-inch globe valve with open blow.

3.1.2.16 Pressure Gage Installation

Provide with a shutoff valve or petcock between the gage and the line, and provide gage on steam lines with a siphon installed ahead of the gage.

3.1.2.17 Thermometers and Thermal Sensing Element of Control Valves

Provide with a separable socket. Install separable sockets in pipe lines in such a manner to sense the temperature of the flowing fluid and minimize obstruction to flow.

3.1.2.18 Strainer Locations

Provide strainers with meshes suitable for the services upstream of each control valve and where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.1.2.19 Dissimilar Piping Materials

Provide dielectric unions or flanges between ferrous and nonferrous piping, equipment, and fittings, except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or nonferrous-to-nonferrous connections. Dielectric fittings shall utilize a nonmetallic filler which will prevent current flow from exceeding one percent of the short circuit current. Spacer shall be suitable for pressure and temperature of the service. Fittings shall otherwise be as specified in this section.

3.1.2.20 Surface Treating, and Pipe Wrapping

Uninsulated steel piping buried in the ground shall have exterior surfaces protected with a tape wrapping system or a continuously extruded polyethylene coating system as specified in Section 09 97 13.28 PROTECTION OF BURIED STEEL PIPING AND STEEL BULKHEAD TIE RODS.

3.1.3 PAINTING

3.1.3.1 Piping, Fittings, and Mechanical and Electrical Equipment

Equipment shall be factory finished to withstand the intended end use environment in accordance with the specifications for particular end item. Retouch damaged areas on factory finished equipment on which finish has been damaged and then give a complete finish coat to restore finish to original condition. Finish coat shall be suitable for exposure in the intended end use environment.

3.1.3.2 Painting

Unless specified otherwise, paint pipe hangers, structural supports, pipe and pipe fittings, conduit and conduit fittings, air grilles, pipe coverings, insulation, and metal surfaces associated with mechanical and electrical equipment including zinc-coated steel ducts as specified in Section 09 90 00 PAINTS AND COATINGS. Zinc-coated steel duct in unpainted areas shall not be painted. Apply a protective coating to piping to be insulated, except zinc-coated and copper pipe, prior to installing insulation.

3.1.3.3 Boilers

After erecting and testing boilers, clean as necessary exposed surfaces of the boiler normally painted in commercial practice to remove grease, coal dust, flyash and other foreign matter and finish with one coat of aluminum heat resisting paint applied to minimum dry film thickness of 0.025 mm one mil.

3.1.3.4 Vertical Fuel Oil Tank

Clean interior surfaces to bare metal in accordance with

SSPC SP 10/NACE No. 2. Clean to bare metal by powered wire brushing or other mechanical means surfaces that cannot be cleaned satisfactorily by blasting. Wash members which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Remove weld backing plates prior to blast cleaning; when left in place, round off corners prior to blast cleaning and coating.

3.1.3.5 Surfaces Not to be Painted

Unless specified otherwise, do not paint equipment having factory applied permanent finish, switchplates and nameplates, motor starters, and concrete foundations.

3.1.4 INSULATION

Insulate mechanical equipment, systems and piping as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2 FIELD QUALITY CONTROL

Provide labor, equipment, test apparatus and materials required for preparation and performance of tests and inspections specified to demonstrate that boilers and auxiliary equipment as installed are in compliance with contract requirements. During start up and during tests, ensure that factory trained engineers or technicians employed by the boiler manufacturer and system suppliers or manufacturers of such components as the boiler, burner, forced draft fan, feedwater treatment equipment, and other auxiliary equipment be present, to ensure the proper functioning, adjustment, and testing of the individual components and systems. Furnish a detailed written record of test conditions, test procedures, field data, and start up and operational performance of the entire heating plant to the Contracting Officer before the Contractor's operational and test personnel leave the site. The Government will furnish, if available, water, electricity and fuel for the tests, except fuel required for retesting. The Contractor shall rectify defects disclosed by tests and retest equipment. The Contractor's boiler plant personnel shall be experienced in starting up and operating boiler plants.

3.2.1 Tests and Inspections (Piping)

Examine, inspect, and test piping in accordance with ASME B31.1except as modified below. Rectify defects disclosed by tests. Necessary subsequent tests required to prove system tight after additional work by the Contractor shall be provided by the Contractor. Make tests under the direction of and subject to the prior approval of the Contracting Officer.

3.2.1.1 Hydrostatic and Leak Tightness Tests

a. Perform hydrostatic and leak tightness test on piping systems attached to the boilers and included under jurisdiction of ASME BPVC SEC I in accordance with requirements of that Code. Piping bearing ASME Code symbol stamp will be accepted only as indicating compliance with the design and material requirements of the code.

b. Test piping which is a part of the steam generation or auxiliary systems, including piping within the boiler room and external to the boiler room, by the following methods:

    (1) Perform hydrostatic test at 150 percent of design pressure for

welded and screwed steel piping systems except those for air, oil, and gas. Hold hydrostatic tests for a period of one hour with no pressure loss. Temperature of testing fluid shall not exceed 38 degrees C 100 degrees F.

(2) Test air and oil lines in accordance with requirements of ASME B31.1 for pneumatic tests with exception that the test pressure shall be held for one hour. Examination for leaks shall be by a soap or other foaming agent test.

(3) Inspection and test of gas piping shall conform to the requirements of NFPA 54.

c. For tests install a calibrated test pressure gage in the system to observe loss in pressure.

3.2.2 Preliminary Operation

The Contractor under the direction of the respective manufacturer's representative shall place in operation equipment provided by the Contractor except as specifically noted otherwise. Make adjustments to equipment that are necessary to ensure proper operation as instructed by the equipment manufacturer.

a. Lubricate equipment prior to operation in accordance with manufacturer's instructions. Provide lubricants. Furnish lubrication gun with spare cartridges of lubricant to operating personnel.

b. Dry out motors before operation as required to develop and maintain proper and constant insulation resistance.

c. Check drive equipment couplings for proper alignment at both ambient and operating temperature conditions.

3.2.3 General Start-Up Requirements

Prior to initial operation of complete system, check each component as follows:

a. Inspect bearings for cleanliness and alignment and remove foreign materials found. Lubricate as necessary and in accordance with manufacturer's recommendations. Replace bearings that run roughly or noisily.

b. Adjust direct drives for proper alignment of flexible couplings. Provide lubrication when a particular coupling so requires. Check security of couplings to driver shafts. Set drive components to ensure free rotation with no undesirable stresses present on the coupling of attached equipment.

c. Check motors for amperage comparison to nameplate value. Correct conditions that produce excessive current flow and that exist due to equipment malfunction.

d. Check speeds of each motor and driven apparatus to ensure that motors are operating at the desired point.

e. Check actual suction and discharge pressure of each pump against desired performance curves.

f. Check pump packing glands or seals for cleanliness and adjustment before running each pump. Inspect shaft sleeves for scoring and proper placement of packing; replace when necessary. Ensure piping system is free of dirt and scale before circulating liquid through pumps.

g. Inspect both hand and automatic control valves. Clean bonnets and stems, tighten glands to ensure no leakage, but permit valve stems to operate without galling. Replace packing in valves that require same to retain maximum adjustment after system is judged complete. Replace entire packing in valves that continue to leak after adjustment. Remove and repair bonnets that leak. Coat packing gland threads and valve stems with a suitable surface preparation after cleaning.

h. Inspect and make certain that control valve seats are free from foreign matter and are properly positioned for intended service.

i. Check flanges and packing glands after system has been placed in operation. Replace gaskets in flanges that show signs of leakage after tightening.

j. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts, apply compound and remake joint.

k. Thoroughly blow out strainers through individual valved blow-off connection on each strainer prior to placing in operation.

l. Thoroughly blow out or dismantle and clean strainers after systems have been in operation one week. Thoroughly clean, repair, and place back in service traps or other specialties in which foreign matter has accumulated, causing malfunction or damage.

m. Adjust pipe hangers and supports for correct pitch and alignment.

n. Remove rust, scale and foreign materials from equipment and renew defaced surfaces. When equipment is badly marred, the Contracting Officer shall have authority to request new materials be provided.

o. Adjust and calibrate temperature, pressure and other automatic control systems.

p. Inspect each pressure gage and thermometer for calibration, and replace those that are defaced, broken or read incorrectly.

[q. Vertical Fuel Oil Tank Calibration: After completing installation of tank, prepare a calibration table for the tank showing fuel volume in liters gallons in the tank to any height of liquid in meters and mm feet, inches, and eighths of an inch when measured by a steel tape lowered through the roof. Calibrate tank in accordance with[API MPMS 2.2A][API MPMS 2.2B] for "critical measurement" "operating control." Perform calibration of tank by a qualified organization that can certify to at least 2 years of prior successful and accurate experience in calibrating tanks of comparable type and size. Correct data obtained for use with product to be stored.

]3.2.4 Plant Equipment Tests

3.2.4.1 Plant Air Compressors

Test plant air compressors in service to determine compliance with contract requirements and warranty. During tests, test equipment under every condition of operation. Test safety controls to demonstrate performance of their required function. Completely test system for compliance with specifications.

3.2.4.2 Instrument Air Compressors

Test air compressor package at full load for not less than 2 hours. Check capacity, smoothness of operation, alternation of units, and proper operation of the air unloaders during the test.

3.2.4.3 Coal Handling System

Test coal handling system under operating conditions and demonstrate that work is in conformance with the specified requirements. Conduct this test in the presence of the Contracting Officer.

3.2.4.4 Ash Handling System

Test ash handling system under operating conditions and demonstrate that work is in conformance with specified requirements. Conduct test in the presence of the Contracting Officer.

[3.2.4.5 Horizontal Fuel Oil Tanks (Below Ground)

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NOTE: Choose this subparagraph or the subparagraph below, VERTICAL FUEL OIL TANK.

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a. Test tanks before placing in service, in accordance with applicable paragraphs of the code under which tanks were built.An UL label, ASME Code Stamp, or API monogram on a tank shall be evidence of compliance with code requirements.

b. Holiday Detection Test: Inspect coal tar epoxy coating system for film imperfections using a low voltage (75 volt) holiday tester. Inspect FRP coated tanks with a 10,000 volt spark test for imperfections or holidays. Repair holidays or pinholes in the coatings.

][3.2.4.6 Vertical Fuel Oil Tank

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NOTE: Choose this subparagraph or the subparagraph above, HORIZONTAL FUEL OIL TANKS (BELOW GROUND).

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Inspect and test vertical fuel oil tank as specified in API Std 650. Use the radiographic method of inspection of butt welds as required by API Std 650; sectioning method will not be acceptable as an alternative to radiographic inspection.

]3.2.4.7 Blowdown Valves and Try Cocks

Test blowdown valves and try cocks for proper operation.

3.2.4.8 Draft Fans, Fuel Oil Heaters, Fuel Pumps, and Electric Motors

Test draft fans, fuel oil heaters, fuel pumps, and electric motors to determine compliance with the referenced standards. Standard symbols and certifications from the referenced organization may be accepted at the discretion of the Contracting Officer. Closely observe the operation of fans, fuel oil heaters, fuel pumps, and electric motors[including variable speed motor controllers] and correct defects.

3.2.5 Boilers and Auxiliaries Tests and Inspections

The Contractor, with qualified personnel provided by the Contractor, shall make tests and inspections at the site under the direction of and subject to the approval of the Contracting Officer. The Contractor's boiler plant personnel under the direction of the respective manufacturer's representatives and consultants, shall operate each boiler and appurtenances through the entire testing period and shall ensure that necessary adjustments have been made. Notify the Contracting Officer in writing at least 7 days in advance that equipment is ready for testing. The Contractor shall provide testing equipment, including gages, thermometers, calorimeter, Orsat apparatus, thermocouple pyrometers, fuel flow meters, water meters and other test apparatus and calibrate instruments prior to testing. Draft, fuel pressure and steam flow may be measured by permanent gages and meters installed under the contract. The Contractor is responsible for providing an analysis of the fuel being used for the tests. Control of noise levels developed by exhaust steam shall be as directed by the Contracting Officer to satisfy environmental conditions of the surrounding area. Perform the following tests and, when feasible, in the sequence listed:

a. Strength and tightness tests

b. Standards compliance tests

c. Preliminary operational tests (steady state combustion test and variable load combustion test)

d. Tests of auxiliary equipment

e. Feedwater equipment test

f. Capacity and efficiency tests

3.2.5.1 Strength and Leak Tightness Tests

Subject the boiler[s] to the following strength and tightness tests:

a. Watersides Including Fittings and Accessories: Hydrostatically test watersides in accordance with requirements of ASME BPVC SEC I. The ASME label will be accepted as evidence of this test.

b. Boiler Casing, Breeching and Ductwork: Prior to installing breeching and ductwork, boiler[s] [on the furnace side] shall be pneumatically tested, at the maximum possible draft pressure of the boiler furnace; the soap bubble method [and] [or] a smoke test shall be used to verify tightness of the casing. Boiler casing, breeching and ductwork shall be pressurized with the forced draft fan to the maximum draft pressure; the smoke test shall be used to verify tightness of the casing, breeching and ductwork. Leaks observed or detected shall be sealed.

3.2.5.2 Boiler Inspection

Ensure that the Boiler Inspector is present to witness the appropriate tests which need to be observed in order to certify the safety of the boiler. The inspection shall include requirements of NAVFAC MO 324. The Boiler Inspector shall complete NAVFAC form 9-11014/40, Data Record Sheet; NAVFAC form 9-11014/41, Inspection Report; NAVFAC form 9-11014/32 Inspection Certificate for each boiler after boiler has been inspected and found to be safe. No boiler may be fired until it has passed the inspection of the Boiler Inspector. The boiler inspection forms shall be submitted through the Contractor to the Contracting Officer. Place the Inspection Certificate under framed glass, and mounted on or near the boiler in a conspicuous location.

3.2.5.3 Boiler Cleaning and Startup

Dry out, boil out, and operate the firing rate of the new boiler[s] under direct responsibility and supervision of the manufacturer[, and in the presence of the boiler room operating personnel]. Provide chemicals that are required. Allow sufficient time for the boiling out process to ensure interior surfaces are clean. This time shall be at least 24 continuous hours and generally not more than 36 hours; boil out shall continue until water is clear. Boil out, cleaning and starting procedures shall be in accordance with requirements of ASME BPVC SEC VII and FM DS 12-17.

3.2.5.4 Boiler Preliminary Operational Tests

Conduct a boiler operational test on each unit continuously for two weeks. Operate one boiler at a time to demonstrate control and operational conformance to requirements of the specifications including ability to respond to load swings from the specified capacity to minimum turndown. Operational test shall be under the supervision of a registered professional engineer or a licensed power plant operator and shall serve to prove safeties, controls, maintenance of stable combustion at low loads, [proper coal distribution and combustion, and ability to operate without furnace slagging,] [proper flame lengths and patterns to avoid flame impingement on the tubes for oil firing,] and proper mechanical and electrical functioning of each system. Test shall include items specified in this section as well as items mentioned in the specification of the particular pieces of equipment. Conduct tests with factory trained combustion equipment engineers as previously specified. Test and record steam quality, steam flowrates, flue gas temperature, percentages of carbon dioxide, carbon monoxide, oxygen and nitrogen in flue gas and percent excess air for each boiler at tested load and graphically present the test data.

3.2.5.5 General Operational Tests

a. Steady State Combustion Tests: Test fuel burning and combustion control equipment with each of the specific fuels at the minimum limit of the turndown range and at increments of 50, 75 and 100 percent of full rated load. Each test run shall be at least two hours on each fuel and until stack temperatures are constant and capacity and efficiency requirements of this specification have been verified and recorded. Verify proper operation of instrumentation and gages during the tests.

b. Varying Load Combustion Tests: Test boiler continuously under varying load conditions to demonstrate proper operability of the combustion control, flame safeguard control, programming control and safety interlocks. Conduct these tests after adjustment of combustion controls has been completed under the steady state combustion tests. Continue variable load operational tests for a period of at least 8 hours.

(1) Sequencing: Boiler shall start, operate and stop in strict accordance with the specified operating sequence.

(2) Flame Safeguard: Verify operation of the flame safeguard controls by simulated flame and ignition failures. Verify trial-for-main flame ignition, combustion control reaction and valve closing times by stop watch.

(3) Immunity to Hot Refractory: Operate burner at high fire until combustion chamber refractory reaches maximum temperature. Main fuel valve shall then be closed manually. Combustion safeguard shall drop out immediately causing the safety shutoff valves to close within the specified control reaction and valve closing times.

[(4) Pilot Intensity Required: Gradually reduce the fuel supply to the pilot flame to the point where the combustion safeguard begins to drop out (sense "no flame") but holds in until the main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame shall be capable of safely igniting the main burner. When the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, the boiler shall be rejected.

] (5) Boiler Limit and Fuel Safety Interlocks: Safety shutdown shall be caused by simulating interlock actuating conditions for each boiler limit and fuel safety interlock. Safety shutdowns shall occur in the specified manner.

(6) Combustion Controls: Demonstrate accuracy, range and smoothness of operation of the combustion controls by varying steam demand through the entire firing range required by the turndown ratio specified for the burner. The control accuracy shall be as specified.

(7) Safety Valves: High pressure limit switch shall be locked out or otherwise made inoperative and boiler safety valves shall be lifted by steam. Determine relieving capacity, popping pressure, blowdown and reseating pressure by observation and measurement in accordance with ASME BPVC SEC I. The ASME standard symbol will be accepted only as indicating compliance with design and material requirements of the code.

3.2.5.6 Auxiliary Equipment and Accessory Tests

Observe and test blowdown valves, stop valves, try cocks, draft fans, fuel oil heaters, pumps, electric motors, and other accessories and appurtenant equipment during operational and capacity tests for leakage, malfunctions, defects, and for compliance with referenced standards.

3.2.5.7 Feedwater Equipment Tests

Perform test of the feedwater treatment equipment in two steps. Conduct one test concurrently with the combustion tests. The Government will perform a second test during the first period of heavy loading after the plant has been accepted and put in service. Correct deficiencies revealed during the Government tests under the guarantee provisions of the contract. Both the first and second series of tests shall determine compliance with the limits for chemical concentrations of this specification. Supply equipment for taking samples and test kit for analyzing the samples. Sampling equipment and test kit shall become the property of the Government when tests are completed.

3.2.5.8 Capacity and Efficiency Tests

Perform capacity and efficiency tests after operating tests have been satisfactorily completed and boiler has been operated continuously for at least 14 days with no nuisance shutdowns and without the necessity for frequent or difficult adjustments. Perform capacity and efficiency tests on each boiler. Conduct tests using specified fuel[s]. Test procedures shall be in accordance with the heat loss method[and the input-output method] of ASME PTC 4. Before performing tests, the Contracting Officer and the Contractor shall reach agreement on those items identified in ASME PTC 4, Section 3, paragraph 3.01 "Items on Which Agreement Shall be Reached." A test run shall not start until boiler and accessories have reached an equilibrium and stabilization condition for at least one hour in duration. Duration of tests shall be sufficient to record necessary data but in no case shall each run be less than [4] [10] [24] hours.

a. Accomplish maximum output testing by means of a single 2 hour run at 110 percent load on the boiler under test. Calculate boiler efficiency, both input-output and heat loss, from the consistent readings taken during the runs. Runs shall be made at four different loads 30, 50, 70, and 100 percent of boiler rating during which both heat loss and input-output data shall be taken. Predict unmeasured losses used in conjunction with heat loss calculations and include with equipment data when submitted for approval. Subsequent tests required because of failure of the equipment to perform adequately during specified capacity and efficiency tests shall be the financial responsibility of the Contractor, including the cost of fuel.

b. Should analysis of the fuel being burned during performance tests vary from that specified as the performance fuel, adjust guarantees in accordance with accepted engineering practice to determine compliance. Carbon loss shall be determined in accordance with ABMA Boiler 103.

3.2.5.9 Temporary Waste Steam Connection

When necessary to obtain sufficient load for these tests, provide a temporary steam line at a point outside the building. Provide necessary pipe, fittings, supports, anchors and appurtenances including a field fabricated silencer as directed by the Contracting Officer. Remove temporary piping and silencer after satisfactorily completing tests.

[3.2.5.10 Fire Safety for Oil-Fired Boilers

Conduct tests as necessary to determine compliance with the applicable UL

Safety Standards. The presence of the applicable Underwriters' label may be accepted as evidence of compliance in this respect.

a. Oil-fired Boilers: Meet test requirements of UL 726.

b. Oil Burners: Meet test requirements of UL 296.

]3.2.5.11 Plant Acceptance Operation

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NOTE: Include bracketed portion if project is for coal fired installation with flue gas desulfurization system.

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After satisfactory completion of tests specified, operate the complete plant including each boiler[, its related flue gas cleaning equipment] and subsystems for a period of 30 continuous 24 hour operational days prior to final acceptance by the Government. Furnish labor, chemicals, test equipment and apparatus; the Government will furnish fuel, electricity and water. During this 30 day period, provide readily available, the services of qualified representatives from manufacturers of plant components and systems for the purpose of additional operational assistance, component and system adjustment and repairs. Government personnel will observe Contractor's operational procedures and will be asking pertinent questions, which the Contractor's representatives shall answer, about plant operation.

3.2.5.12 NAVFACENGCOM Acceptance

Operational, piping systems, auxiliary equipment and accessory tests shall be conducted prior to requesting an acceptance inspection by a Naval Facilities Engineering Systems Command (NAVFACENGCOM) Boiler Inspector. The Contracting Officer, upon receipt of 14 calendar days advance notice from the Contractor, shall request the boiler be inspected by a NAVFACENGCOM Boiler Inspector. The Contractor shall perform final operational performance testing of all plant systems in the presence of the NAVFACENGCOM Boiler Inspector, at the discretion of the NAVFACENGCOM Boiler Inspector. The NAVFACENGCOM Boiler Inspector shall receive copies, and review the results, of all pertinent operational test reports before approving acceptance of the boiler plant by the Government.

3.2.6 Manufacturers Field Services

3.2.6.1 Erection/Installation Supervisors and Service Engineers

a. Boiler: Furnish the services of a competent supervisor who is in the direct employ of the boiler manufacturer. Supervisor shall remain on the construction site the full 8 hours per day, 5 days per week, or the same hours, that the boiler installation takes place. Supervisor shall be responsible for the complete steam generating unit, including steam generator, stoker,[burner,] fans and related work, such as refractory, or insulation regardless of whether stoker,[burner,] fans or other related items of work are furnished by manufacturers other than the boiler manufacturer.

b. Stoker: Furnish a competent erection supervisor for the equipment furnished by the stoker manufacturer.

c. Fans: Furnish a company service engineer to advise on the erection or installation of fans and related equipment.

d. Service Engineers: Services of the manufacturing companies' service engineers and the system suppliers' service engineers shall be provided by the Contractor to advise during erection and installation of other systems and equipment such as control system, coal handlings system, ash handling system, air compressors, air dryers, boiler feedwater pumps, fuel oil pumps, condensate pumps, water treatment equipment, chemical feed pumps, deaerating feedwater heater and stacks.

3.2.6.2 Boiler and System Representatives

a. Furnish factory trained engineers or technicians who are representatives of the boiler manufacturer and system suppliers to supervise testing of the boilers and auxiliary equipment.

b. Furnish the services of a Boiler Inspector who is qualified and certified as such by the National Board of Boiler and Pressure Vessel Inspectors and who is presently employed full time by an independent firm, such as Hartford Steam Boiler Inspection and Insurance Company, which has a business of inspecting boilers.

3.2.7 Instruction to Government Personnel

In accordance with the provisions of Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, supervisors and service engineers shall provide instruction for the Government's operators in the operation and maintenance of the equipment furnished under this section. The minimum number of hours provided shall be as follows:

Equipment	Operation Instruction	Maintenance Instruction
Boiler and auxiliaries	40 hours	16 hours
Stoker	40 hours	16 hours
FD and ID fans	16 hours	16 hours
Coal handling system	16 hours	32 hours
Ash handling system	24 hours	8 hours
Air compressors and dryers	8 hours	16 hours
Boiler feedwater pumps	8 hours	8 hours
Miscellaneous equipment	16 hours	16 hours

3.2.8 SCHEDULE

Some metric measurements in this section are based on mathematical

conversion of inch-pound measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
Steam Gage	12 inch diameter	300 mm diameter
Boiler	4,000-18,000 #/hr capacity	1/2-2 1/4 kg/sec capacity
Electric Motor	10 hp	7 1/2 kW
Thermometer	5 inch Dial	125 mm Dial
Pressure Gage	6 inch Dial	180 mm Dial

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 52 33.02 20 (November 2008)**
Change 5 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-23 52 33.02 20 (July 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-23 52 33.02 20 (November 2008)**
Change 5 - 02/22

Preparing Activity: NAVFAC **Superseding**
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SECTION 23 52 33.02 20

STEAM HEATING PLANT WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL

11/08, CHG 5: 02/22

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NOTE: This guide specification covers the requirements for steam heating plants from 7 1/2 to 60 1/2 kg/sec 60,000 to 480,000 lbs/hr steam capacity using a field erected watertube boiler.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This guide specification covers requirements for equipment for a steam heating plant which will generate from 7 1/2 to 60 1/2 kg of steam per second 60,000 to 480,000 pounds of steam per hour. This specification is intended to be used in the procurement and installation of heating plant equipment. Requirements for materials and procedures for special or unusual design shall be added to and modifications made to this specification as necessary to fit specific projects. This guide specification shall be used in conjunction with the following NAVFAC definitive drawings:

NAVFAC NO./DRAWING TITLE

1429345 - STEAM HEATING PLANT NO.5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE PLAN

1429346 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL MAIN FLOOR PLAN

1429347 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL BASEMENT FLOOR PLAN

1429348 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL LONGITUDINAL SECTION

1429349 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL TRANSVERSE SECTION

1429350 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL PIPING SCHEMATIC

1429351 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL PIPING SCHEMATIC

1429352 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED)

1429353 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL CONTROL SCHEMATIC

1429354 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL HANDLING CONTROLS

1429355 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL DETAILS

1429357 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL FUEL OIL UNLOADING

1429358 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL FUEL OIL STORAGE

1429359 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE DETAILS-COAL HANDLING

1429360 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD

ERECTED) COAL/OIL OR COAL RESERVE COAL STORAGE

1429361 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE PLAN - ELECTRICAL

1429362 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL BASEMENT FLOOR PLAN - ELECTRICAL

1429363 - STEAM HEATING PLANT NO. 5 7 12/ - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL MAIN FLOOR PLAN - ELECTRICAL

1429364 - STEAM HEATING PLANT NO. 5 7 1/2 - 34 kg/sec 60,000 - 270,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL ONE-LINE DIAGRAM - ELECTRICAL

1429366 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE PLAN

1429367 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL MAIN FLOOR PLAN

1429368 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL BASEMENT FLOOR PLAN

1429369 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL LONGITUDINAL SECTION

1429370 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL TRANSVERSE SECTION

1429371 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL PIPING SCHEMATIC

1429372 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL PIPING SCHEMATIC

1429373 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL CONTROL SCHEMATIC

1429374 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL CONTROL SCHEMATIC

1429375 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE

(FIELD ERECTED) COAL/OIL OR COAL COAL HANDLING CONTROLS

1429376 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL DETAILS

1429378 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL FUEL OIL UNLOADING

1429379 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL FUEL OIL STORAGE

1429380 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE DETAILS-COAL HANDLING

1429381 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL RESERVE COAL STORAGE

1429382 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL SITE PLAN - ELECTRICAL

1429383 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL

1429384 - BASEMENT FLOOR PLAN - ELECTRICAL STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL MAIN FLOOR PLAN - ELECTRICAL

1429385 - STEAM HEATING PLANT NO. 6 25 1/4 - 60 1/2 kg/sec 200,000 - 480,000 POUNDS PER HOUR WATERTUBE (FIELD ERECTED) COAL/OIL OR COAL ONE-LINE DIAGRAM - ELECTRICAL

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)

ABMA Boiler 103	(2001) Selected Codes and Standards of the Boiler Industry

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2011	(2014B) Cylindrical Wormgearing Tolerance and Inspection Methods
ANSI/AGMA 2009	(2001B; R 2008) Bevel Gear Classification, Tolerances, and Inspection Methods

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings
ANSI/AISC 303	(2022) Code of Standard Practice for Structural Steel Buildings and Bridges

AMERICAN PETROLEUM INSTITUTE (API)

API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats
API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B29.100	(2011) Precision Power Transmission, Dbl-P-Power Transmission, Dbl-P-conveyor Roller Chains, Attachments and Sprockets
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-A	(2017) BPVC Section II-Materials-Part A-Ferrous Materials Specifications
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC VII	(2017) BPVC Section VII-Recommended Guidelines for the Care of Power Boilers
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
ASME PTC 4	(2013; R 2023) Fired Steam Generators

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C510	(2017; R 2021) Double Check Valve Backflow Prevention Assembly
AWWA C511	(2017; R 2021) Reduced-Pressure Principle Backflow Prevention Assembly
AWWA C651	(2023) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A211	(1975; R 1985) Specification for Spiral-Welded Steel or Iron Pipe
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved

	Formability, and Ultra-High Strength
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM C27	(1998; R 2022) Fireclay and High-Alumina Refractory Brick
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C401	(2012; R 2022) Alumina and Alumina-Silicate Castable Refractories
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM D1047	(2016) Poly(Vinyl Chloride) Jacket for Wire and Cable
ASTM D1220	(1965; R 1990) Measurement and Calibration of Upright Cylindrical Tanks

FM GLOBAL (FM)

FM DS 12-17	(2001) Watertube Boilers

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-27	(1991) National Board Rules and Recommendations for the Design and Construction of Boiler Blowoff Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA MG 1	(2021) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code

PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION (PHCC)

NAPHCC NSPC	(2015) National Standard Plumbing Code Illustrated

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 11.01	(1982; E 2004) Black (or Dark Red) Coal Tar Epoxy Polyamide Painting System
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-18480	(1982; Rev B; Notice 2 2009; Notice 3 2022) Coating Compound, Bituminous, Solvent, Coal-Tar Base
MIL-DTL-17813	(2009; Rev H; Supp 1 2009; Notice 1 2013; Notice 2 2018; Notice 3 2023) Expansion Joints, Pipe, Metallic Bellows, General Specification for
MIL-DTL-18436	(2017; Rev G; Notice 1 2024) Valves, Check, Bronze, Cast Iron, and Steel Body
MIL-E-17814	(1992; Rev F; CANC Notice 1) Expansion Joints, Pipe, Slip-Type, Packed
MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
MIL-T-19646	(1990; Rev A; Notice 1 2021) Thermometer, Gas Actuated, Remote Reading

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 150/5345-43	(2019; Rev J) Specification for Obstruction Lighting Equipment

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50494	(Basic; Notice 1) Exhaust Head, Steam

CID A-A-50555	(Basic) Pumping Units, Sewage, Duplex, Centrifugal, Automatic Wet-Pit Type
CID A-A-50558	(Basic; Notice 1) Valves, Pressure Regulating, Steam
CID A-A-50562	(Basic) Pump Units, Centrifugal, Water, Horizontal; General Service and Boiler-Feed: Electric-Motor or Steam-Turbine-Driven
CID A-A-59222	(Basic; Notice 1; CANC Notice 1 2021) Fans, Centrifugal, Draft, Forced and Induced
CID A-A-59224	(Basic; Notice 2) Meters, Fluid Quantity Volumetric
CID A-A-60001	(Rev A) Traps, Steam
FS F-B-2910	(Basic) Burners, Single Oil, Gas, and Gas-Oil Combination for Packaged Boilers (320,001 to 125,000,000 BTU/HR Thermal Output Capacity)
FS TT-P-28	(Rev H) Paint, Aluminum, Heat Resisting (1200 Degrees F.)
FS W-H-2904	(Basic; Notice 1) Heaters, Fluid, Deaerating (For Water Only) 1,000 to 1,600,000 Pounds Per Hour Capacity
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam
FS XX-C-2816	(Rev A) Compressor, Air, Reciprocating or Rotary, Electric Motor Driven, Stationary, 10 HP and Larger

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910-SUBPART Q	Welding, Cutting, and Brazing
40 CFR 82	Protection of Stratospheric Ozone

U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

NAVFAC MO 324	(1992) Inspection and Certification of Boilers and Unfired Pressure Vessels

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners

UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies

WATER QUALITY ASSOCIATION (WQA)

WQA S-100	(2000) Household, Commercial, and Portable Exchange Cation Exchange Water Softeners

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section with the additions and modifications specified herein.

1.3 DEFINITIONS

****

NOTE: Information describing any specific project and site conditions which the Contractor would need to know in order to submit a firm price shall be specified in Division 1 of the project specifications. Such conditions include:

1. Allocated space for storage of materials.

2. Railway spurs and sidings available to the Contractor for delivery of materials.

3. Any restrictions on daily working hours.

4. Procedure for scheduling outages and tests.

5. Any noise or traffic restrictions.

6. Availability of utilities required for construction.

****

1.3.1 Effective Radiant Heating Surface

Heat exchange surface, exclusive of superheat elements, which is directly exposed to radiant heat of the flame on one side and to water or water-steam mixture being heated on the other. Effective radiant heating surface shall be calculated on the side receiving heat and shall consist of plain or finned tubes and headers which may be bare, metal covered, or metallic-ore covered. Refractory covered surfaces shall not be counted. Computations shall be made as follows:

a. Flat projected area of bare, metal covered, or metallic-ore covered tubes and headers shall be considered as effective radiant heating surface.

b. Metal and metallic surfaces extending from tubes or headers shall be considered to have an effective radiant heating surface equal to 60 percent of their flat projected area except that the following extended surfaces shall not be considered as effective radiant heating surface.

    (1) Metal blocks not integral with tubes or headers.

    (2) Extended surfaces less than 6 mm 1/4 inch thick.

(3) That portion of the extended surface more than one tube or header radius from the tube or header from which it extends.

(4) Extended surfaces larger than 32 mm 1 1/4 inches.

c. Flat projected areas of portions of first two rows of furnace exit tubes that receive radiant heat from the fire shall be considered as effective radiant heating surface.

1.3.2 Flue Gas Velocity

****

NOTE: The maximum velocity to prevent erosion will vary according to whether boiler is multipass or single pass, the type of stoker and the type of fuel. See DM-3.6, Table 4, Maximum Velocities (MPS FPS) in Convection Sections for Coal, Wood or Solid Waste Boilers.

****

Velocity of the gas entering the convection section shall not exceed [10] [15] [18] [23] meters per second (m/s) [35] [50] [60] [75] feet per second (fpm).

1.3.3 FRP

Fiberglass reinforced plastic.

1.3.4 Furnace Volume

The cubic volume of the space provided for combustion of the fuel between the top grate line and the first plane of entry into, or between the tubes, of the furnace face of the bridge wall. When screen or superheater tubes are utilized, they shall be considered as the first plane of entry. The manufacturer shall state the furnace volume of the boiler.

1.3.5 PVC

Poly-vinyl chloride.

1.3.6 Standard Commercial Product

Standard commercial product is a product which has been sold or is being currently offered for sale on the commercial market through advertisements or manufacturer's catalogs, or brochures, and represents the latest production model.

1.3.7 System Supplier

A manufacturer, fabricator, erector, corporation or firm that regularly is employed in the design, fabrication, erection (or erection supervision), testing and startup of systems comparable in size and type to those specified and indicated. System supplier shall arrange the equipment selected, design equipment interconnections, produce related shop drawings, supervise erection, and startup and test the equipment.

1.4 SYSTEM DESCRIPTION

1.4.1 Design Requirements

1.4.1.1 Boiler

Design boiler in accordance with the ASME BPVC SEC I. Provide design data with computations and performance guarantees covering the full range of operation at full load, 75 percent load, 50 percent load and 30 percent load. Assemble tubes, drums, and headers so that the entire boiler can be drained dry. The furnace shall be water cooled on the side, top, front and back walls.

a. Boiler design and service conditions

(1) Steam capacity:
Continuous peak for 2 hours: [_____] kg/sec lb/hr
Maximum continuous: [_____] kg/sec lb/hr
Minimum (without smoking): [_____] kg/sec lb/hr

(2) Design pressure: [_____] kPa (gage) psig

(3) Operating pressure: [_____] kPa (gage) psig

(4) Steam temperature: [_____] degrees C F

(5) Feedwater temperature to economizer: [_____] degrees C F
(6) Continuous blowdown: [_____] percent

(7) Maximum moisture content of steam leaving drum at peak rating: [_____] percent

(8) Total solids concentration in drum: [_____] PPM

(9) Fuel:
Coal (see coal analysis):
[Oil (see oil analysis)]:

(10) Heating surface, minimum:
Radiant: [_____] sq. m ft.
Convective: [_____] sq. m ft.

(11) Furnace volume, minimum: [_____] cu. m ft.

(12) Maximum boiler flue gas exit
Temperature: [_____] degrees C F
Continuous rating: [_____] degrees C F

(13) Maximum economizer flue gas exit
Temperature: [_____] degrees C F
Continuous rating: [_____] degrees C F

(14) Efficiency at maximum continuous rating [includes economizer]
Coal: [_____] percent
[Oil]: [_____] percent

(15) Elevation above sea level: [_____] meters feet

(16) Boiler room & combustion air ambient: [_____] degrees C F

(17) Maximum allowable total draft loss furnace, boiler, exit damper, and economizer outlet at continuous rating: [_____] Pa inches of Water

(18) Steam drum, minimum diameter: [_____] mm inches

(19) Mud drum, minimum diameter: [_____] mm inches

(20) Seismic zone: [_____]

1.4.1.2 Economizer

****

NOTE: Feedwater temperatures should be 110 degrees C 230 degrees F when sulfur (S) content of fuel is 0.5 percent to 1.5 percent; 116 degrees C 240 degrees F, S = 1.5 percent to 2 percent; 121 degrees C 250 degrees F, S = 2.0 percent to 2.7 percent. Where fuels having more than 1.5 percent sulfur content are to be fired, finned tubes shall not be used unless the steel tubes are covered with cast iron fin casing.

****

a. Flue gas quantity: [_____] kg/s lbs/hr

b. Flue velocity: [_____] m/s ft/min

c. Flue gas temperature entering economizer: [_____] degrees C F

d. Flue gas temperature leaving economizer: [_____] degrees C F

e. Feedwater Temperature entering economizer: [_____] degrees C F

f. Feedwater Temperature leaving economizer: [_____] degrees C F

g. Fouling factor on feedwater side: [_____]

h. Fouling factor on gas side: [_____]

i. Boiler operating pressure: [_____] kPa (gage) psig

j. Design pressure: [_____] kPa (gage) psig

k. Steam loads shall be as specified under boiler[s]

l. Performance: The efficiency due to the economizer shall be included with and stated as part of the overall boiler efficiency.

1.4.1.3 Forced Draft Fan

Design fan to handle air at temperatures from [_____] to [_____] degrees C F. Fan shall be [single] [double] width inlet, [single] [double] width outlet, with [clockwise] [counter-clockwise] rotation; viewed from the [motor] [turbine] end.

1.4.1.4 Induced Draft Fan

Design fan of materials which will withstand flue gas temperatures up to 316 degrees C 600 degrees F without damage. Fan shall be [single] [double] width inlet, [single] [double] width outlet, with [clockwise] [counter clockwise] rotation when viewed from [motor] [turbine] end. Provide outboard pedestal bearings with sole plates[and dual extension shaft].

1.4.1.5 Screw Conveyors for Coal Handling Equipment

Each screw conveyor shall meet the following minimum design and performance specifications when handling [_____] size coal:

	CONVEYOR NO. 1	CONVEYOR NO. 2
Capacity	[_____] Mg/hr	[_____] Mg/hr
Screw diameter	[_____] mm	[_____] mm
Length	[_____] meters	[_____] meters
Coupling diameter	[_____] mm	[_____] mm
Motor horsepower	[_____] kW	[_____] kW
Screw flight thickness	[_____] mm	[_____] mm
Trough thickness	[_____] mm	[_____] mm
Trough cover thickness	[_____] mm	[_____] mm
Trough end plate thickness	[_____] mm	[_____] mm
Maximum speed	[_____] rpm	[_____] rpm

	CONVEYOR NO. 1	CONVEYOR NO. 2
Capacity	[_____] tons/hr	[_____] tons/hr
Screw diameter	[_____] inches	[_____] inches
Length	[_____] feet	[_____] feet
Coupling diameter	[_____] inches	[_____] inches
Motor horsepower	[_____] hp	[_____] hp
Screw flight thickness	[_____] inches	[_____] inches
Trough thickness	[_____] inches	[_____] inches
Trough cover thickness	[_____] inches	[_____] inches

	CONVEYOR NO. 1	CONVEYOR NO. 2
Trough end plate thickness	[_____] inches	[_____] inches
Maximum speed	[_____] rpm	[_____] rpm

1.4.1.6 Screw Conveyors for Ash Handling Systems (Mechanical)

Each screw conveyor shall meet the following minimum design and performance specifications when handling dry fly ash of density not greater than [_____] kg per cubic meter pounds per cubic foot:

	CONVEYOR NO. 1	CONVEYOR NO. 2
Capacity	[_____] Mg/hr	[_____] Mg/hr
Screw diameter	[_____] mm	[_____] mm
Length	[_____] meters	[_____] meters
Coupling diameter	[_____] mm	[_____] mm
Motor horsepower	[_____] kW	[_____] kW
Screw flight thickness	[_____] mm	[_____] mm
Trough thickness	[_____] mm	[_____] mm
Trough cover thickness	[_____] mm	[_____] mm
Trough end plate thickness	[_____] mm	[_____] mm
Maximum speed	[_____] rpm	[_____] rpm

	CONVEYOR NO. 1	CONVEYOR NO. 2
Capacity	[_____] tons/hr	[_____] tons/hr
Screw diameter	[_____] inches	[_____] inches
Length	[_____] feet	[_____] feet
Coupling diameter	[_____] inches	[_____] inches
Motor horsepower	[_____] hp	[_____] hp
Screw flight thickness	[_____] inches	[_____] inches
Trough thickness	[_____] inches	[_____] inches
Trough cover thickness	[_____] inches	[_____] inches
Trough end plate thickness	[_____] inches	[_____] inches

	CONVEYOR NO. 1	CONVEYOR NO. 2
Maximum speed	[_____] rpm	[_____] rpm

1.4.1.7 Stacks With Flue Gas Scrubbers

Stacks with flue gas scrubbers, boilers 5 kg/sec 40,000 lb/hour and over:

a. Temperature

(1) Maximum ambient: [_____] degrees C F

(2) Minimum ambient: [_____] degrees C F

(3) Inlet gas at maximum gas flow (coal): [_____] degrees C F

(4) Inlet gas at maximum gas flow (oil): [_____] degrees C F

(5) Inlet gas at minimum gas flow (coal): [_____] degrees C F

(6) Inlet gas at minimum gas flow (oil): [_____] degrees C F

b. Gas Flow at Inlet

(1) Maximum: [_____] kg/s lbs/hr

(2) Minimum: [_____] kg/s lbs/hr

c. Required net available draft at stack inlet

Maximum gas flow: [_____] Pa inches water

d. Gas exit velocity (cone exit)

Maximum at maximum conditions: [_____] m/s ft/sec

e. Flue gas dew point

(1) Fuel oil: [_____] degrees C F

(2) Fuel-coal: [_____] degrees C F

f. Test pressures

Shop test: [_____] Pa inches water

g. Thermal efficiency of stack: 96 to 98 percent

h. Stack friction

Maximum at design conditions: [_____] Pa inches water

i. Stack height

(1) Ground elevation: [_____] m ft

(2) Roof elevation: [_____] m ft

(3) Stack height: [_____] m ft

(4) Foundation or footing elevation: [_____] m ft

j. Wind pressure: [_____] kg/m2 psf

Elevation Above Ground Level (m)	Wind Pressure (kg/m2)
0 - 9	[_____]
15	[_____]
23	[_____]
30	[_____]
38	[_____]
46	[_____]
53	[_____]
61	[_____]

Elevation Above Ground Level (ft)	Wind Pressure (psf)
0 - 30	[_____]
50	[_____]
75	[_____]
100	[_____]
125	[_____]
150	[_____]
175	[_____]
200	[_____]

k. Wind velocity, gusting: [_____] km/hr mph

l. Stack inside diameter, minimum (below velocity cone): [_____] mm inches

m. Maximum stack deflection (from vertical center line): [_____] mm inches

n. Soil bearing stress, maximum: [_____] kg/m2 psf

o. Seismic zone: [_____]

1.4.1.8 Fuel Oil Pumps

a. Transfer pumps (for fuel oil tank truck or railroad tank car unloading and transfer to tanks):

****

NOTE: At the text below, the values enclosed in brackets are for No. 6 Low Sulfur fuel oil. Adjust values to suit fuel oil used when other than No. 6.

****

(1) Number of assemblies: [_____]

(2) Tag numbers: [_____]

(3) Capacity each at 450 ssu: [_____] L/s gpm

(4) Suction lift required: [_____] kPa ft of water

(5) Discharge pressure: [_____] kPa (gage) psig

(6) Operating temp.: [27 to 54 80 to 130] [_____to_____] degrees C F

(7) Viscosity range: [450 to 5000] [_____to_____] ssu

(8) Specific gravity: [.92 to .99] [_____to_____]

(9) Viscosity at brake power selection point: [9000] [_____] ssu

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, Low Sulfur] [_____]

b. Transfer pumps (for fuel oil transfer from tanks to heating plant):

****

NOTE: At the text below, the values enclosed in brackets are for No. 6 Low Sulfur fuel oil. Adjust values to suit fuel oil used when other than No. 6.

****

(1) Number of assemblies: [_____]

(2) Tag numbers: As indicated

(3) Capacity at 450 ssu: [_____] L/s gpm

(4) Suction lift required: [_____] kPa (gage) ft of water

(5) Discharge pressure: [_____] kPa (gage) psig

(6) Operating temperature: [49 120] [_____] degrees C F

(7) Viscosity range: [450 to 3000] [_____] to [_____] ssu

(8) Specific gravity: [.92 to .99] [_____] to [_____]

(9) Viscosity at brake power point: [5000] [_____] ssu

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, low sulfur] [_____]

c. Fuel oil recirculation pump sets (at remote storage):

****

NOTE: At the text below, the values enclosed in brackets are for No. 6 Low Sulfur fuel oil. Adjust values to suit fuel oil used when other than No. 6.

****

(1) Number of assemblies: [_____]

(2) Tag numbers: As indicated

(3) Capacity: 1.58 L/s 25 gpm at 450 ssu

(4) Suction lift required: [_____] kPa ft. water

(5) Discharge pressure: [_____] kPa (gage) psig

(6) Operating temperature: [49 120] [_____] degrees C F

(7) Viscosity range: [450 to 3000] [_____] to [_____] ssu

(8) Specific gravity: [.92 to .99] [_____] to [_____]

(9) Viscosity at brake power point: [5000] [_____] ssu

(10) Maximum pump speed: 1750 rpm

(11) Motor kW hp: [_____]

(12) Fuel oil: No. [6, low sulfur] [_____]

1.4.1.9 Fuel Oil Pump and Heater Set for Fuel Oil System

****

NOTE: At the text below, the values enclosed in brackets are for No. 6 Low Sulfur fuel oil. Adjust values to suit fuel oil used when other than No. 6.

****

a. Pump/heater set

(1) Capacity each pump and each steam heater: [_____] L/s gpm

(2) Suction lift: [_____] kPa ft water

(3) Discharge pressure at outlet of heater: [_____] kPa (gage) psig

(4) Maximum pump speed: 1750 rpm

(5) Specific gravity range: [.92 to .99] [_____] to [_____]

(6) Viscosity at brake power point: 5000 ssu

(7) Viscosity range: [500 to 5000] [_____] to [_____] ssu

(8) Oil temperature at inlet of heater: [_____] degrees C F

(9) Oil temperature at outlet of heater: [_____] degrees C F

(10) Maximum oil pressure drop through heater: [_____] kPa psi

(11) Heating medium: Steam

(12) Steam pressure available: [_____] kPa (gage) psig

(13) Steam temperature: [_____] degrees C F

(14) Heater type: [Extended surface][Bare tube]

b. Electric startup heater

(1) Oil temperature at heater inlet: [_____] degrees C F

(2) Oil temperature at heater outlet: [_____] degrees C F

(3) Maximum oil pressure drop through heater: [_____] kPa psi

(4) Capacity of heater: [_____] L/s gpm

(5) Heating power supply at three phase, 60 Hz [_____] volts

(6) Control power supply 120 volts, single phase, 60 Hz

1.4.1.10 Ash Handling System (Mechanical)

a. Capacity:

(1) Ash handling system: Estimated capacities at maximum plant output are listed below; ash handling system capacity shall be sized for twice the amounts listed.

[_____] Mg tons per hour for fly ash
[_____] Mg tons per hour for bottom ash
[_____] Mg tons per hour in bucket elevator leaving the boiler house (minimum).

(2) Ash silo: Storage capacity of ash silo is specified in the paragraph ASH STORAGE SILO.

(3) Rotary unloader: [_____] Mg tons per hour

b. General data

(1) Available water pressure: [_____] kPa (gage) psig

(2) Available air pressure: [_____] kPa (gage) psig

(3) Seismic zone: [_____]

(4) Wind velocity (gusts): [_____] km/hr mph

(5) Altitude of plant: [_____] m ft

(6) Steam rating of plant: [_____] kg/s lb/hr

(a) Maximum continuous rating of boiler no. 1 [_____] kg/s lb/hr

(b) Maximum continuous rating of boiler no. 2 [_____] kg/s lb/hr

[(c) Maximum continuous rating of boiler no. 3 [_____] kg/s lb/hr

][(d) Maximum continuous rating of boiler no. 4 [_____] kg/s lb/hr

] (7) Coal analysis

(a) Ash [_____] percent

(b) Carbon [_____] percent

(c) Hydrogen [_____] percent

(d) Sulfur [_____] percent

(e) Moisture [_____] percent

(f) Nitrogen [_____] percent

(g) Oxygen [_____] percent

(8) Ash Analysis

(a) Carbon [_____] percent

(b) Calcium [_____] percent

1.4.1.11 Ash Handling System (Pneumatic)

a. Capacity:

(1) Ash handling system: Estimated capacities at maximum plant output are listed below; ash handling system capacity shall be sized for twice the amounts listed.

[_____] Mg tons per hour for fly ash
[_____] Mg tons per hour for bottom ash
[_____] Mg tons per hour in bucket elevator leaving the boiler house (minimum).

(2) Ash silo: Storage capacity of ash silo is specified in the paragraph ASH STORAGE SILO.

(3) Rotary unloader: [_____] Mg tons per hour.

b. General Data

(1) Available water pressure: [_____] kPa (gage) psig

(2) Available air pressure: [_____] kPa (gage) psig

(3) Seismic zone: [_____]

(4) Wind velocity (gusts): [_____] km/hr mph

(5) Altitude of plant: [_____] m ft

(6) Steam rating of plant: [_____] kg/s lb/hr

(a) Maximum continuous rating of boiler no. 1 [_____] kg/s lb/hr

(b) Maximum continuous rating of boiler no. 2 [_____] kg/s lb/hr

[(c) Maximum continuous rating of boiler no. 3 [_____] kg/s lb/hr

][(d) Maximum continuous rating of boiler no. 4 [_____] kg/s lb/hr

] (7) Coal analysis

(a) Ash: [_____] percent

(b) Carbon: [_____] percent

(c) Hydrogen: [_____] percent

(d) Sulfur: [_____] percent

(e) Moisture: [_____] percent

(f) Nitrogen: [_____] percent

(g) Oxygen: [_____] percent

(8) Ash analysis

(a) Carbon: [_____] percent

(b) Calcium: [_____] percent

(9) Minimum velocities required for materials

(a) Fly ash: 19.30 m/s 3800 ft./min.

(b) Bottom ash (traveling grate stoker): 28.44 m/s 5600 ft./min.

(c) Bottom ash (spreader stoker): 26 m/s 5100 ft./min..

1.4.1.12 Miscellaneous Equipment

a. Deaerating heater: Design the deaerating heater for the following conditions:

(1) Design pressure: 207 kPa (gage) 30 psig

(2) Normal steam operating pressure: [_____] kPa (gage) psig

(3) Maximum steam operating pressure: [_____] kPa (gage) psig

(4) Capacity (minimum): [_____] kg/s lb/hr of feedwater

(5) Inlet Conditions at Heater:

	Maximum Pressure kPa(gage)	Temperature Range Degrees C	Flow Rate kg/sec
(1) Condensate return	[_____]	[_____] to [_____]	[_____]
(2) High pressure trap returns	[_____]	[_____] to [_____]	[_____]
(3) Makeup water (softened)	[_____]	[_____] to [_____]	[_____]

	Maximum Pressure psig	Temperature Range Degrees F	Flow Rate lb/hr
(1) Condensate return	[_____]	[_____] to [_____]	[_____]
(2) High pressure trap returns	[_____]	[_____] to [_____]	[_____]
(3) Makeup water (softened)	[_____]	[_____] to [_____]	[_____]

(6) Outlet temperature of feedwater from heater at design capacity: [_____] degrees C F

(7) Heating steam pressure: [_____] kPa (gage) psig

(8) Heating steam enthalpy: [_____] kJ/kg Btu/lb

(9) Storage capacity to overflow of storage tank: [_____] liters gallons.

****

NOTE: At the text below, analysis of the water available for makeup shall govern the water treatment system selected. A competent water treating consultant shall be obtained to formulate specific system recommendations when the makeup water analysis indicates any of the following:

1. Iron in excess of 0.1 ppm as Fe.

2. Mg alkalinity in excess of 50 ppm as CaCO3.

3. Silica in excess of 6 ppm as SiO2.

****

b. Water softening system: Base the water softening system on the

following:

(1) Raw water analysis: Source of raw water is [_____]. It is available at pressures of [_____] to [_____] kPa (gage) psig. The analysis of the water available for makeup is approximately as follows:

TABLE 1: MAKEUP WATER ANALYSIS

	Constituent	Analysis	Parts Per Million
Cations	Calcium (Ca++)	as CaCO3	[_____]
	Magnesium (Mg++)	as CaCO3	[_____]
	Sodium (Na+)	as CaCO3	[_____]
	Hydrogen (H+)	as CaCO3	[_____]
TOTAL CATIONS		as CaCO3	[_____]
Anions	Bicarbonate (HCO3 -)	as CaCO3	[_____]
	Carbonate (CO3 --)	as CaCO3	[_____]
	Hydroxide (OH -)	as CaCO3	[_____]
	Sulfate (SO4 --)	as CaCO3	[_____]
	Chloride (Cl -)	as CaCO3	[_____]
	Phosphate PO4 ---)	as CaCO3	[_____]
	Nitrate (NO3 -)	as CaCO3	[_____]
TOTAL ANIONS		as CaCO3	[_____]

TABLE 1: MAKEUP WATER ANALYSIS			
	Total hardness	as CaCO3	[______]
	Methyl orange alkalinity	as CaCO3	[______]
	Phenolphthalein alkalinity	as CaCO3	[______]
	Iron, total	as Fe	[______]
	Carbon dioxide	as Free CO2	[______]
	Silica	as SiO2	[______]
	Suspended solids (Turbidity)		[______]
	Total dissolved solids (TDS)		[______]
	Free acids		[______]
	Color		[______]
	pH		[______]
	Specific Conductance Microhms/cm		[______]

(2) Softener effluent analysis:

Hardness: Maintain hardness of the softened feedwater near zero and in no case allow it to exceed 1.0 part per million as CaCO3.

****

NOTE: At the text below, total solids of 175 ppm in the feedwater concentrated 20 times give 3,500 ppm in the boiler water.

****

Total solids: Maintain total solids in the softened feedwater at a level to ensure a total solids concentration in the boiler water of less than 3,500 ppm without excessive blowdown.

1.4.2 Detail Drawings

1.4.2.1 Boiler Drawing

Submit safety valve calculation sheets or Manufacturer's standard sheets) and detail drawings for the following:

a. Refractory details, expansion joints

b. Certified outline, general arrangement (setting plan), and anchor bolt detail drawings including foundation loading diagrams

c. Plans and elevations detailing piping connections

d. Detailed dimensional drawings of auxiliaries furnished with the unit

e. Piping schematics for auxiliaries, such as sootblowers or hydraulic stoker drives (when used)

f. Shop fabrication details of boiler/furnace: Include details showing tubing, spacing, radii dimensions, and gage; sections through walls and expansion joints showing refractory construction and replacement details; internal and external dimensions of the boiler

g. Wiring diagrams for subsystems

h. Economizers and economizer inlet breeching

i. Soot blowers

j. Auxiliaries furnished with the boilers

k. Forced draft fan, drives and duct work

l. Induced draft fan, drives and duct work

m. Structural steel and loading diagrams

n. Overfire air fan system

1.4.2.2 Boiler Room Auxiliary Equipment

Submit descriptive information for the following items on the drawings including arrangements, wiring diagrams, piping diagrams, and details of valves and piping.

a. Water softening equipment

b. Brine storage tank

c. Condensate receiver

d. Condensate transfer pumps including certified performance curves

e. Deaerator

f. Boiler feed pumps including certified performance curves

g. Steam turbines and their drives

h. Continuous blowdown system

i. Chemical feed units

j. Air compressors

k. Air dryers

l. Cranes and hoists

m. Plant heating and ventilation equipment showing related ductwork

1.4.2.3 Stokers

Include the following:

a. General arrangement

b. Foundation drawings

c. Front plates

d. Ash hoppers

e. Fuel gate mechanism

f. Grate details

g. Zone dampers

h. Air seal details

i. Overfire air nozzle arrangement, overfire air fan and drives

j. Coal feeder details

k. Fuel feeder drives

l. Piping schematics

m. Wiring schematics

n. Access doors

1.4.2.4 Ash Handling System

Include the following:

a. General arrangement

b. Construction details ash storage silo complete with loading diagrams

c. Control panel arrangement and schematics

d. Wiring and control diagrams

e. Ash piping arrangement drawings and schematic drawings

f. Wear back fitting details

g. Piping and fittings

h. Details of [steam] [motor driven mechanical] exhauster[and air washer-steam condenser]

i. Details of separators, tertiary bag filter, and ash silo vent bag filter

j. Silo fluidizing system and rotary ash conditioner

k. Bottom ash hopper and vertical lift doors

l. Ash crusher

1.4.2.5 Burners

Include the following:

a. General arrangement

b. Piping details

c. Burner control schematics

d. Flame safety schematics

e. Component details

f. Throat tile details

1.4.2.6 Dampers, Stacks and Breechings

Include the following:

a. General arrangement

b. Breeching, reinforcing details

c. Breeching hangers and support details

d. Dampers and operators

e. Access doors and frames

f. Expansion joints

g. Stack details including anchor bolt and foundation details, stack sampling ports, platforms, and accessories

[Submit drawings stamped by a registered professional engineer for stacks with flue gas scrubbers, boilers 5 kg/sec 40,000 lb/hour and over.

]1.4.2.7 Coal Handling Equipment

Include the following:

a. Certified outline and general arrangement drawings for complete coal handling system

b. Dimensional equipment and fabrication drawings, including all equipment weights, equipment locations, support details, and anchor bolt arrangements for items and equipment specified under the coal handling section

c. Control panel, coal presence indicators, and equipment response switch details

d. Control schematic diagrams and complete wiring diagrams

1.4.2.8 Fuel Oil Equipment

Drawings may be manufacturer's standard size for pumps, pump curves, valves, strainers and pump wiring.

a. Certified outline and general arrangement drawings

b. Certified pump and performance curves and tabulations

c. Equipment detail sheets including viscosity controller, heater and valves

d. Electrical wiring diagrams

e. Oil tanks, foundations, tank heaters, appurtenances, water draw-off and level indication.

1.4.2.9 Piping and Specialty Items

Drawings may be manufacturer's standard size.

a. Details of valves and special fittings

b. Feedwater regulator details and schematics

c. Details and schematics of feedwater automatic recirculation

1.4.2.10 Flexible Ball Expansion Joint Installation Details

Include allowable angular flex and minimum offset dimensions for approval.

1.4.2.11 Reinforced Concrete Foundation

Concrete and reinforcing for the foundation shall be detailed on the Contractor's submitted shop drawings as specified under Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.4.2.12 Reproducible Drawings

Submit one reproducible plastic shop drawing of each approved drawing sheet to the Contracting Officer for the following items:

a. Boiler layout, foundations, construction and details including [preheaters,] [economizers,] auxiliaries and details

b. Breeching layout, construction and details

c. Burner construction, control and flame safety schematics, and details

d. Burner details

e. Wiring diagrams

f. Fuel tanks, foundations and appurtenances

g. Feedwater automatic recirculation system

h. Piping schematics

i. Control diagrams schematics including panel construction and layout

j. Coal handling equipment

k. Stoker drawings and details

l. Ash handling system, including panels, schematics and details

1.4.3 Test Reports

1.4.3.1 Boiler Predicted Performance Data

Submit certified copies of design, production and conformance tests for approval before delivery of the equipment.

1.4.3.2 Fan Performance Data

Submit to the Contracting Officer manufacturer's fan performance data based on performance tests made in accordance with the requirements of AMCA 210. AMCA certified test data from prototype fan designs is acceptable.

1.4.4 Performance Requirements

1.4.4.1 Boiler

****

NOTE: The specified efficiency for the boiler at maximum continuous load shall be not less than 80 percent for coal and 82 percent for oil. When an economizer is provided, use 82 and 84 percent respectively for coal and oil firing. Depending on the particular application and fuel used, these efficiencies could be higher.

****

The efficiency listed for coal burning shall be based on stoker firing with [_____] percent excess air.[The efficiency for fuel oil firing shall be based on [_____] percent excess air]. The efficiency shall allow for [_____] percent continuous blowdown and 1.5 percent unaccounted losses and manufacturer's margin. Base the performance on the boiler burning fuels in accordance with the Coal Analysis [Fuel Oil Analysis] listed below.

a. Coal analysis

(1) Ultimate analysis (percent by weight)

Carbon	[_____]
Hydrogen	[_____]
Oxygen	[_____]
Nitrogen	[_____]
Sulfur	[_____]

Ash	[_____]
Moisture	[_____]
TOTAL	[_____]

(2) Proximate analysis (percent by weight)

Moisture	[_____]
Volatile Matter	[_____]
Fixed Carbon	[_____]
Ash	[_____]
TOTAL	[_____]

(3) Coal characteristics:

Heating value: [_____] kJ/kg Btu/lb

Ash softening temperature reducing: [_____] degrees C F

Oxidizing: [_____] degrees C F

Free swelling index (coke button): [_____]

Size: 32 by 19 mm: [_____] percent; 19 by 6.35 mm: [_____] percent; 6.35 by 0 mm: [_____] percentSize: 1 1/4 by 3/4 inch: [_____] percent; 3/4 by 1/4 inch: [_____] percent; 1/4 by 0 inch: [_____] percent

(4) Coal Variations: Due to periodic changes in coal suppliers, the boiler and stoker combination shall be designed to burn any coal within the following limits (percent by weight unless indicated otherwise):

	Minimum	Maximum
Ash	[_____]	[_____]
Sulfur	[_____]	[_____]
Hydrogen	[_____]	[_____]
Carbon	[_____]	[_____]
Moisture	[_____]	[_____]
Nitrogen	[_____]	[_____]

Oxygen	[_____]	[_____]
kJ per kg Btu per pound	[_____]	[_____]
Ash softening temperature	[_____]	[_____]
Volatile matter	[_____]	[_____]
Fixed carbon	[_____]	[_____]

b. Fuel oil analysis

****

NOTE: Use Fuel Oil Analysis Schedule only when fuel oil burners are used.

****

Grade of fuel oil ultimate analysis (percent by weight)

Carbon	[_____]
Hydrogen	[_____]
Oxygen	[_____]
Nitrogen	[_____]
Sulfur	[_____]
Ash	[_____]
Moisture	[_____]
TOTAL	[_____]

(1) Heating value: [_____] kJ/kg Btu/lb
(2) Specific gravity: [_____] degrees API
(3) Viscosity at burner: [_____] SSF at 50 degrees C 122 degrees F
(4) Water and sediment (by volume): [_____] percent
(5) Flash point: [_____] degrees C F.

1.4.4.2   Oil/Burner Windbox Package

Burner turndown ratio on the specified fuel oil shall be not less than eight to one, with excess air not over 15 percent at full steam load, and excess air not over 22 percent at 20 percent steam load.[Air flow shall be modulated through a single set of register louvers.]

1.4.4.3   Miscellaneous Equipment

a. Boiler feed pump service requirements:

(1) Capacity: [_____] L/s gpm

(2) Pumping temperature: [_____] degrees C F

(3) Liquid pH: [_____]

(4) Discharge head: [_____] kPa feet

(5) Available NPSH: [_____] kPa feet

(6) In addition to the operating point established above, the pump curve shall also run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

b. Condensate pump service requirements

(1) Capacity: [_____] L/s gpm

(2) Pumping temperature range: [_____] to [_____] degrees C F

(3) Liquid pH: [_____]

(4) Discharge head: [_____] kPa feet

(5) Available NPSH: [_____] kPa feet

(6) In addition to the operating point established above, the pump curve shall run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal

items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Boiler Drawing

Boiler Room Auxiliary Equipment

Stokers

Ash Handling System

Burners

Dampers, Stacks and Breechings

Coal Handling Equipment

Fuel Oil Equipment

Piping and Specialty Items

Flexible Ball Expansion Joint Installation Details

Reinforced Concrete Foundation

Reproducible Drawings

Submit for approval within [60] [75] [90] days after award of contract. Drawing size shall be A1 (841 by 594 mm) 34 by 22 inches.

SD-03 Product Data

Boiler

Boiler Room Auxiliary Equipment

Stacks

Coal Handling Equipment

****

NOTE: Include refrigerant submittal when a compressed air refrigerated air dryer is included.

****

[Refrigerant (compressed air refrigerated air dryers) - Provide SDS sheets for all refrigerants

] Insulation

Submit for approval within [60] [75] [90] days after award of contract.

SD-04 Samples

Each Type of Insulation

Include the intended application for each type of insulation and attach manufacturer's stamp or label giving name of manufacturer, brand and description of material.

[SD-05 Design Data

****

NOTE: Choose this paragraph only if the paragraph STACKS WITH FLUE GAS SCRUBBERS and its subparagraphs are chosen.

****

Stacks with Flue Gas Scrubbers, boilers 5 kg/sec 40,000 lb/hour and over

Submit design calculations for static and dynamic analysis and damping. Submit manufacturer's foundation and stack calculations. Submit as specified under the paragraph STACKS WITH FLUE GAS SCRUBBERS.

] SD-06 Test Reports

Boiler Predicted Performance Data

Fan Performance Data

Instrument Air Compressors

Variable Speed Motor Controller

Submit certified copies of variable speed motor controller design, production and conformance tests for approval before delivery of the equipment.

Steam Heating Plant

Submit for tests and inspections specified under the paragraph FIELD QUALITY CONTROL.

SD-07 Certificates

List of Equipment Manufacturers

Proof of Experience

Submit the required information and experience certificates prior to commencing work on the site.

System and Equipment Installation

Vertical Fuel Oil Tank Calibration

Backflow Preventer

Ozone Depleting Substances Technician Certification

SD-10 Operation and Maintenance Data

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Equipment, Data Package 3

Control Components, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions

1.6 QUALITY ASSURANCE

Equipment shall be factory assembled except for steam generators, coal handling equipment, and ash handling equipment which shall utilize shop assembled components to the maximum extent to facilitate erection and minimize field labor.

1.6.1 Standard Commercial Product

Boilers and equipment shall as a minimum, be in accordance with the requirements of this specification and shall be the manufacturer's standard commercial product. Include additional or better features which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product in the boilers and equipment being provided.

1.6.2 Equipment Furnished

Equipment furnished by the Contractor shall be furnished by the manufacturers listed.

1.6.3 Responsibility

The Contract drawings show the required general arrangement configuration and location of equipment items. However, this contract allows selection of vendor's equipment, at the option of Contractor, provided that vendor's experience and equipment meet requirements of these drawings and specifications. Because there may be significant variation between the drawings and individual vendor's equipment as to foundations, physical dimensions and detailed arrangement of these equipment items, the Contractor is required to furnish detailed design and shop drawings and calculations for the systems selected. Foundation arrangements, walkways and other information as required shall be shown for a completely coordinated, useable and properly functional system. A single system supplier shall be responsible for a complete system including erection or erection supervision for each of the following systems:

a. Boiler system, including but not limited to the boiler, stoker, oil burners, [economizer,] [air preheater,] refractories, insulation, induced draft fan, sootblowers, steam separator, forced draft fan, overfire air fan, reinjection system, boiler trim, blowdown valves, safety valves and trim, and breeching. System manufacturer shall coordinate required instrumentation and control logic with controls and instrumentation supplier. Controls and instrumentation are specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

b. Coal handling system, including but not limited to the track and reclaim hoppers, belt feeders, belt conveyors and tube galleries, telescoping chute, flight conveyor, coal bunker, under bunker conveyor with triple valves, coal scale and non-segregating distributor.

c. Ash handling system including clinker crusher, ash intakes, ash silo with baghouse filter, vacuum pump and rotary dustless filter.

d. Stack system including steel stack, internal acid resistant lining and external coating.

e. Emission equipment including precipitator, scrubber and baghouse.

1.6.4 Certification of Backflow Preventer

Certificate of Full Approval or current Certificate of Approval for each backflow preventer being provided for this project shall be from the Foundation for Cross-Connection Control Research, University of Southern California, and shall attest that the design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval will not be acceptable in lieu of the above.

1.6.5 Modification of References

In the API publications referred to in this paragraph, the advisory provisions shall be considered mandatory, as though the word "shall" had been substituted for "should" and "suggested" wherever they appear.

1.6.6 Certificates

1.6.6.1 List of Equipment Manufacturers

Submit a letter which names the equipment manufacturers for the following equipment. When the Contracting Officer determines that a manufacturer does not meet the qualification or experience requirements of the specifications, the Contractor shall submit, to the Contracting Officer, the name of another manufacturer within fifteen days of notification.

a. Boilers and stokers

b. Boiler feedwater pumps

c. Coal car handling equipment

d. Induced draft fans

e. Coal handling equipment

f. Ash handling equipment

1.6.6.2 Proof of Experience

Submit proof of experience of manufacturers, system suppliers and installers as follows:

a. Experience, Responsibility and Certification: Submit to the Contracting Officer, the required information and experience certificates within 30 days after award and prior to commencing work on the site.

****

NOTE: Verify number of manufacturers' installations operating and years of operation for coal handling systems, ash handling systems and control systems to avoid an unnecessarily restrictive experience requirement.

****

b. Experience Requirements: Boilers and equipment installed within or as a part of the heating plant shall be of proven designs. Each manufacturer or system supplier shall be regularly engaged in designing, fabricating, erecting or erection supervision, testing and starting up of the equipment or system. Within 30 days after award or at any time during performance of the contract, when the Contractor is required to use another manufacturer or system supplier is required through no fault of the Contractor, the Contractor shall submit a certificate and other evidence from each manufacturer or each system supplier to show that equipment and systems, made or furnished by the manufacturers or system suppliers, have substantially comparable operating requirements to the equipment or systems specified under this section and that they have been successfully installed and reliably operated in at least [one] [two] [three] installations under substantially comparable operating conditions for a period of not less than two years.

c. Information Required: Submit to the Contracting Officer, evidence or proof of experience required from the equipment manufacturer or system supplier containing the following information:

(1) List of installations meeting the aforementioned requirements including detailed description of equipment furnished for each one.

(2) Owner and location of each installation.

(3) Name and phone number of supervisory person at each installation.

(4) Date of Owner acceptance of such installation.

d. Vertical Fuel Oil Tank Calibration Experience: Submit to the Contracting Officer evidence or proof that the tank calibration organization has at least 2 years of prior successful and accurate experience in calibrating tanks of comparable type and size.

1.6.6.3 System and Equipment Installation

Submit from each system supplier and each manufacturer of the equipment, written certification that the system and equipment installation is in accordance with the system supplier's and equipment manufacturer's instructions and recommendations, that the unit or system has been run, rotating parts have been dynamically balanced, fluid (including air) flows have been balanced, instrumentation and controls are properly functioning, adjusted and have been calibrated, and the sub-system (or equipment) is ready for final testing, before entire boiler plant may be given an acceptance test.

1.6.6.4 Vertical Fuel Oil Tank Calibration

Submit four copies of the certified record.

1.6.6.5 Backflow Preventer

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project.

1.6.6.6 Ozone Depleting Substances Technician Certification

****

NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

****

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.6.7 Posted Operating Instructions

Provide posted operating instructions for each piece of equipment installed.

1.6.8 Operation and Maintenance Data

Submit operation and maintenance data for each equipment, including control components. Include the following supplemental information in addition to requirements of Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.

a. Illustrations, catalog information, shop drawings, and certified drawings of each item of equipment and control components

b. Tests and test results

c. Adjustments

d. Fan and blower characteristics curves

e. Pump characteristic curves superimposed on system curves at various pumping rates (20, 40, 60, 80, 100 percent capacity)

f. Boiler predicted performance data

g. List of special tools required

1.7 DELIVERY, STORAGE AND HANDLING

1.7.1 Assembly of Components

Each assembly of components packaged as a unit shall be of the size that can be transported by common carrier without disassembly insofar as shipping clearances are concerned.

1.7.2 Storing Tubes

Grind tube ends before shipment and properly coat against elements that may cause rusting or decomposition prior to erection. Store tubes used in erection of boiler with full protection from elements and at no time shall tubes be stored upon the ground. Maintain sufficient space between bottom row of tubes and ground to give good circulation of air at all times. Before installing tubes, remove mill scale and other foreign matter.

1.8 ENVIRONMENTAL REQUIREMENTS

1.8.1 Air Permits

Permits for construction and operation of the boiler plant shall be obtained from the local environmental regulatory agency prior to the start of construction.

1.8.2 Boiler Emissions

Comply with local, state, and federal emission regulations for the fuel to be fired.

1.8.3 Oil Burner/Windbox Package

The emission requirements shall be met at the maximum required continuous output. The burner shall meet environmental rules and regulations. Emission requirements to be considered are oxides of nitrogen (NOx), opacity, particulates, sulfur dioxide, and carbon monoxide. Compliance with NOx emission regulations shall be met using one [a combination] of the following:

a. Low NOx burners

b. Flue gas recirculation

c. Other NOx reduction methods

1.9 EXTRA MATERIALS

a. Furnish two extra sets of air filters for each compressor.

****

NOTE: At the text below, choose one of the two following items in coordination with the option chosen in Part 2 "Compressed Air Desiccant Air Dryer" or "Compressed Air Refrigerated Air Dryer."

****

[b. Furnish 4 spare prefilters and 4 spare afterfilters for compressed air desiccant air dryer.

][c. Furnish 4 spare disposable cartridge type prefilters and afterfilters each, for compressed air refrigerated air dryer.

] d. Furnish a spare set of refractory bricks for each thawing unit.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials free of defects which would adversely affect the performance or maintainability of individual components or of the overall assembly. Materials not specified herein shall be of the same quality used for the intended purpose in commercial practice. Unless otherwise specified herein, equipment, material, and articles incorporated in the work covered by this specification shall be new.

2.1.1 Identical Items

Provide physically and mechanically identical boilers and equipment of the same classification, size or capacity to permit the interchangeability of replacement parts. This requirement includes parts, assemblies, components, and accessories. Parts provided on the same type unit regardless of size and identifiable by identical part number shall be functionally and dimensionally interchangeable. No deviation is acceptable without prior written approval of the Contracting Officer.

2.2 [COAL/OIL] [COAL] FIRED BOILER

Multiple-drum, bent tube, field erected, cross drum, high static head, and vertical combustion chamber type designed for stoker [and oil] firing.

Stoker [and oil burner] shall be as specified elsewhere in this section. Utilize shop assembled components to the maximum extent to facilitate erection and minimize field labor. Materials shall be as specified herein. Materials and piping shall meet requirements of ASME BPVC SEC I. Boiler shall be a fully erected water tube boiler, including engineering, labor, supervision, tools, materials, and testing required for a complete operational unit. Equipment shall include boiler, waterwalls, refractories, insulation, supporting structural steel, steel casing and lagging, windbox, ductwork, sootblowers, stoker, [oil burners], ASME required safety valves, valves and trim, forced draft fan, induced draft fan and overfire air fan. Boiler design shall be fully integrated with and coordinated with stoker, [fuel oil burner,] economizer, and forced draft fan, induced draft fan, and controls specified elsewhere in this section. Boilers with [welded wall,][or][tube and tile] are acceptable.

2.2.1 Operational Requirements

Boiler shall be capable of operating continuously at the maximum specified conditions without damage or deterioration to boiler, settings, firing equipment or auxiliaries. Boiler shall be capable of automatically controlled operation while burning specified fuel[s].

2.2.1.1 Furnace Heat Input

****

NOTE: See NAVFAC Design Manual DM-3.6, Table 12 Stoker Selection Criteria.

****

When boiler is operating at a maximum continuous rating, heat input to furnace shall not exceed either of the following limits:

a. [310] [362] kW [30,000] [35,000] Btu per hour per cubic meter foot of furnace volume.

b. 315 kW 100,000 Btu per hour per square meter foot of effective radiant heating surface.

Combustion gas temperature at furnace exit shall not exceed [1149 degrees C 2100 degrees F when firing oil and] 93 degrees C 200 degrees F below ash fusion temperature when firing coal.

2.2.2 Construction

2.2.2.1 Boiler Drums

****

NOTE: Boilers 11 1/4 kg of steam per second 90,000 pounds of steam per hour or more should have a steam drum of not less than 1372 mm 54 inches in diameter and a lower drum of not less than 1067 mm 42 inches in diameter.

****

Drums shall be steel plate, fusion welded in conformance with the ASME BPVC SEC I. The manufacturer shall determine the inside diameter and overall length of each drum except that the steam drum shall be sized sufficiently large to contain the steam-water separating equipment, to prevent excessive rise of water due to sudden change in steam demand, and to allow for ready access into the drum. The steam drum shall be at least [_____] mm inches internal diameter. The lower drum shall be at least [_____] mm inches internal diameter. Provide each drum with an elliptical manhole at each end not less than 300 by 400 mm 12 by 16 inches, with hinged manhole cover, yoke and gaskets and machined to fit manhole flange of head. Provide flat bar ring of not less than 10 gage steel plate welded to the exterior of the drum heads around the manholes for protection of the drum head insulation. Rings shall be continuous and shape shall conform to the general outline of the manhole opening. Groove the tube holes in the drums for maximum holding power. Fusion weld the longitudinal seams in drums and the circumferential joints between heads and shells. Remove excess welding material and clean drum surface. Relieve stresses caused by welding by heat treatment in annealing furnaces, and X-ray the seams to ensure complete and proper welding. Drum variation shall not exceed one percent between maximum and minimum diameters at any section and when necessary, reheat, reroll or reform drums to meet this requirement.

a. No part of the boiler drum or header surface shall be directly exposed to furnace radiation unless it is adequately protected by a water screen in such a manner that no part of the exposed drum or header surface shall be more than 50 mm 2 inches from the nearest water tube.

b. Fit the steam outlet drum of the boiler with easily removable efficient dry pipe, special baffle, or other separating device so that the steam delivered to the boiler header shall have not more than 1.0 ppm of total solids at maximum continuous load, and during change of load from 50 percent to 100 percent of continuous rated capacity within a three minute period, provided that the total solids concentration in the boiler water does not exceed 3500 parts per million, the total alkalinity concentration does not exceed 700 parts per million, and no organic matter is present.

c. Nozzles for safety valves, main steam outlet, feed and blowdown lines, shall be forged steel, straight neck type, flanged and fusion welded to drums. Weld threaded connections in the steam drum for the feed water regulator, continuous blowdown, vent gage, and chemical feed lines.

d. Provide steam drum with internals for continuous blowdown, running the length of the steam drum at the point of highest concentration of dissolved solids, and an internal distribution pipe for chemical feed. Continuous blowdown and chemical feed pipe inside of drum shall be stainless steel.

2.2.2.2 Headers

Horizontal lower and upper side wall headers shall preferably be square. However, round headers are acceptable, provided approved stoker seals are provided. Provide rear wall and front wall headers. Protect the front wall header by studs and pack with insulating cement. Provide headers with key caps or gasketed type handhole fittings.

2.2.2.3 Tubes

Boiler design pressure shall not be less than 1724 kPa (gage) 250 psig. Water tube rows and first two rows of main boiler bank shall be one gage heavier than other tubes. Tubes shall be resistance welded or seamless, ASME BPVC SEC II-A SA-178/SA-178M, Grade A carbon steel not less than 63.50 mm 2 1/2 inches O.D.; tubes shall not be reduced in size at the boiler drums. Manufacturer shall indicate the size, weight, and kind of tubes on the submittal drawings. Furnace walls and roof shall be water cooled. Radii of bends in tubes shall be such that standard turbine type cleaners can easily pass through the full length of the tubes.

a. When a boiler is provided with welded wall construction, the tube side walls, front wall, and furnace roof shall be of gastight construction, tubes shall be skin cased for gastight construction.

b. The width of the water wall tubes, as determined by the outside diameter of the tubes, shall cover at least 50 percent of each of the front, rear furnace, side walls, and roof of the boiler.

c. Tube connections to upper drum shall be so arranged that the ends of downcomer tubes shall be covered with water when the water level in the steam drum is 50 mm 2 inches below the bottom of the gage glass with the gage glass being centered at the normal water level in the drum. Tube bends shall be free of wrinkles and at no point of the bend shall the diameter of the tube be more than 3 mm 1/8 inch less than the minimum allowable diameter of the tubes.

d. Space boiler and water wall tubes so that tubes may be removed and replaced without disturbing another tube.

2.2.3 Boiler Setting and Insulation

Provide a complete setting including firebrick, refractory tile, insulation, tile supports, supporting steel, steel casing, material for expansion joints, and necessary work and materials to provide a complete gas envelope for the convector and water walls.

2.2.3.1 Expansion Joints

Provide expansion joints where required to permit brickwork to expand freely without interference with the boiler. Joints shall be of adequate width, tightly sealed against leakage, and free from mortar, with the outer 100 mm 4 inches sealed with resilient material suitable for 927 to 1093 degrees C 1,700 to 2,000 degrees F. In addition, to allow for expansion of the inner face, a series of 3 mm 1/8 inch wide vertical openings spaced 1.83 meters 6 feet apart shall be provided on the furnace side of the wall. Proper provision shall be made for expansion and contraction between boiler foundation and floor.

2.2.3.2 Welded Wall

a. Inner Casing: Provide No. 10 gage inner casing for tangent tube construction.

b. Insulation and Firebrick: Back up the walls and roof of the furnace with not less than 63.50 mm 2 1/2 inches of block insulation (816 degrees C 1500 degrees F class) or ASTM C155 insulating firebrick. Provide standard welded casing or lagging to cover and protect insulation.

c. Furnace Roof Tube Openings: Where necessary, such as where the furnace roof tubes are separated to enter the drum, the opening shall be completely inner cased and filled with ASTM C401 castable refractory.

2.2.3.3 Tube and Tile Furnace Construction

Sides, front and rear walls, and the roof of the boiler, as far as is practical, shall include water wall tubes backed up with not less than a thickness of 63.50 mm 2 1/2 inches of super duty Class, regular type, ASTM C27 fire brick followed by high temperature block insulation 816 degrees C 1500 degrees F Class or ASTM C155 insulating firebrick. Insulation shall not be less than 127 mm 5 inches thick on the furnace walls and roof, 100 mm 4 inches thick on the side walls beyond the furnace, and 76 mm 3 inches thick on the rear wall, consisting of two layers with staggered joints. Plaster the entire exterior of the setting with a thin coating of plastic high temperature cement before the casing is applied.

2.2.3.4 Drum, Header and Miscellaneous Insulation

a. Drum Heads: Insulate drum heads with a minimum thickness of 51 mm 2 inches of calcium silicate blocks applied in two 25 mm one inch layers with 25 mm one inch mesh wire fabric embedded between layers. Entire surface shall be neatly finished with 13 mm 1/2 inch coat of smooth, hard finish hydraulic setting insulating cement with one inch chicken wire mesh embedded therein. Neatly finish drum heads with a field applied 0.47 kg 14 ounce per square meter yard glass cloth.

b. Drum Top and Header: Insulate the top half of the steam drum as previously specified for drum heads, but finish with 16 gage welded steel casing. Provide insulation to the flange on smoke outlet of the boiler. Insulate headers and downcomer tubes with not less than 38 mm 1 1/2 inch thick calcium silicate blocks banded in place, covered with 13 mm 1/2 inch thick coat of hydraulic setting insulating cement and enclosed in an 18 gage metal lagging with openings for access to handhole fittings, as required.

c. Miscellaneous: Provide special firebrick and tile required in connection with fitting of doors and seals, and around stoker and headers. Build arches of wedge brick where arches are required for door openings. Line doors exposed to furnace radiation for full depth of door with plastic refractory properly fastened to door. Caulk expansion joints with temperature resisting caulking material at points where setting joins parts of boiler. Provide air passages in insulated walls or brick work required for the stoker.

2.2.3.5 Baffles

When provided, baffles shall be properly located and practically gastight. Maximum velocity at end of baffle where gas turns shall be 17 meter 55 feet per second, except at baffle above rear pass hopper where maximum velocity shall not exceed 12 meter 40 feet per second.

2.2.3.6 Casing

****

NOTE: Designer shall fill in this blank depending on type of air pollution equipment and maximum pressure possible to be exerted on boiler casing by induced draft fan. Do no use less than 4980 Pa 20 inches of water gage.

****

Provide the entire setting, other than the top half of the steam drum with a continuously welded tight skin steel casing of not less than 10 gage, or an integral wall construction with outer casing of not less than 12 gage construction. Weld other steel casing joints where practicable, and reduce the number of bolted joints to a minimum. In places where sections of the casing are subject to removal periodically for inspection and maintenance, the casing shall be bolted using 18 mm 5/8 inch bolts on not more than 76 mm 3 inch centers with joints gasketed. Design the steel cased settings to withstand an internal negative or positive pressure of not less than the maximum static pressure generated by the boiler fans at shutoff and test block, plus a 25 percent safety factor without objectionable deflection of sides, or damage to side walls, casing, or refractory materials, or other parts of the unit. The minimum design pressure shall be a [_____] Pa inch water column. Make proper provisions for expansion and contraction of the casing without creating breakage or air leaks. With a surface wind velocity of 0.07 meter 2 feet per second, the average surface temperature of the casing shall not exceed 66 degrees C 150 degrees F while the boiler is operated at full rated load in an ambient temperature of 38 degrees C 100 degrees F. Finish the top half of the steam drum with 16 gage welded steel casing, as previously specified for the setting.

2.2.3.7 Access and Observation Doors

a. General: Provide boiler with a sufficient number of access and observation doors, to give free and easy access and observation to parts of the interior of the boiler.

b. Access and Cleaning Doors: Provide a minimum of [_____] by 450 mm 18 inch access and cleaning doors to give free and easy access to parts of the interior of the setting and the convection section of boiler. Brick up the furnace access door openings with No. 1 firebrick or firebrick tile properly held in place, between door and furnace.

****

NOTE: At the text below, consider that access is essential to all spaces between boiler tube banks, the convection section, and on both sides of baffles within these spaces. Consider access door under burner box when oil fired.

****

c. Observation Doors: Provide boiler with not less than [_____] by 250 mm 10 inch observation doors and [_____] 100 by 100 mm 4 by 4 inch peep doors.

****

NOTE: At the text below, do not specify less than 8 observation doors and consider using more when it is desired. On traveling grate stokers an observation door should be located above each air zone on both sides of the boiler which will probably result in using a greater number of observation doors.

****

d. Door and Opening Frames: Frames and front plates for openings for doors, soot blowers, overfire air openings, and other such items, in the pressure parts shall be completely gastight and airtight. Doors shall close against planed seats or the equivalent and shall be provided with heavy latches. Anchor door frames securely. There shall be no air leaks between door frames and setting.

2.2.3.8 Draft Connections

Provide draft connections through setting and steel casing for draft and airflow connections for combustion control and metering. Provide draft connections for measuring furnace draft, boiler outlet gas pressure, [and] economizer outlet gas pressure[, and fly ash collector outlet gas pressure]. Provide other openings as required for temperature elements and other combustion control and metering items in accordance with ABMA Boiler 103, recommended standard instrument connections unless otherwise specified.

Connection	Minimum Size
Thru setting	50 mm
Flue gas	25 mm
Air ducts (windbox)	25 mm

Connection	Minimum Size
Thru setting	2 inches
Flue gas	1 inch
Air ducts (windbox)	1 inch

2.2.4 Support and Framing

a. Support the boiler entirely independent of the casing and tile work, in a manner that will allow for expansion and contraction without straining part of boiler or affecting the setting. Support boiler and stoker entirely on structural steel work extending down to foundations as indicated.

****

NOTE: At the text below, provisions must be made for adequate boiler foundations based on soil conditions at each plant location. Foundations should be typically detailed on the drawings.

****

b. Provide structural steel columns and beams to support the boiler [_____], [_____] [and] [stoker] [and the boiler operating floor adjacent to the boiler,] [walkways, and platforms] [as indicated]. Size steel to support the equipment dead loads imposed, plus a minimum live load of 976 kg 200 pounds per square meter foot.

****

NOTE: Designer should include here any provisions where boiler steel is to serve as support for portions of building, or equipment.

****

[c. Boiler manufacturer shall furnish a drawing showing the magnitude and location of the loads imposed by the equipment and structural steel on the building structural steel.

] d. Provide anchor bolt setting plans along with anchor bolts with nuts and sleeves that shall be set in concrete for attachment in support of boiler and allied equipment. Provide bolts and nuts as required for items furnished.

2.2.5 Boiler Hoppers

2.2.5.1 Rear Pass Hoppers

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NOTE: Delete bracketed portions with cinder return (fly ash reinjection) when a cinder return system will not be incorporated into the project.

****

Provide rear pass hoppers at the rear of the stoker or boiler setting. Construct hoppers of 6 mm 1/4 inch thick welded steel plate as approved. Hoppers shall have minimum storage capacity based on 8 hours of operation at full load with no cinder return (fly ash reinjection) and shall have 200 mm 8 inch diameter outlets with standard flanges on the bottom of the hoppers.[Coordinate hoppers and hopper outlet flanges with overfire air-cinder return reinjection system furnished by the stoker manufacturer.] Provide insulation and lagging for the hoppers as specified for the boiler.

2.2.5.2 Plenum Chamber

Enclose the underside of the grates so as to form a plenum chamber and not permit any leakage of siftings onto the floor. Provide this chamber with a single hopper complete with access door and supporting steel. Provide manually operated double leaf stoker blast gates at duct connection to plenum chamber. Provide an 200 mm 8 inch diameter outlet with standard flange on bottom of the hopper.

2.2.5.3 Ash Storage Hopper

Hopper is specified under the paragraph ASH HANDLING SYSTEM in this section.

2.2.6 Boiler Trim

Fittings, drain valves, drain piping, feed piping, pressure gages, feed valves, stop valves, check valves, safety valves, and other appurtenances shall comply with the applicable requirements of the ASME Boiler and Pressure Vessel Code. Components shall conform to the following:

2.2.6.1 Boiler Blowoff Valve

Provide flanged [Class 250 cast iron] [Class 300 cast steel] body, seatless, sliding plunger type valves mounted in tandem at each boiler blowoff connection.

a. Steel gate, globe and angle valves: ASME B16.34.

b. Safety, relief, and safety relief valves: MIL-DTL-18436.

2.2.6.2 Steam Gage

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NOTE: Select gage scale to operate within the middle third of the range.

****

Provide a 300 mm 12 inch diameter indicating steam gage with chromium plated trim and zero to [_____] kPa (gage) psig scale. Gage shall be complete with siphon, valve, piping, and fittings to properly connect same. Gage shall be flush mounted on a 368 mm 14 1/2 inch square by 5 mm 3/16 inch thick steel plate. Provide plugged tee connection for connection to remote steam gage.

2.2.6.3 Water Column

Provide a safety water column with high and low water alarm suitable for the design pressure of the boiler. Column shall be complete with three-chain-operated gage cocks, heavy duty inclined gage glass, and quick-closing water gage valves having cross levers and chains operated from floor. Gage glass shall be readable from any point directly below unit. Make connections to water column from boiler with extra strong steel pipe and forged steel fittings. Provide crosses instead of tees or elbows, with screwed plugs in open ends. Terminate bottom of water column and water column gage glass with plug-in type valves accessible from operating floor. Provide plugged, screw-in type connections in water column piping to accommodate a remote level indicator. Provide gate valves immediately below water column and gage glass. Provide a suitable lamp fixture to illuminate water column.

2.2.6.4 Safety Valves

Provide not less than [_____] cast steel or cast iron body high capacity safety valves to give a total steam relieving capacity in accordance with the ASME BPVC SEC I requirements as to total boiler and water wall heating surface. Valves shall be set with a set pressure of [_____] kPa (gage) psig, [_____ kPa (gage) psig] [,_____ kPa (gage) psig] [and kPa (gage) psig] respectively. Valves shall have flanged inlet and outlet connections.

2.2.6.5 Non-Return Valve

Provide a non-return valve on each boiler steam outlet. The valve shall be a stop check angle body valve, flanged, Class 250 cast iron or Class 300 steel body with handwheel shutoff, pressure operated disc and external equalizer. The assembly for manual operation shall be outside screw and yoke type.

2.2.6.6 Blowoff Connections

Bottom drum blowoff connection on boiler shall be [_____] mm inch diameter and extended to outside of setting terminating with Class 250, tandem iron body, flanged blowoff valves, and shall be in accordance with ASME BPVC SEC I, Art. PG-59. Boiler water wall blowoff connections and economizer inlet pipe blowoff shall be 40 mm 1 1/2 inch diameter and extended to outside of setting and equipped with same type valves. Provide stop valves for water column blowoff connections.

2.2.6.7 Miscellaneous Stop Valves

Provide stop valves for each connection to boiler near boiler; include valves for soot blowers, chemical feed, vent, continuous blowoff, and required drains.

2.2.6.8 Tube Cleaner

Provide one tube cleaner suitable for cleaning tubes of the boiler. Tube cleaner shall operate on water at 1034 kPa (gage) 150 psig pressure. Tube cleaner shall be complete with one motor, one wrench, one cutter head assembled, one universal coupling for cutter head, two sets of cutters, two sets of cutter pins, one set of arm pins, one set of keeper pins, one brush with a set of refills, one tool box, and two 15 meter 50 foot lengths of heavy duty hose with 20 mm 3/4 inch diameter pipe connections.

2.2.6.9 Wrenches

Provide special wrenches required for proper maintenance of equipment.

2.2.7 Boiler Limit Interlocks

Provide applicable boiler limit interlocks required by FS F-B-2910 and connect to effect safety shutdown of the stoker[and oil burners]. Interlocks shall be compatible with and integrated into the instrumentation system as specified.

2.2.8 Sootblowers

Provide the boiler [and] [economizer] [and air preheaters] with a sootblowing system using [steam] [compressed air] for removing the deposits of soot and fly ash from the heat transfer surfaces. Sufficient number of blower elements shall be provided to adequately clean the heat transfer surfaces. Fixed position, multi-nozzle rotating elements may be provided in applications where flue gas temperatures do not exceed 982 degrees C 1800 degrees F. Retractable soot blowers shall be provided where flue gas temperatures exceed 982 degrees C 1800 degrees F.

2.2.8.1 Fixed Position Soot Blowers (Steam)

Soot blowers shall be steam, fixed position, multi-nozzled, rotating, valve-in-head type with electric motor operation to permit the proper cleaning of the heat transfer surfaces with cam operated valves arranged to automatically open the steam valve through the proper arc of rotation. Cams shall be adjustable to give the proper operating arc or shall be specifically designed for each location. Furnish and install soot blowers complete, including valve-in-head blower heads, wall sleeve bushings, high temperature elements, low temperature elements, [_____] volt, [_____] Hz., [_____] kW hp motor operators, hand operated drain valve, with drilled orifice and disc to prevent tight shutoff, element supports, clamps, bolts, and other such items. Furnish necessary piping and valves including drainlines, shut-off valves, piping supports and insulation. Weld soot blower piping and fittings. No screwed piping or fittings will be permitted. Blower elements shall be carefully installed to avoid rubbing on tubes which would cause eventual tube failure. Scavenging air connections from forced draft fan shall be provided where required to protect blowers in non-blowing position. Provide a single control station containing start and stop pushbuttons and necessary relays to control the motor operators.

2.2.8.2 Fixed Position Sootblowers (Air Puff)

Sootblowers shall be air puff type, fixed position, multi-nozzled rotating element type complete with air master controller for each boiler, entirely air-operated and designed for controlled automatic sequential operation. Units shall be operated in such a manner that air issues from the element in a series of sustained high pressure puffs of approximately one second duration each. During each puff, the element shall be rotated through a predetermined and measured short arc (17 1/2 degrees) by means of a ratchet mechanism in the sootblower head. Between each puff, no air shall flow through the blowers and there shall be sufficient time for the system to be restored to full pressure. When the blowing cycle has been completed, the controller shall automatically stop the sequence. Provide sootblowers complete with wall sleeve bushings, element supports, clamps bolts and other required components. Provide necessary piping and valves, including shutoff valves, piping and supports. Weld sootblower piping and fittings. No screwed piping or fittings will be permitted. Carefully install blower elements to avoid rubbing on tubes which would cause eventual tube failure.

2.2.8.3 Retractable Sootblowers

Provide in lieu of fixed position type and where flue gas temperatures exceed 982 degrees C 1800 degrees F. Sootblowers shall be [air] [electric] motor operated. Rotation of the blower shall be continuous from the moment the lance begins to extend. Rotating and traversing speeds shall be independently adjustable by changing sprockets. Blowers shall be complete with heavy steel housing, outside adjustment of nozzle pressure, alloy lance, wall sleeve, supports, and other necessary appurtenances required for a completely workable system.

2.2.8.4 Elements

Equip units with elements specially designed for use with [steam] [air]. Elements subjected to temperatures of 482 to 816 degrees C 900 to 1500 degrees F shall be chromium covered extra heavy carbon steel tubing or a chrome alloy as specified for a higher temperature; between 817 to 927 degrees C 1501 to 1700 degrees F, they shall contain not less than 20 to 23 percent chrome; from 928 to 982 degrees C 1701 to 1800 degrees F, not less than 24 to 27 percent chrome. Provide a flexible connection between each head and element.

2.2.8.5 Control

On the operating floor provide a pushbutton for each boiler for starting and stopping system.

2.2.8.6 Control for Sootblowing System

Provide sootblowing system with an automatic programmable control system which will automatically start and stop each sootblower in programmable sequence and monitor and display operation of sootblowers. Provide an overriding control which will permit manual start-stop operation of sootblowers.

2.3 ECONOMIZER

Provide economizer [separate from the boiler] [integral to and within the boiler setting]. Economizer shall be of the [bare tube] [cast iron fin covered steel tube] design complete with feedwater piping between economizer and boiler drum. Economizer shall be constructed in accordance with the requirements of ASME BPVC SEC I meeting the design and operating conditions as specified for the boiler and bearing the ASME Code symbol stamp. Economizer shall be suitable for the operating conditions and the fuels specified. Materials provided shall withstand temperatures and pressures prevailing under maximum load conditions. Economizer casing, insulation, and lagging shall be specified for the boiler.

2.3.1 Accessories

Provide the following accessories and equipment for each economizer.

a. Sootblowers of the same manufacturer and construction as sootblowers to be provided for boilers;

b. Stack temperature control with sensor and motorized feedwater temperature control valves to function to limit flue gas temperature to a minimum of [_____] degrees C F by modulating feedwater to the bypass;

c. Temperature and pressure indicators on feedwater outlet;

d. Temperature and pressure indicator on feedwater inlet;

e. Temperature and pressure indicator on flue gas outlet;

f. Temperature and pressure indicator on flue gas inlet;

g. Manual shutoff and bypass piping and valving;

h. Low point drain pipe complete with two blowoff valves as specified for the boiler; and

i. Audible alarm with silencing switch and indicating lights for high feedwater exit temperature, low feedwater exit temperatures, low or high flue gas exit temperature, low feedwater entrance temperature or pressure.

2.4 COAL GRATE STOKERS

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NOTE: Choose from either the paragraphs and subparagraphs below TRAVELING GRATE COAL STOKER or the paragraphs and subparagraphs TRAVELING GRATE SPREADER COAL STOKER that follow it.

****

[2.4.1 Traveling Grate Coal Stoker

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NOTE: Designer shall select type of stoker most suited for each project. Stoker Selection Criteria is shown in NAVFAC Design Manual DM-3.6, Table 12.

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NOTE: When the boiler is not part of this project insert Coal Analysis at end of this paragraph.

****

Stoker shall be of the bar and key traveling grate type arranged for rear ash discharge. Stoker shall be capable of continuous operation at such rate as required for the continuous output of not less than that specified for the boiler and shall satisfactorily provide for automatic operation, by means of combustion control system, within the range given when burning the specified coal and operated in accordance with instructions supplied by the manufacturer. Obtain satisfactory operating conditions throughout the full operating range of the stoker. The stoker shall be considered as an integral part of the steam generator and shall be subject to applicable provisions of the boiler design and service conditions together with requirements of tests, performance guarantees and other warranties specified for the boiler. Coal analysis shall be as specified in the Coal Analysis Schedule for the boiler. The gate moving mechanism shall be positive, up and down, and equipped with suitable operating mechanism for manual control. Provide an indicator to show the vertical position of the gate and the thickness of the fuel bed.

2.4.1.1 Stoker Grate Heat Release Rate

****

NOTE: Normally the stoker grate heat release will be 1417 kW per square meter 450,000 Btu per square foot per hour when coal meeting the criteria set out in the Stoker Selection Criteria shown in NAVFAC Design Manual DM-3.6, Table 12 is used. When coal is specified which does not meet this criteria then the grate heat release will have to be lowered accordingly.

****

Not greater than [_____] kW per square meter Btu per square foot per hour at the specified maximum continuous rating for the boiler. The square meter feet of projected grate area shall be the product of the length measured between the inside of the coal gate and the centerline of the rear shaft or return bend and the width of the grate.

2.4.1.2 Construction

a. Fuel Feed Control: Control fuel feed to the stoker by the stoker speed and the vertical position of the coal regulating gate. Coal gate to vary the thickness of the fuel bed shall be of heavy cast iron with refractory facing to protect it from the furnace heat. The gate moving mechanism shall be positive, up and down, and equipped with suitable operating position of the gate and the thickness of the fuel bed.

b. Coal Hopper: Provide a coal hopper of 6 mm 1/4 inch thick Type 304 or 316 stainless steel plate at the front of each stoker. The capacity of the hoppers shall not be less than [_____] cubic meters feet.

c. Stoker Front Enclosure: Provide stoker fronts with dust tight enclosures of not less than 10 gage plate to eliminate dust from the boiler room and prevent air infiltration to the grate. Fit these fronts with access doors.

d. Air Plenum (Siftings Hopper) and Ducts: Provide an undergrate air plenum and air ducts for the stoker which will receive air from the forced draft fan. Plenum and air ducts shall be not less than 10 gage steel plate. Provide concrete ducts or airways along the sides of the setting when adaptable to use by the stoker submitted. Provide ducts in accordance with drawings and requirements furnished by the stoker manufacturer. Provide unit with necessary observation doors or ports of the self-closing glass-covered type for side walls, including a minimum of four for observing the underside of the grate.

e. Stoker Air Zones: The stokers shall have not less than [_____] air zones with individual control to each zone in order to provide optimum control of combustion conditions for loads within the specified range and shall be so arranged that a positive air seal will be formed between each zone. Design the zones to provide removal of siftings. To ensure proper air distribution to each zone, provide an air control valve or damper for each zone. Control valves or dampers shall be hand controlled and shall be accessible for instant adjustment by the operator from the side of the stoker. Provide each zone with a pipe opening for a draft gage connection and provide connection in the overfire air duct for the same purpose.

f. Stoker Grate: Mount the traveling grate stoker grate keys (clips) on carrier bars supported from an endless heat treated type steel chain. Provide wearing shoes on the carrier bars to carry the grate weight on skid rails extending the length of the furnace. The chain links shall mesh with the shaft sprockets transmitting the driving force to the endless chain. Grate keys (clips) shall be chrome alloyed cast iron to resist growth. Links shall be uniform. Grates shall be made of the best quality, heavy duty, heat resisting, cast iron or cast alloy carefully cast to minimize initial strain. The sifting hoppers and removal system shall be so arranged that siftings may be removed from zones.

g. Grate Thermocouples: Provide two grate temperature sensing thermocouple arrangements on each grate to indicate and record grate temperatures on the operator's [interface console] [control panel].

h. Tension Adjustment: Provide a conveniently located adjustment accessible from outside of the boiler or through access plates in the stoker front cover for regulating the tension of the grate. Provide adequate adjustment for the chain length.

i. Stoker Seals: Provide the stoker with seals between the bottom of the sidewall header and the frame. Provide restraints in the boiler setting to prevent seals at rear of stoker from opening up.

j. Stoker Support: Stoker and drive shall be complete with supporting structural steel framework. Locate and protect structural supports so that they will not be overheated or damaged by heat from either the furnace or ash pit.

k. Grate Return Run Support: Adequately support the lower return run of the grate on a system of cross members and longitudinal members or skids. Provide an air seal between this lower drag frame and ash pit and siftings hopper.

2.4.1.3 Grate Ash Discharge Enclosure

Enclose rear end of grate, where ash is discharged into the hopper below the floor line, with a dust tight enclosure made of heavy steel plates properly protected with fire brick where exposed to the furnace. Fit vertical ends of this enclosure with cast iron, refractory lined inspection and access doors, one for each feeder. Seal off roof of this enclosure with refractory, protecting metal parts from the furnace temperature with refractory. Exposed metal parts in the enclosure are not acceptable. Enclosure shall be compatible with the ash storage hopper as specified under the paragraph ASH HANDLING SYSTEM in this section.

2.4.1.4 Stoker Grate Drive

Drive the grate of the stoker through hydraulic drive, or with electrical motor and transmission equipment as specified below. Drive shall have a variable speed ratio of not less than six to one with the speed changing device, controlled automatically by the combustion control system. Provide a manual and reversing adjustment so the grate speed can be operated independent of the combustion control system. Provide adequate safety release to prevent damage to the drive or grates due to foreign material or jamming of the grates. Provide the front and rear shafts of the grates with an adequate lubrication system with fittings located on the outside of the setting.

a. Electric Motor: Motor shall be [_____] volt, [_____] phase, [_____] rpm, 60 Hz, totally enclosed, fan cooled, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

b. Mechanical Drive: Mechanical drive shall include variable speed transmission with gears and chains, enclosed in an oil tight case, and running in a bath of oil. Bearings shall be of the anti-friction type, with hardened inner and outer races and fitted with forced lubrication fittings.

c. Hydraulic Drive: Hydraulic drive shall include a complete hydraulic system with adequately sized reservoir, dual pumps, oil piping to and from drive, control and isolating valves, oil cooler, when required, with self-operated cooling water control valve, oil temperature indicator, and other accessories for a complete, satisfactory operating system.

2.4.1.5 Miscellaneous Equipment

Provide shafting, couplings, bearings, drives with guards, linkages, rods, and other miscellaneous equipment from the stoker manufacturer required or necessary for interconnecting of the stoker units and drives necessary for a complete operating system. Provide equipment even though it is not specifically mentioned herein. Gears, chains, belts, couplings, and other moving parts shall be properly enclosed or guarded.

2.4.1.6 Lubrication

The entire stoker mechanism shall have adequate provisions for proper lubrication where required and shall be equipped with conveniently located fittings for this purpose.

2.4.1.7 Overfire Air System

Provide an overfire air system from the stoker manufacturer to ensure good ignition at the stoker front and adequate control of smoking. System shall include necessary nozzles, ducts, and overfire air fan with motor drive. When more than one row of nozzles is supplied, provide individual air volume control for each row or set as required. Locate nozzles or protect them with shields so as to prevent plugging of the nozzles in service. Nozzles shall be constructed of materials suitable for service at maximum temperatures anticipated. Provide necessary arrangements to the water wall tubes, arch construction, refractory, insulation, and casing from the boiler manufacturer, to permit installation of an adequate overfire air system. Overfire system shall be capable of providing a minimum of 15 percent of total combustion air at the required static pressure.

][2.4.2 Traveling Grate Spreader Coal Stoker

****

NOTE: Choose this paragraph and its subparagraphs or the paragraphs and subparagraphs above, TRAVELING GRATE COAL STOKER.

****

****

NOTE: When the boiler is not part of this project insert Coal Analysis at end of this paragraph.

****

Stoker shall be of the overfeed, synchronized, self-feeding, spreader stoker type with continuous cleaning forward moving bar and key grates suitable for burning a portion of the coal in suspension and burning the balance on the grates. Stoker shall be capable of continuous operation at such rate as required for the continuous output of not less than that specified for the boiler, and shall satisfactorily provide for automatic operation by means of the combustion control system, within the range given when burning the specified coal and operated in accordance with instructions supplied by the manufacturer. Stoker shall be considered an integral part of the steam generator and shall be subject to all applicable provisions of the boiler design and service conditions together with requirements of tests, performance guarantees and other warranties specified for the boiler. Coal analysis shall be [as specified in the Coal Analysis Schedule for the boiler] [as listed below].

2.4.2.1 Stoker Grate Heat Release

****

NOTE: Normally the stoker grate heat release will be 2205 kW per square meter 700,000 Btu per square foot per hour when coal meeting the criteria set out in the Stoker Selection Criteria shown in NAVFAC Design Manual DM-3.6, Table 12 is used. When coal is specified which does not meet this criteria then the grate heat release will have to be lowered accordingly.

****

The active grate area shall be such that the heat release at the maximum continuous rating shall not exceed [_____] kW per square meter Btu per hour per square foot. At minimum boiler rating the stoker grate heat release shall be a minimum of [2280] [2850] MJ per square meter [200,000] [250,000] Btu per square foot; this results in a guaranteed turndown ratio of [_____] to 1. Grate area shall be the product of the width between the inside faces of the sidewall heaters at the grate line and the length of the air-supplied grate area. The grate shape shall be designed so that the heat release per front meter foot of stoker width does not exceed 2930 kW

10,000,000 Btu/hour at the maximum continuous boiler rating.

2.4.2.2 Construction

a. Fuel Feed Control: Coal shall be fed to and distributed in the furnace by not less than three overfeed type spreader stoker feeders for each boiler. Feeders shall be operated simultaneously and at synchronized speeds so that any one feeder may be taken out of service without affecting the operation of the others. Each feeder shall be readily adjustable to ensure proper fuel distribution within the furnace. Design and size the total combined width of the feeder openings for proper distribution of the fuel over the width of the stoker grate. Design shall be such that the combined width of the feeders shall not be less than 40 percent of the width of the stoker grate. The feeders shall be capable of handling and uniformly distributing coal varying in size from 6 to 32 mm 1/4 to 1 1/4 inches with no more than 40 percent passing a 6 mm 1/4 inch round mesh over the entire grate area. The feeder shall be capable of properly performing with moisture in the fuel as high as 15 percent by weight. Materials of construction shall be such that coal with high sulfur content can be satisfactorily used without extensive corrosion over the lifetime of the parts. Provide moving parts of the feeders with anti-friction type bearings and with a forced system of lubrication. Bearings subject to high temperatures shall be water cooled. Gear teeth shall be machine cut.

b. Coal Hopper: Provide a metal hopper for each spreader stoker feeder. Hoppers shall be not less than 6 mm 1/4 inch thick 304 stainless steel plate, rigidly reinforced and connected to the coal grates. Support hoppers from the floor or boiler columns to eliminate weight on the feeders. Provide hoppers with suitable cleanout doors located in the front.

c. Air Plenum (Siftings Hopper) and Ducts: The traveling grate/stoker shall be complete with under grate air plenum, manually operated blast gates and operating handles, and siftings hopper. Plenum and air ducts shall be not less than 10 gage steel plate. Locate and protect structural supports so that they will not be overheated or damaged by heat from either the furnace or ash pit. Provide unit with necessary observation doors or ports of the self-closing glass-covered type for side walls, including a minimum of four for observing the underside of the grate.

d. Stoker Grate: Grates shall be made of the best quality, heavy duty, heat resisting, cast iron or cast alloy carefully cast to minimize initial strain. Specially design the grates for spreader stoker firing. Grates shall be of high resistance, air metering type with closely and uniformly spaced self-cleaning air openings. The grates shall have close fitting, overlapping edges to prevent air leakage at the joints. Provide undergrate air seals at both the front and rear ends fabricated of cast iron and counterweighted so that they will always be in close contact with the under sides of the grates. Construct the rear seal to proportion the air flow through the rear end of the grate to expedite coking and ignition of the coal, thereby properly conditioning it for efficient combustion when the fuel bed reaches the active air admitting area. Side seals between edge of stoker grate and boiler shall be approved bellows type.

e. Grate Thermocouples: Provide two grate temperature sensing thermocouple arrangements on each grate to indicate and record grate temperatures on the operator's [interface console] [control panel].

f. Tension Adjustment: Provide a conveniently located adjustment accessible from outside of the boiler or through access plates in the stoker front cover for regulating the tension of the grate. Provide adequate adjustment for the chain length.

g. Stoker Support: Stoker and drive shall be complete with supporting structural steel framework. Locate and protect structural supports so that they will not be overheated or damaged by heat from either the furnace or ash pit.

2.4.2.3 Grate Ash Discharge Enclosure

Enclose front end of grate, where ash is discharged into the hopper below the floor line, with a dust tight enclosure made of heavy steel plates properly protected with fire brick where exposed to the furnace. Fit vertical fronts of this enclosure with cast iron, refractory lined inspection and access doors, one for each feeder. Seal off roof of this enclosure with refractory, protecting the metal parts from the furnace temperature with refractory. Exposed metal parts in the enclosure are not acceptable. Enclosure shall be compatible with the ash storage hopper as specified under "Ash Handling System" this section.

2.4.2.4 Feeder Drives

At the option of the Contractor, the drives shall be either individually driven and controlled feeders or feeders driven by a line shaft with individual clutch arrangements.

a. Controlled Feeders: The individually driven and controlled feeders shall have a variable speed drive on each distributor and a silicon controlled rectifier (SCR) D.C. motor drive for each drum or feed box. A master controller shall receive a fuel demand signal from the combustion control system and control the individual slave controllers of the individual SCR units to satisfy the particular fuel demand. Control arrangement shall provide for simple adjustments between feeders for equal fuel delivery and also for single feeder biasing.

b. Line Shaft Feeder: The feeders driven by a line shaft shall be driven through a variable speed drive having a ratio of not less than three to one. Feeder drive shall be so arranged that each feeder is independently driven from a lineshaft so that any feeder can be engaged or disengaged without disturbing the operation of the remaining feeders. Fuel delivery shall be governed by the combustion control system.

c. For either stoker drive system, provide a complete operating unit with necessary shafting, couplings, bearings, drives with guards, linkages, rods, and other equipment, as required or necessary for any interconnecting of the stoker units and drives. This equipment shall be provided even though it is not specifically mentioned. Provide safety release to prevent damage to the units due to foreign materials in the coal or other causes of overload.

d. Distributor: The distributor shall be driven by a variable speed electric drive which is manually adjusted to achieve optimum distribution.

2.4.2.5 Stoker Grate Drive

Drive the grate the stoker by [hydraulic package] [electrical motor] [a steam turbine] through a variable speed device with a speed ratio of at least six to one, with the speed changing device, controlled automatically by the combustion control system. Provide a manual adjustment to regulate grate speed ratio to fuel feed in order to compensate for variations in the ash content. Provide a suitable safety release device to prevent damage to the drive or grates due to foreign material or other obstruction interfering with the grate operation.

****

NOTE: Make heat balance to determine whether it is more economical to use turbine drives rather than electric motors.

****

a. Electric Motor: Motor shall be [_____] volt, [_____] phase, [_____] rpm, 60 Hz, totally enclosed, fan cooled, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

b. Steam Turbines: Drive shall be by steam turbine conforming to NEMA SM 23 as modified below. Turbine shall be noncondensing capable of producing braking power [_____] kW horsepower at [_____] rpm at a steam rate of not more than [_____] kg pounds per brake power hour. Inlet steam condition, upstream of built-in governor, shall be [_____] kPa (gage) psig and [_____] degrees C F. Exhaust steam conditions at exhaust nozzle shall be [_____] kPa (gage) psig. Turbine rotation shall be [clockwise] [counterclockwise] and shall be [direct connected] [geared] to the driven piece of equipment which shall operate at [_____] rpm. Piping connections 50 mm 2 inches and smaller shall be screwed. Connections 65 mm 2 1/2 inches and larger shall be flanged. Inlet flanges shall be raised face suitable for the inlet pressure specified. Exhaust flanges shall be Class 125 or Class 150 flat-faced flanges. Turbine shall be complete with insulation and lagging. Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Turbine governor shall be of direct oil relay type with 10 percent adjustable speed range. Lubrication shall be of the manufacturer's standard non-pressure type.

[c. Mechanical Drive: Mechanical drive shall include variable speed transmission with gears, worm drives and bearings, enclosed in an oil tight case, and running in a bath of oil. Bearings shall be of the anti-friction type, with hardened inner and outer races and fitted with forced lubrication fittings.

][d. Hydraulic Drive: Hydraulic drive when required shall include a complete hydraulic system with adequately sized reservoir, dual pumps, oil piping to and from drive, control and isolating valves, oil cooler, when required, with self-operated cooling water control valve, oil temperature indicator, and other accessories for a complete, operating system. Hydraulic drive system motor, shall be [_____] volt, [_____] phase, 1200 rpm, 60 Hz totally enclosed, fan cooled, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

] e. Miscellaneous Equipment: For a stoker drive system, provide a complete operating unit with necessary shafting, couplings, bearings, drives with guards, linkages, rods, and other equipment, as required or necessary for any interconnecting of the stoker units and drives. This equipment shall be provided even though it is not specifically mentioned herein. The front and rear shafts of the grate are to be fitted with a forced system of lubrication with fittings located on the outside of the setting. The devices for changing the speed ratio of the grate drives shall be connected to the fuel feed regulation system, so both fuel feed and grate speed can be synchronized and controlled automatically by the combustion control system. A manual adjustment shall be provided to regulate grate speed ratio to fuel feed in order to compensate for variations in ash content of the fuel. A suitable safety release device shall be provided to prevent damage to the drives or grates, due to foreign material or other obstruction interfering with the grate operation. Gears, chains, belts, couplings, and other moving parts shall be properly enclosed or guarded.

2.4.2.6 Overfire Air System

****

NOTE: Designer should include bracketed sentence when cinder return (fly ash reinjection) will not be incorporated in the project.

****

Provide a high pressure overfire air system for each stoker, including fan, [motor drive,] ductwork, dampers and nozzles. The fan shall have a capacity of not less than 15 percent of the total air required at maximum steaming capacity when operating at the predicted amount of excess air in the furnace. Static pressure of the fan shall be sufficient to ensure full penetration of the furnace by the air jets, but not less than 6225 Pa 25 inches of water. Overfire air distribution nozzles shall be fabricated from heat resistant alloy. Locate air jets properly and in sufficient numbers to create proper furnace turbulence for complete combustion at all ratings. Make modifications and additions to the system to ensure penetration and turbulence of areas of the furnace as required after startup. [There will be no cinder return system incorporated in the overfire air system.]

****

NOTE: At the text below, delete the following paragraph on pneumatic cinder return (fly ash reinjection) system when this system will not be incorporated in the project.

****

[a. Cinder Return System (Fly Ash Reinjection): Provide a pneumatic cinder return system to reinject collected fly ash and unburned combustibles into the furnace. The system shall operate in conjunction with the overfire air system and shall be complete with necessary air lines, nozzles, ducts, and dampers for returning the cinders from the rear convection pass hopper of the boiler and the economizer soot hopper or air heater hopper. Cinder return lines, shall be constructed of abrasion-resistant iron having a Brinnell hardness of not less than 350, with the exception that the straight conveyor lines, starting at a point not less than 600 mm 2 feet downstream from each cinder pickup nozzle or elbow extending to within not less than 600 mm 2 feet of the furnace, may be constructed of extra strong Schedule 80 steel pipe. Provide glass viewing ports at the end of each cinder return line so that interior of lines are visible all the way through to furnace.

]]2.5 OIL BURNER/WINDBOX PACKAGE

****
NOTE: Choose this paragraph and its subparagraphs when oil is used.
****

****
NOTE: The designer shall fill in the appropriate information as defined in FS F-B-2910.
****

Provide a fully modulating, oil burner conforming to FS F-B-2910 Rev F, Class [_____], except as modified below. Provide burner with windbox, forced draft fan, dampers, fuel train and associated controls to comprise a complete factory assembled package. Total heat input to boiler furnace shall be provided by [_____] burners. Burner package shall be considered an integral part of the steam generator and shall be subject to applicable provisions of the boiler design and service together with requirement of tests, performance guarantees and other warranties specified for the boiler.

2.5.1 Burner

2.5.1.1 Burner Characteristics

The burner shall be quiet in operation and operate with a balanced clean, stable flame so as not to localize heat in any part of the combustion chamber. Burner shall be capable of completely atomizing and effectively mixing oil with air so as to ensure complete combustion. Air admitted shall be of sufficient quantity for complete combustion, but not of such quantity as to produce an undue percentage of excess air with high stack loss. Oil burner shall operate without clogging and shall have sufficient capacity to develop not less than the specified capacity. Burner unit shall be easily removed from firing position and readily accessible for inspection, cleaning and other purposes. Provide adequate observation ports on burner. Burner manufacturer shall guarantee that there will be no flame impingement on sidewalls, top, bottom, or rear walls of furnace. Burner manufacturer shall furnish, and contractor shall install refractory throat tiles or other items required for proper installation of burner.

2.5.1.2 Atomization

****
NOTE: Burners may be air atomizing or steam atomizing. When a separate compressed air system is used the designer shall fill in blanks with the quantity and pressure of compressed air that will be available for fuel oil atomization. The designer should allow for an adequate amount of atomizing air. Atomizing air requirements will vary depending on many factors including burner design, fuel oil characteristics, fuel oil pressure, air pressure and even furnace conditions. See NAVFAC Design Manual DM-3.6 for empirical information.
****

Burner shall be [steam atomizing; steam pressure at header is [_____] kPa (gage) psig; steam temperature at header is [_____] degree C F] [air atomizing; filtered compressed air shall be available for burner atomization and the maximum requirement for each burner shall not exceed [_____] L/s scfm of air at [_____] kPa (gage) psig]. Provide pressure reducing valve and controls as required.

2.5.1.3 Electric Ignition System

Burner shall be equipped with an electric ignition system. System shall be either the high energy ignition or glow rod type. Gas ignition system is not acceptable. The high energy ignition system shall use stored energy to develop 2000 Vdc pulses. The glow rod system shall use a low voltage, carbon rod electrode which develops a tip temperature of 1427 degrees C 2600 degrees F. Provide ignition system complete in all respects.

2.5.1.4 Windbox

Construct of carbon steel plate not less than 10 gage thickness with 6 mm 1/4 inch thick front plate. Design windbox to provide even and uniform air entrance into the burner register and seal weld to the boiler front wall. Provide windbox with support legs.

2.5.1.5 Purge Connection

Provide [steam] [air] purge connection, properly valved, for purging oil from gun prior to removal from burner.

2.5.1.6 Aspirating System

****

NOTE: Provide aspirating system only for boilers in which the expected furnace pressure exceeds 1245 Pa 5 inches water.

****

Provide an air aspirating system for the fuel oil atomizer guide pipes to prevent blowback of hot furnace gases. Aspirating system shall use approximately [_____] L/s scfm of [_____] kPa (gage) psig compressed air.

2.5.1.7 Guide Pipe Purge

Provide piping and flexible hoses for the guide pipe purge and aspirating systems. Air from the forced draft fan shall be provided for guide pipe purging during normal operation.

2.5.1.8 Metal Parts

Metal parts exposed to radiant heat, including the atomizer shield, shall be of stainless steel or other approved alloy.

2.5.1.9 Fuel Oil Control Valve

Fuel oil will be supplied at [_____] kPa (gage) psig and [_____] degrees C F at the inlet of the fuel piping train. Size fuel oil automatic control valve for 103 kPa 15 psi differential pressure as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.5.1.10 Fuel

ASTM D396, Grade no. [_____].

2.5.1.11 Forced Draft Fan

****

NOTE: The designer shall make a technical evaluation to determine when the forced draft fan should be integrated with or mounted separately from the windbox on the floor next to the boiler. When the forced draft fan is to be mounted separately, delete this paragraph and specify the fan in the paragraph FANS.

****

Fan shall be fully integrated with and mounted on the windbox. Provide an inlet silencer, when required, to ensure operation at noise level below 85 dBA.

2.5.1.12 Electric Motor

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine when forced draft fan motor shall be provided with variable speed control. Generally, variable speed drives for forced draft fans over 7 1/2 kW 10 hp will be cost effective.

****

Motor shall be [variable speed], [_____] volt, [_____] phase, 60 Hz, [totally enclosed, fan cooled], [totally enclosed, non-ventilated], not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

2.5.2 Flame Safeguard Controls

Provide a complete system of valves, interlocks and controls in accordance with NFPA 85 and as approved by Factory Mutual Engineering and Research.

2.5.2.1 Fuel Oil Train

Provide fuel oil train consisting of [steam] [air] atomizing oil gun, auxiliary [steam] [air] atomizing oil gun for changing guns without a shutdown, fuel oil control valve, two safety shutoff valves recirculation valve, strainer, and flexible hose connections to oil burner package the following gages. Gages shall be 150 mm 6 inch with white coated dials and black figures:

a. Fuel oil supply pressure (0 to 1034 kPa (gage) 150 psig)

b. Fuel oil pressure at burner (0 to 1034 kPa (gage) 150 psig)

[c. Atomizing air pressure at burner (0 to 1034 kPa (gage) 150 psig)

][d. Atomizing steam pressure at burner (0 to 1034 kPa (gage) 150 psig).

]2.5.2.2 Control Sequencing

Flame safeguard system shall be designed to ensure safe purge, light-off and shutdown procedures, and to monitor light-off, main flame and boiler operating conditions.

a. The flame safeguard system shall be of the automatically sequenced type with programming timed and sequenced by a heavy duty, industrial type timer. This timer shall be tamper-proof and shall be designed so that advancement of the timer to shorten purge will shut down the unit.

b. Provide system with [ultraviolet] [infrared] scanner and electronic relay located in the front wall which will shut down the fuel within 2 to 4 seconds of loss of flame.

c. Provide scanner output meter in panel for indication of scanner signal strength.

d. The safety system shall include the following limit devices incorporated into a limit circuit:

  (1) Flame failure

  (2) High boiler outlet pressure

  (3) Low fuel oil pressure

  (4) Low water level cutout

  (5) Low combustion air flow

  (6) Low atomizing [air] [steam] pressure

  (7) Any additional devices as required by FM or NFPA

[(8) Low fuel oil temperature

] e. Safety system limits specified above shall be displayed on a first out annunciator mounted in the burner panel. [Provide a common alarm contact to be wired to the operator control console, specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.5.2.3 Light Off

Failure shall require a manual restart of the programmer. The safety system shall provide a mandatory purge with the forced draft fan vanes proven open, and a return to proven low fire position before light off. Main fuel valve shall open for a timed period of 10 seconds during trial for ignition.

2.5.2.4 Circuit Analyzer

Provide a circuit analyzer system, which, by means of 12 or more lights, will indicate which circuits are energized at specific time, and will thereby indicate any improperly operating circuit.

2.5.2.5 Control Panel

Programmer, limit control, relays, annunciator, shall be mounted in a [NEMA MG 1 control panel, modified with fully gasketed doors and panels mounted on burner package] [control panel as specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS].

2.6 FANS

2.6.1 Forced Draft Fan

****

NOTE: The fan type shall be specified in accordance with CID A-A-59222.

****

CID A-A-59222, Type [_____], Class 1, except as specified otherwise.

2.6.1.1 Fan Size

Size fans for complete combustion of fuel at maximum firing rate. Maximum fan speed shall not exceed 1800 rpm at test block rating with [10] [20] [40] percent excess air, taking into account design allowances, corrections for burner or stoker pressure drop, furnace pressure, combustion air temperature, plant elevation, and other design factors. Minimum static efficiency at maximum continuous rating shall be [_____] percent. Add the following allowances for momentary overloads and normal deterioration of fans, firing equipment, and boilers after sizing fans in accordance with the above to obtain the test block rating:

	Excess Volume	Excess Pressure
Coal Fired		
Forced draft	20 percent	32 percent
Oil Fired		
Forced draft	10 percent	20 percent

2.6.1.2 Fan Construction

Fan shall be arrangement [_____] in accordance with AMCA 801. Fan shall have backward inclined or backward curved single thickness blades. Fan shall have stable characteristics with self-limiting power curve. Construct fan wheel of steel. Balance fan wheel both statically and dynamically at factory. Provide fan with air cooled roller bearings mounted in horizontally split pillow blocks. Fan housing shall be welded constructed of a minimum of 12 gage steel. Provide flanged inlet and outlet connections, 50 mm 2 inch plugged opening in low point of scroll and hinged, quick opening access door in scroll. Provide a multi-blade vortex ball bearing damper in fan inlet with an extended, ball bearing mounted control lever for field connections to control actuator. Interior of fan, including wheel, shall be painted with two coats of red primer and one coat of rust resistant enamel with a total dry film thickness of 0.152 mm 6 mils. Exterior surface of the fan shall have two coats of red primer with a total dry film thickness of 0.10 mm 4 mils. Cleaning and painting shall be in accordance with the manufacturer's standards.

2.6.1.3 Fan Drive

Equip fans with [both] [a motor] [and] [steam turbine] drive. The [motor] [and] [turbine] shall be direct connected to the fan [with a gear type flexible coupling] [with a roller type, hardened steel clutch coupling consisting of an over-running clutch and double flexing coupling to permit instantaneous change-over from one drive to the other. One clutch coupling shall be provided between the fan and each driver. Clutch couplings shall be selected for the maximum torque requirement of the fan, with a 1.5 service factor. Provide a removable guard over each clutch coupling].

2.6.1.4 Electric Motor

Motor for driving the forced draft fan shall be [_____] volt, three phase, 60 Hz, [open drip-proof] [totally enclosed fan cooled] [two speed] [variable speed] not less than [_____] kW hp, as specified under MOTORS AND DRIVES in this section, and shall not overload at the specified capacity with unheated cold air. [Fan motor shall be suitable for installation in a hazardous location as defined by NFPA 70.] Provide [_____] mm inch thick steel soleplate for motor. Soleplate shall be common for four motor mounting bolts. Separate parallel soleplate bars are not acceptable.

2.6.1.5 Steam Turbine

Steam turbine shall drive the fan through a reduction gear shall be single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig, [_____] degrees C F total temperature and a normal exhaust back pressure of [_____] kPa (gage) psig or a maximum back pressure of [_____] kPa (gage) psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg pounds per brake power hour. Maximum turbine speed shall not exceed [_____] rpm.

a. Turbine Construction: Turbine casing split on the horizontal centerline constructed of ASTM A48/A48M cast iron, with design pressure rating of 1724 kPa (gage) 250 psig at 232 degrees C 450 degrees F at the inlet, and 379 kPa (gage) 55 psig at 232 degrees C 450 degrees F at the outlet. Turbine shall also include a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and two hand valves.

b. Turbine Bearings and Shaft: Bearings horizontally split, ring-oiled, sleeve type water-cooled. Shaft shall be stainless steel sprayed or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

c. Speed Governor: Variable speed oil relay NEMA Class [A] [D] governor for speed limiting [and pneumatic operator to maintain an adjustable turbine speed]. [Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal.] [Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the controller specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.] [Turbine shall go to maximum rated speed on air failure.]

d. Emergency Overspeed Governor: Completely independent of the speed governor and shall operate a separate trip valve.

e. Insulation: Turbine shall be insulated and lagged by the manufacturer as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

f. Reduction Gear: High speed, heavy duty, double helical, full pressure lubricated, horizontal offset type with a service factor not less than 2 provided in a horizontally split casing. The gear and pinion shall be spray lubricated from a pressure lubricating system. The pressure lubricating system shall include a shaft driven oil pump, strainer, cooler, pressure gage, low oil pressure switch, relief valve, reservoir and piping. Provide a high speed, gear type, forge steel coupling between the turbine and the gear. Reduction gear and turbine shall be mounted on a common baseplate.

g. Turbine Trip: Provide solenoid valve to trip turbine on failure of induced draft fan.

2.6.1.6 Noise Level

Noise level shall not exceed 85 dBA sound pressure level at 1 1/2 meters 5 feet above the floor and 1 1/2 meters 5 feet from the fan in any direction. [Provide heavy duty sound attenuator with screen on fan inlet to meet the sound pressure level requirements.]

2.6.2 Induced Draft Fan

****

NOTE: The fan type shall be specified in accordance with CID A-A-59222.

****

CID A-A-59222, Type [_____], Class 2.

2.6.2.1 Fan Size

Size fans to handle combustion gases at maximum firing rate. Maximum fan speed shall not exceed 1200 rpm at test block rating. Design allowances and corrections for furnace, economizer, [scrubber,] [baghouse,] dust collector, breeching pressure drop when operating at [10] [20] [40] percent excess air, flue gas temperature, plant elevation, and other design factors shall be made. Add the following allowances for momentary overloads and normal deterioration of fans, firing equipment and boilers after sizing fans in accordance with the above, to obtain the required test block rating:

	Excess Volume	Excess Pressure
Coal Fired		
Induced draft	20 percent	32 percent
Oil Fired		
Induced draft	10 percent	20 percent

2.6.2.2 Fan Construction

Fan shall be arrangement [_____] in accordance with AMCA 801. Fan wheel shall be radial tip design (forward curved-backward inclined) or straight radial blade with shrouds for high efficiency design. Blading shall be 8 gage minimum thickness steel [with the addition of 6 mm 1/4 inch thick steel partial blade wear strips, 125 mm 5 inch minimum width each side of centerplate]. A minimum number of blades is preferred; a maximum of twenty-four is acceptable. Balance fan wheels both statically and dynamically at factory. Minimum static efficiency at maximum rating including allowances shall be 67 percent.

****

NOTE: At the text below, heat slingers may not be necessary on low temperature flue gas applications.
****

a. Bearings and Pedestals: Provide fan with water-cooled self-aligning sleeve type bearings mounted in suitable pillow blocks. Bearings shall be independent high temperature, oil lubricated, pedestal type with dust seals. [Provide fan shaft heat slingers.] Cast iron or fabricated steel pedestals mounted on fabricated steel soleplates shall be provided. Provide a self-contained temperature control valve, with water piping to control temperature of bearings.

b. Housing: Fan shall have 5 mm 3/16 inch thick welded steel housing and inlet boxes which shall be split with flanged and gasketed joints. Construction shall permit one piece removal of rotor from rear of fan without disturbing duct connections. Provide hinged, quick opening access door in scroll and inlet boxes and 50 mm 2 inch plugged openings in low points of scroll and inlet boxes.

c. Dampers: Provide inlet dampers with multi-parallel-stream flow blades with anti-friction bearings with 80 mm 3 inch minimum spacers and stuffing boxes to keep bearings cool. Dampers shall be mounted in 200 mm 8 inch channel frames and interconnected with one extended, ball bearing mounted control level for connection to control actuator.

d. Welding: Welding of fan components shall be in accordance with current production standards. High stress fan wheels shall be continuously welded. Low stress exterior housing bracing, dampers, and other similar components shall be intermittently, plug or continuously welded.

e. Painting: Interior of fan, including wheel, shall be coated with protective coatings suitable for the flue gas conditions expected to be encountered by this fan. Exterior surface of fan shall have coatings of quality weather and heat resistant paint. Fan shall be shop assembled and match-marked by manufacturer before dismantling for shipment. Surface cleaning and painting shall be in accordance with the manufacturer's standards for the service expected.

2.6.2.3 Fan Drive

Fans shall be equipped with [both] [a motor] [and] [steam turbine] drive. The [motor] [and] [turbine] shall be directly connected to the fan [with a gear type flexible coupling] [with a roller type, hardened steel clutch coupling consisting of an over-running clutch and double flexing coupling to permit instantaneous change-over from one drive to the other. One clutch coupling shall be provided between the fan and each driver. Clutch couplings shall be selected for the maximum torque requirement of the fan, with a 1.5 service factor. Provide a removable guard over each clutch coupling].

2.6.2.4 Electric Motor

Motor for driving the induce draft fan shall be [_____] volt, three phase, 60 Hz, [open drip-proof,] [totally enclosed fan cooled,] variable speed not less than [_____] kW hp, as specified under the paragraph MOTORS AND DRIVES in this section, and shall not overload over the range of the fan with unheated air. [Fan motor shall be suitable for installation in a hazardous location as defined by NFPA 70.] Provide [_____] mm inch thick steel soleplate for motor. Soleplate shall be common for each of the four motor mounting bolts. Separate parallel soleplate bars are not acceptable.

2.6.2.5 Steam Turbine

Steam turbine shall drive the fan through a reduction gear and shall be single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig, [_____] degrees C F total temperature and a normal exhaust back pressure of [_____] kPa (gage) psig or a maximum back pressure of [_____] kPa (gage) psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg pounds per brake power hour. Maximum turbine speed shall not exceed [_____] rpm.

a. Turbine Construction. Turbine casing shall be split on the horizontal centerline constructed of ASTM A48/A48M, cast iron, with design pressure rating of 1724 kPa (gage) 250 psig at 232 degrees C 450 degrees F at the inlet, and 379 kPa (gage) 55 psig at 232 degrees C 450 degrees F at the outlet. Turbine shall include a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and two hand valves.

b. Turbine Bearings and Shaft. Turbine bearings shall be horizontally split, ring-oiled, sleeve type water-cooled. Shaft shall be stainless steel sprayed or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

c. Speed governor variable speed oil relay NEMA Class D governor for speed limiting and pneumatic operator to maintain an adjustable, preset draft pressure in boiler by variation of turbine speed. Input to the operator shall be a 30 to 103 kPa (gage) 3 to 15 psig pneumatic signal. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the controller specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS. [Turbine shall go to maximum rated speed on air failure.]

d. Emergency Overspeed Governor. Completely independent of the speed governor and shall operate a separate trip valve.

e. Insulation. Turbine shall be insulated and lagged by the manufacturer as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

f. Reduction Gear. High speed, heavy duty, double helical, full pressure lubricated, horizontal offset type with a service factor not less than 2 provided in a horizontally split casing. The gear and pinion shall be spray lubricated from a pressure lubricating system. The pressure lubricating system shall include a shaft driven oil pump, strainer, cooler, pressure gage, low oil pressure switch, relief valve, reservoir and piping. Provide a high speed, gear type, forged steel coupling between the turbine and the gear. Reduction gear and turbine shall [each] be provided with a [common] [_____] mm inch thick steel baseplate[s].

2.6.2.6 Noise Level

Not to exceed 85 dBA sound pressure level at 1 1/2 meters 5 feet above the floor and 1 1/2 meters 5 feet from the fan in any direction. Sound attenuation shall be provided to meet the sound pressure level requirements.

2.7 COMPRESSED AIR SYSTEM

2.7.1 Plant Air Compressor

Provide two plant air compressor systems, each with a compressor, filters, intercooler, aftercooler, accessories, control panel and controls. Provide a receiver for each of the two compressor systems.

2.7.1.1 Air Compressor

****

NOTE: Select standard L/s SCFM of air to compensate for plant elevation.

****

Packaged unit, FS XX-C-2816, as modified below. Each compressor capacity shall be not less than [94] [118] [142] [165] standard L/s [200] [250] [300] [350] scfm of air, at 20 degrees C 68 degrees F and [862] [1379] kPa (gage) [125] [200] psig at the discharge. Compressor speed shall not exceed [_____] rpm. Compressor shall be [belt drive] [direct drive] double acting, two stage, with flange mounted water cooled cylinders and heads. Provide a safety valve between each compressor discharge and its shutoff valve which is required on the discharge piping of the compressor. Provide a full flow type oil filter for positive forced feed lubrication and an electric thermostatically controlled immersion heater. Provide lifting lugs and tie downs.

2.7.1.2 Air Filter

Provide a dry type air filter constructed of pleated filter paper with protective stainless steel cloth on each side. Filter shall also act as a muffler and shall be readily removed for cleaning.

2.7.1.3 Intercooler and Aftercooler

Compressed air intercooler and aftercooler heat exchangers shall each be water cooled, with counter current flow, and shall be integrally mounted with no external air piping between compressor cylinders and cooler. Design heat exchangers to cool the total output air flow of the compressor to within 9 degrees C 15 degrees F of the inlet cooling water temperature. The tube bundles shall be removable for cleaning and inspection.

2.7.1.4 Air Receiver

Vertical tank with a minimum volume of [1585] [1840] [2717] liters [56] [65] [96] cubic feet. Design unit for [1034] [1724] kPa (gage) [150] [250] psig working pressure in accordance with the ASME BPVC SEC VIII. A receiver bearing the ASME Code Symbol stamp will be accepted as meeting these requirements. Provide an automatic condensate trap, safety valve, outlet connection, and a 114 mm 4 1/2 inch pressure gage ([1379] [2068] kPa (gage) [200] [300] psig range).

2.7.1.5 Electric Motor

Motor shall be [totally enclosed fan cooled], [open-drip proof], [_____] kW hp, [_____] volts, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section. Control circuits for motor shall be nominal 120 volts. [Provide removable totally enclosed belt guard.]

2.7.1.6 Controls

Provide controls and shutdowns necessary for automatic operation of the compressor package. House controls in NEMA 12 control cabinet. Controls shall consist of alarm and running lights, push buttons and selection switches for automatic dual control, 120 volt control transformer connected to power circuit serving the compressor, along with necessary time delay and control relays, and indicators. Provide automatic solenoid-operating cooling

a. Start-and-Stop Control: When set for start and stop control, motor shall stop automatically when discharge pressure reaches maximum pressure setting and start automatically when discharge pressure falls to minimum setting. Cylinders shall unload during periods of motor shutdown.

b. Constant Speed Control: Compressor shall operate continuously at constant speed. Provide means to automatically load and unload compressor at preset minimum and maximum pressure settings respectively. Provide means for automatic release of pressure within cylinders when the unit is operating without load. Also provide means for manual or automatic unloading of cylinders during starting of unit. Equip each compressor with a timed control to stop compressor after a 10 minute unloaded period when air is not used. Compressor shall re-start automatically at a preset minimum pressure.

c. A lead-lag system shall be provided to alternate compressor start-ups and to operate both compressors when discharge pressure cannot be met with one operational compressor. The operator selector switch shall have the following positions:

    (1) Both compressors alternating as specified above;

    (2) Compressor "A" operation only;

    (3) Compressor "B" operation only;

    (4) Off.

    Total elapsed time shall be recorded for operation time of each compressor.

d. Compressor Safety Controls and Management Panel:

    (1) Provide light in panel, alarm and shutdown of compressor for the following functions:

        (a) High Main Bearing Temperature

        (b) High Discharge-air Temperature

        (c) High Discharge-air Pressure

        (d) High Water Temperature for [Water Supply,] [Intercooler,] [Aftercooler,] [Lubrication Oil Cooler]

        (e) Excessively High Motor Temperature

        (f) Excessive Vibration

(g) Low Crankcase Oil Level

(h) Low Oil Pressure

1. Provide light in panel and alarm for the following functions:
2. a. High Lubrication Oil Temperature
3. b. Low Suction Pressure (Dirty Filter)

2.7.2 Instrument Compressed Air System

Provide two instrument air compressor systems each with a compressor, filters, aftercooler, accessories control panel, controls and receiver, [mounted on one supporting steel base with skids] [mounted separately].

2.7.2.1 Air Compressor

Each compressor shall deliver a minimum of [_____] std. L/s scfm of air at 20 degrees C 68 degrees F at a discharge pressure of 862 kPa (gage) 125 psig. Compressor speed shall not exceed [_____] rpm. Air compressor shall be belt drive, single stage, crosshead type, vertical, double acting, water cooled, non-lubricated head type. Compressor shall be specially designed for non-lubricated service, with a honed cylinder, piston rod packing, piston rings, and piston wearing rings. Valve guide inserts and wear rings shall be TFE. Valves shall be reversible and hardened, with stainless steel seat plates for nonlubricated service. Provide necessary sleeves, baffles, and collars to prevent oil carryover. Provide air-operated, piston type, free air unloaders for capacity reduction and starting. Mount inlet filter-silencer directly on the air inlet to the cylinder.

2.7.2.2 Aftercooler

Water cooled, with counter current flow, and installed directly between each compressor cylinder and the air receiver. Design cooler to cool the total output air flow of the compressor to within minus 9 degrees C 15 degrees F of the inlet cooling water temperature. Tube bundle shall be removable for cleaning and inspection.

2.7.2.3 Air Receiver

Horizontal tank with a minimum volume of [_____] liters cubic feet. Design unit for 1034 kPa (gage) 150 psig working pressure in accordance with ASME BPVC SEC VIII receiver bearing the ASME Code Symbol stamp will be accepted as meeting these requirements. Provide an automatic condensate trap, safety valve, and outlet connection.

2.7.2.4 Electric Motor

Motor shall be [totally enclosed, fan controlled], [open drip proof], [_____] kW hp, [_____] volt, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section. Provide a removable, totally enclosed belt guard.

2.7.2.5 Accessories

Factory assemble air compressors, drives, controls, air receiver, aftercoolers, and miscellaneous hardware and mount on a steel supporting base. Provide lifting lugs and tie down attachments. Air, water, and condensate piping shall be provided and terminated at the edge of the supporting base.

2.7.2.6 Controls

Provide controls and shutdowns necessary for automatic operation of the compressor package. House controls in NEMA 12 control cabinet. Controls shall include alternator control to switch compressors from lead to lag and run both compressors when needed; 120 volt control transformer connected to power circuit of compressor; air discharge pressure gage; selection switches for constant speed for automatic dual control, along with necessary time delay and control relays. Provide automatic solenoid-operated cooling water valve in the cooling water line to the compressors and aftercoolers. Factory wire control cabinet and mount as a part of the package. Compressor safety controls and management panel shall be provided as specified in the paragraph PLANT AIR COMPRESSOR, located in this section.

2.7.3 Air Dryers

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NOTE: Choose the following subparagraph or the subparagraph COMPRESSED AIR REFRIGERATED AIR DRYER.

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2.7.3.1 Compressed Air Desiccant Air Dryer

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NOTE: The refrigerated air dryer is limited with an atmospheric dew point of approximately minus 23 degrees C 10 degrees F equivalent to minus 12 degrees C plus 10 degrees F at 172 kPa (gage) 25 psig and 2 degrees C 35 degrees F at 690 kPa (gage) 100 psig, and where this may be a problem the desiccant air dryer should be used as a much lower dew point can be attained.

****

Provide for systems exposed to freezing temperatures [one] [two] compressed air dual chamber type desiccant dryer[s] each of sufficient capacity for each system listed below. Each dryer shall be equipped with an automatic regeneration system which uses [steam heated dry air] [unheated dry air] for the regenerative media. The capacity of each dryer shall be such that compressed air, in the quantities listed below will be dried from a saturated condition at [_____] degrees C F to a pressure dew point of minus 40 degrees C F.

Service	Capacity (Each Tower)
Baghouses	[_____] L/s at 862 kPa (gage)
Ash Handling	[_____] L/s at 862 kPa (gage)
Instrumentation	[_____] L/s at 862 kPa (gage)

Service	Capacity (Each Tower)
Baghouses	[_____] cfm at 125 psig
Ash Handling	[_____] cfm at 125 psig
Instrumentation	[_____] cfm at 125 psig

The contact time of the air in the chambers shall not be less than 4.5 seconds. Velocity of the air shall be less than that which will fluidize the desiccant bed. Pressure drop through the unit when operating at rated flow shall not exceed 27 kPa 4 psi. Units shall be field adjustable to maintain the pressure dew point of the dried air at any preselected value below operating temperature, to minus 40 degrees C F. Units shall have as an integral part of the construction an indicator showing the water content of the dry air and a calibrated adjustment control to change the water content to any preselected level. Desiccant dryers shall provide a continuous supply of dry air by automatically cycling operation of the desiccant beds.

a. Chambers: Designed for 1034 kPa (gage) 150 psig working pressure in accordance with the ASME BPVC SEC VIII, and so stamped. Each chamber shall be fitted with separate fill and drain ports so that inlet and outlet piping manifolds need not be removed to fill or drain the chambers. Each chamber shall be provided with stainless steel screens at the inlet and the outlet to contain the desiccant bed, pressure gage, and safety valve. Normal air flow during drying shall be upward through the desiccant chamber. Desiccant shall be spherical activated alumina.

b. Regeneration: Accomplish by depressurizing the chamber on reactivation and purging with a portion of the dry outlet air from the chamber on stream. Purge air flow shall be downward. Maximum allowable purge flow rate at design conditions shall be 10 percent of design capacity of dryer. Purge system shall be controlled by a cam timer such that each desiccant bed is regenerated as required. Provide a flow control valve, flow indicator, and exhaust muffler for the purge system.

c. Controls: Cam timer, switches and relays shall be housed in a NEMA 12 control panel, mounted as part of the dryer. Provide interconnecting wiring in accordance with Division 16. In the case of electrical power failure, automatic valves shall fail in the open position to allow the wet gas to pass through the chambers. Provide gages to indicate pressure in each chamber.

d. Accessories: Dryer shall be complete with necessary solenoid operated control valves, check valves, and interconnecting piping. Mount equipment on a steel base plate suitable for floor mounting. [Provide pressure reducing valve to reduce pressure to suit desiccant dryer.]

e. Prefilter: Provide prefilter upstream of dryer to remove oil vapor, liquid water, and solid particles. Prefilter shall have greater than 99 percent efficiency in removing both 0.5 micron diameter solid particles and 0.5 micro diameter oil aerosol. Filter shall have replaceable oil absorbing filter element which turns red to indicate saturation with oil and which shall be mounted in a transparent cast methyl methacrylate tube for visibility and inspection while on stream. Protect transparent acrylic tube by a safety shield.

f. Afterfilter: Provide an additional afterfilter for instrument air. Filter shall combine three filter mechanisms - mechanical separation, coalescence and absorption in a single, cartridge type unit. Filtration efficiency shall be greater than 99.99 percent at 0.5 micron particle size for oil and other contaminants. A visible color change shall indicate when element should be replaced.

[2.7.3.2 Compressed Air Refrigerated Air Dryer

****

NOTE: Choose this subparagraph or the above subparagraph COMPRESSED AIR DESICCANT AIR DRYER.

****

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NOTE: The refrigerated air dryer is limited with an atmospheric dew point of approximately minus 23 degrees C 10 degrees F equivalent to minus 12 degrees C plus 10 degrees F at 172 kPa (gage) 25 psig and 2 degrees C 35 degrees F at 690 kPa (gage) 100 psig, and where this may be a problem the desiccant air dryer should be used as a much lower dew point can be attained.

****

Provide for systems not exposed to freezing temperatures a self-contained refrigerated type compressed air dryer capable of drying [_____] std. L/s scfm of air to an atmospheric dew point of not less than minus 23 degrees C 10 degrees F with entering air at 38 degrees C 100 degrees F, saturated. Dryer shall be complete with heat exchanger, a commercial quality refrigeration system, a moisture separator and condensate trap. Maximum operating pressure of the dryer shall be [_____] kPa (gage) psig. Install dryer between the receiver and distribution line.

Provide internal tubing, wiring, and piping complete, such that only connections to air inlet and outlet, to refrigerant compressor contractor, and to condensate drain are necessary.

a. Heat Exchanger: Heat exchanger shall consist of air and refrigerant coils surrounded by aluminum granules of sufficient mass to ensure adequate cooling capacity for varying air flow loads without causing excessive refrigeration cycling. Moisture separator shall be of centrifuge type and shall be located within the heat exchanger to provide for moisture separation at point of minimum air temperature. Suitably control heat exchanger temperature and provide an automatic control system, whose sensing element is located in the aluminum granules, to shut down the refrigeration system on low or no load conditions. Provide means to ascertain exchanger temperature.

b. Refrigeration Unit: Hermetically sealed type and shall operate intermittently at all but maximum load conditions. House entire unit in a steel cabinet. Provide cabinet with access door and panel for easy access to each part for maintenance and inspection.

c. Refrigerant: CFC-based refrigerants are prohibited. Refrigerant must have an Ozone Depletion Potential (ODP) no greater than 0.0, with exception to R-123.

d. Instrumentation and Control: Include control panel in dryer cabinet containing:

(1) Indicators for the following services: Inlet air pressure gage, discharge air pressure gage, inlet air temperature gage, refrigeration compressor suction pressure gage, refrigeration compressor discharge pressure gage, power interruption light, and high temperature light.

(2) Electrical relays located in an enclosed portion of panel, accessible for ease of servicing.

(3) Green "POWER ON" indicating light.

(4) Controls and interlocks to maintain required compressed air dew point and to cycle air-cooled condenser with refrigeration compressor.

(5) Dryer capable of automatic zero to 100 percent capacity control. Dryer shall use an automatic control expansion valve with sensing bulb to control capacity; dryer to have automatic shutdown switch sensor located at point of lowest temperature to prevent freezing.

e. Filters: Provide a disposable cartridge type prefilter and afterfilter at the air dryer. Filter cartridges shall have a 517 kPa 75 psi differential pressure rating, and the design flow clean pressure drop shall not exceed 1.40 kPa 0.2 psi. Filter shall be designed to remove liquid water and oil particles 5 microns and larger. Provide an additional afterfilter for instrument air. Filter shall combine three filter mechanisms - mechanical separation, coalescence and absorption - in a single, cartridge type unit. Filtration efficiency shall be greater than 99.99 percent at 0.5 micron particle size for oil and other contaminants. A visible color change shall indicate when element should be replaced.

f. Pressure Reducing Regulator: Self-operating type designed for not less than a 1724 kPa (gage) 250 psig operating pressure, a normal operating temperature range of minus 29 degrees C 20 degrees F to plus 66 degrees C 150 degrees F, and shall deliver constant reduced pressure compressed air. Regulator shall have an adjustable outlet pressure range of at least 34 to 690 kPa (gage) 5 to 100 psig with not less than 4 ranges. Provide external adjusting screw for adjustment throughout each spring range. Provide internal pressure tap for outlet pressure registration.

]2.8 BREECHING, EXPANSION JOINTS, STACKS AND DAMPERS

2.8.1 Breeching

Rectangular cross section, stiffened on sides, top and bottom, and fabricated of not less than 5 mm 3/16 inch thick black steel plate unless otherwise noted. Stiffeners shall be not less than 65 by 50 by 6 mm 2 1/2 by 2 by 1/4 inch steel angles welded to exterior with 50 mm 2 inch leg outstanding. Separation of stiffeners shall not exceed one meter 3 feet o.c. [Connect breeching to [each boiler flue gas outlet,] [intermediate heat recovery equipment,] [air pollution control equipment,] [and to stack as required].]

2.8.1.1 Breeching Access Doors

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NOTE: Specify locations for breeching access and cleanout doors. Where practical show locations on project drawings. Show access and cleanout door details on project drawings.

****

Construct access doors with frame and hinged door of cast iron or reinforced steel plate. Frame shall be not less than 686 by 787 mm 27 by 31 inches with access opening of not less than 508 by 610 mm 20 by 24 inches. Connection to breeching shall be gasketed and made with minimum 15 mm 1/2 inch diameter hot-dipped galvanized bolts, lockwashers, and nuts spaced not more than 125 mm 5 inches on center. Sides of the access door shall have not less than two quick clamp positive closing latches, with the long side opposite the hinges containing three clamps to give a gastight seal. Side of access door opposite the hinges shall contain a minimum 80 by 125 mm 3 by 5 inch size handle. Provide a gasket consisting of 10 mm 3/8 inch diameter fire proof resilient rope seal and mastic compound between the hinged access door and the access door frame. Provide breeching access doors at the following locations [and where indicated]:

[a. [_____]

][b. [_____].

]2.8.1.2 Breeching Cleanout Doors

****

NOTE: Specify locations for breeching access and cleanout doors. Where practical show locations on project drawings. Show access and cleanout door details on project drawings.

****

Construct cleanout doors of not less than 5 mm 3/16 inch thick steel plate. Secure cleanout doors to a 32 by 32 by 5 mm 1 1/4 by 1 1/4 by 3/16 inch thick angle frame with 10 mm 3/8 inch hot-dipped galvanized mounting bolts welded to the angle frame and spaced not over 150 mm 6 inches on center. Weld frame to breeching and provide a 3 mm 1/8 inch gasket between frame and cleanout door. Cleanout doors shall be not less than 610 by 610 mm 24 by 24 inches except where breeching dimensions are smaller, in which case the cleanout door shall be full height of the breeching and not less than 610 mm 24 inches in width. Provide breeching cleanout doors at the following locations [and where indicated]:

[a. [_____]

][b. [_____].

]2.8.1.3 Breeching Connections and Joints

Weld breeching joints [unless indicated or specified otherwise]. Welding shall conform to AWS D1.1/D1.1M and AWS D1.3/D1.3M. Bolts for bolted connections shall be hot-dipped galvanized bolts not less than 15 mm 1/2 inch diameter and spaced not more than 80 mm 3 inches apart, with hot-dipped galvanized lockwashers, and nuts. Provide bolted joints with a minimum of 3 mm 1/8 inch thick gaskets. Bolt flanged breeching connections to boilers, equipment items, dampers, expansion joints, and breeching accessories. Flanged breeching connections to equipment shall be drilled to match flanges on equipment. Flanged joints shall be sealed welded to make connection gas-tight.

2.8.1.4 Breeching Structural Materials

****

NOTE: Designer shall detail breeching supports and breeching stiffening. Breeching hangers shall be designed to carry not less than 5 times the breeching weight, or the breeching weight plus weight of fly ash when breeching is half full plus 136 kg 300 pounds whichever is greater. Hangers for rectangular breeching shall be of the trapeze type with angle or channel support members and hanger rods. Breeching shall be stiffened with angle or channel members as required to withstand internal breeching static pressure. Designer shall verify that expansion joint flexure for axial travel is suitable. Expansion joints shall be detailed on the drawings.

****

Structural and support materials shall be steel and comply with the applicable sections of the ANSI/AISC 303 or AISC 360. [Support and stiffen breeching as indicated].

2.8.1.5 Insulation

Provide insulation on breeching as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8.1.6 Breeching Paint

When breeching is shop fabricated, wire brush and clean interior and exterior with a nonflammable solvent and paint with FS TT-P-28 heat resistant paint, immediately after fabrication. When breeching is to be fabricated on the job, prime paint steel sheets, one coat each side, prior to delivery to job site.

2.8.2 Expansion Joints

2.8.2.1 Metallic Breeching Expansion Joints

Provide factory fabricated metallic breeching expansion joints [where indicated]. Expansion joints shall be guided metal bellows type capable of a minimum of [_____] mm inches of axial travel. Form metal bellows from not less than 1.60 mm 1/16 inch thick type 321 stainless steel plate. Cover plates shall be not less than 3 mm 1/8 inch thick steel plate.

2.8.2.2 Non-metallic Expansion Joints

Provide factory fabricated non-metallic breeching expansion joints 3 mm 1/8 inch minimum thickness [where indicated]. Expansion joints shall be constructed of fluoroelastomer vulcanized to two plies of knitted wire mesh capable of a minimum of [_____] mm inches of axial compression, [_____] mm inches of axial extension and [_____] mm inches of lateral offset [unless indicated otherwise]. Joints shall have a continuous operating temperature rating of 204 degrees C 400 degrees F, with excursion design standards up to 400 degrees C 750 degrees F. Operating pressure range shall be minus 34 kPa (gage) 5 psig to plus 34 kPa (gage) 5 psig. Expansion joints shall be pre-formed with integrally molded corners, suitable for mounting against a 150 mm 6 inch flange. Provide carbon steel backup bars with slotted holes, bolts, and nuts.

2.8.3 Stacks

2.8.3.1 Stacks With Flue Gas Scrubbers

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NOTE: Use stack with acid resistant lining if temperatures below dew point of flue gas are expected in stack. Designer has to consider down drafts in stack at low firing rate.

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Stacks shall be free standing, self-supporting, steel construction with an acid resistant lining system. Provide each stack complete with all accessories and appurtenances, including test ports, sampling platforms, ladders, safety climb devices, anchors, sleeves, insulation, stainless steel base and chair rings, and clean-out door.

a. Construction: Acid resistant lined steel stacks shall be fabricated of [ASTM A242/A242M, Type 1] [ASTM A36/A36M] structural steel plate with a 1.60 mm 1/16 inch corrosion allowance. Design shall include a static analysis of stack of wind loadings and critical wind velocity and dynamic analysis of stack including damping of vortex shedding and seismic response. Minimum steel plate thickness of stack shall not be less than 6 mm 1/4 inch. Stack sections shall be of welded construction and fabricated in sections not to exceed normal shipping limitations. Longitudinal seams shall have full penetration, continuous butt-welded joints. The section or horizontal joints of the stack shall also be full penetration continuous buttwelds. Welding shall be done by certified welders. Secure the stack to the foundation by a base plate with gussets, counterforts or steel beams provided as required. A reinforced concrete foundation, the design of which shall be approved by the stack manufacturer, shall be provided. Base construction of the stack shall transmit forces and moments in the shell to the [foundation] [supporting steel] without local stresses of appreciable magnitude being induced in the shell or exceeding the allowable stresses of the supporting [concrete] [steel].

b. Stack-Breeching Connection: A lined breeching connection of the same wall thickness as the stack shall be welded to the stack and the steel jacket of the stack reinforced as required to compensate for the structural strength of steel removed. A flange for bolting breeching to the connection shall be provided. A hinged cast iron or steel cleanout door with refractory lining and heavy duty steel frame shall be provided at the bottom of the stack. Frame and door shall be fitted gastight. Door shall be a minimum of 457 by 610 mm 18 by 24 inches in size.

c. Block Lining: Provide a lining consisting of inorganic borosilicate glass blocks bonded to the steel. Entire inside of each stack shall be sandblasted to a white metal blast finish. Block shall be 40 mm 1 1/2 inches thick, constructed of totally organic-free closed cell borosilicate glass. Blocks shall be shaped to reasonably match the inside of the stack and beveled to match adjacent blocks such that no gaps between surfaces shall be greater than 3 mm 1/8 inch. Blocks shall be bonded to the steel and adjacent blocks with a two compound, urethane adhesive membrane. Adhesive membrane shall be trowelled to both the steel and block. Blocks shall be pressed into place in accordance with the manufacturer's instructions to provide a bond free of voids.

d. Optional Stack Lining: In lieu of the borosilicate glass block lining specified above an acid resistant cast insulating refractory lining with an acid resistant membrane liner over an anchoring system may be provided. Lining system shall be suitable for use in the pH range of 1.6 to 8. Liners composed of calcium aluminate or calcium silicate will not satisfy service requirements of the stack system.

  (1) Membrane Liner: Urethane-Asphalt, or suitable similar material, which has been used successfully in similar installations to protect stacks from acid attack when flue gas temperatures are below their dew point. Service temperature range of the liner shall be minus 40 to plus 82 degrees C 180 degrees F, when applied to a thickness of 3 mm 1/8 inch.

  (2) Refractory Lining: Potassium silicate single component chemically hardened cement or two component potassium silicate bonded cement with an inert filler material such as silica, or suitable similar material, gunite applied or cast monolithic insulating refractory, suitable for use on flue gas from 66 degrees C 150 degrees F and up to 232 degrees C 450 degrees F and resistant to continuous exposure of sulfuric acid, nitric and nitrous acid, carbonic acid and other liquids, in the pH range of 1.6 to 8 and formed when the surface of the stack is at a temperature at and below the flue gas dewpoint.

  (3) Membrane/Refractory Lining Certification: Manufacturers of the membrane liner and the refractory lining shall certify that the lining system to be provided in the stack shall be suitable for the specific application, considering the flue gas temperature, velocities, moisture content and corrosive qualities of the fuel being burned.

  (4) Refractory Lining Anchor System: Tinned metal anchors welded to the stack wall, or wire mesh fabric welded to anchors welded to stack wall, shall support the refractory lining of the stack. Tinned anchor system shall have anchors welded to stack shell on vertical spacing not greater than 200 mm 8 inches on center and horizontal spacing not greater than 100 mm 4 inches on center, in staggered rows to provide a minimum of 48 4.5 anchors per square meter foot. Wire mesh fabric shall be No. 10 or 12 wire gage made into a welded fabric approximately 50 by 50 mm 2 by 2 inches mesh size. Mesh shall be welded to anchors o.c. not to exceed [250] [300] mm [10] [12] inches. Mesh and anchors shall be of the same alloys.

  (5) After anchor system is welded in place, blast clean entire inside surface of stack including stack base, and anchor system to a white metal blast finish and then coat with two coats of membrane liner to a total minimum thickness of 3 mm 1/8 inch. The stack base shall be included in the coating system. Prior to the installation of the refractory, spark test coated surfaces with a

holiday detector to ensure membrane is free of voids. Refractory lining shall be trowelled on or pneumatically applied to a minimum thickness of 76 mm 3 inches.

(6) Design of anchor system and application of refractory lining shall permit expansion and prevent cracking of the refractory.

e. Manufacturer's Calculations Required for Foundation and Stack:

(1) Foundation (including bearing and moment forces) reinforcement and anchor bolts

(2) Stack

- Stresses due to various loading conditions including wind and seismic loads

- Vibration and damping

- Heat transfer at various design and ambient conditions

- Expansion profiles

- Shipping and erection stress analysis

f. Finish: Stacks shall be shop coated prior to shipping from the factory. After erection, touch-up damaged shop coated surfaces and apply a prime coat and two coats of finish paint suitable for the temperatures and environmental exposure as specified in Section 09 90 00 PAINTS AND COATINGS.

g. Platforms and Ladders: Stacks shall be provided with platforms for sampling tests, monitoring equipment maintenance and obstruction-lighting maintenance. Access to lower platform shall be by ASTM A242/A242M, Type 1, steel [stairway] [catwalk or platform] [ladder] from the [heating plant] [pollution control building] [ground level]. Design for a minimum live load on platforms to be 488 kg 100 pounds per square meter foot. Platforms shall be not less than 1220 mm 48 inches wide and the sampling platform shall be a minimum width of 610 mm 2 feet plus the stack diameter, but not more than 3 meters 10 feet in width. Toe plates shall be not less than 150 mm 6 inches high around the platform perimeter. Platform railings shall have two intermediate railings. Ladders shall be [caged] corrosion resistant steel, 406 mm 16 inches wide with 305 mm 12 inch rung spacing. Ladders shall be provided from the lower platform to the top of each stack and shall be provided with a full length stainless steel safety climb device. The climb device shall consist of a notched rail attached to the rings' centerline with a sleeve which rides on the rail and locks into position on a sudden downward pull. Two belts for attaching the device to the climber shall be furnished.

h. Anchor Bolts: Provide anchor bolts, nuts, washers and sleeves to properly anchor the stacks. Stack manufacturer shall furnish certified dimensional drawings showing location for setting bolts in concrete.

i. Miscellaneous:

(1) Sample Ports: Provide two sample ports at 90 degree orientation to each other about 1220 mm 4 feet above platform. Each sample

port shall consist of a 100 mm 4 inch diameter pipe welded to the steel jacket and provided with a flange and mating blind flange. Provide openings required for installation of opacity monitor and SO2 analyzer specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.[Locations of sample ports and instrumentation openings shall be as detailed on drawings].

(2) Obstruction Lighting: Provide an obstruction lighting system for each heating plant stack, consisting of one red, flashing, 300 millimeter hazard beacon atop each stack, two steady burning, red obstruction marker lights halfway up each stack, photoelectric and flasher controls, weather-tight terminal boxes, cable, and conduit.

(a) Hazard Beacons: Federal Aviation Administration FAA AC 150/5345-43, Type L-866.

(b) Obstruction Lights: FAA AC 150/5345-43 Type L-810.

(3) Painter's Trolley: Provide a ring of Type 304 stainless steel to support an inspection or painter's trolley. Provide a three wheel standard steel flat rail trolley of 227 kg 500 pounds capacity. Guide trolley to prevent it from leaving the track.

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NOTE: Velocity cones decrease cold air down drafts and increase velocity of discharged flue gas but increase flow resistance of stack; they may be used when justified.

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(4) Velocity Cone: Provide stack with an acid resistant lined truncated velocity cone. Velocity cone shall be lined with the same insulating refractory as applied to the stack with a 80 mm 3 inch minimum thickness. Cone shall be 1220 mm 4 feet long, bolted to top of stack, and shall taper to a diameter of [_____] mm inches inside.

2.8.4 Dampers

2.8.4.1 Multilouver Dampers

Provide factory fabricated parallel multilouver dampers for two position service (open-closed) and opposed blade damper for modulating control. Construct damper frame of distortion resistant welded steel channels with raised seat to ensure free nonbinding operation of blades and to keep blades square in the frame. Construct blades of [_____] mm inch thick steel plate in a stressed skin airfoil-shape with fully welded seams containing no external ribs. Blade deflection in mm inches shall not exceed the length in mm inches divided by 360, consistent with AISC 360 beam deflection criteria. Blade shafts shall be stainless steel. Blades shall be pinned to blade shafts. Louver shaft bearings shall be outboard type and shall be self-lubricating and self-cleaning. Bearing seals shall be gastight.

a. Multilouver Damper Linkage: Damper linkage shall be adjustable and of pinned construction for easy removal and shall be designed to handle full operation torque. Linkage on dampers in clean flue gas areas shall operate from a single connection point.

b. Control Damper Operators: Provide control damper operators as shown. Operators shall be pneumatically operated with positive positioning, manual override, and hydraulic or oil immersed gear trains. Each operator shall be full-proportioning type, with spring return to position shown in case of loss of power. Damper operating speeds shall be selected and adjusted so that operators will remain in step with controllers. Operators acting in sequence with other operators shall have adjustment of control sequence as required by the operating characteristics of the system.

c. Two-Position Damper Operations: Two-position damper operators shall be pneumatically operated with air cylinder, four-way valve, and solenoid valve arrangement.

2.8.4.2 Guillotine Dampers

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NOTE: Guillotine dampers shall be used for open-shut service where tight shutoff is required for example, for air pollution control equipment bypass dampers.

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Provide factory fabricated guillotine dampers with heavy structural frame rigid enough to support the extended blade and external loads through the breeching flange. Damper shall be capable of operating without precleaning or manual assistance under normal operating conditions. Provide enclosed bonnets [where indicated]. Provide 80 mm 3 inch diameter cleanout ports on both sides for cleaning bottom sections.

a. Guillotine Damper Blade: A stress-relieved flat plate. Damper blade shall be nonwarping; intermediate blade supports are acceptable to limit blade deflection. Leading edge of damper blade shall be beveled and capable of guiding damper blade into frame seat. Blade guides shall be continuous and self-cleaning and capable of preventing binding from deposits and damage from misalignment. Bonnet guides shall be removable and damper shall be designed so that a damper blade can be replaced without opening the frame.

b. Guillotine Damper Bonnet Seal: Provide bonnet seal to effectively seal against atmospheric leakage under normal operating conditions.

c. Double-bladed Guillotine Dampers: Provide where indicated. Damper frame, blades, and bonnet seals shall be as specified for single-bladed guillotine dampers, except frame shall be thicker and two blades shall be provided instead of one. Double-bladed guillotine damper shall provide absolute zero leakage across damper blades. This shall be accomplished by utilizing a blower to introduce air into the space between the damper blades. Blower shall be mounted on damper frame complete with isolation valve. Blower shall have sufficient capacity to maintain a pressure of at least 498 Pa 2 inch water column over breeching pressure.

d. Guillotine Damper Drive: A positive dual endless chain drive capable of driving damper in both directions. Chain-drive head shaft shall have sufficient torsional rigidity to prevent binding of blade when the blade is stalled. Damper shall be motor-operated with manual override. Design drive mechanism to prevent back driving of motor. Entire drive mechanism shall be of a simple design and require no routine maintenance other than inspection. Chain shall be capable of operating up to the stall torque of the damper drive motor.

e. Electric Motor: Motor shall be [totally enclosed fan cooled] [open drip-proof], [_____] kW hp, [_____] volt, [_____] phase, 60 Hz, as specified under the paragraph MOTORS AND DRIVES in this section. Provide removable, totally enclosed chain guard.

2.9 COAL HANDLING EQUIPMENT

2.9.1 Railroad Hopper Car Thawing System

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NOTE: Pit type railcar thawing system is capable of operating on natural gas, liquified petroleum gas or No. 2 fuel oil. The radiant heat (infrared) type railcar thawing system can only burn natural gas or liquified petroleum gas or use electric resistance heaters. The radiant heat (infrared) type provides a slower method of thawing but causes less damage to the railroad car finish and is preferred provided natural gas or liquified petroleum gas or electrical power is economically available and permitted by current D.O.D. policy.

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Hopper car thawing system shall be pit-type or prefabricated surface mounted enclosed type [or electric radiant type] hopper car thawing unit and shall include burners, controls, combustion air blowers, fuel storage and handling, and related work. Design system to thaw 56 Mg 55 ton, 71 Mg 70 ton and 102 Mg 100 ton capacity coal cars. System shall be capable of thawing [_____] bottom hopper unloading coal cars simultaneously. Railroad hopper car thawing system shall utilize [No. 2 fuel oil] [natural gas] [liquified petroleum gas] as a fuel. Provide a sufficient number of heaters to have a minimum heat input of 2198 kW 7,500,000 Btu/hr per car station, with heaters distributed under hopper car, or under and beside hopper car, such that the entire car is heated. Locate burner pits or heater units for even heating of the hopper cars without subjecting air hoses, air brake equipment, and bearings to excessive heat.

2.9.1.1 Pit-type Railroad Hopper Car Thawing System

a. Pit-type Thawing Unit: Pit-type hopper car thawing unit shall be complete with a refractory lined steel box, burner assemblies, steel burner enclosure with cover, valves, piping, and hinged main pit protective covers. Each pit shall have the capacity to generate 366 kW 1,250,000 Btu/hr when burning [No. 2 fuel oil] [natural gas] [liquified petroleum gas]. Burners shall fire horizontally and tangentially into the pit from opposite sides to heat the refractory lined pit up to radiant temperature. Heat shall be transferred to the hopper car by radiation from hot refractory surfaces and by convection from exhaust gases and evaporated moisture to rail car bottom and sides. Construct pit outer shell of not less than 6 mm 1/4 inch thick corrosion resistant steel plate, with the end plates of 10 gage (3.42 mm 0.1345 inch) steel. Provide supporting flanges and handling loops on both ends and provide cap strips on top of both sides. Place cast iron heat deflecting plates with overlapping edges on pit sides and bottom supported off the ledge on the outer shell. Provide a minimum 25 mm one inch air space between plates and outer shell. Pit side walls and bottom shall have a minimum 65 mm 2 1/2 inch thickness of standard firebrick with one course of standard end skew brick along the top of the side walls. Firebrick shall be easily replaceable. End section shall have not less than 114 mm 4 1/2 inch thick precast high temperature refractory panels. Provide burner refractory ignition tiles with steel jacket casings having mounting lugs for bolting to end plates of pit. Provide concrete railroad ties adjacent to each thawing pit. Deliver combustion air to burners by means of pressure blowers which take fresh air from outside thawing area. Factory wire and assemble heaters, control panels, blowers, and zone controls. Shop fabricate burner piping and control valve assemblies.

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NOTE: Designer shall make selection here based on fuel to be used in thawing system.

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b. Fuel System: [Provide complete fuel system for operation with, [natural] [liquified petroleum] gas including piping, regulators, low and high pressure limit switches interlocked with combustion controls, gages, solenoid valves, shutoff valves, and other accessories which may be required for each manufacturer's particular system.] [Provide complete fuel system for operation with duplex fuel oil pump set with [_____] liters gallon horizontal [below] [above] ground fuel tank and other accessories which may be required for each manufacturer's particular system. Provide fuel oil system in accordance with the requirements specified under the paragraph FUEL OIL SYSTEM this section.]

c. Burner controls shall meet Industrial Risk Insurers' (I.R.I., formerly F.I.A.) requirements. Connect fuel system piping to fuel supply piping as indicated. Burners shall be controlled (modulate) to regulate heat output to suit the operating requirements. Provide a manual light-off, low pressure [gas] [oil] pilot for automatic light-off of each thawing unit.

d. Air System: Provide complete air systems for operation with blowers, inlet silencers, gages, shutoff valves, low pressure limit switches interlocked with combustion controls, and other accessories which may be required for each manufacturer's particular system.

e. Control Panel: Provide centrally located control panel, with panel front consisting of a graphic display of the thawing system. Display shall be approximately to scale and coordinated with control and light indication for combustion air blowers and on-off control of convenient groups of heaters. Provide on-off control with indicating light for each thawing pit. Panel shall have a [NEMA 12] [NEMA 3R-8], dust-tight enclosure with internal equipment and wiring accessible from the panel front. Provide nameplates on panel front to designate function of switches and indicating lights. Controls shall be suitable for [_____] volt, [_____] phase, 60 Hz operation. Provide and mark terminals for connections with the exception of the neutral. Terminal blocks shall be 600 volt rated. Control relays shall have convertible contacts and shall have rating suitable for intended services but in any case, not less than 10 amp, 600 volt rating. Components shall be oiltight type. Connections to panel shall be watertight. Motor starters for combustion air blowers shall be installed in each respective blower cabinet.

2.9.1.2 Surface Mounted Enclosed Railroad Hopper Car Thawing System

a. Surface Mounted Enclosed Thawing Unit: Burner shall be of multiport cast iron construction and provide for even heating of radiant elements. Heater design shall be essentially the same for undercar and sidecar heaters, with heat transmitted to hopper car by both radiation and convection. Design burner and radiant element for radiation being the primary mode of heat transfer. Make radiant element over the burner of a heavy corrosion-resistant metal material. Design burner to operate on [No. 2 fuel oil] [natural gas] [liquified petroleum gas], and such that open flame from combustion will not extend beyond the emitter surface either during normal operation or in the event of emitter deterioration or burnout. Provide shields where necessary to direct radiation and hot exhaust gases to hopper car surface. Provide means for shielding car air hoses, air brake equipment, and bearings from excessive heat. Provide each heater with individual heater control boxes constructed as to provide positive air pressure inside control box. Control boxes shall contain mixing valve for maintaining proper gas-air ratio for satisfactory combustion. Locate gas and air piping connections for easy removal of individual burners. Deliver combustion air to heaters by means of pressure blowers which take fresh air from outside thawing area to ensure continued satisfactory combustion of gaseous fuels. Factory wire and assemble thawing units, control panels, blowers, and zone controls. Fuel system and burner control for oil fired units shall be as specified under the paragraph PIT-TYPE RAILROAD HOPPER CAR THAWING SYSTEM above.

b. Burner Controls (for gas fired units): Burners shall be electrically ignited with controls meeting I.R.I. requirements. Provide a gas pressure regulator for serving not more than eight individual burners. Regulator shall reduce gas pressure in supply line to pressure required for burners. Provide each burner with an air regulating valve for fuel-air ratio adjustment. Regulating valve shall contain positive vibration-proof locking device for maintaining critical adjustment.

c. Control Panel: Provide centrally located control panel with panel front having a graphic display of the thawing system. Display shall be approximately to scale and coordinated with control and light indication for combustion air blowers and on-off control of individual heaters. Provide a modulating control for each heater to regulate heat output to suit the operating requirements. Panel shall be [NEMA 12] [NEMA 3R-8], dust-tight enclosure with internal equipment and wiring accessible from the panel front. Provide nameplates on panel front to designate function of switches and indicating lights. Controls shall be suitable for [_____] volt, [_____] phase, 60 Hz operation. Provide and mark terminals for connections, with the exception of the neutral. Terminal blocks shall be 600 volt rated. Control relays shall have convertible contacts and shall have rating suitable for intended service but not less than 10 amp, 600 volt rating. Components shall be an industrial design of the oiltight type. Connections to the panel shall be watertight. Motor starters for combustion air blowers shall be installed in each respective blower cabinet.

[d. Thawing unit may be an electric radiant heat thawing unit which includes self-contained heater banks such as under-car outside the rail heater sections, lower side car heater sections and vertical side car heater sections, with reflectors, hinged cover, waterproof and weatherproof wired terminal blocks and zone controls for flexibility of operation.

]2.9.1.3 Shed

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NOTE: Shed should be used in the severe climate areas. Consult appropriate DM-2 series design manuals for design criteria for the shed.

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Provide shed of pre-engineered metal space frame construction with corrugated siding as indicated. Provide ventilation with roof vents and openings along bottom of sides of shed.

2.9.2 Top-Mounted Railroad Hopper Car Shaker

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NOTE: When noise is a major factor of concern, design a shaker enclosure with acoustical treatment which will be capable of reducing the noise to a tolerable level.

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Provide top-mounted rail car shaker complete with shaker, frame, vibrator, motors, hoists, hoist frame, [enclosure], and controls. Design unit for operation under all weather conditions.

2.9.2.1 Shaker

Shaker shall operate with a nominal 4 mm 5/32 inch stroke at 1200 rpm. Stroke shall be generated by large eccentric SAE 1045 steel shaft mounted in high capacity, self-aligning, spherical roller bearings. Seal bearings with a double piston ring labyrinth seal and dust and water slinger to retain lubricant and prevent entry of contaminants. Shaker frame shall be stress-relieved, welded steel construction. Fabricate frame of heavy steel plate, with bearing housing seats machined after stress relieving. Provide four lifting eyebolts of heat-treated forged alloy steel for connecting to hoist chains.

Shaker Electric Motor and Drive: Motor shall be totally enclosed, fan cooled, 1,800 rpm, [_____] volt, three phase, 60 Hz, not less than 15 kW 20 hp, as specified under the paragraph MOTORS AND DRIVES in this section. Motor shall be mounted on heavy spring isolated supporting frame with adjustable motor base. Shaker shall be belt driven with special deep groove sheaves, taper locking type hubs, and constant belt tensioning spring.

2.9.2.2 Shaker Hoist

Hoist shall be twin hook type having a rated capacity exceeding the weight of the shaker unit. Hoist shall have a lift of not less than 7 1/2 meters 25 feet with a hoist speed of not less than 0.08 meter per second (m/s) 16 feet per minute (fpm). Hoist shall have not less than 460 mm 18 inch long sling chains for connecting hoist to shaker lifting eyes, and hooks shall have U-bolt safety latches. Hoist shall be mounted on an electrified trolley as specified in Section 41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING.

Shaker Hoist Electric Motor: Motor shall be totally enclosed, [fan cooled], [non ventilated], 1,800 rpm, [_____] volt, three phase, 60 Hz, not less than 5 1/2 kW 7 1/2 hp as specified under the paragraph MOTORS AND DRIVES in this section. Motors shall be high slip type and shall with thermal overload protection embedded in the windings.

2.9.2.3 Controls

Provide [remote] [pendant] pushbutton station for both shaker and hoist operation. Provide automatic controls with upper and lower screw type limit switches to limit hook travel, slack cable limit switch to stop lowering of hooks when car shaker has been lowered on top of car, electrical interlock to prevent operation of car shaker motor until shaker is lowered on car, and electrical interlock to prevent operation of hoist motor while car shaker is running. Mount electrical equipment in NEMA 4 enclosures.

2.9.2.4 Frame [and Enclosure]

Provide frame [and enclosure] as indicated for support of hoist and shaker unit [and for attenuation of noise].

2.9.3 Car Pullers

2.9.3.1 Capstan Car Puller

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NOTE: Choose this subparagraph or the subparagraph REVERSIBLE DRUM TYPE CAR PULLER.

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Designed with capacity of not less than 4540 kg 10,000 pounds of starting pull and an average rope speed of approximately 0.23 m/s 45 fpm. Assembly shall be totally enclosed, weatherproof, and suitable for exterior installation with vertical capstan. Capstan shall be semisteel alloy construction designed for use with marlin-covered wire rope.

a. Accessories: Provide capstan complete with accessories, including controls, rope, rope storage reel, car hooks, sheaves, snatch blocks, anchors, and ratchet holdback.

b. Rope: Capstan rope shall be not less than 25 mm one inch outside diameter marlin clad wire rope with a breaking strength of not less than 13,620 kg 30,000 pounds.

c. Rope Storage Reel: Construct rope storage reel of metal, hand operated with the drum not less than 300 mm 12 inches in diameter and the reel faces not less than one meter 3 feet in diameter. Drum shall have not less than [_____] mm inches face width and store not less than [_____] meters feet of 25 mm 1 inch diameter marlin clad wire rope.

d. Electric Motor: [Totally enclosed], [fan cooled], high starting torque, reversing type, [_____] volt, three phase, 60 Hz, not less than 7 1/2 kW 10 hp as specified under the paragraph MOTORS AND DRIVES in this section.

2.9.3.2 Reversible Drum Type Car Puller

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NOTE: Choose this subparagraph or the above subparagraph CAPSTAN CAR PULLER.

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NOTE: Designer shall detail required footings and foundations based on the selected puller and soil conditions at each plant site.

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[Single drum reversing] [Double drum] type designed with a capacity of not less than [_____] kg pounds of running rope pull. Starting pull capacity shall be not less than twice the running pull capacity. Provide assembly on one-piece heavy steel base with weatherproof motor and gear reducers suitable for exterior location.

a. Puller: Unit shall consist of a [_____] mm inch pitch diameter by [_____] mm inch face, spirally grooved for [_____] mm inch diameter wire rope with sealed anti-friction bearings, alloy steel ring mounted spur gear and SAE 1045 steel shaft. Provide an SAE 1045 steel countershaft with anti-friction pillow blocks and heat-treated alloy steel spur pinion roller chain drive with steel sprockets and enclosed guard. Speed shall be a minimum of [_____] m/s fpm.

    (1) Electric Motor: [Totally enclosed], [fan cooled], high starting torque, reversing type, [_____] volt, [_____] phase, 60 Hz, not less than [_____] kW hp, as specified under the paragraph MOTORS AND DRIVES in this section. Provide clutch for engaging and disengaging power to drum.

    (2) Reduction Gear: ANSI/AGMA 2009 or AGMA 2011, "AGMA Gear Handbook," sized for the motor horsepower with motor base and coupling. Motor shall include motor mounted disc brake in dust and watertight enclosure. Provide rope overwind switch assembly and rotary type limit assembly.

b. Accessories:

    (1) Rope Sheaves: Provide four stationary type, 762 mm 30 inch pitch diameter single sheaves and one 762 mm 30 inch take up sheave assembly. Sheave shall be cast steel, grooved for [_____] mm inch diameter rope and shall be oriented horizontally and mounted in a welded steel frame with self-lubricating bronze bushings. Provide removable steel rope guards over sheaves.

    (2) Wire Rope: Wire rope shall be not less than [_____] mm inch in diameter with a breaking strength of not less than [_____] kg pounds. Rope shall consist of six 19 wire strands of improved plow steel rope with hemp center.

    (3) Safety Warning System: Provide a safety warning system, including an audible horn and three flashing lights to indicate cars in motion. System shall activate 30 seconds before puller motor is energized and shall not deactivate until puller motor is de-energized. Provide a permanent warning sign at each light indicating "RAILCAR IN MOTION."

    (4) Miscellaneous: Provide reversing controls, car hooks, snatch blocks, and anchors.

2.9.4 Track Hopper

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NOTE: Determine when a track hopper will be required.

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Welded construction of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate not less than 4 1/4 meters 14 feet wide and 8 1/2 meters 28 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.4.1 Track Girders

Two wide flanged beams designed for Cooper's E-[_____] loading with 50 percent impact allowance and sized at W [_____] by [_____]. Provide beams with cross struts for rigidity and bearing plates for mounting on pit wall as indicated.

2.9.4.2 Grating

Hopper grating between rails of [_____] by 10 mm 3/8 inch steel bars and [_____] by 10 mm 3/8 inch steel cross bars with openings [100] [150] by [100] [150] mm [4] [6] by [4] [6] inches. Grating outside rails shall have openings 100 by 100 mm 4 by 4 inches and be constructed of same size steel bars as specified above. Construct grating in removable panels and support from concrete pit walls and by steel angle supports resting on track girders.

2.9.4.3 Cover

Structurally reinforced 5 mm 3/16 inch thick raised pattern floor plate. Cover for portions of hopper outside rails shall be hinged with edges turned down. Construct cover between rails in easily removable sections with handles.

2.9.4.4 Hopper Outlet

Flanged not less than [_____] by [_____] mm inches. Outlet shall contain a water-collecting reclaim hopper type coal gate not less than [_____] by [_____] mm inches in size along with a dust tight metal slip joint, constructed of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate. Slip joint shall be of split construction to allow for disassembly and replacement. Design slip joint to allow for necessary flexibility to take care of deflection of hopper outlet due to varying coal loads and temperature variations without imposing load on feeder enclosure. Provide rope packing or other resilient gasket material to make the slip joint completely dust tight.

2.9.5 Truck Hopper

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NOTE: Determine when a truck hopper will be required.

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Welded construction of not less than 6 mm 1/4 inch thick [410 stainless steel] [structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel] plate not less than 3 meters 10 feet wide and 3 meters 10 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.5.1 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches. Construct grating of 125 by 13 mm 5 by 1/2 inch steel bars and 25 by 10 mm one by 3/8 inch steel cross bars. Weld grating and make in sections for ease of removal. Provide two intermediate support beams sized not less than W8 by 31 arranged for a maximum grating span of 1016 mm 3 feet 4 inches.

2.9.5.2 Hopper Outlet

Flanged not less than [_____] by [_____] mm inches. Outlet shall contain a water-collecting reclaim hopper type coal gate not less than [_____] by [_____] mm inches size.

2.9.5.3 Cover

Structurally reinforced 5 mm 3/16 inch thick raised pattern floor plate. Construct cover in sections with handles for ease of removal.

2.9.6 Reclaim Hoppers

Welded construction of not less than 6 mm 1/4 inch thick structurally reinforced steel plate lined with 8 gage (4.18 mm 0.1644 inch) 410 stainless steel plate not less than 3 meters 10 feet wide and 3 meters 10 feet long. Side slopes not less than 60 degrees from horizontal. Interior bolts shall have flat heads. Support hopper from concrete pit walls as indicated.

2.9.6.1 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches. Construct grating of 125 by 13 mm 5 by 1/2 inch steel bars and 25 by 10 mm one by 3/8 inch steel cross bars. Weld grating and make in sections for ease of removal. Provide two intermediate support beams sized not less than W8 by 31 arranged for a maximum grating span of 1016 mm 3 feet 4 inches.

2.9.6.2 Hopper Outlet

Flanged not less than [_____] by [_____] mm inches. Outlet shall contain a special reclaim hopper gate not less than [_____] by [_____] mm inches.

2.9.6.3 Reclaim Hopper Cover

Structurally reinforced 5 mm 3/16 inch thick raised pattern floor plate. Construct cover in sections with handles for ease of removal.

2.9.7 Belt Feeder

Totally enclosed, dust tight, approximately [_____] meter feet between pulley centers, designed to operate at a speed not to exceed [_____] m/s fpm, and having a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide belt feeder complete with continuous belt, shafts, pulleys, idlers, belt cleaner, frame, enclosure, reduction gear, and drive motor.

2.9.7.1 Head and Foot Shafts

Cold rolled steel, not less than [_____] mm inches and [_____] mm inches in diameter respectively. Mount shafts in antifriction roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than a [_____] mm inch adjustment. Shafts shall fit tight in pulley hubs.

2.9.7.2 Pulleys

Welded steel type with detachable compression grip-type hubs, steel plate ends, and crown faces 50 mm 2 inches wider than the belt width. [Provide an adjustable spring loaded or counter weighted type rubber bladed belt wiper beneath the head pulleys].

2.9.7.3 Belt

Mine Safety and Health Administration (MSHA) approved fire resistant construction, belt not less than [_____] mm inches wide, [_____] ply, [_____] kg ounces per square meter foot, with 3 mm 1/8 inch thick oil and chemical resistant cover on carrying side 0.79 mm 1/32 inch thick oil and chemical resistant rubber cover on under side. Cover shall be fire resistant. Belt shall have a cover tensile strength of not less than [_____] kPa psi and friction between plies of not less than [_____] kPa psi. Belt shall have vulcanized splice.

2.9.7.4 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, [_____] phase, 60 Hz, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES. Motor shall be direct connected by means of flexible coupling with guard to a reduction gear.

2.9.7.5 Reduction Gear

Alloy steel helical gear type enclosed in oiltight housing. Provide an adjustable base for motor and reducer unit. Drive from output shaft of the speed reducer to the conveyor head shaft shall be by means of finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100. Provide means to properly tension drive chain.

2.9.7.6 Backstop

Differential band brake type, cam type, or internal type to prevent reversal of belt.

2.9.7.7 Idlers

Flat type with 125 mm 5 inch diameter steel shells, malleable iron end brackets, grease sealed roller-type antifriction bearings, and self-cleaning angle bases. Idler spacing shall be not greater than 1372 mm 4 feet 6 inches. Return idler shall be of the flat single-pulley type having 125 mm 5 inch diameter steel shells, grease sealed roller-type antifriction bearings spaced on not more than [_____] meter feet centers.

Provide self-aligning training type idlers, as required, to ensure proper training of the belt. Provide additional idlers, as required, beneath track or truck hopper for support of belt and coal and to properly protect belt from impact caused by the coal. Extend grease pipes to one side for four point lubrication from tunnel walkway.

2.9.7.8 Load Skirts

Steel plate 6.35 mm 1/4 inch thick supported by structural brackets from conveyor frame. Skirts shall have rubber strips along the bottom edge to seal belt. Strips shall be easily adjustable by means of a clamp bar arrangement not requiring slotted bolt holes.

2.9.7.9 Frame, Supports, and Enclosure

Construct frame of either structural steel channel side stringers properly tied and braced for support of head and foot shafts with 12 gage (2.66 mm 0.1046 inch) steel deck plate the full length of the feeder, or integrally formed plate conveyor and deck frame. Support idlers from conveyor frame. Support frame from floor of tunnel [by steel channel legs] [as indicated]. Completely enclose feeder in a dust-tight enclosure constructed of not less than 10 gage (3.42 mm 0.1345 inch) steel plate with easily removable gasketed side panels containing handles at each panel end.

2.9.7.10 Loading Hopper

Constructed of not less than 10 mm 3/8 inch thick steel plate connected to bottom flange of the track or truck hopper. Provide an adjustable regulating gate adjacent to loading hopper for regulating height of coal on the belt.

2.9.7.11 Vibrating Feeder

Flat pan type vibrating feeder to convey coal from the day hopper to the belt conveyor. Pan shall be [_____] mm inches wide by [_____] mm inches long, with 150 mm 6 inch sides, constructed of 6.35 mm 1/4 inch thick stainless steel. Provide feeder with integral electromechanical drive and a remote controller. Controller shall contain operating switches and rate of flow adjustment and the power source for the feeder drive. Controller shall be designed for 460 volt, 60 Hz supply voltage. Support feeder from the hopper.

2.9.8 Shallow-In-Built Bar Flight Feeder and Receiving Hopper

Bar flight feeder shall be totally enclosed, dusttight type with shallow-in-built [track] [truck] hopper. Bar flight feeder shall have a horizontal length of [_____] meter feet [_____] mm inches between sprocket centers, operate at not greater than [_____] m/s fpm, and have a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide feeder complete with continuous chains and attached bars, terminal sprockets, gears, shafts, bearings, troughs, enclosure, frames, [truck] [track] hopper, grating, regulating gate, hinged inspection doors, discharge chute, electric motor, reduction gear, and supports.

2.9.8.1 Head and Foot Shafts

Head and foot shafts shall be not less than [_____] mm inches and [_____] mm inches in diameter, respectively. Construct shafts of coal rolled steel and mount in antifriction roller bearings. Mount head shaft in fixed pillow blocks and foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.9.8.2 Terminal Sprockets

Cast iron terminal sprockets with chilled rims not less than 380 mm 15 inches in diameter. Foot shaft sprockets shall be split type in two 180 degree sections to facilitate removal in shallow pit.

2.9.8.3 Chains and Flights

Chains shall be bar link type each having a pitch of not greater than 150 mm 6 inches and an ultimate strength of not less than 20,430 kg 45,000 pounds. Construct chain of heat treated carbon steel components with not less than a 22 by 38 mm 7/8 by 1 1/2 inch wide center link, 10 mm 3/8 inch wide by 38 mm 1 1/2 inch thick side bars, fastened with 18 mm 5/8 inch diameter pins. Construct bar flights of 10 mm 3/8 inch thick steel bars not less than 50 mm 2 inches high with flight width of not less than [_____] mm inches. Flight spacing shall be such that feeder shall move the required coal with a head shaft speed not greater than [_____] rpm.

2.9.8.4 Frame and Enclosure

Construct feeder frame of structural steel properly tied and braced, complete with guides and track for both the carrying and return runs, of not less than 80 by 80 by 10 mm 3 by 3 by 3/8 inch steel angles with not less than 6 mm 1/4 inch high renewable carbon steel wear bars. Enclosure shall be dusttight of not less than 10 gage (3.42 mm 0.1345 inch) commercial hot rolled steel plate. Enclosure shall be removable in sections. Top and side panels at head and foot sections shall be hinged and removable for access to chain sprockets.

2.9.8.5 Trough

Construct trough with flat bottom of not less than 10 mm 3/8 inch thick steel plate. Trough shall be removable and constructed with flanged discharge opening.

2.9.8.6 Hopper

Construct hopper not less than 2 1/2 meters 8 feet long and 3 meters 10 feet wide of structurally reinforced 10 mm 3/8 inch thick steel plate lined with 10 gage (3.42 mm 0.1345 inch) 410 stainless steel plate. Hopper sides shall not slope less than 55 degrees from the horizontal. Construct hopper with a shield over the return run so that coal is fed directly to the bottom conveying run.

2.9.8.7 Grating

Hopper grating shall have openings 90 by 90 mm 3 1/2 by 3 1/2 inches. Construct grating of 65 by 10 mm 2 1/2 by 3/8 inch steel bars and 20 mm 3/4 inch diameter steel rods. Weld grating and make in sections for ease of removal. Provide intermediate beams to support the grating.

2.9.8.8 Flight Feeder Drive

Flight feeder shall be driven by an electric motor direct connected by means of flexible coupling to a reduction gear unit having alloy steel helical or herringbone gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and gear. Drive from output speed shaft of the reduction gear to the conveyor head shaft shall be by means of standard finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100.

2.9.8.9 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

2.9.9 Bucket Elevator

Dusttight [centrifugal discharge] [continuous bucket] type having approximately [_____] meter feet [_____] mm inches sprocket centers, vertical chain and bucket, operating at a speed not to exceed [_____] m/s fpm, and having a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide bucket elevator complete with continuous double chains and attached buckets, upper and lower sprockets, gears, shafts, bearings, casing, top hood, discharge spout, bottom boot, access doors, electric motor drive, reduction gear, service platform, and accessories.

2.9.9.1 Head and Foot Shafts

Cold rolled steel not less than [_____] mm inches and [_____] mm inches in diameter, respectively. Mount shafts in antifriction roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than a [_____] mm inch adjustment. Shafts shall fit tight in sprocket hubs.

2.9.9.2 Terminal Sprockets

Cast iron with chilled rims. Head sprockets shall be not less than [_____] mm inches in diameter and foot sprockets not less than [_____] mm inches in diameter.

2.9.9.3 Buckets and Chain

Construct buckets of [malleable iron] [not less than [_____] mm inch steel plate] not less than [_____] mm inches long, [_____] mm inches wide, and [_____] mm inches deep. Buckets shall be mounted by not less than four bolt attachments to double strand of steel bushed chain each having an ultimate strength of not less than [_____] kg pounds and pitch of [_____] mm inches. Bucket spacing shall not be greater than [_____] mm inches.

2.9.9.4 Backstop

Differential band brake type, cam type or internal type to prevent reversal of chain and buckets in case of power failure.

2.9.9.5 Elevator Casing

Not less than [_____] by [_____] mm inches inside of not less than [_____][gage] [mm inch thick] commercial hot rolled mild steel plate with 50 by 50 by 6 mm 2 by 2 by 1/4 inch corner angles for full height of elevator casing. Construct casing in standard sections from 3 to 3.66 meters 10 to 12 feet high with 50 by 50 by 6 mm 2 by 2 by 1/4 inch angle flanges at the end of each section. Provide a hinged inspection door not less than 610 by 760 mm 24 by 30 inches in the section immediately above the boot section [and where indicated]. Casing and inspection doors shall be of dust-tight construction with flange angles continuously welded and gasketed. No makeshift repairs or field patching to overcome leakage shall be permitted. Casing interior shall be given a 1.60 mm 1/16 inch thick coating of coal tar primer and enamel in accordance with SSPC PS 11.01.

2.9.9.6 Head Section

Not less than [_____] mm inch thick commercial hot rolled mild steel plate in heavy angle frame with split, hinged, and removable top cover hood. Construct hood of not less than [_____] mm inch thick commercial hot rolled mild steel plate with flanged discharge throat built of not less than [_____] mm inch thick commercial hot rolled mild steel plate. Design head section to support the drive machinery and head bearings. Provide maintenance access ladder and platform conforming to applicable OSHA regulations [as indicated].

2.9.9.7 Boot Section

Not less than [_____] mm inch thick commercial hot rolled mild steel plate in heavy angle frame with curved and renewable bottom plate built of not less than [_____] mm inch thick commercial hot rolled mild steel plate, and flanged inlet. Take up and foot terminal bearing on one side of the boot shall be mounted in a bolted removable side panel so the foot shaft and [sprocket] [sprockets] may be removed through the side of the door. Bolt end panels so they are removable for cleanout and inspection.

2.9.9.8 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz not less than [_____] kW hp, as specified under the paragraph MOTORS AND DRIVES in this section. Motor shall be direct connected by means of flexible coupling to a reduction gear.

2.9.9.9 Reduction Gear

Alloy steel herringbone or helical gear type enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear unit. Drive from output shaft of reduction gear to elevator head shaft shall be by means of standard finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100. Provide means to properly tension drive chain.

2.9.9.10 Anchoring Brackets

Provide steel brackets at intervals [as indicated] at [not less than [_____] meters feet over centers] for anchoring elevator and to increase rigidity.

2.9.10 Rotary Vane Feeder

Provide a fully enclosed, dusttight, rotary vane feeder designed to feed [_____] size coal at a constant rate of not less than [_____] Mg tons per hour. Provide feeder complete with housing, feeder vanes, removable panels and inspection doors.

2.9.10.1 Body

Construct feeder body dusttight of not less than 12.7 mm 1/2 inch thick formed carbon steel plate with 19.05 mm 3/4 inch thick flanges. Continuously weld joints both inside and out. Top cover of feeder between inlet and outlet flanges shall be removable to allow access to interior of feeder. Provide hinged inspection doors in both sides of the outlet section.

2.9.10.2 Feeder Vanes

Feeder section shall consist of not less than four vanes, equally spaced, extending radially from drive shaft. Feeder section shall be not less than 457 mm 18 inches long and 457 mm 18 inches in diameter. Construct shaft of turned and polished cold rolled steel mounted in externally flanged babbitted type bearing blocks with forced lubrication type fittings. Protect bearings with felt seal between bearing blocks and feeder body.

2.9.10.3 Drive Sprocket

Provide cast iron drive sprocket with chilled rims. Coordinate diameter with drive motor and reduction gear for required feeder speed.

2.9.10.4 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section. Motor shall be directly connected by means of flexible coupling to a reduction gear unit having alloy steel helical or herringbone gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear unit. Drive from output speed shaft of the reduction gear to the conveyor head shaft shall be by means of finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100.

2.9.11 Screw Conveyors

Provide each dusttight and furnished complete, with trough, screw, inlet and discharge spouts, discharge gates, bearings, bearing hangers, dust cover, electric motor, reduction gear, [service platform,] and supports.

2.9.11.1 Inlet and Discharge Spouts

Arrange as indicated. Spouts shall be flanged and square with opening dimensions equal to inside diameter of trough.

2.9.11.2 Screw Trough

Provide dusttight screw trough with trough covers. Support trough by 6 mm 1/4 inch thick steel plate feet at not less than 3 meters 10 foot intervals. Individual trough sections shall not be greater than 3 meters 10 feet long with steel angle end flanged connections.

2.9.11.3 Bearings and Hangers

Provide thrust bearings and trough end dust seals for both drive and tail bearings. Thrust bearings shall be bronze in antifriction pillow blocks.

Screw hanger bearings shall be rabitted-type, with cast iron hangers having removable bearing caps held in place by a U-bolt. Design hangers to fit inside the conveyor trough and equip bearing for grease lubrication with grease fittings penetrating the dust cover to allow bearings to be greased without removing dust cover. Hangers shall not be located at trough joints, feed, or discharge openings. Locate hangers at not less than [3.66 meter 12 foot intervals for screw diameters larger than 250 mm 10 inches] [and] [3 meters 10 foot intervals for screw diameters 250 mm 10 inches in diameter and smaller].

2.9.11.4 Conveyor Screws and Couplings

Construct conveyor screws of helocoid-type flights and connect with cold rolled steel couplings. Assemble conveyor screws so that at the hangers there is 180 degrees rotation between the flight ends of each adjacent screw section. Screw flight shall end over last discharge spout so bare pipe extends across this area to prevent material carry-over.

2.9.11.5 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section. Install motor at discharge end of conveyor. Motor shall be supported by a unit bracket attached to the screw conveyor trough end plate and shall be connected to reduction gear through a -belt drive. Reduction gear shall be shaft mounted, double reduction type mounted directly on conveyor shaft. Provide tie rods, when required, to prevent reduction gear rotation and for adjusting belt tension.

2.9.11.6 Service Platforms

Provide service platform conforming to OSHA regulations as indicated to properly maintain and service conveyor drive unit.

2.9.12 Belt Conveyor

Inclined and approximately [_____] meter feet between pulley centers, operated at a speed not to exceed [_____] m/s fpm, and have a capacity of not less than [_____] Mg tons per hour of [_____] size coal. Provide belt conveyor complete with continuous belt, shafts, pulleys, idlers, takeups, belt cleaner, frame with conveyor cover and walkway, transfer chute, hopper, emergency stop cord and switch, alignment switch, reduction gear, electric motor, bin high level limit switch and alarm.

2.9.12.1 Head and Foot Shafts

Construct shafts of turned and polished cold rolled steel not less than [_____] mm inches and [_____] mm inches in diameter, respectively. Mount shafts in antifriction roller bearings with forced lubricating type fittings. Mount head shaft in fixed pillow blocks. Foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.9.12.2 Takeups

[Three pulley guided vertical counter weighted type] [Screw type] to maintain proper belt tension. Shafts shall be as specified above and not less than [_____] mm inches in diameter. Provide a safety device to prevent free fall of take-up pulley. Takeups shall provide a minimum adjustment of 1.5 percent of total belt length.

2.9.12.3 Pulleys

Welded steel type with detachable compression grip-type hubs, steel plate ends, and crown faces 50 mm 2 inches wider than the belt width. Provide a multiple belt scraper at each head pulley.

2.9.12.4 Magnetic Pulley

Drive pulley of [_____] conveyor shall be a nonelectric permanent magnet type designed to remove tramp iron. Provide a removable pan to collect the tramp iron.

2.9.12.5 Belt

Synthetic fabric, not less than [_____] mm inches wide, a minimum of [_____] ply, with 3 mm 1/8 inch thick oil and chemical resistant cover on carrying side, [1.59] [0.79] mm [1/16] [1/32] inch thick oil and chemical resistant rubber cover on under side. Cover shall be fire resistant. Belt shall have a tension pull strength of not less than [_____] N per mm pounds per inch of belt width. Belt shall have vulcanized splice.

2.9.12.6 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section. Motor shall be direct connected by means of flexible coupling with guard to a reduction gear.

2.9.12.7 Reduction Gear

Alloy steel helical gear type enclosed in an oil tight housing. Provide an adjustable base for mounting motor and reducing unit. Drive from the output shaft of the speed reducer to the conveyor head shaft shall be by means of finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 and complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100. Provide means to properly tension drive chain.

2.9.12.8 Backstop

Differential band brake type, cam type, or internal type to prevent reversal of belt.

2.9.12.9 Emergency Stop Cord and Switch

Provide emergency stop cord the length of the conveyor to actuate a switch for stopping the conveyor. Switch shall have flag to indicate actuated switch and shall have positive safety lock that cannot be accidentally reset. Cord shall be not less than 2.38 mm 3/32 inch galvanized aircraft cable with a minimum 1.19 mm 3/64 inch vinyl or nylon protective coating. Provide sufficient number of switches to prevent cable weight from actuating switch.

2.9.12.10 Belt Alignment Switch

Provide on each side of belt mounted off conveyor frame or discharge chute to stop conveyor under belt misalignment or runoff conditions. Mount switches on breakaway mounts to prevent damage from runaway belt.

2.9.12.11 Idlers

Troughing idlers shall be the [20] [35] degree three-pulley type with 125 mm 5 inch diameter steel shells, malleable iron end brackets, grease sealed roller type antifriction bearings, and self-cleaning angle bases. Troughing idler spacing shall be not greater than 1.37 meters 4 feet 6 inches, with additional idlers at the loading point. Return idler shall be of the flat single-pulley type having 125 mm 5 inch diameter steel shells, grease sealed roller type antifriction bearings and spaced on not more than 3 meters 10 foot centers. Provide self-aligning training type trough and return idlers at not greater than 15.24 meters 50 foot intervals to ensure proper training of belt. Extend grease pipes to one side for four point lubrication from walkway.

2.9.12.12 Load Skirts

Not less than 6 mm 1/4 inch thick steel plate and supported by structural brackets from conveyor frame. Skirts shall have rubber strips along bottom edge to seal belt. Strips shall be easily adjustable by means of a clamp bar arrangement not requiring slotted bolt holes.

2.9.12.13 Frame, Supports, and Walkway

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NOTE: Designer shall detail footings based on load and soil conditions at each plant site. Walkway shall be detailed.

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Frame shall be of the structural steel truss type with head and foot terminals framed of structural steel. Support frame from grade on structural A-frames set on concrete footings as indicated. Support idlers on not less than 150 mm 6 inch channel stringers braced and tied to structural steel truss frame. Provide a 12 gage (2.66 mm 0.1046 inch) steel deck plate for full length of conveyor. Provide a curved belt cover constructed of not less than 16 gage (1.52 mm 0.0598 inch) corrugated galvanized metal having removable panels on the walkway side for access to the idlers. Provide walkway not less than 914 mm 36 inches wide, supported from the structural steel framing for the entire length of the conveyor. Walkway shall be complete with handrails and metal nonslip grating meeting the requirements of 29 CFR 1910-SUBPART D.

2.9.12.14 Discharge Hopper

Construct discharge hopper of not less than 6 mm 1/4 inch thick steel plate to discharge on a discharge chute. Provide a discharge hood built of 10 gage (3.42 mm 0.1345 inch) steel plate enclosing the top, front, and sides above the discharge hopper.

2.9.13 Coal Scales

Stationary, automatic, dust-proof, belt-fed, batch type with rated capacity of not less than [_____] Mg tons per hour and a hopper capacity of 91 kg 200 pounds. Coal scales shall be complete units, including the body, belt feeder, feeder drive, bypass, weighing mechanism, weigh hopper, controls, counters, and other items required to make a completely automatic coal scale.

2.9.13.1 Body

Dusttight, of welded heavy steel plate construction with base angles not less than 6 mm 1/4 inch thick. Top plate, bypass plate, and reducer mounting plate shall be not less than 6 mm 1/4 inch thick, with other plates of not less than 11 gage (3.04 mm 0.1196 inch) steel plate. Provide large, gasketed, dusttight doors with adjustable pre-set compression type latches and forged steel hinges for inspection and maintenance purposes. Door openings shall be sufficient to allow removal of feeder and hopper without removal of screws or bolts.

2.9.13.2 Feeder

Feeder shall be a self-contained unit with an endless belt which shall be capable of being removed from one end or side. Construct feeder of heavy rigid steel frame with an 11 gage (3.04 mm 0.1196 inch) stainless steel plate to support the belt on the carrying run. Head and take-up shafts shall be cold rolled steel carried on self-aligning ball bearings equipped with dust seals and fitted for pressure lubrications. Bearings shall be capable of being lubricated during scale operation. Take-up shaft shall have screw-type take-up bearings and pulleys shall be crown faced steel for proper belt tracking.

2.9.13.3 Feed Belt

Channel type and of endless construction without splice. Belt shall be not less than 7.94 mm 5/16 inch thick of three ply heavy fabric core construction with chemical and abrasion resistant rubber coating. Feeder skirts and leveling plate shall be stainless steel and shall be arranged to provide a continuous stream of constant width and depth coal on the feed belt.

2.9.13.4 Electric Motor And Drive

Totally enclosed [_____] volt, [_____] phase, 60 Hz, with heavy duty reduction gear not less than 0.56 kW 3/4 hp as specified under the paragraph MOTORS AND DRIVES in this section. Scale shall be capable of bypassing coal without disconnection of the drive. Drive disconnection shall not be required for feeder removal unless special provisions are made for a quick and simple drive disconnection.

2.9.13.5 Coal Bypass

Provide a quick-operating coal bypass with an easily operable lever located on the outside of scale body. Operating lever operation shall instantly bypass coal around the feeder section and weighing mechanism without release of belt tension to prevent entry of coal between belt and pulley or support plates. Bypass construction shall not restrict inlet opening size for normal scale operation.

2.9.13.6 Weighing Mechanism

Enclose in a dusttight compartment. Construct weighing mechanism of cold rolled steel for minimum deflection, warp, and twist. Pivot points shall be self-aligning with hardened double bearing surfaces. Weighing mechanism shall be complete with weight lever, tare adjustment, and compensator, [with design subject to approval by the Contracting Officer], and scale shall be guaranteed to weigh coal accurately within 0.25 percent.

2.9.13.7 Scale Weigh Hopper

Construct scale weigh hopper and discharge gate of not less than 14 gage stainless steel plate, continuously welded and stiffened with angle irons. Weigh hopper shall be of such design and construction to ensure clean discharge.

2.9.13.8 Controls

Provide controls, except those required for weigh hopper discharge, prewired and located in a [NEMA 12] [NEMA 3] dusttight enclosure. Provide circuit breaker interlocked with the electrical panel door. Control circuits shall be two wire nominal 120 volt systems obtained by using an isolation transformer with one side grounded and shall be wired to a single terminal block which shall be included in the electrical panel. Segregate circuits of different voltage levels. Controls shall include large, oiltight, industrial type pushbuttons for use as "start-stop," "test," and "dump" switches mounted on the scale body adjacent to the electrical panel.

2.9.13.9 Counters

Mount a mechanical type coal counter on the scale body. Counter shall be rugged, reliable, with heavy duty register and designed so that double counting is impossible.[A remote motor operated counter shall be furnished located on the coal handling control panel in the control room. Counter shall be designed so that double counting is impossible.][Provide a contact closure for sending a pulse signal of each weigh hopper discharge to the operator control console, specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.9.13.10 Scale Inlet

Scale inlet shall contain coal gate with opening not less than 457 by 457 mm or 406 by 508 mm 18 by 18 inches or 16 by 20 inches along with a dusttight metal slip joint constructed of not less than 4.76 mm 3/16 inch thick steel plate. Slip joint shall be of split construction to allow for installation after coal scale is in place. Design slip joint to allow the necessary flexibility to take care of deflection of the [bunker] [silo] outlet due to varying load and temperature variations without imposing load on the scale. Rope packing or other resilient gasket material shall be provided to make the slip joint completely dusttight.

2.9.13.11 Scale Outlet Hopper

Not less than 6 mm 1/4 inch thick 410 stainless steel plate of capacity not less than 227 kg 500 pounds and 13 mm 1/2 inch thick steel plate flanges.

2.9.14 Stoker Hopper Extension

Stoker hopper extensions shall be dusttight and bolted to hopper furnished with stokers. Construct hopper extensions approximately as indicated of 6 mm 1/4 inch thick 410 stainless steel plate with structural stiffeners. Hopper extension shall hold not less than [_____] Mg tons of coal at a density of 800 kg per cubic meter 50 pounds per cubic foot. Hopper extensions shall have bolted emergency firing doors of not less than 610 by 610 mm 24 by 24 inches which shall contain a 152 by 152 mm 6 by 6 inch glass observation window. Connections shall be dusttight.

2.9.15 Coal Valve

Dusttight and drip proof of the double ladder rack-and-pinion type sized as indicated for each valve. Valve shall be capable of closing through a standing coal column. Valve opening shall be full size with no bridges, internal braces, or other barriers.

2.9.15.1 Valve Body

Not less than 6 mm 1/4 inch thick formed 410 stainless steel with heavy 19 mm 3/4 inch thick flanges. Continuously weld joints in contact with coal both inside and out and grind smooth. Valve body shall have dusttight steel gate assembly cover with molded gasket for removal of gate without removing the coal valve. Provide a minimum of two dusttight poke holes with rigid covers and molded gaskets.

2.9.15.2 Valve Gate

Drip proof and siftproof of 10 mm 3/8 inch thick steel plate with an 11 gage (3.04 mm 0.1196 inch) 410 stainless steel liner. Support gate by ball bearing rollers with 16 gage (1.52 mm 0.0598 inch) stainless steel shells equipped with felt grease seals and stainless steel grease retainers. Provide rollers with grease fittings extended through the valve body for pressure lubrication. Design gate so that supporting rollers, racks, and pinions are located completely out of the coal stream. Racks shall be cold formed and self cleaning, with stainless steel self cleaning pinions located over racks for positive tooth engagement.

2.9.15.3 Operating Shaft

Mount operating shaft in ball bearings with felt seals, stainless steel shells, stainless steel grease retainers, and grease fittings. Provide handwheels with proper finger clearance or pocket sheaves with heavy hot-dipped galvanized chain and chain guard as indicated. Handwheels and sheaves shall be not less than 457 mm 18 inches in diameter. Provide valves with mechanical type position indicator consisting of large pointer and legend to indicate the position of the valve gate.

2.9.15.4 Electric Motor Operators

Provide motor operators where indicated and capable of remote operation from the coal handling control panel. Operator shall consist of totally enclosed, fan cooled, high torque, [_____] volt, [_____] phase, 60 Hz motor as specified under the paragraph MOTORS AND DRIVES in this section with reduction gear, clutch and limit switches. Motor horsepower shall be as recommended by the manufacturer. Provide motorized valves that have manual operators, with fail-safe interlocks that make manual operation impossible while motor is operating.

2.9.16 Track and Reclaim Hopper Valves

Dusttight, double rack and pinion type, with water collecting trough. Valve shall have inlet opening not less than [_____] by [_____] mm inches in the direction of gate travel with a larger outlet opening. Inlet and outlet shall be flanged and constructed of mild steel.

2.9.16.1 Valve Body

Not less than 10 mm 3/8 inch thick mild steel continuously welded both internally and externally and lined with 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate where body comes in direct contact with coal. Construct inlet skirt of not less than 6 mm 1/4 inch thick 410 stainless steel with outlet body plates constructed of 10 mm 3/8 inch thick mild steel lined with 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate. Construct water collecting trough of not less than 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate and containing water sprays for flushing. Valve body shall have dust-tight steel gate assembly cover with molded gasket for removal of gate without removing the coal valve. Provide a hinged access panel not less than [_____] by [_____] mm inches in the direction of gate travel with compression-type latches over the water collecting trough for removing obstructions.

2.9.16.2 Valve Gate

Slope gate plate toward water collecting trough and mount it on large ball bearing rollers with 16 gage (1.52 mm 0.0598 inch) stainless steel shells equipped with felt grease seals and stainless steel grease retainers. Provide rollers with grease fittings extended through the valve body for pressure lubrication. Gate shall be U-shaped with ladder racks on both sides and shall be constructed of not less than 16 mm 5/8 inch thick mild steel lined with 11 gage (3.04 mm 0.1196 inch) 410 stainless steel plate. Gate design shall be such that supporting rollers, racks, and pinions are located completely out of the coal stream. Racks shall be cold formed and self-cleaning, with stainless steel, self cleaning pinions over racks.

2.9.16.3 Operating Shaft

Mount in ball bearings with felt seals, stainless steel shells, stainless steel grease retainers, and grease fittings. Mount a reduction gear on the gate shaft and provide an ample gate clearance pocket in the body to ensure ease of operation through a standing column of coal. Handwheel for operating the valve shall be not less than 457 mm 18 inches in diameter.

2.9.17 Chutes

Construct coal chutes dusttight as indicated of not less than 6 mm 1/4 inch thick 410 stainless steel plate. Weld chutes with flanges located as indicated to facilitate equipment and chute section removal. Flanges shall be not less than 10 mm 3/8 inch thick steel and gasketed to maintain dust-tight seal. Poke holes and access panels shall be provided where indicated.

2.9.18 Coal Presence Indicators and Equipment Response Switches

May be of the following types and shall be interlocked with the coal handling controls to indicate equipment failures, coal stoppages, and provide for a semi-automatic system. Enclosures for components shall meet the requirements of NEMA Type 7, Class I, Division I, Groups C and D, and NEMA Type 9, Class II, Division I, Groups E, F, and G.

2.9.18.1 Type A - Diaphragm Type Presence Indicator

Pressure-sensitive to presence of coal consisting of housing, diaphragm, limit switches, wiring, and mounting bracket flanges. Housing shall be either cast iron, stainless steel, or protected cast aluminum, with synthetic diaphragm as recommended for coarse slightly abrasive materials. Diaphragm deflection shall actuate a limit switch to indicate coal presence. Design unit so that maintenance, diaphragm replacement and sensitivity adjustment can be made from outside the bin. Type and number of contacts and voltages shall be as indicated on the control diagrams.

2.9.18.2 Type B - Paddle Type Presence Indicator

Paddle mounted on a counterweighted horizontal shaft so that deflection of the paddle rotates a cam which actuates a limit switch in a control box mounted on the shaft. Unit shall consist of paddle, shaft, enclosure, limit switches, wiring, and mounting brackets. Shaft shall be cold rolled steel and paddle shall be stainless steel with control enclosure of cast iron, stainless steel, or suitably protected cast aluminum. Type and number of contacts and voltages shall be as indicated on the control diagram. Mount shaft in ball bearings equipped with suitable dust seals and fittings for pressure grease lubrication.

2.9.18.3 Type C - Tilt Type Presence Indicator

Conical steel float that shall be tilted by presence of coal. Unit shall consist of housing, conical float, universal pivot-collar, pendant mechanism, dust seal, limit switches, wiring, and mounting brackets. Unit shall operate so that the tilting of the float actuates a limit switch in the enclosed housing above. Provide a hood constructed according to manufacturer's recommendations for the indicator's location of not less than 5 mm 3/16 inch thick steel plate. Provide access panel for servicing the unit. Tilt type indicator may be a totally enclosed type in which tilting causes a ball to roll off the center actuating a limit switch. Design unit to be cable hung and to tilt on the presence of coal. Type and number of contacts and voltages shall be as indicated on the control diagram.

2.9.18.4 Type D - Rotating Type Presence Indicator

Rotating paddle where presence of coal stalls motor and actuates a limit switch. Unit shall have either cast iron or cast aluminum housing, stainless steel paddle, couplings, and flexible shaft. Shaft seal shall be spring loaded and shall prevent the buildup of fines between shaft and hub. Operation shall be such that when paddle stalls, motor continues to operate until the limit switch is actuated, which in turn shuts off the current to the motor. Vane and baffle arrangements shall be according to manufacturer's recommendations for each indicator location. Type and number of contacts and voltages shall be as indicated on the control diagrams.

2.9.18.5 Type E - Vibrating Type Presence Indicator

Vibrating sensing rod so that the presence of coal dampens the vibrations actuating a control signal. Sensing rod shall be stainless steel not less than 10 mm 3/8 inch in diameter. Control unit shall be solid state, with type and number of contacts and voltages as indicated on the control diagrams.

2.9.18.6 Equipment Speed Response Switch

Actuates a control signal when preset abnormal equipment operating conditions are encountered. Switch shall be adjustable so that it may be used as an underspeed switch, overspeed switch, or zero speed switch. Switch shall consist of input shaft from which the equipment speed is measured and compared to a preset point. Enclosure shall be cast iron or suitably protected cast aluminum. Mount speed response switches as indicated on drawings. Type of switch adjustment, type and number of contacts, and voltages shall be as indicated on the control diagrams.

2.9.18.7 Presence Indicators and Response Switches

Provide at hoppers and conveyor discharges located and protected according to manufacturer's recommendations to ensure safe and reliable operation. Mount presence indicators in such a manner that they will not be injured by occasional large lumps nor falsely operated by stray lumps or collected amounts of coal.

2.9.19 Control Panel and Controls

Provide a semi-automatic control system for the coal handling system as indicated. Control panel NEMA 12 construction, centrally located in the main plant control room. Panel front shall include a system graphic display as indicated. Display shall be approximately to scale and painted with an industrial acrylic enamel. Outline items with 3 mm 1/8 inch wide black lines. Lettering shall be on engraved plastic screwed to the front of the panel, with white letters on a black background. Provide controls for operation on [_____] volt, [_____] phase, 60 Hz a.c. Panel shall be complete with an annunciator and interlocks, relays, switches, running and safety lights, and auxiliary parts necessary to safely control and operate the system. Items located in the door shall be dust-tight and oil tight with push-to-test indicating lights being of the transformer type. Control relays shall be 10 amp, 600 volt class with convertible contacts. Provide and mark terminals for connections with the exception of the neutral. Panel shall contain [_____] percent spare terminals. Wiring shall be No. 14 AWG type THHN stranded. Neutral wire shall be white and other wiring of 120 volts or less shall be color coded and labeled. Provide a plastic wire duct of sufficient size to provide [_____] percent cross sectional spare. Wiring shall be in accordance with requirements of NFPA 70.

2.9.19.1 Panel Devices

Control panel shall include the following indicating lights and color:

a. Power - ON	red
b. System Run (3 required)	
Rail unloading hopper to boiler plant	green
Rail unloading hopper to storage yard	green
Reclaim hopper to boiler plant	green
c. Rail unloading hopper surfactant sprays - ON	green
d. Reclaim hopper surfactant sprays - ON	green
e. Stackout tube belt conveyor - ON	green
f. Reclaim belt conveyor - ON	green
g. Bunker rotary vane feeder - ON	green

h. Bunker reclaim belt feeder - ON	green
i. Bucket elevator - ON	green
j. Bunker - HIGH LEVEL	green
k. Bunker - LOW LEVEL	red
l. Screw conveyor no. 1 - ON	green
m. Screw conveyor no. 2 - ON	green
[n. Stoker surge hopper no. 1 inlet valve - OPEN]	[green]
[o. Stoker surge hopper no. 2 inlet valve - OPEN]	[green]
p. Emergency discharge chute - OPEN	green
q. Stoker hopper - HIGH LEVEL (one required for each hopper)	
r. Stoker hopper - LOW LEVEL (one required for each hopper)	
s. Stoker hopper - LOW LOW LEVEL (one required for each hopper)	
[t. Coal scale - ON]	[green]

2.9.19.2   Switches and Pushbuttons

Provide momentary contact pushbuttons or selector switches for the following:

a. System- START (3 required)
    (1) Rail unloading hopper to storage yard
    (2) Reclaim hopper to boiler plant
    (3) Bunker to boiler plant

b. System - STOP (red head)

c. Rail unloading hopper surfactant spray - START/STOP

d. Reclaim hopper surfactant spray - START/STOP

e. Alarm - ACKNOWLEDGE

2.9.19.3   Annunciator Panel

Annunciator panel shall include the following:

a. Bunker - HIGH LEVEL

b. Bunker - LOW LEVEL

c. Stoker surge hopper (one required for each hopper) - HIGH LEVEL

d. Stoker surge hopper (one required for each hopper) - LOW LEVEL

e. Stoker surge hopper (one required for each hopper) - LOW LOW LEVEL

f. EMERGENCY SHUTDOWN (Auxiliary contacts for remote alarm)

g. Blank (3 required)

2.9.19.4 Panel Size

Size panel to accommodate future addition of one stoker surge hopper and associated equipment.

2.9.19.5 Auxiliary Devices

Provide auxiliary devices required for the control functions indicated above.

2.9.19.6 Name Plates

Provide laminated plastic name plates for devices on panel face.

2.9.19.7 Control Sequence

To ensure that coal does not back up during system startup or shutdown, design the controls so that on startup, the last piece of equipment to handle coal starts first and on shutdown, stops last.

2.9.19.8 Additional Controls

Provide as shown. These controls include local START and STOP pushbuttons or three-position selector switches for the following:

a. Belt feeders

b. Rotary vane feeder

c. Belt conveyor (at head pulley)

d. Screw conveyors

[e. Coal scale

] f. EMERGENCY STOP pushbuttons which stop the entire system shall be provided where indicated.

2.9.20 Multiple Belt Scrapers

Equip conveyor belts at the head pulley, with multiple belt scrapers. Adequate room and service access shall be provided in the head chute design for multiple cleaners. Provide a doctor blade on the face of the head pulley to remove most of the carryback material and a torsion arm type multiple blade cleaner to scrape and remove material that bypasses the primary cleaner. Tail pulley takeups shall be provided with a plow to protect against material being carried back between the belt and the pulleys. Both cleaners and plows shall have features that enable the operator to safely inspect and adjust blades. Dribble chutes shall be designed to resist material buildup and shall be plastic lined. A convenient dust tight door for clean out and inspection purposes shall be provided on each side of the dribble chute.

2.9.21 Steel Coal Bunker

Cylindrical shaped type having a storage capacity of not less than [_____] Mg tons of coal having a density of 800 kg per cubic meter 50 pounds per cubic foot.

2.9.21.1 Construction

Welded construction, not less than [_____] meters feet in diameter with a vertical cylindrical section [_____] meters feet [_____] mm inches high. Construct vertical cylindrical section of not less than 7.94 mm 5/16 inch thick steel plate. Slope bottom cone shaped hopper section at not less than 55 degrees and fabricate from not less than 10 mm 3/8 inch thick 410 stainless steel plate. Top of bunker shall be conical 35 degree sloped structurally reinforced 6 mm 1/4 inch thick steel plate. Provide ladder inside bunker and immediately above ladder the bunker top shall contain dusttight, weather tight access hatch of not less than 610 by 610 mm 24 by 24 inches. Shell and bottom plates shall be beveled for full butt weld on inside of bunker and a finish weld on outside of bunker. Provide bunker with flanged outlet drilled to match inlet of gate.

a. Responsibility: Contractor with whom contract is drawn shall assume full responsibility for the design and final details of construction of the steel coal bunker.

b. Supports: Bunker shall be self supporting from four steel columns which shall be supported from on top of a concrete foundation. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

c. Liner: Surface blast vertical inside surfaces of the bunker to a near white metal, and then coat with 6 mm 1/4 inch thick troweled-on heavy duty three compound corrosion resistant liner consisting of a resin, a hardener and graphite aggregate. Liner shall have an operating temperature limitation of not less than 66 degrees C 150 degrees F.

2.9.21.2 Accessories

a. Alarm Switches: Provide bunker with two automatic bin level indicators with neoprene rubber diaphragm and a single pole, double throw switch mounted in explosion proof aluminum housing to signal high and low level alarms. Provide mounting plates on bunker shell and holes for installation of indicator housing on outside of bunker. Wiring shall be as specified in 26 11 16 SECONDARY UNIT SUBSTATIONS.

b. Vibrators: Provide on the cone bottom of the coal bunker a heavy duty pulsating magnet electric vibrator, semi-noiseless type, complete with mounting plate. Provide one vibrator controller panel arranged for mounting in wall mounted control panel. Panel shall contain an "ON-OFF" switch, power control dial, fuses and rectifier. Power supply to panel shall be 460 volt, single phase, 60 Hz current.

2.9.22 Stoker Surge Hoppers

Construct stoker surge hoppers dusttight approximately as indicated of 6 mm 1/4 inch, 410 stainless steel plate with structural stiffeners, to hold not less than [_____] Mg tons of coal at a density of 800 kg per cubic meter 50 pounds per cubic foot. Connection transition between surge hopper discharge chute and stoker hopper extension shall have bolted emergency firing door of not less than 610 by 457 mm 24 by 18 inches which shall contain a 150 by 150 mm 6 by 6 inch glass observation window. Connections shall be dusttight.

2.9.23 Coal Meter

Vane type, where a direct readout counter is directly connected by a flexible shaft to a vane projected into center of coal downspout.

2.9.23.1 Vane

Construct vane of stainless steel design so that each foot of coal travel in the downspout causes the vane to turn a definite amount.

2.9.23.2 Counter

Counter shall have not less than four 25 mm one inch high figures on translucent material, illuminated from within the counter. Counter shall record directly the number of pounds of coal passing through the downspout.

2.9.24 Stackout Tube

Provide a stackout type discharge tube not less than 10 mm 3/8 inch thick, reinforced, stainless steel plate for discharging coal from the stackout conveyor to the coal storage yard. Tube shall be 1220 mm 4 feet 0 inches in diameter, and shall be designed as the structural support for a portion of the stackout conveyor and support steel as indicated on the drawings. Tube shall be a window chute designed to discharge coal at not more than 1.83 meters 6 feet above coal pile.

2.10 FUEL OIL SYSTEM

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NOTE: In reference to the following text, choose Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS if specifying below grade level fuel oil tanks. The rest of the system (including above ground tanks) shall be constructed to Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).

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The fuel oil system shall be designed and built in accordance with Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION)[.][, except when underground fuel oil tanks are specified. Below grade level fuel oil tanks shall be constructed in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.]

2.11 ASH HANDLING SYSTEM (MECHANICAL)

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NOTE: Choose this article and its paragraphs and subparagraphs or the following article ASH HANDLING SYSTEM (PNEUMATIC) and its paragraphs and subparagraphs.

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2.11.1 General

2.11.1.1 System Requirements

Provide a complete integrated, mechanical, semi-automatic, ash handling system with chain drag conveyor, screw conveyors, bucket elevator, material intakes, rotary valves, [ash doors and enclosures,] silo vent filter, ash silo, rotary ash conditioner, and additional equipment required for a complete mechanical ash handling system. Provide related electrical work required to operate the ash handling system.

2.11.1.2 Routing

The system shall receive, and convey to the ash silo, ash from the stoker fired boiler ash storage pits, [economizer hoppers,] [baghouse hoppers,] and other pollution control equipment hoppers.

2.11.1.3 Discharge

Discharge ash into ash storage silo in a dry condition. Arrange silo equipment for disposal of conditioned ash to trucks. Operation shall be as dustless as possible.

2.11.1.4 Maximum Noise Level

Noise level of the operation shall not exceed 85 decibels sound pressure level 1.52 meters 5 feet from the equipment in any direction.

2.11.2 System Valving

2.11.2.1 Rotary Valves

Provide rotary valve feeders of carbon steel construction complete with drive, guard, motor mount and gaskets, carbon steel adjustable blade tips, adjustable shoe type air seal and right angle gearhead drive motor. Rotor blade tips and shoes shall have a minimum Brinnell hardness of 500. Valves requiring part of the housing to form an airlock seal are not acceptable.

Electric Motor: Totally enclosed, fan cooled, [_____] volt, [_____] phase, 60 Hz not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section.

2.11.2.2 Manual Valve Intakes for Bottom Ash

Provide in front of the stoker ash pit doors a 610 by 610 mm 24 by 24 inch cast iron grid and hopper with opening approximately sized for the conveyor. Provide intake with dusttight, removable 6 mm 1/4 inch thick checkered steel plate cover.

2.11.2.3 Silo Discharge Valve

Provide a rotary feeder for discharging bottom ash and fly ash from the ash silo. Feeders shall be of ductile iron or cast steel and shall be complete with motor, motor support, chain drive, and necessary guards. Chain shall be driven through a torque limiting clutch on the driven sprocket equipped with electric cutout switch and alarm. [Feeder shall have spring-loaded hinged bypass plate to permit passage of clinkers.] Inlet and outlet flanges shall be standard drilled pipe flange. Rotor blades and sealing arrangement shall be the manufacturer's standard for the intended service. When rotors are equipped with adjustable tips, provide a service door in the body of the valve for tip adjustment. Shaft seals shall be of the packing gland type with suitable packing materials. Shaft bearings shall be outboard sealed ball bearings. Periphery seals shall be such that a complete seal is accomplished at a differential of [_____] Pa inches of water static pressure.

2.11.3 Conveyors

2.11.3.1 Chain Drag Conveyor

Provide endless chain for dragging coal ashes from front of boilers along a recessed trough to the inlet chute of a bucket elevator. Conveyor shall have [_____] meters feet sprocket centers, operate at speed not greater than 35 mm per second 7 feet per minute, and have a capacity of not less than [_____] Mg per hour of 640 kg per cubic meter tons per hour of 40 pounds per cubic foot ash. Provide conveyor complete with continuous chain, drive, and take up terminals, gears, shafts, bearings, return rolls, hard white iron trough, ash intake gratings, floor plates, discharge chute, electric motor, reduction gear, and supports. [Chain drag conveyor shall be designed for future length of [_____] meter feet.]

a. Head and Foot Shafts: Provide SAE 1045, steel head and foot shafts not less than [_____] and [_____] mm inches in diameter, respectively, mounted in anti-friction roller bearings in pillow blocks. Foot shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

b. Terminal Sprockets: Terminal sprockets shall be gray iron chilled rim not less than [_____] mm inches in diameter with solid web and not less than eight teeth each.

c. Chain: Combination drag type of riveted construction. Design chain symmetrically so that it can be turned over after one side is worn. Chain shall be [_____] mm inches wide with a pitch not greater than 200 mm 8 inches and an ultimate strength of not less than [187] [249] kN [42,000] [56,000] pounds. Construct chain of promal, a pearlitic malleable iron, center links not less than [_____] mm inches high, and heavy [_____] mm inch thick heat treated carbon steel side bars. Steel pins shall be cold rolled steel not less than [_____] mm inch in diameter, press-fitted into sidebars, and machined flat on one side to prevent rotation. Center section shall be rugged block type forming a rigid rectangle for maximum resistance to distortion with broad wearing shoes contoured to prevent snagging and damage to chain or trough. Barrels of center section shall be chambered to provide lubricant reservoir and still provide maximum bearing area for pins. Shape barrel with pushing surface on one side and for contact with sprocket on the other side.

d. Trough: Concrete lined with not less than [_____] mm inch thick hard white iron approximately as indicated. Trough shall be [_____] mm inches wide with hinged 6 mm 1/4 inch thick checkered steel plate covers. Covers shall be installed to be dusttight. Coordinate concrete work with conveyor manufacturer's requirements.

e. Return Rollers: Chilled rim, single flange, enclosed-oiling type on [_____] mm inch diameter carbon steel shafts spaced at not more than 3 meters 10 feet apart.

f. Discharge Chute: Construct of not less than 10 mm 3/8 inch steel plate and slope at not less than 60 degrees.

g. Electric Motor and Drive: Totally enclosed, fan cooled, high torque, [_____] volt, [_____] phase, 60 Hz not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section, direct connected by means of flexible coupling to a reduction gear unit having alloy steel helical or herringbone gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear. Drive from output shaft of the reduction gear to the conveyor head shaft shall be by means of finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100.

2.11.3.2 Screw Conveyors

Provide each screw conveyor dusttight and furnished complete, with trough, screw, inlet and discharge spouts, discharge gates, bearings, bearing hangers, dust cover, electric motor, reduction gear, [service platform,] and supports.

2.11.3.3 Inlet and Discharge Spouts

Arrange as indicated. Spouts shall be flanged and square with opening dimensions equal to the inside diameter of the trough.

2.11.3.4 Screw Trough

Provide dusttight screw trough with trough covers. Support trough by 6 mm 1/4 inch thick steel plate feet at not less than 3 meters 10 foot intervals. Individual trough sections shall not be greater than 3 meters 10 feet long with steel angle end flanged connections.

2.11.3.5 Bearings and Hangers

Provide thrust bearings and trough end dust seals for both drive and tail bearings. Thrust bearings shall be bronze in antifriction pillow blocks. Screw hanger bearings shall be babitted-type, with cast iron hangers having removable bearing caps held in place by a U-bolt. Design hangers to fit inside the conveyor trough and equip bearings for grease lubrication with grease fittings penetrating the dust cover to allow bearings to be greased without removing dust cover. Hangers shall not be located at trough joints, feed, or discharge openings. Locate hangers at not less than [3.66 meter 12 foot intervals for screw diameters larger than 250 mm 10 inches] [and] [3 meters 10 foot intervals for screw diameters 250 mm 10 inches in diameter and smaller].

2.11.3.6 Conveyor Screws and Couplings

Construct conveyor screws of helocoid-type flights and connect with cold rolled steel couplings. Assemble conveyor screws so that at the hangers there is 180 degrees rotation between the flight ends of each adjacent screw section. Screw flight shall end over last discharge spout so bare pipe extends across this area to prevent material carry-over.

2.11.3.7 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60

Hz, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section. Install motor at discharge end of the conveyor. Motor shall be supported by a unit bracket attached to the screw conveyor trough end plate and shall be connected to reduction gear through a V-belt drive. Reduction gear shall be shaft mounted, double reduction type mounted directly on the conveyor shaft. Provide tie rods, when required, to prevent reduction gear rotation and for adjusting belt tension.

2.11.3.8 Service Platforms

Provide service platform conforming to OSHA regulations as indicated to properly maintain and service conveyor drive unit.

2.11.4 Bucket Elevator

Provide a dusttight bucket elevator centrifugal discharge type, having approximately [_____] meter foot [_____] mm inch sprocket centers, vertical chain and bucket, operating at a speed not to exceed [_____] meters per second (m/s) feet per minute (fpm), and having a capacity of not less than [_____] Mg per hour of 640 kg per cubic meter tons per hour of 40 pounds per cubic foot ash. Provide bucket elevator complete with continuous chain and attached buckets, sprockets, gears, shafts, bearings, casing, top hood, discharge spout, bottom boot, access doors, electric motor, reduction gear, service platform, and accessories.

2.11.4.1 Head and Foot Shafts

Head and foot shafts shall be not less than [_____] and [_____] mm inches in diameter, respectively. Construct shafts of cold rolled steel and mount in antifriction roller bearings with forced lubricating type fittings. Mount foot shaft in fixed pillow blocks. Head shaft shall have screw-type takeups with not less than [_____] mm inches adjustment.

2.11.4.2 Terminal Sprockets

Cast iron with chilled rims. Head sprocket shall be not less than [_____] mm inches in diameter and foot sprocket not less than [_____] mm inches in diameter.

2.11.4.3 Buckets and Chain

Construct buckets of malleable iron not less than 200 mm long, 127 mm wide, 140 mm deep 8 inches long, 5 inches wide, and 12 inches deep. Buckets shall be mounted by not less than four bolt attachments to a single strand of steel bushed chain having an ultimate strength of not less than 178 kN 40,000 pounds and pitch of 100 mm 4 inches. Bucket spacing shall be not greater than 406 mm 16 inches.

2.11.4.4 Backstop

Differential band brake type to prevent reversal of chain and buckets in case of power failure.

2.11.4.5 Casing

Elevator casing shall be not less than 298 by 991 mm 11 3/4 by 39 inches inside and constructed of not less than 5 mm 3/16 inch thick commercial hot rolled mild steel plate with 50 by 50 by 6 mm 2 by 2 by 1/4 inch corner angles for full height of elevator casing. Fabricate casing in standard sections from 250 to 300 meter high with 50 by 50 by 6 mm 10 to 12 feet high with 2 by 2 by 1/4 inch angles at both flanges for each section. Provide a hinged inspection door not less than 610 by 762 mm 24 by 30 inches in the section immediately above the boot section and at other indicated points. Casing and inspection doors shall be of dusttight construction with flange angles continuously welded and gasketed. No makeshift repairs or field patching to overcome leakage shall be permitted. Give casing interior a 1.60 mm 1/16 inch thick coating of coal tar primer and enamel conforming to SSPC PS 11.01.

2.11.4.6 Head Section

Construct of not less than 5 mm 3/16 inch thick commercial hot rolled mild steel plate in heavy angle frame with split, hinged, and removable top cover hood built of not less than 10 gage (3.42 mm 0.1345 inch) commercial hot rolled mild steel plate and flanged discharge throat built of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate. Design head section to support the drive machinery and head bearings. Provide access ladder and service platform conforming to applicable OSHA regulations as indicated for providing proper service and maintenance of elevator.

2.11.4.7 Boot Section

Construct of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate in heavy angle frame with curved and renewable bottom plate and renewable internal loading leg, both built of not less than 5 mm 3/16 inch commercial hot rolled mild steel plate, and flanged inlet. Mount take-up and foot terminal bearing on one side of the boot in a bolted removable side panel so the foot shaft and sprocket may be removed through the side of the door. Bolt end panels so they are removable for cleanout and inspection.

2.11.4.8 Electric Motor

Totally enclosed, fan cooled, high torque, [_____] volt, three phase, 60 Hz, not less than [_____] kW hp as specified under the paragraph MOTORS AND DRIVES in this section, direct connected by means of flexible coupling to a reduction gear unit having alloy steel herringbone or helical gears and antifriction bearings enclosed in oiltight housing. Provide an adjustable base for motor and reduction gear unit. Drive from the output speed shaft of the reduction gear to the elevator head shaft shall be by means of finished steel roller chain conforming to ASME B29.100 running over cut tooth sprockets conforming to ASME B29.100 complete with steel plate chain guard. Roller chain attachments shall conform to ASME B29.100.

2.11.4.9 Anchoring Brackets

Provide steel brackets as indicated at intervals for anchoring elevator to increase rigidity.

2.11.4.10 Discharge Chute

Construct discharge chute to ash silo of not less than 10 mm 3/8 inch thick steel plate.

2.11.5 Ash Storage Silo

[_____] meters feet in diameter with [_____] meters feet high walls with a live bottom and flyash storage capacity of not less than [_____] Mg tons, based on ash bulk density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing. Structural joints shall be dusttight and watertight. Provide columns, beams, bracing, and other structural members as required for complete erection of silo and accessories. Live storage capacity shall allow for 20 degree angle of repose from silo outlet. Height of silo storage shall not be more than twice the diameter. Provide a minimum of one meter 3 feet of freeboard above the ash level. Design of support steel shall be approved by the ash system supplier. Design silo in accordance with the Uniform Building Code. The design shall take into account seismic load, wind load, snow load, equipment loads and an ash bulk density of 1120 kg per cubic meter 70 pounds per cubic foot. Ash silo support shall be free standing and shall be of sufficient height to allow gravity discharge of ash through the rotary ash conditioner to a [truck] [railroad car]. Provide access to the stair tower with intermediate platforms at 3.66 meters 12 feet intervals which access the ash conditioner level, silo floor level and silo roof level. Platforms from adjacent structures with stair access may be provided in lieu of the stair tower, but ladders with safety cages and access platforms must be additionally provided. Provide ladder with stainless steel fall prevention device on inside of silo from manhole in top of silo to bottom of silo. [Provide silo roof enclosure and unloader room enclosure each with a single one by 2 meters 3 by 7 foot access door, [_____] by [_____] meter foot double door, two windows, ventilator, [heater], insulated metal panel siding to match boiler plant walls and electrical lighting and convenience receptacles. Unloader room enclosure shall have reinforced concrete floor.]

2.11.5.1 Construction

Construct silo of steel with refractory lining or of concrete staves with steel hoops and concrete roof. Roof accessories shall include manhole, relief valve and vent filter. Bottom of silo shall be [conical, sloped a minimum of 45 degrees.] [flat with a steel plate feeding hopper in bottom of silo to funnel the ash into the inlet of the rotary vane feeder.] Provide hopper with expansion joints and sufficient poke holes with cover or cap.

2.11.5.2 Concrete Stave Silo

Construct concrete stave silo of either lightweight solid or hollow precast concrete staves with post-tensioned steel reinforcing hoops around the exterior. Mechanically measure and mix materials in concrete staves. Vibrate and shape staves under pressure and steam or air cure.

a. Wall Coating: Coat interior surface with a three-step process of a brush coat, scratch coat, and finish trowel coat of a mixture of fine sand and portland cement in accordance with silo manufacturer's recommendations. Apply each coat successively to produce a smooth interior surface. Work mixture into the formed horizontal and vertical grooves to permanently interlock the concrete staves. Brush coat the exterior surface with a double application of waterproof mixture. Mixture shall include a chemical agent for waterproofing and portland cement, sand, and water. Work coating into joints and over the steel reinforcing hoops to form a weatherproof protective coating.

b. Steel Reinforcing Hoops: Galvanized steel rods not less than 14 mm 9/16 inch in diameter with not less than 16 mm 5/8 inch rolled threads. Join hoop ends together with nuts and heavy malleable galvanized iron lugs or heavy duty galvanized steel lugs to a close tolerance for a tight fit. Electrogalvanize rods, nuts, and lugs to ensure adequate protection against corrosion. Rods shall be high quality, metallurgically sound steel with tensile strength not less than 448 MPa 65,000 pounds per square inch (psi), yield point not less than 276 MPa 40,000 psi, and a minimum elongation of 14 percent in 229 mm 9 inches. Reinforcing shall be sufficient to resist the maximum lateral pressure and loads imposed by the ash pressure within the silo. Hoop rods shall be structurally connected together where they pass through silo outlets on inspection frames.

c. Hollow Concrete Stave Silos: Construct silo of precast concrete staves with lateral air spaces. Cast staves from a well proportioned mix of portland cement and an expanded clay light weight aggregate. The minimum compressive strength of the concrete at 28 days shall be 34.50 MPa 5,000 psi. Hollow staves shall be 92 mm thick by 250 mm wide by 762 mm long 3 5/8 inches thick by 10 inches wide by 30 inches long with five lateral air cores per stave, except that shorter starter staves may be used to permit the horizontal joints to be staggered.

d. Solid Concrete Stave Silos: Construct silo of solid lightweight precast concrete staves. Solid staves shall be not less than 92 mm thick and 250 mm wide by 762 mm long 3 5/8 inches thick and 10 inches wide by 30 inches long, except starter staves may be shorter. Solid staves shall be constructed from a well proportioned mix of portland cement, washed sand and gravel which is free from injurious organic impurities and contains less than 5 percent of deleterious substances. Grade fine aggregate from coarse to fine. Compressive strength of solid concrete staves at 28 days shall be 34.50 MPa 5,000 psi.

2.11.6 Pulse Jet Bag Filter Vent

Provide for the silo constructed of 10 gage steel plate, fitted with rain hood. Bag material shall be sateen cotton capable of withstanding not less than 91 degrees C 195 degrees F, weighing 0.33 kg per square meter 9.75 ounces per square yard, having thread count of 4 by 2 per square mm 96 by 60 per square inch and permeability of 76 to 102 L/s per square meter at 249 Pa 15 to 20 cfm per square foot at one inch water column. Vent shall have not less than [_____] square meter feet effective cloth filtering area, with each bag having a maximum effective cloth filtering area of 0.56 square meter 6 square feet.

2.11.7 Rotary Ash Conditioner (Unloader)

Provide a complete dustless horizontal, floor mounted unloading device to discharge ashes from silo to a [truck] [railroad car]. Unloader (ash conditioner) shall include a 762 mm 30 inch diameter revolving drum which rotates about fixed spray nozzles, and shall be complete with conditioner and discharge compartments, scrapers, and other accessories as required. Unloader drum shall be constructed of steel plate not less than 10 mm 3/8 inch thick and shall be roller chain driven by a totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz electric motor not less than 3.75 kW 5 hp as specified under the paragraph MOTORS AND DRIVES in this section. Unloader shall discharge the conditioned ashes to a truck through a 6 mm 1/4 inch thick steel plate chute. The unloader shall be designed to eliminate most dust in unloading ash from the ash silo. An unloader that utilizes screws as a means of mixing is unacceptable. The dustless unloader shall add water to the ash, but not to the extent that there is free or surplus water running or dripping from the ash after discharge. Discharge ash shall be in a semi-fluid, loose, free flowing condition.

2.11.8 Fluidizing System

Provide on the silo floor to ensure a constant and uniform feed of ash through the silo discharge outlet. System shall consist of a series of diffuser modules, a conical diffuser hood, designed to support the total weight of ash when the silo is full, and compressed air piping. Each diffuser module shall be mounted on the silo floor using sloped concrete pads. System shall operate from the plant air system. Provide pressure reducing valves, safety valves, and controls for a complete system.

2.11.9 Control Panel and Controls

Provide a semi-automatic control system for the ash handling system[as indicated]. Provide a centrally controlled operation, with auxiliary local operation, and a monitoring control system with graphic display for the ash conveying system. Provide local control stop-start pushbuttons and indication stations for chain drag conveyor, screw conveyors, bucket elevator, and rotary ash conditioner. Ash handling system manufacturer shall provide measuring devices, status switches, solenoid valves, and auxiliary parts necessary to safely control and operate the system. Provide related electrical work required to operate the ash handling system.[Ash handling system manufacturer shall provide detailed control logic diagrams to the manufacturer of the digital process control and data acquisition system specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.11.9.1 Control Panel

Provide a [separate control panel] [subpanel mounted in the main plant control panel] of NEMA 12 construction, centrally located in the main plant control room. Panel front shall include a system graphic display as indicated. Display shall be approximately to scale and painted with an industrial acrylic enamel. Outline items with 3 mm 1/8 inch wide black lines. Lettering shall be on engraved plastic screwed to the front of the panel, with white letters on a black background. Provide controls for operation on [_____] volt, [_____] phase, 60 Hz a.c. Panel shall be complete with an annunciator and interlocks, relays, switches, running and safety lights, and auxiliary parts necessary to safely control and operate the system. Items located in the door shall be dusttight and oil tight with push-to-test indicating lights being of the transformer type. Control relays shall be 10 amp, 600 volt class with convertible contacts. Provide and mark terminals for connections with the exception of the neutral. Panel shall contain [_____] percent spare terminals. Wiring shall be No. 14 AWG Type THHN stranded. Neutral wire shall be white and other wiring of 120 volts or less shall be color coded and labeled. Provide a plastic wire duct of sufficient size to provide [_____] percent cross sectional spare. Wiring shall be in accordance with the requirements of NFPA 70.

2.11.9.2 Control Panel Devices

a. Control panel shall include the following indicating lights and color:

(1) Power - ON	red
(2) System Run (3 required)	
Chain drag conveyor to elevator	green

Screw conveyors to drag conveyor	green
Bucket elevator to silo	green
(3) Ash Silo - HI LEVEL	red
(4) Ash Silo - LOW LEVEL	red
(5) Silo Vent Filter - ON	green

b. Provide momentary contact pushbuttons or selector switches for the following:

(1) System - START (3 required)
Bucket elevator
Chain drag conveyor
Screw conveyors

(2) System - STOP (red head)

c. Provide sensors such that the following items can be alarmed on an ash handling system control panel annunciator.

(1) Ash silo - HIGH LEVEL

(2) Bucket elevator - EMERGENCY SHUTDOWN

(3) Screw conveyor - EMERGENCY SHUTDOWN

(4) Chain drag conveyor - EMERGENCY SHUTDOWN

(5) Silo vent filter - OFF

(6) Plugged Hopper

d. Provide auxiliary devices required for the control functions above and laminated plastic name plates for devices on the panel front.

e. Provide local control panel for operating and indication of the rotary ash conditioner with the following functions:

(1) Power - ON (red)

(2) Water - ON/OFF

(3) Ash feeder - ON/OFF

(4) Rotary ash conditioner - START/STOP/JOG

(5) Normal Stop

(6) Wash out - START/STOP

(7) Emergency Stop

f. Provide control panel mounted at grade level for remote operation of the rotary ash conditioner with the following functions:

(1) Rotary ash conditioner - START/STOP

(2) Normal stop

(3) Emergency stop

2.12 ASH HANDLING SYSTEM (PNEUMATIC)

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NOTE: Choose this article and its paragraphs and subparagraphs or the above article ASH HANDLING SYSTEM (MECHANICAL) and its paragraphs and subparagraphs.

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2.12.1 System Requirements

Provide a complete integrated, pneumatic, automatic sequencing, ash handling system with air intakes, material intakes, ash doors and enclosures, iron alloy conveyor line, fittings, rotary slide gates, primary and secondary materials separators, tertiary bag filter, [steam exhauster,] [electric motor driven positive displacement blower (mechanical exhauster),] [air washer,] silo vent filter, ash silo, rotary ash conditioner, and any other equipment that may be necessary for a complete pneumatic ash handling system. Provide related electrical work required to operate the ash handling system. Design system so that the ash silo is never placed under a partial vacuum.

2.12.2 System Type

System shall be of the intermittent vacuum type, whereby the vacuum is interrupted permitting periodic discharge of collected materials into the silo on a programmed time cycle. System shall have sufficient air velocity to pick up ash that may be deposited in the pipe.

2.12.3 Hoppers

System shall receive, and on a sequenced basis convey to the ash silo, ash from the stoker fired boiler ash storage hoppers, siftings hoppers, soot hoppers, baghouse hoppers, and other pollution control equipment hoppers. Convey from only one pickup point at a time.

2.12.4 Discharge

Discharge ash into the ash storage silo in a dry condition. Arrange silo equipment for disposal of conditioned ash to trucks. Operation shall be as nearly dustless as possible.

2.12.5 Maximum Noise Level

The noise level of the operation shall not exceed 85 decibels sound pressure level 1.52 meters 5 feet from the equipment in any direction.

2.12.6 Ash Storage Hopper

Provide a dry storage hopper for each boiler to receive and store bottom ash as it is discharged from the traveling grate. Hopper shall be compatible with the grate ash discharge enclosure as specified under the paragraph COAL GRATE STOKERS and shall have a net volume to receive and store material for an 8 hour period at maximum boiler output. Size hopper for mean ash level for one meter 3 feet below the step floor with ash density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing.

2.12.6.1 Construction

Not less than 6 mm 1/4 inch thick, ASTM A36/A36M, steel plate, dust tight, floor supported steel structure with refractory lining. Provide required steel columns, beams stiffeners and cross bracing. Bolt top section of the hopper to the stoker support steel. Design load of hopper shall be based on 1120 kg per cubic meter 70 pounds per cubic foot. Slope sides at not less than 45 degrees from the horizontal to maintain positive feed to the outlet.

2.12.6.2 Refractory Materials

As recommended by the manufacturer; the minimum total thickness of the refractory and insulating block lining shall not be less than 178 mm 7 inches. Refractory shall be minimum of 114 mm 4 1/2 inches.

2.12.6.3 Discharge Doors or Gates

Provide each hopper with refractory lined, dust tight, water cooled, vertical lift doors, of an opening size not less than 560 by 560 mm 22 by 22 inches. Each door shall be [air-cylinder operated] [chain wheel operated]. [Provide intermediate positioning capability with air cylinder operators.] Provide each door with guide rollers and support arms to ensure smooth operation without binding. When doors are vertical the minimum number of rollers shall be 4; for a sloping surface, the minimum number of rollers shall be 6.

2.12.6.4 Hopper Lift Door Enclosure

Provide not less than 6 mm 1/4 inch thick steel, dust tight, enclosure, for each vertical lift door. Match enclosure to housing of the clinker crusher and make it large enough to enclose the outlet and the vertical lift door. Provide hinged inspection and cleanout door on the front of the enclosure.

2.12.6.5 Hopper Access Door

Provide hinged access door on one side wall of each hopper. Door shall be cast iron, air tight swing-away locking type with refractory lining. Install door so that it is convenient and easy to use.

2.12.7 Clinker Crusher

Provide a clinker crusher mounted under each hopper discharge outlet, below the vertical lift door enclosure, capable of reducing clinkers from bottom ash to a maximum size of 50 mm 2 inches at a rate not less than the conveyer system capacity.

2.12.7.1 Construction

Single roller crusher unit with extra heavy housing, outboard bearings sealed against grit infiltration, motor and drive. Housing shall be 15 mm 1/2 inch thick. Crusher rollers shall have replaceable cam segments (teeth) with a minimum Brinell hardness of 450. Each cam tooth shall be designed to permit resurfacing with hard material. Stationary heavy cast iron or manganese steel abrasion resistant wear plates, of a Brinell hardness not less than 350, shall be mounted about the crusher rollers. Cam shaft rotational speed shall not exceed 20 rpm.

2.12.7.2 Fluid Gear Drive

Crushers shall be driven by a fluid gear drive including a totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz electric motor not less than 3.75 kW 5 hp, as specified under the paragraph MOTORS AND DRIVES in this section, fluid coupling and reduction gear, integrally mounted in dust and oil tight enclosures. Fluid drive shall protect the unit from excessive shock. Drive shall automatically reverse when stalled; crusher shall reverse and move forward three times and, after the third time, shall shut down and alarm when still stalled.

2.12.8 System Valving

2.12.8.1 Side Intake Valve for Fly Ash

Provide side intake valve for fly ash collection at each hopper, including dust collection hoppers and rear pass hoppers, and other collection points. Side intake valve shall be pneumatically opened, spring closed, totally enclosed disc valve of cast iron construction with wearing surfaces of Brinell hardness not less than 350. Provide valve complete with flanged inlet hopper, handhole with gasketed cover and clamp and couplings. Side intake valve shall feed ash to conveyor line on an angle, thus permitting air to mingle with the ash in the proper proportion to eliminate clogging. Valves shall provide positive and automatic air tight shutoff and dust tight pickup. Valve shall close on failure of operating air and before the discharge cycle of the intermittent conveyor operation. A full load regulating switch shall control each valve to prevent overloading of the conveyor system.

2.12.8.2 Rotary Valve Intakes for Bottom Ash

Provide a rotary valve, designed for regulating bottom ash to the a conveyor pipeline, under each crusher. Valve shall provide intake isolation and prevent overfilling or plugging of the conveyor line. Construction of valve shall be of cast iron with wearing surfaces of Brinell hardness not less than 350. Valve shall be pneumatically operated.

2.12.8.3 Air Intake

Provide spring loaded, swing disc, check valve type air intake, designed for air induction, at the end of each conveyor branch. When intake is located exposed to the weather, provide a rain hood.

2.12.8.4 Isolating Valves (Line Valves)

Provide an air operated, totally enclosed rotary slide gate isolating valve at each branch pipe line connection to prevent air flow through an unused branch line. Construct valve of abrasion resistant metal, machined and fitted to ensure a vacuum tight fit and guard against leakage and excessive maintenance. Provide purge air connection and a solenoid valve in the valve housing or cavity for purging the gate cavity of ash.

2.12.8.5 Silo Discharge Valve

Provide a rotary feeder for discharging bottom ash and fly ash from the ash silo. Feeders shall be of ductile iron or cast steel and shall be complete with motor, motor support, chain drive, and necessary guards. Chain shall be driven through a torque limiting clutch on the driven sprocket equipped with electric cutout switch and alarm. [Feeder shall have spring-loaded hinged bypass plate to permit passage of clinkers.] Inlet and outlet flanges shall be standard drilled pipe flange. Rotor blades and sealing arrangement shall be the manufacturer's standard for the intended service. When rotors are equipped with adjustable tips, provide a service door in the body of the valve for tip adjustment. Provide packing gland type shaft seals with suitable packing materials. Shaft bearings shall be outboard sealed ball bearings. Periphery seals shall be such that a complete seal is accomplished at a differential of [_____] inches of water static pressure.

2.12.9 Ash Conveyor Pipe and Fittings

Abrasion resistant cast iron alloy free of blowholes and other defects and suitable for use in ash conveying systems.

2.12.9.1 Conveyor Piping

Centrifugally cast, abrasion resistant cast iron alloy pipe with a Brinell hardness of not less than 280.

2.12.9.2 Elbows and Fittings

Cast iron alloy with a Brinell hardness of not less than 350 and shall have renewable wearbacks not less than 25 mm one inch thick.

2.12.9.3 Hangers and Supports

Provide adjustable roller supports and pipe hangers to properly support the pipe. System supplier shall design support system and furnish supports.

2.12.9.4 Contractor's Option

At the Contractor's option, conveyor pipe handling only fly ash may be Schedule 80 black steel pipe in lieu of the iron alloy pipe; however outlet fitting, elbows, tees and laterals shall be cast iron alloy with wearbacks and the pipe for a distance of one meter 3 feet after the cast iron alloy fittings shall be cast iron alloy pipe. Provide pipe with couplings or split flanges, bolts and gaskets, rated not less the 530 degrees C 1000 degrees F.

2.12.9.5 Expansion Joints

Stainless steel bellows type with abrasion resistant liners of a Brinell hardness not less than 350 or slip tube expansion joints fabricated of cast iron alloy, of Brinell hardness not less than 280, machined for smooth sliding fit with its mating part to absorb system thermal movement and shock loads.

2.12.10 Vacuum Air Piping

Provide from the secondary separator to the tertiary bag filter and from the tertiary bag filter to the [steam exhauster] [mechanical exhauster] not less than 10 gage, ASTM A211, spiral welded, vacuum air piping with ASTM A1011/A1011M, standard radius, mitered 10 gage elbows.

2.12.11 Compressed Air Piping and Accessories

Provide pressure reducing valves, safety valves, pressure gages, manual plug or ball valves, compressed air piping, as specified under the paragraph PIPING in this section and other items required for a complete, operable, pneumatic system.

2.12.12 Primary Ash Receiver-Separator and Secondary Ash Separator

Provide on top of ash silo two stages of receiving and separating, with each stage a complete self-contained unit with efficient dust and air separation and gravity dump bottom gates to open with interruption of vacuum and discharge into a silo. Design system so that suction is positively shut off from the receiver during its dumping period, so that no dust can be sucked out through the exhaust while the discharge of the receiver is open or opening. Air from the primary receiver shall enter the external secondary separator which shall remove approximately 85 percent of the dust not collected by the primary receiver. Combined efficiency of the primary and external secondary separators shall be not less than 95 percent. Provide completely contained gate assemblies in a dust-tight enclosure fitted with access doors large enough to remove entire gate assembly. Provide receivers of hard, abrasion-resistant, cast alloy iron with a Brinell hardness of not less than 500 constructed as described below:

2.12.12.1 Primary Receiver-Separator

Not less than [914] [1219] mm [36] [48] inches inside diameter with cast sections 19 mm 3/4 inch thick and 50 mm 2 inch thick impingement section. Cylinder, along with the discharge hopper shall be of segmental bolted construction. Construct receiver to ensure dropping of the maximum quantity of solids from the transporting air. Provide carbon steel outlet pipe and discharge gate. Receiver-separator shall have an internal baffle assembly to prevent re-entrainment of ash.

2.12.12.2 Secondary Separator

Not less than [406] [508] [610] mm [16] [20] [24] inches inside diameter of not less than 8 mm 5/16 inch thick one piece construction with at least 13 mm 1/2 inch thick inlet wear section. Design the receiver to minimize the carry-over of fly ash into the [air washer] [tertiary bag filter]. Separator shall have an internal baffle assembly to prevent re-entrainment of ash once it has fallen into the collection hopper of the separator.

2.12.12.3 Dust Tight Enclosure

Support primary and secondary receivers on not less than 6 mm 1/4 inch thick, dust tight, carbon steel support boxes with hinged access doors or removable panels on each side for servicing the receiver swing gates. Provide support box with airtight roller bearings, hinged, counterweighted swing gates with removable neoprene seals. Gates may, as an option, be air cylinder operated gates in lieu of the counterweighted gates.

2.12.13 Mechanical Exhausters

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NOTE: When environmental restraints, availability of steam or water or economics preclude the use of steam exhausters, use a mechanical (electrical

driven) exhauster with a pulse jet bag filter to produce the required system air flow.
****

Provide two, V-belt drive, positive displacement blowers with electric motors and accessories with each capable of producing a vacuum of at least 41 kPa 12 inches of mercury and with the air flow necessary for handling ashes through the system. One blower (exhauster) shall be used as a prime mover and the other as a standby unit.

2.12.13.1 Isolation Gates

Each exhauster shall include a manual bolt-up type gate for isolation and crossover. Gates shall include limit switches for status indication.

2.12.13.2 Accessories

Exhauster shall be complete with belt guard, air inlet silencer, air discharge snubber, support stand, expansion joint on inlet and outlet, belt and shaft guards, high temperature safety switch and vacuum relief valve.

2.12.13.3 Electric Motor

Totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz, as specified under the paragraph MOTORS AND DRIVES in this section.

2.12.13.4 Noise Level

Noise level shall not exceed 85 dBA sound pressure level at 1.50 meters 5 feet above the floor and 1.50 meters 5 feet from the blower in any direction.

2.12.14 Bag Filter

Provide a pulse jet self-cleaning bag filter assembly to provide a tertiary means of removing fine ash particles from the conveying air system. Installation of this assembly shall be on the silo roof, downstream of the two-stage cyclone type mechanical separator so as to permit a combined minimum separating efficiency of 99.5 percent (by weight), with a guaranteed outlet emission less than 0.005 grains particulate per dry standard cubic foot of exhaust air. The filter assembly shall include a main housing, bag assemblies, bag cleaning mechanism, discharge gate and control panel. This equipment shall be integrated with cyclone type separators, vacuum breakers, vacuum switches and conveying system controls as specified elsewhere. Bag filter shall be capable of operating at 25 percent above the system design vacuum. Filter housing shall be capable of withstanding a vacuum of 96 kPa 28.5 inches of mercury.

2.12.14.1 Cloth Area

Size filter on the basis of not greater than 25.40 L/s 5 acfm of air per square meter foot of cloth area. Calculate acfm on the maximum system air flow.

2.12.14.2 Filter Construction

Welded construction housing or body of, ASTM A36/A36M plate with an upper clean gas plenum, bag compartment, hopper bottom, internal access platform and support structure. Plate thickness shall be a minimum of 6 mm 1/4 inch with exception of the plenum tube sheet, which shall be a minimum of 13 mm 1/2 inch thick. Housing shall be cylindrical, having a minimum diameter of [_____] meter feet [_____] mm inches.

a. Upper Gas Plenum: Dished head, with flanged inlet and discharge connections, tube sheet, venturis and blow tubes. These appurtenances shall be welded airtight. Venturis shall be fabricated from carbon steel having a minimum thickness of 16 gage. Minimum centerline spacing between venturis shall be 191 mm 7 1/2 inches. A series of blow tubes shall be employed over the venturis. Each tube shall extend through the wall of the dished housing and be manifolded externally. Include support of external manifold.

b. Bag Compartment: Of sufficient height to allow internal access by maintenance personnel. Base of this compartment shall include a metal platform supported by steel angle cross bracing. Platform shall extend over the entire base area of the compartment. Sidewall of this compartment shall include a hinged access door with locking handle. Door shall be gasketed and the opening shall be a minimum of 762 mm high by 406 mm wide 30 inches high by 16 inches wide.

c. Hopper Bottom: Conical having a slope angle of not greater than 45 degrees with a flanged outlet.

d. Access Platform: With [stairs] [ladder] and safety handrail for external mounting to the filter housing. Mount platform at a height to allow convenient access through the hinged door located on the bag compartment sidewall. Platform floor area shall be not less than 1.40 square meter 15 square feet.

e. Provide filter housing with required columns and cross bracing to support structure from the silo roof to discharge directly into the silo. This support shall be of sufficient height to allow convenient installation of the filter discharge gate.

2.12.14.3 Discharge Gate

Air cylinder operated swing disc type. A rotary feeder type gate is not acceptable. When in the open position, gate disc shall swing out of the path of material being discharged. Both gate disc and seal shall be replaceable. A handhole shall be included on the gate housing for easy access to both disc and seat.

2.12.14.4 Bag Cleaning Mechanism

Provide venturis, blow tubes, manifold, solenoid air valves, diaphragm valves and differential pressure switch conveniently located at the filter unit. Operation of these devices shall be on a sequential basis (adjustable setting) to allow periodic surges of compressed air through the filter venturi sections. Compressed air requirement for bag cleaning shall be not greater than 7.08 cubic meter per second at 690 kPa (gage) 15 scfm at 100 psig.

2.12.14.5 Bag Assemblies

Each filter bag assembly shall include the filtering media, wire retainer and stainless steel clamping device. Filter bag shall slide over the retainer and both shall be clamped to the venturi by a stainless steel common band clamp. Top portion of the retainer shall have inside dimension equal to the mating venturi to ensure a tight fit.

a. Retainers: Cage type construction, fabricated from No. 1018 rounds or equal, using minimum of 3 mm 1/8 inch diameter rounds on vertical strands and 5 mm 3/16 inch diameter rounds on horizontal strands. Coat retainer with nickel and zinc after completion of fabrication.

b. Filter Bags: Not less than 474 g per square meter 14 ounces per square yard felted material. Provide felted polyester or dacron bags when operating temperatures are below 135 degrees C 275 degrees F. Provide Nomex bags or bags of similar abrasion and temperature resistant qualities when temperatures are above 135 degrees C 275 degrees F but not greater than 218 degrees C 425 degrees F. Bags shall have an exterior finish to aid in dust release.

2.12.14.6 Control Panel

Provide NEMA 4, wall mounted control panel to sequentially control the bag cleaning and dump operations of the filter unit. Locate panel near the filter unit to permit easy field adjustment of sequence timers. Panel overall dimensions shall be not less than 610 mm wide by 762 mm high by 200 mm deep 24 inches wide by 30 inches high by 8 inches deep. As a minimum, the panel instrumentation shall include a dump cycle timer, pulse valve sequence timer, two high differential pressure delay relays, alarm relay, time delay relay, manual/auto selector switch, pulse valve "ON" indicating light, high differential indicating light, terminal blocks and internal wiring. Welds and scratches of panel enclosure shall be free from blemishes. Paint panel exterior with manufacturer's standard enamel. Interior of panel shall be white enamel. Shop inspect panel and test prior to shipment.

2.12.14.7 Vacuum Breakers

Provide two air cylinder operated vacuum breakers. One shall be a pop-up or single ported type for installation in the air line between the secondary separator and tertiary bag filter. Second breaker shall be a three-ported type for locations in the air line between the tertiary bag filter and the exhauster. Each breaker shall use a disc type gate or equivalent to ensure full closure of the gate against its mating seat.

2.12.15 Steam Exhauster

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NOTE: The steam exhauster system requires 0.32 kg 2500 pounds of steam per second hour for a 150 mm 6 inch system (8 to 23 Mg 9 to 25 tons per hour) and 0.44 kg 3500 pounds of steam per second hour for an 200 mm 8 inch system (13.6 to 31.75 Mg 15 to 35 tons per hour) and approximately 1.89 L/s 30 gpm of water to the air washer. A steam condenser, air washer and silencer should be used when the steam exhauster is used and should not be used when a mechanical exhauster is specified.

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Provide a steam jet exhauster of cast iron construction with venturi throat of the high efficiency type for producing the vacuum necessary for handling ashes through the system. Make inlet air connection on the steam jet exhauster through a special spiral fitting so that the air enters the exhauster unit tangentially, avoiding direct impingement on the nozzle. Provide a unit capable of producing a vacuum of at least 40.56 kPa 12 inches of mercury column at shutoff and not requiring more than [0.32] [0.44] kg of steam per second at 690 kPa (gage) [2500] [3500] pounds of steam per hour at 100 psig.

2.12.16 Steam Condenser, Air Washer and Silencer

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NOTE: The steam exhauster system requires 0.32 kg 2500 pounds of steam per second hour for a 150 mm 6 inch system (8 to 23 Mg 9 to 25 tons per hour) and 0.44 kg 3500 pounds of steam per second hour for an 200 mm 8 inch system (13.6 to 31.75 Mg 15 to 35 tons per hour) and approximately 1.89 L/s 30 gpm of water to the air washer. A steam condenser, air washer and silencer should be used when the steam exhauster is used and should not be used when a mechanical exhauster is specified.

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Provide a double stage cyclone type steam condenser, which also extracts the remaining solids from the steam-air system. Construct steam condenser body of hard metal castings not less than 16 mm 5/8 inch thick suitable for this special service except that the inlet connector shall be not less than 19 mm 3/4 inch thick. Castings shall have a Brinell hardness of not less than 250. Other metal used in the condenser shall be at least 6 mm 1/4 inch thick steel with the top not less than 13 mm 1/2 inch thick steel plate. Provide drain connection not less than 76 mm 3 inches and water connection not less than 38 mm 1 1/2 inches. Provide silencer as required for quiet operation.

2.12.17 Ash Storage Silo

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NOTE: Use enclosures for silo roof and unloader in climates where protection of equipment and personnel from the weather is desired.

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[_____] meters feet in diameter with [_____] meters feet high walls with a live bottom and flyash storage capacity of not less than [_____] Mg tons, based on ash bulk density of 640 kg per cubic meter 40 pounds per cubic foot for volumetric sizing. Structural joints shall be dusttight and watertight. Provide columns, beams, bracing, and other structural members as required for complete erection of silo and accessories. Live storage capacity shall allow for 20 degree angle of repose from silo outlet. Height of silo storage shall not be more than twice the diameter. Provide a minimum of one meter 3 feet of freeboard above the ash level. The design of the support steel shall be approved by the ash system supplier. Design silo in accordance with the Uniform Building Code. The design shall take into account seismic load, wind load, snow load, equipment loads and an ash bulk density of 1120 kg per cubic meter 70 pounds per cubic foot. Ash silo support shall be free standing and shall be of sufficient height to allow gravity discharge of ash through the rotary ash conditioner to a [truck] [railroad car]. Provide access stair tower with intermediate platforms at 3.66 meters 12 foot intervals for access to ash conditioner level, silo floor level and silo roof level. Platforms from adjacent structures with stair access may be provided in lieu of the stair tower, but ladders with safety cages and access platforms must be additionally provided. Provide ladder with stainless steel fall prevention device on inside of silo from manhole in top of silo to bottom of silo. [Provide silo roof enclosure and unloader room enclosure each with single one by 2 meter 3 by 7 foot access door, [_____] by [_____] meter foot double door, two windows, ventilator, [heater], insulated metal panel siding to match boiler plant walls and electrical lighting and convenience receptacles. Unloader room enclosure shall have reinforced concrete floor.]

2.12.17.1 Construction

Construct silo of steel with refractory lining or of concrete staves with steel hoops and concrete roof. Roof accessories shall include manhole, relief valve and vent filter. Bottom of silo shall be [conical, sloped a minimum of 45 degrees.] [flat with a steel plate feeding hopper in bottom of silo to funnel ash into inlet of rotary vane feeder.] Provide hopper with expansion joints and sufficient poke holes with cover or cap.

2.12.17.2 Concrete Stave Silo

Construct concrete stave silo of either lightweight solid or hollow precast concrete staves with post-tensioned steel reinforcing hoops around the exterior. Mechanically measure and mix materials in concrete staves. Vibrate and shape the staves under pressure and steam or air cure.

a. Wall Coating: Coat interior surface with a three-step process of a brush coat, scratch coat, and finish trowel coat of a mixture of fine sand and portland cement in accordance with the silo manufacturer's recommendations. Apply each coat successively to produce a smooth interior surface. Work mixture into the formed horizontal and vertical grooves to permanently interlock the concrete staves. Brush coat the exterior surface with a double application of waterproof mixture. Mixture shall include a chemical agent for waterproofing and portland cement, sand, and water. Work coating into joints and over the steel reinforcing hoops to form a weatherproof protective coating.

b. Steel Reinforcing Hoops: Galvanized steel rods not less than 14 mm 9/16 inch in diameter with not less than 16 mm 5/8 inch rolled threads. Join hoop ends together with nuts and heavy malleable galvanized iron lugs or heavy duty galvanized steel lugs to a close tolerance for a tight fit. Electrogalvanize rods, nuts, and lugs to ensure adequate protection against corrosion. Rods shall be high quality, metallurgically sound steel with tensile strength not less than 448 MPa 65,000 psi, yield point not less than 276 MPa 40,000 psi, and a minimum elongation of 14 percent in 229 mm 9 inches. Reinforcing shall be sufficient to resist the maximum lateral pressure and loads imposed by the ash pressure within the silo. Structurally connect hoop rods that pass through silo outlets on inspection frames together.

c. Hollow Concrete Stave Silos: Construct silo of precast concrete staves with lateral air spaces. Cast staves from a well proportioned mix of portland cement and an expanded clay light weight aggregate. Minimum compressive strength of the concrete at 28 days shall be 34.50 MPa 5,000 psi. Hollow staves shall be 92 mm thick by 250 mm wide by 762 mm long 3 5/8 inches thick by 10 inches wide by 30 inches long with five lateral air cores per stave, except that shorter starter staves may be provided to permit the horizontal joints to be staggered.

d. Solid Concrete Stave Silos: Construct silo of solid lightweight precast concrete staves. Solid staves shall be not less than 92 mm thick and 250 mm wide by 762 mm long 3 5/8 inches thick and 10 inches wide by 30 inches long, except starter staves may be shorter. Solid staves shall be constructed from a well proportioned mix of portland cement, washed sand and gravel which is free from injurious organic impurities and contains less than 5 percent of deleterious substances. Grade fine aggregate from coarse to fine. Compressive strength of solid concrete staves at 28 days shall be 34.50 MPa 5,000 psi.

2.12.18 Pulse Jet Bag Filter Vent

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NOTE: Consult the manufacturer of ash handling equipment for venting requirements.

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Provide for the silo constructed of 10 gage steel plate, fitted with rain hood. Bag material shall be sateen cotton capable of withstanding not less than 91 degrees C 195 degrees F, weighing 0.33 kg per square meter 9.75 ounces per square yard, having thread count of 4 by 2 per square mm 96 by 60 per square inch and permeability of 76 to 102 L/s per square meter 15 to 20 cfm per square foot at 249 Pa one inch water column. Vent shall have not less than [_____] square meter feet effective cloth filtering area, with each bag having a maximum effective cloth filtering area of 0.56 square meter 6 square feet.

2.12.19 Rotary Ash Conditioner (Unloader)

Provide a complete dustless horizontal, floor mounted unloading device to discharge ashes from silo to a [truck] [railroad car]. Unloader (ash conditioner) shall include a 762 mm 30 inch diameter revolving drum which rotates about fixed spray nozzles, and shall be complete with conditioner and discharge compartments, scrapers, and other accessories as required. Unloader drum shall be constructed of steel plate not less than 10 mm 3/8 inch thick and shall be roller chain driven by a totally enclosed, fan cooled, [_____] volt, three phase, 60 Hz electric motor not less than 3.75 mm 5 hp as specified under the paragraph MOTORS AND DRIVES in this section. The unloader shall discharge the conditioned ashes to a truck through a 6 mm 1/4 inch thick steel plate chute. Unloader shall be designed to eliminate most dust in unloading ash from the ash silo. An unloader that utilizes screws as a means of mixing is unacceptable. Dustless unloader shall add water to the ash, but not to the extent that there is free or surplus water running or dripping from the ash after discharge. Discharge ash shall be in a semi-fluid, loose, free flowing condition.

[2.12.20 Fluidizing System

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NOTE: Delete fluidizing system when not necessary.

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Provide a fluidizing system on the silo floor to ensure a constant and uniform feed of ash through the silo discharge outlet. System shall consist of a series of diffuser modules, a conical diffuser hood, designed to support the total weight of ash when the silo is full, and compressed air piping. Each diffuser module shall be mounted on the silo floor using sloped concrete pads. System shall operate from the plant air system. Provide pressure reducing valves, safety valves, and controls for a complete system.

]2.12.21 General Controls

Provide a centrally controlled operation, with auxiliary local operation, and a monitoring control system with graphic display for the ash conveying system. Provide local control stop-start push buttons and indication stations for chain drag conveyor, screw conveyors, bucket elevator, and rotary ash conditioner. Ash handling system manufacturer shall provide measuring devices, status switches, solenoid valves, and auxiliary parts necessary to safely control and operate the system. Provide related electrical work required to operate the ash handling system.[Ash handling system manufacturer shall provide detailed control logic diagrams to the digital process control and data acquisition system manufacturer specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.12.21.1 Functions

Provide capability to perform any of the following functions from the operator interface console specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

a. System Start

b. System Stop

c. Auto/Manual/Index Mode of Operation Selection

d. Selection of Bypass of any Boiler

e. Manual Index to any Intake

f. Selection of Ash Silo for Baghouse Ash

2.12.21.2 Status Indicators

Provide sensors or contact closures for status indication on the operator interface console specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS[, or on the annunciator over the central control panel] for the following:

a. Conveyor On

b. Unit On (one required for each unit)

c. Final Line Purge On/Complete

d. Baghouse Ash to Ash Silo

2.12.21.3 Alarms

Provide sensors such that the following items can be alarmed on the operator interface console specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS[or on the annunciator over the central control panel]:

a. Blower Failure

b. Blower High Temperature

c. Bag Filter Failure

d. Bag Filter High Differential

e. Bag Filter Off

f. Plugged Hopper

g. Conveying Complete

h. Clinker Crusher Abnormal Shutdown (1 required for each boiler)

i. Low Conveying Air

j. High Conveying Vacuum

2.12.21.4 Vacuum Transmitter

To measure conveying system vacuum. Range shall be zero to 101 kPa 30 inches mercury with 4 to 20 mA dc linear transmitter output. Display vacuum on the operator interface console specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.12.22 Controls Operation

2.12.22.1 Automatic

Normally operated in the automatic mode. Automatically sequence through automatic intakes except the clinker crusher for each boiler after the system is started. When a unit is not in operation, selecting the "bypass mode" shall cause intakes on that unit to be skipped. For Manual operation, "index" is used to select the desired intake. As the conveying system shuts down automatically, the main conveyor line shall be purged for approximately one minute to remove ash remaining in it.

2.12.22.2 Switching

Sequence system under the control of vacuum switches and timers. Maximum vacuum will be when system is conveying material. When a hopper is empty, vacuum will drop and a "no load" vacuum switch shall cause the system to shift to the next intake. Prevent premature sequencing due to momentary low vacuum with a timer. When a plugged hopper occurs, vacuum will be between "no load" and normal value. Provide a timer to allow packed or arched material to break loose before alarming the condition.

2.12.22.3 Valves

Provide solenoid air valves for each air operated device, timers, contactors, relays and devices and equipment required for system control, measuring and operation. Identify each device with an engraved plastic identification plate [in accordance with a system graphic display] provided by the ash handling system supplier.

2.12.22.4 Bottom Ash Hopper Local Control Stations

Provide a wall mounted, NEMA 250, control station at each bottom ash hopper with front access door, lock, circuit breakers, selector switches, lights and push buttons.

a. Selector Switches:

  (1) Crusher: three position switch, "Reverse (momentary)-Off-Forward"

  (2) Rotary Valve Intake: two position switch "Open-Close"

  (3) Vertical Lift Door: position switch "Open-Intermediate-Close"

b. Emergency "Stop" Pushbutton, For clinker crusher, with manual reset.

  (1) "On-Manual"

  (2) "Crusher Stalled"

2.13 AIR POLLUTION CONTROL EQUIPMENT

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NOTE: Mechanical cyclone collectors should be used for soot blowing and as a prefilter on baghouse fabric filters or electrostatic precipitators. The fabric filter should be used where necessary to meet local, state or federal regulations or statutes for particulate emissions, when sulfur emissions are within regional limits through the burning of low sulfur "compliance coal." When coal containing more than 2 percent sulfur is burned, an electrostatic precipitator is generally more economical for control of particulates than the fabric filters, when sulfur emissions will meet regional limitations. When sulfur emissions are not within the regional limits, a scrubber with a prefilter mechanical cyclone and possibly a baghouse filter may be required to meet the emission limitations.

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2.13.1 Mechanical Cyclone Collectors

As specified in Section 23 51 43.01 20 MECHANICAL CYCLONE DUST COLLECTOR OF FLUE GAS PARTICULATES.

2.13.2 Fabric Filter Baghouse

As specified in Section 23 51 43.03 20 FABRIC FILTER DUST COLLECTOR OF FLYASH PARTICULATES IN FLUE GAS.

2.13.3 Electrostatic Precipitator Filters

As specified in Section 23 51 43.02 20 ELECTROSTATIC DUST COLLECTOR OF FLUE GAS PARTICULATES.

2.13.4 Scrubbers

As specified in Section [23 51 43.00 20 DUST AND GAS COLLECTOR DRY SCRUBBER AND FABRIC FILTER TYPE.]

2.14 MISCELLANEOUS EQUIPMENT

2.14.1 Condensate Receiver

Provide a [horizontal] [vertical] type tank not less than [_____] meter feet [_____] mm inches in diameter by [_____] meter feet [_____] mm inches [long] [high] overall with a storage capacity of not less than [_____] liters gallons. Tank shall be constructed of welded steel plate not less than 10 mm 3/8 inch thick. Provide condensate tank with a 610 mm 24 inch diameter manway, dual gage glasses with protective guards, saddles, and other connections as indicated.

2.14.1.1 Coating

Surface blast interior of tank to bare metal and coat with a bake-on phenolic lining or corrosion resistant liner consisting of a resin and hardener suitable for immersion in water at not less than 121 degrees C 250 degrees F. Coat the exterior of the tank with one shop coat of manufacturer's standard primer rated for service of not less than 121 degrees C 250 degrees F.

2.14.1.2 Accessories

Provide the condensate receiver with the following:

a. Connections for condensate pumped return, vent, water outlet, drain, sampling outlet, level transmitter and controls.

b. [_____] mm inch vent.

c. Reflex type water gage glasses with shutoff valves and guards.

d. One, 125 mm 5 inch dial, thermometer, 10 to 149 degrees C 50 to 300 degree F range, with lagging extension type wells, for steam and water space.

e. [_____] mm inch overflow trap.

f. One high water alarm switch with stainless steel float and trim. Circuit shall close as liquid level rises. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of receiver.

g. One low water alarm switch with stainless steel float and trim. Close circuit as liquid level falls. Locate switch to close circuit when water level drops to 25 percent of the storage capacity of the storage tank.

h. Switches on a single column with valved connections to tank. Provide unions in pipe on each side of each float switch.

i. Pipe, fittings, controls, specialties, bolts, gaskets, drains, and valves, necessary for a complete unit.

j. Provide automatic control system to control level in condensate tank by modulating discharge from condensate pumps.

2.14.2 Deaerating Heater

Provide a deaerating feedwater heater with storage tank conforming to FS W-H-2904, except as modified below and to ASME BPVC SEC VIII. Tank shall be ASME Code stamped. Provide stainless steel trays. No test model will be required.

Model A - Pressurized operation.
Type I - Tray-type heating and deaerating element.
Class 3 - 10 minute water storage capacity (minimum).
Grade A - Guaranteed removal from water of dissolved oxygen in excess of .005 cubic centimeters (cc) per liter, over a ten to one load swing.

2.14.2.1 Heater Capacity

Provide deaerating heater capable of heating and deaerating makeup water consisting of [_____] kilograms per second (kg/sec) pounds per hour of softened makeup water from [_____] to [_____] degrees C F (outlet temperature).

2.14.2.2 Inlet Water Characteristics

Softened makeup water:

Ph: [_____]
Total hardness (as CaC03): [_____]

2.14.2.3 Storage Tank

Horizontal design with steel supports [drilled for bolting] of approved design. Provide storage tank with not less than a 410 by 510 mm 16 by 20 inch minimum size manhole and cover and provide heater section with not less than a 300 by 460 mm 12 by 18 inch minimum size tray access handhole and door.

2.14.2.4 Vent Condensing Arrangement

Provide the deaerating heater with a vent condenser which shall condense the vented steam when the heater is operating at full capacity with the inlet water mixture at a temperature not exceeding 82 degrees C 180 degrees F. Construct the vent condenser, when of the direct contact type, with stainless steel baffling.

2.14.2.5 Materials

Construct trays, tray supports, water distributors, and other parts coming in contact with underaerated water or air laden steam of 430 stainless steel.

2.14.2.6 Accessories

Provide the deaerating heater unit with the following accessories:

a. Pressure relief valve: Sized in accordance with FS W-H-2904.

b. Thermometers: Two, 125 mm 5 inch dial thermometers, 10 to 149 degrees C 50 to 300 degrees F, with lagging extension type wells for the storage tank and the heater section. Provide a thermometer similar to above but with range of minus [_____] degrees C F to plus [_____] degrees C F for the makeup water connection.

c. Lifting attachments for the deaerator unit and the storage tank.

d. Water gage glasses: Reflex type with shutoff valve and guards.

e. Pressure gages: One 150 mm 6 inch dial compound pressure gage for the heater section with range from [_____] kPa inches of mercury (vacuum) to [_____] kPa (gage) psig.

f. Float controllers:

    (1) Inlet condensate controller

    (2) Makeup water controller

    (3) Overflow controller

g. Overflow control valve: With pneumatic controller arranged for local automatic operation.

h. Storage tank gage glass: Full height, shielded, for storage tank including shutoff valve and drain cocks.

i. Makeup water inlet control valve: With pneumatic controller.

j. Switches: For low water level alarm in the storage tank, high water level alarm, condensate pump shut-down in the storage tank, and low steam pressure alarm. Install switches on a single column with connections valved and unions provided in pipe on each side of each float switch.

k. Special tools: One set for maintenance.

l. Condensate pump reset: With stainless steel float and trim to reset pump shutdown switch on fall of liquid level in tank to [_____] mm inches below level of overflow level of storage tank.

m. Furnish pipe, fittings, controls, specialties, bolts, gaskets, drains, and valves, necessary for proper attachment of accessories and trimmings and install.

[n. Oil separator

]2.14.2.7 Connections

Provide necessary connections for condensate, steam, makeup water, removal of vented gases, vacuum breakers, discharge of deaerated water, and as required for instruments and controls.

a. Provide heater connections as follows:

    (1) [_____] mm inch steam inlet

    (2) [_____] mm inch makeup water inlet

    (3) [_____] mm inch condensate

    (4) [_____] mm inch high pressure trap return

(5) [_____] relief valves sized as required

(6) [_____] mm inch vent

(7) [_____] mm inch for thermometer well

(8) [_____] mm inch for pressure gage

(9) Vacuum breakers: As required

(10) [_____] mm inch heater drain

(11) [_____] mm inch spare [capped] [flanged]

(12) [_____] mm inch spare [capped] [flanged]

(13) Handholes And manhole: With covers

b. Tank connections shall include:

(1) [_____] mm inch drain

(2) [_____] mm inch boiler feed recirculation ([_____] required)

(3) 25 mm one inch sampling

(4) 25 mm one inch chemical feed

(5) [_____] mm inch for sight glass ([_____] sets required)

(6) [_____] mm inch for high and low alarm switches

(7) [_____] mm inch thermometer well

(8) Vacuum breakers: As required

(9) [_____] mm inch spare (capped)

(10) [_____] mm inch spare (flanged)

(11) [_____] mm inch level transmitter and controller ([_____] sets required)

(12) Downcomer and equalizer: As required

(13) [_____] mm inch feedwater outlet

(14) [_____] mm inch overflow outlet with internal water seal

2.14.2.8 Level Control

Provide an automatic control system to control the water level in the storage tank, by modulating valves in the makeup water lines. Output of the condensate pump shall be controlled by level in condensate storage tank.

a. Controllers: Provide external cage type air operated level controllers for both the condensate and makeup water lines complete with 40 mm 1 1/2 inch screwed connections, external cage, and controller. Cage body shall be Class 125 cast iron construction. Internal components including displacer, torque tube, displacer rod, displacer rod driver and bearings shall be 316 stainless steel. Displacer shall be 356 mm 14 inches long. Controller shall be direct acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band adjustment. Locate controller to maintain an operating level at 2/3 full point of storage tank. Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

b. Air operated regulating valves: Provide air operated control valves for both the condensate and makeup water lines. Valves shall have Class 125 or Class 150 rating with iron or semi-steel bodies and 316 stainless steel internals. Provide open on air failure condensate valve and provide makeup water valve with an air lock mounted on valve diaphragm and piped to hold valve in last position on air failure. Design valves for the following conditions:

	Condensate	Makeup Water
Valve size	[_____]	[_____]
Capacity (L/s)	[_____]	[_____]
Maximum pressure drop at above capacity (kPa (gage))	[_____]	[_____]
Available pressure (kPA (gage))	[_____]	[_____]
Minimum Cv at 100 percent open	[_____]	[_____]

	Condensate	Makeup Water
Valve size	[_____]	[_____]
Capacity (gpm)	[_____]	[_____]
Maximum pressure drop at above capacity (psig)	[_____]	[_____]
Available pressure (psid)	[_____]	[_____]
Minimum Cv at 100 percent open	[_____]	[_____]

2.14.2.9 Low Pressure Steam Control

Provide an automatic control system to control the steam to the deaerating feedwater heater. Maintain steam pressure in the heater by modulating a pressure reducing valve in the steam supply line. Control shall be local and remote from the control panel.

a. Controller: Adjustable proportional band, 0 to 103 kPa (gage) 0 to 15 psig brass bellows for input signal, and 20 to 103 kPa (gage) 3 to 15 psig output air pressure range, pilot controller complete with air set (valve, filter, drier and pressure regulator) mounted on control valve yoke.

b. Pressure reducing station control valve: Provide a [_____] mm inch air operated pressure reducing valve with proper internals to pass a flow of [_____] kg per second pounds per hour of steam. Steam at the valve inlet shall be [_____] kPa (gage) psig saturated, and the outlet shall be controlled at [_____] kPa (gage) psig. Minimum steam flow shall be approximately [_____] kg per second pounds per hour. Minimum valve Cv shall be [_____] at 100 percent open. Valve shall be Class 250 or Class 300 flanged, iron or semi-steel body with stainless steel internals equal percentage flow characteristics and a full size port. Provide valve actuator including travel indicator, hand jack, valve positioner, and air supply filter-reducer set. Valve shall move to open position in case of failure.

2.14.2.10 Gage Glasses

Provide to cover the entire range of water level in the storage section. Gage glasses shall not be greater than 610 mm 24 inches center-to-center. Provide gage glasses complete with [chain operated] ball check shutoff and drain cock valves and safety shield.

2.14.2.11 Alarms

Provide high and low water level alarms for storage tank as follows:

a. High water level alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of storage tank.

b. Low water level alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level falls to [_____] meters feet [_____] mm inches above bottom of storage tank.

c. Coordinate alarms with annunciator panel as indicated.

2.14.2.12 Multiport Back Pressure Relief Valve

Capable of relieving not less than [_____] kg per second pounds per hour of steam with not more than a [_____] kPa (gage) psig pressure rise when set at [_____] kPa (gage) psig initial operating pressure and fully adjustable by means of an external handwheel or chain operator for an initial set pressure of 0 to 172 kPa (gage) 0 to 25 psig. Locate on low pressure steam header manifold for the deaerating heater. Valve shall be multiport vapor cushion type rated for operating temperatures up to but not greater than 149 degrees C 300 degrees F with Class 125 cast iron body, bronze trim and carbon steel springs.

2.14.2.13 Exhaust Head

CID A-A-50494, Type [I (cast iron)] [II (fabricated steel plate)] of [_____] mm inch size with [_____] mm inch diameter drain, and a capacity of [_____] kg/sec pounds per hour of steam at [_____] kPa (gage) psig.

2.14.3 Boiler Feed Pumps

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NOTE: Use this paragraph for centrifugal boiler feed pumps. Use Style 1, horizontal split case pumps in all sizes. Pump service requirements shall include pump capacity of a minimum of 125 percent of boiler requirements at maximum load. Discharge head

must be sufficient to deliver water to the boiler at a pressure 3 percent higher than the setting of the highest setting of the boiler safety valves and up to 6 percent over the maximum operating pressure of the boiler in accordance with ASME BPVC.
****

CID A-A-50562, Type II (boiler feed pump), Style 1 (horizontally split case), Class 2 (multi-stage) except as modified below. Each pump shall be two stage with horizontal split casing, enclosed single suction opposed type impellers, renewable casing and impeller wearing rings, stuffing box with quenching gland and flooded oil lubricated, water cooled bearings.

2.14.3.1 Construction

Bronze fitted including bronze impeller and impeller wear rings, and ASTM A48/A48M, Class 30, cast iron casing. Provide casing with suction and discharge gages in tapped openings. Mount each pump and prime mover on a fabricated steel bed plate having a drip collection chamber with tapped drain openings. Provide lifting attachments to enable equipment to be set into its normal position and to enable split case pumps to be easily dismantled in place.

2.14.3.2 Drives

Variable speed motors and turbines direct connected to respective pumps with a gear type, forged steel, flexible coupling. Provide a shaft and coupling guard.

a. Electric motors: Variable speed, [open drip proof], [totally enclosed], [fan cooled], [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified under the paragraphs MOTORS AND DRIVES and VARIABLE SPEED CONTROL FOR MOTORS in this section.

b. Steam turbine: Single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F and normal exhaust back pressure of 34 kPa (gage) 5 psig or a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg pounds per brake power hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve.

    (1) Turbine construction: Turbine casing split on the horizontal centerline constructed of ASTM A48/A48M, cast iron, with a design pressure rating of 1724 kPa (gage) at 232 degrees C 250 psig at 450 degrees F at inlet, and 379 kPa (gage) at 232 degrees C 55 psig at 450 degrees F at the outlet.

    (2) Turbine bearings and shaft: Horizontal split, ring oiled, sleeve type, water cooled. Shaft shall be stainless steel or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

    (3) Speed governor: Variable speed oil relay, NEMA Class D, governor for speed control and pneumatic operator to maintain an adjustable, preset pump discharge header pressure by variation of turbine speed. Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from

the control system controller specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

(4) Emergency overspeed governor: Completely independent of the speed governor and shall operate a separate trip valve.

(5) Insulation: Turbine shall be insulated and lagged by the manufacturer as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.14.3.3 Minimum Flow Protection for Boiler Feed Water Pumps

a. Automatic flow control valve: Provide with each pump an automatic bypass valve. Valve shall automatically program the recirculation flow, the detection of low flow, the cycling of control valve and pressure letdown for high pressure boiler feedwater return to the feedwater heater. Bypass valve shall be cast steel with stainless steel internals, and shall have a rating of not less than 2068 kpa (gage) at 204 degrees C 300 psig at 400 degrees F. Valve shall have a line size body with a one inch recirculation connection. Provide pumps and turbine with all trimmings which the manufacturer considers essential for proper operation of units.

b. Boiler feedwater automatic recirculation system: (Option to Automatic Valve). Provide a boiler feedwater automatic recirculation system to protect the feedwater pumps at low flow conditions. System shall be capable of recirculating the minimum flow recommended by the pump manufacturer. System shall be an engineered system consisting of the various functional components specified or shall be a self-contained and self-powered mechanical system. Components of the engineered system shall include a flow transmitter with orifice in feedwater line, bypass flow controller with bypass flow control valve, and a bypass pressure reducing orifice.

(1) System bypass flow controller: Include detection of low flow and modulation of a control valve in a bypass line returning to a low pressure sink. Incorporate a pressure let-down feature or device to reduce the pressure from the boiler feedwater pump discharge pressure to that of the low pressure sink.

(2) System bypass control valve: Modulate to provide minimum flow recommended by the pump manufacturer and to provide shutoff or recirculation flow when feedwater flow to boilers exceeds the minimum flow required for pump protection.

2.14.3.4 Feedwater Stop and Check Valves

Provide a Class 300, flanged, cast steel feedwater stop gate valve and check valve on the feedwater outlet of each pump. Provide piping from the valves to the economizer inlet, and from the economizer to the flanged connection on the boiler drum. Provide connection on pipe at economizer outlet for remote recording thermometer.

2.14.4 Condensate Pumps

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NOTE: Use this paragraph for centrifugal condensate pumps. Pump service requirements shall include pump capacity at a minimum of 125 percent of full load

boiler requirements. Discharge into deaerator heater shall be modulated.
****

CID A-A-50562, Type I, Style [1 (horizontally split cast)] [2 (end suction)], Class 1 (single stage) unless modified below.

2.14.4.1 Construction

Bronze impellers and impeller wear rings. [Cast iron] [ductile iron] pump casing designed for the specified conditions. Bearings shall be oil lubricated. Equip casing with tapped openings for suction and discharge gages. Provide gages in openings. Mount pump and driver on a fabricated steel bed plate having a drip collection chamber with tapped drain openings. Provide lifting attachments for installation and maintenance.

2.14.4.2 Drives

Variable speed motors and turbines direct connected to the respective pumps with a gear type flexible coupling. Provide shaft and coupling guards.

a. Electric motors: Variable speed, [open drip proof], [totally enclosed], [fan cooled], [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified under the paragraphs MOTORS AND DRIVES and VARIABLE SPEED CONTROL FOR MOTORS in this section.

b. Steam turbine: Single stage, rated at not less than [_____] with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F, normal exhaust back pressure of 34 kPa (gage) 5 psig and a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg pounds per brake power hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve.

    (1) Turbine construction: Turbine casing split on the horizontal or vertical centerline constructed of ASTM A48/A48M cast iron, with a design pressure rating of 1724 kPa (gage) at 232 degrees C 250 psig at 450 degrees F at inlet, and 379 kPa (gage) at 232 degrees C 55 psig at 450 degrees F at the outlet.

    (2) Turbine bearings shaft: Ring oiled, anti-friction type. The shaft shall be stainless steel or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

    (3) Speed governor: Variable speed governor for speed limiting and pneumatic operator to maintain an adjustable preset level in [deaerator tank] [condensate receiver] by variation of turbine speed. Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal and vary the turbine speed from minimum to full speed in a linear response. Maximum and minimum speed shall be adjustable. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the controller specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

    (4) Emergency overspeed governor: Completely independent of the speed governor and shall operate a separate trip valve.

    (5) Insulation: Turbine shall insulated and lagged as specified in

Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.14.5 Variable Speed Control for Motors

Remotely installed cabinet housed units with solid state rectification and inverter equipment to vary frequency of electrical power to drive motors.

2.14.5.1 Housing

a. House controller in a [wall] [floor] mounted, NEMA 250 enclosure finished with manufacturers standard painted finish. Provide control panel complete with fused disconnect switches, magnetic [across the line] [part winding] starters with thermal overload protection, transformer, hand-off-automatic selector switches, hand potentiometer for manual speed control, fuses and running lights.

b. Provide manual switch within control panel so that in the event of failure of a component, the motor can be put across the line at full voltage to maintain air or pump pressure. Provide a mechanical door interlock that will allow the panel to open only when the fused disconnect is in the off position.

2.14.5.2 Variable Frequency Controllers

Variable frequency controllers shall use solid-state semiconductor power conversion equipment. Provide controllers as integrated and assembled products. Provide controllers by the same manufacturer.

a. Each controller shall be rated for a supply of [_____] volts, three phase, 60 Hz. The output shall be [_____] volts, three phase with frequency variable between zero and 60 Hz. Controllers shall be rated to operate the motors continuously at their rated horsepower and frequency. Speed regulation shall be three percent or better without tachometer feedback. The electrical supply system has an available short circuit rating of [_____] amperes symmetrical.

b. Each controller shall be capable of driving the motor continuously at a lower speed no greater than 20 percent of full rated motor speed with stable operation and without overheating the motor under rated ambient conditions. Provide estimate of minimum speed at which motor can be operated continuously without overheating or problems of instability due to overhauling of the load.

c. Provide controller fault protection so that a single or three phase short circuit at the controller terminals or inverter commutation failure will not result in damage to power circuit components. Provide overload protection so that motor and controller are protected against operating overloads.

d. Provide adjustable time delay undervoltage protection so that motors will continue to operate during momentary voltage fluctuation or loss of voltage. Time adjustment shall be zero to 5 seconds. Provide for orderly shutdown on undervoltage conditions exceeding the time delay interval.

e. Provide adjustable timed linear acceleration and deceleration.

f. Provide volts/hertz control to prevent motor overheating throughout the speed range.

g. Provide door interlocks to prevent opening of enclosure doors unless power is disconnected.

h. Controllers shall be self protecting and shall provide orderly shutdown for, but not limited to, the following conditions:

  (1) Loss of input power

  (2) Undervoltage

  (3) Sustained gradual overload

  (4) Fault or large instantaneous overload

  (5) Overtemperature

  (6) Failure of ventilating system

  (7) Overvoltage

  (8) Control circuit failure

i. Provide contacts for remote annunciation of shutdown or abnormal condition.

j. Electrical bypass: Provide each controller with manual isolation and bypass switching. The switch shall be manually operated with controller deenergized. Switch shall be two position with provisions for locking the switch in either position.

  (1) Normal position: Bypass shall be open and the controller shall be connected to the supply circuit and the load.

  (2) Bypass position: Bypass shall be closed and controller shall be electronically isolated from the supply and the load. Isolating contacts shall be located so that it is possible to verify by visual inspection that the contacts are open and the controller is electrically isolated. In the bypass position the motor shall be operated at constant speed and controlled from the air circuit breaker. Provide auxiliary contacts that close in the bypass position. The auxiliary contacts shall be used to activate the damper control to provide fan load control in the bypass position.

2.14.5.3 Controller Environmental Protection

a. Ventilation: Design controllers enclosed and ventilated for installation in a moderately dusty area. Provide forced filtered ventilation including fans, filters, controls and accessories required for operation. Enclosures shall be operated under positive pressure at all times. Provide filtered ventilating openings and gasketed doors to prevent infiltration of dust.

b. Heating: Provide electric heaters to prevent condensation in the enclosure and to prevent low in going air temperatures that exceed the equipment rating. Provide a low temperature alarm to sound when enclosure temperature falls below required minimum temperature. Provide contacts for remote annunciation of alarm condition.

2.14.5.4 Method of Control

Supply each controller from an electrically operated air circuit breaker or motor starter. Controller ventilation and heating shall be from another circuit.

a. Start signal: Closes the electrically operated air circuit breaker or motor starter to energize the controller. Controller shall accelerate fan to operating speed. Fan speed shall be controlled from the load control signal.

b. Stop signal: Opens the electrically operated air circuit breaker or motor starter to de-energize the controller. Upon deenergization, the controller control system shall revert to the stop condition.

c. Boiler feedwater pump speed control system: Matches pump discharge to system demand and maintains a system header pressure controlled to the set point values. Provide Manual/Automatic control stations for master pressure and for each boiler feed pump. Provide indicators for feedwater header pressure and individual boiler feedwater pump flow. See Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.14.6 Valve Actuators

[Electrically] [or] [pneumatically] operated designed so that valve may be manually operated by removing the drive pins. Actuators shall be operated by push button control. Locate one push button at a position adjacent to the valve. Locate a second push button within the boiler control room. Provide a valve position indicator utilizing indicating lights. A green light shall indicate the valve is fully open and an amber light shall indicate the valve is fully closed. Both lights on shall indicate when the valve is partially open. [Provide torque limit controls to protect the valve during opening and closing for electrically operated valves.] Actuator electric motor shall be totally enclosed, [_____] volts, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section. Provide NEMA 4 control enclosures.

2.14.7 Sump Pumps

CID A-A-50555 with automatic float switch and disconnect switch in NEMA 6 enclosure.

2.14.8 Water Softening System

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NOTE: Size the system for 125 percent of the maximum expected steam load to 100 percent of plant capacity. Include losses from blowdown. Size with one tower regenerating. Frequency of regeneration should be between 12 and 24 hours at peak loading.

****

Ion exchange resin type, conforming to WQA S-100 except as modified below. [Manual] [Push button automatic] [Fully automatic] in operation with operating controls housed in a NEMA 12 enclosure having a total capacity between regenerations of not less than [_____] liters gallons of water of [_____] grams grains hardness when operated at a sustained softening rate of [_____] L/s gpm. Maximum effluent water temperature shall be [_____] degrees C F.

2.14.8.1 Softener Equipment

Including but not limited to the following:

a. Water hardness monitor: Provide a water hardness monitor with an alarm point at 1.0 ppm to assure compliance for boilers rated above 3150 grams/sec 25,000 lbs./hr.

b. Total solids monitor/controller: Provide a continuous monitor and controller when required to control the concentration of dissolved solids and treatment chemicals in the water for boilers rated above 3150 grams/sec 25,000 lbs./hr.

c. Water meter: Provide a [_____] mm inch cold water meter on each softener unit.

d. Ion exchange resin: High capacity, polystyrene base, sulfonated synthetic type except that the exchange capacity shall be not less than 68.70 kg per cubic meter 30 kilograins per cubic foot at a salt dosage of 240 kg per cubic meter 15 pounds per cubic foot.

e. Tank sizing: Minimum acceptable bed depth of 762 mm 30 inches; maximum acceptable bed depth of 1829 mm 72 inches. Base reactor tank sizes on allowing a freeboard above the resin bed of not less than 75 percent of the resin bed depth, and flow rate between 1.11 and 7.13 L/s per cubic meter 0.5 and 3.2 gpm per cubic foot of resin.

2.14.8.2 Brine Storage System

Provide a complete brine storage system including fiberglass storage tank, sight level gage, bulk salt delivery tube, internal distribution system, level control system, tank vent with dust collection system, top and side manholes, access ladder, and other required appurtenances.

a. Storage tank: Filament wound fiberglass with flat bottom and domed top as recommended by the manufacturer for brine storage. The tank shall be [_____] meters feet [_____] mm inches in diameter by [_____] meters feet [_____] mm inches wall height with a nominal capacity of [_____] liters gallons and a dry salt storage capacity of [_____] Mg tons. Design the water distribution system, internal piping distributors, and brine collection system so that system shall be capable of dissolving [_____] kg pounds of rock salt per second minute to produce [_____] L/s gpm of brine. System shall be able to dissolve [_____] Mg tons of salt before cleanout.

b. Accessories: Provide the following accessories:

  (1) Steel holddown lugs securely bonded to the tank in adequate number to properly anchor tank to concrete base

  (2) Side bottom flanged drain not less than 100 mm 4 inches in diameter

  (3) Side and top manholes not less than 559 mm 22 inches in diameter

  (4) Flanged top connections for delivery pipe and vent

  (5) Ladder for access to top manhole

(6) Water inlet connection

(7) Brine outlet connection

(8) Level control system

(9) Sight level gage

c. Pneumatic delivery pipe: Not less than 100 mm 4 inches in diameter.

d. Dust collection vent system and safety relief valve: Provide storage tank with dust collection vent system and safety relief valve.

e. Access ladder: Of steel construction to be bolted to tank by means of FRP mounting lugs complete with safety cage. Platform shall connect ladder to tank for safe access to manhole.

f. Tank internals: Construct tank internals including water distribution piping and brine collectors of FRP or polyvinyl chloride (PVC).

g. Tank nozzles: ASME B16.5, Class 150, reinforced FRP or PVC flanges.

h. Level control system: Electrode holder and electrodes mounted in a standpipe exterior to the tank. Position electrodes so that a solenoid operated water makeup valve will be opened or closed to maintain the liquid level to within plus or minus 25 mm one inch of the set level. Provide tank with a high water alarm. Electrodes shall be easily removable for cleaning and constructed of materials, that will allow continual immersion in brine.

2.14.9 Chemical Feed Systems

Provide systems complete with storage tank, supporting framework, hinged cover, mixer, strainers, level indicators, proportioning pumps, relief valves and interconnecting piping for a complete chemical feed packaged unit.

2.14.9.1 Storage Tank

190 liters50 gallon capacity constructed of FRP. Provide removable, hinged cover.

2.14.9.2 Exterior Gage Glass

Protected, full height of the tank complete with gage cocks.

2.14.9.3 Low Level Alarm

Provide tank with a low level switch to sound alarm and shut down pumps should level drop to preset minimum.

2.14.9.4 Dissolving Baskets

Construct baskets of a corrosion resistant material suitable for continuous immersion in a [_____] solution.

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NOTE: The chemical feed solution to be used shall be inserted here.

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2.14.9.5 Tank Strainer

In suction line to pump.

2.14.9.6 Supporting Steelwork

Provide supporting steelwork to adequately support tank, mixer, and the number of proportioning pumps specified.

2.14.9.7 Agitator

Provide an agitator with mounting bracket to mount to storage tank. Agitator shaft and propeller shall be of stainless steel.

2.14.9.8 Proportioning Pumps

Provide [two] [three] [_____] proportioning pumps of the [simplex] [duplex] type. Each pump shall have a minimum capacity of [_____] L/s gph at a [_____] kPa (gage) psig discharge pressure. Capacity shall be adjustable from zero to 100 percent by a convenient screw adjustment of stroke length. Provide pump with integral check valves. Electric motors shall be [totally enclosed], [fan cooled], [_____] volts, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section.

2.14.9.9 Safety Relief Valve

Provide for each pump to discharge back into the tank in event of excessive line pressure.

2.14.10 Welded Blowdown Tank

Provide in accordance with the Recommended Rules for the Design and Arrangement of Boiler Blowoff Equipment supplemental to the National Board Inspection Code latest edition published by the National Board of Boiler and Pressure Vessel Inspectors, Columbus, Ohio.

a. Construction: Construct equipment and accessories in accordance with the requirements of the ASME BPVC SEC VIII for a working pressure of at least the maximum allowable working pressure of the boiler but in no case shall the plate thickness be less than 10 mm 3/8 inch. Provide corrosion allowance of [2.55 mm] [0.1 inch] [_____]. Tank dimensions shall be [_____] meters feet [_____] mm inches O.D. by [_____] meters feet [_____] mm inches long over the heads (overall). Provide tank with wear plate not less than 10 mm 3/8 inch thick and [279 by 381 mm 11 by 15 inch] [457 by 508 mm 18 by 20 inch] manhole.

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NOTE: The volume of the blowdown tank shall be calculated to be twice the volume of water removed from one boiler when the normal water level is reduced not less than 100 mm 4 inches.

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b. Tank connections: Provide the following connections:

(1) Blowdown inlet for bottom blowdown [20] [25] mm [3/4] [1] inch

(2) Tangential blowdown inlet [_____] mm inch

(3) Steam vent, flanged [_____] mm inch

(4) Discharge water outlet, flanged [_____] mm inch with internal water seal and 20 mm 3/4 inch siphon breaker

(5) Drain 50 mm 2 inch

(6) Thermometer connection 20 mm 3/4 inch

(7) Pressure gage connection 6 mm 1/4 inch

(8) Cold water inlet [_____] mm inch with temperature regulating valve and backflow preventer

(9) Two gage glass connections 15 mm 1/2 inch

c. Angle supports and coating: Provide the tank with steel angle support legs extending [_____] meter feet below the bottom of the tank. Coat the tank with one coat of manufacturer's standard high temperature primer.

2.14.10.1 Accessories

a. Gage glass: 300 mm 12 inch reflex type with shutoff valves and guard.

b. Thermometer: Bi-metal dial type with separable socket, 125 mm 5 inch dial, 10 to 149 degrees C 50 to 300 degrees F range.

c. Pressure gage: Zero to 172 kPa (gage) Zero to 25 psig range.

d. Internal baffles and pipes: As detailed.

2.14.10.2 Controls

Provide a self operating regulator to control the flow of cooling water to the tank. Regulator shall include a 20 mm 3/4 inch screwed bronze body with stainless steel trim, reverse acting actuator for cooling, capillary tubing and a union connection bulb with a stainless steel well. Control setting shall be 60 degrees C 140 degrees F with a minimum Cv of [_____].

2.14.11 Continuous Boiler Blowdown System

Provide a complete automatic continuous boiler blowdown system, in accordance with NBBI NB-27, which shall include a controller/programmer unit and flow assembly for each boiler, plus a continuous blowoff heat exchanger, flash tank and boiler water sample cooler.

2.14.11.1 Automatic Blowdown Controller

Intermittent type boiler blowdown system rated for not less than 1724 kPa (gage) 250 psig steam pressure.

a. Flow assembly: Include a 25 mm one inch ball valve with 316 stainless steel ball and stem and stainless steel electrode assembly.

b. Controller/programmer: Include a conductivity meter with zero to 6000 microhms range, valve open/closed indicators and manual/auto control switch. Cycle interval and sample duration shall both be adjustable over a wide range. Mount units at the operating floor near the boiler front.

c. Accessories and connections:

(1) Continuous blowdown connection: At each boiler, provide a gate valve and extend piping to header at flash tank.

(2) Header connections: Provide with a tee with valved sampling connection. Provide a 20 mm 3/4 inch, three globe valve bypass around each flow assembly.

(3) Common header: Provide from valved outlet connections on flow assembly units, to connection on flash tank.

2.14.11.2 Flash Tank

ASME code stamped and constructed in accordance with the ASME BPVC SEC VIII designed for [_____] kPa (gage) psig. Tank shall be [_____] mm inches in diameter by [_____] mm inches long including heads.

a. Provide tank with blowdown inlet, steam outlet, gage glass, float operated outlet valve, relief valve, and inspection openings. Tank shall have steel angle legs with plate feet for bolting to floor and legs shall be of sufficient length so that bottom of lower head of tank will be not less than 457 mm 18 inches above floor.

b. Automatic control system: Control level in the flash tank, by modulating a valve in the water outlet line.

(1) Level controller: External cage type air operated level controller, complete with 40 mm 1 1/2 inch screwed connection, 350 mm 14 inch stainless steel float and Class 125 cast iron body. Controller shall be direct acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band. Locate controller to maintain an operating level at center line of storage tank. Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

(2) Outlet water valve: [_____] air operated control valve with a capacity to pass [_____] L/s gpm at a pressure drop of [_____] kPa (gage) psig. Cv shall not be less than [_____] at 100 percent open. Valve shall be Class [_____], flanged, iron or semi-steel body with stainless steel internals. Valve shall have equal percentage flow characteristics with a full size port. Provide an air lock mounted on valve diaphragm and piped to hold valve in last position on air failure.

2.14.11.3 Sample Cooler

Water cooled shell and tube type with valves and accessories required to safely withdraw a water sample from the boiler drum. Provide drain under sampling valve terminating with a 20 mm 3/4 inch splash proof funnel, 229 mm 9 inches below outlet of valve.

2.14.11.4 Heat Exchanger

Provide an ASME code stamp continuous blowoff heat exchanger designed and constructed in accordance with the ASME BPVC SEC VIII, to transfer heat from the continuous blowoff water leaving the existing continuous blowoff flash tank to the treated makeup water entering the feedwater heater. Heat exchanger shall be a bare tube, helical coiled bundle, installed in a one piece casing with removable front plate. Bundle shall be removable. Tube diameter shall not be less than 20 mm 3/4 inch. Tubes shall be ASTM B111/B111M copper alloy, with cast iron shell. Design tube side for not less than [_____] kpa (gage) psig pressure at [_____] degrees C F. Design shell side for not less than [_____] kpa (gage) psig pressure at [_____] degrees C F.

2.15 PIPING

Piping work shall include the provision, of piping systems, including valving and specialty items, for the steam plant and related external auxiliary equipment.

a. Piping materials, design, and fabrication shall be in accordance with ASME B31.1 except as modified otherwise below or indicated otherwise.

b. Compute expansion of pipe with operating temperatures above minus 19 degrees C zero degrees F in lieu of 21 degrees C 70 degrees F specified in ASME B31.1.

c. Requirements of ASME B31.1 apply to the building steam heating and steam distribution piping designed for 103 kpa (gage) 15 psig or lower and hot water heating systems 207 kpa (gage) 30 psig or lower.

2.15.1 Materials

Suitable for the maximum pressure at the maximum temperature at which the equipment must operate.

2.15.1.1 Pipe Materials

a. Steel pipe

(1) Steam pipe, boiler feedwater pipe, relief pipe and steam tracer pipe: Black, ASTM A53/A53M or ASTM A106/A106M seamless steel pipe, Grade A or B. Wall thickness not less than Schedule 40. Steam tracer pipe, with steam up to 103 kPa (gage) 15 psig, may be ASTM B88M ASTM B88, type K copper tubing.

(2) Condensate pipe and boiler blowdown pipe: Black, welded or seamless ASTM A53/A53M or ASTM A106/A106M, steel pipe, Grade A or B. Wall thickness not less than extra strong (XS or Schedule 80).

(3) Chemical feed pipe and coal pile-runoff water sump pump discharge piping: ASTM A312/A312M austenitic stainless steel.

(4) Fuel oil pipe: ASTM A53/A53M or ASTM A106/A106M, seamless black steel pipe, Grade A or B.

(5) Treated water, hot water heating, high temperature water, drains (other than sanitary), and overflow pipe: black, welded or seamless steel up to a maximum pressure of 1724 kPa (gage) 250 psig

or ASTM A53/A53M or ASTM A106/A106M, Grade A or B.

(6) Gas pipe and compressed air pipe: Welded or seamless pipe up to a maximum pressure of 1724 kpa (gage) 250 psig or ASTM A53/A53M or ASTM A106/A106M, Grade A or B.

b. Copper tubing

(1) Instrument air pipe: ASTM B88M ASTM B88 hard copper tubing, Type K or L; except in a corrosive atmosphere or outside pipe shall be copper tubing, Type K or L, with ASTM D1047 PVC jacketing.

(2) Steam tracer pipe: Contractor may at the Contractor's option provide ASTM B88M ASTM B88, Type K, copper tubing for steam up 103 kPa (gage) 15 psig.

(3) Potable water, sanitary drains and storm drains: As specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE, unless otherwise specified. Chlorinated polyvinyl chloride (CPVC) and other plastic tubing and fittings shall not be used in the steam heating plant.

2.15.1.2 Fittings

a. Fittings for steel pipe:

(1) Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.3 malleable iron, screwed end fittings, for working pressures not greater than 2068 kpa (gage) 300 psig at temperatures not greater than 232 degrees C 450 degrees F or ASME B16.11 forged steel.

(2) Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.11 steel, socket welded end fittings.

(3) Sizes 6 to 65 mm 1/8 to 2 1/2 inches: ASME B16.9 steel, butt welding fittings.

(4) Sizes 65 to 600 mm 2 1/2 to 24 inches: ASME B16.5 forged steel, flanged fittings.

b. Welded outlets and welding saddles: Make branch connections of 45 and 90 degrees either with ASME B16.9 forged steel welded outlet fittings or welding saddles. Welding outlets and saddles shall not be smaller than two pipe sizes less than the main pipe sizes.

c. Fittings for copper tubing: ASME B16.18 cast bronze solder joint or ASME B16.22 wrought copper solder joint. For instrument air, fittings may be ASME B16.26 compression joint type.

d. Unions:

(1) Unions for steel pipe: ASME B16.11, ASME B16.39 threaded. Unions for zinc coated pipe shall be zinc coated.

(2) Unions for copper tubing: ASME B16.22. For instrument air, unions may be compression joint type.

2.15.1.3 Flanges

ASME B16.5, forged steel, welding type. Remove the raised faces on flanges when used with flanges having a flat face. Except as specified otherwise, pressure and temperature limitations shall be as specified in ASME B16.5 for the proper class and service, and the type face specified.

2.15.1.4 Valves

a. Valves for maximum working pressure of 1034 kpa (gage) 150 psig saturated steam or 1550 kPa (gage) 225 psig W.O.G. (Water, Oil, Gas) at 93 degrees C 200 degrees F (non-shock service). (For working pressures not exceeding 862 kPa (gage) 125 psig saturated steam or 1379 kpa (gage) 200 psig water at 93 degrees C 200 degrees F non shock service, Class 125 may be used in lieu of Class 150 or Class 250).

(1) Valve sizes 50 mm 2 inches and smaller:

(a) Non throttling valves: Gate valves, bronze, wedge disc, rising stem, Class 150, MSS SP-80 or ball valves, bronze, double stem seals, stainless steel ball and shaft, tight shutoff.

(b) Globe valves and angle valves: Bronze, Class 150, MSS SP-80.

(c) Check valves: Bronze, Type [IV, swing check] [III, lift check], Class 150, MSS SP-80.

(2) Valve sizes 65 mm 2 1/2 inches and larger.

(a) Gate valves: Flanged, cast iron, Class 250, MSS SP-70 or steel, Class 150, ASME B16.34. Valves shall have wedge disc, outside screw and yoke (OS&Y), rising stem; valves 200 mm 8 inches and larger shall have globe valved bypass.

(b) Globe valves and angle valves: Flanged, cast iron, Class 250, MSS SP-85 or steel, Class 150, ASME B16.34.

(c) Check valves: Flanged, cast iron, Class 250 or steel, Class 150, Type [_____], [lift] [swing] check, style [_____], MIL-DTL-18436.

b. Valves for maximum working pressure of 1724 kPa (gage) 250 psig steam at a maximum temperature of 232 degrees C 450 degrees F or 3447 kPa (gage) 500 psig W.O.G. at 93 degrees C 200 degrees F (non-shock).

(1) Valve sizes 65 mm 2 1/2 inches and larger.

(a) Gate valves: Flanged or butt welded, cast iron, Class 250, MSS SP-70 (maximum size 300 mm 12 inches) or steel, Class 300, ASME B16.34. Valves shall have wedge disc, OS&Y, rising stem; each valve 200 mm 8 inches and larger shall have globe valved bypass.

(b) Globe valves and angle valves: Flanged or butt welded, cast iron, Class 250, MSS SP-85 or steel, Class 300, ASME B16.34.

(c) Check valves: Flanged or butt welded, iron body, Class 250 or steel, Class 300, Type [_____] [lift] [swing] check, style [_____], MIL-DTL-18436.

c. Valves for maximum working pressure of 2068 kPa (gage) 300 psig steam at a maximum temperature of 454 degrees C 850 degrees F or a maximum W.O.G. pressure of 4653 kPa (gage) 675 psig at 149 degrees C 300 degrees F (non shock).

(1) Valve sizes 65 mm 2 1/2 inches and larger:

(a) Gate valves, Globe Valves, and Angle Valves: Flanged or butt welded, ASME B16.34, steel, Class 300, rising stem, OS&Y. Gate valves 200 mm 8 inches and larger shall have globe valved bypass.

(b) Check valves: Flanged or butt welded, steel, Class 300, Type [_____], [lift] [swing] check, style [_____], MIL-DTL-18436.

d. Ball valves: ASME B16.5 and API Std 607 double stem seal type for bubble tight shutoff. Seats and seals shall be TFE material. Ball and shaft shall be stainless steel. Provide mechanical stops to prevent cycling valve in wrong direction and self-aligning stem seal.

e. Valve accessories: ASME B16.34 valve operating mechanisms including chain wheels, gear operators, floor stands, electric motors, air motors and cylinder-type actuating devices. Provide the accessories as follows and as indicated.

(1) Provide power operators with remote position indicators on the following valves: soot blowers, [_____], [_____].

(2) Provide floor stands and valve extensions on platforms and floors for the following valves: deaerator drain valves, [_____].

(3) Provide motorized actuators or chain wheels with chain and guides on valves with handwheel centerline higher than 2 meters 7 feet above the floor or platform except where specified otherwise. Chains shall extend from the valve to within one meter 3 feet above the floor. Provide impact chain wheels on steam headers and other locations where the valve has a tendency to stick. When a valve is motorized, provide hand operation for emergency.

(4) Provide gear operators on ball valves larger than 80 mm 3 inches and on gate valves 200 mm 8 inches and larger.

f. Steam pressure regulating valves: CID A-A-50558, minimum of Class [125] [150] [250] [300], except as specified otherwise. [Cast iron], [cast steel] valve body with valve seats and disc of replaceable heat treated stainless steel. Valves shall be single seated, shall seat tight under dead end conditions, and shall go to the closed position in the event of pressure failure of the operating medium. Valves shall be spring loaded diaphragm operated type, except valves exposed to ambient temperature of less than 2 degrees C 35 degrees F or exposed to the weather shall be piston operated type. Capacity of valves shall be not less than that indicated. Pilot valves shall have strainer at inlet from external feeder piping.

(1) Spring loaded diaphragm operated valves: Fabricate main spring of stainless steel, and it shall not be in the path of steam flow through the valve. Control valves by pilot valve through external

feeder piping.

(2) Piston operated valves: Control valves by integral pilot valve through external feeder piping.

g. Safety relief valves: MIL-DTL-18436, Style D or E, with Class [150] [300] inlet flange, with test lever, designed for the intended service.

2.15.1.5 Bolts and Nuts

a. Bolts: ASTM A193/A193M, Grade B8. Lengths of bolts shall be such that not less than two full threads will extend beyond the nut with bolts tightened to required tensions and washers seated.

b. Nuts: ASTM A194/A194M, Grade 8.

2.15.1.6 Gaskets

ASME B31.1 and as specified below, except provide spiral wound metal covered non-asbestos gaskets in lieu of compressed sheet non-asbestos. Gaskets shall be as thin as the finish of surfaces will permit. Do not use paper, vegetable fiber, rubber, or rubber inserted gaskets for temperatures greater than 121 degrees C 250 degrees F. Provide metal or metal jacketed non-asbestos gaskets with small male and female and small tongue-and-groove flanges and flanged fittings; they may be used with steel flanges with lapped, large male and female, large tongue-and-groove, and raised facings. Provide full face gaskets with flat-faced flanges. Raised face cast iron flanges, lapped steel flanges, and raised faced steel flanges shall have ring gaskets with an outside diameter extending to the inside of the bolt holes. Widths of gaskets for small male and female and for tongue-and-groove joints shall be equal to the widths of the male face and tongue. Gaskets shall have an inside diameter equal to or larger than the port opening. Dimensions for nonmetallic gaskets shall be in accordance with ASME B16.21. Materials for flanged gaskets shall be as listed below for service specified:

a. Steam, boiler blowdown, exhaust steam: Spiral wound metal composition or copper

b. Boiler feed water: Metal jacketed non-asbestos, copper or monel

c. Hot water, above 38 degrees C 100 degrees F: Spiral wound metal non-asbestos

d. Cold water: Red rubber or neoprene rubber

e. Heavy fuel oil (No. 6): Spiral wound metal non-asbestos, soft steel, or monel

f. Diesel fuel (No. 2): ASME B16.21 metallic

g. Compressed air: Spiral wound metal non-asbestos

2.15.1.7 Expansion Joints

a. Slip tube expansion joints: MIL-E-17814, Type IV, single or double slip tube as indicated, designed for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Expansion joints shall be of the type which permits the injection of semi plastic type packing while the joint is in service under full line pressure. Slip tube shall be of chromium plated, wrought steel construction, guided by internal and external guides integral with joint body. Fit slip tube ends with forged steel pipe flanges or bevel for welding into pipe line where indicated. Deliver joints complete with packing and ready for installation.

b. Flexible ball expansion joint: Capable of 360 degrees rotation plus 15 degrees angular flex movement and shall be installed in strict accordance with recommendations of the manufacturer. Ball joints shall have steel bodies and polished steel balls. Provide end connections to suit class of piping herein before specified. Seals shall be of pressure molded composition designed for the working pressure. Design joints for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Cold set joints as necessary to compensate for temperature at time of installation. Do not use ball joints on superheated steam or on joints subject to frequent flexure.

c. Bellows expansion joints: MIL-DTL-17813 flexible guided type with stainless steel expansion element, internal sleeves and external covers. Joints shall be designed for a working pressure of [_____] kPa (gage) psig and a temperature of [_____] degrees C F.

2.15.1.8 Pipe Hangers and Supports

MSS SP-58, Type [_____] or Type [_____] of the adjustable type, except as specified or indicated otherwise. Suspended steam and condensate piping shall have pipe hangers Type [_____] with insulation protection saddles Type [_____]. Provide insulated piping, except steam and condensate piping, with insulation protection shields Type 40. Provide bronze or copper plated collars on uninsulated copper piping. Support rods shall be steel. Rods, hangers and supports shall be zinc plated, except for uninsulated copper piping which shall be copper plated; cast iron rollers, bases and saddles may be painted with two coats of heat resisting aluminum paint in lieu of zinc plating. Axles for cast iron rollers shall be stainless steel. Size hanger rods with a 150 percent safety factor for a seismic design.

2.15.1.9 Instrumentation

a. Pressure and vacuum gages: Conform to applicable requirements of ASME B40.100.

b. Indicating thermometers: MIL-T-19646 dial type. Thermometer shall include a separable immersion well.

2.15.1.10 Miscellaneous Pipeline Components

a. Cold and hot water meters: CID A-A-59224 for maximum flow of [_____] L/s at 38 degrees C gpm at 100 degrees F and reduced flow of up to [_____] L/s at 121 degrees C gpm at 250 degrees F.

b. Air traps: Float controlled valves arranged to close properly when water enters the traps. Air traps shall conform to requirements for float operated steam traps (non-thermostatic), CID A-A-60001, except that the valve mechanism shall be inverted so as to be closed, not opened, by rising water.

c. Steam traps: CID A-A-60001. Inverted bucket high pressure steam traps designed for use at [_____] kPa (gage) psig at [_____] degrees C F. Low pressure steam traps shall be float and thermostatic type for pressures up to 103 kPa (gage) 15 psig. Provide traps with separate strainers unless specified otherwise.

d. Strainers: FS WW-S-2739 for Class [125] [250] with blow off outlet. Construct strainers for Class 300 of cast carbon steel in accordance with ASME B16.5 for minimum of 2068 kPa (gage) 300 psig saturated steam pressure. Provide blow off outlet with pipe nipple and gate valve.

e. Steam exhaust heads: CID A-A-50494 for atmospheric discharge of exhaust steam.

2.15.1.11 Backflow Preventers

Reduced pressure principle type conforming to the applicable requirements of [AWWA C510 and AWWA C511.] [Section 22 00 00 PLUMBING, GENERAL PURPOSE.]

2.15.1.12 Insulation

Materials and application shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15.1.13 Pipe Sleeves

a. Floor Slabs, Roof Slabs, and Outside Walls Above and Below Grade: Galvanized steel pipe having an inside diameter at least 15 mm 1/2 inch larger than the o.d. diameter of the pipe passing through it. Provide sufficient sleeve length to extend completely through floors, roofs, and walls, so that sleeve ends are flush with finished surfaces except that ends of sleeves for floor slabs shall extend 13 mm 1/2 inch above finished floor surface. Sleeves located in waterproofed construction shall include flange and clamping ring.

b. Partitions: Galvanized sheet steel, 26 gage or heavier, of sufficient length to completely extend through partition thickness with sleeve ends flush with partition finished surface.

2.15.1.14 Piping Identification

Piping Identification shall conform to MIL-STD-101 and shall be placed in clearly visible locations; except that piping in the boiler room shall be painted the primary color of the color code. Labels and tapes conforming to ASME A13.1 shall be used in lieu of band painting or stenciling. Labels shall be outdoor grade acrylic plastic. Markings on labels shall indicate the direction of flow, flowing media, and media design pressure and temperature. Spacing of identification marking shall not exceed 3 meters 10 feet. Provide two copies of the complete color and stencil codes used. Frame codes under glass and install where directed.

2.16 FIRE PROTECTION SYSTEM

Provide the fuel oil room with a wet sprinkler system as specified in Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION.

2.17 MARKING

Identify equipment, valves, switches, motor controllers, and controls or indicating elements, by printed, stamped or manufactured identification plates or tags of rigid plastic or non-ferrous material. Lettering for identification plates or tags shall be not less than 5 mm 3/16 inch high. Nomenclature and identification symbols used on the identification plates or tags shall correspond to those used in the maintenance manuals, operating instructions, and schematic diagrams. Identification plates or tags shall be rigidly affixed to the equipment or devices without impairing functions or, when this is not possible, shall be attached using a non-ferrous wire or chain. In addition to the identification plate or tag, each major component of equipment shall have a nameplate listing the manufacturer's name, model number, and when applicable, electrical rating and other information required by pertinent standards or codes.

2.18 TOOLS AND TESTING EQUIPMENT

Provide special tools and wrenches required for the installation, maintenance, and operation of the equipment. Testing equipment to be provided shall include necessary equipment to perform routine tests:

a. On lubricating oil for acidity (pH-potentiometer), viscosity (saybolt test), and dirt (gravimetric).

b. On softened water for hardness (soap test or colorimetric test), and boiler blowdown water for pH (colorimetric) and conductivity (potentiometer).

c. For water (distillation) and sediment (gravimetric) in fuel oil.

2.19 WELDING MATERIALS

Welding materials shall comply with Section 2, ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

2.20 MOTORS AND DRIVES

A.C. electric motors shall meet the requirements of NEMA MG 1. Motors shall be designed for continuous operation at rated load under usual service conditions as defined by NEMA. Unless specifically noted otherwise, motors less than 3/8 kW 1/2 hp shall be 115 volt, 60 Hz, single phase, capacitor-start, or permanent split capacitor, with Class B insulation for 40 degrees C 104 degrees F ambient. Unless specifically noted otherwise, motors 3/8 kW 1/2 hp and larger shall be 460 volt, 60 Hz, three phase, Design B, squirrel cage induction with a minimum insulation of Class F for 40 degrees C 104 degrees F ambient. Size motors to meet power requirements of the driven unit at design conditions, including drive and coupling losses which are incurred, without loading the motor beyond its nameplate horsepower rating. Minimum service factor for open drip-proof motors shall be 1.15 and for totally enclosed, fan cooled motors 1.0. Motor shall be quiet operating. Bearings shall be heavy duty, grease lubricated, anti-friction, single shielded, regreasable type and shall have approved lubricating fittings extended to an easily accessible location for field servicing. Provide sole plates for motors installed on concrete pads. Motors shall have copper windings.

2.21 SOURCE QUALITY CONTROL

2.21.1 Instrument Air Compressors

Factory test air compressor package at full load for not less than 2 hours. Check capacity, smoothness of operation, alternation of units, and proper operation of the air unloaders during the test.

2.21.2 Variable Speed Motor Controller Factory Test

Burn-in tests shall be conducted for at least 50 hours at rated conditions. Replace each component that fails during the burn-in test, and the test shall be run on the entire assembly for the complete 50 hours. Burn-in test shall not be complete until the entire assembly has operated for 50 hours without failure.

PART 3 EXECUTION

3.1 INSTALLATION

Install materials and equipment as indicated and in accordance with manufacturer's recommendations.

3.1.1 Boiler

3.1.1.1 Installing Tubes In Headers

Tubes may be rolled into the headers provided the holes used for rolling will not be blocked for access in the future by any item of equipment or piping, provided under this contract. Otherwise, weld tubes into the headers by use of stubs or socket welds. Stub end tubes may be welded into headers in shop and tubes welded to same in field.

3.1.1.2 Installing Tubes In Drums

Before installing tubes, polish tube ends and tube seats in the drums to bright metal using a No. 60 grit cloth grinding band driven on a pneumatic or electric polishing motor. Do not polish these tubes until ready for immediate installation. Install the tubes and hold in place with proper width, hard maple wood spacers and by lapping the tubes in the tube sheet. Lap tubes only enough to hold them in place for rolling. Check tube stock on each end of the tube before rolling. Furnish 10 mm 3/8 inch stock on each tube end with no deviation. When, after the tubes are rolled in place, there remains more than 10 mm 3/8 inch stock due to extra length of tube, excess shall be milled off to 10 mm 3/8 inch using a milling wheel driven by a pneumatic or electric motor. At no time shall there be less than 10 mm 3/8 inch stock between end of tube and nearest surface of header. Tubes shall then be rolled with a bell roll of the proper size and tension. Tubes shall not be rolled to excess. Drive bell roll by a pneumatic or electric motor using a proper size mandrel pin. At no time will a manual operation of tube rolling be permitted. Lubricant for the expanding operation shall be a water soluble compound.

3.1.1.3 Inspecting Tubes

After tubes are rolled in place, provide, under manufacturer's supervision, one person in steam drum and one in mud drum. The person in the steam drum shall drop a ping pong ball through every tube to be sure that no foreign matter or misalignment obstructs the tube. After boiler tubes have been tested, follow the same procedure on the water wall tubes. Remove each tube that is not in alignment after being installed and install a new tube in its place.

3.1.1.4 Installing Firebrick

Lay up in air-setting mortar. Dip each brick in mortar, rub, shove into its final place, and then tap with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel will not be permitted. Maximum mortar joint thickness shall not exceed 3 mm 1/8 inch and average joint thickness shall not exceed 1.60 mm 1/16 inch.

3.1.1.5 Installing Plastic Refractory

Install in accordance with the manufacturer's recommendations and by workmen skilled in its application.

3.1.1.6 Installing Casing Insulation

Before application of the insulations, clean exterior surfaces of the boiler not covered by brick work by commercial blast and finish with one coat of FS TT-P-28 aluminum heat-resisting paint. Apply paint directly to cleaned metal surfaces to a minimum dry film thickness of 0.0254 mm one mil.

3.1.2 Equipment Installation

Install equipment in strict accordance with this specification, and with manufacturer's installation instructions. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place strain on equipment. Flanged joints shall not be bolted to final torque settings until the flanges are aligned, gasketed and mated properly. Expansion bends shall be adequately extended before installation. Grade, anchor, guide and support piping, without low pockets.

3.1.2.1 Equipment Foundations

Provide foundations of sufficient size and weight, and proper design to preclude shifting of equipment under operating conditions, or under abnormal conditions which could be imposed upon the equipment. Equipment vibration shall be limited within acceptable limits, and shall be isolated. Foundations shall be adequate for soil conditions of the site and shall meet requirements of the equipment manufacturer. Trowel exposed foundation surfaces smooth except surfaces which are to receive grout, which shall be properly roughened.

3.1.2.2 Induced Draft Fan

Provide each driver and reduction gear with a 38 mm 1 1/2 inch thick steel base plate. Shim base plate level, using steel shim stock which is at least as large as the equipment foot and is slotted for installation around studs or bolts. Anchor and grout into place prior to setting driver. An approved millwright shall align and shim the drive unit. Millwright shall drill and ream foot and base plate and install taper pins with nut on top for pullout removal. One front foot and diagonally opposite rear foot shall be pinned to base plate. Bolt equipment in place in a manner approved by the manufacturer. Level and grout fan and bearing pedestal sole plates in place.

3.1.2.3 Stack

Stack shall be leveled and plumb during installation. Erected stack shall be no more than 25 mm one inch out of plumb per 15 meters 50 feet in height. Remove roughness, marks, and lifting lugs from stack. Grind surfaces smooth and flush with surrounding surfaces.

3.1.2.4 Fuel Oil Tanks

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NOTE: At the text below, choose one of the following fuel oil tanks found below.

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[a. Horizontal Fuel Oil Tanks (Below Ground). Provide concrete ballast slabs for tanks and concrete protective ground level slabs for FRP tanks. Ballast slabs shall be full length and width of tanks and protective slabs shall extend 610 mm 2 feet beyond the tanks. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

(1) Install backfill fiberglass reinforced tanks as recommended by the manufacturer; backfill adjacent to the tanks shall be pea gravel unless otherwise recommended by the manufacturer. Backfill for steel tanks shall be sand.

(2) Set steel tanks on a bed of sand not less than 152 mm 6 inches deep over the concrete slab and strap in place with stainless steel hold-down straps with stainless steel turnbuckles. Set FRP tanks on a bed of pea gravel not less than 305 mm 12 inches thick and pre-shape for the tank contours for FRP tanks. Fabricate straps for FRP tanks from FRP resins reinforced with stainless steel to prevent breaking of straps and floating of empty tanks.

(3) Slope tank toward sump not less than 25 mm in each 1.50 meters one inch in each 5 feet.

][b. Horizontal Fuel Oil Tanks (Above Ground). Continuously support steel tank saddles along the full length of the base and level and grout to ensure full bearing.

][c. Vertical Fuel Oil Tank. Provide [sand, crushed stone or fine gravel cushion] [concrete base].

]

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NOTE: Choose for a base material either sand/ crushed stone/fine gravel or a concrete base.

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(1) Sand, Crushed Stone or Fine Gravel Cushion: Area beneath tank shall be covered with a fuel resistant plastic membrane with a thickness of not less than 0.50 mm 20 mils. Carefully fuse or cement plastic membrane seams. Lay plastic over a thoroughly compacted select subgrade free from rocks that could puncture the plastic. Over the plastic provide a bed of sand, crushed stone or fine gravel not less than 152 mm 6 inches thick. Stabilize the bed with an approved material and shape to the tank bottom. Slope bed down to the center sump approximately 152 mm 6 inches for each 3 meters 10 feet of tank radius. When in place, tank shell shall be plumb.

(2) Concrete base shall be as indicated and in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

(3) Mastic Seal: Place the mastic seal between the tank and the concrete ring to the cross section indicated. Compact the mastic thoroughly. Immediately before placing the mastic, coat the tank surfaces to be in contact with the concrete ring with a coat of MIL-C-18480 bituminous material.

3.1.3 Piping

Unless specified otherwise, erection, welding, brazing, testing and inspection of piping shall be in accordance with ASME B31.1 and Section 40 17 26.00 20 WELDING PRESSURE PIPING. Piping shall follow the general arrangement shown. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing, except where cold-springing is specified. Piping and equipment within buildings shall be entirely out of the way of lighting fixtures and doors, windows, and other openings. Locate overhead piping in buildings in the most inconspicuous positions. Do not bury or conceal piping until piping has been inspected, tested, and approved. Where pipe passes through building structure, pipe joints shall not be concealed, but shall be located where they may be readily inspected and building structure shall not be weakened. Avoid interference with other piping, conduit, or equipment. Except where specifically shown otherwise, vertical piping shall run plumb and straight and parallel to walls. Piping connected to equipment shall be installed to provide flexibility for vibration. Support and anchor piping so that weight of the piping is not putting equipment under a load.

3.1.3.1 Fittings

Provide long radius elbows on welded piping to reduce pressure drops due to bends in the piping runs. Do not miter pipe to form elbows or notch straight runs to form full sized tees, or similar construction. Make branch connections with welding tees or factory made forged welding branch outlets and nozzles having integral reinforcements conforming to ASME B31.1.

3.1.3.2 Grading of Pipe Lines

Unless indicated otherwise, install horizontal lines of steam and return piping to grade down in the direction of flow with a pitch of not less than 25 mm in 9 meters one inch in 30 feet, except in loop mains and main headers where flow may be either direction. Pitch air lines to the source of supply, and make provisions for draining off condensate. Install water lines to drain to a shutoff valve.

3.1.3.3 Anchoring, Guiding, and Supporting Piping

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NOTE: Pipe hangers and supports shall be spaced and designed to support steam piping filled with water for hydrostatic tests.

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Anchor and support piping in a manner such that expansion and contraction will take place in the direction desired, prevent vibration by use of vibration dampeners, and prevent undue strains on boilers and equipment served. Fabricate hangers used for the support of piping of 50 mm 2 inch nominal pipe size and larger to permit adequate adjustment after erection while still supporting the load. Provide wall brackets where pipes are adjacent to walls or other vertical surfaces which may be used for supports. Provide supports to carry the weight of the lines and maintain proper alignment. Provide inserts and sleeves for the supports in concrete where necessary and place in new construction before pouring concrete. Provide insulated piping with a pipe covering protection saddle at each support. Provide pipe guides and anchors of approved type at points where necessary to keep pipes in accurate alignment, to direct expansion movement, and to prevent buckling and swaying and undue strain. Provide pipe guides for alignment of pipe connecting the free unanchored ends of each expansion joint. Support pipe rollers in concrete conduits and trenches by extra strong steel pipe with ends inserted in slots provided in concrete walls. Set pipe supports for rollers at correct elevations either by metal shims or by cutting away of concrete and after placing pipe lines in alignment, grout ends of pipe supports and fix in place. Space pipe supports to provide adequate support for pipes. Pipe shall not have pockets formed in the span due to sagging of the pipe between supports, caused by the weight of the pipe, medium in the pipe, insulation, valves, and fittings. Maximum spacing for pipe supports for steel pipe shall be in accordance with ASME B31.1; maximum spacing for supports for copper tubing shall be in accordance with NAPHCC NSPC.

3.1.3.4 Copper Tubing

Copper tubing shall have solder joints with solder suitable for the pressure-temperature ratings of the piping system. Tubing 20 mm 3/4 inch and smaller for instrument air may be compression joint in lieu of soldered joint. Tin-antimony (95/5) solder is suitable for saturated steam up to 103 kPa (gage) 15 psig but tin lead (50/50) solder is not acceptable for steam service. Flux shall be non corrosive. Wipe excess solder from the joints.

3.1.3.5 Sleeves

Provide pipe sleeves where pipes and tubing pass through masonry and concrete walls, floors, and partitions. Space between pipe, tubing, or insulation and the sleeve shall be not less than 6 mm 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, and slabs. Sleeves in floor slabs shall extend 13 mm 1/2 inch above the finished floor. Firmly pack space between pipe or tubing and the sleeve with oakum and caulk on both ends of the sleeve with elastic cement.

3.1.3.6 Flashing for Buildings

Where pipes pass through building roofs and outside walls, provide proper flashing and counter flashing and make tight and waterproof.

3.1.3.7 Outlets for Future Connections

Locate as directed capped or plugged outlets for connections to future equipment, when not located exactly by the project drawings.

3.1.3.8 Screwed Joints in Piping

Provide teflon tape or suitable pipe joint compound applied to male threads only for making up screwed joints. Piping shall be free from fins and burrs. Ream or file out pipe ends to size of bore, and remove chips.

3.1.3.9 Welded Joints

Weld joints in piping by the metal-arc or gas welding processes in accordance with ASME B31.1 and as specified in Section 40 17 26.00 20 WELDING PRESSURE PIPING. Number or mark each weld to identify the work done by each welder on welds on which stress relieving or radiographic inspection is required.

a. Contracting Officer reserves the right to require the Contractor to provide re-examination and re-certification of welders.

b. Radiographic testing of circumferential butt welded joints of pipe with operating temperature of 177 degrees C 350 degrees F and above shall be required on ten percent of the joints, the location of which will be determined by the Contracting Officer; when more than ten percent of the radiographically tested joints show unacceptable defects radiographically test joints of this type piping.

c. Equipment and Protection: Items of equipment for welding shall be so designed and manufactured, and shall be in such condition as to enable qualified operators to follow procedures and to attain the results specified. Protect welders and gas cutters from the light of the arc and flame by approved goggles, shields, helmets, and gloves. Replace cover glasses in helmets and shields when they become sufficiently marred to impair the operator's vision. Take care to avoid risk of explosion and fire when welding and gas cutting near explosive or flammable materials. Ventilate welding and gas cutting operations in accordance with paragraph 29 CFR 1910-SUBPART Q (f) of Title 29 of the Code of Federal Regulations).

d. Surface Conditions: Do not weld when atmospheric temperature is less than minus 18 degrees C zero degrees F, when surfaces are wet, when rain or snow is falling or moisture is condensing on surfaces to be welded, nor during periods of high wind, unless welder and work are protected properly. At temperatures between zero and minus 18 degrees C 32 and zero degrees F heat with a torch the surface for an area within 80 mm 3 inches of the joint to be welded to a temperature warm to the hand before welding. Free surfaces to be welded from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces shall be smooth, uniform and free from fins, tears, and other defects which might affect proper welding. Remove slag from flame-cut edges to be welded by grinding, but temper color need not be removed. Thoroughly clean each layer of weld metal by wire brushing prior to inspection or deposition of additional weld metal.

3.1.3.10 Cleaning of Piping

Before installing pipe, thoroughly clean it of sand, mill scale and other foreign material. After erection but before final connections are made to apparatus thoroughly clean interior of piping. Flush with water piping except air and fuel lines, in addition, blow out steam lines with intermittent high pressure steam blows to promote shedding of internal scale; blow compressed air and fuel oil lines clean with 552 to 690 kPa (gage) 80 to 100 psig air dried to a 2 degrees C 35 degree F dew point at 552 kPa (gage) 80 psig. Sterilize potable water piping by means of liquid chlorine or hypochlorite in accordance with AWWA C651 before placing water system in service. Take care during fabrication and installation, to keep piping, valves, fittings and specialties free of loose welding metal chips of metal or slag, welding rods and other foreign matter. Blowing or flushing shall in no case be channeled through equipment, pump, control valve, regulating valve, instrument gage or specialty in the system. Provide temporary screens, strainers, connections, spool pieces and bypasses consisting of piping or hoses, pumps and other required equipment temporarily installed for the purpose of cleaning and flushing piping. Drain flushing water and test water to the sanitary sewer system.

3.1.3.11 Reduction in Pipe Size

Provide reducing fittings for changes in pipe size; the use of bushings will not be permitted. In horizontal steam lines, reducing fittings shall be the eccentric type to maintain the bottom of the lines in the same plane. In horizontal water mains, reducers shall be set to maintain top of lines in the same plane.

3.1.3.12 Expansion Control

Provide bends, loops, and offsets wherever practical to relieve overstressed piping systems due to thermal expansion and to provide adequate flexibility. Cold spring piping system as indicated but not more than an amount greater than 50 percent of the total linear expansion.

3.1.3.13 Connection to Equipment

Provide unions or flanges where necessary to permit easy disconnection of piping and apparatus. Provide unions and gate valves at each connection to threaded end control valves, strainers and equipment.

3.1.3.14 Valve Installation

Install valves in positions accessible for operation and repair. Install stems in a vertical position with handwheels or operators on top or in a horizontal position. Do not install handwheels on stop valves below the valve. When the centerline of any valve is more than 2 meters 7 feet above the floor or platform, provide the valve with a chain-operated handwheel. When the valve is motorized, provide hand operation for emergency use.

a. Gate Valves: Arrange back outlet gate valves for turbine exhaust for hand operation and provide with a floor stand.

b. Globe Valves: Pressure shall be below the disc. Install globe valves with stems horizontal on steam and exhaust lines, when better drainage is required or desired.

c. Steam Pressure-Reducing Valves: Provide the steam line entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two shutoff valves and with a globe or angle bypass valve and bypass pipe. A bypass around a reducing valve shall be of reduced size to restrict its capacity to approximately that of the reducing valve. Provide each pressure-reducing valve unit with indicating steam gages to show the reduced pressure and the upstream pressure and an adequately sized safety valve on the low pressure side.

d. Valve Tags and Charts: Permanently tag each valve with a black and white engraved laminated plastic tag showing valve number, valve function and piping system and whether another valve must be opened or closed in conjunction with this valve. Provide a typed chart which will show the required valve tagging plus the location of each valve; frame valve charts under glass and install as directed.

3.1.3.15 Traps and Connections

Traps shall be of the type and capacity for the service required, and shall be properly supported and connected. Except for thermostatic traps in pipe coils, radiators, and convectors, install traps with a dirt pocket and strainer between it and the piping or apparatus it drains. Whenever it is necessary to maintain in continuous service apparatus or piping which is to be drained, provide a three valve bypass so that the trap may be removed and repaired and condensate drained through the throttled bypass valve. Provide a check valve on the discharge side of the trap whenever the trap is installed for lift or operating against a back pressure, or it discharges into a common return line. Provide test connections on the discharge side of the high and medium pressure traps when they are specifically required. Test connection shall include a 15 mm 1/2 inch globe valve with open blow.

3.1.3.16 Pressure Gage Installation

Pressure gages shall have a shutoff valve or petcock installed between the gage and the line, and gage on steam lines shall have a siphon installed ahead of the gage.

3.1.3.17 Thermometer and Sensing Element Installation

Provide thermometers and thermal sensing elements of control valves, with a separable socket. Install separable sockets in pipe lines in such a manner to sense flowing fluid temperature and minimize obstruction to flow.

3.1.3.18 Strainer Locations

Provide strainers with meshes suitable for the services upstream of each control valve and where dirt might interfere with proper operation of valve parts, orifices, or moving parts of equipment.

3.1.3.19 Dissimilar Piping Materials

Provide dielectric unions or flanges between ferrous and nonferrous piping, equipment, and fittings, except that bronze valves and fittings may be provided without dielectric couplings for ferrous-to-ferrous or nonferrous-to-nonferrous connections. Dielectric fittings shall utilize a nonmetallic filler which will prevent current flow from exceeding one percent of the short circuit current. Spacer shall be suitable for the pressure and temperature of the service. Fittings shall otherwise be as specified in this section.

3.1.3.20 Surface Treating, and Pipe Wrapping

Uninsulated steel piping buried in the ground shall have exterior surfaces protected with a tape wrapping system or a continuously extruded polyethylene coating system as specified in Section 09 97 13.28 PROTECTION OF BURIED STEEL PIPING AND STEEL BULKHEAD TIE RODS.

3.1.4 Painting

Unless specified otherwise, pipe hangers, structural supports, pipe and pipe fittings, conduit and conduit fittings, air grilles, pipe coverings, insulation, and metal surfaces associated with mechanical and electrical equipment including zinc-coated steel ducts shall be painted utilizing the painting systems as specified in Section 09 90 00 PAINTS AND COATINGS. Zinc-coated steel duct in unpainted areas shall not be painted. Piping to be insulated, except zinc-coated and copper pipe, shall be given a protective coating prior to installing the insulation.

3.1.4.1 Piping, Fittings, and Mechanical and Electrical Equipment

Equipment shall be factory finished to withstand the intended end use environment in accordance with the specifications for particular end item. Factory finished equipment on which the finish has been damaged shall have damaged areas retouched and then be given a complete finish coat to restore the finish to its original condition. Finish coat shall be suitable for exposure in the intended end use environment.

3.1.4.2 Boilers

After erecting and testing boilers, clean as necessary exposed surfaces of boiler normally painted in commercial practice to remove grease, coal dust, flyash and other foreign matter and finish with one coat of aluminum heat resisting paint applied to minimum dry film thickness of 0.025 mm one mil.

3.1.4.3 Vertical Fuel Oil Tank

Clean interior surfaces to bare metal in accordance with SSPC SP 10/NACE No. 2. Clean to bare metal by powered wire brushing or other mechanical means surfaces that cannot be cleaned satisfactorily by blasting. Wash members which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Remove weld backing plates prior to blast cleaning; when left in place, round off corners prior to blast cleaning and coating. Internally coat tanks in accordance with Section 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS.

3.1.4.4 Surfaces Not to be Painted

Unless specified otherwise, do not paint equipment having factory applied permanent finish, switchplates and nameplates, motor starters, and concrete foundations.

3.1.5 Insulation

Insulate mechanical equipment, systems and piping as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2 FIELD QUALITY CONTROL

Furnish labor, equipment, test apparatus required and materials for preparation and performance of tests and inspections specified to demonstrate that the steam heating plant as installed, are in compliance with contract requirements. During start-up and during tests, ensure the presence of factory trained engineers or technicians employed by the boiler manufacturer and system suppliers of such components as the boiler, stoker, burner, combustion controls, ash handling system, air pollution control system, feedwater treatment equipment, and other auxiliary equipment, to ensure proper functioning, adjustment, and testing of the individual components and systems. Furnish a detailed written record of test conditions, test procedures, field data, and the start-up and operational performance of the entire heating plant to the Contracting Officer before the Contractor's operational and test personnel leave the site. The Government will furnish, when available, water, electricity and fuel for the tests, except fuel required for retesting. The Contractor shall rectify defects disclosed by the tests and retest the equipment. The Contractor's boiler plant personnel shall be experienced in starting up and operating boiler plants.

3.2.1 Tests and Inspections (Piping)

Examine, inspect, and test piping in accordance with ASME B31.1 except as modified below. The Contractor shall rectify defects disclosed by the tests. Necessary subsequent tests required to prove system tightness after additional work by the Contractor shall be furnished by the Contractor. Make tests under the direction of and subject to the prior approval of the Contracting Officer.

3.2.1.1 Hydrostatic and Leak Tightness Tests

a. Test piping systems attached to the boilers and included under the jurisdiction of ASME BPVC SEC I in accordance with the requirement of that Code. Piping bearing ASME Code symbol stamp will be accepted only as indicating compliance with the design and material requirements of the code.

b. Test piping which is a part of the steam generation or auxiliary systems, including piping within the boiler room and external to the boiler room, by the following methods:

   (1) Perform hydrostatic test at 150 percent of design pressure for welded and screwed steel piping systems except those for air, oil, and gas. Hold hydrostatic tests for a period of one hour with no pressure loss. Temperature of testing fluid shall not exceed 38 degrees C 100 degrees F.

   (2) Test air and oil lines in accordance with the requirements of ASME B31.1 for pneumatic tests with the exception that the test pressure must be held for one hour. Examine for leaks by a soap or other foaming agent test.

   (3) Inspection and test of gas piping shall conform to the requirements of NFPA 54.

c. For each test, install a calibrated test pressure gage in the system to observe loss in pressure.

3.2.2 Preliminary Operation

The Contractor under the direction of the respective manufacturer's representative shall perform the work of placing in operation equipment provided by the Contractor, except as specifically noted otherwise. Make adjustments to equipment that are necessary to ensure proper operation as instructed by the manufacturer of the equipment.

a. Lubricate equipment prior to operation in accordance with the manufacturer's instructions. Lubricants shall be provided by the Contractor. Contractor shall furnish lubrication gun with spare cartridges of lubricant to operating personnel.

b. Dry out motors before operation as required to develop and maintain proper and constant insulation resistance.

c. Check drive equipment couplings for proper alignment at both ambient and operating temperature conditions.

3.2.3 General Startup Requirements

Prior to initial operation of complete system, check each component as follows:

a. Inspect bearings for cleanliness and alignment and remove foreign materials found. Lubricate as necessary and in accordance with the manufacturer's recommendations. Replace bearings that run roughly or noisily.

b. Adjust direct drives for proper alignment of flexible couplings. Provide lubrication when a particular coupling so requires. Check security of couplings to driver shafts. Set drive components to ensure free rotation with no undesirable stresses present on the coupling of attached equipment.

c. Check motors for amperage comparison to nameplate value. Correct conditions that produce excessive current flow and that exist due to equipment malfunction.

d. Check speeds of each motor and driven apparatus to ensure that they are operating at the desired point.

e. Check the actual suction and discharge pressure of each pump against the desired performance curves.

f. Check pump packing glands or seals for cleanliness and adjustment before running each pump. Inspect shaft sleeves for scoring and proper placement of packing; replace when necessary. Ensure piping system is free of dirt and scale before circulating liquid through pumps.

g. Inspect both hand and automatic control valves. Clean bonnets and stems, tighten glands to ensure no leakage, but permit valve stems to operate without galling. Replace packing in valves that require same to retain maximum adjustment after system is judged complete. Replace entire packing in valves that continue to leak after adjustment. Remove and repair bonnets that leak. Coat packing gland threads and valve stems with a suitable surface preparation after cleaning.

h. Inspect and make certain that control valve seats are free from foreign material and are properly positioned for the intended service.

i. Check flanges and packing glands after the system has been placed in operation. Replace gaskets in flanges that show signs of leakage after tightening.

j. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts, apply compound and remake joint.

k. Strainers installed shall be thoroughly blown out through individual valved blow-off connection on each strainer prior to placing in operation.

l. Thoroughly blow out or dismantle and clean strainers after systems have been in operation one week. Thoroughly clean, repair, and place back in service traps or other specialties in which foreign matter has accumulated, causing malfunction or damage.

m. Adjust pipe hangers and supports for correct pitch and alignment.

n. Remove rust, scale and foreign materials from equipment and renew defaced surfaces. When equipment is marred, the Contracting Officer shall have the authority to request that new materials be provided.

o. Adjust and calibrate temperature, pressure and other automatic control systems.

p. Inspect each pressure gage and thermometer for calibration, and replace those that are defaced, broken or read incorrectly.

q. Vertical Fuel Oil Tank Calibration: After completing installation of tank, prepare a calibration table for the tank showing volume of fuel in liters gallons in tank to any height of liquid in meters and mm feet, inches, and eighths of an inch when measured by a steel tape lowered through the roof. Calibrate tank in accordance with ASTM D1220 for "critical measurement" "operating control." Correct the data obtained for use with the product to be stored.

3.2.4 Plant Equipment Tests

3.2.4.1 Plant Air Compressors

Test plant air compressors in service to determine compliance with contract requirements and warranty. During the tests, test equipment under every condition of operation. Test safety controls to demonstrate performance of their required function. Completely test system for compliance with specifications.

3.2.4.2 Coal Handling System

Test coal handling system under operating conditions and demonstrate that the work is in conformance with the specified requirements. Conduct this test in the presence of the Contracting Officer.

3.2.4.3 Fuel Oil Tanks

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NOTE: Choose one of following subparagraphs.

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[a. Horizontal Fuel Oil Tanks (Below Ground)

(1) Test tanks before placing in service, in accordance with the applicable paragraphs of the code under which they were built. A UL label, ASME Code Stamp, or API monogram on a tank shall be evidence of compliance with code requirements.

(2) Holiday Detection Test: Inspect coal tar epoxy coating system for film imperfections using a low voltage (75 volt) holiday tester. Inspect FRP coated tanks with a 10,000 volt spark test for imperfections or holidays. Repair holidays or pinholes in the coatings.

][b. Vertical Fuel Oil Tank: Inspect and test as specified in API Std 650. Use the radiographic method of inspection of butt welds as required by API Std 650; sectioning method will not be acceptable as an alternative to radiographic inspection.

]3.2.4.4 Blowdown Valves and Try Cocks

Test blowdown valves and try cocks for proper operation.

3.2.4.5 Fans, Heaters, Pumps, and Motors

Test draft fans, fuel oil heaters, fuel pumps, and electric motors to determine compliance with the referenced standards. Standard symbols and certifications from the referenced organization may be accepted at the discretion of the Contracting Officer. Closely observe the operation of fans, fuel oil heaters, fuel pumps, and electric motors for possible defects or nonconformance.

3.2.5 Boilers and Auxiliaries Tests and Inspections

The Contractor, with qualified personnel provided by the Contractor, shall make tests and inspections at the site under the direction of and subject to the approval of the Contracting Officer. Furnish direction of the Contractor's boiler plant personnel in the operation of each boiler and appurtenances through the entire testing period, from the respective manufacturer's representatives and consultants and ensure that necessary adjustments have been made. The Contractor shall notify the Contracting Officer in writing at least 7 days in advance that equipment is ready for testing. The Contractor shall furnish testing equipment, including gages, thermometers, calorimeter, Orsat apparatus, thermocouple pyrometers, fuel flow meters, water meters and other test apparatus and calibrate instruments prior to the test. Draft, fuel pressure and steam flow may be measured by permanent gages and meters installed under the contract. The Contractor is responsible for providing an analysis of the fuel being used for the tests. Control of noise levels developed by exhaust steam shall be as directed by the Contracting Officer to satisfy the environmental conditions of the surrounding area. The Contractor shall perform the following tests when feasible in the sequence as listed:

a. Strength and tightness tests

b. Standards compliance tests

c. Preliminary operational tests (steady state combustion test and variable load combustion test)

d. Tests of auxiliary equipment

e. Feedwater equipment test

f. Capacity and efficiency tests

3.2.5.1 Strength and Leak Tightness Tests

Subject boilers to the following strength and tightness tests:

a. Watersides Including Fitting and Accessories: Hydrostatically test watersides in accordance with the requirements of ASME BPVC SEC I The ASME label will be accepted as evidence of this test.

b. Boiler Casing, Air Casing, and Ducts: Test air casing and ducts exterior to the furnace pneumatically at the maximum working pressure. Use the soap bubble method to verify tightness. Test gas sides of boilers normally operated under pressure for tightness at one and one half times the predicted operating pressure in the furnace at maximum continuous output. For this test, tightly seal the boiler with a suitable means to blank off openings. Admit air to the boiler until the test pressure is reached, and then hold. When, in a 10 minute period the pressure drop does not exceed 1245 Pa 5 inches water gage, the casing shall be regarded as tight and accepted. Use air pressure and soap bubble tests or comparative carbon dioxide readings for induced draft boilers.

3.2.5.2 Boiler Inspection

The Boiler Inspector shall be present to witness the appropriate tests which need to be observed in order to certify the safety of the boiler. The inspection shall include the requirements of NAVFAC MO 324. The Boiler Inspector shall complete NAVFAC form 9-11014/40, Data Record Sheet; NAVFAC form 9-11014/41, Inspection Report; NAVFAC 9-11014/32 Inspection Certificate for each boiler after inspecting the boiler and finding it to be safe. No boiler may be fired until it has passed the inspection of the Boiler Inspector. The boiler inspection forms shall be submitted through the Contractor to the Contracting Officer. The Inspection Certificate shall be placed under framed glass, mounted on or near the boiler in a conspicuous location.

3.2.5.3 Boiler Cleaning and Startup

Dry out, boil out, and operate the firing rate of the new boiler(s) under direct responsibility and supervision of the manufacturer[, and in the presence of the boiler room operating personnel]. Provide chemicals that are required. Allow sufficient time for the boiling out process to ensure interior surfaces are clean. This time shall be at least 24 continuous hours and generally not more than 36 hours; boil out shall continue until water is clear. Boil out, cleaning and starting procedures shall be in accordance with requirements of ASME BPVC SEC VII, and FM DS 12-17.

3.2.5.4 Boiler Preliminary Operational Tests

Conduct a boiler operational test on each unit continuously for two weeks. Operate one boiler at a time to demonstrate control and operational conformance to specified requirements including ability to respond to load swings from the specified capacity to minimum turndown. Operational test shall be conducted under the supervision of a registered professional engineer or a licensed power plant operator and shall serve to prove safeties, controls, maintenance of stable combustion at low loads[, proper coal distribution and combustion, and ability to operate without furnace slagging][, proper flame lengths and patterns to avoid flame impingement on the tubes for oil firing], and proper mechanical and electrical functioning of systems. This test shall include each item mentioned in this specification as well as each item mentioned in the specification of the particular pieces of equipment. Conduct tests with factory trained combustion equipment engineers, as previously specified. Test and record steam quality rates of steam flow, flue gas temperature, percentages of carbon dioxide, carbon monoxide, oxygen and nitrogen in the flue gas and percent excess air for each boiler at tested load and graphically present test data.

3.2.6 General Operational Tests

3.2.6.1 General Controls

Operational tests, performance tests, and demonstration tests shall be conducted with boiler controls functional and on line. No bypassing, use of jumpers, or other disablement of control systems will be allowed unless specified elsewhere.

3.2.6.2 Steady State Combustion Tests

Test fuel burning and combustion control equipment with each of the specific fuels at the minimum limit of the turndown range and at increments of 50, 75 and 100 percent of full rated load. Each test run shall be at least two hours on each fuel and until stack temperatures are constant and capacity and efficiency requirements of this specification have been verified and recorded. Verify proper operation of instrumentation and gages during the tests.

3.2.6.3 Varying Load Combustion Tests

Test boilers continuously under varying load conditions to demonstrate proper operability of the combustion control, flame safeguard control, programming control and safety interlocks. Conduct these tests after adjustment of combustion controls has been completed under the steady state combustion tests. Continue variable load operational tests for a period of at least 8 hours.

a. Sequencing: Boiler shall start, operate and stop in strict accordance with the specified operating sequence.

b. Flame Safeguard: Verify operation of flame safeguard controls by simulated flame and ignition failures. Verify trial-for-pilot ignition, trial-for-main flame ignition, combustion control reaction and valve closing times by stop watch.

c. Immunity to Hot Refractory: Operate burner at high fire until combustion chamber refractory reaches maximum temperature. Main fuel valve shall then be closed manually. Combustion safeguard shall drop out immediately causing safety shutoff valves to close within the specified control reaction and valve closing times.

d. Pilot Intensity Required: Gradually reduce fuel supply to the pilot flame to the point where the combustion safeguard begins to drop out (sense "no flame") but holds in until main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame shall be capable of safely igniting the main burner. When the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, the boiler shall be rejected.

e. Boiler Limit and Fuel Safety Interlocks: Safety shutdown shall be caused by simulating interlock actuating conditions for each boiler limit and fuel safety interlock. Safety shutdowns shall occur in the specified manner.

f. Combustion Controls: Demonstrate accuracy, range and smoothness of operation of the combustion controls by varying steam demand through entire firing range required by turndown ratio specified for the burner. Control accuracy shall be as specified.

g. Safety Valves: High pressure limit switch shall be locked out or otherwise made inoperative and the boiler safety valves shall be lifted by steam. Determine the relieving capacity, popping pressure, blowdown and reseating pressure by observation and measurement in accordance with the ASME BPVC SEC I. The ASME standard symbol will be accepted only as indicating compliance with the design and material requirements of the code.

3.2.6.4 Auxiliary Equipment and Accessory Tests

Observe and test blowdown valves, stop valves, try cocks, draft fans, fuel oil heaters, pumps, electric motors, and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctions, defects, and for compliance with referenced standards.

3.2.6.5 Feedwater Equipment Tests

Perform the test of the feedwater treatment equipment in two steps. Conduct one test concurrently with the combustion tests. The Government will perform a second test during the first period of heavy loading after the plant has been accepted and put in service. Correct deficiencies revealed during the Government tests under the guarantee provisions of the contract. Both the first and second series of tests shall determine compliance with the limits for chemical concentrations of this specification. Supply equipment for taking samples and test kit for analyzing samples. Sampling equipment and test kit shall become the property of the Government when tests are completed.

3.2.6.6 Capacity and Efficiency Tests

Perform capacity and efficiency tests after operating tests have been satisfactorily completed and boiler has been operated continuously for at least 14 days with no nuisance shutdowns and without the necessity for frequent or difficult adjustments. Perform these tests on each boiler. Conduct tests using [the] [each] specified fuel. Test procedures shall be in accordance with the heat loss method [and the input-output method] of ASME PTC 4. Before performing tests, the Contracting Officer and the Contractor shall reach agreement on those items identified in ASME PTC 4 Section 3, paragraph 3.0l "Items on Which Agreement Shall be Reached." A test run shall not start until the boiler and accessories have reached an equilibrium and stabilization condition for at least one hour in duration. Duration of tests shall be sufficient to record necessary data but in no case shall each run be less than [4] [10] [24] hours.

a. Accomplish maximum output testing by means of a single 2 hour run at 110 percent load on the boiler under test. Calculate boiler efficiency, both input-output and heat loss, from the consistent readings taken during the runs. Runs shall be made at four different loads 30, 50, 70, and 100 percent of boiler rating during which both heat loss and input-output data shall be taken. Predict unmeasured losses used in conjunction with heat loss calculations and include with equipment data when submitted for approval. Subsequent tests required because of failure of the equipment to perform adequately during specified capacity and efficiency tests shall be the financial responsibility of the Contractor, including the cost of fuel.

b. Should analysis of the coal being burned during performance tests vary from that specified as the performance coal, the guarantees shall be adjusted in accordance with accepted engineering practice to determine compliance. Carbon loss shall be determined in accordance with American Boiler Manufacturers Association curves for carbon loss.

3.2.6.7 Temporary Waste Steam Connection

When necessary to obtain sufficient load for these tests, provide a temporary steam line at a point outside of building. Provide necessary pipe, fittings, supports, anchors and appurtenances including a field fabricated silencer as directed by the Contracting Officer. Remove temporary piping and silencer after tests have been satisfactorily completed.

3.2.6.8 Fire Safety for Oil-Fired Boilers

Conduct tests as necessary to determine compliance with the applicable UL Safety Standards. The presence of the applicable Underwriters' label may be accepted as evidence of compliance in this respect when equipment is manufacturer's standard commercial product.

a. Oil-Fired Boilers: Meet test requirements of UL 726.

b. Oil Burners: Meet test requirements of UL 296.

3.2.6.9 Plant Acceptance Operation

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NOTE: Include bracketed portion when project is for coal fired installation with flue gas desulfurization system.

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After satisfactory completion of tests specified, operate complete plant including each boiler [and its related flue gas cleaning equipment] and subsystems for a period of 30 continuous 24 hour operational days prior to final acceptance by the Government. Furnish labor, chemicals, test equipment and apparatus; the Government will furnish fuel, electricity and water. During this 30 day period, furnish readily available, services of qualified representatives from manufacturers of each plant component and system for the purpose of additional operational assistance, component and system adjustment and repairs. Government personnel will observe Contractor's operational procedures. The Contractor's representatives shall be prepared to answer pertinent questions from the Government about the plant operation.

3.2.6.10 NAVFACENGCOM Acceptance

Operational, piping systems, auxiliary equipment and accessory testing shall be completed prior to requesting an acceptance inspection by a Naval Facilities Engineering Systems Command (NAVFACENGCOM) Boiler Inspector. The Contracting Officer, upon receipt of 14 calendar days advance notice from the Contractor, shall request that the boiler plant by a qualified NAVFACENGCOM Boiler Inspector. Contractor shall perform final operational performance testing of all plant systems in the presence of the NAVFACENGCOM Boiler Inspector, at the inspector's discretion. The NAVFACENGCOM Boiler inspector shall receive copies, and review the results, of all pertinent operational test reports before approving acceptance of the boiler plant by the Government.

3.2.7 Manufacturer's Field Services

3.2.7.1 Erection/Installation Supervisors and Service Engineers

a. Boiler: Furnish the services of a competent supervisor who is in the direct employ of the boiler manufacturer. This supervisor shall remain on the construction site the full 8 hours per day, 5 days per week, or the same hours as the boiler erectors are on the job. This supervisor shall be responsible for the complete steam generating unit, including the steam generator, stoker, fans and related work, such as refractory, or insulation regardless of whether the stoker, fans or other related items of work are furnished by manufacturers other than the boiler manufacturer.

b. Stoker: Furnish a competent erection supervisor for the equipment furnished by the stoker manufacturer.

c. Fans: Furnish a company service engineer to advise on the erection or installation of fans and related equipment.

d. Service Engineers: Furnish services of the manufacturing companies' service engineers and the system suppliers' service engineers to advise during erection and installation of other systems and equipment such as control system, ash handling system, coal handling system, air compressors, air dryers, boiler feedwater pumps, fuel oil pumps, condensate pumps, water treatment equipment, chemical feed pumps, deaerating feedwater heater and stacks.

3.2.7.2 Boiler and System Representatives

Furnish factory trained engineers or technicians who are representatives of the boiler manufacturer and system supplier to supervise testing of the boilers and auxiliary equipment.

Furnish the services of a Boiler Inspector who is qualified and certified as such by the National Board of Boiler and Pressure Vessel Inspectors and who is presently employed full time by a firm, such as Hartford Steam Boiler Inspection and Insurance Company, which has a business of inspecting boilers.

3.2.7.3 Instruction to Government Personnel

Supervisors and service engineers shall provide instruction for the Government's operators in the operation and maintenance of the equipment furnished under this section. The minimum number of hours provided shall be as follows:

Equipment	Operation Instruction	Maintenance Instruction
Boiler and auxiliaries	40 hours	16 hours
Stoker	40 hours	16 hours
FD and ID fans	16 hours	16 hours
Coal handling system	16 hours	32 hours
Ash handling system	24 hours	8 hours
Air compressors and dryers	8 hours	16 hours
Boiler feedwater pumps	8 hours	8 hours
Miscellaneous equipment	16 hours	16 hours

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 52 33.03 20 (November 2008)**
Change 4 - 02/22

Preparing Activity: NAVFAC **Superseding**
UFGS-23 52 33.03 20 (July 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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WATER-TUBE BOILERS, OIL/GAS OR OIL

11/08, CHG 4: 02/22

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-23 52 33.03 20 (November 2008)**
Change 4 - 02/22

Preparing Activity: NAVFAC | **Superseding**
UFGS-23 52 33.03 20 (July 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 23 52 33.03 20

WATER-TUBE BOILERS, OIL/GAS OR OIL

11/08, CHG 4: 02/22

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NOTE: This guide specification covers the requirements for steam heating plants from 2 1/2 to 47 1/4 kg/sec 20,000 to 375,000 lbs/hr of steam capacity using packaged watertube boilers which burn either oil or gas or both fuels combined.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: This specification is intended to be used in the procurement and installation of heating plant equipment. Requirements for materials and procedures for special or unusual design shall be added to and modifications made to this specification as necessary to fit specific projects. This guide specification shall be used in conjunction with the following NAVFAC definitive drawings and UFC 3-410-06N, "Central Heating Plants Operation and Maintenance".

NAVFAC NO.	**DRAWING TITLE**
1429301 -	**STEAM HEATING PLANT NO.2 2 1/2 - 47 1/4 kg**

PER HOUR 20,000 - 375,000 POUNDS PER HOUR WATERTUBE (PACKAGED) OIL/GAS OR OIL FLOOR PLANS

1429302 - STEAM HEATING PLANT NO. 2 2 1/2 - 47 1/4 kg PER HOUR 20,000 - 375,000 POUNDS PER HOUR WATERTUBE (PACKAGED) OIL/GAS OR OIL LONGITUDINAL SECTION

1429303 - STEAM HEATING PLANT NO. 2 2 1/2 - 47 1/4 kg PER HOUR 20,000 - 375,000 POUNDS PER HOUR WATERTUBE (PACKAGED) OIL/GAS OR OIL PIPING SCHEMATIC

1429304 - STEAM HEATING PLANT NO. 2 2 1/2 - 47 1/4 kg PER HOUR 20,000 - 375,000 POUNDS PER HOUR WATERTUBE (PACKAGED) OIL/GAS OR OIL DETAILS

1429305 - STEAM HEATING PLANT NO. 2 2 1/2 - 47 1/4 kg PER HOUR 20,000 - 375,000 POUNDS PER HOUR WATERTUBE (PACKAGED) OIL/GAS OR OIL FUEL OIL UNLOADING

1429306 - STEAM HEATING PLANT NO. 2 2 1/2 - 47 1/4 kg PER HOUR 20,000 - 375,000 POUNDS PER HOUR WATERTUBE (PACKAGED) OIL/GAS OR OIL FUEL OIL STORAGE

1429307 - STEAM HEATING PLANT NO. 2 2 1/2 - 47 1/4 kg PER HOUR 20,000 - 375,000 POUNDS PER HOUR WATERTUBE (PACKAGED) OIL/GAS OR OIL FLOOR PLAN - ELECTRICAL

1429308 - STEAM HEATING PLANT NO. 2 2 1/2 - 47 1/4 kg PER HOUR 20,000 - 375,000 POUNDS PER HOUR WATERTUBE (PACKAGED) OIL/GAS OR OIL ONE LINE DIAGRAM - ELECTRICAL

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NOTE: Information describing any and all specific project and site conditions which the Contractor would need to know in order to submit a firm price shall be specified in Division 1 of the project specifications. Such conditions include:

1. Allocated space for storage of materials.

2. Railway spurs and sidings available to the Contractor for delivery of materials.

3. Any restrictions on daily working hours.

4. Procedure for scheduling outages and tests.

5. Any noise or traffic restrictions.

6. Availability of utilities required for construction.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 118	(1979) Coal-Tar Bitumen Used in Roofing, Damp-Proofing, and Waterproofing

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA/BOIL)

ABMA Boiler 103	(2001) Selected Codes and Standards of the Boiler Industry

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN LADDER INSTITUTE (ALI)

ALI A14.3	(2008; R 2018) Ladders - Fixed - Safety Requirements

AMERICAN PETROLEUM INSTITUTE (API)

API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats
API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC VII	(2017) BPVC Section VII-Recommended Guidelines for the Care of Power Boilers
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 4	(2013; R 2023) Fired Steam Generators

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C511	(2017; R 2021) Reduced-Pressure Principle

	Backflow Prevention Assembly
AWWA C651	(2023) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM D1047	(2016) Poly(Vinyl Chloride) Jacket for Wire and Cable
ASTM D1220	(1965; R 1990) Measurement and Calibration

	of Upright Cylindrical Tanks
ASTM D5864	(2011) Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components
ASTM D6081	(1998; R 2014) Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation
ASTM F1007	(2018; R 2022) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2024) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications
ASTM F1508	(1996; R 2021) Standard Specification for Angle Style, Pressure Relief Valves for Steam, Gas, and Liquid Services

FM GLOBAL (FM)

FM DS 12-17	(2001) Watertube Boilers

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-27	(1991) National Board Rules and Recommendations for the Design and Construction of Boiler Blowoff Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1424	(2016) Engineering and Design -- Lubricants and Hydraulic Fluids

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders
MIL-T-19646	(1990; Rev A; Notice 1 2021) Thermometer, Gas Actuated, Remote Reading

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50494	(Basic; Notice 1) Exhaust Head, Steam
CID A-A-50555	(Basic) Pumping Units, Sewage, Duplex, Centrifugal, Automatic Wet-Pit Type
CID A-A-50558	(Basic; Notice 1) Valves, Pressure Regulating, Steam
CID A-A-50562	(Basic) Pump Units, Centrifugal, Water, Horizontal; General Service and Boiler-Feed: Electric-Motor or Steam-Turbine-Driven
CID A-A-59222	(Basic; Notice 1; CANC Notice 1 2021) Fans, Centrifugal, Draft, Forced and Induced
CID A-A-59224	(Basic; Notice 2) Meters, Fluid Quantity Volumetric
CID A-A-60001	(Rev A) Traps, Steam
FS F-B-2902	(Basic; Notice 1) Boilers, Steam Watertube (Bent Tube, Multi-Drum and Cross Drum) Packaged Type (10,000,000 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-B-2910	(Basic) Burners, Single Oil, Gas, and Gas-Oil Combination for Packaged Boilers (320,001 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-F-351	(2019; Rev G; Notice 1) Filters and Filter Elements, Fluid Pressure: Lubricating Oil, Bypass and Full Flow
FS W-H-2904	(Basic; Notice 1) Heaters, Fluid, Deaerating (For Water Only) 1,000 to 1,600,000 Pounds Per Hour Capacity

FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam
FS XX-C-2816	(Rev A) Compressor, Air, Reciprocating or Rotary, Electric Motor Driven, Stationary, 10 HP and Larger

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910-SUBPART Q	Welding, Cutting, and Brazing
40 CFR 82	Protection of Stratospheric Ozone

U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

NAVFAC MO 324	(1992) Inspection and Certification of Boilers and Unfired Pressure Vessels

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

WATER QUALITY ASSOCIATION (WQA)

WQA S-100	(2000) Household, Commercial, and Portable Exchange Cation Exchange Water Softeners

1.2 RELATED REQUIREMENTS

The following UFGS sections apply to this section, with the additions and modifications specified herein:

a. 01 78 23 OPERATION AND MAINTENANCE DATA

b. 03 30 00 CAST-IN-PLACE CONCRETE

c. 09 90 00 PAINTS AND COATINGS

d. 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS

e. 09 97 13.28 PROTECTION OF BURIED STEEL PIPING AND STEEL BULKHEAD TIE RODS

f. 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS

g. 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION

h. 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS

i. 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS

j. 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS

k. 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION)

l. 40 17 26.00 20 WELDING PRESSURE PIPING

m. 22 00 00 PLUMBING, GENERAL PURPOSE

n. 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS

1.3 SYSTEM DESCRIPTION

1.3.1 Design Requirements

****

NOTE: The Energy Policy Act of 2005 and UFC 1-200-02 require new buildings to use 30 percent less energy than the ASHRAE 90.1 - SI ASHRAE 90.1 - IP baseline.

****

1.3.1.1 Boiler Design and Service Conditions

a. Design pressure: [_____] kPa (gage) psig

b. Operating pressure: [_____] kPa (gage) psig

c. Steam temperature: [_____] degrees C F

d. Feedwater temperature: [_____] degrees C F

e. Site elevation: [_____] meters feet

f. Ambient air temperature:

Minimum: [_____] degrees C F

Maximum: [_____] degrees C F

g. Maximum continuous output (steam): [_____] kg/sec lb/hr

h. Excess air leaving the boiler: [_____] percent

i. Gas temperature leaving boiler: [_____] degrees C F

j. Total forced draft fan static pressure: [_____] Pa inches WC

k. Gas draft at boiler outlet: [_____] Pa inches WC

l. Oxygen (O2) concentration in flue gas: [_____] percent

m. Carbon monoxide (CO) flue gas concentration: [_____] ppm

n. Nitrogen oxide (NOx) conc. in flue gas: [_____] ppm

****
NOTE: Due to limited manufacturer and boiler size options for FEMP stated efficiency requirements, this document includes boiler efficiency requirements in conformance with ASHRAE 90.1. ASHRAE 90.1 requires that low and medium pressure boilers used primarily in commercial space heating applications meet the following thermal (Et) or combustion (Ec) efficiencies.

Natural Gas-fired Steam (excluding natural draft) rated at 88 kW 300,000 Btuh capacity and larger, Et = 79 percent.

Natural Gas-fired - Natural Draft Steam rated at 88 kW 300,000 Btuh capacity and larger, Et = 77 percent.

#2 Oil-fired Steam rated at 88 kW 300,000 Btuh capacity and larger, Et = 81 percent.

Include all equipment efficiencies on the equipment schedules on the drawings.
****

o. Boiler thermal efficiency: [_____][_____] percent

1.3.1.2 Economizer

a. Design pressure: [_____] kPa (gage) psig

b. Operating pressure: [_____] kPa (gage) psig

c. Fuel [Natural Gas] [No.: [_____] Fuel Oil]

d. Specific heat of the flue gas: [_____] kJ/kg. C Btu/lb-degree F

e. Feedwater flow: [_____] L/s gpm

f. Flue gas temperature entering economizer: [_____] degrees C F

g. Flue gas temperature leaving economizer: [_____] degrees C F

h. Feedwater temperature entering economizer: [_____] degrees C F

i. Feedwater temperature leaving economizer: [_____] degrees C F

****
NOTE: Unless fuel oil to be burned has an uncommon tendency to foul tubes, finned tube economizers should be suitable for gas and oil. Feedwater temperatures should be 110 degrees C 230 degrees F when sulphur (S) content of oil is 0.5 percent to 1.5 percent; 116 degrees C 240 degrees F, S=1.5 percent to 2 percent; 121 degrees C 250 degrees F, S=2.0 percent to 2.7 percent.
****

j. Maximum pressure drop, economizer gas side: [_____] Pa in. WC

k. Maximum pressure drop, economizer water side: [_____] kPa psi

l. Fouling factor on feedwater side: [_____]

m. Fouling factor on gas side: [_____].

1.3.1.3 Fans

Design fan to handle air at temperatures from [_____] to [_____] degrees C F. Fan shall be [single] [double] width inlet, [single] [double] width outlet, with [clockwise] [counter clockwise] rotation when viewed from the motor end.

1.3.1.4 Expansion Joints and Stacks

a. Temperature:

  (1) Maximum ambient: [_____] degrees C F

  (2) Minimum ambient: [_____] degrees C F

  (3) Inlet gas at maximum gas flow (gas): [_____] degrees C F

  (4) Inlet gas at maximum gas flow (oil): [_____] degrees C F

  (5) Inlet gas at minimum gas flow (gas): [_____] degrees C F

  (6) Inlet gas at minimum gas flow (oil): [_____] degrees C F.

b. Gas Flow at Inlet

  (1) Maximum: [_____] kg/s lb/hr

  (2) Minimum: [_____] kg/s lb/hr

c. Required Net Available Draft at Stack Inlet At maximum gas flow: [_____] Pa inches water

d. Gas Exit Velocity (Cone Exit) Maximum at maximum conditions: [_____] m/s ft/sec

e. Flue Gas Acid Dew Point Fuel oil: [_____] degrees C F

f. Test Pressures Shop Test: [_____] Pa inches water

g. Thermal Efficiency of Stack: 96 to 98 percent

h. Stack Friction Maximum at design conditions: [_____] Pa inches water

i. Stack Height

  (1) Ground elevation: [_____] m ft

  (2) Roof elevation: [_____] m ft

  (3) Stack height: [_____] m ft

  (4) Foundation or footing elevation: [_____] m ft

j. Wind pressure: [_____] Pa psf

k. Wind velocity, gusting: [_____] km/h mph

l. Stack Diameter Minimum (below exit cone): [_____] mm inches

m. Stack deflection Maximum (from vertical center line): [_____] mm inches

n. Soil bearing stress, maximum: [_____] kg/m2 psf

o. Seismic zone: [_____].

1.3.1.5 Vertical Fuel Oil Storage Tanks

Design the tank to resist the following loads and forces:

Wind: [_____] Pa pounds per square foot

Seismic zone: [_____]

Roof live load: [_____] kg/m2 pounds per square foot

Density of liquid: [_____] kg/m3 pounds per cubic foot.

Allow the following combinations of loads, with corresponding percentages of basic stresses to be used in design:

Load Combination	Percent of Basic Stress
Dead load plus live load	100
Dead load plus live load plus wind load	133
Dead load plus live load plus seismic load	133

1.3.1.6 Fuel Oil Pump and Heater Set

****

NOTE: Tabulated pump data is included in the specifications but it is preferred that such information be shown on the drawings instead.

****

a. Pump/Heater Set

(1) Capacity each pump and each steam heater: [_____] L/s gpm

(2) Suction lift: [_____] kPa ft of water

(3) Discharge pressure at outlet of heater: [_____] kPa (gage) psig

(4) Maximum pump speed: 1750 rpm

(5) Specific gravity range: [.92 to .99] [_____to_____]

(6) Viscosity at BHP selection point: 5000 ssu

(7) Viscosity range: [500 to 5000] ssu [_____to_____] ssu

(8) Oil temperature at inlet of heater: [_____] degrees C F

(9) Oil temperature at outlet of heater: [_____] degrees C F

(10) Maximum oil pressure drop through heater: [_____] kPa psi

(11) Heating medium: Steam

(12) Steam pressure available: [_____] kPa (gage) psig

(13) Steam temperature: [_____] degrees C F

(14) Heater type: [Bare Tube] [Extended Surface]

b. Fuel Oil Heater Set With Electric Startup Heater

(1) Oil temperature at inlet of heater: [_____] degrees C F

(2) Oil temperature at outlet of heater: [_____] degrees C F

(3) Maximum oil pressure drop through heater: [_____] kpa psi

(4) Capacity of heater: [_____] L/s gpm

(5) Heating power supply at three phase, 60 Hz: [_____] volts

(6) Control power supply 120 volts, single phase, 60 Hz.

1.3.1.7 Deaerating Heater

a. Design pressure: 207 kpa (gage) 30 psig

b. Normal steam operating pressure: [_____] kPa (gage) psig

c. Maximum steam operating pressure: [_____] kPa (gage) psig

d. Capacity (minimum): [_____] kg/sec lb/hr of feedwater

e. Inlet Conditions at Heater:

	Pressure kPa(gage)	Temperature Range Degrees C	Maximum Flow Rate kg/sec
(1) Condensate return	[_____]	[_____] to [_____]	[_____]
(2) High pressure trap returns	[_____]	[_____] to [_____]	[_____]
(3) Makeup water (softened)	[_____]	[_____] to [_____]	[_____]

	Pressure psig	Temperature Range Degrees F	Maximum Flow Rate lb/hr
(1) Condensate return	[_____]	[_____] to [_____]	[_____]
(2) High pressure trap returns	[_____]	[_____] to [_____]	[_____]
(3) Makeup water (softened)	[_____]	[_____] to [_____]	[_____]

f. Outlet temperature of feedwater from heater at design capacity: [_____] degrees C F

g. Heating steam pressure: [_____] kPa (gage) psig

h. Heating steam enthalpy: [_____] kJ/kg Btu/lb

i. Storage capacity to overflow of tank: [_____] liters gallons storage.

1.3.2 Detail Drawings

1.3.2.1 Boiler

Show arrangement and details of foundations, plans, elevations, wall sections, insulation, tubing details, expansion joints, external piping details and schematics, wiring schematics, [economizer and economizer structural details]. Submit descriptive information with the drawings on each item of the drawings.

1.3.2.2 Boiler Room Auxiliary Equipment

Drawings shall show equipment arrangements, wiring and piping diagrams. Include descriptive information for each item shown. Submit drawings showing the following:

a. Water softening equipment

b. Brine storage tank

c. Condensate receiver

d. Condensate transfer pumps including certified performance curves

e. Deaerator

f. Boiler feed pumps including certified performance curves

g. Steam turbines

h. Continuous blowdown system

i. Chemical feed units

j. Air compressors

k. Air dryers

l. Cranes and hoists

m. Plant heating and ventilating equipment and related ductwork

1.3.2.3 Burners

Submit drawings showing the following:

a. General arrangement

b. Piping details

c. Burner control schematics

d. Flame safety schematics

e. Component details

f. Throat tile details

1.3.2.4 Dampers, Stacks, and Breechings

Submit drawings showing the following:

a. General arrangement

b. Breeching and reinforcing details

c. Breeching hangers and support details

d. Dampers and operators

e. Access doors and frames

f. Expansion joints

g. Stack details

For stack details, include anchor bolt and foundation details, stack sampling ports, platforms, and accessories.

1.3.2.5 Fuel Oil Equipment

Drawings may be manufacturer's standard size for pumps, pump curves, valves, strainers manufacturer's standard size for pumps, pump curves, valves, strainers and pump wiring. Submit drawings showing the following:

a. Certified outline and general arrangement

b. Certified pump curves

c. Equipment detail sheets including viscosity controller, heater, valves

d. Electrical wiring diagrams

e. Oil tanks, foundations, tank heaters, appurtenances, water drawoff, level indication

1.3.2.6 Piping and Specialty Items

Drawings may be manufacturer's standard size. Submit drawings showing the following:

a. Details of special valves and fittings

b. Feedwater regulator details and schematics

c. Details and schematics of feedwater automatic recirculation

1.3.2.7 Ball Joint Installation Details

Include allowable angular flex and minimum offset dimensions for approval.

1.3.2.8 Reproducible Drawings

Submit one reproducible mylar shop drawing of each approved drawing sheet to the Contracting Officer for the following items:

a. Boiler layout, construction and details

b. Breeching layout and details

c. Burner control schematics and burner details

d. Wiring diagrams

e. Fuel oil tanks, foundations and appurtenances

f. Automatic feedwater recirculation system

g. Piping schematics

1.3.3 Design Data

1.3.3.1 Engineering Calculations

Furnish the following calculations from the manufacturer:

a. Foundation (including bearing and moment forces) and anchor bolts.

b. Stack

    (1) Stresses due to various loading conditions including wind and seismic loads.

    (2) Vibration and damping.

    (3) Heat transfer at various design and ambient conditions.

    (4) Expansion profiles.

    (5) Shipping and erection stress analysis.

1.3.4 Test Reports

Submit the predicted economizer performance along with and as part of the boiler predicted performance report.

1.3.5 Performance Requirements

1.3.5.1 Boiler

****

NOTE: When analyses of the specific fuels to be burned are known, insert the proper values in this paragraph. When unknown and the analyses given in FS F-B-2902 are sufficient, omit this paragraph.

****

Base performance requirements, including furnace heat release rates, on the following ultimate analysis and high heating values.

a. Fuel Oil Analysis

(1) Grade of fuel oil: [_____]

(2) Ultimate analysis (percent by weight, as fired)

Carbon	[_____]
Hydrogen	[_____]
Nitrogen	[_____]
Sulfur	[_____]
Oxygen (O2)	[_____]
TOTAL	[_____]

(3) Heating valve: [_____] kJ/kg Btu/lb

(4) Specific gravity: [_____] degrees API

(5) Viscosity at burner: [_____] SSF at 50 degrees C 122 degrees F

(6) Water and sediment: [_____] percent by volume

(7) Flash point: [_____] degrees C F.

b. Natural gas analysis

(1) Proximate Analysis (percent by volume, as fired)

Methane:	[_____] percent
Ethane:	[_____] percent

Propane:	[_____] percent
Butane:	[_____] percent
Carbon Dioxide:	[_____] percent
Nitrogen:	[_____] percent
Miscellaneous:	[_____] percent
TOTAL	[_____] percent

(2) Ultimate analysis (percent by weight, as fired)

Hydrogen:	[_____] percent
Carbon:	[_____] percent
Nitrogen:	[_____] percent
Oxygen:	[_____] percent
Miscellaneous:	[_____] percent
TOTAL	[_____] percent

(3) Heating value: [_____] kJ/m3 Btu/cu ft

(4) Heating value: [_____] kJ/kg Btu/lb

(5) Density: [_____] kg/m3 lb/cu ft

(6) Specific gravity: [_____].

1.3.5.2 Economizer

The increase in efficiency due to the economizer shall be not less than [_____] percent at full load. Fully coordinate the economizer with the boiler to which it is to be applied.

1.3.5.3 Oil Burner/Windbox Package

Burner turndown ratio on specified fuel oil shall be not less than eight to one, with excess air not over 15 percent at full steam load, and excess air not over 22 percent at 20 percent steam load. [Air flow shall be modulated through a single set of register louvers.]

1.3.5.4 Oil and Gas Burner/Windbox Package

Burner turndown ratio shall not be less than eight to one, when firing fuel oil only and ten to one when firing natural gas only with excess air not over 15 percent at full steam load, and excess air not over 22 percent at 20 percent steam load. [Air flow shall be modulated through a single set of register louvers.]

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submittals required by this section require the approval of the Contracting Officer. Within [60] [75] [90] days after award of the contract, shop drawings accompanied with complete manufacturer's descriptive information shall be submitted for approval as specified in Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS. Drawing size shall be 841 by 594 mm 34 by 22 inches.

SD-02 Shop Drawings

Boiler; G, [_____]

Boiler Room Auxiliary Equipment; G, [_____]

Burners; G, [_____]

Dampers, Stacks, and Breechings; G, [_____]

Fuel Oil Equipment; G, [_____]

Piping and Specialty Items; G, [_____]

Ball Joint Installation Details; G, [_____]

Reproducible Drawings; G, [_____]

SD-03 Product Data

Insulation Types and Installation Procedures; G, [_____]

Boiler

****

NOTE: Include refrigerant submittal when a compressed air refrigerated air dryer is included.

****

[Refrigerant (compressed air refrigerated air dryers) - Provide SDS sheets for all refrigerants

] SD-05 Design Data

Engineering Calculations; G, [_____]

SD-06 Test Reports

Boiler Predicted Performance

Economizer Performance

Variable Speed Motor Controller; G, [_____]

Submit certified copies of design, production and conformance tests for approval before delivery of the equipment.

Hydrostatic and Leak Tightness Tests; G, [_____]

Preliminary Operation; G, [_____]

General Startup Requirements; G, [_____]

Fuel Oil Tanks; G, [_____]

Boilers and Auxiliaries Tests and Inspections; G, [_____]

Submit for tests and inspections as specified in the paragraph FIELD QUALITY CONTROL. Submit a detailed written record of test conditions, test procedures, field data, and startup and operational performance of entire heating plant to the Contracting Officer before the Contractor's operational and test personnel leave the site.

Aquatic Toxicity

SD-07 Certificates

Compatibility of Boiler Components and Equipment; G, [_____]

System and Equipment Installation; G, [_____]

Tank Calibration; G, [_____]

Backflow Preventer; G, [_____]

Submit the required information and experience certificates as specified under the paragraph EXPERIENCE REQUIREMENTS, within 30 days after award and prior to commencing work on the site.

Identical Equipment; G, [_____]

Ozone Depleting Substances Technician Certification

SD-10 Operation and Maintenance Data

Boiler, Data Package 3; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include the following supplemental information in addition to the requirements of Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.

a. Illustrations, catalog information, shop drawings, and certified drawings of each item of equipment and control components

b. Tests and Test Results

c. Adjustments

d. Fan and Blower Characteristics Curves

e. Pump Characteristic Curves

f. Boiler Predicted Performance Data

g. List of Special Tools Required

h. Posted Operating Instructions

i. Controls Drawings, Setup and Calibration Data

1.5 QUALITY ASSURANCE

1.5.1 Experience

1.5.1.1 Experience Requirements

****

NOTE: Verify number of manufacturers' installations operating and years of operation for boiler, forced draft fan, burner/windbox package and control systems to avoid an unnecessarily restrictive experience requirement.

****

The boiler(s), with auxiliary equipment installed, within, or as a part of the heating plant, shall be of a proven design; the manufacturer shall be regularly employed in designing, fabricating, erecting, testing and startup of the equipment.

1.5.2 Responsibility of the Boiler Manufacturer

Contractor shall ensure that the manufacturers of boiler components and auxiliaries provide equipment compatible with the boiler. Equipment includes but is not limited to the following: Blowdown valves, burner/windbox package, combustion control system, emission control components, fans, economizer, refractories, insulation, sootblowers, steam separator, scanner, [air preheater,] dust collector, breeching between boiler outlet and stack inlet, boiler trim, safety valves and drains.

1.5.3 Standard Commercial Product

Boilers and equipment shall be manufactured in accordance with the requirements of this specification and shall be the manufacturer's standard commercial product. Additional or higher quality features which are not specifically prohibited by this specification, but which are a part of the manufacturers' standard commercial product, shall be included in the boilers and equipment being provided. A standard commercial product is a product which has been sold or is being currently offered for sale on the commercial market through advertisements or manufacturer's catalogs, or brochures, and represents the latest production model.

1.5.4 Modification of References

In API Std 650, the advisory provisions shall be considered mandatory, as though the word "shall" had been substituted for "should" and "suggested" wherever they appear.

1.5.5 Assembly of Components

The equipment shall be factory assembled except for steam generators which may utilize factory assembled components to the maximum extent to facilitate erection and minimize field labor.

1.5.6 Certificates

1.5.6.1 Backflow Preventer

Certificates of Approval for each backflow preventer from the Foundation for Cross-Connection Control Research, University of Southern California, and shall attest that this design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval will not be acceptable in lieu of the above.

1.5.6.2 Compatibility of Boiler Components and Equipment

Contractor shall submit certifications from the boiler manufacturer stating that boiler components, including auxiliary equipment, are compatible with the boiler. Certificates of compatibility for boiler components and auxiliary equipment not directly produced by the boiler manufacturer may be submitted through the boiler manufacturer.

1.5.6.3 System and Equipment Installation

Contractor shall submit written certification from each system supplier and each manufacturer of the equipment that the system and equipment installation is in accordance with the system supplier's and equipment manufacturer's instructions and recommendations, that the unit or system has been run, rotating parts have been dynamically balanced, fluid (including air) flows have been balanced, instrumentation and controls are properly functioning, adjusted and have been calibrated, and the equipment or system is ready for final testing. Certificates shall be submitted before the entire boiler plant may be given an acceptance test.

1.5.6.4 Tank Calibration

Submit four copies of a certified record of the vertical fuel oil tank calibration.

1.5.6.5 Backflow Preventer

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project.

1.5.6.6 Identical Equipment

Contractor shall submit evidence from the equipment manufacturer to show that substantially identical equipment produced by the manufacturer and of comparable operating parameters (within plus or minus 20 percent) has been successfully installed and operated in not less than [one] [two] [three] installations under comparable operating conditions for a period of not less than two years.

1.5.6.7 Ozone Depleting Substances Technician Certification

****

NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

****

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.6 DELIVERY, STORAGE, AND HANDLING

Each assembly of components packaged as a unit shall be of a size that can be transported by common carrier without disassembly insofar as shipping clearances are concerned.

1.7 ENVIRONMENTAL REQUIREMENTS

1.7.1 Burner Emission Requirements

The emission requirements shall be met at the maximum required continuous output. The burner shall meet environmental rules and regulations. Emission requirements to be considered are oxides of nitrogen (NOx), opacity, particulate, sulfur dioxide, and carbon monoxide. Other emission requirements may be imposed.

1.7.1.1 NOx Emission Regulations

Compliance shall be met using [one] [a combination] of the following:

a. Low NOx burners

b. Flue gas recirculation equipment which conforms to UL 795

c. Other NOx reduction techniques. See Nitrogen oxide control for stationary combustion sources.

1.7.1.2 Aquatic Toxicity

Assess potential effects of all lubricants on aquatic organisms in accordance with ASTM D6081 and submit aquatic toxicity reports. Assess biodegradation in accordance with ASTM D5864. In accordance with EM 1110-2-1424 Chapter 8, aquatic toxicity shall exceed 1,000 ppm at LL50 and biodegradation shall exceed 60 percent conversion of carbon to carbon dioxide in 28 days.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials free of defects which could adversely affect the performance or maintainability of individual components or of the overall assembly. Materials not specified herein shall be of the same quality used for the intended purpose in commercial practice. Unless specified otherwise herein, equipment, material, and articles incorporated in the work covered by this specification shall be new.

2.1.1 Identical Equipment

Provide physically and mechanically identical boilers and equipment of the same classification size or capacity to permit the interchangeability of replacement parts. This requirement includes parts, assemblies, components, and accessories. Parts provided on the same type unit regardless of unit size and identifiable by identical part number shall be functionally and dimensionally interchangeable. No deviation is acceptable without prior written approval of the Contracting Officer.

2.2 BOILERS

2.2.1 Packaged Watertube Boiler

FS F-B-2902, Type [_____] except as modified below. Provide lifting attachments.

2.2.2 Tubes

****

NOTE: Use this paragraph when tube diameters larger than specified in FS F-B-2902 are desired and insert minimum acceptable diameter.

****

Boiler and furnace tubes shall be at least [_____] mm inches in outside diameter.

2.2.3 Furnace

****

NOTE: When a D-type boiler is acceptable, use this paragraph and insert desired hand.

****

Furnaces for D-type boilers shall be on the [_____] hand side of the drums when viewed from the front of the boiler.

2.2.4 Transition

****

NOTE: This paragraph should be used when a breeching transition piece is desired to be provided with the boiler.

****

Provide a transition piece to permit adapting the [boiler] [economizer] outlet to the [stack] [breeching]. Design transition pieces for [vertical] [horizontal] discharge.

2.2.5 Combustion Controls

As specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.2.6 Access and Observation Doors

Provide boiler with sufficient number of access doors and observation doors, to give free and easy access and observation to all parts of the interior of the boiler.

2.3 ECONOMIZERS

****

NOTE: Economizers shall be specified for all boilers with operating pressure greater than 345 kPa (gage) 50 psig and a capacity of 2 1/4 kg per second 18,000 pounds per hour and larger. For boilers from 1/2 to 2 1/4 kg per second 4,000 to 18,000 pounds per hour the designer shall make the decision based upon a specific economic analysis. This paragraph shall be included as applicable.

****

****

NOTE: Unless fuel oil to be burned has an uncommon tendency to foul tubes, finned tube economizers

should be suitable for gas and oil. Feedwater temperatures should be 110 degrees C 230 degrees F when sulphur (S) content of oil is 0.5 percent to 1.5 percent; 116 degrees C 240 degrees F, S=1.5 percent to 2 percent; 121 degrees C 250 degrees F, S=2.0 percent to 2.7 percent.

****

Provide a modular unit constructed in accordance with the ASME Boiler and Pressure Vessel Code, Section 1, of one of the following types:

a. Internal Tubular Type: Boiler feedwater flows through the outer shell and flue gases circulate up through internal tubes provided with removable flue gas spinners.

b. Finned or Spiral Wound Tube Type: Feedwater circulates through finned tubes and flue gas flows through outer shell.

2.3.1 Construction

Provide manufacturer's standard economizer design for the operating conditions and the fuel(s) specified. Coordinate the amount of heating surface with the flue gas conditions exiting the boiler or boilers on which the economizer is to be applied to preclude reaching the "acid dew point" for the fuels specified. When necessary (if there is sulfur in the specified fuel, and the designed inlet temperature could fall below the acid dew point), provide a feedwater temperature control system to maintain temperatures above the acid dew point. Provide casing of not less than 12 gage steel plate reinforced as required with support lugs and breeching flanges. Provide building framing steel to support the economizer. [Provide built-in soot blower for each economizer to thoroughly clean the surfaces exposed to the flue gas.] Design the economizer so that internal construction can be easily cleaned and inspected.

2.3.2 Equipment

Provide the following equipment for each unit:

a. Relief valve.

b. Shutoff gate valve on feedwater outlet and shutoff globe valve on inlet with globe valve bypass. Size valves as shown in economizer piping detail.

c. Temperature indicator on feedwater outlet.

d. Temperature indicator on feedwater inlet.

e. Temperature indicator on flue gas outlet.

f. Temperature indicator on flue gas inlet.

g. Temperature alarm switches for high and low flue gas temperatures.

h. Alarm with trouble light and silencing switch.

i. Panel with annunciator and temperature indicators for feedwater inlet, feedwater outlet, flue gas inlet and flue gas outlet for each economizer.

j. A drain valve downstream of the economizer before the shutoff valve.

k. A stack flue gas temperature control system to control and limit flue gas temperature to not less than 149 degrees C 300 degrees F by modulating motorized feedwater control valves in a bypass around the economizer. Provide shutoff valve on each side of the control valves with a strainer upstream of each valve. Provide this system in parallel to the manual shutoff and bypass described above.

l. Differential pressure indicator on water side.

m. Differential pressure indicator on gas side.

n. Pressure gages on feedwater inlet and outlet.

2.3.3 Insulation

Insulate the economizer with not less than the equivalent of 50 mm 2 inches of mineral wool insulation and lag with not less than 27 gage galvanized, weatherproof lagging.

2.4 BURNER AND WINDBOX PACKAGES

2.4.1 Oil Burner/Windbox Package

****

NOTE: The designer shall fill in the appropriate information as defined in FS F-B-2910.

****

Provide a fully modulating, oil burner conforming to FS F-B-2910, Size [_____], Class [_____], Control sequence [_____], Combustion control system [_____] except as modified below. Provide burner with windbox, [forced draft fan,] dampers, fuel train and associated controls to comprise a complete factory assembled package. Total heat input to the boiler furnace shall be provided by [_____] burners. The burner package shall be considered an integral part of the steam generator and shall be subject to applicable provisions of the boiler design and service together with requirement of tests, performance guarantees and other warranties specified for the boiler.

2.4.1.1 Oil Burner

****

NOTE: At the text below, for boilers below 3.15 kg/sec 25,000 pounds per hour the designer shall select either compressed air or steam atomization after performing an economic analysis. For 3.15 kg/sec 25,000 pounds per hour and above, atomization shall be by compressed air unless steam pressure is required for greater turndown.

****

a. Oil Burner Characteristics: The burner shall be quiet in operation and shall operate with a balanced clean stable flame so as not to localize heat in any part of the combustion chamber. The burner shall be capable of completely atomizing and effectively mixing the oil with air so as to insure complete combustion. The air admitted shall be of sufficient quantity for complete combustion, but not of such quantity as to produce an undue percentage of excess air with attendant high stack loss. The burner shall operate without clogging or failure, and shall have sufficient capacity to develop not less than the specified capacity. The burner unit shall be easily removed from firing position and readily accessible for inspection, cleaning, and other purposes. Provide observation ports to view operation of burner. There shall be no flame impingement on the sidewalls, top, bottom or rear walls of the furnace. Burner manufacturer shall furnish, and Contractor shall install refractory throat tiles or other items required for proper installation of burner.

b. Atomization: Burner shall be [steam atomizing; steam pressure at header is [_____] kPa (gage) psig; steam temperature at header is [_____] degree C F] [air atomizing; filtered compressed air shall be available for burner atomization and the maximum requirement for each burner shall not exceed [_____] standard L/s scfm of air at [_____] kPa (gage) psig]. Provide pressure reducing valve and controls as required.

c. Electric Ignition System: Burner shall be equipped with an electric ignition system. System shall be either the high energy ignition or glow rod type. Gas ignition system is not acceptable. The high energy ignition system shall use stored energy to develop 2000 Vdc pulses. The glow rod system shall use a low voltage, carbon rod electrode which develops a tip temperature of 1427 degrees C 2600 degrees F. Provide ignition system complete in all respects.

d. Windbox: Construct of carbon steel plate not less than 10 gage thickness with 6 mm 1/4 inch thick front plate. Design windbox to provide even and uniform air entrance into the burner register and seal weld to the boiler front wall. Provide windbox with support legs.

e. Purge Connection: Provide [steam] [air] purge connection, properly valved, for purging oil from gun prior to removal from burner.

****

NOTE: At the text below, provide aspirating system only for boilers in which the expected furnace pressure exceeds 1245 Pa 5 inches water.

****

[f. Aspirating System: Provide an air aspirating system for the fuel oil atomizer guide pipes to prevent blowback of hot furnace gases. Aspirating system shall use approximately [_____] L/s scfmof [_____] kPa (gage) psig compressed air.

] g. Piping: Provide piping and flexible hoses for the guide pipe purge [and aspirating] system[s]. Air from the forced draft fan shall be used for guide pipe purging during normal operation.

h. Material: All metal parts exposed to radiant heat, including the atomizer shield, shall be of stainless steel or other approved alloy.

i. Fuel Oil Control Valve: Fuel oil will be supplied at [_____] kPa (gage) psig and [_____] degrees C F at the inlet of the fuel piping train. Size fuel oil automatic control valve for 103 kPa 15 psi differential pressure as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

(1) j. Fuel: ASTM D396, Grade no. [_____].

****

NOTE: At the text below, the designer shall make a technical evaluation to determine if the forced draft fan should be integrated with or mounted separately from the windbox on the floor next to the boiler. If the forced draft fan is to be mounted separately, delete this paragraph and specify the fan in the paragraph FANS.

****

[j. Forced Draft Fan: Fan shall be fully integrated with and mounted on the windbox. Provide an inlet silencer, if required, to insure operation at noise level below 85 dBA.

k. Electric Motor: Motor shall be [variable speed], [_____] volt, [_____] phase, 60 Hz, [totally enclosed, non-ventilated] [totally enclosed, fan cooled], not less than [_____] hp as specified under MOTORS AND DRIVES in this section.

]2.4.1.2 Flame Safeguard Controls

a. General: Provide a complete system of valves, interlocks and controls in accordance with NFPA 85 and FM DS 12-17.

b. Fuel Oil Train: Provide fuel oil train consisting of [steam] [air] atomizing oil gun, auxiliary [steam] [air] atomizing oil gun for changing guns without a shutdown, fuel oil control valve, two safety shutoff valves, recirculation valve, strainer, and flexible hose connections to oil burner. Provide low oil pressure and low atomizing air pressure switches, and other safety interlocks and devices as required. Provide in panel mounted on burner package the following gages. Gages shall be 150 mm 6 inch diameter with white coated dials and black lettering:

(1) Fuel oil supply pressure (0 to 1034 kPa (gage) 150 psig)

(2) Fuel oil pressure at burner (0 to 1034 kPa (gage) 150 psig)

[(3) Atomizing air pressure at burner (0 to 1034 kPa (gage) 150 psig)

][(4) Atomizing steam pressure at burner (0 to 1034 kPa (gage) 150 psig)

] c. Control Sequencing: Flame safeguard system shall be designed to insure safe purge, light-off and shutdown procedures, and to monitor light-off, main flame and boiler operating conditions.

[(1) Control Type: Flame safeguard system shall be of the automatically sequenced type with programming timed and sequenced by a heavy duty, industrial type timer. This timer shall be tamper-proof and shall be designed so that advancement of the timer to shorten purge will shut down the unit.

] (2) Scanner and Relay: Provide system with [ultraviolet] [infrared] scanner and electronic relay located in the front wall which will shut down the fuel within 2 to 4 seconds of loss of flame.

(3) Output Meter: Provide scanner output meter in panel for

indication of scanner signal strength.

(4) Limit Devices: Safety system shall include the following limit devices incorporated into a limit circuit:

(a) Flame failure

(b) High boiler outlet pressure

(c) Low fuel oil pressure

(d) Low water level cutout

(e) Low combustion air flow

(f) Low atomizing [air] [steam] pressure

(g) Any additional as required by FM DS 12-17 or NFPA 85

[(h) Low fuel oil temperature

] (5) Annunciator: Safety system limits specified above shall be displayed on a first out annunciator mounted in the burner panel. [Provide a common alarm contact to be wired to the operator control console, specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

d. Light Off: Failure shall require a manual restart of the programmer. Safety system shall provide a mandatory purge with the forced draft fan vanes proven open, and a return to proven low fire position before light off. Main fuel valve shall open for a timed period of 10 seconds during trial for ignition.

e. Circuit Analyzer: Provide a circuit analyzer system, which, by means of 12 or more lights, will indicate which circuits are energized at any specific time, and will thereby indicate improperly operating circuit.

f. Control Panel: Programmer, limit control, relays, annunciator, shall be mounted in a [NEMA 1 control panel, modified with fully gasketed doors and panels mounted on burner package] [control panel as specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.4.2 Oil and Gas Burner/Window Package

****

NOTE: Choose this paragraph and subparagraphs or the paragraph and subparagraphs above, OIL BURNER/WINDBOX PACKAGE.

****

Provide, fully modulating, dual fuel burner conforming to FS F-B-2910, Class [_____], Combustion control system [_____] except as modified below. Provide burner with windbox, [forced draft fan,] dampers, fuel train and associated controls to comprise a complete factory assembled package. Total heat input to the boiler furnace shall be provided by [_____] burners. Burner package shall be considered an integral part of the steam generator and shall be subject to applicable provisions of the boiler design and service together with requirement of tests, performance guarantees and other warranties specified for the boiler.

2.4.2.1 Burner

a. Burner Characteristics: The burner shall be quiet in operation and shall operate with a balanced clean stable flame so as not to localize heat in any part of the combustion chamber. The burner shall be capable of completely atomizing and effectively mixing the oil with air so as to insure complete combustion. The air admitted shall be of sufficient quantity for complete combustion, but not of such quantity as to produce an undue percentage of excess air with attendant high stack loss. The oil burner shall operate without clogging or failure, and shall have sufficient capacity to develop not less than the specified capacity. The burner unit shall be easily removed from firing position and readily accessible for inspection, cleaning, and other purposes. Provide adequate observation ports on burner. There shall be no flame impingement on the sidewalls, top, bottom or rear walls of the furnace. Contractor shall install refractory throat tiles or other items provided by the burner manufacturer which may be required for proper installation of the burner.

b. Atomization: Burner shall be [steam atomizing; steam pressure at header is [_____] kPa (gage) psig; steam temperature at header is [_____] degree C F] [air atomizing; filtered compressed air shall be available for burner atomization and the maximum requirement for each burner shall not exceed [_____] L/s scfm of air at [_____] kPa (gage) psig]. Provide pressure reducing valve and controls as required.

[c. Electric Ignition System: Burner shall be equipped with an electric ignition system. System shall be either the high energy ignition or glow rod type. Gas ignition system is not acceptable. High energy ignition system shall provide stored energy to develop 2000 volt DC pulses. Glow rod system shall provide a low voltage, carbon rod electrode which develops a tip temperature of 1427 degrees C 2600 degrees F. Provide ignition system complete in all respects.
]
****

NOTE: At the text below, a gas pilot ignition system is optional for a combination oil/gas burner.

****

[d. Natural Gas Pilot Ignition System: Provide a complete interrupted type natural gas-fired, spark ignited pilot system for the burner assembly. Combustion air supply shall be from the burner windbox. Lighting system shall have capacity to stabilize the firing during startup periods. Lighter shall be arranged for easy removal and servicing while the boiler is in operation. Furnish igniter complete with a spark rod and a power pack. Power pack shall operate on 120 volt, 60 cycle, single phase power. Provide gas piping, to one point of supply, including necessary gas pressure regulators. Igniter system shall include controls, gages, flame safety systems, interlocks and accessories to comply with Industrial Risk Insures' (I.R.I) (formerly F.I.A.) requirements and applicable codes and regulations.

] e. Windbox: Construct of carbon steel plate not less than 10 gage thickness with 6 mm 1/4 inch thick front plate. Design windbox to provide even and uniform air entrance into the burner register and seal weld to the boiler front wall. Provide windbox with support legs.

f. Purge Connection: Provide [steam] [air] purge connection, properly valved, for purging oil from gun prior to removal from burner.

[g. Aspirating System: Provide an air aspirating system for the fuel oil atomizer guide pipes to prevent blowback of hot furnace gases. Aspirating system shall use approximately [_____] L/s scfm of [_____] kPa (gage) psig compressed air.

] h. Guide Pipe Purging: Provide piping and flexible hoses for the guide pipe purge [and aspirating] system[s]. Air from the forced draft fan shall be provided for guide pipe purging during normal operation.

i. Materials: Metal parts exposed to radiant heat, including the atomizer shield, shall be of stainless steel or other approved alloy.

j. Natural Gas Control Valve: Natural gas shall be supplied at [_____] kPa (gage) psig and [_____] degrees C F at the inlet of the fuel piping train. Size the natural gas automatic control valve for [_____] kPa psi differential pressure as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

k. Fuel Oil Control Valve: Fuel oil will be supplied at [_____] kPa (gage) psig and [_____] degrees C F at the inlet of the fuel piping train. Size fuel oil automatic control valve for 103 kPa 15 psi differential pressure as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

l. Fuel: ASTM D396, Grade no. [_____] and natural gas.

[m. Forced Draft Fan: Fan shall be fully integrated with and mounted on the windbox. Provide an inlet silencer, when required, to insure operation at noise level below 85 dBA. The F. D. Fan Electric Motor shall be [variable speed], [_____] volt, [_____] phase, 60 Hz, [totally enclosed, non-ventilated] [totally enclosed, fan cooled], not less than [_____] kW hp as specified under MOTORS AND DRIVES in this section.

]2.4.2.2 Flame Safeguard Controls

Provide a complete system of valves, interlocks and controls in accordance with NFPA 85 and as approved by Factory Mutual Engineering and Research.

a. Natural Gas Train: Provide natural gas train consisting of gas ring, gas control valve, two safety shutoff valves, high gas valve, and manual shutoff cock. Provide low gas pressure switch, high gas pressure switch, and other safety interlocks and devices as required. Provide in panel mounted on burner package the following gages. Gages shall be 150 mm 6 inch with white coated dial and black figures.

(1) Natural gas supply (0 to 172 kPa (gage) 25 psig)

(2) Burner gas supply pressure (0 to 172 kPa (gage) 25 psig)

b. Fuel Oil Train: Provide fuel oil train consisting of [steam] [air] atomizing oil gun, auxiliary [steam] [air] atomizing oil gun for changing guns without a shutdown, fuel oil control valve, two safety shutoff valves, recirculation valve, strainer, and flexible hose connection(s) to oil burner. Provide low oil pressure and low atomizing air pressure switches, and other safety interlocks and devices as required. Provide in panel mounted on burner package the following gages. Gages shall be 150 mm 6 inch with white coated dials and black figures:

(1) Fuel oil supply pressure (0 to 1034 kpa (gage) 150 psig)

(2) Fuel oil pressure at burner (0 to 1034 kPa (gage) 150 psig)

[(3) Atomizing air pressure at burner (0 to 1034 kPa (gage) 150 psig)

][(4) Atomizing steam pressure at burner (0 to 1034 kPa (gage) 150 psig)

] c. Control Sequencing: Flame safeguard system shall be designed to ensure safe purge, light-off and shutdown procedures, and to monitor light-off, main flame and boiler operating conditions.

[(1) Control Type: The flame safeguard system shall be of the automatically sequenced type with complete programming timed and sequenced by a heavy duty, industrial type timer. This timer shall be tamper-proof and shall be designed so that advancement of the timer to shorten purge will shut down the unit.

] (2) Scanner and Relay: Provide system with ultraviolet [and infrared] scanner[s] and electronic relay located in the front wall which will shut down the fuel within 2 to 4 seconds of loss of flame.

(3) Output Meter: Provide scanner output meter in panel for indication of scanner signal strength.

(4) Limit Devices: The safety system shall include the following limit devices incorporated into a limit circuit:

(a) Flame failure

(b) High boiler outlet pressure

(c) Low fuel oil pressure

(d) Low natural gas pressure

(e) High natural gas pressure

(f) Low water level cutout

(g) Low combustion air flow

(h) Low atomizing [air] [steam] pressure

(i) Any additional as required by FM DS 12-17 or NFPA 85

(5) Annunciator: Safety system limits specified above shall be displayed on a first out annunciator mounted in the burner panel. [Provide a common alarm contact to be wired to the operator control console, specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

d. Light Off: Failure shall require a manual restart of the programmer. Safety system shall provide a mandatory purge with the forced draft fan vanes proven open, and a return to proven low fire position before light off. Main fuel valve shall open for a timed period of 10 seconds during trial for ignition.

e. Circuit Analyzer: Provide a circuit analyzer system, which, by means of 12 or more lights, will indicate which circuits are energized at any specific time, and will thereby indicate improperly operating circuit.

f. Control Panel: Programmer, limit control, relays and annunciator, shall be mounted in a [NEMA 1 control panel, modified with fully gasketed doors and panels mounted on burner package] [control panel as specified under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

2.5 FANS

****

NOTE: The designer shall make a technical evaluation to determine if the forced draft fan should be integrated with or mounted separately from the windbox on the floor next to the boiler. If the forced draft fan is to be mounted separately, delete this paragraph and specify the fan in the paragraph FANS.

****

2.5.1 Forced Draft Fan

CID A-A-59222, Type [_____], Class 1, except as specified otherwise.

2.5.1.1 Fan Size

Size fans for complete combustion of fuel at maximum firing rate taking into account design allowances, corrections for burner pressure drop, furnace pressure, combustion air temperature, plant elevation, and other design factors [including allowance for economizer]. After fans have been sized in accordance with the above, add the following allowances for momentary overloads and normal deterioration of fans, firing equipment and boilers:

a. Excess volume: 10 percent

b. Excess pressure: 20 percent

2.5.1.2 Fan Construction

Construct fan wheel of steel. Direction of fan discharge shall be easily changed at angles of 45 degrees. Provide fan with roller bearings mounted in pillow blocks.

2.5.1.3 Electric Motor

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the forced draft fan motor shall be provided with variable speed control. Generally, variable speed drives for forced draft fans over 7 1/2 kW 10 HP will be cost effective.

****

Motor for driving the forced draft fan shall be [variable speed], [two speed], [_____] volt, three phase, 60 Hz, [open drip-proof] [totally enclosed, fan cooled] not less than [_____] kW hp, as specified under MOTORS AND DRIVES in this section, and shall not overload at the specified capacity with unheated cold air. [Provide [_____] mm inch thick steel soleplate for motor. Soleplate must be common for all four motor mounting bolts. Separate parallel soleplate bars are not acceptable.]

2.5.1.4 Noise Level

Noise level shall not exceed 85 dBA sound pressure level at 1 1/2 meters 5 feet above the floor and 1 1/2 meters 5 feet from the fan in any direction. [Provide heavy duty sound attenuator with screen on fan inlet, if required, to meet the sound pressure level requirements.]

2.6 COMPRESSED AIR SYSTEM

****

NOTE: Refer to utilities schedule on definitive drawings for suggested plant air requirements.

****

2.6.1 Plant Compressed Air System

Provide [two] packaged units conforming to FS XX-C-2816 Type [_____], and ASME BPVC SEC VIII D1, except as modified below. Each compressor capacity shall be not less than [_____] L/s scfm of air, at 20 degrees C 68 degrees F and [_____] kPa (gage) psig (equivalent to pressure at an elevation of [_____] meters feet), compressed to 1379 kPa (gage) 200 psig at the discharge. Compressor speed shall not exceed [_____] rpm. Number of stages shall be [_____]. [Compressor shall have water cooled cylinders and heads.] [Oil free delivery is required.] Provide a safety valve between each compressor discharge and its shutoff valve. Provide a shutoff valve on the discharge piping of each compressor. Provide an electric thermostatically controlled immersion heater. Provide compressor with [air cooled] [water cooled] [intercooler and] aftercooler. [Compressor and motor shall be tank mounted.] Provide lifting lugs and tie down attachments.

2.6.1.1 Air Filter

Air filter on inlet shall act as a muffler. Provide filter of the [oil wetted type] [dry type] readily removable for cleaning.

2.6.1.2 Oil Filter

Provide full flow type filter for positive forced feed lubrication conforming to FS F-F-351.

2.6.1.3 Air Receiver

Receiver shall be [_____] cubic meters feet minimum volume designed in conformance with FS XX-C-2816 and ASME BPVC SEC VIII D1, except that working pressure shall be 1724 kPa (gage) 250 psig. Provide the receiver, with a safety valve set at a pressure not to exceed the maximum allowable working pressure of the receiver, a drain valve and an air trap with shutoff valve. [Provide a stand for mounting the receiver.] Provide a dial gage, not less than 114 mm 4 1/2 inches diameter, range zero to 2068 kPa (gage) 300 psig, on the receiver.

2.6.1.4 Electric Motor

Motor shall be [_____] volt, [_____] phase, 60 Hz, totally enclosed, fan cooled not less than [_____] kW hp, as specified under MOTORS AND DRIVES in this section. Control circuits for motors shall be nominal 120 volts.

2.6.1.5 Controls

Provide [constant speed] [dual control] regulation and the "optional safety controls" as specified in Table I of FS XX-C-2816 for the compressor system. In addition, provide a lead-lag control system with alternating lead-lag cycles.

2.6.2 Instrument Compressed Air System

Provide air compressor package with two compressors, two electric motors, one horizontal receiver, and control panel, [all mounted on one supporting steel base with skids] [mounted separately].

2.6.2.1 Air Compressor

Each air compressor shall be a single stage, cross head type, vertical, double acting, water cooled, nonlubricated head type. Compressor shall be specially designed for non-lubricated service, with a honed cylinder, piston rod packing, piston rings and piston wear rings. Valve guide inserts and wear rings shall be TFE. Valves shall be reversible and hardened, with stainless steel seat plates for nonlubricated service. Provide necessary sleeves, baffles, and collars to prevent oil carryover. Provide air operated, piston type, free air unloaders for capacity reduction and starting. Mount filter-silencer directly on the air inlet to the cylinder.

Design and Performance: Each compressor shall deliver not less than [_____] L/s scfm of free air at a discharge pressure of 690 kPa(gage) 100 psig.

2.6.2.2 Air Receiver

Air receiver shall be a horizontal tank with a volume not less than [_____] cubic meters feet. Design unit for 1034 kPa (gage) 150 psig working pressure in accordance with ASME BPVC SEC VIII D1. A receiver bearing the ASME Code Symbol stamp will be accepted as meeting these requirements. Provide an automatic condensate trap, safety valve, and outlet connection.

2.6.2.3 Aftercooler

Aftercoolers shall be water cooled, with counter current flow, and shall be installed directly between each compressor cylinder and the air receiver. Design cooler to cool the total output air flow of the compressor to within minus 9 degrees C 15 degrees F of the inlet cooling water temperature. The tube bundle shall be removable for cleaning and inspection.

2.6.2.4 Electric Motor

Each compressor shall be V-belt driven by a [_____] volt, [_____] phase, 60 Hz motor not less than [_____] kW hp as specified under MOTORS AND DRIVES in this section. Provide a removable, totally enclosed belt guard.

2.6.2.5 Controls

Provide controls and shutdowns for automatic operation of the compressor package. House controls in NEMA 12 control cabinet. Controls shall include two, full voltage, automatic across-the-line starters; alternator to switch compressors from lead to lag and to run both compressors when required; 120 volt control transformer; air discharge pressure gage; selection switches for constant speed for automatic dual control, along with necessary time delay and control relays. Provide automatic solenoid operated cooling water valve in the cooling water line to the compressors and aftercoolers. Factory wire control cabinet and mount as a part of the package.

2.6.2.6 Accessories

Factory assemble compressors, electric motors, controls, air receiver, aftercoolers, and miscellaneous hardware and mount on steel supporting base. Provide lifting lugs and tiedown attachments. Provide air, water, and condensate piping and terminate them at the edge of the supporting base. Lubricate inspection ports so that they can easily be removed for visual inspections.

2.6.2.7 Air Dryers

****

NOTE: Choose this item or item (b) below REFRIGERATED AIR DRYER.

****

[a. Desiccant Air Dryer: Provide for systems exposed to freezing temperatures a compressed air desiccant dryer with noncorrosive desiccant housed in twin pressure vessels, capable of drying [_____] L/s scfm of air to [_____] degrees C Fpressure dewpoint. Unit shall be field adjustable to maintain the pressure dewpoint of the dried air at any preselected value below operating temperature, to minus 40 degrees C F. As an integral part of the unit provide an indicator showing the water content of the dry air and a calibrated adjustment control to change the water content to any preselected level.

(1) Design: Design unit for maximum temperature of not less than 49 degrees C 120 degrees F and maximum operating pressure of not less than 1034 kPa (gage) 150 psig. Pressure drop through the unit operating at full rated flow shall not exceed 28 kPa 4 psi.

(2) Controls: Provide continuous supply of dry air by automatically cycling operation of the desiccant beds. Dryer shall be complete with panel mounted gages showing pressure in each drying tower and spark suppressor to protect microswitch in timer circuit. Total electrical power requirements shall not exceed 75 watts at 110 Vac.

(3) Filters: Provide prefilter upstream of dryer to remove oil vapor, liquid water, and solid particles. It shall have greater than 99 percent efficiency in removing both 0.5 micron diameter solid particles and 0.5 micron diameter oil aerosol. Filter shall have replaceable oil absorbing filter element which turns red to indicate saturation with oil and which shall be mounted in a transparent cast methyl methacrylate tube for visibility and inspection while on stream. Protect transparent acrylic tube by a safety shield. Provide afterfilter for removal of solid particles

down to 5 microns size.

]

****

NOTE: Choose this item or item (a) above DESICCANT AIR DRYER.

****

[b. Refrigerated Air Dryer: Provide for systems not exposed to freezing temperatures a compressed air dryer of self-contained refrigerated type complete with heat exchanger, a commercial quality refrigerated system, a moisture separator and condensate trap, and internal wiring and piping. Install dryer between the receiver and distribution line.

(1) Heat Exchanger: Provide air and refrigerant coils surrounded by aluminum granules of sufficient mass to insure adequate cooling capacity for varying air flow loads without causing excessive refrigeration cycling. Provide an automatic control system, for the heat exchanger with a sensing element located in the aluminum granules, to shut down the refrigeration system on low or no-load conditions. Provide means to determine exchanger temperature.

(2) Moisture Separator: Provide centrifuge type located within the heat exchanger to provide for moisture separation at point of minimum air temperature.

(3) Refrigeration Unit: Provide hermetically sealed type which operates intermittently at all but maximum load conditions. The unit shall be capable of drying [_____] L/s scfm of air to an atmospheric dew point of not less than minus 23 degrees C 10 degrees F with entering air at 38 degrees C 100 degrees F, saturated. The maximum operating pressure of the dryer shall be [_____] kPa (gage) psig. House the entire unit in a steel cabinet. Provide cabinet with access door and panel for easy access to parts for maintenance and inspection.

(4) Refrigerant: CFC-based refrigerants are prohibited. Refrigerant must have an Ozone Depletion Potential (ODP) no greater than 0.0, with exception to R-123.

]

2.6.3 Pressure Reducing Regulator

Provide self-operating type designed for not less than a 1724 kPa (gage) 250 psig operating pressure, and a normal operating temperature range of minus 29 degrees to plus 66 degrees C minus 20 degrees F to plus 150 degrees F. Regulator shall have an adjustable outlet pressure range not less than 34 to 690 kPa (gage) 5 to 100 psig with not less than four ranges. Provide external adjusting screw for adjustment throughout each spring range. Provide internal pressure tap for outlet pressure regulation.

2.7 BREECHING, EXPANSION JOINTS, STACKS, AND DAMPERS:

2.7.1 Breeching

Provide with rectangular cross section and fabricate of not less than 5 mm 3/16 inch thick black steel plate unless otherwise noted. Stiffeners shall be not less than 65 by 50 by 6 mm 2 1/2 by 2 by 1/4 inch steel angles welded to exterior with 50 mm 2 inch leg outstanding. Stiffeners shall not exceed one meter 3 feet on centers. Breeching shall connect to [each boiler flue gas outlet,] [intermediate heat recovery equipment,] [air pollution control equipment,] [and to stack as required].

2.7.1.1 Breeching Connections and Joints

Weld or bolt breeching joints unless indicated otherwise. Welding shall conform to AWS D1.1/D1.1M and AWS D1.3/D1.3M. Bolts for bolted connections shall be not less than 15 mm 1/2 inch diameter and spaced not more than 80 mm 3 inches apart, with bolts, lockwashers and nuts being hot-dipped galvanized. Provide bolted joints with a minimum of 3 mm 1/8 inch thick gaskets. Bolt breeching connections to boilers, equipment items, dampers, expansion joints, and breeching accessories. Flanged breeching connections to equipment shall be drilled to match flanges on equipment. Flanged joints shall be seal welded to make connection gas-tight.

2.7.1.2 Uninsulated Breeching

Thoroughly wire brush breeching which is not to be insulated and clean by degreasing with nonflammable solvent such as trichloroethylene prior to painting.

2.7.1.3 Breeching Access Doors

Provide breeching access doors where indicated. Construct access doors with frame and hinged door of cast iron or reinforced steel plate. Frame shall be not less than 635 by 940 mm 25 by 37 inches with access opening of 457 by 762 mm 18 by 30 inches. Connection to breeching shall be gasketed and made with minimum 15 mm 1/2 inch diameter hot-dipped galvanized bolts, lockwashers, and nuts spaced not less than 127 mm 5 inches on center. Each side of the access door shall have not less than two quick-clamp positive closing latches, with the long side opposite the hinges containing three clamps to give a gastight seal. Side of access door opposite hinges shall contain a minimum 80 by 125 mm 3 by 5 inch size handle. Provide a gasket consisting of 10 mm 3/8 inch diameter fire resistant resilient rope seal and mastic compound between the access door and the access door frame.

2.7.1.4 Breeching Cleanout Doors

Provide breeching cleanout doors where indicated. Construct cleanout doors of not less than 5 mm 3/16 inch thick steel plate. Secure cleanout doors to a 32 by 32 by 5 mm 1 1/4 by 1 1/4 by 3/16 inch thick angle frame with 10 mm 3/8 inch hot-dipped galvanized mounting bolts welded to the angle frame and spaced not more than 150 mm 6 incheso.c. Weld frame to breeching and provide a 1.50 mm 1/16 inchgasket between frame and cleanout door. Cleanout doors shall be not less than 610 mm 24 inches square except where breeching dimensions are smaller, in which case the cleanout door shall be full height of the breeching and not less than 305 mm 12 inches in length.

2.7.1.5 Breeching Structural Materials

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NOTE: The designer shall detail breeching supports and breeching stiffening. Breeching hangers shall be designed to carry not less than 5 times the breeching weight, or the breeching weight plus 136 kg 300 pounds whichever is greater. Hangers for rectangular breeching shall be of the trapeze type with angle or channel support members and hanger rods. Breeching shall be stiffened with angle or channel members as required to withstand internal

breeching static pressure.
****

Structural and support materials shall be steel and shall comply with the applicable sections of AISC 360. [Support and stiffen breeching as indicated.]

2.7.2 Expansion Joints

2.7.2.1 Metallic Breeching Expansion Joints

Provide factory fabricated metallic breeching expansion joints [where indicated]. Expansion joints shall be guided metal bellows type capable of a minimum of [_____] mm inches of axial travel. Form metal bellows from not less than 1.50 mm 1/16 inch thick type 321 stainless steel plate. Cover plates shall be not less than 3 mm 1/8 inch thick steel plate.

2.7.2.2 Non-Metallic Expansion Joints

Provide factory fabricated non-metallic breeching expansion joints 3 mm 1/8 inch minimum thickness [where indicated]. Expansion joints shall be constructed of fluoroelastomer vulcanized to two plies of knitted wire mesh capable of a minimum of [_____] mm inches of axial compression, [_____] mm inches of axial extension and [_____] mm inches of lateral offset [unless indicated otherwise]. Joints shall have a continuous operating temperature rating of 204 degrees C 400 degrees F, with excursion design standards up to 400 degrees C 750 degrees F. Operating pressure range shall be minus 34 kPa (gage) to plus 34 kPa (gage) minus 5 psig to plus 5 psig. Expansion joints shall be preformed with integrally molded corners, suitable for mounting against a 150 mm 6 inch flange. Provide carbon steel backup bars with slotted holes, bolts, and nuts.

2.7.3 Stacks (For Installation Without Flue Gas Scrubbers)

Stacks shall be free standing, dual wall with insulated annular space, self supporting, steel construction. Contractor shall assure that the design of the stack and supporting steel or concrete foundations meets or exceeds the design conditions listed below. Provide each stack complete with accessories and appurtenances, including test ports, sampling platforms, caged safety ladders, anchors, sleeves, insulation, base and chair rings, and cleanout door.

2.7.3.1 Construction

a. Air Space: Provide in the annular air space between the two steel shells insulation with sealing means to accommodate thermal expansion differentials and lateral deflections or sway of the inner and outer shells.

b. Opening Reinforcement: Provide openings with adequate reinforcement to minimize stress concentrations.

c. Inner Shell: Design wall thickness of the inner shell to be 1.50 mm 1/16 inch thicker than that required by dynamic and static structural design but not less than 5 mm 3/16 inch.

d. Outer Shell: Construct of ASTM A242/A242M steel with a plate thickness not less than [_____] mm inch.

e. Expansion Devices: Construct of corrosion resistant stainless steel suitable for the temperatures and flue gas combinations to be experienced by the stacks.

f. Base construction of the stack shall transmit forces and moments in the shell to the [foundation] [supporting steel] without local stresses of appreciable magnitude being induced in the shell or exceeding the allowable stresses of the supporting [concrete] [steel].

g. Provide openings in breeching and stack for test equipment for sampling flue gas and for metering devices. Openings shall be properly reinforced and designed for differential expansion. Breeching opening shall be of double wall construction. All penetrations through inside shell of stack shall be completely welded to provide proper sealing between the stack and the opening.

h. Provide top 1.22 meters 4 feet cone section of the stack of corrosion resistant steel.

i. Anchor Bolts: provide suitable anchor bolts.

2.7.3.2 Construction Accessories

Accessories to be provided:

a. Cleanout Door: Provide double wall insulated steel plate door complete with 25 mm one inch round hinge pin, gasket and not less than 18 swing bolts.

b. Inspection Trolley: Provide a ring of Type 304 Corrosion Resistant Steel (CRES) to support an inspection or painter's trolley. Weld ring and support from the stack plates with not less that three brackets 10 by 65 by 381 mm 3/8 by 2 1/2 by 15 inches. Space brackets at not more than 610 mm 2 feet on centers around the circumference of the stack.

c. Provide a three wheel CRES flat rail trolley of 227 kg 500 pound capacity. The trolley shall have guides to prevent it from leaving the track and a hole shall be provided in the hinge plate for the attachment of [_____] meters feet of 6 mm 1/4 inch CRES plow steel cable.

d. Ladder: Provide each stack with an external ladder with cage for the full height of the stack. Construct ladder and cage of corrosion resistant steel in accordance with ALI A14.3.

e. Thermocouples: Provide a flue gas sensing thermocouple well with thermocouple one meter 3 feet above the breeching opening and 1 1/2 meters 5 feet below the top of the stack. The wells shall be CRES and shall extend about halfway into the stack.

2.7.3.3 Finish

Stacks shall be shop coated prior to shipping from the factory.

2.7.3.4 Stack Sampling Platform

****

NOTE: Designer shall detail a stack sampling platform if required. If not required delete this

paragraph. If required the platform will have to be located at a point as approved by air pollution control agency having jurisdiction. Many local and state codes incorporate Title 40 Code of Federal Regulations, Part 60. Depending upon final air pollution control equipment arrangement this location may be on the stack or possibly on a long length of horizontal breeching. Stack sampling platform should have the following features:

1. Location of sampling ports would be according to 40 CFR 60 Appendix A, Method.

2. Platform should be one meter 36 inches wide but at ports location it should project away from breeching or stack a minimum of 600 mm 2 feet plus the diameter of the breeching or stack for up to 3 meters 10 feet in diameter stack.

3. If any type of continuous air pollution monitoring devices are located at stack sampling point or anywhere else on breeching, a non-vertical access (stairs or catwalk) is required. For stack sampling purposes a non-vertical ladder is preferred but is not required. Platform with grating shall be designed for a live loading of 1464 kg/m2 300 lbs/sq. ft; platform should have railing with two intermediate railings and 100 mm 4 inch toeplate. Four 30 amp weatherproof receptacles and adequate lighting including lights over the test ports should be provided.

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Provide stack sampling platform conforming to the requirements of 29 CFR 1910-SUBPART D.

2.7.4 Dampers

2.7.4.1 Multilouver Dampers

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NOTE: Opposed blade dampers shall be used for throttling service and parallel blade dampers shall be used for two-position service.

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Provide factory fabricated multilouver dampers with [parallel] [or] [opposed] blade type operation. Construct damper frame of distortion resistant welded steel channels with raised seat to ensure free nonbinding operation of blades and to keep blades square in the frame. Construct blades of 6 mm 1/4 inch thick steel plate in a stressed skin airfoil-shape with fully welded seams containing no external ribs. Blade shafts shall be stainless steel. Blades shall be pinned to blade shafts. Louver shaft bearings shall be outboard type and shall be self-lubricating and self-cleaning. Bearing seals shall be gas-tight.

a. Multilouver Damper Linkage: Damper linkage shall be adjustable and of pinned construction for easy removal and shall be designed to handle full operation torque. Linkage on dampers in clean flue gas areas shall operate from a single connection point. Design linkage on dampers in dirty flue gas areas, between boiler outlet and inlet to air pollution equipment, so that the bottom blade linkage arm is not connected to the above linkage, to allow this blade to operate separately. The remaining linkage for this damper shall be constructed to operate from a single operating point.

b. Control Damper Operators: Provide control damper operators as noted. Operators may be either electrically or pneumatically operated with positive positioning, manual override, and hydraulic or oil immersed gear trains. Each operator shall be full-proportioning type, with spring return to position indicated in case of loss of power. Damper operating speeds shall be selected or adjusted so that the operators will remain in step with the controller. Operators acting in sequence with other operators shall have adjustment of control sequence as required by the operating characteristics of the system.

c. Two-Position Damper Operators shall be pneumatically operated with air cylinder, four way valve, and solenoid valve arrangement.

2.7.4.2 Guillotine Dampers

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NOTE: Guillotine dampers shall be used for open-shut service where tight shutoff is required; for example, for air pollution control equipment bypass dampers.

****

Provide factory fabricated guillotine dampers with heavy structural frame rigid enough to support the extended blade and external loads through the breeching flange. Damper shall be capable of operating without precleaning or manual assistance under normal operating conditions. Enclosed bonnets will only be required where indicated. Provide three inch diameter cleanout ports on both sides for cleaning bottom sections.

a. Guillotine Damper Blades: Provide stress-relieved flat plate guillotine damper blades. Damper blade shall be nonwarping. Intermediate blade supports are acceptable to limit blade deflection. The leading edge of the damper blade shall be beveled and capable of guiding damper blade into frame seat. Blade guides shall be continuous and self cleaning and capable of preventing binding from deposits and damage from misalignment. Bonnet guides shall be removable. Design damper so that a damper blade can be replaced without opening the frame.

b. Guillotine Damper Bonnet Seal: Provide bonnet seal to effectively seal against atmospheric leakage under normal operating conditions.

c. Guillotine damper drive shall be a positive dual endless chain drive capable of driving damper in both directions. Chain drive headshaft shall have sufficient torsional rigidity to prevent binding of blade if the blade is stalled. Damper shall be motor operated with manual override. Design drive mechanism to prevent back driving of motor. Entire drive mechanism shall be of a simple design and require no routine maintenance other than inspection. Chain shall be capable of operating up to the stall torque of the damper drive motor.

d. Electric Motor: Shall be [_____] volt, [_____] phase, 60 Hz, [totally enclosed, fan cooled] [open drip-proof], not less than [_____] kW hp, as specified under MOTORS AND DRIVES in this section. Provide removable, totally enclosed chain guard.

2.7.5 Sampling Ports

Weld two sampling ports to [breeching] [stack] at 90 degrees apart. Each port shall consist of a section of 100 mm 4 inch diameter steel pipe with threaded cap.

2.8 FUEL OIL SYSTEM

Provide fuel oil system as specified in Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION), for tanks located above grade, and Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS, for tanks below grade.

2.9 MISCELLANEOUS EQUIPMENT

2.9.1 Condensate Receiver

Provide a [horizontal] [vertical] type tank not less than [_____] meters feet [_____] mm inches in diameter by [_____] meters feet [_____] mm inches [long] [high] overall with a storage capacity of not less than [_____] liters gallons. Tank shall be constructed of welded steel plate not less than 10 mm 3/8 inch thick. Provide condensate tank with a 600 mm 24 inch diameter manway, dual gage glasses with protective guards, saddles, and other connections as indicated.

2.9.1.1 Coating

Surface blast interior of tank to bare metal and coat with a baked-on phenolic lining or corrosion resistant liner consisting of a resin and hardener suitable for immersion in water at not less than 121 degrees C 250 degrees F. Coat tank exterior with one shop coat of manufacturer's standard primer rated for service of not less than 121 degrees C 250 degrees F.

2.9.1.2 Accessories

Provide the condensate receiver with the following:

a. Connections for condensate pumped return, vent, water outlet, drain, sampling outlet, level transmitter and controls.

b. [_____] mm inch vent.

c. Reflex type water gage glasses with shutoff valves and guards.

d. One, 125 mm 5 inch dial, thermometer, 10 to 149 degrees C 50 to 300 degree F range, with lagging extension type wells, for steam and water space.

e. [_____] mm inch overflow trap.

f. One high water alarm switch with stainless steel float and trim. Circuit shall close as liquid level rises. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of receiver.

g. One low water alarm switch with stainless steel float and trim. Close circuit as liquid level falls. Locate switch to close circuit when water level drops to 25 percent of the storage capacity of the storage tank.

h. Install switches on a single column with valved connections to tank. Provide unions in pipe on each side of each float switch.

i. Furnish pipe, fittings, controls, specialties, bolts, gaskets, drains, valves, necessary for a complete unit. Install at the jobsite.

j. Provide automatic control system to control level in condensate tank by modulating discharge from condensate pumps.

2.9.2 Deaerating Heater

2.9.2.1 General

Provide a deaerating feedwater heater with storage tank conforming to FS W-H-2904 and to ASME BPVC SEC VIII D1, except as modified below. Tank shall be ASME Code stamped. Provide stainless steel trays. No test model will be required.

Model A - Pressurized operation.

Type I - Tray-type heating and deaerating element.

Class 3 - 10 minute water storage capacity (minimum).

Grade A - Guaranteed removal from water of dissolved oxygen in excess of 0.005 cubic centimeters(cc) per liter 0.0012 in3/gal, over a ten to one load swing.

2.9.2.2 Heater Capacity

Provide deaerating heater capable of heating and deaerating makeup water consisting of [_____] kg per second pounds per hour of softened makeup water from [_____] degrees C F to [_____] degrees C F (outlet temperature).

2.9.2.3 Inlet Water Characteristics

Softened makeup water:

Ph: [_____]
Total hardness (as CaC03): [_____]

2.9.2.4 Storage Tank

Horizontal design with steel supports [drilled for bolting] of approved design. Provide storage tank with not less than a 400 by 500 mm 16 by 20 inch minimum size manhole and cover and provide heater section with not less than a 300 by 450 mm 12 by 18 inch minimum size tray access handhole and door.

2.9.2.5 Vent Condensing Arrangement

Provide the deaerating heater with a vent condenser which shall condense the vented steam when the heater is operating at full capacity with the inlet water mixture at a temperature not exceeding 82 degrees C 180 degrees F. Construct the vent condenser, when of the direct contact type, with stainless steel baffling.

2.9.2.6 Materials

Construct trays, tray supports, water distributors, and other parts coming in contact with underaerated water or air laden steam of 430 stainless steel.

2.9.2.7 Accessories

Provide deaerating heater with the following accessories:

a. Pressure Relief Valve: Sized in accordance with FS W-H-2904.

b. Thermometers: Two, 125 mm 5 inch dial thermometers, 10 to 149 degrees C 50 to 300 degrees F, with lagging extension type wells for the storage tank and the heater section. Provide a thermometer similar to above but with range of minus [_____] degrees C F to plus [_____] degrees C F for the makeup water connection.

c. Lifting attachments for the tray section and the storage tank.

d. Water Gage Glasses: Reflex type with shutoff valve and guards.

e. Pressure Gages: One 150 mm 6 inch dial compound pressure gage for the heater section with range from [_____] kPa inches of mercury (vacuum) to [_____] kPa (gage) psig.

f. Float Controllers:

    (1) Inlet condensate controller

    (2) Makeup water controller

    (3) Overflow controller

g. Overflow Control Valve: With pneumatic controller arranged for local automatic operation.

h. Storage Tank Gage Glass: Full height, shielded, for storage tank including shutoff valve and drain cocks.

i. Makeup Water Inlet Control Valve: With pneumatic controller.

j. Switches: For low water level alarm in the storage tank, high water level alarm, condensate pump shutdown in the storage tank, and low steam pressure alarm. Install switches on a single column with connections valved and unions provided in pipe on each side of each float switch.

k. Special tools: One set for maintenance.

l. Condensate Pump Reset: With stainless steel float and trim to reset pump shutdown switch on fall of liquid level in tank to [_____] mm inches below level of overflow level of storage tank.

m. Furnish pipe, fittings, controls, specialties, bolts, gaskets, drains, and valves, necessary for proper attachment of accessories and trimmings and install.

[n. Oil separator

]2.9.2.8 Connections

Provide necessary connections for condensate, steam, makeup water, removal of vented gases, vacuum breakers, discharge of deaerated water, and instruments and controls.

a. Provide heater connections as follows:

(1) [_____] mm inch steam inlet

(2) [_____] mm inch makeup water inlet

(3) [_____] mm inch condensate

(4) [_____] mm inch high pressure trap return

(5) [_____] relief valves sized as required

(6) [_____] mm inch vent

(7) [_____] mm inch for thermometer well

(8) [_____] mm inch for pressure gage

(9) Vacuum breakers as required

(10) [_____] mm inch heater drain

(11) [_____] mm inch spare [capped] [flanged]

(12) [_____] mm inch spare [capped] [flanged]

(13) Handholes and manhole with covers

b. Tank connections shall include:

(1) [_____] mm inch drain

(2) [_____] mm inch boiler feed recirculation ([_____] required)

(3) 25 mm One inch sampling

(4) 25 mm One inch chemical feed

(5) [_____] mm inch for sight glass ([_____] sets required)

(6) [_____] mm inch for high and low level alarm switches

(7) [_____] mm inch thermometer well

(8) Vacuum breakers as required

(9) [_____] mm inch spare (capped)

(10) [_____] mm inch spare (flanged)

(11) [_____] mm inch level transmitter and controller ([_____] sets required)

(12) Downcomer and equalizer as required

(13) [_____] mm inch feedwater outlet

(14) [_____] mm inch overflow outlet with internal water seal

2.9.2.9 Level Control

Provide an automatic control system to control water level in the storage tank, by modulating valves in makeup water lines. Condensate pump output shall be controlled by level in condensate storage tank.

a. Controllers: Provide external cage type air operated level controllers for both the condensate and makeup water lines complete with 40 mm 1 1/2 inch screwed connections, external cage, and controller. Cage body shall be Class 125 cast iron construction. Internal components including displacer, torque tube, displacer rod, displacer rod driver and bearings shall 316 stainless steel. Displacer shall be 350 mm 14 inches long. Controller shall be direct acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band adjustment. Locate controller to maintain an operating level at 2/3-full point of storage tank. Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

b. Air Operated Regulating Valves: Provide air operated control valves for both the condensate and makeup water lines. Valves shall have Class 125 or Class 150 rating with iron or semi-steel bodies and 316 stainless steel internals. Provide condensate valve which fails open on loss of air and makeup water valve with an air lock mounted on valve diaphragm to hold valve in last position on loss of air. Design valves for the following conditions:

	Condensate	Makeup Water
Valve size	[_____] mm	[_____] mm
Capacity	[_____] L/s	[_____] L/s
Maximum pressure drop at above capacity	[_____] kPa (gage)	[_____] kPa (gage)
Available pressure	[_____] kPa (gage)	[_____] kPa (gage)
Minimum Cv at 100 percent open	[_____]	[_____]

	Condensate	Makeup Water
Valve size	[_____] inch	[_____] inch
Capacity	[_____] gpm	[_____] gpm
Maximum pressure drop at above capacity	[_____] psig	[_____] psig

	Condensate	Makeup Water
Available pressure	[_____] psig	[_____] psig
Minimum Cv at 100 percent open	[_____]	[_____]

2.9.2.10 Low Pressure Steam Control

Provide an automatic control system to control the steam to the deaerating heater. Maintain steam pressure in the heater by modulating a pressure reducing valve in the steam supply line. Control shall be local and remote from the control panel.

a. Controller: Adjustable proportional band, 0 to 103 kPa (gage) 15 psig brass bellows for input signal, and 20 to 103 kPa (gage) 3 to 15 psig output air pressure range, pilot controller complete with air set (valve, filter, drier and pressure regulator) mounted on control valve yoke.

b. Pressure Reducing Station Control Valve: Provide a [_____] mm inch air operated pressure reducing valve with proper internals to pass a flow of [_____] kg per second pounds per hour of steam. Steam at the valve inlet shall be [_____] kPa (gage) psig saturated, and the outlet shall be controlled at [_____] kPa (gage) psig. Minimum steam flow shall be approximately [_____] kg per second pounds per hour. Minimum valve Cv shall be [_____] at 100 percent open. Valve shall be Class 250 or Class 300 flanged, iron or semi-steel body with stainless steel internals equal percentage flow characteristics and a full size port. Provide valve actuator including travel indicator, hand jack, valve positioner, and air supply filter-reducer set. Valve shall move to open position in case of failure.

2.9.2.11 Gage Glasses

Provide gage glasses to cover the entire range of water level in the storage section. Gage glasses shall not be greater than 600 mm 24 inches center-to-center. Provide gage glasses complete with [chain operated] ball check shutoff and drain cock valves and safety shield.

2.9.2.12 Alarms

Provide high and low water level alarms for storage tank as follows:

a. High Water Level Alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level rises to 25 mm one inch below overflow level of storage tank.

b. Low Water Level Alarm: Switch with stainless steel float and trim. Locate switch to close circuit when water level falls to [_____] meters feet [_____] mm inches above bottom of storage tank.

c. Coordination: Coordinate alarms with annunciator panel as indicated.

2.9.2.13 Multiport Back Pressure Relief Valve

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NOTE: Use multiport valve on systems where deaerating heater will be subject to occasionally

overpressuring.

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Provide valve capable of relieving not less than [_____] kg per second pounds per hour of steam with not more than a [_____] kPa (gage) psig pressure rise when set at [_____] kPa (gage) psig initial operating pressure. Set pressure shall be fully adjustable by means of an external handwheel or chain operator for a range of zero to 172 kPa (gage) 25 psig. Locate on low pressure steam header manifold for the deaerating heater. Valve shall be multiport vapor cushion type rated for operating temperatures up to but not greater than 149 degrees C 300 degrees F with Class 125 cast iron body, bronze trim and carbon steel springs.

2.9.2.14 Exhaust Head

CID A-A-50494, Type [I (cast iron)] [II (fabricated steel plate)] of [_____] mm inch size with [_____] mm inch diameter drain, and a capacity of [_____] kg per second pounds per hour of steam at [_____] kPa (gage) psig.

2.9.3 Boiler Feed Pumps

****

NOTE: Use this paragraph for centrifugal boiler feed pumps. Use Style 1, horizontal split case pumps in all sizes. Pump service requirements shall include a minimum pump capacity of 125 percent of boiler requirements at maximum load. Discharge head must be sufficient to deliver water to the boiler at a pressure 3 percent higher than the boiler safety valves setting and up to 6 percent over the maximum operating pressure of the boiler in accordance with the ASME Boiler and Pressure Vessel Code.

****

CID A-A-50562, Type II (boiler feed pump), Style 1 (horizontally split case), Class 2 (multi-stage) except as modified below. Each pump shall be two stage with horizontal split casing, enclosed single suction opposed type impellers, renewable casing and impeller wearing rings, stuffing box with quenching gland and flooded oil lubricated, water cooled bearings.

2.9.3.1 Pump Service Requirements

a. Capacity: [_____] L/s gpm

b. Pumping temperature: [_____] degrees C F

c. Liquid pH: [_____]

d. Discharge head: [_____] Pa feet

e. Available NPSH: [_____] Pa feet

f. In addition to the operating point established above, the pump curve shall also run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

2.9.3.2 Construction

Boiler feed pumps shall be bronze fitted including bronze impeller and impeller wear rings, and ASTM A48/A48M, Class 30, cast iron casing. Provide casing with suction and discharge gages in tapped openings. Mount each pump and prime mover on a fabricated steel bed plate having a drip collection chamber with tapped drain openings. Provide lifting attachments to enable equipment to be set into its normal position and to enable pumps to be easily dismantled in place.

2.9.3.3 Electric Motors

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the boiler feed or condensate pump motors shall be provided with variable speed control. Generally, variable speed drives for boiler feed or condensate pumps over 5 1/2 kW 7 1/2 HP will be cost effective.

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[Variable speed], [open dripproof], [totally enclosed], [fan cooled], [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified under MOTORS AND DRIVES [and VARIABLE SPEED CONTROL FOR MOTORS] in this section. [Variable speed] electric motors [or turbines] direct connected to respective pumps with a gear type, forged steel, flexible coupling. Provide a shaft and coupling guard.

2.9.3.4 Steam Turbines

Single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F and normal exhaust back pressure of 34 kPa (gage) 5 psig or a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg per BkW per second pounds per BHP per hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve. [Variable speed] turbines direct connected to respective pumps with a gear type, forged steel, flexible coupling. Provide a shaft and coupling guard.

a. Turbine Construction: Turbine casing split on the horizontal centerline constructed of ASTM A48/A48Mcast iron, with a design pressure rating of 1724 kpa (gage) 250 psig at 232 degrees C 450 degrees F at inlet, and 379 kpa (gage) 55 psig at 232 degrees C 450 degrees F at the outlet.

b. Turbine Bearings and Shaft: Horizontal split, ring oiled, sleeve type, water cooled. The shaft shall be stainless steel or chrome plated under the packing glands. The shaft seals shall be segmented carbon rings with springs and stops.

c. Speed Governor: Variable speed oil relay, NEMA Class D governor for speed control and pneumatic operator to maintain an adjustable, preset pump discharge header pressure by variation of turbine speed. Input to the operator shall be a 20 to 103 kPa (gage) 3 to 15 psig pneumatic signal. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the control system controller specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

d. Emergency Overspeed Governor: Completely independent of the speed governor and shall operate trip valve.

e. Insulation: Turbine shall be insulated and lagged by the manufacturer as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.9.3.5 Minimum Flow Protection for Boiler Feed Water Pumps

a. Automatic Flow Control Valve: Provide with each pump an automatic bypass valve. Valve shall automatically program the recirculation flow, the detection of low flow, the cycling of control valve and pressure letdown for high pressure boiler feedwater return to the feedwater heater. Bypass valve shall be cast steel with stainless steel internals, and shall have a rating of not less than 2068 kpa (gage) 300 psig at 204 degrees C 400 degrees F. Valve shall have a line size body with a 25 mm one inch recirculation connection.

b. Boiler Feedwater Automatic Recirculation System: (Option to Automatic Valve). Provide a boiler feedwater automatic recirculation system to protect the feedwater pumps at low flow conditions. System shall be capable of recirculating the minimum flow recommended by the pump manufacturer. The system shall be an engineered system consisting of the various functional components specified or shall be a self-contained and self-powered mechanical system. Components of the engineered system shall include a flow transmitter with orifice in feedwater line, bypass flow controller with bypass flow control valve, and a bypass pressure reducing orifice.

   (1) System Bypass Flow Controller: Include detection of low flow and modulation of a control valve in a bypass line returning to a low pressure sink. Incorporate a pressure let-down feature or device to reduce the pressure from the boiler feedwater pump discharge pressure to that of the low pressure sink.

   (2) System Bypass Control Valve: Modulate to provide minimum flow recommended by the pump manufacturer and to provide shutoff or recirculation flow when feedwater flow to the boilers exceeds the minimum flow required for pump protection.

c. Feedwater Stop and Check Valves: Provide a Class 300, flanged, cast steel feedwater stop gate valve and check valve on the feedwater outlet of each pump. Provide piping from the valves to the economizer inlet, and from the economizer to the flanged connection on the boiler drum.

Provide connection on pipe at economizer outlet for remote recording thermometer.

2.9.4 Condensate Pumps

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NOTE: Use this paragraph for centrifugal condensate pumps. Pump service requirements shall include pump capacity a minimum of 125 percent of boiler requirements. Discharge into deaerator heater shall be modulated.

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CID A-A-50562, Type I, Style [1 (horizontally split case)] [2 (end suction)], Class 1 (single stage) unless modified below.

2.9.4.1 Condensate Pump Service Requirements

a. Capacity: [_____] L/s gpm

b. Pumping temperature range: [_____] to [_____] degrees C F

c. Liquid pH: [_____]

d. Discharge head: [_____] Pa feet

e. Available NPSH: [_____] Pa feet

f. In addition to the operating point established above, the pump curve shall also run through the following points:

Capacity	Discharge Head
[_____] L/s	[_____] meters
[_____] L/s	[_____] meters

Capacity	Discharge Head
[_____] gpm	[_____] feet
[_____] gpm	[_____] feet

2.9.4.2 Construction

Condensate pumps shall have bronze impellers and impeller wear rings. Pump casings shall be [cast iron] [ductile iron], and shall be designed for the specified conditions. Bearings shall be oil lubricated. Casings shall have tapped openings for suction and discharge pressure gages. Provide suction and discharge pressure gages in openings. Mount pump and driver on a fabricated steel bed plate having a drip collection chamber with tapped drain openings. Provide lifting attachments for installation and maintenance.

2.9.4.3 Electric Motors

****

NOTE: The designer shall perform an economic analysis and make a technical evaluation to determine if the boiler feed or condensate pump motors shall be provided with variable speed control. Generally, variable speed drives for boiler feed or condensate pumps over 5 1/2 kW 7 1/2 HP will be cost effective.

****

[Variable speed], [open dripproof], [totally enclosed], [fan cooled], [_____] volt, three phase, 60 Hz of not less than [_____] kW hp, as specified under the paragraph MOTORS AND DRIVES [and VARIABLE SPEED CONTROL FOR MOTORS] in this section. [Variable speed] electric motors direct connected to the respective pumps with a gear type flexible coupling. Provide shaft and coupling guards.

2.9.4.4 Steam Turbines

Single stage, rated at not less than [_____] kW hp, with inlet steam pressure of [_____] kPa (gage) psig and [_____] degrees C F, normal exhaust back pressure of 20 kpa (gage) 5 psig and a maximum back pressure of 103 kPa (gage) 15 psig. Water rate at full load and normal steam conditions shall not exceed [_____] kg per BkW per second pounds per BHP per hour. Provide a stainless steel steam strainer, sentinel relief valve, sight oil level indicator and one hand valve. [Variable speed] turbines direct connected to the respective pumps with a gear type flexible coupling. Provide shaft and coupling guards.

a. Turbine Construction: Turbine casing split on the horizontal or vertical centerline constructed of ASTM A48/A48M cast iron, with a design pressure rating of 1724 kPa (gage) 250 psig at 232 degrees C 450 degrees F at inlet, and 379 kpa (gage) 55 psig at 232 degrees C 450 degrees F at the outlet.

b. Turbine Bearings Shaft: Ring oiled, anti-friction type. Shaft shall be stainless steel or chrome plated under the packing glands. Shaft seals shall be segmented carbon rings with springs and stops.

c. Speed Governor: Variable speed governor for speed limiting and pneumatic operator to maintain an adjustable preset level in [deaerator tank] [condensate receiver] by variation of turbine speed. Input to the operator shall be a 34 to 103 kPa (gage) 3 to 15 psig pneumatic signal and vary the turbine speed from minimum to full speed in a linear response. Maximum and minimum speed shall be adjustable. Provide an electro-pneumatic transducer to accept the 4 to 20 mA signal from the controller specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

d. Emergency Overspeed Governor: Completely independent of the speed governor and shall operate a separate trip valve.

e. Insulation: Turbine shall insulated and lagged as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.9.5 Variable Speed Motor Controller

Remotely installed cabinet housed units with solid state rectification and inverter equipment to vary frequency of electrical power to the drive motors.

2.9.5.1 Housing

House the controller in a [wall] [floor] mounted, NEMA [_____] enclosure finished with manufacturers standard painted finish. Provide control panel complete with fused disconnect switches, magnetic [across the line] [part winding] starters with thermal overload protection, transformer, hand-off-automatic selector switches, hand potentiometer for manual speed control, fuses and running lights.

Manual Switch: Locate the manual switch within the control panel so that in the event failure of any of the components the motor can be put across the line at full voltage to maintain air or pump pressure. Provide a mechanical door interlock that allows the panel to open only when the fused disconnect is in the off position.

2.9.5.2 Variable Frequency Controllers

Variable frequency controllers shall use solid-state semiconductor power conversion equipment. Provide controllers as integrated and assembled products. Controllers shall be furnished by the same manufacturer.

2.9.5.3 Ratings

Each controller shall be rated for a supply of [_____] volts, three phase, 60 Hz. The output shall be [_____] volts, three phase with frequency variable between zero and 60 Hz. Controllers shall be rated to operate the motors continuously at their rated kilowatt horsepower and frequency. Speed regulation shall be within (plus or minus) three percent of set point without tachometer feedback. Electrical supply system shall have an available short circuit rating of [_____] amperes symmetrical.

2.9.5.4 Minimum Speed

Each controller shall be capable of driving the motor continuously at a lower speed no greater than 20 percent of full rated motor speed with stable operation and without overheating the motor under rated ambient conditions. Provide estimate of minimum speed at which motor can be operated continuously without overheating or problems of instability due to overhauling of the load.

2.9.5.5 Fault Protection

Provide controller fault protection so that a single or three phase short circuit at the controller terminals or inverter commutation failure will not result in damage to power circuit components. Provide overload protection so that motor and controller are protected against operating overloads.

2.9.5.6 Time Delay

Provide adjustable time delay under voltage protection so that motors will continue to operate during momentary voltage fluctuation or loss of voltage. Time adjustment shall be zero to 5 seconds. Provide for orderly shutdown on undervoltage conditions exceeding the time delay interval.

2.9.5.7 Acceleration/Deceleration

Provide adjustable timed linear acceleration and deceleration.

2.9.5.8 Voltage/Frequency Control

Provide volts/Hz control to prevent motor overheating throughout the speed range.

2.9.5.9 Door Interlocks

Provide door interlocks to prevent opening of enclosure doors unless power is disconnected.

2.9.5.10 Shutdown Conditions

Controllers shall be self protecting and shall provide orderly shutdown for, but not limited to, the following conditions:

a. Loss of input power

b. Undervoltage

c. Sustained gradual overload

d. Fault or large instantaneous overload

e. Overtemperature

f. Failure of ventilating system

g. Overvoltage

h. Control circuit failure

Provide contacts for remote annunciation of shutdown or abnormal condition.

2.9.5.11 Electrical Bypass

Provide each controller with manual isolation and bypass switching. Switch shall be manually operated with controller deenergized. Switch shall be two position with provisions for locking the switch in either position.

a. Normal Position: Bypass shall be open and connect controller to the supply circuit and the load.

b. Bypass Position: Bypass shall be closed and the controller shall be electronically isolated from the supply and the load. Isolating contacts shall be located so that it is possible to verify by visual inspection that the contacts are open and the controller is electrically isolated. In the bypass position the motor shall be operated at constant speed and controlled from the air circuit breaker. Provide auxiliary contacts that close in the bypass position. Auxiliary contacts shall be used to activate the damper control to provide fan load control in the bypass position.

2.9.5.12 Controller Environmental Protection

a. Ventilation: Design controllers enclosed and ventilated for installation in a moderately dusty area. Provide forced filtered ventilation including fans, filters, controls and accessories required for operation. Enclosures shall be operated under positive pressure at all times. Provide filtered ventilating openings and gasketed doors to prevent infiltration of dust.

b. Heating: Provide electric heaters to prevent condensation in the enclosure and to prevent low ingoing air temperatures that exceed the equipment rating. Provide a low temperature alarm to sound when enclosure temperature falls below required minimum temperature. Provide contacts for remote annunciation of alarm condition.

2.9.5.13 Method of Control

Supply each controller from an electrically operated air circuit breaker or motor starter. Controller ventilation and heating shall be from another circuit.

a. Start Signal: Closes the electrically operated air circuit breaker or motor starter to energize the controller. The controller shall accelerate the fan to operating speed. Fan speed shall be controlled from the load control signal.

b. Stop Signal: Opens the electrically operated air circuit breaker or motor starter to deenergize the controller. Upon deenergization, the controller control system shall revert to the stop condition.

c. Boiler Feedwater Pump Speed Control System: Matches pump discharge to system demand and maintains a system header pressure controlled to the set point values. Provide Manual/Automatic control stations for master pressure and for each boiler feed pump. Provide indicators for feedwater header pressure and individual boiler feedwater pump flow. See Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.9.6 Valve Actuators

[Electrically] [or] [pneumatically] operated and designed so that valve may be manually operated by removing the drive pins. Actuators shall be operated by push button control. Locate one push button at a position adjacent to the valve. Locate a second push button within the boiler control room. Provide a valve position indicator utilizing indicating lights. A green light shall indicate the valve is fully open and an amber light shall indicate the valve is fully closed. Both lights on shall indicate when the valve is partially open. [Provide torque limit controls to protect the valve during opening and closing for electrically operated valves.] Actuator electric motor shall be totally enclosed, [_____] volts, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section. Provide NEMA 4 control enclosures.

2.9.7 Sump Pumps

CID A-A-50555 with automatic float switch and disconnect switch in NEMA 6 enclosure.

2.9.8 Water Softening System

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NOTE: One hundred percent makeup shall be assumed in calculating the sustained softening rate.

****

Ion exchange resin type conforming to WQA S-100 except as modified below. [Manual] [Push button automatic] [Fully automatic] in operation with operating controls housed in a NEMA 12 enclosure having a total capacity between regenerations of not less than [_____] liters gallons of water of [_____] grains hardness when operated at a sustained softening rate of [_____] L/s gpm. The maximum effluent water temperature shall be [_____] degrees C F.

2.9.8.1 Raw Water Analysis

****

NOTE: Regarding the text below: Analysis of the water available for makeup shall govern the softener system selected. A competent water treating consultant shall be obtained to formulate specific system recommendations if the makeup water analysis indicates any of the following:

1. Iron in excess of 0.1 ppm as Fe.

2. Mg Alkalinity in excess of 50 ppm as CaCO3.

3. Silica in excess of 6 ppm as SiO2.

****

The source of the raw water is [_____]. It is available at pressures of [_____] to [_____] kPa (gage) psig. The analysis of the water available for makeup is approximately as follows:

TABLE 1: MAKEUP WATER ANALYSIS			
	Constituent	Analysis	Parts Per Million
Cations	Calcium (Ca++)	as CaCO3	[_____]
	Magnesium (Mg++)	as CaCO3	[_____]
	Sodium (Na+)	as CaCO3	[_____]
	Hydrogen (H+)	as CaCO3	[_____]
TOTAL CATIONS		as CaCO3	[_____]

TABLE 1: MAKEUP WATER ANALYSIS

Anions	Bicarbonate (HCO3 -)	as CaCO3	[_____]
	Carbonate (CO3 --)	as CaCO3	[_____]
	Hydroxide (OH -)	as CaCO3	[_____]
	Sulfate (SO4 --)	as CaCO3	[_____]
	Chloride (Cl -)	as CaCO3	[_____]
	Phosphate PO4 ---)	as CaCO3	[_____]
	Nitrate (NO3 -)	as CaCO3	[_____]
TOTAL ANIONS		as CaCO3	[_____]
	Total hardness	as CaCO3	[_____]
	Methyl orange alkalinity	as CaCO3	[_____]
	Phenolphthalein alkalinity	as CaCO3	[_____]
	Iron, total	as Fe	[_____]
	Carbon dioxide	as Free CO2	[_____]
	Silica	as SiO2	[_____]
	Suspended solids (Turbidity)		[_____]
	Total dissolved solids (TDS)		[_____]
	Free acids		[_____]
	Color		[_____]
	pH		[_____]
	Specific Conductance Microhms/cm		[_____]

2.9.8.2 Softener Effluent Analysis

****

NOTE: At the text below, total solids of 175 ppm (parts per million) in the feedwater concentrated 20 times give 3,500 ppm in the boiler water.

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a. Hardness: Maintain hardness of the softened feedwater near zero and in no case allow it to exceed 1.0 ppm (parts per million) as $CaCO_3$.

b. Total Solids: Maintain total solids in the softened feedwater at a level to ensure a total solids concentration in the boiler water of less than 3,500 parts per million (ppm) without excessive blowdown.

2.9.8.3 Softener Equipment

Including but not limited to the following:

a. Water Hardness Monitor: Provide a water hardness monitor with an alarm point at 1.0 ppm to ensure compliance for boilers rated above 3150 gram per second (g/s) 25,000 lb/hr.

b. Total Solids Monitor/Controller: Provide a continuous monitor and controller (when required) to control the concentration of dissolved solids and treatment chemicals in the water for boilers rated above 3150 g/s 25,000 lb/hr.

c. Water Meter: Provide a [_____] mm inch cold water meter on each softener unit.

d. Ion Exchange Resin: High capacity, polystyrene base, sulfonated synthetic type except that the exchange capacity shall be not less than 2 kg per cubic meter 30 kilograins per cubic foot at a salt dosage of 240 kg per cubic meter 15 pounds per cubic foot.

e. Tank Sizing: Minimum acceptable bed depth of 760 mm 30 inches; maximum acceptable bed depth of 1830 mm 72 inches. Base reactor tank sizes on allowing a freeboard above the resin bed of not less than 75 percent of the resin bed depth, and flow rate between 1.11 and 7.14 L/s per cubic meter 0.5 and 3.2 gpm per cubic foot of resin.

2.9.8.4 Brine Storage System

Provide a complete brine storage system including fiberglass storage tank, sight level gage, bulk salt delivery tube, internal distribution system, level control system, tank vent with dust collection system, top and side manholes, access ladder, and other required appurtenances.

2.9.8.5 Brine Storage System Accessories

Provide the following accessories:

a. Steel holddown lugs securely bonded to the tank in adequate number to properly anchor tank to concrete base;

b. Side bottom flanged drain not less than 100 mm 4 inches in diameter;

c. Side and top manholes not less than 560 mm 22 inches in diameter;

d. Flanged top connections for delivery pipe and vent;

e. Ladder for access to top manhole;

f. Water inlet connection;

g. Brine outlet connection;

h. Level control system; and

i. Sight level gage.

2.9.8.6 Storage Tank

Filament wound fiberglass with flat bottom and domed top as recommended by the manufacturer for brine storage. Tank shall be [_____] meters feet [_____] mm inch in diameter by [_____] meters feet[_____] mm inch wall height with a nominal capacity of [_____] liters gallons and a dry salt storage capacity of [_____] Mg tons. Design the water distribution system, internal piping distributors, and brine collection system so that the system shall be capable of dissolving [_____] kg pounds of rock salt per second minute to produce [_____] L/s gallons per minute of brine. System shall be able to dissolve [_____] Mg tons of salt before cleanout.

a. Pneumatic Delivery Pipe: Not less than 100 mm 4 inches in diameter.

b. Dust Collection Vent System and Safety Relief Valve: Provide storage tank with dust collection vent system and safety relief valve.

c. Access Ladder: Of steel construction to be bolted to tank by means of fiberglass reinforced plastic mounting lugs complete with safety cage. Platform shall connect the ladder to the tank for safe access to the manhole. Safety requirements shall be in accordance with ALI A14.3.

d. Tank Internals: Construct tank internals including water distribution piping and brine collectors of fiberglass reinforced plastic (FRP) or polyvinyl chloride (PVC).

e. Tank Nozzles: ASME B16.5, Class 150, reinforced FRP or PVC flanges.

f. Level Control System: Electrode holder and electrodes mounted in a standpipe exterior to the tank. Position electrodes so that a solenoid operated water makeup valve will be opened or closed to maintain the liquid level to within plus or minus one inch of the set level. Provide tank with a high water alarm. Electrodes shall be easily removable for cleaning and constructed of materials, that will allow continual immersion in brine.

2.9.9 Chemical Feed Systems

Provide systems complete with storage tank, supporting framework, hinged cover, mixer, strainers, level indicators, proportioning pumps, relief valves and interconnecting piping for a complete chemical feed packaged unit.

2.9.9.1 Storage Tank

190 liters 50 gallon capacity constructed of fiberglass reinforced plastic. Provide removable, hinged cover.

2.9.9.2 Exterior Gage Glass

Protected, full height of the tank complete with gage cocks.

2.9.9.3 Low Level Alarm

Provide tank with a low level switch to sound alarm and shut down pumps should level drop to preset minimum.

2.9.9.4 Dissolving Baskets

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NOTE: The chemical feed solution to be used shall be inserted here.

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Construct baskets of a corrosion resistant material suitable for continuous immersion in a [_____] solution.

2.9.9.5 Tank Strainer

Install tank strainer in suction line to pump.

2.9.9.6 Supporting Steelwork

Provide supporting steelwork to adequately support tank, mixer, and the number of proportioning pumps specified.

2.9.9.7 Agitator

Provide an agitator with mounting bracket to mount to storage tank. Agitator shaft and propeller shall be of stainless steel.

2.9.9.8 Proportioning Pumps

Provide [two] [three] [_____] proportioning pump[s] of the [simplex] [duplex] type. Each pump shall have a minimum capacity of [_____] L/s gallons per hour at a [_____] kPa (gage) psig discharge pressure. Capacity shall be adjustable from zero to 100 percent by a convenient screw adjustment of stroke length. Provide pump with integral check valves. Electric motors shall be [totally enclosed], [fan cooled], [_____] volts, [_____] phase, 60 Hz as specified under the paragraph MOTORS AND DRIVES in this section.

2.9.9.9 Safety Relief Valve

Provide safety relief valve for each pump to discharge back into the tank in event of excessive line pressure.

2.9.10 Blowdown Tank

Provide a welded blowdown tank in accordance with NBBI NB-27, (supplemental to the National Board Inspection Code) latest edition published by the National Board of Boiler and Pressure Vessel Inspectors, Columbus, Ohio.

2.9.10.1 Construction

****

NOTE: The volume of the blowdown tank shall be calculated to be twice the volume of water removed from one boiler when the normal water level is reduced not less than 100 mm 4 inches.

****

Construct equipment and accessories in accordance with the requirements of the ASME BPVC SEC VIII D1 for a working pressure of at least the maximum allowable working pressure of the boiler but in no case shall the plate thickness be less than 10 mm 3/8 inch. Provide corrosion allowance of [2.54 mm] [0.1 inch] [_____]. Tank dimensions shall be [_____] meters feet [_____] mm inches O.D. by [_____] meters feet [_____] mm inches long over the heads (overall). Provide tank with wear plate not less than 10 mm 3/8 inch thick and [280 by 380 mm 11 by 15 inch] [460 by 510 mm 18 by 20 inch] manhole.

2.9.10.2 Tank Connections

Provide the following connections:

a. Blowdown inlet for bottom blowdown [20] [25] mm [3/4] [1] inch;

b. Tangential blowdown inlet [_____] mm inch;

c. Steam vent, flanged [_____] mm inch;

d. Discharge water outlet, flanged [_____] mm inch with internal water seal and 20 mm 3/4 inch siphon breaker;

e. 50 mm Two inch drain;

f. Thermometer connection 20 mm 3/4 inch;

g. Pressure gage connection 6 mm 1/4 inch;

h. Cold water inlet [_____] mm inch with temperature regulating valve and backflow preventer; and

i. Two gage glass connections 5 mm 1/2 inch.

2.9.10.3 Angle Supports and Coating

Provide tank with steel angle support legs extending [_____] meters feet below bottom of the tank. Coat tank with one coat of manufacturer's standard high temperature primer.

2.9.10.4 Accessories

a. Gage Glass: 300 mm 12 inch reflex type with shutoff valves and guard;

b. Thermometer: Bi-metal dial type with separable socket, 125 mm 5 inch dial, 10 to 149 degrees C 50 to 300 degrees Frange;

c. Pressure Gage: Zero to 172 kpa (gage) 25 psig range; and

d. Internal Baffles and Pipes: As detailed.

2.9.10.5 Controls

Provide a self operating regulator to control the flow of cooling water to the tank. Regulator shall include a 20 mm 3/4 inch screwed bronze body with stainless steel trim, reverse acting actuator (for cooling), capillary tubing and a union connection bulb with a stainless steel well. Control setting shall be 60 degrees C 140 degrees F with a minimum Cv of [_____].

2.9.11 Continuous Blowdown System

Provide a complete automatic continuous boiler blowdown system which shall include a controller/programmer unit and flow assembly for each boiler, plus a continuous blowoff heat exchanger, flash tank and boiler water sample cooler.

2.9.11.1 Automatic Blowdown Controller

Intermittent type boiler blowdown system rated for not less than 1724 kPa (gage) 250 psig steam pressure.

2.9.11.2 Flow Assembly

Include a 25 mm one inch ball valve with 316 stainless steel ball and stem and stainless steel electrode assembly.

2.9.11.3 Controller/Programmer

Include a conductivity meter with zero to 6000 microhms range, valve open/closed indicators and manual/auto control switch. Cycle interval and sample duration shall both be adjustable over a wide range. Mount units at operating floor near boiler front.

2.9.11.4 Accessories and Connections

a. Continuous Blowdown Connection: At each boiler, provide a gate valve and extend piping to header at flash tank.

b. Header Connections: Provide with a tee with valved sampling connection. Provide a 20 mm 3/4 inch, three globe valve bypass around each flow assembly.

c. Common Header: Provide from valved outlet connections on flow assembly units to connection on flash tank.

2.9.11.5 Flash Tank

Designed for [_____] kPa (gage) psig and constructed in accordance with the ASME BPVC SEC VIII D1. Tank shall be [_____] mm inches in diameter by [_____] mm inches long including heads and shall be ASME Code stamped.

2.9.11.6 Blowdown Inlet

Provide tank with blowdown inlet, steam outlet, gage glass, float operated outlet valve, relief valve, and inspection openings. Tank shall have steel angle legs with plate feet for bolting to floor and legs shall be of sufficient length so that bottom of lower head of tank will be not less than 460 mm 18 inches above floor.

2.9.11.7 Automatic Control System

Control level in the flash tank, by modulating a valve in the water outlet line.

a. Level Controller: External cage type air operated level controller, complete with 40 mm 1 1/2 inch screwed connection, 350 mm 14 inch stainless steel float and Class 125 cast iron body. Controller shall be direct acting with 20 to 103 kPa (gage) 3 to 15 psig range with proportional band. Locate controller to maintain an operating level at center line of storage tank. Provide level controller with air pressure reducing valve, filter, gages and isolating valves for float cage. Provide unions on each side of float cage.

b. Outlet Water Valve: [_____] mm inch air operated control valve with a capacity to pass [_____] L/s gpm at a pressure drop of [_____] kPa (gage) psig. Cv shall not be less than [_____] at 100 percent open. Valve shall be Class [_____], flanged, iron or semi-steel body with stainless steel internals. Valve shall have equal percentage flow characteristics with a full size port. Provide an air lock mounted on valve diaphragm and piped to hold valve in last position on air failure.

2.9.11.8 Sample Cooler

Water cooled shell and tube type with valves and accessories required to safely withdraw a water sample from the boiler drum. Provide drain under sampling valve terminating with a 20 mm 3/4 inch splash proof funnel, 230 mm 9 inches below outlet of valve.

2.9.11.9 Heat Exchanger

Provide an ASME code stamped continuous blowoff heat exchanger designed and constructed in accordance with ASME BPVC SEC VIII D1 to transfer heat from the continuous blowoff water leaving the continuous blowoff flash tank to the treated makeup water entering the feedwater heater. Heat exchanger shall be a bare tube, helical coiled bundle, installed in a one piece casing with removable front plate. Bundle shall be removable. Tube diameter shall be not less than 20 mm 3/4 inch. Tubes shall be ASTM B111/B111M copper alloy with cast iron shell. Design tube side for not less than [_____] kPa (gage) psig pressure at [_____] degrees C F. Design shell side for not less than [_____] kPa (gage) psig pressure at [_____] degrees C F.

2.10 PIPING

Piping work shall include the provision of piping systems, including valving and specialty items, for the steam plant and related external auxiliary equipment. Piping materials, design, and fabrication shall be in accordance with ASME B31.1 except as modified below or indicated otherwise. The requirements of ASME B31.1 apply to the building steam heating and steam distribution piping designed for 103 kPa (gage) 15 psig or lower and hot water heating systems 207 kpa (gage) 30 psig or lower. Provide piping materials suitable for the maximum pressure at the maximum temperature at which the equipment must operate. Compute expansion of pipe with operating temperatures above minus 18 degrees C zero degrees F with minus 18 degrees C zero degrees F in lieu of 21 degrees C 70 degrees F specified in ASME B31.1.

2.10.1 Piping Materials

a. Steam Pipe, Boiler Feedwater Pipe, Relief Pipe and Steam Tracer: Pipe Black, ASTM A53/A53M or ASTM A106/A106M seamless steel pipe, Grade A or B. Wall thickness not less than Schedule 40. Steam tracer pipe, with steam up to 103 kPa (gage) 15 psig, may be ASTM B88M ASTM B88, Type K copper tubing.

b. Condensate Pipe and Boiler Blowdown Pipe: Black, welded or seamless

ASTM A53/A53M or ASTM A106/A106M, steel pipe, Grade A or B. Wall thickness not less than extra strong (XS or Schedule 80).

c. Chemical Feed Pipe: ASTM A312/A312M austenitic stainless steel.

d. Fuel Oil Pipe: ASTM A53/A53M or ASTM A106/A106M, seamless black steel pipe, Grade A or B.

e. Treated Water, Hot Water Heating, High Temperature Water, Drains (Other Than Sanitary), and Overflow Pipe: ASTM A53/A53M, black, welded or seamless steel up to a maximum pressure of 1724 kpa (gage) 250 psig or ASTM A106/A106M, Grade A or B.

f. Gas Pipe and Compressed Air Pipe: ASTM A53/A53M welded or seamless pipe up to a maximum pressure of 1724 kPa (gage) 250 psig or ASTM A106/A106M, Grade A or B.

g. Instrument Air Pipe: ASTM B88M ASTM B88 hard copper tubing, Type K or L; except in a corrosive atmosphere or outside pipe shall be copper tubing, Type K or L, with ASTM D1047 PVC jacketing.

h. Steam Tracer Pipe: As an option, the, contractor may provide ASTM B88M ASTM B88, Type K, copper tubing for steam up 103 kPa (gage) 15 psig.

2.10.2 Chlorinated Polyvinyl Chloride (CPVC)

Chlorinated polyvinyl chloride (CPVC) and other plastic tubing and fittings shall not be used in the steam heating plant, unless otherwise specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Systems for potable water, sanitary drains and storm drains are also covered in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.10.3 Fittings

2.10.3.1 Fittings for Steel Pipe

a. Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.3 malleable iron, screwed end fittings, for working pressures not greater than 2068 kPa (gage) 300 psig at temperatures not greater than 232 degrees C 450 degrees F or ASME B16.11forged steel.

b. Sizes 6 to 50 mm 1/8 to 2 inches: ASME B16.11 steel, socket welded end fittings.

c. Sizes 6 to 65 mm 1/8 to 2 1/2 inches: ASME B16.9 steel, butt welding fittings.

d. Sizes 65 to 600 mm 2 1/2 to 24 inches: ASME B16.5 forged steel, flanged fittings.

2.10.3.2 Welded Outlets and Welding Saddles

Make branch connections of 45 and 90 degrees either with ASME B16.9 forged steel welded outlet fittings or welding saddles. Welding outlets and saddles shall not be smaller than two pipe sizes less than the main pipe sizes.

2.10.3.3 Fittings For Copper Tubing

ASME B16.18 cast bronze solder joint or ASME B16.22 wrought copper solder joint. For instrument air, fittings may be ASME B16.26 compression joint type.

2.10.3.4 Unions

a. Unions For Steel Pipe: ASME B16.11, ASME B16.39threaded. Unions for zinc coated pipe shall be zinc coated.

b. Unions For Copper Tubing: ASME B16.22. For instrument air, unions may be compression joint type.

2.10.4 Flanges

ASME B16.5, forged steel, welding type. Remove the raised faces on flanges when used with flanges having a flat face. Except as specified otherwise, pressure and temperature limitations shall be as specified in ASME B16.5 for the proper class and service, and the type face specified.

2.10.5 Valves

2.10.5.1 Low Pressure

Valves for maximum working pressure of 1034 kPa (gage) 150 psig saturated steam or 1550 kPa (gage) 225 psig W.O.G. (Water, Oil, Gas) at 93 degrees C 200 degrees F, non-shock service. For working pressures not exceeding 862 kPa (gage) 125 psig saturated steam or 1379 kPa (gage) 200 psig water at 93 degrees C 200 degrees F non-shock service, Class 125 may be used in lieu of Class 150 or Class 250.

a. Valve Sizes 50 mm 2 Inches and Smaller:

    (1) Non-Throttling Valves: Gate valves, bronze, wedge disc, rising stem, Class 150, MSS SP-80 or ball valves, bronze, double stem seals, stainless steel ball and shaft, tight shutoff.

    (2) Globe Valves and Angle Valves: Bronze, Class 150, MSS SP-80.

    (3) Check Valves: Bronze, Type [IV, swing check] [III, lift check], Class 150, MSS SP-80.

b. Valve sizes 65 mm 2 1/2 inches and larger.

    (1) Gate Valves: Flanged, cast iron, Class 250, MSS SP-70 or steel, Class 150, ASME B16.34. Valves shall have wedge disc, outside screw and yoke (OS&Y), rising stem; valves 200 mm 8 inches and larger shall have globe valved bypass.

    (2) Globe Valves and Angle Valves: Flanged, cast iron, Class 250, MSS SP-85 or steel, Class 150, ASME B16.34.

    (3) Check Valves: Flanged, cast iron, Class 250 or steel, Class 150, Type [_____], [lift] [swing] check, style [_____], ASME B16.34.

2.10.5.2 Medium Pressure

Valves for maximum working pressure of 1723 kPa (gage) 250 psig steam at a maximum temperature of 232 degrees C 450 degrees F or 3445 kPa (gage) 500 psig W.O.G. at 93 degrees C 200 degrees F (non-shock).

Valve sizes 65 mm 2 1/2 inches and larger:

a. Gate Valves: Flanged or butt welded, cast iron, Class 250, MSS SP-70 (maximum size 300 mm 12 inches) or steel, Class 300, ASME B16.34. Valves shall have wedge disc, OS&Y, rising stem; each valve 200 mm 8 inches and larger shall have globe valved bypass.

b. Globe Valves and Angle Valves: Flanged or butt welded, cast iron, Class 250, MSS SP-85 or steel, Class 300, ASME B16.34.

c. Check Valves: Flanged or butt welded, iron body, Class 250 or steel, Class 300, Type [_____] [lift] [swing] check, style [_____], ASME B16.34.

2.10.5.3 High Pressure

Valves for maximum working pressure of 2068 kPa (gage) 300 psigsteam at a maximum temperature of 454 degrees C 850 degrees F or a maximum W.O.G. pressure of 4653 kPa (gage) 675 psig at 149 degrees C 300 degrees F (non-shock).

Valve sizes 65 mm 2 1/2 inches and larger:

a. Gate Valves, Globe Valves, and Angle Valves: Flanged or butt welded, ASME B16.34, steel, Class 300, rising stem, OS&Y. Gate valves 200 mm 8 inches and larger shall have globe valved bypass.

b. Check Valves: Flanged or butt welded, steel, Class 300, Type [_____], [lift] [swing] check, style [_____], ASME B16.34.

2.10.5.4 Ball Valves

ASME B16.5 and API Std 607 double stem seal type for bubble tight shutoff. Seats and seals shall be TFE material. Ball and shaft shall be stainless steel. Provide mechanical stops to prevent cycling valve in wrong direction and self-aligning stem seal.

2.10.5.5 Valve Accessories

ASME B16.34 valve operating mechanisms including chain wheels, gear operators, floor stands, electric motors, air motors and cylinder-type actuating devices. Provide accessories as follows and as indicated.

a. Provide power operators with remote position indicators on the following valves: soot blowers, [_____], [_____].

b. Provide floor stands and valve extensions on platforms and floors for the following valves: deaerator drain valves, [_____].

c. Provide motorized actuators or chain wheels with chain and guides on valves with handwheel centerline higher than 2 meters 7 feet above the floor or platform except where specified otherwise. Chains shall extend from valve to within one meter 3 feet above floor. Provide impact chain wheels on steam headers and other locations where valve has a tendency to stick. When a valve is motorized, provide hand operation for emergency.

d. Provide gear operators on ball valves larger than 80 mm 3 inches and on gate valves 200 mm 8 inches and larger.

2.10.5.6 Steam Pressure Regulating Valves

CID A-A-50558, minimum of Class [125] [150] [250] [300], except as specified otherwise. [Cast iron], [cast steel] valve body with valve seats and disc of replaceable heat treated stainless steel. Valves shall be single seated, shall seat tight under dead end conditions, and shall go to the closed position in the event of pressure failure of the operating medium. Valves shall be spring loaded diaphragm operated type, except valves exposed to ambient temperature of less than 2 degrees C 35 degrees F or exposed to the weather shall be piston operated type. Capacity of valves shall be not less than that indicated. Pilot valves shall have strainer at inlet from external feeder piping.

a. Spring Loaded Diaphragm Operated Valves: Fabricate main spring of stainless steel, which shall not be in the path of steam flow through the valve. Control valve by pilot valve through external feeder piping.

b. Piston Operated Valves: Control valve by integral pilot valve through external feeder piping.

2.10.5.7 Safety Relief Valves

ASME BPVC SEC I ASTM F1508, Style D or E, with Class [150] [300] inlet flange, with test lever, designed for the intended service.

2.10.6 Bolts and Nuts

a. Bolts: ASTM A193/A193M, Grade B8. Lengths of bolts shall be such that not less than two full threads will extend beyond the nut with the bolts tightened to required tensions and washers seated.

b. Nuts: ASTM A194/A194M, Grade 8.

2.10.7 Gaskets

ASME B31.1 and as specified below, except provide spiral wound metal covered non-asbestos gaskets in lieu of compressed sheet non-asbestos. Gaskets shall be as thin as the finish of surfaces will permit. Do not use paper, vegetable fiber, rubber, or rubber inserted gaskets for temperatures greater than 121 degrees C 250 degrees F. Provide metal or metal jacketed non-asbestos gaskets with small male and female and small tongue-and-groove flanges and flanged fittings; they may be used with steel flanges with lapped, large male and female, large tongue-and-groove, and raised facings. Provide fullface gaskets with flat-faced flanges. Raised face cast iron flanges, lapped steel flanges, and raised faced steel flanges shall have ring gaskets with an outside diameter extending to the inside of the bolt holes. Widths of gaskets for small male and female and for tongue-and-groove joints shall be equal to the widths of the male face and tongue. Gaskets shall have an inside diameter equal to or larger than the port opening. Dimensions for nonmetallic gaskets shall be in accordance with ASME B16.21. Materials for flanged gaskets shall be as listed below for service specified:

a. Steam, Boiler Blowdown, Exhaust Steam: Spiral wound metal composition or copper.

b. Boiler Feed Water: Metal jacketed non-asbestos, copper or monel.

c. Hot Water, (above 38 degrees C 100 degrees F): Spiral wound metal non-asbestos.

d. Cold Water: Red rubber or neoprene rubber.

e. Heavy Fuel Oil (No. 6): Spiral wound metal non-asbestos, soft steel, or monel.

f. Diesel Fuel (No. 2): ASME B16.21 metallic.

g. Compressed Air: Spiral wound metal non-asbestos.

2.10.8 Expansion Joints

2.10.8.1 Slip Tube Expansion Joints

ASTM F1007, single or double slip tube as indicated, designed for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Expansion joints shall be of the type which permits the injection of semi plastic type packing while the joint is in service under full line pressure. Slip tube shall be of chromium plated, wrought steel construction, guided by internal and external guides integral with joint body. Fit slip tube ends with forged steel pipe flanges or bevel for welding into pipe line where indicated. Deliver joints complete with packing and ready for installation.

2.10.8.2 Flexible Ball Expansion Joints in Piping

Capable of 360 degrees rotation plus 15 degrees angular flex movement. Ball joints shall have steel bodies and polished steel balls. Provide end connections to suit class of piping here in before specified. Seals shall be of pressure molded composition designed for the working pressure. Provide joints for [1034] [2068] kPa (gage) [150] [300] psig saturated steam working pressure. Cold set the joints as necessary to compensate for temperature at time of installation. Do not use ball joints on superheated steam or on joints subject to frequent flexure. Install ball joints in strict accordance with manufacturer's recommendations.

2.10.8.3 Bellows Expansion Joints

ASTM F1120 flexible guided type with stainless steel expansion element, internal sleeves and external covers. Joints shall be designed for a working pressure of [_____] kPa (gage) psig and a temperature of [_____] degrees C F.

2.10.9 Pipe Hangers and Supports

MSS SP-58, Type [_____] or Type [_____] of the adjustable type, except as specified or indicated otherwise. Suspended steam and condensate piping shall have pipe hangers Type [_____] with insulation protection saddles Type [_____]. Provide insulated piping, except steam and condensate piping, with insulation protection shields Type 40. Provide bronze or copper plated collars on uninsulated copper piping. Support rods shall be steel. Rods, hangers and supports shall be zinc plated, except for uninsulated copper piping which shall be copper plated; cast iron rollers, bases and saddles may be painted with two coats of heat resisting aluminum paint in lieu of zinc plating. Axles for cast iron rollers shall be stainless steel. Size hanger rods with a 150 percent safety factor for a seismic design.

2.10.10 Instrumentation

2.10.10.1 Pressure and Vacuum Gages

Conform to the applicable requirements of ASME B40.100.

2.10.10.2 Indicating Thermometers

MIL-T-19646 dial type. Thermometer shall include a separable immersion well.

2.10.11 Miscellaneous Pipeline Components

2.10.11.1 Cold and Hot Water Meters

CID A-A-59224 for maximum flow of [_____] L/s at 38 degrees C gpm at 100 degrees F and reduced flow of up to [_____] L/s at 121 degrees C gpm at 250 degrees F.

2.10.11.2 Air Traps

Float controlled valves arranged to close properly when water enters the traps. Air traps shall conform to the requirements for float operated steam traps (non-thermostatic), CID A-A-60001, except that the valve mechanism shall be inverted so as to be closed, not opened, by rising water.

2.10.11.3 Steam Traps

CID A-A-60001. Inverted bucket high pressure steam traps designed for use at [_____] kPa (gage) psig at [_____] degrees C F. Low pressure steam traps shall be float and thermostatic type for pressures up to 103 kPa (gage) 15 psig. Provide traps with separate strainers unless specified otherwise.

2.10.11.4 Strainers

FS WW-S-2739, Style Y for Class [125] [250] with blow off outlet. Construct strainers for Class 300 of cast carbon steel in accordance with ASME B16.5 for minimum of 2068 kPa (gage) 300 psigsaturated steam pressure. Provide blow off outlet with pipe nipple and gate valve.

2.10.12 Backflow Preventers

Provide reduced pressure principle type conforming to applicable requirements of AWWA C511, and as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.10.13 Insulation Types and Installation Procedures

Materials and application shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.10.14 Pipe Sleeves

2.10.14.1 Floor Slabs, Roof Slabs, and Outside Walls Above and Below Grade

Galvanized steel pipe having an i.d. at least 12.7 mm 1/2 inch larger than the o.d. of the pipe passing through it. Provide sufficient sleeve length to extend completely through floors, roofs, and walls, so that sleeve ends are flush with finished surfaces except that ends of sleeves for floor slabs shall extend 13 mm 1/2 inch above finished floor surface. Sleeves located in waterproofed construction shall include flange and clamping ring.

2.10.14.2 Partitions

Galvanized sheet steel, 26 gage or heavier, of sufficient length to completely extend through partition thickness with sleeve ends flush with partition finished surface.

2.10.15 Piping Identification

Conform to MIL-STD-101 and place in clearly visible locations; except that piping in the boiler room shall be painted the primary color of the color code. Labels and tapes conforming to ASME A13.1 shall be used in lieu of band painting or stenciling. Labels shall be outdoor grade acrylic plastic. Markings on the labels shall indicate the direction of flow, flowing media, and media design pressure and temperature. Spacing of identification marking shall not exceed 3 meters 10 feet. Provide two copies of the complete color and stencil codes used. Frame codes under glass and install where directed.

2.11 FIRE PROTECTION SYSTEM

Provide the fuel oil [and gas metering] room[s] with a wet sprinkler system as specified in Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION.

2.12 MARKING

Identify equipment, valves, switches, motor controllers, and controls or indicating elements by printed, stamped or manufactured identification plates or tags of rigid plastic or non-ferrous material. Lettering for identification plates or tags shall be not less than 5 mm 3/16 inchhigh. Nomenclature and identification symbols used on identification plates or tags shall correspond to those used in the maintenance manuals, operating instructions, and schematic diagrams. Rigidly affix identification plates or tags to equipment or devices without impairing functions or, when this is not possible, attach using a non-ferrous wire or chain. In addition to the identification plate or tag, each major component of equipment shall have a nameplate listing the manufacturer's name, model number, and when applicable, electrical rating and other information required by pertinent standards or codes.

2.13 TOOLS AND TESTING EQUIPMENT

Provide special tools and wrenches required for the installation, maintenance, and operation of the equipment. Provide testing equipment necessary to perform routine tests:

a. On lubricating oil for acidity (pH-potentiometer), viscosity (saybolt test), and dirt (gravimetric).

b. On softened water for hardness (soap test or colorimetric test), and boiler blowdown water for pH (colorimetric) and conductivity (potentiometer).

c. For water (distillation) and sediment (gravimetric) in fuel oil.

2.14 WELDING MATERIALS

Comply with ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

2.15 MOTORS AND DRIVES

Alternating current electric motors shall meet requirements of NEMA MG 1. Motors shall be designed for continuous operation at rated load under usual service conditions as defined by NEMA. Motors less than 3/4 kW 1 hp shall meet NEMA High Efficiency requirements. Motors 3/4 kW 1 hp and larger shall meet NEMA Premium Efficiency requirements. Unless specifically noted otherwise, motors less than 3/8 kW 1/2 hp shall be 115 volt, 60 Hz, single phase, capacitor-start, or permanent split capacitor, with Class B insulation for 40 degrees C 104 degrees F ambient. Unless specifically noted otherwise, motors 3/8 kW 1/2 hp and larger shall be 460 volt, 60 Hz, three phase, Design B, squirrel cage induction with a minimum insulation of Class F for 40 degrees C 104 degrees F ambient. Size motors to meet the power requirements of the driven unit at design conditions, including drive and coupling losses which are incurred, without loading the motor beyond its nameplate power rating. Minimum service factor for open drip-proof motors shall be 1.15 and for totally enclosed, fan cooled motors 1.0. Motor shall be quiet operating. Bearings shall be heavy duty, grease lubricated, anti-friction, single shielded, regreasable type and shall have approved lubricating fittings extended to an easily accessible location for field servicing. Provide sole plates for motors installed on concrete pads. Motors shall have copper windings.

2.16 SOURCE QUALITY CONTROL

2.16.1 Plant Equipment Tests

Tests specified below shall be conducted at factory prior to delivering equipment to job site.

2.16.1.1 Plant Air Compressors

Test plant air compressors in service to determine compliance with contract requirements and warranty. During the tests, test equipment under every condition of operation. Test safety controls to demonstrate performance of their required function. Completely test system for compliance with specifications.

2.16.1.2 Instrument Air Compressors

Factory test air compressor package at full load for not less than 2 hours. Check capacity, smoothness of operation, alternation of units, and proper operation of the air unloaders during the test.

2.16.1.3 Variable Speed Motor Controller Factory Test

Burn-in tests shall be conducted for at least 50 hours at rated conditions. If a component fails during the burn-in test it shall be replaced, and the entire test shall be run again on the complete assembly for another 50 hours. The burn-in test shall not be complete until the entire assembly has operated for 50 hours without failure.

PART 3 EXECUTION

3.1 INSTALLATION

Install materials and equipment as indicated and in accordance with manufacturer's recommendations.

3.1.1 Equipment Installation

Install equipment in accordance with this specification, and the installation instructions of the manufacturers. Equipment mounted on concrete foundations shall be grouted before installing piping. Install piping in such a manner that it will not impart a stress on equipment. Flanged joints shall not be bolted tight unless they match adequately. Expansion bends shall be adequately extended before installation. Support, grade, anchor, and guide all piping so that there are no low pockets, which could accumulate fluids, along the piping run.

3.1.1.1 Equipment Foundations

Equipment foundations shall be of sufficient size and weight, and proper design to prevent shifting of equipment under operating conditions, or under abnormal conditions which could be imposed upon equipment. Equipment vibration shall be limited within acceptable limits, and isolated. Foundations shall be adequate for soil conditions of the site and shall meet requirements of the equipment manufacturer. Trowel exposed foundation surfaces smooth except when properly roughened surfaces are necessary to receive grout.

3.1.1.2 Forced Draft Fan

Fan assembly shall be set, shimmed level, anchored and grouted in place prior to setting driver. Driver shall be properly shimmed on base plate using steel shim stock. Shims shall be full size of feet and shall have a slotted hole for installation. After the drive has been properly aligned and shimmed, by an approved millwright, the millwright shall drill and ream the foot and base plates and, install taper pins with nut on top for pullout removal. One front foot and diagonally opposite rear foot shall be pinned to base plate. Bolt equipment into place in an approved manner. Level and grout the fan and bearing pedestal sole plates into place.

3.1.1.3 Stack

Install, level and plumb. Erected stack shall be no more than 25 mm one inch out of plumb (out of vertical) per 15 meters 50 feet. Remove roughness, marks, and lifting lugs, from stack and grind surfaces smooth and flush with surrounding surfaces.

3.1.1.4 Fuel Oil Tanks

****

NOTE: At the text below, choose one of the following options.
****

[a. Horizontal Fuel Oil Tanks (Below Ground): Provide concrete ballast slabs for tanks and concrete protective ground level slabs for FRP tanks. The ballast slabs shall be full length and width of the tanks and the protective slabs shall extend 600 mm 2 feet beyond the tanks. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

(1) Installation: Install and backfill fiberglass reinforced tanks as recommended by the manufacturer; backfill adjacent to the tanks shall be pea gravel unless otherwise recommended by the manufacturer. Backfill for steel tanks shall be sand.

(2) Placement: Set steel tanks on a bed of sand not less than 150 mm 6 inches deep over the concrete slab and strap in place with stainless steel hold-down straps with stainless steel turnbuckles. Set FRP tanks on a bed of pea gravel not less than 300 mm 12 inches thick and pre-shape for the tank contours for FRP tanks. Fabricate straps for FRP tanks from FRP resins reinforced with stainless steel to prevent breaking of straps and floating of empty tanks.

(3) Slope tank toward sump not less than25 mmone inch in each 1 1/2 meters 5 feet.

][b. Horizontal Fuel Oil Tanks (Above Ground): Continuously support steel tank saddles along the full length of the base and level and grout to ensure full bearing.

][c. Vertical Fuel Oil Tank: Provide [sand, crushed stone or fine gravel cushion] [concrete base].

][(1) Sand, Crushed Stone or Fine Gravel Cushion: Cover area beneath tank with a minimum 0.51 mm 20 mil thick fuel resistant plastic membrane. Carefully fuse or cement plastic membrane seams. Lay plastic over a thoroughly compacted select subgrade free from rocks that could puncture the plastic. Over plastic, provide a bed of sand, crushed stone or fine gravel not less than 150 mm 6 inches thick. Stabilize bed with an approved material and shape to the tank bottom. Slope bed down to center sump approximately 150 mm 6 inches for each 3 meters 10 feet of tank radius. When in place, tank shell shall be plumb.

][(2) Concrete base shall be as indicated and in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

][(3) Mastic Seal: Place the mastic seal between the tank and the concrete ring to the cross section indicated. Compact the mastic thoroughly. Immediately before placing the mastic, coat the tank surfaces to be in contact with the concrete ring with a coat of AASHTO M 118 bituminous material.

]3.1.2 Piping

Unless specified otherwise, erection, welding, brazing, testing and inspection of piping shall be in accordance with ASME B31.1 and Section

40 17 26.00 20 WELDING PRESSURE PIPING. Piping shall follow the general arrangement shown. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing, except where cold-springing is specified. Piping and equipment within buildings shall be entirely out of the way of lighting fixtures and doors, windows, and other openings. Locate overhead piping in buildings in the most inconspicuous positions. Do not bury or conceal piping until it has been inspected, tested, and approved. Where pipe passes through building structure, pipe joints shall not be concealed, but shall be located where they may be readily inspected and building structure shall not be weakened. Avoid interference with other piping, conduit, or equipment. Except where specifically shown otherwise, vertical piping shall run plumb and straight and parallel to walls. Install piping connected to equipment to provide flexibility for vibration. Support and anchor piping so that strain from weight of piping is not imposed on equipment.

3.1.2.1 Fittings

Provide long radius elbows on welded piping to reduce pressure drops. Do not miter pipe to form elbows, notch straight runs to form full sized tees, or use similar construction. Make branch connections with welding tees, except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1 may be used.

3.1.2.2 Grading of Pipe Lines

Unless indicated otherwise, install horizontal lines of steam and return piping to grade down in the direction of flow with a pitch of not less than 25 mm in 9 meters one inch in 30 feet, except in loop mains and main headers where flow may be either direction. Pitch air lines to the source of supply, and make provisions for draining off condensate. Install water lines to drain to a shutoff valve.

3.1.2.3 Anchoring, Guiding, and Supporting Piping

Anchor and support piping in a manner such that expansion and contraction will take place in the direction desired, prevent vibration by use of vibration dampeners, and prevent undue strains on boilers and equipment served. Fabricate hangers used for support of piping of 50 mm 2 inch nominal pipe size and larger to permit adequate adjustment after erection while still supporting the load. Provide wall brackets where pipes are adjacent to walls or other vertical surfaces which may be used for supports. Provide supports to carry weight of lines and maintain proper alignment. Provide inserts and sleeves for supports in concrete where necessary and place in new construction before pouring concrete. Provide insulated piping with a pipe covering protection saddle at each support. Provide pipe guides and anchors of approved type at points where necessary to keep pipes in accurate alignment, to direct expansion movement, and to prevent buckling and swaying and undue strain. Provide pipe guides for alignment of pipe connected to free unanchored end of each expansion joint. Support pipe rollers in concrete conduits and trenches by extra strong steel pipe with ends inserted in slots provided in concrete walls. Set pipe supports for rollers at correct elevations either by metal shims or by cutting away of concrete and after placing pipe lines in alignment, grout ends of pipe supports and fix in place. Space pipe supports to provide adequate support for pipes. Pipe shall not have pockets formed in the span due to sagging of pipe between supports, caused by weight of pipe, medium in pipe, insulation, valves, and fittings. Maximum spacing for pipe supports for steel pipe shall be in accordance with ASME B31.1; maximum spacing for supports for copper tubing shall be in accordance with MSS SP-58.

3.1.2.4 Copper Tubing

Copper tubing shall have solder joints with solder suitable for the pressure-temperature ratings of the piping system. Tubing 20 mm 3/4 inch and smaller for instrument air may be compression joint in lieu of soldered joint. Tin-antimony (95/5) solder is suitable for saturated steam up to 103 kPa (gage) 15 psig but tin-lead (50/50) solder is not acceptable for steam service. Flux shall be non-corrosive. Wipe excess solder from the joints.

3.1.2.5 Sleeves

Provide pipe sleeves where pipes and tubing pass through masonry and concrete walls, floors, and partitions. Space between pipe, tubing, or insulation and the sleeve shall be not less than 6 mm 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, and slabs. Sleeves in floor slabs shall extend 15 mm 1/2 inch above the finished floor. Firmly pack space between pipe or tubing and the sleeve with oakum and caulk on both ends of the sleeve with elastic cement.

3.1.2.6 Flashing for Buildings

Where pipes pass through building roofs and outside walls, provide proper flashing and counter flashing and make tight and waterproof.

3.1.2.7 Outlets for Future Connections

Locate as directed capped or plugged outlets for connections to future equipment, when not located exactly by the project drawings.

3.1.2.8 Screwed Joints in Piping

Provide teflon tape or suitable pipe joint compound applied to male threads only for making up screwed joints. Piping shall be free from fins and burrs. Ream or file out pipe ends to size of bore, and remove chips.

3.1.2.9 Welds and Welded Joints

Weld joints in piping by the metal-arc or gas welding processes in accordance with ASME B31.1. Number or mark each weld to identify the work done by each welder on welds which stress relieving or radiographic inspection is required.

a. Recertification: The Contracting Officer reserves the right to require the Contractor to provide re-examination and recertification of welders.

b. Radiographic testing of circumferential butt welded joints of pipe with operating temperature of 177 degrees C 350 degrees F and above shall be required on ten percent of the joints, the location of which will be determined by the Contracting Officer; when more than ten percent of the radiographically tested joints show unacceptable defects radiographically test joints of this type piping.

c. Equipment and Protection: Items of equipment for welding shall be so designed and manufactured, and be in such condition as to enable qualified operators to follow procedures and to attain the results specified. Protect welders and gas cutters from the light of the arc and flame by approved goggles, shields, helmets, and gloves. Replace cover glasses in helmets and shields when they become sufficiently marred to impair the operator's vision. Take care to avoid risk of explosion and fire when welding and gas cutting near explosive or flammable materials. Ventilate welding and gas cutting operations in accordance with paragraph 29 CFR 1910-SUBPART Q.

d. Surface Conditions: Do not weld when atmospheric temperature is less than minus 18 degrees C zero degrees F, when surfaces are wet, when rain or snow is falling or moisture is condensing on surfaces to be welded, nor during periods of high wind, unless the welder and work are protected properly. At temperatures between zero degrees C 32 degrees F and minus 18 degrees C zero degrees F heat with a torch the surface for an area within 80 mm 3 inches of the joint to be welded to a temperature warm to the hand before welding. Free surfaces to be welded from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces shall be smooth, uniform and free from fins, tears, and other defects which might affect proper welding. Remove slag from flame-cut edges to be welded by grinding, but temper color need not be removed. Thoroughly clean each layer of weld metal by wire brushing prior to inspection or deposition of additional weld metal.

3.1.2.10 Cleaning of Piping

Before installing pipe, thoroughly clean it of sand, mill scale and other foreign material. After erection but before final connections are made to apparatus thoroughly clean the interior of piping. Flush with water piping except air and fuel lines, in addition, blow out steam lines with intermittent high pressure steam blows to promote shedding of internal scale. Blow compressed air and fuel oil lines clean with 552 to 690 kPa (gage) 80 to 100 psig air dried to a 2 degrees C 35 degree F dew point at 552 kPa (gage) 80 psig. Sterilize potable water piping by means of liquid chlorine or hypochlorite in accordance with AWWA C651 before placing water system in service. Take care during fabrication and installation, to keep piping, valves, fittings and specialties free of loose welding metal chips of metal or slag, welding rods and other foreign matter. Blowing or flushing shall in no case be channeled through equipment, pump, control valve, regulating valve, instrument gage or specialty in the system. Provide temporary screens, strainers, connections, spool pieces and bypasses consisting of piping or hoses, pumps and other required equipment temporarily installed for the purpose of cleaning and flushing piping. Drain flushing water and test water to the sanitary sewer system.

3.1.2.11 Reduction in Pipe Size

Provide reducing fittings for changes in pipe size; the use of bushings will not be permitted. In horizontal steam lines, reducing fittings shall be the eccentric type to maintain the bottom of the lines in the same plane. In horizontal water mains, reducers shall be set to maintain the top of the lines in the same plane.

3.1.2.12 Expansion Control

Provide bends, loops, and offsets wherever practical to relieve overstressed piping systems due to thermal expansion and to provide adequate flexibility. Cold spring piping system as indicated but not more than 50 percent of the total linear expansion.

3.1.2.13 Connection to Equipment

Provide unions or flanges where necessary to permit easy disconnection of piping and apparatus. Provide unions and gate valves at each connection to threaded end control valves, strainers and equipment.

3.1.2.14 Valve Installation

Install valves in positions accessible for operation and repair. Install stems in a vertical position with handwheels or operators on top or in a horizontal position. Do not install handwheels on stop valves below the valve. When centerline of valve is more than 2 meters 7 feet above floor or platform, provide valve with a chain-operated handwheel. When valve is motorized, provide hand operation for emergency use.

a. Gate Valves: Arrange back outlet gate valves for turbine exhaust for hand operation and provide with a floor stand.

b. Globe Valves: Pressure shall be below the disc. Install globe valves with the stems horizontal on steam and exhaust lines, when better drainage is required or desired.

c. Steam Pressure-Reducing Valves: Provide the steam line entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two shutoff valves and with a globe or angle bypass valve and bypass pipe. A bypass around a reducing valve shall be of reduced size to restrict its capacity to approximately that of the reducing valve. Provide each pressure-reducing valve unit with indicating steam gages to show the reduced pressure and the upstream pressure and an adequately sized safety valve on the low pressure side.

d. Valve Tags and Charts: Permanently tag each valve with a black and white engraved laminated plastic tag showing valve number, valve function and piping system and whether another valve must be opened or closed in conjunction with this valve. Provide a typed chart which will show the required valve tagging plus the location of each valve. Frame valve charts under glass and install as directed.

3.1.2.15 Traps and Connections

Traps shall be of the type and capacity for the service required, and shall be properly supported and connected. Except for thermostatic traps in pipe coils, radiators, and convectors, install traps with a dirt pocket and strainer between it and the piping or apparatus it drains. When it is necessary to maintain in continuous service apparatus or piping which is to be drained, provide a three valve bypass so that trap may be removed and repaired and condensate drained through the throttled bypass valve. Provide a check valve on discharge side of trap whenever trap is installed for lift or operating against a back pressure, or it discharges into a common return line. Provide test connections on discharge side of high and medium pressure traps when they are specifically required. Test connection shall include a 15 mm 1/2 inch globe valve with open blow.

3.1.2.16 Pressure Gage Installation

Provide with a shutoff valve or petcock between the gage and the line, and gage on steam lines shall have a siphon installed ahead of the gage.

3.1.2.17 Thermometer and Sensing Element Installation

Provide thermometers and thermal sensing elements of control valves, with a separable socket. Install separable sockets in pipe lines in such a manner to sense flowing fluid temperature and minimize obstruction to flow.

3.1.2.18 Strainer Locations

Provide strainers with meshes suitable for the services upstream of each control valve and where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.1.2.19 Dissimilar Piping Materials

Provide dielectric unions or flanges between ferrous and nonferrous piping, equipment, and fittings, except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or nonferrous-to-nonferrous connections. Dielectric fittings shall utilize a nonmetallic filler which will prevent current flow from exceeding one percent of the short circuit current. Spacer shall be suitable for the pressure and temperature of the service. Fittings shall otherwise be as specified in this section.

3.1.2.20 Surface Treating, and Pipe Wrapping

Uninsulated steel piping buried in the ground shall have exterior surfaces protected with a tape wrapping system or a continuously extruded polyethylene coating system as specified in Section 09 97 13.28 PROTECTION OF BURIED STEEL PIPING AND STEEL BULKHEAD TIE RODS.

3.1.3 Painting

3.1.3.1 Piping, Fittings, and Mechanical and Electrical Equipment

Equipment shall be factory finished to withstand the intended end use environment in accordance with the specifications for particular end item. Factory finished equipment on which the finish has been damaged shall have damaged areas retouched and then be given a complete finish coat to restore the finish to its original condition. Finish coat shall be suitable for exposure in the intended end use environment.

3.1.3.2 Other Items

Unless specified otherwise, pipe hangers, structural supports, pipe and pipe fittings, conduit and conduit fittings, air grilles, pipe coverings, insulation, and metal surfaces associated with mechanical and electrical equipment including zinc-coated steel ducts shall be painted utilizing the painting systems as specified in Section 09 90 00 PAINTS AND COATINGS. Zinc-coated steel duct in unpainted areas shall not be painted. Except zinc-coated and copper pipe, give piping to be insulated, a protective coating prior to installing insulation.

3.1.3.3 Boilers

After erecting and testing boilers, clean exposed surfaces of the boiler normally painted in commercial practice to remove grease, coal dust, flyash and other foreign matter and finish with one coat of aluminum heat resisting paint applied to minimum dry film thickness of 0.025 mm one mil.

3.1.3.4 Vertical Fuel Oil Tank

Clean interior surfaces to bare metal in accordance with SSPC SP 10/NACE No. 2. Clean to bare metal by powered wire brushing or other mechanical means surfaces that cannot be cleaned satisfactorily by blasting. Wash members which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Remove weld backing plates prior to blast cleaning; when left in place, round off the corners prior to blast cleaning and coating. Tanks shall be internally coated in accordance with Section 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS.

3.1.3.5 Surfaces Not to be Painted

Unless specified otherwise, do not paint equipment having factory applied permanent finish, switchplates and nameplates, motor starters, and concrete foundations.

3.1.4 Insulation

Insulate mechanical equipment, systems and piping as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2 FIELD QUALITY CONTROL

Provide labor, equipment, test apparatus and materials required for preparation and performance of tests and inspections specified to demonstrate that the boilers and auxiliary equipment as installed are in compliance with contract requirements. During startup and during tests, factory trained engineers or technicians employed by the boiler manufacturer and system suppliers or manufacturers of such components as the boiler, burner, forced draft fan, feedwater treatment equipment, and other auxiliary equipment shall be present, to ensure the proper functioning, adjustment, and testing of the individual components and systems. The Government will furnish, when available, water, electricity and fuel for the tests, except fuel required for retesting. The Contractor shall rectify defects disclosed by the tests and retest the equipment. The Contractor's boiler plant personnel shall be experienced in starting up and operating boiler plants.

3.2.1 Tests and Inspections (Piping)

3.2.1.1 General Requirements

Examine, inspect, and test piping in accordance with ASME B31.1except as modified below. The Contractor shall rectify defects disclosed by the tests. Necessary subsequent tests required to prove system tight after additional work by the Contractor shall be provided by the Contractor. Make tests under the direction of and subject to the prior approval of the Contracting Officer.

3.2.1.2 Hydrostatic and Leak Tightness Tests

a. Test piping systems attached to the boilers and included under the jurisdiction of the ASME BPVC SEC I in accordance with the requirement of that Code. Piping bearing ASME Code symbol stamp will be accepted only as indicating compliance with the design and material requirements of the code.

b. Test piping which is a part of the steam generation or auxiliary systems, including piping within the boiler room and external to the boiler room, by the following methods:

   (1) Perform hydrostatic test at 150 percent of design pressure for welded and screwed steel piping systems except those for air, oil, and gas. Hold hydrostatic tests for a period of one hour with no pressure loss. Temperature of the testing fluid shall not exceed 38 degrees C 100 degrees F.

   (2) Test air and oil lines in accordance with the requirements of ASME B31.1 for pneumatic tests with the exception that the test pressure must be held for one hour. Examination for leaks by a soap or other foaming agent test.

   (3) Inspection and test of gas piping shall conform to the requirements of NFPA 54.

c. For tests install a calibrated test pressure gage in the system to observe loss in pressure.

3.2.2 Preliminary Operation

The Contractor under the direction of the respective manufacturer's representative shall perform the work of placing into operation equipment provided except as specifically noted otherwise. Make adjustments to equipment that are necessary to ensure proper operation as instructed by the manufacturer of the equipment.

a. Lubricate equipment prior to operation in accordance with the manufacturer's instructions. Lubricants shall be provided by the Contractor. Contractor shall furnish lubrication gun with spare cartridges of lubricant to operating personnel.

b. Dry out motors before operation as required to develop and maintain proper and constant insulation resistance.

c. Check drive equipment couplings for proper alignment at both ambient and operating temperature conditions.

3.2.3 General Startup Requirements

Prior to initial operation of any complete system, check each component as follows:

a. Inspect bearings for cleanliness and alignment and remove foreign materials found. Lubricate as necessary and in accordance with manufacturer's recommendations. Replace bearings that run roughly or noisily.

b. Adjust direct drives for proper alignment of flexible couplings. Provide lubrication when a particular coupling so requires. Check security of couplings to driver shafts. Set drive components to ensure free rotation with no undesirable stresses present on the coupling of attached equipment.

c. Check motors for amperage comparison to nameplate value. Correct conditions that produce excessive current flow and that exist due to equipment malfunction.

d. Check speeds of each motor and driven apparatus to ensure that they are operating at the desired point.

e. Check actual suction and discharge pressure of each pump against desired performance curves.

f. Check pump packing glands or seals for cleanliness and adjustment before running each pump. Inspect shaft sleeves for scoring and proper placement of packing; replace when necessary. Ensure piping system is free of dirt and scale before circulating liquid through pumps.

g. Inspect both hand and automatic control valves. Clean bonnets and stems, tighten glands to ensure no leakage, but permit valve stems to operate without galling. Replace packing in valves that require same to retain maximum adjustment after system is judged complete. Replace entire packing in valves that continues to leak after adjustment. Remove and repair bonnets that leak. Coat packing gland threads and valve stems with a suitable surface preparation after cleaning.

h. Inspect and make certain that control valve seats are free from foreign material and are properly positioned for the intended service.

i. Check flanges and packing glands after the system has been placed in operation. Replace gaskets in flanges that show signs of leakage after tightening.

j. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts, apply compound and remake joint.

k. Strainers installed shall be thoroughly blown out through individual valved blow-off connection on each strainer prior to placing in operation.

l. Thoroughly blow out or dismantle and clean strainers after systems have been in operation one week. Thoroughly clean, repair, and place back in service traps or other specialties in which foreign matter has accumulated, causing malfunction or damage.

m. Adjust pipe hangers and supports for correct pitch and alignment.

n. Remove rust, scale and foreign materials from equipment and renew defaced surfaces. When equipment is badly marred, the Contracting Officer shall have the authority to request that new materials be provided.

o. Adjust and calibrate temperature, pressure and other automatic control systems.

p. Inspect each pressure gage and thermometer for calibration, and replace those that are defaced, broken or read incorrectly.

[q. Vertical Fuel Oil Tank Calibration: After completing installation of tank, prepare a calibration table for tank showing the volume of fuel in liters gallons in the tank to height of liquid in meters and mm feet and inches, when measured by a steel tape lowered through the roof. Calibrate tank in accordance with ASTM D1220 for "critical measurement" "operating control." Calibration of the tank shall be done by a qualified organization that can certify to at least 2 years of prior successful and accurate experience in calibrating tanks of comparable type and size. Correct the data obtained for use with the product to be stored.

]3.2.4 Fuel Oil Tanks

****
NOTE: Choose one of the following options.
****

[a. Horizontal Fuel Oil Tanks (Below Ground):

(1) Test tanks before placing in service, in accordance with the applicable paragraphs of the code under which they were built. An UL label, ASME Code Stamp, or API monogram on a tank shall be evidence of compliance with code requirements.

(2) Holiday Detection Test: Inspect coal tar epoxy coating system for film imperfections using a low voltage (75 volt) holiday tester. Inspect FRP coated tanks with a 10,000 volt spark test for imperfections or holidays (voids). Repair holidays or pinholes in the coatings.

][b. Vertical Fuel Oil Tank: Inspect and test as specified in API Std 650. Use the radiographic method of inspection of butt welds as required by API Std 650; sectioning method will not be acceptable as an alternative to radiographic inspection.

]3.2.4.1 Blowdown Valves and Try Cocks

Test blowdown valves and try cocks for proper operation.

3.2.4.2 Fans, Heaters, Pumps, and Motors

Test draft fans, fuel oil heaters, fuel pumps, and electric motors to determine compliance with the referenced standards. Standard symbols and certifications from the referenced organization may be accepted at the discretion of the Contracting Officer. Closely observe the operation of fans, fuel oil heaters, fuel pumps, and electric motors for possible defects or nonconformance.

3.2.5 Boilers and Auxiliaries Tests and Inspections

The Contractor, with qualified personnel provided by the Contractor, shall make tests and inspections at the site under direction of and subject to approval of the Contracting Officer. The respective manufacturer's representatives and consultants shall direct the Contractor's boiler plant personnel in the operation of each boiler and appurtenances through the entire testing period and shall ensure that necessary adjustments have been made. The Contractor shall notify the Contracting Officer in writing, at least 7 days in advance, indicating that equipment is ready for testing. The Contractor shall provide testing equipment, including gages, thermometers, calorimeter, flue gas analyzers, thermocouple pyrometers, fuel flow meters, water meters and other test apparatus and calibrate instruments prior to the test. Draft, fuel pressure and steam flow may be measured by permanent gages and meters installed under the contract. The Contractor is responsible for providing an analysis of the fuel being used for the tests. Control of noise levels developed by exhaust steam shall be as directed by the Contracting Officer to satisfy environmental conditions of the surrounding area. The Contractor shall perform the following tests in the sequence as listed when feasible:

a. Strength and tightness tests

b. Standards compliance tests

c. Preliminary operational tests (steady state combustion test and variable load combustion test)

d. Tests of auxiliary equipment

e. Feedwater equipment test

f. Capacity and efficiency tests

3.2.5.1 Strength and Leak Tightness Tests

Subject boiler[s] to the following strength and tightness tests:

a. Watersides Including Fitting and Accessories: Hydrostatically test watersides in accordance with the requirements of the ASME BPVC SEC I. Since damage to the boiler components may have occurred during shipping, the factory ASME label will not be accepted as evidence of this test. Therefore, the final hydrostatic test must be performed after the installation of the boiler and its auxiliary components have been installed.

b. Boiler Casing, Air Casing, and Ducts: Test air casing and ducts exterior to the furnace pneumatically at the maximum working pressure. Use the soap bubble method to verify tightness. Test gas sides of boilers normally operated under pressure for tightness at one and one half times the predicted operating pressure in the furnace at maximum continuous output. For this test, tightly seal the boiler with a suitable means to blank off openings. Admit air to the boiler until the test pressure is reached, and then hold. If in a 10 minute period the pressure drop does not exceed 1245 Pa 5 inches water gage, the casing shall be regarded as tight and accepted.

3.2.5.2 Boiler Inspection

The Boiler Inspector shall be on hand to witness the appropriate tests which need to be observed in order to certify the safety of the boiler. The inspection shall include the requirements of NAVFAC MO 324Inspection and Certification of Boilers and Unfired Pressure Vessels. The Boiler Inspector shall complete NAVFAC form 9-11014/40, Data Record Sheet; NAVFAC form 9-11014/41, Inspection Report; NAVFAC 9-11014/32 Inspection Certificate for each boiler after boiler has been inspected and found to be safe. No boiler may be fired until it has passed the inspection of the Boiler Inspector. Boiler inspection forms shall be submitted through the Contractor to the Contracting Officer. Place Inspection Certificate under framed glass, mounted on or near the boiler in a conspicuous location.

3.2.5.3 Boiler Cleaning and Startup

Dry out, boil out, and operate firing rate of new boiler(s) under direct responsibility and supervision of the manufacturer, [and in the presence of boiler room operating personnel]. Provide required chemicals. Allow sufficient time for boiling out process to ensure interior surfaces are clean. This time shall be at least 24 continuous hours and generally not more than 36 hours; boil out shall continue until water is clear. Boil out, cleaning and starting procedures shall be in accordance with requirements of ASME BPVC SEC VII and FM DS 12-17.

3.2.5.4 Boiler Preliminary Operational Tests

Conduct a boiler operational test on each unit continuously for two weeks. Operate one boiler at a time to demonstrate control and operational conformance to specified requirements including ability to respond to load swings from the specified capacity to minimum turndown. Conduct operational test under the supervision of a registered professional engineer or a licensed power plant operator and demonstrate operation of safeties, controls, maintenance of stable combustion at low loads, proper flame lengths and patterns to avoid flame impingement on the tubes for oil firing [or gas firing], and proper mechanical and electrical functioning of systems. This test shall include items mentioned in this specification as well as items mentioned in the specification of the particular pieces of equipment. Conduct tests with factory trained combustion equipment engineers as previously specified. Test and record steam quality, steam flowrates, flue gas temperature, percentages of carbon dioxide, carbon monoxide, oxygen and nitrogen in the flue gas and percent excess air for each boiler at tested load and graphically present test data.

3.2.5.5 General Controls Operational Tests

Conduct operational tests, performance tests, and demonstration tests with boiler controls functional and on line. No bypassing, use of jumpers, or other disablement of control systems will be allowed unless specified elsewhere.

3.2.5.6 Steady State Combustion Tests

Test fuel burning and combustion control equipment with each of the specific fuels at the minimum limit of the turndown range and at increments of 50, 75 and 100 percent of full rated load. Each test run shall be at least two hours on each fuel and until stack temperatures are constant and capacity and efficiency requirements of this specification have been verified and recorded. Verify proper operation of instrumentation and gages during the tests.

3.2.5.7 Varying Load Combustion Tests

Test boilers continuously under varying load conditions to demonstrate proper operability of the combustion control, flame safeguard control, programming control and safety interlocks. Conduct these tests after the adjustment of the combustion controls has been completed under the steady state combustion tests. Continue the variable load operational tests for a period of at least 8 hours.

a. Sequencing: Boiler shall start, operate and stop in strict accordance with the specified operating sequence.

b. Flame Safeguard: Verify operation of flame safeguard controls by simulated flame and ignition failures. Verify the trial-for-pilot ignition, trial-for-main flame ignition, combustion control reaction and valve closing times by stop watch.

c. Immunity to Hot Refractory: Operate burner at high fire until combustion chamber refractory reaches maximum temperature. Main fuel valve shall then be closed manually. Combustion safeguard shall drop out immediately causing safety shutoff valves to close within the specified control reaction and valve closing times.

[d. Pilot Intensity Required: Gradually reduce fuel supply to the pilot flame to the point where the combustion safeguard begins to drop out (sense "no flame") but holds in until the main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame shall be capable of safely igniting the main burner. When the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, the boiler shall be rejected.

] e. Boiler Limit and Fuel Safety Interlocks: Safety shutdown shall be caused by simulating interlock actuating conditions for each boiler limit and fuel safety interlock. Safety shutdowns shall occur in the specified manner.

f. Combustion Controls: Demonstrate accuracy, range and smoothness of operation of the combustion controls by varying the steam demand through the entire firing range required by the turndown ratio specified for the burner. Control accuracy shall be as specified.

g. Safety Valves: High pressure limit switch shall be locked out or otherwise made inoperative and the boiler safety valves shall be lifted by steam. Determine the relieving capacity, popping pressure, blowdown and reseating pressure by observation and measurement in accordance with the ASME BPVC SEC I. The ASME standard symbol will be accepted only as indicating compliance with the design and material requirements of the code.

3.2.5.8 Auxiliary Equipment and Accessory Tests

Observe and test blowdown valves, stop valves, try cocks, fans, fuel oil heaters, pumps, electric motors, and other accessories and appurtenant equipment during operational and capacity tests for leakage, malfunctions, defects, and for compliance with referenced standards.

3.2.5.9 Feedwater Equipment Tests

Perform tests of feedwater treatment equipment in two steps. Conduct one test concurrently with the combustion tests. The Government will perform a second test during the first period of heavy loading after plant has been accepted and put in service. Correct deficiencies revealed during the Government tests under the guarantee provisions of the contract. Both the first and second series of tests shall determine compliance with limits for chemical concentrations of this specification. Supply equipment for taking samples and test kit for analyzing samples. Sampling equipment and test kit shall become the property of the Government when tests are completed.

3.2.5.10 Capacity and Efficiency Tests

Perform capacity and efficiency tests after satisfactorily completing operating tests and after operating boiler continuously for at least 14 days with no nuisance shutdowns and without the necessity for frequent or difficult adjustments. Perform these tests on each boiler. Conduct tests using [the] [each] specified fuel. Test procedures shall be in accordance with the heat loss method [and the input-output method] of ASME PTC 4. Before tests are performed, the Contracting Officer and the Contractor shall reach agreement on those items identified in ASME PTC 4, Section 3, paragraph 3.0l "Items on Which Agreement Shall be Reached." A test run shall not start until boiler and accessories have reached an equilibrium and stabilization condition for at least one hour in duration. Duration of tests shall be sufficient to record necessary data but in no case shall each run be less than [4] [10] [24] hours.

3.2.5.11 Test Runs

Accomplish maximum output testing by means of a single 2 hour run at 110 percent load on the boiler under test. Calculate boiler efficiency, using [the][both input-output and] heat loss method[s], from the consistent readings taken during the runs. Make runs at four different loads 30, 50, 70, and 100 percent of boiler rating during which take both heat loss and input-output data. Predict unmeasured losses used in conjunction with heat loss calculations and include with equipment data when submitted for approval. Subsequent tests required because of failure of equipment to perform adequately during specified capacity and efficiency tests shall be financial responsibility of the Contractor, including fuel cost.

3.2.5.12 Fuel Analysis

When analysis of fuel being burned during performance tests vary from that specified as the performance fuel the guarantees shall be adjusted in accordance with accepted engineering practice to determine compliance. Carbon loss shall be determined in accordance with ABMA Boiler 103, American Boiler Manufacturers Association curves for carbon loss.

3.2.5.13 Temporary Waste Steam Connection

When necessary to obtain sufficient load for these tests, provide a temporary steam line at a point outside of the building. Provide necessary pipe, fittings, supports, anchors and appurtenances including a field fabricated silencer as directed by the Contracting Officer. Remove temporary piping and silencer after tests have been satisfactorily completed.

3.2.5.14 Fire Safety for Oil-fired Boilers

Conduct tests as necessary to determine compliance with the applicable UL Safety Standards. The presence of the applicable Underwriters' label will be accepted as evidence of compliance in this respect.

a. Oil-Fired Boilers: Oil fired boilers shall meet test requirements of UL 726.

b. Oil Burners: Oil burners shall meet test requirements of UL 296.

3.2.5.15 Plant Acceptance Operation

After satisfactory completion of tests specified, operate the complete plant including each boiler, [its related flue gas cleaning equipment] and subsystems for a period of 30 continuous 24 hour operational days prior to final acceptance by the Government. Furnish labor, chemicals, test equipment and apparatus; the Government will furnish fuel, electricity and water. During this 30 day period, furnish readily available, the services of qualified representatives from manufacturers of plant components and systems for the purpose of additional operational assistance, component and system adjustment and repairs. Government personnel will observe Contractor's operational procedures. The Contractor's representatives shall be prepared to answer pertinent questions from the Government, about the plant operation.

3.2.6 Manufacturer's Field Services

3.2.6.1 Erection/Installation Supervisors and Service Engineers

a. Boiler: Furnish the services of a competent supervisor who is in the direct employ of the boiler manufacturer. This supervisor shall remain on the construction site the full 8 hours per day, 5 days per week, or the same hours, that the boiler installation takes place. This supervisor shall be responsible for the complete steam generating unit, including the steam generator, forced draft fan, burner and other related work, such as refractory, or insulation regardless of whether the forced draft fan, burner or the other related items of work are furnished by manufacturers other than the boiler manufacturer.

b. Forced Draft Fans: The Contractor shall furnish a company service engineer to advise on the erection or installation of fans and related equipment.

c. Service Engineers: Services of the manufacturing companies' service engineers and the system suppliers' service engineers shall be provided by the Contractor to advise during erection and installation of other systems and equipment such as air compressors, air dryers, boiler feedwater pumps, fuel oil pumps, condensate pumps, water treatment equipment, chemical feed pumps, deaerating feedwater heater and stacks.

3.2.6.2 Boiler and System Representatives

a. Furnish factory trained engineers or technicians who are representatives of the boiler manufacturer and system suppliers to supervise testing of the boilers and auxiliary equipment.

b. Furnish the services of a Boiler Inspector who is qualified and certified as such by the National Board of Boiler and Pressure Vessel Inspectors and who is presently employed full time by a firm, such as Hartford Steam Boiler Inspection and Insurance Company, which has a business of inspecting boilers.

3.2.6.3 Instruction to Government Personnel

In accordance with the provisions of Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, supervisors and service engineers shall provide instruction for the Government's operators in the operation and maintenance of the equipment furnished under this section. The minimum number of hours of instruction provided shall be as follows:

Equipment	Operation Instruction	Maintenance Instruction
Boiler and auxiliaries	40 hours	16 hours
Forced draft fans	16 hours	16 hours

Equipment	Operation Instruction	Maintenance Instruction
Fuel handling system	16 hours	32 hours
Air compressors and dryers	8 hours	16 hours
Boiler feedwater pumps	8 hours	8 hours
Miscellaneous equipment	16 hours	16 hours

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
Boilers	Capacity-18,000 #/hr	Capacity 2 1/4 kg/sec
Fan Motor	Size - 19 hp	Size - 7/12 kW
Thermometer	5 inch Dial; 50 to 300 degrees F	125 mm Dial; 10 to 149 degrees C
Pressure Gage	6 inch Dial	150 mm Dial
Electric Motor	Size - 7 1/2 hp	Size - 5 1/2 kW

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 52 43.00 20 (May 2015)**
Change 2 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-23 52 43.00 20 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 23 52 43.00 20

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PART 1 GENERAL

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USACE / NAVFAC / AFCEC **UFGS-23 52 43.00 20 (May 2015)**
Change 2 - 08/18

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SECTION 23 52 43.00 20

LOW PRESSURE WATER HEATING BOILERS (UNDER 800,000 BTU/HR OUTPUT)
05/15, CHG 2: 08/18

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NOTE: This guide specification covers the requirements for low pressure hot water heating boilers under 235 kilowatt 800,000 BTU/hr output.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13/CSA 4.9	(2022) Gas-Fired Low Pressure Steam and Hot Water Boilers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C592	(2024) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-23 PART 1	(2013) National Board Inspection Code - Part 1 Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein.

1.3 DESIGN REQUIREMENTS

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NOTE: Insert boiler output capacity or indicate in boiler schedule. Select boiler design working pressure, operating pressure, operating temperature, and return water temperature and indicate in boiler schedule on drawings.

****

Boiler must be suitable for installation in the space shown with ample room for opening doors and cleaning and removal and replacement of tubes. Boiler must have an output of [_____] kW BTU/hr. Boiler must be designed and tested in accordance with ASME BPVC SEC IV, ASME CSD-1, NFPA 54, NFPA 31, NFPA 70 and ANSI Z21.13/CSA 4.9. Boiler must be installed in accordance with NBBI NB-23 PART 1. Paint boiler in accordance with manufacturer's recommendations. Boiler design working pressure must be [207 kPa (gage)] [30 psig] [_____]. Boiler operating pressure must be [83 kPa (gage)] [12 psig] [_____]. Boiler operating temperature must be [82 degrees C] [180 degrees F] [_____]. Boiler return water temperature must be [71 degrees C] [160 degrees C] [_____]. Provide a thermostatically controlled three-way mixing valve on boiler suitable for operating conditions of the boiler.

1.3.1 Boiler Installation Requirements

1.3.1.1 Location

Install Boiler(s) and associated hot water pumps in a mechanical room inside the facility in accordance with NBBI NB-23 PART 1. Provide ample clearance around boilers to allow access for inspection, maintenance and repair. Passageways around all sides of boilers must have an unobstructed minimum width of 36 inches or the clearances recommended by the boiler manufacturer whichever is greater.

1.3.1.2 Combustion Air

Provide supply of air for combustion and ventilation. In accordance with

NFPA 54, NFPA 211 and manufacturer's installation manual, calculate the amount of combustion air necessary to operate the boiler. Install and locate properly sized combustion air dampers and louvers.

1.3.1.3 Sequence of Operation

Local, manual starting of boilers is required. Remote starting and stopping of the boiler by the HVAC control system is not permitted. This is to ensure that an operator witness the initial firing of the boiler at the beginning of each heating season to verify proper operation of the boiler and to promote proper maintenance.

1.3.2 Detail Drawings

1.3.2.1 Drawings

Show boiler hot water isolation valves, emergency disconnect switch, and complete boiler gas train on the contract drawings.

1.3.2.2 Fuel Train / Wiring Diagram

Submit fuel train and wiring diagram.

1.3.3 Water Analysis

Provide test reports of water analysis. UFC 3-240-13FN Industrial Water Treatment must be followed for all boiler installations.

1.4 SAFETY STANDARDS

Hot water boilers, burners and supplementary control devices, safety interlocks, or limit controls required under this specification, must meet requirements of the following standards as applicable:

a. Oil-Fired Units: UL 726, NFPA 31, NFPA 70, ASME CSD-1.

b. Gas-Fired Units: ASME CSD-1, NFPA 54, NFPA 70, ANSI Z21.13/CSA 4.9 or UL 795.

c. Combination Gas- and Oil-Fired Units: ASME CSD-1, NFPA 54, NFPA 31, NFPA 70, UL 726, ANSI Z21.13/CSA 4.9, UL 795 or UL 296.

d. All Units: ASME BPVC SEC IV, NFPA 70 and ASME CSD-1.

Controls not covered by the above must have a UL label, UL listing mark, or must be listed in the Factory Mutual Approval Guide.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

[Submittals for this Section must be delivered to the project Contracting Officer, who will forward two complete sets of copies to the appropriate approving official for review and approval.

] SD-02 Shop Drawings

Fuel Train

Wiring Diagram

SD-03 Product Data

Boilers

[Energy Star Label for Gas Fired Residential Boiler Product; S

][Energy Star Label for Oil-Fired Residential Boiler Product; S

] Boiler Trim and Control Equipment

Burners and Control Equipment

Stack, Breeching, and Supports

SD-06 Test Reports

Operational Tests

Water Analysis

SD-07 Certificates

Boilers

Burners and Control Equipment

Boiler Trim and Control Equipment

Boiler manufacturer's certificate of boiler performance including evidence that the burners provided must be a make, model, and type certified and approved by the manufacturer of the boiler being provided.

SD-08 Manufacturer's Instructions

Boilers

Feedwater Treatment Feeder

SD-10 Operation and Maintenance Data

Boilers, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions for Heating Water Boilers

PART 2 PRODUCTS

2.1 BOILERS

****

NOTE: Select options based on fuel source, residential or commercial application, and boiler capacity. Efficiencies included below are based on Energy Star for residential applications and ASHRAE 90.1 for commercial applications.

****

Provide hot water heating boiler complete with firing equipment, combustion chamber, insulation with steel jacket, safety and operating controls, integral electrical wiring and other appurtenances, to make the boiler a complete, self-contained, fully-automatic unit, ready for service upon completion of utility connections.[Gas fired residential boilers less than 88 kW 300,000 Btuh must have an Annual Fuel Utilization Efficiency (AFUE)of at least 90 percent, and be Energy Star labeled. Provide proof of Energy Star label for oil-fired residential boiler product.][Oil-fired residential boilers less than 88 kW 300,000 Btuh must have an Annual Fuel Utilization Efficiency (AFUE) of at least 87 percent, and be Energy Star labeled. Provide proof of Energy Star label for gas fired residential boiler product.][Commercial boilers less than 88 kW 300,000 Btuhmust have an Annual Fuel Utilization Efficiency (AFUE) of at least 80 percent.][Gas fired boilers greater than 88 kW 300,000 Btuh input must have a thermal efficiency of at least 80 percent when fired at the maximum and minimum capacities which are provided and allowed by the controls.][Oil-fired boilers greater than 88 kW 300,000 Btuh output must have a thermal efficiency of at least 82 percent when fired at the maximum and minimum rated capacities which are provided and allowed by the controls.]

2.1.1 General Requirements

Design, construction, installation, testing, and operation of boiler and appurtenances must comply with NBBI NB-23 PART 1, ASME BPVC SEC IV, ASME CSD-1, NFPA 54, NFPA 31, ANSI Z21.13/CSA 4.9, and the manufacturer's instructions.

2.2 BURNERS AND CONTROL EQUIPMENT

****

NOTE: Indicate fuel trains on the drawings. Conform to the requirements of ASME CSD-1.

****

[2.2.1 Atmospheric-Type Gas Burner

Atmospheric-type gas burner (under 117 kW 400,000 BTU/hr input). ASME CSD-1 and ANSI Z21.13/CSA 4.9. Automatic recycling burner. ON-OFF type combustion control system.[Interrupted] [Intermittent] pilot type ignition system, and pilot must be electrode-ignited natural gas type. Design burner and combustion control equipment for firing natural gas having a specific gravity of [0.6] [_____] and a heating value of approximately [37,300 kJ per cubic meter] [1000 BTU per cubic foot] and be an integral part of the boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1 and ANSI Z21.13/CSA 4.9, including complete gas shut-off and pilot gas. Gas pressure available: [[_____] inches of water gage (WC)] kPa gage psig.

][2.2.2 Gas-Fired Power Burner

Gas-fired power burner (over 117 kW 400,000 BTU/hr input). Interrupted pilot type ignition system, and pilot must be the electrode-ignited natural gas type. Design burner and combustion control equipment for firing natural gas having a specific gravity of [0.6] [_____] and a heating value of approximately [37,300 kJ per cubic meter] [1000 BTU per cubic foot] [_____] and be an integral part of the boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 54, ANSI Z21.13/CSA 4.9 and UL 795. Mount controls; including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of control systems on a single control panel or cabinet designed for separate mounting not on the burner. The combustion control system must be the [on/off] [high-low-off] [positioning] [metering] type. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner. Provide fuel train as indicated. Gas pressure available: [[_____] Pa inches of water gage] [[_____] kPa (gage) psig].

][2.2.3 Oil-Fired Power Burner

Oil-fired power burner (under 117 kW 400,000 BTU/hr input). Direct electric-spark-ignited type ignition system. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 31 and UL 726. The combustion control system must be the [on/off] [high-low-off] [positioning] [metering] type.

][2.2.4 Oil-Fired Power Burner

Oil-fired power burner (over 117 kW 400,000 BTU/hr input). Pressure-atomizing type burner. Direct electric-spark-ignited type ignition system. Design burner and combustion control equipment for firing commercial grade number 2 fuel oil and be an integral part of the boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 31 and UL 726. The combustion control system must be the [on/off] [high-low-off] [positioning] [metering] type. Mount controls; including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of control systems on a single control panel or cabinet designed for separate mounting not on the burner. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner. Provide fuel train as indicated.

][2.2.5 Gas and Light Oil-Fired Power Burner

Gas and light oil-fired power burner (over 117 kW 400,000 BTU/hr Input). The combustion control system must be the [on/off] [high-low-off] [positioning] [metering] type. Pressure-atomizing type oil burner. Interrupted-pilot type ignition system, and pilot be electrode-ignited natural gas type, except that the oil burner be direct electric-spark-ignited. Design burner and combustion control equipment for firing commercial grade number 2 fuel oil and natural gas having a specific gravity of [0.6] [_____] and a heating value of approximately [37,300 kJ per cubic meter] [1000 BTU per cubic foot] [_____] and be an integral part of boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 31, UL 726, NFPA 54, ANSI Z21.13/CSA 4.9 and UL 795. Mount controls; including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of control systems on a single control panel or cabinet designed for separate mounting not on the burner. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner. Provide fuel train as indicated. Gas pressure available: [[_____] Pa inches of water gage] [[_____] kPa (gage) psig].

]2.3 BOILER TRIM AND CONTROL EQUIPMENT

Provide in accordance with ASME CSD-1 and ASME BPVC SEC IV and additional requirements specified below.

2.3.1 Emergency Disconnect Switch

****

NOTE: Indicate location of emergency disconnect switch on drawings. Insert emergency switch amperage required.

****

Provide and locate on wall outside boiler room entrance or just inside door, when boiler room door is on building exterior as required by ASME CSD-1 to allow rapid and complete shutdown of the boiler in the event of an emergency. Emergency switch must be a [_____]-amp. fuse-type safety switch. Switch must be red and furnished with a label indicating function of switch.

2.3.2 Relief Valves

Provide relieving capacity for the full output of boiler installed. Safety relief-valve piping must conform to ASTM A53/A53M, schedule 40 steel pipe and be piped full-size [to a floor drain] [to 150 mm 6 inches above floor].

2.3.3 Pressure and Altitude Gage or Combination Pressure/Altitude Gage

Provide one located on supply water piping and one on return water piping.

2.3.4 Thermometer

Provide thermometer with a scale equivalent to 1.5 times outlet water temperature. Provide one located on supply water piping and one on return water piping.

2.3.5 Drain Tapping

Provide drain valve and piping [to a floor drain] [to 150 mm 6 inches above floor].

2.3.6 Make-up Water Station

2.3.6.1 Pressure Reducing Station

****

NOTE: Select operating pressure required.

****

Provide a water pressure-reducing valve and relief valve, or a combination of the two in the makeup water line to the boiler to maintain a water pressure of [83 kPa (gage)] [12 psig] [_____] in the hot water system. Provide a 20 mm 3/4 inch globe valve by-pass around this valve.

2.3.6.2 Backflow Preventers

Section 22 00 00 PLUMBING, GENERAL PURPOSE. Locate upstream of by-pass.

2.3.7 Feedwater Treatment Feeder

Provide floor mounted, Type II - Shot-Type Feeder (manual, intermittent feed), as indicated for use with pressures up to 1379 kPa (gage) 200 psig maximum.

2.3.8 Combustion Regulator

Provide adjustable temperature, thermostatic immersion type that must limit boiler water temperature to a maximum of 121 degrees C 250 degrees F. Control must actuate burner through an electric relay system to maintain boiler water temperature within normal prescribed limits at loads within rated capacity of boiler.

2.3.9 Air Vent Valve

Provide with screwed connection, stainless steel disk, and stainless steel seats to vent entrapped air.

2.3.10 High Temperature Limit Switch

****

NOTE: Specify alarm and indicating lights if input exceeds 117 kW 400,000 BTU/hr.

****

Provide adjustable immersible aquastat type with a temperature setting above that of the combustion regulator and below that of the lowest relief valve setting. Aquastat must function to cause a safety shutdown by closing fuel valves[,] [and] shutting down burner equipment [, activating a red indicating light, and sounding an alarm] in the event that boiler water temperature rises to the high temperature limit setting. A safety shutdown due to high temperature must require manual reset before operation can resume and prevent recycling of burner equipment. Pre-set high temperature limit devices that cannot be easily tested are not allowed.

2.3.11 Low Water Level Cutoff Switch

****

NOTE: Specify alarm and indicating lights if input exceeds 117 kW 400,000 BTU/hr.

****

Low water level cutoff must cause a safety shutdown by closing fuel valves[,] [and] shutting down burner equipment [, activating a red indicating light, and sounding an alarm] in the event that water level drops below the lowest safe permissible water level established by the boiler manufacturer and ASME BPVC SEC IV. A safety shutdown due to low water must require manual reset before operation can resume and prevent recycling of burner equipment.

2.3.12 Boiler Safety Control Circuits

****

NOTE: Include draft fan if power burner is specified.

****

Provide boiler safety control circuits, including control circuits for burner [and draft fan], must be single-phase, two-wire one-side grounded, and not over 120 volts. Provide safety control switching in ungrounded conductors. Provide overcurrent protection. In addition to circuit grounds, ground metal parts which do not carry current to a grounding conductor.

2.3.13 Indicating Lights

****

NOTE: Delete entire paragraph if boiler input does not exceed 117 kW 400,000 BTU/hr. Include draft fan if power burner is specified.

****

Each safety interlock requiring a manual reset must have an individually labeled red indicating light. Non-recycling control interlocks must have the reset located on the control itself. Red indicating lights on the control panel may be omitted if the burner combustion control system has a Keyboard Display Module installed that will identify the lockout information required in Item c. below. Indicating lights must have colors as follows:

a. Amber: Ignition on

b. Green: Main fuel safety shut-off valves open

c. Red (One for Each): Safety lockout, flame failure, low water level, and high temperature

[d. Blue: Draft

]2.3.14 Alarm Bell

****

NOTE: Delete entire paragraph if boiler input does not exceed 117 kW 400,000 BTU/hr.

****

Provide alarm bell, electrically operated, with a manual disconnect switch. Disconnect switch must be type and wired so that switching off alarm following a safety shutdown will not prevent alarm from sounding again upon recurrence of a subsequent safety shutdown condition.

2.3.15 Post-Combustion Purge

****

NOTE: Delete entire paragraph if atmospheric burner is specified.

****

Provide controls and wiring necessary to ensure operation of draft fan for a period of not less than 15 seconds or of sufficient duration to provide four complete air changes in the boiler combustion chamber (whichever is greater) following shutdown of burner upon satisfaction of heat demand and in accordance with ASME CSD-1 . Upon completion of post-combustion purge period, draft fan must automatically shutdown until next restart.

2.3.16 Draft

Comply with boiler manufacturer's recommendations.

2.3.17 Stack, Breeching, and Supports

****

NOTE: NFPA 211, Type B vent can only be used with an atmospheric burner.

****

****

NOTE: Boiler stacks must conform to the boiler manufacturer's installation and operational manual.

****

[Provide boiler stack constructed of sheet steel having a thickness of not less than 2.47 mm 0.0972 inches with welded joints. Insulate stack located inside the building with 38 mm 1 1/2 inches of mineral wool conforming to applicable requirements of ASTM C592, Class II - for use up to 649 degrees C 1200 degrees F. Insulation must receive a finish coat of finishing cement not less than 19 mm 3/4 inch thick, trowelled to a smooth finish. Provide stack supports, umbrella collar and cap, and flue transition piece. Stack diameter and height must be in accordance with manufacturer's recommendations and conform to NFPA 211.]

[NFPA 211, [Type B - gas] [Type L - oil and gas/oil], prefabricated multi-wall type, flashed to the roof, and complete with rain cap. Stack diameter and height must be in accordance with manufacturer's recommendations and conform to NFPA 211.]

2.3.18 Hot Water Coils

****

NOTE: Delete entire paragraph unless hot water coils are required to instantaneously heat domestic water.

****

Provide coils capable of heating [_____] L/s GPM of water with [_____] degree C F rise conforming to ASME BPVC SEC IV.

2.3.19 Stack Thermometer

Provide flue gas dial type thermometer with scale calibrated from 66 to 399 degrees C 150 to 750 degrees F and mounted in flue gas outlet.

2.4 ELECTRIC MOTORS

Electric motors must meet requirements of NEMA MG 1. Motors less than 3/4 kW 1 hp must meet NEMA High Efficiency requirements. Motors 3/4 kW 1 hp and larger must meet NEMA Premium Efficiency requirements. Motors which are an integral part of the packaged boiler system must be the highest efficiency available by the manufacturer of the packaged boiler. Motors must be variable speed.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

Install equipment in accordance with manufacturer's installation instructions and NBBI NB-23 PART 1. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets. Feedwater treatment feeders must be mounted so that the top of the feeder is no higher than 1219 mm 48 inches above the finished floor.

3.2 EQUIPMENT FOUNDATIONS

Locate equipment foundations as indicated, designed, and made of sufficient size and weight to preclude shifting of equipment under operating conditions or under abnormal conditions that could be imposed upon the equipment. Foundations must meet requirements of the equipment manufacturer. Concrete and grout must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3 BOILER CLEANING

Before being placed in service, boiler must be boiled out for a period of

24 hours at a pressure not exceeding 83 kPa (gage) 12 psig. Solution to be used in the boiler for the boiling out process must consist of two pounds of trisodium phosphate per 379 liters 100 gallons of water. Upon completion of boiling out, flush out boiler with potable water, drain, and charge with chemically treated water. Protect boiler and appurtenances against internal corrosion until testing is completed and boiler is accepted. Professional services are required for cleaning/treatment process.

3.4 FIELD QUALITY CONTROL

Perform and furnish everything required for inspections and tests as specified herein to demonstrate that boiler and auxiliary equipment, as installed, are in compliance with contract requirements. Start-up and operate the system. During this time, clean strainers until no further accumulation of foreign material occurs. Exercise care to minimize loss of water when strainers are cleaned. Adjust safety and automatic control instruments as necessary to place them in proper operation and sequence. Test instrumentation must be calibrated and have full scale readings from 1.5 to 2 times test values.

3.4.1 Operational Tests

Furnish the services of an engineer or technician approved by the boiler manufacturer of installation, startup, operational and safety testing. This person must remain on the job until each boiler has been successfully operated. Furnish and perform everything required for inspections and tests of the boiler and auxiliary equipment. Test instrumentation must be calibrated and have full-scale reading from 1.5 to 2 times test values. Demonstrate proper operability of combustion control, flame safeguard control and safety interlocks. Provide a detailed description of all boiler startup and operational tests in the Commissioning Plan.

3.4.1.1 Preliminary Operational Test

Operate the boilers continuously for a period of at least 8 hours to demonstrate proper operability of the combustion control, flame safeguard control, and safety interlocks.

3.4.1.2 Acceptance Operational Test and Inspection

****

NOTE: Insert the appropriate Facility Engineering Command Acceptance Operational test and inspection by NAVFAC Boiler Inspector only required for boilers with capacity of 400,000 Btu/hr or greater.

****

Prior to requesting an acceptance test, conduct a satisfactory operational test for at least 8 hours, and provide a certified statement that the equipment is installed per all requirements of this guide. Contracting Officer, upon receipt of the notice from the Contractor, will request a boiler inspection by a Naval Facilities Engineering and Expeditionary Warfare Center (EXWC) NAVFAC boiler inspector. Fifteen days advance notice is required for scheduling inspector to conduct acceptance operational test and inspection.

3.5 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Alarm Bell Diameter	= 4 inches	= 100 mm
b. Stack Thermometer Scale Range	= 150-750 degrees F	= 66-399 degrees C

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 52 46.00 20 (May 2015)**
Change 3 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-23 52 46.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 52 46.00 20

LOW PRESSURE WATER HEATING BOILERS (OVER 800,000 BTU/HR OUTPUT)

05/15, CHG 3: 08/18

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

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****

SECTION 23 52 46.00 20

LOW PRESSURE WATER HEATING BOILERS (OVER 800,000 BTU/HR OUTPUT)

05/15, CHG 3: 08/18

****

NOTE: This guide specification covers the requirements for low pressure hot water heating boilers over 235 kilowatt 800,000 BTU/hr output.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13/CSA 4.9	(2022) Gas-Fired Low Pressure Steam and Hot Water Boilers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C592	(2024) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-23 PART 1	(2013) National Board Inspection Code - Part 1 Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Sep 2024) UL Standard for Safety Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein.

1.3 DESIGN REQUIREMENTS

****

NOTE: Insert boiler output capacity or indicate in boiler schedule. Select boiler design working pressure, operating pressure, operating temperature, and return water temperature and indicate in boiler schedule.

****

Boiler must be suitable for installation in the space shown with ample room for opening doors and cleaning and removal and replacement of tubes. Boiler must have an output of [_____] kW BTU per hour with an efficiency of not less than required by the applicable military specification. Boiler must be designed and tested in accordance with ASME BPVC SEC IV, ASME CSD-1, NFPA 70, NFPA 54, NFPA 31, and ANSI Z21.13/CSA 4.9. Install boiler in accordance with NBBI NB-23 PART 1. Boiler must be complete with an explosion-relief door, located in accordance with manufacturer's recommendations. Paint boiler in accordance with manufacturer's standard requirements. Boiler design parameters must be as follows: working pressure of [207 kPa (gage)] [30 psig] [_____]; operating pressure of [83 kPa (gage)] [12 psig] [_____]; operating temperature of [82 degrees C] [180 degrees F] [_____]; and return water temperature of [71 degrees C] [160 degrees F] [_____]. Provide a thermostatically controlled three-way mixing valve on the water supply to the boiler suitable for operating conditions of the boiler.

1.3.1 Boiler Installation Requirements

1.3.1.1 Location

Install Boiler(s) and associated hot water pumps in a mechanical room inside the facility in accordance with NBBI NB-23 PART 1. Provide ample clearance around boilers to allow access for inspection, maintenance and repair. Passageways around all sides of boilers must have an unobstructed minimum width of 36 inches or the clearances recommended by the boiler manufacturer whichever is greater.

1.3.1.2 Combustion Air

Provide supply of air for combustion and ventilation. In accordance with NFPA 54, NFPA 211 and manufacturer's installation manual, calculate the amount of combustion air necessary to operate the boiler. Install and locate properly sized combustion air dampers and louvers.

1.3.1.3 Sequence of Operation

Local, manual starting of boilers is required. Remote starting and stopping of the boiler by the HVAC control system is not permitted. This is to ensure that an operator witness the initial firing of the boiler at the beginning of each heating season to verify proper operation of the boiler and to promote proper maintenance.

1.3.2 Detail Drawings

1.3.2.1 Drawings

Show boiler hot water isolation valves, emergency disconnect switch, and complete boiler gas train on the contract drawings.

1.3.2.2 Fuel Train / Wiring Diagram

Submit fuel train and wiring diagram.

1.3.3 Water Analysis

Provide test reports of water analysis. Follow UFC 3-240-13FN Industrial Water Treatment for all boiler installations.

1.3.4 Safety Standards

Hot water boilers, burners, and any supplementary control devices, safety interlocks, or limit controls required under this specification must meet requirements of the following standards as applicable:

a. Oil-Fired Units: UL 726 or NFPA 70, NFPA 31, ASME CSD-1.

b. Gas-Fired Units: ASME CSD-1, NFPA 70, NFPA 54, ANSI Z21.13/CSA 4.9 or UL 795.

c. Combination Gas and Oil-Fired Units: ASME CSD-1, NFPA 54, NFPA 31, NFPA 70, UL 726, ANSI Z21.13/CSA 4.9, UL 795 or UL 296.

d. All Units: ASME BPVC SEC IV, NFPA 70 and ASME CSD-1.

Controls not covered by the above must have a UL label, UL listing mark, or be listed in the Factory Mutual Approval Guide.

1.4 SUBMITTALS

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] SD-02 Shop Drawings

Fuel Train

Wiring Diagram

SD-03 Product Data

Boilers: power output, efficiency, ASME certification, allowable working pressure, model number

Boiler Trim and Control Equipment

Burners and Control Equipment

Stack, Breeching, and Supports

SD-06 Test Reports

Operational Tests

SD-07 Certificates

Boilers

Burners and Control Equipment

Boiler Trim and Control Equipment

Water Analysis

Boiler manufacturer's certificate of boiler performance including evidence that the burners provided are a make, model, and type certified and approved by the manufacturer of the boiler being provided.

SD-08 Manufacturer's Instructions

Boilers

Feedwater Treatment System

SD-10 Operation and Maintenance Data

Boilers, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions for Heating Water Boilers

PART 2 PRODUCTS

2.1 BOILERS

****

NOTE: Select boiler size required.

****

Conform to the applicable requirements of ASME BPVC SEC IV and ASME CSD-1. Hot-water boilers must be horizontal firetube, multipass, modified scotch-type of the dry or wet-back type, packaged units mounted on a skid-type structural steel base. Provide each boiler complete burner and fuel system, a forced or induced draft fan, an automatic electronic control system complete with combustion and flame safeguard controls, firing sequence programmer, safety interlocks, limit controls and central control panel, and such trim and appurtenances as are peculiar to water units as specified herein. Units must be factory-wired and assembled except for such readily installed appurtenances as safety valves, water columns, and pressure gages. Units must be complete and ready for operation when connected to water, fuel, and electrical supplies.

2.2 BURNERS AND CONTROL EQUIPMENT

****

NOTE: Indicate fuel trains on the drawings. Conform to the requirements of ASME CSD-1 and ANSI Z21.13/CSA 4.9.

****

[2.2.1 Gas-Fired Power Burner

Automatic recycling burner. Interrupted pilot type ignition system, and pilot must be electrode-ignited natural gas type. The combustion control system must be the [high-low-off] [positioning] [metering] type. Design burner and combustion-control equipment for firing natural gas having a specific gravity of [0.6] [_____] and a heating value of approximately [_____] [37,300] kJ per cubic meter [_____] [1000] BTU per cubic foot and be an integral part of the boiler. Burner controls and safety equipment must conform to the applicable requirements of ASME CSD-1, NFPA 54, ANSI Z21.13/CSA 4.9 and UL 795. Mount controls; including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of control systems on a single control panel or cabinet designed for separate mounting not on the burner. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner. Provide fuel train as indicated. Gas pressure available: [[_____] Pa in. wc] [[_____] kPa (gage) psig].

][2.2.2 Oil-Fired Power Burner

****

NOTE: Due to limited manufacturer and boiler size options for FEMP stated efficiency requirements, this document includes boiler efficiency requirements in conformance with ASHRAE 90.1.

****

Automatic recycling burner. [Pressure-atomizing] [Air-atomizing; compressor or pump furnished with the burner] type burner. The combustion control system must be the [high-low-off][positioning] [metering] type. Ignition system must be [direct electric-spark-ignited type] [interrupted pilot type, and pilot must be [electrode-ignited [natural] [propane] gas type] [light oil spark-ignition type]]. Design burner and combustion control equipment for firing commercial grade no. 2 fuel oil and be an integral part of boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 31 and UL 726. Mount controls; including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of control systems on a single control panel or cabinet designed for separate mounting not on burner. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner. [Provide fuel train as indicated.] Oil fired boilers with inputs less than 732 kW 2,500,000 Btuh must have a thermal efficiency of at least 82 percent and oil fired boilers with inputs greater than 732 kW 2,500,000 Btuh must have a minimum steady state combustion efficiency of at least 84 percent.

][2.2.3 Combination Gas and Light Oil-Fired Power Burner

Automatic recycling burner. The combustion control system must be the [high-low-off] [positioning] [metering] type. Partial pre-mix type gas burner, complete with primary air fan. [Pressure-atomizing] [Air-atomizing; compressor or pump furnished with burner] type oil burner. Ignition system for firing natural gas must be interrupted pilot type, and pilot be electrode-ignited natural gas type. Ignition system for firing light oil must be the [direct electric-spark-ignited type] [interrupted pilot type, and pilot must be [electrode-ignited [propane] [natural] gas type] [light oil spark-ignition type]]. Design burner and combustion control equipment for firing commercial grade number 2 fuel oil and natural gas having a specific gravity of [0.6] [_____] and a heating value of approximately [_____] [37,300] kJ per cubic meter [_____] [1000] BTU per cubic foot and be an integral part of boiler. Burner controls and safety equipment must conform to applicable requirements of ASME CSD-1, NFPA 31, UL 726, NFPA 54, ANSI Z21.13/CSA 4.9 and UL 795 . Mount controls; including operating switches, indicating light, gages, alarms, motor starters, fuses, and circuit elements of control systems on a single control panel or cabinet designed for separate mounting not on the burner. Locate flame scanner such that testing and cleaning of scanner can be accomplished without disassembly of burner. Provide fuel train as indicated. Gas pressure available: [[_____] Pa in. WC] [[_____] kPa (gage) psig].

]2.3 BOILER TRIM AND CONTROL EQUIPMENT

Provide in accordance with ASME CSD-1 and ASME BPVC SEC IV. Boiler trim must comply with ASME BPVC SEC IV and additional appurtenances specified below. Non-recycling control interlocks must have the reset located on control interlock.

2.3.1 Emergency Disconnect Switch

****

NOTE: Indicate location of emergency disconnect switch on drawings. Insert emergency switch amperage required.

****

Provide and locate on wall outside boiler room entrance or just inside door, when boiler room door is on the building exterior to allow rapid and complete shutdown of the boiler in the event of an emergency as required by ASME CSD-1. Emergency switch must be a [_____]-amp. fuse-type safety switch. Switch must be red and furnished with a label indicating function of switch.

2.3.2 Relief Valves

Provide relieving capacity for the full output of boiler installed. Safety relief-valve piping must conform to ASTM A53/A53M, schedule 40 steel pipe and be piped full size [to a floor drain] [to 150 mm 6 inches above floor].

2.3.3 Pressure Gage

Provide with a scale equivalent to 1.5 time outlet water pressure with a 150 mm 6 inch diameter. Locate one on supply water piping and one on the return water piping.

2.3.4 Thermometers

Provide thermometers with a scale equivalent to 1.5 times the outlet water temperature. Provide one located on supply water piping and one on return water piping.

2.3.5 Drain Tapping

Provide drain valve and piping [to a floor drain] [to 150 mm 6 inches above floor].

2.3.6 Make-up Water Station

2.3.6.1 Pressure Reducing Station

****

NOTE: Select operating pressure required.

****

Provide a water pressure-reducing valve and relief valve, or a combination of the two in the makeup water line to the boiler to maintain a water pressure of [_____] [83] kPa (gage) [_____] [12] psig in the hot water system. Provide a 20 mm 3/4 inch globe valve by-pass around this valve.

2.3.6.2 Backflow Preventers

Section 22 00 00 PLUMBING, GENERAL PURPOSE. Locate upstream of by-pass.

2.3.7 Stack Thermometer

Provide flue gas-dial type thermometer with scale calibrated from 66 to 399 degrees C 150 to 750 degrees F and mount in flue gas outlet.

2.3.8 Air Vent Valve

Provide with screwed connections, stainless steel disk, and stainless steel seats to vent entrapped air from boiler.

2.3.9 Feedwater Treatment System

Provide floor mounted Type II - shot-type feeder (manual, intermittent feed), Style A - as indicated with pressure up to 1379 kPa (gage) 200 psig maximum.

2.3.10 Combustion Regulator

Provide adjustable temperature, thermostatic immersion type that limits boiler water temperature to a maximum of 121 degrees C 250 degrees F. Control must actuate burner through an electric relay system to maintain boiler water temperature within normal prescribed limits at loads within rated capacity of boiler.

2.3.11 High Temperature Limit Switch

Provide adjustable immersible aquastat type with a temperature setting above that of the combustion regulator and below that of the lowest relief valve setting. Aquastat will function to cause a safety shutdown by closing fuel valves, shutting down burner equipment, activating a red indicating light, and sounding an alarm in the event that boiler water temperature rises to the high temperature limit setting. A safety shutdown due to high temperature will require manual reset before operation can resume and prevent recycling of the burner equipment. Pre-set high temperature limit devices that cannot be easily tested are not allowed.

2.3.12 Low Water Level Cutoff Switch

Provide float actuated type. Low water level cutoff must cause a safety shutdown by closing fuel valves, shutting down burner equipment, activating a red indicating light, and sounding an alarm in the event that water level drops below the lowest safe permissible water level established by the boiler manufacturer and ASME BPVC SEC IV. A safety shutdown due to low water level will require manual reset before operation can resume and prevent recycling of burner equipment.

2.3.13 Boiler Safety Control Circuits

Provide boiler safety control circuits, including control circuits for burner and draft fan, that are single-phase, two-wire one-side grounded, and not over 120 volts. Provide safety control switching in ungrounded conductors. Provide overcurrent protection. In addition to circuit grounds, ground metal parts which do not carry current to a grounding conductor.

2.3.14 Indicating Lights

****

NOTE: Include indicating lights for low gas pressure and high gas pressure on all but size 1 burners.

****

Each safety interlock requiring a manual reset must have an individually labeled red indicating light. Non-recycling control interlocks must have the reset located on the control itself. Red indicating lights on the control panel may be omitted if the burner combustion control system has a Keyboard Display Module installed that will identify the lockout information required in Item c. below. Indicating light colors are as follows
:

a. Amber: Ignition on

b. Blue: Draft

c. Green: Main fuel safety shut-off valves open

d. Red (One for Each): Safety lockout, flame failure, low water level, and high temperature.

2.3.15 Alarm Bell

Provide alarm bell, electrically operated, with a manual disconnect switch. Disconnect switch must be type and wired so that switching off alarm following a safety shutdown will not prevent alarm from sounding again upon recurrence of a subsequent safety shutdown condition.

2.3.16 Post-Combustion Purge

****

NOTE: Select four-air-change purge for Size 1, Size 2, and Size 3 burners. Select eight-air-change purge for Size 4 burners.

****

Provide a post-combustion purge in accordance with ASME CSD-1. Provide controls and wiring necessary to assure operation of draft fan for a period of not less than 15 seconds or of sufficient duration to provide [four] [eight] complete air changes in the boiler combustion chamber (whichever is greater) following shutdown of burner upon satisfaction of heat demand.

Upon completion of post-combustion purge period, draft fan must automatically shutdown until next restart.

2.3.17 Draft

Comply with boiler manufacturer's recommendations.

2.3.18 Stack, Breeching, and Supports

****

NOTE: Boiler stacks must conform to the boiler manufacturer's installation and operational manual.

****

Provide boiler stack constructed of sheet steel having a thickness of not less than 2.47 mm 0.0972 inches with welded joints. Insulate stack located inside the building with 38 mm 1 1/2 inches of mineral wool conforming to applicable requirements of ASTM C592, Class II - for use up to 649 degrees C 1200 degrees F. Insulation must receive a finish coat of finishing cement not less than 19 mm 3/4 inch thick, trowelled to a smooth finish. Provide stack supports, umbrella collar and cap, and flue transition piece. Stack diameter and height must be in accordance with manufacturer's recommendation and conform to NFPA 211.

2.3.19 Hot-Water Coils

****

NOTE: Delete entire paragraph unless hot-water coils are required to instantaneously heat domestic water.

****

Provide coils capable of heating [_____] L/s GPM of water with [_____] degrees C F rise conforming to ASME BPVC SEC IV.

2.3.20 Smoke Density Indicator

****

NOTE: Select ASME CSD-1 for input less than 3663 kW 12,500,000 Btuh. Select NFPA 85 for input greater than 3663 kW 12,500,000 Btuh.

****

2.3.21 Annunciator

****

NOTE: Specify only if input exceeds 1465 kW 5,000,000 BTU/hr.

****

Provide in accordance with ASME CSD-1 or NFPA 85.

2.4 ELECTRIC MOTORS

****

NOTE: Select standard efficiency for motors used less than 750 hours per year and high efficiency for motors used over 750 hours per year. Packaged boilers should utilize the manufacturer's standard

efficiency motor.
****

Motors which are not an integral part of a packaged boiler must be rated for [standard] [high] efficiency service per Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motors which are an integral part of the packaged boiler system must be the highest efficiency available by the manufacturer of the packaged boiler.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

Install equipment in accordance with the manufacturer's installation instructions and NBBI NB-23 PART 1. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets. Mount feedwater treatment feeders so that the top of the feeder is not higher than 1219 mm 48 inches above the finished floor.

3.2 EQUIPMENT FOUNDATIONS

Locate equipment foundations as indicated, designed, and made of sufficient size and weight to preclude shifting of equipment under operating conditions or under any abnormal conditions that could be imposed upon the equipment. Foundations must meet requirements of the equipment manufacturer. Concrete and grout must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3 MANUFACTURER'S FIELD SERVICES

Furnish the services of an engineer or technician approved by the boiler manufacture for installation inspection, startup, and tests of equipment as specified below. After installation of equipment the engineer or technician must provide a signed certificate or certified written statement that the equipment is installed in accordance with the manufacturer's recommendations. Services of more than one engineer or technician may be required based on types of specific equipment. One engineer or technician as appointed by the Contractor must supervise and be responsible for the overall installation, start-up, test, and check out of systems. This person must remain on the job until each unit has been in successful operation for 3 days and accepted.

3.4 BOILER CLEANING

Before being placed in service, boiler must be boiled out for a period of 24 hours at a pressure not exceeding 83 kPa (gage) 12 psig. Solution to be used in the boiler for the boiling out process will consist of two pounds of trisodium phosphate per 379 liters 100 gallons of water. Upon completion of boiling out, flush out boiler with potable water, drain, and charge with chemically treated water. Protect boiler and appurtenances against internal corrosion until testing is completed and boiler is accepted. Professional services are required for cleaning/treatment process.

3.5 FIELD QUALITY CONTROL

Perform and furnish everything required for inspections and tests as specified herein to demonstrate that boiler and auxiliary equipment, as installed, are in compliance with contract requirements. Start up and operate the system. During this time, clean strainers until no further accumulation of foreign material occurs. Exercise care to minimum loss of water occurs when strainers are cleaned. Adjust safety and automatic control instruments as necessary to place them in proper operation and sequence. During startup and during tests, factory-trained engineers or technicians employed by individual suppliers of such components as the burner, flame safeguard and combustion controls, and other auxiliary equipment must be present as required, to insure proper functioning, adjustment, and testing of individual components and systems. Test instrumentation must be calibrated and have full scale reading from 1.5 to 2 times test values.

3.5.1 Operational Tests

Furnish the services of an engineer or technician approved by the boiler manufacturer of installation, startup, operational and safety testing. This person must remain on the job until each boiler has been successfully operated. Furnish and perform everything required for inspections and tests of the boiler and auxiliary equipment. Test instrumentation must be calibrated and have full-scale reading from 1.5 to 2 times test values. Demonstrate proper operability of combustion control, flame safeguard control and safety interlocks. Provide a detailed description of all boiler startup and operational tests in the Commissioning Plan.

3.5.1.1 Preliminary Operational Test

Operate boilers continuously for a period of at least 8 hours to demonstrate proper operability of the combustion control, flame safeguard control, and safety interlocks.

3.5.1.2 Acceptance Operational Test and Inspection

****

NOTE: Insert the appropriate Facility Engineering Command.

****

Prior to requesting an acceptance test, conduct a satisfactory operational test for at least 8 hours, and provide a certified statement that the equipment is installed per all requirements of this guide. The Contracting Officer, upon receipt of the notice from the Contractor, will request a boiler be inspected by a Naval Facilities Engineering and Expeditionary Warfare Center (EXWC) NAVFAC boiler inspector. Fifteen days advance notice is required for scheduling inspector to conduct acceptance operational test and inspection.

3.6 SCHEDULE

Some metric measurements in this section are based on mathematical

conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Pressure Gage Diameter	= 6 inches	= 150 mm
b. Stack Thermometer Scale Range	= 150-750 degrees F	= 66-399 degrees C
c. Alarm Bell Diameter	= 4 inches	= 100 mm

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 52 49.00 20 (November 2008)**
Change 2 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-23 52 49.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 52 49.00 20

STEAM BOILERS AND EQUIPMENT (500,000 - 18,000,000 BTU/HR)

11/08, CHG 2: 08/18

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-23 52 49.00 20 (November 2008)**
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****

SECTION 23 52 49.00 20

STEAM BOILERS AND EQUIPMENT (500,000 - 18,000,000 BTU/HR)

11/08, CHG 2: 08/18

****

NOTE: This guide specification covers the requirements for steam boilers and related equipment for capacities from 150 to 5275 kW 500,000 to 18,000,000 Btu/Hr.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification supersedes the requirements for these boilers and equipment contained in specification 52Y. Some paragraphs may need to be supplemented to meet the project requirements. The boilers are equipped for oil-, gas-, or oil-and-gas combination firing, as specified.

****

****

NOTE: The following information shall be shown on the project drawings:

1. Dimensions of construction

2. Relationship of materials

3. Quantities, location and capacity of equipment.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers
ASME PTC 4	(2013; R 2023) Fired Steam Generators

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B111/B111M	(2024) Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B395/B395M	(2018) Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM D888	(2012; E 2013) Dissolved Oxygen in Water

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-27	(1991) National Board Rules and Recommendations for the Design and Construction of Boiler Blowoff Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-B-18897	(Rev F; CANC Notice 1) Boilers, Steam and Hot Water, Watertube (Straight Bare and Finned Tube), Cast Iron and Firebox, Packaged Type (40,000 to 35,000,000 BTU/HR Thermal Output Capacity)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50504	(Basic) Analyzers, Flue-Gas, Orsat-Type, Portable
CID A-A-50562	(Basic) Pump Units, Centrifugal, Water, Horizontal; General Service and Boiler-Feed: Electric-Motor or Steam-Turbine-Driven
CID A-A-50566	(Basic) Monitoring Devices, Emission, Stack Related
CID A-A-50573	(Basic, Notice 1) Water Softener Unit, Lime-Soda Type
CID A-A-59249	(Basic; Notice 1; Notice 2) Filters, Fluid, Pressure, Feedwater
FS F-B-2903	(Basic; Notice 2) Boilers, Steam and or Water, Firetube, Scotch Packaged Type (320,001 to 35,000,000 BTU/HR Thermal Output Capacity)
FS F-B-2910	(Basic) Burners, Single Oil, Gas, and Gas-Oil Combination for Packaged Boilers (320,001 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-F-2901	(Basic; Notice 1) Feeders, Boiler Water Treatment, By-Pass and Compound Receiver Types
FS F-P-2908	(Basic; Notice 1) Pumping Units, Condensate, Return; and Boiler Feed Package
FS TT-P-28	(Rev H) Paint, Aluminum, Heat Resisting (1200 Degrees F.)
FS W-H-2904	(Basic; Notice 1) Heaters, Fluid, Deaerating (For Water Only) 1,000 to 1,600,000 Pounds Per Hour Capacity

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

NAVFAC MO 225	(1990) Industrial Water Treatment

WATER QUALITY ASSOCIATION (WQA)

WQA S-100	(2000) Household, Commercial, and Portable Exchange Cation Exchange Water Softeners

1.2 SYSTEM DESCRIPTION

Describe the performance or design requirements and tolerances of the boiler system.

1.2.1 Heating Surface and Volume Measurements

Submit heating surface and volume measurements, including heat release calculations and performance data at minimum, 25 percent, 50 percent, 75 percent, and 100 percent load sufficient to establish compliance of boilers with heat release requirements. Base calculations on the specified efficiency and capacity.

1.3 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies, with the additions and modifications stated herein.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Steam Boiler System

SD-05 Design Data

Heating Surface and Volume Measurements

Heat Release Calculations

Performance Data at Minimum, 25 Percent, 50 Percent, 75 Percent, and 100 Percent Load

SD-06 Test Reports

Boiler System Start-Up Tests

Submit test reports in accordance with section FIELD QUALITY CONTROL. Submit a detailed written record of the start-up performance, including burner setting data over the entire load range, before the Contractor's and sub-contractor's test personnel leave the site.

SD-07 Certificates

Report of Prior Installations

Qualifications of Engineer

Start-Up Plan

Start-Up Certification

Boilers

Submit evidence that boilers meet requirements of standards specified. Include with the certificate of compliance acceptable evidence that standards are met. Acceptable evidence will be the official UL listing mark prescribed in the UL gas and oil equipment list for oil-fired, gas-fired, or gas and oil-fired boiler assemblies, as applicable plus the appropriate official ASME symbol stamp. In lieu of the above certification, acceptable evidence will be a test report from an independent testing laboratory, indicating that the boilers and accessories have been inspected and tested and meet requirements of the applicable standards specified.

SD-10 Operation and Maintenance Data

Boilers, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND

MAINTENANCE DATA.

1.5 QUALITY ASSURANCE

1.5.1 Report of Prior Installations

Boilers shall be shipped to the site of installation as [a] [an] [completely assembled packaged boiler-burner unit] [unassembled package. A competent installation engineer or technician as stated in paragraph QUALIFICATIONS OF ENGINEER shall assemble an unassembled boiler-burner package in strict accordance with the manufacturer's instructions.] Boilers and feedwater equipment installed shall be of proven design which has been tested, successfully installed, and operated in commercial or industrial installations. Submit a certified written report from the boiler and feedwater equipment manufacturer indicating date of installation, type, model, capacity, and address location of installed boilers along with maintenance records and operating conditions including operating load and load swings. Show that substantially identical equipment of comparable capacity, within 20 percent, has been successfully installed and operated in not less than three installations under similar operating conditions for a period of not less than 2 years.

1.5.2 Start-Up and Installation Engineer

Provide the services of a qualified engineer or technician for start-up and tests and installation of equipment as specified below. More than one engineer or technician may be employed based on the types of specific equipment. One engineer or technician appointed by the Contractor shall supervise and be responsible for the overall installation, start-up, test, and checkout of systems.

1.5.3 Qualifications of Engineer

Submit a printed certified qualification resume of the engineer or technician. The engineer's or technician's resume shall list applicable experience related to installation, start-up, and testing of equipment and applicable factory training and education. Qualifications require the engineer to have supervised two installations of similar size and type which are operating satisfactorily. If more than one engineer or technician is employed, provide a certified resume for each one indicating their specific specialty and item of work.

1.5.4 Installation

****

NOTE: Delete this paragraph for boilers under 2930 kW 10,000,000 Btu/hr capacity.

****

Provide an installation engineer or technician to install and supervise the installation of steam boiler system including instrumentation and boiler controls. Provide the technician or engineer until the installation of equipment is coordinated and checkout completed.

1.5.5 Start-Up Plan

Submit a written schedule with dates of start-up tests, installation, and checkout of equipment.

1.5.6 Start-Up and Test

Start-up and test engineer or technician shall be approved by the manufacturer of the specific piece of equipment including boiler, boiler controls, boiler instrumentation, and feedwater equipment. The start-up and test engineer or technician shall remain on the job until the unit has been in successful operation for [_____] days, and has been accepted by the Contracting Officer.

1.5.7 Start-Up Certification

After installation of equipment, the engineer or technician shall submit a signed certificate or certified written statement that the equipment is installed in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 BOILERS

****

NOTE: Only allow option of MIL-B-18897 for low pressure boilers of capacities less than 2930 kW 10,000,000 Btu/h. On/off combustion controls may be used for up to 880 kW 3,000,000 Btu/h, hi-low-off type may be used for 585 to 1465 kW 2,000,000 to 5,000,000 Btu/h, and modulating positioning type may be used for over 880 kW 3,000,000 Btu/h.

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NOTE: Research local, state, and federal emission standards and place any new or unusual requirements in this specification section.

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[Firetube, packaged type of standard duty conforming to FS F-B-2903] [or] [Firetube type (horizontal return tubular and horizontal fire box)] [Water tube type] [Cast iron, sectional type conforming to MIL-B-18897] [except that treatment and painting shall be in accordance with manufacturer's standard practice,] Boilers shall have gross output capacity of at least [_____] kW Btu per hour when operating at a steam pressure of [_____] kPa (gage) pounds per square inch gage (psig) at the site under design conditions when the burner is firing [[No. [_____] oil conforming to [ASTM D396] having a higher heating value of [_____] MJ/kg Btu per gallon] [or] [[natural] [manufactured] [mixed] [liquified petroleum] gas having a higher heating value of [_____] MJ/kg Btu per cubic foot and a pressure of [_____] kPa (gage) psig at the fuel train connection].] [Gas fired boilers shall have a steady state combustion efficiency of at least 80 percent when fired at the maximum and minimum rated capacities which are provided and allowed by the controls.] [Oil fired boilers shall have a steady state combustion efficiency of at least 81 percent when fired at the maximum and minimum rated capacities which are provided and allowed by the controls.] Boilers shall comply with local, state, and federal emission regulations for the fuel being used. Smoke emission shall not exceed Ringlemann No. 1, except during start-up, cleaning, or soot blowing. Boiler furnaces shall be equipped with combustion control safety devices conforming to [ASME CSD-1, for boilers of less than 3660 kW 12,500,000 BTU/HR thermal heating capacity.] [NFPA 85, for boilers with thermal heating capacity of 3660 kW 12,500,000 BTU/HR or larger.] [Burners and controls for boilers conforming to MIL-B-18897 shall conform to FS F-B-2910.] Burners of the rotary type are not acceptable. Programming controls shall be of the automatic [recycling] [non recycling] type and shall incorporate means for automatic self-checking of the circuit at the beginning of each start-up cycle. Include a repetitive self-checking circuit to check components at intervals not to exceed the specified flame failure response time in [FS F-B-2910] [or] [FS F-B-2903] [as applicable] during the entire period of burner operation. Combustion controls, shall be of the [on-off], [hi-low-off] [modulating-positioning] type. [Provide connections for remote starting or stopping of the boilers.] [Explosion relief doors are required.] [Provide steam operated feedwater injectors.] [Cast iron boilers shall be of the sectional type and shall conform to the requirements above and as specified. Boilers shall be [automatic] [semi-automatic,] [or] [manual] start.] [For each boiler, provide a steam operated soot blower made of materials that shall withstand expected temperatures.]

2.1.1 Boiler Connections

Requirements for interconnecting piping, insulation, fuel supply, [vibration isolation,] [_____], and other related work necessary to provide a complete and operable steam system, whether or not specifically mentioned above, shall conform to applicable requirements of other UFGS sections.

2.1.2 Boiler Instrumentation

In addition to the instruments required by the boiler specifications referenced above, provide the following instruments and locate where shown and where recommended by instrument manufacturer:

a. A flue gas temperature gage.

b. A draft gage, [single point] [two point], conforming to ASME B40.100.

****

NOTE: Select the applicable paragraph(s) from the following:

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NOTE: These instruments are not normally required on boilers under 2930 kW 10,000,000 Btu/h.

****

[c. A carbon dioxide recorder to measure, record, and indicate the percentage by volume of carbon dioxide detected in the flue gas. Flush mount the recording unit and furnish with locking device and master key. The carbon dioxide recorder shall in other respects conform to CID A-A-50566.]

****

NOTE: These instruments are not normally required on boilers under 2930 kW 10,000,000 Btu/h.

****

[d. A complete oxygen analyzer system to measure oxygen content of flue gases generated by combustion of [gas] [or] [oil] as specified in paragraph BOILERS shall be provided for each boiler. The output of the analyzer shall range from zero to [_____] [25] percent oxygen:

(1) Provide a complete aspirating system with proper connection to stack, necessary steam or water aspirating facilities, and piping of proper specification to analyzer. Provide piping in accordance with the oxygen analyzer manufacturer's recommendations and install tight. Install equipment in accordance with the manufacturer's instructions.

(2) Provide a paramagnetic analyzer. Analyzer shall provide oxygen analysis in the zero and 25 percent oxygen range, and have means of calibration. Provide zero range and span adjustments as required.

(3) Analyzer output and recorder input shall be compatible. Provide, connect, and place in proper operation necessary transducers. Follow special instructions relating to electrical transmission between analyzer and recorder as to the application of shielded wiring in conduit.

(4) Check the system with two calibrating gases as follows: (a) 100 percent nitrogen, and (b) 3.5 percent oxygen and remainder nitrogen.

]

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NOTE: These instruments are not normally required on boilers under 2930 kW 10,000,000 Btu/h.

****

[e. Direct Probe In-Situ Type: Oxygen analyzer shall be the direct probe type utilizing an in-situ zirconium sensing element. Insert element directly in the process flue gas stream and in direct contact with process gasses. Sensing element shall be contained within a protective shield mounted to the duct work by means of an adapter plate, all furnished by the manufacturer. Analyzer shall be equipped with a facility to allow daily automatic calibration check without removing the analyzer from the process. That is, sample gases may be injected directly on the sensing element while the analyzer is in the process. In order to eliminate the temperature effect of the flue gases, maintain the cell temperature in the probe at 843 degrees C 1,550 degrees F by means of an externally mounted temperature controller equipped with cold junction compensation and coupled to the probe with at least 6 meters 20 feet of flexible cable. Analyzer shall be FM APP GUIDE approved and certified for "in-stack" analysis technique. Output signal range shall be 4 to 20 milliamps and shall represent 0.25 percent to 25 percent oxygen as a logarithmic function, 0.1 percent to 10 percent oxygen as a logarithmic function, or zero percent to 10 percent as a linear function. [Circular chart recorder shall consist of a two-pen recording control mechanism having 110 volt ac electric motor drive. Chart shall be 300 mm 12 inch diameter and have 24-hour revolution. Output control signal will be 20 to 103 kPa (gage) 3 to 15 psig pneumatic. Sufficient blank charts and four ink cartridges per pen for 400 days operation shall be provided. Recorder shall have a dual 30 degrees strip indicator. Strip indicator and chart paper scale shall be logarithmic or linear and consistent with the analyzer signal conditioning.] [Strip chart recorder shall consist of a two pen solid state electronic recording/controlling mechanism. Strip chart shall be 100 mm 4 inches wide and shall be driven at a speed of 19 mm per hour 3/4 inch per hour. Recording/controlling mechanism will operate on 110 volt ac power. Recorder shall be furnished with twelve usable 24-hour logarithmic or linear charts consistent with the analyzer signal conditioning. Inking system shall be a breakaway inking system with replaceable fiber tip pens and 12 ink cartridges. Strip chart recorder/controller shall have vertical scale and horizontal driven chart. Output control signal will be 4 to 20 milliamps dc.] Flue gas temperature scale shall be 149 to 427 degrees C 300 to 800 degrees F. Entire system response shall be not more than 3 seconds.

]

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NOTE: These instruments are not normally required on boilers under 2930 kW 10,000,000 Btu/h. However, smoke density recorders are mandatory for all residual oil fired boilers having capacities above 2930 kW 10,000,000 Btu/h.

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f. A smoke density [indicator] [recorder] of the [density limit] [continuous density] type with a scale calibrated in Ringlemann units. Indicating and recording systems shall include circuits for the audible warning of the maximum smoke density-limit. Supply a vibrating electric horn to sound the audible signal. Otherwise the smoke density [indicator] [recorder] shall conform to CID A-A-50566.

2.1.3 Boiler Plant Controls and Instruments

Provide the following plant [controls and] instruments:

a. Orsat Gas Analyzer : Provide a flue gas analyzer, Orsat type, conforming to CID A-A-50504. Analyzer shall determine the CO2, CO, and O2 in the flue gas and shall be complete with chemicals and accessories for use in such determinations.

b. Steam flow recorder: to remotely indicate, record, and totaling the steam flow per hour through the steam header. Provide the panel-mounted indicating recorder with a tamper proof case.

****

NOTE: Insert section number(s) for oil and/or gas piping systems in the blanks below.

****

c. Volumetric fuel flow meters in accordance with [_____] [and [_____]].

****

NOTE: The value of tolerance limit shall be 3 percent for modulating positioning type, shall be 5 percent for high/low/off type, and shall be 6 percent for on/off type. See paragraph 3 for which type of combustion control is specified.

****

d. Master Combustion Control: Provide a common boiler master controller on the free standing boiler instrument and control panel to control all boilers with each individual boiler controller acting as a submaster controller. Boiler master control system shall provide for base loading one [or more] boilers. Base loaded boiler(s) shall be selected manually by an externally accessible switch. On call for heat, lead boiler shall cut in and moderate firing rate to satisfy demands. When maximum desired firing rate is reached, lag boiler or boilers shall cut in. Only one boiler shall be on modulating firing at one time. Maximum desired firing rate for base loaded boiler shall be adjusted initially for boiler peak efficiency and shall be capable of easy manual adjustment by operating engineer. Provide adequate indicators approved by the Contracting Officer to show the method of loading of each boiler, and load being carried by it. Make adjustments at front of panel and no linkage adjustment shall be necessary. Combustion control system shall be capable of maintaining the plant steam pressure at the main header within the tolerance limits of plus or minus [_____] percent expressed as a percent of the set point values. The specified tolerance shall apply to a load which, within a one-minute period, swings from a steady-state condition to an increase (or decrease) in load equal to a maximum of 10 percent of the plant. Regulation tolerances shall apply to any steady state condition within the plant turndown ratio of [_____]. Combustion efficiency shall not be less than that specified in the boiler specifications.

e. Pressure gage conforming to ASME B40.100 or indicating steam pressure in main steam header, [for indicating atomizing steam pressure,] and for indicating feedwater pressure.

2.1.4 Boiler Control and Instrument Cabinet(s)

Provide boiler control and instrument cabinet(s) as specified in the referenced boiler specification(s) and may be mounted either on the boiler front or adjacent thereto. The arrangement may consist of a boiler mounted cabinet containing controls normally provided by the manufacturer and a supplementary cabinet containing additional controls and instruments required herein. Mount [plant master combustion control] [and] [steam flow recorder] on or adjacent to control panel for number [_____] boiler.

2.1.5 Free-Standing Multi-Boiler Plant Control and Instrument Panel

Provide a free-standing panel and locate as indicated. The panel shall contain all individual and multi-boiler controls, monitoring system, and panel-mounted instruments specified herein and in the reference specifications, except that flame safeguard system may remain separately mounted in a cabinet at each boiler.

[2.1.5.1 Control Panel Construction

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NOTE: Select the applicable paragraph(s) from the following:

****

****

NOTE: Delete inapplicable paragraph(s).

****

Construct control panel of not less than 3 mm 11 gage reinforced steel for face, top, and sides. The enclosed panel shall be not less than 610 mm 24 inches in depth with inside rigidly welded braces. Design control panel so that all indicating and recording devices and manually operated switches shall be flush mounted in a gasketed removable-top front panel with indicating and recording devices at eye-level. Provide a similar removable-top rear panel located opposite front panel to facilitate wiring, piping, and maintenance. Install other operating controls on a sub-panel within the enclosure. Access to panel enclosure shall be through gasketed, double piano-hinged doors of not less than 1.52 mm 16 gage steel. The doors shall be reinforced to prevent sagging and shall be provided with a three point compression type fastener and polished key lock handle. Include a full width fluorescent lighting canopy also. Prime coat complete control panel and lighting canopy and finished in baked enamel. Identify flush-mounted devices on panel with engraved lamicore nameplates. Adequately reinforce, skirt, and suitably design panel base to permit anchoring to the floor or foundation.

][2.1.5.2 Control Panel Wiring and Piping

****

NOTE: Delete inapplicable paragraph(s).

****

Control panel shall be factory pre-wired in accordance with NFPA 70. Wire shall be thermoplastic Type THW, THWN, XHHW, or UL approved for the intended use, color or number coded, and run in plastic ducts to numbered terminal blocks. Control circuits shall be separately fused with properly rated cartridge type fuses. Power leads to and from magnetic starters and contractors shall terminate at terminal blocks so that field wiring is necessary only from terminal blocks to external equipment. Control leads to and from external control devices shall terminate at separate terminal blocks from power leads. Steam-, draft-, and air-operated devices shall be factory piped to permanently affixed external connections. Pneumatic signals shall be either 20 to 103 kPa (gage) 3 to 15 psig or 20 to 207 kPa (gage) 3 to 30 psig. Piping connections to indicators shall be copper tubing conforming to ASTM B88M ASTM B88. The boiler operating switch shall be a dust-tight sealed snap-action type. The precision switches shall have cadmium, silver, or platinum contacts, wiping action type, rated at 10 amperes. Electrically or pneumatically tested, controls and equipment shall be to simulate complete operational sequence.

]2.1.6 Hot Water Heater

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NOTE: Hot water heaters are only used on boilers operating at 103 kPa 15 psi or less.

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[The] [Each] [Number [_____]] boiler shall be equipped with internal hot water heating coils conforming to the ASME BPVC SEC VIII. Heaters shall have gasketed cast iron or steel flange mountings and shall be designed, fabricated, and tested to withstand 207 kPa (gage) 30 psig maximum working pressure at 121 degrees C 250 degrees F. The heating coil shall be finned tube type not less than 19 mm 3/4 inch outside diameter and shall be constructed of seamless copper or copper alloy that meet the requirements of [ASTM B75/B75M,] [ASTM B111/B111M,] or [ASTM B395/B395M ASTM B395/B395M]. The heating coil while submerged in water under pneumatic pressure shall withstand 2068 kPa (gage) 300 psig. The pressure drop through the coil at maximum temperature and draw rate shall not exceed 34 kPa (gage) 5 psig, unless otherwise indicated. The coils shall terminate in threaded inlet and outlet connections on the exterior of the boiler and shall be designed for the indicated temperature rise and maximum draw rate. When applicable, provide instrumentation for metering hot water production load on boiler.

2.1.7 Noise Levels

Noise measurements and exposure analyses should be conducted under the overall supervision of an industrial hygienist or suitably qualified medical officer from the Navy Regional Medical Center (NRMC). Safety personnel, engineers and others who have been certified by the Chief, Bureau of Medicine and Surgery (BUMED) also may supervise the work. Exposure limits for potentially hazardous noise levels of 85 dBA, continuous or intermittent, and 140 dB peak sound pressure, impulse or impact, shall be maintained. The sound level meter shall conform as a minimum to the Type 2 requirements cited in ASA S1.4.

2.2 BOILER BREECHING

2.2.1 Round Breeching

Construct round breeching of black iron or steel in accordance with NFPA 211 for metal connectors for medium-heat appliances and shall be constructed with welded beams and joints. Round breechings also may consist of approved factory-built chimney sections for medium-heat appliances if the sections are joined together with continuous welds, flanges, or couplings. Provided suitable cleanouts that will permit cleaning the entire breeching without dismantling.

2.2.2 Rectangular Breeching

****

NOTE: Specifier should check structural steelwork section of the project specification, if used, as well as notes on structural drawings to ensure against conflict of requirements.

****

Structural materials shall comply with the applicable sections of AISC 360. Shop connections may be welded or bolted as required for joining breeching to equipment. Supply hot dipped galvanized bolts and lock washers for bolted connections. Bolts shall be not less than 10 mm 3/8 inch in diameter, and spaced not more than 76 mm 3 inches apart. Furnish bolted joints with 3.20 mm 1/8 inch thick non-asbestos gaskets. Breeching [plate] shall be not less than [12 MS gage steel][4.80 mm 3/16 inch thick]. Welds shall conform to AWS D1.1/D1.1M. Breeching system shall provide for maximum expansion and contraction. Expansion joints shall be of the guided flexible crease type with flexible element of not less than 1.60 mm 0.0625 inch thick stainless steel. Provide access doors and cast iron or reinforced steel plate with non-asbestos gaskets 3.20 mm 1/8 inch thick and positive closing latches of sufficient number to ensure a gas-tight seal. Thoroughly clean breeching of rust and scale after fabrication by commercial sand blasting.

2.2.3 Breeching Hangers

Design breeching hangers to carry not less than five times the breeching weight. Hangers for round breeching shall be of the band type with hanger rods. Provide steel trapeze type hangers for rectangular breeching with angle support member and hanger rods.

2.2.4 Cleanout Doors

Secure cleanout doors to the ends and sides of the breeching where indicated or where required to effectively clean the breeching. Construct cleanout doors of a gage steel not less than that of the breeching and secure to a 32 by 32 inch 1 1/4 by 1 1/4 inch angle frame not less than 3.20 mm 1/8 inch in thickness with mounting bolts welded to the angle frame and spaced not over 152 mm 6 inches on center; provide 1.60 mm 1/16 inch thick long fiber non-asbestos gasket between cleanout doors and frames. Doors shall be squared and shall be full height of diameter or side of breeching up to a size of 610 mm by 610 mm 24 inches by 24 inches maximum, except that cleanout doors less than 305 mm 12 inches in height shall be rectangular and shall be 305 mm 12 inches in length. Plug type cleanouts are not acceptable.

2.2.5 Stacks

Stacks shall be constructed of not less than [12] [10] MS gage steel, welded construction, and of proper size to adequately serve the respective boiler. Stacks shall project above the boiler house roof not less than that indicated and shall be supported by a substantial steel framework. Provide structural steel framework at boiler room roof around each stack and attached to roof joints to brace stack against swaying and to support new roof curb and stub stack. Construct stacks as indicated to include automatic damper access door, gas sampling connection, smoke density indicator, temperature sensing connection, and other features shown or required. When rain can fall into contact with internal boiler parts, provide stub stacks with rain caps or hoods. Provide stacks with the following:

a. Provide curb openings in roof and properly flash and counterblock to roofing. Furnish and install flashing hoods around stacks and over roof curbs.

b. Provide a bellows type flexible [fabric] [_____] type expansion joint approximately 152 mm 6 inches wide in the stacks at the location shown. Joint system shall consist of 4.80 mm 3/16 inch steel plate welded to inside of bottom section of stack. Top section of stack shall be free to move up and down outside the plate. Weld steel reinforcing angles around both top and bottom sections of stack. Fit and weld to the angles an expansion angle type bellows of 12 gage steel.

c. Clean stacks of dirt, rust, oil and grease by wire brushing and solvent degreasing and give one shop coat of heat-resisting aluminum paint conforming to FS TT-P-28 on the inside and outside. The coat of paint shall have a minimum dry film thickness of one mil.

2.3 BLOWDOWN EQUIPMENT

Furnish the [boiler] [plant] with all equipment, tanks, and controls necessary for bottom [and continuous] blowdown of the boilers. The equipment for bottom blowdown systems shall include a [blowdown tank] [and sample cooler]. [Continuous blowdown systems shall be of the packaged, proportional type consisting essentially of a heat exchanger, flow control valve, surge tank, [and] sample cooler, [and blowdown control console with test sink].] Install and pipe blowdown equipment as indicated, and conform to recommendations of the NBBI NB-27, Recommended Rules for National Board Boiler Blowoff Equipment.

2.3.1 Bottom Blowdown Tank

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NOTE: Cathodic protection or magnesium anodes only required when steel tank is buried.

****

Blowdown tank shall be fabricated of welded steel plate in accordance with ASME BPVC SEC VIII. Tank shall be a vertical cylindrical tank designed for the working pressure of the boiler(s). Tank shall be equipped with a tangential blowdown inlet located so as to impinge on a carbon steel wear plate extending at least 180 degrees around the interior circumference of the tank from the point of inlet. Tank shall be equipped with an internal overflow, vent, drain, safety relief valve, and gage glass with try cocks, blowdown cock, and guard. Tank interior shall be protected by an epoxy coating system suitable for continuous water immersion and operation at a minimum temperature of [121] [149] degrees C [250] [300] degrees F. The tank [shall be fitted [with renewable magnesium anodes] [with cathodic protection equipment] to minimize galvanic corrosion of the exterior.] [shall be constructed of Class A reinforced concrete and shall be fitted with a bolted steel manhole frame and cover. Install blowoff pipe, vent pipe, and drain pipe in pipe sleeves built into concrete. Fill the space between the pipe and sleeves and caulk with lead wool or equivalent to make a watertight seal. Tank shall be divided into two sections by means of a baffle to form a sediment chamber.] Size and locate blowoff tank shall be size and located as shown.

2.3.2 Sample Cooler

Provide a water-cooled, shell-and-tube, or shell-and-coil type heat exchanger designed for cooling sample of boiler water prior to chemical testing. Furnish the sample cooler as a component of the packaged continuous blowdown system when such a system is being furnished. The cooler shall consist of a cast iron or steel shell with copper coil or copper alloy tubes and shall be equipped with a brass or bronze sampling cock. [The cooler shall be connected to a header and so valved that a sample can be withdrawn from any boiler as desired.] [Furnish a concentrometer kit containing necessary glassware, reagents, and instructions for determining boiler water concentrations.]

2.3.3 Continuous Blowdown System

****

NOTE: Specify continuous blowdown only where makeup water ratio is in excess of 20 percent of the boiler output or where the total dissolved solids of this makeup water are in excess of 500 parts per million.

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NOTE: Include last sentence if a console type unit is indicated.

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Provide a complete packaged unit of the [automatic-proportioning] [manual-apportioning] type wherein the amount of blowdown from the [boiler] [plant] is automatically proportioned to the amount of make-up feedwater [and the total amount of blowdown from the plant is manually apportioned between boilers according to their steaming rate]. The system shall include either an automatic-proportioning valve and a heat exchanger or a concentric tube automatic proportioning control which shall be provided with a separate heat exchanger when necessary to meet the performance requirements indicated or specified herein. The system shall be designed for not less than boiler design pressure and shall be capable of heating the feedwater from [_____] degrees C degrees F to [_____] degrees C degrees F at the flow rates indicated. Heat exchanger shall consist of a steel shell and heads with Type 304 stainless steel tubes arranged in a removable U-bend bundle. Construct and test shell in accordance with ASME BPVC SEC VIII for the specified boiler operating pressure. Automatic proportioning valve shall be provided with a sensing orifice on both the makeup and blowdown lines and shall be of the adjustable ratio type in which the ratio of makeup to blowdown may be set anywhere within a range of [30:1] [_____] to [4:1] [_____]. Automatic proportioning control shall consist of two concentric tubes, the inner tube being of a thermostatic design which acts directly against an adjustable seat in response to the temperature differential between the blowdown in the inner tube and the makeup water between the inner and outer tubes. [Manual apportioning valves shall have bronze bodies with stainless steel seats and disks and shall be of the indicating type specifically designed for blowoff service.] Blowdown system shall be complete with strainers, stop valves, [blowdown meters,] thermometers, and other accessories necessary to form complete packaged units. [Blowdown control console shall include illuminated sight flow indicators, automatic flushing and cooling valves, and complete panelboard instrumentation as well as a cabinet type laboratory sink with drain board, back splash, hot and cold service water faucets, [air cock,] and electrical outlets.]

2.4 FEEDWATER EQUIPMENT

2.4.1 Boiler Feed Pumps

Conform to CID A-A-50562 for motor driven, horizontal split case or support head boiler feed pumps except as otherwise specified herein. Pumps may be of either the centrifugal or peripheral-turbine type with [cast iron] [or] [alloy steel] casing and shall be [bronze] [or] [alloy steel] fitted. For turbine type pumps, provide pressure relief valves and for centrifugal type pumps, provide by-pass orifice. Packed stuffing boxes or mechanical seals suitable for the design conditions indicated shall be provided. Pumps shall be designed for the net positive suction head, discharge head, and water temperature indicated. [Capacity under the above condition shall be not less than indicated.] [Capacity of each pump under the above conditions shall be not less than the following percentage of maximum total boiler capacity: Centrifugal pumps 125 percent; Turbine pumps 150 percent.] Pump motors shall be [totally enclosed] [dripproof] [dripproof with encapsulated windings].

2.4.2 Boiler Feed Tank

Feed tank and stand construction shall conform to FS F-P-2908 for horizontal, cylindrical, stand-mounted receivers and shall be [hot dip galvanized or cement lined] [epoxy coated] [coated]. Provide tanks with vents, gage glass, drain and overflow connections, pressure gage, thermometer, [float operated makeup water feeder] [float switch and makeup water solenoid valve] [and preheater assembly consisting of corrosion resistant steam diffuser tube, steam corrosion resistant steam diffuser tube, steam pressure reducing valve, strainer, and thermostatic steam valve]. Boiler feed tank assembly shall include boiler feed pumps as herein specified, interconnecting piping including strainer and pump control box. Tank capacity and connection sizes shall be as indicated.

2.4.3 Deaerator

Provide pressurized packaged type conforming to FS W-H-2904, be constructed and stamped in accordance with ASME BPVC SEC VIII D1, and requirements specified herein. Deaerating assembly and deaerated water storage may be in the same or separate shells. When external vent condensers are provided, they may be located as recommended by the manufacturer. Provide a pressure relief valve sized [as indicated] [in accordance with Table II of FS W-H-2904]. Inlet piping and accessories shall be as indicated. Provide feedwater pumps, as specified herein, interconnecting piping, and control box as part of the deaerator package. Deaerator capacity shall be not less than [indicated] [1.25 times that required to supply the boiler(s) at maximum firing rate]. The temperature of the water delivered at maximum capacity shall be equivalent to saturated steam temperature at the operating pressure of the deaerator, which shall be as indicated and the oxygen content shall not exceed [0.005] [0.003] cubic centimeters per liter as determined by the Referee Method A (Colorimetric Indigo Carmine) of ASTM D888. Water storage capacity shall be sufficient to operate the boilers at maximum capacity for [10] [_____] minutes.

2.4.4 Surge Tank and Transfer System

The condensate storage and surge tank shall be a cylindrical welded steel tank mounted and supported as indicated. The tank shall be designed and constructed in accordance with the ASME BPVC SEC VIII D1 for the indicated working pressure. Storage capacity shall be [as indicated] [sufficient to provide adequate water to the deaerator for [10] [_____] minutes of [boiler] [plant] operation at maximum capacity]. Inlet connections for condensate and make-up water shall be as indicated. The tank shall be equipped with liquid level controllers and valves and alarms as indicated. Tank shall be equipped with pressure and temperature gages, water level gage, vent, drain, and overflow. Tank shall be [hot dip galvanized or cement lined] [epoxy coated] [_____]. Surge tank assembly shall include condensate transfer pumps and interconnecting piping including strainer and control box as indicated. Transfer pumps, except for head and temperature requirements which shall be as indicated, shall conform to requirements for boiler feed pumps specified herein.

2.4.5 Feedwater Treatment Equipment

2.4.5.1 Feedwater Characteristics

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NOTE: Insert source of water supply.

****

Equipment for the chemical treatment of the boiler makeup feedwater shall be designed to reduce the boiler water concentrations to the limits specified herein when handling raw water having the following impurities reported as milligrams per liter (mg/liters) (formerly parts per million):

a. Total hardness as CaCO3_______________________

b. Calcium hardness as CaCO3_____________________

c. Magnesium hardness as CaCO3______________________

d. Alkalinity as CaCO3______________________

e. Sodium as Na______________________

f. Chlorides as Cl______________________

g. Sulfates as SO4______________________

h. Sulfites as SO4______________________

i. Phosphate as PO4_____________________

j. Silica as SiO4_______________________

k. Nitrates as NO3______________________

l. Iron as Fe______________________

m. Free carbon dioxide as CO2______________________

n. Total dissolved solids_______________________

o. Suspended solids______________________

Raw water shall be delivered to the plant [from the water distribution system of the [_____]] [from [_____]] at a normal pressure of [_____] kPa (gage) psig measured at the meter to the plant. See NAVFAC MO 225 for additional guidance on boiler water concentration limits.

2.4.5.2 Water Softener

Equipment shall be of the type, size, and arrangement indicated. When operating [under the indicated design conditions] [with an inlet water flow of [_____] liters per second gpm] effluent analysis shall be as follows:

a. Total hardness as CaCO3 less than [_____] Mg/liter

[b. pH [_____] to [_____]

c. Total dissolved solids less than [_____] Mg/liter

d. [_____]

] (1) Zeolite Water Softener: Conform to WQA S-100 and shall have [automatic] [manual] controls. The softener(s) shall be equipped for [a sodium cycle] [a hydrogen cycle] [the type of cycle necessary to provide the treated water analysis specified above]. [Each softener tank shall be provided an operating valve to permit the regeneration of one tank while the other is in service.]

(2) Lime Soda Softener: Conform to CID A-A-50573 for the type indicated.

(3) Ion Exchange Softener: Refer to NAVFAC MO 225 for additional information.

2.4.6 Pressure Filter

Provide [a] pressure filters of the type and arrangement indicated and with [manual] [automatic] controls. The filter shall conform to CID A-A-59249. Performance shall be as specified in CID A-A-59249 with raw water analysis as specified herein, and operating conditions as indicated. Filter shall be equipped to operate properly for not less than 2 days without operator attention to renew or regenerate filter coatings, chemicals, or other filter media.

2.4.7 Chemical Feeder

Size and connect as indicated. Chemical feeder shall be suitable for the flow, pressure, and temperature conditions at the point of connections. Provide chemical feed storage as indicated. [The feeder shall be of the [automatic proportioning type] [shot-type] conforming to FS F-F-2901.] [The feeder shall be of metering pump type conforming to the requirements of CID A-A-50573 for chemical feeders.]

2.4.8 Feedwater Test Equipment

Provide for the determination of boiler water condition which includes an assembly of indicator solutions, standardized solutions, and test glassware with cabinet. The solution types shall permit tests for water hardness, total alkalinity, hydroxide, carbonite alkalinity, and chloride content in milligrams per liter. Feedwater test equipment shall employ a standardized soap solution for hardness test and a dilute sulfuric acid solution with a methyl orange indicator for total alkalinity. The hydroxide and carbonate alkalinity shall be determined with a phenolphthalein indicator and the chloride content, with a silver nitrate solution. Furnish standardized phenolphthalein color slides for accuracy in alkalinity tests.

2.5 ELECTRIC MOTORS

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NOTE: Select standard efficiency for motors used less than 750 hours per year and high efficiency for motors used over 750 hours per year. Packaged boilers should utilize the manufacturer's standard efficiency motor.

****

Motors which are not an integral part of a packaged boiler shall be rated for [standard] [high] efficiency service per Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motors which are an integral part of the packaged boiler system shall be the highest efficiency available by the manufacturer of the packaged boiler.

PART 3 EXECUTION

3.1 INSTALLATION

Arrange work in a neat and orderly manner so that minimum storage of equipment and material is required at the project site. Install equipment and material in accordance with the best commercial practices. A competent installation engineer or technician as stated in paragraph QUALIFICATIONS OF ENGINEER shall assemble an unassembled boiler-burner package in strict accordance with the manufacturer's instructions. Systems shall be neat in appearance, compact, adequate in construction and assembly, and installed for long and continuous service. Parts shall be readily accessible for inspection, repair, and renewal. Inspect equipment and material upon delivery and test after installation. Protect material and equipment from the weather. Repair damage caused by the Contractor in execution of the work and leave in a condition equal to that existing before work was started.

3.1.1 Equipment Foundations

Locate as shown and construct of sufficient size and weight and of proper design to preclude shifting of equipment under operating conditions or under abnormal conditions that could be imposed upon the equipment. Foundations shall meet requirements of equipment manufacturer. Grout equipment mounted on concrete foundations before installing piping. Concrete shall conform to Army Corps of Engineers Guide Specification Section [03 30 00] CAST-IN-PLACE CONCRETE, and grout shall be non-shrinkable type approved by the Contracting Officer. Install piping in such a manner so as not to place a strain on equipment.

3.1.2 Welding

****
NOTE: Use of the ASME code or the Federal Construction Guide Specification section on welding depends upon the agency's requirements.
****

****
NOTE: Insert appropriate Section number in blank below.
****

Work shall be in accordance with [the applicable sections of the ASME BPVC SEC I] [[_____] WELDING] and AWS Z49.1.

3.1.3 Painting

Equipment shall be factory finished to withstand the intended end use environment in accordance with the specifications for the particular end item. Field paint equipment not factory finished as specified herein. Retouch damaged areas of factory-finished equipment on which the finish has been damaged and then give a complete finish coat to restore the finish to its original condition. The finish coat shall be suitable for exposure in the intended end use environment. Spray painting shall comply with OSHA 29 CFR 1910.

3.1.3.1 Cleaning and Application

Remove dirt, rust, oil, and grease by wire brushing and solvent degreasing prior to application of paint. Apply paint to clean and dry surfaces only. Where more than one coat of paint is specified, apply the second coat after the first coat is thoroughly dry. Retouch damaged painting before applying the succeeding coat. Finished surfaces shall be smooth. The painting of zinc coated and other corrosion-resistant metal surfaces is not required unless otherwise specified herein.

3.1.3.2 Smoke Flues, Boiler Casing, and Draft Ducts

In unfinished areas, paint smoke flues, boiler casing, and black steel draft ducts with heat-resisting aluminum paint, two coats on the inside of flues and ducts and one coat on the outside, each coat to a minimum dry film thickness of 0.025 mm one mil applied directly to clean bare metal surfaces. Paint exposed surfaces of protective metal covering over insulation, including zinc-coated surfaces, with two coats of heat-resisting black paint to a minimum dry film thickness of 0.05 mm two mils applied directly to the clean bare metal surfaces. Do not paint zinc-coated ducts.

3.1.3.3 Gratings, Pipe Railings, and Pit Covers

Apply a pre-treatment coating to gratings, pipe railings, pit covers, and similar plant appurtenances to a dry film thickness of 0.008 to 0.013 mm 0.3 to 0.5 mil. After installation, touch up damaged surfaces with then paint with two coats of finish paint matching type and color of adjacent areas. Do not paint zinc-coated surfaces.

3.1.4 Boiler Cleaning

After installation, [the] [each] boiler shall be boiled out, under supervision of the manufacturer, with soda ash or equivalent solution to clean internal surfaces of oil, grease, mill scale, and dirt. Following treatment, the boiler(s) shall be flushed, drained and then opened and washed down and inspected to ensure that no traces of oil or foreign matter are present. The boiler and associated piping shall then be drained and refilled with treated softened water. At all times after initial cleaning, the Contractor shall protect the boiler, tanks, and piping against internal corrosion until testing is completed and the boiler(s) [is] [are] accepted. Provide chemicals, labor for introducing chemicals, and professional services for control and supervision of the treatment process.

3.1.5 Piping

Material and installation requirements including welding shall be as specified in Section 23 11 20 FACILITY GAS PIPING, Section 33 51 15 NATURAL-GAS / LIQUID PETROLEUM DISTRIBUTION PIPELINES, Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION), and Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS.

3.2 FIELD QUALITY CONTROL

Perform inspections and tests as specified herein to demonstrate that the boiler(s) and auxiliary equipment, as installed, are in compliance with contract requirements. During boiler system start-up tests, factory-trained engineers or technicians employed by individual suppliers of such components as the burner, flame safeguard and combustion controls, feedwater treatment equipment, and other auxiliary equipment shall be present, as required, to ensure the proper functioning, adjustment, and testing of individual components and systems. No bypassing, use of jumpers, or other disablement of control systems will be allowed unless specified elsewhere. Labor, equipment, fuel, and test apparatus required for testing shall be furnished by the Contractor. Rectify defects disclosed by the tests by the Contractor within time period specified by the Contracting Officer.

3.2.1 Inspections and Test

****

NOTE: These field tests shall not be mandatory for all size boilers but shall be employed where advisable due to largeness, type, or complexity of boiler plant. The designer shall determine, on a case by case basis, which tests are appropriate.

****

Make inspections and tests at the site under the direction of and subject to the approval of the Contracting Officer. The Contractor shall operate [the] [each] boiler and appurtenances prior to final testing and shall ensure that necessary adjustments have been made. A [24-] [48-] [_____] hour written notice shall be submitted to the Contracting Officer indicating the equipment is ready for inspection or testing. Provide testing equipment, including gages, thermometers, calorimeter, Orsat apparatus, thermocouple pyrometers, fuel flow meters, water meters, and other test apparatus and set up and calibrate prior to the test. Draft, fuel pressure, and steam flow may be measured by permanent gages and meters installed under the contract. [Gas flow may be measured by utility company meters.] Provide an analysis of the fuel being used for tests. Control of noise levels developed by exhaust steam including muffler, globe, and gate valves shall be conducted in such a manner as not to create a nuisance or hazard and shall be subject to the approval of the Contracting Officer. Tests shall include the following, and shall be performed when feasible, in the sequence listed:

a. Strength and tightness tests

b. Standards compliance tests

c. Combustion tests

d. Operational tests

e. Capacity and efficiency tests

f. Tests of auxiliary equipment

g. Feedwater equipment test

3.2.2 Strength and Tightness Tests

****

NOTE: These field tests shall not be mandatory for all size boilers but shall be employed where advisable due to largeness, type, or complexity of boiler plant. The designer shall determine, on a case by case basis, which tests are appropriate.

****

Subject boiler to the following strength and tightness tests:

3.2.2.1 Hydrostatic Test

After installation and connection, subject [the] [each] boiler to an inspection and hydrostatic test to determine that the boiler and appurtenances have not been damaged in transit or handling. The hydrostatic test shall be in accordance with the ASME Code with the test pressure applied for a period required by the Contracting Officer. This test shall be in addition to the hydrostatic tests performed at the factory. [The hydrostatic test at the site shall be certified by an inspector holding an authorized commission from the National Board of Boiler and Pressure Vessel Inspectors.]

3.2.2.2   Pneumatic Tests

Pneumatically test air casing and ducts exterior to the furnace at the maximum working pressure. Use the soap bubble method to verify tightness. Test gas sides of boilers normally operated under pressure for tightness at 2.5 kPa (gage) 10 inches water gage. For this test, tightly seal the boiler with a suitable means to blank off openings. Admit air to the boiler until test pressure is reached and then hold. If in a 10-minute period the pressure drop does not exceed 250 kPa one inch water gage, the casing shall be regarded as tight and accepted. Use air pressure and soap bubble tests or comparative carbon dioxide readings for induced draft boilers.

3.2.2.3   Internal Component Pressure Tests

[Hydrostatically test at 1-1/2 times the maximum operating pressure] the part of the pre-assembled fuel oil system that is furnished integrally with the boiler. [The part of the pre-assembled gas system that is furnished integrally with the boiler shall be pneumatically tested at operating pressure. Use the soap bubble test method to verify tightness of the gas system.]

3.2.3   Combustion Tests

****

NOTE: These field tests shall not be mandatory for all size boilers but shall be employed where advisable due to largeness, type, or complexity of boiler plant. The designer shall determine, on a case by case basis, which tests are appropriate.

****

Test the fuel burning and combustion control equipment with [the] [each of the] specified fuel at the minimum limit of the turndown range and at increments of 50, 75, and 100 percent of full rated load [plus [_____] percent overload]. Tests shall be conducted by factory-trained combustion equipment engineers as previously specified. [The combustion control system shall demonstrate that equipment installed will meet the requirements of the specification, and that an overall efficiency as specified, with not over 15 percent excess air, can be obtained with boiler operating at 100 percent capacity.] Analyze test data and graphically present to show for [the] [each] boiler at tested loads: rates of steam flow; flue gas temperature; percent excess air; steam quality; and percentages of carbon dioxide, carbon monoxide, and oxygen in the flue gas. Monitor concentrations of sulfur oxides, particulate, and nitrogen oxides in the flue gas to ensure compliance with environmental requirements. Run tests on each fuel until stack temperatures are constant and conformance with the combustion requirements of this specification has been verified and recorded. Verify proper operation of instrumentation and gauges in the control panel during the test.

3.2.4   Operational Test

****

NOTE: These field tests shall not be mandatory for all size boilers but shall be employed where advisable due to largeness, type, or complexity of boiler plant. The designer shall determine, on a case by case basis, which tests are appropriate.

****

Continuously test the boiler(s) under varying load conditions to demonstrate proper operability of the combustion control, flame safeguard control, programming control, and safety interlocks. Conduct this test after the adjustment of the combustion controls has been completed under the combustion test. The operational test shall continue for a period of at least [8] [_____] hours and shall include the following:

3.2.4.1 Sequencing

The boiler shall start, operate, and stop in strict accordance with the specified operating sequence.

3.2.4.2 Flame Safeguard

Verify the operation of the flame safeguard controls by simulated flame and ignition failures. Test burners having intermittent pilots by simulating main flame failure while the pilot is burning. Verify by stop watch the trial-for-pilot ignition, trial-for-main flame ignition, combustion control reaction, and valve closing times.

3.2.4.3 Immunity to Hot Refractory

Operate the burner at high fire until the combustion chamber refractory reaches maximum temperature. Then manually close the main fuel valve. The combustion safeguard shall drop out immediately causing the safety shutoff valves to close within the specified control reaction and valve closing times.

3.2.4.4 Pilot Intensity Required

Gradually reduce the fuel supply to the pilot flame to the point at which the combustion safeguard begins to drop out (sense "no flame") but holds in until the main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame shall be capable of safely igniting the main burner. If the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, readjustment of fire eye is required.

3.2.4.5 Immunity to Ignition Spark

Where ultra violet flame detectors are employed, the pilot and main burner manual safety shut off valves shall be closed. The burner shall then be operated through the trial for pilot ignition period. The flame safeguard relay shall not respond to the presence of electric spark. If the flame safeguard relay responds to the presence of electric spark, reject the boiler.

3.2.4.6 Boiler Limit and Fuel Safety Interlocks

Safety shutdowns shall be caused by simulating interlock actuating conditions for each boiler limit and fuel safety interlock. Safety shutdowns shall occur in the specified manner.

3.2.4.7 Combustion Controls

Demonstrate the accuracy, range, and smoothness of operation of the combustion controls by varying the steam demand through the entire firing range required by the turndown ratio specified for the burner [and in case of automatic recycling burners, by further varying the firing rate to require "on-off" cycling]. Control accuracy shall be as specified

3.2.4.8 Safety Valves

The high-pressure limit switch shall be locked out or otherwise made inoperative, and the boiler safety valves shall be lifted by steam. Determine the relieving capacity, popping pressure, blowdown, and reseating pressure by observation and measurement to be in accordance with the ASME Boiler and Pressure Vessel Code. The ASME standard symbol will be accepted only as indicating compliance with the design and material requirements of the code.

3.2.5 Capacity and Efficiency Tests

Perform the capacity and efficiency tests after satisfactory completion of all tests previously specified herein and after the boilers have been operating [continuously] for [one] [5] [_____] days with no nuisance shutdowns and without the necessity for frequent or difficult adjustments. Perform these tests on each boiler. Conduct tests using [the] [each of the] specified fuels. Test procedures shall be in accordance with the heat loss method of the ASME PTC 4 and shall be reported on the ASME Test Form for Abbreviated Efficiency Test. The duration of the tests shall be sufficient to record necessary data but in no case shall test duration be less than [4] [_____] hours [on each fuel].

3.2.6 Auxiliary Equipment and Accessory Tests

Observe and check blowdown valves, stop valves, try cocks, draft fans, fuel oil heaters, pumps, electric motors, and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctions, defects, noncompliance with referenced standards, or overloading, as applicable.

3.2.7 Feedwater Equipment Tests

Perform the test of the feedwater treatment equipment in two steps. Conduct one test by the Contractor concurrently with either the combustion test or the capacity and efficiency test. A second test will be performed by the Government during the first period of heavy loading after the plant has been accepted and put in service. Deficiencies revealed during the Government tests will be corrected under the guarantee provisions of the contract. Both the first and second series of tests shall determine compliance with the limits for oxygen content and hardness concentrations of this specification. Equipment for taking samples and the test kit for analyzing the samples shall be supplied by the Contractor and shall revert to the Government when the tests are completed.

3.2.8 Preliminary Operational Test

Operate each boiler and appurtenances prior to final testing and insure that necessary adjustments have been made. Provide testing equipment required to perform tests. During this testing period, provide operating instructions and training to persons tasked with operation of the boiler. Tests shall be accomplished with both fuels on dual fuel units.

****

NOTE: Insert the appropriate Engineering Field

Division.

****

Conduct a preliminary operational test prior to requesting an acceptance operational test and inspection by a [_____] Division, Naval Facilities Engineering Systems Command Boiler Inspector. The Contracting Officer, upon receipt of the notice from the Contractor, shall request the boiler be inspected by [_____] Division, Naval Facilities Engineering Systems Command. Ten days advance notice is required for scheduling the inspector to conduct acceptance operational test and inspection.

3.3   SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Boilers Capacity	= 500,000 Btu/hr	= 150 kW
	= 10,000,000 Btu/hr	= 2930 kW
	= 18,000,000 Btu/hr	= 5275 kW

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 52 53.00 20 (April 2006)**
Change 2 - 08/18

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15517N (June 2005)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 52 53.00 20

STEAM BOILERS AND EQUIPMENT (18,000,000 - 60,000,000 BTU/HR)

04/06, CHG 2: 08/18

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-23 52 53.00 20 (April 2006)**
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SECTION 23 52 53.00 20

STEAM BOILERS AND EQUIPMENT (18,000,000 - 60,000,000 BTU/HR)

04/06, CHG 2: 08/18

****

NOTE: This guide specification covers the requirements for packaged steam boilers and equipment with gross outputs over 5275 kW 18,000,000 Btu's per hour.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: These boilers are equipped for oil-, gas-, or oil-and-gas combination firing, as specified.

****

****

NOTE: The following information shall be shown on the project drawings:

1. Dimensions of construction

2. Relationship of materials

3. Quantities, location and capacity of equipment.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC	(2010) Boiler and Pressure Vessels Code
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 4	(2013; R 2023) Fired Steam Generators
ASME PTC 19.5	(2022) Flow Measurement
ASME PTC 19.11	(2008; R 2013) Steam and Water Sampling, Conditioning, and Analysis in the Power

Cycle

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM D888	(2012; E 2013) Dissolved Oxygen in Water
ASTM D1066	(2018; E 2018) Standard Practice for Sampling Steam
ASTM D2186	(2005; R 2009) Deposit-Forming Impurities in Steam

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-27	(1991) National Board Rules and Recommendations for the Design and Construction of Boiler Blowoff Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50504	(Basic) Analyzers, Flue-Gas, Orsat-Type,

	Portable
CID A-A-50562	(Basic) Pump Units, Centrifugal, Water, Horizontal; General Service and Boiler-Feed: Electric-Motor or Steam-Turbine-Driven
CID A-A-50566	(Basic) Monitoring Devices, Emission, Stack Related
CID A-A-50573	(Basic, Notice 1) Water Softener Unit, Lime-Soda Type
CID A-A-59249	(Basic; Notice 1; Notice 2) Filters, Fluid, Pressure, Feedwater
FS F-B-2902	(Basic; Notice 1) Boilers, Steam Watertube (Bent Tube, Multi-Drum and Cross Drum) Packaged Type (10,000,000 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-B-2910	(Basic) Burners, Single Oil, Gas, and Gas-Oil Combination for Packaged Boilers (320,001 to 125,000,000 BTU/HR Thermal Output Capacity)
FS F-F-2901	(Basic; Notice 1) Feeders, Boiler Water Treatment, By-Pass and Compound Receiver Types
FS F-P-2908	(Basic; Notice 1) Pumping Units, Condensate, Return; and Boiler Feed Package
FS TT-P-28	(Rev H) Paint, Aluminum, Heat Resisting (1200 Degrees F.)
FS W-H-2904	(Basic; Notice 1) Heaters, Fluid, Deaerating (For Water Only) 1,000 to 1,600,000 Pounds Per Hour Capacity

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART D	Walking - Working Surfaces

U.S. NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (NAVFAC)

NAVFAC MO 225	(1990) Industrial Water Treatment
NAVFAC MO 324	(1992) Inspection and Certification of Boilers and Unfired Pressure Vessels

WATER QUALITY ASSOCIATION (WQA)

WQA S-100	(2000) Household, Commercial, and Portable Exchange Cation Exchange Water Softeners

1.2 SYSTEM DESCRIPTION

Describe the performance or design requirements and tolerances of the complete system. Section 23 52 33.01 20 STEAM HEATING PLANT WATERTUBE SHOP ASSEMBLED COAL/OIL OR COAL.

1.2.1 Heating Surface and Volume Measurements

Submit heating surface and volume measurements, including heat release calculations sufficient to establish compliance of boilers with heat release requirements. Base calculations on the specified efficiency and capacity.

1.3 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS with the following additions and modifications applies.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Steam Boiler System

SD-03 Product Data

Boiler Efficiency

SD-05 Design Data

Heating Surface and Volume Measurements

Heat Release Calculations

SD-06 Test Reports

Boiler System Start-Up Tests

Submit in accordance with paragraph FIELD QUALITY CONTROLS. Submit detailed written record of the start-up performance, including burner setting data over the entire load range, to the cognizant authority before the Contractor's and sub-contractor's test personnel leave the site.

SD-07 Certificates

Report of Prior Installations

Engineer's Qualification Resume

Start-Up Plan

Start-Up Certification

Boilers

Submit evidence that boilers meet requirements of standards specified below. Include with the certificate of compliance acceptable evidence that standards are met. Acceptable evidence of meeting these standards will be the official UL listing for oil-fired, gas-fired or gas-oil fired boiler assemblies, as applicable, plus the appropriate official ASME symbol stamp.

SD-10 Operation and Maintenance Data

Boilers, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit evidence for boiler, boiler controls, instrumentation and feedwater equipment manufacturers that a permanent service organization is either maintained by each manufacturer or is trained and franchised by the equipment manufacturer, which will be able to render satisfactory service to the equipment on a regular and emergency basis. Provide the name and telephone number of the person to contact for services.

1.5 QUALITY ASSURANCE

The Contractor shall provide the service of a qualified engineer or technician for start-up, testing, and installation of equipment as specified below. Provide the services of technician or engineer until the installation of equipment is coordinated and completed with checkout. The Contracting Officer reserves the right to reject the engineer or technician proposed if the engineer or technician's qualifications are not suitable or are questionable. More than one engineer or technician may be provided based on the types of specific equipment. One engineer or technician as appointed by the Contractor shall supervise and be responsible for the overall installation, start-up, and testing and checkout of systems.

1.5.1 Report of Prior Installations

Boilers, burners, combustion controls, and feedwater equipment shall be of proven design. Submit evidence to show that substantially identical equipment of comparable capacity within 20 percent has been successfully installed and operated in not less than three installations under comparable operating conditions for a period of not less than 2 years.

1.5.2 Engineer's Qualification Resume

Submit a printed certified qualification resume of the engineer or technician to the Contracting Officer. The engineer or technician's resume shall list applicable experience related to installation, start-up and testing of equipment and applicable factory training and education. Qualifications require the engineer to have supervised two installations of similar size and type which are operating satisfactorily. More than one engineer or technician may be provided based on the types of specific equipment. In event more than one engineer or technician is provided, provide a certified resume for each one and indicate his specific specialty and item of work on the resume.

1.5.3 Start-Up, Testing, and Installation Engineer

The Contractor shall provide the services of a qualified engineer or technician for start-up, testing, and installation of equipment as specified under paragraph QUALIFICATIONS OF ENGINEER. The engineer or technician shall be an employee of the equipment manufacturer.

1.5.4 Installation

Provide an installation engineer or technician to install and supervise the installation of steam boiler system including instrumentation and boiler controls. Provide the technician or engineer until equipment installation is coordinated and completed with checkout.

1.5.5 Start-Up Plan

Submit a written schedule with dates of start-up, test, installation and checkout of equipment to the Contracting Officer.

1.5.6 Start-Up and Test

The specific equipment tested shall be the boiler, boiler controls, boiler instrumentation and feedwater equipment. The start-up and testing engineer or technician shall remain on the job until the unit has been successfully operated for [_____] days and the unit has been accepted by the Contracting Officer.

1.5.7 Start-Up Certification

After installation of equipment, submit a certificate or certified written statement, signed by the engineer or technician, that the equipment is installed in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 BOILERS

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NOTE: Steam-atomizing burners should be specified only if the boiler operating pressure exceeds 690 kPa (gage) 100 psig.

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NOTE: Oil burners can have turndown ratio of 4,5, or 6 to 1.

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NOTE: Repetitive self checking circuits are required only on boilers with modulating controls which operate for long periods of time without burner shutdown.

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NOTE: Steam operated feedwater injectors should be specified only for boilers operating at or above 345 kPa (gage) 50 psig.

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NOTE: Combustion units should have metering combustion controls. Investigate energy savings. Combustion units larger than 7034 kW 24,000,000 Btu/hr input should have oxygen trim in order to optimize fuel usage. CO trim should be considered for larger boiler installations as an adjunct to oxygen trim for increased efficiency.

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Provide boilers that conform to FS F-B-2902 and have a gross output capacity of at least [_____] kW Btu per hour when operating at a steam pressure of [_____] kPa (gage) pounds per square inch gage (psig) at the site under design conditions when the burner is firing No. [_____] oil conforming to [ASTM D396] having a higher heating value of [_____] MJ/kg Btu per gallon [or] [[natural] [manufactured] [mixed] [liquified petroleum] gas having a higher heating value of [_____] MJ/kg Btu per cubic foot and a pressure of [_____] kPa (gage) psig at the fuel train connection]. Provide [air-atomizing] [or] [steam atomizing] burners. Rotary type burners are unacceptable. Provide burners capable of operating at a turn down ratio of [_____]. Provide automatic [recycling] [nonrecycling] programming controls and incorporate means for automatic self-checking of the circuit beginning of each start-up cycle. [Include a repetitive self-checking circuit to check all components at not more than the specified time interval in FS F-B-2910 during the entire period of burner operation, and sensor shall be of the ultraviolet type.] [Connections shall be provided for remote starting or stopping of the boilers.] [Provide steam operated feedwater injectors.] Provide combustion control system of the [modulating positioning type where the final control elements for fuel and air inputs, between minimum and maximum limits, are positioned in proportion to load] [semi-metering type where the final control element for one input, either fuel or air, is positioned in proportion to load; flow of the other input is measured and controlled in proportion to load as indicated by the position of the control element for the first input] [full metering (fuel flow/air flow basis) type where the final control element for one input, either fuel or air, is positioned in proportion to load, or the flow for that input is controlled in proportion to load, and the other input is measured and controlled in proportion to the measured flow of the first input] [Provide with oxygen compensation where one of the control elements is biased, modified slightly, on the basis of continuous flue gas analyses, to maintain the proper percentage of oxygen for various firing rates.] Boilers shall be designed in accordance with the applicable provisions of ASME BPVC SEC I and current addenda therein. Boilers shall be equipped with combustion control safety devices conforming to NFPA 85. The following design requirements and conditions shall apply:

a. Maximum allowable steam working pressure of [_____] kPa (gage) psig, as designated by the symbol "P" in the ASME Code and determined by employing the allowable stress values, design rules, and dimensions therein.

b. Operating pressure of [_____] kPa (gage) psig at the steam drum outlet.

c. Feedwater temperature of [_____] degrees C degrees F at entrance to the boiler plant.

d. Elevation of [_____] meter feet above sea level at the site.

e. Ambient air temperatures outside the plant of [_____] degrees C degrees F minimum to [_____] degrees C degrees Fmaximum; average inside temperature of [_____] degrees C degrees F and relative humidity of [_____] percent.

f. Steam quality of [99.5] [99.0] [_____] percent.

[g. Make-up feedwater analysis of [_____] parts per million (ppm) total solids and [_____] ppm total alkalinity.

][h. Steam temperature of [_____] degrees C degrees F at the steam drum outlet.

]2.1.1 Boiler Connections

Requirements for interconnecting piping, insulation, fuel supply, [vibration isolation] [_____] and other related work necessary to provide a complete and operable steam system, whether or not specifically mentioned above, shall conform to applicable requirements of other sections of Division 15, and electrical work shall conform to applicable requirements in Division 16.

2.1.2 Boiler Efficiency

[Gas fired boilers shall have a steady state combustion efficiency of at least 80 percent.] [Oil fired boilers shall have a steady state combustion efficiency of at least 81 percent.] Boiler efficiency, when tested as specified herein, shall be not less than [79-83] [percent when firing No. [_____] fuel oil] [and] [78-82] [percent when firing [_____] gas]. Obtain efficiency at all loads in a range from the lower limit of the turndown ratio to 100 percent.

2.1.3 Furnace Heat Input

When boiler is operating at maximum rated output, heat input to furnace shall not exceed limits specified in FS F-B-2902 both for input per cubic meter foot of furnace volume and input per square meter foot of effective radiant heating surface.

2.1.4 Steam Quality

The steam releasing surface, drum internals, and steam passages out of the drum shall be such that, with load swings from [50] [75] to 100 percent of the rated capacity per [1] [3] minute period at a boiler feedwater solids concentration of [3500 ppm] [[_____] ppm], the carryover shall not exceed [[_____] ppm] at the boiler nozzle, and moisture in the steam shall not exceed [0.5] [1.0] percent.

2.1.5 Noise Levels

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NOTE: The value for decibels for boiler shall be that required for operating personnel and OSHA requirements taking into consideration room design and other requirements.

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Conduct noise measurements and exposure analysis under the overall supervision of an industrial hygienist or suitably qualified medical officer from the Navy Regional Medical Center (NRMC). Safety personnel, engineers and others who have been certified by the Chief, Bureau of Medicine and Surgery (BUMED) also may supervise the work. Maintain exposure limits for potentially hazardous noise levels of 85 dB, continuous or intermittent and 140 dB peak sound pressure, impulse or impact. Sound level meter shall conform as a minimum to the Type 2 requirements cited in ASA S1.4.

2.1.6 Air Pollution Control

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Note: Research local, state, and federal emission standards and place any unusual or new requirements in this specification section.

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Provide fuel burning equipment, combustion control system(s) [and] stack(s) [and emission control equipment] designed, installed, and when applicable, adjusted so that emissions at any loading within the range of the boiler output specified do not exceed federal, state, and local environmental rules and regulations. Emission requirements to be considered include sulfur oxides, carbon monoxide, particulate, or nitrogen oxides. In addition, the density of any emission to the atmosphere, except during start-up, cleaning of fires, or soot blowing, shall not exceed [No. 1] [No. 2] on the Ringlemann Scale or the Smoke Inspection Guide. The plant shall otherwise conform to applicable Federal, State and Local regulatory requirements. Air quality board "Permit to construct" [will be provided by the contracting officer][will be obtained by the contractor].

2.2 BOILER CONSTRUCTION

2.2.1 General

Provide boilers constructed for specified design conditions and performance requirements in accordance with applicable provisions of ASME BPVC SEC I, and current addenda thereto, and FS F-B-2902. Mount [the] [each] boiler on an internal structural steel base frame of welded construction designed to serve as skids in shipment and to permanently support the unit off the prepared foundation at the site. Assemble and install tubes, drums, and headers in a manner to permit the boiler(s) to be drained dry by gravity. [Show location of the flue gas outlet on drawings.]

2.2.2 Drums

Drums shall conform to FS F-B-2902 and requirements herein. Provide sufficient drum-internals to preclude thermal shock, ensure steam quality as specified herein, Ensure drum capacity addresses expected load swings to insure maintenance of drum level within set points during high load swings, and to properly condition the water in accordance with chemical feed and blowdown systems specified [indicated] [and] [specified]. Nuts, bolts, and other hardware used in assembling steam separators shall be stainless steel. Where drum internals interfere with inspection of part of the boiler drum, make provisions for the easy removal and replacement of whatever internals must be removed in order to effect a complete internal drum inspection and to provide access to tubes. Construct lower drums to preclude build-up of suspended solids, and to permit the complete drainage.

2.2.3 Tubes

Boiler and furnace tubes shall meet the applicable requirements of FS F-B-2902. Tangent tubes or tubes with welded flat studs or a combination thereof shall be provided for water cooling of the furnace rear wall, side walls, roof, and floor. Maximum tube spacing for tubes with welded flat studs should be given so that the problem of studs driving through tube sidewalls due to expansion and contraction does not occur. Burner wall shall be refractory-covered with optional tubes for water cooling. Tubes shall enter the steam drum below the normal water line.

2.3 BOILER TRIM

Boiler trim, including steam stop valves, feedwater stop and check valves, blowoff valves, water level indicators, water columns, pressure gages, safety valves and associated piping, and fittings located within the jurisdictional limits of the ASME Code shall conform to and be installed in accordance with the Code and shall meet supplemental requirements specified herein. Material selection and pressure ratings for valves and piping shall be in accordance with applicable ANSI standards cited in the ASME Code and shall be based on the maximum allowable boiler working pressure specified herein except as otherwise permitted by the ASME Code.

2.4 BOILER INSTRUMENTATION

In addition to the instruments required by the boiler specification referenced above, provide the following instruments:

a. Temperature gages to indicate temperature of [preheated oil] [air preheater inlet and outlet air][steam temperature].

b. Meters for indicating air flow, drum level and indicating, recording, and totalizing steam and fuel flow. Installation and calibration of these meters shall confirm to ASME PTC 19.5.

c. Instruments to indicate and record flue gas temperature.

d. A draft gage, diaphragm or bellows type, conforming to ASME B40.100. Circular scale with graduations in Pa inches of water. Numerals shall be suitable for reading by persons with normal vision from a distance of 6 meters 20 feet. Select range for intended service and contain completely within the calibrated range. Encompassing no more than 80 percent of the total range. Gages shall be designed and constructed to ensure accuracy within plus or minus 2 percent of the full scale reading in ambient temperatures varying from 2 degrees C to 57 degrees C 35 degrees F to 135 degrees F. Operating mechanisms shall withstand, without affecting gage accuracy or damage to the instrument, surges equal to 100 percent above or below the entire scale range. Gages shall be calibrated prior to installation and shall require no further calibration or adjustment other than setting the pointer to zero. Provide gages with a single pressure connection to the diaphragm, or bellows. Provide pressure connections with a 3-way stopcock which will permit checking of the zero setting and calibration at any time without breaking service connections.

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NOTE: Select the applicable paragraph(s) from the following

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[e. A carbon dioxide recorder which shall measure, record, and indicate the percentage by volume of carbon dioxide (CO2) detected in the flue gas. The recording unit shall be flush mounted and furnished with locking device and master key.

][f. Provide complete oxygen analyzer system to measure oxygen content of flue gases generated by combustion of [gas] [or] [oil] as specified in paragraph BOILER PLANT CONTROLS AND INSTRUMENTS herein for each boiler. The output of the analyzer shall range from zero to 25 percent oxygen. The analyzer shall include the following:

(1) Provide complete aspirating system with proper connection to stack, necessary steam or water aspirating facilities, and piping of proper specification to analyzer. Provide piping in accordance with the oxygen analyzer manufacturer's recommendations and install tight. Install equipment install in accordance with manufacturer's instructions.

(2) Provide a paramagnetic analyzer. Analyzer shall provide oxygen analysis in the zero to 25 percent oxygen range, and have means of calibration. Provide zero range and span adjustments as required.

(3) Analyzer output and recorder input shall be compatible. Provide necessary transducers, connect, and place in proper operation. Follow special instructions relating to electrical transmission between analyzer and recorder as to the application of shielded wiring in conduit.

(4) Check system with two calibrating gases as follows: (a) 100 percent nitrogen, and (b) 3.5 percent oxygen and remainder nitrogen.

][g. Direct Probe In Situ Type: Oxygen analyzer shall be the direct probe type utilizing an in-situ zirconium sensing element. Determine flow characteristic and insert element in location where flue gas is in transition and is representative. Sensing element shall be contained within a protective shield mounted to the ductwork by means of an adapter plate, all furnished by the manufacturer. Analyzer shall be equipped with a facility to allow daily automatic calibration check without removing the analyzer from the process. That is, sample gases may be injected directly on the sensing element while the analyzer is in the process. In order to eliminate temperature effect of flue gases, maintain the cell temperature in the probe at 843 degrees C 1,550 degrees F by means of an externally mounted temperature controller equipped with cold junction compensation and coupled to the probe with at least 6 meters 20 feet of flexible cable. Analyzer shall be FM APP GUIDE approved and certified for "in-stack" analysis technique. Output signal range shall be 4 to 20 milliamps and shall represent 0.25 percent to 25 percent oxygen as a logarithmic function, 0.1 percent to 10 percent oxygen as a logarithmic function, or zero percent to 10 percent as a linear function. [Circular chart recorder shall consist of a two-pen recording control mechanism having 110 volt a.c. electric motor drive. Chart shall be 300 mm 12 inch diameter and rotate once every 24 hours. Output control signal will be 20 to 103 kPa (gage) 3 to 15 psig pneumatic. Sufficient blank charts and four ink cartridges per pen for 400 days operation shall be provided. Recorder shall have a dual 30 degrees strip indicator. Strip indicator and chart paper scale shall be logarithmic or linear and consistent with the analyzer signal conditioning.] [Strip chart recorder shall consist of a two pen solid state electronic recording/controlling mechanism. Strip chart shall be 100 mm 4 inches wide and shall be driven at a speed of 19 mm per hour 3/4 inch per hour. Recording/controlling will operate on 110 volt ac power. Recorder shall be furnished with twelve usable 24 hour logarithmic or linear charts consistent with the analyzer signal conditioning. Inking system shall be a breakaway inking system with replaceable fiber tip pens and 12 ink cartridges. Strip chart recorder/controller shall have vertical scale and horizontal driven chart. Output control signal will be 4 to 20 milliamps dc.] Flue gas temperature scale shall be 149 to 427 degrees C 300 to 800 degrees F. Entire system response shall be not more than 3 seconds.

] h. A smoke density [indicator] [recorder] of the [density limit] [continuous density] type with a scale calibrated in Ringlemann units. Indicating and recording systems shall include circuits for the audible warning of the maximum smoke density-limit. A vibrating electric horn shall be supplied to sound the audible signal. Otherwise the smoke density [indicator] [recorder] shall conform to CID A-A-50566.

[i. The annunciator shall be of the solid state type and shall annunciate safety interlock and limit switch shut-downs, including flame failure, high and low water, high steam pressure, [high gas pressure,] [low gas pressure,] [high oil pressure,] [low oil pressure,] [low atomizing steam pressure,] [draft fan failure,] [high and low temperature,] [and] [_____]. Annunciator shall include at least [two] [_____] spare points and audible alarms for at least high and low water conditions.

Annunciator shall not require special or additional devices which could affect the sensitivity of the boiler limit switches. Annunciator shall provide means to indicate the first limit or off-limit condition causing burner shutdown and to sound an alarm. Annunciator shall have a test button and a feature capability to store information on additional causes of burner shutdown. Subsequent causes of burner shutdown will be indicated after the operator acknowledges the first burner shutdown. A dust tight enclosure shall be provided.

]2.4.1 Instrumentation

[Instrumentation, such as the steam flow recorder, steam flow totalizer, air flow recorder, [carbon dioxide] [oxygen] recorder, and flue gas temperature recorder may be combined into one or more meters having multiple pens plus integrating capabilities as required for specified totalization functions.] [Instrumentation for recording and integrating steam flow, for recording percent of CO2 or O2 in the flue gas, and for recording flue gas temperature shall be combined in a single boiler operation meter having three pens using different colored ink.]

2.4.2 Control Panel

The boiler control panel shall include the following switches, controls, and accessories:

a. Boiler on-off pushbutton station with indicating lights.

b. Draft fan manual, start-stop, pushbutton station with indicating lights for on, off, and tripped.

c. Controllers for the combustion control system.

d. Manual-automatic stations for individual controllers of the combustion control system.

e. [Indicating lights and alarm with silencer switch to signal nonrecycling safety shutdowns as specified herein [and excess smoke density conditions].] [Annunciator.]

f. Manual switch to transfer combustion burner and controls from oil to gas and vice versa.

g. Switch and indicating lights to control emergency gas shut-off valve.

h. [Electric clock, 300 mm 12 inch dial, with second sweep hand and seal-in driving unit] [Digital clock that indicates hour, minutes, and seconds, with numerals suitable for reading by persons with normal vision from a distance of 6 meters 20 feet].

2.4.3 Control Systems

The flame safeguard and programming control systems shall be mounted in the central control panel or an auxiliary control panel located adjacent to the main panel adjacent to the boiler. Auxiliary panels, if provided, shall be fabricated as specified herein for the main control panel.

2.5 BOILER PLANT CONTROLS AND INSTRUMENTS

Provide the following plant [controls and] instruments:

a. Instruments to indicate and record feedwater temperature and steam pressure in the deaerator.

b. Pressure gages to indicate steam pressure in main header, conforming to ASME B40.100 [gas pressure in main supply line] [oil pressure] [atomizing steam pressure].

c. A flue gas analyzer, Orsat type, conforming to CID A-A-50504. The analyzer shall determine the CO2, CO, O2 in the flue gas and shall be complete with chemicals and accessories for use in such determinations.

d. A steam flow recorder which shall remotely indicate, record, and totalize the steam flow per hour through the steam header. Provide panel-mounted indicating recorder with a tamper-proof case.

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NOTE: Insert section numbers for oil and/or gas piping systems in the blanks below.

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e. Volumetric fuel flow meters in accordance with [_____], [and] [_____].

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NOTE: Master combustion controller should be used only for automatic recycling boilers.

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f. A common boiler master combustion controller located on the free standing instrument and control panel to control all boilers with each individual boiler controller acting as a submaster controller. The boiler master control system shall provide for base loading one [or more] boilers. Base loaded boilers shall be selected manually by an externally accessible switch. On call for heat, lead boiler shall cut in and moderate firing rate to satisfy demands. When maximum desired firing rate is reached, lag boiler or boilers shall cut in. Only one boiler shall be on modulating firing at one time. Maximum desired firing rate for base loaded boiler shall be adjusted initially for boiler peak efficiency and shall be capable of easy manual adjustment by operating engineer. Adequate indicators shall be provided to show the method of loading of each boiler, and load being carried by it. Make adjustments at the front panel and no linkage adjustment shall be necessary.

g. The combustion control system shall be capable of maintaining the plant steam pressure at the main header within the tolerance limits of [_____] percent expressed as a percent of the set point values. The specified tolerance shall apply to any load which, within a one minute period, swings from a steady-state condition to an increase (or decrease) in load equal to a maximum of 10 percent of the plant. Regulation tolerances shall apply to any steady state condition within the plant turndown ratio of [_____]. After a load swing of 10 percent the concentration of oxygen in the flue gas shall not vary more than plus or minus [_____] percent of the values established at time of system set up within a time period of 30 seconds for firing rates of or above 33 percent of maximum, and plus or minus [_____] for firing rates below 33 percent of maximum. [For oxygen compensation, a continuous analysis of flue gases leaving the boiler shall be made and recorded by an oxygen indicator and recorder mounted on the control panel. From this analysis, a signal shall be sent to the fuel-air ratio system which shall be biased in response to the signal to maintain the oxygen levels within plus or minus [10] [_____] percent of the original setting for excess combustion air]. Combustion efficiency shall not be less than that specified in the boiler specification.

2.6 BOILER CONTROL AND INSTRUMENT CABINET(S)

Provide boiler control and instrument cabinet(s) as specified in FS F-B-2902, and may be mounted either on the boiler front or adjacent thereto. The arrangement may also consist of a boiler mounted cabinet containing controls normally provided by the manufacturer and a supplementary cabinet containing controls normally provided by the manufacturer and a supplementary cabinet containing additional controls and instruments required herein. [[Plant master combustion control] [and] [steam flow recorder] shall be mounted on or be adjacent to control panel for number [_____] boiler.]

2.7 FREE-STANDING MULTI-BOILER PLANT CONTROL AND INSTRUMENT PANEL

Provide a free-standing panel and locate as indicated. The panel shall contain all multi-boiler controls, monitoring systems, and panel mounted instruments specified herein and in the reference specifications, except that flame safeguard systems may remain separately mounted in a cabinet at each boiler.

2.7.1 Control Panel Construction

Control panel shall be constructed of not less than 11 gage (3 mm) (0.1196 inch) reinforced steel for face, top, and sides. The enclosed panel shall be not less than 610 mm 24 inches in depth with inside rigidly welded braces. Control panel shall be designed so that all indicating and recording devices and manually operated switches shall be flush mounted in a gasketed removable top front panel with indicating and recording devices at eye-level. A similar removable top rear panel located opposite front panel shall be provided to facilitate wiring, piping, and maintenance. Other operating controls shall be installed on a sub-panel within the enclosure. Access to panel enclosure shall be through gasketed, double piano-hinged doors of not less than 16 gage (1.52 mm) (0.0598 inch) steel. Reinforced doors to prevent sagging and provided with a 3 point compression type fastener and polished key lock handle. A full width fluorescent lighting canopy shall be prime coated and finished in baked enamel. Identify flush mounted devices with engraved lamicore nameplates. Adequately reinforce, suitably skirt, and suitably design panel base to permit anchoring to the floor or foundation.

2.7.2 Control Panel Wiring and Piping

Control panel shall be factory pre-wired in accordance with NFPA 70. Wire shall be thermoplastic Type THW, THWN, XHHW, or UL approved for the intended use, color or number coded, and run in plastic ducts to numbered terminal blocks. Control circuits shall be separately fused with properly rated cartridge type fuses. Power leads to and from magnetic starters and contactors shall terminate at terminal blocks so that no field wiring in control compartment is necessary except from terminal blocks to external equipment. Control leads to and from external control devices shall terminate at separate terminal blocks from power leads. Steam, draft, and air operated devices shall be factory piped to permanently affixed external connections. Pneumatic signals shall be either 20 to 103 kPa (gage) 3 to

15 psig or 20 to 207 kPa (gage) 3 to 30 psig. Piping connections to indicators shall be copper tubing conforming to ASTM B88M ASTM B88. The boiler operating switch shall have a dust-tight sealed snap-action type. The precision switches shall have cadmium, silver, or platinum contacts, wiping action type, rated at 10 amperes. Electrically or pneumatically test controls and equipment to simulate complete operational sequence.

2.8 BREECHING

Connect breeching to [the] [each] boiler and to intermediate heat recovery equipment as required. Structural materials shall comply with the applicable sections of the AISC 360, "Structural Steel Buildings Allowable Stress Design and Plastic Design." Shop connections shall be welded gas-tight. Field connections may be welded or bolted as required for joining breeching to equipment. Hot dipped galvanized bolts and lock washers shall be supplied for all bolted connections, shall not be less than 10 mm 3/8 inch diameter and spaced not more than 76 mm 3 inches apart. Furnish bolted joints with 3.20 mm 1/8 inchthick non-asbestos gaskets. Breeching plate shall be not less than 10 gage (3.40 mm) (0.1345 inch) in thickness. Welding shall conform to AWS Z49.1 and AWS D1.1/D1.1M. Breeching system shall provide for maximum expansion and contraction. Expansion joints shall be of the guided, flexible-crease type with flexible element of not less than 16 gage (1.50 mm) (0.0598 inch) thick stainless steel. Provide access doors constructed of cast iron or reinforced steel plate with gaskets and positive closing latches of sufficient number to ensure a gas-tight seal. Clean breeching of rust and scale after fabrication. Insulation and covering for breeching shall be as specified in [Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS].

2.8.1 Round Breeching

Construct round breeching 305 mm 12 inches in diameter and smaller of not less than No. 10 gage (3.40 mm) (0.1345 inch) steel with longitudinal groove type seam. Joints between lengths of breeching shall be of the tight slip fit type with not less than 100 mm 4 inchengagement. Construct round breeching over 305 mm 12 inches in diameter of not less than No. 10 gage (3.40 mm) (0.1345 inch) steel with welded seams and joints. Construct round breeching over 457 mm 18 inches in diameter of not less than No. 10 gage (3.40 mm) (0.1345 inch) tank steel with seams and joints welded.

2.8.2 Expansion Joints

2.8.2.1 Metallic Breeching Expansion Joints

Provide factory fabricated metallic breeching expansion joints [where indicated]. Expansion joints shall be guided metal bellows type capable of a minimum of [_____] mm inches of axial travel. Form metal bellows from not less than 1.60 mm 1/16 inch thick type 321 stainless steel plate. Cover plates shall be not less than 3.20 mm 1/8 inch thick steel plate.

2.8.2.2 Non-Metallic Expansion Joints

Provide factory fabricated non-metallic breeching expansion joints 3.20 mm 1/8 inch minimum thickness [where indicated]. Expansion joints shall be constructed of a fluoroelastomer vulcanized to two plies of knitted wire mesh capable of a minimum of [_____] mm inches of axial compression, [_____] mm inches of axial extension and [_____] mm inches of lateral offset [unless indicated otherwise]. Joints shall have a continuous operating temperature rating of 204 degrees C 400 degrees F, with excursion design standards up to 400 degrees C 750 degrees F. Operating pressure range shall be minus 34 kPa (gage) 5 psig to plus 34 kPa (gage) 5 psig. Expansion joints shall be preformed with integrally molded corners, suitable for mounting against a 150 mm 6 inch flange. [Provide carbon steel backup bars with slotted holes, bolts, and nuts.]

2.8.3 Breeching Hangers

Design breeching hangers to carry not less than 5 times the breeching weight. Hangers for round breeching shall be of the band type, with hanger rods. Hangers for rectangular breeching shall be of the trapeze type, with angle support member and hanger rods. Make all hangers of steel.

2.8.4 Cleanout Doors

Secure cleanout doors to the ends and sides of the breeching where indicated or where required to effectively clean the breeching. Construct cleanout doors of a gage steel not less than that of the breeching and secure to a 32 by 32 mm 1 1/4 by 1 1/4 inch angle frame and spaced not over 152 mm 6 inches on center; provide 1.60 mm 1/16 inch thick fiber non-asbestos gasket between cleanout doors and frames. Doors shall be squared and shall be full height of diameter or side of breeching up to a size of 610 mm 24 inches maximum, except for cleanout doors less than 305 mm 12 inches in height shall be rectangular and shall be 305 mm 12 inches in length. Plug type cleanouts are not acceptable. Provide additional cleanout doors where needed.

2.9 BOILER STACKS

Provide [One] [_____] [refractory-lined], [dual wall insulated], steel stack(s), [each] [_____] mm inches in diameter inside [refractory] by [_____] meter feet overall length, and install where indicated.

2.9.1 Construction

[The] [Each] stack may be factory or field assembled. [The] [Each] stack shall be [prefabricated double or triple walled] [fabricated] of 6.40 mm 1/4 inch structural steel plates in accordance with ASTM A283/A283M. Stack sections shall be of welded construction and fabricated in sections not greater than 6 meters 20 feet nor less than 1.50 meters 5 feet in length. Longitudinal seams shall have continuous butt welded joints. The section or horizontal joints of [refractory lined] stacks shall be flanged with angles welded to the shell, and sections bolted together. Angles shall be not less than 50 mm by 50 mm by 6.40 mm 2 inches by 2 inches by 1/4 inch. [The refractory joint shall be "buttered" with a high temperature air setting bonding refractory before each section is assembled.] Stacks shall be set on a 13 mm 1/2 inch thick steel base plate having a diameter 50 mm 2 inches larger than the outside diameter of the base angle. Base angles and anchor shall be a minimum of 10 mm 3/8 inch thick and 13 mm 1/2 inch diameter. A reinforced concrete foundation shall be provided. Concrete for foundation and reinforcing shall be as detailed on drawings and as specified under the concrete section of this specification. Provide stacks with steel guide shoes and bearing plates on all four sides at the roof level. Guides and bearing plates shall be structural shapes not less than 6.40 mm 1/4 inch thick. Guides shall be not less than 305 mm 12 inches long and shall be welded to the stacks. Bearing member shall be fastened with steel stud anchors welded to the bearing member. Provided a clearance of 3.20 mm 1/8 inch between guide and bearing member for stack diameter expansion after stacks are in normal operation. Provide flashing and counter-flashing around [the] [each] stack as detailed on drawings.

2.9.2 Breeching Connection

Provide a breeching connection of the same thickness as the stack and weld to [the] [each] stack and reinforce the stack externally with steel plates and/or structural members as required to compensate the stack for the structural strength of the metal removed. Provide a flange for bolting breeching to this connection. Provide a hinged cast-iron or steel cleanout door with a heavy duty cast steel frame at the bottom of each stack. Frame and door shall be fitted gas-tight. Doors shall be a minimum of 457 by 610 mm 18 by 24 inches in size.

2.9.3 Lining

Stack lining shall be an alumina-silica-base castable insulating refractory of the hydraulic setting type certified by the manufacturer to be suitable for the specific application, considering the flue gas temperature, velocities, moisture content, and corrosive qualities of the fuel being burned, applied to each stack under the direct supervision of a qualified representative of the manufacturer. The lining thickness shall be 76 mm 3 inches. Stack base plate exposed inside of each stack shall be covered with castable insulating refractory as specified for stack lining. Boiler stack lining shall have a minimum pyrometric cone equivalent (PCE) of 10 1304 degrees C 2380 degrees F with a maximum installed dry weight of 720 kilogram per cubic meter 45 pounds per cubic foot and a recommended service temperature of 1093 degrees C 2000 degrees F. The top 3 meters 10 feet of lining shall be a dense castable refractory 1840 kilograms per cubic meter 115 lb/ft 3 suitable for all weather and flue gas temperature conditions encountered in the top of stacks. Stack lining shall be fastened to each stack with heat and corrosion resistant alloy metal anchors which maintain their structural strength up to 760 degrees C 1400 degrees F. Anchor clips shall be spaced vertically not greater than 610 mm 24 inches on centers and closer horizontally as required by diameter of the stack. Types, size, and number per section shall be randomly located by the stack and refractory manufacturer to adequately support refractory lining to permit expansion and prevent cracking of refractory. A 50 mm 2 inch mesh galvanized wire screen of 8 gage (4.10 mm) (0.1620 inch) wire shall be attached to the clips for reinforcing the refractory. Locate screen at midpoint of the refractory thickness and cover end of clips with at least 25 mm one inch of refractory.

2.9.4 Stacks

Clean stacks of dirt, rust, oil, and grease by wire brushing and solvent degreasing and given one shop coat of heat-resisting aluminum paint conforming to FS TT-P-28 on the inside and outside. The coat of paint shall have a minimum dry film thickness of 0.025 mm one mil.

2.10 BLOWDOWN EQUIPMENT

Furnish [the boiler] [the plant] with equipment, tanks, and controls necessary for bottom [and continuous] blowdown of the boiler(s). The equipment for bottom blowdown systems shall include a [blowdown tank] [and sample cooler]. [Continuous blowdown systems shall be of the packaged, proportional type consisting of a heat exchanger, flow control valve, surge tank, [and] sample cooler, [and blowdown control console with test sink]]. Install and pipe blowdown equipment as indicated and it shall conform to the recommendations of the NBBI NB-27.

2.10.1 Bottom Blowdown Tank

The blowdown tank shall be fabricated of welded steel plate in accordance with ASME BPVC SEC VIII D1. The tank shall be a vertical cylindrical tank designed for the working pressure of the boilers. The tank shall be equipped with a tangential blowdown inlet located so as to impinge on a 10 mm 3/8 inch carbon steel wear plate extending at least 180 degrees around the interior circumference of the tank from the point of inlet. The tank shall be equipped with an internal overflow, vent, drain, safety relief valve, and gage glass with try cocks, blowdown cock, and guard. The interior of the tank shall be protected by an epoxy coating system suitable for continuous water immersion and operation at a minimum temperature of [121] [149] degrees C [250] [300] degrees F. When buried, the tank [shall be fitted [with renewable magnesium anodes] [with cathodic protection equipment] to minimize galvanic corrosion.] [shall be constructed of Class A reinforced concrete and shall be fitted with a bolted steel manhole frame and cover. Install the blowoff pipe, vent pipe, and drain pipe in pipe sleeves built into the concrete. Fill and caulk the space between the pipe and sleeves with lead wool or equivalent to make a watertight seal. The tank shall be divided into two sections by means of a baffle to form a sediment chamber.] Size and locate the blowoff tank as shown.

2.10.2 Sample Cooler

Provide a water-cooled, shell-and-tube or shell-and-coil type heat exchanger designed for cooling sample of boiler water prior to chemical testing. The sample cooler shall be furnished as a component of the packaged continuous blowdown system when such a system is being furnished. The cooler shall consist of a cast iron or steel shell with copper coil or copper alloy tubes and shall be equipped with a brass or bronze sampling cock. [The cooler shall be connected to a header and so valved that a sample can be withdrawn from any boiler as desired.] [Furnish concentrometer kit containing necessary glassware, reagents, and instructions for determining boiler water concentrations.]

2.10.3 Continuous Blowdown System

****

NOTE: Specify continuous blowdown only where makeup water ratio is in excess of 20 percent of the boiler output or where the total dissolved solids of the makeup water are in excess of 500 ppm.

****

****

NOTE: Include this requirement if a console type unit is indicated.

****

Provide a complete packaged unit of the automatic-proportioning, [manual-apportioning] type wherein the amount of blowdown from the [boiler] [plant] is automatically proportioned to the amount of make-up feedwater [and the total amount of blowdown from the plant is manually apportioned between boilers according to their steaming rate]. The system shall include either an automatic-proportioning valve and a heat exchanger, or a concentric tube automatic proportioning control which shall be provided with a separate heat exchanger when necessary to meet the performance requirements indicated or specified herein. The system shall be designed for not less than boiler design pressure and shall be capable of heating the feedwater from [_____] degrees C F to [_____] degrees C F at the flow rates indicated. The heat exchanger shall consist of a steel shell and heads with Type 304 stainless steel tubes arranged in a removable U-bend bundle. The shell shall be constructed and tested in accordance with ASME BPVC SEC VIII D1 for the specified boiler operating pressure. The automatic proportioning valve shall be provided with a sensing orifice on both the make-up and blowdown lines and shall be of the adjustable ratio type in which the ratio of make-up to blowdown may be set anywhere within a range of [30:1] [_____] to [4:1] [_____]. The automatic proportioning control shall consist of two concentric tubes, the inner tube being of a thermostatic design which acts directly against an adjustable seat in response to the temperature differential between the blowdown in the inner tube and the makeup water between the inner and outer tubes. Manual apportioning valves shall have bronze bodies with stainless steel seats and disks and shall be of the indicating type specifically designed for blowoff service. The blowdown system shall be complete with strainers, stop valves, [blowdown meters,] thermometers, and other accessories necessary to form complete packaged units. [The blowdown control console shall include illuminated sight flow indicators, automatic flushing and cooling valves, and complete panelboard instrumentation, as well as a cabinet type laboratory sink with drain board, back splash, hot and cold service water faucets, [air cock,] and electrical outlet.]

2.11 FEEDWATER EQUIPMENT

2.11.1 Boiler Feed Pumps

Boiler feed pumps shall conform to CID A-A-50562 for motor driven, horizontal split case or support head boiler feed pumps, except as otherwise specified herein. Pumps may be of either the centrifugal or peripheral-turbine type with alloy steel casing and shall be bronze or alloy steel fitted. For centrifugal type pumps, by-pass orifice shall be provided, and for turbine type pumps, pressure relief valves shall be provided. Packed stuffing boxes or mechanical seals suitable for [121 degrees C 250 degree F operation] [the design conditions indicated] shall be provided. Pumps shall be designed for the net positive suction head, discharge head, and water temperature indicated. Pump casings should be rated at suction head plus shutoff head at design temperature. [Capacity under the above condition shall be not less than indicated.] [Capacity of each pump under the above conditions shall be not less than the following percentage of maximum total boiler capacity: centrifugal pumps, 125 percent; turbine pumps, 150 percent.] Pump motors shall be [totally enclosed] [dripproof with encapsulated windings].

2.11.2 Boiler Feed Tank

Feed tank and stand construction shall conform to FS F-P-2908 for horizontal cylindrical stand mounted receivers, and shall be [hot dip galvanized or cement lined] [epoxy coated] [[_____] coated]. Tanks shall be provided with vents, gage glass, drain and overflow connections, pressure gage, thermometer, [float operated make-up water feeder] [float switch and make-up water solenoid valve] [and preheater assembly consisting of corrosion resistant steam diffuser tube, steam pressure reducing valve, strainer and thermostatic steam valve]. The boiler feed tank assembly shall include strainer and pump control box. Tank capacity and connection sizes shall be as indicated.

2.11.3 Deaerator

The deaerator shall be of the pressurized type having an ASME stamped pressure vessel and conforming to FS W-H-2904 and requirements specified herein. Deaerating assembly and deaerated water storage may be in the same or separate shells. When external vent condensers are provided, they may be located as recommended by the manufacturer. Provide an ASME certified pressure relief valve sized [as indicated][in accordance with Table II of FS W-H-2904]. Inlet piping and accessories shall be as indicated. Feedwater pumps, as specified herein, interconnecting piping, and control box shall be provided as part of the deaerator package. Deaerator capacity shall be not less than [indicated] [1.25 times that required to supply the boiler(s) at maximum firing rate]. The temperature of the water delivered at maximum capacity shall be equivalent to saturated steam temperature at the operating pressure of the deaerator, which shall be as indicated, and the oxygen content shall not exceed [0.005] [0.003] cubic centimeters per liter as determined by the Referee Method A (Colorimetric Indigo Carmine) of ASTM D888 without O2 scavenging chemical addition. Water storage capacity shall be sufficient to operate the boilers at maximum capacity for [10] [_____] minutes. A power and control panel shall be furnished with the package deaerator unit. The panel enclosure shall be NEMA ICS 6, Type 12 and shall be fabricated and painted in accordance with the manufacturer's standard practice. A separate compartment shall be furnished for each feedwater pump and each shall include a fused disconnect switch with external operating handle and a magnetic starter with three-leg overload protection. The panel shall include signal lights, an audible alarm to signal high and low levels in the deaerator, and required relays, transformers, and manual-automatic switches.

2.11.4 Surge Tank and Transfer System

The condensate storage and surge tank shall be a cylindrical welded steel tank mounted and supported as indicated. Design and construct the tank in accordance with the ASME BPVC for the indicated working pressure. Storage capacity shall be [as indicated] [sufficient to provide adequate water to the deaerator for [10] [_____] minutes of [boiler] [plant] operation at maximum capacity]. Inlet connections for condensate and make-up water shall be as indicated. Equip the tank with liquid level controllers and valves and alarms as indicated. Equip tank with pressure and temperature gages, water level gage, vent, drain, and overflow. Tank shall be [hot dip galvanized or cement lined] [epoxy coated] [[_____] coated]. The surge tank assembly shall include condensate transfer pumps, interconnecting piping including strainer, and control box as indicated. The transfer pumps, except for head and temperature requirements which shall be as indicated, shall operate continuously with a float controlled flow and shall conform to the requirements for boiler feed pumps specified herein.

2.11.5 Feedwater Treatment Equipment

2.11.5.1 Feedwater Characteristics

****

NOTE: Insert source of water supply.

****

Equipment for the chemical treatment of the boiler make-up feedwater shall be designed to reduce the boiler water concentrations to the limits specified herein when handling raw water having the following impurities reported as milligrams per liter (mg/liter) (formerly parts per million):

a. Total hardness as CaCO3 ____________________

b. Calcium hardness as CaCO3 ____________________

c. Magnesium hardness as CaCO3 ___________________

d. Alkalinity as CaCO3 _____________________

e. Sodium as Na ___________________

f. Chlorides as Cl _____________________

g. Sulfates as SO4 _____________________

h. Sulfites as SO3 _____________________

i. Phosphate as PO4 _____________________

j. Silica as SiO4 _____________________

k. Nitrates as NO3 _____________________

l. Iron as Fe _____________________

m. Free carbon dioxide as CO2 _____________________

n. Total dissolved solids _______________________

o. Suspended solids _____________________

Raw water shall be delivered to the plant [from the water distribution system of the [_____]] [from [_____]] at a normal pressure of [_____] kPa (gage) psig measured at the meter to the plant. See NAVFAC MO 225 for additional guidance.

2.11.5.2 Water Softener

Provide water softener equipment of the type, size, and arrangement indicated. When operating [under the indicated design conditions] [with an inlet water flow of [_____] liter per second gpm] effluent analysis shall be as follows:

a. Total hardness as CaCO3 less than [_____] mg/liter.

[b. pH [_____] to [_____].

c. Total dissolved solids less than [_____] mg/liter.

d. [_____].

]2.11.5.3 Zeolite Water Softener

****
NOTE: The type of equipment used shall be left to the designer and local condition.
****

Conform to WQA S-100 and shall have [automatic] [manual] controls. The softener(s) shall be equipped for [sodium cycle] [hydrogen cycle] [the type of cycle necessary to provide the treated water analysis specified above]. [Each softener tank shall be provided an operating valve to permit the regeneration of one tank while the other is in service.]

2.11.5.4 Lime Soda Softener

****

NOTE: The type of equipment used shall be left to the designer and local condition.

****

Conform to CID A-A-50573 for the type indicated.

2.11.5.5 Salt Regeneration Dealkalizer

****

NOTE: The type of equipment used shall be left to the designer and local conditions.

****

Provide a salt regeneration dealkalizer as indicated.

2.11.5.6 Pressure Filter

Provide [a] pressure filters of the type and arrangement indicated, and with [manual] [automatic] controls. The filter shall conform to CID A-A-59249. Performance shall be specified in CID A-A-59249 with raw water analysis as specified herein, and operating conditions as indicated. Filter shall be equipped to operate properly for not less than 2 days without operator attention to renew or regenerate filter coatings, chemicals, or other filter media.

2.11.5.7 Chemical Feeder

Size and connect the chemical feeder as indicated. Chemical feeder shall be suitable for the flow, pressure, and temperature conditions at the point of connections. Provide chemical feed storage as indicated. [The feeder shall be of the [automatic proportioning type] [shot type] conforming to FS F-F-2901.] [The feeder shall be of metering pump type conforming to CID A-A-50573 for chemical feeders.]

2.11.5.8 Feedwater Test Equipment

Provide for determining boiler water condition which includes an assembly of indicator solutions, standardized solutions and test glassware, with cabinet. The solution types shall permit tests for water hardness, total alkalinity, hydroxide, carbonite alkalinity, and chloride content, in parts per million. Feedwater test equipment shall employ a standardized soap solution for the hardness test, and a dilute sulfuric acid solution with a methyl orange indicator for total alkalinity. Hydroxides and carbonate alkalinity shall be determined with a phenolphthalein indicator, and the chloride content with a silver nitrate solution. Furnish standardized phenolphthalein color slides shall be furnished for accuracy in alkalinity tests.

2.12 ELECTRIC MOTORS

****

NOTE: Select standard efficiency for motors used less than 750 hours per year and high efficiency for motors used over 750 hours per year. Packaged boilers should utilize the manufacturer's standard efficiency motor.

****

Motors which are not an integral part of a packaged boiler shall be rated for [standard] [high] efficiency service per Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motors which are an integral part of the packaged boiler system shall be the highest efficiency available by the manufacturer of the packaged boiler.

PART 3 EXECUTION

3.1 INSTALLATION

Arrange work in a neat and orderly manner so that minimum storage space for equipment and material is required at the project site. Install equipment and material in accordance with the best commercial practices. Systems shall be neat in appearance, compact, workmanlike in construction and assembly, and installed for continuous service. Parts shall be readily accessible for inspection, repair, and renewal. Inspect equipment and material upon delivery and test after installation. Protect material and equipment from the weather. Contractor shall repair any damage to equipment, building or worksite that occurs during the execution of his work. Contractor shall leave worksite in a condition equal to or better than that existing before the work was started.

3.1.1 Equipment Foundations

Locate as shown and construct of sufficient size and weight, and proper design to preclude shifting of equipment under operating conditions, or under abnormal conditions which could be imposed upon equipment. Foundations shall meet requirements of equipment manufacturer. Maintain equipment vibration within acceptable limits, and shall be suitably damped and isolated. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on equipment. When foundations submitted by Contractor shop drawings are different from those shown, submit calculations by the equipment supplier.

3.1.2 Welding

****

NOTE: Use of the ASME code or the Federal Construction Guide Specification section on welding depends upon the agency's requirements.

****

****

NOTE: Insert appropriate Section number in blank below.

****

Work shall be in accordance with [the applicable sections of the ASME BPVC SEC I] [[_____] WELDING] and AWS Z49.1.

3.1.3 Painting

Equipment shall be factory finished to withstand the intended end use environment in accordance with the specifications for the particular end item. Field paint equipment not factory finished as specified herein. Retouch damaged areas of factory-finished equipment on which finish has been damaged and then give a complete finish coat to restore the finish to its original condition. The finish coat shall be suitable for exposure in the intended end use environment. Spray painting shall comply with OSHA 29 CFR 1910-SUBPART D.

3.1.3.1 Cleaning and Application

Remove dirt, rust, oil, and grease by wire brushing and solvent degreasing prior to application of paint. Apply paint to clean and dry surfaces only. Where more than one coat of paint is specified, apply the second coat after the first coat is thoroughly dry. Retouch damaged painting before applying the succeeding coat. Finished surfaces shall be smooth. The painting of zinc coated and other corrosion-resistant metal surfaces is not required unless otherwise specified herein.

3.1.3.2 Smoke Flues, Boiler Casing, and Draft Ducts

In unfinished areas, paint smoke flues, boiler casing, and black steel draft ducts with heat-resisting aluminum paint, two coats on the inside of flues and ducts and one coat on the outside, each coat to a minimum dry film thickness of 0.025 mm one mil applied directly to clean bare metal surfaces. Paint exposed surfaces of protective metal covering over insulation, including zinc-coated surfaces, with two coats of heat-resisting black paint to a minimum dry film thickness of 0.05 mm two mils applied directly to the clean bare metal surfaces. Do not paint zinc-coated ducts.

3.1.4 Boiler Cleaning

After installation, boil out [the] [each] boiler, under supervision of the manufacturer, with a soda ash or another alkaline cleaning solution to cleanse internal surfaces of oil, grease, mill scale, and dirt. Dispose of the waste products from this process according to the requirements of the applicable federal, state, and local environmental regulations. Following initial cleaning, the boilers should be flushed, drained, washed down (internally and externally) and reinspected to ensure that no traces of oil or foreign matter are present. Next, drain the boiler and associated piping and refill it with treated, softened water. At all times after initial cleaning, the Contractor shall protect the boiler, tanks, and piping against internal corrosion until testing is completed and the boiler[s] [is] [are] accepted. Provide chemicals, labor for introducing chemicals, and professional services for control and supervision of the treatment process.

3.1.5 Marking

Equipment, switches, motor controllers, and other controls or indicating elements not located on the main control panel shall be identified by stencils or printed, stamped, or manufactured signs of rigid plastic or non-ferrous material. Lettering for identification signs shall be not less than [4.80] [_____] mm [3/16] [_____] inch high. The nomenclature and identification symbols used on the signs shall correspond to those used in the maintenance manuals, operating instructions, and schematic diagrams.

The signs shall be rigidly affixed to the equipment or devices without impairing functions or, if this is not possible, shall be attached as a tag using a wire or chain. In addition to the identification signs, each major component of equipment shall have a nameplate listing the manufacturer's name, model number, and when applicable, electrical rating and other information required by pertinent standards or codes.

3.2 FIELD QUALITY CONTROL

Performance of tests and inspections as specified herein to demonstrate that boilers and auxiliary equipment, as installed, are in compliance with contract requirements. During boiler system start-up tests, factory-trained engineers or technicians employed by manufacturer of such components as the burner, flame safeguard and combustion controls, feedwater treatment equipment, and other auxiliary equipment shall be present, as required, to ensure the proper functioning, adjustment, and testing of individual components and systems, and to train plant operation personnel in the operation and maintenance of them. No bypassing, use of jumpers, or other disablement of control systems will be allowed unless specified elsewhere. Labor, equipment, fuel, and test apparatus required for testing shall be furnished by the Contractor.

3.2.1 Inspections and Test

Inspections and tests at the site shall be made under the direction of and be subject to the approval of the Contracting Officer. The Contractor shall operate [the] [each] boiler and appurtenances prior to final testing and shall ensure that necessary adjustments have been made. A [24-] [48-] [_____] hour advance written notice shall be submitted to the Contracting Officer indicating the equipment is ready for testing. Provide testing equipment, including gages, thermometers, calorimeter, CO, O2, CO2 test equipment that independently analyzes each gas, thermocouple pyrometers, fuel flow meters, water meters, and other test apparatus and set up and calibrated prior to the test. Draft, fuel pressure, and steam flow may be measured by permanent gages and meters installed under the contract. [Gas flow may be measured by utility company meters.] Provide an analysis of the fuel being used for tests. Control of noise levels developed by exhaust steam, including muffler, globe, and gate valves, shall be conducted in such a manner as not to create a nuisance or hazard, and shall be subject to the approval of the Contracting Officer. Tests shall include the following, and shall be performed when feasible, in the sequence listed:

a. Strength and tightness tests - Hydro test per NAVFAC MO 324.

b. Standards compliance tests - All environmental compliance test as required by federal, state and local laws.

c. Combustion test

d. Operational tests

e. Capacity and efficiency tests per ASME PTC 4

f. Emission test

g. Tests of auxiliary equipment

h. Feedwater equipment test

3.2.2 Strength and Tightness Tests

Subject [_____] [_____] boilers to the following strength and tightness tests:

3.2.2.1 Hydrostatic Testing

After installation and connection, subject [_____] [_____] boilers to an inspection and hydrostatic test to determine that the boiler and appurtenances have not been damaged in transit or handling. The hydrostatic test shall be in accordance with ASME BPVC SEC I, with the test pressure applied for a period required by the Contracting Officer. This test shall be in addition to the hydrostatic tests performed at the factory. [The hydrostatic test at the site shall be certified by an inspector holding an authorized commission from the National Board of Boiler and Pressure Vessel Inspectors.]

3.2.2.2 Pneumatic Testing

Pneumatically test air casing and ducts exterior to the furnace at the maximum working pressure. Use the soap bubble method to verify tightness. Test gas side of boiler normally operated under pressure for tightness at 1-1/2 times the predicted operating pressure in the furnace at the maximum continuous output. For this test, tightly seal the boiler with suitable means to blank off all openings. Admit air to the boiler until the test pressure is reached and then hold. If in a 10-minute period the pressure drop does not exceed 1245 Pa 5 inches water gage, the casing shall be regarded as tight and accepted. Use air pressure and soap bubble tests or comparative carbon dioxide readings for induced draft boilers.

3.2.2.3 Internal Component Test

Hydrostatically test the part of the preassembled fuel oil system that is furnished integrally with the boiler at one and one-half times the maximum operating pressure. Pneumatically test the part of the preassembled gas system that is furnished integrally with the boiler at operating pressure. Use the soap bubble test method to verify tightness of the gas system.

3.2.3 Combustion Tests

Test the fuel burning and combustion control equipment with [the] [each of the] specified fuels at the minimum limit of the turndown range and at increments of 50, 75, and 100 percent of full rated load [plus [_____] percent overload]. [The combustion control system shall maintain 25 to 35 percent excess air at 20 percent of full rated load, and at 50, 75, and 100 percent of load shall maintain an excess air below 15 percent.] Tests shall be conducted by factory-trained combustion equipment engineers as previously specified. Analyze and graphically present test data to show for [the] [each] boiler at tested loads: rates of steam flow; flue gas temperature; percent excess air; steam quality; and percentages of carbon dioxide, carbon monoxide, and oxygen in the flue gas. Test concentrations of sulfur oxides, particulates, volatiles, and nitrogen oxides in the flue gas to ensure compliance with federal, state, and local environmental requirements. Run tests on each fuel after stack temperatures have stabilized with surroundings. Verify and record conformance to the combustion requirements of this specification. Verify proper operation of instrumentation and gages in the control panel during the test.

3.2.4 Operational Test

Continuously test the boiler(s) continuously under varying load conditions to demonstrate proper operability of the combustion control, flame safeguard control, programming control, and safety interlocks. Conduct this test after the adjustment of the combustion controls has been completed under the combustion test. The operational test shall continue for a period of at least [8] [_____] hours and shall include the following:

3.2.4.1 Sequencing

The boiler shall start, operate, and stop in strict accordance with the specified operational sequence.

3.2.4.2 Flame Safeguard

Verify the operation of the flame safeguard controls by simulated flame and ignition failures. Test burners having intermittent pilots by simulating main flame failure while the pilot is burning. Verify the trial-for-pilot ignition, trial-for-main flame ignition, combustion control reaction, and valve closing times by stop watch.

3.2.4.3 Immunity to Hot Refractory

Operate the burner at high fire until the combustion chamber refractory reaches maximum temperature. The main fuel valve shall then be closed manually. The flame sensing safeguard device shall immediately cause the safety shutoff valves to close within the specified control reaction and valve closing times. This test ensures that the flame sensing device will not send a "false positive" signal from glowing refractory.

3.2.4.4 Pilot Intensity Required

Gradually reduce the fuel supply to the pilot flame to the point where the combustion safeguard begins to drop out (sense "no flame") but holds in until the main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame shall be capable of safely igniting the main burner. If the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, readjustment of the flame sensing device is required.

3.2.4.5 Boiler Limit and Fuel Safety Interlocks

Safety shutdown shall be caused by simulating interlock actuating conditions for high and low temperature, high and low steam pressure, high and low drum level, low feedwater, and fuel safety interlock. Safety shutdowns shall occur in the specified manner.

3.2.4.6 Combustion Controls

Demonstrate the accuracy, range, and smoothness of operation of the combustion controls by varying the steam demand through the entire firing range required by the turndown ratio specified for the burner and in case of automatic recycling burners, by further varying the firing rate to require "on-off" cycling. Control accuracy shall be as specified.

3.2.4.7 Safety Valves

The high-pressure limit switch shall be locked out or otherwise made inoperative, and the boiler safety valves shall be lifted by steam. The relieving capacity, popping pressure, blowdown, and reseating pressure shall be determined by observation and measurement to be in accordance with the ASME BPVC SEC I. The ASME standard symbol will be accepted only as indicating compliance with the design and material requirements of the code.

3.2.5 Capacity and Efficiency Tests

Perform the capacity and efficiency tests after satisfactory completion of all tests previously specified herein and after the boilers have been operating [continuously] for [one] [5] [_____] days with no nuisance shutdowns and without the necessity for frequent or difficult adjustments. The contractor is to continuously man the boiler during the test. Perform these tests on each boiler. Conduct tests using [the] [each of the] specified fuels. Test procedures shall be in accordance with the heat loss method of ASME PTC 4 and shall be reported on the ASME Test Form for Abbreviated Efficiency Test. Tests shall be performed at [25], 50, 75 and 100 percent loads. The duration of the tests shall be sufficient to record necessary data but in no case shall test duration be less than [4] [_____] hours [on each fuel].

3.2.6 Auxiliary Equipment and Accessory Tests

Observe and check blowdown valves, stop valves, try cocks, draft fans, oil heaters, pumps, electric motors, and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctions, defects, noncompliance with referenced standards, or overloading, as applicable.

3.2.7 Feedwater Equipment Tests

Perform test of the feedwater treatment equipment in two steps. One test shall be conducted by the Contractor concurrently with either the combustion test or the capacity and efficiency test. A second test will be performed by the Government during the first period of heavy loading after the plant has been accepted and put in service. Deficiencies revealed during the Government tests will be corrected under the guarantee provisions of the contract. Both the first and second series of tests shall determine compliance with the limits for oxygen content and hardness concentrations of this specification. Equipment for taking samples and the test kit for analyzing the samples shall be supplied by the Contractor and shall revert to the Government when the tests are completed.

3.2.8 Deaerating Feed-Water Heater

Test of deaerating feed-water heater shall demonstrate that the equipment installed shall meet the specified requirements as to performance, capacity, and quality of effluent. During the operating test of the boilers, conduct tests to determine oxygen content in accordance with ASTM D888, Method A. Test with no O2 scavenging chemical addition. Boilers shall be operated at varying loads, up to maximum heater capacity, while oxygen tests are being made.

3.2.9 Water Treatment Equipment

Test of water treatment equipment shall meet the requirements specified as to capacity and quality of effluent. Tests for ion exchange units shall cover at least two complete regenerations and capacity runs. Test for hot process or other precipitation type softeners shall cover a minimum continuous period of 48 hours with samples being taken at 2 hour intervals.

3.2.10 Steam Quality

Test for steam quality and water level stability shall be simultaneous under the operating conditions specified.

3.2.11 Steam Tests

Tests for boilers over 2068 kPa (gage) 300 psig not used for power generation or large turbine drives and without super-heaters, shall be made on steam sampled in accordance with ASTM D1066, and tested for moisture in accordance with the calorimetric method outlined in Section 3, ASME PTC 19.11. Conductivity method may be used in lieu of the calorimetric method, in which case the conductivity of the steam corrected for carbon dioxide and ammonia content shall not exceed 30 microhms/cm at 18 degrees C. The steam for boilers less than 2068 kPa (gage) 300 psig used for power generation or turbine drive for air conditioning equipment or with super-heaters, and for boilers over 2068 kPa (gage) 300 psig, shall be tested in accordance with the conductivity method in ASTM D2186, with the conductivity of the steam corrected for carbon dioxide and ammonia content not to exceed 4.0 microhms/cm at 18 degrees C.

3.2.12 Water Level Stability Test

Test shall first be conducted by use of the manual bypass around the feed-water regulator. Test shall be repeated using the automatic feed-water regulator. To be acceptable, the boiler should maintain specified water level stability under both conditions.

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. [_____]	[_____]	[_____]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 54 19 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 54 19 (November 2008)
UFGS-23 82 01.00 10 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 54 19

BUILDING HEATING SYSTEMS, WARM AIR

08/21

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 54 19 (August 2021)**

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****

SECTION 23 54 19

BUILDING HEATING SYSTEMS, WARM AIR
08/21

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NOTE: This guide specification covers the requirements for warm air heating systems for buildings (not including Family Housing) using direct or indirect; oil-fired or gas-fired; vented; forced air furnaces. It does not cover wall furnaces or floor furnaces. Warm air systems applications include but are not limited to barracks, offices, warehouses, maintenance, and production facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

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NOTE: Coordinate with the Installation and provide specific requirements "to match existing systems" when necessary. If specifying proprietary products, insure that appropriate "Justification and Authorization (J & A)" documentation has been obtained by project manager and "proprietary language requirements" have been added to Division 1 as well as adding the following lines above the section number and title at the top of the first

page of this section of this section:

"
This Specification Contains Brand Name Products.
"

The use of brand name items has been the subject of many Contract claims. Project designers and specifiers must be aware of the restriction on the specification of brand name items and take special precautions to avoid their use unless formal written approval is obtained.

****

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NOTE: Identical Terminology: It is highly unlikely that this section will use the same terminology as CADD programs or CADD drafters. Specifier should ensure that each piece of equipment, or item, or system is identified or marked identically in the section paragraphs as the item is identified on the drawings. If this is not done, confusion will result as to which specification paragraph applies to a particular item on the drawings, thereby affecting the quality of the design package.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2016) Laboratory Methods of Testing Fans

	for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
AHRI 430	(2009) Central-Station Air-Handling Units
AHRI 640	(2017) Performance Rating of Commercial and Industrial Humidifiers

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611	(2014) Voluntary Specification for Anodized Architectural Aluminum

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.47/CSA 2.3	(2021) Gas-Fired Central Furnaces
ANSI Z21.66/CGA 6.14	(2023) Automatic Vent Damper Devices for Use with Gas-Fired Appliances
ANSI Z83.4/CSA 3.7	(2017; R 2022) Non-Recirculating Direct Gas-Fired Heating and Forced Ventilation Appliances for Commercial and Industrial Application
ANSI Z83.8/CSA 2.6	(2016; R 2021) Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

CSA GROUP (CSA)

CSA Directory	(updated continuously online) Product Index

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code
ICC IMC	(2024) International Mechanical Code
ICC IPC	(2024) International Plumbing Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA DC 3	(2013) Residential Controls - Electrical Wall-Mounted Room Thermostats
NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2024) Standard for the Installation of Warm Air Heating and Air Conditioning Systems

NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	(2023) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UL SOLUTIONS (UL)

UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 441	(2016; Reprint Apr 2024) UL Standard for Safety Gas Vents
UL 499	(2014; Reprint May 2023) UL Standard for Safety Electric Heating Appliances
UL 641	(2010; Reprint Oct 2022) UL Standard for Safety Type L Low-Temperature Venting Systems
UL 727	(2018; Reprint May 2024) UL Standard for Safety Oil-Fired Central Furnaces
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units
UL 1738	(2023) UL Standard for SafetyVenting Systems for Gas-Burning Appliances, Categories II, III and IV
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit data packages in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor Qualifications; G, [_____]

SD-02 Shop Drawings

Equipment Layouts

SD-03 Product Data

Self-Contained Furnaces; G, [_____]

[Energy Star Label for Residential Gas Fired Furnace Product; S

][Energy Star Label for Residential Oil-Fired Furnace Product; S

] Vent Connections; G, [_____]

Controls; G, [_____]

Dampers; G, [_____]

Air Filters; G, [_____]

Humidifiers; G, [_____]

Duct Furnace; G, [_____]

[Heating and Ventilating Units; G, [_____]

][Heating Only Makeup Air Units; G, [_____]

] System Diagrams; G, [_____]

SD-06 Test Reports

Field Acceptance Test Plans and Test Reports; G, [_____]

Field Acceptance Testing; G, [_____]

Test Reports; G, [_____]

SD-08 Manufacturer's Instructions

Self-Contained Furnaces - Installation Instructions; G, [_____]

Vent Connections - Installation Instructions; G, [_____]

Controls - Installation Instructions; G, [_____]

Dampers - Installation Instructions; G, [_____]

Air Filters - Installation Instructions; G, [_____]

Humidifiers - Installation Instructions; G, [_____]

Duct Furnace - Installation Instructions; G, [_____]

[Heating and Ventilating Units - Installation Instructions; G, [_____]

][Heating Only Makeup Air Units - Installation Instructions; G, [_____]

] SD-10 Operation and Maintenance Data

Self-Contained Furnaces, Data Package 3; G, [_____]

Vent Connections, Data Package 3; G, [_____]

Controls, Data Package 3; G, [_____]

Dampers, Data Package 3; G, [_____]

Humidifiers, Data Package 3; G, [_____]

[Duct Furnace, Data Package 3; ; G, [_____]

][Heating and Ventilating Units, Data Package 3; G, [_____]

][Heating Only Makeup Air Units, Data Package 3; G, [_____]

] SD-11 Closeout Submittals

Field Training

Indoor Air Quality During Construction; S

1.3 QUALITY CONTROL

1.3.1 Installing Contractor Qualifications

Submit contractor qualifications demonstrating successful completion of similar services by the mechanical contractor on at least five projects of similar award amount and scope with equipment submittal.

1.3.2 Service Contractor Qualifications

****

NOTE: Prior to selecting a bracketed distance (or inputting a custom distance), confirm a minimum of three suppliers are within the selected radius. Consult with the installation to determine if further edits to this paragraph are required to align with sole- or limited-source Justification and Approval's (J&A's) that would further restrict the manufacturer pool.

****

The submitted equipment must be supported by manufacturer-approved service organization[s]. Provide service organization names and locations along with the Operation and Maintenance submittal. The service organization[s] must have an office within [_____][50][100] miles of the site with factory certified technicians, spare parts inventory and all necessary test and diagnostic equipment for the installed system. The service organization must be able to render service to the equipment on both a regular and emergency basis during the warranty period of the contract as determined by the Contracting Officer.

Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy. The data must include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 12 months operation, and a list of the parts recommended by the manufacturer to be replaced after [1][and][3] year(s) of service.

1.3.3 Modification to Reference

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.3.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For government owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.3.3.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.3.4 Equipment Layouts

Submit Equipment Layouts showing equipment assembly and installation details with electrical, ductwork layout, supports, utility connections, and details. Include any information required to demonstrate that the system has been coordinated and functions properly as designed.

1.3.5 System Diagrams

Proposed system diagrams, must be submitted, approved and posted prior to start of related testing. System diagrams that show the layout of equipment and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system must be framed under glass or laminated plastic. After approval, these items must be posted where directed.

1.4 DELIVERY STORAGE AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 ACCESSIBILITY

****

NOTE: The following requirement is intended to solicit the installer's and HVAC shop senior mechanical's help in the prudent location of equipment when he has some control over locations. However, designer's should not rely on it at all since enforcing this requirement in the field would be difficult. Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors. Access door must be adequately sized for removal and replacement. Installation must provide both manufacturer and code required clearances.

PART 2 PRODUCTS

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NOTE: Reference NFPA 31 for oil-fired units. Reference NFPA 54 for gas-fired units. Reference NFPA 58 for liquid petroleum gas-fired units.

****

Provide warm air heating system, including equipment, equipment, materials, installation, workmanship, fabrication, assembly, erection, inspection, examination, and testing in accordance with the applicable requirements contained in ICC IBC, ICC IMC, ICC IPC, NFPA 90A or NFPA 90B, and [NFPA 31][NFPA 54] [NFPA 58] as modified and supplemented by this specification section and accompanying drawings.

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard product of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate equipment that has been in satisfactory use at least [1][_____] year[s] prior to bid opening.

2.1.2 Material and Equipment Qualifications

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NOTE: Prior to selecting a bracketed distance (or inputting a custom distance), confirm a minimum of two suppliers are within the selected radius. Consult with the installation to determine if further edits to this paragraph are required to align with sole- or limited-source Justification and Approval's (J&A's) that would further restrict the manufacturer pool.

****

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products and materials must have a local supplier within [_____][50][100] miles of the site. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

2.1.3 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

2.1.4 Nameplates

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number. As applicable, affix an Energy Star label to the product.

2.1.5 Bearings

Motor bearings must be fitted with grease supply fittings and grease relief to outside of the enclosure.

2.2 ELECTRICAL WORK

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NOTE:
1. Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm in the equipment schedules on the drawings.

2. Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (ASD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in 3-520-01, "Interior Electrical Systems".

****

Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, must be provided. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

2.2.1 Motors

a. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

b. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

c. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

d. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.

2.3 AIR SYSTEMS EQUIPMENT

2.3.1 Ductwork and Accessories

Ductwork and accessories must be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.3.2 Fans

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly. Indirectly connected motors must use V-belt drives designed for not less than [150][140][120] percent of the connected driving capacity. Provide variable pitch motor sheaves for 11 kW 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated.

2.3.3 Air Filters

****

NOTE: Normally, replaceable type filters must be specified; however, permanent type filters may be included in the project specifications provided maintenance facilities are available for cleaning.

References to inapplicable filters types will be General recommended MERV value is 7 to 11. For Air Force, use a minimum filter of MERV 7, however, filters up to MERV 11 may be considered. Include below section if specification 23 30 00 HVAC AIR DISTRIBUTION is not included.

****

Air Filters must be listed in accordance with requirements of UL 900.

2.3.4 Replaceable Media Filters

The air flow capacity of the filter must be based on net filter face velocity not exceeding [1.5][_____] m/s [300][_____] feet per minute, with initial resistance of [3][_____] mm [0.13][_____] inches water gauge. Minimum Efficiency Reporting Value (MERV) must be not less than [_____] when tested according to ASHRAE 52.2.

2.4 GAS-FIRED COMPONENTS

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NOTE: Gas-fired and oil-fired components must be applied to Self-Contained Furnaces, Duct Furnaces and Heating and Ventilating Units.

****

2.4.1 Gas-Burning Components

Gas-burning equipment must include the gas burners, ignition equipment, gas-control valve, gas piping, gas-pressure regulating valve, when applicable, and accessories necessary for a fully automatic system that is listed in CSA Directory. Gas-fired units equipped with programming controls must be furnished both with high and with low gas supply pressure switches in the fuel supply piping.[Provide Energy Star labeled equipment for high efficiency furnaces installed in residential applications (input less than 65.9 kW 225 MBtuh). Provide proof of Energy Star label for residential gas fired furnace product.]

2.4.2 Gas Burners

The gas burners must include ignition equipment, gas-control valve, gas piping, gas-pressure regulating valve, gas shut-off cocks,[combustion air blower,] when applicable, and accessories necessary for a fully automatic system that conforms to ANSI Z21.47/CSA 2.3 and NFPA 54.

Do not provide manually ignited type burners. Burners must always return to low fire for ignition. Provide control system for [on-off][high-low-off][modulated]operation. Provide interrupted type ignition systems for burners with input capacities over 117 kW 400,000 Btu's per hour.

2.4.3 Ignition System

Ignition systems must be of the [direct spark][hot surface][or][interrupted intermittent]type with automatic electric ignition. The pilots must be of the electrically-ignited proven type. Continuous pilots will not be permitted. Burner must be designed in accordance with NFPA 54 and located so that parts are protected against overheating. Provisions must be made in the burner housing for inspection of the pilot flame.

2.4.4 Fuel-Gas Supply System

Fuel-gas supply system must be as specified in Section 23 11 20 FACILITY GAS PIPING.

2.5 OIL-BURNING COMPONENTS

2.5.1 Oil-Burning Components

The equipment must include the oil burner motor, ignition equipment safety devices, and accessories necessary for a full automatic system that conforms to UL 296. Oil-fired units equipped with programming controls must be furnished with low oil-pressure switches in the fuel supply piping. Oil-fired units not equipped with programming controls must be equipped with a delayed opening or shutoff valve. The valve must automatically delay delivery of oil to the burner until such time as the combustion air fan and, when applicable, the induced draft fan are operated at rated speed.[Provide Energy Star labeled equipment for high efficiency furnaces installed in residential applications (input less than 65.9 kW 225 MBtuh). Provide proof of Energy Star label for residential oil burning furnace product.]

2.5.2 Ignition System

Ignition systems for oil-fired units must be of the [direct-electrical spark type][or][interrupted type]in accordance with UL 296.

2.5.3 Fuel-Oil Systems

Fuel oil systems must conform to Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.6 VENT CONNECTIONS

****

NOTE: Induced draft fans must be required on units with inputs of 200,000 to 400,000 Btu's per hour intended for horizontal, inverted, or other special installations. On units with inputs above 400,000 Btu's per hour, provide with a power burner.

When using room direct intake systems, confirm requirements in UFC 3-410-01, NFPA 31, NFPA 54, and NFPA 58 have been included in the mechanical room design to ensure that positive pressure has been provided in the mechanical room to ensure proper burner performance and prevent carbon monoxide build-up.

In climates where high efficiency furnaces may be exposed to freezing temperatures, provide heat in the furnace/mechanical room to prevent freezing of the condensate.

****

Flue vent connections must be furnished as indicated. Provide a[draft regulator of the barometric-type for oil-fired draft control][draft hood for atmospheric gas-fired draft control]. Flue vent connections, including pipe and fittings, must conform to NFPA 211 and must be galvanized sheet steel having a nominal thickness not less than that required by NFPA 211. The weight of zinc-coating must not be less than 1.25 ounces per square foot commercial. If the standard flue connection on the furnace is other than the size specified for the furnace pipe, provide a suitable adapter. Provide suitable cleanouts to permit cleaning of the entire flue connection without dismantling.[Provide a resilient mount induced draft fan with an integral sail switch to sense flow, in the exhaust system.][Provide double-wall metal chimneys.]

A 9 mm 0.3125 inch diameter hole must be provided in the vent stack not greater than 150 mm 6 inches from the furnace flue outlet for sampling of the exit gases. A method must be provided to seal the hole to prevent exhaust gases from entering the indoor space when samples are not being taken. Each exhaust stack must be provided complete with bird screen and rain hood.

2.6.1 Gas-Fired Units

Vent piping must be in accordance with UL 441,[Type B][Type BW]. Vent must conform to NFPA 211 and NFPA 54. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are unacceptable for vent piping of combustion gases.

2.6.2 Oil-Fired Units

Vent piping must be in accordance with UL 641, Type L. Vent must conform to NFPA 211. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are unacceptable for vent piping of combustion gases.

2.6.3 Vents for High Efficiency Furnaces

****

NOTE: Delete this paragraph if gas-fired high efficiency, condensing type furnaces are not used. Conventional vents are not needed for condensing furnaces due to low exhaust air temperature. Precautions should be taken due to the acidic condition of the condensate. The location and size of the vents should be shown on the drawings. Consult NFPA 54, UL 1738, and available vendor data to design the vents. The vents can be mounted on the roof or exterior wall with proper separation. The vents should be extended above the typical snow level. Vents should be located in such a manner as to prevent vandalism and to prevent discharge of the condensate across the walkways.

****

Direct venting must be used for condensing type furnaces. Both the air intake and exhaust vents must be sized and located as indicated on the drawings and as recommended by the furnace manufacturer. A separate combustion air intake vent and exhaust must be provided for each furnace. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are unacceptable for vent piping of combustion gases.

2.6.3.1 Combustion Air Intake Vent

The combustion air intake piping must be constructed of Schedule 40 PVC in accordance with ASTM D1784. The vent must be suitable for the temperature at the furnace combustion air intake connection point. Each intake must be provided complete with bird screen[and rain hood].

2.6.3.2 Exhaust Vent

The exhaust vent piping must be constructed of Schedule 40 CPVC or stainless steel in accordance with UL 1738 and the furnace manufacturer's recommendations. The exhaust vent must be suitable for the maximum anticipated furnace exhaust temperature and must withstand the corrosive effects of the condensate.

2.6.4 Automatic Vent Dampers

****

NOTE: Delete this paragraph if high efficiency furnaces are specified.

****

Automatic vent dampers must be provided in the vents of all gas burning equipment that uses indoor air for combustion. Vent dampers must conform to ANSI Z21.66/CGA 6.14.

2.6.5 Condensate Neutralization Kit

Factory-supplied condensate trap[with condensate trip sensor], high capacity condensate receiver prefilled with appropriate medium.

2.7 CONTROLS

2.7.1 Thermostat

Provide wall mounted, low voltage type conforming to NEMA DC 3 with an operating range from 12 to 32 degrees C 55 to 90 degrees F. Housing must have [concealed setpoint dials][, covers with allen head screws][, aspirator type wall box with flushplate and locking screws][, built-in concealed thermometers][, exposed adjustment covers with visible thermometers].[Provide clear, lockable with key thermostat cover.] The mounting plate or base must be made of thermal insulating material or must support the thermal element not less than 6 mm 1/4 inch from the wall. The control unit of the thermostat must consist of a temperature sensing element, control switch, and anticipating heater. The control switch must be a hermetically-sealed switch. Thermostat must have provisions for calibrating the unit to the accuracy specified in NEMA DC 3. The design must preclude calibration adjustment with ordinary tools, such as screwdriver or pliers. Unless otherwise specified, a system selector switch having "heat" and "off" positions, and a fan selector switch having "auto" and "on" positions must be provided integral to or mounted on a sub-base of the thermostat. Mercury must not be allowed in switches and thermometers.

2.7.2 Carbon Monoxide Detection

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NOTE: The designer should refer to UFC 3-600-01 FIRE PROTECTION ENGINEERING FOR FACILITIES for carbon monoxide detection requirements

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Provide Carbon Monoxide Detector(s) and monitoring system for all installations.

Carbon monoxide detection systems must conform to Sections 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE, 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE, 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, and 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE.

[2.7.3 OPTIONAL CONTROLS

On units with input capacities over 117 kW 400,000 Btu/hr, [electronic][electrical] controls may be provided for regulation of temperature and operation of power operators.

]2.7.4 Cybersecurity

Control systems must conform to Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

2.8 SELF CONTAINED FURNACES

****

NOTE: Indicate on the drawings the unit's thermal output required, the nominal air temperature rise required, the calculated air flow rate, the unit's pressure requirements, the unit's air discharge (i.e. upflow downflow, or horizontal), etc. These units generally range in size from 11.7 kW up to 35.1 kW 40 MBtuh up to 120 MBtuh.

Dual fuel (oil & gas) fired equipment is only available for large units (131.9 kW 450 MBtuh and larger). Factory Mutual (FM) is the governing standard for these units.

When using fuel burning appliances, ensure safety requirements in UFC 3-600-01 and IMC (as adopted by UFC 3-410-01) have been provided to monitor and alarm any carbon monoxide build up inside any spaces.

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NOTE: Aluminized steel heat exchangers will be satisfactory in most applications. Omit the aluminized steel if the project is in a Corrosion Prone Location. Refer to UFC 1-200-01 for definition of Corrosion Prone Locations.

Carefully consider the selected casing construction based on material availability and installed location (indoor, outdoor, or outdoor corrosion prone). Refer to UFC 1-200-01 for definition of Corrosion Prone Locations.

****

Provide manufacturer's standard, self-contained, indirect, [oil][and][gas]-fired, forced-air, furnaces conforming to[UL 727][ANSI Z21.47/CSA 2.3]. Furnace and furnace components must be completely factory-assembled and must consist of a[n] [aluminized][stainless] steel heat exchanger; burner; centrifugal blower, a sheet metal cabinet-type casing with provisions for duct, vibration isolators, and all required operating, limit, and safety controls. Furnace casing must be [galvanized sheet steel with factory painting as specified in paragraph FACTORY PAINTING][or][corrosion-resisting sheet steel conforming to ASTM A167, type 316][or][aluminum with factory painting as specified in paragraph FACTORY PAINTING]. Dissimilar materials must be separated by appropriate means to avoid creation of galvanic cells. Furnace casing must be factory insulated and be compatible with the operating temperatures. Furnace must be provided with removable service panels which allow access to all internal components requiring cleaning, servicing, or adjustment. Provide a 24 volt control transformers, high temperature limit, and fan time delay relay.

Provide [upflow, high-boy][upflow, low-boy][downflow][horizontal flow][duct mounted]style designed to supply heated air through a duct system.[Provide cooling evaporator coil module with cabinet suitable for use with furnace.]

2.8.1 Gas-Fired Unit

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NOTE: High efficiency type units will be specified unless the conventional type units are calculated to be more life cycle cost effective.

For conventional type furnace with a capacity less than 65.9 kW 225 MBtuh require a minimum AFUE of 78 percent. FEMP requires gas-fired warm air furnaces with a capacity greater than 65.9 kW 225 MBtuh have a minimum thermal efficiency of 80 percent at the maximum rated capacity.

For residential applications, Energy Star requires warm air furnaces with capacity less than 65.9 kW 225 MBtuh have a minimum AFUE of 90 percent for US South applications, and a minimum AFUE of 95 percent for US North applications. Refer to Energy Star "Furnaces Key Product Criteria" for identification of US North and US South applications.

The first cost of a high efficiency, condensing type furnace is approximately 60 to 75 percent higher than the first cost of a conventional type furnace.

NOTE: Dual fuel (oil and gas) fired equipment is only available for large units(131.9 kW 450 MBtuh and larger). Factory Mutual (FM) is the governing standard for these units.

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NOTE: Use both subparagraphs if combination gas-oil burning equipment is to be specified.

When using room direct intake systems, confirm requirements in UFC 3-410-01, NFPA 54, and NFPA 58 have been included in the mechanical room design to ensure that positive pressure has been provided in

the mechanical room to ensure proper burner performance and prevent carbon monoxide build-up.

In climates where high efficiency furnaces may be exposed to freezing temperatures, provide heat in the furnace/mechanical room to prevent freezing of the condensate.

****

Gas-fired furnace must be the [conventional][high efficiency, condensing]type in accordance with ANSI Z21.47/CSA 2.3. Furnace design must be certified by the AMERICAN GAS ASSOCIATION LABORATORIES (AGA). Furnace must have a minimum certified Annual Fuel Utilization Efficiency (AFUE) of [_____] percent . Furnace must be suitable for burning [natural][propane]gas ([_____] kJ per cubic meter Btu's per cubic foot), [combination [natural][propane]gas ([_____] kJ per cubic meter Btu's per cubic foot)][and [light oil (Grade 2)]].[Provide Energy Star labeled equipment for high efficiency furnaces installed in residential applications (input less than 65.9 kW 225 MBtuh). Provide proof of Energy Star label for residential gas fired furnace product.]

2.8.2 Oil-Fired Unit

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NOTE: Furnace with a capacity less than 65.9 kW 225 MBtuh require a minimum AFUE of 78 percent. FEMP requires oil-fired warm air furnaces with a capacity greater than 65.9 kW 225 MBtuh have a minimum thermal efficiency of 81 percent at the maximum rated capacity.

For residential applications, Energy Star requires oil-fired warm air furnaces with capacity less than 65.9 kW 225 MBtuh have a minimum AFUE of 85 percent.

NOTE: Dual fuel (oil and gas) fired equipment is only available for large units (131.9 kW 450 MBtuh and larger). Factory Mutual (FM) is the governing standard for these units.

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NOTE: Use both subparagraphs if combination gas-oil burning equipment is to be specified.

When using room direct intake systems, confirm requirements in UFC 3-410-01 and NFPA 31 have been included in the mechanical room design to ensure that positive pressure has been provided in the mechanical room to ensure proper burner performance and prevent carbon monoxide build-up.

In climates where high efficiency furnaces may be exposed to freezing temperatures, provide heat in the furnace/mechanical room to prevent freezing of the condensate.

****

Oil-fired furnace must be in accordance with UL 727 and have a minimum certified Annual Fuel Utilization Efficiency (AFUE) of [_____] percent. Equipment must be suitable for burning [[No. 2][No. 4] oil][,][combination [natural][propane] gas ([_____] kJ per cubic meter Btu's per cubic foot) [and [No. 2][No. 4] oil]].[Provide Energy Star labeled equipment for high efficiency furnaces installed in residential applications (input less than 65.9 kW 225 MBtuh). Provide proof of Energy Star label for residential oil-fired furnace product.]

2.9 HUMIDIFIERS

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NOTE: Delete inapplicable paragraphs. Verify steam availability if steam humidifiers are specified. Recirculating or reservoir type will not used without automatic bleed where the supply water has a mineral content greater than 4 grams per liter 0.53 ounces per gallon. Capacity must be computed as recommended by ARI 640 assuming average building construction and single glass windows are used in calculations.

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NOTE: Steam generators for humidifiers should be located indoors to the greatest extent possible to minimize corrosion and the need to protect the steam generator from freezing conditions. Where steam generators are located outdoors, edit the specification to enhance the weather- and corrosion-resistance of the casing.

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2.9.1 Steam Spray Type

Steam spray humidifiers must be AHRI 640 rated, ARI labeled, and must inject steam directly into the [surrounding air][or][air stream] as indicated.[Single grid humidifiers must consist of a stainless steel distribution grid with pipe connection on one end and cap on the other end. Automatic steam control valves and condensate traps must be field-installed.][Enclosed grid must be housed in a copper enclosure with a build-in condensate drain connection. Exposed grid must be wick wrapped.][Package type steam spray humidifiers must be equipped to trap out and to re-evaporate condensate and to supply dry steam to a single distribution grid. Grid must be steam jacketed and condensate drained. Unit must trap excess condensate to return system. Package type steam spray humidifiers must have modulating electric, electronic, or pneumatic steam control valve, as indicated.] Unit must have internal drain water tempering to 60 degrees C 140 degrees F. Steam spray humidifiers must be rated for humidifying capacity in pounds of steam per hour and at steam pressure as indicated.

****

NOTE: Humidifiers specified in this paragraph are available with capacities up to 21 gallons per 24 hours. Where larger capacities are required, humidifiers as specified in Section 23 30 00 HVAC AIR DISTRIBUTION should be used and this rewritten to refer thereto. Recirculating or reservoir type must not be used with automatic bleed where the

supply water has a high mineral content greater than 4 grams per liter 0.53 ounces per gallon. Capacity must be computed as recommended by ARI 640 assuming average building construction and single glass windows are used in calculations.
****

2.9.2 Steam Diffuser Type

Diffuser units must be of a design that will separate any condensate from steam supply and provide positive drain of condensate to waste and supply dry steam only to air stream. Humidifiers may be installed on single or multiple units. All materials must be[noncorrosive materials][Type 300 stainless steel].

[2.9.3 Ultrasonic Type

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NOTE: Ultra sonic type humidifiers should only be use water with total dissolved solids level of less than 5 mg/L 5 ppm in order to minimize particulate matter. In general reverse osmosis or deionized water will be required
****

Humidifiers must be AHRI 640 rated and ARI labeled and be of the ultrasonic type permitted herein, and of the manufacturer's standard catalog product. The ultrasonic type must introduce moisture into the air stream in the form of 1 micron water droplets. The ultrasonic unit must be installed in the ductwork. The humidifiers must consume less than 33 watts per lb/hr 100 btu per lb/hr of water introduced to the air stream. Water with a total dissolved solids level of less than 5 mg/L 5 ppm must be supplied to the humidifier. The piezoelectric transducers must be capable of a minimum of 10,000 hours of continuous operation. Provide a manual on-off switch [remotely located][or][integral with the humidifier]. Unit must have an internal solenoid valve for drain command from the internal controller and must automatically drain if the humidifier is idle for 72 hours. Humidifier must be designed for easy maintenance and must not require removing or disconnecting sheet metal duct work for ordinary cleaning and service procedure. Humidistat must be furnished by the humidifier manufacturer and must be factory calibrated in percent relative humidity.

]2.9.4 Electrode Steam Humidifier

Provide steam electrode humidifiers to generate steam from potable water. Unit must utilize an electrode steam cylinder. The cylinder must be replaceable assembly that complies with UL 499. Unit cabinet must be sheet metal enclosure with baked enamel finish and must be hinged or feature a removable access door. The cabinet must feature integral control panel. Unit must have internal drain water tempering to 60 degrees C 140 degrees F and a drain pump system complete with integral pump discharge check valve, integral float switch, reservoir, and pump motor assembly. Provide unit with supply domestic water backflow preventer.

2.9.4.1 Unit Mounted Distribution Manifold

Provide unit mounted manifold with integral fan to discharge vapor directly into occupied space.

2.9.4.2 Remote Mount Blower Pack

Provide remote mount blower pack with integral fan to discharge vapor directly into occupied space. Steam must be constructed of 316 stainless steel. The steam line must have a constant slope (minimum upslope of 10 degrees or minimum downslope of 2 degrees), and have no restrictions in the line.

2.9.5 Gas Fired Steam Humidifier

Provide natural gas-fired humidifier to generate steam from potable water. Unit cabinet must be sheet metal enclosure with baked enamel finish and must be hinged or feature a removable access door. Insulated humidifier tank must ensure safe surface temperature. The cabinet must feature integral control panel. Unit must feature at Category IV sealed combustion condensing appliance featuring a stainless steel combustion chamber/heat exchanger. The burner must be capable of no less than 5:1 modulation with an overall efficiency of 90 percent. Humidifier is to feature variable speed blower, modulating gas valve, precision water fill and is to have internal safeties. Unit must have internal drain water tempering to 60 degrees C 140 degrees F[and a drain pump system complete with integral pump discharge check valve, integral float switch, reservoir, and pump motor assembly]. Provide unit with supply domestic water backflow preventer.

2.9.5.1 Duct Mounted Manifold

Provide remote duct mounted stainless steel humidifier manifold. Distributor must be sized to have a maximum absorption length of ten feet. Provide type 316 stainless steel tubing and fittings for steam and steam condensate in accordance with ASTM A269/A269M. Pipe must be suitable for 150 percent of humidifier steam pressure and temperature. Pipe insulation must be in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Installation of steam and steam condensate between humidifier and manifold in accordance with manufacturer's requirements. Unit installation and venting must comply with NFPA 54. Intake air and flue vent must be per paragraph VENT CONNECTIONS and must be stainless steel. Intake and flue must be installed per humidifier manufacturers recommendations.

2.9.6 Operation

Humidifier must be controlled by a manually adjustable humidistat[located in occupied spaces][with sensing bulb in[return][supply]]. Humidifier must operate when the furnace operates.

2.10 DUCT FURNACE

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NOTE: Aluminized steel heat exchangers will be satisfactory in most applications. Omit the aluminized steel if the project is in a Corrosion Prone Location. Refer to UFC 1-200-01 for definition of Corrosion Prone Locations.

****

Duct furnace must be in accordance with ANSI Z83.8/CSA 2.6. Furnace must be [power][gravity]-vented type. Furnace must have automatic ignition. Furnace must employ metered combustion air with enclosed draft diverter (no open flue collar). Furnace heat exchangers must be [aluminized steel][or

][stainless steel]. Furnace must have minimum steady state thermal efficiency of 80 percent at maximum rated capacity and 75 percent at minimum rated capacity that is provided and allowed by the controls. Furnace must be provided with a [space][discharge air] thermostat which controls the unit's burner.

2.11 [HEATING AND VENTILATING UNITS][HEATING ONLY MAKEUP AIR UNITS]

Units must be equipped for and adjusted to burn [natural][liquified petroleum][dual fuel natural/liquified petroleum] gas. Each heater must be provided with a gas pressure regulator that will satisfactorily limit the main gas burner supply pressure. Heaters must have an intermittent or interrupted electrically ignited pilot or a direct electric ignition system. Safety controls must conform to the ANSI standard specified for each heater. Mounting brackets and hardware must be furnished by the heater manufacturer and must be factory finished to match the supported equipment.

****

NOTE: Select paragraph below for Heating and Ventilation Unit or Heating Only Makeup Air Unit with heating coil. Coordinate with paragraph Coils.

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[Provide [single-zone draw-through type][or][single-zone blow-through type][or]units as indicated. Units must include fan(s), coils, airtight insulated casing,[prefilters,][secondary filter sections,][and][diffuser sections where indicated,][air blender,][adjustable V-belt drives, belt guards for externally mounted motors,][directly driven motors,] access sections where indicated,[mixing box,][combination sectional filter-mixing box,][[pan][drysteam][spray type] humidifier,] vibration-isolators, and appurtenances required for specified operation . Provide vibration isolators as indicated. Physical dimensions of each air handling unit must be suitable to fit space allotted to the unit with the capacity indicated. Provide unit that is rated in accordance with AHRI 430.

]2.11.1 [Direct Fired Heating and Ventilating Units][Heating Only Makeup Air Units]

Units must be in accordance with ANSI Z83.4/CSA 3.7. Direct fired [heating and ventilating units][heating only makeup air units] use outdoor air[and return air] directly ducted to the heater. The products of combustion generated by the heater are released into the air stream being heated. Heaters must be equipped with[motorized [inlet][, return][and][outlet]][backdraft] dampers,[discharge air diffuser,][duct collar,][air filters,][mixing box][and][bird screen]. Gas control valve must be [single-stage][two stage][modulating] type. Maximum air temperature rise during minimum burner fire must be 2 degrees C 5 degrees F. Fan must be [single-speed][two speed, with low speed approximately two-thirds of high speed][variable speed]. Motorized [inlet][and][outlet] dampers must be closed when the unit is shut down. Dampers must be interlocked to prevent burner operation when dampers are closed. Heaters must be provided with a [space][discharge air] thermostat, a low limit air stream thermostat, and an ambient air thermostat. The [space][discharge air] thermostat must control the gas control valve. The low limit air stream thermostat must shut down the entire unit if the discharge air temperature drops below the [space][discharge] thermostat setting. The ambient air thermostat must shut down the burner if the outdoor air exceeds the [discharge][space] thermostat setting.

2.11.2 Indirect Fired [Heating and Ventilating Units][Heating Only Makeup Air Units]

Units must be in accordance with ANSI and CSA Standards. Indirect fired [heating and ventilating units][heating only makeup air units] use heat exchanger to isolate products of combustion generated by the heaters from the air stream being heated. Heaters must be equipped with[motorized [inlet,] [return,][and][outlet]] [backdraft] dampers,[discharge air diffuser,][duct collar,][air filters,][mixing box,][and][bird screen]. Gas control valve must be [single-stage][two stage][modulating] type. Maximum air temperature rise during minimum burner fire must be 2 degrees C 5 degrees F. Fan must be [single-speed][two speed, with low speed approximately two-thirds of high speed][variable speed]. Motorized [inlet][and][outlet] dampers must be closed when the unit is shut down. Dampers must be interlocked to prevent burner operation when dampers are closed. Heaters must be provided with a [space][discharge air] thermostat, a low limit air stream thermostat, and an ambient air thermostat. The [space][discharge air] thermostat must control the gas control valve. The low limit air stream thermostat must shut down the entire unit if the discharge air temperature drops below the [space][discharge] thermostat setting. The ambient air thermostat must shut down the burner if the outdoor air exceeds the [discharge][space] thermostat setting.

2.11.3 Coils

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NOTE: Research local conditions to determine the effect of corrosive atmosphere on dissimilar metals. Where coils are to be installed in corrosion-prone locations, as defined in UFC 1-200-01, and locations with air-pollution or water quality causing corrosion issues, choose coated coils and fins listed in a, b, and c, and materials and thickness providing the best life-cycle-cost for the best corrosion resistance in these locations.

For existing installations within ESC C3, C4, and C5 locations, where installation space is limited and coatings cannot be used, choose the more robust material items d or e. Coatings tend to require more space as the coating limits the maximum face velocities across the coils which plausibly results in a larger unit size. In other locations, specify coil and fin combinations based on past experience with the suitability of these materials in dealing with the local conditions.

a. Copper coil and aluminum fins, coated.
b. Copper coil and copper fins, coated.
c. Aluminum coil and aluminum fins, coated.
d. Aluminum coil and aluminum fins, uncoated.
e. Copper coil and copper fins, uncoated.

Provide either phenolic, vinyl or epoxy/electrodeposition coating. For coils with relatively close fin spacing, the phenolic or epoxy/electrodeposition coating is preferred, as these have less tendency to bridge across the fins

than vinyl, better thermal conductivity than vinyl and in many conditions weathers better than vinyl.
****

Provide fin-and-tube type coils constructed of seamless [copper][red brass] tubes and [aluminum][or][copper] fins mechanically bonded or soldered to the tubes.[Provide copper tube wall thickness that is a minimum of [0.406][0.508][0.6096] mm [0.016][0.020][0.024] inches.][Provide red brass tube wall thickness that is a minimum of [0.89][1.24] mm [0.035][0.049] inches.][Provide aluminum fins that are [0.14][0.19] mm [0.0055][0.0075] inch minimum thickness.][Provide copper fins that are 0.114 mm 0.0045 inch minimum thickness.] Provide casing and tube support sheets that are not lighter than 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Mount coils for counterflow service. Rate and certify coils to meet the requirements of AHRI 410.[Provide factory applied phenolic, vinyl, or epoxy/electrodeposition coating uniformly applied to all coil surfaces without material bridging between fins. Provide complete coil encapsulation and a uniform dry film thickness of 0.8 - 1.2 mils on all surface areas including fin edges. Coating must have a corrosion durability through testing of no less than 5000 hours salt spray per ASTM B117.]

2.11.3.1 Water Coils

Install water coils with a pitch of not less than 10 mm/m 1/8 inch/foot of the tube length toward the drain end. Use headers constructed of cast iron, welded steel or copper. Furnish each coil with a plugged vent and drain connection extending through the unit casing. Provide removable water coils with drain pans. Pressure test coils in accordance with UL 1995.

2.11.3.2 Steam Heating Coils

Construct steam coils from cast semisteel, welded steel or copper headers, and [red brass][copper] tubes. Construct headers from cast iron, welded steel or copper. Provide fin tube and header section that float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide each coil with a field or factory installed vacuum breaker. Provide single-tube type coils with tubes not less than 13 mm 1/2 inch outside diameter, except for steam preheat coils. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure test coils in accordance with UL 1995.

2.11.3.3 Electric Heating Coil

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NOTE: Use this paragraph for Navy projects only.
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Provide an electric duct heater coil in accordance with UL 1995 and NFPA 70. Provide duct- or unit-mounted coil. Provide [nickel chromium resistor, single stage, strip][nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type coil. Provide coil with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Provide galvanized steel or aluminum coil casing and support brackets. Mount coil to eliminate noise from expansion and contraction and for complete accessibility for service.

2.11.4 Unit Casing

****

NOTE: Carefully consider the selected casing construction based on material availability and installed location (indoor, outdoor, or outdoor corrosion prone). Refer to UFC 1-200-01 for definition of Corrosion Prone Locations.

****

Casing must be insulated [single][double] wall panels constructed of minimum 18-gage [galvanized sheet steel with factory painting as specified in paragraph FACTORY PAINTING][or][corrosion-resisting sheet steel conforming to ASTM A167, type 316][or][aluminum with factory painting as specified in paragraph FACTORY PAINTING]. Reinforce casing with [angles][a formed structural metal frame] and provided with easily removable panels located for access to all parts of the equipment. Ensure that the casing and insulation are designed to limit noise and vibration within acceptable levels. Outdoor heaters must be weatherized. Dissimilar materials must be separated by appropriate means to avoid creation of galvanic cells.

2.11.5 Fans

Fan must be [centrifugal][airfoil][backward curve][mixed flow][plenum] type. Statically and dynamically balance fan and motor. Fan ratings are to be determined in accordance with AMCA 210. Motor must be heavy-duty, permanently lubricated type with [belt-drive][direct-drive]. Provide fan assembly with internal vibration isolation.

2.12 FACTORY PAINTING

Equipment painting must be factory or shop applied, and must be as specified herein, and provided under each individual section.

2.12.1 Factory Painting of Indoor Equipment

Indoor Equipment must be coated with a manufacturer's factory-applied finish that meets the following requirements:

a. The finish system designed for the equipment must have been tested in accordance with Federal Test Method Standard No. 141 (Method 6061) and passed the 125-hour salt-spray fog test of that standard. The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the successful test specimens.

b. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to working temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for service at the finished surface's working temperature and must meet the test requirements specified above for Federal Test Method Standard No. 141 when the finished surface temperature is at the service working temperature.

****

NOTE: Select the first set of brackets for outdoor

equipment in locations that do not meet the definition of Corrosion Prone Locations as defined in UFC 1-200-01. Select the second set of brackets for outdoor equipment in Corrosion Prone Locations as defined in UFC 1-200-01. When using the Corrosion Prone Location paragraph also edit Section 09 90 00 PAINTS AND COATINGS, Part 3, "MPI Division 5: Exterior Metal, Ferrous And Non-Ferrous Paint Table" to include Division 23 and include the appropriate metallic surfaces included in this specification (galvanized steel or aluminum).

****

[2.12.2 Factory Painting of Outdoor Equipment

Outdoor equipment must be coated with a manufacturer's factory-applied finish that meets the following requirements:

a. The finish system designed for the equipment must have been tested in accordance with Federal Test Method Standard No. 141 (Method 6061) and passed the 500-hour salt-spray fog test of that standard. The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the successful test specimens.

b. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to working temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for service at the finished surface's working temperature and must meet the test requirements specified above for Federal Test Method Standard No. 141 when the finished surface temperature is at the service working temperature.

][2.12.3 Factory Painting of Exterior Equipment in Corrosion Prone Locations

a. Galvanized Steel: Provide three-part coating system Epoxy Primer / Waterborne Light Industrial Coating as specified in Section 09 90 00 PAINTS AND COATINGS.

b. Type 316 or Duplex Stainless Steel: No requirement for factory painting.

c. Aluminum: Provide either coating or anodized finish that meets the following requirements:

    (1) Coating Provide three-part coating system Waterborne Light Industrial Coating as specified in Section 09 90 00 PAINTS AND COATINGS.

    (2) Anodized finish: Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish must be Architectural Class I (0.0175 mm 0.7 mil or thicker), designation AA-M10-C22-[A41, clear (natural)][A42, integral color][A44, electrolytically deposited color] anodized.

]2.12.4 Shop Applied Painting of Equipment

Shop applied painting must meet same requirements as factory painting. Field retouch only if approved by the Contracting Officer. Otherwise, return equipment to the factory for refinishing.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

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NOTE: Reference NFPA 31 for oil-fired units. Reference NFPA 54 for gas-fired units. Reference NFPA 58 for liquid petroleum gas-fired units.

****

The warm air heating system installation must be in accordance with the manufacturer's written instructions and be in compliance with the requirements contained in ICC IBC, ICC IMC, ICC IPC, NFPA 90A or NFPA 90B, and[NFPA 31][NFPA 54][NFPA 58].

Combustion air supply and ventilation must be in accordance with[NFPA 31][NFPA 54][NFPA 58]. Systems and equipment include:

a. Self-contained furnaces - Installation Instructions

[b. Vent connections - Installation Instructions

][c. Controls - Installation Instructions

][d. Dampers - Installation Instructions

][e. Air filters - Installation Instructions

][f. Humidifiers - Installation Instructions

][g. Duct Furnace - Installation Instructions

][h. Heating and Ventilating Units - Installation Instructions

][i. Heating Only Makeup Air Units - Installation Instructions

][3.2.1 Seismic

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NOTE: Select first bracket for Navy projects. Select second bracket for all others and coordinate any other required references with Section 23 05 48.19 [SEISMIC] BRACING FOR HVAC.

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Provide seismic bracing as specified in Section 23 05 48.19 SEISMIC BRACING FOR HVAC.

][3.2.2 Anti-Terrorism

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NOTE: Review UFC 4-010-01 DoD Minimum Antiterrorism

Standards For Buildings and revise requirements and use to edit section below.
****

Provide outdoor air intakes, relief air, and exhaust openings with low leakage dampers that are automatically closed when the emergency air distribution shutoff switch is activated. Exterior wall penetrations for outdoor air intakes must be a minimum of 3 meters 10 feet above grade. Emergency air distribution shutoff switches must clearly labeled and located in an accessible location. Switch must be mushroom type pushbutton with plastic clear cover.[If shutting down an exhaust system will violate building or fire codes or create an unsafe condition, then the exhaust system may continue to operate.]

Mount all overhead utilities and other fixtures weighing 14 kilograms 31 pounds or more (excluding distributed systems such as piping networks that collectively exceed that weight) using either rigid or flexible systems to minimize the likelihood that they will fall and injure building occupants. Design all equipment mountings to resist forces of 0.5 times the equipment weight in any horizontal direction and 1.5 times the equipment weight in the downward direction. Requirement must does not preclude the need to design equipment mountings for forces required by other criteria such as seismic standards.

]3.2.3 Furnaces

Foundations, settings, or suspensions for mounting equipment and accessories including supports, vibration isolators, stands, guides, anchors, clamps, and brackets must be provided. Foundations and suspension for equipment must conform to the recommendations of the manufacturer, unless otherwise indicated on drawings. Anchor bolts and sleeves must be set accurately using properly constructed templates. Anchor bolts, when embedded in concrete, must be provided with welded-on plates on the head end and guarded against damage until equipment is installed. Equipment bases must be leveled, using jacks or steel wedges, and when resting on concrete must be neatly grouted-in with a non-shrinking type of grout. Equipment must be located as indicated and in such a manner that working space is available for all necessary servicing, such as shaft removal, replacing, or adjusting drives, motors, or shaft seals, air filters, access to automatic controls, humidifiers, and lubrication. Electrical isolation must be provided between dissimilar metals for the purpose of minimizing galvanic corrosion. The interior of cabinets or casings must be cleaned before completion of installation. The furnace must be connected to the vent or chimney with the specified connectors, draft regulators, draft loads, and induced draft fans, as applicable, in accordance with NFPA 211.

3.2.4 Automatic Vent Dampers

Automatic vent dampers must be installed in accordance with ANSI Z21.66/CGA 6.14.

3.2.5 Humidifiers

Humidifiers must be installed in accordance with manufacturer's instructions and in an arrangement that will permit access and ease of maintenance. Provide water piping, drain, manual shut-off valve, and solenoid valves when required for type of humidifier furnished and install in accordance with the ICC IPC and Section 22 00 00 PLUMBING, GENERAL PURPOSE. Drain lines must be provided for humidifiers and must be piped to drains shown. Humidifiers installed in a bypass arrangement must be provided with an integral damper that can be conveniently operated to regulate or shut off flow through the humidifier. To permit humidifier operation, a manual ON-OFF switch must be provided near the humidifier. The ON-OFF switch may be integral with the humidifier. Provide an access door in the ductwork located two feet downstream of the humidifier for verifying operation and inspecting the ductwork. When humidifier is installed in glass fiber ductwork, ductwork must be adequately reinforced to support the humidifier.[For reservoir or re-circulating type humidifier, the automatic bleed must be connected to the humidifier drain.]

3.2.6 Access Panels

Access panels must be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels must be of sufficient size and so located that the concealed items may be serviced and maintained or completely removed for replacement. Access panels must be as specified in[Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

3.2.7 Flexible Connectors

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NOTE: Flexible connectors will be provided where required to absorb expansion and contraction, isolate vibration, absorb noise, compensate offset motion, absorb continuous flexing, and relieve equipment from piping stresses. Where flexible connectors are needed to correct lateral, parallel, and angular misalignment, their use will be limited to maximum offset as recommended, in writing, by the manufacturer.

****

Pre-insulated flexible connectors and flexible duct must be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, must be of the type recommended by the connector or duct manufacturer and must be provided at the intervals recommended.

3.2.8 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation must be packed as specified in Section 07 84 00 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space must be packed as specified in Section 07 92 00 JOINT SEALANTS.

3.2.9 Ductwork

Ductwork and accessories must be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.2.10 Air Filters

Air filters must be installed[in heater casings][in return air ducts at furnaces][in return air grilles]. Fans or blowers must not be operated until filters are installed. After completion of tests and before the building is accepted by the Government, the Contractor must[provide a new second set of replaceable filters, where utilized][clean the permanent type filters]. Perform and document that proper Indoor Air Quality During Construction procedures have been followed; this includes providing documentation showing that after construction ends, and prior to occupancy, [new filters were provided and installed][the permanent filters were cleaned].

3.2.11 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection must be provided. The distribution system (supply and return) must be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection must remain in place until system is ready for startup.

3.2.12 Insulation

Thickness and application of insulation materials for ductwork and equipment must be in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.13 Duct Test Holes

****

NOTE: The location of duct test holes will be shown on the drawings. Locate holes so as to implement the requirements of Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

****

Holes with closures or threaded holes with plugs must be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, must be provided where the ducts are insulated.

3.2.14 Condensate Collection and Disposal

****

NOTE: Coordinate collection system arrangement and condensate disposal method with installation mechanical and installation environmental.

****

For high efficient, condensing type units provide condensate collection system consisting of p-traps, acid neutralizers,[condensate pump,] and corrosion resistant piping. Provide drains for heating unit and exhaust vents. All condensate must be captured and appropriately treated prior to entering sanitary system or discharging to outdoors. Install system in accordance manufacturer's installation instructions, ICC IMC and ICC IPC requirements. Provide piping as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Provide [dedicated collection system per heating unit][combined collection system serving multiple heating units].

3.2.15 Fuel-Oil System

Fuel oil systems must be installed in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.2.16 Fuel-Gas Supply System

Fuel-gas supply system must be installed in accordance with Section 23 11 20 FACILITY GAS PIPING.

3.3 FIELD PAINTING

Finish painting of items only primed at the factory or surfaces not specifically noted otherwise, are specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 CLEANING

Ducts, plenums, and casings must be thoroughly cleaned of all debris and blown free of all small particles of rubbish and dust and then must be vacuum cleaned before installing outlet faces. Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided prior to startup of all fans that are operated during construction, and new filters must be installed after all construction dirt has been removed from the building, the ducts, plenums, casings, and other items specified have been vacuum cleaned, and after completion of all tests. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. All equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.5 FIELD QUALITY CONTROL

Inspect equipment when it is delivered to the job site. The right is reserved to inspect any equipment at the plant of the manufacturer, during or after manufacture. Inspect and repair all refractory after installation and prior to startup. Continually inspect equipment during installation, after installation, and during the tests. Upon completion and prior to acceptance, perform tests and furnish all necessary equipment and materials required for the tests as specified herein to demonstrate that warm air heating system is in compliance with contract requirements. Make all tests under the direction of the[Contracting Officer][Contractor Quality Control representative]. Read all indicating instruments no less frequently than at half-hour intervals.

3.6 TESTS

Upon completion and prior to acceptance of the installation, furnish all equipment, instruments, materials, labor, and supervision required for the tests as specified. Submit proposed test procedures for ductwork leak and performance tests, at least 2 weeks prior to the start of related testing.

a. Obtain necessary natural gas, water and electricity as specified in [the SPECIAL CONTRACT REQUIREMENTS][Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS]. Provide necessary quantities of propane gas or No. [_____] fuel oil when propane gas or fuel oil is require for testing.

b. Defects disclosed by the tests must be rectified. Tests must be made under the direction and subject to the approval of the Contracting Officer. All indicating instruments must be read at 1/2-hour intervals unless otherwise directed by the Contracting Officer. Submit proposed

System Diagrams, at least 2 weeks prior to start of related testing.

c. System diagrams that show the layout of equipment and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system must be framed under glass or laminated plastic. After approval, these items must be posted where directed.

d. Submit test reports for the ductwork leak test and the performance tests in booklet form, upon completion of testing. Reports must document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

3.7 TESTING, ADJUSTING, AND BALANCING

[Testing, adjusting, and balancing requirements are specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Testing, adjusting, and balancing must begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

][Perform in accordance with SMACNA 1780, Chapter VII, "Air System TAB Procedures," to achieve and confirm compliance with drawings and specifications; prepare complete report of final test results.

]3.7.1 Firing Tests

a. Test combustion controls and equipment with[each] specified fuel at 100 percent rated load. Demonstrate satisfactory smoke-count numbers and combustion efficiency. Maintain firing for at least 4 hours[, and where high-low-off combustion controls are provided, operate the furnace for one hour at low fire and 3 hours at high fire]. During tests, verify proper operation of controls. Adjust burners for maximum efficiency using Orsat or similar apparatus.

b. Record temperature rises across heat exchangers.

c. Minimum requirements for satisfactory combustion efficiency must be [10.0 percent carbon dioxide for oil burners][and][8.5 percent carbon dioxide for gas burners].[Minimum temperatures of flue gas at the stack must be 38 degrees C 100 degrees F above the flue-gas dew points.] The observed smoke at all firing rates during the prescribed tests must not exceed that indicated by a number 2 spot for the burners firing a distillate fuel or gas and a number 4 spot for burners firing a residual type fuel on the Shell-Bacharach scale.

[3.7.2 Operating Test

Perform the following operating tests to demonstrate satisfactory [furnace][and][humidifier] operation. Check burner safety controls by simulating flame failure in accordance with the manufacturer's instructions. Operate furnace for a period sufficient to make the following observations and record the following data but in no case less than one hour. These tests may be run concurrent with fire tests specified below to the extent practical. Demonstrate satisfactory operation of all heat-regulating controls and safety controls.[Observe the humidifier for satisfactory operation and check humidifier drain to insure proper drainage.][Record humidity of air entering and leaving the humidifier during steady state furnace operation.] Record temperature rise across the heat exchanger under all firing rates after equilibrium conditions have been reached at each firing rate. Record ammeter and voltmeter readings for the [furnace motor][,][circulating blower motor][,][induced draft fan motor][,][and][humidifier motor].

]3.7.3 Performance Tests

After testing, adjusting, and balancing has been completed as specified, each system must be tested as a whole to see all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments must be conducted by an experienced engineer. Tests must cover a period of not less than [_____] days for each system and must demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings must be made at points indicated on the drawings for the duration of the time period and must record the temperature at space thermostats or space sensors,[the humidity at the humidistat(s) location(s),] and the outdoor air temperature[and humidity] in an immediately adjacent shaded and weather protected outdoor area.

3.8 FIELD ACCEPTANCE PROCEDURES

****

NOTE: Use the following equipment test paragraphs for systems with inputs greater than 400,000 Btu's per hour or other special installations.

****

3.8.1 Field Acceptance Test Plans and Test Reports

a. Manufacturer's Test Plans: Within [120] [_____] calendar days after contract award, submit the Field Acceptance Test Plan. Field acceptance test plans must developed by the furnace manufacturer detailing recommended field test procedures for that particular type and size of equipment. Field acceptance test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment, will not be acceptable.

b. The Contracting Officer will review and approve the field acceptance test plan for each of the furnaces prior to commencement of field testing of the furnaces. The approved field acceptance test plans must be the plan and procedures followed for the field acceptance tests of the furnaces and resultant test reporting.

c. Coordinated testing: Indicate in each field acceptance test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of furnace controls which interlock and interface with controls factory prewired or external controls for the equipment provided under Section [23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS].

d. Prerequisite testing: Equipment for which performance testing is dependent upon the completion of the work covered by Section [23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC][SMACNA 1780] must have that work completed as a prerequisite to testing work under this section. Indicate in each field acceptance test plan when such prerequisite work is required.

e. Test procedure: Indicate in each field acceptance test plan each equipment manufacturers published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer. Each test plan must include the required test reporting forms to be completed by the Contractor's testing representatives. Procedures must be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

f. Controllers must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

g. Performance variables: Each test plan must list performance variables that are required to be measured or tested as part of the field test.

h. Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Manufacturer must furnish with each test procedure a description of acceptable results that have been verified.

i. Job specific: Each test plan must be job specific and must address the particular item of equipment and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.

j. Specialized components: Each test plan must include procedures for field testing and field adjusting specialized components, such temperature control valves, or pressure control valves.

3.8.2 Field Acceptance Testing

a. Equipment Requiring Test Reports: Each self-contained furnace must be field acceptance tested in compliance with its approved field acceptance test plan and the resulting field acceptance test report submitted for approval.

b. Manufacturer's recommended testing: Conduct the manufacturer's recommend field testing in compliance with the approved test plan.[Furnish a factory trained field representative authorized by and to represent the equipment manufacturer throughout the complete execution of the field acceptance testing.]

c. Operational test: Conduct a continuous 24 hour operational test for each item of equipment. Equipment shutdown before the test period is completed must result in the test period being started again and run for the required duration. For the duration of each test period, compile an operational log of each item of equipment. Log required entries every two hours. Use the test report forms for logging the operational variables. Submit test logs for each test period.

d. Notice of tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.

e. Report forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment must be reviewed, approved, and signed by the Contractor's test director and the QC manager. The manufacturer's field test representative must review, approve, and sign the report of the manufacturer's recommended test. Signatures must be accompanied by the person's name typed.

f. Deficiency resolution: The test requirements acceptably met; deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations and corrections retested in order to verify compliance.

3.9 FIELD TRAINING

****

NOTE: The number of hours of instruction should be determined based on the number and complexity of the systems specified.

****

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of [_____] hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals, manufacturer’s troubleshooting and repair manuals, as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals, manufacturer's troubleshooting and repair manuals, and at least 14 days prior to conducting the training course.

3.10 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work. Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 57 10.00 10 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-23 57 10.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-23 57 10.00 10 (November 2019)**

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SECTION 23 57 10.00 10

FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS
11/19

****
NOTE: This guide specification covers the requirements for forced hot water heating system using a steam or high temperature water heat exchanger.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250,

	and 300
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2022) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure

	Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B251/B251M	(2017) Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
ASTM B265	(2020a) Standard Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate
ASTM B333	(2003; R 2018) Standard Specification for Nickel-Molybdenum Alloy Plate, Sheet, and Strip
ASTM B395/B395M	(2018) Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM B424	(2022) Standard Specification for Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and UNS N08221, and UNS N06845) Plate, Sheet, and Strip
ASTM B650	(1995; R 2023) Standard Specification for Electrodeposited Engineering Chromium Coatings on Ferrous Substrates
ASTM B687	(1999; R 2023) Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples

ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B828	(2023) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM D596	(2001; R 2018) Standard Guide for Reporting Results of Analysis of Water
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1384	(2005; R 2019) Corrosion Test for Engine Coolants in Glassware
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

HYDRONICS INSTITUTE DIVISION OF AHRI (HYI)

HYI-005	(2008) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators

PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION (PHCC)

NAPHCC NSPC	(2015) National Standard Plumbing Code Illustrated

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Heating System

SD-03 Product Data

Spare Parts

Welding

Framed Instructions

SD-06 Test Reports

Testing and Cleaning

Water Treatment Testing

SD-07 Certificates

Bolts

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

1.3 QUALITY ASSURANCE

Procedures and welders must be qualified in accordance with the code under which the welding is specified to be accomplished.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

****

NOTE: This guide specification covers low temperature forced hot water heating systems using water temperatures of 99 degrees C 210 degrees F and less, at a working pressure of 207 kPa 30 psig using a steam or high temperature water heat exchanger. A steam supply pressure of approximately 689 kPa 100 psig) and a high water temperature of 177 to 232 degrees C 350 to 450 degrees F were used in preparation of this specification. The high temperature water portion of this specification may

be used for medium water temperature system of 121 to 177 degrees C 250 to 350 degrees F if the tests and class of valves, fittings, and piping are adjusted for the temperature and pressure required, but not less than 68 kg 150 pound class system. The designer should consider all pressure reductions such as pump suction and system cool-down effects and should not consider any pressure increases such as pump discharge heads and system heat-up effects when determining the high or medium temperature water system pressurization required to prevent flash steaming and water hammer.

In order to comply with Executive Order 13423 and Public Law 109-58 (Energy Policy Act of 2005), designs must achieve energy consumption levels that are at least 30 percent below the level required by the 2013 publication of ASHRAE 90.1. In accordance with P.L. 109-58 (Energy Policy Act of 2005), Executive Order 13423, and Federal Acquisition Regulation (FAR) 23.203 Energy-efficient Products must meet or exceed the performance criteria for ENERGY STAR®-qualified or FEMP-designated products as long as these requirements are nonproprietary. The FEMP and ENERGY STAR product requirements are available on the web at www.eere.energy.gov/femp/procurement **and** www.energystar.gov/products**. Where ENERGY STAR or FEMP products are not applicable, energy consuming products and systems must meet or exceed the requirements of ASHRAE 90.1.**

****

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Place a plate on each major item of equipment having the manufacturer's name, address, type or style, model or serial number, and catalog number secured to the item of equipment.

2.1.3 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard must be properly guarded or covered with insulation of a type specified. [Catwalks, operating platforms, ladders, and guardrails must be provided where shown and must be constructed in accordance with Section [08 31 00

ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].]

2.1.4 Asbestos Prohibition

Asbestos and asbestos-containing products will not be accepted.

2.1.5 Electrical Work

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls. Electric equipment (including motor efficiencies), and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide integral size motors of the premium efficiency type in accordance with NEMA MG 1. Electrical characteristics must be as specified or indicated. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor must be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring, conduit, and connection to power required for controls and devices but not shown must be provided.

2.2 PIPING, TUBING, AND FITTINGS

****

NOTE: Copper tubing and steel pipe will be considered as competitive unless one is not applicable for service.

****

2.2.1 General

Piping, tubing, and fittings must be as follows:

a. Low temperature water piping must be black steel or copper tubing with cast iron, malleable iron or steel, solder-joint, flared-tube or grooved mechanical joint fittings.

b. Steam pipe must be black steel with malleable iron or steel fittings.

c. Condensate return piping must be black steel Schedule 80 with cast iron or malleable iron, Class 250 minimum.

d. High temperature water piping must be black steel, Schedule 40.

e. Vent piping must be black steel, Schedule 40, with black malleable iron fittings.

2.2.2 Steel Pipe

Pipe must conform to ASTM A53/A53M or ASTM A106/A106M, Grade A or B, black steel, Schedule 40, unless otherwise specified. Steel pipe to be bent must be ASTM A53/A53M, Grade A, standard, or Grade B, extra strong weight. Steam pipe must be ASTM A53/A53M Grade A.

2.2.3 High Temperature Water Piping

Piping must be Type S for 40 mm 1-1/2 inches and smaller, Type S or Type E for pipe 50 mm 2 inches and larger, schedule 40 steel conforming to ASTM A53/A53M, Grade B; or to ASTM A106/A106M, Grade B.

2.2.4 Gauge Piping

Piping must be copper tubing for [steam] [and] [low temperature water]. [Use black steel, ASTM A106/A106M, seamless, Grade A pipe for high temperature.]

2.2.5 Copper Tubing

Tubing must conform to ASTM B88, ASTM B88M, Type K or L. Tubing for compressed air tubing must conform to ASTM B251/B251M.

2.2.6 High Temperature Water Fittings

Fittings must be steel welding fittings conforming in physical and chemical properties to ASTM A234/A234M. Buttwelding fittings must conform to ASME B16.9. Socket welded fittings must conform to ASME B16.1. Screwed fittings, when required, must be black forged steel, 2000-pound class, conforming to ASME B16.11. Flanges must be serrated or raised-faced type.

2.2.7 Malleable Iron Pipe Fittings

Fittings must conform to ASME B16.3, type required to match adjacent piping.

2.2.8 Cast Iron Pipe Fittings

Fittings must conform to ASME B16.1 or ASME B16.4 type required to match adjacent piping.

2.2.9 Steel Pipe Fittings

Fittings must have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.2.9.1 Welded Fittings

Welded fittings must conform to ASTM A234/A234M with WPA marking. Butt welded fittings must conform to ASME B16.9, and socket welded fittings must conform to ASME B16.11.

2.2.9.2 Grooved Mechanical Fittings

Standard fittings must be of malleable iron conforming to ASTM A47/A47M, Grade 32510, or ductile iron conforming to ASTM A536, Grade 65-45-12. Fittings may also be constructed of steel, conforming to ASTM A106/A106M, Grade B or ASTM A53/A53M.

2.2.9.3 Grooved Mechanical Pipe Joints

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NOTE: Gasket material must be specified: EPDM for temperatures to 110 degrees C 230 degrees F; Buna-N for temperatures to 82 degrees C 180 degrees F. Review manufacturer's data for other requirements and limits. Do not use for steam.

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Pipe joints must conform to AWWA C606. Grooved mechanical joint fittings must be full flow factory manufactured forged steel fittings. Fittings, couplings, gaskets, and pipe grooving tool or grooved end pipe must be products of the same manufacturer. Mechanical pipe couplings must be of the bolted type and must consist of a housing fabricated in two or more parts, a synthetic rubber gasket, and nuts and bolts to secure unit together. Housings must be of malleable iron conforming to ASTM A47/A47M, Grade 32510 or ductile iron conforming to ASTM A536, Grade 65-45-12. Coupling nuts and bolts must be of steel and conform to ASTM A183. Submit written certification that the bolts furnished comply with the requirements of this specification, provided by the bolt manufacturer. The certification must include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification. Gaskets must be of molded synthetic rubber, Type [EPDM] [Buna-N] with central cavity, pressure responsive configuration and must conform to ASTM D2000.

2.2.10 Joints and Fittings for Copper Tubing

Wrought copper and bronze fittings must conform to ASME B16.22 and ASTM B75/B75M. Cast copper alloy fittings must conform to ASME B16.18 and ASTM B828. Flared fittings must conform to ASME B16.26 and ASTM B62. Adaptors may be used for connecting tubing to flanges and threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Cast bronze threaded fittings must conform to ASME B16.15. Grooved mechanical joints and fittings must be designed for not less than 862 kPa 125 psig service and must be the product of the same manufacturer. Grooved fitting and mechanical coupling housing must be ductile iron conforming to ASTM A536. Gaskets for use in grooved joints must be molded synthetic polymer of pressure responsive design and must conform to ASTM D2000 for circulating medium up to 110 degrees C 230 degrees F. Grooved joints must conform to AWWA C606. Coupling nuts and and bolts for use in grooved joints must be steel and must conform to ASTM A183.

2.2.11 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns., etc. must be in accordance with ASME B16.5 class 150 and must have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material must conform to ASTM A105/A105M. Flanges for high temperature water systems must be serrated or raised-face type. Blind flange material must conform to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Bolts must be high strength or intermediate strength with material conforming to ASTM A193/A193M.

2.2.12 Pipe Threads

Pipe threads must conform to ASME B1.20.2MASME B1.20.1.

2.2.13 Nipples

Nipples must conform to ASTM A733 or ASTM B687, standard weight.

2.2.14 Unions

Unions must conform to ASME B16.39, type to match adjacent piping.

2.2.15 Adapters

Adapters for copper tubing must be brass or bronze for soldered fittings.

2.2.16 Dielectric Waterways

Dielectric waterways must conform to the tensile strength and dimensional requirements specified in ASME B16.39. Waterways must have metal connections on both ends to match adjacent piping. Metal parts of dielectric waterways must be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Dielectric waterways must have temperature and pressure rating equal to or greater than that specified for the connecting piping. Dielectric waterways must be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges must meet the performance requirements described herein for dielectric waterways.

2.2.17 Grooved Mechanical Joints

Rigid grooved pipe joints may be provided in lieu of unions, welded, flanges or screwed piping connections at chilled water pumps and allied equipment, and on aboveground pipelines in serviceable locations, if the temperature of the circulating medium does not exceed 110 degrees C 230 degrees F. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints must incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to insure positive rigid clamping of the pipe. Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications, will not be permitted. Rigid grooved pipe couplings must be used with grooved end pipes, fittings, valves and strainers. Rigid couplings must be designed for not less than 862 kPa 125 psi service and appropriate for static head plus the pumping head, and must provide a water-tight joint. Grooved fittings and couplings, and grooving tools must be provided from the same manufacturer. Segmentally welded elbows must not be used. Grooves must be prepared in accordance with the coupling manufacturer's latest published standards. Grooving must be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations. The Contracting Officer must be notified 24 hours in advance of test to demonstrate operator's capability, and the test must be performed at the work site, if practical, or at a site agreed upon. The operator must demonstrate the ability to properly adjust the grooving tool, groove the pipe, and verify the groove dimensions in accordance with the coupling manufacturer's specifications.

2.2.18 Flexible Pipe Connectors

Flexible pipe connectors must be designed for 1.034 MPa 125 psi or 1.034 MPa 150 psi service as appropriate for the static head plus the system head, and 121 degrees C 250 degrees F. Connectors must be installed where indicated. The flexible section must be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration must be suitable for the pressure, vacuum, temperature, and circulating medium. The flexible section may have threaded, welded, soldered, flanged, grooved, or socket ends. Flanged assemblies must be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors must be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, must be provided when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.3 MATERIALS AND ACCESSORIES

2.3.1 Iron and Steel Sheets

2.3.1.1 Galvanized Iron and Steel

Galvanized iron and steel must conform to ASTM A653/A653M, with general requirements conforming to ASTM A653/A653M. Gauge numbers specified are Manufacturer's Standard Gauge.

2.3.1.2 Uncoated (Black) Steel

Uncoated (black) steel must conform to ASTM A653/A653M, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to Manufacturer's Standard Gauge.

2.3.2 Solder

Solder must conform to ASTM B32. Solder and flux must be lead free. Solder flux must be liquid or paste form, non-corrosive and conform to ASTM B813.

2.3.3 Solder, Silver

Silver solder must conform to AWS A5.8/A5.8M.

2.3.4 Thermometers

Mercury must not be used in thermometers. Thermometers must have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 225 mm 9 inch scale, and thermometers must have rigid stems with straight, angular, or inclined pattern.

2.3.5 Gauges

Provide gauges conforming to ASME B40.100.

2.3.6 Gaskets for Flanges

Composition gaskets must conform to ASME B16.21. Gaskets must be nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, full face or self-centering flat ring type. Gaskets must contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder must be used for hydrocarbon service. Gaskets must be suitable for pressure and temperatures of piping system.

2.3.7 Polyethylene Tubing

Low-density virgin polyethylene must conform to ASTM D1248, Type I, Category 5, Class B or C.

2.3.8 Bellows-Type Joints

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NOTE: Select bellows-type or slip-type to satisfy specific design conditions.

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Joints must be flexible, guided expansion joints. Expansion element must be of stainless steel. Bellows-type expansion joints must be in accordance with the applicable requirements of EJMA Stds and ASME B31.1 with internal liners.

2.3.9 Expansion Joints

Expansion joints must provide for either single or double slip of connected pipes, as required or indicated, and for not less than the traverse indicated. Joints must be designed for hot water working pressure not less than [_____] kPa psig and must be in accordance with applicable requirements of EJMA Stds and ASME B31.1. Joints must be designed for packing injection under full line pressure. End connections must be flanged or beveled for welding as indicated. Provide joints with anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip must be seamless steel plated with a minimum of 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Joint components must be fabricated from material equivalent to that of the pipeline. Initial settings must be made in accordance with manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides must be installed as recommended by joint manufacturer, but in any case must not be more than 1.5 m 5 feet from expansion joint except for lines 100 mm 4 inches or smaller, guides must be installed not more than 600 mm 2 feet from the joint. Provide service outlets where indicated.

2.3.10 Flexible Ball Joints

Flexible ball joints must be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint must be designed for packing injection under full line pressure to contain leakage. Joint ends must be threaded (to 50.8 mm 2 inches only), grooved, flanged or beveled for welding as indicated or required and must be capable of absorbing a minimum of 15-degree angular flex and 360-degree rotation. Balls and sockets must be of equivalent material as the adjoining pipeline. Exterior spherical surface of carbon steel balls must be plated with 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Ball type joints must be designed and constructed in accordance with ASME B31.1 and ASME BPVC SEC VIII D1, where applicable. Flanges where required must conform to ASME B16.5. Gaskets and compression seals must be compatible with the service intended.

2.3.11 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to MSS SP-58.

2.4 VALVES FOR LOW TEMPERATURE WATER HEATING AND STEAM SYSTEMS

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NOTE: Valves apply to low temperature water heating or low pressure steam systems. Delete for high or medium temperature water systems.

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2.4.1 Check Valves

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NOTE: Indicate the type of valves, vertical lift or horizontal, on the drawings.

****

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 3 or 4, Class 125. Sizes 80 mm 3 inches through 300 mm 24 inches, cast iron must conform to MSS SP-71, Type III or IV, Class 125.

2.4.2 Globe Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 80 mm 3 inches through 300 mm 12 inches, cast iron must conform to MSS SP-85, Type III, Class 125.

2.4.3 Angle Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 80 mm 3 inches through 300 mm 12 inches, cast iron must conform to MSS SP-85, Type III, Class 125.

2.4.4 Gate Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1 or 2, Class 125. Sizes 80 mm 3 inches through 1200 mm 48 inches, cast iron must conform to MSS SP-70, Type I, Class 125, Design OT or OF (OS&Y), bronze trim.

2.4.5 Air Vents

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NOTE: Air vent locations will be indicated on drawings; distinguish between manual vents and automatic air vents.

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Provide air vents at all piping high points in water systems, with block valve in inlet and internal check valve to allow air vent to be isolated for cleaning and inspection. Outlet connection must be piped to nearest open site or suitable drain, or terminated 300 mm 12 inches above finished grade. Pressure rating of air vent must match pressure rating of piping system. Body and cover must be cast iron or semi-steel with stainless steel or copper float and stainless steel or bronze internal parts. Air vents installed in piping in chase walls or other inaccessible places must be provided with an access panel.

2.4.6 Balancing Valves

Balancing valves must have meter connections with positive shutoff valves. An integral pointer must register degree of valve opening. Valves must be calibrated so that flow in L/minute gpm can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve must be constructed with internal seals to prevent leakage and must be supplied with preformed insulation. Valves must be suitable for 121 degrees C 250 degrees F temperature and working pressure of the pipe in which installed. Valve bodies must be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions must be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter must be furnished. The meter suitable for the operating pressure specified must be complete with hoses, vent, and shutoff valves and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing. Provide plug valves and ball valves 200 mm 8 inches or larger with manual gear operators with position indicators.

2.4.7 Gravity Flow Control Valves

Ends must be soldered, threaded, or flanged type as applicable, and designed for easy cleaning without disconnecting piping. Valves for copper tubing must be bronze. Valves must prevent flow due to gravity when circulators are off.

2.4.8 Radiator Valves

Automatic thermostatic radiator valves must be self-contained [direct sensor] [remote sensor] [wall thermostat] controlled nonelectric temperature control valves. Valve bodies must be constructed of chrome plated brass and must be angle or straight pattern as indicated, with threaded or brazed end connections. Valve disc must be of ethylene propylene or composition material. Thermostatic operators must be a modulating type consisting of a sensing unit counter balanced by a spring setting.

2.5 VALVES FOR HIGH AND MEDIUM TEMPERATURE WATER SYSTEMS

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NOTE: Valves apply to high and medium temperature water systems and high pressure steam systems. Delete for low temperature water heating systems or low pressure steam systems.

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2.5.1 Check Valves

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NOTE: Indicate the type of valves, vertical lift or horizontal, on the drawings.

****

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Class 300 Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Class 300 minimum. Sizes 80 mm 3 inches through 600 mm 24 inches, steel must conform to ASME B16.34, Class 300 minimum, flanged ends, swing disc; water, oil gas or steam service to 454 degrees C 850 degrees F.

2.5.2 Globe Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, 2 or 3, Class 300 minimum. Sizes 80 mm 3 inches through 600 mm 24 inches, steel must conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas, or steam service to 454 degrees C 850 degrees F.

2.5.3 Angle Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, 2 or 3, Class 300 minimum. Sizes 80 mm 3 inches through 600 mm 24 inches, steel must conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas, or steam service to 454 degrees C 850 degrees F.

2.5.4 Gate Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, or 2, Class 300 minimum. Sizes 80 mm 3 inches through 600 mm 24 inches, steel must conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas or steam service to 454 degrees C 850 degrees F. Gate must be split wedge (double disc) type.

2.6 COLD WATER CONNECTIONS

Connections must be provided which include consecutively in line a strainer, backflow prevention device, and water pressure regulator. The backflow prevention device must be provided as indicated and in compliance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.6.1 Strainers

Basket or Y-type strainers must be the same size as the pipelines in which they are installed. Strainer bodies must be rated for [0.862] [1.72] MPa [125] [250] pound service, with bottoms drilled and plugged. Bodies must have arrows cast on the sides to indicate the direction of flow. Each strainer must be equipped with a removable cover and sediment basket. Basket must not be less than 0.795 mm (22 gauge) 22 gauge and must have perforations to provide a net free area through the basket of at least four times that of the entering pipe.

2.6.2 Pressure Regulating Valve

Valve must be a type that will not stick nor allow pressure to build up on the low side. Valve must be set to maintain a terminal pressure approximately 35 kPa 5 psi in excess of the static head on the system and must operate within a 138 kPa 20 psi variation regardless of initial pressure and without objectionable noise under any condition of operation.

2.7 FLASH TANK

Tank must be sized and installed as indicated, and must be of welded construction utilizing black steel sheets not less than 3.175 mm (11 gauge) 11 gauge. Provide tank with a handhole and with tapping for the condensate returns, drip lines, vent line, and condensate discharge line to the condensate receiver. Discharge line must be equipped with a float trap. Tank must be ASME rated for [_____] kPa psig in accordance with ASME BPVC SEC VIII D1.

2.8 EXPANSION TANK

Pressurization system must include a replaceable diaphragm-type captive air expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system must be the permanent sealed-in air cushion contained in the diaphragm-type tank.

Sizes must be as indicated. Expansion tank must be welded steel, constructed, tested and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of [862] [_____] kPa [125] [_____] psig and precharged to the minimum operating pressure. Tank air chamber must be fitted with an air charging valve. Tank must be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations.

2.9 AIR SEPARATOR TANK

External air separation tank must be steel, constructed, tested, and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of [862] [_____] kPa [125] [_____] psi. The capacity of the air separation tank indicated is minimum.

2.10 STEAM TRAPS

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NOTE: Applicable to steam systems only. A schedule of steam trap selection will be located on drawings showing trap orifice size, capacity (kg/hr#/hr), and pressure drop (kPapsi), for each trap required. Delete steam traps not required.

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2.10.1 Float Traps

Capacity, working pressure, and differential pressure of the traps must be as indicated.

2.10.2 Float-and-Thermostatic Traps

Traps must be designed for a steam working pressure of approximately 103 kPa 15 psig, but must operate with a supply pressure of approximately 35 kPa 5 psig. The capacity of the traps must be as indicated. Trap capacity must be based on a pressure differential of 2 kPa 1/4 psi. Provide each float-and-thermostatic trap a hard bronze, monel, or stainless steel valve seat and mechanism and brass float, all of which can be removed easily for inspection or replacement without disturbing the piping connections. Inlet to each trap must have a cast iron strainer, either an integral part of the trap or a separate item of equipment.

2.10.3 Bucket Traps

Traps must be inverted or vertical bucket type with automatic air discharge. Traps must be designed for a working pressure of 1034 kPa 150 psig, but must operate under a steam supply pressure of approximately 276 to 690 kPa 40 to 100 psig as required. Each trap must have a heavy body and cap of fine-grained, gray cast iron. The bucket must be made of brass; the mechanism of hard bronze; the valve and seat of stainless or monel; or each of equivalent material. Traps must be tested hydrostatically under a pressure of 1.38 MPa 200 psig. Traps must have capacities as indicated when operating under the specified working conditions. A strainer must be installed in the suction connection of each trap. Impact operated traps, impulse-operated traps, or thermodynamic traps with continuous discharge may be installed in lieu of bucket traps, subject to approval. Thermostatic traps designed for a steam working pressure suitable for the application may be furnished in lieu of the traps specified above. Thermostatic traps must be equipped with valves and seats of stainless steel or monel metal, and must have capacities based on a pressure differential not in excess of the following:

Steam Working Pressure, kPa (psi) psi	Differential, kPa (psi) psi
172 - 345 (25-50)25-50	138 (20)20
621 - 689 (90-100)90-100	552 (80)80

2.11 HEAT EXCHANGERS

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NOTE: The following information applicable to the project will be indicated on the drawings:

a. Capacity of heat exchanger in liters per minute (gpm).

b. Supply and return temperatures of low temperature water in degrees C degrees F.

c. Supply and return temperatures of high or medium temperature water in degrees C degrees F.

d. Steam pressure in kPa psig.

e. Pressure drops in mm feet of water or kPa psig.

f. Fouling allowances for steam or high temperature water and for low temperature water will be determined by the system designer. Recommended allowances are listed in the Tubular Exchanger Manufacturers Association (TEMA) Standards. Insert system fouling allowance in blank space.

****

Heat exchangers must be multiple pass shell and U-tube type or plate and frame type as indicated, to provide low temperature hot water for the heating system when supplied with [steam] [or] [high temperature hot water] [or] [medium temperature hot water] at the temperatures and pressures indicated. Temperature and pressure for plate and frame exchangers must not exceed 138 degrees C 280 degrees F and 1.93 MPa 280 psig for medium temperature hot water, or 138 degrees C 280 degrees F and 241 kPa 35 psig for steam. Temperature and pressure for shell and U-tube exchangers must not exceed 170 degrees C 338 degrees F and 689 kPa 100 psig for steam or 221 degrees C 430 degrees F and 2.76 MPa 400 psig for high temperature hot water. Exchangers must be constructed in accordance with ASME BPVC SEC VIII D1 and certified with ASME stamp secured to unit. U-tube bundles must be completely removable for cleaning and tube replacement and must be free to expand with shell. Shells must be of seamless steel pipe or welded steel construction and tubes must be seamless tubing as specified below unless otherwise indicated. Tube connections to plates must be leakproof. Provide saddles or cradles to mount shell and U-tube exchangers. Frames of plate and frame type exchangers must be fabricated of carbon steel and finished with baked epoxy enamel. Design fouling factor must be [_____].

2.11.1 Steam Heat Exchangers, Shell and U-Tube Type

Exchangers must operate with steam in shell and low temperature water in tubes. Shell and tube sides must be designed for 1.03 MPa 150 psig working pressure and factory tested at 2.02 MPa 300 psig. Steam, water, condensate, and vacuum and pressure relief valve connections must be located in accordance with the manufacturer's standard practice. Connections larger than 80 mm 3 inches must be ASME 1.03 MPa 150 pound flanged. Water pressure loss through clean tubes must not exceed 41 kPa 6 psi and water velocity must not exceed 1.8 m/second 6 fps unless otherwise indicated. Minimum water velocity in tubes must be not less than 300 mm/second 1 fps and assure turbulent flow. Tubes must be seamless copper or copper alloy, constructed in accordance with ASTM B75/B75M or ASTM B395/B395M, suitable for the temperatures and pressures specified. Tubes must be not less than 19 mm 3/4 inch unless otherwise indicated. Maximum steam inlet nozzle velocity must not exceed 30.5 m/second 6000 fpm.

2.11.2 High Temperature Water Heat Exchangers, Shell and U-tube Type

Exchangers must operate with low temperature water in shell and high temperature water in tubes. Shell side must be designed for 1.03 MPa 150 psig working pressure and factory tested at 2.07 MPa 300 psig. Tubes must be designed for 2.76 MPa 400 psig working pressure and an operating temperature of 232 degrees C 450 degrees F. High and low temperature water and pressure relief connections must be located in accordance with the manufacturer's standard practice. Water connections larger than 80 mm 3 inches must be ASME 4.14 MPa 600 pound flanged for high temperature water, and ASME 4.03 MPa 150 pound flanged for low temperature water. Water pressure loss through clean tubes must not exceed 41 kPa 6 psig unless otherwise indicated. Minimum water velocity in tubes must be 300 mm/second 1 fps and assure turbulent flow. Tubes must be cupronickel or inhibited admiralty, constructed in accordance with ASTM B395/B395M, suitable for the temperatures and pressures specified. Tubes must be not less than 19 mm 3/4 inch unless otherwise indicated.

2.11.3 Steam Heat Exchangers, Plate and Frame Type

Plates, frames and gaskets must be designed for a working pressure of 2.07 MPa 300 psig and factory tested at 3.10 MPa 450 psig. Steam, low temperature water, condensate, and vacuum and pressure relief valve connections must be located in accordance with the manufacturer's standard practice. Connections larger than 80 mm 3 inches must be ASME 4.03 MPa 150 pound flanged. Water pressure drop through clean plates and headers must not exceed [_____] kPa psig at the flow rates and temperatures indicated. Plates must be designed to assure turbulent flow at a minimum rate of [_____] L/minute gpm through any 2 plate segment. Plates must be corrugated [Type 304 stainless steel] [Type 316 stainless steel] [nickel-iron-chromium alloy conforming to ASTM B424] [nickel-molybdenum alloy conforming to ASTM B333] [titanium alloy conforming to ASTM B265]. Plate thickness must be not less than [_____] mm inch.

2.11.4 Medium Temperature Water Heat Exchangers, Plate and Frame Type

Plates, frames and gaskets must be designed for a working pressure of 2.07 MPa 300 psig and factory tested at 31.0 MPa 450 psig. Medium temperature water, low temperature water, and pressure relief valve connections must be located in accordance with the manufacturer's standard practice. Connections larger than 80 mm 3 inches must be ASME 2.07 MPa 300 pound flanged. Water pressure drop through clean plates and headers must not exceed [_____] kPa psi at the flow rates and temperatures indicated. Plates must be designed to assure turbulent flow at a minimum rate of [_____] L/second gpm through any 2 plate segment. Plates must be corrugated [Type 304 stainless steel] [Type 316 stainless steel] [nickel-iron-chromium alloy conforming to ASTM B424] [nickel-molybdenum alloy conforming to ASTM B333] [titanium alloy conforming to ASTM B265]. Plate thickness must be not less than [_____] mm inch.

2.12 SYSTEM EQUIPMENT AND ACCESSORIES

2.12.1 Circulating Pumps

Pumps for hot water must be of the single-stage centrifugal type, electrically driven. Pumps must be supported [on a concrete foundation] [or] [by the piping on which installed] [as indicated]. Pumps must be either integrally mounted with the motor or direct-connected by means of a flexible-shaft coupling on a cast iron, or steel sub-base. Pump housing must be of close grained cast iron. Shaft must be carbon or alloy steel, turned and ground. Shaft seal must be mechanical-seal or stuffing-box type. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve must be bronze. Bearings must be ball-, roller-, or oil-lubricated, bronze-sleeve type, and must be sealed or isolated to prevent loss of oil or entrance of dirt or water. Motor must be of a type approved by the manufacturer of the pump.

2.12.2 Condensate Pumping Unit

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NOTE: Size condensate pumping rate for three times the expected condensate flow. Size receiver for five times the expected condensate flow for expected condensate flow up to 30 liters per minute 8 GPM. Size receiver two times the expected condensate flow for expected condensate flow over 30 liters per minute 8 GPM.

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Pump must have a minimum capacity, as indicated, of [_____] L/second gpm when discharging against the specified pressure. The minimum capacity of the tank must be [_____] liters gallons. Condensate pumping unit must be of the [single] [duplex], [horizontal-shaft] [vertical-shaft] type, as indicated. Unit must consist of [one pump] [two pumps], [one electric motor] [two electric motors] and a single receiver. Pumps must be centrifugal or turbine type, bronze-fitted throughout with impellers of bronze or other corrosion-resistant metal. Pumps must be free from air-binding when handling condensate with temperatures up to 93 degrees C 200 degrees F. Pumps must be connected directly to dripproof enclosed motors. Receiver must be cast iron and must be provided with condensate return, vent, overflow, and pump suction connections, and water level indicator and automatic air vent. Inlet strainer must be provided in the inlet line to the tank. Vent pipe must be galvanized steel, and fittings must be galvanized malleable iron. Vent pipe must be installed as indicated or directed. Vent piping must be flashed as specified. Pump, motor, and receiving tank may be mounted on a single base with the receiver piped to the pumps suctions. Provide a gate valve and check valve in the discharge connection from each pump.

2.12.2.1 Controls

Install enclosed float switches complete with float mechanisms in the head of the receiver. The condensate pump must be controlled automatically by means of the [respective] float switch that will automatically start the motor when the water in the receiving tank reaches the high level and stop the motor when the water reaches the low level. Provide motors with magnetic across-the-line starters equipped with general purpose enclosure and Automatic-Manual-Off selector switch in the cover.

2.12.2.2 Factory Testing

Submit a certificate of compliance from the pump manufacturer covering the actual test of the unit and certifying that the equipment complies with the indicated requirements.

2.12.3 Pressure Gauges and Thermometers

Provide gauges for each heat exchanger and piping as indicated. Provide a thermometer and pressure gauge on the high temperature water supply and return mains. Thermometers must be separable socket type.

2.12.4 Vacuum Relief Valve

Install a vacuum relief valve on the shell of each shell and U-tube steam heat exchanger and on the factory supplied steam inlet nozzle of each plate and frame heat exchanger. On shutoff of steam supply and condensing of steam, the vacuum relief valve must automatically admit air to the heat exchanger.

2.12.5 Pressure Relief Valves

Provide one or more pressure relief valves for each heat exchanger in accordance with ASME BPVC SEC VIII D1. The aggregate relieving capacity of the relief valves must be not less than that required by the above code. Discharge from the valves must be installed as indicated. Pressure relief valves for steam heat exchangers must be located on the low temperature water supply coming from near the heat exchanger as indicated. Relief valves for high temperature water heat exchanger must be installed on the heat exchanger shell.

2.12.6 Drains

****

NOTE: Drawings must indicate low-point drains.

****

Install a drain connection with 19 mm 3/4 inch hose bib at the lowest point in the low temperature water return main near the heat exchanger. In addition, install threaded drain connections with threaded cap or plug wherever required for thorough draining of the low temperature water system.

2.12.7 Strainers

****

NOTE: Select the correct piping and pipe fittings (steam or high-temperature water) and delete the inapplicable system.

****

Basket or Y-type strainer-body connections must be the same size as the pipe lines in which the connections are installed. The bodies must have arrows clearly cast on the sides to indicate the direction of flow. Each strainer must be equipped with an easily removable cover and sediment basket. The body or bottom opening must be equipped with nipple and gate valve for blowdown. The basket for steam systems must be of not less than 0.635 mm 0.025 inch thick stainless steel, or monel with small perforations of sufficient number to provide a net free area through the basket of at least 2.5 times that of the entering pipe. The flow must be into the basket and out through the perforations. [For high temperature water systems, only cast steel bodies must be used.] [The strainer bodies for steam systems must be of cast steel or gray cast iron with bottoms drilled and plugged.]

2.13 INSULATION

Shop and field applied insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.14 FACTORY PAINTED EXPOSED SPACE HEATING EQUIPMENT

Radiator and convector enclosures must be coated with the manufacturer's standard rust inhibiting primer for painting in the field as specified in Section 09 90 00 PAINTS AND COATINGS. All other exposed heating equipment must be painted at the factory with the manufacturer's standard primer and enamel finish.

2.15 RADIATORS AND CONVECTORS

****

NOTE: Drawings must indicate the types, sizes, and capacities of radiators and convectors. Show typical piping details on drawings for radiators and convectors.

****

The radiator and convector must be the type and size indicated. The supply and return connections must be the same size. Cast iron radiators and nonferrous convectors must be tested hydrostatically at the factory and proved tight under a pressure of not less than [207 kPa][30 psig][[_____] kPa][[_____] psig] or 150 percent of the system operating pressure, whichever is greater. Furnish a certified report of these tests in accordance with paragraph SUBMITTALS.

2.15.1 Cast Iron Radiators

Cast iron radiators must be gray cast iron, free from sandholes and other defects. The sections must be connected with malleable iron nipples not less than 2.286 mm 0.09 inch thick at any point. Cast iron radiators must be the legless type mounted on the walls by means of hangers as specified. Adjustable radiator hangers must be secured to the wall and must hold the radiators near both ends, at both top and bottom, in such a manner that the radiators cannot be removed without the use of tools. Not less than two bolts must be used to secure each hanger to the wall. Necessary angles, bolts, bearing plates, toggles, radiator grips, and other parts required for complete installation of the radiators must be provided.

2.15.2 Extended-Surface, Steel, or Nonferrous Tube-Type Radiators

****

NOTE: The type of cover grille selected for fin-type radiators must suit the particular building involved.

****

Radiators must consist of metal fins permanently bonded to steel or nonferrous pipe cores, with threaded or sweat fittings at each end for connecting to external piping. Radiators must have capacities not less than those indicated, determined in accordance with HYI-005. Radiators must be equipped with [expanded-metal cover grilles fabricated from black steel sheets not less than 1.519 mm (16 gauge) 16 gauge, secured either directly to the radiators or to independent brackets.] [solid-front, slotted horizontal-top cover grilles fabricated from black steel sheets not less than 1.214 mm (18 gauge) 18 gauge, secured either directly to the radiators or to independent brackets.] [solid-front, slotted sloping-top cover grilles fabricated from black steel sheets not less than 1.519 mm (16 gauge) 16 gauge, independently secured to masonry with brackets.]

2.15.3 Convectors

Convectors must be constructed of cast iron or of nonferrous alloys, and must be installed where indicated. Capacity of convectors must be as indicated. Overall space requirements for convectors must not be greater than the space provided. Convectors must be complete with heating elements and enclosing cabinets having bottom recirculating opening, manual control damper and top supply grille. Convector cabinets must be constructed of black sheet steel not less than 0.912 mm (20 gauge) 20 gauge.

2.15.4 Radiators and Convectors Control

[The space temperature must be maintained automatically by regulating water flow to the radiators and convectors by the self contained, automatic thermostatic radiator control valves.] [Provide controls as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.]

2.16 UNIT HEATERS

****

NOTE: Indicate capacity of unit heaters and heating and ventilating units on drawings. Show typical piping details on drawings for these units.

In critical areas where maximum noise level limits are required, the sentence in brackets will be retained and the brackets deleted. The maximum acceptable noise limits for these critical areas will be determined in NC level or dbA and should be indicated on the drawings. The sentence in brackets will be deleted for noncritical areas. Sound values will be selected by the designer based on a study of the design goal. The ASHRAE Handbook, Fundamentals, shows the range of sound pressure values for speech communications as being 50 dB for fair, 44 dB for very good, and 38 dB for perfect speech intelligibility.

****

Heaters must be as specified below, and must have a heating capacity not in excess of 125 percent of the capacity indicated. [Noise level of each unit heater for areas noted must not exceed the criteria indicated.]

2.16.1 Propeller Fan Heaters

Heaters must be designed for suspension and arranged for [horizontal] [vertical] discharge of air as indicated. Casings must be not less than 0.912 mm (20 gauge) 20 gauge black steel and finished with lacquer or enamel. Suitable [stationary] [rotating air] deflectors must be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. [Fans for vertical discharge type heaters must operate at speeds not in excess of 1,200 rpm, except that units with 84.4 MJ 80,000 Btu output capacity or less may operate at speeds up to 1,800 rpm.] [Horizontal discharge type unit heaters must have discharge or face velocities not in excess of the following:

Unit Capacity, Liters per Second cfm	Face Velocity, Meters per Second fpm
Up to 472 (1000) 1000	4.06 (800)800
473 (1001)1001	4.57 (900)900
1417 (3001) 3001 and over	5.08 (1,000)1000

]

2.16.2 Centrifugal Fan Heaters

Heaters must be arranged for floor or ceiling mounting as indicated. Heating elements and fans must be housed in steel cabinets of sectionalized steel plates or reinforced with angle-iron frames. Cabinets must be constructed of not lighter than 1.27 mm (18 gauge) 18 gauge black steel. Provide each unit heater with a means of diffusing and distributing the air. Fans must be mounted on a common shaft, with one fan to each air outlet. Fan shaft must be equipped with self-aligning ball, roller, or sleeve bearings and accessible means of lubrication. Fan shaft may be either directly connected to the driving motor or indirectly connected by adjustable V-belt drive rated at 150 percent of motor capacity. All fans in any one unit heater must be the same size.

2.16.3 Heating Elements

****

NOTE: For project designs requiring air-supply and distribution systems, consider using the optional choice of referencing Section 23 30 00 HVAC AIR DISTRIBUTION for the equipment in this paragraph.

****

[Heating coils and radiating fins must be of suitable nonferrous alloy with [threaded] [brazed] fittings at each end for connecting to external piping. The heating elements must be free to expand or contract without developing leaks and must be properly pitched for drainage. The elements must be tested under a hydrostatic pressure of 1.38 MPa 200 psig and a certified report of the test must be submitted to the Contracting Officer.] [Heating coils must be as specified in Section 23 30 00 HVAC AIR

DISTRIBUTION for types indicated.] Coils must be suitable for use with water up to 121 degrees C 250 degrees F.

2.16.4 Motors

Provide motors with NEMA 250 general purpose enclosure. Motors and motor controls must otherwise be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.16.5 Motor Switches

Provide motors with manual selection switches with "Off," and "Automatic" positions and must be equipped with thermal overload protection.

2.16.6 Controls

Provide controls as specified in 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.17 HEATING AND VENTILATING UNITS

Heating and ventilating units must be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.18 WATER TREATMENT SYSTEM

****

NOTE: Typically, large amounts of makeup water will not be required for new closed loop heating systems. However, if a large amount of makeup water is anticipated, an automatic chemical feed system should be used in lieu of a shot feeder. The automatic system can be found in Section 23 52 00 HEATING BOILERS.

****

The water treatment system must be capable of [manually] [automatically] feeding chemicals into the heating system to prevent corrosion and scale within the heat exchanger and piping system. Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Also show on the drawings complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show on the drawings proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work including clearances for maintenance and operation. All water treatment equipment and chemicals must be furnished and installed by a water treatment company regularly engaged in the installation of water treatment equipment and the provision of water treatment chemicals based upon water condition analyses. The water treatment company must provide a water sample analysis taken from the building site, each month for one year.

2.18.1 Chemical Shot Feeder

Provide a shot feeder indicated. Size and capacity of feeder must be based upon local requirements and water analysis. The feeder must be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping. All materials of construction must be compatible with the chemicals being used.

2.18.2 Make Up Water Analysis

****
NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.
****

The make up water conditions reported as prescribed in ASTM D596 are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees C F
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (C1)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] ppm (mg/1)
Noncarbonate Hardness	[_____] epm (mg/1)
Total Hardness	[_____] epm (mg/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)

Conductivity	[_____] microsiemens/cm

2.18.3 Chemicals

The chemical company must provide pretreatment chemicals that will remove and permit flushing of mill scale, oil, grease, and other foreign matter from the water heating system. The chemical company must also provide all treatment chemicals required for the initial fill of the system and for a period of one year of operation. The chemical company must determine the correct chemicals and concentrations required for the water treatment. The chemicals must not be proprietary and must meet required federal, state, and local environmental regulations for the treatment of heating water systems and discharge to the sanitary sewer. The chemicals must remain stable throughout the operating temperature range of the system, and must be compatible with pump seals and other elements of the system.

2.18.4 Glycol Solutions

****

NOTE: If freeze protection is not required, this paragraph should be deleted. When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC Systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. The glycol solution will decrease the heat transfer capacity of the system. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient temperature. The concentration of the glycol solution should not go below 20 percent due to the degradation of the corrosion inhibitors at lower concentrations.

****

Provide a [_____] percent concentration by volume of industrial grade [ethylene] [propylene] glycol. The glycol must be tested in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. The glycol must contain corrosion inhibitors. Silicate based inhibitors must not be used. The solution must be compatible with pump seals, other elements of the system, and all water treatment chemicals used within the system.

2.18.5 Test Kits

Provide all required test kits and reagents for determining the proper water conditions.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install all work as indicated and in accordance with the manufacturer's diagrams and recommendations.

3.3 COLOR CODE MARKING AND FIELD PAINTING

****

NOTE: Designer will coordinate color code marking with Section 09 90 00. Color code marking for piping not listed in Table I of Section 09 90 00, will be added to the table.

****

Color code marking, field painting of exposed pipe, and field painting of factory primed equipment must be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 WELDING

****

NOTE: If the need exists for more stringent pipe welding requirements, delete the sentences in the first set of brackets.

****

Submit [_____] copies of qualified procedures and list of names and identification symbols of qualified welders and welding operators, prior to welding operations. [Piping must be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer must be notified 24 hours in advance of tests and the tests must be performed at the work site if practical. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record.] Structural members must be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING. [Welding and nondestructive testing procedures for piping must be as specified in Section 40 05 13.96 WELDING, PRESSURE PIPING.]

3.5 PIPING

****

NOTE: Indicate on the drawings, the direction of piping pitch, details of branch take-offs from mains, and pipe size reductions.

****

Unless otherwise specified, pipe and fittings installation must conform to the requirements of ASME B31.1. Pipe must be cut accurately to measurements established at the job site and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cuttings or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing must be cut square, must have burrs removed by reaming, and must be so installed as to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Changes in direction must be made with factory made fittings, except that bending of pipe up to 100 mm 4 inches will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center line radius of bends must not be less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes must be installed through the roof as indicated and must be flashed as specified. Horizontal mains must pitch up or down in the direction of flow as indicated. The grade must be not less than 25 mm in 12 m 1 inch in 40 feet. Reducing fittings must be used for changes in pipe sizes. Open ends of pipelines and equipment must be capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified must be uncoated. Unions and other components for copper pipe or tubing must be brass or bronze. Connections between ferrous and copper piping must be electrically isolated using dielectric unions.

3.5.1 Joints

Except as otherwise specified, joints used on steel pipe must be threaded for fittings 25 mm 1 inch and smaller; threaded or welded for 32 mm 1-1/4 inches up through 65 mm 2-1/2 inches; and flanged or welded for 80 mm3 inches and larger. Joints between sections of copper tubing or copper pipe must be flared or sweated. Pipe and fittings 32 mm 1-1/4 inches and larger installed in inaccessible conduits or trenches beneath concrete floor slabs must be welded. Unless otherwise specified, connections to equipment must be made with black malleable iron unions for pipe 65 mm 2-1/2 inches or smaller in diameter, and with flanges for pipe 80 mm 3 inches or larger in diameter.

3.5.2 Low Temperature Systems

Piping may have threaded, welded, flanged or flared, sweated, or grooved mechanical joints as applicable and as specified. Reducing fittings must be used for changes in pipe sizes. In horizontal lines, reducing fittings must be the eccentric type to maintain the top of the adjoining pipes at the same level.

3.5.3 Steam Systems

Piping may have threaded, welded, or flanged joints as applicable and as specified. Reducing fittings must be used for changes in pipe sizes. In horizontal steam lines, reducing fittings must be the eccentric type to maintain the bottom of the lines at the same level. Grooved mechanical joints must not be used.

3.5.4 High And Medium Temperature Systems

Temperature systems must have welded joints to the maximum extent practicable, except screwed joints and fittings may be used at connections to equipment and on piping 65 mm 2-1/2 inches and smaller. Equipment connections 80 mm 3 inches and larger must be flanged. Piping connections 80 mm 3 inches and larger may be welded or flanged. In horizontal lines, reducing fittings must be the eccentric type to maintain the tops of adjoining pipes at the same level. Grooved mechanical joints must not be used.

3.5.5 Threaded Joints

Threaded joints must be made with tapered threads properly cut, and must be made tight with PTFE tape complying with ASTM D3308, or equivalent thread joint compound applied to the male threads only, and in no case to the fittings.

3.5.6 Welded Joints

Joints must be fusion-welded unless otherwise required. Changes in direction of piping must be made with welding fittings only. Branch connection may be made with either welding tees or branch outlet fittings. Branch outlet fittings must be forged, flared for improvement of flow where attached to the run, and reinforced against external strains.

3.5.7 Flanged Joints or Unions

Provide flanged joints or unions in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and similar items. Flanged joints must be faced true, provided with gaskets, and made square and tight. Full-faced gaskets must be used with cast iron flanges.

3.5.8 Flared and Sweated Pipe and Tubing

Pipe and tubing must be cut square and burrs must be removed. Both inside of fittings and outside of tubing must be cleaned with an abrasive before sweating. Care must be taken to prevent annealing of fittings and hard drawn tubing when making connection. Installation must be made in accordance with the manufacturer's recommendations. Changes in direction of piping must be made with flared or soldered fittings only. Solder and flux must be lead free. Joints for soldered fittings must be made with silver solder or 95:5 tin-antimony solder. Cored solder must not be used. Joints for flared fittings must be of the compression pattern. Provide swing joints or offsets on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing.

3.5.9 Mechanical Tee Joint

An extracted mechanical tee joint may be made in copper tube. Joint must be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. The branch tube must be notched for proper penetration into fitting to assure a free flow joint. Joints must be brazed in accordance with NAPHCC NSPC. Soldered joints will not be permitted.

3.5.10 Grooved Joints for Copper Tube

Grooves must be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools must be products of the same manufacturer. Pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints must not be used in concealed locations.

3.6 CONNECTIONS TO EQUIPMENT

Provide supply and return connections unless otherwise indicated. Valves and traps must be installed in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of the supply and return pipes to each piece of equipment must be not smaller than the connections on the equipment. Bushed connections are not permitted. Change in sizes must be made with reducers or increasers only.

3.6.1 Low Temperature Water and Steam and Return Connections

Connections, unless otherwise indicated, must be made with malleable iron unions for piping 65 mm 2-1/2 inches or less in diameter and with flanges for pipe 80 mm 3 inches or more in diameter.

3.6.2 High And Medium Temperature Water Connections

Connections must be made with 13.8 MPa 2000 pound black malleable iron unions for pipe 19 mm 3/4 inch or less in diameter and with flanges for pipe 25 mm 1 inch and larger in diameter.

3.7 BRANCH CONNECTIONS

****

NOTE: Indicate on the drawings the direction of piping pitch, details of branch take-offs from mains, and pipe size reductions.

****

Branches must pitch up or down as indicated, unless otherwise specified. Connection must be made to insure unrestricted circulation, eliminate air pockets, and permit drainage of the system.

3.7.1 Low Temperature Water Branches

****

NOTE: If the system is not to be a one-pipe system, reference to the special flow fittings brackets will be deleted.

****

Branches taken from mains must pitch with a grade of not less than 25 mm in 3 m 1 inch in 10 feet. [Special flow fittings must be installed on the mains to bypass portions of water through each radiator. Special flow fittings must be installed as recommended by the manufacturer.]

3.7.2 Steam Supply and Condensate Branches

Branches taken from mains must pitch with a grade of not less than 25 mm in 3 m 1 inch in 10 feet, unless otherwise indicated.

3.7.3 High And Medium Temperature Water Branches

****

NOTE: The following is recommended in the sizing of

branch line connections to a high or medium temperature water main:

The following table will be used in metric projects.

Diameter of main, mm inches	**Diameter of branch line connection, mm (inches)**
200 8	**80 3 minimum**
100, 125, 150 4, 5, 6	**50 2 minimum**
50, 65, 80 2, 2-1/2, 3	**one pipe size larger than sized branch line, but not more than 50 mm 2 inches in diameter**

****

Branches must take off at 45 degrees in the direction of the fluid flow from the supply and return lines and should be branched from the top or upper half of the main line unless otherwise indicated. Abrupt reduction in pipe sizes must be avoided.

3.8 RISERS

The location of risers is approximate. Exact locations of the risers must be as approved. [Steam supply downfeed risers must terminate in a dirt pocket and must be dripped through a trap to the return line.]

3.9 SUPPORTS

****

NOTE: Steam and high or medium temperature water piping layout must be analyzed for thermal stresses due to expansion. Spring hangers will be indicated on drawings and used to absorb vertical expansion of piping. Drawings must detail anchors and pipe guide and indicate location. Submit expansion calculations, including guide and anchor reactions for review.

****

3.9.1 General

****

NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 22 kg 50 pounds must have the excess hanger loads suspended from panel points.

****

Hangers used to support piping 50 mm 2 inches and larger must be fabricated to permit adequate adjustment after erection while supporting the load. Pipe guides and anchors must be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, must be supported by variable spring hangers and supports or by constant support hangers. Where threaded rods are used for support, they must not be formed or bent.

3.9.1.1 Seismic Requirements for Pipe Supports, Standard Bracing

****

NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record and show on the drawings. Delete the bracketed phrase if seismic details are not included. UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

****

All piping and attached valves must be supported and braced to resist seismic loads as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT [and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS] [as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown must be provided under this section. Material used for supports must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.9.1.2 Structural Attachments

Structural steel brackets required to support piping, headers, and equipment, but not shown, must be provided under this section. Material and installation must be as specified under Section 05 12 00 STRUCTURAL STEEL. [Pipe hanger loads suspended from steel joist panel points must not exceed 222 N 50 pounds. Loads exceeding 222 N 50 pounds must be suspended from panel points.]

3.9.1.3 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp must be used where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run.

3.9.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts and supports must conform to MSS SP-58, except as specified as follows:

3.9.2.1 Types 5, 12, and 26

Use of these types is prohibited.

3.9.2.2 Type 3

Type 3 is prohibited on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.

3.9.2.3 Type 18 Inserts

Type 18 inserts must be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

3.9.2.4 Type 19 and 23 C-Clamps

Type 19 and 23 C-clamps must be torqued in accordance with MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.9.2.5 Type 20 Attachments

Provide Type 20 attachments used on angles and channels with an added malleable iron heel plate or adapter.

3.9.2.6 Type 24

Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.9.2.7 Type 39 Saddle or Type 40 Shield

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle must be used on all pipe 100 mm 4 inches and larger.

3.9.2.8 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58 and install a support not over 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Do not space pipe supports over 1.5 m 5 feet apart at valves.

3.9.2.9 Vertical Pipe Supports

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m 15 feet, except support pipe not more than 2.4 m 8 feet from end of risers, and at vent terminations.

3.9.2.10 Type 35 Guides

Provide Type 35 guides using steel, reinforced PTFE or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Slide materials must be suitable for the system operating temperatures, atmospheric conditions and bearing loads encountered. Where steel slides do not require provision for restraint or lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe must be separated from the slide material by at least 100 mm 4 inches or by an amount adequate for the insulation, which ever is greater.

3.9.2.11 Pipe Hanger Size

Except for Type 3, pipe hangers on horizontal insulated pipe must be the size of the outside diameter of the insulation.

3.9.3 Piping in Trenches

****

NOTE: Detail the methods of supporting pipe in trenches.

****

Support piping as indicated.

3.10 PIPE SLEEVES

3.10.1 Pipe Passing Through Concrete or Masonry

Provide pipe passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Sleeves must not be installed in structural members except where indicated or approved. Rectangular and square openings must be as detailed. Each sleeve must extend through its respective wall, floor, or roof, and must be cut flush with each surface. Unless otherwise indicated, sleeves must provide a minimum of 6 mm 1/4 inch annular space between bare pipe or insulation surface and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas must be steel pipe or cast iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, cast iron pipe, or galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls and floors must be sealed as indicated and specified in Section 07 92 00 JOINT SEALANTS. Seal penetrations in fire walls and floors in accordance with Section 07 84 00 FIRESTOPPING.

3.10.2 Pipes Passing Through Waterproofing Membranes

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NOTE: Indicated on drawings details of pipes through flashing or waterproof membrane, and method of sealing.

****

Install pipes passing through waterproofing membranes through a 19.5 kg/square meter 4 pound lead-flashing sleeve, a 4.9 kg/square meter 16 ounce copper sleeve, or a 0.813 mm 0.032 inch thick aluminum sleeve, each having an integral skirt or flange. Flashing sleeve must be suitably formed, and the skirt or flange must extend 200 mm 8 inches or more from the pipe and must be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve must extend up the pipe a minimum of 50 mm 2 inches above the highest flood level of the roof or a minimum of 250 mm 10 inches above the roof, whichever is greater, or 250 mm 10 inches above the floor. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation must be sealed as indicated. At the Contractor's option, pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane must be clamped into place and sealant must be placed in the caulking recess.

3.10.3 Mechanical Seal Assembly

In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. The seals must consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. The links must be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolts must cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly must be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.10.4 Counterflashing Alternate

As an alternate to caulking and sealing the annular space between the pipe and flashing sleeve or metal-jacket-covered insulation and flashing sleeve, counterflashing may be by standard roof coupling for threaded pipe up to 150 mm 6 inches in diameter; lead-flashing sleeve for dry vents and turning the sleeve down into the pipe to form a waterproof joint; or tack-welded or banded-metal rain shield round the pipe and sealing as indicated.

3.10.5 Waterproofing Clamping Flange

Pipe passing through wall waterproofing membrane must be sleeved as specified. In addition, a waterproofing clamping flange must be installed as indicated.

3.10.6 Fire Seal

****

NOTE: Fire walls and fire partitions must be designated on the drawings.

****

Where pipes pass through fire walls, fire partitions, fire rated pipe chase walls or floors above grade, provide a fire seal as specified in Section 07 84 00 FIRESTOPPING.

3.10.7 Escutcheons

Provide escutcheons at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons must be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons must be used. Escutcheons must be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrew.

3.11 ANCHORS

****

NOTE: Detail and indicate locations of pipe anchors.

****

Provide anchors where necessary or indicated to localize expansion or prevent undue strain on piping. Anchors must consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces must be installed using turnbuckles where required. Supports, anchors, or stays must not be attached in places where construction will be damaged by installation operations or by the weight or expansion of the pipeline.

3.12 PIPE EXPANSION

****

NOTE: Whenever possible, provisions for the expansion of piping will be made by offsets or changes in the direction of the run of pipe or by expansion loops. Expansion joints, when used, must be installed in readily accessible locations. Location and details of offsets, expansion joints, and expansion loops will be shown.

****

The expansion of supply and return pipes must be provided for by changes in the direction of the run of pipe, by expansion loops, or by expansion joints as indicated. Low temperature water and steam expansion joints may be one of the types specified. [High] [Medium] temperature water system expansion joints may be one of the joints specified, except slip-tube type.

3.12.1 Expansion Loops

Expansion loops must provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops must be cold-sprung and installed where indicated. Provide pipe guides as indicated.

3.12.2 Slip-Tube Joints

****

NOTE: Type I and III slip joint, packed expansion joints are adjustable gland type and require continuing maintenance to contain leakage and are now manufactured by only one company, making them proprietary.

****

Slip-tube type expansion joints must be used for steam and low temperature water systems only and must be installed where indicated. The joints must provide for either single or double slip of the connected pipes as indicated and for the traverse indicated. The joints must be designed for a working temperature and pressure suitable for the application and in no case less than [_____] kPa psig. The joints must be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connections must be flanged. Provide anchor bases or support bases must be provided as indicated or required. Initial setting must be made in accordance with the manufacturer's recommendations to allow for ambient temperature at time of installation. Pipe alignment guides must be installed as recommended by the joint manufacturer, but in any case must be not more than 1.5 m 5 feet from expansion joint, except in lines 100 mm 4 inches or smaller where guides must be installed not more that 600 mm 2 feet from the joint.

3.12.3 Bellows-Type Joint

Bellows-type joint design and installation must comply with EJMA Stds standards. The joints must be designed for the working temperature and pressure suitable for the application and must be not less than 1.03 MPa 150 psig in any case.

3.12.4 Flexible Ball Joints

****

NOTE: Ball joints may often be used to advantage instead of loops and expansion joints. Where used, they must be indicated on drawings in detail. Guides for ball joints will be as recommended by the manufacturer. Design details will include dimension between ball center-points in offset leg, and the distance and direction of desired cold set from offset leg centerline. Each expansion unit will consist of two, three, or four joints, but in no case less than two joints, as required to handle the system expansion. The ball joint arrangement at each expansion location must provide for total movement. The ball joint only moves in an angular offset or rotation mode. The configuration of the ball joint link will permit a 2 or 3 ball joint offset to absorb axial and/or lateral movement, but not a single ball joint; therefore, if axial and/or lateral movement is expected, use a 2 or 3 ball joint offset.

****

Flexible ball joints may be threaded (to 50 mm 2 inches only), flanged, or welded end as required. The ball-type joint must be designed and constructed in accordance with the generally accepted engineering principle stated in ASME B31.1, and ASME BPVC SEC VIII D1, where applicable. Flanges must conform to the diameter and drilling of ASME B16.5. Molded gaskets furnished must be suitable for the service intended.

3.13 VALVES AND EQUIPMENT ACCESSORIES

****

NOTE: Indicate type and location of valves on the drawings.

****

3.13.1 Valves and Equipment

Install valves at the locations shown or specified, and where required for the proper functioning of the system as directed. Gate valves must be used unless otherwise indicated, specified, or directed. Valves must be installed with their stems horizontal to or above the main body of the valve. Valves used with ferrous piping must have threaded or flanged ends and sweat-type connections for copper tubing.

3.13.2 Gravity Flow-Control Valve

****

NOTE: Paragraph will be deleted if the system is not to be used for heating domestic hot water or if the system is not an up-feed type with intermittent operation of the circulating pump. A flow-control valve is not required in such instances.

****

Install the valve to control the flow of water in the supply main near the heat exchanger. The valve must operate so that when the circulating pump starts, the increased pressure within the main will open the valve; when the pump stops, the valve will close. The valve must be constructed with a cast iron body and must be provided with a device whereby the valve can be opened manually to allow gravity circulation. The flow-control valve must be designed for the intended purpose, and must be installed as recommended by the manufacturer.

3.13.3 Thermometer Socket

Provide a thermometer well in each return line for each circuit in multicircuit systems.

3.13.4 Air Vents

****

NOTE: Indicate location of all air vents on the drawings and include details for high or medium temperature water vents.

****

Install vents where indicated, and on all high points and piping offsets where air can collect or pocket.

3.13.4.1 Water Air Vents

[High] [Medium] temperature water air vents must be as indicated. Vent discharge lines must be double-valved with globe valves and must discharge into a funnel drain.

3.13.4.2 Steam Air Vents

Steam air vents must be a quick-acting valve that continuously removes air. Valve must be constructed of corrosion-resisting metal, must be designed to withstand the maximum piping system pressure, and must automatically close tight to prevent escape of steam and condensate. Vent must be provided with a manual isolation valve. Provide a vent on the shell of each steam heat exchanger.

3.14 STEAM TRAPS

Install float Traps in the condensate line as indicated. Other steam traps must be installed where indicated.

3.15 UNIT HEATERS

Install unit heaters as indicated and in accordance with the manufacturer's instructions.

3.16 INSULATION

Thickness of insulation materials for piping and equipment and application must be in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.17 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, and testing of the equipment.

3.18 TESTING AND CLEANING

Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

3.18.1 Pressure Testing

Notify the Contracting Officer [_____] days before the tests are to be conducted. Perform the tests in the presence of the Contracting Officer. Furnish all instruments and personnel required for the tests. Electricity, steam, and water will be furnished by the Government. All test results must be accepted before thermal insulation is installed. The entire low temperature heating system, including heat exchanger, radiators and fittings, must be hydrostatically tested and proved tight under a pressure of 310 kPa 45 psig for a period of four hours.

3.18.2 Test of Backflow Prevention Assemblies

Test backflow prevention assemblies in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.18.3 Cleaning

After the hydrostatic and backflow prevention tests have been made and prior to the operating tests, the heat exchanger and piping must be thoroughly cleaned by filling the system with a solution of 0.5 kg 1 pound of caustic soda or 0.5 kg 1 pound of trisodium phosphate per 200 L 50 gallons of water. Observe the proper safety precautions in the handling and use of these chemicals. Heat the water to approximately 66 degrees C 150 degrees F, and circulate the solution in the system for a period of 48 hours, then drain and flush the system thoroughly with fresh water. Wipe clean all equipment , and remove all traces of oil, dust, dirt, or paint spots. The Contractor will be responsible for maintaining the system in a clean condition until final acceptance. Lubricate bearings with oil or grease as recommended by the manufacturer.

3.18.4 Water Treatment Testing

Identify in the water quality test report the chemical composition of the heating water. The report must include a comparison of the condition of the water with the chemical company's recommended conditions. Document any required corrective action within the report. Analyze the heating water [prior to the acceptance of the facility] [and] [a minimum of once a month for a period of one year] by the water treatment company. The analysis must include the following information recorded in accordance with ASTM D596.

Date of Sample	[_____]

Temperature	[_____] degrees C F
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (C1)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] ppm (mg/1)
Noncarbonate Hardness	[_____] epm (mg/1)
Total Hardness	[_____] epm (mg/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] microsiemens/cm

3.19 FRAMED INSTRUCTIONS

Submit proposed diagrams, instructions, and other sheets, prior to posting. Show in the instructions wiring and control diagrams and complete layout of the entire system. The instructions must include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system. Post framed instructions, containing wiring and control diagrams under glass or in laminated plastic, where directed. Condensed operating instructions, prepared in typed form, must be framed as specified above and posted beside the diagrams. Post the framed instructions before acceptance testing of the system.

3.20   FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [_____] hours of normal working time starting after the system is functionally complete but prior to final acceptance tests. Field training must cover all of the items contained in the approved Operation and Maintenance Manuals. Submit [6] [_____] copies of operation and [6] [_____] copies of maintenance manuals for the equipment furnished. One complete set, prior to performance testing and the remainder upon acceptance. Operating manuals must detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals must include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals must list routine maintenance procedures, water treatment procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals must include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Provide manuals prior to the field training course.

3.21   TESTING, ADJUSTING AND BALANCING

Except as specified herein, testing, adjusting, and balancing must be in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 58 00.00 10 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-23 70 03.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 58 00.00 10

CENTRAL STEAM HEATING AND UTILITIES SYSTEMS

05/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 58 00.00 10 (May 2020)**

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References are in agreement with UMRL dated January 2025
****

SECTION 23 58 00.00 10

CENTRAL STEAM HEATING AND UTILITIES SYSTEMS
05/20

****
NOTE: This guide specification covers the requirements for two types of central steam heating systems and one type of central steam utilities system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: If the steam is required exclusively either for heating or for utilities, the specification will be revised by the deletion of requirements which are inapplicable to the system required for the project.

a. Steam heating systems: Operate steam heating systems at a pressure of approximately 35 kPa 5 psig. Supply steam from a central steam plant and reduce to the specified gauge pressure.

(1) Vacuum-return system: Retuen condensate from the heating system by vacuum to the vacuum pumping unit which will pump the condensate back to the

central steam plant.

(2) Gravity-return system: Return condensate from the heating system by gravity to a condensate pumping unit which will pump the condensate back to the central steam plant.

b. Steam utility systems: Steam utility systems must be of the two-pipe gravity-return type with steam supplied from a central plant at a gauge pressure of approximately 690 kPa 100 psig and reduced to a gauge pressure of approximately 275 kPa 40 psig. Supply steam to steam-using equipment without further reduction in pressure and return the condensate through medium-pressure traps, flash tanks, and a condensate pumping unit to the central system.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

ANSI/AHRI 850	(2004) Performance Rating of Commercial and Industrial Air Filter Equipment

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2022) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A504/A504M	(2018; R 2023) Standard Specification for Wrought Carbon Steel Wheels
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A659/A659M	(2012; R 2017) Standard Specification for Commercial Steel (CS), Sheet and Strip, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B251/B251M	(2017) Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
ASTM C700	(2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1693	(2015) Standard Test Method for Environmental Stress-Cracking of Ethylene

	Plastics
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

CAGI B19.1	(2010) Safety Standard for Compressor Systems

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

HYDRONICS INSTITUTE DIVISION OF AHRI (HYI)

HYI-005	(2008) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION (PHCC)

NAPHCC NSPC	(2015) National Standard Plumbing Code Illustrated

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings

Installation

Pipe Anchors

SD-03 Product Data

Welding

System Equipment

Framed Instructions

SD-06 Test Reports

Adjusting, Balancing, Testing and Inspecting

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Welding

****

NOTE: If need exists for more stringent requirements for weldments, delete the first bracketed statement and the welding submittal.

****

[Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Weld piping in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify Contracting Officer 24 hours in advance of tests and perform tests at the work site if practical. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.3.2 Use of Asbestos Products

Products which contain asbestos are prohibited. This prohibition includes items such as packings or gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Provide the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment for each major item of equipment.

2.1.3 Prevention of Rust

Unless otherwise specified, surfaces of ferrous metal subject to corrosion must be factory prime painted with a rust inhibiting coating and subsequently factory finish painted in accordance with the manufacturer's standard practice. Equipment exposed to high temperature when in service must be prime and finish painted with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil.

2.1.4 Equipment Guards and Access

****

NOTE: Catwalk, ladder, and guardrail will be indicated if required for access to equipment. If not applicable delete the entire sentence within the brackets.

****

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact. Properly guard or cover high temperature equipment and piping exposed to contact by personnel or where a fire hazard will be created with insulation of a type specified. Provide items such as catwalks, operating platforms, ladders, and guardrails where shown and construct them in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.2 MATERIALS

****

NOTE: Copper tubing and steel pipe will be considered competitive unless one is not considered satisfactory for the project.

****

Submit spare parts data for each item of equipment provided, after approval of the drawings and not later than [_____] months before the date of beneficial occupancy. Include in the data a complete list of spare parts and supplies, with current unit prices and supply sources. Provide materials conforming to the following:

2.2.1 Filters

ANSI/AHRI 850.

2.2.2 Iron and Steel Sheets

2.2.2.1 Galvanized Iron and Steel

ASTM A659/A659M, ASTM A653/A653M with general requirements conforming to ASTM A504/A504M. Gauge numbers specified refer to manufacturer's standard gauge.

2.2.2.2 Uncoated (Black) Steel

Composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to manufacturer's standard gauge.

2.2.3 Pipe and Pipe Fittings

2.2.3.1 Adapters

Provide brass or bronze adapters for copper tubing for soldered fittings.

2.2.3.2 Cast Iron Pipe Fittings

ASME B16.1 or ASME B16.4, Class 125, type to match adjacent piping.

2.2.3.3 Clay Sewer Pipe

ASTM C700, Class 1, Type I, Style a.

2.2.3.4 Copper Tubing

ASTM B88, ASTM B88M, Type K or L. For compressed air tubing, ASTM B251/B251M.

2.2.3.5 Fittings for Brass or Copper Pipe

ASME B16.15, Class A or B.

2.2.3.6 Fittings for Copper Tubing

Cast or wrought bronze or wrought copper, soldered-joint, brazed-joint, or flared-joint type, as specified, completely fabricated at the factory. Provide bronze threaded fittings conforming to the applicable requirements of ASME B16.15. Proide cast copper alloy solder joint pressure fittings conforming to ASME B16.18. Use fittings on Type L tubing that are brazed-joint type of cast or wrought bronze or wrought copper. Use fittings on Type K tubing that are cast bronze flared joint type. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Design grooved mechanical joints and fittings for no less than 862 kPa 125 psig service and must be the product of the same manufacturer. Provide ductile iron grooved fitting and mechanical coupling housing conforming to ASTM A536. Use gaskets in grooved joints that are molded synthetic polymer of pressure responsive design and conforming to ASTM D2000 for circulating medium up to 110 degrees C 230 degrees F. Provide grooved joints conforming to AWWA C606. Use steel coupling nuts and bolts in grooved joints conforming to ASTM A183.

2.2.3.7 Malleable Iron Pipe Fittings

ASME B16.3, type required to match adjacent piping.

2.2.3.8 Nipples

ASTM A733, standard weight.

2.2.3.9 Pipe

ASTM A53/A53M or ASTM A106/A106M, Grade A or B, black steel. Provide standard weight pipe unless otherwise specified.

2.2.3.10 Welding Fittings for Pipe

ASME B16.9.

2.2.3.11 Pipe Flanges and Flanged Fittings

Steel flanges, ASTM A181/A181M and ASME B16.5. Convoluted flanges must mate with ASME B16.5, Class 150 flanges. Affix the manufacturer's trademark to flanges and fittings in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.2.3.12 Pipe Hangers, Inserts, and Supports

MSS SP-58.

2.2.3.13 Pipe Threads

ASME B1.20.2MASME B1.20.1.

2.2.3.14 Solder, Silver

AWS A5.8/A5.8M, or the solder metal must conform to ASTM B32 95-5 tin antimony.

2.2.3.15 Unions

ASME B16.39, type to match adjacent piping.

2.2.3.16 Gaskets

ASME B16.21. Approved metallic self-centering style and ring style gasket consisting of metallic retainer and sealing gland may be used for intended service.

2.2.4 Polyethylene Tubing

Low-density virgin polyethylene conforming to ASTM D1248, Type I, Category 5, Class B or C.

2.2.5 Valves

2.2.5.1 Check Valves

a. Sizes 80 mm 3 inches and less, bronze: MSS SP-80, Type 3 or 4, Class 125.

b. Sizes 50 mm 2 inches through 600 mm 24 inches, cast iron: MSS SP-71, Type III or IV, Class 125.

2.2.5.2 Globe Valves

a. Sizes 80 mm 3 inches and less, bronze: MSS SP-80, Type 1, 2, and 3, Class 125.

b. Sizes 50 mm 2 inches through 300 mm 12 inches, cast iron: MSS SP-85, Type III, Class 125.

2.2.5.3 Angle Valves

a. Sizes 80 mm 3 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 125.

b. Sizes 50 mm 2 inches through 300 mm 12 inches, cast iron: MSS SP-85, Type IV, Class 125.

2.2.5.4 Gate Valves

a. Sizes 80 mm 3 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 125.

b. Sizes 50 mm 2 inches through 1200 mm 48 inches, cast iron: MSS SP-70, Type I, Class 125, Design OT or OF (OS & Y), bronze trim.

2.2.5.5 Radiator Valves

Quick-opening disk type, angle-patterned, and constructed of brass. Provide valves with union radiator connections, spring-retained packing, and composition mushroom handles.

2.2.6 Electrical Motors

Provide motors as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.3 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls. Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics must be as specified or indicated. Provide premium efficiency type integral size motors in accordance with NEMA MG 1. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor must be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices not shown.

2.4 SYSTEM EQUIPMENT

2.4.1 Condensate Pumping Unit

****

NOTE: The number of pumps and the type of unit

required for the condensate pumping unit will be specified, and the inapplicable requirements will be deleted. If a vertical-type unit is specified, the motor may be mounted on the receiving tank top. Indicate size and location of vent pipe. If a condensate pumping unit is not required for the project, delete this paragraph. Requirements relative to the capacity of the condensate pumping unit will be supplied in brackets as follows.

Minimum Capacity for Condensate Pumps and Receivers

EDR, sq m sq ft	Pump capacity, L/s gpm	Capacity Receiving Tank, liters gallons
93 1000	0.10 1.5	75 20
186 2000	0.19 3.0	75 20
372 4000	0.38 6.0	114 30
557 6000	0.57 9.0	170 45
744 8000	0.76 12.0	227 60
929 10,000	0.95 15.0	284 (75)
1394 15,000	1.4 22.5	435 115
1858 20,000	1.9 30.0	568 150
2323 25,000	2.4 37.5	719 190)
2787 30,000	2.8 45.0	852 225
3716 40,000	3.8 60.0	1136 300
4645 50,000	4.7 75.0	1420 375
6968 75,000	7.1 112.5	2158 570

****

Each pump must have a minimum capacity of [_____] L/second gpm when discharging against the specified pressure. Minimum capacity of the tank must be [_____] liters gallons. Provide condensate pumping unit of the [single] [duplex], [horizontal-shaft] [vertical-shaft] type. Provide unit consisting of [one pump] [two pumps] [one electric motor] [two electric motors] and a single receiver. Pump must be centrifugal or turbine type, bronze-fitted throughout, with impellers of bronze or other corrosion-resistant metal. Use pumps that are free from air-binding when handling condensate up to 95 degrees C 200 degrees F. Connect pumps directly to drip-proof enclosed motors. Provide cast iron receiver with condensate return, vent, overflow, and pump suction connections, water level indicator and automatic air vent. Provide strainer in the inlet line to tank. Provide galvanized steel vent pipe with galvanized malleable iron fittings. Install vent pipe as indicated. Flash vent piping as specified. Pump, motor, and receiving tank may be mounted on a single base with the receiver pipe to the pump suction. Provide a gate valve and check valve in the discharge connection from each pump. Install enclosed float switches complete with float mechanism in the head of the receiver. Control each condensate pump automatically by means of the respective float switch that will automatically start or stop the motor when the water in the receiver reaches the high or low level respectively. Provide motors with magnetic across-the-line starters equipped with general purpose enclosure and "Automatic-Manual-Off" selector switch in the cover. Provide automatic alternator for duplex units.

2.4.2 Vacuum Pumping Unit

****

NOTE: The number of pumps for the vacuum pumping unit will be specified; and the inapplicable material in brackets will be deleted. If a vacuum pumping unit is not required for the project, delete the paragraph.

****

Provide vacuum pumping unit consisting of a [single pump, motor, and receiving tank, [pumps, motors, and other functioning parts in duplicate, and a single receiving tank, as indicated]]. Arrange unit for automatic operation. Each pump must be suitable for the number of square feet of equivalent direct radiation (EDR) and the discharge pressure indicated. Provide a two-compartment type receiver, constructed of close-grained cast iron with multijet vacuum producers. Pumping unit must be close coupled vertical design, bronze-fitted with stainless steel shafts, enclosed bronze impeller, renewable bronze case ring, and mechanical shaft seal. Mount equipment, including pumps, motors, and receiver preferably on a single base. Accessories consist of a compound gauge, inlet strainer, thermometer, water level gauge with stopcocks, adjustable vacuum relief valve, air and condensate discharge check valves, and companion flanges for all flanged connections. Provide pump discharge line with a check valve and globe valve.

2.4.2.1 Capacity

****

NOTE: The following information will be used as a guide for information, relative to the capacity of the vacuum pumping unit.

Vacuum Pump Sizing Guide, Metric Inch-Pound			
A	**B**	**C**	**D**
2,500 232	**3.8 0.24**	**1.3 0.08**	**1.3 0.04**
5,000 465	**7.5 0.47**	**2.5 0.16**	**2.5 0.07**
10,000 929)	**15.0 0.95**	**5.0 0.32**	**4.0 0.11**
15,000 1394	**22.5 1.4)**	**7.5 0.47**	**5.4 0.15**

Vacuum Pump Sizing Guide, Metric Inch-Pound

A	B	C	D
20,000 1858	**30.0 1.9**	**10.0 0.63**	**6.8 0.19**
25,000 2323	**37.5 2.4**	**12.5 0.79**	**8.3 0.24**
30,000 2787	**45.0 2.8**	**15.0 0.95**	**9.7 0.27**
40,000 3716	**60.0 3.8**	**20.0 1.3**	**12.6 0.36**
65,000 6039	**97.5 6.2**	**32.5 2.1**	**19.8 0.56**
100,000 9290	**150.0 9.5**	**50.0 3.2**	**30.0 0.85**

Column A - Square meters feet equivalent direct radiation (EDR).

Column B - Minimum water capacity (liters per secondgallons per minute) only at 71 degrees C 160 degrees F, with 140 mm 5-1/2 inch heating vacuum and the required discharge pressure.

Column C - Minimum capacity liters per second gpm from system with simultaneous pumping of both water and air, maintaining 140 mm 5-1/2 inch vacuum at 71 degrees C 160 degrees F.

Column D - Minimum liters cubic feet of air handled by the pump with simultaneous pumping of both water and air, maintaining 140 mm 5-1/2 inch vacuum at 71 degrees C 160 degrees F.

The condensate receiving tank will have a capacity between the float-switch start and stop of not less than 1/2 the flow capacity of the pump listed in column B.

****

Minimum capacity, water only, of the pumping unit must be [_____] L/second gpm, at 70 degrees C 160 degrees F with 139.7 mm 5-1/2 inch heating vacuum and the required discharge pressure. Minimum capacity of the pumping unit must be [_____] liters gallons of water and [_____] L/second cfm of air with simultaneous pumping of both water and air and with a 139.7 mm 5-1/2 inch vacuum at 70 degrees C 160 degrees F. Provide condensate receiver with a capacity, between float-switch start and stop, of no less than [_____] liters gallons.

2.4.2.2 Motor and Controls

Drive each pump by a sleeve- or ball-bearing motor of such size that the brake horsepower required by the pumping unit under the specified rated capacities does not exceed the nameplate rating of motor. Motor must be drip-proof type and conform to the requirement specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide fully automatic controls for each pump motor, consisting of a float in the receiving tank, a float switch, an adjustable vacuum switch, an automatic across-the-line magnetic starter providing thermal-overload protection, and a Float and Vacuum (fully automatic control) Float Only-Continuous-Off selector switch.

2.4.3 Space Temperature Controls

****

NOTE: The space temperature controls shown will be reviewed and the inappropriate paragraphs will be deleted. Indicate on the drawings the locations where metallic raceway or electric metallic tubing is not required for protection of nonmetallic tubing. Delete air dryer and standby compressor when not required.

****

Provide pneumatic, electric, or electronic space temperature control system. Include control wiring and tubing required to complete the space temperature control system.

2.4.3.1 Air Compressor

Where pneumatic controls are furnished, provide an air compressor of the standard piston type complete with air tanks, air dryer, and other appurtenances. Compressor and installation must comply with CAGI B19.1. Compressor must be of sufficient capacity to provide continuous control air when operating on a 1/3-on 2/3-off cycle and provide with a visible oil-level sight glass and oil filter. Use air dryers of the silicagel type with reactivation, or of the refrigerated type, and maintain the air in the system with a dew point low enough to prevent condensation (minus 11 degrees C 13 degrees F at 125 kPa 18 psi main pressure). Locate air dryer at the outlet of the tank. Provide a standby compressor of capacity equal to the basic compressor with interlocked control system to provide automatic changeover upon the malfunction or failure of basic compressor. Provide a manual selector switch to index the lead compressor including the automatic changeover.

2.4.3.2 Air Lines

Air lines for pneumatic controls must be seamless copper tubing or nonmetallic tubing. Conceal piping except in mechanical rooms or areas where other piping is exposed. Use hard-drawn copper tubing in exposed areas and either hard-drawn or annealed in concealed intervals and run parallel to the lines of the building. Only tool-made bends will be acceptable. Fittings for copper tubing must be brass or copper solder joint-type except at connections to apparatus, where fittings must be brass compression-type. Nonmetallic tubing must be polyethylene, meeting the stress crack test of ASTM D1693. Individual tube polyethylene or multitube instrument tubing bundle must be classified as flame retardant under UL 94 and the polyethylene material must be rated as self-extinguishing when tested in accordance with ASTM D635. Run nonmetallic tubing within securely supported rigid metallic raceway or electric metallic tubing except as indicated. Single nonmetallic tubing in a protective sheath may be used above accessible ceilings and in other concealed accessible locations. Tubing concealed in walls containing insulation, fill, or other packing materials must be hard-drawn copper tubing or nonmetallic tubing run in conduit. Terminal single lines must be hard-drawn copper tubing, except if the run is less than 300 mm 12 inches, flexible polyethylene may be used. Do not use nonmetallic tubing for applications where the tubing could be subjected to a temperature exceeding 55 degrees C 130 degrees F. Multitube instrument bundle may be used in place of single tube where a number of tubes run to the same points. Periodically test tubing for leaks during installation and verify all tubing is free of installation impurities and moisture before connecting to the control instrument. Fittings for polyethylene tubing must be for instrument service and may be brass or acetal homopolymer of the compression or barb push-on type. Tubing must be number coded or color coded and keyed to the submittal drawings for future identifying and servicing of the control system.

2.4.3.3 Room Thermostats

Provide standard commercial type thermostats with an adjustable differential and a set-point range of [15 to 30 degrees C 60 to 90 degrees F] [5 to 20 degrees C 40 to 70 degrees F].

2.4.3.4 Outdoor Reset Thermostat

Provide adjustable type thermostat set for a design temperature of [_____] degrees C degrees F with a heating supply water temperature of [_____] degrees C degrees F. Provide a suitable ventilated weather shelter for the outside sensing element. Mount unit indoors with its sensing element located in the outside air. Unit must proportionally reset the control point of a remote sensing temperature controller.

2.4.3.5 Seven-Day Program Timer

Provide timer with the proper switching action so that one timer will switch all zones. Provide timer schedule for each zone to raise and lower the temperature twice during each 24-hour period throughout the week. During the weekend, there must be one cycle of raising and lowering the zone temperature.

2.4.4 Control Valves and Controllers

****

NOTE: Use the thermostatic steam regulating valve for constant temperature applications such as domestic hot water. Use steam pressure reducing valves where reduced constant downstream pressure is required. A central steam plant often requires this type of valve to reduce pressure prior to the distribution system.

****

2.4.4.1 Thermostatic Steam Regulating Valve

Provide adjustable valve with an operating range of approximately 38 to 95 degrees C 100 to 200 degrees F and furnish with a thermostatic element, steam valve, connecting capillary tubing, and all required accessories. Insert thermostatic element in a separable socket in the hot-water supply main. Construct parts subject to wear of noncorrodible metal and ensure parts are easily replaceable.

2.4.4.2 Pressure-Reducing Valves

Provide valves designed for a working pressure of no less than 860 kPa 125 psig where indicated or otherwise required. Adjust each reducing valve to maintain the desired terminal pressure within 20 kPa 3 psi, regardless of fluctuations in the initial pressure. Valves must be quiet in operation. Reducing valves provided in lines for space heating only must be of the double disk and seat type or sliding gate and plate type. Provide single-seated or sliding gate and plate type reducing valves for dead-end service. Construct parts subject to wear of noncorrodible metal and ensure parts are easily replaceable.

2.4.4.3 General Purpose Control Valves and Controllers

Provide control valves and controllers as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.4.5 Flash Tank

****

NOTE: If no flash tanks are required for the project, this paragraph will be deleted.

****

Size and install tank as indicated. Provide tank of welded construction utilizing black steel sheets no less than [_____] mm inches thick. Provide tank with a handhole and with tapping for the condensate returns, drip lines, vent line, and condensate discharge line. Equip discharge line with a float trap. Provide galvanized steel vent pipe and galvanized malleable iron fittings. Install vent pipe as indicated. Flash vent piping as specified.

2.4.6 Steam Traps

2.4.6.1 Float Traps

****

NOTE: Indicate steam trap capacities, working pressures, and differential pressures on drawings.

****

Provide capacity, working pressure, and differential pressure of the traps as indicated.

2.4.6.2 Float-and-Thermostatic Traps

Design traps for a steam working pressure of approximately 105 kPa 15 psig, but operate with a supply pressure of approximately 35 kPa 5 psig. Capacity of the traps must be as indicated. Base trap capacity on a pressure differential of 2 kPa 1/4 psig. Provide each float-and-thermostatic trap with a hard-bronze, monel, or stainless steel valve seat and mechanism and brass float, easily removable for inspection or replacement without disturbing the piping connections. Inlet to each trap must have a cast-iron strainer, either an integral part of the trap or a separate item of equipment.

2.4.6.3 Bucket Traps

Provide inverted or vertical bucket type traps with automatic air discharge. Design traps for a working pressure of 1.03 MPa 150 psig, but operate under a steam supply pressure of approximately 275 to 690 kPa 40 to 100 psig. Each trap must have a heavy body and cap of fine-grained, gray cast iron. Make bucket of brass; the mechanism of hard bronze; the valve and seat of stainless or monel; or each of equivalent material. Test traps hydrostatically under a pressure of 1.5 MPa 200 psig. Traps must have capacities as indicated when operating under the specified working conditions. Provide strainer on the inlet connection of each trap.

Impact-operated traps, impulse-operated traps, or thermodynamic traps with continuous discharge may be installed in lieu of bucket traps, subject to approval. Thermostatic traps designed for a steam working pressure suitable for the application may be furnished in lieu of the traps specified above. Equip thermostatic traps with valves and seats of stainless steel, or monel metal, and base capacities on a pressure differential not in excess of the following:

Steam Working Pressure, kPa psig	Differntial, kPa psig
170-34525-50	14020
620-69090-100	55080

2.4.6.4 Thermostatic Traps

Install traps in the return connection from each radiator. Provide size and capacity of the traps as indicated. Install drip traps for mains, risers, and similar live lines with a cooling leg of 1.5 m 5 feet of bare 19 mm 3/4 inch pipe. Base capacity of all traps on a pressure differential of 20 kPa 3 psi. Design traps for a steam working pressure of 105 kPa 15 psig, but operate with a supply pressure of approximately 35 kPa 5 psig. Traps must be of the angle pattern with union inlet connections. Trap bodies and covers must be brass.

2.5 SPACE HEATING EQUIPMENT

2.5.1 Radiators and Convectors

****

NOTE: Delete references to types of radiation not required for the project. Indicate test pressures desired. Indicate types and sizes of radiators and convectors on drawings.

****

Provide radiators and convectors that are the types and sizes indicated. Provide each radiator and convector with a top supply and a bottom return connection at opposite ends. Supply connection to each radiator and convector must contain the radiator control valve, and the return connection must contain the thermostatic trap. Test radiators and nonferrous convectors hydrostatically at the factory under a pressure of [_____]kPa psig. Test cast iron convectors, after assembly, pneumatically under water at a pressure of no less than [_____] kPa psig.

2.5.1.1 Cast-Iron Radiators

Provide be gray cast iron radiators, free from sandholes and other defects. Connect sections with malleable iron nipples no less than 2.3 mm 0.09 inch thick at any point. Provide legless type cast-iron radiators, wall mounted by means of hangers as specified. Secure adjustable radiator hangers to the wall and hold the radiators near both ends, at both top and bottom, in such manner that the radiators cannot be removed without the use of tools. Use no less than two bolts to secure each hanger to the wall. Provide necessary angles, bolts, bearing plates, toggles, radiator grips, and other parts required for complete installation of the radiators.

2.5.1.2 Extended-Surface, Steel, or Nonferrous Tube-Type Radiators

****

NOTE: The types of cover grille selected for fin-type radiators will suit the particular building involved, and the bracketed portions of the paragraph which are not desired will be deleted.

****

Provide radiators consisting of metal fins permanently bonded to steel or nonferrous pipe cores, with threaded or sweat fittings at each end for connecting to external piping. Provide radiators with capacities no less than those indicated, determined in accordance with HYI-005. Equip radiators with [expanded-metal cover grilles fabricated from black steel sheets no less than 1.519 mm (16 gauge) 16 gauge, secured either directly to the radiators or to independent brackets.] [solid-front, slotted horizontal-top cover grilles fabricated from steel sheets no less than 1.214 mm (18 gauge) 18 gauge, secured either directly to the radiators or to independent brackets.] [Solid-front, slotted sloping-top cover grilles fabricated from black steel sheets no less than 1.519 mm (16 gauge) 16 gauge, independently secured to wall with brackets.]

2.5.1.3 Convectors

Construct convectors of cast iron or of nonferrous alloys, and install where indicated. Capacity of convectors must be as indicated. Overall space requirements for convectors must not be greater than the space provided. Provide convectors complete with heating units and enclosing cabinets having bottom recirculating opening, manual control damper and top supply grille. Construct convector cabinets of sheet steel no less than 0.91 mm (20 gauge) 20 gauge.

2.5.2 Unit Heaters

****

NOTE: Indicate capacity of unit heaters and heating and ventilating units on drawings.

If the project has critical areas where maximum noise level limits are required, the sentence in brackets will be retained and the brackets deleted. The maximum acceptable noise limits for these critical areas should be determined in NC level or dBA and should be indicated on drawings. The sentence in brackets will be deleted for noncritical areas. Sound values used should be selected based on a careful study of the design goal by the design engineer. Recommended sound values for speech communication, based on normal voice are, according to ASHRAE FUN SI ASHRAE FUN IP, as follows: 50 for fair; 44 for very good; and 38 for perfect speech intelligibility.

****

Provide heaters with a heating capacity not in excess of 125 percent of the capacity indicated. [Noise level of each unit heater for areas noted must not exceed the criteria indicated.]

2.5.2.1 Propeller Fan (Type I) Heaters

Design heaters for suspension and arrange for [horizontal] [vertical] discharge of air. Provide casings that are no less than 0.91 mm (20 gauge) 20 gauge black steel and finished with lacquer or enamel. Provide suitable stationary or rotating air deflectors to ensure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. Operate fans for vertical discharge type heaters at speeds not in excess of 1,200 rpm, except that units with 53 Megajoules (50,000 Btu) 50,000 Btu output capacity or less may operate at speeds up to 1,800 rpm. Use horizontal discharge type unit heaters that have discharge or face velocities not in excess of the following:

Unit capacity, liters per second cfm	Face velocity, meters per second fpm
Up to 472 1000	4.1800
473-14001001-3000	4.6900
1401 3001 and over	5.11000

2.5.2.2 Centrifugal Fan (Type II) Heaters

Arrange heaters for floor or ceiling mounting. House heating elements and fans in steel cabinets of sectionalized steel plates or reinforce with angle-iron frames. Construct cabinets of no lighter than 1.214 mm (18 gauge) 18 gauge black steel. Provide each unit heater with a means of diffusing and distributing the air. Mount fans on a common shaft, with one fan to each air outlet. Equip fan shaft with self-aligning ball or roller bearings and accessible means of lubrication. Fan shaft may be either directly connected to the driving motor or indirectly connected by adjustable V-belt drive rated at 150 percent of motor capacity. Fans in any one unit heater must be the same size.

2.5.2.3 Heating Elements

Provide heating coils and radiating fins consisting of nonferrous alloy. Ensure heating elements are free to expand or contract and pitched for drainage. Test elements under a hydrostatic pressure of 1.4 MPa 200 psig.

2.5.2.4 Motors

Provide motors with manual selection switches for [On-Off-Automatic] [On-Off] [High/Low-Off] operation and equip with thermal overload protection.

2.5.3 Heating and Ventilating Units

****

NOTE: Indicate capacity of unit heaters and heating and ventilating units on drawings.

****

Provide ceiling- or floor-mounted type, self-contained, units with the heating coils, fans, dampers, and filters completely encased in a steel housing of sectionalized steel plates or reinforced with an angle-iron frame. Provide each unit with latched, removable access panels located so that any equipment within the housing can be removed for cleaning or maintenance. Insulate fan section of the housing internally with no less than 40 mm 1-1/2 inches of fibrous glass insulation of no less than 12 kg/cubic meter 3/4 pound/cubic foot density and maximum K-factor of 0.26.

2.5.3.1 Heating Coil

Use nonferrous alloy coil that is free to expand and contract, and pitched for drainage. Test coil hydrostatically after assembly of the unit and provide tight under a gauge pressure of 1.4 MPa 200 psig.

2.5.3.2 Fans and Drive

Provide multiblade centrifugal type fans, one to each air outlet, mounted on a common shaft. Use the same size fans within any one unit. Install fan units on vibration isolators and completely isolate from the building structure. Provide ball, roller, or taper type bearings with lubrication fittings, externally accessible at the drive side of the unit. Connect fans directly or indirectly to the driving motors through V-belt drive. V-belt drive must be rated for 150 percent of motor capacity. Provide adjustable sheaves to produce at least 20 percent fan speed adjustment. Select sheaves to produce specified fan capacity at the midpoint of the adjustment.

2.5.3.3 Motor

Provide motor with general purpose type enclosure. Operate direct-connected motors at a speed not in excess of 1,200 rpm, and operate motors using V-belt drives at 1,750 rpm. Provide adjustable base rails for motors of V-belt driven fans.

2.5.3.4 Filters

****

NOTE: Where the number of filters required is too small to justify the installation of washing tanks, disposable filters will be specified and cleanable filters will be deleted. Otherwise disposable will be deleted. The requirement for washing and charging tanks will be deleted if centralized washing and charging facilities are available, and the sentences in brackets will be deleted.

****

Provide filters and filter racks of the V- or flat-type arrangement. Use filters that are removable from one accessible side of the unit. Filters must be [[25 mm 1 inch] [50 mm 2 inches] thick replaceable throw-away type, in accordance with ANSI/AHRI 850] [of cleanable type, in accordance with ANSI/AHRI 850, 25 mm 1 inch thick, or the size required to suit the application. Furnish viscous adhesive in 19 L 5 gallon containers in sufficient quantity for 12 cleaning operations; provide no less than one quart for each filter section. [Provide one washing and charging tank for every 100-filter section or fraction thereof. Each washing and charging unit must accommodate [_____] filters.]]

2.5.3.5 Duct Connections

Provide outside air intake with aluminum, copper, or galvanized steel rain louvers with [13 mm 1/2 inch mesh, 18 gauge galvanized wire screen] [and] [16 by 18 mesh] [copper] [aluminum] [insect screen]. Construct intake box of no less than 0.91 mm (20 gauge) 20 gauge galvanized steel. Separate dissimilar metal from galvanized steel by plastic membrane. Provide discharge ductwork, diffusers, registers, and grilles as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5.3.6 Dampers

Provide galvanized steel, opposed-blade type dampers with ball bearings. Provide mixing dampers for outside and return air as one assembly in a mixing box.

2.6 SYSTEM ACCESSORIES

2.6.1 Foundations and Anchorage

Provide foundations and anchorage for pumping units and for other heating equipment in accordance with the manufacturer's requirements.

2.6.2 Pressure Gauges and Thermometers

Provide gauges for piping as indicated. Provide gauges that comply with ASME B40.100 and thermometers that comply with ASME PTC 19.3 TW. Provide a thermometer and pressure gauge on the steam supply and return mains. Provide separable socket type thermometers.

2.6.3 Vacuum Relief Valve

Install an approved vacuum relief valve where indicated. On shutoff of steam supply and condensing of steam, the vacuum relief valve must automatically admit air to the system.

2.6.4 Safety Valves

Provide pop safety valves on the low side of each pressure reducing valve. Set valves to open automatically and to relieve steam at 35 kPa 5 psi in excess of the setting of the reducing valve, or as indicated. Provide safety valves conforming to the requirements of ASME BPVC SEC VIII D1 and install as indicated.

2.6.5 Drains

Install a drain connection with 25 mm 1 inch gate valve or 19 mm 3/4 inch hose bib at the lowest point in the return main. In addition, install threaded drain connections with threaded cap or plug wherever required for thorough draining of the steam system.

2.7 PIPING AND ACCESSORIES

2.7.1 Pipe and Fittings

2.7.1.1 Steam Piping and Fittings

Provide black steel piping conforming to ASTM A53/A53M, Grade A. Provide black, malleable iron or steel fittings. For fittings adjacent to valves, use fittings that suit valves specified. Use reducing fittings for changes in pipe sizes. In horizontal steam lines, use the eccentric type reducing fittings to maintain the bottom of the lines at the same level.

2.7.1.2 Condensate Return Piping and Fittings

Provide black steel, extra strong weight piping conforming to ASTM A53/A53M, Grade A. Provide cast iron or malleable iron, extra heavy fittings.

2.7.1.3 Vent Piping and Fittings

Provide black steel piping, conforming to ASTM A53/A53M, Grade A. Use black malleable iron fittings to suit piping. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.7.1.4 Gauge Piping

Provide copper tubing, Type K or L, piping for steam and condensate 170 kPa 25 psig and less and steel for greater than 170 kPa 25 psig.

2.7.2 Joints

Except as otherwise specified, use fittings on steel pipe that is threaded for fittings 25 mm 1 inch and smaller; threaded or welded for fittings 32 mm 1-1/4 inches up through 65 mm 2-1/2 inches; and flanged or welded for fittings 80 mm 3 inches and larger. Use flared or sweated joints between sections of copper tubing or pipe. Weld pipe and fittings 32 mm 1-1/4 inches and larger and installed in inaccessible conduits or trenches beneath concrete floor slabs. Unless otherwise specified, make connections to equipment with black malleable iron unions for pipe 65 mm 2-1/2 inches or smaller in diameter, and with flanges for pipe 80 mm 3 inches or more, in diameter.

2.7.2.1 Bellows-Type Joints

Provide flexible, guided type joints. Provide stainless steel. Provide joints in accordance with the applicable requirements of EJMA Stds and ASME B31.1 with internal liners.

2.7.2.2 Flexible Ball Joints

Construct joints of stainless steel, malleable iron, ductile iron, carbon steel, bronze, or other alloys as appropriate for the service intended.

2.7.2.3 Dielectric Waterways and Flanges

Provide dielectric waterways conforming to the tensile strength and dimensional requirements specified in ASME B16.39. Provide waterways with metal connections on both ends suited to match adjacent piping. Line dielectric waterways internally with an insulator specifically designed to prevent current flow between dissimilar metals. Provide dielectric waterways with pressure and temperature rating equal to or greater than that specified for the connecting piping. Use dielectric flanges meeting the performance requirements described herein for dielectric waterways.

2.7.3 Strainers

Provide basket or Y-type strainers that are the same size as the pipelines in which they are installed. Provide cast-iron strainer bodies rated for Class 125 125 pound service, with bottoms drilled and plugged. Cast arrows cast on the sides of bodies to indicate the direction of flow. Equip each strainer with a removable cover and sediment basket. Basket must not be less than 0.76 mm (22 gauge) 22 gauge and have perforations to provide a net free area through the basket of at least four times that of the entering pipe.

2.8 SEQUENCE OF AUTOMATIC CONTROLS

Sequence of automatic controls must be as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.9 FACTORY COATING

Coat radiator and convector enclosures with the manufacturer's standard rust inhibiting primer. Other equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

****

NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 222 Newtons 50 pounds must have the excess hanger loads suspended from panel points.

All pertinent piping and related equipment supports should be designed and indicated in accordance with paragraph Pipe Supports and Structural Bracing, Seismic Requirements below. The reference to the ICC IBC will allow for deviations from the design drawings where required to match equipment actually supplied. Drawings must detail anchors and pipe guide and indicate location.

****

Install all work as indicated and in accordance with the manufacturer's diagrams and recommendations. Submit detail drawings consisting of schedules, performance charts, brochures, diagrams, drawings, and instructions necessary for installation of the systems as specified. Submit detail drawings for pumping units and appurtenances, including controls. Indicate in the Drawings clearances required for maintenance and operation and complete wiring and schematic diagrams, equipment layout and anchorage, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

3.2.1 Piping

Unless otherwise specified, install pipe and fittings conforming to the requirements of ASME B31.1. Cut pipe accurately to measurements established at the jobsite and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Cut piping or tubing square, remove burrs by reaming, and install to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Wipe filings, dust, or dirt from interior of the pipe or tubing before connections are made. Make changes in direction with fittings, except that bending of pipe up to 100 mm 4 inches size will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center line radius of bends must not be less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattenings, or other malformations will not be accepted. Install vent pipes through the roof as directed and flash as specified. Pitch horizontal supply mains up or down in the direction of flow as indicated. The grade must be no less than 25 mm in 12 m 1 inch in 40 feet. Use reducing fittings for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the systems. Provide uncoated pipe not otherwise specified. Use brass or bronze unions for copper pipe or tubing. Isolate connections between ferrous piping and copper piping electrically from each other with dielectric waterways.

3.2.1.1 Threaded Joints

Make threaded joints with tapered threads properly cut, and make tight with polytetrafluoroethylene (PTFE) tape complying with ASTM D3308, or equivalent joint compound applied to the male threads only, and in no case to the fittings.

3.2.1.2 Welded Joints

Welded joints must be fusion-welded unless otherwise required. Make changes in direction of piping with welding fittings only. Branch connection may be made with either welding tees or forged branch outlet fittings. Provide forged, flared branch outlet fittings for improvement of flow where attached to the run, and reinforce against external strains. Beveling, alignment, heat treatment, and inspection of weld must conform to ASME B31.1. Remove weld defects and make repairs to the weld, or remove the weld joints entirely and reweld at no additional cost to the Government. Store and dry electrodes in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Do not use electrodes that have been wetted or that have lost any of their coating.

3.2.1.3 Flanges and Unions

Flanges and unions must be faced true, and made square and tight. Provide gaskets consisting of nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, full face or self-centering flat ring type. The gaskets must contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Use NBR binder for hydrocarbon service. Provide union or flange joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.2.1.4 Flared and Sweated Pipe and Tubing

Cut flared and sweated pipe and tubing square and remove burrs. Clean both inside of fittings and outside of tubing with an abrasive before sweating.

Take care to prevent annealing of fittings and hard drawn tubing when making connection. Install in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Make joints for soldered fittings with silver solder. Provide joints for flared-type fittings on all branch connections, mains, and risers to provide for expansion and contraction of the pipe without stress to fittings, pipe, or tubing.

3.2.1.5 Copper Tube Extracted Joint

An extracted mechanical tee joint may be used in copper tube. Produce joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch branch tube for proper penetration into fitting to ensure a free flow joint. Braze joints in accordance with the NAPHCC NSPC. Soldered joints will not be permitted.

3.2.1.6 Grooved Mechanical Joints

Prepare grooves according to the coupling manufacturer's instructions. Use grooved fittings, couplings, and grooving tools that are products of the same manufacturer. Pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Measure and record groove width and dimension of groove from end of pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Do not use grooved joints in concealed locations.

3.2.2 Connections to Equipment

Provide supply and return connections by the Contractor unless otherwise indicated. Install valves and traps in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of the supply and return pipes to each piece of equipment must not be smaller than the equipment connections. Make steam and return connections, unless otherwise indicated, with malleable iron unions for piping 65 mm 2-1/2 inches or less in diameter and with flanges for pipe 80 mm 3 inches or more, in diameter.

3.2.3 Branch Connections

****

NOTE: Indicate on the drawings the direction of piping pitch, details of branch take-offs from mains, and pipe size reductions.

****

Pitch branches up or down as indicated, unless otherwise specified. Make connection to ensure unrestricted circulation; eliminate air pockets; and permit drainage of the system. Pitch steam supply and condensate branches taken from mains with a grade of no less than 25 mm in 3 m 1 inch in 10 feet, unless otherwise indicated.

3.2.4 Risers

The location of risers is approximate. Exact locations of the risers must be as approved. Terminate steam supply downfeed risers in a dirt pocket and drip trap to the return.

3.2.5 Supports

3.2.5.1 General

Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support all piping subjected to vertical movement when operating temperatures exceed ambient temperatures, by variable spring hangers and supports or by constant support hangers. Pipe hanger loads suspended from steel joist between panel points must not exceed 222 Newtons 50 pounds. Supend loads exceeding 222 Newtons 50 pounds from panel points.

3.2.5.2 Pipe Supports and Structural Bracing, Seismic Requirements

****

NOTE: Provide seismic requirements, if a Government designer (Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

****

Supported and brace piping and attached valves to resist seismic loads as specified in UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS [as indicated]. Provide structural steel required for reinforcement to properly support piping, headers, and equipment but not shown,as specified in this section. Use material for supports as specified in Section 05 12 00 STRUCTURAL STEEL.

3.2.5.3 Pipe Hangers, Inserts, and Supports

Provide pipe hangers, inserts and supports conforming to MSS SP-58, except as modified herein.

a. Do not use Types 5, 12, and 26.

b. Do not use Type 3 on insulated pipe.

c. Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Torque Type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Do not construct C-clamp body from bent plate.

e. Furnish Type 20 attachments used on angles and channels with an added malleable iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Where type 39 saddle or type 40 shield are permitted for a particular pipe attachment application, use the type 39 saddle welded to the pipe, on all pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher. Use Type 40 shields on all piping less than 100 mm 4 inches and all piping 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F. Use a high density insulation insert of a density 130 kg/cubic meter 8 pcf or greater under the type 40 shield for piping 50 mm 2 inches and larger.

h. Space horizontal pipe supports as specified in MSS SP-58 and do not install a support over 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Do not space pipe supports over 1.5 m 5 feet apart at valves. In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. Connect clips or clamps rigidly to the common base member. Provide a clearance of 3 mm 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

i. Support vertical pipe at each floor, except at slab-on-grade, and at intervals of no more than 4.5 m 15 feet, no more than 2.4 m 8 feet from end of risers, and at vent terminations.

j. Provide Type 35 guides using steel, reinforced PTFE or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Provide slide materials suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

  (1) Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger carrying medium 16 degrees C 60 degrees F or higher, a type 39 saddle may be welded to the pipe and freely rest on the steel plate. On piping under 100 mm 4 inches and piping 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F a type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel plate. Use a high density insulation insert of density 130 kg/cubic meter 8 pcf or greater under all shields on piping 50 mm 2 inches and larger.

  (2) Where there are high system temperatures and welding to piping is not desirable, then the type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 100 mm 4 inches, or by an amount adequate for the insulation, whichever is greater.

k. Use pipe hangers on horizontal insulated pipe that are the size of the outside diameter of the insulation. Make insulation continuous through the hanger on all pipe sizes and applications.

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NOTE: Detail the methods of supporting pipe in trenches.

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l. Support piping in trenches as indicated.

3.2.6 Pipe Sleeves

****
NOTE: Fire walls and fire partitions must be designated on the drawings.
****

Provide pipe passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make rectangular and square openings as detailed on the drawings. Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Unless otherwise indicated, provide sleeves of such size as to provide a minimum of 6 mm 1/4 inch all around clearance between sleeve and bare pipe or insulation surface. Use steel pipe or cast-iron pipe sleeves in bearing walls, waterproofing membrane floors, and wet areas. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, cast-iron pipe, or galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire-rated walls and floors as indicated and specified in Section 07 92 00 JOINT SEALANTS and in fire-rated walls and floors must be as indicated and specified in Section 07 84 00 FIRESTOPPING. Pipes passing through wall waterproofing membrane must be sleeved as described above. In addition, install a waterproofing clamping flange as indicated.

3.2.6.1 Roof or Floor Penetrations of Waterproofing Membrane

****
NOTE: Indicate on drawings details of pipes through flashing or waterproof membrane, and method of sealing.
****

Install pipes through a 1.8 kg 4 pound lead-flashing sleeve, a 453 g 16 ounce copper sleeve, or a 0.081 mm 0.032 inch thick aluminum sleeve, each having an integral skirt or flange. Flashing sleeve must be suitably formed. Extend the skirt or flange 200 mm 8 inches or more from the pipe and set over the roof or floor membrane in a troweled coating of bituminous cement. Extend the flashing sleeve up the pipe a minimum of 50 mm 2 inches above the highest flood level of the roof or a minimum of 250 mm 10 inches above the floor or roof, whichever is greater. Seal the annular space between the flashing sleeve and the bare pipe or insulation surface as indicated. Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.2.6.2 Optional Sealing of Uninsulated Pipes

A modular mechanical type sealing assembly may be installed. Provide seals consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates.

Assemble links loosely with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.2.6.3 Optional Counterflashing

As an alternate to caulking and sealing the annular space between the flashing sleeve and bare pipe or insulation surface, counterflashing may be by standard roof coupling for threaded pipe up to 150 mm 6 inchesin diameter; lead-flashing sleeve for dry vents, sleeve turned down into the pipe to form a waterproof joint; or tack-welded or banded-metal rain shield around the pipe, sealed as indicated.

3.2.6.4 Escutcheons

Provide escutcheons at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Fasten escutcheons securely to pipe sleeves or to extensions of sleeves without any part of sleeves visible. Where sleeves project slightly from floors, use special deep-type escutcheons. Use chromium-plated iron or brass escutcheons, either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.2.6.5 Clay Sewer Pipe

Install pipe where indicated for housing steam-supply and condensate-return lines. Install sewer pipe on properly graded and well-tamped earth or gravel base. Pack joints with twisted-jute packing and sealed with bituminous sealing compound or portland cement mortar.

3.2.7 Pipe Anchors

****

NOTE: Detail and indicate location of pipe anchors.

****

Submit detailed drawings of pipe anchors, before installation. Provide anchors where necessary or indicated to localize expansion or prevent undue strain on piping. Provide anchors consisting of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces using turnbuckles where required. Locate supports, anchors, or stays located to prevent damage by installation operations or by the weight or expansion of the pipeline.

3.2.8 Pipe Expansion

****

NOTE: Steam piping layout should be analyzed for thermal stresses due to expansion. Spring hangers must be indicated on drawing and used to absorb vertical expansion of piping and seismic conditions.

Whenever possible, provisions for the expansion of piping will be made by offsets or changes in the

direction of the run of pipe or by expansion loops. Expansion joints will be permitted where restrictions of space prevent use of expansion loops or piping offsets. Install expansion joints, when used, in readily accessible locations. Drawings must detail anchors, pipe guide offsets, and expansion joints. Drawings must also indicate location.

****

Provide expansion of supply and return pipes for changes in the direction of the run of pipe, by expansion loops, or by expansion joints as indicated. Condensate and steam expansion joints must be one of the types specified.

3.2.8.1 Expansion Loops

Use expansion loops to provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. Provide cold-sprung loops and install where indicated. Provide pipe guides as indicated.

3.2.8.2 Slip-Tube Type Expansion Joints

Use slip-tube type expansion joints for steam and condensate systems only and install where indicated. Joints must provide for either single or double slip of the connected pipes and temperature and pressure suitable for application, in no case less than [_____] kPa psig. Joints must be in accordance with applicable requirements of EJMA Stds and ASME B31.1, Type I or III. End connections must be flanged. Provide anchor bases or support bases as indicated or required. Make initial setting in accordance with the manufacturer's recommendations to allow for ambient temperature at time of installation. Install pipe alignment guides as recommended by the joint manufacturer, but no more than 1.5 m 5 feet from expansion joint, except in lines 100 mm 4 inches or smaller where guides are installed no more than 600 mm 2 feet from the joint.

3.2.8.3 Bellows-Type Joint

Bellows-type joint design and installation must comply with EJMA Stds. Design joints for the working temperature and pressure suitable for the application but no less than 1.03 MPa 150 psig in any case.

3.2.8.4 Flexible Ball Joints

****

NOTE: Ball joints may often be used to advantage instead of loops and expansion joints. Where used, they must be indicated on plans in detail. Guides for ball joints will be as recommended by the manufacturer. Design details will include dimension between ball center-points in offset leg, and the distance and direction of desired cold set from offset leg centerline. Each expansion unit will consist of two, three, or four joints, but in no case less than two joints, as required to handle the system expansion. The ball joint arrangement at each expansion location must provide for total movement.

****

Flexible ball joints may be threaded, flanged, or welded end as required, and must be capable of absorbing the normal operating axial, lateral, or angular movements or combination in accordance with ASME B31.1, and ASME BPVC SEC VIII D1 where applicable. Provide flanges conforming to the diameter and drilling of ASME B16.5. Furnish molded gaskets suitable for the service intended.

3.2.9 Valves and Equipment

Install valves at the locations shown, where specified, and where required for the proper functioning of the system as directed. Use gate valves unless otherwise shown, specified, or directed. Install valves with their stems horizontal or above. Use valves with ferrous piping that have threaded or flanged ends for ferrous piping and sweat-type connections for copper tubing.

3.2.9.1 Thermometer Socket

Provide a thermometer well in each return line circuit in multicircuit systems.

3.2.9.2 Radiator Valves

Install an automatic or manual control valve and a 6 mm 1/8 inch air valve on each radiator and convector. Control valve must be the same size as supply connection. Deliver ten keys for air valves to the Contracting Officer. A fully automatic type air vent may be furnished for convectors in lieu of the manual air valves specified.

3.2.9.3 Steam Air Vents

****

NOTE: Indicate location of all air vents on the drawings. Details for vents must be indicated on the drawings.

****

Install vents where indicated. Run discharge pipes from the vent to a point as indicated. Vent must be a quick-acting valve that continuously removes air. Construct valve of corrosion-resisting metal, designed to withstand the maximum piping system pressure, and automatically closes tight to prevent escape of steam and condensate. Provide vent with a manual isolation valve.

3.2.9.4 Pressure Reducing Valves

Provide valves designed for a working pressure of no less than 860 kPa 125 psig wherever indicated or required. Install aech valve with a strainer, a three-valve bypass, and a safety valve.

3.2.10 Steam Traps

****

NOTE: Indicate size of flash tanks and installation detail on drawings. If no flash tanks are required for the project, modify bracketed choices.

****

Install float traps [in the condensate-discharge line from the flash tank and elsewhere as] [where] indicated. Install all other steam traps where indicated.

3.2.11 Unit Heaters

Install unit heaters as indicated and in accordance with the manufacturer's recommendation.

3.2.12 Insulation

Thickness and application of insulation materials for piping and equipment must be in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.3 FRAMED INSTRUCTIONS

Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, where directed. Submit proposed diagrams, instructions, and other sheets, before posting. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, frame as specified above for the wiring and control diagrams, and post beside the diagrams. Post framed instructions before acceptance testing of the system.

3.4 MANUFACURERS' FIELD SERVICES

Provide services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the specified equipment. Supervise installing, adjusting, and testing the equipment.

3.5 FIELD TRAINING

****

NOTE: The number of hours required to instruct a Government representative in operation and maintenance of the system will depend on the complexity of the system specified. Designer is to establish the number of hours of training based on equipment manufacturer recommendations, system complexity and consultation with the installation.

****

Conduct a training course for the maintenance and operating staff. Start training period of [_____] hours normal working time after the system is functionally complete but before the final acceptance tests. Give the Contracting Officer at least 2 weeks advance notice of such training. Include all of the items contained in the approved Operating and Maintenance Instructions as well as demonstrations of routine maintenance operations. Submit [6] [_____] complete copies of operation manuals outlining the step-by-step procedures required for system startup, operation, and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and a brief description of all equipment and their basic operating features. Submit [6] [_____] complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the manuals piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

3.6 ADJUSTING, BALANCING, TESTING AND INSPECTING

****

NOTE: Before occupancy of a facility, inspect the boilers in accordance with the Code of Boiler and Pressure Inspectors (BPVI) and the American Society of Mechanical Engineers (ASME). Inspectors must be certified in accordance with BPVI standards.

****

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completing and testing the system. Indicate in each test report the final position of controls.

3.6.1 Field Tests

Notify the Contracting Officer [_____] days before the performance and acceptance tests are to be conducted. Perform tests in the presence of the Contracting Officer. Furnish all instruments and personnel required for the tests. Electricity, steam, and water will be furnished by the Government. Before thermal insulation is installed, hydrostatically test the entire heating system, including all heating units, valves and fittings, at 1-1/2 times the design operating pressure for a minimum of 4 hours.

3.6.2 Cleaning and Adjusting

After hydrostatic tests have been made and prior to the operating tests, thoroughly clean piping by filling the system with a solution of one pound of caustic soda or 1.4 kg 3 pounds of trisodium phosphate per 380 liters 100 gallons of water. Heat water to approximately 65 degrees C 150 degrees F, and circulate the solution in the system for a period of 48 hours, then drain and thoroughly flush out with fresh water. Wipe equipment clean, with all traces of oil, dust, dirt, or paint spots removed. It is the Contractor's responsibility to maintain the system in a clean condition until final acceptance. Lubricate bearings as recommended by the manufacturer. Adjust belts with correct tension, and adjust other miscellaneous equipment to setting indicated or as recommended by the respective manufacturers.

3.6.3 System Operation

Upon completion and prior to acceptance of the project, the installation must be subjected to such operating tests as may be required to demonstrate that the steam heating system will operate as specified or indicated. Conduct tests by a qualified test engineer at such times as directed. Provide instruments, facilities, and labor required to conduct the tests. Read indicating instruments at 1/2-hour intervals, unless otherwise directed. Tests must cover a period of 3 or more hours for each system tested, and include the following applicable specific information together with conclusions as to the adequacy of the system in the test reports:

a. Time, date, and duration of test.

b. Flow and pressure of steam to the inlet of the equipment.

c. Make, model, and size of each piece of equipment.

d. Dry bulb temperature entering and leaving heating and ventilating units.

e. Static discharge pressure actually obtained, total cfm handled, and voltmeter and ammeter readings for fan motor during operation.

f. Heating output for space-heating equipment.

g. Capacity and discharge pressure of each pump.

h. Automatic control sequence and operation.

3.6.4 Balancing

Systems must be completely balanced by a qualified engineer. Submit a complete balancing procedure for approval. Provide all required piping, valves, and connections required to balance the systems.

Balance air systems as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

3.6.5 Retesting

Correct any deficiencies revealed during testing and reconduct tests.

3.7 FIELD PAINTING

****

NOTE: Color coding for piping identification as required by the using agency will be developed and inserted in the "Color Code Schedule" in Section 09 90 00 PAINTS AND COATINGS.

****

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 63 00.00 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-23 63 00.00 10 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 63 00.00

COLD STORAGE REFRIGERATION SYSTEMS

08/22

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 63 00.00 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-23 63 00.00 10 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 23 63 00.00

COLD STORAGE REFRIGERATION SYSTEMS

08/22

****

NOTE: This guide specification covers the requirements for refrigeration equipment for cold storage facilities.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 420	(2008) Performance Rating of Forced-Circulation Free-Delivery Unit Coolers for Refrigeration
AHRI 450	(2007) Water-Cooled Refrigerant Condensers, Remote Type
AHRI 490 I-P	(2011) Performance Rating of Remote Mechanical-Draft Evaporatively-Cooled Refrigerant Condensers
AHRI 700	(2016) Specifications for Fluorocarbon Refrigerants
AHRI 710 I-P	(2009) Performance Rating of Liquid-Line Driers
AHRI 711	(2009) Performance Rating of Liquid-Line Driers
AHRI 720	(2002) Refrigerant Access Valves and Hose Connectors
AHRI 750 I-P	(2016) Performance Rating of Thermostatic Refrigerant Expansion Valves
AHRI 751 SI	(2016) Performance Rating of Thermostatic Refrigerant Expansion Valves
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers
ANSI/AHRI 510	(2006) Performance Rating of Positive Displacement Ammonia Compressors and Compressor Units
ANSI/AHRI 520	(2004) Performance Rating of Positive Displacement Condensing Units

ANSI/AHRI 760	(2014) Performance Rating of Solenoid Valves for Use With Volatile Refrigerants

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 17	(2022) Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves
ASHRAE 23.1	(2019) Methods for Performance Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant
ASHRAE 64	(2020) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(2024) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A197/A197M	(2020; R 2023; E 2023) Standard Specification for Cupola Malleable Iron
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A278/A278M	(2001; R 2024) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)

ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A334/A334M	(2004a; R 2021) Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B280	(2023) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM C534/C534M	(2024) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D5864	(2011) Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components
ASTM D6081	(1998; R 2014) Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

COOLING TECHNOLOGY INSTITUTE (CTI)

CTI ATC-105	(2000) Acceptance Test Code

INTERNATIONAL INSTITUTE OF AMMONIA REFRIGERATION (IIAR)

IIAR 2	(2021) Standard for Design of Safe Closed-Circuit Ammonia Refrigeration Systems

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1424	(2016) Engineering and Design -- Lubricants and Hydraulic Fluids

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UL SOLUTIONS (UL)

UL 207	(2022) UL Standard for Safety Refrigerant-Containing Components and Accessories, Nonelectrical

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit

the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G, [_____]

Refrigeration Equipment; G, [_____]

SD-03 Product Data

Refrigeration System; G, [_____]

Spare Parts

Framed Instructions

Qualifying Procedures

Verification of Dimensions

Coil Corrosion Protection

Tests

Training; G, [_____]

Energy Star Label for Air-Cooled Condenser Product; S

Energy Star Label for Water-Cooled Condenser Product; S

Energy Star Label for Unit Cooler Product; S

SD-06 Test Reports

Tests

Pressure Vessels; G, [_____]

Aquatic Toxicity

SD-07 Certificates

Refrigeration System

Service Organizations

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Refrigeration Equipment; G

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

****

NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement; otherwise delete the second.

****

[Submit a letter listing the qualifying procedures for each welder including supporting data and a list of the names of qualified welders. Weld piping in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform at the work site if practical. Apply the personally assigned symbol near each weld made by the welder or welding operator as a permanent record.] [Use welding and nondestructive testing procedures as specified in Section 40 05 13.96 WELDING PROCESS PIPING.] Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

1.3.2 Drawings

Investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Fit equipment, ductwork, and piping arrangements into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Submit drawings providing adequate detail to demonstrate compliance with contract requirements and consisting of:

(1) Equipment layouts identifying assembly and installation details.

(2) Piping layouts which identify valves, fittings, pipe sizes, and pipe slopes. Clearly identify and explain any changes to the design.

(3) Plans and elevations which identify clearances required for maintenance and operation.

(4) Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

(5) Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

(6) Details of supports, if other than those indicated, including loadings and type of frames, brackets, stanchions, or others.

(7) Automatic temperature control diagrams and control sequences.

(8) Installation details which include the amount of factory set superheat and corresponding refrigerant pressure/temperature.

1.3.3 Service Organizations

Submit a certified list of qualified permanent service organizations for the specified equipment, as specified. Include their addresses and qualifications, for support of the specified equipment. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Modifications of References

Accomplish work in accordance with the referenced publications, except as modified by this section. Consider the advisory or recommended provisions to be mandatory, as though the word "must" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to "the Authority having jurisdiction," "the Administrative Authority," "the Owner," or "the Design Engineer" to mean the Contracting Officer.

1.3.5 Safety

Design, manufacture, and installat refrigeration equipment conforming to ASHRAE 15 & 34, UL 207, and NFPA 70. Provide personnel protection from moving parts including fans, pulleys chains gears and couplings. Guard or cover with insulation high temperature machinery and piping.

1.3.6 Pressure Vessels

The design, fabrication, inspection, and testing of pressure vessels including the waterside and refrigerant side of condensers and evaporators must be in accordance with ASME BPVC SEC VIII D1, and ASHRAE 15 & 34. The presence of the ASME official Code U-Symbol or Code UM-Symbol stamped or marked on the vessels, and the submitting of the applicable ASME required manufacturer's data report will be accepted as evidence that the pressure vessels comply to the ASME rules for construction. Where referenced publications do not apply, test pressure components tested at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed. [Where service temperatures below minus 7 degrees C 20 degrees F are encountered, materials of construction must be low temperature alloy carbon steel.] Nozzle length must be approximately 1/3 greater than insulation thickness. Fit insulated vessels with rings and other insulation supports as required for installation of insulation. Exterior surfaces of vessels which are insulated and vapor barrier sealed must be abrasive blasted and primed with 0.076 mm 3 mil dry film thickness of inorganic zinc rich coating.

1.3.7 Refrigeration Equipment

Include layout drawings and control diagrams of the refrigeration equipment.

1.3.8 Ozone Depleting Substances Technician Certification

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NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants, such as R-123, into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

****

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4 ENVIRONMENTAL REQUIREMENTS

Assess potential effects of all lubricants on aquatic organisms in accordance with ASTM D6081 and submit aquatic toxicity reports. Assess biodegradation in accordance with ASTM D5864. In accordance with EM 1110-2-1424 Chapter 8, aquatic toxicity must exceed 1,000 ppm at LL50 and biodegradation must exceed 60 percent conversion of carbon to carbon dioxide in 28 days.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather and contamination. Proper protection and care of material before, during, and after installation is the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. Cap piping and similar openings during installation to keep out dirt and other foreign matter.

1.6 MAINTENANCE

1.6.1 Operation Manual

Provide an operation manual in PDF format listing step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, parts list, and a brief description of all equipment and their basic operating features.

1.6.2 Maintenance Manual

Provide a maintenance manual in PDF format listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manual must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

1.6.3 Extra Materials

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis

PART 2 PRODUCTS

****

NOTE: Projects which include vapor-compression type refrigeration systems will comply with the safety standards defined in ASHRAE 15 & 34. Designers will be responsible for thoroughly researching and implementing the ASHRAE 15 & 34 safety requirements. For refrigerant-containing parts (excluding piping) located within an indoor space, a designer can use the following 6-step synopsis as a guide in determining "System Application Requirements" from ASHRAE 15 & 34.

Step 1. Identify the safety group classification of the refrigerant anticipated to be used in the new refrigeration equipment. Refrigerants R-22 and R-134a are considered Group A1 refrigerants. Refrigerant R-123 is considered a Group B1 refrigerant. Ammonia is considered a Group B2 refrigerant. Do not use ammonia for Navy and Marine Corps projects.

Step 2. Identify the occupancy classification of the facility which will house the new refrigerant equipment. Occupancies include institutional, public assembly, residential, commercial, large mercantile, industrial, and mixed types.

Step 3. Determine the system probability (high or low) of the new refrigeration equipment. Split system applications are typically considered high-probability systems according to ASHRAE 15 & 34.

Step 4. Estimate the quantity of refrigerant (grams or pounds) in the largest single refrigerant circuit of the new equipment. The designer will research catalog data from a minimum of 2 different manufacturers in order to get an approximation.

Step 5. Determine the volume (cubic meters or cubic feet) of the indoor space which is planned to house the new refrigeration equipment.

Step 6. Identify the "System Application Requirements" from the applicable table in ASHRAE 15 & 34 based upon the information identified in the previous steps (e.g., safety group, occupancy, system probability, refrigerant quantity, and indoor space volume). The "System Application Requirements" will dictate applicable refrigerant limitations as well as occupied space or mechanical room requirements.

ASHRAE 15 & 34 refers to a mechanical room as a machinery room, however, the terms are synonymous. On mechanical room design, ASHRAE 15 & 34 touches on criteria concerning equipment placement, ventilation design, door and passageway restrictions, refrigerant monitoring, open-flame devices, pressure-relief and purge piping. In addition to mechanical room design, ASHRAE 15 & 34 also touches on criteria concerning refrigerant piping, signs, self-contained breathing apparatus (SCBA), and miscellaneous installation restrictions. (SCBAs cannot be considered MCA funded items and are therefore not included in this specification.)

****

2.1 STANDARD PRODUCTS

Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use includes applications of equipment and materials under similar circumstances and of similar size. The 2 years experience includes products which have been sold or are offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products must be supported by a service organization. System components must be environmentally suitable for the indicated locations.

2.2 NAMEPLATES

****

NOTE: In a salt water environment substitute acceptable non-corroding metal such as but not limited to nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the

designer.
****

Secure a plate on major equipment including compressors, condensers, unit coolers, receivers, heat exchanges, fans, and motors with manufacturer's name, address, type or style, model or serial number, and catalog number. Provide plates that are durable and legible to last throughout equipment life and made of [anodized aluminum] [stainless steel] [_____]. Fix plates in prominent locations with nonferrous screws or bolts.

2.3 ELECTRICAL WORK

****
NOTE: Delete references to motor starters where motor starters for mechanical equipment are provided in motor-control centers.
****

Electrical equipment, motors, motor efficiencies, and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide specified electrical motor driven equipment complete with motors, motor starters, and controls. Electrical characteristics and enclosure type must be as shown, and unless otherwise indicated, motors of 746 W 1 horsepower and above with open, dripproof, or totally enclosed fan cooled enclosures, must be high efficiency type. Field wiring must be in accordance with manufacturer's instructions. Each motor must conform to NEMA MG 1 and NEMA MG 2 and must be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide continuous duty motors with the enclosure specified. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Furnish motors with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Size motors for the applicable loads. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Fit motor bearings with grease supply fittings and grease relief to outside of enclosure. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown. Mount unit control panels and electrical components in a NEMA ICS 6, Type 1 or 3A enclosure.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Refrigerant and Oil

****
NOTE: References to ammonia and IIAR are made throughout this section. If ammonia is inapplicable, then delete these references. Do not use ammonia for Navy and Marine Corps projects
****

Use the number designations and safety classifications in accordance with ASHRAE 15 & 34 for refrigerants. Refrigerants must meet the requirements of AHRI 700 as a minimum. Ammonia to be in accordance with IIAR 2 and as defined herein. Charge refrigerant systems in accordance with manufacturer's recommendations, including types and quantities of refrigerant and lubricating oil. Except for factory sealed units, furnish two complete charges of lubricating oil for each compressor. Use one charge during the system performance testing period. Following the satisfactory completion of the performance testing, drain the oil and replace the second charge.

2.4.2 Gaskets

Provide gaskets that conform to ASTM F104 classification for compressed sheet with nitrile binder and acrylic fibers for temperature ranges of minus 40 to 370 degrees C minus 40 to 700 degrees F service.

2.4.3 Bolts and Nuts

Bolts and nuts, except as required for piping applications, must conform to ASTM A307. Mark the bolt head to identify the manufacturer and the standard with which the bolt complies, in accordance with ASTM A307.

2.4.4 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to MSS SP-58.

2.4.5 Escutcheons

Escutcheons must be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.4.6 Pressure and Vacuum Gauge

Gauge must conform to ASME B40.100, Class 1, 2, or 3, Style X, Type I or III as required, 115 mm 4-1/2 inches in diameter with phenolic or metal case. Select each gauge range so that at normal operating pressure, the needle is within the middle third of the range.

2.4.7 Temperature Gauges

Provide industrial duty thermometers for the required temperature range. Thermometers must have a Fahrenheit scale on a white face. The pointer must be adjustable.

2.4.7.1 Stem Cased-Glass

Stem cased-glass case must be polished stainless steel or cast aluminum, 229 mm 9 inches long, with clear acrylic lens, and non-mercury filled glass tube.

2.4.7.2 Bimetallic Dial

Bimetallic dial type case must be not less than 89 mm 3-1/2 inches, stainless steel, and must be hermetically sealed with clear acrylic lens. Dampen bimetallic element with silicone and fit unit with external calibrator adjustment. Accuracy must be one percent of dial range.

2.4.7.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases must be not less than 89 mm 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens.

Fill must be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing must be double-braided bronze.

2.4.7.4 Thermal Well

Thermal well must be identical size, 13 or 19 mm 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 13 mm 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Extended neck thermal wells must be of sufficient length to clear insulation thickness by 25 mm 1 inch.

2.4.8 Unicellular Plastic Foam

Provide unicellular plastic foam in accordance with ASTM C534/C534M, Type I. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.4.9 Bird Screen

Provide screen consisting of square mesh, plain weave, 2 by 2 mesh, 1.6 mm 0.063 inch diameter aluminum wire or 0.79 mm 0.031 inch diameter stainless steel wire.

2.4.10 Galvanized Steel Sheet

ASTM A653/A653M, Coating Class G-90, lockforming quality.

2.4.11 Galvanized Steel Shapes

ASTM A36/A36M to commercial weight of not less than 0.70 kg/square meter 2.3 ounces/square foot of single side surface.

2.4.12 Aluminum Sheets and Plates

ASTM B209M ASTM B209, Alloy 3003, H-14. Sheets must be lockforming quality.

2.4.13 Aluminum Shapes

ASTM B221M ASTM B221, Alloy 6061, T-5 and T-6.

2.5 COMPRESSOR/CONDENSING UNITS

****

NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

[Compressor] [Condensing] unit must be factory fabricated, assembled, tested, packaged, and ready for full capacity operation after terminal point connection and field charging with operating fluids. Unit must conform to ANSI/AHRI 520, ASHRAE 23.1, and ASHRAE 15 & 34. Ammonia systems must also conform to IIAR 2 and ANSI/AHRI 510.

2.5.1 Capacity Criteria

****

NOTE: Show the capacity and saturated suction temperature, saturated condensing temperature, superheat, and subcooling on the drawings.
****

Application capacity rating shown must include suction superheat and liquid subcooling. Do not exceed compressor design saturated condensing temperature and saturated suction temperature limits.

2.5.2 Compressor

Select compressors for good operating reliability. Rotating parts must be statically and dynamically balanced at the factory to eliminate vibration at both partial and full load conditions. [Provide compressor system above 5 H.P. with variable speed capability.]

2.5.2.1 Construction

****
NOTE: Delete the second to last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.
****

Compressors must be the [reciprocating] [or] [scroll] type of either the open or hermetic design. Reciprocating compressors must have integrally cast housings of close-grained iron with an oil-level bull's eye, cast cylinder heads, cast aluminum or forged steel connecting rods, and cast iron or forged steel crankshafts with sleeve-insert type main bearings. Fit ammonia service compressor cylinder blocks and heads with self-draining water- or refrigerant-cooled jackets where recommended by the manufacturer. Freeze protect water jackets.

2.5.2.2 Lubrication System

The lubrication system on compressors 2.2 kW 3 hp or larger must be the forced-feed, positive-displacement type with oil strainer. The oil pump must be reversible. Provide lube oil pressure gauge and failure switch for forced-feed lubrication type compressors. Provide compressor with an adjustable oil level regulator with a shutoff valve on each inlet to allow removal of individual compressors without shutting down the entire system.

2.5.2.3 Motor

Compressor motors must be of the [constant-speed, squirrel-cage, induction, hermetically sealed, low-starting-current, high-torque type] [permanent magnet type with an inverter type drive].[Furnish motors with magnetic NEMA across-the-line motor starters in general purpose enclosures.]

2.5.2.4 Compressor Components

Compressor systems must include, as a minimum, the following:

a. Provide compressors 1.1 kW 1-1/2 hp and larger with double seated suction and discharge service valves each with gauge ports.

b. Compressors 3.7 kW 5 hp or larger must have a solid state oil pressure safety switch with a manual reset with auxiliary alarm contacts. Time delay duration must be as recommended by compressor manufacturer.

c. Each compressor must have a single low-pressure control with automatic reset and adjustable cut-in and cut-out range. Use braided steel lines.

d. Each compressor must have a single high-pressure control with manual reset, adjustable set-point, and auxiliary alarm contact. Use braided steel lines.

e. Provide a compressor cooling fan for each compressor which operates below minus 18 degrees C 0 degrees F saturated suction temperature.

f. Each compressor must have a crankcase oil heater. Control of the heaters must be as recommended by the compressor manufacturer.

g. When required by the compressor manufacturer, provide compressors with a hot-gas muffler to reduce vibration and noise from pulsations.

2.5.3 Base Mounting

****

NOTE: Where condensing units or compressors are located on top of walk-in boxes, mount on spring vibration isolators. Mass of inertia block must be an engineered solution accommodating site conditions.

****

Factory mount compressor and accommodating components on a rigid, steel [base,][rack,] where indicated. Mount the compressor assembly [with spring type vibration isolation mountings[. Place elastomer pads between the assembly base and the floor.][selected to limit transmissibility of imbalanced forces at lowest equipment rpm to 5 percent.]][on a concrete inertia block, fitted with spring type vibration isolation mountings. Mass of the concrete inertia block must be [2.0][_____] times mass of supported assembly. Select spring mountings to limit transmissibility of imbalanced forces at lowest equipment rpm to 3 percent.]

2.5.4 Unit Accessories

[Integral] [Remote] condensers must be in accordance with paragraph CONDENSER, [_____]. Provide accessories to be used in combination with each unit as indicated and in accordance with paragraph REFRIGERANT ACCESSORIES. Provide outdoor condensing units with weather hoods.

2.5.5 Electrical Controls

****

NOTE: Verify that reverse-phase, and phase-imbalance protection provisions are available in sizes under 70 kW 20 tons. Check with manufacturers before specifying other than across-the-line starting. If the transmissibility of equipment vibration is critical, indicate the use of service-rated flexible connectors on all pipe, tubing, and conduit to the equipment.

****

Provide electrical controls for the unit in accordance with paragraph ELECTRICAL WORK and include at a minimum main and branch circuit overload protective devices compensated for ambient temperatures as recommended by the manufacturer; status pilot lights; compressor safety, operating and capacity controls; defrost controls; local and remote audible and visual alarms with provisions to silence; short cycling control with lock-out timer; time delay for sequenced compressor starts; and remote component interface.

2.6 CONDENSER, AIR-COOLED

Unit must be factory fabricated and tested, packaged, self-contained and ready for full capacity operation after terminal point connections. Provide unit conforming to ANSI/AHRI 460. Split systems must be manufacturer matched units. Fans must be propeller or centrifugal type as specified in paragraph Fans. Provide fan motors that have [open][dripproof][totally enclosed][explosion proof] enclosures. Provide electrical controls for the unit in accordance with paragraph ELECTRICAL WORK, include a control transformer, and are capable of interfacing with local and remote components.

2.6.1 Capacity Rating

Size the condenser for the capacity and conditions indicated. Do not oversize.

2.6.2 Energy Performance

Equipment efficiency must meet the requirements of Energy Star designated efficiency. Provide proof of Energy Star label for air-cooled condenser product.

2.6.3 Unit Casing

Casing must be weatherproof and enclose all unit components. Construct structural members and sheet metal for the unit casing of galvanized steel or aluminum. Fit casing with lifting provisions, access panels, removable legs, and fan and heat rejection coil guards and screens.

2.6.4 Finishes

Equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings and subject to a salt atmosphere must have weather resistant finishes that will withstand 240 hours exposure to the salt spray test conducted in accordance with ASTM B117, using a 20 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no sign of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3.18 mm 1/8 inch on either side of the scratch mark.

2.6.5 Condenser Coil

****

NOTE: When coils are located in a corrosive or salt-laden environment, require both the copper or aluminum tubes and the protective coating.

****

Coil must have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. [Protect coil in accordance with paragraph COIL

CORROSION PROTECTION.] Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Coils must be tested in accordance with ASHRAE 15 & 34 at the factory and must be suitable for the working pressure of the installed system. Condenser may be used for refrigerant storage in lieu of separate receiver, provided that storage capacity is 20 percent in excess of fully charged system. Coil must be dehydrated and sealed after testing and prior to evaluation and charging. Provide unit with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge must be field charged. Provide separate expansion devices for each compressor circuit.

2.7 CONDENSER, WATER-COOLED

Condenser must be [remote mounted, tested and rated to AHRI 450][an integral component of a water-cooled condensing unit, be tested and rated to ANSI/AHRI 520]. Condensers must have safety provisions conforming to ASHRAE 15 & 34. Coils must conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Condenser heads must be removable and have flanged side inlet pipe connections which permit access to or removal of the tubes. Provide a separate condenser for each compressor circuit. Fans must be propeller or centrifugal type as specified in paragraph Fans. Fan motors must have [open][dripproof][totally enclosed][explosion proof] enclosures.

2.7.1 Unit Casing

Casing must be weatherproof and enclose all unit components. Construct structural members and sheet metal for the unit casing of galvanized steel or aluminum. Fit casing with lifting provisions, access panels, removable legs, and fan and heat rejection coil guards and screens.

2.7.2 Condenser Coil

****

NOTE: Normally 70/30 copper nickel performance is superior to 90/10 copper nickel in brackish water and salt water. Where conditions are not detrimental to 90/10 copper nickel, incorporate same as an alternative acceptable material. Use the higher fouling factor for open systems.

****

Condensers must be of the shell-and-tube type with the coolant in the tubes. Water-wetted metals must be [copper][or][[90/10][or][70/30] copper-nickel], except that heads may be ferrous metal in systems with chemically treated recirculating water. Unit must be rated for not less than 2758 kPa 400 psig refrigerant side and 860 kPa 125 psig water side pressure service at operating temperatures. Water supply, return and control system wetted parts must be copper, bronze or stainless steel. Water supply, return connections and piping internal to unit must be copper with brazed or threaded copper or bronze fittings, terminating in a threaded connection. Include valved access for recirculation of acidic scale removal chemicals and isolation pressure taps to determine pressure drop and water flow in piping arrangement. Base performance on an allowable water velocity not less than 0.9 m/s 3 fps nor more than 3 m/s 10 fps with a fouling factor of [0.0005][0.001]. The design pressure drop must govern the number of passes. Control valve on the water supply line must be [the automatic, self-contained type, controlled by condensing pressure which close bubble-tight when compressor is not operating.] [the modulating three-way type, controlled by pressure controller.]

2.7.3 Energy Performance

****
NOTE: UFC 1-200-02 requires new buildings to use 30 percent less energy than the ASHRAE 90.1 - SI ASHRAE 90.1 - IP baseline level.
****

Equipment efficiency must meet the requirements of Energy Star designated efficiency. Provide proof of Energy Star label for water-cooled condenser product.

2.8 CONDENSER, EVAPORATIVE

Each unit must be the counter-flow blow-through design, with single-side air entry. The unit must have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of items such as the pan section, the cabinet, must be not lighter than 1.6 mm (16 gauge) 16 gauge steel, protected against corrosion by a zinc coating. The zinc coating must conform to ASTM A153/A153M and ASTM A123/A123M, as applicable and have an extra heavy coating of not less than 0.76 kg/square m 2-1/2 ounces per square foot of surface. Give cut edges a protective coating of zinc-rich compound. After assembly, apply the manufacturer's standard zinc chromatized aluminum or epoxy paint finish to the exterior of the unit. Rate unit in accordance with AHRI 490 I-P and tested in accordance with ASHRAE 64.

2.8.1 Design and Performance Requirements

****
NOTE: When 53 m/s 10,500 fpm velocity is exceeded, noise may become a significant factor. Low tip speeds may or may not increase size of cooling tower. Consider probability of chemically-treated high-dissolved-solids drift loss causing damage to adjacent structures and environment (such as trees, shrubs).
****

The requirements of CTI ATC-105 must be the basis of establishing unit capacity and performance. Unit capacity must include a site recirculation factor. Performance wind velocity must be 8 km 5 miles per hour. Drift loss must not exceed 0.1 percent of unit circulation rate. Minimum unit design wind load must be [146 kg per square meter] [30 pounds per square foot] [_____]. [Minimum design fan deck live load must be [195 kg per square meter] [40 pounds per square foot] [_____].] Fan tip speed must not exceed [53 mps] [10,500 feet per minute][_____]. Design and construction of steel members must conform to AISC 360 and AISI SG03-3.

2.8.2 Access and Safety Provisions

Fit unit with access provisions as indicated to facilitate inspection, maintenance and replacement of components. Provide guard screens at unducted fan inlets and far discharge. Provide guards for moving power transmission components.

2.8.3 Pan Section

Provide watertight pan with drain, overflow, and make-up water connections. Standard pan accessories include access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

2.8.4 Fan Section

Furnish [centrifugal][propeller] type fan in accordance with paragraph Fans. Do not locate fan and fan motor in the discharge airstream of the unit. Provide motors that have [open][dripproof][totally enclosed][explosion proof] enclosure and are suitable for the indicated service. The condensing unit design must prevent water from entering into the fan section.

2.8.5 Condensing Coil

****

NOTE: Delete the copper or aluminum tubes and the protective coating except in corrosive environments.

****

Provide coils that have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter without fins.[Protect coil in accordance with paragraph COIL CORROSION PROTECTION.] Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Coils must be tested in accordance with ASHRAE 15 & 34 at the factory and suitable for the working pressure of the installed system. Each coil must be dehydrated and sealed after testing and prior to evaluation and charging. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge must be field charged.

2.8.6 Water Distribution System

Distribute water uniformly over the condensing coil to ensure complete wetting of the coil at all times. Provide brass, stainless steel, or high-impact plastic spray nozzles. Nozzles must be the cleanable, nonclogging, removable type. Design nozzles to permit easy disassembly and arrange for easy access.

2.8.7 Water Pump

The water pump must be the bronze-fitted centrifugal or turbine type, and may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pumps must have cast iron casings. Impellers must be bronze, and shafts must be stainless steel with bronze casing wearing rings. Shaft seals must be the mechanical type. Pump casing must be factory coated with epoxy paint. Pump motors must have [open][dripproof][totally enclosed][explosion proof] enclosures. Provide a bleed line with a flow valve or fixed orifice in the pump discharge line and extend to the nearest drain for continuous discharge. Fully submerge pump suction and provide with a galvanized steel or monel screened inlet.

2.8.8 Drift Eliminator

Provide eliminators to limit drift loss to not over 0.005 percent of the specified water flow. Construct eliminators of zinc-coated steel or polyvinyl chloride (PVC). Eliminators must prevent carry over into the unit's fan section.

2.9 UNIT COOLERS

****

NOTE: If it is more economical to use one big air handling unit instead of several unit coolers, use Section 23 30 00 HVAC AIR DISTRIBUTION to develop the requirements and delete the unit coolers. Use Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC to develop the control requirements for the air handling unit.

Delete the second to last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

Unit must be [forced circulation][free delivery] type, factory fabricated, assembled and tested, and packaged in accordance with AHRI 420. Ammonia systems must conform to IIAR 2. Fan must be the [centrifugal][propeller] type in accordance with paragraph Fans. Motors must be ECM type or rated for variable frequency drives and have [open][dripproof][totally enclosed][explosion proof] enclosures.

2.9.1 Construction

****

NOTE: Coils for fluorocarbon systems will have copper tubes and aluminum fins. Coils for ammonia systems will be hot-dip galvanized steel or aluminum. Do not use ammonia for Navy and Marine Corps projects

****

Casing must be Type 300 stainless steel, aluminum, mill galvanized or hot-dip galvanized steel after fabrication. Protectzinc-coated carbon steel in accordance with paragraph COIL CORROSION PROTECTION.. Coils must [be hot-dip galvanized steel or aluminum.][have copper tubes and aluminum fins.] Provide watertight, corrosion resistant drain pan. Insulate drainage piping for units in spaces maintained at less than 2 degrees C 35 degrees F.

2.9.2 Energy Performance

Size equipment based on Design Manual CS from the Air Conditioning Contractors of America; do not oversize. Equipment efficiency must meet the requirements of Energy Star. Provide proof of Energy Star label for unit cooler product.

2.9.3 Defrosting

****

NOTE: Spaces maintained at 2 degrees C 35 degrees F will be defrosted with ambient air. Spaces below 2 degrees C 35 degrees F will use either a hot gas or electric heat defrosting system. For a defrosting system choose between a timer defrost controller or a demand defrost controller.

****

Unit must be [defrosted with ambient space air.][fitted with a [hot gas][electric heat] defrosting system.][Control defrost system by timer defrost controller adjustable for up to 6 defrost cycles per 24 hours, each of 5 to 120 minutes duration. Include an adjustable timer to control frequency of cycles; defrost initiating thermostat; adjustable program timer to control sequence of defrost cycle; defrost terminating thermostat; manual override switch; selector switch; and status pilot light.][Control defrost system by demand defrost controller. Include an automatic, solid-state circuitry to initiate defrost cycle based on sensing adjustable temperature difference of air moving across coil in direct proportion to frost build-up; thermostat to terminate defrost; adjustable lockout to prevent initiation of defrost during pull-down after defrost cycle; manual override switch; and status pilot light.]

2.10 CONTROLS AND INSTRUMENTS

Refrigeration system controls, instruments and devices must be industrial quality, and must conform to applicable requirements of ASHRAE 15 & 34. Submit manufacturer's standard catalog data, prior to the purchase or installation of a particular component, highlighted to show items such as brand name, model number, size, options, performance charts and curves, in sufficient detail to demonstrate compliance with contract requirements.

a. Provide data for each specified component including manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

b. Rate fluid containing surfaces for the service and construct of materials suitable for the fluid. Component electrical rating must be 120 volt ac, unless otherwise indicated and must be suitable for imposed loads.

****

NOTE: Delete item c. if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

c. Ammonia systems must conform to IIAR 2. Do not use copper, copper alloy and white metals, except aluminum, for ammonia service.

d. Submit proof of compliance where the system, components, or equipment are specified to comply with requirements of AHRI, ASHRAE, ASME, or UL. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted.

e. When performance requirements of this project's drawings and specifications vary from standard AHRI rating conditions, include computer printouts, catalog, or other application data certified by AHRI or a nationally recognized laboratory as described above. If AHRI does not have a current certification program that encompasses such application data, the manufacturer may self certify that its application data complies with project performance requirements in accordance with the specified test standards.

2.10.1 Refrigeration System Alarms

2.10.1.1 Audible Alarm

Provide surface-mounted audible alarm, 100 mm 4 inch vibrating bell type suitable for indoor or outdoor service.

2.10.1.2 Visual Alarm

Visual alarm must be pilot light type. Alarm must be 100 watt, incandescent, vapor-tight fixture with cast metal guard and [red][green][amber] lens.

2.10.2 Controllers

2.10.2.1 Differential Pressure Controller

Provide differential pressure controller with high and low pressure sensing ports that is direct or reverse acting with calibrated proportional band and set point adjustments. Controller output must be [low voltage electric][pneumatic][4-20 mA dc], proportional to the pressure differential sensed. Include local and remote set point adjustments. Range must meet system requirements.

2.10.2.2 Differential Temperature Controller

Provide differential temperature controller with two filled, remote sensing bulbs connected to the controller by [capillary][armored capillary] tubing. Controller must be direct or reverse acting with calibrated proportional band and set point adjustments. Controller output must be [low voltage electric][pneumatic][4-20 mA dc], proportional to the temperature differential sensed. Include provisions for local and remote set point adjustments. Range must be as required to meet system requirements. For immersion service, provide thermal wells.

2.10.3 Pilot Lights

Panel-mounted pilot lights must be NEMA Class 12 oil-tight, push-to-test transformer for 6-8 Vac lamps. Lamps must be replaceable by removal of color cap. Cap color must be as indicated.

2.10.4 Programmer, Demand Control/Load

****

NOTE: Before application of energy management systems/load shedders to refrigeration systems, and related fans and pumps, the designer must ascertain that application will be neither conducive to equipment damage nor counterproductive. Safety trips, compressor slugging, freeze-ups and reloading of circuits may occur.

****

Programmer must be fully automatic, fail safe, field programmable, solid-state, demand control and load programmable for [_____][16] loads.

Demand control portion must monitor power consumption by[watt][or][current] transducers. Set point must be field adjustable with adjustable dead band. Load shedding sequence time and differential time between load shedding must be adjustable. Contacts must store alarm condition. Meter readout must indicate demand deviation from set point. Load profile recorder must be strip-chart type with readily discernable event record. Load programmer must permit programming of on/off time of each load for any time element within a week and must equalize power demand over a preset time cycle. Include input override and time cycle accelerator for checkout. Visually indicate and record alarm condition, status of all loads and time period. Include a H-O-A toggle switch for each load. Alarm provisions must include relay contacts for external, remote alarm functions and test provisions. Provide override [thermostat][pressure switch][timer] to restore shedded loads indicated. Control panel enclosure must be NEMA ICS 6, Type 1, surface mounted type with key lock. Load profile recorder must be [surface][flush panel] mounted type. Load relays must be plug-in type with critical load failure in "on" mode and contacts rated for pilot duty at 120 volt ac. Load shedding position switches must shed loads on a first shed/last restore basis and remove loads from system logic for shedding cycle. Fit time clock with spring motor to maintain time in event of power failure.

2.10.5 Switches, Fluid Service

Switches must be field adjustable SPDT type and must have NEMA ICS 6, Type 1 enclosure with operating range specified or indicated. Provide circuits as required for the applicable functions.

2.10.5.1 Air Flow Switch

Provide air flow switch that has a service pressure range of 31 to 2542 Pa 0.12 to 10 inches wg.

2.10.5.2 Water-Flow Switch

Water flow switch must have a body rating suitable for the service, field-adjustable activating flow rate, and a pressure drop not in excess of 13.8 kPa 2 psi at maximum flow rate.

2.10.5.3 Pressure Switch

Provide factory set pressure switch, one or two stage as indicated, with adjustable operating and differential pressure. Fit bourdon tube inlet with damper screw adjustment.

2.10.5.4 Differential Pressure Switch

Provide factory set differential pressure switch with high and low sensing ports, one or two stages and adjustable differential range and pressure.

2.10.5.5 Temperature Switch

Provide factory set temperature switch with [capillary][armored capillary] tubing and filled sensing system, one or two stages as indicated, and operating adjustable differential range. For immersion service, provide thermal wells.

2.10.5.6 Differential Temperature Switch

Provide factory set differential temperature switch with two [separate][separate armored] capillary systems, one or two stages, and adjustable differential range and temperature. For immersion service, provide thermal wells.

2.10.6 Push-Button Stations

Stations must be NEMA Class 12 oil-tight, momentary or maintained-contact type, as indicated. Start push-buttons must have a fully guarded or flush black operator button. Stop push-buttons must have an unguarded or extended red operator button.

2.10.7 Selector

Switches must be NEMA Class 12 oil-tight, momentary or maintained contact type, as indicated, with standard operator.

2.11 HEAT RECOVERY DEVICES

2.11.1 Heat Recovery Coil, Air

****

NOTE: When coils are located in a corrosive or salt-laden environment, require both the copper or aluminum tubes and the protective coating.

****

Coil must be compatible with the type of refrigerant used in the system. Coil must have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes.[Protect coil in accordance with paragraph COIL CORROSION PROTECTION.] Provide galvanized steel or aluminum casing. Avoid contact of dissimilar metals. Coils must be tested in accordance with ASHRAE 15 & 34 at the factory and must be suitable for the working pressure of the installed system. Coil must be dehydrated and sealed after testing and prior to evaluation and charging. Provide unit with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge must be field charged. Mount coil within a heat recovery, factory-fabricated, draw-through, central station type air conditioner in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.11.2 Hot Water Reclaim

****

NOTE: Indicate on the drawings the size of the exchanger either as a percent of the total rated condenser load or as a percent of the superheated portion of the total rated condenser load. The refrigerant compressor head pressure control and the circulating pump can be deleted if inapplicable.

****

Unit must be a double-wall, tube-within-tube heat exchanger type, complete with thermostatic control. Unit must be constructed and refrigerant pressure/temperature rated in accordance with ASHRAE 15 & 34. Heat exchanger coil must consist of an external refrigerant containing carbon steel tube and an internal, double-wall-in-metallic contact, convoluted, potable water containing copper tube. Fabricate cabinet of zinc-protected steel and insulate internally in coil space. Provide recovery device with a refrigerant compressor head pressure control and an interlocked, potable water circulating pump. Pump and motor assembly must be close-coupled, manufacturer's standard type with indicated head and capacity characteristics, and with brass, bronze, copper or stainless steel wetted parts. Mount pump [remotely][integral] to the exchanger and rate for [115][208][230] volt ac power supply.

2.12 REFRIGERANT LEAK DETECTOR

****

NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ASHRAE 15 & 34.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 450 mm 18 inches above the finished floor since all commonly-used refrigerants are heavier than air.

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point shouldn't exceed 15 m 50 feet. In order to meet the recommended 15 m 50 feet distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

In accordance with ASHRAE 15 & 34, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a minimum indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room. Include the electrical design for the alarm system on the drawings.

As an additional item, ASHRAE 15 & 34 states that open-flame devices (i.e., boilers) cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to the device; or the alarm relay from the detector is used to automatically shutdown the combustion process in the event of refrigerant leakage. Indicate all applicable alarm controls on the

drawings.

Delete the information in the last bracketed sentence if an EMCS is not applicable to the design.

****

Provide continuously-operating, halogen-specific type detector that is appropriate for the refrigerant in use. Design detector specifically for area monitoring and include [a single sampling point][[_____] sampling points] install where indicated. Detector design and construction must be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Supply factory-calibrated detector for the appropriate refrigerant. Provide an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant in use. The detector's relay should be capable of initiating corresponding alarms and ventilation systems as indicated on the drawings. Provide a failure relay output that energizes when the monitor detects a fault in its operation.[Detector must be compatible with the facility's energy management and control system (EMCS). The EMCS must be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.13 REFRIGERANT RELIEF VALVE/RUPTURE DISC ASSEMBLY

****

NOTE: ASHRAE 15 & 34 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly as well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be in accordance with ASHRAE 15 & 34.

****

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. Provide assembly in accordance with ASME BPVC SEC IX and ASHRAE 15 & 34. Provide assembly with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Provide rupture disc of the non-fragmenting type.

2.14 REFRIGERANT SIGNS

Provide refrigerant signs that are a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 13 mm 0.5 inches in height.

2.14.1 Installation Identification

Provide each new refrigerating system with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name
b. Refrigerant number and amount of refrigerant.
c. The lubricant identity and amount.
d. Field test pressure applied.

2.14.2 Controls and Piping Identification

Provide refrigerant systems containing more than 50 kg 110 lb of refrigerant with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow [, the ventilation system,] and the refrigerant compressor.

b. Pressure limiting device.

2.15 CONDENSER WATER SYSTEMS

****

NOTE: Delete this paragraph if inapplicable. Use Section 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS and 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS to develop the requirements for a condenser water system.

****

Cooling towers, condenser water pumps, condenser water treatment systems, condenser water piping, fittings, valves and accessories must be in accordance with Sections 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS and 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.16 DRAIN AND MISCELLANEOUS PIPING

Piping, fittings, valves and accessories for drain and miscellaneous services must be in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.17 PIPING AND FITTINGS, FLUOROCARBONS

Piping, valves, fittings, and accessories must conform to the requirements of ASHRAE 15 & 34and ASME B31.5, except as specified.

2.17.1 Steel Pipe

Steel pipe for fluorocarbon service must conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

2.17.2 Steel Pipe Joints and Fittings

Joints and fittings must be steel butt-welding, socket-welding, or malleable iron threaded type. Weld pipe except that joints on lines 50 mm

2 inches and smaller may be threaded. Threads must be tapered type conforming to ASME B1.20.2MASME B1.20.1. The malleable iron threaded type fitting must be of a weight corresponding to adjacent pipe. Flanges and flange faces of fittings must be tongue-and-groove type with gaskets suitable for the refrigerant used; size 25 mm 1 inch and smaller must be oval, two-bolt type; size above 25 mm 1 inch, up to and including 100 mm 4 inch, must be square four-bolt type; and sizes over 100 mm 4 inch must be round.

2.17.3 Steel Tubing

Steel tubing for refrigeration service must be in accordance with ASTM A334/A334M, Grade 1. Tubing with a nominal diameter of 10 mm 3/8 inch or 13 mm 1/2 inch must have a wall thickness of 1.22 mm 0.049 inches. Tubing with a nominal diameter of 19 mm 3/4 inch through 50 mm 2 inches must have a wall thickness of 1.62 mm 0.065 inches. Tubing with a nominal diameter of 65 through 100 mm 2-1/2 through 4 inches must have a wall thickness of 2.4 mm 0.095 inches. Steel tubing must be cold-rolled, electric-forged, welded-steel. Provide one end of the tubing with a socket. Clean, dehydrate, and cap steel tubing.

2.17.4 Steel Tubing Joints and Fittings

Provide socket type joints and fittings by the steel tubing manufacturer.

2.17.5 Copper Tubing

Copper tubing must conform to ASTM B280 annealed or hard drawn as required. Copper tubing must be soft annealed where bending is required and hard drawn where no bending is required. Do not use soft annealed copper tubing in sizes larger than 35 mm 1-3/8 inches. Braze joints except that joints on lines 22 mm 7/8 inch and smaller may be flared.

2.17.6 Copper Tube Joints and Fittings

Copper tube joints and fittings must be flare joint type with short-shank flare, or solder-joint pressure type. Joints and fittings for brazed joint must be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings will not be allowed for brazed joints.

2.18 PIPING AND FITTINGS, AMMONIA

****

NOTE: Delete this paragraph and subparagraphs if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

At system application conditions to minus 6.7 degrees C 20 degrees F piping system components including but not limited to piping, flanges, fittings, valves, and all accessories including flange bolts, nuts, and bolt patterns must conform to ASME B31.5. Do not use unions in this piping system. Other requirements are as follows:

2.18.1 Pipe, Black Carbon Steel

ASTM A53/A53M, Type E or S, Grade A or B, Schedule 40, standard weight, or Schedule 80, or extra strong as required.

2.18.2 Fittings, Threaded

ASTM A105/A105M or ASTM A181/A181M and ASME B16.11, 2.07 MPa 3000 psig WOG, forged steel.

2.18.3 Fittings, Welding

In sizes 25 mm 1 inch and under, ASTM A105/A105M or ASTM A181/A181M, and ASME B16.11, 2.07 MPa 3000 psig WOG, forged steel, socket weld, bored to match pipe wall thickness. Sizes exceeding 25 mm 1 inch must be wrought carbon steel, long radius, butt-weld, to match pipe wall thickness, conforming to ASTM A234/A234M and ASME B16.9.

2.18.4 Fittings, Flanged

High strength gray cast iron conforming to ASTM A126, Class B, or ASTM A278/A278M, Class 40, or malleable iron conforming to ASTM A197/A197M, manufacturer's standard long radius. Provide flange configuration as specified for flanges.

2.18.5 Flanges

Forged carbon steel conforming to ASTM A181/A181M, with industry standard tongue and groove face finish, 2-bolt oval shape in sizes 19 mm 3/4 inch and under; 4-bolt square shape in sizes 25 mm 1 inch through 100 mm 4 inches; round shape in sizes 127 mm 5 inches and larger; weld neck, except in sizes 50 mm 2 inches and under socket weld is acceptable. Threaded connection flanges are not acceptable. Flange template dimensional and shape criteria must be identical and/or interchangeable with valve flanges specified in paragraph VALVES, AMMONIA AND FLUOROCARBON.

2.19 VALVES, AMMONIA AND FLUOROCARBON

****

NOTE: Construction of valves for ammonia service should be stainless steel or ferrous based only. Do not use ammonia for Navy and Marine Corps projects.

****

Provide pressure and temperature rated valves for contained refrigerant service and comply with ASME B31.1. Metals of construction must be of Type 300 stainless steel, or [ferrous or copper][ferrous] based. Atmosphere exposed valve stems must be stainless steel or corrosion resistant metal plated carbon steel. Valve body connections must be brazed or welded socket, flanged or combination thereof. Do not use threaded connections, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Valves must be suitable for or fitted with extended copper ends for brazing in-place without disassembly. Fit ferrous body valves with factory fabricated and brazed copper transitions. To minimize system pressure drops, where practicable, globe valves must be angle body type, and straight line valves must be full port ball type. Fit control valve inlets with integral or adapted strainer or filter where recommended or required by manufacturer. Clean valves and seal moisture-tight.

2.19.1 Refrigerant-Stop Valves

Design stop valves for use with the refrigerant used and provide pressure ratings compatible with system working pressures encountered. Gate valves will not be acceptable.

2.19.1.1 Fluorocarbon Service

Valves 16 mm 5/8 inch and smaller must be handwheel operated, straight or angle, packless diaphragm globe type with back-seating stem, brazed ends, except where SAE flare or retained seal cap connections are required. Valves larger than 16 mm 5/8 inch must be globe or angle type, wrench operated with ground-finish stems, or ball valves, packed especially for refrigerant service, back seated, and provided with seal caps. Refrigerant isolation and shutoff valves must have retained or captive spindles and facilities for tightening or replacement of the gland packing under line pressure as applicable. Stop valves must have back-seating plated steel stem, bolted bonnet in sizes 25 mm 1 inch OD and larger, integral or flanged transition brazed socket. Valves, in sizes through 65 mm 2-1/2 inches must be full-port, floating ball type, with equalizing orifice fitted chrome plated ball, seats and seals of tetrafluoroethylene, chrome plated or stainless steel stem, and seal cap. In sizes 100 mm 4 inch IPS and larger, and in smaller sizes where carbon steel piping is used, valve bodies must be tongue and groove flanged and complete with mating flange, gaskets and bolting for socket or butt-weld connection. Purge, charge and receiver valves must be of manufacturer's standard configuration.

2.19.1.2 Ammonia Service

****

NOTE: Delete this paragraph and subparagraphs if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

Valves must be straight or angle, packed, rising stem/handwheel fitted, globe type. Stem must be back-seating type, fitted with non-rotating, self-aligning, retained lead alloy seat disc. In sizes 19 mm 3/4 inch IPS and larger, bolt bonnets and buttweld or tongue and groove flange body end connections and furnish with mating flange, gaskets, and fasteners. Provide mating flange that is socket or buttweld connection type. In sizes under 19 mm 3/4 inch IPS, threaded ends will be acceptable. Ball valves constructed specifically for ammonia refrigeration service are acceptable.

2.19.2 Check Valve

Design valve for service application, spring-loaded type where required, with resilient seat and with flanged body in sizes 13 mm 1/2 inch and larger. Provide positive shutoff at [10.3][13.8][20.7] kPa [1-1/2][2][3] psi differential pressure.

2.19.3 Liquid Solenoid Valves

Provide valves in compliance with ANSI/AHRI 760 and suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves must be direct-acting or pilot-operating type, packless, except that packed stem, seal capped; furnish manual lifting provisions. Solenoid coils must be moistureproof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves must have safe working pressure of 2758 kPa 400 psi and a maximum operating pressure differential of at least 1380 kPa 200 psi at 85 percent rated voltage. Valves must have an operating pressure differential suitable for the refrigerant used.

2.19.4 Expansion Valves

****

NOTE: Choose AHRI 751 SI AHRI 750 I-P for fluorocarbon service and ASHRAE 17 for ammonia service. Do not use ammonia for Navy and Marine Corps projects.

****

Provide expansion valves conforming to the requirements of [AHRI 751 SI AHRI 750 I-P][ASHRAE 17]. Valve must be of the diaphragm and spring type with internal or external equalizers, and bulb and capillary tubing. Provide valve with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1 degree C 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge must be determined by the manufacturer for the application and liquid must remain in the bulb at all operating conditions. Do not use gas limited liquid charged valves and other valve devices for limiting evaporator pressure without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves must have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. Provide an isolatable pressure gauge in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicated or for constant evaporator loads. In direct-expansion unit cooler applications, thermostatic expansion valve discharge must be through distributor and distributing tubes or through a single tube outlet leading to an orificed header provided by the unit cooler manufacturer, supplying an evaporator coil with not more than four circuits. Size distributor orifices for application conditions and provide distributor by the thermostatic expansion valve manufacturer as a matched combination to suit evaporator coil circuitry. Where indicated, fit distributor tube with side inlet for hot gas bypass or defrosting. In single compressor/evaporator combinations, where compressor capacity control is only by on-off cycling, and if recommended by the compressor manufacturer, furnish thermostatic expansion valve with a small bleed passage between inlet and outlet to facilitate equalization of high and low side during off cycle. Electronic expansion valves suited for the application by the manufacture are acceptable.

2.19.5 Safety Relief Valve

****

NOTE: Three way valves should be used on ammonia vessels and equipment. Do not use ammonia for Navy and Marine Corps projects.

****

Valve must be the [two-way][three-way] type. Use single type valves only where indicated. Valve must bear the ASME code symbol. Valve capacity must be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve must be of an automatically reseating design after activation.

2.19.6 Evaporator Pressure Regulators, Direct-Acting

Valve must include a diaphragm/spring power assembly, external pressure adjustment with seal cap, and pressure gauge port. Maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load must not exceed the pressure difference corresponding to a 1 degree C 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Select spring for indicated maximum allowable suction pressure range. Electronic valves suited for the application by the manufacture are acceptable.

2.19.7 Refrigerant Access Valves

Provide refrigerant access valves and hose connections conforming to AHRI 720.

2.19.8 Service Gauge Fittings

Design fittings for connecting a pressure gauge with a hose fitting. Provide these fittings in the suction pipe at each unit cooler.

2.20 REFRIGERANT ACCESSORIES

2.20.1 Fans

Support fan wheel shafts by either maintenance-accessible lubricated anti-friction block-type bearings, or permanently lubricated ball bearings. Select unit fans to produce the air flow required at the fan total pressure. Thermal overload protection must be of the manual or automatic-reset type. Construct fan wheels or propellers of aluminum or galvanized steel. Provide galvanized steel centrifugal fan wheel housings, and construct both centrifugal and propeller fan casings of aluminum or galvanized steel. Hot-dip galvanize steel elements of fans, except fan shafts, after fabrication or fabricate of mill galvanized steel. Recoat mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Limit forward curved fan wheels to [_____] mm inches. Direct-drive fan motors must be of the ECM variety. Provide centrifugal scroll-type fans with streamlined orifice inlet and V-belt drive. Each drive must be independent of any other drive. Propeller fans must be [direct-drive][V-belt] drive type with [adjustable][fixed] pitch blades. Mount v-belt driven fans on a corrosion protected drive shaft supported by either maintenance-accessible lubricated anti-friction block-type bearings, or permanently lubricated ball bearings.

2.20.2 Pressure Vessels

Provide pressure vessels conforming to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, test pressure components at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed. Where service temperatures below minus 6.7 degrees C 20 degrees F are encountered, materials of construction must be low temperature alloy carbon steel.

2.20.2.1 Hot Gas Muffler

Unit must be selected by the manufacturer for maximum noise attenuation. Units rated for 105.5 kW 30 tons capacity and under may be field tunable type.

2.20.2.2 Liquid Receiver

****

NOTE: Delete the last sentence if inapplicable. Insulation may be required if the room where the receiver is located can reach a higher temperature than the saturation temperature of the refrigerant. Insulation is generally not needed in most applications.

****

Design, fill, and rate receiver in accordance with the recommendations of ANSI/AHRI 495, except as modified herein. Size receiver so that it is never filled beyond 80 percent of its total capacity. The remaining 20 percent must allow for liquid expansion. Provide receiver with a relief valve of capacity and setting in accordance with ASHRAE 15 & 34. Fit receiver to include an inlet pipe; an outlet drop pipe with oil seal and oil drain where necessary; two bulls-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves;[a thermal well for thermostat;][a float switch column;][external float switches;] purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver must be factory insulated with not less than 25 mm 1 inch thick, 100 percent adhesive bonded, vaportight, flexible, closed-cell elastomer and finished with two coats of solvent base PVC protective coating or 0.41 mm 0.016 inch thick aluminum jacket.

2.20.2.3 Oil Separator

****

NOTE: An oil separator may be required if a system has very low evaporator temperatures (minus 18 degrees C 0 degrees F or less), or very long runs of piping, or multiple compressors. Use ASHRAE Handbook, Refrigeration Systems and Applications for further guidance. Note that the inclusion of oil separators will not decrease the need for using proper pipe sizing and layout/sloping techniques to ensure oil return.

****

Separator must be the high efficiency type, provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Do not exceed [69 kPa 10 psi][_____] pressure drop through a separator during the removal of hot gas entrained oil. Connections to compressor are as recommended by the compressor manufacturer. Provide separator with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass,[filter for removal of all particulate sized 0.01 mm and larger,][thermometer and low temperature thermostat fitted to thermal well,][immersion heater,][external float valve fitted with three-valve bypass,] and strainer.

2.20.2.4 Oil Reservoir

Reservoir capacity must equal one charge of all connected compressors. Provide reservoir with an external liquid gauge glass, plugged drain, and isolation valves. Provide vent piping between the reservoir and the suction header with a 34.5 kPa 5 psi pressure differential relief valve. Provide reservoir with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.20.3 Condenser and Head Pressure Control

Unit must be capable of automatically operating without daily or seasonal adjustments in ambient temperature of [_____] degrees C degrees F. Set control for refrigerant condensing temperature of [_____] degrees C degrees F. Permit proper operation of system with proper differential pressure across the thermostatic expansion valve. Base control system on sensing of actual condensing pressure in conjunction with manufacturer's standard method of subcooling the saturated refrigerant. Set controls to produce a minimum [_____] degrees C degrees F subcooling. Liquid seal subcooling circuit. Air volume control will not be acceptable for ambient conditions below 2 degrees C 35 degrees F. Provide necessary accessories to maintain safe compressor discharge temperatures for low temperature systems.

2.20.4 Filter Driers

Driers must conform to AHRI 711AHRI 710 I-P. Sizes 16 mm 5/8 inch and larger must be the full flow, replaceable core type. Sizes 13 mm 1/2 inch and smaller must be the sealed type. Furnish cores of suitable desiccant that will not plug, cake, dust, channel, or break down, and that remove water, acid, and foreign material from the refrigerant. Construct filter driers so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure must be 10 MPa 1,500 psig.

2.20.5 Sight Glass and Liquid Level Indicator

2.20.5.1 Assembly and Components

Assembly must be pressure- and temperature-rated and constructed of materials suitable for the service. Glass must be borosilicate type. Ferrous components subject to condensation must be electro-galvanized.

2.20.5.2 Gauge Glass

Include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

2.20.5.3 Bulls-Eye and Inline Sight Glass Reflex Lens

Provide bulls-eye and inline sight glass reflex lens for dead-end liquid service. For pipe line mounting, provide two plain lenses in one body suitable for backlighted viewing.

2.20.5.4 Moisture Indicator

Indicator must be a self-reversible action, moisture reactive, color changing media. Furnish indicator with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator must be an integral part of each corresponding sight glass.

2.20.6 Flexible Pipe Connectors

Connector must be pressure and temperature rated for the service in accordance with ASHRAE 15 & 34 and ASME B31.5. Connector must be a composite of interior corrugated phosphor bronze or Type 300 series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Construct assembly with a safety factor of not less than 4 at 150 degrees C 300 degrees F. Unless otherwise indicated, the length of a flexible connector must be as recommended by the manufacturer for the service intended.

2.20.7 Strainers

Strainers used in refrigerant service must have brass or cast iron body, Y or angle pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than 10 times the pipe diameter with pressure rating compatible with the refrigerant service. Screens must be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.20.8 Brazing Materials

Furnish brazing materials for refrigerant piping in accordance with AWS A5.8/A5.8M, Classification BCuP-5.

2.20.9 Liquid and Suction Headers

Provide liquid and suction headers on each multi-compressor system. Size headers according to manufacturer's recommendations. Provide each header with service valves to permit servicing each unit cooler and forced circulation air coil. Each service valve must have a gauge port which can be closed by back-seating the valve and a front seat which can close off the line connected to the manifold. Provide each service valve with a removable, protective valve stem cap or cover.

2.20.10 Suction Accumulators

****

NOTE: Delete this paragraph if other means are taken to prevent liquid carry-over and to assure oil return to the compressors.

****

Design and install accumulator within each suction header to provide a positive trap for liquid carry-over and to assure oil return to the compressors. An accumulator's internal liquid holding volume must be at least [_____] cubic meters feet. Ensure that oil is not trapped in the accumulator.

2.21 FACTORY FINISHES

2.21.1 Coil Corrosion Protection

****

NOTE: Research local conditions to determine the corrosiveness of the environment. Where condenser or evaporator coils are to be installed in highly

corrosive atmospheres, carefully consider the coil and fin combinations specified. Standard coil construction is typically copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered.

For maximum coil protection, include the requirements of this paragraph. This paragraph addresses phenolic, vinyl, and epoxy type coatings. For coils with relatively close fin spacing the phenolic or epoxy coating are the preferred types as these have less tendency to bridge across the fins than vinyl. In addition, the phenolic and epoxy type coatings can typically provide better thermal conductivity than vinyl.

If coatings are specified, note that a coil's heat transfer capacity can be reduced anywhere between 1 to 5 percent; total unit capacity may have to be increased as a result.

****

Provide coil with a uniformly applied [epoxy electrodeposition] [phenolic] [vinyl] [epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Apply coating at either the coil or coating manufacturer's factory. Ensure complete coil encapsulation. Provide coating capable of withstanding a minimum 1,000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.21.2 Equipment and Components

****

NOTE: A salt fog test should be required for all outdoor equipment. Specify a 125-hour test in noncorrosive environments and a 500-hour test in corrosive environments.

****

Unless otherwise specified, factory finish equipment and component items, when fabricated from ferrous metal, with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand [125] [500] hours exposure to the salt spray test specified in ASTM B117 using a 25 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Coat cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used with a zinc-rich coating conforming to ASTM D520, Type I.

2.21.3 Color Coding

****

NOTE: Color coding for piping identification required by the using agency will be developed and

inserted in the "Color Code Schedule" in Section 09 90 00 PAINTS AND COATINGS. For Air Force Installations, piping will be color-coded in accordance with Attachment 4 of AFM 88-15.

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Color coding for piping identification is specified in Section 09 90 00 PAINTS AND COATINGS.

2.21.4 Color Coding Scheme

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NOTE: Color Coding Scheme may be deleted in accordance with Notes in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

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A color coding scheme for locating hidden piping must be in accordance with [Section 22 00 00 PLUMBING, GENERAL PURPOSE][Section 22 00 70 PLUMBING, HEALTHCARE FACILITIES].

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform verification of dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work. Submit a letter, at least 2 weeks prior to beginning construction, including the date the site was visited, confirmation of existing conditions, and any discrepancies found.

3.2 INSTALLATION

****

NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

Perform the work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Design, fabricate, and install system conforming to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX as applicable. Where applicable, perform work in accordance with ASHRAE 15 & 34 and IIAR 2 for ammonia systems.

3.2.1 Equipment

****

NOTE: Determine in the initial stages of design the approximate distances required for maintenance clearances of all new equipment. The maintenance clearances will be used in determining the final layout of the equipment.

****

Properly level, align, and secure equipment in place in accordance with manufacturer's instructions. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps and similar items. Isolate compressors from the building structure. Select and size isolators based on load-bearing requirements and the lowest frequency of vibration to be isolated. Furnish foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.2 Mechanical Room Ventilation

****

NOTE: For mechanical rooms which are intended to house refrigeration equipment, designers will use ASHRAE 15 & 34 to determine applicable design criteria. Delete this paragraph if a mechanical room is not applicable to the design.

In summary, ASHRAE 15 & 34 allows the use of either natural or mechanical ventilation systems, however natural ventilation is allowed only in certain limited applications. Natural ventilation is allowed only when "a refrigerant system is located outdoors more than 6 m 20 feet from building openings and is enclosed by a penthouse, lean-to or other open structure", otherwise mechanical ventilation is required.

The amount of ventilation air required for a mechanical room will be determined based upon the ventilation equations in ASHRAE 15 & 34. In order to use these equations, a designer must approximate the mass of refrigerant (kgs or lbs) expected in the largest system located in the mechanical room. Refrigerant quantities will be determined based upon a minimum of 2 different system manufacturers.

a. For a natural ventilation system, ASHRAE 15 & 34 provides an equation for sizing the amount of free opening area required.

b. For a mechanical ventilation system, ASHRAE 15 & 34 requires both normal and alarm ventilation. Normal ventilation will be sized to cover personnel ventilation requirements (2.5 1/s/m2 or 0.5 cfm/ft2) and heat buildup requirements if applicable. Alarm ventilation will be sized based upon the equations in ASHRAE 15 & 34. Both the normal and alarm ventilation rates can be achieved using the same ventilation system (e.g., multi-speed exhaust fans), however, individual systems are preferred. For the alarm ventilation, exhaust intakes will be located near the equipment and close to the finished floor. Most commonly used refrigerants are heavier-than-air and subsequently sink to the floor. Also as prescribed in ASHRAE 15 & 34, air supply and exhaust ducts to the mechanical room will serve no other area within a facility. Discharge air from a mechanical ventilation system will be to the outdoors.

****

Mechanical ventilation systems must be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.2.3 Building Surface Penetrations

Provide sleeves in nonload bearing surfaces consisting of galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 1 mm (20 gauge) 20 gauge. Provide sleeves in load bearing surfaces consisting of uncoated carbon steel pipe, conforming to ASTM A53/A53M, [Schedule 30][Schedule 20][Standard weight]. Apply sealants to moisture and oil-free surfaces and elastomers to not less than 13 mm 1/2 inch depth. Do not install sleeves in structural members.

3.2.3.1 Refrigerated Space

Fit refrigerated space building surface penetrations with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Construct sleeves with integral collar or fit cold side with a bonded slip-on flange or extended collar. In the case of masonry penetrations where sleeve is not cast-in, fill voids with latex mixed mortar cast to shape of sleeve, and assemble flange/external collar type sleeve with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fasten to surface with masonry anchors. Integral cast-in collar type sleeve must be flashed [as indicated.] [with not less than 100 mm 4 inches of cold side vapor barrier overlap of sleeve surface.] Seal normally noninsulated penetrating round surfaces to sleeve bore with mechanically expandable seals in vapor tight manner and insulate remaining warm and cold side sleeve depth with not less than [100][_____] mm [4][_____] inches of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer. Apply vapor barrier sealant to finish warm side insulation surface. Warm side of penetrating surface must be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Seal wires in refrigerated space surface penetrating conduit with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

3.2.3.2 General Service Areas

Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Provide pipes passing through concrete or masonry wall or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Provide a minimum of 6 mm 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over-insulation and sleeve in accordance with Section 07 92 00 JOINT SEALANTS.

3.2.3.3 Waterproof Penetrations

Install pipes passing through roof or floor waterproofing membrane through a 0.48 kg 17 ounce copper sleeve or a 0.81 mm 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Suitably form flasing sleeve, and extend skirt or flange no less than 200 mm 8 inches from the pipe and set over the roof or floor membrane in a troweled coating of bituminous cement. Extend the flashing sleeve up the pipe a minimum of 50 mm 2 inches above the roof or floor penetration. Seal the annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation as indicated. Seal penetrations by either one of the following methods.

3.2.3.3.1 Waterproof Clamping Flange

Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.2.3.3.2 Modular Mechanical Type Sealing Assembly

In lieu of a waterproof clamping flange, a modular mechanical type sealing assembly may be installed. Seals must consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Loosely assemble links with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameter.

3.2.3.4 Fire-Rated Penetrations

Seal penetration of fire-rated walls, partitions, and floors as specified in Section 07 84 00 FIRESTOPPING.

3.2.3.5 Escutcheons

Provide escutcheons for finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, use special deep-type escutcheons. Secure escutcheon to pipe or pipe covering.

3.2.4 Access Panels

Provide access panels for concealed valves, vents, controls, and items requiring inspection or maintenance. Provide access panels of sufficient size and locate so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels must be as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.2.5 Refrigeration Piping

****

NOTE: For the design of a refrigerant piping system a designer has basically two options:

1) Perform the design of the entire system including pipe sizes and layout/slopes based on guidance from ASHRAE. On the drawings indicate that it will be the Contractor's responsibility to coordinate the pipe sizes and layout/slopes with the equipment and piping configurations to be provided.

2) For small systems (systems with 1 or 2 compressors and 1 or 2 coolers; 1 compressor for each cooler), the designer may elect to show only the individual components and their relative layout or schematic with no pipe sizes or slopes. For these types of systems, it will be the Contractor's responsibility to submit shop drawings and calculations to completely define the entire system based on the equipment to be provided.

3) Due to the possibility of stress fractures resulting from repeated temperature related expansion and contraction, the designer of record is responsible for determining whether to allow the use of 45 degree elbow fittings on each project.

****

Unless otherwise specified, perform pipe and fittings installation conforming to the requirements of ASME B31.5. Cut pipe accurately to the measurements established at the jobsite and work into place without springing or forcing. Cutting or otherwise weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipes must be cut square, must have burrs removed by reaming, and be installed in a manner to permit free expansion and contraction without damage to joints or hangers. Wipe filings, dust, or dirt from interior of pipe before connections are made.

3.2.5.1 Directional Changes

Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller will be permitted, provided a pipe bender is used and wide-sweep bends are formed. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, or other malformations will not be accepted.

3.2.5.2 Functional Requirements

Slope piping 13 mm/3 m 1/2 inch/10 feet of pipe in the direction of flow to ensure adequate oil drainage. Properly cap or plug ends of refrigerant lines or equipment during installation to keep moisture, dirt, or other foreign material out of the system. Keep piping capped until installation. Equipment piping must be in accordance with the equipment manufacturer's recommendations and the contract drawings.

3.2.5.3 Brazed Joints

Perform brazing in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings must be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting must be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material must be removed at all joints. Steel tubing joints must be made in accordance with the manufacturer's recommendations. Protect tubing against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping must be supported prior to brazing and must not be sprung or forced.

3.2.5.4 Threaded Joints

Make threaded joints with tapered threads and make tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Do not show more than three threads after the joint is made.

3.2.5.5 Welded Joints

Welded joints in steel refrigerant piping must be fusion welded. Make changes in direction of piping with welded fittings only; mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. Make branch connections with welding tees or forged welding branch outlets. Thoroughly clean steel pipe of all scale and foreign matter before the piping is assembled. During welding, fill the pipe and fittings with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Perform beveling, alignment, heat treatment, and inspection of weld conforming to ASME B31.1. Remove weld defects and reweld at no additional cost to the Government. Store and dry electrodes in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Do not use electrodes that have been wetted or that have lost any of their coating.

3.2.5.6 Flanged Joints

Assemble flanged joints square and tight with matched flanges, gaskets, and bolts. Provide gaskets that are suitable for use with the refrigerants to be handled. When steel refrigerant piping is used, provide union or flange joints in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, refrigeration equipment, control valves, and other similar items.

3.2.5.7 Flared Connections

When flared connections are used, use a suitable lubricant between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.2.6 Piping Supports

Refrigerant pipe supports must conform to ASME B31.5. Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, by variable spring hangers and supports or by constant support hangers.

3.2.6.1 Seismic Requirements

****

NOTE: Provide seismic requirements for piping and related equipment supports , if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

****

Support and brace piping and attached valves to resist seismic loads[as specified in UFC 3-301-01 and Sections 13 48 73SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS][as indicated]. Provide structural steel, required for reinforcement, to properly support piping, headers, and equipment but not shown. Material used for support must be as specified in Section 05 12 00 STRUCTURAL STEEL.

3.2.6.2 Structural Attachments

Attachment to building structure concrete and masonry must be by cast-in-concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors must be applied with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead applications of ferrous materials only. Material used for support must be as specified in Section 05 12 00 STRUCTURAL STEEL.

3.2.7 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to MSS SP-58, except as modified herein. Pipe hanger types 5, 12, and 26 must not be used.

3.2.7.1 Hangers

Do not use type 3 on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.2.7.2 Inserts

Secure type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.2.7.3 C-Clamps

Torque type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.2.7.4 Angle Attachments

Furnish type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

3.2.7.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, use the Type 39 saddle, connected to the pipe, on all pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher. Use type 40 shields on all piping less than 100 mm 4 inches and all piping 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F. Use a high density insulation insert of cellular glass under the Type 40 shield for piping 50 mm 2 inches and larger.

3.2.7.6 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58. Install a support not over 300 mm 12 inches from the pipe fitting joint at each change in direction of the piping. Space pipe supports not over 1525 mm 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 23 kg 50 pounds must have the excess hanger loads suspended from panel points.

3.2.7.7 Vertical Pipe Supports

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of no more than 4570 mm 15 feet, no more than 2440 mm 8 feet from end of risers, and at vent terminations.

3.2.7.8 Pipe Guides

Provide type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Slide materials must be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.2.7.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, use a Type 39 saddle. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.2.7.10 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, include a pipe cradle, with the Type 35 guide, welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 100 mm 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.2.7.11 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.2.8 Pipe Alignment Guides

Provide pipe alignment guides where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1525 mm 5 feet on each side of each expansion joint, and in lines 100 mm 4 inches or smaller not more than 610 mm 2 feet on each side of the joint.

3.2.9 Pipe Anchors

Provide anchors wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors must consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, anchor these items immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Submit detailed drawings of pipe anchors for approval before installation.

3.2.10 Piping Identification

Identiy each piping system and direction of fluid flow in accordance with applicable provisions of ASME A13.1 with color coded, water, moisture and broad-spectrum temperature resistant, plastic labels.

3.2.11 Manual Valves

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NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.

****

Install stop valves on each side of each piece of equipment such as compressors, condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Install angle and globe valves with stems horizontal unless otherwise indicated. Install ball valves with stems positioned to facilitate operation and maintenance. Provide isolating valves for pressure gauges and switches external to thermal insulation. Do not fit safety switches with isolation valves. Extend thermal wells for insertion thermometers and thermostats beyond thermal insulation surface no less than 25 mm 1 inch. Filter dryers having access ports may be considered a point of isolation. Provide purge valves at all points of systems where accumulated noncondensable gases would prevent proper system operation. Furnish valves to match line size, unless otherwise indicated or approved. Provide drain valves in bottom of risers and low points of ammonia piping.

3.2.12 Expansion Valves

Install expansion valves with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 50 mm 2 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 50 mm 2 inches. Securely fasten the bulb with two clamps. Insulate the bulb. Install the bulb in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb is installed in a vertical line, the bulb tubing must be facing up.

3.2.13 Valve Identification

Tag each system valve, including those which are part of a factory assembly. Tags must be in alphanumeric sequence, progressing in direction of fluid flow. Tags must be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately 35 mm 1-3/8 inch diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Attach tags with nonferrous, heavy duty, bead or link chain, 14 gauge 14 gauge annealed wire, nylon cable bands or as approved. Reference tag numbers in Operation and Maintenance Manuals and system diagrams.

3.2.14 Strainers

Provide strainers immediately ahead of solenoid valves and expansion devices and where indicated. Strainers may be an integral part of the expansion valve.

3.2.15 Filter Dryer

Provide a liquid line filter dryer on each refrigerant circuit located so that all liquid refrigerant passes through a filter dryer. Size dryers in accordance with the manufacturer's recommendations. Install dryer so that it can be isolated from the system, evacuate the isolated portion of the system, replace and the filter dryer. Install dryers in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.2.16 Sight Glass

Install a moisture indicating sight glass in refrigerant circuits down stream of filter dryers and where indicated. Sight glass must be full line size.

3.2.17 Thermometers

Fit thermometers with thermal well. Do not use Mercury in thermometers. Where test thermometer locations are indicated, only provide plugged thermal well. Thermometers located within 1525 mm 5 feet of floor may be rigid stem type. Where thermal well is located above 1525 mm 5 feetabove floor, thermometer must be universal adjustable angle type or remote element type to 2135 mm 7 feet above floor and remote element type where thermal well is 2135 mm 7 feet or more above floor. Locate thermometers in coolant supply and return or waste lines at each heat exchanger, at each automatic temperature control device without an integral thermometer, refrigerant liquid line leaving receiver, refrigerant suction line at each unit cooler, and where indicated or required for proper operation of equipment.

3.2.18 Flexible Connectors

Install flexible metallic connectors perpendicular to line of motion being isolated. Fit piping for equipment with bidirectional motion with two flexible connectors, in perpendicular planes. Install reinforced elastomer flexible connectors in accordance with manufacturer's instructions. Provide piping guides and restraints related to flexible connectors as required. Provide connectors in the suction and discharge lines on spring mounted compressors. Anchor connectors firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.2.19 Power Transmission Components Adjustment

V-belts and sheaves must be properly aligned and tensioned preliminary to operation and after 72 hours of operation at final speed. Belts on drive side must be uniformly loaded, not bouncing. Alignment of direct-drive couplings must be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2.20 Unit Cooler Drainage

Drain lines from product storage spaces maintained at 2 degrees C 35 degrees F or lower must be fitted with NSF approved connections and cleanout tee; must be short as possible; must not be trapped; and must not be combined, unless all combined units are defrosted simultaneously and are controlled by a single timer. Drain lines may be combined in spaces maintained at nonfreezing temperatures after individual trapping. Heat trace and insulate drain lines starting with drain pan fitting through the surface penetration into a nonfreezing space, a distance sufficient to ensure freedom from ice during defrost cycle. Drain line size must be not less than drain pan outlet size. Drain line must be pitched as shown on the project design documents, and not less than 6 mm/300 mm 1/4 inch/foot where not shown. Drain line heat tracing must be[electric][and][hot gas] as indicated.[Route hot gas supply line to the unit cooler in contact with the drain line by banding with all stainless steel worm drive hose clamps on no more than 300 mm 12 inch centers and increase heat transfer area by continuous tangential fillets of heat conducting paste.][Electrically heat traced drain lines must utilize external or internal to drain line heating elements, applied to produce watt-density and temperature recommended by the manufacturer. Where metallic sheathed heat tracer is used in contact with metallic drain line or internal thereto, sheath material must be stainless steel. Install external metallic sheathing by banding on no more than 300 mm 12 inch centers with all stainless steel worm drive hose clamps and increase heat transfer area by continuous tangential fillets of heat conducting paste. Electric heat tracing power supply must be as indicated.]

3.2.21 Field Applied Insulation

Field applied insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.22 Factory Applied Insulation

****

NOTE: Include or delete items requiring factory applied insulation as applicable.

****

Insulate suction headers, liquid receivers, oil separators, and oil reservoirs with no less than 19 mm 3/4 inch thick unicellular plastic foam as a standard manufacturer's process.

3.2.23 Framed Instructions

Submit framed instructions for posting, at least 2 weeks prior to construction completion. Frame under glass or laminated plastic and post where directed. Include equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. Include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system in the condensed operation instructions. Post the instructions before acceptance testing of the system.

3.3 LOCATIONS AND CLEARANCES

Locate equipment so that working space is available for necessary servicing such as shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead lines.

3.4 TESTS

Submit a letter, at least [10] [_____] working days in advance of each test, advising the Contracting Officer of the test. Submit individual letters for the refrigerant system, the system performance, and the acceptance tests. Identify the date, time, and location for each test. Conduct tests in the presence of the Contracting Officer. Provide utilities for testing as specified in the SPECIAL CONTRACT REQUIREMENTS. Water and electricity required for the tests will be furnished by the Government. Provide material, equipment, instruments, and personnel required for the test.

a. Coordinate field tests with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

b. Submit [6] [_____] copies of each test containing the information described below in bound 216 by 279 mm 8-1/2 by 11 inch booklets. Submit individual reports for the refrigerant system, the system performance, and the acceptance tests.

   (1) The dates the tests were started and completed.
   (2) A list of equipment used, with calibration certifications.
   (3) Initial test summaries.
   (4) Repairs/adjustments performed.
   (5) Final test results and comments.

3.4.1 Refrigerant System

****

NOTE: Where applicable condensing temperature is over 55 degrees C 130 degrees F, equipment and piping will be capable of withstanding leak pressure tests at not less than the design pressure corresponding to the condensing pressure during the higher ambient conditions. (Refer to ASHRAE 15 & 34.)

****

After all components of the refrigerant system have been installed and connected, subject the entire refrigeration system to a pneumatic test as specified.

3.4.1.1 Preliminary Procedures

Prior to pneumatic testing, isolate equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, from the test pressure or remove from the system. Remove safety relief valves and rupture discs, where not part of factory sealed systems, and cap or plug openings.

3.4.1.2 Pneumatic Test

****

NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and

Marine Corps projects.
****

Provide pressure control and excess pressure protection at the source of test pressure. Valves must be wide open, except those leading to the atmosphere. Test gas must be dry nitrogen, with minus 56.7 degrees C minus 70 degree F dewpoint and less than 5 ppm oil. Apply test pressure in two stages before any refrigerant pipe is insulated or covered. First stage test is at 69 kPa 10 psig with every joint being tested with a thick soap or color indicating solution. During second stage tests raise the system to the minimum refrigerant leakage test pressure specified in ASHRAE 15 & 34 or IIAR 2 with a maximum test pressure of 25 percent greater than specified. Test ammonia unloading lines at 2415 kPa 350 psig. Pressure above 690 kPa 100 psigmust be raised in 10 percent increments with a pressure acclimatizing period between increments. Record the initial test pressure along with the ambient temperature to which the system is exposed. Maintain final test pressures of the second stage on the system for a minimum of 24 hours. At the end of the 24 hour period, record the system pressure along with the ambient temperature to which the system is exposed. A correction factor of 2 kPa 0.3 psi will be allowed for each degree change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, investigate the system for leaking joints. To repair leaks, take the joint apart, thoroughly clean, and reconstruct as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing will not be acceptable. Following repair, retest the entire system using the pneumatic tests described above. Reassemble the entire system once the pneumatic tests are satisfactorily completed.

3.4.1.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, relieve the pressure and evacuate the entire system to an absolute pressure of 300 microns. During evacuation of the system, the ambient temperature must be higher than 2 degrees C 35 degrees F. Do not evacuate more than one system at one time by one vacuum pump. Once the desired vacuum has been reached, close the vacuum line and allow the system to stand for 1 hour. If the pressure rises over 500 microns after the 1 hour period, evacuate the system again down to 300 microns and let set for another 1 hour period. Do not charge the system until a vacuum of at least 500 microns is maintained for a period of 1 hour without the assistance of a vacuum line. If, during the testing, the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure repeated. During evacuation, record pressures by a thermocouple type, electronic type, or a calibrated-micron type gauge.

3.4.1.4 System Charging and Startup Test

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NOTE: Delete the last sentence if an ammonia system is not specified. Do not use ammonia for Navy and Marine Corps projects.
****

Following satisfactory completion of the evacuation tests, charge the system with the required amount of refrigerant by raising pressure to normal operating pressure, and in accordance with manufacturer's procedures. Following charging, operate the system with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. Test the entire system for leaks. Test fluorocarbon systems with halide torch or electronic leak detectors. Test ammonia systems with sulphur tapers. When charging and testing with ammonia under pressure, provide gas masks.

3.4.1.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, immediately isolate the leaking portion of the system from the remainder of the system and pump the refrigerant into the system receiver or other suitable container. Do not discharge the refrigerant into the atmosphere.

3.4.1.6 Contractor's Responsibility

Take steps to prevent the release of refrigerants into the atmosphere at all times during the installation and testing of the refrigeration system. The steps include, but are not limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. Do not release more than 85 grams 3 ounces of refrigerant to the atmosphere in any one occurrence. Repair system leaks within the first year in accordance with the requirements herein at no cost to the Government, including material, labor, and refrigerant, if the leak is the result of defective equipment, material, or installation.

3.4.2 System Performance

After the foregoing tests have been completed and before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's startup representative experienced in system startup and testing, at such times as directed. Tests must cover a period of not less than [_____] days for each system and demonstrate that the entire system is functioning in accordance with the drawings and specifications. Make corrections and adjustments as necessary and re-conduct tests to demonstrate that the entire system is functioning as specified. Replace any refrigerant lost during the system startup. During the system performance tests, maintain a report to document compliance with the specified performance criteria upon completion and testing of the system. Include the following information at a minimum and must be taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart:

a. Date and outside weather conditions.

b. The load on the system based on the following:
    (1) The refrigerant used in the system.
    (2) Condensing temperature and pressure.
    (3) Suction temperature and pressure.
    (4) Ambient, condensing and coolant temperatures.
    (5) Running current, voltage and proper phase sequence for each phase of all motors.

c. The actual onsite setting of operating and safety controls.

d. Thermostatic expansion valve superheat-value as determined by field test.

e. Subcooling.

f. High and low refrigerant temperature switch set-points.

g. Low oil pressure switch set-point.

h. Defrost system timer and thermostat set-points.

i. Moisture content.

j. Capacity control set-points.

k. Field data and adjustments which affect unit performance and energy consumption.

l. Field adjustments and settings which were not permanently marked as an integral part of a device.

3.5 TRAINING

Conduct training for the operating staff as designated by the Contracting Officer. Submit a letter, at least 14 working days prior to the date of the proposed training, identifying the date, time, and location for the training which must start after the system is functionally completed but prior to final acceptance tests. Training must be under the direction of a registered professional engineer who must attest to installed systems and equipment compliance with the requirements of the contract documents. Training includes operation of systems equipment and controls through normal ranges and sequences and simulation of abnormal conditions. Each device must be caused to function manually and automatically in accordance with its purpose. The field instructions must cover the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

3.6 ACCEPTANCE TESTS

Upon completion and prior to acceptance of the work, perform pre-operational checkout, calibration and adjustment of system components to ensure and demonstrate stable, accurate, reproducible, energy efficient operation and optimum performance. Operate systems for [48][_____] hours after all major corrections have been made. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest system. Prior to acceptance, install and tightenservice valve seal caps and blanks over gauge points.

3.7 FIELD PAINTING

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.8 CLEANING AND ADJUSTING

Wipe equipment clean, with all traces of oil, dust, dirt, or paint spots removed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 64 10 (November 2016)**
Change 2 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-23 64 10 (August 2008)
UFGS-23 64 00.00 10 (January 2008)
UFGS-23 66 00.00 20 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 64 10

WATER CHILLERS, VAPOR COMPRESSION TYPE

11/16, CHG 2: 08/18

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 64 10 (November 2016)**
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****

SECTION 23 64 10

WATER CHILLERS, VAPOR COMPRESSION TYPE
11/16, CHG 2: 08/18

****
NOTE: This guide specification covers the requirements for water chilling equipment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 450	(2007) Water-Cooled Refrigerant Condensers, Remote Type
AHRI 480	(2007) Refrigerant-Cooled Liquid Coolers, Remote Type
AHRI 550/590 I-P	(2020) Performance Rating Of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle
AHRI 575	(2017) Method of Measuring Machinery Sound Within an Equipment Space
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 37	(2024) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 54	(2024) National Fuel Gas Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J537	(2016) Storage Batteries

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UL SOLUTIONS (UL)

UL 1236	(2015; Reprint Feb 2021) UL Standard for Safety Battery Chargers for Charging Engine-Starter Batteries

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Water Chiller; G, [_____]

Posted Instructions

Verification of Dimensions

Factory Tests

System Performance Tests

Demonstrations

Refrigerant

[Water Chiller - Field Acceptance Test Plan

] SD-06 Test Reports

Field Acceptance Testing

[Water Chiller - Field Acceptance Test Report

] Factory Tests

System Performance Tests

SD-07 Certificates

Refrigeration System; G, [_____]

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

[Water Chiller - Installation Instructions; G, [_____]

] SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.3 CERTIFICATIONS

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NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants, such as R-123, into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

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1.3.1 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

1.5 DELIVERY, STORAGE, AND HANDLING

Stored items must be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation will be the Contractor's responsibility. Any materials found to be damaged must be replaced at the Contractor's expense. During installation, piping and similar openings must be capped to keep out dirt and other foreign matter.

1.6 PROJECT REQUIREMENTS

1.6.1 Verification of Dimensions

The Contractor must become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

PART 2 PRODUCTS

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NOTE: Job specifications will be written to avoid restrictions on specific types of refrigerant (excluding CFC refrigerants) in order to encourage competitive bidding of available product offerings.

Electric chillers are required to meet performance requirements specified by FEMP. The link for energy requirements for air-cooled chillers is found at:
http://energy.gov/eere/femp/covered-product-category-air-cooled-electric-chill

Information on requirements for water-cooled chillers can be found at:

The link for energy requirements for water-cooled chillers is found at:
http://energy.gov/eere/femp/covered-product-category-water-cooled-electric-chi

These specifications conform to the efficiency requirements as defined in Public Law (PL) 109-58 - "Energy Policy Act of 2005" for federal procurement of energy-efficient products. Equipment selected will have as a minimum the efficiency ratings.

Performance requirements for air-cooled chillers are provided in both kilowatt (kW)/ton and energy efficiency ratio (EER or Btu/watt) units for convenience. When comparing only air-cooled chillers, EER (Btu/watt) is a common metric. When comparing air-cooled and water-cooled chillers, kW/ton is a common metric. Performance requirements for water-cooled chillers are provided in kW/ton.

Equipment having a lower efficiency than FEMP requirements may be specified if the designer determines the equipment to be more life-cycle cost effective using the life-cycle cost analysis methodology and procedure in 10 CFR 436.

The driving forces in the procurement of higher efficient equipment are Executive Orders 13423 and 13514.

When editing this specification to eliminate a type

of chillers technology (oil-free magnetic bearings compressors versus oil-lubricated compressors), the design analysis must include both calculations to demonstrate that the edit is the most LCC effective and manufacturer's literature demonstrating that this edit does not result in a sole-source chiller procurement.

Minimum chiller efficiencies will either be presented in this specification or on the design drawings. Delete chiller efficiencies in the specification if efficiencies are shown on the drawings. If the efficiencies are shown on the drawings, reference the applicable AHRI standard.

Use minimum full load and part load efficiency ratings to specify electrically driven, air-cooled and water-cooled water chillers.

Projects which include vapor-compression type water chillers will comply with the safety standards defined in ASHRAE 15. Designers will be responsible for thoroughly researching and implementing the ASHRAE 15 safety requirements. For refrigerant-containing parts (excluding piping) located within an indoor space, a designer can use the following 6-step synopsis as a guide in determining "System Application Requirements" from ASHRAE 15.

Step 1. Identify the safety group classification of the refrigerant anticipated to be used in the new water chilling equipment.

Step 2. Identify the occupancy classification of the facility which will house the new water chilling equipment. Occupancies include institutional, public assembly, residential, commercial, large mercantile, industrial, and mixed types.

Step 3. Determine the system probability (high or low) of the new water chilling equipment. Water chillers are typically considered low-probability systems according to ASHRAE 15.

Step 4. Estimate the quantity of refrigerant (kilograms or pounds) in the largest single water chiller or largest refrigerant circuit of the new equipment. The designer will research catalog data from a minimum of two different water chiller manufacturers in order to get an approximation.

Step 5. Determine the volume in cubic meters cubic feet of the indoor space which is planned to house the new water chilling equipment.

Step 6. Identify the "System Application Requirements" from the applicable table in ASHRAE 15 based upon the information identified in the

previous steps (e.g., safety group, occupancy, system probability, refrigerant quantity, and indoor space volume). The "System Application Requirements" will dictate applicable refrigerant limitations as well as occupied space or mechanical room requirements. Typically, indoor spaces housing water chilling equipment must meet the mechanical room requirements defined in ASHRAE 15.

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2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment will be standard Commercial cataloged products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. These products must have a two year record of satisfactory field service prior to bid opening. The two year record of service must include applications of equipment and materials under similar circumstances and of similar size. Products having less than a two year record of satisfactory field service will be acceptable if a certified record of satisfactory field service for not less than 6000 hours can be shown. The 6000 hour service record must not include any manufacturer's prototype or factory testing. Satisfactory field service must have been completed by a product that has been, and presently is being sold or offered for sale on the commercial market through the following copyrighted means: advertisements, manufacturer's catalogs, or brochures.

2.2 MANUFACTURER'S STANDARD NAMEPLATES

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NOTE: In a salt water environment, substitute acceptable non-corroding metal such as but not limited to nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

Choose first bracketed paragraph for Army projects. Second bracketed paragraph for Navy projects.

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[Major equipment including chillers, compressors, compressor drivers, condensers, water coolers, receivers, refrigerant leak detectors, heat exchanges, fans, and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates must be durable and legible throughout equipment life. Plates must be fixed in prominent locations with nonferrous screws or bolts.

][Nameplates are required on major components if the manufacturer needs to provide specific engineering and manufacturing information pertaining to the particular component. Should replacement of this component be required, nameplate information will insure correct operation of the unit after replacement of this component.

]2.3 ELECTRICAL WORK

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NOTE: Where motor starters for mechanical equipment

are provided in motor-control centers, the references to motor starters will be deleted.

Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm on the drawings in the equipment schedules.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (ASD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01, "Interior Electrical Systems".

****

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, must be provided. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.

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NOTE: Bracketed sentence "Motor bearings..." to be used for Army projects only.

****

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. [Motor bearings must be fitted with grease supply fittings and grease relief to outside of the enclosure.] Motor enclosure type may be either TEAO or TEFC.

e. [Where two-speed motors are indicated, variable-speed controllers may be provided to accomplish the same function.][Use adjustable frequency drives for all variable-speed motor applications.] Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.

f. Provide inverter duty premium efficiency motors for use with variable frequency drives.

2.4 SELF-CONTAINED WATER CHILLERS, VAPOR COMPRESSION TYPE

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NOTE: Typically, units 1760 kW 500 tons or smaller are fully assembled and run-tested at the factory. Units larger than 1760 kW 500 tons are typically shipped and then assembled, charged, and run-tested in the field.

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Unless necessary for delivery purposes, units must be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. In lieu of delivery constraints, a chiller may be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site by a factory representative. Unit components delivered separately must be sealed and charged with a nitrogen holding charge. Parts weighing 23 kg 50 pounds or more which must be removed for inspection, cleaning, or repair, such as motors, gear boxes, cylinder heads, casing tops, condenser, and cooler heads, must have lifting eyes or lugs. Chiller must be provided with a single point wiring connection for incoming power supply. Chiller's condenser and water cooler must be provided with [standard] [marine] water boxes with [grooved mechanical] [flanged] [welded] connections.

2.4.1 Scroll, Reciprocating, or Rotary Screw Type

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NOTE: These type units are typically available in capacities of 1406 kW 400 tons or less.

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Chiller must be certified for performance per AHRI 550/590 I-P. If specified performance is outside of the Application Rating Conditions of AHRI 550/590 I-P, Table 2 then the chiller's performance must be rated in accordance with AHRI 550/590 I-P. Chiller must conform to ANSI/ASHRAE 15 & 34. As a minimum, chiller must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil

b. Structural base

c. Chiller refrigerant circuit

d. Controls package

e. Scroll, reciprocating, or rotary screw compressor

f. Compressor driver, [electric motor] [gas-engine]

g. Compressor driver connection

h. Water cooler (evaporator)

i. [Air][Water]-cooled condenser coil

[j. Heat recovery condenser

][k. Receiver
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NOTE: Tools to be used for Army projects only.

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[l. Tools

]2.4.2 Centrifugal or Rotary Screw Type

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NOTE: These type units are typically available in capacities of 703 kW 150 tons or more.

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Chiller must be certified for performance per AHRI 550/590 I-P. If specified performance is outside of the Application Rating Conditions of AHRI 550/590 I-P, Table 2 then the chiller's performance must be rated in accordance with AHRI 550/590 I-P. Chiller must conform to ANSI/ASHRAE 15 & 34. As a minimum, chiller must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil

b. Structural base

c. Chiller refrigerant circuit

d. Controls package

e. Centrifugal or rotary screw compressor

f. Compressor driver, [electric motor] [gas-engine] [steam turbine]

g. Compressor driver connection

h. Water cooler (evaporator)

i. [Air][Water]-cooled condenser coil

[j. Heat recovery condenser coil

][k. Receiver

] l. Purge system for chillers which operate below atmospheric pressure

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NOTE: Tools to be used for Army projects only.

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[m. Tools

]2.5 SPLIT-SYSTEM WATER CHILLER, VAPOR COMPRESSION TYPE

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NOTE: Typically, units 500 tons or smaller are fully assembled and run-tested at the factory. Units larger than 1760 kW 500 tons are typically shipped and then assembled, charged, and run-tested in the field.

****

Total chiller system must be certified for performance per AHRI 550/590 I-P. If chiller is not in scope of AHRI 550/590 I-P then chiller must be rated in accordance with AHRI 550/590 I-P. Individual chiller components must be constructed and rated in accordance with the applicable AHRI standards. Chiller system must conform to ANSI/ASHRAE 15 & 34. The chiller must be ASHRAE 90.1 - SI ASHRAE 90.1 - IP compliant and meet 10 CFR Part 433, 434 and 435 efficiency performance standards for federal construction. The manufacturer must provide certification of compliance. Chiller must be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site in strict accordance with manufacturer's recommendations. Unit components delivered separately must be sealed and charged with a nitrogen holding charge. Unit assembly must be completed in strict accordance with manufacturer's recommendations. Chiller must operate within capacity range and speed recommended by the manufacturer. Parts weighing 23 kg 50 pounds or more which must be removed for inspection, cleaning, or repair, must have lifting eyes or lugs. Chiller must include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Chiller's water cooler must be provided with [standard] [marine] water boxes with [grooved mechanical] [flanged] [welded] connections. Chillers must operate at partial load conditions without increased vibration over normal vibration at full load, and must be capable of continuous operation down to minimum capacity. As a minimum, chiller must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil

b. Structural base

c. Chiller refrigerant circuit

d. Controls package

[e. Receiver
]

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NOTE: Tools to be used for Army projects only.

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[f. Tools

]2.5.1 Compressor-Chiller Unit

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NOTE: These type units are typically available in capacities of 1406 kW 400 tons or less.

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As a minimum, the compressor-chiller unit must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Scroll, reciprocating, or rotary screw compressor

b. Compressor driver, electric motor

c. Compressor driver connection

d. Water cooler (evaporator)

2.5.2 Condensing Unit

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NOTE: These type units are typically available in capacities of 703 kW 150 tons or more.
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As a minimum, the condensing unit must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Scroll, reciprocating, or rotary screw compressor

b. Compressor driver, electric motor

c. Compressor driver connection

d. Air or water cooled condenser

2.5.3 Remote Water Cooler (Evaporator)

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NOTE: Coil bundles to be used for Army projects only.

Confirm the current standard fouling factor with AHRI.
****

2.5.3.1 Shell and Tube Type

Cooler must be constructed and rated in accordance with AHRI 480. Cooler must be of the shell-and-coil or shell-and-tube type design. Cooler's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Cooler's water side must be designed and factory pressure tested for not less than [1,000] [1,700] [2,000] kPa [150] [250] [300] psi. Cooler shell must be constructed of seamless or welded steel. [Coil bundles must be totally removable and arranged to drain completely.] Tubes must be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable. Tubes must be installed into carbon mild steel tube sheets by rolling. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Cooler must be skid-mounted. Refrigerant circuit must be complete with liquid solenoid valve and expansion device capable of modulating to the minimum step of capacity unloading. For the water side of water cooler, performance must be based on a fluid velocity not less than 0.91 m/s 3 fps and not more than 3.7 m/s 12 fps and a fouling factor per AHRI 550/590 I-P.[Evaporator must be provided with electric freeze protection type.]

2.5.3.2 Brazed Plate Type

Cooler must be rated in accordance with AHRI 480. Cooler must be of the brazed plate design. Cooler's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Cooler's water side must be designed and factory pressure tested for not less than [1,000] [1,700] [2000] kPa [150] [250] [300] psi. Cooler shell must be constructed of stainless steel plates brazed together with copper. Refrigerant circuit must be complete with liquid solenoid valve and expansion device capable of modulating to the minimum step of capacity unloading. For the water side of water cooler, performance must be based on a fluid velocity not less than 0.91 m/s 3 fps and not more than 3.7 m/s 12 fps and a fouling factor per AHRI 550/590 I-P. [Evaporator must be provided with electric freeze protection type.]

2.5.4 Remote Air-Cooled Condenser

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NOTE: Louvered panels to be used for Army projects only.

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Condenser must be a factory-fabricated and assembled unit, consisting of coils, fans, and condenser fan motors. Condenser must be rated in accordance with ANSI/AHRI 460. [Unless the condenser coil is completely protected through inherent design, louvered panel coil guards must be provided by the manufacturer to prevent physical damage to the coil.] Manufacturer must certify that the condenser and associated equipment are designed for the submitted condensing temperature. For design conditions, if matched combination catalog ratings matching remote condensers to compressors are not available, the Contractor must furnish a crossplotting of the gross heat rejection of the condenser against the gross heat rejection of the compressor, for the design conditions to show the compatibility of the equipment furnished.

2.5.4.1 Condenser Casing

Condenser casing must be aluminum not less than [1.016] [2.032] mm [0.040] [0.080] inch or hot-dip galvanized steel not lighter than 18 gauge 1.311 mm 0.0516 inch. [Condensers having horizontal air discharge must be provided with discharge baffle to direct air upward, constructed of the same material and thickness as the casing].

2.5.4.2 Coil

[Condenser coil must be of the extended-surface fin-and-tube type and must be constructed of seamless [copper] [or] [aluminum] tubes with compatible [copper] [or] [aluminum] fins. Fins must be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils must be circuited and sized for a minimum of 3 degrees C 5 degrees F subcooling and full pumpdown capacity. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.][The condenser coil must be of the microchannel heat exchanger technology (MCHX) type consisting of a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds in a two-pass arrangement. Provide coils constructed of aluminum alloys for fins, tubes, and manifolds. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.]

[Coil must be entirely coated in accordance with the requirements of paragraph COIL CORROSION PROTECTION.

]2.5.4.3 Fans

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NOTE: Belt drives to be used for Army projects only.

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Provide centrifugal or propeller type fans as best suited for the application. Fans must be direct [or] [V-belt] driven. [Belt drives must be completely enclosed within the unit casing or equipped with a guard.] [When belt drive is provided, an adjustable sheave to furnish not less than 20 percent fan-speed adjustment must be provided. Sheave sets must be matched and selected to provide the capacity indicated at the approximate midpoint of the adjustment.] Fans must be statically and dynamically balanced.

2.5.4.4 Condenser Sizing

Size condensers for full capacity at 16.67 degrees C 30 degrees F temperature difference between entering outside air and condensing refrigerant. Subcooling must not be considered in determining compressor and condenser capacities. For design conditions, submit a cross-plot of net refrigeration effect of compressor to establish net refrigeration effect and compatibility of equipment furnished.

2.5.4.5 Low Ambient Control

Provide factory mounted head pressure control for operation during low ambient conditions. Head pressure must be controlled by [fan cycling,] [fan speed control,] [condenser refrigerant flooding]. Low ambient control must permit compressor operation below[4.4 degrees C40 degrees F][minus 17.7 degrees C0 degrees F][[_____] degrees C[_____] degrees F].

2.5.4.6 High Ambient Unloading

Provide unloading capability to allow operation in high ambient conditions [[_____] degrees C[_____] degrees F] above design conditions.

2.5.5 Remote Water-Cooled Condenser

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NOTE: Coil bundles to be used in Army projects only.

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Condenser must be a factory-fabricated and assembled unit constructed and rated in accordance with AHRI 450. Condenser may be of either the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Condenser's water side must be designed and factory pressure tested for not less than [1,000] [1,700] [2000] kPa [150] [250] [300] psi. Condensers must be complete with pressure relief valve or rupture disk, water drain connections, refrigerant charging valve, refrigerant valves, liquid-level indicating devices, and stand or saddle. Low pressure refrigerant condenser must be provided with a purge valve located at the highest point in the condenser to purge non-condensibles trapped in the condenser. Condenser shell must be constructed of seamless or welded steel. [Coil bundles must be totally removable and arranged to drain completely.] Tubes may be either seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable, except for the coaxial tubes. Tubes must be installed into carbon mild steel tube sheets by rolling. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Condenser performance must be based on water velocities not less than 0.91 m/s 3 fps nor more than 3.7 m/s 12 fps and a fouling factor per AHRI 550/590 I-P. Water-cooled condensers may be used for refrigerant storage in lieu of a separate liquid receiver, if the condenser storage capacity is 20 percent in excess of the fully charged system for remote water cooled condensers. As a minimum, the condenser must include the following components as defined in paragraph CHILLER COMPONENTS.

a. Liquid-level indicating devices.

b. Companion flanges, bolts, and gaskets for flanged water connections.

2.6 CHILLER COMPONENTS

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NOTE: Coordinate the type of chiller components required with the type of chiller specified in the previous paragraphs.

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2.6.1 Refrigerant and Oil

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NOTE: Chillers must operate on a refrigerant with an ODP equal to 0. R-134a, R-407C, and R-410A all meet this requirement. The exception is equipment using R-123 which will continue to be produced until January 1, 2020 and will remain acceptable for installation in DoD facilities until then.

On January 1, 2020, R-123 will no longer be allowed.

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Refrigerants must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. CFC-based refrigerants are prohibited. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0, with the exception of R-123. Provide SDS sheets for all refrigerants.

2.6.2 Structural Base

Chiller and individual chiller components must be provided with a factory-mounted structural steel base (welded or bolted) or support legs. Chiller and individual chiller components must be isolated from the building structure by means of [molded neoprene isolation pads.] [vibration isolators with published load ratings. Vibration isolators must have isolation characteristics as recommended by the manufacturer for the unit supplied and the service intended.]

2.6.3 Chiller Refrigerant Circuit

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NOTE: Filter dryers are not needed on chillers which make use of a purge system.

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Chiller refrigerant circuit must be completely piped and factory leak tested in accordance with ANSI/ASHRAE 15 & 34. [For multicompressor units, not less than 2 independent refrigerant circuits must be provided.]Circuit must include as a minimum a [combination filter and drier,] combination sight glass and moisture indicator, an electronic or thermostatic expansion valve with external equalizer or float valve, charging ports, compressor service valves for field-serviceable compressors, and superheat adjustment.

2.6.4 Controls Package

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NOTE: For large water-cooled chillers (centrifugal or rotary screw), motor starters and disconnects switches which are to be remotely-mounted are not typically supplied by the chiller manufacturer.

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Provide chillers with a complete [factory-mounted] [remote-mounted where indicated], microprocessor based operating and safety control system. Controls package must contain as a minimum a digital display, an on-auto-off switch, [motor starters,] [variable frequency motor controller,] [disconnect switches,] power wiring, and control wiring. Controls package must provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and [BAS] [UMCS] interfaces as defined below.

2.6.4.1 Operating Controls

****

NOTE: For proper startup and head pressure controls, enter the winter design temperature to which the equipment will be subjected. Coordinate this temperature with manufacturers to assure available equipment.

A cooling tower bypass line and modulating control valve should be evaluated and incorporated into a design which requires chiller operation in ambient temperatures less than 13 degrees C 55 degree F.

****

Chiller must be provided with the following adjustable operating controls as a minimum.

a. Leaving chilled water temperature control

b. Adjustable timer or automated controls to prevent a compressor from short cycling

c. Automatic lead/lag controls (adjustable) for multi-compressor units

d. Load limiting

e. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls must automatically re-cycle the chiller on power interruption.

f. Startup and head pressure controls to allow system operation at all ambient temperatures down to [_____] degrees C F.

[g. Fan sequencing for air-cooled condenser

]2.6.4.2 Monitoring Capabilities

During normal operations, the control system must be capable of monitoring and displaying the following operating parameters. Access and operation of display must not require opening or removing any panels or doors.

a. Entering and leaving chilled water temperatures

b. [Entering and leaving chilled water pressure][Chilled water flow]

c. [Entering and leaving condenser water pressure][Condenser water flow]

d. Self diagnostic

e. Operation status

f. Operating hours

g. Number of starts

h. Compressor status (on or off)

i. Compressor load (percent)

j. Refrigerant discharge and suction pressures

k. Magnetic bearing levitation status (if applicable)

l. Magnetic bearing temperatures (if applicable)

m. Oil pressure

[n. Condenser water entering and leaving temperatures

][o. Number of purge cycles over the last 7 days

]2.6.4.3 Configurable Setpoints

****

NOTE: Small sized chillers may not have security setting capabilities.

****

The control system must be capable of being configured directly at the unit's interface panel. [No parameters may be capable of being changed without first entering a security access code.] The programmable setpoints must include the following as a minimum:

a. Leaving Chilled Water Temperature

[b. Leaving Condenser Water Temperature

][c. Time Clock/Calendar Date

]2.6.4.4 Safety Controls with Manual Reset

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NOTE: Conventional compressors with oil-lubricated bearings will require low oil flow protection.

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Chiller must be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

a. Low chilled water temperature protection

b. High condenser refrigerant discharge pressure protection

c. Low evaporator pressure protection

d. Chilled water flow detection

e. High motor winding temperature protection

f. Low oil flow protection if applicable

g. Magnetic bearing controller (MBC), Internal fault (if applicable)

h. MBC, High bearing temperature (if applicable)

i. MBC, Communication fault (if applicable)

j. MBC, Power supply fault (if applicable)

[k. Motor current overload and phase loss protection

]2.6.4.5 Safety Controls with Automatic Reset

Chiller must be provided with the following safety controls which automatically shutdown the chiller and which provide automatic reset.

a. Over/under voltage protection

b. Chilled water flow interlock

c. MBC, Vibration (if applicable)

d. MBC, No levitation (if applicable)

[e. Phase reversal protection

]2.6.4.6 Remote Alarm

During the initiation of a safety shutdown, a chiller's control system must be capable of activating a remote alarm bell. In coordination with the chiller, the Contractor must provide an alarm circuit (including transformer if applicable) and a minimum 100 mm 4 inch diameter alarm bell. Alarm circuit must activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell must not sound for a chiller that uses low-pressure cutout as an operating control.

2.6.4.7 Utility Monitoring and Control System Interface

Provide a Utility Monitoring and Control System (UMCS) interface meeting the requirements of Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and the requirements of [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS]. The interface must provide all system operating conditions, capacity controls, and safety shutdown conditions as network points. In addition, the following points must be overridable via the network interface:

a. Unit Start/Stop

[b. Leaving Chilled Water Temperature Setpoint

][c. Leaving Condenser Water Temperature Setpoint

]2.6.5 Compressor(s)

****

Note: Reciprocating compressors are used by very few manufacturers, typically for special applications such as refrigeration. Efficiency and production costs have pushed most comfort cooling application manufacturers to scroll compressors. Reciprocating compressors for refrigeration applications are specified in Sections 23 63 00.00 COLD STORAGE REFRIGERATION SYSTEMS and 23 69 00.00 20 REFRIGERATION EQUIPMENT FOR COLD STORAGE.

****

2.6.5.1 Scroll Compressor(s)

****

Note: Designer must consider unloading for more precise leaving water temperature control. Also, chiller manufacturers recommend minimum system volumes to prevent short-cycling of the chiller(s) to promote long chiller life and good chilled water temperature control, especially in smaller chilled water systems. In small systems it may be necessary to install an inertia tank in the chilled water loop to achieve the required minimum system volume. Check the requirements of the chiller manufacturer and provide an insulated inertia tank of sufficient volume when required. Install the chilled water storage tank downstream of the chiller and upstream of the cooling coils. The designer should provide calculations to demonstrate compliance with this requirement. Volumes for components may be estimated where manufacturer's data is not available.

****

Compressors must be of the hermetically sealed design. Compressors must be mounted on vibration isolators to minimize vibration and noise. Rotating parts must be statically and dynamically balanced at the factory to minimize vibration. Lubrication system must be centrifugal pump type equipped with a means for determining oil level and an oil charging valve.

Crankcase oil heater must be provided.[Provide continuous compressor unloading to [10 percent][15 percent] of full-load capacity by way of variable speed compressor motor controller or variable unloading of the scroll.]

2.6.5.2 Rotary Screw Compressor(s)

Compressors must operate stably for indefinite time periods to at least 25 percent capacity reduction without gas bypass external to the compressor. Provision must be made to insure proper lubrication of bearings and shaft seals on shutdown with or without electric power supply. Rotary screw compressors must include:

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NOTE: If an open drive (air cooled) motor is used, provide mechanical ventilation if required to reject the additional heat added to the space at the source. The additional mechanical ventilation should be counted into the efficiency calculations for the chiller.

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a. An open or hermetic, positive displacement, oil-injected design directly driven by the compressor driver. Allow access to internal compressor components for repairs, inspection, and replacement of parts.

b. Rotors must be solid steel, possessing sufficient rigidity for proper operation.

c. A maximum rotor operating speed no greater than 3600 RPM. Provide cast iron rotor housing.

d. Casings of cast iron, precision machined for minimal clearance about periphery of rotors with minimal clearance at rotor tops and rotor ends.

e. A lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.

f. Bearing housing must be conservatively loaded and rated for an L(10) life of not less than 200,000 hours. Shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11.

g. A differential oil pressure or flow cutout to allow the compressor to operate only when the required oil pressure or flow is provided to the bearings.

h. [A temperature- or pressure-initiated, hydraulically actuated, single-slide-valve, capacity-control system to provide minimum automatic capacity modulation from 100 percent to 15 percent.] [Use a Variable Frequency Drive (VFD) to modulate capacity modulation from 100 percent to 15 percent.]

i. An oil separator and oil return system to remove oil entrained in the refrigerant gas and automatically return the oil to the compressor.

j. Crankcase oil heaters must be provided.

2.6.5.3 Centrifugal Compressor(s)

****

NOTE: Conventional compressors will require provisions to ensure proper lubrication of bearings.

When centrifugal chillers are used for heat recovery duty, the entering heat recovery condenser water temperature is usually controlled to between 35 and 40 degrees C 95 and 105 degrees F so that the water temperature leaving the heat recovery condenser is high enough to be used as a heat source. Under these conditions, the chiller will be operating at a higher head pressure than normally encountered. At these high head conditions, the centrifugal compressor may surge at part-load conditions of as high as 30 percent to 40 percent depending upon the conditions to which the chiller is subjected. In these cases, the designer should survey the manufacturers to determine at what load the available chillers will surge, at the conditions and loads to be encountered at the site. The bracketed sentences will be removed from the centrifugal chiller paragraph and replaced with the appropriate capacity control requirements. The designer should also consider multiple chillers to satisfy the load and to partition the loading to the chillers such that the heat recovery chiller load is sufficiently high to avoid surge. When examining heat recovery, full consideration should be given to the effect of 35-40 degrees C 95-105 degree F water and the resulting power requirements of the chiller on the economic benefit of heat recovery.

If an open drive (air cooled) motor is used, provide mechanical ventilation if required to reject the additional heat added to the space at the source. The additional mechanical ventilation should be counted into the efficiency calculations for the chiller.

****

Centrifugal compressors may be either single or multistage, having dynamically balanced impellers, either direct or gear driven by the compressor driver. Impellers must be over-speed tested at 1.2 times the impeller-shaft speed. Impeller shaft must be steel with sufficient rigidity for proper operation at any required operating speed. Compressors must be capable of variable speed operation and may have either oil-free bearing drives or oil-lubricated bearing drives. Centrifugal compressors must include:

a. Shaft main bearings that are either oil lubricated, oil free ceramic or magnetic levitated. The oil lubricated bearings must be the rolling element type in accordance with ABMA 9 or ABMA 11, journal type with bronze or babbitt liners, or of the aluminum-alloy one-piece insert type. Oil lubricated or oil free ceramic bearings must be rated for an L(10) life of not less than 200,000 hours. Magnetic levitated main shaft bearings must be in accordance with ISO 14839-1, ISO 14839-2, ISO 14839-3, ISO 14839-4, and provided with radial and axial magnetic levitated bearings (combination permanent and electro magnets) to levitate the shaft thereby eliminating metal to metal contact and thus eliminating the need for oil. The active magnetic bearings must be equipped with an automatic vibration reduction and balancing system. Each bearing position must be sensed by position sensors and provide real time positioning of the rotor shaft, controlled by on-board digital electronics. In the event of a power failure, the magnetic bearings will remain in operation throughout the compressor coast-down using a reserve power supply. Provide mechanical bearings designed for emergency touchdowns, as a backup to the magnetic bearings.

b. Casing of cast iron, aluminum, or steel plate with split sections gasketed and bolted or clamped together.

c. Lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.

d. Provisions to ensure proper lubrication of bearings and shaft seals prior to starting and upon stopping with or without electric power supply (if applicable). On units providing forced-feed lubrication prior to starting, a differential oil pressure cutout interlocked with the compressor starting equipment must allow the compressor to operate only when the required oil pressure is provided to the bearings (if applicable).

e. Oil sump heaters controlled as recommended by the manufacturer.

f. Temperature-or pressure-actuated prerotation vane, variable geometry diffuser or suction damper to provide automatic capacity modulation from 100 percent capacity to 25 percent capacity. If operation to 25 percent capacity cannot be achieved without providing gas bypass external to the compressor, then the Contractor must indicate in the equipment submittal the load percent at which external hot gas bypass is required to prevent surge and to provide the specified capacity reduction and its impact on performance.

2.6.6 Compressor Driver, Electric Motor

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NOTE: If an open drive (air cooled) motor is used, provide mechanical ventilation if required to reject the additional heat added to the space at the source. The additional mechanical ventilation should be counted into the efficiency calculations for the chiller.

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Components such as motors, [starters], [variable speed drives] and wiring must be in accordance with paragraph ELECTRICAL WORK. [Motor starter][Variable frequency drive] must be [unit mounted] [remote mounted] as indicated with [starter][variable frequency drive] type, wiring, and accessories coordinated with the chiller manufacturer.

2.6.7 Compressor Driver, Gas-Engine

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NOTE: Natural gas-engine drives are used in conjunction with either reciprocating, rotary, or centrifugal type compressors.

The decision to use a heavy duty industrial type engine as compared to a standard automotive type engine will be based strictly on an economic comparison. The standard automotive type engines have a much lower initial cost, but they must be replaced and/or overhauled much more often. Also note that typically, standard automotive type engines are only available for chillers with a capacity of 1760 kW 500 tons or less.

Guidance to Project Designers: When specifying natural gas-engine drive chillers, close coordination with the DPW (customer) must be exercised. The designer should inform the DPW that preventive maintenance and periodical overhaul of the gas-engine drives is essential to ensure continued operation, and that energy demand savings are realized. While the initial cost of gas-engine drives is much lower than other types, gas-engine drives require more frequent maintenance and overhaul.

****

Gas-engine compressor driver must operate on natural gas and be in accordance with NFPA 37 and NFPA 54. Engine must be designed for stationary applications and include all ancillaries necessary for operation. Engine must be a manufacturer's standard production model and be specifically designed for chiller operation. Engine must include as a minimum a [heavy duty industrial] [standard automotive] grade block, starting system, lubrication system, coolant system, engine heat exchanger, [engine cooling radiator,] fuel supply system, electronic ignition, and controls package. Engine must be either [naturally aspirated,] [supercharged,] or [turbocharged] and include appropriate air filters. Engine must be 2- or 4-stroke-cycle and compression-ignition type. Engine must be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. Engine must have a minimum of 2 cylinders. Opposed-piston type engines must have not less than 4 cylinders. Engine block must have a coolant drain port.

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NOTE: For pneumatic start systems size air receiver tank and compressor per manufacturer's recommendations.

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2.6.7.1 Starting System

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NOTE: Specify either an electric or pneumatic type starting system. Electric type system will be used for most applications. For installations where a compressed air system exists or is to be installed, a pneumatic starting system should be considered.

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Engine starting system must be either the [electric] [pneumatic] type and be of sufficient capacity, at the maximum temperature specified, to crank the engine without damage or overheating. [Electric starting system must operate on a [24] [_____]-volt DC system utilizing a negative circuit ground. A starting battery system must be provided and must include the battery, corrosion resistant battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. Battery must be in accordance with SAE J537. Battery charger must conform to UL 1236 and be the current-limiting type with overcurrent protection.] [Pneumatic starting system must be as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE, for a working pressure of 1.03 MPa 150 psi.]

2.6.7.2 Lubrication System

Engine must be provided with a pressurized oil lubrication system. System must include a lubrication oil pump that is engine driven. One full-flow filter must be provided for each pump. Filters must be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. System pressure must be regulated as recommended by the engine manufacturer. A pressure relief valve must be provided on the crankcase. Crankcase breathers must be piped to the outside. System must be readily accessible for servicing such as draining, refilling, and overhauling.

2.6.7.3 Coolant System

Engine must include an automatic engine jacket water cooling system. Water must be circulated through the system with an engine-driven circulating pump. [System coolant must use a combination water and ethylene-glycol sufficient for freeze protection at the minimum temperature specified.]

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NOTE: If engine heat exchanger is used the cooling tower must be sized to include heat rejected from both engine and chiller.

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[2.6.7.4 Engine Heat Exchanger

Engine heat exchanger must be of the shell-and-tube type construction and be in accordance with ASME BPVC SEC VIII D1. Shell material must be carbon steel. Tubes must be seamless copper or copper-nickel. Tubes must be individually replaceable. Unit's waterside working pressure must be rated for not less than 1,000 kPa 150 psig and factory tested at 150 percent of design working pressure. Water connections larger than 75 mm 3 inches must be ASME Class 1500 flanged. Unit must be provided with gasketed removable covers, drains, and vents.

][2.6.7.5 Engine Cooling Radiator

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NOTE: An engine cooling radiator will be needed to satisfy an engine's cooling requirements if cooling tower water or heat recovery is not used.

****

Heat exchanger may be factory coated with corrosive resistant film, provided that correction measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Internal surfaces must be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers must be the pressure type incorporating a pressure valve, vacuum valve and a cap. Caps must be designed for pressure relief prior to removal. Each heat exchanger and the entire cooling system must be capable of withstanding a minimum pressure of 48 kPa 7 psi and must be protected with a strong grille or screen guard. Each heat exchanger must have at least 2 tapped holes; one must be equipped with a drain cock, the rest must be plugged.

]2.6.7.6 Fuel Supply System

Engine fuel supply system must be factory mounted. System must include as a minimum a solenoid shut-off valve, a gas pressure regulator, and carburetors (including a throttle body assembly) or fuel injectors.

2.6.7.7 Controls Package

The controls for the gas-engine must be incorporated into the overall controls package for the water chiller. The engine controls must be capable of monitoring, displaying, and controlling, as applicable, the following conditions. The control system must be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data must include as a minimum all system operating conditions, capacity controls, and safety shutdown conditions. The control system must also be capable of receiving at a minimum the following operating conditions:

a. Coolant-fluid inlet and outlet temperatures

b. Lubricating-oil inlet and outlet temperatures and pressures

c. Engine run-time hours

d. Engine current status mode (on/off)

e. Engine speed

f. Percent engine load

g. Engine jacket temperature

2.6.7.8 Exhaust Piping

Exhaust piping must be ASTM A53/A53M Schedule 40 seamless black iron, exhaust piping installation must be per the engine manufacturer's recommendations, except as modified herein. Horizontal sections of exhaust piping must be sloped downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction must be long radius. Exhaust piping and mufflers must be insulated in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Vertical exhaust piping must be provided with a hinged, gravity-operated, self-closing, rain cover.

2.6.7.9 Exhaust Muffler

Engine must be provided with a chamber type exhaust muffler. The muffler must be of welded steel and designed for [outside] [inside] [vertical] [horizontal] mounting. Eyebolts, lugs, flanges, or other items must be provided as necessary for support in the location and position indicated. Pressure drop through the muffler must not exceed the recommendations of the engine manufacturer. Outside mufflers must be zinc coated or painted with high temperature [_____ degrees C] [_____ degrees F] resisting paint. The muffler and exhaust piping together must reduce the noise level to less than [_____] dBa at a distance of 22.9 m 75 feet from the end of the exhaust piping with the chiller operating at 100 percent of rated output capacity. The muffler must have a drain valve, nipple, and cap at the low-point of the muffler.

2.6.7.10 Exhaust System Connections

Flexible connectors must be provided at the exhaust piping connection to the engine. An expansion joint must be provided in the exhaust piping at the muffler connection. Flexible connectors and expansion joints must have flanged connections. Flexible sections must be made of convoluted seamless tube without joints or packing. Expansion joints must be the bellows type. Expansion and flexible elements must be stainless steel suitable for engine exhaust gas at 649 degrees C 1200 degrees F. Flexible connectors and expansion joints must be capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2.6.8 Compressor Driver, Steam Turbine

Steam turbine must be suitable for direct connection to the compressor. Turbine must have a capacity 10 percent greater than the compressor brake horsepower requirement at full-load condition. Steam strainer must be either internally mounted or installed in connecting piping. Turbine must include sentinel warning valve, forced-feed lubrication, oil cooler, oil reservoir, oil relief valve, oil piping, oil-pressure gauge, tachometer, and gland-seal piping if a condensing turbine is used. If a non-condensing turbine is used, provision must be made for drain piping. The turbine must be suitable for automatic control. An overspeed trip governor must be provided to shut off the steam supply at 115 percent of design speed. Provision must be made to stop the turbine upon operation of the compressor safety devices and upon power failure by the use of a solenoid trip on the emergency overspeed governor. Turbine must be governed by a pneumatically controlled hydraulic governor during automatic operation and with a manual control effective during failure of the air supply. Pneumatic valve must be actuated by a temperature controller with its sensing element in contact with the chilled water. Turbine must be designed to operate at the steam pressure and exhaust conditions indicated. If the turbine is a condensing type, a surface-type steam condenser complete with single-stage air ejector, inter- and after-condenser, electric-driven dual condensate pumps, atmospheric relief valve, and expansion joint must be furnished.

2.6.9 Compressor Driver Connections

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NOTE: Delete the first set of brackets if a large water-chilling package is specified. Delete the second set of brackets if a condensing and compressing unit or a small water-chilling package is used.

****

[Each compressor must be driven by a V-belt drive or direct connected through a flexible coupling, except that flexible coupling is not required on hermetic units. V-belt drives must be designed for not less than 150 percent of the driving motor capacity. Flexible couplings must be of the type that does not require lubrication.] [Each machine driven through speed-increasing gears must be so designed as to assure self-alignment, interchangeable parts, proper lubrication system, and minimum unbalanced forces. Bearings must be of the sleeve or roller type. Gear cases must be oil tight. Shaft extensions must be provided with seals to retain oil and exclude all dust.

]2.6.10 Water Cooler (Evaporator)

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NOTE: Confirm the current standard fouling factor with AHRI.

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Cooler must be of the shell-and-coil or shell-and-tube type design. Cooler shell must be constructed of seamless or welded steel. Coil bundles must be totally removable and arranged to drain completely. Tubes must be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable. Tubes must be installed into carbon mild steel tube sheets by rolling. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Performance must be based on a water velocity not less than 0.91 m/s 3 fps nor more than 3.7 m/s 12 fps and a fouling factor per AHRI 550/590 I-P.

Brazed plate heat exchanger must be constructed of 304 or 316 stainless steel, designed to a refrigerant-side working pressure of 3,000 kPa 430 psig and a waterside working pressure of 1,000 kPa 150 psig. Evaporator must be factory tested at 1.1 times maximum allowable refrigerant side working pressure and 1.5 times maximum allowable water side working pressure. [Provide cooler heaters to protect the evaporator to an ambient ofminus 29 degrees C minus 20 degrees F.]Provide cooler with factory-installed flow switches. All water connections must use either flanged or grooved-pipe connections. Factory insulate all cold surfaces.

2.6.11 Air-Cooled Condenser Coil

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NOTE: Standard coil construction is copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered. For additional corrosion protection, specify the manufacturer's standard epoxy or vinyl coating.

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[Condenser coil must be of the extended-surface fin-and-tube type and must be constructed of seamless [copper] [or] [aluminum] tubes with compatible [copper] [or] [aluminum] fins. Fins must be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils must be circuited and sized for a minimum of 3 degrees C 5 degrees F subcooling and full pumpdown capacity. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.][The condenser coil must be of the microchannel heat exchanger technology (MCHX) type consisting of a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds in a two-pass arrangement. Provide coils constructed of aluminum alloys for fins, tubes, and manifolds. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.]

[Coil must be entirely coated in accordance with the requirements of paragraph COIL CORROSION PROTECTION.

]2.6.12 Water-Cooled Condenser Coil

****

NOTE: Confirm the current standard fouling factor with AHRI.

****

Condenser must be of the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Condenser's water side must be designed and factory pressure tested for not less than [1,000] [1,700] [2000] kPa [150] [250] [300] psi. Condensers must be complete with refrigerant relief valve/rupture disc assembly, water drain connections, and refrigerant charging valve. Low pressure refrigerant condenser must be provided with a purging device to purge non-condensibles trapped in the condenser while keeping refrigerant emissions below requirements of ASHRAE Std 147. Purge units must be certified per AHRI 580. Condenser shell must be constructed of seamless or welded steel. Coil bundles must be totally removable and arranged to drain completely. Tubes must be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable, except for the coaxial tubes. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Performance must be based on water velocities not less than 0.91 m/s 3 fps nor more than 3.7 m/s 12 fps and a fouling factor per AHRI 550/590 I-P. Water-cooled condensers may be used for refrigerant storage in lieu of a separate liquid receiver, if the condenser storage capacity is 5 percent in excess of the fully charged system for single packaged systems.

2.6.13 Heat Recovery Condenser Coil

****

NOTE: The designer will conduct feasibility studies to determine if a heat recovery condenser is an economical addition to the system. Heat recovery condensers generally come in two sizes. The smaller of the two is generally sized to reject the superheat to the domestic water. The larger is sized to reject the same amount of heat as the standard condenser. The drawings will indicate the heat rejection capacity of the heat recovery condenser and the temperatures of the water to which it must reject the heat.

****

Condenser must be of the shell-and-coil or shell-and-tube type design and must not be a part of the standard condenser. Condenser must be provided and installed by the chiller manufacturer. Condenser's refrigerant side must be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Condenser's water side must be designed and factory pressure tested for not less than [1,000] [1,700] [2000] kPa [150] [250] [300] psi. Condenser must have performance characteristics as indicated on the drawings. Condenser shell must be constructed of seamless or welded steel. Coil bundles must be totally removable and arranged to drain completely. Tubes must be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube must be individually replaceable, except for the coaxial tubes. Tube baffles must be properly spaced to provide adequate tube support and cross flow. Performance must be based on water velocities not less than 0.91 m/s 3 fps nor more than 3.7 m/s 12 fps and a fouling factor per AHRI 550/590 I-P.

2.6.14 Receivers

Receiver must bear a stamp certifying compliance with ASME BPVC SEC VIII D1 and must meet the requirements of ANSI/ASHRAE 15 & 34. Inner surfaces must be thoroughly cleaned by sandblasting or other approved means. Each receiver must have a storage capacity not less than 20 percent in excess of that required for the fully-charged system. Each receiver must be equipped with inlet, outlet drop pipe, drain plug, purging valve, relief valves of capacity and setting required by ANSI/ASHRAE 15 & 34, and two bull's eye liquid-level sight glasses. Sight glasses must be in the same vertical plane, 90 degrees apart, perpendicular to the axis of the receiver, and not over 75 mm 3 inches horizontally from the drop pipe measured along the axis of the receiver. In lieu of bull's eye sight glass, external gauge glass with metal glass guard and automatic closing stop valves may be provided.

2.6.15 Chiller Purge System

****

NOTE: Refrigeration systems which operate below atmospheric pressure (i.e., R-123 machines) will require a refrigerant purge piping system. Indicate the routing of the piping on the drawings. Require the Contractor to delete the piping if a purge system is not required for the type of chiller that is to be provided. Indicate that it will be the Contractor's responsibility to size the piping based upon the chiller manufacturer's recommendations. Purge discharge piping may be connected to the pressure-relief piping on the chiller side of the piping's vibration isolators.

****

Chillers which operate at pressures below atmospheric pressure must be provided with a purge system. Purge system must automatically remove air, water vapor, and non-condensible gases from the chiller's refrigerant while keeping refrigerant emissions below requirements of ASHRAE Std 147. Purge units must be certified per AHRI 580. Purge system must condense, separate, and return all refrigerant back to the chiller. An oil separator must be provided with the purge system if required by the manufacturer. Purge system must not discharge to occupied areas, or create a potential hazard to personnel. Purge system must include a purge pressure gauge, number of starts counter, and an elapsed time meter. Purge system must include lights or an alarm which indicate excessive purge or an abnormal air leakage into chiller.

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NOTE: Tools to be used for Army projects only.

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[2.6.16 Tools

One complete set of special tools, as recommended by the manufacturer for field maintenance of the system, must be provided. Tools must be mounted on a tool board in the equipment room or contained in a toolbox as directed by the Contracting Officer.

]2.7 ACCESSORIES

2.7.1 Refrigerant Leak Detector

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NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ASHRAE 15.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 460 mm 18 inches above the finished floor since all commonly-used refrigerants are heavier than air.

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point should not exceed 15.24 m 50 feet. In order to meet the recommended 15.24 m 50 foot distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

Per ASHRAE 15, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a minimum, indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room. Include the electrical design for the alarm system on the drawings.

As an additional item, ASHRAE 15 states that open-flame devices such as boilers cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to the device; or the alarm relay from the detector is used to automatically shutdown the combustion process in the event of refrigerant leakage. Indicate all applicable alarm controls on the drawings.

The last bracketed sentence in the paragraph below is for Army projects only. Delete the information

in the last bracketed sentences if a Building Control Network (BCN) is not applicable to the design.
****

Detector must be the continuously-operating, halogen-specific type. Detector must be appropriate for the refrigerant in use. Detector must be specifically designed for area monitoring and must include [a single sampling point] [[_____] sampling points] installed where indicated. Detector design and construction must be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector must be supplied factory-calibrated for the appropriate refrigerant(s). Detector must be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant(s) in use. The detector's relay must be capable of initiating corresponding alarms and ventilation systems as indicated on the drawings. Detector must be provided with a failure relay output that energizes when the monitor detects a fault in its operation. [Detector must be compatible with the facility's Building Control Network (BCN). The BCN must be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.7.2 Refrigerant Relief Valve/Rupture Disc Assembly

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NOTE: ASHRAE 15 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly as well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be per ASHRAE 15.
****

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly must be in accordance with ASME BPVC SEC VIII D1 and ANSI/ASHRAE 15 & 34. The assembly must be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc must be the non-fragmenting type.

2.7.3 Refrigerant Signs

Refrigerant signs must be a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 13 mm 0.5 inches in height.

2.7.3.1 Installation Identification

Each new refrigerating system must be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.7.3.2 Controls and Piping Identification

Refrigerant systems containing more than 50 kg 110 lb of refrigerant must be provided with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow [, the ventilation system,] and the refrigerant compressor(s).

b. Pressure limiting device(s).

[2.7.4 Automatic Tube Brush Cleaning System

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NOTE: Delete this paragraph unless specifically required by the onsite staff.

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2.7.4.1 Brush and Basket Sets

One brush and basket set (one brush and two baskets) must be furnished for each condenser tube. Brushes must be made of nylon bristles, with titanium wire. Baskets must be polypropylene.

2.7.4.2 Flow-Diverter Valve

Each system must be equipped with one flow-diverter valve specifically designed for the automatic tube brush cleaning system and have parallel flow connections. The flow-diverter valve must be designed for a working pressure of [1,000][1,700][2000] kPa [150][250][300] psig. End connections must be flanged. Each valve must be provided with an electrically operated air solenoid valve and position indicator.

2.7.4.3 Control Panel

The control panel must provide signals to the diverter valve at a preset time interval to reverse water flow to drive the tube brushes down the tubes and then signal the valve to reverse the water flow to drive the brushes back down the tubes to their original position. The controller must have the following features as a minimum:

a. Timer to initiate the on-load cleaning cycle.

b. Manual override of preset cleaning cycle.

c. Power-on indicator.

d. Diverter-position indicator.

e. Cleaning-cycle-time adjustment

f. Flow-switch bypass.

]2.7.5 Gaskets

Gaskets must conform to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 371 degrees C 700 degrees F service.

2.7.6 Bolts and Nuts

Bolts and nuts, except as required for piping applications, must be in accordance with ASTM A307. The bolt head must be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

2.8 FABRICATION

2.8.1 Factory Coating

****

NOTE: For equipment to be installed outdoors, adequate protection will be specified. Manufacturers must submit evidence that unit specimen have passed the specified salt spray fog test. A 125 hour test will be specified in a noncorrosive environment and a 500 hour test will be specified in a corrosive environment.

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Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand [125] [500] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

2.8.2 Factory Applied Insulation

Chiller must be provided with factory installed insulation on surfaces subject to sweating including the water cooler, suction line piping, economizer, and cooling lines. Insulation on heads of coolers may be field applied, however it must be installed to provide easy removal and replacement of heads without damage to the insulation. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

[2.8.3 Coil Corrosion Protection

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NOTE: Research local conditions to determine the corrosiveness of the environment. Where condenser or evaporator coils are exposed to corrosive atmospheres such as sea coast applications, carefully consider the coil and fin combinations specified. Standard coil construction is typically copper tubes with aluminum fins. For more corrosive environments, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered.

For maximum coil protection, include the requirements of this paragraph. This paragraph addresses phenolic, vinyl, and epoxy type coatings. For coils with relatively close fin spacing the phenolic or epoxy coating are the preferred types as these have less tendency to bridge across the fins than vinyl. In addition, the phenolic and epoxy type coatings can typically provide better thermal conductivity than vinyl.

If coatings are specified, note that a coil's heat transfer capacity can be reduced anywhere between 1 to 5 percent; total unit capacity may have to be increased as a result. Provide coil coatings with 3,000 hour salt spray compliance for sea coast installations.

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[Provide coil with a uniformly applied [epoxy electrodeposition] [phenolic] [vinyl] type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum [1,000][3,000] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

]]2.9 FACTORY TESTS

2.9.1 Chiller Performance Test

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NOTE: Currently, most chiller manufacturers do not

have the ability to factory performance test anything other than water-cooled chillers (centrifugal or rotary screw) which have flooded evaporators. In addition, most testing facilities are only setup to test chillers 300 tons or larger in capacity. The ability to performance test small DX systems (water- or air-cooled) is almost non-existent.

Chiller performance testing is a very expensive requirement and should be carefully evaluated before including it into a job specification. The AHRI certification program has gone a long way in recent years of assuring chiller performance as specified. The need for a performance test will be evaluated against the customer's requirements and the criticality of the installation. When a chiller performance test is not required, ensure that paragraph SUBMITTALS is edited to remove the requirements for factory tests in SD-03 and SD-06.

If a performance test is deemed necessary to assure that the capacity and efficiencies specified will be met, then include this paragraph. Testing should only be specified on water-cooled chillers between 1054 and 5622 kW 300 and 1600 tons. Tests may be specified for smaller chillers in critical applications where the tests are felt justified, however, the designer must determine in the design stage if such tests are available. In no case should a test be required on more than one unit of multiple, identical capacities.

The AHRI testing of chillers allows a deviation to chiller capacity of up to 5 percent at full load. Load calculations should consider this tolerance.
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The Contractor and proposed chiller manufacturer must be responsible for performing the chiller factory test to validate the specified full load capacity, full load EER, and [IPLV] [NPLV] in accordance with AHRI 550/590 I-P except as indicated. The Contractor and chiller manufacturer must provide to the Government a certified chiller factory test report in accordance with AHRI 550/590 I-P to confirm that the chiller performs as specified. Tests must be conducted in an AHRI certified test facility in conformance with AHRI 550/590 I-P procedures and tolerances, except as indicated. At a minimum, chiller capacity must be validated to meet the scheduled requirements indicated on the drawings. Tolerance or deviation must be in strict accordance with AHRI 550/590 I-P. Stable operation at minimum load of [10] [_____] percent of total capacity must be demonstrated during the factory test.

2.9.1.1 Temperature Adjustments

Temperature adjustments must adhere to AHRI 550/590 I-P to adjust from the design fouling factor to the clean tube condition. Test temperature adjustments must be verified prior to testing by the manufacturer. There must be no exceptions to conducting the test with clean tubes with the temperature adjustments per AHRI 550/590 I-P. The manufacturer must clean the tubes prior to testing to obtain a test fouling factor of 0.0000.

2.9.1.2 Test Instrumentation

The factory test instrumentation must be per AHRI 550/590 I-P and the calibration must be traceable to the National Institute of Standards and Technology.

2.9.1.3 Equipment Adjustments

If the equipment fails to perform within allowable tolerances, the manufacturer must be allowed to make necessary revisions to his equipment and retest as required. [The manufacturer must assume all expenses incurred by the Government to witness the retest.]

[2.9.2 Chiller Sound Test

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NOTE: Require factory sound tests for chiller applications where sound levels are a critical issue. Typically, factory sound tests are only performed on large centrifugal and rotary screw machines. As a minimum if a factory sound test is not deemed necessary, indicate the maximum allowable sound level requirements for all applicable chiller components on the drawings.

In the paragraph below, select 85 decibels if military personnel (90 decibels for civilian personnel) will operate the equipment without hearing protection. Other decibel requirements may be specified if hearing protection is provided.

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Chillers must be sound tested at the factory prior to shipment to confirm the sound pressure level specified herein. Tests and data must be conducted and measured in strict accordance with AHRI 575 at the full load system operating conditions. The chiller sound pressure level, in decibels (dB), with a reference pressure of 20 micropascals, must not exceed [85] [90] [_____] dB, A weighted. Ratings must be in accordance with AHRI 575. No reduction of entering condenser water temperature or raising of leaving chilled water temperature will be allowed. A minimum of 75 percent of the sound data points must be taken along the length of the machine, and established as the minimum percentage of total possible points used to determine sound levels. In the event that the chiller does not meet the dBA sound pressure level, the manufacturer must, at his expense, provide sufficient attenuation to the machine to meet the specified value. This attenuation must be applied in such a manner that it does not hinder the operation or routine maintenance procedures of the chiller. The attenuation material, adhesives, coatings, and other accessories must have surface burning characteristics as determined by ASTM E84.

]2.10 SUPPLEMENTAL COMPONENTS/SERVICES

2.10.1 Chilled and Condenser Water Piping and Accessories

Chilled and condenser water piping and accessories must be provided and installed in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.10.2 Refrigerant Piping

Refrigerant piping for split-system water chillers must be provided and installed in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.10.3 Cooling Tower

Cooling towers must be provided and installed in accordance with Section 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS.

2.10.4 Temperature Controls

****

NOTE: Modify this paragraph as required to coordinate the central equipment controls with the air-side system controls. In projects where this section of the specifications is intended to produce control equipment for existing air-side systems, this paragraph will be rewritten to secure controls to match existing controls and to properly integrate the specified controls into the existing temperature control system.

A sequence of control, a schematic of controls, and a ladder diagram should be included on the drawings for each major system component such as cooling tower fan, chilled water pump, condenser water pump, in order to define the overall system operation.

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Chiller control packages must be fully coordinated with and integrated [into the temperature control system indicated in Section 23 30 00 HVAC AIR DISTRIBUTION and [Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC] and [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS]] [into the existing air-conditioning system].

PART 3 EXECUTION

3.1 INSTALLATION

Installation of water chiller systems including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with the manufacturer's written installation instructions, including the following:

[(1) Water chiller - installation instructions

]3.1.1 Installation Instructions

Provide manufacturer's standard catalog data, at least [5] [_____] weeks prior to the purchase or installation of a particular component, highlighted to show features such as materials, dimensions, options, performance and efficiency. Data must include manufacturer's recommended installation instructions and procedures. Data must be adequate to demonstrate compliance with contract requirements.

3.1.2 Vibration Isolation

If vibration isolation is specified for a unit, vibration isolator literature must be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

3.1.3 Posted Instructions

Provide posted instructions, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

3.1.4 Verification of Dimensions

Provide a letter including the date the site was visited, conformation of existing conditions, and any discrepancies found.

3.1.5 System Performance Test Schedules

Provide a schedule, at least [2] [_____] weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test.

3.1.6 Certificates

Where the system, components, or equipment are specified to comply with requirements of AGA, NFPA, ARI, ASHRAE, ASME, or UL, proof of such compliance must be provided. The label or listing of the specified agency must be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above must be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

3.1.7 Operation and Maintenance Manuals

Provide [Six] [_____] complete copies of an operation manual in bound 216 by 279 mm 8 1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least [4] [_____] weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features. [Six] [_____] complete copies of maintenance manual in bound 216 by 279 8 1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.1.8 Connections to Existing Systems

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.9 Refrigeration System

3.1.9.1 Equipment

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NOTE: Determine in the initial stages of design the approximate distances required for maintenance clearances of all new equipment. The maintenance clearances will be used in determining the final layout of the equipment.

For installations where noise and vibration transmission to the building must be reduced, the maximum tolerable transmissibility, in percent, should be determined and the blank filled in with the appropriate value. When it is not necessary to specify the percent of transmissibility, the item in the brackets will be deleted and brackets removed. Recommended transmissibility in percentages are: 10 percent for equipment mounted in very critical areas; 10 to 20 percent for critical areas; and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors and the conditions surrounding the equipment to be provided with the vibration isolation units favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values, based on the equipment location, the specification may be revised to indicate the appropriate values on the drawings.

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Refrigeration equipment and the installation thereof must conform to ANSI/ASHRAE 15 & 34. Necessary supports must be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, water coolers, and similar items. Compressors must be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations must be provided. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment must be set on not less than a 150 mm 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps must have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the combined pump, motor, and base weights. Isolators must be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators must limit vibration to [_____] percent at lowest equipment rpm. Lines connected to pumps mounted on pedestal blocks must be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts must be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.9.2 Field Refrigerant Charging

a. Initial Charge: Upon completion of all the refrigerant pipe tests, the vacuum on the system must be broken by adding the required charge of dry refrigerant for which the system is designed, in accordance with the manufacturer's recommendations. Contractor must provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Upon satisfactory completion of the system performance tests, any refrigerant that has been lost from the system must be replaced. After the system is fully operational, service valve seal caps and blanks over gauge points must be installed and tightened.

b. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must immediately be isolated from the remainder of the system and the refrigerant must be pumped into the system receiver or other suitable container. The refrigerant must not be discharged into the atmosphere.

c. Contractor's Responsibility: The Contractor must, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time must more than 85 g 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year must be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.1.9.3 Oil Charging

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase must be furnished. One charge must be used during the performance testing period, and upon the satisfactory completion of the tests, the oil must be drained and replaced with the second charge.

3.1.10 Mechanical Room Ventilation

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For mechanical rooms which are intended to house refrigeration equipment, designers will use ASHRAE 15 to determine applicable design criteria. Delete this paragraph if a mechanical room is not applicable to the design.

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Mechanical ventilation systems must be in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.1.11 Field Applied Insulation

Field installed insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.12 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.2 FACTORY TEST SCHEDULING AND REPORTS

Provide schedules which identify the date, time, and location for each test. Schedules must be submitted for the Chiller Performance Tests [and the Chiller Sound Test].[The Chiller Performance Test schedule must also allow the witnessing of the test by a Government Representative.]

[Six] [_____] copies of the certified test report must be forwarded to the Government for approval prior to project acceptance. Calibration curves and information sheets for all instrumentation must be included. Provide copies in bound 216 by 279 mm 8 1/2 by 11 inch booklets. Reports must certify the compliance with performance requirements and follow the format of the required testing standard for the Chiller Performance Tests [and the Chiller Sound Tests]. Test report must include certified calibration report of all test instrumentation. Calibration report must include certification that all test instrumentation has been calibrated within 6 months prior to the test date, identification of all instrumentation, and certification that all instrumentation complies with requirements of the test standard. Test report must be submitted [1] [_____] week after completion of the factory test.

3.3 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative must be provided for [_____] days. The representative must advise on the following:

a. Hermetic machines:

    (1) Testing hermetic water-chilling unit under pressure for refrigerant leaks; evacuation and dehydration of machine to an absolute pressure of not over 300 micrometers.

    (2) Charging the machine with refrigerant.

    (3) Starting the machine.

b. Open Machines:

    (1) Erection, alignment, testing, and dehydrating.

    (2) Charging the machine with refrigerant.

    (3) Starting the machine.

3.4 CLEANING AND ADJUSTING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Provide temporary filters for all fans that are operated during construction. Perform and document that proper Indoor Air Quality During Construction procedures have been followed; this includes providing documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions. At least one week before the official equipment warranty start date, all condenser coils on air-cooled water chillers and split-system water chillers must be cleaned in accordance with the chiller manufacturer's instructions. This work covers two coil cleanings. The condenser coils must be cleaned with an approved coil cleaner by a service technician, factory trained by the chiller manufacturer. The condenser coil cleaner must not have any detrimental affect on the materials or protective coatings on the condenser coils. Testing, adjusting, and balancing must be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.5 FIELD ACCEPTANCE TESTING

3.5.1 Test Plans

a. Manufacturer's Test Plans: Within [120][_____] calendar days after contract award, submit the following plans:

[(1) Water chiller - Field Acceptance Test Plan

] Field acceptance test plans must be developed by the chiller manufacturer detailing recommended field test procedures for that particular type and size of equipment. Field acceptance test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment, will not be acceptable.

The Contracting Officer will review and approve the field acceptance test plan for each of the listed equipment prior to commencement of field testing of the equipment. The approved field acceptance tests of the chiller and subsequent test reporting.

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NOTE: In the paragraph below, specification Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS is for Navy projects only.

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b. Coordinated testing: Indicate in each field acceptance test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of tower system controls which interlock and interface with controls for the equipment provided under [Section 23 09 53.00 20, SPACE TEMPERATURE CONTROL SYSTEMS] [Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][Section 23 09 23.01

LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

c. Prerequisite testing: Chillers for which performance testing is dependent upon the completion of the work covered by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC must have that work completed as a prerequisite to testing work under this section. Indicate in each field acceptance test plan when such prerequisite work is required.

d. Test procedure: Indicate in each field acceptance test plan each equipment manufacturers published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

Each test plan must include the required test reporting forms to be completed by the Contractor's testing representatives. Procedures must be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

Controller must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

e. Performance variables: Each test plan must list performance variables that are required to be measured or tested as part of the field test.

Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Chiller manufacturer must furnish with each test procedure a description of acceptable results that have been verified.

Chiller manufacturer must identify the acceptable limits or tolerance within which each tested performance variable must acceptably operate.

f. Job specific: Each test plan must be job specific and must address the particular cooling towers and particular conditions which exist in this contract. Generic or general preprinted test procedures are not acceptable.

g. Specialized components: Each test plan must include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3.5.2 Testing

a. Each water chiller system must be field acceptance tested in compliance with its approved field acceptance test plan and the resulting following field acceptance test report submitted for approval:

[(1) Water chiller - Field Acceptance Test Report

] b. Manufacturer's recommended testing: Conduct the manufacturer's recommended field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field acceptance testing.

c. Operational test: Conduct a continuous 24 hour operational test for each item of equipment. Equipment shutdown before the test period is completed must result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every two hours. Use the test report forms for logging the operational variables.

d. Notice of tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.

e. Report forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment must be reviewed, approved, and signed by the Contractor's test director. The manufacturer's field test representative must review, approve, and sign the report of the manufacturer's recommended test. Signatures must be accompanied by the person's name typed.

f. Deficiency resolution: The test requirements acceptably met; deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations and corrections retested in order to verify compliance.

3.6 SYSTEM PERFORMANCE TESTS

[Six] [_____] copies of the report must be provided in bound 216 by 279 mm 8 1/2 by 11 inch booklets.

3.6.1 General Requirements

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment must be conducted by the manufacturer's approved start-up representative experienced in system start-up and testing, at such times as directed. Tests must cover a period of not less than [48] [_____] hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments must be made as necessary and tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points must be installed and tightened. Any refrigerant lost during the system startup must be replaced. If tests do not demonstrate satisfactory system performance, deficiencies must be corrected and the system must be retested. Tests must be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test must be provided by the Contractor. Field tests must be coordinated with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.6.2 Test Report

The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report must also include the following information and must be taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart:

a. Date and outside weather conditions.

b. The load on the system based on the following:

    (1) The refrigerant used in the system.

    (2) Condensing temperature and pressure.

    (3) Suction temperature and pressure.

    (4) Running current, voltage and proper phase sequence for each phase of all motors.

    (5) The actual on-site setting of all operating and safety controls.

    (6) Chilled water pressure, flow and temperature in and out of the chiller.

    (7) The position of the [capacity-reduction gear] [gas supply control valve] [fuel oil supply valve] at machine off, one-third loaded, one-half loaded, two-thirds loaded, and fully loaded.

3.7 DEMONSTRATIONS

Contractor must conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The training course must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

Provide a schedule, at least [2] [_____] weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 64 26 (August 2009)**
Change 7 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-23 64 26 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 64 26

CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

08/09, CHG 7: 02/24

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 64 26 (August 2009)**
Change 7 - 02/24

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SECTION 23 64 26

CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

08/09, CHG 7: 02/24

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NOTE: This guide specification covers requirements for chilled water, chilled-hot (dual service) water and condenser water piping systems associated with HVAC systems, and located within, on, or under buildings, or connected to equipment adjacent to buildings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Project design may require supplemental information to be added to paragraphs of this section.

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NOTE: Show the following information on project drawings:

1. Only drawings (not specifications) shall indicate capacity, efficiency, dimensions, details, plan views, sections, elevations and location of equipment; and space required for equipment

maintenance.

2. Show configuration, slope and location of each piping system such as: above or below floors, above or below ceilings, above or below roofs, above or below ground.

3. Location, sizes, and type of each valve.

4. Details of expansion joints for aboveground piping.

5. Locations and installation details of aboveground pipe hangers and supports.

6. Scale ranges for pressure gages and thermometers.

7. Whether piping is run aboveground on pedestals or poles, or run buried underground.

8. Design working pressures and temperatures for each system.

9. Cathodic protection for buried metal piping.

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NOTE: System requirements must conform to UFC 3-410-01, "Heating, Ventilating, and Air Conditioning Systems".

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.2.6M	(2012; R 2021) Metric Fasteners for Use in Structural Applications
ASME B31.9	(2020) Building Services Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2023) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2022) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting

	Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A197/A197M	(2020; R 2023; E 2023) Standard Specification for Cupola Malleable Iron
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper

	and Copper Alloy Tube
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D596	(2001; R 2018) Standard Guide for Reporting Results of Analysis of Water
ASTM D1384	(2005; R 2019) Corrosion Test for Engine Coolants in Glassware
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials
ASTM F1007	(2018; R 2022) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2024) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications
ASTM F1199	(2021) Standard Specification for Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)
ASTM F2389	(2024a) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2014) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MSS SP-67	(2022) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials

1.2 SYSTEM DESCRIPTION

Provide the water systems having the minimum service (design) temperature-pressure rating indicated. Provision of the piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the required and advisory provisions of ASME B31.9 except as modified or supplemented by this specification section or design drawings. This specification section covers the water systems piping which is located within, on, and adjacent to building(s) within the building(s) 1.66 meter 5 foot line.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Grooved Mechanical Connections For Steel; G, [_____]

Grooved Mechanical Connections For Copper; G, [_____]

Calibrated Balancing Valves; G, [_____]

Automatic Flow Control Valves; G, [_____]

Water Temperature Mixing Valve; G, [_____]

Water Temperature Regulating Valves; G, [_____]

Water Pressure Reducing Valve

Pressure Relief Valve

Combination Pressure and Temperature Relief Valves

Expansion Joints; G, [_____]

Pumps; G, [_____]

Combination Strainer and Pump Suction Diffuser

Expansion Tanks

Air Separator Tanks

Water Treatment Systems; G, [_____]

Proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in paragraph WATER ANALYSIS, a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

SD-06 Test Reports

Piping Welds NDE Report

Pressure Tests Reports; G, [_____]

Report shall be provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets. In the reports, document all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results.

Condenser Water Quality Test Reports; G, [_____]

Test reports, each month for a period of one year after project completion, in bound 216 by 279 mm 8-1/2 by 11 inch booklets. In the reports, identify the chemical composition of the condenser water. Also include the comparison of the manufacturer's recommended operating conditions for the cooling tower and condenser in relation to the condition of the condenser water. Document in the report any required corrective action taken.

One-Year Inspection Report For Cooling Water; G, [_____]

At the completion of one year of service, in bound 216 by 279 mm 8-1/2 by 11 inch booklets. In the report, identify the condition of each cooling tower and condenser. Include a comparison of the condition of the cooling tower and condenser with the manufacturer's recommended operating conditions. Identify all actions taken by the Contractor and manufacturer to correct deficiencies during the first year of service.

SD-07 Certificates

Employer's Record Documents (For Welding)

Welding Procedures and Qualifications

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Piping for Steam and Condensate

Piping for High-Pressure Compressed-Air Systems

Fittings

Unions

Flanges

Gaskets

Bolting

SD-08 Manufacturer's Instructions

Lesson plan for the Instruction Course; G, [_____]

SD-10 Operation and Maintenance Data

Requirements for data packages are specified Section 01 78 23 OPERATION AND MAINTENANCE DATA, except as supplemented and modified by this specification section.

Submit spare parts data for each different item of equipment specified, with operation and maintenance data packages. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for one year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Submit a list of qualified permanent service organizations with operation and maintenance data packages. Include service organization addresses and service area or expertise. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Water Treatment Systems; G, [_____]

An operation manual in bound 216 by 279 mm 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown. Include testing procedures used in determining water quality.

A maintenance manual in bound 216 by 279 mm 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide.

Calibrated Balancing Valves, Data Package 3; G, [_____]

Automatic Flow Control Valves, Data Package 3; G, [_____]

Water Temperature Mixing Valve, Data Package 3; G, [_____]

Water Temperature Regulating Valves, Data Package 3; G, [_____]

Water Pressure Reducing Valve, Data Package 3; G, [_____]

Pressure Relief Valve, Data Package 2; G, [_____]

Combination Pressure and Temperature Relief Valves, Data Package 2; G, [_____]

Expansion Joints, Data Package 2; G, [_____]

Pumps, Data Package 3; G, [_____]

Combination Strainer and Pump Suction Diffuser, Data Package 2; G, [_____]

Expansion Tanks, Data Package 2; G, [_____]

Air Separator Tanks, Data Package 2; G, [_____]

1.4 MODIFICATIONS TO REFERENCES

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.5 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter. Any porous materials found to be contaminated with mold or mildew will be replaced at the Contractor's expense. Non-porous materials found to be contaminated with mold or mildew will be disinfected and cleaned prior to installation.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.7.3 Accessibility

****

NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when he has some control over locations.

However, designer's should not rely on it at all since enforcing this requirement in the field would be difficult.

Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures.

Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. System components shall be environmentally suitable for the indicated locations.

The equipment items shall be supported by service organizations. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.2 STEEL PIPING

Water piping shall be steel pipe or copper tubing. Provide steel piping with a ANSI/ASME Class 125 service rating, which for 66 degrees C the pressure rating is 1207 kPa 150 degrees F, the pressure rating is 175 psig.

2.2.1 Pipe

Steel pipe, conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

2.2.2 Fittings and End Connections (Joints)

****

NOTE: Do not use press fittings on NAVFAC projects. Do not use grooved connections on NAVFAC projects.

****

Piping and fittings 25 mm 1 inch and smaller shall have threaded connections. Piping and fittings larger than 25 mm 1 inch and smaller than 80 mm 3 inches shall have either threaded,[grooved,] or welded connections. Piping and fittings 80 mm 3 inches and larger shall have[grooved,] welded, or flanged connections. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

2.2.2.1 Threaded Connections

Use threaded valves and pipe connections conforming to ASME B1.20.1. Used threaded fitting conforming to ASME B16.3. Use threaded unions conforming to ASME B16.39. Use threaded pipe nipples conforming to ASTM A733.

2.2.2.2 Flanged Connections

Flanges shall conform to ASME B16.1, Class 125. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1.59 mm

1/16 inch thickness, full face or self-centering flat ring type. These gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.1.

2.2.2.3 Welded Connections

Welded valves and pipe connections (both butt-welds and socket-welds types) shall conform to ASME B31.9. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11. Welded fittings shall be identified with the appropriate grade and marking symbol.

2.2.2.4 Grooved Mechanical Connections For Steel

****

NOTE: Do not use this paragraph on NAVFAC projects.

****

Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 110 degrees C 230 degrees F. Flexible grooved connections shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein.

Each grooved mechanical joint shall be a system, including coupling housing, gasket, fasteners, all furnished by the same manufacturer. Joint installation shall be in compliance with joint manufacturer's written instructions.

Use fitting and coupling houses of malleable iron conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12; or steel conforming ASTM A106/A106M, Grade B or ASTM A53/A53M. Use gaskets of molded synthetic rubber with central cavity, pressure responsive configuration and conforming to ASTM D2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 110 degrees C 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 93 degrees C 200 degrees F. Grooved mechanical connections shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A183. Pipe connections and fittings shall be the product of the same manufacturer. Provide joint installation be in compliance with joint manufacturer's written instructions.

2.2.2.5 Dielectric Waterways and Flanges

Provide dielectric waterways with a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Provide dielectric waterways constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Provide dielectric flanges with the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

2.3 POLYPROPYLENE PIPING (CHILLED WATER APPLICATIONS ONLY)

2.3.1 Pipe

****

NOTE: Copolymer is not quite as strong as homopolymer, but it is more durable because it is less brittle, meaning that it has higher impact strength, higher stress crack resistance, and better toughness at low temperatures.

****

Polypropylene pipe shall be Schedule 40, copolymer, and shall meet ASTM F2389 and NSF/ANSI 14.

2.3.2 Fittings

****

NOTE: This specification is intended for hydronic systems, and therefore it is not intended that this specification would apply to drinking water. Many persons are not aware of the NSF-PW designation for potable water systems, and as a safety precaution, require that all of the polypropylene materials have the NSF-PW rating to prevent job materials on the construction site from being installed in the wrong application, or the pipe being converted later for reuse. Furthermore, systems can become intertwined if solar water heating is used without a heat exchanger.

****

Fittings shall meet ASTM F2389 and NSF/ANSI 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement shall bear the NSF seal "NSF-PW."

Polypropylene fittings shall conform to dimensional requirements of Schedule 40. Polypropylene piping that will be exposed to UV light shall be provided with a Factory applied UV resistant coating.

2.4 PIPING FOR STEAM AND CONDENSATE

****

NOTE: Paragraph PIPING FOR STEAM AND CONDENSATE and its sub-paragraphs should not be used in Navy projects.

****

Steam and condensate piping for 1034-, 2413-, 13790-, 41369- kilopascal 150-, 350-, 2,000-, and 6,000-pound per square inch (psi) service shall be black carbon steel (BCS). Steam and condensate piping includes fittings, unions, flanges, gaskets, and bolting.

2.4.1 Type BCS-150 (1034 kilopascal 150-psi Service)

****

NOTE: Avoid screwed-end connections in condensate piping wherever possible. Bend pipe for change in direction where practicable.

****

Pipe or tube (DN6 through DN25) (1/8 inch through 10 inches): Schedule 40 for steam, Schedule 80 for condensate, seamless black carbon steel, conforming to ASTM A106/A106M, Grade B and ASME B36.10M.

****

NOTE: Select 1034 or 2068 kilopascal 150- or 300-psi malleable-iron or forged-steel fittings; delete fittings not applicable if option is not given.

****

Fittings (DN6 through DN50): 2068 kilopascal (1/8 inch through 2 inches): 300-psi working steam pressure (wsp) banded malleable iron, screwed end, conforming to ASTM A197/A197M and ASME B16.3.

Fittings (DN6 through DN50): 15- or 20- megapascal (1/8 inch through 2 inches): 2,000-or 3,000-psi water, oil, or gas (wog) forged carbon steel, socket weld or screwed end, conforming to ASTM A105/A105M and ASME B16.11.

Fittings (DN65 through DN250) (2-1/2 through 10 inches): Wall thickness to match pipe, long radius, butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9.

****

NOTE: Select 1724 kilopascal 250-psi malleable iron or forged steel unions.

****

Unions (DN6 through DN50): 1724 kilopascal (1/8 inch through 2 inches): 250-psi wsp, malleable iron, screwed end, ground joint, with brass or bronze seat insert, conforming to ASME B16.39.

Unions (DN6 through DN50): 15- or 20- megapascal (1/8 inch through 2 inches): 2,000 or 3,000-psi wog, forged carbon steel; socket weld through 50 millimeter 2-inch, screwed end through 25 millimeter 1-inch, conforming to ASTM A105/A105M and ASME B16.11, with ground joint and stainless-steel seat insert.

Flanges (DN65 through DN250): 1034-kilopascal (2-1/2 through 10 inches): 150-pound, forged carbon steel, welding neck, with raised face or flat face and concentric finish, conforming to ASTM A105/A105M and ASME B16.5.

Flange Gaskets: Compressed non-asbestos sheet conforming to ASTM F104, Type 1, P1161A, coated on both sides with graphite or similar lubricant, containing not less than 75-percent non-asbestos fiber materials.

Bolting: Bolting and flange bolting shall be hexhead and shall conform to ASTM A325M ASTM A325. Heavy hex-nuts shall conform to ASME B18.2.6M ASME B18.2.2. Square-head bolts and nuts are not acceptable.

2.4.2 Type BCS-350 (2413 kilopascal 350-psi Service)

****

NOTE: Avoid screwed-end connections in condensate piping wherever possible. Bend pipe for change in direction, where practicable.

****

Pipe or tube (DN6 through DN25) (1/8 inch through 10 inches): Schedule 40 for steam, Schedule 80 for condensate; seamless black carbon steel, conforming to ASTM A106/A106M, Grade B and ASME B36.10M.

Fittings (DN6 through DN50): 15- or 20- megapascal (1/8 inch through 2 inches): 2,000-or 3,000-psi wog to match pipe wall, forged carbon steel, socket weld or screwed end, conforming to ASTM A105/A105M and ASME B16.11.

Fittings (DN6 through DN25) (1/8 inch through 10 inches): Schedule 40, long-radius, butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9.

Unions (DN6 through DN50): 15- or 20- megapascal (1/8 inch through 2 inches): 2,000-or 3,000-psi wog to match pipe wall, forged carbon steel, socket weld through 50 millimeter 2-inch, screwed end through 25 millimeter 1-inch, conforming to ASTM A105/A105M and ASME B16.11, with ground joint and stainless-steel seat insert.

Flanges (DN65 through DN250): 2068 kilopascal (2-1/2 through 10 inches): 300-pound, forged carbon steel, weld neck, with raised face and concentric serrated finish, conforming to ASTM A181/A181M, Class 70, and ASME B16.5.

Gaskets: Spiral-wound, non-asbestos-fiber-filled, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1.

Bolting: Heavy hex-head, carbon-steel bolts or bolt studs and semifinished heavy hexnuts, conforming to ASTM A325M ASTM A325.

Square-head bolts are not acceptable.

2.5 PIPING FOR HIGH-PRESSURE COMPRESSED-AIR SYSTEMS

High-pressure compressed-air condensate piping includes fittings, unions, flanges, gaskets, and bolting.

****

NOTE: Paragraph PIPING FOR HIGH-PRESSURE COMPRESSED-AIR SYSTEMS and its sub-paragraphs should not be used in Navy projects.

****

****

NOTE: ASME B31.1 Does not cover industrial compressed air piping outside of power houses. ANSI B31.2 covers only fuel gas portion of obsolete industrial gas and air piping systems. ANSI committee recommends interim use of ASME B31.3 for compressed-air piping.

The following system pressures are based on ASME B31.3, zero corrosion factor, welded joints, and a stress value of 138 megapascal 20,000 psi systems with pipe size larger than 80 millimeter 3 inches.

The following material specifications do not take into account material temperatures lower than minus 7 degrees C 20 degrees F.

****

2.5.1 Type BCS-2,000 (15 megapascal 2,000-psi Service)

Pipe or tube (DN6 through DN80) (1/8 inch through 3 inches): Schedule 40, seamless black carbon steel, conforming to ASTM A106/A106M, Grade B, or ASTM A53/A53M, Grade B, Type S, and ASME B36.10M.

Fittings (DN6 through DN40): 15 megapascal (1/8 inch through 1-1/2 inches): 2,000-psi wog, forged carbon steel, socket weld, conforming to ASTM A105/A105M and ASME B16.11.

Fittings (DN50 through DN80) (2 through 3 inches): Schedule 40, long radius, butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB, and ASME B16.9.

Flanges (DN25 through DN80): 6200 kilopascal (1 inch through 3 inches): 900-pound, forged carbon steel, welding neck, with raised face and concentric serrated finish, conforming to ASTM A105/A105M or ASTM A181/A181M, Class 60, and ASME B16.5.

Gaskets: Spiral wound, non-asbestos-fiber-filled, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1.

Bolting: Alloy-steel bolt studs conforming to ASTM A193/A193M, Grade B7, and semifinished heavy hex-nuts, conforming to ASTM A194/A194M, Grade 2H.

2.5.2 Type BCS-6,000 (41368-kilopascal 6,000-psi Service)

Pipe or tube (DN15 through DN80) (1/2 inch through 3 inches): XXS, seamless, black carbon steel, conforming to ASTM A106/A106M, Grade B, or ASTM A53/A53M, Grade B, Type S and ASME B36.10M.

Fittings (DN15 through DN40): 41.3 megapascal (1/2 inch through 1-1/2 inches): 6,000-psi wog, forged carbon steel, socket weld, conforming to ASTM A105/A105M and ASME B16.11.

Fittings (DN50 through DN80) (2 through 3 inches): XXS, long-radius, butt weld, black carbon steel, conforming to ASTM A234/A234M, Grade WPB, ASME B16.9, and ASME B36.10M.

Flanges (DN50 through DN80): 17.2 megapascal (2 through 3 inches): 2,500-pound, forged carbon steel, welding neck with raised face and concentric serrated finish, conforming to ASTM A105/A105M and ASME B16.5.

Gaskets: Spiral-wound, non-asbestos-filled, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1.

Bolting: Alloy steel bolt studs conforming to ASTM A193/A193M, Grade B7, and semifinished heavy hex-nuts, conforming to ASTM A194/A194M, Grade 2H.

2.6 COPPER TUBING

Provide copper tubing and fittings with a ANSI/ASME Class 125 service rating, which for 66 degrees C, the pressure rating is 1207 kPa 150 degrees F., the pressure rating is 175 psig.

2.6.1 Tube

Use copper tube conforming to ASTM B88M ASTM B88, Type L or M for aboveground tubing, and Type K for buried tubing.

2.6.2 Fittings and End Connections (Solder and Flared Joints)

Wrought copper and bronze solder joint pressure fittings, including unions ands flanges, shall conform to ASME B16.22 and ASTM B75/B75M. Provide adapters as required. Cast copper alloy solder-joint pressure fittings , including unions and flanges, shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B62. ASTM B42 copper pipe nipples with threaded end connections shall conform to ASTM B42.

Copper tubing of sizes larger than 100 mm 4 inches shall have brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

Extracted brazed tee joints may be used if produced with an acceptable tool and installed in accordance with tool manufacturer's written procedures.

2.6.3 Grooved Mechanical Connections For Copper

****
NOTE: Do not use this paragraph on NAVFAC projects.
****

Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 110 degrees C 230 degrees F. Flexible grooved connections shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein.

Each grooved mechanical joint shall be a system, including coupling housing, gasket, fasteners, all furnished by the same manufacturer. Joint installation shall be in compliance with joint manufacturer's written instructions.

Grooved fitting and mechanical coupling housing shall be ductile iron conforming to ASTM A536. Provide gaskets for use in grooved joints shall constructed of molded synthetic polymer of pressure responsive design and shall conform to ASTM D2000 for circulating medium up to 110 degrees C 230 degrees F. Provide grooved joints in conformance with AWWA C606.

2.6.4 Solder

Provide solder in conformance with ASTM B32, grade Sb5, tin-antimony alloy. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

2.6.5 Brazing Filler Metal

Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.7 VALVES

Provide valves with a ANSI/ASME Class 125 service rating, which for 66 degrees C, the pressure rating is 1207 kPa 150 degrees F, the pressure rating is 175 psig.

****

NOTE: Indicate on the design drawings valves that are located more than 3 m 10 feet or higher above the floor. Indicate the valves that are to be provided with chain operators.

****

Valves in sizes larger than 25 mm 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be furnished by the same manufacturer as the grooved pipe joint and fitting system.

2.7.1 Gate Valve

Gate valves 65 mm 2-1/2 inches and smaller shall conform to MSS SP-80 Class 125 and shall be bronze with wedge disc, rising stem and threaded, soldered, or flanged ends. Gate valves 80 mm 3 inches and larger shall conform to MSS SP-70, Class 125, cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.7.2 Globe and Angle Valve

Globe and angle valves 65 mm 2-1/2 inches and smaller shall conform to MSS SP-80, Class 125. Globe and angle valves 80 mm 3 inches and larger shall conform to MSS SP-85, Class 125.

2.7.3 Check Valve

Check valves 65 mm 2-1/2 inches and smaller shall conform to MSS SP-80. Check valves 80 mm 3 inches and larger shall conform to MSS SP-71, Class 125.

2.7.4 Butterfly Valve

Butterfly valves shall conform to MSS SP-67, Type 1 and shall be either the wafer or lug type. Valves smaller than 200 mm 8 inches shall have throttling handles with a minimum of [two][seven] locking positions. Valves 200 mm 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators.

****

NOTE: Indicate on the design drawings valves that are located in insulated lines that require extended necks to accommodate insulation thickness. Indicate which valves require weatherproof operators with mechanical position indicators.

****

2.7.5 Plug Valve

Plug valves 50 mm 2 inches and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 50 mm 2 inches and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valve shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valve shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valve shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug.[Valve shall have weatherproof operators with mechanical position indicators.] Valves 200 mm 8 inches or larger shall be provided with manual gear operators with position indicators.

2.7.6 Ball Valve

Full port design. Ball valves 15 mm 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be cast iron or bronze with threaded, soldered, or flanged ends. Valves 200 mm 8 inches or larger shall be provided with manual gear operators with position indicators. Ball valves may be provided in lieu of gate valves.

2.7.7 Square Head Cocks

Provide copper alloy or cast-iron body with copper alloy plugs, suitable for 125 psig water working pressure.

2.7.8 Calibrated Balancing Valves

****

NOTE: Plug and ball valves uses include being used as manual balancing valves and will be indicated on the drawings. A supplemental flow measuring scheme or device must be used to measure flow with a manual balancing valve. A calibrated balancing valve incorporates a flow measuring element and can be used in place of a manual balancing valve and a flow measuring device. Delete the last sentence of this paragraph if inapplicable.

****

Copper alloy or cast iron body, copper alloy or stainless internal working parts. Provide valve calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valve shall have an integral pointer which registers the degree of valve opening. Valve shall function as a service valve when in fully closed position. Valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation.

Provide valve bodies with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable differential pressure meter connections to verify the pressure differential. Provide metal tag on each valve showing the liters per second gallons per minute flow for each differential pressure reading.[In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.]

2.7.9 Automatic Flow Control Valves

****

NOTE: An automatic flow control valve offers complete flow control in many applications; however, the flow control range is dependent on inlet pressure being within a given range, the flow selection is limited, and, in some cases it may

require pump power slightly more than alternative balancing means.

In any facility where typical load imbalances cannot be tolerated and where automatic control is needed to ensure constant hydronic flow, the design shall incorporate automatic flow control valves. Show the location, capacity and pressure range of the automatic flow control valves on the drawings. Provide a cyclonic separator in the water system where automatic flow control valves are used for removing particles.

Do not use automatic flow control valves where there is a high risk of dirty sediment-laden water in the system.

****

Valve shall automatically maintain the constant flow indicated on the design drawings. Valve shall modulate by sensing the pressure differential across the valve body. Valve shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Provide valve that controls the flow within 5 percent of the tag rating. Valve materials shall be the same as specified for the ball or plug valves.

Provide valve that are [electric][or][pneumatic] type as indicated. Valve shall be capable of positive shutoff against the system pump head, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings and differential meter, suitable for the operating pressure specified. Provide the meter complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer.

2.7.10 Water Temperature Mixing Valve

Valve, ASSE 1017 for water service.

2.7.11 Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended service.

2.7.12 Water Pressure Reducing Valve

Valve, ASSE 1003 for water service, copper alloy body.

2.7.13 Pressure Relief Valve

Valve shall prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Valve, ANSI Z21.22/CSA 4.4 and shall have cast iron bodies with corrosion resistant internal working parts. The discharge pipe from the relief valve shall be the size of the valve outlet unless otherwise indicated.

2.7.14 Combination Pressure and Temperature Relief Valves

ANSI Z21.22/CSA 4.4, copper alloy body, automatic re-seating, test lever, and discharge capacity based on AGA temperature steam rating.

2.7.15 Float Valve

[Angle pattern][and][or][Globe pattern]. Valve bodies 80 mm 3 inches nominal pipe size and smaller shall be bronze. Valve bodies larger than 80 mm 3 inches shall be cast iron or bronze. Steel parts shall be corrosion resistant. Where float rods are extended for tank applications, extension shall be properly supported and guided to avoid bending of float rod or stressing of valve pilot linkage.

2.7.16 Drain Valves

****

NOTE: Indicate the location of each drain valve on the design drawings. Indicate if a drain valve is freeze-proof. Indicate whether a manual or automatic air venting valve. Delete freeze-proof drain valve specification if not required.

****

Valves, MSS SP-80 gate valves. Valve shall be manually-operated, 20 mm 3/4 inch pipe size and above with a threaded end connection. Provide valve with a water hose nipple adapter.[Freeze-proof type valves shall be provided in installations exposed to freezing temperatures.]

2.7.17 Air Venting Valves

****

NOTE: Indicate the location of each air venting valve on the drawings. Indicate whether a manual or automatic air venting valve.

****

[Manually-operated general service type air venting valves, brass or bronze valves that are furnished with threaded plugs or caps.][Automatic type air venting shall be the ball-float type with brass/bronze or brass bodies, 300 series corrosion-resistant steel float, linkage and removable seat.]Air venting valves on water coils shall have not less than 3 mm 1/8 inch threaded end connections. Air venting valves on water mains shall have not less than 20 mm 3/4 inch threaded end connections. Air venting valves on all other applications shall have not less than 15 mm 1/2 inch threaded end connections.

2.7.18 Vacuum Relief Valves

ANSI Z21.22/CSA 4.4

2.8 PIPING ACCESSORIES

2.8.1 Strainer

Strainer, ASTM F1199, except as modified and supplemented in this specification. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. Strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. The bodies shall have arrows clearly cast on the sides indicating the direction of flow.

Provide strainer with removable cover and sediment screen. The screen shall be made of minimum 0.8 mm 22 gauge[brass sheet,][monel,][corrosion-resistant steel,] with small perforations numbering not less than 60 per square centimeter 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.8.2 Cyclonic Separator

Metal-bodied, with removal capability of removing solids 45 microns/325 mesh in size and heavier than 1.20 specific gravity, maximum pressure drop of 35 kPad 5 psid, with cleanout connection.

2.8.3 Combination Strainer and Pump Suction Diffuser

Angle type body with removable strainer basket and internal straightening vanes, a suction pipe support, and a blowdown outlet and plug. Strainer shall be in accordance with ASTM F1199, except as modified and supplemented by this specification. Unit body shall have arrows clearly cast on the sides indicating the direction of flow.

Strainer screen shall be made of minimum 0.8 mm 22 gauge[brass sheet,][monel,][corrosion-resistant steel,] with small perforations numbering not less than 60 per square centimeter 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Flow shall be into the screen and out through the perforations. Provide an auxiliary disposable fine mesh strainer which shall be removed 30 days after start-up. Provide warning tag for operator indicating scheduled date for removal.

Casing shall have connection sizes to match pump suction and pipe sizes, and be provided with adjustable support foot or support foot boss to relieve piping strains at pump suction. Provide unit casing with blowdown port and plug. Provide a magnetic insert to remove debris from system.

2.8.4 Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid. Equip flanged assemblies with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.8.5 Pressure and Vacuum Gauges

Gauges, ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Provide gauges with 115 mm 4.5 inch dial, brass or aluminum case, bronze tube, and siphon. Gauge shall have a range from 0 kPa 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.8.6 Temperature Gauges

****

NOTE: If known, indicate on the design drawings the locations where all universal adjustable angle type

or remote element type temperature gauges shall be provided in accordance with requirements specified below.

****

Temperature gauges, shall be the industrial duty type and be provided for the required temperature range. Provide gauges with fixed thread connection, dial face gasketed within the case; and an accuracy within 2 percent of scale range. Gauges shall have Celsius scale in 1 degree Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 1.5 m 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 1.5 to 2.1 m 5 to 7 feet above the finished floor or in locations indicated. Remote element type temperature gauges shall be provided in thermal wells located 2.1 m 7 feet above the finished floor or in locations indicated.

2.8.6.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 229 mm 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.8.6.2 Bimetallic Dial

Bimetallic dial type case shall be not less than 89 mm 3-1/2 inches, stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment.

2.8.6.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than 89 mm, 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.8.6.4 Thermal Well

Thermal well shall be identical size, 15 or 20 mm 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 15 mm 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 25 mm 1 inch.

2.8.7 Pipe Hangers, Inserts, and Supports

****

NOTE: In project locations with Environmental Severity Classification (ESC) of C4 or C5 or high humidity areas as identified in ASHRAE 90.1 as climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C, include bracketed sentence below to require hot-dipped galvanized hangers if ferrous materials are used. See UFC 1-200-01 for determination of ESC for project locations.

****

Pipe hangers, inserts, guides, and supports: to MSS SP-58.[If ferrous materials are utilized provide hot-dipped galvanized hangers, inserts and supports.]

2.8.8 Escutcheons

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Secure plates in place by internal spring tension or set screws. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.8.9 Expansion Joints

****

NOTE: Expansion loops, offsets, and bends will be used where possible instead of expansion joints. Indicate all expansion provisions, including necessary details, on the drawings. Locate expansion joints in serviceable areas.

****

2.8.9.1 Slip-Tube Type

Slip-tube expansion joints, ASTM F1007, Class I or II. Joints shall be provided with internally-externally alignment guides, injected semi-plastic packing, and service outlets. End connections shall be flanged or beveled for welding as indicated. Initial settings shall be made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer.

2.8.9.2 Flexible Ball Type

****

NOTE: The ball joint only moves in an angular offset or rotation mode. The configuration of the ball joint link will require a 2 or 3 ball joint offset to absorb axial and/or lateral movement.

****

Flexible ball expansion joints shall be capable of 360 degrees rotation plus 15 degrees angular flex movement. Joints shall be constructed of carbon steel with the exterior spherical surface of carbon steel balls plated with a minimum 0.12 mm 5 mils of hard chrome in accordance with EJMA Stds. Joint end connections shall be threaded for piping 50 mm 2 inches or smaller. Joint end connections larger than 50 mm 2 inches shall be grooved, flanged, or beveled for welding. Provide joint with pressure-molded composition gaskets suitable for continuous operation at twice design temperature.

2.8.9.3 Bellows Type

Bellows expansion type joints, ASTM F1120 with Type 304 stainless steel corrugated bellows, reinforced with equalizing rings, internal sleeves, and external protective covers. Joint end connections shall be grooved, flanged, or beveled for welding. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint.

2.9 PUMPS

****

NOTE: Indicate pump capacity, efficiencies, motor sizes, and impeller types on the drawings. Typical impeller types include the double-suction horizontal split-case type, end-suction vertical split-case type, close-coupled end-suction type, and close-coupled in-line type.

****

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.2. Pumps shall be selected at or within 5 percent of peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall conform to NEMA MG 1, be [open][splash-proof][totally enclosed], and have sufficient wattage horsepower for the service required. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 180 kPa 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover.

2.9.1 Construction

****

NOTE: In most cases, mechanical shaft seals will be the preferred type of shaft seal rather than the stuffing-box type. Although less costly in many cases, the stuffing-box type seals require periodic maintenance which means that the seals are typically only economically justifiable for very large pumps where the first cost difference is great. The shaft seal selection should be based upon a life cycle cost comparison.

****

Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 862 kPa 125 psig. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Provide threaded suction and discharge pressure gage tapping with square-head plugs.

Impeller shall be statically and dynamically balanced. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water.

[Pump and motor shall be mounted on a common cast iron base having lipped edges and tapped drainage openings or structural steel base with lipped edges or drain pan and tapped drainage openings. Pump shall be provided with steel shaft coupling guard. Base-mounted pump, coupling guard, and motor shall each be bolted to a fabricated steel base which shall have bolt holes for securing base to supporting surface.][Close-coupled pump shall be provided with integrally cast or fabricated steel feet with bolt holes for securing feet to supporting surface. Close- coupled pumps shall be provided with drip pockets and tapped openings.]Pump shall be accessible for servicing without disturbing piping connections. Shaft seals shall be mechanical-seals or stuffing-box type.

2.9.2 Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone particle separator in line.

2.9.3 Stuffing-Box Type Seals

Stuffing box shall include minimum four rows of square, impregnated TFE (Teflon) or graphite cord packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.

2.10 EXPANSION TANKS

****

NOTE: Indicate the requirements for these tanks on the drawings including operating pressure.

****

Tank shall be welded steel, constructed for, and tested to pressure-temperature rating of 862 kPa at 66 degrees C 125 psi at 150 degrees F. Provide tanks precharged to the minimum operating pressure. Tank shall have a replaceable polypropylene or butyl lined diaphragm which keeps the air charge separated from the water; shall be the captive air type.

Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.11 AIR SEPARATOR TANKS

****

NOTE: Indicate the requirements for these tanks on the drawings including operating pressure.

****

****

NOTE: Indicate the routing of all vent and blow-down piping.

****

[External air separation tank shall have an internal design constructed of stainless steel and suitable for creating the required vortex and subsequent air separation. Tank shall be steel, constructed for, and tested to pressure-temperature rating of 862 ka at 66 degrees C 125 psi at 150 degrees F. Tank shall have tangential inlets and outlets connections, threaded for 50 mm 2 inches and smaller and flanged for sizes 65 mm 2-1/2 inches and larger. Air released from a tank shall be[to the atmosphere][vented as indicated]. Tank shall be provided with a blow-down connection.

][Design to separate air from water and to direct released air to automatic air vent. Unit shall be of one piece cast-iron construction with internal baffles and two air chambers at top of unit; one air chamber shall have outlet to expansion tank and other air chamber shall be provided with automatic air release device. Tank shall be steel, constructed for, and tested to a ANSI Class 125 pressure-temperature rating.

]2.12 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing equivalent chromium (CPR) is prohibited.

2.12.1 Water Analysis

****

NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.

****

Conditions of make-up water to be supplied to the condenser and chilled water systems were reported in accordance with ASTM D596 and are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees C F
Silica (Sino 2)	[_____] pp (mg/1)
Insoluble	[_____] pp (mg/1)
Iron and Aluminum Oxides	[_____] pp (mg/1)
Calcium (Ca)	[_____] pp (mg/1)
Magnesium (Mg)	[_____] pp (mg/1)
Sodium and Potassium (Nan and AK)	[_____] pp (mg/1)
Carbonate (HO 3)	[_____] pp (mg/1)
Sulfate (SO 4)	[_____] pp (mg/1)
Chloride (JCL)	[_____] pp (mg/1)
Nitrate (NO 3	[_____] pp (mg/1)

Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] pp (mg/1)
Total Alkalinity	[_____] PM (me/1
Non-Carbonate Hardness	[_____] PM (me/1
Total Hardness	[_____] PM (me/1
Dissolved Solids	[_____] pp (mg/1)
Fluorine	[_____] pp (mg/1)
Conductivity	[_____] McMahon/cm

2.12.2 Chilled and Condenser Water

Water to be used in the chilled and condenser water systems shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

2.12.3 Glycol Solution

****

NOTE: If freeze protection for chilled water is not required, this paragraph should be deleted.

When a glycol system is used, the size of the VAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "VAC Systems and Equipment Handbook" should be consulted for the appropriate calculation procedures.

Ethylene glycol should be used for VAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient or operating temperature.

****

A [_____] percent concentration by volume of industrial grade [ethylene][propylene] glycol shall be provided in the chilled water. The glycol shall be tested in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

2.12.4 Water Treatment Services

****

NOTE: The services of a water treatment company to treat a chilled water system should only be required if the makeup water available is of very poor quality.

****

The services of a company regularly engaged in the treatment of[condenser][condenser and chilled] water systems shall be used to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall maintain the chemical treatment and provide all chemicals required for the[condenser][condenser and chilled] water systems for a period of 1 year from the date of occupancy. The chemical treatment and services provided over the 1 year period shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Acid treatment and proprietary chemicals shall not be used.

2.12.5 Chilled Water System

****

NOTE: For dual temperature systems (chilled and heated water), coordinate the compatibility of the separate water treatment systems.

****

A shot feeder shall be provided on the chilled water piping as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.12.6 Condenser Water

****

NOTE: Cooling towers with a capacity of greater than 176 kW 50 tons will be provided with automatic chemical feed and blow down systems. Smaller towers will be provided with continuously activated systems. Indicate the location of the entire water treatment system. Specify only non-toxic chemicals for use in cooling towers with automatic blowdown systems. Delete all the information under this paragraph if a cooling tower is not used in the system.

****

The water treatment system shall be capable of[automatically][continuously] feeding chemicals and bleeding the system to prevent corrosion, scale, and biological formations.[Automatic chemical feed systems shall automatically feed chemicals into the condenser water based on varying system conditions.][Continuous chemical feed systems shall continuously feed chemicals into the condenser water at a constant rate. The system shall be initially set manually based on the water analysis of the make-up water.]

2.12.6.1 Chemical Feed Pump

One pump shall be provided for each chemical feed tank. The chemical feed pumps shall be positive displacement diaphragm type. The flow rate of the pumps shall be adjustable from 0 to 100 percent while in operation. The discharge pressure of pumps shall not be less than 1.5 times the line pressure at the point of connection. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge.

2.12.6.2 Tanks

Two chemical tanks shall be provided. The tanks shall be constructed of[high density polyethylene][stainless steel] with a hinged cover. The tanks shall have sufficient capacity to require recharging only once per 7 days during normal operation. A level indicating device shall be included with each tank. An electric agitator shall be provided for each tank.

2.12.6.3 Injection Assembly

An injection assembly shall be provided at each chemical injection point along the condenser water piping as indicated. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the condenser water piping. Each assembly shall include a shutoff valve and check valve at the point of entrance into the condenser water line.

2.12.6.4 Water Meter

Water meters shall be provided with an electric contacting register and remote accumulative counter. The meter shall be installed within the make-up water line, as indicated.

2.12.6.5 Timers

Timers shall be of the automatic reset, adjustable type, and electrically operated. The timers shall be suitable for a 120 volt current. The timers shall be located within the water treatment control panel.

2.12.6.6 Water Treatment Control Panel

****

NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems. In areas where a panel could come in contact with the water treatment chemical, choose the stainless steel construction.

****

The control panel shall be a NEMA 12 enclosure suitable for surface mounting. The panel shall be constructed of[stainless steel][steel] with a hinged door and lock. The panel shall contain a laminated plastic nameplate identifying each of the following functions:

(1) Main power switch and indicating light

(2) MAN-OFF-AUTO selector switch

(3) Indicating lamp for bleed-off valve

(4) Indicating lamp for each chemical feed pump

(5) Set point reading for each timer

2.12.6.7 Chemical Piping

The piping and fittings shall be constructed of[schedule 80 PVC][stainless steel] suitable for the water treatment chemicals.

2.12.6.8 Sequence of Operation

****

NOTE: Choose the first set of brackets for automatic chemical feed systems. Choose the second set of brackets for continuous chemical feed systems.

****

[The chemicals shall be added based upon sensing the make-up water flow rate and activating appropriate timers. A separate timer shall be provided for each chemical. The blow down shall be controlled based upon the make-up water flow rate and a separate timer.][The system shall contain an adjustable valve for continuous blow down. The flow rate from the appropriate chemical tanks shall be manually set at the metering pump for continuous chemical feed.]The injection of the chemical required for biological control shall be controlled by a timer which can be manually set for proper chemical feed. Timer set points, blow down rates, and chemical pump flow rates shall be determined and set by the water treatment company.

2.12.6.9 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

2.12.6.10 Bleed Line

****

NOTE: Delete the following paragraph on bleed lines if an automatic chemical system is chosen.

****

A bleed line with a flow valve of the needle-valve type sized for the flow requirement or fixed orifice shall be provided in the pump return to the tower. The bleed line shall be extended to the nearest drain for continuous discharge.

2.13 ELECTRICAL WORK

****

NOTE:
1. Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm in the equipment schedules on the drawings.

2. Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when

recommended by the manufacturer. Where adjustable speed drives (SD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01 "Interior Electrical Systems".
****

Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

[Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW 10 hp or less and adjustable frequency drives for larger motors.][Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.]

2.14 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

2.14.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. The factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be in accordance with ASTM B117, and for that test, the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of 3 mm 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen.

If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system shall be designed for the temperature service.

2.14.2 Shop Painting Systems for Metal Surfaces

Clean, retreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F shall be cleaned to bare metal.

Where hot-dip galvanized steel has been cut, resulting surfaces with no galvanizing shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm one mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm one mil per coat.

b. Temperatures Between 50 and 205 degrees C 120 and 400 degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F shall receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F shall receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

2.15 FACTORY APPLIED INSULATION

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 25 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84.

Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.16 NAMEPLATES

****

NOTE: In a salt water environment, substitute acceptable non-corroding metal such as but not limited to nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

****

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, type or style, model or serial number on a plate secured to the item of equipment. The nameplate of the distributing agent will not be acceptable. Plates shall be durable and legible throughout equipment life and made of[anodized aluminum][stainless steel][_____]. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.17 RELATED COMPONENTS/SERVICES

2.17.1 Drain and Make-Up Water Piping

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NOTE: Indicate all drain and makeup water piping on the drawings.

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Requirements for drain and make-up water piping and backflow preventer is specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.17.2 Cathodic Protection

Requirements for cathodic protection systems is specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM][and][Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

2.17.3 Field Applied Insulation

Requirements for field applied insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.17.4 Field Applied Insulation

Requirements for field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as supplemented and modified by this specification section.

2.17.5 Field Painting

Requirements for painting of surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00PAINTS AND COATINGS.

[2.17.5.1 Color Coding

****

NOTE: Color coding for piping identification required by the using agency will be developed and inserted in the "Color Code Schedule" in Section 09 90 00 PAINTS AND COATINGS.

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Requirements for color coding for piping identification are specified in Section 09 90 00 PAINTS AND COATINGS.

][2.17.5.2 Color Coding For Hidden Piping

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NOTE: Use this paragraph for Army projects only.

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****

NOTE: Color Coding Scheme may be deleted in accordance with Notes in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

****

A color coding scheme for locating hidden piping shall be in accordance with[Section 22 00 00 PLUMBING, GENERAL PURPOSE][Section 22 00 70 PLUMBING, HEALTHCARE FACILITIES].

]PART 3 EXECUTION

3.1 INSTALLATION

Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove burrs by reaming, and fashion to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.1 Welding

Provide welding work specified this section for piping systems in conformance with ASME B31.9, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, brazers, brazing operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

3.1.1.1 Employer's Record Documents (For Welding)

Submit for review and approval the following documentation. This documentation and the subject qualifications shall be in compliance with ASME B31.9.

a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.

b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.

c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

3.1.1.2 Welding Procedures and Qualifications

a. Specifications and Test Results: Submit copies of the welding procedures specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

b. Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

3.1.1.3 Examination of Piping Welds

Conduct non-destructive examinations (NDE) on piping welds and brazing and verify the work meets the acceptance criteria specified in ASME B31.9. NDE on piping welds covered by ASME B31.9 is visual inspection only. Submit a piping welds NDE report meeting the requirements specified in ASME B31.9.

3.1.1.4 Welding Safety

Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

3.1.2 Directional Changes

Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.

3.1.3 Functional Requirements

Pitch horizontal supply mains down in the direction of flow as indicated.

The grade shall not be less than 2 mm in 1 m 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 65 mm 2-1/2 inches or less in diameter, and with flanges for pipe 80 mm 3 inches and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges.

Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

3.1.4 Fittings and End Connections

3.1.4.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.4.2 Brazed Connections

Brazing, AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.4.3 Welded Connections

Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.9. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.4.4 Grooved Mechanical Connections

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NOTE: Do not use this paragraph on NAVFAC projects.

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Prepare grooves in accordance with the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.1.4.5 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.4.6 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

3.1.5 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.6 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Flexible Pipe Connectors

****

NOTE: Flexible pipe connectors will be provided where required to absorb expansion and contraction, isolate vibration, absorb noise, compensate offset motion, absorb continuous flexing, and relieve equipment from piping stresses. Where flexible pipe connectors are needed to correct lateral, parallel, and angular misalignment, their use will be limited to maximum offset as recommended, in writing, by the manufacturer. Flexible pipe connectors will only be used on water piping.

****

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.9   Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 25 mm 1 inch.

3.1.10   Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58, except as supplemented and modified in this specification section. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 50 mm 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.10.1   Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.10.2   Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.10.3   C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.10.4   Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.10.5   Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher. Type 40 shields shall be used on all piping less than 100 mm 4 inches and all piping 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 50 mm 2 inches and larger.

3.1.10.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-58 and a support shall be installed not over 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m 5 feet apart at valves.[Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 23 kg 50 pounds shall have the excess hanger loads suspended from panel points.]

3.1.10.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m 15 feet, not more than 2.4 m 8 feet from end of risers, and at vent terminations.

3.1.10.8 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.10.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, a Type 39 saddle shall be used. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.10.10 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.10.11 Seismic Requirements

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NOTE: Use this subparagraph for Army projects only.

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NOTE: Provide seismic details, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if no seismic details are provided. Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR HVAC, properly edited, must be included in the contract documents.

****

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR HVAC[as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.1.10.12 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.1.11 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1.5 m 5 feet on each side of each expansion joint, and in lines 100 mm 4 inches or smaller not more than 600 mm 2 feet on each side of the joint.

3.1.12 Pipe Anchors

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NOTE: Designer shall indicate locations and details of pipe anchors on the design drawings.

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Anchors shall be provided where indicated. Unless indicated otherwise, anchors shall comply with the requirements specified. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required.

Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.

3.1.13 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Except as indicated otherwise piping sleeves shall comply with requirements specified. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 1.0 mm 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M,[Schedule 30][Schedule 20][Standard weight]. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 13 mm 1/2 inch depth. Sleeves shall not be installed in structural members.

3.1.13.1 Refrigerated Space

Refrigerated space building surface penetrations shall be fitted with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Sleeves shall be constructed with integral collar or cold side shall be fitted with a bonded slip-on flange or extended collar.

In the case of masonry penetrations where sleeve is not cast-in, voids shall be filled with latex mixed mortar cast to shape of sleeve and flange/external collar type sleeve shall be assembled with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fastened to surface with masonry anchors.

Integral cast-in collar type sleeve shall be flashed[as indicated.][with not less than 100 mm 4 inches of cold side vapor barrier overlap of sleeve surface.] Normally noninsulated penetrating round surfaces shall be sealed to sleeve bore with mechanically expandable seals in vapor tight manner and remaining warm and cold side sleeve depth shall be insulated with not less than [100][_____] mm [4][_____] inches of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer.

Vapor barrier sealant shall be applied to finish warm side insulation surface. Warm side of penetrating surface shall be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Wires in refrigerated space surface penetrating conduit shall be sealed with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

3.1.13.2 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 6.35 mm 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

3.1.13.3 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a 5.17 kg/sq. m .17 ounce copper sleeve, or a 0.81 mm 0.032 inch thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 200 mm 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 50 mm 2 inches above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut.

c. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.13.4 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 00 FIRESTOPPING.

3.1.13.5 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.14 Access Panels

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NOTE: To the extent possible, designer shall indicate locations of access panels on the design drawings.

****

Access panels shall be provided where indicated for all concealed valves, vents, controls, and additionally for items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in[Section 08 31 00 ACCESS DOORS AND PANELS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

3.2 INSTALLATION FOR POLYPROPYLENE PIPING (CHILLED WATER APPLICATIONS ONLY)

3.2.1 Locations

****

NOTE: Fire retardant grades of polypropylene may be worthwhile to specify, but it has been reported that

the physical properties of the pipe are lowered after the addition of flame retardant filler material. Fusion equipment and tools used for joining the pipe are unlike PVC piping connecting methods and associated PVC cement. It should be noted that the fusion tools can be challenging using in overhead or confined spaces. The designer should consider the recommended working clearances by the manufacturer. Maintenance staff shall be made aware when polypropylene piping exists in their area of responsibility. Proper equipment and tools for polypropylene piping used to address maintenance problems such as changing valves should be kept available to maintenance personnel. The applicable training for this equipment and tools should occur shortly after a facility with polypropylene piping is turned over to the customer.

****

Plastic pipe to include polypropylene shall not be installed in air plenums. Plastic pipe to include polypropylene shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

3.2.2 Pipe Joints

Joints for polypropylene pipe and fittings shall be made by heat fusion welding socket-type or butt-fusion type fittings and shall comply with ASTM F2389. Joint surfaces shall be clean and free from moisture, and shall be undisturbed until cool.

3.2.3 Overheating Precautions

Adequate provisions shall be taken to ensure that the pipe does not exceed operating temperatures recommended by the manufacturer. This includes a safeguard provision from preventing a pump from running with zero flow, if such operation could overheat the pipe beyond pipe manufacturer's recommendations. If heat tracing is permitted elsewhere in the specifications, ensure that the heat tracing is installed per piping manufacturer's recommendations to prevent overheating of the pipe.

3.2.4 Testing and Flushing

Pressure test shall be conducted for 15 minutes at 1.5 times the operating pressure or 1034 kPa 150 psi, whichever is greater, with no observable loss in pressure. Water, rather than air, must be used for pressure testing plastic pipe. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 1.2 m/s 4 fps through all portions of the piping system. Flushing shall be continued until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials. Upon completion of flushing, drain all water from system at low points, and remove/clean/replace strainers.

3.3 ELECTRICAL INSTALLATION

Install electrical equipment in accordance with NFPA 70 and manufacturers instructions.

3.4 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.5 FIELD TESTS

Field tests shall be conducted in the presence of the QC Manager or his designated representative to verify systems compliance with specifications. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor.

3.5.1 Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the tests shall be properly isolated.

3.5.2 Pressure Tests

Each piping system , except for polypropylene piping, shall be hydrostatically tested at a pressure not less than 1297 kPa (gage) 188 psig for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a currently calibrated test pressure gauge. Leaks shall be repaired and piping retested until test requirements are met. No leakage or reduction in gage pressure shall be allowed.

Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

Submit for approval pressure tests reports covering the above specified piping pressure tests; describe the systems tested, test results, defects found and repaired, and signature of the pressure tests' director. Obtain approval from the QC Manager before concealing piping or applying insulation to tested and accepted piping.

3.5.3 Condenser Water Quality Test Reports

The condenser water system shall be analyzed by the water treatment company a minimum of once a month for a period of one year after system acceptance. Submit for approval the specified condenser water quality test reports. The analysis and resulting reports shall include the following information recorded in accordance with ASTM D596.

Date of Sample	[_____]
Temperature	[_____] degrees C F

Silica (Sino 2)	[_____] pp (mg/1)
Insoluble	[_____] pp (mg/1)
Iron and Aluminum Oxides	[_____] pp (mg/1)
Calcium (Ca)	[_____] pp (mg/1)
Magnesium (Mg)	[_____] pp (mg/1)
Sodium and Potassium (Nan and AK)	[_____] pp (mg/1)
Carbonate (HO 3)	[_____] pp (mg/1)
Sulfate (SO 4)	[_____] pp (mg/1)
Chloride (JCL)	[_____] pp (mg/1)
Nitrate (NO 3	[_____] pp (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] epm (meq/1)
Non-Carbonate Hardness	[_____] epm (meq/1)
Total Hardness	[_____] epm (meq/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] microhm/cm

3.5.4 Related Field Inspections and Testing

3.5.4.1 Piping Welds

Examination of Piping Welds is specified in the paragraph EXAMINATION OF PIPING WELDS (above).

3.5.4.2 HVAC TAB

Requirements for testing, adjusting, and balancing (TAB) of HVAC water piping, and associated equipment is specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Coordinate with the TAB team, and provide support personnel and equipment as specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC to assist TAB team to meet the TAB work requirements.

3.6 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the[chilled water,][chilled-hot water,][and][condenser water piping system[s]]. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and maintenance manuals.

Conduct a training course for the operating staff and maintenance staff selected by the Contracting Officer. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be[one man-day][[_____][_____] continuous man-days]. Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

[3.7 ONE-YEAR INSPECTION REPORT FOR COOLING WATER

****

NOTE: Include this paragraph and the corresponding submittal requirements if the piping specified by this specification is to be used in conjunction with either a cooling tower and/or water-cooled refrigeration/air-conditioning equipment.

****

At the conclusion of the one year period, each connecting[cooling tower][and][liquid chiller condenser] inspect for problems due to corrosion, scale, and biological growth. If the equipment is found not to conform to the manufacturers recommended conditions, and the water treatment company recommendations have been followed; the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 65 00 (November 2016)**

Change 2 - 08/18

Preparing Activity: NAVFAC **Superseding**

UFGS-23 65 00 (August 2008)

UFGS-23 65 00.00 10 (January 2008)

UFGS-23 66 00.00 20 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 65 00

COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS

11/16, CHG 2: 08/18

-- End of Section Table of Contents --

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SECTION 23 65 00

COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS

11/16, CHG 2: 08/18

****

NOTE: This guide specification covers the requirements for induced mechanical draft cooling towers (both packaged and field-erected).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.13	(2005; R 2010) Methods for the Measurement of Sound Pressure Levels in Air (ASA 118)

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 64	(2020) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C67/C67M	(2024) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

COOLING TECHNOLOGY INSTITUTE (CTI)

CTI ATC-105	(2000) Acceptance Test Code
CTI ESG-114	(2007) Design of Cooling Towers with Douglas Fir Lumber
CTI STD-111	(2018) Gear Speed Reducers for Application on Industrial Water Cooling Towers
CTI STD-134	(2022) Plywood for Use in Cooling Towers
CTI Std-103	(2022) Redwood Lumber Specifications
CTI Std-112	(2019) Pressure Preservative Treatment of Dimensional Lumber
CTI Std-137	(2017) Fiberglass Pultruded Structural Products for Use in Cooling Towers
CTI Std-201	(2011) Standard for the Certification of Water Cooling Tower Thermal Performance

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 214	(2021) Standard on Water-Cooling Towers

REDWOOD INSPECTION SERVICE (RIS) OF THE WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

RIS Grade Use	(2019) California Redwood Lumber Grades and Uses

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J534	(2021) Lubrication Fittings

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5	(2021) Western Lumber Grading Rules

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Cooling Towers; G, [_____]

Posted Instructions; G, [_____]

Demonstrations; G, [_____]

Verification of Dimensions; G, [_____]

Remote Evaporatively-Cooled Condensers

SD-06 Test Reports

[Packaged Cooling Tower - Installation Instructions; G, [_____]

][Field-Erected Cooling Tower - Installation Instructions; G, [_____]

][Packaged Cooling Tower - Field Acceptance Test Plan; G, [_____]

][Field-Erected Cooling Tower - Field Acceptance Test Plan; G, [_____]

][Packaged Cooling Tower - Field Acceptance Test Report; G, [_____]

][Field-Erected Cooling Tower - Field Acceptance Test Report; G, [_____]

] SD-07 Certificates

Service Organization

Cooling Tower

Remote Evaporatively-Cooled Condensers

SD-08 Manufacturer's Instructions

[Packaged Cooling Tower - Installation Instructions

][Field-Erected Cooling Tower - Installation Instructions

] Remote Evaporatively-Cooled Condensers

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

Remote Evaporatively-Cooled Condensers

1.3 SAFETY REQUIREMENTS

****

NOTE: Catwalk, ladder and guardrail may be required. If so, select the applicable item and

delete the others and indicate on drawings the selected item. If not applicable, delete the entire sentence within the brackets.
****

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.[[Catwalk,] [ladder,] [and guardrail] must be provided where indicated and in accordance with[Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].]

1.4 DELIVERY, STORAGE, AND HANDLING

Stored items must be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation must be the Contractor's responsibility. Any materials found to be damaged must be replaced at the Contractor's expense. During installation, piping and similar openings must be capped to keep out dirt and other foreign matter.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Verification of Dimensions

The Contractor must become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.5.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor must carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and must arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment must be standard commercial catalogued products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use in field service for two years prior to bid opening. The two year use must include applications of equipment and materials under similar circumstances and of similar size. Products having less than a two year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. This 6000 hour record must not include any manufacturer's prototype or factory testing. Records of satisfactory field use must be completed by a product that had been, and presently is, sold, or offered for sale on a commercial market through the following copyrighted means: advertisements, manufacturer's catalogs, or brochures. Products must be supported by a service organization. System components must be environmentally suitable for the indicated locations.

2.2 MANUFACTURER'S STANDARD NAMEPLATES

Major equipment including cooling towers, cooling tower gear drive assemblies, fans, and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates must be durable and legible throughout equipment life. Plates must be fixed in prominent locations.

2.3 ELECTRICAL WORK

****

NOTE: Where motor starters for mechanical equipment are provided in motor-control centers, the references to motor starters will be deleted.

Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm on the drawings in the equipment schedules.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (ASD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01, "Interior Electrical Systems".

****

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, must be provided. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.

****

NOTE: Bracketed sentence "Motor bearings..." to be

used for Army projects only.
****

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. [Motor bearings must be fitted with grease supply fittings and grease relief to outside of the enclosure.] Motor enclosure type may be either TEAO or TEFC.

e. [Where two-speed motors are indicated, variable-speed controllers may be provided to accomplish the same function.][Use adjustable frequency drives for all variable-speed motor applications.] Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.

f. Provide inverter duty premium efficiency motors for use with variable frequency drives.

2.4 COOLING TOWER MATERIALS

2.4.1 Lumber

2.4.1.1 Douglas Fir

CTI ESG-114, WWPA G-5, Grade B and better, Industrial Clear. Douglas fir must have a preservative treatment in accordance with CTI Std-112.

2.4.1.2 Plywood

CTI STD-134, Exterior Grade, type and thickness as specified for the application.

2.4.1.3 Pressure Treated Lumber

Pressure treated lumber must be in accordance with CTI Std-112. Wood exposed as the result of notching, cutting, or drilling must be saturated with the preservative.

2.4.1.4 Redwood

CTI Std-103, RIS Grade Use California Redwood, clear of all hearts.

2.4.2 Fiberglass Reinforced Plastic (FRP)

FRP components must be inert, corrosion resistant, and fire-retardant with a thickness of 3.66 kg per square meter 12 ounces per square foot. FRP components must contain an ultraviolet (UV) ray inhibitor as per CTI Std-137, Grade 1 or 3. Components manufactured of polystyrene will not be permitted.

2.4.3 Zinc-Coated Steel

Components fabricated of zinc-coated steel must be not lighter than 16 gauge

1.613 mm 0.0635 inch steel, protected against corrosion by a zinc coating. The zinc coating must conform to ASTM A653/A653M, as applicable and have an extra heavy coating of not less than 760g per square meter 2.35 ounces per square foot of surface. Galvanized surfaces damaged due to welding must be coated with zinc rich coating conforming to ASTM D520, Type 1.

2.4.4 Polyvinyl Chloride (PVC) Formed Sheets

ASTM D1784, Type I, Grade 1 with a flame spread rating in accordance with ASTM E84, Class A.

2.4.5 High Density Polyethylene (HDPE)

Components manufactured from HDPE must be seamless with a minimum thickness of 10 mm 0.375 inch. The material must have the appropriate inhibitors to protect the component from any UV degradation. Tanks and cooling tower shells must be seamlessly molded to minimize water loss/consumption.

2.4.6 Stainless Steel Sheets

Type [304][316].

****

NOTE: Designer should consider location (non-coastal, coastal, extremely corrosive areas) when specifying corrosion protection. Additional lead time and cost may be a factor. Designer must consult local review team for guidance on corrosion protection.

****

2.4.7 Concrete

Concrete must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE. Exposed concrete must be rub-finished for smooth and uniform surfaces free of form marks and defects. Honeycomb concrete will not be permitted.

2.4.8 Hardware

Bolts must be cadmium-plated, zinc-coated steel, or Type 304 stainless steel. Each bolt must be provided with neoprene and cadmium-plated steel washers under the heads. Nails must be silicon bronze, commercial bronze, or stainless steel. Hardware must meet the salt-spray fog test as defined by ASTM B117. Angle brackets and similar parts must be zinc-coated steel. Zinc coatings must conform to ASTM A153/A153M and [ASTM A123/A123M], as applicable, and must have an extra heavy coating of not less than 760g per square meter 2.35 ounces per square foot of surface. Nails must be silicon bronze, commercial bronze, or stainless steel. Subject hardware to a salt-spray fog test in accordance with ASTM B117. No signs of corrosion must be evident after 1,000 hours continuous exposure to a 5 percent salt spray.

2.5 COOLING TOWERS

2.5.1 Factory Assembled Towers

2.5.1.1 Description

The cooling tower must be of the [induced mechanical draft][or forced mechanical draft] type. The cooling tower must include frames and casings, louvers, drift eliminators, partitions, windbreak baffles, drift-check walls, cold water basin equipment, fans and fan walls, blowers, drives, electric motors, access doors, [working platforms,] inspection plates, and panels.

2.5.1.2 Construction

Tower must be constructed to withstand a wind pressure of not less than 1.44 kilopascal (kPa) 30 psf on any external surface. Fan deck must be constructed to withstand a live load of not less than 2.87 kPa 60 psf in addition to the concentrated or distributed loads of equipment mounted on the fan deck. [A 15 percent increased loading must be included for ice or snow load.]

The hot water distribution system must be of the open basin gravity feed type or the pressurized spray header type design.

2.5.1.3 Tower Frame and Louvers

Provide frame constructed from [galvanized steel][_____]. Intermediate structural members must be provided for rigidity and support of casings, louvers, fill, distribution systems, fan decks, and other equipment. Inlet air louvers must permit free air passage but no splashout, and must be designed to prevent debris and sunlight from entering the cold water basin.

[2.5.1.4 Air Inlet And Discharge Connections

On forced draft centrifugal type units, the air inlet and discharge connections must have flanged or lipped projections for connecting to ductwork.

]2.5.1.5 Fill

The fill must support expected loads without sag or failure and arranged to effectively break up the water. The fill must be manufactured and performance tested by the cooling tower manufacturer. The fill must be of the materials as specified. Polyvinyl chloride (PVC) fill is suitable for inlet temperatures to 51.7 degrees C 125 degrees F on cross flow type units and temperatures to 54.4 degrees C 130 degrees F on counterflow type units. Chlorinated polyvinyl chloride(CPVC) fill must be used for applications where inlet temperatures are greater than 54.4 degrees C 130 degrees F. Fill must be in accordance with ASTM E84, Class A.

2.5.1.6 Drift Eliminators

Provide drift eliminator sections designed and arranged to effectively trap water droplets entrained in the discharge airstream. Sections must be assembled in easily removable sections for [forced mechanical drift tower][and][counterflow induced mechanical draft tower]. Drift eliminators must be constructed of Polyvinyl chloride (PVC) in accordance with ASTM E84, Class A.

2.5.1.7 Cold Water Basin Equipment.

****

NOTE: Choose galvanized steel, except in corrosive environments, choose Type 304 stainless steel.

****

Include [galvanized steel] [Type 304 stainless steel] sump with stainless steel removable screen and vortex breaker, float valves, and necessary pipe connections and fittings within the tower. [Provide float valves with adjustable arms. Valve sizes larger than 13 mm 1/2 inch pipe size must be the balanced piston type. Valve seats and disks must be replaceable.] [Electronic water level control must be provided.]

Provide cold water basins and casings suitably sealed and flashed at joints and connections to ensure watertight construction.

2.5.1.7.1 Electric Basin Heater

Heater must be the electric immersion type with water-tight junction boxes mounted in the basin with sufficient capacity to maintain the basin water temperature above 12.8 degrees C 55 degrees F at an ambient temperature of 4.4 degrees C 40 degrees F. Heater must be complete with control thermostat, transformer, contactor, and low water level heater protection.

****

NOTE: Designer should consider reduced maintenance requirements associated with direct drive assemblies.

****

2.5.1.8 Fans, Blowers, and Drives.

The towers must have axial propeller-type fans having not less than four aluminum alloy or glass-reinforced polypropylene blades or squirrel-cage, centrifugal-type blowers, as applicable. Fans and blowers must be designed and constructed to withstand 50 percent overspeed above normal maximum operating speeds.

If belt drives are utilized, multi-grooved solid back single belt design must be used to avoid uneven belt stretch. Adjustment must be provided for belt tension and drive centers. Belt drives must be designed and constructed for 150 percent overload. Sheaves located in the airstream must be corrosion-resistant material. Shafting for gear drives must have flexible-type couplings requiring no lubrication. The gear assemblies must be enclosed in an oil filled housing provided with fill and drain plugs.

2.5.1.9 Tower Piping

Piping must be schedule 40 PVC and conform to ASTM D2996. Fittings for other piping materials must be of the same material or equal and of the same class and grade as the pipe.

2.5.1.10 Electric Motors

Requirements are specified in paragraph ELECTRICAL WORK.

[2.5.1.11 Vibration Cutout Switch.

Provide [mechanical vibration cutout switch] [electronic vibration cutout switch with auxiliary contacts] in a protected position and most effective location, interlocked with the fan wiring to electrically open the motor circuit under excessive fan vibration.

]2.5.1.12 Performance

The factory assembled tower must have Cooling Tower Institute certification that, in accordance with CTI Std-201, the cooling tower will perform thermally at the rating published by the tower manufacturer in his copyrighted literature.

2.5.1.13 Sound Power Level

Sound power levels, in decibels (dB)with a reference pressure of 0.0002 microbars, of the cooling tower must be not greater than the maximum permitted dB levels for the designated octave band as set forth in Table I or Table II. The sound power level data for the cooling tower must have been verified in tests conducted in accordance with ASA S1.13.

Table I. Sound Power Level For Induced Mechanical Draft Type

Octave Band (Hz)	63	125	250	500	1000	2000	4000	8000
Sound Power Level (dB)	112	112	110	108	102	98	93	90

Table II. Sound Power Level For Forced Mechanical Draft Type

Octave Band (Hz)	63	125	250	500	1000	2000	4000	8000
Sound Power Level (dB)	112	112	110	108	102	98	93	90

****

NOTE: The numbers shown in Tables I & II are ranges of acceptable/recommended sound power levels.

****

2.5.1.14 Drift Loss

Drift loss must be not greater than 0.005 percent of the water circulated.

2.5.2 Lubrication

The lubricating points must be extended to the outside of the unit for easy accessibility. Hydraulic lubrication fittings must be in accordance with SAE J534. Where use of high pressure lubricating equipment, 6894 kPa 1000 psi or higher, will damage grease seals or other parts, a suitable warning must be affixed to the equipment in a conspicuous location.

2.5.3 Factory Finish System

****

NOTE: Galvanized metal is the standard finish for most manufacturers. Provide finish systems with 3,000 hour salt spray compliance for sea coast installations

****

[Factory painting system] [Galvanized metal] must have been proven to withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Equipment located in a sea coast environment must withstand 3,000 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117. For salt-spray fog test, the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for the temperature service and must have been proven to pass the specified salt-spray test.

[2.5.4 Field-Assembled Cooling Towers

Factory fabricated, factory-assembled towers which are shipped to the job site in separate cells or modules must be provided with all appropriate manufacturer's hardware for assembly in the field. Factory fabricated, field-assembled towers must be assembled and adjusted at the job site by a factory representative.

2.5.4.1 Framework, Casing, and Supports

****

NOTE: Packaged type cooling towers are typically constructed to withstand a 1.4 kPa (30 psf) windload.

****

Towers must be designed and constructed to withstand a wind pressure of not less than [1.4] [_____] kPa [30] [_____] pound-force per square foot (psf) on external surfaces. [A 15 percent increased loading must be included for ice or snow load.] [Air inlet and discharge terminations must have flanged or lipped projections for connecting ductwork.] Framework, structural supports, and equipment supports must be [zinc-coated steel,] [Type 304 stainless steel,] [air-entrained concrete] [FRP,] [or] [lumber]. Casing (exterior enclosing walls) must be constructed of [zinc-coated steel] [Type 304 stainless steel] [air-entrained concrete] [FRP] [or] [lumber]. Framework design for wood towers must conform to requirements of CTI Std-103 for redwood construction and CTI ESG-114 for Douglas fir construction. Notching structural wood members may be permissible only if the members are increased proportionately in size to provide equivalent strength. Materials provided for framework, casings and equipment supports must be compatible. Structural supports must be provided in accordance with the recommendations of the manufacturer of the tower unless otherwise indicated. [Cold-pour concrete joints in vertical walls must have a continuous water-stop stripping of molded polyvinyl plastic (150 mm 6 inch dumbbell).]

2.5.4.2 Foundations

****

NOTE: For the design of a tower foundation, indicate the location, the size, the reinforcement requirements, etc. necessary for a cooling tower available from three commonly known manufacturers. For small retrofit type jobs the designer may choose to show the general layout of the foundation and rely on the Contractor to design and construct the foundation based on the cooling tower to be provided. Delete the last two sentences of the paragraph if the foundation is not to be designed by the Contractor.

****

Cooling tower foundations must meet the requirements of the cooling tower manufacturer and wind and seismic loads, wind and seismic loads and be as indicated. Foundation design must be based on the load conditions and soil bearing value indicated. Foundation calculations must be submitted with the equipment drawings.

2.5.4.3 Stairways and Ladders

Provide stairs, 60-degree ship ladders or straight-rung ladders of standard design, starting at [ground] [roof] level and extending as high as required to gain access to fan decks and water distribution systems. Stairways and ladders must be hot-dip, zinc-coated steel. Ladders higher than 3.66 meters 12 feet must have a safety cage.

2.5.4.4 Hand Railings

Steel hand railings must be not less than 1067 mm 42 inches high around the exterior of each working surface that is 3.66 m 12 feet or more above the ground, roof, or other supporting construction. Railings must be not smaller than 32 mm 1-1/4 inch zinc-coated steel pipe with standard zinc-coated steel railing.

2.5.4.5 Access Doors

Each tower must be provided with access doors at grade level to provide entry to the interior for service maintenance without removal of the fill. Doors must be provided on each endwall of each cooling tower cell. Frame and brace access doors to prevent damage when opening and closing. Doors must be located adjacent to float controls.

2.5.4.6 Louvers

Air inlets for each cooling tower must be provided with individually removable louvers arranged to prevent the escape of water. Louvers must be constructed of [PVC] [fiberglass reinforced polyester] [zinc-coated steel] [Type 304 stainless steel] [FRP] [lumber]. Materials provided for casings and louvers must be compatible; one material must not produce stains upon the other. Louvers constructed of lumber must be of a thickness to withstand alternate wetting and drying without cracking or splitting. Air intakes must be provided with 25 mm 1 inch zinc-coated steel mesh.

2.5.4.7 Fan Deck and Cylinder

Each fan must be mounted in a fan cylinder (or stack) to elevate the fan discharge air. Total extension height must not exceed the fan diameter. Each fan cylinder must be provided with a zinc-coated steel, 12 gauge 2.753 mm 0.108 inch wire mesh securely mounted to the top of the cylinder in accordance with manufacturer's recommendations. Fan decks must be designed to withstand a live load of not less than [1.9] [2.9] kPa [40] [60] psf in addition to the concentrated or distributed loads of equipment mounted on the fan decks. [Fan deck and cylinders must be constructed of zinc-coated steel, lumber, Type 304 stainless steel, or FRP and be compatible with the entire tower construction.] [Fan deck must be constructed of precast, reinforced lightweight concrete, in multiple sections, forming a complete, vibration-free base for mounting fan, speed reducer, drive shaft, motor, and fan stacks. Fan cylinders (or stacks) must be constructed of precast, reinforced lightweight concrete in multiple sections, constrained with bands of zinc-coated steel conforming to ASTM A123/A123M, not less than 3 by 75 mm 1/8 by 3 inches, and bolted to form a compressive load on stack perimeter. Fan cylinder must be secured in place on the fan deck with Class A mortar.]

2.5.4.8 Fans

****

NOTE: When the density of the ambient air to be handled by the fans differs substantially from the density of the standard air value of 1.2 kg per cubic m (0.075 pound per cubic foot) at 21 degrees C (70 degrees F) and 101 kPa (29.92 inches mercury), the density of the air and/or the elevation above mean sea level will be shown on the drawings.

****

Fans must be the [centrifugal] [or] [adjustable-pitch propeller] type, constructed of zinc-coated steel, Type 304 stainless steel, aluminum or an aluminum alloy, or FRP. Propeller type fans must have a maximum tip speed of 330 m/minute 10,800 fpm. Fan blade assembly must be both statically and dynamically balanced after assembly of the cooling tower. Fan hub must be constructed of [zinc-coated steel] [stainless steel] [cast aluminum] with adequate surface protection against corrosion. Complete fan assembly (fan and mounting) must be designed to give maximum fan efficiency and long life when handling saturated air at high velocities. Each cooling tower fan must be provided with a ball and pedestal type vibration limit switch which must stop the corresponding fan motor in the event of sensing excessive fan vibration.

2.5.4.9 Speed Reducers Gears and Drive Shaft

****

NOTE: Double reduction gear reducer should be considered where low noise requirement is a factor.

****

Speed reducer gears must be rated in accordance with CTI STD-111. Gear reducers must be of the [spiral bevel, single reduction] [spiral or helical, double reduction] type. Reducer must be mounted in accordance with manufacturer's recommendations. Each reducer must be provided with an oil level cutoff switch interlocked to the fan motor. Each reducer must be provided with an oil level sight glass, fill, drain, and vent lines located in a readily accessible position. Drive shafts must be the full floating type with flexible couplings at both ends and have a service factor of 1.0 or greater. Drive shafts must be of stainless steel, fitted each end with flexible couplings (stainless steel plate type). Each drive shaft must be provided with a galvanized steel guard, to prevent damage to surrounding equipment in case of shaft failure. Provision must be made for lubrication of all bearings. Bearings must be accessible to the extent that each bearing can be lubricated without dismantling fan.

2.5.4.10 Electric Motors

****

NOTE: Delete the last sentence if inapplicable.

Consider the following for energy efficiency in cooling towers:

Induced draft fans, VFD's and designing to 0.4 percent wet bulb temperature.

****

Each motor must be a [single speed] [two speed] [variable speed], totally enclosed, insulation Class B, NEMA Design B, continuous-rated type which conforms to NEMA MG 1. Motors must have [open] [dripproof] [totally enclosed] [explosion proof] enclosures and be located outside the discharge airstream. Motors must be mounted according to manufacturer's recommendations. [Two-speed motors must have a single winding with variable torque characteristics.][Motors for variable speed application must be inverter-duty type.]Motors must be provided specifically for either pump or fan application and must comply with the requirements of paragraph ELECTRICAL WORK.

2.5.4.11 Cold Water Basin

****

NOTE: Choose zinc-coated steel, except in corrosive environments, choose Type 304 stainless steel or FRP.

****

Basin must be completely watertight and constructed of [zinc-coated steel] [Type 304 stainless steel] [FRP]. Basin must be constructed and installed to ensure that air will not be entrained in outlets when operating and no water will overflow on shutdown. Each individual sump must be provided with an individual outlet. Each outlet must be provided with a 13 mm 1/2 inch stainless steel wire mesh, securely mounted to prevent trash from entering the outlet. Each basin must be provided with overflow and drain valve connections. Each basin must be provided with a float-controlled, makeup water valve as indicated. The makeup water must discharge not less than 50 mm 2 inches or two pipe diameters, whichever is greater, above the top of the basin.

2.5.4.12 Electric Basin Heater

Heater must be the electric immersion type with water-tight junction boxes mounted in the basin with sufficient capacity to maintain the basin water temperature above 4.4 degrees C 40 degrees F at an ambient temperature of [_____] degrees C degrees F. Heater must be complete with control thermostat, transformer, contactor, and low water level heater protection.

2.5.4.13 Hot Water Distribution System

****
NOTE: The gravity-flow type distribution system will be the system of choice. Pressurized-flow type systems will typically only be specified for field-erected, counterflow type towers

Piping connecting to a cooling tower will be externally supported, independent of the tower structure and piping.
****

Water distribution must be the [gravity-flow] [pressurized-flow] type system which distributes waters evenly over the entire fill surface. Each tower cell must be designed so that a water flow of 140 percent capacity will not cause overflowing or splashing. The distribution system for each cell must include adjustable flow control valves. The entire distribution system must be self-draining and nonclogging. Piping must be either cast iron, ductile iron, threaded-glass-fiber reinforced epoxy pipe, polypropylene, PVC or Schedule 80 black steel.

a. Gravity-Flow System: System must be provided with open basins which include a splash box or baffles to minimize splashing of incoming hot water and holes that evenly distribute the water over the entire decking area. Holes used in a water basin must be provided with ceramic or plastic orifice inserts.

b. Pressurized-Flow System: System must include piping, fittings, branches, and spray nozzles. Spray nozzles must be schedule 40 PVC. Nozzles must be cleanable, nonclogging, removable, and spaced for even distribution.

c. Basin Cover: Hot water distribution basins must be provided with the tower manufacturer's standard removable, [zinc-coated galvanized steel] [304 stainless steel] [FRP] covers. Covers must prevent airborne debris from entering the basin.

]2.5.5 Drift Eliminators

****
NOTE: Per ASHRAE 189.1, 6.3.2.3(b), as invoked from UFC 1-200-02, cooling towers must be equipped with efficient drift eliminators that achieve drift reduction to a maximum of 0.002 percent if the recirculated water volume for counterflow towers and 0.005 percent of the recirculated water flow for cross-flow towers.

Delete the last set of bracketed sentences if a field-erected type tower is not specified.
****

Eliminators must be provided in the tower outlet to limit drift loss to not over [0.005] percent of the circulating water rate. Eliminators must be constructed of polyvinyl chloride (PVC).[Eliminators sections must be supported on PVC or FRP tee sections. Tee sections must be suspended with 6.35 mm 1/4 inch brass rods connected to stainless steel clips embedded in the bottom side of the roof deck at the time of casting. Stainless steel clips must be supplied by cooling tower manufacturer for installation by Contractor at time of roof deck pour. Eliminators may be supported by brass or stainless steel suspension rods from the fan deck or supported directly on concrete beams.]

2.5.6 Cold Water Basin Equipment.

Include sump with removable screen and vortex breaker, float valves, and necessary pipe connections and fittings within the tower. Provide float valves with adjustable arms. Valve sizes larger than 13 mm 1/2 inch pipe size must be the balanced piston type. Valve seats and disks must be replaceable. [Electric water level control must be provided.]

Provide cold water basins and casings suitably sealed and flashed at joints and connections to ensure watertight construction.

2.5.7 Fill (Heat Transfer Surface)

****

NOTE: Typically, both the splash or film type tower fill will be allowed. Film type fill will not be allowed where there is a highly likely possibility that the circulating water will become contaminated with debris (leaves, etc.). Debris in the circulating water will significantly impact the efficiency of a tower with film type fill because of the close spacing of the film material. Note that hot water distribution basin covers will typically prevent most debris from every getting to the fill material.

The most predominant fill material is PVC formed sheets. PVC formed sheets, zinc-coated steel, or lumber will be the typical choices for fill material. Aluminum and/or stainless steel fill will only be specified where either high inlet water temperatures or fireproof construction are concerns. PVC formed sheets will not be provided when the inlet water temperature exceeds 125 degrees F. Tile file will only be considered on field-erected type towers where economically justified.

Delete the bracketed sentences at the end of the paragraph if tile type fill material is not specified.

****

Tower fill must be the [splash] [or] [film] type. Fill material must be free to expand or contract without warping or cracking. No plasticized wood cellulose must be provided for fill material. Fill must be removable or otherwise made accessible for cleaning. Space supports must be corrosion resistant and must prevent warping, sagging, misalignment, or vibration of the fill material. Fill material and supports must be designed to provide for an even mixing of air and water. Fill material must be constructed of [aluminum] [stainless steel] [tile of multi-cell design, set without mortar] [PVC formed sheets, zinc-coated steel, or lumber] in a pattern, and of sufficient height to meet the performance specifications. [Tile fill must be vitreous, with a low water absorption that will pass a freeze-thaw test conducted in accordance with ASTM C67/C67M. Tile fill must have a minimum crushing strength of 13.8 MPa 2,000 psi over the gross area of the tile when the load is applied parallel to the cells as tested in accordance with ASTM C67/C67M. Cast iron tee section lintels supporting the tile fill must conform to ASTM A48/A48M, Class 25, 3.2 mm 1/8 inch additional thickness for corrosion. Lintels must be designed with a safety factor of 2 minimum.]

2.5.8 Fire Safety

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NOTE: Locate the tower in accordance with NFPA 214, and determine the extent and type of fire protection required for all size towers using the factors indicated in NFPA 214.

****

Towers must conform to NFPA 214. Fire hazard rating for plastic impregnated materials must not exceed 25. Plastics must not drip or run during combustion. Fire hazard ratings must be in accordance with ASTM E84, Class A and UL 723.

[2.5.9 Meters and Controls

Tower must be provided with makeup and blowdown meters, conductivity controller, and overflow alarm.

]2.6 REMOTE EVAPORATIVELY-COOLED CONDENSERS

Condenser must be rated and tested in accordance with the requirements of ASHRAE 64. Condenser must include fans, water pump with suction strainer, electric motor and drive equipment, water eliminators if required, condensing coil, liquid receiver if required, water pan or sump, spray nozzles or water-distribution pan, water strainer, water make-up assembly, bleeder with flow valve of the needle valve type sized for the flow required or a fixed orifice, enclosure with suitable access doors, and air-inlet and outlet openings. No water may carry over into the unit discharge outlet.

****

NOTE: Standard casing construction is galvanized steel. For excessively corrosive atmospheres, Type 304 stainless steel should be considered.

****

2.6.1 Condenser Casing

Enclosure must be constructed of not lighter than 18 gauge 1.311 mm 0.516 inch[hot-dip galvanized steel][304 stainless steel], reinforced and braced. Access doors or panels suitably sized and located must be provided for access to water nozzles or distribution pan, coils, and valves for cleaning, repair, or removal of the item. Access doors or panels must be gasketed with synthetic rubber, or equivalent gasket material, and locked in place with thumb screws or catches. One-half inch mesh hot-dip galvanized steel or copper air-inlet screens must be provided on each air inlet.

2.6.2 Refrigerant Section

Condenser coil must be constructed of unfinned copper or steel tubes hot-dip galvanized after fabrication. The receiver must be welded steel and must be fitted and tested in accordance with ANSI/AHRI 495. A refrigerant charging valve must be installed in the liquid line between the receiver cut-off valve and the expansion device. Refrigerant section must be tested in accordance with ANSI/ASHRAE 15 & 34 for the refrigerant employed in the system. CFC-based refrigerants are prohibited.

2.6.3 Fans

Fans must be centrifugal or propeller type as best suited for the application. Fans must be direct or V-belt driven. Belt drives must be completely enclosed within the unit casing or equipped with a guard. When belt drive is provided, an adjustable sheave to furnish not less than 20 percent fan-speed adjustment must be provided. Sheave set must be matched and selected to provide the capacity indicated at the approximate midpoint of the adjustment. Fans must be statically and dynamically balanced. Fan motor must be totally enclosed type or open drip-proof and located within an enclosure to be fully protected from the weather.

2.6.4 Water Section

Water eliminators must be constructed of nonferrous metal, of an approved nonmetallic material, or of not lighter than 24 gauge 0.701 mm 0.0276 inch steel, hot-dip galvanized after fabrication. Spray nozzles must be brass non-clogging type designed to permit easy disassembly, and must be arranged for easy access. Water pump must be bronze-fitted centrifugal or turbine type, and may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pump suction must be fully submerged and provided with screened inlet. Water pan or sump must be constructed of not lighter than 14 gauge 1.994 mm 0.0785 inch steel, hot-dip galvanized after fabrication, or molded acid-resistant glass-fiber-reinforced polyester. Water distribution pan must be constructed of not lighter than 16 gauge 1.613 mm 0.0635 inch steel, hot-dip galvanized after fabrication. Joints must be watertight. Water pan or sump must be provided with drain, overflow, and make-up water connection with stop valve and float valve. A bleed line with a flow valve of the needle type sized for the flow required or fixed orifice must be provided in the pump discharge line and must be extended to the nearest drain for continuous discharge.

2.7 FABRICATION

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NOTE: For equipment to be installed outdoors, adequate protection will be specified. Manufacturers must submit evidence that unit specimen have passed the specified salt spray fog test. A 500 hour test will be specified in a non corrosive environment. A 3,000 hour test will be specified for sea coast environments.

****

Equipment and component items, must have been proven to withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Equipment located in a sea coast environment must withstand 3,000 hours in a salt-spray fog test.

Salt-spray fog test must be in accordance with ASTM B117. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

2.8 SUPPLEMENTAL COMPONENTS/SERVICES

2.8.1 Condenser Water Piping and Accessories

Condenser water piping and accessories must be provided and installed in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.8.2 Cooling Tower Water Treatment Systems

Cooling tower water treatment systems must be provided and installed in accordance with Section 23 64 26 CHILLED, CHILLED-HOT AND CONDENSER WATER PIPING SYSTEMS.

2.8.3 Temperature Controls

****

NOTE: Modify this paragraph as required to coordinate the central equipment controls with the cooling tower system controls. In projects where this section of the specifications is intended to produce control equipment for existing systems, this paragraph will be rewritten to properly integrate the specified controls into the existing temperature control system.

A sequence of control, a schematic of controls, and a ladder diagram should be included on the drawings for each cooling tower fan, chilled water pump, condenser water pump, etc. in order to define the overall system operation.

****

Cooling towers must be fully coordinated with and integrated [into the temperature control system specified in [Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS]] [into the existing air-conditioning system].

PART 3 EXECUTION

3.1 DEMONSTRATIONS

Contractor must conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The training course must cover all of the items contained in the approved Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

Provide a schedule, at least [2] [_____] weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

3.2 INSTALLATION

Installation of cooling tower systems including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with NFPA 70, and in compliance with the manufacturer's written installation instructions, including the following:

[(1) Packaged cooling tower - installation instructions

][(2) Field-erected cooling tower - installation instructions

]3.2.1 Installation Instructions

Provide manufacturer's standard catalog data, at least [5] [_____] weeks prior to the purchase or installation of a particular component, highlighted to show features such as materials of construction, dimensions, options, performance and efficiency. Data must include manufacturer's recommended installation instructions and procedures. Data must be adequate to demonstrate compliance with contract requirements.

3.2.2 Vibration Isolation

If vibration isolation is specified for a unit, vibration isolator literature must be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

3.2.3 Posted Instructions

Provide posted instructions, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

3.2.4 Verification of Dimensions

Provide a letter including the date the site was visited, conformation of existing conditions, and any discrepancies found.

3.2.5 Demonstrations

Provide a schedule, at least [2] [_____] weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

3.2.6 Certificates

Where the system, components, or equipment are specified to comply with requirements of AGA, NFPA, ARI, ASHRAE, ASME, or UL, proof of such compliance must be provided. The label or listing of the specified agency must be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above must be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

3.2.7 Operation and Maintenance Manuals

Provide [Six] [_____] complete copies of an operation manual in bound 216 by 279 mm 8 1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least [4] [_____] weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features. [Six] [_____] complete copies of maintenance manual in bound 216 by 279 8 1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.2.8 Connections to Existing Systems

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

[3.3 RELATED FIELD TESTING

3.3.1 Test Plans

a. Manufacturer's Test Plans: Within [120] [_____] calendar days after contract award, submit the following plans:

[(1) Packaged cooling tower - field acceptance test plan

][(2) Field-erected cooling tower - field acceptance test plan

] Field acceptance test plans must developed by the cooling tower manufacturer detailing recommended field test procedures for that particular type and size of equipment. Field acceptance test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment, will not be acceptable.

The Contracting Officer will review and approve the field acceptance test plan for each of the listed equipment prior to commencement of field testing of the equipment. The approved field acceptance test plans must be the plan and procedures followed for the field acceptance tests of the cooling towers and subsequent test reporting.

****

NOTE: **In the paragraph below, specification Section**

23 09 53.00 20, SPACE TEMPERATURE CONTROL SYSTEMS are for Navy projects only.
****

b. Coordinated testing: Indicate in each field acceptance test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of tower system controls which interlock and interface with controls for the equipment provided under [Section 23 09 53.00 20, SPACE TEMPERATURE CONTROL SYSTEMS] [Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [or] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

c. Prerequisite testing: Cooling towers for which performance testing is dependent upon the completion of the work covered by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC must have that work completed as a prerequisite to testing work under this section. Indicate in each field acceptance test plan when such prerequisite work is required.

d. Test procedure: Indicate in each field acceptance test plan each equipment manufacturers published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

    (1) Each test plan must include the required test reporting forms to be completed by the Contractor's testing representatives. Procedures must be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

    (2) Controllers must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

e. Performance variables: Each test plan must list performance variables that are required to be measured or tested as part of the field test.

    (1) Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Tower manufacturer must furnish with each test procedure a description of acceptable results that have been verified.

    (2) Tower manufacturer must identify the acceptable limits or tolerances within which each tested performance variable must acceptably operate.

f. Job specific: Each test plan must be job specific and must address the particular cooling towers and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.

g. Specialized components: Each test plan must include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

]3.4 TESTING

a. Each cooling tower system must be field acceptance tested in compliance with its approved field acceptance test plan and the resulting following field acceptance test report submitted for approval:

[(1) Packaged cooling tower - field acceptance test report

][(2) Field-erected cooling tower - field acceptance test report

] b. Manufacturer's recommended testing: Conduct the manufacturer's recommend field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field acceptance testing.

c. Operational test: Conduct a continuous 24 hour operational test for each item of equipment. Equipment shutdown before the test period is completed must result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every two hours. Use the test report forms for logging the operational variables.

d. Notice of tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.

e. Report forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment must be reviewed, approved, and signed by the Contractor's test director. The manufacturer's field test representative must review, approve, and sign the report of the manufacturer's recommended test. Signatures must be accompanied by the person's name typed.

f. Deficiency resolution: The test requirements acceptably met; deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations and corrections retested in order to verify compliance.

g. Towers with thermal performance not CTI certified to CTI Std-201 must have their thermal performance verified by field testing that meets the requirements of CTI ATC-105

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 69 00.00 20 (July 2006)**
Change 2 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-23 69 00.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

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REFRIGERATION EQUIPMENT FOR COLD STORAGE

07/06, CHG 2: 08/18

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USACE / NAVFAC / AFCEC **UFGS-23 69 00.00 20 (July 2006)**

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SECTION 23 69 00.00 20

REFRIGERATION EQUIPMENT FOR COLD STORAGE

07/06, CHG 2: 08/18

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NOTE: This guide specification covers the requirements for requirements for refrigeration equipment for cold storage facilities.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 420	(2008) Performance Rating of Forced-Circulation Free-Delivery Unit Coolers for Refrigeration
AHRI 450	(2007) Water-Cooled Refrigerant Condensers, Remote Type
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 270	(2008) Sound Rating of Outdoor Unitary Equipment
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers
ANSI/AHRI 520	(2004) Performance Rating of Positive Displacement Condensing Units

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 23.1	(2019) Methods for Performance Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units that

	Operate at Subcritical Temperatures of the Refrigerant

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D5864	(2011) Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components
ASTM D6081	(1998; R 2014) Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

COOLING TECHNOLOGY INSTITUTE (CTI)

CTI ATC-105	(2000) Acceptance Test Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC

NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1424	(2016) Engineering and Design -- Lubricants and Hydraulic Fluids

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-59223	(Basic; Notice 1) Cooling Towers, Liquid

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UL SOLUTIONS (UL)

UL 207	(2022) UL Standard for Safety Refrigerant-Containing Components and Accessories, Nonelectrical

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Refrigeration Equipment; G, [_____]

Atmospheric Cooling Equipment, including supporting members; G, [_____]

SD-03 Product Data

Unit Coolers; G, [_____]

Energy Star Label for Unit Cooler Product; S

[Compressor] [Condensing] Units; G, [_____]

Condensers; G, [_____]

Energy Star Label for Air-Cooled Condenser Product; S

Energy Star Label for Water-Cooled Condenser Product; S

Atmospheric Cooling Equipment; G, [_____]

Water Treatment System; G, [_____]

Automatic Controls; G, [_____]

Heat Recovery Devices; G, [_____]

Motors; G, [_____]

SD-06 Test Reports

Pressure Vessels; G, [_____]

Aquatic Toxicity

SD-07 Certificates

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Refrigeration Equipment; G, [_____]

Water Treatment System; G, [_____]

Include instruction for evacuation and charging procedures and equipment start-up and initial operation.

SD-10 Operation and Maintenance Data

Refrigeration Equipment, Data Package 3; G, [_____]

Automatic Controls, Data Package 3; G, [_____]

Motors, Data Package 3; G, [_____]

Motor Starters, Data Package 3; G, [_____]

Water Treatment System, Data Package 3; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 QUALITY ASSURANCE

1.3.1 Modifications of References

Accomplish work in accordance with the referenced publications, except as modified by this section. Consider the advisory or recommended provisions to be mandatory, as though the word "must" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to "the Authority having jurisdiction," "the Administrative Authority," "the Owner," or "the Design Engineer" to mean the Contracting Officer.

1.3.2 Safety

Design, manufacture, and installation of refrigeration equipment must conform to ANSI/ASHRAE 15 & 34, UL 207, and NFPA 70. Provide personnel protection from moving parts including fans, pulleys chains gears and couplings. Guard or cover with insulation high temperature machinery and piping.

1.3.3 Pressure Vessels

The design, fabrication, inspection, and testing of pressure vessels including the waterside and refrigerant side of condensers and evaporators must be in accordance with ASME BPVC SEC VIII D1, and ANSI/ASHRAE 15 & 34. The presence of the ASME official Code U-Symbol or Code UM-Symbol stamped or marked on the vessels, and the submitting of the applicable ASME required manufacturer's data report will be accepted as evidence that the pressure vessels comply to the ASME rules for construction. Where referenced publications do not apply, pressure components must be tested at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed. [Where service temperatures below minus 7 degrees C 20 degrees F are encountered, materials of construction must be low temperature alloy carbon steel.] Nozzle length must be approximately 1/3 greater than insulation thickness. Insulated vessels must be fitted with rings and other insulation supports as required for installation of insulation. Exterior surfaces of vessels which are insulated and vapor barrier sealed must be abrasive blasted and primed with 0.076 mm 3 mil dry film thickness of inorganic zinc rich coating.

1.3.4 Refrigeration Equipment

Include layout drawings and control diagrams of the refrigeration equipment.

1.3.5 Ozone Depleting Substances Technician Certification

****

NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants, such as R-123, into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

****

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4 REFRIGERATION PIPING AND ACCESSORIES

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

Provide as specified under [_____].

1.5 ENVIRONMENTAL REQUIREMENTS

Assess potential effects of all lubricants on aquatic organisms in accordance with ASTM D6081 and submit aquatic toxicity reports. Assess biodegradation in accordance with ASTM D5864. In accordance with EM 1110-2-1424 Chapter 8, aquatic toxicity must exceed 1,000 ppm at LL50 and biodegradation must exceed 60 percent conversion of carbon to carbon dioxide in 28 days.

PART 2 PRODUCTS

2.1 UNIT COOLERS

[Forced circulation] [Free delivery] type, factory fabricated, assembled and tested, and packaged in accordance with AHRI 420.

2.1.1 Construction

Construct casings of Type 300 Series stainless steel, aluminum, mill galvanized or hot-dip galvanized steel after fabrication. Provide zinc coated carbon steel with protective coating. Direct or V-belt drive fans of the propeller or centrifugal type. Statically and dynamically balance the fan wheels. Coils service must have copper tubes and aluminum fins. Provide water-tight, corrosion resistant drain pans. Drain pans and drainage piping for units in spaces maintained at less than 2 degrees C 35 degrees F must be insulated and fitted with means for defrosting and condensate removal.

2.1.2 Energy Performance

Size equipment based on Design Manual CS from the Air Conditioning Contractors of America; do not oversize. Equipment efficiency must meet the requirements of Energy Star. Provide proof of Energy Star label for unit cooler product.

2.1.3 Defrosting

Defrost units mounted in spaces maintained at 2 degrees C 35 degrees F or higher with ambient space air. Provide units mounted in spaces maintained at less than 2 degrees C 35 degrees F with [hot gas] [electric heat] defrosting system. Control room air defrosting by a timer defrost controller adjustable for up to 6 defrost cycles per 24 hours, each of 5 to 120 minutes duration. Defrost systems must be controlled by [timer] [demand] defrost controller.

2.1.3.1 Timer Defrost Controller

Controller must include an adjustable timer to control frequency of cycles; [defrost initiating thermostat;] adjustable program timer to control sequence of defrost cycle; [defrost terminating thermostat;] manual override switch; selector switch; and status pilot light.

2.1.3.2 Demand Defrost Controller

Controller must include an automatic, solid-state circuitry to initiate defrost cycle based on sensing adjustable temperature difference of air moving across coil in direct proportion to frost build-up; thermostat to terminate defrost; adjustable lockout to prevent initiation of defrost during pull-down after defrost cycle; manual override switch; and status pilot light.

2.2 [COMPRESSOR] [CONDENSING] UNITS

****

NOTE: HFC-134a refrigerant is non-ozone depleting, but contributes to global warming. HCFC-123 refrigerant is ozone-depleting (but much less so than R-11), and contributes minimally to global warming. EPA, per the Significant New Alternative Policy rule, reviews refrigerant substitutes on the basis of ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Lists of acceptable and unacceptable substitutes are updated several times each year. A chronological list of SNAP updates is available at http://www.epa.gov/ozone/snap/refrigerants/lists/index.html **or from the stratospheric ozone information hotline at 1 (800) 296-1996. Reducing ozone depletion and global warming potential by reducing or eliminating**

CFC, and reducing or eliminating HCFC and Halon use in air conditioning equipment contributes to achieving sustainability requirements.
****

Factory fabricated, assembled and tested, packaged, ready for full capacity operation after terminal point connection and field charging with operating fluids. Units must conform to ANSI/AHRI 520, ASHRAE 23.1, and ANSI/ASHRAE 15 & 34. Provide two charges of lubricating oil for each compressor. The first charge must be used during the operating test period, and at the end of this period must be withdrawn and replaced with the second charge. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0, with the exception of R-123. CFC-based refrigerants are prohibited. [HCFCs][and Halons]must not be permitted.[Use HFC-134a refrigerant.][Use HCFC-123 refrigerant.]

2.2.1 Capacity Criteria

****
NOTE: Show the capacity and saturated suction temperature, saturated condensing temperature, superheat, and subcooling on the drawings.
****

Application capacity rating shown must include suction superheat and liquid subcooling. Compressor design saturated condensing temperature and saturated suction temperature limits must not be exceeded.

2.2.2 Reciprocating Compressors

[Hermetic] [Open], [direct] [V-belt] drive reciprocating piston type, designed and constructed for indicated compression ratio service. [Design welded hermetic compressors for high compression ratio heat pump and low temperature refrigeration service.] Machine cylinder blocks and heads from aged, fine-grained, cast iron. [Provide ammonia service compressor cylinder blocks and heads with self-draining water- or refrigerant-cooled jackets where recommended by the manufacturer.] [Freeze-protect water jackets.] Forge crankshafts of steel or cast nodular iron. Dynamically balance rotating parts, including crankshaft and power transmission components. Design compressors to operate at partial loads without vibration greater than full load vibration and be capable of continuous operation at lowest partial load. Piston speed must not exceed manufacturer's recommendation or 4 1/2 m/s 875 fpm, whichever is lesser. Provide main journals and ferrous and bronze connecting rods with replaceable sleeve insert type, steel-backed, antifriction metal wear surface bearings, or antifriction bearings or a combination thereof. Aluminum connecting rod bearings must be integral or replaceable sleeve insert type. Provide bulls-eye type oil sight glass at crankcase operating level. Compressors with a rated input of 2 1/4 kW 3 horsepower and over must have forced-feed lubrication with reversible, self-priming, suction strainer fitted, direct crankshaft drive, positive-displacement pump. [Open compressor shaft seals must be oil lubricated and cooled rotary mechanical type with externally, individually, replaceable wearing components.] External drive motor enclosures must be [open drip-proof.] [totally enclosed.]

2.2.3 Helical Rotary Compressors

Provide positive displacement, oil-injected type, driven by an electric motor. Solid steel rotors, Society of Automotive Engineers Grade 1141 or 1144. Shaft main bearings must be either sleeve-design type with leaded bronze or steel-backed babbit; or frictionless bearing design, ball or roller type. Provide housings and covers of high-grade cast-iron pressure castings. Lubrication systems must lubricate rotors, bearings, shaft seal as well as rotor sealing and cooling. Provide an oil safety cutout interlocked with the compressor starter to allow compressor to operate only when the oil management system is operational. Provide for lubrication of bearings and shaft seals on shutdown with or without electric power supply.

2.2.4 Accessories

Unit accessories with 1 1/8 kW 1 1/2 horsepower and larger compressor must include suction, discharge and liquid gage ported shutoff valves, suction and discharge service valves, suction strainers, mufflers, crankcase heaters, and pressure relief. Provide double seated service valves with gage ports. Provide lube oil pressure gages and failure switches for forced-feed lubricated open and accessible hermetic compressors. Unless continuous heating is recommended by compressor manufacturer, crankcase heaters must function only when compressor is stopped.[Provide condensers with purge valves.][Where low ambient control incorporates condenser flooding, receiver must be sized as required.]

2.2.5 Capacity Controls

Compressors must start from rest unloaded.[Provide with start-stop control.] [Provide with capacity modulation.][Provide not less than [_____] capacity control steps.]

2.2.6 Condenser, Integral

Provide with [air-cooled] [water-cooled] condenser.[Open compressor unit rated through 2 1/4 kW 3 horsepower may utilize integrally cast blades of compressor flywheel or sheave as the air moving device supplemented by a propeller fan mounted on extended compressor drive motor shaft.][Provide condensers and compressors with manufacturer's standard direct-drive propeller fans which are elastomer mounted in combined, enclosing, guard or support.] Construct coils with separate subcooling circuit [and circuiting as indicated,] of copper tubing with aluminum fins. Test coils in accordance with ANSI/ASHRAE 15 & 34. Provide coils with sheet steel frame and venturi fan shroud.

2.2.7 Condenser, Water-Cooled, Integral

Provide cleanable tube-in-tube condenser with [copper] [70/30 copper-nickel] coolant wetted surfaces and coolant regulating valve. Base condenser rating on coolant fouling factor of [0.0005] [0.001].

2.2.8 Condenser-Receiver, Water-Cooled, Integral

****

NOTE: Normally 70/30 copper nickel performance is superior to 90/10 copper nickel in brackish and salt water. Where conditions are not detrimental to 90/10 copper nickel, incorporate same as an alternative acceptable material. Use the higher fouling factor for open systems.

****

Provide cleanable shell and tube condenser-receiver with [copper] [70/30 copper-nickel] tubes and coolant regulating valve. Base condenser rating on coolant fouling factor of [0.0005.] [0.001.]

2.2.9 Control Panels

****

NOTE: Verify that reverse-phase, and phase imbalance protection provisions are available in sizes under 70 kW 20 tons. Check with manufacturers before specifying other than across-the-line starting.

****

Control panels and electrical components must conform to NFPA 70,NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4 and NEMA ICS 6, and mounted in a NEMA ICS 6, Type 1 enclosure. Electrical controls must include [[fused] [unfused] disconnect;] control transformers with 50 percent excess capacity; main and branch circuit overload protective devices compensated for ambient temperatures as recommended by the manufacturer; reverse phase protection where necessary to preclude damage; single-phase and phase-imbalance protection; low voltage protection; manual reset on power interruption or safety shutdown; [power factor correction capacitors;] [status pilot lights;] compressor safety, operating and capacity controls; [defrost controls;] [local and remote audible and visual alarms with provisions to silence;] short cycling control with lock-out timer; time delay for sequenced compressor starts; remote component interface; and intercomponent wiring to terminal blocks with 10 spares. Provide stranded copper wire of required ampacity and insulation at encountered temperatures. Identify wires at terminal points.

2.2.10 Base Mounting

****

NOTE: Where condensing units or compressors are located on top of walk-in boxes, mount on spring vibration isolators. Weight of inertia block must be an engineered solution accommodating site conditions.

****

Mount compressors and components on a rigid, fabricated steel [base,] [rack,]. [Mount compressor assembly to the base on spring type vibration isolation mountings. Mount the base on the floor on elastomer pads.] [Mount assembly supporting base on [cantilevered, height reducing,] spring type vibration isolation mountings, selected to limit transmissibility of imbalanced forces at lowest equipment revolutions per minute to 5 percent.] [Mount assembly on concrete inertia block, fitted with cantilevered, height reducing, spring type vibration isolation mountings. Weight of concrete inertia block must be [2.0] [_____] times weight of supported assembly. Select spring mountings to limit transmissibility of imbalanced forces at lowest equipment revolutions per minute to 3 percent.] [Integral-to-unit pipe or tubing, and conduit connection to [control panel] [and] [building services] must be through service rated flexible connectors.]

2.3 CONDENSERS, AIR-COOLED

****

NOTE: Currently, lowest SRN ratings, in the order

of 16 or 17, occur in units rated under 19,045 kW 65 MBH. Largest "quiet" equipment ratings are in 19-20 range.

****

Factory fabricated and tested, packaged, self-contained and ready for full capacity operation after terminal point connections. Unit [must be manufacturer matched part of split system, and] must conform to ANSI/AHRI 460, ANSI/AHRI 210/240, and ANSI/AHRI 270. Unit must produce a Sound Rating Number (SRN) not greater than [16] [21] [_____].

2.3.1 Capacity Rating

Size the condenser for the capacity and conditions indicated. Do not oversize.

2.3.2 Energy Performance

Equipment efficiency must meet the requirements of Energy Star designated efficiency. Provide proof of Energy Star label for air-cooled condenser product.

2.3.3 Unit Casing

Construct casing of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Provide with lifting provisions, access panels, removable legs, [discharge hood,] and fan and heat rejection coil guards and screens.

2.3.4 Finishes

Equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings and subject to a salt atmosphere must have weather resistant finishes that will withstand 240 hours exposure to the salt spray test conducted in accordance with ASTM B117, using a 20 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no sign of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3.18 mm 1/8 inch on either side of the scratch mark.

2.3.5 Fans

2.3.5.1 Propeller Fans

Propeller type fans must be [direct] [V-belt] drive type with dynamically balanced, adjustable or fixed pitch, aluminum or corrosion protected steel blades. [V-belt drive wheels must be mounted on corrosion protected drive shaft supported by grease lubricated antifriction bearings with cast ferrous pillow block or extended housing.] Each wheel drive must be independent of any other wheel. Extended lubricant lines must be provided for maintenance access. Drive bearings must be protected with water slingers or shields.

2.3.5.2 Centrifugal Fans

[Forward curve] [Backward inclined] centrifugal scroll type fans must be provided with streamlined orifice inlet and V-belt drive, limited to three wheels mounted on a corrosion protected drive shaft. Wheels and housing must be fabricated from aluminum or galvanized steel. Wheels must be dynamically balanced. Fan shaft first critical speed must be not less than 25 percent greater than operating speed. Fan shaft must be mounted in grease lubricated antifriction bearings with cast ferrous pillow block housing. Extended lubricant lines must be provided for maintenance access.

2.3.5.3 Fan Drives

V-belt drives must be fitted with guards, [fixed pitch] [or] [adjustable pitch] sheaves.

2.3.6 Fan Motors

Motors less than 3/4 kW 1 hp must meet NEMA High Efficiency requirements in accordance with NEMA MG 1. Motors 3/4 kW 1 hp and larger must meet NEMA Premium Efficiency requirements in accordance with NEMA MG 1. Motors must be variable speed. Motor enclosures must be [open drip-proof] [totally enclosed] type. Motors and bearings must be protected by location or with water slingers or shields.

2.3.7 Refrigerant Circuit

Refrigerant containing components must comply with ANSI/ASHRAE 15 & 34, must be factory tested, cleaned, dehydrated, charged, and sealed. Each condenser coil connection must be fitted with a manual isolation valve of the ball type and an access valve on the coil side. Receiver must conform to ANSI/AHRI 495. [Receiver must be insulated with not less than 25 mm 1 inch thick, 100 percent adhesive bonded, vaportight, flexible, closed-cell elastomer and finished with two coats of solvent base PVC protective coating or 0.41 mm 0.016 inch thick aluminum jacket.]

2.3.8 Coils

Coils must be constructed of copper or aluminum tubing with permanently attached fins for thermally efficient contact. Indoor and outdoor coils must be matched and from same manufacturer. Use a low sensible heat ratio for more moisture removal. Casing must be galvanized steel or aluminum. [Coils for service in corrosive or salt laden atmosphere must be constructed of aluminum or with copper tubes and fins and galvanized end sheets.] [In addition, coils must be protected with baked-on, minimum 0.076 mm 3 mil thick, phenolic coating.] [Separate condenser circuit must be provided for each compressor complete with separate controls for each related fan.] [Unit must provide not less than [_____] degrees C degrees F subcooling.] Subcooling circuit must be liquid sealed. Condenser may be used for refrigerant storage in lieu of separate receiver, provided that storage capacity is 20 percent in excess of fully charged system. Where liquid flooding low ambient control is furnished, a separate receiver must be provided.

2.3.9 Low Ambient Condenser Controls

Unit must be capable of operating in ambient temperature of [_____] degrees C degrees F. Controls must permit proper operation of system with proper differential pressure across thermostatic expansion valve. Control system must be based on sensing of actual condensing pressure in conjunction with manufacturer's method of fan or damper control or by flooding the condenser. [Multifan units with power operated fan discharge dampers, must include gravity dampers.] [Electric damper operator torque must be at least 2.0 times required torque.] [Air volume control is not acceptable for ambient conditions below 2 degrees C 35 degrees F.] Controls must be set to produce a minimum 21 degrees C 70 degrees F saturated refrigerant condensing temperature.

2.3.10 Control Panels

Unit mounted control panels must be housed in NEMA ICS 6, Type 1 or 3A enclosures. Controls must include [control transformer,] [fan motor [contactor] [starters],] [solid-state speed control,] overload protective devices, interface with local and remote components, miscellaneous electric devices, and intercomponent wiring to terminal block points.

2.4 CONDENSERS, WATER-COOLED

Condenser must be [remote mounted] [and] [integral to water-cooled condensing unit] and must conform to AHRI 450.

2.4.1 Capacity Criteria

Ratings must be in Btuh heat rejection for AHRI 450 Group [1] [3] conditions, and for application at indicated design conditions. Ratings must be based on [0.0005] [0.001] cooling water side fouling factor at design velocity. Coolant side pressure drop at design condition flow and fouling factor must not exceed that indicated and must be based on tube-side velocities of not less than 1.07 nor greater than 2.44 m/s 3.5 nor greater than 8 fps. When condenser is used for refrigerant storage during pumpdown, system charge must be held within 80 percent of unit volume and storage capacity must be stated. [Condensers must be designed for coolant side working pressure of not less than [690] [1034] kPa (gage) [100] [150] psig, refrigerant side working pressure of not less than 2068 kPa (gage) 300 psig.] A portion of entering coolant must be in heat transfer contact with liquid refrigerant to provide [_____] degrees C degrees F subcooling. Do not oversize equipment.

2.4.2 Energy Performance

****

NOTE: UFC 1-200-02 requires new buildings to use 30 percent less energy than the ASHRAE 90.1 - SI ASHRAE 90.1 - IP baseline level.

****

Equipment efficiency must meet the requirements of Energy Star designated efficiency. Provide proof of Energy Star label for water-cooled condenser product.

2.4.3 Shell and Tube Type

Condensers must be of the shell and tube type with the coolant in the tubes. The design pressure drop must govern the number of passes. Condenser heads must have pipe connections which permit access to or removal of the tubes. Materials of construction must be suitable for the service in which used. Condensers must conform to AHRI 450, with safety provisions conforming to ANSI/ASHRAE 15 & 34. Where coolant may be subject to freezing, condensers must be gravity drainable and must be fitted with automatic drain and vent valves.

2.4.4 Coolant Control

Control valves must be [automatic, self-contained, controlled by condensing pressure, and must close bubble-tight when compressor is not operating.] [modulating three-way mixing type, controlled by pressure controller.] [Atmospheric cooling equipment must be deenergized at indicated set point.] Control must be set for a saturated refrigerant condensing temperature of 21 degrees C 70 degrees F.

2.5 ATMOSPHERIC COOLING EQUIPMENT

[Cooling tower] [Evaporative water cooler] [Evaporative condenser] must be [induced] [or] [forced] mechanical draft, [vertical] [horizontal] discharge [parallel-flow] [counter-flow] [or] [cross-flow] type of fire-resistant construction. Cooling equipment must be factory fabricated, assembled and tested. [Cooling tower must conform to requirements of CID A-A-59223, except as modified hereinafter.]

2.5.1 Design and Performance Requirements

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NOTE: When 53 m/s 10,500 fpm velocity is exceeded, noise may become a significant factor. Low tip speeds may or may not increase size of cooling tower. Consider probability of chemically-treated high-dissolved-solids drift loss causing damage to adjacent structures and environment (trees, shrubs, etc.).

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The requirements of CTI ATC-105 must be the basis of establishing unit capacity and performance. Unit capacity must include a site recirculation factor. Performance wind velocity must be 8 km 5 miles per hour. Drift loss must not exceed 0.1 percent of unit circulation rate. Minimum unit design wind load must be [146 kg per square meter] [30 pounds per square foot] [_____]. [Minimum design fan deck live load must be [195 kg per square meter] [40 pounds per square foot] [_____].] Fan tip speed must not exceed [53 mps] [10,500 feet per minute][_____]. Design and construction of steel members must conform to AISC 360 and AISI SG03-3.

2.5.2 Materials of Construction

Metallic materials of construction must be mill galvanized or hot-dip galvanized after fabrication. Plastics must have an ASTM E84 flame spread rating of 25 or less, except as otherwise specified.

2.5.3 Framework and Casing

Structure must withstand maximum stresses imposed. Panel joints must drain to interior. Seals, fasteners, and flashing must be provided to preclude external to unit water leakage. [Discharge cylinder height must be not less than [_____] mm inches above fan deck.]

2.5.4 Inlets and Louvers

Louver material must be of thickness, configuration and support span to prevent flutter or sagging under loads imposed during operation. Inlet must be fitted with square mesh galvanized hardware cloth with minimum 80 percent open area.

2.5.5 Distribution System

Hot-water distribution system must be [open basin] [or] [pressurized spray nozzle] type. [Open basin must be designed to permit surge water flow 40 percent greater than specified flow without overflow of basin. Basin must be fitted with removable cover.] System must be self-draining and nonclogging. [Means to isolate and balance flow to each section of unit must be provided.]

2.5.5.1 Pumps

Pump casing must be designed to withstand discharge head indicated, plus static head on system, plus 50 percent of the total, but not less than 862 kPa (gage) 125 psig. Motor must not be overloaded with pump operating at any point on its characteristic curve, and must have [open drip-proof] [totally enclosed] enclosure. Pump speed must not exceed [1800] [3600] revolutions per minute. Pumps must be [horizontal split-case] [end-suction vertical split-case] [close-coupled in-line] centrifugal type. Casing and bearing housings must be cast ferrous metal. Casing must be fitted with manual air vents and drain plugs. [Suction and discharge must be provided with pressure gage taps.] Shaft seal must be mechanical type. Impeller and trim must be bronze. Shaft must be stainless steel or carbon steel sleeved with stainless steel. Bearings must be sealed, grease lubricated, antifriction type. Pump must be accessible for servicing without disturbing piping connections. [Pump and motor must be mounted on a common cast iron or fabricated structural steel base having lipped edges and tapped drainage openings.] [Pump must be provided with elastomer-in-shear type shaft coupling with guard.] [Close-coupled pumps must be provided with drip pockets and tapped openings.] Pump rotating assembly must be dynamically balanced.

2.5.6 Heat Exchangers

[Evaporative condenser coil must comply with ANSI/ASHRAE 15 & 34]. Coils must be completely drainable [serpentine] [or] [straight length, individually cleanable] type. Coil tubes and headers must be [seamless deoxidized copper] [or] [electric resistance welded, hot rolled, mill scale free, carbon steel tube and header, externally hot-dip galvanized after fabrication to provide not less than 0.70 kg of zinc per square meter 2.3 ounces of zinc per square foot of single side surfaces]. [Coil tubes must be Schedule 40 carbon steel, internally cleaned to remove mill scale and particulate and externally hot-dip galvanized after fabrication to provide not less than 0.70 kg of zinc per square meter 2.3 ounces of zinc per square foot of single side surfaces.] [[Split-] [Multi] [circuit]] [desuperheater] [subcooling] [refrigerant and jacket cooling water] coils must be provided as indicated. [Refrigerant subcooling circuit must produce [_____] degrees C degrees F of subcooling.] Refrigerant receiver must conform to requirements of ANSI/AHRI 495. [Receiver insulation must be not less than 25 mm 1 inch thick, 100 percent adhesive bonded, flexible, closed-cell elastomer, and finished with two coats of solvent base PVC protective coating.] [Copper coils must) be dielectrically isolated.] Header connections must be fitted with [thermometer wells,] [pressure gage taps,] and [manual] [automatic] vent connections. Heat exchanger must be pressure and temperature rated and tested to the same fluid service standards and codes as connecting external piping.

2.5.7 Fill

Fill for cooling tower must be minimum [0.38 mm 15 mil thick corrugated or molded PVC plastic] [0.48 mm 19 mil thick chloroprene bound asbestos sheet], in honeycomb or wave form, impregnated with melamine or chlorinated rubber, having an ASTM E84 flame spread rating of 5 or less. Fill must be supported to prevent sagging or misalignment.

2.5.8 Eliminators

Metal eliminators must be not less than 24 gage steel. Nonmetallic eliminators must conform to requirements specified for fill.

2.5.9 Cold Water Basin and Accessories

Basin must be constructed of steel [, and must be sized for dry-basin operation] [, and must be sized to have sufficient water capacity and free-board to prevent [pump cavitation,] air-entrainment and to accommodate run-back without overflow]. Basin assembly must be water-tight. [Multiple basins must operate as one basin with common water level and must be complete with interconnecting piping.] Basin outlet screen must be constructed of galvanized, 13 mm 1/2 inch square mesh hardware cloth, reinforcement, and framing. Basin must be fitted with overflow and valved drain. [Manufacturer's standard modulating float-controlled makeup valve must be provided.] [A nonmodulating, pilot actuated, float-controlled, diaphragm type makeup valve must be provided where a water meter is indicated or specified in the makeup supply line.] Makeup must discharge 50 mm 2 inches or two pipe diameters, whichever is greater, above maximum attainable basin water level during overflow condition, or as required to preclude backflow. A drainable 20 mm 3/4 inch hose bib connection must be provided with a vandalproof vacuum breaker for makeup line mounting. [Basin must be fitted with indicated heaters.]

2.5.10 Access and Safety Provisions

Unit must be fitted with access provisions as indicated to facilitate inspection, maintenance and replacement of components. Guard screens must be provided at unducted fan inlets and far discharge. Guards must be provided for moving power transmission components.

2.5.11 Fans and Drives

[Induced draft counter-flow and cross-flow cooling tower fans must be propeller type and drive must be [gear type with motor out of wet airstream] [or] [belt type with motor [in] [out of] wet airstream].] [Induced draft evaporative [water cooler] [condenser] fans must be propeller type and drive must be [gear] [belt] type with motor out of wet airstream.] [Forced draft fans must be propeller or centrifugal type, with multiple V-belt drive and motor out of wet airstream.]

2.5.11.1 Propeller Fans

Must be airfoil section type with fixed or adjustable pitch blades fabricated from solid aluminum alloy, except fans sized 1220 mm 48 inches and under may be manufacturer's standard. Fixed pitch fans combined with gear drives are not acceptable. Adjustable pitch fans, with pitch set at or near maximum pitch, combined with gear drives, are not acceptable. Fans must be statically or dynamically balanced to limit imbalance forces on drive shaft.

2.5.11.2 Centrifugal Fans

Must be forward curve, double-inlet, drainable scroll type with streamlined inlets, constructed of galvanized or stainless sheet steel or aluminum. Fan shaft must be corrosion protected. Bearings must be double-shielded, grease lubricated, self-aligning, ball or roller, cast iron (split-bolted), pillow block housed, antifriction type. Sleeve bearings may be used in conjunction with one or more antifriction bearings at locations other than drive-end. Sleeve bearings must be oil-lubricated, grooved, cast iron housed, antifriction metal liner type, with an effective length at least two times shaft diameter. Fan wheel assembly must be dynamically balanced. Lubrication of bearings must be safely accomplished while unit is operating. Oil lubricated sleeve bearings must be fitted with reservoir.

2.5.11.3 Gear Drive Speed Reducer

Must have a service factor of not less than 1.5 and must be reversible. Oil level, vent and drain lines must be nonferrous metal, vibration isolated, and extended to maintenance access points. Nonlubricated, dynamically balanced, floating shaft and couplings must be provided. Construction must be stainless steel or corrosion protected metals.

2.5.11.4 Fan Shafts

Wet service belt drive fan shaft must be supported by drip and splash protected, grease lubricated, split-bolted, pillow block antifriction bearings. Lubrication provisions must include automatic grease relief to visible point and grease supply fittings extended to permit lubrication under operating conditions. Belt drive must be [reversible,] one-piece, integral-back, multiple-groove type, constructed of synthetic fabric or fiber reinforced neoprene.

2.5.11.5 Motors

Motors less than 3/4 kW 1 hp must meet NEMA High Efficiency requirements in accordance with NEMA MG 1. Motors 3/4 kW 1 hp and larger must meet NEMA Premium Efficiency requirements in accordance with NEMA MG 1. Motors must be variable speed. Enclosure must be totally enclosed, [single] [two] speed, [nonreversing] [reversing] type, fitted with 120 volt a.c. resistance heaters. [Reversing starters must be fitted with adjustable time delay deceleration relays.] Manufacturer's standard, adjustable set point, manual reset type vibration cut-out switch must provide to deenergize fans upon excessive vibration.

2.5.12 Vibration Isolation

Unit must be vibration isolated from supporting structure by mountings which limit imbalanced force transmissibility to [5] [_____] percent at lowest equipment revolutions per minute.

2.5.13 Corrosion Protection

Galvanize cast and wrought ferrous metal in accordance with [ASTM A123/A123M] [ASTM A653/A653M]. Sheared edges must receive additional corrosion protection of a zinc rich coating. Other steel items specified to be galvanized must be coated in accordance with ASTM A153/A153M.

2.5.14 Capacity Control

Unit must be fitted with [modulating manual] [vortex] [inlet] [internal bypass] [and discharge] damper controls [in addition to [on-off] [fan] [and] [pump] [cycling] [and] [fan motor speed control]]. Dampers must be constructed of aluminum or galvanized, steel and fitted in such a manner as to preclude freeze-up, mechanical binding or corrosion. Dampers must be fitted with a non-lubricated damper shaft bearings; corrosion resistant damper shaft journals and pivots; pre-lubricated, antifriction, ball type adjustable linkage; [NEMA Type 4 limit switches;] [waterproof electric operator torque must be not less than 2.0 times required torque;] and temperature sensing control system with output controlling damper position.

2.6 AUTOMATIC CONTROLS

Temperatures in the refrigerated rooms must be regulated by room thermostats and electric solenoid valves in the refrigerant supply piping to the evaporators. Compressors for each system must operate on suction pressure switches, functioning in such a manner as to cut in and cut out compressors as the suction pressure rises above or falls below predetermined operating conditions. Provide a multiple step controller for multiple compressor units in a single system.

2.6.1 Temperature Control Cabinets

Provide the necessary controllers, relays, clocks, alarms, and temperature gages in or on the face of control cabinets for each system. Construct cabinets of steel or aluminum with hinged door and lock. Provide temperature gages, pressure switches and pilot lights flush on the cabinet door. Provide controllers and relays in the interior of the cabinet on a steel or aluminum subpanel which must also act as the back of the cabinet. Electrical controls must be prewired to numbered screw type terminal strips. Cabinets must be [floor-mounted free-standing type] [or] [integral with refrigeration compressor unit control panels].

2.6.2 Safety Cutout Switches

Provide automatic high pressure, low oil level, and compressor overload safety cutout switches for each compressor. The switches must be located in the condensing unit control panel. The cutout switches must automatically stop the respective compressors and simultaneously ring an alarm bell whenever the pressure within the condenser rises above the predetermined safe point.

2.6.3 Thermostats

Must be of a lock shield type suitable for operation in connection with its respective solenoid valve. The thermostats must maintain the temperature of the refrigerated rooms within a maximum range of plus or minus one degrees C 2 degrees F. The thermostats must be of the adjustable type, with gas filled tube. The thermostats must have temperature range of minus 34 degrees C to plus 10 degrees C 30 degrees F to plus 50 degrees F. Thermostats must be mounted adjacent to interior door, unless otherwise indicated.

2.6.4 Controllers

2.6.4.1 Differential Pressure

Controller must be provided with high and low pressure sensing ports and must be direct or reverse acting with calibrated proportional band and set point adjustments. Controller output must be [low voltage electric] [pneumatic] [4-20 mA dc], proportional to the pressure differential sensed. Local and remote set point adjustments must be included. Range must be as required to meet system requirements.

2.6.4.2 Differential Temperature

Controller must be provided with two filled, remote sensing bulbs connected to the controller by [armored] capillary tubing. Controller must be direct or reverse acting with calibrated proportional band and set point adjustments. Controller output must be [low voltage electric] [pneumatic] [4-20 mA dc], proportional to the temperature differential sensed. Provisions for local and remote set point adjustments must be included. Range must be as required to meet system requirements. For immersion service, thermal wells must be provided.

2.6.5 Pilot Lights

Panel mounted pilot lights must be NEMA Class 12 oil-tight, push-to-test transformer type for 6-8 Vac lamps. Lamps must be replaceable by removal of color cap. Caps color must be as indicated.

2.6.6 Programmer, Demand Control/Load

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NOTE: Before application of energy management systems/load shedders to refrigeration systems, and related fans and pumps, the designer must ascertain that application will not be conducive to equipment damage and counterproductive. Safety trips, compressor slugging, freeze-ups and reloading of circuits may occur.

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Programmer must be fully automatic, fail safe, field programmable, solid-state, demand control and load programming for [_____] [16] loads. Demand control portion must monitor power consumption by [watt] [or] [current] transducers. Set point must be field adjustable with adjustable dead band. Load shedding sequence time and differential time between load shedding must be adjustable. Contacts must store alarm condition. Meter readout must indicate demand deviation from set point. Load profile recorder must be strip chart type with readily discernable event record. Load programmer must permit programming of on/off time of each load for any time element within a week and must equalize power demand over a preset time cycle. System must include input override and time cycle accelerator for checkout. Alarm condition, status of loads and time period must be visually indicated and recorded. Each load must include a H-O-A toggle switch. Alarm provisions must include relay contacts for external, remote alarm functions and test provisions. Override [thermostat] [pressure switch] [timer] must be provided to restore shedded loads indicated. Control panel enclosure must be NEMA ICS 6, Type 1, surface mounted type with key lock. Load profile recorder must be [surface] [flush panel] mounted type. Load relays must be plug-in type with critical load failure in "on" mode and contacts rated for pilot duty at 120 volt a.c. Load shedding position switches must shed loads on a first shed/last restore basis and remove loads from system logic for shedding cycle. Time clock must be fitted with spring motor to maintain time in event of power failure.

2.6.7 Switches, Fluid Service

Switches must be field adjustable SPDT type and must have NEMA ICS 6, Type 1 enclosure with operating range specified or indicated. Circuits must be as required for the applicable functions.

a. Provide air flow switches with a service pressure range of 30 to 2940 Pa 0.12 to 10 inches water gage.

b. Provide water flow switches with a body rating suitable for the service, field adjustable activating flow rate, and a pressure drop not in excess of 13.8 kPa 2 pounds per square inch at maximum flow rate.

c. Pressure switches must be factory set, one or two stage as indicated, with adjustable operating and differential pressure. Bourdon tube inlet must be fitted with damper screw adjustment.

d. Differential pressure switches must be factory set, provided with high and low sensing ports, one or two stages and adjustable differential range and pressure.

e. Temperature switches must be factory set, provided with [armored] capillary tubing and filled sensing system, one or two stages as indicated, and operating adjustable differential range. For immersion service, thermal wells must be provided.

f. Differential temperature switch must be factory set, provided with two separate, [armored] capillary systems, one or two stages, and adjustable differential range and temperature. For immersion service, thermal wells must be provided.

2.6.8 Push-Button Stations

Stations must be NEMA Class 12 oil-tight, momentary or maintained contact type, as indicated. Start-push-buttons must have a fully guarded or flush black operator button. Stop-push-buttons must have an unguarded or extended red operator button.

2.6.9 Selector

Switches must be NEMA Class 12 oil-tight, momentary or maintained contact type, as indicated, with standard operator.

2.7 HEAT RECOVERY DEVICES

Water heater must be double-wall, tube-within-tube heat exchanger type, complete with thermostatic control. [Heater must be provided with [refrigerant compressor head pressure control] [and] [interlocked, potable water circulating pump].] [Cabinet must be fabricated of zinc protected steel and must be internally insulated in coil space.] Heat exchanger coil must consist of an external refrigerant containing carbon steel tube and an internal, double-wall-in-metallic contact, convoluted, potable water containing copper tube. [Pump and motor assembly must be close-coupled, manufacturer's standard type with indicated head and capacity characteristics, and with brass, bronze, copper or stainless steel wetted parts.] Pump must be [remotely mounted and] rated for [115] [208] [230] volt a.c. power supply. [Heat exchanger must be sized to extract not more than [_____] [25] percent [of the superheated portion] of the total rated condenser load.]

2.8 MOTORS

Provide continuous duty rated motors conforming to NEMA MG 1. Unless otherwise specified, motor synchronous speed must be 1800 rpm. Motors less than 3/4 kW 1 hp must meet NEMA High Efficiency requirements. Motors 3/4 kW 1 hp and larger must meet NEMA Premium Efficiency requirements. Motors must be variable speed. Refrigeration compressor motors must comply with compressor manufacturer's recommendations. Rate motors with nameplate power less than 3/8 kW 1/2 hp for 115 volts, single-phase, 60 Hz power supply. Rate motors with nameplate power 3/8 kW 1/2 hp and greater as indicated. Extended voltage motors nameplated 208-230 and rated for 187-253 volts are not acceptable. Provide NEMA Class B insulated polyphase motors, normal torque and starting current, Design B, squirrel-cage induction type, except as otherwise specified. Provide Nema Design Class C when high starting torque is required. [Provide [one] [two] -winding type two-speed polyphase motors.] Nameplate for polyphase motors must include efficiency index letter. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide [open drip-proof] [totally enclosed] [explosion-proof] motor enclosures. Polyphase motor bearings must be double-shielded, grease lubricated, antifriction type with provisions for radial and thrust loads as imposed by application duty. Provide bearings with grease supply fitting and grease relief to outside of enclosure. Single phase motor bearings must be as specified for polyphase motors, except manufacturer's standard prelubricated, sealed cartridge types are acceptable. Provide [across-the-line magnetic] [reduced voltage] type motor starters conforming to NEMA ICS 1 and NEMA ICS 2.

2.9 POWER TRANSMISSION COMPONENTS

Fan and open compressor drives must be [direct] [and] [V-belt] type as specified or indicated. Provide drives in accordance with the manufacturer's published recommendations, except as otherwise specified. Base horsepower rating of V-belt drives on maximum pitch diameter of sheaves. Provide compressors with fixed sheaves and drives with a minimum service factor of [1.5] [2.0]. Drives with motors rated up to and including 7 1/2 kW 10 horsepower must be classical belt section, adjustable sheave type, with a service factor of not less than 1.5. Drives with motors rated over 7 1/2 kW 10 horsepower [up to and including 22 3/8 kW 30 horsepower,] must be classical section, adjustable sheave type with a service factor of not less than 1.5. Where the number of unit starts exceeds 8 per 24 hours, add 0.1 to the required drive service factor. Provide statically and dynamically balanced sheaves, machined ferrous metal, bushing type, secured by key and keyway. Pitch diameter of fixed pitch sheaves and adjustable sheaves, when adjusted to specific limits, must be not less than that recommended by NEMA MG 1. Select adjustable sheaves to provide the required operating speed with the sheave set at mid-point of its adjustment range. The adjustment range for various size and type belts must be 16 percent minimum for classical section belts and 12 percent minimum for narrow section belts. Provide belt drive motors with slide rail or equivalent adjustable motor bases. Provide manufacturer's standard direct drive couplings for motors rated less than 2 1/4 kW 3 horsepower. For 2 1/4 kW 3 horsepower and greater, direct drive couplings must be elastomer-in-shear type.

2.10 ALARM SYSTEM

Provide both audible alarms and trouble lights to indicate when an abnormal condition exists in each room. Locate pushbuttons inside each room and adjacent to door. Alarm bell must be located outside of each refrigerated room and adjacent to door. Each refrigerant room having electric defrost must be provided with a defrost compensator which must deenergize the abnormal condition alarm system during the defrost cycle; these devices must be coordinated with defrost time clock on the respective compressors. Systems must detect a temperature rise above the designated temperature or actuation of entrapment pushbutton and must energize an alarm lamp and horn at cooler local alarm panel.

2.10.1 Refrigeration Alarm System

Provide an electrically supervised refrigeration alarm system. Operation of any high-temperature alarm devices must cause an alarm to register as follows:

a. Lamp and horn at local alarm panel

b. Annunciator panel must light up and identify which cooler is malfunctioning

c. Alarm bell must ring

2.10.2 Refrigeration Local Alarm Panel

Provide local alarm panel adjacent to refrigerator. Alarm panel must include alarm lamp, "power on" lamp, alarm test switch, reset switch, an alarm line supervisory meter, alarm silencing switch, high temperature alarm device entrapment manual switch, alarm horn, and required relays. System must normally work off 120 volts a.c. and transfer automatically to 24 volt d.c. operation in the event of power failure. The d.c. power must be from rechargeable batteries and operate the system for a minimum of 24 hours in supervisory condition and 15 minutes in alarm condition. The power supply must be capable of fully recharging the batteries (as well as powering the system) within 36 hours.

2.10.3 Annunciator Panel

Provide an electrically supervised annunciator panel. Provide the panel adjacent to local alarm panel. Cover must be such as to prevent tampering and yet allow full viewing of annunciator lamps and zone identification lettering. Detector loops must be electrically supervised by the remote alarm panel. Panels must be equipped with terminals for all necessary wiring. Annunciator panel must be so connected to detection panel so that zone lights must be battery-powered in case of electrical failure.

2.10.4 High Temperature Alarm Device

Each refrigerated room must have a high temperature alarm device of the remote bulb type with minimum 1 1/2 meters 5 feet of capillary. Temperature range must be minus 34 degrees C to plus 10 degrees C 30 degrees F to plus 50 degrees F, with adjustable differential of not less than 2 to 5 degrees C 4 to 10 degrees F.

2.11 COOLING TOWER WATER TREATMENT SYSTEM

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NOTE: If the activity has a cooling water treatment contract in effect, ensure that the system specified is compatible with it.

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Must automatically feed chemicals, and bleed system water to prevent scale, corrosion, and biological growths. The system must include chemical feed pump, tank, bleed-off solenoid valve, electric impulse water meter, electric timer, and conductivity controller. Provide a polyethylene tank and injection valve assembly for each feed pump.

2.11.1 Feed Pumps

Must be positive displacement type with an adjustable capacity and discharge pressure not less than 1.5 times the line pressure at the point of connection. Provide with pressure relief valve, and check valve mounted in the pump discharge.

2.11.2 Tanks

Construct of high density polyethylene, cylindrical in shape, and with a hinged cover. The tank must have sufficient capacity to require recharging only once per 7 days during normal operation. Provide tank with a valved cold water line and, if necessary, a valved hot water fill line with suitable air gap. Provide tank with device to indicate quantity of solution in the tank. Provide electric mixing device with tank.

2.11.3 Valve Injection Assembly

Provide for each feed pump. Construct of bronze or material suitable for chemicals being used and install in condenser water line common to all pumps. Injection fitting must have male pipe threads. Each assembly must include a shut-off valve and a check valve installed close to condenser water line.

2.11.4 Bleed-off Solenoid Valve

Provide in bleed-off line. Valve must normally be in closed position and be opened by a 120 volt waterproof solenoid coil. Connect bleed-off line to condenser water line and include a gate valve ahead of solenoid valve. Extend a discharge line from solenoid valve to sewer drain.

2.11.5 Water Meter

Provide with electric contacting register, and remote accumulative counter and installed in make-up water line near cooling tower. Meter must be standard product used in water treatment.

2.11.6 Timers

Must be automatic reset, adjustable type, and electrically operated. House in metal NEMA type cabinet with a hinged front. Timer must be suitable for 120 volt current.

2.11.7 Conductivity Controller

Controller must measure the total dissolved solids in system water by conductivity. The conductivity sensor must consist of epoxy insulated carbon electrodes and must not require platinizing. Controller must have a meter with a visual readout, set point adjustment with a range between 200 micromhos/cm and 4000 micromhos/cm and a red pilot light indicating water conductivity above set point. Unit must operate from a 120 volt power source.

2.11.8 Control Panel

Provide a factory-wired, NEMA 12, control panel for each system. Construct of steel with hinged door and lock, and suitable for surface mounting. Pre-wire controls to numbered terminal strips. Provide laminated plastic nameplates identifying the switch function. Include the following with the panel:

a. Main power switch and indicating lamp

b. MAN-OFF-AUTO selector switch

c. Indicating lamp for bleed-off valve

d. 120 Volt, heavy-duty, grounded duplex receptacle

e. Conductivity controller

f. Electric timer

g. Accumulative counter

2.11.9 Sequence of Operation

2.11.9.1 Conductivity Controller

Must open the bleed-off solenoid valve when the conductivity of the cooling water rises above the set point of the controller. When the conductivity falls below the set-point, the valve must close.

2.11.9.2 Water Meter

Must start the timer after a pre-set volume of make water has been measured.

2.11.9.3 Timer

Must turn the feed pumps on for a pre-set amount of time.

2.11.10 Piping

Provide plastic piping and fittings conforming to ASTM D2996 for water treatment system. Piping for feed pump suction must contain a foot valve and strainer.

2.11.11 Chemicals

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NOTE: Select the applicable paragraphs from the following:

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[Provide sufficient chemicals to initially place system in service and make tests.] [Provide same chemicals used for treatment at station's other towers.]

2.11.11.1 Water Analysis

Description	[_____]
Silica (Si02)	[_____]
Insoluble	[_____]
Iron and Aluminum Oxides	[_____]
Calcium (Ca	[_____]
Magnesium (Mg)	[_____]
Sodium and Potassium (Na and K)	[_____]
Carbonate (C03)	[_____]
Bicarbonate (HC03)	[_____]
Sulfate (S04	[_____]
Chloride (C1)	[_____]
Nitrate (N03)	[_____]
Turbidity	[_____]
pH	[_____]
Residual Chlorine	[_____]
Total Alkalinity	[_____]
Noncarbonate Hardness	[_____]
Total Hardness	[_____]
Dissolve Solids	[_____]
Fluorine	[_____]

[Furnish water analysis and provide sufficient chemicals to initially place system in service and make tests prior to start up and acceptance by Government. [Provide same chemicals used for treatment at station's other towers.]]

PART 3 EXECUTION

3.1 INSTALLATION

Installation procedures must conform to ANSI/ASHRAE 15 & 34 and the manufacturer's instructions. Set floor mounted equipment on 150 mm 6 inches thick concrete housekeeping pads, complete with anchor bolts and grouting. Finish housekeeping pads with two coats of oil-resistant epoxy polyamid coating. No drilling, cutting, burning, or welding of structural parts of building will be permitted. Provide access panels for concealed valves, vent controls, and control devices and items requiring periodic operation, inspection, or maintenance. Access panels must be of sufficient size and so located that concealed items may be serviced and maintained or removed and replaced. Refrigerant safety relief devices must have discharge piped to building exterior. Interlock compressor operation with the water pump starters, so that the compressors cannot operate unless the pumps are operating.

3.2 MANUFACTURER'S FIELD SERVICES

Furnish manufacturer's representatives who are directly employed by the equipment manufacturers and trained to perform the services specified. The manufacturers representatives must furnish advice and services on the following matters:

a. Erection, alignment, testing and dehydrating

b. Charging equipment with refrigerant and oil

c. Starting equipment and training Government personnel as to its proper care, operation, and maintenance.

3.3 LOCATIONS AND CLEARANCES

Equipment must be located so that working space is available for necessary servicing such as shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead lines.

3.4 IDENTIFICATION TAGS AND PLATES

Provide equipment with tags numbered and stamped for their use. Plates and tags must be brass or nonferrous material. Minimum letter and numeral sizes must be 3.18 mm 1/8 inch high.

3.5 OPERATION AND MAINTENANCE MANUALS

Submit six copies of operating instructions outlining the step-by-step procedures required for system start-up, operation and shutdown. The instructions must include the manufacturer's name, model number, service manual, parts list, and a brief description of equipment and their basic operating features. Submit 6 copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides. The instructions must include simplified wiring diagrams. Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, must be posted where directed. Condensed operating instructions explaining preventative maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, must be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Proposed diagrams, instructions, and other sheets, must be submitted prior to posting. The framed instructions, including wiring and control diagrams, must be posted before acceptance testing of the systems.

3.6 INSTRUCTIONS TO GOVERNMENT PERSONNEL

Contractor must conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total [_____] hours of normal working time and must start after the system is functionally completed but prior to final acceptance tests. The field instructions must cover the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.7 TESTS

Perform the tests and provide everything required. Notify the Contracting Officer, in writing, 10 days before performing tests. Tests must be performed in the presence of a manufacturer's representative.

3.7.1 Initial Start-Up and Operational Test

Provide chemicals and place water treatment systems in operation before initial start-up. Equipment must be started and operated. Follow the manufacturer's procedures and place the systems under all modes of operation. Initial charges of lubricating oil must be supplemented to assure maximum operating capacity. Safety and automatic control instruments must be adjusted. Record manufacturer's recommended readings hourly. Operational tests must cover a period of not less than [_____] days.

3.7.2 Test Reports

Submit the final test report for each system tested, describing test apparatus, instrumentation calculations, and equipment data based on industry standard forms or reasonable facsimiles thereof. Data must include: compressor suction and discharge pressure; refrigerant charge pump, compressor and air moving device ampere readings; power supply characteristics, including phase imbalance, with 1/2 percent accuracy; thermostatic expansion valve superheat-value as determined by field test; subcooling; high and low refrigerant temperature switch set-points; low oil pressure switch set-point; [defrost system timer and thermostat set-points;] moisture content; ambient, condensing and coolant temperatures; capacity control set-points; field data and adjustments which affect unit performance and energy consumption. Where final adjustments and settings cannot be permanently marked or drilled and pinned as an integral part of device, adjustment and setting data must be included in test report.

3.8 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Thermostat Temp-Range	= minus 30 to 50 degrees F	= minus 34 to 10 degrees C
b. Motors Capacity	= 1/2 hp	= 3/8 kW
	= 10 hp	= 7 1/2 kW
	= 30 hp	= 22 3/8 kW
	= 3 hp	= 2 1/4 kW

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 71 19 (May 2018)**

Preparing Activity: USACE **Superseding**
UFGS-23 71 19 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 71 19

THERMAL ENERGY STORAGE SYSTEM: ICE-ON-COIL

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 71 19 (May 2018)**

Preparing Activity: USACE **Superseding**
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SECTION 23 71 19

THERMAL ENERGY STORAGE SYSTEM: ICE-ON-COIL

05/18

****

NOTE: This guide specification covers the requirement for ice-on-coil type thermal energy storage systems, including the system refrigeration, controls, piping and electrical work.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The use of this specification will be coordinated with other sections as appropriate in order to specify a complete thermal energy storage system. These other sections include UFGS 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC; UFGS 23 64 10 WATER CHILLERS, VAPRO COMPRESSION TYPE; UFGS 01 91 00.15 , BUILDING COMMISSIONING. The designer should be familiar with ASHRAE's Design Guide for Cool Thermal Storage and AHRI Guideline T before preparing the design. Note that this is tailored for ice-on-coil systems. This specification will be a document that develops further based on the needs of our customers and

changing technology.

****

1.1 MODIFICATION OF REFERENCES

In each of the publications referred to herein, interpret references to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 150	(2019) Method of Testing the Performance of Cool Storage Systems
ASHRAE HVAC APP IP HDBK	(2023) HVAC Applications Handbook, I-P Edition
ASHRAE HVAC APP SI HDBK	(2023) HVAC Applications Handbook, SI Edition

ASTM INTERNATIONAL (ASTM)

ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Quantity and submission requirements for Operation and Maintenance Data are identified in Section 01 33 00 for Navy projects. Select bracketed quantity and submission requirements for Operation and Maintenance Data for Army projects only.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Graphic layouts for dashboards; G, [_____]

Controls sequence of operation; G, [_____]

Point-to-point wiring diagrams; G, [_____]

Installation Drawings; G, [_____]

Table C1; G, [_____]

Table C2; G, [_____]

Table 1; G, [_____]

SD-03 Product Data

Equipment and Installation; G, [_____]

Test Procedures; G, [_____]

Field Acceptance Test Procedures; G, [_____]

System Diagrams; G, [_____]

Manufacturer's Representative; G, [_____]

Testing, Adjusting, and Balancing; G, [_____]

Field Training; G, [_____]

Control Valves; G, [_____]

Sensors; G, [_____]

Motors; G, [_____]

Integral disconnects; G, [_____]

Paint; G, [_____]

Glycol; G, [_____]

Glycol management system; G, [_____]

Ice Inventory System; G, [_____]

Controls; G, [_____]

Ice Storage Units; G, [_____]

Liquid Chillers; G, [_____]

SD-06 Test Reports

System Performance Tests Report; G, [_____]

SD-07 Certificates

Installation Drawings; G, [_____]

SD-10 Operation and Maintenance Data

Thermal Energy Storage System; G, [_____]

Training Schedule and Content; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Manufacturer's Representative

Perform the Performance testing work specified in this section under the supervision of and certified by the Manufacturer's Representative. Provide certification for installation drawings, test procedures, and test results. The Manufacturer's Representative must have no less than 3 continuous years of experience directly involved in the design and installation of thermal energy storage systems, and must have served in similar capacity on no fewer than five projects of similar size and scope during that period. Submit the following:

a. A letter from the system manufacturer, at least 2 weeks prior to the start of work, listing the experience and training of the Manufacturer's Representative.

b. Installation Drawings consisting of equipment layout including assembly and installation details and electrical connection diagrams; layout and installation details of thermal storage units including support structure, thermal storage system circulation pumps, distribution manifolds and all piping, including support structure for system piping and points of connection to storage units and to piping specified in related sections, controls sequence of operation, point-to-point wiring diagrams, graphic layouts for dashboards and schematic controls diagram. Include on the drawings any information required to demonstrate that the system has been coordinated and will function properly within the HVAC system, and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Concurrent with installation drawings, submit manufacturer's certification of installation drawings.

c. Proposed field acceptance test procedures for performance tests of systems, at least 2 weeks prior to the start of related testing.

1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.5 EXTRA MATERIALS

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment. In addition, furnish a two year supply of all spare parts required for system operation.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a closed circuit, single source Thermal Energy Storage System designed and assembled by a manufacturer located in the United States and regularly engaged in the manufacturing of systems that are of a similar design, workmanship, capacity, and operation. The system must be installed by the system manufacturer or a service organization certified by the system manufacturer. The manufacturer is responsible for the selection and full integration of the major components of the thermal energy storage system. The major components of the thermal energy storage system include ice storage units, liquid chillers, and system controls. Systems of similar design and capacity must have been in satisfactory commercial [or industrial] use for 3 years before bid opening. The 3 years must be satisfactorily completed by a system which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Systems having less than a 3-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

2.2 EQUIPMENT

2.2.1 Nameplates

Provide a nameplate on all equipment that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.2.2 Equipment Guards and Access

****

NOTE: Catwalks, ladders, and guardrails may be required. If so, select the applicable item and indicate on drawings. If not applicable, delete the entire last sentence.

****

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Provide guards or cover high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard with insulation of a type specified. The requirements for catwalks, operating platforms, ladders, and guardrails are specified in Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS]

2.3 SYSTEM OPERATION CHARACTERISTICS

****

NOTE: Designers will include all energy efficient applications that optimize the complete thermal storage system, and are technically feasible and life cycle cost effective. The installation's capability to operate and maintain proposed systems will be a primary consideration in the life cycle cost analyses. Possible energy saving measures include cool storage with provisions for heat reclamation for preheating domestic hot water, or, in instances where both heating and cooling are required during the heating season, rejected heat from the cool storage system can be used to offset heating loads.

Ice on coil internal melt systems are typically used on HVAC applications such as administrative buildings, schools, day care facilities, and stores where cooling requirements are relatively constant over a minimum 6 hour period and operating control systems need to be simple. Ice-on-coil external melt systems are typically used on applications such as process cooling where cooling requirements change rapidly and for short on-peak demand periods of 2 to 6 hours. External melt systems require more complex controls and air agitation pumps.

****

Provide a system of the [internal][or][external] melt ice-on-coil storage system type as described in the ASHRAE HVAC APP SI HDBK ASHRAE HVAC APP IP HDBK chapter on Thermal Storage. Base the system performance on operation with a glycol solution (type and concentration) that is recommended by both the refrigeration system manufacturer and the storage system manufacturer to meet the system capacity profile at the specified design conditions. Design all system components that are in contact with glycol solution for use with the solution.

2.3.1 Refrigeration System

****

NOTE: Section 23 64 10 WATER CHILLERS, VAPOR COMPRESSION TYPE must be specifically tailored to fit the needs of the type of storage system specified. Designer should obtain detailed efficiency data for water chillers at design operating conditions to specify minimum energy performance standards for the chiller. Typically air-cooled chillers are used for this application. A table, such as the one below, should be filled in and located with the chiller specification to specify minimum efficiency.

CHILLER DESIGNATION	**MODE**	
	ICE BUILD MODE	**ICE MELT MODE**
Evaporator Fluid Type		
Evaporator Fluid Concentration percentage		
Efficiently (EER)		
Integrated Part Load Value (IPLV) EER		**N/A**
Non-Standard Part Load Value (NPLV) EER	**N/A**	
Evaporator Leaving Temperature (Degrees C) (Degrees F)		
Evaporator Entering Temperature (Degrees C) (Degrees F)		

CHILLER DESIGNATION	**MODE**	
	ICE BUILD MODE	**ICE MELT MODE**
Evaporator Flow Rate (L/sec) (GPM)		
Ambient Temperature (Degrees C) (Degrees F)		

****

In addition to meeting the capacity requirements specified herein and on the drawings, the refrigeration system must be as specified in Section 23 64 10 WATER CHILLERS, VAPOR COMPRESSION TYPE.

2.3.2 Designer Specified Application Rate

****

NOTE: Designer of Record to complete Table C1 and C2. These tables come from AHRI Guideline T

****

Table C1. Specification Information			
Discharge Fluid used to define the following design data			
	Supply Temperature to Load at peak conditions, T1, Degrees C F		
	Return Temperature from Load at peak conditions, T2, Degrees C F		
	Flow rate to Load at peak conditions, L/sec gpm		
	Maximum allowable pressure drop through storage device, kPa psi		
System Schematic (shown on drawings)			
Charge Fluid			
Maximum time and minimum temperature available to charge Thermal Storage Device from fully discharged condition (Initial Charge Cycle), h and Degrees C F			
*Design Heat Sink Rejection Temperature Degrees C F			
* denotes optional data for this table			

Table C2. User-specified Data

Hour	Thermal Storage System Load kW Tons	*Supply Temp to Load, T1, Degrees C F	*Return Temp from Load, T2, Degrees C F	*Flow Rate to Load, L/s gpm	*Heat Sink Rejection Temp (Wet-Bulb or Dry-Bulb), Degrees C F	Thermal Storage Refrigeration Equipment Use during this hour (Charge / Partial Cooling / Off
0-1						
1-2						
2-3						
3-4						
4-5						
5-6						
6-7						
7-8						
8-9						
9-10						
10-11						
11-12						
12-13						
13-14						
14-15						
15-16						
16-17						
17-18						
18-19						
19-20						
20-21						

Table C2. User-specified Data

Hour	Thermal Storage System Load kW Tons	*Supply Temp to Load, T1, Degrees C F	*Return Temp from Load, T2, Degrees C F	*Flow Rate to Load, L/s gpm	*Heat Sink Rejection Temp (Wet-Bulb or Dry-Bulb), Degrees C F	Thermal Storage Refrigeration Equipment Use during this hour (Charge / Partial Cooling / Off
0-1						
21-22						
22-23						
23-0						
Totals						

* denotes optional data for this table

2.3.3 System Capacity Profile

****

NOTE: It is critical that the hourly design day requirements listed below be adequate to meet anticipated loads, otherwise unwanted consequences such as uncomfortable conditions, insufficient cooling for critical functions, or the use of refrigeration equipment during periods that increase demand charges could occur. The system capacity should typically be optimized with respect to the installation electrical demand rather than that of the building for which the system is being installed.

The designer should coordinate with the customer as to which demand profile (installation or building) should be used to determine system operation. Note that the design conditions for the refrigeration system should be determined in accordance with the ASHRAE HVAC APP SI HDBK ASHRAE HVAC APP IP HDBK chapter on Thermal Storage. The design conditions in most cases should not be less than 1 percent dry bulb temperature and the 1 percent wet bulb temperature for cooling towers, otherwise the 1 percent mean coincident wet bulb temperature.

****

The system manufacturer must provide the data in Table 1 below at the design day conditions listed for the refrigeration system. The system must meet both system performance and minimum scheduled equipment capacities to meet the design requirements.[Factory system capacity test results from proto-type testing must be provided that demonstrate that system performance meets or exceeds these requirements. The manufacturer must provide calculations with the factory system capacity test that demonstrate compliance with the system profile when installed as proposed at the specified design conditions.] Include the following ambient load losses where applicable: maximum solar heat gain, heat gains from soil, and equipment room temperatures of 5.5 degrees C 10 degrees F above the refrigeration system design dry bulb temperature.

Design Day ([_____]DB Degrees C F / [_____]WB Degrees C F)	
Net Usable Storage Capacity: [_____] kWh Ton-Hours (Total Column D)	
Heat Transfer Fluid: [_____]	
Specific Gravity: [_____] @ [_____] Degrees C F	Hours to Recharge from Fully Discharged Condition: [_____] hours
Specific Heat Calorie/gm/Degrees C Btu/lb/Degrees F [_____]: @ [_____] Degrees C F	Hours to Recharge on Design Day: [_____] hours

Table 1. Thermal Energy Storage System Data

Hour	A Thermal Storage System Load kW tons	B Refrigeration Equipment Load kW tons	C Storage Device Charge Rate kW tons	D Storage Device Discharge Rate1 kW tons	E Parasitic and Accessory Heat Load into Storage Device kW tons	F Ambient Heat Load into Storage Device kW tons
0-1						
1-2						
2-3						
3-4						
4-5						
5-6						
6-7						
7-8						
8-9						
9-10						
10-11						

Table 1. Thermal Energy Storage System Data

11-12						
12-13						
13-14						
14-15						
15-16						
16-17						
17-18						
18-19						
19-20						
20-21						
21-22						
22-23						
23-0						
Totals						
Notes:						
1.	Greater Discharge Rates may not be possible at defined discharge temperature (T4).					
2.	Totals for Column B must be greater than or equal to the sum of totals for Columns A, E and F.					

Table 1. Thermal Energy Storage System Data (continued)

Hour	G Net Storage Inventory2 kW-hour ton-hours	H Supply Temperature to Load, T1 Degrees C F	I Return Temperature from Load, T2 Degrees C F	J Flow Rate to Load L/s gpm	K Fluid Temperature Entering Storage Device T3 Degrees C F	L Fluid Temperature Leaving Storage Device T4 Degrees C F
0-1						
1-2						

Table 1. Thermal Energy Storage System Data (continued)

2-3						
3-4						
4-5						
5-6						
6-7						
7-8						
8-9						
9-10						
10-11						
11-12						
12-13						
13-14						
14-15						
15-16						
16-17						
17-18						
18-19						
19-20						
20-21						
21-22						
22-23						
23-0						
Totals						
Notes:						
3.	Net Storage Inventory values are not available for instantaneous discharge.					
4.	The values in Column I must always be less than maximum temperature defined on the "User-Specified Data" Sheet.					

Table 1. Thermal Energy Storage System Data (continued)

Hour	M Flow Rate through Storage Device L/s gpm	N Pressure Drop for Service Device kPa psi	O Storage Device Refrigeration Energy Input, kWh (electric chiller) or kWh kBtu (gas-fired chiller)	P Saturated Suction Temperature5 Degrees C F	Q Storage Device Parasitics Electrical Input
0-1					
1-2					
2-3					
3-4					
4-5					
5-6					
6-7					
7-8					
8-9					
9-10					
10-11					
11-12					
12-13					
13-14					
14-15					
15-16					
16-17					
17-18					
18-19					
19-20					

Table 1. Thermal Energy Storage System Data (continued)

20-21					
21-22					
22-23					
23-0					
Totals					
Notes:					
5.	Applicable where refrigerant is the charge fluid.				

2.4 CONTROLS

****

NOTE: The sequence of control for the thermal energy storage system should be shown on the drawings in text as a performance sequence so that the system manufacturer's standard controls can be used. The designer should investigate the requirement for connection of the thermal storage system to the installation's Utility Monitoring Control System (UMCS).

****

Coordinate and integrate controls for the thermal energy storage system with the refrigeration system controls package specified in Section 23 64 10 WATER CHILLERS, VAPOR COMPRESSION TYPE. Design thermal energy storage system in accordance with the manufacturer's recommendations and to comply with the sequence of controls indicated. Design controls, control strategies, storage system configuration, piping, sensors and all ancillary equipment to ensure that the system performs as specified during partial, peak, and intermittent loading.

The controls for the thermal energy storage system must continuously measure the ice inventory of storage unit and relay this to the refrigeration controls package.

a. The controls must relay an alarm when; (a) any chiller fails to switch to the operating mode specified in the system capacity profile at any hourly interval; or (b) the total ice inventory falls [20][_____] percent below the latent cooling storage specified in the system capacity profile at any hourly interval.

b. The controls must relay alarm and initiate system shutdown when the total ice inventory falls below [40][_____] percent below the latent cooling storage specified in the system capacity profile at any hourly interval.

2.4.1 Communicating System Controller

A fully programmed [LonWorks] [BACnet] compatible communicating system controller must be furnished by the thermal energy storage manufacturer to provide completely integrated control of the thermal storage system for 24 hour system performance.

a. Provide digital application controllers capable of advanced preprogrammed functions with all memory and clock backed up for minimum 72 hours without data loss. Interface with chiller microprocessor to provide lead-lag operation and partial loading as required to meet hourly load profile for the building.

b. Provide graphical software that shows all equipment, temperatures and system modes/status. Provide software for automatic, schedule based, and manual operator control system. System must include preprogrammed control sequences, operator graphics reports, and drawings. Preprogrammed sequences must include one chiller, no heat exchanger; two chillers, no heat exchanger; one chiller with heat exchanger and two distribution pumps; and two chillers with heat exchanger and two distribution pumps.

c. System must include the following control functions: system scheduling; at least six modes of operation including off; chiller only - single and multiple chillers; ice only; chiller and ice; make ice; and make ice and cool.

d. Control system must have system mode determination; chiller plan demand limiting; ice inventory system management; chilled fluid system control; chiller/ice sequencing and control; color graphic based chiller and plant status screens; system and chiller diagnostic messages; system and chiller reporting; [and] failure modes and recovery; [heat exchanger sequencing and control;] [and pump control for water loops].

e. System must automatically switch between full ice storage mode on cool days, partial storage ice priority on warm days, and partial storage chiller priority on hot humid days as required to maintain indoor design temperature and relative humidity.

f. Graphical dashboards must indicate real time kW tons capacity, KW usage by chillers and pumps, ice inventory and melt rate.

g. System must have logging and trending capability to monitor various control points, status points, setpoints, and monitoring points.

2.4.2 Custom Color Graphics

Provide all information to show custom color graphics of all system components and schematic piping with temperature, pressure and diagnostics and status. Graphics include, but are not limited to:

2.4.2.1 System Schematic

Include temperature, setpoints, valve positions, tank status and ice inventory, key system operating parameters and hot links to other graphics pages.

2.4.2.2 Trends and Gauges

Dashboard style graphical representation of chiller, tank and system temperatures with override hot links, gauges showing instantaneous real time load on chiller, tanks, and building, with links to 7-day history

2.4.2.3 Savings Summary

Graphs showing kW demand, and kW usage savings, including present day, month to date and year to date.

2.4.2.4 Mode Chart

Printable matrix indication of modes as described above and position/status of pumps, chillers, and valves, with present values indicated and with present operating mode highlighted.

2.4.2.5 Strategic Data

Recap of thermal storage performance, including tons and kW, KWh and dollar savings, with hot links to the following trend logs and graphs. Take data at 15 minute intervals:

a. Building load

b. Chiller load

c. Ice inventory

d. Ice melt rate

e. Ice freeze cycle

f. Ice tank status

g. Chiller kW

h. End of day ice charge

i. kW shifted

2.5 ICE STORAGE UNITS

****

NOTE: The number and size of storage units should be based on the size of the load, the sequence of operations, the space available for storage units, and any reliability requirements that are applicable. The designer should identify the space available for installation and maintenance of storage units and necessary auxiliaries on the drawings.

Tanks specified below are constructed of plastic and have a capacity range of [_____] kWh 50 to 500 ton hours each. These can be manifolded together to increase capacity. These are internal melt type storage units.

****

Each ice storage unit must have a net usable capacity of [____] kWh ton-hours. Design the ice storage tanks for a minimum 25 year service life and construct solely of corrosion-resistant materials, consisting basically of a cylindrical container, spiral tubular heat exchanger and supply and return headers. Each tank must have factory rated and published charge and discharge performance curves. The tanks must be suitable as standard for [installation above ground] [partially buried as shown in partially buried specifications] [fully buried as shown in fully buried specifications] and must produce a floor loading of no more than [____] kg/m2 pounds per square foot.

Each tank must be capable of being individually isolated from the thermal storage system so that each may be serviced without interrupting the operation of the total system. Provide factory rated and published charge and discharge performance curves for each tank that clearly indicate usable ton-hours of storage at the system design temperatures shown in the plans and specifications. Show usable kWh ton-hours on these curves and submit with the submittal package. Average charging ethylene glycol temperature (average over ice making hours) and final charging temperature must meet minimum scheduled performance as listed.

[2.5.1 Polyethylene Ice Storage Unit

2.5.1.1 Tank Container

Provide a cylindrical container constructed of polyethylene with an average thickness of 9.5 mm 3/8 inch and a minimum ultimate strength of 18,000 kPa 2600 psi in accordance with ASTM D638. The tank must be able to withstand total freezing of the water within it through repeated cycles without damage. Insulate the bottom and sides of the tank with a minimum R-factor of [9] [_____] and insulate the top with a minimum R-factor of [16] [_____]. Standby losses must not exceed 1 percent of the total stored capacity over an 29 Degrees C 85 Degrees F day. Cover the sides of the tank with 0.8 mm 0.032 inch textured aluminum sheet; weighing no more than 113 kg 250 pounds, with smoothed edges or handles for easy and safe gripping. Design tanks to withstand, without damage or distortion, repeated cycles of total freezing of all water within it due to control malfunctions or ambient temperatures for warranty period. Warrant the tank container for a period of 10 years.

2.5.1.2 Tank Heat Exchanger

Provide tank of welded polyethylene construction. The tank must contain a spiral-wound, mat-type heat exchanger consisting of polyethylene tubing arranged in multiple parallel circuits with opposite direction of flow in adjoining tubes. The heat exchanger must be capable of operating up to a 620 kPa 90 psi maximum pressure and have a minimum burst pressure rated for 4 times the maximum operating pressure. Factory hydrostatically pressure test each ice tank heat exchanger and its associated piping to a minimum of 1724 kPa 250 psi after tank insertion, not prior.

][2.5.2 Steel Ice Storage Unit

****

NOTE: Steel tanks are used for larger capacity thermal storage systems. They are available in either internal melt (primarily for HVAC applications) or external melt systems (primarily for process applications)

****

The ice storage units must be modular in design. Unit design must allow units of different sizes to be installed in order to optimize unit selection and minimize space requirements. Assure internal piping arrangements that create a balanced flow due to uniform pressure drop through the coil circuits allow mixed tank sizes.

2.5.2.1 Tank Container

Construct the tank of heavy-gauge galvanized steel panels and include double brake flanges for structural strength. Provide the tank walls with a minimum of 114 mm 4-1/2 inches of insulation that provides a total insulating value of R-18. Utilize multiple liners: the primary liner, which forms the interior of the unit, must be of single piece construction and be suitable for low temperature applications; the secondary liner/vapor barrier must be separated from the primary liner by 38 mm 1-1/2 inches of extruded polystyrene insulation. Insulate the tank bottom must be insulated with 50 mm 2 inches of expanded polystyrene insulation and 25 mm 1 inch of extruded polystyrene insulation.

Provide the ice storage unit with watertight, sectional covers constructed of hot-dip galvanized steel. Insulate the covers with a minimum of 50 mm 2 inches of expanded polystyrene insulation.

2.5.2.2 Tank Heat Exchanger

Contained within the tank must be a steel heat exchanger that is constructed of 27 mm 1.05 inch O.D., all prime surface serpentine steel tubing encased in a steel framework. Pneumatically test the coil, which is hot-dip galvanized after fabrication, at 1310 kPa 190 psig and rated for 1034 kPa 150 psig operating pressure. Configure the coil circuits to provide maximum storage capacity. Provide the galvanized steel coil connections on the unit that are grooved for mechanical coupling.

2.5.2.3 Sight Tube

Provide each ice storage unit with a sight tube. Fabricate the sight tube from clear plastic pipe to display the tank water level and corresponding ice inventory.

]2.6 PIPING COMPONENTS

Provide piping components as specified in Sections 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS and 23 23 00 REFRIGERANT PIPING. Provide all heat tracing tape required for inventory meters, site glasses, and connections.

2.7 ELECTRICAL WORK

****

NOTE: Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm on the drawings in the equipment schedules.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable

speed drives (SD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.
****

Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and in accordance with NFPA 70. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

a. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11

b. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.

c. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

d. [Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW (10 hp) or less and adjustable frequency drives for larger motors.][Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.]

2.8 FACTORY FINISH SYSTEM

Coat new equipment with a manufacturer's factory-applied finish that meets the following requirements:

a. The [factory paint system] [galvanized metal] finish system designed for the equipment must have been tested in accordance with Federal Test Method Standard No. 141 (Method 6061) and passed the 125-hour salt-spray fog test of that standard, except that equipment located outdoors must have passed the 500-hour salt-spray fog test of that standard. [Equipment located in a sea coast environment must withstand 3,000 hours in a salt-spray fog test.]

b. The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the successful test specimens.

c. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for the temperature service.

2.9 GLYCOL

Provide a fully formulated, inhibited ethylene, or propylene glycol-based, industrial heat transfer fluid specifically designed for use in HVAC and ice storage systems. The fluid must contain a complete package of corrosion inhibitors, buffers (reserve alkalinity), antifoam agent to lessen pitting and erosion, and a fluorescent dye to help detect leaks.

[2.10 GLYCOL TO WATER PLATE AND FRAME HEAT EXCHANGER

****

NOTE: Choose either this option or the next subpart option.

****

Provide heat exchanger consisting of embossed (pressed) plates with V-shaped herringbone pattern. Build the exchanger for design operating pressure, temperatures, capacities and fluids. Heat exchanger must be produced and supplied by thermal energy storage system manufacturer. The heat exchanger construction must consist of a frame, plate pack, fixed head, moveable follower, carrying bar, guiding bar, support column and tightening bolts. Construct plates of cold formed 316 stainless steel. Gaskets must be single piece molded design of Nitrile Rubber (NBR), EPDM or Viton. Glue gaskets to keep gasket in place during opening and closing. Arrange the plates and gaskets to ensure that the fluids do not intermix and any leaks are to the outside of the heat exchanger.

][2.11 GLYCOL MANAGEMENT SYSTEM

****

NOTE: Choose either this option or the previous subpart option.

****

Glycol management system must pressurize system to maintain proper volume of liquid in the building circulating loop, monitor the system pressure, and add fluid from a reservoir to the system when the pressure drops below the set point. The liquid pressurization system must be factory engineered and tested as a complete unit. Provide a unit approved for outdoor use using a TEFC pump motor and hot-dipped galvanized frame. Include a minimum 225 L 60 gallon covered, vented, reservoir with 30 L 10 gallon graduations. Provide system with an adjustable pressure relief valve which protects against accidental over-pressurization by the management system; and a check valve between building and filling system along with a service valve between reservoir and pump. Provide alarms with both visual indicating lights and remote contact points indicating the following conditions: low system pressure, low liquid level in reservoir, high liquid level, loss of power and low solution level. The minimum pumping capacity must be 0.2 L per second 3 gallons per minute at 550 kPa 80 psig.

]2.12 ICE INVENTORY METER

Provide an ice inventory meter to measure the quantity of ice in the thermal storage tank and provide both a visual indication and an electronic signal (4-20mA) suitable for remote monitoring. The inventory meter must consist of a weather resistant control box, air pump, tank probe and twin tubing. Supply [115V] [230V] power to the control box and draw less than one amp. Provide meter with an analog magnehelic type visual indicator factory calibrated at 0 to 100 percent and the 4-20mA signal must also be factory adjusted to the same range. Avoid requiring field adjustment of the analog meter or electronic transducer. Mount and position the measurement probe (air supply tube) in a thermal storage tank cover in accordance with manufacturer's instructions.[Provide special adaptors as required for buried thermal storage tank.] Include factory supplied twin tubing to connect it to tank probe. Instrument must be accurate to within plus or minus 5 percent and provide data required to determine remaining ice inventory. Do not use the instrument to indicate full charge for the purpose of terminating the ice building process.

2.13 SOURCE QUALITY CONTROL

Submit test reports for the factory tests in booklet form, upon completion of testing. Document all phases of tests performed including initial test summary, all corrections and adjustments made, and final test results.

PART 3 EXECUTION

3.1 INSTALLATION

Installed as indicated and according to the manufacturer's system diagrams and recommendations, including space required for maintenance. Submit proposed diagrams, at least 2 weeks prior to start of related testing and as specified.

3.1.1 Piping

Install piping as specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS. Arrange piping for easy dismantling to permit tube cleaning.

3.1.2 Equipment and Installation

****

NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Pertinent portions of Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

****

Install all equipment within the space allotted on the drawings. Include adequate space in the layout to accommodate the maintenance requirements as recommended by the manufacturer. Set floor-mounted equipment, unless otherwise indicated, on not less than 150 mm 6 inch thick concrete pads or curbs doweled in place. Concrete foundations for equipment must be heavy enough to minimize the intensity of the vibrations transmitted to attached piping, equipment, or the surrounding structure, as recommended by the equipment manufacturer. In lieu of a concrete pad foundation, a concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. The concrete foundation or concrete pedestal block must be of a mass not less than three times the weight of the components to be supported.

a. Provide piping connections to equipment mounted on pedestal blocks and piping connections to storage units with flexible connectors. Furnish foundation drawings, bolt setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations.

b. Provide concrete for all foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. [In addition, install tanks, compressors, pumps, valves, heat exchangers, and other similar items as specified under [Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT,] [23 05 48.19 SEISMIC BRACING FOR HVZC,] [and as shown on the drawings].]

c. Provide structural steel required for reinforcement to properly support piping, headers, and equipment but not shown under this section. Material used for support must be as specified under Section 05 21 00 STEEL JOIST FRAMING. The method of anchoring and fastening must be in accordance with manufacturer's instructions unless otherwise indicated.

d. Submit proposed test procedures for performance tests of systems, at least 2 weeks prior to the start of related testing.

e. Submit manufacturer's catalog data included with the detail drawings for the following items. Highlight the data to show model, size, options, etc., that are intended for consideration. Provide adequate data to demonstrate compliance with contract requirements for the following:

    (1) Controls.

    (2) Storage Units (including heat exchanger).

    (3) Maximum charge and discharge rates and latent cooling capacity of each unit.

    (4) Type of glycol recommended for use by both the refrigeration system and the storage system manufacturers. Provide information that lists the latent storage capacity. Highlight the recommended concentration of glycol for optimal performance based on the system capacity profile at the specified design conditions.

f. Protect units on site from physical damage. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

g. Level and support tank bottoms over the entire area and insulate from their supporting surface with insulation supplied by the tank manufacturer. Set non-plastic tanks on pressure treated Douglas Fir sleepers. Metal tank manufacturers must provide a factory applied mastic coating for corrosion protection.[

****

NOTE: Include following paragraph for burying of corrosion resistant ice storage units with covers exposed above ground level.

****

h. Only tanks that are certified by manufacturer as being designed for partial below ground installation are allowed. Install tanks in accordance with manufacturer's instructions.

(1) Place tanks in the bottom of a pit on a level placed concrete pad base which has a minimum load bearing capacity required by the manufacturer. Construct the pit so that no water will accumulate above the bottom of the base. Backfill with sand.

(2) After the concrete pad has set, the tanks can be lowered into the pit using a crane, rigging planks and straps. Fill the tanks with water to a height just covering the top of the heat exchanger tube in accordance with manufacturer's installation manual, then backfill with sand. The sand must be put into the pit in a uniform fashion, never creating more than a 300 mm 1 foot difference in the sand level in any portion of the pit. Install headers and then pipe them to the rest of the system.][

****

NOTE: Include following paragraph for burying of corrosion resistant ice storage units totally buried below ground level.

****

i. Only tanks that are certified by manufacturer as being designed for full below ground installation are allowed. Install tanks in accordance with manufacturer's instructions.

(1) Place tanks in the bottom of a pit on a level placed concrete pad base which has a minimum load bearing capacity required by the manufacturer. Construct the pit so that no water will accumulate above the bottom of the base. Backfill with sand.

(2) Place no more than [_____] mm inches of fill on top of the tank covers. Backfill with sand up to the tops of the tanks. Install an inspection port pipe extension on each tank for checking the water level in the tank. [Provide a special inspection port extension for an ice inventory meter internally housing the meter's insertion probe.]This extension can also be used to check the depth of backfill above the tank.

(3) After the concrete pad is set, the tanks can be lowered into the pit using a crane, rigging planks and straps. Fill the tanks with water to a height just covering the top of the heat exchanger tube in accordance with the manufacturer's installation manual; then backfill the pit with sand. Place the sand into the pit in a uniform fashion, never creating more than a 300 mm 1 foot difference in the sand level in any portion of the pit. Install headers and then pipe them to the rest of the system.

(4) Charge the system with glycol/water mixture. Before burying the headers, run the system for a week at normal operating pressure with no loss of heat transfer fluid. After no loss is detected, insulate and cover the headers with sand flush to the tops of the pipes. Install inspection port extension pipes and then apply sand on top of the tank covers enough to just cover them. Fill final [_____] mm inches with [wood chips] [top soil]. Make the area above the tanks inaccessible to heavy equipment or wheeled vehicles that could damage tanks.]

3.1.3 Access Panels

Provide access panels for all concealed valves, vents, controls, and items requiring inspection or maintenance. Make access panels of sufficient size and locate so that the concealed items may be serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.1.4 Insulation

Unless otherwise specified, provide thickness and application of insulation materials for piping and equipment according to Section 23 07 00THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.5 Special Requirements

Install the manufacturer's special requirements and recommendations, including field-applied insulation and vapor barriers, storage tank installation, distribution and air agitation system, clearances, materials, appurtenances, and all other necessary features to provide a complete and operational thermal storage system.

3.2 FIELD PAINTING

Finish paint items only primed at the factory or surfaces not specifically noted otherwise as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 CLEANING AND ADJUSTING

Wipe equipment clean, with all traces of oil, dust, dirt, or paint spots removed. Maintain the system in this clean condition until final acceptance. Lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions.

3.4 GLYCOL SYSTEM FILL

Install, clean, test and drain the piping system in accordance with good industry practice. Isolate the thermal storage tanks from the system during all cleaning and flushing prior to the final fill. Have sufficient new, empty drums at the job site to accommodate any overage of the fluid.

3.4.1 Fill for Flush

Measure the volume of the initial fill for flush with a water meter. The next to last drain must be an all low points drain. Meter the last fill for flush. Use high quality water, such as deionized, distilled or municipal water with less than 100 ppm calcium carbonate hardness and less than 50 ppm chloride plus sulfate ions.

Compare the water volume of the initial fill for flush with the water volume of the final fill for flush. Forward these two volume figures to the manufacturer's representative for the heat transfer fluid. Also, inform the manufacturer's representative if the storage tanks have been filled with water. Concentrated heat transfer fluid is required to adjust for the volume of water in the storage tanks.

3.4.2 Flush

Remove residue from cleaning solutions and corrosives. The final drain must be an all low points drain. If a hydrostatic pressure test is specified for the storage tanks prior to filling the system with heat transfer fluid, it should be performed only with high quality water after flushing the system since the water will remain in the storage tanks.

3.4.3 Heat Transfer Fluid

Order the heat transfer fluid by an option of three methods:

a. Premixed with deionized water and furnished in 208 L 55-gallon drums

b. Premixed with deionized water and delivered in volumes above 7570 L 2000 gallons via tanker truck

c. Furnished in 208 L 55-gallon drums of concentrate to be site-mixed with high quality water as specified above before adding to the system.

Fill out and return to the heat transfer fluid manufacturer a questionnaire detailing site conditions before bulk delivery.

3.4.4 Heat Transfer Fluid Filling

With the thermal storage tanks opened to the system, pump the heat transfer fluid into the fill connection. Before starting the fill pump, high points of the system must have vents open. Unlike filling with water, these vent locations must be manned at all times during the filling process in case the heat transfer fluid is inadvertently spilled. When the fluid reaches the vent, manually close the vent and stop the fill pump. Installers must take care to not pressurize the system above 620 kPa 90 psi.

3.4.5 Removing Air

Turn on the system pump for a few minutes at low speed or valve back to half flow. This action will move most air to the system high points. With the system pump off, open the vents and start the fill pump again. Repeat this procedure a few times. When most of the air is eliminated, run the system pump at full flow.

Use the system air eliminator to remove final amounts of air.

3.5 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Begin testing, adjusting, and balancing when the entire HVAC system, including controls, has been completed with the exception of performance tests. Submit proposed test schedules for Performance Test and Operational Test, at least 2 weeks prior to the start of related testing. Charge the thermal energy storage system with premixed glycol solution (type and concentration as specified by the manufacturers of both the refrigeration and storage systems) prior to testing, adjusting, and balancing.

3.6 FIELD TRAINING

****

NOTE: The number of hours of instruction should be

determined based of the number and complexity of the systems specified.
****

The Manufacturer's Representative for the thermal energy storage system must conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Submit proposed schedule and training material for field training at least 2 weeks prior to the start of related training. Provide training for a period of [_____] hours of normal working time and start after the system is functionally complete but prior to the performance tests. The field instruction must cover all of the items contained in the approved Operating and Maintenance Instructions.

3.6.1   Video Recording

Provide to the Contracting Officer two copies of the training course in DVD video recording. The recording must record in video and audio all instructors' training presentations including question and answer periods with the trainees.

3.6.2   Unresolved Questions From Trainees

If, at the end of the training course, there are questions from trainees that remain unresolved, the instructor must send the answer, in writing, to the Contracting Officer for transmittal to the trainees.

3.7   PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, test the system as a whole to see that all items perform as integral parts of the system and that operation is as specified. Submit detailed test plan for the cool energy storage system as part of the overall Commissioning Plan. Submit system performance tests report for performance tests in booklet form, upon completion of testing. Test report must have a Statement of Design Intent that includes:

a. Narrative description of the system

b. Performance goals for energy consumption and electric demand

c. Hourly operating profile for design day and minimum-load day

d. Schematic diagram of piping system, including cool storage system

e. Description of control strategies for all possible modes and conditions

f. Maximum usable ice storage discharge temperature

g. Maximum usable cooling supply temperature

h. Criteria for determining fully charged and fully discharged conditions

i. Maximum amount of time available for charging storage

Document all phases of tests performed in the report, including initial test summary, all corrections and adjustments made, and final test results. Make corrections and adjustments as necessary to produce the conditions indicated or specified, and test(s) repeated in entirety until results are satisfactory. Tests must be conducted by the thermal energy storage system and chiller manufacturer's representative. Furnish all instruments required for tests. The accuracy of test instruments must be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING. Perform tests as described in the paragraphs below:

3.7.1 Operational Test

****

NOTE: Operational Test should be performed when temperatures are approaching or exceeding design day conditions and all lights are on in building so that there is a significant building cooling load to utilize the cool storage energy and demonstrate the various modes of operation.

****

Demonstrate that the entire system is functioning according to the specifications in all modes of operation such as charging (ice making only), partial storage - ice priority (warm day with both ice storage and supplemental chiller), partial storage - chiller priority (hot, humid design day with both chiller and supplemental ice storage), discharge (cooling from ice storage only), and chiller off (cold day) modes of operation. Where the system is designed for high cost on-peak window utility rate structure, demonstrate appropriate modes of operation at specified times of day. All other systems such as hot day/mild day/cold day control scheme must also demonstrate appropriate modes of operation at specified times of day. Test systems designed for proportional control to divide the load between chiller and ice storage to demonstrate components are proportionally loaded per specification. The operational test must cover a period of not less than [72][_____] continuous hours of operation using only system controls in normal mode and specified sequence of operation. Make ice inventory recordings in each storage unit at hourly intervals for the duration of the time period. In addition, record weather controls, including the ambient temperature and humidity in a shaded and weather protected area at hourly intervals along with ice inventory. Also record the building temperature and relative humidity for all zones served at hourly intervals.

3.7.2 Discharge Test

****

NOTE: Discharge testing under field conditions will usually not provide accurate results. Where tank manufacturer already has factory rated and published discharge performance curves, consider whether discharge testing adds value. Discharge testing must also be scheduled during the cooling season so that there is a building cooling load for discharging the cool storage energy and chiller cooling capacity.

****

Conduct discharge test in accordance with ASHRAE 150 with the exception of staying within acceptable deviations from the Specified Load Profile. The actual field tested profile may be done on a best effort basis allowing for reduced building cooling load conditions. This test is intended to measure the amount of cooling energy that can be delivered from the thermal storage device to meet the building cooling load. Begin the test with the thermal storage device in the fully charged condition. Continue the test until the thermal storage device can no longer provide the maximum leaving storage water temperature. Record data and determine total discharge cooling capacity in accordance with ASHRAE 150. In addition, record weather conditions, including ambient temperature and humidity in a shaded and weather protected area and all other pertinent temperatures and weather conditions at hourly intervals along with ice inventory.

3.7.3 Charge Test

****

NOTE: Charge testing under field conditions will usually not provide accurate results. Where tank manufacturer has factory rated and published charge performance curves, consider whether charge testing adds value. Charge testing should only be used on "full storage" systems where the chiller operates only during the 12-hour unoccupied period to charge the ice storage and there is no building cooling load. More often,"partial storage" systems in which a fully loaded chiller operates continuously throughout a design cooling day both charging the ice storage and cooling the building are used, which would be difficult to replicate in a field test unless it occurs on a design day.

****

Conduct charge testing in accordance with ASHRAE 150. The test is intended to measure the amount of cooling that can be stored in the thermal storage device within the time period available for charging. Begin the Charge Test with the thermal storage device in the fully discharged condition. Supply chilled fluid to the thermal storage device at the rate and at the temperatures specified for the design day. Continue the charge test until the thermal storage device reaches the fully charged condition or until the maximum allowable charging period has elapsed. Record data and determine total discharge cooling capacity in accordance with ASHRAE 150.

3.8 OPERATIONS AND MAINTENANCE

3.8.1 Operation Manual

Submit [six] [_____] operation manuals listing step-by-step procedures required for system startup, and shutdown, at least 2 weeks prior to field training. Include in the manuals the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. [Each service organization submitted must be capable of providing [4] [_____] hour on-site response to a service call on an emergency basis.]

3.8.2 Maintenance Manual

Submit [six] [_____] maintenance manuals at least 2 weeks prior to field training, Data Package 3, and data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.8.3 Operation and Maintenance Training

Provide training in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Training must also include preventative maintenance procedures to minimize Legionella contamination in accordance with manufacturer. Submit training schedule and content for review and approval prior to training.

-- End of Section --

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USACE / NAVFAC / AFCEC　　　　**UFGS-23 72 00 (May 2024)**

Preparing Activity: USACE　　　　**Superseding**
UFGS-23 72 00.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 72 00

ENERGY RECOVERY SYSTEMS

05/24

PART 1   GENERAL

PART 2   PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 72 00 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-23 72 00.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 23 72 00

ENERGY RECOVERY SYSTEMS
05/24

****
NOTE: This guide specification covers the requirements for energy recovery systems for power plant installations and boilers where a steady source of waste heat is available. This specification also covers air-to-air energy recovery for HVAC systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D1066	(2018; E 2018) Standard Practice for Sampling Steam
ASTM D2186	(2005; R 2009) Deposit-Forming Impurities in Steam
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units
UL 1812	(2013; Reprint Apr 2024) UL Standard for Safety Ducted Heat Recovery Ventilators
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welding Procedures And Qualifications

SD-02 Shop Drawings

Installation

SD-03 Product Data

Spare Parts

Posted Instructions

Performance Tests; G, [_____]

Water Treatment Equipment

Fixed Plate Heat Exchangers

Energy Recovery Wheel

Engine Jacket Heat Recovery Equipment

Engine Heat Recovery Silencer

Gas Turbine Heat Recovery Section

Steam Separator Unit

Load Control Condenser

Auxiliary Boiler

Heat Exchangers

SD-05 Design Data

Calculations

SD-06 Test Reports

Tests

Performance Test Procedure; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

Training; G, [_____]

1.3 WELDING PROCEDURES AND QUALIFICATIONS

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NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement.
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[Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Furnish qualified procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. Notify Contracting Officer 24 hours in advance of tests and perform tests at the work site if practicable. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.5 EXTRA MATERIALS

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NOTE: If fire-tube boilers are specified, delete paragraph "Tube Cleaner;" if water-tube boilers are specified, delete paragraph "Tube Brush." If the boiler design utilizes bent tubes, both paragraphs "Tube Cleaner" and "Tube Brush" should be deleted.
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Furnish all special tools necessary for the operation and maintenance of boilers, pumps, fans, and other equipment. Furnish small hand tools with a suitable cabinet, mounted where directed.

1.5.1 Tube Cleaner

Provide water-driven type with three rotary cutters and rotary wire brush, complete with the necessary length of armored water hose, valves, and other appurtenances necessary for operation. Provide tube cleaner and rotary brush for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Provide necessary valves and fittings to permit quick connection of the raw water supply hose to one boiler feed pump for operation of the cleaner.

1.5.2 Tube Brush

Provide tube brush, with steel bristles and jointed handle of sufficient length to clean full length of fire tubes.

1.5.3 Smoke Pipe Cleaner

Provide smoke pipe cleaner to clean the breeching and smoke connections. Provide cleaner with a jointed handle long enough to clean breeching and smoke connections without dismantling the system.

1.5.4 Special Wrenches

Provide special wrenches as required for opening boiler manholes, handholes, and cleanouts.

1.5.5 Spare Parts

Submit spare parts data for each different item of equipment specified, after approval of the detail drawings and not later than [_____] months before the date of beneficial occupancy. Include in the data a complete list of spare parts and supplies with current unit prices and source of supply.

1.6 OPERATION AND MAINTENANCE MANUALS

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NOTE: The designer should require the Contractor to prepare (in addition to providing O&M manuals for each piece of equipment) O&M manuals for the completed work which consists of diverse equipment integrated into a system not covered by instructions from a single manufacturer; in that case retain the first bracketed statement. Remove the first bracketed statement when the manufacturer's instructions are sufficient to operate and maintain the completed work.

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The manuals will be approved by [the Contracting Officer] [_____] before acceptance of the installed system. Submit [6] [_____] complete copies of operation manual for energy recovery system outlining the step-by-step procedures required for system startup, operation, and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and a brief description of all equipment items and their basic operating features. Submit [6] [_____] copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and provide troubleshooting guide. Include in the manuals contact information for repairs, point of contact information for customer support, piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

For each major item of equipment, secure a plate to the item of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.1.3 Prevention of Rust

Unless otherwise specified, factory prime-paint surfaces of ferrous metal subject to corrosion with a rust-inhibiting coating and subsequently factory finish-painted in accordance with the manufacturer's standard practice. Prime heat recovery equipment exposed to high temperature when in service and finish paint with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil[_____].

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NOTE: For equipment to be installed outdoors, adequate protection must be specified. Manufacturers must submit evidence that unit specimen has passed the specified salt spray fog test. A 125 hour test will be specified in a noncorrosive environment, and a 500 hour test will be specified in a corrosive environment.

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[Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand [125][500] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used it must be coated with a zinc-rich coating conforming to ASTM D520, Type I.]

2.1.4 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts. Guard or cover high temperature equipment and piping with insulation of a type specified by the manufacturer. Provide items such as catwalks, operating platforms, ladders, and guardrails where shown and construct them in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.1.5 Electrical Equipment

Provide electric motor-driven equipment specified complete with motors and necessary motor control devices. Provide motors and motor control devices conforming to the applicable requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM including requirements for hazardous area locations. Provide premium efficiency integral size motors in accordance with NEMA MG 1.

2.1.5.1 Motor Ratings

Furnish motors that are suitable for the voltage and frequency provided. Motors 373 watt 1/2 horsepower and larger must be three-phase, unless otherwise indicated. Ratings must be adequate for the duty imposed, but not less than indicated.

2.1.5.2 Motor Controls

Where a motor controller is not shown in a motor control center on the electrical drawings, provide a motor controller. Where required, provide motor controllers complete with properly sized thermal overload protection and other equipment at the specified capacity including an allowable service factor, and other appurtenances necessary for the motor control specified. Provide manual or automatic control and protective or signal devices required for operation specified and any wiring required to such devices not shown on the electrical drawings. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function.

2.1.6 Condensate Pumps and Receivers

Furnish condensate unit with duplex pumps and receiver and skid-mount. Provide pump that is capable of full capacity at 120 percent full steam rate when all of the heat is wasted under 110 percent engine load in an ambient temperature of [40][_____] degrees C [105][_____] degrees F. Provide an alternator for automatically switching the pumps under response from the liquid level control of the steam generator units each time an ON-OFF cycle is completed. Provide electric motor-driven pumps with stainless steel shafts and bronze impellers for operation with condensate at 95 degrees C 200 degrees F. Control pump operation to maintain condensate level between high and low visible levels indicated on the glass gauge of the receiver. Provide receiver sized to hold at least enough condensate for 15 minutes of operation without raw water makeup and complete with skid mounting, gauge glass, float-type makeup water valve with emergency manual valve, air vent, high-and low-level controlled pump switch, low-level alarm, and drain connection. Provide air vent suitable for use with coolant selected.

2.1.7 Pressure Gauges

Provide heavy-duty industrial type gauges conforming to ASME B40.100, style as required, suitable for pressure or vacuum specified, with minimum 152 mm 6 inch diameter dial, except as otherwise specified. Install pressure gauges on each boiler, on the low-pressure side of each pressure reducing valve, on the discharge side of each pump, and where shown or where required for proper operation. Provide gauges that are readily accessible and easily read from the operating floor. Equip gauges with integral or separate siphons and connect by brass pipe and fittings with shutoff cocks. Where pressure-reducing valves are used, place gauges close to the pressure-reducing assembly, both downstream and upstream, but connect approximately 3 m 10 feet therefrom. Provide operating ranges of the gauges be as follows:

Gauges	Operating Pressure, kPa psig	Pressure Range, kPapsig
Boiler	690-860100-125	0-13800-200
Medium-Pressure Steam	34550	0-6900-100
Low-Pressure Steam	14-352-5	0-2100-30
Boiler Feed Pump	10342-5	0-13800-200

Gauges	Operating Pressure, kPa psig	Pressure Range, kPapsig
Other Pumps	140-34520-50	0-6900-100

2.1.8 Thermometers

Furnish thermometers conforming to ASME PTC 19.3 TW, Type I, Class 3, with wells. Do not use Mercury in thermometers. Temperature ranges must be suitable for the intended use. Install thermometers in the feedwater pipeline between the feedwater heater and boiler feed pump in the main condensate return line before entering the surge tank, and elsewhere as indicated or specified. Thermometers must have straight or angle stems as required and must be easily read from the operating floor.

2.2 EXHAUST HEAT ENERGY RECOVERY EQUIPMENT

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NOTE: Exhaust heat energy recovery equipment is closely associated with the boiler or prime mover and it will frequently be more advantageous to specify this equipment in the same section in which the boiler or prime mover is specified. The designer must insure that drawings defining the interrelationship between all components and design data such as flows, pressures, temperatures, and heat transfer rate are included.

Heat Recovery Steam Generators (HRSG) for Gas Turbines are not included in this specification. Gas Turbines may have duct burners to increase efficiency. Duct burners raise the exhaust gas to a much higher temperature than found in boilers and engines. Boiler exhaust is typically below 800 deg F and engine exhaust below 1250 deg F. Gas turbine exhaust downstream of duct burners can raise exhaust gas up to 2600 deg F. HRSG's for gas turbines must be integrated into the gas turbine assembly to meet unique requirements and is not included in these generic specifications. The Designer will need to specify this equipment as required for each project.

Specify 2, 3, 4, or 8 degrees C 3, 5, 8, or 15 degrees F for the maximum temperature differential for coolant in and out of engine. Differential selected must be in accordance with engine manufacturer's recommendations. The 2 degree C 3 degree F) range is for conventional ebullient cooling where the heat of evaporation is used to remove the rejected heat from the engine. A 8 degrees C 15 degree F differential across the engine is desirable for all other systems but may be limited by engine manufacturer's recommendations.

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Provide a heat recovery system that is an integrated design package compatible with the prime mover [cooling] [and] [exhaust] system in accordance with the drawings and data sheets. Provide a [diesel engine exhaust waste heat boiler only to generate [saturated steam at [_____] Pa psig pressure] [hot water at [_____] degrees C degrees F and [_____] Pa psig pressure].] [diesel engine [jacket water cooling and heat reclaim system] [and] [lube oil cooling and heat reclaim facilities].] [diesel engine ebullient cooling system combining jacket water heat reclaim and exhaust waste heat boiler to generate up to 105 kPa 15 psig steam.] [gas turbine exhaust heat reclaim unit to generate [steam at [_____] Pa psig] [hot water at [_____] degrees C degrees F and [_____] Pa psig pressure].]

2.2.1 Boiler Economizer

[Unit performance requirements are shown in the equipment schedules on the drawings.]

2.2.1.1 Rectangular Tube Recovery Unit

Provide a rectangular tube recovery (RTR) unit in the exhaust duct of the boiler. RTR must have heat transfer design manufactured and tested in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Code, and stamped for a minimum 250 [_____] psig design pressure. RTR must include stainless steel, internal flue gas bypass diverter to provide full emergency bypass requiring no additional ductwork for controlling. RTR unit must have removable, gas-tight inspection doors providing complete access to the entire heating surface for inspection, tube removal, and cleaning. RTR must be capable of draining completely when mounted in vertical or horizontal position. Liquid inlet and outlet pipe connections greater than 2 inch NPT must be flanged. Liquid header manifolds must also contain connections for venting, draining and safety relief valves as required. Tube to tube or tube to header joint welds must not be in contact with the exhaust stream to minimize potential vessel failure.

Water side design pressure must be 250 [_____] psig at 350 [_____] deg F and 375 [_____] psig test pressure. Unit must be designed for [_____] deg F flue gas inlet temperature with a design pressure of 3 [_____] in. water column. Tube and fin design must be [SA178GrA ERW x 1.0 in OD x 0.083 in wall thickness with carbon steel 0.030 in fin thickness x 0.50 hgt nickel brazed or welded to the tube][TP316L x 1.0 in OD x 0.065 in wall thickness with aluminum 0.020 fin thickness x 0.50 in hgt Al-Fuse bonded to the tube][TP316L x 1.0 in OD x 0.065 in wall thickness with 304 stainless steel 0.020 fin thickness x 0.50 hgt nickel brazed or welded to the tube][_____].

2.2.1.2 Fin Coil Recovery Unit

Provide a fin coil recovery (FCR) unit in the exhaust duct of the boiler. FCR must have heat transfer design manufactured and tested in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Code, and stamped for a minimum 250 [_____] psig design pressure. FCR must include stainless steel, internal flue gas bypass diverter to provide full emergency bypass requiring no additional ductwork for controlling. RTR must have removable, gas-tight inspection doors providing complete access to the entire heating surface for inspection, tube removal, and/or cleaning. RTR must be capable of draining completely when mounted in vertical or horizontal position. Liquid inlet and outlet pipe connections greater than 2" NPT must be flanged. Liquid header manifolds must also contain connections for venting, draining and/or safety relief valves as required. Tube to tube or tube to header joint welds must not be in contact with the exhaust stream to minimize potential vessel failure.

Water side design pressure must be 250 [_____] psig at 350 [_____] deg F and 375 [_____] psig test pressure. Unit must be designed for [_____] deg F flue gas inlet temperature with a design pressure of 3 [_____] in. water column. Tube and fin design must be [SA178GrA ERW x 1.0 in OD x 0.083 in wall thickness with carbon steel 0.030 in fin thickness x 0.50 hgt nickel brazed or welded to the tube][TP316L x 1.0 in OD x 0.065 in wall thickness with aluminum 0.020 fin thickness x 0.50 in hgt Al-Fuse bonded to the tube][TP316L x 1.0 in OD x 0.065 in wall thickness with 304 stainless steel 0.020 fin thickness x 0.50 hgt nickel brazed or welded to the tube][_____].

2.2.1.3 Condensing Economizer Unit

Provide a [single][two] stage condensing economizer unit in the exhaust duct of the boiler. Unit must have heat transfer design manufactured and tested in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Code, and stamped for a minimum 250 [_____] psig design pressure. Unit must include stainless steel, internal flue gas manual bypass assembly requiring no additional ductwork for bypassing. Unit must have removable, gas-tight inspection door providing complete access to the entire heating surface for inspection and cleaning. Unit must have stainless steel condensate drain assembly. Unit must have stainless steel interior and exterior construction, 2 inch thick minimum factory insulation, exhaust stack flanged connections, and removable finned tubes.

Water side design pressure must be 250 [_____] psig at 350 [_____] deg F and 375 [_____] psig test pressure. Unit must be designed for [_____] deg F flue gas inlet temperature with a design pressure of 3 [_____] in. water column.

2.2.2 [Boiler][Engine] Exhaust Steam Generator

Exhaust Steam Generator (ESG) must be manufactured and tested in accordance with the requirements of Section 1 of the ASME Boiler and Pressure Vessel Code and stamped at 150 [_____] psig to the appropriate Section. The operating pressure must be [_____] psig. The ESG must operate in a fully automatic mode under fluctuating steam loads and exhaust volumes. The ESG must be pre-piped, pre-wired and mounted on a structural steel base requiring no field assembly. The ESG must include finned tube heating surface, modulating full port exhaust bypass, steam flash drum assembly, and integral circulating pump to circulate water from the heat transfer section back to the steam flash drum assembly. All water, air and blowdown connections must have a common manifold assembly for ease of piping installation.

Explosion proof heat exchanger surface must be nickel [brazed][welded] fin to tube. Finned tubing must be designed in multiple sections for ease of replacement. The heat exchanger section must contain a main inspection door for removal, cleaning, and inspection. The reinforced enclosure must contain [304 stainless steel][_____] baffles with 4 inch [_____] minimum thickness thermal insulation. The enclosure must be designed to operate with exhaust temperatures entering at 1250 [_____] deg F maximum, have a gas tight seal, and have a continuously welded 10 [_____] gauge carbon steel exterior. ESG must be designed for a exhaust side design pressure of 10 [_____] inches water column. ESG must be primed or painted with high temperature metallic paint.

2.2.2.1 Modulating Bypass

ESG modulating bypass assembly must be constructed of [plate steel][stainless steel] and exhaust connections must be 150 lb [_____]

design SA105 exhaust flanges. Bypass assembly must be bolted to the heat exchanger section. Bypass must be controlled by a modulating positioning actuator and steam pressure dial control for controlling the volume of waste heat exhaust gas dependent on steam pressure. The reinforced damper assembly must be constructed of 304 stainless steel and designed for tight seal during full bypass. Damper shaft must contain high temperature bearings and packing glands to seal exhaust leakage. In the event of an air pressure or electrical failure to the ESG, the modulating bypass assembly must contain an alarm fail safe operating mode whereby the damper assembly must automatically move to the full exhaust bypass position.

2.2.2.2 Steam Flash Drum

ESG steam flash drum assembly must contain internal baffles and dry pipes for dry steam output and 1 inch [_____] thick thermal insulation with carbon steel exterior. ESG must include circulating pump to maintain high water flow turbulence for minimum fouling, main flash drum blowdown valving assembly, continuous surface blowdown valve, and water level control blowdown valve all manifolded into a single blowdown connection. Safety controls must include low and high water cutout, excess steam pressure cutout, and low air pressure cutouts where required for pneumatic exhaust bypass actuator. ESG must have water level control system with boiler feedwater on and off auxiliary switch and red line water level sight glass with drain cock. ESG must include all required gauges for steam, feedwater, pump cooling water and air indication. ESG must include ASME and National Board stamped steam safety relief valve. All interconnecting piping linkages and valving must be factory installed. Control panel must be NEMA 12 construction and accept a single main power connection with disconnect, starter, power and run indicating lights, fill indicating light, low and high water alarm indicating lights, and ow air and excess steam pressure lights.

2.3 Engine Jacket Heat Recovery Equipment

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NOTE: Jacket heat recovery equipment is closely associated with the prime mover and it will frequently be more advantageous to specify this equipment in the same section in which the prime mover is specified. The Designer must insure that drawings defining the interrelationship between all components and design data such as flows, pressures, temperatures, and heat transfer rate are included.

Specify 2, 3, 4, or 8 degrees C 3, 5, 8, or 15 degrees F for the maximum temperature differential for coolant in and out of engine. Differential selected must be in accordance with engine manufacturer's recommendations. The 2 degree C 3 degree F) range is for conventional ebullient cooling where the heat of evaporation is used to remove the rejected heat from the engine. A 8 degrees C 15 degree F differential across the engine is desirable for all other systems but may be limited by engine manufacturer's recommendations.

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2.3.1 Engine Cooling

2.3.1.1 Antifreeze

[For ebullient cooling where steam is required, provide a cooling system suitable for a combination of water and an azeotropic antifreeze compatible with the equipment (methoxy propanol) as a cooling medium, hereafter called the coolant.] [For cooling systems where steam is not required, utilize an ethylene glycol permanent type antifreeze. Base size of cooling system upon the use of an antifreeze solution which will protect the system down to minus 45 degrees C minus 50 degrees F.] Provide a permanent type antifreeze for cooling the lube oil and auxiliaries suitable for use with water, or use the antifreeze solution specified above and connect to a separate section of the waste heat condenser from the engine coolant. Provide valve trim and materials that are compatible for use with the antifreeze solution. Operation of the cooling system must be fully automatic while the prime mover is running.

2.3.1.2 Water Jacket Temperature

For diesel engine ebullient cooling, provide jacket water temperature no lower than 110 degrees C 230 degrees F, nor higher than 120 degrees C 250 degrees F in the steam separator at all loads with a maximum differential of [_____] degrees C degrees F for coolant in and out of the engine.

2.3.1.3 Construction

Where cooling system design is part of prime mover installation, components other than the wasteheat condenser and condensate receiver or pump units may be mounted on the engine skid extension. For any antifreeze cooling system, provide a PVC makeup tank with an electric motor-driven pump unit as indicated. Manifold pump to allow using it as a mixing unit by shunting the flow back to the tank. System fill must be [manual] [automatic] with feed into the piping system steel expansion tank connection line as indicated.

[Construction for Ebullient steam generator from engine jacket water must be as follows. The Exhaust Cooling Steam Generator (ECSG) must be designed to produce low pressure steam (15 psig and under) from engine jacket water using natural circulation. Steam flash tank must be ASME stamped and built in accordance with ASME Section VII Div 1, shipped as a packaged unit, include continuous water level feed control with low water cutoff, auxiliary low water cutoff, excess steam pressure switch, gauge glass assembly, surface and man blowdown assembly, vent valve, ASME steam safety valve, steam pressure gauge and wall or floor mounting provisions. Connections must include 150 psig steam outlet, 150 psig water/steam inlet, blowdown, an boiler feedwater. ECSG must be pre-piped and wired for single point power connection.]

2.3.2 Forced Circulation Pump

Where an engine-driven pump is not provided for jacket water circulation, provide a separate electric motor-driven pump interlocked with engine operation as required by the engine manufacturer.

2.3.3 Lube Oil Cooling

Provide lube oil cooling and heat reclamation exchangers as part of the engine. The designs must provide for the oil to be on the outside of the tubes and the cooling water on the inside. Provide a thermal sensing unit in the oil outlet piping where it can sense the mixed average temperature of the oil leaving the cooler and actuate the control valve on the cooling water flow to prevent overcooling the lube oil.

2.4 ENGINE HEAT RECOVERY SILENCER

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NOTE: The degree of silencing will match the environmental requirement. In a retrofit installation, the unit should match the original silencer installation. As a general guide the attenuation will be approximately as follows:

Grade of Silencer	**Electric Generating Systems Association (EGSA) Rating**	**dBA Reduction Range**
Commercial	**1**	**10-15**
Residential	**3**	**20-25**
Hospital	**7**	**40-45**

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For each Heat Recovery silencer or supplementary silencer, reduce the generated sound spectrum to EGSA Rating and dBA reduction range specified here. Silencer EGA Rating must be [_____] with a dBA reduction range of [_____]. Provide Heat Recovery silence that is a combination boiler silencer or a boiler with a supplementary silencer in accordance with ASME BPVC SEC VIII D1 for [_____] Pa psig steam working pressure. Design the boiler for maximum efficient heat recovery under any load condition up to 110 percent of full load with an exit exhaust gas temperature not less than 165 degrees C 330 degrees F. Design each boiler for continuous wet operation (flue gas condensation exists) or for periods of dry operation (flue gas condensation does not exist) without interruption of the diesel engine operation when located and connected as indicated. Make provisions for expansion and contraction to prevent overstressed conditions in the pressure vessel during continuous wet or dry operation. Gas side pressure drop through the boiler exceeding the recommendations of the engine manufacturer is not permitted. Provide each boiler with standard boiler trim including, but not limited to, pressure gauge, water gauge with try cocks, water level control, ASME-rated safety relief valve, surface blowoff valve, bottom blowdown valves, and bottom dump valves. Insulate the shell as required by the paragraph "INSULATION" and cover the insulation by lagging.

2.5 GAS TURBINE HEAT RECOVERY SECTION

Provide unit consisting of a [fire tube] [water tube or water wall] exhaust boiler equipped with an exhaust gas bypass. Design unit for the specified installation and provide a complete package with thermal insulation, controls, accessories, and base. The insulation must be in accordance with the paragraph "INSULATION." If heat recovery section does not meet the turbine exhaust sound levels specified, supply a supplementary exhaust silencer to meet specification requirements for both on-stream and bypass conditions.

2.6 STEAM SEPARATOR UNIT

Provide unit consisting of a combination flash tank and steam separator unit of sufficient size for the engine cooling and waste heat recovery system when engine is operated at 110 percent load in an ambient temperature of [40] [_____] degrees C [105] [_____] degrees F at [_____] m feet altitude. The unit must be complete with low-water alarm switch, low-level cutout switch (set at a level lower than the low-water alarm switch), pressure gauge, safety valve, gauge glass and cocks, vent valve, water-level control, high-water-level alarm, condensate-motor control, and blowdown connection. Position controls so that coolant level is visible in gauge glass at all times. Construct and certify the vessel in accordance with the ASME requirements and hydrostatically test conforming to ASME requirements. Use steam at 105 kPa 15 psig from this separator for [space heating][and][absorption cooling][_____]. Insulate the unit as required by paragraph "INSULATION."

2.7 LOAD CONTROL CONDENSER

Provide condenser unit with a capacity to dissipate the heat rejected by the engine and its components at 110 percent full-rated load under temperature of [_____] degrees C degrees F and at [_____] m feet elevation from above sea level. The maximum coolant temperatures leaving the engine must not be in excess of that recommended by the engine manufacturer; however, temperature differential must not be greater than [_____] degrees C degrees F for coolant in and out of the engine.

2.7.1 Air-Cooled Condenser

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NOTE: Designer will select proper speed, based on air requirements. The larger units will generally require the slowest speed motor but the type of fan drive must also be considered. The fan speed and pitch of the blades are determined from manufacturer's rating data.

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Provide main core unit suitable for condensing the vapor generated during engine operation from zero to 110 percent of full load when there is no utilization of the steam for useful purposes. Use a secondary core for cooling the auxiliary system coolant. The condenser must be the [vertical] [horizontal] air discharge type with round tubes. Construct fins and tubes of nonferrous materials; provide carbon steel headers of the plug type. Firmly bond fins to tubes; construct tanks and supporting framework of steel; and construct adjustable-pitch fan of aluminum. Make inlet and outlet coolant connections on one side. Install a drain cock at the low point of each core. Provide a welded structural frame for entire unit, drilld and arrange for mounting on a concrete base, and design to withstand winds up to [80] [_____] km/hour [50] [_____] mph. [Provide hail screens in areas where hails storms are prevalent.] Provide reliefs to protect against excessive pressures and temperatures developed in the system.

a. Furnish condenser complete with motor-driven fan or fans and with face dampers controlled by the condensate temperature. [Provide two fans per bay.] Avoid excessive subcooling of the condensate by overexposure to the air stream. Provide freeze protection for all modes of operation. Do not exceed fan tip speed of 60 meters/second 12,000 feet/minute.

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NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the reference to motor starters.

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b. Direct-connect or belt connect rhe fan motor to the fan and seal bearings. Provide motor that is three-phase, squirrel cage induction type, [208] [460] volts at 60 Hz, synchronous speed not to exceed [1,200] [1,800] rpm. Provide motor size such that seasonal adjustments of the fan blade pitch are not necessary to prevent motor overloads when ambient air temperature drops to lowest value or rises to highest value specified for the prime mover operating conditions. Provide a 60 Hz, across-the-line, enclosed type, magnetic motor starter having thermal overload protection in each ungrounded phase. If the condenser fan motor is large enough to cause a transient voltage dip of 20 percent or more during starting inrush, use a reduced-voltage type magnetic motor starter. Make connections such that the fan motor will start automatically as its respective engines are started.

c. The distance between condenser and engine must be [[_____] m feet] [as shown]. Furnish complete unit with a matched float and thermostatic trap installation. Provide air flow from the fan motor [upward] [downward] [inward] [outward] through the condenser. Furnish 300 mm twelve-inch lengths of flexible hose or pipe for all inlet and outlet pipe connections. Provide a valved vent for release of noncondensible gases. Provide condenser sized by the engine manufacturer for this application. Auxiliary system coolant temperature must not exceed 80 degrees C 180 degrees F, with a maximum differential of 8 degrees C 15 degrees F. Maintain temperature for the system by regulating the steam pressure.

2.7.2 Water-Cooled Condenser

Provide a shell-and-tube type unit rated for 30 degrees C 85 degrees F entering water and 40 degrees C 105 degrees F leaving water. Furnish a complete unit with a matched float and thermostatic trap installation as well as a subcooler unit to reduce flashing of condensate. Provide a valved vent for release of noncondensible gases.

2.7.2.1 Pressure-Operated Control Valve

Provide butterfly control valve with maximum 60 percent full open operating position for good control characteristics. Nominal rating must be 7 kPa 1 psig with pressure drop at 60 percent of full open position. For use as a back pressure valve when there is no auxiliary fired boiler, provide metal-to-metal seats which do not provide 100 percent shutoff to condenser. For use with an auxiliary fired boiler, provide high temperature butyl or silicone rubber or EPDM seats for bubble-tight shutoff to the condenser. Provide valve operator that is [electric proportional operator with pressure control mounted internally] [pneumatic with controller with proportional band, reset and filter regulator mounted on operator]. Valve must open on loss of air supply pressure.

2.8 AUXILIARY BOILER FOR SUPPLEMENTAL FIRING

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NOTE: Delete this paragraph if auxiliary fired boiler is not required. Auxiliary boiler is required when a constant source of heat must be maintained during maintenance or overhaul of prime movers or to supplement heating requirements during peak demands which are beyond the capacity of the heat recovery installation.

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Provide boiler and related equipment in accordance with Section 23 52 30.00 10 HEAT RECOVERY BOILERS.

2.9 HEAT EXCHANGERS

Provide heat exchangers as shown on drawings. Provide heat exchangers that are the [shell-and-tube design, either U-tube type or helical coil type][plate frame type]. Other types of construction are not acceptable unless prior written approval is received. Design, fabricate, test, and stamp heat exchangers in accordance with ASME BPVC SEC VIII D1.

a. Provide construction materials suitable for the intended service except do not use cast material. The manufacturer's drawing submittal must indicate the grade of material that has been used, giving the full ASME specification number designation for each component.[Provide U-tube materials as light drawn temper; provide fully annealed helical coils. Provide carbon construction materials on the shell side [casing]. Provide tube side materials that are 90-10 Copper-Nickel for the tubes, tubesheets, and channel bonnets for U-tube designs. Provide tubing and headers for the helical coil designsthat are 90-10 Copper-Nickel.]

[b. Provide either rolled or welded tube-to-tube sheet connections and tube-to-header connections for helical coils for the condensate cooler and lube oil cooler, and welded for lube oil preheater.]

2.9.1 Fuel Oil Preheating Heat Exchanger

If fuel oil preheating is required, provide this heat exchanger as part of the boiler package. The designs must provide for the oil to be on the outside of the tubes and the steam or high temperature water on the inside. Provide a thermal sensing unit in the oil outlet piping where it can sense the mixed average temperature of the oil leaving the preheater and actuate the control valve on the high temperature hot water/steam to ensure that oil temperature is in the proper range for the prime mover.

2.9.2 Condensate Heat Exchanger

High pressure condensate heat exchanger must provide heating of domestic or boiler feedwater while reducing the condensate temperature to minimize flashing in the condensate surge tank. The designs must provide for the condensate to be on the outside of the tubes and the cooling water (domestic or boiler feedwater) to be on the inside.

2.10 HIGH TEMPERATURE WATER HEAT RECOVERY SYSTEMS

****

NOTE: Delete this paragraph if high temperature

water heat recovery is not utilized.
****

Where high temperature water is utilized as a heat recovery system medium, provide system with proper expansion tank, dump tank, pressurization system, circulation pumps, makeup water facilities, controls, unit heaters, and piping as specified in Section 23 50 52.00 10 CENTRAL HIGH TEMPERATURE WATER (HTW) GENERATING PLANT AND AUXILIARIES.

2.11 WATER TREATMENT EQUIPMENT

****
NOTE: The proper condition of feedwater and boiler water is of major importance in assuring long life and minimum maintenance of any heat recovery system. Due to varying conditions in different locations, it is impossible to set forth specific control standards. If water treatment is covered in another section, the requirements should be reviewed for compatibility with the requirements of waste heat recovery systems. A study should be made as follows:

a. Internal Treatment: Conventional internal water treatment should be used along with regular boiler blowdown. Water treatment should consist of alkalinity adjustments and chemical additions for the removal of dissolved oxygen and treatment of residual hard-scale-forming materials. Treatment may also be required for sludge dispersal and to prevent foaming.

The following values can be used as a guide:

pH	**10.5 - 11.2**
02	**0 ppm**
PO4	**20-40 ppm**
TDS	**3500 ppm, max**

b. External Treatment: Makeup water must be treated to remove calcium, magnesium, and total iron. Special attention should be given to water which contains suspended solids, a high residual of iron and sodium chloride, and dissolved oxygen.

c. Condensate Return Line Corrosion: Corrosion in the return line will allow harmful iron oxide to enter the boiler system where it can adhere to the internal surfaces and reduce the heat transfer. It is recommended that steps be taken to protect the condensate return system from the corrosive effects of oxygen and carbon dioxide.

For additional information concerning control of internal chemical conditions, refer to ASME Boiler

and Pressure Vessel Code, Section VII (Recommended Rules for Care of Power Boilers), Subsection C7.
****

Water treatment equipment is required and must be as specified in Section 23 25 00 CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS.

2.12 INSULATION

Apply insulation in sufficient thickness to limit the surface temperature of the lagging to not more than [50] [65] degrees C [120] [150] degrees F when in still air at site maximum dry bulb temperature. Submit Heat transfer calculations to the Contracting Officer to substantiate insulation material and thickness selection. Provide insulation with waterproof lagging when installed outdoors. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.13 AIR-TO-AIR ENERGY RECOVERY DEVICES

2.13.1 Fixed Plate Heat Exchangers

The enthalpy plate energy exchanger must transfer both sensible and latent energy between outgoing and incoming air streams in a cross or counter flow arrangement. The enthalpy plate exchanger media must be coated with hydrophilic resin. The hydrophilic resin will allow the exchange of water by direct vapor transfer using molecular transport without the need of condensation. The plate exchanger will be constructed of alternate layers of corrugated spacer and liner material coated with a hydrophilic resin. The enthalpy plate must transfer both sensible and latent energy. Frame supporting enthalpy matrix must be constructed of G90 galvanized material with end caps constructed of 18 gauge, minimum, galvanized plates. The enthalpy plate exchanger must be operable at temperatures between -40 degree C and 60 degree C-40 degree F and 140 degree F.

****
NOTE: Fixed plate heat exchanger below is for sensible only energy recovery where no humidity transfer is wanted such as Natatoriums and Kitchens.
****

[The enthalpy plate energy exchanger must transfer sensible energy between outgoing and incoming air streams in a cross or counterflow arrangement. The enthalpy plate must be [epoxy coated] corrugated aluminum, flat plate laminar designs are unacceptable. Exchanger must withstand a maximum pressure differential of [7] [_____] inches wg. Plate corners must be sealed with silicone free polymer sealant and rated for air temperatures up to [190] [_____] deg F. Leakage must not exceed [0.1] [_____]% percent of rated airflow at 1.6 in wc differential pressure. Exchanger casing must be constructed of extruded aluminum corner profiles and aluzinc steel or aluminum endplate framing.]

2.13.1.1 Performance

The enthalpy plate exchanger must bear the AHRI 1060 Certified Product Seal. Sensible, latent and total effectiveness along with supply and exhaust air pressure drop, Exhaust Air Transfer Ratio (EATR) and Outside Air Correction Factor (OACF) rating must be clearly documented with performance tests conducted in accordance with ASHRAE Standard 84 and per the official AHRI laboratory. Exchangers that do not bear the AHRI 1060 certified seal are unacceptable. The enthalpy plate exchanger must withstand pressure differentials of at least 5 inch w.g. The enthalpy plate exchanger must be a UL Recognized Component and bear the UL Certification Mark as an indication of meeting UL 723 testing requirements when tested by a UL Laboratory also following UL 1995 procedures. The exchanger must have a flame spread of less than 25 and a smoke developed of less than 50 when rated in accordance with ASTM E84. Exchangers only tested in accordance with UL 723 will not be acceptable. The membrane must not promote the growth of mold or bacteria and must have successfully passed ASTM-G21 testing.

2.13.2 Energy Recovery Wheel

****

NOTE: Energy Recovery Wheel specified below applies to wheel sections integrated into equipment such as standalone heat recovery ventilators, air handling systems, and packaged direct expansion units.

****

The energy recovery cassette must incorporate a rotary wheel in an insulated cassette frame complete with removable energy transfer media, seals, drive motor, and drive belt. Energy recovery wheel performance will be AHRI 1060 certified and bear the AHRI certified label. Components that are independently tested or "rated in accordance with" will not be acceptable. Certified components must be listed as active in the AHRI Directory (www.ahridirectory.org). The energy recovery cassette must be an Underwriters Laboratory (UL) recognized component for fire and electrical safety and bear the UL symbol. Recognized components are to be listed in the UL directory (http://database.ul.com). The energy recovery cassette must be in accordance with NFPA 90A by virtue of UL 1812 and UL 900 fire test for determination of flammability and smoke density.

2.13.2.1 Cassette Construction

Cassette frame and structural components must be constructed of G90 galvanized steel for corrosion resistance. Wheel structure must consist of a welded hub, spoke and continuous rolled rim assembly of stainless steel, and must be self-supporting without energy transfer segments present. Wheel bearings must be permanently sealed and selected for a minimum 30 year L-10 life of 400,000 hours. Bearings requiring external grease fittings or periodic maintenance are not acceptable. Wheels 30 inch in diameter and greater must be provided with removable energy transfer segments to facilitate maintenance and cleaning. All diameter and perimeter seals must be provided as part of the cassette assembly and must be factory set. Seals must be non-contact type oriented in a labyrinth style configuration. Diameter seals must be fully adjustable and easily accessible. Perimeter seals must be permanently mounted to the wheel rim and not require adjustment. The wheel drive motor must be an Underwriters Laboratory Recognized Component, be mounted in the cassette frame and supplied with a service connector or junction box. Three phase motors must be suitable for use in both standard and inverter rated applications. Wheels 50 inch and smaller must use a urethane stretch belt for wheel rim drive without the need for external tensioners. Wheels 60 inch and larger must use a urethane non-stretch belt with integral cord and constant tensioner. Wheel drive system must not require periodic adjustment.[Provide double wall G90 galvanized steel construction to encapsulate all exposed insulation within the cassette frame.]

****
NOTE: For corrosive environments, select options below.
****

[Corrosion protection must consist of powder coating on all exposed metals and inclusion of stainless steel bearings. The powder coating must have a minimum thickness of 2.0 mils and be rated for a 1,000 hour salt spray.]

2.13.2.2 Energy Transfer Media

Energy transfer media must be constructed of a durable synthetic lightweight polymer. Media must be wound continuously with one flat and one structural layer in an ideal parallel plate geometry. Airflow across heat exchanger surface must remain laminar. Energy transfer media must be suitable for use in corrosive, marine or coastal environments without the need for additional coatings.[Sensible only energy transfer media must be constructed in the same fashion as the enthalpy transfer media with the exception of the desiccant coating process required for enthalpy wheels.][Desiccant must be either silica gel or molecular sieve and be permanently bonded to the energy transfer media without the use of binders or adhesives, which may degrade desiccant performance. Desiccants not permanently bonded are not acceptable due to potential delamination or erosion of the desiccant from the energy transfer media. Desiccant must be non-migrating and must not dissolve or deliquesce in the presence of water or high humidity. Energy transfer media must be capable of repeated washings without significant degradation of the desiccant bond.] Energy recovery segments are to be cleanable outside of the cabinet with detergent or alkaline coil cleaner and water. Energy transfer segments must be capable of submersion in a cleaning solution. Submersion must be capable of restoring [latent]performance within AHRI certified performance limits.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

****
NOTE: All pertinent piping and related equipment supports are to be designed and indicated in accordance with UFC 3-301-01 for seismic design.
****

Install equipment in accordance with manufacturer's instructions and recommendation. Bolt all pieces of equipment in place on foundations unless they are skid-mounted on the prime mover base skid. Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, drawings, and installation instructions. Include in the drawings complete piping and wiring drawings, schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Also show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances required for maintenance and operation. Use flexible connectors to connect any piping to the prime mover. Provide piping for interconnecting various components of the heat recovery equipment conforming to the requirements of ASME B31.1. Submit calculations, manufacturer's design data and structural computations for walls, roof, foundations, and other features for specialty type of construction, with design data for lateral forces that may be encountered due to wind loads and seismic zone forces.

3.3 CLEANING OF BOILERS AND PIPING

3.3.1 Boiler Cleaning

After the hydrostatic tests have been made and before starting the operating tests, thoroughly and effectively clean the boiler of foreign materials, including mill scale, grease, and oil deposits in accordance with Section 23 52 30.00 10 HEAT RECOVERY BOILERS.

3.3.2 Boiler Water Conditioning

Provide chemical treatment and blowdown of boiler water during periods of boiler operation to prevent scale and corrosion in boilers and in steam and return distribution systems from initial startup of the system, through the testing period, and to final acceptance by the Government. Chemicals used and method of treatment must be approved by the Contracting Officer.

3.4 POSTED INSTRUCTIONS

Submit framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, to be posted where directed. Submit proposed diagrams, instructions, and other sheets, prior to posting, as specified. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, frame as specified above for the wiring and control diagrams, and post beside the diagrams. Post the framed instructions before acceptance testing of the systems.

3.5 FIELD TRAINING

Provide a field training course for designated operating staff members. Training must be provided for a total of [_____] hours of normal working time and must start after the system is functionally complete, but prior to final acceptance tests. Cover all of the items contained in the approved operation and maintenance instructions.

3.6 TESTS

Following installation, test each boiler hydrostatically and prove that the system is tight under a gauge pressure of 1.5 times the working pressure specified and in accordance with applicable ASME requirements. Following the installation of piping and heat recovery equipment, but before the application of any insulation, perform hydrostatic tests and prove that the system is tight under gauge pressures of 1.5 times the working pressure specified, but no less than the following:

Low-pressure lines	275 kPa40 psi

Medium-pressure lines	415 kPa60 psi
High-pressure-steam lines	1035 kPa150 psi
Boiler feed lines	1550 kPa225 psi

The boilers and the piping must be inspected by a boiler inspector qualified as required by ASME BPVC SEC VIII D1, ASME BPVC SEC I, or ASME BPVC SEC IV, as applicable. Supply a certificate of approval for each boiler. Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

3.7 HEAT RECOVERY PLANT EFFICIENCY AND OPERATING TESTS

Upon completion, and before acceptance of the work, subject the heat recovery plant to such operating tests as may be required to demonstrate satisfactory functional operation. Conduct each operating test at such times as directed by the Contracting Officer. Use water meter in the test that is suitable for hot water. Provide instruments, test equipment, and test personnel required to properly conduct all tests; the necessary fuel, water, and electricity will be furnished by the [Government] [_____]. Conduct boiler operating tests, as a minimum, continuously at the following capacities for the following time:

Test Percentage of Operating Capacity		
Testing Time	Water Wall or Water Tube Boilers	Firebox Boilers
First 2 hours	50	50
Next 2 hours	75	75
Next 6 hours	100	100*
Next 2 hours	110	--

a. Do not operate firebox boiler above 100 percent of capacity.

b. Conduct general performance tests on the heating plant by an experienced test engineer and tests will be observed by the Contracting Officer. Submit a proposed performance test procedure, 30 days prior to the proposed test date. Include in the procedure a complete description of the proposed test with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. Do not start the test until the procedure has been approved. Deliver test report including logs, heat balance calculations, tabulated results, heat recovery efficiencies, and conclusions to the Contracting Officer as stated in the paragraph "TESTS."[Submit an analysis of the fuel being burned on the test to the Contracting Officer.]

c. Test of capacity of water treatment equipment and quality of the effluent must meet the requirements specified. Perform tests for ion-exchange units covering at least two complete regenerations and capacity runs. Conduct tests for hot process or other precipitation type softeners continuously for a period of at least 48 hours, with samples taken at 2-hour intervals.

d. Conduct tests for steam quality in accordance with ASTM D1066 under the operating conditions specified.

e. Test quality of steam used for air conditioning equipment in accordance with the conductivity method in ASTM D2186 with the conductivity of the steam corrected for carbon dioxide and ammonia content not to exceed 4.0 microsiemens 4.0 micromhos at 18 degrees C 65 degrees F.

3.8 ENERGY RECOVERY WHEEL INSPECTION AND TESTING

Verify that the wheel is rotating in the direction of the rotation arrow located on cassette frame and is not damaged. Visually inspect belt, ensure belt is tracking near the center of the rim and is not flipped or twisted. Check for excessive noise such as scraping, brushing, or banging. Measure and verify running amps do not exceed nameplate Full Load Amperes (FLA). Measure and record entering and leaving air dry bulb and wet bulb temperatures, airflow and pressure drop across wheel; then determine sensible heat, latent and total effectiveness for those conditions. Airflow and pressure drop must be within plus or minus five percent of specified values. Show access and removal procedure to clearly show how wheel is to be cleaned.

3.9 FIXED PLATE HEAT EXCHANGER INSPECTION AND TESTING

Inspect heat exchanger plate for damage and show access procedure to show how plate is to be cleaned. Measure and record entering and leaving air dry bulb and wet bulb temperatures, airflow and pressure drop across heat exchanger; then determine sensible heat, latent and total effectiveness for those conditions. Airflow and pressure drop must be within plus or minus five percent of specified values.

3.10 RETESTING

If any deficiencies are revealed during test, correct such deficiencies and reconduct the tests at no additional costs to the Government.

3.11 FIELD PAINTING

****

NOTE: Where identification of piping is required by the using service, this paragraph will be amplified to include appropriate requirements, either directly or by reference to a separate section.

****

Clean, prepare, and paint ferrous metal surfaces not specified to be coated at the factory as specified in Section 09 90 00 PAINTS AND COATINGS. Paint exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum lagging over insulation.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 74 33 (May 2024)**

Preparing Activity: NAVFAC **NEW**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-23 74 33 (May 2024)**

Preparing Activity: NAVFAC **NEW**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 23 74 33

DEDICATED OUTDOOR AIR SYSTEMS (DOAS)

05/24

****

NOTE: This guide specification covers the requirements for dedicated outdoor air systems (DOAS) where ventilation airflow exceeds 354 L/S 750 cfm per UFC 3-410-01, as calculated by ASHRAE 62.1 and/or air balance requirements. "DOAS" in this specification refers to the air handling piece of equipment and internal components only. Other components such as ductwork and sensors should be specified elsewhere.

Show cooling and dehumidification requirements, capacity, mounting details, power connections, etc. on drawings or schedule.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This note applies to this whole specification section. Refer to applicable UFCs for requirements on how to size and design DOAS and all components; including but not limited to UFC 3-400-02 Design: Engineering Weather Data, UFC 3-401-01 Mechanical Engineering, UFC 3-410-01 Heating, Ventilating, and

Air Conditioning Systems, and UFC 3-410-02 Direct Digital Control for HVAC and Other Building Control Systems.

****

****

NOTE: This specification uses tailoring options to select the required protocol for control system interfaces for equipment. These tailoring options are:

1. **BACnet Only**
2. **LonWorks Only**
3. **BACnet or LonWorks (this will require the unit match the building control system)**

DESELECT all three if not requiring control system interfaces. Otherwise SELECT exactly ONE of these tailoring options.

You have currently SELECTED the following option:

BACnet Only

LonWorks Only

BACnet or LonWorks

If more than one item appears between the dashes above, you have included more than one control system interface tailoring option and need to DESELECT all but one. If there is no text between the dashes above, you have not included any control system interface tailoring option. Select ONE of the control system interface tailoring options for inclusion.

Service Tailoring Option

This specification also includes tailoring options for the Service (Air Force, Army, Navy) the specification is used for. There is a "NAVY ACCEPTANCE ENGINEER" tailoring option that is used on Navy projects which have an Acceptance Engineer. There is a "Service Generic" tailoring option that can also be used when none of the other services tailoring options apply. Only ONE of the five tailoring options related to the services should be used. You have currently included the following option:

AIR FORCE

ARMY

NAVY

NAVY WITH ACCEPTANCE ENGINEER

SERVICE GENERIC

If more than one item appears between the dashes above, you have included more than one service tailoring option and need to DESELECT all but one. If there is no text between the dashes above, you

have not included any service tailoring option. Select ONE of the service tailoring options for inclusion.

****

PART 1 GENERAL

****

NOTE: Coordinate the use of this specification with other sections, as appropriate, in order to specify a complete HVAC built-up system.

****

Submit equipment and performance data for each DOAS consisting of use life, total static pressure, all entering and leaving temperatures of each component, fan curves, provide psychrometric chart with processes shown for both summer and winter conditions, power ratings, capacity ranges, face area classifications, rotational velocities, controls instrument locations [with recommended installation locations], [and][all information shown on the equipment schedule on the design drawings][and][_____].

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

[Design and construction must comply with current applicable Host Nation codes and standards. In case of conflicting U.S. and H.N. codes and standards, the most stringent must apply, unless otherwise specified by the applicable Bilateral U.S./H.N. Agreements.

] AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 201	(2002; R 2011) Fans and Systems

AMCA 204	(2005; R 2012) Balance Quality and Vibration Levels for Fans
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
AHRI 430	(2009) Central-Station Air-Handling Units
AHRI 490 I-P	(2011) Performance Rating of Remote Mechanical-Draft Evaporatively-Cooled Refrigerant Condensers
AHRI 540	(2015) Performance Rating Of Positive Displacement Refrigerant Compressors And Compressor Units
AHRI 920 I-P	(2020) Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units
AHRI 921 SI	(2020) Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units
AHRI 1060 I-P	(2014) Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Heat Equipment
AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 370	(2015; Addendum 1 2016) Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 640	(2005) Performance Rating of Commercial and Industrial Humidifiers

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality
ASHRAE 64	(2020) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers
ASHRAE 84	(2024) Method of Testing Air-to-Air Heat/Energy Exchangers

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B280	(2023) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D4587	(2011; R 2019; E 2019) Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST RP-CC-001	(2016; Rev 6) HEPA and ULPA Filters

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1884	(2003) Fibrous Glass Duct Construction Standards, 7th Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-200-01	(2022; with Change 4, 2024) DoD Building Code
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

UL SOLUTIONS (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 705	(2017; Reprint Sep 2024) UL Standard for Safety Power Ventilators
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Compressor; G, [_____]

Coils; G, [_____]

Controls; G, [_____]

Unit Cabinet; G, [_____]

Casing; G, [_____]

Air-Cooled Condenser; G, [_____]

Evaporative Condenser; G, [_____]

Installation Drawings; G, [_____]

SD-03 Product Data

Equipment and Performance Data; G, [_____]

Air-Conditioning Systems; G, [_____]

Compressor; G, [_____]

Coils; G, [_____]

Fans; G, [_____]

Controls; G, [_____]

Unit Cabinet; G, [_____]

Casing; G, [_____]

Air Filters; G, [_____]

Air-Cooled Condenser; G, [_____]

Evaporative Condenser; G, [_____]

Energy Recovery Devices; G, [_____]

[Humidifier; G, [_____]

] SD-06 Test Reports

Refrigerant Tests, Charging, and Start-Up; G, [_____]

System Performance Tests; G, [_____]

SD-07 Certificates

List of Product Installations

Manufacturer's Warranty; G, [_____]

[Coil Coating Warranty; G, [_____]

] SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

****

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and Section 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW).

****

Operation and Maintenance Manuals, Data Package 2

1.3 RELATED DOCUMENTS

****

NOTE: If the following sections are not included in the project specification, insert applicable requirements and delete the following paragraphs as needed.

****

[Section 01 45 00 QUALITY CONTROL applies to work specified in this section.

][Section 01 91 00.15 BUILDING COMMISSIONING applies to work specified in this section.

][Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT applies to work specified in this section.

][Section 23 05 48.19 [SEISMIC] BRACING FOR HVAC applies to work specified in this section.

][Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC applies to work specified in this section.

][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC applies to work specified in this section

][Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC applies to work specified in this section.

][Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS applies to work specified in this section.

][Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS applies to work specified in this section.

][Section 23 23 00 REFRIGERANT PIPING applies to work specified in this section.

][Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

][Section 23 81 00 DECENTRALIZED UNITARY HVAC EQUIPMENT applies to work specified in this section.

][Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS applies to work specified in this section.

]1.4 QUALITY CONTROL

Submit a list of product installations of each DOAS showing a minimum of five installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Provide a list that includes the purchaser, address of installation, service organization, and date of installation.

1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 5 years prior to bid opening. The 5-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 5 year period.

1.4.2 Service Support

The equipment items must be supported by service organizations. Submit a certified list of a minimum of three qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract within [24][48][_____] hours.

1.4.3 Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.4.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer. "Authority having jurisdiction" must be in accordance with the applicable year of UFC 1-200-01 DOD BUILDING CODE.

1.4.5 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.4.6 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.5 DELIVERY, STORAGE AND HANDLING

Handle, store, and protect equipment and materials to prevent damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Additionally, cap or plug all pipes until installed. Replace damaged or defective items.

1.6 ELECTRICAL WORK

****

NOTE: Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm on the drawings in the equipment schedules.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting interferes with other electrical equipment and circuits and when recommenced by the manufacturer. Where adjustable speed drives (SD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01 INTERIOR ELECTRICAL SYSTEMS.

****

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system , and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

e. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.

1.7 INSTRUCTION TO GOVERNMENT PERSONNEL

****

NOTE: Coordinate this with paragraph OPERATION AND MAINTENANCE TRAINING.

****

Furnish the services of competent instructors to give full video recorded instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work. Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section.[When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.]

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.8 ACCESSIBILITY

****

NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when he has some control over locations. However, designer's should not rely on it at all since enforcing this requirement in the field would be difficult. Therefore, the system

designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors. Contractor and manufacturer are responsible for verifying equipment, including any additional parts such as controls devices and other equipment requiring access, fits in the space provided. The Government review does not relieve contractor from delivering the product that meets minimum capacity and mandatory efficiency requirements to meet all codes and standards.

1.9 WARRANTY

Submit the manufacturer's warranty for the unit.

[Submit the coil coating warranty.] Provide unit with the [Manufacturer's Standard Warranty.][[1 year][2 year][5 year][10 year][_____ year]manufacturer's warranty.][Provide [compressors][and][gas heat exchangers] with the[Manufacturer's Standard Warranty.][[1 year][2 year][5 year][10 year][_____ year]manufacturer's warranty.]]

PART 2 PRODUCTS

2.1 TYPES

****

NOTE: Designer must, at a minimum, comply with applicable year of ASHRAE 90.1 and ASHRAE 55 for equipment efficiencies, energy recovery effectiveness, thermal comfort, etc. All applicable design requirements should be incorporated by the designer into the contract documents.

****

****

NOTE: Coordinate with paragraph FANS and paragraph COILS.

****

Provide [single-zone draw-through type][or][single-zone blow-through type][or][multizone blow-through type][blow-through double-deck type][blow-through triple deck type] units as indicated. Units must include fans, coils, airtight insulated casing,[energy recovery devices,][required controls devices for temperature and humidity control,][prefilters,][secondary filter sections,][and][diffuser sections where indicated,][air blender] adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated,[mixing box][combination sectional filter-mixing box,][[pan][drysteam][spray type] humidifier,] vibration-isolators, and appurtenances required for specified operation. Provide vibration isolators as indicated. Physical dimensions of each air handling unit must be suitable to fit space allotted to the unit with the capacity and efficiencies indicated. Provide air handling unit that is rated in accordance with [AHRI 920 I-P] [AHRI 921 SI] [AHRI 430] [_____] and AHRI certified for cooling.[Protect outdoor air coils from incidental contact to coil fins by a coil guard. Coil guard must be constructed of cross wire welded steel with PVC coating.]

2.2 UNIT CONSTRUCTION

2.2.1 Unit Cabinet

Units must have a leakage rate not to exceed 1 percent of supply air volume to [2][2.5][_____] kPa [8][10][_____] inches water gauge static pressure in either positive or negative pressure tests. Manufacturer must provide test data confirming cabinet construction can meet the requirement. Indoor cabinets must be suitable for the specified indoor service and enclose all unit components. Outdoor cabinets must be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

****

NOTE:
Class A total static pressure to 750 pascals 3 inches water gauge.

Class B total static pressure of 750 to 1375 pascals 3 to 5.5 inches water gauge.

Class C total static pressure over 1375 pascals 5.5 inches water gauge.

****

2.2.1.1 Class A and Class B Cabinets

****

NOTE: Select the following paragraph for AMCA Class A and Class B cabinets.

****

Provide an AHU cabinet suitable for the pressure class shown and has leaktight joints, closures, penetrations, and access provisions. Provide a cabinet that does not expand or contract perceptibly when fans are starting or stopping and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.004167 of unsupported span before acceptance. Stiffen pulsating panels, which produce low-frequency noise due to diaphragming of unstable panel walls, to raise the natural frequency to an easily attenuated level. Fabricate the enclosure from continuous hot-dipped-galvanized steel no lighter than 0.91 millimeter 20 gauge thickness, to match the industry standard. Provide mill-galvanized sheet-metal that conforms to ASTM A653/A653M and that is coated with not less than 0.38 kilogram of zinc per square meter 1.25 ounces of zinc per square foot of a two-sided surface. Provide mill-rolled structural-steel that is hot-dip-galvanized or primed and painted. Corrosion-protect cut edges, burns, and scratches in galvanized surfaces. Provide primed and painted black carbon steel cabinet construction that complies with this specification.

Provide removable panels to access the interior of the unit cabinet. Provide seams that are welded, bolted, or gasketed and sealed with a rubber-based mastic. Make entire cabinet floor and ceiling hot-dipped-galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

2.2.1.2 Class C Cabinets

****
NOTE: Select the following paragraph for AMCA Class C cabinets.
****

Provide an AHU cabinet that is suitable for the pressure class shown and has leaktight joints, closures, penetrations, and access provisions. Provide a cabinet that does not expand or contract perceptibly when the fans are starting or stopping and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.002778 of unsupported span before acceptance by the Contracting Officer. Stiffen pulsating panels, which produce low-frequency noise due to diaphragming of unstable panel walls, to raise the natural frequency to an easily attenuated level. Provide the enclosure that is fabricated from mill-galvanized or primed and painted carbon sheet steel. Provide mill-galvanized sheet metal that conforms to ASTM A653/A653M and that is coated with not less than 0.38 kilogram of zinc per square meter 1.25 ounces of zinc per square foot of a two-sided surface. Provide mill-rolled structural steel that is hot-dip galvanized or primed and painted. Corrosion-protect edges, burns, and scratches in galvanized surfaces. Provide primed and painted black carbon steel cabinet construction that complies with this specification.

Provide removable panels to access the interior of the unit cabinet. Provide seams that are welded, bolted, or gasketed and sealed with a rubber-based mastic. Make the entire cabinet floor and ceiling hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

2.2.2 Casing

Provide the following:

a. [Casing sections[[single][50 mm 2 inch double] wall type][as indicated], constructed of a minimum 1.3 mm 18 gauge galvanized steel, or 1.3 mm 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304.][Inner casing of double-wall units that are a minimum one mm 20 gauge solid galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304.]Design and construct casing with an integral insulated structural galvanized steel frame such that exterior panels are non-load bearing.

b. Individually removable exterior panels with standard tools. Removal must not affect the structural integrity of the unit. Furnish casings with access sections, inspection doors, and access doors, all capable of opening a minimum of 90 degrees, as indicated.

c. Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum 1.3 mm 18 gauge outer and one mm 20 gauge inner panels made of either galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Provide rigid doors with heavy duty hinges and latches. Inspection doors must be a minimum 300 mm 12 inches wide by 300 mm 12 inches high. Access doors must be a minimum 600 mm 24 inches wide, the full height of the unit casing or a minimum of 1800 mm 6 foot, whichever is less.[Install a minimum 200 by 200 mm 8 by 8 inches sealed glass window suitable for the intended application, in all access doors.]

d. Access doors must be installed to open against the greatest pressure relative to air pressure on each side of access door. Provide 25 mm 1 inch diameter test ports with screwed caps on casing upstream and downstream of all coils and filters for pressure and temperature measurement across internal components to limit unnecessary or unauthorized access inside the unit.

e. Double-wall insulated type drain pan (thickness equal to exterior casing) constructed of 1.4 mm 16 gauge[stainless steel][corrosion resisting sheet steel conforming to ASTM A167, Type 304], conforming to ASHRAE 62.1. Galvanized steel pans are not acceptable. Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage.[When two or more cooling coils are used, with one stacked above the other, condensate from the upper coils must not flow across the face of lower coils. Provide intermediate drain pans or condensate collection channels and downspouts, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover.] Construct drain pan to allow for easy visual inspection, including underneath the coil without removal of the coil and to allow complete and easy physical cleaning of the pan underneath the coil without removal of the coil. Provide coils that are individually removable from the casing. Provide[40 mm 1.5 inch][_____] minimum drain pan connection[as indicated].

f. Casing insulation that conforms to NFPA 90A. Insulate single-wall casing sections handling conditioned air with not less than 25 mm 1 inch thick, 24 kg/cubic meter 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.033 W/m-K 0.23 Btu/hr-sf-F. Insulate double-wall casing sections handling conditioned air with not less than 50 mm 2 inches of the same insulation specified for single-wall casings. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Seal double wall insulation completely by inner and outer panels.

g. Factory applied fibrous glass insulation that conforms to ASTM C1071, except that the minimum thickness and density requirements do not apply, and that meets the requirements of NFPA 90A. Make air handling unit casing insulation uniform over the entire casing. Foil-faced insulation is not an acceptable substitute for use on double-wall access doors and inspections doors [and casing sections].

h. Duct liner material, coating, and adhesive that conforms to fire-hazard requirements specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Protect exposed insulation edges and joints where insulation panels are butted with a metal nosing strip or coat to meet erosion resistance requirements of ASTM C1071.

i. A latched and hinged inspection door, in the fan, filter and coil sections. Plus additional inspection doors, access doors and access sections [_____][where indicated].

2.2.3 Access Sections and Filter/Mixing Boxes

Provide access sections where indicated and furnish with access doors as shown. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

2.2.4 Diffuser Sections

Furnish diffuser sections between the discharge of all housed supply fans [and cooling coils of blow-through single zone units][and][filter sections of those units with high efficiency filters located immediately downstream of the air handling unit fan section]. Provide diffuser sections that are fabricated by the unit manufacturer in a manner identical to the remainder of the unit casing, designed to be airtight under positive static pressures up to [2][_____] kPa [8][_____] inches water gauge and with an access door on each side for inspection purposes. Provide a diffuser section that contains a perforated diffusion plate, fabricated of galvanized steel, Type 316 stainless steel, aluminum, or steel treated for corrosion with manufacturer's standard corrosion-resisting finish, and designed to accomplish uniform air flow across the down-stream[coil][filters] while reducing the higher fan outlet velocity to within plus or minus 5 percent of the required face velocity of the downstream component.

2.2.5 Roof Curb

****

NOTE: Roof curb must be in accordance with the Hurricane, Seismic and Wind requirements associated with the site.

****

Provide a roof curb that mates with the unit to provide support and be completely weather tight. Provide curb with sealing strips to ensure an airtight seal between supply and return openings of the curb and unit. Design curb to allow ductwork to be directly connected to the curb.[The roof curb must be provided by the Manufacturer of the equipment.][The roof curb must be a minimum of [_____] mm inches tall.][Provide an acoustical roof curb to meet noise requirements.]

2.2.6 Corrosion Protection

****

NOTE: Higher Corrosion Protection is required in high-humidity locations and coastal environments.

****

****

NOTE: Refer to UFC 1-200-01 DoD Building Code, Chapter 4 for additional requirements for corrosion protection.

****

Provide the interior of the unit with corrosion protection which must be capable of withstanding at least 3000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117 test procedure. Air tunnel, fans and dampers must all include the corrosion protection. Provide all coils in contact with outside air a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Confirm corrosion durability through testing to no less than 3000 hours salt spray per ASTM B117. Coated coil must receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating is not required on coils utilizing copper tubes and copper fins.

2.2.6.1 Remote Outdoor Condenser Coils

Epoxy Immersion Coating - Electrically Deposited: The multi-stage corrosion-resistant coating application comprised of cleaning (heated alkaline immersion bath) and reverse-osmosis immersion rinse prior to the start of the coating process. Maintain the coating thickness between 0.6-mil and 1.2-mil. Before the coils are subjected to high-temperature oven cure, treat to permeate immersion rinse and spray. Where the coils are subject to UV exposure, apply UV protection spray treatment comprising of UV-resistant urethane mastic topcoat. Provide complete coating process traceability for each coil and minimum five years of limited warranty. The coating process must be such that uniform coating thickness is maintained at the fin edges. Comply with the applicable ASTM Standards for the following:

a. Salt Spray Resistance: [500][1,000][3,000][6,000][10,000][_____] hours (ASTM B117)

b. Humidity Resistance (Minimum 1,000 Hours)

c. Water Immersion (Minimum 260 Hours)

d. Cross-Hatch Adhesion (Minimum 4B-5B Rating)

e. Impact Resistance (Up to 160 Inch/Pound)

2.2.6.2 Exposed Outdoor Cabinet

****

NOTE: Recommend minimum salt-spray resistance of 3,000 hours unless specifically not required.

****

Casing Surfaces (Exterior and Interior): Protect all exposed and accessible metal surfaces with a water-reducible acrylic with stainless steel pigment spray-applied over the manufacturer's standard finish. The spray coating thickness must be 2-4 mils and provide minimum salt-spray resistance of [500][1,000][3,000][6,000][10,000][_____] hours (ASTM B117) and [500][1,000][_____] hours UV resistance (ASTM D4587).

Provide outdoor cabinets with a roof panels sloped at a minimum pitch of 2 percent 1/4 inch per foot. The roof must overhang side and end panels by a minimum of 50 mm 2 inches.

2.2.6.3 Corrosion Protection for Coastal Installations

****

NOTE: Use this paragraph for Navy projects only.

Specify corrosion protection for exterior HVAC equipment, including air handling units, heat exchanger coil surfaces, equipment casings, air-cooled water chiller coils, heat pumps, and air conditioning units, that is exposed to the weather within 8 km 5 miles of a sea (salt) water coast.

At these coastal locations, this corrosion protection is also required on HVAC equipment within

buildings that are subject to the outside weather conditions. Specifically, equipment requiring protection is defined as the first HVAC equipment (excluding louvers) met by the outside air in the supply air ductwork system.

Specifier will survey the HVAC equipment market place, find and specify the manufacturer's standard off-the-shelve anti-corrosion options for "coastal" or "sea coast" installations. Specify the various systems (utilizing the word "or") offered by three competitive equipment selections. This approach is by far less costly than specifying custom corrosion protection.

Manufacturer's standard off-the-shelve anti-corrosion options for "coastal" or "sea coast" installations also vary with type and size of HVAC equipment.

After thorough investigation of the commercial market, determines manufacturer's standard off-the-shelve anti-corrosion options are not available for the selected equipment, contact the Mechanical Design Branch, NAVFAC LANT for consultation if the need for this protection is considered mandatory by the station.

For installations at MCAS Cherry Point and MCB Camp LeJeune, including New River, and installations at NAS Oceana including Dam Neck, specify corrosion protection for all outside, and specific inside HVAC equipment exposed to the weather. Follow the guidance specified in the criteria NOTE above.
****

[_____]

2.3 FANS

****

NOTE: Refer to UFC 3-450-01, Noise and Vibration Control for vibration criteria. Detail vibration isolation required on the drawings and include it in the appropriate schedule. Include any applicable noise criteria in appropriate equipment schedule on the drawings.

Design and detail ductwork near air moving devices to minimize system effect on the fans in accordance with AMCA 201. Add system effect to the duct friction loss and indicate fan static pressure on drawings for the designed ductwork configuration.

Indicate the location of each duct smoke detector in the HVAC system and include the detectors on the schematic and associated ladder diagram. Provide duct smoke detectors according to NFPA 90A. Duct

detectors are intended to shut associated air distribution fans and smoke dampers, if provided. Duct smoke detectors are not for use inside ducts where ambient temperatures exceeds 38 degrees C 100 degrees F.

When the building is equipped with a fire alarm system, connect the duct smoke detectors to the fire alarm control panel (FACP) for alarm initiation. Show wiring to the FACP for either new or existing fire alarm systems.

Fans with motors greater than 0.5 kW 3/4 hp must have automatic controls capable of shutting off fans when not required.

HVAC systems having a total fan system power exceeding 3.7 kW 5 hp must meet the provisions of ASHRAE 90.1. These include ASHRAE 90.1, Table 6.5.3.1, Fan Power Limitation:

For supply air volumes less than 9,400 L/s 20,000 cfm the allowable nameplate motor power for a constant volume fan is 1.9 kW/1000 L/s 1.2 hp/1000 cfm and for a variable volume fan is 2.7 kW/1000 L/s 1.7 hp/1000 cfm.

For supply air volumes of 9,400 L/s 20,000 cfm and greater the allowable nameplate motor power for a constant volume fan is 1.7 kW/1000 L/s 1.1 hp/1000 cfm and for a variable volume fan is 2.4 kW/1000 L/s 1.5 hp/1000 cfm.

****

a. Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than [150][140][120] percent of the connected driving capacity. Provide variable pitch motor sheaves for 11 kW 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

b. Each fan/motor assembly must be factory balanced to AMCA 204, [BV-5, Balance Quality Grade G1.0][BV-4, Balance Quality Grade G2.5][BV-3, Balance Quality Grade G6.3][Balance Quality Grade indicated on Drawings][_____] or better through entire operating speed range from minimum speed to maximum speed.

c. Mount fan/motor on [aluminum][galvanized-steel][or][powder-coated steel]base. Include base and vibration isolators in accordance with requirements indicated. Weld structural members to form a rigid base. Size and design the base construction to withstand the rigors of shipping and rigging. Include the base with lifting lugs or holes.

d. Each fan/motor assembly must be capable of lock-out/tag-out procedure without interrupting operation of other fans in air-handling unit. Fan wheel/motor assembly must pass through the air-handling unit access door servicing fans. Design and incorporate features to permit safe, rapid, and economical maintenance.

e. Include easily removable safety screens where fan inlet and outlet are exposed to maintenance personnel, including walk-in air-handling unit plenums.[Safety screens are not required on fan inlets and outlets with backdraft dampers.] Safety screens must be expanded-metal or wire screens, fastened to a flat bar perimeter frame. Screens must comply with OSHA requirements. Screens and frame must be constructed of aluminum, stainless steel, or powder-coated steel. Fasten screens to fan using removable and reusable hardware designed for easy removal by maintenance personnel.

2.3.1 Centrifugal Fan Arrays

****

NOTE: Determine sizing, number of fans, and redundancy requirements based on project needs.

****

Fan arrangement within fan array must produce a uniform airflow and velocity profile across air-handling unit air tunnel when measured[300 mm 12 inches][_____] upstream of fan inlet and[1200 mm 48 inches][_____] downstream of fan inlet. Remaining fans in array must continue to operate with one or multiple failed fans. A single mechanical, electrical, and control device failure must not result in a fan array available capacity of less than [33][_____] percent of air-handling unit total scheduled airflow capacity.

Each fan/motor assembly must be controlled through a variable-frequency controller, except for fans with electronically commutated (EC) motors having integral motor controls.[Include a dedicated variable-frequency controller for each fan/motor assembly in the fan array.][If fan array is served from a single variable-frequency controller, include a redundant variable-frequency controller with automatic switchover in event of primary variable-frequency controller failure.]

[2.3.1.1 Airflow Measurement

****

NOTE: Retain paragraph below to include airflow measurement as integral part of air-handling unit.

****

Each fan within fan array must include airflow measurement indication in L/s cfm. Include airflow totalization of all operating fans in fan array. Airflow measurement instrumentation must not restrict or deflect air travel through fan and must not impact fan air and sound performance. Include digital display of individual fan airflow and total fan array airflow on face of fan control panel. Include a 4- to 20-mA output signal for remote monitoring of total fan array airflow.

]2.3.1.2 Fan Array Control

****

NOTE: Retain one of the two paragraphs below.

****

[Include fan control panel with operator interface to control fan array locally through the fan control panel and to switch to control of fan array through a remote-control source. Local control must include on/off operation [and speed adjustment]for entire fan array and each individual fan/motor in fan array.

a. The component panel functional intent is manual operation of the fan array which is independent from the building automation system and automated control for the VFD / ECM motor by the building automation system. The component panel must provide all life safety and HVAC equipment safeties AHU shutdown interlocks wired to termination blocks.

b. The component panel must be designed using only ladder logic hard wired methods and must not execute any programmed logic specified in the sequence of operation which cannot be submitted in a ladder wiring diagram. The component panel must provide all relevant inputs and outputs necessary for the building automation system to execute the specified sequence of operation.

c. Coordinate component panel design with Division 25. Submit design for approval prior to construction of component panel. Laminate final approved as-built ladder wiring diagram and mount inside component panel door.

][Include fan control panel with control interface for remote control. Fan array on/off operation must be remotely controlled through a single hardwired digital output signal. Fan array speed must be remotely controlled through a single hardwired analog (4- to 20-mA) output signal.

]2.3.1.3 Fan Array Construction

Include a precision-spun or die-formed, matched inlet and wheel cone to ensure streamlined airflow into the wheel and full loading of fan blades. Inlet cone must be a smooth hyperbolic shape. Inlet cone must be a single piece, constructed of aluminum or powder-coated steel. Fasten inlet cone to fan panel using bolts, nuts, and washers to provide a positive and secure attachment that can be field removable. Fan blades must be a true hollow airfoil shape, welded to backplate and wheel cone. Construct blades of aluminum, reinforced for AMCA fan class. Design blades to provide smooth airflow over all surfaces of blade. Construct fan hubs of aluminum with integral bracing for extra strength and stiffness. Castings must be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects. Clean surfaces of castings by blasting, pickling, or any other standard method. Mold-parting fins and remains of gates and risers must be chipped, filed, and ground flush. Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance. Hubs must be keyed and setscrewed to motor shaft for positive attachment. Construct wheel backplates of aluminum. Select entire rotating assembly so first critical speed is at least [30][_____] percent greater than fan design speed and at least [20][_____] percent greater than maximum speed in AMCA fan class.

Fan must be direct drive, arrangement 4 in accordance with AMCA 99. Adjust wheel width and diameter to match motor speed while providing performance scheduled. Fasten fan wheel directly to motor shaft using a key in motor shaft and setscrew. Construct motor base and pedestal supports of [aluminum][galvanized steel][or][powder-coated steel].

2.3.1.4 Fan Array Motors

****

NOTE: Retain one of two bracketed paragraphs below and coordinate with Fan Motors paragraph.

****

[See Fan Motors for more information.

][Provide Electronically Commutated (EC), variable-speed, dc, programmable brushless motor with integral controller/inverter that operates a wound stator and senses rotor position to electronically commutate the stator. Controller must control motor speed either through manual adjustment locally at fan array control panel or through a remote 0- to 10-V-dc control signal. Coordinate motor mounting with driven equipment. Motor must be suitable for mounting with motor shaft in either horizontal or vertical position. Motor must be suitable for operation at site altitude and ambient temperature range. Electrical characteristics must be suitable for operation with field power source. Coordinate with electrical installer. Motor efficiency must comply with governing energy codes; [80][_____] percent or higher maintained throughout entire operating range. Power Factor must be [0.9][_____] or higher at full load. Service Factor must be 1.0 or higher.

a. Provide with zero to 100 percent variable speed control. Controller must be capable of synchronous speed rotation with no slip losses, gradual ramp-up to set point upon receiving a start signal, soft speed change ramps, overcoming reverse rotation without impact, and controlling airflow within 5 percent of set point regardless of static pressure.

b. Provide with thermal protection to automatically break electrical power to motor when temperature exceeds a safe value and automatically resets and restores power when temperature returns to normal range.

c. Bearings must be sealed and permanently lubricated ball bearings. Enclosure must be ODP or TEFC. Insulation must be Class B or Class F. Rotor must be permanent magnet with near zero rotor losses that operates independent of motor current.

d. Enclosure and Frame must be constructed of aluminum, painted steel, or stainless steel. End brackets must be cast aluminum. Shaft must be steel or stainless steel. Motor leads must be Pin or screw terminals. Provide with manufacturer's standard nameplates and paint.

]2.3.1.5 Fan Array Discharge

****

NOTE: Retain paragraph below to add fan discharge enclosure for physical separation between operating fans without sound attenuation.

****

[Include each fan in fan array with integral single-wall enclosure constructed of solid [aluminum][galvanized-steel][or][powder-coated steel]sheet. Enclosure must not increase fan array length beyond size indicated on Drawings. Enclosure must not add static pressure loss. Enclosure must provide a physical separation between operating adjacent fans to prevent negative performance.

] **

NOTE: Retain paragraph below to add fan discharge sound attenuation. Consult manufacturers about expected sound attenuating performance.

****

[Include each fan of fan array with integral sound silencer enclosure to reduce the bare fan discharge sound levels by at least [8][15][_____] dBs through octave band frequencies from 125 to 8000 Hz. Enclosure must not increase the fan array length beyond size indicated on Drawings. Silencing enclosure must not add static pressure loss. Double-wall construction consisting of sound-absorbing insulation sandwiched between a solid metal outer skin and perforated metal inner skin. Outer skin material must be[Aluminum][Galvanized steel][Powder-coated steel]. Inner skin material must be [Aluminum][Galvanized steel][Powder-coated steel]. Insulation must be [Mineral fiber][mineral fiber wrapped in a tight woven fiberglass cloth or polymer sheet][or][fiber free]. Enclosure must provide a physical separation between operating adjacent fans to prevent a negative performance.

]2.3.1.6 Fan Array Accessories

****

NOTE: Retain paragraph below to include backdraft dampers on fans.

****

[Include each fan in the fan array with a backdraft damper at the fan [inlet][or][outlet] to prevent air circulation through a fan that is not operating. Open backdraft damper when fan is operating and close when fan is not operating. Design backdraft damper assembly to operate with little to no static pressure loss with fan operating throughout entire operating range from design to minimum airflow. Add damper pressure loss to fan scheduled total static pressure. If pressure loss requires a change field electrical power, air-handling unit manufacturer must be responsible for associated cost of change. Fasten backdraft damper assembly to fan panel or enclosure using hardware designed for easy removal by maintenance personnel. Dampers must not create measurable additional noise above the sound level of fan. Dampers must not vibrate or rattle. Construct dampers of extruded aluminum, stainless steel, or powder-coated steel.

] **

NOTE: Retain paragraph below to include blank-off panels to prevent bypass airflow through individual fans that are not operating. Coordinate with backdraft paragraph above. Fan arrays with backdraft dampers do not require blank-off panels.

****

[Include[one][two][10 percent of][_____] blank-off panel(s) with each air-handling unit fan array for use by operators in the field to prevent air circulation through any of the fans in fan array that are not operating. Design blank-off panels for attachment to fan panels using easily removable and reusable hardware. Construct blank-offs of aluminum, stainless steel, or powder-coated steel sheets, not less than[1.8 mm 0.07 inch][_____] thick. Mount fan blank-off panels in the fan inlet access section for convenient operator access and use in the future.

]2.3.2 Centrifugal Plenum Fans

a. Construct fan panel of aluminum or powder-coated steel. Support fan wheel and bearings from a structural aluminum or powder-coated steel framework. Reinforce and brace fan panel to prevent vibration and pulsation. Include stiffeners to form a rigid panel that is free of structural resonance and vibration.

b. Include a precision-spun or die-formed, matched inlet and wheel cone to ensure streamlined airflow into the wheel and full loading of blades. Inlet and wheel cones must be hyperbolic. Inlet cone must be a single piece, constructed of aluminum or powder-coated carbon steel. Fasten inlet cone to fan panel using bolts, nuts, and washers to provide a positive and secure attachment that can be field removable. Inlet cones that are held in place using retaining clips are unacceptable.

c. Fan blades must be a true hollow airfoil shape,[continuously] welded to backplate and wheel cone. Construct blades of aluminum, reinforced for AMCA fan class and operating conditions scheduled. Design blades to provide smooth and aerodynamic airflow over all surfaces of blade. Construct fan hubs of cast aluminum or cast iron, ASTM A48/A48M Class 20A and better, with integral bracing for extra strength and stiffness. Castings must be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects. Clean surfaces of castings by blasting, pickling, or other standard method. Mold-parting fins and remains of gates and risers must be chipped, filed, and ground flush. Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance. Hubs must be keyed and set-screwed to shaft for positive attachment. Construct the wheel backplates of aluminum. Statically and dynamically balance fan wheel before fan is assembled. Select entire rotating assembly so first critical speed is at least [30][_____] percent greater than fan design speed and at least [20][_____] percent greater than maximum AMCA class speed.

****

NOTE: Only direct drives are indicated. If applications require belt-drive plenums fans, copy

requirements for belt drives indicated in HOUSED CENTRIFUGAL FANS paragraph and revise to suit application.
****

d. Fans must be direct drive, arrangement 4 in accordance with AMCA 99 for single-width, single-inlet fans. Adjust wheel width and diameter to match motor speed while providing performance scheduled. Fasten fan wheel directly to motor shaft using a key and setscrew as previously specified. Construct motor base and pedestal of aluminum or powder-coated carbon-steel plate.

2.3.3 Housed Centrifugal Fans

Continuously weld housing constructed of [aluminum][carbon-steel][or][stainless steel]sheets, plates, and structural shapes. Support fan housing and shaft bearings from a rigid structural framework. Brace fan housing to prevent vibration and pulsation with external stiffeners to form a rigid housing that is free of operating resonance. Extend fan housing side sheets not more than[13 mm 1/2 inch][_____] past fan scroll. Fan Cut-off: Designed for pressure distribution required by the application. Fan Blast Area: At least [80][_____] percent of fan outlet area. Wheel Removal: Construct fan housing for fan wheel(s) removal through the inlet opening when the inlet cone is removed.

2.3.3.1 Housed Centrifugal Fan Construction

****
NOTE: Retain the following subparagraphs below as needed for the indicated items. These include requirements for:

a. Split housings on large fans for enhanced access.
b. Access doors for enhanced access.
c. Drains on fans capable of accumulating moisture.
d. Fans with flanged discharge connections.
e. Fans with flanged inlet connections.
****

[a. For fans with wheel diameters nominal[1225 mm 49 inches][_____] and larger, include diagonally flanged, gasketed, and bolted split housings.

][b. Provide access doors with quick-opening, gasketed, with heavy-duty latches. Conform to housing contour. Locate in 5 o'clock or 7 o'clock position about the end of the shaft and position to gain internal access. Maximize size of square access door up to[600 mm 24 inches][_____].

][c. Provide[DN 25 NPS 1][_____] female NPT threaded half coupling welded to lowest point of fan housing. Position the drain connection to accommodate field-installed drain piping. Include each drain coupling with a stainless steel threaded plug.

][d. Provide welded flanged discharge with a matching companion flange having evenly spaced holes for threaded hardware.

][e. Provide welded flanged inlet with a matching companion flange having evenly spaced holes for threaded hardware.

] f. Include precision-spun or die-formed, matched inlet and wheel cones with hyperbolic shape to ensure streamlined airflow into the wheel and fully load the blades for efficient aerodynamic performance. Inlet cone must be a single piece, constructed of[aluminum][carbon steel][or][stainless steel]. Fasten inlet cone to fan housing using bolts, nuts, and washers to provide a positive and secure attachment that can be removed and replaced in the field.

Provide fan blades with true hollow airfoil shape, continuously welded to backplate or centerplate and wheel cone(s). Construct blades of[aluminum][carbon steel][or][stainless steel], reinforced for AMCA fan class. Design blades to provide smooth and aerodynamic airflow over all surfaces of blade. Construct fan hubs of[cast aluminum][cast iron, ASTM A48/A48M Class 20A and better][or][stainless steel], with integral bracing for extra strength and stiffness. Castings must be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects. Clean surfaces of castings by blasting, pickling, or other standard method. Mold-parting fins and remains of gates and risers must be chipped, filed, and ground flush. Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance. Key and setscrew hubs to shaft for positive attachment. Construct wheel backplates or centerplates of[aluminum][carbon steel][or][stainless steel]. Statically and dynamically balance fan wheel before fan is assembled. Select entire rotating assembly so first critical speed is at least [30][_____] percent greater than fan design speed and at least [20][_____] percent greater than maximum AMCA class speed.

[2.3.3.2 Housed Centrifugal Fan Drive

****

NOTE: Retain paragraph below for belt-drive fan applications and for direct-drive fan applications with a drive coupling. Paragraph is not required for applications where fan wheel is directly connected to motor shaft.

****

Fan shaft must be one piece, solid [carbon][or][stainless] steel, accurately turned, ground, polished, and inspected. Polish shafts at the point of bearing contact to comply with bearing manufacturer's recommended tolerances. Inspect shafts for straightness after the keyways are cut. Coat carbon-steel shafts with a rust-inhibitive coating. Fan bearings must be foot-mounted type, bolted on a rigid welded steel framework that is integral with, or independent of, the housing. Size bearings for L-10 life of at least [200,000][_____] hours, a DN factor less than [200,000][_____] and a load factor less than [2,700,000][_____] at the maximum fan class load limit horsepower, including belt pull. Select bearings in accordance with [ABMA 9][and][or][ABMA 11].

Bearings for Fans with Motor Horsepower up to[7.5 kW 10 HP][_____]: Single-row ball or spherical bearings, self-aligning, grease lubricated, and housed in a pillow block housing. Bearings for Larger-Size Fans: Double-row spherical, self-aligning, grease lubricated, and housed in a horizontally split pillow block housing. Extend [copper][or][plastic] grease lines to an accessible location within sight of bearing for greasing the bearings without removing guards, inlet screens, linkages, and other appurtenances. Terminate bearings and extended grease lines with grease gun fittings.

[2.3.3.2.1 Direct Drive

****
NOTE: Retain subparagraph below for direct-drive fan applications.
****

Fans must be direct drive Double-Width, Double-Inlet: Arrangement 7 in accordance with AMCA 99. Single-Width, Single-Inlet: Arrangement [4][or][5] in accordance with AMCA 99. For AMCA arrangements 4 and 5, fasten fan wheel directly to motor shaft using a key and setscrew indicated. Construct motor base and pedestal for AMCA arrangement 4 and 7 fans of[aluminum][carbon-steel][stainless steel] plate.

][2.3.3.2.2 Belt Drive

****
Retain paragraphs below for belt-drive fan applications.
****

Fans must be Multiple V-Belt Design. Size two belt drives for at least [2.0][_____] times the fan motor horsepower. Size belt drives with more than two belts, for at least [1.5][_____] times the fan motor horsepower. Coordinate, with motor manufacturer, the size and location of motor sheave required to satisfy motor L-10 bearing life using motor manufacturer's written instructions.

]]2.3.3.3 Additional Fan Requirements

****
NOTE: Retain paragraphs below for belt-drive fan applications.
****

[a. Sheave and V-belt selections must be in accordance with manufacturer's published data. For constant-Speed Applications, utilize fixed or variable sheaves for applications up to[4 kW 5 hp][_____] and fixed sheaves for applications with larger horsepower. For variable-speed applications, utilize fixed sheaves. Sheave profile must be machined to Mechanical Power Transmission Association Standards. Construct sheaves of high-strength cast iron having a minimum tensile strength of[172.4 MPa 25,000 psi][_____]. Sheave rim speeds must not exceed[25.4 m/s 5000 fpm][_____]. Sheave side wobble and runout, and eccentricity must be within Mechanical Power Transmission Association and Rubber Manufacturers Association (RMA) tolerances. Balance sheaves to satisfy vibration performance requirements. Mount sheaves on the shaft using a taperlock split and keyed bushing or an integral keyed bushing. V-belts must be oil resistant, non-static conducting, and high quality in accordance with RMA standards. Classic A, B, C, D, and E, non-cogged, cross sections. Multiple belt drives must be a matched set with belt tolerances in accordance with RMA standards. Tension belts in accordance with manufacturer's written instructions.

b. Furnish and factory install fan drive guard(s) for bearing assemblies, rotating shafts, sheaves, belts, couplings, and heat slingers. Arrangement 3 fans do not require guards for bearings on the side opposite the drive. Make provision for motor and fan rpm measurement without removing the guard. Construct the guard of flattened expanded aluminum or steel wrapped around a channel frame, suitably braced to prevent vibration. Paint guards using the same coating as fan, except color must be safety yellow. Design attachment to fan for easy removal by maintenance personnel using a clamp and latch.

] **

NOTE: Retain paragraph below for exhaust applications requiring a seal to minimize leakage.

****

[c. Provide single-width, single-inlet fans with shaft seal(s) where indicated on Drawings. Shaft seal(s) must minimize fan leakage when operating and not operating. Construct shaft seal of an aluminum or split stainless steel plate with non-asbestos material fitted under the split metal plate and seated around the shaft. Secure split plates to housing using threaded hex-head hardware. Shaft seals must be replaceable from outside the housing without disturbing the shaft or bearings. Select shaft seal clearances and materials for operating temperature, pressure, and air quality encountered. Shaft seals, including labyrinth, floating bushing, or close clearance annulus, are acceptable alternatives.

][d. Piezometer Ring: Mount piezometer ring at fan inlet cone for airflow measurement.

]2.3.4 Special Fan Construction

Where indicated on Drawings, construct individual fans with the following additional features.

2.3.4.1 Spark-Resistant Construction

Construct fans in accordance with AMCA 99[Type A][Type B][Type C] spark-resistant construction[where indicated on Drawings].

2.3.4.2 Heat Slinger

Provide for fans handling air with temperatures exceeding[65 deg C 150 deg F][_____]. Provide a cast aluminum, split-design, internally-finned rotor to create a strong circulation of air over the shaft and inboard bearing, and reduce heat conduction along the shaft to bearings. Secure the split halves together using at least two stainless steel bolts and use a setscrew to secure the assembly to fan shaft.

2.3.4.3 Corrosion-Resistant Coating

Provide Baked phenolic[, equal to Heresite's "P-4403 Brown Baked Phenolic Coating."] <Insert manufacturer's name and product name or designation.> Total Dry Film Thickness: [7][_____] mils. Application in accordance with manufacturer's written instructions. Mist bonding pass and allow to flash off for several minutes, but not long enough to allow film to completely dry. Not less than three crisscross multipasses maintaining a wet-appearing film. Air dry approximately 45 to 60 minutes with ventilation before applying heat. After air dry period has elapsed, raise temperature in recommended increments of 30 minutes until desired temperature is reached. Bake intermediate coats at approximately half the final temperature for 10 to 20 minutes. Final Bake: [205 deg C 400 deg F][_____] for 1-1/2 hours.

2.3.5 Fan Motors

a. Comply with NEMA MG 1 unless more stringent requirements are indicated. NEMA MG 1, [Design B][_____], as required to comply with capacity and torque characteristics; medium-induction motor.

b. Capacity and torque must be sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor. Provide NEMA Premium Efficiency rating complying with NEMA MG 1. Motor must operate fan under all conditions indicated without exceeding motor nameplate and without use of motor service factor. Comply with minimum requirements of Class F or Class H insulation, suitable for "inverter-duty" or "drive-duty" applications in accordance with NEMA MG 1. Motor operation through a variable-frequency controller must not adversely affect the motor performance, operation, useful life, and warranty. Motor Service Factor must be [1.15][_____]. Enclosure Type: must be [ODP][or][TEFC].

c. Provide Shaft grounding system to protect bearings from induced voltage. Shaft grounding system must have low drag (less than 0.05 percent of motor horsepower), and must operate for a minimum of 3 years without periodic maintenance or adjustments. Shaft grounding system must be mounted external [or internal] to motor enclosure. Provide frames with integrally cast feet unless other requirements of driven equipment require a different arrangement. Frame, front and back end brackets, and front and back end bearing intercaps constructed of cast iron, ASTM A48/A48M, Class 25 or better. Fabricate rotor frame from die-cast aluminum, copper, or associated alloys. Key rotors to motor shaft. Rotating assembly must be dynamically balanced to within limits defined in NEMA MG 1. Motors must have the entire rotating assembly between bearing inner caps coated with a corrosion-resistant coating.

d. Copper windings must be spike resistant to withstand 1600 peak V. Entire wound and insulated stator coated with a coating to protect against moisture and corrosion.

e. Solid shaft fabricated of[carbon][Type 304 stainless][Type 316 stainless][Type 416 stainless] steel, accurately turned, ground and polished, and inspected for accuracy. End of shaft with drilled hole for use in field measurements.

f. Grease-lubricated ball or roller bearings. ABMA 11 L-10 motor bearing life of [100,000][_____] hours. Factory lubricate motor bearings using a premium moisture-resistant polyurea thickened grease with rust inhibitors suitable for extreme operating temperatures encountered. Coordinate special requirements that may impact lubrication and include appropriate lubrication.

g. Equip each bearing housing with an easily accessible grease inlet. Fit grease inlets with a grease fitting and protective fitting cap. Equip inlets with an automatic grease relief fitting to prevent excessive greasing. Equip each bearing housing with grease drain and threaded plug.

h. Conduit box material must be the same as frame. For motor frames 365T and below, furnish conduit boxes sized with internal volumes in accordance with NEMA MG 1. For motor frames larger than 365T, furnish conduit boxes one size larger than NEMA MG 1. Coordinate the location and mounting of conduit box with driven equipment manufacturer. Factory mount conduit box on motor. Provide NRTL-listed clamp-type grounding lug mounted in conduit box.

i. Motor leads must be non-wicking type, Class F temperature rating or better, and permanently numbered over entire length for identification. Lead terminals must be manufacturer's standard.

j. Provide motor with drain holes at the lowest point for drainage of condensate. Each drain hole with a threaded removable plug.

[k. TEFC Motor Fans must be corrosion-resistant construction, non-sparking, metallic or non-metallic, bi-directional, and keyed to shaft. Motor Fan Cover must be[Steel][Same material as frame].

] l. Motor hardware must be hex-head, high-strength, zinc-plated carbon steel or stainless steel.

m. Provide lifting eyebolts threaded into frame receptacle and designed to prevent moisture and other foreign material from entering motor cavity when eyebolt is removed.

n. Construct nameplates of aluminum or stainless steel and attach to motor frame with aluminum, stainless steel, or brass drive pins. Engrave or stamp data on the nameplate. At a minimum, include nameplate data in accordance with NEMA MG 1.[Also include ABMA bearing designation for the drive and opposite end bearing.]

o. Motor must successfully pass[500][1000][2000][_____]-hour salt spray test for corrosion in accordance with ASTM B117.

2.4 COILS

****

NOTE: Refer to UFC 1-200-01 DoD Building Code, Chapter 4 for additional requirements for corrosion protection and coordinate with CORROSION PROTECTION sub-paragraph. Research local conditions to determine the effect of corrosive atmosphere on dissimilar metals. Where condenser or evaporator coils are to be installed in corrosive atmospheres, rewrite the specification for coils and fins for these specific conditions. Consider the following coil and fin combinations based on past experience with the suitability of these materials in dealing with the local conditions.

a. Copper coil and aluminum fins, coated.

b. Copper coil and copper fins, coated.

c. Aluminum coil and aluminum fins, coated.

d. Aluminum coil and aluminum fins, uncoated.

e. Copper coil and copper fins, uncoated.

Provide either phenolic, vinyl or

epoxy/electrodeposition coating. For coils with relatively close fin spacing such as those found in most unitary equipment, the phenolic or epoxy/electrodeposition coating is preferred, as these have less tendency to bridge across the fins than vinyl, better thermal conductivity than vinyl and in many conditions weathers better than vinyl.
****

Provide fin-and-tube type coils constructed of seamless [copper][red brass] tubes and [aluminum][or][copper] fins mechanically bonded or soldered to the tubes.[Provide copper tube wall thickness that is a minimum of [0.406][0.508][0.6096] mm [0.016][0.020][0.024] inches.][Provide red brass tube wall thickness that is a minimum of [0.89][1.24] mm [0.035] [0.049] inches.][Provide aluminum fins that are [0.14][0.19] mm [0.0055][0.0075] inch minimum thickness.][Provide copper fins that are 0.114 mm 0.0045 inch minimum thickness.] Provide casing and tube support sheets that are not lighter than 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Mount coils for counterflow service. Rate and certify coils to meet the requirements of AHRI 410.[Provide factory applied phenolic, vinyl or epoxy/electrodeposition coating.]

2.4.1 Direct-Expansion Coils

****
NOTE: Use this paragraph for Army and Air Force projects only.
****

Provide suitable direct-expansion coils for the refrigerant involved. Provide refrigerant piping that conforms to ASTM B280 and clean, dehydrate and seal. Provide seamless copper tubing suction headers or seamless or resistance welded steel tube suction headers with copper connections. Provide supply headers that consist of a distributor which distributes the refrigerant through seamless copper tubing equally to all circuits in the coil. Provide circuited tubes to ensure minimum pressure drop and maximum heat transfer. Provide circuiting that permits refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Provide field installed coils which are completely dehydrated and sealed at the factory upon completion of pressure tests. Pressure test coils in accordance with UL 1995.

2.4.2 Water Coils

Install water coils with a pitch of not less than 10 mm/m 1/8 inch/foot of the tube length toward the drain end. Use headers constructed of cast iron, welded steel or copper. Furnish each coil with a plugged vent and drain connection extending through the unit casing. Provide removable water coils with drain pans. Pressure test coils in accordance with UL 1995.

2.4.3 Steam Heating Coils

Construct steam coils from cast semisteel, welded steel or copper headers, and [red brass][copper] tubes. Construct headers from cast iron, welded steel or copper. Provide fin tube and header section that float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide each coil with a field or factory installed vacuum breaker. Provide single-tube type coils with tubes not less than 13 mm 1/2 inch outside diameter, except for steam preheat coils. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure testcoils in accordance with UL 1995.

2.4.4 Steam Preheat (Nonfreeze) Coils

Provide steam-distribution-tube type steam (nonfreeze) coils with condensing tubes not less than 25 mm 1 inch outside diameter for tube lengths 1.5 m 60 inches and over and 13 mm 1/2 inch outside diameter for tube lengths under 1.5 m 60 inches. Construct headers from cast iron, welded steel, or copper. Provide distribution tubes that are not less than 15 mm 5/8 inch outside diameter for tube lengths 1.5 m 60 inches and over and 10 mm 3/8 inch outside diameter for tube lengths under 1.5 m 60 inches with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes and hold securely in alignment. Limit maximum length of a single coil to 3.66 m 144 inches. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure test coils in accordance with UL 1995.

2.4.5 Electric Heating Coil

****

NOTE: Use this paragraph for Navy projects only. Choose the second set of brackets if an air-conditioning unit for EDP is specified.

****

Provide an electric duct heater coil in accordance with UL 1995 and NFPA 70. Provide duct- or unit-mounted coil. Provide[nickel chromium resistor, single stage, strip][nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type coil. Provide coil with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Provide galvanized steel or aluminum coil casing and support brackets. Mount coil to eliminate noise from expansion and contraction and for complete accessibility for service.

2.4.6 Eliminators

****

NOTE: Use this paragraph for Navy projects only.

****

Equip each cooling coil having an air velocity of over 2 m/s 400 fpm through the net face area with moisture eliminators, unless the coil manufacturer guarantees, over the signature of a responsible company official, that no moisture can be carried beyond the drip pans under actual conditions of operation. Construct of minimum 24 gage[zinc-coated steel][copper][copper nickel][or][stainless steel], removable through the nearest access door in the casing or ductwork. Provide eliminators that have not less than two bends at 45 degrees and are spaced not more than 63 mm 2-1/2 inches center-to-center on face. Provide each bend with an integrally formed hook as indicated in the SMACNA 1884.

2.4.7 Sprayed Coil Dehumidifiers

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NOTE: Sprayed coil dehumidifiers are not recommended due to additional maintenance and the potential of mold and mildew, only use when another option is not feasible. Consider weather impacts when deciding to use this or not.

****

Provide assembly with reinforced, braced, and externally insulated galvanized steel casing, vertical in-line spray pump, bronze self-cleaning spray nozzles, galvanized steel pipe spray headers, adjustable float valve with replaceable neoprene seat, manufacturer's standard cooling coil, and welded black steel drain tank. Provide overflow drain, make-up, and bleed connection.

2.5 REFRIGERATION

****

NOTE: Designer must at a minimum comply with applicable year of ASHRAE 90.1 for equipment efficiencies and indicate required efficiencies on the equipment schedules on the drawings.

****

2.5.1 Air-to-Refrigerant Coils

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NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive or coastal environments.

****

Provide air-to-refrigerant coils with [seamless copper][or][aluminum] tubes of 8 mm 5/16 inch minimum diameter with [copper][or][aluminum] fins that are mechanically bonded or soldered to the tubes. Casing must be [galvanized steel][or][aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and must be suitable for the working pressure of the installed system. Factory pressure and leak test each coil.

a. Provide separate expansion devices for each compressor circuit. Condensate drain pans must be removable and double-sloped.

b. Dual compressor units must have intermingled evaporator coils.

c. Condensate drain pans must be removable and double-sloped.

[d. Provide condenser coils with hail protection guards.

] e. Coat[condenser][evaporator][condenser and evaporator] coil with a uniformly applied[epoxy electrodeposition][phenolic][vinyl][epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum [500][1000][_____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.5.2 Compressor

Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Equip compressors of 35 kW 10 tons and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor has an independent refrigeration circuit through the condenser and evaporator. Start compressors in the unloaded position. Provide each compressor with vibration isolators, crankcase heater, thermal overloads,[lubrication pump,][high][high and low] pressure safety cutoffs and protection against short cycling.

2.5.3 Refrigeration Circuit

Refrigerant containing components must comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant lines with service pressure tap ports and refrigerant line filter.

2.5.4 Remote Condenser or Condensing Unit

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NOTE: Delete the sound requirements unless the unit is located in a sound-sensitive area.

****

Units with capacities 39.5 kW 135,000 Btuh or greater must produce a maximum AHRI sound rating of [85][_____] dB when rated in accordance with ANSI/AHRI 370. Fit each remote condenser coil with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 49 degrees C 120 degrees F at 40 degrees C 95 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of [-6][13][_____] degrees C [20][55][_____] degrees F. Provide fan and cabinet construction must be provided as specified in paragraph UNIT CONSTRUCTION. Fan and condenser motors must have[open][dripproof][totally enclosed][explosion proof] enclosures.[Condensing unit must have controls to initiate a refrigerant pump down cycle at system shut down on each refrigerant circuit.][Provide outdoor unit with louvered, weather-proof enclosure for protection of integral elements.]

2.5.4.1 Air-Cooled Condenser

Provide unit rated in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit. Unit must be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

a. Provide interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit as required and as indicated. Provide electrical and refrigeration piping terminal connections between[condenser][condensing unit] and evaporator units.

b. Low ambient control for multi-circuited units serving more than one evaporator coil must provide independent condenser pressure controls for each refrigerant circuit. Set controls to produce a minimum of 40 degrees C 95 degrees F saturated refrigerant condensing temperature. Provide unit with a liquid subcooling circuit that ensures proper liquid refrigerant flow to the expansion device over the specified application range of the condenser. Unit must be provided with[manufacturer's standard][not less than [4][_____] degrees C [8][_____] degrees F] liquid subcooling. Liquid seal the subcooling circuit.

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive environments.

****

c. Coils must have[nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes.[Protect coil in accordance with paragraph COILS.] Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide separate expansion devices for each compressor circuit.

d. Provide a complete control system with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Construct unit mounted control panels or enclosures in accordance with applicable requirements of NFPA 70 and house in NEMA ICS 6, Class 1 or 3A enclosures. Controls must include[control transformer,][fan motor[starters],][solid-state speed control,][electric heat tracing controls,][time delay start-up,] overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.5.4.2 Evaporative Condenser

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NOTE: Evaporative condensers are only used in dry climates due to problems with condensate scaling and algaie formation in other climates. Verify with the user that their environmental conditions support the installation or evaporative condensers.

****

[Provide a counter-flow blow-through design, with single-side air entry.]The unit must have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of the pan section and the cabinet must not be lighter than 1.6 mm 16-gauge steel, protected against corrosion by a zinc coating. Conform the zinc coating ASTM A153/A153M and ASTM A123/A123M, as applicable and have an extra heavy coating of not less than 0.76 kg/square meter 2.5 ounces/square foot of surface. Give cut edges a protective coating of zinc-rich compound. After assembly, apply the manufacturer's standard zinc chromatized aluminum or epoxy paint finish to the exterior of the unit. Unit must be rated in accordance with AHRI 490 I-P and tested in accordance with the requirements of ASHRAE 64.

a. Provide a watertight pan complete with drain, overflow, and make-up water connections. Provide standard pan accessories to include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

b. Provide a direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fan. Do not locate fan and fan motor in the discharge airstream of the unit. Enclose motors in[open][splashproof][totally enclosed] enclosure that is suitable for the indicated service. Design the condensing unit design to prevent water from entering into the fan section.

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive environments.

****

c. Provide condensing coils with[nonferrous][copper][or][aluminum] tubes of 10 mm 3/8 inch minimum diameter without fins.[Protect coil in accordance with paragraph COILS.] Provide [galvanized steel][or][aluminum] casing. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with [a factory operating charge of refrigerant and oil][or][a holding charge].[Field charge unit shipped with a holding charge with refrigerant and oil.]

d. Provide a water distribution system that distributes water uniformly over the condensing coil to ensure complete wetting of the coil at all times. Provide[brass,][stainless steel,][or][high-impact plastic] spray nozzles that are the cleanable, non-clogging, removable type. Design nozzles to permit easy disassembly and arrange for easy access.

e. Provide [a][two] bronze-fitted [centrifugal][or][turbine] type water pump[s] that may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pumps must have cast-iron casings. Impellers must be bronze, and shafts stainless steel with bronze casing wearing rings. Use mechanical type shaft seals. Factory coat the pump casing with epoxy paint. Pump motors must have[open][drip proof][totally enclosed][explosion proof] enclosures. Provide a bleed line with a flow valve or fixed orifice in the pump discharge line and extend to the nearest drain for continuous discharge. Fully submerge pump suction and provide with a [galvanized steel][or][monel] screened inlet.

f. Provide drift eliminators to limit drift loss to not over 0.005 percent of the specified water flow. Construct eliminators of [zinc-coated steel][or][polyvinyl chloride (PVC)]. Eliminators must prevent carry over into the unit's fan section.

g. Provide the evaporative condenser unit with modulating capacity control dampers mounted in the discharge of the fan housing. On a decrease in refrigerant discharge pressure the dampers must modulate to reduce the airflow through the evaporative condenser. Controls must include a proportional acting pressure controller, a control transformer, motor actuator with linkages and end switches to cycle fan motor on and off. Cycle a fan motor on and off in accordance with the manufacturer's instructions.

[2.5.4.3 Compressor

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NOTE: Delete this paragraph if only a remote condenser is required.

****

Provide compressor rated in accordance with AHRI 540. Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Provide units 35 kW 120,000 Btuh and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor must have an independent refrigeration circuit through the condenser and evaporator. Each compressor must start in the unloaded position. Provide each compressor with vibration isolators, crankcase heater,[lubrication pump,] thermal overloads, and[high][high and low] pressure safety cutoffs and protection against short cycling.

]2.5.4.4 Fans

Provide fan wheel shafts supported by either maintenance-accessible grease lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Mount fan motor and fan assembly on a common base to allow consistent belt tension with no relative motion between fan and motor shafts. The entire fan motor and fan assembly must be completely vibrationally isolated from the unit. Select unit fans to produce the airflow required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a[n][open drip-proof][totally enclosed][explosion proof] enclosure. Provide [manual][or][automatic-reset] type thermal overload protection. Construct fan wheels of [aluminum][or][galvanized steel]. Provide centrifugal fan wheel housings of galvanized steel, and construct centrifugal fan casings of [aluminum][or][galvanized steel]. Steel elements of fans, except fan shafts, must be [hot-dipped galvanized after fabrication][or][fabricated of mill galvanized steel]. Recoat mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting with an approved zinc-rich compound. Statically and dynamically balance [fan wheels][or][propellers]. Provide double inlet[forward-curved][air foil] type fan wheels. Fan must reach rated rpm before the fan shaft passes through the first critical speed. Fans must be belt-driven with adjustable sheaves. Select the sheave size so that the fan speed at the approximate midpoint of the sheave adjustment produces the specified air quantity. Provide centrifugal scroll-type fans with streamlined orifice inlet and V-belt drive. Each drive must be independent of any other drive. Condenser fans must be propeller type, direct drive, statically balanced with galvanized steel blades and permanently lubricated ball bearings. Protect condenser fan motor drive bearings with water slingers or shields. Fit all belt drives with guards where exposed to contact by personnel.

2.6   GAS-FIRED HEATING SECTION

Construct gas-fired heat exchanger and burner of stainless steel suitable for[natural gas][liquid propane gas] fuel supply. Provide burner with[direct spark][pilot] ignition. Heating section must have modulation with a turn down ratio of at least [4][3] to 1. Provide heating section completely assembled and integral to unit. Fire test all units prior to shipment. Valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount heater section to eliminate noise from expansion and contraction and completely accessible for service. Gas equipment must bear the AGA label for the type of service involved.[Provide burner in accordance with NFPA 54.]

2.6.1   Direct Gas-Fired Heating Section

Direct gas-fired heat module(s) must have a stainless-steel burner with aluminum burner head casting, non-clogging gas ports; spark-ignition intermittent pilot, flame safeguard system with integral flame sensing, air pressure switch and automatic high limit switch set to [85][_____] degrees C [185][_____] degrees F. Burner assembly must be mechanically secured to vestibule panels. The burner combustion must be clean and odorless, with combustion efficiency limiting the products of combustion to a maximum of 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide. The burner profile to be equipped with adjustable profile plates.

2.6.2   Indirect Gas-Fired Heating Section

Heat module must be listed for outdoor installation with a Category IV venting system. Vent connectors provided must be suitable for connection to commercially available PVC pipe. Module must have [2][4][_____]-pass tubular heat exchangers, constructed of[aluminized steel][type 409 stainless steel]. Heat exchanger tubes must be installed on the vest plate by means of swaged assembly, welded connections are not acceptable. Module must be encased in a weather-tight metal housing with intake air vents.

2.7   AIR FILTERS

****

NOTE: Select filters based on the functional needs of the area served, including indoor air quality. The combination of the extended surface pleated panel filters and the extended surface nonsupported pocket filters or the cartridge filter of the same efficiency are intended to fulfill the filtration requirements in UFC 3-410-01, Heating, Ventilating, and Air-Conditioning Systems for areas where indoor air quality is of primary concern. Consider limiting the variety of filter sizes required to minimize inventory requirements for system maintenance.

In the event the retention of efficiency values in the specification becomes too cumbersome, revise the requirements by referring to the efficiencies indicated on the drawings, to show for each air handling unit or system the efficiency of the air

filters required, and the maximum initial resistance.
****

List air filters according to requirements of UL 900, except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of UL 586.

2.7.1 Extended Surface Pleated Panel Filters

Provide 50 mm 2 inch depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to ASHRAE 52.2. Provide initial resistance at 2.54 m/s 500 fpm that does not exceed 0.09 kPa 0.36 inches water gauge. Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.7.2 Extended Surface Nonsupported Pocket Filters

Provide [750][_____] mm [30][_____] inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [2.54][_____] m/s [500][_____] fpm that does not exceed [0.1125][_____] kPa [0.45][_____] inches water gauge. Provide UL Class 1 filters. Provide fibrous glass media, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Provide pockets that do not sag or flap at anticipated air flows. Install each filter [with an extended surface pleated panel filter as a prefilter] in a factory preassembled, side access housing or a factory-made sectional frame bank, as indicated.

2.7.3 Cartridge Type Filters

Provide 305 mm 12 inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [2.54][_____] m/s [500][_____] fpm that does not exceed [0.14][_____] kPa [0.56][_____] inches, water gauge. Provide UL class 1 filters, and pleated microglass paper media with corrugated aluminum separators, sealed inside the filter cell to form a totally rigid filter assembly. Fluctuations in filter face velocity or turbulent airflow have no effect on filter integrity or performance. Install each filter[with an extended surface pleated media panel filter as a prefilter] in a factory preassembled side access housing, or a factory-made sectional frame bank, as indicated.

2.7.4 Sectional Cleanable Filters

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NOTE: Delete washing and charging racks when not required.
****

Provide [25][50] mm [1][2] inch thick cleanable filters. Provide viscous adhesive in 20 L 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than one L one quart for each filter section. Provide one washing and charging tank for every 100 filter sections or fraction thereof; with each washing and charging unit consisting of a tank and[single][double] drain rack mounted on legs and drain rack with dividers and partitions to properly support the filters in the draining position.

2.7.5 Replaceable Media Filters

Provide the[dry-media][viscous adhesive] type replaceable media filters, of the size required to suit the application. Provide filtering media that is not less than 50 mm 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Enclose pad in a holding frame of not less than 1.6 mm 16 gauge galvanized steel, equipped with quick-opening mechanism for changing filter media. Base the air flow capacity of the filter on net filter face velocity not exceeding [1.5][_____] m/s [300][_____] fpm, with initial resistance of [32][_____] Pa [0.13][_____] inches water gauge. Provide MERV that is not less than [_____] when tested according to ASHRAE 52.2.

2.7.6 Electrostatic Filters

Provide the following:

a. The combination dry agglomerator/extended surface, nonsupported pocket electrostatic filters or the combination dry agglomerator/automatic renewable, media (roll) type electrostatic filters, as indicated (except as modified). Supply each dry agglomerator electrostatic air filter with the correct quantity of fully housed power packs and equip with silicon rectifiers, manual reset circuit breakers, low voltage safety cutout, relays for field wiring to remote indication of primary and secondary voltages, with lamps mounted in the cover to indicate these functions locally. Equip power pack enclosure with external mounting brackets, and low and high voltage terminals fully exposed with access cover removed for ease of installation. Furnish interlock safety switches for each access door and access panel that permits access to either side of the filter, so that the filter is de-energized in the event that a door or panel is opened.

b. Ozone generation within the filter that does not exceed five parts per one hundred million parts of air. Locate high voltage insulators in a serviceable location outside the moving air stream or on the clean air side of the unit. Fully expose ionizer wire supports and furnish ionizer wires precut to size and with formed loops at each end to facilitate ionizer wire replacement.

c. Agglomerator cell plates that allow proper air stream entrainment of agglomerates and prevent excessive residual dust build-up, with cells that are open at the top and bottom to prevent accumulation of agglomerates which settle by gravity. Where the dry agglomerator electrostatic filter is indicated to be the automatic renewable media type, provide a storage section that utilizes a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass for dry agglomerator storage section service supplied in 19.8 m 65 foot lengths in convenient roll form. Otherwise, provide section construction and roll media characteristics as specified for automatic renewable media filters. Also a dry agglomerator/renewable media combination with an initial air flow resistance, after installation of clean media, that does not exceed 62.3 Pa 0.25 inch water gauge at 2.54 m/s 500 fpm face velocity.

d. A MERV of the combination that is not less than 15 when tested according to ASHRAE 52.2 at an average operating resistance of 125 Pa

0.50 inch water gauge. Where the dry agglomerator electrostatic filter is indicated to be of the extended surface nonsupported pocket filter type, provide a storage section as specified for extended surface non-supported pocket filters, with sectional holding frames or side access housings as indicated.

e. A dry agglomerator/extended surface nonsupported pocket filter section combination with initial air flow resistance, after installation of clean filters, that does not exceed 162 Pa 0.65 inch water gauge at 2.54 m/s 500 fpm face velocity, with a MERV of the combination not less than 16 when tested according to ASHRAE 52.2. Furnish front access filters with full height air distribution baffles and upper and lower mounting tracks to permit the baffles to be moved for agglomerator cell inspection and service. When used in conjunction with factory fabricated air handling units, supply side access housings which have dimensional compatibility.

2.7.7 High-Efficiency Particulate Air (HEPA) Filters

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NOTE: Use high-efficiency particulate air filters in CLEAN ROOMS (White Rooms or Dust Controlled Facilities), clean work stations, and for critical areas of hospitals. Show the efficiency of the prefilter on the drawings. Provide efficiency that is sufficient for the anticipated contamination load and the degree of prefiltration required. Reference ASME AG-1 either all or in part when extreme temperature or humidity requirements exist. Ensure that requirements added to text from ASME AG-1 are essential to customer's needs to prevent unnecessary expenses from being added to the project, as this standard is not intended for routine commercial applications. When used, add ASME AG-1 to paragraph REFERENCES.

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Provide HEPA filters that meet the requirements of IEST RP-CC-001 and are individually tested and certified to have an efficiency of not less than [95][99.97] percent, and an initial resistance at [_____] m/s fpm that does not exceed [_____] Pa inches water gauge. Provide filters that are constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by corrugated aluminum or mineral-fiber inserts, strips of filter medium, or by honeycomb construction of the pleated filter medium. Provide interlocking, dovetailed, molded neoprene rubber gaskets of 5-10 durometer that are cemented to the perimeter of the[upstream][downstream] face of the filter cell sides. Provide self-extinguishing rubber-base type adhesive or other materials conforming to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide filter cell sides that are[19 mm 3/4 inch thick exterior grade fire-retardant plywood][cadmium plated steel][galvanized steel] assembled in a rigid manner. Provide overall cell side dimensions that are correct to 2 mm 1/16 inch, and squareness that is maintained to within 3.2 mm 1/8 inch. Provide holding frames that use spring loaded fasteners or other devices to seal the filter tightly within it and that prevent any bypass leakage around the filter during its installed life. Provide air capacity and the nominal depth of the filter as indicated. Install each filter in a factory preassembled side access housing or a factory-made sectional supporting frame as indicated. Provide prefilters of the type, construction and efficiency indicated.

2.7.8 Holding Frames

Fabricate frames from not lighter than 1.6 mm 16 gauge sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.7.9 Filter Gauges

Provide dial type filter gauges, diaphragm actuated draft for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Provide gauges that are at least 98 mm 3-7/8 inches in diameter, with white dials with black figures, and[graduations][graduated in 0.0025 kPa 0.01 inch water gauge,] with a minimum range of 0.25 kPa 1 inch water gauge beyond the specified final resistance for the filter bank on which each gauge is applied. Provide each gauge with a screw operated zero adjustment and two static pressure tips with integral compression fittings, two molded plastic vent valves, two 1.5 m 5 foot minimum lengths of 6.35 mm 1/4 inch diameter[aluminum][vinyl] tubing, and all hardware and accessories for gauge mounting.

2.8 ENERGY RECOVERY DEVICES

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NOTE: Designer must comply with applicable year of ASHRAE 90.1 for energy recovery effectiveness, including calculation methodology as part of the calculations submittal package. Include exhaust air transfer ratio (EATR) or outdoor air correction factor (OACF) in the equipment schedule on the drawings as applicable.

****

2.8.1 Energy Recovery Performance

Energy recover equipment must comply with[ASHRAE Design Guide for Dedicated Outdoor Air Systems (DOAS)][ANSI/AHRI Guideline V Calculating the Efficiency of Energy Recovery Ventilation and its Effect on Efficiency and Sizing of Building HVAC Systems][and][ANSI/AHRI Guideline W Selecting, Sizing, and Specifying Packaged Air-to-Air Energy Recovery Ventilation Equipment].

[Energy transfer ratings must be AHRI Certified to AHRI 1060 I-P and bear the AHRI certification seal for AHRI Air-to-Air Energy Recovery Ventilation Equipment Program based on AHRI 1060 I-P.][The manufacturer must provide certified performance data in accordance with ASHRAE 84 and AHRI 1060 I-P. Independent performance test results must be used to rate the product in accordance with the AHRI Air-to-Air Energy Recovery Ventilation Equipment Program.]

2.8.2 Rotary Wheel

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NOTE: Show energy recovery device supply/exhaust filters, preheat coils, backdraft dampers, exhaust dampers, recirculation dampers, face and bypass dampers, drainage provisions, controls and like

ancillaries on the drawings and supplement by the specifications as necessary. Select minimum acceptable energy transfer effectiveness and maximum acceptable cross-contamination.

Delete moisture resistance and chain drive if not required.

****

Provide unit that is a factory fabricated and tested assembly for air-to-air energy recovery by transfer of sensible[and latent] heat from exhaust air to supply air stream, with device performance according to ASHRAE 84 and that delivers an energy transfer effectiveness of not less than [70][85][_____] percent with cross-contamination not in excess of [0.1][1.0][_____] percent of exhaust airflow rate at system design differential pressure, including purging sector if provided with wheel. Provide exchange media that is chemically inert, moisture-resistant, fire-retardant, laminated, nonmetallic material which complies with NFPA 90A. Isolate exhaust and supply streams by seals which are static, field adjustable, and replaceable. Equip chain drive mechanisms with ratcheting torque limiter or slip-clutch protective device. Fabricate enclosure from galvanized steel and include provisions for maintenance access. Provide recovery control and rotation failure provisions as indicated.

2.8.3 Run-Around-Coil

****

NOTE: Delete "factory fabricated and tested" if not required.

Coordinate with paragraph GLYCOL SOLUTION in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS. Glycol is considered a hazardous waste. If the base does not have a used glycol waste program, using glycol can be an expensive maintenance item.

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Provide assembly that is factory fabricated and tested air-to-liquid-to-air energy recovery system for transfer of sensible heat from exhaust air to supply air stream and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination with maximum energy recovery at minimum life cycle cost. Computer optimize components for capacity, effectiveness, number of coil fins per inch, number of coil rows, flow rate, heat transfer rate of [_____] percent by volume of[ethylene][propylene] glycol solution, and frost control. Provide coils that conform to paragraph COILS. Provide related pumps, and piping specialties that conform to requirements of[Section 23 63 00.00 COLD STORAGE REFRIGERATION SYSTEMS][Section 23 57 10.00 10 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS][Section23 69 00.00 20 REFRIGERATION EQUIPMENT FOR COLD STORAGE] [_____].

2.8.4 Heat Pipe

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NOTE: Include face air velocity, static pressure drop, temperature requirements for entering and leaving air or exhaust streams on the equipment schedule for heat pipes.

Delete flexible connectors if not required.
****

Provide a device that is a factory fabricated, assembled and tested, counterflow arrangement, air-to-air heat exchanger for transfer of sensible heat[between exhaust and supply streams] and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination. Provide heat exchanger tube core that is [15][18][25] mm [1/2][5/8][1] inch nominal diameter, seamless aluminum or copper tube with extended surfaces, utilizing wrought aluminum Alloy 3003 or Alloy 5052, temper to suit. Provide maximum fins per unit length and number of tube rows as indicated. Provide tubes that are fitted with internal capillary wick, filled with a refrigerant complying with ANSI/ASHRAE 15 & 34, selected for system design temperature range, and hermetically sealed. Refrigerants containing chlorofluorocarbons (CFC) are prohibited. Provide heat exchanger frame that is constructed of not less than 1.6 mm 16 gauge galvanized steel and fitted with intermediate tube supports, and flange connections. Provide tube end-covers and a partition of galvanized steel to separate exhaust and supply air streams without cross-contamination and in required area ratio.[Provide a drain pan constructed of welded Type 300 series stainless steel.] Provide heat recovery regulation by[system face and bypass dampers and related control system as indicated][interfacing with manufacturer's standard tilt-control mechanism for summer/winter operation, regulating the supply air temperature and frost prevention on weather face of exhaust side at temperature indicated]. Coil must be fitted with pleated flexible connectors.

2.8.5 Desiccant Wheel

Provide counterflow supply, regeneration airstreams, a rotary type dehumidifier designed for continuous operation, and extended surface type wheel structure in the axial flow direction with a geometry that allows for laminar flow over the operating range for minimum air pressure differentials. Provide the dehumidifier complete with a drive system utilizing a fractional-horsepower electric motor and speed reducer assembly driving the rotor. Include a slack-side tensioner for automatic take-up for belt-driven wheels. Provide an adsorbing type desiccant material. Apply the desiccant material to the wheel such that the entire surface is active as a desiccant and the desiccant material does not degrade or detach from the surface of the wheel which is fitted with full-face, low-friction contact seals on both sides to prevent cross leakage. Provide rotary structure that has underheat, overheat and rotation fault circuitry. Provide wheel assembly with a warranty for a minimum of five years.

2.8.6 Plate Heat Exchanger

Provide energy recovery ventilator unit that is factory-fabricated for indoor installation, consisting of a flat plate cross-flow heat exchanger, cooling coil, supply air fan and motor and exhaust air fan and motor. The casing must be 1 mm 20 gauge G90, galvanized steel, double wall construction with 25 mm one inch insulation. Provide fibrous desiccant cross-flow type heat exchanger core capable of easy removal from the unit.

2.8.7 Plate Total Energy Exchanger

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NOTE: Coordinate filter requirements of the DOAS with the plate total energy exchanger.

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Provide enthalpy plate energy exchanger that must transfer both sensible and latent energy between outgoing and incoming air streams in a cross or counter flow arrangement with no moving parts. The enthalpy plate exchanger media must be [coated with hydrophilic resin][or][impregnated with a polymeric desiccant]. The material must allow the exchange water by direct vapor transfer using molecular transport without the need of condensation. The frame supporting enthalpy matrix must be constructed of G90 Galvanized material with end caps constructed of [1.3][1.6] mm [18][16] gauge galvanized plates. The enthalpy plate exchanger must operate at temperatures between minus 40 degrees C and 60 degrees C minus 40 degrees F and 140 degrees F.[The enthalpy plate exchanger must have a warranty of at least 5 years against manufacturing defects.][The enthalpy plate exchanger manufacturer must have at least 10 years of experience in the manufacturing of energy recovery components.]

The enthalpy plate exchanger must bear the AHRI 1060 Certified Product Seal. Sensible, latent and total effectiveness along with pressure drop, exhaust air transfer ratio (EATR) and outdoor air correction factor (OACF) rating must be clearly documented with performance tests conducted in accordance with ASHRAE 84 and per the official AHRI laboratory. The enthalpy plate exchanger must withstand pressure differentials of minimum 1.25 kPa 5 inches water gauge 2.5 kPa 10 inches water gauge. Following UL 1995, the enthalpy plate exchanger must be a UL Recognized Component and bear the UL Certification Mark (tested under UL723 with success by the UL laboratory). The exchanger must have a flame spread rating not more than 25 and a smoke developed rating not more than 50 when tested in accordance with ASTM E84. The membrane must not promote the growth of mold or bacteria and must have successfully passed ASTM G21 testing. Provide heat exchanger core capable of easy removal from the unit. Enthalpy plate exchangers must be cleanable outside of cabinet.

[2.9 HUMIDIFIER

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NOTE: Designer must decide when to use a humidifier provided by the DOAS manufacturer or to specify separately under a separate specification section. If humidifier is not provided by DOAS manufacturer, remove the entire section.

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Provide humidifiers that meet the requirements of ANSI/AHRI 640.

2.9.1 Electrode Canister Type Humidifier

Provide humidifier of the self-contained steam generating electrode type utilizing a[plastic][disposable] canister with full probes connected to electric power via electrode screw connectors. Construct the electrodes from expanded low carbon steel, zinc plated and dynamically formed for precise current control. The humidifier assembly must include integral fill cup, fill and drain valves and associated piping. Design the canister to collect the mineral deposits in the water and provide clean particle free steam to the air stream. Water chemistry requirements must be provided with humidifier submittal data.

2.9.2 Ultrasonic Type Humidifier

Provide self-contained ultrasonic type humidifier operating on the principle of ultrasonic nebulization of water. Make the casing of high-quality stainless steel. The ultrasonic humidifier must not produce any unacceptable noise radiation or frequency interference with communications or other electronic equipment. Water chemistry requirements must be provided with humidifier submittal data.

2.9.3 Gas-Fired Steam Humidifiers (Stand-Alone)

Provide a stand-alone gas-fired steam humidifier that includes an enclosed cabinet of[powder coated][baked enamel] [14][_____] gauge steel construction with an air gap between cabinet and insulated humidifier tank to ensure safe surface temperatures. Install all tank surfaces insulated with minimum 12 mm 1/2 inch thick insulation and enclosed within unit cabinetry.

Unit must include a drain water cooler to ensure drain water tempering to below 60 degrees C 140 degrees F. Humidifier must prevent "back-siphoning" using an internal air gap for supply water and the drain line must include a vacuum breaker to prevent siphon drainage of the tank in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

a. Provide a unit that includes heat treated type [316][_____] Stainless Steel combustion chamber(s) and heat exchanger(s).

b. Each burner, capable of modulation at a [5:1][_____] ratio must provide steam production as indicated on the HUMIDIFIER SCHEDULE. Provide burner in accordance with NFPA 54.

c. [Control system must seamlessly interface with temperature control system as specified in [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] without requiring gateways or any other interface devices.]Ensure that all controls equipment meets the requirements of UFC 4-010-06.

2.9.4 Electrically Heated Steam Humidifiers (Stand-Alone)

Provide a stand-alone electrically heated steam humidifier that includes an enclosed cabinet of[powder coated][baked enamel] [14][_____] gauge steel construction with an air gap between cabinet and insulated humidifier tank to ensure safe surface temperatures. Install all tank surfaces insulated with minimum 12 mm 1/2 inch thick insulation and enclosed within unit cabinetry.

Unit must include a drain water cooler to ensure drain water tempering to below 60 degrees C 140 degrees F. Humidifier must prevent "back-siphoning" using an internal air gap for supply water and the drain line must include a vacuum breaker to prevent siphon drainage of the tank in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

a. Provide a unit that includes heat treated type [316][_____] Stainless Steel combustion chamber(s) and heat exchanger(s).

b. Each humidifier must operate at the voltage and provide steam production as indicated on the HUMIDIFIER SCHEDULE.

c. [Control system must seamlessly interface with temperature control system as specified in[Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] without requiring gateways or any other interface devices.]Ensure that all controls equipment meets the requirements of UFC 4-010-06.

]2.10 CONTROLS

****

NOTE: This paragraph uses tailoring options to select the required protocol for control system interfaces for equipment.

Select Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for use on all USACE and AFCEC projects and for additions or retrofits to existing NAVFAC LonWorks systems. New NAVFAC systems should use Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Also coordinate with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

Ensure that all controls equipment meets the requirements of UFC 4-010-06 Cybersecurity of Facility-Related Control Systems.

****

2.10.1 Unit Controls

****

NOTE: In regards to head pressure control, insert the appropriate minimum or lowest expected ambient temperature. Delete head pressure controls if inapplicable. Delete low cost cooling if inapplicable.

****

Provide units internally prewired by manufacturer with a 24 volt electromechanical control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Internally protect unit by [fuses][or][a circuit breaker] in accordance with UL 1995. Units with three-phase power must be equipped with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal.

a. [Provide unit with microprocessor controls to provide all 24V control functions.]Control unit by a[two stage heating /cooling thermostat][one stage heating/cooling thermostat] with[manual][automatic] changeover.[Control unit by a programmable electronic thermostat with heating setback and cooling setup with 7-day programming capability.]

b. Provide unit with[low voltage electric controls][factory supplied DDC control system].

2.10.2 Unit DDC Controller

a. Unit controller must include input, output and self-contained programming as needed for complete control of unit.

b. All program sequences must be stored on board in EEPROM. Batteries cannot be used to retain logic program. Execute all program sequences by controller 10 times per second and must be capable of multiple PID loops for control of multiple devices. Programming of logic controller must be completely modifiable in the field over installed[BACnet LANs][LonWorks LANs].

c. Temperature Control System Interface: Points must be available from the unit controller for service access and display or control.

d. Provide device, either graphical interface or an additional laptop with communication cabling along with the manufacturer’s diagnostic software, to enable the maintenance/service technicians to log directly into the DOAS stand-alone controller for system diagnostics/maintenance.

2.10.3 Control System Interface

Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment in accordance with the manufacturer's installation instructions and manufacturer's recommendations.

Submit installation drawings for each DOAS in accordance with referenced standards in this section. Contractor and manufacturer are responsible for verifying equipment, including any additional parts such as controls devices and other equipment requiring access, fits in the space provided. The Government review does not relieve contractor from delivering the product that meets minimum capacity and mandatory efficiency requirements to meet all codes and standards.

3.2 TESTING

3.2.1 Quality Control

Test and rate components of the air-conditioning systems as a system in accordance with ANSI/AHRI 210/240.

3.2.2 SYSTEM PERFORMANCE TESTS

Before each system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Provide in electronic format.[Also provide with [six][_____] copies of the report provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets.] The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system.

For equipment providing heating and cooling the system performance tests must be performed during the heating and cooling seasons.

a. Submit a schedule, at least [2][_____] weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test. Tests must cover a period of not less than [48][_____] hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications.

b. Make corrections and adjustments, as necessary, tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, install and tighten service valve seal caps and blanks over gauge points. Replace any refrigerant lost during the system startup.

c. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest the system. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test.

d. Coordinate field tests with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit [six][_____] copies of the report provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart):

    (1) Date and outside weather conditions.

    (2) The load on the system based on the following:

        (a) The refrigerant used in the system.

(b) Condensing temperature and pressure.

(c) Suction temperature and pressure.

(d) Ambient, condensing and coolant temperatures.

(e) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Thermostatic expansion valve superheat - value as determined by field test.

(5) Subcooling.

(6) High and low refrigerant temperature switch set-points

(7) Low oil pressure switch set-point.

(8) Defrost system timer and thermostat set-points.

(9) Moisture content.

(10) Capacity control set-points.

(11) Field data and adjustments which affect unit performance and energy consumption.

(12) Field adjustments and settings which were not permanently marked as an integral part of a device.

3.3 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems must be tested and charged as specified in Section 23 23 00 REFRIGERANT PIPING. Packaged refrigerant systems which are factory charged must be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems must be tested for leaks with a halide torch or an electronic leak detector. Provide in electronic format.[Also provide with [six][_____] copies of each test containing the information described below in bound 216 by 279 mm 8-1/2 by 11 inch booklets. Individual reports must be submitted for the refrigerant system tests.]

a. The date the tests were performed.

b. A list of equipment used, with calibration certifications.

c. Initial test summaries.

d. Repairs/adjustments performed.

e. Final test results.

3.3.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances must the refrigerant be discharged into the atmosphere.

3.3.2 Contractor's Responsibility

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time must more than 85 g 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year must be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Operation and Maintenance Manuals, Data Package 2

Submit [six][_____] manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW). Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.4.2 Operation and Maintenance Training

****

NOTE: Determine the number of hours of instruction based on the number and complexity of the systems specified.

****

Conduct a video recorded training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of [16][_____] hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course. Provide a copy of the recorded training to the designated operating staff.

3.4.3 Acceptance

With the warranty, provide a cover letter/sheet clearly marked with the system name, date, and the words "Equipment Warranty" - "Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.5 PAINTING OF NEW EQUIPMENT

****

NOTE: For NAVFAC SE projects, delete all painting

requirements.
****

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.5.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system must be designed for the temperature service.

3.5.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm 1 mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm 1 mil per coat.

b. Temperatures Between 50 and 205 Degrees C 120 and 400 Degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F must receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 Degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F must receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 75 15 (February 2020)**
Change 1 - 05/24

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 75 15

CUSTOM-PACKAGED, AIRCRAFT PRE-CONDITIONED AIR UNITS

02/20, CHG 1: 05/24

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 75 15 (February 2020)**
Change 1 - 05/24

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 23 75 15

CUSTOM-PACKAGED, AIRCRAFT PRE-CONDITIONED AIR UNITS

02/20, CHG 1: 05/24

****

NOTE: This specification covers the requirements for high-pressure, preconditioned air units, ductwork and controls for aircraft cooling systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 SUMMARY

This specification covers the requirements for high-pressure, pre-conditioned air units, air distribution piping and controls for aircraft cooling systems.

1.2 RELATED SECTIONS

1.2.1 Electrical

Electrical installation must be in accordance with section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.2.2 Insulation

Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, applies to this section, with the additions and modifications specified herein.

1.2.3 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory is specified in Section 09 90 00 PAINTS AND COATINGS.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B16.25	(2022) Buttwelding Ends
ASME B31.3	(2022; Errata 2023) Process Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	(2022) Standard Specification for Stainless Steel Nuts

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 281	(2007) Rolling Bearings -- Dynamic Load Ratings and Rating Life

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE ARP5374	(2001; R 2016) Method of Testing Pre-Conditioned Air Equipment
SAE AS38386	(1999; R2013) Duct Assembly, Ground, Conditioned Air, Insulated, Flexible

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.4 SEQUENCING

Submit drawings showing foundation bolt locations, trench sizes, and access hatch points as required by paragraph PRE-CONDITIONED AIR SYSTEM DETAIL DRAWINGS prior to concrete foundation construction.

As a prerequisite to government witnessed acceptance testing, the Contractor must submit a Certificate of Completion that certifies all PCA System work and quality control documentation has been completed.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

System Supplier's Qualifications; G, [_____]

Manufacturer's Factory Test Plan; G, [_____]

Pre-Conditioned Air System Performance Test Plan; G, [_____]

SD-02 Shop Drawings

Pre-Conditioned Air System Detail Drawings; G, [_____]

SD-03 Product Data

Pre-Conditioned Air Unit; G, [_____]

Pre-Conditioned Air Piping; G, [_____]

Insulation; G, [_____]

Pre-Conditioned Air Flexible Duct, Storage And Accessories; G, [_____]

SD-05 Design Data

Insulation Thickness Calculations; G, [_____]

SD-06 Test Reports

Final Pneumatic Test; G, [_____]

Performance Test Report; G, [_____]

SD-07 Certificates

Factory Test Report; G, [_____]

Manufacturer's System Certification; G, [_____]

Certificate of Completion; G, [_____]

Notification of Pre-Conditioned Air System Performance Testing; G, [_____]

SD-08 Manufacturer's Instructions

Installation Manual; G, [_____]

SD-11 Closeout Submittals

Operation and Maintenance Manual

Training Plan

Safety Data Sheets

1.6 QUALITY CONTROL

1.6.1 System Supplier's Qualifications

PCA system supplier must have at least three previous successful PCA system installations in the last five years. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. The system supplier must supervise the installing, adjusting and testing of the equipment.

1.6.2 Pre-Conditioned Air System Detail Drawings

****

NOTE: Size PCA units for the greatest enthalpy condition when comparing the 0.4 percent dry-bulb and mean coincident wet-bulb (DB/MCWB) and the 0.4 percent humidity ratio and mean coincident dry-bulb (HR/MCDB) design conditions using weather data prescribed by UFC 3-400-02.

The greatest enthalpy condition usually occurs at the 0.4 percent HR/MCDB condition. Include PCA pipe and flexible duct heat losses in PCA unit sizing. Use a safety factor of 10 percent when sizing PCA equipment.

Select minimum continuous operation capacity and heating components based on the 99.6 percent winter design dry bulb for the location using weather data prescribed by UFC 3-400-02.

In cold climates, a heater may be required to deliver the minimum aircraft delivery temperature. In high altitude locations, ensure air density corrections factors are provided for PCA unit and test bullet mass airflow calculations.

****

Submit design calculations and detail drawings stamped by a licensed professional engineer showing equipment layout, including assembly and installation details and electrical connection diagrams; piping layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and pressure testing locations. Show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing foundation bolt locations, trench sizes, and access hatch points prior to concrete foundation construction. Submit product data of the equipment, materials and all accessories specified throughout this Section required to deliver a fully functional system. Provide control system drawings which include point-to-point electrical wiring diagrams. Include any information required to demonstrate that the system has been coordinated and functions properly. Include step-by-step operating procedures with detail drawings.

Provide calculations demonstrating the equipment meets the performance requirements at the design condition [of [_____] grams per kilogram grains per pound humidity and [_____] degrees C degrees F dry-bulb][as scheduled]. Provide calculations demonstrating that equipment meets the performance requirements at the winter design condition [of [_____] degrees C degrees F] [as scheduled]. Provide unit capable of continuous stable operation under a minimum load of [10 percent] [_____] of the rated capacity. If minimum operating temperature is less than the minimum aircraft delivery temperature, provide PCA unit with heating capability and sizing calculations. Include fan heat gain in the calculation of heater size. Provide schedule of equipment supplied. Schedule must provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule must include the total quantity of each item of equipment supplied. Provide recommended spare parts listing for each assembly or component.

1.6.3 Certificate of Completion

As a prerequisite to government witnessed acceptance testing, the Contractor must submit a Certificate of Completion that certifies all PCA System work and quality control documentation has been completed. Certificate of Completion must include all quality control documentation including preliminary test reports, pneumatic test reports weld inspection reports and NDE testing reports required by 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

Further, the Contractor Quality Control Manager must certify that all required checks, inspections, and preliminary tests have been successfully completed. The Contractor must provide the Contracting Officer at least [45][30] calendar days' notice prior to commencement of acceptance testing.

1.7 SYSTEM DESCRIPTION

Provide aircraft preconditioned air system having the performance requirements indicated. Provision of the equipment, piping, controls, insulation, flexible duct, reel, and other appurtenances, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with this specification section, design drawings and referenced requirements.

1.7.1 Standard Operating Procedure

****

NOTE: Do not modify the SOP.

****

The control points, components, and capabilities specified herein will support the PCA system standard operating procedures (SOP) as follows.

(1) Remove dust cap from PCA piping.

(2) Start PCA purge mode.

(3) Prepare to connect flex duct to aircraft. If present, open manual blow-down valve(s) to purge any trapped condensation.

(4) When desired temperature is reached as indicated at temperature gauge, and there is no visible moisture in the duct, stop PCA purge mode.

(5) Connect flexible duct to the PCA duct and aircraft, then start PCA normal mode.

(6) Stop PCA unit, disconnect flexible duct, and replace dust cap.

1.8 SYSTEM SUPPLIER INVOLVEMENT

The Contractor and the System Supplier must work together to prepare the work plan, commissioning plan, test reports and final reports. They must both be present during all field testing activities and must coordinate and schedule the work during construction, testing, calibration and acceptance of the system, and operator training. The System Supplier must be responsible to the Contractor for scheduling all Contractor, Sub-Contractor, and manufacturer's service personnel during system startup, commissioning, and acceptance.

1.9 DELIVERY, STORAGE, AND HANDLING

Stored equipment and materials must be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation is the Contractor's responsibility. Any materials found to be damaged must be replaced at the Contractor's expense. During installation, piping and similar openings must be capped to keep out dirt and other foreign matter.

1.10 PROJECT/SITE CONDITIONS

1.10.1 Field Measurements

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

****

NOTE: Obtain performance requirements from aircraft manufacturer. F-35 cooling air performance requirements are found in the Joint Strike Fighter Facilities Requirement Document (FRD).

****

Unit Performance Criteria Measured at Point of Aircraft Connection	
Air Temperature	[_____] degrees C F Minimum [_____] degrees C F Maximum

Unit Performance Criteria Measured at Point of Aircraft Connection	
Mass Flow Rate	[_____] kg/min lb/min (ppm) Minimum
Air Pressure	[_____] kPa psig Minimum [_____] kPa psig Maximum
Moisture Content of Dry Air	[_____] kg/kg dry air grains/lb dry air Maximum

2.2 STANDARD COMMERCIAL PRODUCTS

Use a product from a manufacturer who is regularly engaged in the design, fabrication, testing, and service of pre-conditioned air units of type and size required for this project. Materials and equipment will be standard commercial cataloged products. These products must have a two year record of satisfactory field service prior to proposal due date. The two year record of service must include applications of equipment and materials under similar circumstances and of similar size.

2.3 MANUFACTURER'S STANDARD NAMEPLATES

Nameplates are required on major components if the manufacturer needs to provide specific engineering and manufacturing information pertaining to the particular component. Should replacement of this component be required, nameplate information will insure correct operation of the unit after replacement of this component.

2.4 PRE-CONDITIONED AIR UNIT

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NOTE: For units located near sound sensitive spaces, use noise criteria in brackets. Designer of record must determine the allowable sound power noise level and select equipment location to ensure interior noise requirements are met.

****

Provide high pressure, packaged pre-conditioned air unit designed for 100 percent fresh air. Unit must be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. Unit must operate within capacity range and speed recommended by the manufacturer based on the maximum outdoor enthalpy condition as shown. Unit must be fully UL listed under UL 1995. Certification must be submitted with product data. Unit must be designed to minimize noise and vibration to adjacent buildings.[Unit must operate at all conditions with a measured sound power noise level less than [85][_____] dBA.]

Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair, must have lifting eyes or lugs. Include customary auxiliaries for each unit as deemed necessary by the manufacturer for safe, controlled, automatic operation of equipment. Provide unit with single point wiring connection for incoming power supply. Access doors or panels suitably sized and located must be provided for access to filters, coils, valves, and any other items requiring cleaning, repair, or removal. Access doors or panels must be gasketed with synthetic rubber, or equivalent gasket material, and locked in place with thumb screws or catches.

2.4.1 Refrigerant and Oil

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NOTE: Pre-conditioned air units must operate on a refrigerant with an ODP equal to 0. R-134a, R-407C, and R-410A all meet this requirement.

****

Provide factory refrigerant charge and oil. Refrigerants must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. CFC-based refrigerants are prohibited. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0. Provide safety data sheets for all refrigerants.

2.4.2 Structural Base

Provide a structural steel base (welded or bolted) or support legs with factory finish specified in paragraph FACTORY COATING. Unit and individual components must be isolated from the building structure by means of vibration isolators with published load ratings. Vibration isolators must have isolation characteristics as recommended by the manufacturer for the unit supplied and the service intended.

2.4.3 Receivers

Receivers, if required, must bear a stamp certifying compliance with ASME BPVC SEC VIII D1 and must meet the requirements of ANSI/ASHRAE 15 & 34. Inner surfaces must be thoroughly cleaned by sandblasting or other approved means. Each receiver must have a storage capacity not less than 20 percent in excess of that required for the fully-charged system. Each receiver must be equipped with isolation valve and relief valves of capacity and setting required by ANSI/ASHRAE 15 & 34, and two bull's eye liquid-level sight glasses. Provide sight glass in receiver liquid line.

2.4.4 Compressors

Compressors must be of the hermetically sealed design. Compressors must be mounted on vibration isolators to minimize vibration and noise. Rotating parts must be statically and dynamically balanced at the factory to minimize vibration. Lubrication system must be centrifugal pump type equipped with a means for determining oil level and an oil charging valve. Crankcase oil heater must be provided for cold climates. Provide compressor capable of unloading to 10 percent of rated capacity.

2.4.5 Motors and Drives

a. Electric motors and motor efficiencies must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work must be included under this section. Provide variable-speed motors with variable frequency drive as required by the manufacturer and as specified in Section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS. Drives speed controls must be programmed to prevent blower and condenser fans from operating in the region of instability on the fan airflow-pressure curve.

b. Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Unless otherwise indicated, all motors of one horsepower and above with totally enclosed, or explosion proof fan cooled enclosures, must be the premium efficiency type in accordance with NEMA MG 1. Each motor must conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor.

c. Motors must be continuous duty with the enclosure specified. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors must be sized for the applicable loads. Provide inverter duty premium efficiency motors for use with variable frequency drives.

d. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of enclosure where applicable. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided. Motor enclosure type must be either TEAO or TEFC.

2.4.6 Evaporator

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NOTE: Standard coil construction is copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or copper tubes with pre-plated aluminum fins.

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Provide AHRI 410 coils constructed of seamless copper tubes with compatible [aluminum] [pre-plated aluminum] fins. Fins must be soldered or mechanically bonded to the tubes and installed in a stainless steel or aluminum casing. Evaporator air velocity must be sufficiently low to prevent moisture carryover into the air distribution piping.

2.4.7 Condenser

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NOTE: Standard coil construction is copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or copper tubes with pre-plated aluminum fins.

****

Condenser coil must be of the extended-surface fin-and-tube type and must be constructed of seamless copper tubes with compatible [aluminum] [pre-plated aluminum] fins. Fins must be soldered or mechanically bonded to the tubes. Coils must be circuited and sized for a minimum of 5 degrees F subcooling and full pump down capacity.

Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34. Provide coils constructed of aluminum alloys for fins, tubes, and manifolds. Coil must be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34.

2.4.8 High Pressure Blower Assembly

High pressure centrifugal blower, permanently-lubricated high-speed bearings. Integral cooling system for blower assembly. Bearing housing must be conservatively loaded and rated for an L(10) life of not less than 200,000 hours per ISO 281. Precision main bearings with heavy duty bushings in accordance with ABMA 9 or ABMA 11. Shaft seal suitable for high pressure applications.

2.4.9 Filters

Provide washable pre-filter and final filter installed at the inlet of the blower and accessible for maintenance through an access opening. Pre-filter must be constructed of washable mesh media that traps dust, foreign matter, and contaminants and is easily cleaned by flushing with water. Final filter efficiency must be high-efficiency, minimum MERV-8 and approved by manufacturer.

2.4.10 Factory Applied Insulation

PCA equipment must be provided with factory installed insulation on surfaces subject to condensation including the evaporator enclosure, suction line piping, economizer, and cooling lines. Factory insulated items installed outdoors are not required to be fire-rated.

2.4.11 Condensate Removal

Provide a means for condensate removal including an automatic drain valve, stainless steel drain line, stainless steel condensate pan and condensate sensor. Condensate drain valve must open intermittently, as needed, to prevent continuous air leakage from evaporator housing. Include a high condensate level alarm and safety shut down. Insulate condensate drain piping per Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.4.12 Operating Controls

Provide units complete with factory installed, UL 508-listed microprocessor based operating and safety control system. Controls must process the signals for complete control and monitoring of pre-conditioned air cooling units. Provide safety alarms with automatic shutoff. Provide proportional-integral controls to regulate system capacity and fan speed control to satisfy adjustable set points. Provide a defrost cycle to prevent coil freezing. Defrost cycles will allow discharge temperature from individual units to increase to 35-55 degrees F for up to 90 seconds every 15 minutes.

Provide a dedicated, low-pressure purge mode to allow cool-down of the duct. Purge mode set points including temperature, pressure, and mass flow rate, and automatic shutoff timer (5-30 minutes) must be independently adjustable at the unit control panel.

2.4.12.1 Unit Control Panel and Display

Provide a unit-mounted, touch-screen display to allow adjustment of set points including temperature, pressure, and mass flow rate. Display must show sensor data, set points, operating status of components, monitored points, and alarms. Each safety interlock requiring a manual reset must be displayed at the top-level screen without requiring a password. Non-recycling control interlocks must have the reset located on the control itself that will identify the lockout information required below. Controls must illuminate the fault indicator at the unit and remote controller upon a power failure.

2.4.12.2 Remote Controller

Provide a remote controller along the hangar back wall for each PCA unit with step-by-step operating procedures posted on the controller cover. The remote controller must be one panel provided by equipment manufacturer. Remote controller must perform the following functions:

a. Blue purge mode start button.

b. Green aircraft cooling mode start button.

c. Red stop button.

d. White unit run status light.

e. Red illuminated fault light.

f. Digital display of PCA unit discharge temperature, humidity, pressure, and mass flow rate.

2.4.12.3 Internal Sensors

The following sensors must be provided internal to the unit. All sensors must have accuracy as indicated.

a. Discharge temperature sensor, minus 17.8 to 65.6 degrees C 0 to 150 degrees F, accurate to plus or minus 0.3 degrees C 0.5 degrees F.

b. Ambient temperature sensor, minus 17.8 to 65.6 degrees C 0 to 150 degrees F, accurate to plus or minus 0.3 degrees C 0.5 degrees F.

c. Discharge pressure sensor, minus 103 to 345 kPa minus 15 to 50 psig, accurate to plus or minus 0.5-percent.

d. Discharge humidity sensor, 0 to 100 percent relative humidity (RH), accurate to plus or minus 5 percent RH.

e. Air velocity measurement sensor, 0 to 20.3 m/s 0 to 4,000 fpm, accurate to plus or minus 5 percent over a temperature range of minus 28.9 to 101.1 degrees C minus 20 to 150 degrees F.

f. Mass air flow sensor, 0 to 45.4 kg/min 0 to 100 lb/min, accurate to plus or minus 5 percent over a temperature range of minus 28.9 to 101.1 degrees C minus 20 to 150 degrees F.

2.4.12.4 Adjustable Setpoints

The following points must be capable of being adjusted directly at the unit. A security access code must be entered before parameters can be changed.

a. Leaving air temperature control.

b. Leaving air pressure control.

c. Mass air flow rate.

2.4.12.5 Monitoring Capabilities

During normal operations, the control system must be capable of monitoring and displaying the following operating parameters on the operator interface terminal at the unit. The display must be accessible without opening or removing any panels or doors.

a. Leaving air temperatures.

b. Leaving air pressure.

c. Leaving air mass flow rate.

d. Leaving air humidity.

e. Self-diagnostic.

f. Operation status.

g. Operating hours.

h. Number of starts.

i. Compressor status (on or off).

j. Compressor speed.

k. Condenser fan status.

l. Refrigerant discharge and suction pressures.

2.4.12.6 Safety Controls with Manual Reset

Pre-conditioned air cooling unit must be provided with the following safety controls which automatically shut down the pre-conditioned air cooling unit, display an alarm at unit and remote controller, and which require manual reset.

a. Low airflow detection.

b. High discharge air pressure.

c. High refrigerant pressure.

d. High motor winding temperature protection.

e. Motor current overload and phase loss protection.

f. High condensate level.

2.4.12.7 Safety Controls with Automatic Reset

Pre-conditioned air cooling unit must be provided with the following safety controls with automatic reset, and alarm.

a. Low refrigerant pressure safety shutdown.

b. Over/under voltage protection.

c. Phase reversal protection.

d. Short cycle protection.

e. Load limiting to prevent over-pressurization.

2.4.13 Factory Coating

Equipment casing and structural base, when fabricated from ferrous metal, must be factory coated with a coating rated for 3,000 hours' exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.4.14 Test Apparatus

One testing spool piece, or test bullet, must be provided to support field testing. Test bullet must be provided with calibrated gauges to measure all cooling air performance parameters including, but not limited to, temperature, flow, pressure, and humidity. Provide lab testing for air particulates if required by the contracting officer. Provide test bullet with calibrated orifice plate to simulate aircraft back pressure. Provide test bullet complete with carrying case, and turn over to the contracting officer upon contracting officer acceptance of the PCA system.

2.4.15 Tools

One complete set of special tools, if required for access to PCA equipment panels and routine maintenance, must be provided. Tools must be [provided to the maintenance activity][provided with a weatherproof toolbox attached to the unit structure].

2.5 ELECTRICAL WORK

2.5.1 Controllers, Contactors, and Disconnects

Furnish with respective pieces of equipment. Electrical equipment, controllers, contactors and disconnects must conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, as modified and supplemented by this section. Provide electrical connections under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide controllers and contactors with maximum of 120 volt control circuits, and auxiliary contacts for use with controls furnished.

2.5.2 Electrical Control Wiring

****

NOTE: Choose the control specification applicable to the basis of design. Use Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC for low voltage remote control panels and use Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM for line voltage control panels.

****

[Provide control wiring under Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.] [Provide control wiring under this section in accordance with NFPA 70 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.] Field wiring must be in accordance with manufacturer's instructions.

2.6 SUPPLEMENTAL COMPONENTS

2.6.1 Seismic Requirements

****

NOTE: Provide seismic details on the drawings, if performed by the DoR. Delete the bracketed phrase "as shown on the drawings" if no seismic details are provided.

If seismic design is delegated, specify seismic bracing of PCA piping and equipment in accordance with applicable codes and standards. UFC 3-301-01, "Structural Engineering" and SECTIONS 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR HVAC, properly edited, must be included in the contract documents.

****

Piping and equipment must be supported and braced to resist seismic loads as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and[23 05 48.19 SEISMIC BRACING FOR HVAC][as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown must be provided under this section. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

2.6.2 Pre-Conditioned Air Piping

****

NOTE: Choose pressure rating of 150 percent of maximum operating pressure of the equipment specified.

****

Provide fully welded air distribution piping of schedule [5][10], type 304L stainless steel conforming to ASTM A312/A312M and suitable for a working pressure of [15][_____] psig. Stainless fittings and joints must be butt-welded in accordance with ASME B16.25. Piping must be supported by the hangar structure or utility trench. Piping design including supports must account for and control thermal expansion. Provide ASME A13.1 compliant piping labels every 20 feet and at each change in direction indicating direction of flow and associated PCA unit equipment designation. Provide flanged piping within 18 inches of the hangar floor and in utility trenches in the hangar. Provide non-absorptive neoprene or rubber gaskets at all flanges. Provide stainless steel nuts, bolts, and washers for all flanges in accordance with ASTM F593 and ASTM F594.

Do not install valves downstream of the pre-conditioned air unit. Provide duct-mounted, mechanical temperature and pressure gauges at the PCA duct connection point. Provide a water tight, soft rubber cover with lanyard to protect the PCA duct opening while not in use. End cap must connect to piping with the use of hand-operated quick-connect connectors.

2.6.3 Insulation

Insulate pre-conditioned air system piping with factory applied polyisocyanurate insulation and jacket covers meeting ASTM C578. Insulation must meet the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84. Provide a water-tight embossed aluminum or high density polyurethane (HDPE) jacket for all insulation. Installation must conform to requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.6.3.1 Insulation Thickness Calculations

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NOTE: Designers must increase insulation in high humidity areas to prevent condensation. For example, the outdoor air dew point for Guam is 27.3 degrees C 81.2 degrees F at the 0.4 percent humidity ratio condition.

****

Perform heat loss calculations based on insulation thickness and equipment performance requirements to demonstrate that insulation is sufficient to deliver the prescribed conditions in section titled PERFORMANCE REQUIREMENTS at the aircraft and to prevent condensation based on outdoor dew point at 0.4 percent humidity ratio condition. Actual insulation values and maximum PCA piping length for the project must be used in calculations.

2.6.4 Pre-Conditioned Air Flexible Duct, Storage and Accessories

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NOTE: Specify flexible duct length based on the maximum distance between aircraft parking positions and duct connection points.

****

Provide [35][_____]-foot flexible duct, [6][_____]-inch diameter, conforming to SAE AS38386 with hand-operated quick-connect connectors for connection between the PCA piping termination and the aircraft. Flexible duct must be fully insulated with a metal helical stiffener core to prevent collapse and suitable for an operating pressure of 150 percent of the aircraft delivery pressure. Provide manufacturer's certification that the air temperature rise in the flexible duct is less than 0.2 degree F per foot when tested at the maximum outdoor ambient design temperature and median aircraft delivery temperature and pressure conditions.

Provide a hard 45-degree transition attached to the inlet of the flexible duct. Provide all necessary transitions with insulating sleeve. Obtain list of approved aircraft connectors from aircraft program Facilities Requirements Document (FRD). Provide insulated flexible duct with a mobile basket or reel to connect from the PCA pipe connection to the aircraft PCA connection. Equip flexible duct storage basket or reel with heavy-duty casters and integral storage for transitions.

2.7 FACTORY TESTS

2.7.1 Manufacturer's Factory Test Plan

Perform factory test on PCA equipment prior to delivery to validate the specified full load capacity. Testing must be performed at the factory in accordance with SAE ARP5374 by manufacturer. At a minimum, PCA equipment capacity must be validated to meet the scheduled requirements as indicated. Factory testing to be performed in a controlled environment lab that is capable of simulating extreme ambient conditions witnessed by the installation location. PCA unit must also be tested under minimum load conditions. Stable operation at minimum load of 10 percent of total capacity must be demonstrated during the factory test. Test reports to include ambient conditions and results from each test.

For each unit, submit a factory test plan which verifies the scheduled performance is met by the produced units. Indicate in each test plan the factory acceptance test procedures. Include a detailed step-by-step procedure to test all modes of operation to confirm that the controls through all modes of control to confirm that the controls are performing in accordance with the intended sequence of control. Perform calibration of controllers and sensors, ensure set points are programmed, and control variables are tuned to provide stable control of their respective equipment. Include the required test reporting forms to be completed by the Manufacturer's testing representatives. Submit the required test plans for review and approval to the Contracting Officer at least 90 calendar days before scheduled factory test date.

2.7.1.1 Performance Variables

List performance variables that are required to be measured or tested as part of the factory test plan. Include the actual performance variables during testing as well as the performance requirements indicated on equipment schedules on the contract design drawings on each test form. Provide a description of acceptable performance results and objective quality evidence which will verify performance results. Identify the limits or tolerances within which each tested performance variable is deemed to be acceptable.

2.7.1.2 Test Configuration

Tests must be performed for a minimum of four continuous hours in a wet coil condition. If test period is interrupted, restart the four-hour test period. Each test plan must be job specific and address the particular units and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.

2.7.1.3 Test Variables

Air side testing variables must include recording of the airflow, total static pressure; fan drive motor KW, amperage and RPM; and fan RPM. Perform test with entering air at scheduled design conditions.

2.7.1.4 Specialized Components

Include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

2.7.2 Production Schedule and Factory Test Schedule

The Government reserves the right to witness factory tests for pre-conditioned air cooling units. Provide the production schedule and factory test schedule for tests to be performed at the manufacturer's test facility. Submit planned production schedule, and factory test schedule and test location, to the Contracting Officer as soon as it is scheduled but not less than 90 calendar days prior to the scheduled factory test date. Track this schedule through the production phases and if scheduled factory tests date changes, give advanced notice to Contracting Officer as soon as possible, but at least 30 calendar days in advance of the scheduled test dates.

2.7.3 Factory Test

Conduct the factory testing in compliance with the Contracting Officer approved Manufacturer's Factory Test Plan, and in accordance with additional field testing requirements specified herein. Conduct the test for each unit for the continuous test period in the approved test plan. If a unit shuts down before the continuous test period is completed, the test procedure must restarted and run for the required duration.

2.7.4 Factory Test Report

Record the required data using the test reporting forms of the approved test plan. Final test report forms must be typed including data entries and remarks. Completed test report forms for each unit must be reviewed, approved, and signed by the Manufacturer's test director. Submit factory test reports, referencing each tested unit's serial number, and receive approval before delivery of unit to the project site.

2.7.5 Deficiency Resolution

Deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations and corrections tested as specified in the paragraph titled FACTORY TEST.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform verification of dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

Provide manufacturer's installation manual for each type of unit. Perform all work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.

Piping installation must conform to ASME B31.3. Welding, vents, drains, hangers, inserts, penetrations, and supports must conform to the requirements of Section 23 64 26 CHILLED, CHILLED-HOT AND CONDENSER WATER PIPING AND ACCESSORIES paragraph titled "INSTALLATION".

3.2.1 Refrigeration System

3.2.1.1 Equipment

Refrigeration equipment and the installation thereof must conform to ANSI/ASHRAE 15 & 34 and ASME B31.5. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, condensers, and similar items. Select and size isolators based on load-bearing requirements and the lowest frequency of vibration to be isolated. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.2.2 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory is specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 FIELD QUALITY CONTROL

3.3.1 Manufacturer's System Certification

Upon completion and before final acceptance testing of work, a factory-trained representative must verify on-site the PCA equipment installation compliance with manufacturer's recommendations. Manufacturer's representative must check each unit under pressure for refrigerant leaks. If leaks are found, evacuate and dehydrate the machine to an absolute pressure of 300 microns prior to repair and recharge. Verify and record proper refrigeration charge.

Manufacturer's representative must test controls through every cycle of operation, verify safeties, make necessary adjustments, and balance systems prior to scheduling acceptance testing of completed systems. Controllers must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment. Submit manufacturer's system certification at least 30 calendar days in advance of the scheduled acceptance test date.

3.3.2 Cleaning

Clean piping before placing in operation. Clean equipment, piping, filters, and accessories. Prior to commencement of field testing, remove all filters and provide new filters.

3.3.3 Preliminary Pneumatic Test

Prior to insulating PCA piping joints, apply a 15 psig pneumatic test to PCA piping, not including flexible duct and connector. Maintain the pressure while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). If leaks are discovered, repair the leaks accordingly and retest

3.3.4 Final Pneumatic Test

Prior to insulating PCA piping joints, tightness test PCA piping, not including flexible duct and connector, with air at a pressure of 15 psig. Pressurize the system and isolate the source of pressure. No leakage is permitted at the end of one hour as indicated by a drop in system pressure. Test must be witnessed by government personnel, and a final pneumatic test report submitted for approval by the quality control manager (QCM). If any test section fails tightness testing, repair or replace all defective materials and/or workmanship.

3.4 COMPONENT INSTALLATION

3.4.1 Route Control Wiring

Route control wiring in rigid conduit per Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.4.2 Preconditioned Air Piping

Support all above ground piping including piping located in trench per Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS. Provide insulation shields at supports and provide a water-tight embossed aluminum or HDPE jacket over entire service.

3.5 ACCEPTANCE TESTS

Pre-conditioned air system final acceptance tests will be witnessed by the Contracting Officer and other Government representatives. Furnish a factory trained field test director authorized by the PCA equipment manufacturer to oversee the complete execution of the field testing. This test representative must also review, approve, and sign the completed Performance Test Report. Signatures must be accompanied by the person's name.

3.5.1 Pre-Conditioned Air System Performance Test Plan

Submit a performance test plan for each PCA system at least 90 calendar days in advance of the scheduled acceptance test date for Contracting Officer approval. Submit the performance test plan along with the completed factory test plan specified herein. Include field test director's qualifications and factory training certification.

3.5.1.1 Functional Tests

Test plan must include detailed step-by-step procedures to verify the functional performance of the complete PCA system including all modes of operation and safety controls. Each test step must include the procedure used to simulate conditions, the expected responses, and space for comments. Test plan must include list of participants and equipment needed to perform the test. Describe test set-up to simulate real-world operation of the entire system including flexible duct.

3.5.1.2 Endurance Test

In addition to functional tests, test plan must include an endurance test to verify system performance when the ambient outdoor conditions are within 10percent of the design maximum enthalpy condition. Include a form to record performance variables at 15-minute intervals during the test. Performance variables must be measured at aircraft connection point under the same test set-up as the functional tests.

a. Pre-conditioned air unit discharge temperature (degrees C F)

b. Aircraft connection temperature (degrees C F)

c. Pre-conditioned air unit discharge pressure (kPa psig)

d. Aircraft connection pressure (kPa psig)

e. Aircraft connection humidity ratio (kg/kg gr/lb)

f. Pre-conditioned air unit discharge air mass flow rate (kg/min lb/min)

g. Aircraft connection discharge air mass flow rate (kg/min lb/min)

h. Ambient temperature (degrees C F)

i. Ambient humidity (kg/kg gr/lb)

3.5.1.3 Instruments

List the instruments used to measure performance data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field, and calibration must be traceable to the measuring standards of the National Institute of Standards and Technology. All instrumentation must bear a valid NIST traceable calibration certificate during field work and during government acceptance testing.

3.5.2 Notification of Pre-Conditioned Air System Performance Testing

Notify the Contracting Officer in writing at least 30 calendar days in advance of all acceptance tests. Notification must include PCA System Certificate of Completion. If partial performance testing is necessary because outdoor conditions are not within the required range, include the anticipated endurance test dates in the Notification of PCA Performance Testing. Test each unit for Contracting Officer acceptance in accordance with the approved test plan.

3.5.3 Performance Testing

Conduct the field testing in compliance with the Contracting Officer approved performance test plan, and in accordance with additional testing requirements specified herein. Record the required data using the test reporting forms approved of the approved field test plan.

Conduct the endurance test for each PCA for a continuous 4-hour test period. If a unit shuts down before the continuous 4-hour test period is completed, the test must be started again and run for the required duration. If any performance variable measured at the aircraft connection falls outside of the acceptable range in paragraph titled PERFORMANCE REQUIREMENTS for more than one measurement interval, the endurance test will be failed. Record the cool down time required for air measurements to be within the required performance parameters. If the cool down time exceeds 30 minutes, the test will be failed. If the system experiences any failures during the endurance test portion of the test, repair the system and repeat the endurance test portion until the system operates continuously and without failure for the specified endurance test period.

3.5.4 Performance Test Report

Within 30 calendar days after acceptable completion of testing, submit each test report for the review and approval of the Contracting Officer. Use the test reporting forms approved in the Performance Test Plan. Final test report forms must be typed, including data entries and remarks. Completed test report forms for each PCA must be reviewed, approved, and signed by the Contractor's test director and the QC manager.

3.5.5 Deficiency Resolution and Re-testing

Deficiencies identified during the tests must be corrected in compliance with the contract requirements and retested as specified in the paragraph titled ACCEPTANCE TESTS. Any deficiencies observed must be corrected by the Contractor without cost to the Government.

3.6 ADJUSTING AND CLEANING

Wipe equipment clean, removing all traces of oil, dust, dirt, or paint spots. Provide temporary filters for all fans that are operated during construction, and install new filters after all construction dirt has been removed from the building. Maintain the system in this clean condition until final acceptance.

Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Operation and Maintenance Manual

Submit operation and maintenance manuals meeting requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA and 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW) no later than 30 calendar days before contract completion. Provide recommended spare parts listing for each assembly or component.

3.7.2 Training Plan

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the PCA system in accordance with requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA. Instructors must be thoroughly familiar with all parts of the installation and instructed in operating theory as well as practical operation and maintenance work. Submit a training plan for the instruction course including instructor's qualifications and certifications for approval.

Conduct a training course as designated by the Contracting Officer. The training period must consist of a maximum of 16 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 76 00 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 76 00.00 10 (April 2008)
UFGS-26 76 00.00 20 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 76 00

EVAPORATIVE COOLING SYSTEMS

08/21

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SECTION 23 76 00

EVAPORATIVE COOLING SYSTEMS

08/21

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NOTE: This guide specification covers the requirements for evaporative cooling systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification covers evaporative cooling systems. As mentioned in the ASHRAE Handbook Applications, evaporative cooling systems provide life cycle cost savings in many areas of the U.S. Evaporative cooling may be used for total cooling or for precooling of outdoor or mixed return air. Other potential uses are also addressed in the ASHRAE Handbook Applications. The coolers covered in this specification are intended for use in areas where climatic conditions generally provide dry-bulb temperatures in excess of 29 degrees C 85 degrees F and concurrent wet-bulb temperatures below 21 degrees C 70 degrees F. Moderate success can be expected with wet-bulb temperatures as high as 24

degrees C 76 degrees F; however, for general practice, use of the coolers with prevailing wet-bulb temperatures above 22 degrees C 72 degrees F is not recommended. Types of evaporative cooling equipment are described in the ASHRAE Handbook Systems and Equipment. Use of evaporative is further discussed in UFC 3-410-01 Heating, Ventilating, and Air Conditioning Systems.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon

	Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B696	(2000; R 2023) Standard Specification for Coatings of Cadmium Mechanically Deposited
ASTM E2016	(2022) Standard Specification for Industrial Woven Wire Cloth

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 10.01	(1982; E 2004) Hot-Applied Coal Tar Enamel Painting System
SSPC Paint 16	(2023) Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 200-1-13	(2016) Environmental Quality -- Minimizing the Risk of Legionellosis Associated with

Building Water Systems on Army Installation

UL SOLUTIONS (UL)

UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 507	(2017; Reprint Aug 2018) UL Standard for Safety Electric Fans
UL 746C	(2018; Reprint Jul 2024) UL Standard for Safety Polymeric Materials - Use in Electrical Equipment Evaluations
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Letter Of Qualification

Manufacturer's Authorized Service Representative; G, [_____]

SD-02 Shop Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

Evaporative Coolers; G, [_____]

Air Washers; G, [_____]

Water Tanks; G, [_____]

[Thermostats; G, [_____]

] Corrosion Coating; G

SD-06 Test Reports

Performance Tests; G, [_____]

SD-07 Certificates

Test Procedures; G, [_____]

Energy Efficient Products for Evaporative Cooler; S, [_____]

System Diagrams; G, [_____]

SD-08 Manufacturer's Instructions

Installation; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

Operational Training; G, [_____]

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Coordination of Trades

Furnish tank supports, piping offsets, fittings, and any other accessories as required to provide a complete and functional system in accordance with the manufacturer's published criteria for the type of system installed and to eliminate interference with other construction.

1.4 QUALITY CONTROL

1.4.1 Standard Products

Provide evaporative air-cooling equipment designed and assembled by a manufacturer regularly engaged in the manufacturing of systems that are of a similar design, workmanship, capacity, and operation. Systems of similar design and capacity must have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2 years must be satisfactorily completed by a system which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Systems having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The system must be supported by a Manufacturer's Authorized Service Representative.

1.4.2 Manufacturer's Representative

Perform the work specified in this section under the supervision of a manufacturer's authorized representative. Provide manufacturer-approved installation drawings, test procedures, and test results.

a. The Manufacturer's Representative must have no less than 3 continuous years of experience directly involved in the design and installation of evaporative air-cooling equipment, and have served in a similar capacity on no fewer than five projects of similar size and scope during that period. Submit a letter of qualification, at least 2 weeks prior to the start of work, listing the actual experience and training of the Manufacturer's Representative.

b. Submit installation drawings consisting of layout of equipment including assembly and installation details and electrical connection diagrams. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function as a unit and showing equipment relationship to other parts of the work, including clearances required for operation and maintenance. Concurrent with installation drawings, submit manufacturer's certification of installation drawings.

c. Submit proposed test procedures for performance tests of systems, at least 2 weeks prior to the start of related testing.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Store equipment in shipping crates and original packaging containers until ready to install. When required to be removed for inspection; repackage to protect equipment. In the event original packaging material is no longer suitable for storing the equipment or its components, provide storage containers agreed to by the government.

PART 2 PRODUCTS

****

NOTE: For Army projects, minimize the risk of legionellosis in building water system by following guidance in the U.S. Army Corps of Engineers

Engineering Manual EM 200-1-13.
****

2.1 SYSTEM DESRIPTION

Provide water treatment and positive water bleed-off for the evaporative air-cooling equipment. The color of finished coat, lubrication, and treatment for fungus resistance must be the manufacturer's standard. Provide solenoid valves in water supply lines. Furnish starting switch separated from coolers, [as a stand-alone switch][integral with the thermostat control][as part of the DDC controls].[Provide manual reset control for motors rated greater than 3/4 kW one HP.][Provide air filters for air inlets for rotary-type evaporative coolers.][Minimize the risk of Legionellosis by following the guidance in EM 200-1-13.]

2.2 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

2.2.1 Energy Efficient Products for Evaporative Coolers

Provide equipment meeting the efficiency requirements as stated within this section and provide documentation in conformance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph ENERGY EFFICIENT PRODUCTS.

2.3 MATERIALS AND EQUIPMENT

2.3.1 Standard Products

Provide evaporative air-cooling equipment designed and assembled by a manufacturer regularly engaged in the manufacturing of systems that are of a similar design, workmanship, capacity, and operation. Systems of similar design and capacity must have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2 years must be satisfactorily completed by a system which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Systems having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The system must be supported by a Manufacturer's Authorized Service Representative.

2.3.2 Asbestos Prohibition

****
NOTE: Use this paragraph for Army only.
****

Asbestos and asbestos-containing products will not be accepted.

2.3.3 Nameplates

All equipment must have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.3.4 Equipment Guards and Access

****

NOTE: Catwalks, ladders, and guardrails may be required. If so, select the applicable item and indicate on drawings. If not applicable, delete the entire sentence within the brackets.

****

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard must be properly guarded or covered with insulation of a type specified.[Provide catwalks, operating platforms, ladders, and guardrails where shown and construct according to Section [05 50 13 MISCELLANEOUS METAL FABRICATIONS][05 51 33 METAL LADDERS]].

2.4 PIPING COMPONENTS

Piping components must be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5 SYSTEM COMPONENTS

2.5.1 Air Supply, Distribution, Ventilation and Exhaust

****

NOTE: Gas-fired furnaces, which are often used in conjunction with evaporative air-cooling equipment, are specified in Section 23 54 19 BUILDING HEATING SYSTEMS, WARM AIR.

****

Provide ductwork and related accessories, including air filters and terminal units, as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5.2 Electrical Components

Electrical motor-driven equipment specified must be provided complete with motor, motor starter, controls and appropriate enclosures. Unless otherwise specified, electric equipment, including wiring, must be according to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motor controllers, contactors and overloads must comply with NEMA ICS 2. Enclosures must comply with NEMA ICS 6. Electrical characteristics and enclosure type must be as shown. Integral size motors must be the premium efficiency type in accordance with NEMA MG 1. Each motor must be according to NEMA MG 1 and must be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, must be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers must be utilized for 0.745 kW through 7.45 kW fractional hp through 10 hp ratings. Provide adjustable frequency drives for motors larger than 10 hp.

a. Provide pump motors with moisture-proof windings and a factory installed three conductor rubber sheathed flexible cord with the third wire being the grounding conductor.

b. Provide [dripproof] [totally enclosed] type pump motors, suitable for the available electric service. Provide [manual] [magnetic] across-the-line type motor starter with [general purpose] [weather resistant] [watertight] enclosure. Provide thermal overload protection in the starter or integral with the motor.

2.6 MISCELLANEOUS MATERIALS

Materials must conform to the following:

2.6.1 Aluminum Sheets

ASTM B209M ASTM B209, Alloy 3003, temper H14.

2.6.2 Steel Sheets, Galvanized

ASTM A924/A924M, commercial quality.

2.6.3 Steel Sheets, Uncoated

ASTM A1011/A1011M, hot-rolled, commercial quality.

2.6.4 Structural Steel

ASTM A36/A36M.

2.6.5 Stainless Steel

ASTM A240/A240M.

2.6.6 Structural Polymeric Components

Components made of structural polymeric materials must meet the applicable requirements of UL 746C.

2.6.7 Nonstructural Polymeric Components

Components not made of structural polymeric materials must meet or exceed the requirements of UL 94 for Classifying Materials 94HB.

2.7 EVAPORATIVE COOLERS

****

NOTE: Drip type evaporative coolers are the most widely used; pads are uniformly and sufficiently wetted to reduce scale buildup. Indirect evaporative coolers are used when the designer wishes to add no moisture to the supply air. Two stage coolers incorporate both indirect and direct sections to provide lower supply temperatures, a degree of humidity control. In general, a blow through unit can provide discharge air that is slightly cooler than a comparable draw through units. In addition, the fan and motor in a blow through unit is not located in the saturated air stream, as is typically the case with draw through units.

****

Units must be a self-contained [direct] [indirect] [indirect/direct] [multi-stage], weather resistant [drip,] [rotary,] [slinger] type, [blow through] [draw through] and must conform to UL 507 and UL 746C. Unit must be the [side] [or] [vertical downblast] discharge type as indicated. A guillotine type manual winterizing damper complete with holding rack must be provided on the discharge side of each unit. Holding rack must retain damper during operating season.

2.7.1 Fan Unit

****

NOTE: Inapplicable motor enclosures, motor starters, and starter enclosures will be deleted. In areas where severe sand and dust conditions exist, totally enclosed motors will be considered.

****

The unit must be the centrifugal or axial type, complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing. Water distributor or rotary wheel motor must be [synchronized to start and stop with the fan unit] [separately controlled] [provided with a time delay in the fan circuit to allow media to be thoroughly wetted before air flow starts] [provided with a time delay in the fan circuit to allow media to be thoroughly dried before air flow terminates].[Remote manual switch with pilot indicating light must be provided where indicated.] Fan scroll and wheel must be constructed of galvanized steel, aluminum, stainless steel, or polymeric material with stainless steel, hot-dip zinc coated steel or cadmium coated steel shaft. Fan scroll may be made of a different material than the wheel. Bearings must be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings must be connected to tubing and serviceable from a single accessible point. Bearing life must be L50 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11.

2.7.1.1 Fan Rating

****

NOTE: Each fan powered by a motor of 5.6 kW 7.5 hp or larger must have the capability to operate that fan at two-thirds of full speed or less and must have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device per ASHRAE 90.1.

****

Evaporative cooler fans must have air delivery ratings based on AMCA 210 tests by an AMCA approved laboratory.

2.7.1.2 Retarding Agent

An ultraviolet retarding agent such as additives, gel coatings or other manufacturer approved equivalents must be part of or applied on exterior nonmetallic components susceptible to ultraviolet degradation from sun rays and must conform to UL 746C.

2.7.2 Evaporative Media

2.7.2.1 Evaporative and Eliminator Media for [_____] Type Units

Media must be fabricated of [wood aspen fibers,] [refined cellulose matrix,] [bonded synthetic fiber,] [glass fiber,] [nonferrous metal]. Media must conform to UL 900 Class II. Media must be of the type specifically manufactured for use with evaporative coolers. Nonferrous metal media must be constructed of corrosion and fungus resistant material not susceptible to decomposition by fungal or bacterial action. [Eliminator media must be provided for slinger-type systems.] Media-pad face velocities must not exceed [1.27 m/s 250 fpm for wood aspen fiber]. Media must be securely mounted in a galvanized steel, stainless steel, or polymeric material frame. Louvers must be positioned in such manner that the water will not run on the outside surface. Nonrigid filter media must be held in frame by a rigid retainer grid, a 6 mm 1/4 inch wire mesh or fabric netting.

2.7.2.2 Evaporative Media for Rotary-Type Units

The evaporative filter unit must be either drum or disk type. Media must be fabricated of copper, bronze, or polymer material. No moisture entrainment must occur. Where necessary to prevent such entrainment, eliminator media constructed of copper, copper alloy, or polymer material must be provided. Face velocities must be limited to those recommended by media manufacturer.

2.7.3 Water Handling Equipment

2.7.3.1 Water Handling Equipment for Drip Coolers

Water handling equipment must thoroughly wet and continuously flush evaporative surfaces of the media material. The water distribution system must be designed, to provide equal flow of water directly to the pads or to each trough. Troughs, if used, must be adjustable hot-dip galvanized steel, stainless steel, or polymeric and suitably designed in a manner that will effectively regulate the flow of water to the media pad to obtain even and complete saturation. Troughs must be adjustable for leveling or sectionalized and each section supplied with water by means of an individual tube. The water pump must be a centrifugal type with capacity and head characteristics for the specified operation of the unit and must be provided with a low water safety shut-off. The motor shaft must be constructed of stainless steel, hot-dip galvanized steel or cadmium coated steel. The impeller must be constructed of stainless steel or polymeric material conforming to UL 746C. Pump housing must be constructed of [painted] [hot-dip zinc coated] steel, brass, or polymeric material conforming to UL 746C. Pump housing bottom must be removable for impeller cleaning and must not permit galvanic action with cooler bottom. Water pump must be provided with a filter screen constructed of plastic or bronze which must project 25 mm 1 inch above the high water level of the water tank.

2.7.3.2 Water Handling Equipment for Slinger Coolers

Water distribution to the evaporative pad must be accomplished by a motor driven water slinger to uniformly distribute water to the pad.

2.7.3.3 Water Blowdown Equipment

Water must be periodically dumped (approximately every six to twelve hours). This must be done by either the use of a mechanical timer or by measuring the conductivity and dumping the water when the conductivity reaches 1500-2000 micro mhos.

2.7.4 Indirect Cooler Section

The indirect cooler must consist of a [frame and plate counter flow] [finned tube water-to-air] heat exchanger, [evaporative media] water distribution header, scavenger fan and motor, and recirculating water pump, [cooling coil,] drain, overflow and makeup water.

2.7.4.1 Heat Exchanger

The unit must be constructed of stainless steel, polymeric material, or aluminum with the surface exposed to water being fully protected against corrosion by an epoxy coating. The plates must be constructed in such a way as to withstand a 250 Pa 1 inch water gauge differential pressure without collapsing the plates. Units having horizontal air discharge must be provided with discharge baffle to direct air upward, constructed of the same material and thickness as the casing. The unit must be at least 80 percent efficient. For cleaning purposes coils on finned tube water-to-air heat exchangers must be plugged at the return bins.

2.7.4.2 Water Distribution Header

The water distribution header must be a nonwettable, nondrip type. Water must be distributed by means of copper spray headers with brass nozzles, or PVC header and nozzles, to impart a fine water mist into the scavenger air side of the heat exchanger.

2.7.4.3 Scavenger Fan

The fan must be the centrifugal or axial type and must be complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing on single-phase motors. The fan motor must be [synchronized to start and stop with the indoor fan unit] [controlled by the HVAC system controls]. Water distributor motor must be synchronized to start and stop with the scavenger fan unit. Manual or automatic reset type thermal overload protection must be provided in the starter or must be integral with the motor. Motor starters must be [manual] [magnetic] across-the-line type with [general purpose] [weather resistant] enclosure.[Remote manual switch with pilot indicating light must be provided where indicated.] Fan scroll and wheel must be constructed of galvanized steel, aluminum, stainless steel or polymeric material with stainless steel, hot-dip zinc coated steel or cadmium coated steel shaft. Fan scroll may be made of a different material than the wheel. Fans must have an air delivery rating based on AMCA 210 tests by an AMCA approved laboratory.

2.7.4.4 Water Pump

The water pump must be a self-priming centrifugal type with capacity and head characteristics for the specified operation of the unit. The motor shaft must be constructed of stainless steel, cadmium coated steel or hot-dip zinc galvanized steel. The impeller must be constructed of stainless steel or polymeric material conforming to UL 746C. Pump housing must be constructed of factory [painted] [hot-dip zinc coated] steel or polymeric material conforming to UL 746C. Pump housing bottom must be removable for impeller cleaning and must not permit galvanic action with cooler bottom. Water pump must be provided with a filter screen constructed of plastic which must project 25 mm 1 inch above the high water level of the water tank.

2.7.5 Cooling Coil

Supplemental water cooling coil must be located [upstream from the direct stage] [between stages] [downstream from the second stage]. The coil must be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to tubes. Headers must be constructed of cast iron, welded steel or copper. Casing and tube support sheets must be 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. Tubes must be correctly circuited for proper water velocity without excessive pressure drop and be drainable where required or indicated. Factory test each coil at not less than 1720 kPa 250 psi air pressure and must be suitable for 1380 kPa 200 psi working pressure. Install drainable coils in the units with a pitch of not less than 10 mm per m 1/8 inch per foot of tube length toward the drain end.[Coils must conform to the provisions of AHRI 410.]

2.8 AIR WASHERS

Furnish air washers as a factory package unit, complete with fan unit, spray pump, nozzles, piping, evaporative cells, washdown cycle and eliminators. Air washers must be spray type[or sprayed cell type]. Provide a guillotine type manual winterizing damper complete with holding rack on the discharge side of each unit. Holding rack must retain damper during operating season.

2.8.1 Fan Unit

****

NOTE: Each fan powered by a motor of 5.6 kW 7.5 hp or larger shall have the capability to operate that fan at two-thirds of full speed or less and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device per ASHRAE 90.1.

****

Provide a centrifugal type fan unit complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing. Spray pump must be synchronized to start and stop with fan unit or on a timed cycle which allows the evaporative cells to be wetted prior to fan start.[Remote manual switch with pilot indicating light must be provided where indicated.] Provide fans and motors with vibration isolation supports or mountings. Construct fan scroll and wheel of galvanized steel, aluminum, stainless steel or polymeric material with a stainless steel, hot-dip zinc coated steel, or cadmium coated steel shaft. Fan scroll may be made of a different material than the wheel. Fans must have air delivery ratings based on tests by an AMCA approved laboratory to the AMCA 210.

2.8.2 Water-Handling Equipment

One or more banks of spray nozzles, flooding nozzles, water piping, spray pump, and strainers constitute water handling equipment. Provide the number of banks of spray nozzles required to produce the specified efficiency. Provide self-cleaning, centrifugal type spray nozzles, constructed of brass, and provided with removable caps for cleaning.

Construct flooding nozzles of machined brass or low pressure PVC nozzles. Provide centrifugal type spray pumps with capacity and static pressure required for the spray equipment provided. Unless otherwise indicated, all piping materials and installations must be in conformance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.8.3 Evaporative Cells

Cells must consist of galvanized steel, stainless steel or polymeric material frames packed with [glass fiber] [bonded synthetic fiber] [nonferrous metal] screens, arranged in tiers. Media must be of the type specifically manufactured for the use with air washers. Construct non-ferrous metal media of corrosion and fungus resistant material not susceptible to decomposition by fungal or bacterial action. Each tier must be independent of the others and include separate spray headers, drain sheets and drain conduits to the tank below.

2.8.4 Eliminator

****

NOTE: If the velocity over the media is less than 2.5 m/s 500 fpm, this paragraph may be deleted.

****

Eliminators must consist of vertical plates having a series of bends presenting a large surface area against which the water drops impinge and return down to the tank. Construct eliminator plates of galvanized steel or polymeric material, positioned at both top and bottom and designed to prevent water carryover.

2.9 WATER TANKS

Construct water tanks of stainless steel, polymeric material, or minimum G90 galvanized steel with welds coated with zinc-rich paint. Provide the tank with a means for drainage, a makeup connection, a float-operated valve, an overflow connection and, when required, a recirculating pump suction connection. The float valve must be capable of a water working pressure of 862 kPa 125 psi. Both valve stems and seat disks must be constructed of brass or other approved corrosion resisting material. Provide continuous bleed-off assembly or automatic flush system, adjustable to limit the concentrations from three to ten times the incoming water concentration. Where practicable install water storage tanks with access hatches in order to facilitate annual cleaning and inspections.

2.10 CABINETS

Provide cabinets constructed of galvanized steel sheets, stainless steel or polymeric material. Protect outside air inlets with bird screens that conform to ASTM E2016, Type I, Class 1, 2 by 2 mesh, 1.6 mm 0.063 inch diameter aluminum wire or 0.8 mm 0.031 inch diameter stainless steel wire. Provide access to all moving parts including fans, pumps, and float valves.

2.10.1 Metal Cabinets

Where possible, provide factory-assembled cabinets with either welded or bolted and screwed construction. Cabinets must be braced and reinforced. Bolts, screws, hinges, trim, and other metal appurtenances must be cadmium plated or galvanized in accordance with ASTM B696 or ASTM A123/A123M. When it is necessary to ship the unit disassembled, the cabinet sections must be designed for assembly with cadmium plated or galvanized bolts. [Clean and chemically treat the interior and exterior of the galvanized steel cabinet, including hinges, handles, and other trim, to assure paint adhesion.] [Factory][Field]coat the interior bottom of cabinet with coal tar based enamel or epoxy meeting the requirements of SSPC PS 10.01 or SSPC Paint 16.[Galvanized surfaces damaged during fabrication or handling must be given a coat of zinc-rich paint. Provide finish as specified in paragraph FIELD PAINTING AND FINISHING.] Gauge of cabinet components must be as indicated in TABLES I and II.

TABLE I. STEEL CABINET (MINIMUM THICKNESS mm gauge)

Component part of cooler	Nominal Size of Industry Standard Air Rating			
	0/1650 L/s 0-3500 cfm	1651/2600 L/s 3501/5500 cfm	2601-3300 L/s 5501/7000 cfm	3301/7500 L/s 7001/16000 cfm
Water tank	0.8522	0.8522	1.020	1.318
Corner posts	0.7523	0.7523	0.7523	1.020
Sides	0.8522	0.8522	0.8522	0.8522
Louver pad holder	0.527	0.527	0.527	0.527
Blower scroll	0.7523	0.8522	1.020	1.020
Blower wheel	0.8522	0.8522	0.8522	1.020
Drip trough	0.527	0.5526	0.5526	0.5526
Top	0.8522	0.8522	1.020	1.020

TABLE II. STAINLESS STEEL CABINET (MINIMUM THICKNESS mm gauge)

Component part	Nominal Size of Industry Standard Air Rating		
	0/2100 l/s4500 cfm	2101/3050 L/s 4501/6500 cfm	Beyond 3050 L/s 6500 cfm
Corner posts	0.6524	0.6524	*
Bottom pan	0.8522	1.020	*
Top pan	0.8522	1.020	*

* In accordance with manufacturer's standards.

2.10.2 Polymeric Material Cabinets

Construct unit cabinets of polymeric materials, such as fiberglass or polypropylene which meet the requirements of UL 746C, Figure 12.1. Polymeric cabinets are not acceptable for outdoor installations or where the unit cabinet is exposed to sunlight.

2.11 PREVENTION OF GALVANIC CORROSION

Materials that will be exposed to water during operation of the unit must be such that galvanic action will not occur in the normal operation of the equipment. Finish the interior of water tank and cabinet and the exterior of the fan housing with an enamel paint coat or epoxy coating. There will be no evidence of holidays particularly at sealing joints. Media retainer will not be coated. This paragraph does not apply to nonmetallic materials or the interior water tank and cabinet of stainless steel materials.

2.12 CONTROLS

****

NOTE: This section may be omitted for less complex systems.

****

Specify controls in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC AND Section [23 09 23.01, LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][23 09 23.02, BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

[2.13 THERMOSTATS

****

NOTE: Show thermostats on the drawings.

****

Thermostats must be the low-voltage type or line voltage heavy duty type 115 volt ac with an electrical rating greater than the cooler being controlled. Provide thermostats with a range of 7 to 29 degrees C 45 to 85 degrees F with [an adjustable] [1 degree C 2 degree F] differential range. Thermostats must be UL listed and with an indicator[and a transparent cover with lock].

]2.14 FACTORY COATING

Equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish except that all components inside and outside of the evaporative cooling section must have weather resistant finishes as described in paragraph "Corrosion Coating."

[2.14.1 Corrosion Coating

****

NOTE: For all outdoor applications and in Environmental Severity Classification (ESC) locations C3 thru C5 and all humid locations, as well as all indoor applications in a harsh environment, see UFC 1-200-01 for determination of ESC for a project location; humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1).

****

For equipment located within five miles of a body of salt water and either installed outdoors or handles outside air, provide a uniformly applied [epoxy electrodeposited] [phenolic] [vinyl] type coating to all exposed surface areas. Submit product data on the type coating selected, the coating thickness, the application process used, and verification of conformance with ASTM B117 for a duration of 3,000 hours. Apply coatings at either the unit manufacturer's or coating manufacturer's factory.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

****

NOTE: Indicate supply line stop and waste valves on the drawings. Where required, show backflow preventers on the drawings

****

During construction, cover and seal all openings to ductwork, plenums and control equipment. Uncover ductwork, plenums and control equipment prior to start-up of unit. Install all equipment as shown and in accordance with the manufacturer's approved diagrams and recommendations, in order to provide a complete and functioning system, except where otherwise indicated. Provide manufacturers data on proper maintenance schedules to avoid "scale", "micro biological infestation", and "corrosion" resistance.Connect units to the building's water supply system. Install piping as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

a. Submit installation drawings consisting of layout of equipment including assembly and installation details and electrical connection diagrams. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function and showing equipment relationship to other parts of the work, including clearances required for operation and maintenance.

b. Install a ball valve and union in the water supply line adjacent to each unit. Do not install valves with stems below the horizontal. Slope all supply piping to drain to the indicated stop and waste valve.

c. Submit proposed system diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, controls, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system must be framed under glass or laminated plastic. After approval, post diagrams where directed.

3.2.1 Air-Supply And Distribution System

Install equipment, sheet metal work, air filters, and terminal units as specified in Section [23 30 00 HVAC AIR DISTRIBUTION][23 54 19 BUILDING HEATING SYSTEMS, WARM AIR].

3.3 FIELD QUALITY CONTROL

3.3.1 Field Painting And Finishing

Painting of surfaces not otherwise specified, including nonferrous metals, finish painting of items only primed at the factory, and field repair of factory finish, is specified in Section 09 90 00 PAINTING, GENERAL.

3.3.2 Testing, Adjusting, And Balancing

Perform testing, adjusting, and balancing as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.3.3 Performance Tests

****

NOTE: The evaporative air-cooling equipment may require coordination with Section 01 91 00.15 BUILDING COMMISSIONING.

****

Conduct the test with entering air at 35 degrees C, dry-bulb, plus or minus 2.78 degrees C and a spread between wet-bulb and dry-bulb temperature of minus 4 degrees C plus or minus 3 degrees C. Show the capacity in liter per second (L/s) and efficiency. Meet the following requirements:

Evaporative Cooler	Minimum Efficiency, Percent
Single Stage	80
Two Stage	Indirect Section, 60; Direct Section, 90

$$\text{Efficiency} = \frac{T1-T2}{T1-Tw} \times 100 \text{ percent}$$

where: T1 is the entering dry-bulb temperature in degrees C.
T2 is the leaving dry-bulb temperature in degrees C.
Tw is the entering wet-bulb temperature in degrees C.

Conduct the test with entering air at 95 degrees F, dry-bulb, plus or minus 5 degrees F and a spread between wet-bulb and dry-bulb temperature of 25 degrees F plus or minus 5 degrees F. Show the capacity in cubic feet per minute (cfm) and efficiency. Meet the following requirements:

Evaporative Cooler	Minimum Efficiency, Percent
Single Stage	80
Two Stage	Indirect Section, 60; Direct Section, 90

$$\text{Efficiency} = \frac{T1-T2}{T1-Tw} \times 100 \text{ percent}$$

where: T1 is the entering dry-bulb temperature in degrees F.
T2 is the leaving dry-bulb temperature in degrees F.
Tw is the entering wet-bulb temperature in degrees F.

After testing, adjusting, and balancing has been completed as specified, test the system as a whole to see that all items perform as integral parts of the system and that operation is as specified. Submit proposed test schedules for performance tests, at least 2 weeks prior to the start of related testing. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests must be conducted by the Manufacturer's Representative. Tests must cover a period of not less than [_____] days and must demonstrate that the entire system is functioning according to the specifications. Record ambient air temperature and supply air temperature and quantity readings at hourly intervals for the duration of the test period. Submit test reports for the performance tests in booklet form, upon completion of testing. Document in the reports all phases of tests performed including initial test summary, all repairs/adjustments made, and final test results.

3.3.4 Cleaning

Thoroughly clean ducts, plenums, and casings of all debris; blow them free of all small particles of rubbish and dust before installing outlet faces. Wipe equipment clean, with all traces of oil dust, dirt, or paint spots removed. Provide temporary filters for all fans that are operated during construction; and after all construction dirt has been removed from the building, install new filters. Properly lubricate bearings with oil or grease as recommended by the manufacturer.

3.4 OPERATIONAL TRAINING

****

NOTE: Provide training when justified and approved in programming documents, otherwise delete this paragraph.

****

a. Conduct operational training for operating staff as designated by the Contracting Officer. Submit proposed schedule for field training at least 2 weeks prior to the start of related training. The training period, for a total of [_____] hours of normal working time, must start after the system is functionally completed but prior to final acceptance tests.

b. The field instructions must cover all of the items contained in the approved operation and maintenance manuals. Submit [6] [_____] manuals listing step-by-step procedures required for system startup, operation, shutdown, cleaning - especially to reduce legionella, and routine maintenance, at least 2 weeks prior to field training. Include in the manuals the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and Manufacturer's Authorized Service Representative (including address and telephone number) for each item of equipment.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-23 80 20.00 10 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-23 54 16.00 10 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 80 20.00 10

GAS-FIRED HEATING EQUIPMENT

05/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 80 20.00 10 (May 2020)**

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SECTION 23 80 20.00 10

GAS-FIRED HEATING EQUIPMENT

05/20

****

NOTE: This guide specification covers the requirements for gas-fired heaters, including unit heaters, wall furnaces, and infrared heaters.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.66/CGA 6.14	(2023) Automatic Vent Damper Devices for Use with Gas-Fired Appliances
ANSI Z21.86/CSA 2.32	(2016) Vented Gas-Fired Space Heating Appliances
ANSI Z83.4/CSA 3.7	(2017; R 2022) Non-Recirculating Direct Gas-Fired Heating and Forced Ventilation Appliances for Commercial and Industrial Application
ANSI Z83.8/CSA 2.6	(2016; R 2021) Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces
ANSI Z83.19/CSA 2.35	(2017; R 2022) Gas-Fired High-Intensity Infrared Heaters

CSA GROUP (CSA)

CSA Directory	(updated continuously online) Product Index

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings
Installation

SD-03 Product Data

Spare Parts

SD-06 Test Reports

Testing, Adjusting, and Balancing

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions

1.3 QUALITY ASSURANCE

****

NOTE: All Federal buildings must comply with Executive Order 13423 and Public Law 109-58 (Energy Policy Act of 2005); whether new construction, replacement construction, or, to the greatest extent practical, refurbishment and system replacement. In order to comply with E.O. 13423 and the Energy Policy Act of 2005, building designs must achieve energy consumption levels that are at least 30 percent below the level required by the 2004 publication of ASHRAE 90.1.

In accordance with P.L. 109-58 (Energy Policy Act of 2005), Executive Order 13423, and Federal Acquisition Regulation (FAR) 23.203 Energy-efficient Products must meet or exceed the performance criteria for ENERGY STAR®-qualified or FEMP-designated products as long as these requirements are nonproprietary. The FEMP and ENERGY STAR product requirements are available on the web at www.eere.energy.gov/femp/procurement **and** www.energystar.gov/products**. Where ENERGY STAR or FEMP products are not applicable, energy consuming products and systems must meet or exceed the requirements of ASHRAE 90.1.**

****

Submit detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system. Detail drawings for space heating equipment, controls, associated equipment, and for piping and wiring. Show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings, and not later than [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 General

Provide materials and equipment which are standard products of a manufacturer regularly engaged in manufacturing of the products and that essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening. All gas fired appliances must meet the requirements of NFPA 54.

2.1.2 Nameplates

Secure a plate to each major component of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number. Also, affix an ENERGY STAR label as applicable.

2.1.3 Equipment Guards

Completely enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto. Guard or cover high-temperature equipment and piping so located as to endanger personnel or create a fire hazard with insulation of type specified for service.

2.2 ELECTRICAL WORK

****

NOTE: Indicate motor type, class, and enclosure type on the drawings.

****

Provide electrical motor driven equipment complete with motors, motor starters, and controls. Provide motors conforming to NEMA MG 1. Provide electrical equipment and wiring accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical characteristics as specified or indicated. Provide premium efficiency integral size motors in accordance with NEMA MG 1. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor must be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided.

2.3 HEATERS

****

NOTE: Heater mounting brackets and related hardware should be specified to be furnished by the equipment manufacturer with factory finish if project does not warrant separate specification sections for miscellaneous metals and field painting. The designer should consult UFC 3-31-04 and Sections 13 48 73 and 23 05 48.19 to determine if seismic details are required. If required, refer to specification sections 13 48 73 and 23 05 48.19 or include the necessary details on the drawings. Delete the reference to seismic details, if they are not required. Indicate all applicable vent pipe routing on drawing.

Unless stated otherwise, heaters must have a minimum combustion efficiency of 80 percent at maximum capacity. Show heater combustion efficiencies on the drawings.

****

Equip heaters for and adjust to burn [natural][liquified petroleum][dual fuel natural/liquified petroleum] gas. Provide each heater with a gas pressure regulator that will satisfactorily limit the main gas burner supply pressure. Heaters must have an intermittent or interrupted electrically ignited pilot or a direct electric ignition system. Provide safety controls that conform to the ANSI standard specified for each heater. Furnish mounting brackets and hardware by the heater manufacturer and factory finish to match the supported equipment. Seismic details must be [in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS][as indicated].

2.3.1 Direct Fired Make-Up Air Heaters

****

NOTE: Designer should choose inlet or discharge damper according to climate zone. Generally, locations which experience more than 2220 heating degree C days 4,000 heating degree F days should use discharge dampers on units located outdoors, and inlet dampers on units located indoors. Applications in moderate climates can be specified at the designer's option.

****

Furnish heaters in accordance with ANSI Z83.4/CSA 3.7. Direct fired make-up air heaters use outside air directly ducted to the heater. The products of combustion generated by the heater are released into the outside air stream being heated. Equip heaters with [motorized [inlet][and][outlet]] [backdraft] dampers,[discharge air diffuser,][duct collar,][air filters,][and][bird screen]. Provide [single-stage][two stage][modulating] gas control valve. Maximum air temperature rise during minimum burner fire must be 4 degrees C 7 degrees F. Fan must be [single-speed][two speed, with low speed approximately two-thirds of high speed][variable speed]. Provide weatherized outdoor heaters with manufacturer's standard exterior finish for outdoor units. Provide motorized [inlet][and][outlet] dampers that close when the unit is shut down. Dampers must be interlocked to prevent burner operation when dampers are closed. Provide heaters with a [space][discharge air] thermostat, a low limit air stream thermostat, and an ambient air thermostat. The [space][discharge air] thermostat must control the gas control valve. Provide low limit air stream thermostat to shut down the entire unit if the discharge air temperature drops below the [space][discharge] thermostat setting. Provide ambient air thermostat to shut down the burner if the outside air exceeds the [discharge][space] thermostat setting.

2.3.2 Indirect Fired Make-Up Heaters

Provide heaters in accordance with ANSI and CSA Standards. Equip heaters with motorized inlet dampers, duct collar, and air filters. Provide modulating gas control valve. Maximum air temperature rise during minimum burner fire must be 4 degrees C 7 degrees F. Fan must be two speed, with low speed approximately two-thirds of high speed. Provide motorized inlet dampers that close when the unit is shut down. Dampers must be interlocked to prevent burner operation when dampers are closed. Provide heaters with a space thermostat, a low limit air stream thermostat, and an ambient air thermostat. The space thermostat must control the modulating gas control valve. Provide low limit air stream thermostat to shut down the entire unit if the discharge air temperature drops below the space thermostat setting. Provide ambient air thermostat to shut down the burner if the outside air exceeds the space thermostat setting.

2.3.3 Unit Heaters

****

NOTE: Aluminized steel heat exchangers will be satisfactory in most applications. Omit the aluminized if there is a corrosive condition.

****

Provide heaters conforming to requirements of ANSI Z83.8/CSA 2.6. Provide [aluminized steel][or][stainless steel] heat exchangers. Equip air discharge section with adjustable [horizontal louvers][and][vertical louvers or fins]. Fan shafts must be either directly connected to the driving motor, or indirectly connected by multiple V-belt drive. Fans in one unit must be of the same size. Furnish power-vented heaters, suitable for sidewall vent discharge and single-wall-thickness vent piping. Provide heaters that have automatic ignition. Heaters must employ metered combustion air with enclosed draft diverter (no open flue collar). Provide heaters with a space thermostat which controls both unit's fan and burner.

2.3.4 Wall Furnace

****

NOTE: ANSI Z21.49 defines the gravity type units which are designed to draw combustion air from within the space. Indicate on the drawings the type of air discharge; top or front.

Wall furnace must have a minimum combustion efficiency of 77 percent and a minimum AFUE of 73 percent. Indicate wall furnace efficiencies on the drawings.

****

Provide [gravity][fan] wall furnace in accordance with ANSI Z21.86/CSA 2.32 and as indicated. Provide a space thermostat which controls both the unit's fan and burner.

2.3.5 Duct Furnace

****

NOTE: Aluminized steel heat exchangers will be satisfactory in most applications. Omit the aluminized steel if there is a corrosive condition.

****

Provide duct furnace in accordance with ANSI Z83.8/CSA 2.6. Provide power-vented furnace, suitable for sidewall vent discharge and single wall thickness vent piping. Provide furnace with automatic ignition. Furnace must employ metered combustion air with enclosed draft diverter (no open flue collar). Provide [aluminized steel][or][stainless steel] furnace heat exchangers. Provide furnace with minimum steady state thermal efficiency of 80 percent at maximum rated capacity and 75 percent at minimum rated capacity that is provided and allowed by the controls. Provide furnace with a [space][discharge air] thermostat which controls the unit's burner.

2.3.6 Infrared Heaters

****

NOTE: Unvented infrared heaters may be employed only in buildings with high ceilings such as shop buildings, industrial buildings, etc. Exhaust vents will not be located directly above infrared heaters. The location of the heaters should be coordinated with light fixtures, sprinkler systems, structural members, and any other items that may be sensitive to the heat that will be generated. Where the units are used in metal buildings, the roof will be insulated and an adequate noncombustible vapor barrier will be provided. Unvented infrared heaters will not be used in hazardous areas. Select type of heater required and delete the inapplicable type of ventilation. Capacity of the exhaust system must be a minimum of 6.4 liters per second per 1000 Watt hour 4 cfm per 1,000 Btu per hour input to properly dilute the carbon dioxide produced. Provision will be made to provide air to the space in an amount equal to the exhaust.

****

Furnish heaters conforming to the requirements of ANSI Z83.19/CSA 2.35 and [vented][or][unvented] type[as indicated].[Vented heaters must be vented to the outside atmosphere.] Heater style must be [surface combustion][tubular] type[as indicated]. Reflector shape must be[parabolic][horizontal][or][standard][as indicated]. Provide heaters with space thermostats which control the unit's burner. Cover thermostats located in the direct radiation pattern with a metal shield.

2.4 THERMOSTATS

****

NOTE: Single stage thermostats are used to control a unit at 100 percent capacity only. Two stage thermostats can be used to stage a unit's capacity to either 50 or 100 percent. Two stage thermostats are only applicable for unit heaters and duct furnaces.

****

Provide adjustable electric or electronic thermostats. Include control wiring required to complete the space temperature control system. Provide thermostats that have a 2 degree C 3 degree F differential and a set point range of [4 to 24 degree C 40 to 75 degrees F][minus 18 to plus 38 degrees C 0 to 100 degrees F][27 to 49 degrees C 80 to 120 degrees F]. Provide [single][two] stage thermostats.

2.5 VENT PIPING

Provide vent piping conforming to the requirements of NFPA 54. Plastic material polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.6 ELECTRIC AUTOMATIC VENT DAMPERS

Provide electric automatic vent dampers conforming to the requirements of ANSI Z21.66/CGA 6.14 and provide in the vents of heaters [except unvented infrared heaters] using indoor air for combustion air.

2.7 INSULATION

Provide insulation for piping and equipment and application in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 FACTORY FINISHES

Equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming thoroughly familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

install equipment as indicated and in accordance with the recommendations of the equipment manufacturer and the listing agency, except as otherwise specified.

3.2.1 Heating Equipment

Install heaters with clearance to combustibles, complying with minimum distances as determined by CSA Directory, UL FLAMMABLE & COMBUSTIBLE and as indicated on each heater approval and listing plate. Support heaters independently from the building structure, as indicated, but not relying on suspended ceiling systems for support.

3.2.2 Vents

Locate vent dampers, piping and structural penetrations as indicated. Perform vent damper installation in conformance to ANSI Z21.66/CGA 6.14. Extend vent pipes, where not connected to a masonry chimney conforming to NFPA 211, through the roof or an outside wall and terminate, in compliance with NFPA 54. Provide vents passing through waterproof membranes with the necessary flashings to obtain waterproof installations.

3.2.3 Gas Piping

Connect gas piping as indicated, complying with the applicable requirements at Section 23 11 20 FACILITY GAS PIPING.

3.3 TRAINING

****

NOTE: Insert the number of hours to train personnel for equipment operations. Consult equipment manufacturer for recommended time.

****

Conduct a training course for the maintenance and operating staff. The training period of [_____] hours normal working time must start after the system is functionally complete but before the final acceptance tests. Give the Contracting Officer at least two weeks advance notice of such training. Include all of the items contained in the approved operation and maintenance instructions as well as demonstrations of routine maintenance operations. Submit [6] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and basic operating features. Submit [6] [_____] complete copies of maintenance instructions listing routine maintenance, possible breakdowns, repairs and troubleshooting guide. Include simplified piping, wiring, and control diagrams for the system as installed.

3.4 TESTING, ADJUSTING, AND BALANCING

Perform testing, adjusting, and balancing as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate the final position of controls.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 81 00 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-23 81 00 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 81 00

DECENTRALIZED UNITARY HVAC EQUIPMENT

05/24

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 81 00 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-23 81 00 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 23 81 00

DECENTRALIZED UNITARY HVAC EQUIPMENT
05/24

****

NOTE: This guide specification covers the requirements for unitary (packaged and split systems) air conditioners, heat pumps, and accessories.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Variable Refrigerant Flow (VRF) systems, also known as Variable Refrigerant Volume (VRV) systems, are not included in this specification due to issues and concerns described in UFC 3-410-01 Heating, Ventilating, and Air Conditioning Systems. Do not specify or permit VRF systems which do not meet the requirements of UFC 3-410-01.

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NOTE: This specification uses tailoring options to select the required protocol for control system interfaces for equipment. These tailoring options

are:

1. **BACnet Only**
2. **LonWorks Only**
3. **BACnet or LonWorks (this will require the unit match the building control system)**

DESELECT all three if not requiring control system interfaces. Otherwise SELECT exactly ONE of these tailoring options.

You have currently SELECTED the following options:

BACnet Only
LonWorks Only
BACnet or LonWorks

If more than one item appears between the dashes above you have included more than one services tailoring option and need to DESELECT tailoring options.

****

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with the additions and modifications specified herein.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D	(2018) Laboratory Methods of Testing

	Dampers for Rating
AMCA 500-L	(2015) Laboratory Methods of Testing Louvers for Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 340/360 I-P	(2015) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
AHRI 350	(2015) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
AHRI 390	(2003) Performance Rating of Single Package Vertical Air-Conditioners and Heat Pumps
AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
AHRI 490 I-P	(2011) Performance Rating of Remote Mechanical-Draft Evaporatively-Cooled Refrigerant Condensers
AHRI 540	(2015) Performance Rating Of Positive Displacement Refrigerant Compressors And Compressor Units
AHRI 700	(2016) Specifications for Fluorocarbon Refrigerants
AHRI DCAACP	(Online) Directory of Certified Applied Air-Conditioning Products
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 270	(2008) Sound Rating of Outdoor Unitary Equipment
ANSI/AHRI 340/360	(2007; Addendum 1 2010; Addendum 2 2011) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
ANSI/AHRI 370	(2015; Addendum 1 2016) Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers

ANSI/AHRI 640	(2005) Performance Rating of Commercial and Industrial Humidifiers
ANSI/AHRI/CSA 310/380	(2014) Standard for Packaged Terminal Air-Conditioners and Heat Pumps

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z83.8/CSA 2.6	(2016; R 2021) Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 55	(2023) Thermal Environmental Conditions for Human Occupancy
ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality
ASHRAE 64	(2020) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)

AHAM RAC-1	(1982; R2008) Directory of Certified Room Air Conditioners

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D4587	(2011; R 2019; E 2019) Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E2129	(2024) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5541	(2006; Rev F; Notice 2 2024) Chemical Conversion Coatings on Aluminum and Aluminum Alloys
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

UL SOLUTIONS (UL)

UL 207	(2022) UL Standard for Safety Refrigerant-Containing Components and Accessories, Nonelectrical
UL 484	(2014; Reprint Jun 2022) UL Standard for Room Air Conditioners
UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Spare Parts

Posted Instructions

Coil Corrosion Protection

System Performance Tests

Training; G, [_____]

Inventory

Environmental Data

Supplied Products

Manufacturer's Standard Catalog Data

Humidifier

SD-06 Test Reports

Refrigerant Tests, Charging, and Start-Up; G, [_____]

System Performance Tests; G, [_____]

SD-07 Certificates

Service Organizations

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

SD-11 Closeout Submittals

Ozone Depleting Substances; S, [_____]

1.4 QUALITY ASSURANCE

Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Submit drawings consisting of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

h. Equipment schedules

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Properly protect and care for all material both before and during installation. Submit an inventory of all the stored items. Replace any materials found to be damaged, at no additional cost to the Government. During installation, cap piping and similar openings capped to keep out dirt and other foreign matter.

1.6 ENVIRONMENTAL REQUIREMENTS

For proper Indoor Environmental Quality, maintain pressure within the building as indicated. Ventilation must meet or exceed ASHRAE 62.1 and all published addenda. Meet or exceed filter media efficiency as tested in accordance with ASHRAE 52.2. Thermal comfort must meet or exceed [ASHRAE 55][AFGM 2016-01].

1.7 WARRANTY

Provide equipment with the [Manufacturer's Standard Warranty.] [[1 year] [2 year] [5 year] [10 year] [_____ year] manufacturer's warranty.]

PART 2 PRODUCTS

****

NOTE: Inapplicable equipment and system requirements will be deleted or modified in all paragraphs to suit the system designed. Coordinate the standard and design option features typical for

each air conditioning/Heat Pump unit and individual installation. Care must be taken to avoid specifying design options which are generally unavailable in certain combinations or are inappropriate for the application.

Projects which include vapor-compression type refrigeration systems will comply with the safety standards defined in ASHRAE 15 & 34. Designers will be responsible for thoroughly researching and implementing the ASHRAE 15 & 34 safety requirements. For refrigerant-containing parts (excluding piping) located within an indoor space, a designer can use the following 6-step synopsis as a guide in determining "System Application Requirements" from ASHRAE 15 & 34.

Step 1. Identify the safety group classification of the refrigerant anticipated to be used in the new refrigeration equipment. Refrigerants R-22 and R-134a are considered Group A1 refrigerants. Refrigerant R-123 is considered a Group B1 Refrigerant.

Step 2. Identify the occupancy classification of the facility which will house the new refrigerant equipment. Occupancies include institutional, public assembly, residential, commercial, large mercantile, industrial, and mixed types.

Step 3. Determine the system probability (high or low) of the new refrigeration equipment. Split system applications are typically considered high-probability systems according to ASHRAE 15 & 34.

Step 4. Estimate the quantity of refrigerant (gramspounds) in the largest single refrigerant circuit of the new equipment. The designer will research catalog data from different manufacturers in order to get an approximation.

Step 5. Determine the volume (cubic meters cubic feet) of the indoor space which is planned to house the new refrigeration equipment.

Step 6. Identify the "System Application Requirements" from the applicable table in ASHRAE 15 & 34 based upon the information identified in the previous steps (e.g., safety group, occupancy, system probability, refrigerant quantity, and indoor space volume). The "System Application Requirements" will dictate applicable refrigerant limitations as well as occupied space or mechanical room requirements.

ASHRAE 15 & 34 refers to a mechanical room as a machinery room, however the terms are synonymous. On mechanical room design, ASHRAE 15 & 34 touches on criteria concerning equipment placement, ventilation

design, door and passageway restrictions, refrigerant monitoring, open-flame devices, pressure-relief and purge piping. In addition to mechanical room design, ASHRAE 15 & 34 also touches on criteria concerning refrigerant piping, signs, self-contained breathing apparatus (SCBA), and miscellaneous installation restrictions. (SCBAs cannot be considered MCA funded items and are therefore not included in this specification.)

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2.1 ENERGY EFFICIENCY REQUIREMENTS

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NOTE: Delete this paragraph and references to Energy Star program for all Air Force Projects.

****

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NOTE: 10 CFR 436.42 specifies that ENERGY STAR qualified and FEMP designated products may be assumed to be life-cycle cost effective. Equipment having a lower efficiency may be specified if the designer determines the lower efficiency equipment to be more life-cycle cost effective. In making such a determination, the designer should rely on the life-cycle cost analysis method in 10 CFR 436, Subpart A.

****

42 USC 8259b requires the procurement of energy efficient products in product categories covered by the Energy Star program or the Federal Energy Management Program for designated products. A list of covered product categories is available from the Federal Energy Management Web site at: https://www.energy.gov/femp/search-energy-efficient-products. A list of qualified light commercial products is available at: http://www.energystar.gov/productfinder/product/certified-light-commercial-hvac/results.

Submit Material, Equipment, and Fixtures List of all supplied products within a covered product category, including manufacturer's catalog numbers, specification and drawing reference number, warranty information, fabrication site, and energy performance data. For product categories covered by the Energy Star program, submit documentation that the product is Energy Star-qualified. For product categories covered by the Federal Energy Management Program, submit documentation that the product meets or exceeds FEMP-designated efficiency requirements.

2.1.1 Room Air Conditioners

Selected room air conditioners are required to meet performance requirements specified by Energy Star. Information on the requirements can be found at: https://www.energystar.gov/products/room_air_conditioners/partners.

2.1.2 Air-Source Heat Pumps

Selected air-source heat pumps are required to meet applicable performance requirements specified by Energy Star. Information on the requirements can be found for residential models (single-phase units of 65,000 BTU/h or less)at:https://www.energystar.gov/products/air_source_heat_pumps/partners. For light commercial models (three-phase units of less than 240,000 BTU/h) at: https://www.energystar.gov/products/light_comm_heating_cooling/partners.

2.2 MATERIALS

Provide Manufacturer's standard catalog data, at least [5 weeks] [_____] prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data includes manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Submit data for each specified component. Minimum efficiency requirements must be in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

2.2.1 Standard Products

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for 2 years prior to [bid opening] [request for proposal]. The 2 year use includes applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products must be supported by a service organization. Ensure system components are environmentally suitable for the indicated geographic locations.

2.2.2 Product Sustainability Criteria

2.2.2.1 Energy Efficient Equipment

****

NOTE: Design federal buildings to conform to the requirements defined in Executive Order 13423 and Public Law (PL) 109-58 - "Energy Policy Act of 2005 (EPAct05)." In accordance with these policies design buildings to achieve energy consumption levels that are at least 30 percent below the levels established in the 2004 publication of ASHRAE 90.1. In addition, all new energy consuming equipment must be either an "energy Star Qualified Product" or a "FEMP Designated Product" unless no such products exist. Where Energy Star Qualified Products or FEMP Designated Products are not applicable, products must meet or exceed the requirements of ASHRAE 90.1.

Present applicable efficiencies either in this paragraph or on the design drawings. Delete this paragraph if equipment efficiencies are shown on the

drawings.

The following is a list of terms which are commonly used in regard to efficiency ratings.

COP - Coefficient of Performance (dimensionless)
EER - Energy Efficiency Ratio (Btuh/Watt)
HSPF - Heating System Performance Factor (Btuh/Watt)
SEER - Seasonal Energy Efficiency Ratio (Btuh/Watt)
SCOP - Seasonal Coefficient of Performance (dimensionless)
IPLV - Integrated Part Load Value (dimensionless)

COP and HSPF values are typically used in regard to heating efficiencies. COP values should also be used to define cooling efficiencies when a job is being specified in SI units (EER = 3.415 x COP). COP and EER values are established based strictly upon a unit's full load capacity and not part load capacities.

Equipment selected will have as a minimum the efficiency rating determined in ASHRAE 90.1 - SI ASHRAE 90.1 - IP or CID A-A-50502 may be specified if the designer determines the equipment to be more life-cycle cost effective.
****

Provide equipment meeting the efficiency requirements as stated within this section and provide documentation in conformance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph ENERGY EFFICIENT EQUIPMENT.

2.2.2.2 Electrical Equipment / Motors

****
NOTE: Where motor starters for mechanical equipment are provided in motor-control centers, the references to motor starters will be deleted.
****

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Electrical characteristics must be as shown, and unless otherwise indicated, all motors of 746 W 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, must be the premium efficiency type in accordance with NEMA MG 1. Field wiring must be in accordance with manufacturer's instructions. Each motor must conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors must be continuous duty with the enclosure specified. Motor starters must be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors must be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors must be sized for the applicable loads. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided.

2.2.2.3 Ozone Depleting Substances

Unitary air conditioning equipment must not use CFC-based refrigerants. Refrigerant may be an approved alternative refrigerant in accordance with EPA's Significant New Alternative Policy (SNAP) listing. Provide documentation in conformance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph OZONE DEPLETING SUBSTANCES.

2.2.2.4 Local/Regional Materials

****

NOTE: Using local materials can help minimize transportation impacts, including fossil fuel consumption, air pollution, and labor.

****

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [800][_____] kilometer [500][_____] mileradius from the project site, if available from a minimum of three sources.

2.2.2.5 Environmental Data

****

NOTE: ASTM E2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products.

****

Submit Table 1 of ASTM E2129 for the following products: [_____].

2.2.3 Nameplates

****

NOTE: In a salt water environment substitute acceptable non-corroding metal, such as but not limited to nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

****

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates must be durable and legible throughout equipment life and made of [anodized aluminum] [stainless steel] [_____]. Fix plates in prominent locations with nonferrous screws or bolts.

2.2.4 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

2.3 EQUIPMENT

****

NOTE: Equipment having a higher efficiency than required by ASHRAE 90.1 or CID A-A-50502 must be specified if shown to be life-cycle cost effective. Minimum efficiencies must be according to Energy Star (https://www.energystar.gov/products) and FEMP https://www.energy.gov/femp/search-energy-efficient-products recommendations.

****

2.3.1 Packaged Terminal [Air Conditioners] [Heat Pumps]

****

NOTE: Refer to ASHRAE 90.1 Table 6.8.1D for the minimum efficiency requirements of electrically operated packaged terminal air conditioners and heat pumps. Air conditioners with a SEER of 14.0 are readily available.

****

2.3.1.1 Packaged Terminal Unit

Provide a [vertical] [through-the-wall], [grade/floor mounted][wall mounted],[wall hung] heavy-duty commercial grade, factory assembled and precharged [air conditioner] [heat pump] unit in accordance with [AHRI 390] [ANSI/AHRI/CSA 310/380] and UL 1995. Provide units listed in AHRI DCAACP.[Provide Units removable from inside the building for servicing without removing the outside cabinet.] Provide unit with a noise rating in accordance with AHRI 350 that does not exceed [85][_____] dB while the entire unit is operating at any fan or compressor speed.[Heat pump units must contain a reversing valve to change unit to heating cycle.] Provide an outdoor coil temperature sensor to guard against coil freeze-up by either switching to supplemental heat only, or by cycling the compressor to defrost the coil. Provide [Air Conditioners][Heat pumps] with [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].] [Provide units suitable for use with minimal ductwork having a total external static resistance up to 25 Pa 0.1 inch of water.]

2.3.1.2 Compressor

Provide a hermetically sealed [reciprocating] [rotary] [variable speed] [digital scroll] [scroll] type Compressor. Provide compressor with permanent split capacitor motor, overload protection, and vibration isolators. Protect compressor against high discharge pressure, loss of charge, low voltage, and short cycling.

2.3.1.3 Air to Refrigerant Coils

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive environments.

****

Provide evaporator and condenser coils with [nonferrous] [copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter with [copper][or][aluminum] fins that are mechanically bonded or soldered to the tubes. [Protect coil in accordance with paragraph COIL CORROSION PROTECTION.] Provide casing of galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure they are suitable for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with a [factory operating charge of refrigerant and oil][or][holding charge].[Unit shipped with a holding charge must be field charged with refrigerant and oil.] Provide a condensate removal system.

2.3.1.4 Fans

Provide direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

2.3.1.5 Air Filters

Provide standard filter on all packaged terminal units;[25 mm 1 inch] [50 mm 2 inch] [_____] mm inch MERV [7] [8] [13] [_____], throwaway filter capable of filtering the entire air supply.

2.3.1.6 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****

NOTE: Choose the applicable from the following subparts.

****

[2.3.1.6.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service. Electric resistance heating elements with high temperature-limit safety device, factory-mounted, and wired to chassis.

][2.3.1.6.2   Gas-Fired Heating Section

****

NOTE: Gas-fired heating sections are not available for air conditioning units for electronic data processing (EDP) spaces.

****

[Provide completely assembled, wired and piped gas fired heating systems within the unit suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [intermittent pilot] ignition. fire test all units prior to shipment. Valve must include a pressure regulator. Safety controls must include a flame sensor and air pressure switch. Provide heater section with a forced combustion blower to insure flame stability under varying wind conditions. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.]

****

NOTE: The following section applies to Rooftop Units with high efficiency condensing, gas-fired heat exchangers. This equipment is cost effective when used in a dedicated outside air unit with a cooling capacity greater than 60,000 Btu/hr and high run time in a climate with a substantial heating season.

****

[Heating section must be [91 percent][_____] efficient condensing type, factory installed, and design certified to ANSI Z83.8/CSA 2.6. The heating section must be suitable for [natural gas] [liquid propane gas] fuel supply. The power vented system must maintain specified efficiency as a minimum throughout a modulation range of [5:1] [10:1] [_____]. The primary and secondary heat exchanger, burner and condensate drip pan will be constructed of Type 409 series stainless steel. Heating section must be completely assembled and integral to the rooftop unit with complete condensate drainage through the base of the unit. The primary heat exchanger must be specifically designed to handle the treatment of 100 percent outside air including capability of 100 degrees temperature rise. The gas control system must provide ignition control, gas modulation and all necessary safeties. The heating section must be factory wired and include the minimum components as follows: main and pilot manual shutoff valves, main and pilot regulators, main and pilot automatic shut-off valve and adequate union and test ports for unconstrained service. A condensate neutralizer must be provided with the rooftop unit. The condensate neutralizer will contain enough neutralizing agent for the volume of condensate generated annually by the heating section. The condensate neutralizer must allow for ease of replacement of neutralizing media or agent. Condensate drain piping system must be in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE, Table 1. Condensate drain must be conveyed from the drain pan outlet to an approved place of disposal.]

][2.3.1.6.3   Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.1.6.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.1.7 Cabinet Construction

Provide cabinet free of visible fasteners, sharp protuberances and edges. Enclosure sheet metal must be a minimum of 1.2 mm 18 gauge steel with a protective coating. Provide removable face panels and allow full access to unit appurtenances. Access to controls must be without removal of the face panel. Discharge conditioned air through adjustable louvers. Thermally and acoustically insulate the cabinet with materials which conform to NFPA 90A. Furnish units with a [field-wired] [prewired] subbase that has leveling screws [with] [without] provisions for remote unit control. Subbase must be of 1.3 mm 18 gauge galvanized steel construction with a protective coating to match that of the room cabinet. Paint and finishes must comply with the requirements specified in paragraph EQUIPMENT AND COMPONENTS FACTORY COATING.

2.3.1.8 Louver

Provide storm proof type Louver, constructed of [anodized,] [stamped] [or] [extruded] aluminum.

2.3.1.9 Ventilation Damper Assembly

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NOTE: Delete requirement for ventilation damper when outside air is supplied to the spaced by a central system.

****

Operated by automatic actuator. Dampers must close on unit shutdown or loss of power and open on heating or cooling start-up. Dampers must have a maximum leakage rate of 8 (L/Min)/m2 at 249 Pa 3 CFM/ft2 at 1 inch w.g. static pressure.

2.3.1.10 Wall Sleeve

Provide water and airtight [completely insulated] [non-insulated] assembly, with weather-resistant protective coating.

2.3.1.11 Duct Package

Duct extension must consist of 1.3 mm 18 gauge minimum galvanized steel plenum extender with all necessary internal dampers and baffles to divert [25] [_____] percent of the supply air as indicated. Duct extension must be painted with a protective coating that matches room cabinet.

2.3.1.12 Unit Controls

Controls must include an on-off switch, high and low selector switch for [the cooling mode] [both the heating and cooling mode], multiple speed fan [cooling] [cooling and heating] mode, room air fan switch, outside air damper control, and an adjustable cooling [only] [and heating] thermostat. Function and temperature controls must be [integral to unit] [remotely mounted as indicated or as accepted by the Contracting Officer].

Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.3.2 Room [Air Conditioner] [Heat Pump]

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NOTE: Indicate unit capacity, voltage, phase, installation requirements, etc. on the drawings. At a minimum, the unit will be required to have an Energy Star Label and efficiency for the unit will be in accordance with the International Code Council (ICC) International Green Construction Code (IGCC).

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Provide a [window] [through-the-wall] mounted, appliance grade, factory assembled [air conditioner] [heat pump] unit in accordance with AHAM RAC-1 and UL 484. Units must include a self-contained, precharged, slide-in and removable chassis-mounted, air-cooled refrigeration system. Provide units removable from inside the building for servicing without removing the outside cabinet. Mount compressors on vibration isolators. Minimum cooling capacity must be not less than that indicated. Provide units listed in the AHAM RAC-1.[Provide light tight units serving dark rooms.] Cooling section must be equipped with a filter-drier on the suction line. Fan and condenser motors must have [open] [drip proof] [totally enclosed] [explosion proof] enclosures.[Room Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]] [Room Heat Pumps must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]]

2.3.2.1 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****

NOTE: Choose the applicable from the following subparts.

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[2.3.2.1.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service. Electric resistance heating elements with high temperature-limit safety device, factory-mounted, and wired to chassis.

][2.3.2.1.2 Gas-Fired Heating Section

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NOTE: Gas-fired heatng sections are not available for air conditioning units for electronic data processing (EDP) spaces.

****

Provide completely assembled, wired and piped gas fired heating systems within the unit suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [intermittent pilot] ignition. Fire test all units prior to shipment. Valve must include a pressure regulator. Safety controls must include a flame sensor and air pressure switch. Provide heater section with a forced combustion blower to insure flame stability under varying wind conditions. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.

][2.3.2.1.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.2.1.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.2.2 Filters

[Provide replaceable media filters of the [dry-media] [washable] type, of the size required to suit the application. Average efficiency must be not less than [25][_____] percent when tested in accordance with ASHRAE 52.2.] [Provide air filters of the [throw-away] [or] [permanent washable] type removable without the use of tools and arranged to filter both room and ventilating air. Filters must have a minimum efficiency reporting value (MERV) of [6][8][_____] when tested in accordance with ASHRAE 52.2.]

2.3.2.3 Fans

Provide direct driven, statically and dynamically, [centrifugal][or

][propeller] type fans. Design outdoor fan so that condensate evaporates without drip, splash, or spray on building exterior. Remove condensate by means of a drain or by evaporation and diffusion.

2.3.2.4 Casing

Provide exterior casings for the specified room HVAC Units constructed of factory phosphatized and painted galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Fit casing with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Incorporate provisions to permit replacement of major unit components. Seal penetrations of cabinet surfaces, including the floor. Unit base must be watertight. Fit unit with a drain pan which extends under all areas where water may accumulate. Fabricate drain pan from Type 30X stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071.

Construct outside cabinets, including metal grilles to protect condenser coils, of zinc-coated steel or aluminum. Steel and zinc-coated surfaces must receive at least one coat of primer and manufacturer's standard factory-applied finish Insulate cabinets to prevent condensation and run off of moisture. Provide mounting hardware made of corrosion-resistant material or protected by a corrosion-resistant finish. Provide with metal or plastic mounting flanges on each side, top, and bottom of unit. For through-the-wall installations provide aluminum or shop painted zinc-coated steel flanged telescopic wall sleeves. Design wall sleeves to restrict driving rain. For window mounted units provide shop-painted metal mounting brackets, braces, and sill plates.

2.3.2.5 Energy Efficiency

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NOTE: FEMP requires Energy Star-qualified room air conditioners. "Energy Star Program Requirements Product Specification for Room Air Conditioners. Eligibility Criteria Version 3.1" requires the following minimum EER values:

For room air conditioners with louvered sides and a capacity smaller than 2.34 kW 8,000 Btuh Energy Star requires a minimum EER of 11.2, for capacities between 2.34 kW and 4.10 kW 8,000 and 13,999 Btuh Energy Star requires a minimum EER of 11.3, for capacities between 4.10 kW and 5.86 kW 14,000 Btuh and 19,999 Btuh Energy Star requires a minimum EER of 11.2, for capacities greater than or equal to 5.86 kW 20,000 Btuh Energy Star requires a minimum EER of 9.8.

For room air conditioners without louvered sides and a capacity smaller than 2.34 kW 8,000 Btuh Energy Star requires a minimum EER of 10.4, and for

capacities graeter than or equal to 2.34 kW 8,000 Btuh Energy Star requires a minimum EER of 9.8.
****

Minimum energy efficiency ratio (EER) must be in accordance with the paragraph EQUIPMENT EFFICIENCY. [Room air conditioners must include the Energy Star label affixed to the equipment.]

2.3.2.6 Units for Operation on 115 Volts

Provide 3-wire cords of manufacturer's standard length. If not existing, provide a receptacle within reach of the standard length cord. Cords must have a 15- or 20-amp, 3-pole, 125-volt ground type plug to match receptacle.

2.3.2.7 Units for Operation on 208 or 230 Volts

Provide 3-wire cords of manufacturer's standard length. If not existing, provide a receptacle within reach of the standard length cord. Cords must have a 15-, 20-, or 30-amp, 3-pole, 250-volt ground type plug to match receptacle.

2.3.2.8 Controls

****
NOTE: Ensure that all controls equipment meets the requirements of UFC 4-010-06 Cybersecurity of Facility-Related Control Systems.
****

Provide units internally prewired by manufacturer with a 24 volt control circuit powered by an internal transformer. Terminal blocks must be provided for power wiring and external control wiring. Unit must be internally protected by [fuses] [or] [a circuit breaker] in accordance with UL 1995. [Unit must be provided with microprocessor controls to provide all 24V control functions.]
Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Mount controls in cabinet. Manual controls must permit operation of either the fan or the fan and refrigerating equipment. Fan control must provide two fan speed settings. Automatic controls must include a thermostat for controlling air temperature. Thermostat must have an adjustable range, including 22 to 27 degrees C 72 to 80 degrees F and must automatically turn the refrigeration system on or off to maintain the preselected temperature within plus or minus 20 degrees C 4 degrees F.

2.3.3 Self-Contained Air Conditioners [Heat Pumps]

2.3.3.1 Small-Capacity Self-Contained air conditioners [Heat Pumps] (Not exceeding 19 kW 65,000 Btu/h)

2.3.3.1.1 General

Unit must be an air-cooled, factory assembled, weatherproof packaged unit as indicated. Unit must be the [air conditioning][heat pump] type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][ANSI/AHRI 340/360]. Unit must be provided with equipment as specified in paragraph UNITARY EQUIPMENT COMPONENTS. Evaporator or supply fans must be direct drive forward curved centrifugal scroll type. Condenser fans must be manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Unit must be provided with a full factory operating charge of refrigerant. Unit must have an Energy Star label.[Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Unit must be provided with hot gas reheat.]

2.3.3.1.2 Air-to-Refrigerant Coils

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NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive or coastal environments.

****

Air-to-refrigerant coils must have [seamless copper][or] [aluminum] tubes of 8 mm 5/16 inch minimum diameter with [copper] [or] [aluminum] fins that are mechanically bonded or soldered to the tubes. Casing must be [galvanized steel] [or] [aluminum]. Contact of dissimilar metals must be avoided. Coils must be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil must be factory pressure and leak tested. Separate expansion devices must be provided for each compressor circuit.

[Condenser] [Evaporator] [Condenser and Evaporator] coil must be coated with a uniformly applied [epoxy electrodeposition][phenolic][vinyl][epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum [500][1,000][____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.3.3.1.3 Fan Section

Fan must be the [centrifugal] [propeller] type in accordance with paragraph FANS. Do not locate fan and fan motor in the discharge airstream of the unit. Motors must have [open] [splash proof] [totally enclosed] enclosure and be suitable for the indicated service. The unit design must prevent water from entering into the fan section.

2.3.3.1.4 Compressor

Provide direct drive, [hermetic reciprocating,] [variable speed] [digital scroll] [scroll] type Compressor. Compressor must have internal over current and over temperature protection, internal pressure relief, rotor lock suction and discharge refrigerant connections, centrifugal oil pump, vibration isolation, and discharge refrigerant connections.

2.3.3.1.5 Refrigeration Circuit

Refrigerant containing components must comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant lines must have service pressure tap ports and refrigerant line filter.

2.3.3.1.6 Unit Controls

****

NOTE: In regards to head pressure control, insert the appropriate minimum or lowest expected ambient temperature. Delete head pressure controls if inapplicable. Delete low cost cooling if inapplicable. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated.

Ensure that all controls equipment meets the requirements of UFC 4-010-06 Cybersecurity of Facility-Related Control Systems.

****

Provide units internally prewired by manufacturer with a 24 volt control circuit powered by an internal transformer. Terminal blocks must be provided for power wiring and external control wiring. Unit must be internally protected by [fuses] [or] [a circuit breaker] in accordance with UL 1995.

a. [Unit must be provided with microprocessor controls to provide all 24V control functions.]Unit must be controlled by a [two stage heating /cooling thermostat] [one stage heating/cooling thermostat] with [manual] [automatic] changeover.[Unit must be controlled by a programmable electronic thermostat with heating setback and cooling setup with 7-day programming capability.]

b. Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

c. Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

d. Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.3.3.1.7 Roof Curb

Provide a roof curb that mates with the unit to provide support and be completely weather tight. Provide curb with sealing strips to ensure an airtight seal between supply and return openings of the curb and unit. Design curb to allow ductwork to be directly connected to the curb.[The roof curb must be provided by the Manufacturer of the equipment.][The Roof Curb must be a minimum of [_____] mm inches tall.][Provide an acoustical roof curb to meet noise requirements.]

2.3.3.1.8 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****

NOTE: Choose the applicable from the following subparts.

****

[2.3.3.1.8.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.

****

NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.

****

][2.3.3.1.8.2 Gas-Fired Heating Section

Provide factory assembled heating section as an integral part of the packaged unit. Design must be UL certified for outdoor application. Unit must have threaded gas connection. Provide heating section with [an intermittent pilot][an electronic] ignition system to light burner each time thermostat calls for heat. A flame sensor must prove flame and keep main burner on. The main valve must close should a loss of flame occur. When the thermostat is satisfied, extinguish the main burner. Provide a forced combustion blower to supply combustion air to the heating section.

Construct the heat exchanger and burners of [aluminized steel][stainless steel].

][2.3.3.1.8.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.3.1.8.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.3.1.9 Single Source Power Entry

Provide single source power entry to allow single source power connection to unit and heater combination. Single source power entry kit includes specific matching heater(s), high voltage terminal blocks, fuse blocks and fuses, cut-to-length interconnecting wiring, and [plug with matching receptacle][junction box (if required)] to provide power sources with fuse protection as required for both the unit and accessory heater. [The equipment disconnect must be provided by the Manufacturer of the equipment.]

****

NOTE: For Army, Air Force, and Navy projects, ensure compliance with UFC 3-410-01 paragraph ECONOMIZER.

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[2.3.3.1.10 Fully Modulating Economizer

Provide a fully modulating economizer with 0-100 percent fresh air damper, damper drive motor, and fixed dry bulb enthalpy control [solid state enthalpy control] [differential enthalpy control]. Control economizer operations by the pre-set position of the enthalpy control. Include a barometric relief damper with the down flow economizer to provide a pressure operated damper that is gravity closing and prohibits entrance of outside air on equipment "off" cycle.

]2.3.3.1.11 Manual Outside Air Damper

Provide manual outside air damper with rain hood and screen suitable for up to [25][____] percent outside air. Dampers must have a maximum leakage rate of 8 (L/Min)/m2 at 249 Pa 3 CFM/ft2 at 1 inch w.g. static pressure

2.3.3.1.12 Low Ambient Control

Provide low ambient control to allow cycling of compressor for cooling operation at low ambient temperatures down to [minus 18][_____] degrees C [0][_____] degrees F.

2.3.3.1.13 Filters

Provide a [25][50][_____] mm [1][2][_____] inch MERV [7][8][13][_____], throwaway filter.

2.3.3.2 Large-Capacity Self-Contained air conditioners [Heat Pumps] (Greater than 19 kW 65,000 Btu/h)

2.3.3.2.1 General

Provide an air-cooled, factory assembled, weatherproof packaged unit for [dedicated downflow][or][horizontal] airflow. Exterior panels must be zinc coated galvanized steel phosphatized and painted.[All access doors and panels must be hinged with neoprene gaskets.] Unit must be listed, labeled, and classified in accordance with UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][ANSI/AHRI 340/360]. Provide unit with equipment as specified in paragraph UNITARY EQUIPMENT COMPONENTS. Evaporator or supply fans must be direct drive forward curved centrifugal scroll type. Condenser fans must be manufacturer's standard for the unit specified and may be [either] [propeller] [or] [centrifugal scroll] type. UProvide unit with a full factory operating charge of refrigerant. Unit must be 100 percent run tested at the factory. No penetrations are allowed within the perimeter of the curb in the down flow unit's base pan other than the raised 29 mm 1-1/8 inch high supply/return openings to provide added water integrity precaution from condensate drain back up.

Provide a belt driven, forward curved centrifugal indoor fan with adjustable motor sheaves. Thermally protect all motors. Provide unit with a removable, reversible, double-sloped condensate drain pan.[Air conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Provide unit with hot gas reheat.]

2.3.3.2.2 Casing

Construct exterior casings for the specified unitary equipment of factory phosphatized and painted galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Fit casing with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. All access doors and panels must have neoprene gaskets.[Casing must have double-wall, hinged access doors for filters, heating, return/exhaust air, and supply fan section.] Incorporate provisions to permit replacement of major unit components. Seal penetrations of cabinet surfaces, including the floor. Unit base must be watertight. Fit unit with a drain pan which extends under all areas where water may accumulate. Fabricate drain pan from Type 30X stainless steel, galvanized steel with protective coating, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071.

2.3.3.2.3 Air-to-Refrigerant Coils

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive or coastal environments.

****

Provide air-to-refrigerant coils with [seamless copper][or][aluminum] tubes of 8 mm 5/16 inch minimum diameter with [copper][or][aluminum] fins that are mechanically bonded or soldered to the tubes. Casing must be [galvanized steel] [or] [aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and must be suitable for the working pressure of the installed system. Factory pressure and leak test each coil.

a. Provide separate expansion devices for each compressor circuit. Condensate drain pans must be removable and double-sloped.

b. Dual compressor units must have intermingled evaporator coils.

c. Condensate drain pans must be removable and double-sloped.[

d. Provide condenser coils with hail protection guards.]

e. Coat [condenser] [evaporator] [condenser and evaporator] coil with a uniformly applied [epoxy electrodeposition] [phenolic] [vinyl] [epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum [500][1000][_____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.3.3.2.4 Compressor

Provide direct drive, [hermetic reciprocating,] [or] [scroll] type compressor. Compressor must have internal over current and over temperature protection, internal pressure relief, high pressure cutout, rotor lock suction and discharge refrigerant connections, centrifugal oil pump, vibration isolation, and discharge refrigerant connections. Compressors must have crankcase heaters. Motor must be suction gas-cooled. Cooling partial load capacity must be provided by [a dual stage compressor] [two or more compressors controlled to stage up and down based on load] [a variable speed compressor].

2.3.3.2.5 Refrigeration Circuit

Refrigerant containing components must comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant lines with service pressure tap ports and refrigerant line filter.

2.3.3.2.6 Unit Controls

****

NOTE: In regards to head pressure control, insert the appropriate minimum or lowest expected ambient temperature. Delete head pressure controls if inapplicable. Delete low cost cooling if inapplicable. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the

compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated.

Ensure that all controls equipment meets the requirements of UFC 4-010-06 Cybersecurity of Facility-Related Control Systems.

****

Provide units internally prewired by manufacturer with a 24 volt electromechanical control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Internally protect unit by [fuses] [or] [a circuit breaker] in accordance with UL 1995. Units with three-phase power must be equipped with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal.

a. [Provide unit with microprocessor controls to provide all 24V control functions.]Control unit by a [two stage heating /cooling thermostat] [one stage heating/cooling thermostat] with [manual] [automatic] changeover. [Control unit by a programmable electronic thermostat with heating setback and cooling setup with 7-day programming capability.]

b. Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

c. Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

d. Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.3.3.2.7 Supply Air Fan

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NOTE: Delete the following paragraph when air ventilation rates or air exchange rates require constant volume.

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Units having AHRI cooling capacity equal or greater than 32 kW 110,000 Btu/h must have supply fans controlled by [two-speed motors] [variable speed motors].

[Provide direct drive, forward curved, centrifugal scroll type supply air fan.][Provide supply air plenum fan with backward-curved fan wheel.]

2.3.3.2.8 Roof Curb

Provide a roof curb that mates with the unit to provide support and be completely weather tight. Provide curb with sealing strips to ensure an airtight seal between supply and return openings of the curb and unit. Design curb to allow ductwork to be directly connected to the curb.[The roof curb must be provided by the Manufacturer of the equipment.][The roof curb must be a minimum of [_____] mm inches tall.][Provide an acoustical roof curb to meet noise requirements.]

2.3.3.2.9 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****

NOTE: Choose the applicable from the following subparts.

****

[2.3.3.2.9.1 Electric Heating

Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.

][2.3.3.2.9.2 Gas-Fired Heating Section

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NOTE: Gas-fired heating sections are not available for air conditioning units for EDP spaces.

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NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.

****

Construct gas-fired heat exchanger and burner of aluminized steel [stainless steel] suitable for [natural gas] [liquid propane gas] fuel supply. Provide burner with [direct spark] [intermittentpilot] ignition. Heating section must have modulation with a turn down ratio of at least [4] [3] to 1. Provide heating section completely assembled and integral to unit. Fire test all units prior to shipment. Valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount heater section to eliminate noise from expansion and contraction and completely accessible for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.

][2.3.3.2.9.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.3.2.9.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.3.2.10 Single Source Power Entry

Provide single source power entry to allow single source power connection to unit and heater combination. Single source power entry kit includes specific matching heater(s), high voltage terminal blocks, fuse blocks and fuses, cut-to-length interconnecting wiring, and [plug with matching receptacle][junction box (if required)] to provide power sources with fuse protection as required for both the unit and accessory heater. [The equipment disconnect must be provided by the Manufacturer of the equipment.]

[2.3.3.2.11 Fully Modulating Economizer

Provide fully modulating economizer to include 0-100 percent fresh air damper, damper drive motor, and [fixed dry bulb enthalpy control] [solid state enthalpy control] [differential enthalpy control]. Control economizer operations by the pre-set position of the enthalpy control. Include a barometric relief damper with the down flow economizer to provide a pressure operated damper that is gravity closing and prohibits entrance of outside air on equipment "off" cycle. [Economizer dampers must be ultra low-leak type with leakage rate of one percent based on testing data completed in accordance with AMCA 500-D.]

]2.3.3.2.12 Manual Outside Air Damper

Provide manual outside air damper with rain hood and screen suitable for up to [25][_____] percent outside air. [Test Louvers in accordance with AMCA 500-L.]

2.3.3.2.13 Low Ambient Control

Provide low ambient control to allow cycling of compressor for cooling operation at low ambient temperatures down to [minus 18][_____] degrees C [0][_____] degrees F.

2.3.3.2.14 Filters

Provide 50 mm 2 inch thick high efficiency throwaway type filters that are MERV [8] [13]. Filters must have an average dust spot efficiency of [25-35][_____] percent and an average arrestance of [90][_____] percent when tested in accordance with ASHRAE 52.2. Filters must be UL Class 1.

2.3.4 Computer Room Air Conditioner

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NOTE: Please refer to the new spec, UFGS 23 81 23 COMPUTER ROOM AIR CONDITIONING UNITS, for computer room air conditioning applications.

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2.3.5 [Mini-]Split-System Air Conditioners [Heat Pumps]

2.3.5.1 Small-Capacity Split-System Air-Conditioners (Not Exceeding 19 kW 65,000 Btu/hr)

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NOTE: A remote condensing unit includes both the condensing coil and the compressor. A remote condenser includes only the condensing coil.

Air-cooled, water-cooled, and evaporatively-cooled air conditioning units with capacities less than 19 kW 65,000 Btuh will be rated in accordance with ANSI/AHRI 210/240.

Air-cooled, water-cooled, and evaporatively-cooled air conditioning and heat pump units with capacities greater than or equal to 19 kW 65,000 Btuh will be rated in accordance with AHRI 340/360 I-P.

Air-cooled heat pump units with capacities less than 19 kW 65,000 Btuh will be rated in accordance with ANSI/AHRI 210/240.

At a minimum, efficiencies for split-systems will be in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP

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Provide an air-cooled, split system which employs a remote condensing unit, a separate [floor mounted][wall mounted][ceiling mounted] indoor unit, and interconnecting refrigerant piping. Provide the [air conditioning][heat pump] type unit conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][AHRI 340/360 I-P]. Provide indoor unit with necessary fans, air filters, and galvanized steel cabinet construction. The remote unit must be as specified in paragraph CONDENSING UNIT. Provide double-width, double inlet, forward curved backward inclined, or airfoil blade, centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard condenser or outdoor fans for the unit specified and may be [either] [propeller] [or] [centrifugal scroll] type. Fan and condenser motors must have [open][drip proof][totally enclosed][explosion proof] enclosures. Design unit to operate at outdoor ambient temperatures up to [46][_____] degrees C [115] [_____] degrees F.

2.3.5.1.1 Energy Efficiency

Provide unit with an Energy Star label. [Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Provide unit with hot gas reheat.]

2.3.5.1.2 Air-to-Refrigerant Coil

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NOTE: Delete the copper or aluminum tubes and the coating requirement except in coastal or corrosive environments.

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Provide condensing coils with [copper] [or] [aluminum] tubes of 10 mm 3/8 inch minimum diameter with [copper] [or] [aluminum] fins that are mechanically bonded or soldered to the tubes. Casing must be [galvanized steel] [or] [aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging.

Coat [condenser] [evaporator] [condenser and evaporator] coil with a uniformly applied [epoxy electrodeposition][phenolic][vinyl][epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation and be capable of withstanding a minimum [500][1,000][____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.3.5.1.3 Compressor

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NOTE: Delete this paragraph if a remote condensing unit is specified.

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Provide direct drive [hermetic reciprocating] [variable speed] [digital scroll] [scroll] type compressor.Provide compressor with internal over temperature and pressure protector; sump heater; oil pump; high pressure and low pressure controls; and liquid line dryer.

2.3.5.1.4 Refrigeration Circuit

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide refrigerant charging valves. Provide filter-drier in liquid line.to prevent freeze-up in event of loss of water flow during heating cycle.

2.3.5.1.5 Unit Controls

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NOTE: In regards to head pressure control, insert the appropriate minimum or lowest expected ambient temperature. Delete head pressure controls if inapplicable. Delete low cost cooling if inapplicable. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the

compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated. Enthalpy controls will not be used.

Ensure that all controls equipment meets the requirements of UFC 4-010-06 Cybersecurity of Facility-Related Control Systems.

****

Provide unit internally prewired with a [24][120][_____] volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Internally protect unit by fuses or a circuit breaker in accordance with UL 1995. Equip units with three-phase power with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal. [Provide unit with microprocessor controls to provide all 24V control functions.] [Control unit by a [two stage heating /cooling thermostat] [one stage heating/cooling thermostat] with [manual] [automatic] changeover.] [Control unit by a programmable electronic thermostat with heating setback and cooling setup with 7-day programming capability.]

Controls must include a control system interface to a BACnet Control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a LonWorks control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

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NOTE: The following bracketed requirement is only used when no protocol tailoring option is selected. Since a protocol tailoring option has been selected, remove the bracketed text.

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Communication networks between physically separate units in a split system must be in accordance with either Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. and must match the protocol used by the control system interface.

]2.3.5.1.6 Condensing Coil

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NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive environments.

****

Provide coils with [nonferrous][copper] [or] [aluminum] tubes of 10 mm 3/8 inch minimum diameter with [copper] [or] [aluminum] fins that are mechanically bonded or soldered to the tubes. [Protect coil in accordance with paragraph CORROSION PROTECTION.] Provide galvanized steel or aluminum casing. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide separate expansion devices for each compressor circuit.

2.3.5.1.7 Remote Condenser or Condensing Unit

Fit each remote condenser coil fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 49 degrees C 120 degrees F at 40 degrees C 104 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of [-6][13] [_____] degrees C [20][55][_____]degrees F. Provide fan and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Fan and condenser motors must have [open][drip proof][totally enclosed][explosion proof] enclosures. [Condensing unit must have controls to initiate a refrigerant pump down cycle at system shut down on each refrigerant circuit.]

[2.3.5.1.7.1 Sound Rating

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NOTE: Delete the sound requirements unless the unit is located in a sound-sensitive area.
****

Provide units of capacities less than 39.5 kW 135,000 Btu/h with a maximum AHRI sound rating of [85][_____] dB when rated in accordance with ANSI/AHRI 270.

]2.3.5.1.7.2 Air-Cooled Condenser

Provide Unit in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit; complete with casing, [propeller] [or] [centrifugal] type fans, heat rejection coils, connecting piping and wiring, and all necessary accessories.

2.3.5.1.8 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****
NOTE: Choose the applicable from the following subparts.
****

[2.3.5.1.8.1 Electric Heating

[Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit.

Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.][

Construct electric heater of heavy-duty nickel chromium elements. Achieve staging through the unit control processor. Each heater must have automatically reset high limit control. Heaters must be individually fused from the factory and comply with NEC requirements. Power assemblies must provide single point connection. Electric heat modules must be listed and labeled by a national recognized testing laboratory acceptable to authorities having jurisdiction. Electric heater controls must confirm the supply fan is operating before electric elements are energized. Operate electric heater in [2][3] stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.]

][2.3.5.1.8.2 Gas-Fired Heating Section

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NOTE: Gas-fired heatng sections are not available for air conditioning units for EDP spaces.

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NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.

****

[Construct the gas-fired heat exchanger and burner of aluminized steel [stainless steel] suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [intermittent pilot] ignition. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount heater section to eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.][

Construct the gas-fired furnace and burner of materials suitable for [natural gas][liquid propane gas] fuel supply. Furnace must have [direct spark] [intermittent pilot] ignition. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Gas valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount burner to eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54. Gas furnaces must have the Energy Star Label and a minimum efficiency of

[78][85][90][_____] percent AFUE.]

][2.3.5.1.8.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.5.1.8.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.5.1.9 Air Filters

Provide filters of the [sectional] [or] [panel] [cleanable] type that are capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible [by hinged access panel(s)]. [25] [50] mm [1] [2] inch MERV [7][8][13], provide throwaway filter on all units below 19kW 6 Tons.

Provide filter rack that can be converted to 50 mm 2.0 inch capability. Filters must have an average dust spot efficiency of [25-35][90-95] percent and an average arrestance of [90][_____] percent when tested in accordance with ASHRAE 52.2. Provide UL Class 1 filters.

2.3.5.1.10 Fans

Provide direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

2.3.5.2 Large-Capacity Split-System Air Conditioners (Greater Than 19 kW 65,000 Btu/h)

Provide an air-cooled, split system which employs a remote condensing unit, a separate [floor mounted][wall mounted][ceiling mounted] indoor unit, and interconnecting refrigerant piping. Provide the [air conditioning][heat pump] type unit conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with [ANSI/AHRI 210/240][AHRI 340/360 I-P]. Provide unit with necessary fans, air filters, and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Provide double-width, double inlet, [forward curved] [backward inclined] [airfoil blade] centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard for the unit specified and may be [either] [propeller] [or] [centrifugal scroll] type condenser or outdoor fans. Enclose fan condenser motors in [open][drip proof][totally enclosed][explosion proof] enclosures [and permanently lubricate ball bearings]. [Air Conditioners must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]][Provide unit with hot gas reheat.]

2.3.5.2.1 Air-To-Refrigerant Coil

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive or coastal environments.

****

Provide coils with [nonferrous][copper] [or] [aluminum] tubes tubes of 10 mm 3/8 inch minimum diameter with [copper] [or] [aluminum] fins that are mechanically bonded or soldered to the tubes. Provide casing of [galvanized steel] [or] [aluminum]. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging. Provide each unit with [a factory operating charge of refrigerant and oil] [or] [a holding charge]. Field charge unit shipped with a holding charge with refrigerant and oil. Provide separate expansion devices for each compressor circuit. [Condenser coil must have an integral sub-cooler.] [Condenser coil must have special coating for corrosion resistance.] [Condenser coil must be copper finned.]

Coat [condenser] [evaporator] [condenser and evaporator] coil with a uniformly applied [epoxy electrodeposition][phenolic][vinyl][epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation and be capable of withstanding a minimum [500][1,000][____] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.3.5.2.2 Compressor

Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Equip compressors of 35 kW 10 tons and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor has an independent refrigeration circuit through the condenser and evaporator. Start compressors in the unloaded position. Provide each compressor with vibration isolators, crankcase heater, thermal overloads,[lubrication pump,] [high][high and low] pressure safety cutoffs and protection against short cycling.

2.3.5.2.3 Refrigeration Circuit

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NOTE: Filter-driers are optional and may be deleted on most precharged systems. Delete the last two sentences if an integral water-cooled condenser is not specified.

****

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant charging valves and connections, and pumpdown valves for each circuit. Provide reversible-flow type filter-drier in each liquid line. Refrigerant flow control devices must be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. Provide a refrigerant suction line [thermostatic][thermostatic and water flow switch] control to prevent freeze-up in event of loss of water flow during heating cycle.

2.3.5.2.4 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

****

NOTE: Choose the applicable from the following subparts.

****

[2.3.5.2.4.1 Electric Heating

[Provide electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be completely assembled, unit-mounted, and integral to the unit. Provide coil with nickel chromium elements and a maximum density of 258 Watts per square centimeter 40 watts per square inch. Provide coil with automatic reset high limit control operating through heater backup contactors. Provide coil casing and support brackets of [galvanized steel] [or] [aluminum]. Mount coil to eliminate noise from expansion and contraction and be completely accessible for service.][

Construct electric heater of heavy-duty nickel chromium elements. Achieve staging through the unit control processor. Each heater must have automatically reset high limit control. Heaters must be individually fused from the factory and comply with NEC requirements. Power assemblies must provide single point connection. Electric heat modules must be listed and labeled by a national recognized testing laboratory acceptable to authorities having jurisdiction. Electric heater controls must confirm the supply fan is operating before electric elements are energized. Operate electric heater in [2][3] stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.]

][2.3.5.2.4.2 Gas-Fired Heating Section

****

NOTE: Gas-fired heatng sections are not available for air conditioning units for EDP spaces.

****

****

NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.

****

[Construct the gas-fired heat exchanger and burner of stainless steel suitable for [natural gas][liquid propane gas] fuel supply. Burner must have [direct spark] [intermittent pilot] ignition. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount heater section to eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54.][

Construct the gas-fired furnace and burner of materials suitable for [natural gas][liquid propane gas] fuel supply. Furnace must have [direct spark] [intermittent pilot] ignition. Heating section must be completely assembled and integral to unit, having modulation with a turn down ratio of at least [4] [3] to 1. Fire test all units prior to shipment. Gas valve must include a pressure regulator. Supply combustion air with a centrifugal combustion air blower with built-in thermal over load protection. Safety controls must include a flame sensor and air pressure switch. Mount burner to eliminate noise from expansion and contraction, and allow accessibility for service. Gas equipment must bear the AGA label for the type of service involved. Provide burner in accordance with NFPA 54. Gas furnaces must have the Energy Star Label and a minimum efficiency of [78][85][90][_____] percent AFUE.]

][2.3.5.2.4.3 Hot Water Coils

Serpentine type constructed of seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Provide factory-furnished tee and manual air vent on return connection. Factory test coils at twice maximum operating pressure.

][2.3.5.2.4.4 Steam Coils

Serpentine type constructed of red brass or seamless copper tubes with aluminum fins mechanically or hydraulically bonded to tubes. Factory test coils at twice the maximum operating pressure.

]2.3.5.2.5 Unit Controls

****

NOTE: In regards to head pressure control, insert the appropriate minimum or lowest expected ambient temperature. Delete head pressure controls if inapplicable. Delete low cost cooling if inapplicable. In those areas where the outdoor seasonal climatic conditions permit, an outdoor temperature sensing unit (dry bulb) may be used in an external control circuit to take advantage of outside air to satisfy the cooling load. Under such conditions, the control circuit would lock out the compressors and position the outdoor and return air dampers to allow 100 percent fresh air to be circulated.

Ensure that all controls equipment meets the requirements of UFC 4-010-06 Cybersecurity of Facility-Related Control Systems.

****

Provide unit internally prewired with a [24][120][_____] volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Unit must have cutoffs for [high][high and low] pressure,[and] low oil pressure for compressors with positive displacement oil pumps, [supply fan failure], [and safety interlocks on all service panels]. Head pressure controls must sustain unit operation with ambient temperature of [-6][13] [_____] degrees C [20][55][_____]degrees F. Adjustable-cycle timers must prevent short-cycling. Stage multiple compressors by means of a time delay. Internally protect unit by [fuses] [or] [a circuit breaker] in accordance with UL 1995. Make low cost cooling possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

Controls must include a control system interface to a BACnet Control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a LonWorks control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

****

NOTE: The following bracketed requirement is only used when no protocol tailoring option is selected. Since a protocol tailoring option has been selected, remove the bracketed text.

****

[

Communication networks between physically separate units in a split system must be in accordance with either Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. and must match the protocol used by the control system interface.

]

2.3.5.2.6 Remote Condenser or Condensing Unit

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NOTE: Delete the sound requirements unless the unit is located in a sound-sensitive area.

****

Units with capacities 39.5 kW 135,000 Btuh or greater must produce a maximum AHRI sound rating of [85][_____] dB when rated in accordance with ANSI/AHRI 370. Fit each remote condenser coil with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 49 degrees C 120 degrees F at 40 degrees C 95 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of [-6] [13] [_____] degrees C [20] [55] [_____] degrees F. Provide fan and cabinet construction must be provided as specified in paragraph UNITARY EQUIPMENT COMPONENTS. Fan and condenser motors must have [open][dripproof][totally enclosed][explosion proof] enclosures. [Condensing unit must have controls to initiate a refrigerant pump down cycle at system shut down on each refrigerant circuit.]

2.3.5.2.6.1 Air-Cooled Condenser

Provide unit rated in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit. Unit must be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

a. Provide interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit as required and as indicated. Provide electrical and refrigeration piping terminal connections between [condenser][condensing unit] and evaporator units.

b. Low ambient control for multi-circuited units serving more than one evaporator coil must provide independent condenser pressure controls for each refrigerant circuit. Set controls to produce a minimum of 95 degrees F saturated refrigerant condensing temperature. Provide unit with a liquid subcooling circuit that ensures proper liquid refrigerant flow to the expansion device over the specified application range of the condenser. Unit must be provided with [manufacturer's standard] [not less than [4][_____] degrees C [8][_____] degrees F] liquid subcooling. Liquid seal the subcooling circuit.

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive environments.

****

c. Coils must have [nonferrous][copper or aluminum] tubes of 10 mm 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes.[Protect coil in accordance with paragraph COIL CORROSION PROTECTION.] Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide separate expansion devices for each compressor circuit.

d. Provide a complete control system with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Construct unit mounted control panels or enclosures in accordance with applicable requirements of NFPA 70 and house in NEMA ICS 6, Class 1 or 3A enclosures. Controls must include [control transformer,] [fan motor [starters,]] [solid-state speed control,] [electric heat tracing controls,] [time delay start-up,] overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.3.5.2.6.2 Evaporative Condenser

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NOTE: Evaporative condensers are only used in dry climates due to problems with condensate scaling and algae formation in other climates. Verify with the user that their environmental conditions support the installation or evaporative condensers.

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[Provide a counter-flow blow-through design, with single-side air entry.]The unit must have fan assemblies built into the unit base, with all moving parts factory mounted and aligned. Primary construction of the pan section and the cabinet must not be lighter than 1.6 mm 16-gauge steel, protected against corrosion by a zinc coating. Conform the zinc coating ASTM A153/A153M and ASTM A123/A123M, as applicable and have an extra heavy coating of not less than 0.76 kg/square meter 2.5 ounces/square foot of surface. Give cut edges a protective coating of zinc-rich compound. After assembly, apply the manufacturer's standard zinc chromatized aluminum or epoxy paint finish to the exterior of the unit. Unit must be rated in accordance with AHRI 490 I-P and tested in accordance with the requirements of ASHRAE 64.

a. Provide a watertight pan complete with drain, overflow, and make-up water connections. Provide standard pan accessories to include circular access doors, a lift-out strainer of anti-vortexing design and a brass make-up valve with float ball.

b. Provide a direct driven, statically and dynamically balanced, [centrifugal][or][propeller] type fan. Do not locate fan and fan motor in the discharge airstream of the unit. Enclose motors in [open] [splashproof] [totally enclosed] enclosure that is suitable for the indicated service. Design the condensing unit design to prevent water from entering into the fan section.

****

NOTE: Delete the copper or aluminum tubes and the coating requirement except in corrosive environments.

****

c. Provide condensing coils with [nonferrous][copper] [or] [aluminum] tubes of 10 mm 3/8 inch minimum diameter without fins. [Protect coil in accordance with paragraph CORROSION PROTECTION.] Provide [galvanized steel] [or] [aluminum] casing. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with [a factory operating charge of refrigerant and oil] [or] [a holding charge]. [Field charge unit shipped with a holding charge with refrigerant and oil.]

d. Provide a water distribution system that distributes water uniformly over the condensing coil to ensure complete wetting of the coil at all times. Provide [brass,] [stainless steel,] [or] [high-impact plastic] spray nozzles that are the cleanable, non-clogging, removable type. Design nozzles to permit easy disassembly and arrange for easy access.

e. Provide [a][two] bronze-fitted [centrifugal] [or] [turbine] type water pump[s] that may be mounted as an integral part of the evaporative condenser or remotely on a separate mounting pad. Pumps must have cast-iron casings. Impellers must be bronze, and shafts stainless steel with bronze casing wearing rings. Use mechanical type shaft seals. Factory coat the pump casing with epoxy paint. Pump motors must have [open][drip proof][totally enclosed][explosion proof] enclosures. Provide a bleed line with a flow valve or fixed orifice in the pump discharge line and extend to the nearest drain for continuous discharge. Fully submerge pump suction and provide with a [galvanized steel] [or] [monel] screened inlet.

f. Provide drift eliminators to limit drift loss to not over 0.005 percent of the specified water flow. Construct eliminators of [zinc-coated steel] [or] [polyvinyl chloride (PVC)]. Eliminators must prevent carry over into the unit's fan section.

g. Provide the evaporative condenser unit with modulating capacity control dampers mounted in the discharge of the fan housing. On a decrease in refrigerant discharge pressure the dampers must modulate to reduce the airflow through the evaporative condenser. Controls must include a proportional acting pressure controller, a control transformer, motor actuator with linkages and end switches to cycle fan motor on and off. Cycle a fan motor on and off in accordance with the manufacturer's instructions.

2.3.5.2.6.3 Compressor

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NOTE: Delete this paragraph if only a remote condenser is required.

****

Provide compressor rated in accordance with AHRI 540. Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Provide units 35 kW 120,000 Btuh and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor must have an independent refrigeration circuit through the condenser and evaporator. Each compressor must start in the unloaded position. Provide each compressor with vibration isolators, crankcase heater,[lubrication pump,] thermal overloads, and [high][high and low] pressure safety cutoffs and protection against short cycling.

2.3.5.2.6.4 Fans

Provide fan wheel shafts supported by either maintenance-accessible grease lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Mount fan motor and fan assembly on a common base to allow consistent belt tension with no relative motion between fan and motor shafts. The entire fan motor and fan assembly must be completely vibrationally isolated from the unit. Select unit fans to produce the cfm required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a [open drip-proof][totally enclosed][explosion proof] enclosure. Provide [manual] [or] [automatic-reset] type thermal overload protection. Construct fan wheels of [aluminum] [or] [galvanized steel]. Provide centrifugal fan wheel housings of galvanized steel, and construct centrifugal fan casings of [aluminum] [or] [galvanized steel]. Steel elements of fans, except fan shafts, must be [hot-dipped galvanized after fabrication] [or] [fabricated of mill galvanized steel]. Recoat mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting with an approved zinc-rich compound. Statically and dynamically balance [fan wheels] [or] [propellers]. Provide double inlet [forward-curved] [air foil] type fan wheels. Fan must reach rated rpm before the fan shaft passes through the first critical speed. Fans must be belt-driven with adjustable sheaves. Select the sheave size so that the fan speed at the approximate midpoint of the sheave adjustment produces the specified air quantity. Provide centrifugal scroll-type fans with streamlined orifice inlet and V-belt drive. Each drive must be independent of any other drive. Condenser fans must be propeller type, direct drive, statically balanced with galvanized steel blades and permanently lubricated ball bearings. Protect condenser fan motor drive bearings with water slingers or shields. Fit all belt drives with guards where exposed to contact by personnel.

2.3.5.2.7 Filters

Provide filters of the [sectional] [or] [panel] [cleanable] type, capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible [by hinged access panel(s)]. Factory supply 50 mm 2.0 inch, MERV [8][13], throwaway filters. Filters must have an average dust spot efficiency of [25-35][90-95] percent and an average arrestance of [90][__] percent when tested in accordance with ASHRAE 52.2. Provide UL Class 1 filters.

2.3.6 Air-Source Unitary Heat Pumps

Provide air source unitary heat pumps with capacity up to 19 KW 65,000 Btu/hr that comply with ANSI/AHRI 210/2400. Provide air source heat pumps with capacity above 19KW above 65,000 Btu/hr that comply with ANSI/AHRI 340/360.

Provide units with assembled refrigerant circuit or circuits [packaged unit][or][split system having remote outdoor section separate from indoor section]. [Provide unit with hot gas reheat.]

2.3.6.1 Energy Efficiency

Provide unitary heat pumps that bear the Energy Star label. [Heat pumps must have [a minimum [seasonal] energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],] and [a minimum COP of [_____].]]

2.3.6.2 Casing

Construct the casing of zinc coated, heavy-gage (14-gage minimum) galvanized steel. Clean, phosphatize and finish exterior surfaces with a weather-resistant baked enamel finish. Test unit surfaces [500] [1,000] [_____] hours in a salt spray test in compliance with ASTM B117. Fabricate cabinet panels with lifting handles and water- and air-tight seal. Insulate all exposed vertical, top covers and base pan [13 mm] [25 mm] [50 mm] [1/2-inch] [1-inch] [2-inch], [matt-faced,] [fire-resistant,] [odorless,] [glass fiber material]. Surfaces in contact with the airstream must comply with requirements in ASHRAE 62.1. Provide for forklift and crane lifting the base of the unit.

2.3.6.3 Filters

Provide[25mm 1 inch][50 mm 2 inch], MERV [7][8][13], throwaway filter on all units below 19kW 6 Tons. Filter rack may be converted to 50 mm 2.0 inch capability. Factory supply 50 mm 2.0 inch, MERV [8][13], throwaway filters on all units above 19 kW 6 Tons.

2.3.6.4 Compressors

Provide direct-drive, [variable speed] [digital scroll] [hermetic scroll] type compressors with centrifugal type oil pumps. Motor must be suction gas-cooled. Use internal overloads and crankcase heaters with all compressors.

2.3.6.5 Refrigerant Circuit

A minimum of two circuits are required. Provide each refrigerant circuit with independent fixed orifice or thermostatic expansion devices, service pressure ports, and refrigerant line filter driers factory installed as standard. An area must be provided for replacement suction line driers.

2.3.6.6 Evaporator and Condenser Coils

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NOTE: For high-humidity locations and coastal environments, provide E-coated aluminum fins and corrosion-resistant cabinets.

****

Provide internally finned, DN 10 (NPS 3/8) copper tubes mechanically bonded to a configured aluminum plate fin. Leak test the evaporator coil and condenser coil at the factory to 1378 kPa 200 psig and pressure test to 2756 kPa 400 psig. All dual compressor units must have intermingled evaporator coils. Provide sloped condensate drain pans.

2.3.6.7 Outdoor Fans

Direct driven, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motors must be permanently lubricated and have built-in thermal overload protection.

2.3.6.8 Indoor Fan

Provide forward-curved, centrifugal, v-belt driven fan with adjustable motor sheaves and adjustable idler-arm assembly for quick-adjustment of fan belts and motor sheaves. Thermally protect motors. Provide oversized motors for high static application.

2.3.6.9 Defrost Controls

Provide a time initiated, temperature terminated defrost system shipped with a setting of 70-minute cycle, and a choice of 50 or 90-minute cycle. Timed override limits defrost cycle to 10 minutes must be available on units from 35-kW to 70-kW 10 to 20 tons. Provide adaptive demand defrost on units below 35 kW 10 Tons.

2.3.6.10 Unit Electrical

a. Provide single point unit power connection.

b. Locate the Unit control box within the unit that contains controls for compressor, reversing valve and fan motor operation and must have a 50 VA 24-volt control circuit transformer and a terminal block for low voltage field wiring connections.

c. Wire high pressure, low temperature, and low pressure safety switches through a latching lockout circuit to hold the conditioner off until it is reset electrically by interrupting the power supply to the conditioner. All safety switches must be normally closed, opening upon fault detection.

2.3.6.11 Operating Controls

****

NOTE: Select UFGS 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for use on all USACE and AFCEC projects and for additions or retrofits to existing NAVFAC LonWorks systems. New NAVFAC systems should use UFGS 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Ensure that all controls equipment meets the requirements of UFC 4-010-06 Cybersecurity of Facility-Related Control Systems.

****

a. Provide unit with [low voltage electric controls][factory supplied DDC control system].

b. Low voltage, adjustable room thermostat to control heating and cooling in sequence with delay between stages, compressor and supply fan to maintain temperature setting. Include system selector switch [(heat-off-cool)][(off-heat-auto-cool)][and] [fan control switch (auto-on)].

2.3.6.11.1 Unit DDC Controller

a. Unit controller must include input, output and self-contained programming as needed for complete control of unit.

b. All program sequences must be stored on board in EEPROM. Batteries cannot be used to retain logic program. Execute all program sequences by controller 10 times per second and must be capable of multiple PID loops for control of multiple devices. Programming of logic controller must be completely modifiable in the field over installed [BACnet LANs][LonWorks LANs].

c. Temperature Control System Interface: Points must be available from the unit controller for service access and display or control.

d. The wall mounted space temperature sensor must include occupied and unoccupied set point control, pushbutton unoccupied override, space temperature offset and space temperature indication. Refer to [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] for additional requirements.

2.3.6.11.2 Control System Interface

Controls must include a control system interface to a BACnet Control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a LonWorks control system. The control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Controls must include a control system interface to a BACnet or LonWorks control system, whichever is used by the control system in the building in which the unit is installed. For BACnet, the control system interface must meet DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For LonWorks, the control system interface must meet DDC Hardware requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.3.6.12 Corrosion Protection

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NOTE: Corrosion Protection is required in high-humidity locations and coastal environments.

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2.3.6.12.1 Remote Outdoor Condenser Coils

Epoxy Immersion Coating - Electrically Deposited: The multi-stage corrosion-resistant coating application comprised of cleaning (heated alkaline immersion bath) and reverse-osmosis immersion rinse prior to the start of the coating process. Maintain the coating thickness between 0.6-mil and 1.2-mil. Before the coils are subjected to high-temperature oven cure, treat to permeate immersion rinse and spray. Where the coils are subject to UV exposure, apply UV protection spray treatment comprising of UV-resistant urethane mastic topcoat. Provide complete coating process traceability for each coil and minimum five years of limited warranty. The coating process must be such that uniform coating thickness is maintained at the fin edges. Comply with the applicable ASTM Standards for the following:

a. Salt Spray Resistance (Minimum 6,000 Hours)

b. Humidity Resistance (Minimum 1,000 Hours)

c. Water Immersion (Minimum 260 Hours)

d. Cross-Hatch Adhesion (Minimum 4B-5B Rating)

e. Impact Resistance (Up to 160 Inch/Pound)

2.3.6.12.2 Exposed Outdoor Cabinet

Casing Surfaces (Exterior and Interior): Protect all exposed and accessible metal surfaces with a water-reducible acrylic with stainless steel pigment spray-applied over the manufacturer's standard finish. The spray coating thickness must be 2-4 mils and provide minimum salt-spray resistance of [500][1,000][____] hours (ASTM B117) and [500][1,000][____] hours UV resistance (ASTM D4587).

2.4 COMPONENTS

2.4.1 Refrigerant and Oil

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NOTE: Equipment must operate on a refrigerant with an ozone depletion potential (ODP) less than or equal to 0.05. R-22, R-123 and R-134a all meet this requirement. R-22 is the most commonly used refrigerant.

****

Refrigerant must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with ASHRAE 15 & 34. Refrigerants must meet the requirements of AHRI 700 as a minimum. Provide a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil must be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge must be in accordance with manufacturer's recommendation.

2.4.2 Fans

Fan wheel shafts must be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans must be selected to produce the LPS cfm required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a [open][dripproof][totally enclosed][explosion proof] enclosure. Thermal overload protection must be of the manual or automatic-reset type. Fan wheels or propellers must be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings must be of galvanized steel, and both centrifugal and propeller fan casings must be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, must be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting must be recoated with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Forward curved fan wheels must be limited to [_____] mm inches. Direct-drive fan motors must be of the multiple-speed variety. Belt-driven fans must have adjustable sheaves to provide not less than [_____] percent fan-speed adjustment. The sheave size must be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans must be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans must be [direct-drive][V-belt] drive type with [adjustable][fixed] pitch blades. V-belt driven fans must be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings must be protected with water slingers or shields. V-belt drives must be fitted with guards where exposed to contact by personnel and [fixed pitch] [adjustable pitch] sheaves.

2.4.3 Primary/Supplemental Heating

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NOTE: Inapplicable types of heating coils will be deleted. In some cases, unitary products are not available with steam or water heating coils.

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2.4.3.1 Water Coil

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NOTE: Drainable coils will be specified where coils are subject to freezing during the heating season. If drainable coils are not required, delete the last sentence.

****

Coil must conform to the provisions of AHRI 410. Coil must be fin-and-tube type constructed of seamless copper tubes and [aluminum][or][copper] fins mechanically bonded or soldered to tubes. Headers must be constructed of cast iron, welded steel or copper. Coil must be constructed to float within the casing to allow free expansion and contraction of tubing. Casing and tube support sheets must not be lighter than 1.6 mm 16 gauge galvanized steel formed to provide structural strength. When required, multiple tube supports must be provided to prevent tube sag. Coil must be circuited for suitable water velocity without excessive pressure drop and properly pitched for drainage where required or indicated. Each coil must be tested at the factory under water at not less than 2000 kPa 300 psi air pressure, tested hydrostatically after assembly of the unit and proved tight under a gauge pressure of 1400 kPa 200 psi. Coil must be suitable for use with water up to 120 degrees C 250 degrees F. Coil must allow complete coil drainage with a pitch of not less than 10 mm/meter 1/8 inch/foot slope to drain.

2.4.3.2 Steam Coil

Coil must conform to the provisions of AHRI 410. Coil must be constructed of cast semi-steel, welded steel, or copper headers, red-brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered. Tubes must be rolled and bushed and brazed or welded into headers. Coil casings and tube support sheets, with collars of ample width, must be not lighter than 1.6 mm 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports must be provided to prevent tube sag. The fin tube and header section must float within the casing to allow free expansion of tubing for coils subject to high pressure-steam service. Coils must be factory pressure tested and capable of withstanding 1700 kPa 250 psi hydrostatic test pressure or 1700 kPa 250 psi air pressure, and be for [700][1400] kPa [100][200] psi steam working pressure. Preheat coils must be steam-distributing tube type. Condensing tubes must be not less than 15 mm 5/8 inch outside diameter. Distribution tubes must be not less than 10 mm 3/8 inch outside diameter, and be equipped with orifices to discharge steam to condensing tubes. Distribution tubes must be installed concentrically inside of condenser tubes and be held securely in alignment. The maximum length of a single coil must be limited to 120 times the diameter of the outside tube. Other heating coils must be minimum 13 mm 1/2 inch outside diameter single-tube type. Supply headers must distribute steam evenly to all tubes at the indicated steam pressure. Coil must allow complete coil drainage with a pitch of not less than 10 mm/meter 1/8 inch/foot slope to drain.

2.4.3.3 Electric Heating Coil

****

NOTE: Choose the second set of brackets if an air conditioning unit for EDP is specified.

****

Coil must be an electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be duct- or unit-mounted. Coil must be of the [nickel chromium resistor, single stage, strip][nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type. Coil must be provided with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Coil casing and support brackets must be of galvanized steel or aluminum. Coil must be mounted to eliminate noise from expansion and contraction and be completely accessible for service. Supplemental Electric Resistance Heating controls must be provided to prevent operation when the heating load can be met by the primary source.

2.4.3.4 Gas-Fired Heating Section

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NOTE: Gas-fired heating sections are not available for air conditioning units for EDP spaces.

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NOTE: Choose stainless steel heat exchanger for gas-fired makeup air units where air temperatures drop below 40 deg F forming condensation in the combustion chamber that reacts with sulfur in natural gas to form sulfuric acid.

****

Gas-fired heat exchanger must be constructed of aluminized steel[stainless steel] suitable for [natural gas][liquid propane gas] fuel supply. Burner must have direct spark or hot surface ignition. Valve must include a pressure regulator. Combustion air must be supplied with a centrifugal combustion air blower. Safety controls must include a flame sensor and air pressure switch. Heater section must be mounted to eliminate noise from expansion and contraction and must be completely accessible for service. Gas equipment must bear the AGA label for the type of service involved. Burner must be in accordance with NFPA 54.

2.4.4 Air Filters

Provide filters to filter outside air and return air and locate [as indicated] [inside air conditioners] [inside filter box] [inside combination air filter mixing box]. Provide [replaceable (throw-away)] [high efficiency] [cleanable (reusable)] type. Filters must conform to UL 900, [Class 1] [or] [Class 2]. Polyurethane filters cannot be used on units with multiframe filters.

Air filters must be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method must be as listed under the label service and must meet the requirements of UL 586.

2.4.4.1 Extended Surface Pleated Panel Filters

Filters must be 50 mm 2 inch depth sectional type of the size indicated and must have an average efficiency of 25 to 30 percent when tested in accordance with ASHRAE 52.2. Initial resistance at 2.54 m/s 500 feet/minute must not exceed 90 Pa 0.36 inches water gauge. Filters must be UL Class 2. Media must be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media must be attached to a moisture resistant fiberboard frame. Four edges of the filter media must be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.4.4.2 Replaceable Media Filters

Provide replaceable media filters of the [dry-media] [viscous adhesive] type, of the size required to suit the application. Filtering media must not be less than 50 mm 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad must be enclosed in a holding frame of not less than 1.6 mm 16 gauge galvanized steel, and equipped with quick-opening mechanism for changing filter media. Base the air flow capacity of the filter on net filter face velocity not exceeding [1.52] [_____] m/s [300][_____] feet/minute, with initial resistance of [32][_____] Pa [0.13][_____] inches water gauge. Average efficiency must be not less than [_____] percent when tested in accordance with ASHRAE 52.2.

2.4.4.3 Sectional Cleanable Filters

Provide sufficient oil to coat filters six times based on 0.5 L 1 pint of oil per each square meter 10 square feet of filter area. Provide washing and charging tanks for cleaning and coating filters. Filters must have a MERV of [6] [8] [_____] when tested in accordance with ASHRAE 52.2.

Cleanable filters must be [25][50] mm [1][2] inches thick. Viscous adhesive must be provided in 18.9 L 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than 1 L one quart for each filter section. One washing and charging tank must be provided for every 100 filter sections or fraction thereof. Each washing and charging unit must consist of a tank and [single] [double] drain rack mounted on legs. Drain rack must be provided with dividers and partitions to properly support the filters in the draining position.

2.4.4.4 High Efficiency Filters

Filters must have a MERV of 17 when tested in accordance with ASHRAE 52.2. Filter assembly must include; holding frame and fastener assembly, filter cartridge, mounting frame, and retainer assembly. Reinforce filter media with glass fiber mat. Pressure drop across clean filter exceeding [_____] Pa inches of water gage is not permitted. Precede high efficiency filters with a UL Class 2 replaceable type filter.

2.4.4.5 Manometers

Provide inclined-type manometers for filter stations of 944 L/s 2,000 cfm capacity or larger including filters furnished as integral parts of air-handling units and filters installed separately. Provide sufficient length to read at least 250 Pa one inch of water column with 10 major graduations, and equipped with spirit level. Equip manometers with overpressure safety traps to prevent loss of fluid, and two three-way vent valves for checking zero setting. [Mercury cannot be used as the operating fluid.]

2.4.5 Coil Frost Protection

Provide each circuit with a manufacturer's standard coil frost protection system. The coil frost protection system must use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Use timers to prevent the compressor from rapid cycling.

2.4.6 Pressure Vessels

Pressure vessels must conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, test pressure components at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.4.6.1 Hot Gas Muffler

Unit must be selected by the manufacturer for maximum noise attenuation. Units rated for 100 kW 30 tons capacity and under may be field tunable type.

2.4.6.2 Liquid Receiver

A liquid receiver must be provided when a system's condenser or compressor does not contain a refrigerant storage capacity of at least 20 percent in excess of a fully charged system. Receiver must be designed, filled, and rated in accordance with the recommendations of ANSI/AHRI 495, except as modified herein. Receiver must be fitted to include an inlet connection; an outlet drop pipe with oil seal and oil drain where necessary; two bull's-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves;[thermal well for thermostat;][float switch column;][external float switches;] and purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver must be provided with a relief valve of capacity and setting in accordance with ASHRAE 15 & 34.

2.4.6.3 Oil Separator

Separator must be the high efficiency type and be provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Pressure drop through a separator must not exceed [70][_____] kPa [10][_____] psi during the removal of hot gas entrained oil. Connections to compressor must be as recommended by the compressor manufacturer. Separator must be provided with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass, [filter for removal of all particulate sized 10 microns and larger,][thermometer and low temperature thermostat fitted to thermal well,] [immersion heater,][external float valve fitted with three-valve bypass,] and strainer.

2.4.6.4 Oil Reservoir

Reservoir capacity must equal one charge of all connected compressors. Reservoir must be provided with an external liquid gauge glass, plugged drain, and isolation valves. Vent piping between the reservoir and the suction header must be provided with a 35 kPa 5 psi pressure differential relief valve. Reservoir must be provided with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.4.7 Internal Dampers

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NOTE: Specify the sequence of operation of all damper operations on the drawings.

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Dampers must be parallel blade type with renewable blade seals and be integral to the unitary unit. Damper provisions must be provided for each outside air intake, exhaust, economizer, and mixing boxes. Dampers must [have minimum position stops][be linked together][have [manual][automatic] modulation] and operate as specified.

2.4.8 Mixing Boxes

Mixing boxes must match the base unit in physical size and must include equally-sized[flanged] openings, each capable of full air flow. Arrangement must be as indicated.

2.4.9 Cabinet Construction

****

NOTE: Delete this paragraph if room air conditioner/heat pumps or air conditioners for EDP spaces are specified.

****

Casings for the specified unitary equipment must be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces must be 1.3 mm 18 gauge galvanized steel or 1.8 mm 0.071 inch thick aluminum on units with a capacity above 70 kW 20 tons and 1.0 mm 20 gauge galvanized steel or 1.6 mm 0.064 inch thick aluminum on units with a capacity less than 70 kW 20 tons. Casing must be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness must be 1.0 mm 20 gauge. Provisions to permit replacement of major unit components must be incorporated. Penetrations of cabinet surfaces, including the floor, must be sealed. Unit must be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan must be fabricated from

Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071. Paint and finishes must comply with the requirements specified in paragraph FACTORY COATING.

2.4.9.1 Indoor Cabinet

Indoor cabinets must be suitable for the specified indoor service and enclose all unit components.

2.4.9.2 Outdoor Cabinet

Outdoor cabinets must be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

2.4.10 Condenser Water Piping And Accessories

Provide condenser water piping and accessories in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

2.4.11 Refrigerant Piping

Provide refrigerant piping in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.4.12 Cooling Tower

Provide cooling towers in accordance with Section 23 65 00 COOLING TOWERS.

2.4.13 Condensate Drain Piping

provide condensate drain piping in accordance with Section 23 05 15 COMMON PIPING FOR HVAC.

2.4.14 Ductwork

Provide ductwork in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4.15 Temperature Controls

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NOTE: This paragraph should only be included for packaged and self-contained unitary systems requiring controls (i.e. thermostats, duct modulation, SLDC, etc.) not covered by this specifications. In projects where this section of the specification is intended to produce control equipment for existing air-side systems, this paragraph will be rewritten to secure controls to match existing controls and to properly integrate the specified controls into the existing temperature control system.

A sequence of control, a schematic of controls, and a ladder diagram should be included on the drawings for each cooling tower fan, chilled water pump, condenser water pump, etc. in order to define the overall system operation.

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Provide temperature controls [in accordance with [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDNG CONTROL SYSTEMS]][fully coordinated with and integrated into the existing air-conditioning system].

2.5 UNITARY EQUIPMENT ACCESSORIES AND MISCELLANEOUS EQUIPMENT

2.5.1 Air Economizer

Provide [down flow][horizontal flow][field][factory] installed economizer with fully modulating 0-100 percent motor and dampers, barometric relief, minimum position setting and fixed dry bulb. [Field install solid state enthalpy and differential enthalpy control.]

2.5.2 Humidifier

Provide humidifiers that meet the requirements of ANSI/AHRI 640

2.5.2.1 Steam Spray Type Humidifier

Provide steam spray humidifiers that inject steam directly into the [surrounding air][or][air stream]. [Single grid humidifiers must consist of a single copper distribution grid with pipe connection on one end and cap on the other end. Field install automatic steam control valves and condenser traps.][House enclosed grid in a copper enclosure with a built-in condensate drain connection.] [Exposed grid must be wick wrapped.][Equip package type steam spray humidifiers to trap out and to evaporate condensate and to supply dry steam to a single distribution grid. Grid must be steam jacketed and condensate drained. Unit must trap excess condensate to return system. Package type steam spray humidifiers must have modulating electric, electronic, or pneumatic steam control valve.] Steam spray humidifiers must be rated for humidifying capacity in pounds of steam per hour and at steam pressure as indicated.

2.5.2.2 Steam-Diffuser Type Humidifier

Provide diffuser units that separate any condensate from steam supply and provide positive drain of condensate to waste and supply dry steam only to air stream. Humidifiers may be installed on single or multiple units. Materials must be [noncorrosive materials][Type 30X stainless steel].

2.5.2.3 Electrode Canister Type Humidifier

Provide humidifier of the self-contained steam generating electrode type utilizing a [plastic] [disposable] canister with full probes connected to electric power via electrode screw connectors. Construct the electrodes from expanded low carbon steel, zinc plated and dynamically formed for precise current control. The humidifier assembly must include integral fill cup, fill and drain valves and associated piping. Design the canister to collect the mineral deposits in the water and provide clean particle free steam to the air stream. Water chemistry requirements must be provided with humidifier submittal data.

2.5.2.4 Ultrasonic Type Humidifier

Provide self-contained ultrasonic type humidifier operating on the principle of ultrasonic nebulization of water. Make the casing of high-quality stainless steel. The ultrasonic humidifier must not produce any unacceptable noise radiation or frequency interference with communications or other electronic equipment. Water chemistry requirements must be provided with humidifier submittal data.

2.5.2.5 Gas-Fired Steam Humidifiers (Stand-Alone)

Provide a stand-alone gas-fired steam humidifier that includes an enclosed cabinet of [powder coated][baked enamel] [14][_____] gauge steel construction with an air gap between cabinet and insulated humidifier tank to ensure safe surface temperatures. Install all tank surfaces insulated with minimum 12 mm 1/2 inch thick insulation and enclosed within unit cabinetry.

Unit must include a drain water cooler to ensure drain water tempering to below 60 degrees C 140 degrees F. Humidifier must prevent "back-siphoning" using an internal air gap for supply water and the drain line must include a vacuum breaker to prevent siphon drainage of the tank in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

a. Provide a unit that includes heat treated type [316][_____] Stainless Steel combustion chamber(s) and heat exchanger(s).

b. Each burner, capable of modulation at a [5:1][_____] ratio must provide steam production as indicated on the HUMIDIFIER SCHEDULE. Provide burner in accordance with NFPA 54.

c. [Control system must seamlessly interface with temperature control system as specified in [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] without requiring gateways or any other interface devices.] Ensure that all controls equipment meets the requirements of UFC 4-010-06.

2.5.2.6 Electrically Heated Steam Humidifiers (Stand-Alone)

Provide a stand-alone electrically heated steam humidifier that includes an enclosed cabinet of [powder coated][baked enamel] [14][_____] gauge steel construction with an air gap between cabinet and insulated humidifier tank to ensure safe surface temperatures. Install all tank surfaces insulated with minimum 12 mm 1/2 inch thick insulation and enclosed within unit cabinetry.

Unit must include a drain water cooler to ensure drain water tempering to below 60 degrees C 140 degrees F. Humidifier must prevent "back-siphoning" using an internal air gap for supply water and the drain line must include a vacuum breaker to prevent siphon drainage of the tank in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

a. Provide a unit that includes heat treated type [316][_____] Stainless Steel combustion chamber(s) and heat exchanger(s).

b. Each humidifier must operate at the voltage and provide steam production as indicated on the HUMIDIFIER SCHEDULE.

c. [Control system must seamlessly interface with temperature control system as specified in [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] without requiring gateways or any other interface devices.] Ensure that all controls equipment meets the requirements of UFC 4-010-06.

2.5.2.7 Refrigerant Leak Detector

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NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ASHRAE 15 & 34.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 458 mm 18 inches above the finished floor since all commonly-used refrigerants are heavier than air

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point shouldn't exceed 15 m 50 feet. In order to meet the recommended 15 m 50 feet distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

As required by ASHRAE 15 & 34, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a minimum indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room. Include the electrical design for the alarm system on the drawings.

As an additional item, ASHRAE 15 & 34 states that open-flame devices (i.e., boilers, etc.) cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to the device; or the alarm relay from the detector is used to automatically shutdown the combustion

process in the event of refrigerant leakage. Indicate all applicable alarm controls on the drawings.

Delete the information in the last bracketed sentences if an EMCS is not applicable to the design.

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Provide continuously-operating, halogen-specific type refrigerant leak detector. Detector must be appropriate for the refrigerant in use. Detector must be specifically designed for area monitoring and must include [a single sampling point][[_____] sampling points] installed where indicated. Detector design and construction must be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector must be supplied factory-calibrated for the appropriate refrigerant(s). Detector must be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant in use. The detector's relay must be capable of initiating corresponding alarms and ventilation system as indicated on the drawings. Detector must be provided with a failure relay output that energizes when the monitor detects a fault in its operation.[Detector must be compatible with the facility's energy or utility management and control system (EMCS/UMCS). The EMCS/UMCS must be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.5.2.8 Refrigerant Relief Valve/Rupture Disc Assembly

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NOTE: ASHRAE 15 & 34 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly as well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be in accordance with ASHRAE 15 & 34.

****

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly must be in accordance with ASME BPVC SEC VIII D1 and ASHRAE 15 & 34. The assembly must be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc must be the non-fragmenting type.

2.5.2.9 Refrigerant Signs

Refrigerant signs must be a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 13 mm 0.5 inches in height.

2.5.2.9.1 Installation Identification

Provide each new refrigeration system with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.5.2.9.2 Controls and Piping Identification

Provide refrigerant systems containing more than 50 kg 110 lb of refrigerant with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow[, the ventilation system,] and the refrigerant compressor.

b. Pressure limiting device(s).

2.5.2.10 Heat Recovery Devices

2.5.2.10.1 Hot Air Reclaim

Provide a [built in] heat recovery unit, factory-fabricated in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5.2.10.2 Hot Water Reclaim

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NOTE: Indicate the size of the exchanger either as a percent of the total rated condenser load or as a percent of the superheated portion of the total rated condenser load. The refrigerant compressor head pressure control and the circulating pump can be deleted if inapplicable.

****

Unit must be a double-wall, tube-within-tube heat exchanger type, complete with thermostatic control. Unit must be constructed and refrigerant pressure/temperature rated in accordance with ASHRAE 15 & 34. Heat exchanger coil must consist of an external refrigerant containing carbon steel tube and an internal, double-wall-in-metallic contact, convoluted, potable water containing copper tube. Cabinet must be fabricated of zinc-protected steel and be internally insulated in coil space. The recovery device must be provided with a refrigerant compressor head pressure control and a interlocked, potable water circulating pump. Pump and motor assembly must be close-coupled, manufacturer's standard type with indicated head and capacity characteristics, and with brass, bronze, copper or stainless steel wetted parts. Pump must be mounted [remotely][integral] to the exchanger and be rated for [115][208][230] volt ac power supply.

2.5.2.11 Gaskets

Provide gaskets conforming to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 370 degrees C 700 degrees F service.

2.5.2.12 Bolts and Nuts

Bolts and nuts must be in accordance with ASTM A307. The bolt head must be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

2.5.2.13 Bird Screen

Screen must be 1.6 mm 0.063 inch diameter aluminum wire or 0.79 mm 0.031 inch diameter stainless steel wire.

2.6 FINISHES

2.6.1 Coil Corrosion Protection

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NOTE: Research local conditions to determine the corrosiveness of the environment. Where condenser or evaporator coils are to be installed in highly corrosive atmospheres, carefully consider the coil and fin combinations specified. Standard coil construction is typically copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered.

For maximum coil protection, include the requirements of this paragraph. This paragraph addresses phenolic, vinyl, and epoxy type coatings. For coils with relatively close fin spacing the phenolic or epoxy coating are the preferred types as these have less tendency to bridge across the fins than vinyl. In addition, the phenolic and epoxy type coatings can typically provide better thermal conductivity than vinyl.

If coatings are specified, note that a coil's heat transfer capacity can be reduced anywhere between 1 to 5 percent; total unit capacity may have to be increased as a result.

****

Provide coil with a uniformly applied [epoxy electrodeposition] [phenolic] [vinyl] [epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum 1,000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.6.2 Equipment and Components Factory Coating

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NOTE: For equipment to be installed outdoors, adequate protection will be specified. Manufacturers must submit evidence that unit specimen have passed the specified salt spray fog test. A 125 hour test will be specified in a noncorrosive environment and a 500 hour test will be specified in a corrosive environment.

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Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand [125][500] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where stipulated in equipment specifications of this section, coat finned tube coils of the affected equipment as specified below. Apply coating at the premises of a company specializing in such work. Degrease and prepare for coating in accordance with the coating applicator's procedures for the type of metals involved. Completed coating must show no evidence of softening, blistering, cracking, crazing, flaking, loss of adhesion, or "bridging" between the fins.

2.6.2.1 Phenolic Coating

Provide a resin base thermosetting phenolic coating. Apply coating by immersion dipping of the entire coil. Provide a minimum of two coats. Bake or heat dry coils following immersions. After final immersion and prior to final baking, spray entire coil with particular emphasis given to building up coating on sheared edges. Total dry film thickness must be 0.064 to 0.076 mm 2.5 to 3.0 mils.

2.6.2.2 Chemical Conversion Coating with Polyelastomer Finish Coat

Dip coils in a chemical conversion solution to molecularly deposit a corrosion resistant coating by electrolysis action. Chemical conversion coatings must conform to MIL-DTL-5541, Class 1A. Cure conversion coating at a temperature of 43 to 60 degrees C 110 to 140 degrees F for a minimum of 3 hours. Coat coil surfaces with a complex polymer primer with a dry film thickness of 0.025 mm 1 mil. Cure primer coat for a minimum of 1 hour. Using dip tank method, provide three coats of a complex polyelastomer finish coat. After each of the first two finish coats, cure the coils for 1 hour. Following the third coat, spray a fog coat of an inert sealer on the coil surfaces. Total dry film thickness must be 0.064 to 0.076 mm 2.5 to 3.0 mils. Cure finish coat for a minimum of 3 hours. Coating materials must have 300 percent flexibility, operate in temperatures of minus 46 to plus 104 degrees C 50 to plus 220 degrees F, and protect against atmospheres of a pH range of 1 to 14.

2.6.2.3 Vinyl Coating

Apply coating using an airless fog nozzle. For each coat, make at least two passes with the nozzle. Materials to be applied are as follows:

a. Total dry film thickness, 0.165 mm 6.5 mils maximum

b. Vinyl Primer, 24 percent solids by volume: One coat 0.051 mm 2 mils thick

c. Vinyl Copolymer, 30 percent solids by volume: One coat 0.114 mm 4.5 mils thick

2.6.3 Factory Applied Insulation

Refrigeration equipment must be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor in accordance with manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

All manufactured units must be inspected and tested, and documentation provided to demonstrate that each unit is in compliance with ANSI/AHRI and UL requirements and that the minimum efficiency requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP have been met.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

Perform work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1and ASME BPVC SEC IX, the design, fabrication, and installation of the system must conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.2.1 Equipment

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NOTE: Determine in the initial stages of design the approximate distances required for maintenance clearances of all new equipment. The maintenance clearances will be used in determining the final layout of the equipment.

For installations where noise and vibration transmission to the building must be reduced, the maximum tolerable transmissibility, in percent, should be determined and the blank filled in with the appropriate value. When it is not necessary to specify the percent of transmissibility, the item in the brackets will be deleted and brackets removed. Recommended transmissibility in percentages are: 10 percent for equipment mounted in very critical areas; 10 to 20 percent for critical areas; and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors and the conditions surrounding the equipment to be provided with the vibration isolation units favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values, based on the equipment location, the specification may be revised to indicate the appropriate values on the drawings.

****

Provide refrigeration equipment conforming to ASHRAE 15 & 34. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Isolate compressors from the building structure. If mechanical vibration isolators are not provided, provide vibration absorbing foundations. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment must be set on not less than a 150 mm 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps must have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the combined pump, motor, and base weights. Isolators must be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators must limit vibration to [10] [10-20] [20-40] [_____] percent at lowest equipment rpm. Provide lines connected to pumps mounted on pedestal blocks with flexible connectors. Provide foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.2.2 Mechanical Room Ventilation

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NOTE: For mechanical rooms which are intended to house refrigeration equipment, designers will use

ASHRAE 15 & 34 to determine applicable design criteria. Delete this paragraph if a mechanical room is not applicable to the design.

In summary, ASHRAE 15 & 34 allows the use of either natural or mechanical ventilation systems, however, natural ventilation is allowed only in certain limited applications. Natural ventilation is allowed only when "a refrigerant system is located outdoors more than 6 m 20 ft from building openings and is enclosed by a penthouse, lean-to or other open structure", otherwise mechanical ventilation is required.

The amount of ventilation air required for a mechanical room will be determined based upon the ventilation equations in ASHRAE 15 & 34. In order to use these equations, a designer must approximate the mass of refrigerant (kgs or lbs) expected in the largest system located in the mechanical room.

Refrigerant quantities will be determined based upon a minimum of 2 different system manufacturers.

a. For a natural ventilation system, ASHRAE 15 & 34 provides an equation for sizing the amount of free opening area required.

b. For a mechanical ventilation system, ASHRAE 15 & 34 requires both normal and alarm ventilation. Normal ventilation will be sized to cover personnel ventilation requirements (2.5 1/s/m2 or 0.5 cfm/ft2) and heat buildup requirements if applicable. Alarm ventilation will be sized based upon the equations in ASHRAE 15 & 34. Both the normal and alarm ventilation rates can be achieved using the same ventilation system (e.g., multi-speed exhaust fans), however, individual systems are preferred. For the alarm ventilation, exhaust intakes will be located near the equipment and close to the finished floor. Most commonly used refrigerants are heavier-than-air and subsequently sink to the floor. Also in accordance with ASHRAE 15 & 34, air supply and exhaust ducts to the mechanical room will serve no other area within a facility. Discharge air from a mechanical ventilation system will be to the outdoors.

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Provide mechanical ventilation systems in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.2.3 Field Applied Insulation

Apply field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2.4 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 CLEANING AND ADJUSTING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided for all fans that are operated during construction, and new filters must be installed after all construction dirt has been removed from the building. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing must be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4 TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total [8] [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

a. Submit a schedule, at least [2] [_____] weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

b. Submit the field posted instructions, at least [2] [_____] weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

c. The posted instructions must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations. [Submit [6] [_____] complete copies of an operation manual in bound 216 by 279 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least [4] [_____] weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.]

d. Submit [[6] [_____] complete copies of maintenance manual in bound 216 by 279 mm 8-1/2 by 11 inch booklets listing] routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.5 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems must be tested and charged as specified in Section 23 23 00 REFRIGERANT PIPING. Packaged refrigerant systems which are factory charged must be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems must be tested for leaks with a halide torch or an electronic leak detector. [Submit [6] [_____] copies of each test containing the information described below in bound 216 by 279 mm 8-1/2 by 11 inch booklets. Individual reports must be submitted for the refrigerant system tests.]

a. The date the tests were performed.
b. A list of equipment used, with calibration certifications.
c. Initial test summaries.
d. Repairs/adjustments performed.
e. Final test results.

3.5.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances must the refrigerant be discharged into the atmosphere.

3.5.2 Contractor's Responsibility

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time must more than 85 g 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year must be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.6 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. [Six] [_____] copies of the report provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system.

For equipment providing heating and cooling the system performance tests must be performed during the heating and cooling seasons.

a. Submit a schedule, at least [2] [_____] weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test. Tests must cover a period of not less than [48] [_____] hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications.

b. Make corrections and adjustments, as necessary, tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, install and tighten service valve seal caps and blanks over gauge points. Replace any refrigerant lost during the system startup.

c. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest the system. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test.

d. Coordinate field tests with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit [6] [_____] copies of the report provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart):

(1) Date and outside weather conditions.

(2) The load on the system based on the following:

(a) The refrigerant used in the system.
(b) Condensing temperature and pressure.
(c) Suction temperature and pressure.
(d) Ambient, condensing and coolant temperatures.
(e) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Thermostatic expansion valve superheat - value as determined by field test.

(5) Subcooling.

(6) High and low refrigerant temperature switch set-points

(7) Low oil pressure switch set-point.

(8) Defrost system timer and thermostat set-points.

(9) Moisture content.

(10) Capacity control set-points.

(11) Field data and adjustments which affect unit performance and energy consumption.

(12) Field adjustments and settings which were not permanently marked

as an integral part of a device.

3.7 MAINTENANCE

3.7.1 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than [2] [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

3.7.2 Maintenance Service

Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 81 23 (November 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 81 23.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

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COMPUTER ROOM AIR CONDITIONING UNITS

11/20

PART 3 EXECUTION

-- End of Section Table of Contents --

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SECTION 23 81 23

COMPUTER ROOM AIR CONDITIONING UNITS

11/20

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NOTE: This guide specification covers the requirements for heating, ventilating, and cooling (HVAC) equipment for thermal, humidity, and airflow control in data processing environments.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Use the most efficient, competitively available CRAC for which there are at least two products available for the indicated ranges of comparability. Design parameters for each item of equipment must be indicated on the drawings including capacity, efficiency, sound ratings, motor speeds, electrical characteristics, and special features.

System requirements must conform to UFC 3-410-01, "Heating, Ventilating, and Air Conditioning Systems".

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
AHRI 1360	(2017) Performance Rating of Computer and Data Processing Room Air Conditioners
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 520	(2004) Performance Rating of Positive Displacement Condensing Units

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 127	(2012) Method of Testing for Rating Computer and Data Processing Room Unitary Air-Conditioners

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2024) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME BPVC	(2010) Boiler and Pressure Vessels Code

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM C1338	(2019) Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
ASTM D5864	(2011) Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components
ASTM D6081	(1998; R 2014) Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM G21	(2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

ETL TESTING LABORATORIES (ETL)

ETL DLP	(updated continuously) ETL Listed Mark Directory

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1424	(2016) Engineering and Design -- Lubricants and Hydraulic Fluids

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials
40 CFR 82	Protection of Stratospheric Ozone

UL SOLUTIONS (UL)

UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 181	(2013; Reprint Dec 2021) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL Elec Equip Dir	(2011) Electrical Appliance and Utilization Equipment Directory

1.2 DEFINITIONS

Computer Room Air Conditioner (CRAC): A single, self-contained unit or split-system unit designed and manufactured specifically for temperature and humidity control of data processing environments.

Cold Aisle: The aisle between or adjacent to rows of racks from which the computing equipment draws cool air.

Hot Aisle: The aisle between or adjacent to rows of racks to which the computing equipment ejects hot air.

Rack: Telecommunications support frame that can consist of post-and-frame or full cabinet construction. Racks are provided under Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Computer Room Air Conditioner; G, [_____]

Small Computer Room Air Conditioners; G, [_____]

Space Temperature Control System Drawings; G, [_____]

Filters

Refrigerants; S

[[Cold][and][Hot] Aisle Containment Systems; G, [_____]

][Rack Mounted Fans; G, [_____]

][Leak Detection; G, [_____]

] SD-06 Test Reports

****

NOTE: Factory witness testing is expensive and rarely necessary for commonly manufactured mechanical equipment such as CRAC. Confirm with the facility owner that witness testing is necessary and worth the cost.

****

[CRAC Production Schedule and Factory Test Schedule; G, [_____]

] Manufacturer's Factory Test Plans; G, [_____]

Factory Test Reports; G, [_____]

Field Test Schedule; G, [_____]

Manufacturer's Field Test Plans; G, [_____]

Field Test Reports; G, [_____]

SD-07 Certificates

[Certificate of Specification Compliance; G, [_____]

] Credentials of the Manufacturer's Field Test Representative; G, [_____]

Ozone Depleting Substances Technician Certification

Certified List Of Qualified Permanent Service Organizations

[Seismic Certification; G, [_____]

] SD-08 Manufacturer's Instructions

Installation Manual for Each Type of CRAC

[Installation Manual for Each Type of Aisle Containment System

][Installation Manual for Each Type of Rack Mounted Fan

] SD-10 Operation and Maintenance Data

Computer Room Air Conditioner Operation and Maintenance Data, Data Package 4; G, [_____]

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.4 REFRIGERANTS

****

NOTE: EPA, per the Significant New Alternative Policy rule, reviews refrigerant substitutes on the basis of ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Lists of acceptable and unacceptable substitutes are updated several times each year. A chronological list of SNAP updates is available at https://www.epa.gov/snap/substitutes-refrigeration-and-air-conditioning or from the stratospheric ozone information hotline at 1 (800) 296-1996. Reducing ozone depletion and global warming potential by reducing or eliminating CFC, and reducing or eliminating HCFC and Halon use in air conditioning equipment is required.

****

Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0. CFC-based refrigerants are prohibited. [HCFCs][and][Halons] are not permitted. Provide SDS sheets for all refrigerants.

1.5 QUALIFICATIONS

1.5.1 Ozone Depleting Substances Technician Certification

****

NOTE: The following paragraph requires a certification for technicians who work on equipment that could release ozone depleting refrigerants, such as R-123, into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

****

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.6 QUALIFICATIONS

1.6.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacturer of such products, which are of a similar material, design, and workmanship. Standard products must have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two-year period.

1.6.2 Alternative Equipment Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.6.3 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.4 Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.6.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.6.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.6.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.7 PROJECT REQUIREMENTS

1.7.1 Verification of Dimensions

Become familiar with the details of the work, verify all dimensions in the field, and provide adequate clearance for all connections and service access. Notify the Contracting Officer of any discrepancy before performing any work.

1.7.2 Energy Efficiency

****

NOTE: Refer to ASHRAE 90.1 - SI ASHRAE 90.1 - IP Table 6.8.1-11 for the minimum efficiency requirements of air conditioners and condensing units serving computer rooms. Efficiencies should be indicated on schedules and should be better than or equal to the minimum efficiencies required by ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

****

Provide equipment with minimum efficiencies [as indicated][as required by ASHRAE 90.1 - SI ASHRAE 90.1 - IP].

1.8 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

PART 2 PRODUCTS

2.1 COMPUTER ROOM AIR CONDITIONER (CRAC)

****

NOTE: The indoor components of the CRAC are inherently noisy. In noise sensitive areas, designers should take steps to attenuate CRAC generated sound. Determine the maximum acceptable sound level limit for the application in NC level or dbA and add the limit to the CRAC equipment schedule. This sound level compliance may be verified by the CRAC factory and field tests.

****

****

NOTE: Designers should locate the floor registers in a raised floor system as far from the CRAC as possible to reduce direct sound transmission from the unit to the conditioned space and to improve air distribution performance. Floor registers should be coordinated with Section 09 69 13 RIGID GRID ACCESS FLOORING.

****

****

NOTE: Designers should indicate the mandatory routing of piping around the floor stand of a downflow CRAC in their piping plan view and piping details. Ensure, by dimensioning of piping details, that no piping interferes with the air flow performance of the CRAC.

****

****

NOTE: Refer to ASHRAE 90.1 - SI ASHRAE 90.1 - IP Table 6.8.1K for the minimum efficiency requirements of air conditioners and condensing units serving computer rooms.

****

Provide complete working CRACs, designed, [and] factory assembled[, and factory tested]. Equipment must be listed in UL Elec Equip Dir or ETL DLP for computer room application. CRACs must have a minimum sensible coefficient of performance of [_____] in accordance with ASHRAE 127. Computer Room Air Conditioners must have [a minimum [seasonal]energy efficiency ratio ([S]EER) of [_____],] [a minimum Heating Seasonal Performance Factor (HSPF) of [_____],] [a minimum Integrated Part Load Value (IPLV) of [_____],][and][a minimum COP of [_____]]. CRACs must include room cabinet and frame, [floor stand,]fan section, filter section, cooling coil, [reheat coil,][humidifier,][compressor[s],][condenser[s],]controls, and, interconnecting piping internal to the CRAC. Provide units rated in accordance with AHRI 1360.

2.1.1 Unit Airflow Configuration

****

NOTE: Indicate the airflow configuration for each unit on the equipment schedule.

****

2.1.1.1 Downflow Units

The CRAC must draw return air in at the top [or sides]of the cabinet and discharge supply air at the bottom of the cabinet.

2.1.1.2 Upflow Units

The CRAC must draw return air in at the bottom [or sides]of the cabinet and discharge supply air at the top of the cabinet.

2.1.1.3 In-row Units

****

NOTE: Security and procurement constraints may not allow the use in in-row units. In-row units must be coordinated with the support frame provided under Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM, which, in some instances, may be provided under a separate contract.

****

The CRAC must be designed and manufactured to be installed within the row of server cabinets where it must draw return air in at the back (from the hot aisle) and discharge supply air at the front (into the cold aisle). In-row units must match the height and depth of the adjacent racks and integrate into the row such that no gaps exist that would allow air to bypass from the cold aisle to the hot aisle.

2.1.1.4 Ceiling Mounted Units

The CRAC must be designed to be installed at or above the ceiling where it must draw return air in at a duct connection or integral return grille and discharge supply air at a duct connection or integral supply register.

2.1.2 Cabinet and Frame

2.1.2.1 Unit Frame

Unit frame must be manufactured of welded steel tubes and must be mill-galvanized or coated with an epoxy finish.

2.1.2.2 Unit Cabinet

Exterior panels must be steel sheet, minimum of 1.0 mm 20 gage, mill-galvanized or coated with a corrosion-inhibiting epoxy finish in [manufacturer's standard][the specified][the indicated] color. Mill galvanized sheet metal must be coated with not less than 380 gram of zinc per square meter 1.25 ounces of zinc per square foot of two-sided surface. Mill rolled structural steel must be hot-dip galvanized or primed and painted. Cut edges, burns and scratches in hot-dip galvanized surfaces must be coated with galvanizing repair coating. Manufacturer's standard cabinet materials and finishes will be acceptable if equivalent to the above requirements and approved by the Contracting Officer.

Provide removable panel for access to controls without interrupting airflow. Panels must be gasketed to prevent air leakage under system operating pressure and must be removable for service access without the use of special tools.

[Provide double deflection [supply][and][return] grille[s] integral to unit. Grilles must be factory coated the same as the unit cabinet.

][2.1.2.3 Cabinet Interiors Sound Attenuation

****

NOTE: For CRAC interior cabinets located in spaces which require low sound levels because of interaction requirements of the operating personnel, select desired sound attenuation methods specified in this paragraph. In noise sensitive areas, specifiers should take special steps to attenuate CRAC generated sound, such as using the two inch foam requirement, in lieu of the fiber glass insulation.

****

Provide a factory-installed sound attenuation system in the interior of the CRAC cabinet.

[CRAC cabinet panels interior must be provided with 25 millimeters of 24 kilogram per cubic meter 1 inch of 1 1/2 pound per cubic foot fiber glass insulation on interior of cabinet panels. Insulation must be applied to the cabinet panels with 100 percent adhesive coverage and both the insulation and the adhesive must conform to NFPA 90A. Insulation must be rated for 6000 fpm per UL 181 and ASTM C1071. Insulation must resist the growth of microorganisms per ASTM C1338 and ASTM G21.

][CRAC cabinet panels interior must be provided with minimum 50 millimeters two inch thick acoustical sound absorbing foam with a minimum Noise Reduction Coefficient (NRC) of 0.85.

][Compressors located in CRAC interior cabinets must be either wrapped in a sound absorbing insulating blanket or enclosed in its' own sound absorbing insulated mini-cabinet inside of the larger CRAC interior cabinet.

][Fans and compressors located in the CRAC interior cabinet must be provided with vibration isolators between their respective support frames and the cabinet framing.

] CRAC manufacturer's standard interior cabinet sound attenuation materials and finishes will be acceptable if equivalent to the above requirements and approved by the Contracting Officer.

]2.1.3 Fan Section

****

NOTE: For CRAC units of sizes 6 tons and more, when specifying a belt drive, specify dual V-belt fan drives.

****

Provide fan(s) and fan motor(s) as integral, factory installed components of the CRAC.[Provide units with capability to lower fans into the floorstand below the raised floor. The procedure to lower the fans must be described in the manufacturer's written installation instructions.]

2.1.3.1 Fan Wheel

The supply air fan must be AMCA certified. Provide [steel][aluminum], [forward curved, double-width, double-inlet][backward curved, plenum/plug type] fan wheel. The fan must be statically and dynamically balanced. The fan must have self-aligning, permanently lubricated ball bearings with a minimum life span of 100,000 hours. Assess potential effects of lubricant on aquatic organisms in accordance with ASTM D6081 and submit aquatic toxicity reports. Assess biodegradation in accordance with ASTM D5864. In accordance with EM 1110-2-1424 Chapter 8, aquatic toxicity must exceed 1,000 ppm at LL50 and biodegradation must exceed 60 percent conversion of carbon to carbon dioxide in 28 days.

2.1.3.2 Motor and Drive

[Provide fan wheel directly coupled to motor shaft.] [Provide [V-belt drive][dual V-belt drive] sized for 200 percent of the motor nameplate rating. Fan speed must be adjustable with cast iron variable pitch pulleys. Sheaves must be within the middle one third of the sheave adjustment range.]

[Provide drip-proof, permanent split capacitor type, NEMA rated motor with inherent overload protection and sliding adjustable motor base.] [Provide electronically commutated motor with integrated electronic control board and direct microprocessor control signaling for speed control.]

[Provide variable frequency drive(s) in accordance with Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.

]2.1.4 Cooling Coil

****

NOTE: Indicate on the design drawings the minimum required head for the coil condensate pump. Do not

locate units with hydronic coils directly above computer racks. A double-sloped pan prevents water from standing and stagnating in the pan.

****

Provide AHRI 410 coil and slope for drainage. Coil must be manufactured of seamless copper tubes with plate [aluminum][copper] fins.[Indoor and outdoor coils must be matched and from same manufacturer.] Each coil, in the production process, must be individually tested at 2200 kPa 320 psi with compressed air under water and verified to be air tight. Factory dehydrate and seal each coil after testing and prior to evaluation and charging.[Provide DX coil complete with a distributor and thermostatic expansion valve with external equalizer.][Provide hydronic coils complete with drain and vent connections.] Provide [double-sloped]condensate drain pan of [minimum 1.0 millimeter 22 gage Type 304 stainless steel][plastic] with nonferrous connections[,[and] internal trap,][, and a condensate pump system complete with integral pump discharge check valve, integral float switch, reservoir, and pump and motor assembly.]

2.1.5 Filters

****

NOTE: MERV 13 filters are typically at least 6 inches deep with 0.8 inch wg pressure drop or higher, making them only feasible in applied, belt-driven central station air handling units. Terminal equipment or smaller packaged rooftop equipment cannot achieve this level of filtration or generate the static pressure needed to deliver proper airflow when using this high efficiency filtration. Typically MERV 6 or 8 is the highest efficiency filter that can be applied for that equipment.

****

Provide UL listed [50] [100] [_____] mm [2] [4] [_____] inches thick deep pleated fiberglass throwaway type filters.[Additionally, provide [50] [_____] mm [2] [_____] inches thick deep pleated fiberglass throwaway type pre-filters.] Provide filtration media with a Minimum Efficiency Reporting Value (MERV) of [6][8][13] as determined by ASHRAE 52.2. Provide one complete spare filter bank set per unit for installation prior to final acceptance testing covered in Part 3 of this section.

2.1.6 Reheat Coil

[Provide AHRI 410 reheat coils and slope for drainage. Provide coil manufactured of seamless copper tubes with plate [aluminum][copper] fins. Each coil, in the production process, must be individually tested at 2200 kPa 320 psi with compressed air under water and verified to be air tight.

][Provide electric reheat coils with low watts density. The electric reheat coils must be enclosed in 304 stainless steel tubes and 304 stainless steel fins. Provide modulating control of the electric reheat coils by [multiple stages][or][Silicon Controlled Rectifier (SCR)]. Provide UL or ETL listed safety switches to protect system from overheating.

][2.1.7 Humidifier

****

NOTE: Investigate the water source conditions of the project site and specify the appropriate type of humidifier. If site water is very poor, a water treatment system may be required. Provide a deionized water system if using adiabatic humidifiers such as ultrasonic type. Specify an evaporator pan for infrared and ultrasonic humidifiers. Specify dispersion tube for steam generating humidifiers. Indicate steam generating capacities on the equipment schedule.
****

Humidifier section must include liquid-level control, emergency overflow and automatic water supply system factory pre-piped for final connection.[Provide stainless steel evaporator pan with water high level and low level alarms].[Provide [copper][stainless steel] atmospheric steam dispersion tube for installation in a [vertical][or][horizontal] air stream. Dispersion tube must have integral condensate return to the steam generator.] Arrange system to be cleanable and serviceable. Provide water chemistry requirements with humidifier submittal data.

[Provide infrared type humidifier, including high intensity quartz lamps mounted above and out of water supply.

][Provide humidifier of the self-contained steam generating electrode type utilizing a [plastic][disposable] canister with full probes connected to electric power via electrode screw connectors. Provide electrodes manufactured from expanded low carbon steel, zinc plated and dynamically formed for precise current control. The humidifier assembly must include integral fill cup, fill and drain valves and associated piping. Design the canister to collect the mineral deposits in the water and provide clean particle free steam to the air stream.

][Provide humidifier of the self-contained ultrasonic type operating on the principle of ultrasonic nebulization of water. Provide 300 series stainless steel casing. The ultrasonic humidifier must not produce any unacceptable noise radiation or frequency interference with communications or other electronic equipment. Provide water chemistry requirements with humidifier submittal data.

]][2.1.8 Compressor

Provide compressor that is direct drive, [semi-hermetic][or][hermetic reciprocating,][or][scroll] type capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Provide compressors of 26 kW 7.5 tons and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor has an independent refrigeration circuit through the condenser and evaporator. Start each compressor in the unloaded position. Provide compressor[s] complete with vibration isolation, suction and discharge service valves, high and low pressure safety switches, protection against short cycling, and built-in overload protection. Provide refrigeration circuits including hot gas mufflers, liquid-line filter-drier, refrigerant sight glass,[lubrication pump,] and moisture indicator, externally equalized expansion valve, and liquid-line solenoid valve factory connected with refrigeration copper tubing.[

Crankcase heaters are required.][Provide hot gas bypass.]

2.1.8.1 Refrigeration Circuit

****

NOTE: Filter-driers are optional and may be deleted on most pre-charged systems.

Delete the last two sentences in the last paragraph except when needed for a self contained heat pump with an integral water cooled condenser.

****

Provide field-installed refrigerant tubing for split systems in accordance with Section 23 23 00 REFRIGERANT PIPING.

Refrigerant-containing components must comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged with [nitrogen][refrigerant and oil] and sealed. Provide refrigerant charging valves and connections, and pumpdown valves for each circuit.[Provide reversible-flow type filter-drier in each liquid line.][Refrigerant flow control devices must be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. Provide a refrigerant suction line [thermostatic][thermostatic and water flow switch] control to prevent freeze-up in event of loss of water flow during heating cycle.]

]2.1.9 Condenser[and][Dry Cooler]

****

NOTE: Insert minimum temperature at which the mechanical cooling equipment will be required to operate.

****

Provide condenser circuit pre-piped with start-up and head pressure controls to maintain system operation at ambient temperatures down to [4.4 degrees C] [minus 6.6 degrees C] [[_____] degrees C] [40 degrees F] [20 degrees F] [[_____] degrees F].

[Provide an integral factory wired and tested control panel for each condenser[and][dry cooler]. The factory control board must control each condenser fan speed individually to optimize overall system performance.

][2.1.9.1 Air-cooled Condenser

Provide remote air-cooled condenser arranged for [vertical][or][horizontal] air discharge, designed and manufactured specifically for permanent outdoor installation. Condenser performance must be rated in accordance with ANSI/AHRI 460. Condenser must have head pressure control to allow unit operation down to [minus 18 degrees C] [minus 29 degrees C] [minus 34 degrees C] [0 degrees F] [minus 20 degrees F] [minus 30 degrees F].

2.1.9.1.1 Condenser Fans

Provide direct-driven propeller fans with factory balanced [aluminum][or][glass-reinforced polymer] blades and equipped with fan guards. Provide [permanent split capacitor][or][electronically commutated] fan motors with [drip proof][totally enclosed][explosion proof] enclosures.

2.1.9.1.2 Condenser Coils

Air-cooled condenser coils must be [seamless copper tubes with plate type [aluminum][cooper] fins][or][all aluminum microchannel type][with coating as described in [paragraph CORROSION PROTECTION FOR COASTAL INSTALLATIONS][Section 09 96 00 HIGH PERFORMANCE COATINGS]]. The coils, in the production process, must be pressure tested with compressed air at 2068 kPa 300 psig under water and verified to be leak-free. Factory dehydrate and seal each coil after testing and prior to evaluation and charging.

2.1.9.1.3 Unit Casing

Provide air-cooled condenser casings and mounting legs manufactured from [aluminum][or][galvanized steel] with[manufacturer's standard corrosion-resistant finish][coating as described in [paragraph CORROSION PROTECTION FOR COASTAL INSTALLATIONS][Section 09 96 00 HIGH PERFORMANCE COATINGS]].

][2.1.9.2 Liquid-cooled Condenser

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NOTE: In cold climates it is often cost effective to install an economizer coil that is used instead of the evaporator during cold weather. During periods of cold weather "free cooling" can be provided. When the glycol in the condenser can be cooled to about 10 degrees C 50 degrees F or less, the refrigeration unit is bypassed and the air that is normally passed through the evaporator goes through the economizer coil which contains cold glycol flowing from the condenser.

Specify a fouling factor of 0.001 for projects with unknown water quality and/or questionable water treatment practices. Otherwise, specify 0.0005 fouling factor.

****

Provide cleanable, cast iron or steel shell and [copper][copper-nickel] tubes, [counterflow type,][water-cooled][or][glycol-cooled]condenser with removable cast iron or steel heads. The condenser must be constructed in accordance with ASME BPVC.[As an option, a coaxial [copper][copper-nickel] tube-in-copper tube type water-cooled condenser may be provided.] Select liquid cooled condensers with a fouling factor of [0.001][0.0005]. Condensers must be rated for not less than 2758 kPa 400 psi refrigerant pressure and 862 kPa 125 psi water pressure at operating temperatures.

Water supply and return connections and piping internal to unit must be copper with brazed or threaded copper or bronze fittings, terminating in a threaded connection. Piping arrangement must include valved access for recirculation of acidic scale removal chemicals and isolation pressure taps to determine pressure drop and water flow. Provide a separate condenser for each compressor circuit.

][2.1.9.3 Dry Coolers

Provide dry cooler arranged for vertical air discharge, designed and manufactured specifically for permanent outdoor installation.

2.1.9.3.1 Dry Cooler Fans

Provide direct-driven propeller fans with factory balanced [aluminum][or][glass-reinforced polymer] blades and equipped with fan guards. Provide [permanent split capacitor][or][electronically commutated] fan motors with [drip proof][totally enclosed][explosion proof] enclosures.

2.1.9.3.2 Dry Cooler Coils

Dry cooler coils must be seamless copper tubes with plate type [aluminum][copper] fins[with coating as described in [paragraph CORROSION PROTECTION FOR COASTAL INSTALLATIONS][Section 09 96 00 HIGH PERFORMANCE COATINGS]]. The coils, in the production process, must be pressure tested with compressed air 2068 kPa 300 psig under water and verified to be leak-free. Factory dehydrate and seal each coil after testing and prior to evaluation and charging.

2.1.9.3.3 Dry Cooler Casing

The dry cooler casings and mounting legs must be manufactured from [aluminum][or][galvanized steel] with[manufacturer's standard corrosion-resistant finish][coating as described in [paragraph CORROSION PROTECTION FOR COASTAL INSTALLATIONS][Section 09 96 00 HIGH PERFORMANCE COATINGS]].

[2.1.9.3.4 Integral Pump Package

Provide dry cooler with a [single][double] pump package complete with an open expansion tank. The pump package must be mounted in a weatherproof enclosure.

]][2.1.10 Economizers

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NOTE: In most cases, the conditions for economizer operation should be determined by the CRAC controller. In some cases, a facility manager may want to control this with the Building Automation System. Coordinate this specification with the specific site requirements.

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The factory mounted CRAC controls must control the economizer operation process to ensure coordination of all components. The conditions for economizer operation must be determined[by the factory mounted CRAC controls based on indoor and outdoor conditions][by the HVAC control system].

[2.1.10.1 Air Economizers

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NOTE: The use of air economizers in computer rooms requires careful evaluation for each individual application. In warm, moist climates, the number of

available economizer hours often does not warrant the construction expense. In cold dry climates, the cooling savings may be partially offset by humidification loads.
****

Provide factory mounted dampers and duct connection flanges to allow up to 100 percent outdoor air through the unit for free cooling. Dampers must meet the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC.

][2.1.10.2 Water Economizers

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NOTE: For use with water cooled direct expansion systems. Economizer operation in chilled water systems is accomplished at the chiller plant and is beyond the scope of this specification.
****

Provide factory mounted coil and condenser water changeover valve. When commanded, the changeover valve must divert condenser water flow from the condenser coil to the economizer coil.

Coil must meet AHRI 410 and be sloped for drainage. Provide coil manufactured of seamless copper tubes with plate aluminum fins. Each coil, in the production process, must be individually tested at 320 psi 2200 kPa with compressed air under water and verified to be air tight.

][2.1.10.3 Refrigerant Economizer

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NOTE: For use with air cooled direct expansion systems. Verify the capability of site personnel to operate and maintain this system.
****

Provide fully integrated, pumped refrigerant economizer operation. In addition to the specified CRAC and air cooled condenser, provide a refrigerant pump package from the same manufacturer. The entire system must be controlled and optimized by the CRAC controls. During cold outdoor temperatures, the compressors must reduce capacity as much as possible. As compressor capacity decreases, a variable speed pump on each refrigeration circuit must then pump the liquid refrigerant through the air cooled condenser and evaporator for free cooling.

]][2.1.11 Floorstand

Provide a[n] [adjustable] [225] [300] [450] [600] [_____] mm [9] [12] [18] [24] [_____] inches high [seismic rated]floorstand for each CRAC for freestanding installation on the main building structural floor. Floorstand must elevate the unit to the height of the raised computer floor and must allow for leveling and locking at the desired height. Floorstand must be retractable, or removable, for installing the unit directly on the raised floor. Unit must be fully gasketed (rubber or neoprene) to prevent air leakage at the raised floor penetration.[Provide radiused turning vane integral to floorstand.]

[For units requiring seismic certification, the floorstand must be included in the unit certification.

]]2.2 SMALL COMPUTER ROOM AIR CONDITIONERS

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NOTE: Use this section for console type and ceiling mounted type computer room air conditioners under 5 tons. These units are typically used in telecom closets or small, low density computer rooms where airflow management is less of a concern.

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Provide complete working CRACs, designed and factory assembled. Equipment must be listed in UL Elec Equip Dir or ETL DLP for computer room application. CRACs must have a minimum sensible coefficient of performance of [_____] in accordance with ASHRAE 127. CRACs must include room cabinet and frame, fan, filter, cooling coil, [reheat coil,][humidifier ,][compressor[s],][condenser[s],]controls, and, interconnecting piping internal to the CRAC. Provide units rated in accordance with AHRI 1360. Provide all refrigerant piping in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.2.1 System Configuration

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NOTE: Specify each configuration type needed. If multiple types are required, indicate type for each equipment mark on the schedule. Retain the applicable subparagraphs "[EVAPORATOR][OR][COOLING COIL] CABINET CONSTRUCTION" through "INDOOR [WATER][GLYCOL] COOLED CONDENSING UNIT" to specify the various components necessary for each configuration included in the design.

****

[Self Contained Air Cooled: Provide an indoor unit for [ducted concealed][exposed] application. Unit must have connections for supply and return ducts from the central air handling system for heat rejection. Unit must consist of a direct expansion system evaporator and an indoor, air cooled condensing unit.

][Split System Air Cooled: Provide an indoor unit for [ducted concealed][exposed] application, an outdoor condensing unit, and interconnecting refrigerant piping. Unit must consist of a direct expansion system evaporator and an outdoor, air cooled condensing unit.

][[Water][Glycol] Cooled: Provide an indoor unit for [ducted concealed][exposed] application.[Provide dry cooler as specified elsewhere in this section.][Provide [cooling tower][remote evaporatively cooled condenser] as specified in 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS.] Unit must consist of a direct expansion system evaporator and an indoor, [water][glycol] cooled condensing unit.

][Chilled Water: Provide an indoor unit for [ducted concealed][exposed] application with a chilled water coil.

]2.2.2 [Evaporator][or][Cooling Coil] Cabinet Construction

Provide cabinet and chassis constructed of heavy gauge galvanized steel with all service access from a single side of the unit. Mounting brackets must be integral to the cabinet. Internal cabinet insulation must meet ASHRAE 62.1 requirements for Mold Growth, Humidity & Erosion, tested per UL 181 and ASTM C1338 standards.

2.2.3 Air Distribution Components

Provide direct-drive fan assembly equipped with double-inlet blower, self-aligning ball bearings and lifetime lubrication. Fan motor must be permanent-split capacitor, high-efficiency type, equipped with two speeds for airflow modulation. The microprocessor controller must use the lower fan speed for precise dehumidification control. Fan speed must also be user selectable from the wall controller. System must be suitable for supply and return air plenum or ducted supply and return air distribution. Provide filter rack designed to accept 100 mm 4 inch thick filters. Provide pleated filters with a MERV 8 rating in accordance with ASHRAE 52.2.

[2.2.4 Direct Expansion System Evaporator Components

The evaporator section must include evaporator coil, thermostatic expansion valve and filter drier. The evaporator coil must be constructed of copper tubes and aluminum fins. Provide an externally equalized thermostatic expansion valve to control refrigerant flow. The refrigerant piping must be spun-closed and filled with a nitrogen holding charge. Evaporator and condensing unit must be field piped using copper lines, brazed, evacuated and field charged with R-407C refrigerant. The evaporator unit can be coupled directly with the condensing unit or mounted remote to the condensing unit. The coil assembly must be mounted in a condensate drain pan with an internally trapped drain line. The evaporator drain pan must include a factory-installed float switch to shut down the evaporator upon high water condition.

][2.2.5 Chilled Water System Components

Provide a motorized, slow-close, two-position, chilled water control valve. Valve design pressure rating must be not less than 2068 kPa 300 psig static pressure, with a maximum close-off pressure rating of not less than 414 kPa 60 psig.

Provide a cooling coil constructed of copper tubes and aluminum fins with integral drain and vent. The coil assembly must be mounted in a condensate drain pan with an internally trapped drain line. The evaporator drain pan must include a factory-installed float switch to shut down the evaporator upon high water condition.

][2.2.6 Indoor, Air-Cooled Condensing Unit

Condensing unit components must include condenser coil, direct drive centrifugal blower, scroll compressor, high-pressure switch, refrigerant receiver, head pressure control valve, hot gas bypass system, and liquid line solenoid valve. Provide a factory mounted disconnect switch in the high voltage section of the electrical panel. The switch handle must be accessible from the unit front. The cabinet and chassis must be constructed of heavy gauge galvanized steel, and must be serviceable from one side of the unit. Mounting brackets must be integral to the cabinet design and be designed for ceiling mounting.

Provide hot gas bypass to reduce compressor cycling and improve operation under low-load conditions. The hot gas bypass must be completely contained in the condensing unit. Field installed third refrigerant line is not acceptable. Hot gas bypass must be automatically deactivated upon a call for dehumidification. Provide a high pressure switch to protect the unit from abnormal refrigerant pressure conditions and deactivate the compressor and annunciate an alarm at the wall controller. The blower must continue to circulate air. The wall controller must be used to manually restart the compressor function after the automatic pressure switch resets. Three high head pressure alarms in a rolling 12-hour period must lock out the manual restart feature until power is cycled to the evaporator unit. A pressure balancing valve must be factory installed to reduce the chance of high pressure cut-out due to excessive refrigerant migration to the receiver due to changing outdoor temperatures during off-cycles. The refrigerant piping must be spun-closed and filled with a nitrogen holding charge. Evaporator and condensing unit must be field piped using copper lines, brazed, evacuated and field charged with R-407C refrigerant. Condensing unit must be designed for 35 degrees C 95 degrees F ambient and be capable of operation to minus 34 degrees C minus 30 degrees F. The condensing unit can be mounted directly to the evaporator or can be mounted remote to the evaporator. The condensing coil must be constructed of copper tubes and aluminum fins. The condenser fan must be centrifugal type, double inlet, direct drive.

][2.2.7 Outdoor, Air-Cooled Condensing Unit

Provide condensing unit rated in accordance with ANSI/AHRI 520 and designed for permanent outdoor installation. Provide removable panels for access to all components. Condensing unit components must include condenser coil, direct drive propeller fan, scroll compressor, high-pressure switch, refrigerant receiver, head pressure control valve, hot gas bypass system, and liquid line solenoid valve. Unit casing and chassis must be constructed of heavy gauge galvanized steel.

Provide hot gas bypass to reduce compressor cycling and improve operation under low-load conditions. The hot gas bypass must be completely contained in the condensing unit. Field installed third refrigerant line is not acceptable. Hot gas bypass must be automatically deactivated upon a call for dehumidification. Provide a high pressure switch to protect the unit from abnormal refrigerant pressure conditions and deactivate the compressor and annunciate an alarm at the wall controller. The blower must continue to circulate air. The wall controller must be used to manually restart the compressor function after the automatic pressure switch resets. Three high head pressure alarms in a rolling 12-hour period must lock out the manual restart feature until power is cycled to the evaporator unit. A pressure balancing valve must be factory installed to reduce the chance of high pressure cut-out due to excessive refrigerant migration to the receiver due to changing outdoor temperatures during off-cycles. The refrigerant piping must be spun-closed and filled with a nitrogen holding charge. Evaporator and condensing unit must be field piped using copper lines, brazed, evacuated and field charged with R-407C refrigerant. Condensing unit must be designed for [35 degrees C] [40.6 degrees C] [95 degrees F] [105 degrees F] ambient and be capable of operation to [minus 18 degrees C] [minus 34 degrees C] [0 degrees F] [minus 30 degrees F].[Condensing unit must operate at a sound level less than 58 dbA.] The condensing coil must be constructed of copper tubes and aluminum fins.

][2.2.8 Indoor [Water][Glycol] Cooled Condensing Unit

Condensing unit components must include coaxial condenser coil, scroll compressor, high-pressure switch, water regulating valve, hot gas bypass system, and liquid line solenoid valve. Provide a factory mounted disconnect switch in the high voltage section of the electrical panel. The switch handle must be accessible from the unit front. The cabinet and chassis must be constructed of heavy gauge galvanized steel, and must be serviceable from one side of the unit. Mounting brackets must be integral to the cabinet design and be designed for ceiling mounting.

Provide hot gas bypass to reduce compressor cycling and improve operation under low-load conditions. The hot gas bypass must be completely contained in the condensing unit. Field installed third refrigerant line is not acceptable. Hot gas bypass must be automatically deactivated upon a call for dehumidification. Provide a high pressure switch to protect the unit from abnormal refrigerant pressure conditions and deactivate the compressor and annunciate an alarm at the wall controller. The blower must continue to circulate air. The wall controller must be used to manually restart the compressor function after the automatic pressure switch resets. Three high head pressure alarms in a rolling 12-hour period must lock out the manual restart feature until power is cycled to the evaporator unit. The refrigerant piping must be spun-closed and filled with a nitrogen holding charge. Evaporator and condensing unit must be field piped using copper lines, brazed, evacuated and field charged with R-407C refrigerant. The condenser circuit must be pre-piped with a [2-way][3-way] regulating valve which is head-pressure actuated. The condenser water/glycol circuit must be designed for a static operating pressure of [1034 kPa] [2413 kPa] [150 PSI] [350 PSI].

][2.2.9 Steam Generating Humidifier

Provide a factory mounted steam generating humidifier that is controlled by the integral unit controls. Humidifier must include disposable canister, all supply and drain valves, 25.4 mm 1 inch air gap on fill line, inlet strainer, steam distributor and electronic controls. The need to change canister must be annunciated on the wall-mounted controller. An LED light on the humidifier assembly must indicate cylinder full, overcurrent detection, fill system fault and end of cylinder life conditions. The canister flush water must not drain into the coil drain pan. The humidifier wand must be mounted over the coil drain pan.

][2.2.10 Electric Reheat

Provide factory mounted, 304/304 stainless steel, finned-tubular electric resistance heater. Reheat must be controlled by the integral unit controls to maintain room dry bulb temperature when dehumidification is required. Provide UL listed safety switch to protect the system from overheating. Provide a factory mounted ground current detector to shut-down the entire unit if a ground fault in the reheat system is detected.[Provide Silicon Controlled Rectifier (SCR) controller to proportionally control the reheat elements to maintain the selected room temperature.]

][2.2.11 Hot Water Reheat

Provide hot water reheat coil constructed of copper tubes and aluminum fins with integral drain and vent.

]2.2.12 Controls

Provide remote mounted color touchscreen display for each unit. Provide remote mounted temperature[and humidity] sensor[s] for each unit. Controls must be organized by menus with minimum menu selection of: Alarms, Event Log, Graphics, and Status Overview. The Graphics menu must display a minimum of the following: zone temperature[and humidity], zone setpoints, fan status[, and valve position]. Controls must include a control system interface. The control system interface must meet DDC Hardware requirements of Section [23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

[Integrate CRAC control into the HVAC control system defined in Section [23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][23 09 23.02 BACNET DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][and][UMCS defined in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION].[HVAC control system interface point is located in [indicate room number].][UMCS interface is located in [indicate building and room number].][Refer to controls drawings for minimum points required to interface with the [HVAC control system][and][UMCS].]

][2.3 [COLD][AND][HOT] AISLE CONTAINMENT SYSTEMS

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NOTE: Aisle containment systems must be closely coordinated with the communications, lighting, and fire protection systems. The ceiling of an aisle containment system is an obstruction to light and sprinkler spray and can make routing of data cable in overhead cable tray more difficult. Containment systems are typically only required in very high density data centers or in retro-fit applications where fundamental best practice in airflow design cannot be applied due to physical constraints. If containment is required, it should be provided under the same contract as the server racks themselves. Containment systems connect directly to the racks, so this must be a fully coordinated system. Coordinate with fire protection to extend the suppression system into the contained aisles.

****

Provide an engineered and manufactured system of solid panels to fully enclose each [hot][cold] aisle. The system must connect to uniform rows of same-height racks. The containment system must be provided in its entirety from a single manufacturer. All components must be selected for compatibility with the equipment support frame provided under Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. All materials in the containment system must have a flame spread index not greater than 75 and a smoke developed index not greater than 450 when tested in accordance with ASTM E84 or UL 723.

Wall Panels: [Translucent][or][Transparent] 6.0 mm 0.236 inch minimum thickness polycarbonate panels framed within 25.4 mm x 25.4 mm 1 inch x 1 inch T-slot aluminum extrusion or extruded aluminum tube. Panels must be UL 94 listed with a minimum rating of V-1.

Roof Panels: Construction same as wall panels.

Doors: [Sliding][or][Hinged] doors of similar construction to wall panels. Doors must comply with the requirements of CPSC 16 CFR 1201.

Grommets: At each penetration through the aisle enclosure system, provide brush-type grommets to minimize air leakage. Grommets must be of ABS or polypropylene construction with nylon brush filaments and EPDM gasket.

Blanking Panels: Provide panels to blank off openings in the aisle. Panel construction must be similar to wall panel construction or rack enclosure construction.

][2.4 RACK MOUNTED FANS

****

NOTE: Provide a fan schedule on the drawings that, at minimum, indicates: airflow, configuration (top, side, bottom, front, or back of rack), number of fans, and electrical requirements.

Similar to containment systems, the need for rack mounted fans should be closely evaluated by the designer, and only specified when absolutely needed.

****

Provide an engineered and manufactured fan system, designed to attach directly to the equipment support frame provided under Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. Fan system must circulate air evenly through the entire rack that it serves.

2.4.1 Cabinet

Exterior panels must be steel sheet, minimum of 1.0 mm 20 gage, mill-galvanized or coated with a corrosion-inhibiting epoxy finish in [manufacturer's standard][the specified][the indicated] color. Mill galvanized sheet metal must be coated with not less than 380 gram of zinc per square meter 1.25 ounces of zinc per square foot of two-sided surface. Mill rolled structural steel must be hot-dip galvanized or primed and painted. Cut edges, burns and scratches in hot-dip galvanized surfaces must be coated with galvanizing repair coating. Manufacturer's standard cabinet materials and finishes will be acceptable if equivalent to the above requirements and approved by the Contracting Officer.

2.4.2 Fan

Provide array of propeller type fans powered via single point cord-and-plug connection.[Provide dual power feeds for redundancy.]

]2.5 INSTRUMENTATION AND CONTROLS

****

NOTE: Evaluate the project in accordance with UFC 4-010-06 Cybersecurity of Facility Related Control Systems. Coordinate with, reference, and provide content in Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS to ensure that control systems provided under this section meet the project cybersecurity requirements.

Indicate on the controls drawings the required control points that the CRAC unit manufacturer must provide to the HVAC control system. Coordinate with

the system owner to determine the minimum points.

The recommended method of CRAC unit control is a rack mounted temperature and humidity sensor. Selection of the appropriate rack for mounting the sensors may be coordinated during the design if the racks are part of the construction contract, or the contractor should be required to coordinate with the Contracting Officer if the racks are part of another contract.

For buildings with an HVAC control system, provide a room temperature sensor independent of the CRAC unit controls. monitor the room temperature and send an alarm when out of range. Critical applications or the use of aisle containment systems may necessitate the use of multiple room temperature sensors.
****

All controls provided under this section must comply with the requirements of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

[2.5.1 Unit Level Controls

Provide factory installed components and wiring to control a unit's basic functions and space ambient conditions[including [humidification][and][dehumidification]] at one factory installed and tested station. Controller modules must provide automatic centralized control of computer room critical equipment, simplifying emergency switching and unit testing. When the module recognizes an alarm condition, it must automatically switch to a stand-by device. User must be able to program a switching delay to allow time to correct emergency conditions. Provide modules with capability to balance the runtime of all connected air units. Provide clear, simplified instructions for programming and configuration of controllers, minimizing the chances of operator error. Provide an electronic temperature and humidity recorder, integral or external to the unit, readable to specified control accuracy, complete with supplies required for one year of operation. Controls must include a control system interface to an HVAC control system. The control system interface must meet DDC Hardware requirements of Section [23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS]. Unit controls must comply with the requirements of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

2.5.1.1 Display Panel

Provide[color LED touchscreen display with graphical menu navigation][LCD digital display with push button navigation]. Display panel must include the following minimum data: power on, power off, unit in alarm, description of alarm, filter status,[rack inlet temperature,][room temperature,][room relative humidity ,][event log,][service contact information,] and unit run hours.[Display must have capability to set up password protection].

Provide the following minimum externally accessible controls at the unit: start and stop total system functions, silence audible alarm, main power disconnect.

2.5.1.2 Alarms

Display alarms on unit display panel. Alarm for the following: high and low space temperature, high and low space humidity, dirty filters, loss of airflow,[loss of [water][or][glycol] flow,] compressor high head pressure,[custom alarms as indicated on the controls drawings,] humidifier problems, and leak detection. Provide field accessible local audible alarm with silence pushbutton. Provide push-to-test lamps or all-lamp test pushbutton.[CRACs must have local devices which provide signals for remote audible and visual alarming capability for the above specified alarm conditions.]

2.5.1.3 Leak Detection

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NOTE: Describe here or indicate on drawings the layout of rope type detection systems. For mission critical applications with tier 3 or tier 4 infrastructure, the rope detection system should monitor the entire underfloor area in the data center. For mission critical applications with tier 1 or tier 2 infrastructure, the rope detection system should monitor the areas around the CRACs. Ultimately, the extent of the leak detection system should be coordinated with the owner of the computer room.

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Provide [spot][or][rope] moisture detection system for each computer room. Leak detection must be designed for installation on the subfloor below the raised floor of the computer room. Leak detection system must interface with the associated CRAC control panel to alarm upon detection of moisture on the subfloor.

2.5.1.4 Factory Wired Components

[Provide factory installed and wired[chilled][,][and][condenser][,][and][hot] water valve[s]. Valve[s] must meet the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC.

][Provide CRAC manufacturer's remote [room temperature sensor][,][and][rack mounted temperature sensor array][,][and][room humidity sensor]. Sensors must meet the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC.

][Provide factory wired discharge air temperature sensor. Sensors must meet the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC.

]][2.5.2 Supervisory CRAC Controls

In addition to stand alone controls, provide [a]device[s] to network together all CRACs [in each computer room][in this contract][as indicated]. The network device must integrate all data for each CRAC, as required under stand alone controls, and display it on any connected CRAC's display panel.[The network device must optimize the operation of all connected CRACs to minimize energy use.] The network device must balance runtime across all connected units. The network device must automatically switch to a standby unit upon detection of failure of a duty unit. Provide all control wiring among CRACs and network device[s] as required to meet this specification.

][2.5.3 Integration to [HVAC control system] [and] [Basewide Utility Monitoring and Control System (UMCS)]

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NOTE: Coordinate with the owner/operator of the data center for which points must be interfaced into the HVAC control system and/or UMCS. Indicate those points on the controls drawings. At a minimum, call for entering and leaving air temperatures, valve positions, fan speed, and alarms.

****

Integrate CRAC control into the HVAC control system defined in Section [23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][23 09 23.02 BACNET DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][and][UMCS defined in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION].[HVAC control system interface point is located in [indicate room number].][UMCS interface is located in [indicate building and room number].]

[Refer to controls drawings for minimum points required to interface with the [HVAC control system][and][UMCS].

]][2.6 CORROSION PROTECTION FOR COASTAL INSTALLATIONS

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NOTE: For all outdoor applications and in Environmental Severity Classification (ESC) locations C3 thru C5 and all humid locations, as well as all indoor applications in a harsh environmental, add sentence below to paint in accordance with Section 09 96 00 HIGH PERFORMANCE COATINGS. See UFC 1-200-01 for determination of ESC for a project location; humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1 - SI ASHRAE 90.1 - IP).

High Performance coatings are specified for all outdoor applications because ultraviolet radiation breaks down most standard coatings, causing a phenomena know as chalking, which is the first stage of the corrosion process. For additional information, contact The Coating Industry Alliance, specific suppliers such as Keeler and Long PPG and NACE International (NACE).

****

[Coat exterior coils, exterior casings, interior coils exposed to outdoor air, and interior casings exposed to outdoor air, in accordance with Section 09 96 00 HIGH PERFORMANCE COATINGS.

][Provide the [polyelastomer][or][phenolic] finish coating system on exterior coils, exterior casings, interior coils exposed to outdoor air, and interior casings exposed to outdoor air. The coating system must not reduce the HVAC equipment's performance rating.

] Finish coating must be applied at the premises of the HVAC equipment manufacturer or at the premises of the coating manufacturer or his authorized applicator. Provide finish coating in colors gray, or aluminum, or ivory. All components of the special finish coating systems, including primers and intermediate coats, must be applied by immersion dip-coating or spray-coating in accordance with coating manufacturer's written procedures.

If special finish coatings are applied at the finish coating manufacturer's (or his authorized applicator's) premises, the equipment to be finish coated must be transported to and from the finish coating manufacturer's premises by the Contractor. The finish-coating manufacturer must be responsible for necessary disassembly of the HVAC equipment and re-assembly of final finish coated equipment.

Submit for approval a Certificate of Specification Compliance provided by the finish coating system manufacturer. Requirements for certificate include:

a. Name of firm that provided the finish coating system.

b. Project title and Navy construction contract number.

c. Listing of the pieces of equipment that were finish coated by this firm.

d. Certificate must certify that the finish coating materials and application procedures employed conform to the contract specifications.

e. Date of final inspection by this firm and printed name and signature of the inspector.

f. Printed name and signature of the officer of the firm that is responsible for firm's certification program.

[2.6.1 Polyelastomer Finish Coating System

2.6.1.1 Heat Exchanger Coil (Including Evaporator Coil) Surfaces

a. Acrylic polymer resin primer: 0.025 mm 1 mil minimum dry film thickness.

b. Polyelastomer resin top coating: 3 coats, 0.038 mm 1.5 mils minimum total dry film thickness.

c. In lieu of coating, provide copper tubes and copper fins

2.6.1.2 Uninsulated Interior Surfaces and Exterior Surfaces

Polyelastomer resin: 3 coats, 0.100 to 0.150 mm 4 to 6 mils minimum total dry film thickness.

2.6.1.3 Insulated Interior Surfaces

Vinyl: 0.050 to 0.250 mm 2 to 10 mils minimum dry film thickness.

][2.6.2 Phenolic Finish Coating System

Provide a resin base thermosetting phenolic finish.

2.6.2.1 Heat Exchanger Coil (Including Evaporator Coil) Surfaces

a. Apply phenolic finish to the entire coil. Provide a minimum of two coats. Total minimum dry film thickness must be 0.075 mm 3 mils.

b. In lieu of coating, provide coil of copper tubes and copper fins

2.6.2.2 Uninsulated Interior Surfaces and Exterior Surfaces

Amine cured epoxy phenolic finish: 0.150 to 0.175 mm 6 to 7 mils minimum total dry film thickness.

2.6.2.3 Insulated Interior Surfaces

Polyester or Vinyl Ester finish: 0.050 to 0.250 mm 2 to 10 mils minimum dry film thickness.

]]2.7 FACTORY PAINTING SYSTEMS

Provide manufacturer's standard factory painting. Certify that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. The factory painting system must be designed for the anticipated temperature service.

2.8 ELECTRICAL

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NOTE: Coordinate the Short Circuit Current Rating (SCCR) with the electrical engineer. This value varies for every application and is not easily fixed in the field if the equipment is not specified correctly. For multiple CRACs with different SCCR requirements, indicate this information on the equipment schedule or reference its location on the electrical drawings.

****

Provide an integral electrical panel of similar construction to the unit cabinet. Within the electrical panel, provide a single point power connection terminal block and [fused disconnect switch,][fuse block and disconnect switch]. The electrical panel must provide at least [65,000][_____] amp Short Circuit Current Rating (SCCR).[Refer to electrical drawing [_____] for Short Circuit Current Rating (SCCR).]

****

NOTE: Use this paragraph for other than NAVFAC SE projects.

****

[2.8.1 Electrical Motors, Controllers, Contactors, and Disconnects

Provide motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors must have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls provided. When motors and equipment provided are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

]

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NOTE: Use this paragraph and its subparagraphs regarding electrical components and energy efficient motors for NAVFAC SE projects.

****

[2.8.2 Electrical Installations

Conform to IEEE C2, NFPA 70, and requirements specified herein.

2.8.2.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters[(except starters/controllers which are indicated as part of a motor control center)], control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not to be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit,[the motor control equipment forming a part of motor control centers,] and the electrical power circuits must be provided under Division 26, except internal wiring for components of package equipment must be provided as an integral part of the equipment. When motors and equipment provided are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

2.8.2.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

2.8.2.3 High Efficiency Motors

2.8.2.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors must be high efficiency types corresponding to the applications listed in NEMA MG 11.

2.8.2.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors must be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings must meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

2.8.2.4 Three-Phase Motor Protection

Provide controllers for motors rated 1.34 kilowatts 1 horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

]2.8.3 Electrical Control Wiring

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NOTE: This paragraph contains NAVY Tailoring.

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[Provide control wiring under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.][Provide control wiring under Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.][Provide control wiring under this section in accordance with NFPA 70 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.] Provide Space temperature control system drawings which include point-to-point electrical wiring diagrams.

2.9 [HVAC WATER PIPING][AND][METAL DUCTWORK]

****

NOTE: Do not locate units with hydronic coils directly above computer racks. Design piping systems to limit the amount of overhead hydronic piping installed in the computer room. Do not locate hydronic piping directly above computer racks. Ideally, hydronic piping should be installed below the raised access floor. Locate hydronic piping under raised access floors such that it does not block airflow from downflow CRAC units.

****

Requirements for HVAC water piping and metal ductwork are specified in [Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS][and][Section 23 30 00 HVAC AIR DISTRIBUTION].

[2.10 FIRE PROTECTION DEVICES

The requirements for duct smoke detectors are specified in Section [23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS].

]2.11 SOURCE QUALITY CONTROL

Provide factory test plan[s], factory test schedule[s], factory test[s] and factory test report[s] on [each of the CRAC[s];][CRAC-1 through CRAC-[_____]].

2.11.1 Manufacturer's Factory Test Plans

For [each CRAC][insert specific unit marks], submit a factory test plan which when followed during factory testing must verify that the performance scheduled on the drawings is met by the produced CRAC models.

The manufacturer must perform factory tests on the actual CRAC[s] produced for this project. The test reports must document the performance tests conducted on the factory assembled computer room air conditioning units. Performance testing on the individual computer room air conditioning unit components, not factory assembled, is not acceptable.

Submit the required test plans for review and approval to the Contracting Officer at least [90][_____] calendar days before scheduled factory test date.

2.11.1.1 Test Procedure

Indicate in each test plan the factory acceptance test procedures. Procedures must be structured to test all modes of operation to confirm that the controls are performing in accordance with the intended sequence of control.

Controllers must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

2.11.1.2 Performance Variables

Each test plan must list performance variables that are required to be measured or tested as part of the field test. Include in the performance variables list the performance indicated on the equipment schedules on the contract design drawings.

Manufacturer must provide with each test procedure a description of acceptable performance results that must be verified. Manufacturer must identify the acceptable limits or tolerances within which each tested performance variable must acceptably operate.

2.11.1.3 Test Configuration

Plans must indicate that tests are to be performed for a minimum of four continuous hours[in a wet coil condition]. If test period is interrupted, the four hour test period must be started over. Each test plan must be job specific and must address the particular CRAC[s] and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.[Tests must include [a pressurized raised floor discharge configuration at the specified or indicated height above the floor,][with or without the air discharge elbows;][or a top air discharge configuration][and phenolic coated coils].]

2.11.1.4 Tested Variables

Plans must provide for air side testing which includes verification of the airflow, total static pressure; fan drive motor KW, amperage and RPM; and fan RPM. Provide entering air temperatures equal to those indicated on the CRAC schedules.

2.11.1.5 Thermal Testing

Plans must provide thermal testing utilizing [chilled water][40 percent ethylene glycol and 60 percent water solution][and][hot water] with temperatures equal to those indicated on the CRAC schedules. Thermal testing must verify CRAC heating, sensible cooling, total cooling, and humidifying performance scheduled on the contract drawings.

2.11.1.6 Specialized Components

Include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

[2.11.1.7 Factory Test For Sound Pressure Level

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NOTE: Do not include the following sound rating tests in the specification without written permission from the Engineering Field Division's Mechanical Design Branch for a particular project. Prior to including the following sound testing paragraph, coordinate the following aspects of the requirements:

1. Determining the sound ratings of CRACs requires specific factory testing. This testing may need to be witnessed by a representative of the Contracting Officer to verify compliance since no manufacturer to date has performed these sound rating tests.

2. Sound rating testing will add significant cost to each CRAC and therefore must be covered by the project cost estimate.

3. Ensure that acceptable sound ratings for each CRAC is indicated.

****

Determine the A-weighted sound pressure level for the indoor portion of each of the CRACs; [CRAC-1 through CRAC-[_____]].

Each unit must be mounted on a [raised]floor duplicating of the installation configuration indicated on the contract drawings. Unit must be located at least 1.5 meters 150 mm 5 feet 6 inches from test room walls. No other equipment must be operating in the test room during sound level testing of subject unit. Background sound levels must be at least 10 dB below lowest sound pressure level measured on subject unit. Testing must be conducted by using an ANSI Type 1 or 2 sound level meter located 1.0 meter 3.3 feet from the unit under test and 1.0 meter 3.3 feet above raised floor. Measure and record A-weighted sound pressure level on all four sides of unit.

]2.11.1.8 Factory Tests Reporting Forms

Each test plan must include the required test reporting forms to be completed by the Contractor's testing representatives. Submit factory test reports, referencing each tested CRAC serial number, and receive approval before delivery of CRAC to the project site.

[2.11.2 CRAC Production Schedule and Factory Test Schedule

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NOTE: Factory witness testing is expensive and rarely necessary for commonly manufactured mechanical equipment such as CRAC. Confirm with the facility owner that witness testing is necessary and worth the cost. If desired, remove the brackets from the "CRAC Production Schedule and Factory Test Schedule" paragraph.
****

The Government [will][reserves the right to] witness factory tests for [CRAC-1][and CRAC-[_____] through CRAC-[_____]].

Provide the CRAC production schedule and factory test schedule for tests to be performed at the manufacturer's test facility. Submit planned production schedule, and factory test schedule and test location, to the Contracting Officer as soon as it is scheduled but not less than 60 calendar days prior to the scheduled factory test date. Track this schedule through the production phases and if a scheduled factory test date changes, give advanced notice to Contracting Officer as soon as possible but at least 15 calendar days in advance of the scheduled test dates.

]2.11.3 Factory Tests

Conduct the factory testing in compliance with the Contracting Officer approved manufacturer's field test plan, and in accordance with additional field testing requirements specified herein. Record the required data using the test reporting forms approved of the approved field test plan. Conduct the test for each CRAC for the continuous test period in the approved test plan. A CRAC shutdown before the continuous test period is completed must result in the test period being started again and run for the required duration.

2.11.4 Deficiency Resolution

The test requirements must be acceptably met; deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations and corrections tested as specified in the paragraph MANUFACTURER'S FACTORY TEST PLANS.

2.11.5 Factory Test Reports

Use the test reporting forms approved in the factory test plan. Final test report forms must be typed including data entries and remarks. Completed test report forms for each CRAC must be reviewed, approved, and signed by the Manufacturer's test director.

[2.12 SEISMIC REQUIREMENTS

CRAC units must be seismically certified in accordance with the requirements in Section 23 05 48.19 SEISMIC BRACING FOR HVAC. Provide seismic bracing in accordance with Section 23 05 48.19 SEISMIC BRACING FOR HVAC.

]PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 CRAC System

Installation of each CRAC system including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing, must be in accordance with ASME B31.1, ASME B31.5, NFPA 70, as modified and supplemented by the requirements of this section and the CRAC manufacturer's written installation instructions.

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

3.1.2 Installation Instructions

Provide a manufacturer's installation manual for each type of CRAC.[Provide a manufacturer's installation manual for each type of aisle containment system.][Provide a manufacturer's installation manual for each type of rack mounted fan.]

3.1.3 Operation and Maintenance Data

Submit Computer Room Air Conditioner Operation and Maintenance Data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.1.4 Connections to Existing Systems

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Provide materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Provide labor and tools for making actual connections to existing systems.

3.2 FIELD QUALITY CONTROL

Upon completion and before final acceptance of work, test each CRAC subsystem in service to demonstrate compliance with the contract requirements, including field testing specified below. Adjust controls and balance systems prior to final acceptance of completed systems. Test controls through every cycle of operation. Test safety controls to demonstrate performance of required function. Correct defects in work provided and repeat tests. Provide steam, fuel, water, electricity, instruments, connecting devices, and personnel for tests. Flush and clean piping before placing in operation. Clean equipment, piping, strainers, and ducts. Prior to commencement of field testing, remove all filters and provide new filters. Perform and document that proper Indoor Air Quality During Construction procedures have been followed; this includes providing documentation showing that after construction ends, and prior to occupancy, new filters were provided.

3.3 FIELD TESTING

Provide field test plan[s], field test schedule[s], field test[s] and field test report[s] on each of the CRAC[s]. Field test each CRAC for

Contracting Officer acceptance in accordance with the CRAC manufacturer's approved field test plan.

3.3.1 Manufacturer's Field Test Plans

Submit field test plans developed by the manufacturer for each CRAC; [submit the field test plans along with the factory test plans specified herein before][submit the field test plans at least 90 calendar days prior to planned date of the field test]. Field test plans developed by the installing Contractor, or the equipment sales agency furnishing the CRAC, will not be acceptable.

The Contracting Officer will review and approve the field test plan for each of the listed CRACs prior to commencement of field testing of the equipment. The approved field test plans must be followed for the field tests of the CRAC and test reporting.

3.3.1.1 Coordinated Testing

Indicate in each field test plan when work required by this section requires coordination with test work required by other specification sections. Provide test procedures for the simultaneous or integrated testing of: CRAC controls which interlock and interface with controls factory prewired[; and external controls for the CRAC provided under [Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC]].

3.3.1.2 Prerequisite Testing

Each CRAC for which performance testing is dependent upon the completion of the work covered by Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC must have that work completed as a prerequisite to testing work under this section. Indicate in each field test plan when such prerequisite work is required.

3.3.1.3 Test Procedure

Indicate in each field test plan the CRAC manufacturer's published start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

Procedures must be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

Controllers must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

3.3.1.4 Performance Variables

Each test plan must list performance variables that are required to be measured or tested as part of the field test.

Include, in the listed performance variables, requirements indicated on the CRAC schedules on the design drawings. Manufacturer must provide, with each test procedure, a description of acceptable results that have been verified.

Manufacturer must identify the acceptable limits or tolerances within which each tested performance variable must acceptably operate.

3.3.1.5 Test Configuration

Plans must indicate that tests are to be performed for a minimum of four continuous hours[in a wet coil condition]. If test period is interrupted, the four hour test period must be started over. Each test plan must be job specific and must address the particular CRAC[s] and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.[Tests must include [a pressurized raised floor discharge configuration at the specified or indicated height above the floor,][with or without the air discharge elbows;][or a top air discharge configuration][and corrosion protection.]]

3.3.1.6 Tested Variables

Plans must provide for air side testing which includes verification of the airflow, total static pressure; fan drive motor KW, amperage and RPM; and fan RPM. Provide entering air temperatures equal to those indicated on the CRAC schedules.

3.3.1.7 Thermal Testing

Plans must provide thermal testing utilizing [chilled water][40 percent ethylene glycol and 60 percent water solution][and][hot water] with temperatures equal to those indicated on the CRAC schedules. Thermal testing must verify CRAC heating, sensible cooling, total cooling, and humidifying performance scheduled on the contract drawings.

3.3.1.8 Specialized Components

Include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3.3.1.9 Field Test Reporting Forms

Each test plan must include the required test reporting forms to be completed by the Contractor's testing representatives.

3.3.2 Field Test Schedule

Notify the Contracting Officer in writing at least 30 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for the review and approval of the Contracting Officer.

3.3.3 Manufacturer's Test Representative

Provide a factory trained field test representative authorized by the CRAC manufacturer to oversee the complete execution of the field testing. This test representative must also review, approve, and sign the completed field test report. Signatures must be accompanied by the person's name typed.

Submit credentials of the manufacturer's field test representative proposed, including current telephone number, to the Contracting Officer for review and approval. Submit these credentials with the written advance notice of the field tests.

3.3.4 Field Tests

Conduct the field testing in compliance with the Contracting Officer approved manufacturer's field test plan, and in accordance with additional field testing requirements specified herein. Record the required data using the test reporting forms approved of the approved field test plan. Conduct the test for each CRAC for a continuous 24-hour test period. A CRAC shutdown before the continuous 24-hour test period is completed must result in the 24-hour test period being started again and run for the required duration.

3.3.5 Deficiency Resolution

The test requirements must be acceptably met; deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations. Corrections must be tested again in compliance with the requirements specified in the paragraph MANUFACTURER'S FIELD TEST PLANS.

3.3.6 Field Test Reports

Use the test reporting forms approved in the field test plan. Final test report forms must be typed, including data entries and remarks. Completed test report forms for each CRAC must be reviewed, approved, and signed by the Contractor's test director and the QC manager.

3.4 INSTRUCTION TO GOVERNMENT PERSONNEL

Provide the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. Provide [4][_____] hours of training for each type of CRAC specified.[Provide [2][_____] hours of training for each [aisle containment system][and][rack mounted fan] specified.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 81 29 (February 2020)**

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Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 81 29

VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

02/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-23 81 29 (February 2020)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 23 81 29

VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

02/20

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NOTE: This guide specification covers the requirements for variable refrigerant flow (VRF) type air conditioning and heat pumps systems and accessories.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This specification uses tailoring options to select the required protocol for control system interfaces for equipment. These tailoring options are:

1. **BACnet Only**
2. **LonWorks Only**

You have currently SELECTED the following options:

BACnet Only

LonWorks Only

If more than one item appears between the dashes above you have included more than one services tailoring option and need to DESELECT tailoring

options.
****

****
NOTE: This Section MUST be used in conjunction with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC (as well as Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC and either Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS). Be sure to include the appropriate Sections and to select matching protocol tailoring options in each of them.

VRF systems may not be able to meet the open protocol requirements of Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. UFC 3-410-02 includes a process by which specific systems can be excepted from some of the open protocol requirement and permitted to implement proprietary communication. Refer to UFC 3-410-02 for the requirements to permit these exceptions.
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****
NOTE: You have currently SELECTED Energy Star in the tailoring options.
****

PART 1 GENERAL

1.1 SUMMARY

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NOTE: VRF systems are manufactured with limited dehumidification and outside air ventilation capability. Selected systems must support an overall design that meets UFC 3-410-01 HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS for dehumidification and ventilation requirements.
****

Provide a complete[Air Source][Water Source],[Cooling Only][Heat Pump][Simultaneous Heating an Cooling][Simultaneous Heating an Cooling with Heat Recovery] type Variable Refrigerant Flow (VRF) System consisting of one or more outdoor compressor units and multiple indoor fan coil units as specified in this Section and in accordance with the following:

a. Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC applies to the VRF system, and all work under this Section must be in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC including but not limited to the open system, protocol, installation, submittal, testing and training requirements of that Section. Unless the specific VRF system being installed is specifically excepted from the open protocol requirements by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, the use of non-CEA-709.1-D Non-ASHRAE 135 networks are prohibited.

b. The VRF control system must be in accordance with Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

c. The complete system must be a tested combination in accordance with AHRI 1230.

****

NOTE: When specifying a VRF system, coordinate cooling only or heating/cooling selection with VRF system selection.

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d. Provide[cooling only][heating /cooling][two stage heating/cooling] control for each zone.[Second stage heating will activate supplemental heating.]

e. For systems which simultaneously heat and cool, the outdoor units must be interconnected to the indoor units through branch selector boxes in accordance with the manufacturer's engineering data detailing each indoor unit. The indoor units and outdoor must be connected to the branch selector boxes utilizing the manufacturer's specified piping joints and headers.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 1230	(2010; Addendum 1 2011; Addendum 2 2014) Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment

ANSI/AHRI 270	(2008) Sound Rating of Outdoor Unitary Equipment
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers
ANSI/AHRI 760	(2014) Performance Rating of Solenoid Valves for Use With Volatile Refrigerants

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2022) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 135	(2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B117	(2019) Standard Practice for Operating

	Salt Spray (Fog) Apparatus
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5541	(2006; Rev F; Notice 2 2024) Chemical Conversion Coatings on Aluminum and Aluminum Alloys

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UL SOLUTIONS (UL)

UL 207	(2022) UL Standard for Safety Refrigerant-Containing Components and Accessories, Nonelectrical

UL 429	(2013; Reprint Mar 2021) Electrically Operated Valves
UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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NOTE: The following submittals are required in addition to submittals specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Submittals specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC are required for the VRF system.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification Of Installer; G, [_____]

Verification Of Existing Conditions; G, [_____]

SD-02 Shop Drawings

VRF System Contractor Design Drawings; G, [_____]

SD-03 Product Data

Spare Parts Data; G, [_____]

Coil Corrosion Protection; G, [_____]

Manufacturer's Standard Catalog Data; G, [_____]

Sample Warranty; G, [_____]

Refrigerant SDS Sheets; G, [_____]

SD-05 Design Data

Manufacturer's Engineering Data; G, [_____]

SD-06 Test Reports

System Performance Tests; G, [_____]

SD-07 Certificates

Service Organizations; G, [_____]

Warranty; G, [_____]

Electronic Refrigerant Leak Detector Calibration; G, [_____]

Ozone Depleting Substances Technician Certification; G, [_____]

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G, [_____]

SD-09 Manufacturer's Field Reports

Refrigerant Charging; G, [_____]

SD-11 Closeout Submittals

Posted Instructions; G, [_____]

Inventory; G, [_____]

1.4 QUALITY ASSURANCE

Complete VRF systems must be purchased from a single supplier. The VRF system supplier must be responsible for providing a fully functional VRF system.

1.4.1 VRF System Contractor Design Drawings

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NOTE: The refrigerant piping system plans are required to be apart of the approval package by the manufacturer for complete system installations. Modify Section 23 23 00 REFRIGERANT PIPING to indicate that the piping systems plans for the VRF will be packaged with the VRF System Contractor Design Drawings in a single transmittal.

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NOTE: Select a minimum of five weeks for the shop drawings submittal.

****

Submit VRF System Contractor Design Drawings drawings [5][_____] weeks prior to purchasing the VRF components in a single transmittal. Equipment layouts must be drawn to scale. Shop drawings must be approved by the VRF manufacturers representative. Include approval with name and contact information of VRF manufacturer's representative in the submittal. Place separation sheets before each of the following items covering each item with title and number.

a. Equipment layouts which identify assembly and installation details. Identify scheduled items with indicating marks. Include manufacturer's selection report for equipment, components and fittings.

b. Plans and elevations which identify dimensioned clearances required for maintenance and operation. Show access panels with dimensions.

c. Foundation drawings, bolt-setting information, and foundation bolts.

d. Details which include loadings and type of frames, brackets, stanchions, guides, anchors or other supports. Drawings must conform to Section 23 05 48.19 SEISMIC BRACING FOR HVAC.

e. Installation details which includes refrigerant type and charge weight for the system (not only the factory-supplied outdoor unit). Indicate factory setpoints for superheat/subcooling, target evaporating/condensing and corresponding refrigerant pressures/temperatures. Also include saturation reset schedule.

f. Refrigerant piping system plans as required by Section 23 23 00 REFRIGERANT PIPING. Piping layouts must be to scale and piping must have radial and linear dimensions identifying pipe type. Identify each refrigerant circuit and indicate refrigerant type and mass. Indicate piping expansion components and directions of thermal expansion. Piping layouts must be in accordance with ANSI/ASHRAE 15 & 34.

g. Schedules of equipment, valves, and manufacturer fittings. Mark each item with a common type identifier and unique number.

h. Calculations for refrigerant mass and pipe expansion.

i. Sequence of Operations of system and components.

j. Calculations demonstrating compliance with ANSI/ASHRAE 15 & 34.

1.5 QUALITY CONTROL

1.5.1 Qualifications

1.5.1.1 Qualification Of Installer

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NOTE: It is the responsibility of the Designer of Record to validate experience when reviewing Qualifications

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NOTE: Select a minimum of three copies of qualifications for submittal.

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Submit [3][_____] copies of qualifications prior to installation. The installers must be trained and qualified to install the same type of VRF system components to be installed under this contract by the same manufacturer. Include training certificates in submittal. The installer must have performed three complete installations of VRF systems of the same type and manufacturer that resulted in successful commissioning. Include project VRF installation and product information, location, customer contact information and VRF manufacturer representative contact information. The customer and VRF representative will be contacted to validate information given.

1.5.1.2 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

If all products do not contain any refrigerants identified in 40 CFR 82, submit all refrigerant SDS sheets and a general statement of exemption from 40 CFR 82 in alternate to the certifications. Statement of exemption must indicate all equipment containing refrigerants with respective refrigerant types.

1.5.2 Standard Products

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for 3 years immediately prior to the solicitation of this contract. The 3 year use includes applications of equipment and materials under similar circumstances and of similar size. The 3 years' experience must be satisfactorily completed by a product which has been sold on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products must be supported by a service organization. Ensure system components are environmentally suitable for the indicated geographic locations.

1.5.3 Manufacturer's Engineering Data

Submit VRF manufacturer's engineering data with the shop drawings under separate cover. Strike out irrelevant items and options not to be installed. Provide all input and output reports for all selection procedures required by the manufacturer and as required by this section. Engineering data must include:

a. Selection Procedures:
    (1) Indoor and Outdoor Units
    (2) Branch Selector Units
    (3) Piping Material and Fittings
    (4) Refrigerant Mass for system
    (5) Refrigerant Classification

b. System Efficiency Curves/Data including:
    (1) Efficiency correlated with OAT
    (2) At least five (5) data points covering full range of operation
    (3) Minimum and maximum values over the operational range
    (4) Efficiency at Standard AHRI conditions.

1.5.4 Manufacturer's Instructions

Submit VRF manufacturer's instructions with the shop drawings under separate cover. Strike out irrelevant items and options not to be installed. Provide with the following:

a. Installation: Include mechanical, electrical, controls and piping complete installation requirements.

b. Operation: Include startup, normal operation and shutdown procedures.

c. Maintenance: Include preventative.

1.6 PROJECT SEQUENCING

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NOTE: Include a project sequencing table here or include sequencing for this section in the table for Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

****

[Project sequencing must be in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

]

1.7 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Properly protect and care for all material both before and during installation. Submit an inventory of all the stored items. Replace any materials found to be damaged, at no additional cost to the Government. During installation, keep piping and similar openings capped to keep out dirt and other foreign matter.

1.8 WARRANTY

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NOTE: Manufacturer's provide up to a 10 year warranty for manufacturer components if the installation is in accordance with the manufacturer specific installation requirements. All installation requirements for each manufacturer are categorically similar but will require manufacturer specific methods in the selection, designing, installation and commissioning of the complete system. If installing a complete system, research the specific VRF type such as cooling only, heat pump or simultaneous heating/cooling and determine the maximum common warranty provided among at least three of the manufacturers for the specific system type. Select the maximum common warranty duration for the warranty duration.

****

Provide VRF manufactured equipment with the [Manufacturer's Standard Warranty.] [Manufacturer's Standard Warranty or [_____] year manufacturer's warranty, whichever is the longer duration] in addition to the Warranty of Construction. Submit Sample Warranty prior to construction. Compare warranty requirements with the requirements of this contract and identify discrepancies in the submittal that would prevent coverage of warranty by the manufacturer.

PART 2 PRODUCTS

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NOTE: Inapplicable equipment and system requirements will be deleted or modified in all paragraphs to suit the system designed. Coordinate the standard and design option features typical for each VRF type air conditioning/Heat Pump unit and individual installation. Care must be taken to avoid specifying design options which are generally unavailable in certain combinations or are inappropriate for the application.

Projects must comply with the safety standards defined in ANSI/ASHRAE 15 & 34. Designers will be responsible for thoroughly researching and implementing the ANSI/ASHRAE 15 & 34 safety requirements.

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All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 MATERIALS

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NOTE: Select a minimum of five weeks for the Manufacturer's standard catalog data

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Provide Manufacturer's standard catalog data, at least [5 weeks] [_____] prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, in adequate detail to demonstrate compliance with contract requirements. If field installed vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Submit data for each specified component. Minimum efficiency requirements must be in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

2.1.1 Performance Requirements

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NOTE: Do not use the following Energy Efficiency paragraph and subparagraphs for Air Force Projects.

****

2.1.1.1 Energy Efficiency

Provide equipment meeting the efficiency requirements as stated within this section and provide documentation in conformance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph ENERGY EFFICIENT PRODUCTS.

****

NOTE: ENERGY STAR tailoring option is in this subpart. Research available ENERGY STAR products and if three or more different manufacturers of the same type VRF specified in this SECTION are listed then select ENERGY STAR.

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NOTE: 10 CFR 436.42 specifies that ENERGY STAR qualified and FEMP designated products may be assumed to be life-cycle cost effective. Equipment having a lower efficiency may be specified if the designer determines the lower efficiency equipment to be more life-cycle cost effective. In making such a determination, the designer should rely on the life-cycle cost analysis method in 10 CFR 436, Subpart A.

****

Provide energy efficiency curve and data of EFFICIENCY vs. OAT. Provide at least five data points over the full range of operation capturing the minimums and maximums.

2.1.1.1.1 Variable Refrigerant Flow Multi-Split Air Conditioners

Information on Energy Star requirements can be found at https://www.energystar.gov/products/heating_cooling/light_commercial_heating_cooling/light_commercial_hvac_key_product_criteria

2.1.1.1.2 Variable Refrigerant Flow Multi-Split Heat Pumps

Information on Energy Star requirements can be found at https://www.energystar.gov/products/heating_cooling/light_commercial_heating_cooling/light_commercial_hvac_key_product_criteria

2.1.1.2 Electrical Equipment / Motors

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Electrical characteristics must be as shown, and unless otherwise indicated and field wiring must be in accordance with manufacturer's instructions. All motor(s):

a. 746 W 1 horsepower and above must be the premium efficiency type in accordance with NEMA MG 1.

b. Conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating.

c. Continuous duty with the enclosure specified.

d. Starters must be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated.

e. Furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer.

f. Duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop.

g. Must be sized for all applicable loads.

h. Bearings with grease supply fittings must have grease relief to outside of enclosure.

i. [Manual][Automatic] control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided.

2.1.1.3 Refrigerant

****

NOTE: EPA, per the Significant New Alternative Policy rule, reviews refrigerant substitutes on the basis of ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Lists of acceptable and unacceptable substitutes are updated several times each year. A chronological list of SNAP updates is available at http://www.epa.gov/ozone/snap/refrigerants/lists/index.html **or from the stratospheric ozone information hotline at 1 (800) 296-1996. Reducing ozone depletion and global warming potential by reducing or eliminating CFC, and reducing or eliminating HCFC and Halon use in air conditioning equipment is required.**

****

Refrigerants must have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0, with the exception of R-123. Provide Refrigerant SDS sheets for all refrigerants.

2.1.2 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices.

2.2 CONTROLS

The control system, components and network must be in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.2.1 Zone Control

Provide a Space Sensor Module, in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, for each fan coil unit unless otherwise indicated in contract drawings and with the following additional requirements:

a. Displays the current temperature, temperature setpoint, fans status, occupancy status and conditioning mode at the same time. If information is displayed electronically then it must be illuminated.

b. Temperature setpoint adjustment in one degree increments.

****

NOTE: Keep bracketed text for override button if override is required. Specify the maximum amount of time for override accumulation.

****

c. Fans speed control (At least: High-low-Auto).

[d. Occupancy override button which changes the mode of the zone to occupied for one hour per press of occupancy override button with [3][_____] hours maximum at any instance.

]

2.3 INDOOR FAN COIL UNITS

Provide with the following:

a. Factory complete, tested and pre-wired with all necessary electronic and refrigerant controls.

b. Equipped with auto-restart function and test run capability either via a switch or controller.

c. Refrigerant: Refrigerant circuits factory-charged with dehydrated inert gas.

d. Coils: Direct expansion type constructed from copper, aluminum, or copper and aluminum.

****

NOTE: If ECM are required, select ECM, otherwise select "or multi-speed."

****

e. Fans: Direct-drive, with statically and dynamically balanced impellers; variable speed [ECM][or multi-speed supporting at least high and low speeds] unless otherwise indicated; motor thermally protected.

f. Return Air Filter: Washable long-life net filter with mildew proof resin, or replaceable, unless otherwise indicated.

g. Condensate Drainage: Built-in condensate drain pan with drain connection.

h. Dedicated electronic modulating refrigerant expansion and flow control.

i. Unit must be in accordance with UL 1995 and AHRI 1230.

j. For units with Built-In Condensate Pumps, provide condensate safety shutoff and alarm. For units without Built-In Condensate Pump, provide built in or field supplied overflow protection.

2.3.1 Concealed-In-Ceiling Units

Provide with the following:

a. Ducted horizontal discharge and return; galvanized steel cabinet in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

b. Field adjustable external static pressure switch for high efficiency filter operation.

c. Switch box accessible from side or bottom.

2.3.2 Recessed Ceiling Units

Provide with the following:

a. Four-way airflow cassette with central return air grille, for installation in a fixed ceiling, unless otherwise indicated.

****

NOTE: Coordinate with the end user for color selection.

****

b. Exposed Housing: [White][_____], impact resistant, with washable decoration panel.

c. Supply Airflow Adjustment:

    (1) Via [motorized][manual] louvers which can be horizontally and vertically adjusted from 0 to 90 degrees.

    (2) Field-modifiable to 3-way and 2-way airflow.

2.3.3 Wall Surface-Mounted Units

Provide with the following:

****

NOTE: Coordinate with the end user for color selection.

****

a. Finished [white][_____] casing, with removable front grille; sound insulation; wall mounting plate; condensate drain pan.

b. Airflow Control: Auto-swing louver that closes automatically when unit stops; adjustable discharge angle, set using remote controller; upon restart, discharge angle defaulting to same angle as previous operation.

c. Fan: Direct-drive cross-flow type.

d. Condensate Drain Connection: Side (end), not concealed in wall.

2.4 OUTDOOR COMPRESSOR UNIT

Provide with the following:

a. The outdoor unit must have one or more variable capacity compressors or alternative method resulting in three or more steps of capacity needed to load match the indoor unit fan coils at all times.

b. The unit must be factory complete, tested and pre-wired with all necessary electronic and refrigerant controls.

****

NOTE: Select 58 dB(A) at 1 meter 3 feet unless otherwise approved by the Contracting Officer.

****

c. The sound pressure dB(A) at rated conditions must be a value of [58][_____] decibels at 1 meter 3 feet from the front of the unit when rated in accordance with ANSI/AHRI 270.

d. The unit must automatically restart normal operation after a power failure of any duration without reprogramming or manual assistance.

e. Oil recovery cycle must be automatic occurring a minimum of 2 hours after start of operation and then at least every 8 hours of operation.

f. Each outdoor unit must have it's own dedicated power feed, each with disconnect and main power circuit breaker.

g. The unit must be in compliance with ANSI/ASHRAE 15 & 34, factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant charging valves. Filter-drier must be provided in liquid line.

h. The outdoor units capacity must meet or exceed the scheduled value in the contract drawings. The ratio of the outdoor unit capacity to the total connected indoor capacity must be in accordance with the manufacturer's recommendations for selecting the outdoor unit.

i. Unit must be in accordance with UL 1995 and AHRI 1230.

2.4.1 Air-Cooled

****

NOTE: Input final outside air temperatures used in approved final load calculations.

****

a. The unit must must have full design cooling capacity at [_____] degrees C [_____] degrees F dry bulb ambient.

b. For units other than cooling only, the unit must have full design heating capacity at [_____] degrees C [_____] degrees F dry bulb ambient.

2.4.2 Water-Cooled

a. Provide condenser water piping and accessories in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

b. Units must have full capacity at heating and cooling water temperature ranges as identified in the contract drawings.

2.4.3 Casing

Construct the unit of zinc coated, heavy-gage (14-gage minimum) galvanized steel. Provide cabinet panels with lifting handles and water- and air-tight seal. Insulate all exposed vertical panels, top covers and base pan.

2.4.4 Compressor

Each compressor system must have the following:

a. High pressure safety switch, and internal thermal overload protection.

b. Factory installed vibration dampeners on all mounting points.

c. Factory installed crank case heater or other control logic to ensure reliable operation in freezing environments.

d. Oil separator with an oil balance circuit.

2.5 COMPONENTS

2.5.1 Fans

****

NOTE: AIR FORCE tailoring option is in this subpart. Select AIR FORCE tailoring option for Air Force projects.

****

Fan wheel shafts must be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans must be selected to produce the flow rate required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a[n][open][dripproof][totally enclosed][

explosion proof] enclosure. Thermal overload protection must be of the manual or automatic-reset type. Fan wheels or propellers must be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings must be of galvanized steel, and both centrifugal and propeller fan casings must be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, must be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting must be recoated with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Forward curved fan wheels must be limited to [_____] mm inches. Direct-drive fan motors must be of the multiple-speed variety. Belt-driven fans must have adjustable sheaves to provide not less than [_____] percent fan-speed adjustment. The sheave size must be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans must be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans must be[direct-drive][V-belt] drive type with[adjustable][fixed] pitch blades. V-belt driven fans must be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings must be protected with water slingers or shields. V-belt drives must be fitted with guards where exposed to contact by personnel and[fixed pitch][adjustable pitch] sheaves. Axial fans may not be used to distribute air through duct systems.

2.5.2 Supplemental Electric Heating Coil

Coil must be an electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be duct- or unit-mounted. Coil must be of the[nickel chromium resistor, single stage, strip][nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type. Coil must be provided with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Coil casing and support brackets must be of galvanized steel or aluminum. Coil must be mounted to eliminate noise from expansion and contraction and be completely accessible for service. Supplemental Electric Resistance Heating controls must be provided to prevent operation when the heating load can be met by the primary source alone during both steady-state operation and setback recovery. Supplemental heater operation is permitted during outdoor coil defrost cycles.

2.5.3 Air Filters

Air filters must be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency must be as listed under the label service and must meet the requirements of UL 586.

2.5.4 Coil Frost Protection (Defrost Mode)

Provide each circuit with a manufacturer's standard coil frost protection (Defrost Mode) system.

2.5.5 Pressure Vessels

Pressure vessels must conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered.

Where referenced publications do not apply, test pressure components at 1-1/2 times design working pressure.

2.5.5.1 Liquid Receiver

Receiver must be rated in accordance with the recommendations of ANSI/AHRI 495.

2.5.5.2 Suction Accumulator

Accumulators must comply with UL 207. Accumulators over 15 cm 6 inch in diameter must comply with ASME BPVC SEC VIII.

2.5.5.2.1 Vertical Type

Provide heat exchanger or heating element around the U-tube in freezing environments.

2.5.5.2.2 Horizontal Type

Provide only in non-freezing environments.

2.5.5.3 Oil Separator

Separator must be the high efficiency type and be provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Connections to compressor must be as recommended by the compressor manufacturer. Separator must be provided with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass and strainer. Provide an oil separator for each refrigerant circuit.

2.5.5.4 Oil Reservoir

Reservoir capacity must equal one charge of all connected compressors. Reservoir must be provided with an external liquid gauge glass, plugged drain, and isolation valves. Vent piping between the reservoir and the suction header must be provided with a 35 kPa 5 psi pressure differential relief valve. Reservoir must be provided with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.5.6 Internal Dampers

Dampers must be parallel blade type with renewable blade seals and be integral to the unitary unit. Damper provisions must be provided for each outside air intake, exhaust, economizer, and mixing boxes. Dampers must[have minimum position stops][be linked together][have[manual][automatic] modulation] and operate as specified.

2.5.7 Mixing Boxes

Mixing boxes must match the base unit in physical size and must include equally-sized[flanged] openings, each capable of full air flow. Arrangement must be as indicated.

2.5.8 Refrigerant Piping

Provide refrigerant piping external to equipment in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.5.9 Condensate Drain Piping

Provide condensate drain piping in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.5.10 Ductwork

Provide interface to ductwork in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5.11 Refrigerant Solenoid Valves

Solenoid valves must comply with ANSI/AHRI 760 and UL 429, be suitable for continuous duty rated voltage at maximum and minimum encountered pressure and temperature service conditions. Solenoid valves must be direct-acting or pilot-operating type, packless, seal capped. Manual lifting provisions must be furnished. Solenoid coils must comply with NEMA 250 type 4. Valves must have safe working pressure of 125 percent of maximum working pressure and a maximum operating pressure differential of at least half of the valve maximum working pressure at 85 percent rated voltage. Valves must have an operating pressure differential suitable for the fluid phase and refrigerant used.

2.5.12 Branch Selector Unit

Branch Selector port control must be provided for each connected indoor unit to enable individual heating and cooling selection year round unless otherwise indicated in the contract drawings. The cabinet must be galvanized steel. The branch selector units must be factory assembled, wired, piped and run tested.

2.6 EQUIPMENT ACCESSORIES AND MISCELLANEOUS EQUIPMENT

2.6.1 Refrigerant Leak Detector

****

NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ANSI/ASHRAE 15 & 34.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 458 mm 18 inches above the finished floor since all commonly-used refrigerants are heavier than air.

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point shouldn't exceed 15 m 50 feet. In order to meet the recommended 15 m 50 feet distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

As required by ANSI/ASHRAE 15 & 34, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a minimum indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room.

Include the electrical design for the alarm system on the drawings.

As an additional item, ANSI/ASHRAE 15 & 34 states that open-flame devices (i.e., boilers, etc.) cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to the device; or the alarm relay from the detector is used to automatically shutdown the combustion process in the event of refrigerant leakage. Indicate all applicable alarm controls on the drawings.

Delete the information in the last bracketed sentences if an EMCS is not applicable to the design.

****

Provide continuously-operating, halogen-specific type refrigerant leak detector. Detector must be appropriate for the refrigerant in use. Detector must be specifically designed for area monitoring and must include[a single sampling point][[_____] sampling points] installed where indicated. Detector design and construction must be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector must be supplied factory-calibrated for the appropriate refrigerant(s). Detector must be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant in use. The detector's relay must be capable of initiating corresponding alarms and ventilation system as indicated on the drawings. Detector must be provided with a failure relay output that energizes when the monitor detects a fault in its operation.[Detector must be compatible with the facility's energy or utility management and control system (EMCS/UMCS). The EMCS/UMCS must be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.6.2 Refrigerant Relief Valve/Rupture Disc Assembly

****

NOTE: ANSI/ASHRAE 15 & 34 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire

or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly as well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be in accordance with ANSI/ASHRAE 15 & 34.

****

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly must be in accordance with ASME BPVC SEC VIII D1 and ANSI/ASHRAE 15 & 34. The assembly must be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc must be the non-fragmenting type.

2.6.3 Refrigerant Signs

Refrigerant signs must be a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 13 mm 0.5 inches in height.

2.6.3.1 Installation Identification

Provide each new refrigeration system with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.6.3.2 Controls and Piping Identification

Provide refrigerant systems containing more than 50 kg 110 lb of refrigerant with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow[, the ventilation system,] and the refrigerant compressor.

b. Pressure limiting device(s).

2.6.4 Gaskets

Provide gaskets conforming to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 370 degrees C 700 degrees F service.

2.6.5 Bolts and Nuts

Bolts and nuts must be in accordance with ASTM A307. The bolt head must be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

2.7 FINISHES

2.7.1 Coil Corrosion Protection

****

NOTE: Research local conditions to determine the corrosiveness of the environment. Where condenser or evaporator coils are to be installed in highly corrosive atmospheres, carefully consider the coil and fin combinations specified. Standard coil construction is typically copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered.

For maximum coil protection, include the requirements of this paragraph. This paragraph addresses phenolic, vinyl, and epoxy type coatings. For coils with relatively close fin spacing the phenolic or epoxy coating are the preferred types as these have less tendency to bridge across the fins than vinyl. In addition, the phenolic and epoxy type coatings can typically provide better thermal conductivity than vinyl.

If coatings are specified, note that a coil's heat transfer capacity can be reduced anywhere between 1 to 5 percent; total unit capacity may have to be increased as a result, see manufacturer's guidance.

****

Provide coil with a uniformly applied[epoxy electrodeposition][phenolic][vinyl][epoxy electrodeposition, phenolic, or vinyl] type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum 1,000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.7.2 Equipment and Components Factory Coating

****

NOTE: For equipment to be installed outdoors, adequate protection will be specified. Manufacturers must submit evidence that unit specimen have passed the specified salt spray fog test. A 100 hour test will be specified in a noncorrosive environment and a 500 hour test will be specified in a corrosive environment.

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Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand [100] [500] hours exposure to the salt spray test specified in ASTM B117. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where stipulated in equipment specifications of this section, coat finned tube coils of the affected equipment as specified below. Apply coating at the premises of a company specializing in such work. Degrease and prepare for coating in accordance with the coating applicator's procedures for the type of metals involved. Completed coating must show no evidence of softening, blistering, cracking, crazing, flaking, loss of adhesion, or "bridging" between the fins.

2.7.2.1 Phenolic Coating

Provide a resin base thermosetting phenolic coating. Apply coating by immersion dipping of the entire coil. Provide a minimum of two coats. Bake or heat dry coils following immersions. After final immersion and prior to final baking, spray entire coil with particular emphasis given to building up coating on sheared edges. Total dry film thickness must be 0.064 to 0.076 mm 2.5 to 3.0 mils.

2.7.2.2 Chemical Conversion Coating with Polyelastomer Finish Coat

Dip coils in a chemical conversion solution to molecularly deposit a corrosion resistant coating by electrolysis action. Chemical conversion coatings must conform to MIL-DTL-5541, Class 1A. Cure conversion coating at a temperature of 43 to 60 degrees C 110 to 140 degrees F for a minimum of 3 hours. Coat coil surfaces with a complex polymer primer with a dry film thickness of 0.025 mm 1 mil. Cure primer coat for a minimum of 1 hour. Using dip tank method, provide three coats of a complex polyelastomer finish coat. After each of the first two finish coats, cure the coils for 1 hour. Following the third coat, spray a fog coat of an inert sealer on the coil surfaces. Total dry film thickness must be 0.064 to 0.076 mm 2.5 to 3.0 mils. Cure finish coat for a minimum of 3 hours. Coating materials must have 300 percent flexibility, operate in temperatures of minus 46 to plus 104 degrees C 50 to plus 220 degrees F, and protect against atmospheres of a pH range of 1 to 14.

2.7.2.3 Vinyl Coating

Apply coating using an airless fog nozzle. For each coat, make at least two passes with the nozzle. Materials to be applied are as follows:

a. Total dry film thickness, 0.165 mm 6.5 mils maximum

b. Vinyl Primer, 24 percent solids by volume: One coat 0.051 mm 2 mils thick

c. Vinyl Copolymer, 30 percent solids by volume: One coat 0.114 mm 4.5 mils thick

2.7.3 Factory Applied Insulation

Refrigeration equipment must be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor in accordance with manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.8 TESTS, INSPECTIONS, AND VERIFICATIONS

All manufactured units must be inspected and tested, and documentation provided to demonstrate that each unit is in compliance with applicable ANSI/AHRI and UL requirements and that the minimum efficiency requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP have been met.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, submit verification of existing conditions at least 2 weeks prior to beginning construction, indicating the date the site was visited, confirming existing conditions, and noting any discrepancies found.

3.2 INSTALLATION

The VRF system must be installed by the contractor identified in Qualification Of Installer. The contractor must install the VRF system in accordance with the manufacturer's instructions and Shop Drawings.

3.2.1 Equipment General

Provide necessary supports for all equipment, appurtenances, and pipe as required. Isolate outdoor units from the building structure. If mechanical vibration isolators are not provided, provide vibration absorbing foundations. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the equipment weight. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions. Air-source outdoor units must be installed per manufacturer's recommendations and must not blow air in the direction of other outdoor unit intakes.

3.2.2 Safety Devices

Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

3.2.3 Controls

Install Controls in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, as indicated by the Points Schedule and to provide the following functionality:

a. On/Off selection for each individual fan coil unit and group.

b. Temperature set point adjustment for each fan coil unit.

c. Fan speed adjustment for each fan coil.

d. Heat/cool/automatic changeover mode selection for indoor and outdoor units.

e. Priority settings for restriction of local access for start/stop, heat/cool mode and set point adjustment.

f. Temperature limitation in both heating and cooling mode.

g. Weekly occupancy schedule with start up and shut off times, temperature settings and operation modes. Yearly occupancy schedule for holidays and periods of non-use.

h. Reset for non-blocking malfunction codes and maintenance warnings.

Provide a Local Display panel as indicated on the points schedule and to provide access to the above specified functionality. The Local Display Panel must additionally indicate current date and time.

3.2.4 Isolation Valves

****

NOTE: Isolation valve seals can be a possible source of leakage over time. Provide isolation valves only if required by the end user.

****

Provide Isolation Valves in accordance with Section 23 23 00 REFRIGERANT PIPING. Provide with service ports on downstream side.

3.2.5 Electrical Equipment / Motors

Install electrical equipment, motors, motor efficiencies, and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2.6 Branch Selector Unit

Locate Branch Selector Units inside of the facility with full access for inspection, maintenance and removal. Locate no more then 2 meters 6 feet above finished floor. The unit must have a minimum clearance of 30 centimeters 12 inches from all serviceable sides and be removable without modification to the surroundings.

3.2.7 Condensate Removal

Provide condensate removal through gravity flow where possible. Where gravity flow is not possible, provide a condensate pump sufficient ensure complete removal of condensate.

3.2.8 Access Panels

Provide access panels for all concealed equipment, valves, controls, dampers, refrigerant fittings, and other fittings for inspection, maintenance and removal. Size panel large enough as to be able to remove the part without modification or damage to the surroundings.

3.2.9 Air Filters

Allow access space for servicing filters. Install filters with suitable sealing to prevent bypassing of air. Perform and document that proper indoor air quality during construction procedures have been followed in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING, paragraph Indoor Air Quality During Construction; this includes providing documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed.

3.2.10 Flashing and Pitch Pockets

Provide flashing and pitch pockets for equipment supports and roof penetrations and flashing where piping or ductwork passes through exterior walls in accordance with Section 07 60 00 FLASHING AND SHEET METAL.

3.2.11 Identification Tags and Plates

Provide equipment, gages, thermometers, valves, and controllers with tags numbers stamped or engraved into the material for their use. Provide plates and tags of brass or suitable nonferrous rigid material, securely mounted or attached. Provide minimum letter and numeral size of 3.18 mm 1/8 inch high.

3.2.12 Refrigerant Signs

Locate refrigerant signs with in reading distance of outdoor unit.

3.2.13 Field Applied Insulation

Apply field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2.14 Piping

3.2.14.1 Pipe Hangers and Supports

Design and fabrication of pipe hangers, supports, and welding attachments must conform to MSS SP-58. Installation of hanger types and supports for bare and covered pipes must conform to MSS SP-58 for the system temperature range. Unless otherwise indicated, horizontal and vertical piping attachments must conform to MSS SP-58.

3.2.14.2 Refrigerant Piping

Cut pipe to measurements established at the site and work into place without springing or forcing. Install piping with sufficient flexibility to provide for expansion and contraction due to temperature fluctuation and as indicated in shop drawings. Where pipe passes through building structure pipe joints must not be concealed, but must be located where they may be readily inspected. Install piping to be insulated with sufficient clearance to permit application of insulation. Install piping as indicated and detailed, to avoid interference with other piping, conduit, or equipment. Except where specifically indicated otherwise, run piping plumb and straight and parallel to walls and ceilings. Provide sleeves of suitable size for lines passing through building structure. Braze refrigerant piping with silver solder complying with AWS A5.8/A5.8M. Inside of tubing and fittings must be free of flux. Clean parts to be jointed with emery cloth and keep hot until solder has penetrated full depth of fitting and extra flux has been expelled. Cool joints in air and remove flame marks and traces of flux. During brazing operation, prevent oxide film from forming on inside of tubing by slowly flowing dry nitrogen through tubing to expel air. Make provisions to automatically return oil on halocarbon systems. Installation of piping must comply with ASME B31.5. All refrigerant lines external to units must have field applied insulation per Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS unless otherwise indicated.

All refrigerant lines external to units must be isolated from system vibrations including those generated by compressors, fans, or pumps, to minimize the risk of refrigerant leaks.

3.2.14.3 Condenser Water Piping

Install condenser water piping and accessories in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

3.2.14.4 Solenoid Valve Installation

Install liquid solenoid valves in horizontal lines with stem vertical and with flow in direction indicated on valve. If not incorporated as integral part of the valve, provide a strainer upstream of the solenoid valve. Provide service valves upstream of the solenoid valve, upstream of the strainer, and downstream of the solenoid valve. Remove the internal parts of the solenoid valve when brazing the valve.

3.2.15 Auxiliary Drain Pans, Drain Connections, And Drain Lines

Provide auxiliary drain pans under units located above finished ceilings or over mechanical or electrical equipment. Pan must extend beyond the limits of the units. Provide separate drain lines for the unit drain and auxiliary drain pans. Trap drain pans from the bottom to ensure complete pan drainage. Provide drain lines full size of drain opening. Traps and piping to drainage disposal points must conform to Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.3 REFRIGERANT PIPING TESTS

Perform refrigerant piping tests as specified in Section 23 23 00 REFRIGERANT PIPING and per manufacturer's recommendations in the presence of the contracting officer. Use electronic type leak detector with a sensitivity of 3 grams/year 0.1 ounces/year and a calibrated reference leak rated at 5 grams/year 0.17 ounces/year. Submit current electronic refrigerant leak detector calibration certificate prior to testing. Before testing the refrigerant piping system, perform a test of the leak detector with the reference leak fitting in the presence of the Contracting Officer.

3.4 REFRIGERANT CHARGING

After refrigerant piping test and before system performance test, perform evacuation and dehydration procedures in accordance with manufacturers recommendations and requirements and Section 23 23 00 REFRIGERANT PIPING. Evacuate system to a minimum of 100 microns 0.004 inches Hg for one hour or per manufacturers requirements. Use fresh oil in the vacuum pump. Connect electronic vacuum gauge to system piping for measurement. The refrigerant must be to the weight specified in the shop drawing calculations. The supplemental refrigerant must be weighed in with an electronic scale. Supplemental refrigerant must be introduced to the system in a liquid state for refrigerant blends. Conduct refrigerant charging in the presence of the Contracting Officer. Submit refrigerant charging report before system performance test. Outline refrigerant charging procedures in the report. Report must indicated who performed and witnessed the task. Provide signatures from all parties.

3.5 SYSTEM PERFORMANCE TESTS

****

NOTE: Select at minimum the default value for the following bracketed items

****

Before each VRF system is accepted, conduct tests to demonstrate the general operating characteristics of the VRF as directed by COR/COTR. Submit [three] [_____] bound copies of the report as 216 by 279 mm 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Include manufacturer commissioning report for each VRF system.

For equipment providing heating and cooling the system performance tests must be performed during the heating and cooling seasons. For systems capable of simultaneous heating and cooling, perform testing of this mode.

a. Submit a schedule, at least [2] [_____] weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test. Tests must cover a period of not less than [48] [_____] hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications.

b. Make corrections and adjustments, as necessary, tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, install and tighten service valve seal caps and blanks over gauge points.

c. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest the system. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test.

****
NOTE: For the next item, choose either Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS or Section 01 91 00.15 BUILDING COMMISSIONING.
****

d. Coordinate field tests with [Section 01 91 00.15 BUILDING COMMISSIONING] [Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS]. Submit [3] [_____] copies of the report provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart):

(1) Date and outside weather conditions.

(2) The load on the system based on the following:

(a) The refrigerant used in the system.
(b) Condensing temperature and pressure.
(c) Suction temperature and pressure.
(d) Ambient, condensing and coolant temperatures.
(e) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Electronic expansion valve superheat - value as determined by field test.

(5) Subcooling.

(6) High and low refrigerant temperature switch set-points

(7) Low oil pressure switch set-point.

(8) Defrost system timer and thermostat set-points.

(9) Moisture content.

(10) Capacity control set-points.

(11) Field data and adjustments which affect unit performance and energy consumption.

(12) Field adjustments and settings which were not permanently marked as an integral part of a device.

3.6 CLEANING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided for all fans that are operated during construction, and new filters must be installed after all construction dirt has been removed from the building. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.7 CLOSEOUT ACTIVITIES

Provide closeout activities in addition to and in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS.

3.7.1 Extra Materials

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than [2] [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

3.7.2 Maintenance Service Providers

Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

3.7.3 Warranty

****

NOTE: Navy tailoring option is in this subpart. Select Navy tailoring option for Navy and Marine Corps projects.

****

Submit warranty certificate to the Contracting Officer. Provide warranty management plan in accordance with 01 78 00 CLOSEOUT SUBMITTALS.

3.7.4 VRF Operation And Maintenance Manual

****

NOTE: Modify Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC to include items from this Section by reference.

****

Provide the following in addition to and accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC:

a. Condensed operating instructions listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown.

b. Manufacturer's Engineering Data.

c. Manufacturer's Instructions.

d. Shop Drawings on 279 by 432 mm 11 by 17 inches sheets.

3.7.5 Posted Instructions

Submit the field posted instructions, at least [2] [_____] weeks prior to construction completion. Including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions on one sheet of paper. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

3.7.6 Training

****

NOTE: Modify Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC to include items from this section by reference.

****

Provide training, for all items provided under this section, in addition to and accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Also include refrigeration leak detection and leak detection response training. The training period must consist of a total [8] [_____] hours of normal working time for items covered in this section.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-23 81 47 (February 2025)**

Preparing Activity: NAVFAC **Superseding**
UFGS-23 81 47 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-23 81 47 (February 2025)**

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SECTION 23 81 47

WATER-LOOP AND GROUND-LOOP HEAT PUMP SYSTEMS
02/25

****

NOTE: This guide specification covers the requirements for water source heat pump systems and ground source closed-loop heat pump systems.

This specification is based on two contract approaches for providing these systems: separate design and contractor installed systems (Design-Bid-Build) and contractor design and installed systems (Design-Build or performance based contracting). The designer selects required preference for the contract approach. Contractor design and install is limited to ground source closed-loop heat pump systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTES:

1. There are two main types of ground source heat pump system: closed loop systems and open systems. Open systems use and dispose of ground water. There

are variations of closed loop systems based on the configuration of pipe orientations. This specification covers only closed-loop systems. This specification also covers water loop systems that are of the not ground-source type.

2. System design requirements must conform to UFC 3-410-01 "Heating, Ventilating, and Air Conditioning Systems", ASHRAE Ground-Source Heat Pumps Manual - ASHRAE Item 90376 (ISBN1-883413-52-4), ASHRAE 90.1 - SI ASHRAE 90.1 - IP including paragraph 6.5.2.2.3, and IGSHPA Design Manuals.

3. The designer must become familiar with the local and state regulations regarding geothermal wells and water wells. Design and specify the heat exchanger systems to meet the specific local and state regulations that may be required, such as:
a. Well driller licensing
b. Pump installer licensing
c. Well construction permit
d. State approved well permit
e. Allowable grout requirements
f. Allowable heat transfer fluids
g. Allowable pipe materials
h. Well construction log record
i. Authorization to Install and Operate
j. Antifreeze fluid
k. Water treatment chemicals
l. Corrosion inhibitors

****

****

NOTE: Show the following information on the project design drawings:

1. Design parameters for each item of equipment including capacity, efficiency, sound ratings, motor speeds, electrical characteristics, and special features.

2. Design heat pump systems for energy efficiency in compliance with FEMP/Energy Star requirements specified at www.eere.energy.gov/femp/procurement **and** www.energystar.gov/products**. In selection of equipment, consider life cycle cost. Select the most efficient equipment for which there are at least two products available for the designed capacity. Indicate the equipment operating requirements, including efficiency, on the drawings.**

3. The locations of access doors for valves.

4. Show configuration, slope and location of each piping system such as: above or below floors, above or below ceilings, above or below roofs, above or below ground.

5. Show a piping diagram with valves, flushing

station, fill station, flexible connections, hose kits, Pete's plugs, drains, and other required hydronic accessories. Show location, sizes, and type of each valve.

6. Show water flow rate, entering and leaving water temperatures, air flow rate, and entering and leaving air temperatures for both cooling and heating loads. Show a water-loop and/or ground-loop heat pump schedule. Show a well depth schedule.

7. Show a ground-loop heat pump well and piping plan. Show recommended minimum distance between wells. Show the well pattern arrangement. Show any existing utilities.

8. Scale ranges for pressure gages and thermometers.

9. Show control schemes. Show optional desuperheater for domestic water use where necessary.

10. Design working pressures and temperatures for each system.

11. Only drawings (not specifications) shall indicate capacity, efficiency, dimensions, details, plan views, sections, elevations and location of equipment; and space required for equipment maintenance.

12. Show specific geothermal well requirements as they relate to local and state regulations.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality
ASHRAE 188	(2021) Legionellosis: Risk Management for Building Water Systems
ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition
ASHRAE FUN SI	(2021) Fundamentals Handbook, SI Edition
ASHRAE Item 90376	(1997) Ground-Source Heat Pumps, Design of Geothermal Systems for Commercial and Institutional Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B31.9	(2020) Building Services Piping

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B265	(2020a) Standard Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate
ASTM B333	(2003; R 2018) Standard Specification for Nickel-Molybdenum Alloy Plate, Sheet, and Strip
ASTM B424	(2022) Standard Specification for Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and UNS N08221, and UNS N06845) Plate, Sheet, and Strip
ASTM D92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D1177	(2017) Standard Test Method for Freezing Point of Aqueous Engine Coolants
ASTM D2513	(2018a) Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings

ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2683	(2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D3035	(2022) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3892	(2015) Standard Practice for Packaging/Packing of Plastics
ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F714	(2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F1105	(2009; R 2014) Preparing Aircraft Cleaning Compounds, Liquid-Type, Temperature-Sensitive, or Solvent-Based, for Storage Stability Testing
ASTM F1290	(2019) Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings

INTERNATIONAL GROUND SOURCE HEAT PUMP ASSOCIATION (IGSHPA)

CSA/IGSHPA C448	(2016; R 2021) Design and Installation of Ground Source Heat Pump Systems for Commercial and Residential Buildings
IGSHPA 21015	(2000) Grouting for Vertical GHP Systems
IGSHPA 21020	(1988) Closed-Loop/Ground-Source Heat Pump System/Installation Guide
IGSHPA 21035	(2017) Design and Installation Standards
IGSHPA 21060	(1989) Soil and Rock Classification Field Manual

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 13256-1	(2021) Water-Source Heat Pumps - Testing and Rating for Performance - Part 1: Water-to-Air and Brine-to-Air Heat Pumps
ISO 13256-2	(2021) Water-Source Heat Pumps - Testing and Rating for Performance - Part 2: Water-to-Water and Brine-to-Water Heat Pumps

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 10009	(2022) Energy Management Guide for Selection and Use of Single-Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 704	(2022) Standard System for the Identification of the Hazards of Materials for Emergency Response

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 135	(1995; Annual Suppl 2010) Life Cycle Costing Manual for the Federal Energy Management Program

NSF INTERNATIONAL (NSF)

NSF/ANSI 600	(2023) Health Effects Evaluation and Criteria for Chemicals in Drinking Water

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
40 CFR 82	Protection of Stratospheric Ozone

UL SOLUTIONS (UL)

UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic

Materials for Parts in Devices and
Appliances

1.2 SYSTEM DESCRIPTION

****

NOTES:

1. Select fourth sentence for water-loop heat pump systems and fifth sentence for ground-loop heat pump systems.

2. For contractor design and installed systems (performance based contracting), select bracketed "Design and". Tailoring is added for design-build optional brackets. For projects that have separate design and contractor installed work, do not select "Design and" brackets. Select the appropriate brackets.

3. For water to air applications that have ductwork to distribute hot or cold air and to provide humidity control, use ARI/ISO 13256-1 as the standard for water source heat pumps.

4. For water to water applications such as in hydronic or circulating fluid systems, domestic water heating systems, and radiant heating systems, use ISO 13256-2 as the standard for water source heat pumps.

****

[Design and]Provide[new][and modify existing][ground-loop][water-loop] heat pump systems complete and ready for operation. Systems include heat pumps, system equipment, piping, pumps, electrical equipment, controls,[wells,] and[ground heat exchanger][condenser]. [Design and]Installation of[ground-loop][water-loop] heat pump systems including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.9, ASME B31.5, ASHRAE FUN SI ASHRAE FUN IP, IGSHPA 21015, IGSHPA 21020, IGSHPA 21035, CSA/IGSHPA C448, IGSHPA 21060, NFPA 70, ASHRAE Item 90376,[ISO 13256-2][ISO 13256-1] and[ISO 13256-2] as supplemented and modified by this section.[Provide water-loop heat pump condenser piping under Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.][Provide ground coupled condenser loop piping by the requirements of this section.]

[1.3 GROUND-LOOP HEAT PUMP SYSTEM DESIGN

****

NOTE: Insert the following paragraphs for design and install projects: GROUND-LOOP HEAT PUMP SYSTEM DESIGN, CALCULATIONS, DETAIL DRAWINGS, SOIL THERMAL CONDUCTIVITY TESTING, and SYSTEM DESIGNER. Tailoring is used for Design-Build optional brackets.

****

Design ground-loop heat pump systems in accordance with the required and advisory provisions of NFPA 70, ASHRAE Item 90376, IGSHPA 21020, IGSHPA 21035 and CSA/IGSHPA C448 except as modified herein. Provide calculations. Each system must include materials, accessories, and equipment inside and outside the building to provide each system complete and ready for use. Design and provide each system to give full consideration to optimum well spacing and location, piping, electrical equipment, pumps, ground heat exchanger, and other construction and equipment in accordance with detailed working drawings to be submitted for approval. Locate ground-loop wells in a consistent pattern that would give the proper spacing between wells and the optimum performance. Provide well and piping system layout drawings.

[1.3.1 Calculations

[1.3.1.1 Methodology

Submit all calculations as part of the design documentation. Provide all calculations used to determine the system design of the ground-loop heat pump system. Provide calculations for the HVAC loads and load profiles. Calculations must include computer aided design programs that include the effects of thermal interaction between adjacent boreholes. Include submission of the software name and version, and design parameters. Design parameters include soil conditions, ground water level, soil heat transfer coefficients and heat transfer coefficient for grout materials. Heat transfer and other calculations are to be prepared by the System Designer using computer software specifically intended for ground-loop heat pump systems. The design is to be based on calculations that will provide the most life cycle cost effective ground-loop heat pump system using an expected life of 25 years and must be sized based upon the loads shown on the drawings. Life cycle cost analysis must be performed as required by the NIST HB 135 using the current discount rates, factors, and energy cost rates.

]1.3.1.2 Design

****

NOTES:

1. For ground-loop heat pump systems in the South where there are limited heating requirements and where heat transfer fluids are not required, use the second option regarding the minimum water temperature or the 5th sentence.

2. In first sentence, the designer should select items required for software output based on anticipated software input.

3. The designer should select the maximum entering water temperature: 90 degrees F is more conservative and allows longer vertical loops as opposed to the industry standard of 35 degrees 95 degrees.

****

[The diameter, length, flow, velocity,[friction loss,][number and type fittings,][total friction loss,] and the[maximum expected expansion and contraction] of the pipe must be indicated in the program output. An accompanying schematic drawing showing reference points used in the calculations is to be included with the calculations. The maximum entering water temperature to the heat pumps under the peak air conditioning load design condition should not exceed [32][35] degrees C [90][95] degrees F. The minimum entering water temperature to the heat pumps under the peak heating load design condition should be no lower than minus 1 degrees C 30 degrees F.][The entering water temperature to the heat pumps under peak heating load design is to be [7.2][10] degrees C [45][50] degrees F for ground-loop heat pump systems with limited heating requirements.][Adjacent wells/system will not be spaced closer than [4.5][6][_____] meters [15][20][_____] feet.]

][1.3.2 Detail Drawings

Prepare and provide A1 841 by 594 mm 24 by 36 inch detail working drawings showing the ground-loop heat pump system, layout, assembly and installation details, electrical connection diagrams and wiring diagrams, installation and details of pumps, distribution manifolds, heat pumps, piping, and well field layout. Show well grouting details in accordance with IGSHPA 21015. Show data essential for proper installation of each system. Show details, plan view, elevations, and sections of the systems supply and piping. Drawings must be to scale, show the North arrow, show the graphic scales, equipment schedules, legends, abbreviation definitions, notes, symbol lists, and any key plans. Provide equipment schedules indicating the pump motor horsepower and power consumption. Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show the well field arrangement. Show point to point Electrical Wiring Diagrams. The design and drawings must show the piping lay out, piping sizes to transfer the heat required, including any boring, trenching, installation of piping, and connection to the piping in applicable HVAC System. Drawings must include any information required to demonstrate that the system has been coordinated and will properly function within the HVAC system and indicate equipment relationship to other parts of the work, including clearances required for operation and maintenance and the test point locations where the ground-loop heat pump system will be monitored during testing. Submit drawings signed by the System Designer. Concurrent with submittal of the Detail Drawings, submit certification by the System Designer that the design and calculations conform to all contract requirements, including signed approval of the Soil Thermal Conductivity Test Reports..

][1.3.3 Soil Thermal Conductivity Testing

****

NOTES:

1. Also known as In Situ Thermal Properties Testing

2. For Thermal Conductivity Property Testing, this work is to be performed by the designer for systems where the total cooling load is 700 kW 40 tons or greater. This requires the installation of a test well. This requirement is for both design-build and design-bid-build type projects.

3. Due to possible variance in soil properties and ground water, it is advisable to perform multiple soil thermal conductivity testing at various locations on the project site.

****

For projects where the total heating design load for the ground-loop heat pump system exceeds 140.7 kW 480,000 btu/hr or the total cooling design load exceeds 140.7 kW 40 tons, in situ thermal properties testing will be conducted to determine soil thermal properties prior to the design. These tests must be conducted in accordance with the procedures outlined in ASHRAE Item 90376 and Part 3.0 herein.

][1.3.4 System Designer

****

NOTES:

1. This paragraph is intended for design-build projects. The system designer performs the design of the ground-loop heat pump system.

2. The designer must select the option for the requirements of the system designer as a professional engineer, a certified GeoExchange Designer, or both.

****

The ground-loop heat pump system(s) must be designed by an individual who is a[registered professional engineer][Certified GeoExchange Designer] and is regularly engaged in the design of the type and capacity of system(s) specified in this project for the immediate 3 years prior to the submittal of the System Designer's Statement of Qualifications.[Certification as a certified GeoExchange Designer must be kept up to date and maintained with the Association of Energy Engineers.] The System Designer's Statement of Qualifications must include design experience in ground-loop heat pump systems, geothermal heat pump design, data identifying the location, ground-loop heat pump system type, and capacity of at least three systems designed by the proposed System Designer during that period. The Contractor must furnish documentation from the owner of each of these three systems verifying that each system has performed in the manner intended for the 6 months prior to submission of the Statement of Qualifications. Provide a letter no later than [14][_____] calendar days after the Notice to Proceed providing the name and Statement of Qualifications of the individual who will prepare the Design and Calculations.

]][1.4 GROUND SOURCE HEAT PUMP INSTALLER

****

NOTES:

1. The ground-loop heat pump system is provided by an accredited geoexchange heat pump installer. The work includes material, installation, and commissioning. The design of the ground-loop heat pump system is performed by the system designer.

2. Delete this paragraph for water-loop heat pump systems.

****

Work specified in this section must be performed by accredited ground source heat pump (GSHP) installers. The GSHP installer must be an "Accredited Installer." Accreditation as an Accredited Installer must be kept up to date and maintained with the International Ground Source Heat

Pump Association (IGSHPA). The Accredited Installer must be engaged in the installation of the type and capacity of the system(s) specified in this project for the immediate 3 years prior to the submittal of the GSHP installer's Statement of Qualifications. The GSHP installer's Statement of Qualifications must include a copy of IGSHPA Installer Certification and data identifying the location, GSHP system type, and capacity of at least three systems installed under the guidance of the proposed GSHP Installer during that period. The Contractor must furnish documentation from the owner of these three GSHP systems verifying that each system has performed in the manner intended for the 6 months prior to submission of the Statement of Qualifications. Provide a letter not later than [14][_____] calendar days after the Notice to Proceed, providing the name and Statement of Qualifications of the individual(s) who will serve as Ground Source Heat Pump Installer.

]1.5 RELATED REQUIREMENTS

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NOTE: These related requirements are for both water-loop as well as ground-loop water source heat pump systems.

****

****

NOTE: Use the following references for ARMY Projects, if required.

****

[Requirements for cooling towers are specified in Section 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS.][Requirements for water heating boilers are specified in Section 23 52 00 HEATING BOILERS.]

****

NOTE: Use the following references for NAVY Projects, if required.

****

[Requirements for cooling towers are specified in Sections 23 64 10 WATER CHILLERS, VAPOR COMPRESSION TYPE and 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS.]

[Requirements for water heating boilers are specified in Section 23 52 46.00 20 LOW PRESSURE WATER HEATING BOILERS (OVER 800,000 BTU/HR OUTPUT).]

****

NOTE: Use the following references for all Projects, if required.

****

[Requirements for metal duct systems are specified in Section 23 30 00 HVAC AIR DISTRIBUTION.][Requirements for above ground piping are specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.][Requirements for pumps are specified in Section 23 21 23 HYDRONIC PUMPS.]

1.6 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

****

NOTE: Insert the following for design and install projects: "Detail Drawings", "Calculations", "Electrical Wiring Diagrams", "Soil Thermal Conductivity Testing", and "Well and Piping System Layout Drawings". These submittal items are tailored for DESIGN-BUILD.

****

[Detail Drawings; G, [_____]

][Calculations; G, [_____]

][Electrical Wiring Diagrams; G, [_____]

][Soil Thermal Conductivity Testing; G, [_____]

][Well and Piping System Layout Drawings; G, [_____]

] System Diagrams; G, [_____]

SD-03 Product Data

[Water-Source Water-to-Air Heat Pumps; G, [_____]

][Energy Star Label for Residential WAHP Product; S

][Water-Source Water-to-Water Heat Pumps; G, [_____]

][Energy Star Label for Residential WWHP Product; S

] Refrigerants

Ground Heat Exchanger Piping System; G, [_____]

[Thermally-Enhanced Bentonite Grout; G, [_____]

][High Grade Bentonite Grout; G, [_____]

][Cementitious Thermally Enhanced Grout; G, [_____]

][Closed Circuit Coolers; G, [_____]

][Plate Heat Exchangers; G, [_____]

] Heat Tape; G, [_____]

Antifreeze; G, [_____]

Pipe; G, [_____]

Fittings; G, [_____]

Piping Components; G, [_____]

U-Bend Assemblies; G, [_____]

SD-06 Test Reports

[Water-Source Water-to-Air Heat Pumps - Field Acceptance Test Plan; G, [_____]

][Water-Source Water-to-Water Heat Pumps - Field Acceptance Test Plan; G, [_____]

][Closed Circuit Coolers - Field Acceptance Test Plan; G, [_____]

][Plate Heat Exchangers - Field Acceptance Test Plan; G, [_____]

][Water-Source Water-to-Air Heat Pumps - Field Acceptance Test Report; G, [_____]

][Water-Source Water-To-Water Heat Pumps - Field Acceptance Test Report; G, [_____]

][Closed Circuit Coolers - Field Acceptance Test Report; G, [_____]

][Plate Heat Exchangers - Field Acceptance Test Report; G, [_____]

] SD-07 Certificates

[ARI/ISO Performance Data For Water Source Heat Pumps; G, [_____]

] Qualifications Of Ground Heat Exchanger Fabricators; G, [_____]

Qualifications Of Ground Heat Exchanger Installers; G, [_____]

[Qualifications of Ground Source Heat Pump Installer; G, [_____]

] Hydrostatic Test; G, [_____]

****
NOTE: Insert the following for design and install projects: "System Designer".
****

[System Designer; G, [_____]

] Work Coordination and Performance Certificate; G, [_____]

Ground Source Heat Pump Installation Certificate; G, [_____]

Well Driller License; G, [_____]

Pump Installer License; G, [_____]

Well Construction Permit; G, [_____]

Approved Well Permit; G, [_____]

Well Construction Log Record; G, [_____]

Test Borehole Well Construction Log Record; G, [_____]

Refrigeration Technician Certification

SD-08 Manufacturer's Instructions

[Water-Source Water-to-Air Heat Pumps - Installation Instructions

][Water-Source Water-to-Water Heat Pumps - Installation Instructions

][Closed Circuit Coolers - Installation Instructions

][Plate Heat Exchangers - Installation Instructions

][Heat Tape - Installation Instructions

] Closed Circuit Coolers - Operating Instructions

[On-Site Training; G, [_____]

] SD-10 Operation and Maintenance Data

[Water-Source Water-to-Air Heat Pumps, Data Package 2; G, [_____]

][Water-Source Water-to-Water Heat Pumps, Data Package 2; G, [_____]

][Closed Circuit Coolers, Data Package 2; G, [_____]

][Plate Heat Exchangers, Data Package 2; G, [_____]

] Heat Tape, Data Package 2; G, [_____]

SD-11 Closeout Submittals

[As-Built Drawings; G, [_____]

] Ground Heat Exchanger Piping System As-Built Drawings; G, [_____]

Indoor Air Quality During Construction; S

1.7 QUALITY ASSURANCE

1.7.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

1.7.2 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.7.3 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be located within a[1][1.5] hour drive of the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7.4 Manufacturer's Nameplate

Each item of equipment is to have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. As applicable the Energy Star label also affixed to the equipment.

1.7.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.7.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions are to be considered mandatory, the word "should" must be interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.7.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, are to be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.7.6 Ground Heat Exchanger Piping System As-Built Drawings

Provide dimensioned as-built drawings of each complete ground heat exchanger piping system, depicting its relationship to other utilities and buildings in its proximity before burying, covering, or concealing. Drawings must be of a quality equivalent to the contract design drawings. The as-built drawings of the installed ground heat exchanger piping system are to be laminated or stored in a clear plastic envelope and affixed visibly to the heat pump unit or on the wall in the mechanical room if serving a system of multiple heat pumps. As-built drawings must be submitted with operation and maintenance data. A permanent label is to be affixed to each heat pump unit indicating basic information for that unit. The information must include: nominal flow rate [_____] l/s gpm, pressure [_____] drop kPa feet, temperature drop/rise [_____] degree C degree F, and capacity [_____] W Btu/hr.

1.7.7 System Diagrams

After completion, but before final acceptance, submit System diagrams that show the layout of equipment, piping, and circulation pumps, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. Provide diagrams framed under glass or laminated plastic. After approval, these items are to be posted where directed.

1.7.8 Plastic Piping Heat Fusion Requirements

All plastic pipe must be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Heat joining must be performed in accordance with ASTM D2657. Electrofusion joining must be performed in accordance with ASTM F1290. Qualifications for plastic pipe fabricators are given in this section under paragraph QUALIFICATIONS OF GROUND HEAT EXCHANGER FABRICATORS. Conduct heat fusion tests to verify the quality of the joints.

1.7.9 Qualifications of Ground Heat Exchanger Fabricators

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NOTE: The experience clause in this section has been approved by a Level 1 Contracting Officer, and may be used without further approval or request for waiver.

****

The only acceptable method for joining buried pipe systems is by a heat fusion process. Submit documentation substantiating the following qualifications: ground heat exchanger fabricators are to have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of an approved manufacturing certification program, or a DOT certified heat fusion technician.

1.7.10 Refrigeration Technician Certification

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NOTE: The following paragraph requires a certification for technicians who work on equipment that could release Class I or II refrigerants, such as R-123, into the atmosphere. This is required as of January 1, 2018 to meet the requirements of 40 CFR 82, Subpart F.

****

All technicians working on equipment that contain Class I or II refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.7.11 Qualifications of Ground Heat Exchanger Installers

Submit documentation substantiating the following qualifications: installers must have completed an approved manufacturer's certification program and have successfully completed at least two projects with ground heat exchanger work similar in size and complexity to that required for this project within the last 4 years. In documentation submit licensing requirements as regulated by local and state regulations for well drillers and pump installers. Submit for each well driller, the Well Driller License. For each pump installer, submit the Pump Installer License. Certification and licenses for each well driller and pump installer must be in the state where the work occurs. All required certification and licenses must be kept current. Out of date licenses and certification will not be accepted. Submit to contracting officer for approval the licenses and certification.

1.8 DELIVERY, STORAGE, AND HANDLING

Materials delivered and placed in storage are to be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged will be replaced at the Contractor's expense. During installation, piping is to be capped to keep out dirt and other foreign matter. A material Safety Data Sheet (SDS) in conformance with 29 CFR 1910 Section 1200(g) must accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling must be in accordance with ASTM F402. Storage facilities are to be classified and marked in accordance with NFPA 704. Materials must be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings must be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe is to be packed, packaged and marked in accordance with ASTM D3892. Upon delivery of piping, fitting, components, and equipment to the site, inspect items for damage and verify items meet project requirements.

1.9 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices are to be installed so that proper operation of equipment is not impaired.

1.10 PROJECT/SITE CONDITIONS

1.10.1 Verification of Dimensions

The Contractor is to become familiar with all details of the work, verify all dimensions indicated in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.10.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor must carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.10.3 Accessibility

****

NOTES:

1. The following requirement is intended to solicit the installer's help in the prudent location of equipment when he has some control over locations. However, designers should not rely on it at all since enforcing this requirement in the field would be difficult.

Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.

2. On Air Force projects, the designer must provide work/service platforms for accessibility around

equipment, such as heat pumps connected to condenser loop, which are installed more than two feet above a suspended ceiling or more than 12 feet above the floor. Refer to 29 CFR 1910 for specific requirements.

3. Provide on drawings access requirements for unit replacement, compressor replacement, and equipment repair.
****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

1.11 COORDINATION OF WORK AND SYSTEM PERFORMANCE

a. Pump supports, piping offsets, fittings, and any other accessories required must be furnished as required to provide a complete installation and to eliminate interference with other construction.

b. Submit a Work Coordination and Performance Certificate. Concurrent with submittal of the Detail Drawings and the Calculations, submit a Certificate by[both] the[System Designer][and the][Ground Source Heat Pump Installer] stating that the drawings and calculations have been coordinated with all related work and the Ground Source Heat Pump System will perform as[specified][and indicated].

c. Submit a Ground Source Heat Pump Installation Certificate. Concurrent with submittal of the Test Reports, submit certification by the Ground Source Heat Pump Installer stating that the Ground Source Heat Pump System and related work is installed in accordance with the contract requirements, including signed approval of the test reports.

PART 2 PRODUCTS

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NOTE: In accordance with P.L. 109-58 (Energy Policy Act of 2005), Executive Order 13423, and FAR 23.203 Energy-Efficient Products, energy consuming products and systems must meet or exceed the performance criteria for ENERGY STAR qualified or FEMP-designated products as long as these requirements are nonproprietary. The FEMP and ENERGY STAR product requirements are available on the web at www.eere.energy.gov/femp/procurement and www.energystar.gov/products. Where ENERGY STAR or FEMP products are not applicable, energy consuming products and systems must meet the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP
****

2.1 EQUIPMENT

Refrigerants containing chlorofluorocarbons (CFC) are prohibited. Provide refrigerants, or refrigerants with ozone depleting potential (ODP) of 0.0. Provide SDS Sheets for all refrigerants.Refrigerants must comply with all EPA rulings - refer to Code of Federal Regulations (CFR) Part 84

(https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-84)

Product data for integral or appurtenant space temperature controls (STC) supplied with the equipment must include point-to-point electrical wiring diagrams for each STC.

[2.1.1 Water-Source Water-to-Air Heat Pumps (WAHP)

****

NOTES:

1. Indicate the equipment operating requirements, including efficiency, on the drawings. Units must have EER and COP ratings meeting or exceeding FEMP/Energy Star requirements.

2. For housing or residential applications, the designer should consider residential class water source heat pumps as opposed to commercial class heat pump units. Residential class heat pumps can be provided by the manufacturer with factory installed optional selections of:

a. A factory installed energy management relay to allow unit control by an external source.

b. A factory installed internal heat recovery kit for domestic hot water production.

c. A factory installed ground loop pump kit.

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[Provide water-source water-to-air heat pump units factory assembled, designed, tested, and rated in accordance with ISO 13256-1.][Provide ground-coupled closed-loop water-to-air heat pump (extended range) units factory assembled, designed, tested, and rated in accordance with ISO 13256-1.]Units are to be ISO 13256-1 certified, or listed in ISO 13256-1 directory. Units must include fans, refrigerant-to-air heat exchangers, filters,[dampers,] compressor, reversing valve, expansion valve, refrigerant-to-water heat exchangers,[desuperheater,][hose kits,] bypass for flushing and purging, and controls. A permanent label must be affixed to each heat pump unit indicating basic information for that unit. The information must include: nominal flow rate l/s gpm, pressure drop kPa feet, temperature drop/rise degree C degree F, and capacity W Btu/hr.[For housing or residential applications, provide heat pump units with factory installed[energy management relay,][factory installed internal heat recovery kit,][and a][factory installed ground loop pump kit].] Provide certificates of ARI/ISO Performance Data For Water Source Heat Pumps.[Provide residential ground-coupled closed-loop water-to-air heat pumps that are Energy Star labeled. Provide proof of Energy Star label for residential WAHP product.]

a. Cabinet: Provide manufacturer's standard[galvanized steel][stainless steel] cabinet[finished with corrosion resistant epoxy coating or lacquer acrylic]. Provide access panels for inspection and access to internal parts. Insulate cabinet with minimum 12 mm 1/2 inch multi-density, fiberglass insulation with exposed edges sealed or tucked under flanges to prevent introduction of fibers into the airstream. Female threaded pipe condensate drain connections, supply water connections, and return water connections are to be copper threaded fittings mechanically fastened to the cabinet. Water piping must be insulated. Construct cabinet with compartments and locate the compressor, reversing valve, and water coil out of the airstream. Insulate the divider between the compressor and fan sections. The control box is to be located within the unit.

b. Fans: Provide centrifugal type, direct drive fans with permanently lubricated motors.[Provide motors of the permanent split capacitor (PSC) type with thermal overload protection.][Provide Electronically Commutated Motor (ECM) microprocessor controlled DC type motor with internal programming factory set for the specific unit and featuring soft start/stop and a delay off feature for maximum efficiency and quiet operation. There will further be provisions for adjusting the air delivery of the motor and blower by plus or minus 15 percent from rated air flow.]

c. Refrigerant-to-Air Heat Exchanger: Provide coil constructed of rifled copper tubes with plate aluminum fins designed for refrigerant working pressure of 3102 kPa 450 psi. Fins must be mechanically bonded to tubes. The condensate drain pan must be epoxy coated and insulated. Provide internal traps on vertical units. Provide drain pan with overflow protection. Provide drain pan constructed of[corrosion-resistant plastic][galvanized steel][stainless steel].

d. Filter Section: Provide[replaceable][(throwaway)][[25][50] mm [1][2] inch] thick UL listed[fiberglass][permanent washable] type filters with a MERV Rating of[8][11][13] in accordance with ASHRAE 52.2. Mount filters in filter frames and provide access panels or doors for removal and replacement of filters. Access panels or doors for filter access must be provided with appropriate seals and closure mechanisms to prevent unit leakage and mitigate bypassing of air around the filter.

e. Compressor: Provide hermetically sealed type compressor, installed on vibration isolators enclosed in an acoustically treated enclosure. Provide high and low pressure switches, low suction temperature cut-out, motor thermal overload protection, 5 minute anti-recycle timer, and start capacitor kit. Provide capability to reset compressor lockout circuit at the remote thermostat and at the disconnect.[Provide units with factory installed sound attenuation package.]

f. Reversing Valve: Provide solenoid activated refrigerant reversing valves energized only during the cooling mode and designed to fail in the heating position.

g. Refrigerant-to-Water Heat Exchangers: Provide two-position automatic valve interlocked to shut off water flow when the compressor is off. Provide refrigerant-to-water heat exchangers of coaxial type (tube-in-tube), with inner[cupronickel][copper] water tube and outer steel refrigerant tube. The refrigerant side of the heat exchanger is to be tested and rated for 3102 kPa 450 psig refrigerant working pressure. The water side of the heat exchanger is to be tested and rated for 2758 kPa 400 psig working pressure. A parallel capillary tube/thermal expansion valve assembly must provide superheat over the entire liquid temperature range. Refrigerant-to-water heat exchangers and refrigerant piping must be insulated to prevent condensation on the piping containing low temperature water.

****

NOTES:

1. For heat pump units serving a water-loop application, the inlet water temperature range to the heat exchanger is to be[1 to 43 degree C 34 to 110 degree F. For heat pump units serving a ground-loop, the inlet water temperature range to the heat exchanger is to be][7 to 32 degree C 45 to 90 degree F] liquid temperature range. Show these ranges on the drawings.

2. Extended range heat pumps usually provide performance in the range of minus 4 to 38 degrees C 25 to 100 degrees F.

3. Low temperature applications such as boiler and closed loop cooling tower or dry cooler usually provide performance in the range of 4 to 43 degrees C 40 to 110 degrees F.

****

****

NOTE: Provide on the drawings a sequence of operation, control schematic, and applicable points on the control points schedule for the heat pump and desuperheater.

Check ASHRAE 90.1 - SI ASHRAE 90.1 - IP Chapter 6 to determine whether heat recovery for service water heating is required.

****

[h. Factory-Installed Domestic Hot Water Desuperheater: Provide desuperheater of vented double-wall construction and factory installed within indoor heat pump cabinet. Provide desuperheater units factory assembled, designed, tested, and rated.

i. Provide with the desuperheater, factory-installed water pump powered by a sealed magnetic drive motor, water line thermostat, secondary safety thermostat to prevent scalding, internal fuse, internally mounted disconnect switch, outside air thermostat, manual on-off switch, low refrigerant gas temperature limit switch, air bleed port, and refrigerant ports. Units must be UL listed. Desuperheater units must be UL listed. Units must be provided by the[ground source][water source] closed loop heat pump manufacturer.

j. Controls: The manual on- off switch is to be a push button type with a cover. Provide an indicating light next to the switch to indicate the desuperheater pump energized mode.[Provide an outside air thermostat with sun shield set for 4 degree C 40 degree F. The outside air thermostat de-energizes the desuperheater pump.] Provide in the water return to the desuperheater unit, a high water temperature limit with adjustable settings, which de-energizes the desuperheater pump at 60 degree C 140 degree F Also provide low refrigerant gas temperature limit which de-energizes the desuperheater pump and is set to open at 38 degree C 100 degree F.

][k. Emergency Heater: Provide UL or ETL listed, electric resistance heater with internal fusing integral with heat pump unit; fan must run until heater cools. Locate downstream of indoor coil. The emergency heater coil is to be provided as a supplementary electric heater. The heater must be provided with a rack, control box with hinged cover, safety limits, and relay. Control voltage of the heater must be compatible with the heat pump. The electric heater must be provided by the heat pump manufacturer. The control of the electric heater must only be utilized as second stage heating. The first stage heating is to be normal heat pump operations.

] **

NOTE: For residential or housing projects, discuss with customer's or activity's housing department the need for emergency back-up electric heater. The designer should consider using an emergency heater for situations such as very cold weather and equipment outages.

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NOTE: The functionality of the hose kits are:

a. Allow ease and convenience of maintenance and installation of the heat pump units.

b. The hose kits allow the ease and convenience of purging and flushing of the system piping.

c. The hose kits also minimize vibration transmission from the heat pump units to the system piping.

Designer must review hose kit pressure drop and include in pump head calculations to assure adequate pump head capacity is scheduled to accommodate the use of hose kits.

****

[l. Hose Kits: Provide hose kits with two 0.6 m 2 foot long metal (stainless steel) braided hoses with swivel connectors on one end, an manual flow control valve with test ports, two shutoff ball valves with memory stops (one with test port), blow down ball valve, and Y-strainer. Hoses must be fire rated to meet UL 94. Provide hoses with a maximum working pressure of 2067 kPa 300 psi.[For residential or housing applications, provide flexible hose kits using heavy-duty radiator rubber hose kits. Provide a bypass around the heat pump unit condenser coil.]

] m. Bypass for Purging and Flushing: Provide a bypass around the heat pump unit condenser coil. The bypass is to include isolation valves and piping that allows for purging and flushing of the system piping. Provide the necessary flushing pump, hoses, and isolation valves.

n. Hanger Kits: Provide horizontal units with hanger kits consisting of galvanized steel brackets, bolts, washers, and vibration isolators. The hanger kit must be designed to support the unit from below and suspend from threaded rods.

o. Floor Mounted Units: Floor mounted units must be installed in accordance with manufacturer's installation requirements. Provide concrete housekeeping pads when installing within mechanical equipment rooms .

****

NOTE: Microprocessor based controls should normally be utilized on large projects. Electromechanical controls should be used on small installations, housing, and remote location projects.

****

p. Controls: Controls and safety devices must be factory wired and mounted within the control box of the unit cabinet.

(1) Provide a microprocessor based controller that communicates with an electronic multi-stage space thermostat. The microprocessor must control sequencing, high and low pressure switch monitoring, freeze protection, lockout control, night setback, emergency shutdown, short cycle protection, random start, LED mode and fault indicators, fault memory, input and output diagnostics, and a communications port. Provide a factory-installed low voltage terminal block for field control wiring and a low voltage transformer.[Provide communications capability for remote direct digital control (DDC). Use standard communication protocol such as[LonWorks,][BACnet,] or other [_____] protocol.][Provide a hand held, remote service terminal from the heat pump manufacturer capable of interfacing with heat pump unit microprocessor controller to perform diagnostics, data retrieval, and calibration functions. When in the heating mode, where there is a continued drop in room temperature, the controller is to energize the second stage of heating, which would be the emergency heater. Provide night setback. The controller is to raise the night setback temperature gradually. Provide 7 day schedule capability.]

[(2) Provide 24 volt electromechanical controls supplied with a low voltage transformer, controls for compressor, reversing valve, and fan motor operation. Controls are to include a random start relay, a night setback relay, a compressor cycling relay for demand load shedding, and a condensate overflow switch. Provide a low voltage terminal block for field control wiring.

] (3) [The ECM interface board is to include a screw type terminal board for a thermostat connection, LED's to indicate thermostat status and air delivery.][Provide a factory installed energy management relay to allow unit control by an external source.]

q. Space Temperature Controls: Provide electronic multi-stage, auto-changeover, adjustable thermostats with OFF-HEAT-AUTO-COOL-EMERGENCY system switch and AUTO-ON fan switch. Thermostats must be the programmable type and are to be furnished by the unit manufacturer.[Thermostats must have the Energy Star rating.] Provide 7 day schedule capability. Provide with battery back-up. The thermostat must have night setback and can raise the night setback temperature gradually. When in the heating mode, where there is a continued drop in room temperature, the thermostat must energize the second stage of heating, which would be the emergency heater. Provide relays, transformers, contractors, and control wiring between thermostats and unit. Thermostats must read out in degrees C and degrees F.

][2.1.2 Water-Source Water-to-Water Heat Pumps (WWHP)

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NOTES:

1. In compliance with FEMP/Energy Star requirements, closed loop units shall have minimum EER of 16.1 and minimum heating performance COP of 3.1; open loop units shall have minimum EER of 20.1 and a minimum heating performance COP of 3.5. Indicate the equipment operating requirements, including efficiency, on the drawings.

2. For housing or residential applications, the designer should consider residential class water source heat pumps as opposed to commercial class heat pump units. Residential class heat pumps can be provided by the manufacturer with factory installed optional selections of:

a. A factory installed energy management relay to allow unit control by an external source.

b. A factory installed internal heat recovery kit for domestic hot water production.

c. A factory installed ground loop pump kit.

3. For projects where the water-to-water heat pump unit is used for domestic water heating, the plumbing code shall be followed. Refer to the International Plumbing Code. To prevent cross connection or contamination of the potable water supply from the refrigerant in the heat pump unit, several approaches should be considered:

a. Consider using a desuperheater. Check ASHRAE 90.1 - SI ASHRAE 90.1 - IP Chapter 6 to determine whether heat recovery for service water heating is required.

b. Consider using a double wall heat exchanger that is vented.

c. Consider using a secondary heat exchange in the water circuit such as a plate heat exchanger.

****

[Provide water-source water-to-water heat pump units factory assembled, designed, tested, and rated in accordance with ISO 13256-2.][Provide ground-coupled closed-loop water-to-water heat pump (extended range) units factory assembled, designed, tested, and rated in accordance with ISO 13256-2.]Units must be listed by ETL, or listed in ISO 13256-2. Units are to include compressor, reversing valve, expansion valve, refrigerant-to-water condensing coil, refrigerant-to-water evaporator coil,[desuperheater,][hose kits,][dampers,] bypass for flushing and purging, and controls. A permanent label must be affixed to each heat pump unit indicating basic information for that unit. The information is to include: nominal flow rate l/s gpm, pressure drop kPa feet, temperature drop/rise degree C degree F, and capacity W Btu/hr.[For housing or residential applications, provide heat pump units with factory installed[energy management relay,][factory installed internal heat recovery kit,][and a][factory installed ground loop pump kit].] Provide certificates of ARI/ISO Performance Data For Water Source Heat Pumps.[Provide residential water-source water-to-water heat pumps that are Energy Star labeled. Provide proof of Energy Star label for residential WWHP product.]

a. Cabinet: Provide manufacturer's standard[galvanized steel][stainless steel] cabinet[finished with corrosion resistant epoxy coating or lacquer acrylic]. Provide access panels for inspection and access to internal parts. Insulate cabinet with minimum 12 mm 1/2 inch multi-density, fiberglass insulation. Provide copper or stainless steel female threaded pipe connections for supply water and return water connections; these connections are to be mechanically fastened to the cabinet. Water piping must be insulated.

b. Compressor: Provide hermetically sealed type compressor, installed on vibration isolators enclosed in an acoustically treated enclosure. Provide high and low pressure switches, low suction temperature cut-out, motor thermal overload protection, 5 minute anti-recycle timer, and start capacitor kit. Provide capability to reset compressor lockout circuit at the remote thermostat and at the disconnect.[Provide units with factory installed sound attenuation package.]

c. Reversing Valve: Provide solenoid activated refrigerant reversing valves energized only during the cooling mode and designed to fail in the heating position.

d. Refrigerant-to-Water Heat Exchangers: Provide refrigerant-to-water heat exchangers of coaxial type (tube-in-tube), with inner [cupronickel][copper] water tube and outer steel refrigerant tube. The refrigerant side of the heat exchanger is to be tested and rated for 3102 kPa 450 psig refrigerant working pressure. The water side of the heat exchanger is to be tested and rated for 2758 kPa 400 psig working pressure. A parallel capillary tube/thermal expansion valve assembly must provide superheat over the entire liquid temperature range. Refrigerant-to-water heat exchangers and refrigerant piping must be insulated to prevent condensation on the piping containing low temperature water.

****

NOTES:

1. For heat pump units serving a water-loop application, the inlet water temperature range to the heat exchanger is to be 1 to 43 degree C 34 to 110 degree F . For heat pump units serving a ground-loop application, the inlet water temperature range to the heat exchanger is to be 7 to 32 degree C 45 to 90 degree F liquid temperature range. Show these ranges on the drawings.

2. Extended range heat pumps usually provide performance in the range of minus 4 to 38 degrees C 25 to 100 degrees F.

3. Low temperature applications such as boiler and

closed loop cooling tower or dry cooler usually provide performance in the range of 4 to 43 degrees C 40 to 110 degrees F.

****

[e. Factory-Installed Domestic Hot Water Desuperheater: Provide desuperheater of vented double-wall construction and factory installed within indoor heat pump cabinet. Provide desuperheater units factory assembled, designed, tested, and rated.

f. Provide with the desuperheater, factory-installed water pump powered by a sealed magnetic drive motor, water line thermostat, secondary safety thermostat to prevent scalding, internal fuse, internally mounted disconnect switch, outside air thermostat, manual on-off switch, low refrigerant gas temperature limit switch, air bleed port, and refrigerant ports. Units must be UL listed. Desuperheater units must be UL listed. Units must be provided by the[ground source][water source] closed loop heat pump manufacturer.

g. Controls: The manual on- off switch is to be a push button type with a cover. Provide an indicating light next to the switch to indicate the desuperheater pump energized mode.[Provide an outside air thermostat with sun shield set for 4 degree C 40 degree F. The outside air thermostat de-energizes the desuperheater pump.] Provide in the water return to the desuperheater unit, a high water temperature limit with adjustable settings, which de-energizes the desuperheater pump at 60 degree C 140 degree F. Also provide low refrigerant gas temperature limit which de-energizes the desuperheater pump and is set to open at 38 degree C 100 degree F

]**

NOTE: Provide on the drawings a sequence of operation and control schematic for the heat pump and desuperheater.

****

h. Hose Kits: Provide hose kits including two 0.6 m 2 foot long metal (stainless steel) braided hoses with swivel connectors on one end,[a flow control valve with test ports,] two shutoff ball valves with memory stops (one with test port), blow down ball valve, and Y-strainer. Hoses must be fire rated to meet UL 94. Provide hoses with a maximum working pressure of 2067 kPa 300 psi.[For residential applications, provide flexible hose kits using heavy-duty radiator rubber hose kits. Provide a bypass around the heat pump unit condenser coil.]

****

NOTE: The functionality of the hose kits are:

-Allow ease and convenience of maintenance and installation of the heat pump units.

-The hose kits allow the ease and convenience of purging and flushing of the system piping.

-The hose kits also minimize vibration transmission from the heat pump units to the system piping.

Designer must review hose kit pressure drop and

include in pump head calculations to assure adequate pump head capacity is scheduled to accommodate the use of hose kits.

****

i. Bypass for Purging and Flushing: Provide a bypass around the heat pump unit condenser coil. The bypass includes isolation valves and piping that allows for purging and flushing of the system piping. Provide the necessary flushing pump, hoses, and isolation valves.

j. Hanger Kits: Provide units with hanger kits consisting of galvanized steel brackets, bolts, washers, and vibration isolators. The hanger kit must be designed to support the unit from below and suspend from threaded rods.

****

NOTE: Microprocessor based controls should normally be utilized on large projects. Electromechanical controls should be used on small installations, housing, and remote location projects.

****

k. Controls: Controls and safety devices must be factory wired and mounted within the control box of the unit cabinet.

(1) Provide a microprocessor based controller. The microprocessor must control sequencing, high and low pressure switch monitoring, freeze protection, lockout control, night setback, emergency shutdown, short cycle protection, random start, LED mode and fault indicators, fault memory, input and output diagnostics, and a communications port. Provide a factory-installed low voltage terminal block for field control wiring and a low voltage transformer.[Provide communications capability for remote direct digital control (DDC). Use standard communication protocol such as[LonWorks,][BACnet,] or other [_____] protocol.][Provide a hand held, remote service terminal from the heat pump manufacturer capable of interfacing with heat pump unit microprocessor controller to perform diagnostics, data retrieval, and calibration functions.]

[(2) Provide 24 volt electromechanical controls supplied with a low voltage transformer, pump relay, controls for compressor, reversing valve coil, and lock out relay. Controls are to include a random start relay, a night setback relay, and a compressor cycling relay for demand load shedding, and a condensate overflow switch. Provide a low voltage terminal block for field control wiring.

] l. Space Temperature Controls: Provide electronic multi-stage, auto-changeover, adjustable thermostats with OFF-HEAT-AUTO-COOL-EMERGENCY system switch and AUTO-ON fan switch. Thermostats are to be furnished by the unit manufacturer. Provide relays, transformers, contractors, and control wiring between thermostats and unit. Thermostats must read out in degrees C and degrees F.

][2.1.3 Closed Circuit Coolers

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NOTE: It has been proposed as a forthcoming action that this specification paragraph for the closed circuit cooler be moved into Section 23 64 10 WATER CHILLERS, VAPOR COMPRESSION TYPE or Section 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS.

****

a. Fan and Casing: Construct the fan section (up to top of intake louvers) of heavy gage stainless steel and construct casing of hot-dip galvanized steel. Standard pan accessories must include louver access, overflow, drain, Type 304 stainless steel strainers, and brass make-up valve with plastic float.

b. Axial Propeller Fans: Fans are to be heavy duty axial propeller type, statically balanced. Construct fans with aluminum alloy blades, and install in a closed fitted cowl with venturi air inlet.

c. Fan Motors: Motors are to be totally enclosed, ball bearing type, and suitable for outdoor service. Motors 1 Hp and greater must be the premium efficiency type in accordance with NEMA MG 1. Fan motor speed control is to be provided for motors 7.5 hp or larger.

d. Drive: Fan drive is to be multi-groove, solid V-belt type with taper lock sheaves designed for 150 percent of nameplate kW HP. Fan and motor sheave must be aluminum alloy construction. Belt adjustment is to be accomplished from exterior of unit.

e. Heat Transfer Coil: The coil must be steel, encased in steel framework with the entire assembly hot-dip galvanized after fabrication. Arrange tubes in a self-spacing, staggered pattern in the direction of airflow for maximum heat transfer efficiency and minimum pressure drop, without the use of additional spacers between the coil tubes. Design coil with sloping tubes for free drainage of liquid and test to 2413 kPa 350 psi air pressure under water.

f. Water Distribution System: The system must provide a water flow rate of not less than .3846 l/sec 6 gpm over each square foot of unit face area to ensure proper flooding of the coil. Construct spray header of Schedule 40 polyvinyl chloride (PVC) pipe for corrosion resistance. Spray branches are to be removable for cleaning. Distribute water over the entire coil surface by spray nozzles (381 by 8 mm 15 by 5/16 inch orifice) with internal sludge ring to eliminate clogging. Thread nozzles into spray header to provide easy removal for maintenance.

g. Water Recirculation Pump: The pump is to be close-coupled, centrifugal type with mechanical seal, installed vertically at the factory to allow free drainage at shutdown.

h. Eliminators: Construct eliminators of inert PVC in easily handled sections. Provide with eliminator design that incorporates three changes in air direction to ensure complete removal of entrained moisture from the discharge airstream. Maximum drift rate must be less than 0.001 percent of the circulating water rate.

i. Construct Louvers From PVC: Mount louvers in removable frames for maintenance access to the pan. Louvers are to have a minimum of two changes in air direction to prevent splash out and block direct sunlight.

j. Finish: Apply corrosion protection system to the outside of galvanized surfaces. Construct non-stainless metal components of mill hot-dip galvanized steel. Coat component edges and welds with a 95 percent pure zinc-rich compound. Include degreasing, cleaning, and a light surface burnishing in preparation for coating. The coating is to be suitable for field repair with the same original coating material applied in the same manner.

k. Electric Pan Heater Package: Provide electric pan heater package consisting of electric immersion heaters, heater thermostat, and low water cutout, all installed in pan. Size heaters to maintain plus 5 degrees C plus 40 degrees F pan water temperature with the fans off at outdoor design conditions indicated on drawings. Control the heaters with a thermostat, and provide water cutout to prevent heaters from cycling on unless they are completely submerged. Provide heater contactor and wiring under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

[l. Discharge Hood With Positive Closure Dampers: Provide unit with discharge hood, positive closure dampers, and 120-volt actuator for reduction of heat loss during idle periods of winter time operation. Construct the discharge hood and dampers of hot dipped galvanized steel. Equip hoods with access panels to facilitate maintenance on the eliminators and water distribution system. Factory assemble the dampers, damper actuator, and linkage.

]][2.1.4 Plate Heat Exchangers

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NOTES:

1. Plate heat exchangers provide flexibility for the designer. Plate heat exchangers are recommended where there is a requirement to isolate the outside loop that may have a glycol antifreeze fluid from the inside loop - where separation is necessary from the inside loop due to different heat transfer fluids. Also plate heat exchangers should be considered for use with systems using closed circuit coolers or cooling towers to isolate the ground heat exchanger loops from the building terminal loops.

2. It has been proposed as a forthcoming action that this specification paragraph for the plate heat exchanger be moved into Section 23 64 10 WATER CHILLERS, VAPOR COMPRESSION TYPE or Section 23 65 00 COOLING TOWERS AND REMOTE EVAPORATIVELY-COOLED CONDENSERS.

3. Provide the following flat plate heat exchanger information on the drawing:

a. Maximum water pressure drop through clean plates and headers in kPa psi at the flow rates and temperatures indicated.

b. Minimum rate of turbulent flow in l/sec gpm through any two plate segment.

c. Minimum plate thickness in mm inch.

****

Plates, frames, and gaskets are to be designed for a working pressure of 2.07 MPa 300 psi and factory tested at 31.0 MPa 450 psi. Medium temperature water, low temperature water, and pressure relief valve connections are to be located in accordance with the manufacturer's standard practice. Connections larger than 80 mm 3 inches must be ASME 2.07 MPa 300 pound flanged. Plates are to be corrugated[Type 304 stainless steel][Type 316 stainless steel][nickel-iron-chromium alloy conforming to ASTM B424][nickel-molybdenum alloy conforming to ASTM B333][titanium alloy conforming to ASTM B265].

]2.2 ELECTRICAL WORK

****

NOTES:

1. Show the electrical characteristics, motor starter type(s), enclosure type, and maximum rpm in the equipment schedules on the drawings.

2. Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (ASD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01, "Interior Electrical Systems".

3. Use the bracketed item where polyphase motors are part of an assembly. Premium efficiency motors are required by Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM for individual motors that are not part of an assembly.

4. For Air Force projects, the base or activity will designate which electrical specification section applies.

5. The designer should show the motor starter size with the pump schedule. The pump schedule should be shown on the drawings.

****

a. Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 10009. In addition to the requirements of Section 26 20 00

INTERIOR DISTRIBUTION SYSTEM, provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

b. Motors are to be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period.

c. Motor bearings are to be fitted with grease supply fittings and grease relief to outside of the enclosure.

d. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, are to be provided. For packaged equipment, the manufacturer is to provide controllers including the required monitors and timed restart.

[e. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Use solid-state variable -speed controllers for motors rated 7.45 kW (10 hp) or less and adjustable frequency drives for larger motors.][Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS.

][2.3 ABOVEGROUND PIPING SYSTEMS

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NOTES:

1 Generally the above ground piping pertains to the interior building systems and the interior loop. Consider using a plate heat exchanger to avoid pumping glycol heat transfer fluids around the building. Minimize exposure of glycol fluids to personnel. For the interior building systems, consider using steel or copper piping. For the outside ground loop piping, use high density polyethylene piping.

2 For the interior loop, the designer should consider air separation and water treatment.

3 Refer to other sections for above ground piping systems, such as Section 23 64 26 CHILLED, CHILLED-HOT, CONDENSER WATER PIPING SYSTEMS.

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Provide above ground piping as specified in Section 23 64 26 CHILLED, CHILLED-HOT, CONDENSER WATER PIPING SYSTEMS.

]2.4 GROUND HEAT EXCHANGER PIPING SYSTEM

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NOTE: When specifying pipe and fittings for the project, ensure that the total system pressure and temperature does not exceed the performance capabilities of the pipe and fittings.
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Provide high density polyethylene pipe, fittings, and piping components for the underground portions of the ground heat exchanger. Use of polyvinyl chloride (PVC) or polybutylene pipe and fittings is not permitted.[Provide high density polyethylene pipe coiled on reel, with U-bend factory installed, pipe pre-marked for depth, and U-bend connections factory tested. Because of their size and weight, coiled PE piping require appropriate equipment and procedures for safe handling, installation, and use. Reels and coiled pipe must allow easy and thorough inspection of the pipe exterior for any shipping and handling damage. The reel is to be capable of securing the pipe coil while the pipe is being pressure tested. The reel and pipe coil are to allow easy access and handling while spooling the pipe coil off the reel for insertion into the bore hole.] Pipe coil on reel must be factory marked to show depth graduations.

For the pipe and piping components submittals, include recommendations for the connection of joints, including the preparation of joints for the electrofusion process.

2.4.1 High Density Polyethylene Pipe

Pipe is to be manufactured from virgin high density polyethylene extrusion material in accordance with ASTM D2513 with PE345434C or PE355434C cell classification and UV stabilizer of C, D, or E as specified in ASTM D3350. Provide ASTM D3035 pipe with a standard dimension ratio (SDR) of 11.0 for pipe less than 32 mm 1.25 inches diameter. Provide ASTM F714, Schedule 40 or ASTM D3035 pipe with a minimum SDR of 13.5 for pipe 32 mm 1.25 inches diameter or greater, and a minimum SDR of 17.0 for pipe 75 mm 3 inches diameter or greater. Provide ASTM D3035 pipe in vertical bores greater than 60 m 200 feet and up to 107 m 350 feet deep with a SDR of 11.0. Provide ASTM D3035 pipe in vertical bores greater than 107 m 350 feet deep with a SDR of 9.0.

2.4.2 Fittings

Provide ASTM D3261 butt and saddle fusion fittings and ASTM D2683 socket fusion fittings manufactured in accordance with ASTM D2513. Barbed fittings, compression type fittings, mechanical joint fittings, grove fittings, and hose clamps are not permitted in polyethylene[or polybutylene] pipe systems. All pipe fittings underground must be fusion type joints. Flange joints and fittings are not to be provided on underground piping.

2.4.2.1 Threaded Transition Fittings

Provide ASTM D2513 reinforced threaded [steel][brass]-to-polyethylene fittings. Fittings must have a factory applied external epoxy coating.

2.4.3 U-Bend Assemblies

Provide factory-assembled and fused, injection-molded, 180 degree, U-bend assemblies equipped with anti-buoyancy devices. U-bend assemblies must be used for the vertical well field vertical loop heat exchangers. U bend assemblies must be prefabricated assemblies with u-bends and continuous pipe. The assemblies must be pre-marked[by the manufacturer] with depth graduations. Each assembly must be the indicated length of the vertical loop heat exchanger. Each assembly must be factory pressure tested to 689.5 kPa gage 100 psig. Each assembly must be provided with a factory pressure test report. Each U-bend assembly must be temporarily capped to prevent the entry of dirt during storage and installation.

2.5 PIPING ACCESSORIES

Provide piping accessories for above ground piping as specified in Section 23 64 26 CHILLED, CHILLED-HOT, CONDENSER WATER PIPING SYSTEMS.

2.5.1 Tracer Wire for Nonmetallic Piping

Provide bare copper or aluminum wire not less than 2.5 mm 0.10 inch in diameter in sufficient length to be continuous over each separate run of nonmetallic pipe.

2.5.2 Pipe Casings

Provide rigid nonmetallic conduit and fittings (PVC) as pipe casings at floor penetrations and underground building entries for the entry of ground heat exchanger piping. The conduit is to serve as a casing for ease of installation and removal of the piping into the building. The pipe casing diameter is to be at least four times the diameter of the carrier pipe to allow "pulling the pipe through the casing". Provide rigid nonmetallic conduit and fittings specified complete with fittings and necessary hardware as specified herein[and in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM].

****

NOTE: Use for small systems where the PVC conduit act as a casing and allows ease of installation of the high density polyethylene piping into the building.

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Carrier Pipe Size		Casing Size	
(mm)	(Inches)	(mm)	(Inches)
19	3/4	100	4
25	1	100	4
32	1-1/4	100	4
38	1-1/2	150	6
50	2	200	8

2.6 HEAT TAPE

****

NOTES:

1. The designer should avoid requiring exposed piping outside on the drawings. All ground source

heat pump system piping should be designed and installed underground below the frost line.

2. Water source heat pump system piping to a closed circuit cooling tower or other heat transfer device should be designed and installed underground below the frost line.

3. The designer should consider heat tracing any exposed piping and valves, depending on the climate, such as piping exposed at a closed circuit cooling tower or water piping to a condenser.

4. Where piping is required to be exposed outside, the designer should consider using steel or copper pipe and fittings. The designer should provide heat tape on steel or copper pipe.

****

Provide UL listed parallel conduction type heat tape, with electrical characteristics indicated, and adjustable thermostat for outdoor aboveground winterized piping. The heat trace system is to meet requirements of the NFPA 70, Section 427. The tape is not to be affected by direct sunlight, ambient temperature, operating temperature, rain, or salt laden atmosphere.

2.6.1 Heat Tape Construction

Provide flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation must prevent overheating and burnouts even where the cable overlaps itself.

a. Provide end seals for ends of circuits. Wire at the ends of circuits are not to be tied together.

b. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at 1.1 degrees C 34 degrees F minimum during winter outdoor design temperature[of [_____]] [as indicated], but not less than the following:

    (1) 80 mm 3 inch pipe and smaller with 25 mm one inch thick insulation, 4 watts/0.3 m 4 watts/feet.

    (2) 100 mm 4 inch pipe and larger 38 mm 1.5 inch thick insulation, 8 watts/0.3 m 8 watts/feet of pipe.

2.6.2 Electrical Accessories

a. Power supply connection fitting and stainless steel mounting brackets. Provide stainless steel worm gear clamp to fasten bracket to pipe.

b. 13 mm 0.5 inch wide fiberglass reinforced pressure sensitive cloth tape to fasten cable to pipe at 305 mm 12 inch intervals.

c. Pipe surface temperature control thermostat is to be cast aluminum, NEMA 4 (watertight) enclosure, 15 mm 0.5 inch NPT conduit hub, SPST switch rated 20 amperes at 480 volts ac, with capillary and copper bulb sensor. Set thermostat to maintain pipe surface temperature at not less than 1.1 degrees C 34 degrees F.

d. Signs must be manufacturer's standard (NEC), stamped "ELECTRIC TRACED" located on the insulation jacket at 3 mm 10 feet intervals along the pipe on alternating sides.

2.7 AUXILIARY DRAIN PAN, DRAIN CONNECTIONS, AND DRAIN LINES

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NOTE: Indicate on the design drawings the locations of access doors for valves.

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Provide galvanized steel auxiliary drain pans under units where indicated. Provide separate drain lines for the unit drain and auxiliary drain pans. Drain pans are to be fully and freely draining in compliance with ASHRAE 62.1. Trap drain pans to ensure complete pan drainage. Provide drain lines full size of drain opening. Traps and piping to drainage disposal points to conform to Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.8 ANTIFREEZE PROTECTION

****

NOTES:

1. Antifreeze solutions may be necessary in colder climates where the temperature of the ground heat exchanger fluid falls below the freezing point of water.

2. The designer should determine the need for antifreeze based on analysis of the system, loads, and the resulting fluid temperatures over the annual cycle.

3. The designer should determine the amount of antifreeze required. The designer should not specify beyond what is required. The heat transfer fluid with antifreeze affects the pump power consumption and also quantity the heat transfer from the heat pump. Specify percent antifreeze solution in paragraph below.

4. The designer is to comply with local, state, and federal regulations regarding the use of antifreeze in the ground loop heat exchangers.

5. The designer should always evaluate the life-health safety risk and impact of the selected heat transfer fluid.

6. The designer should indicate the percentage of antifreeze required for the heat transfer fluid on the drawings.

****

Provide [_____] percent[ethylene glycol][propylene glycol] antifreeze fluid in a water based solution which meets local, State, and Federal requirements and is acceptable to heat pump component manufacturers. The antifreeze and water-based heat transfer fluid are to be used in closed-loop ground source heat pump systems for the transfer of energy to provide heating and cooling. The heat transfer fluid is to contain the necessary corrosion inhibitors to protect pipe and equipment from attack by the antifreeze solution utilized. The mixture of antifreeze and corrosion inhibitors in a water based solution is defined as a heat transfer fluid.

2.8.1 Biodegradability

The heat transfer fluid is not to be less than 90 percent biodegradable.

2.8.2 Properties of the Heat Transfer Fluid

The heat transfer fluid is to conform to the following requirements, and tests must be performed in accordance with specified test methods on the fluid.

2.8.2.1 Flash Point

The flash point of the heat transfer fluid is to not be lower than 90 degrees C 194 degrees F, determined in accordance with ASTM D92.

2.8.2.2 Biological Oxygen Demand (BOD)

For 5 days the BOD, at 10 degrees C 50 degrees F, must not exceed 0.2 gram 0.007 ounce oxygen per gram nor be less than 0.1 gram 0.0035 ounce oxygen per gram.

2.8.2.3 Freezing Point

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NOTE: The designer should determine the resulting freeze point of the heat transfer fluid after careful analysis. The designer should indicate the required freezing point of the heat transfer fluid.

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The freezing point must not exceed minus 9 degrees C 15 degrees F, determined in accordance with ASTM D1177.

2.8.2.4 Toxicity

The toxicity is not to be less than LD 50 (oral-rats) of 5 grams 0.175 ounce per kilogram. The NFPA hazardous material rating for health must not be more than 1 (slight).

2.8.2.5 Storage Stability

The heat transfer fluid, tested in accordance with ASTM F1105, must neither show separation from exposure to heat or cold nor show an increase in turbidity.

2.8.3 Quality

The heat transfer fluid, is to be homogeneous, uniform in color, and free from skins, lumps, and foreign materials detrimental to usage of the fluid.

[2.9 CHEMICAL FEED PROVISIONS

Provide chemical feed provisions as specified in Section 23 64 26 CHILLED, CHILLED-HOT, CONDENSER WATER PIPING SYSTEMS.

[2.9.1 Aboveground Condenser Water Piping System

Add borate-nitrite corrosion inhibitors, acceptable to heat pump component manufacturers, to initial fill water for heating and cooling water systems in concentrations of[0.0039 liter/liter 0.5 ounce/gal] of system water if corrosion inhibitors are not contained in freeze protection solution in the ground heat exchanger loop.

][2.9.2 Chilled/Hot Water Piping System

Add borate-nitrite corrosion inhibitors, acceptable to heat pump component manufacturers, to initial fill water for heating and cooling water systems in concentrations of[0.0039 liter/liter 0.5 ounce/gal] of system water if corrosion inhibitors are not contained in freeze protection solution in the ground heat exchanger loop.

][2.9.3 Ground Heat Exchanger Piping

Provide corrosion inhibitors acceptable to heat pump manufacturers with concentrations suitable for each system[and appropriate for the antifreeze used].

]]2.10 PAINTING OF NEW EQUIPMENT

New equipment painting is to be factory applied or shop applied, and must be as specified herein. New equipment surfaces constructed of non-ferrous surfaces and materials do not have to be factory or shop painted.

2.10.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors which is to withstand [125][500][3000] hours in a salt-spray fog test. Field applied coatings are not acceptable. Provide a factory coating system on the fins of exterior heat transfer equipment that meets ASTM B117.85 salt-fog test duration for [125][500][3000] hr. Salt-spray fog test is to be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment is not to be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory painting system is to be designed for the temperature service.

2.10.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except stainless steel, aluminum, or bronze alloy surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat is to be aluminum or light gray.

a. Temperatures Less Than 50 Degrees C 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm 0.3 mil, one coat of primer applied to a minimum dry film thickness of 0.0255 mm one mil; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm one mil per coat.

b. Temperatures Between 50 and 205 Degrees C 120 and 400 Degrees F: Metal surfaces subject to temperatures between 50 and 205 degrees C 120 and 400 degrees F are to receive two coats of 205 degrees C 400 degrees F heat-resisting enamel applied to a total minimum thickness of 0.05 mm 2 mils.

c. Temperatures Greater Than 205 Degrees C 400 Degrees F: Metal surfaces subject to temperatures greater than 205 degrees C 400 degrees F are to receive two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm 2 mils.

2.11 BENTONITE GROUT

Provide bentonite grout mixture for pressure grouting and sealing the bore hole of the vertical well. Provide grouting of wells in accordance with IGSHPA 21015. The grout selected is to meet NSF/ANSI 600. The grout is to meet all local and state rules and regulations. The bentonite will be a slurry that will be tremie grouted from the bottom of the boring to the surface in accordance with the IGSHPA installation manual. The contractor will work quickly to assure that there are no air voids forming as a result of the bentonite placing.

[2.11.1 High Grade Bentonite Grout

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NOTE: Check with local and State requirements regarding the use of bentonite for sealing of the bore hole. Consider the use of high grade bentonite grout where thermal performance is not an issue. The thermal conductivity of the grout will have to be considered the designer in the heat transfer calculation and well design and sizing. High grade bentonite grout is usually used for wells that have unconsolidated (sand and gravel or soil like) aquifers. The high grade bentonite grout mixture consists of 50 pounds of bentonite mixed with 23 gallons of potable water which gives a mixture of 27 gallons of high grade bentonite grout.

****

Provide high grade bentonite grout mixture. The grout is to be mixed with potable water. The grout is to be mixed per manufacturer instructions.

The thermoconductivity of the grout must be 0.744 W/mK 0.43 Btu/hr-ft-F or greater. The minimum solids content must be 23 percent. The target grout weight must be 1140 kg/m3 9.5 lb/gallons to 1176 kg/m3 9.8 lb/gallon.

][2.11.2 Thermally-Enhanced Bentonite Grout

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NOTE: Check with local and State requirements regarding the use of bentonite for sealing of the bore hole. Use thermally enhanced bentonite grout mixture where the thermal characteristic of the well is critical to the performance of the well system. The thermal conductivity of the grout will have to be considered by the designer in the heat transfer calculation and well design and sizing. Thermally enhanced bentonite grout is usually used for wells that have unconsolidated (sand and gravel or soil like) aquifers. The thermally enhanced bentonite grout mixture consists of 54 pounds of bentonite mixed with 350 pounds of silica sand, and 21.5 gallons of potable water which gives a mixture of 41 gallons of thermally enhanced bentonite grout.with a solids content of 69 percent, a weight of 14.2 lb/gallon, and a thermal conductivity of 1.12 Btu/hr-ft F.

****

Provide thermally enhanced bentonite grout mixture. Thermally enhanced bentonite grout mixture is to be a high solids bentonite grout. The grout is to be mixed per the manufacturer instructions. Potable water is to be used for mixing the grout. Grout is to have a minimum solids content of 65 to 70 percent. The thermal conductivity of the grout mixture compound must be a minimum of 1.73 W/mK 1.0 Btu/hr-ft-F or greater. The target grout weight must be 1596 kg/m3 13.3 lb/gallons to 1728 kg/m3 14.4 lb/gallon. The thermally-enhanced bentonite grout must have a thermal enhancement compound consisting of a high-grade silica compound that constitutes a minimum of 50 percent by weight of the aqueous slurry.

][2.11.3 Cementitious Thermally Enhanced Grout

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NOTE: Use cementitious thermally enhanced bentonite grout mixture where the thermal characteristic of the well is critical to the performance of the well system. The thermal conductivity of the grout will have to be considered by the designer in the heat transfer calculation and well design and sizing. Cementitious thermally enhanced bentonite grout is usually used for wells that have consolidated (rock, limestone, sandstone, bed rock, granite, etc) aquifers. Use this grout where the ground water has a pH less than 5.0 and/or a total dissolved solids content greater than 1000 ppm. The cementitious thermally enhanced bentonite grout mixture consists of 94 pounds of portland cement mixed with 200 pounds of silica sand, 1.04 pounds of 200 mesh sodium bentonite, 6.19 gallons of potable water, and 21 fluid ounces of a superplasticizer (sulfonated naphthalene) which gives a mixture of 19 gallons of

cementitious thermally enhanced bentonite grout.with a weight of 18 lb/gallon, and a thermal conductivity of 1.4 Btu/hr-ft F. For salt water zones, use a grouting material that is resistant to salt water.
****

Provide cementitious thermally enhanced grout mixture. The cementitious thermally enhanced grout mixture is to be a high solids sodium bentonite grout with portland cement, potable water, silica sand compound, and a super plasticizer compound. The grout is to be mixed per the manufacturer instructions. Use potable water for mixing the grout. The thermal conductivity of the grout mixture compound is to be a minimum of 2.42 W/mK 1.4 Btu/hr-ft-F or greater. The target grout weight must be 1920 kg/m3 16 lb/gallon.

]2.12 CONTROLS

Controls for the[ground-loop][water-loop] heat pump systems complete and ready for operation to be integrated with the HVAC system controls package specified in Section[23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS,] 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Systems include heat pumps, system equipment, piping, pumps, electrical equipment, controls,[wells,] and condenser Controls are to be designed in accordance with the manufacturer's recommendations and to comply with the sequence of controls shown on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Heat Pump System

Maintenance access to each piece of equipment is not to be compromised by any type of piping, electrical conduit, or any other utility. Further, install equipment in accordance with NFPA 70 and with the manufacturer's written installation instructions, including the following:

[Water-Source Water-to-Air Heat Pumps - Installation Instructions

][Water-Source Water-to-Water Heat Pumps - Installation Instructions

][Closed Circuit Coolers - Installation Instructions

][Plate Heat Exchangers - Installation Instructions

][Heat Tape - Installation Instructions

][As-Built Drawings of the installed systems. As-built drawings are to also show and document the as-constructed locations of the well field with dimensions, including all wells and loop fields.

]3.1.2 Closed Circuit Cooler Installation

Installation, operation and maintenance of the closed circuit cooler must be in compliance with the requirements of ASHRAE 188. Provide Closed Circuit Coolers - Operating Instructions defining required maintenance, cleaning and operating procedures for the mitigation of legionellosis in accordance with ASHRAE 188.

3.1.3 Connections to Existing Systems

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems. Flush existing systems in accordance with paragraph FLUSHING AND PURGING GROUND HEAT EXCHANGER prior to making connections.

3.2 ABOVEGROUND PIPING

Provide above ground piping as specified in Section 23 64 26 CHILLED, CHILLED-HOT, CONDENSER WATER PIPING SYSTEMS.

a. Cleaning of Piping: Keep interior and ends of new piping and existing piping, affected by Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

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NOTE: It is extremely important to vent and purge all air out of the loops, especially the plastic piping systems. Leaving any air in the piping could lead to potential flow blockage and could lead to a catastrophic pipe failure by explosion.

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b. Flushing and Purging of Piping: Before connection of the header to the polyethylene ground heat exchanger loops, flush and purge the entire aboveground piping system thoroughly in accordance with IGSHPA 21020 recommendations and leave filled with clean water. If the header is not immediately joined to the ground heat exchanger loop, the open ends are to be taped or capped. Purge and vent the above ground system piping of all air.

3.3 EARTHWORK

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NOTES: For the designer to consider - geothermal piping do not require trenches with graded bottoms, load bearing bottoms, or sand fill bedding unless the piping is on rock. Backfill trenches with soil fine enough to fill completely around the pipe. Compacting to 150 mm 6 inch lifts is not required.

a. Consider for large systems: Lay all supply piping in an orderly way in one trench. Consider the same trench method for return systems.

b. Consider for residential systems: consider geothermal piping on one side of trench for utilities.

c. Aside from building entries or vault connection areas, the geothermal pipe loops are flexible, and

contract and expand due to temperature variations.
****

Earthwork to be performed in accordance with applicable provisions of Section 31 00 00 EARTHWORK, except that bentonite and thermally enhanced grouts to be used where indicated.

3.4 GROUND HEAT EXCHANGER PIPING

Examine areas and conditions under which ground heat exchanger systems will be installed. Prior to excavation, trenching, or drilling, locate and mark buried utilities. Do not proceed with work until approved by the Contracting Officer. Sharp bends and mitered joints are to not be used in piping. Provide fittings for changes in direction when minimum bend radius, as recommended by the pipe manufacturer, is exceeded. All pipe bends are to be radius type elbows. Make changes in piping sizes through tapered concentric fittings. Leaks are to be "cut-out" and repaired in accordance with the pipe manufacturer's recommendations. Direct buried threaded or flanged connections are not permitted. Prior to installation of the ground heat exchanger systems, verify that the installers are certified Ground Heat Exchanger Installers. Inspect all piping for damage prior to installation. Installation to follow IGSHPA guidelines as well as local, state, and Federal guidelines and regulations. Upon delivery of piping, inspect the pipe for damage and verify that the pipe meets the project specifications. Prior to installation of pipe, carefully inspect pipe for damage. Do not use the pipe if it has a cut or a gouge that is more than 10 per cent of the minimum wall thickness of the pipe.[Provide reels and pipe coil. Reels to be be used to securely hold the pipe coil while being pressure tested. When inserting the pipe into the bore hole, spool off pipe from the reel into the hole.]

3.4.1 Vertical Well Fields

****
NOTE: The designer must become familiar with the local and state regulations regarding geothermal wells and water wells. The designer must modify these specifications in accordance to the local and state regulations. The designer must design and specify the heat exchanger systems to meet the specific local and state regulations and statutes that may be required, such as:

a. Well driller licensing and certification
b. Pump installer licensing
c. Well construction permit
d. Local and/or State approved well permit
e. Allowable grout requirements
f. Allowable heat transfer fluids
g. Allowable pipe materials
h. Well construction log record
i. Well abandonment and abandonment records
j. Well closing and closing records.
k. Antifreeze fluids, if any
l. Water treatment chemicals, if any
m. Corrosion inhibitors, if any
n. Groundwater conservation
o. Protection of different aquifers
p. Authorization to install and operate

****

Each vertical well and ground heat exchanger loop is to have a Well Construction Permit as required by local and state regulations. In addition, each well and ground heat exchanger loop is to have a local [and][or] state Approved Well Permit as required by local and state regulations. The contractor must maintain these permits during the construction contract period. Submit a copy of the permits with the As-built documentation. Construction and installation of each well are to be in accordance to these permits. Each well is to be performed by a state [_____] certified well driller. Certifications are to be in the state where the work occurs. Prior to installation of wells, verify the the well drillers and pump installers are certified. For any well that is abandon, abandonment must be performed in accordance to local and state regulations. Provide abandonment records with certification to the contracting officer for review and submittal to the state. For any well that is closed, closing to be performed in accordance to local and state regulations. Provide closing records with certification to the contracting officer for review and submittal to the state. All well submittals and records are to have the names of the well drillers and pump installers, copies of their certifications.

Each U-bend loop is to be factory assembled, laid out straight, taped to reduce springback, and water pressure tested at 689 kPa 100 psi for leaks and flow by IGSHPA 21020 recommended procedures before the hole is bored. Comply with all local and state codes, regulations, and requirements during the construction of the vertical wells or bore holes. Submit for each vertical well a Well Construction Log Record.

a. The borehole is to be constructed[in accordance with all local and state regulations and guidelines for geothermal wells][as indicated]. Where any discrepancy exists between local and state codes, regulations, and requirements and this specification, the more stringent requirement applies. The U-bend is to be factory assembled and pressure tested to 689.5 kPa gage 100 psig prior to insertion into the vertical bore. All connections are to be by heat fusion. When inserting the U-bend assembly into the bore hole, use the depth graduations as another means of verification of depth of the bore hole. There is to be no joint in either leg of each vertical loop except for the factory assembled connection at the U-bend.

b. Vertical bores are to be 1.5 m 5 feet deeper than the length of the U-bend assembly loop, be clean (no casing), and of sufficient diameter to facilitate the installation of the U-bend assembly and a third pipe for pressure grouting. Fill the loop with water and pressurize to 276 kPa 40 psi to prevent the pipe from being crushed by backfill material. Temporarily cap the ends of the U-bend assemblies until the actual testing begins. The cap must be fused to the pipe end in order to hold the pressure. Pressure testing can be performed while the bore hole is being drilled.

****

NOTE: The loop must be filled with water prior to insertion into the hole that has drilling mud and/or water in it. However, for dry holes (drilled with air and have very little water in them), consider installing tubing without water and fill and test after insertion. The disadvantage with this is during pressure testing - leaks will be hard to see

visually.
****

c. Backfill the bores from the bottom up with a bentonite grout material and grouting process in conformance with IGSHPA 21015 to ensure pipe contact and compliance with local and State requirements for sealing. Prepare and mix bentonite grout in accordance with manufacturer's recommendations for water-to-mix ratio. Place grouting materials using a pressure pump with a tremie pipe system. Install the grouting material from the bottom to the top of the vertical borehole. If any settling occurs during the initial 24-hour period after installation, add additional material to insure the grouting material remains at the desired surface level. The bores are not to contain large, sharp, or jagged rocks or debris. Take reasonable and prudent care during installation and backfilling to not crush, cut, or kink the pipe.

d. In the event that a geological formation is encountered, that prevents the grouting material from forming a solid seal, either a 9.5 mm 3/8 inch or 19 mm 3/4 inch cementitious bentonite grout material may be used to seal the specific formation zone. Notify the contracting officer of any problems encountered. Upon completion of the specific zone, resume grouting until the desired surface of the vertical well or bore hole is reached.

e. During installation of the vertical well, maintain a water and soils log indicating depth of water encountered, materials encountered, depth intervals of materials, and physical description. If water is encountered, indicate in the log the depths at which it was encountered, and the static water level. Include in the log the type of drill rig used, the actual drilling time to complete the bore hole.

f. In absence of other requirements or as indicated, provide u-bend assemblies having the following pipe diameters for the u-bend assembly length as follows:

g. 19 mm 3/4 inch diameter for 30 to 60 m 100 to 200 feet loop length

h. 25 mm 1 inch diameter for 45 to 90 m 150 to 300 feet loop length

i. 32 mm 1-1/4 inch diameter for 76 to 150 m 250 to 500 feet loop length

j. Show and identify each well location on as built drawings.[Provide a tracer wire system.][The tracer wire system is to include a locator device to identify the well field. Locate the locator device in the mechanical room.]

k. Minimum vertical well distance: In absence of other requirements or as indicated, provide a minimum well separation distance between wells of 4.572 [_____] m 15 [_____] feet. Provide a minimum separation distance between wells and building foundation walls of 6.0 [_____]m 20 [_____] feet.

3.4.2 Horizontal Well Fields and Header Piping

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NOTE: For insulation on buried piping: The intent with the option or bracketed requirement noted below is to prevent frost heave. The specifying engineer/designer should delete the option where

fluid temperatures are not below 1.7 degrees C 35 degrees F.
****

Horizontal trenches for ground heat exchanger piping may be dug with a chain type trenching machine or a backhoe. Bury the piping a minimum of 1.2 m 48 inches deep or as indicated. Make joints while pipe is laying beside the trench. If the soil contains rocks, dig the trench 152 mm 6 inches deeper than required and install a base of 152 mm 6 inches of fines or sand before placing the pipe.[Buried piping in systems containing antifreeze and installed within 1.5 m 60 inches of any building wall, structure, or pipe to be insulated with R-2 minimum closed cell insulation.] After the piping is installed, tested, and flushed, purged, inspected, and approved while still under pressure, backfill 152 mm 6 inches above with fines or sand. Complete backfill in accordance with IGSHPA 21020 recommended procedures. When laying pipe in trench, insure the bottom of the trench is smooth, free from rocks and debris. When laying pipe, use a fine to medium backfill to fill trench. If there are multiple pipes in the trench, insure each pipe is completely surrounded and supported with backfill before the next pipe is installed.

[3.4.2.1 Piping at Building Entries

****
NOTE: For ease of pipe installation of small systems, consider using PVC conduit as a means of a pipe casing for pipe entries into buildings.
****

Install a rigid non-metallic conduit (PVC) as a pipe casing at building entries and floor penetration. The casing allows ease of installation of the ground heat exchanger piping into the building. The conduit should extend 610 mm 24 inches from the building foundation. The conduit should end 152 mm6 inches above the floor. The ends of the conduit where the pipe is located, fill the annular space with insulation and a silicone seal.

]3.4.3 Polyethylene Piping

Install piping in accordance with manufacturer's written instructions. Do not use polybutylene piping. Join piping components by a heat fusion method that conforms the piping manufacturer's recommendation for this application. During installation, keep trash, soil, and foreign objects out of the pipe. Tape or cap ends of the pipe until the pipe is joined to the circuit. The vertical loop take-off tee fittings may be made using tee fittings or the saddle fusion process on header piping 32 mm 1.25 inches diameter and above. Completely remove the cutout on the saddle tees. Use bell reductions at pipe reductions. Use reducing socket tees when fabricating socket type reducing headers. Avoid sharp bends and mitered elbows and bends in piping. Consult pipe manufacturer for minimum bend radius. Install elbow fittings at changes in pipe direction that are tighter than the minimum recommended bend radius. Use only continuous pipe in vertical U-bend loops.

3.4.4 Heat Fusion Process

Joining is to be either by butt, socket, or saddle (for sidewall applications only) fusion in accordance with the manufacturer's Heat Fusion Qualification Guide. Use socket fusion joints for pipe 20 mm 3/4 inches diameter and less. Use butt fusion joints for pipe greater than 20 mm 3/4 inches diameter. Different plastics or grades of plastic are not to be fused together. When fusing pipe, perform heat fusion tests to verify the quality of the joints. Notify the Contracting Officer, the results of the heat fusion tests.

3.4.5 Pressurizing

After assembly of the entire ground loop system, fill the system with water and pressure test to 689 kPa 100 psi. Visually inspect welds prior to backfill of the trenches.

3.4.6 Pipe Identification

Install metalized (detectable) warning and identification tape above each horizontal pipe run. Install tape a minimum of 152 mm 6 inches below finish grade. Install mechanical identification of vertical bore holes and connecting headers.

[3.4.7 Tracer Wire

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NOTE: In lieu of a tracer wire system, consider a a metalized warning tape.

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Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations. [Provide a tracer wire system with a locator device for identifying the well field.]

]3.4.8 Threaded Fittings

Seal threaded joints with a sealant compatible with the circulating fluid; use of lubricating tape for sealing is not permitted. Do not thread metal pipe into plastic pipe or vice versa. Direct buried threaded joints are not permitted. Threaded joints may be used only above grade, within mechanical spaces, or within valve pits.

3.5 FIELD PAINTING AND FINISHING

Requirements for field painting and finishing are specified in Section 09 90 00 PAINTS AND COATINGS.

3.6 FLUSHING AND PURGING GROUND HEAT EXCHANGER

Before connection of the plastic ground heat exchanger loops to the header, flush and purge each loop thoroughly in accordance with IGSHPA 21020 recommendations and leave filled with clean water. If the loop is not immediately joined to the header, it must be taped or capped. Purge and vent the ground heat exchanger system piping of all air.

3.7 ADJUSTMENTS

****

NOTE: All design water and air flowrates are to be indicated on the plans.

****

Adjust controls and equipment so as to give satisfactory operation. Adjust entire water temperature control system and place in operation so that water quantities circulated are as indicated. Adjust and balance air duct systems so that air quantities at outlets are as indicated and so that distribution from supply outlets is free from drafts and has uniform velocity over the face of each outlet.

3.8 INSTRUCTING OPERATING PERSONNEL

Upon completion of work and at time designated by Contracting Officer, provide services of water source heat pump manufacturer's technical representative for period of not less than one 8-hour working day for instruction of Government operating personnel in proper operation and maintenance of equipment.

3.9 FIELD QUALITY CONTROL

Upon completion and before final acceptance of work, test each system in service to demonstrate compliance with the contract requirements. Adjust controls and balance systems prior to final acceptance of completed systems. Test controls through every cycle of operation. Test safety controls to demonstrate performance of required function. Correct defects in work provided by Contractor and repeat tests. Furnish fuel, water, electricity, instruments, connecting devices, and personnel for tests. Flush and clean piping before placing in operation. Clean equipment, piping, strainers, ducts, and filters. Perform and document that proper Indoor Air Quality During Construction procedures have been followed; this includes providing documentation showing that after construction ends, and prior to occupancy, new replaceable filters were provided and installed and permanent filters were cleaned.

3.9.1 Piping Systems Except for Ground Heat Exchanger and Refrigerant

For above ground piping systems, and steel or copper piping systems: Before insulating, hydrostatically test each new piping system at not less than[1.5 times the system working pressure][1296 kPa gage 188 psi based on 1.5 times a system pressure of 862 kpa gage 125 psig]. Maintain pressure for 2 hours with no leakage or reduction in gage pressure. Obtain approval before applying insulation.

3.9.2 Flow Test of Ground Heat Exchanger Piping

Before backfilling the trenches, flush, purge, and vent systems of air and flow test to ensure all portions of the heat exchanger are properly flowing using the procedures recommended by IGSHPA 21020. Utilize a portable temporary purging unit consisting of the following: high volume, high head purge pump; open reservoir; filter assembly with bypass; flow meter; pressure gage; connecting piping; and connecting hoses.

****

NOTES:

1. These purging and venting requirements are for heat pump systems with a connected loop capacity of 35.2 kilowatt 10 tons or less of connected loop capacity.

2. In larger systems greater than 35.2 kilowatt 10 tons of connected loop capacity, the designer must indicate on the drawings a system design that allows

purging and venting of air with high horsepower circulating pumps, air ejectors, and valved-off header systems. A portable purge pump may not be necessary if the ground heat exchanger and indoor piping is free of debris and other construction material.

3. For larger ground source heat pump systems, greater than 35.2 Kilowatt 10 tons of connected loop capacity, the designer should show on the drawings ground exchanger loops with accessible valves and flushing/vent connections inside a building or in manholes for each section.

****

a. Using a purge pump and the procedures recommended by IGSHPA 21020, flush and purge each ground heat exchanger system until free of air, dirt, and debris. A velocity of 0.6 m/sec 2 feet/sec is required in pipe sections to remove the air. Purge and vent all air from the piping.

b. Perform the flushing and purging operation with the water source heat pumps isolated by shutoff valves from the ground heat exchanger system. Allow purge pump to run 15 minutes after the last air bubbles have been removed. After the ground heat exchanger is completely flushed of air and debris, open the isolation valves and permit circulation through the heat pumps until the entire system is flushed and purged.

c. Utilizing the purging unit and the procedures recommended by IGSHPA 21020, conduct a pressure and flow test on the ground heat exchanger to ensure the system is free of blockage. If the flow test indicates blockage, locate the blockage using the manufacturer's recommendation, remove the blockage, then repeat the purge procedure and conduct the pressure and flow test again until all portions of the system are free flowing. The flow test is to be observed and approved by the Contracting Officer.

d. After purging has been completed, add the required amount of antifreeze to the system to achieve the required solution concentration. [Fill the open reservoir with the quantity of antifreeze required for minus 9 degree C 15 degree F freeze protection and run the purge pump 15 minutes to deliver the antifreeze to the system. Test the solution with a hydrometer to determine the actual freezing point.]

e. Form 1, "Ground Heat Exchanger Inspection and Test Report" located in Appendix A of this section is to be completed for each system by the[Contractor][or QC Manager] after completion of the flow[and injection of required antifreeze to the system and] before the systems can be backfilled.

3.9.3 Pressure Test of Ground Heat Exchanger Piping

Prior to any cover or backfill of bore holes or trenches and after flow testing, flushing, and purging, the ground heat exchanger piping and headers are to be pressure tested by hydrostatic test. Isolate the system from all connections to piping. Ensure that the piping system has been flushed of all dirt and debris. The piping must then be plugged or capped as necessary in preparation for the hydrostatic test(s).

3.9.3.1 Hydrostatic Test

The piping is to be hydrostatically pressurized to 150 percent of system pressure [or [1000][_____] kPa [150][_____] psi] and monitor piping. If there is any pressure loss or visible leakage during the testing, the leak must be identified and repaired in accordance with the piping components manufacturer's recommendations. Repeat the test until there is no loss in pressure during the test period. Provide results of test in test report. During testing, do not exceed the pipe/pipe fitting manufacturer test pressure rating[or 150 percent of the pipe pressure rating]. Do not pneumatic test the pipe. Prior to testing, remove all air from the system. Provide test in accordance to IGSHPA standards.

3.9.4 Refrigerant Piping Pressure Test and Evacuation

Perform the following when field piping connections are provided.

a. Pressure Test: Test refrigerant piping using dry, oil-free nitrogen, and prove tight at 2068 kPa 300 psi on the high side and 1027 kPa 150 psi on the low side. Maintain pressure for 2 hours with no leakage or reduction in gage pressure.

b. Evacuation: Use a high vacuum pump and certified micron gage to reduce the absolute pressure on both sides of system simultaneously to 300 microns 300 microns. After reaching this point charge system with proper refrigerant until pressure of 0 kPa 0 psi is obtained. Repeat evacuation-charging procedure for two more cycles, totaling to three evacuation-charging cycles. On final evacuation, secure pump and maintain 300 microns 300 microns for 2 hours before charging with required final refrigerant.

3.9.5 Equipment Tests

3.9.5.1 Field Testing

****

NOTE: It needs to be understood that this is a standard operation test, not a continuous operation test. A long continuous test of more than 24 hours, could artificially and unnecessarily load the ground mass around the ground heat exchanger.

****

Test each item of equipment in operation,[for continuous period of not more than 24 hours] under every condition of operation in accordance with each equipment manufacturer's recommendation. Verify that each item of equipment operating parameters are within limits recommended by the manufacturer.

3.9.5.2 Field Test Plans

Furnish water-source heat pump[and closed circuit cooler] field test plans developed by each equipment manufacturer detailing recommended field test procedures for each item of equipment. Field test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment will not be acceptable. The Contracting Officer will review and approve the field test plan for each item of equipment listed below prior to commencement of field testing of the equipment.

a. Equipment Items to Test:

[(1) Water-Source Water-to-Air Heat Pumps - Field Acceptance Test Plan

][(2) Water-Source Water-to-Water Heat Pumps - Field Acceptance Test Plan

][(3) Closed Circuit Coolers - Field Acceptance Test Plan

][(4) Plate Heat Exchangers - Field Acceptance Test Plan

] b. Coordinated Testing: Indicate in each field test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of equipment controls which interlock and interface with controls factory prewired or external controls for the equipment provided under Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

c. Prerequisite Testing: Equipment for which performance testing is dependent upon the completion of the work covered by 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC must have that work completed as a prerequisite to testing work under this section. Indicate in each field test plan when such prerequisite work is required.

d. Test Procedure: Indicate in each field test plan each equipment manufacturer's published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer. Each test plan is to include the required test reporting forms to be completed by the Contractor's testing representatives. Structure procedures to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control. Controllers are to be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

e. Performance Variables: Each test plan lists performance variables that are required to be measured or tested as part of the field test. Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Furnish with each test procedure a description of acceptable results that have been verified. Identify the acceptable limits or tolerances within which each tested performance variable must acceptably operate.

f. Job Specific: Each test plan is to be job specific and to address the particular item of equipment and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.

g. Specialized Components: Each test plan is to include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3.9.5.3 Field Test Reports

a. Equipment Items to Test:

[(1) Water-Source Water-to-Air Heat Pumps - Field Acceptance Test Report

][(2) Water-Source Water-to-Water Heat Pumps - Field Acceptance Test Report

][(3) Closed Circuit Coolers - Field Acceptance Test Report

][(4) Plate Heat Exchangers - Field Acceptance Test Report

] b. Manufacturer's Recommended Test: Conduct the manufacturer's recommended field testing in compliance with the approved test plan specified above. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field testing.

c. Operational Test: Conduct a standard[continuous 24 hour] operational test for each item of equipment. Equipment shutdown before the test period is completed must result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every 2 hours. Use the test report forms for logging the operational variables.

****

NOTE: It needs to be understood that this is a standard operation test, not a continuous operation test. A long continuous test of more than 24 hours, could artificially and unnecessarily load the ground mass around the ground heat exchanger.

****

d. Notice of Tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.

e. Report Forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment are to be reviewed, approved, and signed by the Contractor's test director and the QC Manager. The manufacturer's field test representative is to review, approve, and sign the report of the manufacturer's recommended test. Signatures are required to be accompanied by the person's name, typed.

f. Deficiency Resolution: The test requirements acceptably met; deficiencies identified during the tests must be corrected in compliance with the manufacturer's recommendations and corrections retested to verify compliance.

3.9.6 Additional Field Testing

[Requirements for testing, adjusting, and balancing (TAB) of ducts, piping, and equipment are specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.][Begin testing, adjusting, and balancing only when the entire HVAC system, including controls, has been completed with the exception of performance tests. Where required, charge the heat pump systems with premixed antifreeze solution (type and concentration as indicated in paragraph ANTIFREEZE PROTECTION) prior to testing, adjusting, and balancing.]

****

NOTE: For Navy projects, use this paragraph for each building which has less than 28.1 kW 96,000 Btuh of cooling, less than 372 square meters 4000 square feet of floor space, or less than 15 supply air outlets. Include bracketed option for Navy projects.

****

[Balance air flows to that indicated in accordance with SMACNA 1966, as supplemented and modified by this section. Begin testing, adjusting, and balancing only when the entire HVAC system, including controls, has been completed with the exception of performance tests. Where required, charge the heat pump systems with premixed antifreeze solution (type and concentration as indicated in paragraph ANTIFREEZE PROTECTION) prior to testing, adjusting, and balancing. Submit written certificate to report the following:

a. Water source heat pump unit nameplate data, and actual voltage and ampere consumption.

b. Supply and return terminal airflow, and equipment used to measure airflow.

c. Water source heat pump liters/sec cfm and entering and leaving air temperatures.

d. Water source heat pump unit condenser water liters/sec gpm and entering and leaving temperatures.

e. Ambient outside air temperature, date, and person testing, balancing, and reporting.

]3.9.7 Soil Thermal Conductivity Testing

****

NOTES:

1. This subparagraph is for the designer to establish the thermal and sub-surface conditions of the thermal well field.

2. In addition, this paragraph can be utilized as a requirement for the contractor to establish the well field conditions after installation for verification purposes.

****

Perform soil thermal conductivity testing of the well system project location. The test will establish the thermal properties for design of the well field and the subsurface conditions at the site. The test will be performed by performed under the supervision of and certified by the ground source heat pump (GSHP) specialist. The test will be performed at[multiple] locations as[indicated][determined by the designer]. Each test will contain a minimum of 48 hours of recorded data.[Use the test for verification of the design and installation.]

3.9.7.1 Soil Thermal Conductivity Testing Set-up

Conduct and perform tests in accordance with the procedures outlined in ASHRAE Item 90376.

3.9.7.2 Data Recording and Sensor Accuracy

Record data by means of automatic data logging equipment intended for such purposes and suitable for service of local ambient outside conditions. Protect compensated thermocouple reference junctions, if used, either from separate from the data logging equipment or integral to it, from rapid changes in environmental conditions. Record data at uniform[5 minute] time intervals during the 48 hour test period. Data recorded will include a minimum time, inlet and outlet temperatures, heater power input, circulating pump power input, and ambient temperatures.

a. Temperature Measurements: Measure inlet and outlet temperatures with immersion temperature sensors. The temperatures sensors must be calibrated every 6 months and have a valid calibrated stamp. Include the date and results from the most recent calibration in the test report. Any change-out of the temperature sensor in the system or data logger will require re-calibration.

[b. Temperature Sensor calibration and accuracy: The combined rated sensor and data logger accuracy will be [as indicated] plus or minus 0.5 degrees C 1 degree F or better. Verify temperature sensor and data logger accuracy and calibration at first use of the testing device during the test. The testing equipment is to have been calibrated semi-annually by immersion in ice and water bath. A calibration certificate stamp with date must be on the test device. The result from the verification test using ice water bath is not to differ from 0 degrees C 32 degrees F by more than the required data accuracy. Additional readings will not differ from one another by more than plus or minus 0.2 degrees C 0.5 degrees F when simultaneously immersed in the ice bath.

] c. Power Measurements: Measure heater and circulating pump power input.[Power measurements are to be independently determined by using power transducers with the manufacturer stated accuracy of plus or minus two percent or better at the level of power consumption for the test.]

d. Flow Rate Measurements: Measure the flow rate.[Measure flow rate using a variable flow meter calibrated by the flow meter manufacturer having a rated accuracy of plus or minus two percent of full scale. Full scale or maximum rated flow for the flow meter is not to exceed actual flow rate by more than 70 percent.]

3.9.7.3 Test Borehole Construction

Prepare the bore hole in a manner in which the heat exchangers will be ultimately installed to the extent possible with respect to the bore hole size, pipe diameter grouting method, and grout types[as indicated]. The installation of the test bore hole must be as designed for the vertical well field. The bore hole depth is not to vary more than 5 percent from the indicated design depth. Materials of the test borehole and heat exchanger must be as utilized in the designed vertical well field.

a. At least 2 m 6 feet of excess pipe is to be left protruding above grade upon completion of the test borehole construction. Temporarily cap the ends of the protruding pipes until the actual testing begins. All local and state codes and regulations will be adhered to during the construction of the test bore hole. Where any discrepancy exists between local codes and regulations and this specification, the more stringent requirement applies. The U-tube assembly must be factory assembled and pressure tested to 689.5 kPa gage 100 psig prior to insertion into the vertical bore. All connections are to be by heat fusion.

b. During the completion of the test borehole, maintain a water well and soils property log. For each well submit a Test Borehole Well Construction Log Record

[3.9.8 On-Site Training

****

NOTE: For the designer to consider - consider 8 hours of training for residential and light commercial projects. Consider 16 hours for large geothermal projects. Training should be attended by the appropriate operation and maintenance station personnel.

****

The[System Designer][Ground Source Heat Pump Specialist] is to conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Provide training for a period of [16][_____] hours of normal working time and start after the system is functionally complete but prior to the performance tests. The on-site training is to cover all of the items contained in the approved Operation and Maintenance Data packages.

]3.10 APPENDIX A

Form 1 - Ground Heat Exchanger (Ghx) Inspection And Test Report

FORM 1

GROUND HEAT EXCHANGER (GHX) INSPECTION AND TEST REPORT

NOTE: Use separate form for each GHX loop system.

Building:_________________________ Inspection Date:_______________________

Ground Heat Exchanger No. or Description:_________________________________

Does the ground heat exchanger have a Well Construction Permit? Permit No.?

Does the ground heat exchanger have an approved well permit? Permit No.

List the WSHP Unit No.'s served by this GHX: _____________________________

Ground Heat Exchanger Design Water Flow - _____ liters/sec gpm

Calculated purging flow and press to achieve 0.61 m 2 feet/sec

Purging: Flow _____ liters/sec gpm Head _____ kPa psi, Duration of test _____ min.

Hydrostatic test pressure _____ kPa psi; Duration _____ min.

Did the system pass the pressure test? ___________________________________

Is antifreeze required in system?____ If yes, was antifreeze measured?____

Has a dimensioned drawing been prepared, completely and accurately showing the layout of the ground heat exchanger? _________________________________

Does the layout differ substantially from the contract documents? ________
If so is the deviation approved? _______________

Depth of installed vertical loops is _____m feet. (Design is ____ m feet.)

Depth of horizontal piping is _____ m feet. (Design is _____m feet.)

Are the trenches clear of sharp bends, rocks, or other sharp objects that could restrict flow?___________________

Are all joints heat fused (butt-, socket-, or saddle-fusion)?_____________
Do the joints have the proper amount of roll-out?_________________________

Has the piping material been cut-out and properly removed from saddle-fusion tees?_______________

Grout Manufacturer? ______________; Percent of solids used in grout?________Grout Type?_________Grout Thermal conductivity, k? (give units)______

Was the system backfilled properly with good clean backfill material?_____

Attach the soil boring and water well log sheet for the bore hole?__For each well submit a Well Construction Log Record

Comments:____
____
____
____
____
____

Inspected and approved this _________ date by ____________________________

Title: ____

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 82 00.00 20 (February 2016)**
Change 1 - 08/18

Preparing Activity: NAVFAC **Superseding**
UFGS-23 82 00.00 20 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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TERMINAL HEATING UNITS

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USACE / NAVFAC / AFCEC **UFGS-23 82 00.00 20 (February 2016)**
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SECTION 23 82 00.00 20

TERMINAL HEATING UNITS

02/16, CHG 1: 08/18

****

NOTE: This guide specification covers the requirements for unit heaters and infrared heaters.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z83.8/CSA 2.6	(2016; R 2021) Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces
ANSI Z83.19/CSA 2.35	(2017; R 2022) Gas-Fired High-Intensity Infrared Heaters

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 33	(2016) Method of Testing Forced Circulation Air Cooling and Air Heating Coils

ASTM INTERNATIONAL (ASTM)

ASTM A109/A109M	(2024) Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2024) Standard for the Installation of Warm Air Heating and Air Conditioning Systems
NFPA 91	(2020) Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

UL SOLUTIONS (UL)

UL 441	(2016; Reprint Apr 2024) UL Standard for Safety Gas Vents
UL 731	(2018; Reprint Nov 2021) UL Standard for Safety Oil-Fired Unit Heaters

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Unit Heaters

Infrared Heaters

SD-10 Operation and Maintenance Data

Unit Heaters, Data Package 2

Infrared Heaters, Data Package 2

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

****

NOTE: In order to comply with UFC 1-200-02, designs must achieve energy consumption levels that are at least 30 percent below the baseline established in the 2010 publication of ASHRAE 90.1. The Designer of Record must design heating and cooling systems that assist in achieving this requirement.

****

2.1 UNIT HEATERS

Self-contained and factory assembled, [propeller] [or] [centrifugal] fan with capacities expressed as Btu per hour output and cubic foot-per-minute air delivery, operating conditions, and mounting arrangements as indicated. Average fan bearing life must be minimum 200,000 hours at operating conditions. Provide fan motor with [direct] [or] [belt] drive. Construct fan-guard motor mount of steel wire. Equip each heater with individually adjustable package discharge louver. Louvers may be substituted by discharge cones or diffusers. Provide thermostats [as indicated]. Furnish circuit breaker disconnect switch.

2.1.1 Gas-Fired Unit Heater

ANSI Z83.8/CSA 2.6 and AGA label.

2.1.1.1 Casing

Minimum [22] [_____] gage [steel] [or] [aluminum]. Provide removable access panels.

2.1.1.2 Heat Exchanger

Minimum [20] [_____] gage all-welded steel construction with corrosion-resistant aluminum finish.

2.1.1.3 Burners

Die-formed, slot ports, and steel construction with aluminum paint.

2.1.1.4 Draft Diverter

All-welded steel construction and an integral part of each heat exchanger section. Allows backdrafts to bypass burner assembly without affecting normal operation.

2.1.1.5 Controls

Consisting of a combination pressure regulator, [two-stage gas valve in 100 percent and [55] [_____] percent of full rating,] main shutoff valve, pilot cock, pilot safety switch for 100 percent shutoff, high temperature limit switch, and time-delay fan switch. Include power and control connections in an integral junction box.

2.1.1.6 Efficiency

Unit heater must have a minimum combustion efficiency of 80 percent when tested in accordance with ANSI Z83.8/CSA 2.6.

[2.1.1.7 Accessories

****

NOTE: Do not acquire propane-gas conversion kit for project locations where it is not cost effective to use propane gas as fuel. Delete this paragraph if not required.

****

Provide [propane-gas conversion kit] [automatic electric pilot recognition kit].

]2.1.2 Oil-Fired Unit Heater

UL 731 and UL labeled.

2.1.2.1 Casing

Minimum [22] [_____] gage [aluminum] [or] [[enamel] [or] [vinyl] coated steel]. Provide removable access door.

2.1.2.2 Heat Exchanger

Minimum 16 gage primary combustion chamber constructed of [perlite-clad steel] [, aluminum-clad steel] [, or] [400 series stainless steel]; minimum 14 gage secondary heating section composed of aluminized, mild, or hot-rolled steel. Provide a flame observation port on the burner side of the heater.

2.1.2.3 Burner

Provide pressure oil-atomizing burner with mechanically forced draft, suitable for fuel oil No. 2. Provide two-stage oil pump. Equip burner motor with a combustion air damper.

2.1.2.4 Controls

Include fan and limit switch, low voltage (24-volt) transformer, electronic flame safeguard with flame safety relay, and electric spark ignition.

2.1.2.5 Accessories

Provide [power exhauster,] oil filter, oil pressure regulator, and barometric damper.

2.1.2.6 Efficiency

Unit heater must have a minimum combustion efficiency of 80 percent when tested in accordance with UL 731.

2.1.3 [Steam] [or] [Hot-Water] Unit Heater

ASHRAE 33 tested for heating coils; UL listed for motor and controls.

2.1.3.1 Casing

Minimum [20] [_____] gage [steel] [or] [aluminum] with removable access panels or means to remove, service, and maintain major components.

2.1.3.2 Coil

****

NOTE: Use copper for maximum 517 kPa (gage) 75 psig steam or maximum 163 degrees C 325 degrees F hot water at 1379 kPa (gage) 200 psig, red brass for maximum 1379 kPa (gage) 200 psig steam or 218 degrees C 425 degrees F hot water at 2068 kPa (gage) 300 psig, copper nickel for maximum 2758 kPa (gage) 400 psig steam or maximum 232 degrees C 450 degrees F at 4136 kPa (gage) 600 psig, and steel for maximum 232 degrees C 450 degrees F hot water at 4136 kPa (gage) 600 psig.

****

Fin-and-tube coil constructed of [copper,] [red brass,] [90-10 copper nickel,] [or] [steel] tubes and [copper] [or] [aluminum] fins. Use maximum design pressure of [steam at [_____] kilopascal (kpa (gage)) pounds per square inch gage (psig)] [and] [hot water at [_____] kpa (gage) psig and [_____] degrees C F].

2.1.3.3 Controls

[Automatic controls of [modulating] [on-off-auto] [or] [combination of modulating and on-off-auto] system] [As indicated]. [Provide a three-position selector switch.]

2.1.4 Electric Unit Heater

****

NOTE: Check if Section 23 83 00.00 20 ELECTRIC SPACE HEATING EQUIPMENT covers electric unit heater. Recommend to cover unit heaters exclusively in this section. Avoid redundant statement.

****

UL listed; wattage, voltage, phase, and number of steps as indicated. Provide control-circuit terminals and single source of power supply. Heater 5 Kw and larger must be three-phase, with load balanced on each of the three phases. Limit leaving air temperature below 60 degrees C at 15.5 degrees C 140 degrees F at 60 degrees F entering air.

2.1.4.1 Casing

Minimum [21] [_____] gage steel.

2.1.4.2 Heating Element

Nickel-chromium heating wire element, free from expansion noise and 60 Hz hum. Embed element in magnesium-oxide insulating refractory. Seal element in high-mass steel or corrosion-resisting metallic sheath with fins. Enclose element ends in terminal box. Space fins at maximum six fins per inch. Limit fin surface temperature 288 degrees C 550 degrees Fat any point during normal operation.

2.1.4.3 Controls

Include limit controls for thermal overheat protection of heaters. For remote thermostatic operation, provide contactor rated for 100,000 duty cycles. [Provide a control transformer to supply 120-volt thermostat control circuit for each heater.] Provide room thermostat for pilot duty.

2.1.4.4 Wiring

Completely factory-prewired to terminal strips, ready to receive branch circuit and control connections for 60 degrees C 140 degrees F [copper] [or] [aluminum] wiring.

[2.1.4.5 Accessories

****

NOTE: These accessories are not integral components of electric unit heater. Delete this paragraph if not required.

****

Provide fan switching devices to independently operate fan motor for summer ventilation and winter heat recovery.

]2.2 INFRARED HEATERS

****

NOTE: Check if Section 23 83 00.00 20 ELECTRIC SPACE HEATING EQUIPMENT covers electric unit heater. Recommend to cover unit heaters exclusively in this section. Avoid redundant statement.

****

[Reflector-beam spread] [and] operating conditions as indicated. Provide pre-wired control boxes, thermostats, and reflector [and duct] hangers.

2.2.1 Sheet Metal

[a. Aluminum-Clad Steel: ASTM A463/A463M, nominal thickness of minimum 16 gage for radiant tubing between burners and vacuum pump or vent.

][b. Aluminum: ASTM B209M ASTM B209, manufacturer's standard thickness.

][c. Stainless Steel: ASTM A240/A240M, nominal thickness of not less than 20 gage.

][d. [Ceramic-Coated] [Enamel-Coated] Steel: ASTM A1011/A1011M hot rolled or ASTM A109/A109M cold rolled, low-carbon steel. Provide coating able to withstand infrared heater operating temperatures.

]2.2.2 Unvented Gas Infrared Heater

****

NOTE: Use only if adequate ventilation ensured for the project location.

****

ANSI Z83.19/CSA 2.35 and AGA approved.

2.2.2.1 Heating Element

Perforated ceramic capable of withstanding thermal shock in [3] [_____]

minutes from 1093 to 0 degrees C 2000 to 32 degrees F without fatigue and of minimum 871 degrees C 1600 degrees F operating temperature. When re-radiating screens are used to obtain operating temperature, provide [stainless-steel] [or] [chromized-steel] matching screen.

2.2.2.2 Reflector

[Polished [aluminum] [stainless steel]] [or] [approved high infrared reflector materials]. Provide reflector supports of manufacturer's standard.

2.2.2.3 Controls

Provide either an intermittent pilot ignition system or a solid-state direct ignition system. Provide automatic gas safety valve capable of withstanding a 10 percent voltage fluctuation.

2.2.2.4 Ventilation

Section 23 30 00 HVAC AIR DISTRIBUTION.

2.2.3 Vented Gas Infrared Heater

****

NOTE: For spot heating, use single-burner power vented heater; for small area heating, uses single-burner vacuum vented heater; and for large area or entire building heating, use multiple-burner vacuum vented heater.

****

ANSI Z83.19/CSA 2.35 with AGA label, [single-burner power vented] [single-burner vacuum vented] [or] [multiple-burner vacuum vented].

2.2.3.1 Vent

NFPA 54 and NFPA 211, [Type 316 stainless steel] [or] [high-temperature corrosion-resistant plastic rated for minimum 204 degrees C 400 degrees F]. Vent flue gas to outdoors by induced draft.

2.2.3.2 Reflector

[Polished [aluminum] [stainless steel]] [or] [approved high infrared reflector materials]. Provide manufacturer's standard reflector supports.

2.2.3.3 Heat Exchanger and Combustion Chamber

Construct heat exchanger and combustion chamber of [aluminum-clad steel] [ceramic-coated steel] [or] stainless steel.

2.2.3.4 Controls

Incorporate either an intermittent pilot ignition system or a solid-state direct ignition system. Provide safety air-flow switch for each burner.

2.2.3.5 Fan or Vacuum Pump

Heater manufacturer's standard.

2.2.3.6 Performance

****

NOTE: Performance Criteria are:

	Minimum Steady State Thermal Efficiency (Percent)	Maximum Heat Release (kJ Per Square Meter of Heating Surface
Single-Burner Power Vented Heater	80	31,350
Single-Burner Vacuum Vented Heater	80	33,060
Multiple-Burner Vacuum Vented Heater	85	23,940

	Minimum Steady State Thermal Efficiency (Percent)	Maximum Heat Release (BTU Per Square Meter of Heating Surface
Single-Burner Power Vented Heater	80	2,750
Single-Burner Vacuum Vented Heater	80	2,900
Multiple-Burner Vacuum Vented Heater	85	2,100

****

Provide sufficient radiant heating surface to attain a minimum steady-state thermal efficiency of [80] [85] percent and a maximum heat release of [31,350] [33,060] [23.940] kJ per square meter [2,750] [2,900] [2,100] Btu per square foot.

2.2.4 Electric Infrared Heater

****

NOTE: Check if Section 23 83 00.00 20 ELECTRIC SPACE HEATING EQUIPMENT covers electric unit heater. Recommend to cover unit heaters exclusively in this section. Avoid redundant statement.

****

Self-contained, factory assembled, and UL listed and including the heating element, reflector, heater housing, mounting brackets, element holders, wire guards, and high-temperature internal wiring.

2.2.4.1 Heating Element

Minimum 9 1/2 mm 3/8 inch diameter quartz tube or metal sheath with coiled resistor wire. Element operating temperature range must be 649 to 982 degrees C 1200 to 1800 degrees F.

2.2.4.2 Heater Housing

[Weatherproof] [aluminum-clad steel] [stainless-steel] [aluminum] [or] [low-carbon steel] construction. Provide a baked enamel finish over a corrosion-resistant primer. Provide a chrome-plated or stainless-steel wire guard to prevent heating elements from accidental damage. Furnish swivel brackets to position heater in any horizontal angle.

2.2.4.3 Reflector

Polished [aluminum] [or] [stainless steel].

2.2.4.4 Wiring

Fully enclosed internal wiring. Provide minimum 152 mm 6 inch slack fixture (heater) wire for connection to branch circuit wiring.

[2.2.4.5 Accessories

****

NOTE: Electric-clock controller is an input controller provided separately as an optional addition to unit heaters. Delete this paragraph if not required.

****

Provide electric-clock controller with self-starting synchronous motors and snap acting switch, rated for 125 percent of the load which it controls. Provide a 30-second time cycle with an infinitely adjustable "on-off" period each cycle. Equip controller with external indicating knob for manual adjustment from zero to 100 percent. If surface mounted, furnish steel enclosure with a baked enamel finish over a corrosion-resistant primer. If flush mounted, furnish galvanized steel enclosure with knockouts for conduit in bottom and sides. Provide a connection wiring diagram on the inside cover of the enclosure. Where loads exceed the maximum available rating of controller, provide high duty-cycle contactors serving as pilot devices.

]2.3 FAN

Provide [steel] [or] [aluminum] fans with ball or roller bearings for motors over 0.09 kW 1/8 horsepower (hp) and sleeve bearings for motors 0.09 kW 1/8 hp and under. Provide sleeve bearings with oil reservoir, if not permanently lubricated.

2.4 MOTOR AND STARTER

****

NOTE: The motor control requirements should be coordinated with the electrical section and will depend on field conditions. The following types of motor starters should be used as a guide only. When electrical power circuits to which equipment are connected are heavily loaded, the full voltage-across line starting may result in excessive voltage drop on the circuit.

Motor kW	**Voltage**	**Type Starter**
Up to 5 1/2	**208-230**	**Across line magnetic**
5 1/2 to 11	**208-230**	**Across line magnetic part wind or wye delta**
11 to 22 3/8	**460**	**Across line magnetic part wind or wye delta**
Above 11	**208-230**	**Part wind or wye delta**
Above 22 3/8	**460**	**Part wind or wye delta**

Motor kW	**Voltage**	**Type Starter**
Up to 7-1/2	**208-230**	**Across line magnetic**
7-1/2 to 15	**208-230**	**Across line magnetic part wind or wye delta**
15 to 30	**460**	**Across line magnetic part wind or wye delta**
Above 15	**208-230**	**Part wind or wye delta**
Above 30	**460**	**Part wind or wye delta**

****

NEMA MG 1, and NEMA ICS 2, and NEMA ICS 6, respectively. [Provide explosion-proof motors and motor starters where indicated.] Provide continuous-duty motor with built-in automatic reset thermal overload protection. For motor 0.37 kW 1/2 hp and larger, use three-phase. Provide single-phase motor of permanent split capacitor or capacitor start. Limit motor speed at 1800 rpm r/min. Wire motor to heater power supply source.

[2.5 SEISMIC BRACINGS

****

NOTE: Depending upon various heaters, delete any irrelevant paragraph for piping systems.

****

Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS.

][2.6 GAS PIPING SYSTEM AND FLUE VENT

Comply with Section 23 11 20 FACILITY GAS PIPING, Section 33 51 15 NATURAL-GAS / LIQUID PETROLEUM DISTRIBUTION PIPELINES, for gas valves and piping. Use UL 441 flue vents [and] [gas-vent roof jacks], of [galvanized steel] [aluminum] [or] [stainless steel].

][2.7 FUEL OIL [TANK] AND PIPING SYSTEM

Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).

][2.8 HOT WATER PIPING SYSTEM

Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEMS.

][2.9 STEAM AND CONDENSATE PIPING SYSTEM

Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS.

]2.10 SOURCE QUALITY CONTROL

Special protection is not required for equipment that has a zinc coating conforming to [ASTM A123/A123M] [ASTM A653/A653M]. Otherwise, protect affected equipment items by manufacturers' corrosion-inhibiting coating or paint system that has proved capable of withstanding salt-spray test in accordance with ASTM B117. Test indoor and outdoor equipment for 125 hours; test outdoor equipment used in a marine atmosphere for 500 hours. For each specimen, perform a scratch test as defined in ASTM D1654.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment where indicated and as recommended by manufacturer's recommendations, NFPA 54, NFPA 90A, NFPA 90B, NFPA 91 and NFPA 211.

3.1.1 Suspensions of Equipment

Provide equipment supports including beam clamps, turnbuckles and twist links or weld-wire chains, wire ropes with rope clips and rope thimbles, threaded-eye rod hangers with lock nuts and heat-duct hangers, threaded-eye bolts with expansion screws, brackets, platform and mounting frame, and vibration isolators. Locate equipment in such a manner that working space is available for servicing, such as vacuum pump and burner removal, access to automatic controls, and lubrication. Provide electrical isolation of dissimilar metals. Clean interior of casings or cabinets before and after completion of installation.

3.1.2 Vents

NFPA 54 and NFPA 211. Provide vents with weatherproofing flashings in accordance with Section 07 60 00 FLASHING AND SHEET METAL.

3.1.3 Electrical Work

NFPA 70 and Division 26, "ELECTRICAL." When replacing original control wires, provide No. 16 AWG with minimum 105 degrees C insulation.

3.2 FIELD QUALITY CONTROL

Administer, schedule, and conduct specified tests. Furnish personnel, instruments and equipment for such tests. Correct defects and repeat the respective inspections and tests. Conduct inspections and testing in the presence of the Contracting Officer.

3.2.1 Test Instruments and Apparatus

Provide instruments and apparatus currently certified as being accurate to within one percent of their full scale. Use gages with a maximum scale between 1 1/2 and 2 times test pressure.

3.2.2 Field Inspection

Prior to initial operation, inspect equipment installation to ensure that indicated and specified requirements have been met.

3.2.3 Field Tests

3.2.3.1 Fuel Piping Pressure Tests

[Pneumatically test gas piping at 1 1/2 times operating pressure and check for leakage with soap solution.] [Hydrostatically test fuel oil piping at 1 1/2 times maximum working pressure.]

3.2.3.2 Fire Tests for Nonelectrical Heating Equipment

Test combustion controls and equipment with specified fuel at 100 percent full rated load. During tests, verify proper operation of controls. Adjust burners for maximum efficiency using Orsat or similar apparatus. Maintain firing for at least four hours [, and where high-low-off combustion controls are provided, operate the heating equipment for one hour at low fire and 3 hours at high fire]. For acceptable combustion efficiency, allow maximum 4.5 percent carbon dioxide in flue gases.

3.2.3.3 Insulation-Resistance Tests for Electrical Equipment

At the completion of wiring, test 600 volt wiring to verify that no short circuits exist before or after the attachment of electrical heating equipment to the power source. Make tests with an instrument which applies a voltage of approximately 500 volts for a direct reading of insulation resistance.

3.2.3.4 Operational Tests

After completing fire tests and insulation-resistance tests, operate equipment continuously under varying load conditions to verify functioning of combustion controls, electrical controls, flame safeguard controls, safety interlocks, and specified operating sequence. Run each test for a minimum period of one hour.

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Motor Capacity	= 7 1/2 hp	= 5 1/2 kW
	= 15 hp	= 11 kW
	= 30 hp	= 22 3/8 kW

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 83 00.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15768N (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 83 00.00 20

ELECTRIC SPACE HEATING EQUIPMENT

04/06

PART 1 GENERAL

PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-23 83 00.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15768N (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 23 83 00.00 20

ELECTRIC SPACE HEATING EQUIPMENT

04/06

****

NOTE: This guide specification covers the requirements for electric space heating equipment for construction projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Include a schedule of heaters on the drawings. Information, as indicated in Appendix A, should be included in the schedules. The following generic terms should be used in the specifications and drawings to ensure consistent terminology.

1. Unit heater. A self-contained heating unit, usually suspended from ceiling or structure, with fan and heating elements. Electric unit heaters are also specified in Section 23 82 00.00 20 TERMINAL HEATING UNITS. If that section is included in the specifications, do not include electric unit heaters in this section.

2. Cabinet heater. A unit consisting of a heating element and a fan, in an enclosure designed for

recessed or surface mounting, to provide circulation of heated air for general heating. Cabinet heaters are generally fan-coil units without cooling provisions. Fan coil units are specified in Section 23 30 00 HVAC AIR DISTRIBUTION. If that section is included in the specifications, do not include cabinet heaters in this section.

3. Baseboard heater. A unit consisting of an enclosed heating element, designed for wall mounting near the intersection of the wall and floor. Also known as a convection heater. Intended for general heating or a draft barrier.

4. Sill heater. A unit similar to a baseboard unit but intended for wall mounting below window sills and other heights above the intersection of the wall and floor.

5. Pedestal heater. A unit similar to a baseboard heater but intended for floor mounting on short pedestals near but separated from the wall.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA DC 3	(2013) Residential Controls - Electrical Wall-Mounted Room Thermostats
NEMA ICS 2	(2000; R 2020) Industrial Control and

	Systems Controllers, Contactors, and Overload Relays Rated 600 V

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 1025	(1980; R 1990, Bul. 1991) Electric Air Heaters
UL 1042	(2009; Reprint Feb 2021) UL Standard for Safety Electric Baseboard Heating Equipment

1.2 GENERAL REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, applies to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Heater Installation Drawing

SD-03 Product Data

Electric [Unit][and][Cabinet] Heaters

Electric [Baseboard] [Sill] [Pedestal] Units

[Electric Infrared Heater

] Thermostat

Unit Thermostat

[Infrared Heater Thermostat

] SD-10 Operation and Maintenance Data

Electric [Unit][and][Cabinet] Heaters, Data Package 5

Electric [Baseboard] [Sill] [Pedestal] Units, Data Package 5

[Electric Infrared Heater, Data Package 5

] Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 ELECTRIC [UNIT][AND][CABINET] HEATERS

UL 1025; wattage, voltage, phase, number of steps, watts and cubic meter per second Btu/hr and CFM as indicated. Provide control-circuit terminals and single source of power supply. Heaters 5 Kw and larger shall be 3-phase, with load balanced on each of the three phases. Limit leaving air temperature to 60 degrees C 140 degrees F with entering air of 15 degrees C 60 degrees F.

[2.1.1 Enclosure

****

NOTE: UL 1025 provides enclosure construction requirements that are adequate for installation in ordinary locations. Use this paragraph for heaters to be located in areas where the heater may be subject to abuse.

****

Minimum [20] [_____] gage steel.

]2.1.2 Heating Element

Nickel chromium heating wire element, free from expansion noise and 60 Hz hum. Embed element in magnesium-oxide insulating refractory. Seal element in high-mass steel or corrosion-resisting metallic sheath with fins. Enclose element ends in terminal box. Provide not more than six fins per 25 mm inch. Limit fin surface temperature 285 degrees C 550 degrees F at any point during normal operation.

2.1.3 Controls

Include limit controls for overheat protection of heaters. For remote thermostatic operation, provide contactor rated for 100,000 duty cycles.[Provide a control transformer to supply 120-volt thermostat control circuit for each heater.]

2.1.4 Wiring

Completely factory-prewired to terminal strips, ready to receive branch circuit and control connections for 60 degrees C 140 degrees F [copper][or][aluminum] wiring.

[2.1.5 Accessories

****

NOTE: These accessories are not integral components of electric unit heater. Delete this paragraph if not required.

****

Provide fan switching devices to independently operate the fan motor for summer ventilation and winter heat recovery.

]2.1.6 Thermostat

****

NOTE: Choose integral or space thermostat, except for restroom facilities and bathrooms, modify paragraph to provide timer control with maximum time setting of 30 minutes.

****

Provide tamper resistant [integral] [space] thermostat, adjustable without requiring removal of heater components. Thermostat operating range shall be approximately 10 degrees C 50 degrees F to a maximum of [24] [_____] degrees C [75] [_____] degrees F with operating differential of 0.5 degrees C 3 degrees F or less.

2.1.7 Disconnect Means

Provide factory-installed safety disconnect switch [in the housing or in an auxiliary matching control section] [in combination with thermostat] with "off" position marking on the face plate.

[2.1.8 Outdoor Sensor

Provide outdoor sensor with sunlight-and-rain protection shield. The sensor shall provide a positive heater shut off when outdoor air temperature is 18 degrees C 65 degrees F or higher.

]2.2 ELECTRIC [BASEBOARD] [SILL] [PEDESTAL] UNITS

UL 1042; wattage, voltage, phase, heat in watts Btu per houroutput indicated. Provide units complete with heating elements, mounting brackets, end closures, splice plates, interior and exterior corners and accessible wiring compartment. Limit outlet air temperature and enclosure surfaces to 93 degrees C 200 degrees F under continuous operating conditions.

2.2.1 Enclosure

****

NOTE: UL 1042 provides enclosure construction requirements that are adequate for installation in ordinary locations. Select heavier gage materials for units which may be subject to abuse.

****

Fabricate from [steel][or][aluminum] [not less than [18] [_____] gage.] Provide [galvanized] [factory applied rust-inhibiting paint] [factory primed for field painting] [manufacturer's standard] [_____] finish. Locate terminal blocks for branch circuit conductor [and control wiring] connections from the [bottom] [rear] [[right] or [left] side] [as required]. Wiring shall conform to NFPA 70.

2.2.2 Accessories

Where continuous wall-to-wall installations are indicated, provide accessories; including corner fittings, fillers, splice plates, and end caps. Accessories shall have the same profile as the basic unit, and contain no sharp edges.[Provide for expansion of enclosure.]

2.2.3 Limit Control

Provide thermal overload and over voltage protection.

2.2.4 Disconnect Means

Provide factory-installed safety disconnect switch [in the housing or in an auxiliary matching control section] [in combination with thermostat] with "off" position marking on the face plate.

2.2.5 Unit Thermostat

****

NOTE: Choose integral or space thermostat, except for restroom facilities and bathrooms, modify paragraph to provide timer control with maximum time setting of 30 minutes.

****

Provide tamper resistant [integral] [space] tool adjustable thermostat, without requiring removal of cabinet parts. Thermostat, operating range shall be approximately 10 degrees C 50 degrees F to a maximum of [24] [_____] degrees C [75] [_____] degrees F with operating differential of 0.5 degrees C 3 degrees F or less.

[2.2.6 Outdoor Sensor

Provide outdoor sensor with sunlight-and-rain protection shield. The sensor shall provide a positive heater shut off when outdoor air temperature is 18 degrees C 65 degrees F or higher.

][2.3 ELECTRIC INFRARED HEATER

Comply with Section 23 82 00.00 20 TERMINAL HEATING UNITS.

][2.4 INFRARED HEATER THERMOSTAT

NEMA DC 3.

][2.5 CONTACTORS

NEMA ICS 2, Enclosure Type [1] [_____].

][2.6 DISCONNECTS

****

NOTE: Include this paragraph for installation where a separate disconnecting means is required by NFPA 70, Article 424 Part C, "Control and Protection of Fixed Electric Space Heating Equipment."

****

Disconnect. UL listed. [Enclosed [fused] [non-fusible] switch, rated [_____] volt, [_____] phase, [_____] wire, NEMA Type [1] [3R] enclosure.] [Enclosed molded case circuit breaker, rated [_____] ampere, [_____] volt, [_____] poles, NEMA Type [1] [3R] enclosure.] [Disconnect shall be capable of being locked in the open position.]

]PART 3 EXECUTION

3.1 INSTALLATION

Install in conformance with the approved heater installation drawing, NFPA 70, UL listing, and manufacturer's instructions, with necessary clearances for air circulation, maintenance, inspection, service testing and repair. Connect to electrical supply in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.1 Unit Heaters

Mount units plumb, square and level with ceiling and walls.

3.1.2 Cabinet Heaters

Where recessed mounting is indicated, seal entire recessed opening from exterior wall cavities, and provide a minimum 15 mm 1/2-inch thick rigid fire resistant insulation on the wall behind the cabinet.[Verify manufacturer's clearance requirements from electrical cords, drapes, and other furnishings.]

3.1.3 Remote Thermostat

Mount remote room space thermostats [1375 mm4 feet 6 inches above finished floor on wall] [or as indicated].[Connect remote thermostats with conduit and wiring to heaters as indicated.]

[3.1.4 [Baseboard] [Sill] [Pedestal] Heaters

Verify manufacturer's clearance requirements from electrical cords, drapes, and other furnishings.

][3.1.5 Electric Infrared Heaters

Comply with Section 23 82 00.00 20 TERMINAL HEATING UNITS.

]3.2 FIELD QUALITY CONTROL

Provide necessary personnel, instruments, and equipment to perform tests. Notify the Contracting Officer [5] [_____] working days prior to scheduled testings and locations.

3.2.1 Field Inspection

Prior to initial operation, inspect installed equipment for conformance with drawings and specifications.

3.2.2 Insulation Resistance Tests

Test 600-volt wiring to verify that no short circuits or grounds exist. Tests shall be made using an instrument which applies a voltage of approximately 500 volts and provides a direct reading of resistance in ohms.

3.2.3 Operational Tests

Test equipment circuits and devices to demonstrate proper operation.Test each item of control equipment not less than 5 times.

3.3 APPENDIX A - DESIGN INFORMATION

<table>
<tr><th colspan="9">APPENDIX A</th></tr>
<tr><th colspan="9">DESIGN INFORMATION: ELECTRIC UNIT AND CABINET HEATER</th></tr>
<tr><td>Unit No.</td><td>KW</td><td>Volts</td><td>Phase</td><td>No. of Steps</td><td>Watts Btu/hr</td><td>Cubic Meter Per Second CFM Air</td><td>Mounting Heights</td><td>Remarks</td></tr>
<tr><th colspan="9">ELECTRIC BASEBOARD, SILL AND PEDESTAL HEATERS</th></tr>
<tr><td>Unit No.</td><td>KW</td><td>Volts</td><td colspan="2">Phase</td><td colspan="2">Watts Btu/hr Output</td><td colspan="2">Remarks</td></tr>
<tr><th colspan="9">ELECTRIC INFRARED RADIANT HEATERS</th></tr>
<tr><td>Type Letter</td><td>Watts</td><td>Volts</td><td colspan="2">No. of Elements Per Fixture</td><td>Beam Spread</td><td>Fixture</td><td>Mounting</td><td>Remarks</td></tr>
</table>

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-23 84 19.00 (February 2018)**

Preparing Activity: USACE **Superseding**
UFGS-23 72 26.00 10 (April 2008)
UFGS-23 84 16.00 20 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 84 19.00

DESICCANT COOLING SYSTEMS

02/18

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USACE / NAVFAC / AFCEC **UFGS-23 84 19.00 (February 2018)**

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SECTION 23 84 19.00

DESICCANT COOLING SYSTEMS
02/18

****

NOTE: This guide specification covers the requirements for desiccant cooling systems, both solid and liquid types, which offset the latent cooling load by removing moisture from the outside air before it reaches the cooling coil. For Navy projects, use only solid desiccant systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of

the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 700	(2016) Specifications for Fluorocarbon Refrigerants
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 84	(2024) Method of Testing Air-to-Air Heat/Energy Exchangers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2024) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B210/B210M	(2019a) Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes

ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G, [_____]

SD-03 Product Data

Verification of Dimensions
Standard Products; G, [_____]
Spare Parts
Qualifications
Field Instructions
Performance Tests
Demonstrations

SD-06 Test Reports

Performance Tests
Inspections

SD-07 Certificates

Standard Products

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual; G, [_____]
Data Package 5

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

****

NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement, otherwise delete the second.

****

Weld pipe in accordance with the qualified procedures, using performance qualified welders and welding operators in accordance with ASME BPVC SEC IX. Submit [_____] copies of qualification procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform the tests onsite, if practical. The welder or welding operator must apply the assigned symbol near each weld personally made as a permanent record. Weld structural members in accordance with [Section 05 05 23.16 STRUCTURAL WELDING][welding and nondestructive testing procedures specified in Section 40 05 13.96 WELDING PROCESS PIPING].

1.3.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and any other features or conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such features or conditions. Submit drawings, at least [5 weeks] [_____] prior to beginning construction, providing adequate detail to demonstrate compliance with contract requirements and consisting of:

a. Equipment layouts which identify assembly and installation details to include energy recovery equipment.

b. Piping layouts which identify all valves and fittings.

c. Plans and elevations which identify clearances required for maintenance and operation.

d. Wiring diagrams which identify each component individually, by showing actual location in equipment, and schematically, by showing all interconnected or interlocked relationships between components.

e. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations.

f. Details, if piping and equipment are to be supported other than as indicated, which include loading and type of frames, brackets, stanchions, or other supports.

1.4 DELIVERY, STORAGE, AND HANDLING

Store all equipment delivered and placed in storage with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with source of supply.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

****

NOTE: Desiccant cooling systems are of two basic types: dry desiccant on a rotor with hot air regeneration and liquid desiccant with spray coils and heated desiccant.

A schematic drawing, sequence of operation, and an equipment schedule must be included on the drawings. Equipment which the basic dehumidification system vendor lists as optional or "provided by others" must be clearly shown and sized.

****

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of such products and that essentially duplicate equipment which is similar in material, design, and workmanship. The standard products must have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year use must include applications of equipment and materials under similar circumstances and of similar size. The two years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. All products must be supported by a service organization.

a. Submit manufacturer's catalog data, at least [5 weeks] [_____] prior to beginning construction, highlighted to show model number, size, options, performance charts and curves, etc., in adequate detail to demonstrate compliance with contract requirements. Provide performance data over the full range of outdoor conditions for which dehumidification will be required, with the conditions defined by the Contracting Officer. Supply data from manufacturer on all energy recovery methods and equipment available for the system. Include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

b. Submit a certified list of qualified, permanent service organizations for support of the equipment including their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

c. The system must be a complete stand alone system with all necessary controls, motors, fans, rotors, motors, drive components, pumps, reactivation components and filtration to provide automatic continuous operation. Internal regeneration heat sources must be a part of the system, except external heat sources may be used under the following conditions: coordinate connections to external heat sources with the system manufacturer, and connecting equipment such as pumps, piping, traps, etc., as shown on the drawings and schedules. The desiccant must be of the [solid type on a rotary wheel] [liquid type utilizing spray coils].

d. Submit proof of compliance with AHRI, ASHRAE, ASME, or UL requirements where specified for the system, components, or equipment. The label or listing of the specified agency is acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, must be submitted stating that the items have been tested and conform to the requirements and testing methods of the specified agency. When performance requirements of this project's drawings and specifications vary from standard AHRI rating conditions, computer printouts, catalog, or other application data certified by AHRI or a nationally recognized laboratory as described above must be included. If AHRI does not have a current certification program that encompasses such application data, the manufacturer must self certify that his application data complies with project performance requirements.

2.2 MATERIALS

2.2.1 Gaskets

Gaskets must conform to ASTM F104 classification for compressed sheet with nitrile binder and acrylic fibers for maximum 371 degrees C 700 degrees F service.

2.2.2 Bolts and Nuts

Bolts and nuts, except as required for piping applications, must be in accordance with ASTM A307. Mark the bolt head to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

2.3 DESICCANT SYSTEMS

****

NOTE: Desiccant systems are used basically for large latent loads. These systems should be engineered around a total system. They can be used in buildings with humidity requirements lower than mechanical equipment capacity, for preprocessing of OA to lower the load on mechanical systems, and as liquid systems to maintain exact humidity requirements during all seasons. The designer should look at existing energy sources for regeneration when considering a desiccant system to maximize equipment usage and energy savings. Application of desiccant systems should involve manufacturer input when coordinating equipment usage.

Designer should determine the type of DESICCANT SYSTEM required and delete the unwanted systems.

****

2.3.1 Solid Desiccant System

****

NOTE: Desiccant cooling system equipment is sized to meet space and ventilation latent cooling loads. Typically, the desiccant dehumidifies ventilation air so that, when the desiccant ventilation air is mixed with return air from the space, the resulting mixture is of sufficiently low specific humidity to satisfy the latent load of the space. The refrigerant-based post-cooling system is sized to reduce the dry-bulb temperature of the mixture to handle the space sensible cooling load. In some cases, an optional pre-cooling coil is placed upstream of the desiccant wheel so that the wheel can more effectively dehumidify the outside air to be introduced for ventilation or makeup. Optional heating coils may be added in the desiccant unit enclosure to partially or totally handle the space heating loads. For Navy projects, use only solid desiccant systems.

****

The unit must be a complete, factory assembled and tested system, suitable for outdoor installation. Each unit must produce a capacity as rated in accordance with [ASHRAE 84] [ANSI/AHRI 210/240]. It must be designed for either curb mounting or structural steel support. Include the following components as defined in paragraph SYSTEM COMPONENTS:

a. Desiccant Rotor
b. Thermal Rotor (or heat pipe)
c. Supply Fan
d. Regeneration Fan
e. Regeneration and Process Heating System
f. Filters
g. Indirect Evaporative Cooling System
h. Gas fired Boiler (optional)
i. Circulating pumps (boiler, evaporative cooling)
j. Refrigeration Section (optional) for pre- and/or post-cooling

2.3.1.1 Control Package

Each unit must be factory wired and equipped with a central electrical control panel mounted inside the service compartment. Mount variable-speed drive controller, if provided, inside the service compartment. Provide switched lighting in the service compartment so that the panel can be easily seen. Compartment must be ventilated, if necessary, for cooling variable speed drive controller. Provide single power supply for the unit. All internal wiring must be in accordance with the National Electrical Code. Include all electrical components required for automatic operation, based on signals from remotely mounted humidity and temperature sensors/controllers. Make connections to remote devices at the marked terminals. The internal control panel must report discharge temperature and humidity. Additional reporting of all control data must be available to a central control station, as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.3.1.2 Unit Mounting

[Curb mount unit] [Support unit with structural steel]. Isolate the entire unit from the building structure on vibration isolators with submitted and published load ratings. Vibration isolators must have isolation characteristics as recommended by the manufacturer for the unit supplied and the service intended.

2.3.2 Liquid Desiccant System

****

NOTE: Liquid desiccant systems are capable of maintaining year round humidity control due to characteristics of the conditioner solution and the units ability to maintain the concentration of the solution. Additionally, these units are capable of lowering the air temperature because the conditioner solution passes through a heat exchanger utilizing a cold liquid such as chilled water. The designer should work with the manufacturer to integrate these systems with the existing mechanical units. One approach would be to use the desiccant system to precondition supply air for several chiller-AHU systems.

****

The unit must be a complete, factory assembled and tested, system suitable for outdoor installation and produce a capacity as rated in accordance with ANSI/AHRI 210/240. It must be designed for [curb mounting] [or] [structural steel support]. Include the following components as defined in paragraph SYSTEM COMPONENTS:

a. Conditioner unit
b. Conditioner cooler
c. Regenerator
d. Regenerator heater
e. Level control
f. Filter screening
g. Freestanding pump assembly
h. Make up water system
i. Conditioner fan
j. Regenerator fan

2.3.2.1 Control Panel

Each unit must be factory wired and equipped with a central electrical control panel mounted inside the service compartment. Provide a single power supply. All internal wiring must be in accordance with the National Electrical Code. Include all electrical components required for automatic operation, based on signals from remotely mounted humidity and temperature sensors/controllers. Make connections to remote devices at the marked terminals. The internal control panel must report discharge temperature and humidity. Additional reporting of all control data must be available to a central control station, as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.3.2.2 Equipment Mounting

Set the conditioner and regenerator units on level concrete floor or slab. Seal the floor with epoxy sealant before the equipment is set in place. Unit must be surrounded by a curb.

2.4 UNIT CONSTRUCTION

2.4.1 Solid Desiccant System

Unit must be suitable for outdoor installation and designed for either structural or curb mounting without field modification. The enclosure system must be air-tight (2 percent maximum leakage at 150 percent design static pressure from section to section). Construct the unit base of formed minimum 10 GA steel coated with red- oxide primer. Locate cross members to support each major component. Fit lifting lugs fitted to required structural members. Paint unit exterior painted with a low-gloss enamel.

2.4.1.1 Housing

Construct the unit housing and internal partitions of minimum 18 GA galvanized steel with the exterior panels treated to allow for painting. Insulate all external walls with foil-faced fiber glass insulation at least 25 mm 1 inch thick and secured by permanent mechanical fasteners welded to the panels. Seal adjoining panels sealed by permanent mechanical fasteners welded to the panels and with silicone compound, as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.4.1.2 Service Panels

Provide removable service access panels for all components. The openings must be of sufficient size to allow service to all maintenance items. Provide all service panels with resilient gaskets and hardware to assure compression. Provide access doors for boiler and control sections with continuous hinges. Seal roof panels to provide a weather-tight enclosure.

2.4.2 Liquid Desiccant System

The unit must consist of conditioner and regenerator watertight housings containing the sump of vinylester FRP with additives to achieve a U.L. Class 1 flame spread rating, or equal. The conditioner cooler, and regenerator heater must be of the plate-and-frame type, with carbon steel frame carrier bars and tiebolts; titanium plates and nitrile or EPDM gaskets.

2.4.2.1 Piping

****

NOTE: Edit Section 22 00 00 to the extent necessary to specify FRP and CPVC piping, valves and pressure testing of piping system.

****

The conditioner piping must be FRP or CPVC rated for continuous service at 107 degrees C 225 degrees F with the desiccant solution. Install FRP piping for the regenerator. Blackiron, galvanized and stainless steel are not acceptable. CPVC piping must be Schedule 80, Type IV, Grade 1, 4120, in accordance with ASTM D1784, as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Support the piping so that no stress is placed on connections to the equipment. Install piping at least 610 mm 2 ft away from all maintenance access openings and belt guards. Solution pump discharge piping must be arranged to allow removal of the pump from the pump tank. Incorporate a 90 degree elbow or a vertical spool piece to the pump discharge piping at least 1.2 m 4 ft long so the pump can be lifted vertically from the tank. Pressure test all piping for leaks before insulating. Where possible, complete equipment start-up before the insulation is applied.

2.4.2.2 Valves and Thermowells

Valves in the conditioner solution piping must be made of CPVC, thermoplastic-lined cast iron, or as recommended by the manufacturer. Thermowells in the solution piping must be monel or TFE-coated steel. Stainless steel thermowells are not acceptable. Install flanged pipe fittings when possible. Avoid threaded fittings and connections. Install red rubber or neoprene full-face gaskets in flanged connections.

2.4.2.3 Insulation

Insulate conditioners whenever a coolant other than cooling tower water is used to prevent surface condensation. Insulate the entire unit including the solution and coolant piping. Install flexible rubber, rigid foam plastic, or other non-permeable, vapor-tight insulation material for conditioners. When the equipment is installed outside, an ultraviolet and weather protective coating must be applied to the insulation. Insulate regenerators and steam or hot water piping with 50 mm 2 inch of rigid, foil- or plastic-faced, fiberglass board. Insulate solution piping for personnel protection. Apply weather protective covering if the equipment is installed outside. Do not penetrate the outer casing of the conditioner and regenerator with insulation fasteners. Contact cement or other adhesive as recommended by the insulation manufacturer for use with an FRP substrate must be used for insulation fastening. Install insulation in conformance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.4.3 Insulation

Insulate conditioners whenever a coolant other than cooling tower water is used to prevent surface condensation. Insulate the entire unit including the solution and coolant piping. Install flexible rubber, rigid foam plastic, or other non-permeable, vapor-tight insulation material for conditioners. When the equipment is installed outside, an ultraviolet and weather protective coating must be applied to the insulation. Insulate regenerators and steam or hot water piping with 50 mm 2 inch of rigid, foil- or plastic-faced, fiberglass board. Insulate solution piping for personnel protection. Apply weather protective covering if the equipment is installed outside. Do not penetrate the outer casing of the conditioner and regenerator with insulation fasteners. Contact cement or other adhesive as recommended by the insulation manufacturer for use with an FRP substrate must be used for insulation fastening. Install insulation in conformance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.4.4 Safety Requirements

****

NOTE: Catwalk, ladder and guardrail may be required. Select the applicable bracketed items, delete the others, and indicate on the drawings the selected items. If not applicable, delete the entire sentence within the brackets.

****

Insulate,fully enclose, guard, or fit with other types of safety devices all exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel , fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices installed so that proper operation of equipment is not impaired. Provide [[Catwalk][Ladder][Guardrail] where indicated and in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].]

2.4.5 Electrical Work

****

NOTE: Where motor starters for mechanical equipment are provided in motor-control centers, the references to motor starters will be deleted.

****

Electrical equipment, motors, motor efficiencies, and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical motor driven equipment specified complete with motors, motor starters, and controls (including variable speed control of process air flow for solid units, where applicable). Electrical characteristics and enclosure type must be as shown, and unless otherwise indicated, all integral size motors with open, dripproof, or totally enclosed fan cooled enclosures, must be premium efficiency type in accordance with NEMA MG 1.

Field wire in accordance with manufacturer's instructions. Each motor must conform to NEMA MG 1 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. All motors must be continuous duty with the enclosure specified. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Furnish motors with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Provide motor starter with [NEMA 1][NEMA 3R][NEMA [_____]] enclosures. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown.

2.4.6 Duct Work

2.4.6.1 Plenums and Ductwork

Provide desiccant units with flanges on the air openings for duct connection. Bolt inlet and outlet plenums to the flange with a gasket between the connection. Provide access doors, for servicing diffusers and eliminators, in the inlet and outlet plenums. Inlet ductwork must be designed to allow uniform distribution of air across the entire opening. Outlet plenums and ductwork must allow adequate room for servicing the eliminators and must provide proper airflow through the equipment. Provide plenum and ductwork sizes as shown and specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4.6.2 Regenerator Exhaust Ductwork

The regenerator exhaust ductwork must be made of glass-fiber reinforced polyester (FRP) or monel. FRP must be rated for continuous duty at 82 degrees C 180 degrees F. Construct duct joints watertight. Incorporate a drip collar in the exhaust plenum and duct to capture any condensation that occurs inside the duct. Pitch long horizontal duct runs slightly in the direction of air flow, and incorporate low-point condensate drains.

2.5 SYSTEM COMPONENTS

2.5.1 Desiccant Rotor

Provide and install dehumidifiers of a non-cyclic adsorption type with a single desiccant rotary structure designed for continuous operation. Provide counter flow construction arrangement of process and regeneration air streams with full face pressure seals to prevent cross leakage with static pressure differentials up to 200 mm 8 inches water gauge. The rotary structure must consist of a stable, hygroscopic desiccant material, such as Silica Gel, Titanium Silicate, or a Zeolite, deposited on a honey-combed substrate designed to maximize the desiccant area exposed to the air stream and minimize the thermal carryover from the regeneration side to the adsorption side. Ensure laminar air flow through the structure for minimum pressure loss. The rotor must be complete with an electric motor with over-current protection and a speed reducer assembly driving the rotor through a flexible circumferential drive belt. Include a slack side belt tensioner for automatic take-up.

2.5.2 Heat Exchanger

2.5.2.1 Thermal Rotor

Minimize the transfer of water vapor between the process and regeneration sides of the unit with a rotary, non-hygroscopic type thermal rotor. Construct and size the rotor to maximize the transfer of heat from the supply air stream to the regeneration air stream while minimizing the transfer of moisture back to the supply air stream. Supply and cooling air streams must be counter flow and the component fitted with full face contact seals on both sides to prevent leakage.

2.5.2.2 Heat Pipe

****

NOTE: The designer will research local conditions to determine the effect of corrosive atmosphere on dissimilar metals. Where condenser or evaporator coils are to be installed in corrosive atmospheres, the specification for coils and fins will be rewritten for these specific conditions. Consideration should be given to the following coil and fin combinations based on past experience with the suitability of these materials in dealing with the local conditions.

a. Copper coil and aluminum fins, coated.

b. Copper coil and copper fins, coated.

c. Aluminum coil and aluminum fins, coated.

d. Aluminum coil and aluminum fins, uncoated.

e. Copper coil and copper fins, uncoated.

Coating may be either phenolic or vinyl. For coils with relatively close fin spacing such as those found in most unitary equipment, the phenolic coating is preferred. Phenolic has less tendency to bridge across the fins than vinyl, has better thermal conductivity than vinyl and in many conditions weathers better than vinyl.

****

Heat pipe coils must be of the extended-surface fin-and-tube type and be constructed of seamless [15] [18] [25] mm[1/2] [5/8] [one] inch nominal diameter [copper] [or] [aluminum] utilizing wrought aluminum Alloy 3003 or Alloy 5052tubes with compatible [copper] [or] [aluminum] fins. On heat pipes with all aluminum construction, tubes must conform to ASTM B210/B210M, alloy 1100 and aluminum alloy conforming to chemical requirements of ASTM B209M ASTM B209; use alloy 7072 for the fins and end sheets. Solder or mechanically bond fins to the tubes and installed in a metal casing. Test coils after assembly at pressure specified in ASHRAE 15 & 34 for the refrigerant employed in the system. [After testing of the heat pipe coils, dry coils to remove free moisture, and cap to prevent entrance of foreign matter.]

2.5.2.3 Refrigerants

Refrigerants must be one of the hydrochlorofluorocarbon or hydrofluorocarbon gases and have number designations and safety classifications in accordance with ASHRAE 15 & 34. Refrigerants must meet the requirements of AHRI 700 as a minimum. Refrigerants must have an Ozone

Depletion Potential (ODP) of less than or equal to 0.05 and be in compliance with pertinent EPA regulations. Factory leak test and dehydrate the unit, as specified in Section [23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS] [23 23 00 REFRIGERANT PIPING].

2.5.3 Fans (Solid Desiccant System) For Supply and Regeneration

Equip the unit with two belt driven backward inclined blowers. Provide a drive belt rated for minimum 150 percent of motor horsepower on each motor. Provide sheaves with the supply fan motor for air balancing. Provide nominal 3500 RPM motors, NEMA B with open dripproof housings and a minimum service factor of 1.15.

2.5.4 Heating System (Solid Desiccant System)

Regeneration and process heating coils must be of the finned tube type, and be constructed of 13 mm 1/2 inch OD seamless copper tube mechanically bonded to aluminum fins. Include a flanged, heavy-gauge, galvanized steel housing for mounting the coils to the unit. The coils must be rated for 1135 kPa 150 psig.

2.5.5 Filters (Solid Desiccant System)

Equip outside air inlets and return air plenums with 50 mm 2 inch, 30 percent minimum efficiency filters. Provide pleated and disposable filters.

2.5.6 Indirect Evaporative Cooling System (Solid Desiccant System)

****

NOTE: Where water is of high hardness (>121 ppm or mg/L), make provisions to facilitate automatic or manual blowdown to reduce solids build-up. Alternatively, water should be softened prior to use as make-up for the evaporative cooling system.

****

Use evaporative cooling to indirectly cool the supply air. Include an evaporative cooling media of cellulose paper impregnated to resist degradation and PVC piping with the system.

2.5.7 Gas Fired Boiler (Solid Desiccant System)

****

NOTE: Boiler regeneration capacity, as determined by the manufacturer, may be based on the regeneration capacity required under "design day" conditions, or 1 percent or 2.5 percent summer outdoor design conditions. The supporting rationale behind such sizing is that the specific humidity of the air leaving the desiccant will be fairly constant over variable outdoor conditions. The boiler will substantially regenerate the desiccant at relatively high outdoor dry-bulb temperatures and specific humidity ratios, while full-capacity regeneration at lower outdoor dry-bulb temperatures and specific humidity ratios will still produce a process air stream with a specific humidity ratio comparable to that achieved at outdoor conditions of higher dry-bulb temperature and specific humidity

ratio. This approach minimizes the expense of a higher capacity boiler, boiler short-cycling at light dehumidification loads and the unnecessary expense of excessive dehumidification. If a higher capacity boiler is required, the designer should discuss this with the manufacturer and investigate the possibility of modulating control of regeneration heat (which will be simpler to obtain with an external, rather than internal, heat source for regeneration).

****

Provide a gas-fired water heater boiler suitable for delivering fluid temperatures of 99-104 degrees C 210-220 degrees F. Construct boiler with a copper tube exchanger and cast iron wet walls. Provide complete unit with all controls, including an automatic gas valve, automatic pilot spark ignition system, power draft inducer, supply water control temperature sensor, and suitable safety controls. Include properly sized diaphragm type expansion tank for the hydronic system. Diaphragm must be flexible butyl securely attached to inner tank wall. Maximum allowable working pressure must be at least 791 kPa 100 psig, and 116 degrees C 240 degrees F temperature.

2.5.8 Circulating Pumps (Solid Desiccant System)

Provide a submersible type evaporative cooling pump with a hooded intake, polypropylene screen, and thermal overload protection. Provide an in-line close coupled single stage centrifugal boiler pump.

2.5.9 Refrigeration Section (Solid Desiccant System)

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NOTE: The addition or elimination of the refrigeration section to a rotary wheel desiccant should not hinder the designer from selecting additional refrigeration equipment downstream or upstream (pre-cooling coil) of the desiccant unit. The designer can choose this option, but should view the desiccant system as part of the total air delivery system.

****

The refrigeration loop must be integral to the unit, and factory charged. The condenser section must provide the heat required to regenerate the desiccant rotor, and the evaporator section must provide additional cooling/dehumidification. Provide one of the hydrochlorofluorocarbon or hydrofluorocarbon gas type refrigerants with number designations and safety classifications in accordance with ASHRAE 15 & 34. Refrigerants must meet the requirements of AHRI 700 as a minimum. Refrigerants must have an Ozone Depletion Potential (ODP) of less than or equal to 0.05 and be in compliance with EPA regulations. Factory leak test and dehydrate the unit, as specified in Section [23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS] [23 23 00 REFRIGERANT PIPING] [or] [Section 23 81 00 DECENTRALIZED UNITARY HVAC EQUIPMENT].

2.5.10 Conditioner unit (Liquid Desiccant System)

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NOTE: Lithium chloride salt solution is now being

used in liquid desiccant systems. If another solution is to be used, the designer must edit those parts that make reference to lithium chloride solution to reflect the properties of the solution used.

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The conditioner unit must consist of a watertight housing containing the sump, inlet air diffusers, desiccant solution-to-air contact surface, desiccant solution distribution system and mist eliminator system; and a free standing pump assembly with tank, vertical seal-less solution pump and motor, and full-flow solution filter screen. Fabricate the housing and pump tank from corrosion resistant materials resistant to the desiccant solution. Construct internal parts made of cupronickel or nonmetallic corrosion-proof materials. Construct the desiccant solution pump and all other wetted parts with corrosion resistant materials. Fiberglass reinforced plastic surfaces must be pigmented and U.V. stabilized for exposure to direct sunlight.

2.5.10.1 Humidity Conditioning

The humidity conditioning system must be of the liquid desiccant type. The system be capable of simultaneous air cooling and dehumidification as indicated on the drawings. The system must automatically, fully modulate the usage of conditioner coolant and regenerator heat to match the system cooling and dehumidification loads. Deliver with the humidity conditioning system air containing not more than 5 microorganisms per 0.3 Cu. m 10 Cu. Ft, as measured by the Six-Plate Andersen Sampling Method, provided the supply air to the system contains not more than 100 organisms per 0.3 Cu. m 10 Cu. Ft.

2.5.10.2 Desiccant Solution

The desiccant solution must be stable and non-toxic and the desiccant not exist in the vapor phase in the conditioned air stream. The maximum loss rate of desiccant to the conditioned air stream must not exceed two parts lithium per billion parts air, by weight. Provide the end user with analysis and recommendations for maintenance of the desiccant solution six times yearly, free of charge, for the life of the equipment.

2.5.11 Conditioner Cooler (Liquid Desiccant System)

Provide conditioner desiccant solution cooler of the plate-and-frame type, with carbon steel frame carrier bars and tiebolts; titanium plates and nitrite or EPDM gaskets. Provide the solution heater complete with heating fluid control valve. The heat exchangers must be shipped loose for field installation.

2.5.12 Regenerator (Liquid Desiccant System)

The regenerator units must each consist of a watertight housing containing the sump, inlet air diffusers, desiccant solution-to-air contact surface, desiccant solution distribution system and mist eliminator system; and a free standing pump assembly with tank, vertical seal-less solution pump and motor, and full-flow solution filter screen. Fabricate the housing and pump tank of corrosion resistant materials resistant to the desiccant solution. Construct internal parts of cupronickel or nonmetallic corrosion-proof materials. Construct the desiccant solution pump and all other wetted parts with corrosion resistant materials resistant to the desiccant solution. Fiberglass reinforced plastic surfaces must be pigmented and U.V. stabilized for exposure to direct sunlight.

2.5.12.1 Humidity Conditioner

The humidity conditioning system must consist of separate conditioning and desiccant regeneration units providing complete separation of conditioned and regeneration air streams. The manufacturer must guarantee that there will be no cross-leakage of conditioner and regenerator air streams under any circumstances.

2.5.12.2 Fan Assembly

Supply the regenerator with a separate field-mounted fan and fan box assembly, consisting of housing, forward-curved fan motor, and drive. Construct the fan wheel of steel. Construct the fan box of galvanized steel. Heresite coat the fan wheel and fan box interior. Paint the fan box exterior with a prime and finish coat of industrial-grade acrylic machine enamel.

2.5.12.3 Equipment Location

Design the equipment so that the conditioner and regenerator units need not be installed in the same location, and may be located wherever convenient. Where units are installed outside, weatherproof insulation is required and adequate freeze protection for water, steam, and condensate piping is required.

2.5.13 Regenerator Heater (Liquid Desiccant System)

The regenerator solution heater must be of the plate-and-frame type, with carbon steel frame carrier bars and tiebolts; titanium plates and nitrite or EPDM gaskets. Supply the solution heater complete with heating fluid control valve. The heat exchangers must be shipped loose for field installation.

2.5.14 Level Control (Liquid Desiccant System)

The level control panel must consist of safety interlock pressure switch, unit pressure drop indicator, bubbler type supply pneumatics, P/I transducer, I/P transducer, and PID single-loop controller, all contained in a NEMA 12 enclosure. Ship the level control panel mounted to the unit.

2.5.15 Filter Screening (Liquid Desiccant System)

Equip the unit with noncorrosive diffuser and filtering system capable of filtering any droplets in the air stream and diffusing the stream for uniform airflow distribution.

2.5.16 Freestanding Pump Assemblies (Liquid Desiccant System)

Equip the conditioner and regenerator with a freestanding seal-less pump and motor. Construct the pumps shaft with an corrosion resistant materials suitable for the desiccant solution and all other wetted parts of vinylester FRP, or equal.

2.5.17 Make Up Water System (Liquid Desiccant System)

Equip the unit with piping, valving, and controls to automatically maintain solution level in the conditioner section. The level control panel must consist of a safety interlock pressure switch, unit pressure drop indicator, bubbler tube ("type" is indicated above) supply pneumatics, P/I transducer, I/P transducer, and PID single-loop controller, all contained in a NEMA 12 enclosure. The level control panel must be shipped mounted to the unit.

2.5.18 Conditioner Fan (Liquid Desiccant System)

Equip the unit with a conditioner fan only to the extent necessary to supply static pressure to existing equipment, or if used as a stand alone unit, as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5.19 Regeneration Fan (Liquid Desiccant System)

Supply the regeneration fan with a separate field-mounted fan and assembly rated for the requirements of the regeneration system. The fan and assembly must be of such design and construction to be resistant to the chemicals within the regenerator, as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.6 SUPPLEMENTAL ACCESSORIES/SERVICES

2.6.1 Nameplates

Include for each major component of equipment the manufacturer's name, address, type or style, and catalog or serial number on a plate securely attached to the item of equipment. Secure nameplates to the cabinet of dry desiccant units, indicating the equipment enclosed within the cabinet behind the nameplate. Provide cabinets with hinged panels, as specified, to facilitate maintenance of the component described on the nameplate secured to the cabinet.

2.6.2 Drain and Makeup Water Piping

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NOTE: All drain and makeup water piping should be indicated on the drawings.

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Provide and install piping in accordance with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE. Connect drains which connect to sanitary sewer system by means of an indirect waste.

2.6.3 Steam Piping and Accessories

Provide and install steam piping and accessories in accordance with Section 23 52 00 HEATING BOILERS.

2.6.4 Conditioner Solution Concentration

Provide the conditioner solution concentration capable of maintaining the humidity level specified on the drawings.

2.6.5 Automatic Controls

****

NOTE: Change paragraph as required to coordinate the central equipment controls with the air-side

system controls. In projects where this specification is intended to produce control equipment for existing air-side systems, this paragraph will be edited to secure controls to match existing controls and to properly integrate the specified controls into the existing temperature control system. Designer will be required to put a sequence of control for each cooling tower fan, chilled water pump, condenser water pump, etc. on the contract drawings.

One control measure recommended for consideration by the designer for solid desiccant units is a bypass damper arrangement whereby desiccant unit components are de-energized when the desiccant unit is not performing dehumidification, and a damper in the process air ductwork is closed. At the same time, a (bypass) damper in the outside air ductwork is open so that a central station air handling unit will not have to draw minimum (or economizer cycle) outside air quantities through the desiccant unit; i.e., outside air will bypass the desiccant unit on its way to the central air handler. When dehumidification is called for, the bypass damper will close and the damper in the process air ductwork will open, which will enable desiccant unit components to be energized (the dampers can be near one another and set to assume reversible and opposite positions through mounting on a common jackshaft). This control has numerous advantages: it reduces aggregate flow through desiccant unit filters and rotors, extending their useful lives; it reduces fan head pressure loss from particulate accumulation on filters and rotors, simultaneously reducing desiccant fouling and accompanying loss of dehumidification capacity; also, it reduces electrical energy consumption since the desiccant unit process air fan will not (and cannot) operate to move air through the desiccant unit to the central station air handler when dehumidification is not called for. The differential on the controls must be set; however, so that dampers and desiccant unit components do not short cycle.
****

Provide automatic controls for the specified desiccant system swith the desiccant equipment. These controls must operate automatically [in accordance with Section 23 09 93 Sequences of Operation] to balance the equipment capacity with the load on the air conditioning system, and be fully coordinated with and integrated into the [temperature control system specified in Sections 23 30 00 HVAC AIR DISTRIBUTION and 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][existing air-conditioning system].

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform verification of dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work. Submit a letter, at least 2 weeks prior to beginning construction, indicating the date the site was visited, confirming existing conditions, and noting any discrepancies found.

3.2 INSTALLATION

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NOTE: All pertinent piping and related equipment supports are to be designed and indicated in accordance with UFC 3-301-01 for seismic design.

****

Perform all work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.

3.2.1 Equipment

****

NOTE: Designer will determine, in the initial stages of design, the approximate distances required for maintenance clearances of all new equipment. he maintenance clearances will be used in determining the final layout of the equipment. For installations where noise and vibration transmission to the building must be reduced, the maximum tolerable transmissibility, in percent, should be determined and the blank filled with the appropriate value. When it is not necessary to specify the percent of transmissibility, the item in the brackets will be deleted and brackets removed. Recommended transmissibility in percentages is: 10 percent for equipment mounted in very critical areas; 10 to 20 percent for critical areas; and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors and the conditions surrounding the equipment to be provided with the vibration isolation units favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values, based on the equipment location, the specification may be revised to indicate the appropriate values on the drawings.

****

Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports. Isolate housings from the building structure. If mechanical vibration isolators are not provided, furnish vibration absorbing foundations. Include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material for each foundation. Set other floor-mounted equipment on not less than a 150 mm 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps must have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the combined pump, motor, and base weights. Select and size isolators based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators must limit vibration to [_____] percent at lowest equipment rpm. Provide lines connected to pumps mounted on pedestal blocks with flexible connectors. Furnish foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Install concrete for foundations and concrete-structured or cast-cooling towers as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Properly level, align, and secure in place all equipment in accordance with manufacturer's instructions.

3.2.2 General Piping, Valves, and Duct Installation

Install all piping, valve, and duct installation in accordance with the desiccant equipment manufacturer's recommendation or in accordance with Sections 23 30 00 HVAC AIR DISTRIBUTION[, 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS][, 23 23 00 REFRIGERANT PIPING,] and 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2.3 Pipe Color Code Marking

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NOTE: Designer will coordinate color code marking with Section 09 90 00. Color code marking for piping not listed in Table I of Section 09 90 00, will be added to the table.

****

Color code as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 MANUFACTURER'S FIELD SERVICE

Provide the services of a factory-trained representative for [_____] days. The representative must advise on the proper operation and servicing of the equipment and make any adjustments necessary to insure full compliance with design criteria.

3.4 DEMONSTRATIONS

Conduct a training course for the operating staff as designated by the Contracting Officer. Submit a schedule for training demonstrations, at least 2 weeks prior to the date of the proposed training course, identifying the date, time, and location for the training. The training period must consist of a total [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

a. The field instructions must cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed, condensed, operation instructions. Include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system in the condensed operation instructions. Post instructions framed under glass or laminated plastic and be post where indicated by the Contracting Officer.

b. Submit [6] [_____] complete bound copies (216 by 279 mm 8-1/2 x 11 inches) of an operation and maintenance manual listing step-by-step procedures required for system startup, operation, maintenance, and shutdown. The manual must include the manufacturer's name, model number, parts list, service manual, and a brief description of all equipment and their basic operating features. Include routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide in the manual. Include piping and equipment layouts and simplified wiring and control diagrams of the system as installed in the manuals.

3.5 PERFORMANCE TESTS

****

NOTE: Performance data should be provided at other than or in addition to "design day" conditions, or the 1 percent or 2.5 percent outdoor "Summer Design Data - Air Conditioning" dry-bulb (Db) temperature conditions defined in UFC 3-400-02. Peak humidity loads arising from ventilation or makeup air occur when the outdoor specific humidity (Gr./lb) is highest, frequently at dry-bulb temperature conditions other than design day, or 1 percent or 2.5 percent outdoor summer design dry-bulb temperature conditions. Also, there may be significantly more hours occurring annually at conditions of higher outdoor specific humidity than at higher outdoor dry-bulb temperature. However, dry-bulb temperature can be important, as at times during the summer when the regeneration heating required is less than capacity due to a relatively low outdoor dry-bulb temperature that is coincident with a relatively high outdoor specific humidity. The foregoing is predicated on the assumption that outside air would be used as the source of process air and regeneration air. Obviously, other arrangements are possible, such as facility exhaust air providing the source of regeneration air, or a mixture of both return and outside air, providing the source for process air. Designer needs to indicate the range of humidities the equipment should cover in the plans or specifications.

****

Before each desiccant system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's startup representative experienced in system startup and testing, at such times as directed. Submit test schedules, at least 2 weeks prior to the start of the field tests and the system performance test. Identify the date, time, and location for the performance test in the schedules. Test and measure quantities listed below. Tests must cover a period of not less than [_____] days for each system and demonstrate that the entire system is functioning in accordance with the drawings and specifications. Make corrections and adjustments necessary and re-conduct tests to demonstrate that the entire system is simultaneously functioning as specified. Submit a report documenting the data taken versus the specified performance criteria, upon completion of installation and performance testing of the system. Submit [6] [_____] copies of the bound report (216 by 279 mm

8-1/2 by 11 inches). Document compliance with the specified performance criteria upon completion and testing of the system in the report and indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Include the information below recorded at least three different times at outside dry-bulb temperatures that are at least 5 degrees C F apart. Prepare a report for each desiccant system, including the information outlined below. Record data for the tests at least three different times at outside wet-bulb temperatures which are at least 3 degrees C 5 degrees F apart.

3.5.1 Liquid Desiccant System

a. Date and outside weather conditions (at least two parameters to define the state of the outside air: DB (dry bulb temperature), Gr./LB (grains water per LB dry air), Wb (wet bulb temperature), relative humidity).

b. The load on the system based on the following:

(1) CFM entering the system (Process and Regeneration).
(2) Conditioner side - entering air conditions (Db, Gr./LB).
(3) Conditioner side - discharge air conditions (Db, Gr./LB).
(4) Conditioner side - coolant entering temperature.
(5) Regenerator side - entering air conditions (Db, Gr./LB).
(6) Regenerator side - discharge air conditions (Db, Gr./LB).
(7) Regenerator side - heat source temperature (Btu/hr).
(8) Running current, voltage and proper phase sequence for each phase of all motors.
(9) The actual on-site setting of all operating and safety controls.

3.5.2 Solid (Wheel) Desiccant System:

a. Date and outside weather conditions (at least two parameters to define the state of the outside air: DB, Gr./LB, Wb, relative humidity).

b. The load on the system based on the following:

(1) CFM entering the system (Process and Regeneration).
(2) Process side - entering air conditions (Db, Gr./LB).
(3) Process side - discharge air conditions (Db, Gr./LB).
(4) Process side - post coolant capacity (tons).
(5) Regenerator side - entering air conditions (Db, Gr./LB).
(6) Regenerator side - discharge air conditions (Db, Gr./LB).
(7) Regenerator side - heat source capacity (Btu/hr).
(8) Running current, voltage and proper phase sequence for each phase of all motors.
(9) The actual on-site setting of all operating and safety controls.

3.6 INSPECTIONS

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NOTE: It is strongly suggested that the customer obtain a service contract on these units (solid and liquid) to insure proper operation of the desiccant.

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The manufacturer of the liquid desiccant system must supply, free of charge, testing of solution samples sent to them by the customer every two months for the life of the equipment. The manufacturer of each type system must inspect the systems after one year of operation to insure the systems are operating properly. Submit a bound inspection report (216 by 279 mm 8-1/2 x 11 inches) at the completion of one year of service. Identify in the report the condition of the desiccant system and include a comparison of the condition of the desiccant system with the manufacturer's recommended operating conditions.

3.7 CLEANING AND ADJUSTING

Wipe equipment clean, with all traces of oil, dust, dirt, or paint spots removed. Provide temporary filters for all fans that are operated during construction, and install new filters after all construction dirt has been removed from the building. Maintain system in this clean condition until final acceptance. Lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to the setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-25 05 11 (August 2024)**

Preparing Activity: USACE **Superseding**
UFGS-25 05 11 (May 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-25 05 11 (August 2024)**

Preparing Activity: USACE **Superseding**
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SECTION 25 05 11

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS

08/24

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NOTE: This guide specification covers the requirements for cybersecurity for LOW and MODERATE impact facility-related control systems to meet the requirements of the Department of Defense Risk Management Framework (RMF).

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR).

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Note: Facility-related control systems are a subset of control systems that are used to monitor and control equipment and systems related to DoD real property facilities (e.g., building control systems, utility control systems, electronic security systems, and fire and life safety systems). This section includes Cybersecurity requirements to be included on every DoD project which includes a facility-related control system. This Section does not provide general requirements for a control system, nor are the requirements in this section sufficient to procure a control system. This section must be used in conjunction with another

controls system specification. For example, for a HVAC controls project, this section should be used in conjunction with Section 23 09 00 and related sections.

Requirements and activities in this section must be coordinated with the other relevant control specification sections. Requirements specific to Cybersecurity should be incorporated into this section, and requirements not specific to Cybersecurity should be included in the appropriate controls section.

This section includes requirements in support of the DoD Risk Management Framework (RMF) for implementing cybersecurity. Refer to UFC 4-010-06, Cybersecurity for Facility-Related Control Systems for requirements on incorporating cybersecurity into control system design and for general information on the RMF process as it applies to control systems.

Assistance for control system cybersecurity is available from the following Service organizations:
Army (other than USACE Civil Works):
Control System Cybersecurity Mandatory Center of Expertise (CSC-MCX), Huntsville Engineering and Support Center (CSC-MCX@usace.army.mil).

Navy (and Marine Corps):
Naval Facilities Engineering Systems Command, Command Information Office (CIO)

Air Force (and Space Force):
Air Force Civil Engineering Center (AFCEC) Operations Directorate, Tyndall Air Force Base

USACE Civil Works:
USACE Critical Infrastructure Cybersecurity Mandatory Center of Expertise (UCIC-MCX) (uciccybersecurity@usace.army.mil)

Note that all projects where USACE is the design-construction agent require coordination with the relevant cybersecurity MCX as well as all other relevant control system MCXs.

Since this Section covers a wide range of control systems, and those systems often have different capabilities and requirements, there are requirements identified in this Section which need extensive designer input or decisions.

Many designer selections in this Section will require coordination with the project site, System Owner, Authorizing Official or a subject matter expert in the specific control systems being

installed.

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NOTE: This Guide Specification is for use on control systems having no impact rating higher than MODERATE. If the project includes systems with impact ratings of HIGH, this specification must be modified to include those additional requirements.

Systems of different types at the same impact level may have different requirements based on the specific needs and capabilities of the control system. This is addressed in this Guide Specification by indicating when requirements apply to a specific system type.
Systems of the same type may have different requirements. This may be due to those systems having different impact levels or due to system-specific requirements for systems at the same impact level.

If a project includes multiple systems, it's critical that it be clear which requirements apply to which systems. This can be done by a) using a single Section and specifying the applicability of requirements (indicating for each system what impact level and system type it is) or b) using multiple Sections. Which approach to employ depends on the needs of the project and the preferences of the specifier and project manager. If using multiple sections use the fourth level specification numbering to differentiate the Sections and indicate in each which systems the Section applies to, for example, one project may have:
1) Section 25 05 11.01 CYBERSECURITY FOR LOW IMPACT HVAC CONTROL SYSTEMS

2) Section 25 05 11.02 CYBERSECURITY FOR LOW IMPACT LIGHTING SYSTEMS

3) Section 25 05 11.03 CYBERSECURITY FOR MODERATE IMPACT ELECTRONIC SECURITY SYSTEMS

4) Section 25 05 11.04 CYBERSECURITY FOR LOW IMPACT CIVIL WORKS CONTROL SYSTEMS

(The fourth level numbering is not required to be sequential, as long as the mapping between the cybersecurity specification and the control system is clear. Some projects may wish to use fourth level numbering that matches the division they support (25 05 11.23 for HVAC (mechanical) for example).)

In accordance with UFC 4-010-06, for projects designed by or under contract to USACE use multiple specifications as described in this note, where each system has a corresponding cybersecurity section which is included with the section(s) specifying the

control system.

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NOTE: This specification makes use of SpecsIntact Tailoring Options.

Services tailoring options:
Army
Air Force

Impact Level tailoring options:
LOW Impact
MODERATE Impact

Control system type tailoring options:
HVAC Control Systems
Lighting Control Systems
Electronic Security Systems (ESS)
Fire Protection Systems
USACE CW (for USACE Civil Works systems)
Designer Specified Requirements
Default Requirements

Currently, all text in Fire Protection tags is also within MODERATE Impact tags, and LOW Impact Fire Protection systems are addressed by the default requirements.

These tailoring options affect the subparts that are included throughout the specification to "break out" specific requirements. The "Default Requirements" tailoring option includes "generic" requirements that are intended to apply to a wide range of control systems. The "Designer Specified Requirements" tailoring option will include blank subparts for the specification of requirements, and is intended to be used when customizing requirements to a control system type for which there is no specific tailoring option and for which the "Default Requirements" are not applicable.

Include only tailoring options for the specifications to be addressed. Only include "Default Requirements" if the section is to cover a system not covered by one of the specific system type options AND the "Default Requirements" are adequate. Only include "Designer Specified Requirements" if the section is to cover a system not covered by one of the specific system type options, AND the "Default Requirements" are NOT adequate. When selecting "Designer Specified Requirements", requirements must be added throughout the specification.

****

PART 1 GENERAL

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NOTE: As described in the paragraph below, this

Section includes text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. When editing this specification to incorporate requirements for other controls or CCIs or to remove requirements related to specific controls or CCIs, revise the list of controls and CCIs accordingly. DO NOT REMOVE THE TEXT IN CURLY BRACES in the final specification; this information is needed for reference during construction, commissioning and cybersecurity assessments.

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NOTE: This subpart points the contractor to the locations of STIGs and SRGs, as this Section requires the contractor to meet available STIGs or SRGs. It's not necessary for the designer/specifier to review the STIGs or SRGs for applicability. The contractor is responsible for determining which STIGs or SRGs are applicable and for meeting the relevant requirements.

While most STIGs/SRGs do not require a CAC to access, FOUO STIGs/SRGs do. See the SRG-STIG Compilation Read-Me for more information - https://dl.dod.cyber.mil/wp-content/uploads/stigs/pdf/U_STIG_Library-zip_Read-ME_v1-07.pdf

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Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

This Section refers to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs). STIGs and SRGs are available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/ and an SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this Section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

[1.1 CONTROL SYSTEM APPLICABILITY

****

NOTE: If multiple versions of this Section are used on a single project, keep this subpart and list all the systems to which this specific version of the Section applies.

****

There are multiple versions of this Section associated with this project. Different versions have requirements applicable to different control systems. This specific Section applies only to the following control systems: [_____].

]1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the [Contracting Officer][_____] to determine which requirement applies to the project.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.1x	(2010) Local and Metropolitan Area Networks - Port Based Network Access Control

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 2819	(2000) Remote Network Monitoring (RMON) Management Information Base (MIB)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 140-2	(2001) Security Requirements for Cryptographic Modules
NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8551.01	(2014) Ports, Protocols, and Services Management (PPSM)
DTM 08-060	(2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement

1.4 DEFINITIONS

1.4.1 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Administrator Account'.

1.4.2 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows

b. a device running a non-embedded version of MacOS

c. a device running a non-embedded version of Linux

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux

e. a device running a version of Apple iOS

Unless otherwise indicated or clear from context use of the word "device" in this Section includes computers.

1.4.3 Controller

****
NOTE: This subpart uses the USACE CW tailoring option to add IP Router.
****

A device other than a computer, IP Router, or Ethernet switch. For Fire Protection systems this includes fire alarm control panels, remote operating consoles, and remote annunciators.

1.4.4 Mission Space

****
NOTE: Define "Mission space" such that the contractor is able to determine when a network or device is outside of the mission area. Coordinate the definition of Mission Space with the physical security design and the security organization at the project site.

Select whether to leave the definition or to define mission space on a drawing.
****

[A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a variable air volume (VAV) box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an air handling unit (AHU) in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.][Mission space is shown on the drawings.]

1.4.5 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network. Addresses may be other than IP addresses, and addressing may be at either Open Systems Interconnection (OSI) layer 2 or layer 3.

1.4.6 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.4.6.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.4.7 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.4.8 Network Segmentation

****

NOTE: This subpart is only included when the USACE CW tailoring option is selected.

****

Segmenting or segregating networks either by logical or physical methods. Examples of logical methods include firewall zones, virtual local area networks (VLANs), or virtual private networks (VPNs). Physical separation is done by deploying additional hardware. Network segmentation is used for isolation of discrete functions or processes. Each network segment will have its own IP address space or subnet.

1.4.9 Operational Technology (OT)

****

NOTE: This subpart is only included when the USACE CW tailoring option is selected.

****

The hardware and software dedicated to detecting and/or causing changes in physical processes through direct monitoring and control of physical devices to accomplish a specific mission in real time.

1.4.10 User Account Support Levels

The support for user accounts is categorized in this Section as one of three levels:

1.4.10.1 FULLY Supported

Device supports configurable individual accounts. Accounts can be created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.4.10.2 MINIMALLY Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration; and b) a room lighting control touchpad interface that has a single account.

1.4.10.3 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.4.11 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.4.12 Card Reader

A card reader is an input/output device whose primary function is to assist in two-factor authentication. A card reader must have an interface to read data from a card and may be able to write data to a card. A card reader may have a means (such as buttons, keypad, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.

1.4.13 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).

1.4.13.1 Local User Interface

A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full

User Interface".

1.4.13.2 Remote User Interface

A Remote User Interface implements a Client/Server model where the physical hardware the user interacts with (Client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the Client. The Client and Server communicate via a network connection. A common example of a remote user interface is a web-based interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a Client on the same hardware as the Server. What is important is that a) the Client may be on different hardware than the Server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.13.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.13.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.13.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of LIMITED UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.13.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.4.13.3.4 View-Only User Interface

See Read-Only User Interface

1.4.13.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.13.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.13.4.2 Privileged User Interface

****

NOTE: This subpart uses tailoring options for the lettered requirements. After selecting tailoring options edit the letters in this subpart accordingly.

****

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage. Unless otherwise specified, user interfaces can be determined to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. User Interfaces that can inhibit or force the activation of a fire suppression system (e.g. such as for a pre-action or deluge system) are always privileged user interfaces. Other Full User interfaces for Fire Alarm Systems are privileged user interfaces as indicated and shown, or when another requirement of this Section establishes they are privileged. For all other systems, Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allows for modification or deletion of audit logs are privileged user interface.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Writeable User Interfaces in Electronic Security Systems (ESS) are privileged user interfaces.

f. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.14 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, long and short wave radio, 2.4 GHz, free space optical, point-to-point laser, microwave, and IR.

1.4.15 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

****

NOTE: Indicate the appropriate point of contact (POC) for each POC.

Previous versions of this specification identified the Contracting Officer Representative (COR) as the POC. UFC 1-300-02**, 2-3.7 states, "Use the term "Contracting Officer" \1\; do not use terms such as /1/ “Officer in Charge of Construction,” “Contracting Officer Representative ,” or “Government Representative.” The Contracting Officer (KO) will likely designate a representative, but this is an internal decision and not something the Contractors need to be apprised of.**

Government Computer Access Point of Contact: To provide contractor user access to Government computers. Specifically, this POC may be required to arrange for elevated permissions to computers to create a backup disk image or install malware protection software.

HTTPS Certificate Point of Contact: To provide the contractor with web certificates.

Email Address Point of Contact: The POC who will provide the contractor with email addresses for the ISSM and application administrator for auditing.

Password Point of Contact: The POC who will either coordinate the selection of passwords with the contractor or who will indicate individuals to change the passwords in coordination with the contractor.

Mobile Code Point of Contact: The POC who will

provide access to the mobile code repository. (This will generally be someone from the installation IT organization (for the Army, the NEC).)

<u>PKI Infrastructure Point of Contact</u>: The POC who will provide access to the PKI Infrastructure. If PKI is not required by PART 3 of this Section, remove this bracketed text. (This will generally be someone from the installation IT organization (for the Army, the NEC).)

These points of contact are used by name in the specification, and can be found by searching the document for the POC (using underlined text).

Not all projects will require all POCs. If unsure of the POC keep "The Contracting Office Representative (COR)" and the contractor will request as needed.

****

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with the [Contracting Officer (KO)][_____].

a. Government Computer Access Point of Contact: [Contracting Office (KO)][_____]

b. HTTPS Certificate Point of Contact: [Contracting Officer (KO)][_____]

c. Email Address Point of Contact: [Contracting Officer (KO)][_____]

d. Password Point of Contact: [Contracting Officer (KO)][_____]

e. Mobile Code Point of Contact: [Contracting Officer (KO)][_____][

f. PKI Infrastructure Point of Contact: [Contracting Officer (KO)][_____]]

1.5.2 Coordination

****

NOTE: This subpart deals with cybersecurity related coordination requirements for the contractor, and does not indicate coordination that must be done by the designer/specifier. In addition to the normal project coordination, authorization for wireless use, alternate account lock permissions and devices with multiple IP connections may be impacted by site (or Service) policies and need to be coordinated with the appropriate Government representatives before authorization is provided.

****

Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for wireless or wired broadcast communication, the Wireless and Wired Broadcast Communication Request submittal must be approved prior to control system device selection and installation.

b. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

c. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

d. Wireless testing may be required as part of the control system testing. See requirements for the Wireless Communication Test Report submittal.

e. If the Device Audit Record Upload Software is to be installed on a computer not being provided as part of the control system, coordination is required to identify the computer on which to install the software.

f. The Cybersecurity Interconnection Schedule must be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

g. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.

h. Passwords must be coordinated with the indicated contact for the project site.

i. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.

j. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: All submittals in this Guide Specification require Government approval and must have a "G" designation.

Government review of submittals in this Section impact Cybersecurity, and must be coordinated with the appropriate Cybersecurity experts to ensure appropriate review and the identification of issues or concerns that may affect the cybersecurity posture of the system or the ability of the system to receive an RMF authorization.

****

****

NOTE: Throughout this subpart, the USACE CW Tailoring Option is used to add "(Encrypted)" after some submittal names.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****

NOTE: When the FIRE PROTECTION tailoring option is selected, the Wireless and Wired Broadcast Communication Request will be in brackets. If this specification is used ONLY for Fire Protection Systems remove the bracketed text. Otherwise keep it.

****

****

NOTE: When the USACE CW tailoring option is selected, the USACE OT/Control Systems Acceptable Use Policy (AUP) and Account Level Permissions List submittals are included.

****

[Wireless and Wired Broadcast Communication Request; G, [_____]

] Device Account Lock Exception Request; G, [_____]

Multiple Ethernet Connection Device Request; G, [_____]

Contractor Computer Cybersecurity Compliance Statements; G, [_____]

Contractor Temporary Network Cybersecurity Compliance Statements; G, [_____]

Cybersecurity Interconnection Schedule (Encrypted); G, [_____]

Protection of Information At Rest Proposal; G, [_____]

Proposed STIG and SRG Applicability Report; G, [_____]

Pre-Construction Control System Inventory Report (Encrypted); G, [_____]

Contractor Personnel Certifications; G, [_____]

USACE OT/Control Systems Acceptable Use Policy (AUP); G, [_____]

Account Level Permissions List (Encrypted); G, [_____]

SD-02 Shop Drawings

****

NOTE: When the USACE CW tailoring option is selected, the System Data Flow Diagram submittal is included.

****

Network Communication, Ports, Protocols and Services Report; G[, [_____]]

Cybersecurity Network (Riser) Diagram (Encrypted); G, [_____]

System Data Flow Diagram (Encrypted); G, [_____]

SD-03 Product Data

****

NOTE: When the USACE CW tailoring option is selected, the Certificate Protection Status submittal is included.

****

Control System Cybersecurity Documentation; G, [_____]

Certificate Protection Status (Encrypted); G, [_____]

SD-06 Test Reports

****

NOTE: When the FIRE PROTECTION tailoring option is selected, the Wireless Communication Test Report will be in brackets. If this specification is used

ONLY for Fire Protection Systems remove the bracketed text. Otherwise keep it.
****

[Wireless Communication Test Report; G, [_____]
]
Control System Cybersecurity Testing Procedures; G, [_____]

Control System Cybersecurity Testing Report; G, [_____]

Antivirus/Antimalware Scan Results; G, [_____]

SD-07 Certificates

Software Licenses; G, [_____]

SD-11 Closeout Submittals

****
NOTE: In PART 3 of this Section there is a designer selection to indicate whether the contractor changes passwords or accompanies site personnel while they change passwords.

If requiring contractor to change passwords, keep "Confidential Password Report" and remove "Password Change Summary Report"

If requiring contractor to accompany site personnel to change passwords, keep "Password Change Summary Report" and remove "Confidential Password Report"
****

[Confidential Password Report; G, [_____]

][Password Change Summary Report; G, [_____]

] Enclosure Keys; G, [_____]

Software and Configuration Backups (Encrypted); G, [_____]

Auditing Front End Software; G, [_____]

Device Audit Record Upload Software; G, [_____]

System Maintenance Tool Software; G, [_____]

Control System Scanning Tools; G, [_____]

STIG, SRG and Vendor Guide Compliance Result Report (Encrypted); G, [_____]

Final Control System Inventory Report (Encrypted); G, [_____]

Integrity Verification Software; G, [_____]

Vulnerability Resolution Report; G, [_____]

BIOS/UEFI Protection Password/Passphrase List (Encrypted); G,

[_____]

1.7 ENCRYPTED SUBMITTAL REQUIREMENTS

****
NOTE: This subpart is only included when the USACE CW tailoring option is selected
****

Submittals with sensitive data are marked with "(encrypted)" and must be encrypted with NIST FIPS 140-2 compliant encryption methods with a password that meets the requirements under paragraph PASSWORDS. Encrypted submittals must be sent via DoD SAFE (https://safe.apps.mil/) and only sent to those who need to know. If DoD SAFE is not available, the government will provide an alternative secure file transfer that must be used. Do not store encrypted submittals on shared storage systems. Store and send encrypted information separately than the password.

1.8 QUALITY CONTROL

****
NOTE: If using these subparts to add requirements, be sure to add submittal requirements as needed to support these requirements.
****

[1.8.1 Regulatory Requirements

****
NOTE: If there are regulatory requirements related to a control system, specify those in the control system specification. If there are regulatory requirements related to cybersecurity for a control system they can be specified here.
Regulatory requirements specified here must indicate which system or systems they apply to, DO NOT include requirements here that are not directly linked to a specific control system.

For typical UMCS or building control system projects there will not be requirements to include here.
****

For the [_____] control system: [_____].

][1.8.2 [Certifications][Qualifications]

****
NOTE: THIS SUBPART IS NOT USED FOR USACE CW SYSTEMS. When the USACE CW tailoring option is selected, a subpart with USACE CW requirements is included, and this subpart should be removed during bracket replacement.

For all other systems:
If there are contractor qualification or certification requirements related to the control system, specify those in the control system specification. If there are contractor

qualifications or certifications specifically related to cybersecurity they can be specified here.

Use care when including requirements here, as many cybersecurity certifications are IT-centric and do not apply to control systems.

Requirements specified here must indicate which system or systems they apply to, DO NOT include requirements here that are not directly linked to a specific control system.

For typical UMCS or building control system projects there will not be requirements to include here.
****

For the [_____] control system: [_____].

]1.8.3   Certifications

****
NOTE: This subpart only applies to USACE Civil Works systems and is only included when the USACE CW Tailoring Option is selected.
****

Personnel performing cybersecurity functions must have current [IAT level 1][IAT level II][_____] certification according to approved DoD IA baseline certifications. Provide Contractor Personnel Certifications no later than [30][_____] days following Notice To Proceed. A cybersecurity function includes security-relevant functions that ordinary users are not authorized to perform. Examples of these activities include, but are not limited to, creating/modifying user accounts, configuring auditing levels, configuring functionality of a device that is restricted from general users, network architecture design, and applying secure configuration to an Operating System or device. See https://public.cyber.mil/cwmp/dod-approved-8570-baseline-certifications/.

Personnel who will have access to make changes to the OT system must read, agree to, and sign the USACE OT/Control Systems Acceptable Use Policy (AUP), provided by the government prior to accessing the OT system. Provide signed AUPs no later than [30][_____] days after notice to proceed.

[1.8.4   Pre-Construction Testing

****
NOTE: If there are cybersecurity Pre-Construction Testing requirements, include them here.

For a LOW-LOW-LOW Impact system pre-construction testing will generally not be required. For systems with a MODERATE or HIGH impact there may be some pre-construction testing requirements based on the specific needs of the project site.

Requirements specified here must indicate which system or systems they apply to, DO NOT include requirements here that are not directly linked to a specific control system.

Note, these concern testing of the control system, requirements on testing of the contractor's network during construction are separately covered below.
****

For the [_____] control system: [_____].

][1.9   DELIVERY, STORAGE, AND HANDLING

****
NOTE: If there are general delivery, storage or handling requirements related to a control system, specify those in the control system specification If there are delivery, storage or handling requirements specific to cybersecurity, include them here.

For a LOW-LOW-LOW Impact system delivery, storage and handling requirements will generally not be needed. For systems with a MODERATE or HIGH impact there may be some requirements based on the specific needs of the project site.

****

[_____]

]1.10   CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.10.1   Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model. Provide the Proposed STIG and SRG Applicability Report concurrently with the Pre-Construction Control System Inventory Report.

[1.10.2   Cybersecurity Interconnection Schedule (Encrypted)

****
NOTE: When the USACE CW Tailoring Option is selected, the text "(Encrypted)" is included following the submittal title in the title of this subpart.
****

****
NOTE: The Cybersecurity Interconnection Schedule is used in two situations:

1) The control system communicates with a separately authorized system or an unauthorized system. In this case, include a Cybersecurity Interconnection Schedule in the design showing the following interconnection details: Name/description of other

system, POC for the other system, type of data/information.

2) The control system is a sub-part of a larger system and will communicate with and integrate to the larger system (and will be part of the same authorization as the larger system). In this case, the control system design must include requirements for the expected communication between the sub-system and the larger system. The Cybersecurity Interconnection Schedule will not be a design drawing, but will still be a contractor submittal.

If neither of these situations apply (if the system is stand-alone with no connection or integration to another system), remove the bracketed text requiring the Cybersecurity Interconnection Schedule, and remove the Cybersecurity Interconnection Schedule from the SUBMITTALS paragraph of this Section.

If Case 1 applies, keep the bracketed text referring to Foreign Destination and POC for Destination, otherwise remove this text.

In situations where both cases apply, a single submittal will serve both purposes.

Note that this submittal does not create a requirement for interconnections, but documents interconnection details in accordance with other requirements.
****

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Manufacturer, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication. [For communication with other authorized systems also provide the Foreign Destination and POC for Destination.] For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11.

]1.10.3 Network Communication, Ports, Protocols and Services Report

****

NOTE: Control system specifications should include requirements related to protocol and documentation. In the design cybersecurity documentation required by the UFC, document what, if any, protocol requirements are included in the control system specification (CCI-002103). Also document any requirements or submittals related to network communication, such as Points Schedules (CCI-002105).

****

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, including CM-7(3), CCI-000388.}

Provide a Network Communication, Ports, Protocols and Services Report. For each networked device, document device identifier and the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP communication, document all TCP and UDP ports used. For each device using non-IP communication, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication, Ports, Protocols and Services Report as an editable Microsoft Excel file.

1.10.4 Control System Inventory Reports

****

NOTE: Select whether the inventory report must include non-networked devices.

Unless specifically required by the project, keep the first bracketed text to require inventory of only networked devices and remove the later bracketed text requiring inventory of non-networked devices, input devices and output devices.

This subpart contains text that is only included when the USACE CW tailoring option is selected.

When the CW tailoring option is selected, "Inventory Spreadsheet" and "Hardware-Software List Template" will be in brackets. KEEP "Hardware-Software List Template" and REMOVE "Inventory Spreadsheet".

****

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Provide a Pre-Construction Control System Inventory Report (Encrypted) report and a Final Control System Inventory Report (Encrypted), using the [Inventory Spreadsheet][Hardware-Software List Template] listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11. In the Control System Inventory Reports, document all [networked devices, including network infrastructure devices][devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators)], and all software. For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Reports as editable Microsoft Excel files. Provide the Pre-Construction Control System Inventory Report concurrently with the Proposed STIG and SRG Applicability Report

1.10.5 System Data Flow Diagram (Encrypted)

****

NOTE: This subpart is included only when the USACE CW tailoring option is selected

****

Submit a system data flow diagram (encrypted) a minimum of 60 days prior to installed operation of the equipment. Provide diagrams electronically in PDF as well as either Microsoft Visio (VSDX) or Microstation (DGN), formatted for 11" x 17" sheets. Include:

a. All devices that communicate via routable protocols.

b. The normal system communications among the devices on the network, including the ports and protocols utilized for communications

c. Arrows to indicate direction of data flow between components. Define the physical media and protocol for each link.

d. Logical boundary of the system marked with a red line clearly defining components inside the boundary as well as components outside the boundary. Label connections to external networks and indicate the boundary protection.

e. Indicate VLAN segmentation of the devices on the diagram.

1.10.6 Software and Configuration Backups (Encrypted)

****

NOTE: This requirement covers disk images to allow recovery and reconstitution of applications on computers, and also covers program and configuration backups for controllers. As described in UFC 4-010-06 Cybersecurity for Facility-Related Control Systems, as-built documentation (including copies of custom programming and device settings) must be required in the Section specifying the control system itself, but is included here in case that has not been done.

For MODERATE Impact Systems: Support of Information System Recovery and Reconstitution requires that the information system have spare parts available on site and that staff are properly trained in repair, recovery, and reconstitution of the system. Make sure the underlying controls spec has requirements in support of this requirement.

When the USACE CW tailoring option is selected, the requirement for the submittal to be on an encrypted external hard drive and the requirement to test the backup are included (and otherwise they are not).
****

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For each computer on which software is installed under this project, provide a recovery image of the final as-built computer on an encrypted external hard drive. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact.

For all Ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

Test backups to verify as functional for restoring the system prior to submittal. Include verification of testing and functionality with submittal. If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.

1.10.7 Cybersecurity Network (Riser) Diagram (Encrypted)

****
NOTE: Select or specify the format for the riser diagram.

This subpart contains additional text when using the USACE CW tailoring option
****

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity network (riser) diagram of the complete control system including all network and device hardware. For each device, include the device identifier, device type, and manufacturer. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in [one-line format][one-line format overlayed on a facility schematic][tabular format][_____].

Provide diagrams electronically in Portable Document Format (PDF) as well as either Microsoft Visio (VSDX) or Microstation (DGN), formatted for 11" x 17" sheets.

1.10.8 STIG, SRG and Vendor Guide Compliance Result Report (Encrypted)

****

NOTE: Select whether SCAP or Evaluate-STIG is required.

****

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, document compliance with the STIG or SRG requirements.

a. For components which are scannable by [the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), include the SCAP][the Evaluate-STIG tool (available online at (CAC Required), include the Evaluate-STIG] report and raw scan results in addition to the final, manually reviewed and revised, documentation of compliance with STIG and SRG requirements. Checklist files should not contain any findings with a Not Reviewed (NR) status after manual reviews.

b. For components which do not support automated scanning, a manual review using the General Purpose STIG option should be done. A completed Checklist file should not contain any findings with a Not Reviewed (NR) status after manual reviews

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.10.8.1 STIG, SRG and Vendor Guide Compliance Result Report Deviations List

****

NOTE: This subpart is only included when the USACE CW Tailoring Option is selected.

****

Within the STIG, SRG and Vendor Guide Compliance Result Report, include a Deviations List documenting all deviations required for system operation, and reasons why a STIG, patch, firmware update, or other requirement cannot be met. Include for each deviation:

a. STIG, SRG, Patch, Firmware Update, or other requirement being deviated

b. Vulnerability Identification

c. Rule Identification

d. Control

e. Control Correlation Identifier (CCI)

f. Finding

g. Justification

h. Current Risk-Mitigation Actions

1.10.9 Control System Cybersecurity Documentation

****

NOTE: The following enumerates very detailed requirements for documentation; requirements that would be impossible to meet for some control devices. The requirements are broken out in the sub paragraphs such as:

1) Requirements to be met by all software running on computers
2) Requirements to be met by HVAC control devices
3) Requirements to be met by Lighting Control System Devices
4) Requirements to be met by [fill in the blank] control devices
5) Default requirements for control system devices (when not covered in 1-4 above)

If the project incorporates devices other than HVAC or Lighting devices, and the general requirements in sub-paragraph 5 are not satisfactory, add requirements to subparagraph 4. If multiple different requirements are needed (e.g. the project incorporates a micro-grid and an electronic security system, both with specific requirements) add additional paragraphs similar to paragraph 4. Leave the "devices not otherwise covered" at the end of the list and do not edit those requirements.

Note that within HVAC and Lighting devices, a further distinction is made between devices that FULLY support accounts and those that do not. This distinction is a surrogate to account for the range of capabilities and complexity among various HVAC or Lighting control devices.

****

{For Government Reference Only: This subpart (and its subparts) relates to SA-5(a),SA-5(b),SA-5(c), SA-22(b); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131, CCI-003374}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.10.9.1 Software Applications

For all software applications running on computers provide:

a. administrator documentation that describes secure configuration of the software {For Government Reference Only: relates to CCI-003124}

b. administrator documentation that describes secure installation of the software and software updates. {For Government Reference Only: relates to CCI-003125}

c. administrator documentation that describes secure operation of the software {For Government Reference Only: relates to CCI-003124}

d. administrator documentation that describes effective use and maintenance of security functions or mechanisms for the software {For Government Reference Only: relates to CCI-003127}

e. administrator documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the software {For Government Reference Only: relates to CCI-003128}

f. user documentation that describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. user documentation that describes methods for user interaction which enables individuals to use the software in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. user documentation that describes user responsibilities in maintaining the security of the software {For Government Reference Only: relates to CCI-003131}

1.10.9.2 For HVAC Control System Devices

1.10.9.2.1 HVAC Control System Devices FULLY Supporting User Accounts

For all HVAC Control System Devices which FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

c. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

d. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

e. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms; or a specific indication that there are no user-accessible security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003129}

f. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

1.10.9.2.2 All Other HVAC Control System Devices

For all HVAC Control System Devices which do not FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003127}

c. For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

1.10.9.3 For Lighting Control System Devices

1.10.9.3.1 Lighting Control System Devices FULLY Supporting User Accounts

For all Lighting Control System Devices which FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

c. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

d. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

e. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms; or a specific indication that there are no user-accessible security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003129}

f. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

1.10.9.3.2 All Other Lighting Control System Devices

For all Lighting Control System Devices which do not FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device {For

Government Reference Only: relates to CCI-003127}

c. For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

[1.10.9.4 [_____] Control System Devices

****

NOTE: Use this bracketed subpart if needed to add requirements for a specific control system type (e.g. lighting, electrical distribution etc.), similar to how HVAC and Lighting control system devices are covered above.

If adding a new control system type, submit a Criteria Change Request with the relevant requirements to have that system included in the published UFGS.

****

[_____]

]1.10.9.5 For USACE Civil Works Control System Devices

1.10.9.5.1 USACE Civil Works Control System Devices FULLY Supporting User Accounts

For all USACE Civil Works Control System Devices which FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

c. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

d. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

e. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms; or a specific indication that there are no user-accessible security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003129}

f. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

1.10.9.5.2 All Other USACE Civil Works Control System Devices

For all USACE Civil Works Control System Devices which do not FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003127}

c. For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

1.10.9.6 Default Requirements for Control System Devices

****

NOTE: Do not edit these requirements (beyond selection of bracketed text). These default requirements should only be used in lieu of technology-specific requirements in the preceding paragraphs. If these default requirements are inappropriate, ensure that the preceding paragraphs provide appropriate technology-specific requirements.

****

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to

CCI-003131}

i. Documentation of the published last date of support by the manufacturer or indication that a published date is not available. {For Government Reference Only: relates to CCI-003374}

1.11 SOFTWARE LICENSING

****

NOTE: The installation may procure its own software update licensing or contract and thus needs less than 5 years. Alternatively, the installation may require longer than five years (although this will likely increase the costs significantly). Coordinate with the installation to determine if they have any specific requirement; if they don't then keep the 5 year requirement.

Note that this requirement may already exist in the control system specifications, in which case it can removed from this Section (or kept in this Section and removed from the control system specification).

****

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the [Government][project site][_____] for a period [of no less than 5 years][___], and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

1.12 CYBERSECURITY DURING CONSTRUCTION

****

NOTE: The requirements in this subpart do not tie to cybersecurity specific cybersecurity controls or CCIs as tightly as most other requirements in this Section. They are included to provide a basic level of "cyber hygiene" during the construction process, and the controls that they are related to are still noted for reference.

These requirements are not related to the networks contractors will often establish in their project offices/trailers. They are specific to temporary networks used by the control system during installation. For example, a wireless access point set up in a mechanical room to allow construction personnel laptops to access the control system

during construction before the building IT infrastructure is operational..
****

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, CA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.

1.12.1   Contractor Computer Equipment

Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.12.1.1   Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.12.1.2   Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must perform a full antivirus scan at least once per day. Computers which have connected to any other network since the last full antivirus scan must perform a full antivirus scan prior to connection to the control system network or to the temporary contractor-installed IP network. Perform an antivirus scan on all removable media (e.g., external hard drives, CDs, DVDs, USB flash drives) prior to connecting to the control system environment.

1.12.1.3   Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.12.1.4   User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.12.1.5   Firewall

****
NOTE: This subpart is only included when the USACE CW Tailoring Option is selected
****

Computers must have a firewall enabled and set to "public".

1.12.1.6 Encryption

****

NOTE: This subpart is included only when the USACE CW Tailoring Option is selected

****

Employ data-at-rest encryption to protect information stored on the device. The types of information that must be protected include site specific drawings, configuration files, project files, vulnerability data, and any other specific information that could potentially lead to a compromise. Immediately notify the Contracting Officer in the event that a Contractor-owned computer that stores this information is lost or stolen.

1.12.1.7 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.12.1.8 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11. Each Statement must be signed by a cybersecurity representative for the relevant company.

1.12.2 Temporary IP Networks

****

NOTE: The allowance of connection to "Government furnished IP networks provided for this purpose" covers the case of there being a "guest" network the contractor can use. This is likely not available in many cases, but is covered here for the instances in which it is offered by the project site.

****

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.12.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.12.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.12.4 Temporary Wireless IP Networks

****

NOTE: For USACE Civil Works Projects, wireless networks are not permitted. When the USACE Civil Works Tailoring Option is selected, the text concerning the use of wireless networks will be in brackets, and the statement prohibiting them will be added.

For USACE Civil Works projects, remove the bracketed text.

****

[In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.]

Temporary wireless networks are NOT PERMITTED.

1.12.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.12.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11. Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.13 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

****

NOTE: The product requirements of this Section are the minimum requirements necessary to meet the cybersecurity requirements of this Section, and add to the product requirement specified in the control system specifications. Components (Network media, switches, routers, firewalls, controllers, computers, software etc.) must be specified in the control system specifications, and submittals for those components must be included in those Sections as this Section does not contain separate submittals

for these products.
****

All products used on this project must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

2.1.1 Required Functionality

****
NOTE: Include bracketed options which correspond to required switch functionality, and change bullet letters accordingly. Determine functionality in coordination with the system owner organization and do not include any requirements that are not specifically needed.

Use particular caution in requiring IEEE 802.1x as most controllers will not support it.
****

Switches must:

a. Copper Ethernet ports must auto negotiate for 10, 100 and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.[

d. For LOW Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.][

e. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819][

f. Configure target port and analysis port such that switch clones all target port traffic to analysis port.][

g. Support authentication via RADIUS server (for management and 802.1x)][

h. Support IEEE 802.1x network login.]

2.1.2 Configuration Requirements

****
NOTE: Coordinate with the system owner organization to determine if the capability to lock to a

dedicated management port is required, and include or remove bracketed text requiring this as needed.
****

Switches must:

a. Support configuration save and restore.

b. Support both manual IP address assignment and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.[

d. Support the ability to lock configuration capability to a dedicated management port.]

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

****
NOTE: Indicate the permitted database and web servers.
****

{For Government Reference Only: This subpart (and its subparts) relate to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906}

All computer-based databases must use [Microsoft SQL Server][or][Oracle][or][MySQL]. All computer-based web interfaces must use [Internet Information Services (IIS)][or][Apache] as the web server.

2.4 Lockable Enclosures with Padlock

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NOTE: This subpart is only included when the USACE CW tailoring option is selected.
****

Provide lockable enclosures with lockable handles, doors, or accessories allowing the cabinet to be secured using a padlock. Provide a stainless steel padlock with a minimum of a 3/8-inch diameter hardened shackle for each enclosure.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Configure hardware and software in accordance with the applicable STIGs and SRGs per the STIG and SRG applicability report. Install the most current versions of operating systems, software updates, firmware updates, security patches, service packs, and BIOS/UEFI, unless otherwise specified or approved. Do not implement specific hardening actions if that action would conflict with required functionality or another requirement of this Section.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

****

NOTE: For non-IP networks (In MODERATE Impact Systems), ensure that the control specifications require that those networks limit traffic to that required for the control system.

****

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

3.2.2 Wireless and Wired Broadcast Communication for Fire Protection Systems

****

NOTE: Indicate whether the communication from a facility fire protection system to the central monitoring station must meet FIPS 140-2. Coordinate this requirement with the project site, and if the existing system does not use FIPS certified radios and it is not certain the existing system is able to employ FIPS certified radios DO NOT include this requirement.

Note that mitigation measures for non-FIPS 140-2 radios are covered in "Process Isolation and Boundary Protection in Moderate Impact Fire Protection Systems"

****

The use of wireless and wired broadcast communication for fire protection systems within a facility is prohibited. Wireless communication may be used to provide communication from the fire protection system in a facility to the central monitoring station. [Communication between the fire protection system and the central monitoring station must be via FIPS 140-2 certified devices.]

[3.2.3 Wireless and Wired Broadcast Communication for Systems Other than Fire Protection Systems

****

NOTE: When the FIRE PROTECTION tailoring options is selected, this subpart is in brackets. If this specification is only for fire protection systems remove this subpart. If this specification includes requirements for other systems, keep this subpart.

****

****

NOTE: Avoid wireless and wired broadcast networks to the greatest extent possible. Wireless may be considered for retrofits where running wires would be prohibitive. While powerline carrier should be avoided where possible, it (and other wired broadcast networks) are likely more secure than wireless and should be considered as a potential alternative to cases where wireless seems unavoidable. If the site has a clear preference for non-wireless broadcast (e.g. powerline or similar) over wireless, include the bracketed text.

In general, contractors should never install a wireless network which carries the IP protocol. The Air Force may allow wireless IP networks to be installed in some instances, when it is installed in accordance with existing site requirements - coordinate with the project site to determine if this is required and remove the bracketed text if not required.

Note that contractors may (where permitted and supported) USE a government provided wireless IP network.

****

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-001449}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication. [If requesting authorization for wireless or wired broadcast communication, wired broadcast media such as powerline carrier is preferred to wireless.]

3.2.3.1 Wireless and Wired Broadcast IP Communications

[Unless specifically approved and installed in accordance with the project site requirements,]Do not install wireless or wired broadcast IP networks, including: do not install a wireless access point; do not install or configure an ad-hoc wireless network; do not install or configure a WiFi Direct communication.

When explicitly authorized by the Government, wireless IP communication may be used to communicate with an existing wireless network.

3.2.3.2 Non-IP Wireless Communication

****

NOTE: Note that the MODERATE requirement for FIPS 140-2 may effectively prohibit the use of non-IP wireless. This is intentional, for MODERATE Impact systems wireless encryption is required.

****

For LOW Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, use the maximum level of encryption supported by the specific protocol employed and select signal strength and radiated power to the minimum necessary for reliable communication.

For MODERATE Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, the radios must meet NIST FIPS 140-2 Level 2.

3.2.3.3 Wireless and Wired Broadcast Communication Request

****

NOTE: The Wireless and Wired Broadcast Communication Request submittal will be used to authorize specific use of wireless communication, and to indicate whether or not testing of the signal strength is required. In general, testing is not required for a LOW impact system.

There may be project site or Service policies that govern the use of wireless. Before authorizing wireless use coordinate with the relevant Service and project site representatives.

****

Provide a report documenting the proposed use of wireless or wired broadcast communication prior to device selection using the Wireless and Wired Broadcast Communication Request Schedule at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11. If there is no proposed use of wireless or wired broadcast communication, provide a document indicating this instead of the Request Schedule.

For each device proposed to use wireless or wired broadcast communication show: the device identifier, a description of the device, the location of the device, the device identifiers of other devices communicating with the device, the protocol used for communication, encryption type and strength. For wireless communication, also show: RF Frequency, Radiated Power in dBm (decibel with a milliwatt reference), free-space range, and the expected as-installed range.

3.2.3.4 Wireless Communication Testing

****

NOTE: Select or enter appropriate name for the system-level test of the control system.

Select or indicate the wireless network test boundary.

****

As part of [Performance Verification Testing (PVT)][Functional Performance Testing {FPT}][_____], conduct testing of wireless communication for all devices indicated on the approved Wireless and Wired Broadcast Communication Request as requiring testing.

To test wireless communication, test for wireless network reception at multiple points along the wireless test boundary in the vicinity of the wireless device, and record whether a network connection can be established at each point. The wireless test boundary is [the building exterior walls][the facility fence line][_____]. If wireless testing is required, provide a Wireless Communication Test Report documenting the testing points and results at each point for each wireless device.

]3.2.4 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.5 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.

3.2.5.1 IP Network Routers

****

NOTE: This subpart is only included when the USACE CW tailoring option is selected.

For USACE systems, coordinate with the UCIC MCX to identify and coordinate IP routing requirements for the specified control system. Depending upon the type of system, routing may be required.

If routing is required, keep the first bracketed text and edit the requirements accordingly.

If routing is not required, keep the second bracketed text.

****

[For IP-based communications across control systems, use Routers to control and restrict traffic flow between network and virtual local area network (VLAN) traffic. Configure routers using Access Control Lists (ACLs) using a deny-all, permit by exception approach. When network traffic is within the local perimeter use Traditional Network Routers. When network traffic leaves the local perimeter, use Integrated Service Routers (ISR) or Firewalls with VPN capability instead.]

[Do not install any device that performs IP routing.]

3.2.5.2 IP Devices With Multiple Ethernet Connections

****

NOTE: Some cases where devices with multiple IP connections might be desired or required as part of the control system design are:

1) Use of a field device with two Ethernet ports to separate the upstream (base-wide) network from the building network. This device lives on two separate networks and - while maintaining network separation - passes control data between the two different networks.

2) Use of a front end with two network cards to separate the control network from the operator interface network. Like the field device, this front end resides on two separate networks and passes control data from the control system to operator interfaces and commands from operator interfaces to the control system.

****

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.6 Cryptographic Protection

****

NOTE: HTTPS is a form of cryptographic protection and hence is included here for all cases.

In general, additional cryptographic requirements should be avoided, or at least minimized. (Note that even for systems where cryptography is required, it may not be required at every node and interconnection in the system.)

With regard to other cryptography, there are 3 possibilities to consider:
1. The control system contains no classified information and cryptography has not been specifically required by the Authorizing Official. In that case, there are no UFGS requirements and this Subpart should be removed.
2. The control system contains no classified information, but the Authorizing Official has determined that cryptography is required. Select text requiring cryptography.

3. The control system contains classified information. First, confirm that the system truly needs to contain classified information - if this is only to fulfil some reporting requirement, consider removing the information from the CS and meeting the reporting requirement via some other means. If the requirement for cryptography cannot be eliminated, select text requiring cryptography.

Keep bracketed text only when cryptography is required. If cryptography is required, select whether to require it everywhere, only on the IP network, or only at specific locations within the system. Note that some systems will not support cryptography even at the IP level, and most systems will not support the use of cryptography at non-IP devices.

****

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.[

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that [all][IP][_____] network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.]

3.2.6.1 Additional Cryptographic Protection Requirements for USACE Civil Works Systems

****

NOTE: This subpart is only included when the USACE CW tailoring option is selected.

When included through the USACE CW tailoring option, determine the need for this subpart and include only if needed, revising to meet project requirements.

****

Protect the following communications using NIST FIPS 140-2 compliant encryption methods:

a. Public switched telephone network

b. Leased lines

c. Any wireless communication

Establish Virtual Private Network IPSec tunnels between different facilities and between wireless devices. Provide firewalls to control communications between tunnels. Firewalls must meet STIG requirements. Network and wireless devices must be on the DISA approved product list (APL). See https://aplits.disa.mil/processAPList.

3.2.7 Device Identification and Authentication

****
NOTE: If site required use of IEEE 802.1x, keep bracketed text requiring its implementation. Otherwise remove bracketed text.
****

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

All computers must support [and implement]IEEE 802.1x for device authentication to the network.

3.2.7.1 For HVAC Control System Devices

****
NOTE: If widely supported or specifically required by the project site, keep the bracketed text requiring Ethernet devices to meet 802.1x. Note many IP-based controllers do not support 802.1x, so only include this requirement if confident it can be sufficiently supported or if it is a specific project requirement.

Unless the project site specifically indicates that 802.1x is not a requirement, keep the bracketed text requiring Fox Protocol components to support 802.1x.

Do not require network security with BACnet (BACnet Secure Connect) without determining both a) that it is a specific project requirement, and b) that it can be met by multiple vendors.
****

Devices using HTTP as a control protocol must use HTTPS instead. [Devices using Ethernet must support IEEE 802.1x.][Devices using Fox Protocol must support IEEE 802.1x.][Devices using BACnet must support network security as specified for BACnet Secure Connect in ASHRAE 135.]

3.2.7.2 For Lighting Control System Devices

****
NOTE: If widely supported or specifically required by the project site, keep the bracketed text requiring Ethernet devices to meet 802.1x. Note many IP-based controllers do not support 802.1x, so only include this requirement if confident it can be sufficiently supported or if it is a specific project requirement.

Unless the project site specifically indicates that 802.1x is not a requirement, keep the bracketed text requiring Fox Protocol components to support 802.1x.

Do not require network security with BACnet (BACnet Secure Connect) without determining both a) that it

is a specific project requirement, and b) that it can be met by multiple vendors.

****

Devices using HTTP as a control protocol must use HTTPS instead. [Devices using Fox Protocol must support IEEE 802.1x.][Devices using Ethernet must support IEEE 802.1x.][Devices using BACnet must support network security as specified for BACnet Secure Connect in ASHRAE 135.]

3.2.7.3 [_____] Control System Devices

****

NOTE: Use this subpart if needed to add requirements for a specific control system type (e.g. electrical distribution etc.), similar to how HVAC and Lighting control system devices are covered above.

If adding a new control system type, submit a Criteria Change Request with the relevant requirements to have that system included in the published UFGS.

****

[_____]

3.2.7.4 Default Requirements for Control System Devices

****

NOTE: Do not edit these requirements (beyond selection of bracketed text). These default requirements should only be used in lieu of technology-specific requirements in the preceding paragraphs. If these default requirements are inappropriate, ensure that the preceding paragraphs provide appropriate technology-specific requirements.

If widely supported, require Ethernet devices to meet 802.1x. Note many IP-based controllers do not support 802.1x, so only include this requirement if confident it can be sufficiently supported or if it is a specific project requirement.

****

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: [Devices using Ethernet must support IEEE 802.1x.]Devices using HTTP as a control protocol must use HTTPS instead.

3.2.8 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.2.9 Secure Network Design

****
NOTE: This subpart is only included when the USACE CW Tailoring Option is selected.
****

Provide network segmentation for networks leaving a local physical boundary, containing multiple types of systems (such as control and electronic security systems), or controlling more than one process that does not require direct communication of the control system components amongst discrete processes. Dual-homed hosts are prohibited. Protect external connections to the outside with a router, firewall, VPN, and IDS.

Network Interface Cards (NICs) or network transceivers are considered to be network connected regardless of network protocol used. Unused NICs must be disabled. A device is considered to be wireless network connected unless the wireless network controller is physically disabled. It is not sufficient to disable the wireless NIC in settings.

3.2.10 OT Monitoring System (OTMS)

****
NOTE: This subpart is only included when the USACE CW Tailoring Option is selected.

Coordinate with the UCIC MCX to determine if monitoring will be implemented as part of the design. If monitoring is required, keep this subpart and edit to meet project requirements. Otherwise, remove this subpart during bracket replacement.
****

Provide [1 rack unit][2 rack units][[_____]rack units] of rack space for data taps to be furnished, installed, and configured by the Government.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

****
NOTE: Ensure that control system specifications define roles (such as operator with view-only, operator with control, control system admin) for applications which FULLY support accounts. Different devices, particularly those with very different functions and residing at different places in the system architecture, may require different account roles.

The determination of whether a device has a STIG or SRG, and the installation and configuration of devices in accordance with relevant STIGs or SRGs are contractor responsibilities. The designer/specifier is not expected to identify relevant STIGs or SRGs
****

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764. For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification. Disable any unnecessary or unused accounts. Disable any "guest-level" accounts that are created on the system by default.

3.3.1.1   Computers

All computer operating systems must FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer must be installed such that use of the software is restricted by the computer operating system to specific users.

Applications running on computers must not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.

3.3.1.1.1   User Account Levels

****

NOTE: This Subpart is only included when the USACE CW tailoring option is selected.

****

Configure OT using three account access levels: operator level, service level, and administration level. Configure normal operations to occur using an operator level account. Configure the operator level with minimum privileges required to operate the system that does not allow for configuration changes. Disable removable media devices and USB ports (with the exception of keyboard and mouse) for all levels except the administrator level. Submit an Account Level Permissions List (Encrypted) documenting the names all levels and which permissions are allowed for each level.

3.3.1.2   Controllers

****

NOTE: Note from the definition of Privileged User Interface: "In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged."

For ESS, we assume that there is a possibility of sensitive information (either security or PII) being displayed.

The notes below provide guidance on how to select the appropriate requirement where a choice is given. Do not use guidance in this note to alter entries where no designer option is given.

Local Read Only UI:
For ESS, discuss with the project site to determine whether to require a key lock or to require at least MINIMAL support of accounts. For non-ESS, unless specifically requested by the site, select NONE (not required to support accounts).

Local Limited UI, Non-Privileged:
Unless specifically requested by the site, select None Required.

Local Limited UI, Privileged:
For LOW impact ESS, discuss with the project site to determine whether to allow a key lock along with at least MINIMALLY supporting accounts, or whether to require FULL support of accounts. For LOW impact non-ESS, unless specifically requested by the site, select MINIMALLY. For MODERATE systems, use great care before requiring FULL support of accounts as these interfaces may be difficult to obtain. Entries of “KEY and Physical Security” (or “MINIMALLY and Physical Security") are there as a reminder: This is an important function and everything associated with it, including the controlled equipment, should be protected by physical security in addition to other safeguards.

Local Full UI:
Verify that interfaces FULLY supporting accounts are available before selecting FULLY (requiring FULL support of accounts).

Remote Read Only UI:
For ESS, discuss with the project site to determine if there are any confidentiality issues associated with the interface. For non-ESS, unless specifically requested by the site, select None Required

****

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface must at FULLY support user accounts.

e. For table entries of "KEY": The user interface must have physical security in the form of either a key lock on the interface itself or be furnished inside a lockable enclosure. Where this is required for a read only interface, the lockable enclosure must prevent viewing of data on the interface; for other interfaces, this lockable enclosure must prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.

h. Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

3.3.1.2.1 HVAC Control Systems

User Interface Requirements for LOW Impact HVAC Control Systems

User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	[None Required][MINIMALLY]
Local Limited, Privileged	[MINIMALLY][Physical Security]
Local Full	MINIMALLY

User Interface Requirements for LOW Impact HVAC Control Systems	
User Interface Type	**Access Control Requirement**
Remote Read Only	None Required
Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	

User Interface Requirements for MODERATE Impact HVAC Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	[None Required][MINIMALLY]
Local Limited, Privileged	[MINIMALLY and Physical Security][FULLY]
Local Full	MINIMALLY and Physical Security
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2.2 Lighting Control Systems

User Interface Requirements for LOW Impact Lighting Control Systems	
User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	[None Required][MINIMALLY]
Local Limited, Privileged	[MINIMALLY][Physical Security]

User Interface Requirements for LOW Impact Lighting Control Systems	
User Interface Type	**Access Control Requirement**
Local Full	MINIMALLY
Remote Read Only	None Required
Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	

User Interface Requirements for MODERATE Impact Lighting Control Systems	
User Interface Type	**Access Control Requirement (See note 3)**
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	[None Required][MINIMALLY]
Local Limited, Privileged	[MINIMALLY and Physical Security][FULLY]
Local Full	MINIMALLY and Physical Security
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2.3 Electronic Security Systems (ESS)

User Interface Requirements for LOW Impact Electronic Security Systems	
User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	[KEY][MINIMALLY]
Local Limited, Non-privileged	NA

User Interface Requirements for LOW Impact Electronic Security Systems	
User Interface Type	**Access Control Requirement**
Local Limited, Privileged	[MINIMALLY and KEY][FULLY]
Local Full	FULLY and Physical Security
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	

User Interface Requirements for MODERATE Impact Electronic Security Systems	
User Interface Type	**Access Control Requirement (See note 3)**
Local Read Only (see note 1)	[KEY][MINIMALLY]
Local Limited, Non-privileged	NA
Local Limited, Privileged	FULLY
Local Full	FULLY and Physical Security
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2.4 Fire Protection Systems

User Interface Requirements for LOW Impact Fire Protection Systems	
User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	None Required

User Interface Requirements for LOW Impact Fire Protection Systems

User Interface Type	**Access Control Requirement**
Local Limited, Non-privileged	[None Required][KEY or MINIMALLY]
Local Limited, Privileged	KEY and Physical Security
Local Full	KEY
Remote Read Only	None Required
Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND Remote Full	FULLY

Notes:
1)Local Read Only User Interfaces are always Non-Privileged

User Interface Requirements for MODERATE Impact Fire Protection Systems

User Interface Type	**Access Control Requirement**
Local Read Only	None Required
Local Limited, Non-privileged	[None Required][KEY or MINIMALLY]
Local Limited, Privileged	[KEY and Physical Security][FULLY]
Local Full	KEY
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full	FULLY

Notes:
1)Local Read Only User Interfaces are always Non-Privileged
2)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")

3.3.1.2.5 USACE Civil Works Control Systems

****

NOTE: This subpart is only included when the USACE CW tailoring option is selected

Typical Civil Works (CW) OT devices (e.g. PLCs, meters, relays, etc.) do not have a local user interface. Adjust interface requirements for device type, application, and manufacturer-specific features.

For a CW Control System that utilizes a programmable logic controller (PLC), it is assumed that it can only provide the local read only interface and all other local interfaces are not applicable. The designer must edit the table and notes to ensure that all other local interfaces cannot be provided. With a PLC the local read only interface is likely limited to a few single or multi-color LEDs or an alpha-numeric display.

A Remote Full interface for the PLC system is assumed to be a programming PC, an operator interface terminal (touch panel) or human machine interface software running on a PC.

The Designer must determine whether a Remote Read Only interface is required for the application, although this could be implemented in the Remote Full interface based on user account permissions.

The user interface requirements table is different from the operational schemes used as part of USACE Civil Works Operational Technology. For example, the Remote Full user interface can be used to implement local or campus operation and does not necessarily indicate remote (offsite) operation of the facility.

****

User Interface Requirements for LOW Impact USACE Control Systems

User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	KEY
Local Limited, Non-privileged	[(see note 3)][MINIMALLY]
Local Limited, Privileged	[(see note 3)][MINIMALLY][Physical Security]
Local Full	[(see note 3)][NA]
Remote Read Only	[(see note 3)][FULLY]
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged	NA
Remote Full (see note 2)	FULLY

User Interface Requirements for LOW Impact USACE Control Systems	
User Interface Type	**Access Control Requirement**
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged [3)Device or system should not be capable of providing the interface type, otherwise notify the COR]	

User Interface Requirements for MODERATE Impact USACE Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only	KEY
Local Limited, Non-privileged	[(see note 4)][MINIMALLY]
Local Limited, Privileged	[(see note 4)][MINIMALLY and Physical Security]
Local Full	[(see note 4)][NA]
Remote Read Only	[(see note 4][FULLY]
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged	NA
Remote Full	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS") [4) Device or system should not be capable of providing the interface type, otherwise notify the COR]	

3.3.1.2.6 [_____] Control Systems

****

NOTE: Use this subpart if needed to add requirements for a specific control system type (e.g. electrical distribution etc.), similar to how other control systems are covered above.

If adding a new control system type, submit a Criteria Change Request with the relevant requirements to have that system included in the published UFGS.

****

User Interface Requirements for LOW Impact [_____] Systems

User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	[_____]
Local Limited, Non-privileged	[_____]
Local Limited, Privileged	[_____]
Local Full	[_____]
Remote Read Only	[_____]
Remote Limited, Non-Privileged	[_____]
Remote Limited, Privileged AND Remote Full (see note 2)	[_____]

Notes:
1)Local Read Only User Interfaces are always Non-Privileged
2)Remote Full User Interfaces are always Privileged

User Interface Requirements for MODERATE Impact [_____] Systems

User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only	[_____]
Local Limited, Non-privileged	[_____]
Local Limited, Privileged	[_____]
Local Full	[_____]
Remote Read Only	[_____]
Remote Limited, Non-Privileged	[_____]
Remote Limited, Privileged AND Remote Full (see note 2)	[_____]

Notes:
1)Local Read Only User Interfaces are always Non-Privileged
2)Remote Full User Interfaces are always Privileged
3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")

3.3.1.2.7 Default Requirements for Other Control Systems

****

NOTE: Do not edit these requirements (beyond selection of bracketed text). These default requirements should only be used in lieu of technology-specific requirements in the preceding paragraphs. If these default requirements are inappropriate, ensure that the preceding paragraphs provide appropriate technology-specific requirements.

****

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

Default User Interface Requirements for LOW Impact Control Systems	
User Interface Type	**Access Control Requirement**
Local Read Only (see note 1)	[None Required][MINIMALLY]
Local Limited, Non-privileged	[None Required][MINIMALLY]
Local Limited, Privileged	[MINIMALLY][Physical Security]
Local Full	[MINIMALLY][FULLY]
Remote Read Only	[None Required][MINIMALLY]
Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	

Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only (see note 1)	[None Required][MINIMALLY]
Local Limited, Non-privileged	[None Required][MINIMALLY]
Local Limited, Privileged	[MINIMALLY and Physical Security][FULLY]
Local Full	[MINIMALLY and Physical Security][FULLY]
Remote Read Only	[None Required][MINIMALLY]

Default User Interface Requirements for MODERATE Impact Control Systems

User Interface Type	**Access Control Requirement** (See note 3)
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY

Notes:
1)Local Read Only User Interfaces are always Non-Privileged
2)Remote Full User Interfaces are always Privileged
3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")

3.3.1.3 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing must be configured as indicated.

3.3.1.3.1 For Control System Applications Running on Computers

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 35 days of inactivity.

3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity.

3.3.2 Unsuccessful Logon Attempts

****

NOTE: Note that most field devices that only MINIMALLY support accounts (e.g. a Local Display Panel) cannot be locked. Keep the bracketed text requiring that these devices lock ONLY if this is a specific project requirement. If keeping this text, include requirements on when the interface must lock and how to unlock. Some unlocking conditions to consider are: network command or a physical button which is protected by a locked enclosure.

Note that a requirement for a HIGH availability at the front end may preclude locking out an account for failed logon attempts. If the system includes high availability user interfaces which should not be locked, include the bracketed text exempting high availability interfaces and keep the bracketed table. Indicate in the table the exempt interfaces, their location and action to take for each in lieu of locking the screen. Use care with high availability user interfaces, as in most cases the control system should act without user intervention, and a high availability user interface depends on a

"high availability" operator.

****

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1   Devices MINIMALLY Supporting Accounts

****

NOTE: For LOW Impact Systems: Indicate whether devices MINIMALLY supporting accounts must lock based on unsuccessful logon attempts. Generally, for LOW Impact control systems, locking is not required - keep the first bracketed text to indicate so.

Use care when requiring that devices minimally supporting accounts lock to specify a reasonable requirement that will not introduce an additional O&M burden.

****

For LOW Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts [are not required to lock based on unsuccessful logon attempts][must lock the user account [after [five][_____] consecutive failed login attempts][_____] and must unlock the user account after [15][_____] minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account].

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account[after [five][_____] consecutive failed login attempts][_____] and must unlock the user account after [60][_____] minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2   Devices FULLY Supporting Accounts

****

NOTE: Select or indicate the number and time period for unsuccessful logon attempts to lock an account.

When a device has a single administrator account, that account cannot be manually unlocked (as unlocking requires an administrator account, and the only one is now locked). Select the time period for sole administrator accounts to remain locked before automatically unlocking.

****

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when [three][_____] unsuccessful logon attempts occur within a [15 minute][_____] interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for [1 hour][_____] and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

****

NOTE: Indicate whether or not there are high availability interfaces which are exempt from unsuccessful logon attempts requirements. If there are, specify them in the table provided.

****

[There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.][The following high availability interfaces are exempt from unsuccessful logon attempts requirements:

High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

User Interface	Location	Action to take in lieu of locking screen
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

]

3.3.3 System Use Notification

****

NOTE: Note that the point of restricting the requirement to devices "connected to the network" is to exclude things like a thermostat that has a PIN to lockout changes but isn't networked.

****

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

****

NOTE: Indicate duration of inactivity before terminating or locking a session.

Also indicate the maximum number of concurrent sessions to prevent a single user from being logged in multiple ("too many") times.

****

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface must be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Computers

****

NOTE: Include bracketed text referring to Session Lock and Session Termination Exception Table only if the subpart containing the table is included below.

Unless specifically required by the site, do not include bracketed text with requirements for support of session lock.

****

[Except as shown in the Session Lock and Session Termination Exception Table,]User Interface sessions provided by computer operating systems must support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination must be capable of being initiated by the user and must also be initiated by lack of activity. Session Lock must occur after [15][_____] minutes of inactivity, and Session Termination must occur after [30][_____] minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to [1][_____].

[Except as shown in the Session Lock and Session Termination Exception Table,]Other User Interface sessions running on computers (for local user interfaces) or hosted on a computer (for remote user interfaces) and supporting accounts must support user initiation of Session Termination[and session lock. Session lock may be initiated by user initiation or automatically after [15][_____] minutes of inactivity]. In addition, remote User Interface sessions must also initiate Session Termination after [30][_____] minutes of inactivity [unless otherwise indicated in the Session Lock and Termination Exceptions table].

3.3.4.4 Session Lock and Termination for Controllers

****

NOTE: Include bracketed text referring to Session Lock and Session Termination Exception Table only if the subpart containing the table is included below.

Unless specifically required by the site, do not include bracketed text with requirements for support of session lock.

****

[Except as shown in the Session Lock and Session Termination Exception Table,]Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after [30][_____] minutes of inactivity.

[Except as shown in the Session Lock and Session Termination Exception Table,]Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination[, unless otherwise indicated in the Session Lock and Termination Exceptions table], with

Session Termination initiated at [30][_____] minutes of inactivity.[They must also support session lock, where session lock may be initiated by user initiation or automatically after [15][_____] minutes of inactivity.]

[3.3.4.5 Session Lock and Termination Exceptions

****

NOTE: Include this subpart only when exceptions to the Session Lock and Termination requirements are being indicated using the provided table.

****

Table: Session Lock and Termination Exceptions

Device	**Location**	**Session Lock and Termination Requirements for Device (or "none" to indicate session lock or session termination is not required)**
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

]3.3.5 Permitted Actions Without Identification or Authentication

****

NOTE: These requirements are specifically about user actions, not actions taken automatically by control system components.

Unless there is a project-specific confidentiality concern or other project-specific requirement keep the bracketed text "except read only actions".

Notes concerning how this requirement addresses cybersecurity when bracketed text "except read only actions" is NOT included:

1) **This requirement indicates that there are no actions that can be taken without identification and authentication for any user interface where account support is required.**

2) **This requirement does not limit actions taken by a user on a user interface that does not support accounts, but other requirements limit this to READ-ONLY interfaces.**

3) **Thus the "permitted actions" referred to by control AC-14 are "read-only access to information from devices which are not required to have user accounts."**

When "except read only actions" IS included, read-only actions even from devices supporting accounts are permitted without authentication and thus the "permitted actions" referred to by

control AC-14 are "read-only access to information"
****

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions[except read-only actions] by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6   Physical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1   Physical Security for Media

3.3.6.1.1   Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2   Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.1.3   Physical Security for Non-Network Media in Fire Protection Systems

For Fire Suppression Systems which can be inhibited or forced to activate by manipulation of non-network wiring, install all non-network media outside of mission space, including analog and binary instrumentation wiring and power wiring, in rigid metallic conduit.

3.3.6.2   Physical Security for Devices

****
NOTE: For MODERATE impact system, all devices should be in spaces controlled by the mission being served. For such devices these requirements often add additional physical security requirements on devices above and beyond the user interface requirements specified in "ACCESS CONTROL REQUIREMENTS".
****

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers, and other OT devices, connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.2.1 Physical Security for Devices in Fire Protection Systems

For Fire Suppression systems with a release panel, install all components of the suppression system either inside mission space, or within locked enclosures. Components of these systems include: release panel, any relay or interface panels, analog and binary inputs or outputs, control valves, manual valves.

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceding paragraphs of this Section.

[3.3.6.4 Additional Physical Security for Confidentiality of User Interfaces and Printers

****

NOTE: If specific user interfaces or printers require additional security controls to protect the confidentiality of the information displayed or printed, keep this Subpart and indicate these requirements in the table. Otherwise remove this bracketed subpart.

These additional requirements will generally NOT be required as these are secured due to the multiple MODERATE controls already applied. It's possible additional requirements will be needed for systems containing PII or other sensitive data.

Additional controls may include increased physical security, locating shredders/burn bags near printers, and installing privacy screens on monitors.

****

For each user interface or printer indicated in the "User Interfaces and Printers Requiring Additional Security Controls" table, implement the additional confidentiality controls indicated.

User Interfaces and Printers Requiring Additional Security Controls		
User Interface or Printer	Location	Additional Confidentially Control to be Implemented
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

]3.3.7 Enclosures

Prior to final acceptance of the system, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

****

NOTE: Remove all requirements for multifactor authentication unless:
1) specifically required by the project site
AND
2) either (a) the project includes the IT infrastructure required to support multifactor authentication or (b) the project site already has the needed infrastructure.

Note that if there are a very limited number of devices requiring something other than passwords, it might be better to simply always allow passwords in general and list the specific device exceptions in the Device Specific IA Requirements table.

Also note that the default implementation of multifactor authentication (if selected) is the use of PIV (typically a CAC).

****

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)-IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

****

NOTE: The bracketed requirement for LOW impact systems, and the first bracketed requirement for MODERATE impact systems are equivalent to the typical computer requirement that users login with PIV, which in DoD means CAC. These requirements will still need infrastructure support within the control system and should only be included when required and supported by the project site.

The other three bracketed requirements for MODERATE Impact systems go beyond the above requirements and require, in addition to infrastructure support,

support by control system specific interfaces. Before including any of these options, ensure that there is a requirement for and infrastructure to support these requirements, and that there are control system vendors who can support the requirement.
****

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

[For LOW Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV.]

For MODERATE Impact Systems:[User interfaces provided by computer operating systems must implement multifactor authentication via PIV.][User interfaces supporting accounts (FULLY or MINIMALLY) on computers must implement multifactor authentication via PIV.][Devices with writable remote user interfaces must implement multifactor authentication via PIV.][Devices with Privileged Remote User Interfaces must implement multifactor authentication via PIV.] Software running on computers and computer operating systems must manage cached authenticators in accordance with the relevant STIGs. All other devices and software must not use cached authenticators.

3.4.2   User Identification and Authentication for Specific System Types

****
NOTE: This subpart allows system type specific requirements which supersede the general requirements in the previous subpart (User IA for All System Types). Only include additional requirements here when specifically required by the project; otherwise select the "no additional requirements" text.

Note there is a later subpart allowing for specification of requirements for specific devices. Should a small number of devices have a requirement use that subpart and list those specific devices rather than creating a more general requirement here.
****

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.2.1   HVAC Control Systems Devices

[No additional system specific requirements apply.][User Interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV.]

3.4.2.2   Lighting Control Systems Devices

[No additional system specific requirements apply][User Interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV.]

3.4.2.3 Electronic Security System Devices

****

NOTE: Select whether to require PIV, or allow alternate mechanisms.

****

User interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV.[Other user interfaces which FULLY support accounts must use multifactor authentication via PIV.][User interfaces which MINIMALLY support accounts must use either passwords or multifactor authentication via PIV.]

3.4.2.4 [_____] Control System Devices

****

NOTE: Use this subpart if needed to add requirements for a specific control system type (e.g. lighting, electrical distribution etc.), similar to how HVAC and Lighting control system devices are covered above.

If adding a new control system type, submit a Criteria Change Request with the relevant requirements to have that system included in the published UFGS.

****

[_____]

3.4.3 User Identification and Authentication for Specific Devices

****

NOTE: If there are specific devices (e.g. "Rm 17 lighting user interface", "all model 17 controllers"), keep the bracketed text including the table and list them along with the required methods in the table. Otherwise keep bracketed text indicating there are no device specific user interface requirements

****

[There are no additional device specific user interface requirements][Additional user identification and authentication requirements are defined in the TABLE.

TABLE: Additional Device Specific User Identification and Authentication Requirements

User Interface Device or Description	**Identification and Authorization Requirements**
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

TABLE: Additional Device Specific User Identification and Authentication Requirements

User Interface Device or Description	**Identification and Authorization Requirements**
[_____]	[_____]

]
[3.4.3.1 [_____]

****
NOTE: Use this subpart (and make additional copies as needed) to define any unique Identification and Authorization Requirements used in the table above.
Two common alternate methods for multifactor authentication are:
1) Text/SMS/email Based - where a message (code) is sent as a text to a cell phone or to an email address.
2) Hardware Token Based - where there is a hardware device such as a USB key or a pseudo random number generator (RSA token) that is used instead of a PIV card.
****

[_____]

]

3.4.4 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.

c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.5 Password-Based Authentication Requirements

3.4.5.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a minimum lifetime of 24 hours.

g. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

h. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

i. Passwords must be cryptographically protected during storage and transmission.

3.4.5.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters.

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.4 Passwords for Devices Minimally Supporting Accounts

****

NOTE: Indicate minimum password requirements for devices MINIMALLY supporting accounts. Use as large a value as practical, but use caution to pick a number that is supportable by the components.

Never allow a minimum length less than four characters. For HVAC control systems, simple Local Display Panels may not support more than four characters, and keeping four as the minimum is generally recommended.

****

Devices MINIMALLY supporting accounts must support passwords with a minimum length of [four][_____] characters.

3.4.5.5 Password Configuration and Reporting

****

NOTE: Select whether the contractor will change passwords and submit a copy of the passwords or accompany site personnel while they change passwords.

In the case of contractor changing the passwords: Provide a POC for password coordination. This will generally be a supervisor or other senior member of the project site maintenance organization.

The Password Summary Report is needed by the project site system owner or O&M staff. This report is required to be delivered as hardcopy in a sealed envelope to keep passwords more confidential. Note that the contractor will know the passwords, so there remains a risk, but by changing the default the number of individuals knowing the password for a specific device is greatly reduced (from "everyone" to "the contractor and the installation")

In the case of site personnel changing the passwords, indicate the POC for coordination.
****

[For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Summary Report in electronic format. Provide [two][_____] hardcopies of the Password Summary Report, each copy in its own sealed envelope.

][For all devices with a password, coordinate the changing of passwords with the project site following testing of the system but prior to turnover to the Government. Coordinate with Password Point of Contact to determine appropriate project site personnel to complete password changes. Accompany identified personnel to each device with a password and instruct personnel on the process of changing password. Record the time, date and personnel present when each device's password is changed and submit a Password Change Summary Report documenting this information.

Provide the Password Summary Report electronically in both PDF and Microsoft Excel.
]

3.4.6 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

[3.4.7 Implementation of PKI Infrastructure in Moderate Impact Systems (Except USACE Civil Works Systems)

****
NOTE: When the USACE CW Tailoring Option is selected, a subpart covering Implementation of PKI Infrastructure is included below. When using the USACE CW tailoring option, remove this subpart during bracket replacement.

For MODERATE Impact Systems: Most systems will not use PKI (typically implemented as PIV (CAC) authentication). If PKI is supported at the front end, it may be implemented by the base-wide network (Platform Enclave) and not the controls contractor. If there is a requirement for the contractor to support PKI, include this subpart, otherwise remove it.

Note, PKI Infrastructure is not required to support the requirement for use of HTTPS for remote user

interfaces.
****

Coordinate with the PKI Infrastructure Point of Contact to configure the system to implement PKI such that the system validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information; the system enforces authorized access to the corresponding private key; the system maps the authenticated identity to the account of the individual or group; and the system implements a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network.

]3.4.8 Implementation of PKI Infrastructure in USACE Civil Works Systems

****
NOTE: This subpart is only included when the USACE CW tailoring option is selected.
****

Coordinate with the PKI Infrastructure Point of Contact to configure the PKI system. Implement PKI digital certificates for communications where possible, such that the system validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information. Configure the system to enforce authorized access to the corresponding private key, to map the authenticated identity to the account of the individual or group, and to implement a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network. [Self-signed certificates are acceptable.]Document communications devices that cannot be Certificate protected in a Certificate Protection Status (Encrypted) submittal for all communication devices prior to any equipment requiring certificates arriving at the site.

3.5 CYBERSECURITY AUDITING

****
NOTE: Auditing within the control system is a complex requirement. For standard information systems, DoD has extensive auditing requirements, which largely cannot be met within a typical control system. For more information on auditing, see UFC 4-010-06, Cybersecurity for Facility-Related Control Systems

DoD requires (see AU-2) the capability to audit the following events:

a. ***Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. Classification levels)*** **- generally only applicable to computers.**

b. ***Successful and unsuccessful logon attempts*** **- generally only applicable to computers and devices FULLY supporting accounts.**

c. ***Privileged activities or other system level***

access **- generally only applicable to computers.**

d. ***Starting and ending time for user access to the system*** **- generally only applicable to computers and devices FULLY supporting accounts.**

e. ***Concurrent logons from different workstations*** **- generally only applicable to computers and devices with web interfaces.**

f. ***Successful and unsuccessful accesses to objects*** **- generally only applicable to computers.**

g. ***All program initiations*** **- generally only applicable to computers; for a controller, this is covered under kernel module actions, below.**

h. ***All direct access to the information system*** **- generally only for computers.**

i. ***All account creations, modifications, disabling, and terminations*** **- generally only applicable to devices that FULLY support accounts.**

j. ***All kernel module load, unload, and restart*** **- this could apply to computers or controllers.**

DoD also requires that the selection of which events get audited is under the control of the Information System Security Manager (ISSM).

DoD requires (see AU-3) that audit records contain the following:
type of event
time of the event
location of the event
source of the event
result of the event
the identity of any individuals or subjects associated with the event.
Note that much of this information will be not applicable for field control system devices.

DoD requires that all devices in the system be capable of auditing events, but allows the ISSM to select which devices must perform auditing (see AU-12 (b)).

Note that there is a large gap between what is theoretically required in terms of a capability ("audit all events at all devices") vs. what is practical and reasonable to implement in a specific control system. The designer needs to provide input

on what can and cannot be done in terms of what devices in the system can perform auditing, and what events can they audit.

Require implementation for what is possible but do not require unreasonable requirements. Be prepared to document/explain impractical requirements if required by the System Owner (SO) or Authorizing Official (AO)

Control System Alarms:
Control system alarms should have similar requirements. The designer should specify what alarms should be generated, which devices should perform alarm generation, the accuracy of alarm time stamps, response to alarm generation failures (e.g. loss of communication with a field device), and sufficient storage capacity at the front end to maintain alarm/event logs for a specified period of time. These requirements should be defined in the relevant control system specifications, not in this Section.

Note the ability for the control system to send emails is dependent on the site having the proper infrastructure in place. Coordinate with the site if this capability is required and is not already available as part of existing control system requirements or functionality.

****

****

NOTE: When the USACE CW tailoring option is selected, the below text about email notification is in brackets and a statement indicating that email notification is not permitted is included. For USACE Civil Works systems, delete the bracketed text.

****

[Where an auditing requirement exists for email notification, notify via email the application administrator and Information System Security Officer (ISSO) of the event. Coordinate with the Email Address Point of Contact for email addresses. If outgoing email is not available to the system, disable email notifications.]

USACE Civil Works systems do not permit email notification. Disable all email notification. Auditing requirements for email notification in this section do not apply to USACE Civil Works control systems

3.5.1   Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-001230, CCI-000133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Computers

For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event. Send logs to a syslog server that is only accessible via accounts on the system with privileged level access.

3.5.1.1.1 Audited Events

Configure each computer to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Privileged activities or other system level access

e. Concurrent logons from different workstations

f. Successful and unsuccessful accesses to objects

g. Program initiations

h. Direct access to the information system

i. Account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

j. Kernel module load, unload, and restart

k. Operator actions related to operation of the system

3.5.1.1.2 Audit Event Information To Record

Configure each computer to record, for each auditable event, the following information (where applicable to the event):

a. What type of event occurred

b. When the event occurred

c. Where the event occurred

d. The source of the event

e. The outcome of the event

f. The identity of any individuals or subjects associated with the event

g. For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2 For HVAC Control System Controllers

3.5.1.2.1 HVAC Control System Controllers FULLY Supporting User Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.2.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful logon attempts to the controller

b. Successful logouts

c. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

d. All controller shutdown and startup

e. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.2.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. the identity of any individuals or subjects associated with the event

d. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2.2 Other HVAC Control System Controllers

There are no requirements to perform auditing at HVAC field controllers that do not FULLY support accounts.

3.5.1.3 For Lighting Control System Controller

3.5.1.3.1 Lighting Control System Controllers FULLY Supporting User Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.3.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful logon attempts to the controller

b. Successful logouts

c. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

d. All controller shutdown and startup

e. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.3.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. the identity of any individuals or subjects associated with the event

d. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.3.2 Other Lighting Control System Controllers

There are no requirements to perform auditing at Lighting field controllers that do not FULLY support accounts.

3.5.1.4 [_____] Control System Controllers

****

NOTE: Use this subpart if needed to add requirements for a specific control system type (e.g. lighting, electrical distribution etc.), similar to how HVAC and Lighting control system controllers are covered above.

If adding a new control system type, submit a Criteria Change Request with the relevant requirements to have that system included in the published UFGS.

****

[_____]

3.5.1.5 Default Requirements for Control System Controllers

****

NOTE: Do not edit these requirements. These default requirements should only be used in lieu of technology-specific requirements in the preceding paragraphs. If these default requirements are inappropriate, ensure that the preceding paragraphs provide appropriate technology-specific requirements.

****

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.5.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.5.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.5.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.5.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

****

NOTE: Auditing Front End Software may be a component of the control system front end or a separate software package. In either case - but particularly when it is part of an existing control system front end -- the site may already have this software.

Confirm with the project site whether they already have this software. If they do, indicate the current software.

Use the bracketed text to indicate where software is to be installed (either on the control system front end computer or indicate another computer) or to require that the software be provided for installation by the project site.

****

****

NOTE: For USACE CW Systems, the Designer must coordinate with the UCIC MCX to determine the auditing software requirements for the system being designed. Given the size and/or type of system, auditing software may not be required and should be removed from the spec section during bracket replacement.

Although some auditing functions may be implemented by the ISSO/SA upon acceptance of the system, it could require software to be provided by the Contractor. In this scenario edit the paragraph as needed to identify the auditing software contract requirements for the Civil Works application.

****

The project site currently has the following software to support control system auditing: [none][_____]. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license [for subsequent Government installation][and install the software on [_____]][the control system front end computer in [_____]]. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems

The auditing front end software must be capable of receiving notifications of audit failure from control system devices and computers and be able to provide email notification based on receipt of the notification.

3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems

****

NOTE: Indicate the time stamp discrepancy between audit logs that the system must be able to accommodate for correlating audit logs. This accounts for timestamp errors between different auditing devices, and will allow for multiple entries to be linked to the same event. The 2-second default is based on the time stamp accuracy requirement in the Time Stamps subpart, and accounts for device clocks being plus or minus 1 second (total of a 2 second span).

****

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to [2][_____] seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

****

NOTE: Select or indicate duration and rate of audit record generation for field devices. Unless there is a known need, do not add requirements for computer storage capability.

****

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For controllers capable of generating audit records, provide [60][_____] days worth of secure local storage, assuming [10][_____] auditable events per day.[

c. For computers, provide storage for at least [_____] audit records.]

3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems

****

NOTE: Indicate who, in addition to the ISSO and ISSM, will receive notification that audit logs are nearly full. Indicate who to coordinate with for email addresses.

****

{For Government Reference Only: This subpart (and its subparts) relates to AU-5(1); CCI-001855.}

Controllers storing audit logs must provide notification when audit logs reach 75 percent of capacity either directly through email or indirectly by sending a notification to a computer, and the computer sending an email. Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity directly through email.

3.5.4.2 Device Audit Record Upload Software

****

NOTE: If you indicated an installation location for the Auditing Front End Software, keep bracketed text requiring the Device Audit Record Upload Software to be installed on the same computer.

Note that this software may not be required for every project if all devices and computers can upload to the Auditing Front End.

****

For each device (computer or controller) required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

[When Device Audit Record Upload Software is capable of uploading audit logs over the network, install Device Audit Record Upload Software on the same computer as the Auditing Front End Software.] Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

****

NOTE: The requirement that audit processing failures notify a person implies that this control can only be met at a computer with network access, not by a control device within the control system. The action taken should be "overwrite oldest audit records" if possible; it should almost certainly never be "shut down information system". Provide a POC to notify, either the Security Controls Assessor (SCA) or the Information System Security Officer

(ISSO). Provide a default action.
****

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In the case of a failure in the auditing system, computers associated with auditing must provide email notification[and must [_____]]. For MODERATE Impact systems, the computer must also notify the associated auditing front end software. In case of an audit failure, if possible, continue to collect audit records by [overwriting existing audit records][_____].

For MODERATE Impact Systems: In the case of an audit failure at a controller performing auditing, the device must notify the associated auditing front end software of the audit failure if able, and must continue to collect audit records by [overwriting existing audit records][_____] if able. The auditing front end software must provide notification as indicated, treating the notification of failure from the device as a failure in the auditing system.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

****
NOTE: The control system should be designed to have the least capability possible while still meeting the minimum needs of the government. This means disabling unnecessary functionality. Do not install unnecessary software. Ensure that unnecessary accounts, maintenance passwords, etc. are all changed, disabled, or removed.

For systems other than HVAC control systems: Consider disallowing unrequested user interfaces and consider disallowing networked sensors/actuators where they are not required.
****

{For Government Reference Only: This subpart (and its subparts), along with the Network Communication, Ports, Protocols and Services Report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

For HVAC Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

For Lighting Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required.

For Other Control Systems: For LOW Impact Systems: [Do not provide devices with remote user interfaces or with full user interfaces where one was not required.] [Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.]

For Other Control Systems: For MODERATE Impact Systems: Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

For all MODERATE Impact Systems: Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

Do not install software that is not specifically required to meet a contract requirement. Remove any previously installed that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

****

NOTE: For electrical systems, coordination studies are performed and breaker setting coordinated such that a fault is cleared by the tripping of the first upstream breaker. Consider the possibility that the settings of that first upstream breaker may be altered in a deliberate attempt to cause an outage of an unrelated load via tripping of the second upstream breaker. In extreme cases, provide additional protection for that first upstream breaker, or provide additional series breakers in secure locations."

****

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

****

NOTE: Note that reducing the dependence on the network helps mitigate threats caused by a weak boundary defense.

****

{For Government Reference Only: This subpart relates to SC-5, SC-12, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Network Reliance in MODERATE Impact HVAC Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.2.2 Network Reliance in MODERATE Impact Lighting Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

[3.7.2.3 Network Reliance in MODERATE Impact [_____] Control Systems

****

NOTE: Use this bracketed subpart if needed to add requirements for a specific control system type (e.g. electrical distribution etc.), similar to how HVAC and Lighting control system devices are covered above.

If adding a new control system type, submit a Criteria Change Request with the relevant requirements to have that system included in the published UFGS.

****

[_____]

]3.7.2.4 Default Requirements for MODERATE Impact Control Systems

****

NOTE: Do not edit these requirements (beyond selection of bracketed text). These default requirements should only be used in lieu of technology-specific requirements in the preceding paragraphs. If these default requirements are inappropriate, ensure that the preceding paragraphs provide appropriate technology-specific requirements.

****

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

****

NOTE: In general, do not allow exceptions to the Web Browsers and Application SRG.

Unless compelling reasons exist, keep the bracketed text restricting the source of mobile code downloads

****

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

[Mobile code may only be downloaded from a specifically authorized mobile code repository. Coordinate with the Mobile Code Point of Contact for the location of a repository.]

3.7.4 Protection of Information at Rest In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-28, SC-28(1); CCI-001199, CCI-002472, CCI-002475, CCI-002476}

Computers must protect information at rest in accordance with applicable STIGs.

Any control system device storing personally identifiable information (PII), controlled unclassified information (CUI), or classified information must be protected by an Information At Rest encryption solution or by a physical security solution. Provide a Protection of Information At Rest Proposal indicating each device storing PII, CUI, or classified information and the encryption or physical security solution proposed for that device for government approval. If no devices stores PII, CUI, or classified information, provide a document stating this as the Protection of Information At Rest Proposal submittal. Do proceed with device selection and installation until the Protection of Information At Rest Proposal is approved. Once approved, implement approved Information At Rest protections.

3.7.5 Process Isolation and Boundary Protection in Moderate Impact Fire Protection Systems

{For Government Reference Only: This subpart relates to SC-7(a), SC-7(c), SC-7(4)(a), SC-7(4)(c), SC-7(5), SC-7(7), SC-7(9)(a), SC-7(11), SC-7(13), SC-7(13), SC-7(18); CCI-001097, CCI-001098, CCI-001102, CCI-002396, CCI-001109, CCI-002397, CCI-002398, CCI-002399, CCI-002403, CCI-001120, CCI-001119, CCI-001126}

****

NOTE: For many FRCS (Fire Protection being a notable exception), implementation of boundary protection is typically outside the scope of the controls contractor. The site IT staff should implement boundary protection via rules (e.g. a firewall) isolating the control system from the wider network. This is true even for a control system which will be later integrated to a larger system; the field point of connection (FPOC) should be configured to allow the minimum traffic necessary for operation. Critical to this is the Cybersecurity Interconnection Schedule, which defines what traffic must be allowed through the boundary for the proper operation of the system.

For Fire Protection Systems, some aspects of boundary protection are likely the responsibility of the installing contractor. In general, the ability to play a live audio message will be required and include the bracketed text. However, in many cases, the ability to play live audio is a vulnerability and in some cases, the site may not be willing to accept the risk. Coordinate with the site to determine whether to allow this functionality.

Select whether relays must use the normally open or normally closed contact. If a code requirement exists, follow the code. Otherwise coordinate with the fire protection specification and the project site and consider whether the greater risk is the potential to send a message when none should be sent, or the failure to send a message when one should be sent. If it is clear that one case is of greater concern than the other, select the appropriate bracketed text, otherwise remove the bracketed text to not introduce a specific requirement.

Coordinate requirements with those of "Safe Mode and Fail Safe Operation" in the following paragraph.

****

3.7.5.1 Radio Interfaces for Fire Protection Systems

When radios interfacing a local fire protection system to a supervisory system are not NIST FIPS 140-2 validated, use a relay panel interface between the local fire protection system and the radio. Install and configure the relay panel to prohibit initiating any action within the local fire protection system other than causing the system to play a pre-recorded message[or causing the system to play a live audio message]. [Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal][Install relays using the normally closed contact such that they pass a signal when they open, and so that a relay that loses power or has a failed coil passes the signal]

3.7.5.2 Fire Suppression System Network Isolation

For fire suppression systems including a release panel, any network used in these systems must be dedicated to these systems and must be isolated from any other network, including other components of the Fire Alarm and Fire Suppression systems. Use only dry contacts and relays to transfer signals from these systems to any other systems. [Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal][Install relays using the normally closed contact such that they pass a signal when they open, and so that a relay that loses power or has a failed coil passes the signal]

3.7.6 Application Separation

****

NOTE: This subpart is only included when the USACE CW tailoring option is selected

****

Configure operating systems, applications, and network accessible devices using application separation. Utilize the operating system on the primary partition of the hard drive. Install application databases on a different partition than the operating system. Install web servers on a different partition than the operating system. Do not install web servers and database servers on the same computer. Do not host web servers and database servers on the same Virtual Machine.

3.8 SAFE MODE AND FAIL SAFE OPERATION

****

NOTE: The designer should determine, based on the criticality of the controlled equipment, what conditions to consider and which actions, if any, including possible alarm requirements, the control system should take when these conditions are true. This should include external conditions (e.g. loss of off-site utility power), internal conditions (e.g. network or sensor failure), and operator input (e.g. manual command to a safe mode of operation). This should all be specified in the control logic (e.g. sequence of operations), in particular by addressing normal/failed positions of output devices, including default positions upon loss of network, and in the overall system design. Where

high reliability is required, the analysis should consider the addition of redundant equipment to the design. See also guidance on SC-24 (Fail in Known State), guidance on SI-17 (Fail-Safe Procedures) and the MINIMUM CYBERSECURITY DESIGN REQUIREMENTS in UFC 4-010-06, Cybersecurity for Facility-Related Control Systems.

Note that any requirements in the control system needed to meet CP-12 (Safe Mode) or SI-17 (Fail-Safe Procedures) should be specified in existing specifications and design, for example, redundant AHUs in the mechanical design and sequences of operation. Any specific requirements for CP-12 or SI-17 should be addressed in those sections, not in this UFGS.

****

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

****

NOTE: Indicate the number of hardcopy manuals required.

****

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system, including programming of devices, without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal. Provide any hardware keys or dongles, software keys, license numbers, and other information required to enable the Government to access or change the system.

For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit [one hard copy][[_____] hard copies] of the software user manual for each piece of software.

3.10 DEVICE POWER

****

NOTE: A long term alternate power supply is almost never required by the control system itself (independent of the controlled equipment).

Alternate long term power, if required, will be because of a tenant requirement or by the overall system design and should seldom be added as an ad-hoc requirement. Control systems for underlying systems with alternate power should use that alternate power source.

A UPS may be desired for specific control system components where rapid recovery after a power outage is required, or where the control system itself is necessary for restoration of power. Again, this should be driven by mission requirements and control system specifications should already require adequate system restoration after loss of power. If there are specific requirements for either short-term (UPS) or long-term (generator or alternate power source), include them as part of the design and in the relevant specification sections rather than adding requirements to this section.

Note that use of small local UPSes creates additional maintenance burdens due to the requirements for periodic battery replacement and may ultimately result in a less reliable system. For MODERATE Impact Systems: This is a particularly important consideration and designers are strongly cautioned against small per-controller UPS and recommended to use a central UPS instead.

Brackets are provided here for the EXTREMELY RARE case in which emergency power requirements must be specified here. In most cases, keep the bracketed text indicating emergency power requirements are in accordance with the control system and equipment specifications. For MODERATE Impact Systems: As the system has a MODERATE impact there is a particularly strong presumption the mission already requires and is providing emergency power, and the control system should therefore use the same emergency power as the underlying equipment.

****

****

NOTE: For MODERATE Impact Systems, the requirement is for redundant power cabling paths. For this to result in significantly increased availability, the paths must be fed from independent power sources (i.e. the cable paths must be redundant all the way back to redundant power sources). Coordinate with the electrical designer to see if this level of power redundancy has been designed into the system.

If this level of redundancy is required for availability, coordinate with the designer of the controlled equipment (e.g., for HVAC controls, coordinate with the HVAC system designer) to determine if there is a requirement for redundant controlled equipment as well - redundant power to a single piece of controlled equipment still has a

single point of failure at the controlled equipment.

The specification requirement covers these issues by simply requiring the controller power to be as reliable as the equipment power. If there is no requirement for redundant (controlled) equipment power or redundant (controlled) equipment, then there is little value in trying to provide redundant power to the control system as the most likely failures are mechanical or electrical failures in the controlled equipment or loss of equipment power, not independent loss of power to the control system.

Note that sequences of operation often lock out equipment in case of failure. Consider carefully how to address general loss of power to ensure that automatic recovery after loss of power is possible.

****

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

[For LOW Impact Systems: [Provide emergency power in accordance with the control system and equipment specification Sections, [_____]]

] For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSes) as a source of device power.

3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

****

NOTE: The requirement that "In the event of a loss of power, when power is restored, controllers (and the underlying equipment) must recover and resume their normal sequences of operation." may conflict with the sequence of operation specified in the control system specification. For example, the sequence may normally "lock out" a piece of equipment when power is out (for example, a motor proof). Coordinate with the control system specifications to make sure that equipment can restart after power failure.

****

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

3.11 VULNERABILITY SCANNING

****

NOTE: In general, it won't be possible to assume that devices will respond to an IT scanning tool. There might be specific cases where it is desirable for devices to provide specific responses to specific IT tools. If so, add the appropriate requirements to indicate the scanning tools and response information.

****

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

3.11.1 Computers and Software Running on Computers

Computers and applications running on computers must meet relevant vulnerability scanning STIGs/SRGs and respond to approved DoD vulnerability scanning tools.

3.11.2 Controllers

Provide controllers that are scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information must contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 VULNERABILITY ALERTS

****

NOTE: This subpart is included only when the USACE CW tailoring option is selected

****

Prior to installation, adhere to all vendor-specific and CISA Information Assurance Vulnerability Alert (IAVA, see https://www.cisa.gov/uscert/ncas/alerts) requirements for reporting, patching, and/or mitigating. For alerts which occur after installation but before government acceptance:

a. Notify the Contracting Officer within 48 hours of receipt of the alert and within 48 hours of resolution of vulnerabilities.

b. Resolve the vulnerabilities within 30 days of the alert.

c. Submit a Vulnerability Resolution Report within 14 days of resolving the vulnerabilities in the alert. The report must identify the vulnerability alert ID and the date of resolution for each component.

3.13 FIPS 201-2 REQUIREMENT

****

NOTE: Select brackets to indicate if any systems require devices using PIV to be on the FIPS 201-2 approved product list.

Many control systems will not be able to meet a requirement for devices to be on the FIPS 201-2 approved product lists. Only require this when necessary.

****

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list (https://www.idmanagement.gov/approved-products-list/): [NONE][electronic security systems(ESS)][_____].

3.14 BIOS/UEFI PROTECTION

****

NOTE: This subpart is included only when the USACE CW tailoring option is selected

****

Provide a protection mechanism to prevent unwanted changes to the system BIOS/UEFI for all devices on the system, where technically feasible. BIOS/UEFI Protection Mechanisms must utilize passwords or passphrases that conform to DoD STIG requirements. BIOS/UEFI Protection passwords must be used to allow access by system engineering and administrative personnel after initial commissioning of the system. Enable UEFI Secure Boot if hardware and Operating System support the option. Provide a BIOS/UEFI Protection Password/Passphrase List (Encrypted) documenting all passwords and passphrases.

3.15 SYSTEM AND INTEGRATION INTEGRITY

3.15.1 Malicious Code Protection

****

NOTE: Malware protection software media may be government or contractor furnished; it may be either Government or contractor installed, and the license may be government or contractor furnished.

For each of media, license and installation select the bracketed text indicating contractor or Government responsibility.

This subpart uses the USACE CW tailoring option. When selected, additional requirements for virus protection and a submittal are included.

****

{For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}

For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Provide the most up-to-date DoD approved software with up-to-date signatures. Verify that the software does not negatively affect the operation of the OT system. Computers being installed must be configured with up-to-date signatures, not older than 10 days, prior to deployment. Submit Antivirus/Antimalware Scan Results to show evidence of a clean scan. Coordinate with the Government Computer Access Point of Contact as required.

a. [Provide malware protection software licenses.][Malware protection software licenses will be Government furnished.]

b. [Provide malware protection software media.][Malware protection software media will be Government furnished.]

c. [Install and configure malware protection software in accordance with the relevant STIGs.][Malware protection software will be Government installed.]

3.15.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

****

NOTE: Integrity checks are a desirable characteristic of critical control systems, but many controls technologies (for example, commercial HVAC controls) do not support their implementation. One example of a controls technology that does meet this is a redundant PLC system where the dual PLCs are set up in a hot swap standby configuration and each PLC has self-check routines to detect a failure and transfer control to the other PLC. Note, however, that the requirement for redundancy is above and beyond what SI-7 control requires (which does not mention redundancy).

If you already have a requirement for redundant controls and if your control technology supports meeting these requirements, then consider adding language (if not already present) similar to the following to your controls specification: "Controllers that are redundant must be fully redundant and implement hot-standby redundancy where each controller continually monitors its own integrity and process control seamlessly passes from one controller to the other if a loss of integrity is detected."

Including these requirements where not generally supported by the technology will certainly raise the project cost and may result in less reliable systems as the project may be implemented by people who can meet this requirement, but are otherwise inexperienced in the other requirements of the project. (i.e. a factory automation company that does not understand the thermodynamics of HVAC control).

If no integrity verification software is available a compensating approach is to provide fully redundant mechanical systems and a sequence of operation where the two mechanical systems (and their controls) are fully independent such that failure of one controller does not compromise the other redundant system. This will also increase system cost and complexity and should be carefully considered and only implemented when there is a strong project need.

{This paragraph relates to SI-10, Information Input Validation, CCI-001310, CCI-002744.} For MODERATE systems, consider requiring redundant sensors where sensed values are critical inputs to the sequence. User input which could have serious adverse impact on the system should have confirmation dialogs prior to user input. In extreme cases, user inputs should require validation by an additional user prior to input.

{This paragraph relates to SI-11, Error Handling, CCI-001312.} Designer should require alarm messages and other control system feedback to provide notification of errors in support of corrective action. (Note that the DoD definition of recipients for this CCI is not applicable for a control system, and the recipient of these messages should be the entities responsible for the control system operation.)

****

{For Government Reference Only: This subpart relates to CM-5(3); CCI-001749, CCI-002704, CCI-002726}

If there exists Integrity Verification Software that can check boot process, software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists, provide a statement to this affect in lieu of the software.

[The system prevents the installation of software and firmware without verification of the digital signature using an approved certificate.]

[3.15.3 Information System Monitoring

****

NOTE: Delete this subpart unless specifically required for the project. If required, indicate requirements for the monitoring of the control system.

****

{For Government Reference Only: This subpart relates to SI-4 (a),(b); CCI-001253, CCI-002645}

[_____]

]3.16 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.16.1 Control System Cybersecurity Testing Procedures

Prepare and submit Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.16.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.16.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package

3.17 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

****

NOTE: Coordinate with the entity performing cybersecurity testing to determine support requirements for cybersecurity testing.

Some possible values to consider:

1) **A control system with no IP devices: 1-2 days.**

2) **A control system with IP devices: 5 days**

3) **If the system includes a new front-end (server): +5 additional days**

****

In addition to testing and testing support required by other Sections, provide a minimum of [_____] hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.18 CYBERSECURITY TRAINING

****

NOTE: Indicate the number of hours of training and number of attendees. Unless training is specifically waived by the project site, DO NOT remove training requirements.

****

Provide [eight][_____] hours of classroom[and hands-on] training for [six][_____] Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-25 08 10 (May 2021)**

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Preparing Activity: USACE **Superseding**
UFGS-25 08 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 25 - INTEGRATED AUTOMATION

SECTION 25 08 10

UTILITY MONITORING AND CONTROL SYSTEM TESTING

05/21

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USACE / NAVFAC / AFCEC **UFGS-25 08 10 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-25 08 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 25 08 10

UTILITY MONITORING AND CONTROL SYSTEM TESTING
05/21

****
NOTE: This guide specification covers the requirements for testing of UMCS and field control systems. Requirements for a performance verification test (PVT) which incorporates an endurance test, and optional requirements for a factory test are included. The factory test is similar to the PVT, but performed at the factory prior to system installation while the PVT is performed on the installed system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: The designer will need to edit this specification if only a portion of the testing is required on the project. The engineer must keep in mind there can be testing of 1) new UMCS, 2) building level controls, and/or 3) combined building level controls and UMCS.
****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1.2 DEFINITIONS

In addition to the definitions provided in this Section, 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION contain definitions related to this Section.

1.2.1 Algorithm

A set of well-defined rules or procedures for solving a problem or providing an output from a specific set of inputs.

1.2.2 Analog

A signal that can take on continuous (as opposed to discrete) values. Sensors (e.g. temperature, pressure, flow) typically provide analog signals as outputs to represent the measured variable. Within the UMCS, analog signals are generally represented by either 0-10 volt or a 4-20 milliamp signal.

1.2.3 Binary

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level.

1.2.4 Change-Of-Value (COV)

A type of data transmission over the network where the point value is transmitted over the network only when its value changes. COV is an efficient use of network bandwidth.

1.2.5 Control Wiring

This includes conduit, wire, and wiring devices to install complete HVAC control systems, including motor control circuits, interlocks, sensors, PE and EP switches, and like devices. This also includes all wiring from node to node, and nodes to all sensors and points defined in the I/O summary shown on drawings or specified herein, and required to execute the sequence of operation. Does not include line voltage power wiring.

1.2.6 Demand

The maximum rate of use of electrical energy averaged over a specific interval of time, usually expressed in kW.

1.2.7 Graphical User Interface (GUI)

Human-machine interfacing allows the operator to manage, command, monitor, and program the system.

1.2.8 Integration

Establishing communication between two or more systems to create a single system.

1.2.9 Protocol

In control systems, "protocol" is generally shorthand for "communication protocol"; a defined method by which digital information is exchanged electronically. Often more than one protocol is used in a BAS, for example, a typical BACnet system will use at a minimum (in addition to BACnet/IP and BACnet MS/TP) IP, UDP, ARP, Ethernet, and RS-485 protocols (and this does not include any protocols used internally in the front end or for communication with front end client workstations).

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Sequencing

Performance Verification Testing required by this Section must be proceeded by successful and accepted "contractors field testing" or "start-up and start-up testing" of the control system to be tested.

1.3.2 Scheduling

Coordinate testing schedules with the Government and with work in other Sections performed on the components or systems to be tested.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

PVT Plan; G, [_____]

PVT Phase I Report; G, [_____]

PVT Phase II Report; G, [_____]

SD-07 Certificates

Test Instrumentation Calibration Certificates; G, [_____]

1.5 TEST EQUIPMENT

Provide all test equipment unless otherwise noted in the contract documents. Use only test equipment with current calibration traceable to the National Institute of Science and Technology (NIST). For each test instrument, submit Test Instrumentation Calibration Certificates demonstrating calibration traceable to NIST. Use test equipment and test methods such that the overall accuracy of the test method, including all test instrumentation and any errors inherent in the test procedure, is at least 50 percent better than the accuracy specified for the sensor. For example, if a temperature sensor has an accuracy requirement of plus or minus 0.5 degrees Celsius1 degree Fahrenheit degree overall accuracy of the test method, must be 0.25 Celsius0.5 degree Fahrenheit or better.

When validating sensor accuracy, the test instrument is treated as if it is perfectly accurate; that is, the measured value from the test instrument must lie within the bounds of the specified accuracy of the sensor. Expressed mathematically:

Given:
Sensor accuracy: Plus or minus X
Sensor reading: Y
Test equipment reading: Z
Where X, Y and Z are real numbets.

Then
Sensor passes if: (Y-X) <= Z <= (Y+X)
otherwise, sensor fails

PART 2 PRODUCTS

Not applicable

PART 3 EXECUTION

3.1 PERFORMANCE VERIFICATION TEST (PVT)

Perform a Performance Verification Test (PVT) to demonstrate that the installed control system meets all requirements of the project specifications. Coordinate scheduling of the PVT with the Government, and do not begin the PVT until the PVT Plan submittal is accepted.

3.1.1 PVT PLAN

Provide a PVT Plan including system documentation and PVT Procedures.

3.1.1.1 PVT Plan System Documentation

****

NOTE: If Section 23 09 00 is part of the project, keep the bracketed text referencing Section 23 09 00, otherwise remove it.

****

Include the following system documentation in the PVT Plan:

a. Copies of the most recent as-built drawings for the system, including but not limited to one-line drawings and Points Schedules [as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC] showing device address, point descriptions, network point names and types, hardware point types, settings and ranges including units.

b. Copies of manufacturer's product data sheets when needed to demonstrate compliance with project requirements. In particular, provide data sheets showing that surge protection requirements have been met.

c. Operation or user manuals for all software and all DDC Hardware to be tested.

d. List of test equipment.

3.1.1.2 PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

3.1.1.3 PVT Procedures

Develop PVT procedures using the test procedures in this Section, modifying the procedures and adding tests as appropriate to develop procedures that test all requirements of the project specifications. The test procedures must consist of detailed instructions for test setup, execution, and evaluation of test results.

When developing additional procedures, provide the same information and fields as shown in the Test Template.

3.1.2 PVT Phases

Conduct PVT testing in two phases:

I. Field testing for devices, components, subsystems and the overall system using the approved PVT Procedures.

II. A one-week endurance test during which the system is operated continuously.

3.1.2.1 PVT Phase I (Field Tests)

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems fully and correctly implement the sequences of operation. PVT for surge protection is not required to include introducing a surge to the equipment; surge protection may instead be demonstrated through product documentation.

Do not start the performance verification test until after receipt of written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing of the HVAC System. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. At the completion PVT Phase I and in accordance with the project schedule and project sequencing provide a PVT Phase I Report documenting all PVT testing including all approved test procedures with test results indicated on the procedures, and a record of all actions taken to address PVT test failures.

3.1.2.2 PVT Phase II (Endurance Test)

Complete an endurance test as part of the PVT in which the system is operated continuously for [one-week][_____] without failure. During the endurance test trend all points shown as requiring a trend on the Points Schedule for the entire duration of the endurance test. If insufficient buffer or storage capacity exists to trend the entire endurance test, offload trend logs during the course of the endurance test to ensure that no trend data is lost. If the control system specification includes bandwidth requirements for bandwidth usage on a non-IP network, measure and record the network bandwidth usage on each non-IP channel during the endurance test.

If the system experiences any failures during the endurance test portion of the PVT, repair the system and repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period. At the completion of PVT Phase II and in accordance with the project schedule and project sequencing provide a PVT Phase II Report documenting failures and repair actions taken during PVT Phase II.

3.1.2.2.1 Temporary Trending Capability

Unless trending capability exists, either within the building control system or through a connected Utility Monitoring and Control System (UMCS) Front End, temporarily install hardware on the building control network to perform trending during the endurance test as indicated. Remove the temporary hardware at the completion of all testing and commissioning activities.

3.2 FACTORY TEST

Perform a Factory Test to demonstrate the capability of the proposed control system solution to meet the requirements of project specifications. Coordinate scheduling of the Factory Test with the Government, and do not begin the Factory Test until the Factory Test Plan submittal is accepted.

3.2.1 Factory Test Setup

Design the Factory Test Setup to represent the system as it will be fielded and to demonstrate the capability of the system to meet the requirements of the project specification. At a minimum:

a. Include at least one of each model of DDC hardware, instrumentation and control device to be used on the project.

b. Include at least one network of each type to be used on the project.

c. Include a programmable controller programmed as it will be installed, or, if no programmable controller is to be installed on the project, include a programmable controller with a sample application.

d. Include sample hardware to provide a mock field control system for the front end to communicate with if the project requires a front end but does not require a field control system.

3.2.2 Factory Test Plan

****

NOTE: Factory Test Plan to be submitted in conjunction with submittals and requirements of Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

****

Provide a Factory Test Plan documenting the test setup and procedures.

3.2.2.1 Factory Test Plan Setup Documentation

Include the following information, at a minimum, to document the factory test setup:

a. System one-line block diagram of equipment used in the factory test identifying computers (servers and workstations), network hardware, DDC hardware, and other instrumentation including, but not limited to, sensors, actuators, test signal generators, and meters.

b. System hardware description used in the factory test.

c. System software description used in the factory test.

****

NOTE: It is best to keep the first bracketed text to require the use of the Points Schedule format specified in UFGS 23 09 00. If this is not feasible, the second bracketed text may used and edited to address additional specific requirements.

****

d. Points Schedules for each controller showing the configuration to be used during the test. Points Schedules must [be as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][include the following information at a minimum: device address, point descriptions, network point names and types, hardware point types, settings and ranges including units].

e. Required passwords for each operator access level.

f. List of other test equipment.

3.2.2.2 Test Procedures

Develop factory test procedures using the Test Procedures in this Section, modifying the procedures and adding tests as appropriate to develop test procedures that test all requirements of the specification. The test procedures must consist of detailed instructions for test setup, execution, and evaluation of test results. Factory test procedures must include testing of surge protection by introducing a surge to the equipment and demonstrating that the equipment survives.

When developing additional procedures, provide the same information and fields as shown in the Test Template.

3.2.3 Factory Test Report

Upon completion of the Factory Test provide a complete test report, consisting of a short summary of the factory test, a copy of the Factory Test Plan, and copies of the executed test procedures separated by test. For each test, include date performed and identify the Government representative who witnessed and approved the test.

If a portion of any test failed, document the failure and corrective action.

3.2.4 Factory Test Execution

Conduct the Factory Test at a location and time approved by the Government. The Government will witness the factory test.

If the system fails a portion of a test, the Government will determine whether the entire test or only the portion that failed must be repeated.

3.3 TEST PROCEDURES

Develop test procedures using the template procedure in the Appendix. A test template and sample test procedures in electronic format are available at the Whole Building Design Guide page for this section: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-08-10 Refer to the Sample Test Procedures Table to view the existing sample tests.

Sample Test Procedures	
Test No.	Test Title
1	System Equipment Verification
2	System Start-up
3	Monitoring and Control (M&C) Software Passwords
4	Graphic Display of Data
5	Graphic Navigation Scheme
6	Command Functions
7	Command Input Errors
8	Special Functions
9	Software Editing Tools
10	Scheduling
11	Alarm function
12	Trending
13	Demand Limiting
14	Report Generation
15	Uninterruptable Power Supply (UPS) Test
16	Routers and Repeaters
17	Gateways (Building Level)
18	Gateways (Device Level)
19	Local Display Panel (LDP)
20	Open Network Point Verification
21	Custom Test Template

APPENDIX A

TEST NUMBER: <TEST NUMBER>
TEST TITLE: <TEST TITLE>

OBJECTIVE: <STATE TEST OBJECTIVE>

INITIAL REQUIREMENTS/CONDITIONS

1. Submittals: <LIST REQUIRED SUBMITTALS>

2. Equipment: <LIST EQUIPMENT REQUIRED FOR TEST>

3. Reference Documentation: <LIST REQUIRED REFERENCE DOCUMENTATION>

Date of Test: __________
Time of Test: __________
Contractor's Representative: ____________________
Government's Representative: ____________________

Specification References for this verification:
<LIST SECTIONS REFERENCED FOR THIS TEST>

TEST PROCEDURES: <USE THE FOLLOWING FORMAT FOR TEST PROCEDURES, EXPAND AS NECESSARY TO CAPTURE ALL TEST ITEMS>

Item	Action	Expected Results	Approved
1			
2			
3			
4			

Item	Action	Expected Results	Approved
Notes:			

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-25 08 11.00 20 (November 2020)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-25 08 11.00 20 (November 2020)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 25 08 11.00 20

RISK MANAGEMENT FRAMEWORK FOR FACILITY-RELATED CONTROL SYSTEMS

11/20

****

NOTE: This guide specification covers the Navy requirements to support the Risk Management Framework (RMF) Authority to Operate (ATO) Process for Facility-Related Control Systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

****

Note: Facility-Related Control Systems (FRCS) are a subset of control systems that are used to monitor and control equipment and systems related to DoD real property facilities (e.g., building control systems, utility control systems, electronic security systems). This section includes Risk Management Framework (RMF) requirements to be included on DOD projects which has a facility-related control system requiring an Authority To Operate (ATO). This Section does not provide general requirements for a control system,

nor are the requirements in this section sufficient to procure a control system. This section also does not repeat requirements from UFGS 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS or other technical sections.

The use of UFGS 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS does not necessarily make this specification applicable.

Only use this specification on control systems which are obtaining a new ATO.

If an installation obtained a J&A to procure specific equipment based on an existing authorization, this specification is not needed. Instead include the make/model of equipment referenced in the J&A on the plans and include configuration settings into the technical specifications to match the existing authorization. Where equipment is procured and configured to match an existing authorization, a memo for the record (MFR) to the existing authorization is needed ILO performing a new authorization.

Refer to UFC 4-010-06, "Cybersecurity for Facility-Related Control Systems" for requirements on incorporating cybersecurity into control system design and for general information on the RMF process as it applies to control systems. Assistance for control system cybersecurity is available from the following Service organizations:

Navy: Naval Facilities Engineering Systems Command,
Command Information Office (CIO)

Marine Corps: Contact Navy POC for Marine Corps POC information

Many designer selections in this Section will require coordination with the project site, System Owner, Information System Security Manager (ISSM), Authorizing Official (AO) or a subject matter expert in the specific control systems being installed.

****

PART 1 GENERAL

This specification includes the contract requirements to to support the Government in obtaining an Authority To Operate (ATO) following the Department of Defense Risk Management Framework process.

This Section does not provide technical requirements for a control system, nor are the requirements in this section sufficient to procure a control system. This section must be used in conjunction with other technical control system specifications and UFGS 25 05 11 CYBERSECURITY FOR FACILITY RELATED CONTROL SYSTEMS.

1.1 CONTROL SYSTEM APPLICABILITY

****

NOTE: List each control system requiring an authorization and the corresponding impact rating categorization (Confidentiality-Integrity-Availability) of Low, Moderate, or High. Typical systems to consider are utility monitoring control systems, building control systems, lighting control systems, UPS control systems, generator control systems, and SCADA systems.

****

This section applies to the following control systems:

a. [Building DDC System] [_____] with a categorization of [Low-Low-Low] [Moderate-Moderate-Moderate] [_____].

[b. [_____] Control System with a categorization of [Low-Low-Low] [Moderate-Moderate-Moderate] [_____].

][c. [_____] Control System with a categorization of [Low-Low-Low] [Moderate-Moderate-Moderate] [_____].

]1.2 RELATED REQUIREMENTS

All Sections containing facility-related control systems (FRCS) or control system components as identified in paragraph CONTROL SYSTEM APPLICABILITY are related to the requirements of this Section. Review all specification sections to determine related requirements.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors
NIST SP 800-82	(2015; Rev 2) Guide to Industrial Control Systems (ICS) Security

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems
DODI 8551.01	(2014) Ports, Protocols, and Services Management (PPSM)

1.4 DEFINITIONS

1.4.1 Assured Compliance Assessment Solution (ACAS) Scans

Automated vulnerability scanning and risk assessment tool mandated for use in DOD to identify security compliance and secure configuration of connected devices.

1.4.2 Authority To Operate (ATO)

The Authority granted by an organization's Authorizing Official (AO or FAO), which indicates the system has undergone the first five steps of the RMF process and has been assessed and deemed to be at an acceptable level of risk to allow connection to other Authorized systems, (any limitations to this connectivity will be documented within the RMF package). Retention of a system's Authorization status is contingent upon successful completion of all conditions as documented in the ATO package, as well as lifecycle compliance with Step 6 of the RMF; "Continuous Monitoring".

1.4.3 Control Correlation Identifier (CCI) or Security Control

Each Security Control is broken down into individual Assessment Procedures (AP's), to enable more granular assessment of the compliance status of a given control, (e.g. AC-1 is broken out into AC-1.1, AC-1.2, AC-1.3); each of these is assigned a CCI number and is individually assessed and tracked for compliance.

1.4.4 Enterprise Mission Assurance Support Service (eMASS)

A web-based application for the cybersecurity management of system information, which provides automated capabilities for documentation and tracking in support of Authorization within the Risk Management Framework Process.

1.4.5 Functional Authorizing Official (FAO) or Authorizing Official (AO)

Signature authority for granting an Authority to Operate (ATO) and the responsible individual for accepting risk imposed by the implementation and operation of systems in their AOR. The AO is exclusively accountable for organizational cybersecurity risk exposure corresponding to all IT under their cognizant authority. The AO makes an authorization decision based on all the artifacts related to the activities within the RMF process and in accordance with the AO's cybersecurity risk tolerance. This risk tolerance accounts for the probability of a breach to confidentiality, integrity, and availability of information and the potential impact that breach would conceivably have.

1.4.6 Information System Owner (ISO) or System Owner (SO)

Has overall ownership of the system and is involved in the design, development, and cybersecurity implementation of the system, ensuring that the system is maintained and tracked throughout its lifecycle.

1.4.7 Information System Security Manager (ISSM)

Government-appointed Command Information Office Representative with overall responsibility for the cybersecurity of a program, organization, system, or enclave; and is accountable to the system Program Manager/Information System Owner. Often the ISSM/Information System Security Officer (ISSO) will delegate execution of tasks to other RMF team members, however accountability remains with the ISSM/ISSO. During sustainment, the ISSM/ISSO will be solely responsible and report to the PM/ISO. As their responsibilities are mandated by Department of Defense instruction, ISSM's are generally designated in writing by Senior Command Leadership (SYSCOM CIO, Base Commander)

1.4.8 Information System Security Engineer (ISSE)

The ISSE (contractor) is responsible for developing and maintaining the cybersecurity architecture of a program, organization, system, or enclave.

1.4.9 Risk Management Framework (RMF)

The process mandated by DOD 8510.01 for the management of cybersecurity risk across the DOD enterprise; the RMF leverages a risk-based approach for the formal Authorization of IT systems and services. The RMF implements and enforces a tailored set of security controls, focused on security as an integral part of a system’s overall lifecycle.

1.4.10 Security Assessment Plan (SAP)

A plan developed by the SCA / Validator which provides the specific test objectives for the security controls assessment, identifies the personnel, procedures and tools to be used, identifies any 'exceptions' to the plan, and documents 'false positives' [and][or] misleading reports discovered during testing.

1.4.11 Security Assessment Report (SAR)

A report produced by the SCA/Validator which documents the residual risk of the non-compliant security controls after the risk assessment work is completed. The SAR provides a summary of the vulnerabilities, interconnected systems, rationale for aggregated risk, and a recommendation to the FAO/AO regarding an Authorization decision.

1.4.12 Security Content Automation Protocol (SCAP)

An assessment methodology which leverages specific standards to enable automated vulnerability management, measurement, and policy compliance evaluation of IT and computing systems. SCAP may be used to enumerate security-related software and configuration issues. SCAP scan data may also be uploaded into a STIG viewer utility to assist in automating STIG checklist processing for those technologies that offer this functionality.

1.4.13 Security Control Accessor - Validator (SCA-V)

A Government-assigned independent third party which assesses and validates that the system has correctly implemented the approved security control baseline. To determine the overall effectiveness of the security controls, the SCA performs an independent, comprehensive assessment of the management, operational, and technical controls employed within or inherited by a system. To perform the SCA function in the most efficient manner, the Navy will utilize SCA Liaisons and Validators to assist with SCA responsibilities.

1.4.14 Security Plan (SP)

Includes essential operational, architectural, and functional information about the system. This plan is generated by eMASS from the information provided during eMASS registration process and is updated whenever pertinent information about the system is entered or changed. The SP is a living document which can be exported and downloaded in real time from eMASS.

1.4.15 Security Technical Implementation Guidance (STIG)

Standard security protocols and procedures that provide a methodology for secure configuration of computing, networking, software and control system assets. STIG checklists may be utilized as tools for determining compliance with a given set of security controls.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Coordination

****

NOTE: This subpart deals with coordination requirements for the contractor, and does not indicate coordination that must be done by the designer/specifier. In addition to the normal project coordination, authorization for wireless use, alternate account lock permissions and devices with multiple IP connections may be impacted by site (or Service) policies and need to be coordinated with the appropriate Government representatives before authorization is provided.

****

Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS.

1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: All submittals in this Guide Specification require Government approval and must have a "G" designation.

Government review of submittals in this Section impact Cybersecurity, and must be coordinated with the appropriate Cybersecurity experts to ensure appropriate review and the identification of issues or concerns that may affect the cybersecurity posture of the system or the ability of the system to receive an RMF authorization. Cybersecurity Experts are in the following organizations:

Army: Control System Cybersecurity Center of Expertise, Huntsville Engineering and Support Center

Navy: Naval Facilities Engineering Systems Command, Command Information Office (CIO)

Air Force: Civil Engineer Maintenance, Inspection, and Repair Team (CEMIRT) ICS Branch, Tyndall AFB

Marine Corps: Contact Navy POC for Marine Corps POC information

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Authorization Strategy Plan; G, [_____]

SD-05 Design Data

Control System Security Controls; G, [_____]

Security Plan; G, [_____]

Ports, Protocols, And Services Management Registration Form; G, [_____]

SD-06 Test Reports

ACAS Vulnerability Reports; G, [_____]

Security Technical Implementation Guide Checklists; G, [_____]

SCAP Report; G, [_____]

ISSE Checklist (Step 3); G, [_____]

ISSE Checklist (Step 4); G, [_____]

SD-07 Certificates

Information Assurance Technical Level II/Security Plus; G, [_____]

1.7 QUALITY CONTROL

1.7.1 Certifications

****

NOTE: If there are contractor qualification or certification requirements related to the control system, specify those in the control system specification. If there are contractor qualifications or certifications specifically related to risk management framework they can be specified here.

****

Submit the Information Assurance Technical Level II/Security Plus certification for the Information System Engineer (ISSE) for the project. The ISSE is required to have a background check and be able to obtain a Common Access Card (CAC). The background check and ability to obtain a CAC are necessary to perform the eMASS requirements in this section. The ISSE is also responsible for developing and maintaining the cybersecurity architecture for all control systems. In addition to requirements in this section the ISSE will perform the following duties:

a. Overseeing the development of all facility-related control system's cybersecurity solutions.

b. Identifying the security control baseline set and any applicable overlays and tailoring.

c. Construction Quality Control for Risk Management Framework submittals in this section and section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

d. Obtain and maintain an eMASS account. The Government will initially set up eMASS records and authorization packages. Manage the authorization packages and eMASS records for all facility-related control systems as identified in paragraph CONTROL SYSTEM APPLICABILITY.

e. Lead the security control selection, security control implementation, self assessment, and testing efforts.

f. Work with the Government to complete the Security Assessment Plan.

g. Attend the Cybersecurity Commissioning Construction Coordination Meeting.

h. Attend the RMF Step 2 Checkpoint Meeting.

1.8 CYBERSECURITY DOCUMENTATION

1.8.1 Authorization Strategy Plan

Provide the Authorization Strategy Plan to include a narrative on the overall authorization approach for each control system identified in paragraph CONTROL SYSTEM APPLICABILITY. The narrative will outline the different anticipated leveraged authorizations, connections to the control system platform enclave, describe the process as outlined in paragraph RISK MANAGEMENT FRAMEWORK, and include how the RMF steps integrate with the overall construction schedule.

PART 2 PRODUCTS

****

NOTE: Specify representative spare parts to be provided to the Control Systems Test Bed, EXWC in Port Hueneme, CA if devices need additional testing performed by the government. This is normally not needed.

****

[2.1 SPARE PARTS

Provide one representative extra spare part for each ethernet capable Level 1 and Level 2 device in the control system.

] [Not used.]

PART 3 EXECUTION

3.1 RISK MANAGEMENT FRAMEWORK

The Risk Management Framework (RMF) is a 6 step process adopted by the DoD to manage risk operating Facility-Related Control Systems. The following paragraphs identify construction requirements to support the Government in obtaining an Authority To Operate (ATO) for the control systems identified in paragraph CONTROL SYSTEM APPLICABILITY. Requirements for Steps 1 through 4 are below. RMF Steps 5 and 6 are performed by others and not part of this contract.

3.1.1 RMF Step 1: Control System Categorization

RMF Step 1, Control System Categorization is completed during the design phase of the control system. Control system categorization is listed by control system in paragraph CONTROL SYSTEM APPLICABILITY.

3.1.2 RMF Step 2: Security Control Selection

****

NOTE: RMF Step 2: Security Control Selection: Append the initial list of tailored security controls developed during design as outlined by UFC 4-010-06 to the end of this specification such that the contractor can complete RMF Step 2.

****

The security controls selected for a FRCS are initially developed during design, but the final list of security controls necessary to obtain an ATO cannot be determined without considering the specific equipment make/model/firmware selected for this contact.

3.1.2.1 Tailor Control System Security Controls

In eMASS, initiate the Security Control Selection Workflow. Next, take the initial list of security controls appended to this specification and complete tailoring the list based on specific equipment selected for this contract in accordance with NIST SP 800-82 and NIST FIPS 201-2.

3.1.2.2 Security Assessment Plan

In eMASS, initiate the Security Assessment Plan (SAP) Workflow. Track development and approval of the SAP by the Government. Provide information as necessary to complete the SAP.

3.1.2.3 Security Plan

In eMASS, initiate the Security Plan (SP) Approval Workflow. Track the review of the SP by the Government.

3.1.2.4 Ports, Protocols, And Services Management Registration Form

Obtain a Ports, Protocols, and Services Management Registration Form from https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-08-11-00-20 and fill it out with project specific information following DODI 8551.01.

3.1.2.5 RMF Step 2 eMASS Uploads

Upload the following artifacts into eMASS:

a. Cybersecurity Riser Diagrams from UFGS 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

b. Completed Control System Inventory Report from UFGS 25 05 11

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

c. Completed Cybersecurity Interconnection Schedule from UFGS 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

d. Ports, Protocols, and Services Management Registration Form

e. Control System Cybersecurity Documentation from UFGS 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

3.1.2.6 RMF Step 2 Checkpoint Meeting

Attend the RMF Step 2 Checkpoint Meeting.

3.1.3 RMF Step 3: Implement Controls

3.1.3.1 Security Control Implementation

In eMASS, initiate the Security Control Implementation Workflow.

3.1.3.2 Security Testing

Execute the Security Assessment Plan (SAP)

3.1.3.3 ACAS Vulnerability Scans

Conduct ACAS vulnerability scans. Generate summary and detailed ACAS Vulnerability Reports in accordance with NAVFAC FRCS AA ACAS Scan Policy Settings.

Remediate/Mitigate all discovered findings, especially high risk prior to RMF Step 4.

Generate and upload the scan summary and detailed vulnerability list into eMASS as an artifact.

Map ACAS vulnerability findings to the most appropriate CCI in the security control baseline. Upload ACAS Scan results as an artifact to eMASS Asset manager at the AP/CCI Level and add justifying statements for any non-compliance.

3.1.3.4 Security Content Automation Protocol (SCAP) Report

Complete the SCAP XCCDF XML and SCAP Report PDF/HTML files

3.1.3.5 Security Technical Implementation Guide Checklists

Apply the Security Technical Implementation Guide Checklists (STIGs) as identified in the Security Assessment Plan.

Utilize Security Content Automation Protocol (SCAP) Scans to supplement the STIG checklist where applicable.

Map STIG findings to all CCIs identified for that particular finding according to the STIG guidance. Fully document the CKL files. Utilizing Asset Manager to import the checklists into eMASS.

3.1.3.6 POA&M

Document open (non-compliant remaining findings in the Plan of Action and Milestones (POA&M) within eMASS either manually or through the use of Asset Manager in eMASS.

3.1.3.7 ISSE Checklist (Step 3)

Complete the NAVFAC FRCS RMF Step 3 and 4 ISSE Checklist.

3.1.3.8 RMF Step 3 eMASS Uploads

Upload the following artifacts into eMASS:

a. SCAP benchmark XCCDF XML and SCAP Report (utilizing Asset Manager)

b. Fully documented STIG Checklists (utilizing Asset Manager)

c. ACAS Scans/reports (utilizing Asset Manager)

d. ISSE Checklist (Step 3)

3.1.4 RMF Step 4: Validate Controls

3.1.4.1 Security Control Accessor - Validator (SCA-V) Site Assessment

Ensure the control system(s) are ready for an assessment.

Schedule the Validator site assessment coordinating the schedules of the Validator and all control system subject matter experts.

Ensure supplier/installer and other control system subject matter experts are available at the discretion of the validator to support the assessment.

3.1.4.2 Security Assessment Workflow

Re-initiate the Security Assessment Plan Workflow in eMASS.

Submit all security controls in eMASS for Validator review.

3.1.4.3 ISSE Checklist (Step 4)

Update previously submitted NAVFAC FRCS RMF Step 3 and 4 ISSE Checklist and upload it into eMASS.

3.1.4.4 Validation Findings

Remediate/mitigate Validator findings and update the Security Assessment Report (SAR) and POA&M accordingly.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-25 10 10 (February 2019)**
Change 1 - 05/21

Preparing Activity: USACE **Superseding**
UFGS-25 10 10 (November 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 25 10 10

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USACE / NAVFAC / AFCEC **UFGS-25 10 10 (February 2019)**
Change 1 - 05/21

Preparing Activity: USACE **Superseding**
UFGS-25 10 10 (November 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 25 10 10

UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION

02/19, CHG 1: 05/21

****
NOTE: This guide specification covers the requirements for a Utility Monitoring and Control System (UMCS) Front End using Open protocols (LonWorks, BACnet, Modbus, DNP and OPC), a UMCS using the Niagara Framework, and the integration of field control systems.

This specification includes tailoring options to select the protocol(s) required to be supported at the Monitoring and Controls Software (Front-end). Note that unselected protocols can be integrated through the use of a gateway.

This guide specification also includes tailoring options for service-specific requirements for the Air Force, Army and Navy as well as a "Service Generic" tailoring option for use on other projects. In order for this specification to be properly tailored one (and only one) of the services tailoring options (Air Force, Army, Navy, Service Generic) must be selected.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**. CCRs for this specification can be submitted through the Whole Building Design Guide page for this section:**
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-
****

PART 1   GENERAL

****

NOTE: Use of this UFGS, and the UMCS design, must be in accordance with UFC 3-470-01 Utility Monitoring and Control System (UMCS) Front End and Integration. The release process for UFCs is longer than for UFGS. Once released UFC 3-470-01 will be available online at
http://www.wbdg.org/

Note that the previous (outdated) version of the UFC contains "LonWorks" in the title and should not be used.

Template Points Schedules in electronic format for use with this section are available online at the Whole Building Design Guide page for this section:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-

****

****

NOTE: NOTE ON THE USE OF THIS SECTION WITH OTHER SECTION. When using this Section on the same project with specifications for building control systems (Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS) there may requirements that appear at first to be conflicting but which are actually designed to be complementary.

For example, Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC excludes a front end while this section (Section 25 10 10) requires a front end - this is to avoid getting multiple front ends.

****

****

NOTE: This specification makes use of SpecsIntact Tailoring Options. This note describes these options and how to use them.

"TAILORING OPTION NOTES" Tailoring Option
Each time tailoring options are used there is an accompanying designer note describing the text that is tailored. As this Section makes heavy use of tailoring options there are many of these notes and they can distract from designer notes describing other decisions. The designer notes describing tailoring options are all in a "TAILORING OPTION NOTES" tailoring option which can be hidden (in SpecsIntact select View-Tailoring Options and then deselect "TAILORING OPTION NOTES") once this section is tailored and the tailoring option notes are no longer needed.

Protocol Tailoring Options

This specification includes tailoring options for selection of protocol, and whether the Niagara Framework is required. There are five tailoring options:

1) **BACNET: A (non-Niagara Framework) BACnet front end (using a BACnet B-AWS)**

2) **LONWORKS: A LonWorks front end using LNS.**

3) **NIAGARA FRAMEWORK: A Niagara Framework front end**

4) **MODBUS: The front end must also support the MODBUS protocol.**

5) **OPC: The front end must also support OPC.**

In general, it is recommended that only one of BACNET, LONWORKS or NIAGARA FRAMEWORK be selected. It is also recommended neither MODBUS and OPC be selected with BACNET.

You have currently selected the following options:

BACNET
LONWORKS
NIAGARA FRAMEWORK
MODBUS
OPC

If you don't see any text between dashes above, you have deselected all of the protocol tailoring options and this specification is not valid. Select at least one of the tailoring options.

If you see more than one line of text between the dashes above you have left multiple tailoring options related to protocol selected. This may result in conflicting requirements. See UFC 3-470-01 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION to determine if one or more tailoring options should be deselected.

Service Tailoring Option

This specification also includes tailoring options for the Service (Air Force, Army, Navy) the specification is used for. There is a "Service Generic" tailoring option that can also be used. Only ONE of the four tailoring options related to the services should be used. You have currently selected the following options:

AIR FORCE
ARMY
NAVY
SERVICE GENERIC

If more than one item appears between the dashes above you have left more than one services tailoring options selected and need to deselect all but one of them.
****

****
NOTE: WARNING - The BACNET tailoring option has been selected with another protocol tailoring option (LONWORKS, MODBUS, NIAGARA FRAMEWORK). As described in UFC 3-470-01, many of the Monitoring and Control Software packages which support BACnet support ONLY BACnet, so the inclusion of other protocol tailoring options may unnecessarily limit the number of vendors able to provide the UMCS. The need for supporting multiple protocols at the Monitoring and Control Software should be verified/checked with the project site. Note that any protocol can be integrated to the UMCS with the use of a gateway, so omitting a tailoring option does not prohibit the integration of systems using that protocol.

See UFC 3-470-01 for more information.
****

****
NOTE: WARNING - The NIAGARA FRAMEWORK tailoring option has been selected with the LONWORKS tailoring option. As described in UFC 3-470-01, LNS-based LonWorks (required by the LONWORKS tailoring option) is generally not compatible with the Niagara Framework.
****

1.1 SUMMARY

****
NOTE: Designer must add location and site specific requirements.
****

****
NOTE: This subpart uses tailoring options:

The sentence referring to only UFGS 23 09 23.01 will be included if the LONWORKS tailoring options is selected.

The sentence referring to only UFGS 23 09 23.02 will be included if the BACNET tailoring option is selected.

The sentence referring to both UFGS 23 09 23.01 and UFGS 23 09 23.02 will be included if the NIAGARA FRAMEWORK tailoring option is selected.
****

Provide a Utility Monitoring and Control System (UMCS) which performs supervisory monitoring and supervisory control of base-wide building control systems and utility control systems using one or more of: CEA-709.1-D (LonWorks) with LonWorks Network Services (LNS), ASHRAE 135 (BACnet), MODBUS Protocol, MODBUS TCP/IP, OPC DA, or the Niagara Framework with Fox protocol as indicated and shown. Integrate CEA-709.1-D field control systems installed per Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS into the UMCS as specified and maintain the LNS database(s) for the entire network at the UMCS Front End. Integrate field control systems installed per Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS to the UMCS via Niagara Framework Supervisory Gateways as specified. Integrate ASHRAE 135 (BACnet) field control systems installed per Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS as specified.

1.1.1 System Requirements

****

NOTE: Select the appropriate text in the type specific communication system requirements to indicate whether or not the IP network will be Government furnished. If the IP network is *not* Government furnished be sure to include complete requirements for the IP network in the contract package. This specification does not provide sufficient requirements for the procurement of an IP network.

Use "[an IP network as specified in [_____] and]" only if the contractor is expected to install an IP network. In this case provide the information on the specification for the IP network in the "[_____]" provided.

For Army, coordinate with the installation (DPW and NEC) but the default selection will be "[the Government furnished IP network]"

****

Provide a UMCS as specified and indicated, and in accordance with the following characteristics:

1.1.1.1 General System Requirements

a. The system performs supervisory monitoring and control functions including but not limited to Scheduling, Alarm Handling, Trending, Overrides, Report Generation, and Electrical Demand Limiting as specified.

b. The system includes a Graphical User Interface which allows for graphical navigation between systems, graphical representations of systems, access to real-time data for systems, ability to override points in a system, and access to all supervisory monitoring and control functions.

c. All software used by the UMCS and all software used to install and configure the UMCS is licensed to and delivered to the installation.

d. All necessary documentation, configuration information, configuration tools, programs, drivers, and other software is licensed to and otherwise remains with the Government such that the Government or their agents are able to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor. Software licenses must not require periodic fees and must be valid in perpetuity.

e. Provide sufficient documentation and data, including rights to documentation and data, such that the Government or their agents can execute work to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor.

f. The UMCS interfaces directly to ASHRAE 135, CEA-709.1-D, MODBUS Protocol, MODBUS TCP/IP, OPC DA, and Niagara Framework field control systems as specified and may interface to field control systems using other protocols via an M&C Software protocol driver or a Gateway.

g. For UMCS systems with Monitoring and Control Software functionality implemented in Monitoring and Control (M&C) Controller Hardware, provide sufficient additional controller hardware to support the full capacity requirements as specified.

****

NOTE: The following TWO list paragraphs are included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

h. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license.dat file:

```
accept.station.in="*"
accept.station.out="*"
accept.wb.in="*"
accept.wb.out="*"
```

****

NOTE: Select the required version of the Niagara Framework. This choice must be carefully coordinated with the project site.

Niagara Framework is currently (2015) in a transition between two releases: "AX" and "Version 4". A Version 4 UMCS front end (e.g. as specified in Section 25 10 10) will work with either an AX or Version 4 Niagara Framework Supervisory Gateway, but an AX front end will ONLY work with an AX Niagara Framework Supervisory Gateway.

If this Section is being used to procure a new front end AND sufficient local support for Version 4 exist, keep the bracketed text to require Version 4. Otherwise, if this section is being used for integration OR if there is insufficient local support to allow requiring Version 4 remove the

bracketed text allow either Version 4 or AX.
****

[i. The version of Niagara Framework used on this project must be Version 4.0 or later.]

1.1.1.2 LonWorks Requirements

****
NOTE: This subpart is only included when the LONWORKS tailoring option is selected.
****

a. The UMCS must communicate using CEA-709.1-D over [the Government furnished IP network] [an IP network as specified in [_____] and][the Navy PSNet] in accordance with CEA-852-C as specified and must interface to CEA-709.1-D building control networks using LonWorks/IP Routers as specified.

b. All communication between the UMCS and LonWorks field control networks must be via the CEA-709.1-D protocol over the IP network in accordance with CEA-852-C.

c. Except for communication for device commissioning, configuration, and programming, all communication between the M&C Software and the field control system devices must be via SNVT.

1.1.1.3 BACnet Requirements

****
NOTE: This subpart is only included when the BACNET tailoring option is selected.

In addition, the reference to the Navy PSNet is included only when the NAVY tailoring option is selected.
****

a. The UMCS must communicate using ASHRAE 135 Annex J over [the Government furnished IP network][an IP network as specified in [_____] and][the Navy PSNet] as specified.

b. All communication between the UMCS and ASHRAE 135 field control networks must be via the ASHRAE 135 protocol over the IP network.

c. All communication between the M&C Software and the field control system devices must be via standard ASHRAE 135 services other than PrivateTransfer and ConfirmedPrivateTransfer except as follows:

    (1) PrivateTransfer and ConfirmedPrivateTransfer may be used for device configuration and device programming.

    (2) PrivateTransfer and ConfirmedPrivateTransfer may be used for communication between the M&C Software and the field control system if and only if both the M&C Software and the field control system devices automatically (without requiring reconfiguration) revert to the use of other standard ASHRAE 135 services when one of the components is modified or replaced.

1.1.1.4 Modbus Requirements

****

NOTE: This subpart is included only when the MODBUS tailoring option is selected.

In addition, the reference to the Navy PSNet is included only when the NAVY tailoring option is selected.

****

The UMCS must communicate using MODBUS Protocol, MODBUS TCP/IP over [the Government furnished IP network] [an IP network as specified in [_____] and][the Navy PSNet] as specified.

Modbus communications must support all of the following Modbus data types:

****

NOTE: FYI - the four standard data types in Modbus are:
1) Discrete Input - a single bit (read only)
2) Coil - a single bit
3) Input Register - 16 bit (read only)
4) Holding Register - 16 bit

The Modbus standard does not define how the data is interpreted. For example it does not say if the 16 bits from a Holding register are 16 different binary flags, or an integer, or two ASCII characters or something else entirely. The below requirements specify how to format data for some common data types.

****

a. The four standard data types defined by MODBUS Protocol, MODBUS TCP/IP: Discrete Inputs, Coils, Input Registers, and Holding Registers. (Note that these four data types are included in the MODBUS Protocol, MODBUS TCP/IP standard. The remaining data types indicated in this Section are not included in the MODBUS Protocol, MODBUS TCP/IP standard but are defined by this Section to provide a standard for communication between systems.)

b. Character: Character data using a single Input Register or single Holding Register where that Modbus register is interpreted as two 8 bit ISO 8859-1 characters, with the low order bits representing the right-hand character.

c. Floating Point: Floating point data using two consecutive Input Registers or two consecutive Holding Registers where the resulting 32 bits are interpreted as a Binary32 (Single Precision Floating point) number as specified in IEEE 754. Use the first Register for the higher 16 bits, and the second Register for the lower 16 bits.

d. Integer Date: Date data using three consecutive Input Registers or three consecutive Holding Registers where the resulting 48 bits are interpreted as a 48-bit unsigned big-endian integer. The value is the number of milliseconds, not including leap seconds, from 1970-01-01T00:00:00.000 (12AM, January 1, 1970). Use the first Register for the highest 16 bits and the third Register for the lowest

16 bits.

e. Character Date: Date data using the format specified in ISO 8601 of "YYYY-MM-DDTHH:MM:SS.SSS", where the individual characters are formatted as specified for character data.

1.1.1.5 OPC Requirements

****

NOTE: This subpart is included only when the OPC tailoring option is selected.

****

The UMCS must communicate using OPC DA over [the Government furnished IP network] [an IP network as specified in [_____] and][the Navy PSNet] as shown and specified.

1.1.1.6 Niagara Framework Requirements

****

NOTE: This subpart is included only when the NIAGARA FRAMEWORK tailoring option is selected.

In addition, this subpart used services tailoring options:
1) the reference to the Navy PSNet is included only when the NAVY tailoring option is selected.
2) The HTTP requirement is bracketed when the AIR FORCE, ARMY or SERVICE GENERIC tailoring options are selected.

****

****

NOTE: For the Navy, keep the bracketed text "and HTTP".

For other services keep the bracketed text "and HTTP" if the Niagara Framework Supervisory Gateways will be permitted to serve web pages. Remove the bracketed text "and HTTP" otherwise.

In general, for the Army remove the "and HTTP" text.

****

The UMCS must use the Niagara Framework and must communicate with Niagara Framework field control systems using the Fox protocol[and HTTP] over [the Government furnished IP network] [an IP network as specified in [_____] and][the Navy PSNet] as indicated and specified.

1.1.2 Symbols, Definition and Abbreviations

Use symbols, definitions, and engineering unit abbreviations indicated in the contract drawings for displays, submittals and reports. For symbols, definitions and abbreviations not in the contract drawings use terms conforming at a minimum to IEEE Stds Dictionary and the ASHRAE FUN SI ASHRAE FUN IP, as applicable.

1.1.3 System Units and Accuracy

****

NOTE: Accuracy of calculations and precision and resolution of displays for the UMCS is specified in terms of the accuracy of the sensors used in the building controls connected to the UMCS. Edit the brackets to indicate a reference to UFGS 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC to reference a different specification, or to include accuracy requirements.

****

Use [metric (SI)] [English (inch-pound)] units for displays, print-outs and calculations. Perform calculations with an accuracy of at least three significant figures. For displays and printouts present values to at least three significant figures.

1.1.4 Data Packages/Submittals Requirements

****

NOTE: Coordinate the review of all submittals with the project site. The site may have a System Integrator or other individual/office that should review all submittals before acceptance of the system.

The acquisition of all technical data, data bases and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Defense Acquisition Regulation Supplement (DFARS). Those regulations as well as the Services implementations thereof should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost. Specifically, DFARS 252.227-7013 Rights in Technical Data - Noncommercial Items as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS.

In addition, the appropriate DD Form 1423 Contract Data Requirements List, will be filled out for each distinct deliverable data item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, will be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to ensure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government.

Include with the request for proposals a completed DD Form 1423, Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified, both description and quantity being required.

****

Technical data packages consisting of computer software and technical data (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered shop drawings under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and must be delivered with unrestricted rights.

1.2 RELATED SECTIONS

****

NOTE: If Section 25 05 11 has been renumbered and/or renamed use the blank brackets to indicate the appropriate section, otherwise keep the reference to Section 25 05 11.

****

Cybersecurity requirements related to this Section are specified in a separate cybersecurity specification derived from UFGS 25 05 11. Section [25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS][____] specifies cybersecurity requirements related to this Section.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID (Reference ID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI INCITS 154	(1988; R 2004) Office Machines and Supplies - Alphanumeric Machines -

Keyboard Arrangement

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks
ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition
ASHRAE FUN SI	(2021) Fundamentals Handbook, SI Edition

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification
CEA-709.3	(1999; R 2015) Free-Topology Twisted-Pair Channel Specification
CEA-852-C	(2014) Tunneling Device Area Network Protocols Over Internet Protocol Channels

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 754	(2008) Floating-Point Arithmetic - IEEE Computer Society
IEEE 802.11	(2020; BD 2022) Information Technology-Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks - Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 3: Wake-Up Radio Operation
IEEE 1815	(2015; CORR 2016) Exchanging Information Between Networks Implementing IEC 61850 and IEEE Std 1815 [Distributed Network Protocol (DNP3)]
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8601	(2004) Data Elements and Interchange Formats - Information Interchange - Representation of Dates and Times

ISO 8859-1	(1998) Information Technology - 8-Bit Single-Byte Coded Graphic Character Sets - Part 1: Latin Alphabet No. 1

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 4361	(2006) Node-specific Client Identifiers for Dynamic Host Configuration Protocol Version Four (DHCPv4)
IETF RFC 7465	(2015) Prohibiting RC4 Cipher Suites
RFC 821	(2001) Simple Mail Transfer Protocol (SMTP)

LONMARK INTERNATIONAL (LonMark)

LonMark Interoperability Guide	(2005) LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4
LonMark SNVT List	(2014) LonMark SNVT Master List; Version 15
LonMark XIF Guide	(2001) LonMark External Interface File Reference Guide; Revision 4.402

MODBUS ORGANIZATION, INC (MODBUS)

MODBUS Protocol	(2012) Modbus Application Protocol Specification; Version 1.1b3
MODBUS TCP/IP	(2006) Modbus Messaging on TCP/IP Implementation Guide; Version V1.0b

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 262	(2023) Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

OPC FOUNDATION (OPC)

OPC DA	(Ver 3.0; Errata) OPC Data Access (DA)

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure

TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

TRIDIUM, INC (TRIDIUM)

Niagara Framework	(2021) NiagaraAX User's Guide
Tridium Open NiCS	(2021) Understanding the NiagaraAX Compatibility Statement (NiCS)

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC EMC	(2002) FCC Electromagnetic Compliance Requirements
FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 1778	(2014; Reprint Apr 2023) UL Standard for Safety Uninterruptible Power Systems
UL 60950	(2000; Reprint Oct 2007) Safety of Information Technology Equipment

1.4 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in this Section but are included here for completeness. Some terms are followed with a protocol reference in parenthesis indicating to which protocol the term and definition applies. Inclusion of protocol-specific definitions does not create a requirement to support that protocol, nor does it relax any requirements to support specific protocols as indicated elsewhere in this section.

1.4.1 Alarm Generation

The process of comparing a point value (the point being alarmed) with a pre-defined alarm condition (e.g. a High Limit) and performing some action based on the result of the comparison.

1.4.2 Alarm Handling

see Alarm Routing

1.4.3 Alarm Routing

Alarm routing is M&C software functionality that starts with a notification that an alarm exists (typically as the output of an Alarm Generation process) and sends a specific message to a specific alarm recipient or device.

1.4.4 Application Generic Controller (AGC)(LonWorks)

A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable Controller (GPPC).

1.4.5 Application Specific Controller (ASC)(LonWorks)

A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

1.4.6 BACnet (BACnet)

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall technology related to the ASHRAE 135 protocol.

1.4.7 BACnet Advanced Application Controller (B-AAC)(BACnet)

A hardware device BTL Listed as a B-AAC. A control device which contains BIBBs in support of scheduling and alarming but otherwise has limited resources relative to a B-BC. It may be intended for specific applications and supports some degree of programmability.

1.4.8 BACnet Advanced Operator Workstation (B-AWS)(BACnet)

Monitoring and Control (M&C) Software BTL Listed as an Advanced Operator Workstation and includes the ability to manage scheduling, alarming and trending in an open manner. The B-AWS is the advanced operator's window into a BACnet system. It is primarily used to monitor the performance of a system and to modify parameters that affect the operation of a system.

1.4.9 BACnet Application Specific Controller (B-ASC)(BACnet)

A hardware device BTL Listed as a B-ASC. A controller with limited resources relative to a B-AAC. It is intended for use in a specific application and supports limited programmability.

1.4.10 BACnet Building Controller (B-BC)(BACnet)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

1.4.11 BACnet Internetwork (BACnet)

Two or more BACnet networks connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

1.4.12 BACnet Interoperability Building Blocks (BIBBs) (BACnet)

A BIBB is a collection of one or more BACnet services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by an M&C client, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

1.4.13 BACnet Operator Display (B-OD)(BACnet)

A hardware device BTL Listed as a B-OD. A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. The B-OD profile could be used for wall-mounted LCD devices, displays affixed to BACnet devices; hand-held terminals or other very simple user interfaces.

1.4.14 BACnet Operator Workstation (B-OWS)(BACnet)

Monitoring and Control (M&C) Software BTL Listed as a B-OWS. An operator interface with limited capabilities relative to a B-AWS. The B-OWS is used for monitoring and basic control of a system, but differs from a B-AWS in that it does not support configuration activities, nor does it provide advanced troubleshooting capabilities.

1.4.15 BACnet Smart Actuator (B-SA)(BACnet)

A hardware device BTL Listed as a B-SA. A simple control output device with limited resources; it is intended for specific applications.

1.4.16 BACnet Smart Sensor (B-SS)(BACnet)

A hardware device BTL Listed as a B-SS. A simple sensing device with very limited resources.

1.4.17 BACnet Testing Laboratories (BTL)(BACnet)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

1.4.18 BACnet Testing Laboratories (BTL) Listed (BACnet)

A device that has been certified by BACnet® Testing Laboratory. Devices may be certified to a specific device profile, in which case the certification indicates that the device supports the required capabilities for that profile, or may be certified as "other".

1.4.19 Binary

A two-state system or signal; for example one where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.4.20 Binding (LonWorks)

The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that information is automatically (and regularly) sent without being requested by the recipient.

1.4.21 Broadcast

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.4.22 Building Control Network (BCN)

The network used by the Building Control System. Typically the BCN is a BACnet ASHRAE 135 or LonWorks CEA-709.1-D network installed by the building control system contractor.

1.4.23 Building Control System (BCS)

One type of Field Control System. A control system for building electrical and mechanical systems, typically HVAC (including central plants) and lighting. A BCS generally uses Direct Digital Control (DDC) Hardware and generally does NOT include its own local front end.

1.4.24 Building Point of Connection (BPOC)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware)

1.4.25 Channel (LonWorks)

A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

1.4.26 Commandable (BACnet)

A point (Object) is commandable if its Present_Value Property is writable and it supports the optional Priority_Array Property. This functionality is useful for Overrides.

1.4.27 Configuration Property (LonWorks)

Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see 'Standard Configuration Property Type (SCPT)'

1.4.28 Control Logic Diagram

A graphical representation of control logic for multiple processes that make up a system.

1.4.29 Device Object (BACnet)

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object_Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

1.4.30 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices.

1.4.31 External Interface File (XIF) (LonWorks)

A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.

1.4.32 Field Point Of Connection (FPOC)

The FPOC is part of the UMCS IP network and acts as the point of connection between the UMCS IP Network and the field control IP network. The FPOC is an IT device such as a switch, IP router, or firewall, typically managed by the site IT staff. (Note that the field control IP network may consist of a single IP device, or that integration may require installation of a field control network IP device.)

1.4.33 Field Control Network

The network used by a field control system.

1.4.34 Field Control System (FCS)

A building control system or utility control system.

1.4.35 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911

1.4.36 Functional Profile (LonWorks)

A standard description, defined by LonMark International, of a LonMark Object used to classify and certify devices.

1.4.37 Gateway

A device that translates from one protocol to another. Devices that change only the transport mechanism of the protocol - "translating" from LonWorks over TP/FT-10 to LonWorks over IP for example - are not gateways as the underlying protocol (data format) does not change. Gateways are also called Communications Bridges or Protocol Translators.

1.4.38 General Purpose Programmable Controller (GPPC) (LonWorks)

Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.

1.4.39 Internetwork (BACnet)

See BACnet Internetwork.

1.4.40 JACE (Niagara Framework)

Java Application Control Engine. See Niagara Framework Supervisory Gateway

1.4.41 LonMark Object (LonWorks)

A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).

1.4.42 LNS Plug-in (LonWorks)

Software which runs in an LNS compatible software tool, typically a network configuration tool. Device configuration plug-ins provide a 'user friendly' method to edit a device's configuration properties.

1.4.43 LonMark (LonWorks)

See LonMark International. Also, a certification issued by LonMark International to CEA-709.1-D devices.

1.4.44 LonMark International (LonWorks)

Standards committee consisting of independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.

1.4.45 LonWorks (LonWorks)

The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.

1.4.46 LonWorks Network Services (LNS) (LonWorks)

A network management and database standard for CEA-709.1-D devices.

1.4.47 LonWorks Network Services (LNS) Database (LonWorks)

The standard database created and used by LonWorks Network Services (LNS) compatible tools, such as LNS Network Configuration tools.

1.4.48 Modbus

A basic protocol for control network communications generally used in utility control systems. The Modbus protocol standard is maintained by The Modbus Organization.

1.4.49 Master-Slave/Token Passing (MS/TP)(BACnet)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

1.4.50 Monitoring and Control (M&C) Software

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.51 Network (BACnet)

In BACnet, a portion of the control internetwork consisting of one or more segments of the same media connected by repeaters. Networks are separated by routers.

1.4.52 Network Variable (LonWorks)

See 'Standard Network Variable Type (SNVT)'.

1.4.53 Network Configuration Tool (LonWorks)

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.4.54 Niagara Framework

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.4.55 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-browser based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include "EC-BOS", "FX-40", and "UNC".

1.4.56 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.4.57 Node Address (LonWorks)

The logical address of a node on the network, consisting of a Domain number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during installation and is unique within a subnet. This is not the factory-set unique Node ID (see Node ID).

1.4.58 Node ID (LonWorks)

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.

1.4.59 Object (BACnet)

A BACnet Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

1.4.60 Override

To change the value of a point outside of the normal sequence of operation where this change has priority over the sequence. An override can be accomplished in one of two ways: the point itself may be Commandable and written to with a priority or there may be a separate point on the controller for the express purpose of implementing the override.

Typically this override is from the Utility Monitoring and Control System (UMCS) Monitoring and Control (M&C) Software. Note that this definition is not standard throughout industry.

1.4.61 Point, Calculated

A value within the M&C Software that is not a network point but has been calculated by logic within the software based on the value of network points or other calculated points. Calculated points are sometimes called virtual points or internal points.

1.4.62 Point, Network

A value that the M&C Software reads from or writes to a field control network.

1.4.63 Polling

A requested transmission of data between devices, rather than an unrequested transmission such as Change-Of-Value (COV) or Binding where data is automatically transmitted under certain conditions.

1.4.64 Program ID (LonWorks)

An identifier (number) stored in the device (usually EEPROM) that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and intended device usage.

1.4.65 Property (BACnet)

A BACnet Property - a data element associated with an Object. Different Objects have different Properties, for example an Analog Input Object has a

Present_Value Property (which provides the value of the underlying hardware analog input), a High_Limit Property (which contains a high limit for alarming), as well as other properties.

1.4.66 Protocol Implementation Conformance Statement (PICS)(BACnet)

A document, created by the manufacturer of a device, which describes which potions of the BACnet standard are implemented by a given device.

1.4.67 Repeater

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.68 Router (LonWorks)

A device that connects two channels and controls traffic between the channels by retransmitting signals received from one subnet onto the other based on the signal destination. Routers are used to subdivide a control network and to control bandwidth usage.

1.4.69 Router (BACnet)

A device that connects two or more BACnet networks and controls traffic between the networks by retransmitting signals received from one network onto another based on the signal destination. Routers are used to subdivide an internetwork and to control bandwidth usage.

1.4.70 Segment

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, a TP/FT-10 segment with locally powered devices is limited to 64 devices, and a BACnet MS/TP segment is limited to 32 devices.

1.4.71 Service (BACnet)

A BACnet Service. A defined method for sending a specific type of data between devices. Services are always defined in a Client-Server manner, with a Client initiating a Service request and a Server Executing the Service. Some examples are ReadProperty (a client requests a data value from a server), WriteProperty (a client writes a data value to a server), and CreateObject (a client requests that a server create a new object within the server device).

1.4.72 Service Pin (LonWorks)

A hardware push-button on a device which causes the device to broadcast a message containing its Node ID and Program ID. This broadcast can also be initiated via software.

1.4.73 Standard BACnet Object/Property/Service (BACnet)

BACnet Objects, Properties, or Services that are standard Objects, Properties, or Services enumerated and defined in ASHRAE 135. Clause 23 of ASHRAE 135 defines methods to extend ASHRAE 135 to non-standard or proprietary information. Standard BACnet Objects/Properties/Services specifically exclude any vendor specific extensions.

1.4.74 Standard Configuration Property Type (SCPT) (LonWorks)

Pronounced 'skip-it'. A standard format type (maintained by LonMark International) for Configuration Properties.

1.4.75 Standard Network Variable Type (SNVT) (LonWorks)

Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

1.4.76 Subnet (LonWorks)

Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also Node Address.

1.4.77 Supervisory Controller

A controller implementing a combination of supervisory logic (global control strategies or optimization strategies), scheduling, alarming, event management, trending, web services or network management. Note this is defined by use; many supervisory controllers have the capability to also directly control equipment.

1.4.78 Supervisory Gateway

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NOTE: This subpart uses tailoring options: The phrase ", such as a Niagara Framework Supervisory Gateway" is only included when the NIAGARA FRAMEWORK tailoring option is selectedT

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A device that is both a supervisory controller and a gateway, such as a Niagara Framework Supervisory Gateway.

1.4.79 TP/FT-10 (LonWorks)

A Free Topology Twisted Pair network (at 78 kbps) defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.

1.4.80 TP/XF-1250 (LonWorks)

A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10 networks.

1.4.81 UMCS Network

An IP network connecting multiple field control systems to the Monitoring and Control Software using one or more of: LonWorks (CEA-709.1-D and CEA-852-C), BACnet (ASHRAE 135 Annex J), MODBUS Protocol, MODBUS TCP/IP or

OPC DA.

1.4.82 User-defined Configuration Property Type (UCPT) (LonWorks)

Pronounced 'u-keep-it'. A Configuration Property format type that is defined by the device manufacturer.

1.4.83 User-defined Network Variable Type (UNVT) (LonWorks)

A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.4.84 Utility Control System (UCS)

One type of field control system. Used for control of utility systems such as an electrical substation, sanitary sewer lift station, water pump station, etc. Building controls are excluded from a UCS, however it is possible to have a Utility Control System and a Building Control System in the same facility, and for those systems to share components such as the FPOC. A UCS may include its own local front-end.

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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NOTE: Coordinate the review of all submittals with the project site. The site may have a Building Automation System (BAS) Manager or other individual/office that should review all submittals before acceptance of the system.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and TABLE 1: PROJECT SEQUENCING:

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NOTE: The submittals included in this guide specification are critical and require Government review. Any added submittals normally should be for information only and reviewed through the Contractor Quality Control system.
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SD-02 Shop Drawings

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NOTE: Either indicate drawing size, or leave both options to allow the contractor to decide.

When selecting format for electronic drawings coordinate with the project site. Be sure to require drawings in a format that is usable by the site maintenance staff. This may require including multiple format requirements here.

Indicate quantities for submittals.
****

UMCS Contractor Design Drawings; G, [_____]

UMCS Contractor Design Drawings as a single complete package: [_____] hard copies and [_____] copies on CDROM. Submit hardcopy drawings on [ISO A1 841 by 594 mm 34 by 22 inches][or][A3 420 by 297 mm 17 by 11 inches] sheets, and electronic drawings in both PDF and [AutoCAD][Microstation][Bentley BIM V8][Autodesk Revit 2013] format.

Draft As-Built Drawings; G, [_____]

Draft As-Built Drawings as a single complete package: [_____] hard copies and [_____] copies on CDROM. Submit hardcopy drawings must on [ISO A1 841 by 594 mm 34 by 22 inches][or][A3 420 by 297 mm 17 by 11 inches] sheets, and electronic drawings in both PDF and [AutoCAD][Microstation][Bentley BIM V8][Autodesk Revit 2013] format.

Final As-Built Drawings; G, [_____]

Final As-Built Drawings as a single complete package: [_____]

hard copies and [_____] copies on CDROM. Submit hardcopy drawings on [ISO A1 841 by 594 mm 34 by 22 inches][or][A3 420 by 297 mm 17 by 11 inches] sheets, and electronic drawings in both PDF and [AutoCAD][Microstation][Bentley BIM V8][Autodesk Revit 2013] format.

SD-03 Product Data

Product Data Sheets; G, [_____]

Computer Software; G, [_____]

The most recent versions of all computer software provided under this specification delivered as a Technical Data Package. Submit the user manuals for all software delivered for this project with the software.

Enclosure Keys; G, [_____]

SD-05 Design Data

UMCS IP Network Bandwidth Usage Estimate; G, [_____]

[Four][_____] copies of the UMCS IP Network Bandwidth Usage Estimate.

SD-06 Test Reports

Pre-Construction QC Checklist; G, [_____]

[Four] [_____] copies of the Pre-Construction QC Checklist.

Post-Construction QC Checklist; G, [_____]

[Four] [_____] copies of the Post-Construction QC Checklist.

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NOTE: If not requiring a Factory Test in PART 3 EXECUTION, remove the submittal requirements for Factory Test Procedures and Factory Test Report

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Factory Test Procedures; G, [_____]

[Four] [_____] copies of the Factory Test Procedures. The Factory Test Procedures may be submitted as a Technical Data Package.

Factory Test Report; G, [_____]

[Four] [_____] copies of the Factory Test Report. The Factory Test Report may be submitted as a Technical Data Package.

] Existing Conditions Report; G, [_____]

[Four] [_____] copies of the Existing Conditions Report.

Start-Up and Start-Up Testing Report; G, [_____]

[Four] [_____] copies of the Start-Up and Start-Up Testing Report. The Start-Up and Testing report may be submitted as a Technical Data Package.

PVT Phase I Procedures; G, [_____]

[Four] [_____] copies of the PVT Phase I Procedures. The PVT Procedures may be submitted as a Technical Data Package.

PVT Phase I Report; G, [_____]

[Four] [_____] copies of the PVT Phase I Report. The PVT Phase I Report may be submitted as a Technical Data Package.

PVT Phase II Report; G, [_____]

[Four] [_____] copies of the PVT Phase II Report. The PVT Phase II Report may be submitted as a Technical Data Package.

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, [_____]

[Four] [_____] bound O&M Instructions[and [_____] copies of the Instructions in PDF format on optical disc]. Index and tab bound instructions.[Submit instructions in PDF form as a single PDF file, or as multiple PDF files with a PDF file table of contents containing links to the other files.] O&M Instructions may be submitted as a Technical Data Package.

Preventive Maintenance Work Plan; G, [_____]

[Four] [_____] copies of the Preventive Maintenance Work Plan. The Preventive Maintenance Work Plan may be submitted as a Technical Data Package.

Basic Training Documentation; G, [_____]

Training manuals for Basic Training delivered for each trainee on the Course Attendance List with [two] [_____] additional copies delivered for archival at the project site. Submit [two] [_____] copies of the Course Attendance List with the archival copies. The Basic Training Documentation may be submitted as a Technical Data Package.

Advanced Training Documentation; G, [_____]

One set of training manuals delivered for each trainee on the Course Attendance List with [two] [_____] additional copies delivered for archival at the project site. Submit [two] [_____] copies of the Course Attendance List with the archival copies. The Advanced Training Documentation may be submitted as a Technical Data Package.

Refresher Training Documentation; G, [_____]

One set of training manuals delivered for each trainee on the Course Attendance List with [two] [_____] additional copies delivered for archival at the project site. Submit [two] [_____]

copies of the Course Attendance List with the archival copies. The Refresher Training Documentation may be submitted as a Technical Data Package.

SD-11 Closeout Submittals

Closeout QC Checklist; G, [_____]

[Four] [_____] copies of the Closeout QC Checklist.

1.6 PROJECT SEQUENCING

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NOTE: Table I provides bracketed text in which the number of days between items may be specified. In many cases this information will be specified elsewhere. When project schedule is specified elsewhere remove bracketed text and Table I will provide sequencing but not specific intervals. If time intervals are to be specified here keep the bracketed text and enter the number of days in the space provided.

****

TABLE I: PROJECT SEQUENCING specifies the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column).

1.6.1 Sequencing for Submittals

The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within [14] [_____] days of notification that the submittal has been rejected. Upon re-submittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

1.6.2 Sequencing for Activities

The sequencing specified for activities indicates the earliest the activity may begin.

1.6.3 Abbreviations

In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

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NOTE:
If requiring a Factory Test in PART 3 EXECUTION, keep "Acceptance of Factory Test Report" in the DESCRIPTION column for item 1. If NOT requiring a factory test keep "Notice to proceed" or edit to indicate other starting condition.

Complete TABLE I by entering the appropriate number of days in the spaces provided in the SEQUENCING column.

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NOTE: If this project includes work to be performed under Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, that work will need to be coordinated with, and in many cases will need to be completed before, work specified in this Section under paragraph "Integration of Field Control Systems".

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NOTE: This subpart uses tailoring options: The Certificate of Networthiness Documentation is only required for Army projects and is only included when the ARMY tailoring options is selected.

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TABLE I. PROJECT SEQUENCING

ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
1		[Acceptance of Factory Test Report][Notice to proceed][_____]	
2	S	Existing Conditions Report	[_____] days after #1
3	S	Design Drawings	[_____] days after #1
4	S	Product Data Sheets and Certificate of Networthiness Documentation	[_____] days after #1
5	S	UMCS IP Network Bandwidth Usage Estimate	[_____] days after #1
6	S	Pre-construction QC Checklist	[_____] days after #1
7	E	Install UMCS	AAO #2 thru #6
8	E	Start-Up and Start-Up Testing	ACO #7
9	S	Post-Construction QC Checklist	[_____] days ACO #8

TABLE I. PROJECT SEQUENCING

ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
10	S	Computer Software	[_____] days ACO #8
11	S	Start-Up and Start-Up Testing Report	[_____] days ACO #8
12	S	Draft As-Built Drawings	[_____] days ACO #8
13	S	PVT Phase I Procedures	[_____] days before scheduled start of #14 and AAO #11
14	E	PVT Phase I	AAO #13 and #12
15	S	PVT Phase I Report	[_____] days ACO #14
16	S	Preventive Maintenance Work Plan	AAO #11
17	S	O&M Instructions	AAO #11
18	S	Basic Training Documentation	AAO #11 and [_____] days before scheduled start of #19
19	E	Basic Training (PVT Phase II)	AAO #16, #17 and #18
20	S	PVT Phase II Report	[_____] days ACO #19
21	S	Final As-Built Drawings	[_____] days AAO #20
22	S	Advanced Training Documentation	[_____] days before schedule start of #23 and AAO #18
23	E	Advanced Training	ACO #19, [_____] days AAO #22, and no later than [60] days ACO #19
24	S	Refresher Training Documentation	[_____] days before #25 and AAO #18 and #22
25	E	Refresher Training	between [_____] and [_____] days ACO #19 and AAO #24
26	S	Closeout QC Checklist	ACO #23

1.7 QUALITY CONTROL (QC) CHECKLISTS

The Contractor's Chief Quality Control (QC) Representative must complete the QC Checklist in APPENDIX A, and must submit the Pre-Construction QC

Checklist, Post-Construction QC Checklist and Closeout QC Checklist as specified. The QC Representative must verify each item in the Checklist and initial in the provided area to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.[

The APPENDIX A QC Checklist is available as an editable file at http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-10-10.
]

1.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide UMCS Operation and Maintenance Instructions which include:

a. Procedures for the UMCS system start-up, operation and shut-down.

b. Final As-Built drawings.

c. Routine maintenance checklist, arranged in a columnar format: The first column listing all installed devices, the second column stating the maintenance activity or stating that no maintenance required, the third column stating the frequency of the maintenance activity, and the fourth column providing any additional comments or reference.

d. Qualified service organization list including points of contact with phone numbers.

e. Start-Up and Start-Up Testing Report.

f. Performance Verification Test (PVT) Procedures and Reports.

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

2.1.1 Product Certifications

For computing devices, as defined in FCC Part 15, supplied as part of the UMCS provide devices which are certified to comply with the requirements of Class B computing devices.

2.1.2 Product Sourcing

For units of the same type of equipment, provide products of a single manufacturer. For each major component of equipment provide equipment with the manufacturer's name and the model and serial number in a conspicuous place. For materials and equipment, provide new standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products.

2.1.3 General Requirements

Provide components that meet the following requirements:

****

NOTE: In particularly hot or cold environments, increase the temperature range requirements for equipment in unconditioned space

****

a. Portions of the data communications equipment system installed in unconditioned spaces must operate properly in an environment with ambient temperatures between [0 and 49] [_____] degrees C [32 and 120] [_____] degrees F and ambient relative humidity between 10 percent and 90 percent noncondensing.

b. Components must accept 100 to 125 volts AC (Vac), 60 Hz, single phase, three wire with a three-pronged, dedicated circuit outlet or be provided with a transformer to meet the component's power requirements.

c. The equipment must meet the requirements of NFPA 70, UL 60950, NFPA 262, FCC EMC, and FCC Part 15.

2.1.4 Nameplates

Provide nameplates of laminated plastic identifying the function, network address, if applicable, and identifier of the device. Laminated plastic must be at least 3 mm 0.125 inch thick, white with black center core. Nameplates must be a minimum of 25 by 75 mm 1 by 3 inch with minimum 6 mm 0.25 inch high engraved block lettering.

2.1.5 Product Data Sheets

****

NOTE: This subpart uses tailoring options: The sentence containing the PICS requirement is only included when the BACNET tailoring option is selected.

****

For all products (equipment) specified in PART 2 and supplied under this contract, submit copies of all manufacturer catalog cuts and specification sheets to indicate conformance to product requirements. For Monitoring and Control (M&C) Software also include the PICS verifying BTL Listing as a B-AWS.

2.2 CONTROL HARDWARE

2.2.1 Control Protocol Routers

2.2.1.1 LonWorks/IP Router

Provide LonWorks/IP Routers which perform layer 3 routing of CEA-709.1-D packets over an IP network in accordance with CEA-852-C. The router must provide the appropriate connection to the IP network and connections to the CEA-709.3 TP/FT-10 or TP/XF-1250 network. LonWorks/IP Routers must support the Dynamic Host Configuration Protocol (DHCP; IETF RFC 4361) for IP configuration and the use of an CEA-852-C Configuration Server (for CEA-852-C configuration), but must not rely on these services for configuration. LonWorks/IP Routers must be capable of manual configuration via a console RS-232 port.

2.2.1.2 BACnet/IP Router

****

NOTE: Include the bracketed text "[, or other ASHRAE 135]" as needed to allow for integration to non-MS/TP networks.

****

Provide BACnet/IP Routers which perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to a ASHRAE 135 MS/TP[, or other ASHRAE 135] network. Devices used as BACnet/IP Routers must be BTL Listed and must support the Network Management-Router Configuration-B (NM-RC-B) BIBB.

2.2.1.3 Modbus/IP Router

Provide Modbus/IP Routers which perform layer 3 routing of MODBUS Protocol/ MODBUS TCP/IP packets over an IP network in accordance with MODBUS Protocol/ MODBUS TCP/IP. The router must provide the appropriate connection to the IP network and connections to a non-IP MODBUS Protocol/MODBUS TCP/IP network. Modbus/IP Routers must support the Dynamic Host Configuration Protocol (DHCP; IETF RFC 4361) for IP configuration but must not rely on this service for configuration. Modbus/IP Routers must be capable of disabling the capability for remote configuration of Modbus routing information from the IP network.

2.2.2 Monitoring and Control (M&C) Controller Hardware

****

NOTE: This subpart uses tailoring options: "a Niagara Framework Supervisory Gateway" is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Provide Monitoring and Control (M&C) Controller Hardware which is a Niagara Framework Supervisory Gateway or a microprocessor-based direct digital control hardware and which communicates over the UMCS IP network using one of:

a. CEA-709.1-D in accordance with CEA-852-C and using only Standard Network Variable Types (SNVTs) as defined by the LonMark SNVT List.

b. ASHRAE 135 in accordance with ASHRAE 135 Annex J and using only Standard ASHRAE 135 services.

Monitoring and Control (M&C) Controller Hardware must either meet the requirements of the LonMark Interoperability Guide or be BTL Listed.

2.2.3 BACnet Supervisory Controller Hardware

****

NOTE: This subpart only applies to BACnet systems and is only included when the BACNET tailoring option is only included when the BACNET tailoring option is selected.

****

Provide BACnet Supervisory Controller Hardware which is direct digital control hardware and which:

a. is BTL Listed

b. communicates using ASHRAE 135 over an IP network in accordance with

ASHRAE 135 Annex J

c. has a configurable Object_Name Property

d. supports the following BIBBS

   (1) DS-RP-B (Data Sharing–Read Property–B) BIBB for Objects requiring read access from the M&C Software

   (2) DS-WP-B (Data Sharing–Write Property–B) BIBB for Objects requiring write access from the M&C Software.

   (3) SCHED-E-B (Scheduling-External-B)

   (4) AE-N-I-B (Alarm and Event-Notification Internal-B)

   (5) AE-ACK-B (Alarm and Event-ACK-B)

   (6) T-VMT-I-B (Trending-Viewing and Modifying Trends-Internal-B)

   (7) T-ATR-B (Trending-Automated Trend Retrieval-B)

e. has a Writable Recipient_List Property of the Notification Class Object

2.2.4 Control Protocol Gateways

****

NOTE: FYI: Except for the use of Niagara Framework Supervisory Gateways with Niagara Framework M&C Software, Gateways should be used only for the integration of legacy building control systems (HVAC, lighting etc) or for the integration of new or legacy utility control systems. Gateways should not be used to permit the installation of new building control systems which do not use,CEA-709.1-D or ASHRAE 135.

Indicate if additional capability may be required. Note that since the Legacy system should not change this requirement shouldn't be needed, and when used will normally be intended to cover the case of 'forgotten' points (when the mapping requirements from the legacy system have not been fully/properly identified). Requiring excess capacity may add cost.

****

****

NOTE: This subpart uses tailoring options. Fox Protocol is included in the protocol list only when the NIAGARA FRAMEWORK tailoring option is selected.

****

Provide Control Protocol Gateways which perform bi-directional protocol translation between two of the following protocols, or between one of the following protocols and another protocol: CEA-709.1-D, ASHRAE 135, MODBUS Protocol, MODBUS TCP/IP, Fox protocol, and OPC DA. Provide Control Protocol Gateways which also meet the following requirements.

a. Gateways must have two or more separate network connections, each appropriate for the protocol and media used. A single network connection must not be used for both protocols.

b. Gateways must be capable of being installed, configured and programmed through the use of instructions in the manual supplied by the Contractor.

c. Provide and license to the Government all software required for gateway configuration.

d. Gateways must retain their configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.

e. Gateways must provide capacity for mapping all required points as indicated[plus an additional [10 percent][_____]] between the two protocols it uses.

f. Gateways must, in addition, meet all requirements specified (in the following subparagraphs) for each of the two protocols it translates.

2.2.4.1 Gateway for CEA-709.1

For a gateways using CEA-709.1-D provide gateways which meet the following requirements in addition to the requirements for all gateways:

a. It must allow bi-directional mapping of data in the Gateway to Standard Network Variable Types (SNVTs) according to the LonMark SNVT List.

b. Gateways communicating CEA-709.1-D over an IP network must communicate in accordance with CEA-852-C.

c. It must allow of its standard network variables (SNVTs) and support transmitting data using the "min, max, and delta" (throttling and heartbeat) methodology.

d. It must provide the ability to label SNVTs.

e. It must supply a LonMark external interface file (XIF) as defined in the LonMark XIF Guide for use with LNS tools and utilities.

f. It must have a "service pin" which, when pressed, will cause the Gateway to broadcast its 48-bit NodeID and ProgramID over the network.

g. It must provide a configurable self-documenting string.

2.2.4.2 Gateway for ASHRAE 135

For gateways using ASHRAE 135 provide gateways which meets the following requirements in addition to the requirements for all gateways:

a. It must allow bi-directional mapping of data in the Gateway to Standard Objects as defined in ASHRAE 135.

b. All ASHRAE 135 Objects must have a configurable Object_Name Property.

c. It must be BTL Listed.

d. Gateways communicating ASHRAE 135 over an IP network must communicate in accordance with ASHRAE 135 Annex J.

****

NOTE: The following 2 requirements cover 2 ways in which the gateway can be used:

1) The gateway communicates with a BACnet building control system. In this case the gateway has to be able to read from and write to devices in the BACnet building control system.

2) The gateway communicates with a BACnet front-end (M&C Software). In this case the gateway must be able to be read from and be written to by the M&C Software. In addition, the gateway must provide scheduling, alarming and trending for the building system.

Note that it would be possible to have a BACnet-BACnet gateway that is used in both of these ways at the same time.

****

e. Gateways communicating ASHRAE 135 to a field control systems must support the DS-RP-A (Data Sharing–Read Property–A) BIBB and the DS-WP-A (Data Sharing–Write Property–A) BIBB.

f. Gateways communicating ASHRAE 135 to the M&C Software or to a BACnet Supervisory Controller must support the DS-RP-B (Data Sharing–Read Property–B) BIBB for Objects requiring read access from the M&C Software and the DS-WP-B (Data Sharing–Write Property–B) BIBB for Objects requiring write access from the M&C Software

2.2.4.3 Gateway for Modbus

****

NOTE: This subpart uses tailoring options. Requirements for the presentation of data in accordance with the MODBUS REQUIREMENTS paragraph is only included when the MODBUS tailoring option is selected.

****

For gateways that use MODBUS Protocol/MODBUS TCP/IP provide gateways that meet the requirements specified for all gateways and which allow bi-directional mapping of data in the Gateway to MODBUS Protocol/ MODBUS TCP/IP registers using the four standard Modbus register types (Discrete Input, Coil, Input Register,and Holding Register). Gateways communicating MODBUS Protocol/MODBUS TCP/IP to the M&C Software must communicate via MODBUS Protocol/MODBUS TCP/IP over TCP/IP and must present floating point values, character values, and date values using the appropriate data type as specified in paragraph MODBUS REQUIREMENTS.

2.2.4.4 Gateway for OPC

For gateways that use OPC DA, provide gateways that meet the requirements specified for all gateways and which allow bi-directional mapping of data in the Gateway using OPC DA tags and which communicate over an IP network in accordance with OPC DA.

2.2.4.5 Gateway for DNP3

For gateways that use DNP3, provide gateways that meet the requirements specified for all gateways and which allow bi-directional mapping of data in the Gateway to DNP3 object groups and variations as defined by IEEE 1815. Gateways communicating DNP3 over an IP network must communicate in accordance with the LAN/WAN Networking volume of IEEE 1815.

2.2.4.6 Niagara Framework Supervisory Gateway

****

NOTE: This subpart is only required for Niagara Framework systems, or for Navy Projects and is only included when the NIAGARA FRAMEWORK or NAVY tailoring option is selected.

****

****

NOTE: FYI - The Niagara Framework Supervisory Gateway is known by many names within industry, and this specification uses the name "Niagara Framework Supervisory Gateway" in order to remain vendor neutral. Probably the most common term used for this device in industry is a "Java Application Control Engine", or JACE.

****

Niagara Framework Supervisory Gateway Hardware must:

a. be direct digital control hardware.

b. have an unrestricted interoperability license and a Niagara Compatibility Statement (NiCS) that follows the Tridium Open NiCS Specification.

c. manage communications between a field control network and the Niagara Framework Monitoring and Control Software and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components.

d. be fully programmable using the Niagara Framework Engineering Tool and support the following:

    (1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects

    (2) Alarm generation and routing using the Niagara Alarm Service

    (3) Trending using the Niagara History Service and Niagara Trend Log Objects

    (4) Integration of field control networks using the Niagara Framework Engineering Tool

    (5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. meet the following minimum hardware requirements:

    (1) [One][Two] 10/100/1000 Mbps Ethernet Ports

    (2) One port compatible with the field control system to be integrated using this product.[

    (3) Central Processing Unit of 600 Mhz or higher.][

    (4) Embedded operating system.]

f. provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users

2.3 COMPUTER HARDWARE

****

NOTE: Coordinate with the project site to determine if the server(s) will be contractor supplied or Government Furnished. If Government Furnished remove the following bracketed text.

****

For computer hardware furnished under this specification provide standard products of a single manufacturer which advertises service in all 48 contiguous states, and provide only model currently in production. Except for PCI-E cards installed into expansion slots provided in a desktop or server computer in order to meet the requirements of this specification, do not modify computer hardware from the manufacturer configuration.

2.3.1 Server Hardware

****

NOTE: Coordinate with the project site to determine if the server(s) will be contractor supplied or Government Furnished.

If contractor supplied, coordinate with the Project Site's NEC (IT group) and include the sites 'standard' server redundancy requirements.

Note that computer technology changes quickly and these requirements should be edited to reflect current products. Default requirements (current as of 2012) have been provided in brackets.

****

Computer Server Hardware (server) [will be furnished by the Government] [must be a desktop or server computer meeting the following minimum requirements:]

[2.3.1.1 Processor

[_____][Quad-core processor designed for server applications. Processor speed must be at least 50 percent of the speed of the fastest Intel server processor commercially available].

2.3.1.2 Random Access Memory (RAM)

[_____][300 percent of the recommended requirements of the software to be installed on the server[and no less than 24GB].]

2.3.1.3 Communications Ports

[_____][Four USB ports.]

2.3.1.4 Hard Drives

2.3.1.4.1 Internal Hard Drives

[____][Hard drives with SATA-3 Controller providing at least [2TB][____] usable disk space. Hard drives must use RAID (Redundant Array of Inexpensive Disks) at levels 1 or 5 (RAID-1 or RAID-5).]

2.3.1.4.2 External Hard Drive

[____][[4TB][____] disk space with a USB 3.0 interface.]

2.3.1.5 Optical Drive

[____][Blueray burner drive.]

2.3.1.6 Video Output

[____][32-bit color at a minimum resolution of 1920 by 1080 at a minimum refresh rate of 70 Hz and a DVI or display port output.]

2.3.1.7 Network Interface

[____][[Two] integrated 1000Base-T Ethernet with RJ45 connector.]

2.3.1.8 Monitor

[____][Widescreen flat panel LCD monitor sized as indicated but no less than 24 inch nominal with a minimum resolution of 1600 by 1050 pixels and a minimum refresh rate of 70Hz.]

2.3.1.9 Keyboard

[____][101 key wired USB keyboard having a minimum 64 character standard ASCII character set based on ANSI INCITS 154 and an integral smart card reader compatible with a Department of Defense Common Access Card (CAC).]

2.3.1.10 Mouse

[____][2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.]

2.3.1.11 Power Supplies

[____][Hot-swappable redundant power supplies.]

]2.3.2 Workstation Hardware (Desktop and Laptop)

****

NOTE: Coordinate with the project site to determine

if the workstation(s) will be contractor supplied or Government Furnished, or a mix where some workstations are Gov't furnished and others are contractor supplied:

"Replace Brackets" instructions
1) Government furnished only : Keep first bracketed text and remove the [as indicated].

2) Contractor supplied only: Keep the second bracketed text.

3) Combination of Government furnished and Contractor supplied: Keep all bracketed text.

When keeping bracketed text (Contractor supplied or combination of Government and Contactor supplied) note that computer technology changes quickly and these requirements should be edited to reflect current products. Default requirements (current as of 2012) have been provided in brackets.
****

[The Government will provide the] [Provide a standard desktop computer or a laptop meeting the following minimum requirements for the] Computer Workstation Hardware (workstation) [as indicated].

[2.3.2.1 Processor

2.3.2.1.1 Desktop

Quad-core processor designed for desktop applications. Processor speed must be at least 75 percent of the speed of the fastest Intel desktop processor commercially available.

2.3.2.1.2 Laptop

Quad-core processor designed for laptop applications. Processor speed must be at least 50 percent of the speed of the fastest Intel laptop processor commercially available.

2.3.2.2 Random Access Memory (RAM)

[____][300 percent of the recommended requirements of the software to be installed on the server[and no less than 8GB].]

2.3.2.3 Communications Ports

2.3.2.3.1 Desktop

[____][Six USB ports.]

2.3.2.3.2 Laptop

[____][Two USB ports, plus a PCMCIA card slot or an additional USB port, plus an integral RS-232 serial port or an additional USB port and a USB to RS-232 serial adapter.]

2.3.2.4 Hard Drive and Controller

2.3.2.4.1 Desktop

[____][[1.5TB][____] or larger with a SATA-3 controller.]

2.3.2.4.2 Laptop

[____][[250GB][____] or larger solid state drive.]

2.3.2.5 Optical Drive

[____][DVD-RW drive]

2.3.2.6 Video Output

2.3.2.6.1 Desktop

[____][32-bit color with dual monitor support minimum resolutions of 1920 by 1080 at minimum refresh rates of 70 Hz and dual DVI or display port outputs.]

2.3.2.6.2 Laptop

[____][32-bit color with a minimum resolution of 1920 by 1080 at minimum refresh rates of 70 Hz and VGA or HDMI output.]

2.3.2.7 Network Interface

2.3.2.7.1 Desktop

[____][Integrated 1000Base-T Ethernet with RJ45 connector.]

2.3.2.7.2 Laptop

[____][Integrated 1000Base-T Ethernet with RJ45 connector and an integrated IEEE 802.11b/g/n wireless interface. The Laptop must have a physical switch for activation and deactivation of the wireless interface.]

2.3.2.8 Monitor

2.3.2.8.1 Desktop

[____][Dual widescreen flat panel LCD monitors sized as indicated but no less than600 mm 24 inch nominal with minimum resolutions of 1920 by 1080 pixels and a minimum refresh rate of 70Hz.]

2.3.2.8.2 Laptop

[____][LCD Screen sized as indicated but no less than 325 mm 13 inch nominal with a maximum supported resolution of no less than 1600 by 900 pixels.]

2.3.2.9 Keyboard and Smart Card Reader

2.3.2.9.1 Desktop

[____][101 key wired USB keyboard having a minimum 64 character standard ASCII character set based on ANSI INCITS 154 and an integral smart card reader compatible with a Department of Defense Common Access Card (CAC).]

2.3.2.9.2 Laptop

[____][Standard laptop keyboard. Internal smart card reader compatible with a Department of Defense Common Access Card (CAC).]

2.3.2.10 Mouse

2.3.2.10.1 Desktop

[____][2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.]

2.3.2.10.2 Laptop

[____][Integrated touch-pad plus a 2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.]

]2.3.3 Printers

Provide local or network printers as indicated. Provide local printers which have a USB interface. Provide network printers which have a 100Base-T or faster interface with an RJ45 connection and a firmware print spooler compatible with the Operating System print spooler.

2.3.3.1 Alarm Printer

Provide alarm printers which use sprocket-fed fanfold paper with adjustable sprockets for paper width up to 280 mm 11 inches. Alarm printers must have programmable control of top-of-form. [Provide floor stands with paper racks for alarm printers.]

2.3.3.2 Laser Printer

Provide laser printers as indicated meeting the following minimum requirements:

Resolution	600 by 600 dots per inch
Printing Time	10 pages per minute
Data Buffer Size	16 Megabytes
Media Type	Paper and transparency film
Media Size	ANSI A(216 by 279 mm 8.5 by 11 inches) and other sizes as indicated
Paper Cassette	250 sheet capacity

2.4 COMPUTER SOFTWARE

2.4.1 Operating System (OS)

****

NOTE: Coordinate with the project site to determine

if the OS license will be contractor supplied or Government Furnished.

****

****

NOTE: This subpart uses tailoring options to indicate the Gold Master version to use.

****

Provide the latest version of the Army [DISA][_____] Gold Master Windows Operating System. The Operating System media will be furnished by the Government. [Provide][The Government will provide] the Operating System license.

2.4.2 Office Automation Software

****

NOTE: Coordinate with the project site to determine if the Office Automation Software will be contractor supplied or Government Furnished.

****

[Provide Office Automation Software consisting of the [e-mail,] spreadsheet and word processing portions of the project site's standard office automation software.] [Office Automation Software will be furnished by the Government.]

2.4.3 Virus Protection Software

****

NOTE: Coordinate with the project site to determine if the Virus Protection Software will be contractor supplied or Government Furnished.

****

[Provide Virus Protection Software consisting of the project site's standard virus protection software complete with a virus definition update subscription] [Virus Protection Software will be furnished by the Government].

2.4.4 Disk Imaging (Backup) Software

****

NOTE: Coordinate with the project site to determine if the Disk Imaging (Backup) Software will be contractor supplied or Government Furnished.

****

[Provide Disk imaging (backup) software capable of performing a bare-metal restore (imaging and restoring to a new blank hard drive such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software).] [Provide Disk imaging (backup) software consisting of the project site's standard disk imaging software.] [Disk imaging (backup) software will be furnished by the Government.]

2.4.5 M&C Controller Hardware Configuration Software

Provide M&C Controller Hardware Configuration Software consisting of the software required to configure, program, or configure and program each Monitoring and Control (M&C) Controller Hardware provided for the functions it performs.

2.4.6 CEA-852-C Configuration Server

****
NOTE: This subpart only applies to LonWorks systems and is only included when the LONWORKS tailoring option is selected.
****

Provide CEA-852-C configuration server software meeting the requirements of CEA-852-C.

2.4.7 CEA-709.1-D Network Configuration Tool

****
NOTE: This subpart only applies to LonWorks systems and is only included when the LONWORKS tailoring option is selected..
****

Provide a network configuration tool software which:

a. Solely uses LonWorks Network Services (LNS) for all network configuration and management of CEA-709.1-D devices.

b. Is capable of executing LNS plug-ins.

c. Is capable of performing network database reconstruction of an CEA-709.1-D control network, such that if connected to an existing CEA-709.1-D network it has the ability to query the network and create an LNS database for that network.

d. Allows configuration of the network while off-line such that an operator may set up changes to the network while disconnected from the network, and then execute all of them once connected.

e. Includes the standard LNS Report Generator and is capable of generating and printing the following reports:

    (1) A table containing domain/subnet/node address and node identifier for the entire network or any subset thereof, selected by the user.

    (2) A table containing Standard Network Variable (SNVT) input and output details for any CEA-709.1-D device on the network.

    (3) A table containing Standard and User-Defined Configuration Properties (SCPTs and UCPTs) for any CEA-709.1-D device on the network.

f. Is capable of merging two existing standard LNS databases into a single standard LNS database.

2.4.8 BACnet Network Browser

****
NOTE: This subpart only applies to BACnet systems

and is only included when the BACNET tailoring option is selected.
****

Provide a BACnet Network Browser software that:

a. Can perform full discovery of a ASHRAE 135 system including but not limited to discovery of all ASHRAE 135 devices, the ASHRAE 135 Objects and Properties of each device, and the standard ASHRAE 135 services supported by each device.

b. Can read any ASHRAE 135 Property of any Object in any device. Proprietary Properties may be presented as read without further interpretation.

c. Can write any Standard ASHRAE 135 Property of any Object in any device.

d. Supports segmentation.

e. Supports all of the following BIBBs:

    (1) DM-ANM-A (Device Management-Automatic Network Management-A)

    (2) DM-ADM-A (Device Management-Automatic Device Management-A)

    (3) DM-DDB-A (Device Management-Dynamic Device Binding-A)

    (4) DM-DOB-A (Device Management-Dynamic Object Binding-A)

    (5) DS-RP-A (Data Sharing-Read Property-A)

    (6) DS-RPM-A (Data Sharing-Read Property Multiple-A)

    (7) DS-WP-A (Data Sharing-Write Property-A)

2.4.9 Niagara Framework Engineering Tool

****
NOTE: This subpart only applies to Niagara Framework systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.
****

Provide Niagara Framework engineering tool software which:

a. has unrestricted interoperability license and a Niagara Compatibility Statement (NiCS) which follows the Tridium Open NiCS Specification.

b. is capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

c. is capable of programming and configuring Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

d. is capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

2.4.10 Monitoring and Control (M&C) Software

****

NOTE: Designer should choose the minimum number of points and clients the M&C software is required to accommodate based on the project site's master plan. The initial number of points to be accommodated should be chosen such that it is sufficient to cover all current and known future projects. The total system expansion requirement should be based on potential/anticipated future projects.

It's a good idea to obtain pricing for several price-points between the current specified points/clients and the future number of points/clients. Depending on the vendor the cost increase for system expansion may be drastically different.

For non-Niagara Framework systems, points means "points that the M&C software can read/write on the network". In general, points will be SNVTs for LonWorks and the Present Value Property of Objects for BACnet. Other examples of Points are other BACnet Properties or LonWorks configuration properties/configuration network variables. For Modbus, a point will generally be a Modbus register. For OPC, a point will be an OPC "tag".

For the Niagara Framework, point licensing only applies to points directly integrated to the M&C Software without first being brought into a Niagara Framework Supervisory Gateway. Discuss with the installation whether integration will generally be accomplished via Niagara Framework Supervisory Gateways (this is the normal method) or not before determining a point licensing requirement When integration will "always" be through a Niagara Framework Supervisory Gateway change the number of network points required below to zero or a very small number. When requiring network points indicate in the space provided the protocol drivers required and network points required to be licensed by each.

This UFGS requires the use of Web based clients (previous versions of this UFGS did not, but most vendors support web-browser based clients and this no longer overly restricts competition.)

FYI: The following paragraphs/pages (the M&C software requirements) specify functionality that is required for the M&C Software but that may not be achievable due to lack of data/support at the building level. In order to meet future needs these requirements should be kept. It is expected that they are usually part of the 'standard' capabilities

of this type of software.
****

****
NOTE: This subpart uses tailoring options to indicate requirements for the M&C software in the first paragraph. Only requirements related to selected tailoring options are included.
****

Provide monitoring and control (M&C) software which is a client-server software package with a graphical user interface (GUI) using web-browser based clients. Provide Niagara Framework monitoring and control software which communicates with Niagara Framework field control systems using the Fox protocol. Provide M&C Software which communicates via CEA-709.1-D, and ASHRAE 135, and MODBUS Protocol/MODBUS TCP/IP, and OPC DA. The M&C Software may support other field control protocols. Provide M&C Software which is BACnet Testing Laboratories Certified ("Listed") as a B-AWS.

Provide a single software package which implements the Scheduling, Alarming, Trending, Graphical System Display, and System Display Editor functionality. Other specified M&C functionality may be implemented in the same software package or in additional software packages. As specified in PART 3 EXECUTION, the M&C Software must operate on Server hardware, except that software for Point Calculations and Demand Limiting may operate on M&C Controller Hardware.

2.4.10.1 M&C Software License

License the M&C Software as specified. Use of multiple copies of M&C Server software working in coordination and sharing data between them such that they function as, and appear to an operator as, a single M&C Server is permitted to meet these requirements.

2.4.10.1.1 Network Points

****
NOTE: This subpart uses tailoring options:
1) The sentence referring to Niagara Framework systems is included only when the NIAGARA FRAMEWORK tailoring option is selected.

2) The sentence referring to NIAGARA FRAMEWORK M&C Software is only included when the NIAGARA FRAMEWORK tailoring option is selected.
****

For Niagara Framework systems, a network point is a point brought directly into the Web Supervisor M&C Software through a protocol other than the Fox Protocol and via a Niagara Framework Supervisory Gateway. Provide M&C Software and licensing to support no less than [_____] network points, and to be capable of expansion to support no less than [50,000] [_____] network points. [Provide Niagara Framework M&C Software which includes the following drivers, each of which is licensed for a number of network points as follows: [____].]

2.4.10.1.2 Web Clients

Provide M&C Software and licensing to support no less than [10] [____]

simultaneous web clients with no limit on the total number of web clients. M&C Software must be capable of expansion to support no less than [30] [_____] simultaneous web clients.

2.4.10.1.3 Calculations

Provide M&C Software and licensing to support no less than one calculated point for every ten network points (see "Network Points" above).

2.4.10.1.4 Other Points

For installations using M&C Software installed on M&C Controller Hardware (as opposed to Server hardware), provide additional licensing to support additional network points for the communications between portions of the M&C Software installed on different hardware. For example, if the Calculations requirement is performed by M&C Software installed on Controller hardware, the M&C Software must be licensed for additional network points to cover the network points required for communication between the Controller hardware and the Server hardware.

2.4.10.1.5 Alarming

****

NOTE: This subpart uses tailoring options:
1) the phrase "alarm generation and" and the work "points" is included if the LONWORKS, MODBUS or OPC tailoring option is selected.

2) the phrase "ASHRAE 135 Alarm Event Notifications" is included if the BACNET tailoring option is selected.

****

Provide M&C Software and licensing to support alarm generation and the handling (routing) of alarms for no less than [10,000] [_____] points and ASHRAE 135 Alarm Event Notifications.

2.4.10.1.6 Trending

Provide M&C Software and licensing to support a minimum of [8,000] [_____] simultaneous trends.

[2.4.10.1.7 Scheduling

****

NOTE: This subpart only applies to LonWorks, Modbus, or OPC systems and is only included when the LONWORKS, MODBUS or OPC tailoring option is selected.

****

****

NOTE: When LonWorks tailoring is selected, this paragraph appears in brackets. This is due to changes in the requirements for LonWorks field control systems. Until recently LonWorks did not support an open means of configuring schedules in field control systems, so all scheduling was done at the M&C Software. The Simple Schedule Functional Profile now provides a standard means for schedule

configuration in the field control systems, and is a requirement in Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Keep the bracketed text for Modbus or OPC, or to maintain compatibility with LonWorks systems which do not employ the Simple Scheduler and thus require scheduling at the M&C Software. If Modbus and OPC are not required and all LonWorks field control systems will use the Simple Scheduler, the bracketed text can be removed.

When uncertain, keep the bracketed text as most M&C Software can support this requirement and keeping the ability to perform scheduling at the M&C Software will support a wider range of field control systems.

****

Provide M&C Software and licensing to support a minimum of [200] [_____] user-definable schedules.

]2.4.10.1.8 Niagara Framework Open License

****

NOTE: This subpart only applies to Niagara Framework systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Provide M&C Software with an unrestricted interoperability license and a Niagara Compatibility Statement (NiCS) which follows the Tridium Open NiCS Specification.

2.4.10.2 M&C Software Update Licensing

****

NOTE: The installation may procure its own software update licensing or contract and thus need less than 5 years. Alternatively the installation may require longer than five years (although this will likely increase the costs significantly). Coordinate with the installation to determine if they have any specific requirement; if they don't then keep the 5 year requirement.

****

In addition to all other licensing requirements, provide M&C Software licensing which includes licensing of the following software updates for a period [of no less than 5 years][____]:

a. Security and bug-fix patches issued by the M&C Software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

2.4.10.3 Supported Field Control Protocols

****

NOTE: FYI: one of the integration methods for legacy systems is to use a protocol driver (a 'software gateway') in the M&C software to integrate the legacy system, and these requirements permit the M&C Software to support protocols other than those specifically required in this specification.

****

****

NOTE: WARNING - The BACnet tailoring option has been selected with another protocol tailoring option (LonWorks, Modbus, OPC). As described in UFC 3-470-01, many of the Monitoring and Control Software packages which support BACnet support ONLY BACnet, so the inclusion of other protocol tailoring options may unnecessarily limit the number of vendors able to provide the UMCS. The need for supporting multiple protocols at the Monitoring and Control Software should be verified/checked with the project site. Note that any protocol can be integrated to the UMCS with the use of a gateway, so omitting a tailoring option does not prohibit the integration of systems using that protocol.

See UFC 3-470-01 for more information.

****

****

NOTE: WARNING - The Niagara Framework tailoring option has been selected with the LonWorks tailoring option. As described in UFC 3-470-01, LNS-based LonWorks (required by the LonWorks tailoring option) is generally not compatible with the Niagara Framework.

See UFC 3-470-01 for more information.

****

Provide M&C Software which supports field control protocols as follows:

****

NOTE: Due to the use of tailoring options in the following list of requirements not all requirements will be included in all projects and items may require renumbering.

****

****

NOTE: The following list paragraph is included only when the LONWORKS tailoring option is selected.

****

a. The M&C Software must include a driver to LNS, or a driver to an OPC interface to LNS, or a driver to CEA-852-C, and must be capable of reading and writing any SNVT on the CEA-852-C network. Software with a driver to LNS or a driver to an OPC interface to LNS must communicate with field control systems via LNS using this driver. Software with a driver to CEA-852-C must obtain all communication information (such as device addresses and network variable indices) from LNS and must automatically update this information whenever the LNS Database changes.

****

NOTE: The following list paragraph is included only when the BACNET tailoring option is selected.

****

b. The M&C Software must include a driver to ASHRAE 135 over IP in accordance with ASHRAE 135 Annex J.

****

NOTE: The following list paragraph is included only when the MODBUS tailoring option is selected.

****

c. The M&C Software must include a driver to MODBUS Protocol/MODBUS TCP/IP over TCP/IP. The M&C Software must be capable of reading and writing the Modbus data types as defined in paragraph MODBUS REQUIREMENTS and must, in addition, be capable of manipulating and presenting arbitrary data formats derived from the four standard Modbus data types.

****

NOTE: The following list paragraph is included only when the OPC tailoring option is selected.

****

d. The M&C Software must be an OPC DA client.

****

NOTE: The following list paragraph is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

e. The Software must use the Niagara Framework and must communicate with Niagara Framework Supervisory Gateways using the Fox protocol.

f. The M&C Software may, in addition, include drivers to other protocols.

Provide M&C Software capable of reading values from and writing values to points via any supported field protocol, and capable of reading values from one field protocol and writing them to another. All points obtained from any field protocol must be available to all M&C Software functionality.

2.4.10.4 Supported Enterprise Protocols

Provide M&C Software which supports oBIX, BACnet Web Services or OPC as an enterprise protocol and which meets the following requirements:

a. It is able to read values from any point or collection of points (network point, internal point, trend log or schedule) and transmit these values via the enterprise protocol.

b. It is able to receive data via the enterprise protocol and use this data to change the value of any point.

c. License the enterprise protocol interface to the project site and document the interface such that any system capable of communicating with that protocol can be used to read and write data from the M&C Software.

2.4.10.5 Point Information

Every point, both network and internal, in the M&C Software must contain the following fields:

2.4.10.5.1 Name

A configurable name used for identification of the point within the M&C Software.

2.4.10.5.2 Description

A configurable description of no less than 80 alpha-numeric characters.

2.4.10.5.3 Value

A field containing the current point value.

2.4.10.5.4 Units

A field containing the engineering units.

2.4.10.5.5 Source

A field identifying the source of the point. For network points, this is generally the address or identification of the field device (for example, the Domain-Subnet-Node address for LonWorks field control devices or the DeviceID for BACnet devices).

2.4.10.6 Point Calculations

Provide M&C software capable of performing calculations and computing the value of a calculated point based on the values of two or more network points and calculated points. Mathematical operators must include: addition, subtraction, multiplication, division, exponentiation (y^x, power), square root, reciprocal, natural logarithm, sin, cos, tan, arcsin, arccos, arctan, and parenthesis. Pi and e must be available as constants for use in calculations.

2.4.10.7 Browser-Based Graphical User Interface (GUI)

****

NOTE: The contractor will require a certificate for the M&C Web Server (in order to use HTTPS as required here). Coordinate with the project site IT organization (NEC) to obtain this certificate.

****

Provide M&C Software which includes a web-browser based (client-server) graphical user interface through which all M&C Software functionality, except for the Graphics Editor, System Display Editor, report configuration, point calculation configuration, and enterprise protocol configuration, is accessible.

Provide graphical user interface web server and web clients meeting the following requirements:

a. The web server must use HTTPS based on the Transport Layer Security (TLS) Protocol in accordance with IETF RFC 7465 using a Government-furnished certificate.

b. The graphical user interface must be Common Access Card (CAC) enabled: It must support web client authentication using certificates obtained from a Department of Defense Common Access Card (CAC) Smart Card.

c. The web client must operate on any version of Windows currently supported by Microsoft.

d. The web client must function in the most recent three version of Internet Explorer [and [the most recent three versions of Firefox][____]].

e. The web client must not require a connection to any server other than the M&C Server.

f. The web client must function in a browser with Java, Shockwave, Silverlight, and Flash installed. The client may require a download of mobile code from the M&C Server, but must not require the download of additional browser plug-ins or add-ins and there must be no limit on the number of downloads. The client must not require ActiveX.

2.4.10.8 Passwords

****

NOTE: Designer must choose if password management for M&C software is performed

a) by the OS
or
b) by the M&C software itself
or
c) if the decision is left to the Contractor.

The password requirements here provide a simple basis for user authentication. More complex password schemes may be required by the installation. Coordinate with the installation and if they have more detailed or complex password requirements enter them in the space provided. Otherwise keep the bracketed defaults.

****

Provide M&C software with user-based access control to M&C functionality. The M&C Software must recognize at least [100] [_____] separate users and have [at least 4] [____] levels of user permissions. User permission levels (from most restrictive to most permissive) must include:[

a. Permission Level 1: View-only access to the graphical user interface.

b. Permission Level 2: Permission Level 1 plus acknowledge alarms and set up (configure) trends and reports.

c. Permission Level 3: Permission Level 2 plus override points and set up (configure) alarms, schedules and demand limiting.

d. Permission Level 4: Permission Level 3 plus create and modify Graphical System Displays using the System Display Editor.][____]

Passwords must not be displayed and must not be logged. The system must maintain a disk file on the server hardware logging all activity of the system. This file must maintain, as a minimum, a record of all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications. If the file format is not plain ASCII text, provide a means to export or convert the file to plain ASCII text. Provide a mechanism for archiving the log files for long term record storage.

2.4.10.9 Graphical System Displays

Provide graphical displays consisting of building system (air handler units, VAV boxes, chillers, cooling towers, boilers, etc.) graphic displays. Data associated with an active display must be updated at least once every 5 seconds.

2.4.10.9.1 Navigation Scheme

System graphic displays of building systems and points must be hierarchical displays using a building-to-equipment point-and-click navigation scheme which allows navigation from a garrison-wide display, through a building-wide display to the individual units. Each display must show the building name and number. Each display must show system wide data such as outside air temperature and humidity in the case of an HVAC system application.

a. For each Building or Building Sub-Area display, show the building foot print and basic floor plan, and clearly show and distinguish between the individual zones and the equipment serving each zone and space. Show all space sensor and status readings, as applicable, for the individual zones such as space temperature, humidity, occupancy status, etc. Show the locations of individual pieces of monitored and controlled equipment.

****

NOTE: Coordinate with the project site and select the style of representation for equipment.

When making this selection consider the effect that detailed graphics have on the performance of the user interface; the more complex the graphic, the longer it will take for the page to load.

****

b. For each equipment display show a [one-line diagram control schematic][3-dimensional] representation of the individual pieces of equipment using the symbols and M&C point data types as specified. Use different colors and textures to indicate various components and real time data. Use consistent color and texture meanings across all displays.

c. Provide displays which clearly distinguish between the following point data types and information:

    (1) Real-time data.

(2) Other user-entered data.

(3) Devices in alarm (unacknowledged).

(4) Out-of-range, bad, or missing data.

(5) Points which are overridden.

2.4.10.9.2 Navigation Commands

Provide system displays which support English language operator commands via point-and-click mouse or keyboard entry for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands must be usable from any operator workstation with individual operator passwords as specified.

2.4.10.10 Graphic Editor

Provide a fully featured graphics editor and capable of creating custom graphics and graphic symbols for use by the System Display Editor.

2.4.10.11 System Display Editor

Provide a system display editor which allows the user to create, modify, and delete graphic displays. The display editor may have a separate user interface and is not required to be accessible via the web browser interface. Provide a display editor which includes the following functions:

a. Create and save displays. Save an existing or modified display as a new display (i.e. "save as")

b. Group and ungroup graphics, where graphics include both alphanumeric and graphic symbols, and where a grouped graphic is manipulated as a single graphic.

c. Place, locate, resize, move, remove, reposition, rotate and mirror a graphic on a display.

d. Overlay graphics over other graphics and assign depths such that when there are coincident graphics the one on top is visible.

e. Modify graphic properties based on the value of network points and create conditions governing the display of a graphics such that different graphics are visible based on the value of network points or calculated points

f. Integrate real-time data with the display.

g. Establish connecting lines.

h. Establish sources of latest data and location of readouts.

i. Display analog values as specified.

j. Assign conditions which automatically initiate a system display.

k. Include library of display symbols which include: Pump, Motor, Two- and Three-way Valves, Flow Sensing Element, Point and Averaging Temperature Sensors, Pressure Sensor, Humidity Sensor, Single and Double Deck Air

Handling Unit, Fan, Chiller, Boiler, Air Compressor, Chilled Water Piping, Steam Piping, Hot Water Piping, Ductwork, Unit Heater, Pressure Reducing Valve, Damper, Electric Meter, Limit Switch, Flow Switch, High- and Low- Point and Averaging Temperature Switches, High- and Low-Pressure Switches, Coil, Solenoid Valve, Filter, Condensing Unit, Cooling Tower, Variable Frequency Drive (VFD), Heat Exchanger, Current Sensing Relays, Generator, Circuit Breaker, Transformer, Tank. Symbols must at a minimum conform to ASHRAE FUN SI ASHRAE FUN IP where applicable.

2.4.10.12 Scheduling

****

NOTE: FYI: For BACnet systems it is expected that there will be Scheduling Objects in the field control system and the M&C Software will edit (configure) these schedules.

For LonWorks the M&C software will be the primary method of scheduling; building systems have 'backup' scheduling capability in the event of a loss of communication with the M&C Software Server.

For Niagara Framework systems it is expected that there will be Niagara Framework Scheduling Objects in the Niagara Framework Supervisory Gateway(s) and the M&C Software will edit (configure) these schedules.

In general it is expected that Modbus and OPC will be used for the integration of utility control systems which will likely have their own scheduling capability. In this case scheduling from the M&C Software will be for secondary/supervisory functions.

Due to the use of tailoring options in the following list of requirements not all requirements will be included in all projects and items may require renumbering.

****

****

NOTE: The following TWO list paragraph is included only when the LONWORKS, MODBUS or OPC tailoring option is selected.

****

a. Provide M&C software capable of changing the value of any network point according to a schedule. The M&C Software must be capable of scheduling points to any value, including a "null" or invalid value if one is defined for the data type of the point.

b. The specified scheduling functions must be operator accessible and adjustable via the graphical user interface. Each schedule must be able to change the value of multiple points. The M&C software must reinforce all schedules by transmitting the scheduled value no less than once every 30 minutes.

****

NOTE: The following list paragraph is included only when the BACNET tailoring option is selected.

****

c. The M&C software must be capable of performing time synchronization and configuring Schedule Objects in ASHRAE 135 field devices in accordance with the DM-MTS-A (Device Management-Manual Time Synchronization-A).

****

NOTE: The following list paragraph is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

d. The M&C software must be capable of performing time synchronization and configuring Niagara Framework Schedule Objects in Niagara Framework Supervisory Gateways.

e. The M&C Software must include a scheduling graphic display, accessible via the graphical user interface, with the following fields and functions:

    (1) Current date and time.

    (2) System identifier(s) and name(s), including location information such as Building name(s) and number(s).

    (3) System group. Systems grouped by the user to perform according to a common schedule.

    (4) Weekly schedules. For each system, a weekly schedule based on a seven day per week schedule with independent schedules for each day of the week including no less than 6 value changes per day.

    (5) Holiday and special event schedules. Support for holiday and special event calendar schedules independent of the daily schedule. Special event schedules include one-time events and recurring events. Scheduling of one-time events include the beginning and ending dates and times of the event. Holiday and special event schedules must have precedence over device weekly schedules.

2.4.10.13 Alarms

Provide M&C Software meeting the following minimum requirements for alarms:

****

NOTE: The following list paragraph uses tailoring options:
1) "generating alarms by comparing the value of any point from any connected system to user-configurable limits" is included when the LONWORKS, MODBUS or OPC tailoring option is selected

2) "configuring alarms in ASHRAE 135 field devices in accordance with the B-AWS BIBBs" is included when

the BACNET tailoring option is selected.

3) "configuring alarms in Niagara Framework Supervisory Gateways using the Niagara Alarm Service" is included when the NIAGARA FRAMEWORK tailoring option is selected.

****

a. The M&C software must be capable of generating alarms by comparing the value of any point from any connected system to user-configurable limits, and configuring alarms in ASHRAE 135 field devices in accordance with the B-AWS BIBBs, and configuring alarms in Niagara Framework Supervisory Gateways using the Niagara Alarm Service.

****

NOTE: The following list paragraph uses tailoring options:
1) "alarms generated by the M&C Software" is included when the LONWORKS, MODBUS or OPC tailoring option is selected

2) "alarms received as an ASHRAE 135 Alarm Event Notifications" is included when the BACNET tailoring option is selected.

3) "alarms received from a Niagara Framework Supervisory Gateway" is included when the NIAGARA FRAMEWORK tailoring option is selected.

****

b. The M&C software must be capable of handling (routing) alarms generated by the M&C Software, and alarms received as an ASHRAE 135 Alarm Event Notifications, and alarms received from a Niagara Framework Supervisory Gateway.

****

NOTE: The following list paragraph is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

c. The M&C software must support Niagara Framework Alarm Classes.

d. The M&C software must support at least two alarm priority levels: critical and informational. Critical alarms must remain in alarm until acknowledged by an operator and the alarm condition no longer exists; informational alarms must remain in alarm until the alarm condition no longer exists or until the alarm is acknowledged.

e. The creation, modification, and handling (routing) of alarms must be fully accessible and fully adjustable from the graphical user interface.

f. Alarm Data. Alarm data to be displayed and stored must include:

   (1) Identification of alarm including building, system (or sub-system), and device name.

   (2) Date and time to the nearest second of occurrence.

(3) Alarm type:

(a) Unreliable: Indicates that the source device has failed due to the sensing device or alarm parameter being out-of-range or bad data.

(b) High Alarm.

(c) Low Alarm.

(4) Current value or status of the alarm point, including engineering units

(5) Alarm limits, including engineering units.

(6) Alarm priority.

(7) Alarm Message: A unique message with a field of at least 60 characters. Assignment of messages to an alarm must be an operator editable function.

(8) Acknowledgement status of the alarm including the time, date and user of acknowledgement.

****

NOTE: The following list paragraph uses tailoring options:
1) "ASHRAE 135 event notification" is included when the BACNET tailoring option is selected.

2) "network variable of type SNVT_alarm or SNVT_alarm_2" is included when the LONWORKS tailoring option is selected

3) "OPC alarm" is included when the OPC tailoring option is selected

4) "or upon generation of an alarm" is included when the LONWORKS, MODBUS or OPC tailoring option is selected.

****

g. Alarm Notification and Routing: The M&C software must be capable of performing alarm notification and routing functions. Upon receipt of ASHRAE 135 event notification, network variable of type SNVT_alarm or SNVT_alarm_2, OPC alarm, or upon generation of an alarm the M&C software must immediately perform alarm notification and routing according to an assigned routing for that alarm. The M&C software must support at least 100 alarm routes, where an alarm route is a unique combination of any of the following activities:

(1) Generate a pop-up active clients. The pop-up display must include the Alarm Data. Alarms must be capable of being acknowledged from the pop-up display by operators with sufficient permissions. Pop-up must be displayed until acknowledged.

(2) Send an e-mail message via simple mail transfer protocol (SMTP;

RFC 821). The e-mail must contain a configurable message and all alarm data. The e-mail recipient and scripted message must be user configurable for each alarm route.

(3) Print alarms to designated alarm printers. The printed message must be the same as the pop-up message.

h. Alarm Display and Acknowledgement. The M&C software must include an alarm display. Alarms must be available for display at each workstation as shown, along with all associated alarm data. Alarms must be capable of being acknowledged from this display. Multiple alarms must be capable of being acknowledged using a single command. Operator acknowledgment of one alarm must not automatically be considered as acknowledgment of any other alarm nor may it inhibit reporting of subsequent alarms.

i. Alarm Storage and Reports: The M&C software must store each alarm and its associated alarm data to hard disk and retain this information after the alarm no longer exists. The stored data must be sortable, searchable, and printable.

2.4.10.14 Trending

****

NOTE: Designer should determine required number of points M&C software is capable of trending based on the project site's master plan.

****

****

NOTE: The following list paragraph uses tailoring options:
1) "of creating, modifying, uploading and archiving ASHRAE 135 Trend Objects in field devices in accordance with the B-AWS BIBBs" is included when the BACNET tailoring option is selected.

2) "of performing real-time trending with a minimum trending rate of 100 points per second " is included when the LONWORKS, MODBUS or OPC tailoring option is selected.

2) "of using the Niagara history service to create, modify, upload and archive trend log objects in Niagara Framework Supervisory Gateways" is included when the NIAGARA FRAMEWORK tailoring option is selected

****

Provide M&C software capable of creating, modifying, uploading and archiving ASHRAE 135 Trend Objects in field devices in accordance with the B-AWS BIBBs and of performing real-time trending with a minimum trending rate of 100 points per second and of using the Niagara history service to create, modify, upload and archive trend log objects in Niagara Framework Supervisory Gateways.

a. The M&C Software must include a graphical display for trend configuration, creation and deletion accessible through the graphical user interface. Each trend must be user-configurable for:

(1) Point to trend.

(2) Sampling interval: adjustable between 1 second and 1 hour.

(3) Start and Stop Time of Trend: Start and stop times determined by one or more of the following methods:

(a) Start time and stop time

(b) Start time and duration

(c) Start time and number of samples

b. The M&C software must be capable of displaying and printing a graphical representation of each trend, and of multiple trended points on the same graph. The software must be capable of saving trend logs to a file. If the file format is not plain ASCII text in a Comma-Separated-Value (CSV) format, provide a means to export or convert the file to plain ASCII text in a CSV format.

2.4.10.15 Electrical Power Demand Limiting

****

NOTE: The critical alarm for actual demand exceeding the Electrical Demand Target (EDT) should be routed such that it is received as soon as possible.

Designer must decide if actual demand exceeding EDT causes the EDT to be reset to a higher value.

The billing structure should be obtained from the utility supplying electrical service in order to coordinate equipment demand limit priorities with the project site's Energy Manager.

If real-time pricing is a part of the billing structure it will require coordination with the demand limiting program. Also, real-time pricing will require a connection to the Internet to obtain the pricing information from the utility. This connection may not exist and may be difficult or impossible to obtain due to Information Assurance requirements.

****

Provide M&C software which includes demand limiting functionality capable of performing electrical demand limiting such that it can change the occupancy mode or setpoint of field control system hardware via a network point based on a projected demand in order to maintain demand below a configured target.[The demand target must incorporate real-time pricing data.] The demand limiting algorithm must incorporate priority levels such that low priority equipment is adjusted before high-priority equipment. The demand limiting algorithm must generate a critical alarm when it begins to impact the system and a critical alarm if the demand target is exceeded.

2.4.10.16 Report Generation

****

NOTE: The list of standard reports should be edited by the designer to remove any reports or sub-items of individual reports not required by the project.
****

Provide M&C Software capable of generating, saving and printing reports. Dynamic operation of the system must not be interrupted to generate a report. The report must contain the time and date when the samples were taken, and the time and date when the report was generated. The software must be capable of saving reports to a PDF file and to a file compatible with the provided Office Automation Software.

The software must allow for automatic and manual generation of reports. For automatic reports an operator must be able to specify the time the initial report is to be generated, the time interval between reports, end of period, and the output format for the report. Manual report generation must allow for the operator to request at any time the output of any report.

2.4.10.17 Custom Report Generation

Provide M&C software capable of generating custom reports, including but not limited to the following standard reports:

2.4.10.17.1 Electrical Power Usage Report

An electrical power Usage summary, operator selectable for substations, meters, or transducers, individual meters and transducers, any group of meters and transducers, and all meters for an operator selected time period. The report must include the voltage, current, power factor, electrical demand, electrical power consumption, reactive power (Kvar) for each substation, facility, system or equipment as selected by the operator. The report must be automatically printed at the end of each summary period and include:

a. Total period consumption.

b. Demand interval peak for the period, with time of occurrence.

c. Energy consumption (kWh) over each demand interval.

d. Time-of-use peak, semi-peak, off-peak, or baseline total kWh consumption.

e. Reactive power during each demand interval.

f. Power factor during each demand interval.

g. Outside air (OA) temperature and relative humidity (RH) taken at the maximum and minimum of OA temperature of the report period with the time and dates of occurrence. At the installation's peak demand interval, the OA temperature and RH must also be recorded.

h. Calculated heating and cooling degree days based on a 18.3 degrees C 65 degrees F balance point.

2.4.10.17.2 Electrical Peak Demand Prediction Report

A report based on the demand limiting program, which includes:

a. Electrical Demand Target (EDT).

b. Actual peak and predicted peak for each demand interval for that day.

c. Predicted demand for the next demand interval.

2.4.10.17.3 Energy usage Report

An energy usage summary, operator selectable, for a unit, building, area, installation, and the entire UMCS. The report must be divided by utility, and must be capable of reporting on at least four separate utilities. The report must include the following information:

a. Beginning and ending dates and times.

b. Total energy usage for each utility for the current and previous day.

c. Total energy usage for each utility for the current and previous month.

d. Maximum 15-minute interval average rate of consumption for each utility for the current and previous day and current and previous month.

e. Outside air (OA) temperature and OA humidity for current and previous month and current and previous day:

    (1) Average temperature and humidity.

    (2) Temperature and humidity at maximum and minimum OA temperature with time and date of occurrence.

    (3) Temperature and humidity at maximum and minimum humidity with time and date of occurrence.

    (4) Temperature and humidity at the installation's peak demand interval with the time and date of occurrence

f. Calculated degree days. Reports which include humidity must be configurable to report either dewpoint or relative humidity.

2.4.10.17.4 Water Usage Report

A water usage summary, operator selectable, for a unit, building, area, installation, and the entire UMCS. The report must include the following information:

a. Beginning and ending dates and times.

b. Total energy water usage for the current and previous day.

c. Total water usage for the current and previous month.

2.4.10.17.5 Alarm Report

Outstanding alarms by building or unit, including time of occurrence.

2.4.10.17.6 M&C Software Override Report

Points overridden by the M&C Software, including time overridden, and identification of operator overriding the point.

2.4.10.17.7 Run Time Reports

A report totalizing the accumulated run time of individual pieces of equipment. The operator must be able to define equipment groupings and to generate reports based on these groupings.

2.4.10.17.8 Cooling Tower Profiles

A cooling tower profile for each cooling tower as indicated, including:

a. Total daily and monthly on-time (each fan).

b. Number of on and off transitions (each fan).

c. Maximum and minimum daily condenser water temperature and the time of occurrence for the current and previous months.

d. Total daily and monthly makeup water consumption.

2.4.10.17.9 Chiller usage Report

A report of the operation of each chiller as shown on a daily and monthly basis, for each of at least 10 discrete loading levels. The report must include:

a. Average power for the month at each level in kW

b. Total monthly energy use in kWh at each level

c. Total monthly energy use in kWh for the chiller (all levels)

d. Total daily run hours at each level

e. Total Monthly run hours at each level

2.4.10.17.10 Device Offline Report

****

NOTE: This subpart is included when the BACNET, LONWORKS or NIAGARA FRAMEWORK tailoring option is selected and uses tailoring options:

1)"CEA-709.1-D" is included if the LONWORKS tailoring option is selected

2) "ASHRAE 135" is included if the BACNET tailoring option is selected.

3) "all offline Niagara Framework Supervisory Gateways" is included if the NIAGARA FRAMEWORK tailoring option is selected

****

A report listing all offline devices in all CEA-709.1-D or ASHRAE 135 building control systems integrated to the M&C Software and all offline Niagara Framework Supervisory Gateways.

2.5 UNINTERRUPTIBLE POWER SUPPLY (UPS)

Provide uninterruptible power supplies (UPS) as self contained devices suitable for installation and operation at the location of Server and Workstation hardware and sized to provide a minimum of 20 minutes of operation of the connected hardware. Equipment connected to the UPS must not be affected in any manner by a power outage of a duration less than the rated capacity of the UPS. Provide the UPS complete with all necessary power supplies, transformers, batteries, and accessories. Provide UPS which include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of AC input loss and low battery power. Provide UL 1778 approved UPS. UPS powering Server Hardware must notify the server via USB interface of impending battery failure.

2.6 RACKS AND ENCLOSURES

2.6.1 Enclosures

****

NOTE: NOTE: In outdoor applications specify Type 3 unless hosedown of the enclosure is anticipated, in which case specify Type 4.

For retrofit projects in older mechanical rooms or where hosedown of the enclosure is anticipated specify Type 4 enclosures. Type 4 provides a greater degree of protection in dirty and wet environments than does Type 2.

****

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

2.6.1.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 [Type 3][Type 4] requirements.

2.6.1.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 [Type 2][Type 4] requirements.

2.6.1.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6.2 Equipment Racks

Provide standard 482 mm 19 inch equipment racks compatible with the electronic equipment provided. Racks must be either aluminum or steel with bolted or welded construction. Steel equipment racks must be painted with a flame-retardant paint. Guard rails must be included with each equipment rack and have a copper grounding bar installed and grounded to the earth.

PART 3 EXECUTION

****

NOTE: Determine the applicability and need for a Factory Test and remove the Factory Test requirements if a Factory Test is not needed.

For Army projects, contact the UMCS MCX (Huntsville Center) for a list of systems which have already been through a Factory Test.

****

[3.1 FACTORY TEST

****

NOTE: Include the reference to section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM TESTING if appropriate. Otherwise indicate another basis for the Factory Test Procedures.

****

Perform factory testing of the UMCS as specified. The Contractor is responsible for providing personnel, equipment, instrumentation, and supplies necessary to perform required testing. Provide written notification of planned testing to the Government at least 21 days prior to testing, and do not give this notice until after receiving written Government approval of the specific Factory Test Procedures. Provide Factory Test Procedures which define the tests required to ensure that the system meets technical, operational, and performance specifications. Within the Procedures define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required. Provide procedures which test all capabilities and functions specified and indicated. Develop Procedures from the design documentation and in accordance with [Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM TESTING][____]. Perform the Factory Test using equipment and software of the same manufacturer, model and revision as will be used for the specified project. Include detailed instructions for test setup, execution, and evaluation of test results in the Procedures. Upon completion of the test, prepare a Factory Test Report, documenting the results of the Test, and submit it as specified.

Perform the Factory Test and provide Factory Test Submittals as shown in TABLE II. FACTORY TEST SEQUENCING.

TABLE II. FACTORY TEST SEQUENCING

ITEM #	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
1	Submit Factory Test Procedures	[[_____] days after notice to proceed][_____]
2	Perform Factory Test	After Approval Of #1

TABLE II. FACTORY TEST SEQUENCING

ITEM #	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
3	Submit Factory Test Report	[_____] days After Completion Of #2

]3.2 EXISTING CONDITIONS SURVEY

Perform a field survey, including but not limited to testing and inspection of equipment to be part of the UMCS, and submit an Existing Conditions Report documenting the current status and its impact on the Contractor's ability to meet this specification. For field control systems to be integrated to the UMCS which are not already connected to the UMCS IP network, verify the availability of the building network backbone at the FPOC location, and verify that FPOCs shown as existing are installed at the FPOC location.

3.3 DRAWINGS AND CALCULATIONS

3.3.1 UMCS IP Network Bandwidth Usage Estimate

Provide a UMCS IP Network Bandwidth Usage Estimate for a small, medium or large systems. In this estimate account for field control systems using all M&C required protocols and the integration of field control system via gateways. Define all assumptions used to create the estimate, including but not limited to: trending, fast trends for commissioning, schedules, alarms, display of system graphics and load shedding.

3.3.2 UMCS Contractor Design Drawings

Revise and update the Contract Drawings to include details of the system design and all hardware components, including contractor provided and Government furnished components. Details to be shown on the Design Drawing include:

****

NOTE: The following list paragraph uses tailoring options:
1) "BACnet Supervisory Controller" is included only if the BACNET tailoring option is selected

2) "Niagara Framework Supervisory Gateway" is included only if the NIAGARA FRAMEWORK tailoring option is selected.

****

a. The logical structure of the network, including but not limited to the location of all Control Hardware (including but not limited to each BACnet Supervisory Controller, Control Protocol Gateway, Control Protocol Router, Niagara Framework Supervisory Gateway and Monitoring and Control (M&C) Controller).

b. Manufacturer and model number for each piece of Computer Hardware and Control Hardware.

c. Physical location for each piece of Computer Hardware and Control Hardware.

d. Version and service pack number for all software and for all Control Hardware firmware.

3.3.3 As-Built Drawings

****

NOTE: The Points Schedule is a submittal from Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC contracts and is a contract drawing for this Section. The Contractor updates the Points Schedule and submits it as an as-built.

Where projects require integration to systems not installed under Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, or where the Points Schedules for the system are not available, create Points Schedules for inclusion in the Contract Drawings.

****

Prepare draft as-built drawings consisting of Points Schedule drawings for the entire UMCS, including Points Schedules for each Gateway, and an updated Design Drawing including details of the actual installed system as it is at the conclusion of Start-Up and Start-Up Testing. Provide As-Built Drawings which include details of all hardware components, including contractor provided and Government furnished components. In addition to the details shown in the design drawings, the as-built drawing must include:

****

NOTE: The following paragraph uses tailoring options:
1) "BACnet Supervisory Controller" is included only when the BACNET tailoring option is selected.
2) "Niagara Framework Supervisory Gateway" is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

a. IP address(es) and Ethernet MAC address(es) as applicable for each piece of Control Hardware (including but not limited to each BACnet Supervisory Controller, Niagara Framework Supervisory Gateway, Control Protocol Gateway, Control Protocol Router, and Monitoring and Control (M&C) Controller).

b. IP address and Ethernet MAC address for each computer server, workstation, and networked printer.

c. Network identifier (name) for each printer, computer server and computer workstation.

d. List of ports, protocols and network services for each device connected to an IP network.

****

NOTE: The following paragraph uses tailoring options for BACNET, LONWORKS, MODBUS and NIAGARA FRAMEWORK and includes requirements only when the

associated tailoring option is selected.

****

e. Network Addresses: CEA-709.1-D address (domain, subnet, node address) for all Control Hardware using CEA-709.1-D.ASHRAE 135 address and Object_ID of the Device Object for all Control Hardware using ASHRAE 135. MODBUS Protocol/MODBUS TCP/IP address for all Control Hardware using MODBUS Protocol/MODBUS TCP/IP. Niagara Framework Station ID for all Niagara Framework components including but not limited to Niagara Framework Supervisory Gateways and the Niagara Framework M&C Software.

Prepare Draft As-Built Drawings upon the completion of Start-Up and Start-Up Testing and Final As-Built Drawings upon completion of PVT Phase II.

3.4 INSTALLATION REQUIREMENTS

3.4.1 General

****

NOTE: Indicate the location of telecommunications closets on the contract drawings.

****

Install system components as shown and specified and in accordance with the manufacturer's instructions and provide necessary interconnections, services, and adjustments required for a complete and operable system. Install communication equipment and cable grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Install Fiber Optic cables and wiring in exposed areas, including low voltage wiring but not including network cable in telecommunication closets, in metallic raceways or EMT conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Do not install equipment in any space which experiences temperatures or humidity outside of the rated operating range of the equipment.

3.4.2 Isolation, Building Penetrations and Equipment Clearance

Provide dielectric isolation where dissimilar metals are used for connection and support. Make all penetrations through and mounting holes in the building exteriors watertight. Drill or core drill holes in concrete, brick, steel and wood walls with proper equipment. Seal conduits installed through openings with materials which are compatible with existing materials. Seal openings with materials which meet the requirements of NFPA 70 and SECTION 07 84 00 FIRESTOPPING.

3.4.3 Nameplates

Provide Nameplates for all Control Hardware and all Computer Hardware. Attach Nameplates to the device in a conspicuous location.

3.5 INSTALLATION OF EQUIPMENT

3.5.1 Wire and Cable Installation

Install system components and appurtenances in accordance with NFPA 70, manufacturer's instructions and as indicated. Provide necessary interconnections, services, and adjustments required for a complete and operable signal distribution system. Label components in accordance with

TIA-606. Firestop Penetrations in fire-rated construction in accordance with Section 07 84 00 FIRESTOPPING. Install conduits, outlets and raceways in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install wiring in accordance with TIA-568.1 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Mark wiring terminal blocks and outlets in accordance with TIA-606. Do not install non-fiber-optic cables in the same cable tray, utility pole compartment, or floor trench compartment with power cables. Properly secure and install neat in appearance cables not installed in conduit or raceways.

3.5.2 Grounding

Install signal distribution system ground in accordance with TIA-607 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Connect equipment racks to the electrical safety ground.

3.5.3 Power-Line Surge Protection

Protect equipment connected to ac circuits must be protected against or withstand power-line surges. Provide equipment protection which meets the requirements of IEEE C62.41. Do not use fuses for surge protection.

3.5.4 IP Addresses

****

NOTE: Select the appropriate option to do one of the following:
1) require the contractor to coordinate IP Addresses with NEC (the IT group)

2) require the contractor use IP addresses from a list of supplied IP addresses. In this case, include a list of IP addresses.

3)(not applicable to Air Force) require the contractor to configure control hardware to obtain IP addresses from a DHCP server.

****

For all Control Hardware requiring an IP address on the UMCS IP Network, [coordinate with the [NEC] [_____] to obtain IP addresses] [use the following IP addresses:[_____]][obtain static IP addresses from a DHCP server].

3.5.5 Computer Hardware and Software

****

NOTE: If computer hardware is Government installed remove the bracketed text requiring hardware installation.

****

[3.5.5.1 Hardware Installation

Install Computer Hardware as specified and indicated. Power Computer Servers through a UPS, and install and configure them such that the server automatically undergoes a clean shutdown upon low battery signal from the UPS.

]3.5.5.2 Software Installation

Install software as follows:

****

NOTE: Due to tailoring options the numbering of the following items may be incorrect and require editing.

****

****

NOTE: The following TWO list paragraphs are included only if the LONWORKS tailoring option is selected

****

a. CEA-852-C Configuration Server: Install and configure one CEA-852-C Configuration Server. Install the CEA-852-C Configuration Server on Server Hardware or on an CEA-709.1-D TP/FT-10 to IP Router.

b. CEA-709.1-D Network Configuration Tool: Install the CEA-709.1-D Network Configuration Tool software as shown. Install the CEA-709.1-D Network Configuration Tool on workstation or server hardware.

****

NOTE: The following designer note and list paragraph are included only if the BACNET tailoring option is selected

****

****

NOTE: The BACnet Network Browser may or may not be needed by the installation. The M&C Software already has this functionality, but in general a copy of a BACnet Network Browser installed on a laptop is beneficial for the installation for O&M, troubleshooting and commissioning.

Keep the bracketed option and show the BACnet Network Browser on the drawings to require it.

****

[c. BACnet Network Browser: Install the BACnet Network Browser software as indicated. Install the BACnet Network Browser on workstation hardware.]

****

NOTE: The following designer note and list paragraph are included only if the NIAGARA FRAMEWORK tailoring option is selected

****

****

NOTE: The Niagara Framework Engineering Tool must be installed on the M&C Software server. It may or may not need to be installed on more than the M&C Software server.

Keep the bracketed option and show the Niagara Framework Engineering Tool on the drawings to require it to be installed on more the M&C Software server.

****

d. Niagara Framework Engineering Tool: Install the Niagara Framework Engineering Tool on the M&C Software Server[and as indicated. Install the Niagara Framework Engineering Tool on workstation hardware].

****

NOTE: The following list paragraph uses tailoring options.

The sentence "Install M&C Software in a manner consistent with its B-AWS listing such that it provides all functionality of a B-AWS." is included only if the BACNET tailoring option is selected

****

e. Monitoring and Control Software: Install the monitoring and control (M&C)software as shown. Except for M&C Software performing Point Calculations or Electrical Peak Demand Limiting, install M&C Software on server hardware. Install M&C Software performing Point Calculations or Electrical Peak Demand Limiting on either server hardware or Monitoring and Control (M&C) Controller Hardware. Install M&C Software in a manner consistent with its B-AWS listing such that it provides all functionality of a B-AWS.

Provide sufficient computer hardware and M&C Controller Hardware and install M&C Software to support the number of points required in PART 2 (PRODUCTS), regardless of the number of points integrated under this project specification. Note that meeting this requirement may entail the installation of unused hardware or spare point licenses to accommodate the full number of required points in order to allow for integration of future field control systems.

f. M&C Controller Hardware Configuration Software: Install the M&C Controller Hardware Configuration Software on server hardware.

****

NOTE: Remove the bracketed text if the software is Government installed. Coordinate with the project site and project site IT organization to determine which software will be Government installed, and to determine the information required to complete the brackets.

Note that if some software is Government installed but others are required the items may need to be renumbered.

If the Operating System is installed by the contractor provide a point of contact for user names and passwords.

If the Virus Protection Software is installed by the contractor indicate whether an update server is available and provide server information or a POC to obtain server information.

****

[g. Operating system: Install the OS on each Server and Workstation and configure usernames and passwords. Coordinate with [_____] for usernames and passwords.

][h. Office Automation Software: Install the office automation software on each server and workstation.

][i. Virus Protection software: Install the virus protection software on each server and workstation and configure weekly virus scans. [Configure the virus protection software to update virus definitions automatically [from the update server at [____]][. Coordinate with [the NEC][____] to obtain update server information.]]

][j. Disk Imaging (Backup) Software: Install the disk imaging (backup) software on each server and configure for imaging the internal hard drive to external hard drive.]

****

NOTE: Indicate who to coordinate with to get connections outside of the UMCS. Note that connections to non-government servers are not required by the UMCS and should not be permitted.

****

Where software requires connection to an IP device outside of the UMCS, coordinate with [the project site NEC][____] to obtain access to a Government-furnished server to provide the needed functionality. Do not connect to any device outside of the UMCS without explicit permission from [the project site NEC][____].

3.5.5.3 Monitoring and Control (M&C) Software Configuration

Configure the Monitoring and Control (M&C) Software as specified, as indicated and as follows:

****

NOTE: Indicate who to coordinate user accounts with.

If in the product section you selected that the M&C software uses Windows for user authentication then remove the bracketed text (3 places) concerning passwords. Otherwise keep the bracketed text concerning passwords.

****

a. Set up M&C Software user accounts[and passwords]. Coordinate user accounts[, passwords] and permissions with [the [Controls] [HVAC] [Electrical] shop supervisor][____].

b. Change the default password on all accounts. Remove or disable any accounts which do not require authentication (such as guest accounts).

****

NOTE: Either provide SMTP (e-mail) server information or a POC for the contractor to obtain this information.

****

c. Configure e-mail capability to use [the government furnished SMTP server using the following server information[____].][a Government furnished SMTP server. Coordinate with [the project site NEC][____]for SMTP server information.]

d. Disable all ports, protocols, and network services other than those required or specifically permitted by this Section. Services to be disabled include but are not limited to: FTP, Telnet and SSH.

****

NOTE: Indicate where contractor should obtain certificate.

****

e. Install web server certificate. Obtain certificate from [the project site NEC][____].

3.5.5.4 Control Hardware Installation

****

NOTE: Select if Control Hardware must be installed in an enclosure. Hardware in telecommunication closets will generally not require an enclosure unless necessary to secure the Hardware (i.e. a locked enclosure).

FYI - the requirements for which (if any) Control Hardware to install and where to install it is covered below in the integration requirements.

If permitting Niagara Framework Supervisory Gateways to serve web pages, keep the bracketed text allowing HTTP from Niagara Framework Supervisory Gateways.

****

Install Control Hardware [in an enclosure] [in a lockable enclosure] and as specified. Configure Control Hardware as specified, as required to meet the functions for which the hardware is used and as follows:

****

NOTE: The following list paragraph uses tailoring options.

The text "[except for HTTP originating in Niagara Framework Supervisory Gateways]" is included only if the NIAGARA FRAMEWORK tailoring option is selected.

****

a. Disable all ports, protocols, and network services other than those required or specifically permitted by this Section. Services to be disabled include but are not limited to: FTP, Telnet, SSH, and HTTP[except for HTTP originating in Niagara Framework Supervisory Gateways]. When disabling of ports, protocols and services is not supported by a product, obtain an exception from this requirement prior to using the product and document non-compliance on the Product Data Sheets and As-Built drawings.

****

NOTE: Indicate who the contractor should coordinate with to determine passwords.

****

b. Change the default passwords in all Control Hardware which have passwords. Coordinate new passwords with [the [Controls] [HVAC] [Electrical] shop supervisor][____].

3.6 INTEGRATION OF FIELD CONTROL SYSTEMS

****

NOTE: For complete integration the contract package must include the following:

1. Points Schedule - make sure Points Schedule includes:
- points to be displayed by the M&C Software
- points that can be overridden by the M&C Software
- trend points.
- Alarm routing (also make sure to include the Alarm Routing Schedule)

2. Alarm Routing Schedule drawings. Identify and assign priorities, e-mail addresses (for e-mail and text notification), and alarms to be printed.

3. Demand Limit schedule drawing. Make sure it includes system name, load shed priority and point needed for shut-down or setpoint reset.

4. Control System Schematics for each field control system (This may be an as-built drawing from the field control system specification - such as Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC)

5. Occupancy Schedules for each field control system. (This may be an as-built drawing from the field control system specification - such as Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC)

While integration *may* be able to be performed without the other drawings, the Points Schedule is required for successful integration of any system and must be provided.

Note that the necessary Points Schedule drawing should be part of the as-built submittal for building control systems - particularly those installed using Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. If a points schedule for the system is not available one must be created and included in the contract package. Alternatively, a requirement can be manually added here (along with appropriate edits to the submittals and project sequencing paragraphs) to include a site survey of

the system prior to integration, the results of which the Government must then use to provide actual integration requirements such as identifying points to be displayed, overridden, trended etc (thus creating a Points Schedule as part of the project).
****

****
NOTE: Contract drawings must indicate the FPOC location or FPOC location must be provided in the empty bracket.

Coordinate with the project site to ensure there is an FPOC available for connection of the building control network to the UMCS IP Network..

****

Fully integrate the field control systems in accordance with the following three step sequence and as specified and shown.

STEP 1: Install and configure Control Hardware as necessary to connect the field control system to the FPOC, which is part of the UMCS IP network, and to provide control protocol translation and supervisory functionality.

STEP 2: Add Field Control System to M&C Software: Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to the field control system.

STEP 3: Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.6.1 Integration Step 1: Install Control Hardware

****
NOTE: Step 1 requires connecting to the FPOC, which is typically managed by the project site IT staff. Provide a POC for making this connection.
****

Install Control Hardware as specified at the FPOC location [as shown][_____] to connect the field control system to the UMCS IP network via the FPOC and, if necessary, to provide control protocol translation and supervisory functionality. Coordinate all connections and other activities related to an FPOC with [_____]. Depending on the field control system media and protocol this must be accomplished through one of the following:

a. Connect the existing field control network hardware at the FPOC location to the FPOC.

****
NOTE: The following list paragraph uses tailoring options.
1) "Control Protocol Gateway" is included if the BACNET, LONWORKS, MODBUS or OPC tailoring option is selected.

2) "Niagara Framework Supervisory Gateway" is included if the NIAGARA FRAMEWORK tailoring option is selected.

3) The "either" and "or" are included if the NIAGARA FRAMEWORK tailoring option AND any of the other 4 protocol tailoring options are selected.

****

b. Install either a Control Protocol Gateway or Niagara Framework Supervisory Gateway connected to both the field control network and the FPOC.

****

NOTE: The following TWO list paragraphs are included if the BACNET, LONWORKS, MODBUS or OPC tailoring option is selected.

****

c. Install a Control Protocol Router connected to both the field control network and the FPOC.

d. Install a Control Protocol Gateway connected to the field control network. Then install a Control Protocol Router connected to both the Control Protocol Gateway and the FPOC.

****

NOTE: The following paragraph is included if the BACNET tailoring option is selected.

****

In addition, for integration of field control systems via ASHRAE 135, also install a BACnet Supervisory Controller as needed to implement scheduling, alarming and trending in the field control system. The BACnet supervisory controller may be the same device as the control protocol gateway or router.

3.6.1.1 Installation of Control Protocol Gateway

****

NOTE: This subpart is included only if the BACNET, LONWORKS, MODBUS or OPC tailoring option is selected.

This subpart also uses tailoring options to:
1) include the references to the protocol only if the corresponding tailoring option is selected

2) include the protocol routers only when the corresponding tailoring option is selected

****

If the field control system uses a protocol which is not supported by the M&C Software, install a gateway to convert the field control system protocol to ASHRAE 135, or to CEA-709.1-D, or to MODBUS Protocol/ MODBUS TCP/IP, or to OPC DA. Install additional field control system network media and hardware as needed to connect the Gateway to the field control system. Connect the Gateway according to one of the two following methods:

a. Connect the Gateway to the field control network and to the FPOC.

b. Connect the Gateway to the field control network and to a BACnet/IP Router, or to a LonWorks/IP Router, or to a Modbus/IP Router installed as specified.

Create and configure points and establish network communication between the Control Protocol Gateway and the field control system to provide points from the field control system to the M&C software.

3.6.1.2 Installation of Niagara Framework Supervisory Gateway

****

NOTE: This subpart only applies to Niagara Framework systems and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

Install Niagara Framework Supervisory Gateway hardware to connect the field control network to the FPOC. Install additional field control system network media and hardware as needed to connect the Niagara Framework Supervisory Gateway to the field control system.

3.6.1.3 Installation of Control Protocol Router

****

NOTE: This subpart is included only if the BACNET, LONWORKS, MODBUS or OPC tailoring option is selected.

This subpart uses tailoring options to include the protocol routers only when the corresponding tailoring option is selected

****

If there is not an existing connection between the FPOC and the field control network, install a BACnet/IP Router, or a LonWorks/IP Router, or a Modbus/IP Router to connect the field control network to the FPOC. Install additional field control system network media as needed to connect the Router to the field control system.

3.6.1.4 Installation of BACnet Supervisory Controller

****

NOTE: This subpart only applies to BACnet systems and is only included when the BACNET tailoring option is selected.

****

If required for implementation of scheduling, alarming and trending, install a BACnet Supervisory Controller connected to the building control system IP network and configure it to provide scheduling, alarming and trending functions for the field control system. When the BACnet Supervisory Controller is the same device as a control protocol router or gateway, install it in accordance with the installation requirements for a router or gateway.

3.6.2 Integration Step 2: Add Field Control System to M&C Software

Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to points and data in the field control system.

3.6.2.1 Integration of Field Control Systems Via ANSI-709.1-C

****

NOTE: This subpart only applies to integration via LonWorks and is only included when the LONWORKS tailoring option is selected.

****

a. When a LNS Database of the field control system is not available, use the Network Configuration Tool software to discover the field control system and create an LNS Database for the field control system.

b. When the UMCS does not already contain an LNS Server, provide an LNS Server to support the UMCS LNS Database.

c. When there is no existing UMCS LNS Database, use the field control system database as the UMCS Database.

d. When there is an existing UMCS LNS Database, merge the field control system with the UMCS LNS database.

3.6.2.2 Integration of Field Control Systems Via ASHRAE 135

****

NOTE: This subpart only applies to integration via BACnet and is only included when the BACNET tailoring option is selected.

****

Use the M&C Software to fully discover the field control system. Full discovery of a field control system includes but is not limited to discovery of all ASHRAE 135 devices, all standard ASHRAE 135 Objects and Properties of each device, and all standard ASHRAE 135 services supported by each device.

3.6.2.3 Integration of Field Control Systems Via Niagara Framework

****

NOTE: This subpart only applies to integration via Niagara Framework and is only included when the NIAGARA FRAMEWORK tailoring option is selected.

****

For each Niagara Framework Supervisory Gateway installed in integration step 1 for this project do both of the following:

a. Use the Niagara Framework Engineering Tool to fully discover the field control system and make all field control system information available to the Niagara Framework Supervisory Gateway.

b. Create and configure points and establish network communication between the Niagara Framework Supervisory Gateway and the field control system to provide points from the field control system to the M&C software and to provide support for supervisory functions, including but not limited to schedule objects, trend logs and alarming.

For each Niagara Framework Supervisory Gateway to be integrated as part of this project, make all information in the Niagara Framework Supervisory Gateway available to the M&C Software.

3.6.2.4 Integration of Field Control Systems Via Modbus

****

NOTE: This subpart only applies to integration via Modbus and is only included when the MODBUS tailoring option is selected.

****

****

NOTE: Detailed documentation will be required for the integration of Modbus systems as there is no standard database (like there is in LonWorks) or no standard means for device discovery (like there is in BACnet).

Keep the first large set of bracketed text if this point information does not exist and the contractor must survey the building to determine the appropriate point information. When using this option, consider providing a POC at the project site who can assist the contractor with this survey.

Keep the second large set of bracketed text if this point information is available, and indicate the source of this point information:

Use [contract document Points Schedule] if the Points Schedule exists and will be included in the contract package

Use [field control system documentation Points Schedules] if the integrating contractor is also providing the Modbus system at the same time.

Use [____] to indicate other ways this information is being conveyed.

If the points required by the M&C Software (for display, trends, alarms etc) are shown on a Points Schedule keep [as shown on the Points Schedule], otherwise remove this bracketed text to require all points be available.

****

[Survey the field control system to create Points Schedules. Using these Points Schedules][Using the [contract document Points Schedule][field control system documentation Points Schedules][____],] make all points[as shown on the Points Schedule] from the field control system available in the M&C Software.

3.6.2.5 Integration of Field Control Systems Via OPC DA

****

NOTE: This subpart only applies to integration via

OPC and is only included when the OPC tailoring option is selected.

****

****

NOTE: If the points required by the M&C Software (for display, trends, alarms etc) are shown on a Points Schedule keep [as shown on the Points Schedule], otherwise remove this bracketed text to require all points be available.

****

Establish a connection between the M&C Software OPC DA client and the field control system OPC DA server and make all points[as shown on the Points Schedule] from the field control system available in the M&C Software.

3.6.2.6 [Enter Appropriate Subpart Title Here]Integration of Field Control Systems Via Other (non-Niagara Framework (Fox Protocol), non-ASHRAE 135, non-CEA-709.1-D, non-Modbus, non-OPC DA) Protocols

****

NOTE: If the points required by the M&C Software (for display, trends, alarms etc) are shown on a Points Schedule keep [as shown on the Points Schedule], otherwise remove this bracketed text to require all points be available.

The requirement here for making points available to the M&C Software are broad since it is not possible to specify how perform these tasks without details about the field control system and M&C Software.

****

Perform all actions necessary to make all points[as shown on the Points Schedule] from the field control system available in the M&C Software.

3.6.3 Integration Step 3: Configure M&C Software

Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.6.3.1 Configure M&C Software Communication

Create and configure points and establish network communication between M&C Software and Field Control Systems as specified to support M&C Software functionality:

a. Update points on currently active displays via polling as necessary to meet M&C Software display refresh requirements.

****

NOTE: The following list paragraph uses tailoring options.
1) LonWorks requirements are included only when the LONWORKS tailoring option is selected.
2) BACnet requirements are included only when the BACNET tailoring option is selected.

****

b. Send points used for overrides to the device receiving the override as shown on the Points Schedule. For LonWorks systems, for points used for overrides use the network variable and SNVT type indicated on the Points Schedule. For SNVTs for overriding schedules (via the Simple Scheduler) use SNVT type SNVT_occupancy and support the following values: OC_OCCUPIED, OC_UNOCCUPIED, OC_STANDBY and OC_NUL. For SNVTs used to override schedules or setpoints for Demand Limiting functions use the acknowledged service. For BACnet systems write operator overrides with a priority of 8 and demand limiting overrides with a priority of 10.

****

NOTE: The following list paragraph uses tailoring options.
1) BACnet requirements are included only when the BACNET tailoring option is selected.
2) LonWorks requirements are included only when the LONWORKS tailoring option is selected.
3) MODBUS requirements are included only when the MODBUS tailoring option is selected.
4) OPC requirements are included only when the OPC tailoring option is selected.

****

c. For Notification Class Objects used for Alarms, configure the Recipient_List Property to point to the appropriate M&C Software process. Use the ConfirmedEventNotification service for events from ASHRAE 135 field control systems used for alarms. Bind points from CEA-709.1-D field control systems used using acknowledged service or poll the point at 5 minute intervals. Poll points from MODBUS Protocol/ MODBUS TCP/IP field control systems used for alarms at 5 minute intervals. For points from OPC DA field control systems used for alarms use a subscription or poll the point at 5 minute intervals.

****

NOTE: The following TWO list paragraphs are included only when the LONWORKS, MODBUS or OPC tailoring option is selected.

Requirements for LonWorks field control system are only included when the LONWORKS tailoring option is selected.

****

d. Update points used for currently active trends via polling as necessary to meet trend interval requirements.

e. Send points used for scheduling to the field control system with a maximum time between subsequent transmissions of the point of 30 minutes. For LonWorks field control systems, send points used for scheduling to the appropriate System Scheduler using SNVTs of type SNVT_occupancy which support the following values: OC_OCCUPIED, OC_UNOCCUPIED and OC_STANDBY.

****

NOTE: Future upward reporting to an enterprise

system will likely require that Real Property Unique IDs (18 digits numeric) be included when point information is transmitted to the enterprise. The following requires that the contractor include the Real Property Unique IDs (RPUID) in a description field of the M&C Software point when performing integration. Coordinate with the project site to determine whether to include this requirement. If including this requirement show the RPUID on the Points Schedule.

****

[Edit the Description field of each point to include the Real Property Unique IDs (RPUID) associated with that point as shown on the Points Schedule

]3.6.3.2 Configure M&C Software Functionality

Fully configure M&C Software functionality using the M&C Software capabilities specified in PART 2 of this Section.

****

NOTE: Indicate if the installation has sample graphic pages. Indicate how points on graphic pages should be labeled. Coordinate with the project site to determine if they have a naming convention.

Indicate who the contractor should coordinate with for user permissions.

****

a. Create System Displays [using the [project site] sample displays,]including overrides, as shown on the Points Schedule and as specified. Label all points on displays with [full English language descriptions][the point name as shown on the Points Schedule][the point description as shown on the Points Schedule][____]. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with [the [Controls] [HVAC] [Electrical] shop supervisor][____]

****

NOTE: The following list paragraph uses tailoring options:
1) the phrase "alarm generation and" is included only when the LONWORKS, MODBUS or OPC tailoring option is selected.
2) The requirements for configuring alarming in BACnet ("Create and configure... and all others as critical.") are included only when the BACNET tailoring option is selected

****

b. Configure alarm generation and alarm handling as shown on the Points Schedule, as shown on the Alarm Routing Schedule, and as specified. Create and configure Objects in BACnet Supervisory Controllers and in the field control system to support alarming as shown on the Points Schedule and as specified. Alarm events with priority 112 are critical and events with priority 224 are non-critical. For alarm events with other priorities, treat events with priorities of 200 or above as non-critical, and all others as critical. For alarms requiring notification via text message or e-mail, configure the alarm notification to use the specified Government furnished SMTP server to send the alarm notification.

****

NOTE: The following 2 list paragraphs use tailoring options to include requirements for the selected protocol tailoring options only.

****

c. Configure scheduling as indicated and as shown on the points schedule. Configure M&C Software scheduling functionality to schedule Modbus systems andOPC systems. Configure M&C Software scheduling functionality for LonWorks field control systems which do not use the Simple Scheduler Object. For LonWorks field control systems which do use the Simple Scheduler Object, configure the Simple Scheduler Objects in the field control system. Create and configure Schedule Objects in BACnet Supervisory Controllers or in the field control system.

Create and configure displays for configuration of M&C Software schedules and Simple Scheduler Objects in the field control system and Schedule Objects in the field control system. Label schedules and scheduled points with full English-language descriptors. Provide a separate configuration capability for each schedule. A single configuration display may be used to configured multiple schedules, provided that each schedule is separately configurable from the display.

****

NOTE: The following list paragraphs uses tailoring options:

1) "Create M&C Software trends for required points as shown on the Points Schedule and as specified." is included when the LONWORKS, MODBUS or OPC tailoring option is selected.

2) "Create and configure Trend Objects in BACnet Supervisory Controllers and in the field control system as shown on the Points Schedule and as specified" is included only when the BACNET tailoring option is selected.

****

d. Create M&C Software trends for required points as shown on the Points Schedule and as specified. Create and configure Trend Objects in BACnet Supervisory Controllers and in the field control system as shown on the Points Schedule and as specified. Trend points at [15] [_____] minute intervals.

Create and configure displays for creation and configuration of trends and for display of all trended points.

e. Configure Demand Limiting as shown on the Demand Limit Schedule and Points Schedule and as specified.

f. Configure M&C Software standard reports.

3.7 START-UP AND START-UP TESTING

Test all equipment and perform all other tests necessary to ensure the system is installed and functioning as specified. Prepare a Start-Up and Start-Up Testing Report documenting all tests performed and their results and certifying that the system meets the requirements specified in the contract documents.

3.8 PERFORMANCE VERIFICATION TEST (PVT)

****

NOTE: A set of Field Test Procedures are being developed by an A/E under contract with Huntsville Center. Once complete, these Test Procedures will be included or referenced here.

Brief interim guidance is provided here.

****

3.8.1 PVT Phase I Procedures

Provide PVT Procedures which include:.

a. Network bandwidth usage and available bandwidth (throughput) measurements. Network bandwidth usage must reference the normal usage network Bandwidth Calculations.

b. Test System Reaction during PVT: The total system response time from initiation of a control action command from the workstation, to display of the resulting status change on the workstation must not exceed 20 seconds under system normal heavy load conditions assuming a zero response time for operation of the node's control device.

c. Verification of IP Connectivity.

d. Verification of configuration of M&C Software functionality.

3.8.2 PVT Phase I

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures previously approved by the Government, demonstrate all physical and functional requirements of the project. Upon completion of PVT Phase I and as specified, prepare and submit the PVT Phase I Report documenting all tests performed during the PVT and their results. In the PVT report, include all tests in the PVT Procedures and any other testing performed during the PVT. Document failures and repairs with test results.

3.8.3 PVT Phase II

Include Basic Training as part of PVT Phase II. Failures or deficiencies of the UMCS during Basic Training are considered PVT failures. Upon completion of PVT Phase II, and as specified, prepare and submit the PVT Phase II Report documenting any failures which occurred and repairs performed during PVT Phase II.

3.9 MAINTENANCE AND SERVICE

****

NOTE: The maintenance and service to be provided by the Contractor for the duration of the IDIQ or maintenance contract is specified in this paragraph. The Maintenance and Service may need to be a separate bid item funded by O&M funds.

Some/many of these Maintenance and Service requirements may not apply if the UMCS networking equipment and supporting infrastructure is Government furnished equipment and maintained by the Government.The requirements here generally assume that the contractor is permitted access to the system and equipment, but the applicability of this assumption will vary site-by-site. It's critical to coordinate with the project site to determine to what extent the contractor will be responsible for system and equipment maintenance. Some notes have been included with bracketed text to provide general guidance, but careful editing of this entire subpart is needed.

Requirements should be coordinated with "WARRANTY MANAGEMENT" in Section 01 78 00 CLOSEOUT SUBMITTALS
****

Perform inspection, testing, cleaning, and part or component replacement as specified and as required to maintain the warranty. Work includes providing necessary preventive and unscheduled maintenance and repairs to keep the UMCS operating as specified, and accepted by the Government, and other services as specified. Perform work in compliance with manufacturer's recommendations and industry standards. Provide technical support via telephone during regular working hours.

3.9.1 Work Coordination

Schedule and arrange work to cause the least interference with the normal Government business and mission. In those cases where some interference may be essentially unavoidable, coordinate with the Government to minimize the impact of the interference, inconvenience, equipment downtime, interrupted service and personnel discomfort.

3.9.2 Work Control

Upon completion of work on a system or piece of equipment, that system or piece of equipment must be free of missing components or defects which would prevent it from functioning as originally intended and designed. Replacements must conform to the same specifications as the original equipment. During and at completion of work, do not allow debris to spread unnecessarily into adjacent areas nor accumulate in the work area itself.

3.9.3 Working Hours

Working hours are from [7:30 A.M.] [_____] to [4:00 P.M.] [_____] local time Mondays through Fridays except Federal holidays.

[3.9.4 Equipment Repairs

****
NOTE: Coordinate with the project site to determine

if equipment (computers and control hardware) repair will be done by the contractor or by local staff, and to what extent. If the equipment is Government furnished then the contractor may not be allowed access to some/all of the equipment for repair. Address Information Assurance (IA) or other equipment access requirements in "Access To UMCS Equipment" below.

Select repair times below.

****

Initiate and complete equipment repairs within the following time periods, where time periods are measured as actual elapsed time from first notification, including working and non-working hours:

a. for non-redundant computer server hardware, initiate within [4] [_____] hours and complete within [8] [_____] hours.

b. for non-redundant computer workstation hardware, initiate within [4] [_____] hours and complete within [8] [_____] hours.

c. for redundant computer server hardware, initiate within [36] [_____] hours and complete within [5] [_____] days.

d. for redundant computer workstation hardware, initiate within [2] [_____] days and complete within [5] [_____] days.

e. for active (powered) control hardware, initiate within [4] [_____] hours and complete within [6] [_____] hours.

f. for cabling and other passive network hardware, initiate within [16] [_____] hours and complete within [5] [_____] days.

Repair is the restoration of a piece of equipment, a system, or a facility to such condition that it may be effectively used for its designated purposes. Repair may be overhaul, reprocessing, or replacement of nonfunctional parts or materials or replacement of the entire unit or system.

]3.9.5 Replacement, Modernization, Renovation

The Government may replace, renovate, or install new equipment as part of the UMCS at Government expense and by means not associated with this contract without voiding the system warranty. Replaced, improved, updated, modernized, or renovated systems and equipment interfaced to the system may be added to the Contractor's maintenance and service effort as a modification.

3.9.6 Access To UMCS Equipment

****

NOTE: Coordinate with the project site to determine any additional access requirements. Specifically, computer and/or control hardware access will likely require meeting certain Information Assurance (IA) requirements.

****

Access to UMCS equipment must be in accordance with the following:

a. Coordinate access to facilities and arrange that they be opened and closed during and after the accomplishment of the work effort. For access to a controlled facility contact the Government for assistance.

b. The Government may provide keys for access to UMCS equipment where the Government determines such key issuance is appropriate. Establish and implement methods of ensuring that keys issued by the Government are not lost or misplaced, are not used by unauthorized persons, and are not duplicated.

c. The Government may provide passwords or issue Common Access Cards (CAC) for access to UMCS computer equipment where the Government determines such issuance is appropriate. Establish and implement methods of ensuring that passwords and Common Access Cards issued by the Government are not used by unauthorized persons.

3.9.7 Records, Logs, and Progress Reports

Keep records and logs of each task, and organize cumulative chronological records for each major component, and for the complete system. Maintain a continuous log for the UMCS. Keep complete logs and be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the UMCS.

3.9.8 Preventive Maintenance Requirements

****

NOTE: If the contractor will not be responsible for Preventive Maintenance keep only the bracketed text requiring a plan "detailing" preventive maintenance (note this may include software maintenance as well as hardware maintenance). Otherwise remove "[detailing]" and keep the other bracketed text.

Delete the requirement for written requests to reschedule maintenance if not required by the project site.

****

[Perform maintenance procedures as described below, or more often if required by the equipment manufacturer.] [Prepare a Preventive Maintenance Work Plan as specified.]

3.9.8.1 Preventive Maintenance Work Plan

Prepare a Preventive Maintenance Work Plan [to schedule] [detailing] all required preventive maintenance. Obtain Government approval of the Work Plan as specified in paragraph PROJECT SEQUENCING.[Strictly adhere to the approved work plan to facilitate Government verification of work.][If it is necessary to reschedule maintenance, make a written request to the Government detailing the reasons for the proposed change at least five days prior to the originally scheduled date. Scheduled dates will be changed only with the prior written approval of the Government.]

[3.9.8.2 Semiannual Maintenance

****

NOTE: Coordinate with the project site to determine whether or not to include the requirements for Semiannual Maintenance. See also above notes regarding maintenance of Government furnished equipment and access requirements.

****

Perform the following Semiannual Maintenance as specified:

a. Perform data backups on all Server Hardware.

b. Run system diagnostics and correct diagnosed problems.

c. Perform fan checks and filter changes for UMCS hardware.

d. Perform all necessary adjustments on printers.

e. Resolve all outstanding problems.

f. Install new ribbons, ink cartridges and toner cartridges into printers, and ensure that there is at least one spare ribbon or cartridge located at each printer.

][3.9.8.3 Maintenance Procedures

****

NOTE: Coordinate with the project site to determine whether or not to include the Maintenance Procedures requirement (in whole or in part). See also above notes regarding maintenance of Government furnished equipment and access requirements.

Select whether notice must be given for maintenance that will result in downtime (off-line) or for any maintenance that MAY result in downtime. A selection of 'will' is recommended unless the project site requests otherwise.

Select appropriate down-times and notice times.

****

3.9.8.3.1 Maintenance Coordination

Coordinate any scheduled maintenance event that [will][may] result in component downtime with the Government as follows, where time periods are measured as actual elapsed time from beginning of equipment off-line period, including working and non-working hours:

a. For non-redundant computer server hardware, provide [14] [_____] days notice, components must be off-line for no more than [8] [_____] hours.

b. For non-redundant computer workstation hardware, provide [7] [_____] days notice, components must be off-line for no more than [8] [_____] hours.

c. for redundant computer server hardware, provide [7] [_____] days notice, components must be off-line for no more than [36] [_____] hours.

d. For redundant computer workstation hardware, provide [4] [_____] days notice, components must be off-line for no more than [48] [_____] hours.

e. For active (powered) control hardware, provide [14] [_____] days notice, components must be off-line for no more than [6] [_____] hours.

f. For cabling and other passive network hardware, provide [21] [_____] days notice, components must be off-line for no more than [12] [_____] hours.

3.9.8.3.2 Software/Firmware

Software/firmware maintenance includes [____] [operating systems,]application programs, and files required for the proper operation of the UMCS regardless of storage medium. User (project site) developed software is not covered by this contract, except that the UMCS software/firmware must be maintained to allow user creation, modification, deletion, and proper execution of such user-developed software as specified. Perform diagnostics and corrective reprogramming as required to maintain total UMCS operations as specified. Back up software before performing any computer hardware and software maintenance. Do not modify any parameters without approval from the Government. Properly document any approved changes and additions, and update the appropriate manuals.

[3.9.8.3.3 Network

****

NOTE: Network maintenance should only be required for Contractor furnished networks. If using a Government furnished network delete the requirement.

****

Network maintenance includes testing transmission media and equipment to verify signal levels, system data rates, errors and overall system performance.

]]3.9.9 Service Call Reception

****

NOTE: Designer should coordinate with the project site to determine if they want the Contractor to be responsible for answering service calls only during working hours or 24-7.

****

a. A Government representative will advise the Contractor by phone or in person of all maintenance and service requests, as well as the classification of each based on the definitions specified. A description of the problem or requested work, date and time notified, location, classification, and other appropriate information will be placed on a Service Call Work Authorization Form by the Government.

b. Submit procedures for receiving and responding to service calls [24 hours per day, seven days a week, including weekends and holidays] [during regular working hours]. Provide a single telephone number for receipt of service calls during regular working hours; service calls are to be considered received at the time and date the telephone call is placed by the authorized Government representative.

c. Separately record each service call request, as received on the Service

Call Work Authorization form and complete the Service Call Work Authorization form for each service call. Include the following information in the completed form: the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion.

d. Respond to each service call request within [two] [_____] working hours. Provide the status of any item of work within [four] [_____] hours of the inquiry during regular working hours, and within [16] [_____] hours after regular working hours or as needed to meet the Equipment Repair requirements as specified.

3.9.10 Service Call Work Warranty

Provide a [1 year] [_____] unconditional warranty on service call work which includes labor and material necessary to restore the equipment involved in the initial service call to a fully operable condition. In the event that service call work causes damage to additional equipment, restore the system to full operation without cost to the Government. Provide response times for service call warranty work equivalent to the response times required by the initial service call.

3.9.11 System Modifications

Make recommendations for system modification in writing to the Government. Do not make system modifications without prior approval of the Government. Incorporate any modifications made to the system into the Operations and Maintenance Instructions, and any other documentation affected. Make available to the Government software updates for all software furnished under this specification during the life of this contract. Schedule at least one update near the end of the contract period, at which time make available the latest released version of all software provided under this specification, and install and validate it upon approval by the Government.

3.10 TRAINING

****

NOTE: Training duration and content should be modified to fit the requirements of the specific job. For example, if this specification is to be used to add to an existing UMCS or to replace a portion of an existing UMCS the training requirements should be relaxed.

****

Conduct training courses for designated personnel in the maintenance, service, and operation of the system as specified, including specified hardware and software. The training must be oriented to the specific system provided under this contract. Provide audiovisual equipment and other training material and supplies required for the training. When training is conducted at Government facilities, the Government reserves the right to record the training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor should assume that attendees will be tradesmen such as electricians or boiler operators. Obtain approval of the training schedule from the Government at least [30] [_____] days prior to the first day of training.

3.10.1 Training Documentation

Prepare and submit one set of Training manuals for each of Basic Training Documentation, Advanced Training Documentation, and Refresher Training Documentation, where each set of documentation consists of:

3.10.1.1 Course Attendance List

Course Attendance List developed in coordination with and signed by the [Controls] [HVAC] [Electrical] shop supervisor.

3.10.1.2 Training Manuals

Include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson in the training manuals. Where portions of the course material are presented by audiovisuals, include copies of those audiovisuals as a part of the printed training manuals.

3.10.2 Basic Training

Conduct a Basic Training course at the project site on the installed system for a period of no less than [5] [_____] training days during Phase 2 of the PVT. A maximum of [ten] [_____] personnel will attend this course. Design training targeted towards training personnel in the day-to-day operation and basic maintenance of the system. Upon completion of this course, each student, using appropriate documentation, should be able to start the system, operate the system, recover the system after a failure, perform routine maintenance and describe the specific hardware architecture and operation of the system. Include the following topics at a minimum:

a. General system architecture.

b. Functional operation of the system, including workstations and system navigation.

c. System start-up procedures.

d. Failure recovery procedures.

e. Schedule configuration.

f. Trend configuration.

g. Perform point overrides and override release.

h. Reports generation.

i. Alarm reporting and acknowledgements.

j. Diagnostics.

k. Historical files.

l. Maintenance procedures:

(1) Physical layout of each piece of hardware.

(2) Troubleshooting and diagnostic procedures.

(3) Preventive maintenance procedures and schedules.

3.10.3 Advanced Training

****

NOTE: This subpart uses tailoring options to include requirements for selected protocols only.
1) CEA-709.1-D Network Configuration Tool is included only when the LONWORKS tailoring option is selected.
2) BACnet Network Browser is included only when the BACNET tailoring option is selected.
3) Niagara Framework Engineering Tool is included only when the NIAGARA FRAMEWORK tailoring option is selected.

****

****

NOTE: Coordinate with the project site to select the location of the Advanced Training (or leave it up to the Contractor). Select the duration of the training and the number of attendees.

****

Conduct an Advanced Operator Training course [at the project site] [off-site or at the project site] for a period of not less then [five] [_____] days. A maximum of [ten] [_____] personnel will attend this course. Structure the course to consist of "hands-on" training under the constant monitoring of the instructor. Include training on the M&C Software, and the CEA-709.1-D Network Configuration Tool , and the BACnet Network Browser, and the Niagara Framework Engineering Tool. Upon completion of this course, the students should be fully proficient in the operation and management of all system operations and must be able to perform all tasks required to integrate a field control system into the UMCS. Report the skill level of each student at the end of this course. Include the following topics at a minimum:

a. A review of all topics in Basic Training

b. Using the CEA-709.1-D Network Configuration Tool for Network Management and using the BACnet Network Browser for network discovery

c. M&C Software configuration, including but not limited to: creating and editing system displays, alarms, schedules, trends, demand limiting and calculations.

3.10.4 Refresher Training

****

NOTE: Refresher Training should be timed to take place near the end of the 1-year warranty period. If the UMCS is contracted out via an IDIQ process, it may be desirable to repeat the Refresher Training periodically.

****

Conduct a Refresher Training course at the project site for a period of [two] [_____] training days when approved by the Government and as specified in paragraph PROJECT SEQUENCING. A maximum of [ten] [_____] personnel will attend the course. Structure the course to address specific topics that the students need to discuss and to answer questions concerning the operation of the system. Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed UMCS. Correct any system failures discovered during the Refresher Training at no cost to the Government.

APPENDIX A

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NOTE: The QC Checklist table may not display properly in SpecsIntact. If it appears empty right-click on the table and select "Make All Rows Same Height" to make the entire table appear and then adjust row heights as needed (such as reducing row height for rows with less text).

****

QC CHECKLIST			
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.			
This checklist is for (check one:)			
	Pre-Construction QC Checklist Submittal (Items 1-2)	( )	
	Post-Construction QC Checklist Submittal (Items 1-6)	( )	
	Close-out QC Checklist Submittal (Items 1-14)	( )	
Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.			
Verify the following items for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:			
1	Contractor Design Drawing Riser Diagram includes location and types of all Control Hardware and Computer Hardware.		|____|
2	M&C Software supports the Niagara Framework, and ASHRAE 135, and CEA-709.1-D, and MODBUS Protocol/MODBUS TCP/IP, and OPC DA. M&C Software is BTL Listed as a B-AWS. M&C Software is LonWorks Network Services (LNS) based.		|____|
Verify the following items for Post-Construction and Closeout QC Checklist Submittal:			

<table>
<tr><th colspan="4"><u>QC CHECKLIST</u></th></tr>
<tr><td>3</td><td>Communication between the M&C Software and Niagara Framework field control systems uses only Fox protocol. Communication between the M&C Software and ASHRAE 135 field control systems uses only ASHRAE 135. Communication between the M&C Software and CEA-709.1-D field control systems uses only CEA-709.1-D. Communication between the M&C Software and MODBUS Protocol/MODBUS TCP/IP field control systems uses only MODBUS Protocol/MODBUS TCP/IP. Communication between the M&C Software and OPC DA field control systems uses only OPC DA.</td><td></td><td>|____|</td></tr>
<tr><td>4</td><td>Connections to field control systems are via Niagara Framework Supervisory Gateways.

[The following is NOT permitted when Niagara Framework is used and therefore IS NOT PERMITTED for this project: Connections to non-ASHRAE 135, non-CEA-709.1-D, non-Modbus, non-OPC DA field control systems are via a Gateway from the field control system to ASHRAE 135, or to CEA-709.1-D, or to Modbus, or to OPC DA, or via a UMCS supported protocol without the use of a hardware Gateway.]</td><td></td><td>|____|</td></tr>
<tr><td>5</td><td>Computer workstations and servers are installed as shown on the UMCS Riser Diagram.</td><td></td><td>|____|</td></tr>
<tr><td>6</td><td>Training schedule and course attendee lists have been developed and coordinated with shops and submitted.</td><td></td><td>|____|</td></tr>
<tr><td colspan="4">Verify the following items for Closeout QC Checklists Submittal:</td></tr>
<tr><td>7</td><td>LNS Database is up-to-date and accurately represents the final installed system. All points in field control systems have been discovered using the Niagara Framework Engineering Tool and are available at the M&C Software.</td><td></td><td>|____|</td></tr>
<tr><td>8</td><td>All software has been licensed to the Government.</td><td></td><td>|____|</td></tr>
</table>

QC CHECKLIST			
9	M&C software monitoring displays have been created for all building systems, including all override and display points indicated on Points Schedule drawings.		|____|
10	Final As-built Drawings accurately represent the final installed system.		|____|
11	Default trends have been set up (per Points Schedule drawings).		|____|
12	Scheduling has been configured at the M&C Software (per Occupancy Schedule drawing).		|____|
13	O&M Instructions have been completed and submitted.		|____|
14	Basic Operator and Advanced Training courses have been completed.		|____|
	______________________________ ______________		
	(QC Representative Signature) (Date)		

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 05 13.00 10 (November 2023)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-26 05 13.00 40 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 05 13.00 10

MEDIUM-VOLTAGE CABLES

11/23

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-26 05 13.00 10 (November 2023)**

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****

SECTION 26 05 13.00 10

MEDIUM-VOLTAGE CABLES

11/23

****

NOTE: This guide specification covers the requirements for medium-voltage cables, including shielded and nonshielded single-and multiple-conductor power cables, portable cables, cable splices and terminations, single- and multiple-conductor potheads, and fireproofing cables in manholes and utility tunnels.

Show plan layout of power cable and power-cable terminations on drawings. Show the size, type, electrical characteristics, and raceway system of power cables and type of cable termination on electrical riser diagrams.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

[Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION] [33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION] applies to work specified in this section.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS1	(2012) Impregnated-Paper-Insulated, Metallic Sheathed Cable, Solid Type
AEIC CS8	(2013) Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM B3	(2013; R 2024) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 383	(2023) Qualifying Electric Cables and

	Splices for Nuclear Facilities
IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE 400.2	(2024) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE 1202	(2006; R 2012; CORR 1 2012) Flame-Propagation Testing of Wire and Cable
IEEE C2	(2023) National Electrical Safety Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI/NEMA WC 71/ICEA S-96-659	(2014; R 2022) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
NEMA WC 27500	(2020) Standard for Aerospace and Industrial Electrical Cable

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70B	(2023) Recommended Practice for Electrical Equipment Maintenance
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-228	(2014; Rev A; Notice 1) Test Methods for Cable and Wire, Insulated

1.2 DEFINITIONS

Medium-voltage power cables include all cables rated above 600 volts up to 35,000 volts.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meetings

No later than [30][   ] days of Contract Award, coordinate with the Contracting Officer to schedule a pre-installation meeting. Submit the following for review and approval prior to the meeting:

a. Pulling Plan including calculations of pulling tension and side wall pressure anticipated, and the maximum allowable pulling tension for each pull. Do not perform any pull until Government reviews and approves the pulling plan.

b. Splicer/Terminator Certifications

c. List of Splices and Terminations to be Installed by Splicer/Terminator

d. Manufacturer's catalog data for all cables, cable supports and fittings, cable tags, fireproof tape, splice kits, terminations, and any other product data required to complete the work.

e. Certificates showing that the cable manufacturer has made factory-conducted tests on each shipping length (reel) of cable. Include certified copies of test data showing conformance with the referenced standards and approval prior to delivery of cable.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

List of Splices and Terminations to be Installed by Splicer/Terminator; G, [_____]

SD-02 Shop Drawings

Pulling Plan; G, [_____]

SD-03 Product Data

Multiple-Conductor Shielded Cables; G, [_____]

Multiple-Conductor Nonshielded Cables; G, [_____]

Single-Conductor Shielded Cables; G, [_____]

Single-Conductor Nonshielded Cables; G, [_____]

Portable Cables; G, [_____]

Cable Supports and Fittings; G, [_____]

Polyethylene Cable Tags; G, [_____]

Fireproof Tape; G, [_____]

Splices; G, [_____]

Terminations; G, [_____]

Polyethylene Cable Tags; G, [_____]

SD-06 Test Reports

Field Testing; G, [_____]

Qualification Test Reports; G, [_____]

Radiographic Tests; G, [_____]

SD-07 Certificates

Splicer/Terminator Certifications; G, [_____]

SD-08 Manufacturer's Instructions

Medium-Voltage Power Cables; G, [_____]

Terminations; G, [_____]

Splices; G, [_____]

1.5 QUALITY CONTROL

1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Ensure equipment, materials, installation, and workmanship are in accordance with the mandatory and advisory provisions of NFPA 70, IEEE C2 unless more stringent requirements are specified or indicated.

1.5.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products which have been in satisfactory commercial or industrial use for 2 years prior to bid opening. Ensure the 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer.

Qualifications`

Verify personnel performing Medium Voltage (MV) splicing or terminations have [5][   ] years minimum experience in cable splicing and terminations of the type used in this project. Submit splicer/terminator certifications issued by the cable splice and termination manufacturer who has examined and tested a test splice or termination of each type required by this contract for each cable splicer. Ensure the certification identifies which splices and terminations it applies to.[Require each individual, certified or not, with the required medium voltage splicing and terminating experience, who is to perform cable splicing or terminating, to perform a minimum of one splice or termination of each type in the presence of the manufacturer's[and Government's] representative. Supply all materials and tools required for the demonstration splices and terminations.][Submit each splice or termination performed by individuals without manufacturer's certification to the manufacturer for testing and subsequent certification.][Certification is not required for load break elbows and dead break connectors.]

Once a splice or termination has been started by a splicer, ensure the same splicer completes that particular splice, and that each termination and splice is started and completed in one continuous work period.

Maintain and submit a list of splices and terminations to be installed by splicer/terminator. Ensure the list includes the following for each splice or termination completed.

a. Name of splicer/terminator.

b. Date splice or termination was performed.

c. Location of splice or termination. For terminations at equipment indicate equipment number as required to completely define the location.

[

d. Feeder number.]

1.6 DELIVERY, STORAGE, AND HANDLING

Ship cables on reels in a way that protects the cable from mechanical injury. Hermetically seal end of each cable length using heat-shrinkable molded cable end caps to exclude moisture and securely attached to the reel..

Make the minimum reel drum diameter [14] [_____] times the overall diameter of the cable. Ensure that each cable length is installed with a pulling eye installed by the manufacturer, for installation in ducts, manholes, and utility tunnels.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide medium-voltage power cables including multiple- and single-conductor cables rated [5,000][15,000][   ] volts, ungrounded neutral, on [2,400/4,160][13,200/13,800][12,470][   ]-volt three-phase, 60-hertz, phase-to-phase, for grounded and ungrounded neutral systems.

Provide conductor cable assemblies consisting of:

a. Conductor core with an extruded semiconductor shield over the conductors

b. Insulation

c. A polyethylene (PE) jacket.[

d. An extruded semiconductor insulation shield, a concentric neutral]

2.2 EQUIPMENT

Ensure that ethylene-propylene rubber and cross-linked polyethylene-insulated conductors are lead-free.

2.2.1 Multiple-Conductor Shielded Cables

****

NOTE: Ethylene propylene or cross-linked polyethylene-insulated cables are considered higher

quality; however, cross-linked polyethylene insulation has been shown to tree (which breaks down the insulation at the microscopic level, lowering the insulation strength - see AEIC C8) when installed in wet environments. Use of ethylene propylene or anti-treeing cross-link is highly recommended.

When the required cables are not listed below, specify cables conforming to the following publications, and, when necessary, adding to or modifying the requirements of the referenced publications:

Rubber-insulated - NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639, IEEE Std 532

Varnished cloth-insulated - NEMA WC 27500

Thermoplastic-insulated - IEEE Std 532

Cross-linked polyethylene-insulated - NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639, AEIC C8, IEEE Std 532

Ethylene propylene rubber-insulated - NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639, AEIC C8, IEEE Std 532
****

2.2.1.1 [Natural] [Synthetic] Rubber with Interlocked Armor

****
NOTE: Specify multiple-conductor, natural- or synthetic-rubber-insulated, interlocked-armor-covered, shielded cable for 6,900-volt and 13,200/13,800-volt phase-to-phase circuits.
****

Provide multiple-conductor, [natural] [synthetic]-rubber-insulated, interlocked-armor-covered, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

****
NOTE: Change interlocked-armor tape from galvanized steel to aluminum if necessary to suit the project requirements.
****

Apply close-fitting, interlocked-armor tape of galvanized steel over the jacket.

2.2.1.2 Cross-Linked Polyethylene

****
NOTE: Specify multiple-conductor, polyethylene-insulated, polyvinylchloride-jacketed, shielded cable for 6,900-volt phase-to-phase

circuits and 13,200/13,800-volt phase-to-phase circuits.
****

Provide multiple-conductor, cross-linked polyethylene-insulated, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC CS8. Provide taped shielding that consists of 0.13 millimeter 5-mil thick copper shielding lap applied over 0.30 millimeter 12-mil thick semiconducting tape. Wrap both helically with [10] [_____]-percent overlap, providing 100-percent coverage.

[Shield cross-linked polyethylene (XLP) single- and multiple-conductor cables for grounded and ungrounded neutral voltage ratings of 2,000 volts or more.

]2.2.1.3 Ethylene Propylene Rubber (EPR) with Jacketed Interlocked Armor

Provide multiple-conductor ethylene propylene rubber insulated interlocked armor covered shielded cables that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC CS8.

[Shield ethylene propylene (EP) or ethylene propylene rubber (EPR), single- and multiple-conductor cables for grounded or ungrounded neutral voltage ratings of more than 8,000 volts.

]2.2.2 Multiple-Conductor, Nonshielded Cables

2.2.2.1 [Natural] [Synthetic] Rubber with Neoprene Jacket

****
NOTE: Specify multiple-conductor, natural- or synthetic-rubber-insulated, neoprene-jacketed, nonshielded cable for 2,400-volt phase-to-phase, ungrounded/grounded neutral circuits.
****

Provide multiple-conductor, [natural] [synthetic]-rubber-insulated, neoprene-jacketed, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

2.2.2.2 Cross-Linked Polyethylene with PVC Jacket

****
NOTE: Specify multiple-conductor, polyethylene-insulated, PVC-jacketed, nonshielded cable for 2,400-volt phase-to-ground circuits.
****

Provide multiple-conductor, polyethylene-insulated, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC CS8.

2.2.2.3 Ethylene-Propylene with PVC Jacket

****
NOTE: Specify multiple-conductor, ethylene-propylene-insulated, PVC-jacketed, nonshielded cable for 2,400-volt phase-to-ground circuits.

****

Provide multiple-conductor, ethylene-propylene-insulated, PVC-jacketed, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC CS8.

2.2.3 Single-Conductor Shielded Cables

2.2.3.1 Cross-Linked Polyethylene with PVC Jacket

****

NOTE: Specify single-conductor, polyethylene-insulated, PVC-jacketed, shielded cable for 6,900- and 13,200/13,800-volt phase-to-phase circuits.

****

Provide single-conductor, polyethylene-insulated, PVC-jacketed, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC CS8.

2.2.3.2 Cross-Linked Polyethylene with Interlocked Armor

****

NOTE: Specify single-conductor, polyethylene-insulated, PVC-jacketed, shielded cable with interlocked armor for 6,900- and 13,200/13,800-volt phase-to-phase circuits.

****

Provide single-conductor, polyethylene-insulated, PVC-jacketed, shielded cable with interlocked armor that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC CS8.

Apply a close-fitting, interlocked-armor tape of [galvanized steel] [aluminum] over the jacket.

2.2.3.3 Ethylene-Propylene-Rubber-Insulated with PVC Jacket

****

NOTE: Specify single-conductor, ethylene-propylene-rubber-insulated, PVC-jacketed, shielded cable for 6,900- and 13,200/13,800 and 12,470-volt phase-to-phase circuits.

****

Provide single-conductor 15 kV rated cable assemblies that consist of the following: Class B stranded copper conductors, an extruded semiconducting shield over the conductors, 5.6 millimeter 220 mils of ethylene propylene rubber insulation, an extruded or other approved semiconducting shield, a 0.130 millimeter 5-mil minimum copper tape shield wrapped helically with a minimum [12.5] [_____] percent overlap and a PVC jacket.

Provide single-conductor, ethylene-propylene-insulated, PVC-jacketed, shielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, NEMA WC 74/ICEA S-93-639 and AEIC CS8.

2.2.4 Single-Conductor Nonshielded Cables

2.2.4.1 Cross-Linked Polyethylene

****

NOTE: Specify single-conductor, cross-linked polyethylene-insulated, nonshielded cable for 2,400-volt phase-to-ground circuits (5,000-volt cable or less).

****

Provide single-conductor, cross-linked polyethylene-insulated, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, and NEMA WC 74/ICEA S-93-639.

2.2.4.2 Ethylene-Propylene-Rubber-Insulated with PVC Jacket

****

NOTE: Specify single-conductor, ethylene-propylene-rubber-insulated, PVC-jacketed, nonshielded cable for 2,400-volt phase-to-ground circuits (5,000-volt cable or less).

****

Provide single-conductor, ethylene-propylene-rubber-insulated, PVC-jacketed, nonshielded cable that conforms to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, and NEMA WC 74/ICEA S-93-639.

2.2.5 Portable Cables

****

NOTE: Specify multiple-conductor, butyl-rubber-insulated, neoprene-jacketed, shielded portable cable for 2,400-volt phase-to-phase circuits, 6,900-volt phase-to-phase ungrounded neutral circuits, and 13,200/13,800-volt phase-to-phase circuits.

****

Provide SHD multiple-conductor, butyl-rubber-insulated, neoprene-jacketed, shielded portable cable conforming to NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639.

[2.2.6 Insulated Medium Voltage Connectors

Provide connector with a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material per IEEE 386. Ensure connections are compatible with equipment bushings. Provide connectors as follows:

a. 200 Ampere loadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 10,000 amperes rms, symmetrical for a time duration of 0.17 seconds.

b. 600 Ampere deadbreak connector ratings: Voltage: 15kV, 95kV BIL. Short time rating: 27,000 ampere rms, symmetrical for a time duration of 4.0 seconds.

c. Provide connectors with a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material per IEEE 386. [Provide hot line voltage indicators on all connectors.]

Ensure connections are compatible with equipment bushings.

]2.2.7 Splices

Provide [heat][cold] shrink splice kits which are the product of a single manufacturer. Ensure the power cable splice meets the requirements of IEEE 404 for a [5][15][   ] kV rating, and must be rated by the manufacturer for use on [5][15][   ] kV class cable systems. Ensure splices are rated for continuous operation at 105 degrees C 221 degrees F, with an emergency overload temperature rating of 140 degrees C 284 degrees F. Ensure the kit is capable of splicing cables with copper[or aluminum] conductors sized as indicated in the contract drawings or accommodate a conductor size transitionProvide splices specifically designed for the cable and grounding provisions.

[Provide heat shrink splices which include but are not limited to the following:

a. Inner heat shrink stress control tube with external end sealant, additional heat shrink tube over inner tube and inner tube end sealant.

b. Heat shrink outer wraparound sleeve with heat sensitive indications on both the tube and rail/channel area to indicate proper torch heating, stress relief material, mastic, sealant, shielding mesh, and silicone grease.

][Provide splices of a cold shrink design which does not require any additional heat source for installation. The cold shrink splice body must be of a molded design made of silicone rubber with splice jacketing made of EPDM rubber.]

2.2.8 Terminations

Provide Class 1 terminations per IEEE 48.

****

NOTE: Coordinate the following paragraph with Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION if Section 33 71 02 is used in this project.

****

2.2.9 Cable Supports and Fittings

[Provide cable supports, related fittings, and accessories for use in corrosive underground locations, such as manholes and utility tunnels, with a factory-applied coating of PVC of at least [0.51] [_____] millimeter [20] [_____] mils thick. Provide PVC coated items that have a uniform thickness and are free of blisters, breaks, and holidays. Provide PVC compound that conforms to ASTM D746.

][Provide cable racks, cable tray supports and related fittings that are UL-listed [standard] [heavy]-duty nonmetallic [glass-reinforced nylon] [polycarbonate].

][2.2.10 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 31 MPa 4500 pounds per square inch, and are 0.9 millimeter 0.035-inch thick, non-corrosive non-conductive. Ensure tags are resistive to acids, alkalis, organic solvents, salt water, and are distortion resistant to 150 degrees C 300 degrees F. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ensure ties have a minimum loop tensile strength of 780 newtons 175 pounds. Provide cable tags with block letters, numbers, and symbols 25 millimeter 1 inch high on a yellow background. Ensure letters, numbers, and symbols do not fall off or change positions regardless of the cable tags orientation.

]2.2.11 Fireproof Tape

Provide fireproof tape approximately 0.8 millimeter 30 mils thick by 76 millimeters 3 inches wide, consisting of a flexible, unsupported elastomer that expands in fire to provide a thick char buildup between the flame and the cable. Ensure the tape does not give off a smoke when subjected to flames or support combustion. Also, ensure tape does not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

2.3 MATERIALS

****

NOTE: If aluminum is to be specified for any of the wire purchased, revise the paragraphs accordingly.

Conductors for wire and cable may be aluminum or copper. Aluminum conductors may be considered for use in accordance with NFPA 70, Article 310.106. When used, aluminum conductor material must be AA-8000 series electrical grade aluminum alloy. The designer must consider several factors when deciding to use aluminum instead of copper including comparisons of electrical properties, mechanical properties, environmental properties specific to the intended installation, reliability, and cost. Specifications for wire and cable may be written to permit either aluminum or copper conductors where aluminum is suitable for the application, suitably reliable, and is determined to be more economical than copper.

Aluminum conductors should be permitted only where cost comparisons show an overall savings and after a careful evaluation of the corrosion problems associated with their use. They should only be allowed where installers are qualified to make reliable connections with them. Proper wire and cable connectors must be suitably rated for installation with the conductor material to which they are applied. Wire and cable connectors used with aluminum conductors must be suitably rated, termination must be prepared correctly, and an antioxidant must be applied when the connector is installed. Costs should be compared to between all pertinent items such as installation, conduit, tray, tunnel and duct banks, lifetime costs of energy

losses if significant, and differences in ventilation needs if losses are evaluated. Conductors should have the required current-carrying capacities, the required short circuit capacities, and should be satisfactory with respect to voltage drop. Aluminum conductors should be sized to have equal or less resistance than the alternate copper conductors unless the total cost comparison, including losses, shows a net advantage otherwise. In such cases where the engineering costs to properly compare the use of the two materials will exceed any possible savings to be achieved by aluminum, the arbitrary choice of copper may be the best policy.

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2.3.1 Conductors

Ensure that conductors conform to the applicable requirements of NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639.

[Ensure that conductors are [solid][annealed] copper core conforming to ASTM B3 and ASTM B8 and that they are bare, or tin-alloy-coated, according to the type of insulation used.][Ensure that aluminum conductors are Type AA-8000 aluminum conductors. Do not use Type 1350 aluminum conductors.] Do not intermix copper and aluminum conductors in the same raceway.

Provide Class B stranded conductors.

2.3.2 Insulation

Ensure the provided cables are rated for minimum[90 degrees C 194 degrees F][105 degrees C 221 degrees F] continuous conductor temperature and 130 degrees C 266 degrees F emergency overload.

****

NOTE: Cable insulation is designed to withstand the voltage stresses a cable will experience over its expected lifetime. An insulation level defines various insulation thicknesses within a single voltage rating. The two most common levels are 100 percent and 133 percent. Normally, 100 percent insulation level is used on a grounded system and the 133 percent level is normally used on an “ungrounded” system. A 173 percent insulation level also exists and is normally used on an ungrounded system where further fault clearing time is needed.

****

Provide cables with [100][133][173] percent insulation. Ensure insulation thickness is in accordance with the following:

Voltage Rating (kV)	Insulation Level (%)	Typical Insulation Thickness	
		mm	mils
5	100	2.29	90
	137	2.92	115
	173	3.56	140
8	100	2.92	115
	133	3.56	140
	173	4.45	175
15	100	4.45	175
	133	5.59	220
	173	6.6	260
25	100	6.6	260
	133	8.13	320
	173	10.67	420
35	100	8.76	345
	133	10.67	420
	173	14.73	580

2.3.3 Cable Identification

Provide cables with printing on the outer jacket showing the cable type, name of the manufacturer, the year in which the cable was manufactured, sequential cable reel length markings and a unique number for identification purposes. Closely group the information on the tape at 1.8 meters 6 foot maximum intervals to permit complete identification.

2.3.4 Non-metallic Insulation Shield

Provide extruded insulation shield made of an extruded thermoset material compatible with the insulation and jacket. Ensure insulation shield is applied directly over and bonded to the insulation, and complies with AEIC CS8.

[2.3.5 Concentric Neutral Shield

Provide [copper][aluminum] wires helically applied over the insulation shield, where the minimum total cross sectional area (of the shield wires) is [1/3 of the core][full core] conductor for the cable. Minimum size of an individual shield wire is 1.6 millimeter No. 14 AWG.

]2.3.6 Jacket

Provide [polyvinyl-chloride (PVC)][polyethylene (PE)] jacketed cable extruded over the cable to a minimum thickness of 2 millimeter 80 mils.

2.3.7 Interlock Armored Cable

Provide a nonmetallic, corrosion-resistant jacket over interlock-armored cable that is [[thermoplastic black] [colored] [PVC]] [black polyethylene] conforming to [NEMA WC 27500] [NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639].

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

2.4.1 FACTORY TESTING

Submit certified evidence that the cable manufacturer has made factory-conducted tests on each shipping length (reel) of cable. Submit certified copies of test data in accordance with applicable provisions of the referenced standard. Include in tests on each length of cable to include:

(1) Conductor Resistance

(2) Accelerated Water Absorption Test

(3) Water Immersion Test

(4) Ionization

(5) High-Voltage

(6) Partial Discharge Test[

Contracting Officer or designee has the option of witnessing required factory testing at no additional cost. Provide a schedule of manufacturing and testing in advance to permit such witnessing, if requested.]

Submit certified qualification test reports in accordance with AEIC CS8 made in accordance with the applicable referenced standards. Ensure certified copies of test data show conformance to the requirements of referenced standards and submit for approval prior to shipment of the cable.

Prior to manufacturing, provide data regarding degradation of proposed insulating material and cable performance due to water immersion test as specified in this specification to the Contracting Officer or designee. Indicate in information AC breakdown stress in kV/mm or V/mil versus immersion time. Ensure a complete description and condition under which cable was tested accompanies the test information. Submit an accelerated water absorption test.[

For cables not to be enclosed in metallic conduit, test for flammability in accordance with [FED-STD-228, Method 5221 [vertical], [spark]][IEEE 383 and IEEE 1202, 20000 watt 70,000 Btu per hour per hour vertical tray flame test].]

PART 3 EXECUTION

[3.1 DEMOLITION OR CABLE CUTTING

Notify the Contracting Officer 14 working days prior to an outage for demolition or cable cutting of medium voltage electrical system.

The Government has established a mandatory inspection point prior to Contractor performing any medium voltage cable cuts or demolition. Notify the Contracting Officer 48 hours in advance of this mandatory inspection point.

As part of the mandatory inspection point, positively identify and label the medium voltage cable to be worked utilizing an electronic cable identifier. Ensure the process of identifying and labeling the cable to be worked is witnessed by the Government. Cable cutting and demolition of any medium voltage cable can occur only after approval by the Contracting Officer.

Cut medium voltage cables and conductors by indirect means using cable cutters specifically designed to be operated remotely only. Cutting of medium voltage cables and conductors by direct means is not permitted.

]3.2 INSTALLATION

Install medium-voltage cables in accordance with NFPA 70, NFPA 70E; and IEEE C2.

[Refer to contract provisions for safety submittals and requirements associated with working in the vicinity of energized cables and equipment. The use of arc-flash and shock prevention equipment and personal protective equipment is mandatory.

] Notify the Contracting Officer 14 working days prior to an outage that requires testing for phasing and phase rotation of medium voltage electrical systems. The [Government][_____] will identify and tag the phasing of equipment and provide to the Contractor, in writing, the results of phasing and phase rotation tests. The Contractor is responsible for maintaining the phasing and phase rotation tests, and is responsible for maintaining the phasing, and matching the existing phase rotation and phasing when installing conductors in existing electrical systems.

Install the cables in the following locations:

Exterior:

a. In underground duct banks

b. In conduit above and below grade

c. In manholes

d. And by direct burial

Inside Buildings:

a. By open wire method

b. On insulator hooks

c. On racks

d. In wall and ceiling mounted cable trays

Secure cables with heavy-duty cable ties in existing or new trays mounted horizontally, where the cable rests on the tray bottom. Install cable ties at a minimum of [3000] [_____] millimeter [10] [_____] foot intervals.

Secure cables with [PVC-coated] [metallic] [non-metallic] cable clamps, straps, hangers, or other approved supporting devices to tunnel walls, ceilings, and in new or existing cable trays mounted vertically, where the tray bottom is in a vertical plane.

When field cuts or other damage occurs to the PVC coating, apply a liquid PVC patch to maintain the integrity of the coating. After the installation is complete, perform an inspection to ensure that the coating has no voids, pinholes, or cuts.

Before installing new armored cable, ensure that cable trays are properly secured and supported. Add new permanent or temporary tray support devices as required to preclude cable tray failure during cable pulling or after cable is installed.

Installed cable or conductors of a primary distribution system will be rejected by the Government when placed:

a. Openly in cable trays or openly racked along interior walls

b. In the same raceway or conduit with AC/DC control circuits or AC power circuits operating at less than 600 volts

c. In a manner allowing the cable to support its own weight

3.2.1 Protection During Splicing Operations

Provide a blower to force fresh air into manholes or confined areas where free movement or circulation of air is obstructed. Have waterproof protective coverings available on the work site to protect against moisture while a splice is being made. Use pumps to keep manholes dry during splicing operations. Never make a splice or termination with the interior of a cable exposed to moisture. Moisture-test the conductor insulation paper before the splice is made. Use a manhole ring at least [150] [_____] millimeter [6] [_____] inches above ground around the manhole entrance to keep surface water from entering the manhole. Before starting the splice, plug unused ducts and stop water seepage through ducts in use.

3.2.2 Duct Cleaning

****

NOTE: Delete the heading and the following paragraph if the installation of power cables is in ducts and manholes provided under this project. Provisions for duct cleaning are adequately covered in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

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Thoroughly clean ducts before installation of power cables. Pull a standard flexible mandrel through each duct to loosen particles of earth, sand, or foreign material in the line. Use a mandrel that is not less than

[300] [_____] millimeter [12] [_____] inches long with a diameter 13 millimeter 1/2 inch less than the inside diameter of the duct. Then pull a brush with stiff bristles through each duct to remove the loosened particles. Use a brush with a diameter that is the same as or slightly larger than the diameter of the duct.

3.2.3 Pulling Cables in Ducts, Manholes and Utility Tunnels

Submit a Pulling Plan including calculations of pulling tension and side wall pressure anticipated, and the maximum allowable pulling tension for each pull. Do not perform any pull until Government reviews and approves the pulling plan.

Pull medium-voltage cables into ducts and utility tunnels with equipment designed for this purpose, including a power-driven winch, cable-feeding flexible tube guide, cable grips, and lubricants. Employ a sufficient number of trained personnel and equipment to ensure correct installation of the cable.

Set up the cable reel at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Install a flexible tube guide through the opening in a manner that prevents the cable from rubbing against the edges of structural members.

Ensure that the pulling force for a cable grip on lead-sheathed cable does not exceed[the force calculated in the pulling plan for the][[6700] [_____] newton per 650 square millimeter [1,500] [_____] pounds per square inch of] sheath cross-sectional area. Use a dynamometer in the pulling line to ensure that the pulling force is not exceeded. Ensure that the pulling force for a nonmetallic-sheathed cable does not exceed the smaller of 4400 newton 1,000 pounds or a value computed from the following equation:

TM = 0.036 X N X CM

Where: TM = maximum allowable pulling tension in newton pounds

N = number of conductors in the cable

CM = cross-sectional area of each conductor in square millimeter circular mils

3.2.3.1 Allowable Sidewall Pressure

The allowable sidewall pressure is the smaller of 7300 newtons per meter 500 pounds per foot of bend radius or the cable manufacturer's recommended maximum value. Show in the pulling plan submittal the calculations for allowable tension and sidewall pressure as well as the anticipated tension and sidewall pressure for each pull in the project.

Unreel cable from the top of the reel, carefully controlling payout. Attach cable to be pulled through a swivel to the main pulling wire by means of a [pulling eye installed by the factory or approved cable splicer] [suitable cable grip permitted only on cables less than 60 meter 200 feet long and less than 50 millimeter2 inches in diameter].

Attach pulling eyes to the cable conductors of the 3-1/C circuit to prevent damage to the cable structure. Pull the entire 3-1/C circuit simultaneously.

3.2.3.2 Minimum Bending Radius

Minimum bending radius during cable pulling operations is 760 millimeter 30 inches. For permanent cable bending/racking the minimum bending radius is 12 times cable diameter.

3.2.3.3 Coating of Cables

Liberally coat cables with a suitable cable-pulling lubricant as it enters the tube guide or duct. Do not use greaser and oil lubricants. Cover nonmetallic sheathed cables with wire-pulling compounds, when required, which have no deleterious effects on the cable. Use rollers, sheaves or tube guides, around which the cable is pulled, conforming to the 760 millimeter 30 inches minimum bending radius of the cable during the pulling operations.

3.2.3.4 Pulling Speed

Pull cables into ducts at a speed not to exceed [15] [_____] meters per minute 50 feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle is not be permitted. Stop pulling operations immediately with any indication of binding or obstruction and do not resume until such difficulty is corrected. Provide sufficient slack for free movement of cable due to expansion or contraction.

3.2.3.5 Cable Splice Support And Sealing

Firmly support cable splices made up in manholes on cable racks as indicated. Do not pull cable splices in ducts. Overlap cable ends at the ends of a section to provide sufficient undamaged cable for splicing. Overlap cables to be spliced in manholes to the centerline of the proposed joint by not less than [600] [_____] millimeters 2 feet.

Immediately seal cut ends of cables cut in the field to prevent entrance of moisture with heat-shrinkable molded cable end caps.

3.2.4 Splices and Terminations

Make splices in manholes or tunnels except where cable terminations are specifically indicated. Expedite splicing and terminating of cables in order to minimize exposure and cable deterioration.

Use only equipment and materials recommended by the splice manufacturer including calibrated cutting equipment to ensure consistent cut depths when preparing cable ends for the application of the splice kit. Connect the cable concentric neutral/shield wires across one side of the splice by split bundling the splice neutral wiring and connecting each bundle set to a continuous No. 4 AWG solid bare copper conductor via two compression conductors. Ensure the No. 4 AWG conductor extrudes from the cable splice jacket and connects to the manholes grounding system. Make all connections within the splice utilizing long barrel-type compression connectors and appropriate compression tools with proper size dies to ensure a satisfactory mechanical and electrical joint. Ensure bare connections of concentric neutral/shield wires are either contained within the splice kit or sealed via an additional outer covering,consisting of a heavy wall, heat-shrinkable tubing containing adhesive material (mastic) that melts as heat is applied and the outer tubing shrinks to form a moisture proof environmental seal. Provide outer tubing conforming to ANSI C119.1. Ensure splice meets the requirements of IEEE 404 for a 15 kV rating and is rated by the manufacturer for use on 15 kV class feeder cable systems. Take extra precautions to seal around the exit area of the bare copper jumpers with an additional mastic per the splice manufacturer's recommendations.

Terminate cables in approved cable terminations, rated Class 1 per IEEE 48. Dry terminations with medium voltage pennants, preformed, and hand wrapped stress cones can be used for terminating cables. Provide terminations with adequate means for making external connections to the cable conductors of single-conductor cables (phase and concentric neutral), protecting the cable insulation against moisture, oil, or other contaminants. Take extra precautions in physically protecting and supporting cables, and maintaining the insulation level of the cable.

Ensure that installation includes built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables and at the terminals of single-conductor lead-covered cables rated 15 kV and above, ungrounded.

Field-fabricate cable splices from splicing kits supplied by and in accordance with the cable manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified. Locate cable splices in manholes midway between the cable racks on the walls of the manholes and supported with cable arms at approximately the same elevation as the enclosing duct.

If cable splices in the tunnel are not installed in cable trays, install the cable splices on cable racks or by other approved methods that minimize physical stress on the splice connections. Support splices at approximately the same elevation as the installed cable except where space limitations or existing cable length limitations make this method impractical or impossible.

Support all universal demountable splices in a manner that minimizes physical stress on the splice connections. Support each cable end termination using a pair of saddle supports under the cable end termination or cable with a minimum [300] [_____] millimeter [12] [_____] inches and a maximum [750] [_____] millimeter [30] [_____] inches separation between the supports. Secure the cable end termination and cable to the supports in a manner that prevents movement of termination or cable at the support. Install saddle supports on a galvanized steel framing channel that is anchored to the wall, securely fastened to the cable tray, or installed by other approved methods.

3.2.5 Fireproofing

Provide fireproofing (Arc Proofing) for individual cable conductor in manholes, handholes and vaults which carry current at 2200 volts or more.

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Extend the tape 25 millimeter 1 inch into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure-sensitive glass cloth tape.

3.2.6 Cable Tag Installation

Install cable tags in each manhole and at each termination as specified.

Install cable tags over the fireproofing and position the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes and equipment.

3.3 FIELD QUALITY CONTROL

After the installation of power cables has been completed, including splices, joints, and terminations, and before the cable is energized, subject each medium voltage cable to field testing in accordance with the following requirements:

a. Provide test equipment, labor, and trained technical personnel as necessary to perform the electrical acceptance tests.

b. Record all tests on an approved medium voltage cable test form and submit completed forms to the Contracting Officer.

c. Make arrangements to have tests witnessed and approved by the Contracting Officer.

d. Isolate each power-cable installation completely from extraneous electrical connections at cable splices/terminations and joints. Observe all safety precautions.

e. Ensure each power cable is first given an insulation resistance test using a meg-ohmmeter with a voltage output of at least 2,500-volts. Apply test for a long enough time to fully charge the cable (no less than one minute). Record readings as indicated on forms provided. The minimum reading is 5000 megohms at an ambient temperature of 20 degrees C 68 degrees F. Correct readings taken at other than 20 degrees C 68 degrees F ambient temperatures accordingly.

f. Conform testing to NETA ATS, and NFPA 70B.

[Upon successful completion of the insulation resistance test, subject the cable to a Very Low Frequency (VLF) AC high potential test. Adhere general VLF testing measures, parameters, considerations, and results to the following:

a. Ensure test voltage duration is continuous duty for 30 minutes (non-interrupted)

b. Provide the test equipment to test the cable capacity in microfarads.

c. Provide the test equipment to generate the test voltages required for the 30 minute test duration and adhere to the following table:

d.

VLF Test Voltage for Sinusoidal Waveform

Cable Rating phase to phase	Acceptance (phase to ground test values)	Acceptance (phase to ground test values)
	(New cable)	(Existing cable spliced to new cable)
(rms voltage, KV)	(peak voltage, KV)	(peak voltage, KV)

VLF Test Voltage for Sinusoidal Waveform		
Cable Rating phase to phase	Acceptance (phase to ground test values)	Acceptance (phase to ground test values)
	(New cable)	(Existing cable spliced to new cable)
[5]	[14]	[10]
[15]	[28]	[22; (EPR TO EPR)]
[15]	[15]	[15; (EPR TO NON-EPR)]

e. Ensure the sinusoidal test frequency is 0.1 Hertz.

f. Do not perform test on cable attached to equipment.

****

NOTE: Include, but do not limit Acceptance test values to peak voltage, frequency, and duration, with respect to the cable rating, and clearly identify each on the test submittal, with pass/fail results identified per cable installation (refer to IEEE 400.2). Notify Contracting Officer or Contracting Officer's Technical Representative 48 hours prior to test start. All testing will be witnessed by the Government.

****

Ensure Splices/terminations are clean, dry, and tested per IEEE 48 and IEEE 400.2.

][Upon successful completion of the insulation resistance tests, subject the cable to a direct-current high-potential test for 5 minutes applying test voltages in accordance with AEIC CS1 and IEEE 400.2 for paper-impregnated, lead-covered cable; AEIC CS8 and IEEE 400.2 for cross-linked, polyethylene-insulated cable; and AEIC CS8 and IEEE 400.2 for ethylene propylene rubber-insulated cable.

Record leakage current readings every 30 seconds during the first 2 minutes and every minute thereafter for the remainder of the test. When the leakage current continues to increase after the first minute, immediately terminate the test and take steps to find and correct the fault. When a second test becomes necessary, repeat this test procedure.

Upon satisfactory completion of the high-potential test, give the cable a second insulation resistance test as before.

Provide results of the second insulation resistance test that agree with the first test and that indicate no evidence that the cable has been permanently injured by the high-potential test.

Record test data identifying the cable and location, megohm readings versus time, leakage current readings versus time, and cable temperature versus time.]

Final acceptance depends upon the satisfactory performance of the cable under test. Do not energize cable until recorded test data has been approved by the Contracting Officer.

Perform radiographic tests on all potheads at the discretion of the Contracting Officer to determine if voids exist in the pothead. Rework unacceptable terminations at no additional expense to the Government.

3.4 CLOSEOUT ACTIVITIES

Provide manufacturer's instructions showing the recommended sequence and method of installation for medium-voltage power cables.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 05 19.00 10 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-26 05 19.10 10 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-26 05 19.00 10 (November 2022)**

Preparing Activity: USACE **Superseding**
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SECTION 26 05 19.00 10

INSULATED WIRE AND CABLE

11/22

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NOTE: This guide specification covers the requirements for insulated wire and cable for use on hydraulic structures, except for wire and cable for special applications, such as low-level circuits for analog signals, data and supervisory control, communication and telemetering systems. Specification of wire and cable for special applications may be found in other technical guide specifications for the system to which the wire and cable will be applied. Otherwise, the designer must develop and write specifications listing the salient characteristics for the basis of design of the special wire and cable needed.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: Procurement documents, including specifications, plans, and wire tables, should be prepared to include relevant portions of the information checklists stated below. The first

list, "Characteristics of Systems on Which Cable Is To Be Used," would be applicable where insulated wire and cable are to be procured via a construction contract, particularly where the Contractor is expected to decide details such as wire size, etc. It may be used in a supply contract for those purchases where all the characteristics are known in advance such that they can be specified in detail. The items of the second list, "Quantities and Description of Cable," are covered in general in these guide specifications, and should be applicable when procuring insulated wire and cable via supply or construction contracts. These items should be verified or specified in the level of detail needed for each particular case.

1). Characteristics of Systems on Which Cable Is To Be Used.

a. Normal operating voltage between conductors.
b. Frequency.
c. Number of phases & conductors.
d. Cable insulation level [100 percent][133 percent] or [173 percent].

(NOTE for characteristic d. only: 600 Volt AC low voltage cables typically do not require in-service voltage stress consideration and require only 100 Percent Insulation Level. However, there may be some special applications for cables rated 2,000 Volts and less where the designer must consider the in-service voltage stress, determine and insert the proper insulation level into this specification section. Refer to ANSI/NEMA WC 70 for additional descriptions regarding "Insulation Levels" for wire and cables rated 2,000 Volts and below.

The in-service voltage stress must be considered and specified for wire and cables rated 2,001 Volts to 5,000 Volts. The designer must consider the in-service voltage stress, determine and insert the proper insulation level into this specifications section. Refer to ANSI/ANSI/NEMA WC 71/ICEA S-96-659 for additional descriptions regarding "Insulation Levels" for wire and cables rated 2,001 Volts to 5,000 Volts.

The in-service voltage stress must be considered and specified for wire and cables rated 5,001 Volts and above. The designer must consider the in-service voltage stress, determine and insert the proper insulation level into this specifications section. Refer to NEMA WC 74/ICEA S-93-639 for additional descriptions regarding "Insulation Levels." for wire and cables rated 5,000 Volts to 46,000 Volts.")

e. Minimum and maximum temperatures at which cable is expected to be operated.
f. Description of installation.

1.In cable trays.
2.In ducts.
3.Other.

g. Conditions of installation.
1.Ambient temperature.
2.Wet or dry location.
3.Number of loaded cables in cable trays, duct bank, or conduit. If in conduit, provide type of conduit (metallic or non-metallic), number of loaded circuits, whether conduit is enclosed or run exposed, and spacing between conduits.
4.Load factor.
5.Method of bonding and grounding of metallic coverings (including shields).
6.Chemical exposure.

2). Quantities and Description of Cable.

a. Total number of meters feet, including lengths for customer testing, and lengths if specific lengths are required.
b. Type of cable. Describe as single-conductor, two-conductor, etc.
c. Rated circuit voltage, phase to phase.
d. Type of conductors - copper or aluminum.
e. Size of conductors - AWG or circular micrometers (mils). If conditions require other than standard stranding, a complete description should be given.
f. Grade of insulation.
g. Thickness of insulation, in micrometers mils.
h. Type of outer covering.
i. Maximum allowable overall diameter, in mm inches. When duct space is not limited, it is not wise to restrict the overall diameter.
j. Method of conductor identification.

In making wiring layouts for those installations using multiple-conductor cables, care should be taken to avoid the use of assemblies not normally stocked by manufacturers, or of small quantities which will not come within the manufacturers' minimum pricing schedules. In general, unless very large quantities are involved, lower overall cable costs can be effected by using manufacturers' standard assemblies, even though more conductors than required are provided, instead of a cable requiring a special setup. Short lengths may be eliminated by substituting cables which will have sufficient quantity to obtain the manufacturers' minimum price. Substitution may consist of a larger number of conductors than required, or a combination of assemblies of a smaller number of conductors. The most economical cable schedule for any particular installation can be obtained only by careful study of all factors involved, particularly increased conduit costs.

****

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1202	(2006; R 2012; CORR 1 2012) Flame-Propagation Testing of Wire and Cable

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-58-679	(2014) Control, Instrumentation and Thermocouple Extension Conductor Identification
ICEA T-30-520	(1986) Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 70,000 B.T.U./Hour

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 71/ICEA S-96-659	(2014; R 2022) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA WC 26	(2008) Binational Wire and Cable Packaging Standard
NEMA WC 57	(2014) Standard for Control, Thermocouple Extension, and Instrumentation Cables
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for

	Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 1685	(2015) UL Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
UL 2556	(2015) UL Standard for Safety Wire and Cable Test Methods

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

[SD-01 Preconstruction Submittals

Cable Installation Plan; G, [_____]

] SD-03 Product Data

Wire and Cable; G, [_____]

Conductors; G, [_____]

Cable Manufacturing Data

SD-06 Test Reports

Test Report(s), Inspection Report(s), and Verification Report(s); G, [_____]

[Cable Installation Report; G, [_____]

]1.3 DELIVERY, STORAGE, AND HANDLING

Furnish cables on reels or coils. Each cable and the outside of each reel or coil, must be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel of cable must contain only one continuous cable without splices. Cables for exclusively dc applications, as specified in paragraph "High-Voltage Test Source," must be identified as such. Shielded cables rated 2,001 volts and above must be reeled and marked in accordance with NEMA WC 26, as applicable. Reels must remain the property of the [Contractor] [Government].

1.4 PROJECT/SITE CONDITIONS

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NOTE: Use this paragraph to describe unusual environments, such as temperature extremes, chemical exposure, etc.

****

[_____]

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Variations from these specifications may be appropriate in some cases. In addition to increasing rated circuit voltage where large overvoltages could occur, material sizes and

strengths should be coordinated to withstand any pulling forces which will be applied. The lower strength of EPR, even jacketed, may at times preclude the use of this material for long pulls. If variations are requested by a Contractor, they should only be approved if the safety and integrity of conservatively designed circuits are not compromised. The use of polyvinyl chloride (PVC) insulation or jacket material is not permitted.

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2.1.1 Wire Table

****

NOTE: An example typical wire table and a Format Template for a Wire Table are located at the end of this Section. Use this paragraph and Format Template, if itemized characteristics for each application are to be tabulated.

****

Furnish wire and cable in accordance with the requirements of the [wire table below] [wire table appended to these specifications], conforming to the detailed requirements specified herein.

2.1.2 Rated Circuit Voltages

All power wire and cable must have minimum rated circuit voltages in accordance with NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Power wire and cable for circuit voltages rated 0-600 volts must be rated not less than 600 volts. Control wire and cable must have minimum rated circuit voltages in accordance with NEMA WC 57, but must be rated 600 volts if routed in raceway with other conductors that are rated 600 volts.

2.1.3 Conductors

****

NOTE: "Electrical conductors and cables must not propagate flame and must be rated as such by passing or being capable of passing one or more of the following applicable tests.

All electrical cable assemblies (multiple-conductor and single-conductor) must pass, or be capable of passing either the vertical cable tray flame tests required by ICEA T-30-520 (as stated in, but not referred to by NEMA WC 70), the vertical tray flame propagation test requirements of UL 1685 and IEEE Std. 1202, the wire and cable burning characteristics test of the UL 2556 VW-1 Test, or (for control cables only) the flame test as required by NEMA WC 57. (The flame testing requirement was previously restricted to cable tray applications. It is extended to all uses for greater safety, since flame-resistant cables are now available from many manufacturers.)

****

2.1.3.1 Material for Conductors

****

NOTE: If aluminum is to be specified for any of the wire purchased, revise the paragraphs accordingly.

Conductors for wire and cable may be aluminum or copper. Aluminum conductors may be considered for use in accordance with NFPA 70, Article 310.106. When used, aluminum conductor material must be AA-8000 series electrical grade aluminum alloy. The designer must consider several factors when deciding to use aluminum instead of copper including comparisons of electrical properties, mechanical properties, environmental properties specific to the intended installation, reliability, and cost. Specifications for wire and cable may be written to permit either aluminum or copper conductors where aluminum is suitable for the application, suitably reliable, and is determined to be more economical than copper.

Aluminum conductors should be permitted only where cost comparisons show an overall savings and after a careful evaluation of the corrosion problems associated with their use. They should only be allowed where installers are qualified to make reliable connections with them. Proper wire and cable connectors must be suitably rated for installation with the conductor material to which they are applied. Wire and cable connectors used with aluminum conductors must be suitably rated, termination must be prepared correctly, and an antioxidant must be applied when the connector is installed. Costs should be compared to between all pertinent items such as installation, conduit, tray, tunnel and duct banks, lifetime costs of energy losses if significant, and differences in ventilation needs if losses are evaluated. Conductors should have the required current carrying capacities, the required short circuit capacities, and should be satisfactory with respect to voltage drop. Aluminum conductors should be sized to have equal or less resistance than the alternate copper conductors unless the total cost comparison, including losses, shows a net advantage otherwise. In such cases where the engineering costs to properly compare the use of the two materials will exceed any possible savings to be achieved by aluminum, the arbitrary choice of copper may be the best policy.

****

Conductors must conform to all the applicable requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Copper conductors must be annealed copper material and they may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used. [Aluminum conductors must be Type AA-8000 aluminum conductors. Type 1350 is not acceptable. Intermixing of copper and aluminum conductors in the same raceway is not permitted.]"

2.1.3.2 Size

Minimum wire size must be as listed below.

a. No. 12 AWG for power and lighting circuits

b. No. 10 AWG for current transformer secondary circuits

c. No. 14 AWG for potential transformer, relaying, and control circuits

d. No. 16 AWG for annunciator circuits

e. No. 19 AWG for alarm circuits

Minimum wire sizes for rated circuit voltages of 2,001 volts and above must not be less than those listed for the applicable voltage in ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable.

2.1.3.3 Stranding

Conductor stranding classes cited herein must be as defined for control conductors in NEMA WC 57 or as defined for 0-2,000 volts power conductors in NEMA WC 70, as applicable. Lighting conductors No. 10 AWG and smaller must be solid or have Class B stranding. Any conductors used between stationary and moving devices, such as hinged doors or panels, must have Class H or K stranding. All other conductors must have Class B or C stranding, except that conductors as shown, or in the schedule, as No. 12 AWG may be 19 strands of No. 25 AWG, and conductors shown as No. 10 AWG may be 19 strands of No. 22 AWG. Conductor stranding classes for circuit voltages 2,001 volts and above must be as defined in ANSI/NEMA WC 71/ICEA S-96-659 and NEMA WC 74/ICEA S-93-639, as applicable.

2.1.3.4 Conductor Shielding

Use conductor shielding conforming to NEMA WC 57 for control wire and cable as applicable. Use conductor shielding conforming to ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable, on power cables having a rated circuit voltage above 2,000 volts.

2.1.3.5 Separator Tape

Where conductor shielding, strand filling, or other special conductor treatment is not required, a separator tape between conductor and insulation is permitted.

2.1.4 Insulation

2.1.4.1 Insulation Material

****

For project applications which require a different insulation than those listed below, reference a Government criteria or an industry standard that the cable or conductor must meet. For projects which require multiple types of insulations, indicate the type for each cable on the project drawings.

The insulation compounds specified herein are of the thermoplastic and thermosetting type. Thermoplastic insulation types such as THHN, THWN, and THWN-2 must meet the requirements of UL 83 and is typical for circuit voltage ratings of 600 volts. Thermosetting insulation type options include cross-linked thermosetting polyethylene (XLPE) and ethylene-propylene rubber (EPR) which must meet the requirements of UL 44. These two materials alone are widely available and can be satisfactorily compounded to meet the requirements of a conservative cable design for long and reliable service. Cross-linked thermosetting polyethylene insulation types include XHHW and RHW. XHHW type insulation provides good thermal expansion and contraction characteristics applicable for power and control conductors with circuit voltage ratings of 2,000 volts or less in installations exposed to large temperature changes or installed outdoors subject to weather cycles from hot summer to cold winter temperatures. XLPE is applicable for all circuit voltage ratings. EPR is applicable to wire and cable for circuit voltages rated greater than 2,000 volts. The insulation grades permitted must be suitable for service in wet or dry locations at 90 C. This specification does not allow the use of "tray cable" meeting only the minimum requirements of the National Electrical Code or Underwriters Laboratories, which permit a 75 C wet rating. Jackets are also thermosetting, except certain thermoplastic compounds are permitted for use below 601 volts, as defined in paragraph JACKET MATERIAL, subparagraph ACCESSIBLE USE ONLY, 2,000 VOLTS OR LESS, in cases where access for cable installation and removal would not be a problem.

****

Unless specified otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt, [Type THWN/THHN conforming to UL 83] [or] [Type [XHHW] [or] [RHW] conforming to UL 44]. Insulation for control wire and cable must meet the requirements of NEMA WC 57. Insulation requirements for wire and cable rated less than 2,000 volts must meet the requirements of NEMA WC 70. Insulation requirements for wire and cable rated 2,001-5,000 volts must meet the requirements of ANSI/NEMA WC 71/ICEA S-96-659. Insulation requirements for wire and cable rated 5,001 volts and greater must meet the requirements of NEMA WC 74/ICEA S-93-639.

For shielded cables of rated circuit voltages above 2,000 volts, the following provisions must also apply:

a. XLPE, if used, must be tree-retardant.

b. Insulation must be chemically bonded to conductor shielding.

c. The insulation material and its manufacturing, handling, extrusion and vulcanizing processes must all be subject to strict procedures to prevent the inclusion of voids, contamination, or other irregularities on or in the insulation. Insulation material must be inspected for voids and contaminants.

d. Cables with repaired insulation defects discovered during factory testing, or with splices or insulation joints, are prohibited [unless specifically approved].

2.1.4.2 Insulation Thickness

****

NOTE: The rated circuit voltage of the insulation should be specified to be 600 volts for all circuits operating below 601 volts. Higher rated circuit voltages may be required by some applications within this range, such as control circuits containing large dc solenoids used in older circuit breakers. Specifications should then be revised to require 1,000- or 2,000-volt insulation in such cases for multiple- or single-conductor cables, respectively. Below 48 volts, 600-volt insulation can be used, but these are special applications that are best considered in light of the particular circumstances. For example, many proprietary detection systems and programmable controller applications typically use 24-volt, low-power circuits, for which lower rated circuit voltages may be appropriate. These specifications also cover rated circuit voltages for systems operating above 600 volts.

****

The insulation thickness for each conductor must be based on its rated circuit voltage.

2.1.4.2.1 Power Cables, 2,000 Volts and Below

The insulation thickness for single-conductor and multiple-conductor power cables rated 2,000 volts and below must be as required by NEMA WC 70, as applicable. Some thicknesses of NEMA WC 70 will be permitted only for single-conductor cross-linked thermosetting polyethylene insulated cables without a jacket. NEMA WC 70 ethylene-propylene rubber-insulated conductors must have a jacket.

2.1.4.2.2 Power Cables, Rated 2,001 Volts and Above

Thickness of insulation for power cables rated 2,001 volts and above must be in accordance with the following

a. Non-shielded cables, 2,001 to 5,000 volts, must comply with ANSI/NEMA WC 71/ICEA S-96-659, as applicable.

b. Shielded cables rated 5,000 volts to 46,000 volts must comply with NEMA WC 74/ICEA S-93-639, as applicable.

2.1.4.2.3 Single-Conductor and Multiple-Conductor Control Cables

The insulation thickness of control conductor sizes 22 AWG to 10 AWG used for control and related purposes must be as required by NEMA WC 57, as applicable. Control conductors larger than 10 AWG must be as required by NEMA WC 70.

2.1.4.3 Insulation Shielding

Unless otherwise specified, provide insulation shielding for conductors having rated circuit voltages of 2,001 volts and above. The voltage limits above which insulation shielding is required, and the material requirements, are given in ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable. The material, if thermosetting, must meet the wafer boil test requirements as described in ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable. The method of shielding must be in accordance with the current practice of the industry; however, the application process must include strict precautions to prevent voids or contamination between the insulation and the nonmetallic component. Voids, protrusions, and indentations of the shield must not exceed the maximum allowances specified in ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable. The cable must be capable of operating without damage or excessive temperature when the shield is grounded at both ends of each conductor. All components of the shielding system must remain tightly applied to the components they enclose after handling and installation in accordance with the manufacturer's recommendations. Shielding systems which require heat to remove are prohibited unless specifically approved.

2.1.5 Jackets

All cables must have jackets meeting the requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, and NEMA WC 74/ICEA S-93-639, as applicable, and as specified herein. Individual conductors of multiple-conductor cables must be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables, except for shielded cables, must be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables and shielded single-conductor cables must be provided with a common overall jacket, which must be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including jacket, afterward fully meets these specifications and the requirements of the applicable standards.

2.1.5.1 Jacket Material

****

NOTE: Modify the restriction against PVC Jackets if they will be permitted on metal-clad cables, in accordance with paragraph METAL-CLAD CABLE, subparagraph JACKETS.

****

The jacket must be one of the materials listed below. [Polyvinyl chloride compounds will not be permitted.] [Variations from the materials required below will be permitted only if approved for each specific use, upon submittal of sufficient data to prove that they exceed all specified requirements for the particular application.]

2.1.5.1.1 General Use

Heavy-duty black neoprene	NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639
Heavy-duty chlorosulfonated polyethylene	NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639
Heavy-duty cross-linked (thermoset) chlorinated polyethylene	NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639

2.1.5.1.2 Accessible Use Only, 2,000 Volts or Less

Cables installed where they are entirely accessible, such as cable trays and raceways with removable covers, or where they pass through less than 3 meters10 feet of exposed conduit only, must have jackets of one of the materials in item "a. General Use" or one of the following:

General-purpose neoprene	NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639
Black polyethylene (MDPE)	NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639
Thermoplastic chlorinated polyethylene	NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639

2.1.5.2 Jacket Thickness

The minimum thickness of the jackets must be not less than 80 percent of the respective nominal thicknesses specified below.

2.1.5.2.1 Multiple-Conductor Cables

Thickness of the jackets of the individual conductors of multiple-conductor cables must be as required by NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable and must be in addition to the conductor insulation thickness required by the applicable respective NEMA publication for the insulation used. Thickness of the outer jackets and associated coverings of the assembled multiple-conductor cables must be as required by NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable.

2.1.5.2.2 Single-Conductor Cables

Single-conductor cables must have a jacket thickness as specified in

NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable.

2.1.6 Metal-Clad Cable

2.1.6.1 General

The metallic covering or sheath must be [interlocked metal tape] [continuous corrugated metal], conforming to the applicable requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639. The type of metal for the metallic covering must be [galvanized steel] [aluminum] [copper] [copper alloy]. If the covering is of ferrous metal, it must be galvanized. Grounding conductor(s) conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable must be furnished for each multiple-conductor metal-clad cable. Assembly and cabling must be as specified in paragraph "Cabling." The metallic covering must be applied over an inner jacket or filler tape. The cable must be assembled so that the metallic covering will be tightly bound over a firm core.

2.1.6.2 Jackets

Metal-clad cables may have a jacket under the armor, and must have a jacket over the armor. Jackets must comply with the requirements of NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. The outer jacket for the metal-clad cable may be of polyvinyl chloride (PVC) only if specifically approved.

2.1.7 Multiple-Conductor Cables

Grounding conductor(s) conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable must be furnished for each multiple-conductor cable. Assembly and cabling must be as specified in paragraph CABLING.

2.2 CABLE IDENTIFICATION

2.2.1 Color-Coding

****

NOTE: The Control wire and cable color code previously referred to NEMA WC 70, however NEMA WC 70 now refers to ICEA S-58-679. Note that NEMA WC 57 applies specifically to control wire and cable industry standards and also includes recommendations for conductor color coding that are color code methods listed in ICEA S-58-679. The control cable color code specified, although widely used by the Corps of Engineers, does not agree with National Electrical Code requirements of dedicated white color for neutral conductor identification and dedicated green color or green/yellow for grounding conductor identification. If this is required, use the coding in either Table 2 or Table 4 in ICEA S-58-679.

****

Insulation of individual conductors of multiple-conductor cables must be color-coded in accordance with ICEA S-58-679, except that colored braids will not be permitted. Only one color-code method must be used for each cable construction type. Control cable color-coding must be [in accordance with ICEA S-58-679, Method [____]] [as indicated] [as follows: - [_____]]. Power cable color-coding must be as follows:

a. 208/120 volt, three-phase

  (1) Phase A - black

  (2) Phase B - red

  (3) Phase C - blue

  (4) Grounded neutral - white

  (5) Insulated grounding conductor - green

b. 480/277 volt, three-phase

  (1) Phase A - brown

  (2) Phase B - orange

  (3) Phase C - yellow

c. 240/120 volt, single phase: Black and red

[Other individual conductors must be color-coded as indicated, but such color-coding may be accomplished by applying colored plastic tapes or colored sleeves at terminations.

]2.2.2 Shielded Cables Rated 2,001 Volts and Above

Marking must be in accordance with ANSI/NEMA WC 71/ICEA S-96-659 or NEMA WC 74/ICEA S-93-639, as applicable.

2.2.3 Cabling

Individual conductors of multiple-conductor cables must be assembled with flame-and moisture-resistant fillers, binders, and a lay conforming to NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639. Flat twin cables are prohibited. Fillers must be used in the interstices of multiple-conductor round cables with a common covering where necessary to give the completed cable a substantially circular cross section. Fillers must be non-hygroscopic material, compatible with the cable insulation, jacket, and other components of the cable. The rubber-filled or other approved type of binding tape must consist of a material that is compatible with the other components of the cable and must be lapped at least 10 percent of its width.

2.2.4 Dimensional Tolerance

The outside diameters of single-conductor cables and of multiple-conductor cables must not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

PART 3 EXECUTION

3.1 INSTALLATION INSTRUCTIONS

Submit cable manufacturing data [as requested]. The following information must be provided by the cable manufacturer for each size, conductor quantity, and type of cable furnished:

a. Minimum bending radius, in inches - For multiple-conductor cables, this information must be provided for both the individual conductors and the multiple-conductor cable.

b. Pulling tension and sidewall pressure limits, in newtons pounds.

c. Instructions for stripping semiconducting insulation shields, if furnished, with minimum effort without damaging the insulation.

d. Upon request, compatibility of cable materials and construction with specific materials and hardware manufactured by others must be stated. Also, if requested, recommendations must be provided for various cable operations, including installing, splicing, terminating, etc.

[3.2 CABLE INSTALLATION PLAN

****

NOTE: Use the following requirements for specialty cables to be installed in difficult conduit routes. If a cable installation plan is required, also require a report of maximum applied pulling tension.

Because the pulling tension is proportional to the conduit length and multiplies around a conduit bend, the direction of the pull can change the tension.

****

Provide a cable installation plan which includes the following for each raceway. Exclude raceways with less than [45][_] degrees of total bending or shorter than [20][_] feet.

a. Raceway name

b. Circuit names with wire sizes and quantities

c. Maximum tolerable pulling tension

d. Maximum tolerable sidewall pressure

e. Estimated maximum pulling tension

f. Estimated maximum sidewall pressure

g. Jam ratio

h. Lubricant and coefficient of friction

i. Pulling device(s)

j. Direction of pull

]3.3 TEST REPORT(S), INSPECTION REPORT(S), AND VERIFICATION REPORT(S)

****

NOTE: Contract schedules should allow sufficient time for an orderly and timely sequence of data submission, manufacturing of equipment and materials, and delivery in accordance with the specifications. However, there may be occasions when wire and cable must be obtained in such a short time that compliance with the requirements of this paragraph and subparagraphs CABLE DATA and INSPECTIONS AND TESTS, is not practical. In those cases, wire and cable from suppliers' stock may be considered for approval, provided a manufacturer's certificate is submitted, which establishes to the satisfaction of the Contracting Officer that the proposed wire and cable, identified by lot number and reel or coil number, meet the applicable standards and specifications. Such deviations should be limited to those cases in which a contract change or incorrect estimate requires the procurement of cable which, if done following the specified approval procedure, would result in unacceptable contract completion dates.

****

3.3.1 Cable Data

Do not begin any wire and cable fabrication until materials are submitted and approved by the Contracting Officer. Submit cable data for approval including, but not limited to, dimensioned sketches showing cable construction and sufficient additional data to show that wire and cable meet the requirements of this Section.

3.3.2 Inspection and Tests

Inspection and tests of wire and cable furnished under these specifications must be made by and at the plant of the manufacturer, [and must be witnessed by the Contracting Officer, unless waived in writing.] [and the manufacturer must provide certification and certification reports of completed inspections and completed tests.] The Government may require or perform further tests before or after installation. Testing in general must comply with NEMA WC 57, NEMA WC 70, ANSI/NEMA WC 71/ICEA S-96-659, or NEMA WC 74/ICEA S-93-639 as applicable. Specific tests required for particular materials, components, and completed cables must be as specified in the sections of the above standards applicable to those materials, components, and cable types. Tests must also be performed in accordance with the additional requirements specified below. Submit [_____] certified copies of test reports.

3.3.2.1 High-Voltage Test Source

Where the applicable standards allow a choice, high-voltage tests for cables to be used exclusively on dc circuits must be made with dc test voltages. Cables to be used exclusively on ac circuits must be tested with ac test voltages. If both ac and dc will be present, on either the same or separate conductors of the cable, ac test voltages must be used.

3.3.2.2 Shielded Cables Rated 2,001 Volts or Greater

The following test(s) must be performed in addition to those specified above:

a. If high-voltage testing is done with an AC test voltage as specified in paragraph "High-Voltage Test Source," an additional test must be made using a DC test voltage rated at 75 percent of the specified full DC test voltage, for 5 consecutive minutes.

b. If voltage tests after installation are required for 5-65kV shielded power cables then testing must be done in accordance with NEMA WC 74/ICEA S-93-639, Appendix F.

3.3.2.3 Flame Tests

All [multiple-conductor and single-conductor] cable assemblies must pass either the vertical cable tray flame tests required by ICEA T-30-520 (stated in, but not required by NEMA WC 70); the vertical tray flame propagation test requirements of UL 1685 Method 1; the vertical tray flame propagation test requirements of UL 1685 FT4 and IEEE 1202; the wire and cable burning characteristics test of the UL 2556 VW-1 Test; or (for control cables only) the flame test as required by NEMA WC 57. If such tests, however, have previously been made on identical cables, these tests need not be repeated. Instead, certified reports of the original qualifying tests must be submitted. In this case the reports furnished under paragraph "Reports," must include information, identify critical information, and verify that all of each cable's materials, construction, and dimensions are the same as those in the qualifying tests.

[3.3.2.4 Cable Installation Report

****

NOTE: This report requires the cable installation plan described above.

****

After installation, provide a report of each cable identified in the cable installation plan. Include the maximum applied pulling tension of each cable. Identify all cables with pulling tensions which exceeded 90% of the limit in the approved cable installation plan.

]3.3.2.5 Independent Tests

The Government may make visual inspections, continuity or resistance checks, insulation resistance readings, power factor tests, or dc high potential tests at field test values. A cable's failure to pass these tests and inspections, or failure to produce readings consistent with acceptable values for the application, will be grounds for rejection of the cable.

3.3.2.6 Reports

Furnish results of tests. No wire or cable must be shipped until authorized. Lot number and reel or coil number of wire and cable tested must be indicated on the test reports.

****

Example Typical Wire Table:

WIRE TABLE						
Item No.	**Size, kcmil AWG**	**No. of Conds.**	**Rated Circuit Voltage**	**Stranding**	**Comments**	**Quantity, m lin ft**
1	12	1	600	B or C	general use	3260
2	12	1	600	* Solid	lighting	960
3	10	4	1000	B or C	transformers	120
4	2/0	shield, armor, 3	15 kV	B or C	jacket	275
17	12	9	1000	B or C	control annunciation	670
Class [_____] stranding may be substituted for [______] where indicated by "*".						

*****NOTE: Cable quantities for construction contracts should only be listed when certain, unless payment is to be per m foot, or if they are stated to be approximate, subject to Contractor verification.**

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<table>
<tr><th colspan="7">WIRE TABLE</th></tr>
<tr><th>Item No.</th><th>Size, AWG or kcmil</th><th>No. of Conds.</th><th>Rated Circuit Voltage</th><th>Stranding</th><th>Comments</th><th>Quantity, m lin ft</th></tr>
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USACE / NAVFAC / AFCEC **UFGS-26 05 33 (February 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 05 33 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 26 05 33

DOCKSIDE POWER CONNECTION STATIONS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 05 33 (February 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 05 33 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 05 33

DOCKSIDE POWER CONNECTION STATIONS

02/22

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NOTE: This guide specification covers 600 V and 15 kV dockside power connection stations for use in 480 V, 4160 V, and 13.8 kV ship service and 480 V industrial service electrical distribution systems meeting the requirements of UFC 4-150-02, "DOCKSIDE UTILITIES FOR SHIP SERVICE". This specification section shall be referenced in Section 26 11 16 SECONDARY UNIT SUBSTATIONS and Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION when the power connection stations are to be included as an auxiliary compartment of the switchgear associated with a secondary or primary unit substation being provided for electrical ship service.

Use the following related guide specification for associated power distribution equipment:

--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
--Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION
--Section 26 11 16 SECONDARY UNIT SUBSTATIONS
--Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION
--Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

Before preparing plans and specifications for a specific project, consult Unified Facilities Criteria UFC 4-150-02, "DOCKSIDE UTILITIES FOR SHIP SERVICE" demand and service requirements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: This section contains the following ACAD files (Graphics) which are available in metric (SI) and U.S. Customary (IP) system dimensions. Use files to develop project specific drawings. Files may be modified as necessary.

File Name	**TITLE**
26 05 33-Layout 1 (SI	**600 V Ship Service Power Connection Station**
26 05 33-Layout 1 (IP)	**600 V Ship Service Power Connection Station**
26 05 33-Layout 2 (SI)	**600 V Industrial Service Power Connection Station**
26 05 33-Layout 2 (IP)	**600 V Industrial Service Power Connection Station**
26 05 33-Layout 3 (SI)	**15 kV Power Connection Station**
26 05 33-Layout 3 (IP)	**15 kV Power Connection Station**

NOTE: Do not include this index in project specification.

NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

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NOTE: This section contains links to the following Shore Power Cable and Connector requirement documents in PDF form. Use these files to develop procurement specifications for components required in OPNAVINST 11310.2B, Operation and Maintenance Policy for Shore-to Ship Power and UFC 4-150-02, "Dockside Utilities for Ship Service". Do not include this index in project specifications.

File (Package) Name	TITLE
26 05 33 Pkg 1	Enhanced Low Voltage Portable Power Cables, 600V
26 05 33 Pkg 2	Enhanced Plus Low Voltage Portable Power Cables, 600V
26 05 33 Pkg 3	Medium Voltage Portable Power Cables, 350 KCMIL, 8KV
26 05 33 Pkg 4	Medium Voltage Portable Power Cables, 500 KCMIL, 8KV
26 05 33 Pkg 5	Medium Voltage Portable Power Cables, 350 KCMIL, 15KV
26 05 33 Pkg 6	Medium Voltage Portable Power Cables, 500 KCMIL, 15KV
26 05 33 Pkg 7	Single Pole Inline Connectors, 600V
26 05 33 Pkg 8	Cable Couplers, 15KV

NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

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NOTE: The following information should be indicated on the project drawings or specified in the project specifications.

1. Site Plan showing location, space available, and desired arrangement of power connection station.

2. Single-line diagram showing number and configuration of power connection stations; type, number, and size of conductors for each circuit; metering; and power cable terminations.

3. Floor plan, and elevation and section views of power connection stations as necessary indicating the number and configuration of receptacles, auxiliary devices, and metering accessories.

4. Control diagrams showing operation of circuit breakers, emergency trip pushbuttons, shunt trip

pushbuttons, electric interlock switches, and control cabling between power connection stations, emergency trip panels, and associated unit substation switchgear.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B33	(2010; R 2020) Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE C2	(2023) National Electrical Safety Code
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7	(2022) Requirements for Watthour Meter Sockets
NEMA WC 58/ICEA S-75-381	(2008) Portable and Power Feeder Cables for Use in Mines and Similar Applications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-24368/1	(2021; Rev C) Connector Assemblies; Plug, Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 500 Amperes, 60 Hertz, Symbol Number 1160
MIL-C-24368/2	(2021; Rev B) Connector Assemblies; Receptacle, and Receptacle-Cabled, Power Transfer, Shore to Ship and Ship to Ship, 500 Volts, 500 Amperes, 60 Hertz, Symbol Number 1161
MIL-DTL-24643/3	(2023; Rev F) Cable, Electrical, -20 Degrees C to +90 Degrees, 600 Volts, Types LSSHOF, LSDHOF, LSTHOF, and LSFHOF

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations

UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

****

NOTE: Revise or amplify these paragraphs where necessary to cover project requirements.

****

600 V Power Connection Station; G, [_____]

15 kV Power Connection Station; G, [_____]

Ship Service Emergency Trip Panel; G, [_____]

Include wiring diagrams and installation details of equipment indicating layout and arrangement, control panels, accessories, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

SD-03 Product Data

600 V Single Pole Connectors; G, [_____]

Industrial Service Auxiliary Devices; G, [_____]

Metering Accessories; G, [_____]

15 kV Cable Couplers; G, [_____]

Deadbreak Junctions; G, [_____]

High-Voltage Connectors; G, [_____]

Flexible Power Cable; G, [_____]

SD-06 Test Reports

Paint Coating System; G, [_____]

600 V Single Pole Connector Compatibility Tests; G, [_____]

600 V Single Pole Connector Torque Test; G, [_____]

Power Receptacle and Plug Assembly Tests; G, [_____]

15 kV Cable Coupler Design Tests; G, [_____]

Acceptance Checks and Tests; G, [_____]

SD-10 Operation and Maintenance Data

600 V Power Connection Station, data package 5; G, [_____]

15 kV Power Connection Station, data package 5; G, [_____]

Ship Service Emergency Trip Panel; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Drawings

Furnish drawings that include, but are not limited to, the following:

a. One-line diagram including breakers, fuses, current transformers, and meters.

b. Outline drawings including front elevation, section views, footprint, and overall dimensions.

c. Markings and NEMA nameplate data, including fuse information (manufacturer's name, catalog number, and ratings).

d. Circuit breaker type, interrupting rating, and trip devices, including available settings.

e. Three-line diagrams and elementary diagrams and wiring diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.

f. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device. These shall be used by the designer of record to provide breaker settings that will insure protection and coordination are achieved.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer and the component parts of the item shall be the products of the same manufacturer.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7 MAINTENANCE

1.7.1 Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 600 V POWER CONNECTION STATION

Ship service and industrial service power connection station assemblies shall include enclosure, power receptacles, auxiliary devices, metering accessories, and related wiring. Each power connection station shall have the number of circuits indicated and each circuit shall provide three-phase, three-wire service.

2.1.1 Enclosure Integrity

****

NOTE: Where exposed to physical damage from vehicular traffic, provide suitable guards.

****

Enclosure shall be UL 50 listed, type 3R, fabricated entirely of ASTM A167 type 304 or 304L stainless steel. All interior and exterior covers and doors shall be minimum 12 gauge stainless steel sheets. Unit shall have fixed top and open bottom. Side covers shall be bolt-on and removable. Rear covers shall be hinged. Optional doors shall have full height continuous hinge and door stop to allow door to be secured open at 90 degrees. Ventilating or similar openings in equipment shall be designed so that foreign objects inserted through these openings are deflected from energized parts. Paint enclosure ASTM D1535 light gray No. 61. Paint coating system shall comply with IEEE C57.12.28.[Provide removable mullions between the doors.]

2.1.2   600 V Single Pole Connectors

Insulated connectors shall be rated for 600 volts, 690 amperes, 60 hertz, single pole, continuous duty operation. Connectors shall be compatible with Leviton and Duraline cam-type positive latching ball nose connectors. Insulation and protective caps shall be ethylene propylene thermoplastic rubber (EPTR) colored black phase A, white phase B, and red phase C, conforming to the following:

a. Constant Service Temperature Range: minus 60 degrees C to 135 degrees C minus 81 degrees F to 275 degrees F

b. Flammability: UL 94 HB Rated

c. Electrical: UL Relative Thermal Index (RTI): 100 degrees C 212 degrees F minimum

d. Durometer Hardness: ASTM D2240, 55 - 65A

2.1.2.1   Panel Mount Connectors

****

NOTE: (1) Provide auxiliary switches with receptacles to be used for supplying industrial service and where required by the activity utility department with receptacles used for supplying ship service. (2) When electric interlock switches are required, indicate circuiting to effect opening of breakers and disabling of closing of breakers via the interlock switches when a connector plug is removed from the associated receptacle.

****

Provide 15 degree angled, panel mount female connectors (receptacles) with threaded stud terminations. Each receptacle shall be provided with a protective cap attached via wirelon.[Panel Mount Connectors (receptacles) indicated to have electric interlock switches shall have a thru-center plunger that engages a single-pole double-throw, water-tight aluminum housed "roller lever actuated" switch upon insertion of a connector plug. UL listed switch shall be electrically rated for 100,000 cycles at 10 amps, 125/250 VAC, and mechanically rated for 20,000,000 cycles.]

[2.1.2.2   Cable Mount In-Line Connectors

Male and female cable mount in-line connectors (plugs) shall be designed for terminating on 500 kcmil cables with a crimp-type connection. The connectors shall lock together so that they can not twist or turn loose unless a push button release mechanism is engaged. The insulated sleeve shall be mechanically secured to the connector contacts to give a minimum of 3100N 700 pounds shear force.[Provide a mating male cable mount in-line connector (plug) for each panel mount connector to be turned over to the contracting officer.][Provide [_____] male and [_____] female cable mount in-line connectors[terminated as indicated][to be turned over to the contracting officer].]

][2.1.3   600 V Power Receptacle

****

NOTE: Select the following paragraph only for

repair projects where the existing MIL-C-24368/2 power receptacles are being replaced in the existing enclosure.
****

Rated for 500 volts, 500 amperes, 60 hertz, three-pole, continuous duty operation. Power receptacle assembly shall conform to MIL-C-24368/2. Provide receptacle assembly with factory potted cable pigtails. Cable pigtails shall be a minimum of 1220 mm 4 feet in length and 3-1/c Type LSSHOF-500 cables conforming to MIL-DTL-24643/3. Provide each receptacle with provisions for interlocking the receptacle with its respective feeder circuit breaker so that breaker will trip automatically if an attempt is made to remove the plug from the receptacle and when the receptacle cover is opened.

][2.1.4 Industrial Service Auxiliary Devices

****
NOTE: Provide circuit breaker overcurrent protection of each service circuit. When the over current protection for the industrial service circuits is located within the associated industrial power connection station, include the paragraphs for "Fusing," "Circuit Breakers," and "Circuit Breaker Operating Mechanism." When the overcurrent protection is located in a remote panelboard, include the paragraph for "Shunt Trip Pushbutton Control" and indicate conduit and wiring from the industrial power connection station shunt trip pushbutton control to the circuit breaker shunt trip. Also indicate circuiting to effect opening of breakers via the shunt trip pushbutton control (in conjunction with the interlock switches).
****

Provide the following auxiliary devices for each industrial service power connection station circuit.

[2.1.4.1 Shunt Trip Pushbutton Control

****
NOTE: Indicate desired location (side cover or rear flange) of pushbutton control on drawings.
****

Provide NEMA Q600 rated, 30 millimeter 12 inches, heavy duty industrial type, normally-open, momentary, red pushbutton behind a spring return cover, each circuited to shunt trip one circuit breaker.

][2.1.4.2 Fusing

****
NOTE: Include "fusing" when metering is provided.
****

Provide a fuse block mounted in the enclosure containing one fuse per phase to protect the voltage input to the[watt hour meter][and][circuit breaker shunt trip].

][2.1.4.3 Circuit Breaker

****

NOTE: Provide 200 kA, non-fused, current limiting circuit breakers when the service transformer is rated 1000 kVA and greater. When the overcurrent protection is located in a remote panelboard, indicate the required circuit breaker ratings on the "Panelboard Schedule."

****

UL 489. 100 percent rated,[non-fused, current limiting,] molded case circuit breaker, 480 VAC, 400 amperes, 3-pole, [200][_____] kaic short circuit current interrupting rating, with a 480 V shunt trip.

]2.1.4.4 Circuit Breaker Operating Mechanism

Provide flexible cable mechanism with flange mounted disconnect handle for each circuit breaker as indicated.

][2.1.5 Metering Accessories

****

NOTE: When metering is required by the activity and the industrial power connection stations are to be directly connected to the industrial power transformer secondary, the industrial power connection stations shall include the following metering accessories. Where a panelboard is to be provided for industrial loads, provide a separate watt-hour meter/current transformer cabinet.

****

Provide watt-hour meter and current transformers for each industrial service power connection station circuit.

2.1.5.1 Watt-hour Meter

Provide a socket-mounted, electronic programmable outdoor watt-hour meter mounted on door of cabinet. Meter shall either be programmed at the factory or shall be programmed in the field. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. Meter shall be coordinated to system requirements and conform to ANSI C12.1.

a. Design: Provide watt-hour meter for use on a three-phase, 3-wire, 480 volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS).

b. Class: 20; Form: 45S, accuracy: plus or minus 1.0 percent; Finish: Class II

c. Cover: Polycarbonate and lockable to prevent tampering and unauthorized removal.

d. Kilowatt-hour Register: Five digit electronic programmable type

e. Demand Register:

(1) Provide solid state.

(2) Meter reading multiplier: Indicate multiplier on the meter face.

(3) Demand interval length: Shall be programmed for 15 minutes with rolling demand up to six subintervals per interval.

f. Socket: ANSI C12.7. Provide NEMA Type 3R, box-mounted socket, ringless, having manual circuit-closing bypass and having jaws compatible with requirements of the meter. Cover unused hub openings with blank hub plates. Provide manufacturers standard enclosure color unless otherwise indicated.

2.1.5.2 Current Transformers

IEEE C57.13. Provide butyl-molded window type current transformers with 600 volt insulation, 10 kV BIL. Provide three current transformers with characteristics listed in the following table.

CT Ratio	RF	Meter Accuracy Class
400/5	4.0	0.3 thru B-0.2

[2.1.5.3 Watt-hour Meter/Current Transformer Cabinet

Cabinet shall be NEMA 3R fabricated of 12 gauge stainless steel and shall have hinged front door with vault handle. Paint enclosure ASTM D1535 light gray No. 61. Paint coating system shall comply with IEEE C57.12.28.

]]2.1.6 Enclosure Configurations

****

NOTE: Ship Service Power Stations shall consist of multiple sections, with each section having a maximum of four vertically arranged receptacle circuits. Provide pad lockable doors to restrict access to unused energized receptacles where ship service circuits are connected in parallel to multiple stations. See Layout 1 for typical enclosure design.

****

a. Enclosures for ship service stations shall be configured as indicated. All three receptacles of the same circuit shall be mounted on a common plate. Each plate shall have handles on both ends and shall be bolted to the front cover so that it can be removed from the front without disconnecting the incoming circuit power cables. Each section shall include a full width ground bus.[Each section shall have a hinged pad lockable door.] Provide nameplates to identify each phase designation and each circuit number as indicated.

****

NOTE: Industrial Power Stations shall consist of multiple sections, with each section having a maximum of two vertically arranged receptacle circuits. Include information concerning circuit breakers, current transformers, fusing, shunt trip

pushbuttons, and watt-hours meters when auxiliary devices and metering accessories are specified. Indicate desired side for mounting external ground bus and shunt trip. See Layout 2 for typical enclosure design.

****

b. Enclosures for industrial service stations shall be configured as indicated. All three receptacles of the same circuit shall be mounted on a common plate. Each plate shall have handles on both ends and shall be bolted to the front cover so that it can be removed from the front without disconnecting the power cable. Include a full width internal ground bus and a ground bus with four NEMA spaced lug mounting holes on the exterior as indicated.[Mount the[circuit breakers,][and][current transformers] on inside of enclosure.][The handle for the circuit breaker operating mechanism shall be located on the rear flange.][Mount watt-hour meters on rear hinged covers.][Mount shunt trip pushbuttons on side cover as indicated.]

2.2 15 KV POWER CONNECTION STATION

15 kV power connection station assemblies shall include enclosure, 15 kV power receptacles, dead-front high-voltage deadbreak junctions, and insulated high-voltage connectors. Each power connection station shall have the number of circuits indicated and each circuit shall provide three-phase, three-wire service.

2.2.1 Enclosure Integrity

****

NOTE: Where exposed to physical damage from vehicular traffic, provide suitable guards.

****

IEEE C57.12.28 fabricated entirely of ASTM A167 type 304 or 304L stainless steel. All interior and exterior covers and doors shall be minimum 12 gauge stainless steel sheets. Unit shall have fixed top and open bottom with padlockable two-door front and removable center post. Side and rear covers shall be bolt-on. Doors shall be 915mm 36 inch wide with full height continuous hinge and door stops to allow doors to be secured open at 90 degrees. Paint enclosure ASTM D1535 light gray No. 61. Paint coating system shall comply with IEEE C57.12.28.[Provide removable mullions between the doors.]

2.2.2 15 kV Cable Couplers

****

NOTE: (1) High voltage cable couplers are used predominately in the mining and tunneling industries. There currently is no industry standard for these products and therefore, couplers from different manufactures may not be compatible. Once the use of a particular model coupler has been established at an activity, it may be necessary to request proprietary procurement of future couplers to ensure compatibility. (2) When couplers are requested by station to have a mechanical interlock feature, coordinate keys with existing or new interlock scheme. (3) The interlock design when

required for new installations shall be as follows: The circuit breakers associated with the receptacles of a respective power connection station shall be electrically locked open via a common electric reset multi-contact auxiliary relay that is controlled by a key-operated selector switch. Placing the selector switch in the key-release position shall electrically lock open the circuit breakers. This same key will then be used for unlocking/locking the associated couplers. Inserting the key into the selector switch will allow return to the "close" position, unlocking the circuit breakers.

****

Provide high voltage cable couplers rated for 15,000 volts, 500 amperes, 60 hertz, three-phase, continuous duty operation, and configured with three insulated phase contacts, one ground contact, and one isolated ground check contact. Couplers shall be aluminum with epoxy powder coating and include hypalon gaskets and seals, all stainless steel hardware and[three-bolt quick flip][or][90 degree turn] connection feature. Receptacles shall be equipment mount type with provisions for terminating [_____] mm [_____] inch diameter [350][_____] kcmil cables and include Live End Covers.[Provide one cable mount type plug with weatherproof cover and provisions for terminating [_____] mm [_____] inch diameter [350][_____] kcmil cables for each receptacle. Turn plugs over to the contracting officer.] Coupler pairs shall[have provisions for padlocking][have a mechanical interlock that allows key release only after the coupler pair is locked].

a. Voltage ratings: Withstand voltages shall comply with IEEE 386 voltage ratings and characteristics of connectors rated 14.4 kV rms phase-to-phase.

b. Current ratings: Short-time current ratings shall comply with IEEE 386 current ratings and characteristics of 600 A connectors.

2.2.3 Separable Insulated Connectors and Accessories

IEEE 386. 15 kV, 95 kV BIL.

2.2.3.1 Deadbreak Junctions

Provide 600 A deadbreak junctions with two interfaces. Brackets shall be stainless steel.

2.2.3.2 Insulated High-Voltage Connectors

Provide 600 Ampere deadbreak connectors.

2.2.4 Flexible Power Cable

ASTM B33, NEMA WC 58/ICEA S-75-381. Flexible power cable Type SH, 15 kV single conductor.

2.2.5 Enclosure Configuration

****

NOTE: See Layout 3 for typical enclosure design.

****

Enclosures shall be configured as indicated. Include a full width ground bus. A power cable terminated with a 600-ampere deadbreak connector shall connect each phase of each receptacle to one of the 600-ampere one-piece deadbreak apparatus bushings of a deadbreak junction. The remaining apparatus bushing for each deadbreak junction shall be used for connection of the incoming circuit power cables terminated with 600-ampere deadbreak connectors. Provide nameplates to identify each phase designation and each circuit number.

[2.3 SHIP SERVICE EMERGENCY TRIP PANEL

****

NOTE: Provide an emergency trip pushbutton circuited to trip all (480 V, 5 kV, and 15 kV) circuit breakers that provide ship service to a respective berth. Locate the emergency trip box where it can be readily accessed by ships force.

****

Provide a stainless steel NEMA 3R cabinet sized as necessary with a color red pushbutton cover mounted behind the front door. Pushbutton shall be rated for 10 amperes continuous at 600 volts, heavy duty, watertight, momentary contact, marked "SHIP SERVICE EMERGENCY TRIP".

]2.4 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.5 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm one by 2.5 inches. Lettering shall be a minimum of 6.35 mm 0.25 inch high normal block style.

2.6 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 178 by 255 mm 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 50 mm 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background.

2.7 SOURCE QUALITY CONTROL

2.7.1 Paint Coating System

Submit IEEE C57.12.28 paint coating system performance requirement tests.

2.7.2 600 V Single Pole Connector Compatibility Tests

Conduct the following tests in the sequence noted on a male in-line connector mated with a Leviton or Duraline female in-line connector and a female in-line connector mated with a Leviton or Duraline male in-line connector with each connector terminated on a bare 500 kcmil copper conductor. After completion of the tests, inspect assemblies. There shall be no evidence of damage to the connectors. Assemblies shall be satisfactory for immediate return to service at full ratings without maintenance or repair.[Contracting Officer or his designated representative will witness the tests.][A factory-certified report of the specified tests previously performed on identical units of each rating will be acceptable.]

2.7.2.1 Impact Test

Drop each mated connector set in a horizontal position from a height of 36-inches onto a concrete floor 50 times.

2.7.2.2 Pull Strain Test

Apply a 500-lb straight pull on each mated connector set for a duration of 5-minutes.

2.7.2.3 Shear Test

Apply a 100-lb perpendicular pull on each mated connector set for a duration of 5-minutes.

2.7.2.4 Torque Test

Apply a 100 ft-lb torque on each mated connector set for a duration of 5-minutes.

2.7.2.5 Heat Rise Test

Apply 400 amperes through each mated connector set for duration of 30-minutes. Record temperature rise at surface of each mated connector set via infrared scanning equipment. Temperature rise shall be less than 45 degree C.

2.7.2.6 Moisture Resistance Test

Subject the mated connectors to a water spray maintained at 5-psi, with a collection rate of 18-in/hr, at a distance of 5-feet, for one hour. Verify that no water penetrated the connection.

2.7.2.7 Dielectric Voltage Withstand Test

Wrap the mated connectors in conductive foil and apply a test potential of 2200 VAC between the conductor and the foil for a period of 5-minutes. Dielectric breakdown shall constitute a failed test.

2.7.2.8 Insulation Resistance Test

Wrap the mated connectors in conductive foil and using a Megger insulation resistance tester with an open circuit output of 500 VDC, measure the insulation resistance between the conductor and foil. Resistance measurement shall be greater than 100 Megohms.

2.7.3 600 V Single Pole Connector Torque Test

Conduct a torque test on three male and three female cable mount in-line connectors as follows: With the metal connector part rigidly secured, apply a rotating (twisting) force of 700 lbs on the insulating sleeve. The insulating sleeve shall not break free and spin around the connector metal part.[Contracting Officer or his designated representative will witness the tests.][A factory-certified report of the specified tests previously performed on identical units of each rating will be acceptable.]

[2.7.4 Power Receptacle and Plug Assembly Tests

****

NOTE: Select the following paragraph only when providing MIL-C-24368/2 receptacles.

****

Conduct design, production, and quality assurance tests, as required by MIL-C-24368/1 and MIL-C-24368/2, at the manufacturer's plant during fabrication and assembly of power receptacle and plug assemblies. After completion of tests, inspect assemblies. There shall be no evidence of damage to the receptacle or plug assembly. Assemblies shall be satisfactory for immediate return to service at full ratings without maintenance or repair.[Contracting Officer or his designated representative will witness the tests.][A factory-certified report of the specified tests previously performed on identical units of each rating will be acceptable.]

]2.7.5 15 kV Cable Coupler Design Tests

Furnish reports which include results of AC withstand voltage, DC withstand voltage, impulse withstand voltage, short time current, and current cycling design tests performed in accordance with IEEE 386.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 POWER CONNECTION STATION GROUNDING

Ground in accordance with NFPA 70. Maximum resistance from assembly to ground shall be 3 ohms.

3.3 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 9 meters 30 feet apart.

3.6 FIELD QUALITY CONTROL

3.6.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.6.1.1 Power Connection Stations and Control Panels

a. Visual and mechanical inspection performed in accordance with inspection and test procedures for Switchgear and Switchboard Assemblies.

b. System function tests.

[3.6.1.2 Current Transformers

a. Visual and mechanical inspection in accordance with inspection and test procedures for Instrument Transformers.

b. Electrical tests in accordance with inspection and test procedures for Instrument Transformers.

][3.6.1.3 Watt-hour Meters

a. Visual and mechanical inspection in accordance with inspection and test procedures for Metering Devices.

b. Electrical tests in accordance with inspection and test procedures for Metering Devices.

][3.6.1.4 Circuit Breakers

a. Visual and mechanical inspection in accordance with inspection and test procedures for Circuit Breakers, Air, Insulated-Case/Molded-Case.

b. Perform Electrical tests in accordance with inspection and test procedures for Circuit Breakers, Air, Insulated-Case/Molded-Case.

]3.7 DEMONSTRATION

Upon completion of the work and at a time approved by the Contracting Officer, the Contractor shall provide instructions by a qualified instructor to the Government personnel in the proper operation and maintenance of the equipment. [_____] Government personnel shall receive training comparable to the equipment manufacturer's factory training. The duration of instruction shall be for not less than one 8 hour working day for instruction of operating and maintenance personnel.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 05 48 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-26 05 48.00 10 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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11/23

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SECTION 26 05 48

SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT

11/23

****

NOTE: This guide specification covers the requirements for seismic protection of electrical equipment systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Projects having both antiterrorism (UFC 4-010-01) and seismic protection requirements will require the specification to be edited such that the most stringent of both requirements is met.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The intent of this specification is to provide for adequate resistance to forces induced by earthquakes for electrical equipment systems described herein. The design seismic lateral and vertical forces are in addition to the "normal" gravity forces (weight) acting on the components of a system.

Use Section 01 45 35 SPECIAL INSPECTIONS for

required inspections and testing of electrical components, supports, and attachments.

Use this guide specification in conjunction with Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS and Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT, for projects that include HVAC or Miscellaneous equipment.

Design supports and attachments in accordance with UFC 3-301-01 Structural Engineering.

Design supports and attachments in accordance with UFC 3-301-02 for Risk Category V Structures.

UFC 3-301-01 adopts ASCE 7-16 "Minimum Design Loads and Associated Criteria for Buildings and Other Structures", with modifications. Refer to UFC 3-301-01 and ASCE 7-16 for seismic design loads and associated criteria. Seismic provisions of UFC 3-301-01 and ASCE 7-16 (Chapter 13) use phrase "Nonstructural electrical components". This specification uses phrase "electrical components" for brevity.

The designer has three options to provide seismic protection for a project:

a. Issue a Contract requiring the Contractor to hire a registered professional engineer to design supports and attachments and submit the stamped calculations and drawings in accordance with this section. The Contracting Officer will "accept" the design but the registered engineer (Engineer of Record) will have final responsibility for the adequacy of the structural supports and attachments.

b. Hire an Architect-Engineer who will use this section and will submit calculations and drawings stamped by a registered professional engineer. The Contracting Officer will "accept" the design but the registered engineer (Engineer of Record) will have final responsibility for the adequacy of the structural supports and attachments. One of the disadvantages of this approach may be that the actual equipment dimensions, weights and mounting details may not be known until the equipment is acquired. The professional engineer should re-evaluate design during the construction phase using actual equipment information when reviewing seismic support and attachment shop drawings and perform field inspections as part of the final responsibility.

c. Perform the design in house, in which case the Government designer will have final responsibility for the adequacy of the structural supports and attachments. One of the disadvantages of this approach may be that the actual equipment

dimensions, weights and mounting details may not be known until the equipment is acquired. The Government designer should re-evaluate design during the construction phase using actual equipment information when reviewing seismic support and attachment shop drawings and perform field inspections as part of the final responsibility.

Regardless of who performs the design, this section, properly edited, must be included in the construction documents to allow the Contractor to provide the seismic protection features.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A603	(2019) Standard Specification for Zinc-Coated Steel Structural Wire Rope
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM E580/E580M	(2024) Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
ASTM F436	(2011) Hardened Steel Washers
ASTM F959/F959M	(2017a; R 2023) Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch

	Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC ES AC156	(2012) Acceptable Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

METAL FRAMING MANUFACTURERS ASSOCIATION (MFMA)

MFMA-4	(2004) Metal Framing Standards Publication

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-810	(2022; Rev H; Change 1) Environmental Engineering Considerations and Laboratory Tests
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military Assets

UL SOLUTIONS (UL)

UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires

VIBRATION ISOLATION AND SEISMIC CONTROL MANUFACTURERS ASSOCIATION (VISCMA)

VISCMA 413	(2014) Installing Seismic Restraints for Electrical Equipment

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

****

NOTE: Designer should verify that specified details do not interfere with the performance of the cathodic protection system (when used) or of vibration isolation systems.

For systems and equipment in Risk Category V buildings that have a performance objective higher than non-mission critical (NMC), the designer should show a "G" classification for the items under SD-02 Shop Drawings in the SUBMITTALS paragraph. The Engineer of Record (EOR) should review the details

of these essential systems and assess their impact on the structural supporting system of the essential building. This also includes Designated Seismic Systems that must remain operational after an earthquake. Use of isolation and energy dissipation systems are allowed for Risk Category V electrical components.

****

****

NOTE: Choose the first paragraph for projects where Contractor will design seismic protection system, or choose the second paragraph for projects where Architect-Engineer (AE) or Government designer will design seismic protection system.

****

[Design and provide seismic supports and attachments in accordance with UFC 3-301-01 and ASCE 7-16.[Design and provide seismic supports and attachments, and isolation and energy dissipation systems in accordance with UFC 3-301-02.]]

[Provide seismic supports and attachments as indicated and in accordance with UFC 3-301-01 and ASCE 7-16.[Provide seismic supports and attachments, and isolation and energy dissipation systems as indicated and in accordance with UFC 3-301-02.]]

Components, supports, and attachments must comply with following structural design criteria:

Risk Category: [I] [II] [III] [IV] [V].
Seismic Design Category: [C] [D] [E] [F].
Seismic Design Spectral Response Acceleration Parameter at Short Period (SDS): [_____].
Seismic Design Spectral Response Acceleration Parameter at period of 1 second (SD1): [_____].
[Seismic relative displacement within structure[, between height [_____] and height [_____]]: [_____ mm _____ inches.]]
[Seismic relative displacement between structure [_____] and structure [_____][, at level _____]: [_____ mm _____ inches.]]

Apply the seismic requirements described in this section and on the drawings to the electrical components listed in paragraph ELECTRICAL COMPONENTS.

Electrical components and their supports must be attached or anchored to structure.

1.2.2 Electrical Components

****

NOTE: Provide list below that includes all electrical items to be supported and attached. Delete the items which are not part of the project and add items which are not included in the list.

The lists should be broken out as follows:

For nonstructural electrical components in Risk

Category I, II, III, or IV structures, two separate lists of components must be provided; components with Ip = 1.0 and components with Ip = 1.5 (Designated Seismic Systems).

For nonstructural electrical components in Risk Category V structures, the designer must provide three separate lists; non-Mission Critical (NMC), Mission Critical Level 1 (MC-1 components must be fully operational immediately after a seismic event), or Mission Critical Level 2 (MC-2 components must be repairable and operable within 3 days after a seismic event).

****

Provide seismic supports and attachments for the following electrical components in accordance with the requirements of this specification:

[Components with Importance Factor (Ip) = 1.0:
  Battery Systems
  Control Panels
  Generators
  Light Fixtures
  Motors
  Motor Control Centers
  Photovoltaic Panels
  Switchgear
  Switchboards
  Solar Heating Units
  Storage Racks
  Transformers
  Unit Substations
  Uninterruptible Power Supply Systems
  Distribution Systems [Conduit, Cable Tray, Busway, and Raceway]
  Utility and Service Lines
  [Premanufacturered modular electrical systems: [_____]]
  [Other electrical components: [_____]]
  [_____]]

[Components with Importance Factor (Ip) = 1.5 [Designated Seismic Systems]
  Emergency and standby power systems
  Fire detection and suppression systems
  Emergency exit lighting
  Utility and service lines in Risk Category IV: [_____]
  [ ]]

[Non-Mission Critical (NMC) Components in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]

[Mission Critical Level 1 (MC-1) Components in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]

[Mission Critical Level 2 (MC-2) Components in Risk Category V
Insert edited list here similar to one above for Ip = 1.0]

[Electrical components classified as nonbuilding structure: [_____]]

1.2.3 [Contractor Designed] Supports and Attachments

Provide seismic supports and attachments[, and isolation and energy dissipation systems] for electrical components.

****

NOTE: Retain following paragraph when the Contractor will design the supports and attachments. Indicate permissible locations of supports and attachments on drawings for projects that require Contractor to design supports and attachments. Engineer of Record (EOR) must review adequacy of structure to resist seismic and other loads, and modify support layout or design reinforcement of structural members if capacity of structural members is exceeded. Delete this paragraph when all supports and attachments details and locations are indicated on the drawings.

****

[Contractor must retain services of a Registered Professional Engineer to design supports and attachments[, and isolation and energy dissipation systems] for electrical components.[Supports and attachments, and isolation and energy dissipation systems that induce torsion in structural members are not permitted.]

Submit copies of the Design Calculations and Design Drawings. Calculations and Drawings must be stamped and signed by Contractor's Registered Professional Engineer.]

[Submit Independent Design Review Report, prepared by Contractor's independent Professional Engineer for Risk Category V electrical components, supports and attachments, and isolation and energy dissipation systems in accordance with UFC 3-301-02.]

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment Requirements; G, [_____]

Lighting Fixtures; G, [_____]

SD-03 Product Data

[Supports and Attachments; G, [_____]

] Equipment Requirements; G, [_____]

Lighting Fixtures; G, [_____]

Flexible Fittings; G, [_____]

Anchors; G

[Isolation And Energy Dissipation Systems; G

] SD-05 Design Data

[Design Calculations; G, [_____]

] Design Drawings; G, [_____]

[Independent Design Review Report; G

] SD-06 Test Reports

Anchors; G, [_____]

SD-07 Certificates

ICC ES AC156 Shake Table Test; G, [_____]

PART 2 PRODUCTS

****

NOTE: Appropriate materials for structural supports

must be used in corrosive environments. Dissimilar metals must be isolated.

****

2.1 EQUIPMENT REQUIREMENTS

****

NOTE: Seismic control does not guarantee that the equipment itself is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, include paragraph SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT.

****

Equipment must be rugged enough to survive design seismic event.[Equipment components designated as Designated Seismic Systems or MC-1 (Mission Critical Level 1) must remain operational as required in paragraph SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT.]

Submit detail drawings of supports and attachments[, and isolation and energy dissipation systems] along with[calculations,] catalog cuts, templates, and erection and installation details, as appropriate, for the items listed in paragraph ELECTRICAL COMPONENTS. Indicate thickness, type, grade, class of metal, and dimensions; and show construction details, reinforcement, anchorage, and installation with relation to the building construction.

[Submit calculations and drawings that are stamped and signed by Contractor's registered professional engineer. Design must be based on actual equipment and system layout. Design must include calculated loads and capacity of materials utilized for the connection of the equipment or system to the structure. Analysis must detail anchoring methods.]Include drawing for[Mission Critical Equipment and] Designated Seismic System Equipment indicating the equipment location in the facility to be used for the installation. Equipment must be rigidly or flexibly mounted as indicated. Roof mounted equipment both vibration isolated and nonisolated, must have support members designed and anchored to building structure.

2.1.1 Rigidly (Base and Suspended) Mounted Equipment

****

NOTE: Rigidly mounted equipment is defined as having a period of vibration of 0.06 seconds or less for the equipment plus its mounting. Equipment with a fundamental period greater than 0.06 seconds should be assumed to be flexibly mounted or nonrigid and designed in accordance with the next paragraph below.

List items that may require additional reinforcements (internally) to prevent permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following a seismic event and to meet the specified requirements (such as engine-driven generators, etc., which consist of a number of individual components built into an assembly by the

manufacturers). For emergency generators include auxiliary items required for the generator to operate, such as battery racks and day tanks.
****

The following specific items of equipment must be constructed and assembled to withstand the seismic forces specified in UFC 3-301-01 [UFC 3-301-02]. Entirely locate each item of rigid electrical equipment and rigidly attach on one side only of a building expansion joint. Provide items such as electrical conduit, which cross the building expansion joint with flexible joints that are capable of accommodating displacements equal to the full width of the joint in each orthogonal direction.

Engine-Generators
Substations
Transformers
Switch Boards and Switch Gear
Motor Control Centers
Free Standing Electric Motors
[_____]

Equipment furnished under this Contract must be [rigidly mounted] [rigidly mounted using cast-in-place anchor bolts or post-installed anchors that are qualified for use in cracked concrete. Cast-in-place anchor bolts must conform to ASTM F1554]. For any rigid equipment which is rigidly anchored, provide flexible joints for electrical conduit, cabletray, busway, and raceway, that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions. [Mission critical base mounted and suspended equipment for Risk Category (RC) V, and]Designated Seismic Systems (DSS) for RC IV buildings assigned to Seismic Design Category (SDC) C, D, E, or F and Risk Category IV components needed for continued operation after an earthquake must have two nuts provided on each bolt.

2.1.2 Nonrigid or Flexibly-Mounted Equipment

The following specific items of equipment must be constructed and assembled to resist seismic loads and meet associated seismic criteria.

Nonrigid or Flexibly-Mounted:
[_____]
[_____]

2.1.3 Premanufactured Modular Electrical Systems

The following specific items of equipment must be manufactured, constructed, and assembled to resist seismic loads and meet associated seismic criteria.

Premanufactured modular electrical systems:
[_____]
[_____]

2.2 LIGHTING FIXTURES

Provide lighting fixtures and supports and attachments conforming to UL 1598.

2.3 SUPPORTS AND ATTACHMENTS

****

NOTE: Select Class C weight zinc-coated wires for wire rope where used in coastal environment.

****

Material used for members listed [in this section] [and] [on the drawings], must conform with the following:

a. Plates, rods, and rolled shapes, ASTM A36/A36M, ASTM A572/A572M Grade 50, or ASTM A992/A992M.

b. Wire rope, ASTM A603 pre-stretched, with [Class B weight zinc-coated][Class C weight zinc-coated] wires throughout rope. Connect rope at ends using ferrule or saddle-type wire rope clamp systems. Ferrule clamps must be qualified by testing for use in seismic applications per VISCMA 413. Saddle-type clamps must be used with minimum of two clamps at each end of wire rope.

c. Tubes, ASTM A500/A500M, Grade B.

d. Pipes, ASTM A53/A53M, Grade B.

e. Angles, ASTM A36/A36M.

f. Channels (Struts) with in-turned lips and associated hardware for fastening to channels at discrete points conforming to MFMA-4.

g. Fasteners:

    (1) High-strength bolts, ASTM F3125/F3125M, Grade A325, heavy hex.

    (2) Nuts, ASTM A563. Use heavy hex nuts for high strength bolts and anchor bolts.

    (3) Washers, ASME B18.22M and ASME B18.21.1, except use ASTM F436 washers for high strength bolts.

    (4) Galvanized coating, ASTM A153/A153M.

    (5) Direct Tension Indicator Washers, ASTM F959/F959M.[Provide ASTM B695, Class 55, Type 1 galvanizing.] Submit product data for direct tension indicator washers.

[(6) Standard bolts, ASTM A307.

] h. Anchor bolts:

    (1) Cast in anchors: Refer to Section 05 12 00 STRUCTURAL STEEL [05 50 13 MISCELLANEOUS METAL FABRICATIONS] for requirements.

    (2) Post-installed anchors: Refer to Section 05 05 20 POST-INSTALLED CONCRETE AND MASONRY ANCHORS for requirements.

i. Welding: Refer to Section 05 12 00 STRUCTURAL STEEL[Section 05 50 14 STRUCTURAL METAL FABRICATIONS] for requirements.

2.4 FLEXIBLE FITTINGS

Provide flexible fittings to allow conduit, cabletray, busway, and raceway systems to accommodate seismic movement between equipment and conduit, cabletray, busway, and raceway systems and supporting structure. Use specification grade steel fittings conforming to [Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM][MIL-STD-810]. Provide suitable [watertight] expansion fittings that maintain electrical continuity by bonding jumper or other means.[Flexible fittings must accommodate minimum of 100 mm 4 inches[[_____] mm[_____] inches] seismic movement in each orthogonal directions].

PART 3 EXECUTION

3.1 SUPPORTS AND ATTACHMENTS

****

NOTE: Designs must include complete seismic details showing support and attachment requirements. The design is for the supports of the equipment, not the equipment itself. Proper supports do not guarantee that the equipment is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, the manufacturer should be consulted regarding the capabilities of the equipment to withstand seismic loading. Refer to paragraph SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT for additional equipment requirements.

****

Provide supports and attachments with continuous load path to distribute electrical component seismic loads to structure.

Provide supports and attachments for electrical components that conform[to the arrangements shown][to UFC 3-301-01 requirements][to UFC 3-301-02 requirements]. Install vertical diagonal braces at a 45-degree slope. Where interference is present, the slope may be minimum of 30 degrees or a maximum of 60 degrees per VISCMA 413.

Provide bolted and welded connections for supports and attachments in accordance with UFC 3-301-01[UFC 3-301-02].

Provide welding in accordance with AWS D1.1/D1.1M.[Grind visible welds smooth in the finished installation.]

3.2 BUILDING DRIFT

****

NOTE: The designer will be guided by the results of the seismic analysis to determine the expected building story drifts, deflections and relative displacements; this information is needed for electrical component, support, and attachment design.

****

Do not attach electrical components to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided. Electrical components, supports, and attachments must be capable of accommodating building story drifts, deflections, and relative displacements.

3.3 CONDUIT, CABLETRAY, BUSWAY, AND RACEWAY

Provide supports and attachments for conduit, cabletray, busway, and raceway conforming to the requirements of UFC 3-301-01[UFC 3-301-02].

3.4 LIGHTING FIXTURES

Provide lighting fixtures and supports conforming to the following:

3.4.1 Pendant Fixtures

Provide pendant fixtures conforming to the requirements of UFC 3-301-01[UFC 3-301-02].

3.4.2 Ceiling Attached Fixtures

3.4.2.1 Recessed Fixtures

Support recessed individual or continuous-row mounted fixtures by a seismic-resistant suspended ceiling support system built in accordance with ASTM E580/E580M. Provide supports and attachments for the fixtures conforming to the requirements of UFC 3-301-01[UFC 3-301-02]. Recessed lighting fixtures not over 25 kg 56 pounds in weight and not required to be supported separately from the structure, may be supported by and attached directly to the ceiling system runners using screws or bolts, number and size as required by the seismic design. Provide lock or screw attachments for fixture accessories, including diffusers and lenses.

3.4.2.2 Surface-Mounted Fixtures

Attach surface-mounted individual or continuous-row fixtures to a seismic-resistant ceiling support system built in accordance with [ASTM E580/E580M][Section 09 51 00 ACOUSTICAL CEILINGS]. Provide supports and attachments for the fixtures conforming to the requirements of UFC 3-301-01[UFC 3-301-02].

3.4.3 Assembly Mounted on Outlet Box

Design a supporting assembly, that is intended to be mounted on an outlet box, to accommodate mounting features on [100] [75] mm [4] [3] inch boxes, plaster rings, and fixture studs.

3.4.4 Wall-Mounted Emergency Light Unit

Design and secure attachments for wall-mounted emergency light units for the worst expected seismic disturbance at the site.

3.5 ANCHORS

3.5.1 General

Submit copies of test results to verify the adequacy of the specific anchor and application, as specified. Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices allowing adequate edge distance and embedment depth for restraint anchor bolts. Identify position of reinforcing steel and other embedded items prior to drilling holes for post-installed anchors. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.[Fill annular gap with nonshrink grout at equipment anchor bolts where clearance between anchor and equipment support hole exceeds 3.175 mm 0.125 inches.]

3.5.2 Cast-In-Place Anchors

****

NOTE: The designer must ensure that foundations and anchor bolts for pad-mounted or floor-mounted equipment are detailed and designed in accordance with UFC 3-301-01 or UFC 3-301-02, as appropriate. When the designer has the necessary size, weight, and other information for a piece of equipment, the anchorage details including sizes, length and number of bolts, thickness and reinforcing of pads and foundations for that piece of equipment will be shown by the designer on the drawings. When this information is not available, it will be the A-E responsibility to design the support and anchorage for the equipment in accordance with the specified requirements.

Design anchors for combined shear and tension.

****

Use templates to locate cast-in-place bolts accurately and securely in formwork. Provide anchor bolts with an embedded straight length with heavy hex nut and [plate] washer as[shown on drawings][to provide required strength and ductility]. Anchor bolts that exceed the normal depth of equipment foundation piers or pads must either extend into concrete floor or the foundation or increase depth of the piers or pads to accommodate bolt lengths.

3.5.3 Post-Installed Anchors

****

NOTE: Verify if restrictions exist on the type of drilling equipment to be used for the project.

****

Refer to Section 05 05 20 POST-INSTALLED CONCRETE AND MASONRY ANCHORS for requirements.

3.6 EQUIPMENT SUPPORT REQUIREMENTS

3.6.1 Suspended Equipment

Provide supports and attachments for components supported from structural systems. Provide supports and attachments that consist of angles, rods, wire rope, bars, channels (struts) or pipes arranged as shown in bracing submittals and secured at both ends with not less than 13 mm 1/2 inch bolts. Provide sufficient supports and attachments to resist seismic forces as specified in UFC 3-301-01[UFC 3-301-02] without exceeding capacity of structural components.[Provide, for approval, specific force calculations in accordance with UFC 3-301-01[UFC 3-301-02] for the project.]

Submit details of supports and attachments for acceptance. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight when hangers are inclined. Where interference is present, the inclined hanger slope may be minimum of 30 degrees or a maximum of 60 degrees per VISCMA 413.

3.6.2 Floor or Pad Mounted Equipment

3.6.2.1 Shear Resistance

Bolt components to floor or pads. Provide bolts to resist seismic forces in accordance with paragraph ANCHORS.

3.6.2.2 Overturning Resistance

Use the ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads to determine if overturning forces need to be considered in the sizing of anchor bolts. Provide calculations to verify the adequacy of the anchor bolts for combined shear and tension. Provide bolts to resist seismic forces in accordance with paragraph ANCHORS.

3.7 SPECIAL TESTING FOR SEISMIC-RESISTING COMPONENTS

****

NOTE: Include this paragraph only for special testing for seismic-resisting components designated as Risk Category V Mission Critical Level 1 (MC-1) by the building owner and specified by the EOR. MC-1 components must be fully operable immediately after a seismic event.

This paragraph may also apply to Designated Seismic System (DSS)(assigned to SDC C thru F) components that must remain operational after an earthquake to function for life safety purposes or is needed for continued operation in a Risk Category IV structure.

This paragraph will be applicable to both new buildings designed according to UFC 3-301-01, UFC 3-301-02, and to existing building seismic rehabilitation designs.

The designer must indicate on the drawings all locations and all components for which special inspection and testing is required for MC-1 equipment.

Add any additional requirements as necessary.

****

Electrical components designated as Designated Seismic Systems [or MC-1 (Mission Critical Level 1)] required to remain operational after an earthquake must be seismic qualified by shake table testing conforming to ICC ES AC156 Shake Table Test procedures. The manufacturer is to provide a certification by a fully qualified testing agency for the specific components. Prequalified certifications are acceptable unless noted otherwise.[Seismic qualification documentation for each component must contain the information required in UFC 3-301-02, Section 2-17.2.5 Component Qualification Documentation.]

Components that are required to be certified must bear permanent marking or nameplates constructed of a durable heat and water resistant material.

Provide component identification nameplates in accordance with UFC 3-301-01 [UFC 3-301-02].

Mechanically attach nameplates to electrical components.

3.8 SPECIAL INSPECTION FOR COMPONENTS, SUPPORTS, AND ATTACHMENTS

****

NOTE: Include this paragraph only for special inspection of designated seismic systems per IBC 1705.13.4; electrical components per IBC 1705.13.6; storage racks per IBC 1705.13.7; and seismic-resisting systems that serve Risk Category V Structures.

The designer must indicate on the drawings all locations and all features for which special inspection is required. This includes indicating the locations of all components, supports, and attachments requiring inspection.

Designated Seismic Systems are required to be operational after a design earthquake. MC-1 components must be fully operable immediately after a seismic event. MC-2 components must be repairable and operable within 3 days after a seismic event.

This paragraph will be applicable to both new buildings designed according to UFC 3-301-01 STRUCTURAL ENGINEERING, and to existing building seismic rehabilitation designs.

****

Perform special inspections for seismic-resisting systems, designated seismic systems, components, supports and attachments, and equipment per[Section 01 45 35 SPECIAL INSPECTION attachment Schedule of Special Inspections and] ICC IBC 1705.13.4; electrical components per ICC IBC 1705.13.6[, and seismic isolators and energy dissipation systems per UFC 3-301-02].

[Special Inspector must inspect and test items required in Schedule of Special Inspections and Statement of Special Inspection.

][Special Inspector must examine Designated Seismic Systems requiring seismic qualification in accordance with ASCE 7-16 and verify the label, anchorage and mounting conform to the certificate of compliance.

][Contractor must employ an independent Professional Engineer to perform "walk down" inspection of MC-1 electrical components and anchorage in accordance with UFC 3-301-02.

] Provide a[Statement of Special Inspections and] Final Special Inspection Report in accordance with UFC 3-301-01 [UFC 3-301-02].

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-26 05 73 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-26 28 01.00 10 (August 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 26 05 73

POWER SYSTEM STUDIES

08/23

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SECTION 26 05 73

POWER SYSTEM STUDIES
08/23

****

NOTE: This guide specification covers the requirements for power system studies typical for incident energy analysis to support an arc flash risk assessment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of

the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1584	(2018; E 2019) Guide for Performing Arc-Flash Hazard Calculations
IEEE 1584.1	(2022) Guide for the Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculation Study
IEEE 3002.2	(2018) Recommended Practice for Conducting Load-Flow Studies and Analysis of Industrial and Commercial Power Systems
IEEE 3002.3	(2018) Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems
IEEE C2	(2023) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-560-01	(2017; with Change 3, 2023) Operation and Maintenance: Electrical Safety

1.2 SYSTEM DESCRIPTION

****
NOTE: Provide brief, general description of the electrical power system project.

Coordinate with Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION; Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION; Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION; Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM; and Section 26 08 00 APPARATUS INSPECTION AND TESTING.
****

The power system covered by this specification consists of: [_____].

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Field Examination Plan; G, [_____]

Arc Flash Label Formats; G, [_____]

SD-06 Test Reports

Field Examination

SD-07 Certificates

System Analyzer; G, [_____]

SD-11 Closeout Submittals

Model Files; G, [_____]

Load Flow Study; G, [_____]

Fault Current Study; G, [_____]

System Coordination Study; G, [_____]

Arc Flash Hazard Study; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 System Analyzer

The System Analyzer must perform the power system studies. The System Analyzer must be a registered professional electrical engineer with a minimum of [3] [_____] years of experience with power system studies. Include a list of three comparable jobs performed by the System Analyzer with specific names and telephone numbers for reference. Include the license number and state of the registered Professional Engineer.

1.4.2 System Verifier

The System Verifier may inspect and record settings, markings, and otherwise document the existing equipment. The System Verifier may also place appropriate hazard labels on equipment. The System Verifier must not make any calibrations or adjustments or place equipment into service. When working with energized equipment, the system verifier must be a Qualified Person per NFPA 70E or working under the direct supervision of a Qualified Person. [The System Verifier may communicate with the system owner to determine if the equipment within the studied system has received maintenance and testing in accordance with NETA MTS or NFPA 70B.]

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 FIELD EXAMINATION

For each pre- and post-study inspection, submit a field examination plan identifying which facilities must be examined to complete the required work. Include a complete information verification procedure, where Qualified Personnel will be required, PPE requirements for "live" equipment examinations, and equipment to be used within the limited approach boundary of the equipment.

3.1.1 General

Perform field inspections of the site and equipment before the first study and after the last study to determine the state and settings of the equipment and to verify the final settings agree with the studies. [Perform the post-study inspection(s) after changing settings, after performing acceptance tests, and before placing equipment in service.][The post-study inspection may be performed by the testing organization approved in 26 08 00 APPARATUS INSPECTION AND TESTING.]

Schedule the field examination by the System Verifier with the Contracting Officer at least [10][_____] business days before conducting examination. Furnish all materials, labor, and equipment necessary to conduct the examination. Maintain a written record of the all equipment examined, equipment location, equipment ratings, settings, personnel involved, and the date the examination was performed. Submit the written record of each field examination.

3.1.2 Safety

Where examination of the equipment requires energized equipment to be opened, provide a Qualified Person to directly supervising any non-Qualified Person within the hazard area. Use PPE, protective barriers, danger signs and other safety devices to protect and warn personnel in the vicinity of "live" equipment being examined.

[3.1.3 Application of Arc Flash Labels

Install arc flash warning labels using Qualified Personnel as necessary after the setting and inspection is complete. For new or modified equipment, install labels before the equipment is energized for the first time after installation/modification or setting changes. Schedule the label placement with the Contracting Officer at least [5][_____] business days before label placement. Furnish all materials, labor, and equipment necessary to place the labels. Maintain a written record of the all equipment that received labels, personnel involved, and the date labels were placed.

]3.2 POWER SYSTEM STUDIES

****

NOTE: The designer of record will be responsible for showing and specifying the requirements for fuses, circuit breakers, protective relays, or other protective devices associated with the project.

The complexity and extent of power system studies depends on the type facilities, on the load demand of facilities, and on the quantity of facilities to be constructed. Facilities having a relatively-low power demand (e.g., 500 kVA or less) generally require protection of: an incoming aerial distribution line or underground, medium-voltage feeder; low-voltage feeders to individual items of equipment; or to power distribution equipment and branch circuits. More complex projects such as facilities with generating capacity, large motors, or larger load demands, will require more detailed and extensive studies.

Choose the first paragraph for construction or modification of equipment. Choose the second paragraph for periodic study of existing equipment.

****

[Perform power system studies to demonstrate that the equipment selected and system constructed meet the contract requirements for fault current and interrupt ratings, coordination, protection, and Arc Flash Hazard. Submit reports of the studies along with protective device equipment submittals.

Apply Arc Flash Hazard labels to equipment after the studies are approved. Update and resubmit the studies after any changes to the equipment or systems which may affect the study results, and re-apply Arc Flash Hazard labels to equipment after the resubmitted studies are approved. The Government is not responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices [or labels]ordered and/or procured before approval of the study.]

[Perform power system studies to demonstrate the system operation with regard to ratings, coordination, protection, and Arc Flash Hazard.]

3.2.1 Scope of Studies

****

NOTE: Provide a description of the scope of the power system studies.

****

[____]

The scope of the studies must begin at [the source bus and extend down to system buses where fault current availability is 10,000 amperes or less (symmetrical) and at most 600 volts for facility-level distribution buses.][the source bus and extended through the secondary side of transformers for medium voltage distribution feeders.] [the source bus and extend through [outgoing breakers] [outgoing medium voltage feeders, down to the individual protective devices for medium voltage radial taps][outgoing medium voltage feeders, through the secondary side of transformers][as indicated] for main electric supply substations.][the nearest upstream device in the existing source system and extend through the downstream devices at the load end.][the utility service entrance of a building and extend down to load buses/panels where the fault current is 2,000 amperes or less (symmetrical) for distribution buses nominally operating at 208 volt AC and above.][For DC system studies, include all DC systems nominally operating at 50 volts and above with fault currents greater than 1,000 amperes.][_____]

The "source bus" is the source of energy for system being analyzed. This may be the energy feed from a utility, the first bus upstream of the work, generators within the work or upstream of the work, or any other source capable of contributing significant energy into the system being analyzed.

In the systems model for the studies, incorporate all existing and new equipment within the scope of the studies. Incorporate any additional sources or load equipment necessary to accurately model the system's performance.

****

NOTE: For simple radial power systems with one source and no alternate power source such as a generator or backup feed, there is usually only one system mode of operation (scenario) to be analyzed. Systems with multiple modes of operation including generators may have the load currents, fault currents, and arc flash energies affected by which sources are in services. Loops in the feeder/distribution system that are opened or closed may affect load currents, faults, currents, and arc flash energies. The multiple modes of operation

(scenarios) must be analyzed to determine which modes are most stressful to the equipment and produce the greatest arc flash hazard.
****

Where multiple sources of power may be in service in various combinations or where electrical loops are in the system, incorporate into the studies all the modes of operation to evaluate the impact of the modes of operation on the system.[The primary modes of operation are listed below.

1. [_____]

2. [_____]]

3.2.2   Determination of Facts

****
NOTE: Require the Contractor to obtain an available fault capacity at the power source or provide a fault capacity on which to base the study. Delete the unused option.

Where fault current is not available, the System Analyzer should used their technical knowledge, experience, and system information to make a reasonable estimate of the fault capacity. Such an estimate may produces results that are less accurate than using the known fault capacity.
****

Determine and document the time-current characteristics, features, ratings, ampacities, and nameplate data for each existing protective device, electrical equipment, and feeder cables. [Obtain the available fault current from the [owner of the source bus][_____].] [Utilize the indicated available fault current.] [For multiple modes of operation, use the mode with available fault current that produces the greatest incident energies in the arc flash hazard study.]

[Utilize field-verified data in the power system studies. Document the field-verified data in the report.]

3.2.3   Single Line Diagram

Provide a single line diagram showing the electrical system buses, devices, transformation points, and all sources of load current and fault current, including generator and motor contributions. Provide a diagram from the system model. Each bus, device or transformation point must have a unique identifier. Show the location of switches, breakers, and circuit interrupting devices on the diagram together with available fault data, and the device interrupting rating.

The naming of existing components within the system model and single line diagram must match existing installed equipment names. The naming of new components within the system model and single line diagram must use unique identifiers and be coordinated with the Government.

3.2.4 Load Flow Study

Perform the load flow study in accordance with IEEE 3002.2 to identify initital steady-state conditions for the fault current study. For each operating scenario, provide load flow results on the diagram or in the report. Show or describe the loading factors and assumptions used in each operating mode.

3.2.5 Fault Current Study

Use the results of the load flow study to perform the fault current study in accordance with IEEE 3002.3. Provide balanced three-phase fault, bolted line-to-line fault, and single line-to-ground fault current values at each voltage transformation point and at each power distribution bus. For each location, show in tabular form on the diagram or in the report the maximum and minimum available fault currents of all modes of operation for that location.

****

NOTE: For some systems the fault current or system impedance may not be available. In some cases the utility may only provide a provide a fault current on the transformer secondary based on an infinite bus on the primary, a withstand current rating, an overcurrent protection kAIC or SCCR rating, transformer nameplate data. For these situations, the source contributions need to be carefully estimated to avoid having currents that are too high or too low. Poor estimates can lead to errors in under or over specifying equipment capabilities, coordination issues, and under or over stating Arc Flash Hazards.

NEMA AB-5, NEMA ABP-1, IEEE 946, IEEE 3004.3, IEEE 3004.5 and IEEE 3004.11 may provide assistance in the coordination of overcurrent devices.

****

Where the available fault current at the source bus is not available, describe how the fault contribution from the source bus was determined and why this method is reasonable for the study.

3.2.6 System Coordination Study

Use the results of the load flow study and fault current study. For normal modes of operation, demonstrate that selectivity has been obtained between the devices within the scope of the project. Demonstrate the equipment, machines, and conductors are protected from damage from overloads and fault conditions. Include a description of the coordination of the protective devices in this project. Provide a written narrative describing which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations; coordination between upstream and downstream devices; and relay settings. Provide recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction). Provide composite coordination plots on a log-log scale. Where recommendations are provided to improve or enhance system reliability, provide separate coordination plots on log-log scale showing the system coordination before and after the implementation of the recommendations.[Where coordination has been adjusted to lower arc flash values, include a discussion of the change and the impact on the system within the report.]

3.2.7 Arc Flash Hazard Study

****

NOTE: Combinations of multiple sources (including generators) and/or loops in the feeder/distribution system can affect the available incident energy. The system owner should be consulted to determine what incident energy thresholds are acceptable and do not need recommendations for reducing the incident energy.

****

Perform the arc flash hazard study in accordance with IEEE 1584.1. Utilize the data from the fault current study to determine the worst case incident energy per IEEE 1584[, IEEE C2,] and OSHA 29 CFR 1910.269 Appendix E. Use identified modes of operation to determine the worst case arc flash energy. If not included in another study, include a description of the devices and device settings for the operating modes that provided the highest arc flash energy. [The use of a "maintenance switch" to temporarily reduce the Arc Flash incident energy for maintenance work is acceptable.][Where the adjusting the coordination of devices to obtain lower arc flash values, include a discussion of the change and the impact on the system within the report.] [Where the arc flash energies exceed [1.2 cal/cm^2][4 cal/cm^2][8 cal/cm^2] provide recommendations to reduce the arc flash energy to [1.2 cal/cm^2][4 cal/cm^2]].[

Where the AC system voltage is 208 volts or less with an available short-circuit current less than 2000 A, an arc flash hazard study is not required.]

3.2.8 Study report(s)

a. Include a narrative describing the studies performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. Include descriptive and technical data for existing devices and new protective devices proposed. Include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices. For existing devices, included statements on the condition of the equipment based upon field inspections and owner's statements and reports.

c. Document [utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings;][generator resistance and reactance values, and time constants;] [and] [existing power system data including time-current characteristic curves and protective device ratings and settings]. Identify all assumptions about the protection devices, equipment, and system where data was not available.

d. For each bus in the system, provide fully coordinated composite time-current characteristics (TCC) curves as required to ensure coordinated power system protection between protective devices and equipment. In a tabular format, provide [existing and]recommended ratings and settings of all protective devices.

e. Provide an arc flash study report in accordance with IEEE 1584.1.

f. Provide the calculations performed for the studies, including computer programs utilized. Provide the name of the software package, developer, and version number.

[

g. The System Analyzer must stamp the study reports.

]

3.2.9 Arc Flash Labels

Provide arc flash warning labels on electrical equipment likely to require examination, servicing, or maintenance while energized. Typical types of equipment include pad-mounted transformers, switchgear, switchboards, panelboards, disconnect switches, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling occupancies. The arc flash label naming must match the naming used in the system modeling and the single line diagram.

Comply with the label requirements specified in UFC 3-560-01NFPA 70E. Obtain approval of arc flash label formats before printing.

a. Provide a [3.5 inch x 5 inch to 4 inch x 6 inch][____] thermal transfer type label of high adhesion polyester for each location device analyzed. The label must remain in place and be legible for at least 5 years in the installed environment.

b. Labels must be machine printed with no field markings. Provide arc flash labels in the following manner. All labels must be based on implemented overcurrent devices and settings.

1. Provide at least one arc flash label for each 480 volt and 208 volt panelboards.

2. Provide at least one arc flash label for each low voltage (less than 1000 V) switchboard.

3. Where the equipment construction has different hazards levels in different areas, provide [a label for each compartment, cubicle, or section separated by barriers][a single label representing the worst case hazard for all branch circuits and a separate unique label for the compartment containing the main protective device. On the worst case label, indicate which branch circuit compartments have the worst case hazard.]

c. Use the worst case hazard of all operating scenarios unless mitigation procedures are used. If mitigation procedures are used, explain the procedures on the label.

3.3 MODELING

Develop a software model of the electrical system identified in the scope of the studies. Use the latest version of [SKM PowerTools(TM)][EasyPower(TM)][ETAP(TM)][_____]. Develop the model with accurate, verified information. Model existing electrical equipment, machines, devices, and conductors directly connected to, altered by, or otherwise affected by the work. This includes, but is not limited to generators, transformers, switchgear, switchboards, panelboards, motor control centers, motors, voltage regulators, tap changers, protective relays, circuit breakers, switches, fuses, conductors, capacitors, reactors, grounding system, and control equipment.

Provide the final model files in their native editable formats for future use by the Government. Include device information for devices not in the software vendor's standard distribution.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 08 00 (November 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 08 00 (November 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 08 00

APPARATUS INSPECTION AND TESTING

11/22

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 08 00 (November 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 08 00 (November 2021)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 08 00

APPARATUS INSPECTION AND TESTING
11/22

****

NOTE: This guide specification covers the requirements for electrical inspection and testing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Use this specification on project specifications where NETA testing is required.

The following sections reference NETA for power distribution services and equipment.

--Section 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES
--Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
--Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
--Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION
--Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION

--Section 26 13 00 SF6/HIGH-FIREPOINT FLUID INSULATED PAD-MOUNTED SWITCHGEAR
--Section 26 11 16 SECONDARY UNIT SUBSTATIONS
--Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION
--Section 26 36 23 AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH
--Section 26 23 00 LOW VOLTAGE SWITCHGEAR
--Section 26 24 13 SWITCHBOARDS
--Section 26 33 53 STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS)
--Section 26 35 43 400-HERTZ (HZ) SOLID STATE FREQUENCY CONVERTER
--Section 26 35 44 270 VDC SOLID STATE CONVERTER

This section will also be used for specification sections containing low-voltage or medium voltage generator control switchboards or switchgear, pad-mounted air switches, and medium voltage circuit breakers. Provide the section numbers and titles in this section, and add NETA testing requirements to the applicable section.

Coordinate the sections in your contract documents with this list and with paragraph ACCEPTANCE TESTS AND INSPECTION in PART 3 of this specification.
****

PART 1   GENERAL

1.1   REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing

Specifications for Electrical Power
Equipment and Systems

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance Tests and Inspections; G, [_____]

SD-07 Certificates

Qualifications of Organization, and Lead Engineering Technician; G, [_____]

Acceptance Test and Inspections Procedure; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph ACCEPTANCE TESTS AND INSPECTIONS herein. Organization must be independent of the supplier, manufacturer, and installer of the equipment. The organization must be a first tier subcontractor. No work required by this section of the specification may be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization must have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization must have a calibration program, and test instruments used must be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments must be performed by an engineering technician, certified by NETA (Level III) or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.4.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.4.3 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization will perform acceptance tests and inspections. Test methods, procedures, and test values must be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph FIELD QUALITY CONTROL of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Place equipment in service only after completion of required tests and evaluation of the test results have been completed. Supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Notify Contracting Officer at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

****

NOTE: Select applicable sections for each project. Ensure each equipment section includes the following information. These changes should be found in NAVFAC LANT's Interim Specification Revision.

1. NETA ATS listed in the references.

2. The words "and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply" added to paragraph RELATED REQUIREMENTS.

3. SD-06 submittals with "Acceptance checks and tests" added in PART 1.

4. Appropriate paragraphs from the NETA manual added under "Field Quality Control" in PART 3.

5. Add any job section numbers and titles containing low-voltage or medium voltage generator control switchgear or switchboards, pad-mounted air switches, or medium voltage circuit breakers. Provide the NETA tests required in the applicable section.

****

[a. Section 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES. Functional engine shutdown tests, vibration base-line test, and load bank test will not be performed by the testing organization, but by the start-up engineer.

][b. Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

][c. Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS

][d. Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION

][e. Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Medium voltage cables and grounding systems only.

][f. Section 26 13 00 SF6/HIGH-FIREPOINT FLUID INSULATED PAD-MOUNTED SWITCHGEAR

][g. Section 26 11 16 SECONDARY UNIT SUBSTATIONS

][h. Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION

][i. Section 26 36 23 AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH

][j. Section 26 23 00 LOW VOLTAGE SWITCHGEAR

][k. Section 26 24 13 SWITCHBOARDS

][l. Section 26 35 43 400 HERTZ ((HZ) SOLID STATE FREQUENCY CONVERTER. The NETA ATS representative must coordinate with the Contractor and the Converter Manufacturers' representative to witness, document, and validate the Converter Field Quality Control, Inspection and Testing. These tests will be performed by the converter manufacturers' representative, however include the documentation in the overall NETA report as well.

][m. Section 26 35 44 270 VDC SOLID STATE CONVERTER. The NETA ATS representative must coordinate with the Contractor and the Converter Manufacturers' representative to witness, document, and validate the Converter Field Quality Control, Inspection and Testing. These tests will be performed by the converter manufacturers' representative, however include the documentation in the overall NETA report as well.

]3.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization must be present when equipment tested by the organization is initially energized and placed in service.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 11 13.00 20 (November 2021)**

Preparing Activity: NAVFAC **Superseding**
26 11 13.00 20 (April 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 11 13.00 20

PRIMARY UNIT SUBSTATION

11/21

PART 1 GENERAL

PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 11 13.00 20 (November 2021)**

Preparing Activity: NAVFAC **Superseding**
26 11 13.00 20 (April 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 11 13.00 20

PRIMARY UNIT SUBSTATION

11/21

****

NOTE: This guide specification covers the requirements for primary substations and associated load break switches and switchgear.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: To download UFGS Forms, Graphics, and Tables, go to: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

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NOTE: A primary substation as used in this specification is a substation in which the primary and secondary voltages are both rated 1000 volts and above, normally in the medium voltage range of 5 kV to 35 kV. This specification includes indoor and outdoor applications.

USE THE FOLLOWING RELATED GUIDE SPECIFICATIONS FOR POWER DISTRIBUTION EQUIPMENT:

--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
--Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
--Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION
--Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION
--Section 26 13 00 SF6/HIGH-FIREPOINT FLUIDS INSULATED PAD-MOUNTED SWITCHGEAR
--Section 26 11 16 SECONDARY UNIT SUBSTATIONS
--Section 26 23 00 LOW-VOLTAGE SWITCHGEAR
--Section 26 24 13 SWITCHBOARDS

****

****

NOTE: The following information must be indicated on the project drawings or specified in the project specifications:

1. Single-line diagram showing transformers, buses, and interrupting devices with interrupting capacities; current transformers and potential transformers with ratings; instruments and meters required; and description of instruments and meters.

2. Location, space available, arrangement, and elevations of substations and switchgear.

3. Grounding plan.

4. Type and number of cables, size of conductors for each power circuit, and point of entry (top or bottom).

5. Minimum and maximum overall dimensions of shipping section which can be handled and installed at destination, as applicable.

6. Transformer primary and secondary voltages. (Use IEEE C57.12.00, Table 11(b), Designation of voltage ratings of three-phase windings".) State the primary voltage (nominal) actually in service and not the voltage class.

7. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gases.

8. Where extensions or additions to existing substations or switchgear are being specified, clearly distinguish the difference between existing equipment and the equipment the Contractor is required to provide under this contract. Clearly indicate the extent of the Contractor's responsibility for testing the existing equipment upon completion of his work.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM D117	(2018) Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D2472	(2000; R 2014) Standard Specification for Sulphur Hexafluoride
ASTM D3487	(2016; E2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus
ASTM D6871	(2017) Standard Specification for Natural (Vegetable Oil) Ester Fluids Used in Electrical Apparatus

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1613	(2023) Environmental and Testing Requirements for Devices with Communications Functions used with Electric Power Apparatus
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.04	(2018; Erta 2019; Corr 2021) Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V Corrigendum 1
IEEE C37.06	(2009) Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltage Above 1000 V
IEEE C37.2	(2022 Standard for Electrical Power System Device Function Numbers, Acronyms and Contact Designations
IEEE C37.20.2A	(2020) Metal-Clad Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear

IEEE C37.41	(2016; Corr 2017) Design Tests for High-Voltage (>1000 V) Fuses and Accessories
IEEE C37.46	(2010) Standard for High Voltage Expulsion and Current-Limiting Type Power Class Fuses and Fuse Disconnecting Switches
IEEE C37.74	(2014) Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems Up to 38 kV
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C37.94	(2021) IEEE Standard for N times 64 kbps Optical Fiber interfaces between Teleprotection and Multiplexer Equipment
IEEE C37.118	(2021) Standard for Synchrophasor Measurements for Power Systems
IEEE C37.121	(2012) American National Standard for Switchgear-Unit Substations - Requirements
IEEE C57.12.00	(2021) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2021) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C57.96	(2013) Guide for Loading Dry-Type Distribution and Power Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60068-2-27	(2008; ED 4.0) Environmental Testing - Part 2-27: Tests - Test Ea and Guidance: Shock
IEC 60255-21-3	(1993; ED 1.0) Electrical Relays - Part 21: Vibration, Shock, Bump And Seismic Tests On Measuring Relays And Protection Equipment - Section 3: Seismic Tests
IEC 61000-4-5	(2017) Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test
IEC 61000-6-2	(2021) Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
IEC 61010	(2021) Overview - Standard for Safety Requirements for Electrical Equipment
IEC 61800-3	(2022) Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
IEC 61850	(2021) Communication networks and systems for power utility automation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.4	(1984; R 2011) Registers - Mechanical Demand
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA TS-2	(2021) Traffic Controller Assemblies with NTCIP Requirements - Version 03.08
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-232	(1997f; R 2012) Interface Between Data

	Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
TIA-485	(1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)	
EPA 712-C-98-075	(1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
EPA 821-R-02-012	(2002) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms
UL SOLUTIONS (UL)	
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 1437	(2006) Electrical Analog Instruments - Panel Board Types

1.2   RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment

****

Section 26 08 00 APPARATUS INSPECTION AND TESTING and Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS applies to this section, with the additions and modifications specified herein.

1.3   SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Include the bracketed options on "DC44 and 074 review" for NAVFAC LANT and NAVFAC SE projects respectively. For other projects, submittal review must be performed by the designer of record. If submittal review by NAVFAC LANT or NAVFAC SE is specifically desired, the responsible Government agency must coordinate with the respective Code DC44 or 074 during the design process. Add appropriate information in Section 01 33 00 SUBMITTAL PROCEDURES to coordinate with the special requirements.

****

[Submit in accordance with paragraph COORDINATED SUBMITTAL REVIEWS herein.

]1.3.1 Coordinated Submittal Reviews

a. Submit transformer submittals to Code [DC44, Atlantic][074, Southern] Division, Naval Facilities Engineering Systems Command for approval. In addition, submit one set of the remaining substation components for surveillance.

b. Submit remaining substation component submittals to Engineer of Record for approval. In addition, submit one set of transformer submittals for review and to insure alignment of equipment and coordination for interconnections.

SD-02 Shop Drawings

Unit Substation Drawings; G, [_____]

[Transformer Drawings[(to Code [DC44] [074])]; G, [_____]

] DC One-Line Diagram; G, [_____]

DC Panel Schedules; G, [_____]

[SCADA Interconnection Diagram; G, [_____]

] SD-03 Product Data

****

NOTE: Use bracketed options referring to Codes DC44 and 074 for NAVFAC LANT and NAVFAC SE projects, respectively. This requires the designer of record to review and approve the substation equipment submittals except for the transformer. The EFD will review and approve the transformer submittals.

****

Primary Unit Substations[Excluding Transformer Data]; G, [_____]

[Unit Substation Transformer[(to Code [DC44] [074])]; G, [_____]

] Submittal must include manufacturer's information for each component, device and accessory provided with the equipment.

SD-05 Design Data

Capacity Calculations for Battery Charger and Batteries; G, [_____]

SD-06 Test Reports

****

NOTE: Include "Calibration test reports" for NAVFAC SE projects.

****

[Calibration Test Reports; G, [_____]

] Submit report of results of Acceptance Checks and Tests specified by paragraph FIELD QUALITY CONTROL; G, [_____]

****

NOTE: Field dielectric tests are recommended only when new units added to an existing installation or after major field modifications. If necessary, service the equipment prior to the field test.

****

[Certified Copies of Dielectric Tests Report; G, [_____]

] SD-09 Manufacturer's Field Reports

****

NOTE: If project includes special requirements or unusual application of the equipment specified in this section, factory tests may be specified on completely assembled unit substations as well as individual components. These completely assembled tests involve additional cost and specific requirements must be added to this specification when they are deemed necessary.

****

Switchgear Design Tests; G, [_____]

Switchgear Production Tests; G, [_____]

Load Interrupter Switch Design Tests; G, [_____]

Load Interrupter Switch Production Tests; G, [_____]

Transformer Design Tests[to Code [DC44] [074]]; G, [_____]

Transformer Routine and Other Tests[(to Code [DC44] [074])]; G, [_____]

SD-10 Operation and Maintenance Data

Primary Unit Substations, Data Package 5; G, [_____]

[Unit Substation Transformer, Data Package 5; G, [_____]

] Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

****

NOTE: Include "Calibration schedule" and "Formal request for settings" for NAVFAC SE projects.

****

[Calibration Schedule; G, [_____]

][Formal Request for Settings; G, [_____]

] Equipment Test Schedule[(to Code [DC44] [074])]; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Battery Power Calculations

Submit capacity calculations for battery charger and batteries. Calculation must verify that battery capacity exceeds station d.c. power requirements.

1.4.2 Unit Substation Drawings

Drawings must include, but are not limited to, the following:

a. An outline drawing with front, top, and side views

b. Ampere ratings of bus bars

c. Maximum short-circuit bracing

d. Nameplate data

[e. Provisions for future extension[and future forced air equipment]

][f. Circuit breaker[and switch] type(s), interrupting ratings, and trip devices including available settings

] g. Elementary diagrams and wiring diagrams with terminals identified and indicating prewired interconnections between items of equipment and the interconnection between the items

h. One-line diagram, including switch(es),[circuit breakers,][current transformers, meters,] and fuses

i. Manufacturer's instruction manuals and published time-current curves (on full size 279 by 431 mm 11 by 17 inches logarithmic paper) of the[fuse in the load interrupter switch,][main secondary breaker,][largest secondary feeder device]; transformer thermal and magnetic damage information; and transformer inrush current information (magnetic inrush point). These must be used by the designer of record to verify fuse size and to[provide breaker settings that will] ensure protection and coordination are achieved.

[1.4.3 Transformer Drawings

****

NOTE: Include bracketed option for separate transformer drawings on NAVFAC LANT and NAVFAC SE projects only.

****

Drawings must include, but are not limited to the following:

a. An outline drawing, with top, front, and side views

b. ANSI nameplate data

][1.4.4 Calibration Schedule

****

NOTE: Include "Calibration schedule" and "Formal request for settings" for NAVFAC SE projects only.

****

a. Provide a calibration schedule including the anticipated dates when equipment requiring coordination and protection will be installed, the anticipated date when the Contractor will submit a formal request for settings, and the anticipated date when the manufacturer's technical representative will perform settings and calibrate equipment.

b. Submit the calibration schedule, via the Contracting Officer to:

NAVFAC SE, Code 05, Construction Department

NAVFAC SE; Code 162; Director, Utilities Engineering Division

][1.4.5 Formal Request for Settings

****

NOTE: The "30" days in brackets below may be extended for projects involving major electrical distribution work. Consult with NAVFAC SE Code 162.

****

a. Where settings will be provided by the Government to achieve protection and coordination via relays and protective devices, submit a formal request for settings [30][_____] days in advance of the date that settings will be needed, to allow the Contracting Officer to forward a copy of approved shop drawings to NAVFAC SE; Code 162; Director, Utilities Engineering Division.

b. The equipment requiring protection and coordination must be installed prior to making this request.

c. Include approved shop drawings, manufacturer's instructions to set the protective devices, and manufacturer's time-current curves.

d. Submit the formal request for settings, via the Contracting Officer to: NAVFAC SE; Code 162; Director, Utilities Engineering Division.

][1.4.6 Calibration Test Reports

****

NOTE: Include this paragraph for NAVFAC SE projects.

****

Submit test results on protective relays via the Contracting Officer to NAVFAC SE; Code 162; Director, Utilities Engineering Division.

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

]1.4.7 DC One-Line Diagram

Submit one-line diagram showing all DC components, interconnecting wiring and over current protective devices.

1.4.8 DC Panel Schedules

Submit panel schedules for each DC panelboard. Schedule must indicate panel ratings, mounting configuration and over current protective device sizes.

[1.4.9 SCADA Interconnection Diagram

Provide a connection diagram for the Supervisory control and data acquisition (SCADA) system. The diagram must show all components along with the required conduit and wire sizes.

]1.5 MAINTENANCE

1.5.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the actual primary unit substations provided.

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, including front view and sectional views with items and devices identified

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Time-Current-Characteristic (TCC) curves of fuses[and circuit breakers]

[f. Information on metering

] g. Actual nameplate diagram

h. Date of purchase

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be secondary unit substations and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 PRIMARY UNIT SUBSTATIONS

IEEE C37.121, [single-ended][double-ended]arrangement, consisting of [one][two] incoming sections, [one][two] transformer sections, [one][two] transition sections, the number of auxiliary sections, bus-tie sections, and outgoing sections indicated.[Substation must be designed for indoor service.][Substation must be designed for outdoor service with ventilation openings and gasketing provided to ensure a weatherproof assembly under rain, snow, sleet, sand/dust storms, and hurricane conditions.] External doors must have provisions for padlocking.

2.2.1 Incoming Sections

****

NOTE: Choose one of the following three choices for each incoming section: a metal-clad switchgear section, a metal-enclosed switch section, or an air filled terminal chamber.

****

[The][Each] incoming section must consist of[a metal-clad switchgear section][a metal-enclosed switch section][an air filled terminal chamber] for connecting the incoming circuit [directly] [through a [circuit breaker] [[fused] [nonfused] load interrupter switch]]to the transformer. If required for proper connection and alignment, include a transition section with the incoming section. Connection between [circuit breaker][interrupter switch] and transformer must be insulated copper bus or insulated copper cable mounted on porcelain insulators spaced no more than 610 mm 2 feet apart.

2.2.1.1 Conductor Termination

Conductor terminations must be designed for terminating [one][two][_____] single conductor cables per phase and must be arranged for conduits entering from [below][above]. Provide cable terminations of the [modular molded rubber][porcelain insulator] type as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

[2.2.1.2 [Vacuum][or][SF6] Circuit Breaker as Main Protective Device

****

NOTE: When a separately enclosed, pad mounted SF6 switch is provided as the incoming

disconnecting/overcurrent protection device for the primary unit substation, use Section 26 13 00 SF6/HIGH-FIREPOINT FLUIDS INSULATED PAD-MOUNTED SWITCHGEAR. Modify Section 26 13 00 for vault-type switches, where applicable.
****

****
NOTE: Choose this subparagraph or paragraph LOAD INTERRUPTER SWITCH AS MAIN PROTECTIVE DEVICE.
****

****
NOTE: Circuit breakers are more costly than fused switches, but may be needed where switching is frequent, and quick reclosing is required.
****

The [vacuum][or][SF6] circuit breaker must be an electrically-operated, three-pole, circuit interrupting device rated for [_____] amperes continuous at [_____] kV and [_____] kV BIL. Breaker must be designed for service on a [_____] kV system with a short-circuit capacity of not less than [_____] [amperes symmetrical][MVA]. Rating must be based on IEEE C37.04 and IEEE C37.06. Circuit breaker must be drawout-mounted with position indicator, operation counter, auxiliary switches, and primary and secondary disconnect devices. Circuit breaker must be operated by an electrically charged, mechanically and electrically trip-free, stored-energy operating mechanism. Provide for manual charging of the mechanism. Circuit breaker control voltage must be [[_____] Vdc][[_____] Vac].[SF6 circuit breakers must be shipped factory filled with SF6 gas conforming to ASTM D2472.]

a. Contacts: Silver-plated, multi-finger, positive pressure, self-aligning type for main drawout contacts.

b. Each drawout breaker must be provided with three-position operation. The connected position and the test/disconnect position must be clearly identified by an indicator on the circuit breaker front panel.

    (1) Connected position: Contacts are fully engaged. Breaker must be tripped before it can be racked into or out of this position.

    (2) Test/disconnect position: Position must allow for complete testing and operation of the breaker without energizing the primary circuit.

    (3) Withdrawn (removed) positions: Places breaker completely out of compartment, ready for removal.

][2.2.1.3 Load Interrupter Switch as Main Protective Device

IEEE C37.20.3. Provide a three-pole, single-throw, deadfront, metal-enclosed, load interrupter switch with manual stored energy operator. Switch must be[fused, with fuses mounted on a single frame][non-fused][in series with [vacuum][or][SF6] interrupters] and designed for easy inspection[and fuse replacement].[SF6 gas must conform to ASTM D2472.] The switch must be operated by a manually charged spring stored energy mechanism which must simultaneously disconnect or connect ungrounded conductors. The moveable blade of the switch must be deenergized when in the open position. The mechanism must enable the switch to close against a fault equal to the momentary rating of the switch without affecting its continuous current carrying or load interrupting ability. A ground bus must extend the width of the switch enclosure and must be bolted directly thereto. Connect frame of unit to ground bus. The door must have an inspection window to allow full view of the position of the three switch blades through the closed door. Switch ratings must be:

a. [_____] kV, [_____] kV BIL for service on a [_____] kV system with a fault close rating of not less than [_____] amperes asymmetrical.

b. The switch must be capable of carrying continuously or interrupting [_____] amperes with a momentary rating of [_____] amperes at [_____] kV.

c. Switch must have provision for padlocking in the open and closed positions.

[d. Fuses must be current limiting type rated[[_____] amperes continuous, and [_____] [amperes interrupting capacity].][approximately [_____] percent of the transformer full-load rating and in accordance with the fuse manufacturer's recommendation.]

]]2.2.2 Primary Transition Section

****

NOTE: Transition section should only be specified where absolutely necessary.

****

Provide transition section for insulated copper [cable][bus-bar] connections to the transformer primary terminals. Support [bus][cable] connections between high-voltage [switch][breaker] and transformer primary by porcelain insulators[spaced no more than 610 mm 2 feet apart]. Size and brace [bus][cable] to withstand the specified available fault.

2.2.3 Transformer Sections

****

NOTE: Indicate and specify the type of transformers required for the project.

1. Use less flammable, bio-degradable liquid insulated transformers and locate transformers away from buildings in accordance with UFC 3-600-01, "Fire Protection for Facilities Engineering for Facilities". A thorough analysis should be made by the designer prior to using silicone filled transformers due to the concern over operation of tap changers within the silicone liquid. Bio-degradable is defined as a substance capable of being decomposed by bacteria or other living organisms.

2. Use the following option(s) when additional capacity is required. This involves special coordination with transformer kVA rating, as well as sizes and ratings of fuses and secondary breakers.

a. If it is anticipated that future load requirements will necessitate increasing the capacity of the transformer, the specification for the transformer should require the provision of components and brackets for future forced air cooling. Forced-air-cooling increases capacity by: 15 percent (750-2000 kVA); 25 percent (2500-5000 kVA).

b. On rare occasions, change "... insulation system rated for a 65 degrees C rise..." to read "...insulation system rated for a 55/65 degrees C rise to allow transformer(s) to have a continuous overload capacity of 12 percent at rated voltage without exceeding 75 degrees C winding temperature rise."

3. Use IEEE C57.12.00, Figure 3(b), voltage designations, such as "13200 V - 4160Y/2400 V".

4. Tap ratings may vary from those indicated, especially in lower kVA ratings.

5. Energy efficient transformers usually have impedance values in the range of 2.95 to 5.75 percent. Perform fault current calculations to determine minimum acceptable transformer impedance. Be sure that specified impedance is available in the size and type transformer required.

6. Delete inapplicable sound levels.

7. Delete last sentence, referring to removable ground strap, if transformer secondary winding is delta type.

****

IEEE C57.12.00. [Less-flammable [bio-degradable]liquid-insulated] [Oil-insulated], two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

2.2.3.1 Transformer Ratings

a. Transformer must be rated [_____] kVA, [_____] kV BIL primary, [_____] kV BIL secondary.

b. Transformer voltage ratings: [_____] V - [_____] V.[For GrdY - GrdY transformers, provide transformer with five-legged core design for third harmonic suppression.]

c. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Provide tap changer, with external, pad-lockable, manual type operating handle, for changing tap setting when the transformer is de-energized.

****

NOTE: Change 85 degrees C to 75 degrees C when transformers are specifically rated for 55/65 degrees C rise.

****

d. Minimum tested impedance must not be less than [_____] percent at 85 degrees C.

e. Audible sound levels must comply with the following:

kVA	DECIBELS (MAX)
225	55
300	55
500	56
750	58
1000	58
1500	60
2000	61
2500	62
5000	65
7500	67
10000	68

f. Diagrammatic stainless steel or laser-etched anodized aluminum nameplate.

g. Transformer must include ground pads, lifting lugs and provisions for jacking under base. The transformer base construction must be suitable for using rollers or skidding in any direction. Provide transformer top with an access handhole. The transformer must have an insulated low-voltage neutral bushing with lugs for ground cable, and with removable ground strap.

h. Transformer must have the following accessories:

(1) Liquid-level indicator

(2) Pressure-vacuum gage

(3) Liquid temperature indicator

(4) Drain and filter valves

(5) Pressure relief device

[(6) Auxiliary cooling equipment and controls

[(a) Transformer must have provisions for future addition of automatically controlled fans for forced-air-cooling.

][(b) Transformer must be forced-air-cooled. Forced-air-cooling fans must have[automatic temperature control relay][winding temperature indicator with sequence contacts].

]][(7) Transformer Monitoring System

(a) Provide a Transformer Monitoring System (TMS) capable of monitoring primary and secondary voltage, primary and secondary current, winding temperature, transformer fluid temperature, transformer liquid level, transformer sudden pressure, gas in transformer fluid, water in transformer fluid, [Load Tap changer position and Load Tap changer liquid level] as a minimum. The transformer monitoring system must have an LCD display capable of displaying measured values, calculated values, I/O statuses, device status and configuration programming of the system. The TMS must be capable of communicating employing a TIA-485-A interface and utilizing DNP level 3 or Modbus protocols. The TMS must have an event monitor capable of logging up to eight events with a minimum of 32 Mbytes of data storage. The TMS must have a minimum of eight programmable output relays and four analog outputs.

][2.2.3.2 Specified Transformer Efficiency

****

NOTE: Transformer losses and efficiency requirements have been modified into the table included within the specification and the previous Navy loss tables have been deleted.

10 CFR 431, Subpart K is a result of the Energy Policy and Conservation Act (EPACT) of 2005 and is the"minimum" industry standard for distribution transformers manufactured on or after January 1, 2016.

****

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "kVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K. Submit certification, including supporting calculations, from the manufacturer indicating conformance.

kVA	EFFICIENCY (percent)
15	98.65
30	98.83
45	98.92

75	99.03
112.5	99.11
150	99.16
225	99.23
300	99.27
500	99.35
750	99.40
1000	99.43
1500	99.48
2000	99.51
2500	99.53
above 2500	99.54

]2.2.3.3 Insulating Liquid

****

NOTE: On Navy projects use biodegradable less-flammable liquid, unless there is a specific requirement otherwise.

****

a. Less-flammable transformer liquids: Must meet the requirements of ASTM D6871, NFPA 70 and be approved by the FM APP GUIDE for Less or Non-Flammable Liquid Insulated Transformers. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

b. Provide a fluid that is a biodegradable, electrical insulating, and cooling liquid classified by UL and approved by FM as "less flammable" with the following properties:

(1) Aquatic biodegradation: EPA 712-C-98-075, 99 percent.

(2) Trout toxicity: The fluid must have passed OECD Test 203 following the methods of EPA 821-R-02-012 and be determined to be non-toxic.

[c. Mineral oil: ASTM D3487, Type II, tested in accordance with ASTM D117. Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

]2.2.3.3.1 Liquid-Filled Transformer Nameplates

Provide nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.2.4 Secondary Transition[and Auxiliary] Section(s)

The secondary transition[and auxiliary] section(s) must have a hinged front panel, a [_____]-ampere, three-phase, [three][four]-wire[insulated] main bus and connections, a ground bus, necessary terminal blocks, wiring and control buses, control power transformer, and cable supports.[In the auxiliary section provide a [_____]-V battery complete with rack and standard accessories, and a battery charger, static type, [without voltage regulation][with automatic charger control], complete with ammeter, voltmeter, and rheostat.]

2.2.4.1 Control Power Transformers

Transformers must be designed for continuous operation at rated kVA 24 hours a day, 365 days a year with normal life expectancy as defined in IEEE C57.96. [Dry-type][Oil insulated], two-winding type, 115 degrees C rise above 40 degrees C maximum ambient designed for mounting in switchgear cubicle or drawer. Transformer must be sized as required to serve the connected load and must have a voltage rating of [_____] kV [three-phase][single-phase], primary, and [120/208] [277/480] [120/240] [120] [_____] V secondary, 60 Hz. Insulation level must be [5KV, 60KV BIL] [15KV, 95KV BIL] [34.5KV, 150KV BIL] [_____].

2.2.4.2 Primary Protection

Provide drawout-mounted, primary current limiting fuses rated for the specified transformer size and the available short-circuit current.

2.2.4.3 Secondary Protection

Provide molded-case circuit breakers or molded-case switch sized as required, mounted in same compartment with transformer and primary fuses to serve the indicated loads.

2.2.5 Metal-Clad Switchgear Outgoing Section

****

NOTE: This paragraph may also be used to specify freestanding switchgear not directly connected to a unit substation. This paragraph is not intended to be used for generator control switchgear without extensive modification and coordination with applicable diesel engine generator guide specifications. Specify Category A requirements when switchgear area is subject to access by the unsupervised general public. Category B enclosures must be fence enclosed or in a locked room.

****

****

NOTE: Specify Category A requirements when switchgear area is subject to access by the unsupervised general public. Category B enclosures must be fence enclosed or in a locked room.

****

****

NOTE: To help determine whether metal-clad switchgear or metal-enclosed interrupter switchgear

is more appropriate for a project, consider that the primary applications for interrupter switchgear are where there are no instantaneous relaying and where switching is infrequent. Also interrupter switchgear is significantly less costly than metal-clad switchgear.

****

IEEE C37.20.2A for metal-clad medium-voltage [vacuum][SF6] circuit breaker type, insulated for [5][15] kV for use on [_____] kV system. Each steel unit forming part of the switchgear structure must be self-contained and must house [one-high][two-high] breaker or instrument compartments, and a full height center and rear compartment for the buses and outgoing cable connections. For two-high breaker units, provide a removable metal barrier to separate the two cable circuits. Equip individual circuit-breaker compartments with drawout contacts, rails, disconnecting mechanism, and a cell interlock to prevent moving the removable element into or out of the "connected" position while the circuit breaker is closed. Provide a steel door for each breaker compartment. Enclosures must be designed for [indoor][outdoor] location and must conform to the Category [A][B] requirements of Table A1 of Appendix A to IEEE C37.20.2A. Design the structure to allow for future additions. Provide laminated plastic nameplates for each relay, switch, meter, device, and cubicle to identify its function. Provide permanent labels for wiring and terminals corresponding to the designations on approved shop drawings. Mount nameplates on each circuit breaker compartment door.

a. Phase buses and connections: Mount bus structure on insulated supports of high-impact, non-tracking, high-quality insulating material and brace bus to withstand the mechanical forces exerted during short-circuit conditions when connected directly to a source having maximum of [_____] amperes rms symmetrical available. Bus bars must be rated [_____] amperes and must be high conductivity copper having silver plated joints. Make bus bar connections from main buses to the incoming circuit breaker studs. Equip outgoing circuit breaker studs with mechanical clamp type cable connectors for the size of cables shown. Provide cable supports for outgoing cables. Wire secondary circuits, including heater circuits, to terminal blocks. Terminal blocks must be readily accessible for making external connections as required.

b. Ground bus: Provide a copper ground bus sized for full short-circuit capacity. Secure ground bus to each vertical structure and extend ground bus the entire length of switchgear. Include provisions for making the station ground connections.

c. DC bus: Provide an insulated copper bus or wire extending the entire length of switchgear. Bus must be rated 100 amperes at 125 Vdc. Wire must be No. 6 AWG minimum.

d. Each breaker compartment must have provision for mounting up to four sets of ANSI rated current transformers, two on line side and two on load side of each breaker.

2.2.5.1 Circuit Breaker

Each [vacuum][SF6] circuit breaker must be an electrically operated, three-pole, circuit interrupting device rated as indicated at maximum voltage of [_____] kV and [_____] kV BIL. Breaker must be designed for service on a [_____] kV system with a short-circuit capacity of not less than [_____] [amperes symmetrical][MVA]. Rating must be based on IEEE C37.04 and IEEE C37.06. Breaker frame size must be as indicated. Provide draw-out mounted circuit breakers with position indicators, operation counter, auxiliary switches, and primary and secondary disconnect devices. Circuit breaker must be operated by an electrically charged, mechanically and electrically trip-free, stored-energy operating mechanism. Provide for manual charging of the mechanism and for slow closing of the contacts for inspection or adjustment. Circuit breaker control voltage must be [_____] Vdc.

a. Contacts: Silver-plated, multi-finger, positive pressure, self-aligning type for main drawout contacts.

b. Each drawout breaker must be provided with three-position operation. The connected position and the test/disconnect position must be clearly identified by an indicator on the circuit breaker front panel.

    (1) Connected position: Contacts are fully engaged. Breaker must be tripped before it can be racked into or out of this position.

    (2) Test/disconnect position: Position must allow for complete testing and operation of the breaker without energizing the primary circuit.

    (3) Withdrawn (removed) positions: Places breaker completely out of compartment, ready for removal.

2.2.5.2 Space Only Compartments

Provide fully equipped with busing, control switch, indicating lights, and drawout breaker mounting and connecting straps to accommodate future breakers. Provide compartments with doors.

2.2.5.3 Breaker Lifter

Provide a portable lifter rated for lifting and lowering circuit breakers from two-high cubicles. Portable lifter must have swivel casters in front for ease of movement.

2.2.5.4 Remote Racking Device

Provide an electrically operated remote racking device for installing and removing circuit breakers. The RRD must mount on the circuit breaker compartment door by insertion of mounting pin into the RRD support bushing in the circuit breaker compartment. The RRD output shaft must be capable of activating the racking shaft through a racking port in the circuit breaker compartment door and operate with the door closed or open. Provide a remote operator control with a lanyard type cord that allows the operator to move a minimum of 15 meters 50 feet from the circuit breaker compartment. Include four hours of training for the correct use and operation of RRD.

2.2.6 Protective Relays, Metering, and Control Devices

****

NOTE: The only manufacturer to currently have an Authority to Operate (ATO) is Schweitzer Engineering Laboratories. This will require a Justification &

Authorization (J&A) be included in the design package that goes to contracting.

****

Relays shall conform to IEEE C37.90. Protective relays shall be microprocessor-based, enclosed in rack-mountable cases with indicating targets and provisions for testing in place by use of test switches. Test switches to fit each type of relay in the equipment shall be provided. Controls, relays, and protective functions shall be provided completely assembled and wired.

All Facility Related Controls Systems (FRCS), which includes at a minimum protective relays and the PAC/RTAC, must meet current Control Systems Platform Enclave/Navy Utilities Monitoring Control Systems (CSPE/NUMCS) Authority to Operate (ATO) requirements.

The following general requirements apply to all protective relays and meters:

a. All protective relays shall be of same manufacturer except for lockout relays.

b. Meters shall display positive power flow when actual primary power flows to switchgear from source circuits identified on drawings.

c. Meters shall display positive power flow when actual primary power flows from switchgear to load circuits identified on drawings.

d. For directional overcurrent relays (Device 67) shall be wired with trip direction away from switchgear bus (exporting power) unless otherwise shown.

e. Current Transformer Mounting and Polarity Marks: Position current transformers in cubicle such that primary current into protected zone results in secondary current into protective relay or meter's polarity terminal.

f. Current transformer secondary circuits shall be wired using 12 AWG minimum, tinned high-stranded SIS wire unless otherwise shown.

g. Voltage transformer secondary circuits shall be wired using 14 AWG minimum, tinned high-stranded SIS wire unless otherwise shown.

h. Control circuits shall be wired using 14 AWG minimum, tinned high-stranded SIS wire unless otherwise shown.

i. Microprocessor based relays shall have connectorized rear terminal blocks. Connectorized terminal blocks shall be arranged by input and output type (i.e. separate terminal blocks for voltage and current inputs).

j. Provide logic in relay for trip coil monitoring.

[2.2.6.1 Line Current Differential Relays (MFR1)

a. Product Description: IEEE C37.90 Microprocessor-based line differential protection relay, IEEE Device numbers as specified herein.

b. Mounting: Rack-mounted in protective relay rack.

c. Output Contacts: Provide output contacts rated for 30 amperes making current, 6 amperes continuous current at 70 degree C. Contacts shall not be rated less than 48 volts DC.

    (1) Provide one high-speed, high-current contact to trip circuit breaker.

    (2) Provide output contact with its own test switch. Wire test switch in series with output contact.

d. Alarm Contact: Provide alarm contact wired in series with relay test switch. Wire alarm to signal supervisory control and data acquisition system (SCADA) upon following conditions.

    (1) Relay failure.

    (2) Battery voltage monitor. Provide dual level substation battery voltage monitor with following adjustable parameters.

        (a) Low level warning adjustable from 15 to 300 volts DC.

        (b) High level warning adjustable from 15 to 300 volts DC.

        (c) Low level failure adjustable from 15 to 300 volts DC.

        (d) High level failure adjustable from 15 to 300 volts DC.

e. Peak to peak AC ripple detection adjustable from 1 to 300 volts AC.

f. Substation battery ground detection, adjustable.

g. Control and Status Inputs:

    (1) Provide status input from a contact on circuit breaker. Contact shall be open when breaker is OPEN and closed when breaker is CLOSED.

h. Current Inputs: Provide individual inputs from current transformers for protected circuit. Route current from current transformer to shorting terminal blocks, from shorting terminal blocks to shorting relay test switches, and from test switches to relay. Current input ratings shall be as follows.

    (1) Nominal current shall be 5 amperes to match current transformer secondary ratings.

    (2) Continuous current shall be 15 amperes, linear to 100 amperes symmetrical.

    (3) Burden shall not exceed 0.30 VA at 5 amperes and 3.0 VA at 15 amperes.

i. Voltage Inputs: Provide three-phase, four-wire voltage inputs from potential transformer circuits shown. Route voltage circuits through non-shorting relay test switches to relay. Voltage input ratings shall be as follows.

    (1) Nominal voltage shall be 120 volts phase to phase to match

potential transformer secondary ratings.

(2) Continuous voltage rating shall be 300 volts.

(3) Burden shall not exceed 0.10 VA.

j. Protective Functions: Provide following adjustable protection functions and settings.

(1) Line Current Differential (87L)

(2) Phase Instantaneous Overcurrent (50P)

(3) Residual Ground Instantaneous Overcurrent (50G)

(4) Phase Time Overcurrent (51P)

(5) Loss Of Potential (60LOP)

(6) Directional Overcurrent (67)

(7) Residual Ground Time Overcurrent (51G)

(8) Breaker Failure Protection

(9) Breaker Wear Monitor

(10) Station DC Battery Monitor

k. IRIG-B. The relay shall include an interface port for a demodulated IRIG-B time synchronization input signal. The relays shall generate a time synchronizing signal to provide a synchronizing signal to other relays.

(1) Line Differential Channels: The relays shall come equipped with IEEE C37.94 modulated 1300nm single-mode fiber-optic interfaces with type ST connectors.

l. Communications Protocols: The relay shall come equipped with the following protocols, whether used by application or not. Refer to paragraph SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) of this Section for supervisory, control, and data acquisition requirements.

(1) Protocols shall include ASCII, Compressed ASCII, DNP3.0, IEC 61850, IEEE C37.118 Synchrophasor data, Telnet, FTP, and Mirrored Bits.

(2) Digital Relay-to-Relay Communications. The relay shall include send and receive logic elements and provide analog and virtual terminal service in two communications ports for dedicated relay-to-relay communication.

(3) IEC 61850 Ethernet Communications. The relay shall provide IEC 61850-compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data points.

m. Communications Ports: Provide ports as follows.

(1) Front TIA-232 serial port for uploading and downloading settings, event reports, and data via laptop computer.

(2) Port 2 shall be serial TIA-232 port supporting Mirrored Bits protocol for transfer tripping and shall support IRIG-B signals.

(3) Port 3 shall be serial TIA-232 port supporting ASCII, DNP, MOD, EVMSG, and PMU.

(4) Port 4 shall be serial TIA-232 port supporting ASCII, DNP, MOD, EVMSG, and PMU.

(5) Port 5 shall be dual redundant 100Base-FX multimode fiber ports for Ethernet communications. Ports shall operate in failover mode. Ports shall support FTP file transfer protocol, IEC 61850 protocol, IEC 61850 GOOSE messaging, and DNP 3.0 protocol with up to three DNP sessions.

][2.2.6.2 Directional Overcurrent Relays (MFR2)

a. Product Description: IEEE C37.90 Microprocessor-based feeder protection relay configured to provide directional comparison blocking. IEEE Device numbers as specified herein.

b. Mounting: Rack-mounted in protective relay rack for protective relays.

c. Output Contacts: Provide output contacts rated for 30 amperes making current, 6 amperes continuous current at 70 degree C. Contacts shall not be rated less than 48 volts DC.

(1) Provide one high-speed, high-current contact to trip circuit breaker.

(2) Provide output contact with its own test switch. Wire test switch in series with output contact. Refer to "PROTECTIVE RELAY AND METERING TEST SWITCHES" in this Section.

d. Alarm Contact: Provide alarm contact wired in series with relay test switch. Wire alarm to signal supervisory control and data acquisition system (SCADA) upon following conditions.

(1) Relay failure.

(2) Battery voltage monitor. Provide dual level substation battery voltage monitor with following adjustable parameters.

(a) Low level warning adjustable from 15 to 300 volts DC.

(b) High level warning adjustable from 15 to 300 volts DC.

(c) Low level failure adjustable from 15 to 300 volts DC.

(d) High level failure adjustable from 15 to 300 volts DC.

(e) Peak to peak AC ripple detection adjustable from 1 to 300 volts AC.

(f) Substation battery ground detection, adjustable.

e. Control and Status Inputs:

(1) Provide status input from a contact on circuit breaker. Contact shall be open when breaker is OPEN and closed when breaker is CLOSED.

f. Current Inputs: Provide individual inputs from current transformers for protected circuit. Route current from current transformer to shorting terminal blocks, from shorting terminal blocks to shorting relay test switches, and from test switches to relay. Current input ratings shall be as follows.

(1) Nominal current shall be 5 amperes to match current transformer secondary ratings.

(2) Continuous current shall be 15 amperes, linear to 100 amperes symmetrical.

(3) Burden shall not exceed 0.30 VA at 5 amperes and 3.0 VA at 15 amperes.

g. Voltage Inputs: Provide three-phase, four-wire voltage inputs from potential transformer circuits shown. Route voltage circuits through non-shorting relay test switches to relay. Voltage input ratings shall be as follows.

(1) Nominal voltage shall be 120 volts phase to phase to match potential transformer secondary ratings.

(2) Continuous voltage rating shall be 300 volts.

(3) Burden shall not exceed 0.10 VA.

h. Protective Functions: Provide following adjustable protection functions and settings.

(1) Phase Instantaneous Overcurrent (50P)

(2) Ground (Residual) Instantaneous Overcurrent (50G)

(3) Neutral Instantaneous Overcurrent (50N)

(4) Phase Time Overcurrent (51P)

(5) Ground (Residual) Time Overcurrent (51G)

(6) Neutral Time Overcurrent (51N)

(7) Loss of Potential (60LOP)

(8) Directional Phase Time Overcurrent (67P)

(9) Directional Ground (Residual) Time Overcurrent (67G)

(10) Directional Neutral Time Overcurrent (67N)

(11) Breaker Failure Protection

(12) Breaker Wear Monitor

(13) Loss of Potential (60LOP)

(14) Station DC Battery Monitor

i. IRIG-B. The relay shall include an interface port for a demodulated IRIG-B time synchronization input signal. The relays shall generate a time synchronizing signal to provide a synchronizing signal to other relays.

j. Communications Protocols: The relay shall come equipped with following protocols, whether used by application or not. Refer to paragraph SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) of this Section for supervisory, control, and data acquisition requirements.

(1) Protocols shall include ASCII, Compressed ASCII, DNP3.0, IEC 61850, IEEE C37.118 Synchrophasor data, Telnet, FTP, and Mirrored Bits.

(2) Digital Relay-to-Relay Communications. The relay shall include send and receive logic elements and provide analog and virtual terminal service in two communications ports for dedicated relay-to-relay communication.

(3) IEC 61850 Ethernet Communications. The relay shall provide IEC 61850-compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data points.

k. Communications Ports: Provide ports as follows.

(1) Front TIA-232 serial port for uploading and downloading settings, event reports, and data via laptop computer.

(2) Port 1 shall be dual redundant 100Base-FX multimode fiber ports for Ethernet communications. Ports shall operate in failover mode. Ports shall support FTP file transfer protocol, IEC 61850 protocol, IEC 61850 GOOSE messaging, and DNP 3.0 protocol with up to three DNP sessions.

(3) Port 2 shall be serial fiber port supporting Mirrored Bits protocol for directional comparison blocking.

(4) Port 3 shall be serial TIA-232 port supporting ASCII, DNP, MOD, EVMSG, and PMU.

(5) Port 4 shall be serial TIA-232 port supporting ASCII, DNP, MOD, EVMSG, and PMU.

l. Operator Interface

(1) Provide relays with front panel layout including color touch-screen human machine interface, circuit breaker control buttons, and indicators. Touch-screen shall be minimum of 800 by 480 pixels and shall be not less than 5 inches in diagonal.

][2.2.6.3 Non-directional Overcurrent Relays (MFR3)

a. Product Description: IEEE C37.90 Microprocessor-based feeder protection relay, IEEE Device numbers as specified herein.

b. Mounting: Flush mounted device, installed on 480 mm 19 inch mounting plates for 480 mm 19 inch equipment rack.

c. Output Contacts: Provide output contacts rated for 30 amperes making current, 6 amperes continuous current at 70 degree C. Contacts shall not be rated less than 48 volts DC.

    (1) Provide one high-speed, high-current contact to trip circuit breaker.

    (2) Provide output contact with its own test switch. Wire test switch in series with output contact. Refer to PROTECTIVE RELAY AND METERING TEST SWITCHES in this Section.

d. Alarm Contact: Provide alarm contact wired in series with relay test switch. Wire alarm to signal supervisory control and data acquisition system (SCADA) upon following conditions.

    (1) Relay failure.

    (2) Battery voltage monitor. Provide dual level substation battery voltage monitor with following adjustable parameters.

        (a) Low level warning adjustable from 15 to 300 volts DC.

        (b) High level warning adjustable from 15 to 300 volts DC.

        (c) Low level failure adjustable from 15 to 300 volts DC.

        (d) High level failure adjustable from 15 to 300 volts DC.

        (e) Peak to peak AC ripple detection adjustable from 1 to 300 volts AC.

        (f) Substation battery ground detection, adjustable.

e. Control and Status Inputs:

    (1) Provide status input from a contact on circuit breaker. Contact shall be open when breaker is OPEN and closed when breaker is CLOSED.

f. Current Inputs: Provide individual inputs from current transformers for protected circuit. Route current from current transformer to shorting terminal blocks, from shorting terminal blocks to shorting relay test switches, and from test switches to relay. Current input ratings shall be as follows.

    (1) Nominal current shall be 5 amperes to match current transformer secondary ratings.

    (2) Continuous current shall be 15 amperes, linear to 100 amperes symmetrical.

    (3) Burden shall not exceed 0.30 VA at 5 amperes and 3.0 VA at 15 amperes.

g. Voltage Inputs: Provide three-phase, four-wire voltage inputs from potential transformer circuits shown. Route voltage circuits through non-shorting relay test switches to relay. Voltage input ratings shall be as follows.

(1) Nominal voltage shall be 120 volts phase to phase to match potential transformer secondary ratings.

(2) Continuous voltage rating shall be 300 volts.

(3) Burden shall not exceed 0.10 VA.

h. Protective Functions: Provide following adjustable protection functions and settings.

(1) Phase Instantaneous Overcurrent (50P)

(2) Ground (Residual) Instantaneous Overcurrent (50G)

(3) Neutral Instantaneous Overcurrent (50N)

(4) Negative-Sequence Overcurrent (50Q)

(5) Phase Time Overcurrent (51P)

(6) Ground (Residual) Time Overcurrent (51G)

(7) Neutral Time Overcurrent (51N)

(8) Station DC Battery Monitor

i. IRIG-B. The relay shall include an interface port for a demodulated IRIG-B time synchronization input signal. The relays shall generate a time synchronizing signal to provide a synchronizing signal to other relays.

j. Communications Protocols: The relay shall come equipped with following protocols, whether used by application or not. Refer to paragraph SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) of this Section for supervisory, control, and data acquisition requirements.

(1) Protocols shall include ASCII, Compressed ASCII, DNP3.0, IEC 61850, IEEE C37.118 Synchrophasor data, Telnet, FTP, and Mirrored Bits.

(2) Digital Relay-to-Relay Communications. The relay shall include send and receive logic elements and provide analog and virtual terminal service in two communications ports for dedicated relay-to-relay communication.

(3) IEC 61850 Ethernet Communications. The relay shall provide IEC 61850-compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data points.

k. Communications Ports: Provide ports as follows.

(1) Front TIA-232 serial port for uploading and downloading settings, event reports, and data via laptop computer.

(2) Port 1 shall be dual redundant 100Base-FX multimode fiber ports for Ethernet communications. Ports shall operate in failover mode. Ports shall support FTP file transfer protocol, IEC 61850 protocol, IEC 61850 GOOSE messaging, and DNP 3.0 protocol with up to three DNP sessions.

(3) Port 2 shall be serial fiber port supporting Mirrored Bits protocol for transfer tripping.

(4) Port 3 shall be serial TIA-232 port supporting ASCII, DNP, MOD, EVMSG, and PMU.

(5) Port 4 shall be serial TIA-232 port supporting ASCII, DNP, MOD, EVMSG, and PMU.

][2.2.6.4 Transformer Differential Relays (MFR4)

Provide high-speed, microprocessor based transformer differential relays. Relays shall be configurable for single-phase and three-phase protection. Bus configurations having more than 6 terminals require additional relays to protect all busses. The relays shall utilize mirrored bits communications for transfer trip functions.

a. Product Description: IEEE C37.90 Microprocessor-based bus differential protection relay, IEEE Device number 87B.

b. Mounting: Flush mounted device, installed on 480 mm 19 inch mounting plates for 480 mm 19 inch equipment rack.

c. Output Contacts: Provide output contacts rated for 30 amperes making current, 6 amperes continuous current at 70 degrees C. Contacts shall not be rated less than 48 volts DC.

(1) Provide one contact to trip lock-out relay on bus differential trip function. Wire test switch in series with this output contact.

(2) Provide multiple contacts to function as back-up overcurrent protective devices (IEEE 50/51) for sources and loads on protected bus. Circuit breakers on protected bus shall have their own output contacts and relay test switches. Wire test switch in series with output contacts. Refer to PROTECTIVE RELAY AND METERING TEST SWITCHES in this Section.

d. Alarm Contact: Provide alarm contact wired in series with relay test switch. Wire alarm to signal supervisory control and data acquisition system (SCADA) upon following conditions.

(1) Current transformer open.

(2) Relay failure.

(3) Battery voltage monitor. Provide dual level substation battery voltage monitor with following adjustable parameters.

(a) Low level warning adjustable from 15 to 300 volts DC.

(b) High level warning adjustable from 15 to 300 volts DC.

(c) Low level failure adjustable from 15 to 300 volts DC.

(d) High level failure adjustable from 15 to 300 volts DC.

(e) Peak to peak AC ripple detection adjustable from 1 to 300 volts AC.

(f) Substation battery ground detection, adjustable.

e. Control and Status Inputs:

(1) Provide status input of lockout relay and wire to indicate trip condition.

(2) Provide status input from contact on circuit breakers on protected bus. Contacts shall be open when breaker is OPEN and closed when breaker is CLOSED.

f. Current Inputs: Provide individual inputs from current transformers for circuit breakers on protected buses. Route current from current transformers to shorting terminal blocks, from shorting terminal blocks to shorting relay test switches, and from test switches to relay. Paralleling current transformers is prohibited. Current input ratings shall be as follows.

(1) Nominal current shall be 5 amperes to match current transformer secondary ratings.

(2) Continuous current shall be 15 amperes, linear to 100 amperes symmetrical.

(3) Burden shall not exceed 0.30 VA at 5 amperes and 3.0 VA at 15 amperes.

g. Protective Functions:

(1) Six or more low-impedance current differential circuits per phase (zone of protection).

(2) Relay shall have high sensitivity for internal faults and low sensitivity for external faults.

(3) Open and short circuit current transformer detection and alarm.

(4) Breaker failure detection.

(5) Instantaneous overcurrent protection (Device 50) for protected circuit breakers.

(6) Time-overcurrent protection (Device 51) for protected circuit breakers.

(7) End-zone protection for faults between open circuit breaker and CT.

h. IRIG-B. The relay shall include an interface port for a demodulated IRIG-B time synchronization input signal. The relays shall generate a time synchronizing signal to provide a synchronizing signal to other relays.

i. Communications Protocols: The relay shall come equipped with following protocols, whether used by application or not. Refer to SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) of this Section for supervisory, control, and data acquisition requirements.

(1) Protocols shall include ASCII, Compressed ASCII, DNP3.0, IEC 61850,

Telnet, FTP, and Mirrored Bits.

(2) Digital Relay-to-Relay Communications. The relay shall include send and receive logic elements and provide analog and virtual terminal service in two communications ports for dedicated relay-to-relay communication.

(3) IEC 61850 Ethernet Communications. The relay shall provide IEC 61850-compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data points.

j. Communications Ports: Provide ports as follows.

(1) Front TIA-232 serial port for uploading and downloading settings, event reports, and data via laptop computer.

(2) Port 1 shall be serial TIA-232 port supporting SEL ASCII, Compressed ASCII, and Settings File Transfer, SEL Fast Meter with Configuration, Fast Operate, Fast SER, Enhanced MIRRORED BITS Communications, and DNP3 Level 2 Slave Plus Dial-out.

(3) Port 2 shall be serial TIA-232 port supporting SEL ASCII, Compressed ASCII, and Settings File Transfer, SEL Fast Meter with Configuration, Fast Operate, Fast SER, Enhanced MIRRORED BITS Communications, and DNP3 Level 2 Slave Plus Dial-out.

(4) Port 3 shall be serial TIA-232 port supporting SEL ASCII, Compressed ASCII, and Settings File Transfer, SEL Fast Meter with Configuration, Fast Operate, Fast SER, Enhanced MIRRORED BITS Communications, and DNP3 Level 2 Slave Plus Dial-out.

(5) Port 4 not used.

(6) Port 5 shall be dual redundant 100 Base-FX multimode fiber ports for Ethernet communications. Ports shall operate in failover mode. Ports shall support FTP file transfer protocol, IEC 61850 protocol, IEC 61850 GOOSE messaging, and DNP 3.0 protocol with up to three DNP sessions.

][2.2.6.5 Synchronism Check Relays (MFR5)

a. Product Description: IEEE C37.90 Microprocessor-based feeder protection relay, IEEE Device numbers as specified herein.

b. Mounting: Flush mounted device, installed on 480 mm 19 inch mounting plates for 480 mm 19 inch equipment rack.

c. Output Contacts: Provide output contacts rated for 30 amperes making current, 6 amperes continuous current at 70 deg C. Contacts shall not be rated less than 48 volts DC.

(1) Provide one high-speed, high-current contact to trip circuit breaker.

(2) Provide output contact with its own test switch. Wire test switch in series with output contact. Refer to PROTECTIVE RELAY AND METERING TEST SWITCHES in this Section.

d. Alarm Contact: Provide alarm contact wired in series with relay test switch. Wire alarm to signal supervisory control and data acquisition system (SCADA) upon following conditions.

(1) Relay failure.

(2) Battery voltage monitor. Provide dual level substation battery voltage monitor with following adjustable parameters.

(a) Low level warning adjustable from 15 to 300 volts DC.

(b) High level warning adjustable from 15 to 300 volts DC.

(c) Low level failure adjustable from 15 to 300 volts DC.

(d) High level failure adjustable from 15 to 300 volts DC.

(e) Peak to peak AC ripple detection adjustable from 1 to 300 volts AC.

(f) Substation battery ground detection, adjustable.

e. Control and Status Inputs:

(1) Provide status input from a contact on circuit breaker. Contact shall be open when breaker is OPEN and closed when breaker is CLOSED.

f. Current Inputs: Provide individual inputs from current transformers for protected circuit. Route current from current transformer to shorting terminal blocks, from shorting terminal blocks to shorting relay test switches, and from test switches to relay. Current input ratings shall be as follows.

(1) Nominal current shall be 5 amperes to match current transformer secondary ratings.

(2) Continuous current shall be 15 amperes, linear to 100 amperes symmetrical.

(3) Burden shall not exceed 0.30 VA at 5 amperes and 3.0 VA at 15 amperes.

g. Voltage Inputs: Provide three-phase, four-wire voltage inputs from potential transformer circuits shown. Route voltage circuits through non-shorting relay test switches to relay. Voltage input ratings shall be as follows.

(1) Nominal voltage shall be 120 volts phase to phase to match potential transformer secondary ratings.

(2) Continuous voltage rating shall be 300 volts.

(3) Burden shall not exceed 0.10 VA.

h. Protective Functions: Provide following adjustable protection functions and settings.

(1) Sync-check, IEEE C37.2 device designation 25

(2) Breaker Failure Protection

(3) Breaker Wear Monitor

(4) Undervoltage IEEE C37.2 device designation 27

(5) Overvoltage IEEE C37.2 device designation 59

(6) Loss of Potential, IEEE C37.2 device designation 60LOP

(7) Station DC Battery Monitor

i. IRIG-B. The relay shall include an interface port for a demodulated IRIG-B time synchronization input signal. The relays shall generate a time synchronizing signal to provide a synchronizing signal to other relays.

j. Communications Protocols: The relay shall come equipped with following protocols, whether used by application or not. Refer to paragraph SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) of this Section for supervisory, control, and data acquisition requirements.

(1) Protocols shall include ASCII, Compressed ASCII, DNP3.0, IEC 61850, IEEE C37.118 Synchrophasor data, Telnet, FTP, and Mirrored Bits.

(2) Digital Relay-to-Relay Communications. The relay shall include send and receive logic elements and provide analog and virtual terminal service in two communications ports for dedicated relay-to-relay communication.

(3) IEC 61850 Ethernet Communications. The relay shall provide IEC 61850-compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data points.

k. Communications Ports: Provide ports as follows.

(1) Front TIA-232 serial port for uploading and downloading settings, event reports, and data via laptop computer.

(2) Port 1 shall be dual redundant 100 Base-FX multimode fiber ports for Ethernet communications. Ports shall operate in failover mode. Ports shall support FTP file transfer protocol, IEC 61850 protocol, IEC 61850 GOOSE messaging, and DNP 3.0 protocol with up to three DNP sessions.

(3) Port 2 shall be serial fiber port supporting Mirrored Bits protocol for transfer tripping.

(4) Port 3 shall be serial TIA-232 port supporting ASCII, DNP, MOD, EVMSG, and PMU.

(5) Port 4 shall be serial TIA-232 port supporting ASCII, DNP, MOD, EVMSG, and PMU.

][2.2.6.6 Bus Differential Relays (MFR6)

Provide high-speed, microprocessor based bus differential relays. Relays shall be configurable for single-phase and three-phase protection. Bus configurations having more than 6 terminals require additional relays to protect all busses. The relays shall utilize mirrored bits communications for transfer trip functions.

a. Product Description: IEEE C37.90 Microprocessor-based bus differential protection relay, IEEE Device number 87B.

b. Mounting: 480 mm 19 inch rack mounted device in equipment rack.

c. Output Contacts: Provide output contacts rated for 30 amperes making current, 6 amperes continuous current at 70 degree C. Contacts shall not be rated less than 48 volts DC.

    (1) Provide one contact to trip lock-out relay on bus differential trip function. Wire test switch in series with this output contact.

    (2) Provide multiple contacts to function as back-up overcurrent protective devices (IEEE 50/51) for sources and loads on protected bus. Circuit breakers on protected bus shall have their own output contacts and relay test switches. Wire test switch in series with output contacts. Refer to PROTECTIVE RELAY AND METERING TEST SWITCHES in this Section.

d. Alarm Contact: Provide alarm contact wired in series with relay test switch. Wire alarm to signal supervisory control and data acquisition system (SCADA) upon following conditions.

    (1) Current transformer open.

    (2) Relay failure.

    (3) Battery voltage monitor. Provide dual level substation battery voltage monitor with following adjustable parameters.

        (a) Low level warning adjustable from 15 to 300 volts DC.

        (b) High level warning adjustable from 15 to 300 volts DC.

        (c) Low level failure adjustable from 15 to 300 volts DC.

        (d) High level failure adjustable from 15 to 300 volts DC.

        (e) Peak to peak AC ripple detection adjustable from 1 to 300 volts AC.

        (f) Substation battery ground detection, adjustable.

e. Control and Status Inputs:

    (1) Provide status input of lockout relay and wire to indicate trip condition.

    (2) Provide status input from contact on circuit breakers on protected bus. Contacts shall be open when breaker is OPEN and closed when breaker is CLOSED.

f. Current Inputs: Provide individual inputs from current transformers for circuit breakers on protected buses. Route current from current transformers to shorting terminal blocks, from shorting terminal blocks to shorting relay test switches, and from test switches to relay.

Paralleling current transformers is prohibited. Current input ratings shall be as follows.

(1) Nominal current shall be 5 amperes to match current transformer secondary ratings.

(2) Continuous current shall be 15 amperes, linear to 100 amperes symmetrical.

(3) Burden shall not exceed 0.30 VA at 5 amperes and 3.0 VA at 15 amperes.

g. Protective Functions:

(1) Six or more low-impedance current differential circuits per phase (zone of protection).

(2) Relay shall have high sensitivity for internal faults and low sensitivity for external faults.

(3) Open and short circuit current transformer detection and alarm.

(4) Breaker failure detection.

(5) Instantaneous overcurrent protection (Device 50) for protected circuit breakers.

(6) Time-overcurrent protection (Device 51) for protected circuit breakers.

(7) End-zone protection for faults between open circuit breaker and CT.

h. IRIG-B. The relay shall include an interface port for a demodulated IRIG-B time synchronization input signal. The relays shall generate a time synchronizing signal to provide a synchronizing signal to other relays.

i. Communications Protocols: The relay shall come equipped with following protocols, whether used by application or not. Refer to paragraph SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) of this Section for supervisory, control, and data acquisition requirements.

(1) Protocols shall include ASCII, Compressed ASCII, DNP3.0, IEC 61850, Telnet, FTP, and Mirrored Bits.

(2) Digital Relay-to-Relay Communications. The relay shall include send and receive logic elements and provide analog and virtual terminal service in two communications ports for dedicated relay-to-relay communication.

(3) IEC 61850 Ethernet Communications. The relay shall provide IEC 61850-compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data points.

j. Communications Ports: Provide ports as follows.

(1) Front TIA-232 serial port for uploading and downloading settings, event reports, and data via laptop computer.

(2) Port 1 shall be serial TIA-232 port supporting SEL ASCII, Compressed ASCII, and Settings File Transfer, SEL Fast Meter with Configuration, Fast Operate, Fast SER, Enhanced MIRRORED BITS Communications, and DNP3 Level 2 Slave Plus Dial-out.

(3) Port 2 shall be serial TIA-232 port supporting SEL ASCII, Compressed ASCII, and Settings File Transfer, SEL Fast Meter with Configuration, Fast Operate, Fast SER, Enhanced MIRRORED BITS Communications, and DNP3 Level 2 Slave Plus Dial-out.

(4) Port 3 shall be serial TIA-232 port supporting SEL ASCII, Compressed ASCII, and Settings File Transfer, SEL Fast Meter with Configuration, Fast Operate, Fast SER, Enhanced MIRRORED BITS Communications, and DNP3 Level 2 Slave Plus Dial-out.

(5) Port 4 not used.

(6) Port 5 shall be dual redundant 100Base-FX multimode fiber ports for Ethernet communications. Ports shall operate in failover mode. Ports shall support FTP file transfer protocol, IEC 61850 protocol, IEC 61850 GOOSE messaging, and DNP 3.0 protocol with up to three DNP sessions.

][2.2.6.7 Lockout Relays (Device 86)

Provide manually reset lock-out relays with light emitting diode (LED) indicators. Provide green LED to indicate a healthy trip coil circuit. Provide red LED to indicate a trip condition. Provide remote annunciation of the trip coil condition that warns the SCADA operator when trip circuit continuity is lost. Provide a minimum of 8 spare contacts on each relay. Relay shall be wired to trip the all circuit breakers in the protected zone and shall block all tripped circuit breakers from being reclosed until the relay is manually reset.

][2.2.6.8 Auxiliary Control Relays

Provide as required to implement protective functions and interlocking as indicated. Auxiliary relays shall have contacts rated to carry 30 amperes for one minute and 12 amperes continuously. Coils shall be a long-life design with a projected service life of 40 years.

a. Auxiliary relays used for tripping circuit breakers shall be multicontact, high-speed relays operating in one-half cycle or less.

b. Auxiliary relays for functions other than tripping circuit breakers shall be normal-speed relays operating in two cycles or less.

c. Auxiliary timing relays shall be electro-pneumatic relays with contacts rated for at least the load they are controlling.

]2.2.6.9 Instrument Control Switches

Provide rotary cam-operated type with positive means of indicating contact positions. Switches shall have silver-to-silver contacts enclosed in a protective cover which can be removed to inspect the contacts.

a. Circuit breaker control switches shall be Heavy-duty type rated for 600 volts, UL listed and CSA certified. Breaker control Switches shall have a miniature pistol-grip type handle and a mechanical target to indicate the last operating position of the switch. Switches shall be hard-wired directly to the related circuit breaker for manual control. Switches shall have spring return action, 3 position with spring return to center, with the adequate number of contacts for the required operation and SCADA monitoring.

b. Red and green position indication LED lights shall be either installed immediately above each circuit breaker switch position or incorporated into the switch itself.

c. Circuit breaker control switches shall include the following positions: 1) "TRIP"; 2)"NAT" (normal after trip)/"NAC" (normal after close); 3) "CLOSE". The control switches shall have a minimum of two trip contacts with one trip contact per deck. Switch contacts shall have a minimum current rating of 30 amperes for one minute and 12 amperes continuously.

2.2.6.10 Protective Relay and Metering Test Switches

a. Product Description: Semi-flush mounted knife blade test switches for protective relays with following features:

    (1) Clear cover. Shall allow switches to be in open position when cover is on.

    (2) Every relay analog and digital input and output shall pass through a test switch.

    (3) Every current transformer circuit shall pass through a shorting test switch.

    (4) Every trip circuit shall have a red switch.

    (5) All switches shall be black in color except for red trip circuit switch.

b. All switches shall be wired such that source (current transformer, voltage transformer, and other output and input) is wired to bottom terminals. The relay terminals shall be wired to top of test switch.

c. Power to protective relay shall be wired through a relay test switch or wired from a dedicated disconnecting means in cubicle to relay.

2.2.6.11 Pilot and Indicating Lights

Provide light emitting diode type indicating lights. Lights shall be red when the circuit breaker is in the "CLOSED" position and shall be green when the circuit breaker is in the "OPEN" position. Light color shall be visible from a distance not less than the full length of the switchgear and shall be visible at a 175 degree viewing angle. Match control voltage.

2.2.6.12 Instruments

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NOTE: Select essential instruments and meters. Add to the specification any special metering not listed which is required for a specific project. Use of an Electronic Monitoring System and Electronic Trip Assemblies in the breakers may eliminate the need

for many individual electro-mechanical meters. This may also be accomplished on simpler systems by using the electronic watthour meter and identifying the desired special programming features. For NAVFAC SE projects, provide three thermal demand ammeters.
****

a. AC wattmeters: Transformer rated for 120-volt input, 60 Hz, three-phase, four-wire, with scale range coordinated to the ratios of the associated current transformers and potential transformers.[Provide external dropping resistors.]

b. Frequency meters: Rated for 120-volt input, 60 Hz nominal frequency, [_____] to [_____] Hz scale range.

c. Synchroscope: Transformer rated at 120-volt input, 60 Hz, with slow-fast scale.

d. Power-factor meters: Transformer rated 5-ampere, [120][208]-volt input, [_____] scale range for use on [three][four]-wire, three-phase circuits. The accuracy must be plus or minus 0.01.

e. DC ammeters: [Self-contained][Shunt-rated], [0 to [_____] ampere][[_____] to 0 to [_____] ampere] scale range.

f. DC voltmeters: Self-contained, [0 to [_____] volt][[_____] to 0 volt] scale range. Furnish resistors, if required, with the voltmeter.

2.2.6.13 Electronic Watthour Meter

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NOTE: On standard projects, use of the electronic meter versus the optional electro-mechanical meter is recommended due to decreasing availability of electro-mechanical meters.
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Provide a switchboard style electronic programmable watthour meter, semi-drawout, semi-flush mounted, [in the outgoing section][as indicated]. Meter must either be programmed at the factory or must be programmed in the field. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. Meter must be coordinated to system requirements.

a. Design: Provide meter designed for use on a 3-phase, 4-wire, [___/___] volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS)[as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC].

b. Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

c. Class: [_____]. Form: [_____]. Accuracy: plus or minus 1.0 percent. Finish: Class II.

d. Kilowatt-hour Register: 5 digit electronic programmable type.

e. Demand Register:

(1) Provide solid state.

(2) Meter reading multiplier: Indicate multiplier on meter face.

(3) Demand interval length: must be programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.

f. Meter fusing: Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to the watthour meter. Size fuses as recommended by the meter manufacturer.

[g. Special Programming Instructions: [_____].

][2.2.6.14 Electro-mechanical Watthour Meters

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NOTE: On bases that employ Energy Monitoring and Control Systems (EMCS) and monitor each building individually, add the following to this paragraph: "Provide watthour meter with a three-wire, single-pole double-throw, quick-make, quick-break pulse initiator. Coordinate pulse output ratio with main circuit breaker rating."

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NEMA/ANSI C12.10. Kilowatt-hour meters must be transformer rated, polyphase, 60 Hz, semiflush mounted, drawout or semidrawout switchboard meters for use on a four-wire wye, three-phase system. Kilowatt-hour meters must be[two and one-half][three]-stator.[Totalizing kilowatt-hour meters must be four-stator, two-circuit. For totalizing meters, provide devices and equipment required to provide single point metering of real power and reactive power from two inputs as indicated.] Each meter must have a five-dial pointer type register and must be secondary reading. Register ratio must be selected to provide a meter reading multiplier of even hundreds after applying the product of the current transformer ratio and the potential transformer ratio. Indicate the meter reading multiplier on the meter face. The kilowatt-hour meter must have a [sweep hand][cumulative] type KW demand register with 15-minute interval conforming to NEMA C12.4.

][2.2.6.15 Electric Strip-Chart Recording AC Wattmeter

UL 1437 for [surface][semiflush] mounting. Chart speed must be [_____] mm [_____] inches per [hour][minute] and chart drive motor must be rated [240][120][120/240] V, 60 Hz. The instrument must have a full scale accuracy of one percent.

]2.2.6.16 Instrument Transformers

IEEE C57.13, as applicable.

a. Current transformers: Transformers must be [multi-ratio][or][single ratio] as indicated, 60 Hz, and coordinated to the rating of the associated switchgear, relays, meters, and instruments.

b. Provide shorting blocks to create an intermediate contact point between the meter and the load where it is safe to make wiring alterations. The shorting blocks must be wired such that the negative leads of the current transformers are connected to the same node and tied to ground.

c. Potential transformers: Transformers must be drawout type, 60 Hz, with voltage ratings and ratios coordinated to the ratings of the associated switchgear, relays, meters, and instruments. Potential transformers must be with [one fuse][two fuses] in the primary. Fuses must be current limiting and sized as recommended by the potential transformer manufacturer.

2.2.6.17 Pilot and Indicating Lights

Provide transformer, resistor, or diode type.

2.2.7 Station Batteries and Charger

****

NOTE: For NAVFAC SE projects, specify maintenance-free sealed batteries only.

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Provide station batteries and charger, suitable for the requirements of the switchgear and [vacuum][SF6] circuit breakers. Batteries must be [_____] V, 60 cells, lead-acid, [pasted plate type][or][sealed, totally absorbed electrolyte type].

a. Pasted plate type batteries: Positive plates must be of the manchester type and negative plates must have a life equal to or greater than the positive plates. Battery containers must be heat and impact resistant clear plastic with electrolyte level lines permanently marked on all four sides. A permanent leakproof seal must be provided between cover and container and around cell posts. Sprayproof vent plugs must be provided in covers. Sufficient sediment space must be provided so that the battery will not have to be cleaned out during its normal life. High porosity separators to provide correct spacing between plates must be provided. Capacity must be calculated by switchgear manufacturer and approved by Contracting Officer before acceptance.

b. Sealed batteries: Provide batteries with leakproof, spillproof electrolyte utilizing highly absorbent material to separate the positive and negative plates. Battery jars must be hermetically sealed with welded seams. Batteries must be maintenance-free and must not require water to be added. Capacity must be calculated by switchgear manufacturer and approved by Contracting Officer before acceptance.

c. Battery charger must be full-wave rectifier type, utilizing silicon semiconductor devices. Charger must maintain a float charge of 2.15 V per cell and an equalizing charge of 2.33 V per cell. An equalizing charge timer must be provided which operates automatically after an AC power failure of 5 seconds or more. Timer must be adjustable for any time period up to 24 hours. Timer must also be capable of being actuated manually. Adjustable float and equalizing voltage potentiometers must be provided. Charger voltage must be maintained within plus or minus 1/2 percent from no load to full load with AC line variations of plus or minus 10 percent and frequency variations of plus or minus 5 percent. DC voltmeter and ammeter with a minimum 90 mm 3 1/2 inch scale and 2 percent accuracy of full scale must be provided. Output current must be limited to 115 percent of rated output current, even down to short circuit of the DC output terminals. Solid state circuit must have AC and DC transient voltage terminals. AC and DC magnetic circuit breakers must be provided. Circuit breakers must not be overloaded or actuated under any external circuit condition, including recharge of a fully discharged battery and short circuit of the output terminals. Charger must be capable of continuous operation at rated current at an ambient temperature of 40 degrees C. Output DC current capacity must match the requirements of the batteries provided. Provide alarm outputs [Individual Form C contacts] [Single summary Form C contact] as follows:

(1) AC power failure.

(2) DC ground detection.

(3) High DC voltage.

(4) Low DC voltage.

(5) Charger failure.

(6) Battery discharging.

(7) End of discharge.

(8) DC current limit.

(9) Common summary alarm.

d. Secure battery rack such that it can not overturn or be disrupted by lateral forces accompanying a seismic disturbance. Provide steel, three-step racks, painted with two coats of acid resistant paint for mounting batteries. Provide lead-plated copper inter-rack connectors and cell numbers with each rack.

2.2.8 Metal-Enclosed Interrupter Switchgear Outgoing Section

****

NOTE: This paragraph may also be used to specify freestanding switchgear not directly connected to a unit substation. This paragraph can not be used for generator control switchgear. Specify Category A requirements when switchgear area is subject to access by the unsupervised general public. Category B enclosures must be fence enclosed or in a locked room.

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NOTE: To help determine whether metal-clad switchgear or metal-enclosed interrupter switchgear is more appropriate for a project, consider that the primary applications for interrupter switchgear are where there are no instantaneous relaying and where switching is infrequent. Also interrupter switchgear is significantly less costly than metal-clad switchgear.

****

IEEE C37.20.3 for metal-enclosed [air] [vacuum] [SF6] load interrupter type switches, insulated for [5][15][27][_____] kV for use on [_____] kV system. The metal-enclosed switchgear assembly must consist of individual, factory-assembled, freestanding modular units, each with provisions for bolt-together installation. Modules must have uniform dimensions, constructed of rigidly braced 14-gage steel with a durable corrosion-resistant finish. Units must include a removable front panel, capable of being locked, for access to cable connections and fusing, internal venting for air circulation, lifting/mounting provisions and centralized, front facing controls[with mimic bus line diagram] and identification nameplates. Modules must allow incoming/outgoing cable entry from the bottom, sides or rear with adequate access for training and connection of cable using lugs and indoor terminations. Modular units must include necessary provisions for future expansion with removable end covers and extendable high-conductivity copper main and ground bus interconnections. Main bus must be fully insulated and mounted on insulated supports of high-impact, non-tracking, high-quality insulating material. Bus must be braced to withstand the mechanical forces exerted during short-circuit conditions when connected directly to a source having maximum of [_____] amperes rms symmetrical available. Phase bus bars must be rated [_____] amperes. Ground bus must be sized for full short-circuit capacity and must include provisions for external ground connections. Enclosures must be designed for [indoor][outdoor] location and must conform to Category [A][B] requirements of Table A1 of Appendix A to IEEE C37.20.3. Provide permanent labels for wiring and terminals corresponding to the designations on approved shop drawings. A safety glass window must be provided in the door panel in front of each interrupter switch to observe its position.

[2.2.8.1 Air-Insulated Load Interrupter Switches

****

NOTE: Choose this paragraph or one of the subparagraphs below, SF6-INSULATED LOAD INTERRUPTER SWITCHES or VACUUM-INSULATED LOAD INTERRUPTER SWITCHES.

****

Load interrupter switches must be three-pole, gang-operated, [fused][non-fused], arranged with hinge end of switch on load side to provide for "dead blade."[Fuses must be located on hinge side of switch.] Switch handles must be non-removable, operable from front of cubicle. Switch must be equipped with stored-energy, quick-make and quick-break device to operate the switch independent of the handle or power operator speed. Load interrupter switches must be rated at [600][1200] amperes continuous, 61 kA momentary, 38 kA short-time fault closing. Switches must be [manual handle operated "close" and "open"][manual handle operated "close" and remote operated "open" by electrical release device][power operated "close" and "open" utilizing motor charged closing spring mechanism and electrical release device].

][2.2.8.2 SF6-Insulated Load Interrupter Switches

SF6 filled, puffer-type load interrupter switches must be [fused][or][non-fused] as indicated. Switches must incorporate self-aligning, copper-silver plated, wiping-type contacts. SF6 puffer interrupters to minimize arcing during operation; and an internal absorbent to neutralize arc by-products. Switch contacts must be enclosed and sealed in maintenance-free, SF6 filled, molded epoxy insulated case, surrounded by dead-front metallic barriers. Switch operation must be controlled by permanently lubricated quick-make, quick-break spring operator with solid linkage connection to contact operating shaft. Switch operator must be mounted in separate dead-front compartment with access for addition of remote or automatic accessories, and must include removable operating handle with storage provision, positive position indicators, and padlock provisions. SF6 gas must conform to ASTM D2472.[Fused load interrupter switches must be provided with clip-style, mounted air-insulated current limiting fuses and molded epoxy interphase barriers. Provide neon voltage indicators for blown fuse indication.] Load interrupter switch must be rated [_____] continuous, [_____] kA momentary, [_____] kA short-time fault closing.

][2.2.8.3 Vacuum-Insulated Load Interrupter Switches

Circuit interrupting device must be [fused][non-fused], fixed mounted, [manually][electrically] operated, and must be quick-make, quick-break with speed of operation independent of the operator. Electrically operated device must be [120 Vac][125 Vdc]. Spring charging mechanism must not rely on chains or cables.[Motor operator assembly must be a separate device, isolated from high voltage and coupled through a direct drive shaft.] Circuit interrupter must consist of automatic visible blade disconnects in series with vacuum interrupters. Arc interruption must take place within the envelope of the vacuum interrupter. Upon opening, contacts in the vacuum interrupter must separate 12 to 18 milliseconds before disconnect blades open. Total circuit interrupt opening time must not exceed 3.0 cycles after the trip coil is energized at 85 to 100 percent of rated control voltage. Upon closing, disconnect blades must close 9 to 12 milliseconds before contact is made in the vacuum interrupter. Local interrupter switch must be rated [_____] continuous, [_____] kA momentary, [_____] kA short-time fault closing.

][2.2.8.4 Fuses

****

NOTE: Other fuse types may be specified if more appropriate to the project.

****

IEEE C37.41 and IEEE C37.46 as applicable. High-voltage fuses and non-disconnecting fuse mountings must be accessible only through a separate door mechanically interlocked with the load break switch, to ensure the switch is in the open position when fuses are accessible. Switch must be designed with full height fuse access doors and must have a solid barrier covering the area of the main cross bus and line side of the switch. Metal screen barriers are not acceptable. No energized parts must be within normal reach of the opened doorway. Four single full length interphase barriers must isolate the three phases of the switch from each other and from the enclosures. Fuses must be [current limiting type of self-contained design to limit available fault current stresses on the system and must have interrupting capacity [as indicated][of [_____] amperes symmetrical rms].][boric acid type with provisions for refill units complete with muffler exhaust. Furnish three spare fuse refill units for each switch and fuse assembly.] Fuses must be affixed in position with provisions for removal and replacement from the front of the gear without the use of special tools.

]2.2.9 Insulated Barriers

Where insulated barriers are required by reference standards, provide barriers in accordance with NEMA LI 1, Type GPO-3, 6.35 mm 0.25 inch minimum thickness.

[2.2.10 SF6 Refill Cylinders

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NOTE: Coordinate with activity to determine if refill cylinders are required. Many activities have an adequate supply of SF6 gas on hand.
****

Provide two SF6 refill cylinders, with a minimum of 2.724 kg 6 pounds of SF6 in each. Include regulator, valves, and hose for connection to the fill valve of the switch.

]2.2.11 Corrosion Protection

****
NOTE: Choose the level of corrosion protection required for the specific project location. Use stainless steel bases for most applications. In less corrosive environments galvanized steel can be included as an alternative to stainless steel. In hostile environments, the additional cost of totally stainless steel tanks and metering may be justified. Manufacturer's standard construction material is acceptable only in noncoastal and noncorrosive environments.
****

Bases frames, and channels of unit substation must be corrosion resistant and must be fabricated of stainless steel[or galvanized steel]. Base must include any part of unit substation that is within 75 mm 3 inches of concrete pad. Paint unit substation, including bases, light gray No. 61 or No. 49.[Paint coating system must comply with IEEE C57.12.28 regardless of base and substation material.] The color notation is specified in ASTM D1535.

2.2.11.1 Stainless Steel

Type 304 or 304L.

[2.2.11.2 Galvanized Steel

ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

]2.2.12 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Terminal boards associated with current transformers must be short-circuiting type. Terminate conductors for current transformers with ring-tongue lugs. Terminal board identification must be identical in similar units. External wiring must be color coded consistently for similar terminal boards.

2.2.13 Wire Marking

Mark control and metering conductors at each end. Provide factory-installed white plastic tubing heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide multiple white preprinted polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve must contain multiple characters, must be elliptically shaped to fit the wire securely, and must be keyed, or otherwise arranged, in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Wire markers for factory installed conductors must indicate wire designations corresponding to the schematic drawings. Wire markers on field installed conductors must indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached, as well as the terminal number to which the wire is directly attached (near end/far end marking).

2.2.14 Surge Arresters

Provide one surge arrester for each conductor on circuits where indicated. Surge arresters must conform to IEEE C62.11 for [station class][class indicated] and must be rated [_____] kV.

2.2.15 Neutral Grounding Resistors

****

NOTE: Low Resistance systems use a neutral ground resistor to reduce ground fault current. Low resistance grounding is typically used in systems with voltages exceeding 1000 volts line-to-line. Low resistance grounding limits the magnitude of transient over-voltage thereby reducing equipment damage. In addition, the line-to-ground fault current can be limited to a predetermined value while also providing adequate tripping values for selective coordination.

****

Neutral grounding resistors must be in accordance with IEEE-32. The resistive elements must be low temperature coefficient, resistor grade stainless steel of sufficient mass to withstand the rated current and prescribed duty. The resistors must be mounted in corrosion resistant support frames, using stainless-steel hardware. The entire resistor assembly must be mounted on insulators rated for the system voltage.

Resistor terminals and interconnections between resistor units must be stainless-steel using stainless steel hardware including lock washers. Connections between resistors and bushings or current transformers must be solid copper copper cables.

Provide NEMA 4X enclosure, type 304 or 316 stainless steel with gray powder coat finish.

a. System Voltage: [4,160V] [12,470V] [13,200V] [13,800V] [_____].

b. Line-To-Neutral Voltage: [2,400V] [7,200V] [7,620V] [8,000V] [_____].

c. Initial Current: [10] [50] [100A] [200A] [400A] [600A] [_____]

d. Duty Cycle: [Continuous] [60] [_____] seconds.

e. Resistance: [_____] Ohms.

2.2.16 Automatic Load Tap Changers

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NOTE: Coordinate the inclusion of this with the base Public Works Department.

****

Provide automatic Vacuum Reactance Load Tap Changer (VRLTC) on-load tap-changer in the load end of the low-voltage winding. The automatic tap-changing equipment must provide sixteen 5/8-percent taps above rated voltage and sixteen 5/8-percent taps below rated voltage. Accessories must include draining valve, pressure relief device, oil level indicator with analog output for transformer monitoring system, vent for oil filling, oil temperature gauge with analog output for transformer monitoring system, and provisions for upper oil valve. Three-phase, 60 hz, [_____] volt power must be provided for the motor. Single-phase, 60 hz, [_____] volt power must be provided for the heater. Single-phase, 60 hz, [_____] volt power must be provided for controls.

a. Insulating liquid must be Less-flammable liquid-insulated, ASTM D3487, type II, tested in accordance with ASTM D117. Provide identification as "Non-PCB" and oil type on nameplate.

b. Tap-changer tank, flanges, lifting provisions, and hardware must be fabricated of ASTM A240/A240M type 304, 304L or 316 stainless steel. Paint coating system must comply with IEEE C57.12.28.

2.3 SOURCE QUALITY CONTROL

****

NOTE: Use "reserves the right to" on all projects, except those for NAVFAC SE.

****

2.3.1 Equipment Test Schedule

The Government [reserves the right to][will] witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

    (1) The manufacturer must have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

    (2) The accuracy must be directly traceable to the National Institute of Standards and Technology.

    (3) Instrument calibration frequency schedule must not exceed 12 months for both test floor instruments and leased specialty equipment.

    (4) Dated calibration labels must be visible on all test equipment.

    (5) Calibrating standard must be of higher accuracy than that of the

instrument tested.

(6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

[2.3.2 Integral Assembly Test

****

NOTE: Coordinate with paragraph FACTORY TEST REPORTS prior to use of option requiring testing of integral assemblies.

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Switchgear and substation transformer must be tested as an integral assembly at the transformer manufacturer's test facility. Once acceptance of test results is received, ship switchgear and substation.

]2.3.3 Switchgear Design Tests

IEEE C37.20.2A or IEEE C37.20.3 as applicable. Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification. Required tests must be as follows:

a. Design Test

[(1) Dielectric test

][(2) Rated continuous current test

][(3) Short-time current withstand tests

][(4) Short-circuit current withstand tests

] (5) Mechanical endurance tests

(6) Flame-resistance tests

(7) Rod entry tests

[(8) Rain test for outdoor MV switchgear

]2.3.4 Switchgear Production Tests

IEEE C37.20.2A or IEEE C37.20.3 as applicable. Furnish reports which include results of production tests performed on the actual equipment for this project. Required tests must be as follows:

a. Production Test

(1) Dielectric test

    - (2) Mechanical operation tests
    - (3) Grounding of instrument transformer case test
    - (4) Electrical operation and control-wiring tests
    - (5) Impulse withstand test.

2.3.5 Load Interrupter Switch Design Tests

IEEE C37.74 and IEEE C37.20.3. Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification. Required tests must be as follows:

a. Design Tests
  - (1) Dielectric:
    - (a) Low-frequency withstand
    - (b) Impulse withstand
  - (2) Continuous current
  - (3) Short-time current withstand (2 - second)
  - (4) Momentary current (10 cycles)
  - (5) Mechanical endurance
  - (6) Insulator supports
    - (a) Flame-resistance
    - (b) Tracking-resistance
  - (7) Bus-bar insulation
    - (a) Dielectric strength
    - (b) Flame-resistance
  - (8) Paint qualification
  - (9) Rain

2.3.6 Load Interrupter Switch Production Tests

IEEE C37.74 as applicable, and IEEE C37.20.3. Furnish reports of production tests performed on the actual equipment for this project. Required tests must be as follows:

a. Production Tests
  - (1) Dielectric
  - (2) Mechanical operation

[(3) Grounding of instrument transformer case

][(4) Electrical operation and control wiring

]2.3.7 Transformer Design Tests

In accordance with IEEE C57.12.00 and IEEE C57.12.90. Additionally, IEEE C57.12.80, section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for[each of] the specified transformer(s). Design tests must have been performed prior to the award of this contract.

a. Tests must be certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a unit-substation transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a unit-substation transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer (if specified). Design lightning impulse tests must include both the primary and secondary windings of that transformer.

   (1) IEEE C57.12.90 paragraph entitled "Lightning Impulse Test Procedures" and IEEE C57.98.

   (2) State test voltage levels.

   (3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" for the lifting and moving devices test means a transformer in the same weight range as the transformer specified.

e. Pressure: "Basically the same design" for the pressure test means a unit-substation transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

2.3.8 Transformer Routine and Other Tests

In accordance with IEEE C57.12.00 and IEEE C57.12.90. Routine and other tests must be performed by the manufacturer on[each of] the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence must be as follows:

a. Cold resistance measurements (provide reference temperature)

b. Phase relation

c. Ratio

d. Insulation power-factor by manufacturer's recommended test method.

e. No-load losses (NLL) and excitation current

f. Load losses (LL) and impedance voltage

g. Dielectric

  (1) Impulse: Per IEEE C57.12.90 paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98. Test the primary winding only.

    (a) State test voltage levels

    (b) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test reports.[As an alternative, photographs of oscilloscope display waveforms or plots of digitized waveforms may be hand-delivered at the factory witness test.]

  (2) Applied voltage

  (3) Induced voltage

h. Leak

2.4 HEATERS

Provide 120-volt heaters in each switchgear section. Heaters must be of sufficient capacity to control moisture condensation in the compartments, and must be sized 250 watts minimum. Heaters must be controlled by a thermostat[and humidistat] located inside each section. Thermostats must be industrial type, high limit, to maintain compartments within the range of 15 to 32 degrees C 60 to 90 degrees F.[Humidistats must have a range of 30 percent to 60 percent relative humidity.] Provide transformer rated to carry 125 percent of heater full load rating. Transformers must have 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and must conform to NEMA ST 20. Provide din-rail mounted circuit breakers or fuse block in each switchgear assembly to serve the heaters in that switchgear assembly. The overcurrent protective devices serving the heaters must be in an accessible location with the circuit breaker racked in and the inner door closed. Energize electric heaters in switchgear assemblies while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source.

[2.5 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

Provide SCADA system including programmable automation controller, substation ethernet switches, GPS clock, fiber optic cable, serial to fiber converters, power supplies, programming, settings, terminal blocks, SCADA interface, relay racks, and additional items shown on the Drawings.

SCADA system shall be installed integral to the primary substation, inside the prefabricated switchgear enclosure. The system shall be fully assembled and all interconnections made at the factory. The system shall be fully programmed, tested and demonstrated during the Factory Witness

Tests. The substation manufacturer shall make a laptop available during the testing. Program the laptop to interface with the SCADA system in the same way as the existing SCADA system will be programmed. Demonstrate the data retrieval and control functions including circuit breaker controls, metering, and synchrophasors.

All Facility Related Controls Systems (FRCS), which includes the SCADA System, must meet current Control Systems Platform Enclave/Navy Utilities Monitoring Control Systems (CSPE/NUMCS) Authority to Operate (ATO) requirements.

2.5.1 Programmable Automation Controller (PAC)

a. Product Description: Microprocessor based, substation hardened, programmable automation controller.

b. Mounting: 480 mm 19 inch rack mounted.

c. Power Supply: 125 volts DC.

d. Ethernet Connections: Two 100 BASE-FX fiber optic connections.

e. Input/Output (IO) Board: 8 Outputs, 24 Inputs rated for 125 volts DC.

f. Provide web human machine interface (HMI) license.

g. Client Protocols: SEL, DNP3, Modbus, IEEE C37.118 Synchrophasors.

h. Server Protocols: SEL, DNP3, Modbus.

i. Peer to Peer Protocols: Mirrored Bits.

j. Rear Serial Ports: Twenty-four TIA-232 serial ports per programmable automation controller. Provide additional programmable automation controllers, each with 24 serial ports, where drawings show more than 24 serial connections into one programmable automation controller.

k. Conformal Coating: Provide conformal coating for outdoor substations within 500 feet of salt water.

2.5.2 Human Machine Interface (HMI) Monitor

Provide multi-touch monitor, complete with accessories including power cord, user manual, remote control, batteries, DVI-D cable, HDMI cable, Display Port cable, drivers, software, and instructions. Monitor shall meet the following requirements:

a. Viewing Screen Size: 680 mm 27 inches minimum; 810 mm 32 inches maximum.

b. Touch Type: Projected Capacitive Touch, with minimum 10 points of simultaneous touch.

c. Inputs: HDMI, DVI-D, DisplayPort. Coordinate with the programmable automation controller.

d. Resolution: 1080P (1920 x 1080) minimum.

e. Power Supply: 125VAC. Include separate DC to AC power inverter, compatible with the HMI display. Inverter shall not distort displayed content, shall not reduce display life, and shall not void display warranty.

f. Operating Temperature: 5-40 degrees C 41-104 degrees F.

g. Operating Humidity: 10-90 percent.

h. Operation: HMI monitor will function as a display and touch-screen type input device only and shall not have on-board programming requirements and shall not introduce more than 0.25 second delay in commands sent to the programmable automation controller.

2.5.3 Substation Ethernet Switches

a. Product Description: Managed, substation hardened Ethernet switch.

b. Environmental Requirements: Meet requirements for harsh environments including IEEE 1613 Class 2 (electric utility substations), IEC 61850 (electric utility substations), IEC 61800-3 (variable speed drive systems), IEC 61000-6-2 (generic industrial), and NEMA TS-2 (traffic control equipment).

(1) Switch shall operate in an environment from minus 40 degrees C to plus 85 degrees C without fans.

(2) Switch shall have conformal coated circuit boards when installed within 500 feet of saltwater.

(3) Switch shall be certified for Class 1, Division 2 hazardous locations.

c. Power Supply: Fully integrated, redundant power supplies rated for 88 to 300 volts DC. Provide screw terminals.

d. Encryption: SSH/SSL 128-bit minimum.

e. Passwords: Provide multi-level user passwords. Provide passwords to the government.

f. Port Security: MAC based port security to enable and disable ports. Provide network access control 802.1x.

g. Ports: Provide single mode gigabit 1000LX SFP uplink ports. Provide 100BASE-FX multimode fiber ports and copper RJ45 Ethernet ports as shown and in accordance with connected device manufacturer's connection requirements.

2.5.4 GPS Clock

a. Product Description: Global positioning satellite clock.

b. High Accuracy: The IRIG-B demodulated output shall be within minus 100 nanoseconds to plus 100 nanoseconds (average) of UTC time.

c. Holdover Accuracy: The clock shall have an accuracy of minus 0.08 ppm to plus 0.08 ppm for 20 minutes (over entire operating temperature range) while clock is not locked to GPS satellite reference.

d. Time Outputs: Clock shall have a minimum of one modulated IRIG-B output and six demodulated IRIG-B outputs programmable to IRIG-B, 1 PPS, or 1k PPS. Demodulated time outputs shall be capable of being programmed for UTC or local time. The clock shall provide IRIG-B connection capability and ASCII time output at one serial port. Provide fiber-optic serial port.

e. IEEE Extended Control Functions: IRIG-B outputs shall be capable of adding extended control functions specified by IEEE C37.118.

f. Daylight Time: The clock shall have automatic daylight-saving time advance/return with presets for North America, Europe, and custom DST-setting capability.

g. Alarm Contact: The alarm contact shall indicate diagnostic self-test failure and be programmable to include loss-of-satellite lock, power supply, and processor as an alarm condition.

h. Display: Front-panel LEDs shall display UTC or local day and time as well as clock operational status.

i. Settings: Settings shall be accomplished through use of easily accessible control (DIP) switches.

j. Software: No proprietary software shall be required to communicate with clock. Standard PC-compatible ASCII terminal emulation programs shall be sufficient to establish communication, provide commands and settings, and download data.

k. Computer Clock-Setting Software: The clock shall support capability to provide date and time to a PC or computer via a communications link using accessory software.

l. Security: Password security shall be provided to control clock access. Security features shall include a 12-character password length, requiring old password entry before changing to a new password, never showing password on communications ports, and providing a lockout for failed password-entry attempts.

m. Mounting: The clock shall be wall-mounted as indicated.

n. Power Supply: The clock shall have a power supply with an operating range of 18 to 300 Vdc and 85 to 264 Vac.

o. Operating Temperature: The clock shall have an operating range of minus 40 degrees C to plus 80 degrees C with rated accuracy.

p. Robust Hardware: The clock shall meet and be tested for EMI, RFI, shock, vibration, and environmental compliance per IEEE C37.90, IEC 60255-21-3, IEC 61000-4-5, and IEC 60068-2-27.

q. Safety: The clock shall be CE-compliance marked, meeting IEC 61010 standard.

r. Warranty: The clock shall have a minimum warranty period of 10 years.

2.5.5 IRIG-B Distribution Module

Provide IRIG-B distribution module with input connector coordinated with the GPS satellite clock and output connector ports coordinated with the digital clocks and other IRIG-B devices connected to the system. Provide quantity of distribution modules required to connect all IRIG-B devices plus an additional 4 output ports.

2.5.6 Digital Clocks

Provide surface-mounted, digital clocks with IRIG-B inputs. Display numbers shall be not less than 75 mm 3 inches in height and shall be GREEN in color. Enclosure shall be less than 50 mm 2 inches deep, measured from the face of the clock to the back of the enclosure. Provide complete with filtered power supply adapter, rated for input of 125 VDC. Coordinate output rating of the power supply adapter to the clock power input voltage and connection requirements. Coordinate IRIG-B input with the IRIG-B output of the IRIG-B distribution module.

2.5.7 Fiber Optic Cable

Comply with Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

2.5.8 Source Programming Requirement

a. Program programmable automation controller, protective relays, meters, switches, GPS clock, and other programmable devices prior to scheduling Factory Witness Tests. Programming shall include all logical inputs, outputs, ports, protocols, and other such settings required to achieve a fully usable, SCADA-ready application.

b. Furnish and upload all setting files.

2.5.9 Relay Racks

a. Product Description: Equipment enclosures for mounting protective relays, HMI, network switches, GPS clock, relay test switches, bus differential relays, and lock-out relays.

b. Construction: Main frames and bases of 11 Gage ASTM A240/A240M Type 316 stainless steel. Side and top panels 14 Gage corrosion resistant steel. Rack holes according to ECIA EIA/ECA 310-E Standard with universal spacing. Rack holes threaded for 10-32 fasteners. Provide full length and width rear doors. Front shall be filled with modular, removable steel panels. Arrange panels to accommodate relay heights and widths. Provide panels in unused spaces. Fasteners shall be ASTM A240/A240M Type 316 stainless steel.

c. Equipment Arrangement: Arrange relays and test switches so that the topmost button or switch is no higher than 1800 mm 72 inches above finished floor.

d. Cabling Arrangement: Arrange cables in horizontal and vertical runs parallel and perpendicular to structural members and panels. Fasten cable bundles to steel frame and panels using bolt-on, nylon clamps.

]2.6 FIELD FABRICATED NAMEPLATES

Provide laminated plastic nameplates for each primary unit substation equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 3 mm 0.125 inch thick, white with [black][_____]

center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 by 65 mm one by 2 1/2 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

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NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, specify other methods of grounding. Where it is impractical to obtain indicated ground resistance values, the designer should make every effort, to obtain ground resistance values as near as possible to the indicated values.

****

NFPA 70 and IEEE C2, except that grounds and grounding systems must have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic welds or compression connectors. Provide compression connectors at equipment ends of ground conductors.

3.2.2 Substation Grounding

Provide bare copper cable not smaller than No. 4/0 AWG, not less than 610 mm 24 inches below grade connecting to the indicated ground rods. Substation transformer neutral connections must not be smaller than No. 1/0 AWG. When work, in addition to that indicated or specified, is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" must apply.[Fence and equipment connections must not be smaller than No. 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding 3050 mm 10 feet. Bond each gate section to the fence post through a 3 by 25 mm 1/8 by one inch flexible braided copper strap and clamps.]

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Exothermic welds and compression connectors must be installed as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, paragraph regarding GROUNDING.

3.2.4 Ground Cable Crossing Expansion Joints in Structures and Pavements

Protect from damage by means of approved devices or methods of installation to allow the necessary slack in the cable across the joint to permit movement. Provide stranded or other approved flexible copper cable across such separations.

3.2.5 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect unit substations furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Medium-Voltage Switchgear and Load Interrupter Switches

IEEE C37.20.2A and IEEE C37.20.3 as applicable.

3.3.2 Meters and Instrument Transformers

ANSI C12.1.

3.3.3 Galvanizing Repair

Repair damage to galvanized coatings caused by handling, transporting, cutting, welding, or bolting. Make repairs in accordance with ASTM A780/A780M, zinc rich paint. Do not heat surfaces that repair paint has been applied to.

3.3.4 Field Fabricated Nameplates

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

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NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the equipment is located. Include construction requirements for concrete slab only if slab is not detailed in drawings. Curbs or raised edges may also be required around liquid filled transformers.

****

3.4.1 Exterior Location

Mount [substation][and][switchgear] on concrete slab. Unless otherwise indicated, the slab must be at least 200 mm 8 inches thick, reinforced with a 152 by 152 - MW19 by MW19 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 100 mm 4 inches from the top of the slab. Slab must be placed on a 150 mm 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 100 mm 4 inches above finished grade. Edges above grade must have 15 mm 1/2 inch chamfer. Slab must be of adequate size to project at least 200 mm 8 inches beyond equipment, except that front of slab must be large enough to serve as a platform to withdraw breakers or to operate two-high breaker lifters. Provide conduit turnups and cable entrance space required by the equipment to be mounted[and as indicated]. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm 3 inches above slab surface. Concrete work must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4.2 Interior Location

Mount [substation][and][switchgear] on concrete slab. Unless Otherwise indicated, the slab must be at least 100 mm 4 inches thick. Top of concrete slab must be approximately 100 mm 4 inches above finished floor. Edges above floor must have 15 mm 1/2 inch chamfer. Slab must be of adequate size to project at least 200 mm 8 inches beyond the equipment, except that front of slab must be large enough to serve as a platform to withdraw breakers or to operate two-high breaker lifters. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm 3 inches above slab surface. Concrete work must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.[The [_____] Division, Naval Facilities Engineering Systems Command will witness formal tests after receipt of written certification that preliminary tests have been completed and that system is ready for final test and inspection.]

****

NOTE: Thermographic surveying is not required on most projects. NETA recommends that surveys be performed during periods of maximum possible loading but with not less than 40 percent of rated load on the electrical equipment being inspected. Testing at start-up will therefore not be beneficial except for hard-to-reach areas where solid connections cannot be verified by mechanical methods. Thermographic surveying may be useful if equipment operates under load for a specified period of time, preferably 3 to 6 months, before testing. The additional costs and the additional trip (3 to 6 months after the initial inspection) for the NETA contractor to perform the survey should be considered prior to specifying the requirement.

****

3.5.1.1 Interrupter Switch(es)

a. Visual and Mechanical Inspection

    (1) Compare equipment nameplate data with specifications and approved shop drawings.

    (2) Inspect physical and mechanical condition.

    (3) Confirm correct application of manufacturer's recommended lubricants.

(4) Verify appropriate anchorage and required area clearances.

(5) Verify appropriate equipment grounding.

(6) Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.

[(7) Verify that fuse sizes and types correspond to approved shop drawings.

][(8) Verify that each fuse holder has adequate mechanical support.

] (9) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic surveying [is not][is] required.

(10) Test interlocking systems for correct operation and sequencing.

(11) Verify correct phase barrier materials and installation.

(12) Compare switch blade clearances with industry standards.

(13) Inspect all indicating devices for correct operation

b. Electrical Tests

(1) Perform insulation-resistance tests.

(2) Perform over-potential tests.

(3) Measure contact-resistance across each switch blade[and fuse holder].

[(4) Measure fuse resistance.

] (5) Verify heater operation.

3.5.1.2 Medium-Voltage Circuit Breakers (Vacuum)

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Inspect anchorage, alignment, and grounding.

(5) Perform all mechanical operational tests on both the circuit breaker and its operating mechanism.

(6) Measure critical distances such as contact gap as recommended by manufacturer.

(7) Verify tightness of accessible bolted connections by calibrated

torque-wrench method. Thermographic survey [is not][is] required.

(8) Record as-found and as-left operation counter readings.

b. Electrical Tests

(1) Perform a contact-resistance test.

(2) Verify trip, close, trip-free, and antipump function.

(3) Trip circuit breaker by operation of each protective device.

(4) Perform insulation-resistance tests.

(5) Perform vacuum bottle integrity (overpotential) test across each bottle with the breaker in the open position in strict accordance with manufacturer's instructions. Do not exceed maximum voltage stipulated for this test.

3.5.1.3 Medium-Voltage Circuit Breakers (SF6)

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Inspect anchorage and grounding.

(5) Inspect and verify adjustments of mechanism in accordance with manufacturer's instructions.

[(6) Inspect and service air compressor in accordance with manufacturer's instructions.

] (7) Test for gas leaks in accordance with manufacturer's instructions.

(8) Verify correct operation of all air and SF6 gas pressure alarms and cutouts.

(9) Slow close/open breaker and check for binding.

(10) Perform time-travel analysis.

(11) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey [is not][is] required.

(

(12) Record as-found and as-left operation counter readings.

b. Electrical Tests

(1) Measure contact resistances.

(2) Perform insulation-resistance tests.

(3) Verify trip, close, trip-free, and antipump functions.

(4) Trip circuit breaker by operation of each protective device.

3.5.1.4 Transformers (Liquid-Filled)

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

[(3) Verify that cooling fans operate correctly and that fan motors have correct overcurrent protection.

][(4) Verify operation of all alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.

] (5) Verify tightness of accessible bolted electrical connection by calibrated torque-wrench method. Thermographic survey [is not][is] required.

(6) Verify correct liquid level in transformer tank.

(7) Perform specific inspections and mechanical tests as recommended by manufacturer.

(8) Verify correct equipment grounding.

(9) Verify that positive gas pressure is maintained on gas blanketed transformers.

b. Electrical Tests

(1) Perform insulation-resistance tests.

(2) Perform turns-ratio tests.

(3) Perform insulation power-factor/dissipation-factor tests on windings.

(4) Sample insulating liquid. Sample must be tested for:

(a) Dielectric breakdown voltage

(b) Acid neutralization number

(c) Specific gravity

(d) Interfacial tension

(e) Color

(f) Visual condition

(g) Parts per million water

(h) Measure dissipation factor or power factor.

(5) Perform dissolved gas analysis (DGA).

(6) Test for presence of PCB.

(7) Verify that tap-changer is set at specified ratio.

(8) Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3.5.1.5 Switchgear Assemblies

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical, electrical, and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Verify appropriate anchorage, required area clearances, and correct alignment.

(5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

(6) Verify that[fuse and] circuit breaker sizes and types correspond to approved shop drawings.

[(7) Verify that current and potential transformer ratios correspond to approved shop drawings.

] (8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey [is not][is] required.

(9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(10) Clean switchgear.

(11) Inspect insulators for evidence of physical damage or contaminated surfaces.

(12) Verify correct barrier[and shutter] installation[and operation].

(13) Exercise all active components.

(14) Inspect all mechanical indicating devices for correct operation.

(15) Verify that vents are clear.

(16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

(17) Inspect control power transformers.

b. Electrical Tests

(1) Perform insulation-resistance tests on each bus section.

(2) Perform overpotential tests.

(3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

(4) Perform control wiring performance test.

(5) Perform primary current injection tests on the entire current circuit in each section of assembly.

[(6) Perform phasing check on double-ended switchgear to ensure correct bus phasing from each source.

] (7) Verify operation of heaters.

3.5.1.6 Instrument Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey [is not][is] required.

(6) Verify that all required grounding and shorting connections provide good contact.

(7) Verify correct operation of transformer with drawout mechanism and grounding operation. Removal of instruments must be performed in a manner that the secondary circuits of energized current transformers are not opened.

(8) Verify correct primary and secondary fuse sizes for potential transformers.

b. Electrical Tests - Current Transformers

(1) Perform insulation-resistance tests.

(2) Perform polarity tests.

(3) Perform ratio-verification tests.

(4) Perform excitation test on transformers used for relaying

applications.

(5) Measure circuit burden at transformer terminals and determine the total burden.

(6) When applicable, perform insulation resistance and dielectric withstand tests on the primary winding with secondary grounded.

(7) CAUTION: Changes of connection, insertion, and removal of instruments, relays, and meters must be performed in such a manner that the secondary circuits of energized current transformers are not opened momentarily.

c. Electrical Tests - Voltage (Potential) Transformers

(1) Perform insulation-resistance tests.

(2) Perform a polarity test on each transformer to verify the polarity marks or H1 - X1 relationships as applicable

(3) Perform a turns ratio test on all tap positions , if applicable.

(4) Measure potential circuit burdens at transformer terminals and determine the total burden.

(5) Measure circuit burden at transformer terminals and determine the total burden.

3.5.1.7 Battery Systems

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey [is not][is] required.

(4) Measure electrolyte specific gravity and temperature and visually check fill level.

(5) Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical tests

(1) Set charger float and equalizing voltage levels.

(2) Verify all charger functions and alarms.

(3) Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.

(4) Perform a capacity load test.

3.5.1.8 Metering and Instrumentation

a. Visual and Mechanical Inspection

   (1) Compare equipment nameplate data with specifications and approved shop drawings.

   (2) Inspect physical and mechanical condition.

   (3) Verify tightness of electrical connections.

b. Electrical Tests

   (1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

   (2) Calibrate watthour meters according to manufacturer's published data.

   (3) Verify all instrument multipliers.

   (4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.5.1.9 Grounding System

a. Visual and Mechanical Inspection

   (1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

   (1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

   (2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

[3.5.2 Field Dielectric Tests

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NOTE: Field dielectric tests are recommended when new units are added to an existing installation or after major field modifications. If necessary, service the equipment prior to the field test.

****

Perform field dielectric tests on medium-voltage switchgear according to IEEE C37.20.2A or IEEE C37.20.3 as applicable.

]3.5.3 Follow-Up Verification

****

NOTE: Use "10" working days and include last bracketed sentence in the paragraph for NAVFAC SE projects.

****

Upon completion of acceptance checks, settings, and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers must be tripped by operation of each protective device. Test must require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer [5][10] working days in advance of the dates and times for checks, settings, and tests[, to allow the Contracting Officer to notify NAVFAC SE Code 0742; Electrical Engineering Division and Code 162; Director, Utilities Engineering Division].

3.6 TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period will consist of a total of [_____] hours of normal working time and must start after the system is functionally completed but prior to final acceptance tests. The course instruction must cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions must demonstrate all routine maintenance operations.

a. Submit [6][_____] copies of operation and maintenance manuals, within [7][_____] calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

b. Manuals must also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements must also be included. Documents must be bound in a binder marked or identified on the spine and front cover. A table of contents page must be included and marked with pertinent contract information and contents of the manual. Tabs must be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare-parts data. Index sheets must be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

c. Submit a digital video recording of the entire training session and three additional copies of the instructions manual within 30 days following the approval of the manuals.

3.7 MANUFACTURER'S FIELD SERVICE

3.7.1 Installation Engineer

After delivery of the equipment, furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the on site tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment. Submit a detailed description of the Contractor's proposed procedures for on site tests.

3.7.2 Pre-Energization Services

Calibration, testing, adjustment, and placing into service of the installation must be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience. No part of the electrical system must be energized until all station grounding components have been tested and demonstrated to comply with the specified requirements. The following services must be performed on the equipment listed below. These services must be performed subsequent to testing but prior to the initial energization. The equipment must be inspected to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at station buses and at major equipment must be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations must be inspected to detect possible damage caused during installation. If factory tests were not performed on completed assemblies, tests must be performed after the installation of completed assemblies. Components must be inspected for damage during installation or shipment and to verify that packaging materials have been removed. Components capable of being both manually and electrically operated must be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested must be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer.

3.8 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation material or operation have been corrected.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 11 14.00 10 (November 2021)**

Preparing Activity: USACE **Superseding**
UFGS-26 11 14.00 10 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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DIVISION 26 - ELECTRICAL

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MAIN ELECTRIC SUPPLY STATION AND SUBSTATION

11/21

PART 3   EXECUTION

ATTACHMENTS:

Standard Detail No. 40-06-04

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 11 14.00 10 (November 2021)**

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SECTION 26 11 14.00 10

MAIN ELECTRIC SUPPLY STATION AND SUBSTATION
11/21

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NOTE: This guide specification covers the requirements for main electric supply stations or substations having a nominal voltage class of 15 kV up to 115 kV.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A576	(2023) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A633/A633M	(2024) Standard Specification for Normalized High-Strength Low-Alloy Structural Steel Plates
ASTM B8	(2023) Standard Specification for

	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B188	(2015; R 2023) Standard Specification for Seamless Copper Bus Pipe and Tube
ASTM B231/B231M	(2023) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B317/B317M	(2023) Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, Structural Profiles, and Profiles for Electrical Purposes (Bus Conductor)
ASTM D923	(2007) Standard Practice for Sampling Electrical Insulating Liquids
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D2472	(2000; R 2014) Standard Specification for Sulphur Hexafluoride
ASTM D4059	(2000; R 2018) Standard Test Method for Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 32	(1972; R 1997) Standard Requirements, Terminology, and Test Procedures for Neutral Grounding Devices
IEEE 80	(2013) Guide for Safety in AC Substation Grounding
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 242	(2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE 399	(1997) Brown Book IEEE Recommended Practice for Power Systems Analysis
IEEE 484	(2019) Recommended Practice for Installation Design and Implementation of Vented Lead-Acid Batteries for Stationary Applications

IEEE 485	(2020) Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
IEEE 525	(2007) Guide for the Design and Installation of Cable Systems in Substations
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.04	(2018; Erta 2019; Corr 2021) Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V Corrigendum 1
IEEE C37.06	(2009) Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltage Above 1000 V
IEEE C37.081	(1981; Supp 1997; R 2007) Guide for Synthetic Fault Testing of AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.09	(2018; Errata 2019; Corr 2021) Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.1	(2007) Standard for Supervisory Control, Data Acquisition (SCADA) and Automatic Systems
IEEE C37.2	(2022 Standard for Electrical Power System Device Function Numbers, Acronyms and Contact Designations
IEEE C37.13	(2024) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.16	(2009) Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC 3200 V and below) Power Circuit Breakers
IEEE C37.20.2	(2022) Metal-Clad Switchgear
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE C37.23	(2015) Metal-Enclosed Bus
IEEE C37.30	(1997; INT 1 2011) Standard Requirements for High-Voltage Switches
IEEE C37.32	(2002) High-Voltage Switches, Bus

	Supports, and Accessories - Schedules of Preferred Ratings, Construction Guidelines and Specifications
IEEE C37.34	(1994) Standard Test Code for High-Voltage Air Switches
IEEE C37.41	(2016; Corr 2017) Design Tests for High-Voltage (>1000 V) Fuses and Accessories
IEEE C37.46	(2010) Standard for High Voltage Expulsion and Current-Limiting Type Power Class Fuses and Fuse Disconnecting Switches
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.121	(2012) American National Standard for Switchgear-Unit Substations - Requirements
IEEE C57.12.00	(2021) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.01	(2020) General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings
IEEE C57.12.10	(2017) Requirements for Liquid-Immersed Power Transformers
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2021) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C57.15	(2018) Standard Requirements, Terminology, and Test Code for Step-Voltage Regulators
IEEE C57.19.00	(2023) Standard General Requirements and Test Procedures for Outdoor Power Apparatus Bushings
IEEE C57.19.01	(2000; R 2005; INT 1 2010) Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings

IEEE C57.93	(2007) Guide for Installation and Maintenance of Liquid-Immersed Power Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE C135.30	(1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60255-21-3	(1993; ED 1.0) Electrical Relays - Part 21: Vibration, Shock, Bump And Seismic Tests On Measuring Relays And Protection Equipment - Section 3: Seismic Tests

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 18.1	(2024) Annunciator Sequences and Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C29.1	(2018) Test Methods for Electrical Power Insulators
ANSI C29.9	(2017) Wet Process Porcelain Insulators - Apparatus, Post-Type
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C12.4	(1984; R 2011) Registers - Mechanical Demand
NEMA C29.2B	(2013; R 2023) Wet Process Porcelain and Toughened Glass - Transmission Suspension Type
NEMA LA 1	(2009) Standard for Surge Arresters
NEMA PB 1	(2011) Panelboards
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard
NEMA/ANSI C12.11	(2006; R 2019) Instrument Transformers for

	Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint Aug 2023) UL Standard for Safety Panelboards
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 1236	(2015; Reprint Feb 2021) UL Standard for Safety Battery Chargers for Charging Engine-Starter Batteries

1.2 SYSTEM DESCRIPTION

****

NOTE: Select the features and fill in blanks with selections appropriate for the design condition and in accordance with guidance contained in UFC 3-550-01.

****

1.2.1 General

Configure the system as specified, and include structures, incoming and outgoing lines, transformers, regulators, fuses, circuit breakers, switches, switchgear, and appurtenances to provide a fully functional system.

1.2.2 Service Conditions

****

NOTE: See UFC 3-550-01 for guidance regarding

service conditions. Retain or add the required conditions.

Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not included. Pertinent portions of UFC 3-301-01 and Sections 13 48 73, 23 05 48.19 and 26 05 48, properly edited, must be included in the contract documents.

****

Items provided under this section must be specifically suitable for the following service conditions. Seismic details must conform to UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT, 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS, and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT [as indicated].

Fungus Control	[_____]
Altitude	[_____] m feet
Ambient Temperature	[_____] degrees C F
Frequency	[_____] Hz
Ventilation	[_____] cubic meters/sec cfm
Seismic Parameters	[_____]
Humidity Control	[_____]
Corrosive Areas	[_____]
[_____]	[_____]

1.2.3 Incoming and Outgoing Circuit Compliance

[Aerial line circuits must comply with the requirements of Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.] [Underground circuits must comply with the requirements of Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.] [Circuits in cable trays must comply with the requirements of Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION for cable and with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM for cable trays.]

1.2.4 Detail Drawings

Submit detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Show on the detail drawings the ratings of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system must be coordinated and submitted as a unit. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later must be included with the first submission. Detail drawings must show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings must be drawn to scale and dimensioned. Optional items must be clearly identified as included or excluded. Detail drawings must as a minimum include:

a. Incoming line and station bus structures and integral equipment.

b. Transformers.

c. Switchgear.

d. Battery system including calculations for the battery and charger.

e. Voltage regulators.

f. Grounding resistors.

g. Station single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.

h. Structural or physical features of major items of station equipment and components of equipment or equipment assemblies and structures, including foundations or other types of supports for equipment and conductors. Those structural drawings must include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of station equipment and component parts of the equipment and the relative arrangement of components and any physical connection of related components. Weights of equipment and components of equipment assemblies must be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces must be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings must show the provisions for leveling, anchoring, and connecting all items of station equipment during installation, and must include any recommendations made by the manufacturer of the equipment.

i. Electrical drawings must include single-line and three-line diagrams of the station and station equipment, schematics or elementary diagrams of each electrical system; internal wiring and external connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or other separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; external connection diagrams that show the termination of wiring routed between separate items of station equipment; internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections must be clearly identified.

j. If departures from the contract drawings are deemed necessary, submit complete details of such departures, including changes in related portions of the project and the reasons therefore. Approved departures must be made at no additional cost to the Government.

1.2.5 As-Built Drawings

The as-built drawings must be kept at the job site and updated daily. The as-built drawings must be a full sized set of prints marked to reflect all deviations, modifications, and changes. The as-built drawings must be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings must be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, submit three full sized sets of the marked prints to the Contracting Officer for approval. Keep as-built drawings prepared as a record of the construction as installed. Include in the drawings all the information shown on the contract drawings as well as all deviations, modifications, and changes from the contract drawings, however minor. If upon review, the as-built drawings are found to contain errors or omissions, they will be returned to the Contractor for correction. Correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

1.3 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING and Section 25 05 11 CYBERSECURITY FOR FACILITY RELATED CONTROL SYSTEMS applies to this section, with the addition and modifications specified herein.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL

PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

General Installation Requirements

Detail Drawings

As-Built Drawings

SD-03 Product Data

Support Structures; G, [_____]

Fault Current Analysis

Protective Devices

Coordination Study

Battery; G, [_____]

Nameplates

Materials and Equipment

General Installation Requirements

Onsite Tests; G, [_____]

SD-06 Test Reports

Factory Tests

Field Testing

Field Test Reports

SD-07 Certificates

Materials and Equipment

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

1.5 DELIVERY, STORAGE, AND HANDLING

Visually inspect devices and equipment when received and prior to acceptance from conveyance. Protect stored items from the environment in accordance with the manufacturer's published instructions. Replace damaged items. Oil filled transformers and switches must be stored in accordance with the manufacturer's requirements.

1.6 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element must be delivered to the Contracting Officer when the electrical system is accepted. Provide two complete sets of all special tools required for maintenance, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard product of a manufacturer regularly engaged in the manufacture of the product and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

a. Submit a complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry must include an item number, the quantity of items proposed, and the name of the manufacturer of each such item. Products must conform to the following requirements. Items of the same classification must be identical including equipment, assemblies, parts, and components. Products for aerial construction must conform to IEEE C2 for [heavy] [medium] [light] loading districts, Grade B construction.

b. Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories, Inc., (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), submit proof that the items provided under this section of the specifications conform to such requirements.

c. The label of, or listing by, UL will be acceptable evidence that the items conform thereto. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable evidence that the item conforms thereto. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable evidence that the item conforms thereto.

d. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

2.2 NAMEPLATES

Submit data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

2.2.1 General

Each major component of this specification must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates must be made of noncorrosive metal. As a minimum, provide nameplates for transformers, regulators, circuit breakers, capacitors, meters, switches, switchgear, and grounding resistors.

2.2.2 Liquid-Filled Transformer Nameplates

****

NOTE: Coordinate Nameplate C information with the manufacturer. Select 50 ppm for Army projects and 2 ppm for Air Force projects.

****

Provide power transformers, with Nameplate C information in accordance with IEEE C57.12.00, indicating the number of gallons and composition of liquid-dielectric, permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than [50] [2] ppm PCB content in accordance with paragraph MISCELLANEOUS Liquid Dielectrics. Certifications must be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the [50] [2] ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

2.3 CORROSION PROTECTION

2.3.1 Aluminum Materials

[Aluminum must not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, use fittings conforming to UL 486A-486B.] [Aluminum must not be used.]

2.3.2 Ferrous Metal Materials

2.3.2.1 Hardware

Ferrous metal hardware must be hot-dip galvanized in accordance with ASTM A153/A153M and ASTM A123/A123M.

2.3.2.2 Equipment

****

NOTE: A 120-hour test will be specified in a noncorrosive environment and a 480-hour test will be specified in a corrosive environment.

****

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, must be provided with corrosion-resistant finishes which must withstand [120] [480] hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm 1/16 inch from the test mark. The scribed test mark and test evaluation must be in accordance with ASTM D1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel must be coated with a zinc rich paint conforming to the manufacturer's standard.

2.3.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory must be as specified in Section 09 90 00 PAINTS AND COATINGS.

2.4 STATION ARRANGEMENT

****

NOTE: Coordinate with paragraph SUBSTATION EQUIPMENT.

****

The main electric supply [station] [substation] must be of the [substation transformer type with an open-type bus-and-switch arrangement] [articulated primary unit substation arrangement with close-coupled high-voltage and low-voltage sections] [primary unit substation arrangement with close-coupled low-voltage section].

2.4.1 Support Structures

****

NOTE: Connections to aerial lines will be run underground to new stations (35 kV or less), thus deleting the requirement for aerial buses and line structures. Delete wire brackets if not required.

Maximum use will be made of "standard," "custom," or "pre-fabricated" structure designs. Coordinate with the local utility as well as with structure manufacturers. Also, coordinate with SD-04, Detail Drawings. Modify or delete subparagraphs as required. Structures will be designed for not less than 4.4 kN 1000 pounds tension per conductor. Normally, short slack spans from the utility system should be provided to ensure that conductor tensions are kept to a minimum.

Foundations will be designed based on available data from soil borings and detailed on the project drawings. Where soil-bearing pressures are not known, foundations for a soil-bearing pressure of not more than 191.5 kPa 4000 psf should be provided. The large overturning moments created by the incoming aerial conductors will be considered in the foundation design and a safety factor of not less than 1.5 should be provided. The designer will ensure that Section 03 30 00 CAST-IN-PLACE CONCRETE

covers the class of concrete required for foundations associated with a main electric supply station, but concrete must have not less than 17.2 MPa 2500 psi compressive strength.
****

Provide structures to support incoming line conductors, switches, instrument transformers, air terminals and aerial buses. Steel structural items must conform to Section 05 12 00 STRUCTURAL STEEL. Structures, except for incoming primary lines, must be of the low-profile type. Structures must utilize round or rectangular tubular steel construction or equivalent H/I-beam support elements. Lattice type supports are not acceptable. Submit manufacturer's design analysis and calculations for structures, foundations, anchor bolts, and supports differing from those indicated in the contract drawings, and for prefabricated structures. Calculations must be made by a registered professional engineer with demonstrated experience in substation structural design in the last three years. The manufacturer must provide a list of projects complete with points of contact, addresses and telephone numbers. Structural steel and miscellaneous items must comply with ASTM A36/A36M, ASTM A572/A572M, ASTM A575, ASTM A576or ASTM A633/A633M, or equivalent aluminum. General configurations are indicated. Exact dimensions and arrangements may be varied, dependent upon site limitations, to permit use of a manufacturer's standard equipment and structures. Air terminals, [not less than 1.8 m 6 feet in length] [of the length shown], must be provided on each structure column for lightning protection. [Static wire brackets for incoming overhead ground wires must be provided on each incoming dead-end line structure and elsewhere as indicated.]

2.4.1.1 Pre-fabricated Structure Design

Design structures for a maximum tension of [4.5] [_____] kN [1000] [_____] pounds per conductor. Overhead ground or static wires must be counted as conductors in determining strength requirements. Detail drawings must show markings of units for placement, location and sizes of attachments, and complete data on fabrications.

2.4.1.2 Structure Finish

Aluminum structures must have a uniform satin finish and must not be painted. Steel structures must be hot-dip galvanized in accordance with ASTM A123/A123M after drilling is completed and must not be painted.

2.4.1.3 Structure Foundation Design

Structure foundation design must be as indicated. If the manufacturer's standard structures differ in dimensions from those shown, modify foundation design to suit the structures provided, at no additional cost to the Government. Maximum earth-bearing pressure must be calculated at [191.5] [_____] kPa [4000] [_____] psf.

2.4.2 [Conductors][Tubular Bus Conductors]

****
NOTE: Justify selection of copper or aluminum, based upon an analysis using life, environmental, and cost factors. Refer to UFC 3-550-01 regarding substation conductors and buses.
****

Conductors must be [aluminum-conductor-steel-reinforced (ACSR)] [copper] [high-strength aluminum alloy] with sizes as indicated, and must comply with IEEE 525. Base span lengths on a limiting deflection of 1/150 for spans having two supports and 1/200 for spans having three supports, under maximum wind, ice, and short-circuit loadings, including suitable allowances for any taps. Where required, install larger or stronger bus to maintain specified deflections for the indicated span lengths. Other bus shapes for electrical conductors may be used if detail drawing submittals indicate equivalent ampacity and strength. Short connections, consisting of bare stranded conductors of equivalent bus ampacity, may be used between incoming line conductors and buses or between buses and equipment. Copper flexible braid or aluminum strap expansion couplers, as required to match the bus material, must be installed in bus runs where required to allow for expansion and contraction, and at all connections to transformer bushings.

2.4.2.1 Suspension Insulators

****

NOTE: Refer to UFC 3-550-01 for guidance regarding substation insulators.

****

Provide suspension insulators for dead-end incoming line conductors. Utilize suspension insulator strings and string supports which provide a mechanical strength exceeding the ultimate strength of each dead-end conductor. Minimum ratings of Provide suspension insulators with a minimum rating of not less than NEMA C29.2B Class [52-3-L] [52-3-H] [or] [52-4-L] [52-4-H]. Each suspension string must have not less than [_____] insulators in tandem.

2.4.2.2 Apparatus Post Insulators

Apparatus post insulators must be provided to support conductors, and their mechanical strength must exceed the ultimate strength of the conductor supported and, where necessary, high-strength or ultra high-strength insulators must be provided. Minimum ratings of apparatus post insulators must be not less than ANSI C29.9, Technical Reference Number [_____].

2.5 INCOMING SWITCHING/CIRCUIT INTERRUPTING EQUIPMENT

****

NOTE: Incoming line equipment may be provided by the utility or by the Government. Delete paragraphs not applicable to project. Operating characteristics and ratings of incoming line interrupting/switching must be coordinated with the requirements of the serving utility and the transformer and bus protection requirements. On the drawings, identify the required instruments, relays, instrument transformers, and controls for each switching/interrupting unit, and modify the following paragraphs to reflect the station control and instrumentation schemes and the station single-line diagram.

****

Incoming line switching equipment must be of the outdoor weatherproof type. Operating characteristics and ratings of incoming line switching equipment must be as indicated.

2.5.1 Metal-Enclosed Interrupter Switchgear

****

NOTE: Metal enclosed switchgear with SF6 interrupters is available for voltage levels of 5 kV through 25 kV. Select either air-insulated, vacuum-insulated, or SF6 interrupters.

****

Metal-enclosed interrupter switchgear must comply with IEEE C37.20.2 for metal clad switchgear, IEEE C37.20.3 for metal-enclosed interrupter switchgear, IEEE C37.32for load-interrupter switches, [_____] for power fuses, and must be of the outdoor no-aisle type that meets or exceeds the requirements of applicable publications listed. Switch construction must be of the manually-operated, "OPEN-CLOSED," [air-insulated, load-interrupter type] [vacuum-insulated, load-interrupter type] [SF6-insulated, load-interrupter type], equipped with a stored energy operator for quick-make-quick-break to make operating speeds independent of manual switch operations. Where indicated, bus or lug connections to mount field-installed, slip-on, medium-voltage cable terminations for cable entering from below [and a flanged throat for direct connection to the associated transformer] [and a bus throat for connection to the associated metal-enclosed bus] [and roof bushings for aerial line connections] must be provided. [Roof bushings must [have the same BIL as] [be one BIL higher than] the associated switchgear and must conform to IEEE C57.19.00 and IEEE C57.19.01 when bushings are rated at or above 110 kV BIL.] Primary buses must comply with the requirements for buses in paragraph OUTGOING METAL-CLAD SWITCHGEAR.

2.5.1.1 Ratings

****

NOTE: Preferred ratings are listed in IEEE C37.2, Table 6. A short-circuit study is required to specify ratings. For projects where multiple ratings are required for different applications, delete the table below and provide rating requirements on the drawings in tabular form.

****

Switch ratings at 60 Hz must be in accordance with IEEE C37.2, and IEEE C37.06 and as [follows:] [indicated.]

Nominal voltage	[_____]
Rated maximum voltage	[_____]
Maximum symmetrical interrupting capacity	[_____]
Maximum asymmetrical interrupting capacity	[_____]
3-Second short time current carrying capacity	[_____]
Rated continuous current (kA)	[_____]

BIL (Impulse Level)	[_____]

2.5.1.2 Operating Mechanism Controls and Devices

****

NOTE: The switchgear control switch, status lights, metering, and relaying will be located on the secondary metal-clad switchgear; additionally, a control switch, status lights, and a local-remote selector switch will be mounted at the interrupter switch. If this equipment cannot be mounted on the secondary metal-clad switchgear, then these devices will be installed in an instrument and relay cabinet adjacent to the interrupter switch operating mechanism cabinet. Transformer differential and differential lockout relays will be located in the metal-clad switchgear. Where there is no metal-clad switchgear, the appropriate material from the paragraph will be included as a part of paragraph SUBSTATION EQUIPMENT.

****

An operating mechanism cabinet must house the electrical devices listed below, which must be rated for the application and must be suitable for the ac or dc control voltage available as shown or specified. Unless otherwise noted, provide manufacturer's standard devices for the rating specified including the following:

a. A light connected to a cabinet door-actuated switch, so that the light is energized only when doors are open.

b. A heater continuously energized to prevent condensation within the cabinet over ambient temperature ranges from [minus 29] [_____] to [40] [_____] degrees C [minus 20] [_____] to [104] [_____] degrees F at 90 percent relative humidity and connected to a cabinet door-actuated switch, so the heater is de-energized when doors are open. High-temperature thermal protection must be included.

c. An operator charging motor with thermal-overload relays.

d. A motor control contactor with relays, solenoids, and any other control devices required.

e. Necessary motor-alarm and interlock switches.

f. One-pole or two-pole thermal-magnetic molded-case circuit breakers suitable for the operating voltage for control, heater, and light circuits.

g. A minimum of eight spare circuit breaker auxiliary contacts, four normally open (52a) and four normally closed (52b), wired to interface terminals.

h. Terminal facilities wired for devices installed in the cabinet, and to permit corresponding connections of incoming conductors from remote items of equipment.

i. A key interlock if indicated.

j. A switch-operating handle with provisions for locking in either the open or closed position.

k. Safety devices as necessary to ensure that the load interrupter switch is in the open position whenever unit doors are in the open position.

l. An interface terminal block wired for required exterior connections.

m. Devices specified under specific unit requirements below.

2.5.1.3 Sulfur Hexafluoride (SF6) Interrupter Switchgear

Provide SF6 interrupters of the puffer type where the movement of the contact plunger will initiate the puff of SF6 gas across the contact to extinguish the arc. Switchgear must be provided with a loss-of-pressure alarm remote as shown on the drawings. Before the pressure in the interrupter drops below the point where the interrupter cannot open safely without damage, the switchgear must activate the loss-of-pressure alarm, open automatically, and remain in the locked open position until repaired. The SF6 must meet the requirements of ASTM D2472, except that the maximum dew point must be minus 60 degrees C minus 76 F (corresponding to 11 ppm water by volume), with only 11 ppm water by volume, and the minimum purity must be 99.9 percent by weight. Switchgear must have provisions for maintenance slow closing of contacts and have a readily accessible contact wear indicator. Tripping time must not exceed [3] [5] [8] cycles.

2.5.1.4 Vacuum Circuit Interrupter Switchgear

****

NOTE: See IEEE 37.04 for preferred ratings.

****

Vacuum interrupters must be hermetically-sealed in a high vacuum to protect contacts from moisture and contamination. Switchgear must have provisions for maintenance slow closing of contacts and have a readily accessible contact wear indicator. Tripping time must not exceed [3] [5] [8] cycles.

2.5.1.5 Specific Unit Requirements

****

NOTE: Revise this paragraph and paragraph POWER TRANSFORMERS to include listing of unit items if an articulated primary unit substation is not provided and interrupter switchgear is to be specified. Placing CT's and ammeters/switches in metal-enclosed interrupter switchgear is costly and often leads to additional cubicles. Unlike the metal-clad design which puts grounded metal barriers around bus, switchgear, incoming line, outgoing line, and control sections, metal-enclosed interrupter switchgear is not so compartmentalized. Thus, building a safe compartment for ammeters/switches is not really consistent with the basic design. Ammeter and switch will be located on the secondary main breaker.

****

In addition to basic requirements, switchgear must contain other devices as appropriate to the application and as specified in paragraph SUBSTATION EQUIPMENT.

2.5.2 Devices and Accessories for Switching/Interrupting Equipment

2.5.2.1 Incoming Line

****

NOTE: Delete Items "e" and "f" if not required.

****

Coordinate incoming line units with the requirements of the serving utility, and to the protected transformer, and include the following control and monitoring system items that must be mounted in the instrument and relay cabinet specified below.

a. An ammeter and an ammeter switch.

b. A control switch for local or remote control operation.

c. Microprocessor-based, multi-function overcurrent relay

d. [Microprocessor-based transformer differential relay.]

e. [Single-] [Three-] phase secondary potential test blocks with associated test plug, quantity as shown.

f. [Single-] [Three-] phase secondary current test blocks with associated test plug for [each current transformer circuit] [each three-phase set of current transformers], as indicated.

[g. [_____]]

2.5.2.2 Line Tie

****

NOTE: Delete either 86B or 87B relays if not required.

****

The line tie units must be rated [as indicated] [the same as the incoming line units], and must be electrically or mechanically interlocked with other high-voltage items of equipment as shown. The line tie unit must be equipped with control and monitoring system items the same as described for the incoming line unit. The instrument and relay cabinet must house the same equipment listed for the incoming line unit cabinet except [_____]. The cabinet must also house three bus differential relays, device 87B, and an auxiliary lockout relay, device 86B.

2.5.2.3 Instrument and Relay Cabinet

****

NOTE: The control switch, status lights, metering, and relaying will be located on the secondary metal-clad switchgear; additionally, a control switch, status lights, and a local-remote selector

switch will be mounted at the device. If this equipment cannot be mounted on the secondary metal-clad switchgear, then these devices will be installed in an instrument and relay cabinet adjacent to the operating mechanism cabinet. Transformer differential and differential lockout relays will be located in the metal-clad switchgear. Where there is no metal-clad switchgear, the appropriate material from the paragraph will be included as a part of paragraph SUBSTATION EQUIPMENT.

****

Provide enclosures for housing instruments, relays, and devices specified. Install devices such as instruments, relays, and control and transfer switches in the [metal-clad switchgear lineup where indicated] [an instrument and relay cabinet]. Enclosures must comply with NEMA 250 for Type [3R] [4] [_____], and paragraph CABINETS AND ENCLOSURES. Rigid supports, conduits, fittings, raceways, troughs, must be provided for mounting and connection to the associated equipment. Standard enclosure equipment must include the following:

a. A light connected to a cabinet door-actuated switch, so that the light is energized only when doors are open.

b. A heater continuously energized to prevent condensation within the cabinet over an ambient temperature range of [minus 29] [_____] to [40] [_____] degrees C [minus 20] [_____] to [104] [_____] degrees F. Connect the heater and thermostat contact to a cabinet door-actuated switch, so that the heater is de-energized when the cabinet door or doors are open. High temperature thermal protection must be included.

c. One-pole or two-pole thermal-magnetic molded-case circuit breakers suitable for the operating voltage for heater and light circuits.

d. Devices identified under specific unit requirements hereinafter.

2.5.3 Power Fuse Disconnecting Units

Incoming line power fuse disconnecting units, consisting of power fuses and fuse disconnecting switches, must comply with [_____]. [Expulsion-type] [Current-limiting] power disconnecting units and fuses must have ratings in accordance with IEEE C37.46.

2.5.3.1 Power Fuse Disconnecting Unit Ratings

****

NOTE: For projects where multiple ratings are required for different applications, provide rating requirements on the drawings in tabular form.

****

Power disconnecting units must have ratings [as indicated] [as follows]:

Nominal voltage	[_____]
Rated maximum voltage	[_____]

Maximum symmetrical interrupting capacity	[_____]
Rated continuous current (kA)	[_____]
BIL (Impulse Level)	[_____]

2.5.3.2 Construction

Units must be suitable for outdoor use and must be of the stick (hook) operated, disconnecting, single-pole, single-throw, drop-out type. Fuses must have visible blown-fuse indicators. All ratings must be clearly visible. Units must be suitable for [vertical] [or] [45 degree] [or] [horizontal underhung] mounting [as indicated].

2.5.3.3 E-Rated, Current-Limiting Power Fuses

E-rated, current limiting, power fuses must conform to IEEE C37.46.

2.5.3.4 C-Rated, Current-Limiting Power Fuses

C-rated, current-limiting, power fuses must open in 1000 seconds at currents between 170 and 240 percent of the C rating.

2.5.3.5 Additional Requirements

****

NOTE: Specify three spare fuses for each power fuse current rating. Coordinate this requirement with paragraph EXTRA MATERIALS.

****

Provide at least one fuse tong or other fuse removal and replacement device of sufficient length, and suitable design and voltage rating, for disconnection and replacement of fuses, and where units mounted at different elevations require different lengths, additional devices must be provided as necessary. One set of any special tools, necessary for servicing the unit, must be provided.

2.5.4 Line Switches

2.5.4.1 Ratings

****

NOTE: Preferred ratings are listed in IEEE C37.32, Table 1, but not all ratings may be available for all methods of switching. A short-circuit study is required to specify ratings.

****

Ratings at 60 Hz must be in accordance with IEEE C37.32 and as follows:

Nominal voltage	[_____]
Rated maximum voltage	[_____]

Maximum symmetrical interrupting capacity	[_____]
Maximum asymmetrical interrupting capacity	[_____]
3-Second short time current carrying capacity	[_____]
Rated continuous current (kA)	[_____]
BIL	[_____]

2.5.4.2 Standard Devices and Accessories

One set of special tools, as necessary for servicing, must be provided.

2.5.4.3 Stick (Hook) Operated Line Switches

****

NOTE: Stick (hook) operated switches manufactured especially for bypassing regulators are not listed with a 3-second current rating by manufacturers, but with closed and momentary ratings. Ratings obtainable should be checked with manufacturers. Delete the hook stick requirement for voltage regulator switches if hook sticks are provided for stick operated switches and are of a suitable length.

****

Stick (hook) operated line switches must comply with IEEE C37.32 and must be a stick-operated, single-pole, single-throw, vertical-break switch suitable for [vertical] [or] [horizontal underhung] mounting [as indicated].

2.5.4.4 Group-Operated Line Switches

****

NOTE: Delete switch paragraphs as required. Group-operated line switches are structure-mounted for overhead, incoming-line applications. They may be used for switching and protection of transformers, lines, cables, single-shunt capacitor banks, and line-connected or tertiary connected shunt reactors. Group-operated air-insulated switches are available for voltages from 15 through 345 kV. Group-operated SF6-insulated switches are available for voltages ranging from 15 thru 230 kV. Refer to UFC 3-550-01 for guidance regarding Group-Operated Line Switches.

****

Group-operated line switches must be [air-insulated] [SF6 insulated] with [manual] [and] [motor] -type operators. Group-operated line switches must comply with IEEE C37.32, IEEE C37.30, and IEEE C37.34, and must be three-pole, single-throw, provided with a mechanism which opens the three phases simultaneously. Group-operated switches must be [manually operated] [and] [motor operated] [as indicated].

2.5.4.4.1 Air-Insulated

Air-insulated switches must be of the [vertical-break] [or] [side-break] [or] [indicated-break] type, with either tilting or rotating insulators, for [horizontal upright] [or] [vertical] [or] [horizontal underhung] mounting [as indicated]. Contact surfaces must be silver. The switching capability required must be of the [load interrupter] [or] [disconnecting] type. Switches must be provided with replaceable contacts, arc horns, and other moving parts which have a limited life expectancy.

2.5.4.4.2 SF6-Insulated

Switches must be puffer-type SF6 interrupters. The interrupter must be factory filled with SF6 gas and then permanently sealed. The interrupters must be driven by a single, stored-energy mechanism located at ground level in an operator. The mechanism in the operator must have instantaneous trip-free capability (should the switch be inadvertently closed into a fault).

2.5.4.4.3 Load Interrupter Type, Air-Insulated

Load interrupter switches must be capable of interrupting load currents equal to their continuous current ratings, which meet the requirements of IEEE C37.30.

2.5.4.4.4 Disconnecting Type, Air-Insulated

Disconnecting switches must be provided with quick-break arcing horns rated for interrupting transformer exciting currents or line charging currents, dependent upon the application. A switch used to protect a power transformer must be key-interlocked with its associated transformer's tap changer for de-energized operation (TCDO) and its load side circuit breaker disconnect, so that the manual TCDO can be operated only when the transformer is de-energized, and so that the switch can be only opened or closed after its associated circuit breaker has been placed in the open position. A permanent warning sign having letters at least 50 mm 2 inches high and reading as follows: "WARNING - DISCONNECTING SWITCH - DO NOT OPEN UNDER LOAD" must be mounted on the switch operating mechanism.

2.5.4.4.5 Manually-Operated Type, Air-Insulated

The switch operating handle must be located approximately 1.1 m 3 feet 6 inches above its grounded platform plate. Insulation of the switch operating mechanism must include both insulated interphase rod sections and the insulated vertical shaft.

2.5.4.5 Switch Operators

****

NOTE: Indicate remote control of the motor operator on the project drawings. Delete electrical interlocking if not required. Select stored-energy type operators for use with SF6 interrupters. Delete the requirement for remote telemetry units and SCADA control where not applicable.

****

[Motor operators must be stored-energy mechanisms having a [[24-volt] [48-volt] [125-volt] dc] [120 volt ac], charging motor, with a manual operating mechanism. Opening and closing operating time must be not more than [6] [_____] cycles for each operation.] [Motor operators must be [120-volt] [240-volt] ac, gear-coupled motor operators, with a manual operating mechanism. Opening and closing operating time must be not more than [10] [_____] seconds for each operation.] Operators must be configured so that the switch actuator is padlockable.

2.5.4.5.1 Operation

The operating mechanism must permit both manual and electrical operation of the switch at its operating mechanism cabinet, and electrical operation by the indicated remote control circuitry. The operating shaft or operator cabinet must be clearly and permanently marked to indicate continuously the positions of the switch. An externally operable decoupler must be provided at or near the point of entrance of the shaft into its operator housing so as to permit disengagement of the shaft for inspection, tests, maintenance, or repair of equipment located within the operator enclosure. Where indicated, a switch must be electrically interlocked with [_____] as shown. Switch operators must be provided with remote telemetry units (RTUs) for remote operation and integration with supervisory, control, and data acquisition systems. Systems, components, and equipment must conform to the requirements and recommendations of IEEE C37.1.

2.5.4.5.2 Operating Mechanism Cabinet

A NEMA 250 type [_____] enclosure complying with paragraph CABINETS AND ENCLOSURES must be provided [where indicated] [as suitable for the required operation]. The electrical devices listed below must be rated for the application and must be suitable for the available low-voltage alternating or direct current, [as shown] [specified.] Unless otherwise noted, manufacturer's standard devices for the rating specified must be provided and must include the following:

a. "Trip" and "Close" pushbuttons or switch and position indication lights.

b. A switch-operation counter.

c. Shaft travel limit switches and any required safety devices.

d. A light connected to a cabinet door-actuated switch, so that the light is energized only when doors are open.

e. A heater continuously energized to prevent condensation within the cabinet over an ambient temperature range of [minus 29] [_____] to [40] [_____] degrees C [minus 20] [_____] to [104] [_____] degrees F at 90 percent relative humidity and connected to a cabinet door-actuated switch, so that the heater is de-energized when doors are open. High-temperature thermal protection must be included.

f. An operator charging motor with thermal-overload relays.

g. A motor control contactor, with relays, solenoids, and any other control devices required.

h. Necessary motor-alarm and interlock switches.

i. One-pole or two-pole thermal-magnetic, molded-case circuit breakers suitable for the operating voltage for control, heater, and light circuits.

j. A minimum of eight spare motor operator auxiliary contacts, four normally open and four normally closed, wired to an interconnection terminal block.

k. An interconnection terminal block wired to permit remote open and close operations of the switch and for other required exterior connections.

l. A key interlock if indicated or specified.

m. A local-remote selector switch and position indication lights.

n. Manual trip lever and manual charging handle (in case of loss of control power.

o. "Charged" and "Discharged" indicators for stored energy mechanism.

p. Gas pressure indicator, or low gas pressure indicator.

q. Local/Remote operation selector switch.

2.5.4.6 Grounded Iron Platform Plate

****

NOTE: Provide a detail on the drawings for securing the plate to finished grade.

****

The manually-operated, group-operated switch must be provided with a grounded platform plate located where the switch operator would stand to manually operate the switch. The plate must be constructed of hot-dip galvanized iron at least 6 mm 1/4 inch thick and must be approximately 1.2 m 4 feet in length by 750 mm 2 feet 6 inches in width. The plate must be laid on finished grade and so secured as shown. Two ground clamps must be provided on the plate on the side adjacent to the switch operating mechanism. Each clamp must be connected to the station grounding grid with a No. 4/0 AWG bare copper wire. Separate clamps and a flexible copper braid conductor must be used to connect the plate to the switch operating handle mechanism. The cross sectional area of the braid must be equivalent to a No. 4 AWG conductor, minimum.

2.6 SUBSTATION EQUIPMENT

****

NOTE: Make selections in this paragraph and in paragraph STATION ARRANGEMENT as appropriate for the installation. For this specification an articulated primary unit substation has both high-voltage and low-voltage sections mechanically coupled to the transformer. A primary unit substation has only the low-voltage section mechanically coupled to the transformer. For any given installation, only paragraph Primary Unit Substation or Substation Transformer or Articulate Primary Unit Substation will apply. For voltages through 34.5 kV, the primary switch/breaker should be mechanically-coupled or bus-duct-connected to the transformer primary. For 46 kV and above, the primary circuit breaker/switch should be cable-or

aerial-bus-connected to the transformer primary. In general, the transformer secondary should be mechanically-coupled or bus-duct-connected to the secondary switchgear through and including 34.5 kV.
****

The installation must be [of the switching station] [of the primary unit substation] [of the substation transformer] [an articulated primary unit substation of the [radial] [distributed-network] [spot-network] [secondary-selective] [duplex]] type. [The initial capacity of the substation is based on the [55/65 degrees C] [self-cooled] [single-stage cooled] [two-stage cooled] [transformer capacity shown]]. The number of outgoing [lines] [distribution feeders] must be as shown. Outgoing circuits must be three-phase [three-wire] [four-wire] type [with [a bare] [an insulated] neutral] having a voltage rating of [_____] kV phase-to-phase. The insulated neutral must have insulation rated not less than 1000 volts. Outgoing circuit equipment must be rated for a nominal voltage class of [_____] kV and must have a BIL of not less than [_____] kV. Outgoing circuits must leave the station [aerially] [underground] [in cable trays].

2.6.1 Power Transformer

****
NOTE: Coordinate with paragraph Specific Unit Requirements.

Since some POWER TRANSFORMER manufacturers prefer the use of forced-oil-cooling over forced-air-cooling for the second stage, allow either option. Specify an oil preservation system for self-cooled capacities greater than 5000 kVA. Coordinate load-tap-changing type with Voltage Regulator section of paragraph AUXILIARY SUBSTATION EQUIPMENT.
****

The power transformer must comply with IEEE C57.12.00 and must be of the 55/65 degrees C rise, three-phase, two-winding, mineral-oil-immersed, [load-tap-changing type] and must be [solidly grounded] [resistance grounded through its associated neutral grounding resistor specified below]. [The oil preservation system must be either of the sealed-tank, inert-gas-pressure system as defined in IEEE C57.12.80, or conservator/diaphragm type]. Temperature monitoring, indication, and automatically-controlled cooling equipment must be as specified. The color of the transformer case and auxiliary items must match the color used for switchgear and cabinets as specified for cabinets in paragraph CABINETS AND ENCLOSURES.

2.6.1.1 Ratings

****
NOTE: Standard ratings are listed in IEEE C57.12.10. Refer to UFC 3-550-01 for guidance regarding transformer losses. Coordinate with paragraph FACTORY TESTS. Delete loss requirement when not needed.
****

Transformer losses and impedances must be measured in accordance with IEEE C57.12.90. Ratings at 60 Hz must be in accordance with IEEE C57.12.10 and as follows:

High-voltage winding	[_____] volts
High-voltage BIL	[_____] volts
High-voltage winding connection	[_____]
Low-voltage winding	[_____] volts
Low-voltage BIL	[_____] volts
Low-voltage winding connection	[_____]
Base kVA	[_____]
Percent impedance range	[_____] to [_____]
Maximum no-load (core) losses	[_____]
Maximum full-load (winding) losses	[_____]

2.6.1.2 Auxiliary Cooling Equipment

[Cooling] [Provision for future cooling] equipment must be provided for [single-stage, forced-air-cooling] [two-stage, forced-air-cooling/forced-air-cooling] [or] [forced-air-cooling/forced-oil cooling] utilizing automatic control. Automatic controls, motors, heaters, and their protective devices must be rated for the application and must be suitable for the alternating current available as shown or specified. Radiator isolation valves must be provided for bolted-on radiators. Controls for auxiliary cooling equipment must combine the transformer top oil thermometer, device 26Q, and the transformer winding temperature simulator, device 49, suitable for responding either to the transformer's top liquid or winding temperature, and must include auxiliary devices necessary for sensing temperature changes. These devices must be mounted on the transformer case in a suitable housing so that maintenance is possible without removing the transformer cover or handling oil. Devices 26Q and 49 must have three electrically independent contacts operating and wired as follows:

a. First set of contacts set to close at the manufacturer's recommended setting and wired for starting [future] [first-stage] forced-air-cooled fans.

b. Second set of contacts set to close at the manufacturer's recommended setting and wired to [start the second-stage forced-air-cooling fans] [start pumps for forced-oil-cooling] [alarm terminals in the transformer terminal cabinet] [alarm terminals in the metal-clad switchgear].

c. Third set of contacts set to close at the manufacturer's recommended setting and wired to energize an auxiliary relay, device 49X. The relay must be mounted in the [transformer terminal cabinet] [metal-clad switchgear]. Device 49X must be properly rated and equipped with not less than three normally open and three normally closed sets of electrically independent contacts. One set of contacts must be wired to annunciate excessive transformer temperature.

2.6.1.3 Neutral Grounding Resistor

****

NOTE: Time ratings greater than 10-seconds are required only when the system is not taken off line by a ground fault, but merely monitored.

****

The neutral grounding resistor assembly must comply with IEEE 32and must be [factory-mounted on the associated transformer] [mounted adjacent to the associated transformer] [mounted as indicated]. The assembly must meet the following:

a. The resistor element must be [stainless steel] [cast-iron] and rated [_____] amperes for a [10-second] [1-minute] [10-minutes] [extended time] duty.

b. The resistor must be installed in an aluminized screened or expanded galvanized steel enclosure of the personnel safety type and must be provided with any necessary supports and mounting hardware. The enclosure, including screening and support framing, must have two finish coats applied over a prepared substrate. The color of the finish coats must be the same as the color of the associated transformer.

c. A stress-relief terminator must be provided and arranged to permit the proper termination of the No. [_____] AWG, [_____] [5] [15] kV shielded transformer neutral cable entering the enclosure [from the [bottom] [top]] [as recommended by the manufacturer]. If the terminal bushing is external to the enclosure, the bushing and terminal provisions must be enclosed by a solid metal cable box equipped with conduit fittings correctly sized for the conduit required. An approved type and size of terminal lug must also be provided and arranged for the field termination of the No. 4/0 AWG bare copper grounding cable entering the enclosure from the bottom.

d. One current transformer conforming to the requirements of paragraph INSTRUMENT TRANSFORMERS must be provided and housed in the resistor enclosure. The current transformer must have the ratio shown and be connected as indicated to the associated overcurrent relay, device 51G, located in the [metal-clad switchgear] [instrument and relay cabinet specified above]. The terminals of the current transformer must be wired with not less than No. 10 AWG conductors to the proper terminals of device 51G through a short-circuiting type of terminal block [and test block] located in the [metal-clad switchgear] [instrument and relay cabinet] [transformer terminal cabinet].

2.6.1.4 Load-Tap-Changing Equipment

****

NOTE: The application will determine whether load-tap-changers will be paralleled. System configuration may require reverse power flow equipment. Specify only when required.

****

Load-tap-changing equipment must be provided to provide automatic adjustment of a transformer's low-voltage winding voltage. In addition to the basic load-tap-changing equipment requirements listed in IEEE C57.12.10, the load-tap-changing equipment must include the following:

a. A light wired in series with the control cabinet door-actuated switch, so that the light is energized only when the door or doors are open.

b. A heater continuously energized to prevent condensation within the control cabinet over ambient temperature ranges from [minus 29] [_____] to [40] [_____] degrees C [minus 20] [_____] to [104] [_____] degrees F, with both the heater and thermostat contact wired in series with the control cabinet door-actuated switch, so that the heater is de-energized when doors are open. High-temperature thermal protection must be included.

c. One-pole or two-pole thermal-magnetic molded-case circuit breakers suitable for the control voltage, when required by the manufacturer, and for low-voltage alternating-current power to control devices, motor, heater, and light circuits.

d. Terminal blocks wired for proper interconnection with remote items of equipment.

e. Circulating-current equipment necessary to allow parallel operation of the transformer.

f. Reverse power flow equipment wired so that the load-tap-changer functions only when electric power flows from high-voltage to low-voltage windings in the transformer.

2.6.1.5 Bushings and Equipment Connection Provisions

****

NOTE: A power transformer will require bushings and equipment connection provisions. Substation transformers require only bushings; articulated primary unit substations require only equipment connection provisions.

****

[Bushings] [and equipment connection provisions] [Equipment connection provisions] must be provided as specified for [Primary Unit Substation] [Substation Transformer] [Articulated Primary Unit Substation] in paragraph SUBSTATION EQUIPMENT. Primary and secondary cover bushings for high- and low-voltage line and neutral connections must conform to the requirements of IEEE C57.19.00 and IEEE C57.19.01 and must [have the same BIL as] [be one BIL higher than] the associated power transformer's high- and low-voltage BIL ratings respectively.

2.6.1.6 Accessories

****

NOTE: Delete inapplicable items. Provide devices 63X and 86T when protective device tripping is required. Delete when only an alarm actuation is required.

****

Transformers must be provided with the accessories listed below. Contact devices for remote control features must be rated for the application and must be suitable for the low-voltage ac or dc available, as shown or specified.

a. A tap-changer for de-energized operation (TCDO) provided with padlock provision [and key-interlocked with the disconnecting switch protecting the associated transformer].

b. A liquid-level indicator and relay (device 71L), must be provided with two sets of normally-open and normally-closed contacts, one set for low-liquid-level and the other set for high-liquid-level. The contacts must be rated for the application and wired to one annunciator alarm point.

c. A pressure-vacuum gauge when the transformer is provided with a sealed-tank or inert gas-pressure oil preservation system.

d. Drain and filter valves.

e. Lifting, moving, and jacking facilities.

f. Two transformer case grounding lugs for termination of No. 4/0 AWG bare copper cables.

g. Sudden Pressure Relay: A sudden pressure relay, device 63SPR, must be provided as an integral part of the transformer. A set of contacts of device 63SPR must be [wired to energize an auxiliary relay, device 63X,] [located in the] [transformer terminal cabinet] [metal-clad switchgear] [instrument and relay cabinet]. [A set of contacts of device 63X must be wired to energize the transformer lockout relay, device 86T. In turn, contacts of device 86T must be wired to annunciate abnormal transformer pressure and trip the main secondary breaker and the circuit breaker on the primary side of the faulted transformer.]

2.6.1.7 Miscellaneous Items

****

NOTE: Follow Using Agency policy regarding protective device tripping and annunciation. Show remote control features including any annunciator system connections on the drawings.

****

Miscellaneous items for a transformer must include the following:

2.6.1.7.1 Terminal Cabinet

A weatherproof transformer terminal cabinet for circuits which are connected to devices not mounted integrally on a transformer, but remotely (such as in switchgear units) including interconnection terminals for any future cooling circuits. The gauge of metal for the cabinet must be the manufacturer's standard. Color of the cabinet must match the color of the associated transformer. The door or doors of the cabinet must be equipped with padlocking provisions.

2.6.1.7.2 Connections

Raceway connections and associated interconnection wiring between a transformer terminal cabinet and any remote devices which operate in conjunction with transformer-mounted devices, including necessary wiring for remote control features [and for [future] [cooling circuits]]. Remote control features include the [tripping of associated [primary] [and] secondary circuit breakers] [and] [the actuation of the associated annunciator circuits] by the indicated transformer control or accessory contact.

2.6.1.7.3 Delivery State

The transformer must be shipped from the factory already filled with oil, if possible. If the transformer must be vacuum filled in the field, a four inch NPT nipple, with cap for the vacuum line, must be added to the cover, away from the fill valve.

2.6.2 Primary Unit Substation

****

NOTE: Normally, specify primary unit substations for incoming nominal line voltages of 46 kV or higher.

****

Primary unit substations must comply with IEEE C37.121, must be suitable for outdoor installation, and must consist of transformer section equipment [directly connected] [connected by metal-enclosed bus duct] to outgoing section equipment.

2.6.2.1 Transformer Section Equipment

Transformer section equipment must comply with the requirements for power transformers in paragraph SUBSTATION EQUIPMENT.

2.6.2.2 Outgoing Section Equipment

Outgoing section equipment must comply with the requirements of paragraph OUTGOING METAL-CLAD SWITCHGEAR.

2.6.3 Substation Transformer

****

NOTE: Where single-phase transformers or aerial secondary connections are required, use substation transformer. Where contrary to criteria for new substations, their usage must be justified.

****

Substation transformer must comply with the requirements for power transformers in paragraph SUBSTATION EQUIPMENT.

2.6.4 Articulated Primary Unit Substation

****

NOTE: Normally, specify articulated primary unit substations for incoming nominal line voltages of 35 kV or less.

****

Articulated primary unit substation must comply with IEEE C37.121 and must be of the outdoor [radial] [secondary-selective] [distributed-network] [spot-network] [duplex] type.

2.6.4.1 Incoming Section Equipment

Incoming section equipment must comply with the requirements [for Metal-Enclosed Interrupter Switchgear in paragraph INCOMING SWITCHING/CIRCUIT INTERRUPTING EQUIPMENT.] [in paragraph OUTGOING METAL-CLAD SWITCHGEAR.]

2.6.4.2 Transformer Section Equipment

Transformer section equipment must comply with the requirements for power transformers in paragraph SUBSTATION EQUIPMENT. Primary and secondary equipment connection provisions must be suitable for direct connection to the specified incoming and outgoing switchgear.

2.6.4.3 Outgoing Section Equipment

Outgoing section equipment must comply with the requirements of paragraph OUTGOING METAL-CLAD SWITCHGEAR.

2.6.5 Metal-Enclosed Bus

****

NOTE: Metal-enclosed bus may be necessary between the transformer section and outgoing section for a primary unit substation or where the incoming line section of an articulated primary unit substation is located remote to the power transformer. Provisions for Articulated Primary Unit Substation and Metal-Enclosed Bus in paragraph SUBSTATION EQUIPMENT should be modified as required. Industry standards for continuous, self-cooled, metal-enclosed bus ratings are listed in ANSI C37.23.

****

Metal-enclosed bus must have ratings that equal or exceed the ratings of the buses, circuit breakers, and switchgear to which the bus is connected, unless otherwise indicated. The bus must conform to the requirements of IEEE C37.23. Bus must be of the nonsegregated-phase type. [A ground bus [is] [is not] required.] [A neutral bus [is] [is not] required.] The enclosure is to be the nonventilated type constructed of selected smooth sheet steel not less than [_____] mm gauge, and must be equipped with continuously energized space heaters (with high-temperature thermal protection) to prevent condensation over an ambient temperature range of [minus 29] [_____] to [40] [_____] degrees C [minus 20] [_____] to [104] [_____] degrees F. The finish of the enclosure must be in accordance with the manufacturer's standard. The finish, type, and gauge of the metal enclosure and the details of transitional elements and connections and the lengths and ratings of the bus and enclosure proposed must be as shown on detail drawings.

2.7 OUTGOING METAL-CLAD SWITCHGEAR

****

NOTE: Designer will show on contract drawings the locations of all items specified in other paragraphs that will be located in the metal-clad switchgear. Where two-high units are used, consult manufacturer's literature and catalogs for available options. Ancillary devices such as PTs and metering will not fit in the switch compartment and require a separate compartment or top hat section.

****

Switchgear must comply with IEEE C37.20.2 and must be of the outdoor [no-aisle][protected-aisle][common-aisle] type consisting of incoming line [, tie,] auxiliary compartments and feeder circuit breaker units. Compartments must be provided to accommodate specified or indicated auxiliary equipment. The indicated number of active and [future] circuit breakers and equipped cubicles must be provided.["Future" circuit breaker means sufficient concrete pad space and duct line stubouts for future sections.][The use of two-high circuit breaker units is acceptable.] [Two-high circuit breaker units must be provided.][When two-high circuit breaker units are installed, equipped space units must be provided when necessary to make adjacent sections equal in height.][Units denoted as equipped space or future must consist of fully provisioned space ready for inserting a circuit breaker at a future date without any future modifications. A blank door must close off the front of the compartment.][Current transformers, instruments, instrument switches, and relays must be provided for equipped space or future units as shown.][Continuous current rating of future units must be as indicated.][Continuous current rating of equipped space units must match the most common basic breaker unit ampere rating used elsewhere in the associated switchgear unless otherwise indicated.] Switchgear must be vented according to the manufacturer's standard practice. Intake and exhaust openings must be screened. Switchgear must have relaying as shown. The control voltage must be [120 V ac][240 V ac][24 V dc][48 V dc][125 V dc][250 V dc].

2.7.1 Ratings

****

NOTE: IEEE C37.06, Table 2, lists preferred ratings for indoor oilless circuit breakers. A short-circuit study is required to specify ratings.

****

Main buses must be three-phase [three-wire] [four-wire] with a continuous current rating of [_____] amperes rms. [The neutral bus must be rated for [_____] amperes, continuous.] Switchgear ratings at 60 Hz must be in accordance with IEEE C37.06 and as follows:

Maximum voltage	[_____]
Nominal voltage class	[_____]
BIL	[_____]
Maximum symmetrical interrupting current	[_____]
3-second short-time current	[_____]

Continuous current	[_____][as indicated]

2.7.2 Circuit Breakers

****

NOTE: Cell-mounted switches are seldom needed. Circuits protected by vacuum and SF6 circuit breakers are susceptible to multiple arc re-ignitions and high transient recovery voltages under certain conditions. The designer must evaluate the distribution system and provide surge suppressors or other means recommended by the manufacturer to minimize or eliminate these effects. (Surge suppressors are normally added on the load side of the switch.)

****

Circuit breakers must comply with IEEE C37.04 and IEEE C37.06. Where indicated, bus or lug connections to mount field-installed, slip-on, medium-voltage cable terminations for cable entering from below [and a flanged throat for direct connection to the associated transformer] [and a bus throat for connection to the associated metal-enclosed bus] [and roof bushings for aerial line connections] must be provided. [Roof bushings must [have the same BIL as] [be one BIL higher than] the associated switchgear and must conform to IEEE C57.19.00 and IEEE C57.19.01.] Circuit breakers must be of the [vacuum] [sulfur hexafluoride (SF6)] drawout type having electrically charged, stored-energy mechanisms which are mechanically and electrically trip free. A means for manual charging of each trip mechanism must be provided. Circuit breakers of the same ampere rating must be interchangeable, both mechanically and electrically. [Each circuit breaker must have a cell-mounted switch assembly for control and interlocking.] [Cell switches may be connected either in parallel or in series with control contacts that are used for interlocking, but either connection must permit operation of a circuit breaker when it is in a test position.] In addition to any contacts used or shown, each circuit breaker must be provided with four spare auxiliary [and cell contacts], two normally open and two normally closed, wired to interconnection terminals. If auxiliary relays are used to provide additional contacts, such relays must not be of the latching type. Interconnection terminal blocks must be wired to permit remote open and close operations of each circuit breaker and for other required exterior connections or connections between switchgear sections.

2.7.2.1 Vacuum Circuit Interrupters

Vacuum interrupters must be hermetically-sealed in a high vacuum to protect contacts from moisture and contamination. Circuit breakers must have provisions for maintenance slow closing of contacts and have a readily accessible contact wear indicator. Tripping time must not exceed [3] [5] [8] cycles.

2.7.2.2 Sulphur Hexafluoride (SF6) Interrupters

SF6 interrupters must be of the puffer type where the movement of the contact plunger will initiate the puff of SF6 gas across the contact to extinguish the arc. Breakers must be provided with a loss-of-pressure-alarm remote as shown on the drawings. Before the pressure in the interrupter drops below the point where the breaker or switch cannot open safely without damage, the breaker must activate the loss-of-pressure-alarm, open automatically, and remain in the locked open position until repaired. The SF6 must meet the requirements of ASTM D2472, except that the maximum dew point must be minus 60 degrees C minus 76 degrees F (corresponding to 11 ppm water by volume), with only 11 ppm water by volume, and the minimum purity must be 99.9 percent by weight. Circuit breakers must have provisions for maintenance slow closing of contacts and have a readily accessible contact wear indicator. Tripping time must not exceed [3] [5] [8] cycles.

2.7.3 Buses

Copper bus must comply with ASTM B188. Equivalent aluminum bus must comply with ASTM B317/B317M. Bolted or pressure joints for main and ground buses, interconnections, and external connections to equipment must be of the silver-to-silver or the silver-to-tin high-pressure type. Bolted connections must have a minimum of two bolts, except for the ground bus where one bolt will suffice. Each nut on any bolted connection must be secured with a belleville washer or other locking means torqued in accordance with manufacturer's recommendations. Bus supporting elements must be bolted to switchgear enclosures and must comply with IEEE C37.20.2.

2.7.3.1 Main Buses

Main buses and connections must have at least the same short-circuit current rating as circuit breakers. Buses may be copper or aluminum, but a combination of both metals is not acceptable unless silver-to-silver or silver-to-tin plating is used wherever aluminum and copper buses are connected.

2.7.3.2 Ground Buses

Uninsulated copper ground buses, not less than 51 by 6.2 mm 2 by 1/4 inch in cross-sectional area, must be provided for the full length of a switchgear lineup. Ground buses of aluminum are not acceptable. The short-circuit current rating of the ground bus must be at least equal to the short circuit current rating of the primary bus. Compression indent type cable lugs must be provided at each end of a ground bus for connection of [No. 4/0 AWG] [_____] copper ground cables.

2.7.3.3 Control Buses

****

NOTE: Refer to UFC 3-550-01 for guidance regarding control buses.

****

Control buses must be provided as necessary to supply power to control devices. [Buses must be supplied from low-voltage panelboards. Where one panelboard serves more than one bus, each group of units on each bus must be served by different branch circuit breakers.] For double-ended buses, both buses must be supplied from one low-voltage panelboard and each bus must be served by different branch circuit breakers. The low-voltage panelboard must be served from an automatic transfer [relay] [contactor] [switch], which, in turn, must be served from two control power transformers (CPT). One CPT must be connected via fuses ahead of each main circuit breaker. Each CPT, fuse, transfer device, panelboard, and wiring system must be sized to handle 125 percent of the total load of both buses. The "Normal" and "Backup" sources must be as indicated. Upon the loss of the "Normal" source, transfer to the "Backup" source must be instantaneous. Retransfer back to the "Normal" source must be [automatic upon the restoration of the "Normal" source] [automatic after a [_____] time delay once the "Normal" source is restored]. [The "Normal" and "Backup" source must be selectable.] [An alarm must be provided to indicate a transfer operation.] [An alarm must be provided to indicate loss of a source.] Insulated wire buses must be wired to interface terminal blocks for connection between switchgear units and exterior components. Wire bus must not be less than [No. 8 AWG] [_____], nor less than required to serve the complete switchgear lineup plus 25 percent spare capacity.

2.7.4 Control Power Transformers

****

NOTE: Where an outdoor structure-mounted oil-immersed distribution transformer is used for control power, such as when metal-clad switchgear is not provided, specify requirements using data from Section 33 71 01 ELECTRICAL DISTRIBUTION SYSTEM AERIAL and protect such transformers with power fuse disconnecting units.

****

Control power transformers must comply with IEEE C57.12.01, must be of the ventilated dry type, and must provide [240/120-volt, single-phase] [208Y/120-volt, 3-phase] electric power for station ac control power requirements. The transformer primary voltage rating must be [_____] kV and the transformer capacity must be [_____] kVA [as indicated]. The BIL rating must equal or exceed the BIL rating of the switchgear. Transformer current-limiting primary fuses must be drawout type and must be interlocked with a secondary molded case circuit breaker provided as a part of the transformer installation. Molded case circuit breakers must comply with UL 489. It must not be possible to open the primary fuse compartment unless this secondary circuit breaker is in the open position. Construction must be of the drawout type for either the complete assembly or for primary fuses only, according to the manufacturer's standard. Mechanical interlocks must prevent removal of primary fuses, unless the associated assembly is in a drawout or disconnected position. Transformer compartments must have hinged doors.

2.7.5 SUBSTATION AND SWITCHGEAR PROTECTIVE RELAYS

****

NOTE: Ranges selected will be based on the coordination study. Refer to UFC 3-550-01 and UFC 3-520-01 for guidance regarding protective relays.

****

2.7.5.1 General

[Solid-state] [and] [Electromechanical] [and] [Microprocessor-based] protective relays must be provided as shown and must be of a type specifically designed for use on power switchgear or associated electric power apparatus. Protective relays must conform to IEEE C37.90. Relays and auxiliaries must be suitable for operation with the instrument transformer ratios and connections provided.

2.7.5.2 Construction

Relays must be of the semi-flush, rectangular, back-connected, dustproof, switchboard type. Cases must have a black finish and window-type removable covers capable of being sealed against tampering. Relays must be of a type that can be withdrawn, through approved sliding contacts, from fronts of panels or doors without opening current transformer secondary circuits, disturbing external circuits, or requiring disconnection of any relay leads. Necessary test devices must be incorporated within each relay and must provide a means for testing either from an external source of electric power or from associated instrument transformers. Each relay must be provided with an operation indicator and an external target reset device. Relays must have necessary auxiliaries for proper operation. Relays and auxiliaries must be suitable for operation with the instrument transformer ratios and connections provided.

2.7.5.3 Ratings

Relays must be the manufacturer's standard items of equipment with appropriate ranges for time dial, tap, and other settings. Relay device numbers must correspond to the function names and descriptions of IEEE C37.2.

2.7.5.4 Overcurrent Relays

****

NOTE: Ranges selected will be based on the coordination study. Refer to UFC 3-550-01 and UFC 3-520-01 for guidance regarding protective relays.

****

2.7.5.4.1 Phase Overcurrent Relays for Main [and Tie] Circuit Breakers

Phase overcurrent relays for main [and tie] circuit breakers must be single-phase, nondirectional, [induction] [solid-state] [microprocessor-based] type, time delay, device 51, current taps [[_____] to [_____] amperes] [as indicated] with characteristic curves that are [definite time] [moderately inverse] [inverse] [very inverse] [extremely inverse] [as indicated].

2.7.5.4.2 Ground Overcurrent Relays for Main Circuit Breakers

Ground overcurrent relays for main circuit breakers must be nondirectional, [induction] [solid-state] [microprocessor-based] type, time delay, device [51G wired to a current transformer in the source transformer neutral-to-ground connection] [51N, residually connected], with current taps [[_____] to [_____] amperes] [as indicated] and with characteristic curves that are [definite time] [moderately inverse] [inverse] [very inverse] [extremely inverse] [as indicated].

2.7.5.4.3 Ground Overcurrent Relays for Tie Circuit Breakers

Ground overcurrent relays for tie circuit breakers must be nondirectional, [induction] [solid-state] [microprocessor-based] type, time delay, device 51N, residually connected, with current taps [[_____] to [_____] amperes] [as indicated] and with characteristic curves that are [definite time] [moderately inverse] [inverse] [very inverse] [extremely inverse] [as indicated].

2.7.5.4.4 Phase Overcurrent Relays for Feeder Circuit Breakers

Phase overcurrent relays for feeder circuit breakers must be single-phase, nondirectional, [induction] [solid-state] [microprocessor -based] type, time delay, device 50/51, with instantaneous-current pick-up range [[_____] to [_____] amperes] [as indicated], with time-delay-current taps [[_____] to [_____] amperes] [as indicated] and with characteristic curves that are [definite time] [moderately inverse] [inverse] [very inverse] [extremely inverse] [as indicated].

2.7.5.4.5 Ground Overcurrent Relays for Feeder Circuit Breakers

Ground overcurrent relays for feeder circuit breakers must be nondirectional, [plunger] [solid-state] [microprocessor-based] type instantaneous, device [50GS wired to a ground sensor current transformer] [50N, residually connected], with current pick-up range [[_____] to [_____] amperes] [as indicated].

2.7.5.5 Directional Overcurrent Relays

2.7.5.5.1 Directional Phase Overcurrent Relays

Single-phase, [induction] [solid-state] [microprocessor-based] type with instantaneous units. Phase relays, device 67, must have an instantaneous-current pick-up range [[_____] to [_____] amperes] [as indicated], with time-delay-current taps [[_____] to [_____] amperes] [as indicated] and with characteristic curves that are [definite time] [moderately inverse] [inverse] [very inverse] [extremely inverse] [as indicated].

2.7.5.5.2 Directional Ground Overcurrent Relays

Device 67N, must have an instantaneous-current pick-up range [[_____] to [_____] amperes] [as indicated], with time-delay-current taps [[_____] to [_____] amperes] [as indicated] and with characteristic curves that are [definite time] [moderately inverse] [inverse] [very inverse] [extremely inverse] [as indicated].

2.7.5.6 Automatic Reclosing Relay

Relay, device 79, must be of the three-phase, four-reclosure type, providing immediate initial reclosure, and three time-delay reclosures. Adjustable time delays must be 10 to 60 seconds for reset and 0 to 45 seconds for reclosing. Units must have instantaneous trip lockout after any preset trip or when closing in on a fault. Auxiliary devices must provide for lockout when an associated circuit breaker is tripped after three reclosures and automatically reset when an associated circuit breaker is not tripped after any reclosure.

2.7.5.7 Transformer Differential and Lockout Relays

Differential relays, device 87T, must be of the three-phase or the single-phase high-speed [_____] [percentage] [_____] differential type suitable for the protection of two-winding transformers, and must be provided with a harmonic-restraint feature. Lockout relay, device 86T, must be of the type which, when used in conjunction with the 87T relay, trips and locks out the indicated circuit breakers.

2.7.5.8 Bus Differential and Lockout Relays

Bus differential relay, device 87B, must be of the three-phase or single-phase, high-speed impedance differential type suitable for protection of buses. Lockout relay, device 86B, must be of a type which, when used in conjunction with the 87B relay, trips and locks out the indicated circuit breaker.

2.7.6 Control and Instrument Switches

Control and instrument switches must be of the rotary switchboard type rated for alternating-current operation at 600 volts, or direct-current operation at 250 volts for dc circuits, as applicable. Contacts must be rated for not less than a continuous current of 20 amperes, must be of the silver-to-silver type, and must have positive means for maintaining contact. Each switch must be provided with a black operating handle, and an escutcheon clearly marked to show each operating position. Switch identifications and handle positions must be engraved on escutcheons or may be provided on separate nameplates. Escutcheon engravings must be white on a black background or black on a white background. Instrument switches for potential phase selection must be provided with an oval handle. Ammeter switches for phase selection must have round, notched, or knurled handles and equipped with short-circuiting type of contacts to prevent open-circuiting of current transformer secondary circuits in any position of the ammeter switches. Switches provided for circuit breaker control and local-remote selector switches must have a pistol-grip handle and a mechanical target to indicate the last operating position of the switch. Red and green circuit breaker position indication LED lights must be installed immediately above each circuit breaker switch. Local-remote selector switches must be provided only when shown or specified. Position indication lights must be installed immediately above selector switches, with blue LED lights indicating remote control and amber LED lights indicating local control.

2.7.7 Electrical Indicating Instruments

Electrical indicating instrument relays must comply with ANSI C12.1, NEMA C12.4, and NEMA/ANSI C12.10.[Electrical indicating instruments must be of the semiflush, back-connected, dustproof, direct-reading, switchboard type, approximately 108.0 mm square 4-1/4 inches square, with white dials, black markings, black pointers, and scale arcs of approximately 250 degrees. Cases must have a black finish and shadowproof viewing covers. The accuracy of each instrument must be within 1 percent of full scale. Moving elements must be provided with zero adjustments readily accessible from instrument fronts without disassembly. Each instrument must be accurately calibrated for use with the associated instrument transformers, and must have the indicated scale or a scale suitable for the application, where a specific scale is not indicated. Except for ammeters and voltmeters or unless otherwise specified or approved, the nominal or full-load values must appear at the approximate mid-point, or the 12 o'clock position, of the scales.][Electrical instrumentation devices must be compatible as a system, sealed, dust and water tight, utilize modular components with metal housings and digital instrumentation. Date display must utilize LED or back-lit LCD. Numeral height must be [13 mm 1/2 inch][_____].]

2.7.7.1 Wattmeters

Wattmeters must comply with ANSI C12.1 and NEMA/ANSI C12.10 except for mounting and must be the three-phase, [four-wire type with three current coils and three potential coils] [three-wire type with two current coils and two potential coils].

2.7.7.2 Varmeters

Varmeters must be the center-zero type and provided with integral or separate phase-shifting transformers or compensators. Varmeter must be the three-phase, [four-wire type with three current coils and three potential coils] [three-wire type with two current coils and two potential coils]. Varmeters must have dial markings and be so wired that incoming VAR readings must be to the left of zero and outgoing VAR readings must be to the right of zero. Dials must be so labeled. Meter must be capable of communicating with Lonworks and RS-485 networks.

2.7.7.3 Ammeters and Ammeter Switches

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NOTE: Normally, 3/4 of full-scale should be specified. Mid-scale should be specified when current transformers will be operating at currents exceeding their ratings.

****

Ammeters must be calibrated to indicate full-load current when supplied with a current of 5 amperes. Full-load current must be indicated by the pointer at approximately [mid-scale] [75 percent of the full-scale range]. Ammeter switches must be of the short-circuiting type provided with an off position, wired for indication of current in each phase, and must be provided for each ammeter shown or specified.

2.7.7.4 Voltmeters and Voltmeter Switches

Voltmeters must be provided with expanded scales and calibrated to indicate the nominal [phase-to-phase] [and] [phase-to-neutral] voltages at approximately mid-scale. A voltmeter switch must be provided with an off position, wired for indication of applicable voltages, and must be provided for each voltmeter shown or specified.

2.7.7.5 Demand Registers

Demand registers must comply with NEMA C12.4.

2.7.8 Electrical Recording Instruments

****

NOTE: Recording instruments should be provided when specifically requested by the Using Agency. Coordinate various types and characteristics with the manufacturer.

****

Electrical recording instruments must be of the [direct-acting] [null-balancing] type. Instrument switches must be provided when shown or required to select between different quantities to be recorded, and must comply with the preceding requirements for instrument switches, as applicable.

2.7.8.1 Basic Requirements

Electrical recording instruments must be of the semi-flush, back-connected, dustproof, switchboard and inkless type. The case must have a black finish and shadowproof viewing windows [and, insofar as is practicable, must be of the same size, style, and appearance]. The driving motor must be rated for 120-volt ac operation. Where ungrounded input is required to an instrument, an isolating transformer must be provided. An instrument must have a high visibility scale of a suitable range, and indicating pointer, and an internal fluorescent light for chart illumination. Chart speed must be [20.8] [_____] micrometers/second [3] [_____] inches/hour. An instrument must be correctly calibrated for use on the secondary of any instrument transformer to which it is connected and must have the indicated scale or a scale suitable for the application, where a specific scale is not indicated. Necessary maintenance accessories and a 6-month supply of charts must be provided for each chart-recording instrument. Chart length must be sufficient to permit not less than 30 days of continuous operation at the normal chart speed without the need for replacement.

2.7.8.2 Direct-Acting Type

Direct-acting type instruments must be of the [single-channel,] [two-channel,] strip-chart, self-contained, continuous-marking type with a chart channel calibrated width of not less than 100 mm 4 inches.

2.7.8.3 Null-Balancing Type

****

NOTE: The third and following sentences in this paragraph should also be included in project specifications when a direct-acting type of recorder is to be specified.

****

Null-balancing type instruments must be of strip-chart, self-contained, direct-current potentiometer, periodic-marking type provided with an associated and coordinated transducer for conversion of the measured alternating-current quantity to the direct-current input required for the instrument. Charts must have a calibrated width of not less than 225 mm 9 inches. An instrument must be provided with an internal lamacoid legend plate suitably engraved, a chart supply indicator, a chart tear-off without indices, a rubber chart identification stamp reading the same as the legend plate, a chart reroll, a writing table, and an electric power "ON-OFF" switch. The chart reroll must be self-aligning, smooth in operation, self-contained in the instrument case, and accessible for the changing of chart rolls. The writing table must be located under the uncovered part of the chart between the indicator and reroll in such manner as to permit convenient writing on the chart by merely opening the front hinged cover, and must be designed so that it will not interfere with replacement of charts or access to the recorder mechanism. The chart drive motor must drive the chart through suitable reduction gearing and must have sufficient torque to start the chart when operating on 80 percent of its rated voltage. The motor control switch must be located [within the case so that it can be conveniently reached to start or stop the motor] [_____]. A recorder operation selector switch must be interlocked with its associated medium-voltage circuit breaker to allow either continuous operation of the instrument or automatic isolation of the instrument when the circuit breaker is in the tripped or test position.

2.7.8.4 Transducers

****

NOTE: Transducers will be specified only when remote metering is required.

Watthour, varhour, watt, and varmeters and transducers will be specified as 2, 2-1/2, or 3 element devices as follows:

a. Two element if used on a 3-phase, 3-wire system serving only balanced 3-phase load (requires 2-VTs).

b. Two and one-half element if used on a 3-phase, 3-wire system serving single-phase-to-phase loads (requires 2-VTs)

c. Three element if used on a 3-phase, 4-wire system (requires 3-VTs).

****

Transducers may be integral with an instrument or may be a separate unit and must be of the [unidirectional] [bidirectional] constant-current type providing an analog signal directly proportional to the instantaneous quantity measured. Ratings at 60 Hz must be for a 120-volt nominal input voltage, a 150-volt overload voltage, a 5-ampere nominal input current, a 10-ampere continuous overload current, a 250-ampere 1-second instantaneous overload current, and provide an accuracy of plus or minus 0.5 percent. The maximum individual instrument transformer burden must not exceed 4 volt amperes. Output at full scale must not exceed one mA.

2.7.9 Accumulative Meters

Accumulative type meters must be provided as shown to measure real [and reactive] power consumed, and must be rated for use with instrument transformers shown. [Meters must be equipped with demand pointers.] [Compensators or phase-shifting transformers must be provided for instruments used to measure reactive power.] [Meters must be equipped with detents to prevent negative registration.]

2.7.9.1 Construction

Meters must be of the semiflush, back-connected, dustproof, drawout switchboard type. Cases must have black finish and window-type removable covers capable of being sealed against tampering. Meters must be of a type that can be withdrawn, through approved sliding contacts, from fronts of panels or doors without opening current-transformer secondary circuits, disturbing external circuits, or requiring disconnection of any meter leads. Necessary test devices must be incorporated within each meter and must provide means for testing either from an external source of electric power or from associated instrument transformers.

2.7.9.2 Ratings

****

NOTE: Coordinate with paragraph Transducers.

****

Meters must be [_____]-stator, three-phase, [_____]-wire, [_____] element rated for 120-volt, 2.5 ampere, 60 Hz ac operation calibrated for use with associated instrument transformers. Meters must have primary-rated, direct-reading registers with not less than four dials. The register multiplying factor must be [_____]. Demand meters must have [15-minute] [[_____]-minute] demand registers.

2.7.9.3 Adjustments, Registration Errors, and Other Requirements

Calibrating adjustments for light load and for full load must be of the micrometer type, and adjustable from the front of the meter. Adjustments must be provided for power factor and torque balance. The periphery of the discs must be provided with standard notching to permit direct comparison with a stroboscopic type standard meter. Potential indicating lamps must be provided in the potential coil circuits. The current coils must be capable of withstanding the mechanical and thermal stresses imposed by a current 35 times normal applied for at least 0.5 second. The registration errors of a meter for both unity and 50 percent lagging power factor must not exceed those listed below when tested at rated voltage, frequency, temperature, and full load current, except as otherwise stated.

a. Errors due to applied current must be not more than 1 percent at 10 percent to 50 percent of the rated current and 0.5 percent at 50 percent to 150 percent of the rated current.

b. Errors due to applied potential must be no more than 0.5 percent over a range of plus or minus 10 percent of the rated voltage.

c. Errors due to applied frequency must be no more than 0.004 percent between 59 and 61 Hz.

d. Errors due to a change in ambient temperature must be no more than 0.5 percent over a range of 20 to 40 degrees C 64 to 104 degrees F.

2.7.10 Test Blocks and Accessories

Test blocks and their associated testing accessories must be provided for testing of instruments and protective relays that require periodic testing or calibration in-place, but which are not equipped with integral testing features. Test blocks with covers must be mounted near the base of the switchgear unit beneath the devices to be tested, and must be provided with a nameplate engraved to identify individual current or potential test blocks, or a combination current/potential test block, as applicable. Combination test blocks must not exceed 10 poles. Current test blocks must be the short-circuiting type. Test devices must be provided for insertion into the associated test block to permit application of the proper current or potential source for testing and calibration. Test devices must be rated not less than 20 amperes and 125 volts dc.

2.7.11 Specific Unit Requirements

****

NOTE: Specify devices to be located on a swinging or interior panel for aisleless switchgear and on unit or compartment doors for switchgear provided with interior aisles.

****

In addition to the basic circuit breaker unit requirements, each individual unit or section must contain other devices as required for the application. The following requirements are not to be considered complete in every detail and miscellaneous equipment and devices necessary for correct operation, as indicated or specified, must be provided as necessary. Protective relays, meters, instruments, and control and instrument switches, must be mounted [on a swinging panel located behind the exterior door of no-aisle switchgear] [on a unit or compartment door]. [Where space is not available for these devices, indicated devices may be installed on auxiliary compartment doors as shown.] [Devices specified in paragraph [INCOMING LINE SWITCHING EQUIPMENT] [and paragraph] [SUBSTATION EQUIPMENT] to be installed in the metal-clad switchgear must be located where indicated.]

2.7.11.1 Incoming Line and Transformer Main Secondary Units

****

NOTE: Specify "Incoming Lines" for switching stations and "Transformer Main Secondary" for power transformers.

****

Units must be coordinated with the [requirements of the serving utility] [and] [the transformer to be protected] and must include the following:

a. [Three] [Six] [_____] current transformers.

b. Ammeter and an ammeter switch.

c. [Voltmeter] [Voltmeter, recording type] and a voltmeter switch.

d. Watthour [demand] meter.

e. Wattmeter [, recording type].

f. Varmeter [, recording type].

g. Duplex watt-varmeter, recording type.

h. Watt transducer integral with the associated wattmeter or mounted on the [back of a section door] [interior panel].

i. VAR transducer integral with the associated varmeter or mounted on the [back of a section door] [interior panel].

j. Three overcurrent relays, device 51.

k. Three directional overcurrent relays, device 67.

l. Overcurrent relay, device 51 [N] [G] [connected to the associated transformer neutral [grounding resistor] current transformer].

m. Directional overcurrent relay, device 67N.

n. One three-phase or three single-phase transformer differential relays, device 87T, and an auxiliary lockout relay, device 86T, arranged to trip and to lock out this circuit breaker and the associated transformer primary circuit breaker.

o. One three-phase or three single-phase bus differential relays device 87B, and an auxiliary lockout relay, device 86B, arranged to trip and lock out the associated circuit breaker and other circuit breakers as indicated.

p. [Single-] [Three-] phase secondary potential test blocks with associated test devices, quantity as shown.

q. [Single-] [Three-] phase secondary current test blocks with associated test devices, quantity as shown.

r. Key-interlocking must be provided with the primary disconnecting switch serving the associated transformer.

[s. [_____].]

2.7.11.2 Auxiliary Compartments

****

NOTE: Where switchgear aisle space of sufficient area is available, the station battery installation will be mounted there. Coordinate with NFPA 70 and IEEE C2 for clearances. The designer should indicate the panelboard requirements on the project drawings.

****

Control and instrument transformers and panelboards must be provided and housed in compartments, [unless otherwise noted,] and must supply control power and instrument voltage to each bus section of the switchgear lineup and remote devices as required. Compartments must be provided with a hinged door. Any interconnection wiring and conduit needed to connect the switchgear lineup or other devices requiring control power or instrument voltage must be provided and indicated on the detail drawings. Equipment items must include the following:

a. [Three] [_____] potential transformers.

b. [_____] control power transformers.

c. [_____] low-voltage alternating-current panelboards and [_____] low-voltage direct-current panelboards with main and branch circuits as shown [, located in the switchgear aisle where indicated] [, and with equipment as specified in paragraph AUXILIARY SUBSTATION EQUIPMENT].

[d. [_____].]

2.7.11.3 Bus Tie Unit

[The unit must be electrically interlocked with [incoming line] [transformer main secondary] units as indicated.] [The unit must be provided with [_____].]

2.7.11.4 Feeder Units

Units must be provided for the protection of outgoing feeder circuits and must include the following:

a. [Three] [Six] [Nine] current transformers. [One ground sensor current transformer.]

b. Ammeter and an ammeter switch.

c. Three overcurrent relays, device [50] [51].

d. Ground overcurrent relay, device [50GS] [50N].

e. Wattmeter.

f. An automatic-reclosing relay, device 79.

g. [Single] [Three] phase secondary potential test blocks with associated test devices, quantity as shown.

h. [Single] [Three] phase secondary current test blocks with associated test devices, quantity as shown.

[i. [_____].]

2.7.12 Miscellaneous Items

2.7.12.1 Space Heating and Ventilation

Continuously-energized space heaters (with high-temperature thermal protection) must be installed in each switchgear unit and auxiliary compartment in accordance with the manufacturer's standard practice and must be sized to prevent condensation over an ambient temperature range of [minus 29] [_____] to [40] [_____] degrees C [minus 20] [_____] to [104] [_____] degrees F. Heaters must be controlled by a thermostat [and humidistat] located in the section. [Provide humidistat with a range of 30 to 60 percent relative humidity.] Obtain supply voltage for the heaters from a control power transformer within the switchgear. If heater voltage is different than switchgear voltage, provide transformer rated to carry 125 percent of heater full load rating. Provide transformer with a 428 degrees F220 degrees C insulation system with a temperature rise not exceeding 239 degrees F115 degrees C and conforming to NEMA ST 20. [Energize electric heaters in switchgear assemblies while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source. Provide temporary, reliable external power source if commercial power at rated voltage is not available on site.] Aisle ventilation fans must be provided where indicated and must be sized to provide at least 10 air changes per hour. Fans must be wired to three-way switches located at each end of the switchgear aisle and adjacent to aisle lighting switches. In addition, fans must be thermostatically controlled to turn fans on when interior temperatures exceed 40 degrees C 104 degrees F.

2.7.12.2 Aisle Lighting

LED luminaires must be a manufacturer's standard fixture installed in the switchgear aisle to provide a maintained lighting intensity level of 538.2 lux 50 footcandles at floor level in the aisle and on faces of units and compartments. Luminaires must be wired to three-way switches located at each end of the switchgear aisle. Light fixtures must be lensed vapor tight type fixtures.

2.7.12.3 Duplex Receptacles

Duplex receptacles must be installed on each end wall of the switchgear aisle and at approximately 1.8 m 6-foot intervals along the exterior wall of the aisle. Receptacles and receptacle plates must be ivory in color. Receptacles must be the two-pole, three-wire, grounded type rated at 20 amperes and 125 volts, NEMA WD 1 configuration 5-20R.

2.7.12.4 Lighting and Appliance Branch Circuit Panelboards

Lighting and appliance branch-circuit panelboards for the protection of the indicated low-voltage circuits must be located as specified or indicated and must conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ratings of panelboard mains must be compatible with the supply voltage to the panelboard. Circuit breakers in a direct-current panelboard must be rated for [48] [125] volts dc operation.

2.7.13 Accessories

Accessories must be provided for the inspection, testing, maintenance, and repair of circuit breakers, and must include one set of any special tools, as necessary to repair and maintain circuit breakers and major switchgear components. Maintenance and testing accessories must include, but are not limited to the following:

a. Portable gear motor for electric-power positioning of circuit breakers, if required by the breaker design.

b. Secondary test coupler for testing of drawout circuit breakers in the test position.

c. Hand crank for positioning of circuit breakers.

d. Transfer truck, for movement of circuit breaker units.

e. Test cabinet for closing and tripping of circuit breakers by electrical control operations.

f. Lifting and transfer device for two-high circuit breaker units.

2.7.14 Finish Color

Finish color of the switchgear must comply with the requirements for cabinets specified in paragraph CABINETS AND ENCLOSURES.

2.8 INSTRUMENT TRANSFORMERS

2.8.1 General

Instrument transformers must comply with NEMA/ANSI C12.11 and IEEE C57.13. Instrument transformers must be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers must be visually evident and shown on drawings.

2.8.2 Current Transformers

****

NOTE: See UFC 3-550-01 regarding guidance on current transformers. Accuracy class ratings of current transformers (CTs) at standard burdens are listed in IEEE C57.13. The minimum standard current transformer accuracies for metal-clad switchgear are listed in IEEE C37.20.2. In general, NEMA/ANSI

C12.11 requires a 0.3 accuracy class for up to a B-0.5 burden, except for some 200 and 400 ampere units. Where metering current transformers are provided, this accuracy class should be specified, if available for the ampere rating and burden needed. A "C" classification means the ratio error can be calculated, whereas a "T" classification is one which has to be derived by testing. IEEE C37.20.2 permits either classification up to the indicated ratings.

****

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers must have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers must have the indicated ratios. The continuous thermal-current rating factor must be not less than [1.0] [1.2] [1.5] [2.0] [3.0] [4.0]. Other thermal and mechanical ratings of current transformers and their primary leads must be coordinated with the design of the circuit breaker and must be not less than the momentary rating of the associated circuit breaker. Circuit protectors must be provided across secondary leads of the current transformers to prevent the accidental open-circuiting of the transformers while energized. Each terminal of each current transformer must be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.

2.8.2.1 Current Transformers for Power Transformers

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NOTE: IEEE C57.12.10, Table 20 gives recommended values.

****

[Single-ratio] [Multi-ratio] bushing type current transformers must be provided in circuit breaker bushing wells as indicated. [Single-ratio units must have a minimum metering accuracy class rating of [0.6B-0.5] [0.3B-0.5].] [Multi-ratio units must have a minimum relaying accuracy voltage class of [_____] for either a C or T classification.]

2.8.2.2 Current Transformers for Metal-Clad Switchgear

Single-ratio units, used for metering and relaying, must have a metering accuracy class rating of [_____] [B.____]. Single-ratio units, used only for relaying, must have a relaying accuracy class rating of [_____] for [either] a C [or T] classification.

2.8.2.3 Current Transformers for Kilowatthour and Demand Metering

****

NOTE: Use the following guidelines for specifying current transformers.

1. Select the standard current transformer (CT) primary rating which is just below the full load current of the serving power transformer, i.e., for a 500 kVA transformer with a full load of 1387 amps at 208 volts - select a 1200/5 CT ratio; for a 750 kVA transformer with a full load of 902 amps at 480

volts - select a 800/5 CT ratio.

2. Select a continuous-thermal-current rating factor (RF) in accordance with the following table:

RATIO	RF at 30 degrees C
200/5	4.0
300/5	3.0
400/5	4.0
600/5	3.0
800/5	2.0
1200/5	1.5
1500/5	1.5
2000/5	1.5
3000/5	1.33

3. Select an ANSI Metering Accuracy Class in accordance with the following table:

Primary Amp Rating (of CT)	Accuracy Class
200	0.3 thru B-0.1
300-400	0.3 thru B-0.2
600-1200	0.3 thru B-0.5
1500	0.3 thru B-0.9
2000-3000	.3 thru B-1.8

****

Current transformers must conform to IEEE C57.13. Provide current transformers with a metering accuracy Class of 0.3 through [_____], with a minimum RF of [_____] at 30 degrees C, with 600-volt insulation, and 10 kV BIL. Size current transformers as indicated. Provide butyl-molded window type current transformers mounted [on the transformer low-voltage bushings. Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on ammeters.] [in the current transformer cabinet.]

2.8.3 Voltage Transformers

****

NOTE: See UFC 3-550-01 for guidance regarding voltage transformers. Minimum standard potential transformer accuracies for metal-clad switchgear are not listed in IEEE C37.20.2. Accuracy classes as listed in IEEE C57.13 are 0.3, 0.6, and 1.2. Standard burdens for each accuracy class are W, X, Y, Z, ZZ, and M. The designer should check the burdens connected to determine the actual accuracy class and burden required. In general, NEMA/ANSI C12.11 requires 0.3 accuracy class for up to Y burdens, except for voltages of 5 kV and below. Where metering potential transformers are provided, a 0.3 accuracy class should be specified, if available for the voltage rating and burden needed.

****

Voltage transformers must have indicated ratios. Units must have an accuracy class rating of [_____]. Voltage transformers must be of the drawout type having current-limiting fuses in both primary and secondary circuits. Mechanical interlocks must prevent removal of fuses, unless the associated voltage transformer is in a drawout position. Voltage transformer compartments must have hinged doors.

2.9 AUXILIARY SUBSTATION EQUIPMENT

2.9.1 Voltage Regulator

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NOTE: Bypass arresters are normally standard equipment. Incoming line arresters may not be needed. Coordinate with manufacturer.

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Voltage regulators must comply with IEEE C57.15 and must be of the outdoor, self-cooled, 55/65 degrees C temperature rise, [single-phase] [three-phase] station-type. Two single-phase units connected in open-delta are not acceptable. Windings and the load-tap-changing mechanism must be mineral-oil-immersed. When operating under load, a regulator must provide plus and minus 10 percent automatic voltage regulation in approximately 5/8 percent steps, with 16 steps above and 16 steps below rated voltage. Automatic control equipment must provide Class 1 accuracy. Bypass surge arresters must be suitable for [a grounded] [an ungrounded] system and for the associated regulator voltage. [Station] [Intermediate] class surge arresters must be mounted next to each incoming line bushing on a regulator tank-mounted bracket and connected to a surge arrester ground pad-mounted on the regulator tank.

2.9.1.1 Ratings

Ratings at 60 Hz	
Maximum voltage	[_____]
BIL	[_____]

Ratings at 60 Hz	
Current	[_____]

2.9.1.2 Bypass and Isolation Switches

Switches must be of the outdoor, stick-operated, single-pole, single-throw, vertical-break type suitable for the indicted mounting. One switch stick of adequate length must be provided. Switches must be of a type designed to provide bypass of a single-phase regulator circuit by an integral sequence which always occurs when each switch is opened or closed. Each opening sequence must initially bypass the single-phase regulator circuit, then open the input and output circuits, and finally interrupt the exciting current. Opening any single-phase regulator circuit must not be possible until after the bypass circuit is closed. Unless the voltage regulator is equipped with integral line surge protective devices, [surge protectors must be mounted across terminals of each switch rated up to 25 kV.] [station-class surge arresters must be provided to protect each phase of 35 kV switches.] Ratings at 60 Hz must be in accordance with IEEE C37.41 and as follows:

Maximum voltage	[_____]
Nominal voltage class	[_____]
BIL	[_____]
Momentary asymmetrical current in the closed position	[_____]
Momentary asymmetrical current in the bypass position	[_____]
Continuous and interrupting current	[_____]

2.9.1.3 Miscellaneous

Standard accessories and components in accordance with IEEE C57.15 must be provided. The regulator subbase must elevate the lowest live part of the regulator to a height of at least 2.7 m 9 feet above the concrete pad on which it is mounted. Single-phase units must be provided with additional components and accessories required by IEEE C57.15 for three-phase units.

2.9.2 Station Battery

****

NOTE: Normally, an 8-hour requirement will be sufficient. Indicate required annunciator system connections on the project drawings. Coordinate battery types and characteristics with the manufacturer.

****

The station battery installation must include a battery, battery racks, a battery charger, and protective equipment. The station battery installation must be housed [in the metal-clad switchgear] [where indicated].

2.9.2.1 Battery

Submit calculations for the battery and associated charger indicating the basis used in defining loads, selecting cell types, and determining the battery ampere-hour capacity and physical size. Provide calculations to determine capacity for the battery charger to be similar to those shown in the Appendix to IEEE 485, including explanatory data. Calculations for the battery-charger must demonstrate that the output voltage and current provided are adequate to comply with the preceding requirements. The battery must consist of the required number of [lead-calcium] [nickel-cadmium] cells interconnected with proper connectors provided by the battery manufacturer to provide a nominal battery rating of [48] [125] volts. Rubber or plastic numerals, of at least 25 mm 1 inch in height, must be provided by the battery manufacturer for field attachment to permit proper cell identification. The battery must have an ampere-hour capacity equal to at least 125 percent of the station's direct-current requirements including normal continuous loads plus intermittent loads. Normal continuous load capacity must be adequate for an [8-hour] [_____] period. Intermittent load capacity must be adequate so that at least [three] [_____] openings and [three] [_____] closings of each of the station's associated circuit breakers [and motor-operated] [switches] can occur in [an 8-hour] [_____] period with no more than [three] [_____] circuit breaker [or switch] units simultaneously operating. Battery circuits must be ungrounded. Batteries must have a 20-year minimum life and a 5-year no cost replacement warranty.

2.9.2.2 Battery Racks

Battery racks must have welded steel frames and rails finished with two coats of paint of a color matching the battery charger enclosure. Racks must be no more than two tiers high and top tiers must be low enough to permit maintenance to be done by personnel standing at floor level. Rails must have a top covering of plastic or rubber at least 1.6 mm 1/16 inch thick. Paint, rubber, and plastic must resist corrosion and action of the electrolyte. The installation must be provided with a portable hydrometer syringe and thermometer. Where recommended by the manufacturer, the installation must include a cell lifter.

2.9.2.3 Battery Charger

The battery charger must comply with UL 1236 and must be a constant voltage, filtered, voltage-regulated, fully automatic type rated for full-float charging of the associated battery. The battery charger must be convection cooled and suitable for operation on electric power supplied from the associated low-voltage alternating-current panelboard, must have adequate capacity to fully recharge the associated depleted battery in not more than [8 hours] [_____] while supplying normal direct-current loads, and must have an efficiency of not less than 90 percent. The battery charger must have input and output circuit breakers which automatically disconnect the battery charger when faults occur. The battery charger must have an output ammeter and voltmeter, and equalizing-float selector switch, and an equalizing timer with a range of 0 to 24 hours. The battery charger enclosure must be painted as specified for indoor cabinets in paragraph CABINETS AND ENCLOSURES and must be provided with wall mounting brackets or must be free-standing as required by its size and weight. A relay for sensing loss of alternating-current input, and an adjustable relay for sensing that the battery charger output voltage has fallen to a pre-set level, must be installed on the battery charger to actuate the associated annunciator circuits. DC ground detector LED lights must be provided.

2.9.2.4 Protective Equipment

Protective equipment required by IEEE 484 must be provided and installed in a free-standing cabinet mounted where indicated or directed. The cabinet must conform to paragraph CABINETS AND ENCLOSURES. Water facilities required must be of the portable type consisting of one 18.9 liter 5 gallon tank and one 946.4 milliliter (1 quart) 1 quart basin. The tank must have a removable screw top and a spigot. The basin must be suitable for rinsing eyes or skin in case of acid spillage.

2.9.3 Illumination

****

NOTE: Insert the appropriate pages from CE Standard Detail 40-06-04 into this specification. Add references used in 40-06-04 to paragraph REFERENCES.

****

Luminaires, ballasts, lamps, and control devices required for [general area] [and] [_____] lighting [, including floodlighting] must be in accordance with sheet [_____] sheets [_____] of Standard Detail No. 40-06-04, attached to these specifications.

2.9.4 Annunciator System

****

NOTE: Indicate component malfunctions requiring annunciation on the drawings. One station visual indication light should normally be located at each of the four corner points of the fence enclosure.

****

The annunciator system must consist of the station's audible [and visual] indicator and an annunciator cabinet. The cabinet must house an annunciator drop for each component malfunction indicated plus a system pushbutton and flasher and must be located in [the metal-clad switchgear aisle] [where indicated]. [[_____] spare drops must be included.] Electrical devices required must be rated for the application and must be suitable for the low-voltage alternating-current available as shown or specified. Auxiliary devices must be provided as necessary for correct operation.

2.9.4.1 Station Audible and Visual Indication

One station horn [and the indicated number of station red alarm lights] must be installed where shown. The station horn must be weatherproof and must be of the resonating type having an audible output of not less than 100 dB at 3.1 m 10 feet. Station lights must be LED type with guards and red globes, must be UL listed as enclosed and gasketed for use in wet locations, and must be of a style suitable for the indicated mounting. A horn silencing relay must be wired in series with the horn so that, after an adjustable time delay of 5 to 15 minutes, the horn must be silenced. Necessary auxiliary devices provided in conjunction with the horn must permit signaling to a remote central point.

2.9.4.2 Operating Modes

The system must be wired so that when the component being monitored by an annunciator is operating correctly, the associated annunciator relay actuates the normal mode, and when the component malfunctions, the associated annunciator relay actuates the alert mode. During normal mode no part of the system must be energized by the associated annunciator relay. Upon equipment malfunction, the alert mode must energize the system flasher which must turn the associated annunciators lights on and off, and sound the station horn, including turning on the station exterior visual indication lights. Depressing the station pushbutton must turn off the horn, the station visual indication lights, and the flasher, but must leave the associated annunciator lights on. Correction of a malfunction must automatically return the alarm system to the normal mode for the associated annunciator relay. Turning the system pushbutton during a normal mode must simulate an alert mode for all annunciator relays so that correct operation of annunciator lamps, the station exterior visual indication lights, the system flasher, and the station horn can be checked.

2.9.4.3 Annunciators

Annunciators must comply with ISA 18.1 and must be solid-state logic, modular, hermetically sealed, plug-in relays each with two integral long-life lamps for backlighting a white translucent nameplate window of not less than 75 by 75 mm 3 by 3 inches. Nameplates must have black letters at least 3 mm 1/8 inch in height and the inscription must match the indicated malfunction description.

2.9.4.4 Other Requirements

The annunciator cabinet must be suitable for the indicated location and must conform to requirements specified herein for cabinets. The flasher frequency must be between 1 and 5 Hz. The system pushbutton must be provided with a nameplate inscribed "PUSH TO SILENCE" and "TURN TO TEST."

2.10 CABINETS AND ENCLOSURES

Cabinets and enclosures must comply with NEMA 250 and must be of galvanized steel, must be provided with hinged doors, and must be suitable for indoor or outdoor installation as indicated. Where locations are not indicated, cabinets must be suitable for outdoor installation. Thickness of metal and outdoor construction must be in accordance with UL 50. An indoor cabinet exterior must have one finish coat and an outdoor cabinet exterior must have two finish coats. Finish color must be ANSI 61 light gray. The finish color of outdoor equipment must be the same unless otherwise approved. Finish coats must be applied over a prepared substrate. Each cabinet must be a freestanding type or may be supported by attachment to an enclosure fence or a switchgear interior wall where located adjacent thereto. A concrete pad must be provided to support any outdoor cabinet whose base extends to within 75 mm 3 inches of grade level and pads must extend at least 100 mm 4 inches below grade.

2.11 MISCELLANEOUS

2.11.1 Low-Voltage Power Circuit Breakers

2.11.1.1 Power Circuit Breakers

2.11.1.1.1 Construction

Low-voltage power circuit breakers must conform to IEEE C37.13, and IEEE C37.16, and must be three-pole, single-throw, stored energy, [manually][electrically] operated, with drawout mounting. Solid-state trip elements which require no external power connections must be provided. Circuit breakers must have an open/close contact position indicator, charged/discharged stored energy indicator, primary disconnect devices, and a mechanical interlock to prevent making or breaking contact of the primary disconnects when the circuit breaker is closed. Control voltage must be [24 V dc][48 V dc][125 V dc][120 V dc][as indicated]. The circuit breaker enclosure must be suitable for its intended location.

2.11.1.1.2 Ratings

Voltage-ratings must be not less than the applicable circuit voltage. Circuit breakers must be rated for 100 percent continuous duty and must have trip current ratings and frame sizes as shown. Nominal voltage ratings, maximum short-circuit interrupting ratings must be in accordance with IEEE C37.16. Tripping features must be as follows:

a. Long-time current pick-up, adjustable from 50 percent to 100 percent of sensor current rating.

b. Adjustable long-time delay.

c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.

d. Adjustable short-time delay.

[e. Short-time I square times t switch.]

f. [e][f]. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

g. [f][g]. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap must not be permitted. [Zone-selective interlocking must be provided as indicated.]

h. [g][h]. [Fixed] [Adjustable] ground-fault delay.

[i. [h][i]. Ground-fault I square time t switch.]

j. [h][i][j]. [Overload] [and] [Short-circuit] [and] [Ground-fault] trip indicators must be provided.

2.11.1.2 Molded-Case Circuit Breakers

UL 489 and UL 489.

2.11.2 Wiring

Wiring between separate items of station equipment must conform to the requirements of Section [33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION] [33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION]. Solid wiring may be used for convenience outlets, heating elements, and lighting circuits. Otherwise, the minimum class of stranding must be Class C. Class K stranding must be used for wiring between items of equipment mounted on swinging panels or doors and items mounted on fixed panels or parts of fixed assemblies. The insulation type must be the type SIS unless otherwise specified, indicated, or proposed and approved for use. The minimum wire gauge must be No. 14 AWG, except No. 18 AWG may be used for circuits that use one ampere or less. Circuits rated less than 115 volts ac or 125 volts dc may be wired with wiring rated 300 volts-to-ground. Otherwise, all wiring must be rated for 600 volts ac and 250 volts dc Current transformer circuit wiring must be not less than No. 10 AWG. Wiring for Close and Trip circuits must be not less than No. 8 AWG. Wire markers must be affixed to each end of wires and must contain wire number or designations shown on contract or detail drawings, or as otherwise approved. Wire numbers must also be permanently marked on terminal block marking strips where wires are connected. Only insulated-barrel, crimp-type, ring lugs must be used.

2.11.3 Single-Line Electrical Diagram

A single-line electrical diagram of the station must be provided. The diagram must be enclosed between matte-surface thermoplastic sheets buttoned or otherwise suitably fastened together to allow easy access to the diagram for making any future changes. The diagram must be suitable for outdoor mounting and must be approximately 350 by 525 mm 14 by 21 inches unless another size is approved. The diagram must be attached with temperature- and moisture-resistant, pressure-sensitive adhesive or with other suitable means to the indicated location at the metal-clad switchgear lineup, except when otherwise shown or directed.

2.11.4 Liquid Dielectrics

Liquid dielectrics for transformers, capacitors, reclosers, and other liquid-filled electrical equipment must be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids must not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 Trichlorobenzene (TCB) fluid must not be used. Liquid dielectrics in retrofitted equipment must be certified by the manufacturer as having less than 50 parts-per-million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D923 and have tests performed in accordance with ASTM D4059at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding 50 ppm must be replaced.

2.11.5 Danger Signs

One danger sign inscribed "DANGER-HIGH VOLTAGE" must be permanently and securely mounted approximately 1.5 m 5 feet above finished grade on each outward side of the fence enclosure. Fasteners must be of stainless steel. Signs must be of metal and must have letters of at least 75 mm 3 inches in height. Voltage warning signs must comply with IEEE C2.

2.11.6   Concentric-Lay-Stranded Conductors

Copper conductors must comply with ASTM B8 for soft drawn copper. Equivalent aluminum conductors must comply with ASTM B231/B231M.

2.11.7   Conduits, Rigid Metal

Conduits must comply with UL 6.

2.11.8   Hardware

Ferrous metal threaded items must comply with ASTM A153/A153M and miscellaneous nonthreaded items must comply with ASTM A123/A123M. Other equivalent protective treatment, as required by ASTM A123/A123M or ASTM A153/A153M, or ferrous metals designed to meet ASTM Standards covering corrosion-resisting steel, will be permitted if approved in writing.

2.11.9   Padlocks

Padlocks must comply with Section 08 71 00 DOOR HARDWARE

2.11.10   Panelboards, Circuit-Breaker Type

Panelboards must comply with NEMA PB 1, UL 50 and UL 67.

2.12   GROUNDING AND BONDING

2.12.1   Driven Ground Rods

Ground rods must be [copper-clad steel conforming to UL 467] [zinc-coated steel conforming to IEEE C135.30] [solid stainless steel] not less than 15.9 mm 5/8 inch in diameter by 3.1 m 10 feet in length [of the sectional type].

2.12.2   Grounding Conductors

Grounding conductors must be bare, except where installed in conduit with associated phase conductors. Insulated conductors must be of the same material as the phase conductors and green color-coded, except that conductors must be rated no more than 600 volts. Bare conductors must be ASTM B8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

2.13   SURGE ARRESTERS

Surge arresters must comply with NEMA LA 1, and IEEE C62.11, and must be provided as indicated. Arresters must be [station][intermediate][distribution] class, rated as shown.[Arresters for use at elevations in excess of 1.8 km 6000 feet above mean sea level must be specifically rated for that purpose.] Arresters must be equipped with mounting brackets for the indicated installations. Arresters must be of the [valve][or][metal-oxide varistor][or][combination valve-metal-oxide varistor] type suitable for outdoor installations.

2.14   COORDINATED POWER SYSTEM PROTECTION

****

NOTE: The requirement for the studies in this section depends on the complexity and extent of the power system. Delete this requirement for: projects

of limited scope; projects having protective devices which are not adjustable or for which coordination is not possible (standard molded case circuit breakers); projects involving simple extension of 600 volt level service to a building or facility from an existing transformer (750 kVA or less); or projects involving simple extension of 600 volt level service to a building or facility from a new transformer (750 kVA or less).

The designer will be responsible for showing and specifying the requirements for fuses, circuit breakers, protective relays, or other protective devices associated with the project. The protective devices should be selected and specified to protect electrical power system conductors or equipment against sustained overloads, in-rush conditions, electrical faults, or other abnormal power system or equipment operating conditions, in accordance with UFC 3-520-01, IEEE 242, and IEEE Std 141.

The complexity and extent of coordinated power system protection depends on the type of buildings or facilities or utilities required, on the load demand of facilities, and on the quantity and types of facilities to be constructed. Facilities having a relatively-low power demand (e.g., 2,500 kVA or less) generally require protection of: an incoming aerial distribution line or underground medium-voltage feeder; low-voltage feeders to individual items of equipment, or to power distribution equipment; and branch circuits. More complex projects such as facilities with generating capacity, large motors, or larger load demands, will require more detailed and extensive coordinated power system protection.

Independent of the type or types of facilities or load demands, the coordinated power system protection will be based on: economics, simplicity, and the electrical power availability dictated by the Using Agency or Service, or by the functional use of the facilities or utilities; required to provide maximum power service with a minimum of power interruptions; and the operating speed of protective devices required to minimize damage to electrical components or items of equipment and to prevent injury to personnel and nuisance tripping.

Unless otherwise approved, a dc power source will be shown and specified to ensure proper closing and tripping of protective devices which require a reliable power source during outage of the normal alternating-current power source.

****

Analyses must be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for equipment ratings, coordination, and protection. They must include a load flow analysis, a fault current analysis, and a protective device coordination study. The studies must be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. Provide a list of references complete with points of contact, addresses, and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.14.1 Scope of Analyses

The fault current analysis, and protective device coordination study must begin at: [the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.] [the source bus and extended through the secondary side of transformers for medium voltage distribution feeders.] [the source bus and extend through [outgoing breakers] [outgoing medium voltage feeders, down to the individual protective devices for medium voltage radial taps] [outgoing medium voltage feeders, through the secondary side of transformers] [as indicated] for main electric supply substations.] [the nearest upstream device in the existing source system and extend through the downstream devices at the load end.]

2.14.2 Determination of Facts

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NOTE: Require the Contractor to obtain an available fault capacity at the power source or provide a fault capacity on which he is to base his analysis. Delete the unused option.

****

The time-current characteristics, features, and nameplate data for each existing protective device must be determined and documented. [Coordinate with the [commercial power company] [_____] for fault current availability at the site.] [Utilize the fault current availability indicated as a basis for fault current studies.]

2.14.3 Single Line Diagram

A single line diagram must be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device, or transformation point must have a unique identifier. If a fault-impedance diagram is provided, impedance data must be shown. Locations of switches, breakers, and circuit interrupting devices must be shown on the diagram together with available fault data, and the device interrupting rating.

2.14.4 Fault Current Analysis

2.14.4.1 Method

The fault current analysis must be performed in accordance with methods described in IEEE 242, and IEEE 399.

2.14.4.2 Data

Actual data must be utilized in fault calculations. Bus characteristics and transformer impedances must be those proposed. Data must be documented in the report.

2.14.4.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line, and line-to-ground fault current values must be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location must be shown in tabular form on the diagram or in the report.

2.14.5 Coordination Study

Submit Coordination Study along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed must be based on recommendations of this study. The Government will not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and procured prior to approval of the study. The study must demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study must include a description of the coordination of the protective devices in this project. Provide a written narrative that describes: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost changes (addition or reduction) must be provided. Composite coordination plots must be provided on log-log graph paper.

2.14.6 Study Report

a. The report must include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. The study must include descriptive and technical data for existing devices and new protective devices proposed. The data must include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

c. The report must document [utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings;] [and] [existing power system data including time-current characteristic curves and protective device ratings and settings.]

d. The report must contain fully coordinated composite time-current characteristic curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report must include recommended ratings and settings of all protective devices in tabulated form.

e. The report must provide the calculations performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number must be provided.

2.15 FACTORY TESTS

****

NOTE: Delete tests that are not applicable to the project. Refer to UFC 3-550-01 for guidance. Tests must be justified. Delete transformer losses test when losses are not specified.

****

Factory tests must be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer must be notified at least [10] [_____] days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

2.15.1 Power Transformer

Manufacturer's standard [routine] [design] [and] [other] tests in accordance with IEEE C57.12.00. Reduce full-wave, chopped-wave, and full-wave impulse test on each line [and neutral] terminal, in accordance with IEEE C57.98. Tests for transformer losses in accordance with IEEE C57.12.90.

2.15.2 High-Voltage Circuit Breakers

Manufacturer's standard tests in accordance with IEEE C37.09 and IEEE C37.081.

2.15.3 High-Voltage Air Switches

Manufacturer's standard tests in accordance with IEEE C37.34 and IEEE C37.41.

2.15.4 Protective Relays

Seismic tests in accordance with IEC 60255-21-3. Surge withstand tests in accordance with IEEE C37.90.1.

2.15.5 Relaying Current Transformers

Manufacturer's standard tests in accordance with IEEE C57.13.

2.15.6 Instrument Current Transformers

Manufacturer's standard tests in accordance with IEEE C57.13.

2.15.7 Voltage Regulators

Manufacturer's standard tests in accordance with IEEE C57.15.

2.15.8 High-Voltage Fuses

Manufacturer's standard tests in accordance with IEEE C37.41.

2.15.9 Neutral Grounding Resistor

Manufacturer's standard tests in accordance with IEEE 32.

2.15.10 Electrical Power Insulators

Manufacturer's standard tests in accordance with ANSI C29.1.

2.15.11 Factory Test Submittal Package

Submit [6] [_____] copies of the information described below in 215.9 by 279.4 mm 8-1/2 by 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections must be separated by heavy plastic dividers with tabs.

a. A list of all equipment used, with calibration certifications.

b. A copy of all measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of all adjustments made.

2.16 SUBSTATION AUTOMATION AND CONTROLS

The substation must be Supervisory Control and Data Acquisition (SCADA) ready. Input/output (I/O) modules connected to the substation equipment gathers the field data, including, but not limited to, status of switches, circuit breakers, transformers, batteries, voltage magnitudes, current magnitudes, power factor, real power, apparent power. RTUs collect I/O data and transfer that data to the remote master unit and operator interface panel via network interface modules. All components must be suitable for use in the environment in which the substation is located. The SCADA system will be used to monitor and control the following substation components, provide suitable sensors and auxiliary switches as required for each component to be monitored or controlled.

a. Circuit breaker monitoring of breaker position (i.e. open, closed or tripped).

b. Circuit breaker remote control (i.e. open or close).

c. Station Battery alarm point monitoring.

d. Substation alarm monitoring.

e. Load interrupter switch monitoring of switch position.

f. Load interrupter switch SF6 gas density monitoring.

g. Transformer oil and winding temperatures.

2.16.1 Remote Terminal Units (RTU’s)

RTUs consist of real-time programmable logic controllers (PLCs) which are responsible for properly converting substation information to digital form to transmit the data and also convert the received signals from master units in order to control the process equipment through actuators and switchboxes. Provide RTU’s that have a direct connection with various sensors, meters and actuators associated with the substation.

2.16.2 Master Terminal Units (MTUs)

A central host server referred to as a Master Terminal Unit, is SCADA system central point of control. It communicates with RTUs by performing reading and writing operations during scheduled scanning. In addition, it performs control, alarming, networking with other nodes.

2.16.3 Communications System

The communication network transfers data among central host computer servers and the field data interface devices and control units. The medium of transfer can be cable, radio, telephone, satellite or any combination of these.

2.16.4 Operator Interface Panel

The operator interface panel consists of standard HMI (Human Machine Interface) touchscreen panel The operator interface panel displays all data captured at the input/output (I/O) modules and allows for controlled of each device that is interfaced with the SCADA system. The operator interface panel must be mounted on the substation assembly in a dedicated controls cubicle.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and notify the Contracting Officer of any discrepancy before performing any work.

3.2 GENERAL INSTALLATION REQUIREMENTS

Install and energize equipment and devices in accordance with the manufacturer's published instructions. Submit installation procedures for station buses and insulators, station structures, transformers, switchgear, battery system, voltage regulators and grounding resistors, as a minimum. Procedures must include diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment. Circuits installed in conduits or underground and splices and terminations for medium-voltage cable must conform to the requirements of Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Secondary circuits installed in conduit on poles must conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2.1 Conformance to Codes

The installation must comply with the requirements and recommendations of NFPA 70 and IEEE C2.

3.2.2 Concrete Foundations

3.2.2.1 Structure Foundation Installation

Bolt each column to a concrete foundation by at least four bolts spaced to transmit structure stresses to the foundation. Diameters and lengths of foundation bolts must be as recommended by the structure manufacturer. Embed bolts in concrete in a manner to develop their full strength. Anchor bolts must be accurately set in foundations using templates supplied by the structure manufacturer. When concrete has cured, structure baseplates must be leveled and grouted in place. Columns must then be set on baseplates, leveled on foundations, and secured with holding nuts. Concrete work and grouting must comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.2.2 Concrete Pads

****

NOTE: Do not allow rectangular holes in the concrete pad if rodent intrusion is a problem. Specify concrete pad reinforcing requirements.

****

Construct concrete pads for pad-mounted electrical equipment as indicated. Tops of concrete pads must be level and must project four inches above finished [floor] [paving or grade] and sloped to drain. Set conduits for primary, secondary, and grounding conductors in place prior to placing of concrete pads. Concrete work must comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

a. If the equipment primary compartment is not of sufficient height to allow the installation of the medium-voltage terminators, load break elbows or switches, provide adequate space by providing a rectangular hole in the concrete pad below the primary compartment [and][or] a factory prefabricated steel adjustment ring around the entire perimeter of the base of the equipment. Steel rings must be factory manufactured to fit the base of the equipment of which they support and must be factory painted to match the equipment enclosure. Steel base rings must be constructed using the same or greater thickness of steel as the equipment being supported.

b. Concrete pads to support pad mounted electrical equipment must be reinforced [with [_____] mm inch steel reinforcing rods at [_____] mm inches, on center, each way] [_____]. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves must be installed through the concrete to provide physical protection. When the installation is complete, seal all conduit and other entries into the equipment housing with an approved sealing compound. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, and foreign matter.

3.2.3 Fencing

****

NOTE: Designer will provide detail for fence grounding.

****

The station must be enclosed by chain-link fence as shown. Fencing is specified in Section 32 31 13 CHAIN LINK FENCES AND GATES and must be grounded in accordance with paragraph GROUNDING.

3.2.4 Surface Treatment

Horizontal spaces between concrete foundations or pads and fences must be excavated to minimum depth of [150] [_____] mm [six] [_____] inches below finished gradelines, must be graded to level surfaces, and filled with well-compacted clean coarse gravel or crushed stone of 13 to 38 mm 1/2 to 1-1/2 inches in size up to finished gradelines.

3.2.5 Spare Accessory Storage

A cabinet must be provided for storage of equipment accessories as necessary, including spare fuses, fuse tongs, switch sticks, and other tools and located where indicated. Shelves or other appropriate supporting methods must provide an individual space for each type of item stored.

3.2.6 Fire Extinguisher Storage

An outdoor cabinet for housing a Government-provided, hand-operated, self-expellent, carbon dioxide fire extinguisher of 4.5 to 6.8 kg 10 to 15 pounds capacity for Class C fires must be provided and located as approved. The cabinet must have a glass cover door and be painted red.

3.2.7 Field Welding

Procedures and welders must be qualified in accordance with AWS D1.1/D1.1M for structural welding and ASME BPVC SEC IX for welding of equipment. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.3. Notify the Contracting Officer 24 hours in advance of tests; perform the tests at the work site if practical. The Contracting Officer must be provided with a copy of qualifying procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record. [Structural members must be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.] Gas-metal arc welding must be performed by welders certified to perform gas-metal arc welding.

3.2.8 Connections to Utility Lines

****

NOTE: This paragraph will be further developed to suit the conditions of any connections required to the serving utility's lines.

****

Coordinate the work with the Contracting Officer and provide final connections to the [utility] [installation] electric lines.

3.2.9 Disposal of Liquid Dielectrics

PCB contaminated dielectrics must be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility. Furnish certification of proper disposal. Contaminated dielectric must not be diluted to lower the contamination level.

3.3 EQUIPMENT INSTALLATION

****
NOTE: Delete ANSI reference if transformer is less than 10 MVA or not liquid-filled. Specify phase sequence in accordance with the local practice.
****

3.3.1 Transformer Stations

Install transformer stations in accordance with IEEE C57.93, fence-enclosed type and mounted on concrete pads. Three-phase transformer installations must be installed with [_____] phase sequence. Primary taps must be set in accordance with the coordination study.

3.3.2 Equipment Finishes

Equipment must be carefully installed so as not to scratch finishes. After installation, finished surfaces must be inspected and scratches touched up with a finish provided by the manufacturer especially for this purpose.

3.3.3 Supports

Install enclosures and enclosure supports in accordance with manufacturer's instructions. Supports must consist of anchored channels leveled and then embedded in the concrete foundation. Channels, anchors, shims, or other leveling items must be installed in accordance with the recommendations of the equipment manufacturer.

3.3.4 Switchgear Leveling

After leveling items are correctly installed, switchgear lineups must be out-of-plumb by not more than 6 mm 1/4 inch for the entire length and width. Insertion or withdrawal of removable elements must be easily accomplished, and component devices must operate properly after the switchgear assembly is completely installed.

3.3.5 Incoming Line Surge Arresters

Surge arresters of the [station] [intermediate] type must be provided on each phase of each incoming line circuit, and mounted on station structures as shown.

3.3.6 Transformer Surge Arresters

Surge arresters of the [station] [intermediate] type, suitable for [a grounded] [an ungrounded] system and for the associated transformer primary line-to-ground voltage, must be mounted next to each high-voltage bushing on a transformer tank-mounted bracket and connected to a surge arrester ground pad. Discharge counters must be provided and mounted on the brackets.

3.4 ELECTRICAL BUS CONNECTIONS

All connections to aluminum bus must be cleaned and coated with an inhibitor in accordance with manufacturer's recommended methods. All bolted connections must be torqued to the correct tightness. Establish a checklist to insure that bolted connections have been properly coated and correctly torqued. All welded connections on aluminum buswork must be by the gas metal-arc welding process. The shield inert gas must be argon. The welder must be certified for gas metal-arc welding.

3.5 GROUNDING

****

NOTE: The designer will investigate soil resistivity and other factors in accordance with IEEE 80 and will specify and detail the grounding in accordance with UFC 3-550-01 and IEEE 80.

****

A grounding grid, consisting of the indicated configuration of bare copper conductors and driven ground rods must be installed as shown on the drawings. Grounding grid must comply with IEEE 80. Equipment frames of metal-enclosed equipment, medium-voltage cable terminations, chain-link fencing, metal-structures, and other noncurrent-carrying metal items must be connected to the ground grid as shown. At least two connections must be provided from [a power transformer,] [a switchgear ground bus,] [an oil circuit breaker enclosure,] [and] [a grounded iron platform plate] to the ground grid. Fences must be grounded at each fixed gate post, each corner post, and at intermediate posts as indicated. Each gate section must be bonded to its gate posts with a 3.2 by 25.4 mm 1/8 by 1 inch flexible braided copper strap and ground post clamps. Fence ground clamps must be of a type that inhibits corrosion between metal parts. Outriggers must be grounded as shown.

3.5.1 Grounding Electrodes

****

NOTE: Modify or delete paragraphs in accordance with project requirements.

****

3.5.1.1 Driven Rod Electrodes

Unless otherwise indicated, ground rods must be driven into the earth until the tops of the rods are approximately one foot below finished grade.

3.5.1.2 Grid Grounding Electrodes

A grid grounding electrode must be installed as shown consisting of bare copper conductors installed [300 mm] [450 mm] [600 mm] [12] [18] [24] inches, plus or minus 75 mm 3 inches, below the finished top of soil grade. Grid conductors must be bonded to all rod electrodes, and to all other intersecting grid conductors. Grid conductors must be sized as indicated.

3.5.2 Grounding and Bonding Connections

Connections above grade must be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade must be made by the fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose must be used.

3.5.3 Grounding and Bonding Conductors

****

NOTE: Grounding and bonding conductors will be sized based on the thermal requirements of IEEE 80.

****

Grounding and bonding conductors include all conductors used to bond transformer enclosures, equipment frames and structural members to the grounding grid. Grounding and bonding conductors must be sized as shown. After being located to provide maximum physical protection, exposed grounding conductors must be securely attached to structural supports at not more than two foot intervals with suitable fasteners. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete should be avoided. When concrete penetration is necessary, nonmetallic conduit must be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening must be sealed with a suitable compound after installation.

3.5.4 Surge Arrester Grounding

****

NOTE: Provide a "detail" for surge arrester grounding. For ungrounded and single-grounded systems modify paragraph in accordance with IEEE C2 and UFC 3-550-01.

****

Surge arresters and neutrals must be bonded directly to the transformer enclosure and then to the grounding grid with a bare copper conductor, minimum size [4/0] [as shown]. Lead lengths must be kept as short as practicable with no kinks or sharp bends.

3.6 TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period will consist of a total of [_____] hours of normal working time and must start after the system is functionally completed but prior to final acceptance tests. The course instruction must cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions must demonstrate all routine maintenance operations.

a. Submit [6] [_____] copies of operation and maintenance manuals, within [7] [_____] calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

b. Manuals must also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements must also be included. Documents must be bound in a binder marked or identified on the spine and front cover. A table of contents page must be included and marked with pertinent contract information and contents of the manual. Tabs must be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare-parts data. Index sheets must be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

c. Submit a digital video recording of the entire training session and three additional copies of the instructions manual within 30 days following the approval of the manuals.

3.7 FIELD TESTING

****

NOTE: Select types to suit project conditions and delete all others. Delete all paragraphs not applicable. Tests must be justified.

****

3.7.1 General

a. Submit a detailed description of the Contractor's proposed procedures for onsite tests submitted [20] [30] [_____] days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan must consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

b. Field testing must be performed in the presence of the Contracting Officer. Notify the Contracting Officer [_____] days prior to conducting tests. Furnish all materials, labor, and equipment necessary to conduct field tests. Perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. Maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results.

c. All field test reports will be signed and dated by the Contractor. Submit [6] [_____] copies of the information described below in 215.9 by 279.4 mm 8-1/2 by 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections must be separated by heavy plastic dividers with tabs.

(1) A list of all equipment used, with calibration certifications.

(2) A copy of all measurements taken.

(3) The dates of testing.

(4) The equipment and values verified.

(5) The condition specified for the test.

(6) The test results, signed and dated.

(7) A description of all adjustments made.

(8) Final position of controls, and device settings.

3.7.2 Safety

Provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. Replace any devices or equipment which are damaged due to improper test procedures or handling.

3.7.3 Ground-Resistance Tests

The resistance of [each grounding electrode] [each grounding electrode system] [the grounding grid] must be measured using the fall-of-potential method defined in IEEE 81. Soil resistivity in the area of the grid must be measured concurrently with the grid measurements. Ground resistance measurements must be made before the electrical distribution system is energized and must be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems must be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

Single rod electrode	[25] [_____] ohms
Grid electrode	[_____] ohms

3.7.4 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. Notify the Contracting Officer [_____] hours before the site is ready for inspection.

3.7.5 Liquid-Filled Transformer Tests

Perform the following field tests on all liquid-filled transformers [[_____] kVA and above].

a. Insulation resistance test phase-to-ground.

b. Turns ratio test.

c. Correct phase sequence.

d. Correct operation of tap changer.

[e. [_____].]

3.7.6 Dry-Type Transformer Tests

Perform the following field tests on all dry-type transformers [[_____] kVA and above].

a. Insulation resistance test phase-to-ground.

b. Turns ratio test.

[c. [_____].]

3.7.7 Circuit Interrupter Switchgear Tests

Perform the following field tests on circuit interrupters.

a. Insulation resistance test phase-to-phase.

b. Insulation resistance test phase-to-ground.

c. Closed contact resistance test.

d. Power factor test.

e. High-potential test.

f. SF6 dielectric test for SF6 interrupters in accordance with ASTM D2472.

g. Manual and electrical operation of the switchgear.

3.7.8 Protective Relays

Protective relays must be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests must include pick-up, timing, contact action, restraint, and other aspects necessary to insure proper calibration and operation. Relay settings must be implemented in accordance with the coordination study. Relay contacts must be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers must be field tested in accordance with IEEE C57.13.

3.7.9 Operating Tests

After the installation is completed, and at such time as the Contracting Officer may direct, conduct operating tests for approval. The equipment must be demonstrated to operate in accordance with the requirements herein. Submit an operating test report in accordance with paragraph TEST REPORTS.

3.8 MANUFACTURER'S FIELD SERVICE

3.8.1 Installation Engineer

After delivery of the equipment, furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment. Submit a detailed description of the Contractor's proposed procedures for onsite tests.

3.8.2 Pre-Energization Services

Calibration, testing, adjustment, and placing into service of the installation must be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience. No part of the electrical system must be energized until all station grounding components have been tested and demonstrated to comply with the specified requirements. The following services must be performed on the equipment listed below. These services must be performed subsequent to testing but prior to the initial energization. The equipment must be inspected to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at station buses and at major equipment must be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations must be inspected to detect possible damage caused during installation. If factory tests were not performed on completed assemblies, tests must be performed after the installation of completed assemblies. Components must be inspected for damage during installation or shipment and to verify that packaging materials have been removed. Components capable of being both manually and electrically operated must be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested must be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services must be provided include, but are not limited to, are the following:

Battery, station.
Breakers, circuit.
Bus, metal-enclosed.
Buses, station aerial.
Regulator, step-voltage.
Substation, primary unit.
Substation, primary unit, articulated.
Switches, disconnect [with] [without] power fuses.
Switches, air-break.
Switchgear, metal-clad.
Switchgear, metal-enclosed interrupter.
Transformers, substation.

3.9 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation material or operation have been corrected.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 11 16 (November 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 11 16 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-26 11 16 (November 2021)**

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SECTION 26 11 16

SECONDARY UNIT SUBSTATIONS

11/21

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NOTE:

1. This guide specification covers the requirements for three phase secondary unit substations for step-down operation at primary voltages of 601 volts through 38 kilovolts, and secondary voltages, of 600 volts or less.

2. When feasible, provide a separate liquid-filled pad-mounted transformer outside of the facility and a separately erected switchboard/switchgear assembly inside the respective facility in lieu of a secondary unit substation. For NAVFAC LANT projects, do not use secondary unit substations with secondary current greater than 5000 amperes.

3. For NAVFAC LANT projects, where the available fault current is less than 12,000 amperes rms symmetrical, provide pad-mounted switchgear with a fault interrupting switch-way as the transformer primary protection device in lieu of a load interrupting switch. Clearly indicate requirements for identifying signage at switch-ways and at the transformer.

USE THE FOLLOWING RELATED GUIDE SPECIFICATIONS FOR POWER DISTRIBUTION EQUIPMENT:

--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
--Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
--Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION
--Section 26 13 00 SF6/HIGH-FIREPOINT FLUIDS INSULATED PAD-MOUNTED SWITCHGEAR
--Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION
--Section 26 22 00.00 10 480-VOLT STATION SERVICE

SWITCHGEAR AND TRANSFORMERS
--Section 26 23 00 LOW VOLTAGE SWITCHGEAR
--Section 26 24 13 SWITCHBOARDS
--Section 26 28 00.00 10 MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS
--Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION
--Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: This section utilizes the following energy cost and loss value tables. Graphics/Tables files contain all graphics/tables for the specification.

NOTE: To download UFGS Forms, Graphics, and Tables, go to: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Do not include list of tables, or tables themselves, in project specifications. Use tables to obtain values required in PART 2 of the specification.

For NAVFAC SE facilities use table US-2.

TABLE NUMBER	TITLE
US-1	Transformer Loss & Impedance Data - for Energy Cost (EC) Less Than or Equal to $0.04 (2 pages)
US-2	Transformer Loss & Impedance Data - for Energy Cost (EC) Greater Than $0.04 and Less Than or Equal to $0.08 (2 pages)
US-3	Transformer Loss & Impedance Data - for Energy Cost (EC) Greater Than $0.08 and Less Than or Equal to $0.12 (2 pages)
EC-1	Energy costs at NAVFAC LANT Activities (2 pages)

****

****

NOTE: The following information shall be shown on the project drawings:

1. Single-line diagram showing transformers, buses, and interrupting devices with interrupting capacities; current transformers with ratings; instruments and meters required; and description of instruments and meters.

2. Location, space available, arrangement and elevations of unit substations.

3. Grounding Plan.

4. Type and number of cables, size of conductors for each power circuit, and point of entry (top or bottom).

5. Transformer primary and secondary voltages. (Use IEEE C57.12.00, Table 11(b), "Designation of voltage ratings of three-phase windings".) State the primary voltage (nominal) actually in service and not the voltage class.

6. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gases; and seismic requirements.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering
ANSI Z540.1	(1994; R 2002) Calibration Laboratories and Measuring and Test Equipment - General Requirements

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM D117	(2018) Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D2472	(2000; R 2014) Standard Specification for Sulphur Hexafluoride
ASTM D3487	(2016; E2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus
ASTM D6871	(2017) Standard Specification for Natural (Vegetable Oil) Ester Fluids Used in Electrical Apparatus

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.121	(2012) American National Standard for Switchgear-Unit Substations - Requirements
IEEE C57.12.00	(2021) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.01	(2020) General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.12.50	(1981; R 1998) Ventilated Dry-Type Distribution Transformers, 1 to 500 kVA, Single-Phase, and 15 to 500 kVA, Three-Phase, with High-Volt 601 to 34,500 Volts
IEEE C57.12.51	(2019) IEEE Guide for Mechanical Interchangeability of Ventilated Dry-Type Transformers
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2021) Test Code for Liquid-Immersed Distribution, Power, and Regulating

	Transformers
IEEE C57.12.91	(2011) Standard Test Code for Dry-Type Distribution and Power Transformers
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests
IEEE C57.124	(1991; R 2002) Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO ISO/IEC 17025	(2017) General Requirements for the Competence of Testing and Calibration Laboratories

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.4	(1984; R 2011) Registers - Mechanical Demand
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 712-C-98-075	(1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
EPA 821-R-02-012	(2002) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.

****

Section 26 08 00 APPARATUS INSPECTION AND TESTING, Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, and 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

Include the bracketed paragraph for Navy projects for NAVFAC SE or NAVFAC LANT.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

[In addition, submit in accordance with paragraph COORDINATED SUBMITTAL REVIEWS herein.

]1.4.1 Coordinated Submittal Reviews

****

NOTE: Include bracketed items "a" and "b" for NAVFAC LANT and NAVFAC SE projects. Choose the bracketed option "DC44" or "CI46" for NAVFAC LANT projects, and "074" for NAVFAC SE projects. For other projects, submittal review shall be performed by the designer of record. If submittal review by NAVFAC LANT or NAVFAC SE is specifically desired, the responsible Government agency must coordinate with the respective Code DC44, CI46, or 074 during the design process. Add appropriate information in Section 01 33 00 SUBMITTAL PROCEDURES to coordinate with the special requirements. For NAVFAC LANT, submit liquid-filled transformers to DC44 and dry-type transformers to CI46.

****

[a. Submit transformer submittals to Code [[DC44][CI46], Atlantic] [074, Southern] Division, Naval Facilities Engineering Systems Command for approval. In addition, submit one set of the remaining substation components for surveillance.

][b. Submit remaining substation component submittals to Engineer of Record for approval. In addition, submit one set of transformer submittals for surveillance and to insure alignment of equipment and coordination for interconnections.

] SD-02 Shop Drawings

Unit Substation Drawings; G, [_____]

[Transformer Drawings (to Code [[DC44][CI46]] [074]); G, [_____]

] Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams must identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings must indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals must include the nameplate data, size, and capacity. Submittals must also include applicable federal, military, industry, and technical society publication references.

SD-03 Product Data

[Fuse Curves; G, [_____]

] **

NOTE: Use bracketed options referring to Codes DC44 or CI46 for NAVFAC LANT and to Code 074 for NAVFAC SE projects. This requires the designer of record to review and approve the substation equipment submittals except for the transformer. The EFD will review and approve the transformer submittals. For NAVFAC LANT submit liquid-filled transformers to DC44 and dry-type to CI46.

****

Secondary Unit Substation[Excluding Transformer Data]; G, [_____]

[Unit Substation Transformer (Liquid-filled) (to Code [DC44][074]); G, [_____]

][Unit Substation Transformer (Dry-type) (to Code [CI46][074]); G, [_____]

] Submittal must include manufacturer's information for each component, device, and accessory provided with the transformer.

SD-06 Test Reports

Acceptance Checks and Tests; G, [_____]

SD-07 Certificates

Paint Coating System; G, [_____]

Transformer Efficiencies; G, [_____]

SD-09 Manufacturer's Field Reports

Load Interrupter Switch Production Tests; G, [_____]

Unit Substation Transformer Design Tests (Liquid-filled)[(to Code [DC44][074])]; G, [_____]

Unit Substation Transformer Routine and Other Tests (Liquid-filled)[(to Code [DC44][074])]; G, [_____]

****

NOTE: For dry-type transformers, use the following bracketed options. Delete the previous three options for liquid filled transformers along with their associated subparagraphs in the paragraph SOURCE QUALITY CONTROL.

****

[Unit Substation Transformer Design Tests (Dry-type)[(to Code [CI46][074])]; G, [_____]

][Unit Substation Transformer Routine and Other Tests (Dry-type)[(to Code [CI46][074])]; G, [_____]

] SD-10 Operation and Maintenance Data

Unit Substations, Data Package 5; G, [_____]

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G, [_____]

Equipment Test Schedule[(to Code [[DC44 for Liquid-filled Units][CI46 for Dry-type Units]] [074])]; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Drawing Requirements

1.5.1.1 Unit Substation Drawings

Drawings must include, but are not limited to the following:

a. An outline drawing, with dimensional plan view, elevation, foundation plan and side views showing incoming, transformer, and outgoing sections.[Include [switchboard][switchgear] information from Section[26 28 00.00 10 MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS][26 23 00 LOW-VOLTAGE SWITCHGEAR][26 24 13 SWITCHBOARDS] as part of the total unit substation.]

b. One-line diagram showing all components and their ratings.

c. Elementary diagrams and wiring diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.

d. Three-line diagram showing bus configuration, bus rating and overcurrent protective devices.

[e. Provisions for future extension[and future forced air equipment].

][f. Time-current characteristic fuse curves (on full size logarithmic paper) for the load interrupter switch fuse.

]1.5.1.2 Transformer Drawings

Drawings must include, but are not limited to the following:

a. An outline drawing, with front, top, and side views.

b. ANSI nameplate data.

1.5.2 Paint Coating System

Submit IEEE C57.12.29 coating system performance requirement tests. When interrupter switchgear and transformer are provided by two different manufacturers, each one must provide certification.

1.5.3 Transformer Efficiencies

****

NOTE: Use this paragraph for oil-filled transformers. Also use this paragraph for dry-type transformers on NAVFAC LANT projects.

****

Submit certification from the manufacturer indicating conformance with the paragraph SPECIFIED TRANSFORMER EFFICIENCIES".

1.5.4 Substation Product Data

Submittal must include manufacturer's information for each component, device, and accessory provided with the equipment.

1.5.5 Test Reports

Submit report of acceptance test results as specified by paragraph FIELD QUALITY CONTROL.

1.5.6 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.7 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.7.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.7.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site must not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Assembled Operation and Maintenance Manuals

Manuals must be assembled in durable, hard covered, water resistant binders. The manual must be assembled and indexed in the order noted in a table of contents. The contents of the assembled operation and maintenance manuals must be as follows:

a. Manufacturer's O&M information required by the paragraph, SD-10 OPERATION AND MAINTENANCE DATA.

b. Catalog data required by the paragraph, SD-03 PRODUCT DATA.

c. Drawing required by the paragraph, SD-02 SHOP DRAWINGS.

d. Price for spare parts and supply list

e. Routine and field acceptance test reports

1.6.2 Operation and Maintenance Data

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

1.7 WARRANTY

The equipment items must be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be secondary unit substations and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SECONDARY UNIT SUBSTATION

Secondary Unit substations must comply with IEEE C37.121 regardless of the kVA rating specified. Substation must consist of [one][_____] incoming section[s], [one][_____] transformer section[s], and [one][_____] outgoing section[s].[Substation must be designed for outdoor service with ventilation openings and gasketing provided to ensure a weatherproof assembly under rain, snow, sleet, and hurricane conditions.] Substations must be subassembled and coordinated by one manufacturer and must be shipped in complete sections ready for connection at the site. Where practicable, substation must be shipped as one unit. External doors must have provisions for padlocking. Bus bars and conductors must be copper.

2.2.1 Incoming Section[s]

The incoming section must consist of [a metal-enclosed interrupter switchgear section] [an air-filled terminal chamber] for connecting the incoming circuit [directly] [through a [fused] [non-fused] load interrupter switch] [vacuum circuit breaker] to the transformer. Circuit breaker and switch operating mechanisms must be serviceable items and be accessible from the front. Protective relays, controls, current transformer, voltage transformer and miscellaneous accessories shall be located in low voltage compartments. Operation of the switchgear must not be affected by opening the low voltage compartment doors. If required for proper connection and alignment, include a transition section with the incoming section.

2.2.1.1 Incoming Section Enclosure

****

NOTE: If medium voltage breakers are required for the main protective device, add information from Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION for Navy projects and Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION for other projects.

****

The incoming section enclosure must be NEMA ICS 6 Type [3R][1][_____][as indicated][, fabricated entirely of type 304 or 304L stainless steel].[Bases, frames and channels of enclosure must be corrosion resistant and must be fabricated of [type 304 or 304L stainless steel][or][galvanized steel]. Base must include any part of enclosure that is within 75 mm 3 inches of concrete pad.][Galvanized steel must be ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable.] Paint enclosure, including bases, ASTM D1535 light gray No. 61 or No. 49. Paint coating system must comply with IEEE C57.12.29.

2.2.1.2 Cable Terminations

****

NOTE: Select insulated high-voltage connectors only when connecting directly to a dead-front transformer without using a load interrupter switch.

****

[Provide medium voltage cable terminations as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

][IEEE 386. Insulated High-Voltage Connectors. Connectors must have steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

****

NOTE: Coordinate with connector and bushings specified in transformer section. If available fault is greater than 10,000 rms symmetrical amperes or if cable size is greater than No. 4/0 AWG, do not use 200 ampere loadbreak connectors.

****

[a. 200 ampere loadbreak connector ratings: Voltage: [15kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Short time rating: 10,000 rms symmetrical Amperes.

] **

NOTE: For NAVFAC LANT projects, provide 600 ampere connectors with 200 ampere bushing interface.

****

[b. 600 ampere deadbreak connector ratings: Voltage: [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Short time rating: 40,000 rms symmetrical amperes.[Connectors must have 200 ampere bushing interface[for surge arresters][as indicated].]

] **

NOTE: Include the following paragraph only when the activity requires additional grounding elbows and feed-thru inserts.

****

[c. Provide one set of three grounding elbows[and one set of three feed-thru inserts] for each secondary unit substation. Grounding elbows and feed-thru inserts must be delivered to the contracting officer.

]]2.2.1.3 Surge Arresters

****

NOTE: Surge arresters should be located at both the riser pole (where applicable) and at the equipment. Specify surge arrestors at the riser pole in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION. Dead front surge arresters are only available as distribution class. Substations utilizing station class arresters are covered by Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION for Navy projects and Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION for other projects.

****

IEEE C62.11, rated [3][6][9][10][12][15][_____][kV][as indicated][, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts]. Arresters must be [intermediate] [distribution] class. Arresters for use at elevations in excess of 6000 feet above mean sea level must be specifically rated for that purpose. Arresters must be equipped with mounting brackets suitable for the indicated installations.

2.2.1.4 Load Interrupter Switch

****

NOTE: Verify UL listing is available for specified equipment before including bracketed option. UL listing may not be available for equipment operating above 15 kV.

****

IEEE C37.20.3. Provide a three-pole, single-throw, deadfront, metal-enclosed, load interrupter switch with manual stored energy operator. Switch must be[fused, with fuses mounted on a single frame][non-fused][in series with [vacuum][or][SF6] interrupters] and designed for easy inspection[and fuse replacement].[SF6 gas must conform to ASTM D2472.] The switch must be operated by a manually charged spring stored energy mechanism which must simultaneously disconnect or connect ungrounded conductors. The moveable blade of the switch must be de-energized when in the open position. The mechanism must enable the switch to close against a fault equal to the momentary rating of the switch without affecting its continuous current carrying or load interrupting ability. A ground bus must extend the width of the switch enclosure and must be bolted directly thereto. Connect frame of unit to ground bus. The door must have an inspection window to allow full view of the position of the three switch blades through the closed door. Switch ratings must be:

a. [_____] kV, [_____] kV BIL for service on a [_____] kV system with a fault close rating of not less than [_____] amperes asymmetrical.

b. The switch must be capable of carrying continuously or interrupting [_____] amperes with a momentary rating of [_____] amperes at [_____] kV.

c. Switch must have provision for padlocking in the open and closed positions.

d. Fuses must be current limiting type rated [_____] amperes continuous, and [_____] amperes interrupting capacity.

e. SF6 gas interrupter switch must have three distinct positions of closed, opened and ground (earthed). The switch must have visible indicator to provide positive indication of its status.

[2.2.1.5 Primary Protective Device Connection

Connections between the primary protective device and transformer must be [cable][bus] mounted on porcelain insulators, and sized and braced to withstand the specified short-circuit and short-time currents.

]2.2.1.6 SF6-Insulated Load Interrupter Switches

SF6 filled, puffer-type load interrupter switches shall be [fused][or][non-fused] as indicated. Switches shall incorporate self-aligning, copper-silver plated, wiping-type contacts. SF6 puffer interrupters to minimize arcing during operation; and an internal absorbent to neutralize arc by-products. Switch contacts shall be enclosed and sealed in maintenance-free, SF6 filled, molded epoxy insulated case, surrounded by dead-front metallic barriers. Switch operation shall be controlled by permanently lubricated quick-make, quick-break spring operator with solid linkage connection to contact operating shaft. Switch operator shall be mounted in separate dead-front compartment with access for addition of remote or automatic accessories, and shall include removable operating handle with storage provision, positive position indicators, and padlock provisions. SF6 gas shall conform to ASTM D2472.[Fused load interrupter switches shall be provided with clip-style, mounted air-insulated current limiting fuses and molded epoxy interphase barriers. Provide neon voltage indicators for blown fuse indication.] Load interrupter switch shall be rated [_____] continuous, [_____] kA momentary, [_____] kA short-time fault closing.

2.2.1.7 Vacuum-Insulated Load Interrupter Switches

Circuit interrupting device shall be [fused][non-fused], fixed mounted, [manually][electrically] operated, and shall be quick-make, quick-break with speed of operation independent of the operator. Electrically operated device shall be [120 Vac][125 Vdc]. Spring charging mechanism shall not rely on chains or cables.[Motor operator assembly shall be a separate device, isolated from high voltage and coupled through a direct drive shaft.] Circuit interrupter shall consist of automatic visible blade disconnects in series with vacuum interrupters. Arc interruption shall take place within the envelope of the vacuum interrupter. Upon opening, contacts in the vacuum interrupter shall separate 12 to 18 milliseconds before disconnect blades open. Total circuit interrupt opening time shall not exceed 3.0 cycles after the trip coil is energized at 85 to 100 percent of rated control voltage. Upon closing, disconnect blades shall close 9 to 12 milliseconds before contact is made in the vacuum interrupter. Local interrupter switch shall be rated [_____] continuous, [_____] kA momentary, [_____] kA short-time fault closing.

2.2.1.8 Remote Racking Device

Provide an electrically operated remote racking device for installing and removing circuit breakers. The RRD must mount on the circuit breaker compartment door by insertion of mounting pin into the RRD support bushing in the circuit breaker compartment. The RRD output shaft must be capable of activating the racking shaft through a racking port in the circuit breaker compartment door and operate with the door closed or open. Provide a remote operator control with a lanyard type cord that allows the operator to move a minimum of 15 meters 50 feet from the circuit breaker compartment. Include four hours of training for the correct use and operation of RRD.

[2.2.1.9 Protective Relays

Relays shall conform to IEEE C37.90. Protective relays must be microprocessor-based, multi-functional type, enclosed in rack-mountable cases with indicating targets and provisions for testing in place by use of test switches. Test switches to fit each type of relay in the equipment shall be provided. Controls, relays, and protective functions shall be provided completely assembled and wired. Relay must provide comprehensive transformer protection and monitoring functions.

a. Relay Mounting:

  (1) Each relay shall be mounted in a draw-out case with a two-stage quick-release operation.

  (2) Removal of the relay from the case shall disconnect the trip circuits and short the current-transformer secondaries before the unit control power is disconnected.

  (3) When the relay is inserted into the case, control power connections shall be made before the trip circuits are activated.

  (4) Include a self-shorting contact on the case terminal block for alarm indication and tripping of circuit breaker upon removal of the relay from the case.

b. Equip each relay system with a communications module to transmit the following data.

(1) Relay's metered and target data, such as currents, set points, cause of trip, magnitude of trip current, and open-close trip status.

(2) Ability to close and open the associated breaker with proper access code from remote location over the communication network when the relay is configured in remote open-close mode.

c. Relay must be equipped with the following ANSI devices:

(1) 24 Volts per Hertz

(2) 25 Synchrocheck

(3) 27X Auxiliary Undervoltage

(4) 27P Phase Undervoltage

(5) 32 Directional Power

(6) 49 Hottest Spot Temperature, Aging Factor, Loss of Life

(7) 50/87 Instantaneous Differential Overcurrent

(8) 50BF Breaker Failure

(9) 50G Ground Instantaneous Overcurrent

(10) 50N Neutral Instantaneous Overcurrent

(11) 50P Phase Instantaneous Overcurrent

(12) 50_2 Negative Sequence Instantaneous Overcurrent

(13) 51G Ground Time Overcurrent

(14) 51N Neutral Time Overcurrent

(15) 51_2 Negative Sequence Time Overcurrent

(16) 55 Power Factor

(17) 59N Neutral Overvoltage

(18) 59P Phase Overvoltage

(19) 59X Auxiliary Overvoltage

(20) 59_2 Negative Sequence Overvoltage

(21) 67G Ground Directional Element

(22) 67N Neutral Directional Element

(23) 67P Phase Directional Element

(24) 81O Overfrequency

(25) 81U Underfrequency

(26) 81R Frequency Rate of Change

(27) 87G Restricted Ground Fault (RGF)

(28) 87T Transformer differential

]2.2.2 Transformer (Liquid-Filled) Section[s]

****

NOTE: Indicate and specify the type of transformers required for the project.

1. Previously the use of mineral oil filled transformers were recommended wherever possible. The recent availability of biodegradable less-flammable transformer liquids may have altered that recommendation. For NAVFAC LANT, choose less-flammable transformer liquids as specified below for all projects unless there is a specific requirement to do otherwise. Where adequate distance from structures cannot be attained, consult NAVFAC design manuals and UFC 3-600-01, "Fire Protection Engineering For Facilities." Silicon-filled and R-temp filled transformers shall not be used for less-flammable requirements.

2. Use dry type transformers in unique applications only where their use can be thoroughly justified. Identify the intent to utilize dry type units in the basis of design and obtain approval from the applicable reviewing engineering field division. Dry type transformers, available in a variety of styles (including Cast Coil, Cast / Encapsulated Coil, Vacuum Pressure Encapsulated (VPE), Vacuum Pressure Impregnated (VPI) and Sealed) are normally less efficient and more expensive than oil filled transformers. There are, however, certain applications which warrant their use. This specification is limited to a choice of cast coil and vacuum pressure insulated (VPI) types of transformers which are available from at least three major manufacturers. Cast coil transformers (primary and secondary individually cast in epoxy) are recommended for use when planning de-energization of transformer for extended periods of time, when located outdoors, or in an extremely corrosive chemical environment. VPI transformers are recommended when used in a clean, limited space, indoor environment for continuous service.

3. Use the following option(s) when additional capacity is required. This involves special coordination with transformer KVA ratings, as well as sizes and ratings of fuses and secondary breakers.

a. If it is anticipated that future load

requirements will necessitate increasing the capacity of the transformer, the specification for the transformer should require the provision of components and brackets for future forced air cooling and mechanical circulation for the coolant fluid.

b. On rare occasions, for liquid-filled transformers, change "...insulation system rated for a 65 degrees C rise..." to read "...insulation system rated for a 55/65 degrees C rise to allow transformer(s) to have a continuous overload capacity of 12 percent at rated voltage without exceeding 65 degrees C winding temperature rise."

4. Use IEEE C57.12.00, Table 11(b), "Designation of voltage ratings of three-phase windings", such as "4160 V - 480Y / 277 V."

5. Tap ratings may vary from those indicated especially in lower kVA ratings.

6. Dry-type transformers below 750 kVA usually have impedance values in the range of 2.5 to 5.0 percent. Perform fault current calculations to determine minimum acceptable transformer impedance. Be sure that specified impedance is available in the size and type transformer required.

7. Delete last sentence, referring to removable ground strap, if transformer secondary winding is delta type.

8. Choose stainless steel fabrication where environmental conditions are not suitable for mild steel or where a higher level of corrosion protection is desired (i.e. directly on waterfront).

9. Ship to Shore Power Substations must be specified with the appropriate output voltage, refer to UFC 4-150-02 for ship voltages. Specify transformers with a total of six 2.5 percent full capacity taps, two above and four below the nominal voltage.

****

IEEE C57.12.29. [Mineral oil liquid-filled][Less-flammable, bio-degradable liquid-filled]. Transformer[base][, including the tank, radiators, flanges, base, lifting provisions, and hardware,] must be fabricated of type 304, 304L, or 316 stainless steel.[Transformer base must include any part of the transformer that is within 75 mm 3 inches of concrete pad.] Paint coating system must comply with IEEE C57.12.29.

2.2.2.1 Transformer Ratings

a. Cooling Class: [ONAN-Liquid-filled, self-cooled][ONAN/ONAF-Liquid-filled, self-cooled/forced air cooled][_____].

b. Frequency: [50][60] Hz.

c. Phases: Three phase.

d. Rated Kilovolt Amperes: [_____] kVA

e. Voltage Rating: [_____] v - [_____] V.[For GrdY - GrdY transformers, provide transformer with five-legged core design for third harmonic suppression.]

f. Impedance: Minimum tested impedance must not be less than [_____] percent at 85 degrees C.

g. Insulation Level: [60][95][150][_____] kV BIL

h. Temperature Rise: 65 degree C average winding temperature rise above a 30 degree ambient.

****

NOTE: Delete kVA ranges and sound levels for kVA ratings not used in the job.

****

i. Audible Sound Levels: Audible sound levels must comply with the following:

kVA Range	DECIBELS (MAX)
225-300	55
301-500	56
501-700	57
701-1000	58
1001-1500	60
1501-2000	61
2001-2500	62
2501-3000	63
3001-4000	64

2.2.2.2 Transformer Accessories

The transformer must have the following accessories:

a. [Four][_____] 2.5 percent full capacity taps, [two][_____] above and [two][_____] below rated primary voltage.

b. Tap changer, with external, pad-lockable, manual type operating handle, for changing tap setting when transformer is de-energized.

[c. Dead-front high-voltage bushings; IEEE 386. [15 kV, 95 kV BIL][25kV, 125 kV BIL][35 kV, 150 kV BIL]. Provide [200 ampere bushing wells with bushing well inserts][600 ampere one piece deadbreak apparatus bushings].

] **

NOTE: Include standoff bushings only when the Activity requires the additional items.

****

[d. Parking stands: Provide a parking stand near each dead-front bushing.[Provide insulated standoff bushings for parking of energized load-break connectors on each parking stands.]

] e. Insulated low-voltage neutral bushing with lugs for ground cable and removable ground strap.

f. Ground pads.

g. Liquid-level indicator.

h. Pressure-vacuum gage.

i. Liquid temperature indicator.

j. Drain and filter valves.

k. Pressure relief device, top mounted.

l. Diagrammatic stainless steel or laser-etched anodized aluminum nameplate in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

m. Transformer base with provisions for jacking and for rolling in either direction.

n. Lifting provisions.

o. Bolted transformer top or welded top with bolted handhole access.

[p. Auxiliary cooling equipment and controls.

[(1) Transformer must have provisions for future addition of automatically controlled fans for forced-air-cooling.

][(2) Transformer must be forced-air-cooled. Forced-air-cooling fans must have [automatic temperature control relay][winding temperature indicator with sequence contacts].

]]2.2.2.3 Specified Transformer Efficiencies

****

NOTE: Transformer losses and efficiency requirements have been modified into the table included within the specification and the previous Navy loss tables have been deleted.

10 CFR 431, Subpart K is a result of the Energy Policy and Conservation Act (EPACT) of 2005 and is

the"minimum" industry standard for distribution transformers manufactured on or after January 1, 2016.
****

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K. Submit certification, including supporting calculations, from the manufacturer indicating conformance.

KVA	EFFICIENCY (percent)
15	98.65
30	98.83
45	98.92
75	99.03
112.5	99.11
150	99.16
225	99.23
300	99.27
500	99.35
750	99.40
1000	99.43
1500	99.48
2000	99.51
2500	99.53
above 2500	99.54

2.2.2.4 Insulating Liquid

****
NOTE: On Navy projects use biodegradable less-flammable liquid, unless there is a specific requirement otherwise.
****

[a. Less-flammable transformer liquids: Must meet the requirements of ASTM D6871, NFPA 70 and be approved by the FM APP GUIDE for Less or

Non- Flammable Liquid Insulated Transformers. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

b. Provide a fluid that is a biodegradable, electrical insulating, and cooling liquid classified by UL and approved by FM as "less flammable" with the following properties:

(1) Aquatic biodegradation: EPA 712-C-98-075, 99 percent.

(2) Trout toxicity: The fluid must have passed OECD Test 203 following the methods of EPA 821-R-02-012 and be determined to be non-toxic.

][c. Mineral oil: ASTM D3487, Type II, tested in accordance with ASTM D117. Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

][2.2.2.4.1 Liquid-Filled Transformer Nameplates

Provide nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

][2.2.3 Transformer (Dry-Type) Section[s]

****

NOTE: Delete the paragraphs on Dry-Type Transformers when Liquid-Filled Transformers are used.

****

IEEE C57.12.01, and [IEEE C57.12.50 for dry-type transformers rated up to 500 kVA][IEEE C57.12.51 for dry-type transformers rated 501 kVA and larger]. Transformer[base][, including the enclosure, flanges, base, lifting provisions, and hardware,] must be fabricated of type 304 or 304L stainless steel.[Transformer base must include any part of the transformer that is within 75 mm 3 inches of concrete pad.] Paint coating system must comply with IEEE C57.12.29. Windings must be copper.

****

NOTE: Select either cast coil or VPI transformer.

****

[Provide a cast coil type transformer with primary and secondary windings individually cast in epoxy. Resin-encapsulated windings are not acceptable. Transformer[s] must have an insulation system rated 185 degrees C, with an 80 degree C average winding temperature rise above a 40 degrees C maximum ambient.

][Provide a vacuum pressure impregnated (VPI) type transformer with an insulation system rated 220 degrees C, and with an 80 degree C average winding temperature rise above a 40 degrees C maximum ambient.

]2.2.3.1 Transformer Ratings

****

NOTE: Use 95 kV BIL for 15 kV systems in lieu of the 60 kV BIL allowed by the referenced standards. 10 kV BIL is the standard secondary rating for up to

600 volts. 30 kV BIL is an optional secondary rating that can be specified when required. Perform fault current calculations to verify that the distribution equipment is coordinated with the impedance specified.
****

a. Transformer must be rated [_____] kVA, [95][60][_____] kV BIL Primary and 10 kV BIL Secondary.

b. Transformer voltage ratings: [_____] V - [_____] V.[For GrdY - GrdY transformers, provide transformer with five-legged core design for third harmonic suppression.]

c. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Locate tap adjustments on the face of the high voltage coil. Adjustments must be accessible by removing the front panel and must be made when the transformer is de-energized.

d. Minimum tested impedance must not be less than [_____] percent at 80 degrees C.

****
NOTE: Edit kVA and sound levels for those used in job - delete those not used.
****

e. Audible sound levels must comply with the following:

kVA	DECIBELS (MAX)
225	58
300	58
500	60
700	64
1000	64
1500	65
2000	66
2500	68

f. Diagrammatic stainless steel or laser-etched anodized aluminum nameplate

g. Transformer must include ground pads, lifting lugs and provisions for jacking under base. The transformer base construction must be suitable for using rollers or skidding in any direction. The transformer must have an insulated low-voltage neutral bushing with lugs for ground cable, and with removable ground strap.

h. Dry type transformer must have the following accessories.

(1) Winding temperature indicator

[(2) Auxiliary cooling equipment and controls

[(a) Transformer must have provisions for future addition of automatically controlled fans for forced-air-cooling.

][(b) Transformer must be forced-air-cooled. Forced-air-cooling fans must have [automatic temperature control relay][winding temperature indicator with sequence contacts].

]]]2.2.4 Outgoing Section

[The outgoing section must consist of a full height air terminal compartment for physical protection of and connection point for the secondary conductors between the transformer and the [switchboard][_____] located [in the building][_____].

][The outgoing section must consist of a full height air terminal compartment. This compartment must contain the indicated metering,[instruments,][and][control power transformers] and must be the connection point for the secondary conductors between the transformer and the [switchboard][_____] located [in the building][_____]. Provide one three point latching hinged door, either full height or on the upper half of the outgoing section to provide access to metering. The upper section must contain the current transformers and a watthour meter mounted to a dead front interior barrier as defined below. If using upper half section door only, the lower section must be bolt on type and contain bus bars and lugs to terminate the service entrance conductors. Provide insulated barriers between the upper and lower sections to permit the bus bars to pass between the sections. Provide locking access handle to eliminate unauthorized access.

][The outgoing section must consist of a secondary transition section for connecting to a low-voltage [switchboard][switchgear section]. The [switchboard][switchgear] must be as specified in Section[26 28 00.00 10 MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS][26 22 00.00 10 480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS][26 23 00 LOW VOLTAGE SWITCHGEAR][26 24 13 SWITCHBOARDS]. Connections between the transformer secondary bushings and the outgoing section transition bus must be flexible braid bus. The secondary transition section must have a hinged front panel.

]2.2.4.1 Outgoing Section Enclosure

Provide outgoing section enclosure in accordance with the requirements in paragraph INCOMING SECTION ENCLOSURE.

[2.2.5 Watthour and Digital Meters

2.2.5.1 Electronic Watthour Meter

****

NOTE: On standard projects, use of the electronic meter versus the optional electro-mechanical meter is recommended due to decreasing availability of electromechanical meters.

****

NEMA/ANSI C12.10. Provide a switchboard style electronic programmable watthour meter, semi-drawout, semi-flush mounted, as indicated. Meter must either be programmed at the factory or must be programmed in the field. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. Meter must be coordinated to system requirements.

****

NOTE: Form 9S, in text below, is for three-phase, four-wire wye systems, for other system configurations, designer shall determine the appropriate form designation.

****

a. Design: Provide meter designed for use on a 3-phase, 4-wire, [208Y/120][480Y/277] volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS)[as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC].

b. Coordination; Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

c. Class 20. Form: [9S][_____]. Accuracy: plus or minus 1.0 percent. Finish: Class II.

d. Kilowatt-hour Register: 5 digit electronic programmable type.

e. Demand Register:

    (1) Provide solid state.

    (2) Meter reading multiplier: Indicate multiplier on the meter face.

    (3) Demand interval length: must be programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.

[2.2.5.2 Electro-Mechanical Watthour Meters

NEMA/ANSI C12.10. Kilowatt-hour meters must be[two][three][four]-stator, transformer rated, polyphase, 60 hertz, [surface][semiflush] mounted, [drawout][semi drawout] switchboard meters [120 volt for use on a four-wire wye, three phase, 208Y/120 Volt system][240 volt for use on a four-wire wye, three-phase 480Y/277 volt system]. Meter must have a five-dial pointer type register.[The kilowatt-hour meter must have a[sweep-hand][cumulative] type kilowatt demand register with [15][30][60]-minute interval conforming to NEMA C12.4.] Provide correct multiplier on face of meter.

][2.2.5.3 Digital Meters

****

NOTE: Digital metering incorporates the latest technology and provides additional information, often without additional cost. A control power transformer (115 V or 130 V) is normally required with this type of metering.

****

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meters enclosed in sealed cases with a simultaneous three line display. Meters must have 16 mm 0.56 inch, minimum, LED's.[Watthour meter must have a single line display with 16 mm 0.56 inch, minimum, LED's.] The meters must accept[input from standard 5A secondary instrument transformers][and][direct voltage monitoring range to [300][600] volts, phase to phase to phase]. Programming must be via a front panel display and a communication interface with a computer. Password secured programming must be stored in non-volatile EEPROM memory. Digital communications must be Modbus [ASCII][RTU] protocol via an [RS232C][RS485] serial port[and an independently addressable [RS232C][RS485] serial port]. The meter must calculate and store average max/min demand values for all readings based on a user selectable sliding window averaging period. The meter must have programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions.[Meter must provide THD measurement to the thirty-first order.][Historical trend logging capability must include ability to store up to 100,000 data points with intervals of 1 second to 180 minutes. The unit must also store and time stamp up to 100 programmable triggered conditions.][Event waveform recording must be triggered by the rms of 2 cycles of voltage or current exceeding programmable set points. Waveforms must be stored for all 6 channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.]

[a. Multi-Function Meter: Meter must simultaneously display a selected phase to neutral voltage, phase to phase voltage, percent phase to neutral voltage THD, percent phase to phase voltage THD; a selected phase current, neutral current, percent phase current THD, percent neutral current; selected total PF, kW, kVA, kVAR, FREQ, kVAh, kWh. Detected alarm conditions include over/under current, over/under voltage, over/under kVA, over/under frequency, over/under selected PF/kVAR, voltage phase reversal, voltage imbalance, reverse power, over percent THD. The meter must have a Form C KYZ pulse output relay.

][b. Power Meter: Meter must simultaneously display Watts, VARs, and selected kVA/PF. Detected alarm conditions include over/under kVA, over/under PF, over/under VARs, over/under reverse power.

][c. Volt Meter: Meter must be selectable between simultaneous display of the three phases of phase to neutral voltages and simultaneous display of the three phases of the phase to phase voltages. Detected alarm conditions include over/under voltage, over/under voltage imbalance, and over percent THD.

][d. Ammeter: Meter must simultaneously display phase A, B, and C current. Detected alarm conditions include over/under current, and over percent THD.

][e. Digital Watthour Meter: Meter must have a single selectable display for watts, total kilowatt hours (kWh) and watt demand (Wd). The meter must have a Form C KYZ pulse output relay.

]]][2.2.6 Instruments

****

NOTE: On projects where voltage or amperage readings are required, use of the digital metering equipment versus individual ammeters and voltmeters may be justified due to technological advances and

reduced costs of electronic equipment.
****

Electrical indicating switchboard style instruments, with 2 percent accuracy. The ac ammeters and voltmeters must be minimum of 50.8 mm 2 inches square, with 4.36 rad 250 degree scale. Provide single phase indicating instruments with flush-mounted transfer switches for reading three phases.

[2.2.6.1 Ac Ammeters

[Self-contained][Transformers rated, 5-ampere input, for use with a [_____] to 5-ampere current transformer ratio], 0 to [_____]-ampere scale range, 60 hertz.

][2.2.6.2 Ac Voltmeters

Self-contained.

][2.2.6.3 Instrument Control Switches

Provide rotary cam-operated type with positive means of indicating contact positions. Switches must have silver-to-silver contacts enclosed in a protective cover which can be removed to inspect the contacts.

]][2.2.7 Current Transformers

****
NOTE: Select the appropriate current transformer (CT) ratio, continuous-thermal-current rating factor (RF) at 30 degrees C and ANSI Metering Accuracy Class values based on the CT ratio which is just below the rating of the main protective device.

Select an ANSI Metering Accuracy Class in accordance with the following table:

CT Ratio	**RF**	**Accuracy Class**
200/5	**4.0**	**0.3 thru B-0.1**
300/5	**3.0**	**0.3 thru B-0.2**
400/5	**4.0**	**0.3 thru B-0.2**
600/5	**3.0**	**0.3 thru B-0.5**
800/5	**2.0**	**0.3 thru B-0.5**
1200/5	**1.5**	**0.3 thru B-0.5**
1500/5	**1.5**	**0.3 thru B-0.9**
2000/5	**1.5**	**0.3 thru B-1.8**
2500/5	**1.5**	**0.3 thru B-1.8**

3000/5	**1.5**	**0.3 thru B-1.8**
3500/5	**1.5**	**0.3 thru B-1.8**
4000/5	**1.5**	**0.3 thru B-1.8**
5000/5	**1.5**	**0.3 thru B-1.8**

****

IEEE C57.13. Transformers must be single ratio, 60 hertz, [_____] to 5-ampere ratio, [_____] rating factor, with a metering accuracy class of 0.3 through [_____].

][2.2.8 Control Power Transformers

Transformer must conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

][2.2.9 Meter Fusing

Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

]2.2.10 Heaters

Provide 120-volt heaters in[incoming section,][dry-type transformer section,][and][outgoing section]. Heaters must be of sufficient capacity to control moisture condensation in the compartments, must be 250 watts minimum, and must be controlled by a thermostat[and humidistat] located in each section. Thermostat must be industrial type, high limit, to maintain compartments within the range of 15.5 to 32.2 degrees C 60 to 90 degrees F.[Humidistat must have a range of 30 to 60 percent relative humidity.] If heater voltage is different than substation equipment voltage, provide transformer rated to carry 125 percent of heater full load rating. Transformer must have 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and must conform to NEMA ST 20.[Energize electric heaters while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source.]

2.2.11 Insulated Barriers

Where insulated barriers are required by reference standards, provide barriers in accordance with NEMA LI 1, Type GPO-3, 6.35 mm 0.25 inch minimum thickness.

2.2.12 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Terminal boards associated with current transformers must be short-circuiting type. Terminate conductors for current transformers with ring-tongue lugs. Terminal board identification must be identical in similar units. External wiring must be color coded consistently for similar terminal boards.

2.2.13 Wire Marking

Mark control and metering conductors at each end. Provide factory-installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve must be elliptically shaped to securely grip the wire, and must be keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker must indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.2.14 Grounding and Bonding

Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. A continuous ground bus bar shall run the length of the switchgear, the ground bus bar shall be accessible from the back of the switchgear. The ground bus bar must be hard-drawn copper of 98 percent minimum conductivity, minimum size 6 mm by 50 mm 1/4 by 2 inches.

[2.2.15 Padlocks

****

NOTE: Designer must assure that Section 08 71 00 DOOR HARDWARE is included and is edited to include padlocks. Delete this paragraph if padlocks are not to be provided by the contractor.

Do not use this paragraph for NAVFAC LANT projects unless there is a specific requirement.

****

Padlocks must be provided for secondary unit substation equipment[and for each fence gate]. Padlocks must be keyed[alike][as directed by the Contracting Officer]. Padlocks must comply with Section 08 71 00 DOOR HARDWARE.

]2.2.16 Cast-in-Place Concrete

****

NOTE: Use the first bracketed paragraph when project includes a concrete section in Division 3; otherwise, the second bracketed paragraph may be used. Coordinate requirements with Section 03 30 00 CAST-IN-PLACE CONCRETE.

****

[Concrete associated with electrical work for other than encasement of underground ducts must be 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. All concrete must conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

] **

NOTE: If concrete requirements are detailed and no cast-in-place concrete section is to be included in the project specification, refer to Section 03 30 00 CAST-IN-PLACE CONCRETE, and select such portions as needed to provide complete requirements in addition

to the requirements below.
****

[Must be composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture. Fine aggregate must be of hard, dense, durable, clean, and uncoated sand. The coarse aggregate must be reasonably well graded from 4.75 mm to 25 mm 3/16 inch to one inch. The fine and coarse aggregates must be free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances. Water must be fresh, clean, and free from salts, alkali, organic matter, and other impurities. Concrete associated with electrical work for other than encasement of underground ducts must be 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. Slump must not exceed 100 mm 4 inches. Retempering of concrete will not be permitted. Exposed, unformed concrete surfaces must be given a smooth, wood float finish. Concrete must be cured for a period of not less than 7 days, and concrete made with high early strength portland cement must be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer. Air entrain concrete exposed to weather using an air-entraining admixture conforming to ASTM C260/C260M. Air content must be between 4 and 6 percent.

]2.3 MANUFACTURER'S NAMEPLATES

Each item of equipment must have a nameplate bearing, as a minimum, the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. Include additional information as applicable to fully identify the equipment. Nameplates must be made of noncorrosive metal.[Equipment containing liquid dielectric must include the type of dielectric on the nameplate.][Sectionalizer switch nameplates must have a schematic with all switch positions shown and labeled.] As a minimum, provide nameplates for transformers, circuit breakers, meters, switches, and switchgear.

2.4 FIELD FABRICATED NAMEPLATES

****
NOTE: Use the bracketed sentence to specify labels for secondary unit substations where emergency breakers are located within the secondary unit substations. Provide note on the drawings to indicate where red labels are required.
****

ASTM D709. Provide laminated plastic nameplates for each secondary unit substation, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core.[Provide red laminated plastic label with white center core where indicated.] Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 mm by 65 mm one by 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.5 WARNING SIGNS

Provide warning signs for the enclosures of secondary unit substations having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.29, such as for secondary unit substations, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign must be a decal and must have nominal dimensions of 178 mm by 255 mm 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 50 mm 2 inch high letters. The word "DANGER" must be in white letters on a red background and the words "HIGH VOLTAGE" must be in black letters on a white background.

[b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 355 mm by 255 mm 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 75 mm 3 inch high white letters on a red and black field.

]2.6 SOURCE QUALITY CONTROL

****

NOTE: Use "reserves the right to" on all projects, except those for NAVFAC SE.

****

2.6.1 Equipment Test Schedule

The Government [reserves the right to][will] witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

Test Instrument Calibration

(1) The manufacturer must have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

(2) The accuracy must be directly traceable to the National Institute of Standards and Technology. Test equipment must qualify for the UL standard of Scope of Accreditation ISO ISO/IEC 17025and ANSI Z540.1.

(3) Instrument calibration frequency schedule must not exceed 12 months for both test floor instruments and leased specialty equipment.

(4) Dated calibration labels must be visible on all test equipment.

(5) Calibrating standard must be of higher accuracy than that of the instrument tested.

(6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.6.2 Load Interrupter Switch Production Tests

IEEE C37.20.3. Furnish reports of production tests performed on the actual equipment for this project. Required tests must be as follows:

Production Tests

(1) Dielectric

(2) Mechanical operation

[(3) Grounding of instrument transformer case

][(4) Electrical operation and control wiring

]2.6.3 Transformer Design Tests (Liquid-Filled)

In accordance with IEEE C57.12.00 and IEEE C57.12.90. Additionally, IEEE C57.12.80 section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the product data and shop drawings for[each of] the specified transformer[s]. Design tests must have been performed prior to the award of this contract.

a. Tests must be certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a unit-substation transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a unit-substation transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests must include both the primary and secondary windings of that transformer.

    (1) IEEE C57.12.90 paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

    (2) State test voltage levels.

    (3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" for the lifting and moving devices test means a transformer in the same weight range as the transformer specified.

e. Pressure: "Basically the same design" for the pressure test means a unit-substation transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

2.6.4 Transformer Routine and Other Tests (Liquid-Filled)

In accordance with IEEE C57.12.00 and IEEE C57.12.90. Routine and other tests must be performed by the manufacturer on[each of] the actual transformer[s] prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence must be as follows:

a. Cold resistance measurements (provide reference temperature)

b. Phase relation

c. Ratio

d. Insulation power-factor by manufacturer's recommended test method

e. No-load losses (NLL) and excitation current

f. Load losses (LL) and impedance voltage

g. Dielectric

    (1) Impulse: Per IEEE C57.12.90 paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98. Test the primary winding only.

        (a) State test voltage levels

        (b) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test reports.[As an alternative, photographs of oscilloscope display waveforms or plots of digitized waveforms may be hand-delivered at the factory witness test.]

    (2) Applied voltage

    (3) Induced voltage

h. Leak

i. Sample insulating liquid. Sample must be tested for:

    (1) Dielectric breakdown voltage

    (2) Acid neutralization number

    (3) Specific gravity

    (4) Interfacial tension

    (5) Color

    (6) Visual condition

(7) Water in insulating liquid

(8) Measure dissipation factor or power factor

j. Perform dissolved gas analysis (DGA)

[2.6.5 Transformer Design Tests (Dry-Type)

****

NOTE: Delete the paragraphs on Dry-Type Transformers when Liquid-Filled Transformers are used.

****

In accordance with IEEE C57.12.01 and IEEE C57.12.91. Additionally, IEEE C57.12.80 section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports in the same submittal package as the product data, shop drawings, and certificates of transformer losses for[each of] the specified transformer[s]. Design tests must have been performed prior to the award of this contract.

a. Provide required submittals in a hard-covered binder with index and tabs.

b. Tests must be certified and signed by a registered professional engineer. Engineers stamp and signature must appear on at least the first page of the factory test reports.

c. Temperature rise:

(1) "Basically the same design" for the temperature rise test means a unit-substation transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (AA), the same temperature rise rating, the same insulating class and the same insulating medium as the transformer specified.

(2) Provide temperature rise readings, formulas, calculations of average temperature rise, and description of test method.

d. Lightning impulse:

(1) "Basically the same design" for the lightning impulse dielectric test means a unit-substation transformer with the same BIL and the same coil construction (such as wire wound primary and sheet wound secondary).

(2) IEEE C57.12.91 and IEEE C57.98. Provide design lightning impulse tests consisting of a reduced full-wave, two-chopped waves, and one full wave test for each phase of the primary and secondary windings of the same transformer.

(3) State test voltage levels.

(4) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

(5) Partial Discharge Test per IEEE C57.124. Provide transformer

ratings, description and diagram of test method used, test readings and final results.

][2.6.6 Transformer Routine and Other Tests (Dry-Type)

In accordance with IEEE C57.12.01 and IEEE C57.12.91. Routine and other tests must be performed by the manufacturer on[each of] the actual transformer[s] prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence must be as follows:

a. Resistance measurements

b. Phase relation

c. Ratio

d. Insulation power-factor by manufacturer's recommended test method

e. No-load losses (NLL) and excitation current

f. Load losses (LL) and impedance voltage

g. Lightning impulse: Perform the complete design type impulse tests on the transformer primary winding only.

   (1) IEEE C57.12.91 and IEEE C57.98

   (2) State test voltage levels

   (3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test reports.[As an alternative, photographs of oscilloscope display waveforms or plots of digitized waveforms may be hand delivered at the factory witness test.]

h. Low frequency dielectric

   (1) Applied voltage

   (2) Induced voltage

]2.7 STATION BATTERIES AND CHARGER

****

NOTE: For NAVFAC SE projects, specify maintenance-free sealed batteries only. Provide only when an external control power source is required for circuit breaker or switch operation.

****

Provide station batteries and charger, suitable for the requirements of the switchgear and [vacuum][SF6][circuit breakers][switches]. Batteries must be [_____] V, 60 cells, lead-acid, [pasted plate type][or][sealed, totally absorbed electrolyte type].

a. Pasted plate type batteries: Positive plates must be of the manchester type and negative plates must have a life equal to or greater than the positive plates. Battery containers must be heat and impact resistant clear plastic with electrolyte level lines permanently marked on all four sides. A permanent leak proof seal shall must be provided between cover and container and around cell posts. Spray proof vent plugs must be provided in covers. Sufficient sediment space must be provided so that the battery will not have to be cleaned out during its normal life. High porosity separators to provide correct spacing between plates must be provided. Capacity must be calculated by switchgear manufacturer and approved by Contracting Officer before acceptance.

b. Sealed batteries: Provide batteries with leak proof, spill proof electrolyte utilizing highly absorbent material to separate the positive and negative plates. Battery jars must be hermetically sealed with welded seams. Batteries must be maintenance-free and shall must not require water to be added. Capacity must be calculated by switchgear manufacturer and approved by Contracting Officer before acceptance.

c. Battery charger must be full-wave rectifier type, utilizing silicon semiconductor devices. Charger must maintain a float charge of 2.15 V per cell and an equalizing charge of 2.33 V per cell. An equalizing charge timer must be provided which operates automatically after an AC power failure of 5 seconds or more. Timer must be adjustable for any time period up to 24 hours. Timer must also be capable of being actuated manually. Adjustable float and equalizing voltage potentiometers must be provided. Charger voltage must be maintained within plus or minus 1/2 percent from no load to full load with AC line variations of plus or minus 10 percent and frequency variations of plus or minus 5 percent. DC voltmeter and ammeter with a minimum 90 mm 3 1/2 inch scale and 2 percent accuracy of full scale must be provided. Output current must be limited to 115 percent of rated output current, even down to short circuit of the DC output terminals. Solid state circuit must have AC and DC transient voltage terminals. AC and DC magnetic circuit breakers must be provided. Circuit breakers must not be overloaded or actuated under any external circuit condition, including recharge of a fully discharged battery and short circuit of the output terminals. Charger must be capable of continuous operation at rated current at an ambient temperature of 40 degrees C. Output DC current capacity must match the requirements of the batteries provided. Provide alarm outputs [Individual Form C contacts] [Single summary Form C contact] as follows:

(1) AC power failure

(2) DC ground detection

(3) High DC voltage

(4) Low DC voltage

(5) Charger failure

(6) Battery discharging

(7) End of discharge

(8) DC current limit

(9) Common summary alarm

d. Secure battery rack such that it can not overturn or be disrupted by lateral forces accompanying a seismic disturbance. Provide steel, three-step racks, painted with two coats of acid resistant paint for mounting batteries. Provide lead-plated copper inter-rack connectors and cell numbers with each rack.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

****

NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, specify other methods of grounding. Where it is impractical to obtain the indicated ground resistance values, make every effort to obtain ground resistance values as near as possible to the indicated values.

****

NFPA 70 and IEEE C2, except that grounds and grounding systems must have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Substation Grounding

****

NOTE: Where the rated secondary current exceeds 400 amperes, increase the size of the substation transformer neutral ground connection to not less than 12.5 percent of the cross-sectional area of the secondary phase conductors. Provide a "detail" for surge arrester grounding. For ungrounded and single-grounded systems, modify paragraph in accordance with IEEE C2.

****

Provide bare copper cable not smaller than No. 4/0 AWG not less than 610 mm 24 inches below grade interconnecting the indicated ground rods. Surge arrester and neutrals must be bonded directly to the transformer enclosure and then to the grounding electrode system with bare copper conductors, sized as shown. Lead lengths must be kept as short as practicable with no kinks or sharp bends. Substation transformer neutral connections must not be smaller than No. 1/0 AWG. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" must apply.[Fence and equipment connections must not be smaller than No. 4 AWG. Ground fence at each gate post and cornerpost and at intervals not exceeding 3050 mm 10 feet.

Bond each gate section to the fence post through a 3 mm by 25 mm 1/8 by one inch flexible braided copper strap and clamps.]

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Exothermic welds and compression connectors must be installed as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, paragraph regarding "Grounding".

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect unit substations furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Interrupter Switchgear

IEEE C37.20.3.

[3.3.2 Meters and Instrument Transformers

ANSI C12.1.

]3.3.3 Field Applied Painting

Where field applied painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.3.4 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3.5 Warning Sign Mounting

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 9 meters 30 feet apart.

[3.3.6 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

]3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the equipment is located. Include construction requirements for concrete slab

only if slab is not detailed in drawings. Curbs or raised edges may also be required around liquid filled transformer.
****

3.4.1 Exterior Location

Mount unit substation on concrete slab. Unless otherwise indicated, the slab must be at least 200 mm 8 inches thick, reinforced with a 152 by 152 - MW19 by MW19 6 by 6 - W2.9 by W2.9 mesh placed uniformly 100 mm 4 inches from the top of the slab. Slab must be placed on a 150 mm 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 100 mm 4 inches above the finished grade. Edges above grade must have 15 mm 1/2 inch chamfer. The slab must be of adequate size to project at least 200 mm 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter. Cut off and bush conduits 75 mm 3 inches above slab surface.

3.4.2 Interior Location

Mount unit substation on concrete slab. Unless otherwise indicated, the slab must be at least 100 mm 4 inches thick. The top of the concrete slab must be approximately 100 mm 4 inches above finished floor. Edges above floor must have 15 mm 1/2 inch chamfer. The slab must be of adequate size to project at least 100 mm 4 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter. Cut off and bush conduits 75 mm 3 inches above slab surface.

3.4.3 Cast-in-Place Concrete

****
NOTE: Use the first bracketed option when project includes a concrete section in Division 3; otherwise the second bracketed option may be used.
****

Cast-in-place concrete work must conform to the requirements of[Section 03 30 00 CAST-IN-PLACE CONCRETE][ACI 318M].

[3.5 PADLOCKS

****
NOTE: Delete this paragraph if padlocks are not to be provided by the contractor.
****

Provide padlocks for secondary unit substation equipment[and for each fence gate].

]3.6 FIELD QUALITY CONTROL

3.6.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.6.1.1 Medium-Voltage Circuit Breakers (Vacuum)

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Inspect anchorage, alignment, and grounding.

(5) Perform all mechanical operational tests on both the circuit breaker and its operating mechanism.

(6) Measure critical distances such as contact gap as recommended by manufacturer.

(7) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey[is net][is] required.

(8) Record as-found and as-left operation counter readings.

b. Electrical Tests

(1) Perform a contact-resistance test.

(2) Verify trip, close, trip-free, and antipump function.

(3) Trip circuit breaker by operation of each protective device.

(4) Perform insulation-resistance tests.

(5) Perform vacuum bottle integrity (overpotential) test across each bottle with the breaker in the open position in strict accordance with manufacturer's instructions. Do not exceed maximum voltage stipulated for this test.

3.6.1.2 Medium-Voltage Circuit Breakers (SF6)

a. Visual and mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Inspect anchorage and grounding.

(5) Inspect and verify adjustments of mechanism in accordance with manufacturer's instructions.

(6) Inspect and service air compressor in accordance with manufacturer's instructions.

(7) Test for gas leaks in accordance with manufacturer's instructions.

(8) Verify correct operation of all air and SF6 gas pressure alarms and cutouts.

(9) Slow close/open breaker and check for binding.

(10) Perform time-travel analysis.

(11) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey[is not][is] required.

(12) Record as-found and as-left operation counter readings.

b. Electrical Tests

(1) Measure contact resistances.

(2) Perform insulation-resistance tests.

(3) Verify trip, close, trip-free, and antipump functions.

(4) Trip circuit breaker by operation of each protective device.

3.6.1.3 Transformers (Liquid-Filled)

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

[(3) Verify that cooling fans and pumps operate correctly and that fan and pump motors have correct overcurrent protection.

][(4) Verify operation of all alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.

] (5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Verify correct liquid level in transformer tank.

(7) Perform specific inspections and mechanical tests as recommended by manufacturer.

(8) Verify correct equipment grounding.

(9) Verify the presence of transformer surge arresters.

(10) Verify that positive pressure is maintained on gas blanketed transformers.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) Perform dissolved gas analysis (DGA).

(3) Verify that the tap-changer is set at specified ratio.

(4) Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

[3.6.1.4 Transformers - (Dry-Type)

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify that control and alarm settings on temperature indicators are as specified.

(4) Verify that cooling fans operate correctly and that fan motors have correct overcurrent protection.

(5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Perform specific inspections and mechanical tests as recommended by manufacturer.

(7) Verify that resilient mounts are free and shipping brackets have been removed.

(8) Verify that winding core, frame, and enclosure groundings are correct.

(9) Verify the presence of transformer surge arresters.

(10) Verify that as-left tap connections are as specified.

b. Electrical Tests

(1) Perform insulation-resistance tests.

(2) Perform power-factor tests or dissipation-factor tests in accordance with the test equipment manufacturer's instructions.

(3) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(4) Perform turns-ratio tests.

(5) Perform an applied-voltage test on high and low voltage windings-to-ground. See IEEE C57.12.91. The ac dielectric-withstand-voltage test result must not exceed 75 percent of factory test voltage for one-minute duration. The dc dielectric-withstand-voltage test result must not exceed 100 percent of the ac rms test voltage specified in IEEE C57.12.91 for a one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

(6) Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

]3.6.1.5 Current Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) Perform insulation-resistance tests.

(3) Perform polarity tests.

(4) Perform ratio-verification tests.

3.6.1.6 Metering and Instrumentation

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Verify accuracy of meters at 25, 50, 75, and 100 percent of full scale.

(2) Calibrate watthour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

(4) Verify that current transformer[and voltage transformer] secondary circuits are intact.

3.6.1.7 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod or grounding system, indicating the location of the rod or grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

[3.6.2 Protective Relays

****

NOTE: Do not use this paragraph for NAVY projects.

****

Protective relays must be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests must include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings must be implemented as directed by the Contracting Officer. Relay contacts must be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers must be field tested in accordance with IEEE C57.13.

][3.6.3 Pre-Energization Services

****

NOTE: Do not use this paragraph for NAVY projects or projects where Section 26 08 00 APPARATUS INSPECTION AND TESTING is included.

****

Calibration, testing, adjustment, and placing into service of the installation must be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of 2 years of current product experience. The following services must be performed subsequent to testing but prior to the initial energization. The equipment must be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment must be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations must be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests must be performed after the installation of completed assemblies. Components must be inspected for damage caused during installation or shipment to ensure packaging materials have been removed. Components capable of being both manually and electrically operated must be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested must be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer.

]3.6.4 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Test must require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer must be given 5 working days' advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 12 19 (May 2024)**
Change 2 - 11/23

Preparing Activity: NAVFAC **Superseding without Revision**
UFGS-26 12 19.10 (May 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 12 19

PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

05/24

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 12 19 (May 2024)**
Change 2 - 11/23

Preparing Activity: NAVFAC **Superseding without Revision**
UFGS-26 12 19.10 (May 2019)

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References are in agreement with UMRL dated January 2025

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SECTION 26 12 19

PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

05/24

****

NOTE: This guide specification covers the requirements for three-phase pad-mounted, liquid-filled transformers of the dead-front and live-front types for exterior applications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Use pad-mounted transformers (properly protected with bayonet type, oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses) for kVA ratings up to and including 1500 kVA on 5 kV systems and for kVA ratings up to and including 2500 kVA on 15, 25, and 35 kV systems.

For voltages above 35 kV and in ratings above those previously indicated, this specification requires significant modifications and additional specification sections may need to be added on the project.

This specification is for standard step-down

applications in utility distribution systems. For step-up applications (i.e., solar/wind generation, etc.), this specification requires significant modifications to address proper voltage designations, overcurrent and fault protection, etc.

The use of pad-mounted transformers with secondary currents exceeding 3000 amperes is discouraged due to the size and quantity of secondary conductors. Therefore, transformers above 1000 kVA serving 208Y/120 volt loads and transformers above 2500 kVA serving 480Y/277 volt loads should be in a secondary unit substation configuration.

Available fault current level and arc-flash energy become extremely hazardous at the larger kVA size transformers. Designer should consider these parameters and evaluate multiple service points.

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NOTE: For Navy and Air Force projects, this specification incorporates a "reduced shop drawing submittal process" for listed manufacturers who previously satisfied reduced shop drawing submittal process requirements. This specification also includes unique routine and other test requirements, transformer loss certificate, transformer test schedule, and field quality control acceptance tests and reports. The preparing activity, NAVFAC LANT, has significant experience and technical expertise in these areas. If Reach-back support is desired, for a specific NAVFAC or Air Force project, the technical representative (electrical engineer) editing this document for that project must contact the NAVFAC LANT Capital Improvements Electrical Engineering (Code CI44) Office for consultation during the design stage of the project, prior to including the requirement in the specification.

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NOTE: Use the following related guide specifications for power distribution equipment:
--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 11 13.00 20 PRIMARY UNIT SUBSTATIONS
--Section 26 11 16 SECONDARY UNIT SUBSTATION
--Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
--Section 26 13 00 SF6/HIGH-FIREPOINT FLUID INSULATED PAD-MOUNTED SWITCHGEAR
--Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM
--Section 26 23 00 LOW VOLTAGE SWITCHGEAR
--Section 26 24 13 SWITCHBOARDS
--Section 26 27 13.10 30 ELECTRIC METERS
--Section 26 27 14.00 20 ELECTRICITY METERING
--Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION

Do not use the following related guide specifications except for Army Civil Works projects. They have not been unified.
--Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION
--Section 26 28 00.00 10 MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS
--Section 26 22 00.00 10 480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS

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NOTE: Coordination is required between this section and metering equipment specification sections. See Section 26 27 14.00 20 ELECTRICITY METERING or 26 27 13.10 30 ELECTRIC METERS for metering details, which are available in metric (SI) and U.S. Customary (IP) system dimension. Use these files to develop project specific drawings, including:

File Name	Description
PADMDE1	**Three Phase, Ungrounded or Single Grounded Primary System - with Surge Arresters**
PADMDE2	**Three Phase, Ungrounded or Single Grounded Primary System - without Surge Arresters**
PADMDE3	**Three Phase, Multi-Grounded Primary System (Delta-Wye) - with Surge Arresters**
PADMDE4	**Three Phase, Multi-Grounded Primary System (Delta-Wye) - without Surge Arresters**
PADMDE5	**Three Phase, Multi-Grounded Primary System (Wye-Wye) - with Surge Arresters**
PADMDE6	**Three Phase, Multi-Grounded Primary System (Wye-Wye) - without Surge Arresters**
ARCFLASH	**Arc Flash Warning Label**

To download these details, go to:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables
Pad-mounted transformer graphics are located with Pad-Mounted Transformer Specification UFGS 26 12 19.

Select the appropriate Electrical .ZIP file(s) and extract the desired details.

Do not include list of details, or details themselves, in project specifications. Insert the appropriate details on drawings and modify optional and blank items. If special features are required, modify transformer details as required to indicate the actual requirements for each particular installation.

****

****

NOTE: Show the following information on the project drawings:

1. Single-line diagram showing pad-mounted transformer connectors, inserts, surge arresters, switches, fuses, current transformers with ratings, and meters as applicable.

2. Grounding plan.

3. Type and number of cables, and size of conductors for each power circuit.

4. Transformer primary and secondary voltages. (Use IEEE C57.12.00, Table 8, "Designation of voltage ratings of three-phase windings (schematic representation)".) State the primary voltage (nominal) actually in service and not the voltage class.

5. Special conditions, such as altitude, temperature and humidity; exposure to fumes, vapors, dust, and gases; and seismic requirements.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM D92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97	(2017b) Standard Test Method for Pour Point of Petroleum Products
ASTM D117	(2018) Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
ASTM D877/D877M	(2019) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D3487	(2016; E2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2016) Separable Insulated Connector

	Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.47	(2011) Standard for High Voltage Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches
IEEE C57.12.00	(2021) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.12.34	(2022) Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2021) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7	(2022) Requirements for Watthour Meter Sockets
NEMA 260	(1996; R 2004) Safety Labels for

	Pad-Mounted Switchgear and Transformers Sited in Public Areas
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products
NEMA Z535.4	(2023) Product Safety Signs and Labels
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 712-C-98-075	(1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
EPA 821-R-02-012	(2002) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.

****

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-mounted Transformer Drawings; G, [_____]

SD-03 Product Data

Pad-mounted Transformers; G, [_____]

SD-06 Test Reports

Acceptance Checks and Tests; G, [_____]

SD-07 Certificates

Transformer Efficiencies; G, [_____]

SD-09 Manufacturer's Field Reports

Transformer Test Schedule; G, [_____]

Pad-mounted Transformer Design Tests; G, [_____]

Pad-mounted Transformer Routine and Other Tests; G, [_____]

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5; G, [_____]

****

NOTE: Include the bracketed option below on Navy and Air Force projects where "reach-back support" has already been coordinated with NAVFAC LANT per the 3rd introductory Technical Note. Add appropriate information in Section 01 33 00 SUBMITTAL PROCEDURES to coordinate with the special requirements.

****

[1.4.1 Government Submittal Review

[Code CI44, NAVFAC LANT, Naval Facilities Engineering Systems Command][_____] will review and approve all submittals in this section requiring Government approval.

]1.4.2 Reduced Submittal Requirements

Transformers designed and manufactured by ABB/Hitachi Energy in Jefferson City, MO; by Eaton's Cooper Power Series Transformers in Waukesha, WI; by ERMCO in Dyersburg, TN; or by Howard Industries in Laurel, MS need not submit the entire submittal package requirements of this contract. Instead, submit the following items:

a. A certification, signed by the manufacturer, stating that the manufacturer will meet the technical requirements of this specification.

b. An outline drawing of the transformer with devices identified (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item a).

c. ANSI nameplate data of the transformer (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item b).

****

NOTE: The designer is responsible for providing proper settings for secondary over-current device(s) to ensure proper protection of equipment and coordination with transformer high side fuses. Include the following option for transformers serving secondary over-current devices containing adjustable trips.

****

[d. Manufacturer's published time-current curves in PDF format and in electronic format suitable for import or updating into the [EasyPower] [SKM PowerTools for Windows] [_____] computer program of the transformer high side fuses (paragraph PAD-MOUNTED TRANSFORMER

DRAWINGS, item e).

] e. Provide transformer test schedule and routine and other tests required by submittal item "SD-09 Manufacturer's Field Reports".

f. Provide acceptance test reports required by submittal item "SD-06 Test Reports".

g. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data".

1.5 QUALITY ASSURANCE

1.5.1 Pad-Mounted Transformer Drawings

****

Note: Delete bracketed metering information for Navy and Air Force projects when separate metering specification is used. May still need for Army projects until metering specification is unified.

****

Include the following as a minimum:

a. An outline drawing, including front, top, and side views.

b. IEEE nameplate data.

c. Elementary diagrams and wiring diagrams[with terminals identified of watthour meter and current transformers].

d. One-line diagram, including switch(es)[, current transformers, meters, and fuses].

****

NOTE: Include the following option for transformers serving secondary over-current devices containing adjustable trips.

****

[e. Manufacturer's published time-current curves in PDF format and in electronic format suitable for import or updating into the [EasyPower] [SKM PowerTools for Windows] [_____] computer program of the transformer high side fuses.

]1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, except of NFPA 70 when more stringent requirements are specified or indicated, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

****

NOTE: Delete bracketed information for Navy and Air Force projects when separate metering specification is used. May still need for Army projects until metering specification is unified.

****

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein. In addition to requirements of Data Package 5, include the following on the actual transformer(s) provided:

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, front, top, and side views

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Fuse curves for primary fuses

[f. Information on watthour demand meter, CT's, and fuse block

] g. Actual nameplate diagram

h. Date of purchase

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be pad-mounted transformers and related accessories are specified in[Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION,][Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM,][and] Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS

****

NOTE: According to IEEE 386, 200 ampere separable insulated connectors normally used on dead-front pad-mounted transformers have both a fault closure and a short-time current rating of 10,000 amperes. Therefore, from a safety standpoint, dead-front configurations which utilize these connectors should only be used at system locations which have available fault currents of less than 10,000 rms symmetrical amperes.

This specification does not address the materials used for the winding (copper versus aluminum) and it is assumed that the manufacturer will provide their standard product with respect to the winding construction, based on the cost of materials at the time of order acceptance. No failure data has been obtained indicating that copper windings have a longer life than aluminum windings. If copper windings are specified, the cost increase for three-phase distribution transformers has recently been about 15 percent. Do NOT specify winding materials.

****

IEEE C57.12.34, IEEE C57.12.28 and as specified herein. Submit manufacturer's information for each component, device, insulating fluid, and accessory provided with the transformer.

2.2.1 Compartments

Provide high- and low-voltage compartments separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.1.1 High Voltage, Dead-Front

****

NOTE: Current policy is to use oil-immersed fuses in series with current limiting fuses to achieve better protection and obtain life cycle cost benefits.

For 15 kV and 25 kV, 200 A bushings, select bushing wells and bushing well inserts. For 15 kV and 25 kV, 600 A bushings and for 35 kV bushings, select one-piece bushings.

Do not provide standoff bushings unless this transformer is the only dead-front transformer on the base. The Public Works Department normally carries standoff bushings in their vehicles. Provide protective caps when providing standoff bushings and to cover unused bushing well inserts when not providing surge arresters.

Coordinate lead-in paragraph with bracketed options below.

Choose minimum high-voltage compartment dimensions for transformers used in loop feed applications to accommodate installation of loop feed, feed-through inserts, and surge arresters.

NOTE: For systems with a fault capability greater than 10,000 amps, for applications utilizing loop feed load-break switches, or when the primary cable size is greater than No. 4/0 AWG, use 600A separable insulated dead-break connectors.

****

High-voltage compartment contains: the incoming line, insulated high-voltage [load-break][dead-break]connectors, [bushing well inserts,][feed-thru inserts,] six high-voltage [bushing wells][one-piece bushings] configured for loop feed application, load-break switch handle(s), [access to oil-immersed bayonet fuses,][dead-front surge arresters,] tap changer handle, connector parking stands[with insulated standoff bushings],[protective caps,] and ground pad.

[Minimum high-voltage compartment dimensions: IEEE C57.12.34, Figures 16 and 17.

][a. Insulated high-voltage load-break connectors: IEEE 386, rated [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector must have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

][b. Insulated high-voltage dead-break connectors: IEEE 386, rated [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Current rating: 600 amperes rms continuous. Short time rating: 25,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector must have a [200 ampere bushing interface for surge arresters,] steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

****

NOTE: Provide bushing well inserts and feed-through inserts only on load-break applications, not on dead-break.

****

][c. Bushing well inserts[and feed-thru inserts]: IEEE 386, 200 amperes, [15][25] kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise.[Provide feed-thru inserts as indicated.]

][d. One-piece bushings: IEEE 386, [200][600] amperes, [15][25][35][_____] kV Class.

] e. Load-break switch

****

NOTE: Choose between load-break radial-feed switch and load-break loop feed switches.

There are three types of load-break switches: two-, three-, and four-position. UFC 3-550-01 recognizes only two-position load-break switch. Two-position switch is hot stick operable and requires minimum input torque to operate.

****

[Radial-feed two-position oil-immersed type rated at [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL], with a continuous current rating and load-break rating of [200][300][_____] amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

][Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch must be rated at [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL], with a continuous current rating and load-break rating of [200][300][_____] amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handles in the high-voltage compartment. Operation of switches must be as follows:

ARRANGEMENT NO.	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION					
		LINE A SW.		LINE B SW		XFMR. SW	
		OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE
1	Line A connected to Line B and both lines connected to transformer		X		X		X
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line Bonly	X			X		X
4	Transformer open and loop closed		X		X	X	
5	Transformer open and loop open	X		X		X	

****

NOTE: Provide bayonet type fuses for all

transformer applications 38 kV and below.

****

][f. Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. The bayonet fuse links sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. Include an oil retention valve inside the bayonet assembly housing, which closes when the fuse holder is removed, and an external drip shield to minimize oil spills. Display a warning label adjacent to the bayonet fuse(s) cautioning against removing or inserting fuses unless the transformer has been de-energized and the tank pressure has been released.

Bayonet fuse assembly: 150 kV BIL.

****

NOTE: For transformers with loop-feed sectionalizer switching, delete the bracketed option regarding placement of current-limiting fuses.

****

Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.[Connect current-limiting fuses ahead of the radial-feed load-break switch.]

****

NOTE: Provide bushing-mounted elbow type arresters at the ends of all radials and in normally open locations in loops. Provide arresters for all voltage levels above 5 kV.

****

][g. Surge arresters: IEEE C62.11, rated [3][6][9][10][12][15][18][21][24][27][30][36][_____] kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap.[Provide three arresters for radial feed circuits.][Provide [three][six] arresters for loop feed circuits.]

] h. Parking stands: Provide a parking stand near each bushing.[Provide insulated standoff bushings for parking of energized high-voltage connectors on parking stands.]

[i. Protective caps: IEEE 386, [200][600] amperes, [15][25][35][_____] kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushings.

][2.2.1.2 High Voltage, Live-Front

****

NOTE: Obtain approval from the Authority Having Jurisdiction (AHJ) when live-front is selected and delete the above paragraphs on dead-front.

****

High-voltage compartment contains: the incoming line, transformer high-voltage bushings, load-break switch handle(s),[access to oil-immersed bayonet fuses,][surge arresters,] tap changer handle, insulated phase barriers, and ground pad.

a. Cable terminators: Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

b. Load-break switch

****
NOTE: Choose between load-break radial-feed switch and load-break loop feed switches.
****

[Radial-feed two-position oil-immersed type rated at [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL], with a continuous current rating and load-break rating of [200][300][_____] amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

][Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch must be rated at [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL], with a continuous current rating and load-break rating of [200][300][_____] amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handles in the high-voltage compartment. Operation of switches must be as follows:

ARRANGEMENT NO.	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION					
		LINE A SW.		LINE B SW		XFMR. SW	
		OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE
1	Line A connected to Line B and both lines connected to transformer		X		X		X
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line B only	X			X		X
4	Transformer open and loop closed		X		X	X	
5	Transformer open and loop open	X		X		X	

****
NOTE: Provide bayonet type fuses for all transformer applications 38 kV and below.
****

][c. Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. The bayonet fuse links sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. Include an oil retention valve inside the bayonet assembly housing, which closes when the fuse holder is removed, and an external drip shield to minimize oil spills. Display a warning label adjacent to the bayonet fuse(s) cautioning against removing or inserting fuses unless the transformer has been de-energized and the tank pressure has been released.

Bayonet fuse assembly: 150 kV BIL.

****

NOTE: For transformers with loop-feed sectionalizer switching, delete the bracketed option regarding placement of current-limiting fuses.

****

Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.[Connect current-limiting fuses ahead of the radial-feed load-break switch.]

****

NOTE: Provide arresters at the ends of all radials and in normally open locations in loops. Provide arresters for all voltage levels above 5 kV.

****

][d. Surge arresters: IEEE C62.11, rated [3][6][9][10][12][15][18][21][24][27][30][36][_____] kV.[Provide three arresters for radial feed circuits.][Provide [three][six] arresters for loop feed circuits.]

] e. Insulated phase barriers: NEMA LI 1, Type GPO-3, 6.35 mm 0.25 inch minimum thickness. Provide vertical barriers between the high-voltage bushings and a single horizontal barrier above the high-voltage bushings.

]2.2.1.3 Low Voltage

****

NOTE: Installation of circuit breakers in the secondary compartment is not recognized by IEEE standards, and limits accessibility by covering lugs, gages, and accessories. Do not use.

****

Low-voltage compartment contains: low-voltage bushings with NEMA spade terminals, accessories, metering, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

a. Include the following accessories: drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

****

NOTE: Many Activities have, or are in the process of, converting to basewide metering systems. A unified metering specification is under development to replace the metering requirements in this section.

Use the first bracketed metering paragraph below for Navy projects and possibly for Air Force projects. Navy projects require use of section 26 27 14.00 20 ELECTRICITY METERING. Air Force projects may require use of section 26 27 13.10 30 ELECTRIC METERS.

Delete all other paragraphs for the Air Force and Navy projects.

Coordinate with the Activity and provide specific requirements "to match existing systems" when necessary. If specifying proprietary products, insure that appropriate "Justification and Authorization (J & A)" documentation has been obtained by project manager and "proprietary language requirements" have been added to Division 1 as well as to this section of the specifications.

If there are any components (such as meters, housing, or current transformers) that will be Government Furnished Contractor Installed (GFCI), or Government Furnished Government Installed (GFGI), edit Division 1 and this specification.

****

[b. Metering: Provide as specified in Section [26 27 14.00 20 ELECTRICITY METERING][26 27 13.10 30 ELECTRIC METERS].

][c. Metering: NEMA/ANSI C12.10. Provide a socket-mounted electronic programmable outdoor watthour meter, surface mounted flush against the side of the low-voltage compartment as indicated. Program the meter at the factory or in the field. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. Coordinate the meter to system requirements.

****

NOTE: When Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC is used, coordinate meter requirements. Form 9S, in text below, is for three-phase, four-wire wye systems, for other system configurations, designer must determine the appropriate form designation.

****

(1) Design: Provide meter designed for use on a 3-phase, 4-wire, [208Y/120][480Y/277] volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS)[as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC].

(2) Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

(3) Class: 20; Form: [9S][_____]; Accuracy: plus or minus 1.0 percent; Finish: Class II

(4) Cover: Polycarbonate and lockable to prevent tampering and unauthorized removal.

(5) Kilowatt-hour Register: five digit electronic programmable type

(6) Demand Register:

(a) Provide solid state

(b) Meter reading multiplier: Indicate multiplier on the meter face.

(c) Demand interval length: programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.

(7) Meter fusing: Provide a fuse block mounted in the secondary compartment containing one fuse per phase to protect the voltage input to the watthour meter. Size fuses as recommended by the meter manufacturer.

(8) Socket: ANSI C12.7. Provide NEMA Type 3R, box-mounted socket having automatic circuit-closing bypass and having jaws compatible with requirements of the meter. Cover unused hub openings with blank hub plates. Paint box [Munsell 7GY3.29/1.5 green][Munsell 5BG7.0/0.4 sky gray (ANSI 70)] [_____] to match the pad-mounted transformer to which the box-mounted socket is attached. The Munsell color notation is specified in ASTM D1535.

(9) Current transformers: IEEE C57.13. Provide butyl-molded window type current transformers with 600-volt insulation, 10 kV BIL and mount on the low-voltage bushings. Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters. Provide three current transformers per power transformer with characteristics listed in the following table.

****

NOTE: The following guidelines for specifying current transformers are based on the standard current transformer primary rating which is just below the full load current of the power transformer.

1. Select the appropriate current transformer (CT) ratio, continuous-thermal-current rating factor (RF) at 30 degrees C and ANSI Metering Accuracy Class values based on transformer kVA size and secondary voltage. Example: for a 500 kVA transformer at 208 volts - select 1200/5, 1.5, 0.3 - B-0.5.

	VOLTS					
	208			240		
kVA	**CT Ratio**	**RF**	**Meter Class**	**CT Ratio**	**RF**	**Meter Class**
75	**200/5**	**4.0**	**0.3 thru B-0.1**	**200/5**	**4.0**	**0.3 thru B-0.1**
112.5	**300/5**	**3.0**	**0.3 thru B-0.2**	**200/5**	**4.0**	**0.3 thru B-0.1**
150	**400/5**	**4.0**	**0.3 thru B-0.2**	**300/5**	**3.0**	**0.3 thru B-0.2**
225	**600/5**	**3.0**	**0.3 thru B-0.5**	**400/5**	**4.0**	**0.3 thru B-0.2**
300	**800/5**	**2.0**	**0.3 thru B-0.5**	**600/5**	**3.0**	**0.3 thru B-0.5**
500	**1200/5**	**1.5**	**0.3 thru B-0.5**	**1200/5**	**1.5**	**0.3 thru B-0.5**
750	**2000/5**	**1.5**	**0.3 thru B-1.8**	**1500/5**	**1.5**	**0.3 thru B-0.9**

	VOLTS					
	480			600		
kVA	**CT Ratio**	**RF**	**Meter Class**	**CT Ratio**	**RF**	**Meter Class**
75	**200/5,**	**4.0**	**0.3 thru B-0.1**	**200/5**	**4.0**	**0.3 thru B-0.1**
112.5	**200/5,**	**4.0**	**0.3 thru B-0.1**	**200/5**	**4.0**	**0.3 thru B-0.1**
150	**200/5,**	**4.0**	**0.3 thru B-0.1**	**200/5**	**4.0**	**0.3 thru B-0.1**
225	**200/5,**	**4.0**	**0.3 thru B-0.1**	**200/5**	**4.0**	**0.3 thru B-0.1**
300	**300/5,**	**3.0**	**0.3 thru B-0.2**	**200/5**	**4.0**	**0.3 thru B-0.1**
500	**600/5,**	**3.0**	**0.3 thru B-0.5**	**400/5**	**4.0**	**0.3 thru B-0.2**
750	**800/5,**	**2.0**	**0.3 thru B-0.5**	**600/5**	**3.0**	**0.3 thru B-0.5**
1000	**1200/5**	**1.5**	**0.3 thru B-0.5**	**800/5**	**2.0**	**0.3 thru B-0.5**
1500	**1500/5**	**1.5**	**0.3 thru B-0.9**	**1200/5**	**1.5**	**0.3 thru B-0.5**
2000	**2000/5**	**1.5**	**0.3 thru B-1.8**	**1500/5**	**1.5**	**0.3 thru B-0.9**
2500	**3000/5**	**1.33**	**0.3 thru B-1.8**	**2000/5**	**1.5**	**0.3 thru B-1.8**

2. Incorporate the appropriate values in table below.

****

kVA	Sec. Volt	CT Ratio	RF	Meter Acc. Class
[500]	[208Y/120]	[1200/5]	[1.5]	[0.3 thru B-0.5]
[750]	[480Y/277]	[800/5]	[2.0]	[0.3 thru B-0.5]

]2.2.2 Transformer

****

NOTE: Use the following guidelines for specifying transformers and insulating liquids.

1. On Navy projects use of biodegradable less-flammable liquid is required.

For other projects, biodegradable less-flammable liquid and mineral oil are permitted. Previously the use of mineral oil-filled transformers was recommended wherever possible. Currently, biodegradable less-flammable transformer liquids that improve transformer operating characteristics are available with little, if any premium cost. This requirement is supported by UFC 3-600-01, "Fire Protection Engineering for Facilities", identifies building and equipment separation distances based on insulating liquid type. Mineral oil is more restrictive than less-flammable liquid. For example, a 1500 kVA transformer containing 600 gallons of less-flammable liquid requires a building separation distance of 1.5 meters 5 feet when the construction is fire-resistant or non-combustible. An equally sized mineral oil-filled transformer requires 4.6 meters 15 feet and 7.6 meters 25 feet of separation for fire-resistant and non-combustible construction, respectively. Do not specify silicone-filled transformers.

2. Use IEEE C57.12.00, Table 8 - Designation of voltage ratings of three-phase windings, such as "4160 V - 480Y / 277 V". Connections must be Delta-GrdY configuration for three phase systems. Other system connections require waiver from UFC 3-550-01 criteria.

3. Include bracketed option to display transformer rating on enclosure when directed by Activity.

4. Delete (2) of item g regarding removable ground strap if transformer secondary winding is delta type.

****

a. Less-flammable [bio-based] liquid-insulated[or oil-insulated], two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

b. Transformer rated [_____] kVA.

c. Transformer voltage ratings: [_____] V [Delta][_____] - [_____] V

[GrdY][_____].[For GrdY - GrdY transformers, provide transformer with five-legged core design for third harmonic suppression.]

d. Tap changer: externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Indicate which tap setting is in use, clearly visible when the compartment is opened.

e. Minimum tested percent impedance at 85 degrees C:

(1) .50 for units rated 75kVA and below
(2) .87 for units rated 112.5kVA to 300kVA
(3) .03 for 500kVA rated units
(4) .32 for units rated 750kVA and above

f. Comply with the following audible sound level limits:

kVA	DECIBELS (MAX
75	51
112.5	55
150	55
225	55
300	55
500	56
750	57
1000	58
1500	60
2000	61
2500	62

g. Include:

(1) Lifting lugs and provisions for jacking under base, with base construction suitable for using rollers or skidding in any direction.

[(2) An insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

] (3) Provide transformer top with an access handhole.

[(4) kVA rating conspicuously displayed on its enclosure.

]2.2.2.1 Specified Transformer Efficiencies

****

NOTE: Transformer losses and efficiency requirements have been modified into the table included within the specification and the previous Navy loss tables have been deleted.

10 CFR 431, Subpart K is a result of the Energy Policy and Conservation Act (EPACT) of 2005 and is the "minimum" industry standard for distribution transformers manufactured on or after January 1, 2016.

****

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K. Submit certification, including supporting calculations, from the manufacturer indicating conformance.

kVA	EFFICIENCY (percent)
15	98.65
30	98.83
45	98.92
75	99.03
112.5	99.11
150	99.16
225	99.23
300	99.27
500	99.35
750	99.40
1000	99.43
1500	99.48
2000	99.51
2500	99.53

above 2500	99.54

2.2.3 Insulating Liquid

a. Less-flammable transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D92 and a dielectric strength not less than 33 kV tested per ASTM D877/D877M. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

Provide a fluid that is a biodegradable, electrical insulating, and cooling liquid classified by UL and approved by FM as "less flammable" with the following properties:

(1) Pour point: ASTM D97, less than -15 degree C

(2) Aquatic biodegradation: EPA 712-C-98-075, ultimately biodegradable as designated by EPA.

(3) Trout toxicity: OECD Test 203, zero mortality of EPA 821-R-02-012, pass

[b. Mineral oil: ASTM D3487, Type II, tested in accordance with ASTM D117. Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

]2.2.3.1 Liquid-Filled Transformer Nameplates

Provide nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.2.4 Corrosion Protection

****

NOTE: Use stainless steel bases and cabinets for most applications. In highly corrosive environments, the additional cost of totally stainless steel tanks and metering enclosures may be justified. Manufacturer's standard construction material is acceptable only in noncoastal and noncorrosive environments. Choose the second bracketed option for project locations with Environmental Severity Classifications (ESC) of C4 and C5. See UFC 1-200-01 for determination of ESC for project locations.

****

[Provide corrosion resistant bases and cabinets of transformers, fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L. Base includes any part of pad-mounted transformer that is within 75 mm 3 inches of concrete pad.

][Provide entire transformer assembly, including tank and radiator, base, enclosure, and metering enclosure fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L. Form enclosure of stainless steel sheets. The optional use of aluminum is permitted for the metering enclosure.

] Paint entire transformer assembly [Munsell 7GY3.29/1.5 green][Munsell 5BG7.0/0.4 sky gray (ANSI 70)][_____], with paint coating system complying with IEEE C57.12.28 [and IEEE C57.12.29]regardless of base, cabinet, and tank material. The Munsell color notation is specified in ASTM D1535.

2.3 WARNING SIGNS AND LABELS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts in accordance with NEMA Z535.4 and NEMA 260.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning labels on the outside of the high voltage compartment door(s)with nominal dimensions of 178 by 255 mm 7 by 10 inches with the legend "WARNING HIGH VOLTAGE" printed in two lines of nominal 50 mm 2 inch high letters. Include the work "WARNING" in white letters on an orange background and the words "HIGH VOLTAGE" in black letters on a white background.

[b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 355 by 255 mm 14 by 10 inches with the legend "WARNING HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 75 mm 3 inch high white letters on an orange and black field.

]2.4 ARC FLASH WARNING LABEL

****

NOTE: Include the Arc Flash Warning Label detail on the drawings. See the technical notes at the beginning of section to obtain the AutoCAD drawing file of the label.

****

Provide arc flash warning label for the enclosure of pad-mounted transformers. Locate this self-adhesive warning label on the outside of the high voltage compartment door warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

2.5 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

[2.6 PADLOCKS

****

NOTE: Designer must assure that Section 08 71 00 DOOR HARDWARE is included and is edited to include padlocks.

Do not use this paragraph for Navy and Air Force projects.

****

Provide padlocks for pad-mounted equipment[and for each fence gate], keyed [alike][as directed by the Contracting Officer]. Comply with Section 08 71 00 DOOR HARDWARE.

]2.7 CAST-IN-PLACE CONCRETE

****

NOTE: Use the first bracketed paragraph when project includes a concrete section in Division 03; otherwise, the second bracketed paragraph may be used. Coordinate requirements with Section 03 30 00 CAST-IN-PLACE CONCRETE.

****

[Provide concrete associated with electrical work for other than encasement of underground ducts rated for 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.
]

****

NOTE: If concrete requirements are detailed and no cast-in-place section is to be included in the project specification, refer to Section 03 30 00 CAST-IN-PLACE CONCRETE and select such portions as needed to provide complete requirements in addition to the requirements below.

****

[Provide concrete associated with electrical work as follows:

a. Composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture.

b. Fine aggregate: hard, dense, durable, clean, and uncoated sand.

c. Coarse aggregate: reasonably well graded from 4.75 mm to 25 mm 3/16 inch to 1 inch.

d. Fine and coarse aggregates: free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances.

e. Water: fresh, clean, and free from salts, alkali, organic matter, and other impurities.

f. Concrete associated with electrical work for other than encasement of underground ducts: 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise.

g. Slump: Less than 100 mm 4 inches. Retempering of concrete will not be permitted.

h. Exposed, unformed concrete surfaces: smooth, wood float finish.

i. Concrete must be cured for a period of not less than 7 days, and concrete made with high early strength portland cement must be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer.

j. Air entrain concrete exposed to weather using an air-entraining admixture conforming to ASTM C260/C260M.

k. Air content: between 4 and 6 percent.

]2.8 SOURCE QUALITY CONTROL

2.8.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

  (1) Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

  (2) Accuracy: Traceable to the National Institute of Standards and Technology.

  (3) Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.

  (4) Dated calibration labels: visible on all test equipment.

  (5) Calibrating standard: higher accuracy than that of the instrument tested.

  (6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

    (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

    (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.8.2 Design Tests

IEEE C57.12.00, and IEEE C57.12.90. Section 5.1.2 in IEEE C57.12.80 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for[each of] the specified transformer(s), with design tests performed prior to the award of this contract.

a. Tests: certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (KNAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests includes the primary windings only of that transformer.

  (1) IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

  (2) State test voltage levels.

  (3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.34.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

2.8.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests: performed in accordance with IEEE C57.12.90 by the manufacturer on[each of] the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence as follows:

a. Phase relation

b. Ratio

c. No-load losses (NLL) and excitation current

d. Load losses (LL) and impedance voltage

e. Dielectric

  (1) Impulse

  (2) Applied voltage

  (3) Induced voltage

f. Leak

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Pad-Mounted Transformer Grounding

****

NOTE: Ensure plans show the secondary neutral grounding conductor sized in accordance with NFPA 70 and the primary neutral grounding conductor when required. Ensure the CADD detail used matches how this paragraph is edited. Transformer is to have a ground ring and the normal number of ground rods is either four or two. The one ground rod option should only be chosen if required by local installation requirements.

****

Provide a ground ring around the transformer with [1/0][4/0] AWG bare copper.[Provide four ground rods in the ground ring, one per corner.][Provide two ground rods in the ground ring at opposite corners.][Provide one ground rod in the ground ring with the ground rod located in the transformer cabinet.] Install the ground rods at least 3000 mm 10 feet apart from each other. Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

[3.3.1 Meters and Current Transformers

****

Note: Delete this paragraph for Navy and Air Force projects, this information is covered in their associated metering specifications.

****

ANSI C12.1.

]3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

[3.5 WARNING SIGN MOUNTING

****

NOTE: Include the following option when pad-mounted transformer is guarded by a fence.

****

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 9 meters 30 feet apart.

]3.6 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the requirement is located. Include construction requirements for concrete slab only if slab is not detailed on drawings. Do not provide curbs or raised edges around liquid filled transformers unless specifically approved by Technical Proponent (link provided in the technical note at the beginning of this section).

****

Mount transformer on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 200 mm 8 inches thick, reinforced with a 152 by 152 mm MW19 by MW19 6 by 6 inches - W2.9 by W2.9 mesh placed uniformly 100 mm 4 inches from the top of the slab.

b. Place slab on a 150 mm 6 inch thick, well-compacted gravel base.

c. Install slab such that top of concrete slab is approximately 100 mm 4 inches above the finished grade with gradual slope for drainage.

d. Provide edges above grade with 15 mm 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 200 mm 8 inches beyond the equipment.

Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.6.1 Cast-In-Place Concrete

****

NOTE: Use the first bracketed option when project includes a concrete section in Division 03; otherwise, the second bracketed option may be used.
****

Provide cast-in-place concrete work in accordance with the requirements of[Section 03 30 00 CAST-IN-PLACE CONCRETE][ACI 318][ACI 318M].

[3.6.2 Sealing

****
NOTE: Require sealing of cable wells (windows) in the concrete pad if rodent intrusion is a problem.
****

When the installation is complete, seal all entries into the equipment enclosure with an approved sealing method. Provide seals of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

]3.7 FIELD QUALITY CONTROL

3.7.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS. Submit reports, including acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

3.7.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

   (1) Compare equipment nameplate data with specifications and approved shop drawings.

   (2) Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

   (3) Inspect anchorage, alignment, and grounding.

   (4) Verify the presence of PCB content labeling.

   (5) Verify the bushings and transformer interiors are clean.

   (6) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

   (7) Verify correct liquid level in tanks and bushings.

   (8) Verify that positive pressure is maintained on gas-blanketed transformers.

   (9) Perform specific inspections and mechanical tests as recommended by manufacturer.

(10) Verify de-energized tap changer position is left as specified.

[(11) Verify the presence of transformer surge arresters.

] b. Electrical tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

(2) Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

[(3) Perform insulation-resistance tests, winding-to-winding and each winding-to-ground. Calculate polarization index. Verify that the tap changer is set at the specified ratio.

(4) Perform turns-ratio tests at all tap positions.

(5) Perform insulation power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer’s published data.

(6) Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests.

(7) Measure the resistance of each high-voltage winding in each de-energized tap-changer position. Measure the resistance of each low-voltage winding in each de-energized tap-changer position, if applicable.

(8) Remove and test a sample of insulating liquid for the following: Dielectric breakdown voltage, Acid neutralization number, Specific gravity, Interfacial tension, Color, Visual Condition, Water in insulating liquids (Required on 25 kV or higher voltages and on all silicone-filled units.), and Power factor or dissipation factor.

(9) Perform dissolved-gas analysis (DGA) on a sample of insulating liquid.

][3.7.1.2 Current Transformers

****

Note: Delete bracketed optional paragraphs for Navy and Air Force projects. This information is covered in their associated metering specifications.

****

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and

secondary circuit wiring.

(5) Verify the unit is clean.

(6) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(7) Verify that all required grounding and shorting connections provide good contact.

(8) Verify correct operation of transformer withdrawal mechanism and grounding operation.

(9) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) Perform insulation-resistance test.

(3) Perform a polarity test.

(4) Perform a ratio-verification test.

][3.7.1.3 Watthour Meter

****

Note: Delete bracketed optional paragraphs for Navy and Air Force projects. This information is covered in their associated metering specifications.

****

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical tests

(1) Calibrate watthour meters according to manufacturer's published data.

(2) Verify that correct multiplier has been placed on face of meter, where applicable.

(3) Verify that current transformer secondary circuits are intact.

]3.7.1.4 Grounding System

a. Visual and mechanical inspection

   (1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

   (1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

   (2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

[3.7.1.5 Surge Arresters, Medium- and High-Voltage

a. Visual and mechanical inspection

   (1) Compare equipment nameplate data with specifications and approved shop drawings.

   (2) Inspect physical and mechanical condition.

   (3) Inspect anchorage, alignment, grounding, and clearances.

   (4) Verify the arresters are clean.

   (5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

   (6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

b. Electrical tests

   (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

   (2) Perform an insulation-resistance test on each arrester, phase terminal-to-ground.

   (3) Test grounding connection.

]3.7.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times of checking and testing.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 12 21 (November 2022)**
Change 1 - 11/23

Preparing Activity: NAVFAC **Superseding**
UFGS-26 12 21 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 26 - ELECTRICAL

SECTION 26 12 21

SINGLE-PHASE PAD-MOUNTED TRANSFORMERS

11/22, CHG 1: 11/23

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 12 21 (November 2022)**
Change 1 - 11/23

Preparing Activity: NAVFAC **Superseding**
UFGS-26 12 21 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 26 12 21

SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
11/22, CHG 1: 11/23

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NOTE: This guide specification covers the requirements for single-phase clam shell type and two-compartment type pad-mounted transformers of the dead-front type for exterior applications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: For Navy and Air Force projects, this specification incorporates a "reduced shop drawing submittal process" for listed manufacturers who previously satisfied reduced shop drawing submittal process requirements. This specification also includes unique routine and other test requirements, transformer loss certificate, transformer test schedule, and field quality control acceptance tests and reports. The preparing activity, NAVFAC LANT, has significant experience and technical expertise in these areas. If Reach-back support during construction is desired, for a specific NAVFAC or Air Force project, the technical representative (electrical engineer) editing this document for that project must contact the NAVFAC LANT Capital

Improvements Electrical Engineering (Code CI44) Office for consultation during the design stage of the project, prior to including the requirement in the specification.

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NOTE: Use the following related guide specifications for power distribution equipment:

--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION
--Section 26 11 16 SECONDARY UNIT SUBSTATIONS
--Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
--Section 26 13 00 SF6/HIGH-FIREPOINT FLUID INSULATED PAD-MOUNTED SWITCHGEAR
--Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM
--Section 26 23 00 LOW VOLTAGE SWITCHGEAR
--Section 26 24 13 SWITCHBOARDS
--Section 26 27 13.10 30 ELECTRIC METERS
--Section 26 27 14.00 20 ELECTRICITY METERING
--Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION

Do not use the following related guide specifications except for Army Civil Works projects. They have not been unified:

--Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION
--Section 26 22 00.00 10 480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS
--Section 26 28 00.00 10 MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS

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NOTE: Coordination is required between this Section and metering equipment specification sections. See Section 26 27 14.00 20 ELECTRICITY METERING or Section 26 27 13.10 30 ELECTRIC METERS for metering details, which are available in metric (SI) and U.S. Customary (IP) system dimension. Use these files to develop project specific drawings, including:

File Name	**Description**
PADMDE7	**Single Phase, One Circuit with Surge Arresters**
PADMDE8	**Single Phase, Feed-Thru Circuit with Surge Arresters**
ARCFLASH	**Arc Flash Warning Label**

NOTE: To download these details, go to:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables
Pad-mounted transformer graphics are located with Pad-Mounted Transformer Specification UFGS 26 12 21.

Select the appropriate Electrical .ZIP file(s) and extract the desired details.

Do not include list of details, or details themselves, in project specifications. Insert the appropriate details on drawings and modify optional and blank items. If special features are required, do not modify details, but indicate these changes as notes below the detail.

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NOTE: Show the following information on the project drawings:

1. Single-line diagram showing pad-mounted transformer connectors, inserts, surge arresters, switches, fuses, current transformers with ratings, and meters as applicable.

2. Grounding plan.

3. Type and number of cables, and size of conductors for each power circuit.

4. Transformer primary and secondary voltages. (Use IEEE C57.12.00, Table 7, "Designation of voltage ratings of single-phase windings"). State the primary voltage (nominal) actually in service and not the voltage class.

5. Special conditions, such as altitude, temperature, and humidity; exposure to fumes, vapors, dust, and gases; and seismic requirements.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile

references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM D92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97	(2017b) Standard Test Method for Pour Point of Petroleum Products
ASTM D117	(2018) Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
ASTM D877/D877M	(2019) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D3487	(2016; E2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.47	(2011) Standard for High Voltage Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches
IEEE C57.12.00	(2021) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.25	(1990) Standard for Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers With Separable Insulated High-Voltage Connectors; High Voltage, 34,500 Grdy/ 19,920 Volts and Below; Low Voltage, 240/120 Volts; 167 kVa and Smaller Requirements
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2021) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7	(2022) Requirements for Watthour Meter Sockets
NEMA 260	(1996; R 2004) Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas
NEMA Z535.4	(2023) Product Safety Signs and Labels
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 712-C-98-075	(1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
EPA 821-R-02-012	(2002) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

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NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.

****

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this Section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-Mounted Transformer Drawings; G, [_____]

SD-03 Product Data

Single-Phase Pad-Mounted Transformers (Dead-Front); G, [_____]

SD-06 Test Reports

Acceptance Checks and Tests; G, [_____]

SD-07 Certificates

Transformer Efficiencies; G, [_____]

SD-09 Manufacturer's Field Reports

Transformer Test Schedule; G, [_____]

Pad-Mounted Transformer Design Tests; G, [_____]

Pad-Mounted Transformer Routine and Other Tests; G, [_____]

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5; G, [_____]

[1.4.1 Government Submittal Review

****

NOTE: Include this bracketed option on Navy and Air Force projects where "reach-back support" has already been coordinated with NAVFAC LANT per the 2nd introductory Technical Note. Add appropriate information in Section 01 33 00 SUBMITTAL PROCEDURES to coordinate with the special requirements.

****

[Code CI44, NAVFAC LANT, Naval Facilities Engineering Systems Command][_____] will review and approve all submittals in this section requiring Government approval.

][1.4.2 Reduced Submittal Requirements

****

NOTE: Include this bracketed reduced submittal requirements paragraph on Navy and Air Force Projects.

****

Transformers designed and manufactured by ABB in Jefferson City, MO; by Eaton's Cooper Power Series Transformers in Waukesha, WI; by ERMCO in Dyersburg, TN; or by Howard Industries in Laurel, MS need not submit the entire submittal package requirements of this contract. Instead, submit the following items:

a. A certification, signed by the manufacturer, stating that the manufacturer will meet the technical requirements of this specification.

b. An outline drawing of the transformer with devices identified (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item a).

c. ANSI nameplate data of the transformer (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item b).

****

NOTE: The designer is responsible for providing proper settings for secondary over-current device(s) to ensure proper protection of equipment and coordination with transformer high side fuses. Include the following option for transformers serving secondary over-current devices containing adjustable trips.

****

[d. Manufacturer's published time-current curves in PDF format and in electronic format suitable for import or updating into the [EasyPower] [SKM PowerTools for Windows] [_____] computer program of the transformer high side fuses (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item e).

] e. Routine and other tests (in PART 2, see paragraph SOURCE QUALITY CONTROL, subparagraph ROUTINE AND OTHER TESTS), conducted by the manufacturer. These tests may be witnessed by the government. Provide transformer test schedule required by submittal item "SD-11 Closeout Submittals". Provide certified copies of the tests.

f. Provide acceptance test reports required by submittal item "SD-06 Test Reports".

g. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data".

]1.5 QUALITY ASSURANCE

1.5.1 Pad-Mounted Transformer Drawings

****

NOTE: Delete bracketed information for Navy and Air Force projects when separate metering specification is used. May still need for Army projects until metering specification is unified.

****

Include the following as a minimum:

a. An outline drawing, including front, top, and side views.

b. IEEE nameplate data.

[c. Elementary diagrams and wiring diagrams with terminals identified of meter and current transformers.

] d. One-line diagram, including switch(es)[, current transformers, meters,] and fuses.

e. Manufacturer's published time-current curves in PDF format and in electronic format suitable for import or updating into the [EasyPower] [SKM PowerTools for Windows] [_____] computer program of the transformer high side fuses.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

****

Note: Delete bracketed information for Navy and Air Force projects when separate metering specification is used. May still need for Army projects until metering specification is unified.

****

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein. In addition to requirements of Data Package 5, include the following on the actual transformer(s) provided:

a. An instruction manual with pertinent items and information highlighted.

b. An outline drawing, front, top, and side views.

c. Prices for spare parts and supply list.

d. Routine and field acceptance test reports.

e. Fuse curves for primary fuses.

[f. Information on watthour demand meter, CT's, and fuse block.

] g. Actual nameplate diagram.

h. Date of purchase.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be pad-mounted transformers and related accessories are specified in[Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION,][Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM,][and][Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

2.2 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS (DEAD-FRONT)

****

NOTE: According to IEEE 386, 200 ampere separable insulated connectors normally used on dead-front pad-mounted transformers have both a fault closure and a short-time current rating of 10,000 amperes. Therefore, from a safety standpoint, dead-front configurations which utilize these connectors should only be used at system locations which have available fault currents of less than 10,000 rms symmetrical amperes.

Normally use single compartment (clam shell) transformers. If two-compartment transformers are required, their use must be approved by the the technical review authority.

Utilization of 35 kV single-phase transformers is not a recommended design practice. Therefore, approval for use is required by the technical review authority and significant changes to this specification would be required.

This specification does not address the materials used for the winding (copper versus aluminum) and it is assumed that the manufacturer will provide their standard product with respect to the winding construction, based on the cost of materials at the time of order acceptance. No failure data has been obtained indicating that copper windings have a longer life than aluminum windings. If copper windings are specified, the cost increase for single-phase distribution transformers has recently been about 15 percent. Do NOT specify winding materials.

****

IEEE C57.12.25, IEEE C57.12.28 and as specified herein. Submit manufacturer's information for each component, device, insulating fluid, and accessory provided with the transformer.

2.2.1 Compartment Construction

[a. Single compartment: Provide Type 1 combination high- and low-voltage compartment, clam shell style, with lockable (having pad-locking provisions) hinged cover and single-point latching. Type 1 is defined by IEEE C57.12.25.

][b. Two compartment: Provide high- and low-voltage compartments separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors:

(1) Hinged lift-off type with stop in open position and three-point latching.

(2) High voltage door fastening accessible only after the low voltage door has been opened.

]2.2.1.1 High Voltage

****

NOTE: Current policy is to use oil-immersed fuses in series with current limiting fuses to achieve better protection and obtain life cycle cost benefits.

For 15 kV and 25 kV, 200 A bushings, select bushing wells and bushing well inserts.

Use two bushing wells for phase-to-neutral systems and four bushing wells for phase-to-phase systems. Coordinate with transformer voltage designations in paragraph TRANSFORMER. If feed through applications are required, special transformer compartment sizing may be necessary.

If feed through inserts are used, then ensure the enclosure is specified to be wide enough and deep enough to contain the inserts with conductors terminated.

Delete dead-break connectors and load-break switch handle options except for systems with a fault capability greater than 10,000 amps or when the primary cable size is greater than No. 4/0 AWG. This design requires approval of the technical review authority.

Do not provide standoff bushings unless this transformer is the only dead-front transformer on the base. Public works normally carries standoff bushings in their vehicles. Provide protective caps when providing standoff bushings and to cover unused bushing well inserts when not providing surge arresters.

Coordinate lead-in paragraph with bracketed options below.

****

High-voltage portion contains: the incoming line, insulated high-voltage [load-break][dead-break]connectors, bushing well inserts,[feed-through inserts,] [two][four] high-voltage bushing wells configured for loop feed application,[load-break switch handle(s),] access to oil-immersed fuses,[dead-front surge arresters,] tap changer handle, connector parking stands[

with insulated standoff bushings],[protective caps,] and ground pad.

[a. Insulated high-voltage load-break connectors: IEEE 386, rated [15][_____] kV, [95][_____] kV BIL. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Provide connectors and inserts from the same manufacturer. Provide connectors with a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

][b. Insulated high-voltage dead-break connectors: IEEE 386, rated [15 kV, 95 kV BIL][25 kV, 125 kV BIL]. Current rating: 600 amperes rms continuous. Short time rating: 25,000 amperes rms symmetrical for a time duration of 0.17 seconds. Provide connectors with a [200 ampere bushing interface for surge arresters,] steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

] c. Bushing well inserts[and feed-through inserts]: IEEE 386, 200 amperes, [15][_____] kV class. Provide a bushing well insert for each bushing well unless indicated otherwise.[Provide feed-through inserts as indicated.]

[d. One-piece bushings: IEEE 386, 600 amperes, [15][25] kV Class.

][e. Load-break switch: Radial-feed oil-immersed type rated at [15 kV, 95 kV BIL][25 kV, 125 kV BIL], with a continuous current rating and load-break rating of [200][300][_____] amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

] f. Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. The bayonet fuse links sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. Include an oil retention valve inside the bayonet assembly housing, which closes when the fuse holder is removed, and an external drip shield to minimize oil spills. Display a warning label adjacent to the bayonet fuse(s) cautioning against removing or inserting fuses unless the transformer has been de-energized and the tank pressure has been released.

Bayonet fuse assembly: 150 kV BIL.

****

NOTE: Delete the bracketed option regarding placement of current-limiting fuses except when load-break switch is specified.

****

Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.[Connect current-limiting fuses ahead of the radial-feed load-break switch.]

****

NOTE: Provide bushing-mounted elbow type arresters at the ends of all radials. Provide arresters for

all voltage levels above 5 kV.
****

[g. Surge arresters: IEEE C62.11, rated [3][6][9][10][12][15][_____] kV, fully shielded, dead-front metal-oxide-varistor, elbow type with resistance-graded gap suitable for plugging into inserts as indicated.

] h. Parking stands: Provide a parking stand near each bushing well.[Provide insulated standoff bushings for parking of energized load-break connectors on parking stands.]

[i. Protective caps: IEEE 386, 200 amperes, [15][25][_____] kV class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushing well inserts[and insulated standoff bushings].

]2.2.1.2 Low Voltage

****
NOTE: Installation of circuit breakers in the transformer is not recognized by IEEE standards, and limits accessibility by covering lugs, gauges, and accessories. Do not use.

Coordinate lead-in paragraph with bracketed options below.
****

Low-voltage portion contains: low-voltage bushings with NEMA spade terminals, accessories,[metering,] stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

a. Include the following accessories: drain plug, fill plug, pressure relief device and a liquid level sight gage.

****
NOTE: Many Activities have, or are in the process of, converting to basewide metering systems. A unified metering specification is under development to replace the metering requirements in this section.

For single-compartment (clam shell type) transformers, use the first bracketed paragraph to provide a self-contained meter base at the facility served by the transformer, such as individual housing units or lift stations. For two-compartment transformers, use the second bracketed paragraph below for Navy projects and possibly for Air Force projects. Navy projects require use of Section 26 27 14.00 20 ELECTRICITY METERING. Air Force projects may require use of Section 26 27 13.10 30 ELECTRIC METERS. Delete the third bracketed paragraphs below for Air Force and Navy projects.

Coordinate with the Activity and provide specific requirements "to match existing systems" when necessary. If specifying proprietary products, insure that appropriate "Justification and Authorization (J & A)" documentation has been

obtained by project manager and "proprietary language requirements" have been added to Division 1 as well as to this section of the specifications.

If there are any components (such as meters, housing, or current transformers) that will be Government Furnished Contractor Installed (GFCI), or Government Furnished Government Installed (GFGI), edit Division 1 and this specification section.

****

b. Metering

[For single-compartment (clam shell type) transformers, provide a self-contained meter base at the facility to be served by the transformer, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

][For two-compartment transformers, provide as specified in Section [26 27 13.10 30 ELECTRIC METERS][26 27 14.00 20 ELECTRICITY METERING].

][For two-compartment transformers, provide a transformer-rated meter at the secondary portion of the transformer.

[(1) NEMA/ANSI C12.10. Provide a socket-mounted electronic programmable outdoor watthour meter, surface mounted flush against the side of the low-voltage compartment as indicated. Program the meter at the factory or in the field. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. Coordinate the meter to system requirements.

****

NOTE: When Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC is used, coordinate meter requirements. Form 4S, in text below, is for single-phase, three-wire systems. For other system configurations, designer must determine the appropriate form designation.

****

(a) Design: Provide meter designed for use on a single-phase, three-wire, [240/120][480/240] volt system with two current transformers. Include necessary KYZ pulse initiation hardware for energy monitoring and control system (EMCS)[as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC].

(b) Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

(c) Class: 20; Form: 4S, accuracy: plus or minus 1.0 percent Finish: Class II.

(d) Cover: Polycarbonate and lockable to prevent tampering and unauthorized removal.

(e) Kilowatt-hour register: five digit electronic programmable type.

(f) Demand register:

1. Provide solid state.

2. Meter reading multiplier: Indicate multiplier on the meter face.

3. Demand interval length: programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.

(g) Meter fusing: Provide a fuse block mounted in the secondary side containing one fuse per phase to protect the voltage input to the meter. Size fuses as recommended by the meter manufacturer.

(h) Socket: ANSI C12.7. Provide NEMA Type 3R, box-mounted socket having automatic circuit-closing bypass and having jaws compatible with requirements of the meter. Cover unused hub openings with blank hub plates. Paint box Munsell 7GY3.29/1.5 green to match the pad-mounted transformer to which the box-mounted socket is attached. The Munsell color notation is specified in ASTM D1535.

] (2) Current transformers IEEE C57.13. Provide butyl-molded window type current transformers with 600-volt insulation, 10 kV BIL and mount on the low-voltage bushings. Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters. Provide two current transformers per power transformer with characteristics listed in the following table.

****

NOTE: The following guidelines for specifying current transformers are based on the standard current transformer primary rating which is just below the full load current of the power transformer.

1. Select the appropriate current transformer (CT) ratio, continuous-thermal-current rating factor (RF) at 30 degrees C and ANSI metering accuracy class values based on transformer kVA size and secondary voltage. Example: for a 50 kVA transformer at 240 volts - select 200/5, 4.0, 0.3 through B-0.1.

	VOLTS					
	240			**480**		
kVA	**CT Ratio**	**RF**	**Meter Class**	**CT Ratio**	**RF**	**Meter Class**
15	**200/5,**	**4.0,**	**0.3 thru B-0.1**	**200/5,**	**4.0,**	**0.3 thru B-0.1**
25	**200/5,**	**4.0,**	**0.3 thru B-0.1**	**200/5,**	**4.0,**	**0.3 thru B-0.1**
37.5	**200/5,**	**4.0,**	**0.3 thru B-0.1**	**200/5,**	**4.0,**	**0.3 thru B-0.1**
50	**200/5,**	**4.0,**	**0.3 thru B-0.1**	**200/5,**	**4.0,**	**0.3 thru B-0.1**

	VOLTS					
	240			**480**		
kVA	**CT Ratio**	**RF**	**Meter Class**	**CT Ratio**	**RF**	**Meter Class**
75	**300/5,**	**3.0,**	**0.3 thru B-0.2**	**200/5,**	**4.0,**	**0.3 thru B-0.1**
160	**400/5,**	**4.0,**	**0.3 thru B-0.2**	**200/5,**	**4.0,**	**0.3 thru B-0.1**
167	**600/5,**	**3.0,**	**0.3 thru B-0.5**	**300/5,**	**3.0,**	**0.3 thru B-0.2**

2. Incorporate the appropriate values in table.
****

NAME	kVA	Sec. Volt	CT Ratio	RF	Meter Acc. Class
[T1]	[50]	[240]	[200/5]	[4.0]	[0.3 thru B-0.1]
[T2]	[75]	[480]	[200/5]	[4.0]	[0.3 thru B-0.1]

]2.2.2 Transformer

****
NOTE: Use the following guidelines for specifying transformers and insulating liquids.

1. On Navy projects use of biodegradable less-flammable liquid is required.

For other projects, biodegradable less-flammable liquid and mineral oil are permitted. Previously the use of mineral oil-filled transformers was recommended wherever possible. Currently, biodegradable less-flammable transformer liquids that improve transformer operating characteristics are available with little, if any premium cost. This requirement is supported by UFC 3-600-01, "Fire Protection Engineering for Facilities", identifies building and equipment separation distances based on insulating liquid type. Mineral oil is more restrictive than less-flammable liquid. For example, a 1500 kVA transformer containing 600 gallons of less-flammable liquid requires a building separation distance of 1.5 meters 5 feet when the construction is fire-resistant or non-combustible. An equally sized mineral oil-filled transformer requires 4.6 meters 15 feet and 7.6 meters 25 feet of separation for fire-resistant and non-combustible construction, respectively. Do not specify silicone-filled transformers.

2. Use IEEE C57.12.00, Table 7, voltage designations, such as "4160 V - 240/120 V" for

transformers connected phase-phase on the primary side, or "4160GrdY/2400 V - 240/120 V" for transformers connected phase-neutral on the primary side. Coordinate the number of bushing wells (either two or four depending on phase-to-neutral, or phase-to-phase systems) with the primary voltage.

3. Tap ratings may vary from those indicated, especially in lower kVA ratings.

4. Include bracketed option to display transformer rating on enclosure when directed by Activity.
****

a. Less-flammable[bio-based] liquid-insulated[or oil-insulated], two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

[b. Rated [_____] kVA][With characteristics per the following table:

NAME	LOCATION	kVA	Voltage
[T1]	[AMTC Site 1]	[50]	[240/120]
[T2]	[AMTC Site 2]	[75]	[240/120]

] c. Voltage ratings: [[_____] V - [240/120][480/240] V][see table].

d. Tap changer: externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Indicate which tap setting is in use, clearly visible when the compartment is opened.

e. Minimum tested percent impedance at 85 degrees C:

(1) .50 for units rated 25 kVA and below
(2) .87 for units rated 37.5 kVA to 100 kVA
(3) .03 for 167 kVA rated units

f. Comply with the following audible sound level limits:

kVA	DECIBELS (MAX)
10	48
15	48
25	48
37.5	48
50	48
75	51

kVA	DECIBELS (MAX)
100	51
167	55

****
NOTE: Use "lifting lugs" on two-compartment and "recessed stainless steel lifting provisions" on clam shell type transformers. Delete the "access handhole" on clam shell type transformers.
****

g. Include:

(1) [Lifting lugs and provisions for jacking under base][Recessed stainless steel lifting provisions], with base construction suitable for using rollers or skidding in any direction.

(2) An insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

[(3) Provide transformer top with an access handhole.

][(4) kVA rating conspicuously displayed on its enclosure.

]2.2.2.1 Specified Transformer Efficiencies

****
NOTE: Transformer losses and efficiency requirements have been modified into the table included within the specification and the previous Navy loss tables have been deleted.

10 CFR 431, Subpart K is a result of the Energy Policy and Conservation Act (EPACT) of 2005 and is the "minimum" industry standard for distribution transformers manufactured on or after January 1, 2016.
****

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K. Submit certification, including supporting calculations, from the manufacturer indicating conformance.

kVA	EFFICIENCY (percent)
10	98.70
15	98.82

kVA	EFFICIENCY (percent)
25	98.95
37.5	99.05
50	99.11
75	99.19
100	99.25
167	99.33

2.3 INSULATING LIQUID

****

NOTE: On Navy projects use of biodegradable less-flammable liquid is required.

****

a. Less-flammable[bio-based] transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D92 and a dielectric strength not less than 33 kV tested per ASTM D877/D877M. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

Provide a fluid that is a biodegradable,[bio-based] electrical insulating, and cooling liquid classified by UL and approved by FM as "less flammable" with the following properties:

(1) Pour point: ASTM D97, less than -15 degree C.

(2) Aquatic biodegradation: EPA 712-C-98-075, 100 percent.

(3) Trout toxicity: OECD Test 203, zero mortality of EPA 821-R-02-012, pass.

[b. Mineral oil: ASTM D3487, Type II, tested in accordance with ASTM D117. Provide identification of transformer as non-PCB and Type II mineral oil on the nameplate.

]2.4 LIQUID-FILLED TRANSFORMER NAMEPLATES

Provide nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.5 CORROSION PROTECTION

****

NOTE: Use stainless steel bases and cabinets for most applications. In hostile environments, the additional cost of totally stainless steel tanks and metering enclosures may be justified. Manufacturer's standard construction material is acceptable only in noncoastal and noncorrosive environments. Choose the second main bracketed

option for hostile environments.
****

[Provide corrosion resistant bases and cabinets of transformers, fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L. Base includes any part of pad-mounted transformer that is within 75 mm 3 inches of concrete pad.

][Provide entire transformer assembly, including tank and radiator, base, enclosure, and metering enclosure fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L. Form enclosure of stainless steel sheets. The optional use of aluminum is permitted for the metering enclosure.

] Paint entire transformer assembly [Munsell 7GY3.29/1.5 green][Munsell 5BG7.0/0.4 sky gray (ANSI 70)][_____], with paint coating system complying with IEEE C57.12.28 [and IEEE C57.12.29]regardless of base, cabinet, and tank material. The Munsell color notation is specified in ASTM D1535.

2.6 WARNING SIGNS AND LABELS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts in accordance with NEMA Z535.4 and NEMA 260.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning labels on the outside of the high voltage compartment door(s) with nominal dimensions of 178 by 255 mm 7 by 10 inches with the legend "WARNING HIGH VOLTAGE" printed in two lines of nominal 50 mm 2 inch high letters. Include the word "WARNING" in white letters on an orange background and the words "HIGH VOLTAGE" in black letters on a white background.

[b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 355 by 255 mm 14 by 10 inches with the legend "WARNING HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 75 mm 3 inch high white letters on an orange and black field.

]
****
NOTE: Include the Arc Flash Warning Label detail on the drawings. See the technical notes at the beginning of section to obtain the AutoCAD drawing file of the label.
****

Provide arc flash warning label for the enclosure of pad-mounted transformers. Locate this self-adhesive warning label on the outside of the high voltage compartment side warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

2.7 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

[2.8 PADLOCKS

****

NOTE: Ensure that Section 08 71 00 DOOR HARDWARE is included and is edited to include padlocks.

Do not use this paragraph for Navy and Air Force projects.

****

Provide padlocks for pad-mounted equipment[and for each fence gate], keyed [alike][as directed by the Contracting Officer]. Comply with Section 08 71 00 DOOR HARDWARE.

]2.9 CAST-IN-PLACE CONCRETE

****

NOTE: Use the first bracketed paragraph when project includes a concrete section in Division 03; otherwise, use the second bracketed paragraph. Coordinate requirements with Section 03 30 00 CAST-IN-PLACE CONCRETE.

****

[Provide concrete associated with electrical work for other than encasement of underground ducts rated for 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.
]

****

NOTE: If concrete requirements are detailed and no cast-in-place section is to be included in the project specification, refer to Section 03 30 00 CAST-IN-PLACE CONCRETE and select such portions as needed to provide complete requirements in addition to the requirements below.

****

[Provide concrete associated with electrical work as follows:

a. Composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture.

b. Fine aggregate: hard, dense, durable, clean, and uncoated sand.

c. Coarse aggregate: reasonably well graded from 4.75 mm to 25 mm 3/16 inch to 1 inch.

d. Fine and coarse aggregates: free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances.

e. Water: fresh, clean, and free from salts, alkali, organic matter, and other impurities.

f. Concrete associated with electrical work for other than encasement of underground ducts: 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise.

g. Slump: Less than 100 mm 4 inches. Retempering of concrete will not be permitted.

h. Exposed, unformed concrete surfaces: smooth, wood float finish.

i. Cure concrete for a period of not less than 7 days. Repair concrete made with high early strength portland cement by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer.

j. Air entrain concrete exposed to weather using an air-entraining admixture conforming to ASTM C260/C260M.

k. Air content: between 4 and 6 percent.

]2.10 SOURCE QUALITY CONTROL

2.10.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

2.10.2 Test Instrument Calibration

a. Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. Accuracy: Traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.

d. Dated calibration labels: visible on all test equipment.

e. Calibrating standard: higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

    (1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

    (2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.10.3 Design Tests

IEEE C57.12.00, and IEEE C57.12.90. Section 5.1.2 in IEEE C57.12.80 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for[each of] the specified transformer(s), with design tests performed prior to the award of this contract.

a. Tests: certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests includes the primary windings only of that transformer.

  (1) IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

  (2) State test voltage levels.

  (3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.25.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

2.10.4 Routine and Other Tests

IEEE C57.12.00. Routine and other tests: performed by the manufacturer on[each of] the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests include:

a. Polarity.

b. Ratio.

c. No-load losses (NLL) and excitation current.

d. Load losses (LL) and impedance voltage.

e. Dielectric.

  (1) Impulse.

  (2) Applied voltage.

(3) Induced voltage.

f. Leak.

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Pad-Mounted Transformer Grounding

****

NOTE: Ensure plans show the secondary neutral grounding conductor sized in accordance with NFPA 70 and the primary neutral grounding conductor when required. Ensure the CADD detail used matches how this paragraph is edited. Transformer is to have a ground ring and the normal number of ground rods is either four or two. The one ground rod option should only be chosen if required by local installation requirements.

****

Provide a ground ring around the transformer with [1/0][4/0] AWG bare copper.[Provide four ground rods in the ground ring, one per corner.][Provide two ground rods in the ground ring at opposite corners.][Provide one ground rod in the ground ring with the ground rod located in the transformer cabinet.] Install the ground rods at least 3000 mm 10 feet apart from each other. Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

[3.3.1 Meters and Current Transformers

****

Note: Delete bracketed paragraph for Navy and Air Force projects, this information is covered in their associated metering specifications.

****

ANSI C12.1.

]3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

[3.5 WARNING SIGN MOUNTING

****

NOTE: Include the following option when pad-mounted transformer is guarded by a fence.

****

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 9 meters 30 feet apart.

]3.6 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the requirement is located. Include construction requirements for concrete slab only if slab is not detailed in drawings. Do not provide curbs or raised edges around liquid filled transformers unless specifically approved by Technical Proponent (link provided in the technical note at the beginning of this section).

****

Mount transformer on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 200 mm 8 inches thick, reinforced with a 152 by 152 mm MW19 by MW19 6 by 6 inches - W2.9 by W2.9 mesh placed uniformly 100 mm 4 inches from the top of the slab.

b. Place slab on a 150 mm 6 inch thick, well-compacted gravel base.

c. Install slab such that top of concrete slab is approximately 100 mm 4 inches above the finished grade with gradual slope for drainage.

d. Provide edges above grade with 15 mm 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 200 mm 8 inches beyond the equipment.

Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.6.1 Cast-In-Place Concrete

****

NOTE: Use the first bracketed option when project includes a concrete section in Division 03; otherwise, use the second bracketed option.

****

Provide cast-in-place concrete work in accordance with the requirements of [Section 03 30 00 CAST-IN-PLACE CONCRETE][ACI 318M ACI 318].

[3.6.2 Sealing

****

NOTE: Require sealing of cable wells (windows) in the concrete pad if rodent intrusion is a problem.

****

When the installation is complete, seal all entries into the equipment enclosure with an approved sealing method. Provide seals of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

]3.7 FIELD QUALITY CONTROL

3.7.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS. Submit reports, including acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

3.7.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection.

    (1) Compare equipment nameplate information with specifications and approved shop drawings.

    (2) Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

    (3) Inspect anchorage, alignment, and grounding.

    (4) Verify the presence of PCB content labeling.

    (5) Verify the bushings and transformer interiors are clean.

    (6) Inspect all bolted electrical connections for high resistance

using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(7) Verify correct liquid level in tanks.

(8) Verify that positive pressure is maintained on gas-blanketed transformers.

(9) Perform specific inspections and mechanical tests as recommended by manufacturer.

(10) Verify correct equipment grounding.

[(11) Verify the presence of transformer surge arresters.

] b. Electrical tests.

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

(2) Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

[(3) Perform insulation-resistance tests, winding-to-winding and each winding-to-ground. Calculate polarization index.

(4) Perform turns-ratio tests at all tap positions.

(5) Perform insulation power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer's published data.

(6) Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests.

(7) Measure the resistance of each high-voltage winding in each de-energized tap-changer position. Measure the resistance of each low-voltage winding in each de-energized tap-changer position, if applicable.

(8) Remove and test a sample of insulating liquid for the following: Dielectric breakdown voltage, Acid neutralization number, Specific gravity, Interfacial tension, Color, Visual Condition, Water in insulating liquids (Required on 25 kV or higher voltages and on all silicone-filled units.), and Power factor or dissipation factor.

(9) Perform dissolved-gas analysis (DGA) on a sample of insulating liquid.

][3.7.1.2 Current Transformers

****

NOTE: Delete bracketed optional paragraphs for Navy and Air Force projects. This information is covered in their associated metering specifications.

****

a. Visual and mechanical inspection.

    (1) Compare equipment nameplate data with specifications and approved shop drawings.

    (2) Inspect physical and mechanical condition.

    (3) Verify correct connection.

    (4) Verify that adequate clearances exist between primary and secondary circuit wiring.

    (5) Verify the unit is clean.

    (6) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

    (7) Verify that all required grounding and shorting connections provide good contact.

    (8) Verify correct operation of transformer withdrawal mechanism and grounding operation.

    (9) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical tests.

    (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

    (2) Perform insulation-resistance test.

    (3) Perform a polarity test.

    (4) Perform a ratio-verification test.

][3.7.1.3 Watthour Meter

****

NOTE: Delete bracketed optional paragraphs for Navy and Air Force projects. This information is covered in their associated metering specifications.

****

a. Visual and mechanical inspection.

    (1) Compare equipment nameplate data with specifications and approved shop drawings.

    (2) Inspect physical and mechanical condition.

    (3) Verify tightness of electrical connections.

b. Electrical tests.

(1) Calibrate watthour meters according to manufacturer's published data.

(2) Verify that correct multiplier has been placed on face of meter, where applicable.

(3) Verify that current transformer secondary circuits are intact.

]3.7.1.4 Grounding System

a. Visual and mechanical inspection.

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests.

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

[3.7.1.5 Surge Arresters, Medium- and High-Voltage

a. Visual and mechanical inspection.

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, grounding, and clearances.

(4) Verify the arresters are clean.

(5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

b. Electrical tests.

(1) Perform resistance measurements through all bolted connections

with low-resistance ohmmeter, if applicable.

(2) Perform an insulation-resistance test on each arrester, phase terminal-to-ground.

(3) Test grounding connection.

]3.7.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times of checking and testing.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-26 13 00 (May 2021)**
Change 1 - 05/22

Preparing Activity: NAVFAC **Superseding**
UFGS-26 13 00 (November 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 13 00

SF6/HIGH-FIREPOINT FLUIDS INSULATED PAD-MOUNTED SWITCHGEAR

05/21, CHG 1: 05/22

PART 3 EXECUTION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-26 13 00 (May 2021)**
Change 1 - 05/22

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****

SECTION 26 13 00

SF6/HIGH-FIREPOINT FLUIDS INSULATED PAD-MOUNTED SWITCHGEAR

05/21, CHG 1: 05/22

****

NOTE: This guide specification covers the requirements for SF6 or high-firepoint biodegradable fluid insulated, dead-front, enclosed and non-enclosed, pad-mounted switchgear with load and fault interrupting switched ways, with maximum ratings of 600 amperes and 38 kV, 60 Hz.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification can be used for subsurface (vault) applications with appropriate modifications.

Use the following related guide specifications for power distribution equipment:

--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 11 16 SECONDARY UNIT SUBSTATIONS
--Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION
--Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
--Section 26 12 21 SINGLE-PHASE PAD-MOUNTED

TRANSFORMERS
--Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION
--Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION
****

****
NOTE: Verify that the following information is indicated on the project drawings:

1. Site Plan showing location, space available, and desired arrangement of switchgear.

2. Single-line diagram showing: nominal system voltage; number and configuration of switched ways; type, number, and size of conductors for each circuit; and method of power cable termination (600 ampere deadbreak connectors). Individually identify each switched way as load or fault interrupter and single-pole or three-pole tripping.

3. Grounding Detail with ground rods, ground ring and interconnecting cables when interconnecting with other grounding systems or if multiple switches are provided.

4. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gases.

5. Surge arrester locations.

6. Power source for automatic switch control and SCADA features.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile

references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D2472	(2000; R 2014) Standard Specification for Sulphur Hexafluoride
ASTM D6871	(2017) Standard Specification for Natural (Vegetable Oil) Ester Fluids Used in Electrical Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.60	(2019) High-Voltage Switchgear and Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems Up to 38 kV
IEEE C37.74	(2014) Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems Up to 38 kV
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61099	(2010; ED 2.0) Insulating Liquids - Specifications for Unused Synthetic

	Organic Esters for Electrical Purposes
IEC 62271-103	(2021) High-Voltage Switchgear and Controlgear – Part 103: Switches for Rated Voltages Above 1 Kv up to and Including 52 Kv
IEC 62271-111	(2019) High Voltage Switchgear And Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems up to and including 38 kV

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70B	(2023) Recommended Practice for Electrical Equipment Maintenance

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8500.01	(2014; Change 1-2019) Cybersecurity
DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.

****

Section 26 08 00 APPARATUS INSPECTION AND TESTING, applies to this section, with the additions and modifications specified herein. Cybersecurity requirements are specified in Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

1.3 DEFINITIONS

1.3.1 Switched Way

A switched way is considered a three-phase circuit entrance to the bus through a switch. For single-phase switches, it is a single-phase entrance to the bus through a switch.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal

items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G, [_____]

SD-03 Product Data

****

NOTE: Include the following paragraph when the switchgear will have fault interrupting switched ways.

****

[Electronic Overcurrent Control Curves; G, [_____]

] SF6/High-Firepoint Fluid Insulated Pad-mounted Switchgear; G, [_____]

Include data on switches and associated accessories with each submittal. Include manufacturer's information for each component, device and accessory provided with the equipment with each submittal.

Insulated High-Voltage Connectors; G, [_____]

[Surge Arresters; G, [_____]

] SD-06 Test Reports

Acceptance Checks and Tests; G, [_____]

SD-07 Certificates

Paint Coating System; G, [_____]

[Cybersecurity; G, [_____]

] SD-09 Manufacturer's Field Reports

Switchgear Design and Production Tests; G, [_____]

SD-10 Operation and Maintenance Data

SF6/High-Firepoint Fluid Insulated Pad-mounted Switchgear, Data Package 5; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5 QUALITY ASSURANCE

1.5.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

a. Overall dimensions, weights, plan view, and front view

b. Ratings

c. Single-line diagram.

1.5.2 Paint Coating System

****

NOTE: Select IEEE C57.12.29 when specifying stainless steel enclosures.

****

Submit [IEEE C57.12.28][IEEE C57.12.29] paint coating system performance requirement tests.

[1.5.3 Electronic Overcurrent Control Curves

****

NOTE: Include the following if one or more fault interrupting switched ways are specified and if the time-current curves are not already provided in the specified electrical analysis software package. Most commercially available software packages already contain the time-current curves used in pad-mounted switchgear fault interrupter trip units.

****

Provide time-current characteristic curves in PDF format and in electronic format suitable for import or updating into the [EasyPower][SKM PowerTools for Windows][_____] computer program.

]1.6 MAINTENANCE

1.6.1 SF6/High-Firepoint Fluid Insulated Pad-mounted Switchgear Operation and Maintenance

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

[1.7 CYBERSECURITY

****

NOTE: If the equipment will have SCADA or any remote control system capability, this paragraph must be included and the Designer of Record must coordinate with the activity to determine the required Service Implementation Policy. Add the requirements into this specification.

****

All control systems (including systems separate from an energy management control system) must be planned, designed, acquired, executed and maintained in accordance with DOD 8500.01 and DOD 8510.01, and as required by individual Service Implementation Policy.

Submit certification that equipment complies with the above DoD instructions and [_____].

]PART 2 PRODUCTS

2.1 SF6/HIGH-FIREPOINT FLUID INSULATED PAD-MOUNTED SWITCHGEAR

****

NOTE: Add reference to IEC 62271-103 for projects located in Europe only after verifying that at least three manufacturers of this switchgear comply with this standard.

****

IEEE C37.74[, IEC 62271-103]

2.1.1 Ratings and Test Requirements

****

NOTE: Select rated impulse voltage (BIL) to correspond with the selected rated maximum voltage.

Select short circuit current as applicable for the switchgear type and system requirements.

****

The voltage rating of the switchgear must be [15.5 kV][27 kV][38 kV][as indicated]. Provide the corresponding ratings associated with the required switchgear voltage rating as follows:

****

NOTE: The following optional ratings are available for switchgear assemblies, however, specifying these will require proprietary justification.

1. Optional short-time and short-circuit interrupting current ratings of 16,000, 20,000 and 25,000 rms symmetrical amperes are available.

2. For Norfolk Naval Shipyard projects, select optional 25,000 rms symmetrical amperes short-time and short-circuit interrupting current ratings for switchgear assemblies that are to be installed on the 11.5 kV system.

3. Switchgear is available that is rated for only 200 amperes continuous current, which might be suitable for housing areas or lateral circuits using low-ampacity conductors such as #2 awg. If 200-ampere rated switchgear is desired, modify the table as needed.

****

Rated Maximum Voltage, kV	[15.5][27][38]
Rated Withstand Impulse Voltage, kV BIL	[95][125][150]
Continuous and Load Interrupting Current, A	[600][600][600]
Short-Time Current, kA rms Sym	[[12.5][16][20][25]] [[12.5][16][20][25]] [[12.5][16][20][25]]
[Short-Circuit interrupting Current,kA rms Sym	[[12.5][16][20][25]] [[12.5][16][20][25]] [[12.5][16][20][25]]]

2.1.2 Switchgear Construction

****

NOTE: Select the options below based on the intended configuration.

For the Navy: Select the bracketed option to require viewing windows.

For the Navy: Select the bracketed option to require the three position switch: Open, Closed, Ground.

****

Provide switchgear with switch contacts and cable entrance terminations contained in a sealed, dielectric-filled stainless steel tank. Ship switchgear from factory, filled with appropriate levels of SF6 gas conforming to ASTM D2472 or less-flammable, high-firepoint biodegradable fluid conforming to ASTM D6871 or IEC 61099. Configure switchgear with[load interrupting][and][fault interrupting] switched ways as indicated. Provide switchgear with front accessible terminations suitable for cables entering from below with manual operating provisions either mounted on the rear or capable of hookstick operation per IEEE C37.74.[Switch contact positions for switched ways must be visible through viewing windows in the switchgear tank located adjacent to the manual operating provisions.] Provide internal gas pressure gage or fluid level gage in viewable location from switch operating handle.[Provide each switched way with three position switch; Open, Closed, Ground.]

2.1.2.1 Pad-mounting Provisions

****

NOTE: Choose stainless steel enclosure where environmental conditions are not suitable for mild steel or where a higher level of corrosion protection is desired. Select IEEE C57.12.29 when enclosure is required to be stainless steel.

****

Provide [non-]enclosed switchgear suitable for installation on a concrete pad. Fabricate switchgear[support frame][enclosure base][enclosure] with type 304 or 304L stainless steel.[Enclosure base must include any part of the switchgear enclosure that is within 75 mm 3 inches of concrete pad.] Paint [switchgear tank and support frame][enclosure including base] ASTM D1535 Munsell 7GY3.29/1.5 green. Comply with [IEEE C57.12.28][IEEE C57.12.29] for the paint coating system regardless of equipment material.

2.1.3 Load Interrupting Switched Ways

****

NOTE: Specify the required configuration of load interrupting switched ways and fault interrupting switched ways.

****

[2.1.3.1 Three-Pole Group Operated Switched Ways

Provide three-pole group operated load interrupting switched ways as indicated.

][2.1.3.2 Single-Pole Operated Switched Ways

****

NOTE: Select single-pole switching only for single-phase applications, such as housing areas.

****

Provide single-pole operated load interrupting switched ways as indicated.

][2.1.3.3 Fault Interrupting Switched Ways

****

NOTE: Include the following if fault interrupting switched ways are required. Fault interrupting switched ways provide overcurrent protection.

Each manufacturer has different options available for electronic trip units. These options have not been addressed below because they are specific to

each manufacturer. Consider the requirements for circuit protection and for circuit coordination and modify this paragraph as needed.

The project design must provide for the trip control power source and trip control circuits when selecting remote tripping.

Identify the appropriate operational methodology and incorporate the associated paragraphs from the selections below.

****

IEEE C37.60, IEC 62271-111. Provide non-fused, non-reclosing, manual reset, vacuum interrupters consisting of vacuum interrupter and a spring assisted operating mechanism. Each fault interrupting switched way must utilize internally mounted current transformers and an electronic overcurrent control to provide[single-pole][three-pole ganged] tripping[as indicated] for single-phase[and three-phase] faults. Provide electronic overcurrent control with provisions for a minimum of ten field changeable overcurrent trip settings.[Provide remote tripping via an external dry contact device[as indicated] for fault interrupting switched ways. Provide[120 Vac][48 Vdc][from the switchgear itself][from remote trip control power].]

][2.1.4 Automatic Switch Controls

****

NOTE: Select this option only if an automatic switch control system is part of the design.

If this option is selected, the project design must provide a 120 Vac control power source for the automatic switch control system.

Identify the appropriate operational methodology and incorporate the associated paragraphs from the selections below.

****

Provide an automatic switch control system to execute Manual[, SCADA] [, Automatic Source-Transfer][, and Fault Detection Isolation and Restoration] operations. Power the switch control system[and associated communication port provisions] from an integral battery-charger DC supply system. Use motor operators and associated motor operator controllers for switch way operation. Use 120 Vac control power[from switchgear itself][from remote source] for automatic switch control.

2.1.4.1 Manual Operation

Provide the motor operator controllers with "Close" and "Open" pushbuttons for manual operation.

[2.1.4.2 SCADA Operation

****

NOTE: Include the following if a SCADA operation system is required and coordinate with bracketed option paragraph CYBERSECURITY.

****

The automatic switch control system must execute remote commands received from a SCADA master station and transmit switchgear operation information to a SCADA master station via a DNP 3.0 100Base-FX Ethernet communication port. Include transfer of switch ways to "Close" and "Open" positions[and enabling of the Source-Transfer operation] for execution of remote commands. Include switch way position status, voltage and current readings, and DC supply system status with communication of switchgear information.

][2.1.4.3 Source-Transfer Operation

****

NOTE: Include the following if source-transfer operation is required.

****

Provide an automatic switch control system that opens an incoming switch way when voltage is lost and closes the alternate incoming switch way if voltage is present. Include with the Source-Transfer controls an overcurrent-lockout feature that prevents automatic closing of a switch way into a system fault. Include provisions for returning the system to the normal configuration via manual, SCADA, or automatic operations when voltage is restored.

][2.1.4.4 Fault Detection Isolation and Restoration Operation

****

NOTE: Provide a conduit system between the pad mount switchgear units for installation of the automatic switch control system optical fiber cable.

****

The automatic switch control system must execute circuit fault detection isolation operation for closed and open loop distribution systems. Provide communication via a peer-to-peer fiber optic network for the pad mount switchgear unit automatic switch control systems. Provide an optical fiber cable approved by the automatic switch control system manufacturer.

]][2.1.5 Low Voltage Test Points

Provide load interrupting switch ways with internal load side voltage sensors that allow for low voltage checks with relay interface at test point of elbow connectors to confirm energized and in-phase conditions using a standard high-impedance voltmeter.

][2.1.6 Key Interlock

****

NOTE: Add requirements for key interlock if needed. Provide details of interlock system on the drawings.

****

Provide key interlock system as indicated on the drawings.

]2.1.7 Dead-Front High-Voltage Bushings

****

NOTE: Make selection based on system voltage.
****

IEEE 386. [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Provide 600 ampere one-piece deadbreak apparatus bushings for each switched way.

****
NOTE: Include standoff bushings only when the Activity requires the additional items.
****

[a. Parking stands: Provide a parking stand near each dead-front bushing.[Provide insulated standoff bushings for parking of energized load-break connectors on each parking stands.]

]2.2 INSULATED HIGH-VOLTAGE CONNECTORS

IEEE 386. Provide corresponding connector for each switched way. Provide a grounding eye and test point on each connector.

****
NOTE: Provide 200 ampere bushing interface on all 600 ampere connectors.
****

a. 600 Ampere deadbreak connector ratings: Voltage: [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Short time rating: 25,000 rms symmetrical amperes. Provide connectors with 200 ampere bushing interface.

****
NOTE: Include the following paragraph only when the activity requires additional grounding elbows.
****

[b. Provide [one] [_____] set[s] of three grounding elbows. Deliver grounding elbows to the Contracting Officer.

][2.3 SURGE ARRESTERS

****
NOTE: Provide elbow type arresters at normally open switch locations.
****

IEEE C62.11, rated[[3] [6] [9] [10] [12] [15] [_____] kV] [as indicated], fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide arresters on switched ways as indicated.

][2.4 SF6 REFILL CYLINDERS

****
NOTE: Include the following paragraph only when the activity requires additional SF6 refill cylinders.
****

Provide [two] [_____] SF6 refill cylinders, minimum size of 6 pounds of

SF6; include regulator, valves, and hose for connection to the fill valve of the switch.

]2.5 SOURCE QUALITY CONTROL

2.5.1 Switchgear Design and Production Tests

****

NOTE: Include IEEE C37.60 and IEC 62271-111 when the switchgear will have fault interrupting switched ways.

****

****

NOTE: Add reference to IEC 62271-103 and IEC 62271-111 for projects located in Europe only after verifying that at least three manufacturers of this switchgear comply with this standard.

****

Furnish reports which include results of design and production tests performed according to IEEE C37.74[, IEC 62271-103][and IEEE C37.60[, IEC 62271-111]]. Perform manufacturer production tests on each switchgear assembly to ensure that design performance is maintained in production.

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

****

NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, other methods of grounding should be specified. Where it is impractical to obtain indicated ground resistance values, the designer should make every effort, within reason, to obtain ground resistance values as near as possible to the indicated values.

****

NFPA 70 and IEEE C2, except provide grounds and grounding systems with a resistance to solid earth ground not exceeding [25] [_____] ohms. When work, in addition to that indicated or specified, is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified[in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION][at each corner of switchgear pad][as indicated].

3.2.2 Switchgear Grounding

Connect #4/0 bare copper conductor ground ring, not less than 600 mm 24 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide #4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.2.3 Connections

Make joints in grounding conductors and ground ring by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount switch on concrete slab. Provide slab with dimensions at least 300 mm 12 inches thick, reinforced with a 152 by 152 - MW19 by MW19 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 100 mm 4 inches from the top of the slab. Place slab on a 150 mm 6 inch thick, well-compacted gravel base. Install top of concrete slab approximately 100 mm 4 inches above finished grade. Provide edges above grade with 15 mm 1/2 inch chamfer. Provide slab of adequate size to project at least 200 mm 8 inches beyond equipment.

Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4 FIELD QUALITY CONTROL

3.4.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.4.1.1 Switchgear

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Check for proper anchorage, alignment, required area clearances, and grounding.

(4) Perform mechanical operator tests in accordance with manufacturer's instructions.

(5) Verify that insulating SF6 gas pressure or dielectric fluid level is correct.

(6) Inspect all indicating devices for proper operation.

****

NOTE: Include the following option when key

interlocking is specified.
****

[(7) Test interlock systems for proper operation and sequencing.

] b. Electrical Tests

(1) Perform contact-resistance tests.

[(2) Trip fault interrupters by operation of overcurrent control[and remote trip].

] (3) Perform insulation-resistance tests.

(4) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.

[(5) Set fault interrupter overcurrent control in accordance with government provided settings. Request settings from government, in writing, a minimum of 30 days prior to scheduling electrical tests.

]3.4.1.2 Grounding System

a. Visual and Mechanical Inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.4.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that devices are in good operating condition and properly performing the intended function. Perform each test function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer five working days in advance of the dates and times for checks and tests.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 13 01 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-26 13 01 (August 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 13 01

PAD-MOUNTED DEAD-FRONT AIR INSULATED SWITCHGEAR

05/24

PART 3   EXECUTION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-26 13 01 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-26 13 01 (August 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 13 01

PAD-MOUNTED DEAD-FRONT AIR INSULATED SWITCHGEAR
05/24

****

NOTE: This guide specification covers the requirements for air insulated, enclosed and non-enclosed, dead-front pad-mounted switchgear. This guide specification is not intended for Navy installations and will be used when specified for Army and Air Force projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Use the following related guide specifications for power distribution equipment:

--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 11 16 SECONDARY UNIT SUBSTATIONS
--Section 26 11 13.00 20 PRIMARY UNIT SUBSTATIONS
--Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
--Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
--Section 26 05 73 POWER SYSTEM STUDIES
--Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION

--Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION

****

****

NOTE: Show the following information on the project drawings:

1. Site Plan showing location, space available, and desired arrangement of switchgear.

2. Single-line diagram showing: nominal system voltage; number and configuration of switched ways; type, number, and size of conductors for each circuit; and method of power cable termination (600 ampere deadbreak connectors). Individually identify each switched way as load or fault interrupter and single-pole or three-pole tripping.

3. Grounding Detail with ground rods, ground loop and interconnecting cables when interconnecting with other grounding systems or if multiple switches are provided.

4. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gases.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
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IEEE C37.75	(2023) Standard for Pad-Mounted, Pole-Mounted, and Submersible Switchgear Enclosures and Associated Control Enclosures - Coastal and Non-Coastal Environmental Integrity
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UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.
****

Section 26 08 00 APPARATUS INSPECTION AND TESTING, applies to this section, with the additions and modifications specified herein.

Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

1.3.1 Switched Way

A switched way is considered a three-phase circuit entrance to the bus through a switch.

1.4 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G, [_____]

SD-03 Product Data

****

NOTE: Include the following submittal when the switchgear will have fused switched ways.

****

[Fuse Time-Current Characteristic Curves; G, [_____]

] Air Insulated Pad-mounted Switchgear; G, [_____]

Insulated High-Voltage Connectors; G, [_____]

[Surge Arresters; G, [_____]

] SD-06 Test Reports

Acceptance Checks and Tests; G, [_____]

SD-07 Certificates

Paint Coating System; G, [_____]

SD-09 Manufacturer's Field Reports

Switchgear Design and Production Tests; G, [_____]

SD-10 Operation and Maintenance Data

Air Insulated Pad-Mounted Switchgear Operation and Maintenance, Data Package 5; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

a. Overall dimensions, weights, plan view, and front view

b. Ratings

c. Single-line diagram.

1.5.2 Paint Coating System

Submit IEEE C37.75 paint coating system performance requirement tests.

****

NOTE: Include the following only if the fuse time-current curves are not already provided in the specified electrical analysis software package. Most

commercially available software packages already contain the typical fuses used in pad-mounted switchgear.

****

[1.5.3 Fuse Time-Current Characteristic Curves

Provide time-current characteristic curves in PDF format and in electronic format suitable for import or updating into the [ETAP][EasyPower][SKM PowerTools for Windows][_____] computer program.

]1.6 MAINTENANCE

1.6.1 Air Insulated Pad-mounted Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 AIR INSULATED PAD-MOUNTED SWITCHGEAR

IEEE C37.74. Submit manufacturer's information on switches and each component, device, and accessory provided with the equipment.

2.1.1 Ratings and Test Requirements

****

NOTE: Select rated impulse voltage (BIL) to correspond with the selected rated maximum voltage.

Select short circuit current as applicable for the switchgear type.

Select power fuse style and interrupting rating based on desired system characteristics and fuse style.

****

Provide switchgear with a nominal voltage rating of [14.4][25] kV and the following corresponding ratings:

Rated Maximum Voltage, kV	[17][27][_____]
Rated Withstand Impulse Voltage, kV BIL	[95][125]
Continuous and Load Interrupting Current, A	600
Short-Circuit Current, kA rms Sym	[25][22.4][_____]
[Power Fuses, Amperes, Maximum Interrupting, kA rms Sym]	[[200][200E][200K][14][12.5][_____]]

Provide switched ways rated for the required continuous and load interrupting current.

2.1.2 Switchgear Construction

Provide switchgear with the following construction and configuration:

a. Switch contacts and cable entrance terminations contained in an enclosed, steel compartment.

b. Configured with[load interrupting][and][fused] switched ways as indicated.

c. Accessible terminations suitable for cables entering from below.

d. Switch contact positions for switched ways visible through viewing windows in the switchgear termination compartment.

e. Each switched way with two position switch; Open, Closed and provisions for grounding.

****

NOTE: For Navy-designed projects, select the option below with the switchgear installed on a concrete pad. For some Army and Air Force projects, installation on a fiberglass pad or above a vault is desired. In these cases, select the second bracketed option below. If the switchgear is installed above a vault, provide details on associated drawings.

****

[2.1.2.1 Pad-mounting Provisions

****

NOTE: Choose stainless steel enclosure where environmental conditions are not suitable for mild steel or where a higher level of corrosion protection is desired. Select IEEE C57.12.29 when enclosure is required to be stainless steel.

****

Provide enclosed switchgear suitable for installation on a concrete pad, including the following:

[a. Fabricate switchgear[enclosure and] enclosure base of ASTM A240/A240M type 304 or 304L stainless steel.

] b. Enclosure base includes any part of the switchgear enclosure that is within 75 mm 3 inches of concrete pad.

c. Paint enclosure including base ASTM D1535 [Munsell 7GY3.29/1.5 green][Munsell 8.3G6.1/0.5 light gray (ANSI No. 61)] [_____].

d. Comply with IEEE C37.75 for the paint coating system regardless of equipment material.

][2.1.2.2 Pad/Vault-mounting Provisions

****

NOTE: Choose stainless steel enclosure where environmental conditions are not suitable for mild

steel or where a higher level of corrosion protection is desired. Select IEEE C57.12.29 when enclosure is required to be stainless steel.
****

[Provide enclosed switchgear suitable for installation on a concrete pad or fiberglass box pad, including the following:][Provide enclosed switchgear on a concrete vault, as indicated, including the following:]

[a. Fabricate switchgear[enclosure and] enclosure base of ASTM A240/A240M type 304 or 304L stainless steel.

] b. Enclosure base includes any part of the switchgear enclosure that is within 75 mm 3 inches of concrete pad.

c. Paint enclosure including base ASTM D1535 [Munsell 7GY3.29/1.5 green][Munsell 8.3G6.1/0.5 light gray (ANSI No. 61)] [_____].

d. Comply with IEEE C37.75 for the paint coating system regardless of equipment material.

]2.1.3 Load Interrupting Switched Ways

Provide the following for load interrupter switched ways:

a. Three-pole group operated switching.

b. Interrupter switches operated by means of an externally accessible switch-operating hub.

c. Switch-operating hub located within a recessed stainless steel pocket mounted on the side of the pad-mounted gear enclosure.

d. Padlockable stainless steel access cover and hood on the switch-operating-hub pocket to protect the padlock shackle from tampering.

e. Stops on the switch-operating hub to prevent overtravel.

f. Labels in the switch-operating-hub pocket to indicate switch position.

g. Folding switch-operating handle for each interrupter switch.

2.1.4 Fused Ways

Provide the following:

a. Fuse mountings enclosed in an inner steel compartment.

b. Each fuse mounting installed as an integral part of a fuse handling mechanism that does not allow access to the fuse until the elbow for that fuse has been disconnected and a mechanical interlock to the fuse-access panel has been actuated.

c. The opening into the component compartment covered by the fuse-access panel in both the open and closed positions to prevent access to high voltage.

d. Blown-fuse indicators for fused ways visible through viewing windows in the termination compartment.

2.1.4.1 Fuses

****

NOTE: Indicate on the drawings the fuse rating and type of fusing desired. The type of fusing is important to ensure the switch is equipped with correct fuseholder hardware.

****

Provide fuses in accordance with the following:

a. Fuse ratings as indicated on the drawings.

b. Helically coiled fuses if rated 10 amperes or larger.

c. Solid-material power fuses capable of detecting and interrupting all faults under all realistic conditions of circuitry, with line-to-line or line-to-ground voltage across the fuse, and capable of handling the full range of transient recovery voltage severity associated with these faults.

d. All arcing accompanying operation of the fuse contained within the fuse, and all arc products and gases evolved effectively contained within the exhaust control device during fuse operation.

e. Fusible elements nonaging and nondamagable with melting time-current characteristics that are permanently accurate to within a maximum tolerance of 10 percent in terms of current.

f. Equipped with a blown-fuse indicator that provides visible evidence of fuse operation while installed in the fuse mounting.

[2.1.5 Key Interlock

****

NOTE: Add requirements for key interlock if needed. Provide details of interlock system on the drawings.

Coordinate with the local installation to determine if interlocks are required. If interlocks are not required, then ensure the installation uses only qualified personnel to work on the equipment.

At least one manufacturer requires a formal letter from the installation if key interlocks are not desired.

****

Provide key interlock system as indicated on the drawings.

]2.1.6 Dead-Front High-Voltage Bushings

****

NOTE: Make selection below based on system voltage. Include fused way selection if fused compartments are intended.

****

IEEE 386.[15 kV, 95 kV BIL][25 kV, 125 kV BIL]. Provide 600 ampere one-piece deadbreak apparatus bushings for each switched way. Provide connectors with 200 ampere bushing interface.

****

NOTE: Include standoff bushings only when the Activity requires the additional items.

****

a. Parking stands: Provide a parking stand near each dead-front bushing.[Provide insulated standoff bushings for parking of energized load-break connectors on each parking stand.]

2.2 Insulated High-Voltage Connectors

IEEE 386. Provide corresponding connector for each switched way; provide connectors with a grounding eye and test point.

****

NOTE: Provide 200 ampere bushing interface on all 600 ampere connectors.

****

a. 600 Ampere deadbreak connector ratings: Voltage: [15 kV, 95 kV BIL][25 kV, 125 kV BIL]. Short time rating: 25,000 rms symmetrical amperes. Provide 200 ampere bushing interface[for surge arresters][as indicated].

****

NOTE: Provide bushing-mounted elbow type arresters at normally open switch locations.

****

[2.3 Surge Arresters

IEEE C62.11, rated[[3][6][9][10][12][15][18][_____] kV][as indicated], fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide arresters on switched ways as indicated.

]2.4 Grounding Provisions

Provide a ground-connection pad in each termination compartment.[Provide a continuous copper ground bus across the full width of each termination compartment for fuses.]

****

NOTE: Include the following paragraph only when the activity requires additional grounding elbows and feed-thru inserts.

****

[a. Provide[[one][_____] set[s] of three grounding elbows][and][[one][_____] set[s] of three feed-thru inserts]. [Grounding elbows][and][feed-thru inserts]. Deliver to the Contracting Officer.
]

****

NOTE: Include the following paragraph only when the

activity requires additional grounding elbows and grounded standoff bushings.

****

[b. Provide[[one][_____] set[s] of three grounding elbows][and][[one][_____] set[s] of three grounded standoff bushings]. [Grounding elbows][and][grounded standoff bushings]. Deliver to the Contracting Officer.

]

****

NOTE: If fault indicators are desired, determine type and locations. Provide information on the drawings.

****

[c. Provide [[one][_____] ground ball stud[s] on the ground bus.]]

[2.5 Faulted Circuit Indicators

Install one set of faulted circuit indicators on the test points of each set of separable insulated connectors. Faulted circuit indicators must comply with IEEE 495. Indicators must be self powered, and must have automatic trip with mechanical flag indication upon overcurrent followed by loss of system voltage. Indicators must be compact, sealed corrosion resistant construction with provision for hotstick installation and operation.

]2.6 SOURCE QUALITY CONTROL

2.6.1 Switchgear Design and Production Tests

Furnish reports which include results of design and production tests performed according to IEEE C37.74. Perform production tests by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Remove requirement to conform to IEEE C2 where distribution is premises wiring per NEC and not part of a utility distribution system.

****

Conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

****

NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, specify other methods of grounding. Where it is impractical to obtain indicated ground resistance values, make every effort, within reason, to obtain ground resistance values as near as possible to the indicated values.

25 ohms is the miniumum required resistance by the NEC, but 5 ohms is the recommended resistance by IEEE.
****

Conform to NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding [5][25][_____] ohms. The provision of the contract covering "Changes" applies when work is directed to obtain the specified ground resistance in addition to that indicated or specified.

3.2.1 Grounding Electrodes

****
NOTE: Select the Section reference to correspond to the desired service activity.
****

Provide driven ground rods as specified in [Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION][_____][at each corner of switchgear pad][as indicated].

3.2.2 Switchgear Grounding

Connect #4/0 bare copper conductor ground loop, not less than 610 mm 24 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide #4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.2.3 Connections

****
NOTE: Select the Section reference to correspond to the desired service activity.
****

Make joints in grounding conductors and ground loop by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section [33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION][_____].

3.2.4 Grounding and Bonding Equipment

Conform to UL 467, except as indicated or specified otherwise.

3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****
NOTE: Select from the bracketed options below for the selected installation method. Coordinate with paragraphs PAD-MOUNTING PROVISIONS and PAD/VAULT-MOUNTING PROVISIONS.
****

Mount switch[on concrete slab][on concrete box pad][on fiberglass pad][on fiberglass box pad][on concrete vault][as shown on the drawings], including the following:

[a. Provide box pad with a minimum depth of[813 mm 32 inches][915 mm 36 inches][_____].

][b. Show vault size on the drawings.

][c. Provide slab of size at least 300 mm 12 inches thick, reinforced with a 152 by 152 - MW19 by MW19 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 100 mm 4 inches from the top of the slab.

] d. Place [Slab][Box pad] on a 150 mm 6 inch thick, well-compacted gravel base.

e. Install [top of concrete slab approximately 100 mm 4 inches above finished grade. Provide edges above grade with 15 mm 1/2 inch chamfer.]

f. Provide [slab] [box pad] of adequate size to project at least 200 mm 8 inches beyond equipment.

[g. For installations that use a box pad or vault, train the incoming cables around the box or vault prior to terminating at the switchgear.

][Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

]3.4 FIELD QUALITY CONTROL

3.4.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS, and referenced ANSI standards. Submit reports, including acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.4.1.1 Switchgear

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Check for proper anchorage, alignment, required area clearances, and grounding.

(4) Perform mechanical operator tests in accordance with manufacturer's instructions.

(5) Inspect all indicating devices for proper operation.

****

NOTE: Include the following option when key interlocking is specified.

****

[(6) Test interlock systems for proper operation and sequencing.

] b. Electrical Tests

(1) Perform contact-resistance tests.

(2) Perform insulation-resistance tests.

(3) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.

3.4.1.2 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) Perform ground impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.4.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that devices are in good operating condition and properly performing the intended function. Perform each item not less than three times to demonstrate its function. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times for checks and tests.

****

NOTE: Select the option that best suits the project. For the Navy, do not apply Section 09 90 00 PAINTS AND COATINGS.

****

[3.5 FIELD APPLIED PAINTING

[Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.] [Apply field painting as specified in Section 09 90 00 PAINTS AND COATINGS.]

]   -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 13 02 (November 2024)**

Preparing Activity: NAVFAC **NEW**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

USACE / NAVFAC / AFCEC **UFGS-26 13 02 (November 2024)**

Preparing Activity: NAVFAC **NEW**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 13 02

PAD-MOUNTED SOLID DIELECTRIC SWITCHGEAR

11/24

****

NOTE: This guide specification covers the requirements for Solid dielectric, dead-front, enclosed and non-enclosed, pad-mounted switchgear with load and fault interrupting ways, with maximum ratings of 600 amperes and 38 kV (35kV Class), 60 Hz. 38kV rated switchgear is available but may require proprietary justification. Voltages up to 27kV (25kV Class) and below are available from multiple manufacturers.

Solid Dielectric Switchgear should be considered in locations where flooding or water infiltration are concerns due to site installation conditions. The submersion capability of the equipment is suited to these environments.

Solid Dielectric Switchgear should be considered as an alternate to SF6 insulated switchgear where environmental restrictions on greenhouse gas reductions or potential emissions are a consideration.

The insulation system for solid dielectric insulated switchgear can include any combination of rubberized insulating materials, plastics, phenolic barriers, epoxy (such as cycloaliphatic epoxy) and other solid insulating materials. The use of liquid insulation or synthetic gas insulation in any part of this switchgear is strictly prohibited.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification can be used for subsurface (vault) applications with appropriate modifications.

Use the following related guide specifications for power distribution equipment:

--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 11 16 SECONDARY UNIT SUBSTATIONS
--Section 26 11 13.00 20 PRIMARY UNIT SUBSTATION
--Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM VOLTAGE TRANSFORMERS
--Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
--Section 26 13 00 SF6/HIGH-FIREPOINT FLUIDS INSULATED PAD-MOUNTED SWITCHGEAR
--Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION
--Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION

****

****

NOTE: Verify that the following information is indicated on the project drawings:

1. Site Plan showing location, space available, and desired arrangement of switchgear.

2. Single-line diagram showing: nominal system voltage; number and configuration of switched ways; type, number, frequency, short circuit ratings, BIL,and size of conductors for each circuit; and method of power cable termination (600 ampere deadbreak or 200A load break connectors and adapters for fixed bushings). Individually identify each switched way as load or fault interrupter and single-pole or three-pole tripping.

3. Grounding Detail with ground rods, ground ring and interconnecting cables when interconnecting with other grounding systems or if multiple switches are provided.

4. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gases.

5. Surge arrester locations.

6. Power source for automatic switch control and SCADA features.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE 495	(2007) Guide for Testing Faulted Circuit Indicators
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.60	(2019) High-Voltage Switchgear and Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems Up to 38 kV

IEEE C37.62	(2020) Standard for Pad-Mounted Dry Vault, Submersible and Overhead Fault Interrupters for Alternating Current Systems Up to and Including 38kV
IEEE C37.74	(2014) Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems Up to 38 kV
IEEE C37.75	(2023) Standard for Pad-Mounted, Pole-Mounted, and Submersible Switchgear Enclosures and Associated Control Enclosures - Coastal and Non-Coastal Environmental Integrity
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-102	(2018) High-Voltage Switchgear and Controlgear - Part 102: Alternating-Current Disconnectors and Earthing Switches
IEC 62271-103	(2021) High-Voltage Switchgear and Controlgear – Part 103: Switches for Rated Voltages Above 1 Kv up to and Including 52 Kv
IEC 62271-111	(2019) High Voltage Switchgear And Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems up to and including 38 kV

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70B	(2023) Recommended Practice for Electrical Equipment Maintenance

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8500.01	(2014; Change 1-2019) Cybersecurity
DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.

****

Section 26 08 00 APPARATUS INSPECTION AND TESTING, applies to this section, with the additions and modifications specified herein. Cybersecurity requirements are specified in Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

1.3 DEFINITIONS

1.3.1 Way

A way is considered a three-phase or single-phase circuit connection to the bus, which may contain combinations of switches and protective devices or may be a solid bus.

1.3.2 Switched Way

A switched way is considered a three-phase circuit entrance to the bus through a switch. For single-phase switches, it is a single-phase entrance to the bus through a switch.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G, [_____]

SD-03 Product Data

****

NOTE: Include the following paragraph when the switchgear will have fault interrupting ways.

****

[Electronic Overcurrent Control Curves; G, [_____]

] Insulated High-Voltage Connectors; G, [_____]

[Surge Arresters; G, [_____]

] Solid Dielectric Insulated Pad-mounted Switchgear; G, [_____]

Include data on switches and associated accessories with each submittal. Include manufacturer's information for each component, device and accessory provided with the equipment with each submittal.

SD-06 Test Reports

Acceptance Checks and Tests; G, [_____]

SD-07 Certificates

Paint Coating System; G, [_____]

[Cybersecurity; G, [_____]

] SD-09 Manufacturer's Field Reports

Switchgear Design and Production Tests; G, [_____]

SD-10 Operation and Maintenance Data

Solid Dielectric Insulated Pad-mounted Switchgear Operation and Maintenance, Data Package 5; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA

1.5 QUALITY ASSURANCE

1.5.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

a. Overall dimensions, weights, plan view, and front view

b. Ratings

c. Single-line diagram

d. Nameplate schedule

e. Conduit entry/ exit locations

f. Anchor bolt template and locations

1.5.2 Paint Coating System

****

NOTE: Select IEEE C57.12.29 when specifying stainless steel enclosures.

****

Submit[IEEE C57.12.28][IEEE C57.12.29][IEEE C37.75] paint coating system performance requirement tests.

[1.5.3 Electronic Overcurrent Control Curves

****

NOTE: Include the following if one or more fault interrupting ways are specified and if the time-current curves are not already provided in the specified electrical analysis software package. Most commercially available software packages already contain the time-current curves used in pad-mounted switchgear fault interrupter trip units.

****

Provide time-current characteristic curves in PDF and Excel format and in electronic format suitable for import or updating into the[EasyPower][SKM PowerTools for Windows][ETap] [_____] computer program.

]1.6 MAINTENANCE

1.6.1 Solid Dielectric Insulated Pad-mounted Switchgear Operation and Maintenance

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

[1.7 CYBERSECURITY

****

NOTE: If the equipment will have SCADA or any remote control system capability, this paragraph must be included and the Designer of Record must coordinate with the activity to determine the required Service Implementation Policy. Add the requirements into this specification.

****

All control systems (including systems separate from an energy management control system) must be planned, designed, acquired, executed and maintained in accordance with DOD 8500.01 and DOD 8510.01, and as required by individual Service Imnplementation Policy.

Submit certification that equipment complies with the above DoD instructions and [_____].

]PART 2 PRODUCTS

2.1 SOLID DIELECTRIC INSULATED PAD-MOUNTED SWITCHGEAR

****

NOTE: Add reference to IEC 62271-103 for projects located in Europe only after verifying that at least three manufacturers of this type of switchgear comply with this standard.

****

IEEE C37.74[, IEC 62271-102][, IEC 62271-103]

2.1.1 Ratings and Test Requirements

****

NOTE: Select rated impulse voltage (BIL) to correspond with the selected rated maximum voltage.

Select short circuit current as applicable for the switchgear type and system requirements.

****

The maximum voltage rating of the switchgear must be[15kV][15.5 kV][27 kV][38 kV][as indicated]. Provide the corresponding ratings associated with the required switchgear voltage rating as follows:

****

NOTE: The following optional ratings are available for switchgear assemblies, however, specifying these will require proprietary justification.

1. Optional short-time and short-circuit interrupting current ratings of 16,000, 20,000 and 25,000 rms symmetrical amperes are available depending on voltage. Some of these ratings may be proprietary and not offered at each voltage.

2. Voltage of 38kV.

3. Verify symmetrical rating of bushings specified before selecting ratings above 12.5kA.

****

Rated Maximum Voltage, kV	[15.5] [27] [38]
Rated Withstand Impulse Voltage, kV BIL	[95] [125] [150]
Continuous and Load Interrupting Current, A	[600]
Short-Time Current, kA rms Sym	[[12.5] [16] [20] [25] [_____]]
[Short-Circuit interrupting Current,kA rms Sym]	[[12.5] [16] [20] [25] [_____]]

Provide switch and fault interrupter ways for the required continuous and load interrupting current.

2.1.2 Switchgear Construction

****

NOTE: Select the options below based on the intended configuration. Identify switched ways, fault interrupters, and bus configuration on one line diagrams.

For the Navy: Select the bracketed option to require switch position viewing windows.

Visible contact windows may not be available at higher voltages.

Some manufacturers offer modular individually insulated switched/ fault interrupter ways and others offer components insulated in an overall common tank. Consider keeping the construction type open to either design to avoid proprietary requirements, unless there are dimensional replacement considerations.

Select option for accessory control cabinet only if required for the selected options for the application. A cabinet is typically required for most applications with advanced relaying, SCADA, transfer controls, or battery applications. Include IP 68 rating to match switchgear rating only if control cabinet is expected to be submerged. Option will add cost and complexity to the construction.

****

Provide switchgear with the following construction configuration:

a. Switch contacts and cable entrance terminations contained in a dead front, enclosed in a steel compartment. All penetrations, bussing, switches and interrupters shall be potted in a liquid-tight synthetic solid dielectric insulation compound. Unit shall carry a[IP 68][NEMA 6P] rating on the medium voltage equipment.

b. Configured with[load interrupting][and][fault interrupter] switched ways as indicated.

c. Accessible terminations suitable for cables entering from[below][top].

[d. Switch contact positions for switched ways visible through viewing windows in the switchgear termination compartment.

] e. Each switched way with two position switch; Open and Closed. Grounding provided via grounding parking elbow.

f. Manual operating provisions mounted at switch and capable of hookstick operation per IEEE C37.74.

[2.1.2.1 Pad-mounting Provisions

****

NOTE: For Navy-designed projects, select the option below with the switchgear installed on a concrete pad. For some Army and Air Force projects, installation on a fiberglass pad or above a vault is desired. In these cases, select the second bracketed option below. If the switchgear is installed above a vault, provide details on associated drawings.

****

****

NOTE: Choose stainless steel enclosure where environmental conditions are not suitable for mild steel or where a higher level of corrosion protection is desired. Select IEEE C57.12.29 when enclosure is required to be stainless steel.

****

Provide enclosed switchgear suitable for installation on a concrete pad with[front access][front and rear access], including the following;

[a. Fabricate switchgear[enclosure and] enclosure base of ASTM A240/A240M type 304 or 304L stainless steel.

] b. Enclosure base includes any part of the switchgear enclosure that is within 75 mm 3 inches of concrete pad.

c. Paint enclosure including base ASTM D1535[Munsell 7GY3.29/1.5 green][Munsell 8.3G6.1/0.5 light gray (ANSI No. 61)] [_____].

d. Comply with[IEEE C57.12.28][IEEE C57.12.29] for the paint coating system regardless of equipment material.

[e. Provide[NEMA 4][NEMA 4X][NEMA 6P][IP 68] [_____] accessory control cabinet for[relays][SCADA][transfer controls][instrument transformers][batteries] [_____].

]][2.1.2.2 Pad/Vault-mounting Provisions

****

NOTE: For Navy-designed projects, select the option below with the switchgear installed on a concrete pad. For some Army and Air Force projects, installation on a fiberglass pad or above a vault is desired. In these cases, select the second bracketed option below. If the switchgear is installed above a vault, provide details on associated drawings.

****

****

NOTE: Choose stainless steel enclosure where environmental conditions are not suitable for mild steel or where a higher level of corrosion protection is desired. Select IEEE C57.12.29 when enclosure is required to be stainless steel.

****

[Provide enclosed switchgear suitable for installation on a concrete pad or fiberglass box pad with[front access][front and rear access], including the following:][Provide enclosed switchgear on a concrete vault with[front access][front and rear access], as indicated, including the following:]

[a. Fabricate a switchgear[enclosure and] enclosure base of ASTM A240/A240M type 304 or 304L stainless steel.

] b. Enclosure base includes any part of the switchgear enclosure that is within 75 mm 3 inches of concrete pad.

c. Paint enclosure including base ASTM D1535[Munsell 7GY3.29/1.5 green][Munsell 8.3G6.1/0.5 light gray (ANSI No. 61)] [_____].

d. Comply with[IEEE C57.12.28][IEEE C57.12.29] for the paint coating system regardless of equipment material.

[e. Provide[NEMA 4][NEMA 4X][NEMA 6P][IP68] [_____] accessory control cabinet for[relays][SCADA][transfer controls][instrument transformers][batteries] [_____].

]]2.1.3 Load Interrupting Switched Ways

****

NOTE: Select Single-Pole switching only for single-phase applications, such as housing areas.

****

Provide the following for load interrupter switched ways:

a. [Three][Single]-pole group operated switching.

b. Interrupter switches operated by means of an externally accessible switch-operating handle.

c. Switch-operating handle located at each dead front switch mechanism inside pad-mounted gear enclosure.

d. Pad lockable stainless steel access cover.

e. Labels to indicate switch position.

[f. Switch position viewing window.

][2.1.3.1 Fault Interrupting Ways

****

NOTE: Include the following if fault interrupting ways are required. Fault interrupting ways provide overcurrent protection.

Each manufacturer has different options available for protective relaying. These options have not been addressed below because they are specific to each manufacturer. Consider the requirements for circuit protection and for circuit coordination and modify this paragraph as needed.

The project design must provide for the trip control power source and trip control circuits when selecting remote tripping.

Most manufacturers include standard internal current transformers with self powered basic overcurrent relaying and offer optional advanced microprocessor relaying and current transformer options. Alternate relaying types or current transformer sensitivity may require alternate configurations, external controls enclosures, and external control power and/or battery provisions.

If using internal current transformers with self powered relays, the designer should consider relay "wake-up" time delay for lightly loaded or no load situations on protected circuits which would extend trip time under fault conditions. Consult manufacturers' for parameters. Batteries and control power should be considered if monitoring of relays and status are required when circuits are de-energized.

Identify relaying and instrumentation requirements on one line drawings or schedules on the drawings.

Identify the appropriate operational methodology and incorporate the associated paragraphs from the selections below.

****

IEEE C37.60, IEC 62271-111, IEEE C37.62. Provide non-fused, non-reclosing, manual reset, vacuum interrupters consisting of vacuum interrupter and a spring or magnetic assisted operating mechanism. Each fault interrupting way must utilize[internal][external] mounted current transformers and an electronic overcurrent control to provide[single-pole][three-pole ganged] tripping[as indicated] for single-phase[and three-phase] faults. Provide microprocessor overcurrent relaying with adjustable settings.[Provide remote tripping via an external dry contact device[as indicated] for fault interrupting ways. Provide[120 Vac][48 Vdc][24 Vdc][from the switchgear itself][from remote trip control power][and internal battery].]

][2.1.4 Automatic Switch Controls

****

NOTE: Select this option only if an automatic switch control system is part of the design.

If this option is selected, the project design must provide a control power source for the automatic switch control system.

Identify the appropriate operational methodology and incorporate the associated paragraphs from the selections below.

Validate voltage monitoring methods with selected voltages, accuracy, and design. Voltage transformers may increase housing size.

****

Provide an automatic switch control system to execute Manual[, SCADA][, Automatic Source-Transfer][, and Fault Detection Isolation and Restoration] operations. Power the switch control system[and associated communication port provisions] from an integral battery-charger DC supply system. Use motor operators and associated motor operator controllers for switch way operation. Use[120 Vac][48 Vdc][24 Vdc] [_____] control power[from switchgear itself][from remote source][and internal battery] for automatic switch control. Utilize[capacitive bushing voltage sensors][voltage transformers] for voltage sensing.

2.1.4.1 Manual Operation

Provide the motor operator controllers with "Close" and "Open" pushbuttons for manual operation.[Provide remote pendant operator to permit manual motor operation at a distance.]

[2.1.4.2 SCADA Operation

****

NOTE: Include the following if a SCADA operation system is required and coordinate with 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

****

The automatic switch control system must execute remote commands received from a SCADA master station and transmit switchgear operation information to a SCADA master station via a DNP 3.0 100 Base-FX Ethernet communication port. Include transfer of switch ways to "Close" and "Open" positions[and enabling of the Source-Transfer operation] for execution of remote commands. Include switch way position status, voltage and current readings, and DC supply system status with communication of switchgear information.

][2.1.4.3 Source-Transfer Operation

****

NOTE: Include the following if source-transfer operation is required.

****

Provide an automatic switch control system that opens an incoming switch way when voltage is lost and closes the alternate incoming switch way if voltage is present. Include with the Source-Transfer controls an overcurrent-lockout feature that prevents automatic closing of a switch way into a system fault. Include provisions for returning the system to the normal configuration via manual, SCADA, or automatic operations when voltage is restored.

][2.1.4.4 Fault Detection Isolation and Restoration Operation

****

NOTE: Provide a conduit system between the pad mount switchgear units for installation of the automatic switch control system optical fiber cable.

****

The automatic switch control system must execute circuit fault detection isolation operation for closed and open loop distribution systems. Provide communication via a peer-to-peer fiber optic network for the pad mount switchgear unit automatic switch control systems. Provide an optical fiber cable approved by the automatic switch control system manufacturer.

]][2.1.5 Low Voltage Test Points

Provide load interrupting switch ways with load side voltage sensors that allow for low voltage checks with relay interface at test point of elbow connectors to confirm energized and in-phase conditions using a standard high-impedance voltmeter.

][2.1.6 Key Interlock

****

NOTE: Add requirements for key interlock if needed. Provide details of interlock system on the drawings.

****

Provide key interlock system as indicated on the drawings.

]2.1.7 Dead-Front High-Voltage Bushings

****

NOTE: Make selection based on system voltage.

****

IEEE 386. [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Provide 600 ampere one-piece deadbreak apparatus bushings for each switched way.

****

NOTE: Include standoff bushings only when the Activity requires the additional items.

****

[a. Parking stands: Provide a parking stand near each dead-front bushing.[Provide insulated standoff bushings for parking of energized load-break connectors on each parking stands.]

]2.2 INSULATED HIGH-VOLTAGE CONNECTORS

****

NOTE: If submersion requirements are a consideration, coordinate submersible ratings of dead break elbows to match requirements. IEEE 386 requirements may not align with switchgear IP/NEMA ratings.

****

IEEE 386. Provide corresponding connector for each switched way. Provide a grounding eye and test point on each connector.

****

NOTE: Provide 200 ampere bushing interface on all 600 ampere connectors.

****

a. 600 Ampere deadbreak connector ratings: Voltage: [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Short time rating: 25,000 rms symmetrical amperes. Provide connectors with 200 ampere bushing interface.

****

NOTE: Include the following paragraph only when the activity requires additional grounding elbows.

****

[b. Provide[one] [_____] set[s] of three grounding elbows. Deliver grounding elbows to the Contracting Officer.

]2.3 GROUNDING PROVISIONS

Provide a ground-connection pad in each termination compartment.[Provide a continuous copper ground bus across the full width of each termination compartment switched way.]

****

NOTE: Include the following paragraph only when the activity requires additional grounding elbows and feed-thru inserts.

****

[a. Provide[[one][_____] set[s] of three grounding elbows][and][[one][_____] set[s] of three feed-thru inserts]. [Grounding elbows][and][Feed-thru inserts]. Deliver to the Contracting Officer.

] **

NOTE: Include the following paragraph only when the activity requires additional grounding elbows and grounded standoff bushings.

****

[b. Provide[[one][_____] set[s] of three grounding elbows][and][[one][_____] set[s] of three grounded standoff brushings]. [Grounding elbows][and][Grounded standoff bushings.] Deliver to the Contracting Officer.

][2.4 FAULTED CIRCUIT INDICATORS

****

NOTE: If fault indicators are desired, determine type and locations. provide information on the drawings.

****

Install one set of faulted circuit indicators on the test points of each set of separable insulated connectors. Faulted circuit indicators must comply with IEEE 495. Indicators must be self powered; with automatic trip with mechanical flag indication upon overcurrent followed by loss of system voltage. Indicators must be compact, sealed corrosion resistant construction with provision for hotstick installation and operation.

][2.5 SURGE ARRESTERS

****

NOTE: Provide elbow type arresters at normally open switch locations.

****

IEEE C62.11, rated[[3][6][9][10][12][15] [_____] kV][as indicated], fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide arresters on switched ways as indicated.

]2.6 SOURCE QUALITY CONTROL

2.6.1 Switchgear Design and Production Tests

****

NOTE: Include IEEE C37.60, IEEE C37.62 and IEC 62271-111 when the switchgear will have fault interrupting ways.

****

****

NOTE: Add reference to IEC 62271-103 and IEC 62271-111 for projects located in Europe only after verifying that at least three manufacturers of this switchgear comply with this standard.

****

Furnish reports which include results of design and production tests performed according to IEEE C37.74[, IEC 62271-103][and IEEE C37.60, IEEE C37.62[, IEC 62271-111]]. Perform manufacturer production tests on each switchgear assembly to ensure that design performance is maintained in production.

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

****

NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, other methods of grounding should be specified. Where it is impractical to obtain indicated ground resistance values, the designer should make every effort, within reason, to obtain ground resistance values as near as possible to the indicated values.

****

NFPA 70 and IEEE C2, except provide grounds and grounding systems with a resistance to solid earth ground not exceeding[25] [_____] ohms. When work, in addition to that indicated or specified, is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified[in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION][at each corner of switchgear pad][as indicated].

3.2.2 Switchgear Grounding

Connect No. 4/0 bare copper conductor ground ring, not less than 600 mm 24 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide No. 4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.2.3 Connections

Make joints in grounding conductors and ground ring by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Select from the bracketed options below for the selected installation method. Coordinate with paragraphs PAD-MOUNTING PROVISIONS and PAD/VAULT-MOUNTING PROVISIONS.

****

Mount switch[on concrete slab][on concrete box pad][on fiberglass pad][on fiberglass box pad][on concrete vault][as shown on the drawings], including the following:

[a. Provide box pad with a minimum depth of [813][915] mm [32][36] inches [_____].

][b. Show vault size on the drawings.

][c. Provide slab size at least 300 mm 12 inches thick, reinforced with a

152 by 152 - MW19 by MW19 6 by 6- W2.9 by W2.9 mesh, placed uniformly 100 mm 4 inches from the top of the slab.

] d. Place[slab][box pad] on a 150 mm 6 inch thick, well-compacted gravel base.

e. Install top of concrete slab approximately 100 mm 4 inches above finished grade. Provide edges above grade with 15 mm 1/2 inch chamfer.

f. Provide[slab][box pad] of adequate size to project at least 200 mm 8 inches beyond equipment.

[g. [For installations that use a box pad or vault, train the incoming cables around the box or vault prior to terminating at the switchgear.][Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.]

]3.4 FIELD QUALITY CONTROL

3.4.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards. Submit reports, including acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.4.1.1 Switchgear

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Check for proper anchorage, alignment, required area clearances, and grounding.

(4) Perform mechanical operator tests in accordance with manufacturer's instructions.

(5) Inspect all indicating devices for proper operation.

****

NOTE: Include the following option when key interlocking is specified.

****

[(6) Test interlock systems for proper operation and sequencing.

] b. Electrical Tests

(1) Perform contact-resistance tests.

[(2) Trip fault interrupters by operation of overcurrent control[and remote trip].

] (3) Perform insulation-resistance tests.

(4) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.

[(5) Set fault interrupter overcurrent control in accordance with government provided settings. Request settings from government, in writing, a minimum of 30 days prior to scheduling electrical tests.

]3.4.1.2 Grounding System

a. Visual and Mechanical Inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.4.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that devices are in good operating condition and properly performing the intended function. Perform each test function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer five working days in advance of the dates and times for checks and tests.

3.5 FIELD APPLIED PAINTING

[Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.][Apply field painting as specified in Section 09 90 00 PAINTS AND COATINGS.]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-26 13 13 (November 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-26 13 13 (November 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 26 13 13

METALCLAD SWITCHGEAR
11/21

****

NOTE: This guide specification covers the requirements for metal-clad switchgear. Metal-Clad Switchgear as used in this specification is switchgear rated 1000 volts and above, normally in the medium voltage range of 5 kV to 35 kV. This specification includes indoor and outdoor applications.

This specification is not intended to be used for generator control switchgear without extensive modification and coordination with applicable engine-generator set guide specifications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Verify that the following information is indicated on the project drawings.

1. Single-line diagram showing buses and interrupting devices with interrupting capacities; current transformers with ratings; instruments and meters required; and description of instruments and

meters.

2. Location, space available, arrangement, and elevations of switchgear.

3. Grounding plan.

4. Type and number of cables, size of conductors for each power circuit, and point of entry (top or bottom).

5. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gases; and seismic requirements.

6. Arc flash label requirements. Download the label format at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

7. Available fault current label for service entrance equipment. Download the label format at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

8. Locations with arc energy reduction methods specified.

****

****

NOTE: In corrosive and humid environments, use materials, systems, components, and coatings that are durable and minimize the need for preventative and corrective maintenance over the expected service life of the component or system. Corrosive project locations are those with Environmental Severity Classification (ESC) of C3, C4, and C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project location.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D149	(2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 32	(1972; R 1997) Standard Requirements, Terminology, and Test Procedures for Neutral Grounding Devices
IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.04	(2018; Erta 2019; Corr 2021) Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V Corrigendum 1
IEEE C37.06	(2009) Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltage Above 1000 V
IEEE C37.09	(2018; Errata 2019; Corr 2021) Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.2	(2022 Standard for Electrical Power System Device Function Numbers, Acronyms and Contact Designations
IEEE C37.20.2A	(2020) Metal-Clad Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE C37.20.7	(2017; Corr 2021) Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric

	Power Apparatus
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.4	(1984; R 2011) Registers - Mechanical Demand
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8500.01	(2014; Change 1-2019) Cybersecurity
DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 1437	(2006) Electrical Analog Instruments - Panel Board Types

1.2 SYSTEM DESCRIPTION

****

NOTE: Do not use this paragraph for Navy projects.

For Army projects, select the features and fill in blanks with selections appropriate for the design condition and in accordance with guidance contained in UFC 3-550-01, "Exterior Electrical Power Distribution".

See UFC 3-550-01 for guidance regarding service conditions. Retain or add the required conditions.

Provide seismic requirements, if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Pertinent portions of UFC 3-310-04, "Seismic Design for Buildings" and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT properly edited, must be included in the contract documents.

****

Items provided under this section must be specifically suitable for the following service conditions. Seismic details must [conform to UFC 3-310-04, "Seismic Design for Buildings" and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT] [be as indicated].

a. Fungus Control [_____]

b. Altitude [_____] m feet

c. Ambient Temperature [_____] degrees C F

d. Frequency [_____]

e. Ventilation [_____]

f. Seismic Parameters [_____]

g. Humidity Control [_____]

h. Corrosive Areas [_____]

i. [_____]

1.3 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.

****

Sections 26 08 00 APPARATUS INSPECTION AND TESTING and 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS apply to this section, with the additions and modifications specified herein.

1.4 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G, [_____]

SD-03 Product Data

Switchgear; G, [_____]

SD-06 Test Reports

Switchgear Design Tests; G, [_____]

Switchgear Production Test; G, [_____]

Acceptance Checks and Tests; G, [_____]

SD-07 Certificates

[Cybersecurity Equipment Certification; G, [_____]

Submit certification indicating conformance with the paragraph CYBERSECURITY EQUIPMENT CERTIFICATION.

][Cybersecurity Installation Certification; G, [_____]

Submit certification indicating conformance with the paragraph CYBERSECURITY INSTALLATION CERTIFICATION.

] SD-10 Operation and Maintenance Data

Switchgear Operation and Maintenance, Data Package 5; G, [_____]

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G, [_____]

Equipment Test Schedule; G, [_____]

****

NOTE: Select "Request for Settings" below if protective device settings will be government furnished. Select "Required Settings" below if protective device settings are furnished by the Designer of Record. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the final protective device settings for design/build versus design/bid/build projects. Do not rely on the manufacturer's default settings.

****

[Request for Settings; G, [_____]

][Required Settings; G, [_____]

] **

NOTE: NFPA 70 Article 110.24 requires an available fault current label to be applied at the service entrance. Select "Available Fault Current Label" below if the switchgear is part of the service entrance equipment. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the short circuit calculation for the project. This may vary for design/build versus design/bid/build projects.

****

[Service Entrance Available Fault Current Label; G, [_____]

]1.6 QUALITY ASSURANCE

1.6.1 Product Data

Include manufacturer's information on each submittal for each component, device and accessory provided with the switchgear including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device.

1.6.2 Switchgear Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. The drawings must show adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable federal, military, industry, and technical society publication references on submittals. Include the following:

a. One-line diagram including breakers[, fuses][, current transformers, and meters].

b. Outline drawings including front elevation, section views, footprint, shipping splits, rigging plan, and overall dimensions.

c. Bus configuration including dimensions and ampere ratings of bus bars.

d. Markings and NEMA nameplate data[including fuse information (manufacturer's name, catalog number, and ratings)].

e. Circuit breaker type, interrupting rating, and trip devices, including available settings.

f. Wiring diagrams and elementary diagrams with terminals identified and indicating prewired interconnections between items of equipment and the interconnection between the items.

g. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device. Use this information (designer of record) to provide breaker settings that ensures protection and coordination are achieved.[For Navy installations, provide electronic format curves using SKM's Power Tools for Windows device library electronic format or EasyPower device library format depending on installation modeling software requirements.]

****

NOTE: If selecting provisions for future expansion, ensure the facility and room size is adequate for the additional equipment.
****

[h. Provisions for future expansion by adding switchgear sections.

]1.6.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for not less than 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 1-year prior to date of delivery to site are not acceptable.

1.7 MAINTENANCE

1.7.1 Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.7.2 Assembled Operation and Maintenance Manuals

Assemble and securely bind manuals in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents:

a. Manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA.

b. Catalog data required by the paragraph SD-03, PRODUCT DATA.

c. Drawings required by the paragraph SD-02, SHOP DRAWINGS.

d. Prices for spare parts and supply list.

[e. Information on metering.

] f. Design test reports.

g. Production test reports.

1.7.3 Spare Parts

****
NOTE: Do not use this paragraph for Navy projects. For other services, coordinate with Contracting Officer on whether this paragraph can be included.

Edit as required if additional spare parts are required for a specific project.
****

Provide spare parts as specified below. Provide spare parts that are of the same material and workmanship, meet the same requirements, and are interchangeable with the corresponding original parts furnished.

[a. Quantity 2 - Fuses of each type and size.

] b. [_____]

1.8 WARRANTY

Provide equipment items that are supported by service organizations reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchgear and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 METAL-CLAD SWITCHGEAR

IEEE C37.20.2A.

2.2.1 Ratings

Provide equipment with the following ratings:

****

NOTE: Select "as indicated" if there are multiple switchgear with details of each shown on drawings. Most switchgear will be 4-wire, but might be a 3-wire design for delta-connected or ungrounded systems.

****

a. Voltage rating: [4.76] [8.25] [15.0] [27] kilo-volts AC, three-phase, [grounded] [high resistance grounded] [ungrounded] [as indicated].[For high resistance grounded systems, the conductors from the neutral point to the connection point at the impedance must utilize [copper] [aluminum] conductors, employing the same insulation level and construction as the phase conductors.]

b. Short Circuit Rating: [[_____] rms symmetrical amperes] [as indicated].

c. UL listed and labeled[for its intended use][as service entrance equipment].

d. Impulse Withstand (Basic Impulse Level): [60] [95] [125] KV.

e. Power Frequency Withstand: [19] [36] [60] KV, 1 minute test.

f. Momentary Current Ratings must be equal to the circuit breaker close and latch rating.

g. System voltage: [_____] KV nominal, three-phase [grounded] [ungrounded], [60 hertz] [50 hertz].

h. Continuous current rating of the main bus: [[1200] [2000] [3000 or 2750 at 27KV] amperes][as indicated].

2.2.2 Construction

****

NOTE: Edit the selection options below as needed for the intended project configuration.

Determine if an arc-resistant design will be specified for the installation. A selection of arc-resistant switchgear can affect the installation design. Arc-resistant switchgear is tested and certified to IEEE C37.20.7, and is intended to provide added protection for internal arcing faults. Select Type 1 if arc protection is only required for the freely accessible front of the enclosure. Select Type 2 if arc protection is required for freely accessible front, sides and rear of the enclosure. Select the 'B' suffix for additional protection applied to compartments designated as low voltage control or instrumentation compartments. Select the 'C' suffix where isolation from the effects of an internal arcing fault is desired between all adjacent compartments within a switchgear assembly. Most manufacturers produce Type 2B as a standard product, which could increase the switchgear cost by about 20 percent. Review IEEE C37.20.7 for additional information.

****

Provide the following:

a. Dead-front, metal-clad, draw-out, switchgear assembly of vertical sections, each with vacuum circuit breakers. Switchgear must be front and rear accessible. Provide front and rear vertical section covers with full length hinges. Provide additional vertical sections to house accessories related to the switchgear functions.

b. Switchgear: Vertical sections bolted together to form a rigid assembly and[rear][front and rear] aligned[as indicated].

c. All circuit breakers: Front accessible with rear load connections.

d. Compartmentalized switchgear: Vertical insulating barriers between the front device section, the main bus section, and the cable compartment[with full front to rear vertical insulating barriers between adjacent sections].

e. Where indicated, "space for future" or "space" means to include all necessary components and hardware to be fully equipped for racking in a circuit breaker element.

f. Insulating barriers: Provided in accordance with NEMA LI 1, Type GPO-3, 6.35 mm 0.25 inch minimum thickness.

[g. Moisture resistant coating: Applied to all rough-cut edges of barriers.

][h. Switchgear: Arc-resistant[Type 1[B] [C]][Type 2[B] [C]], tested in accordance with IEEE C37.20.7.

]2.2.2.1 Enclosure

****

NOTE: Choose the level of corrosion protection required for the specific project location. Most switchgear products will be constructed of a cold rolled steel and painted, which is adequate for most indoor locations. Use galvanized steel or stainless steel enclosures or bases for outdoor applications where corrosion is a concern; specify stainless steel for project locations with Environmental Severity Classifications (ESC) of C4 and C5, galvanized is acceptable for project locations with ESC of C3. See UFC 1-200-01 for determination of ESC for project locations. Not all manufacturers offer galvanized steel or stainless steel products as a standard design.

Select IEEE C57.12.28 for galvanized enclosures.
Select IEEE C57.12.29 for stainless steel enclosures.

Infrared viewing windows are typically installed in the switchgear rear covers to facilitate the use of IR cameras for thermally scanning cable terminations.

****

Provide the following:

a. Stationary Structure:

(1) The switchgear must consist of sections including circuit breaker compartments and auxiliary compartments assembled to form a rigid self-supporting completely enclosed structure providing steel barriers between sections.

(2) The sections must be divided by metal barriers into the following separate compartments: Circuit breaker, instrument, main bus, auxiliary device and cable. Each feeder section may have up to two circuit breaker compartments.

b. Indoor Enclosure: NEMA ICS 6 Type 1. [_____]

c. Outdoor Enclosure: NEMA ICS 6 Type [3R] [_____] [as indicated] [3RX fabricated entirely of 12 gauge ASTM A240/A240M type 304 or 304L stainless steel].

d. Enclosure: Bolted together with removable bolt-on side and[hinged] rear covers[, and sloping roof downward toward rear].

[e. Front[and rear] doors: Provided with[stainless steel] pad-lockable vault handles with a three point catch.

][f. Bases, frames and channels of enclosure: Corrosion resistant and fabricated of[ASTM A240/A240M type 304 or 304L stainless steel][or][galvanized steel].

] g. Base: Includes any part of enclosure that is within 75 mm 3 inches of concrete pad.

h. Galvanized steel: ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

i. Paint color: Factory applied finish, ASTM D1535 light gray No. 61 or No. 49 over rust inhibiting primer on treated metal.

j. Paint coating system: Comply with[IEEE C57.12.28 for galvanized steel][and][IEEE C57.12.29 for stainless steel].

k. Infrared viewing windows: Install to allow the use of an infrared camera or thermal imager direct line of site to inspect electrical connections without requiring the opening of panels and doors. These windows are intended to allow thermographers the ability to inspect the electrical equipment without directly exposing themselves to live electrical components and energized devices.

2.2.2.2 Bus Bars

****

NOTE: Only choose the bracketed option requiring insulation on the bus bars for outdoor locations with a high concentration of airborne contaminants. Choose this option primarily for corrosive and high humidity applications as defined in UFC 3-501-01. Most manufacturers will apply an insulating sleeve rather than an epoxy coating.

****

Provide the following:

a. Bus bars: Copper with silver-plated contact surfaces.

    (1) Phase bus bars: [Uninsulated][Insulated with an epoxy finish coating powder or insulating sleeve providing a minimum breakdown voltage per ASTM D149].

b. Make bus connections and joints with hardened steel bolts and nuts. Provide conical disk spring washers under each nut and bolt.

c. Main-bus (through bus): Rated at the full ampacity of the main throughout the switchgear.

d. Minimum 6.35 mm by 50.8 mm 1/4 by 2 inch copper ground bus secured to each vertical section along the entire length of the switchgear.

2.2.2.3 Circuit Breaker Compartments

a. Each circuit breaker must be draw-out metal-clad vacuum circuit breaker. The stationary primary disconnecting contacts must be silver-plated copper and mounted within[glass polyester][porcelain][molded cycloaliphatic epoxy at 27kV] support bushings. The movable contacts and springs must be mounted on the circuit breaker element for ease of inspection/maintenance.

b. Entrance to the stationary primary disconnecting contacts must be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment. Ground bus must be extended into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions. Guide rails for positioning the circuit breaker and all other necessary hardware must be an integral part of the circuit breaker compartment. Blocking devices must interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating.

2.2.2.4 Auxiliary Vertical Sections and Compartments

a. Provide auxiliary sections consisting of[instruments,][metering equipment,][control equipment,][transformers,][and][current transformer compartments] as indicated.

[b. Utility metering compartment that complies with[utility company][base utility] requirements.

][c. Metering: A vertical section with a front hinged door for isolated access to meters and associated terminal and fuse blocks for maintenance, calibration, or testing while the gear is energized.

][d. Metering: Hinged panel in switch or breaker section, for isolated access to meters and associated terminal and fuse blocks for maintenance, calibration, or testing while the gear is energized.

]2.2.2.5 Medium Voltage Cable Terminations

****

NOTE: Provide indoor terminator/outdoor terminations with skirts. By including skirts for "indoor" and "within equipment" locations, tracking resistance is significantly improved. Provision of skirts for indoor terminations automatically makes them IEEE 48 Class 1.

****

a. IEEE 48 Class 1; of the molded elastomer, pre-stretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Terminations, where required, must be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Terminations must be provided in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

b. Cold-Shrink Type: Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all necessary materials (except for the lugs). Termination must be designed for installation in low or highly contaminated indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

c. Heat Shrinkable Type: Terminator must consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is non-tracking, resists heavy atmospheric contaminants, ultra-violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Termination must be designed for installation in low or highly contaminated indoor or outdoor locations.

2.2.2.6 Circuit Breakers

****

NOTE: Switchgear should be placed where the ambient temperature is less than 40 degrees C, which is the basis for rating in accordance with IEEE C37.13. However, should the ambient temperature be expected to exceed 40 degrees C, the designer must require a special calibration for the circuit breakers and confirm the equipment ratings.

This paragraph assumes that circuit breakers are available rated for the specified short circuit current. For very high short circuit currents, the manufacturer might have to install current-limiting fuses upstream of the circuit breaker.

****

The vacuum circuit breakers must be electrically-operated, three-pole, circuit interrupting devices rated for [_____] amperes continuous at [_____] kV and [_____] kV BIL. Breakers must be designed for service on a [_____] kV system with a short-circuit capacity of not less than [_____] [amperes symmetrical] [MVA]. Rating must be based on IEEE C37.04 and IEEE C37.06. Circuit breakers must be draw-out mounted with position indicator, operation counter, auxiliary switches, and primary and secondary disconnect devices. Circuit breakers must have one vacuum circuit interrupter per phase.

Circuit breaker must be operated by an electrically charged, mechanically and electrically trip-free, stored-energy operating mechanism normally charged by a universal motor. Provide for manual charging of the mechanism through a manual handle on the vacuum circuit breaker. Circuit breaker control voltage must be[[_____] VDC][[_____] VAC][from an external power source][from a fused control transformer integral to the switchgear]. Provide one capacitor trip unit for each breaker when AC control power is required.

a. Contacts: Silver-plated, multi-finger, positive pressure, self-aligning type for main draw-out contacts.

b. Each draw-out breaker must be provided with three-position operation. The connected position and the test/disconnect position must be clearly identified by an indicator on the circuit breaker front panel.

    (1) Connected position: Contacts are fully engaged. Breaker must be tripped before it can be racked into or out of this position.

    (2) Test/disconnect position: Position must allow for complete testing and operation of the breaker without energizing the primary circuit.

    (3) Withdrawn (removed) positions: Places breaker completely out of compartment, ready for removal.

c. Secondary control circuits must be connected automatically with a self-aligning, self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position.

d. An interlocking system must be provided to prevent racking a closed circuit breaker to or from any position. An additional interlock must automatically discharge the stored-energy operating mechanism springs upon removal of the breaker out of the compartment.

e. Provision for secondary control plug to be manually connected in test position.

[f. A minimum of 4 auxiliary contacts (2a 2b) for external use.

][2.2.2.7 Circuit Breaker Remote Racking

****

NOTE: UFC 3-520-01 requires consideration of remote racking methods for switchgear circuit breakers. Determine if this feature is desired by electrical personnel that will operate and maintain this

equipment. The remote racking mechanism design varies among manufacturers; however the method of connection to the racking mechanism tends to be similar. Determine if the project budget can fund this device. Do not select this option if other remote racking mechanisms are available within the activity and can be used for this location.

****

Provide a remote racking mechanism to allow an operator to rack a circuit breaker in or out from at least 6096 mm 20 feet away from the front of the equipment.

][2.2.2.8 Control Power Supply

****

NOTE: Retain paragraph below if an internal control power source utilizing step-down transformers is provided.

****

Control power transformer must supply [120] [___]V AC control circuits through secondary disconnect and overcurrent protective devices. Provide [dry type] [oil insulated] transformer, in separate draw-out compartment, with primary and secondary fuses to provide current-limiting and overload protection.

][2.2.2.9 Control Power Supply

****

NOTE: Retain paragraph below if an external control power source utilizing batteries is provided.

****

a. Dedicated [48 V DC] [120 V DC] [240 V DC] battery system.

b. System Requirements: Battery must have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 degrees C with electrolyte at normal level and minimum ambient temperature of 13 degrees C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange to operate ungrounded. Battery system capacity must be as recommended by switchgear manufacturer to operate the circuit breakers for a 1-minute discharge ampere rate down to 1.75V. Cell for Lead-Acid batteries.

c. Battery:

    (1) [Standard VRLA][Premium VRLA] batteries, with system disconnect and overcurrent protective device.

    (2) Rack: [Two][_____]-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads.[Rate battery rack, cell supports, and anchorage for seismic requirements.]

    (3) Accessories: Set of cell numerals. Monitoring system.

    (4) Battery Ground-Fault Detector: Initiates alarm when resistance to

ground of positive or negative bus of battery is less than 5000 ohms.

(5) Control Wiring: Factory installed, complete with bundling, lacing, and protection. Conductors across Hinges and for Interconnections between Shipping units must utilize flexible conductors.

(6) Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of AC input or DC output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

d. DC ammeter.

e. DC Voltmeter: Maximum error of 5 percent at full-charge voltage, with toggle switch to select between battery and charger voltages.

f. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by NO push-button contact.

g. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.

h. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.

i. AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3-Hz variation in frequency. Automatic charger operation must resume after loss of ac power supply for any interval.

j. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. The device must regulate charging current but must not disconnect charger from either battery or ac supply.

k. Charger's Audible Noise: Less than 26 dB.

]2.2.3 Protective Relays

****

NOTE: The definition and application of device function numbers used in electrical switchgear are found in ANSI C37.2, "IEEE Standard Electrical Power System Device Function Numbers." This guide specification does not cover all possible relays.

Choose only the relay types applicable to the specific project.
****

Relays must conform to IEEE C37.90. Protective relays must be solid-state microprocessor based, multi-function type enclosed in rectangular, semi flush, switchboard-type draw-out cases with indicating targets and provisions for testing in place by use of manufacturer's standard test blocks or test switches. One complete set of test blocks or test switches to fit each type of relay in the equipment must be provided. Auxiliary and lockout relays are not required to have draw-out cases or test provisions. Controls, relays, and protective functions must be provided completely assembled and wired.

a. Overcurrent and Ground-Fault Protective Relays:

  (1) IEEE C37.2 device functions [51/50 and 51/50N][_____].

  (2) Field-Selectable Relay Settings.

  (3) Primary Current-Transformer Ratings: Programmable from 5 to 5000 A.

  (4) Phase and Ground Protection (ANSI): Field-selectable curves from definite time, moderately inverse, normally inverse, very inverse, or extremely inverse.

  (5) Phase and Ground Protection (IEC): Field-selectable curves from Curve A (BS142), Curve B (BS142), Curve C (BS142) or short inverse.

  (6) Phase and Ground Protection (IAC): Field-selectable curves from extremely inverse, very inverse, inverse or short inverse.

  (7) Phase Instantaneous Overcurrent Trip Pickup Point: Field selectable as "none" or from 1.0 to 25 times current-transformer primary rating. Include discriminator circuit with "on" and "off" switch so that when phase instantaneous overcurrent has been programmed to "none," the discriminator circuit protects against currents exceeding 11 times current-transformer primary rating when the breaker is being closed and must be deactivated after approximately eight cycles.

  (8) Contacts: Two Form-C contacts, field selectable into contact pairs.

  (9) Alphameric display to show the following parameters with metering accuracy not to exceed 2 percent of full scale:

b. Individual phase currents.

c. Ground current.

d. Cause of trip.

e. Magnitude and phase of current-causing trip.

f. Phase or ground indication.

g. Peak current demand for each phase and ground since last reset.

h. Current-transformer primary rating.

i. Programmed phase and ground set points.

j. Relay alarm and trip contacts must not change state if power is lost or an undervoltage occurs. These contacts must only cause a trip on detection of an overcurrent or fault condition based on programmed settings. A "protection off" alarm must be normally energized when the relay is powered and the self-diagnostics indicates the unit is functional. On loss of power or relay failure, this alarm relay must be de-energized, providing a fail-safe protection off alarm.

****

NOTE: Insert other relay types in paragraph below when adding other relays to operate circuit breakers in the switchgear. The 51/50 overcurrent relay described in "Overcurrent and Ground-Fault Protective Relays" (paragraph above) is typical of microprocessor-based protective relays. Show each relay system on the one-line diagram. Specify setting and testing of microprocessor-based relays for specific applications.

****

[k. Insert other relay types.

]2.2.3.1 Instruments

****

NOTE: Select essential instruments and meters. Add to the specification any special metering not listed which is required for a specific project. Use of an Electronic Monitoring System may eliminate the need for many individual electro-mechanical meters. This may also be accomplished on simpler systems by using the electronic watthour meter and identifying the desired special programming features. For NAVFAC SE projects, provide three thermal demand ammeters.

****

ANSI C39.1 for electrical indicating switchgear instruments, with one percent accuracy class, antiparallax pointer, and glare-free face with scales as indicated and coordinated to the ratios of the current and potential transformers provided. AC ammeters and voltmeters must be a minimum of [50] [115] mm [2] [4 1/2] inches square, with 4.36 rad 250 degree scale. Provide single-phase indicating instruments with flush-mounted transfer switches for reading three phases.

a. AC ammeters: Transformer rated, 5-ampere input, 60 Hz.

b. AC voltmeters: Transformer rated, 150-volt input, 60 Hz.[Provide external dropping resistors.]

c. AC wattmeters: Transformer rated for 120-volt input, 60 Hz, three-phase, four-wire, with scale range coordinated to the ratios of the associated current transformers and potential transformers.[Provide external dropping resistors.]

d. Frequency meters: Rated for 120-volt input, 60 Hz nominal frequency, [_____] to [_____] Hz scale range.

e. Power-factor meters: Transformer rated 5-ampere, [120][208]-volt input, [_____] scale range for use on [three][four]-wire, three-phase circuits. The accuracy must be plus or minus 0.01.

f. DC ammeters: [Self-contained][Shunt-rated],[0 to [_____] ampere][[_____] to 0 to [_____] ampere] scale range.

g. DC voltmeters: Self-contained,[0 to [_____] volt][[_____] to 0 volt] scale range. Furnish resistors, if required, with the voltmeter.

2.2.3.2 Instrument Control Switches

Provide rotary cam-operated type with positive means of indicating contact positions. Switches must have silver-to-silver contacts enclosed in a protective cover which can be removed to inspect the contacts.

[2.2.3.3 Electronic Watthour Meter

****

NOTE: For the Air Force, use Section 26 27 13.10 30 ELECTRIC METERS. For the Navy, use Section 26 27 14.00 20 ELECTRICITY METERING.

For the Army, coordinate meter requirements in accordance with Engineering and Construction Bulletin ECB 2015-2, Advanced Metering and Connectivity.

****

Provide as specified in Section [26 27 14.00 20 ELECTRICITY METERING][26 27 13.10 30 ELECTRIC METERS].

ANSI C12.1. Provide a switchgear style electronic programmable watthour meter, semi-flush mounted, as indicated. Meter can be either programmed at the factory or programmed in the field. Turn field programming device over to the Contracting Officer at completion of project. Coordinate meter to system requirements.

a. Design: Provide meter designed for use on a 3-phase,[4-wire][3-wire][_____] volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS).

b. Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

c. Class: 20. Accuracy: plus or minus 1.0 percent. Finish: Class II.

d. Kilowatt-hour Register: five digit electronic programmable type.

e. Demand Register:

    (1) Provide solid state.

    (2) Display actual values and readings of the metered circuit. No multipliers must be required.

(3) Demand interval length: programmed for [15] [30] [60] minutes with rolling demand up to six subintervals per interval.

f. Meter fusing: Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to the watthour meter. Size fuses as recommended by the meter manufacturer.

g. Provide meter with a communications port, RS485, with Modbus RTU serial or Ethernet, Modbus-TCP communications.

****

NOTE: Select the appropriate current transformer (CT) ratio, continuous-thermal-current rating factor (RF) at 30 degrees C and ANSI Metering Accuracy Class values based on the CT Ratio which is just below the rating of the main protective device.

Select an ANSI Metering Accuracy Class in accordance with the following table: CT Ratio	**RF**	**Accuracy Class**
200/5	**4.0**	**0.3 thru B-0.1**
300/5	**3.0**	**0.3 thru B-0.2**
400/5	**4.0**	**0.3 thru B-0.2**
600/5	**4.0**	**0.3 thru B-0.5**
800/5	**2.0**	**0.3 thru B-0.5**
1200/5	**1.5**	**0.3 thru B-0.5**
1500/5	**1.5**	**0.3 thru B-0.9**
2000/5	**1.5**	**0.3 thru B-1.8**

****

IEEE C57.13. Provide single ratio transformers, 60 hertz, [_____] to 5-ampere ratio, [_____] rating factor, with a metering accuracy class of 0.3 through [_____].

[Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

]][2.2.3.4 Electro-mechanical Watthour Meters

****

NOTE: On bases that employ Energy Monitoring and Control Systems (EMCS) and monitor each building individually, add the following to this paragraph: "Provide watthour meter with a three-wire, single-pole double-throw, quick-make, quick-break pulse initiator. Coordinate pulse output ratio with main circuit breaker rating."

****

NEMA/ANSI C12.10. Kilowatt-hour meters must be transformer rated, polyphase, 60 Hz, semi-flush mounted, draw-out or semi draw-out switchboard meters for use on a four-wire wye, three-phase system. Kilowatt-hour meters must be[two and one-half][three]-stator.[Totalizing kilowatt-hour meters must be four-stator, two-circuit. For totalizing meters, provide devices and equipment required to provide single point metering of real power and reactive power from two inputs as indicated.] Each meter must have a five-dial pointer type register and must be secondary reading. Register ratio must be selected to provide a meter reading multiplier of even hundreds after applying the product of the current transformer ratio and the potential transformer ratio. Indicate the meter reading multiplier on the meter face. The kilowatt-hour meter must have a [sweep hand] [cumulative] type KW demand register with 15-minute interval conforming to NEMA C12.4.

][2.2.3.5 Electric Strip-Chart Recording AC Wattmeter

UL 1437 for [surface] [semi-flush] mounting. Chart speed must be [_____] mm [_____] inches per [hour] [minute] and chart drive motor must be rated [240] [120] [120/240] V, 60 Hz. The instrument must have a full scale accuracy of one percent.

]2.2.4 Instrument Transformers

IEEE C57.13, as applicable.

a. Current transformers: Each breaker compartment must have provision for front-accessible mounting of up to four current transformers per phase (ANSI standard relay accuracy), two on bus side and two on cable side of circuit breaker. The current transformer assembly must be insulated for the full voltage rating of the switchgear. The current transformers wiring must be Type SIS No. 10 AWG copper.

b. Potential transformers: Transformers must be drawout type, 60 Hz, with voltage ratings and ratios coordinated to the ratings of the associated switchgear, relays, meters, and instruments. Potential transformers must be with [one fuse] [two fuses] in the primary. Fuses must be current limiting and sized as recommended by the potential transformer manufacturer.

2.2.5 Heaters

Provide 120-volt heaters in each switchgear section. Heaters must be of sufficient capacity to control moisture condensation in the compartments and must be sized 250 watts minimum. Heaters must be controlled by a thermostat[and humidistat] located inside each section. Thermostats must be industrial type, high limit, to maintain compartments within the range of

15 to 32 degrees C 60 to 90 degrees F.[Humidistats must have a range of 30 percent to 60 percent relative humidity.] Provide transformer rated to carry 125 percent of heater full load rating. Transformers must have 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and must conform to NEMA ST 20. Provide panelboard and circuit breakers in each switchgear assembly to serve the heaters in that switchgear assembly. Energize electric heaters in switchgear assemblies while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source.

2.2.6 Pilot and Indicating Lights

Provide LED type pilot and indicating lights, color as indicated on the drawings.

2.2.7 Metering

2.2.7.1 Digital Metering

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meter enclosed in a sealed case with the following features.

a. Display capability:

[(1) Multi-Function Meter: Display a selected phase to neutral voltage, phase to phase voltage, percent phase to neutral voltage THD, percent phase to phase voltage THD; a selected phase current, neutral current, percent phase current THD, percent neutral current; selected total PF, kW, KVA, kVAR, FREQ, kVAh, kWh. Detected alarm conditions include over/under current, over/under voltage, over/under KVA, over/under frequency, over/under selected PF/kVAR, voltage phase reversal, voltage imbalance, reverse power, over percent THD. Include a Form C KYZ pulse output relay on the meter.

][(2) Power Meter: Display Watts, VARs, and selected KVA/PF. Detected alarm conditions include over/under KVA, over/under PF, over/under VARs, over/under reverse power.

][(3) Volt Meter: Provide capability to be selectable between display of the three phases of phase to neutral voltages and simultaneous display of the three phases of the phase to phase voltages. Detected alarm conditions include over/under voltage, over/under voltage imbalance, over percent THD.

][(4) Ammeter: Display phase A, B, and C currents. Detected alarm conditions include over/under current, over percent THD.

][(5) Digital Watthour Meter: Provide a single selectable display for watts, total kilowatt hours (kWh) and watt demand (Wd). Include a Form C KYZ pulse output relay on the meter.

] b. Design meters to accept [input from standard 5A secondary instrument transformers][and][direct voltage monitoring range to [300] [600] volts, phase to phase].

c. Provide programming via a front panel display and a communication interface accessible by a computer.

d. Provide password secured programming stored in non-volatile EEPROM memory.

e. Provide digital communications in a Modbus [RTU] protocol via a [RS232C] [RS485] serial port[and an independently addressable [RS232C] [RS485] serial port].

f. Provide meter that calculates and stores average max/min demand values with time and date for all readings based on a user selectable sliding window averaging period.

g. Provide meter with programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions.

[h. Provide meter with a display of Total Harmonic Distortion (THD) measurement to a minimum of the thirty-first order.

][i. Include historical trend logging capability with the ability to store up to 100,000 data points with intervals of 1 second to 180 minutes. Provide a unit that can store and time stamp up to 1000 programmable triggered conditions.

][j. Provide event waveform recording triggered by the rms of 2 cycles of voltage or current exceeding programmable set points. Store waveforms for all 6 channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.

][2.2.8 Submetering

****

NOTE: For bases and activities that have an active submetering policy in place and written authorization has been received, edit this section as necessary to specify the desired level of submetering and locations.

If submetering is selected as an option, coordinate references to ASHRAE 90.1 with the lead person editing the Division 1 Sections.

****

ASHRAE 90.1 - IP. Provide submetering for [_____].

]2.2.9 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Provide short-circuiting type terminal boards associated with current transformer. Terminate conductors for current transformers with ring-tongue lugs. Identify each terminal to indicate the load served.

2.2.10 Wire Marking

Mark control and metering conductors at each end. Provide factory installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Provide a single letter or number on each sleeve, elliptically shaped to securely grip the wire, and keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Indicate on each wire marker the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.2.11 Surge Arresters

Provide one surge arrester for each conductor on circuits where indicated. Surge arresters must conform to IEEE C62.11 for [distribution class] [station class] [class as indicated] and must be rated [_____] kV.

2.2.12 Control Wiring

The switchgear control wiring must be type SIS No. 14 AWG copper minimum, except where larger size wire is required.

[2.2.13 Grounding Resistor

****

NOTE: Time ratings greater than 10-seconds are required only when the system is not taken off line by a ground fault, but merely monitored.

****

The neutral grounding resistor assembly must comply with IEEE 32. The assembly shall meet the following:

a. The resistor element must be [stainless steel] [cast-iron] and rated [_____] amperes for a [10-second] [1-minute] [10-minutes] [extended time] duty.

b. The resistor must be installed in an aluminized screened or expanded galvanized steel enclosure of the personnel safety type and shall be provided with any necessary supports and mounting hardware. The enclosure, including screening and support framing, must have two finish coats applied over a prepared substrate. The color of the finish coats shall be the same as the color of the associated transformer.

c. A stress-relief terminator must be provided and arranged to permit the proper termination of the No. [_____] AWG, [_____] [5] [15] kV shielded transformer neutral cable entering the enclosure [from the [bottom] [top]] [as recommended by the manufacturer]. If the terminal bushing is external to the enclosure, the bushing and terminal provisions shall be enclosed by a solid metal cable box equipped with conduit fittings correctly sized for the conduit required. An approved type and size of terminal lug must also be provided and arranged for the field termination of the No. 4/0 AWG bare copper grounding cable entering the enclosure from the bottom.

d. One current transformer conforming must be provided and housed in the resistor enclosure. The current transformer shall have the ratio shown.

]2.3 MANUFACTURER'S NAMEPLATE

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.4 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the bracketed sentence to specify labels for switchgear where emergency breakers are located within the switchgear. Provide note on the drawings to indicate where red labels are required.

****

ASTM D709. Provide laminated plastic nameplates for each switchgear, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Identify on each nameplate inscription the function and, when applicable, the position. Provide nameplates of melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core.[Provide red laminated plastic label with white center core where indicated.] Provide matte finish surface. Provide square corners. Accurately align lettering and engrave into the core. Provide nameplates with minimum size of 25 mm by 65 mm one by 2.5 inches. Provide lettering that is a minimum of 6.35 mm 0.25 inch high normal block style.

2.5 SOURCE QUALITY CONTROL

2.5.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Perform production tests on each circuit breaker housing for this Project, complying with IEEE C37.09.

    (1) Perform mechanical operation tests to ensure proper functioning of shutters, operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.

    (2) Conduct an alignment test with master circuit breaker to verify all interfaces.

    (3) Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.

    (4) Perform the control wiring dielectric test at 1500 V for one minute.

    (5) Perform the dielectric test on primary and secondary circuits.

b. Perform production tests, on each circuit breaker supplied for this Project, complying with IEEE C37.09.

(1) Perform mechanical operation tests to ensure proper functioning of the switch.

(2) Conduct an alignment test with master cell to verify all interfaces and interchangeability.

(3) Verify the contact gap. Perform terminal-to-terminal resistance test.

(4) Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence. Operate the circuit breakers over the range of minimum to maximum of the control voltage.

(5) Perform the control wiring dielectric test at 1500 V for one minute.

(6) Set the contact gap.

[2.5.2 Cybersecurity Equipment Certification

****

NOTE: Coordinate equipment certification with Government's cybersecurity requirements and interpretations. Select this option if the switchgear includes remote control or remote access capability.

****

Furnish a certification that control systems are designed and tested in accordance with DOD 8500.01, DOD 8510.01, and as required by individual Service Implementation Policy.

]2.5.3 Switchgear Design Tests

IEEE C37.20.2A or IEEE C37.20.3 as applicable. Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification. Required tests shall be as follows:

a. Design Tests

(1) . Dielectric test

(2) . Rated continuous current test

(3) . Short-circuit current withstand tests

(4) . Mechanical endurance tests

(5) . Flame-resistance tests

(6) . Rod entry tests

[(7) . Rain test for outdoor MV switchgear

][2.6 COORDINATED POWER SYSTEM PROTECTION

****

NOTE: Use this paragraph only for Army projects. The requirement for studies in this section depends on the complexity and extent of the power system.

****

Provide a power system study as specified in Section 26 05 73 POWER SYSTEM STUDIES.

]2.7 ARC FLASH WARNING LABEL

****

NOTE: Include the Arc Flash Warning Label detail on the drawings.

****

Provide warning label for switchgear. Locate this self-adhesive warning label on the outside of the enclosure warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

[2.8 SERVICE ENTRANCE AVAILABLE FAULT CURRENT LABEL

****

NOTE: NFPA 70 requires that service equipment in other than dwelling units be legibly marked in the field with the maximum available fault current, including the date the fault-current calculation was performed. In addition, include the contact information for the organization that completed the calculation. Select this option if the switchgear will be used as service entrance equipment. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the short circuit calculation for the project. This may vary for design/build versus design/bid/build projects.

****

Provide label on exterior of switchgear used as service equipment listing the maximum available fault current at that location. Include on the label the date that the fault calculation was performed and the contact information for the organization that completed the calculation. Locate this self-adhesive warning label on the outside of the switchgear. Provide label format as indicated.

][2.9 MIMIC BUS LABELING

****

NOTE: Include a mimic bus if the system complexity warrants providing a one-line of the system configuration.

****

Provide a mimic bus on the front of the equipment to diagrammatically show the internal bus structure of the lineup.

]PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

****

NOTE: Include this grounding section for installations involving a switchgear installed in an exterior application. If the switchgear is installed adjacent to a pad-mounted distribution transformer, then coordinate the grounding requirements between the applicable specifications.

****

****

NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, specify other methods of grounding. Where it is impractical to obtain the indicated ground resistance values, make every effort to obtain ground resistance values as near as possible to the indicated values.

Select 25 ohms resistance unless the installation requires a lower resistance to ground.

****

NFPA 70 and IEEE C2, except that grounds and grounding systems with a resistance to solid earth ground not exceeding [25] [_____] ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic weld or irreversible compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 610 mm 24 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Medium-Voltage Switchgear

IEEE C37.20.2A and IEEE C37.20.3 as applicable.

3.3.2 Meters and Instrument

Transformers ANSI C12.1.

3.3.3 Galvanizing Repair

Repair damage to galvanized coatings caused by handling, transporting, cutting, welding, or bolting. Make repairs in accordance with ASTM A780/A780M, zinc rich paint. Do not heat surfaces that repair paint has been applied to.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the equipment is located. Include construction requirements for concrete slab only if slab is not detailed in drawings. Curbs or raised edges may also be required around liquid filled transformers.

****

[3.4.1 Exterior Location

Mount switchgear on concrete slab. Unless otherwise indicated, the slab must be at least 200 mm 8 inches thick, reinforced with a 152 by 152 - MW19 by MW19 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 100 mm 4 inches from the top of the slab. Slab must be placed on a 150 mm 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 100 mm 4 inches above finished grade. Edges above grade must have 15 mm 1/2 inch chamfer. Slab must be of adequate size to project at least 200 mm 8 inches beyond equipment, except that front of slab must be large enough to serve as a platform to withdraw breakers or to operate two-high breaker lifters. Provide conduit turnups and cable entrance space required by the equipment to be mounted[and as indicated]. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm 3 inches above slab surface. Concrete work must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

][3.4.2 Interior Location

Mount switchgear on concrete slab. Unless Otherwise indicated, the slab must be at least 100 mm 4 inches thick. Top of concrete slab must be approximately 100 mm 4 inches above finished floor. Edges above floor must have 15 mm 1/2 inch chamfer. Slab must be of adequate size to project at least 200 mm 8 inches beyond the equipment, except that front of slab must be large enough to serve as a platform to withdraw breakers or to operate two-high breaker lifters. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water and oil-resistant caulking or sealant. Cut off and bush conduits 75 mm 3 inches above slab surface. Concrete work must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

]3.5 FIELD QUALITY CONTROL

****

NOTE: Select "Request for Settings" below if protective device settings will be government furnished. Select "Required Settings" below if protective device settings are furnished by the Designer of Record. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the final protective device settings for design/build versus design/bid/build projects. Do not rely on the manufacturer's default settings.

****

[Submit Request for Settings of breakers to the Contracting Officer after approval of switchgear and at least 30 days in advance of their requirement.

][Submit Required Settings of breakers to the Contracting Officer after approval of switchgear and at least 30 days in advance of their requirement.

]3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.[The [_____] Division, Naval Facilities Engineering Systems Command will witness formal tests after receipt of written certification that preliminary tests have been completed and that system is ready for final test and inspection.]

****

NOTE: Thermographic surveying is not required on most projects. NETA recommends that surveys be performed during periods of maximum possible loading but with not less than 40 percent of rated load on the electrical equipment being inspected. Testing at start-up will therefore not be beneficial except for hard-to-reach areas where solid connections cannot be verified by mechanical methods. Thermographic surveying may be useful if equipment operates under load for a specified period of time, preferably 3 to 6 months, before testing. The additional costs and the additional trip (3 to 6 months after the initial inspection) for the NETA contractor to perform the survey should be considered prior to specifying the requirement.

****

3.5.1.1 Medium-Voltage Vacuum Circuit Breakers

a. Visual and mechanical inspection

    (1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Inspect anchorage, alignment, and grounding.

(5) Perform all mechanical operational tests on both the circuit breaker and its operating mechanism.

(6) Measure critical distances such as contact gap as recommended by manufacturer.

(7) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey [is not] [is] required.

(8) Record as-found and as-left operation counter readings.

b. Electrical Tests

(1) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data, in the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.

(2) Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Microhm or dc millivolt drop values must not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

(3) Perform minimum pickup voltage tests on trip and close coils according to manufacturer's published data. Minimum pickup voltage of the trip and close coils must comply with manufacturer's published data. In the absence of the manufacturer's published data, comply with NETA ATS, Table 100.20.

(4) Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate according to manufacturer's published data.

(5) Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.

(6) Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed.

Power-factor or dissipation-factor values must comply with manufacturer's published data.

(7) Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the vacuum bottle integrity test, the test specimen is considered to have passed the test.

(8) Perform a dielectric-withstand-voltage test according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

Verify operation of heaters.

3.5.1.2 Switchgear Assemblies

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical, electrical, and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Verify appropriate anchorage, required area clearances, and correct alignment.

(5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

(6) Verify that[fuse and] circuit breaker sizes and types correspond to approved shop drawings.

[(7) Verify that current and potential transformer ratios correspond to approved shop drawings.

] (8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey [is not] [is] required.

(9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(10) Clean switchgear.

(11) Inspect insulators for evidence of physical damage or contaminated surfaces.

(12) Verify correct barrier[and shutter] installation[and operation].

(13) Exercise all active components.

(14) Inspect all mechanical indicating devices for correct operation.

(15) Verify that vents are clear.

(16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

(17) Inspect control power transformers.

b. Electrical Tests

(1) Perform insulation-resistance tests on each bus section.

(2) Perform overpotential tests.

(3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

(4) Perform control wiring performance test.

(5) Perform primary current injection tests on the entire current circuit in each section of assembly.

[(6) Perform phasing check on double-ended switchgear to ensure correct bus phasing from each source.

] (7) Verify operation of heaters.

3.5.1.3 Instrument Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey [is not] [is] required.

(6) Verify that all required grounding and shorting connections provide good contact.

(7) Verify correct operation of transformer with drawout mechanism and grounding operation.

(8) Verify correct primary and secondary fuse sizes for potential transformers.

b. Electrical Tests - Current Transformers

(1) Perform insulation-resistance tests.

(2) Perform polarity tests.

(3) Perform ratio-verification tests.

(4) Perform excitation test on transformers used for relaying applications.

(5) Measure circuit burden at transformer terminals and determine the total burden.

(6) When applicable, perform insulation resistance and dielectric withstand tests on the primary winding with secondary grounded.

(7) CAUTION: Changes of connection, insertion, and removal of instruments, relays, and meters must be performed in such a manner that the secondary circuits of energized current transformers are not opened momentarily.

c. Electrical Tests - Voltage (Potential) Transformers

(1) Perform insulation-resistance tests.

(2) Perform a polarity test on each transformer to verify the polarity marks or H1 - X1 relationships as applicable

(3) Perform a turns ratio test on all tap positions, if applicable.

(4) Measure potential circuit burdens at transformer terminals and determine the total burden.

(5) Measure circuit burden at transformer terminals and determine the total burden.

3.5.1.4 Battery Systems

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey [is not] [is] required.

(4) Measure electrolyte specific gravity and temperature and visually check fill level.

(5) Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical tests

(1) Set charger float and equalizing voltage levels.

(2) Verify all charger functions and alarms.

(3) Measure each cell voltage and total battery voltage with charger

energized and in float mode of operation.

(4) Perform a capacity load test.

3.5.1.5 Metering and Instrumentation

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

(2) Calibrate watthour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

(4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.5.1.6 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.5.1.7 Protective Relays

Protective relays must be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests must include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings must be implemented in accordance with the settings[provided by the government] [in accordance with the approved overcurrent protective device coordination study]. Relay contacts must be manually or electrically operated to verify that the proper breakers and alarms initiate.

[3.5.1.8 Cybersecurity Installation Certification

****

NOTE: Coordinate equipment certification with Government's cybersecurity requirements and interpretations. Select this option if the switchgear includes remote control or remote access capability.

****

Furnish a certification that control systems are installed in accordance with DOD 8500.01, DOD 8510.01, and as required by individual Service Implementation Policy.

]3.5.2 Follow-Up Verification

****

NOTE: Use "10" working days and include last bracketed sentence in the paragraph for NAVFAC SE projects.

****

Upon completion of acceptance checks, settings, and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers must be tripped by operation of each protective device. Test must require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer [5] [10] working days in advance of the dates and times for checks, settings, and tests[, to allow the Contracting Officer to notify NAVFAC SE Code 0742; Electrical Engineering Division and Code 162; Director, Utilities Engineering Division].

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-26 13 14 (November 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SWITCHGEAR HOUSE

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PART 1 GENERAL

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****
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****

SECTION 26 13 14

SWITCHGEAR HOUSE
11/21

****
NOTE: This guide specification covers the requirements for environmentally controlled, exterior prefabricated, pre-engineered structures to house a coordinated grouping of electrical switchgear and associated power and control equipment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual
AA ASD1	(2024) Aluminum Standards and Data

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 341	(2016) Seismic Provisions for Structural Steel Buildings
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121	(2007) Standard Definitions for Use in the Design of Steel Structures
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2017) Minimum Design Loads for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A529/A529M	(2019) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for

	Carbon and Alloy Steel Nuts (Metric)
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A606/A606M	(2023) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A755/A755M	(2018; R 2024) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum

	and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C273/C273M	(2020) Standard Test Method for Shear Properties of Sandwich Core Materials
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C553	(2024) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM C665	(2024) Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C991	(2023) Flexible Glass Fiber Insulation for Metal Buildings
ASTM C1289	(2023a) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C1363	(2024) Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1308	(2002; R 2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622/D1622M	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2247	(2015; R 2020) Standard Practice for Testing Water Resistance of Coatings in 100?Percent Relative Humidity
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D4060	(2019) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D6226	(2021) Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM DEFONLINE	(2008) ASTM Online Dictionary of Engineering Science and Technology
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2024) Standard Test Methods for Fire Tests of Building Construction and

	Materials
ASTM E136	(2024c) Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2023) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E1646	(1995; R 2024) Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Air Pressure Difference
ASTM E1680	(2016) Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F1852	(2014) Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

IEEE C37.20.2A	(2020) Metal-Clad Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA MBSM	(2018) Metal Building Systems Manual

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 80	(2025; TIA 24-1) Standard for Fire Doors and Other Opening Protectives
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 15	(1999; E 2004) Steel Joist Shop Primer/Metal Building Primer
SSPC Painting Manual	(2002) Good Painting Practice, Steel Structures Painting Manual, Volume 1
SSPC SP 2	(2024) Hand Tool Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

UL SOLUTIONS (UL)

UL 580	(2006; Reprint Apr 2024) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies
UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 GENERAL REQUIREMENTS

1.2.1 Scope

Provide a prefabricated walk-in skid-mounted switchgear house and foundation system including an insulated metal enclosure, structural steel skid, switchgear, interior power, control equipment, interior and exterior lighting, heating, cooling, [lightning protection] and related equipment. The switchgear house manufacturer must provide the equipment and materials as specified within this and related specifications. All equipment within the switchgear house must be totally complete, fully integrated and tested as an assembly prior to the shipment and arrival to the construction site providing a turn-key operational package. The structural grid base and floor system must be designed for applicable floor loading allowing the switchgear house to be lifted and transported with the interior equipment installed.

The switchgear house must be a completely self-contained pre-engineered package custom designed to specific power requirements and environmental conditions. The enclosure must be designed to house specified electrical equipment and any associated relay and control panels. The minimum aisle space and clearance around the equipment must be [as shown on drawings][designed per Article 110 of the latest National Electric Code (NFPA 70).] Provide provisions for future removal and replacement of all electrical equipment.

There must be a minimum clear space of 24 inches610 mm above the top of the tallest interior electrical equipment cabinet to the interior ceiling structure. Access doors must be provided in the exterior walls where required for each rear accessible equipment cabinets. Each access door must attach to a frame which matches the width of the respective interior equipment cabinet.

The switchgear house supplier must furnish, install, interconnect and test the equipment and materials specified herein, as well as any equipment specified in any related documents.

The specific site conditions must be considered when sizing and designing the equipment and structures.

1.2.2 Structural Performance

Provide prefabricated building capable of withstanding the effects of gravity loads and the following loads and stresses within the limits and conditions indicated.

1.2.2.1 Engineering

Design prefabricated building systems conforming to procedures described in MBMA MBSM.

1.2.2.2 Design Loads

Conform to the requirements of MBMA MBSM, ASCE 7, and the building code applicable to the project geographical location.

1.2.2.3 Live Loads

Include all vertical loads induced by the building occupancy indicated on the drawings, as well as loads induced by maintenance workers, materials and equipment for roof live loads.

1.2.2.4 Roof Snow Loads

****

NOTE: Delete this paragraph if the project is not subject to snow loads. Insert the ground snow load as determined by ASCE 7.

****

Include vertical loads induced by the ground snow load at the project site of [_____]. Allow for unbalanced and drift loads.

1.2.2.5 Wind Loads

****

NOTE: Insert the basic wind speed as determined by ASCE 7. Verify that design wind loads are in accordance with the referenced ASCE 7. It may be necessary to revise the date of the referenced ASCE 7 in 1.1 Reference paragraph to be compatible with the required design wind loads.

****

Include horizontal loads induced by a basic wind speed Project site of [_____].

1.2.2.6 Collateral Loads

Include additional dead loads other than the weight of metal building system for permanent items such as sprinklers, mechanical systems, electrical systems, and ceilings.

1.2.2.7 Auxiliary Loads

Include dynamic live loads, such as those generated by cranes and materials-handling equipment indicated on detail drawings.

1.2.2.8 Load Combinations

Design switchgear house to withstand the most critical effects of load factors and load combinations as required by MBMA MBSM, ASCE 7, and the building code applicable to the project location.

1.2.2.9 Deflection Limits

Engineer assemblies to withstand design loads with deflections no greater than the following:

a. Purlins and Rafters; vertical deflection of [1/180] [1/240] [_____] of the span.

b. Girts; horizontal deflection of [1/180] [1/240] [_____] of the span.

c. Metal Roof Panels; vertical deflection of [1/180] [1/240] [_____] of the span.

d. Metal Wall Panels; horizontal deflection of [1/180] [1/240] [_____] of the span.

Design secondary framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings. Provide metal panel assemblies capable of withstanding the effects of loads and stresses indicated, based on testing according to ASTM E1592.

1.2.3 Seismic Performance

Design and engineer the switchgear house capable of withstanding the effects of earthquake motions determined according to ASCE 7, AISC 341, and the applicable portions of the building code in the geographic area where the construction will take place.

1.2.4 Thermal Movements

Provide metal panel systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss as follows:

Temperature Change (Range); [67 degrees C] [120 degrees F] [_____], ambient; 100 degrees C 180 degrees F [_____], material surfaces.

1.2.5 Thermal Performance

Provide insulated metal panel assemblies with the following maximum U-factors and minimum R-values for opaque elements when tested according to ASTM C1363 or ASTM C518.

1.2.5.1 Metal Roof Panel Assemblies

****

NOTE: Insert the required U factors and R values.

****

a. U-Factor: [_____]

b. R-Value: [_____]

1.2.5.2 Metal Wall Panel Assemblies

a. U-Factor: [_____]

b. R-Value: [_____]

1.2.6 Air Infiltration for Metal Roof Panels

****

NOTE: Select or insert infiltration volume and negative pressure.

****

Air leakage through assembly must not exceed [0.3 L/s per sq. m] [0.06 cfm/sq.ft.] [_____] of roof area when tested according to ASTM E1680 at negative test-pressure difference of [75 Pa] [1.57 lb/sq.ft.] [_____].

1.2.7 Air Infiltration for Metal Wall Panels

****

NOTE: Select or insert infiltration volume and negative pressure.

****

Air leakage through assembly of not more than [0.3 L/s per sq. m] [0.06 cfm/sq.ft.] [_____] of wall area when tested according to ASTM E283 at static-air-pressure difference of [300 Pa] [6.24 lbf/sq.ft.] [_____].

1.2.8 Water Penetration for Metal Roof Panels

No water penetration when tested according to ASTM E1646 at test-pressure difference of [137 Pa] [2.86 lbf/sq.ft.] [_____].

1.2.9 Water Penetration for Metal Wall Panels

No water penetration when tested according to ASTM E331 at a minimum differential pressure of [20] [_____] percent of inward-acting, wind-load design pressure of not less than [300 Pa] [6.24 lbf/sq.ft.] [_____] and not more than 575 Pa 12 lbf/sq. ft.

1.2.10 Wind-Uplift Resistance

Provide metal roof panel assemblies that comply with[UL 580 for Class [30] [60] [90]][ASCE 7,][the building code in the geographic area where the construction will take place].

1.2.11 Skid base and Floor

The switchgear house must be mounted on a AWS D1.1/D1.1M all welded structural steel skid base, constructed entirely of ASTM A36/A36M steel. Structural steel skid base including design, materials, installation, workmanship, fabrication, assembly, erection inspection, quality control, and testing must be in accordance with AISC 325. The exterior perimeter and underside of the skid base must be protected with a minimum 800 micron coating of a coal tar epoxy. The entire skid must be blasted clean to SSPC SP 10/NACE No. 2 requirements prior to coating. The coating must meet the performance requirements of ASTM D4060 for abrasion, ASTM D4541 for adhesion, ASTM D2794 for impact, and ASTM B117 for salt fog. Stainless steel plates not less than 6 mm 1/4 inch must cover entire top of skid base except under incoming cable compartments. Paint coating system must comply with IEEE C57.12.29. After the unit is complete, the top side (floor) is painted with a [_____] color epoxy paint and sand mix for the non-skid finish.

1.3 DEFINITIONS

ASTM DEFONLINE applies to this definition paragraph.

a. Bay: Dimension between main frames measured normal to frame (at centerline of frame) for interior bays, and dimension from centerline of first interior main frame measured normal to end wall (outside face of end-wall girt) for end bays.

b. Building Length: Dimension of the building measured perpendicular to main framing from end wall to end wall (outside face of girt to outside face of girt).

c. Building Width: Dimension of the building measured parallel to main framing from sidewall to sidewall (outside face of girt to outside face of girt).

d. Clear Span: Distance between supports of beams, girders, or trusses (measured from lowest level of connecting area of a column and a rafter frame or knee).

e. Eave Height: Vertical dimension from finished floor to eave (the line along the sidewall formed by intersection of the planes of the roof and wall).

f. Clear Height under Structure: Vertical dimension from finished floor to lowest point of any part of primary or secondary structure, not including crane supports, located within clear span.

g. Terminology Standard: Refer to MBMA "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 SYSTEM DESCRIPTION

General: Provide a complete, integrated set of mutually dependent components and assemblies that form a system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing,[metal roof panels,][metal wall panels,] and accessories complying with requirements indicated.

Provide switchgear house of a size to accommodate the contained electrical equipment while maintaining the code required working clearance around all electrical equipment.

1.4.1 Primary Frame Type

****

NOTE: Select the appropriate primary frame type from the following.

****

[a. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

][b. Truss-Frame Clear Span: Truss-member, structural-framing system without interior columns.

][c. Long Bay: Solid- or truss-member, structural-framing system without interior columns.

][d. Lean To: Solid- or truss-member, structural-framing system without interior columns, designed to be partially supported by another structure.

][e. As determined by the manufacturer.

][1.4.2 Fixed End-Wall Framing

****

NOTE: Select fixed or expandable end wall type and delete the other.

****

Provide manufacturer's standard fixed end wall, for buildings not required to be expandable, consisting of[primary frame, capable of supporting one-half of a bay design load, and end-wall columns][load-bearing end-wall with corner columns, and rafters].

][1.4.3 Expandable End-Wall Framing

Provide engineered end walls to be expandable. Provide primary frame, capable of supporting full-bay design loads, and end-wall columns.

]1.4.4 Secondary Frame Type

Provide manufacturer's standard purlins and joists and [flush-framed] [partially inset-framed] [exterior-framed (bypass)] girts.

1.4.5 Eave Height

Eave height must be [4.9 m] [6.1 m] [7.3 m] [8.5 m] [16 feet] [20 feet] [24 feet] [28 feet] [_____] [as determined by the manufacturer].

1.4.6 Bay Spacing

Bay Spacing must be [6.1 m] [7.6 m] [9.1 m] [20 feet] [25 feet] [30 feet] [_____] [as determined by manufacturer].

1.4.7 Roof Slope

Roof slope must be [1:48] [1:24] [1:12] [1:3] [1/4 inch per 12 inches] [1/2 inch per 12 inches] [1 inch per 12 inches] [4 inches per 12 inches] [_____] [manufacturer's standard for frame type required].

1.4.8 Roof System

Provide manufacturer's standard[vertical-rib, standing-seam][trapezoidal-rib standing-seam][lap-seam] metal roof panels[with insulation].

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

SD-02 Shop Drawings

Switchgear House Drawings; G, [_____]

SD-03 Product Data

Manufacturer's data indicating percentage of recycle material of the following to verify sustainable acquisition compliance; G, [_____]

SD-04 Samples

Coil Stock, 304.8 mm 12 inches long by the actual panel width; G, [_____]

Roof Panels, 304.8 mm 12 inches long by actual panel width; G, [_____]

Wall Panels, 304.8 mm 12 inches long by actual panel width; G, [_____]

Fasteners; G, [_____]

Metal Closure Strips 250 mm 10 inches long of each type; G, [_____]

Insulation, approximately 200 by 280 mm 8 by 11 inches; G, [_____]

Vapor Barrier; G, [_____]

Manufacturer's Color Charts and Chips, 101.6 mm by 101.6 mm 4 by 4 inches; G, [_____]

SD-05 Design Data

Manufacturer's Descriptive and Technical Literature; G, [_____]

Manufacturer's Building Design Analysis; G, [_____]

SD-06 Test Reports

Test Reports; G, [_____]

Coatings; G, [_____]

Finishes; G, [_____]

Submit test reports in accordance with specification Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

SD-07 Certificates

Coil Stock Certification; G, [_____]

Aluminized Steel Repair Paint; G, [_____]

Galvanizing Repair Paint; G, [_____]

Enamel Repair Paint; G, [_____]

Manufacturer's Qualifications; G, [_____]

Qualification of Erection Contractor; G, [_____]

SD-08 Manufacturer's Instructions

Installation of Roof and Wall Panels; G, [_____]

Shipping, Handling, and Storage; G, [_____]

SD-11 Closeout Submittals

Manufacturer's Warranty; G, [_____]

Contractor's Warranty for Installation; G, [_____]

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawing Requirements

Switchgear house drawings must include, but are not limited to the following:

a. Dimensioned architectural floor plan drawings at 6 mm = 304 mm 1/4 inch = 12 inch scale.

b. Building elevations, section views and skid foundation details. Section views must include electrical and mechanical equipment.

c. Electrical and mechanical equipment floor plan drawings at 6 mm = 304 mm 1/4 inch = 12 inch scale. Drawings must show all electrical and HVAC equipment including all required working clearances and access to the electrical equipment. Indicate removal path for large equipment such as switchgear.

d. Electrical floor plan drawing at 6 mm = 304 mm 1/4 inch = 12 inch scale showing electrical receptacle, lighting and lighting control layout and circuiting.

e. Provide drawings showing conduit and cable entry areas for switchgear field connections.

f. Provide rigging plan showing lifting points and shipping splits.

1.6.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products, erection of structural framing and installation of roof and wall panels in the geographical area where construction will take place.

1.6.3 Manufacturer's Qualifications

Switchgear House manufacturer must have a minimum of five years experience as a qualified manufacturer[and a member of MBMA] of metal building systems and accessory products.

Provide engineering services by an authorized currently licensed engineer in the geographical area where construction will take place, having a minimum of five years of experience as an engineer knowledgeable in building design analysis, protocols and procedures for the "Metal Building Systems Manual" (MBMA MBSM); ASCE 7,[the building code in the geographic area where the construction will take place] and ASTM E1592.

Provide certified engineering calculations using the products submitted for:

a. Roof and Wall Wind Loads with basic wind speed, exposure category, co-efficient, importance factor, designate type of facility, negative pressures for each zone, methods and requirements of attachment.

b. Roof Dead and Live Loads

c. Collateral Loads

d. Foundation Loads

e. Roof Snow Load

f. Seismic Loads

1.6.4 Qualification of Erection Contractor

An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and must be approved and certified by the switchgear house manufacturer.

1.6.5 Single Source

Obtain primary and secondary components and structural framing members, each type of metal roof, wall and liner panel assemblies, clips, closures and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.6.6 Welding

Qualify procedures and personnel according to AWS A5.1/A5.1M, AWS D1.1/D1.1M, and AWS D1.3/D1.3M.

1.6.7 Structural Steel

Comply with AISC 325,[AISC 341 for seismic impacted designs,] AISC 360, for design requirements and allowable stresses.

1.6.8 Cold-Formed Steel

Comply with AISC/AISI 121 and AISI SG03-3 for design requirements and allowable stresses.

1.6.9 Fire-Resistance Ratings

Where indicated, provide metal panels identical to those of assemblies tested for fire resistance per ASTM E119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Indicate design designations from UL Bld Mat Dir or from the listings of another qualified testing agency. Combustion Characteristics must conform to ASTM E136.

1.6.10 Surface-Burning Characteristics

Provide metal panels having[field-insulation][insulation core][insulation and vapor barrier] material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency showing:

a. Flame-Spread Index: [25] [_____] or less.

b. Smoke-Developed Index: [450] [_____] or less.

1.6.11 Fabrication

Fabricate and finish the switchgear house at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles with dimensional and structural requirements.

Provide metal panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel. Aluminum and aluminum-alloy sheet and plate must conform to ASTM B209.

Fabricate metal panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within panel assembly.

Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA or by metal building system manufacturer for application, but not less than thickness of metal being secured.

1.6.12 Certifications

The switchgear house must be Third Party certified by UL as NEC (National Electric Code) compliant and / or UL 3R RAIN TEST and / or IEEE C37.20.2A RAIN TEST compliant and must bear a UL Label.

[The switchgear house design must be accomplished by a Professional Engineer and drawings and supporting calculations will bear the Professional Engineer's seal.

]1.6.13 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.6.14 Pre-Erection Conference

After submittals are received and approved but before metal building system work, including associated work, is performed, the Contracting Officer will hold a pre-erection conference to review the following:

a. The detail drawings, specifications, and manufacturer's descriptive and technical literature.

b. Finalize construction schedule and verify availability of materials, erector's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to metal building system erection, including, but not limited to: qualification of manufacturer, qualification of erector, manufacturer's catalog data, manufacturer's building design analysis, lateral force calculations, written instructions and test reports. Lateral force calculations must include all analysis and confirmation of system components required to transfer lateral forces to the foundation.

d. Support conditions for compliance with requirements, including alignment between and erection of structural members.

e. Flashing, special roofing and siding details, roof and wall penetrations, openings, and condition of other construction that will affect the metal building system, including coatings and base metals, factory color finish performance requirements, system components, and coil stock certification.

f. Governing regulations and requirements for, certificates, insurance, tests and inspections if applicable.

g. Temporary protection requirements for metal panel assembly during and after installation.

h. Samples of roof panels, wall panels, aluminized steel repair paint, galvanizing repair paint, and enamel repair paint.

1.6.14.1 Pre-Roofing and Siding Installation Conference

After structural framing system erection and approval but before roofing, siding[, insulation and vapor barrier] work, including associated work, is performed; the Contracting Officer will hold a pre-roofing and siding conference to review the following:

a. Examine purlins, sub-girts and formed shapes conditions for compliance with requirements, including flatness and attachment to structural members.

b. Review structural limitations of purlins, sub-girts and formed shapes during construction and after roofing and siding.

c. Review flashings, special roof and wall details, roof drainage, roof and wall penetrations, roof equipment curbs, and condition of other construction that will affect the metal building system.

d. Review temporary protection requirements for metal roof and wall panels' assembly during and after installation.

e. Review roof and wall observation and repair procedures after metal building system erection.

1.7 SHIPPING, HANDLING AND STORAGE

1.7.1 Delivery

Package and deliver the assembly and other manufactured items so as not to be damaged or deformed and protected during transportation and handling.

For a building that must be shipped in multiple shipping sections, junction boxes must be provided at the shipping splits for easy breakdown of the building wiring for shipment and reconnection at the job site. Prior to shipment the open end/sides of each shipping section will be crated (weatherproofed) for transit to the job site.

Each shipping piece must be designed for lifting by lugs located along the base perimeter members at 4.5 m 15 feet approximate intervals. All lifting lugs must be removable.

1.8 PROJECT CONDITIONS

1.8.1 Weather Limitations

Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into the switchgear house.

1.8.2 Field Measurements

1.8.2.1 Established Dimensions for Foundations

Comply with established dimensions on approved anchor-bolt plans, established foundation dimensions, and proceed with fabricating structural framing. Do not proceed without verifying field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.

1.8.2.2 Verification Record

Verify locations of all framing and opening dimensions by field measurements before metal panel fabrication and indicate measurements on Shop Drawings.

1.9 COORDINATION

Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in section on 03 30 00 CAST-IN-PLACE CONCRETE.

[Coordinate installation of [fire suppression system] [equipment supports] [piping and supports][and][accessories], which are specified in Division 21 - FIRE SUPPRESSION.

][Coordinate installation of [plumbing system] [equipment supports] [piping and supports][and][accessories], which are specified in Division 22 - PLUMBING.

] Coordinate installation of [HVAC system] [equipment supports] [ductwork and supports] [piping and supports][and][accessories], which are specified in Division 23 - HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

Coordinate installation of [equipment supports][and][roof penetrations], which are specified in Division 07 - THERMAL AND MOISTURE PROTECTION.

Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak-proof, secure, and non-corrosive installation.

1.10 WARRANTY

1.10.1 Building System Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal building system. The warranty period is to be no less than [10] [15] [20] years from the date of acceptance of the work and be issued directly to the Government. The warranty must provide that if within the warranty period, the switchgear house shows evidence of deterioration resulting from defective materials and/or workmanship, correcting of any defects is the responsibility of the metal building system manufacturer. Repairs that become necessary because of defective materials and workmanship while metal building system is under warranty are to be performed within [32] [_____] hours after notification, unless additional time is approved by the Contracting Officer.

1.10.2 Roof System Weather-Tightness Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than [10] [20] [_____] years from the date of acceptance of the work and be issued directly to the Government.

The warranty is to provide that if within the warranty period the roof panel system shows evidence of corrosion, perforation, rupture, lost of weather-tightness or excess weathering due to deterioration of the panel system resulting from defective materials and correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.

Repairs that become necessary because of defective materials and workmanship while roof panel system is under warranty are to be performed within [24] [_____] hours after notification, unless additional time is approved by the Contracting Officer. Immediate follow-up and completion of permanent repairs must be performed within [_____] days from date of notification.

1.10.3 Roof and Wall Panel Finish Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than [10] [20] [_____] years from the date of acceptance of the work and be issued directly to the Government.

The warranty is to provide that if within the warranty period the metal panel system shows evidence of checking, delaminating cracking, peeling, chalk in excess of a numerical rating of eight, as determined by ASTM D4214 test procedures; or change colors in excess of five CIE or Hunter units in accordance with ASTM D2244 or excess weathering due to deterioration of the panel system resulting from defective materials and finish or correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.

Liability under this warranty is exclusively limited to replacing the defective coated materials.

Repairs that become necessary because of defective materials and workmanship while roof and wall panel system is under warranty are to be performed within [32] [_____] hours after notification, unless additional time is approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 STRUCTURAL FRAMING MATERIALS

2.1.1 W-Shapes

ASTM A992/A992M; ASTM A572/A572M or ASTM A529/A529M.

2.1.2 Channel, Angles, M-Shapes and S-Shapes

ASTM A36/A36M; ASTM A572/A572M or ASTM A529/A529M.

2.1.3 Plate and Bar

ASTM A36/A36M, ASTM A572/A572M or ASTM A529/A529M.

2.1.4 Steel Pipe

ASTM A36/A36M, ASTM A53/A53M, ASTM A572/A572M or ASTM A529/A529M.

2.1.5 Cold-Formed and Hot Formed Hollow Structural Sections

Cold formed: ASTM A500/A500M or ASTM B221, ASTM B221M. Hot-formed: ASTM A501/A501M.

2.1.6 Structural-Steel Sheet

Hot-rolled, ASTM A1011/A1011M or cold-rolled, ASTM A1008/A1008M.

2.1.7 Metallic-Coated Steel Sheet

ASTM A653/A653M, ASTM A606/A606M.

2.1.8 Metallic-Coated Steel Sheet Pre-painted with Coil Stock Coating

Steel sheet metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A755/A755M.

[a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, and ASTM A123/A123M.

][b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, and ASTM A463/A463M.

][2.1.9 Joist Girders

Refer to Section 05 21 00 STEEL JOIST FRAMING.

][2.1.10 Steel Joists

Refer to the following sections subject to project design requirements:

Section 05 21 00 STEEL JOIST FRAMING.

]2.1.11 High-Strength Bolts, Nuts, and Washers

ASTM A325M ASTM A325 heavy hex steel structural bolts; ASTM A563M ASTM A563 heavy hex carbon-steel nuts; and ASTM F436M ASTM F436 hardened carbon-steel washers.

Finish: [Hot-dip zinc coating, ASTM A153/A153M] [Mechanically deposited zinc coating, ASTM B695] [Stainless steel].

Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F1852, heavy-hex-head steel structural bolts with spline.

Finish: [Mechanically deposited zinc coating, ASTM B695] [Mechanically deposited zinc coating, ASTM B695 baked epoxy coated] [Stainless steel].

2.1.12 Anchor Rods

[ASTM F1554] [ASTM A572/A572M] [ASTM A36/A36M] [ASTM A307].

a. Configuration: Straight.

b. Nuts: Heavy duty stainless steel.

c. Plate Washers: Stainless steel.

d. Washers: Stainless steel.

e. Finish: [Hot-dip zinc coating, ASTM A153/A153M] [Mechanically deposited zinc coating, ASTM B695].

2.1.13 Threaded Rods

[ASTM A193/A193M] [ASTM A572/A572M] [ASTM A36/A36M] [ASTM A307].

a. Nuts: Heavy duty stainless steel.

b. Washers: Stainless steel.

c. Finish: [Hot-dip zinc coating, ASTM A153/A153M] [Mechanically deposited zinc coating, ASTM B695].

2.1.14 Floors

Floor must be 6 mm 1/4 inch minimum thickness flat ASTM A36/A36M steel plate, welded to all longitudinal and transverse base members. Floor plate seams must be continuously welded at all joints, and ground smooth to minimize visibility of seams. Welding of floor plate must be staggered to produce a flat and ripple free surface.

2.1.15 Primer

SSPC Paint 15, Type I, red oxide.

2.2 FABRICATION

2.2.1 General

All facets of construction through coating and weatherproofing must be performed indoors, protected from outdoor weather conditions. Construction prior to this stage out-of-doors is not acceptable.

All permanent coatings and finishes must be applied inside a dedicated paint booth with ventilation and filtration provisions in compliance with the coating manufacturer's requirements. Coatings applied in outside, ambient air conditions must not be acceptable.

2.3 STRUCTURAL FRAMING

2.3.1 General

Clean all framing members to remove loose rust and mill scale. Provide one shop coat of primer to an average dry film thickness of 1 mil according to SSPC SP 2. Balance of painting and coating procedures must conform to SSPC Paint 15 and SSPC Painting Manual.

2.3.2 Primary Framing

Manufacturer's standard structural primary framing system includes transverse and lean-to frames; rafter, rakes, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing designed to withstand required loads and specified requirements. Provide frames with attachment plates, bearing plates, and splice members.

Shop fabricate framing components by welding or by using high-strength bolts to the indicated size and section with base-plates, bearing plates, stiffeners, and other items required.

[a. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.

][b. Rigid Modular Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide interior columns fabricated from [steel round pipe] [steel tube] [shop-welded, built-up steel plates].

] c. Frame Configuration: [Single gable] [One-directional sloped] [Lean to, with high side connected to, and supported by, another structure] [Multiple gables] [Load-bearing-wall type] [Multistory].

d. Exterior Column Type: [Uniform depth] [Tapered].

e. Rafter Type: [Uniform depth] [Tapered].

2.3.3 Secondary Framing

Manufacturer's standard secondary framing members, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet pre-painted with coil coating, unless otherwise indicated.

Shop fabricate framing components by roll-forming or break-forming to the indicated size and section with base-plates, bearing plates, stiffeners, and other plates required for erection. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

a. Purlins: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; minimum depth [as indicated] [as required to comply with system performance requirements] [_____].

b. Girts: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees to flange minimum depth [as indicated] [as required to comply with system performance requirements] [_____].

c. Eave Struts: Unequal-flange, C-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; to provide adequate backup for metal panels.

d. Flange Bracing: Structural-steel angles or cold-formed structural tubing to stiffen primary frame flanges.

e. Sag Bracing: Structural-steel angles.

f. Base or Sill Angles: Zinc-coated (galvanized) steel sheet.

g. Purlin and Girt Clips: Steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.

h. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from [zinc-coated (galvanized) steel sheet] [structural-steel sheet].

i. Framing for Openings: Channel shapes; fabricated cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings, and head, jamb, and sill of other openings.

j. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

2.3.4 Bracing

Provide adjustable wind bracing as follows:

a. Rods: ASTM A36/A36M; ASTM A572/A572M; or ASTM A529/A529M [threaded full length] [threaded a minimum of [_____]] at each end.

b. Cable: ASTM A475, [_____] diameter, extra-high-strength grade, zinc-coated, [_____]-strand steel; with threaded end anchors.

c. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.

d. Rigid Portal Frames: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

e. Fixed-Base Columns: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

f. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

g. Bracing: Provide wind bracing using any method specified above, at manufacturer's option.

2.4 PANEL MATERIALS

2.4.1 Aluminum Sheet

Roll-form aluminum [roof] [wall] [liner] panels to the specified profile, with fy = [30] [40] [50] [80] ksi [.032] [.040] [.050] inch thickness and depth as indicated. Material must be plumb and true, and within the tolerances listed:

a. Aluminum Sheet conforming to ASTM B209M ASTM B209, AA ADM and AA ASD1.

b. Individual panels to have continuous length to cover the entire length of any [roof slope] [wall area] with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

c. Provide panels with thermal expansion and contraction consistent with the type of system specified.

****

NOTE: Select the desired profile from below and delete remaining items.

****

(1) Profile and coverage to be a minimum height and width from manufacturer's standard for the indicated [roof slope] [wall area].

[(2) Profile to be a 38 mm 1-1/2 inch high rib at 304.8 mm 12 inches o.c. with small stiffening ribs, 965.2 mm 38 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][(3) Profile to be a 38 mm 1-1/2 inch high rib at 182.9 mm 7.2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][(4) Profile to be a 25.4 mm 1 inch high rib at 101.6 mm 4 inches o.c., 1260.5 mm 49-5/8 inch overall width with [1219.2] [1117.6] mm [48] [44] inch coverage and exposed fasteners.

][(5) Profile to be a 25.4 mm 1 inch high rib at 203.2 mm 8 inches o.c., 1057.3 mm 41-5/8 inch overall width with 1016 mm 40 inch coverage and exposed fasteners.

][(6) Profile to be a 44.5 mm 1-3/4 inch high V-beam rib at 127 mm 5 inches o.c., 1139.9 mm 44-7/8 inch overall width with 1066.8 mm 42 inch coverage and exposed fasteners.

][(7) Profile to be a 22.2 mm 7/8 inch high corrugated rib at 50 mm 2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][(8) Profile to be a 76 mm 3 inch high standing seam, 609.6 mm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][(9) Profile to be a [25.4] [44.5] [50.8] [63.5] mm [1] [1-3/4] [2]

[2-1/2] inch high standing seam, [304.8] [406.4] [457.2] mm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][(10) [Smooth, flat] [Embossed] Surface Texture.

][(11) Custom profile to be [_____] [as shown on drawings].

]2.4.2 Steel Sheet

Roll-form steel [roof] [wall] [liner] panels to the specified profile, with fy = [30] [40] [50] [80] ksi [26] [24] [22] [20] [18] gauge and depth as indicated. Material must be plumb and true, and within the tolerances listed:

[a. Galvanized Steel Sheet conforming to ASTM A653/A653M and AISI SG03-3.

][b. Aluminum-Zinc Alloy-coated Steel Sheet conforming to ASTM A792/A792M and AISI SG03-3.

][c. Individual panels to have continuous length to cover the entire length of any unbroken [roof slope] [wall area] with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

] d. Provide panels with thermal expansion and contraction consistent with the type of system specified;

[profile and coverage to be a minimum height and width from manufacturer's standard for the indicated [roof slope] [wall area].

][profile to be a 38 mm 1-1/2 inch high rib at 304.8 mm 12 inches o.c. with small stiffening ribs, 965.2 mm 38 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][profile to be a 38 mm1-1/2 inch high rib at 182.9 mm 7.2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][profile to be a 25.4 mm1 inch high rib at 101.6 mm 4 inches o.c., 1260.5 mm 49-5/8 inch overall width with [1219.2] [1117.6] mm [48] [44] inch coverage and exposed fasteners.

][profile to be a 25.4 mm1 inch high rib at 203.2 mm 8 inches o.c., 1057.3 mm 41-5/8 inch overall width with 1016 mm 40 inch coverage and exposed fasteners.

][profile to be a 22.2 mm 7/8 inch high corrugated rib at 50 mm 2 inches o.c., 987.4 mm 38-7/8 inch overall width with 914.4 mm 36 inch coverage and exposed fasteners.

][profile to be a 76 mm 3 inch high standing seam, 609.6 mm 24 inch coverage, factory-caulked and mechanical crimping or snap-together seams with concealed clips and fasteners.

][profile to be a [25.4] [44.5] [50.8] [63.5] mm [1] [1-3/4] [2] [2-1/2] inch high standing seam, [304.8] [406.4] [457.2] mm [12] [16] [18] inch coverage, with mechanical crimping or snap-together seams with concealed clips and fasteners.

][[Smooth, flat] [Embossed] Surface Texture.

][profile to be custom as shown on drawings.

]2.4.3 Foam-Insulation Core Wall Panel

Provide factory-formed [aluminum] [steel] [roof] [wall] panel assembly fabricated from two sheets of metal with modified polyisocyanurate or polyurethane foam insulation core [foamed-in-place] [board] during fabrication with joints between panels designed to form weather-tight seals. Include accessories required for weather-tight installation.

a. Closed-Cell Content: 90 percent when tested according to ASTM D6226, ASTM C1289.

b. Density: 32 to 42 kg/cu. m 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622/D1622M.

c. Compressive Strength: Minimum 140 kPa 20 psi when tested according to ASTM D1621.

d. Shear Strength: 179 kPa 26 psi when tested according to ASTM C273/C273M.

2.4.4 Insulated Panel Construction

Shop fabricate or field assemble insulated panel construction with specified exterior and interior [aluminum] [steel] sheet in accordance with manufacturer's printed instructions.

Insulation to be [glass-fiber-ASTM C991] [slag-wool-fiber] [rock-wool-fiber] conforming to ASTM C553 and ASTM C612 of thickness and density as required for the geographical area where construction will take place. Glass-Fiber and Mineral-Wool-Fiber are materials listed in the EPA's Comprehensive Procurement Guidelines (CPG), and are a component of sustainable acquisition compliance.

Insulation fasteners to be adhesively attached, plate welded to projecting spindle anchors; capable of holding insulation of thickness indicated, secured in position with self-locking washer and complying with the following requirements:

a. Plate: Perforated galvanized carbon-steel sheet, 0.762 mm 0.030 inch thick by 50 mm 2 inches square.

b. Spindle: Copper-coated, low carbon steel; fully annealed; 2.67 mm 0.105 inch in diameter; length to suit depth of insulation indicated.

c. Insulation-Retaining Washers: Self-locking washers formed from 0.41-mm- 0.016-inch-thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 38 mm 1-1/2 inches square or in diameter.

d. Anchor adhesive to be a product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

2.4.5 Finishes

All panels are to receive a factory-applied [polyvinylidene fluoride] [Kynar 500/Hylar 5000] [_____] finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. This prime coat must be oven cured prior to application of finish coat.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll coating to dry film thickness of 0.80 plus 5 mils (3.80 plus 0.50 mils for Vinyl Plastisol) for a total dry film thickness of 1.00 plus 0.10 mils (4.00 plus 0.10 mils for Vinyl Plastisol). This finish coat must be oven-cured.

d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll coating to a dry film thickness of 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. The wash-coat must be oven-cured.

e. [Color: The exterior finish chosen from the manufacturer's color charts and chips.] [_____]

f. Physical Properties: Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

Chalking: ASTM DEFONLINE

Color Change and Conformity: ASTM D2244

Weatherometer: ASTM G152, ASTM G153 and ASTM D822

Humidity: ASTM D2247 and ASTM D714

Salt Spray: ASTM B117

Chemical Pollution: ASTM D1308

Gloss at 60 degrees: ASTM D523

Pencil Hardness: ASTM D3363

Reverse Impact: ASTM D2794

Flexibility: ASTM D522/D522M

Abrasion: ASTM D968

Flame Spread: ASTM E84

2.4.6 Repair Of Finish Protection

Repair paint for color finish enameled metal panel must be compatible paint of the same formula and color as the specified finish furnished by the metal panel manufacturer, conforming to ASTM A780/A780M.

2.5 MISCELLANEOUS METAL FRAMING

2.5.1 General

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M and specified in Section 05 40 00 COLD-FORMED METAL FRAMING unless otherwise indicated.

2.5.2 Fasteners for Miscellaneous Metal Framing

Refer to the following paragraph FASTENERS.

2.6 FASTENERS

2.6.1 General

Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 25.4 mm 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the metal panel manufacturer's and ASCE 7 requirements.

2.6.2 Exposed Fasteners

Fasteners for metal panels to be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads. Fasteners for accessories to be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately .09 mm 3/32 inch thick.

2.6.3 Screws

Screws to be corrosion resistant coated steel, aluminum and/or stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

2.6.4 Rivets

Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

2.6.5 Attachment Clips

Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A653/A653M or Series 300 stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.7 FRAMES AND MATERIALS FOR OPENINGS

2.7.1 Doors

The switchgear house must be provided with a minimum of [two] [_____] entrance doors. The doors must be double wall construction, with brushed aluminum panic hardware with cylinder lock and thumb latch, brushed aluminum automatic closure with built-in hold open device, stainless steel hinges, threshold, weather-stripping, drip shields/water flashing, "DANGER, HIGH VOLTAGE, KEEP OUT" sign.[Provide a [304 mm] [12-inch] [_____] removable transom above the equipment door to allow for future equipment removal.] The personnel door must be [914 mm by 2438 mm] [36-inch by 96-inch] [_____]. The equipment door must be [1219 mm by 2438 mm] [48-inch by 96-inch] [_____].

Fire-Rated and Non-Fire-Rated Door Assemblies conforming with NFPA 80 and based on testing according to NFPA 252 as specified in Division 08 - OPENINGS unless otherwise indicated. Doors must open in the direction of egress from the electrical space and be equipped with listed panic hardware and wind safety chain.

Entrance and egress from the electrical equipment working space must be in accordance with NFPA 70, Article 110.

[For equipment requiring rear access, provide rear access doors in exterior walls. Doors must be equipped as follows:

a. Posts (mullions) must be easily removable (allowing total door and post removal) providing full open access, of (at least) any four continuous doors without temporary structural reinforcement, for potential equipment replacement or the addition of future equipment.

b. Stainless steel continuous piano type hinge.

c. Stainless steel pad lockable vault handle.

d. Three-point latching system.

e. Full gasketing and drip shield.

f. Signage as appropriate for internal equipment.

g. Hold open device.

h. Metal inner skin over insulation welded to door.

i. "Danger High Voltage / Keep Out" signs.

]2.8 ACCESSORIES

2.8.1 General

All accessories to be compatible with the metal panels; sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the metal panels. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips to be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

2.8.2 Roof and Wall Accessories and Specialties

[Aluminum][Steel]roof curbs, equipment supports, roof hatches, dropout-type heat and smoke vents, hatch-type heat and smoke vents, gravity and roof ridge ventilators, wall louvers and other miscellaneous roof and wall equipment or penetrations conforming to AAMA, ASTM, and UL as specified in Division 07 unless otherwise indicated.

2.8.3 Insulation

Faced, Glass-Fiber Blanket Insulation: ASTM C665, Type [I, blankets without membrane coverings][and][II, blankets with non-reflecting coverings][and][III, blankets with reflective coverings]; Class [A, membrane-faced surface with a flame spread of 25 or less] [B, membrane-faced surface with a flame propagation resistance; critical radiant flux of 0.12 W/m2 0.11 Btu/ft2 or greater], except a flame spread rating of [25] [75] [100] or less[and a smoke developed rating of 150 or less] when tested in accordance with ASTM E84.

2.8.3.1 Polyethylene Vapor Retarder

Install polyethylene vapor retarder membrane over entire [wall][and roof] surface. Use fully compatible polyethylene tape to seal the edges of the sheets to provide a vapor tight membrane. Lap sheets not less than 150 mm 6 inch. Provide sufficient material to avoid inducing stresses in sheets due to stretching or binding. All tears or punctures visible in the finished surface, at anytime during the construction process, must be sealed with polyethylene tape.

2.8.3.2 Wall Liner

Securely fasten wall liner into place in accordance with the manufacturer's recommendation and in a neatly presented appearance.

2.8.4 Rubber Closure Strips

Closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified metal panel and in lengths supplied by the metal panel manufacturer.

2.8.5 Metal Closure Strips

Factory fabricated [aluminum] [steel] closure strips to be the same [gauge] [thickness], color, finish and profile of the specified [roof] [wall] panel.

2.8.6 Joint Sealants

2.8.6.1 Sealants

Sealants are to be an approved gun type for use in hand or air-pressure caulking guns at temperatures above 4 degrees C 40 degrees F (or frost-free application at temperatures above minus 12 degrees C 10 degrees F with minimum solid content of 85 percent of the total volume. Sealant is to dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the metal panel manufacturer.

2.8.6.2 Shop-Applied

Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

2.8.6.3 Field-Applied

Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C920, Type II. Color to match panel colors.

2.8.6.4 Tape Sealant

Pressure sensitive, 100 percent solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the metal panel manufacturer.

2.8.6.5 Floor Cutouts

Floor Cutouts: Under equipment for cable entry and exit from below floor with gasketed 1.214 mm 12 ga galvanized top cover plates attached to the floor by screws.

[2.8.6.6 Stairs and Landings

Where required for access, provide landings and stairs for the building. The stairs must be hot-dipped galvanized after fabrication.

]2.9 SHEET METAL FLASHING AND TRIM

2.9.1 Fabrication

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.10 FINISHES

2.10.1 General

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

2.10.2 Appearance of Finished Work

Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved

Samples and are assembled or installed to minimize contrast.

2.11 HEATING VENTILATION AND AIR CONDITIONING (HVAC)

2.11.1 HVAC Performance

[a. Redundancy: NONE. One or multiple units as required to meet atmospheric and internal heating and cooling requirements.

][b. Redundancy: N+1. Multiple units as required to meet atmospheric and internal heating and cooling requirements plus one additional unit for redundancy purposes.

][c. Redundancy: 100 percent. Two independent systems consisting of multiple units as required meeting atmospheric and internal heating and cooling requirements.

] d. Exterior Design Temperatures:

(1) Summer: (Per ASHRAE 2.5 percent design temperature).

(2) Winter: (Per ASHRAE 97.5 percent design temperature).

e. Interior Design Temperatures:

(1) Summer: 27 degrees C 80 degree F.

(2) Winter: 16 degrees C 60 degree F.

f. Occupancy: Number of Persons [_____].

g. Ventilation Air (cfm): [_____].

2.11.2 General

The switchgear house must be provided with self-contained, package type HVAC system. It must consist of through-the-wall type units. The system must have a free or ducted air discharge and return. The total design load for the system must include infiltration, ventilation load and heat generated by the equipment within the house. Provide at least 0.762 (l/s)/sq m 0.15 cfm/sq feet of mechanical induced outside air for ventilation. The HVAC system must be provided with an electronic, automatic changeover thermostat.

HVAC system must maintain the maximum interior temperature required with consideration to ambient conditions and the specified internal equipment total heat load.

HVAC Unit(s): Size and quantity as required to maintain interior design temperatures and redundancy requirements. Industrial quality, vertical, self-contained, wall mounted unit(s) with aluminum fin, and copper coils:

a. Cooling capacity: [_____] tons capacity as required to meet design temperatures as specified.

b. Heating capacity: [_____] Kw as required to meet design temperatures as specified.

c. Thermostat, Auto Change Over, Digital, F or C Display:

(1) Smart recovery (heating mode).

(2) Droopless control, 4 cycles/hr.

(3) Backlit display.

(4) Settings never lost during power failure.

(5) 5-minute compressor protection.

(6) Separate set points for heating and cooling.

(7) Battery-less operation.

(8) Electro-Mechanical relay design.

d. Low Pressure Switch.

e. High Pressure Switch.

f. Low Ambient Control.

g. Compressor anti-cycle relay.

h. Alarm Relay.

i. Barometric Damper.

j. Supply and Return Grills.

k. Pleated Filter 51 mm 2 inches MERV 8.

l. R410A Refrigerant.

2.12 ELECTRICAL

2.12.1 General

Provide conductors, conduits, fittings, panelboards, circuit breakers, receptacles, GFI receptacles, toggle switches,[dry-type transformers,][automatic transfer switches,] surge protective devices, lighting contactors, grounding and related switchgear house accessories in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. All electrical equipment and devices must be UL listed. All wiring must be installed in metallic conduit. Utilize EMT for interior locations and rigid galvanized steel for exterior locations and areas subject to physical damage. Access and working space must be maintained about all electrical equipment to permit ready and safe operation and maintenance of such equipment in accordance with NFPA 70, Article 110.

2.12.2 Interior Lighting

Provide surface mounted interior LED lighting fixtures in accordance with Section 26 51 00 INTERIOR LIGHTING. The interior lighting system must provide a minimum light level of 300 lux with a 3:1 average to minimum ratio. Provide toggle switch type control at each entry door to the switchgear house.

2.12.3 Exit Signs

Provide LED lamp exit sign that operates in normal, AC input with emergency battery power backup in accordance with Section 26 51 00 INTERIOR LIGHTING.

2.12.4 Emergency Lighting

Provide battery backup type emergency lighting units at each entry door. The emergency lighting units must be in accordance with Section 26 51 00 INTERIOR LIGHTING.

2.12.5 Wiring

Provide normal lighting and exit-emergency combo units lighting on the same branch circuit. Wire exit-emergency combo units ahead of the local switch within the same area.

2.12.6 Exterior Lighting

Provide wall pack LED luminaires that are suitable for outdoor applications in accordance with Section 26 56 00 EXTERIOR LIGHTING. Mount wall pack LED luminaires exterior of the switchgear house and above personnel exit doors. Wall packs must utilize LED sources. Wall packs must be constructed of rugged, weather resistant, die cast aluminum housing with an integral photocell. Control for exterior lighting must be in accordance with ASHRAE 90.1 - IP.

2.12.7 Metal-Clad Switchgear

Provide in accordance with Section 26 13 13 METAL-CLAD SWITCHGEAR.

2.12.8 Grounding

Provide grounding system in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide listed grounding pads welded to the switchgear house skid base for bonding of the steel structure in two places.

[2.12.9 Lightning Protection System

Provide lightning protection system in accordance with Section 26 41 00 LIGHTNING PROTECTION SYSTEM.

]PART 3 EXECUTION

3.1 EXECUTION

3.1.1 Examination

Before the installation begins, conduct an inspection with the erector present. The inspection must ensure that the following items are in compliance with the switchgear house manufacturer's approved shop drawings.

a. Concrete foundation dimensions and layout.

b. Anchor bolt size, type and placement.

c. Survey information showing the foundation elevations.

d. Location of bearing plates and other embedment's to receive structural framing.

Examine roughing-in for electrical feeders serving the contained switchgear and equipment within the switchgear house to ensure proper placement.

Submit to the Contracting Officer a written report, endorsed by Erector, listing conditions detrimental to performance of the Work.

Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

Electrical installations must conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.3 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems must have a resistance to solid earth ground not exceeding 5 ohms.

3.3.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.3.2 Connections

Connections must be installed as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Inaccessible connections or connections below finished grade must be exothermic weld type.

3.3.3 Grounding and Bonding Equipment

Grounding and bonding of equipment must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. The switchgear house steel structure must be bonded to the grounding system.

3.4 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect the switchgear house furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.5 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount the switchgear house on concrete slab as required to satisfy the required loading. The mounting design must be performed by a registered structural engineer and included in the Structural Design Report which is sealed by the structural engineer of record. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water and oil-resistant caulking or sealant.

3.6 FIELD QUALITY CONTROL

3.6.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.6.2 Grounding System

a. Visual and Mechanical Inspection

   (1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

   (1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

   (2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.6.3 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers must be tripped by operation of each protective device. Test must require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 10 working days in advance of the dates and times for checks, settings, and tests.

3.7 WARRANTY

3.7.1 Manufacturer's Warranty

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.7.2 Contractor's Warranty for Installation

Submit warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 13 32 (November 2023)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 26 13 32

MEDIUM-VOLTAGE SWITCHGEAR, GAS-INSULATED

11/23

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC UFGS-26 13 32 (November 2023)

Preparing Activity: USACE New

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 13 32

MEDIUM-VOLTAGE SWITCHGEAR, GAS-INSULATED

11/23

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NOTE: This guide specification covers the requirements for gas-insulated switchgear up to 38 kV with vacuum circuit breakers. Reference IEEE C37.20.9.

Adher to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Verify that the following information is indicated on the project drawings.

1. Location, space available, arrangement, and elevations of switchgear.

2. Grounding plan.

3. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gasses; and seismic requirements.

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NOTE: In corrosive and humid environments, use

materials, systems, components, and coatings that are durable and minimize the need for preventative and corrective maintenance over the expected service life of the component or system. Corrosive project locations are those with Environmental Severity Classification (ESC) of C3, C4, and C5. Humid locations are those in ASHRAE climate zonez 0A, 1A, 2A, 3A, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project location.

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM D149	(2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D2472	(2000; R 2014) Standard Specification for Sulphur Hexafluoride

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN/CENELEC)

EN 50181	(2010) Plug-in Type Bushings Above 1 kV Up to 52 kV and From 250 A to 2,50 kA for Equipment Other Than Liquid Filled Transformers

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 32	(1972; R 1997) Standard Requirements, Terminology, and Test Procedures for Neutral Grounding Devices
IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code

IEEE C37.04	(2018; Erta 2019; Corr 2021) Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V Corrigendum 1
IEEE C37.06	(2009) Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltage Above 1000 V
IEEE C37.09	(2018; Errata 2019; Corr 2021) Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.2	(2022 Standard for Electrical Power System Device Function Numbers, Acronyms and Contact Designations
IEEE C37.20.2A	(2020) Metal-Clad Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE C37.20.7	(2017; Corr 2021) Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults
IEEE C37.20.9	(2019) Standard for Metal-Enclosed Switchgear Rated 1 kV to 52 kV Incorporating Gas Insulating Systems
IEEE C37.60	(2019) High-Voltage Switchgear and Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems Up to 38 kV
IEEE C37.74	(2014) Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems Up to 38 kV
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment

	- Enclosure Integrity for Coastal Environments
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60068-3-3	(2019) Environmental Testing - Part 3-3: Supporting Documentation and Guidance - Seismic Test Methods for Equipment
IEC 62271-100	(2021) High-Voltage Switchgear and Controlgear - Part 100: Alternating-Current Circuit-Breakers
IEC 62271-103	(2021) High-Voltage Switchgear and Controlgear – Part 103: Switches for Rated Voltages Above 1 Kv up to and Including 52 Kv
IEC 62271-111	(2019) High Voltage Switchgear And Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems up to and including 38 kV

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ST 20	(2014) Dry-Type Transformers for General Applications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70B	(2023) Recommended Practice for Electrical Equipment Maintenance

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 SYSTEM DESCRIPTION

****

NOTE: Select the features and fill in blanks with selections appropriate for the design condition and in accordance with guidance contained in UFC 3-550-01, "Exterior Electrical Power Distribution".

See UFC 3-550-01 for guidance regarding service

conditions. Retain or add the required conditions.

Provide seismic requirements, if a Government designer is the Engineer of Record, and show on the drawings. Pertinent portions of Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT properly edited, must be included in the Contract documents.
****

Items provided under this section must be specifically suitable for the following service conditions. Equipment must conform to Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

a. Fungus Control [_____]

b. Altitude [_____] m [_____] feet

c. Minimum Ambient Temperature [_____] degrees C [_____] degrees F

d. Maximum Ambient Temperature [_____] degrees C [_____] degrees F

e. Frequency [_____]

f. Ventilation [_____]

g. Humidity Control [_____]

h. Corrosive Areas [_____]

1.3 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING, applies to this section, with the additions and modifications specified herein. Cybersecurity requirements are specified in Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

1.4 DEFINTIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Pre-Installation Meetings

Pre-installation meeting with Purchasing Agent, Engineer, and Contractor held one month prior to equipment arriving on site. Proper storage shelters installed with electricity and space heaters for electrical equipment.

1.5.2 Sequencing

Scheduling equipment involves continuous contact with suppliers for manufacturing, testing, factory acceptance and shipping.

1.6 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G, [_____]

SD-03 Product Data

Electronic Overcurrent Control Curves; G, [_____]

SF6 Insulated Mv Switchgear; G, [_____]

Surge Arresters; G, [_____]

SD-06 Test Reports

Switchgear Conformity to Design Tests; G, [_____]

SD-07 Certificates

Paint Coating System; G

SD-09 Manufacturer's Field Reports

Switchgear Design And Production Tests; G, [_____]

SD-11 Closeout Submittals

Assembled Operation And Maintenance Manuals; G, [_____]

Equipment Test Schedules; G, [_____]

Required Settings; G, [_____]

Service Entrance Available Fault Current Label; G, [_____]

1.7 MAINTENANCE MATERIAL SUBMITTALS

a. Provide accessories for test, inspection, maintenance, and operation.

b. Tool for manually charging breaker closing spring.

c. Include data on switches and associated accessories with each submittal. Include manufacturer's information for each component, device, and accessory provided with the equipment with each submittal.

1.7.1 Spare Parts

Manufacturer to provide List of recommended "start-up" and "running" spare parts with prices.

1.8 QUALITY CONTROL

1.8.1 Product Data

Include manufacturer's information on each submittal for each component, device, and accessory provided with the switchgear including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device.

c. Complete instruction manuals and software for protective relays, metering equipment, and instrumentation.

1.8.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.8.3 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

Include wiring diagrams or wiring lists and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, conduit, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams or wiring lists and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. The drawings must show adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable federal, military, industry, and technical society publication references on submittals. Also include manufacturer's information on each submittal for each component, device, and accessory provided with the switchgear including:

a. Circuit breaker type, interrupting rating, and protection devices.

b. Provide weights, arrangements, plan view, section views, footprint, rigging plan, and front view.

c. Bus configuration including ampere ratings of bus bars.

d. Single-line diagram including breakers[, fuses][, current transformers, and meters]. Showing buses and interrupting devices with interrupting capacities; current transformers with ratings; instruments and meters required; and description of instruments and meters.

e. Manufacturer's instruction manuals to provide breaker information that ensures protection and coordination can be achieved.

f. Markings and NEMA nameplate data[including fuse information (manufacturer's name, catalog number, and ratings)].

g. Provisions for future expansion by adding switchgear sections.

h. Grounding plan.

i. Conductors point of entry (top or bottom).

[j. Provide warning label for switchgear. Locate this self-adhesive warning label on the outside of the enclosure warning of potential electrical.]

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NOTE: NFPA 70 requires that service equipment in other than dwelling units be legibly marked in the field with the maximum available fault current, including the date. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the short circuit calculation for the project. This may vary for design/build versus design/bid/build projects.

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[k. Locate this self-adhesive warning label on the outside of the switchboard. Provide label format as indicated.]

l. Arc resistant ducting and duct supports if required for arc resistant rating.

m. Locations with arc energy reduction methods specified.

n. Wiring diagrams or wiring lists and elementary diagrams with terminals identified and indicating prewired interconnections between items of equipment and the interconnection between the items.

o. Spare parts list.

p. Master Drawing Index including switchgear front view, side view, top view, bottom view, floor plan dimensions, and one-line digram.

1.8.4 Paint Coating System

Ferrous steel components of the equipment must be protected with zinc phosphate. Test paint finish in accordance with IEEE C37.20.3 or [IEEE C57.12.28][IEEE C57.12.29] paint coating system performance requirement tests.

1.8.5 Electronic Overcurrent Control Curves

Provide time-current characteristic curves available in PDF format.

1.8.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship, and:

a. Have been in satisfactory commercial or industrial use for not less than two years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.8.6.1 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.8.6.2 Material and Equipment Manufacturing Date

Products manufactured more than one-year prior to date of delivery to site are not acceptable.

1.9 MAINTENANCE

1.9.1 SF6 Insulated Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.9.2 Assembled Operation and Maintenance Manuals

Assemble and securely bind manuals in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents:

a. Manufacturer's operation and maintenance (O&M) information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA.

b. Catalog data required by the paragraph SD-03, PRODUCT DATA.

c. Drawings required by the paragraph SD-02, SHOP DRAWINGS.

d. Prices for spare parts and supply list.

e. Information on metering.

f. Routine test reports.

1.10 DELIVERY, STORAGE, AND HANDLING

a. Store switchgear in a weather protected area until installation.

b. Handle and store equipment in accordance with manufacturer's instructions. Provide one copy of these instructions outside the switchgear packing with the equipment at time of shipment

1.11 PROJECT/SITE CONDITIONS

1.11.1 Environmental Requirements

Where venting is intended to penetrate an external wall or roof, cover vent such that it meets all specified environmental requirements (e.g., rain-tight, dust-tight, vermin-proof).

1.11.2 Existing Conditions

Install switchgear capable of being structurally supported on structure. Switchgear may require future expansion without modification to existing switchgear structural members or bus work.

1.11.3 Cybersecurity

Control systems (including systems separate from an energy management control system) must be planned, designed, acquired, executed and maintained in accordance with Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, required by individual Service Implementation Policy.

Submit certification that equipment complies with the above DoD instructions.

1.12 SPARE PARTS

Provide spare parts as specified below. Provide spare parts that are of the same material and workmanship, meet the same requirements, and are interchangeable with the corresponding original parts furnished.

[a. Quantity two - Fuses of each type and size.]

1.13 WARRANTY

Provide equipment items that are supported by service organizations reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the Contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchgear and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SF6 INSULATED MV SWITCHGEAR

2.2.1 Ratings and Test Requirements

a. The voltage rating of the switchgear must be [4.76 kV][7.2 kV][15.5 kV][27 kV][38 kV] AC, three-phase, [grounded][high resistance grounded][ungrounded][as indicated].[For high resistance grounded systems, the conductors from the neutral point to the connection point at the impedance must utilize [copper][aluminum] conductors, employing the same insulation level and construction as the phase conductors.] Provide the corresponding ratings associated with the required switchgear voltage rating as follows:

b. Short Circuit Rating: [[16][20][25][31.5][40][_____] rms kA symmetrical amperes] [as indicated].

c. UL or NRTL listed and labeled[for its intended use][as service entrance equipment].

d. Impulse Withstand (Basic Impulse Level): [60][95][125][150][170][200] KV.

e. Power Frequency Withstand: [19][28][36][60][70][80] KV, one minute test.

f. Momentary Current Ratings must be equal to the circuit breaker close and latch rating.

g. System voltage: [_____] KV nominal, three-phase [grounded][ungrounded], [60 hertz][50 hertz].

h. Continuous current rating of the main bus: [[630][1200][2000][2500][2800][3000 or 2750 at 27KV] amperes][as indicated].

2.2.2 MV Gas Insulated Switchgear Construction

Provide switchgear with dead-front, switchgear assembly of vertical sections, cable entrance terminations contained in a non-SF6 compartment. This vertical section contains the circuit breaker, three position (open/close/grounded) switch and the voltage transformer (VT) when required. Ship switchgear from factory, filled with appropriate levels of SF6 gas conforming to ASTM D2472 or less-flammable, high-firepoint gas whenever possible. Provide switchgear with accessible terminations suitable for cables entering from below with manual operating provisions. Provide front vertical section covers with full length hinges. Provide additional vertical sections to house accessories related to the switchgear functions per IEEE C37.74. Gas compartments are to be equipped with a gas pressure monitoring system. Pressure relief devices are to be included. A visual indicator located on the front of the section must display the status of each compartment. Auxiliary contacts are to be provided for remote indication of the warning levels. The device must be self-monitoring.

2.2.2.1 Enclosure

Provide the following:

a. Stationary Structure:

(1) The switchgear must consist of sections including circuit breaker compartments and auxiliary compartments assembled to form a rigid self-supporting completely enclosed structure.

(2) The sections are divided into compartments: circuit breaker, instrumentation, main bus, auxiliary device, and cable may be contained in one compartment. Each feeder section will have one circuit breaker compartment.

(3) Provide the structure with a front accessible low voltage compartments. The low voltage compartments contain the gas pressure gauge, circuit breaker operating mechanism, three position switch\operating mechanism and a front or rear [view port][camera] used for visual confirmation of the three position switch (closed/opened/earthed) status. The low voltage compartment also contains any meters, relays or other low voltage control devices required for the equipment.

(4) Additional control equipment that exceeds the available space on the low voltage compartment door is installed in an additional vertical section designated for low voltage devices.

(5) Each single gas vessel is provided with an SF6 gas density gauge. Contacts are provided to monitor the pressure of the gas adjusted for changes in temperature. Density gauge comes with warning and alarm output contacts.

(6) The switchgear is classified as internal arc resistant classification with the rear of the switchgear enclosure placed near a wall. The arc duct, if required, can be directed out either side of the switchgear lineup or to the rear of the switchgear, IEEE C37.20.7 Type 2B.

(7) Arc containment device housing, if required, are to be designed to contain the arcing within the device and vent gases through ducted

plenums located on the back of the switchgear.

b. Indoor Enclosure.

c. Outdoor Enclosure: [As indicated] [3RX fabricated entirely of 12 gauge ASTM A240/A240M type 304 or 304L stainless steel] [GIS should be provided in standard construction installed in an e-house with the corrosion resistance requirement that the DOD requires].

d. Switchgear Outdoor Enclosure: Welded or bolted together with removable bolt-on side and[hinged] rear covers[, and sloping roof downward toward rear].

e. Outdoor Front Doors: Provided with[stainless steel] pad-lockable vault handles with a three point catch.

f. Bases, Frames, and Channels of Outdoor Enclosure: Corrosion resistant and fabricated of[ASTM A240/A240M type 304 or 304L stainless steel][or][galvanized steel].

g. Base: Includes any part of enclosure that is within 75 mm 3 inches of top of concrete pad.

h. Galvanized Steel: ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

i. Paint Color: Factory applied finish, ASTM D1535 light gray No. 61 or No. 49 on treated metal.

j. Paint Coating System: Comply with[IEEE C57.12.28 for galvanized steel][and][IEEE C57.12.29 for stainless steel].

[k. Infrared Viewing Windows: Install to allow the use of an infrared camera or thermal imager direct line of site to inspect electrical connections without requiring the opening of panels and doors. These windows are intended to allow thermographers the ability to inspect the electrical equipment without directly exposing themselves to live electrical components and energized devices.]

****

NOTE: Continuous thermal monitoring system is not required for connections using inside cone cable termination plugs.

****

[l. Cable connections are to be provided with a continuous thermal monitoring (CTM) system for 24/7 monitoring of cable connections. The cable monitoring system must consist of self-powered wireless sensors mounted at the cable connection and be capable of wireless communication for local or remote monitoring.]

****

NOTE: Voltage detection system is not required for connections using inside cone cable termination plugs.

****

[m. The check of voltage presence is to be done with an electronic and integrated voltage detecting system.

(1) The indication must be tapped from a capacitive voltage divider in the cable connection compartment.

(2) The maintenance free voltage detection system must work without any external energy and must monitor its connected test circuits continuously.

(3) For phase comparison, suitable connections must be provided, which must be covered during general use.]

2.2.2.2 Bus Bars

Provide the following:

a. Bus bars: Copper with silver-plated contact surfaces.

  (1) GIS phase bus bar systems: [Isolated phase design which is copper in an aluminum tank] [Shielded Solid Insulated Switchgear] [Uninsulated][Insulated with an epoxy finish coating powder or insulating sleeve providing a minimum breakdown voltage per ASTM D149.][Insulated with SF6 with bus compartment SF6 gas pressure monitoring system][Insulated with shielded Solid Insulation].

b. Make bus connections and joints with hardened steel bolts and nuts. Provide conical disk spring washers under each nut and bolt.

c. Main-bus (through bus): Rated at the full ampacity of the main bus throughout the switchgear. Typical bus ratings range from 1000 to 3000 amperes. Conductors and busbar connectors must be copper, must carry rated continuous current at 40 degrees C 104 degrees F ambient temperature and must withstand the rated short-circuit current for 2 seconds unless limited to a shorter duration by the protective device.

d. Minimum 30 x 6 mm 1.2 x 0.25 inches (25kA and below) 40 x 10 mm 1.6 x 0.40 inches (31.5kA and above) copper ground bus secured to each vertical section along the entire length of the switchgear. The bus rating is based on the switchgear bus ampacity.

2.2.2.3 Circuit Breaker Compartments

a. Each circuit breaker must be a fixed mounted vacuum circuit breaker.

b. The maintenance requirement would be for the lubrication of the breaker mechanism.

2.2.2.4 Auxiliary Vertical Sections and Compartments

a. Provide auxiliary sections consisting of[instruments,][metering equipment,][control equipment,][transformers,][and][current transformer compartments].

[b. Utility metering compartment that complies with[utility company][base utility] requirements.]

c. Metering: A vertical section with a front hinged door for isolated access to meters and associated terminal and fuse blocks for maintenance, calibration, or testing while the gear is energized.

d. Metering: Hinged panel in switch or breaker section, for isolated access to meters and associated terminal and fuse blocks for maintenance, calibration, or testing while the gear is energized.

2.2.2.5 Medium Voltage Cable Terminations

a. IEEE 48 Class 1; of the molded elastomer, pre-stretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, ethylene propylene rubber, or ethylene propylene diene monomer. Terminations must be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Terminations must be provided in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator. The design of the complete cable termination must be suitable for the switchgear short-circuit current and BIL as specified. Cable termination system are to be plug-in type as per DIN 47637 and EN 50181 standards.

   Option 1 - Plug on type T-Body connector - outer cone type connection and the following paragraph to allow for terminations that are compatible with GIS switchgear. Recommend that these cable terminations be provided by the installing Contractor because they must be matched to the specific cable and insulation dimensions for the cable being provided by the contractor.

   Option 2 - Inner cone style cable connectors can also be used. Type of connector is based on type of equipment construction.

   Cable connections are to be made using fully insulated plug-on cable terminations according to EN 50181, Type C by Euromold, Nexans, Tyco, etc. or acceptable equal.

b. Cold-Shrink Type: Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all materials (except for the lugs). Termination must be designed for installation in low or highly contaminated indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

c. Heat Shrinkable Type: Terminator must consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is non-tracking, resists heavy atmospheric contaminants, ultra-violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Termination must be designed for installation in low or highly contaminated indoor or outdoor locations.

d. Cable terminations must meet the requirements of gas insulated switchgear in accordance with manufacturer recommendations or approved equal, suitable for the switchgear short circuit and BIL ratings.

2.2.2.6 Circuit Breakers

The vacuum circuit breakers must be electrically-operated, three-pole, circuit interrupting devices rated for [_____] amperes continuous at [_____] kV and [_____] kV BIL. Breakers must be designed for service on a [_____] kV system with a short-circuit capacity of not less than [_____] [amperes symmetrical] [MVA]. Rating must be based on IEEE C37.04 and IEEE C37.06. Circuit breakers must be fixed mounted and have a open/closed position indicator, operation counter, primary and secondary disconnect devices, and auxiliary switches. Circuit breakers must have one circuit interrupter per phase.

Circuit breaker must be operated by an electrically charged, mechanically and electrically trip-free, stored-energy operating mechanism normally charged by a universal motor. Provide for manual charging of the mechanism through a manual handle on the vacuum circuit breaker. Circuit breaker control voltage must be[[_____] VDC][[_____] VAC][from an external power source][from a fused control transformer integral to the switchgear]. Provide one capacitor trip unit for each breaker when AC control power is required.

a. Contacts: Fixed-mounted, silver-plated.

b. Each breaker must be provided with open/closed position indication. The connected and disconnect positions must be clearly identified by an indicator on the circuit breaker front panel. A three position switch must have mechanical lockout mechanism that inserts a block into the switch mechanism.

The circuit breakers must be rated in accordance with IEEE C37.06 and IEC 62271-100. Overcurrent protection for the transformer must consider the base rating of the transformer, the through fault protection, transformer in-rush, and transformer impedance.

a. The Duty Cycle must be 0-15 sec-CO or 0-0.3 sec-CO-3 min-CO per IEEE C37.04 and related IEC standards. The circuit breaker short-time rating must be 3 seconds per IEEE C37.04, IEEE C37.06, and related IEC standards. The circuit breakers must be designed to withstand the Transient Recovery Voltage peaks which occur during the breaking of small inductive currents normally encountered in a high voltage system. The vacuum circuit breakers must not produce excessive overvoltage as a result of current chopping. The design must incorporate means to reduce the current chopping value to less than SA.

b. The circuit breaker operating mechanism must be designed for high speed operation and must be located in a separate cabinet at the front of the circuit breaker sections. Access must be from the front of the switchgear and permitted while the primary equipment is in service. The maximum difference in opening time between the three poles must not be more than 2 milliseconds.

c. The switchgear is designed according to the earthquake qualification category 1 of IABG TA13-TM-002/98. Earthquake qualification testing is carried out in accordance with IEC 60068-3-3. The associated test certificate is enclosed from the manufacturer.

d. Closing must be by motor-charged-, spring-operated-, stored-energy-type mechanism with electrical release. The circuit breaker must not close unless the closing spring is fully charged. Provide a visual mechanical indicating device to indicate closing spring status. Provide provisions for manually charging the closing spring. The closing spring must automatically recharge after the completion of a closing operation.

e. Tripping must be by means of a spring that is automatically charged when the circuit breaker is closed. The mechanism must be provided with a shunt release and the necessary auxiliary switches. An operations counter must be fitted to the mechanism and designed to indicate the total number of opening operations. Provide local manual close and trip shrouded pushbuttons, control power cutoff switch, local electrical close and trip at the circuit breaker, and local/remote selector switch at the circuit breaker for connection to SCADA system.

f. Maximum symmetrical interrupting current of 25, 31.5, or 40 kA Amp RMS.

g. Short-time (3 seconds) current carrying capability 25, 31.5, or 40 kA Amp RMS.

h. Minimum closing and latching peak current capability of 65, 82, or 104 kA Amp RMS.

i. 5-cycle maximum interrupting time.

j. 75, 95, 125, 150, 170, or 200kV minimum basic impulse insulation level (BIL).

2.2.2.7 Control Power Supply

a. Dedicated [48 V DC][120 V DC][240 V DC] external battery system.

b. System Requirements: External battery must have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 degrees C 77 degrees F with electrolyte at normal level and minimum ambient temperature of 13 degrees C 55 degrees F. Cycle battery before shipment to guarantee rated capacity on installation. Arrange to operate ungrounded. Battery system capacity is recommended by switchgear manufacturer to operate the circuit breakers for a one-minute discharge ampere rate down to 1.75V. Cell for Lead-Acid batteries.

c. Battery:

(1) [Standard VRLA][Premium VRLA] batteries, with system disconnect and overcurrent protective device.

(2) Rack: [Two][_____]-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads.[Rate battery rack, cell supports, and anchorage for seismic requirements.]

(3) Accessories: Set of cell numerals. Monitoring system.

(4) Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

(5) Control Wiring: Factory installed, complete with bundling, lacing, and protection. Conductors across Hinges and for Interconnections between Shipping units must utilize flexible conductors.

(6) Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit must automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of AC input or DC output of battery charger. Either condition closes contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

d. DC ammeter: Maximum error of five percent at full-load current, with toggle switch to select between battery and charger current.

e. DC Voltmeter: Maximum error of five percent at full-charge voltage, with toggle switch to select between battery and charger voltages.

f. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by normally open (NO) push-button contact.

g. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.

h. Charging-Rate Switch: Manually operated switch to transfer to higher charging rate. Charger operation must be automatic until manually reset.

i. AC Power Supply: 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3 Hz variation in frequency. Automatic charger operation must resume after loss of ac power supply for any interval.

j. Charging Regulator: Protect charger from damage due to overload, including short circuit on output terminals. The device must regulate charging current but must not disconnect charger from either battery or ac supply.

k. Charger's Audible Noise: Less than 26 dB.

2.2.2.8 SCADA Operation

The circuit breaker control system must execute remote commands received from a SCADA master station and transmit switchgear operation information to a SCADA master station. Include transfer of circuit breaker to "Close" and "Open" positions[and enabling of the Source-Transfer operation] for execution of remote commands. Include circuit breaker position status, voltage and current readings, and DC supply system status with communication of switchgear information.

2.2.2.8.1 Source-Transfer Operation

Provide an automatic switch control system that opens an incoming circuit breaker when voltage is lost and closes the alternate incoming circuit breaker if voltage is present. Include with the Source-Transfer controls an overcurrent-lockout feature that prevents automatic closing of a circuit breaker into a system fault. Include provisions for returning the system to the normal configuration via manual, SCADA, or automatic operations when voltage is restored.

2.2.2.8.2 Fault Detection Isolation and Restoration Operation

The automatic control system must execute circuit fault detection isolation operation for closed and open loop distribution systems. Provide communication via a peer-to-peer fiber optic network for the control systems. Provide an optical fiber cable approved by the control system manufacturer.

2.2.2.8.3 Key Interlock

Provide key interlock system as indicated on the drawings.

2.2.3 Protective Relays

****

NOTE: The definition and application of device function numbers used in electrical switchgear are found in ANSI C37.2, "IEEE Standard Electrical Power System Device Function Numbers." This guide specification does not cover all possible relays. Choose only the relay types applicable to the specific project.

****

Relays must conform to IEEE C37.90. Protective relays must be solid-state microprocessor based, multi-function type enclosed in rectangular, semi flush, switchboard-type draw-out cases with indicating targets and provisions for testing in place by use of manufacturer's standard test blocks or test switches. One complete set of test blocks or test switches to fit each type of relay in the equipment must be provided. Auxiliary and lockout relays are not required to have draw-out cases or test provisions. Controls, relays, and protective functions must be provided completely assembled and wired.

a. Overcurrent and Ground-Fault Protective Relays:

    (1) IEEE C37.2 device functions [51/50 and 51/50N][_____].

    (2) Field-Selectable Relay Settings.

    (3) Primary Current-Transformer Ratings: Programmable from 5 to 5000 Amps.

    (4) Phase and Ground Protection (ANSI): Field-selectable curves from definite time, moderately inverse, normally inverse, very inverse, or extremely inverse.

    (5) Phase and Ground Protection (IEC): Field-selectable curves from

Curve A (BS142), Curve B (BS142), Curve C (BS142), or short inverse.

(6) Phase and Ground Protection (IAC): Field-selectable curves from extremely inverse, very inverse, inverse or short inverse.

(7) Phase Instantaneous Overcurrent Trip Pickup Point: Field selectable as "none" or from 1.0 to 25 times current-transformer primary rating. Include discriminator circuit with "on" and "off" switch so that when phase instantaneous overcurrent has been programmed to "none," the discriminator circuit protects against currents exceeding 11 times current-transformer primary rating when the breaker is being closed and must be deactivated after approximately eight cycles.

(8) Contacts: Two Form-C contacts, field selectable into contact pairs.

(9) Alphameric display to show the following parameters with metering accuracy not to exceed two percent of full scale.

b. Individual phase currents.

c. Ground current.

d. Cause of trip.

e. Magnitude and phase of current-causing trip.

f. Phase or ground indication.

g. Peak current demand for each phase and ground since last reset.

h. Current-transformer primary rating.

i. Programmed phase and ground set points.

j. Relay alarm and trip contacts must not change state if power is lost or an undervoltage occurs. These contacts must only cause a trip on detection of an overcurrent or fault condition based on programmed settings. A "protection off" alarm must be normally energized when the relay is powered and the self-diagnostics indicates the unit is functional. On loss of power or relay failure, this alarm relay must be de-energized, providing a fail-safe protection off alarm.

****

NOTE: Insert other relay types in paragraph below when adding other relays to operate circuit breakers in the switchgear. The 51/50 overcurrent relay described in "Overcurrent and Ground-Fault Protective Relays" (paragraph above) is typical of microprocessor-based.

****

k. Insert other relay types.

2.2.3.1 Instruments

****

NOTE: Select essential instruments and meters. Add

to the specification any special metering not listed which is required for a specific project. Use of an Electronic Monitoring System may eliminate the need for many individual electro-mechanical meters. This may also be accomplished on simpler systems by using the electronic watthour meter and identifying the desired special programming features. For NAVFAC SE projects, provide three thermal demand ammeters.
****

ANSI C39.1 for electrical indicating switchgear instruments, with one percent accuracy class, antiparallax pointer, and glare-free face with scales indicated and coordinated to the ratios of the current and potential transformers provided. AC ammeters and voltmeters must be a minimum of [50][115] mm [2][4 1/2] inches square, with 4.36 radians 250 degree scale. Provide single-phase indicating instruments with flush-mounted transfer switches for reading three phases.

a. AC ammeters: Transformer rated, five-ampere input, 60 Hz.

b. AC voltmeters: Transformer rated, 150-volt input, 60 Hz.[Provide external dropping resistors.]

c. AC wattmeters: Transformer rated for 120-volt input, 60 Hz, three-phase, four-wire, with scale range coordinated to the ratios of the associated current transformers and potential transformers.[Provide external dropping resistors.]

d. Frequency meters: Rated for 120-volt input, 60 Hz nominal frequency, [_____] to [_____] Hz scale range.

e. Power-factor meters: Transformer rated five-ampere, [120][208]-volt input, [_____] scale range for use on [three][four]-wire, three-phase circuits. The accuracy must be plus or minus 0.01.

f. DC ammeters: [Self-contained][Shunt-rated],[0 to [_____] ampere][[_____] to 0 to [_____] ampere] scale range.

g. DC voltmeters: Self-contained,[0 to [_____] volt][[_____] to 0 volt] scale range. Furnish resistors, if required, with the voltmeter.

2.2.3.2 Electronic Watthour Meter

Provide as specified in Section [26 27 14.00 20 ELECTRICITY METERING][26 27 13.10 30 ELECTRIC METERS].

ANSI C12.1. Provide a switchgear style electronic programmable watthour meter, semi-flush mounted. Meter can be either programmed at the factory or programmed in the field. Turn field programming device over to the Contracting Officer at completion of project. Coordinate meter to system requirements.

a. Design: Provide meter designed for use on a 3-phase,[4-wire][3-wire][_____] volt system with three current transformers. Include KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS).

b. Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

c. Class: 20. Accuracy: plus or minus 1.0 percent. Finish: Class II.

d. Kilowatt-hour Register: five digit electronic programmable type.

e. Demand Register:

  (1) Provide solid state.

  (2) Display actual values and readings of the metered circuit. No multipliers must be required.

  (3) Demand interval length: programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.

f. Meter fusing: Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to the watthour meter. Size fuses as recommended by the meter manufacturer.

g. Provide meter with a communications port, RS485, with Modbus RTU serial or Ethernet, Modbus-TCP communications.

IEEE C57.13. Provide single ratio transformers, 60 hertz, [_____] to five-ampere ratio, [_____] rating factor, with a metering accuracy class of 0.3 through [_____].

[Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.]

2.2.3.3 Instrument Transformers

IEEE C57.13.

a. Current transformers: Each breaker compartment must have provision for front-accessible mounting of current transformers (ANSI standard relay accuracy), on bus side and cable side of circuit breaker. Standard mounting location of current transformers are to be on the cable side of the circuit breaker. The current transformers wiring must be Type SIS No. 10 AWG copper.

b. Potential transformers: Transformers must be fixed mounted with fuses and disconnect switch, 60 Hz, with voltage ratings and ratios coordinated to the ratings of the associated switchgear, relays, meters, and instruments. Potential transformers must be with [one fuse] [two fuses] in the primary. Fuses must be current limiting and sized as recommended by the potential transformer manufacturer.

2.2.3.4 Heaters

Provide 120-volt heaters in each switchgear control section. Heaters must be of sufficient capacity to control moisture condensation in the compartments and must be sized 250 watts minimum. Heaters must be controlled by a thermostat[and humidistat] located inside each section. Thermostats must be industrial type, high limit, to maintain compartments within the range of 15 to 32 degrees C 60 to 90 degrees F.[Humidistats must have a range of 30 percent to 60 percent relative humidity.] Provide transformer rated to carry 125 percent of heater full load rating. Transformers must have 220 degrees C 430 degrees F insulation system with a temperature rise not exceeding 115 degrees C 240 degrees F and must conform to NEMA ST 20. Provide panelboard and circuit breakers in each switchgear assembly[or outdoor enclosure in case of outdoor switchgear] to serve the heaters in that switchgear assembly. Energize electric heaters in switchgear assemblies while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source.

2.2.3.5 Pilot and Indicating Lights

Provide LED type pilot and indicating lights, color indicated on the drawings.

2.2.3.6 Metering

2.2.3.6.1 Digital Metering

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meter enclosed in a sealed case with the following features.

a. Display capability:

    (1) Multi-Function Meter: Display a selected phase to neutral voltage, phase to phase voltage, percent phase to neutral voltage THD, percent phase to phase voltage THD; a selected phase current, neutral current, percent phase current THD, percent neutral current; selected total PF, kW, KVA, kVAR, FREQ, kVAh, kWh. Detected alarm conditions include over/under current, over/under voltage, over/under KVA, over/under frequency, over/under selected PF/kVAR, voltage phase reversal, voltage imbalance, reverse power, over percent THD. Include a Form C KYZ pulse output relay on the meter.

    (2) Power Meter: Display Watts, VARs, and selected KVA/PF. Detected alarm conditions include over/under KVA, over/under PF, over/under VARs, over/under reverse power.

    (3) Volt Meter: Provide capability to be selectable between display of the three phases of phase to neutral voltages and simultaneous display of the three phases of the phase to phase voltages. Detected alarm conditions include over/under voltage, over/under voltage imbalance, over percent THD.

    (4) Ammeter: Display phase A, B, and C currents. Detected alarm conditions include over/under current, over percent THD.

    (5) Digital Watthour Meter: Provide a single selectable display for watts, total kilowatt hours (kWh) and watt demand (Wd). Include a Form C KYZ pulse output relay on the meter.

b. Design meters to accept [input from standard 5A secondary instrument transformers][and][direct voltage monitoring range to [300][600] volts, phase to phase].

c. Provide programming via a front panel display and a communication interface accessible by a computer.

d. Provide password secured programming stored in non-volatile EEPROM memory.

e. Provide digital communications in a Modbus [RTU] protocol via a [RS232C][RS485] serial port[and an independently addressable [RS232C][RS485] serial port].

f. Provide meter that calculates and stores average max/min demand values with time and date for all readings based on a user selectable sliding window averaging period.

g. Provide meter with programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions.

h. Provide meter with a display of Total Harmonic Distortion (THD) measurement to a minimum of the thirty-first order.

i. Include historical trend logging capability with the ability to store up to 100,000 data points with intervals of one second to 180 minutes. Provide a unit that can store and time stamp up to 1000 programmable triggered conditions.

j. Provide event waveform recording triggered by the rms of two cycles of voltage or current exceeding programmable set points. Store waveforms for all six channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.

[2.2.3.7 Submetering

ASHRAE 90.1 - SIASHRAE 90.1 - IP. Provide submetering for [_____].

]2.2.3.8 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Provide short-circuiting type terminal boards associated with current transformer. Terminate conductors for current transformers with ring-tongue lugs. Identify each terminal to indicate the load served.

2.2.3.9 Wire Marking

Mark control and metering conductors at each end. Provide factory installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Provide a single letter or number on each sleeve, elliptically shaped to securely grip the wire, and keyed to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Indicate on each wire marker the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.2.3.10 Surge Arresters

Provide plug-in type surge arrestors, rated [[3][6][9][10][12][15][_____] kV] as indicated on the drawings, fully shielded, dead-front, metal-oxide-varistor type.

2.2.3.11 Control Wiring

The switchgear control wiring must be type SIS No. 2.1 mm squared 14 AWG copper minimum, except where larger size wire is required.

2.2.3.12 Grounding Resistor

The neutral grounding resistor assembly must comply with IEEE 32. The assembly meets the following:

a. The resistor element must be [stainless steel][cast-iron] and rated [_____] amperes for a [10-second][one-minute][10-minutes][extended time] duty.

b. The resistor must be installed in an aluminized screened or expanded galvanized steel enclosure of the personnel safety type and is provided with supports and mounting hardware. The enclosure, including screening and support framing, must have two finish coats applied over a prepared substrate. The color of the finish coats are the same as the color of the associated transformer.

c. A stress-relief terminator must be provided and arranged to permit the proper termination of the No. [_____] mm squared [_____] AWG, [_____][5][15] kV shielded transformer neutral cable entering the enclosure [from the [bottom][top]] [as recommended by the manufacturer]. If the terminal bushing is external to the enclosure, the bushing and terminal provisions are enclosed by a solid metal cable box equipped with conduit fittings correctly sized for the conduit required. An approved type and size of terminal lug must also be provided and arranged for the field termination of the No. 107 mm squared 4/0 AWG bare copper grounding cable entering the enclosure from the bottom.

d. One current transformer conforming must be provided and housed in the resistor enclosure. The current transformer ratio is shown.

2.2.4 Design Requirements

a. Design equipment enclosure in accordance with seismic requirements.

b. Design switchgear to accommodate entrance of cables where indicated.

2.2.5 Performance Requirements

a. Factory testing in accordance with the latest ANSI standards.

b. Factory test results documentation.

2.3 [ASSEMBLY][FABRICATION]

2.3.1 Manufacturer's Nameplate

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.3.2 Field Fabricated Nameplates

ASTM D709. Provide laminated plastic nameplates for each switchgear, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Identify on each nameplate inscription the function and, when applicable, the position. Provide nameplates of melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core.[Provide red laminated plastic label with white center core where indicated.] Provide matte finish surface. Provide square corners. Accurately align lettering and engrave into the core. Provide nameplates with minimum size off 25 mm by 65 mm 1 by 2.5 inches. Provide lettering that is a minimum of 6.35 mm 0.25 inch high normal block style.

2.3.3 Factory Assembly

Instruction manual and drawings for field assembly.

2.3.4 Shop Fabrication

Install switchgear fully tested at factory.

2.3.5 Finishes

Fully assembled switchgear is paint coated, and protected from environment for shipping to site.

2.4 EQUIPMENT

a. Provide a list of proposed equipment including model numbers, description of breakers, current transformers, voltage transformers, fuses, relays, control switches, and other devices.

b. Provide a list of special equipment required for operation and maintenance of switchgear.

2.5 COMPONENTS

a. Provide complete wiring diagrams or wiring lists showing connections of component devices and equipment.

b. Attach Data Sheets that specify major components and accessories to be provided with clear identification marking.

2.6 ACCESSORIES

Provide a list of instruments and accessories supplied, listing manufacturer, model number, operating ranges, and equipment tag numbers.

2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

2.7.1 Switchgear Design and Production Tests

Furnish reports which include results of routine and production tests performed according to IEEE C37.74[, IEC 62271-103][and IEEE C37.60[, IEC 62271-111]]. Perform manufacturer certified production test reports on each switchgear assembly to ensure that design performance is maintained in production.

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Perform production tests on each circuit breaker housing for this Project, complying with IEEE C37.09.

    (1) Perform mechanical operation tests to ensure proper functioning of operating mechanism, mechanical interlocks.

    (2) Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.

    (3) Perform the control wiring dielectric test at 1500 V for one minute.

    (4) Perform the dielectric test on primary and secondary circuits.

b. Perform production tests, on each circuit breaker supplied for this Project, complying with IEEE C37.09.

    (1) Perform mechanical operation tests to ensure proper functioning of the circuit breaker.

    (2) Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence. Operate the circuit breakers over the range of minimum to maximum of the control voltage.

    (3) Perform the control wiring dielectric test at 1500 V for one minute.

2.7.2 Switchgear Conformity to Design Tests

IEEE C37.20.2A, IEEE C37.20.3, or IEEE C37.20.9 as applicable. Furnish documentation showing the results of routine tests on a product of the same series and rating as that provided by this specification. Required tests are as follows:

a. Design Tests:

    (1) Dielectric test.

    (2) Resistance test of the main bus.

    (3) Pressure check of gas-filled compartments.

    (4) Auxiliary devices test.

    (5) Wiring verification.

    (6) Rated continuous current test.

    (7) Short-circuit current withstand tests.

(8) Mechanical endurance tests.

(9) Rain test for outdoor MV switchgear.

2.8 COORDINATED POWER SYSTEM PROTECTION

Provide a power system study as specified in Section 26 05 73 POWER SYSTEM STUDIES .

2.9 SERVICE ENTRANCE AVAILABLE FAULT CURRENT LABEL

Provide label on exterior of switchgear used as service equipment listing the maximum available fault current at that location. Include on the label the date that the fault calculation was performed and the contact information for the organization that completed the calculation. Locate this self-adhesive warning label on the outside of the switchgear. Provide label format as indicated.

2.10 MIMIC BUS LABELING

Provide a mimic bus on the front of the equipment to diagrammatically show the internal bus structure of the lineup.

PART 3 EXECUTION

3.1 EXAMINATION

a. Verify Site conditions are acceptable for switchgear installation.

b. Inspect all surfaces of switchgear for dents or defects in manufacturing or shipping.

c. Manufacturer to provide detailed storage, installation and handling instructions.

d. Provide manufacturer's field service representative to perform wiring interconnections between shipping splits.

e. Provide manufacturer's field service representative for technical direction and field commissioning services. Relays are programmed in the factory using settings furnished by Engineer or Owner.

3.2 PREPARATION

a. Ship switchgear for installation as completely assembled as practicable.

b. Where switchgear is installed in separate building ship enclosure as complete as practicable with switchgear and components installed inside for ease of installation in field.

c. If shipping splits are required, clearly identify connections between splits for enclosure circuits and switchgear splits.

d. Provide junction and terminal boxes at each connection point.

3.2.1 Protection

a. Cover equipment and accessories and protect from damage during shipment.

b. Acceptable shipping materials used for protecting equipment when manufacturer's recommended storage procedures are maintained.

3.2.2 Surface Preparation

Clean shot blasted factory coated switchgear enclosure as specified.

3.3 INSTALLATION

Conform to IEEE C2, NFPA 70, storage, anchor provisions, O&M manuals, and to the requirements specified herein.

3.4 APPLICATION

3.4.1 Grounding

NFPA 70 and IEEE C2, except provide grounds and grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms. When work, in addition to that indicated or specified, is directed to obtain the specified ground resistance, the provision of the Contract covering "Changes" applies.

3.4.1.1 Grounding Electrodes

Provide driven ground rods as specified[in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION][at each corner of switchgear pad][as indicated].

3.4.1.2 Switchgear Grounding

Connect 107 mm squared 4/0 AWG bare copper conductor ground ring, not less than 600 mm 24 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide 107 mm squared 4/0 AWG bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.4.1.3 Connections

Make joints in grounding conductors and ground ring by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.4.1.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.4.2 Special Technique

When applicable.

3.4.3 Interface with Other Products

3.4.3.1 Foundation for Equipment and Assemblies

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NOTE: Provide details for mounting equipment on foundation.

****

Provide foundation for supporting equipment and assemblies.

[3.4.3.2 Exterior Location

Mount switchgear on concrete foundation slab. Provide slab of adequate size to project at least 200 mm 8 inches beyond equipment.[Slab must be of adequate size to project at least 200 mm 8 inches beyond equipment, except that front of slab must be large enough to serve as a platform.] Provide conduit turnups and cable entrance space required by the equipment to be mounted[and as indicated]. Seal voids around conduit openings in slab with water- and oil -resistant caulking or sealant. Cut off and install bushings on conduits 75 mm 3 inches above slab surface. Concrete work must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

][3.4.3.3 Interior Location

Mount switchgear on concrete slab. Unless Otherwise indicated, the slab must be at least 100 mm 4 inches thick. Top of concrete slab must be approximately 100 mm 4 inches above finished floor. Edges above floor must have 15 mm 1/2 inch chamfer. Slab must be of adequate size to project at least 200 mm 8 inches beyond the equipment. Concrete work must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

]3.4.4 Tolerances

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS, and referenced ANSI standards.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.5 FIELD QUALITY CONTROL

3.5.1 Tests

Submit Required Settings of breakers to the Contracting Officer after approval of switchgear and at least 30 days in advance of their requirement.

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards. The [_____] Division, Naval Facilities Engineering Sytems Command will witness formal tests after receipt of written certification that preliminary tests have been completed and that system is ready for final test and inspection.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

a. Perform contact-resistance tests.

b. Trip fault interrupters by operation of overcurrent control and remote trip.

c. Perform insulation-resistance tests.

d. Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.

e. Set fault interrupter overcurrent control in accordance with Government provided settings. Request settings from Government, in writing, a minimum of 30 days prior to scheduling electrical tests.

3.5.2 Inspection - Medium-Voltage Vacuum Circuit Breakers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Check for proper anchorage, alignment, required area clearances, and grounding.

(4) Perform mechanical operational tests in accordance with manufacturer's instructions.

(5) Confirm correct application of manufacturer's recommended lubricants.

(6) Verify that insulating SF6 gas pressure or dielectric fluid level is correct.

(7) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

(8) Verify that[fuse and] circuit breaker sizes and types correspond to approved shop drawings.

(9) Verify that current and potential transformer ratios correspond to approved shop drawings.

(10) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey is required.

(11) Inspect all indicating devices for proper operation.

(12) Confirm correct operation and sequencing of electrical and mechanical interlock systems for proper operation and sequencing.

(13) Clean switchgear.

(14) Inspect insulators for evidence of physical damage or contaminated surfaces.

(15) Verify correct barrier[and shutter] installation[and operation].

(16) Exercise all active components.

(17) Inspect all mechanical indicating devices operational tests in accordance with manufacturer's instructions for correct operation.

(18) Verify that vents are clear.

(19) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

(20) Inspect control power transformers.

(21) Record as-found and as-left operation readings.

b. Electrical Tests

(1) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data, in the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.

(2) Perform overpotential tests.

(3) Perform control wiring performance test.

(4) Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate according to manufacturer's published data.

(5) Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.

(6) Perform a dielectric-withstand-voltage test according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

(7) Verify operation of heaters.

3.5.2.1 Instrument Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is required.

(6) Verify that all required grounding and shorting connections provide good contact.

(7) Verify correct operation of transformer with drawout mechanism and

grounding operation.

  (8) Verify correct primary and secondary fuse sizes for potential transformers.

- b. Electrical Tests - Current Transformers

  (1) Perform insulation-resistance tests.

  (2) Perform polarity tests.

  (3) Perform ratio-verification tests.

  (4) When applicable, perform insulation resistance and dielectric withstand tests on the primary winding with secondary grounded.

  (5) CAUTION: Changes of connection, insertion, and removal of instruments, relays, and meters must be performed systematically that the secondary circuits of energized current transformers are not opened momentarily.

- c. Electrical Tests - Voltage (Potential) Transformers

  (1) Perform insulation-resistance tests.

  (2) Perform a polarity test on each transformer to verify the polarity marks or H1 - X1 relationships as applicable.

  (3) Perform a turns ratio test on all tap positions, if applicale.

3.5.2.2 Grounding System

- a. Visual and Mechanical Inspection

  (1) Inspect ground system for compliance with Contract plans and specifications.

- b. Electrical Tests

  (1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

  (2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.5.2.3 Protective Relays

Protective relays must be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests must include pick-up, timing, contact action, restraint, to ensure proper calibration and operation. Relay settings must be implemented in accordance with the settings[provided by the Government][in accordance with the approved overcurrent protective device coordination study]. Relay contacts must be electrically operated to verify that the proper breakers and alarms initiate.

3.5.3 Manufacturer Field Service

Schedule training with Owner with at least three weeks advance notice.

Upon completion of acceptance checks, settings, and tests, the Manufacturer must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers must be tripped by operation of each protective device. Test must require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the Contract, notify the Contracting Officer [5][10] working days in advance of the dates and times for checks, settings, and tests[, to allow the Contracting Officer to notify NAVFAC SE Code 0742; Electrical Engineering Division and Code 162; Director, Utilities Engineering Division].

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 20 00 (August 2023)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 20 00 (August 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 26 - ELECTRICAL

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM

08/23

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 20 00 (August 2023)**

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SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM
08/23

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NOTE: This guide specification covers the requirements for the procurement, installation, and testing of electrical wiring systems for construction projects.

Telecommunications cabling is covered in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. These wiring systems primarily involve voltages of 1,000 volts and less and mainly involve interior systems. When voltages greater than 1,000 volts are brought into a facility, consult and use Section 26 11 16 SECONDARY UNIT SUBSTATIONS; Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS; and Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION. Also consult Section 33 71 02, UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION. Add requirements for materials and procedures for special or unusual design as necessary to fit specific projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Ensure the following information is shown on the project drawings:

1. Location of equipment

2. Single-line diagrams elevations, limiting dimensions, and equipment ratings which are not covered in the specifications

3. Remote indicating or control requirements.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2023) National Electrical Safety Code
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7	(2022) Requirements for Watthour Meter Sockets
ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2020) American National Standard for Electrical Metallic Tubing (EMT)
ANSI C80.5	(2020) American National Standard for Electrical Rigid Aluminum Conduit
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA BU 1.1	(2010) General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 V or Less
NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and

	Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors
NEMA RN 1	(2018) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TC 14	(2002) Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
NEMA VE 2	(2018; ERTA 1-2 2018) Cable Tray Installation Guidelines
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2021) Wiring Devices Dimensions Specifications
NEMA Z535.4	(2023) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard

TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.303	Electrical, General

UL SOLUTIONS (UL)

UL 1	(2005; Reprint Jan 2022) UL Standard for Safety Flexible Metal Conduit
UL 4	(2004; Reprint Mar 2021) UL Standard for Safety Armored Cable
UL 5	(2016; Reprint Jul 2022) UL Standard for Safety Surface Metal Raceways and Fittings
UL 5A	(2015; Reprint Apr 2024) Nonmetallic Surface Raceways and Fittings
UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 6A	(2008; Reprint Nov 2024) UL Standard for Safety Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
UL 20	(2018; Reprint May 2023) UL Standard for Safety General-Use Snap Switches
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint Aug 2023) UL Standard for Safety Panelboards
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 248-4	(2010; Reprint Apr 2019) Low-Voltage Fuses - Part 4: Class CC Fuses

UL 248-8	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 8: Class J Fuses
UL 248-10	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 10: Class L Fuses
UL 248-12	(2011; Reprint Aug 2020) Low Voltage Fuses - Part 12: Class R Fuses
UL 248-15	(2018) Low-Voltage Fuses - Part 15: Class T Fuses
UL 360	(2013; Reprint Jan 2024) UL Standard for Safety Liquid-Tight Flexible Metal Conduit
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 486C	(2018; Reprint May 2021) UL Standard for Safety Splicing Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 498	(2017; Reprint Jun 2024) UL Standard for Safety Attachment Plugs and Receptacles
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2024) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Apr 2024) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 674	(2022) UL Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations

UL 719	(2015; Reprint Nov 2023) UL Standard for Safety Nonmetallic-Sheathed Cables
UL 797	(2007; Reprint Apr 2023) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL 817	(2015; Reprint May 2023) UL Standard for Safety Cord Sets and Power-Supply Cords
UL 845	(2021) UL Standard for Safety Motor Control Centers
UL 854	(2020; Reprint Jul 2024) Standard for Service-Entrance Cables
UL 857	(2009; Reprint Apr 2021) UL Standard for Safety Busways
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 870	(2016; Reprint Nov 2023) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 984	(1996; Reprint Sep 2005) Hermetic Refrigerant Motor-Compressors
UL 1004-1	(2012; Reprint Nov 2020) UL Standard for Safety Rotating Electrical Machines - General Requirements
UL 1063	(2017; Reprint Jun 2022) UL Standard for Safety Machine-Tool Wires and Cables
UL 1203	(2023; Reprint May 2024) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1561	(2011; Reprint Aug 2023) Dry-Type General Purpose and Power Transformers
UL 1569	(2018; Reprint Apr 2024) UL Standard for Safety Metal-Clad Cables

UL 1660	(2019; Reprint May 2024) Liquid-Tight Flexible Nonmetallic Conduit
UL 1699	(2017; Reprint Feb 2022) UL Standard for Safety Arc-Fault Circuit-Interrupters
UL 2043	(2023) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 4248-1	(2022) UL Standard for Safety Fuseholders - Part 1: General Requirements
UL 4248-12	(2018; Reprint Feb 2022) UL Standard for Safety Fuseholders - Part 12: Class R

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

1.3 RELATED REQUIREMENTS

****

NOTE: Include Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS on all projects requiring Cybersecurity for 26 20 00: Interior Distribution System.

****

Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS applies to this section, with the additions and modifications specified herein.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panelboards; G, [_____]

Transformers; G, [_____]

Busway; G, [_____]

Cable Trays; G, [_____]

Motor Control Centers; G, [_____]

Wireways; G, [_____]

[Load Centers for Housing Units; G, [_____]

] Marking Strips Drawings; G, [_____]

SD-03 Product Data

Receptacles; G, [_____]

Circuit Breakers; G, [_____]

Switches; G, [_____]

Transformers; G, [_____]

Enclosed Circuit Breakers; G, [_____]

Motor Controllers; G, [_____]

[Combination Motor Controllers; G, [_____]

][Load Centers for Housing Units; G, [_____]

] Manual Motor Starters; G, [_____]

[Residential Load Centers; G, [_____]

][Metering; G, [_____]

][Meter Base Only; G, [_____]

][CATV Outlets; G, [_____]

] Secondary Bonding Busbar; G, [_____]

Surge Protective Devices; G, [_____]

Cable Trays; G, [_____]

[SD-05 Design Data

Cable Tray Design; G, [_____]

] SD-06 Test Reports

600-volt Wiring Test; G, [_____]

Grounding System Test; G, [_____]

Transformer Tests; G, [_____]

Ground-fault Receptacle Test; G, [_____]

Arc-fault Receptacle Test; G, [_____]

SD-07 Certificates

Fuses; G, [_____]

SD-09 Manufacturer's Field Reports

Transformer Factory Tests

SD-10 Operation and Maintenance Data

****

NOTE: Coordinate with options under paragraphs MAINTENANCE and METERING.

****

[Electrical Systems, Data Package 5; G, [_____]

][Metering, Data Package 5; G, [_____]

]1.5 QUALITY ASSURANCE

1.5.1 Fuses

Submit coordination data as specified in paragraph, FUSES of this section.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated. NECA NEIS 1 shall be considered the minimum standard for workmanship.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

****

NOTE: Select the option below only if the system is considered complex and there is a need for detailed system information.

****

[1.6.1 Electrical Systems

Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein. Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

]1.7 WARRANTY

Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

[1.8 SEISMIC REQUIREMENTS

****

NOTE: Do not use this paragraph for Navy projects. When directed to meet seismic requirements, edit Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT to suit the project and include in the contract documents. Edit the following paragraph and include it in the project specification. When a Government designer is the Engineer of Record, provide seismic requirements on the drawings.

****

Provide seismic details[conforming to[Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT][and to][Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]][as indicated].

]PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices.

2.2 CONDUIT AND FITTINGS

****

NOTE: The Uses Permitted are as modified by UFC 3-520-01 (See Table 3-1), "Interior Electrical Systems." The Uses Not Permitted are as specified in NFPA 70 and when restricted by other UFCs for specific types of buildings, such as medical facilities. Do not use flexible metal conduit in damp and wet locations and for pumps. Do not use Electrical Nonmetallic Tubing (ENT).

Use malleable iron seal electrical fittings in fuel valve pits and similar locations where fittings are exposed to potential freeze thaw environments. Nonmetallic fittings have failed in these environments.

****

Conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

2.2.1.2 Rigid Aluminum Conduit

ANSI C80.5, UL 6A.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40[, and EPC-80] in accordance with NEMA TC 2,UL 651[, or fiberglass conduit, in accordance with NEMA TC 14].

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

2.2.5 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40(1 mm 40 mils thick).

2.2.6 Flexible Metal Conduit

UL 1, limited to 1829 mm 6 feet.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360, limited to 1829 mm 6 feet.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings: cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

****

NOTE: Moisture absorbed within die-cast fittings may cause them to deteriorate more rapidly than steel fittings. Utilize steel fittings in damp or wet locations, or when requested by Activity on Installations and Bases that have high ambient humidity environments.

****

[Die Cast][Steel] compression type.

2.2.8 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC[and NEMA TC 14 for fiberglass], and UL 514B.

2.2.9 Liquid-Tight Flexible Nonmetallic Conduit

****

NOTE: Do not use liquid-tight flexible nonmetallic conduits in Continental United States (CONUS). In overseas locations, only use when specifically allowed by the Authority Having Jurisdiction.

****

UL 1660.

2.3 SURFACE RACEWAY

2.3.1 Surface Metal Raceway

****

NOTE: UFC 3-520-01 authorizes the use of surface metal raceway only for building improvements, renovations or for applications where a variety of cord-and-plug connected equipment will be utilized in a limited space, such as in some areas of medical facilities, shops, and laboratories. Authorized for use on acoustic-rated walls to limit the number of penetrations and maintain acoustical integrity. Typical applications include spaces such as Sensitive Compartmented Information Facilities (SCIF) and Special Access Program Facilities (SAPF).

****

UL 5, two-piece painted steel, totally enclosed, snap-cover type.[Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Provide receptacles as specified herein, spaced a minimum of one every [455][_____] mm [18][_____] inches.][Wire alternate receptacles on different circuits.]

2.3.2 Surface Nonmetallic Raceway

****

NOTE: The UFC 3-520-01 definition of "subject to physical damage" prohibits the use of nonmetallic wireways for exterior applications installed less than 2.4 meters 8 feet above finished grade or 2.4 meters 8 feet above floor elevation for raceways on elevated platforms, loading docks, or stairwells. Coordinate with the Authority Having Jurisdiction responsible for the construction contract regarding the use of this wiring method in the project.

****

UL 5A, nonmetallic totally enclosed, snap-cover type.[Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Provide receptacles as specified herein, spaced a minimum of one every [455][_____] mm [18][_____] inches.][Wire alternate receptacles on different circuits.]

2.4 BUSWAY

****
NOTE: Ensure phase sequence of voltages and orientation are indicated on the drawings for existing transformers, switchboards, switchgear, and motor control centers.
****

NEMA BU 1.1, UL 857. Provide the following:

a. Buses: [copper][or][aluminum].

b. Busways: rated [_____] volts, [_____] continuous current amperes, three-phase,[three-][four-]wire, and include integral or internal[50-percent] ground bus.

c. Short circuit rating: [[_____] root mean square (rms) symmetrical amperes minimum][as indicated].

d. Busway systems: suitable for use indoors. [Fixed][Spring] support system.

e. Enclosures: [steel] [aluminum] [metallic].

f. Hardware: plated or otherwise protected to resist corrosion.

g. Joints: one-bolt type with through-bolts, which can be checked for tightness without de-energizing system.

h. Maximum hot spot temperature rise at any point in busway at continuous rated load: do not exceed 55 degrees C above maximum ambient temperature of 40 degrees C in any position.

i. Internal barriers to prevent movement of superheated gases.

j. Coordinate proper voltage phasing of entire bus duct system, for example where busway interfaces with transformers, switchgear, switchboards, motor control centers, and other system components.

2.4.1 Feeder Busways

Provide[ventilated, except that vertical busways within 1830 mm 6 feet of floors must be unventilated,][unventilated, totally enclosed] low-impedance busway. Provide bus bars fully covered with insulating material, except at stabs. Provide an entirely polarized busway system.

2.4.2 Plug-In Busways

Unventilated type. Provide the following:

a. Plug-in units: [fusible, handle-operated, switch type, horsepower-rated][circuit breaker-type][handle-operated, switch type, equipped with high interrupting-capacity, current-limiting fuses].

b. Bus bars: covered with insulating material throughout, except at joints and other connection points.

[c. A hook stick of suitable length for operating plug-in units from the floor.

]2.5 CABLE TRAYS

****

NOTE: Indicate cable tray layout on the drawings. When multiple types and sizes are used, indicate size and type of cable trays on the drawings. When using "as indicated" option, ensure information required is shown on the drawings. Coordinate with structural engineer when designating the Span/Load Class category. This designation is found in NEMA VE 2. Provide designation on drawings and/or in this specification.

****

NEMA VE 2. Provide the following:

[Submit cable tray design, including dimensional layout, load and seismic calculations, and fill calculations. Dimensional layout includes cable spacings, cable tray splices, and supports. Fill calculations include an index of cables for each section and identification of the lb/ft, cross sectional area, and insulation voltage class for each cable.

] a. Cable trays: form a wireway system, with a nominal[[75][100][150] mm [3][4][6] inch] depth[as indicated]. Cable tray is to have a span/load class designation of [_____] per NEMA VE 2.

b. Cable trays: constructed of[aluminum][copper-free aluminum][steel that has been hot-dipped galvanized after fabrication].

c. Cable trays: include splice and end plates, dropouts, and miscellaneous hardware.

d. Edges, fittings, and hardware: finished free from burrs and sharp edges.

e. Fittings: ensure not less than load-carrying ability of straight tray sections and have manufacturer's minimum standard radius.

f. Radius of bends: [[305][610][915] mm [12][24][36] inches.][as indicated.]

2.5.1 Basket-Type Cable Trays

****

NOTE: Basket cable tray is a fabricated structure consisting of wire mesh bottom and side rails.

****

Provide[size as indicated][of nominal [50,][100,][150,][200,][300,][450,][and][600] mm [2,][4,][6,][8,][12,][18,][and][24] inch width and [25,][50,][and][100] mm [1,][2,][and][4] inch depth] with maximum wire mesh spacing of 50 by 100 mm 2 by 4 inch.

2.5.2 Trough-Type Cable Trays

****

NOTE: Trough or ventilated cable tray is a fabricated structure consisting of integral or

separate longitudinal rails and a bottom having openings sufficient for the passage of air and utilizing 75 percent or less of the plan area of the surface to support cables.

****

Provide[size as indicated][of nominal [150][305][455][610][760][915] mm [6][12][18][24][30][36] inch width].[Cable tray must be suitable for use as an equipment grounding conductor.]

2.5.3 Ladder-Type Cable Trays

****

NOTE: Ladder cable tray is a fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

****

Provide[size as indicated][of nominal [150][305][455][610][760][915] mm [6][12][18][24][30][36] inch width] with maximum rung spacing of [150][225][305][455] mm [6][9][12][18] inches.[Cable tray must be suitable for use as an equipment grounding conductor.]

2.5.4 Channel-Type Cable Trays

****

NOTE: Channel cable tray is a fabricated structure consisting of a one-piece ventilated-bottom or solid-bottom channel section, not exceeding 152 mm 6 inches in width.

****

Provide[size as indicated][of nominal [75][100][150] mm [3][4][6] inch width]. Provide trays with one-piece construction having slots spaced not more than 115 mm 4 1/2 inches on centers.[Cable tray must be suitable for use as an equipment grounding conductor.]

2.5.5 Solid Bottom-Type Cable Trays

****

NOTE: Solid bottom or non-ventilated cable tray is a fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.

****

Provide[size as indicated][of nominal [150][305][455][610][760][915] mm [6][12][18][24][30][36] inch width].[Provide solid covers.][Do not provide solid covers.]

[2.5.6 Cantilever

Cantilever-type, center-hung cable trays may be provided at the Contractor's option in lieu of other cable tray types specified.

][2.6 OPEN TELECOMMUNICATIONS CABLE SUPPORT

****

NOTE: Utilize open telecommunications cable

supports (J-Hooks / J-Supports / D-rings) only as specifically permitted in UFC 3-580-01, Telecommunications, Building Cabling System.

****

2.6.1 Open Top Cable Supports

Provide open top cable supports in accordance with UL 2043. Provide[[galvanized][zinc-coated][stainless] steel] open top cable supports[as indicated].

2.6.2 Closed Ring Cable Supports

Provide closed ring cable supports in accordance with UL 2043. Provide[[galvanized][zinc-coated][stainless] steel] closed ring cable supports[as indicated].

]2.7 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.7.1 Floor Outlet Boxes

Provide the following:

a. Boxes: [adjustable][nonadjustable] and concrete tight.

b. Each outlet: consisting of [nonmetallic][or][cast-metal] body with threaded openings,[or sheet-steel body with knockouts] for conduits,[adjustable][,][brass flange] ring, and cover plate with [19][25][31.75][53.92] mm [3/4][1][1 1/4][2 1/8] inch threaded plug.

c. Telecommunications outlets: consisting of[surface-mounted, horizontal][flush], aluminum or stainless steel housing with a receptacle as specified and[25 mm one inch bushed side opening][19 mm 3/4 inch top opening].

d. Receptacle outlets: consisting of[surface-mounted, horizontal][flush] aluminum or stainless steel housing with duplex-type receptacle as specified herein.

e. Provide gaskets where necessary to ensure watertight installation.

[f. Provide plugs with installation instructions to the Contracting Officer for [5] [_____] percent of outlet boxes for the capping of outlets upon removal of service fittings.

]2.7.2 Outlet Boxes for Telecommunications System

****

NOTE: When using "as indicated" option, ensure information required is shown on the drawings. Choose 100 mm 4 inch square boxes for single gang, four outlet, copper telecommunications configurations that do not have provision for fiber optic cabling. Choose 120 mm 4 11/16 inch square boxes for 35 mm 1 1/4 inch conduit installations and for outlet boxes that have or may require fiber

optic cabling. Larger boxes are required to meet bend radii requirements for fiber optic cable.
****

Provide the following:

a. Standard type[100 mm square by 54 mm deep][120 mm square by 54 mm deep][130 mm square by 73 mm deep][4 inches square by 2 1/8 inches deep][4 11/16 inches square by 2 1/8 inches deep][5 inches square by 2 7/8 inches deep].

[b. Outlet boxes for wall-mounted telecommunications outlets: 100 by 54 by 54 mm 4 by 2 1/8 by 2 1/8 inches deep.

] c. Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.

[d. Outlet boxes for fiber optic telecommunication outlets: include a minimum 10 mm 3/8 inch deep single or two gang plaster ring as shown and installed using a minimum 27 mm one inch conduit system.

][e. Outlet boxes for handicapped telecommunications station: [100 by 54 by 54 mm][130 mm square by 73 mm deep][4 by 2 1/8 by 2 1/8 inches][5 inches square by 2 7/8 inches deep] deep.

][2.7.3 Clock Outlet for Use in Other Than Wired Clock System

****
NOTE: Battery-operated clocks are Navy standard. Retain this paragraph only under special conditions.
****

Provide the following:

a. Outlet box with plastic cover, where required, and single receptacle with clock outlet plate.

b. Receptacle: recessed sufficiently within box to allow complete insertion of standard cap, flush with plate.

c. Suitable clip or support for hanging clock: secured to top plate.

d. Material and finish of plate: as specified in paragraph DEVICE PLATES of this section.

]2.8 CABINETS, JUNCTION BOXES, AND PULL BOXES

UL 50; volume greater than 1640 mL 100 cubic inches, NEMA Type 1 enclosure; sheet steel, hot-dip, zinc-coated. Where exposed to wet, damp, or corrosive environments, NEMA Type [3R][4X][_____][as indicated].

2.9 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 24 months prior to date of delivery to site.

2.9.1 Conductors

****

NOTE: UFC 3-520-01 allows the use of aluminum conductors of equivalent ampacity instead of copper for #4 AWG and larger sizes. If only copper is desired for these applications, select the bracketed option below. The second bracketed option follows the UFC guidance.

****

****

NOTE: In overseas locations, for conductors No. 10 AWG and smaller diameter, give consideration to the use of stranded wires, if suitable terminal devices can be applied which enable proper connection. Also, stranded wires in sizes No. 10 AWG and smaller diameter may be required for projects involving uninterrupted power supply (UPS) installations.

****

Provide the following:

a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise.

b. Conductors No. 8 AWG and larger diameter: stranded.

c. Conductors No. 10 AWG and smaller diameter: solid.

d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.

e. [All conductors: copper.][Conductors indicated to be No. 6 AWG or smaller diameter: copper. Conductors indicated to be No. 4 AWG and larger diameter: either copper or aluminum, unless type of conductor material is specifically indicated, or specified, or required by equipment manufacturer.]

[2.9.1.1 Equipment Manufacturer Requirements

****

NOTE: Use this paragraph only if aluminum conductors are allowed.

****

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.

][2.9.1.2 Aluminum Conductors

****

NOTE: In certain instances it may be necessary to require compact stranding, i.e., when outside diameter of cable must be limited. When necessary, specify the following: "Provide conductors with compact stranded utilizing method of stranding

specified in ASTM B400/B400M; however, provide conductor material as specified herein."
****

Provide aluminum conductors of AA-8000 series electrical grade aluminum alloy conductors. Type EC/1350 aluminum is not acceptable. If Contractor chooses to provide aluminum for conductors No. 4 AWG and larger diameter, Contractor is responsible for increasing conductor size to have same ampacity as copper size indicated; increasing conduit and pull box sizes to accommodate larger size aluminum conductors in accordance with NFPA 70; ensuring that pulling tension rating of aluminum conductor is sufficient; providing panelboards[and motor control centers] that are UL listed for use with aluminum, and so labeled; relocating equipment, modifying equipment terminations, resizing equipment; and resolving problems that are direct results of providing aluminum conductors in lieu of copper.

]2.9.1.3 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

a. Branch circuits: No. 12 AWG.

b. Class 1 remote-control and signal circuits: No. 14 AWG.

c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.

d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.

e. Digital low voltage lighting control (DLVLC) system at 24 Volts or less: Category [5 UTP][_____] cables[in EMT conduit][in accordance with DLVLC system manufacturer requirements].

2.9.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling circuit conductors.

2.9.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

a. Grounding conductors: Green.

b. Neutral conductors: White.

c. Exception, where neutrals of more than one system are installed in same raceway or box, other neutrals color coding: white with a different colored (not green) stripe for each.

2.9.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

a. 208/120 volt, three-phase

    (1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase: Black and red

[d. On three-phase, four-wire delta system, high leg: orange, as required by NFPA 70.

]2.9.3 Insulation

****

NOTE: Be sure conduit fill calculations are based on largest diameter insulation type allowed. Designer may select other insulation types which may be more suitable for a particular project. For rewiring project where existing conduit is to be utilized, specify types THHN and THWN.

Conductors must be sized for ampacity at 60 degrees C or 75 degrees C as required in accordance with Section 110.14 of NFPA 70 for the lowest termination value in the circuit; however, ambient temperature correction may be based on the actual conductor insulation temperature rating per NFPA 70 Section 110.14. This requirement also applies to feeders protected by 100 percent rated circuit breakers.

****

Unless specified or indicated otherwise or required by NFPA 70, provide power and lighting wires rated for 600-volts,[Type THWN/THHN conforming to UL 83][or][Type[XHHW][or][RHW] conforming to UL 44], except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits: Type TW or TF, conforming to UL 83. Where equipment or devices require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.9.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.9.4.1 Telecommunications Bonding Backbone (TBB)

****

NOTE: A Telecommunication Bonding Backbone (TBB) is required between the Primary Bonding Busbar (PBB) and all Secondary Bonding Busbars (SBBs). A TBB is not required for installation with only a single SBB or PBB.

Sizing of the TBB

TBB length linear m ft	**TBB Size (AWG)**
less than 4 13	**6**
4 - 6 14 - 20	**4**
6 - 8 21 - 26	**3**
8 - 10 27 - 33	**2**
10 - 13 34 - 41	**1**
13 - 16 42 - 52	**1/0**
16 - 20 53 - 66	**2/0**
greater than 20 66	**3/0**

Choose the second bracketed options where lightning protection system is provided in the job and specified in other sections.

Choose insulated TBB when pathway is a dissimilar metal than copper. See TIA-607-D Section 6.3.1 through 6.3.6 for further information.

****

Provide a copper conductor TBB in accordance with TIA-607 with No. 6 AWG minimum size, and sized at 2 kcmil per linear foot of conductor length up to a maximum size of 750 kcmil.[Provide insulated TBB with insulation as specified in the paragraph INSULATION and meeting the fire ratings of its pathway.]

2.9.4.2 Bonding Conductor for Telecommunications

Provide a copper conductor Bonding Conductor for Telecommunications between the telecommunications main grounding busbar (PBB) and the electrical service ground in accordance with TIA-607. Size the bonding conductor for telecommunications the same as the TBB.

[2.9.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

][2.9.6 Nonmetallic Sheathed Cable

****

NOTE: UFC 3-520-01 authorizes Type NC and NMC cables only in one- and two-family dwellings including attached or detached garages and storage buildings.

****

UL 719, Type NM or NMC.

][2.9.7 Wire and Cable for 400 Hertz (Hz) Circuits

Insulated copper conductors.

][2.9.8 Metal-Clad Cable

****

NOTE: Type MC cable is UL listed and NFPA 70 recognized for most common building applications. Review NFPA 70. MC cable does not protect conductors as well as rigid conduit but is more flexible to install and relocate. For Navy projects, consult with NAVFAC cognizant FEC electrical design branch manager and obtain written approval before specifying this wiring method.

****

****

NOTE: UFC 3-520-01 prohibits using Type MC cable except for branch circuits in the following dry locations: new construction in exposed locations; renovations in exposed locations; concealed in renovations in existing areas where walls and ceilings are not disturbed; and cable trays.

****

UL 1569; NFPA 70, Type MC cable.

][2.9.9 Armored Cable

****

NOTE: UFC 3-520-01 prohibits using Type AC cable except for branch circuits in the following dry locations: new construction and renovations in exposed locations; concealed in renovations in existing areas where walls and ceilings are not disturbed; and cable trays.

****

UL 4; NFPA 70, Type AC cable.

][2.9.10 Mineral-Insulated, Metal-Sheathed Cable

****

NOTE: Type MI cable is used for low temperature, high temperature, hazardous locations, life safety, and heating applications. Refer to NFPA 70. Clearly show the MI cable on the drawings. If MI cable utilized in hazardous areas is likely to be subject to high voltage surges, consider the use of surge suppressors in electrical panels serving the load from outside of the hazardous area. Locate suppressors in appropriately rated enclosures within the hazardous area only if there is no other option. MI cable is not available in ratings above 600 volts.

****

UL listed; NFPA 70, Type MI cable. Do not use sheathing containing asbestos fibers.

][2.9.11 Flat Conductor Cable

****

NOTE: Type FCC cable has been listed by UL and recognized by NFPA 70 for under carpet tile applications. Review NFPA 70. FCC cable is available off the shelf for power and telecommunications transmission applications.

****

UL listed; NFPA 70, Type FCC.

][2.9.12 Cable Tray Cable or Power Limited Tray Cable

UL listed; type TC or PLTC.

][2.9.13 Cord Sets and Power-Supply Cords

****

NOTE: Include this paragraph when equipment utilizing cord sets is permanently connected to boxes in lieu of use of plug and receptacles.

****

UL 817.

]2.10 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.11 DEVICE PLATES

****

NOTE: Use last item below for brig facilities only.

****

Provide the following:

a. UL listed, one-piece device plates for outlets to suit the devices installed.

b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.

c. For nonmetallic boxes and fittings, other suitable plates may be provided.

[d. Plates on finished walls: nylon or lexan, minimum 0.792 mm 0.03 inch wall thickness and same color as receptacle or toggle switch with which they are mounted.

][e. Plates on finished walls: satin finish stainless steel or brushed-finish aluminum, minimum 0.792 mm 0.03 inch thick.

] f. Screws: machine-type with countersunk heads in color to match finish of plate.

g. Sectional type device plates are not be permitted.

h. Plates installed in wet locations: gasketed and UL listed for "wet locations."

[i. Device plates in areas normally accessible to prisoners: brown or ivory finish nylon-device plates rated for high abuse. Test device plates for compliance with UL 514A and UL 514C for physical strength. Attach device plates with spanner head bolts.

]2.12 SWITCHES

2.12.1 Toggle Switches

****

NOTE: Do not use solderless pressure type toggle switches on Navy projects.

****

NEMA WD 1, UL 20,[single pole][, double pole][, three-way][, and four-way], totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

a. Handles: [white][ivory][brown] thermoplastic.

b. Wiring terminals: screw-type, side-wired[or of the solderless pressure type having suitable conductor-release arrangement].

c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.

d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

2.12.2 Switch with Red Pilot Handle

NEMA WD 1. Provide the following:

a. Pilot lights that are integrally constructed as a part of the switch's handle.

b. Pilot light color: red and illuminate whenever the switch is closed or "on".

c. Pilot lighted switch: rated 20 amps and 120 volts or 277 volts as indicated.

d. The circuit's neutral conductor to each switch with a pilot light.

2.12.3 Breakers Used as Switches

For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.

2.12.4 Disconnect Switches

****

NOTE: Select heavy duty-type for those switches requiring frequent operation and indicate as such on the drawings. Use NEMA 4X stainless steel switch enclosures for switches located on building exteriors in areas where salt spray or extended high humidity is a concern.

****

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in NEMA[1][3R][4X Type 304 stainless steel][4X fiberglass][4X plastic][_____], enclosure[as indicated] per NEMA ICS 6.

2.13 FUSES

****

NOTE: Determine the proper fuse class and type based on the requirements of the electrical system and the equipment serviced. This note briefly summarizes some of the UL fuse standards and their application. In addition to 200,000 ampere rms symmetrical UL listing, 300,000 ampere rms symmetrical special purpose rating has been witnessed on UL tested and certified Class RK1, J and Class L.

UL 248-12, Class R: 200,000 ampere, rms symmetrical interrupting rating, RK1 is labeled current limiting, and is available in dual-element time-delay and non-time-delay options. RK5 fuses are dual-element time-delay and labeled current-limiting. Both RK1 and RK5 fuses are rejection type which should be used with rejection mounting on new equipment to satisfy high current interrupting listing by UL. However, these fuses may be used on existing equipment that is non-rejection type as a direct replacement for UL 248-12 fuses.

UL 248-8, UL 248-10, UL 248-4, Classes J, L, and CC: 200,000 ampere, rms symmetrical interrupting rating is available with time-delay option, is not interchangeable with any other UL fuse class, is labeled current-limiting, and is rated 600 volts ac.

UL 248-6, Class H: Maximum 10,000 ampere, symmetrical interrupting rating. Use only in existing equipment where the available fault is known to be less than 10,000 amperes.

UL 248-15, Class T: Maximum 200,000 ampere symmetrical interrupting rating. Is not interchangeable with other UL fuse classes.

****

NEMA FU 1. Provide complete set of fuses for each fusible[switch][

panel][and control center]. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers[or other circuit protective devices] for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

2.13.1 Fuseholders

Provide in accordance with UL 4248-1.

2.13.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 248-12, Class[RK-1][RK-5][time-delay type]. Provide only Class R associated fuseholders in accordance with UL 4248-12.

2.13.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 248-8, UL 248-10, UL 248-4, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.13.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 248-15, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.14 RECEPTACLES

****

NOTE: 1. Provide general purpose convenience receptacles that are specification grade, 20 A, 120 V, duplex. Identify locations where split receptacles will be used with one receptacle controlled by a separate toggle switch. Provide GFI and AFCI protection in accordance with NFPA 70. Use hospital grade receptacles only for those applications that exceed capabilities of specification grade receptacles. Residential grade receptacles are not acceptable.

2. Thermoplastic components provide superior resistance to impacts, chemicals and solvents as compared to thermoset materials. Nylon, Polycarbonate, Polyester, Acrylic and Polypropylene are examples of thermoplastic material. Phenolic. Urea and Melamine are examples of thermoset materials which do not provide high degrees of resistance to impact.

****

Provide the following:

a. [UL 498, general purpose specification grade,][UL 498, hospital grade,] grounding-type. Residential grade receptacles are not acceptable.

b. Ratings and configurations: as indicated.

c. Bodies: [white][ivory][brown] as per NEMA WD 1.

d. Face and body: thermoplastic supported on a metal mounting strap.

e. Dimensional requirements: per NEMA WD 6.

f. Screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.

g. Grounding pole connected to mounting strap.

h. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.

[i. Controlled receptacles: as required per ASHRAE 90.1. Provide marking for controlled receptacle per NFPA 70.

]2.14.1 Split Duplex Receptacles

Provide separate terminals for each ungrounded pole. One receptacle must be controlled separately.

2.14.2 Weatherproof Receptacles

****

NOTE: Provide die-cast metal/aluminum cover plate when matching existing installation.

****

Provide receptacles, UL listed for use in "wet locations" with integral GFCI protection. Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, [polycarbonate, UV resistant/stabilized][die-cast metal/aluminum] extra-duty rated hood.

2.14.3 Ground-Fault Circuit Interrupter Receptacles

****

NOTE: Ground-fault circuit interrupters are spelled out rather than abbreviated as "GFCI" to avoid a potential conflict with "government furnished, contractor installed equipment".

****

UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak when the current to ground is 6 milliamperes or higher, and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.14.4 Special Purpose Receptacles

Receptacles serving [_____] are special purpose.[Provide in ratings indicated.][NEMA [_____] configuration, rated [_____] amperes, [_____] volts.][Furnish one matching plug with each receptacle.]

[2.14.5 Plugs

Provide heavy-duty, rubber-covered[three-,][four-,][or][five-]wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the

Government.

]2.14.6 Range Receptacles

NEMA 14-50 configuration,[flush mounted for housing units,] rated 50 amperes, 125/250 volts.[Furnish one matching plug with each receptacle.]

2.14.7 Dryer Receptacles

NEMA 14-30 configuration, rated 30 amperes, 125/250 volts.[Furnish one matching plug with each receptacle.]

2.14.8 Tamper-Resistant Receptacles

****

NOTE: NFPA 70 defines a tamper-resistant receptacle as one which by its construction limits improper access to its energized parts.

****

Provide duplex receptacle with mechanical sliding shutters that prevent the insertion of small objects into its contact slots.

2.14.9 Arc-Fault Circuit Interrupter Receptacles

UL 1699, duplex type for mounting in standard outlet box. Provide device capable of detecting series arcing current when the current to ground is 5 amperes or higher, and tripping per requirements of UL 1699.

2.15 PANELBOARDS

****

NOTE: For residential applications, use paragraph RESIDENTIAL LOAD CENTERS or LOAD CENTERS FOR HOUSING UNITS instead of PANELBOARDS unless required by the local Activity.

****

****

NOTE: For Navy projects, use the first bracketed paragraph. Select item m. below for unique applications involving non-standard frequencies or voltages.

Limit each panelboard to a maximum of 54 poles. Panelboards with up to 54 poles may be used in electrical renovations where the existing panelboards are replaced and wall space for additional panelboards is limited. Do not use dual section panelboards.

Specific breaker placement is required in panelboards to match the breaker placement indicated on the panelboard schedule in the design drawings. If it is not possible to match specific breaker placement during construction, obtain Government approval prior to device installation.

****

Provide panelboards in accordance with the following:

[a. UL 67 and UL 50 having a short-circuit current rating[as indicated][of 10,000 amperes symmetrical minimum for voltages 240 V and below][of 14,000 amperes symmetrical minimum for 480 V].

b. Panelboards for use as service disconnecting means: additionally conform to UL 869A.

c. Panelboards: circuit breaker-equipped.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the design drawings. If it is not possible to match "specific breaker placement" during construction, obtain Government approval prior to device installation.

f. Use of "Subfeed Breakers" is not acceptable.

g. Main breaker: "separately" mounted["above"][or]["below"] branch breakers.

h. Where "space only" is indicated, make provisions for future installation of breakers.

i. Directories: indicate load served by each circuit in panelboard.

j. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP).

[k. Provide new directories for existing panels modified by this project as indicated.

] l. Type directories and mount in holder behind transparent protective covering.

[m. Panelboards: listed and labeled for their intended use.

] n. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

]2.15.1 Enclosure

****

NOTE: For all outdoor applications at project locations with Environmental Severity Classification (ESC) factors of C4 and C5 and all indoor applications in a harsh environment, select NEMA 4X option below. In other outdoor locations, select NEMA 3R option. See UFC 1-200-01 for determination of ESC for project location. Designer to coordinate NEMA designation on drawings.

****

Provide panelboard enclosure in accordance with the following:

a. UL 50.

b. Cabinets mounted outdoors or flush-mounted: [hot-dipped galvanized after fabrication][fiberglass enclosure].

c. Cabinets: painted in accordance with paragraph FIELD APPLIED PAINTING.

d. Outdoor cabinets: [NEMA 3R raintight][NEMA 4x] with[conduit hubs welded to the cabinet][a removable steel plate 7 mm 1/4 inch thick in the bottom for field drilling for conduit connections].

e. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.

f. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 3 mm 1/8 inch.

g. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 15 mm 1/2 inch clear space between the back of the cabinet and the wall surface.

h. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.

i. Each door: fitted with a combined catch and lock latch.

j. Keys: two provided with each lock, with all locks keyed alike.

k. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

2.15.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.[In addition to equipment grounding bus, provide second "isolated" ground bus, where indicated.]

****

NOTE: Select the bracketed option below only if the non-linear loads are expected to be a majority of the downstream loads.

****

[2.15.2.1 Panelboard Neutrals for Non-Linear Loads

Provide in accordance with the following:.

a. UL listed, with panelboard type specifically UL heat rise tested for use on non-linear loads.

b. Panelboard: heat rise tested in accordance with UL 67, except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing.

c. Verification of the testing procedure: provided upon request.

d. Two neutral assemblies paralleled together with cable is not acceptable.

e. Nameplates for panelboard rated for use on non-linear loads: marked "SUITABLE FOR NON-LINEAR LOADS" and in accordance with paragraph FIELD FABRICATED NAMEPLATES.

f. Provide a neutral label with instructions for wiring the neutral of panelboards rated for use on non-linear loads.

]2.15.3 Circuit Breakers

****

NOTE: For residential and BEQ/BOQ facility applications, use paragraph RESIDENTIAL LOAD CENTERS or LOAD CENTERS FOR HOUSING UNITS instead of PANELBOARDS unless panelboards with bolt-on breakers are required by the local Activity.

****

UL 489,[thermal magnetic-type][solid state-type] having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided.[Where indicated on the drawings, provide circuit breakers with shunt trip devices.] Series rated circuit breakers and plug-in circuit breakers are unacceptable.

2.15.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.15.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with auto-monitoring (self-test) and lockout features, "push-to-test" button, visible indication of tripped condition, and ability to detect and trip when current imbalance is 6 milliamperes or higher per requirements of UL 943 for Class A ground-fault circuit interrupter devices.

2.15.3.3 Arc-Fault Circuit Interrupters

****

NOTE: NFPA 70 requires that all branch circuits that supply 120 volt, single phase, 15 and 20 ampere outlets installed in dwelling unit kitchens, laundry areas, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or areas and in dormitory units bedrooms, living rooms, hallways, closets, and similar rooms or areas are protected by an arc-fault circuit interrupter to provide protection of entire branch

circuit.
****

****
NOTE: The one pole arc-fault circuit-interrupter is not designed for use on circuits in which the neutral conductor is shared with other circuits (defined as a multiwire branch circuit in NFPA 70) and will nuisance trip on shared neutral circuits. Provide and indicate on the drawings one pole arc-fault circuit-interrupter breakers for each circuit, and do not use shared neutral for these circuits in new construction projects. Where wiring is existing and not replaced and where a shared neutral exists, a two pole, 120/240 volt arc-fault circuit-interrupter for shared neutral circuits may be required. It may also be required in new construction if 120/240 volt equipment or circuit is located in the bedroom. Coordinate the requirement with the cognizant Activity.
****

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated.[Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.] Provide with "push-to-test" button.

[2.15.4 Fusible Switches for Panelboards

NEMA KS 1, hinged door-type. Provide switches serving as motor disconnect means rated for kilowatt horsepower.

][2.15.5 400 Hz Panelboard and Breakers

Provide panelboards and breakers for use on 400 Hz systems rated and labeled "400 Hz."

][2.15.6 Branch Circuit Monitoring Panelboards

Provide a microprocessor-based panelboard monitoring system having the following features:

a. ANSI C12.1 and IEC 62053-21 Class 1 energy revenue metering accuracy.

b. Direct reading metered or calculated values for up to forty-two branch circuits.

c. Monitored values at the branch circuit level for current (A), power (kW), and energy (kWh).

d. Four user-configurable alarm thresholds.

e. Communications with building automation system using Modbus RTU protocol via RS-485 cable connection.

][2.15.7 Lighting Control Panelboards

Provided a lighting control panelboard having the following features:

a. Minimum sixteen schedules including a 7-day repeating schedule with sixteen daily on/off periods.

b. Minimum sixteen lighting zones grouping branch breakers that are controlled by schedules, manual inputs, or override commands.

c. Electronic clock including real-time, astronomical clock, and leap year and daylight savings time adjustments.

d. Burn-hour tracking.

e. Remote circuit breaker operation.

[f. Master Lighting Control Panelboard with controller to control up to [8] [_____] control bussed located [individually][in slave panelboard] up to [400] [_____] feet away from the master panelboard.

] g. Communications with building automation system using Modbus RTU protocol via RS-485 cable connection.

][2.16 RESIDENTIAL LOAD CENTERS

****

NOTE: Use the following paragraph and subparagraphs in lieu of the paragraph PANELBOARD and its subparagraphs if designer has chosen to specify residential load centers in the design. Load centers are permitted only for family housing construction/repair projects. Delete for other projects.

****

Provide residential load centers (RLCs) in accordance with the following:

a. UL 67 and UL 50.

b. RLCs for use as service disconnecting means: additionally conform to UL 869A.

c. Circuit breaker equipped.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. Where "space only" is indicated, make provisions for future installation of breakers sized as indicated.

[f. Provide load centers with keyed locks.

] g. Provide printed directories.

2.16.1 RLC Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated groundable neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.16.2 Circuit Breakers

UL 489, thermal magnetic-type with interrupting capacity[as indicated][of 10,000 minimum amperes rms symmetrical]. Breaker terminals: UL listed as suitable for the type of conductor provided.

2.16.2.1 Multipole Breakers

Provide common trip-type with single operating handle. Provide a breaker design such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any two adjacent breaker poles are connected to alternate phases in sequence.

[2.16.2.2 Circuit Breaker With Ground-Fault Circuit Interrupter

****

NOTE: Include for all locations required by NFPA 70.

****

UL 943 and NFPA 70. Provide with auto-monitoring (self-test) and lockout features, "push-to-test" button, visible indication of tripped condition, and ability to detect and trip when current imbalance is 6 milliamperes or higher per requirements of UL 943 for Class A ground-fault circuit interrupter devices.

]2.16.2.3 Arc-Fault Circuit-Interrupters

****

NOTE: NFPA 70 requires that all branch circuits that supply 120 volt, single phase, 15 and 20 ampere outlets installed in dwelling unit family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or areas are protected by an arc-fault circuit interrupter to provide protection of entire branch circuit.

****

****

NOTE: The one pole arc-fault circuit-interrupter is not designed for use on circuits in which the neutral conductor is shared with other circuits (defined as a multiwire branch circuit in NFPA 70) and will nuisance trip on shared neutral circuits. Provide and indicate on the drawings one pole arc-fault circuit-interrupter breakers for each circuit, and do not use shared neutral for these circuits in new construction projects. Where wiring is existing and not replaced and where a shared neutral exists, a two pole, 120/240 volt arc-fault circuit-interrupter for shared neutral circuits may be required. It may also be required in new construction if 120/240 volt equipment or circuit is located in the bedroom. Coordinate the requirement with the cognizant Activity.

****

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated.[Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.] Provide with "push-to-test" button.

][2.17 LOAD CENTERS FOR HOUSING UNITS

****

NOTE: UFC 3-520-01 allows load center style panelboards, with plug-in breakers, which can be used in housing units and BEQ/BOQ rooms.

****

Provide single-phase panelboards for housing units on this project in accordance with the following:

a. Load center type, circuit breaker equipped, conforming to UL 67 and UL 50.

b. Panelboards series short-circuit current rating: 22,000 amperes symmetrical minimum for the main breaker and the branch breakers.

c. Panelboards for use as service disconnecting means: additionally conform to UL 869A.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings.

f. Where "space only" is indicated, make provisions for future installation of breakers.

g. Provide cover with latching door.

h. Directories: indicate load served by each circuit in panelboard.

i. Directories: indicate source of service to panelboard (e.g., Panel PA served from panel MDP)

j. Type directories and mount behind in holder with transparent protective covering on inside of panel door.

2.17.1 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide copper or aluminum bus bars, either tin plated or silver plated. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.17.2 Circuit Breakers

UL 489 thermal magnetic type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided. Half-size and tandem breakers are not acceptable. Provide switch duty rated 15 and 20 ampere breakers. Breakers must not require use of panel trim to secure them to the bus.

2.17.2.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any two adjacent breaker poles are connected to Phases A and B respectively.

2.17.2.2 Arc-Fault Circuit-Interrupters

****

NOTE: NFPA 70 requires that all branch circuits that supply 120 volt, single phase, 15 and 20 ampere outlets installed in dwelling unit family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or areas are protected by an arc-fault circuit interrupter to provide protection of entire branch circuit.

****

****

NOTE: The one pole arc-fault circuit-interrupter is not designed for use on circuits in which the neutral conductor is shared with other circuits (defined as a multiwire branch circuit in NFPA 70) and will nuisance trip on shared neutral circuits. Provide and indicate on the drawings one pole arc-fault circuit-interrupter breakers for each circuit, and do not use shared neutral for these circuits in new construction projects. Where wiring is existing and not replaced and where a shared neutral exists, a two pole, 120/240 volt arc-fault circuit-interrupter for shared neutral circuits may be required. It may also be required in new construction if 120/240 volt equipment or circuit is located in the bedroom. Coordinate the requirement with the cognizant Activity.

****

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated.[Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable.] Provide with "push-to-test" button.

]2.18 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated.[Provide solid neutral.]

[2.19 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

****

NOTE: MSCPs, also called motor circuit protectors (MCPs), are components of combination motor controllers rather than fuses or circuit breakers and are permitted if the motor short-circuit protector is part of a listed combination motor controller.

****

Motor short-circuit protectors, also called motor circuit protectors (MCPs): UL 508 and UL 489, and provided as shown. Provide MSCPs that consist of an adjustable instantaneous trip circuit breaker used only in conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. Rate MSCPs in accordance with the requirements of NFPA 70.

]2.20 TRANSFORMERS

****

NOTE: Coordinate the location of dry-type transformers with the mechanical designer to ensure adequate ventilation. This specification does not apply to transformers over 500 kVA, substation transformers, and transformers rated greater than 600 volts; for these types, see Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS, Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS, or Section 26 11 16 SECONDARY UNIT SUBSTATIONS for all projects; or Section 26 11 13.00 20 PRIMARY UNIT SUBSTATIONS for Navy projects; or Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION for Army projects. Specify 80 degrees C rise for dry-type transformers rated less than 15 kVA or 115 degrees C rise for dry-type transformers rated 15 kVA or larger at a maximum ambient temperature of 40 degrees C. Delete quiet type where noise level does not affect personnel. Relative to noise: the least desirable location for the transformer is in a corner of a room, especially when there is a low ceiling.

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NOTE: NEMA ST 20 is used below as a requirement for general purpose dry-type transformers. Although this document has been withdrawn by NEMA, it is still used as a requirement because manufacturers still use it as a design guide.

****

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NOTE: Transformer taps may be Full Capacity Above Nominal (FCAN) which designates the transformer will deliver its rated kVA when connected to a voltage

source which is higher than the rated primary voltage, or Full Capacity Below Nominal (FCBN) which designates the transformer will deliver its rated kVA when connected to a voltage source which is lower than the rated primary voltage. There may be taps plus/minus 2.5 percent or plus/minus 5 percent of the rated primary voltage and different numbers of taps FCAN and FCBN. Use available Cut Sheets or contact the transformer manufacturers to find out the required taps combinations.

****

Provide transformers in accordance with the following:

a. NEMA ST 20, general purpose, dry-type, self-cooled,[ventilated][unventilated][sealed].

b. Provide transformers in NEMA[1][3R][_____] enclosure.

c. Taps for transformers 15 kVA and larger: [Two 2.5 percent taps Full Capacity Above Nominal (FCAN) and four 2.5 percent taps Full Capacity Below Nominal (FCBN)][Two 2.5 percent taps Full Capacity Above Nominal (FCAN) and two 2.5 percent taps Full Capacity Below Nominal (FCBN)][_____].

d. Transformer insulation system:

    (1) 220 degrees C insulation system for transformers 15 kVA and greater, with temperature rise not exceeding [115] [80] degrees C under full-rated load in maximum ambient of 40 degrees C.

    (2) 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 80 degrees C under full-rated load in maximum ambient of 40 degrees C.

[e. Transformer of 150 degrees C temperature rise is not acceptable.

][f. Transformer of 115 degrees C temperature rise: capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.

][g. Transformer of 80 degrees C temperature rise: capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.

][h. Transformers: quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

]2.20.1 Specified Transformer Efficiency

****

NOTE: Energy Star or energy efficient transformers are generally only available in ventilated enclosures.

****

Transformers, indicated and specified with: 480V primary, 80 degrees C or 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 30 to 500 for three phase, energy efficient type. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in 10 CFR 431, Subpart K.

[2.20.2 K-Rated Transformers

****

NOTE: Complete an analysis of the connected loads to determine the harmonic contents and the appropriate K-Factor rating. K-Factor is defined as the sum from h=1 to infinity of $I_h(pu)^2h^2$ where I_h (pu) is the rms current at harmonic "h" (per unit of rated rms load current) and h is the harmonic order. Transformer K-factor ratings must be based on full-load conditions. K-Factor rated transformers ensure the transformer does not overheat and possibly fail. Use K-4 rating when connected loads are comprised of a large number of 100 percent non-linear single phase electronic equipment. Use K-13 rating when connected loads are comprised of single, large electronic loads, or small numbers of comparatively large single phase loads (i.e., mainframe computers or on-line UPS systems). Use caution in specifying K-ratings above K-13, as the impedance generally decreases as the K-ratings increase. Impedances below 3 percent are not recommended for computer loads connected to transformers with high K-ratings, as even higher neutral currents could result and possibly cause malfunctions or damage sensitive load equipment. Derated transformers also may be used to prevent overheating. Use harmonic mitigating transformer (HMT) if standard transformer has to be derated by more than 10 percent. HMT designed to greatly reduce certain harmonics based on their design, and thus reduce exposure to the rest of the electrical system from current harmonics drawn by downstream loads.

****

Provide K-rated transformers for non-linear loads in accordance with the following:

a. Transformer insulation: UL recognized 220 degrees C system. Neither the primary nor the secondary temperature is allowed to exceed 220 degrees C at any point in the coils while carrying their full rating of non-sinusoidal load.

b. Transformers are to be UL listed and labeled for[K-4][K-9][K-13][K-Factor rating as indicated] in accordance with UL 1561.

c. Transformers evaluated by the UL K-Factor evaluation: listed for[115][80] degrees C average temperature rise only.

d. Transformers with K-Factor ratings with temperature rise of 150 degrees C rise are not acceptable.

e. K-Factor rated transformers impedance: allowed range of 3 percent to 5 percent, with a minimum reactance of 2 percent to prevent excessive neutral current when supplying loads with large amounts of third harmonic.

][2.20.3 Harmonic Mitigating Transformers

Provide harmonic mitigating transformers for non-linear loads in accordance with the following:

a. Transformer insulation: UL recognized 220 or 200 degrees C system. Neither the primary nor the secondary temperature is allowed to exceed 220 or 200 degrees C at any point in the coils while carrying their full rating of non-sinusoidal load.

b. Transformers are to be UL listed and labeled in accordance with UL 1561.

c. Transformers are to have a temperature rise of [115][80] degrees C.

d. 200 percent neutral.

e. Transformers impedance: allowed range of 3 percent to 7 percent, with a minimum reactance of 2 percent to prevent excessive neutral current when supplying loads with large amounts of third harmonic.

]2.21 MOTORS

****

NOTE: Motor and motor controller specifications must be thoroughly coordinated with and cross-referenced in all affected mechanical sections. Apply premium efficiency ratings per the Energy Policy Act of 2005 (EPACT 2005) to all motors. Specify Inverter-Rated motors that feature improved insulation systems for equipment with variable torque loads working with adjustable speed drive (ASD) (also referred to as variable frequency drive VFD) and specify Inverter-Duty motors for equipment with constant torque loads working with ASD per ASD manufacturer requirements including the manufacturer recommended cable type and length. Refer to NEMA MG-1.30. Use three-phase motors if more than 0.5 hp rating. If three-phase service is not available, operate motors larger than 0.5 hp at phase-to-phase voltage. Motors 0.5 hp and smaller should be single phase, with phase-to-phase voltage preferred over phase-to-neutral voltage.

****

Provide motors in accordance with the following:

a. NEMA MG 1[except provide fire pump motors as specified in Section 21 30 00] FIRE PUMPS.

b. Hermetic-type sealed motor compressors: Also comply with UL 984.

c. Provide the size in terms of kW HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified.

d. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters.

e. Rate motors for operation on 208-volt, 3-phase circuits with a terminal voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits with a terminal voltage rating of 460 volts.

f. Use motors designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating.

g. Unless otherwise indicated, use continuous duty type motors if rated 746 Watts 1 HP and above.

h. Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

i. Use [Inverter-Rated][Inverter-Duty]motors designed to operate with adjustable speed drive (ASD).

2.21.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors: high efficiency types are not acceptable. In exception, for special purpose motors and motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.21.2 Premium Efficiency Polyphase and Single-Phase Motors

Select polyphase and continuous-duty single phase motors based on high efficiency characteristics relative to typical characteristics and applications as listed in NEMA MG 10 and NEMA MG 11. In addition, continuous rated, polyphase squirrel-cage medium induction motors must meet the requirements for premium efficiency electric motors in accordance with NEMA MG 1, including the NEMA full load efficiency ratings. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated. Electronically Commutated Motors (ECM) to have an integrated controller that senses rotor position and electronically commutates the stator windings to provide synchronous rotation. The rotor must be of a permanent magnet type supported by ball bearings to increase motor efficiency and longevity. The motor must maintain 70 percent or greater efficiency for its design application. ECM motors to comply with UL 1004-1.

2.21.3 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

2.21.4 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment[using adjustable speed drive (ASD) manufacturer required wiring type and length][, and motor control equipment forming part of motor control centers or switchgear assemblies, the conduit and wiring connecting such centers, assemblies, or other power sources to equipment] as specified herein. Power wiring and conduit: conform to the requirements specified herein. Control wiring: provided under, and conform to, the requirements of the section specifying the associated equipment.

2.22 MOTOR CONTROLLERS

****

NOTE: Motor and motor controller specifications must be thoroughly coordinated with and cross-referenced in all affected mechanical sections. Indicate NEMA size of controller on mechanical drawings. Provide manual control capability for all installations having automatic control that operates the motor directly. Use a double-throw, three-position switch or other suitable device (marked MANUAL-OFF-AUTOMATIC) for the manual control. Confirm that all safety control devices, such as low-high-pressure cutouts, high-temperature cutouts, and motor overload protective devices, remain connected in the motor control circuit in both the manual and automatic positions. Provide motor controllers (starters) for motors larger than 0.125 horsepower and apply the design criteria of NEMA ICS 1 and NEMA ICS 2.

****

Provide motor controllers in accordance with the following:

a. UL 508, NEMA ICS 1, and NEMA ICS 2[, except fire pump controllers as specified in Section 21 30 00 FIRE PUMPS].

b. Provide controllers with thermal overload protection in each phase, and one spare normally open auxiliary contact, and one spare normally closed auxiliary contact.

c. Provide controllers for motors rated 1-hp 746 watts and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage.

d. Provide protection for motors from immediate restart by a time adjustable restart relay.

e. When used with pressure, float, or similar automatic-type or maintained-contact switch, provide a hand/off/automatic selector switch with the controller.

f. Connections to selector switch: wired such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position.

g. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices: connected in motor control circuit in "hand" and "automatic" positions.

h. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device: made in accordance with indicated or manufacturer's approved wiring diagram.

[i. Provide selector switch with the means for locking in any position.

] j. Provide a disconnecting means, capable of being locked in the open position, for the motor that is located in sight from the motor location and the driven machinery location. As an alternative, provide a motor controller disconnect, capable of being locked in the open position, to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

k. Overload protective devices: provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case.

l. Cover of combination motor controller and manual switch or circuit breaker: interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.

[m. Minimum short circuit withstand rating of combination motor controller: [_____] rms symmetrical amperes.

][n. Provide controllers in hazardous locations with classifications as indicated.

]2.22.1 Control Wiring

Provide control wiring in accordance with the following:

a. All control wire: stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and passing the VW-1 flame tests included in those standards.

b. Hinge wire: Class K stranding.

c. Current transformer secondary leads: not smaller than No. 10 AWG.

d. Control wire minimum size: No. 14 AWG.

e. Power wiring for 480-volt circuits and below: the same type as control wiring with No. 12 AWG minimum size.

f. Provide wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.22.2 Control Circuit Terminal Blocks

Provide control circuit terminal blocks in accordance with the following:

a. NEMA ICS 4.

b. Control circuit terminal blocks for control wiring: molded or fabricated type with barriers, rated not less than 600 volts.

c. Provide terminals with removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts.

d. Terminals: not less than No. 10 in size with sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal.

e. Terminal arrangement: subject to the approval of the Contracting Officer with not less than four spare terminals or 10 percent, whichever is greater, provided on each block or group of blocks.

f. Modular, pull apart, terminal blocks are acceptable provided they are of the channel or rail-mounted type.

g. Submit data showing that any proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.22.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks: furnished for all current transformer secondary leads with provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks: comply with the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity: provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. Provide terminals of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Provide each connected terminal with the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.22.3 Control Circuits

****

NOTE: Choose one of the following options.

****

[Control circuits: maximum voltage of 120 volts derived from control transformer in same enclosure. Transformers: conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits: provide primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side.[Provide fuses in each ungrounded primary feeder]. Provide one fused secondary lead with the other lead grounded.[For designated systems, as indicated, provide backup power supply, including transformers connected to[emergency power source][_____]. Provide for automatic switchover and alarm upon failure of primary control circuit.]

][Control circuits: maximum voltage of 120 volts derived from a separate control source. Provide terminals and terminal boards. Provide separate control disconnect switch within controller. Provide one fused secondary lead with the other lead grounded.[For designated systems, as indicated, provide backup power supply, including connection to[emergency power source][_____]. Provide for automatic switchover and alarm upon failure of primary control circuit.]

]2.22.4 Enclosures for Motor Controllers

****

NOTE: Indicate NEMA type of enclosure on the mechanical drawing to suit the application.

****

NEMA ICS 6.

2.22.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers: include compelling relays and multiple-button, station-type with pilot lights for each speed.

2.22.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations: heavy duty, oil-tight design.

2.22.7 Pilot and Indicating Lights

****

NOTE: Choose one of the following bracketed items. LED cluster lamps have an approximate life of 20,000 hours and will fit incandescent lamp bases. Incandescent lamps have an approximate life of 1,000 hours. LED colors are red, amber, yellow, and green and are not available in clear or white.

****

[Provide LED cluster lamps.][Provide transformer, resistor, or diode type.]

[2.22.8 Reduced-Voltage Controllers

****

NOTE: The designer determines, based on the power system characteristics, motor usage, and voltage drop where reduced-voltage controllers are necessary. See UFC 3-520-01 for additional information on selection and application.

****

Provide for polyphase motors [_____] kilowatt horsepower and larger. Reduced-voltage starters: single-step, closed transition[autotransformer,][reactor,][primary resistor-type,][solid state-type,] or as indicated, with an adjustable time interval between application of reduced and full voltages to motors.[Wye-delta reduced voltage starter or part winding increment starter having adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced-voltage starters for starting of[motor-generator sets,][centrifugally operated equipment,][or][reciprocating compressors provided with automatic unloaders].]

]2.23 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

[Single][Double][Three] pole designed for[flush][surface] mounting with overload protection[and pilot lights].

2.23.1 Pilot Lights

****

NOTE: Choose either the incandescent or LED bracketed sentence.

****

[Provide yoke-mounted, seven element LED cluster light module. Color:[green][red][amber][in accordance with NEMA ICS 2].][Provide yoke-mounted, candelabra-base sockets rated 125 volts and fitted with glass or plastic jewels. Provide clear, 6 watt lamp in each pilot switch. Jewels for use with switches controlling motors: green; jewels for other purposes:[white][red][amber].]

2.24 MOTOR CONTROL CENTERS

****

NOTE: Specify motor control center for groups of large motors requiring coordinated control. In other applications, use individual controllers or motor control panelboards. Generally, motor control centers should be NEMA, Class I, Type B. Coordinate controller specifications with the mechanical equipment requirements.

Class I motor control centers consist of mechanical groupings of combination motor-control units, feeder-tap units, other units and electrical devices arranged in a convenient assembly. Class II motor control centers are the same as Class I except with the addition of manufacturer-furnished electrical interlocking and wiring between units as specifically described by the designer on the construction drawings

****

Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices.

Provide motor control centers in accordance with the following:

a. UL 845, NEMA ICS 2, NEMA ICS 3.

b. Wiring: Class[I][II], Type[A][B][C], in NEMA Type[1][3R][

12][_____] enclosure.

c. Provide control centers suitable for operation on [_____]-volt, [_____]-phase, [_____]-wire, [_____] Hz system with minimum short-circuit withstand and interrupting rating of[100,000][65,000][42,000][25,000][_____] amperes rms symmetrical.

d. Incoming power feeder: [bus duct][cable] entering at the[top][bottom] of enclosure and terminating on[terminal lugs][main protective device].

[e. Main protective device: [molded case circuit breaker][low-voltage power circuit breaker][fusible switch] rated at [_____] amperes rms symmetrical interrupting capacity.

][f. Arrange busing so that control center can be expanded from both ends.

] g. Interconnecting wires: copper.

h. Terminal blocks: plug-in-type so that controllers may be removed without disconnecting individual control wiring.

2.24.1 Bus Systems

Provide the following bus systems. Power bus: be braced to withstand fault current of[100,000][65,000][42,000][25,000][_____] amperes rms symmetrical. Wiring troughs: isolated from horizontal and vertical bus bars.

2.24.1.1 Horizontal and Main Buses

****

NOTE: 1,600-ampere, 2,000-ampere, and 2,500-ampere ratings are also available. However, equipment at those ratings may not be UL listed and have not been included as an option.

****

Horizontal bus: continuous current rating of[600][800][1000][1200][_____] amperes. Main bus: [aluminum, tin-plated][copper, silver-plated] enclosed in isolated compartment at top of each vertical section. Main bus: isolated from wire troughs, starters, and other areas.

2.24.1.2 Vertical Bus

****

NOTE: Select from the bracketed options below. Higher ratings might be available; however, equipment at those ratings may not be UL listed and have not been included as an option.

****

Vertical bus: continuous current rating of[300][450][600][_____] amperes, and [aluminum, tin-plated][copper, tin-plated][copper, silver-plated]. Vertical bus: enclosed in flame-retardant, polyester glass "sandwich."

2.24.1.3 Ground Bus

Copper ground bus: provided full width of motor control center and equipped with necessary lugs.

[2.24.1.4 Neutral Bus

Insulated neutral bus: provided continuous through the motor control center; neutral full rated. Provide lugs of appropriate capacity, as required.

][2.24.2 Combination Motor Controllers

****

NOTE: Select Combination Motor Controllers if required by project documents. Select options below and include short circuit rating requirement.

****

UL 508 and other requirements in paragraph, MOTOR CONTROLLERS. Provide in controller a[molded case circuit breaker][fusible switch with clips for [_____]-type fuses for branch circuit protection].[Minimum short circuit withstand rating of combination motor controller: [_____] rms symmetrical amperes.][Circuit breakers for combination controllers: [thermal magnetic][magnetic only].]

][2.24.3 Space Heaters

****

NOTE: Heaters should be connected to an external power source in installations where the motor control center will not be energized continuously.

****

Provide space heaters where indicated on the drawings, controlled using an adjustable 10 to 35 degrees C 50 to 90 degrees F thermostat, magnetic contactor, and a molded-case circuit breaker[and a 480-120 volt single-phase transformer]. Provide space heaters equipped with 250-watt, 240 volt strip elements operated at 120 volts and[supplied from the motor control center bus][wired to terminal blocks for connection to 120-volt single-phase power sources located external to the control centers]. Contactors: open type, electrically-held, rated 30 amperes, 2-pole, with 120-volt ac coils.

]2.25 LOCKOUT REQUIREMENTS

Provide circuit breakers, disconnecting means, and other devices that are electrical energy-isolating capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147, NFPA 70E and 29 CFR 1910.303. Comply with requirements of Division 23, "Heating, Ventilating, and Air Conditioning (HVAC)" for mechanical isolation of machines and other equipment.

2.26 TELECOMMUNICATIONS SYSTEM

****

NOTE: This paragraph provides information related to telecommunications system requirements for

pathway and electrical service. Complete system cabling and interconnecting hardware are specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM, and Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP). Where Section 27 10 00 is not provided and an empty conduit system is required for telecommunications service, copy and paste the subparagraph BACKBOARDS under the major paragraph COMMUNITY ANTENNA TELEVISION (CATV) SYSTEM as a subparagraph to this paragraph.

****

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires[wireways,][cable trays,] and other accessories for telecommunications outlets and pathway in accordance with TIA-569 and as specified herein.[Additional telecommunications requirements are specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.]

[2.27 COMMUNITY ANTENNA TELEVISION (CATV) SYSTEM

****

NOTE: 1. Use paragraph CATV OUTLETS and CATV FACEPLATES for empty conduit systems only, where cable is not provided in the project.

2. Designer: provide riser diagram of system on drawings and provide empty conduit to exterior location for CATV service entrance.

3. Use Section 27 05 13.43 TELEVISION DISTRIBUTION SYSTEM where complete CATV system is provided. Delete paragraphs CATV OUTLETS and CATV FACEPLATES when Section 27 05 13.43 TELEVISION DISTRIBUTION SYSTEM is used on the project.

****

[Additional CATV requirements are specified in Section 27 05 13.43 TELEVISION DISTRIBUTION SYSTEM.

][2.27.1 CATV Outlets

Provide flush mounted, 75-ohm, F-type connector outlet rated from 5 to 1000 MHz in standard electrical outlet boxes[with isolation barrier] with mounting frame.

][2.27.2 CATV Faceplates

Provide modular faceplates for mounting of CATV Outlets.[Faceplate: include designation labels and label covers for circuit identification.] Faceplate color: match outlet and switch coverplates.

][2.27.3 Backboards

****

NOTE: Choose the first bracketed sentence when providing an empty conduit system or choose the second bracketed sentence when Section 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM is used. When using "as indicated" option, ensure information required is shown on the drawings.

****

[Provide void-free, fire rated interior grade plywood, 19 mm 3/4 inch thick, [1200 by 2400 mm] [4 by 8 feet][as indicated]. Do not cover the fire stamp on the backboard.][Coordinate CATV backboard requirements with telecommunications backboard requirements as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING.]

]]2.28 GROUNDING AND BONDING EQUIPMENT

****

NOTE: Select ground rod type. Most applications will only need copper-clad steel.

In high resistivity soils, 3000 mm 10 foot sectional rods may be used to obtain the required resistance to ground; however, where rock is encountered, additional rods, a ground ring electrode, or ground grid may be necessary. Coordinate and standardize rod selection for individual facilities with other specification sections.

****

2.28.1 Ground Rods

UL 467. Ground rods: cone pointed[copper-clad steel][solid copper][stainless steel], with minimum diameter of 19 mm 3/4 inch and minimum length [of 3050 mm][of 6100 mm] 10 feet. Sectional type rods may be used for rods 20 feet or longer.

[2.28.2 Ground Bus

Copper ground bus: provided in the electrical equipment rooms as indicated.

]2.28.3 Secondary Bonding Busbar

****

NOTE: 1. Minimum width for the Primary bonding busbar (PBB) is 100 mm 4 in and for the Secondary bonding busbar (SBB) is 50 mm 2 in. Telecommunications grounding busbar provides grounding termination for voice, data and video (CATV) systems.

2. Choose the bracketed option for Secondary bonding busbars (SBB) when there are more than one telecommunications room or telecommunications equipment rooms included in the project.

****

Provide corrosion-resistant grounding busbar suitable for[indoor][outdoor] installation in accordance with TIA-607. Busbars: plated for reduced contact resistance. If not plated, clean the busbar prior to fastening the conductors to the busbar and apply an anti-oxidant to the contact area to control corrosion and reduce contact resistance. Provide a Primary bonding busbar (PBB) in the telecommunications entrance facility[

and a Secondary bonding busbar (SBB) in all other telecommunications rooms and equipment rooms]. The Primary bonding busbar (PBB)[and the Secondary bonding busbar (SBB)]: sized in accordance with the immediate application requirements and with consideration of future growth. Provide Secondary bonding busbars with the following:

a. Predrilled copper busbar provided with holes for use with standard sized lugs,

b. Minimum dimensions of 6 mm 0.25 in thick by 100 mm 4 in wide for the PBB[and 50 mm 2 in wide for SBBs] with length as indicated;

c. Listed by a nationally recognized testing laboratory.

[2.29 HAZARDOUS LOCATIONS

****

NOTE: Indicate very clearly the limits of all hazardous locations. Edit the last sentence for actual equipment required in hazardous locations.

****

Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70: specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for particular "Class," "Division," and "Group" of hazardous locations involved. Boundaries and classifications of hazardous locations: as indicated. Equipment in hazardous locations: comply with UL 1203 for electrical equipment and industrial controls and UL 674 for motors.

]2.30 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.31 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings. Provide note on panelboard schedules to indicate where red labels are required.

****

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core.

[e. Provide red laminated plastic label with white center core where indicated.

] f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

g. Minimum size of nameplates: 25 by 65 mm one by 2.5 inches.

h. Lettering size and style: a minimum of 6.35 mm 0.25 inch high normal block style.

2.32 WARNING SIGNS

****

NOTE: For the Navy, use general NFPA 70 Arc Flash Warning Label in accordance with UFC 3-560-01, Section 1-12.1 when no arc flash risk assessment program, including documented periodic maintenance and testing, is in place. A detailed arc flash warning label may only be used when the requirements of UFC 3-560-01, Section 1-12.3 have not been met.

****

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.33 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00 FIRESTOPPING.

2.34 WIREWAYS

UL 870. Material: steel[epoxy painted][galvanized] 16 gauge for heights and depths up to 150 by 150 mm 6 by 6 inches, and 14 gauge for heights and depths up to 305 by 305 mm 12 by 12 inches. Provide in length[indicated][required for the application] with[hinged-][screw-]cover NEMA[1][3R][12] enclosure per NEMA ICS 6.

[2.35 METERING

****

NOTE: Include "metering" information when a single-phase self contained meter base is required. Coordinate with Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMER and Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION. Add appropriate verbiage to identify the exterior equipment (such as metering, supports, and disconnect switches) that would then be covered by this section. When a three-phase service is

designed, modify meter requirements accordingly.

For the Air Force, delete this option and use Section 26 27 13.10 30 ELECTRIC METERS.

For the Navy, delete this option and use Section 26 27 14.00 20 ELECTRICITY METERING.
****

ANSI C12.1. Provide a self-contained, socket-mounted, electronic programmable outdoor watthour meter. Meter: either programmed at the factory or programmed in the field. Turn field programming device over to the Contracting Officer at completion of project. Coordinate meter to system requirements. Coordinate meter, system components, and meter location to be compatible with the Activity's central advanced metering system.

****
NOTE: Form 2S, in text below, is for single-phase, three-wire systems. For other system configurations, determine the appropriate form designation. Class 200 meters are for 100A and 200A services.
****

a. Design: Provide watthour meter designed for use on a single-phase, three-wire,[240/120][480/240] volt system. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS).

b. Class: 200; Form: [2S][_____], accuracy: plus or minus 1.0 percent; Finish: Class II.

c. Cover: Polycarbonate and lockable to prevent tampering and unauthorized removal.

d. Kilowatt-hour Register: five digit electronic programmable type.

e. Demand Register:

    (1) Provide solid state.

    (2) Meter reading multiplier: Indicate multiplier on the meter face.

    (3) Demand interval length: programmed for[15][30][60] minutes with rolling demand up to six subintervals per interval.

f. Socket: ANSI C12.7. Provide NEMA Type 3R, box-mounted socket, ringless, having[manual circuit-closing bypass and having] jaws compatible with requirements of the meter. Provide manufacturers standard enclosure color unless otherwise indicated.

][2.36 METER BASE ONLY

****
NOTE: Use METER BASE ONLY paragraph for projects where meters are not currently required, but may be required in the future, for example, military housing units.
****

ANSI C12.7. Provide NEMA Type 3R, box-mounted socket, ringless, having jaws compatible with requirements of a class: 200 and Form: [2S][_____] self contained watthour meter. Provide gray plastic closing cover and bypass links. Provide manufacturers standard enclosure color unless otherwise indicated.

]2.37 SURGE PROTECTIVE DEVICES

****

NOTE: Surge protection should be provided for the following types of facilities: Medical facilities; Air navigation aids and facilities; Petroleum, oil and lubricant (POL) storage and dispensing facilities; Critical utility plants and systems; Communication facilities and telephone exchanges; Fire stations, including fire alarm, fire control and radio equipment; Critical computer automatic data processing facilities; Air traffic control facilities; Base weather stations; Surveillance and warning facilities; Photovoltaic system Solar Arrays (refer to NFPA 70 and NFPA 780); Command and control facilities; Weapon systems; Security lighting systems; Mission, property and life support facilities at remote and not readily accessible sites.

Consider surge protection for all types of facilities located in regions with a high lightning strike probability (refer to IEEE C62.41.1 and C62.41.2) and facilities located near commercial utility systems with routine substation capacitor switching. The IEEE Emerald book recommended practice is that SPDs be applied to service entrance electrical switchboards and panelboards, and panelboards located on the secondary of separate derived systems that support ITE, telephone, telecommunications, signaling, television, or other form of electronic load equipment.

There are 3 types of surge protective devices (SPDs):

1. Type 1 SPDs are line side permanently installed, hard-wired surge protectors which are permitted to be connected to the supply side of the service disconnect following NFPA 70 requirements, and as specified for Type 2 SPDs.

2. Type 2 SPDs are load side permanently installed, hard-wired surge protectors which are permitted to be connected on the load side of a dedicated circuit breaker of the associated main distribution or branch panelboard, switchboard, or switchgear.

3. Type 3 SPDs are load side point-of-use (plug-in type) surge protectors which are protected specific critical equipment that plugs into receptacles. Type 3 SPD may be an integral component of a receptacle. UFC 3-520-01 does not apply to Type 3 SPDs.

Refer to UFC 3-520-01 for additional criteria.
****

****
NOTE: Whenever possible, connect surge protectors to a spare circuit breaker in the associated panel. Locate the surge protectors immediately adjacent to the protected equipment. Do not allow SPD inside a panelboard or switchboard enclosure due to fire risk causing loss of power to entire panelboard or switchboard. Do not allow fuses integral to SPDs due to lack of repetitive capability to protect from surges.

It is not necessary to provide surge protection on all panelboards; the selection of which panelboards should have surge protective devices depends on the importance of the loads served and the sensitivity of electronic equipment connected to the circuits.

Switching loads such as motor control centers should have surge protection to limit the transmission of switching transients to the rest of the facility.

HVAC equipment usually contain electronic controls that are sensitive to surges.
****

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service entrance[, load centers] [, panelboards] [, MCC] [and] [_____]. Provide surge protectors in a NEMA [1][_____] enclosure per NEMA ICS 6. Do not install SPD inside a panelboard or switchboard enclosure. However, SPD may be installed in a separate compartment of a switchgear provided that it is supplied by a dedicated circuit breaker. SPD must have the same short-circuit current rating as the protected equipment and must not be installed at a point of system where the available fault current is in excess of that rating. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker. Submit performance and characteristic curves.

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Phase to phase (L-L)
Each phase to neutral (L-N)
[Neutral to ground (N-G)]
[Phase to ground (L-G)]

[FOR DELTA CONNECTIONS-
Phase to phase (L-L)
Phase to ground (L-G)

] SPDs at the service entrance: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G)[and downstream SPDs rated 40,000 amperes for L-L mode minimum and 20,000 amperes for other modes (L-N, L-G, and N-G)].

****

NOTE: Select the first bracketed section below when surge protection is installed as part of a lightning protection system per NFPA 780. Select the second bracketed option below if the surge protection is not part of a lightning protection system; the second bracketed option values are based on manufacturers' standard products and are not as restrictive as NFPA 780.

****

[Provide SPDs per NFPA 780 for the lightning protection system.

Maximum L-N, and N-G Voltage Protection Rating:

[700V for 120V, single phase system]
[1,000V for 120/240V, single phase system]
[700V for 120/240V, three phase system]
[700V for 208Y/120V, three phase system]
[1,200V for 480Y/277V, three phase system]

Maximum L-G Protection Rating:
[700V for 120V, single phase system]
[1,000V for 120/240V, single phase system]
[700V for 120/240V, three phase system]
[700V for 208Y/120V, three phase system]
[1,200V for 480Y/277V, three phase system]

Maximum L-L Voltage Protection Rating:

[1,200V for 120/240V, three phase system]
[1,200V for 208Y/120V, three phase system]
[1,800V for 480Y/277V, three phase system]

][Provide SPDs.

Maximum L-N, L-G, and N-G Voltage Protection Rating:

[700V for 120V, single phase system]
[700V for 120/240V, single phase system]
[700V for 208Y/120V, three phase system]
[1,200V for 480Y/277V, three phase system]

Maximum L-L Voltage Protection Rating:

[1,200V for 120V, single phase system]
[1,200V for 120/240V, single phase system]
[1,200V for 208Y/120V, three phase system]
[1,800V for 480Y/277V, three phase system]

] The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120 percent of nominal voltage for 240 volts and below; 115 percent of nominal voltage above 240 volts to 480 volts.

****

NOTE: Provide EMI/RFI filtering when required by project documents.

****

[Provide EMI/RFI filtering per UL 1283 for each mode with the capability to attenuate high frequency noise. Minimum attenuation: 20db.

]2.38 FACTORY APPLIED FINISH

****

NOTE: This paragraph covers only the basic painting requirements for most electrical equipment. Include any special finishes for high or low temperatures and corrosive atmospheres.

****

Provide factory-applied finish on electrical equipment in accordance with the following:

a. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.

b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.

c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.

d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.

e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.

f. Equipment located indoors: ANSI Light Gray[, and equipment located outdoors: ANSI[Light Gray][Dark Gray]].

g. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.39 SOURCE QUALITY CONTROL

2.39.1 Transformer Factory Tests

Submittal: include routine NEMA ST 20 transformer test results on each transformer and also provide the results of NEMA "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

[2.40 COORDINATED POWER SYSTEM PROTECTION

****

NOTE: Do not use on Navy projects.

NOTE: The requirement for studies in this paragraph depends on the complexity and extent of the power system. Delete this requirement for projects of limited scope, projects having protective devices which are not adjustable or for which coordination is not possible (standard molded case circuit breakers); projects involving simple extension of 600 volt level service to a building or facility

from an existing transformer (750 kVA or less); or projects involving simple extension of 600 volt level service to a building or facility from a new transformer (750 kVA or less).

****

Prepare analyses as specified in Section 26 05 73 POWER SYSTEM STUDIES.

]PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of NFPA 70[and IEEE C2] and to requirements specified herein.

[3.1.1 Underground Service

****

NOTE: Choose this paragraph or the paragraph, OVERHEAD SERVICE. When using this paragraph, designer may insert additional details describing the specific project.

****

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

][3.1.2 Overhead Service

****

NOTE: Use Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION for overhead service requirements (typical throughout this section).

****

Overhead service conductors into buildings: terminate at service entrance fittings or weatherhead outside building. Overhead service conductors and support bracket for overhead conductors are included in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.

][3.1.3 Hazardous Locations

Perform work in hazardous locations, as defined by NFPA 70, in strict accordance with NFPA 70 for particular "Class," "Division," and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Provide conduit with tapered threads.

]3.1.4 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.1.4.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 6.35 mm 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

3.1.5 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways.[Shared neutral, or multi-wire branch circuits, are not permitted with arc-fault circuit interrupters.] Minimum conduit size: 16 mm 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 150 mm 6 inches. Firestop conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors in accordance with Section 07 84 00 FIRESTOPPING.

3.1.5.1 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 890-N 200-pound force tensile strength. Leave minimum 915 mm 36 inches of slack at each end of pull wire.

[3.1.5.2 Metal-Clad Cable

****

NOTE: Type MC cable is UL listed; NFPA 70 is recognized for most common building applications. MC cable does not protect conductors as well as rigid conduit but is more flexible to install and relocate. Refer to PART 2 PRODUCTS paragraph METAL-CLAD CABLE for UFC 3-520-01 requirements.

****

Install in accordance with NFPA 70, Type MC cable.

][3.1.5.3 Armored Cable

****

NOTE: Type AC cable has more restricted applications than MC cable but offers the same advantages. Review NFPA 70 and refer to PART 2 PRODUCTS paragraph ARMORED CABLE for UFC 3-520-01 requirements.

****

Install in accordance with NFPA 70, Type AC cable.

][3.1.5.4 Flat Conductor Cable

****

NOTE: Type FCC cable has been listed by UL and recognized by NFPA 70 for under carpet tile

applications. FCC cable is available off the shelf for power, and telecommunications transmission applications.

****

Install in accordance with NFPA 70, Type FCC cable.

]3.1.6 Conduit Installation

****

NOTE: Where exposed conduit is installed and subject to vandalism or misuse, such as in toilet or locker rooms, do not allow perpendicular or right angle to ceiling structural members. Provide details on drawings to identify special treatments or offsets as needed.

****

****

NOTE: Do not install exposed conduit systems in inmate housing areas and other areas normally accessible to inmates unless such installations are specifically indicated. Where exposed conduit is indicated, provide rigid metallic type conduit and cast metal-type outlet boxes with threaded hubs. Install conduits flat against wall; offsets or "kicks" are permitted only to enter outlet box. Support conduits on 1525 mm 5 foot maximum centers and within 305 mm 12 inches of each outlet box using two-hole conduit straps attached to surface with nonremovable break off security type bolts.

****

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 150 mm 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.[Run conduits[in crawl space][under floor slab] as if exposed.]

3.1.6.1 Restrictions Applicable to Aluminum Conduit

a. Do not install underground or encase in concrete or masonry.

b. Do not use brass or bronze fittings.

c. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.6.2 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use outdoors.

f. Do not use in fire pump rooms.

g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

[3.1.6.3 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40.

  (1) Do not use where subject to physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, fire pump rooms, and where restrictions are applying to both PVC Schedule 40 and PVC Schedule 80.

  (2) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

b. PVC Schedule 80.

  (1) Do not use where subject to physical damage, including but not limited to, hospitals, power plant, missile magazines, and other such areas.

  (2) Do not use in hazardous (classified) areas.

  (3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

-

]3.1.6.4 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.6.5 Underground Conduit

****

NOTE: Soil conditions in some locations require that underground conduit be supported to prevent damage due to settlement. The designer determines if the problem exists, and, if so, determines the best method for supporting the conduit.

****

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40[; or fiberglass. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before rising through floor slab.] Plastic coating: extend minimum 150 mm 6 inches above floor.

[3.1.6.6 Conduit Interior to Buildings for 400 Hz Circuits

Aluminum or nonmetallic. Where 400-Hz circuit runs underground or through concrete, provide PVC Schedule[40][80] conduit.

]3.1.6.7 Conduit for Circuits Rated Greater Than 600 Volts

Rigid metal conduit or IMC only.

3.1.6.8 Conduit Installed Under Floor Slabs

****

NOTE: Designer must closely coordinate with the design of building floor slab and soil conditions and evaluate the acceptability of conduit being installed directly beneath the floor slab. Consider whether it will be necessary to support conduit in case of soil settlement problems and vapor barrier penetrations. Provide details on the drawings to clarify specification.

****

Conduit run under floor slab: located a minimum of [305][_____] mm [12][_____] inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier. Use NECA NEIS 1 Table 2a (Minimum Raceway Spacing) to determine under floor slab conduit spacing unless greater spacing is required elsewhere in this section.

3.1.6.9 Conduit Through Floor Slabs

Where conduits rise through floor slabs, do not allow curved portion of bends to be visible above finished slab. Where conduit rises through slab-on grade, seal all electrical penetrations to address radon mitigation and prevent infiltration of air, insects, and vermin.

[3.1.6.10 Conduit Installed in Concrete Floor Slabs or Concrete Walls

****

NOTE: When this option is included, (such as in BEQ's and similar projects with precast planks and topping slabs), indicate specific locations and provide installation details on the electrical drawings. Electrical designer must closely coordinate this information with the designer of the slab to ensure that slab thickness, conduit placement/separation, and reinforcement spacing is sufficient to meet requirements of this paragraph. Do not specify metal conduit in concrete that contains coral aggregate or is made with salt or brackish water. This type of concrete is rarely allowed.

For Navy projects, use second bracketed option, limiting conduit type to PVC EPC-40, unless required otherwise for medical facilities.

****

[Rigid steel; steel IMC; fiberglass, or PVC, Type EPC-40.][PVC, Type EPC-40, unless indicated otherwise.]Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab.[Do not stack conduits.][Do not stack conduits more than two diameters high with minimum vertical separation of [_____] mm inches.] Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum 25 mm one inch cover over conduit. Where embedded conduits cross building expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings must allow horizontal and vertical movement of raceway. Conduit larger than 27 mm one inch trade size: installed parallel with or at right angles to main reinforcement; when at right angles to reinforcement, install conduit close to one of supports of slab.[Where nonmetallic conduit is used, convert raceway to plastic coated rigid steel or plastic coated steel IMC before rising above floor, unless specifically indicated.]

]3.1.6.11 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 150 mm 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.6.12 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Plastic cable ties are not acceptable. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than 40 mm 1 1/2 inches in reinforced concrete beams or to depth of more than 20 mm 3/4 inch in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Identify independent conduit support in both fire and non-fire rated assemblies per NFPA 70. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations.[Support exposed risers in wire shafts of multistory buildings by U-clamp hangers at each floor level and at 3050 mm 10 foot maximum intervals.] Where conduit crosses building expansion joints, provide suitable[watertight] expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 63 mm 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.6.13 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.6.14 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.6.15 Flexible Connections

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NOTE: For Navy projects, do not use flexible nonmetallic conduit.

****

Provide flexible steel conduit between 915 and 1830 mm 3 and 6 feet in length for recessed and semirecessed lighting fixtures[; for equipment subject to vibration, noise transmission, or movement; and for motors]. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 16 mm 1/2 inch diameter. Provide liquid tight flexible[nonmetallic] conduit in wet and damp locations[and in fire pump rooms] for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections. Plastic cable ties are not acceptable as a support method.

3.1.6.16 Telecommunications and Signal System Pathway

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NOTE: For guidelines on conduit sizing, see UFC 3-580-01, "Telecommunications Building Cabling System Planning, Design" and NFPA 70.

****

Install telecommunications pathway in accordance with TIA-569.

a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room: installed and cabling length requirements in accordance with TIA-568.1. Size conduits[, wireways][, and cable trays] in accordance with TIA-569[and][as indicated].

b. Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and, telecommunications equipment rooms (backbone cabling): installed in accordance with TIA-569. Size conduits[, wireways][, and cable trays] for telecommunications risers in accordance with TIA-569[and][as indicated].

[3.1.6.17 Community Antenna Television (CATV) System Conduits

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NOTE: Choose the bracketed item depending on the CATV system design. Delete this paragraph if an empty conduit CATV system is not used.

****

Install a system of CATV wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires[wireways,][cable trays,] and other accessories for CATV outlets and pathway in accordance with TIA-569.[Provide distribution system with star topology with empty conduit and pullwire from each outlet box to the telecommunications room and empty conduit and pullwire from each telecommunications room to the headend equipment location][Provide distribution system with star topology with empty conduit and pullwire from each outlet to the headend equipment location].

]3.1.7 Busway Installation

Comply at minimum with NFPA 70. Install busways parallel with or at right angles to ceilings, walls, and structural members. Support busways at 1525 mm 5 foot maximum intervals, and brace to prevent lateral movement. Provide fixed type hinges on risers; spring-type are unacceptable. Provide flanges where busway makes penetrations through walls and floors, and seal to maintain smoke and fire ratings. Provide waterproof curb where busway riser passes through floor. Seal gaps with fire-rated foam and caulk. Provide expansion joints, but only where bus duct crosses building expansion joints. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.8 Cable Tray Installation

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NOTE: For Navy projects, use the second bracketed paragraph. Include bracketed second sentence where cable tray is used for telecommunications system.

****

[Install and ground in accordance with NFPA 70.[In addition, install and ground telecommunications cable tray in accordance with TIA-569, and TIA-607]. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Cable tray and tray supports must not partially nor completely obstruct access to the room. Support[in accordance with NEMA VE 2 and with manufacturer recommendations but at not more than [1830][_____] mm [6][_____] foot intervals][as indicated].[Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly.] Adjacent cable tray sections: bonded together by connector plates of an identical type as the cable tray sections. For grounding of cable tray system provide No. 2 AWG bare copper wire throughout cable tray system, and bond to each section, except use No. 1/0 aluminum wire if cable tray is aluminum. Terminate cable trays 255 mm 10 inches from both sides of smoke and fire partitions. Install conductors run through smoke and fire partitions in 103 mm 4 inch rigid steel conduits with grounding bushings, extending 305 mm 12 inches beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Firestop penetrations in accordance with Section 07 84 00, FIRESTOPPING. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

][[In addition, install and ground telecommunications cable tray in accordance with TIA-569, and TIA-607.]Ensure edges, fittings, and hardware are finished free from burrs and sharp edges. Use No. 1/0 aluminum wire if cable tray is aluminum.

][3.1.9 Telecommunications Cable Support Installation

****

NOTE: Utilize open telecommunications cable supports (J-Hooks / J-Supports / D-rings) only as specifically permitted in UFC 3-580-01, Telecommunications, Building Cabling System.

****

Install open top and closed ring cable supports on 1.2 m to 1.5 m 4 ft to 5 ft centers to adequately support and distribute the cable's weight. Use these types of supports to support a maximum of 50 6.4 mm 0.25 in diameter cables. Install suspended cables with at least 75 mm 3 in of clear vertical space above the ceiling tiles and support channels (T-bars). Open top and closed ring cable supports: suspended from or attached to the structural ceiling or walls with hardware or other installation aids specifically designed to support their weight.[Do not use open top or closed ring cable supports outside of telecommunications rooms.]

]3.1.10 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces,[when surface mounted on interior walls exposed up to 2135 mm 7 feet above floors and walkways,][or when installed in hazardous areas] and when specifically indicated. Boxes in other locations: sheet steel, except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic[sheathed cable] conduit system. Provide each box with volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 100 mm 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; provide readily removable fixtures for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel.[Threaded studs driven in by powder charge and provided with lock washers and nuts[or nail-type nylon anchors] may be used in lieu of wood screws, expansion shields, or machine screws.] In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 610 mm 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.10.1 Boxes

Boxes for use with raceway systems: minimum 40 mm 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 100 mm 4 inches square, except that 100 by 50 mm 4 by 2 inch boxes may be used where only one raceway enters outlet.

3.1.10.1.1 Wall-Mounted Telecommunications Outlet Box

[Provide double gang electrical boxes, minimum standard size 100 mm 4-11/16 inches square and 54 mm 2-1/8 inches deep with plaster ring for connection of single gang faceplate.][Provide double gang electrical boxes, 130 mm 5 inches square and 73 mm 2 7/8 inches deep with plaster ring for connection of single gang faceplate.]Design outlet box for recess mounting with the faceplate flush with the wall surface, at the same height as the electrical outlets.

3.1.10.2 Pull Boxes

Construct of at least minimum size required by NFPA 70[of code-gauge aluminum or galvanized sheet steel,][and][compatible with nonmetallic raceway systems,] except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

[3.1.10.3 Extension Rings

Extension rings are not permitted for new construction. Use only on existing boxes in concealed conduit systems where wall is furred out for new finish.

]3.1.11 Mounting Heights

****

NOTE: In Hazardous Areas extending up to 455 mm 18 inches above the finished floor, the mounting height of receptacles that are not explosion-proof, must be measured to the bottom of the outlet box in lieu of to the center. Coordinate the mounting height with the height indicated on the drawings and use the last bracketed sentence.

****

Mount panelboards,[enclosed] circuit breakers,[motor controller] and disconnecting switches so height of center of grip of the operating handle of the switch or circuit breaker at its highest position is maximum 2007 mm 79 inches above floor or working platform or as allowed in Section 404.8 per NFPA 70. Mount lighting switches[and handicapped telecommunications stations][1220 mm 48 inches above finished floor]. Mount receptacles[and telecommunications outlets] 460 mm 18 inches above finished floor[, unless otherwise indicated].[Wall-mounted telecommunications outlets: mounted at height[1525 mm 60 inches above finished floor][indicated].] [Mount other devices as indicated.][Measure mounting heights of wiring devices and outlets[in non-hazardous areas]to center of device or outlet.][Measure mounting heights of receptacle outlet boxes in the[hazardous area][_____] to the bottom of the outlet box.]

[3.1.12 Nonmetallic Sheathed Cable Installation

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NOTE: Use this paragraph only when Type NM or NMC cable is indicated.
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Where possible, install cables concealed behind ceiling or wall finish. Thread cables through holes bored on approximate centerline of wood members; notching of end surfaces is not permitted. Provide sleeves through concrete or masonry for threading cables. Install exposed cables parallel to or at right angles to walls or structural members. Protect exposed nonmetallic sheathed cables less than 1220 mm 4 feet above floors from mechanical injury by installation in conduit or tubing. When cable is used in metal stud construction, insert plastic stud grommets in studs at each point through which cable passes, prior to installation of cable.

][3.1.13 Mineral Insulated, Metal Sheathed (Type MI) Cable Installation

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NOTE: Type MI cable used for low temperature, high temperature, hazardous locations, life safety, and heating applications. Refer to NFPA 70. Clearly show on drawings the MI cable. Consider surge suppressors in hazardous locations and where high voltage surges are likely. MI cable is not available in ratings above 600 volts.
****

Mineral-insulated, metal-sheathed cable system, Type MI, may be used in lieu of exposed conduit and wiring. Conductor sizes: not less than those indicated for the conduit installation. Fasten cables within 305 mm 12 inches of each turn or offset and at 830 mm 33 inches maximum intervals. Make cable terminations in accordance with NFPA 70 and cable manufacturer's recommendations. Terminate single-conductor cables of a circuit, having capacities of more than 50 amperes, in a single box or cabinet opening. Color code individual conductors in all outlets and cabinets.

]3.1.14 Conductor Identification

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NOTE: Reference the section providing details of identifying control circuit wiring. Use Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS for Navy projects only.
****

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with[Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.][Section [_____], [_____]][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][manufacturer's recommendations].[Provide telecommunications system conductor identification as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS.]

3.1.14.1 Marking Strips

Provide marking strips for identification of power distribution, control, data, and communications cables in accordance with the following:

a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.

b. Use permanent ink for the wire numbers

c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.

d. Size marking strips to accommodate the two sets of wire numbers.

e. Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.

f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations.

g. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.15 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.15.1 Splices of Aluminum Conductors

Make with solderless circumferential compression-type, aluminum-bodied connectors UL listed for AL/CU. Remove surface oxides from aluminum conductors by wire brushing and immediately apply oxide-inhibiting joint compound and insert in connector. After joint is made, wipe away excess joint compound, and insulate splice.

[3.1.16 Terminating Aluminum Conductors

3.1.16.1 Termination to Copper Bus

Terminate aluminum conductors to copper bus either by: (a) inline splicing a copper pigtail, of ampacity at least that of aluminum conductor, or (b) utilizing circumferential, compression-type, aluminum-bodied terminal lug UL listed for AL/CU, and steel Belleville cadmium-plated hardened steel spring washers, flat washers, bolts, and nuts. Carefully install Belleville spring washers with crown up toward nut or bolt head, with concave side of Belleville bearing on heavy-duty, wide series flat washer of larger diameter than Belleville. Tighten nuts sufficiently to flatten Belleville, and leave in position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.

3.1.16.2 Termination to Aluminum Bus

Terminate aluminum conductors to aluminum bus by using aluminum nuts, bolts, washers, and compression lugs. Wire brush and apply joint compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection. When bus contact surface is unplated, scratch-brush and coat with joint compound, without grit.

]3.1.17 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 0.58 mm 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.18 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.19 Grounding and Bonding

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NOTE: Use reference to NFPA 780 and last bracketed sentence where lightning protection is provided. In addition, size and indicate the grounding electrode conductor in accordance with NFPA 780. Coordinate requirements with Section 26 41 00 LIGHTNING PROTECTION SYSTEM.

****

Provide in accordance with NFPA 70[and NFPA 780]. Ground exposed, non-current-carrying metallic parts of electrical equipment,[access flooring support system,] metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, [grounding conductor of nonmetallic sheathed cables,]and neutral conductor of wiring systems.[Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70.][Make ground connection to driven ground rods on exterior of building. Bond additional driven rods together with a minimum of 4 AWG soft bare copper wire buried to a depth of at least 300 mm 12 inches.][Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Make interconnection to the gas line on the customer's side of the meter. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system.] In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA-607. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.19.1 Ground Rods

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NOTE: Do not use chemically charged ground rods without authorization of the local Activity.

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Provide ground rods and measure the resistance to ground using the fall-of-potential method described in IEEE 81. Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod, [_____] additional rods, spaced on center. Spacing for additional rods must be a minimum of 3 meters 10 feet[, or if sectional type rods are used, [_____] additional sections may be coupled and driven with the first rod].[In high-ground-resistance, UL listed chemically charged ground rods may be used.] If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.19.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible,[excepting specifically those connections for which access for periodic testing is required,] by exothermic weld or high compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make high compression connections using a hydraulic or electric compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.19.3 Ground Bus

Provide a copper ground bus in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of[transformer neutrals and other electrical][electrical] equipment: effectively grounded by bonding to the ground bus. Bond the ground bus to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 100 mm 4 inches above the floor. Make connections and splices of the brazed, welded, bolted, or pressure-connector type, except use pressure connectors or bolted connections for connections to removable equipment.[For raised floor equipment rooms in computer and data processing centers, provide a minimum of four, one at each corner, ground buses connected to the building grounding system. Use bolted connections in lieu of thermoweld, so they can be changed as required by additions and alterations.]

3.1.19.4 Resistance

****

NOTE: If difficulties are encountered in obtaining

the proper resistance, the Contracting Officer will make a decision on the number of ground rods to be used, based on local conditions and on the type and size of electrical installation in the project. Insulated grounding conductors will be required where electrolytic corrosion may be encountered. In most applications, it is desirable to have a maximum resistance of much less, typically 5 ohms or less. NFPA 70, approves the use of a single made electrode for the system-grounding electrode, if its resistance does not exceed 25 ohms.
****

Maximum resistance-to-ground of grounding system: do not exceed [5][_____] ohms under dry conditions. Where resistance obtained exceeds [5][_____] ohms, contact Contracting Officer for further instructions.

3.1.19.5 Telecommunications System

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NOTE: 1. Include this paragraph when telecommunications service is provided in job and specified in this section and other sections.

2. Choose the bracketed option for Secondary bonding busbars (SBB) when there are more than one telecommunications room or telecommunications equipment rooms included in the project.

3. Choose Telecommunications Bonding Conductors bracketed option when more than one telecommunications grounding busbar is installed as part of the project.
****

Provide telecommunications grounding in accordance with the following:

a. Telecommunications Grounding Busbars: Provide a Primary bonding busbar (PBB) in the telecommunications entrance facility. Install the PBB as close to the electrical service entrance grounding connection as practicable.[Provide a Secondary bonding busbar (SBB) in all other telecommunications rooms and telecommunications equipment rooms. Install the SBB as close to the telecommunications room panelboard as practicable, when equipped. Where a panelboard for telecommunications equipment is not installed in the telecommunications room, locate the SBB near the backbone cabling and associated terminations. In addition, locate the SBB to provide for the shortest and straightest routing of the grounding conductors. Where a panelboard for telecommunications equipment is located within the same room or space as a SBB, bond that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure to the SBB.] Install Secondary bonding busbars to maintain clearances as required by NFPA 70 and insulated from its support. A minimum of 50 mm 2 inches separation from the wall is recommended to allow access to the rear of the busbar and adjust the mounting height to accommodate overhead or underfloor cable routing.

b. Telecommunications Bonding Conductors: Provide main telecommunications service equipment ground consisting of separate bonding conductor for telecommunications, between the PBB and readily accessible grounding connection of the electrical service. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds one m 3 feet in length, bond the conductors to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.[Provide a telecommunications bonding backbone (TBB) that originates at the PBB extends throughout the building using the telecommunications backbone pathways, and connects to the SBBs in all telecommunications rooms and equipment rooms. Install the TBB conductors such that they are protected from physical and mechanical damage. The TBB conductors should be installed without splices and routed in the shortest possible straight-line path. Make the bonding conductor between a TBB and a SBB continuous. Where splices are necessary, the number of splices should be a minimum. Make the splices accessible and located in telecommunications spaces. Connect joined segments of a TBB using exothermic welding, irreversible compression-type connectors, or equivalent. Install all joints to be adequately supported and protected from damage. Whenever two or more TBBs are used within a multistory building, bond the TBBs together with a grounding equalizer (GE) at the top floor and at a minimum of every third floor in between. Do not connect the TBB and GE to the pathway ground, except at the PBB or the SBB.]

c. Telecommunications Grounding Connections: Telecommunications grounding connections to the PBB[or SBB]: utilize listed compression two-hole lugs, exothermic welding, suitable and equivalent one hole non-twisting lugs, or other irreversible compression type connections. Bond all metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the PBB[or SBB] to the PBB[or SBB respectively]. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; bond each PBB[and SBB] to the vertical steel metal frame using a minimum No. 6 AWG conductor. Where the metal frame is external to the room and readily accessible, bond the metal frame to the SBB or PBB with a minimum No. 6 AWG conductor. When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the SBB may be bonded to these horizontal members in lieu of the vertical column members. All connectors used for bonding to the metal frame of a building must be listed for the intended purpose.

3.1.20 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

3.1.21 Elevator

****

NOTE: To achieve a complete specification, ensure that the controls for HVAC, fire alarm system, elevators, cranes, and special systems are definitely and properly covered by the other sections of the project specification. Should

controls appear in this section of the project specification, modify this paragraph accordingly. Indicate on the drawings required equipment connections. Coordinate elevator paragraph with Section 14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS or Section 14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS and Section 14 24 13 HYDRAULIC FREIGHT ELEVATORS or 14 24 23 HYDRAULIC PASSENGER ELEVATORS for all projects. Where more than one driving machine disconnecting means is supplied by a single feeder, the overcurrent protective devices in each disconnecting means must be selectively coordinated with any other supply side overcurrent protective devices. Coordinate ELEVATOR paragraph and requirements with UFC 3-490-06.

****

Provide circuit to line terminals of elevator controller, and disconnect switch on line side of controller, outlet for control power, outlet receptacle and work light at midheight of elevator shaft, and work light and outlet receptacle in elevator pit.

[3.1.22 Government-Furnished Equipment

Contractor[rough-in for Government-furnished equipment][make connections to Government-furnished equipment] to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

]3.1.23 Repair of Existing Work

Perform repair of existing work[, demolition, and modification of existing electrical distribution systems] as follows:

3.1.23.1 Workmanship

Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

3.1.23.2 Existing Concealed Wiring to be Removed

Disconnect existing concealed wiring to be removed from its source. Remove conductors; cut conduit flush with floor, underside of floor, and through walls; and seal openings.

[3.1.23.3 Removal of Existing Electrical Distribution System

Removal of existing electrical distribution system equipment includes equipment's associated wiring, including conductors, cables, exposed conduit, surface metal raceways, boxes, and fittings,[back to equipment's power source] as indicated.

][3.1.23.4 Continuation of Service

Maintain continuity of existing circuits of equipment to remain. Maintain existing circuits of equipment energized. Restore circuits wiring and power which are to remain but were disturbed during demolition back to original condition.

][3.1.24 Watthour Meters

ANSI C12.1.

]3.1.25 Surge Protective Devices

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NOTE: Do no allow surge protective devices inside a panelboard or switchboard enclosure due to fire risk causing loss of power to entire panelboard or switchboard.

****

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is 900 mm 3 feet avoiding 90 degree bends. Do not locate surge protective devices inside a panelboard or switchboard enclosure.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets. Provide nameplate on all equipment in access controlled spaces and areas.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

****

NOTE: Use and coordinate paint and coating requirements with Section 09 90 00 PAINTS AND COATINGS when provided in the job. Use the second bracketed option when Section 09 90 00 is not provided or when requirements are beyond what is specified in Section 09 90 00.

****

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. [Painting: as specified in Section 09 90 00 PAINTS AND COATINGS.][Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.]

3.5 FIELD QUALITY CONTROL

****

NOTE: Provide any additional test requirements for equipment requiring running tests or tests that must

be coordinated with mechanical equipment.

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Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer [5][_____] working days notice prior to[each][_____] test[s]. Where applicable, test electrical equipment in accordance with NETA ATS.

3.5.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of 1,000 volts DC for 600 volt rated wiring and 500 volts DC for 300 volt rated wiring per NETA ATS to provide direct reading of resistance. All existing wiring to be reused must also be tested.

3.5.3 Transformer Tests

Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NETA ATS. Measure primary and secondary voltages for proper tap settings. Tests need not be performed by a recognized independent testing firm or independent electrical consulting firm.

3.5.4 Ground-Fault Receptacle Test

****

NOTE: If Ground-Fault Receptacle "line" and "load" leads are reversed, "test" will trip downstream loads but not trip the receptacle.

****

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 943.

3.5.5 Arc-Fault Receptacle Test

****

NOTE: If Arc-Fault Receptacle "line" and "load" leads are reversed, "test" will trip downstream loads but not trip the receptacle.

****

Test arc-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 1699.

3.5.6 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

[3.5.7 Watthour Meter

a. Visual and mechanical inspection

  (1) Examine for broken parts, shipping damage, and tightness of connections.

  (2) Verify that meter type, scales, and connections are in accordance with approved shop drawings.

b. Electrical tests

  (1) Determine accuracy of meter.

  (2) Calibrate watthour meters to one-half percent.

  (3) Verify that correct multiplier has been placed on face of meter, where applicable.

]3.5.8 Phase Rotation Test

Perform phase rotation test to ensure proper rotation of service power prior to operation of new or reinstalled equipment using a phase rotation meter. Follow the meter manual directions performing the test.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 22 00.00 10 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-26 22 00.00 10 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 22 00.00 10

480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS

11/23

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 22 00.00 10 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-26 22 00.00 10 (October 2007)

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****

SECTION 26 22 00.00 10

480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS

11/23

****

NOTE: This guide specification covers the requirements for 480-volt station service switchgear and transformers normally used for hydroelectric power plant facilities, navigation locks and pumping plants. This section was originally developed for USACE Civil Works projects.

Adher to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: If this guide specification is used for procurement of items to be installed by the Government or to be furnished to the Contractor as Government furnished equipment, or is used to obtain services which are not part of a construction contract, the following guidance applies:

a. Applicable parts of this guide specification should be adapted to the procurement and included in Section C of the Uniform Contract Format contracts for products or the scope of work portion of

contracts for services.

b. The following provides information and requirements to be included in a contract for procurement of the specified supplies or services.

PART I -- THE SCHEDULE

Section B Supplies or Services and Prices

Select the appropriate schedule applicable to the procurement.

ITEM NO.	SUPPLIES/SERVICES	UNIT QUANTITY	UNIT	PRICE	AMOUNT
SCHEDULE (ALTERNATE 1)					
0001	480-Volt AC Indoor Metal-Enclosed Power Circuit Breaker Switchgear Assembly	[_____]	Each	[_____]	[_____]
0002	Switchgear Accessories and Spare Parts	[_____]	Lot	[_____]	[_____]
0003	600-Volt, AC, [_____]-Amps 3-Phase, Metal-Enclosed Bus	[_____]	Lot	[_____]	[_____]
0004	[[_____]-480] [13,800-480]-Volt. [_____]-kVA, 3-Phase, Indoor, Ventilated, Dry Type (Class AA), Transformer	[_____]	Each	[_____]	[_____]
0005	Bid Data (See DD Form 1423, Exhibit A)	[_____]	[_____]	Not separately priced	[_____]
0006	Contract Data (See DD Form 1423, Exhibit B)	[_____]	[_____]	Not separately priced	[_____]
				TOTAL	[_____]

ITEM NO.	**SUPPLIES/SERVICES**	**UNIT QUANTITY**	**UNIT**	**PRICE**	**AMOUNT**
SCHEDULE (ALTERNATE 2)					
0001	**[[_____]-480] [13,800-480] Volt, [_____]-kVA, 3-Phase, Indoor, Metal-Enclosed Secondary Unit Substation**	**[_____]**	**Each**	**[_____]**	**[_____]**
0002	**Substation Accessories and Spare Parts**	**[_____]**	**Lot**	**[_____]**	**[_____]**
0005	**Bid Data (See DD Form 1423, Exhibit A)**	**[_____]**	**[_____]**	**Not separately priced**	**[_____]**
0006	**Contract Data (See DD Form 1423, Exhibit B)**	**[_____]**	**[_____]**	**Not separately priced**	**[_____]**
				TOTAL	**[_____]**

SCHEDULE (ALTERNATE 2)

NOTE: Bid items above should be copied on Standard Form 36, continuation sheet, when submitting specifications for approval.

Section C Description/Specifications

All materials, components, and equipment not manufactured by the Contractor must be products of manufacturers other than those specified herein will be accepted when it is proved to the satisfaction of the Contracting Officer that such products are adequate and suitable for the intended use. Upon request, furnish to the Contracting Officer for approval the names of all such other manufacturers, together with complete pertinent information regarding all such products which he proposes to incorporate into the work. Submit samples of materials and equipment for approval when so directed. Insofar as practicable, devices and equipment used for the same or similar services must be of the same make and type, and inter-changeable when of the same rating.

Section D Inspection and Acceptance

Include the following:

Test of Materials.

Test all materials, supplies, and parts and assemblies thereof entering into the work to be done under these specifications in accordance with the

requirements of the referenced standard specifications specified herein, except as otherwise indicated or where such tests are waived in writing by the Contracting Officer. In case the Contractor desires to use stock material not manufactured specifically for the work covered by these specifications, submit evidence satisfactory to the Contracting Officer that such material conforms to the requirements of these specifications, in which case detailed tests on these materials may be waived.

Unless waived in writing, make all tests or trials in the presence of a Quality Assurance Representative (QAR) and furnish copies of all test reports by the Contractor as soon as practicable after the tests are made and submitt in such form as to provide means of determining compliance with the applicable specifications for the material tested. Where the presence of a QAR is waived, furnish certified copies of the test reports to the Contracting Officer.

Plainly mark test specimens and samples for analysis to indicate the materials they represent and, if required, properly box and prepare them for shipment.

Except as provided elsewhere, all costs of all test and trials, excepting the pay and expense of the QAR, are borne by the Contractor and no separate payment will be made therefor.

Section E Special Contract Requirements

Include the following:

Contractor's Drawings and Data.

1. Within [_____] calendar days after [date of award] [date of receipt of notice of award], submit for approval outline drawings of all equipment to be furnished under this contract, together with weights and overall dimensions to enable the Contracting Officer to proceed with the final design of the [powerhouse] [pumping plant] [navigation lock]. These drawings must show space requirements, details of any floor supports to be embedded in concrete, location of terminal blocks, and top and bottom conduit entrance areas.

2. Within [_____] calendar days after [date of award] [date of receipt of notice of award], submit for approval such assembly and detailed drawings and data as required to demonstrate fully that all parts of the equipment will conform to the requirements and intent of the specifications. Include applicable schematic diagrams with wire designations, equipment lists, accessories and spare parts lists, nameplate schedules, all necessary descriptive data, and wiring diagrams showing panel

connections, panel interconnections, terminal block and conductor designations, and external cables.

3. All drawings and data submitted and approved will form a part of the contract. The sequence of submission of drawings must be such that all information is available for checking each drawing when it is received.

4. Furnish [_____] reproducible, of a quality that will make legible prints,] [and] black and white copies or blueprints of each drawing for approval. Each submission of drawings by the Contractor must be accompanied by a letter of transmittal containing a list of drawings giving titles and numbers. Address transmittals to [_____]. Decisions on these drawings, either approval or disapproval, will be given by the Contracting Officer by letter or telegram. Within [15] [_____] calendar days after receipt, the Contracting Officer will return one copy to the Contractor marked "Approved", "Approved Except as Noted", or "Returned for Correction". The notations "Approved" and "Approved Except as Noted" authorize the Contractor to proceed with the fabrication of the equipment covered by such drawings, subject to the correction, if any, indicated thereon or described in the letter of transmittal. When prints of drawings have been "Returned for Correction", make the necessary revisions on the drawings and submit [reproducibles] [and] [_____] prints for approval in the same routine as before. Show every revision made during the life of the contract by number, date, and subject in a revision block and make a notation in the drawing margin to permit rapid location of the revision. Include the time consumed by the Contractor in submitting and obtaining approval of assembly and shop drawings in the time allowed for completion of the contract.

5. Upon receipt of prints which have been marked "Approved Except as Noted" or "Returned for Correction", within 30 calendar days after receipt, submit correct [reproducibles] [and] [_____] prints of each drawing. If revisions are made after a drawing has been "Approved", furnish [reproducibles] [and] [corrected prints] subsequent to each revision.

6. All of the applicable requirements of this paragraph with reference to drawing submittals apply equally to catalog cuts, illustrations, printed specifications, weld qualifications, mill tests, factory tests, field tests, or other required data, except submit two additional copes in lieu of any reproducibles. All correspondence, drawings, literature, instruction books, data, and nameplates must be in the English language, with Metric (English) units as currently used in the United States.

7. Any manufacturing work performed prior to the approval of the drawings will be at the Contractor's risk. Make any changes in the design which are necessary to make the equipment conform to the provisions and intent of these specifications without additional cost to the Government. Do not construe approval of the drawings as a complete check but will indicate only that the general method of construction and detailing is satisfactory. Do not hold Contracting Officer's approval of the Contractor's drawing to relieve the Contractor of any part of the Contractor's' obligation to meet all of the requirements of these specifications or of the responsibility for the correctness of the Contractor's drawings.

8. Upon completion of the work under this contract, furnish a complete set of [CADD files] [process tracings together with complete sets of black and white prints or blue-prints] of added drawings as finally approved. [Furnish the CADD files in Microstation format on electronic media; i.e., compact disks, DVD, or approved web based data transferring site, etc.] [The process tracings must be full size reproducibles made on cloth, Mylar, or equal, from the original tracings by photographic-type reproduction, and of such quality and clarity as to permit sharp and thoroughly legible microfilm copying.] These [CADD files] [tracings] [tracings and prints] must show all changes and revisions, including any field changes made up to the time that the equipment is completed and accepted and the contract number must be shown thereon. Locate the number immediately above the title block if possible.

9. Assemble parts catalogs, where applicable, the operating instructions especially prepared covering all equipment furnished under this contract which may be needed or useful in operation, maintenance, repair, dismantling, or assembling, and for repair and identification of parts for ordering replacements under a suitable common cover and [_____] furnish copies of the assembled material. Include complete identification of the spare parts furnished in compliance with the requirements of these specifications.

Part III -- LIST OF DOCUMENTS, EXHIBITS, AND OTHER ATTACHMENTS

Section F List of Documents, Exhibits, and Other Attachments

Suitable drawings showing the location and general arrangements of the equipment, a single-line diagram of the main power connections, and tabulations of feeder circuit data should be included with the

procurement specifications. The drawings should include all features not adequately covered in the specifications which will affect the design of related equipment or the structure.

This section should be modified as required to clearly indicate the specific requirements for the contract. References to other sections which must be incorporated into the equipment design should be added. If general electrical requirements, high resistance ground, transformers, wire and cable, protective systems are specified in other sections, these should be added at the end of this section.

Remove information and requirements not required whether or not brackets are present.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General

	Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)

ASTM INTERNATIONAL (ASTM)

ASTM B187/B187M	(2020) Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar and Shapes
ASTM B188	(2015; R 2023) Standard Specification for Seamless Copper Bus Pipe and Tube
ASTM B236	(2007) Standard Specification for Aluminum Bars for Electrical Purposes (Bus Bars)
ASTM B236M	(2007) Standard Specification for Aluminum Bars for Electrical Purposes (Bus Bars) (Metric)
ASTM B317/B317M	(2023) Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, Structural Profiles, and Profiles for Electrical Purposes (Bus Conductor)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1248	(2020) Guide for the Commissioning of Electrical Systems in Hydroelectric Power Plants
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.13	(2024) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.16	(2009) Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC 3200 V and below) Power Circuit Breakers
IEEE C37.17	(2022) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
IEEE C37.20.1A	(2020) Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
IEEE C37.20.2A	(2020) Metal-Clad Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear

IEEE C37.20.7	(2017; Corr 2021) Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults
IEEE C37.23	(2015) Metal-Enclosed Bus
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.12.01	(2020) General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings
IEEE C57.12.50	(1981; R 1998) Ventilated Dry-Type Distribution Transformers, 1 to 500 kVA, Single-Phase, and 15 to 500 kVA, Three-Phase, with High-Volt 601 to 34,500 Volts
IEEE C57.12.51	(2019) IEEE Guide for Mechanical Interchangeability of Ventilated Dry-Type Transformers
IEEE C57.12.91	(2011) Standard Test Code for Dry-Type Distribution and Power Transformers
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C57.13.3	(2014) Guide for Grounding of Instrument Transformer Secondary Circuits and Cases
IEEE C57.32	(2015) Requirements, Terminology, and Test Procedure for Neutral Grounding Devices
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2020) American National Standard for Electrical Metallic Tubing (EMT)
NEMA AB 3	(2013; R 2023) Molded Case Circuit Breakers and Their Application

NEMA C37.50	(2018) Switchgear--Low-Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures
NEMA C37.51	(2018) Switchgear--Metal Enclosed Low-Voltage AC Power, Circuit-Breaker Switchgear Assemblies-Conformance Test Procedures
NEMA FB 1	(2014) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA PB 2	(2011) Deadfront Distribution Switchboards
NEMA TR 1	(2013) Transformers, Regulators, and Reactors
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.2 SUMMARY

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NOTE: NOTE:To ensure an installation in the desired location and orientation, it is critical for the designer to include layout drawings showing the maximum sizes allowable and any/all clearances required. The designer must base these drawings off of actual equipment capable of being produced as part of a normal product line to avoid custom solutions and dramatically increased costs.

****

a. The location and general arrangement of the low-voltage metal-enclosed switchgear assembly, [metal-enclosed bus structures] [and station service transformers] are shown on the contract drawings. Modifications of the equipment arrangement or the equipment device requirements shown are subject to Government approval. Assemble and wire the switchgear assembly completely at the factory. Assemble at the factory the metal-enclosed bus structures in sections of sufficient length for convenience of tests, shipment, and installation. After complete assembly, disassemble the switchgear group into sections, for convenience of handling, shipment, and installation.

b. Matchmark each shipping section of the switchgear properly to facilitate reassembly, and provide with removable lifting channels with eye bolts for attachment of crane slings to facilitate lifting and handling. Ship equipment as completely assembled and wired as feasible so as to require a minimum of installation work. Provide switchgear groups and metal-enclosed buses which are disassembled into sections for shipment with the associated parts properly matchmarked to facilitate installation by the Government. Carefully pack and ship separately any relay [, indicating instrument] or other device which cannot withstand the hazards of shipment when mounted in place on the switchgear. Mark these pieces with the number of the panel on which they are to be mounted and fully identified so they can be readily mounted and connected.

****

NOTE: Dimension of equipment must be smaller than the associated dimensions of doorways, hatches, hallways, galleries, or any other restrictions in the movement of the equipment to its final location for assembly.

****

c. Wrap all finished painted surfaces and metal work suitably or otherwise protect from damage during shipment. Prepare all parts for shipment so that slings for handling may be attached readily while the parts are in a railway car or transport truck. Ensure switchgear sections crated for shipment are of such size, including crates, that they will pass through a [_____]-meter by [_____]-meter [_____]-foot by [_____]-foot hatch opening, and a [_____]-meter by [_____]-meter [_____]-foot by [_____]-foot wall opening.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G, [_____]

Temporary Power Plan; G, [_____]

Qualifications Of Field Engineering Service Personnel; G, [_____]

Contractor Furnished Training Of Government Personnel; G, [_____]

Course Outline And Course Material; G, [_____]

SD-02 Shop Drawings

Shop Drawings; G, [_____]

Installation; G, [_____]

Terminal Blocks; G, [_____]

Assembly And Detail Drawings; G, [_____]

Outline Drawings; G, [_____]

Schematic Diagrams, Connection Diagrams And One Line Diagrams; G, [_____]

Foundation Detail Drawings; G, [_____]

SD-03 Product Data

Transformers

Power Circuit Breakers

Spare Parts

Metal-Enclosed Bus

480-Volt Station Service Switchgear

Infra-Red (Ir) Viewing Windows; G, [_____]

Digital Trip Units; G, [_____]

Remote Control Device; G, [_____]

Instrument Transformers; G, [_____]

Protective Relays

Test Switches

Fiber Optic Arc Flash Sensors

Control Switches

Station Service Transformer; G, [_____]

Temperature Relay

Surge Protection

Capture Key Interlocks

Annunciation Equipment

Time Current Curves

SD-04 Samples

Nameplates; G, [_____]

SD-06 Test Reports

Factory Inspection and Tests

Design Test Reports; G, [_____]

Factory Test Procedure; G, [_____]

Factory Inspection And Test Reports

Field Test Procedure; G, [_____]

Field Test Reports

Manufacturer's Test Reports

480-Volt Switchgear Factory Inspection And Tests; G, [_____]

SD-07 Certificates

Notification Of Testing; G, [_____]

Certifications Of Switchgear And Breakers Design Tests; G, [_____]

Certifications Of Seismic Requirements; G, [_____]

Qualifications Of Instructor; G, [_____]

SD-10 Operation and Maintenance Data

Operation And Maintenance Manual; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings; G, [_____]

1.4 EXTRA MATERIALS

Submit a list of spare parts as specified herin. Provide spare parts that are duplicates of the original parts furnished, and interchangeable therewith. Furnish the following spare parts for each type and frame size of drawout circuit breaker, except that only one spare is required where parts are applicable to all types and frame sizes of the circuit breakers:

a. One complete set of main, intermediate and arcing contacts and associated springs for one three pole breaker.

b. One complete set of arc chute assemblies for one three pole breaker.

c. One set of primary disconnecting devices for one three pole breaker.

d. One set of secondary disconnecting devices for one three pole breaker.

e. One shunt trip coil.

f. One Spring-charging motor or solenoid for electrically-operated breakers.

g. One control relay of each type and rating for electrically-operated breakers.

h. One auxiliary switch complete for electrically-operated breakers.

i. One cell (housing) switch.

j. One manual operating mechanism handle for drawout feeder air circuit breakers.

k. Twelve fuses of each type and size for voltage transformers.

l. Six Indicating lamp assemblies (three red lens and three green lens.)

m. Ten Indicating lamp color caps of each color.

n. One spring for stored-energy closing mechanism.

o. Four spare blank nameplates for operating unit doors.

p. One lot spare bulbs for indicating lamp assemblies, package to contain not less than 20.

[q. One ground detection relay of each type and size used.]

[r. One protective relay of each type and size used.]

[s. One temperature relay of each type and size used.]

[t. Three voltage transformer of each type and size used.]

[u. Three current transformers of each type and ratings used.]

[v. Three surge arresters of each type and size used.]

[w. Three surge capacitors of each type and size used.]

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

a. Ensure the equipment furnished and the work performed under this Contract is in conformance with the applicable provisions of ANSI & IEEE standards. Furnish documentation substantiating that the circuit breakers and switchgear[and metal enclosed bus] have previously satisfied the requirements for design testing in accordance with IEEE and ANSI standards.

b. All materials, components, and equipment must conform to the requirements of these specifications, be free from defects and imperfections, of recent manufacture, and have mechanical and electrical properties suitable for the intended use. All materials, components, and equipment not manufactured by the Contractor must be products of other recognized reputable manufacturers meeting the requirements of subparagraph Qualifications. Insofar as practicable, devices and equipment used for the same or similar services must be of the same make and type, and be interchangeable when of the same rating.

c. The switchgear[,][and] power circuit breakers,[metal enclosed bus][, and][transformers] must essentially duplicate the standard published catalog item from the manufacturer and such equipment has been in satisfactory service for at least five years.

d. All bolts, studs, machine screws, nuts, and tapped holes must be in accordance with ASME B1.1. Threads for sizes 6 mm to 25 mm 1/4-inch to 1-inch, inclusive, be NC or UNC series. The sizes and threads of all conduit and fittings, tubing and fittings, and connecting equipment must be in accordance with ASME B1.20.1. Manufacturer's standard thread and construction may be used on small items, which in the opinion of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items meet the above requirements.

e. The switchgear will be located[indoors] within ambient temperature extremes of[0 degrees C to +40 degrees C][_____][at 0 to 95 percent relative humidity, non-condensing]. The switchgear will be installed at an altitude [below 1000 m/3280 ft][_____].

2.2 NAMEPLATES

Submit samples of engraved nameplates with a schedule of nameplate sizes and lettering. The Contractor will be permitted to supply and attach to the switchgear assembly a nameplate or trademark. Include a drawing or illustration showing the proposed nameplate, its size, and location. Provide each item of equipment mounted on the switchgear, which does not have a suitable designation included as an integral part of the device, with an engraved nameplate or with other approved suitable means of identification. Make nameplates of laminated sheet plastic or of anodized aluminum approximately 3 mm 1/8 inch thick, engraved to provide white letters on a black background. Provide equipment of the withdrawal type with nameplates mounted on the removable equipment in locations visible when the equipment is in place. Fasten nameplates to the panels in proper positions with black finished roundhead screws. Provide each control switch with an escutcheon clearly marked to show each operating position. Engrave switch identifications on the escutcheon plates or on separate nameplates. The escutcheon and nameplate markings are subject to approval.

2.3 COPPER AND ALUMINUM BARS AND RODS

Provide copper[or aluminum] bars and shapes for main bus and ground bus conductors conforming to the requirements of ASTM B187/B187M, ASTM B188, ASTM B236M ASTM B236, and ASTM B317/B317M.

[2.4 CONDUIT AND ELECTRICAL METALLIC TUBING

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NOTE: THE SECTIONS FOR "CONDUIT AND ELECTRICAL METALLIC CONDUIT ARE TYPICALLY INCLUDED IN THE 26 05 00.00 COMMON WORK RESULTS FOR ELECTRICAL FOR BOTH PRODUCT INFORMATION AND INSTALLATION.

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Provide rigid conduit conforming to ANSI C80.1 that is zinc-coated (galvanized) both inside and outside by the hot-dip method.[Provide electrical metallic tubing (EMT) conforming to ANSI C80.3.] Ensure fittings for rigid metal conduit[and electrical metallic tubing] conform to NEMA FB 1.

]2.5 CONNECTIONS

Provide all bolts, studs, machine screws, nuts, and tapped holes in accordance with ASME B1.1. Ensure threads for sizes 6 to 25 mm 1/4 to 1 inch, inclusive, NC or UNC series. Ensure sizes and threads of all valves, pipe and fittings, conduit and fittings, tubing and fittings, and connecting equipment are in accordance with ASME B1.20.2MASME B1.20.1. Manufacturer's standard thread and construction may be used on small items which, in the opinion of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items must meet the above requirements.

2.6 SECONDARY UNIT SUBSTATION

2.6.1 General

The secondary unit substation is to be indoor metal-enclosed secondary selective [double-ended][single-ended] type rated [13,800-480] [[_____]-480] volts, [_____]kVA, [3-phase, 3-wire,][_____]3-phase, 4-wire, with incoming, transforming, and outgoing sections arranged as indicated. The unit substation must conform to the applicable requirements of NEMA TR 1.

2.6.2 Incoming Sections

Incoming sections for terminating the medium voltage [power cables][bus] are to be in accordance with paragraph STATION SERVICE TRANSFORMERS.

2.6.3 Transforming Sections

The transforming section are to be metal enclosed containing ventilated dry type (Class AA) transformers in accordance with paragraph STATION SERVICE TRANSFORMERS.

2.6.4 Transformer Bus Connections

The transformer low-voltage terminals are to be connected to the power supply breakers in the adjacent 480-volt, outgoing switchgear section by means of copper[or aluminum bus] with thermal and mechanical capacities coordinated with the ratings of the 480-volt power supply circuit breakers. The transformer's medium-voltage and low-voltage bus connections are to be arranged so that the front of the transformer enclosures will line up with the front of adjoining incoming sections and the 480-volt outgoing switchgear section. Suitable bus transition compartments are to be provided.

2.6.5 Outgoing Section

The outgoing section must be an indoor metal-enclosed 480-volt power circuit breaker switchgear assembly, with drawout type circuit breakers, as specified for 480-volt Station Service Switchgear.

2.7 480-VOLT STATION SERVICE SWITCHGEAR

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NOTE: To ensure a product with the layout and configuration of the controls, indication, and options desired, the designer must show them on drawings.

****

2.7.1 General

The design, construction, and tests of the switchgear conforming to the applicable requirements of IEEE C37.13, and [IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3]. The switchgear will be used to distribute power from two [[_____]-kVA, [_____]-480 volt] [13,800-480 volt], 3-phase, 60-Hz, station service transformers to 480-volt power distribution centers and to other station service loads. Provide switchgear assembly that contains two main bus sections connected by a bus tie circuit breaker. Each main bus section will be connected to a supply transformer through a main supply circuit breaker. Provide two main supply circuit breakers and bus tie circuit breaker that are electrically operated and normally remotely controlled. Provide automatic bus transfer as specified in paragraph Automatic Bus Transfer. Provide switchgear with instruments, control accessories, and other equipment mounted on the front panels and inside the switchgear[as shown].[The annunciator window group will be furnished by the Government for mounting and wiring by the Contractor.]

2.7.2 Switchgear Drawings And Data

2.7.2.1 Assembly and Detail Drawings

Prepare and submit assembly, detail drawings, and data to demonstrate that all parts of the equipment conform to the requirements and intent of the specifications. Include drawings and data , sectional views of switchgear units; including bus and bracing, description of removable elements, all relays and other devices, equipment lists,[high resistance ground equipment] and nameplate schedules. On the drawings, show all coordination with other connected equipment including the transformer and metal enclosed bus indicating full electrical details of the connection.

2.7.2.2 Outline Drawings

Prepare and submit outline drawings for coordination of equipment and physical location. Include in the drawings, the overall dimensions and weights of the equipment; the size and location of conduit and cable entrances; details of provisions for bolting equipment to the floor, walls, and ceilings; the equipment crate sizes and proposed routing to the installation site within the facility.

2.7.2.3 Schematic Diagrams, Connection Diagrams and One Line Diagrams

Submit Schematic Diagrams, Connection Diagrams and One Line Diagrams indicating the switchgear assembly, complete assembly full line connection diagram, and control logic to demonstrate that the equipment will satisfy the requirements and intent of the specifications. Account for all the controls and external connections indicated by the Contract drawings. Show all point to point connection wireless wiring diagrams to terminal blocks and connections as seen by the observer. Provide a space at least three inches below and adjacent to the terminal blocks in which external circuits, conduits or connections may be shown. Make wiring diagrams as seen by an observer of the actual wiring, and show all the wiring and devices in the cubicle/sections. Solely using ladder logic or control diagrams to indicate wiring connections is not acceptable. Include in the drawings, space for the addition of devices where mounting space exists on the structure.[Additional information on outgoing circuits will be provided by the Government when the drawings are received for approval, and be added to the drawings by the Contractor.]

2.7.3 Enclosure and Framework

2.7.3.1 General

Provide a totally-enclosed, free-standing, dead-front type switchgear built on a suitable framework of structural steel, or by an equivalent approved method, to provide a self-supporting and stable structure. Metal-enclosed switchgear construction consisting of ribbed side sheets and fabricated framework which is functionally equivalent to the structural steel framework specified will be acceptable. Ensure framework and structure is sufficiently rigid to withstand operation of the equipment or any stresses due to short circuits. Ensure each shipping assembly is also sufficiently rigid, with the addition of temporary members if required, to withstand handling during shipment and installation.

2.7.3.2 Enclosure

Make the enclosure from selected smooth sheet steel panels, suitably supported. Use doors and panels to support instruments and other devices and barriers between compartments that are no less than No. 11 MSG. Use exposed panels on the front and ends of the enclosure consisting of bent angle or channel edges with all corner seams welded and ground smooth, or use the manufacturer's equivalent construction as approved. Do not drill or weld front outside surfaces for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front.

2.7.3.3 Access Doors and Panels

Provide hinged doors that have bent angle or channel edges, invisible hinges and are suitable latches or fastenings. Access to bus compartments can only be through removable bolted panels, cover plates or hinged doors.

Access to circuit breakers, instrument transformers, instrument, relay wiring and fuses[, and high resistance ground equipment], must also be through hinged doors.

2.7.3.4 Drawout Circuit Breaker Compartment

Provide drawout type circuit breakers that are completely enclosed in a metal compartment. Provide access to the circuit breakers through hinged steel doors. Separate each individual circuit breaker compartment from adjacent compartments and sections by means of steel barriers. Equip with drawout rails and primary and secondary disconnecting contacts. Provide each breaker cubicle with positive acting safety shutters that isolate the breaker connections to the main bus when the breaker is withdrawn from the cell[, if this is an option from the manufacturer].

[2.7.3.5 Remote Racking Device

[OPTION 1: Furnish a remote racking device that is a portable unit that may be positioned in front of the breakers in the switchgear to rack the breaker in or out remotely. The device must include a wheeled assembly with brakes, a power module capable of exerting a minimum of 10 pounds of positive pressure and 100 foot-pounds of torque in the braked position to rack the breakers in and out with 15 inches of horizontal traverse, status indicator lights on the assembly visible from all directions, vertical height adjustment, and a control pendant with a minimum 25-foot cord. Power supply for the racking device is 120 volts AC, 15 amps. The remote racking device must be the switchgear manufacturer's standard system designed for racking the breakers provided. If the switchgear manufacturer does not offer such a remote racking device, a different manufactured system may be provided if certified to rack the breakers provided with the switchgear.]

[OPTION 2: Provide a portable remote racking device which can be placed on the breaker door enclosure to allow remote racking of all the breakers within the switchgear. The remote racking device must be the standard product used by the switchgear manufacture and be provided with all the adapters required to remotely rack out the breakers. If battery powered, provide it with a battery charger and minimum of two batteries. The device must have adjustable torque setting to prevent damage during racking the breaker and be equipped with a minimum 25 foot cord. The device must be designed to automatically stop on fully racked in and out position.]

]2.7.3.6 Ventilating Opening

Provide grille type ventilating openings with corrosion-resistant insect-proof screens on the inside.

2.7.3.7 Foundations

Provide continuous channel iron foundations, complete with bolts and drilled holes for grouting and anchoring to the floor, for the complete length (front and rear) of each [substation] [switchgear assembly]. Construct channel and drill as required for mounting the equipment. Design channels for flat mounting and use a maximum channel depth of 63 mm 2-1/2 inches. Place foundation channels on top of the floor, fasten in place, and then fill with grout. Provide additional channel or substantial metal trim flush with the end panels to completely enclose the bases across the ends of the equipment assemblies where exposed to view. The foundation must satisfy the requirements of Section 26 05 48 SEISMIC PROTECTION FOR

ELECTRICAL EQUIPMENT. Submit Foundation Detail Drawings of the foundation and its installation requirements along with the drawing submittals.

[2.7.3.8 Cable Compartment Barriers

[Provide a metal barrier full height and depth between adjacent vertical structures in the cable compartment.][Provide a vented barrier between the cable compartment and the main bus to protect against inadvertent contact with main or vertical bus bars.]

][2.7.3.9 Infra-red (IR) Viewing Windows

Provide Infra-red (IR) viewing windows on the rear of the switchgear enclosures, minimum one window for each vertical breaker section. Provide the number of windows required to view each circuit breaker cable lug to allow IR sensing of each breaker in the closed position under load conditions without having to open the enclosure. Windows must feature a removable steel or aluminum security cover over a 4-inch crystal sight glass. The IR windows must be the switchgear manufacturer's standard product, or a third-party product that is UL certified and arc-flash tested to the fault withstand rating of the breakers or higher, and installed with the coordination and approval of the switchgear manufacturer.

][2.7.3.10 Switchgear Arc Rating

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NOTE: Include the sections below for arc resistant switchgear. The arc resistant switchgear cost is approximately an additional 50% material cost over general metal-enclosed switchgear and require additional height and space for directional venting of any arc produced gasses.

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Provide Type 2B certified switchgear as defined by IEEE C37.20.7 such that the operator is protected around entire perimeter of equipment with the low voltage control, instrumentation, and breaker secondary customer termination compartment doors open.

][2.7.3.11 Switchgear Ventilation

Provide a ventilation system that allows exhaust of arc gasses regardless of the origination location of the arc event to exhaust arc events originating in the breaker cell, bus compartment, and rear cable compartment.[Provide switchgear without an arc plenum for arc exhaust.][Provide switchgear with an arc plenum included.][Provide external connections to arc duct.]

]2.7.4 Buses and Connections

a. Provide buses in each main bus section with a continuous current-carrying capacity of no less than [1,200] [1,600] [2,000] [3,000] [4,000] [_____] amperes without exceeding the temperature limits specified in [IEEE C37.20.1A][IEEE C37.20.3]. Provide buses with mechanical and thermal capacities coordinated with the interrupting rating of the power supply circuit breakers. Provide bus bars consisting of [hard-drawn copper][, aluminum][, or aluminum-alloy]. Braze, pressure-weld or bolt shop splices and tap connections. Bolt all splices for field assembly. Where bolted connections are used, use silver-plated contact surfaces except use tin-plated contact surfaces for aluminum-alloy and equip with provisions for adequate clamping. Mount buses on insulating supports of wet process porcelain, glass polyester, or suitable molded material. Make all primary connections including the power connections to the line side of the circuit breakers by bus bar.

b. Ensure standard phasing within equipment housing for AC power circuits is A-B-C from left to right when facing the front of the equipment, A-B-C from top to bottom, and A-B-C from front to back. Nonstandard phasing in any compartment will be permitted only upon approval and providing each phase is identified and a warning sign, "Nonstandard Phasing," is incorporated within such a compartment.

c. Provide blank compartments without buses and small spare compartments with buses and complete provisions for installing future feeder circuit breakers where shown.

2.7.5 Power Circuit Breakers

2.7.5.1 General

Provide power supply, bus tie, and feeder air circuit breakers that are the 3-pole, dead-front, drawout type rated 600 volts AC, conforming to the requirements of IEEE C37.13; IEEE C37.16; and IEEE C37.17. Ensure all circuit breakers of the same frame size and type of operation (electrical or manual) are interchangeable. Provide suitable means for removing and handling the drawout circuit breakers. These means may include support from the top of the switchgear enclosure without interference with incoming or outgoing wiring. The Government reserves the right to change the indicated current ratings, within frame limits, of the tripping devices at the time the shop drawings are submitted for approval. Furnish overcurrent trip alarm contacts, with means for manual reset, as indicated. Provide covers over readily accessible energized portions to prevent hazards to personnel when withdrawing or inserting the breakers.

****

NOTE: Tie and Tie isolation breakers are located in a separate vertical sections, with barriers between, to provide an electrical isolation point for access to the opposite breaker

Diesel Generator, Station Service Units, or "House Units" are recommended to be interlocked with the corresponding Main and Tie breakers if synchronizing capability is not installed.

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NOTE: Interrupting rating is based on fault current available at that location. Fault current is based on the configuration and components of the system. Perform a fault study on the system to determine maximum available fault current to select the appropriate interrupting rating required. Cost and physical size my increase with a higher rated circuit breakers.

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NOTE: To ensure an interlocking scheme operates as intended, the designer must include drawings showing the configuration or give a narrative on required behavior.

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2.7.5.2 Main and Bus Tie[s] Circuit Breakers

Provide two power supply circuit breakers and the bus tie circuit breaker[and bust tie isolation breaker] must be electrically-operated drawout type with the closing mechanism designed for operation on [125 volts DC] [120 VAC]. Provide circuit breakers rated 600 volts AC, [600] [1,600] [3,000][4,000][_____] ampere frame size, [22,000] [42,000] [65,000] amperes symmetrical interrupting capacity at 600 volts AC, with continuous current ratings as indicated. Provide each circuit breaker with functional components in accordance with Table 1 of IEEE C37.13, including means for manual emergency tripping and manual closing for maintenance operation. Provide each power supply breaker and the bus tie circuit breaker[s] with a solid-state direct-acting over-current tripping device consisting of long-time-delay and short-time-delay elements.[Furnish the bus tie [isolation]circuit breaker [without an overcurrent trip device] but with a 125-volt DC shunt trip device.] Coordinate long-time and short-time-delay operation bands to provide maximum selectivity between the primary supply protective relays, power supply breakers, bus tie breaker, feeder breakers and motor control center molded case breakers for a fault on a feeder circuit. Information on primary relays and molded case breakers will be supplied to the Contractor. The two power supply circuit breakers and the bus tie circuit breaker are to be electrically interlocked such that only two of the three breakers can be in the closed position at the same time. Provide a local test control switch for each electrically-operated circuit breaker which will be electrically interlocked through cell switches or secondary disconnects to prevent breaker operation except when the breaker is in the test position. Sufficient breaker auxiliary switch contacts and cell switches are to be provided to accomplish the required breaker control and interlocking system[as shown]. Provide at least four auxiliary switch contacts on each breaker and at least two spare auxiliary switch contacts, one normally-open and one normally-closed on each electrically-operated breaker.

2.7.5.3 Feeder Air Circuit Breakers

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NOTE: Feeder breakers can have manual or electrical and manual spring charging capabilities if control power is available. Control Power is recommended, if available, to provide indication and power for trip units on open breakers or breakers that have too little current flow to self power to prevent a dead battery.

Feeder breakers can be configured with shunt trips to allow for load shedding of nonessential loads for reduced power demand while on emergency diesel generator source.

****

Provide feeder breakers that are independent [manually-operated][remote operated] type with [electrically][manually]charged stored energy closing mechanism, with frame sizes as indicated, and rated 600 volts AC. Circuit breakers will have a short-circuit interrupting capacity of not less than [22,000][_____] RMS symmetrical amperes at 600 volts AC. Each feeder breaker must have a solid-state direct-acting overcurrent tripping device consisting of a long-time-delay element and a short-time-delay element. The long-time-delay trip elements for direct-acting overcurrent tripping devices must be adjustable over an approximate range of 600 to 100 percent of the trip ampere rating. The short-time-delay trip elements, for the direct-acting overcurrent tripping devices must be adjustable over a range of approximately four to ten times the ampere rating.[Manually-operated drawout type circuit breakers are to be fitted with suitable operating handles, preferably of the pistol grip type, or vertical lever type, designed to close the breaker with a rotary motion of less than 180 degrees.] All breakers are to be designed for tripping [by a rotary motion in the opposite direction or][by pressing a readily accessible trip button].[Make the operating handles easily removable when it is necessary to open the compartment door and easily replaceable for operating the breaker in the withdrawn or test position.][Capture key interlock duplicate feeder breakers.] Equip each breaker with a conspicuous mechanical target[and light] visible with the breaker in the normal operating position to indicate whether the breaker is open or closed and with a manually-reset bell alarm contact[to energize the annunciator circuit only when the breaker is automatically tripped on a fault or overload].[The circuit breaker for the powerhouse crane feeder must be[manually-operated type] electrically operated type equipped with a 125-volt DC shunt trip attachment for emergency stop operation from remote stations.]

[2.7.5.4 Digital Trip Units

Provide digital trip units for each breaker . Loss of control power to the trip unit must not affect the operation of the unit to trip the associated breaker.

a. The digital trip units must have been used successfully on low voltage power circuit breakers of the type and rating to be furnished under these specifications. The minimum requirements to be defined as successful is a minimum of 500 units installed and in operation for five years. Provide a trip unit that is the manufacture's standard type and compatible with the breaker to be provided.

b. Provide a microprocessor-controller based trip unit for use on three-phase, 600 volts AC circuit breakers with a liquid crystal display (LCD) to provide programming and setting capability for the user.

c. The trip units must have three different power supplies:

i. Primary power supply is to be derived from the phase current transformers (CT). The trip unit must be powered with less than 20% of the rated CT tap current.

ii. Provide a battery to power the unit when the CT power is lost. The status of the battery (good/bad) must be displayed and loss of the battery results in an alarm output. The battery can be charged when not in use through the power derived by the CT.

iii. 125 VDC Power for auxiliary power to the trip unit. Provide 125VDC Control power from the existing 125 VDC control power of the corresponding switchgear bus. Limit the uses of control power to recharging the trip unit's internal battery and to change or review the trip unit's settings when the battery charge is low.

d. The trip unit must measure the true RMS current through each of the breakers' three poles. The trip unit must be capable of determining the vector sum of the three phase currents, and calculate the 60 Hz component of the ground fault current. Provide trip units with the following trip settings:

i. long time.
ii. short time delay.
iii. instantaneous pickup.
[iv. ground fault.]

e. The trip unit must store the trip settings and the last trip data in a non-volatile memory for later recall. Include a security means with the trip unit to reduce the risk of unauthorized tampering with the trip unit's settings.

f. Equip each Main and Tie breaker's trip unit with arc flash reduction settings to put the trip unit automatically in instantaneous trip mode by means of a contractor installed control switch mounted on the cubicle door. Provide switch and wiring to connect this function to the trip unit. The switch must have a provision for installing a padlock.

g. The Government reserves the right to change the indicated trip ratings, within the limits of the frame, of the trip devices at the time the shop drawings are submitted for approval.

][2.7.5.5 Remote Control Device

Provide a remote control device that is a portable unit that connects to the exterior of the breaker enclosure to allow remote operation of the breaker (open/close). The remote control device must be a pendant with a minimum 25-foot cord. The cord must be equipped with a plug with threaded or locking coupling and strain relief

]2.7.6 Wiring

2.7.6.1 Control Panel and Power Wiring

Provide control panel wiring consisting of stranded copper switchboard wire with 600-volt insulation. Provide Type SIS wire as listed in NFPA 70 and meeting the requirements of NEMA WC 70. Provide hinge wire with class K stranding. Provide current transformer secondary leads No. 10 AWG and larger. Ensure minimum size of wire for all other control wiring is No. 14 AWG. Use power wiring for 480-volt circuits and below that is the same type as control panel wiring and a minimum size of No. 12 AWG.

2.7.6.2 Terminals and Installation

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NOTE: If incorporating new switchgear into existing installations where terminations are required to interface with existing equipment or systems, the designer may include drawings showing these connections via new contract drawings or as referenced drawings.

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a. Provide control wiring within the assembly housingse[as shown]. All control wiring entering and leaving equipmentt must be terminated on terminal blocks. Provide terminal blocks and internal wiring for connection of remote circuits to all spare auxiliary and alarm contacts, remote annunciators, remote control switches, and pilot devices and remote indicating lights where applicable to the equipment involved. Each individual potential transformer lead must be brought out to a terminal block. Ground the potential transformers at the equipment.[Potential transformers for metering circuits will be remotely grounded][by the Government]. No splices will be allowed in the wiring and all connections are to be made at terminal studs or blocks. Add terminal blocks for wiring to devices having leads instead of using the device's terminals.[Indented terminals are to be used on all wires terminated on screw or stud terminals.] Provide screw terminals with toothed lock washers and all stud with contact nuts and either locking nuts or lock washers.

b. All external control cables and power cables will enter the switchgear in [conduit] [cable trays] [from above] [from below]. Provide space for cables[as shown]. The 600-volt metal-enclosed buses enters the switchgear from [above] [below][through floor slots]. Provide matched openings in the switchgear to permit the entrance of the bus into the switchgear through the concrete openings. Provide clam-style terminals[of sizes indicated] for all main power cable leaving the switchgear. The terminals must be of the heavy-duty, full clamp type. Make provisions for supporting the Government's cables between the conductor terminating points and where they enter or leave the switchgear.

2.7.6.3 Terminal Blocks

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NOTE: DIN rain rail mounted terminal blocks are acceptable for most input/output of PLC. For other terminal block ring type terminals are preferred in most applications.

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Submit prints of wiring and terminal drawings in accordance with Contract Clause CONTRACTOR'S DRAWINGS AND DATA, which will be marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

a. Provide molded or fabricated type terminal blocks for control wiring with barriers, rated no less than 600 volts, type [_____]. Provide removable binding, fillister or washer head screw type, or stud type terminals with contact and locking nuts. Ensure terminals are no less than No. 10 in size and have sufficient length and space for connecting at least 2 indented terminal connectors for No. 10 AWG conductors to each terminal. The terminal arrangement is subject to approval. Provide no less than 10 percent, but in no case less than 2, spare terminals on each block or group of blocks.

b. Furnish short-circuiting type terminal blocks for all current transformer secondary leads and make provision for shorting together all leads from each current transformer without first opening any circuit. Ensure these terminal blocks are made by the same manufacturer as the terminal blocks for control wiring listed above, type [_____].

[c. Provide DIN rail type terminal blocks, they must be modular and rated no less than 600 Volts and 20 Amperes. The terminal connections must be pressure type with length and space for connection of at least two No. 14 AWG stranded conductors on each end of the feed-through. The terminal contacts must be built to prevent the terminated wires from being loosened by vibration or by normal pulling forces. Mounting rails and end covers must be provided for the terminal block assemblies.
]

d. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for control wire designations. Show the manufacturer's wire number and the Government's wire number for each connected terminal on the marking strips with permanent marking fluid. Use reversible marking strips to permit marking both sides, or furnish two marking strips with each block, to accommodate the two sets of wire numbers.

e. Provide load terminal blocks rated no less than 600 volts and of adequate capacity for the conductors of power circuits except those supplied from air circuit breakers. Provide either the stud type terminals with contact nuts and locking nuts or the removable screw type terminals, having length and space for at least two indented terminal connectors of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, ensure all screws have hexagonal heads. For conductors rated 50 to 99 amperes, use a minimum screw size of 8 mm 5/16 inch. Use conducting parts between connected terminals with adequate contact surface and cross section to operate without overheating. Provide each connected terminal with the circuit designation or wire number marked on or near the terminal in permanent contrasting color.

f. Give special attention to wiring the terminal arrangement on the terminal blocks to permit the individual conductors of each external Government-furnished cable to be terminated on adjacent terminal points. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits may be required.

2.7.6.4 Wire Markers

Tube-type heat shrink or self laminating markers must be used at each terminating end of the conductor and must be suitable for contact with the type of insulation material used. Tubing must have permanent black marking on a light-colored background.

2.7.7 Grounding

Provide switchgear assembly that includes a full-length interior ground bus of copper [or aluminum]bar to which the housing, framework, cable supports, bus supports, and non-current carrying metallic parts of all equipment and conduits is grounded insofar as practicable. Do not use soldered connections in the ground leads. If the operating mechanism of drawout units is not permanently grounded, provide ground contacts to automatically connect the movable element to the ground buses. Make these connections before the main disconnecting devices upon insertion, and break after the main disconnecting devices upon withdrawal. Perform grounding in conformance to[IEEE C37.20.1A][IEEE C37.20.2A][IEEE C37.20.3] except that the ground bus must have a continuous current-carrying capacity no less than 25 percent of the continuous rating of the power supply circuit breakers.

2.7.8 Molded Case Circuit Breakers

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NOTE: If included with other systems where molded case breakers are provided, it may be better to reference Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Interrupting rating is based on fault current available at that location. Fault current is based on the configuration and components of the system. Perform a fault study on the system to determine maximum available fault current to select the appropriate interrupting rating required. Cost and physical size my increase with a higher rated circuit breakers.

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2.7.8.1 General

Provide molded case circuit breakers conforming to the applicable requirements of UL 489 and NEMA AB 3, that are fully rated, and with voltage ratings and interrupting ratings stated. For circuit breakers of the same ampere frame size, ensure 3 pole and 2 pole circuit breakers are the same width as 3 single pole and 2 single pole circuit breakers respectively. Provide manually-operated circuit breakers with trip-free operating mechanisms of the quick-make, quick-break type. Operate all poles of each breaker simultaneously by means of a common handle, and enclose in a common molded plastic case. Ensure contacts of multi-pole breakers open simultaneously when the breaker is tripped manually or automatically. Provide operating handles that clearly indicate whether the breakers are in "On", "Off", or "Tripped" position. Provide individually-mounted, stationary type, circuit breakers that are products of the same manufacturer, and are interchangeable when of the same frame size. Provide each circuit breaker with mechanical pressure type terminal lugs for single-conductor stranded copper cables of the size required by the specifications or shown.

2.7.8.2 Trip Units

Provide automatic type circuit breakers with combination thermal and instantaneous magnetic trip units. Set instantaneous magnetic trip units at approximately 10 times the continuous current ratings of the circuit breakers.

2.7.8.3 480-Volt AC Circuits

Provide circuit breakers for 480-volt AC circuits that are rated 600 volts AC with a minimum NEMA interrupting capacity of [10,000] [14,000] [20,000] [_____] symmetrical amperes at 600 volts AC.

2.7.8.4 120-Volt and 208-Volt AC Circuits

Provide circuit breakers for 120-volt and 208-volt AC circuits that are rated no less than 250 volts DC, and either 120/240 or 240 volts AC, and with a minimum NEMA interrupting capacity of [10,000] [14,000] [_____] symmetrical amperes.

2.7.8.5 125 Volt DC Circuits

Provide 2-pole rated 125/250 or 250 volts DC circuit breakers for 125 volt DC circuits with a minimum NEMA interrupting capacity of [_____] [10,000] amperes DC.

2.7.9 Instrument Transformers

[2.7.9.1 General

[Bring all leads from each individual instrument transformer out to switchgear terminal blocks. All instrument transformers must conform to the applicable grounding requirements of IEEE C57.13.]

[Provide relay curves for instrument transformers. Submit typical ratio and phase angle curves for each type and rating of all voltage and current transformers supplied with the equipment.]

][2.7.9.2 Voltage Transformers

[Voltage (Potential) Transformers must conform to the applicable requirements of IEEE C57.13, and be of the indoor dry or compound-filled type with a minimum full-wave impulse level of 10 kV. Provide transformers with a voltage rating and indicate on the drawings, and with a thermal rating for a 55 degrees C ambient and be no less than 150 volt-amperes. Voltage transformers must have a relay and metering accuracy of 0.3W, 0.3X, 0.3Y. Configure the voltage transformer as indicated on the Contract drawings.]

[Mount the voltage transformer in separate switchgear compartments. Use current limiting fuses for each phase connection on the primary side and type J fuses on the secondary. Locate fuses so as to be readily accessible from the front of the switchgear using doors per PARAGRAPH: ACCESS DOORS AND PANELS. Fuses must be able to withstand maximum possible energizing current, but capable of interrupting the circuit in case of a short-circuit on the secondary winding. Install fuses in [finger safe] fuse cartridge holders [with blown fuse indicator] allowing their removal without a fuse puller. Connect each voltage transformer low voltage connection to a terminal block in the switchgear low voltage compartment.]

][2.7.9.3 Current Transformers

[2.7.9.3.1 General

[Provide the quantity, ratios, and functions of the current transformers [as needed][as shown on the drawings].]Current transformers must conform to the applicable requirements of IEEE C37.20.1A, IEEE C57.13, and IEEE C57.13.3. Provide current transformers of the dry or compound-insulated type [relay][metering] accuracy, and with a suitable means of mounting and for grounding the frame. Connect each current transformer secondary lead to a terminal block of the short-circuiting type and be conveniently located to permit short-circuiting the secondary windings without requiring access to the primary bus compartments. Plainly mark the polarity of the current transformers. Short the current transformers at the terminals of each of the current transformers for shipping. All current transformers must be suitable for continuous operation at the full-rated voltage and current at a frequency of 60 Hz. All current transformers are to be designed and built to withstand, without damage, the thermal and mechanical stresses resulting from short-circuit currents corresponding to ratings of the breakers in the circuits to which they are connected. Current transformers must have a continuous thermal current rating factor based on 30 deg C average ambient air temperature of a minimum of 1.33. Current transformer secondary leads cannot be smaller than No. 10 AWG.

][2.7.9.3.2 Window or Bushing Type Current Transformers

Provide window or bushing type current transformers in the 480 volt switchgear unless otherwise noted. Window or bushing type current transformers must have a minimum full-wave insulation level of 10 kV when installed and meet the requirements for a 10-kV BIL rating as listed in Table 2 of IEEE C57.13 for test voltage applied between the bus and transformer secondary terminals.

][2.7.9.3.3 Rating

Current transformers with ratios between 75:5 and 300:5 must have a combination metering/relaying rating of 0.6 B-0.1 / C50. Current transformers with ratios between 400:5 and 500:5 must have a combination metering/relaying rating of 0.3 B-0.1 / C100.

][2.7.9.3.4 Burden Analysis

Calculate the burden of the new relays, conductors and associated equipment to demonstrate that the burden does not exceed the current transformer rating. Notify the Contracting Officer if there is a problem with excessive burdens that could result in current transformers inaccuracies or going into saturation under fault conditions. Submit analysis as part of the Factory Inspection and Test Report.

]][2.7.10 Ground Detection Equipment

Furnish ground detection equipment for each bus section of the switchgear, to be used for indication and annunciation of grounds of the 480-volt system. Provide equipment consisting of 3 instrument voltage transformers complete with primary and secondary fuses, connected wye-delta, with neutral of primary wye grounded and with the coil of a voltage ground detector relay connected in the broken delta corner of the secondary windings of the 3 voltage transformers in accordance with [IEEE C37.20.1A][IEEE C37.20.3]. Provide two ground detector relays, one for each bus section of the switchgear.

]2.7.11 Relays

2.7.11.1 General

a. Provide relays conforming to the applicable requirements of IEEE C37.90. Provide back-connected, semi-flush-mounted, switchboard type relays with black, rectangular, dust-tight cases, removable covers with windows, and means of sealing against tampering. Ensure relays, except auxiliary relays, are drawout type with built-in test facilities arranged so that the relays can be tested in position or withdrawn from the fronts of the cases without opening current transformer secondary circuits, disturbing external circuits, or requiring disconnection of leads from the relay terminals. Use test devices that permit testing with energy from either the instrument transformers or an external power supply.

b. Submit descriptive data, including manufacturer types and catalog numbers for equipment. Curve sheets for power supply and bus tie circuit breakers combining characteristics of the trip elements to show the proposed selectivity. In addition, include [_____] sets of characteristic curves of the individual breaker trip elements to permit checking and for power supply and bus tie circuit breakers. Ensure breaker trip ampere ratings and lug sizes are as indicated.

c. Provide protective relays with all required auxiliaries, including auxiliary instrument transformers and reactors, to adjust currents, potentials and phase angles for proper operation. Mount external relay auxiliaries in compact assemblies back of the panels and adjacent to the relays. Provide AC relays suitable for use on 60-Hz circuits and for operation with the instrument transformer ratings and connections. Ensure relay current coils are able to withstand 35 times normal current for 1/2 second, and relay voltage coils are able to withstand 110 percent rated voltage continuously without damage. Ensure time delay features do not depend upon oil dashpots or other devices which are appreciably affected by temperature. Provide each relay with one or more operation indicators and/or indicating Contractor switches with targets and external target reset devices, and arrange the circuits for positive target operation. Provide seal-in Contractor and suitable loading resistors where required. Provide separate relay operating function, such as instantaneous trip attachments and different zones for distance relays, with separate targets and contacts.

d. Provide silver-to-silver, electrically independent, chatter-proof and non-bouncing relay contacts suitable for use on 125-volt ungrounded DC circuits. Where more than one electrically-independent relay contact is required, as indicated , and it is not feasible to provide more than one such contact, or if two contacts are available but are not electrically independent, furnish auxiliary to provide the required additional contacts.

2.7.11.2 AC Voltage Relays

Provide voltage relays other than ground detector relays of the induction-disc inverse-time type with adjustable time and voltage settings and with semiflush mounting, drawout case type [_____]. Provide ground detector relays of the induction-disc inverse-time overvoltage type rated 199 volts AC with low pickup, semiflush mounting in drawout case with circuit closing contacts suitable for 125-volt DC ungrounded circuits. Ensure they are from the same manufacturer as the AC voltage relays, type [_____].

2.7.11.3 Auxiliary relays

Provide semiflush back-connected type auxiliary relays for bus transfer control for front-of-panel mounting. Provide black semiflush cases that match in appearance other relay cases on the switchgear. Provide auxiliary relays for interior mounting with covers. Provide relay coils and contacts suitable for continuous operation at 125 volts DC, furnish with resistors where required, and of a type that requires a minimum continuous current. Provide high-speed, multi-contact, self-reset type auxiliary relays from the same manufacturer as the AC voltage relays, type [_____].

[2.7.12 Automatic Bus Transfer

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NOTE: Electromechanical relay operation using undervoltage relays is a simple and inexpensive means of automatically transferring to active power sources.

Some power plants have one main and one tie closed or use a station service unit feed as their normal operation. If this is the configuration, need to update the following scheme appropriately. Coordinate with Protection and Control Engineer on the programming of the relay for the auto transfer scheme.

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NOTE: To ensure an auto transfer scheme operates as intended, the designer must include drawings showing the configuration or give a narrative on required behavior.

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Provide the switchgear with automatic bus transfer[,as shown by the schematic diagrams,] incorporating the following (normal operation will be with both supply breakers closed and the bus tie breaker open):

a. Loss of voltage on one bus causes the associated supply breaker to trip and the bus tie breaker to close.

b. Automatic transfer control will cease to function if either of the supply breakers or the bus tie breaker trip on overcurrent.

c. Recovery of voltage from one of the two normal sources will (after a time delay) open the bus tie breaker and close the associated supply breaker.

d. Recovery of voltage from both normal sources will (after a time delay) open the bus tie breaker and close the supply breakers.

e. After pickup by the voltage relays, the bus transfer operation must be accomplished within approximately one second.

][2.7.13 Protective Relays

Provide a microprocessor based protective relay to perform the required functions. The relay must provide overcurrent protection of the main breakers.[The relay must also provide ground detection alarm and tripping in conjunction with three 3-phase voltage transformers connected to each bus section.][The relay must be SEL type 751 or approved equal.][The protective relay must have arc-flash light sensing with high speed detection and be used in conjunction of the fiber optic sensors. The relay must be provided with adequate fiber sensor inputs to implement the required number of protective zones.][The relay must have a minimum 10 year warranty in addition to those requirements in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Provide Protective Relays with programmable button on the front of the relay labeled to "MAINT" for an Arc Flash maintenance mode. Additionally, a front indicating LED must be labeled "ENABLED" to indicate when maintenance mode is active.][The relay will be used to perform the automatic bus transfer function[and be compatible with [SEL] [District's Protective relaying network currently in use] networking equipment.]][Wire the relay to the transformer temperature relay alarm and trip contacts to provide protection of the transformer and provide alarm on over-temperature. The alarm functions must be connected into the existing annunciation system.] Power to operate the Protection relays will be 125 VDC from the Station Battery, with a range of 105 VDC to 140 VDC with a power consumption of less than 25 Watts.

][2.7.14 Test Switches

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NOTE: To ensure existing testing equipment connections can be used on the new equipment, the designer must include drawings showing the orientation and layout of the test switches.

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Provide switches[as shown] for all voltage, current, power and trip signals into the protective relay to alarm for testing and maintenance. Provide test switches with covers and combination test switches not to exceed 14 poles. Current test switches must be the short-circuiting type. Provide test devices for insertion into the associated test switches to permit application of the proper current or potential source for testing and calibration. Test switches must be rated not less than 20 amperes and 125 volts DC and be equivalent to ABB FT-1 and FT-14 test switches.

][2.7.15 Fiber Optic Arc Flash Sensors

Provide the switchgear with arc flash fiber optic [loop][and][point]sensors [two loops run parallel throughout the entire switchgear, one for each relay input][as indicated on the drawings][as recommended by the Protective Relay manufacturer]. The loop sensors must be compatible with the protective relay provided. For double-ended switchgear, run two loops in parallel throughout the entire switchgear, one for each relay input. Provide documentation of their compatibility . The sensors must be designed and built specifically for the use in arc flash sensing and be connected to the relay in accordance with the manufactures recommendations

][2.7.16 Panelboards

Install panelboards in the switchgear[as indicated on the drawings] to supply the control power to the electrically operated breakers and protective relays. Panelboards must be dead front, complete with doors, frames and hardware, rated 125/250 VDC [120/208 VAC] [_____] with breakers and spaces as indicated, be NEMA type 1 and satisfy the requirements of NEMA PB 2 and be painted to match switchgear. Panelboards must bear Underwriters Laboratories label or other reliably recognized testing laboratory. All panelboards must have copper bus and have an internal ground bus which is to be wired to switchgear ground bus. Install the panelboards in switchgear cubicles to allow access to the breakers. Provide a transparent directory holder inside door and a neatly typed directory placed within the holder.

]2.7.17 Control Switches

2.7.17.1 General

Provide control switches of the rotary switchboard type with handles on the front and the operating contact mechanisms on the rear of the panels. Provide each switch with ample contact stages to perform the functions of the control system and with at least two spare contacts. Contacts must be self-aligning and operate with a wiping action. Provide a positive means of maintaining high pressure on closed contacts. Compression springs or pivotal joints must not carry current. All control switches must be suitable for operation on 600-volt AC or 250-volt DC circuits and be capable of satisfactorily withstanding a life test of at least 10,000 operations with rated current flowing in the switch contacts. The switches must be capable of continuously carrying 20 amperes without exceeding a temperature rise of 30 degrees C and have an inductive load interrupting rating of not less than 1.5 amperes for 125 volts DC or 10 amperes for 115 volts AC.

2.7.17.2 Switch Features

a. Provide control and instrument switches suitable for the intended use[with the features shown on the schematic diagrams and switch development drawings]. Provide the switches with a black[pistol grip,][oval,][round notched][or][knurled] handles or as approved.

b. Control switches for electrically-operated circuit breakers must be 3-position momentary-contact type with spring return to neutral position, and have modern-black, heavy duty pistol grip handles. Provide circuit breaker control switches with mechanical operation indicators to show the last manual operation of the switches.

c. Control switches for instrument and meter transfer switches and for selector switches must be the maintained contact type with the required number of positions, and ammeters with round notched type handles and be connected to read all three phases. Connect ammeter switches to not open the secondary circuits of the current transformer at any time.

d. Provide each control switch with an escutcheon clearly marked to show each operating position. The switch identifications be engraved on the escutcheon plates or on separate nameplates. The escutcheon and nameplate markings are subject to approval.

2.7.18 Indicating Lamp Assemblies

Provide indicating lamp assemblies of the switchboard light emitting diode (LED) type, insulated for either 125-volt and 120-volt AC depending on its service and have colored lens cap with integrally mounted resistors. Provided caps must not be softened during operation. Lamps must be long-life LED with a minimum normal life span of not less than 100,000 hours, visible from at least 20 feet away and replaceable from the front of the panels. Furnish special tools required for lamp replacement. Insofar as practicable, all color caps must be similar and interchangeable, and all lamps be the same type and rating.

2.7.19 Indicating Instruments

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NOTE: If remote indication or input into plant

SCADA, or equivalent, is desired, insert analog communication or network protocol in accordance with any and all relevant USACE cyber security requirements.

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2.7.19.1 General

Provide electrical indicating instruments conforming to the applicable requirements of ANSI C39.1 and an accuracy rating within 1 percent of full-scale value. Provide back-connected semiflush mounting, dust proof, direct-reading, of the switchboard type, and approximately 4-1/4 inches square instruments. Provide instruments with white dials, circular scales, black scale markings, and black tapered antiparallax pointers. Ensure instrument cases are dust tight with shadow proof covers and anti-glare windows. Provide taut-band suspension where this design is available. Provide zero adjustments accessible from the front without removal of covers for instruments with spring control. Design and calibrate AC instruments for use on 60-Hz circuits and for operation from 120-volt secondary windings of voltage transformers and 5-ampere secondary windings of current transformers[, as shown]. Design AC instrument potential coils for continuous operation at 150-volts, and ensure AC instrument current coils are capable of withstanding 40 times rated current for two seconds. Print instrument identification legends neatly on the dials or on separate legend plates inside the cases. Provide instrument scales as specified, or as approved if scales are not specified, and appropriate for the application.

2.7.19.2 Ammeters

Full-load current must be indicated by the pointer at approximately 75 percent of the full-scale range.

2.7.19.3 Voltmeters

Provide voltmeters with expanded scales and calibrated to indicate the nominal phase-to-phase voltages at approximately mid-scale.

[2.7.19.4 Wattmeters

Watthour meters must be digital, with RS-485 communications capability having a 15-minute, cumulative form, demand register. Watthour meters must conform to ANSI C12.1. Watthour meters must be accurately calibrated for use with the associated instrument transformers. The Contractor may submit for approval a digital multimeter combining any or all of the functions for indicating meters and watthour meters.

]2.8 STATION SERVICE TRANSFORMER

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NOTE: If the transformer is not close-coupled to the switchgear, the connection between the transformer and the switchgear should generally be made by metal enclosed bus to ensure reliability. Cabling can be used where impractical, where physical limitations prevent bus, or cost prohibitive for bus.

Reference UFGS Specification for Metal enclosed bus

to complete or edit this as needed.
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NOTE: When procuring a 480 volt substation it is preferable that the switchgear and transformer be contained in the same specification to ensure that the equipment is properly coordinated and designed as a system. If it is separated into two sections, care should be taken to ensure all the necessary requirements are moved with the transformer section and requirements for coordination of equipment connections is included. Enclosure, ground bus, terminal blocks and wiring are some of the critical items that must be clearly identified in the transformer section. Also it must be required that the Contractor fully coordinate the bus connections and enclosure requirements for the bus penetrations to connect the equipment. Those details should be clearly indicated on the Contractor's shop drawings.
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NOTE:

1. Consideration should be given for the transformer winding configuration. Existing transformer configurations are most likely delta-delta windings. This configuration allow continuity of service with one ground on the system. Modern configurations are Delta-WYE with a high resistance applied to the neutral of the transformer. This configuration is HDC standard configuration, but not mandatory if project requests otherwise.

2. The impedance of the transformer should be coordinated with fault study to limit fault current to within the equipment rating. Standard impedance should be used where possible. Higher impedances and BIL rating may affect the physical size of the transformer.

3. Lower temperature rise transformers are normally specified to reduce the heat load into the power plant. At times it may be necessary to specify higher temperature rise transformers due to powerhouse space requirements.

4. Use of fans for cooling should be avoided and are not included as an option in these specifications. It complicates the controls. Fans can result increased maintenance by allowing dirt of the power floor to be blown into the transformer. Also increases loading on 125 VDC system.

5. Where it is necessary to place transformer with one side up against the wall, that design requirement should be clearly stated in the

specification and the temperature rise test should be made to simulate that side being blocked. Manufacturers can design transformer to allow more air to enter the bottom of the transformer to compensate for the blocked side, however it may increase the enclosure height. Special configurations should be discussed with the transformer manufacture's while developing the specifications to ensure the requirements can be met within the powerhouse limitations.

6. Evaluation of the room to access the final location should be looked at. Equipment designs have changed and plant may have added equipment that restrict access ways for moving equipment. If the transformer must be disassemble to move into the final location, that requirement should be clearly articulated in the specifications. It should not be assumed that the offerors will determine this prior to bid. Transformers can be designed to be easily disassemble to very narrow widths if that information is known by the factory. All limiting dimensions and size criteria should be clearly indicated in the specifications or on drawings. Disassembly of a transformer in the field which is not designed for that purpose can subject the transformer to potential damage or require modifications in the field.

7. Minimum BIL rating for 13.8 kV winding is 95 kV; for 4.16 kV is 60 kV. An analysis should be performed to determine whether surge capacitors are required. Care should be taken to ensure that capacitors are only installed where required as these devices can have other detrimental affects.

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Connect the transformer low-voltage terminals to the switchgear main breakers in the adjacent 480-volt switchgear section by means of [flexible leads connected to the switchgear bus] [metal enclosed bus] [low voltage cables] with thermal and mechanical capacities coordinated with the ratings of the 480-volt power supply circuit breakers. The transformer medium-voltage and low-voltage bus connections must be arranged so that the front of the transformer enclosures will line up with the front of adjoining incoming sections and the 480-volt switchgear section. Ensure coordination of the housing penetrations and bus connections between equipment. Field cutting or drilling of the enclosure or bus will not be allowed.

2.8.1 Type and Rating

The station service transformers must be indoor ventilated dry-type, self-cooled, Class AA with [155] [220] degrees C insulation and conform to the applicable requirements of IEEE C57.12.01, [IEEE C57.12.50] [IEEE C57.12.51] and IEEE C57.12.91. The transformers are rated [_____]kVA, 3-phase, 60-Hz, [13,800-480 volts],[[4160]-480 volts], [[_____]-480/277] with a primary winding BIL rating of [95] [60] [_____] kV and secondary winding BIL of 10 kV. The windings must be copper and connected [delta-delta] [delta-wye]. The transformer impedance must be [standard] [

[_____] percent] subject to ANSI standard tolerance. The transformer must be rated to carry rated load continuously without exceeding 80 degrees C (Class 155 degrees C) or 150 degrees C (Class 220 degrees C) temperature rise above 40 degrees C ambient temperature when installed in its ventilated sheet metal enclosure and cooled by natural air circulation.

2.8.1.1 Core and Coils

The core, coils and metal enclosure of the transformer must be rigidly attached to a structural steel base suitable for moving the complete transformer by the use of rollers. Provide jacking facilities and removable lifting eyes on the core and coil assembly. The core laminations must be free from burrs which may puncture the insulation between laminations and be securely fastened to prevent excessive vibration in normal service or displacement under short-circuit conditions. Provide four 2-1/2 percent full-capacity taps, 2 above rated voltage and 2 below rated voltage, in the medium-voltage windings, and suitable means provided for changing the taps while the transformer is de-energized. The terminal board must be accessible through a door or removable panel in the enclosure. Securely brace all transformer leads and taps to prevent displacement or injury during transit or installation and under short-circuit condition.

2.8.1.2 Enclosure

Provide the transformer with a ventilated sheet steel enclosure per paragraph 480-volt Station Service Switchgear, except that a formed enclosure of no less than No.12 MSG may be used. Provide doors or removable panels in the enclosure to permit access to the transformer, and suitable removable lifting eyes or other approved means to permit lifting both the enclosure and the complete transformer by the use of a crane. The enclosure must be adequately braced and stiffened on the inside, and be coated with sound-deadening material if necessary, so that the audible sound level of the enclosed transformer when operating at rated load does not exceed the value permitted in Table 6 of IEEE C57.12.01. Install Corrosion resistant insect proof screens in ventilation grills.[There are powerhouse limitations that will not allow the transformer to be moved into its final position fully assembled. The transformer must be designed and built to be disassembled on site and reassembled at its final position. Connection which are to be disassembled must be bolted and not crimped to allow for complete removal of the bus or cable to prevent damage during movement. The transformer must be designed and built to accomplish this disassembly without damage or loss of warranty. Include full set of drawings and instructions with the transformer submittals to accomplish this work.]

2.8.2 Incoming Sections

Provide a metal-enclosed medium voltage transition compartment for terminating the incoming medium voltage shielded cables. Include ground bus and support for cable bracing in this section. Access to the interior of the compartment must be through removable bolted panels or bolted hinged doors. Connections between the terminals of the incoming cables and the medium-voltage winding terminals of the adjacent transformer by means of copper bus with not less than [600][_____] amps continuous current-carrying capacity and [_____] kA asymmetrical amperes momentary current rating. Provide heavy-duty clamp type terminal lugs for connecting the medium-voltage cables to the transformer medium-voltage bus. The design must allow adequate space for bending and bracing of medium voltage shielded cable. The termination point for the medium voltage cable must be no less than 3 feet from where the cable enters the enclosure.[Install grounding studs on all three phases for use by maintenance personnel to install safety grounds.]

[2.8.3 Outgoing Sections

Provide a metal-enclosed low voltage transition compartment for connecting the transformer bus to the low voltage metal enclosed bus. Access to the interior of the compartment must be through removable bolted panels or bolted hinged doors. The connections must be made of copper bus with no less than [1200][1600][3200][_____]amps continuous current-carrying capacity and [25][42][65][_____] kA symmetrical amperes momentary current rating.

][2.8.4 Temperature Relay

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NOTE: The transformer temperature relay must be coordinated with the specific requirements of the project. If the relay is to be used for tripping rather than alarm functions, the contact ratings must be investigated to ensure it will be adequate. If it is used as an input to a protective relay or annunciation the electrical contact requirements are not as stringent. Coordinate with control and protection section within HDC to verify adequate contact ratings.

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Provide the transformers with a temperature monitor relay. The transformer temperature monitor must utilize four inputs: winding 1, winding 2, winding 3, and ambient temperature. Place input RTDs in the anticipated hottest spot of each winding assembly. The monitor equipped operate off of a 125VDC supply. Provide RTDs of the type recommended for the selected monitor. At a minimum, two programmable Form C contacts, rated for operation on a 125VDC system, be available for over-temperature alarm and trip functions. The temperature monitor must include communications provisions for utilizing MODBUS RTU protocol.

][2.8.5 Foundation

The transformer foundations must satisfy the requirements of the foundation for the 480 Volt switchgear.

]2.8.6 Surge Protection

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NOTE: Surge protection must be properly evaluated. The overvoltages as a result of the use of vacuum must be closely evaluated to determine the need for surge protection. Even if the project does not have medium voltage vacuum circuit breakers at the time of this equipment replacement, it will most likely get them within the life of this equipment. Standard HDC practice is to install surge arresters to protect the medium voltage winding. Care must be taken when installing surge capacitors however, as it can result in impacts to he electrical system if

not properly evaluated.
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[Mount surge arresters for each phase in the medium voltage terminal compartment. Surge arresters must be metal-oxide, station class, with a MCOV of 15.3 kV for 13.8 kV winding [MCOV of 5.1 kV for 4.16 kV winding]. Surge arresters must be constructed in accordance with the requirements of IEEE C62.11. Submit the surge arrester design test results for each type of arrester provided and the surge arrester conformance test results for each arrester provided. If surge arresters are not mounted near the base of the enclosure, a ground bus must be run to close proximity of the surge arrester so that cable is not run along the equipment housing to the enclosure ground bus. Perform all tests in accordance with IEEE C62.11]

[Surge Capacitors for each phase must be mounted in the transformer medium voltage terminal compartment. Provide surge capacitors rated 0.25 microfarad at 13.8 kV,[0.5 microfarad for 4.16 KV]. If capacitors are not mounted near the base of the enclosure, a ground bus must be run to close proximity of the capacitors so that cable is not run along the equipment housing to the enclosure ground bus.]

[2.8.7 Ground Bus

Provide a continuous ground bus inside the transformer enclosure including the transition and termination compartments. It must be copper not less than 2 inch by 1/4 inch. The ground bus must be mechanically connected to the core, frame and enclosure. The use of ground cables in lieu of bus is not allowed. Bond the ground bus to the bus within the switchgear.[Ground connections to surge protection equipment, except for final connection must be by adequately sized bus. The final connection to the surge equipment must be by cable to allow disconnection for maintenance and testing.] In the medium voltage compartment, install the bus up the wall to allow the connection of the medium voltage cable shields. Provide a burndy type YA lug to connect a 1/0 AWG copper cable to the powerhouse ground bus.

][2.8.8 High Resistance Ground Equipment

Install the High Resistance Ground (HRG) equipment at the main breaker sections for each bus of the switchgear. The HRG must be a regular catalog off-the-shelf packaged unit of a manufacturer regularly engaged in the design, manufacture, and testing of neutral grounding systems and for use on this type of equipment with no less than five years of successful operation. A device assembled of discrete parts is not acceptable. The HRG must be fully installed during switchgear tests.

2.8.8.1 Grounding Equipment

a. Each set of grounding equipment must include a grounding resistor and all associated controls and wiring. All connections and leads must be insulated for 600 volts AC.

b. Size the grounding resistors to provide 1 to 5 amperes of ground current in the event a single-line-to-ground fault. Tap the resistors with taps wired out to a convenient accessible terminal block. Provide taps for 1-5 amperes of ground current in 1 ampere increments. The resistors must be rated for continuous duty and of the heavy duty industrial stamped steel design. The resistors must conform to

IEEE C57.32 except that they are insulated for not less than 600 volts AC and the rated maximum temperature of the resistors can not exceed 415 degrees C when mounted inside the switchgear with natural air cooling. Provide mounting brackets for the resistors for mounting in the switchgear. All steel support materials must be corrosion-resistant steel or hot-dipped galvanized.

c. Current transformers must be window or bushing type rated 600 volts, ratio 10:10 with full wave insulation of 10-kV BIL when installed, 1.33 continuous thermal current rating factor based on 30 deg C and conform to the applicable requirements of IEEE C37.20.1A, IEEE C57.13, and IEEE C57.13.3. Plainly mark the polarity and provide with a suitable means of mounting and for grounding the frame. Each current transformer secondary lead must be connected to short-circuiting type terminal block with no less than No. 10 AWG and be conveniently located to permit short-circuiting the secondary windings without requiring access to the primary bus compartments. Short the current transformers at the terminals of each of the current transformers for shipping.

d. Each unit must be enclosed in the 480V switchgear, completely wired in the factory, in a location that will not interfere with the installation, operation, repair and maintenance of the switchgear. Manufacturer's standard ventilating openings must be provided for proper ventilation. Intake vents must be filtered, and both intake and exhaust vents be provided with corrosion-resistant insect-proof screens on the inside.

e. Provide engraved nameplates for all devices mounted within the assembly corresponding to appropriate designation on manufacturer's drawings.

f. Submit with the switchgear drawings: outline drawings, connection and assembly drawings, and schematic diagram of high resistance grounding system. Drawings to include overall dimensions, size and location of cable entrances, details for bolting equipment to the switchgear, data for all equipment, nameplate schedule, wiring diagrams. Provide wiring diagrams of the wire-less type and as viewed from the front, as seen by the observer facing the equipment.

][2.8.9 Ground Detection Equipment

Provide the ground detection equipment for each bus section of the switchgear, to be used for indication and annunciation of grounds on the 480-volt system. The equipment must consist of 3 instrument voltage transformers complete with primary and secondary fuses, connected wye-delta, with neutral of primary wye grounded and with the coil of a voltage ground detector relay connected in the broken delta corner of the secondary windings of the 3 voltage transformers. Provide two ground detector relays, one for each bus section of the switchgear. Mount the ground detection relay on the auxiliary compartment doors.

][2.8.10 Heaters

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NOTE: Heaters should be specified when required for the environment or by user request. Normally the station service transformers are always energized from the medium voltage side so heaters are not required for normal operation. In high humid environments, it may be difficult to get proper

insulation resistance reading when the transformer has been out of service for maintenance. The need for heaters should be coordinated with the specific application.

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Provide heaters with the transformer rated for 240VAC, but the number of heaters to be provided must be rated for operation at 120VAC. Provide a thermostat to operate the heaters and the thermostat must have user defined setting range of no less than [60 to 105][[_____] to [_____]] degrees F.

]2.9 METAL-ENCLOSED BUS

Submit the proposed methods for grounding bus housing.

2.9.1 General

Make electrical connections between the 480-volt terminals of the station service transformers and the power supply air circuit breakers in the main 480-volt station service switchgear consisting of 3-phase, nonventilated, nonsegregated-phase, metal-enclosed bus conforming to the applicable requirements of IEEE C37.20.3. Ensure bus is rated 600 volts AC [800][1,600][2,000] [_____] amperes continuous current carrying capacity, and the momentary current rating is no less than [25,000][42,000][50,000][65,000] rms asymmetrical amperes. Fabricate metal-enclosed bus in sections to suit the arrangement[shown]. Provide necessary frames and flange sections required at the bus terminals at the transformers and switchgear, and all required structural supports for the bus structures. Provide expansion sections wherever the bus crosses a [contraction][monolith] joint in the [building][powerhouse]. Coordinate all electrical and mechanical connections at the station service transformers with the station service transformer manufacturer. Provide flexible connections at the switchgear and transformer connections. Coordinate connections at the switchgear with the design of the 480-volt station service switchgear.

2.9.2 Conductors

Provide bare [copper,][aluminum][or][aluminum-alloy] bus phase conductors that when assembled, withstand the specified dielectric tests. Use silver-plated field joints in the conductors except that contact surfaces of aluminum-alloy conductors may be tin plated. Provide joints with sufficient bolts to provide adequate low-resistance contacts.

2.9.3 Enclosure

Mount three phase conductors with insulating supports and spacers inside a common nonventilated dust tight enclosure made of sheet metal no less than No. 14 MSG. Provide covers for enclosure openings that are no less than No. 14 MSG. Design enclosure to permit the installation and alignment of all bus sections and the completion of field joints in the conductors before the enclosure is completely closed.

[2.9.4 Grounding

Connect all sections of the housing to the powerhouse ground system. Bond bus housing sections together or connect to a common ground bus to facilitate connection to the powerhouse ground system. The proposed method of metal-enclosed bus grounding is subject to approval.

][2.10 CAPTURE KEY INTERLOCKS

****

NOTE: Capture Key Interlocks (Kirk Key) are not commonly used in most installation where automatic operation of breakers is required and electrical interlocks prevent inadvertent operation. Where manual breakers capable of feeding from multiple sources exist, capture key interlocks may a viable solution.

****

Where required, provide capture key interlocks that are switchgear mounted. Capture key interlocks must be factory installed and included as part of the breaker design. The key interlocks must hold the breaker mechanically trip-free to prevent electrical or manual closing while key is released. The key interlocks must only release the key with the breaker in the mechanically trip-free status.

][2.11 ANNUNCIATION EQUIPMENT

****

NOTE: Annunciation panels can be installed at the switchgear to display faults and alarms to supplement or duplicate SCADA system alarms from the switchgear. Add specific requirements for operator interface (HMI or light box) and alarms or indications chosen to be displayed.

****

Mount and wire one annunciator on each switchgear assembly as indicated on the drawings. The annunciator must satisfy the requirements of Section [_____].

]2.12 ACCESSORIES

Furnish handling and testing accessories needed to remove, replace, test and maintain the drawout type air circuit breakers. Include the following:

a. One Closing Lever for manually closing the electrically-operated circuit breakers.

b. One set of couplers (if required) for test operation of the electrically-operated breakers.

c. One set of test plugs for drawout relays.

d. Two sets of keys for key interlocks.

e. One Hoist, cart or other suitable means for breaker removal and handling.

f. One complete set of all special wrenches and tools required for the installation, maintenance and repair of the switchgear.

g. Four one-quart containers of paint for outside finish.

h. One portable test set by the same manufacturer as the static trip devices to check the operation of the static trip devices without the need for high primary circuit current.

i. One indicating lamp replacement tool (if required).

2.13 FACTORY INSPECTION AND TESTS

Submit five certified copies of the reports of all tests, including complete test data, and five sets of calibration curves for each trip.

2.13.1 General

Give each item of equipment supplied under this contract the manufacturer's routine factory tests and also other tests, as specified below, to ensure successful operation of all parts of the assemblies. Ensure all tests required are witnessed by the Contracting Officer, unless waived in writing, and do not ship equipment until it has been approved for shipment. Notify the Contracting Officer sufficiently in advance of the test date, so that the Contracting Officer can make arrangements to be present. Ensure factory test equipment and test methods conform to the applicable requirements of ANSI, IEEE and NEMA standards, and are subject to approval. The witnessing representatives of the Contractor and the Contracting Officer must sign all test reports.

2.13.2 Switchgear Assembly Tests

Subject each low-voltage air circuit breaker switchgear assembly to the [_____] ["Production Tests"] described in [IEEE C37.20.1A][IEEE C37.20.3], except as modified or supplemented below:

2.13.2.1 Assembled Equipment

Check assembled equipment for mechanical adjustment, alignment of panels and devices mounted thereon, adequacy of fastenings and general good workmanship.

2.13.2.2 Wiring

Give control, instrument and relay wiring a point-to-point check, and verify the correctness of the control wiring by actual operation of the compartment devices.

2.13.2.3 Switchgear Assembly

Subject each switchgear assembly, with all circuit breakers in operating position and contacts closed, to a 1-minute power frequency withstand dielectric test of 2,200 volts AC. Subject control, instrument and relay wiring to a 1-minute, power frequency withstand dielectric test of 1,500 volts AC to ground.

2.13.2.4 Circuit Breaker

Give each low-voltage power circuit breaker the production tests described in [NEMA C37.50][NEMA C37.51]. Thoroughly check each circuit breaker for proper operation and make all necessary adjustments. Check shunt trip coils for proper operation.

2.13.3 Instrument Transformer Test

Subject voltage and current transformers to routine tests in accordance with paragraph 4.7.2 of IEEE C57.13.

Furnish five copies of typical ratio and phase angle tests for each type and rating of instrument transformer.

2.13.4 Metal-enclosed Bus Test

Subject each shop-assembled section of metal-enclosed bus to a low-frequency dielectric withstand test of 2,200 volts for 1 minute between each conductor and the other conductors, and between all conductors connected together and the grounded metal housing in accordance with [IEEE C37.20.1A][IEEE C37.20.3].

2.13.5 Station Service Transformer Test

Subject station service transformers to the routine tests listed in paragraph 8.3 of IEEE C57.12.01, except that the temperature tests, if made, are made with the transformers in their enclosures in order to simulate actual operating conditions.

PART 3 EXECUTION

****

NOTE: An evaluation of the equipment installation requirements should be made. Requirements should be written to clearly articulate to the bidder the specific site requirements.

Hatch dimensions and doorway restrictions should be clearly indicated to ensure equipment is designed to be disassembled where required. Switchgear should be design for shipping splits where required to prevent factory wiring having to be redone in the field.

Critical powerhouse and main dam loads should be evaluated and a determination should be made as to how these loads are to be supplied while equipment is being replaced. Clear guidance should be provided to the Contractor to eliminate increase costs due to unknown risks. Unwatering pumps and battery chargers should be evaluated based on the time period of the outage and the amount of leakage in the plant. Also head cover pumps can also be critical in some of the plants. Sometimes the projects have the capability to provide temporary power; however, in this case clear time restrictions should be placed on the contractor to limit the impact to the project. Where the loads must be provided by the Contractor, these loads and the allowed location for temporary generators should be identified. A reasonable time period should be specified for the time period that the temporary power will be allowed as it has some impact on powerhouse reliability.

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****

NOTE: The drawings to be used in the contract set should be carefully considered to present a clear biddable package to the prospective bidders. Excessive drawings can add confusion to the work and it should be understood that Government will have significantly more knowledge about the project than the Contractor can have during the short proposal process. It can not be expected that the Contractor can navigate drawing pages with an excessive number of drawings with significant note callouts. Internals of equipment to be removed is not required. When equipment is being retained from existing equipment, reference drawings are usually adequate. New equipment arrangements, site space limitations, means for personnel and equipment access to work area are critical contract drawings. Reference drawings should be used to the maximum extent possible to indicate the existing equipment to be removed. Where minor modifications to existing equipment are being performed, such as replacing the feeder cables to motor control centers, it is not required to put the detailed motor control drawings in the contract set. The appropriate existing drawings can be reference. Reference drawings should be laid out in a logical manner to assist in navigating the information. Bidders will use the reference drawings and the cable and conduit schedule to determine level of work.

Contract Drawings should include:
1. Site Map
2. Index
3. Plan view of all floors affected and required to gain access to work area. This is to include plan view indicating all equipment being modified or replaced.
4. Transverse section of powerhouse indication location of equipment where available.
5. Longitudinal section of powerhouse indication location of equipment where available.
6. Elevation and plan views of new equipment indicating the desired layout, size limitations and conductor entry.
7. Plan view indicating general routing and restrictions of new raceways.
8. One-line diagrams of powerhouse and equipment indicating the equipment to be modified or replaced.
9. Control schematic of electrical operated breakers.
10. Annunciation drawings if modified. If not being modified, reference drawings can be used to indicate reconnection of alarm circuits.
11. Wiring diagrams of affected remaining panels if being modified if substantial work is being performed which cannot be referred to the reference drawings. It should be understood that prospective

bidders are only bidding on the level of work during proposal process, so there are other alternatives than including detailed wiring diagrams in contract set to facilitate bidding process. If not modified, reference drawings can be used to indicate the location of the work.
12. Cable and conduit schedule. These drawings are critical as they indicate to the bidders the amount and routing cables and new raceways. Care should be taken to ensure these accurately represent the scope of the project.
****

3.1 PAINTING

Finish and paint metal surfaces of the low-voltage metal-enclosed switchgear assembly and the enclosures for the metal-enclosed bus and station service transformers in accordance with [IEEE C37.20.1A][IEEE C37.20.3], except give all outside surfaces no less than 2 coats of quick air drying lacquer or synthetic enamel, [ANSI] Indoor Light Gray No. 61 in color, with semi-gloss finish. Finish accessories and interior surfaces in accordance with manufacturer's standard practices.

3.2 480-VOLT SWITCHGEAR FACTORY INSPECTION AND TESTS

****
NOTE: Add appropriate requirements to specify installation by the Contractor.
****

3.2.1 General

****
NOTE: The switchgear assembly to be furnished should be a standard product of a manufacturer that has satisfied all the required design test requirements. Specifying switchgear assemblies that has not been subjected to design testing prior to award should be avoided. If for some reason standard switchgear product can not be installed, the specifications should be carefully modified by knowledgeable individuals to reduce risk to the Government.
****

a. Give each item of equipment supplied under this contract the manufacturer's routine factory inspections and tests and also other tests, as specified below, to ensure successful operation of all parts of the assemblies. All equipment must be completely assembled and wired during testing.[Where controls connect to other equipment to be provided, such as transformer temperature relays, simulate these controls during testing.] All tests required must be witnessed by the Contracting Officer, unless waived in writing, and no equipment is to be shipped until it has been approved for shipment. Provide no less than [14][_____] calendar days advance notification of testing to the Government.

b. Design tests must have been previously performed prior to award on the circuit breakers and switchgear design to be furnished under this contract. Submit Certifications of Switchgear and Breakers Design Tests and Time Current Curves. Design tests require to be conducted are as described in IEEE C37.20.1A as applicable for the ratings of the circuit breakers and switchgear to be furnished under this Contract. Submit proof of adequacy of design by certified reports. Identify all design tests which were performed to certify the design and submit Design Test Reports to permit review of design test data, oscillograph tracings, and other information by the Contracting Officer's Representative (COR).

c. Submit Factory Test Procedure prior to factory testing. Test the equipment for the production tests required in IEEE C37.20.1A. The factory test equipment and test methods used must conform to the applicable requirements of ANSI, IEEE and NEMA standards. Submit Factory Inspection and Test Reports after completion of the tests.

3.2.2 Breaker Assembly Tests

Test each low-voltage air circuit breaker assembly to the Production Tests described in IEEE C37.20.1A, except as modified or supplemented below:

3.2.2.1 Assembled Equipment

Check the assembled equipment for mechanical adjustment, alignment of roll out assemblies and devices mounted thereon to ensure proper fit and insertion into cubicles in existing switchgear assembly. The combined assembly of breaker and switchgear will be checked for adequacy of fastenings and general good workmanship.

3.2.2.2 Wiring

Perform all control, instrument, and relay wiring a point-to-point check. Ensure the correctness of the control wiring by actual operation of the compartment devices.

3.2.2.3 Breaker Assembly

Perform a 1-minute power frequency withstand dielectric test of 2,200 volts AC as recommended in NEMA C37.50 on each breaker assembly. Perform a 1-minute, power frequency withstand dielectric test of 1,500 volts AC to ground unless the required test voltage is reduced per NEMA C37.50 on all control, instrument, and relaying wiring.

3.2.2.4 Circuit Breaker

Test each low-voltage power circuit breaker to the production tests described in NEMA C37.50. Thoroughly check each circuit breaker for proper operation and make all necessary adjustments. Check the shunt trip coils for proper operation.

3.2.2.5 Switchgear Assembly

Perform a 1-minute power frequency withstand dielectric test of 2,200 VAC on each switchgear assembly, with all circuit breakers in the fully racked in position and all breakers closed.

3.3 INSTALLATION

Install all equipment in accordance with the National Electrical Code, NFPA 70, and the National Electrical Safety Code, IEEE C2. Omission of details on the drawings or in the specifications will not be construed as permitting deviations from Code requirements. Plan work and coordinate all outages with the requirements of other contract technical sections to ensure continuity of service to powerhouse equipment and to limit impact to the operation of the powerhouse.

3.3.1 Work Plan

****

NOTE: Edit "WORK PLAN" section based on contract type as described in note under section 1 GENERAL. Reference appropriate specification sections if appropriate or use/edit bracketed text as needed.

****

Submit a work plan for approval per Section 01 33 00 SUBMITTAL PROCEDURES.[For coordination of electrical outages and equipment installation, to be updated as changes occur, but no less than weekly during site work. Include all activities which are hazardous, affect plant operation, or require participation by Government personnel, in the plan. Include an itemized listing of all work to be performed with detailed schedule of outages required for equipment replacements or for temporary power connections. Take into account the time for government switching and safety clearance procedures.]

[3.3.2 Temporary Power

****

NOTE: Temporary power is recommended for loads that are deemed critical for powerhouse operation and are not able to be powered from another normal power source. Examples may include: Battery chargers, head cover pumps, drainage or sump pumps, intake structure power source, lighting, etc.

Edit "TEMPORARY POWER" section based on contract type as described in note under section 1 GENERAL. Reference appropriate specification sections if appropriate or use/edit bracketed text as needed.

****

The existing 480 volt equipment is critical to operation of the [powerhouse][_____]. Provide temporary power to the [powerhouse][_____] per Section 01 11 00 SUMMARY OF WORK.[Only one bus of the existing 480 volt switchgear will be allowed to be taken out at a time. The Government will transfer all loads to the opposite bus prior to de-energization for removal.[Provide temporary power to the equipment listed below.][Provide standby diesel generator(s) to supply these loads. Locations for placing the temporary power supplies are to be indicated on the drawings.][Install temporary feeder cables from existing motor control centers to supply power to the critical loads listed.][Include the temporary power plan as part of the detailed work plan.]]

][3.3.3 Foundations and Seismic Requirements

Level and grout the equipment foundations into place prior to installing the equipment.[Place the foundation channels on top of the floor, leveled, anchored to floor and grouted in place.] The minimum embedment depth of anchors into solid concrete is 4 inches and the installation must comply with the requirements of Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.[Install an equipment housekeeping pad under the equipment with the foundation channels level on the pad using leveling bolts prior to installing pad in accordance with Section 03 33 00 CAST-IN-PLACE ARCHITECTURAL CONCRETE.][The concrete pad must be extended at least 2 inches beyond all sides, front and back of the equipment except where equipment extends to walls.] Bolt the switchgear to the foundation. Welding of the switchgear to the foundation is prohibited. Provide all trim to completely enclose open ends in foundation. Coordinate the foundation construction and install as approved by the COR.

[Submit Certifications of Seismic Requirements with specific ground motion criteria per per Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT prior to installation.]

]3.4 FIELD INSPECTION, TESTING AND COMMISSIONING

3.4.1 General

****

NOTE: The NETA acceptance testing specifications lists the field testing to be performed. The General inspections and tests have been listed below, however, they are not all encompassing. This general listed is used for bidders to understand the general scope of work prior to award and to emphasize the required acceptance testing. If the NETA tests are to be modified, those modifications should be clearly identified in the list.

****

After completion of the installation of the equipment and accessories, perform routine and complete operational tests to insure proper installation and verify proper operation. Perform field testing of switchgear and breakers [, and metal enclosed bus] per IEEE C37.20.1A, IEEE C57.13, NETA ATS,[IEEE C37.23] and applicable IEEE 1248 recommended procedures. Perform routine tests including inspections and tests for location and mechanical alignment, damage to equipment porcelain or painted surfaces, electrical continuity of external circuits, and voltage transformer phase rotation.

a. Following installation, inspect, adjust, test, and commission the equipment following applicable procedures listed in IEEE 1248. Perform all equipment commissioning required by the equipment manufacturers and as noted in Section 01 91 00.15 BUILDING COMMISSIONING of this contract.

b. Include all testing recommended in the referenced standards. All test equipment must have been calibrated within one year of testing. Include test equipment manufacturer, serial number, range and test equipment calibration certificate on all test reports. Record the exact test voltage, current, etc. Include the name of the test engineer and the date the tests were performed as part of the test data.

c. Submit a Field Test Procedure for approval, listing the routine and operational tests to be conducted. Include a detailed step by step process of what tests and inspections are to be performed and their acceptance criteria. Include on the test forms, a row for each activity with a column for pass/fail, testers initials and remarks. The tests must be witnessed by a COR. Furnish a certified copy of all Field Test Reports, including complete test data on all tests. Reports of all witnessed tests must be signed by the witnessing representatives of the Contractor and the COR. The costs of performing all tests is to be included in the prices bid for the items of equipment in the Schedules. Perform the routine and operational tests as outlined below and as recommended by the manufacturer and the Field Service Engineer.

3.4.2 Low Voltage Breakers and Switchgear

At a minimum, perform the following tests:

a. Breaker contact resistance. Provide data on maximum allowable contact resistance from the manufacturer.

b. Mechanical alignment of breaker assembly including the primary and secondary contacts, shutters; verifying operation of auxiliary breaker and cell switches. Rack the breaker out no less than 5 times to verify the proper operation of cell switches and to ensure that the shutters do not bind.

c. Breaker/racking mechanism interlocks to ensure it cannot be inserted or removed unless the breaker is in the open position. If there is a test position, verify operation of breaker in test position.

d. All local and remote breaker controls, auto transfer, interlocks, remote trips and alarms in both the test and the operate positions.

e. Electrical check operation of each low-voltage power circuit breaker.

f. All breaker trip settings at the final settings.

g. Check calibration and accuracy of meters.

h. Subject each switchgear to a 1-minute power frequency withstand dielectric test at 1,600 VAC with circuit breakers in the operate position and with breakers closed.

[i. Accuracy and polarity of all instrument transformers.]

[3.4.3 Metal Enclosed Bus

At a minimum, test each section of metal enclosed bus in accordance with the manufacturer recommendations. Perform a dielectric test with values in IEEE C37.23.

]3.4.4 Transformer

At a minimum, test each transformer after installation in accordance with the manufacturers recommendations and the following tests:

a. Insulation Resistance Test

b. Turns Ratio Test

[3.4.5 Protective Relays

Perform testing of the protective relays in the factory prior to shipment, and visually and mechanically inspected once received at the project. Submit Manufacturer's Test Reports no later than [7][_____] days after shipment.[Program and test the relays with the Government provided relay settings and procedures. Test the functionality of the relays and controls with Government provided test procedures.][Test the functionally of the relays and controls with Government provided program and test procedures.] Notify the Government prior to doing the relay and functional testing to allow a Government representative to be present during the testing. No testing of the relay settings or functionally test of the relay will be allowed without a qualified Government official present unless the Government waives their right to witness the specific test.

]3.5 QUALIFICATIONS OF FIELD ENGINEERING SERVICE PERSONNEL

Provide a qualified field engineering service personnel who is fluent in the English language to supervise, test, and install the new equipment. The personnel must have a minimum of five years experience in the installation and testing of new equipment made by the manufacturer used and is required to be onsite during equipment installation and testing. Submit qualifications for the field service engineer(s) for approval and must demonstrate compliance with the above requirements. The Field Engineering Service personnel must certify that the equipment has been installed in accordance with the manufacturers recommendations and all warranties are in effect. Submit documentation of all adjustments, tests and inspections made by field engineer. The field engineering service personnel is required to be present during both the Contractor's commissioning of equipment and for the Government's commissioning of the system, per Section 01 91 00.15 BUILDING COMMISSIONING. Provide the COR with a current resume for all field engineering service personnel.

3.6 CONTRACTOR FURNISHED TRAINING OF GOVERNMENT PERSONNEL

a. Provide a qualified training engineer(s) who is fluent in the English language to provide training on the breakers and the trip units. The personnel must have a minimum of two years experience in the operations, maintenance, installation and testing of switchgear and power circuit breakers for the manufacturer furnished. Submit Qualifications of Instructor for approvals no less than [60][_____] days prior to training.

b. Include in the training for Project personnel the theory, operation, and maintenance of the new switchgear, breakers and [transformers]. Provide [one][two] training course[s].[One for maintenance personnel and one for operating personnel.] The maintenance course must be a minimum of eight hours in duration with [one][_____] class.[In addition to the maintenance courses, provide [two][_____] courses for operational personnel that will be a minimum of two hours each.] The operational personnel training must occur on different days and be coordinated with Government to ensure shift operators can all attend. Time and date of training is subject to Government approval. Conduct the training with an expectation of approximately 10[_____] Government employees at the Project for each session. Training must occur no more than [30][_____] days after[first] equipment has been placed in service, but in no case prior to equipment installation.

c. Include the operation, maintenance, warranty requirements, inspection repair and adjustment for the power circuit breakers, digital trip units[, and transformer controls] in the maintenance course. Include the theory of operation, calibration, programming, repair, routine maintenance, disassembly, trouble analysis and safety precautions. The operations course must include equipment design, theory of operation, use of displays and explanation of trip and alarm messages. Perform all demonstrations on the actual equipment furnished, to the maximum extent possible.

d. Submit course outline and course material for approval no less than [60][_____] days prior to training. Include, to the maximum extent possible, the site-specific operation and maintenance data that is provided for the project, utilizing the actual on site provided equipment when possible. The Government may videotape the training sessions for future use. Submit for Government approval, a training outline detailing course topics, material, and subjects.

3.7 OPERATION AND MAINTENANCE MANUAL

Provide Operations and Maintenance (O&M) manuals for all the equipment contained in this section in compliance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

[Assemble the O&M manual specifically for this contract. Provide the O&M manual for all equipment provided and include all the requirements for the testing, inspection, maintenance, troubleshooting, and repair of the equipment. Provide an index for each section/sub section and include tabs which correlate to the index. Include final as-built drawings as part of the O&M manual. Submit three draft hard copies of the O&M manual for approval. Once approved, provide [five][_____] final copies of O&M manual along with a CD of the O&M manual with each final manual.]

3.8 AS-BUILT DRAWINGS

Provide a complete set of final As-built Drawings for the equipment furnished per Section 01 78 00 CLOSEOUT SUBMITTALS. Prior to the field training course, all as-built drawings must be approved.[Include at a minimum:

a. Switchgear Manufacturer's Installation Drawings and Details.

b. Switchgear Manufacturer's One-Lines and Three-Lines

c. Circuit Breaker Controls and Schematic Diagrams

d. Switchgear Manufacturer's Wiring Diagrams]

3.9 FINAL ACCEPTANCE

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NOTE: Reference appropriate specification section in summary of work, Quality Control or other section covering the requirements associated with final acceptance by the government. Varies based on contract type.

****

Final acceptance of the switchgear[and installation] [per Section 01 45 00

QUALITY CONTROL][_____][will not be given until the Contractor has successfully completed all testing, test reports have been submitted and approved, and after all defects in installation, material or operation have been corrected.]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-26 23 00 (February 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 23 00 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-26 23 00 (February 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 23 00 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 23 00

LOW-VOLTAGE SWITCHGEAR
02/24

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NOTE: This is a revised guide specification that, in part, replaces 26 23 00, SWITCHBOARDS AND SWITCHGEAR. The original guide specification was separated into two specifications: 26 23 00, LOW-VOLTAGE SWITCHGEAR, and 26 24 13, SWITCHBOARDS.

This guide specification covers the requirements for metal-enclosed low-voltage power circuit-breaker switchgear assemblies in either interior or exterior locations. This guide specification is intended for alternating current applications; additional editing will be necessary to tailor it for direct current applications.

Per UFC 3-520-01 3-2.2, specify metal-enclosed switchgear for service entrance equipment only when the service is 1200 amperes or larger, and all branch and feeder circuits are large, above 400A or if any branch or feeder circuit is larger than 800A. Specify switchboards in accordance with 26 24 13 SWITCHBOARDS for service entrance equipment when the equipment feeds circuit breakers 800A or smaller. Utilize switchboards throughout the distribution system where equipment is 1200 amperes or larger.

When the proposed switchgear is connected to a secondary unit substation, coordinate with Section 26 11 16 SECONDARY UNIT SUBSTATIONS.

This specification is not intended to be used for generator control switchgear without extensive modification and coordination with applicable engine-generator set guide specifications.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide

specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: Verify that the following information is indicated on the project drawings:

1. Single-line diagram showing buses and interrupting devices with interrupting capacities; current transformers with ratings; instruments and meters required; and description of instruments and meters.

2. Location, space available, arrangement, and elevations of switchgear.

3. Grounding plan.

4. Type and number of cables, size of conductors for each power circuit, and point of entry (top or bottom).

5. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gases; and seismic requirements.

6. Arc flash label requirements. Download the label format at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

7. Available fault current label for service entrance equipment. Download the label format at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-table

8. Locations with arc energy reduction methods specified.

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NOTE: In corrosive and humid environments, use materials, systems, components, and coatings that are durable and minimize the need for preventative and corrective maintenance over the expected service life of the component or system. Corrosive project locations are those with Environmental Severity Classification (ESC) of C3, C4, and C5. Humid

locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project location.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2017) Minimum Design Loads for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel

	Hardware
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D149	(2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 1584	(2018; E 2019) Guide for Performing Arc-Flash Hazard Calculations
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.13	(2024) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.20.1	(2020) Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit-Breaker Switchgear
IEEE C37.20.7	(2017; Corr 2021) Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity

IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems- Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products
NEMA ST 20	(2014) Dry-Type Transformers for General Applications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 508A	(2018; Reprint Jul 2022) UL Standard for Safety Industrial Control Panels
UL 1558	(2016; Reprint Nov 2019) UL Standard for Safety Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

1.2 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment

Include Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS for all systems where meters are networkable, circuit breakers have communication features built in, or other communication system being provided with switchgear whether being connected to network or not.

****

Section 26 08 00 APPARATUS INSPECTION AND TESTING[and Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS] applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G, [_____]

SD-03 Product Data

Switchgear; G, [_____]

SD-06 Test Reports

Switchgear Design Tests; G, [_____]

Switchgear Production Tests; G, [_____]

Acceptance Checks and Tests; G, [_____]

SD-10 Operation and Maintenance Data

Switchgear Operation and Maintenance, Data Package 5; G, [_____]

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G, [_____]

Equipment Test Schedule; G, [_____]

****

NOTE: Select "Request for Settings" below if protective device settings will be government furnished. Select "Required Settings" below if protective device settings are furnished by the Designer of Record. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the final protective device settings for design/build versus design/bid/build projects. Do not rely on the manufacturer's default settings.

****

[Request for Settings; G, [_____]

][Required Settings; G, [_____]
]

****

NOTE: NFPA 70 Article 110.24 requires an available fault current label to be applied at the service entrance. Select "Available Fault Current Label" below if the switchgear is part of the service entrance equipment. Coordinate with the person developing the Division 1 Sections and ensure that

Division 1 Sections identify the person responsible for providing the short circuit calculation for the project. This may vary for design/build versus design/bid/build projects.
****

[Service Entrance Available Fault Current Label; G, [_____]

]1.5 QUALITY ASSURANCE

1.5.1 Product Data

Include manufacturer's information on each submittal for each component, device and accessory provided with the switchgear including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device.

1.5.2 Manufacture Qualifications

Manufacturer must be a firm engaged in the manufacture of switchgear of the types and sizes required and whose products have been in satisfactory use in similar service for a minimum of 5 years.

[a. Switchgear must be the product of a single manufacturer. The manufacturer of the assembly must be the manufacturer of the major components within the assembly.

][b. For the equipment specified herein, the manufacturer must be ISO 9001 certified.

][c. The manufacturer or their representative must have service, repair, and technical support services available 24 hours, 7 days a week.

][d. Switchgear must be provided by a manufacturer who offers integrated supply of switchgear enclosures, buses, circuit breakers, and associated control hardware. All major components of the switchgear, including but not limited to enclosures, buses, buckets, circuit breakers, and any other major components must be made and offered by the same manufacturer and must be branded, marketed and manufactured by the same manufacturer as part of an integrated product line available as a catalog product offered through distributor networks with readily available spare parts.

][e. The manufacturer of this equipment must have produced similar electrical equipment for a minimum period of 5 years. When requested by the Engineer, provide an acceptable list of installations with similar equipment demonstrating compliance with this requirement.

]1.5.3 Acceptance Testing Qualifications

Testing personal must show at least 3 years of experience testing similar systems.

[a. Testing personnel must be familiar with NETA ATS and manufacturer's testing recommendations.

][b. Testing personnel must be experienced in manufacturer's acceptance testing recommendations[and NETA ATS requirements].

][c. Testing must be performed by a NETA-accredited testing service. Testing service must provide a NETA-certified technician to perform the testing to NETA ATS[and manufacturer's acceptance testing recommendations].

]1.5.4 Switchgear Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable industry, and technical society publication references on submittals. Include the following:

a. One-line diagram including breakers[, fuses][, current transformers, and meters].

b. Outline drawings including front elevation, section views, footprint, and overall dimensions.

c. Bus configuration including dimensions and ampere ratings of bus bars.

d. Markings and NEMA nameplate data[, including fuse information (manufacturer's name, catalog number, and ratings)]. Comply with the IEEE C37.20.1 section 7.1.4.1 for minimum information for switchgear assembly nameplates.

e. Circuit breaker type, interrupting rating, and trip devices, including available settings.

f. Wiring diagrams and elementary diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.

g. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device. Use this information (designer of record) to provide breaker settings that ensures protection and coordination are achieved.[For Navy installations, provide electronic format curves using SKM's Power Tools for Windows device library electronic format or EasyPower device library format depending on installation modeling software requirements.]

[h. Relaying and SCADA equipment diagrams.

] **

NOTE: If selecting provisions for future expansion, ensure the facility and room size is adequate for the additional equipment.

****

[i. Provisions for future expansion by adding switchgear sections.

]1.5.5   Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.6   Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.6.1   Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.6.2   Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site are not acceptable.

1.6   MAINTENANCE

1.6.1   Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.2   Assembled Operation and Maintenance Manuals

Assemble and securely bind manuals in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents:

a. Manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA.

b. Catalog data required by the paragraph SD-03, PRODUCT DATA.

c. Drawings required by the paragraph SD-02, SHOP DRAWINGS.

d. Prices for spare parts and supply list.

[e. Information on metering.

] f. Design test reports.

g. Production test reports.

[1.6.3 Spare Parts

****

NOTE: Do not use this paragraph for Navy projects. For other services, coordinate with Contracting Officer on whether this paragraph can be included.

Edit as required if additional spare parts are required for a specific project.

****

Provide spare parts as specified below. Provide spare parts that are of the same material and workmanship, meet the same requirements, and are interchangeable with the corresponding original parts furnished.

a. Quantity 2 - Fuses of each type and size.

[b. [_____]

]]1.7 WARRANTY

Provide equipment items that are supported by service organizations reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchgear and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SWITCHGEAR

IEEE C37.20.1 and UL 1558.

2.2.1 Ratings

Provide equipment with the following ratings:

****

NOTE: Select "as indicated" if there are multiple switchgear with details of each shown on drawings. Most switchgear will be 4-wire, but might be a

3-wire design for delta-connected or ungrounded systems.
****

a. Voltage rating: [480Y/277][208Y/120][_____] volts AC, [3][4]-wire [three-phase, [3][4]-wire][as indicated].

b. Continuous current rating of the main bus: [_____ amperes][as indicated].

c. Short-circuit current rating: [_____ rms symmetrical amperes][as indicated].

d. The assembly must be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of [_____] amperes symmetrical at rated voltage[as shown on the drawings].

e. The bus system must have a minimum ANSI short-circuit withstand rating of [_____] amperes symmetrical tested in accordance with IEEE C37.20.1, CSA C22.2 No. 31, and UL 1558.

f. UL listed and labeled[for its intended use][as service entrance equipment].

2.2.2 Construction

****
NOTE: Edit the selection options below as needed for the intended project configuration.

Determine if an arc-resistant design will be specified for the installation. A selection of arc-resistant switchgear can affect the installation design. Arc-resistant switchgear is tested and certified to IEEE C37.20.7, and is intended to provide added protection for internal arcing faults. Select Type 1 if arc protection is only required for the freely accessible front of the enclosure. Select Type 2 if arc protection is required for freely accessible front, sides and rear of the enclosure. Select the 'B' suffix for additional protection applied to compartments designated as low voltage control or instrumentation compartments. Select the 'C' suffix where isolation from the effects of an internal arcing fault is desired between all adjacent compartments within a switchgear assembly. Most manufacturers produce Type 2B as a standard product, which could increase the switchgear cost by about 20 percent. Review IEEE C37.20.7 for additional information.
****

Provide the following:

a. Switchgear: consisting of vertical sections bolted together to form a rigid assembly and [rear][front and rear] aligned[as indicated].

b. All circuit breakers: front accessible with rear load connections.

c. Compartmentalized switchgear: vertical insulating barriers between the front device section, the main bus section, and the cable compartment[with full front to rear vertical insulating barriers between adjacent sections].

d. Where indicated, "space for future" or "space" means to include all necessary components and hardware to be fully equipped for racking in a circuit breaker element.

e. Insulating barriers: provided in accordance with NEMA LI 1, Type GPO-3, 6.35 mm 0.25 inch minimum thickness.

[f. Moisture resistant coating: applied to all rough-cut edges of barriers.

][g. Switchgear: Arc-resistant[Type 1[B][C]][Type 2[B][C]], tested in accordance with IEEE C37.20.7.

]2.2.2.1 Enclosure

****

NOTE: Choose the level of corrosion protection required for the specific project location. Most switchgear products will be constructed of a cold rolled steel and painted, which is adequate for most indoor locations. Use galvanized steel or stainless steel enclosures or bases for outdoor applications where corrosion is a concern; specify stainless steel for project locations with Environmental Severity Classifications (ESC) of C4 and C5, galvanized is acceptable for project locations with ESC of C3. See UFC 1-200-01 for determination of ESC for project locations. Not all manufacturers offer galvanized steel or stainless steel products as a standard design. Stainless steel is not typically available from all manufactures and thus may require integration into an integrated power assembly or e-house with an outdoor rating.

Select IEEE C57.12.28 for galvanized enclosures. Select IEEE C57.12.29 for stainless steel enclosures. Galvanized steel may not be standard option and should only be considered when necessary.

Infrared viewing windows are typically installed in the switchgear rear covers to facilitate the use of IR cameras for thermally scanning cable terminations. Continuous thermal monitoring sensors are another option.

****

Provide the following:

a. Enclosure: [outdoor] NEMA ICS 6 Type [3R][1][_____][as indicated][fabricated entirely of 12 gauge ASTM A240/A240M type 304 or 304L stainless steel].

b. Enclosure: bolted together with removable bolt-on side and[hinged] rear covers[, and sloping roof downward toward rear].

[c. Front[and rear] doors: provided with[stainless steel] padlockable vault handles with a three point catch.

][d. Bases, frames and channels of enclosure: corrosion resistant and fabricated of[ASTM A240/A240M type 304 or 304L stainless steel][or][galvanized steel].

] e. Base: includes any part of enclosure that is within 75 mm 3 inches of concrete pad.

[f. Galvanized steel: ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

] g. Paint color: ASTM D1535 light gray No. 61 or No. 49 over rust inhibitor.

[h. Paint coating system: comply with[IEEE C57.12.28 for galvanized steel][and][IEEE C57.12.29 for stainless steel].

][i. Infrared viewing windows: install to allow the use of an infrared camera or thermal imager direct line of site to inspect electrical connections without requiring the opening of panels and doors. These windows are intended to allow thermographers the ability to inspect the electrical equipment without directly exposing themselves to live electrical components and energized devices.

(1) The infrared viewing window must be a UL recognized component.

(2) Switchgear must include solid infrared transmitting media viewports to be used with an infrared camera. Provide viewing windows to allowing viewing of all termination locations.

(3) Viewing window must maintaina the NEMA 250 environmental rating of the switchgear enclosure.

(4) Provide a metallic cover with the viewing window. Cover and fastener must be permanently attached.

][j. Provide a continuous thermal monitoring sensors and system for cable and bus bolted connections.

]2.2.2.2 Arc Resistance Enclosure

****

NOTE: Arc resistant switchgear enclosure is an option to be considered for any switchgear design and installation. It is important to note that arc-resistant switchgear provides protection from internal arcing faults when the equipment is closed and operating normally. Arc-resistant switchgear should be considered whenever operator safety is a concern and also must be considered for installations where incident energy anywhere within the structure is anticipated to be 8 calories (Cal) or greater. Arc-resistant switchgear is available in Type 1 (in the front of equipment only), Type 2 (entire perimeter of equipment), Type 2B (entire

perimeter of equipment even with instrumentation door open), and Type 2C (arc resistant between adjacent equipment compartments within the assembly, as well as around the perimeter of the equipment). Consider that arc resistant switchgear is not designed to preserve the operation condition of the equipment, but rather to only protect operating personnel located outside of the equipment. There are not any additional maintenance requirements for arc resistant switchgear. Arc resistant and arc mitigation are not the same thing. Arc resistant switchgear is to contain and redirect an arc flash event from operating personnel. Arc Flash mitigation is to reduce the severity or likelihood of an arc flash event.

****

Provide low-voltage metal enclosed, draw-out switchgear constructed to IEEE C37.20.1 standards and designed to contain the effects of arc flash events inside the switchgear per IEEE C37.20.7. Switchgear must be certified as Type 2B arc-resistant in a NEMA 250 Type 1 enclosure."

[Provide switchgear with a ventilation system that allows exhaust of arc gases regardless of the origination location of the arc event. The ventilation system must be designed to exhaust arc events originating in the circuit breaker cell, bus compartment, and rear cable compartment.

][Arc resistant switchgear must not have an arc plenum, and must require 3 meters 10 feet minimum floor-to-ceiling height for arc exhaust, with no obstructions in the space above the switchgear.

][Provide Arc resistant switchgear with an arc plenum included that has been tested according to IEEE C37.20.7 from the same manufacture as the switchgear. Provide external connections to an arc duct. Coordinate exterior location to ensure duct exhausts are free from obstructions.

]2.2.2.3 Bus Bars

****

NOTE: Use copper with silver-plated contact surfaces in exterior or damp locations or for heavy motor loads.

Delete the neutral bus bracketed option if a 3-wire system was selected.

Only choose the bracketed option requiring insulation on the bus bars for outdoor locations with a high concentration of airborne contaminants. Choose this option primarily for corrosive and high humidity applications as defined in UFC 3-501-01. Most manufacturers will apply an insulating sleeve rather than an epoxy coating.

****

Provide the following:

a. Bus bars: [copper with silver-plated contact surfaces][or][aluminum with tin-plated contact surfaces].

(1) Phase bus bars: [uninsulated][insulated with an epoxy finish coating powder or insulating sleeve providing a minimum breakdown voltage of 16,000 volts per ASTM D149].

(2) Neutral bus: rated [100][_____] percent of the main bus continuous current rating[as indicated].

b. Make bus connections and joints with hardened steel bolts.

c. Main-bus (through bus): rated at the full ampacity of the main throughout the switchgear.

d. Minimum 6.35 mm by 50.8 mm one-quarter by 2 inch copper ground bus secured to each vertical section along the entire length of the switchgear.

2.2.2.4 Main Section

****

NOTE: Current-limiting fuses should only be needed if the available fault current exceeds the circuit breaker short circuit rating.

****

Provide the main section consisting of[main lugs only][an individually mounted][drawout][air power circuit breaker[with current-limiting fuses]][and a separate vertical section for the utility transformer meter compartment].

2.2.2.5 Distribution Sections

****

NOTE: Current-limiting fuses should only be needed if the available fault current exceeds the circuit breaker short circuit rating. Utility transformer compartments are rarely used and will require additional review if this bracketed option is selected.

****

Provide the distribution section[s] consisting of[[individually mounted,][drawout,]][air power circuit breakers[with current-limiting fuses]][and utility transformer compartments] as indicated.

[2.2.2.6 Auxiliary Sections

Provide auxiliary sections consisting of indicated[instruments,][metering equipment,][control equipment,][transformer,][and][current transformer compartments] as indicated.

][2.2.2.7 Handles

Provide handles for individually mounted devices of the same design and method of external operation. Label handles prominently to indicate device ampere rating, color coded for device type. Identify ON-OFF indication by handle position and by prominent marking.

][2.2.2.8 Seismic

****
NOTE: Keep this section for sites where the Seismic design class is C or higher. Coordinate with structural for design class determination and Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT. If seismic design class A or B delete.
****

Equipment must be Seismic Qualified and Certified by 3rd party testing to meet ASCE 7/IBC. Equipment capacity must be determined from tri-axial seismic shake table test results as defined in the International Code Council Evaluation Service (ICC ES) Acceptance Criteria for Seismic Qualification Testing of Nonstructural Components (AC156). Apply an equipment importance factor of 1.5 for seismic test. See 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT for additional requirements.

[Equipment must have Pre-approval (OSP) under California Office of Statewide Health Planning & Development (OSHPD) Special Seismic Certification program for California Healthcare Facilities.

]]2.2.3 Protective Device

****
NOTE: Switchgear should be placed where the ambient temperature is less than 40 degrees C, which is the basis for rating in accordance with IEEE C37.13. However, should the ambient temperature be expected to exceed 40 degrees C, the designer must require a special calibration for the circuit breakers and confirm the equipment ratings.

This paragraph assumes that circuit breakers are available rated for the specified short circuit current. For very high short circuit currents, the manufacturer might have to install current-limiting fuses upstream of the circuit breaker.

Provide ground fault protection of equipment for solidly grounded wye electrical services of more than 150 volts to ground for each service disconnect rated 1000 amperes or more in accordance with NFPA 70.

If 48 Vdc or 125 Vdc electrically operated circuit breakers are required, the appropriate DC control power supply information must be added to the specification.
****

Provide[main and] branch protective devices as indicated.

Provide the following:

a. IEEE C37.13. [120 Vac][electrically][manually] operated drawout, [unfused][fused], low-voltage power circuit breaker with a short-circuit current rating[of [_____] rms amperes symmetrical][as indicated] at [_____] volts.

b. Breaker frame size: [as indicated][[_____] amperes].

[c. Equip electrically operated breakers with motor-charged, stored-energy closing mechanism to permit rapid and safe closing of the breaker against fault currents within the short time rating of the breaker, independent of the operator's strength or effort in closing the handle.

] d. Protective relay. Provide relays capable of communicating with [Modbus RTU][Modbus TCP][RS485][_____]. Relays must be equipped with self-checking diagnostics. Coordinate relay requirements with instrument transformers for proper operation. Provide a microprocessor-based relay equipped with the following combination of functions including protection, monitoring, control, automation, and reporting functions. Provide test switches for testing or protective relay. Provide a switch for each function.

[(1) Overcurrent protection with time overcurrent elements for phase, neutral, and ground.

][(2) Under- and overvoltage elements for protection and control schemes.

][(3) Frequency protection with under and overfrequency elements for detection of power system frequency disturbances.

][e. Transformer Terminal Unit

[(1) Provide a transformer terminal unit which monitors the transformer's running state in real time. Monitoring must include voltage, current, power factor, load unbalance, and temperature. Monitoring must provide data necessary to conduct preventive maintenance and planning.

][(2) Provide with flexible input and output for connection and disconnection of transformer.

]][2.2.4 Drawout Breakers

Equip drawout breakers with disconnecting contacts, wheels, and interlocks for drawout application. Provide main, auxiliary, and control disconnecting contacts with silver-plated, multifinger, positive pressure, self-aligning type. Provide drawout compartment shutters to protect operators from accidental contact with breaker stabs when the breaker is withdrawn from its cubicle. Provide each drawout breaker with four-position operation with each position clearly identified by an indicator on the circuit breaker front panel as follows.

a. Connected Position: Primary and secondary contacts are fully engaged. Breaker must be tripped before racking into or out of position.[Red Indicator][Manufacture standard indicator].

b. Test Position: Primary contacts are disconnected but secondary contacts remain fully engaged. This position allows complete test and operation of the breaker without energizing the primary circuit.[Yellow Indicator][Manufacture standard indicator].

c. Disconnected Position: Primary and secondary contacts are disconnected.[Blue Indicator][Manufacture standard indicator].

d. Withdrawn (Removed) Position: Places breaker completely out of compartment, ready for removal. Removal of the breaker actuates assembly that isolates the primary stabs. No indicator is required when the breaker is fully withdrawn.

]2.2.5 Arc Mitigation

****

NOTE: Arc flash mitigation is code required in some instances per NFPA 70 Article 240.87 with overcurrent protection devices which are either properly rated for or able to be adjusted to 1200A or higher. Mitigation should be considered for both arc-resistant and standard low voltage switchgear. Additionally, the designer is encouraged to address arc flash mitigation to include circuits with feeder circuit breakers 800A to 1200A to help ensure a safer electrical environment. More than one arc flash mitigation strategy or feature may be implemented at the same time. There are seven arc flash mitigation methods listed in NFPA 70. Preliminary power studies prepared by the designer should confirm Arc Energy Reduction Maintenance Setting (ERMS) to reduce arc flash incident energy to Category 2 or below. Not all methods of arc flash mitigation are listed below (e.g., differential relaying). The NFPA 70 2020 version requires proof that the method implemented works and is in use.

****

Where indicated on the one-line diagram, provide the following:

[a. Arc Flash Limiting Feeder breakers

(1) Equip circuit breakers with Flash Limiting Feeder option for arc flash limiting.

(2) Circuit breakers must be suitable for 200kA short circuit rating without the use of current limiting fuses.

(3) Provide circuit breaker published testing data and IEEE 1584 equations to support the reduction of arc flash incident energy and flash protection boundary.

][b. Zone Selective Interlocking

(1) Preserve desired selective coordination between main(s), ties(s), and feeder(s) protective devices.

(2) Provide wired connections between relays or protective devices.

][c. Energy Reduction Maintenance Setting Switch.

(1) For each [Main][Tie][or Feeder] circuit breaker, provide a maintenance OFF-ON selector switch on the breaker compartment door to temporarily switch the circuit breaker to ERMS-mode tripping characteristics during maintenance activities.

(2) Provide trip unit with a separate trip curve for the arc energy-reducing maintenance setting.

(3) Operate trip unit in fast instantaneous trip mode (25 to 30 ms), when ERMS trip curve is active.

(4) Provide a lock feature so that the ERMS may be locked in the ON position.

(5) Provide a blue indicating light to indicate the ERMS is enabled.

[(6) Provide ERMS mode indication via remote communication network to plant control system.

]]d. Arc Flash Detection System

(1) Provide an arc flash detection system to satisfy NFPA 70 Article 240.87 requirements.

(2) Provide a system consisting of an arc flash detection relay, point light sensors and current transformers per source bus.

(3) Place relay light sensors in the cable, bus and circuit breaker compartments to provide comprehensive switchgear protection. Switchgear manufacturer must test and prove effective the locations of point sensors.

(4) For the arc flash detection system, utilize techniques to prevent nuisance tripping from the light emitted when an air circuit breaker interrupts a fault downstream from the switchgear during normal operation.

(5) Install the arc flash detection system at the factory.

(6) Provide control power for the arc flash detection system from[a power source internal to the switchgear][an external power source].

][2.2.6 Remote Racking

****

NOTE: UFC 3-520-01 requires consideration of remote racking methods for switchgear circuit breakers. Determine if this feature is desired by electrical personnel that will operate and maintain this equipment. The remote racking mechanism design varies among manufacturers; however the method of connection to the racking mechanism tends to be similar. Determine if the project budget can fund this device (might cost as much as $40,000 with all options including camera and wireless system). Do not select this option if other remote racking mechanisms are available within the activity and can be used for this location.

****

Provide a remote racking mechanism to allow an operator to rack a circuit breaker in or out from at least 20 feet away from the front of the equipment.

]2.2.7 Electronic Trip Units

****

NOTE: Switchgear circuit breakers will be supplied with electronic trip units. Select from the bracketed options below. In the items below, choose the bracketed item "main" when the item only applies to the main breaker.

A digital display for the main breaker will typically not be selected if digital metering is provided per the paragraph DIGITAL METERS is selected.

Provide ground fault protection of equipment for solidly grounded wye electrical services of more than 150 volts to ground for each service disconnect rated 1000 amperes or more in accordance with NFPA 70.

NFPA 70 requires arc energy reduction where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted to 1200 amperes or higher. The option identified below is based on an energy-reducing maintenance switch. Add the additional appropriate information if other methods such as differential relaying or an active arc flash mitigation system are included. Identify locations of alternate arc energy reduction methods in the design.

****

Equip[main and][distribution] breakers[as indicated] with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that provides true rms sensing adjustable time-current circuit protection. Include the following:

a. Current sensors ampere rating: [as indicated][[_____] amperes][the same as the breaker frame rating].

b. Trip unit ampere rating: [as indicated][[_____] amperes].

[c. Ground fault protection: [as indicated][zero sequence sensing][residual type sensing].

][d. Electronic trip units: provide additional features[as indicated]:
]
[(1) [Indicated]Breakers: include long delay pick-up and time settings, and indication of cause of circuit breaker trip.

][(2) Main breakers: include[short delay pick-up and time settings][and][, instantaneous settings][and][ground fault settings][as indicated].

][(3) Distribution breakers: include[short delay pick-up and time settings][, instantaneous settings][, and ground fault settings][as indicated].

][(4) [Main]Breakers: include a digital display for phase and ground current.

][(5) [Main]Breakers: include a digital display for watts, vars, VA, kWh, kvarh, and kVAh.

][(6) [Main]Breakers: include a digital display for phase voltage, and percent THD voltage and current.

][(7) [Main]Breakers: include provisions for communication via a network twisted pair cable for remote monitoring and control. Provide the following communications protocol:[DNP3][Modbus][IEC 61850].

][(8) For electronic trip units that are rated for or can be adjusted to [1,200][_____] amperes or higher, provide arc energy reduction capability with an energy-reducing maintenance switch with local status indicator.

][2.2.8 Metering

[2.2.8.1 Digital Meters

****

NOTE: Digital metering incorporates newer technology and provides additional information, often without additional cost. A control power transformer (115 V or 130 V) is usually required with this type of metering.

Digital meters are continually improving. The display capability can be a simple display of numerical values or a more sophisticated display showing waveforms. Over-specification of the meter physical or software characteristics will likely result in specification of an older obsolete meter.

****

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meter enclosed in a sealed case with the following features.

a. Display capability:

[(1) Multi-Function Meter: Display a selected phase to neutral voltage, phase to phase voltage, percent phase to neutral voltage THD, percent phase to phase voltage THD; a selected phase current, neutral current, percent phase current THD, percent neutral current; selected total PF, kW, KVA, kVAR, FREQ, kVAh, kWh. Detected alarm conditions include over/under current, over/under voltage, over/under KVA, over/under frequency, over/under selected PF/kVAR, voltage phase reversal, voltage imbalance, reverse power, over percent THD. Include a Form C KYZ pulse output relay on the meter.

][(2) Power Meter: Display Watts, VARs, and selected KVA/PF. Detected alarm conditions include over/under KVA, over/under PF, over/under VARs, over/under reverse power.

][(3) Volt Meter: Provide capability to be selectable between display of the three phases of phase to neutral voltages and simultaneous display of the three phases of the phase to phase voltages. Detected alarm conditions include over/under voltage, over/under voltage imbalance, over percent THD.

][(4) Ammeter: Display phase A, B, and C currents. Detected alarm conditions include over/under current, over percent THD.

][(5) Digital Watthour Meter: Provide a single selectable display for watts, total kilowatt hours (kWh) and watt demand (Wd). Include a Form C KYZ pulse output relay on the meter.

] b. Design meters to accept[input from standard 5A secondary instrument transformers][and][direct voltage monitoring range to [300][600] volts, phase to phase].

c. Provide programming via a front panel display and a communication interface accessible by a computer.

d. Provide password secured programming stored in non-volatile EEPROM memory.

e. Provide digital communications in a Modbus [RTU] protocol via a [RS232C][RS485] serial port[and an independently addressable [RS232C][RS485] serial port].

f. Provide meter that calculates and stores average max/min demand values with time and date for all readings based on a user selectable sliding window averaging period.

g. Provide meter with programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions.

[h. Provide meter with a display of Total Harmonic Distortion (THD) measurement to a minimum of the thirty-first order.

][i. Include historical trend logging capability with the ability to store up to 100,000 data points with intervals of 1 second to 180 minutes. Provide a unit that can store and time stamp up to 1000 programmable triggered conditions.

][j. Provide event waveform recording triggered by the rms of 2 cycles of voltage or current exceeding programmable set points. Store waveforms for all 6 channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.

]][2.2.8.2 Electronic Watthour Meter

****

NOTE: For the Air Force, use Section 26 27 13.10 30 ELECTRIC METERS.

For the Navy, use Section 26 27 14.00 20 ELECTRICITY METERING.

For the Army, coordinate meter requirements in accordance with Engineering and Construction

Bulletin ECB 2015-2, Advanced Metering and Connectivity.
****

[Provide as specified in Section 26 27 14.00 20 ELECTRICITY METERING 26 27 13.10 30 ELECTRIC METERS.

][ANSI C12.1. Provide a switchgear style electronic programmable watthour meter, semi-flush mounted, as indicated. Meter can be either programmed at the factory or programmed in the field. Turn field programming device over to the Contracting Officer at completion of project. Coordinate meter to system requirements.

a. Design: Provide meter designed for use on a 3-phase, 4-wire, [208Y/120][480Y/277] volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS).

b. Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

c. Class: 20. Accuracy: plus or minus 1.0 percent. Finish: Class II.

d. Kilowatt-hour Register: five digit electronic programmable type.

e. Demand Register:

    (1) Provide solid state.

    (2) Display actual values and readings of the metered circuit. No multipliers must be required.

    (3) Demand interval length: programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.

f. Meter fusing: Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to the watthour meter. Size fuses as recommended by the meter manufacturer.

g. Provide meter with a communications port, RS485, with Modbus RTU serial or Ethernet, Modbus-TCP communications.

****
NOTE: Select the appropriate current transformer (CT) ratio, continuous-thermal-current rating factor (RF) at 30 degrees C and ANSI Metering Accuracy Class values based on the CT Ratio which is just below the rating of the main protective device.

Select an ANSI Metering Accuracy Class in accordance with the following table:

CT Ratio	**RF**	**Accuracy Class**
200/5	**4.0**	**0.3 thru B-0.1**
300/5	**3.0**	**0.3 thru B-0.2**

CT Ratio	**RF**	**Accuracy Class**
400/5	**4.0**	**0.3 thru B-0.2**
600/5	**4.0**	**0.3 thru B-0.5**
800/5	**2.0**	**0.3 thru B-0.5**
1200/5	**1.5**	**0.3 thru B-0.5**
1500/5	**1.5**	**0.3 thru B-0.9**
2000/5	**1.5**	**0.3 thru B-1.8**

****

IEEE C57.13. Provide single ratio transformers, 60 hertz, [_____] to 5-ampere ratio, [_____] rating factor, with a metering accuracy class of 0.3 through [_____].

[Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

]]][2.2.8.3 Submetering

****

NOTE: For bases and activities that have an active submetering policy in place and written authorization has been received, edit this section as necessary to specify the desired level of submetering and locations.

The intended reference for this section is ASHRAE 90.1-2019, which does address submetering criteria.

If submetering is selected as an option, coordinate references to ASHRAE 90.1 with the lead person editing the Division 1 Sections.

****

ASHRAE 90.1 - IP. Provide submetering for [Interior lighting][,][Exterior lighting][,][HVAC equipment][,][Plug loads][,][Electric vehicle supply equipment] [_____].

]][2.2.9 Transformer

****

NOTE: Coordinate with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, when transformer section is provided.

****

Provide transformer section in switchgear in accordance with UL 1558 and as indicated. Provide the transformer and section that is suitable for the installation. Provide a transformer conforming to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

][2.2.10 Heaters

****
NOTE: Select the heater option if the switchgear will be installed in a non-environmentally controlled area.
****

Provide 120-volt heaters in each switchgear section. Provide heaters of sufficient capacity to control moisture condensation in the section, 250 watts minimum, and controlled by a thermostat[and humidistat] located in the section. Provide industrial type thermostat, high limit, to maintain sections within the range of 15 to 32 degrees C 60 to 90 degrees F.[Provide humidistat with a range of 30 to 60 percent relative humidity.] Obtain supply voltage for the heaters from a control power transformer within the switchgear. If heater voltage is different than switchgear voltage, provide transformer rated to carry 125 percent of heater full load rating. Provide transformer with a 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and conforming to NEMA ST 20.[Energize electric heaters in switchgear assemblies while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source. Provide temporary, reliable external power source if commercial power at rated voltage is not available on site.]

]2.2.11 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Provide short-circuiting type terminal boards associated with current transformer. Terminate conductors for current transformers with ring-tongue lugs. Provide terminal board identification that is identical in similar units. Provide color coded external wiring that is color coded consistently for similar terminal boards.

2.2.12 Standard Indicating Light

Provide indicator lights[showing on, off, stand-by, automatic, manual depending on the application][as indicated on the plans]. Indicator lights must comply with NEMA ICS 1, NEMA ICS 2, and UL 508A. Lights must be heavy duty, round, [metal bezel]and must mount in a 22.5 mm 0.875 inch mounting hole. Indicator lights must be LED type and must operate at [120 VAC][24 VDC][125VDC]. Long life bulbs must be used. For each indicator light, provide a legend plate labeled as shown on the drawings. Lens color must be as indicated on the drawings. Lights must be push-to-test type.

2.2.13 Wire Marking

Mark control and metering conductors at each end.[Provide factory installed, white, plastic tubing, heat stamped with black block type letters.][Each control wire must be marked to the origin zone/wire name/destination zone over the entire length of the wire using a cured ink process] on factory-installed wiring. [For all shipping split control wires, provide plug-in terminal blocks. Terminal connections to remote devices or sources must be front accessible via doors near each circuit breaker.] On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Provide a single letter or number on each sleeve, elliptically shaped to securely grip the wire, and keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Indicate on each wire marker the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.3 MANUFACTURER'S NAMEPLATE

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.4 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the bracketed sentence to specify labels for switchgear where emergency breakers are located within the switchgear. Provide note on the drawings to indicate where red labels are required.

****

ASTM D709. Provide laminated plastic nameplates for each switchgear, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Identify on each nameplate inscription the function and, when applicable, the position. Provide nameplates of melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core.[Provide red laminated plastic label with white center core where indicated.] Provide matte finish surface. Provide square corners. Accurately align lettering and engrave into the core. Provide nameplates with minimum size of 25 by 65 mm one by 2.5 inches. Provide lettering that is a minimum of 6.35 mm 0.25 inch high normal block style.

2.5 SOURCE QUALITY CONTROL

2.5.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

Provide the following as part of test equipment calibration:

a. Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. Accuracy: Traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.

d. Dated calibration labels: visible on all test equipment.

e. Calibrating standard: higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

  (1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

  (2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.5.2 Switchgear Design Tests

****

NOTE: Use the first bracketed option for standard switchgear. Use the second bracketed option for arc-resistant switchgear.

****

[IEEE C37.20.1 and UL 1558][IEEE C37.20.1, IEEE C37.20.7, and UL 1558].

2.5.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification. Submit UL certification documents to show compliance.

a. Short-circuit current test.

b. Enclosure tests.

c. Dielectric test.

[2.5.2.2 Additional Design Tests

****

NOTE: Include additional design tests when the switchgear main bus is rated greater than 4000 amperes.

****

In addition to normal design tests, perform the following tests on the actual equipment. Furnish reports which include results of design tests performed on the actual equipment.

a. Temperature rise tests.

b. Continuous current.

]2.5.3 Switchgear Production Tests

IEEE C37.20.1 and UL 1558. Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

a. 60-hertz dielectric tests.

b. Mechanical operation tests.

c. Electrical operation and control wiring tests.

d. Ground fault sensing equipment tests of continuity and polarity.

[2.5.4 Cybersecurity Equipment

****

NOTE: Coordinate equipment certification with Government's cybersecurity requirements and interpretations. Select this option if the switchgear includes remote control or remote access capability.

****

Furnish cybersecurity documentation as outlined in Section 25 05 11 CYBERSECURITY FOR FACILITY_RELATED CONTROL SYSTEMS.

][2.6 COORDINATED POWER SYSTEM PROTECTION

****

NOTE: Use this paragraph only for Army projects.

The requirement for studies in this section depends on the complexity and extent of the power system. Delete this requirement for projects of limited scope, projects having protective devices which are not adjustable or for which coordination is not possible (standard molded case circuit breakers); projects involving simple extension of 600 volt level service to a building or facility from an existing transformer (750 kVA or less); or projects involving simple extension of 600 volt level service to a building or facility from a new transformer (750 kVA or less).

For new installations, provide power system study. For replacement installations, provide updated power system study in compliance with NFPA 70E.

****

Provide a power system study as specified in Section 26 05 73 POWER SYSTEM STUDIES.

]2.7 ARC FLASH WARNING LABEL

****

NOTE: Include the Arc Flash Warning Label detail on the drawings. See the technical note at the beginning of section to obtain the AutoCAD drawing file of the label.

****

Provide warning label for switchgear. Locate this self-adhesive warning label on the outside of the enclosure warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.[Provide warning label data from Section 26 05 73 POWER SYSTEM STUDIES.]

[2.8 SERVICE ENTRANCE AVAILABLE FAULT CURRENT LABEL

****

NOTE: NFPA 70 requires that service equipment in other than dwelling units be legibly marked in the field with the maximum available fault current, including the date the fault-current calculation was performed. In addition, include the contact information for the organization that completed the calculation. Select this option if the switchgear will be used as service entrance equipment.

Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the short circuit calculation for the project. This may vary for design/build versus design/bid/build projects.

****

Provide label on exterior of switchgear used as service equipment listing the maximum available fault current at that location. Include on the label the date that the fault calculation was performed and the contact information for the organization that completed the calculation. Locate this self-adhesive warning label on the outside of the switchgear. Provide label format as indicated.

][2.9 MIMIC BUS LABELING

****

NOTE: Include a mimic bus if the system complexity warrants providing a one-line of the system configuration.

****

Provide a mimic bus on the front of the equipment to diagrammatically show the internal bus structure of the lineup.

]PART 3 EXECUTION

3.1 INSTALLATION

Conform to [IEEE C2][NFPA 70] and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

****

NOTE: Include the grounding section below for installations involving a switchgear installed in an exterior application. If the switchgear is installed adjacent to a pad-mounted distribution transformer, then coordinate the grounding requirements between the applicable specifications.

****

[3.2 GROUNDING

****

NOTE: Where rock or other soil conditions prevent

obtaining a specified ground value, specify other methods of grounding. Where it is impractical to obtain the indicated ground resistance values, make every effort to obtain ground resistance values as near as possible to the indicated values.

Select 25 ohms resistance unless the installation requires a lower resistance to ground.

****

[NFPA 70][IEEE C2], except maximum resistance-to-ground of grounding electrode system must be [5][25] ohms under dry conditions. Where the resistance obtained per NFPA 70 exceeds [5][25] ohms, contact the Contracting officer for further instructions.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 610 mm 24 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

]3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Switchgear

IEEE C37.20.1.

3.3.2 Meters and Instrument Transformers

ANSI C12.1.

3.3.3 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.3.4 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.3.5 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the equipment is located. Include construction requirements for concrete slab only if slab is not detailed in drawings.

****

3.4.1 Exterior Location

Mount switchgear on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 200 mm 8 inches thick, reinforced with a 150 by 150 mm 6 by 6 inch No. 6 mesh placed uniformly 100 mm 4 inches from the top of the slab.

b. Place slab on a 150 mm 6 inch thick, well-compacted gravel base.

c. Install slab such that the top of the concrete slab is approximately 100 mm 4 inches above the finished grade.

d. Provide edges above grade with 15 mm 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 200 mm 8 inches beyond the equipment.

f. Provide conduit turnups and cable entrance space required by the equipment to be mounted.

g. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.

h. Cut off and bush conduits 75 mm 3 inches above slab surface.

i. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4.2 Interior Location

Mount switchgear on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 100 mm 4 inches thick.

b. Install slab such that the top of the concrete slab is approximately

100 mm 4 inches above the finished grade.

c. Provide edges above grade with 15 mm 1/2 inch chamfer.

d. Provide slab of adequate size to project at least 200 mm 8 inches beyond the equipment.

e. Provide conduit turnups and cable entrance space required by the equipment to be mounted.

f. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.

g. Cut off and bush conduits 75 mm 3 inches above slab surface.

h. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

****

NOTE: Select "Request for Settings" below if protective device settings will be government furnished. Select "Required Settings" below if protective device settings are furnished by the Designer of Record. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the final protective device settings for design/build versus design/bid/build projects. Do not rely on the manufacturer's default settings.

Coordinate breaker settings with Section 26 05 73 POWER SYSTEM STUDIES.

****

[Submit request for settings of breakers to the Contracting Officer after approval of switchgear and at least 30 days in advance of their requirement.

][Submit Required Settings of breakers to the Contracting Officer after approval of switchgear and at least 30 days in advance of their requirement.

]3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

****

NOTE: Select the options below that apply to the specified equipment.

****

3.5.1.1 Switchgear

a. Visual and Mechanical Inspection[per NETA ATS 7.1 A and values per 7.1 C.]

[(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical, electrical, and mechanical condition.

(3) Verify appropriate anchorage, required area clearances, and correct alignment.

(4) Clean switchgear and verify shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.

(5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

(6) Verify that[fuse and] circuit breaker sizes and types correspond to approved shop drawings as well as to the circuit breaker’s address for microprocessor-communication packages.

(7) Verify that current transformer ratios correspond to approved shop drawings.

(8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(10) Confirm correct application of manufacturer's recommended lubricants.

(11) Inspect insulators for evidence of physical damage or contaminated surfaces.

(12) Verify correct barrier and shutter installation[and operation].

(13) Exercise all active components.

(14) Inspect all mechanical indicating devices for correct operation.

(15) Verify that filters are in place and vents are clear.

(16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

(17) Inspect control power transformers.

] b. Electrical Tests[per NETA ATS 7.1 B and values per 7.1 D.]

(1) Perform insulation-resistance tests on each bus section.

(2) Perform dielectric withstand voltage tests.

(3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

(4) Perform control wiring performance test.

(5) Perform primary current injection tests on the entire current

circuit in each section of assembly.

[(6) Perform phasing check on double-ended switchgear to ensure correct bus phasing from each source.

][(7) Verify operation of switchgear heaters.

]3.5.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection[per NETA ATS 7.6.1.2 A and values 7.6.1.2 C.]

(1) Compare nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, and grounding.

(4) Verify that all maintenance devices are available for servicing and operating the breaker.

(5) Inspect arc chutes.

(6) Inspect moving and stationary contacts for condition, wear, and alignment.

(7) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

(8) Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.

(9) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(10) Verify cell fit and element alignment.

(11) Verify racking mechanism.

(12) Confirm correct application of manufacturer's recommended lubricants.

b. Electrical Tests[per NETA ATS 7.6.1.2 B and values 7.6.1.2 D.]

(1) Perform contact-resistance tests on each breaker.

(2) Perform insulation-resistance tests.

(3) Adjust Breaker(s) for final settings in accordance with Government provided settings.

(4) Determine long-time minimum pickup current by primary current injection.

(5) Determine long-time delay by primary current injection.

****
NOTE: Coordinate each option with each breaker type.
****

[(6) Determine short-time pickup and delay by primary current injection.

][(7) Determine ground-fault pickup and delay by primary current injection.

][(8) Determine instantaneous pickup value by primary current injection.

][(9) Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to ensure operation of shunt trip devices; Check the operation of electrically-operated breakers in their cubicle.

] (10) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

(11) Verify operation of charging mechanism.

3.5.1.3 Current Transformers

a. Visual and Mechanical Inspection[per NETA ATS 7.10.1 A and values 7.10.1 C.]

[(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Verify that all required grounding and shorting connections provide good contact.

] b. Electrical Tests[per NETA ATS 7.10.1 B and values 7.10.1 D.]

[(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) Perform insulation-resistance tests.

(3) Perform polarity tests.

(4) Perform ratio-verification tests.

]3.5.1.4 Metering and Instrumentation

a. Visual and Mechanical Inspection[per NETA ATS 7.11.2 A and values 7.11.2 C.]

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests[per NETA ATS 7.11.2 B and values 7.11.2 D.]

[(1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

(2) Calibrate watthour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

(4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

]3.5.1.5 Grounding System

a. Visual and Mechanical Inspection[per NETA ATS 7.13 A and values 7.13 C.]

[(1) Inspect ground system for compliance with contract plans and specifications.

] b. Electrical Tests[per NETA ATS 7.13 B and values 7.13 D.]

[(1) IEEE 81. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

][3.5.1.6 Cybersecurity Installation

****

NOTE: Coordinate Government's cybersecurity requirements and interpretations with Cybersecurity specification Section 25 05 11 CYBERSECURITY FOR

FACILITY-RELATED CONTROL SYSTEMS. Select this option if the switchgear includes remote control, remote access capability, or components with communication ability whether used or not.

****

Provide product information for all components in switchgear that need cybersecurity documentation. See Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

]3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Trip circuit breakers by operation of each protective device. Test each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, provide the Contracting Officer 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 24 13 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 24 13 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-26 24 13 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 24 13 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 24 13

SWITCHBOARDS

08/21

****

NOTE: This guide specification, in part, replaces UFGS 26 23 00, SWITCHBOARDS AND SWITCHGEAR. The original guide specification was separated into two specifications: 26 23 00, LOW-VOLTAGE SWITCHGEAR, and 26 24 13, SWITCHBOARDS.

This guide specification covers the requirements for free standing deadfront switchboard assemblies rated 6000 amperes or less, 600 volts or less. This guide specification is intended for alternating current applications; additional editing will be necessary to tailor it for direct current applications.

Per UFC 3-520-01, specify switchboards for service entrance equipment when the service is 1200 amperes or larger, and branch and feeder circuits are combined sizes from 20 amperes up to 800 amperes. Utilize switchboards throughout the distribution system where feeders are 1200 amperes or larger. Specify metal-enclosed switchgear in accordance with Section 26 23 00 LOW-VOLTAGE SWITCHGEAR for service entrance equipment only when the service is 1200 amperes or larger, and all branch and feeder circuits are large, such as 600 amperes or 800 amperes each. Use Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, for power and distribution panelboards rated less than 1200 amperes.

When the proposed switchboard is connected to a secondary unit substation, coordinate with Section 26 11 16 SECONDARY UNIT SUBSTATIONS.

This specification is not intended to be used for generator control switchboards without extensive modification and coordination with applicable engine-generator set guide specifications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing**

this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Verify that the following information is indicated on the project drawings:

1. Single-line diagram showing buses and interrupting devices with interrupting capacities; current transformers with ratings; instruments and meters required; and description of instruments and meters.

2. Location, space available, arrangement, and elevations of switchboards.

3. Grounding plan.

4. Type and number of cables, size of conductors for each power circuit, and point of entry (top or bottom).

5. Special conditions, such as altitude, temperature and humidity, exposure to fumes, vapors, dust, and gases; and seismic requirements.

6. Arc flash label requirements. Download the label format at:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

7. Available fault current label for service entrance equipment. Download the label format at:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

8. Locations with 100 percent rated circuit breakers.

9. Locations with arc energy reduction methods specified.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D149	(2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.13	(2024) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA PB 2.1	(2023) General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 V or Less
NEMA ICS 6	(1993; R 2016) Industrial Control and

	Systems: Enclosures
NEMA PB 2	(2011) Deadfront Distribution Switchboards
NEMA ST 20	(2014) Dry-Type Transformers for General Applications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 198M	(2018; Reprint May 2023) UL Standard for Mine-Duty Fuses
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 891	(2019) UL Standard for Safety Switchboards
UL 4248-1	(2022) UL Standard for Safety Fuseholders - Part 1: General Requirements
UL 4248-12	(2018; Reprint Feb 2022) UL Standard for Safety Fuseholders - Part 12: Class R

1.2 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment

****

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchboard Drawings; G, [_____]

SD-03 Product Data

Switchboard; G, [_____]

SD-06 Test Reports

Switchboard Design Tests; G, [_____]

Switchboard Production Tests; G, [_____]

Acceptance Checks and Tests; G, [_____]

SD-07 Certificates

Cybersecurity Installation Certification; G, [_____]

Submit certification indicating conformance with the paragraph CYBERSECURITY INSTALLATION CERTIFICATION.

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G, [_____]

SD-11 Closeout Submittals

****

NOTE: Select "Request for Settings" below if protective device settings will be government furnished. Select "Required Settings" below if protective device settings are furnished by the Designer of Record. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the final protective device settings for design/build versus design/bid/build projects. Do not rely on the manufacturer's default settings.

****

Assembled Operation and Maintenance Manuals; G, [_____]

Equipment Test Schedule; G, [_____]

[Request for Settings; G, [_____]

][Required Settings; G, [_____]
]

****

NOTE: NFPA 70 Article 110.24 requires an available fault current label to be applied at the service entrance. Select "Available Fault Current Label" below if the switchboard is part of the service entrance equipment. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the short circuit calculation for the project. This may vary for design/build versus design/bid/build projects.

****

[Service Entrance Available Fault Current Label; G, [_____]

]1.5 QUALITY ASSURANCE

1.5.1 Product Data

Include manufacturer's information on each submittal for each component, device and accessory provided with the switchboard including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device.

1.5.2 Switchboard Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable federal, military, industry, and technical society publication references on submittals. Include the following:

a. One-line diagram including breakers[, fuses][, current transformers, and meters].

b. Outline drawings including front elevation, section views, footprint, and overall dimensions.

c. Bus configuration including dimensions and ampere ratings of bus bars.

d. Markings and NEMA nameplate data[, including fuse information (manufacturer's name, catalog number, and ratings)].

e. Circuit breaker type, interrupting rating, and trip devices, including available settings.

f. Wiring diagrams and elementary diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.

g. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device. Use this information (designer of record) to provide breaker settings that ensures protection and coordination are achieved.[For Navy installations, provide electronic format curves using SKM's Power Tools for Windows device library electronic format or EasyPower device library format depending on installation modeling software requirements.]

****

NOTE: If selecting provisions for future expansion, ensure the facility and room size is adequate for the additional equipment.

****

[h. Provisions for future expansion by adding switchboard sections.

]1.5.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.4.2 Material and Equipment Manufacturing Date

Products manufactured more than one year prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

1.6.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.2 Assembled Operation and Maintenance Manuals

Assemble and securely bind manuals in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents:

a. Manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA.

b. Catalog data required by the paragraph SD-03, PRODUCT DATA.

c. Drawings required by the paragraph SD-02, SHOP DRAWINGS.

d. Prices for spare parts and supply list.

[e. Information on metering.

] f. Design test reports.

g. Production test reports.

[1.6.3 Spare Parts

****

NOTE: Do not use this paragraph for Navy projects. For other services, coordinate with Contracting Officer on whether this paragraph can be included.

Edit as required if additional spare parts are required for a specific project.
****

Provide spare parts as specified below. Provide spare parts that are of the same material and workmanship, meet the same requirements, and are interchangeable with the corresponding original parts furnished.

a. Quantity 2 - Fuses of each type and size.

[b. [_____]

]]1.7 WARRANTY

Provide equipment items that are supported by service organizations reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SWITCHBOARD

NEMA PB 2 and UL 891.

2.2.1 Ratings

Provide equipment with the following ratings:

****
NOTE: Select "as indicated" if there are multiple switchboards with details of each shown on drawings. Most switchboards will be 4-wire, but might be a 3-wire design for delta-connected or ungrounded systems.
****

a. Voltage rating: [480Y/277][208Y/120][_____] volts AC, [three-phase, [3][4]-wire][as indicated].

b. Continuous current rating of the main bus: [_____ amperes][as indicated].

c. Short-circuit current rating: [_____ rms symmetrical amperes][as indicated].

d. UL listed and labeled[as service entrance equipment].

2.2.2 Construction

****
NOTE: Edit the selection options below as needed

for the intended project configuration. Rear aligned switchboards are likely the lowest cost design practice. Front and rear aligned switchboards provide a more appealing installation. Do not specify rear connections if the switchboard will be installed against a wall.
****

Provide the following:

a. Switchboard: consisting of one or more vertical sections[bolted together to form a rigid assembly] and [rear][front and rear] aligned[as indicated].

b. All circuit breakers: front accessible.

[c. Rear aligned switchboards: front accessible load connections.

][d. Front and rear aligned switchboards[: rear accessible load connections].

] e. Where indicated, "space for future" or "space" means to include a vertical bus provided behind a blank front cover. Where indicated, "provision for future" means full hardware provided to mount a breaker suitable for the location.

f. Completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

2.2.2.1 Enclosure

****
NOTE: Choose the level of corrosion protection required for the specific project location. Most switchboard products will be constructed of a cold rolled steel and painted, which is adequate for most indoor locations. Use galvanized steel or stainless steel enclosures or bases for outdoor applications where corrosion is a concern. Not all manufacturers offer galvanized steel or stainless steel products as a standard design.

Select IEEE C57.12.28 for galvanized enclosures. Select IEEE C57.12.29 for stainless steel enclosures.
****

Provide the following:

a. Enclosure: NEMA ICS 6 Type [3R][1][_____][as indicated][fabricated entirely of 12 gauge ASTM A240/A240M type 304 or 304L stainless steel].

b. Enclosure: bolted together with removable bolt-on side and[hinged] rear covers[, and sloping roof downward toward rear].

[c. Front[and rear] doors: provided with[stainless steel] padlockable vault handles with a three point catch.

][d. Bases, frames and channels of enclosure: corrosion resistant and fabricated of[ASTM A240/A240M type 304 or 304L stainless steel][or][galvanized steel]. Separate sections using vertical steel barriers.

] e. Base: includes any part of enclosure that is within 75 mm 3 inches of concrete pad.

[f. Galvanized steel: ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

] g. Paint color: ASTM D1535 light gray No. 61 or No. 49 over rust inhibitor.

[h. Paint coating system: comply with[IEEE C57.12.28 for galvanized steel][and][IEEE C57.12.29 for stainless steel].

]2.2.2.2 Bus Bars

****

NOTE: Use copper with silver-plated contact surfaces in exterior or damp locations or for heavy motor loads.

Delete the neutral bus bracketed option if a 3-wire system was selected.

Only choose the bracketed option requiring insulation on the bus bars for outdoor locations with a high concentration of airborne contaminants. Choose this option primarily for corrosive and high humidity applications as defined in UFC 3-501-01. Most manufacturers will tape wrap rather than apply an insulating sleeve for low voltage equipment.

****

Provide the following:

a. Bus bars: [copper with silver-plated contact surfaces][or][aluminum with tin-plated contact surfaces].

    (1) Phase bus bars: [uninsulated][insulated with a tape wrap or insulating sleeve providing a minimum breakdown voltage of 16,000 volts per ASTM D149].

    (2) Neutral bus: rated [100][_____] percent of the main bus continuous current rating[as indicated].

b. Make bus connections and joints with hardened steel bolts.

c. Main-bus (through bus): rated at the full ampacity of the main throughout the switchboard.

d. Minimum 6.35 mm by 50.8 mm one-quarter by 2 inch copper ground bus secured to each vertical section along the entire length of the switchboard.

2.2.2.3 Main Section

****

NOTE: Select from the options below the configuration to be specified. Refer to UFC 3-520-01 for allowed configurations.

Simpler switchboards will often have a single section that contains the main circuit breaker and branch circuit breakers, referred to here as a Combination Section. Larger switchboards can have multiple sections involving a main section, one or more distribution sections, and one or more auxiliary sections.

Low-voltage power circuit breakers are not normally required for switchboard applications. Utility transformer compartments are rarely used and will require additional review if this bracketed option is selected.

****

Provide the main section consisting of[a combination section with[molded-case circuit breakers] for the[main and] branch devices as indicated][main lugs only][an individually mounted [fixed][drawout][air power circuit breaker[with current-limiting fuses]][insulated-case circuit breaker][molded-case circuit breaker]][and utility transformer compartment].

[2.2.2.4 Distribution Sections

****

NOTE: Select distribution sections as an option if the main section is not a combination section that includes main and branch circuit breakers.

****

Provide the distribution section[s] consisting of[[individually mounted,][drawout,]][air power circuit breakers[with current-limiting fuses]][insulated-case circuit breakers][molded-case circuit breakers][and utility transformer compartments] as indicated.

][2.2.2.5 Auxiliary Sections

Provide auxiliary sections consisting of indicated[instruments,][metering equipment,][control equipment,][transformer,][and][current transformer compartments] as indicated.

][2.2.2.6 Handles

Provide handles for individually mounted devices of the same design and method of external operation. Label handles prominently to indicate device ampere rating, color coded for device type. Identify ON-OFF indication by handle position and by prominent marking.

]2.2.3 Protective Device

****

NOTE: Switchboard should be placed where the ambient temperature is less than 40 deg. C. However, should the ambient temperature be expected to exceed 40 deg. C, the designer must require a

special calibration for the circuit breakers and confirm the equipment ratings.

Provide ground fault protection of equipment for solidly grounded wye electrical services of more than 150 volts to ground for each service disconnect rated 1000 amperes or more in accordance with NFPA 70.

If 48 Vdc or 125 Vdc electrically operated circuit breakers are required, the appropriate DC control power supply information must be added to the specification.

****

Provide[main and] branch protective devices as indicated.

[2.2.3.1 Power Circuit Breaker

****

NOTE: Low-voltage power circuit breakers can be installed in larger switchboards, but are not normally required for switchboard applications. If power circuit breakers are selected, coordinate the ratings and protective device settings with the ratings of the switchboard.

****

Provide the following:

a. IEEE C37.13. [120 Vac][electrically][manually] operated [stationary][drawout], [unfused][fused], low-voltage power circuit breaker with a short-circuit current rating[of [_____] rms amperes symmetrical][as indicated] at [_____] volts.

b. Breaker frame size: [as indicated][[_____] amperes].

[c. Equip electrically operated breakers with motor-charged, stored-energy closing mechanism to permit rapid and safe closing of the breaker against fault currents within the short time rating of the breaker, independent of the operator's strength or effort in closing the handle.

]][2.2.3.2 Insulated-Case Breaker

Provide the following:

****

NOTE: Electrically operated insulated-case circuit breakers are rarely used and would be accomplished by an accessory.

If 100 percent circuit breakers are utilized in the design, select the 100 percent rated circuit breaker option below and indicate the specific locations on the drawings.

****

a. UL 489. UL listed and labeled,[100 percent rated main breaker][standard rated branch breakers],[electrically] [manually] operated, low voltage, insulated-case circuit breaker, with a short-circuit current rating[of [_____] rms symmetrical amperes][as indicated] at [_____] volts.

b. Breaker frame size: [[_____] amperes][as indicated].

c. Series rated circuit breakers are unacceptable.

][2.2.3.3 Molded-Case Circuit Breaker

Provide the following:

****

NOTE: If 100 percent circuit breakers are utilized in the design, select the 100 percent rated circuit breaker option below and indicate the specific locations on the drawings.

****

a. UL 489. UL listed and labeled,[100 percent rated main breaker][standard rated branch breakers],[electrically][manually] operated, low voltage molded-case circuit breaker, with a short-circuit current rating of[[_____] rms symmetrical amperes][as indicated] at [_____] volts.

b. Breaker frame size: [[_____] amperes][as indicated].

c. Series rated circuit breakers are unacceptable.

][2.2.3.4 Fusible Switches

****

NOTE: Do not use fusible overcurrent devices except when necessary to comply with NFPA 70 requirements for selective coordination. Fusible switches are prohibited by UFC 3-520-01 and were not listed as an option above. Their use will require approval by the authority having jurisdiction to allow their use in switchboards.

If specified, select UL 4248-1 fuseholders for Class J or L fuses. Select UL 4248-12 for Class R fuses.

****

Provide the following:

a. Fusible Switches: quick-make, quick-break, hinged-door type.

[b. Switches serving as motor disconnects: horsepower rated.

] c. Fuses: current-limiting cartridge type conforming to[UL 198M, Class J for 0 to 600 amperes and Class L for 601 to 6000 amperes][UL 198M, Class [RK1][RK5] for 0 to 600 amperes].

d. Fuseholders: [UL 4248-1][UL 4248-12].

][2.2.3.5 Integral Combination Breaker and Current-Limiting Fuses

****

NOTE: Current-limiting fuses should only be needed if the available fault current exceeds the circuit breaker short circuit rating. This option will not typically be selected.

****

Provide the following:

a. UL 489.

b. Integral combination molded-case circuit breaker and current-limiting fuses:[as indicated][rated [_____] amperes] with a minimum short-circuit-current rating equal to the short-circuit-current rating of the switchboard in which the circuit breaker will be mounted.

c. Series rated circuit breakers are unacceptable.

d. Coordination of overcurrent devices of the circuit breaker and current-limiting fuses: for overloads or fault currents of relatively low value, the overcurrent device of the breaker operates to clear the fault. The current-limiting fuses operate to clear the fault for high magnitude short circuits above a predetermined value[crossover point].

e. Housing for the current-limiting fuses: an individual molding readily removable from the front and located at the load side of the circuit breaker. If the fuse housing is removed, a blown fuse is readily evident by means of a visible indicator.

f. Removal of fuse housing causes the breaker contacts to open, and the breaker contacts can not close with the fuse housing removed. The fuse housing can not be inserted with a blown fuse or with one fuse missing. The blowing of any of the fuses causes the circuit breaker contacts to open.

][2.2.4 Drawout Breakers

****

NOTE: Determine which circuit breakers should be equipped with drawout mechanisms.

****

Provide drawout breakers[as indicated][_____]. Equip drawout breakers with disconnecting contacts, wheels, and interlocks for drawout application. Provide main, auxiliary, and control disconnecting contacts with silver-plated, multifinger, positive pressure, self-aligning type. Provide each drawout breaker with four-position operation with each position clearly identified by an indicator on the circuit breaker front panel as follows.

a. Connected Position: Primary and secondary contacts are fully engaged. Breaker must be tripped before racking into or out of position.

b. Test Position: Primary contacts are disconnected but secondary contacts remain fully engaged. This position allows complete test and operation of the breaker without energizing the primary circuit.

c. Disconnected Position: Primary and secondary contacts are disconnected.

d. Withdrawn (Removed) Position: Places breaker completely out of compartment, ready for removal. Removal of the breaker actuates assembly that isolates the primary stabs.

]2.2.5 Electronic Trip Units

****

NOTE: Switchboards can have a variety of circuit breaker sizes. Determine which circuit breakers or other protective devices should have electronic trip units and edit the options below accordingly. Smaller circuit breakers will typically have thermal-magnetic trip units.

****

Equip[main and][distribution] breakers[as indicated] with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that provides true rms sensing adjustable time-current circuit protection. Include the following:

a. Current sensors ampere rating: [as indicated][[_____] amperes][the same as the breaker frame rating].

b. Trip unit ampere rating: [as indicated][[_____] amperes].

[c. Ground fault protection: [as indicated][zero sequence sensing][residual type sensing].

][d. Electronic trip units: provide additional features[as indicated]:
]

****

NOTE: In the items below, choose the bracketed item "main" when the item only applies to the main breaker.

Provide ground fault protection of equipment for solidly grounded wye electrical services of more than 150 volts to ground for each service disconnect rated 1000 amperes or more in accordance with NFPA 70.

NFPA 70 requires arc energy reduction where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted to 1200 amperes or higher. The option identified below is based on an energy-reducing maintenance switch. Add the additional appropriate information if other methods such as differential relaying or an active arc flash mitigation system are included. Identify locations of alternate arc energy reduction methods in the design.

****

[(1) [Indicated]Breakers: include long delay pick-up and time settings, and LED indication of cause of circuit breaker trip.

][(2) Main breakers: include[short delay pick-up and time settings][and][, instantaneous settings][and][ground fault settings][as indicated].

][(3) Distribution breakers: include[short delay pick-up and time settings][, instantaneous settings][, and ground fault settings][as indicated].

][(4) [Main]Breakers: include a digital display for phase and ground current.

][(5) [Main]Breakers: include a digital display for watts, vars, VA, kWh, kvarh, and kVAh.

][(6) [Main]Breakers: include a digital display for phase voltage, and percent THD voltage and current.

][(7) [Main]Breakers: include provisions for communication via a network twisted pair cable for remote monitoring and control. Provide the following communications protocol:[DNP3][Modbus][IEC 61850].

][(8) For electronic trip units that are rated for or can be adjusted to 1,200 amperes or higher, provide arc energy reduction capability with an energy-reducing maintenance switch with local status indicator.

][2.2.6 Metering

****

NOTE: When Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC is used, coordinate meter requirements.

****

[2.2.6.1 Digital Meters

****

NOTE: Digital metering incorporates newer technology and provides additional information, often without additional cost. A control power transformer (115 V or 130 V) is usually required with this type of metering.

Digital meters are continually improving. The display capability can be a simple display of numerical values or a more sophisticated display showing waveforms. Over-specification of the meter physical or software characteristics will likely result in specification of an older obsolete meter.

****

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meter enclosed in a sealed case with the following features.

a. Display capability:

[(1) Multi-Function Meter: Display a selected phase to neutral voltage, phase to phase voltage, percent phase to neutral voltage THD, percent phase to phase voltage THD; a selected phase current, neutral current, percent phase current THD, percent neutral current; selected total PF, kW, KVA, kVAR, FREQ, kVAh, kWh. Detected alarm conditions include over/under current, over/under voltage, over/under KVA, over/under frequency, over/under selected PF/kVAR, voltage phase reversal, voltage imbalance, reverse power, over percent THD. Include a Form C KYZ pulse output relay on the meter.

][(2) Power Meter: Display Watts, VARs, and selected KVA/PF. Detected alarm conditions include over/under KVA, over/under PF, over/under VARs, over/under reverse power.

][(3) Volt Meter: Provide capability to be selectable between display of the three phases of phase to neutral voltages and display of the three phases of the phase to phase voltages. Detected alarm conditions include over/under voltage, over/under voltage imbalance, over percent THD.

][(4) Ammeter: Display phase A, B, and C currents. Detected alarm conditions include over/under current, over percent THD.

][(5) Digital Watthour Meter: Provide a single selectable display for watts, total kilowatt hours (kWh) and watt demand (Wd). Include a Form C KYZ pulse output relay on the meter.

] b. Design meters to accept[input from standard 5A secondary instrument transformers][and][direct voltage monitoring range to [300][600] volts, phase to phase].

c. Provide programming via a front panel display and a communication interface accessible by a computer.

d. Provide password secured programming stored in non-volatile EEPROM memory.

e. Provide digital communications in a Modbus [RTU] protocol via a [RS232C][RS485] serial port[and an independently addressable [RS232C][RS485] serial port].

f. Provide meter that calculates and stores average max/min demand values with time and date for all readings based on a user selectable sliding window averaging period.

g. Provide meter with programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions.

[h. Provide meter with a display of Total Harmonic Distortion (THD) measurement to a minimum of the thirty-first order.

][i. Include historical trend logging capability with the ability to store up to 100,000 data points with intervals of 1 second to 180 minutes. Provide a unit that can store and time stamp up to 1000 programmable triggered conditions.

][j. Provide event waveform recording triggered by the rms of 2 cycles of voltage or current exceeding programmable set points. Store waveforms for all 6 channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.

]][2.2.6.2 Electronic Watthour Meter

****

NOTE: For the Air Force, use Section 26 27 13.10 30 ELECTRIC METERS.

For the Navy, use Section 26 27 14.00 20 ELECTRICITY METERING.

For the Army, coordinate meter requirements in accordance with Engineering and Construction Bulletin ECB 2015-2, Advanced Metering and Connectivity.

****

[Provide as specified in Section [26 27 14.00 20 ELECTRICITY METERING][26 27 13.10 30 ELECTRIC METERS].

][ANSI C12.1. Provide a switchboard style electronic programmable watthour meter, semi-flush mounted, as indicated. Meter can be either programmed at the factory or programmed in the field. Turn field programming device over to the Contracting Officer at completion of project. Coordinate meter to system requirements.

a. Design: Provide meter designed for use on a 3-phase, 4-wire, [208Y/120][480Y/277] volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS).

b. Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

c. Class: 20. Accuracy: plus or minus 1.0 percent. Finish: Class II.

d. Kilowatt-hour Register: five digit electronic programmable type.

e. Demand Register:

  (1) Provide solid state.

  (2) Meter reading multiplier: Indicate multiplier on the meter face.

  (3) Demand interval length: programmed for [15][30][60] minutes with rolling demand up to six subintervals per interval.

f. Meter fusing: Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to the watthour meter. Size fuses as recommended by the meter manufacturer.

g. Provide meter with a communications port, RS485, with Modbus RTU serial or Ethernet, Modbus-TCP communications.

****

NOTE: Select the appropriate current transformer (CT) ratio, continuous-thermal-current rating factor (RF) at 30 degrees C and ANSI Metering Accuracy Class values based on the CT Ratio which is just below the rating of the main protective device.

Select an ANSI Metering Accuracy Class in accordance

with the following table:

CT Ratio	**RF**	**Accuracy Class**
200/5	**4.0**	**0.3 thru B-0.1**
300/5	**3.0**	**0.3 thru B-0.2**
400/5	**4.0**	**0.3 thru B-0.2**
600/5	**4.0**	**0.3 thru B-0.5**
800/5	**2.0**	**0.3 thru B-0.5**
1200/5	**1.5**	**0.3 thru B-0.5**
1500/5	**1.5**	**0.3 thru B-0.9**
2000/5	**1.5**	**0.3 thru B-1.8**

****

IEEE C57.13. Provide single ratio transformers, 60 hertz, [_____] to 5-ampere ratio, [_____] rating factor, with a metering accuracy class of 0.3 through [_____].

[Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

]]][2.2.6.3 Submetering

****

NOTE: For bases and activities that have an active submetering policy in place and written authorization has been received, edit this section as necessary to specify the desired level of submetering and locations.

UFC 1-200-02 references ASHRAE 90.1-2010. But ASHRAE 90.1-2010 does not address submetering criteria. The intended reference for this section is ASHRAE 90.1-2013, which does address submetering criteria.

If submetering is selected as an option, coordinate references to ASHRAE 90.1 with the lead person editing the Division 1 Sections. Typically, references to ASHRAE 90.1 in this Section will be to the 2013 edition, whereas references to ASHRAE 90.1 in other Sections will be to the 2010 edition.

****

ASHRAE 90.1 - IP. Provide submetering for [_____].

]][2.2.7 Transformer

****
NOTE: Coordinate with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, when transformer section is provided.
****

Provide transformer section in switchboard in accordance with UL 891 and as indicated. Provide the transformer and section that is suitable for the installation.[Test transformers greater than 10 kVA in accordance with UL 891.] Provide a transformer conforming to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

][2.2.8 Heaters

****
NOTE: Select the heater option if the switchboard will be installed in a non-environmentally controlled area.
****

Provide 120-volt heaters in each switchboard section. Provide heaters of sufficient capacity to control moisture condensation in the section, 250 watts minimum, and controlled by a thermostat[and humidistat] located in the section. Provide industrial type thermostat, high limit, to maintain sections within the range of 15 to 32 degrees C 60 to 90 degrees F.[Provide humidistat with a range of 30 to 60 percent relative humidity.] Obtain supply voltage for the heaters from a control power transformer within the switchboard. If heater voltage is different than switchboard voltage, provide transformer rated to carry 125 percent of heater full load rating. Provide transformer with a 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and conforming to NEMA ST 20.[Energize electric heaters in switchboard assemblies while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of heater to external power source. Provide temporary, reliable external power source if commercial power at rated voltage is not available on site.]

]2.2.9 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Provide short-circuiting type terminal boards associated with current transformer. Terminate conductors for current transformers with ring-tongue lugs. Provide terminal board identification that is identical in similar units. Provide color coded external wiring that is color coded consistently for similar terminal boards.

2.2.10 Wire Marking

Mark control and metering conductors at each end. Provide factory installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Provide a single letter or number on each sleeve, elliptically shaped to securely grip the wire, and keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Indicate on each wire marker the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.3 MANUFACTURER'S NAMEPLATE

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.4 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the bracketed sentence to specify labels for switchboards where emergency breakers are located within the switchboard. Provide note on the drawings to indicate where red labels are required.

****

ASTM D709. Provide laminated plastic nameplates for each switchboard, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Identify on each nameplate inscription the function and, when applicable, the position. Provide nameplates of melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core.[Provide red laminated plastic label with white center core where indicated.] Provide matte finish surface. Provide square corners. Accurately align lettering and engrave into the core. Provide nameplates with minimum size of 25 by 65 mm one by 2.5 inches. Provide lettering that is a minimum of 6.35 mm 0.25 inch high normal block style.

2.5 SOURCE QUALITY CONTROL

2.5.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

Provide the following as part of test equipment calibration:

a. Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. Accuracy: Traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.

d. Dated calibration labels: visible on all test equipment.

e. Calibrating standard: higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.5.2 Switchboard Design Tests

NEMA PB 2 and UL 891.

2.5.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

a. Short-circuit current test.

b. Enclosure tests.

c. Dielectric test.

[2.5.2.2 Additional Design Tests

****

NOTE: Include additional design tests when the switchboard main bus is rated greater than 4000 amperes.

****

In addition to normal design tests, perform the following tests on the actual equipment. Furnish reports which include results of design tests performed on the actual equipment.

a. Temperature rise tests.

b. Continuous current.

]2.5.3 Switchboard Production Tests

NEMA PB 2 and UL 891. Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

a. 60-hertz dielectric tests.

b. Mechanical operation tests.

c. Electrical operation and control wiring tests.

d. Ground fault sensing equipment test.

[2.6 COORDINATED POWER SYSTEM PROTECTION

****

NOTE: Use this paragraph only for Army projects.

The requirement for studies in this section depends on the complexity and extent of the power system. Delete this requirement for projects of limited scope, projects having protective devices which are not adjustable or for which coordination is not possible (standard molded case circuit breakers); projects involving simple extension of 600 volt level service to a building or facility from an existing transformer (750 kVA or less); or projects involving simple extension of 600 volt level service to a building or facility from a new transformer (750 kVA or less).

****

Provide a power system study as specified in Section 26 05 73 POWER SYSTEM STUDIES.

]2.7 ARC FLASH WARNING LABEL

****

NOTE: Include the Arc Flash Warning Label detail on the drawings. See the technical note at the beginning of section to obtain the AutoCAD drawing file of the label.

****

Provide warning label for switchboards. Locate this self-adhesive warning label on the outside of the enclosure warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

[2.8 SERVICE ENTRANCE AVAILABLE FAULT CURRENT LABEL

****

NOTE: NFPA 70 requires that service equipment in other than dwelling units be legibly marked in the field with the maximum available fault current, including the date the fault-current calculation was performed. In addition, include the contact information for the organization that completed the calculation. Select this option if the switchboard will be used as service entrance equipment.

Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the short circuit calculation for the project. This may vary for design/build versus design/bid/build projects.

****

Provide label on exterior of switchboards used as service equipment listing the maximum available fault current at that location. Include on the label the date that the fault calculation was performed and the contact information for the organization that completed the calculation. Locate this self-adhesive warning label on the outside of the switchboard. Provide label format as indicated.

][2.9 MIMIC BUS LABELING

****

NOTE: Include a mimic bus if the system complexity warrants providing a one-line of the system configuration.

****

Provide a mimic bus on the front of the equipment to diagrammatically show the internal bus structure of the lineup.

]PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

****

NOTE: Include the grounding section below for installations involving a switchboard installed in an exterior application. If the switchboard is installed adjacent to a pad-mounted distribution transformer, then coordinate the grounding requirements between the applicable specifications.

****

[3.2 GROUNDING

****

NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, specify other methods of grounding. Where it is impractical to obtain the indicated ground resistance values, make every effort to obtain ground resistance values as near as possible to the indicated values.

Select 25 ohms resistance unless the installation requires a lower resistance to ground.

****

NFPA 70 and IEEE C2, except that grounds and grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 610 mm 24 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

]3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Switchboard

ANSI/NEMA PB 2.1.

3.3.2 Meters and Instrument Transformers

ANSI C12.1.

3.3.3 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.3.4 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.3.5 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the equipment is located. Include construction requirements for concrete slab only if slab is not detailed in drawings.

****

3.4.1 Exterior Location

Mount switchboard on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 200 mm 8 inches thick, reinforced with a 150 by 150 mm 6 by 6 inch No. 6 mesh placed uniformly 100 mm 4 inches from the top of the slab.

b. Place slab on a 150 mm 6 inch thick, well-compacted gravel base.

c. Install slab such that the top of the concrete slab is approximately 100 mm 4 inches above the finished grade.

d. Provide edges above grade with 15 mm 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 200 mm 8 inches beyond the equipment.

f. Provide conduit turnups and cable entrance space required by the equipment to be mounted.

g. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.

h. Cut off and bush conduits 75 mm 3 inches above slab surface.

i. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4.2 Interior Location

Mount switchboard on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 100 mm 4 inches thick.

b. Install slab such that the top of the concrete slab is approximately 100 mm 4 inches above the finished grade.

c. Provide edges above grade with 15 mm 1/2 inch chamfer.

d. Provide slab of adequate size to project at least 200 mm 8 inches beyond the equipment.

e. Provide conduit turnups and cable entrance space required by the equipment to be mounted.

f. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.

g. Cut off and bush conduits 75 mm 3 inches above slab surface.

h. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

****

NOTE: Select "Request for Settings" below if protective device settings will be government furnished. Select "Required Settings" below if protective device settings are furnished by the Designer of Record. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the final protective device settings for design/build versus design/bid/build projects.

Do not rely on the manufacturer's default settings.
****

[Submit request for settings of breakers to the Contracting Officer after approval of switchboard and at least 30 days in advance of their requirement.

][Submit Required Settings of breakers to the Contracting Officer after approval of switchboard and at least 30 days in advance of their requirement.

]3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

****
NOTE: Select the options below that apply to the specified equipment.
****

3.5.1.1 Switchboard Assemblies

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical, electrical, and mechanical condition.

(3) Verify appropriate anchorage, required area clearances, and correct alignment.

(4) Clean switchboard and verify shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.

(5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

(6) Verify that[fuse and] circuit breaker sizes and types correspond to approved shop drawings as well as to the circuit breaker’s address for microprocessor-communication packages.

[(7) Verify that current transformer ratios correspond to approved shop drawings.

] (8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(10) Confirm correct application of manufacturer's recommended lubricants.

(11) Inspect insulators for evidence of physical damage or contaminated

surfaces.

(12) Verify correct barrier installation[and operation].

(13) Exercise all active components.

(14) Inspect all mechanical indicating devices for correct operation.

(15) Verify that filters are in place and vents are clear.

(16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

(17) Inspect control power transformers.

b. Electrical Tests

(1) Perform insulation-resistance tests on each bus section.

(2) Perform dielectric withstand voltage tests.

(3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

(4) Perform control wiring performance test.

(5) Perform primary current injection tests on the entire current circuit in each section of assembly.

[(6) Perform phasing check on double-ended switchboard to ensure correct bus phasing from each source.

][(7) Verify operation of switchboard heaters.

][3.5.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection

(1) Compare nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, and grounding.

(4) Verify that all maintenance devices are available for servicing and operating the breaker.

(5) Inspect arc chutes.

(6) Inspect moving and stationary contacts for condition, wear, and alignment.

(7) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

(8) Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.

(9) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(10) Verify cell fit and element alignment.

(11) Verify racking mechanism.

(12) Confirm correct application of manufacturer's recommended lubricants.

b. Electrical Tests

(1) Perform contact-resistance tests on each breaker.

(2) Perform insulation-resistance tests.

(3) Adjust Breaker(s) for final settings in accordance with Government provided settings.

(4) Determine long-time minimum pickup current by primary current injection.

(5) Determine long-time delay by primary current injection.

****

NOTE: Coordinate each option with each breaker type.

****

[(6) Determine short-time pickup and delay by primary current injection.

][(7) Determine ground-fault pickup and delay by primary current injection.

][(8) Determine instantaneous pickup value by primary current injection.

][(9) Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to ensure operation of shunt trip devices; Check the operation of electrically-operated breakers in their cubicle.

] (10) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

(11) Verify operation of charging mechanism.

]3.5.1.3 Circuit Breakers

[Low Voltage - Insulated-Case][and][Low Voltage Molded Case with Solid State Trips]

a. Visual and Mechanical Inspection

(1) Compare nameplate data with specifications and approved shop drawings.

(2) Inspect circuit breaker for correct mounting.

(3) Operate circuit breaker to ensure smooth operation.

(4) Inspect case for cracks or other defects.

(5) Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

(1) Perform contact-resistance tests.

(2) Perform insulation-resistance tests.

(3) Perform Breaker adjustments for final settings in accordance with Government provided settings.

(4) Perform long-time delay time-current characteristic tests

****

NOTE: Coordinate each option with each breaker type.

****

[(5) Determine short-time pickup and delay by primary current injection.

][(6) Determine ground-fault pickup and time delay by primary current injection.

][(7) Determine instantaneous pickup current by primary injection.

][(8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.

]3.5.1.4 Current Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Verify that all required grounding and shorting connections

provide good contact.

b. Electrical Tests

   (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

   (2) Perform insulation-resistance tests.

   (3) Perform polarity tests.

   (4) Perform ratio-verification tests.

3.5.1.5 Metering and Instrumentation

a. Visual and Mechanical Inspection

   (1) Compare equipment nameplate data with specifications and approved shop drawings.

   (2) Inspect physical and mechanical condition.

   (3) Verify tightness of electrical connections.

b. Electrical Tests

   (1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

   (2) Calibrate watthour meters according to manufacturer's published data.

   (3) Verify all instrument multipliers.

   (4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.5.1.6 Grounding System

a. Visual and Mechanical Inspection

   (1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

   (1) IEEE 81. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

   (2) Submit the measured ground resistance of each ground rod and

grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

[3.5.1.7 Cybersecurity Installation Certification

****

NOTE: Coordinate equipment certification with Government's cybersecurity requirements and interpretations. Select this option if the switchboard includes remote control or remote access capability.

****

Furnish a certification that control systems are installed in accordance with DoD Instruction 8500.01, DoD Instruction 8510.01, and as required by individual Service Implementation Policy.

]3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Trip circuit breakers by operation of each protective device. Test each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, provide the Contracting Officer five working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-26 27 13.10 30 (October 2007)**
Change 2 - 08/18
Preparing Activity: AFCEC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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****

SECTION 26 27 13.10 30

ELECTRIC METERS

10/07, CHG 2: 08/18

****

NOTE: This guide specification covers the requirements for the installation of poly-phase electricity meters suitable for billing, allocation of costs, and recording of data for energy management and control applications and is intended to comply with the metering requirements of EPACT05.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Since metering for energy management and costs allocation varies widely, it is expected that the designer will make significant adjustments and additions to this guide specification.

NOTE: Use the following related guide specifications for power distribution equipment:

- - Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

- - Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION

- - Section 26 22 00.00 10 480-VOLT STATION SERVICE SWITCHBOARD AND TRANSFORMERS

- - Section 26 23 00 SWITCHBOARDS AND SWITCHGEAR

NOTE: This specification provides guidance for the facility energy manager or design engineer after determining what data will be gathered and what analysis procedures will be used.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61000-4-5	(2017) Electromagnetic Compatibility (EMC)

	- Part 4-5: Testing and Measurement Techniques - Surge Immunity Test
IEC 62053-22	(2020) Electricity Metering Equipment (A.C.) - Particular Requirements - Part 22: Static Meters for Active Energy (Classes 0,2 S and 0,5 S)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.18	(2006; R 2023) Protocol Specification for ANSI Type 2 Optical Port
ANSI C12.20	(2015; E 2018) Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes
ANSI C62.61	(1993) American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification and on the drawings are as defined in IEEE 100.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

a. Provide the following in the maintenance manual:
   1. Condensed description of how the equipment operates.
   2. Block diagram indicating major assemblies.
   3. Troubleshooting information
   4. Preventive maintenance.
   5. Spare parts information.

b. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data."

SD-02 Shop Drawings

SD-03 Product Data

Power Meters; G, [_____]

Current Transformers; G, [_____]

Potential Transformer; G, [_____]

Communications Module; G, [_____]

Protocol Modules; G, [_____]

Data Recorder; G, [_____]

Modem; G, [_____]

Include manufacturer's information for each component, device, and accessory provided with the meter, protocol module or communications module.

SD-06 Test Reports

Acceptance Checks and Tests; G, [_____]

SD-10 Operation and Maintenance Data

Power Meters; G, [_____]

Communications Module; G, [_____]

Protocol Modules; G, [_____]

Data Recorder; G, [_____]

Modem; G, [_____]

SD-11 Closeout Submittals

System Function Verification; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Installation Drawings

Drawings indicate but are not limited to the following:

a. Elementary diagrams and wiring diagrams with terminals identified of[kilowatt][advanced] meter,[current transformers,][potential transformers,][protocol modules,][communications modules,][Ethernet connections,][telephone lines]. [For each meter installation, provide a diagram identified by the building number.]

b. One-line diagram, including meters,[switch(es),][current transformers,][potential transformers,][protocol modules,][communications modules,][Ethernet connections,][telephone outlets,][and fuses]. [For each meter installation, provide a diagram identified by the building number.]

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Provide product that has been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.4 Material and Equipment Manufacturing Data

Do not use products manufactured more than 2 years prior to date of delivery to site, unless specified otherwise.

1.5 WARRANTY

Provide equipment items supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6 SYSTEM DESCRIPTION

1.6.1 System Requirements

The metering and reading system, consisting of commercial, off-the-shelf meters, protocol modules, communications modules, and communication channels, will be used to record the electricity consumption and other values as described in the sections that follow and as shown on the drawings.

1.6.2 Selection Criteria

****

NOTE: Coordinate with the Public Works Department - when an installation-wide energy and utility monitoring system exists, include the last sentence.

****

Metering components are part of a system that includes the physical meter, data recorder function and communications (modem) method. Include sufficient metering components to measure the electrical parameters identified and to store and communicate the values as required in the following sections for every building site identified. Verify that the metering system installed on any building site is compatible with the facility-wide communication and meter-reading protocol system.[Contractor must connect the metering system to the facility-wide energy and utility monitoring and control system.]

PART 2 PRODUCTS

2.1 POWER METERS

****

NOTE: This specification is designed for projects where multiple metering systems will be installed on the same project. It is expected that different buildings may have different metering systems depending on the metering system that can be installed economically for any specific building and that meets the needs of the facility analysis and billing system.

Metering features that are unique to a building should be listed in a schedule either in this specification or on accompanying drawings.

****

2.1.1 Physical and Common Requirements

****

NOTE: Meters will generally be installed outside the building in a readily accessible location. In that case, use the socket-mount design. In the situations where panel-mounting is required, add the panel-mounting section.

****

a. Install metering system components according to the Metering System Schedule shown[in this specification][on the drawings].

[b. Power meter must be socket-mount design.]

[c. Power meter must be panel-mounted design. Furnish meters that are semi-flush, back-connected, dustproof, draw-out switchboard type. Provide cases with window removable covers capable of being sealed against tampering. Meters must be of a type that can be withdrawn through approved sliding contacts from fronts of panels or doors without opening current-transformer secondary circuits, disturbing external circuits, or requiring disconnection of any meter leads. Incorporate necessary test devices within each meter and provide means for testing either from an external source of electric power or from associated instrument transformers or bus voltage.]

d. If existing meter base is usable, the meter base determines meter form factor. If a new meter is being installed, use meter and base form factor of 9S.

****

NOTE: If the measured load is less than 220 amps, use Class 200 meters for direct current reading without current transformers.

****

[e. Use Class 200 meters for direct current reading without current transformers.]

f. Provide meter consisting of a Class 20, transformer rated design.

g. Provide meter that is rated for use at temperature from -40 [_____] degrees Centigrade to +70 [_____] degrees Centigrade.

h. Meter must have NEMA 3R enclosure for surface mounting.

****

NOTE: Select if the recorded data will be in a module inside the meter or external in a data logger. The preferred method is to install the recording module inside the meter case. Some retrofit applications may require an external data logger.

****

i. Surge withstand must conform to IEEE C37.90.1.

j. Provide meter with a standard[4] [_____]-year warranty.

k. Provide meter in compliance with IEC 62053-22 (Part 21: Static Meter for Active Energy, classes 0.2S and 0.5S), certified by a qualified third party test laboratory.

2.1.2 Voltage Requirements

a. Furnish meter that is capable of connection to the service voltage phases and magnitude being monitored. If the meter is not rated for the service voltage, provide suitable potential transformers to send an acceptable voltage to the meter.

b. Provide meter that is capable of connection to the service voltage indicated in the Metering System Schedule:

c. Provide meter that accepts independent voltage inputs from each phase and is auto-ranging over the full range of input voltages.

d. Optically isolate voltage input to 2500 volts DC from signal and communications outputs. Use components meeting or exceeding IEEE C37.90.1 (Surge Withstand Capability).

e. The Contractor is responsible for determining the actual voltage ratio of each potential transformer. Provide transformer conforming to IEEE C57.13 and the following requirements.

    (1) . Type: Dry type, of two-winding construction.

    (2) . Weather: Outdoor or Indoor rated for the application.

    (3) . Frequency: Nominal 60Hz, 50Hz for those bases that operate on 50Hz.

    (4) . Accuracy: Plus or minus 0.3% at 60Hz or 0.3% for those systems that operate at 50Hz.

2.1.3 Current Requirements

a. Accept independent current inputs from each phase. Install current transformer with a full load rating as shown in the schedule.

b. Provide single ratio current transformer with an Accuracy Class of [0.3][0.6] [1.2] with a maximum error of +/- [0.3%][0.6%][1.2%] at 5.0 amps.

c. Current transformer must have:

    (1) . Insulation Class: Provide 600 volt and below current transformers rated at 10 KV BIL. Provide current transformers for 2400 and 4160 volt service rated at 25 KV BIL.

    (2) . Frequency: Nominal 60Hz, 50Hz for bases that operate on 50Hz.

    (3) . Burden: Select burden class for the load.

    (4) . Phase Angle Range: 0 to 60 degrees.

d. Provide meter that accepts current input from standard instrument transformers (5A secondary current transformers.)

e. Current inputs must have a continuous rating in accordance with IEEE C57.13.

****

NOTE: Since loads in building can vary over time, multi-ratio current transformers allow the flexibility to change the ratio of the current transformer to match the load. The accuracy of current transformer performance decreases when the actual current is in the lower band of its measuring range.

****

f. Provide multi-ratio current transformer where indicated with a top range equal to or greater than the actual load. The Contractor is responsible for determining the actual ratio of each transformer. Provide current transformer conforming to IEEE C57.13.

2.1.4 Electrical Measurements

Measure and report the following quantities:

****

NOTE: Select each of the following measuring capabilities that are required and include the abbreviation in the Metering System Schedule for each building. Since power meters have a service life greater that 10 years, include optional features that are expected to be used and analyzed over the life of the meter.

****

a. Kilowatt-hours ("kWh" in Metering Systems Schedule) of consumption. Cumulative.

b. Kilowatts of demand ("kW" in Metering Systems Schedule). Peak average over a selectable demand interval between 5 and 60 minutes (typically 15 minutes).

c. Reactive power ("kVAR" in Metering Systems Schedule). Measured over the same interval as the peak kW reading.

d. Power factor ("PF" in Metering Systems Schedule). Measured over the same interval as the peak kW reading.

****

NOTE: At locations where time of use (TOU) billing is required by the electric company, this specification provides that all TOD meters cover the same periods as defined in the next section.

****

e. Time of use consumption ("TOU" in Metering Systems Schedule). Kilowatt-hours recorded separately for each period set by programming into the meter. Time periods must be capable of being changed without removal from service. The meter must internally record and store Time of Use data.

(1) . [Four (4)] minimum [_____] TOU Rates (Registers)

(2) . [Twenty (20)][_____] Year Calendar

(3) . [Two (2)] minimum [_____] seasons per year

****

NOTE: Interval recording is an important tool for analyzing energy consumption within a building. For billing purposes, real-time reporting is not required. For non EPACT05 meters, the meter can be read nominally once per month with all recorded interval data captured at that time. Where real-time

data is needed by an energy management control system (EMCS) or other system, the systems may have their own connection to the meter or its own current and potential transformers.
****

f. Interval recording ("IR" in Metering Systems Schedule). Record kilowatt-hours for each[15][_____] minute interval and accumulate for[30][_____] days. Memory for recording the interval readings must be internal to the meter and ANSI C12.19 compliant. Provide time-stamped readings for every measured parameter.

g. Meter readings must be true RMS.

2.1.5 Meter Accuracy

****
NOTE: Meters used for billing purposes should generally be held to the same metering accuracies as established standards by utility companies.
****

Provide the following accuracies. Measure accuracies as percent of reading at standard meter test points.

a. Provide power meter meeting ANSI C12.20 for Class 0.2 and IEC 62053-22 accuracy requirements.

2.1.6 An on the Meter Display, Output and Reading Capabilities

Include the following output signals.

a. The meter will have a face display plate and will display every electrical parameter indicated to be recorded. Do not require meters to indicate interval data collected in a data logger with a communications output feature. Display peak values, instantaneous and cumulative values.

[b. Include optical output port capable of 9600 bps communication with a hand-held reading device. Provide optical device that is compatible with ANSI C12.18]

****
NOTE: The following optional features will usually be deleted. These features could be used for connection to an Energy Management and Control System.
****

[c. Include output options for analog milliamp signals.]

[d. Provide meter with two channels of analog output, 0-1mA or 4-20mA, for positive[and negative] watt/hour readings.]

[e. Include output option for pulse output. KYZ pulse output related to kWatts/HR.]

[f. Provide meter with two form C, dry contact relay outputs for alarm or control.]

2.1.7 Installation Methods

****

NOTE: Pad-mounted transformers have proven to be very reliable over a long life span. Installing the meters on the outside of the secondary wiring compartment has become somewhat a standard installation for military facilities, resulting in minimal maintenance. However, meters may be installed on the sides of buildings or within buildings.

****

a. Transformer mounted (XFMR)

(1) . Locate meter base outside on the secondary side of the pad-mounted transformer.

****

NOTE: Do not use the stand-mounted method unless the transformer pad is being poured and the instrumentation conduit can be installed before the pour. Provide a drawing to show details for mounting and routing conduit and wires.

****

b. Stand-mounted adjacent to transformer ("STAND" in Metering Systems Schedule)

(1) . Mount meter base on a structural steel pole approximately 4 feet from the transformer pad. See detail on the drawings.

****

NOTE: Provide a drawing to show details for building mounting and routing conduit and wires.

****

c. Building mounted ("BLDG" in Metering Systems Schedule)

(1) . Mount meter base on the side of the existing building near the service entrance. See detail on the drawings.

d. Panel mounted. ("PNL" in Metering Systems Schedule)

(1) . Mount meter where directed. See detail on the drawings.

e. Common features.

(1) . PTs (if required for proper voltage range) and physically connect CTs to the service entrance cables inside the service entrance disconnect enclosure.

2.1.8 Disconnecting Switches

****

NOTE: Shorting-type wiring blocks are recommended to allow connections to be corrected and changed without the necessity of disconnecting power to the

transformer, resulting in another power outage to the building being served.
****

a. Provide disconnecting wiring blocks between the current transformer and the meter. Build a shorting mechanism into the wiring block to allow the current transformer wiring to be changed without removing power to the transformer. Locate the wiring blocks where they are accessible without the necessity of disconnecting power to the transformer. For multi-ratio current transformers, provide a shorting block from each tap to the common lead.

b. Equip voltage-monitoring circuits with disconnect switches to isolate the meter base or socket from the voltage source.

****
NOTE: If programming capability is not required, omit the following section.
****

2.1.9 Meter Programming

a. Provide power meter that is programmable by software supplied by the meter manufacturer.

b. Provide user-friendly software with Windows-compatible interface.

c. Operate software on [Windows][_____] operating systems.

d. Provide software that allows the user to configure the meter, troubleshoot meter, query and display meter parameters and configuration data and stored values.

e. Provide meter firmware that is upgradeable through one of the communications ports without removing the unit from service.

2.2 COMMUNICATIONS

****
NOTE: Communications features may not be needed. Data logging of one month of data may be recorded inside the meter. Recorded data may be read simply by a handheld instrument, if read daily.
****

2.2.1 Communications Methods

2.2.1.1 Optical Port

Communicate with a hand-held reading device according to the following requirements.

a. Communications standards

    (1) . ANSI C12.18

    (2) . MV90 protocol

    (3) . ANSI C12.20

b. Read operations

(1) . Current kWh values

(2) . Demand (kW) values since last reset

(3) . Last reset value

(4) . Meter status

[(5) . Load profile]

c. Write operations

(1) . Meter setup

2.2.1.2 Serial Port

Provide serial port for connection to modem module where required in this specification.

[a. On-Board serial port types]

[(1) . RS232]

[(2) . \[RS485]]

2.2.1.3 Ethernet

For those meters using the Ethernet, send logged information using open standard Internet Protocols.

a. On-board Ethernet port support

(1) . HTTP

(2) . SMTP

(a) Modbus

b. Distribute stored data by

(1) . FTP

[(2) . E-Mail]

[(a) On-board web server]

2.2.2 Communications Protocols and Methods

Use communications protocols and methods that are native to the meter. Provide communications module(s) as required to accomplish the following.

a. Include an IR port ("IR" in Metering Systems Schedule) for communication to external devices such as handheld readers that support a minimum speed of 9600 baud.

b. [Include[one][RS-232 ("RS232" in Metering Systems Schedule)] or[

one][RS-485 ("RS485" in Metering Systems Schedule)] digital communication port. Provide user configurable port with regard to speed, protocol, address, and other communications parameters that support a minimum communication speed of 9600 baud for the RS232 port.]

[c. Provide meter with a port that can be configured as a[10/100 Base-T Ethernet port ("BaseT" in Metering Systems Schedule)]]

[(1) . A communication module that converts serial RS232 or RS485 to Ethernet will be acceptable.]

[d. Auto Answer minimum 1200 baud internal modem ("A56K" in Metering Systems Schedule). Include automatic data buffering to provide faster, more reliable communications and the ability to automatically answer on a connected line.]

[e. Equip meter with one pulse output channel ("Pulse" in Metering Systems Schedule) that can be configured for operation as KYZ pulse output.]

2.2.3 Communications Channels Surge Protection

Protect communications equipment against surges induced on its communications channels. Protect communication interfaces to all field equipment to meet the requirements of IEEE C37.90.1 or the requirements of IEC 61000-4-5, test level 4, while the equipment is operating. Do not use fuses for surge protection. For metallic cables and conductors which serve as communications channels between buildings, install surge protection at equipment rated for the application at each end, within 3 feet 0.9 meters of the building cable entrance. Provide surge protectors meeting the requirements of the applicable extension of ANSI C62 (for example, ANSI C62.61).

****

NOTE: Communication methods, modules and software can be used for automatic meter reading (AMR). AMR may not be needed. If automatic meter reading (AMR) is to be implemented, considerable coordination of the communications sending, receiving and protocols will be required.

****

2.3 METER DATA PROTOCOL

Provide power meters that have communicating data protocols native or provide in supplemental modules to communicate with the communications methods that follow.

2.3.1 Open Protocol

****

NOTE: This section should be modified to be facility specific.

****

Support the following open protocols. Verify that the meter native protocol is consistent with the facility data recording and communication and data storage system. Provide additional converters and modules as required for a complete measurement, recording, communicating and data storage system.

a. Provide meter that is fully supported by MV-90 software system or existing AMR software that is MV-90 compatible.

b. For systems that use proprietary software, an alternative, competitive software system must be available.

Systems capable of using more than one brand of commercially available meters are expected. In addition, if proprietary meter reading software is used, meters are to be capable of being read by more than one manufacturer's software.

2.4 SPARE PARTS

2.4.1 Parts List

Provide spare parts as follows:

a. Power meter - two for each type used.

b. Current transformer - three for each type used.

  c. Potential transformer - three for each type used.

c. Communications module - one for each type used.

d. Protocol module - one for each type used.

e. Other electronic and power components - one for each type used.

2.5 METERING SYSTEM SCHEDULE

****

NOTE: Each building should be listed on a separate row. Identify the characteristics for the specific meter and communications method for each building. The following completed data is an example only. Delete existing values.

****

Metering System Schedule is available at
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-

****

NOTE: Provide a drawing to show locations and details for mounting and routing conduit and wires. Identify CT ratio and multi-tap ratios if known.

****

PART 3 EXECUTION

3.1 INSTALLATION

Perform electrical installations conforming to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

[3.1.1 Existing Condition Survey

****

NOTE: Remove the following section if existing condition surveys are not required.

****

Perform a field survey, including inspection of all existing equipment, resulting clearances, and new equipment locations intended to be incorporated into the system, and furnish an existing conditions report to the Government. Identify those items that are non-workable as defined in the contract documents. The Contractor is responsible for repairs of modifications necessary to make the system perform as required.

]3.1.2 Scheduling of Work and Outages

****

NOTE: Installation of current transformers and potential transformers will require that power be disconnected from the transformer and/or building. Provide coordination steps for the work and require Contractor to perform the work after normal hours.

****

The Contract Clauses govern regarding permission for power outages, scheduling of work, coordination with Government personnel, and special working conditions.

[3.2 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory-applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

]3.3 FIELD QUALITY CONTROL

3.3.1 Performance of Acceptance Checks and Tests

3.3.1.1 Meter Assembly

a. Visual and mechanical inspection

   (1) . Compare equipment nameplate data with specification and approved shop drawings.

   (2) . Inspect physical and mechanical condition.

   (3) . Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

   (4) . Verify grounding of metering enclosure.

   (5) . Verify the presence of surge arresters.

   (6) . Verify that the CT ratio and the PT ratio are properly included in the meter multiplier or the programming of the meter.

b. Electrical tests

[(1) . Calibrate watthour meters according to manufacturer's published data.]

(2) . Verify that correct multiplier has been placed on face or meter where applicable.

(3) . Prior to system acceptance, the Contractor will demonstrate and confirm the meter is properly wired and is displaying correct and accurate electrical information.

3.3.1.2 Current Transformers

a. Visual and mechanical inspection

(1) . Compare equipment nameplate data with specification and approved shop drawings.

(2) . Inspect physical and mechanical condition.

(3) . Verify correct connection.

(4) . Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(5) . Verify that required grounding and shorting connections provide good contact.

b. Electrical tests

(1) . Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) . Perform insulation-resistance test.

(3) . Perform a polarity test.

(4) . Perform a ratio-verification test.

3.3.1.3 Potential Transformers

a. Visual and mechanical inspection

(1) . PT's are rigidly mounted.

(2) . PT's are correct voltage.

(3) . Verify that adequate clearances exist between primary and secondary circuit.

b. Electrical tests

(1) . Perform a ratio-verification test.

3.3.2 Follow-Up System Function Verification

Upon completion of acceptance checks and tests, the show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, give the Contracting Officer 5 working days' advance notice of the dates and times of checking and testing.

3.3.3 Training

Conduct a training course for meter configuration, operation, and maintenance of the system as specified. Orient the training for all components and systems installed under this contract. Deliver training manuals for [_____] trainees with two additional copies delivered for archiving at the project site. Furnish all audiovisual equipment and all other training materials and supplies. A training day is defined as eight hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, assume that attendees have a high school education or equivalent, and are familiar with utility systems. Obtain approval of the planned training schedule from the Government at least 30 days prior to the training.

a. Training: Teach the course at the project site within thirty days after completion of the installation for a period of one [_____] day(s). A maximum of [6][_____] personnel will attend the course. The training includes:

    (1) . Physical layout of each piece of hardware.

    (2) . Meter configuration, troubleshooting and diagnostics procedures.

    (3) . Repair instructions.

    (4) . Preventive maintenance procedures and schedules.

    (5) . Testing and calibration procedures.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 27 14.00 20 (February 2021)**
Change 1 - 05/21

Preparing Activity: NAVFAC **Superseding**
UFGS-26 27 14.00 20 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 27 14.00 20

ELECTRICITY METERING

02/21, CHG 1: 05/21

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-26 27 14.00 20 (February 2021)**
Change 1 - 05/21

Preparing Activity: NAVFAC **Superseding**
UFGS-26 27 14.00 20 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 27 14.00 20

ELECTRICITY METERING

02/21, CHG 1: 05/21

****

NOTE: Many Activities have, or are in the process of, converting to basewide metering systems.

This Navy guide specification covers the requirements for the installation of electricity meters suitable for billing, allocation of costs, and recording of data for energy management and control applications for Navy projects. This specification is intended to comply with the metering requirements of EPACT05.

Although a unified metering specification is under development, some Air Force projects may require use of Section 26 27 13.10 30 ELECTRIC METERS.

Coordinate with the Activity and provide specific requirements "to match existing systems" when necessary. If specifying proprietary products, insure that appropriate "Justification and Authorization (J & A)" documentation has been obtained by project manager and "proprietary language requirements" have been added to Division 1 as well as adding the following lines above the section number and title at the top of the first page of this section of the specifications:

"*
This specification section contains proprietary products.
***"**

If there are any components (such as meters, housing, or current transformers) that will be Government Furnished Contractor Installed (GFCI), or Government Furnished Government Installed (GFGI), edit Division 1 and this specification section appropriately.

The following related guide specifications for power

distribution equipment may contain outdated meter information. Avoid duplication and ensure conflicting information has been removed from project documents.

- Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS
- Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS
- Section 26 11 13.00 20 PRIMARY UNIT SUBSTATIONS
- Section 26 11 16 SECONDARY UNIT SUBSTATIONS
- Section 26 23 00 LOW VOLTAGE SWITCHGEAR
--Section 26 24 13 SWITCHBOARDS

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

NOTE: NOTE: To download these details, go to:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

NOTE: This section utilizes the following sketches, details, and forms (Graphics), and are available in metric (SI) and U.S. Customary (IP) system dimensions. Sketch titles and style numbers are unchanged for both types. The metric values indicated are a conversion of the IP system dimensions.

Do not include this list of sketches, or the sketches themselves, in project specifications. Use sketches as details on drawings whenever possible.

SKETCH NUMBER	**TITLE**
E-M101	**Form 9S - Typical Wye Configuration With Single-Ratio CT's and Without PT's**
E-M102	**Form 9S - Typical Wye Configuration With Dual-Ratio CT's and Without PT's**

SKETCH NUMBER	TITLE
E-M103	Form 9S - Typical Wye Configuration With Multi-Ratio CT's and Without PT's
E-M104	Form 9S - Typical Wye Configuration With 10 Pole Test Switch
E-M105	Form 9S - Typical Delta Configuration Without PT's
E-M106	Form 2S - Typical
E-M107	Form 5S - Typical
E-M108	Form 6S - Typical
E-M110	Form 9S - Typical Wye Configuration With Single-Ratio CT's and With PT's
E-M111	Form 9S - Typical Wye Configuration With Dual-Ratio CT's and With PT's
E-M112	Form 9S - Typical Wye Configuration With Multi-Ratio CT's and With PT's
E-M113	Form 9S - Typical Delta Configuration With PT's
E-M201	Inside Meter Installation - Typical
E-M202	Outside Meter Installation on Wall - Preferred Distance to Gas Meter
E-M203	Outside Meter Installation on Wall - Acceptable Distance to Gas Meter
E-M204	Single Phase Self Contained Meters Residential Service: 0-600 Volts, Enclosed Installation
E-M205	Single Phase Self Contained Meters Residential Service: 0-600 Volts, Semi-Flush Installation
E-M206	Meter Cabinet Enclosure Clearances: 0-600 Volts

DETAILS	TITLE
PADMDE1	Pad-Mounted Transformer Detail
PADMDE2	Pad-Mounted Transformer Detail
PADMDE3	Pad-Mounted Transformer Detail

DETAILS	**TITLE**
PADMDE4	**Pad-Mounted Transformer Detail**
PADMDE5	**Pad-Mounted Transformer Detail**
PADMDE6	**Pad-Mounted Transformer Detail**

FORMS	**TITLE**
E-S1	**Building Meter Installation Sheet Per Building**
E-S2	**Electricity Meter Installation Schedule - Large Project**
E-S3	**Electricity Meter Data Schedule - Large Project**
E-S4	**Sample Contract Data Requirements List (CDRL)- Blank**
E-S5	**Sample Contract Data Requirements List (CDRL)- Example**

The Contract Data Requirements List (CDRL) can also be downloaded at http://www.dtic.mil/dtic/pdf/customer/STINFOdata/DD14231.pdf.
****

PART 1   GENERAL

1.1   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62053-22	(2020) Electricity Metering Equipment (A.C.) - Particular Requirements - Part 22: Static Meters for Active Energy (Classes 0,2 S and 0,5 S)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7	(2022) Requirements for Watthour Meter Sockets
ANSI C12.18	(2006; R 2023) Protocol Specification for ANSI Type 2 Optical Port
ANSI C12.20	(2015; E 2018) Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes
NEMA C12.19	(2021) Utility Industry End Device Data Tables

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: In this specification, special submittals are required for Contract Data Requirements List (CDRL). The CDRL submittals are indicated as bracketed options.

When used, include a completed DD Form 1423, Contract Data Requirements List with the project specifications. This form is essential to obtain delivery of all documentation. Each deliverable must be clearly specified, with both description and quantity required. A sample CDRL and an editable blank CDRL are included in the graphics list at the front of this specification, as Graphics ES-4 and ES-5.

The acquisition of all technical data, data bases and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Department of Defense Acquisition Regulation Supplement (DOD FARS).

Those regulations as well as the Services implementation thereof should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost.

Specifically, the Rights in Technical Data and Computer Software Clause DFARS 252.227-7013, and the Data Requirements Clause DOD FAR 52.227-7031, as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS. In addition, the appropriate DD Form 1423 Contract Data Requirements List (CDRL), will be filled out for each distinct deliverable data item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, will be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to ensure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES[, the CONTRACT CLAUSES and DD Form 1423]:

[Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.

] SD-02 Shop Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

Electricity Meters; G, [_____]

****

NOTE: Determine if a Technical Data Package will be required for electrical meters as described in the above note. If a Technical Data Package is required, include the bracketed option below.

****

[The most recent meter product data must be submitted as a Technical Data Package and must be licensed to the project site. Any software must be submitted on CD-ROM and [_____] hard copies of the software user manual must be submitted for each piece of software provided.

] Current Transformer; G, [_____]

[Potential Transformer; G, [_____]

] External Communications Devices; G, [_____]

[Configuration Software; G, [_____]

The most recent version of the configuration software for each type (manufacturer and model) must be submitted as a Technical Data Package and must be licensed to the project site. Software must be submitted on CD-ROM and [_____] hard copies of the software user manual must be submitted for each piece of software provided.

] SD-06 Test Reports

Acceptance Checks and Tests; G, [_____]

System Functional Verification; G, [_____]

Building Meter Installation Sheet, per Building; G, [_____]

Completed Meter Installation Schedule; G, [_____]

Completed Meter Data Schedule; G, [_____]

Meter Configuration Template; G, [_____]

Contractor must fill in the meter configuration template and submit to the Activity for concurrence.

Meter Configuration Report; G, [_____]

The meter configuration report must be submitted as a Technical Data Package.

SD-10 Operation and Maintenance Data

Electricity Meters and Accessories, Data Package 5; G, [_____]

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

System Functional Verification; G, [_____]

1.3 QUALITY ASSURANCE

****

NOTE: Select from the identified bracketed options the information that is to be provided on the drawings. Delete the items not needed for the project. Determine if communications information will be addressed in the drawings for the metering project or as a separate documentation package. The level of detail required might vary with the project.

Identify the required electronic drawing format in the selection below.
****

1.3.1 Installation Drawings

Drawings must be provided in hard-copy and [_____] electronic format, and must include but not be limited to the following:

a. Wiring diagrams with terminals identified of [kilowatt] [advanced] meter, [current transformers,] [potential transformers,][protocol modules,][communications interfaces,][Ethernet connections,][telephone lines].[For each typical meter installation, provide a diagram.]

b. One-line diagram, including meters, [switch(es),][current transformers,][potential transformers,] [protocol modules,][communications interfaces,][Ethernet connections,][telephone outlets,][and fuses].[For each typical meter installation, provide a diagram.] Provide one-line diagram to the local Public Works department.

1.3.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for one year prior to bid opening. The one-year period must include applications of equipment and materials under similar circumstances and of similar size. The product, or an earlier release of the product, must have been on sale on the commercial market through advertisements, manufacturers catalogs, or brochures during the prior one-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.3.3 Material and Equipment Manufacturing Data

Products manufactured more than 1 year prior to date of delivery to site must not be used, unless specified otherwise.

1.4 MAINTENANCE

1.4.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the actual electricity meters and accessories provided:

a. A condensed description of how the system operates

b. Block diagram indicating major assemblies

c. Troubleshooting information

d. Preventive maintenance

e. Prices for spare parts and supply list

1.5 WARRANTY

The equipment items and software must be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment and software on a regular and emergency basis during the warranty period of the contract.

1.6 SYSTEM DESCRIPTION

1.6.1 System Requirements

Electricity metering, consisting of meters and associated equipment, will be used to record the electricity consumption and other values as described in the requirements that follow and as shown on the drawings. Communication system requirements are contained in a separate specification section as identified in paragraph COMMUNICATIONS INTERFACES.

1.6.2 Selection Criteria

****

NOTE: Select a bracketed option below if it is intended that the new meter system be compatible with the existing system components.

****

Metering components and software are part of a system that includes the physical meter, data recorder function and communications method. Every building site identified must include sufficient metering components to measure the electrical parameters identified and to store and communicate the values as required.

[Contractor must verify that the electricity meter installed on any building site is compatible with the base-wide metering system with respect to the types of meters selected and the method used to program the meters for initial use. Software and meter programming tools are necessary to set up the meters described by this specification. New software tools different from the meter programming methods currently used by base personnel will require an Authority to Operate (ATO) by Command Information Office at the Enterprise level..

][Contractor must verify that the metering system installed on any building site is compatible with the facility-wide or base-wide communication and meter reading protocol system.

]PART 2 PRODUCTS

2.1 ELECTRICITY METERS AND ACCESSORIES

****

NOTE: When an activity has a metering system installed, provide meters to match. Coordinate with the project manager and include proprietary specification information.

Metering features that are unique to a building should be listed in a schedule either in this specification or on accompanying drawings. See Graphic ES-2 for a sample "Metering System Schedule".

****

****

ACTIVITY	CURRENT AMI CONTRACTOR	EXISTING METER TYPE	COMM METHOD	COMMENTS
Naval Base Ventura County	Schneider Electric	ION 8600	Note 1	Ion Enterprise Data Acquisition System (DAS) Software
NAVFAC SW	Schneider Electric	ION 8600	Note 2	StruxureWare Power Monitoring Expert Software
NAVFAC SE	Schneider Electric	ION 8600	Note 1	StruxureWare Power Monitoring Expert Software
NAVFAC NW	Schneider Electric	ION 8600C/ 8650C/ PM 8000	Note 3	StruxureWare Power Monitoring Expert Software
Naval District Washingt	Electro Industries	NEXUS 1272	Note 1	Communicator EXT Pro Software
NAVFAC HI	Electro Industries	Shark 270/ ION 8650C	Note 1	Communicator PQA (JBPHH), Ion Setup (PMRF) [both meter configuration software]
NAVFAC ML	Electro Industries	NEXUS 1272	Note 1	Communicator EXT Pro Software
NAVFAC FE	Schneider Electric	ION 8600C/ 8650C	Note 1	Communicator EXT Pro Software
NAVFAC MA	Schneider Electric	ION 8600C/ 8650C	Note 1	Communicator EXT Pro Software
NAVFAC EURAFCENT	Schneider Electric	ION 8650C/ PM 8000	Note 3	ION Enterprise DAS Software
Note 1: Combination radio mesh with fiber optic links.				
Note 2: Radio mesh. WinPM, similar to Ion enterprise with a wrap interface.				
Note 3: Combination radio mesh with fiber optic links. Includes some existing copper infrastructure.				

****

****

NOTE: One example of a specification paragraph is provided below for the case in which the meter is

programmed using government-owned equipment. If this type of paragraph is used, develop wording applicable to the specific project.
****

Provide meter(s) and connect the meter(s) to the existing AMI DAS. The contractor must use the existing government laptop computers to configure the meter using existing software loaded on the computer. The contractor will not be allowed to modify any software or add any additional software to the computer. Alternatively, the government will configure the meter(s), which must be compatible with the existing system, using existing software. Contractor must insure that the meter(s) will transmit the specified data to the DAS. The current meters being used by [_____] are: [ION 8600C] [ION 8650C] [PM 8000] [SHARK 270] [NEXUS 1272] [_____].

2.1.1 Physical and Common Requirements

****
NOTE: This specification is designed for projects where multiple metering systems will be installed as part of the same project. It is expected that different buildings may have different metering systems depending on the metering system that can be installed economically for any specific building and that meets the needs of the facility analysis and billing system.

This specification has been developed for 60-Hz applications. Designer must review and provide additional modifications necessary for 50-Hz use.

Sub-metering (versus single-metering at a facility) is not specifically addressed and the specification will require modification to address unique sub-metering requirements.

If the "Two-Way Automatic Communications System (TWACS)" is used for communications, this system has additional wire size and fuse requirements. The use of TWACS might limit the maximum voltage provided at each meter. Edit this specification to address these unique needs.

Class 320 meters are not allowed by this specification.

Define the configuration that is required to be initially programmed into each meter. If possible, define a standard programming profile and identify any exceptions to that profile.
****

a. Provide metering system components in accordance with the Metering System Schedule shown [in this specification][on the drawings]. Provide Meter configuration template.

****
NOTE: The bracketed option below allows the selection of whether to use or replace existing

meter bases.

Meter bases should be inspected if they are to be re-used. The second bracketed option requires an assessment of their physical condition before use.

For existing panelboard, switchboard, and switchgear installations, provide the same style meter. A direct replacement with a similar configuration can minimize the need for a design change and avoid clearance issues inside the enclosure.

The designer must have concurrence from the Activity and should exercise caution if changing an existing installation to a socket arrangement using a Form 9S adaptor kit. This can reduce the number of unique meters styles to maintain for spares, but can also cost more during the initial installation and can result in inadequate clearances within the equipment and the exterior.

****

b. [Replace all existing meter bases. For socket arrangements, use meter and base form of 9S unless installation-specific limitations require the use of a different form type. For panelboards, switchboards, and switchgear, match the existing installation with the new meter base.][Existing meter bases can be re-used if they are electrically functional, in physically good condition, and show no signs of corrosion on the electrical contacts. If the existing meter base is usable, the meter base determines meter form factor. If a new meter is being installed, use meter and base form factor of 9S unless installation-specific limitations require the use of a different form type.][If use of a socket adaptor arrangement has been approved by the activity, contractor must verify that all clearances are met and doors are able to be properly closed.]

****

NOTE: Select the bracketed option below if the meter will be installed in an enclosure. A stainless steel enclosure might be necessary for coastal or high humidity areas.

****

[c. Meter must have NEMA [3R] [3R stainless steel] enclosure for surface mounting with bottom or rear penetrations.

] d. Surge withstand capability must conform to IEEE C37.90.1.

****

NOTE: Modify the color scheme below if the activity uses a different identification system. This color scheme is for metering wiring only and does not match the color coding requirements for power conductors.

Wire labeling is also an acceptable approach to identification. If wire labeling is selected, modify the color scheme listed below to identify the label information for each wire.

****

e. Use #12 SIS (XHHW, or equivalent) wiring with ring lugs for all meter connections. Color code and mark the conductors[as follows:

(1) Red - Phase A CT - C1
(2) Orange - Phase B CT - C2
(3) Brown - Phase C CT - C3
(4) Gray with white stripe - neutral current return - C0
(5) Black - Phase A voltage - V1
(6) Yellow - Phase B voltage - V2
(7) Blue - Phase C voltage - V3
(8) White - Neutral voltage

]

****

NOTE: The electricity meters covered by this section are intended for low voltage applications and should be capable of receiving input nominal voltages of 120 to 480 volts. This section assumes that the available low voltage will be used as the meter supply. Potential transformers are not required.

If new medium voltage applications are planned, then include potential transformer requirements as part of the associated switchgear specification. If this section is applied to an existing installation, then use the bracketed options below to establish the potential transformer requirements.

****

2.1.2 Potential Transformer Requirements

a. Meter must be capable of connection to the service voltage phases and magnitude being monitored. If the meter is not rated for the service voltage, provide suitable potential transformers to send an acceptable voltage to the meter.

b. Voltage input must be optically isolated to 2500 volts DC from signal and communications outputs. Components must meet or exceed IEEE C37.90.1.

****

NOTE: Fusing is required to provide circuit protection and to minimize arc flash levels. Include bracketed option if pull-out type arrangement is required.

****

c. Provide [a pull-out type fuse block containing] one fuse per phase, Class RK type, to protect the voltage input to the meter. Size fuses as recommended by the meter manufacturer. Fusing must either be inside the secondary compartment of the transformer or inside the same enclosure as the CT shorting device.

****

NOTE: Select the following bracketed option if potential transformers will be used to transform 480 volt inputs to 120 volts.

****

[d. Potential transformers will be used to convert 480 volt inputs to 120 volts for the locations shown on the metering schedule. Potential transformers must be rated indoor or outdoor, as required for the specific application. Voltage rating must provide 120 volts, wye-connected, 3 phase, 4 wire, [60 Hz][50 Hz], insulation class, 600 volts. Potential transformers BIL must be 10 kV and must have an accuracy class of 0.3 at burdens w, x, and y. Thermal rating must be 500 VA.

]

****

NOTE: The following paragraphs are necessary only for medium voltage applications.

****

[e. The Contractor must be responsible for determining the actual voltage ratio of each potential transformer for medium voltage applications. Transformer must conform to IEEE C57.13 and the following requirements.

(1) Type: Dry type, of two-winding construction.

(2) Weather: Outdoor or indoor rated for the application.

(3) Frequency: Nominal [60 Hz][50 Hz].

(4) Accuracy: Plus or minus 0.3 percent at [60 Hz][50 Hz].

f. Potential transformers installed inside switchgear and panels must be rated for interior use. Voltage rating must provide 120 volts, wye-connected, 3 phase, 4 wire, [60 Hz][50 Hz], insulation class, 600 volts. Potential transformers BIL must be a minimum of 10 kV, and have an insulation class and BIL rating that equals or exceeds the ratings of the associated switchgear. Potential transformers must have an accuracy class of 0.15 at burdens w, x, and y. Thermal rating must be 500 VA. Potential transformers must be accessed from the front and mounted in a metering section.

]2.1.3 Current Transformer Requirements

a. Current transformer must be installed with a rating as shown in the schedule.

b. Current transformers must have an Accuracy Class of 0.15 (with a maximum error of plus/minus 0.3 percent at 5.0 amperes) when operating within the specified rating factor.

c. Current transformers must be solid-core, bracket-mounted for new installations using ring-tongue lugs for electrical connections. Current transformers must be accessible and the associated wiring must be installed in an organized and neat workmanship arrangement. Current transformers that are retrofitted onto existing switchgear busbar can be a busbar split-core design.

d. Current transformers must have:

****

NOTE: Include the bracketed option below only if medium voltage current transformers are used for the

electricity metering covered by this specification.

****

(1) Insulation Class: All 600 volt and below current transformers must be rated 10 KV BIL.[Current transformers for 2400 and 4160 volt service must be rated 25 KV BIL.]

(2) Frequency: Nominal [60 Hz][50 Hz].

(3) Burden: Burden class must be selected for the load.

(4) Phase Angle Range: 0 to 60 degrees.

e. Meter must accept current input from standard instrument transformers (5A secondary current transformers).

f. Current inputs must have a continuous rating in accordance with IEEE C57.13.

****

NOTE: Single-ratio current transformers (CTs) are specified below and are based on a per-meter application. Dual-ratio or multi-ratio CTs are only allowed if future requirements are expected to change the load demand.

This specification will require additional editing if dual-ratio or multi-ratio CTs are used.

****

g. Provide one single-ratio current transformer for each phase per power transformer with characteristics listed in the following table.

****

NOTE: This specification uses the CT rating factor and requires 55 degrees C as the basis for selection. Many CTs are installed outdoors; relying on the CT 30 degrees C rating is not appropriate for these installations.

Select the appropriate CT ratio, continuous-thermal-current rating factor (RF) at 55 degrees C (versus 30 degrees C which was used for previous guidance) and ANSI Metering Accuracy Class values based on transformer kVA size and secondary voltage. The basis for the 55 degrees C value is to allow for CT heating effects and higher ambient temperatures during operation.

The rating factor establishes the minimum electrical current range that will meet the CT accuracy rating. The CT should meet its accuracy requirement for measured current between 10 percent of the CT ratio and the rating factor multiplier applied to the CT ratio.

Example #1: for a 500 kVA transformer at 208 volts - select 1200:5, 1.33, 0.3 - B-0.5. For this selection, the CT should be accurate within its

specifications for an input current between 10 percent to 133 percent of the rating, or 120 to 1,600 amperes. The transformer full-load current rating is 1,388 amperes.

Example #2: for a 150 kVA transformer at 480 volts - select 200:5, 2.0, 0.3 - B-0.1. For this selection, the CT should be accurate within its specifications for an input current between 10 percent to 200 percent of the rating, or 20 to 400 amperes. The transformer full-load current rating is 180 amperes.

The table below lists the minimum allowed rating factor. Some manufacturers might be capable of higher rating factors.

	VOLTS					
	208			**240**		
kVA	**CT Ratio**	**RF**	**Meter Class**	**CT Ratio**	**RF**	**Meter Class**
75	**200:5**	**2.0**	**0.3 thru B-0.1**	**200:5**	**2.0**	**0.3 thru B-0.1**
112.5	**200:5**	**2.0**	**0.3 thru B-0.2**	**300:5**	**2.0**	**0.3 thru B-0.2**
150	**300:5**	**2.0**	**0.3 thru B-0.2**	**400:5**	**2.0**	**0.3 thru B-0.2**
225	**400:5**	**2.0**	**0.3 thru B-0.2**	**600:5**	**2.0**	**0.3 thru B-0.5**
300	**500:5**	**1.5**	**0.3 thru B-0.5**	**1200:5**	**1.5**	**0.3 thru B-0.5**
500	**1200:5**	**1.33**	**0.3 thru B-0.5**	**2000:5**	**1.33**	**0.3 thru B-0.9**
750	**2000:5**	**1.0**	**0.3 thru B-0.9**	**3000:5**	**1.0**	**0.3 thru B-1.8**

	VOLTS					
	480			**600**		
kVA	**CT Ratio**	**RF 55 C**	**Meter Class**	**CT Ratio**	**RF 55 C**	**Meter Class**
75	**100:5**	**2.0**	**0.3 thru B-0.1**	**100:5**	**2.0**	**0.3 thru B-0.1**
112.5	**200:5**	**2.0**	**0.3 thru B-0.1**	**100:5**	**2.0**	**0.3 thru B-0.1**
150	**200:5**	**2.0**	**0.3 thru B-0.1**	**200:5**	**2.0**	**0.3 thru B-0.1**
225	**200:5**	**2.0**	**0.3 thru B-0.1**	**200:5**	**2.0**	**0.3 thru B-0.1**
300	**300:5**	**2.0**	**0.3 thru B-0.2**	**300:5**	**2.0**	**0.3 thru B-0.2**

	VOLTS					
	480			**600**		
kVA	**CT Ratio**	**RF 55 C**	**Meter Class**	**CT Ratio**	**RF 55 C**	**Meter Class**
500	**600:5**	**1.5**	**0.3 thru B-0.5**	**600:5**	**1.5**	**0.3 thru B-0.5**
750	**800:5**	**1.33**	**0.3 thru B-0.5**	**800:5**	**1.33**	**0.3 thru B-0.5**
1000	**1200:5**	**1.33**	**0.3 thru B-0.5**	**1200:5**	**1.33**	**0.3 thru B-0.5**
1500	**1500:5**	**1.33**	**0.3 thru B-0.9**	**1500:5**	**1.33**	**0.3 thru B-0.9**
2000	**2000:5**	**1.0**	**0.3 thru B-0.9**	**2000:5**	**1.0**	**0.3 thru B-0.9**
2500	**3000:5**	**1.0**	**0.3 thru B-1.8**	**3000:5**	**1.0**	**0.3 thru B-1.8**

NOTE: 2. Incorporate the appropriate values in a table similar to the one shown below.
****

Single-Ratio Current Transformer Characteristics				
kVA	Sec. Volt	CT Ratio	RF	Meter Acc. Class
[500]	[208Y:120]	[1200:5]	[1.33]	[0.3 thru B0.05]
[750]	[480Y:277]	[800/5]	[1.33]	[0.3 thru B0.05]

2.1.4 Meter Requirements

****
NOTE: If J&A documentation has been obtained, use the first bracketed option below and fill in the manufacturer and complete model number that defines the intended meter characteristics. Otherwise select the second bracketed option below and edit the general list of meter characteristics.
****

[Notwithstanding any other provision of this contract, meters must be [_____]; no other product will be acceptable. All meters must meet NAVFAC Cyber Security Requirements.

][Electricity meters must include the following features:

a. Meter must comply with ANSI C12.1, NEMA C12.19, and ANSI C12.20 and must match existing AMI meter system at the installation and be the newest version with ATO.

b. Meter sockets must comply with ANSI C12.7.

****

NOTE: Select the following bracketed industry standards if applicable for an OCONUS application.

****

[c. Meter must comply with IEC 62053-22, certified by a qualified third party test laboratory.

d. Meter must be certified by a qualified 3rd party test laboratory.

] e. Provide socket-mounted or panel mounted meters as indicated on the meter schedule.

[(1) Panel-mounted meters must be semi-flush, back-connected, dustproof, draw-out switchboard type. Cases must have window removable covers capable of being sealed against tampering. Meters must be of a type that can be withdrawn through approved sliding contacts from fronts of panels or doors without opening current-transformer secondary circuits, disturbing external circuits, or requiring disconnection of any meter leads. Necessary test devices must be incorporated within each meter and must provide means for testing either from an external source of electric power or from associated instrument transformers or bus voltage.

]

****

NOTE: The default design is a Class 20, transformer rated meter. If the measured or expected load is less than 200 amperes, Class 200 meters can be used for direct current reading without current transformers. Specify the location of these meters.

****

f. Meter must be a Class 20, transformer rated design.

[g. Use Class 200 meters for direct current reading without current transformers for applications with an expected load less than 200 amperes, where indicated.

] h. Meter must be rated for use at temperature from minus 40 [_____] degrees Centigrade to plus 70 [_____] degrees Centigrade.

i. The meters must have an electronic demand recording register and must be secondary reading as indicated. The register must be used to indicate maximum kilowatt demand as well as cumulative or continuously cumulative demand. Demand must be measured on a block-interval basis and must be capable of a 5 to 60 minute interval and initially set to a 15-minute interval. It must have provisions to be programmed to calculate demand on a rolling interval basis. Meter readings must be true RMS.

j. The meter electronic register must be of modular design with non-volatile data storage. Downloading meter stored data must be capable via an [optical][USB] port. Recording capability of data storage with a minimum capability of 89 days of 15 minute, 2 channel interval data. The meter must be capable of providing at least 2 KYZ pulse outputs (dry contacts). Default initial configuration (unless identified otherwise by base personnel) must meet NAVFAC CIRCUITS Call for Consistency document located on the NAVFAC CIRCUITS Portal and must be:

(1) First channel - kWh
(2) Second channel - kVARh
(3) KYZ output #1 - kWh
(4) KYZ output #2 - kVARh

k. All meters must have identical features available in accordance with this specification. The meter schedule identifies which features must be activated at each meter location.

l. Enable switches for Time of Use (TOU), pulse and load profile measurement module at the factory.

m. Meter must have an optical port on front of meter. Optical device must be compatible with ANSI C12.18.

n. Meters must be 120-480 volts auto ranging.

****

NOTE: Include the bracketed option below only if potential transformers are used.

****

o. Provide blank tag fixed to the meter faceplate for the addition of the meter multiplier, which will be the product of the current transformer [and potential transformer]ratio and will be filled in by base personnel on the job site. The meter's nameplate must include:

(1) Meter ID number.
(2) Rated voltage.
(3) Current class.
(4) Metering form.
(5) Test amperes.
(6) Frequency.
(7) Catalog number.
(8) Manufacturing date.

p. On switchboard style installations, provide switchboard case with disconnect means for meter removal incorporating short-circuiting of current transformer circuits.

q. Meter covers must be polycarbonate resins with an optical port and reset. Backup battery must be easily accessible for change-out after removing the meter cover.

r. The normal billing data scroll must be fully programmable. The normal billing data scroll requirements provided in the CIRCUITS Call for Consistency Document located on the NAVFAC CIRCUITS Portal. Data scroll display must include the following.

(1) Number of demand resets.
(2) End-of-interval indication.
(3) Maximum demand.
(4) New maximum demand indication.
(5) Cumulative or continuously cumulative.
(6) Time remaining in interval.
(7) Kilowatt hours.

s. The register must incorporate a built-in test mode that allows it to be tested without the loss of any data or parameters. The following quantities must be available for display in the test mode:

  (1) Present interval's accumulating demand.
  (2) Maximum demand.
  (3) Number of impulses being received by the register.

t. Pulse module simple I/O board with programmable ratio selection.

u. Meters must be programmed after installation via an [optical][USB] port. Optical display must show TOU data, peak kWh, semi-peak kWh, off peak kWh, and phase angles.

v. Self-monitoring to provide for:

  (1) Unprogrammed register.
  (2) RAM checksum error.
  (3) ROM checksum error.
  (4) Hardware failure.
  (5) Memory failure.
  (6) EPROM error.
  (7) Battery status (fault, condition, or time in service).

w. Liquid crystal alphanumeric displays, 9 digits, blinking squares confirm register operation. Six Large digits for data and smaller digits for display identifier.

x. Display operations, programmable sequence with display identifiers. Display identifiers must be selectable for each item. Continually sequence with time selectable for each item.

y. The meters must support three modes of registers: Normal Mode, Alternate Mode, and Test Mode. The meter also must support a "Toolbox" or "Service Information" (accessible in the field) through an optocom port to a separate computer using the supplied software to allow access to instantaneous service information such as voltage, current, power factor, load demand, and the phase angle for individual phases.

****

NOTE: Determine the desired warranty period and update the bracketed option below.

****

z. Meter must have a standard [4] [_____]-year warranty.

]2.1.5 Disconnect Method

****

NOTE: The standard design must include a 10-pole safety disconnect. This permits meter removal without service interruption and includes shorting type wiring blocks so that CTs are not inadvertently open circuited.

The options for the disconnecting wiring blocks requires approval by the authority having jurisdiction and would only be used when installing a meter system using individual components rather

than an integrated switch.
****

a. Provide a 10-pole safety disconnect complete with isolation devices for the voltage and current transformer inputs, including a shorting means for the current transformers.

[b. Disconnecting wiring blocks must be provided between the current transformer and the meter. A shorting mechanism must be built into the wiring block to allow the current transformer wiring to be changed without removing power to the transformer. The wiring blocks must be located where they are accessible without the necessity of disconnecting power to the transformer.

c. Voltage monitoring circuits must be equipped with disconnect switches to isolate the meter base or socket from the voltage source.

]2.1.6 Installation Methods

****
NOTE: Pad-mounted transformers have proven to be very reliable over a long life span. Installing one meter on the outside of the secondary wiring compartment has become the standard installation for military facilities resulting in minimal maintenance. However, to prevent additional compromise of the transformer enclosure integrity, if more than one meter is required for a location or service, add a separate free-standing unistrut frame with each meter in its own enclosure or use commercial meter pedestals for each meter.

Meters may be installed on the sides of buildings. Installing meters inside of a building and behind locked doors has proven to be a burden for meter readers in some instances and is not recommended.
****

a. Transformer Mounted ("XFMR" in Metering Systems Schedule). Meter base must be located outside on the secondary side of the pad-mounted transformer.

b. Stand Mounted Adjacent to Transformer ("STAND" in Metering Systems Schedule). Meter base must be mounted on a structural steel pole approximately 1.2 meters 4 feet from the transformer pad. This can be used for multiple meters associated with a single transformers.

****
NOTE: Provide a drawing to show details for building mounting and routing conduit and wires. Typical detail drawings are referenced at the beginning of this specification.
****

c. Building Mounted ("BLDG" in Metering Systems Schedule). Meter base must be mounted on the side of the existing building near the service entrance.

d. Panel Mounted. ("PNL" in Metering Systems Schedule). Meter must be mounted where directed.

e. Commercial meter pedestal ("PED" in Metering Systems Schedule).

2.2 COMMUNICATIONS INTERFACES

****

NOTE: The default metering condition is to provide two-way communication with an existing DAS, if installed at the Activity already. If a DAS is not installed or is outdated (inadequate), then coordinate with the activity to determine if a new DAS should be provided as part of the contract. If a new DAS is determined to be necessary, edit the requirements below as needed to identify the DAS requirements. New meters must connect to the Control Systems Platform Enclave at the regional level.

The communications requirements must be determined for each location and are not addressed by this specification. A hardwired or optical connection is preferred. Possible communications options include:

RS-232
RS-485
Optical port
Ethernet (RJ-45)
Fiber-optic ST connection
RF (Wireless) Module
Power line carrier and
LTE radio

Determine the communications requirements for the metering system and modify the paragraph below as necessary to define the selected communication system.

****

Meter must have two-way communication with the existing data acquisition system (DAS). Provide a communications interface utilizing [_____].[Refer to Section [_____] for the communication interface requirements for these meters.]

Provide interfacing software if a meter is used that is different than the existing meters at the Activity to ensure compatibility within the metering system.

****

NOTE: Determine the connections requirements for the AMI network and modify the paragraph below as necessary to provide equipment for the system. This could be as simple as providing a fiber optic link to the closest connection point or could be more extensive and requires close coordination with the Activity.

****

Connect to the AMI network utilizing [_____].

****
NOTE: Determine what modifications need to be done to the existing DoD Information Assurance Certification and Accreditation Process (DIACAP) to maintain accreditation. Check with the local Command Information Officer (CIO) for the latest requirements.
****

[Provide [_____].

][2.3 SPARE PARTS

****
NOTE: Spare parts are not normally included as part of the construction contract or on contracts involving a small number of meters. On large projects, involving ten or more meters, the following may be an example of spare parts requirements.
****

Provide the following spare parts:

a. Power Meter - two for each type used with batteries.

b. Communications interface - one for each type used.

]2.4 METERING SYSTEM SCHEDULE

****
NOTE: A schedule of meters and their associated requirements are preferentially included on a separate drawing. As an alternate, the required tabular information can be provided below. In each case, identify the characteristics for the specific meter and communications method for each building.
****

[_____]

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to ASHRAE 90.1 - IP, ASHRAE 90.1 - SI IEEE C2, NFPA 70 (National Electrical Code), and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

****
NOTE: Remove the following section if existing condition surveys are not required. If an existing condition survey is not required as part of the installation, the metering system schedule should address any unique requirements for each installation.
****

[3.1.1 Existing Condition Survey

The Contractor must perform a field survey, including inspection of all existing equipment, resulting clearances, and new equipment locations intended to be incorporated into the system and furnish an existing conditions report to the Government. The report must identify those items that are non-workable as defined in the contract documents. The Contractor must be held responsible for repairs and modifications necessary to make the system perform as required.

3.1.1.1 Existing Meter Sockets

In some cases, the existing meter sockets will have to be replaced to accommodate the new electrical meters. An existing socket is considered unacceptable for any of the following conditions:

a. It is a non-ANSI form factor meter socket.

b. It is weathered beyond the point of being safe to reuse.

c. It is installed incorrectly, such as a non-weather resistant enclosure installed outdoors.

d. It is not the correct form factor for the existing electrical service.

3.1.1.2 Existing Installations

As part of the existing condition survey, the following applies for installations with existing meters:

****

NOTE: Coordinate with the activity for the desired re-use or disposition of existing PTs.

****

a. Replace any meters that do not comply with this section.

b. If CTs are installed, verify that they comply with this section. If they do not comply, replace them with CTs that comply with this section. One CT per phase is required for wye-connected systems.

[c. If potential transformers are installed on low-voltage systems, remove the PTs as part of the installation.

] d. Install disconnect switches as specified in this section.

][3.1.2 Scheduling of Work and Outages

****

NOTE: Installation of current transformers and potential transformers will require that power be disconnected from the transformer and building. Provide coordination steps for the work and require the Contractor to perform the work after normal hours. Coordinate with Division 1 Sections.

****

The Contract Clauses must govern regarding permission for power outages, scheduling of work, coordination with Government personnel, and special working conditions.[_____]

]3.1.3 Configuration Software

The standard meter must include the latest available version of firmware and software. Meter must either be programmed at the factory or must be programmed in the field. Meters must have a password that must be provided to the contracting officer upon project completion. When field programming is performed, turn field programming device over to the Contracting Officer at completion of project. When interfacing software is used for a meter that is different than the existing meters in use at the Activity, turn the software over to the Contracting Officer at completion of the project.

3.2 FIELD QUALITY CONTROL

****

NOTE: Apply 100 percent checks for smaller projects. Use random sampling of acceptance checks and tests for large projects. If no problems are identified in the acceptance checks and tests of the random sample, then the results would be accepted. If problems are identified in the acceptance checks and tests of the random sample, then an additional random sample would be selected for verification.

****

Perform the following acceptance checks and tests on all installed meters.

3.2.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

a. Meter Assembly

****

NOTE: The following requirements are derived from NETA ATS and have been modified for this specification.

****

(1) Visual and mechanical inspection.

(a) Compare equipment nameplate data with specifications and approved shop drawings.

(b) Inspect physical and mechanical condition. Confirm the meter is firmly seated in the socket, the socket is not abnormally heated, the display is visible, and the ring and seal on the cover are intact.

(c) Inspect all electrical connections to ensure they are tight. For Class 200 services, verify tightness of the service conductor terminations for high resistance using low-resistance ohmmeter, or by verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(d) Record model number, serial number, firmware revision, software revision, and rated control voltage.

(e) Verify operation of display and indicating devices.

(f) Record password and user log-in for each meter.

(g) Verify grounding of metering enclosure.

(h) Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements. Verify that the CT ratio and the PT ratio are properly included in the meter multiplier or the programming of the meter. Confirm that the multiplier is provided on the meter face or on the meter.

(i) Provide building meter installation sheet, per building for each facility. See example Graphic E-S1.

[(j) Provide the completed meter installation schedule for the installation if multiple meters are to be used. See example Graphic E-S2

][(k) Provide the completed meter data schedule for the installation if multiple meters are to be used. See example Graphic E-S3.

] (2) Electrical tests.

(a) Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.

(b) Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital, and analog.

(c) After initial system energization, confirm measurements and indications are consistent with loads present.

(d) Make note of, and report, any "Error-Code" or "Caution-Code" on the meter's display.

(3) Provide meter configuration report.

b. Current Transformers

(1) Visual and mechanical inspection.

(a) Compare equipment nameplate data with specification and approved shop drawings.

(b) Inspect physical and mechanical condition.

(c) Verify correct connection, including polarity.

(d) Inspect all electrical connections to ensure they are tight.

(e) Verify that required grounding and shorting connections provide good contact.

(2) Electrical Tests.

Verify proper operation by reviewing the meter configuration report.

****

NOTE: Include the following inspections and tests if potential transformers are included within the scope of the project.

****

[c. Potential Transformers

(1) Visual and mechanical inspection.

(a) Verify potential transformers are rigidly mounted.

(b) Verify potential transformers are the correct voltage.

(c) Verify that adequate clearances exist between the primary and secondary circuit.

(2) Electrical Tests.

(a) Verify by the meter configuration report that the polarity and phasing are correct.

]3.2.2 System Functional Verification

Verify that the installed meters are working correctly in accordance with the meter configuration report:

a. The correct meter form is installed.

b. All voltage phases are present.

c. Phase rotation is correct.

d. Phase angles are correct.

e. The new meter accurately measures power magnitude and direction, and can communicate as required by paragraph COMMUNICATIONS INTERFACES.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-26 27 29 (May 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 27 29 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 27 29 (May 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 27 29 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 27 29

MARINA ELECTRICAL WORK

05/21

****

NOTE: This guide specification covers the requirements for procurement, installation, and testing of electrical wiring systems for construction projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: These wiring systems primarily involve voltages of 600 volts and less and exterior systems. When voltages greater than 600 volts are brought to a facility, consult and use Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION; Section 26 11 16 SECONDARY UNIT SUBSTATIONS; Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION; and Section 26 12 19 PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS or 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS as required. Requirements for materials and procedures for special or unusual design should be added as necessary to fit specific projects.

****

****

NOTE: The following information must be shown on the project drawings.

1. Where specification identifies type, size, color, finish, or other definitive information to be "as indicated," the engineer must include the information on the drawings.

2. Location of manholes, handholes, ducts, and cables.

3. Types of wire and cable; number and sizes of conductors.

4. Limits of each hazardous location, clearly indicating class, division, and group classification of each hazard.

5. Special conditions.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA RN 1	(2018) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 14	(2002) Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 303	(2021) Fire Protection Standards for Marinas and Boatyards

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint Aug 2023) UL Standard for Safety Panelboards
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 498	(2017; Reprint Jun 2024) UL Standard for Safety Attachment Plugs and Receptacles
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514B	(2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Apr 2024) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 870	(2016; Reprint Nov 2023) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1203	(2023; Reprint May 2024) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations

1.2 RELATED REQUIREMENTS

26 20 00 INTERIOR DISTRIBUTION SYSTEM, applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Modify submittals paragraphs to ensure that an appropriate submittal is required for each item in the project.

****

SD-02 Shop Drawings

Panelboards; G, [_____]

Transformers; G, [_____]

Wireways; G, [_____]

SD-03 Product Data

Receptacles

Enclosed Circuit Breakers; G, [_____]

Disconnect Switches; G, [_____]

Conduit and Fittings (each type)

Power Pedestal; G, [_____]

Grounding and Bonding Equipment

Device Plates

Wires and Cables

Outlet Boxes and Covers

Transformers; G, [_____]

Splice and Termination Components

Wireways

Cabinets, Junction Boxes, and Pull Boxes

Mounting Straps

Conduit Support

Marine Signal Lantern; G, [_____]

Solar Power Station; G, [_____]

SD-06 Test Reports

Transformer Tests; G, [_____]

600-volt Wiring Test; G, [_____]

Grounding System Test; G, [_____]

Solar Power Station Test; G, [_____]

Submit test results for approval in report format.

SD-07 Certificates

Solar Power Station; G, [_____]

Submit coordination data as specified in paragraph SOLAR POWER STATION.

1.4 QUALITY ASSURANCE

1.4.1 Grounding System Tests

Submittal must include written results of each test and indicate location of rods as well as resistance and soil conditions at the time measurements were made.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

****

NOTE: Where possible use nonmetallic enclosures, conduits, and mounting hardware.

****

Materials, equipment, and devices must, as a minimum, meet requirements of UL where UL standards are established for those items, and requirements of NFPA 70 and NFPA 303.

2.2 CONDUIT AND FITTINGS

[Rigid nonmetallic conduit][Plastic-coated rigid steel conduit] conforming to the following:

2.2.1 Rigid Nonmetallic Conduit

PVC Type EPC-80[and EPC-40] in accordance with NEMA TC 2, or fiberglass conduit in accordance with NEMA TC 14.

2.2.2 Plastic-Coated Rigid Steel Conduit

NEMA RN 1, Type 40 one millimeter thick 40 mils thick.

2.2.3 Fittings for Metal Conduit and Liquidtight Flexible Metal Conduit

UL 514B. Ferrous fittings must be cadmium or zinc coated in accordance with UL 514B.

2.2.3.1 Fittings for Rigid Metal Conduit

Threaded type. Split couplings unacceptable.

[2.2.3.2 Fittings for Use in Hazardous Locations

UL 1203.

]2.2.4 Fittings for Rigid Nonmetallic Conduit

UL 514B and UL 651.

2.2.5 Expansion Joints

Provide conduit expansion joints having 150 mm 6 inch expansion at each expansion joint in the pier and in each conduit run exceeding 75 meters 250 feet. Provide expansion joints having 50 mm 2 inch expansion in each conduit run of less than 75 meters 250 feet.

2.3 POWER PEDESTAL

A complete factory-assembled and prewired unit specifically constructed for marine applications. Power center must be a [two][or][four] outlet [pedestal][surface] mounted type having a separate circuit breaker for each outlet. Circuit breaker size must be the same size as outlet to which it is connected. Power outlets must be single, locking and grounding type, size and voltage as indicated. Power center enclosure must be stainless steel, fiberglass, or foamed thermoplastic with polyurethane coating. Each individual outlet and circuit breaker enclosure must have a separate gasketed weatherproof cover. Entire exterior surface of power center must be nonmetallic design for exposure to saltwater environment.[Provide photo controlled LED station light.][Provide with [one] [_____] telephone outlet[s].]

2.3.1 Warning Sign

Provide permanently mounted waterproof warning sign at each power center. Sign must have red letters on a white background with letters no less than 6 mm .25 inch in height. Sign must be worded as follows:

"WARNING
To minimize shock and fire hazards:
Turn off the boat's shore connection switch before connecting or disconnecting shore cable.
Connect shore power cable at the boat first.
Disconnect shore power cable at shore outlet first.
Close shore power inlet cover tightly.
DO NOT ALTER SHORE POWER CABLE CONNECTORS"

2.4 OUTLET BOXES AND COVERS

UL 514C.

2.4.1 Outlet Boxes in Hazardous Locations

UL 1203. Suitable for wet locations.

2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 3280 mL 200 cubic inches, UL 50, NEMA 4X [nonmetallic][or][stainless steel].

2.6 WIRES AND CABLES

Must meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not provide wires and cables manufactured more than 12 months prior to date of delivery to site.

2.6.1 Conductors

****

NOTE: In overseas locations, for conductor sizes No. 10 AWG and smaller diameter, consideration may be given to the use of stranded wires, if suitable terminal devices can be applied which enable proper connection. Also, stranded wires in sizes No. 10 AWG and smaller diameter may be required for projects involving uninterrupted power supply (UPS) installations.

****

No. 8 AWG and larger diameter must be stranded; No. 10 AWG and smaller must be solid, except that conductors for remote control, alarm, and signal circuits, Classes 1, 2, and 3, must be stranded. Conductors must be copper. Conductor sizes and ampacities shown are based on copper.

2.6.1.1 Minimum Conductor Sizes

Minimum size for branch circuits must be No. 12 AWG; for Class 1 remote-control and signal circuits, No. 14 AWG; for Class 2 low-energy, remote-control and signal circuits, No. 18 AWG; and for Class 3 low-energy, remote-control, alarm, and signal circuits, No. 22 AWG.

2.6.2 Color Coding

Provide for service, feeder, branch, control, and signaling circuit conductors. Color must be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutral must be white with colored, except green, stripe. Color of ungrounded conductors in different voltage systems must be as follows:

a. 120/208 volt, three phase:

  (1) Phase A - black

  (2) Phase B - red

  (3) Phase C - blue

b. 277/480 volt, three phase:

  (1) Phase A - brown

  (2) Phase B - orange

  (3) Phase C - yellow

c. 120/240 volt, single phase: red and black

[d. On three-phase, four-wire delta system, high leg must be orange, as required by NFPA 70.

]2.6.3 Insulation

****

NOTE: Be sure conduit fill calculations are based on largest diameter insulation type allowed. Designer may select other insulation types which may be more suitable for a particular project. For rewiring project where existing conduit is to be utilized, specify types THHN and THWN. If conduit is sized for conductors other than THW, ensure the specification is properly edited and a note indicating the conductor type specified is added to the drawings. Type RHW insulation is not allowed on Navy projects.

****

Unless otherwise required by NFPA 70, power and lighting wires must be 600-volt, Type THWN, XHHW, [or RHW,]except that grounding wire may be Type TW; remote-control and signal circuits must be Type TW, THW, or TF. Conductors must conform to UL 83. Where lighting fixtures require 90-degree C conductors, provide only conductors with 90-degree C insulation or better.

2.6.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.6.5 Splice and Termination Components

UL 486A-486B, for wire connectors, and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires must be insulated, pressure type in accordance with UL 486A-486B, twist-on splicing connector. Provide solderless terminal lugs on stranded conductors.

2.6.5.1 Watertight Pin Connectors

Connectors must be rated 600 volts, and individual pins must have ampere rating equal to or greater than the cable to which they are joined. Connectors must be molded-to-cable, quick-disconnect, polarized type having full male shroud so that when male and female assemblies are joined the shroud must provide a completely sealed connection. Connector material must be neoprene resistant to oil, dust, acids, and sunlight and must be watertight.

2.7 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. Plates must be nylon or lexan, minimum 2.54 mm 0.10 inch wall thickness. Plates must be same color as receptacle with which they are mounted. Screws must be stainless steel machine type with countersunk heads in color to match finish of plate. Use of sectional-type device plates will not be permitted. Plates must be gasketed and UL listed for wet locations.

2.8 DISCONNECT SWITCHES

****

NOTE: Switches requiring frequent operation should be the heavy-duty type and should be so indicated on the drawings.

****

NEMA KS 1. Switches serving as motor-disconnect means must be horsepower rated. Provide heavy duty-type switches where indicated, where switches are rated greater than 240 volts, and for double-throw switches. Provide switches in NEMA 4X [nonmetallic][or][stainless steel] enclosure in accordance with NEMA ICS 6.

2.9 RECEPTACLES

UL 498 and NEMA WD 1, heavy-duty, grounding type. Bodies must be of [brown] [ivory] thermosetting plastic supported on a metal mounting strap. Provide screw type, side wired wiring terminals. Connect grounding pole to mounting strap.

2.9.1 Duplex Receptacles

Receptacles must be 20 amperes, 125 volts, specification grade.

2.9.2 Weatherproof Receptacles

Provide in nonmetallic box with gasketed, weatherproof, nonmetallic cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Provide UL listed receptacle for use in wet locations.

2.9.3 Ground-Fault Protection of Equipment (GFPE) and Ground-Fault Circuit Interrupter (GFCI) Receptacles

UL 943. Receptacles providing shore power must have individual GFPE set to open at currents not exceeding 30 milliamperes.

GFCI protection for personnel, duplex type for mounting in standard outlet box. Device must be capable of detecting current leak of 5 milliamperes or greater and tripping in accordance with UL 943 for Class A GFCI devices.

2.9.4 Special-Purpose Receptacles

Receptacles serving [_____] are special purpose.[Provide in ratings indicated.][NEMA [_____] configuration, rated [_____] amperes, [_____] volts.][Furnish one matching plug with each receptacle.]

[2.10 PLUGS

[Provide heavy-duty, rubber-covered[three,][four,][or][five]-wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn in plugs and cord assemblies to the Government.

]2.10.1 Weatherproof Cord and Plug Assemblies

Furnish [one] [_____] cord and plug assembly[ies] consisting of a [30-ampere, 125-volt twist-lock plug on one end, a 8 meter 25 foot length of three conductor, No. 10 type STO cord, and two 20-ampere, 125-volt twist-lock receptacles on the other end][and][furnish [one] [_____] cord and plug assembly[ies] consisting of a 20-ampere, 125-volt twist-lock plug on one end, a 8 meter 25 foot length of three conductor, No. 12 type STO cord and a 20-ampere twist-lock receptacle on the other end.] Plugs must be compatible with power center outlets.

]2.11 PANELBOARDS

UL 67 and UL 50 having a short-circuit current rating of [10,000] [_____] amperes symmetrical minimum. Panelboards for use as service disconnecting means must additionally conform to UL 869A. Panelboards must be circuit breaker equipped. Design must be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. Where "space only" is indicated, make provisions for future installation of breakers. Key panelboard locks the same. Directories must indicate load served by each circuit in panelboard and main source of service to panelboard, such as Panel PA served from Panel MDP. Type directories and mount in holder behind transparent protective covering. When panelboards are used as a service disconnecting means, conform to UL 869A

2.11.1 Panelboard Buses

Copper. Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus in accordance with UL 67 for connecting grounding conductors; bond to steel cabinet.

2.11.2 Circuit Breakers

UL 489 thermal magnetic type having a minimum short-circuit current rating equal to the short-circuit rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals must be UL listed as suitable for type of conductor provided. Circuit breakers must be bolt-on type. Din-rail mounted and half-width circuit breakers are not acceptable. Plug-in circuit breakers and series rated circuit breakers are unacceptable.

2.11.2.1 Multipole Breakers

Provide common trip type with single operating handle. Breaker design must be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C respectively.

2.11.2.2 Circuit Breaker With GFCI

UL 943 and NFPA 70. Provide with push-to-test button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater in accordance with UL 943 for Class A GFCI devices.

2.11.3 Panelboard Enclosure

NEMA 4X [nonmetallic][or][stainless steel]. Hardware must be stainless steel.

2.12 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with short-circuit current rating of [10,000] [_____] amperes symmetrical minimum. Circuit breakers must be bolt-on type. Plug-in circuit breakers and series rated circuit breakers are not acceptable. Enclosure must be NEMA 4X [nonmetallic][or][stainless steel] type.[Provide solid neutral.]

2.13 TRANSFORMERS

NEMA ST 20, general purpose, dry-type, self-cooled, [unventilated] [sealed]. Provide transformers in NEMA [3R] [stainless steel] [_____] enclosure. Transformer must have 220 degrees C insulation system for transformers 15 kVA and greater and must have 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding [150] [115] [80] degrees C under full-rated load in maximum ambient of 40 degrees C.[Transformer of 150 degrees C temperature rise must be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.][Transformer of 115 degrees C temperature rise must be capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.][Transformer of 80 degrees C temperature rise must be capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.][Transformers must be quiet type with maximum sound level of 3 decibels less than NEMA standard level for transformer ratings indicated.]

[Submit manufacturer factory test reports with transformers provided.

]2.14 TELEPHONE SYSTEM

****
NOTE: This paragraph applies only if provision is made for telephone system by others. If a complete system is provided by contract, refer to Section 27 51 23 INTERCOMMUNICATION SYSTEM and Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.
****

Provide system of telephone wire-supporting structures, including conduits with pull wires, terminal boxes, outlet and junction boxes, [and]other accessories for telephone outlets[, and telephone cabinets].

2.14.1 Outlet Boxes

Standard type, as specified herein, [[_____] mm inches by [_____] mm inches]. Mount at height [indicated][specified for telephone outlet receptacles].

2.14.2 Cover Plates

Blank cover with same finish specified for receptacle and switch cover plates.

2.14.3 Conduit Sizing

****
NOTE: For guidelines on conduit sizing, see UFC 3-520-01. Telephone raceway requirements should be coordinated with the entity providing the telephone wires and cable.
****

Conduit for single outlets must be minimum of 21 mm 3/4 inch and for multiple outlets minimum of 27 mm one inch.

2.14.4 Terminal Cabinets

****
NOTE: For guidelines on sizing cabinets, see UFC 3-580-01. Coordinate with entity providing telephone service.
****

NEMA 4X [nonmetallic][or][stainless steel] with backboard. Hardware must be stainless steel.

2.15 MOUNTING STRAPS

[Fiberglass][or][PVC coated steel], two-hole type designed for rigid steel conduit support. PVC coating must be between 0.5 and one mm 20 and 40 mil thickness.

2.16 GROUNDING AND BONDING EQUIPMENT

UL 467. Ground rods must be copper-clad steel, with minimum diameter of 19 mm 3/4 inch and minimum length of 3050 mm 10 feet.

2.16.1 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible,[excepting specifically those connection for which access for periodic testing is required,] by exothermic weld or high compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make high compression connections using a hydraulic or electric compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

[2.16.2 Ground Rod Mounting Straps

Provide mounting straps to support ground rods at fueling pier. Do not use dissimilar metals.

][2.16.3 Alligator Clips

Heavy duty type, copper, insulated handles, rated 100 amperes and up to 250 volts for maximum No. 2 AWG.

][2.17 HAZARDOUS LOCATIONS

****

NOTE: The following information must be shown on the project drawings.

1. Where specification identifies type, size, color, finish, or other definitive information to be "as indicated," the engineer must include the information on the drawings.

2. Location of manholes, handholes, ducts, and cables.

3. Types of wire and cable; number and sizes of conductors.

4. Limits of each hazardous location, clearly indicating class, division, and group classification of each hazard.

5. Special conditions.

****

Electrical materials, equipment, and devices for installation in hazardous locations must be specifically approved by UL or Factory Mutual Research Corporation (FM) for particular class, division, and group of hazardous locations involved. Equipment must be waterproof and suitable for marine environment.

]2.18 WIREWAYS

UL 870. Material must be [nonmetallic] [or] [stainless steel], 16 gage for size[s] [63.5 by 63.5] [100 by 100] [150 by 150] mm, [2 1/2 by 2 1/2] [4 by 4] [6 by 6] inches, 14 gage for size[s] [200 by 200] [300 by 300] mm [8 by 8] [12 by 12] inches. Provide in length [indicated] [required for the application] with gasketed [hinged] [screw] cover NEMA 4X enclosure in accordance with NEMA ICS 6.

2.19 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings.

****

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core.

e. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

f. Minimum size of nameplates: 25 by 65 mm one by 2.5 inches.

g. Lettering size and style: a minimum of 6.35 mm 0.25 inch high normal block style.

2.20 ARC FLASH WARNING LABEL

****

NOTE: Include the Arc Flash Warning Label detail on the drawings. See UFC 3-560-01 for more information.

****

Provide arc flash warning labels on electrical equipment likely to require examination, servicing, or maintenance while energized. Some typical types of equipment include pad-mounted transformers, switchgears, switchboards, panelboards, and disconnect switches. Place label on the outside of the enclosure warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

2.21 MARINE SIGNAL LANTERN

Provide with nonmetallic base, [155-mm] [_____], [red] [_____] [acrylic] [UV stable polycarbonate] fresnel lens, LED light source, [solid state flasher,] [lamp changer,] [solar power station,] [1220 mm] [4 foot] [_____] nonmetallic support pedestal, and photo control. The entire system must be watertight and approved for marine environment.

2.21.1 Flasher

****
NOTE: Refer to "USCG Aids to Navigation Manual - Short Range Aids to Navigation" for signaling sequence for lanterns.
****

Flasher must have a [_____]-second cycle period with [[_____]-second "ON" time] [Morse code letter "[_____]"] [_____].

2.21.2 Lamp Changer

[120 volt ac, four place automatic lamp changer with LED lamps] [[6] [12]] volt dc, six place automatic lamp changer with [_____] ampere lamps. When lamps burn out, lamp changer must stop operation[and power must turn off].

[2.21.3 Ac to Dc Converter

Converter must convert [120] [240] [_____] volts ac input into a [6] [12] volt dc output. Converter must be sized for the signal lantern specified.

]2.21.4 Solar Power Station

Power station must consist of encased silicon solar energy cells, nonmetallic battery box with blocking diodes, rechargeable sealed batteries, and mounting brackets. The solar power station must be a complete unit supplied and coordinated by a single manufacturer, sized to provide adequate year-round power to fully operate the signal lantern specified at the exact geographic location of the signal lantern.

2.22 PIER LIGHTING

****
NOTE: Fixture enclosures located on marina piers must be watertight and constructed on nonmetallic material or cast aluminum with baked enamel or powdered polyester finish. Hardware must be nonmetallic or stainless steel. Conduit or cable entrances into lighting fixtures must be watertight.
****

Provide as specified in Section 26 56 00 EXTERIOR LIGHTING.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to requirements of NFPA 70 and to requirements specified herein.

[3.1.1 Underground Service

****
NOTE: Choose this paragraph or the paragraph OVERHEAD SERVICE below. When using this paragraph, designer may insert additional details describing the specific project.

****

Underground service conductors and associated conduit must be continuous from service equipment to the power system connection.

][3.1.2 Overhead Service

****

NOTE: When using this paragraph, coordinate with Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION or Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION (if in project).

****

Overhead service conductors must terminate at service equipment weatherhead. Overhead service conductors and support bracket for overhead conductors are included in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.

][3.1.3 Hazardous Locations

Perform work in hazardous locations, as defined by NFPA 70, in strict accordance with NFPA 70 for particular class, division, and group of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Conduit must have tapered threads.

]3.1.4 Service Entrance Identification

Label or identify service entrance disconnect devices, switches, and enclosures.

3.1.4.1 Nameplates

Where work results in service disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum, must indicate number of service disconnect devices housed by enclosure and must indicate total number of enclosures that contain service disconnect devices. Provide laminated nameplates with letters no less than 6 mm 0.25 inch in height; and engrave on black-on-white matte finish. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.1.5 Wiring Methods

Provide insulated conductors installed in rigid conduit, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor must be separate from electrical system neutral conductor. Provide insulated, green equipment grounding conductors for circuits installed in conduit and raceways. Minimum conduit size must be 16 mm 1/2 inch in diameter for low-voltage lighting and power circuits.

3.1.5.1 Plastic-Coated Galvanized Rigid Steel

Use only for service entrance conduit and as required by NFPA for hazardous locations.

3.1.5.2 PVC Schedule 40 and PVC Schedule 80

a. Do not install PVC Schedule 40 in areas subject to physical damage.

b. Do not install PVC Schedule 80 in areas subject to severe physical damage.

c. Do not install in hazardous areas.

3.1.5.3 Service Entrance Conduit, Overhead

PVC, Type EPC-40, plastic-coated galvanized rigid steel from service entrance to service weatherhead.

3.1.5.4 Service Entrance Conduit, Underground

PVC, Type EPC-40, plastic-coated galvanized rigid steel. Encase underground portion in a minimum of 75 mm 3 inches of concrete. Install a minimum of 460 mm 18 inches below slab or grade.

3.1.5.5 Liquidtight Flexible Metal Conduit

Install in accordance with NFPA 70.

3.1.5.6 Underground Conduit Other Than Service Entrance

****

NOTE: Soil conditions in some locations require that underground conduit be supported to prevent damage due to settlement. The designer must determine if the problem exists, and, if so, determine the best method for supporting the conduit.

****

PVC, Type EPC-40, plastic-coated rigid steel, or fiberglass. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid conduit before rising through pier deck. Plastic coating must extend minimum 150 mm 6 inches above pier deck.

3.1.6 Conduit Installation

Run conduit [exposed on side of [wood][and][existing concrete] pier structures], [supported by hangers under pier structure] [concealed in new concrete pier structure]. Install conduit parallel with or at right angles to structural members.

3.1.6.1 Conduit Support

Support conduit by nonmetallic pipe straps, wall brackets, hangers, or trapeze. Fasten by stainless steel wood screws to wood and by concrete inserts or expansion bolts on concrete. Threaded C-clamps may be provided on rigid steel conduit only. Load applied to fasteners must not exceed one-fourth proof test load. Fasteners attached to concrete ceiling must be vibration resistant and shock resistant. Holes cut to depth of more than 40 mm 1 1/2 inches in reinforced concrete beams or to depth of more than20 mm 3/4 inch in concrete joints must not cut main reinforcing bars. Fill unused holes. Where conduit crosses expansion joints, provide suitable [watertight]expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means.

3.1.6.2 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or molded fittings. Make field-made bends and offsets with conduit-bending machine suitable for type of conduit used. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent dirt or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.6.3 Expansion Joints

Install as recommended by the manufacturer for the temperature conditions at time of installation.

3.1.6.4 Pull Wire

Install in empty conduits in which wire is to be installed by others. Pull wire must be plastic having minimum 890 N 200 pound tensile strength. Leave minimum 300 mm 12 inches of slack at each end of pull wire.

3.1.6.5 Telephone and Signal System Conduits

Install in accordance with specified requirements for conduit and with additional requirement that no length of run must exceed 45 meters 150 feet for trade sizes 50 mm 2 inches and smaller and must not contain more than two 1.57 rad 90 degree bends or equivalent. Provide pull or junction boxes where necessary to comply with these requirements. Inside radii of bends in conduits 16 mm one inch trade size and larger must be minimum five times nominal diameter. Terminate conduit in terminal cabinet with two locknuts and plastic bushing.

3.1.6.6 Conduit Installed in Concrete

****

NOTE: Electrical designer must closely coordinate this information with the designer of the slab to ensure that slab thickness, conduit placement/separation, and reinforcement spacing is sufficient to meet requirements of this paragraph.

****

Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab.[Do not stack conduits.][Do not stack conduits more than two diameters high with minimum vertical separation of [_____] millimeters inches.] Space conduits horizontally minimum three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum 25 mm one inch cover over conduit. Where embedded conduits cross expansion joints, provide suitable watertight expansion fittings[and bonding jumpers when using metallic conduits]. Conduit larger than 27 mm one inch trade size must be parallel with or at right angles to main reinforcement; when at right angles to reinforcement, conduit must be close to one of supports of slab.

3.1.6.7 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are provided, and where bushings cannot be brought into firm contact with the box; otherwise, provide minimum single locknut and bushing. Locknuts must have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

[3.1.6.8 Stub-Ups

Provide conduits stubbed up through concrete structures for connection to freestanding equipment with adjustable top or coupling threaded inside for plugs, set flush with finished structure. Extend conductors to equipment in rigid conduit. Where no equipment connections are made, install screwdriver-operated threaded flush noncorroding plugs in conduit end.

]3.1.6.9 Conduit and Cable Connections

Provide watertight connectors for conduit and cable connections to boxes and cabinets.

3.1.7 Boxes, Outlets, and Supports

Provide boxes in wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways must be stainless steel type 304, hub type, and when specifically indicated. Boxes in other locations must be nonmetallic boxes provided with nonmetallic conduit system. Each box must have volume required by NFPA 70 for number of conductors enclosed in a box. Provide gaskets for boxes. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature. Fasten boxes and supports with wood screws on wood and with bolts and expansion shields on concrete.[Threaded studs driven in by powder charge and provided with lockwashers and nuts[or nail-type nylon anchors] may be provided in lieu of wood screws, expansion shields, or machine screws.] Support boxes directly from structure or by [nonmetallic][or][stainless steel] hangers. Where [nonmetallic] stainless steel bar hangers are provided, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 600 mm 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.7.1 Boxes

Boxes for use with raceway systems must be minimum 38 mm 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes must be minimum 100 mm 4 inches square, except that100 by 50 mm 4 by 2 inch boxes may be provided where only one raceway enters outlet. Telephone outlets must be minimum of 100 mm square by 38 mm 4 inches square by 1 1/2 inches deep.

3.1.7.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 compatible with nonmetallic raceway systems, except where stainless steel boxes are required in locations specified herein. Furnish boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.8 Mounting Heights

Mount panelboards, circuit breakers, and disconnecting switches so maximum height of operating handle is 1980 mm 78 inches above finished structure. Mount receptacles a minimum of [460] [_____] mm [18] [_____] inches above finished structure. In no case must entire or part of panelboards, boxes, cabinets, receptacles, and other electrical devices be mounted below the electrical datum plane as defined in NFPA 303. Measure mounting heights of wiring devices and outlets to center of device or outlet.

3.1.9 Conductor Identification

Provide within each enclosure where tap, splice, or termination is made. For conductor sizes No. 6 AWG and smaller diameter, color coding must be by factory-applied, color-impregnated insulation. For conductor sizes No. 4 AWG and larger diameter, color coding must be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations.

3.1.10 Splices

Make splices in accessible locations. Make splices in conductor sizes No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductor sizes No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.11 Covers and Device Plates

Install gasketed plates with alignment tolerance of 1.6 mm 1/16 inch.

3.1.12 Grounding and Bonding

NFPA 70. Ground-exposed, noncurrent-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, and neutral conductor of wiring systems.[Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. When flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70.][Make ground connection to driven ground rods.] Where ground-fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.12.1 Resistance

Maximum resistance-to-ground of grounding system must not exceed [5] [_____] ohms under dry conditions. Where resistance obtained exceeds [5] [_____] ohms, contact Contracting Officer for further instructions.

[3.1.12.2 Telephone Service

Provide main telephone service equipment ground consisting of separate No. 6 AWG ground wire in conduit between equipment backboard and readily accessible grounding connection. Equipment end of ground wire must consist of coiled length at least twice as long as terminal cabinet.

]3.1.13 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section. Except as otherwise noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section, but must be provided under the section specifying associated equipment.

[3.1.14 Government-Furnished Equipment

Contractor [must rough-in for Government-furnished equipment][must make connections to Government-furnished equipment] to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, and outlet boxes or fittings.

]3.2 REPAIR AND SERVICE OF EXISTING STRUCTURES AND EQUIPMENT

Perform repair of existing structures and equipment[, demolition, and modification of existing electrical distribution systems] as follows:

3.2.1 Workmanship

NECA NEIS 1. Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of existing surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to structure, piping, and equipment using skilled craftsmen of trades involved.

[3.2.2 Existing Concealed Wiring to be Removed

Disconnect from its source. Remove conductors, cut exposed conduit flush with structure, and seal openings with material to match adjacent surfaces.

][3.2.3 Existing Electrical Distribution System Removal

Include removal of equipment's associated wiring, including conductors, cables, exposed conduit, boxes, fittings, anchors, supports, and other such items, [back to equipment's source][as indicated]. Fill holes in structure where electrical equipment is removed with material to match adjacent surface. Provide unused openings in remaining boxes, fittings, and equipment with watertight nonmetallic knockout seals.

][3.2.4 Continuation of Service

Maintain continuity of service to existing circuits of equipment to remain. Existing circuits of equipment must remain energized. Circuits which are to remain but were disturbed during demolition must have circuits wiring and power restored back to original condition.

]3.3 FIELD QUALITY CONTROL

****

NOTE: Provide any additional test requirements for equipment requiring running tests or tests that must be coordinated with mechanical equipment.

****

Furnish test equipment and personnel. Notify Contracting Officer [5] [_____] working days prior to [each] [_____] test[s].

3.3.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.3.2 Transformer Tests

Perform tests classified as routine in accordance with NEMA ST 20 on each transformer.

3.3.3 600-Volt Wiring Test

Test wiring rated 600 volts and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance must be 250,000 ohms.

3.3.4 Grounding System Test

Test grounding system to ensure continuity and resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

3.3.5 Solar Power Station Test

Test solar power station for proper operation in accordance with manufacturer's recommendation.

3.4 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
a. Device plate (thickness)	0.10 inch	2.54 mm
b. Mounting straps (thickness)	20 and 40 mil	0.5 and one mm
c. Ground rod		
Diameter	3/4 inch	19 mm
Length	10 feet	3050 mm
d. Wireways	2 1/2 by 2 1/2 inches	63.5 by 63.5 mm
	4 by 4 inches	100 by 100 mm

PRODUCTS	INCH-POUND	METRIC
	8 by 8 inches	200 by 200 mm
	12 by 12 inches	300 by 300 mm
e. Boxes		
Depth	1 1/2 inches	38 mm
Size	4 inches (square)	100 mm

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-26 28 00.00 10 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-26 28 00.00 10 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS

08/22

PART 1 GENERAL

PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-26 28 00.00 10 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-26 28 00.00 10 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 28 00.00 10

MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS

08/22

****

NOTE: This guide specification covers the requirements for motor control centers, switchboards and panelboards by formal advertising, using a SUPPLY-type contract. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This section includes the technical requirements for the types of equipment provided at navigation locks and dams, flood control pumping plants, and hydroelectric power plants to supply auxiliary power to the power plant, switchyard, dam and other project facilities.

Applicable portions of this document will be incorporated into electrical specifications when equipment is purchased using a CONSTRUCTION-type contract. Modifications needed to do this will

include: Modifying submittal requirements to eliminate submittals tied to notice to proceed dates, adding a PART 3 EXECUTION section covering installation of the equipment, adding installation material, such as conduit and wire, and quality information to PART 2 PRODUCTS. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM may be used as a basis for the EXECUTION section.

Suitable drawings showing the general arrangement and single-line diagram of each motor control center, switchboard, and panelboard should be included with the procurement specifications. The drawings should show the locations of conduit and cable entrances, details of nameplates, and tabulations showing the NEMA size of contactors and motor controllers, trip ratings of circuit breakers, solid state trips where required, alarm and bell contacts and shunt trips where required, sizes of feeder and branch circuit conductors, and ratings of motors and other loads.

This specification covers NEMA Class II motor control centers where interlocking and remote control are required as is engineering effort on the part of the manufacturer. Where cost savings may be realized by grouping motor controls together, but where motor operations are not interlocked, locally or remotely, and no manufacturer's engineering effort required, NEMA Class I should be used. This specification may be modified for NEMA Class I motor control centers by deleting the following paragraphs from PART 2:

WIRING (except when applicable to switchboards)

TERMINAL BLOCKS (except when applicable to switchboards)

MOTOR CONTROL CENTERS - change references to Class II, type B and C.

Horizontal Wireways - the option for mater terminal block compartment should generally not be included.

Wiring for Motor Control Centers

Alternators

Operational Tests

****

1.1 SUMMARY

****

NOTE: Drafts of specifications submitted to higher authority for review and approval will consist of printed copies of this guide specification combined with pertinent sections of procurement documents as

call for on Standard Form 33, both revised as required for the particular procurement. Instructions for the preparation and submission of specifications for approval are included in ER 1110-2-1200.

The following is a bid item list to be included in section B of Standard Form 33 of a supply contract. This example should be modified to fit the individual contract requirements. Dissimilar motor control centers, switchboards and panelboards should be entered as separate bid items.

SECTION B
SUPPLIES/SERVICES AND PRICES

ITEM NO.	**DESCRIPTION**	**ESTIMATED QUANTITY**	**U/M**	**UNIT PRICE**	**AMOUNT**
0001	**480-VOLT, 3-PHASE, UNIT MOTOR CONTROL CENTER (NO.)**	**1**	**JOB**	**EACH**	**[_____]**
000X	**480-VOLT, 3-PHASE, MOTOR CONTROL CENTER**	**1**	**JOB**	**EACH**	**[_____]**
000X	**480-VOLT, 3-PHASE, POWER DISTRIBUTION PANELBOARD (NO.)**	**1**	**JOB**	**EACH**	**[_____]**
000X	**480-VOLT, 3-PHASE, POWER DISTRIBUTION PANELBOARD (NO.)**	**1**	**JOB**	**EACH**	**[_____]**
000X	**ACCESSORIES AND SPARE PARTS**	**1**	**LOT**	**XXXX**	**[_____]**
000X	**CONTRACT DATA (PART 1, THE SCHEDULE) (SEE DD FORM 1423, EXHIBIT B)**			**Not separately priced**	
				TOTAL	**[_____]**

****

These specifications include the design, fabrication, assembly, wiring, testing, and delivery of the items of equipment and accessories and spare parts listed in the Schedule and shown on the drawings.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)

ASTM INTERNATIONAL (ASTM)

ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B187/B187M	(2020) Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar and Shapes
ASTM B317/B317M	(2023) Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, Structural Profiles, and Profiles for Electrical Purposes (Bus Conductor)
ASTM D877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D923	(2007) Standard Practice for Sampling Electrical Insulating Liquids
ASTM D924	(2008) Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids
ASTM D971	(2020) Standard Test Method for Interfacial Tension of Insulating Liquids Against Water by the Ring Method
ASTM D974	(2014; E 2016) Standard Test Method for

	Acid and Base Number by Color-Indicator Titration
ASTM D1500	(2012; R 2017) Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)
ASTM D1524	(2015; R 2022) Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field
ASTM D1533	(2012) Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.04	(2018; Erta 2019; Corr 2021) Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V Corrigendum 1
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.4	(1984; R 2011) Registers - Mechanical Demand
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA PB 1	(2011) Panelboards
NEMA PB 2	(2011) Deadfront Distribution Switchboards

NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard
NEMA/ANSI C12.11	(2006; R 2019) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems
DODI 8500.01	(2014) Cybersecurity

UL SOLUTIONS (UL)

UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint Aug 2023) UL Standard for Safety Panelboards
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 845	(2021) UL Standard for Safety Motor Control Centers
UL 891	(2019) UL Standard for Safety Switchboards
UL 1063	(2017; Reprint Jun 2022) UL Standard for Safety Machine-Tool Wires and Cables

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G, [_____]

Shop Drawings; G, [_____]

Motor Control Centers; G, [_____]

Switchboards; G, [_____]

Panelboards; G, [_____]

SD-03 Product Data

Equipment; G, [_____]

Factory Tests

Required Settings

Request For Settings

SD-06 Test Reports

Factory Tests

Acceptance Checks And Tests; G, [_____]

SD-07 Certificates

Motor Control Centers

1.4 DELIVERY, STORAGE, AND HANDLING

****

NOTE: ABC phasing should be in accordance with NFPA 70 front-to-back, top-to-bottom, and left-to-right. Alternate phasing should be avoided, but where this cannot be done, the drawings should clearly reflect alternate phasing, and these specifications be modified to include requirement for marking the equipment.

****

Submit copies of such descriptive cuts and information as are required to demonstrate fully that all parts of the equipment will conform to the requirements and intent of the specifications, within [30] [_____] calendar days after [date of award] [date of receipt of notice to proceed] for approval. Include descriptive data showing typical construction of the types of equipment proposed, including the manufacturer's name, type of molded case circuit breakers or motor circuit protectors, performance capacities and other information pertaining to the equipment. [Also sets of characteristic curves of the individual breaker trip element.] Ship the equipment as completely assembled and wired as feasible so as to require a minimum of installation work. Properly match mark each shipping section to facilitate reassembly, and provide with removable lifting channels with eye bolts for attachment of crane slings to facilitate lifting and handling. Carefully pack and ship separately any relay or other device which cannot withstand the hazards of shipment when mounted in place on the equipment. Mark these devices with the number of the panel which they are to be mounted on and fully identified. Wrap all finished painted surfaces and metal work or otherwise protect from damage during shipment. Prepare all parts for shipment so that slings for handling may be attached readily while the parts are in a railway car or transport truck. [Sections of equipment crated for shipment must be of such size, including crates, that they will pass through a [_____] by [_____] -meter -foot hatch opening and a [_____] by [_____] -meter -foot wall opening.] Carefully package and clearly mark all spare parts and accessories.

1.5 MAINTENANCE

1.5.1 Accessories and Tools

Furnish a complete set of accessories and special tools unique to equipment provided and required for erecting, handling, dismantling, testing and maintaining the apparatus.

1.5.2 Extra Materials

****

NOTE: If three or more motors of the same size and manufacturer are required, the designer should

specify more spare heater elements.
****

Furnish spare parts as specified below. All spare parts must be of the same material and workmanship, must meet the same requirements, and must be interchangeable with the corresponding original parts furnished.

SPARE PARTS	
Amount	Description
2 of each type and size	Fuses
1	Circuit breaker auxiliary switch
2 for each size ac contactor	Operating coils
1 for each size dc contactor	Operating coil
2 Complete sets for each size ac contactor	3-pole stationary and moving contact assemblies
1 Complete set for each size dc contactor	2-pole stationary and moving contact assemblies
3 of each type and rating	Contactor overload relays, each relay with a complete set of contact blocks
1 Spare set for each heater rating provided	Heater elements
2 for each type	Indicating lamp assemblies
1 of each type and rating	Control transformer
1 of each type and rating	Control relay
1 of each type	Contactor auxiliary contact
4 One quart containers	Finish paint for indoor equipment
2 One quart containers	Paint used for the exterior surfaces of outdoor equipment
4	Keys for motor control center door loc
1 for each type and rating	Circuit Breaker
1 for each type and rating	Motor Circuit Protector

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are standard products of a manufacturer regularly engaged in their manufacture and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening and that conform to the requirements of these specifications. Provide high quality materials, free from defects and imperfections, of recent manufacture, and of the classification and grades designated. All materials, supplies, and articles not manufactured by the Contractor must be the products of other recognized reputable manufacturers.

2.1.1 Rules

****

NOTE: Many manufacturers represent IEC ratings as equivalent to NEMA ratings or UL labeling. The two are different standards philosophies and are not interchangeable. IEC ratings are not acceptable under this specification. For further information, see NEMA ICS 2.4, "NEMA AND IEC DEVICES FOR MOTOR SERVICE - A GUIDE FOR UNDERSTANDING THE DIFFERENCE."

****

Provide equipment conforming to the requirements of NFPA 70 unless more stringent requirements are indicated herein or shown. NEMA rated and UL listed equipment has been specified when available. Provide equipment meeting NEMA and UL construction and rating requirements as specified. No equivalent will be acceptable. Immediately notify the Contracting Officer of any requirements of the specifications or Contractor proposed materials or assemblies that do not comply with UL or NEMA. International Electrotechnical Commission (IEC) rated equipment will not be considered an acceptable alternative to specified NEMA ratings.

2.1.2 Coordination

****

NOTE: Combination motor controllers, using motor circuit protectors (MCP's) instead of thermal-magnetic circuit breakers, are offered as standard by several major manufacturers; however, the thermal-magnetic type is still offered as an option. The MCP is designed especially for motor circuits and will generally provide better protection for motors, controllers, and circuit conductors than the thermal-magnetic type. In any case, one or the other should be specified, so that all bids will be on the same basis. Generally, thermal magnetic breakers should be specified for reduced voltage starters because MCP do not have high enough current settings to avoid nuisance tripping from current inrush and switching transients generated during start to run sequence.

This specification does not cover the use of fused motor protection. Fuses are the least cost alternative, but require more maintenance. They are not recommended for powerhouse applications. Fuses may be acceptable for other applications, provided that suitable phase-voltage-unbalance protection for motors is specified.

When PART 3 criteria are added for CONSTRUCTION contracts, take care to prevent conflicts, gaps, or omissions.

****

The general arrangement of the motor control centers, switchboards and panelboards is shown on the contract drawings. Any modifications of the equipment arrangement or device requirements as indicated will be subject to the approval of the Contracting Officer. If any conflicts occur necessitating departures from the drawings, submit details of and reasons for departures for approval prior to implementing any change. Completely assemble all equipment at the factory. The motor control centers and switchboards may be disassembled into sections, if necessary, for convenience of handling, shipping, and installation.

2.2 NAMEPLATES

Provide nameplates made of laminated sheet plastic or of anodized aluminum approximately 4 mm 1/8 inch thick, engraved to provide white letters on a black background. Fasten the nameplates to the panels in proper positions with anodized round-head screws. Lettering must be minimum 13 mm 1/2 inch high. Provide nameplate designations in accordance with lists on the drawings, and as a minimum provide nameplates for the following equipment:

a. Motor Control Centers

b. Individual items of equipment mounted in the Motor Control Centers

c. Switchboards

[d. Individually-mounted circuit breakers in Switchboard]

[e. Group-mounted circuit breakers in Switchboard]

f. Panelboards

[g. Individually-mounted circuit breakers in Panelboard]

Provide equipment of the withdrawal type with nameplates mounted on the removable equipment in locations visible when the equipment is in place.

2.3 CONNECTIONS

Furnish all bolts, studs, machine screws, nuts, and tapped holes in accordance with ASME B1.1. Provide sizes and threads of all conduit and fittings, tubing and fittings, and connecting equipment in accordance with ASME B1.20.2MASME B1.20.1. Provide ferrous fasteners that have rust-resistant finish and equip all bolts and screws with approved locking devices. Manufacturer's standard threads and construction may be used on small items which, in the opinion of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items must meet the above requirements.

2.4 MOLDED CASE CIRCUIT BREAKERS

Provide molded case circuit breakers conforming to the applicable requirements of UL 489 and UL 489. Provide circuit breakers that are manually-operated, that are the quick-make, quick-break, common trip type, and that are of the automatic-trip type unless otherwise specified or indicated on the drawings. Operate all poles of each breaker simultaneously by means of a common handle. Provide operating handles that clearly indicate whether the breakers are in "On," "Off," or "Tripped" position and have provisions for padlocking in the "Off" position. Provide personnel safety line terminal shields for each breaker. Furnish circuit breakers that are products of only one manufacturer, and are interchangeable when of the same frame size. [Where indicated on the drawings, provide circuit breakers with shunt trip devices.] [Where indicated on the drawings, provide circuit breakers with bell alarm contacts that close on automatic operation only. Provide contacts that are suitable for [125] [_____] volts dc and reset when the breaker is reset.]

2.4.1 Trip Units

****

NOTE: Both thermal magnetic and solid state trip units have been included in this specification. Solid state units can be more reliable and permit more selective coordination since they can have long time pick-up, long time delay, short time pick-up, short time delay, instantaneous pick-up, ground fault pick-up, and ground fault time delay settings. Solid state units have come down in price and are becoming competitive with thermal magnetic units. Specific locations where solid state trips are required should be indicated on the drawings.

****

Except as otherwise noted, provide combination thermal and instantaneous magnetic or solid state trip units for the circuit breakers, of frame sizes and the trip unit ratings as shown on the drawings. The Government reserves the right to change the indicated trip ratings, within frame limits, of the trip devices at the time the shop drawings are submitted for approval. Submit copies of outline drawings of all equipment to be furnished under this contract, together with weights and overall dimensions, within [30] [_____] calendar days after [date of award] [date of receipt of notice to proceed], for the approval of the Contracting Officer. Provide interchangeable breaker trip units and instantaneous magnetic trip units that are adjustable on frame sizes larger than 150 amperes. Set nonadjustable instantaneous magnetic trip units at approximately 10 times the continuous current ratings of the circuit breakers. [Solid state trip units, where indicated, must also have adjustable [long time pick-up and delay],[short time pick-up and delay], [and ground fault pick-up and delay].]

2.4.2 480-Volt AC Circuits

Furnish circuit breakers for 480-volt or 277/480-volt ac circuits that are rated 600 volts ac, andthat have an UL listed minimum interrupting capacity of [14,000] [_____] symmetrical amperes at [600] [_____] volts ac.

2.4.3 120/240-Volt AC Circuits

Circuit breakers for 120-volt ac circuits rated less than 120/240 or 240 volts ac are not permitted, and must have a UL listed minimum interrupting capacity of [10,000] [_____] symmetrical amperes.

2.4.4 125-Volt DC Circuits

Circuit breakers for 125-volt dc circuits must be two-pole rated 125/250 or 250 volts dc, and must have an UL listed minimum interrupting capacity of [5,000] [10,000] [_____] amperes dc.

2.5 WIRING

Provide control wire consisting of stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44 or Type MTW meeting UL 1063, and passing the VW-1 flame tests included in those standards. Provide hinge wire consisting of Class K stranding. Current transformer secondary leads smaller than No. 10 AWG is not permitted. The minimum size of control wire is be No. 14 AWG. Furnish power wiring for 480-volt circuits and below that is the same type as control wiring and a minimum size of No. 12 AWG. Give special attention to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.6 CONTROL SWITCHES

2.6.1 General

All control switches must be of the rotary switchboard type with handles on the front and the operating contact mechanisms on the rear of the panels. Provide each switch with ample contact stages to perform the functions of the control system and provide with at least two spare contacts. Provide self-aligning contacts that operate with a wiping action. Provide a positive means of maintaining high pressure on closed contacts. Compression springs or pivotal joints must not carry current. All control switches must be suitable for operation on 600-volt AC or 250-volt DC circuits. All such switches must be capable of satisfactorily withstanding a life test of at least 10,000 operations with rated current flowing in the switch contacts. Provide switches capable of continuously carrying 20 amperes without exceeding a temperature rise of 30 degrees C. The single-break inductive load interrupting rating of switches must not be less than 1.5 amperes for 125 volts DC or 10 amperes for 115 volts AC.

2.6.2 Switch Features

a. Provide control and instrument switches that are suitable for the intended use and that have the features shown on the schematic diagrams and switch development drawings. Provide switches that have handles as shown or approved and are black in color unless otherwise specified.

b. Control switches for electrically-operated circuit breakers must be 3-position momentary-contact type with spring return to neutral position, and must have modern-black, heavy duty pistol grip handles. Provide circuit breaker control switches that have mechanical operation indicators to show the last manual operation of the switches and slip contacts.

c. Provide control switches for instrument and meter transfer switches and for selector switches that are the maintained contact type with the required number of positions and that have round notched or knurled handles. Connect ammeter and voltmeter switches to read all three phase ammeter switches. Do not open the secondary circuits of the current transformer at any time.

d. Provide each control switch with an escutcheon clearly marked to show each operating position. Engrave the switch identifications on the escutcheon plates or on separate nameplates. The escutcheon and nameplate markings are subject to approval.

2.7 TERMINAL BLOCKS

Furnish control circuit terminal blocks for control wiring that are molded or fabricated type with barriers, rated not less than 600 volts. Provide terminals that are removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals must be no less than No. 10 in size and have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement is subject to the approval of the Contracting Officer and provide no less than four (4) spare terminals or 10 percent, whichever is greater, on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. Submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.7.1 Types of Terminal Blocks

2.7.1.1 Short-Circuiting Type

Furnish short-circuiting type terminal blocks for all current transformer secondary leads and have provision for shorting together all leads from each current transformer without first opening any circuit. Provide terminal blocks meeting the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

2.7.1.2 Load Type

Provide load terminal blocks rated no less than 600 volts and of adequate capacity for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits except those for feeder tap units. Provide terminals that are either the stud type with contact nuts and locking nuts or the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Place the circuit designation or wire number on or near the terminal in permanent contrasting color for each connected terminal.

2.7.2 Marking Strips

Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations. Make wire numbers with permanent ink. Use reversible marking strips to permit marking both sides, or furnish two marking strips with each block. Marking strips must accommodate the two sets of wire numbers. For each device to which a connection is made, assign a device designation in accordance with NEMA ICS 1 and mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations. Show the general arrangement and overall dimensions of the motor control centers, switchboards, and panelboards. Show space requirements, details of any floor supports to be embedded in concrete and provisions for conduits for external cables. Prints of drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

2.8 SPACE HEATERS

****

NOTE: Heaters should be connected to an external power source in installations where the motor control center will not be energized continuously.

****

Provide space heaters where indicated on the drawings and control using an adjustable 10 to 35 degrees C 50 to 90 degrees F thermostat, magnetic contactor, and a molded-case circuit breaker [and a 480-120 volt single-phase transformer]. Provide space heaters that are 250-watt, 240 volt strip elements operated at 120 volts and are [supplied from the motor control center bus] [wired to terminal blocks for connection to 120-volt single-phase power sources located external to the control centers]. Furnish contactors that are open type, electrically-held, rated 30 amperes, 2-pole, with 120-volt ac coils.

2.9 MOTOR CONTROL CENTERS

****

NOTES: This specification covers single stand alone lineup with front access. Not all arrangements can be listed and labeled under UL 845. Consult manufacturer's literature and UL listing availability for specific arrangements.

Auxiliary motor control centers should be NEMA Class II, Type B or C, as applicable. Type C construction includes master section terminal boards at the top or bottom of each vertical section and complete control wiring and power wiring for NEMA Size 3 and smaller controllers between the unit assemblies in each section and the master terminal boards. Type C construction is preferred and should be specified whenever a considerable amounts of interpanel control wiring or external control circuits is required. Designer should consider number of terminal blocks required for type C construction and ensure that there is sufficient space and access.

Where the unit assemblies consist primarily of feeder tap units with circuit breakers to supply power loads or starter units for individually controlled motors (such as for pumps in pumping stations), and very little interpanel and external control wiring is required, the less expensive Type B construction, which does not include master section terminal boards, should be specified. If the procurement includes both types of control centers, the type of each control center should be clearly indicated.

The intent of the submittals below is to require

NEMA Class II drawing packages. When it is desirable for the Government's wire numbers to be included on the drawings or custom drawing sizes and title blocks are required, NEMA Class IIS should be specified.

Should this specification be used in procurement of NEMA Class I equipment, the drawing packages are less involved and this paragraph edited accordingly.

Include this requirement only when contractual certification is required and Factory Test Reports without certification are not acceptable.

****

Design each motor control center for operation on 480-volts ac, 3-phase, 60-Hz system, and equipment conforming to all the applicable requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 4and NEMA ICS 6. List and label vertical sections and individual units under UL 845 where ever possible. In lieu of the UL listing, certification from any nationally recognized, adequately equipped, testing agency that the individual units and vertical sections have been tested and conform to the UL requirements of that agency will be acceptable when approved by the Contracting Officer.

a. Certification of factory test reports. Certification must be signed by official authorized to certify on behalf of the manufacturer, attesting that the motor control center meets the specified requirements. The statement must be dated after the award of this contract, must state the Contractor's name and address, must name the project and location, and must list the specific requirements which are being certified.

b. Furnish motor control center that is NEMA Class II, [Type B] [Type C] [Type B or C as indicated in the bid item list], motor control centers in accordance with NEMA ICS 2. Submit copies of electrical equipment drawings, within [30] [_____] calendar days after [date of award] [date of receipt of notice to proceed], for the approval of the Contracting Officer. [The NEMA Class II[S] motor control center drawings must include a connection diagram with wire designations and schematic diagrams to illustrate operation of associated motor unit controls.]

c. Submit an individual wiring diagram for each motor control center. [Wiring diagrams must be in a form showing physical arrangement of the control center with interconnecting wiring shown by lines or by terminal designations (wireless).] Provide a single-line diagram, equipment list and nameplate schedule for each switchboard and panelboard.

2.9.1 Enclosures

****

NOTES: Stand alone front access line-ups are most desirable for ease of operation and maintenance, but particular installations may require specialized arrangements, such as back-to-back mounted units. Consult manufacturers for specialized requirements.

NFPA 70 Article 430H lists the various NEMA enclosure types for Motor Control Centers. Designer

should ensure that the NEMA type specified meets design requirements.
****

Provide motor control center consisting of the required number of vertical sections of 2250 mm 90 inches nominal height, bolted together, with steel channel sills and suitable for mounting against a wall. Provide vertical section that is 510 mm 20 inches deep and buses, control wiring, control transformers, small power transformers, terminal blocks, line terminals, cable supports, and clamps that are accessible from the front. Provide NEMA Type [1 gasketed] [12] [3R] enclosure. Fabricate the control centers from smooth select steel sheets shaped and reinforced to form rigid free-standing structures. Metal thickness for enclosures less than specified in NEMA ICS 6 are not acceptable. Fabricate and bolt vertical edges of sections exposed to view so that the joints will not pass a 1.6 mm 1/16 inch gage. Design each structure for the addition of future sections required. Isolate individual compartments from adjacent compartments.

2.9.1.1 Unit Compartments

Each operating unit must contain equipment as shown on the drawings, mounted in an individual cell. The unit assembly, except main circuit breakers, panelboards and auxiliary control devices, must be drawout type removed from the front, without rear access or disturbing other units in the control center assembly. Provide drawout type unit assemblies that have positive guide rail system to ensure alignment of connection to vertical bus. Provide units that are mechanically interlocked with the door to prevent removal while in the energized position. Each removable unit must have provision for padlocking in a position in which it is disconnected from the vertical bus although not removed from the stationary structure. Provide all ventilating openings with corrosion-resistant insect-proof screens on the inside. Provide bus closing plugs for all unused openings in vertical bus barriers.

2.9.1.2 Motor Control Center Doors and Covers

Provide each unit compartment, including blank compartments for future use, with either a flange-formed or a rolled-edge door. Mount each door on fully-concealed or continuous full-length piano-type hinges and provide with positive fasteners. Prevent door sag by proper alignment of hinges made of sufficiently strong material. Provide interlocked door fastenings to prevent opening when the equipment is energized. Provide external operating handle that clearly indicates whether the equipment is in an "ON", "OFF" or "TRIPPED" position.

2.9.1.3 Horizontal Wireways

[Structure must have a minimum 300 mm 12 inches high wireway at the top and a 150 mm 6 inches minimum wireway at the bottom.] [Structure must have a minimum 150 mm 6 inches high wireway at the top and a 300 mm 12 inches minimum wireway at the bottom.] Run both horizontal wireways the length of the structure [Provide a master terminal block compartment with full length wireway space at the [top] [bottom] [where indicated] in all Type C assemblies.] Provide cover plates on the side of the assembly to permit extension of the horizontal bus and wireway when vertical sections are added.

2.9.1.4 Vertical Wireways

Provide vertical wireways in all vertical sections accepting multiple plug-in components. Connect vertical wireways with horizontal wireways at the top and bottom and are a minimum 100 mm 4 inches wide. Provide barriers in sections containing both ac and dc vertical buses. Provide doors on each vertical wireway. The exposed surface of any door must not deviate more than 1.5 mm 1/16 inch from a true plane.

2.9.1.5 Sills

****

NOTE: Structural sills are options provided by most manufacturers and provide the structural stability desired for equipment subject to the vibration of a powerhouse. When equipment is to be mounted on sills and on a maintenance pad, the 78" NFPA 70 requirement for height to operating handle may be exceeded unless space for operator to stand on pad is provided.

****

Furnish channel iron foundations, complete with bolts and drilled holes for grouting and anchoring to the floor, for the complete length (front and rear) of each motor control center assembly. Design the channels for flat mounting and a maximum channel depth of 38 mm 1-1/2 inches. Provide additional channel or substantial metal trim flush with the end panels to completely enclose the bases across the ends of the equipment assemblies.

2.9.1.6 NEMA 3R Enclosures

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NOTE: Enclosures covered by this specification are not intended to be non walk-in type. Walk-in front-aisle, walk-in common aisle and walk through common aisle styles are available, and where required should be specified. The latter styles of enclosures must comply with NFPA 101 for means of egress and lighting.

****

The motor control center must be non-walk in NEMA Type 3R rainproof enclosure as shown on the drawings. Provide outside enclosure consisting of smooth select steel sheets on a structural steel frame. Provide full-length single or double doors with top and bottom bolts and a center latch operated by means of a keyed handle. Provide steel sheets and doors that are no less than 3.5 mm No. 10 gage thick and doors that have bent angle or channel edges with all corner seams welded and ground smooth. Assemble the motor control center within the enclosure with adequate gaskets and structure to assure a measure of vandal resistance. Provide ventilating openings and an effective insulating air space of approximately 50 mm 2 inches below the roof of the structure which slopes from front to back for adequate drainage. The outside edges of the control center base must permit easy sealing at the concrete surface with mastic compound. Furnish a 200-watt outdoor lighting fixture with globe and guard to light the front of the assembly. Provide watertight lighting connections. Furnish a weatherproof switch installation on the front or side of the enclosure so that the light can be switched prior to opening the assembly doors. Provide "ac" rated, 15 amperes, 120/277 volts exterior manual switch. Provide two duplex receptacle units within the outer weatherproof enclosure. Wire the lighting fixture and receptacles to the 120-volt ac panelboard located in the control center, and run external wiring in rigid galvanized steel conduit.

2.9.1.7 Shutters

Provide drawout units that have shutters which close when the unit is withdrawn to isolate the vertical bus.

[2.9.1.8 Thermostatically Controlled Strip Heaters

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NOTE: Delete this paragraph when not required.

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Provide thermostatically controlled strip heaters as specified in paragraph SPACE HEATERS [in all motor control centers] [where indicated].

]2.9.2 Buses

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NOTES: When either copper of aluminum bus are allowed the manufacturers will generally provide the less expensive aluminum. Use ASTM 317 when aluminum bus is permitted.

NEMA ICS 2 allows a 65 degrees C 117 degrees F temperature rise on the buses, irrespective of the equipment used. UL 845 allows 65 degrees C 117 degrees F temperature rise only under certain conditions. In general this means all buses must be plated and devices must be UL labeled for the higher temperatures. If this is not the case, the UL standard for temperature rise is 50 degrees C 90 degrees F creating a conflict with NEMA. The designer should be aware of this difference. This specification references the UL standard and bases the rise on the exceptions it permits.

****

Furnish buses that are copper [or aluminum] and furnish [all bolted splices and connections between buses and for extensions or taps for equipment that are tin or silver-plated] [that are tin or silver-plated throughout]. Provide copper [or aluminum] bars and shapes for bus conductors comforming to the applicable requirements of ASTM B187/B187M [, and ASTM B317/B317M]. Bolt all splices for field assembly with at least two bolts and employ the use of "Belleville" washers in the connection. Base the bus ratings on a 65 degree Celsius maximum temperature rise in accordance with UL 845 requirements. Bus must have a short-circuit current rating of not less than [42,000] [65,000] [100,000] RMS symmetrical amperes. Support all bus work on wet process porcelain insulators, glass polyester, or suitable molded material.

2.9.2.1 Horizontal Bus

Provide each control center assembly with a three-phase main horizontal bus, with a continuous current rating not less than [600] [800] [1,000] [1,200] amperes, located across the top of each vertical section. Drill the ends of horizontal buses for future extensions. [Fully insulate the main horizontal bus.]

2.9.2.2 Vertical Bus

Provide each vertical section with a three-phase vertical bus with a continuous current rating of [300] [600] amperes connected to the horizontal bus by brazing, welding, or bolting. Where the incoming feeder breakers are located at the bottom of a control center, rate the vertical bus in that section the same as the main horizontal bus. Extend vertical buses from the horizontal bus to the bottom of the lowest available unit mounting space. Isolate the vertical bus from wireways and equipment in compartments.

2.9.2.3 Ground Bus

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NOTE: Delete this paragraph when not required.

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Provide a full width copper [or aluminum] ground bus at the bottom of the motor control center line-up. Provide a full clamp-type solderless copper or copper alloy lug for No. 2/0 AWG stranded copper cable at each end of the bus for connection to the station grounding system.

[2.9.2.4 Neutral Bus

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NOTE: Delete this paragraph when not required.

****

Furnish a continuous [half] [fully] rated neutral bus through the control center. Lugs of appropriate capacity will be furnished.

]2.9.3 Combination Starters

****

NOTES: The minimum bus short-circuit rating for most manufacturers is 42,000 amps rms symmetrical. Most combination starters without current limiting type circuit breakers or motor circuit protectors have a short circuit rating of 25,000 amps. The designer will evaluate the available short circuit current for a particular installation and place that value in the space provided.

When short-circuit ratings above 25,000 amps are required, the designer should consult manufacturer's data for the availability of non-current limiting devices at the specific rating and where needed, show current limiting circuit breakers or motor circuit protectors the drawings.

In accordance with NEMA ICS 2, the motor control center short-circuit rating is the maximum available rms symmetrical current in amperes permissible at its line terminals which are computed as the sum of the maximum available current of the system at the point of connection and the short-circuit current

contribution of the motors connected to the control center. In the absence of more precise information, the motor short-circuit current contribution may be assumed to equal four times the continuous current rating of the motor control center.

Reduced voltage type starters are specified in the following paragraph. They should be used in specialized applications, and indicated on the drawings. Reduced voltage starting should be avoided where possible.

This specification does not cover reversing starters. Where a reversing starter is required, indicate reversing and non-reversing starters on the drawings, and modify the specification for clarity.

NEMA sizes are based on continuous duty motors. Where acceleration time exceeds 10 seconds, or plugging or jogging duty are required, consult the manufacturer.

For high efficiency motors, the designer will investigate time-current curve characteristics of the circuit breaker or MCP overcurrent protection to ensure that the increased starting current of these motors does not exceed the NFPA 70 standard ratings.

To determine whether to select motor circuit protectors or molded-case circuit breakers, see subparagraph Coordination in Part 1.
****

Furnish combination motor controller units containing [motor circuit protectors] [molded-case circuit breakers], auxiliary and pilot devices and [a magnetic contactor with thermal overload relays] [[or] [and] reduced voltage starter where indicated on the drawings]. Provide ratings of [motor circuit protectors,] air circuit breakers, contactors, motor controllers and other devices as shown on the drawings. All combination motor controller units must have short circuit ratings equal to [_____] or greater. Where control push-buttons, indicating lamps, "Hand-Off-Automatic" switches, and similar control devices are associated with a unit, mount them on the unit compartment door. Door-mounted components must not interfere with access within the compartments. [Provide molded case circuit breakers for use in combination starters meeting the requirements of paragraph MOLDED CASE CIRCUIT BREAKERS.] [Motor circuit protectors are only part of the combination starters as required by NFPA 70 and conform to all requirements of paragraph MOLDED CASE CIRCUIT BREAKERS, except provide trip units that have provision for locking the selected trip setting.]

2.9.3.1 Magnetic Contactors

Provide magnetic contactors of the NEMA sizes indicated on the drawings. Conform to the requirements of NEMA ICS 2 for contactors with continuous current ratings for the duty indicated. Provide contactors for motor control that are rated for full-voltage starting (Class A controllers). Provide contactors that are suitable for at least 200,000 complete operations under rated load without more than routine maintenance.

Minimize the interruption arc and flame by suitable arc chutes or other means so that no damage will be done to other portions of the device. The arc chutes, if provided, must be easily removable without removing or dismantling other parts. The contacts must be easily removable. All current-carrying contact surfaces must be silver-surfaced or of other approved material to prevent the formation of high resistance oxides. Operate the contactor without chatter or perceptible hum while energized. Provide coils that are suitable for continuous operation [120-volt ac] [480-volt ac] [125-volt dc] circuits. Provide alternating-current contactors that are three-pole, except where otherwise noted, and insulated for 600 volts ac and of the electrically- operated, magnetically-held type. Provide direct-current contactors that are two-pole, suitable for controlling circuits operating at 125 volts dc, insulated for 250 volts dc, electrically-operated, magnetically-held type and adequate for full-voltage motor starting service.

[2.9.3.2 Reduced Voltage Starters

****

NOTES: Motor loads using reduced voltage starting must be able to operate with reduced starting torque.

Autotransformer starters should be used when voltage drop due to motor starting current is a problem. Solid state starters may also be used. Designer to determine best alternative.

Solid state starters provide a smooth acceleration and are suitable for pump starting. Acceleration requirements must be coordinated to specific motor.

Delete this paragraph when reduced voltage starters are not required.

****

[Provide autotransformers rated for medium duty and have taps according to NEMA ICS 2. For thermal over load protection, the autotransformer must have normally closed thermostat wired in series with the normally closed thermal overload contact of the starter. Make initial connection to the [65] [_____] percent tap.] [Provide solid state soft-start starters consisting of three phase SCR controlled for stepless reduced voltage starting of induction motors.] Current transformers must provide feedback signal to regulate torque during start up and to prevent overload conditions while motor is running. Furnish starter with starting current of 300 percent of full load amps for thirty seconds, bypass/isolation contactor, and three phase thermal overload relay.

]2.9.3.3 Auxiliary Contacts

Provide each controller with a minimum of three auxiliary contacts which can be easily changed from normally open to normally closed. Where indicated on the drawings, provide a fourth auxiliary contact and red and green indicating lights.

2.9.3.4 Overload Relays

****

NOTE: The standard NEMA Class 20 overload relay operates at 600 percent of its rating after a

maximum of 20 seconds. Other standards are Class 10 and Class 30, operating at a maximum of 10 and 30 seconds. This may be required for special applications.

****

Except as otherwise indicated, provide three NEMA Class 20 thermal or solid state overload relays with external manual reset for each controller. Prior to shipment of the control centers, the Contracting Officer will furnish the ratings of the heater elements to be installed in the relays by the Contractor.

[2.9.3.5 Individual Control Transformers

****

NOTE: Delete this paragraph as well as requirement for spare control transformer when a single control transformer for the motor control center is mounted in a unit compartment or external control source is provided.

Primary fuses for individual control transformers are given as an option. For less than 50 VA, they are not required or desired. Please refer to NFPA 70 section 430-72(c).

****

Where 120 volt ac control of contactors is indicated or required, provide individual control transformer on the line side of the unit disconnect. Provide control transformers rated 480-120 volts and conforming to the requirements for control transformers in UL 508. Provide control transformers that have adequate volt-ampere capacity for the control functions indicated. Install transformers [without] [with] primary fuses. [Provide Class J primary fuses.] Except as otherwise indicated on the drawings, provide each control transformer with a fuse in one secondary lead and ground the other secondary lead.

][2.9.3.6 Voltage Fault Protection

****

NOTE: Voltage fault protection requirements should be evaluated and this paragraph deleted when not required.

****

Where shown, provide starters with protection against [voltage faults,] [phase unbalance,] [phase loss,] [phase reversal,] [undervoltage] [and overvoltage]. Upon sensing one of these faults, the protector must de-energize the starter. Use a combination of voltage and phase-angle sensing to detect phase loss even when regenerated voltages are present. Connect the protector to the load side of the motor circuit disconnect. Provide an adjustable line voltage trip level, adjustable trip delay, automatic reset [and manual reset by an external normally closed push-button,] and Double Pull Double Throw (DPDT) output contacts. Protector operation must have repeatability of +1 percent of set point, maximum, and a dead band of 2 percent maximum. Provide green indicator to show normal status and red indicator to show tripped status. Indicators will be visible through the compartment door. Cover protector with a clear unbreakable cover when LED's are used. Provide nameplates when lamps are used and group with other indicating lights.

]2.9.4 Molded Case Circuit Breakers in Unit Compartments

Provide molded case circuit breakers for installation in unit compartments meeting the requirements of paragraph MOLDED CASE CIRCUIT BREAKERS above.

2.9.5 Panelboards for Motor Control Centers

Provide panelboards meeting the requirements of paragraph PANELBOARDS.

2.9.6 Distribution Transformers

Furnish dry type transformers for power and lighting loads with voltage and kVA ratings as indicated on the drawings. Provide transformers conforming to the requirements for general-purpose transformers in NEMA ST 20. Protect each transformer on the primary side with a molded case circuit breaker as indicated on the drawings. [Provide drawout type transformers.]

[2.9.7 Ground Detector Indicator

****

NOTE: Ground detectors requirements should be evaluated and this paragraph deleted when not required.

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Provide ground-detector indicator (GDI) rated 120-volts; has three lamps, one per phase, three 480-120 volt transformers connected delta-wye, adjustable loading resistor for balancing capacitive charging current, and push-to test-switch. Provide visual indication of a single ground-fault on any phase (A, B, or C) of a three-phase, three-wire ungrounded power system. When no phase is grounded, all lamps must glow at partial brightness, giving long lamp life, the push-to test switch must not affect the brightness of any lamp. When a single ground-fault occurs on any phase, the lamp that corresponds to the faulted phase must be dark and the other two lamps must glow at full brightness. The push-to-test switch must cause all lamps to return to partial brightness, showing the GDI is functioning properly.

]2.9.8 Wiring for Motor Control Centers

All wiring must meet the requirements of paragraph WIRING above. Provide heavy-duty clamp type terminals for terminating all power cables entering the control centers.

2.9.8.1 Contractor's Wiring

Form Contractor's wiring into groups, suitably bound together, properly support and run straight horizontally or vertically. There must be no splices in the wiring. The manufacturer's standard pressure-type wire terminations for connections to internal devices will be acceptable. Add terminal blocks for wiring to devices having leads instead of terminals. Use ring tongue indented terminals on all wires terminated on control terminal blocks for external or interpanel connections and at shipping splits. Provide contact nuts and either locking nuts or lockwashers for all stud terminals.

2.9.8.2 External Connections

****

NOTE: For NEMA 3R enclosures power cables must enter from the bottom.

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Power and control cables will enter the control centers at the [bottom] [top] [where shown on the drawings]. [Where power and control entry points are not shown, and terminal blocks are not given on the drawings, the Government will furnish this information to the Contractor after award of contract.]

2.9.8.3 Terminal Blocks

Furnish terminal blocks meeting the requirements of paragraph TERMINAL BLOCKS above. In no case must the terminals provided for circuit breakers or contactors accommodate less than the number or size of conductors shown on the drawings. Give special attention to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

[2.9.9 Control Transformers

****

NOTE: Delete when individual control transformers are specified or external control circuit is provided.

****

Mount control transformers for several starter units in a separate compartment and connect its primary windings to the main bus through a molded case circuit breaker of suitable rating. Provide control transformers that are rated 480-120 volts and conforming to the requirements for control transformers in UL 508. Provide control transformers with adequate volt-ampere capacity for the control functions indicated and an additional 10 percent capacity. Install transformers without primary fuses. Except as otherwise indicated on the drawings, each unit compartment must provide a fuse for control power in one secondary lead and must have the other secondary lead grounded. Equip the unit disconnect with a normally open contact to isolate the control circuit from the source when the controller disconnect is open.

]2.9.10 Accessories and Control Devices

****

NOTE: Retain only paragraphs for accessories actually used for a given procurement.

****

Provide control accessories that are suitable for mounting on the front of, or inside, the control centers as indicated on the drawings. Provide control accessories meeting the applicable requirements of NEMA ICS 2. Mount relays and other equipment so that mechanical vibration will not cause false operation.

2.9.10.1 Control Stations

Provide push-button stations and selector switches in conformance to

NEMA ICS 2, of the heavy-duty, oil-tight type, rated 600 volts ac, and with a contact rating designation of A600. Provide switches with escutcheon plates clearly marked to show operating positions. [Provide sufficient contact blocks to make up the electrically separate contacts required for lead-lag selector switches.]

2.9.10.2 LED Indicating Lights

Furnish red and green LED's where shown on the drawings, indicating contact "open" and "closed" position. Make LED's accessible and replaceable from the front of the control center through a finished opening in the compartment door. Provide LED assemblies that are the heavy duty oiltight, watertight, and dusttight type.

2.9.10.3 Control Relays

Provide control relays that are electrically operated, magnetically held, self-reset, open type, suitable for mounting inside the starter compartments, and are [125-volt dc] [120-volt ac]. Provide contacts as indicated on the drawings and have a contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2.

2.9.10.4 Timing Relays

Provide pneumatic type timers that are suitable for mounting inside the control center and rated 120 volts ac, 60 Hz. Provide instantaneous and time delay contacts as indicated on the drawings, and have a contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2. Provide means for manual adjustment over a range as indicated on the drawings.

2.9.10.5 Alternators

Alternators 120-volt, 60 Hz, single-phase, open type, suitable for mounting inside of control center as indicated. Alternators must automatically cycle two motor starters in such a manner that No. 1 will lead and No. 2 will lag during the first cycle, and during the second cycle No. 2 will lead and No. 1 will lag, and the third cycle will repeat the first cycle. The duration of a cycle will be determined by an [external device] [adjustable time delay]. Provide contacts with a minimum contact rating designation of A600 or N600, as required, in accordance with NEMA ICS 2.

2.9.10.6 Elapsed-Time Meters

Furnish hour-indicating time meters that have 6- digit registers with counter numbers at least 6 mm 1/4 inch high. Use white numbers on black backgrounds to provide hour indication with the last digit in contrasting colors to indicate tenths of an hour. Provide enclosure that is 90 mm 3-1/2 inches square and dust resistant. Provide operating voltage of 120 volts ac. Provide nonreset type.

2.9.11 Feeder Tap Units

Provide feeder tap units as indicated on the drawings.

2.9.12 Metering Section

Provide metering section with instruments as indicated on the drawings.

2.9.12.1 Instrument Transformers

Use transformers for metering meeting the requirements of NEMA/ANSI C12.11 and IEEE C57.13. Protect voltage transformers with removable primary and secondary fuses. Install fuses in each ungrounded lead and locate adjacent to the transformers in an easily accessible place. If cable connections to current transformer primary are required, furnish terminals of an approved solderless type and proper size. If current transformers are connected to buses, furnish proper connections, complete with bolts, nuts, washers and other accessories.

2.9.12.2 Ammeters

Provide switchboard type ammeter where indicated on the drawings. Ammeter, range 0 to [_____] amperes, complete with selector switch having off position and positions to read each phase current. Provide meters that are long scale 175 mm 6.8 inches), semiflush rectangular, indicating type mounted at eye level.

2.9.12.3 Voltmeters

Provide switchboard type voltmeter where indicated on the drawings. Voltmeter, range 0 to 600 volts, complete with selector switch having off position and positions to read each phase to phase voltage. Provide meters that are long scale 175 mm 6.8 inches, semiflush rectangular, indicating type mounted at eye level.

2.9.12.4 Watthour Meters

Furnish watthour meters conforming to ANSI C12.1 and NEMA/ANSI C12.10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Provide watthour meters of the drawout switchboard type having a 15-minute, cumulative form, demand register meeting NEMA C12.4 and provide with no less than two and one-half stators. [Provide watthour demand meters that have factory installed electronic pulse initiators meeting the requirements of ANSI C12.1.]

2.9.12.5 Switches

Furnish rotary switchboard type metering switches with handles on the front and operating contact mechanisms on the rear of the panels. Provide control switches suitable for operation on 600-volt AC or 250-volt DC circuits. Provide switches that are capable of satisfactorily withstanding a life test of at least 10,000 operations with rated current flowing in the switch contacts. Provide maintained-contact type selector switches with the required number of positions, and that have round notched, or knurled handles. Ammeter switches must not open the secondary circuits of current transformers at any time. Provide instrument switches for potential selection with oval handles.

[2.9.13 Power-Factor-Correction Capacitors

****

NOTES: Power factor correction capacitors should not be used on the load side of solid state starters. Motor control center manufacturers do not normally contact the motor manufacturers, so where possible the designer will show KVAR ratings on the drawings, coordinating these requirements with

actual motors used.

When power factor correction is not needed, delete this paragraph.

****

Three-phase, delta-connected capacitors for power factor improvement must be rated [_____] volts, 60 Hz. [Capacitors must have KVAR capacity as shown on the drawings] [Select the capacitor KVAR capacity to achieve no less than [_____] percent leading nor more than [_____] percent lagging power factor at nameplate value of motor full load current. The KVAR capacity of the capacitors must not be greater than that recommended by the motor manufacturer or if no such recommendation exists, that value which gives with a lagging power factor at no-load.] If size permits, mount the capacitors in an adjacent compartment, or otherwise mount separately and connect to the motor at the motor terminal box. [For reduced voltage starters, separately switch the capacitors with a time-delayed contactor rated according to NEMA ICS 2 for capacitor switching.]

][2.9.14 Space for Mounting PLC's

****

NOTE: Delete this paragraph when PLC's are not used.

****

Provide space for mounting of Programmable Logic Controllers (PLC's) as indicated on the drawings.

]2.10 SWITCHBOARDS

****

NOTES: The switchboard specified below is not intended for applications where the available fault current is above 65,000 amps. Where drawout-type breakers, and high short circuit current ratings are desired, Section 26 22 00.00 10 480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS should be used.

The short-circuit current rating assigned to the switchboard must be in accordance with NEMA PB 2.

****

Provide dead-front switchboards conforming to NEMA PB 2 and label under UL 891. Provide completely enclosed self-supporting metal structures with the required number of vertical panel sections, buses, molded-case circuit breakers, [and other devices] as shown on the drawings. Provide switchboards that are fully rated for a short-circuit current of [14,000] [22,000] [65,000] [_____] symmetrical amperes RMS AC.

2.10.1 Enclosure

****

NOTE: Mounting sills should be included for all new construction to provide structural integrity. NEMA PB2 90" height includes these sills.

****

Provide NEMA type [2] [3R] switchboard enclosure, built with selected smooth sheet steel panels of no less than 1.9 mm No. 14 gage. Exposed panels on the front and ends must have bent angle or channel edges with all corner seams welded and ground smooth. Do not drill or weld the front outside surfaces for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front. Make the front panels in sections flanged on four sides and attach to the framework by screws and arrange for ready removal for inspection or maintenance. [Provide rear access to the bus and device connections.] Provide ventilating openings as required and preferably of the grille type. Provide all ventilating openings with corrosion-resistant insect-proof screens on the inside. [Provide each switchboard with a channel iron base at front, rear, and sides, with exposed ends covered by welded steel plates. Provide grout holes. Bolt the switchboard sections to the base.] [Mount switchboards as shown on the drawings and furnish mounting materials as indicated.] Treat all interior and exterior steel parts to inhibit corrosion and paint as specified in paragraph PAINTING.

2.10.2 Bus

****

NOTE: When either copper or aluminum bus is allowed the manufacturers will generally provide the less expensive aluminum. Use ASTM 317 when aluminum bus is permitted. Silver plating allows for a greater temperature rise on the bus.

****

Provide buses that are copper [or aluminum] and [all bolted splices and connections between buses and for extensions or taps for equipment] that are tin or silver-plated [throughout]. Provide copper [or aluminum] bars and shapes for bus conductors conforming to the applicable requirements of ASTM B187/B187M [, and ASTM B317/B317M]. Bolt all splices for field assembly with at least two bolts and employ the use of "Belleville" washers in the connection. Horizontal and vertical power buses have minimum current ratings as shown on the drawings. Insulate the buses for no less than 600 volts. Braze, pressure-weld or bolt shop splices and tap connections. Bolt all splices for field assembly. Mount the buses on insulating supports of wet process porcelain, glass polyester, or suitable molded material, and brace to withstand no less than [14,000] [22,000] [65,000] [_____] symmetrical amperes ac.

2.10.3 Grounding Bus

****

NOTE: Delete this paragraph when not required.

****

Mount a copper [or aluminum] ground bus, rated no less than 300 amps, extending the entire length of the assembled structure, near the bottom of enclosure. Provide a full clamp-type solderless copper or copper alloy lug for No. 2/0 AWG stranded copper cable at each end of the bus for connection to the station grounding system.

2.10.4 Components

Equip each switchboard with molded-case circuit breakers conforming to paragraph MOLDED CASE CIRCUIT BREAKERS and with frame sizes, trip ratings, and terminal connectors for attachment of outgoing power cables as shown on the drawings. Stationary mount the circuit breakers individually, as shown on the drawings, that are operable and removable from the front. Where shown on the drawings, enclose circuit breakers in individual compartments. [Provide the group-mounted circuit breakers complete with bus work in an integrated assembly on the switchboard and conform to the applicable requirements of paragraph PANELBOARDS.]

2.11 PANELBOARDS

****

NOTE: The short-circuit current rating assigned to the panelboard must be in accordance with NEMA PB 1.

****

Provide panelboards consisting of assemblies of molded-case circuit breakers with buses and terminal lugs for the control and protection of branch circuits to motors, heating devices and other equipment operating at 480 volts ac or less. Provide UL 67 labeled panelboards. "Loadcenter" type panels are not acceptable. Design panelboards for installation in surface-mounted or flush-mounted cabinets accessible from the front only, as shown on the drawings. Provide panelboards that are fully rated for a short-circuit current of [14,000] [22,000] [_____] symmetrical amperes RMS ac.

2.11.1 Enclosure

Furnish enclosures meeting the requirements of UL 50. Fabricate all cabinets from sheet steel of no less than 3.5 mm No 10 gage if flush-mounted or mounted outdoors, and no less than 2.7 mm No 12 gage if surface-mounted indoors, with full seam-welded box ends. Hot-dip galvanize cabinets mounted outdoors or flush-mounted after fabrication. Paint cabinets in accordance with paragraph PAINTING. Provide outdoor cabinets of NEMA 3R raintight and [conduit hubs welded to the cabinet] [a removable steel plate 6 mm 1/4 inch thick in the bottom for field drilling for conduit connections.] Form-flange edges of cabinets or fit with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front. Fabricate all cabinets so that no part of any surface on the finished cabinet deviates from a true plane by more than 3 mm 1/8 inch. Provide holes in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 13 mm 1/2 inch clear space between the back of the cabinet and the wall surface. Mount flush doors on hinges that expose only the hinge roll to view when the door is closed. Fit each door with a combined catch and lock, except provide doors over 600 mm 24 inches long with a three-point latch having a knob with a T-handle, and a cylinder lock. Provide two keys with each lock, and key all locks alike. Provide finished-head cap screws for mounting the panelboard fronts on the cabinets. Provide enclosure nameplates in accordance with paragraph NAMEPLATES. Provide directory holders, containing a neatly typed or printed directory under a transparent cover, on the inside of panelboard doors.

2.11.2 Buses

****

NOTE: When either copper or aluminum bus is allowed the manufacturers will generally provide the less expensive aluminum. Use ASTM 317 when aluminum bus is permitted. Silver plating the bus allows for higher temperature rise and is not generally required.

****

Provide dead-front type panelboards with buses and circuit breakers mounted on a plate or base for installation as a unit in a cabinet. Provide buses that are copper [or aluminum] [and are tin or silver-plated throughout]. Provide copper [or aluminum] bars and shapes for bus conductors conforming to the applicable requirements of ASTM B187/B187M[, and ASTM B317/B317M]. Provide sizes of buses and the details of panelboard construction meeting or exceeding the requirements of NEMA PB 1. Make suitable provisions for mounting the bus within panelboards and adjusting their positions in the cabinets. Provide terminal lugs required to accommodate the conductor sizes shown on the drawing for all branch circuits larger than No. 10 AWG. Provide a grounding bus with a lug suitable for 1/0 AWG wire for each panelboard.

2.11.3 Components

Equip each branch circuit, and the main buses where so specified or shown on the drawings, with molded-case circuit breakers having overcurrent trip ratings as shown on the drawings. Provide circuit breakers designed for bolted connection to buses in a panelboard assembly, and meeting the requirements of paragraph MOLDED CASE CIRCUIT BREAKERS. Circuit breakers of the same frame size and rating must be interchangeable. [Furnish bell alarm contacts as indicated on the drawings and wire to terminal blocks mounted in the cabinet. Furnish terminal blocks conforming to requirements of paragraph TERMINAL BLOCKS.]

2.12 FACTORY TESTS

Each item of equipment supplied under this contract must be given the manufacturer's routine factory tests and tests as specified below, to insure successful operation of all parts of the assemblies. The Contracting Officer will witness all tests required herein unless waived in writing, and no equipment will be shipped until it has been approved for shipment by the Contracting Officer.

a. Submit copies of manufacturer's routine factory test procedures and production line tests for all motor control centers and switchboards, within a minimum of [14] [_____] days prior to the proposed date of tests. Notify the Contracting Officer a minimum of [14] [_____] days prior to the proposed date of the tests so that arrangements can be made for the Contracting Officer to be present at the tests.

b. Use factory test equipment and the test methods conforming to the applicable NEMA Standards, and are subject to the approval of the Contracting Officer. Submit complete reproducible copies of the factory inspection results and complete reproducible copies of the factory test results in booklet form, including all plotted data curves, all test conditions, a listing of test equipment complete with calibration certifications, and all measurements taken.

c. Report must be signed and dated by the Contractor's and Contracting Officer's Representatives. Reports of all witnessed tests must be signed by witnessing representatives of the Contractor and Contracting Officer. The Contractor is responsible for the cost of performing all tests and include in the prices bid in the schedule for equipment.

2.12.1 Motor Control Centers Tests

2.12.1.1 Dielectric Tests

Completely assemble each motor control center and perform dielectric tests in accordance with NEMA ICS 1.

2.12.1.2 Operational Tests

Check the correctness of operation of each air circuit breaker [or motor circuit protector] and magnetic contactor and of all control devices, accessories and indicating lamps. Make these checks rated voltage with power supplies to the main buses. Also check all magnetic contactors for proper operation with power at 90 percent of rated voltage.

2.12.1.3 Short Circuit Tests

If the unit is not UL labeled for the specified short circuit, the Contractor may submit design tests demonstrating that satisfactory short-circuit tests, as specified in NEMA ICS 2, have been made on a motor control center of similar type of construction and having the same available short circuit current at the motor terminals, including any motor contributions, as the motor control centers specified to be furnished under these specifications.

2.12.2 Switchboards Tests

2.12.2.1 Production Tests

Completely assemble each switchboard and give applicable production tests for assembled switchboard as specified in NEMA PB 2.

2.12.2.2 Short Circuit Tests

If the unit is not UL labeled for the specified short circuit, the Contractor may submit design tests demonstrating that satisfactory short-circuit tests have been made on a switchboard of similar type of construction and of the same short-circuit rating as the switchboards specified to be furnished under these specifications.

2.12.3 Panelboards Tests

Assemble each panelboard with cabinet and front to the extent necessary to check the fit and provisions for installing all parts in the field. Give each panelboard a dielectric test in accordance with NEMA PB 1. Operate all circuit breakers to check mechanical adjustments. Check all doors and locks for door clearances and fits and the performance of lock and latches.

2.13 PAINTING

Clean interior and exterior steel surfaces of equipment enclosures thoroughly and then apply a rust-inhibitive phosphatizing or equivalent treatment prior to painting. Exterior surfaces must be free from holes, seams, dents, weld marks, loose scale or other imperfections. Apply no less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice to exterior surfaces. Prime exterior, filld where necessary, and give no less than two coats baked enamel with semigloss finish. Equipment located indoors must be ANSI Light Gray, [and equipment located outdoors must be ANSI [Light Grey] [Dark Gray].] Perform all touch-up work with manufacturer's coatings as supplied under paragraph SPARE PARTS.

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

****

NOTE: Include the grounding section below for installations involving a Motor Control Centers installed in an exterior application. If the MCC is installed adjacent to a pad-mounted distribution transformer, then coordinate the grounding requirements between the applicable specifications.

****

[3.2 GROUNDING

****

NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, specify other methods of grounding. Where it is impractical to obtain the indicated ground resistance values, make every effort to obtain ground resistance values as near as possible to the indicated values.

Select 25 ohms resistance unless the installation requires a lower resistance to ground.

****

NFPA 70 and IEEE C2, except that grounds and grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 610 mm 24 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

]3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Motor Control Centers

NEMA ICS 1.

NEMA ICS 2.

3.3.2 Switchboards

NEMA PB 1.

3.3.3 Panelboards

NEMA PB 2.

3.3.4 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.3.5 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.3.6 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the equipment is located. Include construction requirements for concrete slab only if slab is not detailed in drawings.

****

3.4.1 Exterior Location

Mount Motor Control Centers on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 200 mm 8 inches thick, reinforced with a 150 by 150 mm 6 by 6 inch No. 6 mesh placed uniformly 100 mm 4 inches from the top of the slab.

b. Place slab on a 150 mm 6 inch thick, well-compacted gravel base.

c. Install slab such that the top of the concrete slab is approximately 100 mm 4 inches above the finished grade.

d. Provide edges above grade with 15 mm 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 200 mm [8] [_____] inches beyond the equipment.

f. Provide conduit turnups and cable entrance space required by the equipment to be mounted.

g. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.

h. Cut off and bush conduits 75 mm 3 inches above slab surface.

i. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4.2 Interior Location

Mount Motor Control Centers on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 100 mm 4 inches thick.

b. Install slab such that the top of the concrete slab is approximately 100 mm 4 inches above the finished grade.

c. Provide edges above grade with 15 mm 1/2 inch chamfer.

d. Provide slab of adequate size to project at least 200 mm [8] [_____] inches beyond the equipment.

e. Provide conduit turnups and cable entrance space required by the equipment to be mounted.

f. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.

g. Cut off and bush conduits 75 mm 3 inches above slab surface.

h. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

****

NOTE: Select "Request for Settings" below if protective device settings will be government furnished. Select "Required Settings" below if protective device settings are furnished by the Designer of Record. Coordinate with the person developing the Division 1 Sections and ensure that Division 1 Sections identify the person responsible for providing the final protective device settings for design/build versus design/bid/build projects.

Do not rely on the manufacturer's default settings.
****

[Submit request for settings of breakers to the Contracting Officer after approval of Motor Control Center and at least 30 days in advance of their requirement.

][Submit Required Settings of breakers to the Contracting Officer after approval of the Motor Control Center and at least 30 days in advance of their requirement.

]3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and Section 26 08 00 APPARATUS INSPECTION AND TESTING.

****
NOTE: Select the options below that apply to the specified equipment.

****

3.5.1.1 Motor Control Center

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Compare equipment nameplate data with drawings and specifications.

3. Inspect anchorage, alignment, grounding, and required area clearances.

4. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.

5. Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker address for microprocessor-communication packages.

6. Verify that current and voltage transformer ratios correspond to drawings.

7. Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.

8. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

9. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

10. Confirm correct application of manufacturer's recommended lubricants.

11. Inspect insulators for evidence of physical damage or contaminated

surfaces.

12. Verify correct barrier and shutter installation[and operation].

13. Exercise all active components.

14. Inspect all mechanical indicating devices for correct operation.

15. Verify that filters are in place and vents are clear.

16. Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

17. Inspect control power transformers.

b. Electrical Tests

1. Perform insulation-resistance tests on each bus section.

2. Perform dielectric withstand voltage tests.

3. Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

4. Perform control wiring performance test.

5. Perform primary current injection tests on the entire current circuit in each section of assembly.

[6. Perform phasing check on double-ended motor control center to ensure correct bus phasing from each source.]

7. Verify operation of motor control center heaters.

3.5.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify that all maintenance devices are available for servicing and operating the breaker.

5. Inspect arc chutes.

6. Inspect moving and stationary contacts for condition, wear, and alignment.

7. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

8. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.

9. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

10. Verify cell fit and element alignment.

11. Verify racking mechanism.

12. Confirm correct application of manufacturer's recommended lubricants.

b. Electrical Tests

1. Perform contact-resistance tests on each breaker.

2. Perform insulation-resistance tests.

3. Adjust Breaker(s) for final settings in accordance with Government provided settings.

4. Determine long-time minimum pickup current by primary current injection.

5. Determine long-time delay by primary current injection.

****

NOTE: Coordinate each option with each breaker type.

****

6. Determine short-time pickup and delay by primary current injection.

7. Determine ground-fault pickup and delay by primary current injection.

8. Determine instantaneous pickup value by primary current injection.

9. Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to ensure operation of shunt trip devices; Check the operation of electrically-operated breakers in their cubicle.

10. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

11. Verify operation of charging mechanism.

3.5.1.3 Current Transformers

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify correct connection.

4. Verify that adequate clearances exist between primary and secondary

circuit.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2. Perform insulation-resistance tests.

3. Perform polarity tests.

4. Perform ratio-verification tests.

3.5.1.4 Metering and Instrumentation

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify tightness of electrical connections.

b. Electrical Tests

1. Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

2. Calibrate watthour meters according to manufacturer's published data.

3. Verify all instrument multipliers.

4. Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.5.1.5 Grounding System

a. Visual and Mechanical Inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1. IEEE 81. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than

48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2. Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.5.1.6 Switches, Air, Low-Voltage

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, grounding, and required clearances.

4. Verify the unit is clean.

5. Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.

6. Verify that fuse sizes and types are in accordance with drawings, short-circuit studies, and coordination study.

7. Verify that each fuse has adequate mechanical support and contact integrity.

8. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

9. Verify operation and sequencing of interlocking systems.

10. Verify correct phase barrier installation.

11. Verify correct operation of all indicating and control devices.

12. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, in accordance with Section 7.5.1.1.A.8.1 of NETA ATS.

2. Measure contact resistance across each switchblade and fuseholder.

3. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.1 of

NETA ATS.

4. Measure fuse resistance.

5. Verify cubicle space heater operation.

6. Perform ground fault test in accordance with Section 7.14 of NETA ATS.

7. Perform tests on other protective devices in accordance with Section 7.9 of NETA ATS.

3.5.1.7 Switches, Air, Medium-Voltage, Metal-Enclosed

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, grounding, and required clearances.

4. Verify the unit is clean.

5. Verify correct blade alignment, blade penetration, travel stops, arc interrupter operation, and mechanical operation.

6. Verify that fuse sizes and types are in accordance with drawings, short-circuit study, and coordination study.

7. Verify that expulsion-limiting devices are in place on all fuses having expulsion-type elements.

8. Verify that each fuseholder has adequate mechanical support and contact integrity.

9. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

10. Verify operation and sequencing of interlocking systems.

11. Verify correct phase barrier installation.

12. Verify correct operation of all indicating and control devices.

13. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.5.1.2.A.9.1 of NETA ATS.

2. Measure contact resistance across each switchblade assembly and fuseholder.

3. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.1 of NETA ATS.

4. Perform a dielectric withstand voltage test on each pole with switch closed. Test each pole-to-ground with all other poles grounded. Test voltage will be in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.2 of NETA ATS.

5. Measure fuse resistance.

6. Verify cubicle space heater operation.

7. Perform online partial-discharge survey in accordance with Section 11 of NETA ATS.

3.5.1.8 Circuit Breakers

3.5.1.8.1 Circuit Breakers, Air, Insulated-Case/Molded-Case

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage and alignment.

4. Verify the unit is clean.

5. Operate the circuit breaker to insure smooth operation.

6. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

7. Inspect operating mechanism, contacts, and arc chutes in unsealed nits.

8. Perform adjustments for final protective device settings in accordance with the coordination study.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.6.1.1.A.6.1 of NETA ATS.

2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.1 of NETA ATS.

3. Perform a contact/pole-resistance test.

4. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components, follow manufacturer’s recommendation.

5. Determine long-time pickup and delay by primary current injection.

6. Determine short-time pickup and delay by primary current injection.

7. Determine ground-fault pickup and time delay by primary current injection.

8. Determine instantaneous pickup by primary current injection.

9. Test functions of the trip unit by means of secondary injection.

10. Perform minimum pickup voltage tests on shunt trip and close coils in accordance withmanufacturer’s published data.

11. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators.

12. Verify operation of charging mechanism.

3.5.1.8.2 Circuit Breakers, Low-Voltage Power

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify that all maintenance devices are available for servicing and operating the breaker.

5. Verify the unit is clean.

6. Verify the arc chutes are intact.

7. Inspect moving and stationary contacts for condition and alignment.

8. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

9. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism in accordance with manufacturer’s published data.

10. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey

11. Verify cell fit and element alignment.

12. Verify racking mechanism operation.

13. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

14. Perform adjustments for final protective device settings in accordance with coordination study provided by end user.

15. Record as-found and as-left operation counter readings.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.6.1.2.A.10.1 of NETA ATS.

2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Test voltage will be in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.1 of NETA ATS.

3. Perform a contact/pole-resistance test.

4. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components, follow manufacturer’s recommendation.

5. Determine long-time pickup and delay by primary current injection.

6. Determine short-time pickup and delay by primary current injection.

7. Determine ground-fault pickup and delay by primary current injection.

8. Determine instantaneous pickup value by primary current injection.

9. Test functions of the trip unit by means of secondary injection.

10. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.20 of NETA ATS.

11. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.

12. Verify operation of charging mechanism.

3.5.1.8.3 Circuit Breakers, Air, Medium-Voltage

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify that all maintenance devices are available for servicing and operating the breaker.

5. Verify the unit is clean.

6. Verify the arc chutes are intact.

7. Inspect moving and stationary contacts for condition and alignment.

8. If recommended by manufacturer, slow close/open breaker and check for binding, friction, contact alignment, and penetration. Verify that contact sequence is in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use IEEE C37.04.

9. Perform all mechanical operation tests on the operating mechanism in accordance with manufacturer’s published data.

10. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey

11. Verify cell fit and element alignment.

12. Verify racking mechanism operation.

13. Inspect puffer operation.

14. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

15. Perform contact-timing test.

16. Perform mechanism-motion analysis.

17. Perform trip/close coil current signature analysis.

18. Record as-found and as-left operation-counter readings.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. See Section 7.6.1.3.A.10.1 of NETA ATS.

2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.1 of NETA ATS.

3. Perform a contact/pole-resistance test.

4. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration

will be on minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.

5. With breaker in the test position, make the following tests:

   (a) Trip and close breaker with the control switch.

   (b) Trip breaker by operating each of its protective relays.

   (c) Verify mechanism charge, trip-free, and antipump functions.

6. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.20 of NETA ATS.

7. Perform power-factor or dissipation-factor tests with breaker in both the open and closed positions.

8. Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/ capacitance tap, perform hot-collar tests. These tests will be in accordance with the test equipment manufacturer's published data.

9. Perform a dielectric withstand voltage test on each phase with the circuit breaker closed and the poles not under test grounded. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.19 of NETA ATS.

10. Measure blowout coil circuit resistance.

11. Verify operation of heaters.

12. Test instrument transformers in accordance with Section 7.10 of NETA ATS.

3.5.1.8.4 Circuit Breakers, Oil, Medium- and High-Voltage

a. Visual and Mechanical Inspection

1. Visual and Mechanical Inspection

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, grounding, and required clearances.

4. Verify that all maintenance devices such as special tools and gauges specified by the manufacturer are available for servicing and operating the breaker.

5. Verify correct oil level in all tanks and bushings.

6. Verify that breather vents are clear.

7. Verify the unit is clean.

8. Inspect hydraulic system and air compressor in accordance with manufacturer's published data.

9. Test alarms and pressure-limit switches for pneumatic and hydraulic operators as recommended by the manufacturer.

10. Perform mechanical operation tests on the operating mechanism in accordance with manufacturer’s published data.

11. While performing internal inspection:

    (a) Remove oil. Lower tanks or remove manhole covers as necessary. Inspect bottom of tank for broken parts and debris.

    (b) Inspect lift rod and toggle assemblies, contacts, interrupters, bumpers, dashpots, bushing current transformers, tank liners, and gaskets.

    (c) Verify that contact sequence is in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use IEEE C37.04.

    (d) Fill tank(s) with filtered oil.

12. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    (e) Use of low-resistance ohmmeter in accordance with Section 7.6.2.B.1 of NETA ATS.

    (f) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.12 of NETA ATS.

    (g) Perform thermographic survey in accordance with Section 9 of NETA ATS.

14. Verify racking mechanism operation.

15. Perform contact-timing test.

16. Perform mechanism-motion analysis.

17. Perform trip/close coil current signature analysis.

18. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

19. Record as-found and as-left operation counter readings.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.6.2.A.12.1 of NETA ATS.

2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit-breaker closed, and across each open pole. Test voltage will be in accordance with

manufacturer's published data. In the absence of manufacturer's data, use Table 100.1 of NETA ATS.

3. Perform a static contact/pole resistance test.

4. Perform a dynamic contact/pole resistance test.

5. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components, follow manufacturer's recommendation.

6. Remove a sample of insulating liquid in accordance with ASTM D923. Sample will be tested in accordance with the referenced standard.

    (a) Dielectric breakdown voltage: ASTM D877

    (b) Color: ASTM D1500

    (c) Power factor: ASTM D924

    (d) Interfacial tension: ASTM D971

    (e) Visual condition: ASTM D1524

    (f) Neutralization number (acidity): ASTM D974

    (g) Water content: ASTM D1533

7. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.20 of NETA ATS.

8. Verify correct operation of any auxiliary features such as electrical close and trip operation, trip-free, antipump function.

9. Trip circuit breaker by operation of each protective device. Reset all trip logs and indicators.

10. Perform power-factor or dissipation-factor tests on each pole with breaker open and each phase with breaker closed. Determine tank loss index.

11. Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests. These tests will be in accordance with the test equipment manufacturer's published data.

12. Perform a dielectric withstand voltage test in accordance with manufacturer's published data.

13. Verify operation of heaters.

14. Test instrument transformers in accordance with Section 7.10 of NETA ATS.

3.5.1.8.5 Circuit Breakers, Vacuum, Medium-Voltage

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify that all maintenance devices such as special tools and gauges specified by the manufacturer are available for servicing and operating the breaker.

5. Verify the unit is clean.

6. Perform all mechanical operation tests on the operating mechanism in accordance with manufacturer's published data.

7. Measure critical distances such as contact gap as recommended by manufacturer.

8. Inspect bolted electrical connections for high resistance using one or more of the following methods:

   (a) Use of low-resistance ohmmeter in accordance with Section 7.6.3.B.1 of NETA ATS.

   (b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.12 of NETA ATS.

   (c) Perform thermographic survey in accordance with Section 9 of NETA ATS.

9. Verify cell fit and element alignment.

10. Verify racking mechanism operation.

11. Verify appropriate lubrication on moving, current-carrying parts and on moving and sliding surfaces.

12. Perform contact-timing test.

13. Perform trip/close coil current signature analysis.

14. Perform mechanism motion analysis.

15. Record as-found and as-left operation counter readings.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.6.3.A.8.1 of NETA ATS.

2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and

across each open pole. Test voltage will be in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.1 of NETA ATS.

3. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components, follow manufacturer’s recommendation.

4. Perform a contact/pole-resistance test.

5. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.20 of NETA ATS.

6. Verify correct operation of any auxiliary features such as electrical close and trip operation, trip-free, and antipump function.

7. Trip circuit breaker by operation of each protective device. Reset all trip logs and indicators.

8. Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed.

9. Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests. These tests will be in accordance with the test equipment manufacturer’s published data.

10. Perform magnetron atmospheric condition (MAC) test on each vacuum interrupter.

11. Perform vacuum bottle integrity (dielectric withstand voltage) test across each vacuum bottle with the breaker in the open position in strict accordance with manufacturer’s published data.

12. Perform a dielectric withstand voltage test in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.19 of NETA ATS.

13. Verify operation of heaters.

14. Test instrument transformers in accordance with Section 7.10 of NETA ATS.

3.5.1.8.6 Circuit Breakers, SF6

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify that all maintenance devices such as special tools and gauges specified by the manufacturer are available for servicing and

operating the breaker.

5. Verify the unit is clean.

6. When provisions are made for sampling, remove a sample of SF6 gas and test in accordance with Table 100.13 of NETA ATS. Do not break seal or distort “sealed-for-life” interrupters.

7. Inspect operating mechanism and/or hydraulic or pneumatic system and SF6 gas-insulated system in accordance with manufacturer’s published data.

8. Test for SF6 gas leaks in accordance with manufacturer’s published data.

9. Verify correct operation of alarms and pressure-limit switches for pneumatic, hydraulic, and SF6 gas pressure in accordance with manufacturer’s published data.

10. If recommended by manufacturer, slow close/open breaker and check for binding, friction, contact alignment, and penetration. Verify that contact sequence is in accordance with manufacturer’s published data. In the absence of manufacturer’s data, refer to IEEE C37.04.

11. Perform all mechanical operation tests on the operating mechanism in accordance with the manufacturer’s published data.

12. Inspect all bolted electrical connections for high resistance using one or more of the following methods:

    (a) Use of a low-resistance ohmmeter in accordance with Section 7.6.4.B.1 of NETA ATS.

    (b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.12 of NETA ATS.

    (c) Perform a thermographic survey in accordance with Section 9 of NETA ATS.

13. Verify the appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

14. Perform contact-timing test.

15. Perform trip/close coil signature analysis.

16. Perform mechanism motion analysis.

17. Record as-found and as-left operation counter readings.

b. Electrical Tests

1. Perform resistance measurements through all bolted connections with a low-resistance ohmmeter in accordance with Section 7.6.4.A.12.1 of NETA ATS.

2. Perform insulation-resistance tests in accordance with Table 100.1

of NETA ATS from each pole-to-ground with breaker closed and across open poles at each phase. For single-tank breakers, perform insulation resistance tests in accordance with Table 100.1 from pole-to-pole.

3. Perform a contact/pole-resistance test.

4. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components or for control devices that cannot tolerate the voltage, follow manufacturer's recommendation.

5. Perform minimum pickup voltage tests on trip and close coils in accordance with manufacturer's published data.

6. Verify correct operation of any auxiliary features such as electrical close and trip operation, trip-free, and antipump function. Reset all trip logs and indicators.

7. Trip circuit breaker by operation of each protective device.

8. Perform power-factor or dissipation-factor tests on each pole with the breaker open and on each phase with the breaker closed.

9. Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests. These tests will be in accordance with the test equipment manufacturer's published data.

10. Perform a dielectric withstand voltage test in accordance with manufacturer's publisheddata.

11. Verify operation of heaters.

12. Test instrument transformers in accordance with Section 7.10 from NETA ATS.

3.5.1.9   Motor Control, Motor Starters, Low-Voltage

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify the unit is clean.

5. Inspect contactors.

    (a) Verify mechanical operation.

    (b) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

6. Motor-Running Protection

(c) Verify overload element rating/motor protection settings are correct for application.

(d) If motor-running protection is provided by fuses, verify correct fuse rating.

7. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

8. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.16.1.1.A.7.1 from NETA ATS.

2. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with starter closed, and across each open pole. Test voltage will be in accordance with manufacturer's published data or Table 100.1 from NETA ATS.

3. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components, follow manufacturer's recommendation.

4. Test motor protection devices in accordance with manufacturer's published data. In the absence of manufacturer's data, use Section 7.9 from NETA ATS.

5. Test circuit breakers in accordance with Section 7.6.1.1 from NETA ATS.

6. Perform operational al tests by initiating control devices.

3.5.1.10 Motor Control, Motor Starters, Medium-Voltage

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify the unit is clean.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Test electrical and mechanical interlock systems for correct

operation and sequencing.

7. Verify correct barrier and shutter installation and operation.

8. Exercise active components and confirm correct operation of indicating devices.

9. Inspect contactors.

   (a) Verify mechanical operation.

   (b) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer’s published data.

10. Verify overload protection rating is correct for its application. Set adjustable or programmable devices according to the protective device coordination study.

11. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 7.16.1.2.A.5.1 from NETA ATS.

2. Perform insulation-resistance tests on contactor(s) for one minute, phase-to-ground and phase-to-phase with the contactor closed, and across each open contact. Test voltage will be in accordance with manufacturer’s published data, or Table 100.1 from NETA ATS.

3. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential will be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration will be one minute. For units with solid-state components, follow manufacturer’s recommendation.

4. Perform magnetron atmospheric condition (MAC) test on each vacuum interrupter.

5. Perform a dielectric withstand voltage test in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use Table 100.9 from NETA ATS.

6. Perform vacuum bottle integrity test (dielectric withstand voltage) across each vacuum bottle with the contacts in the open position in strict accordance with manufacturer’s published data.

7. Perform contact resistance tests.

8. Measure blowout coil circuit resistance.

9. Measure resistance of power fuses.

10. Energize contactor using an auxiliary source. Adjust armature to minimize operating vibration.

11. Test control power transformers in accordance with Section 7.1.B.8

from NETA ATS.

12. Test starting transformers, in accordance with Section 7.2.1 from NETA ATS.

13. Test starting reactors, in accordance with 7.20.3 from NETA ATS.

14. Test motor protection devices in accordance with manufacturer’s published data. In the absence of manufacturer’s data, test in accordance with Section 7.9 from NETA ATS.

15. Standard Commissioning Specifications for Electrical Power Equipment & Systems.

16. Verify operation of cubicle space heater.

17. Test instrument transformers in accordance with Section 7.10 from NETA ATS.

18. Test metering devices in accordance with Section 7.11 from NETA ATS.

3.5.1.11 Cybersecurity Installation Certification

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NOTE: Coordinate equipment certification withGovernment's cybersecurity requirements and interpretations. Select this option if the motor control includes remote control or remote access capability.

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Furnish a certification that control systems are installed in accordance with DODI 8500.01, DOD 8510.01, and as required by individual Service Implementation Policy.

3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Trip circuit breakers by operation of each protective device. Test each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, provide the Contracting Officer 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 29 01.00 10 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-26 29 01.00 10 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 26 29 01.00 10

ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE

11/22

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USACE / NAVFAC / AFCEC **UFGS-26 29 01.00 10 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-26 29 01.00 10 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 29 01.00 10

ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE

11/22

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NOTE: This guide specification covers the requirements for procurement of 3-phase vertical induction motors for driving storm-water pumps for local flood-control pumping stations. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: This section covers motors with special features of construction which are considered necessary to provide maximum insurance against failures where the motors are to be operated only for short periods of time, at infrequent intervals, and at locations where the average relative humidity of the air is high. Where operating characteristics or features of motor construction differ from this specification but are considered desirable, this specification may be modified accordingly. The

designer must also consider unusual service conditions such as direct exposure to the sun, vermin infestation, or high altitude.

In adapting this specification to any project, the form and phraseology will be changed as necessary to properly specify the work contemplated. When deviations from this specification are considered necessary, prior approval from HQ USACE will be obtained.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B344	(2020) Standard Specification for Drawn or Rolled Nickel-Chromium and

	Nickel-Chromium-Iron Alloys for Electrical Heating Elements

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 43	(2013) Recommended Practice for Testing Insulation Resistance of Rotating Machinery

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 SUMMARY

The work under this section includes providing all labor, equipment, and material and performing all operations required to design, manufacture, assemble, test, and package and deliver the vertical induction motors for driving pumps specified under Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER TYPE.

a. Supply motors complete with all accessories, spare parts, tools, and manufacturer's data and instructions as specified herein.

b. Submit complete instructions for the proper installation, inspection, and maintenance of the machines provided for this particular service. Submit instruction manuals to the Contracting Officer not later than the date the equipment is shipped from the manufacturer's plant. In the instructions, include a cross-sectional drawing indicating the major component parts of the motor and the procedure for disassembly.

c. With the instruction manual, submit a complete list of renewal parts with prices for each different rating of motor.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Long Term Storage; G, [_____]

Antireverse Device Alternate; G, [_____]

SD-02 Shop Drawings

Motors; G, [_____]

SD-03 Product Data

Insulated Windings; G, [_____]

Duty Cycle; G, [_____]

Motors; G, [_____]

Government Study

Spare Parts

SD-06 Test Reports

Starting Capabilities

Factory Tests

Acceptance Checks And Tests; G, [_____]

SD-07 Certificates

Efficiency

Factory Tests

SD-10 Operation and Maintenance Data

Instructions; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Corrosion Prevention and Finish Painting

The equipment provided under these specifications will be subjected to severe moisture conditions. Design the equipment to render it resistant to corrosion from such exposure. The general requirements to be followed to mitigate corrosion are specified below. Any additional special treatment or requirement considered necessary for any individual items is specified under the respective item. However, other corrosion-resisting treatments that are the equivalent of those specified herein may, with the approval of the Contracting Officer, be used.

1.4.1.1 Fastenings and Fittings

Where practicable, all screws, bolts, nuts, pins, studs, springs, washers, and other similar fittings must be of corrosion-resisting material or must be treated in an approved manner to render them resistant to corrosion.

1.4.1.2 Corrosion-Resisting Materials

Corrosion-resisting steel, copper, brass, bronze, copper-nickel, and nickel-copper alloys are acceptable corrosion-resisting materials.

1.4.1.3 Corrosion-Resisting Treatments

Hot-dip galvanizing must be in accordance with ASTM A123/A123M or ASTM A153/A153M as applicable. Other corrosion-resisting treatments may be used if approved by the Contracting Officer.

1.4.1.4 Frames

Clean rust, grease, millscale, and dirt from motor frames, end bells, covers, conduit boxes, and any other parts, if of steel, and if they will be coated during the process of insulating the windings. Then treat and rinse in accordance with manufacturer's standard process. If any of the above-listed parts are not coated during the process of insulating the windings then, in addition to the above, give the parts one coat of primer and then two coats of manufacturer's standard moisture-resistant coating, processed as required.

1.4.1.5 Cores

Thoroughly clean and immediately prime the assembled motor core by applying a minimum of two coats of a moisture-resisting and oil-resisting insulating compound. Give air gap surfaces a minimum of one coat.

1.4.1.6 Shafts

Clean rust, grease, and dirt from exposed surfaces of motor shafts. Except for bearing surfaces, give motor shafts one coat of a zinc molybdate or equivalent primer and two coats of a moisture-proof coating, each cured as required. Shafts of a corrosion-resisting steel may be used in lieu of the above treatment.

1.4.1.7 Finish Painting

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NOTE: If severely moist conditions exist, a separate paint system should be specified using Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES, system 21, epoxy finish or equivalent. When such painting is specified, care must be taken to specify a paint that will adhere to and not be injurious to the protective painting provided under these specifications.

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Finish painting of all equipment must be in accordance with the standard practice or recommendation of the manufacturer for the installed conditions, as approved by the Contracting Officer.

1.4.2 Government Study

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NOTE: Item d. may be used only when the pump and motor are furnished under the same procurement.

****

Submit the specified data. Supply to the Government, for completion of its Motor Torque and Accelerating Time Studies (MTATS), the following data:

a. Complete equivalent circuit data referred to the stator with friction, windage, and stray load losses.

b. Current, power factor, and torque versus speed (0-100 percent, inclusive, in 1 percent increments up to 95 percent and in 0.1 percent increments above 95 percent) and load (0-125 percent, inclusive, in 25 percent increments) as a function of line voltage (from 80 percent to 110 percent, inclusive, in 5 percent increments), for rated and 90 percent of rated voltage at starter. Only tabulated data will be required.

c. Load inertia, Wk2 of motor rotating parts, pound-foots.

[d. Load inertia, Wk2 of pump rotating parts (wet), pound-foot2.]

1.5 DELIVERY, STORAGE, AND HANDLING

Ship each motor in the vertical position with the rotor blocked inside the stator to prevent damage to the bearings. Securely mount the motor on a skid or pallet of ample size. Box all small parts or elements. Perform the skid mounting and boxing in a manner which will prevent damage or distortion to the motor during loading, shipment, unloading, indoor storage, and subsequent handling. Provide weatherproof covers as necessary to protect the motor and appurtenances during shipment. [Furnish for unloading and handling at the destination any eyebolts, special slings, strongbacks, or other devices used in loading the equipment at the manufacturer's plant, and these items must become the property of the

Government.]

[1.5.1 Impact Recorder

Ship each motor with a three-way temporary impact recorder to measure magnitude and direction of longitudinal (Y), lateral (X), and vertical (Z) impacts suffered during shipment. If the recorder indicates impacts equal to or greater than limits determined by the Contractor prior to shipment for any of the three directions specified herein, inspect and test motor to determine extent of damage, if any, and repair or replace any damaged equipment.

][1.5.2 Long Term Storage

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NOTE: Include this paragraph only when there is no available Government storage.

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Store all provided equipment provided for [_] [days][months]. The storage site must meet the manufacturer's recommendations for indoor storage. The equipment will be subject to periodic inspection by the Government to ensure that proper storage conditions are maintained. Submit the storage site description, location, description of environmental controls, and means of access.

]1.6 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies.

PART 2 PRODUCTS

2.1 NAMEPLATES

Provide nameplates for each motor with motor characteristics in accordance with NEMA MG 1. Nameplates must include rated voltage, rated full-load amperes, rated horsepower, service factor, number of phases, RPM at rated load, frequency, code letter, locked-rotor amperes, duty rating, insulation system designation, and maximum ambient design temperature.

2.2 GUARDS AND PROTECTIVE ENCLOSURES

For all moving, energized, or other parts where accidental contact might be hazardous to personnel, equip with adequate guards, rails, or other suitable enclosures to prevent accidental contact. For all lubrication fittings, pipe to convenient locations where fittings can be serviced.

2.3 MOTORS

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NOTE: For weak source (high Thevenin source impedance), the electric utility must be contacted to determine starting restrictions, maximum inrush, or voltage dip limits. This is especially critical for motors over 75kW 100 hp. The designer must then perform a Motor Torque and Accelerating Time Study (MTATS) to evaluate the motor starting torque and voltage dip requirement. The selection of a reduced voltage starter must then be based on the

electric utility requirements and the motor pump arrangement.

NEMA MG 1, Part 31, covers definite purpose inverter-fed polyphase motors rated 5000 horsepower or less at 7200 volts or less. If the designer determines the need to specify inverter-duty motors; due to constant torque requirements, a speed range beyond standard duty nameplate, where speed synchronization or other reasons, the designer must ensure the motor meets specifications in NEMA MG 1 Part 31.

****

The motors to be supplied under these specifications must be of the vertical shaft type as required by the pump manufacturer, normal or low starting torque, low starting current, squirrel-cage induction type, designed for full voltage starting, of drip-proof construction, and conforming to the applicable requirements of NEMA MG 1, except as hereinafter specified.

a. Submit equipment foundation dimensions; outline drawings with weights, nameplate data, and details showing method of mounting and anchoring the motor. Obtain Contracting Officer's approval in writing prior to the commencement of manufacture of motors.

b. Submit complete descriptive specification of each type and size motor provided, with necessary cuts, photographs, and drawings to clearly indicate the construction of the motor, the materials and treatments used to prevent corrosion of parts, bearing construction, and type of insulation used on all windings.

c. Submit all information required for selection of protective and control equipment and for operational setting, such as, but not limited to, normal and maximum operation temperature for windings and bearings, overload trip setting for motor at pump maximum head condition and starting times for starting at rated and 90 percent starter voltage.

2.3.1 Rating

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NOTE: NEMA MG 1, Parts 10 and 20, cover medium and large induction motors, respectively. Any motor specified by speed and horsepower will be included in either Part 10 or Part 20. References to both parts are listed in some cases, as either or both parts may apply to a particular project.

Consult the local electric utility for the expected voltage unbalance that will be present. If the value exceeds 1 percent, ask the utility to furnish their plans to improve the voltage unbalance. Use NEMA MG 1 to derate the motor if the voltage unbalance exceeds 1 percent. Voltage unbalance must not exceed 5 percent. Consult motor manufacturers for voltage unbalance limits whenever motors have specified limits on locked-rotor currents, particularly the 500-percent limit.

****

Wind each motor for three-phase, 60-Hz, alternating current, and for the respective operating voltage listed below:

PLANT	PUMP	SERVICE	MOTOR OPERATING VOLTAGE
[_____]	[_____]	[_____]	[_____]
[_____]	[_____]	[_____]	[_____]

Design the motor for operation in a 40 degrees C 105 degrees Fambient temperature, and all temperature rises must be above this ambient temperature. The rated horsepower of the motor must be not less than 110 percent of the determined maximum load requirement of the pump. [Supply voltage unbalance will be [_] percent, and the motor must provide the indicated horsepower after the voltage unbalance derating of NEMA MG 1 paragraph 20.24.]Motors must have a service factor of 1.0 or must be applied using a service factor of 1.0 if standard service factor is greater than 1.0. The temperature rise above the ambient temperature for continuous rated full-load conditions and for the class of insulation used must not exceed the values given in NEMA MG 1, paragraph 12.42 or paragraph 20.8.

2.3.2 Operating Characteristics

2.3.2.1 Torques

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NOTE: The "Operating Characteristics" specified are to limit the locked-rotor current to a value sufficiently low to permit full-voltage starting. Manufacturer's standard is to limit locked-rotor current to 600 percent of design full-load current. However, if local conditions are such that lower starting current is desirable, the locked-rotor current may be specified not to exceed 500 percent of the design full-load current. When 500 percent is specified, the breakdown torque of 150 percent of full-load torque will be used. The designer will note that these percentages are for design full-load current at rated power factor and will vary based on actual load and supply conditions. Designer should consult local utility for actual requirements for limitations on inrush currents. When inrush current cannot be sufficiently limited by motor design, a reduced voltage starter will be used.

When reduced voltage starting is required, closed transition autotransformer type reduced voltage starters should be used. These starters provide the most flexibility during installation since both input voltage and inrush current may be adjusted.

This specification is not meant to limit the selection of a reduced voltage starter to only autotransformer type. The use of a wye-delta or solid-state type starter may be appropriate in certain situations. The reduced starter cost for

use of other than autotransformer type starters must be weighed against the increased cost in motor designs; however each design should be evaluated for the most suitable type starter. All reduced voltage starters will reduce the motor starting torque, so the designer should evaluate the load characteristics to ensure that motor torque will be sufficient under all starting conditions. If reduced-kVA starters are required, EM 1110-2-3105 should be consulted for further guidance and possible pump design considerations.

****

Starting torque must be sufficient to start the pump to which the motor will be connected under the maximum conditions specified, but in no case must the starting torque be less than 60 percent of full-load torque. Breakdown torque must be not less than [200] [150] percent of full-load torque.

2.3.2.2 Locked-Rotor Current

****

NOTE: The objective of this specification is to limit the locked-rotor current to a value sufficiently low to permit full-voltage starting. The motor horsepower rating is to be a minimum of 110 percent of the maximum pump load at a service factor of 1.0. Manufacturer's standard is to limit locked-rotor current to 600 percent of full load current. However, local utilities may have additional limitations on inrush currents and should be consulted to supply information requried in this paragraph. Motor design will permit some reduction in inrush current in which case 500 percent should be used. If this is not sufficient, reduced-voltage starting should be used. The inrush current limit should be specified whenever possible. The requirements for locked-rotor current (inrush) must be coordinated with power factor and efficiency requirements below.

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The locked-rotor current must not exceed [600] [500] percent of normal full-load running current. [The locked-rotor current must not exceed [_____] amps at 90 percent of rated voltage during any point in the starting cycle under worst case starting conditions. For reduced voltage starting, apply the above criteria to supply side of the starter.]

2.3.2.3 Starting Capabilities

****

NOTE: Frequency of starting must always be considered in motor applications. The starting capabilities to be met by all motors are set forth below. However, the actual motor duty cycle should be specified in paragraph DUTY CYCLE, along with the requirement for the special motor starting nameplate. Undoubtedly, these starting capabilities will be adequate in most cases since the actual load

inertia, WK2 of the pumps is much less than the NEMA values, the load torque is low, and the frequency of starting (number of starts per unit of time) is low. When the frequency of starting is several times per hour, or the load torque is high, a thorough study and perhaps a modified motor may be required. To ensure that all requirements of the specifications are met, submittal of the operating data should be required. It is possible that with higher starting frequencies the rotor may have to operate at temperatures higher than typical, so that modifications would be required.

****

Large motors, on the basis of the load torque characteristics and the load inertia Wk2 listed in NEMA MG 1, paragraphs 20.10 and 20.11, must as a minimum be capable of making the starts required in NEMA MG 1, paragraph 20.12. Smaller motors must conform to the requirements in NEMA MG 1, paragraph 12.54. Submit certified test reports, when available, of tests previously performed on motors of each type and size specified or calculated data to substantiate the motor's capability to conform to the specified requirements.

2.3.2.4 Duty Cycle

Submit an analysis to verify that the motor, when operated in accordance with the duty cycle specified, will not undergo injurious temperature rise. If the duty cycle cannot be met with a standard NEMA design motor, the motor manufacturer must provide a description of proposed modifications to provide such compliance. Each motor, when operating at rated voltage and frequency and on the basis of the connected pump load inertia Wk2 and the speed-torque characteristics of the load during starting conditions as furnished by the pump manufacturer, must be capable of performing on a continuous basis the following motor duty cycle without injurious temperature rise: [operation at rated load over a period of approximately [_____] [hours] [days]] [a running period at rated load of not less than [_____] [minutes] [hours] and a standstill period of not less than [_____] [minutes] [hours].] Provided on each motor a starting information nameplate setting forth the starting capabilities. This nameplate must also include the minimum time at standstill and the minimum running time prior to an additional start.

2.3.2.5 Balance

The balance for each motor when measured in accordance with NEMA MG 1, Part 7, must not exceed the values specified. [Each motor's characteristics must meet the provisions of Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE.]

2.3.2.6 Noise

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NOTE: The Department of Defense (DoD) considers hazardous noise exposure of personnel as equivalent to 85 decibels or greater A-weighted sound pressure level (dBA) for 8 hours in any one 24-hour period. On the assumption that pumping plant operating personnel may be exposed to noise levels approaching or exceeding that defined by the DOD as hazardous,

the motor noise limit should be specified not to exceed 85 dBA. The additional cost of providing motors meeting this requirement should be investigated and weighed against an alternate of providing a room to isolate these personnel from the noise exposure.
****

All motors must operate at a noise level less than 85 decibels A-weighted mean sound pressure level (dBA). Determine noise in accordance with NEMA MG 1 Part 9. The specified noise limit applies for a reference distance of one meter for free-field conditions.

2.3.2.7 Efficiency

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NOTE: The Energy Policy Act of 2007 (as amended) requires NEMA MG 1 premium efficiency for many general purpose electric motors up to 200 HP. Close-coupled pump motors up to 200 HP and NEMA Design B motors from 200 HP up to 500 HP must be NEMA MG 1 energy efficient.

Energy efficient: NEMA MG 1, Table 12.11
Premium efficient: NEMA MG 1, Table 12.12
****

The tested full load efficiency must meet or exceed the minimum value listed in NEMA MG 1 Table 12.[11][12]. The nameplate full load efficiency must meet or exceed the nominal value listed in NEMA MG 1 Table 12[11][12].

2.3.3 Frames and Brackets

Frames and end brackets must be of cast iron, cast steel, or welded steel. The mounting ring, unless otherwise approved, must be built integral with the frame or lower end bracket and arranged for direct mounting on the pump, or station floor, or as required by the installation conditions. Treatment against corrosion must be as specified in paragraph QUALITY ASSURANCE.

2.3.3.1 Stator Frame

The stator frame must be rigid and sufficiently strong to support the weight of the upper bearing bracket load, the weight of the stator core and windings, and to sustain the operating torques without perceptible distortion. Support the stator frame, if not directly mounted on the pump, on a motor base or drive pedestal which in turn will be supported on sole plates or other suitable structure installed in the concrete foundation constructed as part of the pumping station structure. Provide the motor base or drive pedestal with bolts and dowels for fastening to the sole plates or supporting structure for preserving the alignment.

2.3.3.2 Supporting Bracket

The upper bracket supporting the thrust bearing and upper guide bearings must have sufficient strength and rigidity to support the weight of the entire rotating element of the motor, together with the pump impeller and shaft, and the hydraulic thrust of the pump impeller.

[2.3.3.3 Overspeed Alternate

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NOTE: NEMA MG 1 paragraphs 12.48 and 20.44 specify that overspeeds are for emergencies lasting no longer than two minutes. Using this option will add costs due to requirements well beyond standard limits.
****

Design each motor to withstand indefinitely, without injury, the maximum overspeed to which the motor will be subjected when the pump to which it is connected is acting as a hydraulic turbine under the maximum head with the pump discharge pipe open.

]2.3.3.4 Antireverse Device Alternate

Installed as an integral part of the motor a self-actuated backstop device or antireversing ratchet, to prevent reverse rotation of the pump due to loss of power or failure of the electric prime mover. Submit the design of the device for approval by the Contracting Officer. The design must have sufficient capacity to prevent reverse rotation with a back-flow through the pump due to a [____] foot differential head. If the device requires a lubrication system, provide an oil reservoir independent of the one used for the thrust bearing and complete with visible oil level gauge and 120-volt a.c. rated high and low level contacts. Terminate all electrical leads in the accessory terminal box specified in paragraph MOTOR TERMINALS AND BOXES. The lubricant for the antireverse device must contain a corrosion inhibitor. Show the type and grade of lubricant on a special nameplate attached to the frame adjacent to the lubricating filling device.

2.3.3.5 Eyebolts

Provide eyebolts, lugs, or other approved means for assembling, dismantling, and removing the motor, if required, from above using an overhead crane. Provide with the motor all lifting devices required for use in conjunction with the crane.

2.3.4 Cores

The cores for the stators and rotors must be built up of separately punched thin laminations of low-hysteresis loss, nonaging, annealed, electrical silicon steel, assembled under heavy pressure, and clamped in such a manner as to ensure that the assembled core is tight at the top of the teeth of the laminated core. Properly insulate laminations from each other. Use only laminations free from burrs, and remove all burrs or projecting laminations from the slots of the assembled cores. Cores must be keyed, dovetailed, or otherwise secured to the shaft or frame in an approved manner. Treatment against corrosion must be as specified in paragraph QUALITY CONTROL.

2.3.5 Insulated Windings

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NOTE: If motor temperature rise is of particular concern, the designer may specify Class F insulation with a Class B temperature rise instead of Class F insulation with 110 percent continuous overload factor. Use final sentence of item f. only when the

pump and motor are furnished under the same procurement.
****

All motors must have a nonhygroscopic, sealed, fungus-resisting insulation of a type designed and constructed to withstand severe moisture conditions, and insofar as practicable, to operate after long periods of idleness without previous drying out. All windings and connections must be of the sealed type as defined in NEMA MG 1 paragraph 1.27.2. If, in the opinion of the Contracting Officer, the insulation proposed is not of the quality specified, the motors will not be accepted. Submit motor design curves and motor speed-torque curves, as specified. Unless otherwise approved, completely assemble insulated windings in the motor core before impregnating with the insulating compound. The compound must consist of 100 percent solid resin.

a. Impregnation of the windings with the insulating compound must be by vacuum impregnation method followed by baking. Repeat the procedure as often as necessary to fill in and seal over the interstices of the winding, but in no case must the number of dips and bakes be less than two dips and bakes when the vacuum method of impregnation is used. The completed stator must be of a type that is capable of passing the submerged or sprayed water test, as applicable, required by NEMA MG 1 paragraph 12.62 and 20.18.

b. Random wound coils may be used on motors supplied in NEMA frame size 445 TP and smaller. The components of the insulation system and the conductor insulation of the coils must be Class F insulation with a 1.15 service factor as defined in NEMA MG 1 paragraph 1.66. After winding, encapsulate the completely wound stator with an insulating resin as defined in NEMA MG 1 paragraph 1.27.1.

c. Use form wound coils on motors supplied in NEMA frames larger than 445 TP. The components of the insulation system and the coil insulation of the rectangular conductors must conform to Class F insulation with a 110 percent continuous overload factor as defined in NEMA MG 1, paragraph 1.66. The completed stator windings and connections must be of the sealed type as defined in NEMA MG 1paragraph 1.27.2.

d. Insulation to ground must be processed on the coil. Slot tubes or cells are not acceptable. The insulation must be of adequate thickness and breakdown strength throughout the length of the coil. Use mica in the slot portion, and mica must be of adequate thickness to withstand the dielectric tests specified in paragraph FACTORY TESTS. Form wound coils must be of such uniformity that the stator windings on motors of equal ratings must be alike, in shape and size, and be interchangeable.

e. Submit motor design (characteristic) curves or tabulated data (test or calculated), indicating the speed, power factor, efficiency, current, and kilowatt input, all plotted or tabulated against torque or percent load as abscissa. The base value must be given whether ANSI or IEEE standard system is used. Provide the maximum allowable reverse rotation speed for the motor.

f. Submit [pump and] motor speed-torque curves for the pump starting operation. Plot the motor speed-torque curves for the following values of voltage at the motor terminals: The output of the [closed transition auto-transformer-type reduced voltage] [_____] starter supplied at rated and 90 percent of rated motor voltage [and connected on its 65 percent and 80 percent taps]. [Plot the pump torque curve for starting and accelerating against maximum head. Furnish computations to demonstrate that the motor furnished will carry the pump load under all the foregoing conditions.]

g. Coils of all windings must be fully braced so that vibration is virtually eliminated during repeated starts as required by the duty cycle specified as well as during normal operation. If a tied system is used it must be such that no tie depends upon the integrity of any other tie within the system.

2.3.6 Thermal Protection

For motors rated 6000 hp or greater, provide resistance temperature detectors (two per phase) in accordance with NEMA MG 1, paragraph 20.27. Detectors must have a copper resistance element having a resistance of 10 ohms at 25 degrees C 76 degrees F. Terminate leads on the terminal blocks specified in paragraph MOTOR TERMINALS AND BOXES. For motors rated less than 6000 hp, embed resistance temperature dectors (one per phase) in the windings. The detectors with all necessary additional equipment, as required, must prevent motor operation when the critical temperature is reached. Terminate all outgoing wiring on the terminal blocks specified in paragraph MOTOR TERMINALS AND BOXES.

2.3.7 Winding Heaters

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NOTE: The inclusion or omission of "Winding Space Heaters" will depend upon the decision reached after giving due consideration to the problem of prevention of moisture condensation on the station equipment. If winding space heaters are not required, this paragraph, including all subparagraphs, must be deleted.

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Wrap heaters around the winding end turns. Designate heaters for operation on 120 volts, 1-phase, 60 Hz, alternating current and of sufficient capacity or wattage that, when energized, they will hold the temperature of the motor windings approximately 10 degrees C above the ambient temperature. Design heaters for continuous operation and to withstand at least 10 percent overvoltage continuously. The rate of heat dissipation must be uniform throughout the effective length of the heater. Heaters installed around the winding end turns must consist of the required turns of heating cable wrapped around the end turns and secured in place before the winding is impregnated.

2.3.7.1 Heating Element

Heating element must conform to the requirements of ASTM B344 for an 80 percent nickel and 20 percent chromium alloy.

2.3.7.2 Sheath

Sheath must be of a corrosion-resisting, nonoxidizing metal and must have a wall thickness not less than 0.625 mm 0.025 inch.

2.3.7.3 Insulation

Insulation must be a granular mineral refractory material, highly resistant to heat, and must have a minimum specific resistance of 1,000 megohms per inch cubed at 535 degrees C 1,000 degrees F. Insulation for the heating cable (winding wraparound type) type heaters must be suitable for a conductor temperature of 180 degrees C 356 degrees F.

2.3.7.4 Terminals

Terminals of the heater, including the leads, must be watertight. Provide heater terminals with leads suitable for making connections to the drip-proof terminal box provided in paragraph MOTOR TERMINALS AND BOXES. [The terminal box must be readily accessible through the crating so that winding heaters can be energized while motors are in storage.]

2.3.8 Shafts

****

NOTE: Hollow shaft pumps must be used whenever possible, since they are more readily adjusted. Pumps requiring large motors (above 746 kW 1,000 hp) are limited by the available motors. The exact motor capabilities and sources of supply must be investigated when using hollow shafts with motors above 746 kW 1,000 hp. Solid shafts must be used only when the available motor designs require their use.

****

Shafts must be made of high grade steel, finished all over, and of ample size to drive the pumps under maximum load conditions. Shafts must be of [hollow] [solid] types as required by the pump manufacturer. See paragraph QUALITY ASSURANCE for treatment against corrosion. Coordinate the connection with the pump shaft.

2.3.9 Bearings

2.3.9.1 Loading

Bearings must be capable of withstanding all stresses incidental to the normal operation of the unit [and the maximum speed of the pumping unit when operating in the reverse direction].

2.3.9.2 Thrust Bearings

****

NOTE: If the thrust requirements exceed the standard published ratings of commercially available anti-friction thrust bearings, plate-type bearings should be used. Should this condition exist, a specification for plate-type bearings may be obtained from CDR USACE (DAEN-CWE-E) WASH DC 20314.

****

Thrust bearings must be of the antifriction type of either the ball or roller type. Do not use tandem or series bearing assemblies. Antifriction bearings must conform to the requirements of ABMA 9 an d ABMA 11.

2.3.9.3 Guide Bearings

Guide bearings must be of the sleeve or antifriction type of either the ball or roller type or a combination of sleeve and antifriction bearings.

2.3.9.4 Lubrication

Bearings must be either oil or grease lubricated, and the lubricant used must contain a corrosion inhibitor. Show the type and grade of lubricant used on a special nameplate which must be attached to the frame of the motor adjacent to the bearing lubricant filling device. In addition to the quantity of lubricant required to fill each motor's lubricating system initially, provide spare lubricant in sufficient quantity to purge and refill each motor's lubricating system.

2.3.9.5 Bearing Housings

Bearing housings must be of a design and method of assembly that will permit ready removal of the bearings, prevent escape of lubricant and entrance of foreign matter, and protected by the lubricant when the motor is idle. Except for prelubricated antifriction bearings of an approved type, provide suitable means to apply and drain the lubricant. For oil-lubricated bearing housings, provide readily visible oil-level indicator gauges.

2.3.9.6 Cooling

All bearings must be self-cooling unless otherwise specifically approved by the Contracting Officer. If the use of cooling is approved, the means employed must, unless otherwise approved by the Contracting Officer, require no auxiliary pumping equipment; and provide suitable means to indicate the bearing temperature, actuate an alarm when the bearing temperature is above normal, and actuate a device to shut down the motor when the maximum safe operating temperature of the bearing is reached. Cooling coils must be of copper tubing and designed for the operating pressure used to circulate the cooling water. Cooling water temperature will be [_____] degrees C.

2.3.9.7 Rating

Antifriction bearings must be rated on the basis of a minimum life factor of 8,800 hours, based on the life expectancy of 90 percent of the group, unless otherwise approved by the Contracting Officer.

2.3.9.8 Shaft Currents

Insulate or otherwise protect bearings against the damaging effects of shaft currents.

2.4 SURGE PROTECTION

2.4.1 Surge Capacitors

****

NOTE: To obtain the most reliable protection for 2,300- and 4,000-volt motors, surge capacitors and arresters, mounted at the motor terminals, should be specified. In addition, it is recommended that station-type arresters be installed on the line side

of the supply transformers. For 480-volt systems, surge protection is not generally warranted if the station system is connected to the utility line through a transformer which has adequate surge protection on the high side. Each 480-volt installation should be investigated, however, to determine whether surge protection is required, especially where excessive switching voltages may occur or where the lightning incidence rate is high.
****

Provide a three-pole capacitor unit, equipped with built-in discharge resistors and using a non-polychlorinated biphenyl (PCB) insulating medium, in the main terminal box. Each pole must be rated [0.5 microfarad and [2,400] [4,160] volts line-to-line] [1.0 microfarad and 650 volts line-to-line]. Provide removable bus links for motor testing. These links must be treated to resist corrosion, designed to maintain a positive contact, and have low contact resistance.

2.4.2 Surge Arresters

****
NOTE: Arrester maximum continuous operating voltage (MCOV) rating must be 3,000 volts line-to-ground for 2,400-volt systems and for effectively grounded 4,160-volt systems, 4,500 volts line-to-ground operating voltage for ungrounded or resistance-grounded 4,160-volt systems, or other ratings as required. An effectively grounded system is defined as one in which X0/X1 is positive and less than 3 and R0/X1 must be positive and less than 1 for all system conditions at the point of application of the surge arrestor.
****

In the main terminal box, provide surge arresters of the station type with porcelain tops. The arresters must be of the metal-oxide type rated [3,000] [4,500] [_____] volts maximum continuous operating voltage (MCOV) line-to-ground. Provide removable bus links for motor testing. These links must be treated to resist corrosion, designed to maintain a positive contact, and have low contact resistance.

2.4.3 Space Heater

If recommended by the surge protection manufacturer, provide a space heater of adequate capacity and rated 120 volts. Space heaters must have a maximum watt density of 20 watts per square inch.

2.5 MOTOR TERMINALS AND BOXES

2.5.1 Stator Terminal Box

Supply drip-proof cast iron or steel conduit terminal boxes, treated as specified for frames in paragraph QUALITY ASSURANCE, for housing the stator lead connections [surge capacitors] [and surge arresters]. Boxes must have adequate space to facilitate the installation and maintenance of cables and equipment. Boxes must have a [bolted] [hinged securable] cover providing unrestricted access, be mounted on the motor frame, and have an auxiliary floor supporting structure, when required, supplied by the motor manufacturer. Conduit entrance must be from the bottom. Design the boxes to permit removal of motor supply leads when the motor is removed. [Provide a "HIGH VOLTAGE - [_____] VOLTS" warning sign on the cover of the box.] [When looking down on the motor/pump assembly, the terminal box must be located between [_____] degrees and [_____] degrees clockwise from the discharge elbow of the pump.]

2.5.2 Stator Terminals

Insulated terminal leads must receive a treatment equal to that of the motor winding. Bring leads out of the stator frame and provide with terminal lugs for connection to the motor supply wiring.

2.5.3 Grounding

In the stator terminal box, provide a ground bus and means for external connection to the station grounding system when surge protection is provided.

2.5.4 Accessory Leads and Boxes

Bring terminal leads for motor winding space heaters, [surge protection equipment space heater], [resistance temperature detectors] [thermistors] and any other auxiliary equipment into conveniently located terminal boxes. Provide terminal leads with terminal blocks for extension by others. The terminal boxes must be drip-proof and treated as specified for frames in paragraph GENERAL REQUIREMENTS. All auxiliary wiring must be stranded copper conductors with 600-volt flame-retardant insulation, except temperature detector leads may be in accordance with the manufacturer's standard practice. Legibly and accurately identify all wiring and terminals.

2.6 WRENCHES, TOOLS, AND SPECIAL EQUIPMENT

Provide all nonstandard and special equipment required for dismantling, reassembly, and general maintenance of the motor units. Provide one complete set of lifting attachments such as detachable eyebolts or special slings for handling various parts with a hoist.

2.7 FACTORY TESTS

****

NOTE: The designer should carefully consider whether to allow the Contracting Officer to waive these tests. Decision should be based on expertise in the field within the Division or District.

****

Give one motor of each rating type, selected at random by the Contracting Officer, a complete test. Give the remaining motors a check test.

a. Submit test reports recording all data obtained during the tests specified to the Contracting Officer for each motor used. Test reports must include performance curves indicating the results of subparagraph COMPLETE TEST below.

b. Submit certified results of a "Complete Test" for duplicate equipment. It will be accepted in lieu of the "Complete Test" as specified in subparagraph COMPLETE TEST below for equipment of the respective rating and type.

c. No substitute will be accepted for the "Check Test." The base value must be given whether ANSI or IEEE standard system is used. All complete tests must be [witnessed by the Contracting Officer] [unless waived in writing].

2.7.1 Complete Test

A complete test of a motor must include the following:

2.7.1.1 Excitation Test

Including a plot of volts as abscissa versus amperes and watts as ordinates.

2.7.1.2 Impedance Test

Including a plot of volts as abscissa versus amperes and watts as ordinates.

2.7.1.3 Performance Test

Including a plot of torque or percent load as abscissa versus efficiency, power factor, amperes, watts, and RPM or percent slip as ordinates.

2.7.1.4 Speed-Torque Test

Pony brake or other equivalent method. Including a plot of torque in foot-pounds as abscissa versus speed in RPM as ordinate.

2.7.1.5 Temperature Test

Made on completion of paragraph c above. (If screens are provided over openings, test will be made with screens removed and by thermometer).

2.7.1.6 Insulation Resistance-Temperature Test

Perform the test after a heat run, readings being taken at approximately 10 degrees C intervals. Determine temperature by the resistance method. Plot test result values on semilogarithmic graphs, the insulation resistance values as logarithmic ordinates, and the temperature values as uniform abscissas. For comparison purposes, on the same sheet with the insulation resistance-temperature test curve, plot a curve indicating the safe operating value of insulation resistance.

2.7.1.7 Cold and Hot Resistance Measurement

2.7.1.8 Dielectric Test

2.7.1.9 Sound Level Test

In accordance with EM 385-1-1.

2.7.1.10 Vibration Measurement

In accordance with NEMA MG 1 Part 7.

2.7.1.11 Conformance Tests

In accordance with NEMA MG 1 paragraph [12.62][12.63][20.18].

2.7.2 Check Test

A check test of a motor must include the following:

2.7.2.1 Routine Test

Test in accordance with NEMA MG 1 paragraph [12.55][20.16.2][31.6.2].

2.7.2.2 Cold Resistance Measurement

2.7.2.3 Insulation Resistance and Winding Temperature

Insulation resistance and winding temperature at time the insulation resistance was measured.

[2.7.2.4 Conformance Test

In accordance with NEMA MG 1 paragraph [12.62][12.63][20.18].

]2.7.2.5 Vibration

Vibration measurement in accordance with NEMA MG 1 Part 7.

2.7.3 Form Wound Coil Test

Test all form wound coils, either before or after they are placed in the slots, for short circuits between turns of the individual coils by applying a high frequency voltage of not less than 75 percent of the voltage for which the machine is insulated, or by applying a surge test voltage of equivalent value to the terminals of each coil. Equivalent surge voltage must be a wave whose peak value is equal to 1.06 times the voltage for which the motor is insulated.

2.7.4 Winding Space Heater Test

****

NOTE: Include this test only where winding space heaters are specified.

****

At the factory, test each winding space heater unit for successful operation and dielectric strength.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

Perform the following acceptance checks and tests in accordance with NETA ATS section 7.15.1.

3.1.1 Visual and Mechanical Inspection

(1) Compare equipment nameplate data with drawings and specifications.

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, and grounding.

(4) Inspect air baffles, filter media, stator winding, stator core, rotor, cooling fans, slip rings, brushes, brush rigging, and bearings.

(5) Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Correct values which deviate by more than 50 percent of the lowest value.

(6) Verify the application of appropriate lubrication and lubrication systems.

(7) Verify that resistance temperature detector (RTD) circuits conform to drawings.

3.1.2 Electrical Tests

(1) Perform insulation-resistance tests in accordance with IEEE 43. Test duration must be [10 minutes][one minute]. The [polarization index][dielectric-absorption ratio] must be at least [2.0][1.4].

(2) Perform insulation-resistance test on insulated bearings in accordance with manufacturer's published data.

(3) Test surge protection devices.

(4) Test motor starter.

(5) Perform resistance tests on resistance temperature detector (RTD) circuits.

(6) Verify operation of machine space heater.

... -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 29 02.00 10 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-26 29 02.00 10 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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ELECTRIC MOTORS, 3-PHASE VERTICAL SYNCHRONOUS TYPE

11/22

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USACE / NAVFAC / AFCEC **UFGS-26 29 02.00 10 (November 2022)**

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****

SECTION 26 29 02.00 10

ELECTRIC MOTORS, 3-PHASE VERTICAL SYNCHRONOUS TYPE

11/22

****
NOTE: This guide specification covers the requirements for the procurement of three-phase vertical synchronous motors, 1118 kW 1500 horsepower and above, for driving storm-water pumps for local flood-control pumping stations. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: This Section covers motors with special features of construction which are considered necessary to provide maximum insurance against failures where the motors are to be operated only for short periods of time, at infrequent intervals, and at locations where the average relative humidity of the air is high. Where operating characteristics or features of motor construction are different from those normally specified, this specification must be modified accordingly. The designer must also

consider unusual service conditions such as direct exposure to the sun, vermin infestation, or high altitude.

In adapting this specification to any project, the form and phraseology will be changed as necessary to properly specify the work contemplated. When deviations from this specification are considered, necessary prior approval from HQUSACE will be obtained.

Instructions for Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE, specify that Section 4 of Part IV, Technical Provisions, be reserved for insertion of the technical provisions of this guide specification.

The following should be included in section "L" of standard form 36, Information to Bidders.

"It is preferred that the field poles be secured to the rotor structure by means of dovetails, but an alternate method of construction will be acceptable, provided that evidence of its adequacy, satisfactory to the Contracting Officer, is submitted with the bid."

The designer should consider prequalifying the bidders based on past experience with this type and size of motor. Criteria for qualifying should be included in section "L" of standard form 36.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B344	(2020) Standard Specification for Drawn or Rolled Nickel-Chromium and Nickel-Chromium-Iron Alloys for Electrical Heating Elements

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 43	(2013) Recommended Practice for Testing Insulation Resistance of Rotating Machinery
IEEE 115	(2019) Guide for Test Procedures for Synchronous Machines: Part I Acceptance and Performance Testing; Part II Test Procedures and Parameter Determination for Dynamic Analysis
IEEE C37.96	(2012) Guide for AC Motor Protection
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA MG 1	(2021) Motors and Generators

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Motors; G, [_____]

SD-03 Product Data

Insulated Windings; G, [_____]

Witness Test; G, [_____]

Motors; G, [_____]
Government Study

Spare Parts

Antireverse Device; G, [_____]

SD-06 Test Reports

Factory Tests

Acceptance Checks And Tests; G, [_____]

SD-07 Certificates

Power Factor and Efficiency

Factory Tests

Complete Test

Check Tests

SD-10 Operation and Maintenance Data

Manufacturer's Data and Instructions; G, [_____]

[Long Term Storage; G, [_____]]

1.3 QUALITY ASSURANCE

1.3.1 Corrosion Prevention and Finish Painting

The equipment provided under these specifications will be subjected to severe moisture conditions. Design and construct the equipment to render it resistant to corrosion from such exposure. The general requirements to be followed to mitigate corrosion are specified below. Any additional special treatment or requirement considered necessary for any individual items is specified under the respective item. However, other corrosion-resisting treatments that are the equivalent of those specified herein may, with the approval of the Contracting Officer, be used.

1.3.1.1 Corrosion-Resisting Materials

Corrosion-resisting steel, copper, brass, bronze, copper-nickel, and nickel-copper alloys are acceptable corrosion-resisting materials.

1.3.1.2 Corrosion-Resisting Treatments

Hot-dip galvanizing must be in accordance with ASTM A123/A123M or ASTM A153/A153M as applicable. Other corrosion-resisting treatments may be used if approved by the Contracting Officer.

1.3.1.3 Frames

Clean rust, grease, millscale, and dirt from motor frames, end bells, covers, conduit boxes, and any other parts, if of steel, and if they will be coated during the process of insulating the windings. Then treat and rinse in accordance with manufacturers' standard process. If any of the above-listed parts are not coated during the process of insulating the windings then, in addition to the above, give them two coats of primer and then two coats of manufacturers' standard moisture-resistant coating, processed as required.

1.3.1.4 Cores

Thoroughly clean and then immediately prime the assembled motor core by applying a minimum of two coats of a moisture-resisting and oil-resisting insulating compound. Give air gap surfaces a minimum of one coat.

1.3.1.5 Shafts

Clean rust, grease, and dirt from exposed surfaces of motor shafts. Except for bearing surfaces, give one coat of a zinc molybdate or equivalent primer and two coats of a moisture-proof coating, each cured as required. Shafts of a corrosion-resisting steel may be used in lieu of the above-mentioned treatment.

1.3.1.6 Finish Painting

****
NOTE: If severely moist conditions exist, a separate paint system should be specified using Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES, system 21, epoxy finish or equivalent. When such painting is specified, care must be taken to specify a paint that will adhere to and not be injurious to the protective painting provided under these specifications.
****

Finish painting of all equipment in accordance with the standard practice or recommendation of the manufacturer for the installed conditions, as approved by the Contracting Officer.

1.3.1.7 Fastenings and Fittings

Where practicable, all screws, bolts, nuts, pins, studs, springs, washers, and other similar fittings must be of corrosion-resisting material or must be treated in an approved manner to render them resistant to corrosion.

1.3.2 Government Study

****
NOTE: Item d. may be used only when the pump and motor are furnished under the same procurement.
****

Submit the specified data. Supply to the Government, for completion of its Motor Torque and Accelerating Time Studies (MTATS), the following data:

a. Complete equivalent circuit data referred to the stator with friction, windage, and stray load losses.

b. Current, power factor, and torque versus speed (0-100 percent, inclusive, in 1 percent increments up to 95 percent and 0.1 percent increments above 95 percent) and load (0-125 percent, inclusive, in 25 percent increments) as a function of line voltage (from 80 percent to 110 percent, inclusive, in 5 percent increments), for rated and 90 percent of rated voltage at starter. Only tabulated data will be required.

c. Load inertia, Wk2 of motor rotating parts, pound-foot2.

[d. Load inertia, Wk2 of pump rotating parts (wet), pound-foot2.]

1.4 DELIVERY, STORAGE, AND HANDLING

Ship each motor in the vertical position with the rotor blocked inside the stator to prevent damage to the bearings. Securely mount the motor on a skid or pallet of ample size. Box all small parts or elements. Perform the skid mounting and boxing in a manner which will prevent damage or distortion to the motor during loading, shipment, unloading, indoor storage, and subsequent handling. Provide weatherproof covers as necessary to protect the motor and appurtenances during shipment. [Furnish for unloading and handling at the destination any eyebolts, special slings, strongbacks, or other devices used in loading the equipment at the manufacturer's plant. Devices must become the property of the Government.]

1.4.1 Impact Recorder

Ship each motor with a three-way temporary impact recorder to measure magnitude and direction of longitudinal (Y), lateral (X), and vertical (Z) impacts suffered during shipment. If the recorder indicates impacts equal to or greater than those determined by the Contractor prior to shipment for any of the three directions specified herein, inspect and test motor to determine extent of damage, if any, and repair or replace any damaged equipment.

[1.4.2 Long Term Storage

****

NOTE: The designer will include this paragraph only when there is no available Government storage. The designer should also investigate storage to be used by the installation Contractor and the possibility of making this a requirement under the installation contract.

****

Store all equipment provided under this contract for [_____] [days] [months]. The storage site must meet the manufacturer's recommendations for indoor storage. The equipment will be subject to periodic inspection by the Government to ensure that proper storage conditions are maintained. Submit the storage site description, location, description of environmental controls, and means of access.

]1.5 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies.

1.6 EXTRA MATERIALS

Furnish the following spare parts for each type and rating in addition to the assembled motors:

a. Two complete stator coils but not less than the number of coils to span one coil pitch with necessary wedges and material for installation for one motor.

b. Two complete field coils, including necessary materials for installation.

c. One complete exciter field coil, including necessary materials for installation.

d. One complete set of bearing parts for pump motors. Each set to include:

    (1) Stationary thrust bearing plate.

    (2) Rotating thrust bearing plate.

    (3) Upper guide bearing lining.

    (4) Lower guide bearing lining.

(5) Two sets of oil rings for pump motors.

[(6) One complete set of parts necessary for replacement of antireverse device.]

[(7) Spare lubricant in sufficient quantity to purge and refill the system.]

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The work under this section includes furnishing all labor, equipment, and material and performing all operations required to design, manufacture, assemble, factory test, prepare for shipment and storage, and to deliver the vertical synchronous motors required to drive the flood-control pumps specified under Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE. Supply these motors complete with all accessories, spare parts, tools, and manufacturer's data and instructions as specified herein.

a. With the instruction manuals, submit a complete list of renewal parts for the motor.

b. Submit instructions manual for the proper installation, erection, inspection, and maintenance of the machines furnished under this contract not later than the date the equipment is shipped from the manufacturer's plant. Manuals must include complete installation, maintenance, and service instructions for the motors, lube oil system, thrust bearings (including cooling water requirements), and other accessories.

c. The instructions must include a cross-sectional drawing indicating the major component parts of the motor and procedure for disassembly. [Coordinate the description in the manual for the motor with the installation erection instructions specified in Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE for the pump and integrated with same for a complete motor and pump assembly.]

****

NOTE: Include contract specification number where service conditions are described.

****

d. Insulation for the stator, rotor field, and exciter windings must be full class "F" insulation as defined in NEMA MG 1 paragraph 1.66 and as described herein. The insulation system must be a combination of materials and processes which provides high resistance to moisture, fungus, and other contaminants as experienced by a motor in the service conditions specified herein.

e. The insulation system must also be of a type designed and constructed to withstand severe humidity conditions and to function properly after long periods of idleness without first drying out. All windings and connections must be of the sealed type as defined in NEMA MG 1 paragraph 1.27.2. Completely assemble insulated windings in the motor core before impregnating with the insulating compound. The compound must consist of 100 percent solid resin. Submit a detailed description of and specification for the manufacturing process, the materials and the insulating compound used in insulating the windings for approval before manufacture of the motors is commenced. If, in the opinion of the Contracting Officer, the insulation proposed is not of the quality specified and if the methods of manufacture are not considered to be in accordance with best modern practice, the motors will not be accepted. Impregnation of the windings with the insulating compound must be by vacuum impregnation method followed by baking. Repeat the procedure as often as necessary to fill in and seal over the interstices of the winding, but in no case must the number of dips and bakes be less than two dips and bakes when the vacuum method of impregnation is used.

f. Process insulation to ground on the coil. Slot tubes or cells are not acceptable. The insulation must be of adequate thickness and breakdown strength throughout the length of the coil. Use mica in the slot portion of adequate thickness to withstand the dielectric tests specified in paragraph FACTORY TESTS.

2.2 NAMEPLATES

Include rated voltage, rated full-load amperes, rated horsepower, service factor, number of phases, RPM at rated load, frequency, code letter, locked-rotor amperes, duty rating, insulation system designation, and maximum ambient design temperature in the nameplate data. On each motor, provide a nameplate listing motor characteristics in accordance with NEMA MG 1 paragraph 21.25. Furnish a separate starting information nameplate as specified in paragraph OPERATING CHARACTERISTICS. On each motor, provide a starting information nameplate setting forth the starting capabilities in accordance with NEMA MG 1 paragraph 21.25. This nameplate must also include the minimum time at standstill and the minimum running time prior to an additional start.

2.3 GUARDS AND PROTECTIVE ENCLOSURES

All moving, energized, or other parts where accidental contact might be hazardous to personnel must be equipped with adequate guards, rails, or other suitable enclosures to prevent accidental contact. Pipe all lubrication fittings to convenient locations where they can be serviced from regularly utilized access ways without removal of the guards or enclosures. All guards and protective enclosures must comply with NEMA MG 1 Part 5.

2.4 MOTORS

****

NOTE: For weak source (high thevenin source impedance), the electric utility should be contacted to determine starting restrictions, maximum inrush, or voltage dip limits. This is especially critical for motors over 75 kW 100 hp. The designer must then perform a motor torque and accelerating time study (MTATS) to evaluate the motor starting torque and voltage dip requirement. The selection of a reduced voltage starter will be based on the electric utility requirements and the motor pump arrangement.

****

The motors to be supplied under these specifications must be of the vertical [solid] [hollow] shaft type as required by the pump manufacturer, with direct-connected brushless exciter, designed for full voltage starting, of drip-proof construction, [complete with antireversing ratchet or backstop device], and must conform to the applicable requirements of NEMA MG 1, except as hereinafter specified.

a. Submit equipment foundation dimensions; outline drawings for motor and rotor set-down fixture and jacking provisions with weights, nameplate data, and details showing method of mounting and anchoring the motor. Obtain Contracting Officer's approval in writing prior to the commencement of manufacture of motors.

b. Submit complete descriptive specification for each type and size motor furnished, with necessary cuts, photographs, and drawings to clearly indicate the construction of the motor, specifications for the materials and treatments used to prevent corrosion of parts, and of bearing construction.

c. Submit a complete listing of motor performance data in the form provided in NEMA MG 1 paragraph 21.50. Include with the submittal all information required for the selection of protective and control equipment and for operational settings. Information such as, but not limited to, normal and maximum operating temperatures for windings and bearings, V-curves, field control and protective equipment to be mounted on the motor controller cubicle, locked-rotor current, permissible locked-rotor time, starting times for each type of start as indicated above, and subtransient, transient, and synchronous reactance.

d. If duplicate equipment has not been manufactured previously, perform and confirm calculations or tests as required by paragraph FACTORY TESTS. Obtain Contracting Officer's approval in writing prior to the commencement of manufacture of motors.

2.4.1 Rating

****

NOTE: The local electric utility should be consulted for the expected average and maximum values of percentage voltage unbalance, as defined in NEMA MG 1 paragraph 21.81.2, that will be present at the pumping station. If either value exceeds 1 percent as recommended in NEMA MG 1 paragraph 21.81, the utility should be requested to furnish their plans to improve the voltage unbalance. If they are unable to do so, then the motor should be derated where the voltage unbalance exceeds 1-2 percent. Voltage unbalance should never exceed 5 percent. Motor manufacturers should be consulted for voltage unbalance limits whenever motors have specified limits on locked-rotor currents, particularly the 500 percent limit.

****

Wind each motor for three-phase, 60 Hz, alternating current, and for the respective operating voltage listed below:

PLANT	PUMP	PUMP SERVICE	MOTOR OPERATING VOLTAGE
[_____]	[_____]	[_____]	[_____]

PLANT	PUMP	PUMP SERVICE	MOTOR OPERATING VOLTAGE
[_____]	[_____]	[_____]	[_____]

Design the motor for operation in a 40 degrees C 104 degrees F ambient temperature, and all temperature risers must be above this ambient temperature. The rated horsepower of the motor must be not less than 110 percent of the determined maximum load requirement of the pump. [Supply voltage unbalance will be [_____] percent. The motor rated horsepower will be further derated according to NEMA MG 1 paragraph 21.29 for a voltage unbalance above [1.5 percent] [2 percent].] Motors must have a power factor and service factor of 1.0. The temperature rise above the ambient temperature for continuous rated full load conditions and for the class of insulation specified must not exceed the values given in NEMA MG 1paragraph 21.40.

2.4.2 Operating Characteristics

2.4.2.1 Torques

****

NOTE: This guide specification identifies closed transition autotransformer-type reduced voltage starters. These starters provide the most flexibility during installation, when exact load and line characteristics are not determined, since both input voltage and inrush current may be adjusted. This specification is not meant to limit the selection of reduced voltage starter to only autotransformer type. The use of wye-delta type starter may be appropriate in certain situations. The reduced starter cost must be weighed against the increase cost in motor designs; however each design should be evaluated for the most suitable type starter. All reduced voltage starters will reduce the motor starting torque, so the designer should evaluate the load characteristics to ensure that motor torque will be sufficient under all starting conditions. If reduced-kVA starters are required, EM 1110-2-3105 should be consulted for further guidance.

****

Starting and accelerating torque must be sufficient to start the pump and accelerate it against all torques experienced in passing to the pull-in speed under maximum head conditions and with rated excitation current and a terminal voltage equal to [90 percent of rated value] [the output of a closed-transition autotransformer type reduced-voltage starter supplied at 90 percent of rated voltage and connected on its [80] [65] percent tap]. The pull-in torque must exceed that required by the load under maximum load conditions but must not be less than 100 percent of motor full-load torque, with a terminal voltage equal to 90 percent of rated value. Pull-out torque must not be less than 150 percent of motor full-load torque for one minute minimum and with a terminal voltage equal to 90 percent of rated value.

2.4.2.2 Locked-Rotor Current

****

NOTE: The objective of this specification is to limit the locked-rotor current to a value sufficiently low to permit full-voltage starting. The motor horsepower rating is to be a minimum of 110 percent of the maximum pump load at a service factor of 1.0. Manufacturer's standard is to limit locked-rotor current to 600 percent of full load current. However, local utilities may have additional limitations on inrush currents and should be consulted. Motor design will permit some reduction in inrush current in which case 500 percent should be used. If this is not sufficient, reduced-voltage starting should be used. The inrush current limit should be specified whenever possible.

****

The locked-rotor current must not exceed [600] [500] percent of rated nameplate full load running current. [The locked-rotor current must not exceed [_____] amperes at 90 percent of rated voltage during any point in the starting cycle under worst case starting conditions. For autotransformer reduced voltage starting, the above criteria apply to the primary side and at any prescribed tap.]

2.4.2.3 Starting Capability

Each motor, when operating at rated voltage and frequency and on the basis of the connected pump load inertia, Wk2, and the speed-torque characteristics of the maximum load during starting conditions as furnished by the pump manufacturer, must be capable of making the starts required in NEMA MG 1 paragraph 21.43.

2.4.2.4 Balance

The balance for each motor must be in accordance with NEMA MG 1 Part 7. [Each motor's characteristics must be such that the maximum vibration requirements of Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE are met.]

2.4.2.5 Noise

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NOTE: The Department of Defense considers hazardous noise exposure of personnel as equivalent to 85 dB or greater: A-weighted sound pressure level for eight hours in any one 24-hour period. On the assumption that pumping plant operating personnel may be exposed to noise levels approaching or exceeding that defined by the DOD as hazardous, the motor noise limit should be specified not to exceed 85 dBA. The additional cost of providing motors meeting this requirement should be investigated and weighed against an alternate of providing a room to isolate these personnel from the noise exposure.

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All motors must operate at a noise level less than 85 decibels A-weighted mean sound pressure level (dBA). Determine noise in accordance with NEMA MG 1 Part 9.

2.4.2.6 Overspeed Option

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NOTE: NEMA MG 1 paragraphs 12.48 and 21.45 specify that overspeeds are for emergencies lasting no longer than one minute. Using this option will increase costs due to requirements well beyond standard limits. Designer must do a cost analysis before selection of this option.

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Design each motor to withstand indefinitely, without injury, the maximum overspeed to which the motor will be subjected when the pump to which it is connected is acting as hydraulic turbine under the maximum head with the pump discharge pipe open.

2.4.2.7 [Antireverse Device

Install a self-actuated backstop device or antireversing ratchet, to prevent reverse rotation of the pump due to loss of power or failure of the electric prime mover, as an integral part of the motor. Submit the design of the antireverse device for approval by the Contracting Officer, such that its action is without intentional delay or excessive backlash. It must have sufficient capacity to prevent reverse rotation with a back flow through the pump due to a [_____]-foot differential head. The device must be precision machined and be complete with support housing and oil collector as required. Provide an oil reservoir, independent of the one used for the thrust bearing, complete with oil-level gauge and 120-volt ac rated high and low level contacts for the backstop device. The lubricant for the antireverse device must contain a corrosion inhibitor. Show the type and grade of the lubricant on a special nameplate attached to the frame of the motor adjacent to the lubricating filling device.]

2.4.2.8 [Power Factor and Efficiency

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NOTE: List power factor and efficiency for each size only if high efficiency motors are required. Generally manufacturers' standards will be used.

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The power factor and efficiency at full load, 3/4 full load, and 1/2 full load must be not less than [_____], [_____], [_____] and [_____], [_____], [_____], respectively. Submit certification guaranteeing value of power factor and efficiency for full load, 3/4 full load, and 1/2 full load. Motors will be rejected if factory tests specified in paragraph FACTORY TESTS do not demonstrate that these values will be met or exceeded.]

2.4.3 Frames and Brackets

Frames and end brackets must be of cast iron, cast steel, or welded steel. The mounting ring, unless otherwise approved, must be built integral with the frame or lower end bracket. Coordinate the motor installation with the mounting arrangement specified in Section 35 45 01 VERTICAL PUMPS: AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE, paragraph BASE PLATE AND SUPPORTS. Furnish all equipment and materials required to mount the motor, such as a base or pedestal, sole plates, and bolts or dowels. Install sufficient bolts and dowels to prevent any possible movement of the motor assembly when the motor is subjected to stresses resulting from the most severe short-circuit conditions. Treatment against corrosion must be as specified in paragraph QUALITY ASSURANCE.

2.4.3.1 Stator Frame

The stator frame must be rigid and sufficiently strong to support the weight of the upper bearing bracket load, the weight of the stator core and windings, and to sustain the operating torques without perceptible distortion.

2.4.3.2 Supporting Brackets

The upper bracket supporting the thrust bearing and upper guide bearings must have sufficient strength and rigidity to support the weight of the entire rotating element of the motor, together with the pump impeller and shaft, and the unbalanced hydraulic thrust of the pump impeller. If feasible, design and construct the lower bracket supporting the lower guide bearing so the entire rotor can be lifted out as a unit without disturbing the bearing alignment. If it is not feasible to construct the rotor so that it can be lifted out as a unit, support the lower bracket on separate base plates or structure and design so that it can be removed through the stator. The maximum deflection of the thrust bearing support system at any point must not exceed the limits set by the pump manufacturer to maintain proper clearances for any operating condition.

2.4.3.3 Eyebolts

Provide eyebolts, lugs, or other approved means for assembling, dismantling, and removing the motors from above, utilizing the overhead pumping station building crane. Furnish with the motor all lifting devices for use in conjunction with the building crane.

2.4.3.4 Platforms and Stairways

Furnish each motor with a platform and stairway complete with railing. Provide an easily removed section of railing so that the rotor shaft does not have to be hoisted above the railing when the rotor is removed. The platform must also provide maintenance access as required by the motor furnished. Locate the stairway [_____] degrees [counter-] clockwise from the discharge elbow of the pump, when looking down on the motor/pump assembly.

2.4.4 Insulation Against Stray Currents

The motor must be adequately insulated against stray currents which may be set up by the field of the motor and which might cause injury to the motor or pump bearings. Arrange this insulation to break the possible path of such currents in not less than two places in series.

2.4.5 Motor Cooling

Provide the motor with an open-type system of ventilation, taking cooling air from above the operating floor level and discharging the heated air into the operating room through upper openings in the stator frame. Induce the circulation of air by means of the fan action of the rotor. No openings to the air space below the operating level are to be used in the motor design for ventilation or other uses that are not reasonably airtight.

2.4.6 Stator

2.4.6.1 Stator Core

The cores must be built up of separately punched thin laminations of low-hysteresis loss, nonaging, annealed, electrical silicon steel; assembled under heavy pressure; and clamped in such a manner as to ensure that the assembled core is tight at the top of the teeth of the laminated core. Laminations must be properly insulated from each other. Use only laminations free from burrs, and remove all burrs or projecting laminations from the slots of the assembled cores. Cores must be keyed, dovetailed, or otherwise secured to the shaft or frame in an approved manner. Treatment against corrosion must be as specified in paragraph QUALITY ASSURANCE.

2.4.6.2 Stator Coils

Thoroughly insulate and treat the coils with a moisture and fungus-resisting compound in such a way that air will be excluded and the insulation will be protected from the absorption of moisture. Provide additional insulation for those portions of each coil which are within the slots. The coils must fit the slots accurately and they must be form wound and interchangeable. Design and construct the end turns that they will not be distorted under the most severe short-circuit conditions to which the motor may be subjected.

2.4.6.3 Insulated Stator Windings

Insulate the stator windings as specified in paragraph QUALITY ASSURANCE. Coils must be of such uniformity that the stator windings of all similarly rated motors will be alike, in shape and size, and interchangeable. Fully brace the stator winding and end turn connections to withstand repeated full voltage starts. The bracing system must essentially eliminate coil vibration under these high current conditions as well as during normal operation. A tieless bracing system will be acceptable. If a tied system is used it must be such that no tie depends upon the integrity of any other tie within the system.

2.4.6.4 Temperature Detectors

Provide in the stator six standard copper resistance-type temperature detectors, with a resistance of 10 ohms at 25 degrees C 75 degrees F, in accordance with NEMA MG 1 paragraph 20.27. Detectors must be wired in accordance with paragraph ACCESSORY WIRING AND BOXES.

2.4.6.5 Grounding

The stator frame must have provisions for solidly grounding to the station ground system which will be furnished and installed by others.

2.4.7 Rotor

Build the rotor in accordance with the best modern practice and in such a manner as to secure adequate strength for the operating conditions described herein. Build up the pole pieces of thin steel laminations accurately aligned and securely riveted or bolted together.

2.4.7.1 Field Windings

Insulate the field windings as specified in paragraph QUALITY ASSURANCE. Adequately insulate the field coils between turns and from the pole pieces. Thoroughly brace to withstand the stresses which could be imposed under maximum pump speed.

2.4.7.2 Starting Windings

Design the starting windings for full-voltage starting, securely built into the field poles and designed to ensure conservative stresses when the unit is operating at maximum pump speed. The bars must be silver soldered or brazed to heavy end segments to form a low-resistance joint of high mechanical strength. Design the starting windings to permit any pole or group of poles to be removed.

2.4.8 Exciter

Provide each synchronous motor with a direct connected exciter without brushes, commutators, or additional bearings. The exciter must be capable of supplying continuously, and without overheating, the excitation for the motor to which it is connected when the latter is operating at rated power factor, voltage, frequency, and horsepower. Accomplish the field-protective function and the field switching and application function by semiconductor elements mounted on suitable heat sinks supported on the motor rotor and ventilated by rotation of the rotor. The exciter must be either built into or so arranged that it is ventilated from the main motor enclosure. The enclosure of the exciter must be of drip-proof construction comparable to that of the motor. The control system must apply excitation to the motor field at the speed and phase angle required to obtain maximum pull-in torque. Insulate the exciter windings as specified in paragraph QUALITY ASSURANCE. The field coils must be adequately insulated between turns and from the pole pieces and must be thoroughly braced to withstand the stresses which could be imposed under maximum pump speed.

2.4.9 Shaft

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NOTE: Use hollow shaft pumps whenever possible, since they are more readily adjusted. Pumps requiring large motors (above 746 kW 1,000 hp) are limited by the available motors. Investigate the exact motor capabilities and sources of supply when using hollow shafts with motors above 746 kW 1,000 hp. Solid shafts will be used only when the available motor designs require their use.

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Make the motor shaft of high grade steel, finished all over, and of ample size to drive the pump under maximum load conditions. The shaft must be of the [solid type and must be connected to the pump shaft with a rigid adjustable coupling.] [hollow type and must be connected to the pump shaft above the thrust bearing in a manner that will permit the pump impeller to be adjusted vertically]. Coordinate the connection with the pump shaft and furnish a motor shaft with all provisions, fittings, and devices required to conform to the shafting arrangement specified in Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE, paragraph SHAFTS. See paragraph QUALITY ASSURANCE for treatment against corrosion.

2.4.10 Bearings

2.4.10.1 Thrust Bearings

Provide thrust bearings of the spring type located above the rotor. A design in which each pivot shoe rests upon a support of metal which may take a permanent deformation in order to equalize the load on the bearing shoes, or in which individual shoe pivots are supported on spring plates or spring disks, is not considered to be of the self-equalizing type and will not be acceptable. The stationary shoes must be babbitt-lined. The thrust bearing must have ample capacity to support the maximum pump hydraulic thrust load plus the static load while operating under maximum rated pump conditions. [The thrust bearing must be capable of withstanding without injury the pump being started normally without prior jacking of the rotor.] The thrust bearing must have a removable runner and must be arranged to permit adjustments, dismantling, and assembly of the runner and shoes without disturbing the stator or rotor, other than jacking the load from the bearing. A spacer plate between the thrust bearing runner plate and the thrust block will not be permitted.

2.4.10.2 Guide Bearings

Except as permitted below, provide the motor with two guide bearings, one located above the rotor and the other below the rotor. The guide bearings must be capable of withstanding all stresses incident to the normal operation of the unit [and to the maximum runaway speed]. Both guide bearings must be self-cooled, of the oil-immersed, self-oiling type. Prevent oil or oil vapor from entering the motor cooling system. The guide bearings must be of the split-sleeve type. Design and construct the guide bearing so that they can be dismantled without disturbing the thrust bearing or the motor rotor. The Contractor may combine the thrust bearing and the upper guide bearing into a combination integral guide and thrust bearing assembly in a common housing. In such a combination bearing, use the vertical side of the thrust-bearing block, but not the runner plate, as the journal surface.

2.4.10.3 Lubrication

Use lubricating oil containing a corrosion inhibitor. Show the type and grade of lubricant on a special nameplate and attach to the frame of the motor adjacent to the bearing filling device. Each lubrication system must include oil reservoirs, oil-level sight gauge, oil piping, valves, and necessary appurtenances.

2.4.10.4 Bearing Housing

Bearing housing must be of a design and method of assembly that will permit ready removal of the bearings, and prevent escape of lubricant and entrance of foreign matter. Protect the bearings with the lubricant when the motor is idle. Provide suitable means to apply and drain the lubricant. Provide oil-level indicator gauges for oil-lubricated bearing housings.

2.4.10.5 Cooling

Each thrust bearing must be self-cooling whenever possible. When required by motor speed or load, provide an oil cooler with suitable coils of corrosion-resisting metal in the oil reservoir of sufficient capacity to maintain the oil at the proper temperature with [30 percent glycol] cooling water entering the coils at a temperature of [30] [_____] degrees C and with a minimum pressure of 40 pounds per square inch. Design the cooler for safe operation at a maximum working pressure of 345 kPa 50 psi. At the factory, subjected the cooler to a hydrostatic test pressure of 517 kPa 75 psi for a period of one hour without leakage. Cooling water will be supplied by a central system, furnished by others, consisting of a radiator, circulating water pump, and piping system terminating at the exterior of each motor. If required an auxiliary-motor-driven circulating oil pump, rated at 480 volts, three-phase, with electrical leads terminated in a special terminal box on the motor, include an oil pressure sensing device in the bearing oil cooler system. Construct the cooler system so that the thrust bearing can be readily inspected or removed for repairs. Include a water flow indicator with adjustable alarm contacts in the water supply line. The oil reservoir must have an oil-level gauge with high and low level normally open contacts rated 120 volts ac.

2.4.10.6 Temperature Detectors

Provide a standard copper resistance-type temperature detector, with a resistance of 10 ohms at 25 degrees C 75 degrees F, for each bearing. Casings must be made of copper. Wire detectors in accordance with paragraph ACCESSORY WIRING AND BOXES.

2.5 INSTRUMENTS AND GAUGES

Furnish the following instruments and gauges.

2.5.1 Thermometers

Provide indicating thermometers, 150 mm 6 inch vapor-tension [dial-type] [digital], with adjustable ungrounded alarm contacts suitable for 120 volts ac for (a) the thrust bearing, (b) the thrust bearing oil reservoir, and (c) each guide bearing. Locate the bulbs to indicate the temperatures of the hottest parts. Mount the thermometers on a thermometer panel and locate on the motor housing at a location approved by the Contracting Officer. Provide adequate length of tubing with each thermometer. Insulate the bulb and tubing where necessary to prevent bearing currents. [The dial-type thermometers must be of the [round][square] semiflush type with black cases, white dials, and black figures and pointers.] [The digital thermometers must be square, semiflush type with black cases and minimum 25 mm 1 inch high display.]

2.5.2 Temperature Relay

Provide a pneumatic bearing temperature relay having two sets of electrically independent contacts, located close to the babbitt of the thrust bearing [and each guide bearing]. Each relay must close its contacts when the bearing temperature reaches approximately 105 degrees C 220 degrees F. The contacts must have a current-carrying capacity of not less than 10 amperes, must be ungrounded, and must be suitable for 120 volts ac. Mount the relays in an approved accessible location. Bring the leads to a terminal block mounted on the stator frames in an approved location. The bulbs for the temperature relays must be easily accessible and constructed for removal and testing without disturbing the bearing or bearing housing. Insulate the tubing where necessary to prevent bearing currents.

2.5.3 Oil-Level Gauge

Provide an oil-level gauge for each oil reservoir, with scale of sufficient length to indicate the oil level at all room and operating temperatures. Locate the gauges near the reservoirs in an approved, accessible location where they can be easily read. Each oil-level gauge must have adjustable high and low oil-level ungrounded alarm contacts suitable for 120 volts ac.

2.6 PIPING

Design and furnish all piping systems within the motor for bearings, including valves and fittings. Bring these connections out to approved positions at the bottom of the stator frame. Clean all piping inside and cap for protection where ending in open connections for other work. Valves and other operating devices must be easily accessible, and mount gauges and indicating devices on a control panel as approved by the Contracting Officer. Piping and fittings must be of copper or brass as required. Valves must have bronze seats and stems and must be suitable for the service intended. At all points where the piping system must be disconnected for dismantling operations, provide bolted flange connections or unions. Arrange piping and location of valves and joints to minimize disturbance to piping or interference with other service when the motor is dismantled or parts are removed for inspection or repairs.

2.7 WINDING SPACE HEATERS

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NOTE: The inclusion or omission of "Winding Space Heaters" will depend upon the decision reached after giving due consideration to the problem of prevention of moisture condensation on the station equipment.

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Install heaters in the lower section of the frame or wrap them around the winding end turns. Design heaters for operation on 120 volts, single-phase, 60-Hz, alternating current and with sufficient capacity or wattage that, when energized, they will hold the temperature of the motor windings approximately 10 degrees C above the ambient temperature. Heaters must be de-energized when motor is operating.

2.7.1 Construction

The heaters, except for wrap-around type, must be of the tubular type, constructed with a chrome-nickel heating element embedded in a refractory insulating material, and encased in an approved watertight metal sheath. Design heaters for continuous operation with a maximum watt density of 20 watts per square inch. The rate of heat dissipation must be uniform throughout the effective length of the heater. Cartridge-type heaters of equivalent construction, as approved by the Contracting Officer, will be acceptable. Heaters installed around the winding end turns must consist of the required turns of heating cable wrapped around the end turns and secured in place before the winding is impregnated.

2.7.2 Element

Heating element must conform to the requirements of ASTM B344 for an 80 percent nickel and 20 percent chromium alloy.

2.7.3 Sheath

Sheath must be of a corrosion-resisting, nonoxidizing metal and must have a wall thickness not less than 0.625 mm 0.025 inch.

2.7.4 Insulation

Insulation must be a granular mineral refractory material, highly resistant to heat, and must have a minimum specific resistance of 1,000 megohms per inch cubed at 585 degrees C 1,000 degrees F. Insulation for the heating cable (winding wrap-around type heaters) must be suitable for a conductor temperature of 180 degrees C 356 degrees F.

2.7.5 Terminals

Terminals of the heater, including the leads, must be watertight. Provide heater terminals with leads suitable for making connections to a separate drip-proof terminal box located on the motor frame. The terminal box must be readily accessible through the crating, so that winding heaters can be energized while motors are in storage.

2.8 MAIN LEADS AND TERMINAL BOX

2.8.1 Stator Terminals

Insulated terminal leads must receive a treatment equal to that of the motor winding. Bring six leads out of the stator frame and make connections for the current transformers in paragraph ACCESSORY WIRING AND BOXES. Provide terminal lugs for connection to the motor shielded single-conductor supply wiring.

2.8.2 Stator Terminal Box

Provide drip-proof cast iron or steel terminal boxes, treated in the same manner specified for frames to resist corrosion, for housing the stator lead connections, surge capacitors, surge arresters, and current transformers. Boxes must have adequate space to facilitate the installation and maintenance of cables and equipment. Boxes must have a [bolted] [hinged lockable] cover providing unrestricted access, be mounted on the motor frame, and have an auxiliary floor supporting structure, when required, supplied by the motor manufacturer. Conduit entrance must be from the bottom. Design the boxes to permit removal of the motor supply leads when the motor is removed. Provide a "HIGH VOLTAGE [_____] VOLTS" warning sign on the cover of the box. When looking down on the motor/pump assembly, locate the terminal box between [_____] degrees and [_____] degrees [counter-] clockwise from the discharge elbow of the pump. Provided in the stator terminal box a ground bus and means for external connection to the station grounding system.

2.9 SURGE PROTECTION

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NOTE: To obtain the most reliable protection for 2,300- and 4000-volt motors, surge capacitors and arresters, mounted at the motor terminals, should be specified. In addition, it is recommended that station-type arresters be installed on the line side of the supply transformers.

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2.9.1   Surge Capacitors

Furnish and install, in the main terminal box, a three-pole capacitor unit equipped with built-in discharge resistors and using a non-polychlorinated biphenyl (non-PCB) insulating medium. Each pole must be rated 0.5 microfarad and [2,400] [4,160] volts line-to-line. Provide removable bus links for motor testing. These links must be treated to resist corrosion, designed to maintain a positive contact, and have low contact resistance.

2.9.2   Surge Arresters

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NOTE: Use 3,000 MCOV arresters for 2,400-volt systems or effectively grounded 4,160-volt systems. Use 4,500-MCOV for ungrounded or resistance grounded 4,160-volt systems.

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In the main terminal box, furnish and install surge arresters of the station type with porcelain tops. The arresters must be of the metal-oxide type rated [3,000] [4,500] [_____] maximum continuous operating voltage line-to-ground. Provide removable bus links for motor testing. These links must be treated to resist corrosion, designed to maintain a positive contact, and have low contact resistance.

2.9.3   Space Heater

If recommended by the surge protection manufacturer, furnish a space heater of adequate capacity, rated 120 volts and install it in the terminal box. Space heater maximum watt density must not exceed 20 watts per square inch.

2.10   CURRENT TRANSFORMERS

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NOTE: For motor differential protection, the "Flux-Balancing Current Differential" scheme, as shown in Fig. 16 of IEEE C37.96, is preferred and will generally be applicable. In this case, the window-type current transformers should be used. However, when the KVA rating of a motor is approximately one-half the supply transformer KVA rating, or greater, it may be necessary to use the differential scheme shown in Fig. 15 of IEEE C37.96, in which case the "Differential Protection" scheme should be used.

****

Current transformer must meet the applicable requirements of IEEE C57.13 and IEEE C37.96. [Do not ground][Ground] secondary circuits at the motor. Bring out to terminal blocks all leads from each individual transformer. Terminal blocks must be of the dry or compound-insulated type. Provide terminal blocks with a suitable means of mounting and for grounding the frame. Connect each current transformer secondary lead to a terminal block of the short-circuiting type. Locate terminal blocks to permit short-circuiting the secondary windings without requiring access to the primary bus compartments. Plainly mark the polarity of the current transformers. [Provide each motor with three indoor dry-type window transformers with single secondary and rated [50/5 amperes, 600 volts] [_____]. Current transformers must have minimum full-wave insulation level of 10 kV and, when installed, must meet the requirements for a [60 kV] [_____] basic impulse level (BIL). Mount the transformers in the main terminal box and arrange in the "flux-balancing" connection.] [Provide each motor with three current transformers of rated [4,160] [_____] and [60 kV] [_____] basic impulse level (BIL). Mount the transformers in the main terminal box and connect in the wye point of the winding for use with differential relays.] All current transformers must be suitable for continuous operation at the full-rated voltage and current at a frequency of 60 Hz. Design all current transformers to withstand, without damage, the thermal and mechanical stresses resulting from short-circuit currents corresponding to ratings of the breakers in the circuits to which they are connected.

2.11 ACCESSORY WIRING AND BOXES

Except for current transformer leads and field control leads, terminate all accessory wiring in an accessory terminal box. Boxes must be drip-proof and treated in the same manner specified for frames to resist corrosion. Furnish the accessory terminal box with a door hinged full length and mounted on the motor in a location approved by the Contracting Officer. Use rigid galvanized steel conduit wherever practicable and arrange to make removal unnecessary when the motor is dismantled. Provide a wiring diagram within the enclosure for all circuits. Identify each conductor with the designation shown on the diagram. Terminate all wiring on terminal blocks as specified below.

2.11.1 Wiring

Except as otherwise approved, all wiring must be 125 degrees C rated flexible copper conductors, No. 14 AWG minimum, with 600-volt insulation. The size and type of temperature detector leads may be in accordance with the manufacturer's standard practice and, where required, must be suitable for contact with lubricating oil. Connect each detector by three leads to terminal blocks, with one wire connected to a common point on the blocks. Separate the common point for the stator detectors from that for the bearing detectors.

2.11.2 Terminal Blocks

All terminal blocks must be molded closed-back type as defined in NEMA ICS 4, rated not less than 600 volts, and provided with covers. The terminals must be screw-clamp type or stud-and-nut type. For circuit designation, provide white or other light-colored marking strips, fastened by screws to the molded sections at each block. Permanently mark on a strip the circuit designation or wire number for each connected terminal of each block. Furnish with each block reversible or spare marking strips and at least 10 percent spare terminals.

2.12 JACKING PROVISIONS

Provide suitable means for hydraulic jacking of the rotor to permit inspection, adjustment, or removal of the thrust bearing. Make provisions for blocking the rotor in the fully raised position. The blocking device must not require maintenance of hydraulic pressure on the jacks while the assembly is in the raised position.

2.13 SPECIAL TOOLS AND EQUIPMENT

Provide special tools, jigs, fixtures, lifting tackle, and instruments which may be necessary in assembly, erection, operation, maintenance, and repair of equipment. Special tools and equipment are those the design, purpose, and use of which are peculiar to equipment furnished and which are not available from normal wholesale or retail outlets. The motor manufacturer must provide hydraulic jacking devices as required in order to pull the thrust bearing thrust collar from the upper end of the shaft. The motor manufacturer must furnish one complete set of lifting attachments such as detachable eyebolts or special slings for handling various parts with a hoist.

2.14 SET-DOWN FIXTURES

Furnish one separate motor set-down fixture for each motor rating supplied. This fixture, when installed on the operating floor, must provide sufficient clearance above the floor for the motor shaft and coupling extending below the motor frame. The fixture must be suitable for holding the motor during assembly and disassembly. Furnish one separate rotor set-down fixture for each motor rating supplied. The fixture must hold the rotor in the horizontal position above the floor without unduly stressing the rotor pole pieces or laminations. Ship the motor and rotor fixtures to the destination prior to the shipment of any motor.

2.15 FACTORY TESTS

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NOTE: The designer should carefully consider whether to allow the Contracting Officer to waive these tests. Decision should be based on expertise in the field within the Division or District.

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Give one motor of each rating and type, selected at random by the Contracting Officer, a complete test. Check test the remainder of the motors. Submit test reports recording all data, calculations, and curves for each motor used. All complete tests will be [witnessed by the Contracting Officer][unless waived in writing].

2.15.1 Witness Test

When the Contractor is satisfied that a motor selected for a "Complete Test" performs in accordance with the requirements of the specifications, notify the Contracting Officer and submit the tabulated data, calculations, and curves required by paragraph COMPLETE TEST below.

a. Submit motor design (characteristic) curves or tabulated data indicating the efficiency, current, and kilowatt input at rated voltage and 110 and 90 percent rated voltage, all plotted or tabulated against torque or percent load as abscissas. Where values are given in percentages all base values will be indicated.

b. Three weeks will be required, after receipt, to review the foregoing information. Should the witness test indicate that a motor does not perform in accordance with the requirements of the specifications, make changes or corrections and run new complete witness tests, at no additional cost to the Government.

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NOTE: Use final sentence only when the pump and motor are furnished under the same procurement.

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c. Submit the motor torque curves plotted for the following values of voltage at the motor terminals: [rated and 90 percent of rated voltage] [the output of a closed-transition autotransformer type reduced-voltage starter supplied at rated and 90 percent of rated motor voltage and connected on its [80] [65] percent tap]. [Plot the pump torque curve for starting, accelerating, and synchronizing against maximum head. Furnish computations to demonstrate that the motor will pull into synchronism under all of the foregoing conditions.]

2.15.2 Complete Test

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NOTE: For the large motors (1118 kW 1,500 hp and above), the efficiency is high, i.e. 95 percent at 1/2 to full load, however, efficiency varies with motor design. In general, high efficiency motors are not cost effective in the large size motors covered by this specification. If other than manufacturer's standard efficiency is required, the designer should list those values in paragraph FACTORY TEST.

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Submit certified results of a "Complete Test" for duplicate equipment of the respective rating and type. Test will be accepted in lieu of the "Complete Test" specified for equipment of the respective rating and type. No substitute will be accepted for the "Check Test". Include the following in the complete test of a synchronous motor:

a. Resistance of armature and field windings.

b. Polarity of field coils.

c. High-potential tests of armature and field windings in accordance with NEMA MG 1 paragraph 21.52.

d. Air gap measurement.

e. V-curves (for zero, 1/2, 3/4, and full load).

f. Determination of the subtransient, transient, and synchronous reactance.

g. Conventional efficiency tests, in accordance with NEMA MG 1paragraph 21.44. Motor must meet manufacturer's published efficiency criteria for 1/2, 3/4, and full rated loads. Calculation of efficiency must include [that portion of the thrust bearing loss produced by the motor itself] [bearing loss due to external thrust load].

h. Tests to determine temperature rise in accordance with NEMA MG 1 paragraph 21.40.

i. Insulation resistance-temperature test, in accordance with IEEE 43. Plot test result values on semilogarithmic graphs, the insulation resistance values as logarithmic ordinates and the temperature values as uniform abscissas. Take readings at approximately 10 degrees C intervals. Determine temperature by the resistance method. Also, for comparison purposes, plot on the same sheet a curve indicating the safe operating value of insulation resistance.

j. Noise level tests in accordance with NEMA MG 1 paragraph 20-50.

k. Motor balance in accordance with NEMA MG 1 paragraph 20.54.

l. Conformance test in accordance with NEMA MG 1 paragraph 20.49.

m. Torques. Perform torque tests in accordance with IEEE 115 to demonstrate that the values specified in paragraph "Torques," will be met or exceeded.

2.15.3 Check Tests

Include the following in the check test of a synchronous motor and exciter:

a. Routine test in accordance with NEMA MG 1 paragraph 21.51.

b. Cold resistance measurement.

c. Insulation resistance and winding temperature at time the insulation resistance was measured.

d. Conformance test in accordance with NEMA MG 1 paragraph 20.49.

e. Motor balance in accordance with NEMA MG 1 paragraph 20.54.

2.15.4 Stator Winding Coil Tests

Test all coils, either before or after they are placed in the slots, for short circuits between turns of the individual coils by applying a high frequency voltage of not less than 75 percent of the voltage for which the machine is insulated, or by applying a surge test voltage of equivalent value to the terminals of each coil. Equivalent surge voltage must be a wave whose peak value is equal to 1.06 times the voltage for which the motor is insulated.

2.15.5 Space Heater Tests

Test at the factory each winding space heater unit for successful operation and dielectric strength.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

Perform the following acceptance checks and tests in accordance with NETA ATS section 7.15.2.

3.1.1 Visual and Mechanical Inspection

(1) Compare equipment nameplate data with drawings and specifications.

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, and grounding.

(4) Inspect air baffles, filter media, stator windings, stator core, rotor, cooling fans, slip rings, brushes, brush rigging, and bearings.

(5) Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Correct values which deviate by more than 50 percent of the lowest value.

(6) Perform special tests such as air-gap spacing and machine alignment.

(7) Manually rotate the rotor and check for problems with the bearings or shaft.

(8) Rotate the shaft and measure and record the shaft extension runout.

(9) Verify the application of appropriate lubrication and lubrication systems.

(10) Verify that resistance temperature detector (RTD) circuits conform to drawings.

3.1.2 Electrical Tests

(1) Perform insulation-resistance tests in accordance with IEEE 43. Test duration must be [10 minutes][one minute]. The [polarization index][dielectric-absorption ratio] must be at least [2.0][1.4].

(2) Perform insulation-resistance test on insulated bearings in accordance with manufacturer’s published data.

(3) Test surge protection devices.

(4) Test motor starter.

(5) Perform resistance tests on resistance temperature detector (RTD) circuits.

(6) Verify operation of machine space heater.

(7) Perform insulation-resistance tests on the main rotating field winding, the exciter-field winding, and the exciter-armature winding in accordance with IEEE 43.

(8) Measure resistance of machine-field winding, exciter-stator winding, exciter-rotor windings, and field discharge resistors.

(9) Prior to re-energizing, apply voltage to the exciter supply and adjust exciter-field current to nameplate value.

(10) Verify that the field application timer and the enable timer for the power-factor relay have been tested and set to the motor drive manufacturer’s recommended values.

(11) Measure bearing temperatures while machine is running under load.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 29 23 (February 2020)**
Change 1 - 05/21

Preparing Activity: NAVFAC **Superseding**
UFGS-26 29 23 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 29 23

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02/20, CHG 1: 05/21

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SECTION 26 29 23

ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS

02/20, CHG 1: 05/21

****

NOTE: This guide specification covers the requirements for ASD (also referred to as variable frequency drive (VFD)) for motors rated up to 575 volts, for use on electric power systems of 600 volts or less, 50/60 hertz.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Coordinate this guide specification with a mechanical designer for HVAC ASD application.

Military standard requirements for parent equipment with motors controlled via ASDs also apply to the ASDs. Examples include petroleum, oil and lubricant (POL) systems and Mobile/Tactical generators with ASDs hardening as a part of the generator equipment assembly.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

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NOTE: Pulse width modulated (PWM) is the predominant type of adjustable speed drive (ASD). Other ASD types include current source inverter (CSI), voltage source inverter (VSI), and flux

vector drive (FVD). For guidance of the proper application of ASD's and installation, refer to Appendix B of UFC 3-520-01. Since the carrier-frequency pulse output voltage of a PWM cause rapid rise times in these pulses, the transmission line effects must be considered. The resulting voltage can produce overvoltages equal to twice the DC bus voltage or up to 3.1 times the rated line voltage, putting high stress on the cable and motor windings, and eventual insulation failure. Use ASD manufacturer recommended cable type and maximum safe cable distances before using the external protection devices. Use motors designed for use with ASD.

****

****

NOTE: The use of power capacitors for power factor correction and/or the use of surge protection capacitors on the load side of an electronic control connected to an induction motor is not recommended; damage to the control may occur. Contact the control vender for suitability.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN/CENELEC)

EN 61800-3	(2017) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 519	(2022) Standard for Harmonic Control in Electrical Power Systems
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61000-3-12	(2012) Electromagnetic Compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and </=75 A per phase

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 3.1	(2019) Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA ICS 7	(2020) Adjustable-Speed Drives
NEMA ICS 7.2	(2015) Application Guide for AC Adjustable Speed Drive Systems
NEMA ICS 61800-2	(2005) Adjustable Speed Electrical Power Drive Systems Part 2: General Requirements - Rating Specifications for Low Voltage Adjustable Frequency A.C. Power Drive Systems
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UL SOLUTIONS (UL)

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 61800-5-1	(2016) Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements

1.3.1.1 Electromagnetic Interference Suppression

Computing devices, as defined by 47 CFR 15 and EN 61800-3 rules and regulations, must be certified to comply with the requirements for class A computing devices and labeled.

1.3.1.2 Electromechanical and Electrical Components

Ensure electrical and electromechanical components of the Adjustable Speed Drive (ASD) do not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.

1.3.2 Electrical Requirements

1.3.2.1 Power Line Surge Protection

IEEE C62.41.1 and IEEE C62.41.2, IEEE 519, IEC 61000-3-12 Control panel must have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge protective device must be mounted near the incoming power source and properly wired to all three phases and ground. Fuses must not be used for surge protection.

1.3.2.2 Sensor and Control Wiring Surge Protection

I/O functions as specified must be protected against surges induced on control and sensor wiring installed outdoors and as shown. Test the inputs and outputs in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Schematic Diagrams; G, [_____]

Interconnecting Diagrams; G, [_____]

Installation Drawings; G, [_____]

As-Built Drawings; G, [_____]

SD-03 Product Data

Adjustable Speed Drives; G, [_____]

Wires and Cables

Equipment Schedule

SD-06 Test Reports

ASD Test

Performance Verification Tests

Endurance Test

****

NOTE: Choose a bracketed SD-07 if paragraph 3.3.1 ASD TEST will use an option with engaging qualified testing agency's field supervisor.

****

[SD-07 Certificates

Testing Agency's Field Supervisor NETA Certificate; G, [_____]

] SD-08 Manufacturer's Instructions

Installation instructions

SD-09 Manufacturer's Field Reports

ASD Test Plan; G, [_____]

Standard Products

SD-10 Operation and Maintenance Data

Adjustable Speed Drives, Data Package 4

1.5 QUALITY ASSURANCE

1.5.1 Schematic Diagrams

Submit diagrams showing circuits and device elements for each replaceable module. Schematic diagrams of printed circuit boards are permitted to group functional assemblies as devices, provided that sufficient information is provided for government maintenance personnel to verify proper operation of the functional assemblies.

1.5.2 Interconnecting Diagrams

Show interconnections between equipment assemblies, and external interfaces, including power and signal conductors. Include for enclosures and external devices.

1.5.3 Installation Drawings

Show floor plan of each site, with ASD's and motors indicated. Indicate ventilation requirements, adequate clearances, and cable routes. Submit drawings for government approval prior to equipment construction or integration. Immediately record modifications to original drawings made during installation for inclusion into the as-built drawings.

1.5.4 Equipment Schedule

Provide schedule of equipment supplied. Schedule must provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule must include the total quantity of each item of equipment supplied and data indicating compatibility with motors being driven. For complete assemblies, such as ASD's, provide the serial numbers of each assembly, and a sub-schedule of components within the assembly. Provide recommended spare parts listing for each assembly or component.

1.5.5 Installation Instructions

Provide installation instructions issued by the manufacturer of the equipment, including notes and recommendations, prior to shipment to the site. Provide operation instructions prior to acceptance testing.

1.5.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6 DELIVERY AND STORAGE

Store delivered equipment to protect from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 WARRANTY

The complete system must be warranted by the manufacturer for a period of [one year] [[_____] years]. Repair or replace any component failing to perform its function as specified and documented at no additional cost to the Government. Items repaired or replaced must be warranted for an additional period of at least one year from the date that it becomes functional again, as specified in FAR 52.246-21 Warranty of Construction.

1.8 MAINTENANCE

1.8.1 Spare Parts

Manufacturers provide spare parts in accordance with recommended spare parts list.

****

NOTE: Coordinate with Contracting Officer on whether this paragraph can be included. Edit as required if additional spare parts are required for a specific project. Do not use this paragraph for Navy projects.

****

[Provide one [_____] spare ASD of each model provided for HVAC equipment, fully programmed and ready for back-up operation when connected.

]1.8.2 Operation and Maintenance Data

Provide in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Provide service and maintenance information including preventive maintenance, assembly, and disassembly procedures. Include electrical drawings from electrical general sections. Provide additional information necessary to provide complete operation, repair, and maintenance information, detailed to the smallest replaceable unit. Include copies of as-built submittals. Provide routine preventative maintenance instructions, and equipment required. Provide instructions on how to modify program settings, and modify the control program. Provide instructions on drive adjustment, trouble-shooting, and configuration. Provide instructions on process tuning and system calibration.

1.8.3 Maintenance Support

During the warranty period, provide on-site, on-call maintenance services by drive manufacturer's personnel on the following basis: The service must be on a per-call basis with 36 hour response. Contractor is responsible for the maintenance of all hardware and software of the system during the warranty period. Various personnel of different expertise must be sent on-site depending on the nature of the maintenance service required. Costs must include travel, local transportation, living expenses, and labor rates of the service personnel while responding to the service request. The provisions of this Section are not in lieu of, nor relieve the Contractor of, warranty responsibilities covered in this specification. Should the result of the service request be the uncovering of a system defect covered under the warranty provisions, all costs for the call, including the labor necessary to identify the defect, must be borne by the Contractor.

1.8.4 Technical Support

Provide the ASDs with manufacturer's technical telephone support in English, readily available during normal working hours.

PART 2 PRODUCTS

2.1 ADJUSTABLE SPEED DRIVES (ASD)

Provide adjustable speed drive to control the speed of induction motor(s). The ASD must include the following minimum functions, features and ratings.

a. Input circuit breaker per UL 489 with a minimum of 10,000 amps symmetrical interrupting capacity and door interlocked external operator.

b. A converter stage per UL 61800-5-1 must change fixed voltage, fixed frequency, ac line power to a fixed dc voltage. The converter must utilize a full wave bridge design incorporating diode rectifiers. Silicon Controlled Rectifiers (SCR) are not acceptable. The converter must be insensitive to three phase rotation of the ac line and must not cause displacement power factor of less than .95 lagging under any speed and load condition.

c. An inverter stage must change fixed dc voltage to variable frequency, variable ac voltage for application to a standard NEMA MG 1 Part 30 motor designed for use with adjustable frequency power supplies. Switch the inverter to produce a sine coded pulse width modulated (PWM) output waveform.

d. The ASD shall be capable of supplying 110 percent of rated full load current for one minute at maximum ambient temperature.

****

NOTE: If constant torque required, modify to 150 percent of rated full load. Examples of these constant torque loads include general machinery, hoists, conveyors, printing presses, positive displacement pumps, some mixers and extruders, reciprocating compressors, as well as rotary compresses. Use inverter-duty motors (Standard MG 1 Part 31) for the constant torque loads.

Example of the variable torque loads include fans, centrifugal blowers, centrifugal pumps, propeller pumps, turbine pumps, agitators, and axial compressors. Use inverter-rated motors (Standard MG 1 Part 310) for the variable torque loads.

****

e. The ASD must be designed to operate from a [_____] volt, plus or minus 10 percent, three phase, 60 Hz supply, and control motors with a corresponding voltage rating.

****

NOTE: Choose one of the bracketed sentences when more than an ASD inherent dynamic braking torque is required because an ASD system will produce only 10 to 15 percent of motor full-load torque as dynamic braking retarding torque.

External dynamic braking (also may be called "Shunt Regulator" and "Snubber") may be used when a shorter decelerating time is occasionally required. Dynamic braking method is releasing the motor generated energy in the form of heat through a voltage regulated switching transistor and resistor.

Regenerative braking may be used where a short deceleration time is needed, a high inertia is present, or large amounts of energy losses are undesirable. The regenerative braking method is changing the ASD DC bus energy into fixed frequency utility power.

Common DC bus tie braking may be used together with a dynamic braking as an alternative to dissipating the energy by a dynamic brake resistor when several controls are used in a process and tied in parallel. During braking, energy is returned to the common DC bus tie and may be used by rest of controls and a resistor if not all energy is used by the controls.

Dynamic, regenerative, and common DC bus tie braking

cannot provide holding torque.
****

f. Acceleration and deceleration time must be independently adjustable from one second to 60 seconds.

[Adjust decelerating time by[providing an external dynamic braking resistor designed to meet NEMA ICS 61800-2 to be capable of decelerating six times the motor inertia with no more than 150 percent of rated current with the motor at its base speed.][providing an ASD with a regenerative braking designed to return some of braking energy from the motor to the AC power distribution system.][providing each of several ASD used in a process with a common DC bus tie designed to share the regenerative energy between tied in parallel controls.]]Required deceleration time may be achieved using not only dynamic braking resistor but with other methods described in NEMA ICS 7.2-2015 paragraph 5.2.5.

****
NOTE: Modify this paragraph if constant torque required.
****

g. Adjustable full-time current limiting must limit the current to a preset value which must not exceed 110 percent of the controller rated current. The current limiting action must maintain the V/Hz ratio constant so that variable torque can be maintained. Short time starting override must allow starting current to reach 175 percent of controller rated current to maximum starting torque.

h. The controllers must be capable of producing an output frequency over the range of 3 Hz to 60 Hz (20 to one speed range), without low speed cogging. Over frequency protection must be included such that a failure in the controller electronic circuitry must not cause frequency to exceed 110 percent of the maximum controller output frequency selected.

i. Minimum and maximum output frequency must be adjustable over the following ranges: 1) Minimum frequency 3 Hz to 50 percent of maximum selected frequency; 2) Maximum frequency 40 Hz to 60 Hz.

j. The controller efficiency at any speed must not be less than 96 percent.

k. The controllers must be capable of being restarted into a motor coasting in the forward direction without tripping.

l. Protection of power semiconductor components must be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controllers to any of the following conditions must not result in component failure or the need for fuse replacement:

(1) Short circuit at controller output

(2) Ground fault at controller output

(3) Open circuit at controller output

(4) Input undervoltage

(5) Input overvoltage

(6) Loss of input phase

(7) AC line switching transients

(8) Instantaneous overload

(9) Sustained overload exceeding 115 percent of controller rated current

(10) Over temperature

(11) Phase reversal

****

NOTE: Class 10 means that the protection will trip in 10 seconds when current will be at 600 percent, Class 20 means that the protection will trip in 20 seconds when current will be at 600 percent. Class II ground-fault protection is an equipment protection per NEC. Retain isolated overload alarm contacts on overload relays if they are required for local or remote alarm indication of a tripping overload relay.

****

m. Solid state motor overload protection must [be included such that current exceeding an adjustable threshold must activate a 60 second timing circuit. Should current remain above the threshold continuously for the timing period, the controller will automatically shut down.][have [sensor in each phase,][[Class 10] [Class 20] [Class 10/20 selectable] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing,] [Class II ground-fault protection, with start and run delays to prevent nuisance trip on staring,] [analog communication module,][[NC] [NO] isolated overload alarm contact,] [external overload, reset push button].]

n. Include slip compensation circuit that will sense changing motor load conditions and adjust output frequency to provide speed regulation of NEMA MG 1 Part 30 designed for use with adjustable frequency power supplies motors to within plus or minus 0.5 percent of maximum speed without the necessity of a tachometer generator.

****

NOTE: Retain the last bracketed sentences if the selected time delay may not prevent an ASD from an automatic restart after a power interruption until motor has stopped. Also retain the sentence if there will be an ASD field-selected automatic and manual bypass mode in subparagraph 2.1.r.

****

o. The ASD must be factory set for manual restart after the first protective circuit trip for malfunction (overcurrent, undervoltage, overvoltage or overtemperature) or an interruption of power. The ASD must be capable of being set for automatic restart after a selected time delay. If the drive faults again within a specified time period (adjustable 0-60 seconds), a manual restart will be required.[Provide Bidirectional Autospeed Search capable of starting the ASD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.]

p. The ASD must include external fault reset capability. All the necessary logic to accept an external fault reset contact must be included.

q. Provide critical speed lockout circuitry to prevent operating at frequencies with critical harmonics that cause resonant vibrations. The ASD must have a minimum of three user selectable bandwidths.

****

NOTE: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safety testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.

If a bracketed sentence is chosen with a field-selectable automatic and manual bypass mode, retain requirements for a Bidirectional Autospeed Search in subparagraph 2.1.o. with a requirement for ASD to be capable of being set for automatic restart after a selected time delay.

****

r. Provide preperly sized [NEMA][IEC] rated by-pass and isolation contactors to enable operation of motor in the event of ASD failure[and for safety transfers motor between power converter output and bypass circuit using a field-selectable automatic and manual bypass mode]. Install mechanical and electrical interlocks between the by-pass and isolation contactors. Provide a selector switch and transfer delay timer. Motor overload and short circuit protective features must remain in use during the bypass mode.

****

NOTE: Per NEMA ICS 7.2, the ASD must limit harmonic distortion reflected onto the utility system. 5 percent impedance line reactors have the same benefits as the 3 percent impedance line reactors except that the 5 percent impedance line reactors provide maximum harmonic mitigation without adding capacitance. Investigate ASD voltage performance before using line reactors.

Retain Harmonic Analysis Report bracketed sentence if an analysis from ASD manufacturer is required. IEC 61000-3-12, Table 4 limits the THDI (total harmonic current distortion) produced by equipment connected to public low-voltage systems with input more than 16 A and less or equal to 75 A per phase to be less than 48 percent.

****

****

NOTE: In the last bracketed sentence, insert specific requirements in addition to or in lieu of the manufacturer provided RFI/EMI mitigating method if the method does not comply with the specified limitations.

****

s. Each individual ASD must meet the following Total Harmonic Distortion (THD) requirements at the input terminals to the factory assembly of the ASD or at the load disconnecting means serving the ASD and filter assembly. These measurements should be taken with the drive set at 90 percent frequency (rpms) and the motor under a minimum of 50 percent demand.

(1) The Voltage THD should not exceed 2.0 percent THD.

(2) The Current THD should not exceed 15.0 percent THD.

(3) If the standard factory ASD does not meet or exceed these requirements the factory must install appropriate equipment (Harmonic Traps, Filters, different Drive technology, etc.) to mitigate the distortion to assure performance of the VFD is within the limits.

(4) These tests should be performed at the Manufacturers Laboratory facilities and submitted as part of the Product Data Submittals, in order to prevent the necessity of adding mitigation equipment in the field. If the requirements listed above are met, IEEE 519 will also be met.

[t. Minimum Operating Conditions. Designed and constructed ASD's to operate within the following service conditions:

(1) Ambient Temperature Rating: 0 to 120 degrees F.

(2) Non-condensing relative humidity rating: less than 95 percent.

(3) Ambient rating: Not exceed 1,006 meters 3,300 feet.

][2.1.1 ASD for Industrial Application

Provide the following operator control and monitoring devices mounted on the front panel of the ASD:

a. Manual speed potentiometer.

b. Hand-Off-Auto (HOA) switch.

c. Power on light.

d. Drive run power light.

e. Local display[capable of including ASD status, frequency, motor RPM, phase current, fault diagnostic in descriptive text, and all programmed parameters].

][2.1.2 ASD for HVAC Application

ASDs must have the following features:

a. A local operator control providing the following functions:

   (1) Remote/Local operator selection with password access.

   (2) Run/Stop and manual speed commands.

   (3) All programming functions.

   (4) Scrolling through all display functions.

b. A local operator control panel with the following data displayed:

   (1) ASD status.

   (2) Frequency.

   (3) Motor RPM.

   (4) Phase current.

   (5) Scrolling through all display functions.

   (6) Fault diagnostics in descriptive text.

   (7) All programmed parameters.

c. Standard PI loop controller with input terminal for controlled variable and parameter settings.

d. User interface terminals for remote control of ASD speed, speed feedback, and an isolated form C SPDT relay, which energizes on a drive fault condition.

e. An isolated form C SPDT auxiliary relay which energizes on a run command.

f. An adjustable carrier frequency with 16 KHz minimum upper limit.

****

NOTE: Line reactor is based upon the percent of line impedance. Investigate ASD voltage performance before using line reactors.

****

g. A built-in or external line reactor with 3 percent minimum impedance to protect the DC bus capacitors and rectifier section diodes[, reduce power line transient voltage, line notching, DC bus over-voltage tripping and improve the inverter over-current and over-voltage conditions].

h. Historical logging information and displays:

****

NOTE: Retain first subparagraph below if time and date stamping is not accomplished through the DDC system for HVAC.

****

[(1) Real-time clock with current time and date.

] (2) Running log of total power versus time.

(3) Total run time.

[(4) Fault log, maintaining last [four][_____] faults with time and data stamp for each.

] (5) [_____].

[i. The ASD must be capable of automatic control by a remote [4-20 mA][0 to 10 VDC][_____] signal, by [BACnet][LONworks][_____] network command, or manually by the ASD control panel.

][j. ASDs must include the following operator programmable parameters:

(1) Upper and lower limit frequency.

(2) Acceleration and deceleration rate.

(3) Variable torque volts per Hertz curve.

(4) Starting voltage level.

(5) Starting frequency level.

(6) Display speed scaling.

(7) Enable/disable soft stall feature.

(8) Motor overload level.

(9) Motor stall level.

(10) Jump frequency and hysteresis band.

(11) PWM carrier frequency.

][k. ASD must have the following protective features:

(1) An electronic adjustable inverse time current limit with consideration for additional heating of the motor at frequencies below 45Hz, for the protection of the motor.

(2) An electronic adjustable soft stall feature, allowing the ASD to lower the frequency to a point where the motor will not exceed the full-load amperage when an overload ASD will automatically return to the requested frequency when load conditions permit.

(3) A separate electronic stall at 110 percent ASD rated current, and a separate hardware trip at 190 percent current.

(4) The ability to shut down if inadvertently started into a rotating load without damaging the ASD or the motor.

(5) The ability to keep a log of a minimum of four previous fault conditions, indicating the fault type and time of occurrence in descriptive text.

(6) The ability to sustain 110 percent rated current for 60 seconds.

(7) The ability to shutdown safely or protect against and record the following fault conditions:

  (a) Over current (and an indication if the over current was during acceleration, deceleration, or running).

  (b) Over current internal to the drive.

  (c) Motor overload at start-up.

  (d) Over voltage from utility power.

  (e) Motor running overload.

  (f) Over voltage during deceleration.

  (g) ASD over heat.

  (h) Load and ground fault.

  (i) Abnormal parameters or data in ASD EEPROM.

]]2.2 ENCLOSURES

Provide equipment enclosures conforming to NEMA 250, NEMA ICS 7, and NEMA ICS 6, with a heater if located outdoors. An HMCP device shall provide the disconnecting means. The operating handle shall protrude through the door, but the disconnect shall not be mounted on the door. The handle shall indicate ON, OFF, and tripped conditions. The handle shall have provisions to accommodate a minimum of three padlocks in the OFF position. Interlocks shall prevent unauthorized opening or closing of the ASD door with the disconnect handle in the ON position. The door handle interlock should have provisions to be defeated by qualified maintenance personnel.

2.3 WIRES AND CABLES

All wires and cables must conform to NEMA 250, NEMA ICS 7, NFPA 70.

2.4 NAMEPLATES

Nameplates external to NEMA enclosures must conform with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manufacturer's standard, permanent nameplates for internal areas of enclosures.

2.5 SOURCE QUALITY CONTROL

2.5.1 ASD Test Plan

To ensure quality, each ASD must be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test plans.

2.5.2 ASD Test Report

To ensure quality, each ASD must be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test reports.

PART 3 EXECUTION

3.1 INSTALLATION

Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings. A field representative of the drive manufacturer must supervise the installation of all equipment, and wiring.

3.2 GROUNDING

****

NOTE: Choose one of the bracketed sentences. AC power system grounding is a critical consideration. The control must be solidly grounded to the main distribution system ground. A ground common with electrical welding equipment or large current equipment (5x rating of the control) should not be used. If either of these two conditions exist, use an isolation transformer sized for the ASD control with a wye secondary neutral solidly grounded. Where more than one control is used, ground each directly to the system ground terminal, do not loop ground or install in series. Poor/improper grounding is providing nearly all electric noise issues.

****

Per NEMA ICS 7.2, ASD must be solidly grounded to the main distribution.

3.3 FIELD QUALITY CONTROL

Specified products must be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Conduct performance verification tests in the presence of Government representative, observing and documenting complete compliance of the system to the specifications. Submit a signed copy of the test results, certifying proper system operation before scheduling tests.

3.3.1 ASD Test

A proposed test plan must be submitted to the contracting officer at least 28 calendar days prior to proposed testing for approval. The tests must conform to NEMA ICS 1, NEMA ICS 7, and all manufacturer's safety regulations. The Government reserves the right to witness all tests and review any documentation. Inform the Government at least 14 working days prior to the dates of testing. Perform the ASD test [with the assistance of a factory-authorized service representative][engaging a qualified testing agency's field supervisor currently certified by NETA to supervise on-site testing].

3.3.2 Performance Verification Tests

"Performance Verification Test" plan must provide the step by step procedure required to establish formal verification of the performance of the ASD. Compliance with the specification requirements must be verified by inspections, review of critical data, demonstrations, and tests. The Government reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements. Inform the Government 14 calendar days prior to the date the test is to be conducted.

3.3.3 Endurance Test

Immediately upon completion of the performance verification test, the endurance test must commence. The system must be operated at varying rates for not less than 192 consecutive hours, at an average effectiveness level of 0.9998, to demonstrate proper functioning of the complete PCS. Continue the test on a day-to-day basis until performance standard is met. The contractor is not allowed in the building during the endurance test. The system must respond as designed.

3.4 DEMONSTRATION

3.4.1 Training

Coordinate training requirements with the Contracting Officer. Provide video tapes, if available, of all training provided to the Government for subsequent use in training new personnel. Provide all training aids, texts, and expendable support material for a self-sufficient presentation shall be provided, the amount of which to be determined by the contracting officer.

3.4.1.1 Instructions to Government Personnel

Provide the services of competent instructors with minimum two-year field experience with the operation and maintenance of similar ASDs who will give full instruction to designated personnel in operation, maintenance, calibration, configuration, and programming of the complete control system. Orient the training specifically to the system installed. Instructors must be thoroughly familiar with the subject matter they are to teach. The number of training days of instruction furnished must be as specified. A training day is defined as eight hours of instruction, including two 15-minute breaks and excluding lunch time; Monday through Friday. Provide a training manual for each student at each training phase which describes in detail the material included in each training program. Provide one additional copy for archiving. Provide equipment and materials required for classroom training. Provide a list of additional related courses, and offers, noting any courses recommended. List each training course individually by name, including duration, approximate cost per person, and location of course. Unused copies of training manuals must be turned over to the Government at the end of last training session.

3.4.1.2 Operating Personnel Training Program

Provide one 2-hour training session at the site at a time and place mutually agreeable between the Contractor and the Government. Provide session to train 4 operation personnel in the functional operations of the system and the procedures that personnel will follow in system operation. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. Alarm formats

e. Failure recovery procedures

f. Troubleshooting

3.4.1.3 Engineering/Maintenance Personnel Training

Accomplish the training program as specified. Training must be conducted on site at a location designated by the Government. Provide a one-day training session to train four [_____] engineering personnel in the functional operations of the system. This training must include:

a. System overview

b. General theory of operation

c. System operation

d. System configuration

e. Alarm formats

f. Failure recovery procedures

g. Troubleshooting and repair

h. Maintenance and calibration

i. System programming and configuration

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 31 00 (November 2021)**

Preparing Activity: NAVFAC

Superseding
UFGS-26 31 00 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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11/21

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 31 00 (November 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 31 00 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 31 00

FACILITY-SCALE SOLAR PHOTOVOLTAIC (PV) SYSTEMS
11/21

****

NOTE: This specification covers the requirements for facility-scale solar photovoltaic (PV) systems, and related equipment and materials. Facility-scale systems are typically less than 1 megawatt, maximum DC string input voltage not exceed 1,000 VDC, has the grid interconnection point at the facility's service entrance equipment and generally provides electricity for the facility. Large scale (Utility-scale) systems are considered greater than 1 megawatt and grid connected. Refer to UFC 3-540-08 Utility-Scale Renewable Energy Systems and UFGS-48 14 00 Solar Photovoltaic Systems for the large scale system requirements. Photovoltaic module requirements provided in this document also apply to Section 48 14 00 SOLAR PHOTOVOLTAIC SYSTEMS.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Ensure the following information is shown on the project drawings:

1. Mounting surface features (i.e. drains, hatches,

vents, and lightning protection).

2. Locations of solar PV modules, inverters, combiner and junction boxes, conduits and raceways, system monitoring panels, data acquisition sensors, cable tags with legend, control panels, overcurrent protection, surge protective devices (SPD) if lightning protection is required, and other related equipment and materials.

3. Circuit wiring diagram of solar PV energy system.

4. Mounting structure system for solar PV modules, including building roof or ground.

5. Number, location, and letter designation of nameplates.

6. Troubleshooting instructions.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM D149	(2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D257	(2014) Standard Test Methods for D-C Resistance or Conductance of Insulating Materials
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D903	(1998; R 2017) Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
ASTM D1876	(2008; R 2015; E 2015) Standard Test Method for Peel Resistance of Adhesives (T-Peel Test)
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2765	(2016) Standard Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics
ASTM D5870	(2016) Standard Practice for Calculating Property Retention Index of Plastics
ASTM D7567	(2009) Standard Test Method for Determining Gel Content in Crosslinked Ethylene Plastics Using Pressurized Liquid Extraction
ASTM E308	(2022) Standard Practice for Computing the Colors of Objects by Using the CIE System

ASTM E424	(1971; R 2023) Standard Test Methods for Solar Energy Transmittance and Reflectance (Terrestrial) of Sheet Materials
ASTM E772	(2015; R 2021) Standard Terminology of Solar Energy Conversion
ASTM E1171	(2015) Standard Test Methods for Photovoltaic Modules in Cyclic Temperature and Humidity Environments
ASTM F1249	(2020) Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
ASTM G155	(2021) Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1547	(2018) Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
IEEE C2	(2023) National Electrical Safety Code
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code
ICC IgCC	(2018) International Green Construction Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

ANSI IEC 60529	(2020) Degrees of Protection Provided by Enclosures
IEC 61215	(2005; ED 2.0) Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval
IEC 61646	(2008; ED 2.0) Thin-Film Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval

IEC 61730-1	(2023) Photovoltaic (PV) Module Safety Qualification – Part 1: Requirements for Construction
IEC 61853-1	(2011; ED 1.0) Photovoltaic (Pv) Module Performance Testing and Energy Rating – Part 1: Irradiance and Temperature Performance Measurements and Power Rating
IEC 62446	(2018) Photovoltaic (PV) Systems - Requirements for Testing, Documentation, and Maintenance - Part 1: Grid Connected Systems - Documentation, Commissioning Tests and Inspection
IEC TS 62727	(2012; ED 1.0) Photovoltaic Systems – Specifications for Solar Trackers

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems- Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA IEC 60529	(2004) Degrees of Protection Provided by Enclosures (IP Code)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1	(2021) Fire Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 3767	(2012) NRCA Guidelines for Roof Systems With Rooftop Photovoltaic Components

PILE DRIVING CONTRACTORS ASSOCIATION (PDCA)

PDCA Specification 103	(2007) Installation Specification for Driven Piles

SANDIA NATIONAL LABORATORIES (SAND)

SAND2007-5036	(2007) Performance Model for Grid-Connected. Photovoltaic Inverters

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

UL SOLUTIONS (UL)

UL 969	(2017; Reprint May 2023) UL Standard for Safety Marking and Labeling Systems
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1703	(2002; Reprint Jun 2016) UL Standard for Safety Flat-Plate Photovoltaic Modules and Panels
UL 1741	(2010; Reprint Jan 2015) UL Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
UL 2703	(2015; Reprint Jul 2023) UL Standard for Safety Mounting Systems, Mounting Devices, Clamping/Retention Devices, And Ground Lugs For Use With Flat-Plate Photovoltaic Modules And Panels
UL 6703	(2014, Reprint Jun 2024) Standard for Connectors for Use in Photovoltaic Systems
UL Electrical Construction	(2012) Electrical Construction Equipment Directory

1.2 RELATED REQUIREMENTS

****

NOTE: Include this optional reference to Section 26 08 00 APPARATUS INSPECTION AND TESTING when it is already being used and referred to for other electrical equipment on the project. Coordinate with optional paragraph in PART 3.

Coordinate photovoltaic equipment with Government's cybersecurity requirements and interpretations. Include this optional reference to Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS if the photovoltaic system includes remote control or remote access capability.

Use Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION for an exterior ground mount system.

****

Sections 26 20 00 INTERIOR DISTRIBUTION SYSTEM[, 26 08 00 APPARATUS INSPECTION AND TESTING][, 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS][and 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION] apply to this section with additions and modifications specified herein.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in the IEEE Stds Dictionary.

b. Unless otherwise specified or indicated, solar energy conversion terms used in these specifications, and on the drawings, are as defined in ASTM E772.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Commissioning Plan; G, [_____]

Commissioning Schedule; G, [_____]

SD-02 Shop Drawings

Schematic Diagrams; G, [_____]

Interconnection Diagrams; G, [_____]

Installation Drawings; G, [_____]

Site Plan Drawings; G, [_____]

Riser Diagram and General Notes; G, [_____]

Installation and Assembly Details; G, [_____]

Shop Drawings; G, [_____]

Complete Solar PV System Components and Interconnection Wiring Diagrams; G, [_____]

SD-03 Product Data

Combiner Boxes; G, [_____]

Disconnects; G, [_____]

Inverters; G, [_____]; S

String Inverter Efficiency; G, [_____]; S

Microinverter CEC Efficiency; G, [_____]; S

Roof Mounting Structure for Modules (Racking); G, [_____]

Ground Mounting Structure for Modules; G, [_____]

Photovoltaic Module Backsheet; G, [_____]

Photovoltaic Module Encapsulent; G, [_____]

Photovoltaic Modules; G, [_____]; S

Photovoltaic Wire; G, [_____]

System Monitoring; G, [_____]

System Wiring; G, [_____]

SD-05 Design Data

System Operation; G, [_____]

Calculations; G, [_____]; S

System Performance Calculations; G, [_____]; S

SD-06 Test Reports

NABCEP Acceptance Checks and Tests; G, [_____]

NETA Acceptance Checks and Tests; G, [_____]

Inverter Startup Tests; G, [_____]

Functional Performance Testing; G, [_____]

SD-07 Certificates

Installer; G, [_____]

Materials; G, [_____]

Warranty; G, [_____]

Cybersecurity Equipment Certification; G, [_____]

Commissioning Agent Qualification; G, [_____]

Seismic Certification; G, [_____]

Wind Certification; G, [_____]

SD-08 Manufacturer's Instructions

Installation Instructions; G, [_____]

Manufacturer's Installation Instructions; G, [_____]

SD-10 Operation and Maintenance Data

Electrical Systems, Data Package 5; G, [_____]

Training Course; G, [_____]

SD-11 Closeout Submittals

Solar Posted Operating Instructions; G, [_____]

Solar Training Documentation; G, [_____]

Final Commissioning Report; G, [_____]

Warranty; G, [_____]

As-Built Drawings; G, [_____]

1.5 MAINTENANCE MATERIAL SUBMITTALS

Comply with requirements specified in Section 01 78 00 CLOSEOUT SUBMITTALS.

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officers. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 Installation Drawings

Submit a minimum of three hard copies of drawings for government approval prior to manufacturing and equipment construction or integration. Submit site plan drawings and riser diagram and general notes at a minimum of 610 mm by 915 mm 24 by 36 inches. Submit installation and assembly details at a minimum of 610 mm by 915 mm 24 by 36 inches. Submit at minimum scale of 13 mm 1/2 inch per foot for overview and 51 mm 2 inches per foot for detail.

In addition to requirements in Section 01 33 00 SUBMITTAL PROCEDURES, include the following:

a. All details legible and all text no smaller than 2.54 mm 0.1 inches in height on any drawing. As needed, provide enlargements to ensure clarity of intent.

b. Submit shop drawings at a minimum of 280 mm by 432 mm 11 by 17 inches in size using a minimum scale of 7 mm 1/4 inch per foot, for the exception of drawings not required scale. Shop drawings must include [one][three]-wire diagrams and installation details of photovoltaic (PV) system equipment indicating location as proposed in design drawings, layout and arrangement of PV modules, support and mounting mechanism, inverters, combiner boxes, AC and DC disconnects, equipment enclosures, conduits, monitors, meters, security systems, and all other accessories associated with the installation of the PV system. Wiring diagrams must identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each equipment item.

c. Shop drawings may include legible copies of manufacturer's product literature, with selected items and specifications highlighted thereon.

d. Modifications to original drawings made during installation must be immediately recorded for inclusion into the as-built drawings. When items have changed relative to the approved design, the designer must provide certification indicating that the changes will not negatively affect the system's operation or the structure supporting the system.

1.6.2.1 Installation and Assembly Drawings and Details

Submit site plan drawings, components and interconnection wiring and general notes, and installation and assembly details drawings prior to start of construction. Drawings must include sufficient detail for all parts of the work to enable the Government to check conformity with the requirements of the contract documents. Include in the site plan drawings: topographic and utility survey; bore logs; soils report; site plan(s); site construction details; structural drawings; structural construction details; site electrical plan; and site electrical construction details. Include in the installation and assembly drawings and details: parts lists; assembly drawings; interconnection wiring diagrams; wire and cable schedules; wire and cable termination schedules; instrument plan; instrument and control wire, conduit and cable schedules; instrument wire and cable termination schedule; control diagrams; control sequence of operation; seismic restraint details; and wind restraint details.

1.6.2.2 "As-Built" and Record Drawings

After completion of construction, submit As-built drawings prepared and certified by the construction contractor, showing in red ink, on-site changes to the original construction details and all underground utilities measured from field benchmarks, accurate to within 1" of centerline of the utility. Immediately record for inclusion into the as-built drawings all modifications to original drawings made during installation. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

After submittal and approval of "As-built" drawings, submit Record Drawings, prepared and by the project engineer(s) and architect(s), of the original design drawings reflecting all design changes and contractor noted changes in the "As-built" drawings.

1.6.3 System Operation

Provide a complete description of the function of each component including PV modules, DC wiring, combiner boxes, inverters, AC wiring, AC and DC disconnect switches, and monitoring system. Provide a discussion of the overall system operation.

1.6.4 Installer

Submit NABCEP (North American Board of Certified Energy Practitioners) PV Installation Professional certification, and a resume with references that details least [four][_____] successful projects that, in aggregate, equal or exceed the size of the proposed project. Provide references for each of these referenced projects.

1.6.5 Standard Materials and Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products with satisfactory commercial or industrial use for [2][_____] years prior to bid opening, and past performance documentation with consistent design and bill of materials. Include applications of equipment and materials under similar circumstances and of similar size. Where [two][_____] or more items of the same class of equipment are required, products will be from a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section. Submit proof of compliance with requirements of UL, where material or equipment is specified to comply. The label of or listing in UL Electrical Construction Directory will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved nationally recognized testing laboratory (NRTL) equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters Laboratories may be submitted.

1.6.5.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if the manufacturer has been regularly engaged in the design and production of solar photovoltaic products for a minimum of 5-years. Similar photovoltaic products must have been in satisfactory commercial or industrial use for 5-years prior to bid opening and must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 5-year period.

1.6.5.2 Material and Equipment Manufacturing Date

Products manufactured more than [3][_____] years prior to date of delivery to site must not be used, unless specified otherwise.

[1.6.6 Cybersecurity Equipment Certification

****

NOTE: Select this option if the solar photovoltaic system includes remote control or remote access capability even if the system is separate from an energy management control system. Exercise a Risk Management Framework (RMF) for implementing cybersecurity. Refer to Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS and UFC 4-010-06 Cybersecurity of Facility-Related Control Systems for requirements on incorporating cybersecurity into control system and for general information on the Risk Management Framework (RMF) process as it applies to control system. Coordinate equipment certification with Government's cybersecurity requirements and interpretations.

****

Furnish a certification that control systems are designed and tested in accordance with DoD Instruction 8500.01, DoD Instruction 8510.01, and as required by individual Service Implementation Policy.

]1.6.7 Operation and Maintenance Data

Submit Solar Photovoltaic Systems data package for the following items in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

****

NOTE: To aid in identifying locations of modules for troubleshooting, identify modules on as-built plans according to groups or zones.

****

a. Troubleshooting guide[with as-built plans displaying modules identified according groups or zones, coordinated with activity to organize as required].

b. Warranty.

c. Operation instructions.

d. Preventive maintenance and inspection data, including a schedule for system operators.

1.6.7.1 Electrical Systems

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. In addition to requirements of Data Package 5, include the following for the actual solar photovoltaic (PV) system provided:

a. Service and maintenance information including preventive maintenance, assembly, and disassembly procedures.

b. Complete operation, repair, and maintenance information, detailed to the smallest replaceable unit.

c. Adjustment, trouble-shooting, configuration, tuning, and system calibration instructions.

d. Programming information for the communications and monitoring interface.

e. An instruction manual with pertinent items and information highlighted.

f. A layout drawing showing locations as well as views of equipment; front, top, and side views.

g. A one-line drawing showing all components and interfaces to the electrical system.

****

NOTE: Option to provide spare modules and inverters is prohibited for the Navy, and do not provide for other Services without specific authority of Contracting Officer.

****

h. Prices for spare parts and supply list[including spare modules and inverters].

i. Inverter efficiency report and field acceptance test reports.

j. Actual nameplate diagram.

k. Date of purchase.

1.6.7.2 Training Course

Provide training by a factory trained instructor to provide full instructions to designated Government personnel in the operation, maintenance and programming of the specified systems and equipment. Include safety training for first responders including fire department[,_____][,_____][and][_____] representatives. The proposed Training Course Curriculum (including topics and dates of discussion) indicating that all of the items contained in the operating and maintenance instructions, as well as demonstrations of safety and routine maintenance operations, including testing procedures included in the maintenance instructions, are to be covered. The proposed Training Course must be video-recorded and provided with any PowerPoint slides as part of the final documentation for those that cannot attend. Submit training documentation along with the proposed training date[s], at least [14][_____] days prior to date[s] of proposed training course. Provide training session for [six][_____] personnel specifically oriented to installed equipment, system layout, and user operations.

1.6.8 Bill of Materials

Submit a Bill of Materials listing each product being incorporated into the system. Bill of Materials includes a general description of the product, quantity, and exact manufacturer's model number. Where the manufacturer's model number does not fully identify the product, list options, accessories, or custom features by additional descriptions.

1.6.9 Qualified Testing Organization

Comply with requirements specified in Section 26 08 00 APPARATUS INSPECTION AND TESTING. Engage the services of a qualified testing organization, NABCEP-certified professional, or licensed electrician to provide inspection, testing, calibration, and adjustment of the solar photovoltaic electrical distribution system and equipment listed herein. Organization must be independent of the supplier, manufacturer, and installer of the equipment. The organization must be a first tier contractor.

Submit name and qualifications of organization. Organization must have been regularly engaged in the testing of electrical materials, devices, installations, and regularly engaged in solar PV systems for a minimum of five years.

Organization calibration program requirements:

a. Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. Accuracy: Traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule: Less than or equal to 12 months for both test floor instruments and leased specialty equipment.

d. Dated calibration tables: Visible on all test equipment.

e. Calibrating standard: Higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

    (1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

    (2) Identify the third party laboratory calibrated instrument to verify that calibrating standard is met.

1.6.10 Commissioning Agents

Commissioning Agents Qualifications: Engage commissioning service personnel, that specialize in the types of inspections and tests to be performed.

1.6.11 System Performance Calculations

Submit system performance calculations to show that the components provided will produce the minimum required production of power in accordance with PERFORMANCE REQUIREMENTS paragraph.

1.7 DELIVERY, STORAGE, AND HANDLING

a. Store solar PV modules in their original packaging according to the manufacturer's guidance, and do not remove from packaging until day of installation.

b. If a solar PV module is removed from its packaging, store it according to the manufacturer's guidance.

c. Do not store solar PV modules on-site for more than [12][_____] months.

1.8 WARRANTY

****
NOTE: Option to provide spare modules and inverters is prohibited for the Navy, and do not provide for other Services without specific authority of Contracting Officer.
****

****
NOTE: Generally PV module degradation data is not readily available from the manufacturer. Environmental factors can significantly influence degradation. Long-term field degradation studies indicate 0.5-0.8 percent for monocrystalline and polycrystalline modules. Degradation is higher for thin-film modules at 0.7-1.0 percent. New PV module designs generally have improved degradation rates.
****

Provide a list of all applicable warranties for all equipment and components. Include warranty information, names, addresses, telephone numbers, and procedures for filing a claim and obtaining warranty services. The equipment items must be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Warrant the overall system for both parts and labor for a minimum period of [5][_____] years. Provide specific warranties for solar photovoltaic modules, inverters, combiner boxes, [and]mounting system[, and cybersecurity].

1.8.1 Solar Photovoltaic Modules

Furnish the solar photovoltaic module manufacturer's written warranty. The warranty must be a 25-year linear 80 percent (minimum) power warranty (at the end of the 25th year after purchase an actual minimum power output of 80 percent based on the nameplate rating must be achieved) and not less than 10-years for workmanship material and manufacturing defects from the date of manufacture.

The warranty must state that the malfunctioning solar photovoltaic module must be exchanged by the manufacturer and promptly shipped to the using Government facility. The replacement solar module must be identical to, or an improvement upon, the original design of the malfunctioning solar module.[Provide an extra [_____] percent of spare modules in the event of necessary replacement of malfunctioning installed module.]

1.8.2 Inverters

Furnish the inverter manufacturer's warranty. Inverter to be free from defects in material and workmanship for a minimum of [20][_____] years from the date of manufacture. Inverter device installation, transportation, and on-site storage must not exceed 12 months, thereby permitting [19][_____] years of the [20][_____] year warranty to be in service and energized.

The warranty must state that the malfunctioning inverter must be exchanged by the manufacturer and promptly shipped to the using Government facility, and arrive in no more than ten days. The replacement inverter must be identical to, or an improvement upon, the original design of the malfunctioning inverter.[Provide an extra [_____] percent of spare inverters in the event of necessary replacement of malfunctioning installed inverter.]

1.8.2.1 Inverter Software Updates Title

Provide, at no cost or charge, any inverter software upgrades that become available during the warranty period.

1.8.3 Combiner Boxes

Combiner boxes to be free from defects in material and workmanship for a period of [5][_____] years.

1.8.4 Mounting System

Provide PV mounting system warranty of minimum 15 years.

1.8.5 Warranty Exclusion

The warranty must cover all system malfunctions and failures except those resulting from misuse, abuse, neglect, fire, vandalism, acts of nature, or other causes beyond the control of the Contractor or manufacturer.

[1.8.6 Cybersecurity During Warranty Period

****

NOTE: Select this option if the solar photovoltaic system includes remote control or remote access capability.

****

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

]1.9 CALCULATIONS

If construction deviates from design, provide relevant calculations to demonstrate that new design is satisfactory and approved by a licensed professional engineer.

1.10 CERTIFICATIONS

Provide seismic certification and wind certification, prepared by a licensed professional engineer or National Recognized Testing Laboratory, (NRTL) for all components and assembled systems in accordance with ICC IBC, ASCE 7-16 state and local building codes. Seismic and wind certifications must demonstrate system must withstand wind and seismic requirements as installed and remain online and functional after a seismic or wind event.

1.11 HEALTH AND SAFETY RECOMMENDATIONS

Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS, applies to this section with additions and modifications specified herein.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: System voltage greater than 1,000 VDC is permitted for the utility-scaled PV systems. Refer to UFC 3-540-08 Utility-Scale Renewable Energy Systems and Section 48 14 00 SOLAR PHOTOVOLTAIC SYSTEMS. Air Force does not allow paralleling facility-scale renewable energy systems with any standby power regardless of whether it is for emergency, Critical Operations Power Systems (COPS), or other purposes.

****

a. The PV system described in this document is a facility-scale less than 1 megawatt with system voltage not exceeding 1,000 VDC, [single][multiple] PV systems with a single service, and is of the grid-connected type which provides a direct interconnection of PV system and grid power service supplying building [that do not utilize engine generators][have backup power systems that would never operate in parallel with the grid power and PV system because backup power generator is supplying power via an automatic transfer switch]. The PV system does not include battery/backup storage or secondary electrical generation devices. PV system feeds AC power into the local services when solar energy is available and immediately disconnects from the grid upon loss of grid power to the service in accordance with IEEE 1547 and local utility regulations.

b. PV system must comply with these specifications, all applicable construction document drawings, all applicable codes, and all local authorities having jurisdiction. System must comply with all policies and standards required by the electrical utility having jurisdiction and all applicable incentive program guidelines. PV system equipment includes, but is not limited to, PV modules and electrical insulating components such as encapsulants and backsheets, raceways, inverters, combiner boxes, disconnect switches, wire, conduit, junction boxes, mounting hardware, mounting structure for modules (racking), monitoring and communication equipment.

****

NOTE: Applies if PV array is roof-mounted.

****

[c. Coordinate with roofing to provide certificate of roof warranty not invalidated by solar PV installation. For rigid solar cell PV systems on metal roofing panels, integrate with the roofing system, Section 07 60 00 FLASHING AND SHEET METAL.

]
****

NOTE: Applies if lightning protection system is required.

****

[d. Provide surge protective device (SPD) complying with NFPA 780 requirements and listed to UL 1449.

]2.1.1 System Requirements

Conform electrical installations to IEEE C2, NFPA 70, and requirements specified herein.

****

NOTE: Input values generated from a solar PV computer program such as the System Advisor Model (SAM) computer program or PVWatts or from data supplemented by multiple programs. If another mounting structure is provided, the project documents must fully describe it.

****

a. Solar photovoltaic system characteristics provided includes:

    (1) [_____] minimum rated kW DC output

    (2) [_____] minimum rated kW AC output

    (3) [_____] minimum kWh AC per year for year one

    (4) [_____] system voltage

    (5) [Ground][Roof][_____] mounted.

b. All equipment must be listed and labeled in accordance with NFPA 70 and OSHA-listed nationally recognized testing laboratories (NRTL) and installed in accordance with the listing requirements and the manufacturer's instructions.

c. Provide all accessories needed for a complete, secure, operational grid-tied PV system.

d. Wiring and connections of inverters, PV source circuits, AC branch circuits, and all interconnections must be rated at a minimum for IP65 in accordance with NEMA IEC 60529.

2.1.1.1 System Wiring

****

NOTE: The possible exposure to a corrosive environment should be carefully examined. Even when the correct conductor size and the selected joining (connecting) method have satisfied all the IEEE 837 test requirements, it may be prudent to choose a larger conductor size to compensate for some gradual reduction in the conductor cross section during the design life of the installation where the soil environment tends to promote corrosion. Coordinate

soil environment with Geotechnical Engineer. All wiring must be copper conductor if the Navy eventually takes ownership of system.
****

System wiring must conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and must be in accordance with Section 690 of NFPA 70. Cabling exposed to sunlight must be UV resistant.[All wiring must be copper conductor.]

Provide conduits in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Use galvanized rigid steel conduit above grade and mount on UV resistant high-density polyethylene (HDPE) supports. Conduit below grade must be [Schedule 40 PVC, 25.4 mm 1-inches minimum][Schedule 80 PVC, 25.4 mm 1-inches minimum][as required by Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

[2.1.1.2 Site Design

****
NOTE: Facility-Scale PV system may be up to 1 megawatt. Apply if required.
****

Provide adequate space for personnel, vehicles and equipment throughout the PV array to facilitate installation, inspection and maintenance access to all modules.

]2.1.2 Performance Requirements

****
NOTE: Provide minimum annual renewable energy production requirement of no less than 20 kWh/m^2 6.0 kBtu/ft^2 multiplied by total roof area for single-story buildings, and not less than 32 kWh/m^2 10 kBtu/ft^2 multiplied by total roof area for all other buildings, over the life of the system. This result refers to the rated DC nameplate capacity of the system.
****

System components provided must be selected to achieve a minimum calculated energy production of [_____] kWh per year as required by ICC IgCC.

2.2 PHOTOVOLTAIC MODULES

****
NOTE: For crystalline-silicon modules, manufacturer must submit a Letter of Conformance to certify the consistency and quality of materials used.

TO DOWNLOAD LETTER OF CONFORMANCE, go to: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables
****

****
NOTE: IEC 61215 applies to crystalline-silicon modules and IEC 61646 applies to thin-film modules. Use UL 1703 applies to domestic projects and IEC

61730 applies to international projects.
****

a. PV modules must be [IEC 61215][IEC 61646] compliant and [IEC 61730-1 compliant] [listed to UL 1703], and manufactured in an ISO 9001 certified facility.

****
NOTE: Select commercially-available solar PV module technology that meets the requirements in this UFGS and with the guidance from UFC 3-440-01 Facility-Scale Renewable Energy Systems. The newest technology will provide solar cells made from organic materials, quantum dots, and hybrid organic-inorganic materials (also known as perovskites). The ultra-high efficiency perovskite compound material with a special crystal structure formed through chemistry which would replace silicon. Advance technology of the fine-tuning a mix of lead and tin would provide about 23 percent efficiency of the new solar cell. In comparison, silicon solar panels on the market today have around an 18 percent efficiency rating.
Building-integrated photovoltaics (BIPV) seamlessly blend into building architecture in form of roofs, canopies, facades, and skylight systems. BIPV provides the following benefits: increased thermal and sound insulation; clean and free power output from the sun; decreased O&M costs; zero carbon footprint. Warning: Currently, only monocrystalline and polycrystalline can meet energy density requirements. If BIPV is the chosen technology, there must be at least three manufacturers that offer a viable product. If thin-film is the chosen technology, there must be at last three manufacturers that can be of different thin-film technologies.
****

[b. PV modules must be of [monocrystalline][polycrystalline]technology and

(1) [for rack-mounting.]

(2) [BIPV.]

][c. PV modules must be of thin-film technology and

(1) [for rack-mounting.]

(2) [amorphous.]

(3) [BIPV.]
]
****
NOTE: Select efficiency appropriate to solar PV module technology. If selected technology is not given below, designer of record must have module efficiency measurement verified by a nationally-recognized testing laboratory (NRTL)

under standard test conditions (STC): Irradiance of 1,000 W/m^2, solar spectrum of air mass (AM) 1.5, and module temperature of 25 degrees C 77 degrees F.
****

d. PV module efficiency must be greater than [15 percent for crystalline] [13 percent for thin film] [10 percent for amorphous and BIPV] [_____] technology.

e. PV modules must be of the same manufacturer and model number and consistent sub-components.

f. Submit on cutsheets PV module performance data from the manufacturer that must include a flash test data in accordance with IEC 61853-1, and temperature coefficients at: STC, nominal operating cell temperature (NOCT), low irradiance conditions (LIC), high temperature conditions (HTC), and low temperature conditions (LTC).

****
NOTE: Solar PV modules with single conductor output cables are commonly available. Conduit-ready junction boxes are only necessary in hazardous locations.
****

g. PV module bypass diodes must be inside the solar PV module's [conduit-ready] [single conductor cable] junction box.

h. Photovoltaic wire, wiring methods, and utilization of locking-type connectors must comply with the requirements of NFPA 70 and UL 6703. Provide USE-2 or RHH or RHW-2 wire, and sunlight-resistant wire when exposed to sunlight.

2.2.1 Crystalline Photovoltaic Module Backsheet

****
NOTE: UFC 3-540-08 Utility-Scale Renewable Energy Systems has same module requirements as are described in paragraph PHOTOVOLTAIC MODULES, list item "a.". Facility-scale PV systems allow a maximum system voltage of 1000 VDC and Utility-scale PV systems allow a maximum system voltage greater than 1000 VDC. Use bracketed option for the Facility-scale PV systems if such a clarification is required.
****

a. Backsheet component must consist of a tri-layer construction (minimum thickness of 250 microns 9.8 mils) with outer layers of polyvinyl fluoride (PVF) and an inner layer of polyester for crystalline-silicon modules[with a maximum system voltage of 1000 VDC].

b. Alternate polymeric backsheets consisting of different chemical composition, thickness, or construction must fulfill the safety and performance specifications and acceptance criteria in Table 1. The required component properties in Table 1 must be verified by a test report provided by an OSHA-listed nationally recognized testing laboratory (NRTL) and a cutsheet submitted.

TABLE 1 - PV MODULE BACKSHEET COMPONENT SAFETY AND PERFORMANCE

Items	Test Methods	Specification
Tensile Strength (MPa)	ASTM D882	>=100 (TD) >=100 (MD)
Elongation at Break (percent)	ASTM D882	>=80 (TD) >=100 (MD)
Dimensional Stability (percent, 150 degrees C, 0.5 h)	ASTM D882	<=1.0 (TD) <=1.0 (MD)
Breakdown Voltage (kV)	ASTM D149	>=18
WVTR (g/m^2 day, 37.8 degrees C, 100 percent RH)	ASTM F1249	<=2.5
Interlayer Peeling Strength (N/cm)	ASTM D1876	>=4
Peeling Strength with EVA (N/cm)	ASTM D903	>=40
Damp Heat (85 degrees C, 85 percent RH, 1000 hrs) -Color Change delta b -Elongation Retention (percent) -Appearance	ASTM E1171 ASTM E308/ ASTM D2244 ASTM D882/ ASTM D5870	<=2.5 >=70 No cracking or delamination.
UV Exposure Irradiance of 0.55 W/m^2 at 340 nm (61 W/m^2) using a xenon lamp with a daylight filter (outer layer). Exposure is 4200 hours (260 kWh/m^2 total UV (300-400 nm)) -Color Change delta b -Elongation Retention (percent) -Tensile Retention (percent) -Appearance	ASTM G155 ASTM E308/ ASTM D2244 ASTM D882/ ASTM D5870 ASTM D882/ ASTM D5870	<=2.0 >=70 >=70 No cracking or delamination.

2.2.2 Crystalline Photovoltaic Module Encapsulent

a. Encapsulant component must consist of ethyl vinyl acetate (EVA) with a total nominal (prelamination) thickness of 900 microns 35 mils or greater in the completed module. The EVA must have a minimum of 28 percent VA content. Through statistical process control, the module manufacturer must ensure that the cured EVA has a minimum of 70 percent gel content per ASTM D7567 or ASTM D2765. The EVA must have a UV cutoff wavelength of 360 nm as measured according to ASTM E424. The EVA must have a minimum volume resistivity of 1X10^15 ohm-cm per ASTM D257.

b. Thermoplastic encapsulants consisting of different chemical composition, thickness, or construction must fulfill the safety and performance specifications and acceptance criteria described in Table 2. The required component properties described in Table 2 must be verified by a test report provided by an OSHA-listed nationally recognized testing laboratory (NRTL) and a cutsheet submitted.

TABLE 2 - PV MODULE ENCAPSULANT COMPONENT PROPERTIES		
Items	Test Methods	Specification
Appearance	Visual Examination	No bubble, crack, or delamination.
Gel Content (percent)	ASTM D7567/ASTM D2765	>=70
UV Cutoff Wavelength (nm)	ASTM E424	>=360
Volume Resistivity (ohm-cm)	ASTM D257	>=1X10^15

2.2.3 Electrical Characteristics

Provide high-power type PV module(s), with typical peak power of not less than [315][_____] watts, plus or minus [3][_____] percent power tolerance, under Standard Test Conditions (STC). The AC output must not be less than [80][_____] percent of the DC kWp rating. The individual current harmonics and TRD shall not exceed the limits specified in IEEE 1547.

The operating voltage corresponding to the power output mentioned above must be at least [54][_____] volts. The open circuit voltage of the PV modules under STC should be at least [64][_____] volts. Operate PV module at an ambient temperature range of [minus 40][_____] degrees C [minus 40][_____] degrees F to [plus 85][_____] degrees C [plus 185][_____] degrees F with [100][_____] percent relative humidity.

2.2.4 Terminal Box

Include a terminal box on the module having a provision for opening for replacing the cable, if required.

2.2.5 Nameplate

Include the following on the module nameplate so as to be clearly visible:

a. Name of the Manufacturer or distinctive logo;

b. Model or Type Number;

c. Serial Number;

d. Year of make;

e. Peak wattage rating;

f. Peak voltage; and

g. Peak current.

2.3 INVERTERS

****

NOTE: Where possible, employ maintainable design practices selecting number of inverters for project to prevent the failure of one inverter from affecting the entire system.

****

a. Array-to-inverter kW ratio must not exceed manufacturer recommendations. Inverter must be IEEE 1547 compliant, listed to UL 1741, comply with the latest applicable ANSI and FCC standards and addenda, and inspected before commissioning, testing, and operation of the system. Submit documentation validating system performance requirements.

b. Inverter must be approved by FCC Part 15, Class A as an unintentional radiator.

c. All same-sized inverters supplied must be of the same manufacturer and model number.

****

NOTE: Select the inverter mounting system appropriate for the project environment. Select support structure mount or module attached for microinverters.

****

d. Provide inverter utilizing a [floor-mount][wall-mount][support structure mount][module attached] system.

****

NOTE: Select the NEMA enclosure and enclosure material appropriate for the project environment. Verify that a minimum of three inverter manufacturers can provide inverter enclosure made of the selected material.

****

e. Provide inverter utilizing a [NEMA 6/6P outdoor for coastal environments][NEMA 3R outdoor][NEMA 1 indoor] enclosure in accordance with NEMA 250. Provide enclosure made of [steel][aluminum][stainless steel][polymeric].

f. Provide inverter with anti-islanding protection to prevent back-feeding inverter generated power to the grid in the event of a utility outage. Anti-islanding protection must be listed to UL 1741 and IEEE 1547.

g. Overcurrent protection, ground fault protection, arc fault circuit interrupter (AFCI), and rapid shutdown must comply with the requirements of NFPA 70.

h. Provide inverter with self-diagnostics routines, and remote and local display of operating status and remote monitoring capabilities. Provide inverter compatible with monitoring system and metering system. If capability for remote monitoring and control does not exist, then it must be added.

****

NOTE: Consider implementing an inverter with integrated monitoring system if design allows, for better safety, and operations and maintenance. Most microinverters have this feature as well as some source circuit inverters.

****

[i. Provide inverter with integrated monitoring system. Data monitoring equipment must be able to sustain an overload across its output terminals up the [150][_____] percent load, while supplying any load within its rating and without reducing its output voltage. Fuse power semiconductors in the inverter with fast acting fuses to prevent cascading failures. Provide each fuse with a blown fuse excluding String and Micro inverters and alarm indicating diodes on the control panel.

]

****

NOTE: Where possible, excluding String and Micro inverters, limit inverter size to 500 kW maximum, with a minimum 96 percent efficiency.

****

j. Rate inverter[s] output as [_____] AC kW at unity (1), [_____] phase, [_____] volts, [_____] maximum power point tracking (MPPT) voltage range. The peak inverter[s] power conversion efficiency must be [96][97][_____] percent or greater.

k. Match inverter DC input to the design of the PV module array outputs and account for the following:

(1) The inverter low voltage is 50 percent of the maximum system voltage, to account for 25 year degradation.

(2) Voltage decrease due to high temperatures at project site. Operate inverter at an ambient temperature range of [minus 20][_____] degrees C [minus 4][_____] degrees F to [plus 50][_____] degrees C [plus 122][_____] degrees F with [95][_____] percent humidity (non-condensing).

****

NOTE: If inverters are provided without transformers built-in, provide an isolation transformer to serve multiple inverters for the PV system. Isolation transformer is necessary to isolate inverter AC components from entering the grid. Many utilities do not allow inverters without isolation.

****

l. Provide isolation transformer via [built into each inverter][system central transformer for multiple inverters] to provide safe galvanic separation between the AC side of the inverter and the grid.

****

NOTE: String inverter with integral AC and DC disconnecting means is optional. Disconnecting means may be internal or external to the inverter. Integral disconnecting means is not an option for microinverters.

****

m. [Inverter must include AC and DC disconnecting means. DC and AC disconnecting means must be listed with ratings suitable for the intended use and purpose.]System disconnecting means must meet the requirements of NFPA 70.

2.3.1 String Inverters

****

NOTE: String inverters sized greater than 600kW and DC-optimized string inverters of any size must have an efficiency of at least 98 percent. Conventional and smaller string inverters must have an efficiency of at least 96 percent.

****

a. Submit String Inverter Efficiency of having a weighted average inverter power conversion efficiency of [98 percent][96 percent][93 percent with external isolation transformer] or greater.

b. Allow the use of DC optimizers provided that a design which coordinates the DC optimizers and the inverter(s) is approved by the Contracting Officer.

****

NOTE: Apply if string inverter does not use DC power optimizer. DC power optimizer provides MPPT.

****

[c. Inverter must feature maximum power point tracking (MPPT).

]2.3.2 Micro Inverters

****

NOTE: Micro-inverters may be provided preattached to each solar PV module, or may be installed on the racking or mounting system.

****

a. Provide microinverters [mounted on racking or mounting system by the installer][preinstalled on each solar PV module], and comply with applicable requirements in article INVERTERS.

****

NOTE: The California Energy Commission (CEC) weighted average inverter power conversion efficiency is a standardized method. Inverter efficiencies are updated on the CEC web site https://www.energy.ca.gov/programs-and-topics/programs/solar-equipment-lists

****

b. Submit Microinverter CEC Efficiency as verified by CEC SAND2007-5036 of having a weighted average inverter power conversion efficiency of 96 percent or greater.

c. Inverter must feature maximum power point tracking (MPPT).

2.4 COMBINER BOXES

****

NOTE: If photovoltaic system size becomes larger than 1 megawatt, refer to Section 48 14 00 SOLAR PHOTOVOLTAIC SYSTEMS for large-scaled PV systems.

****

a. All combiner boxes must be listed to UL 1741, and inspected before commissioning, testing, and operation of the system.

b. Provide combiner boxes [in wall-mount][support structure mount], [NEMA 6/6P outdoor for coastal environments][NEMA 4/4X outdoor][NEMA 3R outdoor] [steel][aluminum][stainless steel][polymeric] enclosures in accordance with NEMA 250.

c. Supply combiner boxes designed for use with the inverter provided, and coordinated to the specific PV source circuit design.

d. Include in the combiner box[es] fuses and a bus to combine the outputs of the strings. Each combiner box must be UL 1741 listed and operate at an ambient temperature range of [minus 25][_____] degrees C [minus 13][_____] degrees F to [plus 57][_____] degrees C [plus 135][_____] degrees F. Provide combiner box capable of at least [12][_____] inputs and an input fuse rating of [15][_____] amps.

e. Provide combiner box output terminals for paralleling two conductors for the PV positive and negative, as well as the equipment ground conductors. Run set of wires from the combiner box to the inverter. Provide overcurrent protection and output disconnecting means listed for intended use and purpose that comply with the requirements of NFPA 70.

[2.5 ROOF MOUNTING STRUCTURE FOR MODULES (RACKING)

****

NOTE: Delete paragraph if the project does not utilize a roof mounting structure.

****

****

NOTE: Coordinate with licensed professional engineer for the design of the mounting structure details and connection to existing building. Racking layout may include a gap between continuous rows of modules to allow for ventilation. Coordinate with UFC 3-110-03 Roofing, "Photovoltaic Systems – Rack Mounted Systems"

Coordinate with the Activity and determine if tracking is desired and ensure they understand the unique additional maintenance requirements involved. Refer to UFC 3-440-01 Facility-Scale Renewable Energy Systems for additional information.

****

a. Provide racking [with [single-axis][dual-axis] tracking]for array as indicated on the drawings, including the module azimuth and tilt[for each inverter's separate array].[See paragraph entitled PV TRACKING SYSTEM for tracking requirements.] Provide racking compliant with UL 2703.

****

NOTE: Indicate snow load and wind load requirements as applicable for the location and building

occupancy category in accordance with UFC 3-301-01 Structural Engineering, ASCE 7-16, and IBC modifications in UFC 1-200-01 DoD Building Code.

****

b. Racking and PV array, including modules, hardware, and attachments, must withstand seismic loads, [snow loads], and wind loads as required by ASCE 7-16 and ICC IBC. Coordinate with structural engineer to insure roof will withstand the racking and PV array loads.

****

NOTE: Defer to local code where applicable, UFC 3-301-01 Structural Engineering, ASCE 7-16, and IBC modifications in UFC 1-200-01 DoD Building Code. Otherwise the structure's Seismic Design Category is based on the risk category of the structure, long and short period mapped acceleration parameters for the area, and site class based on soil conditions.

****

c. Racking must be suitable for Seismic Design Category [_____] as defined by ASCE 7-16 and ICC IBC.

d. Submit seismic and wind[and snow] load design calculations for the array mounting system and its attachment to the structure showing compliance with seismic and wind[and snow] requirements while supporting the PV modules.

e. Provide the mechanical hardware for mounting the PV arrays and all other hardware required for assembling the PV modules, and the attachments to the building structure.

****

NOTE: In hostile environments, the additional cost of stainless steel components may be justified. Manufacturer's standard construction material is acceptable only in noncoastal and noncorrosive environments defined as Environmental Severity Classification Category C1 and C2 as determined by Tables A-1 and A-2, Appendix A, UFC 1-200-01 DoD Building Code. Choose bracketed option for hostile environments. All fasteners for PV module aluminum frames must be stainless steel. Galvanized fasteners must not contact aluminum PV module frames or racking. Coordinate with structural engineer and geotechnical report.

****

f. Use array mounting hardware compatible with the site considerations and environment. [Select mechanical hardware for corrosion resistance and durability.]Use a stainless steel, galvanized steel, or aluminum support structure. Do not use wood or plastic components for support.

****

NOTE: Choose bracketed option for corrosive soil. Coordinate with structural engineer and geotechnical report.

****

g. Use cathodic protection compatible with the site considerations and environment. Utilize galvanized anchor[encased in concrete] driven into ground.

2.5.1 Mounting System Base Supports

Fabricate with fastening points integral to the mounting structure. Mounting system supports must be permanently affixed stanchions that are anchored to the building structure. Coordinate height with thickness of roof insulation.

2.5.2 Flashing Boot

Fabricate for precision fit over base support. Coordinate height with base supports.

2.5.3 Base Cap

Fabricate to overlap base support and flashing boot a minimum of 51 mm 2 inches.

2.5.4 Base Cap Gasket

EPDM with self-adhesive closed cell foam or other gasketing material compatible with the roofing material.

2.5.5 Framing

Provide with wall thickness as determined by structural calculations.

2.5.6 Hardware

Bolts, nuts, washers, and screws must be 18-8 stainless steel.

][2.6 GROUND MOUNTING STRUCTURE FOR MODULES

****

NOTE: Delete paragraph if the project does not utilize a ground mounting structure.

****

****

NOTE: Coordinate with licensed professional engineer for the design of the mounting structure details. For tracking array design, refer to UFC 3-440-01 Facility-Scale Renewable Energy Systems and coordinate with Activity.

****

a. Provide racking[with [single-axis][dual-axis] tracking] for array as indicated on the drawings, including the module azimuth and tilt[for each inverter's separate array].[See paragraph entitled PV TRACKING SYSTEM for tracking requirements.] Design all structural components in a manner commensurate with attaining a minimum [50][_____] year design life. Provide racking compliant with UL 2703.

****

NOTE: Indicate snow load, seismic load, and wind load requirements as applicable for the location and

building risk category in accordance with UFC 3-301-01 Structural Engineering, ASCE 7-16, and IBC modifications in UFC 1-200-01 DoD Building Code.

****

b. Racking and PV array, including modules, hardware, and attachments, must withstand [snow loads,]seismic and wind loads as required by ASCE 7-16 and ICC IBC.

****

NOTE: Defer to local code where applicable, UFC 3-301-01 Structural Engineering , ASCE 7-16, and IBC modifications in UFC 1-200-01 DoD Building Code. Otherwise the structure's Seismic Design Category is based on the risk category of the structure, long and short period mapped acceleration parameters for the area, and site class based on soil conditions.

****

c. Racking must be suitable for Seismic Design Category [_____] as defined by ASCE 7-16 and ICC IBC.

d. Submit seismic and wind [and snow] load design calculations for the array mounting system and its attachment to the structure showing compliance with seismic and wind [and snow] requirements while supporting the PV modules.

e. Provide the mechanical hardware for mounting the PV arrays and all other hardware required for assembling the PV modules, and the attachments to the mounting structure.

****

NOTE: In hostile environments defined as Environmental Severity Classification Category C1 and C2 as determined by Tables A-1 and A-2, Appendix A, UFC 1-200-01 DoD Building Code, the additional cost of stainless steel components may be justified. Manufacturer's standard construction material is acceptable only in noncoastal and noncorrosive environments. Choose bracketed option for hostile environments. All fasteners for PV module aluminum frames must be stainless steel. Galvanized fasteners must not contact aluminum PV module frames or racking. Coordinate with structural engineer and geotechnical report.

****

f. Use array mounting hardware compatible with the site considerations and environment. [Select mechanical hardware for corrosion resistance and durability.]Use a stainless steel, galvanized steel, or aluminum support structure. Do not use wood or plastic components for support.

****

NOTE: Choose bracketed option for corrosive soil. Coordinate with structural engineer and geotechnical report.

****

g. Use cathodic protection compatible with the site considerations and environment. Utilize galvanized anchor [encased in concrete] driven into ground.

[2.6.1 Driven Pile

****

NOTE: For appropriate pile type, coordinate with structural engineer and geotechnical report.

****

Provide driven pile as indicated in accordance with PDCA Specification 103.

][2.6.2 Helical Pile

****

NOTE: For appropriate pile type, coordinate with structural engineer and geotechnical report.

****

Provide helical pile as indicated in accordance with ICC IBC. Coordinate helical pile requirements with Section 31 63 26.60 [GROUTED] HELICAL PILES.

]2.6.3 Wind and Seismic Ratings

The mounting system and overall installation must be capable to withstand winds of Category [1][2][3][4] or [5] as defined by the Saffir-Simpson Hurricane Wind Scale for all attachment points and consistent with the manufacturer's installation instructions. Provide wind certifications for all components and assemblies.

All structures and structural elements must be suitable for Seismic Design Category [_____] in accordance with ICC IBC, ASCE 7-16, and all other applicable building codes and standards pertaining to the erection of such structures. Submit seismic and wind [and snow] load design calculations for the array mounting system and its attachment to the structure showing compliance with seismic and wind [and snow] requirements while supporting the PV modules.

][2.7 CAST-IN-PLACE CONCRETE

****

NOTE: Use the first bracketed paragraph when project includes a concrete section in Division 03; otherwise, the second bracketed paragraph may be used. Coordinate requirements with Section 03 30 00 CAST-IN-PLACE CONCRETE. Coordinate with structural engineer and geotechnical report.

****

[Provide concrete associated with electrical work for other than encasement of underground ducts rated for 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.
]

****

NOTE: If concrete requirements are detailed and no cast-in-place section is to be included in the project specification, refer to Section 03 30 00 CAST-IN-PLACE CONCRETE and select such portions as

needed to provide complete requirements in addition to the requirements below.

****

[Provide concrete associated with electrical work as follows:

a. Composed of fine aggregate, coarse aggregate, Portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture. Provide fine and course aggregates in compliance with requirements of ASTM C33, and Portland cement in accordance with requirements of ASTM C150.

b. Fine aggregate: hard, dense, durable, clean, and uncoated sand.

c. Coarse aggregate: reasonably well graded from 4.75 mm to 25 mm 3/16 inch to 1 inch.

d. Fine and coarse aggregates: free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances.

e. Water: fresh, clean, and free from salts, alkali, organic matter, and other impurities.

f. Concrete associated with electrical work for other than encasement of underground ducts: 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise.

g. Slump: Less than 100 mm 4 inches. Retempering of concrete will not be permitted.

h. Exposed, unformed concrete surfaces: smooth, wood float finish.

i. Concrete must be cured for a period of not less than 7 days, and concrete made with high early strength Portland cement must be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer.

j. Air entrain concrete exposed to weather using an air-entraining admixture conforming to ASTM C260/C260M.

k. Air content: between 4 and 6 percent.

l. Welded wire fabric reinforcement must be in accordance with ASTM C185. Deformed bar reinforcement must be in accordance with ASTM 615, Grade 60.

****

NOTE: Coordinate with UFC 1-200-01 DoD Building Code and UFC 3-301-01 Structural Engineering requirements.

****

m. Coordinate reinforced concrete design with environmental severity classification requirements.

]2.7.1 Foundation Anchorage

Anchor mounting structure to concrete pad in accordance with Sections 03 30 00 CAST-IN-PLACE CONCRETE, 05 12 00 STRUCTURAL STEEL, and 05 05 20

POST-INSTALLED CONCRETE AND MASONRY ANCHORS, as required.

][2.8 PV TRACKING SYSTEM

****

NOTE: For tracking array design, refer to UFC 3-440-01 Facility-Scale Renewable Energy Systems which provides the PV tracking system Pros and Cons, and coordinate with Activity.

****

Provide PV tracking system in accordance with IEC TS 62727.

]2.9 PV SYSTEM MONITORING

a. Provide a PV system monitoring panel mounted as indicated.

****

NOTE: Select display option(s) as indicated. Bracketed attributes are optional. Select attribute's source based on use of micro-inverters or string-inverters.

****

b. The following quantities must be viewable [from a [remote][local] [touch]screen display mounted at location as indicated]:

(1) DC Input Voltage from PV [array][modules]

[(2) DC Input Power from PV [system][module]

] (3) DC Input Current from PV [system][module]

(4) AC Phase Current from [inverter][PV system] (average)

(5) AC Voltage from [inverter][PV system] (average)

(6) AC Real Power from [inverter][PV system]

(7) Daily, Weekly, Monthly, Yearly, and Cumulative Energy Production

(8) Fault Status Report

(9) DC Ground Current Report

(10) AC Neutral Current from [inverter][PV system]

[(11) AC Reactive Power from [inverter][PV system]

][(12) AC Apparent Power from [inverter]

] (13) AC Power Factor

[(14) AC Phase Current from inverter (A, B, C)

][(15) AC Voltage from inverter (A, B, C)

][(16) AC Voltage and Current Balance.
]

****

NOTE: Select data acquisition sensors as indicated. Irradiance measures amount of sunlight available. Wind speed, ambient temperature, and PV module temperature can affect performance.

****

c. Provide additional data acquisition sensors to measure [irradiance] [wind speed] [ambient temperature] [PV module temperature]. Any additional data acquisition sensors require a conduit separate from the current conductor conduit.

2.10 PV SYSTEM METERING

****

NOTE: Navy projects require the use of Section 26 27 14.00 20 ELECTRICITY METERING. Air Force projects may require the use of Section 26 27 13.10 30 ELECTRIC METERS. Army projects refer to Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS.

Use a revenue-grade meter if excess power will be sent back to the utility, otherwise use a non-revenue-grade meter.

****

a. Comply with metering requirements in [Section 26 27 14.00 20 ELECTRICITY METERING] [Section 26 27 13.10 30 ELECTRIC METERS] [Section 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS].

b. Provide a [revenue-grade][non-revenue-grade] Interval Data Recording (IDR) meter complete with industry standard telemetry for communications with Ethernet, cellular, or other common output capabilities. Conform to CSI requirements and electrical utility requirements.

c. Connect to a monitoring/data collection recording solar production through time increments applicable to installation and utility standards, with a minimum of 15-minute intervals and 30-day memory.

d. UL listed and conform to ANSI C12.1.

e. Measure kWh, demand, instantaneous power, volts, amps, and watts.

f. Provide UL listed communication and annunciator panel.

2.11 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by the operation and maintenance personnel. The operating instructions include the following:

a. Wiring diagrams, schematic diagrams, interconnection diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Array layout showing the locations of all DC and AC disconnects.

c. Start up, proper adjustment, operating, and shutdown procedures.

d. Safety precautions.

e. The procedure in the event of equipment failure.

f. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions do not fade when exposed to sunlight and secure to prevent easy removal or peeling.

2.12 MANUFACTURER'S NAMEPLATE

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. For PV modules, a label on the back of the module is acceptable.

2.13 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings.

****

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified. Each nameplate inscription identifies the function and, when applicable, the position. Nameplates are of melamine plastic, 3.175 mm 0.125 inch thick, white with black center core. Surface is of matte finish. Square corners. Accurately align lettering and engrave into the core. Minimum size of nameplates is 25.4 mm by 63.5 mm 1 inch by 2.5 inches. Lettering is a minimum of 6.35 mm 0.25 inch high normal block style.

2.14 PV EQUIPMENT MARKING AND WARNING LABELS

Provide PV equipment listed or be evaluated for the application and have a field label applied in compliance with NFPA 70.

****

NOTE: Voltage must not exceed 1,000 VDC.

****

Provide warning signs for the enclosures of electrical equipment having a nominal rating exceeding 600 volts.

a. Provide PV equipment with UL 969 weather-resistant marking and warning labels in compliance with NFPA 1 and NFPA 70.

[b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 355 mm by 255 mm 14 inches by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 75 mm 3 inches high white letters on a red and black field.

]

****

NOTE: Refer to UFC 3-501-01 Electrical Engineering and UFC 3-560-01 Operation and Maintenance: Electrical Safety requirements. UFC 3-560-01 approved the following types of arc flash label formats: General label; General label referring to OSHA; Details label, compliant with NFPA 70E; General label that refers to a separate arc flash calculation for requirements; Label for equipment that has not received adequate maintenance or testing; Label for equipment where an arc flash calculation identifies an available incident energy greater than 40 cal/cm^2. The arc flash label format can be modified provided that the required information is included. For Army projects, provide arc flash labels in accordance with NFPA 70E.

****

[c. Provide warning signs for arc flash protection in accordance with [NFPA 70E] [as indicated] for all electrical equipment and components that are requiring examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electrical arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible and readable from each accessible side to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

]2.15 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS

****

NOTE: Verify cable labeling requirements with the local Activity. Provide lead cable tags only when specifically required by the Activity.

****

Provide tags for each power cable or wire located in manholes, handholes, and vaults. The tags must be polyethylene[or sheet lead]. Do not provide handwritten letters.[The first position on the power cable tag denotes the voltage. The second through [sixth] [_____] positions on the tag identify the circuit.[The next to last position denotes the phase of the circuit and must include the Greek "phi" symbol.] The last position denotes the cable size.][Tag legend must be as indicated.]

2.16 GROUNDING AND BONDING

a. Provide properly sized equipment grounding conductors. Equipment grounding conductors must be insulated stranded copper, except that sizes 10 AWG and smaller must be solid copper. Insulation color must be continuous green for all equipment grounding conductors, except that wire sizes 4 AWG and larger shall be identified per NFPA 70.

b. Provide grounding lugs for aluminum PV solar module frames of either stainless steel or tin-coated copper.

c. Bonding conductors must be bare stranded copper, except that sizes 10 AWG and smaller must be bare solid copper. Bonding conductors must be stranded for final connection to motors, transformers, and vibrating equipment.

d. Provide bonding fittings on concentric/eccentric knockouts with metal conduits for circuits over 250 volts in accordance with NFPA 70.

e. Provide bonding fittings for ferrous metal conduits enclosing grounding electrode conductors in accordance with NFPA 70.

[2.17 PV LIGHTNING PROTECTION SYSTEM

****

NOTE: Provide a lighting risk assessment calculation in accordance with UFC 3-501-01 Electrical Engineering and UFC 3-575-01 Lightning and Static Electricity Protection Systems requirements, and if lighting protection is a design requirement, include this paragraph in the Specification.

****

Provide PV Lightning Protection for electrical and mechanical systems in accordance with Section 26 41 00 LIGHTNING PROTECTION SYSTEM and NFPA 780.

]PART 3 EXECUTION

3.1 MANUFACTURER'S INSTALLATION INSTRUCTIONS AND INSTALLATION DRAWINGS

a. Complete all electrical work in accordance with NFPA 70.

b. Provide all permanent and temporary shoring, anchoring, and bracing required by the nature of this work in order to make all parts absolutely stable and rigid, even when such shoring, anchoring, and bracing are not explicitly called for.

c. Install the solar PV system in accordance with this section, installation drawings, and the printed installation instructions of the manufacturer.

d. Follow the manufacturer's installation recommendations to ensure no electricity is being fed to the grid and that all available disconnects are in the open position and fuses are not installed during wiring operations. Utilize on-site measurements in conjunction with engineering designs to accurately cut wires and layout before making permanent connections. Locate wires out of the way of windows, doors, openings, and other hazards. Ensure wires are free of snags and sharp edges that have the potential to compromise the wire insulation. If the system is roof-mounted, it must have direct current ground fault protection in accordance with NFPA 70. Ensure breakers in combiner box are in the off position (or fuses removed) during combiner box wiring. Ensure wires and conduit are not installed as a trip hazard.

e. Attach solar PV modules to the mounting structure according to the manufacturer's instructions and approved plans.

f. Install instrumentation according to the manufacturer's instructions, with control panels located as indicated.

3.1.1 Wiring Methods

Furnish and install conductors required to connect incoming and outgoing circuits. Install conductors with conduits, boxes, and terminal cabinets in a totally enclosed installation. Install wiring in accordance with NFPA 70 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.2 Electrical Connections

a. Use twist on wire connectors listed for the environment (i.e. wet, damp, direct burial) and installed per manufacturer's instructions.

b. Use listed power distribution blocks.

c. Use terminals containing more than one conductor listed for multiple conductors.

d. Use connectors and terminals used for fine strand conductors that are listed for use with such conductors.

e. Utilize appropriate tools for connector type as recommended by the manufacturer.

f. Tighten and secure module connectors.

g. Provide corrosion protection in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and by adding a stainless steel isolating washer between components of incompatible metals on the racking structure.

h. Rate all enclosures for electrical connections and interconnections for [NEMA 6 in accordance with NEMA 250][or][IP67 in accordance with ANSI IEC 60529].

3.1.3 Disconnects

****

NOTE: UFC 3-440-01 Facility-Scale Renewable Energy Systems and NFPA 70 requires providing a Rapid Shutdown of PV Systems on Buildings. PV system circuits installed on or in buildings must include a rapid shutdown function to reduce shock hazard for firefighters using the Rapid Shutdown Initiation Devices. Multiple PV system initiation device(s) must consist of not more than six switches or six sets of circuit breakers, or a combination of not more than six switches and sets of circuit breakers, mounted in a single enclosure, or a group of separate enclosures.

****

Provide disconnecting means in accordance with NFPA 70 requirements.

a. Install disconnects for all current carrying conductors of the PV source.

b. Install disconnects for the PV equipment. For inverters and other equipment that are energized from more than one source, group and identify the disconnecting means. Equipment disconnecting means or its remote operating device or the enclosure providing access to the disconnecting means must be capable of being locked in the open position when not within sight or not within 3 m 10 ft of the equipment.

c. Install disconnects and overcurrent protection for all ungrounded conductors in ungrounded (transformerless) PV power systems.

d. Install disconnecting means with a rapid shutdown function using the rapid shutdown initiation devices as specified in NFPA 70. Each device's "off" position must indicate that the rapid shutdown function has been initiated for all PV systems connected to that rapid shutdown initiation device.

e. Disconnecting means equipment that performs the rapid shutdown function, other than initiating devices, must be listed for providing rapid shutdown protection.

f. Buildings with rapid shutdown disconnecting means must have a permanent label as specified in NFPA 70.

3.1.4 Overcurrent and Overvoltage Protection

a. Install the PV interconnect overcurrent protective device as indicated in accordance with NFPA 70. Overcurrent devices used in PV system dc circuits must be listed for use in PV systems.

****

NOTE: Applies if lightning protection system is required. Use UFC 3-520-01 Interior Electrical Systems requirements also.

****

[b. Install overvoltage surge protective device (SPD) as indicated and in accordance with NFPA 780 and NFPA 70. PV surge protective devices must be listed for use in PV system and marked "DC" or "PV SPD." If the system inverter is more than 30 m 100 ft from the closest combiner or recombiner box, provide additional PV SPDs at the PV output circuit adjacent to the inverter.

]3.1.5 Fire Safety

****

NOTE: Follow UFC 3-440-01 Facility-Scale Renewable Energy Systems requirements for access to Smoke Ventilation. Office of State Auditor (OSA) may provide safety requirements for roof mounted equipment that requires access for periodic maintenance.

****

Firestop conduit that penetrates fire-rated walls, fire-rated partitions, or fire-rated floors in accordance with Section 07 84 00 FIRESTOPPING. For all buildings other than one and two-family dwellings and townhouses provide access to roof mounted PV systems by providing a minimum 1.8 m 6 ft wide clear perimeter around the edges of the roof.[Follow OSA safety requirements for roof mounted PV system equipment that requires access for periodic maintenance.]

3.2 GROUNDING

3.2.1 PV System Grounding

****

NOTE: Racking manufacturers allow for different grounding schemes. Follow the racking manufacturer's grounding scheme. NFPA 70 approves the use of a single made electrode for the system-grounding electrode, if its resistance does not exceed 25 ohms. In most applications, it is desirable to have a maximum resistance of much less, typically 5 ohms or less.

****

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding [25] [_____] ohms.[Ground according to racking manufacturer's recommendations.]

Install grounding lugs in locations on the solar PV module as designated by the module manufacturer, using stainless steel machine screws of the thread size provided in the pre-tapped holes, along with a stainless steel star washer placed between the grounding lug and the solar module frame.

[3.2.2 Grounding Electrodes

****

NOTE: Include if grounding electrodes are provided.

****

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

****

NOTE: Include if lighting protection is a design requirement. Use UFC 3-550-01 Exterior Electrical Power Distribution requirements.

****

[Provide ground ring electrode in accordance with NFPA 780 encompassing the perimeter of each ground-mounted PV array. Interconnect all building grounding electrode systems, including lighting protection.

]]3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

3.3.1 Roof Mounted Structures

a. Ensure roof access points, paths, and clearances are as indicated.

b. The solar photovoltaic system details must be accepted by warranty roofing system manufacturer prior to installation. Upon completion of a rooftop system installation, obtain written certification that the rooftop warranty is still valid.

    (1) For installation on a new roof, coordinate with roof manufacturer of new roof and obtain certificate.

(2) For installation on existing roof, coordinate with activity to provide certificate of continued validity of warranty from manufacturer.

c. Flash and counter-flash all roof penetrations in accordance with ICC IBC.

****

NOTE: The latest analyses of the phenomenon of heat transfer arrived at optimized gap to be between 100 mm to 110 mm 3.94 inches to 4.33 inches beyond which the benefits are negligible.

****

d. Provide a minimum 115 mm 4.5 inches air gap between the solar PV module frame and the roof surface.

e. Comply with requirements in NRCA 3767 for working with different roof types.

[3.3.2 Ground Mounted Structures

****

NOTE: Include if ground mounted structures are provided, and indicate appropriate foundation type.

****

[a. For concrete ballast or pad, install in accordance with Section 05 12 00 STRUCTURAL STEEL.

][b. For driven pile, install in accordance with PDCA Specification 103.

][c. For helical pile, install in accordance with ICC IBC.

]3.3.2.1 Installation

****

NOTE: Indicate appropriate installation requirements. Account for snow depths and known snowdrift patterns to determine locations and mounting heights in Snowbelt locations.

****

In order to maximize potential energy output from each PV system, the system must be sited to maximize the amount of sunlight it receives daily, without shading from adjacent structures or trees. Existing and proposed land uses adjacent to the PV system must not be taller than the PV location.

a. Site Preparation:

b. Prepare the site for system installation by removing vegetation, grading for adequate drainage and avoid standing water on site[, and excavating and compacting foundations for individual module installation].[Provide access roads, pathways, fencing and other improvements as necessary for site access and security.][Provide vegetation barrier to keep surrounding area free from array-shading vegetation as required.]

c. [Provide walking and vehicle space throughout the PV array to facilitate installation, inspection, and maintenance access to all modules in accordance with NFPA 70 and IEEE C2.][Maintain a minimum ground clearance of [3][_____] m [10][_____] ft around arrays. Maintain a minimum ground clearance of [1][_____] m [3][_____] ft below arrays for all site-specific conditions including possible array-shading vegetation, ground/vegetation maintenance, and/or array-shading snowfall.][Account for snow depths and known snowdrift patterns to determine locations and mounting heights in Snowbelt locations.]

****

NOTE: Comply with UFC 3-260-01 Airfield and Heliport Planning and Design when PV system is sited near an airfield or related facilities and equipment used to sustain flight operations.

****

[d. Airspace Coordination:

e. When PV system to be sited near an airfield or related facilities and equipment used to sustain flight operations submit plans to the airfield manager and safety officer (among other stakeholders) for approval. Contact the DoD Siting Clearinghouse and provide applicable data items required for the DoD Siting coordination. Avoid glare from solar panels following FAA interim policy. Provide Glare and Glint calculation using Sandia Labs software which is maintained by ForgeSolar now. Use link https:/share-ng.sandia.gov/glare-tools.

]][3.3.3 Tracking Equipment

****

NOTE: Apply if tracking equipment is provided.

****

Install solar tracking equipment in accordance with IEC TS 62727.

]3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting must be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.5 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.6 WARNING SIGN MOUNTING

a. Display calculated maximum and minimum voltages and their respective amperages on engraved warning labels.

****

NOTE: Coordinate arc flash warning label requirements with paragraph PV EQUIPMENT MARKING AND WARNING LABELS, list item "c" requirements.

****

b. Display information on the arc flash warning labels [in accordance with

NFPA 70E][as indicated].

c. Provide the number of signs required to be clearly visible and readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.7 CABLE TAG INSTALLATION

Install cable tags in each manhole, handhole, and vault as specified, including each splice.[Tag only new wire and cable provided and existing wire and cable which are indicated to have splices and terminations provided.] Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes, handholes, and vaults.

[3.8 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Provide if ground mounted system. Use the first bracketed option when project includes a concrete section in Division 03; otherwise, the second bracketed option (metric) or the third bracketed option (English) may be used.

****

Provide cast-in-place concrete work in accordance with the requirements of [Section 03 30 00 CAST-IN-PLACE CONCRETE][ACI 318M][ACI 318].

]3.9 FIELD QUALITY CONTROL

****

NOTE: Use Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION for an exterior ground mount system.

****

Perform in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM [and 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

3.9.1 Performance of NABCEP Acceptance Checks and Tests

Perform all inspections using a NABCEP-certified professional and in accordance with NABCEP inspection procedures, and in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests.

3.9.1.1 PV Modules

a. Visual and Mechanical Inspection

    (1) Solar PV module manufacturer, model, and number of modules must match the approved plans.

    (2) Solar PV modules must be in good conditions (including but not limited to no broken glass or cells, no discoloration, frames not damaged).

b. Electrical Tests

    (1) Verify output of PV modules according to manufacturer's recommendations and NABCEP practices.

3.9.1.2 Inverters

a. Visual and Mechanical Inspection

   (1) Inverter manufacturer, model, and number of inverters must match the approved plans.

   (2) Inverters must be in good condition.

b. Electrical Tests

   (1) Verify output of inverters according to manufacturer's recommendations and NABCEP practices.

3.9.2 Performance of NETA Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.9.2.1 Grounding System

a. Visual and Mechanical Inspection

   (1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

   (1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod, perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

   (2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e. pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.9.3 Functional Acceptance Tests

a. Provide final and complete commissioning of the solar PV system in accordance with IEEE 1547.

b. Verify that all electrical components are installed and connected according to the requirements of the PV electrical drawings, specifications, and manufacturer's written instructions.

c. Before starting or operating the system, check continuity of all conductors and grounding conductors to verify that there are no faults and that all equipment has been properly installed according to the manufacturer's recommendations. Check factory instructions to see that installations have been made accordingly. Check equipment for any damage that may have occurred during shipment, after delivery, or during installation. Replace damaged equipment.

d. Before starting or operating the system, obtain a final inspection approval and final inspection from the Contracting Officer. Be present on site for both of these inspections.

e. Make final adjustments to all inverters and monitoring equipment so that they will be placed in an acceptable operating condition. Adjustable parameters must be set so that the PV system will produce the maximum possible amount of energy on an annual basis.

3.10 COMMISSIONING

****

NOTE: Section 01 91 00.15 BUILDING COMMISSIONING is intended for building systems, however, the basic requirements are applicable to PV commissioning processes. Section 01 91 00.15 will need to be tailored for PV systems when compiling project specifications.

****

Conduct Commissioning, after the system is installed and is ready for operation, in accordance with Section 01 91 00.15 BUILDING COMMISSIONING, item (6) renewable energy generation, to verify that the completed and installed system meets the requirements of IEEE 1547. Tailor for non-building systems.

3.10.1 Commissioning Agent Qualification

Individual qualified in testing protective equipment (e.g., professional engineer, factory-certified technician, licensed electrician with experience in testing protective equipment) must perform or directly supervise commissioning tests.

3.10.2 Commissioning Plan and Schedule

Develop and implement a commissioning plan and commissioning schedule in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

3.10.3 Start-up Pre-functional Checklists

Carry out a checklist of startup requirements and conduct a series of safety tests to ensure proper installation, safe operation, and performance conforming to specification.

3.10.4 Functional Performance Testing

Prepare test procedures and conduct functional performance testing of the installed system. Include the following test requirements:

a. All inverter startup tests as specified by the inverter manufacturer in the inverter operation manual;

b. Actual power;

c. Loss of grid;

d. Grid resume;

e. Data monitoring check out;

f. V_{oc} measurement of every source circuit and log it;

g. Verify tightness of all wiring terminations;

h. Verify proper markings and labeling of all wire terminations and enclosures;

i. Verify startup/shut down procedures;

j. Verify system [5][_____] minutes delay upon restart;

k. Verify PV array quick connectors are fully mated and wires are neatly secured;

l. Verify no debris on the modules, no damaged or broken modules;

m. Verification and inspections (see IEEE 1547.1 7.2)

n. Field-conducted type and production tests (see IEEE 1547 7.3)

o. Unintentional islanding functionality test (see IEEE 1547.1)

p. Cease-to-energize functionality test (see IEEE 1547.1)

q. Unintentional islanding functionality test (see IEEE 1547.1)

r. Cease-to-energize functionality test (see IEEE 1547.1 7.5)

s. Revised settings (see IEEE 1547.1 7.6)

3.10.5 Functional Performance Testing Results

Coordinate, observe and record the results of the functional performance testing. Coordinate retesting as necessary until satisfactory performance is verified. Verify the intended operation of individual components and system interactions under various conditions and modes of operation.

Document items of non-compliance in materials, installation or operation. Immediately address observed non-conformance and deficiencies in terms of notification to responsible parties, and provide recommended actions to correct deficiencies.

3.10.6 Final Commissioning Report

Prepare and submit final commissioning report. Summarize all tasks, findings, conclusions, and recommendations of the commissioning process in accordance with IEC 62446. Include the results of all tests and a listing of the final settings.

3.11 FINAL ACCEPTANCE

The acceptance of the solar PV system occurs only after all deficiencies identified by the functional acceptance tests and commissioning report are corrected[, and the system operates successfully during a [30][_____] day initial testing period].

The Contracting Officer must sign appropriate certificates, if equipment and systems are operating satisfactorily in accordance with the specifications, stating the system's operation has been tested and accepted at the end of the final start-up and testing.

3.12 CLOSEOUT ACTIVITIES

3.12.1 Demonstration

Upon completion of the work and at a time approved by the Contracting Officer, provide instructions by a qualified instructor to the Government personnel in the proper adjustment, system operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Government personnel must receive training comparable to the equipment manufacturer's factory training. Instructor must provide a separate training course for the monitoring system.

3.12.2 Instructor's Qualification Resume

****

NOTE: Use the most appropriate and available option to provide the necessary training.

****

Instructor(s) must be employee(s) of [installer] [manufacturer] [certified solar photovoltaic system training program]. Instructors must be thoroughly familiar with all parts of the installation and trained in operating theory as well as practical operation and maintenance work. Submit the name(s) and qualification resume(s) of instructor(s) to the Contracting Officer for approval.

3.12.3 Training

****

NOTE: Use the most appropriate hours to provide the necessary training. Video record instruction for absent and future employees.

****

Furnish training service by a factory-trained representative. Document that each qualified employee has received the required training in accordance with 29 CFR 1910. Maintain all training documentation in a central location for the entire employee's employment duration. Minimum documentation data includes employee's name, training name, and date(s) of training.

The training period must consist of a total of [2] [_____] hours of normal working time and begin after the system is functionally completed but prior to final acceptance tests. Submit the training course curriculum for approval, along with the proposed training date, at least 14 days prior to the date of proposed conduction of the training course. Instruction must be [video-recorded and]given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. Provide [video recording and]any PowerPoint slides as part of the final documentation for those that cannot attend. Extend safety training to fire department representatives. Coordinate with Contracting Officer for Fire Department first responder training.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 32 15 (May 2024)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-26 32 15.00 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 26 32 15

ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES

05/24

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 32 15 (May 2024)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-26 32 15.00 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 32 15

ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES
05/24

****

NOTE: This guide specification covers the requirements for stationary generator sets up to 2500 kilowatt capacity.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification will require modification for applications where automatic transfer switches are not used. When generators are to be operated in parallel with utility or with other generators, and for medium voltage (greater than 600 volt) systems, contact the responsible Facilities Engineering Command (FEC) for determination as to which specification or sample specification is to be used. If Echelon III Reach-back Support from NAVFAC LANT or NAVFAC PAC is required for shop drawing review or field acceptance

testing, the FEC technical representative (electrical engineer) editing this document for a specific project must contact the appropriate Capital Improvements Electrical Engineering Office for consultation during the design stage of the project.

On drawings, show:

1. Engine-generator set foundation design and details.

2. Piping for ventilation of engine crankcase to atmosphere where required.

3. Details of exhaust, cooling water, and fuel piping, including penetrations through walls and roofs showing piping sleeves and exterior flashing where applicable.

4. Fuel day tank capacity where applicable.

5. Location of remote alarm annunciator where applicable.

6. Circuiting for the jacket coolant heating system, electric motor driven radiator fan where applicable, fuel supply system, starting battery charger, remote alarm annunciator storage battery charger where applicable, and generator space heater.

7. Grounding Plan. For applications using transfer switches, the transfer switch must be four pole and the generator must be grounded as a separately derived system.

This specification is for procurement of engine-generator sets which are suitable for serving general purpose and commercial-grade loads (loads which may be served by an electric utility). These are loads which can endure or recover quickly from transient voltage and frequency changes (as much as 30 percent transient voltage drop, and plus or minus 5 percent frequency deviation, with recovery time of 2 seconds). For applications where strict control of voltage, frequency, and transient response is required, provide uninterruptible power supplies.

This specification is for procurement of fossil-fueled engine-generator sets. Transient-load-response performance characteristics of natural gas, digester gas, propane, and liquefied petroleum gas engines differ significantly from those of diesel engines because of the fuel differences. Consult manufacturers for sample specifications.

Select the features and fill in blanks with values appropriate for the design condition. This

specification does not apply to 400 Hz applications.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B31.1	(2024) Power Piping
ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2013) Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM B395/B395M	(2018) Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM D975	(2020) Standard Specification for Diesel Fuel Oils

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

EGSA 101P	(1995) Performance Standard for Engine Driven Generator Sets

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1	(2000; R 2011) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation

	of Electrical Insulation
IEEE 43	(2013) Recommended Practice for Testing Insulation Resistance of Rotating Machinery
IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 115	(2019) Guide for Test Procedures for Synchronous Machines: Part I Acceptance and Performance Testing; Part II Test Procedures and Parameter Determination for Dynamic Analysis
IEEE 120	(2023) Master Test Guide for Electrical Measurements in Power Circuits
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE 484	(2019) Recommended Practice for Installation Design and Implementation of Vented Lead-Acid Batteries for Stationary Applications
IEEE 485	(2020) Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
IEEE 519	(2022) Standard for Harmonic Control in Electrical Power Systems
IEEE C2	(2023) National Electrical Safety Code
IEEE C50.12	(2005; R 2010) Standard for Salient Pole 50 HZ and 60 Hz Synchronous Generators and Generation/Motors for Hydraulic Turbine Applications Rated 5 MVA and above
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C57.13.1	(2006; R 2012) Guide for Field Testing of Relaying Current Transformers

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60034-2A	(1974; ED 1.0) Rotating Electrical Machines Part 2: Methods for Determining Losses and Efficiency of Rotating Electrical Machinery from Tests (Excluding Machines for Traction Vehicles) Measurement of Losses by the Calorimetric Method

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 3046	(2002, 2006, 2009, 2001) Reciprocating Internal Combustion Engines - Performance--Part 1, 3, 4, 5, 6
ISO 8528	(1993; R 2018) Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets--Part 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NEMA MG 1	(2021) Motors and Generators
NEMA PB 1	(2011) Panelboards
NEMA PB 2	(2011) Deadfront Distribution Switchboards
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
NEMA/ANSI C12.11	(2006; R 2019) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 37	(2024) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 54	(2024) National Fuel Gas Code
NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 99	(2024) Health Care Facilities Code
NFPA 110	(2025) Standard for Emergency and Standby Power Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE ARP892	(1965; R 1994) DC Starter-Generator, Engine
SAE J537	(2016) Storage Batteries

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5624	(2024; Rev X) Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-DTL-16884	(2017; Rev P) Fuel, Naval Distillate
MIL-STD-461	(2015; Rev G) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60	Standards of Performance for New

	Stationary Sources

UL SOLUTIONS (UL)

UL 142	(2006; Reprint Jan 2021) UL Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 429	(2013; Reprint Mar 2021) Electrically Operated Valves
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 891	(2019) UL Standard for Safety Switchboards
UL 1236	(2015; Reprint Feb 2021) UL Standard for Safety Battery Chargers for Charging Engine-Starter Batteries
UL 1437	(2006) Electrical Analog Instruments - Panel Board Types

1.2 RELATED MATERIALS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply to this section, except as modified herein.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy

and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Engine-Generator Set and Auxiliary Equipment; G, [_____]

Auxiliary Systems; G, [_____]

Detailed Drawings; G, [_____]

Acceptance; G, [_____]

SD-03 Product Data

Harmonic Requirements; G, [_____]

Engine-Generator Set Efficiencies; G, [_____]

Emissions; G, [_____]

filters; G, [_____]

special tools; G, [_____]

Remote Alarm Annunciator; G, [_____]

Engine-Generator Parameter Schedule

Heat Exchanger

Generator

Manufacturer's Catalog

Site Welding

Spare Parts

Onsite Training

Vibration-Isolation

Posted Data and Instructions; G, [_____]

Instructions; G, [_____]

Experience

Field Engineer

General Installation

Exciter

SD-05 Design Data

Performance Criteria

Sound Limitations; G, [_____]

Integral Main Fuel Storage Tank

Day Tank

Power Factor

Heat Exchanger

Time-Delay on Alarms

Cooling System

Vibration Isolation

Battery Charger

Capacity Calculations for Engine-Generator Set; G, [_____]

Brake Mean Effective Pressure (BMEP) Calculations; G, [_____]

Torsional Vibration Stress Analysis Computations; G, [_____]

Capacity Calculations for Batteries; G, [_____]

Turbocharger Load Calculations; G, [_____]

SD-06 Test Reports

Performance Tests

Factory Inspection and Tests

Factory Tests

Onsite Inspection and Tests; G, [_____]

Acceptance Checks and Tests; G, [_____]

Functional Acceptance Tests; G, [_____]

Maintenance Procedures; G, [_____]

Operation and Maintenance Manuals; G, [_____]

Inspections; G, [_____]

Functional Acceptance Test Procedure; G, [_____]

SD-07 Certificates

Cooling System

Vibration Isolation

Prototype Test

Reliability and Durability

Fuel System Certification; G, [_____]

Start-Up Engineer; G, [_____]

Instructor's Qualification Resume; G, [_____]

Engine Emission Limits; G, [_____]

Sound Limitations

Site Visit

Current Balance

Materials and Equipment

Factory Inspection and Tests

SD-09 Manufacturer's Field Reports

Engine Tests; G, [_____]

Generator Tests; G, [_____]

Assembled Engine-Generator Set Tests; G, [_____]

SD-10 Operation and Maintenance Data

Preliminary Assembled Operation and Maintenance Manuals; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and the paragraph ASSEMBLED OPERATION AND MAINTENANCE MANUALS.

SD-11 Closeout Submittals

Posted Data and Instructions; G, [_____]

Training Plan; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation must also conform to the code.

1.4.2 Site Welding

Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING. For all other welding, qualify procedures and welders in accordance with ASME BPVC SEC IX.

a. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1.

b. Submit a copy of qualifying procedures and a list of names and identification symbols of qualified welders and welding operators.

c. Submit a letter listing the welder qualifying procedures for each welder, complete with supporting data such as test procedures used, what was tested to, and a list of the names of all welders and their identification symbols.

d. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the Contracting Officer 24 hours in advance of qualification tests which must be performed at the work site, if practical.

e. The welder or welding operator must apply the personally assigned symbol near each weld made as a permanent record.

1.4.3 Vibration Limitation

Limit the maximum engine-generator set vibration in the horizontal, vertical, and axial directions to 0.15 mm 6 mils (peak-peak RMS), with an overall velocity limit of 24 mm/second 0.95 inches/second RMS, at rated speed for all loads through 110 percent of rated speed. [Install a vibration isolation system between the floor and the base to limit the maximum vibration transmitted to the floor at all frequencies to a maximum of [_____] (peak force).][The engine-generator set must be provided with vibration isolation in accordance with the manufacturer's standard recommendation.] Where the vibration isolation system does not secure the base to the structure floor or unit foundation, provide seismic restraints in accordance with the seismic parameters specified.

1.4.4 Torsional Analysis

Submit torsional analysis including prototype testing or calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, plus/minus 10 percent.

1.4.5 Performance Data

Submit vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor. Also submit a description of seismic qualification of the engine-generator mounting, base, and vibration isolation.

1.4.6 Seismic Requirements

****

NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73, 23 05 48.19, and 26 05 48, properly edited, must be included in the contract documents.

****

[Seismic requirements must be in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT, 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT] [as shown on the drawings].

1.4.7 Experience

Each component manufacturer must have a minimum of 3 years' experience in the manufacture, assembly and sale of components used with stationary engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler must have a minimum of 3 years' experience in the manufacture, assembly and sale of stationary engine-generator sets for commercial and industrial use. Submit a statement showing and verifying these requirements.

1.4.8 Field Engineer

The engine-generator set manufacturer or assembler must furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. The field engineer must have attended the engine generator manufacturer's training courses on installation and operation and maintenance of engine generator sets. Submit a letter listing the qualifications, schools, formal training, and experience of the field engineer.

1.4.9 Detailed Drawings

Submit detailed drawings showing the following:

a. Base-mounted equipment, complete with base and attachments, including anchor bolt template and recommended clearances for maintenance and operation.

b. Starting system.

c. Fuel system.

d. Cooling system.

e. Exhaust system.

f. Electric wiring of relays, breakers, programmable controllers, and switches including single line and wiring diagrams.

g. Lubrication system, including piping, pumps, strainers, filters, [heat exchangers for lube oil and turbocharger cooling,] [electric heater,] controls and wiring.

h. Location, type, and description of vibration isolation devices for all applications.

i. The safety system, including wiring schematics.

j. One-line schematic and wiring diagrams of the generator, exciter, regulator, governor, and instrumentation.

k. Panel layouts.

l. Mounting and support for each panel and major piece of electrical equipment.

m. Engine-generator set rigging points and lifting instructions.

1.4.10 Auxiliary Systems Engine-Generator Set and Auxiliary Equipment Drawing Requirements

Submit drawings pertaining to the engine-generator set and auxiliary equipment, including but not limited to the following:

a. Certified outline, general arrangement (setting plan), and anchor bolt details. Show total weight and center of gravity of assembled equipment on the steel sub-base.

b. Detailed elementary, schematic wiring, and interconnection diagrams of the engine starting system, jacket coolant heating system, engine protective devices, engine alarm devices, engine speed governor system, generator and excitation system, and other integral devices.

c. Detailed elementary, schematic wiring; and interconnection diagrams of the fuel system, starting battery system, engine-generator control panel, generator circuit breaker[, and remote alarm annunciator].

d. Dimensional drawings or catalog cuts of exhaust silencers, radiator, fuel day tanks, fuel oil cooler, valves and pumps, intake filters, vibration isolators, and other auxiliary equipment not integral with the engine-generator set.

1.4.11 Auxiliary Systems Drawing Requirements

****

NOTE: When the engine-generator set installation includes field installed exhaust, air intake, fuel oil cooler, or jacket coolant water systems (i.e., the engine-generator set is installed internal to a building in lieu of in a self-contained outdoor enclosure), include the following paragraph.

****

Submit drawings showing floor plan arrangement of[exhaust,][air intake,][

fuel oil cooler,][and][jacket coolant water] systems including arrangement of piping and pipe sizes.

1.4.12 Vibration Isolation System Certification

Submit certification from the manufacturer that the vibration isolation system will reduce the vibration to the limits specified in the paragraph VIBRATION ISOLATION.

1.4.13 Fuel System Certification

When the fuel system requires a fuel oil cooler as described in the paragraph FUEL OIL COOLER, submit certification from the engine manufacturer that the fuel system design is satisfactory.

1.5 DELIVERY, STORAGE, AND HANDLING

Properly protect materials and equipment, in accordance with the manufacturers recommended storage procedures,before, during, and after installation. Protect stored items from the weather and contamination. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

Deliver equipment on pallets or blocking wrapped in heavy-duty plastic, sealed to protect parts and assemblies from moisture and dirt. Protect and prepare batteries for shipment as recommended by the battery manufacturer. Store auxiliary equipment at the site in covered enclosures, protected from atmospheric moisture, dirt, and ground water.

1.6 EXTRA MATERIALS

Provide [two] [_____] sets of special tools and [two] [_____] sets of filters required for maintenance. Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. One handset must be provided for each electronic governor when required to indicate and/or change governor response settings. Furnish 4 liters one gallon of identical paint used on engine-generator set in manufacturer's sealed container with each engine-generator set.

Wrenches and tools specifically designed and required to work on the new equipment, which are not commercially available as standard mechanic's tools, must be furnished to the Contracting Officer.

Provide proposed operating instructions for the engine-generator set and auxiliary equipment laminated between matte-surface thermoplastic sheets and suitable for placement adjacent to corresponding equipment. After approval, install operating instructions where directed.

1.7 MAINTENANCE SERVICES

Submit the operation and maintenance manuals and have them approved prior to commencing onsite tests.

1.7.1 Operation Manual

Provide [three] [_____] copies of the [manufacturers standard operation manual] [operation manual in 216 by 279 mm8-1/2 by 11 inch three-ring binders]. Sections must be separated by heavy plastic dividers with tabs which identify the material in the section. Fold drawings with the title block visible, and placed in 216 by 279 mm8-1/2 by 11 inch plastic pockets with reinforced holes. The manual must include:

a. Step-by-step procedures for system startup, operation, and shutdown;

b. Drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems with their controls, alarms, and safety systems;

c. Procedures for interface and interaction with related systems to include [automatic transfer switches] [fire alarm/suppression systems] [load shedding systems] [uninterruptible power supplies] [_____].

1.7.2 Maintenance Manual

Provide [three] [_____] copies of the [manufacturers standard maintenance manual] [maintenance manual containing the information described below in 216 x 279 mm8-1/2 x 11 inch three-ring binders]. Separate each section by a heavy plastic divider with tabs. Fold drawings with the title block visible, and placed in plastic pockets with reinforced holes. The manual must include:

a. [Procedures for each routine maintenance item.][Procedures for troubleshooting.][Factory-service, take-down overhaul, and repair service manuals, with parts lists.]

b. The manufacturer's recommended maintenance schedule.

c. A component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components.

d. A list of spare parts for each piece of equipment and a complete list of materials and supplies needed for operation.

1.7.3 Assembled Operation and Maintenance Manuals

The contents of the assembled operation and maintenance manuals must include the manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA and the manufacturer's O&M information specified in Section 26 36 23 AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH.

a. Manuals must be in separate books or volumes, assembled and bound securely in durable, hard covered, water resistant binder, and indexed by major assembly and components in sequential order.

b. A table of contents (index) must be made part of the assembled O&M. The manual must be assembled in the order noted in table of contents.

c. The cover sheet or binder on each volume of the manuals must be identified and marked with the words, "Operation and Maintenance Manual."

1.8 SITE CONDITIONS

Protect the components of the engine-generator set, including cooling system components, pumps, fans, and similar auxiliaries when not operating and provide components capable of the specified outputs in the following environment:

a. Site Location: [_____]

b. Site Elevation: [_____] meters[_____] feet above mean sea level.

c. Ambient Temperatures:

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NOTE: Ambient temperatures, design wind velocity, and prevailing wind direction must be as defined by UFC 3-400-02, Design Engineering Weather Data.

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(1) Maximum [_____] degrees C[_____] degrees F dry bulb, [_____] degrees C[_____] degrees F wet bulb.

(2) Minimum [_____] degrees C[_____] degrees F dry bulb.

d. Design Wind Velocity: [_____] km/h[_____] mph.

e. Prevailing Wind Direction: [_____]

f. Seismic Zone: Zone [_____] as defined by ICC IBC.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

a. Provide and install each engine-generator set complete and totally functional, with all necessary ancillary equipment to include: air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine-generator set must satisfy the requirements specified in the Engine-Generator Parameter Schedule. Submit certification that the engine-generator set and cooling system function properly in the ambient temperatures specified.

b. Provide each engine-generator set consisting of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and all other necessary ancillary equipment which may be mounted separately. Assemble sets having a capacity of 750 kW or smaller and attach to the base prior to shipping. Sets over 750 kW capacity may be shipped in sections. Provide set components that are environmentally suitable for the locations shown and that are the manufacturer's standard product offered in catalogs for commercial or industrial use. Provide a generator strip heater for moisture control when the generator is not operating. Identify any nonstandard products or components and the reason for their use.

2.1.1 Engine-Generator Parameter Schedule

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NOTE: Where multiple engine-generator sets of different sizes or applications are to be provided, a Parameter Schedule should be shown on the contract drawings (one for each engine-generator set to be

installed). If only one engine-generator set is provided (or multiples of the same type, size, etc.), the schedule may be in the body of the specification. Note that the specifications refer to the Engine Generator Parameter Schedule and the designer must provide one each by that name.

Some load applications require precise generator output frequency, voltage, level waveform characteristics and control of transient response. Most loads do not require stricter control than most off-the-shelf engine generator sets can provide. The criticality of the output and response characteristics can affect: selection of the governor type, whether it is to be isochronous or droop, and its steady state bandwidth; selection of the voltage regulator parameters; transient recovery time for frequency and voltage; maximum voltage and frequency deviation for a transient event; and because of the maximum deviations and transient recovery times, the sizing or oversizing of the engine and generator. The notes below are included to assist the designer in making informed choices when filling in the Engine Generator Parameter Schedule.

Power Ratings and Industry Terminology. The following definitions are from the Electrical Generating Systems Association Standard 101P, Engine Driven Generating Sets. Stationary, diesel-engine-driven, electric generator sets are divided into the following four rating categories: EMERGENCY STANDBY, LIMITED RUNNING TIME, PRIME POWER, and INDUSTRIAL.

"EMERGENCY STANDBY RATING means the power that the generator set will deliver continuously under normal varying load factors for the duration of a power outage." It must be understood that this definition uses the term "normal varying load condition factors". Most manufacturers use this terminology to indicate that their units typically are not rated for continuous operation at the nameplate rating, but rather that the units provided are rated for continuous operation at 70 to 80 percent of their nameplate rating, with periodic loading up to 100 percent of the nameplate rating for short (cyclical) periods during a power outage. Additionally, the designer must analyze the load characteristics and profiles of the load to be served to determine the peak demand, maximum step load increase and decrease, motor starting requirements represented as starting kVA, and the non-linear loads to be served. This information should be included in the engine-generator set parameter schedule or on the drawings for each different unit provided. For this application service load is the peak estimated loading to be placed on the engine generator set. Peak demand calculation provides a figure from which

to determine the service load. When specifying an engine-generator be sure to specify what the peak load is and how much is continuous.

"LIMITED RUNNING TIME RATING means the power that the generator set will deliver when used as a utility type power source, typically in load curtailment type service, for a limited number of hours, where there are non-varying load factors and/or constant dedicated loads."

"PRIME POWER RATING means the power that the generator set will deliver when used as a utility type power plant under normal varying load factors to run continuously. This rating requires a minimum momentary overload capability of 10 percent."

"INDUSTRIAL RATING means the power that the generator set will deliver 24 hours per day when used as a utility type power plant where there are non-varying load factors and/or constant dedicated loads."

Overload Capacity. Overload capacity is only for PRIME rated units. Delete for standby applications.

Gross bhp rating of engine must be the total rated power output before deducting power requirements of electric motor-driven equipment or engine driven radiator fan.

Net brake power rating of engine must include deductions for the total power requirements of electric motor-driven or engine-driven accessories as defined in ISO 3046. Net ratings must include a deduction in power output for cooling media system power requirements including radiator fans and any other power consuming devices required to provide cooling as specified.

Power Factor. Commercial engine-generator power ratings are usually based on 0.8 power factor. Select 0.8 unless the application requires one more stringent.

Loading. When specifying engine-generator sets, the designer will analyze the load characteristics and profiles of the load to be served to determine the peak demand, maximum step load increase and decrease, motor starting requirements represented as starting kVA, continuous and non-continuous (cyclical / periodic), and the non-linear loads to be served. This information should be included in the engine-generator set parameter schedule or on the drawings for each different unit provided. For this application, service load is the peak estimated loading (continuous plus non-continuous) to be placed on the engine generator set.

Peak demand calculation provides a figure from which to determine the service load. For prime applications the service load should include spare capacity for future load growth and spinning reserve (reserve generation beyond that required to satisfy immediate needs and/or system peak demands). Spare capacity for prime applications should be based on the facility master plan load projections.

Motor Starting Load. Motor starting requirements are important to properly size engine generator sets because the starting current for motors can be as much as six times the running current, and can cause generator output voltage and frequency to drop, even though the gensetengine-generator has been sized to carry the running load. The designer must analyze the motor loads to determine if the starting characteristics of a motor or a group of motors to be started simultaneously will cause objectionable engine-generator performance. Provide a motor starting kVA value for the largest motor or combination of motors to be started simultaneously. An increase in the size rating of the engine-generator may be necessary to compensate for the inrush current. This assists the engine-generator supplier in properly sizing the engine generator set.

Maximum Speed. The maximum allowable speed for emergency standby applications is 1800 RPM. If there is not specific requirement or user requirement for slower speed machines, select 1800 RPM. Selection of the maximum 1800 RPM does not preclude provision of slower speed machines, for example, in the larger sizes (above 2000 kW), where 1800 RPM machines may not be available. However, for prime power or continuous duty plant applications, the lowest total cost of ownership would result by specifying a much lower speed, as recommended in UFC 3-540-04N, Section 5.1, Table 7. Lower speed engines require fewer overhauls, fewer oil changes, have a higher availability factor, and can be more fuel efficient. Even though prime duty power plants are the minority case, improper specification can result in very large increase in cost over the life of the installation. Frequently these plants are installed forward in contingency environments at FOBs or base camps which by nature demand reliable power at the lowest total cost. Furthermore, as prime sources of power these plants are relied upon as "the grid" and must perform as such for reliable power. Additionally, several manufacturers' medium speed (600-1200 RPM) engines will tolerate the varieties of fuel found in CONUS and OCONUS with minimal or no power or durability degradation.

Heat Exchanger Type. Fin-tube heat exchangers (radiators) are the predominate method of cooling.

Specify either a fin-tube or a shell-tube heat exchanger for each engine-generator set. Heat exchangers located remote from the engine-generator set (i.e., not mounted on the engine-generator set base) will be shown on the project plans, including the power source for associated fans and pumps.

Governor. The type of governor to be used on each engine generator set should be identified as isochronous or droop on the engine-generator set parameter schedule. Isochronous governors hold frequency at the setpointset-point frequency (within bandwidth) for all steady state loads from 0 to 100 percent load and are required for applications where severe demands are made on voltage and frequency regulation. Droop governors allow frequency to droop to the specified percentage proportional to steady state loads from 0 to 100 percent load and are generally acceptable for general purpose and commercial applications.

Engine-generator sets in stand alonestand-alone service (isolated bus) may utilize either droop or isochronous governors. The designer should analyze the application and loads to determine if the more expensive isochronous unit is actually required. Droop units provide added stability (less engine cycling) in single unit applications where constant speeds are not critical and are less expensive than isochronous governors.

Engine-generator sets in parallel (on an isolated bus) may also utilize either droop or isochronous governors. Load swings are shared proportionally based on the governor droop settings. The load will be split equally among the units for all units equipped with isochronous governors with load sharing controls, or if all units have droop governors that are set with the same droop. "Lead units" are often designated in multiple unit applications for tighter frequency control by setting one governor at a much lower droop than the others. A "lead unit" can be designated for gensetengine-generators equipped with isochronous governors if all units have governors with load sharing controls. In this case the "lead unit" will accept all load swings and the other units will remain at a constant load. When all units have droop governors, the "lead units" will accept most of the load swings and the other units will equally split a small portion of the load. If isochronous governors are specified for two or more units to be paralleled on an isolated bus, the governors must be specified with load sharing controls. For applications involving units in parallel operation which are not operator supervised the designer should specify a load-sharing system which can proportionally load two or more sets in parallel, each having isochronous governors. Generators for

use with existing generators in parallel applications must have similar characteristics. Droop paralleling is specified for electrical and electro-hydraulic governors where interconnection of all controls is not possible such as when paralleling to a large electrical utility grid network. When paralleling two or more droop units with a utility grid (or with other droop units), to achieve load sharing, the unit governors must be compatible, their speed settings must be matched, and the droop must be set the same on all units. Droop adjustment range of 0 to 7 percent is typical for mechanical-hydraulic governors, and 0 to 10 percent is typical for electro-hydraulic governors. Isochronous units should not be paralleled with an infinite bus (utility grid system) without also specifying synchronizing and governor-load sharing controls. Delete speed droop adjustment for isochronous governors in non-parallel applications.

Frequency Bandwidth. Governor frequency bandwidth defines the allowable steady state variation in frequency and is typically quite small for commercially available governors (typically less than plus or minus 0.4 percent with plus or minus 0.25 percent readily available). The predominant type of device loads which are susceptible to steady state frequency deviations less than plus or minus 0.4 percent are those which employ switching power supplies (computers and variable frequency drives). The designer should select the least restrictive value for bandwidth for the application.

Voltage Regulators. Solid state regulators are readily available which maintain the voltage level (regulation or voltage droop) to plus or minus 0.5 percent. Voltage regulator bandwidth is important relative primarily to transient response. EGSA Standard 100R-1992 defines three performance classes for voltage regulators: standard (2 percent bandwidth); high (1 percent bandwidth); and precision (0.5 percent bandwidth). Select the least restrictive bandwidth necessary to satisfy the application requirement.

Generator frequency and voltage should be shown on the engine-generator set schedule. (For example: 208Y/120 volts, 3-phase, 4-wire).

Sub-transient Reactance. The sub-transient reactance of a generator is the impedance characteristic which determines current during the first cycle after a system short circuit condition is presented to the generator. Therefore, it is used to determine the necessary interrupting capacity of the engine-generator circuit interrupting device. It also is utilized to predict generator response to non-linear loads. Typical values for generator sub-transient reactance are

found in IEEE Standard 141. Sub-transient reactance is specified in per unit of the generator rated kVA. Also, see the following discussion on non-linear loads.

Non-linear Loads: Non-linear loads are addressed in IEEE 519. They are loads that draw a non-sinusoidal current waveform when supplied by a sinusoidal voltage source. Typical non-linear loads include solid state switching power supplies, computer power supplies (including those found in desktop PC's, uninterruptible power supplies, variable frequency drives, radar power supplies, and solid state ballasts in fluorescent light fixtures. They cause distortion of the source voltage and current waveforms that can have harmful effects on many types of electrical equipment and electronics, including generators. Non-linear loads are similar to short circuits in that they provide momentary, sub-cycle-duration, short-circuiting of two phases. Switching power supplies consist of SCR/thyristor-controlled rectifier bridges which act as three single-phase loads, each connected across two phases of the power system. When the SCR/thyristors are switched on and off a notch in the voltage waveform will occur as a result of an instantaneous phase-phase short-circuit during the commutation of current. A low generator sub-transient reactance minimizes the voltage waveform distortion in the presence of such loads. For this reason when the non-linear loads comprise 25 percent or more of the loads served, the generator sub-transient reactance should be limited to no more than 0.12. Delete Sub-transient Reactance from the Engine-Generator Parameter Schedule where the engine-generator manufacturer is responsible for sizing the generator breaker and where the non-linear loads served are less than 25 percent.

Generators are particularly vulnerable to control problems and instability, excessive winding heating, neutral overheating, reduced efficiency, reduced torque, shaft fatigue, accelerated aging, and induced mechanical oscillations when non-linear loads are applied without careful consideration of the generator's capability to supply them. Measures which can be used to mitigate the effects of non-linear loads on generators include: procurement of low impedance generators with special windings to compensate for the additional heating; installation of harmonic filter traps; avoidance of self-excited generators; use of 2/3 pitch factor (rather than 5/6 pitch) generator windings; and generator derating with oversized neutrals.

For large non-linear loads, filter traps which are tuned to the dominant harmonic frequencies of the non-linear loads should be procured/provided with

the load component. This approach is normally less costly than procurement of specially designed or de-rated generators.

For combinations of linear and non-linear loads where the percentage of non-linear loads is small relative to the capacity rating of the generator (25 percent or less), standard generator configurations are normally acceptable.

Provide a list of the non-linear loads in the parameter schedule, either on the drawings (and denoted on the single-line diagram) or in tabular form in the specification section. The list should contain a description of the load including equipment type, whether the rectifier is 6-pulse or 12-pulse, kVA rating, and frequency. Provide a linear load value (kVA at PF) which represents the maximum linear load demand when non-linear loads will also be in use. The generator manufacturer will be required to meet the total harmonic distortion limits established in IEEE 519. Delete the non-linear load paragraph when non-linear loads are not served from the engine-generator set.

Maximum Step Load Increase. Maximum step load increase is used to account for the addition of block loads. These affect engine-generator set frequency and voltage output and usually initiate governor and regulator response. The change in engine-generator set output and the response of the governor and regulator defines the transient loading response. In the size range covered by this specification (and for standby applications) acquisition of full load in one step is typical for major engine-generator manufacturers (voltage deviation of 30 percent or less, frequency deviation of plus 5 percent, recovery time 3 to 5 seconds, typical). If the application requires a more stringent response, specify the actual maximum step load and add the allowable deviations and recovery times to the Engine Generator Set Parameter Schedule. If it is critical enough to add these requirements, also add the Transient Response Test to verify the results in the field. It should be noted that this adds significant cost to the cost of an engine-generator. The designer should provide the actual loads to be applied to the engine-generator set because specification of maximum step load increases of 75 or 100 percent requires significant oversizing of engines and generators and/or addition of mass to fly-wheel, all of which add cost. Additionally, oversizing of engines causes maintenance problems and increases operating costs. The following percentages may be used when the actual load acquisition rate cannot be determined. A maximum step load increase of 25 percent should be used for prime rated sets, 50 percent for optional standby rated sets with step

loading, and 100 percent for legally required standby (emergency) service with no step loading.

Transient Response Criteria (short time duration). Engine-generator-set response and recovery times vary according to the size of the set, the block load, and the controls specified. Normal response to addition of a block load will include dips in either output voltage or frequency or both and possible "overshoot" as the governor and voltage regulator respond to bring the voltage and frequency back within bandwidth. Normal response to loss of a block load will include an upward spike in output voltage or frequency back within bandwidth. The Maximum Voltage and Frequency Deviation apply to under-voltage / under-frequency ("dips") from the addition of block loads and any undershoot resulting from the recovery of an upward spike, as well as overvoltage / over-frequency (upward spikes) from the loss of block loads and any overshoot resulting from the recovery of a dip.

Cost Impact. If stringent transient-response requirements are specified, the manufacturer may select engine and generator models which have nominal rating much larger than the service load; may use an unnecessarily expensive governor; and may use a higher inertia flywheel. The designer should investigate what may actually be provided so that the cost estimate will be reasonably accurate and to confirm the selected transient requirements are not unnecessarily stringent. A maximum size for the engine-generator set may be needed to avoid the problems associated with a small load on a large capacity set.

The designer must determine the cost benefits of providing an uninterruptible power system for transient ride-through versus purchasing a generator with stringent transient response requirements. In determining the allowable voltage and frequency variation and recovery times, analyze the effects on equipment performance and recovery. Consult the NEMA utilization equipment standards to determine the maximum allowable voltage dips/overshoots (excursions).

Maximum Voltage Deviation. Select the 5 percent Maximum Voltage Deviation option only if communication equipment or other sensitive electronic equipment are a critical part of the load, and there is no UPS provided. Fluorescent lights can tolerate a maximum of 10 percent voltage variation. NEMA induction motors and control relays can tolerate a maximum of 10 percent variation, for 30 cycles and one cycle respectively. Solenoids (brakes, valves, clutches) and ac and dc starter coils can tolerate a maximum of minus 30 percent variation, for 1/2 cycle, 2 cycles (dropout), and 5

- 10 cycles (dropout) respectively. (The times listed in cycles are not given to define the recovery time back to bandwidth, but to assist the designer in defining the maximum allowable voltage deviation.) The designer should realistically asses the need for limiting the transient voltage dip to less than 30 percent.

Maximum Voltage Deviation [5] [10] [30] [_____] with Step Load Increase percent of rated voltage.

Maximum Frequency Deviation. Computers can usually tolerate only plus or minus 0.5 Hz variation, so an UPS is normally required where computer services should not be interrupted, or where system recovery times are critical. Inverters can tolerate plus or minus 2 Hz variation. NEMA induction motors and control relays can tolerate a maximum of 5 percent frequency variation. (The times listed in cycles are not given to define the recovery time back to bandwidth, but to assist the designer in defining the maximum allowable frequency deviation.) The designer must be realistic in assessing the needs of the facility to be served so that unnecessarily stringent requirements are not specified.

Maximum Frequency Deviation [2.5] [5] [_____] with Step Load Increase frequency.

Recovery Time Back to Bandwidth. The designer should determine the required recovery time for the loads served. The recovery time to bandwidth is not critical to operation of most equipment if the voltage and frequency do not deviate from the critical limits, or if momentary interruption is acceptable to the loads being served. The primary importance of this requirement is to ensure that the engine generator set recovers and stabilizes after load changes. Most engine generator sets can respond to 100 percent block loads and return to voltage and frequency bandwidths within 15 - 20 seconds, depending on the size of the machine (RPM, relative mass of the rotating elements, and ambient conditions).

Transient Recover Time [_____] seconds with Step Load Increase (Voltage).

Transient Recovery Time [_____] seconds with Step Load Increase (Frequency).

Maximum Step Load Decrease (without shutdown). An engine generator set should be capable of being unloaded in a single step without tripping offline. In these situations the voltage and frequency transients are of no concern because there is no load being served.

Nominal Step Load Decrease. Step load decrease is

used to account for dropping of block loads. This affects engine-generator set frequency and voltage output and usually initiates governor and regulator response. The change in engine-generator set output and the response of the governor and regulator defines the transient loading response. Where the load served may be sensitive to voltage and frequency variation due to significant load decrease, include the items below in the Parameter Schedule. The Nominal Step Load Decrease provides the engine-generator manufacturer with the information necessary to set the governor response for load decreases such than an over-speed (over-frequency) condition does not occur. The cost of engine-generator sets increase by large percentages for smaller frequency and voltage deviations from bandwidth and improved recover times. Carefully analyze the user's need for restrictions on frequency, voltage, and waveform characteristics. If required, add the following to the Engine Generator Set Parameter Schedule and also add the Transient Response Test to verify the results in the field.

Nominal Step Load [25] [50] [75] Decrease at [_____] PF percent of Service Load.

Transient Recovery Time [_____] seconds with Step Load Decrease (Voltage).

Transient Recovery Time [_____] seconds with Step Load Decrease (Frequency).

Maximum Voltage Deviation [5] [10] [30] with Step Load Decrease [_____] percent of rated voltage.

Maximum Frequency Deviation [2.5] [5] [_____] with Step load Decrease percent of rated frequency.

Maximum Time To Start and Assume Load. Choose 10 seconds for emergency-standby applications (critical for life safety). NFPA 70 requires that standby engine-generator sets used in emergency applications start and assume load in 10 seconds. Most commercially available engine generator sets are capable of starting and assuming load within 10 seconds, however, a default value of 20 seconds is non-restrictive and provides a reasonable maximum value for non-critical applications.

Temperature Management. The designer is responsible for temperature control in the space occupied by the engine generator set. However, because the engine-generator supplier normally provides the engine cooling system (and block heaters where required), the designer must provide ambient conditions under which the engine generator must operate, so that the supplier can size the equipment. Typically, high temperature provides the

most restrictive condition, therefore the designer must design air-flow of adequate temperature and sufficient quantity to maintain the temperature of the generator and engine space within acceptable limits. This requires the designer to consult manufacturers' literature and/or representatives to determine the nominal heat rejection to the surroundings at rated gensetengine-generator capacity (from all heat sources) to determine the required cooling or air flow through the engine generator set room or enclosure. In turn the manufacturer must submit the specific operating data in order for the contracting officer/designer to verify that the proposed equipment meets the design parameters.

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Engine-Generator Set and Auxiliary Equipment Capacity Calculations for Engine-Generator Set

ENGINE-GENERATOR PARAMETER SCHEDULE	
Identification	Make/Model
Electrical Characteristics	
Power Rating	[Prime][Limited Running Time][Emergency Standby][Industrial] Gross bhp rating / Net brake power rating [_____] kW at 0.8 power factor
Governor Type	Type Make / Model [Isochronous][Droop]
Overload Capacity (Prime applications	110 percent of Service Load for 1 hour in 12 consecutive hours
Service Load	[_____] kVA (maximum) [_____] kVA (continuous)
Motor Starting kVA (Max.)	[_____] kVA
Power Factor	[0.8][_____] lagging
Engine-Generator Applications	[stand-alone][parallel with infinite bus][parallel with other generators on an isolated bus][parallel with other generators on an infinite bus]
Voltage Regulation (No Load to Full Load)(Stand-alone	plus or minus 2 percent (maximum)
Voltage Bandwidth	plus or minus [0.5][1][2] percent
Frequency	[50][60] Hz
Voltage	[_____] volts

ENGINE-GENERATOR PARAMETER SCHEDULE	
Phases	[3 Phase, Wye][3 Phase, Delta][1 Phase]
Minimum Generator Sub-transient	[_____] percent Sub-transient
Nonlinear Loads	[_____] kVA
Max Step Load Increase	[25][50][75] [100] percent of Service Load at [_____] PF
Transient Recovery Time with Step Load Increase	[_____] seconds
Transient Recovery	[_____] seconds
Time with Step Load Increase (Frequency)	
Maximum Voltage Deviation with Step Load	[5][10][30][ ] percent of rated voltage
Maximum Frequency Deviation with	[2.5][5][ ] percent of rated frequency
Max Step Load Decrease (without	100 percent of Service Load at [_____] PF
Frequency Bandwidth (steady state)	plus or minus [ ][0.4][0.25] percent
Frequency Regulation (droop) (No Load to Full Load)	[3][_____] percent (maximum)
Frequency Bandwidth (steady state)	plus or minus [_____][0.4][0.25] percent
Reactances	Synchronous reactance, Xd Transient reactance, X'd Sub-transient reactance, X"d Negative sequence reactance, X2 Zero sequence reactance, Xo
Capacity Calculations	
Calculations must verify that the engine-generator set power rating is adequate for the following load conditions:	
Lighting	[_____] kW
Computer	[_____] kW

ENGINE-GENERATOR PARAMETER SCHEDULE					
Uninterruptible Power Supplies (UPS)	[_____] kVA, [3][6][12][24] pulse				
Variable Frequency Drives	[_____] kVA, [3][6][12][24] pulse				
Motor Starting Sequence	Starting Order	Size (hp)	Locked Rotor NEMA Code	Starting Method	Maximum Voltage Dip
	[_____]	[_____]	[F] [_____]	[Full Voltage] [_____]	[25] [_____] Percent
	[_____]	[_____]	[F] [_____]	[Full Voltage] [_____]	[25] [_____] Percent
	[_____]	[_____]	[F] [_____]	[Full Voltage] [_____]	[25] [_____] Percent
Other Load	kW at 0.8 power factor				
Capacity Calculations for Batteries					
Calculation must verify that the engine starting battery capacity exceeds dc power requirements.					
Mechanical Characteristics					
Engine Description	Strokes/cycle Number of cylinders Bore and Stroke, mminches				
Engine Speed	[_____][900][1200][1800] rpm				
Piston Speed	[_____] m/sfpm				
Heat Exchanger Type	[fin-tube (radiator)][shell-tube]				
Engine Cooling Type	water/ethylene glycol				
Intercooler Type	Air-to-Air / Jacket Water				
Induction Method	Naturally Aspirated / Turbocharged				
Turbocharger	Make / Model				
Max Time to Start and be Ready to Assume	[10][_____] seconds				
Max Summer Indoor Temp (Prior to Engine-generator	[_____] degrees C F				

ENGINE-GENERATOR PARAMETER SCHEDULE	
Min Winter Indoor Temp (Prior to Engine-generator	[_____] degrees C F
Max Allowable Heat Transferred To Engine Generator Space at Rated Output	[_____] MBTU/hr
Max Summer Outdoor Temp	[_____] degrees C F
Min Winter Outdoor Temp	[_____] degrees C F
Installation Elevation	[_____] above sea level
Engine-Generator Set Efficiencies	
Fuel Consumption	At 0.8 power factor, liters / hour Gallons / hour for: 1 / 2 load 3 / 4 load
Generator Efficiency	At 0.8 power factor,(per cent) [in accordance with IEC 60034-2A] for: 1 / 2 load 3 / 4 load Full Load
Radiator Capacity	Coolant Type L/s gpm coolant L/s cfm air through radiator kW Btu per hr of heat exchange based on optimum coolant temperature to and from engine
Engine-Generator Set Emissions Data	
Exhaust Temperature	Degrees C F at full load
Weight of Exhaust Gas	Kg per hr lb per hr at full load
Weight of Intake Air	Kg per hr lb per hr at full load
Total Heat Rejected	kW Btu per hr, at full load to: Jacket Coolant System Fuel Oil Cooling System
Emissions	Kg per hr lb per hr, at full load Total Suspended Particulate Particulate Matter with an average aerodynamic diameter of 10 microns Sulfur Dioxides Nitrogen Oxides (as NO2) Carbon Monoxide Volatile Organic Compounds
Visible Emissions	Percent opacity at full load

ENGINE-GENERATOR PARAMETER SCHEDULE

Brake Mean Effective Pressure (BMEP) Calculations

Calculation must verify that the engine meets the specified maximum BMEP, as follows:

BMEP kPa psi = (120,000 X bkW) X (792,000 X bhp)
(rpm X liters cu. in.)

Where:

bkW bhp = bkW' + bkW" bhp' + bhp"
bkW" bhp" is the Brake kW horsepower required by engine driven fan for cooling radiator or motor driven fan for cooling radiator.
bkW' bhp' = kW/GEN.EFF. kW/(GEN.EFF. times 0.746)
GEN.EFF. = Generator efficiency
liters cu. in. = Total engine piston displacement in liters cubic inches
rpm = Engine revolutions per minute
kW = Minimum power rating

Torsional Vibration Stress Analysis Computations

Torsional vibrational stresses in the crankshaft and generator shaft of assembled engine and driven generator must not exceed 34,450 kPa 5000 psi when engine is driving generator at rated speed while assembled unit is loaded to rated engine-generator set power. Computations must be based on a mathematical model of the assembled generator set provided or based on calculations using measured values from tests on a unit identical to the one provided. Calculations based on models of, or measured data from, the unassembled engine and generator will not be acceptable.
Calculations must include:

a. A description of the system relating information pertinent to analysis such as operating speed range and identification plate data.

b. A mass elastic assembly drawing, showing the arrangement of the units in the generator set and dimensions of shafting, including minimum diameters (or section moduli) of shafting in the system.

c. A labeled line diagram of the mass elastic system indicating values of masses, stiffness, equivalent lengths, and equivalent diameters including basic assumptions and definition of terms.

d. Sample computations showing procedures used to obtain resulting stress values.

e. Computations indicating assembled engine-generator speed of 1800 rpm with assembly loaded to rated generator power and the resulting computed critical torsional stress values in the assembled engine crankshaft and generator shaft.

ENGINE-GENERATOR PARAMETER SCHEDULE
Turbocharger Load Calculations
NOTE: When the engine-generator set installation includes field installed exhaust system (i.e., the engine-generator set is installed internal to a building in lieu of in a self-contained outdoor enclosure), include the following paragraph. When the proposed exhaust system layout is different from that shown on the contract drawings, submit calculations showing that the external loads from the exhaust system such as weight and thermal expansion do not exceed the engine manufacturer's maximum allowed forces and moments on the turbocharger.

2.1.2 Rated Output Capacity

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NOTE: The service load for each engine-generator should be shown on the Engine-Generator Parameter Schedule. The designer must determine the service load. The Contractor, through the supplier's manufacturer/assembler, determines the efficiency and associated ancillary equipment loads. The designer must examine spare capacity requirements for spinning reserve.

****

Provide each engine-generator-set with power equal to the sum of service load plus the machine's efficiency loss and associated ancillary equipment loads. Rated output capacity must also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

****

NOTE: Select the appropriate engine-generator set from three manufacturers that suit the intended application based on power rating (kW) and kind of power (i.e., number of operating hours per year and average power output). Using the specified kW and the total engine piston displacement per the selected engine-generator sets catalog data, calculate the BMEP to be specified in accordance with the paragraph CALCULATIONS FOR BMEP. A value of 0.9 may be used for generator efficiency.

****

The engine must meet the specified maximum BMEP requirements at rated speed as calculated in accordance with the calculations in the engine-generator parameter schedule. The engine capacity must be based on the following:

****

NOTE: Contact the activity to find out fuel type to be used.

****

a. Engine burning diesel fuel conforming to [MIL-DTL-16884][ASTM D975, Grade 2-D,] or [MIL-DTL-5624, Grade JP-5] at an ambient temperature of 29 degrees C 85 degrees F. For stationary engines operated in the United States, diesel fuel requirements are found in 40 CFR 60 Subpart IIII.

b. Engine cooled by a radiator fan mechanically driven by the engine or remote with a motor driven fan.

c. Engine cooled by coolant mixture of water and ethylene glycol, 50 percent by volume of each.

Maximum BMEP, kPa psi			
	Naturally Aspirated	Turbocharged	Turbocharged and Intercooled
Four-cycle engines	[_____]	[_____]	[_____]
Engine speed, rpm:	[1800][1500]	[_____]	[_____]

2.1.2.1 Engine Emission Limits

****

NOTE: Include the following paragraph when an air pollution permit is required by local, state, or federal law to install and operate the engine generator set. Contact the engine-generator set manufacturer for achievable limits. Contact the activities environmental department representative to determine permit requirements.

****

Engine must be certified by the manufacturer to meet applicable EPA emission standards found in 40 CFR 60 Subpart IIII. In addition, engine must meet any applicable state or local emission requirements (ex: California SCAQMD).

2.1.2.2 Performance Class

****

NOTE: See the following guidelines and table for selecting the appropriate performance class:

1. Select Class G1 where the connected loads are such that only basic parameters of voltage and frequency are needed, e.g., general purpose lighting and other simple electrical loads.

2. Select Class G2 where the demands on voltage characteristics are very much the same as for the commercial power system, e.g., lighting systems, pumps, fans, hoists.

3. Select Class G3 where the connected equipment may make severe demands on frequency, voltage, and waveform characteristics, e.g., telecommunications

as thyristor-controlled loads.

4. Select Class G4 where the demands on the frequency, voltage, and waveform characteristics are exceptionally severe, e.g., data processing equipment or computer systems. Performance values for Class G4 must be determined by the designer and an appropriate table similar to the following table must be inserted into the Specification.

Parameter	**Performance Class**		
	G1	**G2**	**G3**
100 Percent Load Increase Frequency Deviation (Percent)	**less than minus 15**	**less than minus 10**	**less than minus 7**
100 Percent Load Decrease Frequency Deviation (Percent)	**less than plus 18**	**less than plus 12**	**less than plus 10**
100 Percent Load Change Frequency Recovery Time (Seconds)	**less than 10**	**less than 5**	**less than 3**
100 Percent Load Increase Voltage Deviation (Percent)	**less than minus 25**	**less than minus 20**	**less than minus 15**
100 Percent Load Decrease Voltage Deviation (Percent)	**less than plus 35**	**less than plus 25**	**less than plus 20**
100 Percent Load Change Voltage Recovery Time (Seconds)	**less than 10**	**less than 6**	**less than 4**
Frequency Droop (Percent)	**less than minus 8**	**less than minus 5**	**less than minus 3**
Steady-State Frequency Band (Percent) (plus or minus	**less than 2.5**	**less than 1.5**	**less than 0.5**
Steady-State Voltage Regulation (Percent) (plus or minus)	**less than 5**	**less than 2.5**	**less than 1.0**

****

The voltage and frequency behavior of the generator set must be in accordance with ISO 8528 operating limit values for performance Class[G1][G2][G3][G4 as follows].

2.1.3 Power Ratings

Power ratings must be in accordance with EGSA 101P.

2.1.4 Transient Response

The engine-generator set governor and voltage regulator must cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set must respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

2.1.5 Reliability and Durability

****

NOTE: Mean time between overhauls describes the average number of operating hours that the engine will operate satisfactorily without overhaul. Overhaul is a natural consequence of the engine in operation due to worn out parts after the indicated operating hours.

****

[Provide prime engine-generator sets that have both an engine and a generator capable of delivering the specified power on a prime basis with an anticipated mean time between overhauls of not less than 10,000 hours operating with a 70 percent load factor. Cite two like engines and two like generators that have performed satisfactorily in a stationary power plant, independent from the physical location of the manufacturer's and assembler's facilities. The engine and generators should have been in operation for a minimum of 8000 actual hours at a minimum load of 70 percent of the rated output capacity. During two consecutive years of service, the units should not have experienced any failure resulting in a downtime in excess of 72 hours. Provide engines that are the same model, speed, bore, stroke, number and configuration of cylinders and rated output capacity. Provide generators that are the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.] [Each standby engine-generator set must have both an engine and a generator capable of delivering the specified power on a standby basis with an anticipated mean time between overhauls of no less than 5,000 hours operating with a load factor of 70 percent. Cite two like engines and two like generators that have performed satisfactorily in a stationary power plant, independent and separate from the physical location of the manufacturer's and assembler's facilities, for standby without any failure to start, including all periodic exercise. Provide like engines and generators that have had no failures resulting in downtime for repairs in excess of 72 hours during two consecutive years of service. Provide engines that are the same model, speed, bore, stroke, number and configuration of cylinders, and rated output capacity. Provide generators that are the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.]

Submit a reliability and durability certification letter from the manufacturer and assembler to prove that existing facilities are and have been successfully utilizing the same components proposed to meet this specification, in similar service. Certification may be based on components, i.e. engines used with different models of generators and generators used with different engines, and does not exclude annual technological improvements made by a manufacturer in the basic standard-model component on which experience was obtained, provided parts interchangeability has not been substantially affected and the current standard model meets the performance requirements specified. Provide a list with the name of the installations, completion dates, and name and telephone number of a point of contact.

2.1.6 Parallel Operation

****

NOTE: Specification of an engine-generator set capable of parallel operation with a utility requires a 2/3 pitch generator winding and special coordination of protective devices with the utility system protection scheme. Do not specify this option without also providing a design for the protective device coordination which has been approved by the utility involved.

****

Configure each engine-generator set specified for parallel operation for [automatic] [manual] parallel operation. Each set must be capable of parallel operation with [a commercial power source on an infinite bus] [one or more sets on an isolated bus] [a commercial power source on an infinite bus and with one or more sets on an isolated bus].

2.1.7 Load Sharing

****

NOTE: Coordinate with paragraph Engine Generator Parameter Schedule.

****

Configure each engine-generator set specified for parallel operation to [manually load share with other sets.] [automatically load share with other sets by proportional loading. Proportional loading must load each set to within 5 percent of its fair share. A set's fair share is its nameplate-rated capacity times the total load, divided by the sum of all nameplate-rated capacities of on-line sets. Incorporate both the real and reactive components of the load.]

2.1.8 Engine-Generator Set Enclosure

****

NOTE: If the engine-generator set is to be installed outdoors include requirements for the weatherproof enclosure in the engine-generator set schedule. Define corrosion resistance and/or material required for the environment. Provide structural loading required for the geographic area (wind loads, snow loads, etc.). A generator set enclosure may also be needed to mitigate excessive noise caused by the engine generator set mechanical components. Delete the reference to mechanical noise limitations if an enclosure is not needed to mitigate sound emissions. If a sound enclosure is not provided, the designer must provide a design to prevent excessive noise (meet OSHA requirements). Delete this paragraph if no engine-generator set enclosure is needed.

****

Provide engine-generator set enclosures that are corrosion resistant and fully weather resistant. The enclosure must contain all set components and provide ventilation to permit operation at Service Load under secured conditions. Provide access doors to controls and equipment requiring periodic maintenance or adjustment. Provide removable panels for access to components requiring periodic replacement. The enclosure must be capable of being removed without disassembly of the engine-generator set or removal of components other than the exhaust system. The enclosure must reduce the noise of the generator set to within the limits specified in the paragraph SOUND LIMITATIONS.

2.1.9 Vibration Isolation

****

NOTE: See UFC 3-450-01, Noise and Vibration Control for Mechanical Equipment for vibration criteria. Vibration isolation systems should be applied where vibration transmitted through the genset support structure produces (either directly or by resonant frequencies of structural members) annoying or damaging vibration in the surrounding environment. Select the manufacturer's standard or provide the maximum allowable vibration force where necessary to limit the maximum vibration. Delete the vibration isolation requirement for applications where vibration does not affect the floor or foundation.

****

[Install a vibration isolation system between the floor and the base. The vibration isolation system must limit the maximum vibration transmitted to the floor at all frequencies to a maximum of [_____] (peak force).] [Provide an engine-generator set with a vibration isolation system in accordance with the manufacturer's standard recommendation.] Submit vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor plus description of seismic qualification of the engine-generator mounting, base, and vibration isolation. Submit torsional analysis including prototype testing or and calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, plus 10 percent. Design and qualify vibration isolation systems as an integral part of the base and mounting system in accordance with the seismic parameters specified. Where the vibration isolation system does not secure the base to the structure floor or unit foundation, provide seismic restraints in accordance with the seismic parameters specified.

2.1.10 Harmonic Requirements

****

NOTE: Coordinate with paragraph ENGINE-GENERATOR PARAMETER SCHEDULE.

****

Non-linear loads to be served by each engine-generator set are as indicated. The maximum linear load demand (kVA at PF) when non-linear loads will also be in use is as indicated.

2.1.11 Starting Time Requirements

Upon receipt of a signal to start, each engine generator set will start, reach rated frequency and voltage and be ready to assume load within the time specified. For standby sets used in emergency power applications, each engine generator set will start, reach rated frequency and voltage, and power will be supplied to the load terminals of the automatic transfer switch within the starting time specified.

2.2 NAMEPLATES

****

NOTE: Delete any equipment not applicable to the project.

****

Provide the manufacturer's name, type or style, model or serial number and rating on a plate secured to the equipment for each major component of this specification. Provide plates and tags sized so that inscription is readily legible to operating or maintenance personnel and securely mounted to or attached in proximity of their identified controls or equipment. Lettering must be normal block lettering, a minimum of 6.4 mm0.25 inch high. As a minimum, provide nameplates for:

Engines

Generators

Regulators

Pumps and pump motors

Generator Breaker

Economizers

Relays

Transformers (CT & PT)

Day tanks

Governors

Air Starting System

Heat exchangers (other than base mounted)

Where the following equipment is not provided as a standard component by the engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger

Switchboards

Switchgear

Battery

Heaters

Exhaust mufflers

Silencers

Exciters

2.2.1 Materials

Construct ID plates and tags of 16 gage minimum thickness bronze or stainless steel sheet metal engraved or stamped with inscription. Construct plates and tags not exposed to the weather or high operational temperature of the engine of laminated plastic, 3.2 mm0.125 inch thick, matte white finish with black center core, with lettering accurately aligned and engraved into the core.

2.2.2 Control Devices and Operation Indicators

Provide ID plates or tags for control devices and operation indicators, including valves, off-on switches, visual alarm annunciators, gages and thermometers, that are required for operation and maintenance of provided mechanical systems. Plates or tags must be minimum of 13 mm0.5 inch high and 50 mm2 inches long and must indicate component system and component function.

2.2.3 Equipment

Provide ID plates of a minimum size of 75 mm 3 inches high and 130 mm 5 inches long on provided equipment indicating the following information:

a. Manufacturer's name, address, type and model number, serial number, and certificate of compliance with applicable EPA mission standards;

b. Contract number and accepted date;

c. Capacity or size;

d. System in which installed; and

e. System which it controls.

2.3 SAFETY DEVICES

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices such that proper operation of the equipment is not impaired.

2.4 MATERIALS AND EQUIPMENT

Submit certification stating that where materials or equipment are specified to comply with requirements of UL, written proof of such compliance has been obtained. The label or listing of the specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

2.4.1 Circuit Breakers, Low Voltage

UL 489.

2.4.2 Filter Elements

Provide the manufacturer's standard fuel-oil, lubricating-oil, and combustion-air filter elements.

2.4.3 Instrument Transformers

NEMA/ANSI C12.11.

2.4.4 Revenue Metering

IEEE C57.13.

2.4.5 Pipe (Fuel/Lube-Oil, Compressed Air, Coolant, and Exhaust)

ASTM A53/A53M, or ASTM A106/A106M steel pipe. Pipe smaller than 50 mm 2 inches must be Schedule 80. Pipe 50 mm 2 inches and larger must be Schedule 40.

2.4.5.1 Flanges and Flanged Fittings

ASTM A181/A181M, Class 60, or ASME B16.5, Grade 1, Class 150.

2.4.5.2 Pipe Welding Fittings

ASTM A234/A234M, Grade WPB or WPC, Class 150 or ASME B16.11, 1360.7 kg 3000 lb.

2.4.5.3 Threaded Fittings

ASME B16.3, Class 150.

2.4.5.4 Valves

MSS SP-80, Class 150.

2.4.5.5 Gaskets

Manufacturer's standard.

2.4.6 Pipe Hangers

MSS SP-58.

2.4.7 Electrical Enclosures

NEMA ICS 6.

2.4.7.1 Switchboards

NEMA PB 2.

2.4.7.2 Panelboards

NEMA PB 1.

2.4.8 Electric Motors

Provide electric motors that conform to the requirements of NEMA MG 1. Motors must have sealed ball bearings and a maximum speed of 1800 rpm. Motors used indoors must have drip-proof frames; enclose those that are used outside. Alternating current motors larger than 373 W 1/2 Hp must be of the squirrel-cage induction type for operation on 208 volts or higher, [50] [60] Hz, and three-phase power. Alternating current motors 373 W 1/2 Hp or smaller, must be suitable for operation on 120 volts, [50] [60] Hz, and single-phase power. Direct current motors must be suitable for operation on [125] [_____] volts.

2.4.9 Motor Controllers

Provide motor controllers and starters that conform to the requirements of

NFPA 70 and NEMA ICS 2.

2.5 ENGINE

****

NOTE: Specify fuel type.

If units are required to operate on more than one fuel the designer must edit the components, performance requirements, and testing requirements of this specification to define the requirements for the fuels specified. If full performance is required for the weakest or poorest burning fuels, then the units will be overrated for other fuels.

****

Each engine must operate on [No. 2-D diesel fuel][_____] conforming to [ASTM D975][_____], must be designed for stationary applications and must be complete with ancillaries. The engine must be a standard production model shown in the manufacturer's catalog describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance. The engine must be naturally aspirated, supercharged, or turbocharged. The engine must be 2- or 4-stroke-cycle and compression-ignition type. The engine must be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. The engine must have a minimum of two cylinders. Opposed-piston type engines must have more than four cylinders. Each block must have a coolant drain port. Equip each engine with an over-speed sensor.

ISO 3046. Diesel engines must be four-cycle naturally aspirated, or turbocharged, or turbocharged and intercooled; vertical in-line or vertical Vee type; designed for stationary service. Engines must be capable of immediate acceleration from rest to normal speed without intermediate idle/warm up period or pre-lubrication to provide essential electrical power. Two-cycle engines are not acceptable.

2.5.1 Sub-base Mounting

Mount each engine-generator set on a structural steel sub-base sized to support the engine, generator, and necessary accessories, auxiliaries and control equipment to produce a complete self-contained unit as standard with the manufacturer. Design the structural sub-base to properly support the equipment and maintain proper alignment of the engine-generator set in the specified seismic zone. In addition, provide sub-base with both lifting rings and jacking pads properly located to facilitate shipping and installation of the unit. Factory align engine and generator on the sub-base and securely bolt into place in accordance with the manufacturer's standard practice. Crankshaft must have rigid coupling for connection to the generator.

2.5.2 Assembly

Completely shop assemble each engine-generator set on its structural steel sub-base. Paint entire unit with manufacturer's standard paints and colors. After factory tests and before shipping, thoroughly clean and retouch painting as necessary to provide complete protection.

2.5.3 Turbocharger

If required by the manufacturer to meet the engine-generator set rating, provide turbine type driven by exhaust gas from engine cylinders, and direct connected to the blower supplying air to the engine intake manifold.

2.5.4 Intercooler

Provide manufacturer's standard intercooler for engine size specified.

2.5.5 Crankcase Protection

****

NOTE: Include details on the drawings for the crankcase ventilation piping and associated penetrations through walls and roofs showing the piping sleeve and exterior flashing when the radiator is remote and the engine-generator set is to be installed inside a building. Provide manufacturer's standard method of preventing crankcase explosions and standard method of crankcase ventilation.[Provide ventilation of crankcase via piping to the atmosphere as indicated on the drawings.]

****

2.5.6 Miscellaneous Engine Accessories

Provide the following engine accessories where the manufacturer's standard design permits:

a. Piping on engine to inlet and outlet connections, including nonstandard companion flanges.

b. Structural steel sub-base and vibration isolators, foundation bolts, nuts, and pipe sleeves.

c. Level jack screws or shims, as required.

d. Rails, chocks, and shims for installation of sub-base on the foundation.

e. Removable guard, around fan. Support guard, on engine sub-base, to suit manufacturer's standard.

2.5.7 Intercooler

Provide manufacturer's standard intercooler for engine size specified.

2.6 FUEL SYSTEM

Provide fuel system conforming to the requirements of NFPA 30 and NFPA 37 and containing the following elements.

****

NOTE: The selection of a gas-fueled (natural or LP) over diesel-fueled engine-generator has significant impact depending on the load characteristics and application. The following general differences between gas and diesel fuels, and their use in

engine-generator applications, should be considered:

Characteristic	**Gas**	**Diesel**
Economy	**Lower initial cost, but higher long-term costs, due to more maintenance and shorter installed life**	**Higher initial cost, but lower long-term costs, due to less maintenance and longer installed life**
Availability	**Non-renewable but available worldwide**	**Non-renewable, less available than gas**
Environmental Emissions	**No significant ground pollution, soot or sulfur dioxide emissions, lower CO2 emissions than diesel. Lean burn mode lowers emissions from traditional gas.**	**Higher viscosity, spills cause ground pollution, must meet EPA Tier 4 standards, except for emergency standby application.**
Noise	**Quieter**	**Louder, requires muffling and noise insulation**
Step Loading	**Step loading and unloading limited to 25-40 percent of load rating**	**Step loading and unloading not limited**
Running Load	**Less problems with light loading, due to higher burn temperature**	**Optimal loading 50-70 percent rated, light loading causes "wet stacking", increasing buildup in exhaust**
Startup Time	**Typ. more than 10 seconds, from startup to ready to assume load**	**Typ. 10 seconds or less, from startup to ready to assume load**
Sizing	**Typ. same as diesel, but sometimes oversized to compensate for step**	**Sized to match existing load, plus anticipated future load growth**
Safety	**Extremely flammable, any leaks can be catastrophic**	**Less flammable, but water contamination during storage of fuel can cause engine damage**

****

2.6.1 Pumps

****

NOTE: Delete this paragraph when remote fuel transfer pump(s) are provided. Select duplex pumps for facilities complying with UFC 4-510-01, "Design: Medical Military Facilities."

****

Fuel transfer pumps may be mounted on the day tank. Pump[s] must be [duplex,] horizontal, positive displacement. Direct-connect pump to motor through a flexible coupling. Equip each pump with a bypass relief valve, if not provided with an internal relief valve. Provide motor and controller in accordance with the paragraphs ELECTRIC MOTORS and MOTOR CONTROLLERS, respectively.

2.6.1.1 Main Pump

Provide engines with an engine driven pump. The pump must supply fuel at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. Base the fuel flow rate on meeting the load requirements and all necessary recirculation.

2.6.1.2 Auxiliary Fuel Pump

****

NOTE: The auxiliary fuel pump is required to support the main pump if the length of pipe from the day tank to the main pump is greater than the value recommended by the engine manufacturer. This value may be approximately 12 m 40 feet; however, engine manufacturers should be consulted during design to verify the pumping requirements.

****

Provide auxiliary fuel pumps to maintain the required engine fuel pressure, if either required by the installation or indicated on the drawings. The auxiliary pump must be driven by a dc electric motor powered by the starting/station batteries. Automatically actuate the auxiliary pump by a pressure-detecting device.

2.6.2 Fuel Filter

Provide a minimum of one full-flow fuel filter for each engine. The filter must be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. Mark the inlet and outlet connections of the filter.

****

NOTE: Select the options for duplex filters when changing of the filter will be required while the engine-generator set is operating. Do not provide duplex filters when the engine-generator set is to be installed in an enclosure or provided with an engine-driven radiator.

****

Provide intake filter assemblies for each engine of the oil bath or dry type, as standard with the manufacturer. Filters must be capable of removing a minimum of 92 percent of dirt and abrasive 3 microns and larger from intake air. Size filters to suit engine requirements at 100 percent of rated full load. Design unit for field access for maintenance purposes.

2.6.3 Relief/Bypass Valve

Provide a relief/bypass valve to regulate pressure in the fuel supply line, return excess fuel to a return line and prevent the build-up of excessive pressure in the fuel system.

2.6.4 Integral Main Fuel Storage Tank

****

NOTE: Delete this paragraph if an integral main fuel storage tank is not desired.

An integral main fuel storage tank will be the only fuel source for the engine. These tanks may be useful for applications that require a minimal fuel storage capacity.

Due to the minimal storage capacity, integral main fuel storage tanks are not practical for prime power usage. They are also not practical for standby units that require large fuel quantities. The designer should consider the availability and anticipated frequency of fuel truck deliveries when deciding whether or not to use an integral main fuel storage tank. These tanks should also not be used in locations where a truck fueling hose can not reach the generator set.

See NFPA 99 and NFPA 110 for guidance on fuel tank sizes.

See NFPA 37 restrictions on allowable tank sizes and enclosures. Integral tanks allow for 1 to 8 hours of operation depending on generator size and configuration. Consult generator set manufacturer for the proper hours of operation for the application of integral tanks. Standby applications for use with fire pumps will have tanks sized for 8 hours duration. The tank can be sized by the designer or the Contractor. The size of the tank should be based on a fuel flow rate that is equal to the value of a typical engine manufacturer for the indicated engine generator size. A value of 200 percent of the expected fuel consumption of the engine is not unusual for the flow rate of the main fuel pump. Since the excess fuel will be returned to the tank, the designer should consider the impact of heat buildup when sizing the tank. If a fuel oil cooler is not used, the day tank size may need to be increased to properly dissipate the heat absorbed by the fuel.

****

Provide each engine with an integral main fuel tank. Each tank must be factory installed and provided as an integral part of the generator manufacturer's product. Provide each tank with connections for fuel supply line, fuel return line, local fuel fill port, gauge, vent line, and float switch assembly. Provide a fuel return line cooler as recommended by the manufacturer and assembler. The temperature of the fuel returning to the tank must be below the flash point of the fuel. Mount the tank within the enclosure for each engine-generator set provided with weatherproof enclosures. The fuel fill line must be accessible without opening the enclosure.

****

NOTE: Use the following guidelines for specifying fuel integral base tanks:

1. Select integral base tank in skid where applicable and available. Tank capacity available varies from 100 gallons to 5,000 gallons.

2. See NFPA 37 for allowable tank sizes and restrictions.

3. Provide an overflow or return line between the fuel day tank and storage tank in accordance with NFPA 37 if the generator is equipped with both an external supply tank and a day tank.

4. Tank capacity must be in accordance with the following table for facilities complying with MIL-HDBK-1191, "DOD Medical and Dental Treatment Facilities Design and Construction Guide."

50 KW - 100 KW GEN SET: 25 MIN - 50 MAX GAL
101 KW - 200 KW GEN SET: 50 MIN - 75 MAX GAL
201 KW - 300 KW GEN SET: 75 MIN - 100 MAX GAL
OVER 300 KW GEN SET: 100 MIN - 250 MAX GAL

****

a. All Tanks: UL 142. Provide [integral in skid] [free standing] double wall (110 percent containment) fuel tanks with a [minimum capacity of [_____] hours of engine-generator set operation at full-rated load] [capacity as indicated]. Epoxy coat day tanks inside and prime and paint outside. Construct tanks of not less than 4.76 mm 3/16 inch steel plate with welded joints and necessary stiffeners on exterior of tank. Provide a braced structural steel framework support. Weld tank top tight. Provide 114 mm 4 1/2 inch square inspection port with a 2 inch NPT fill connection and spill box. Provide proper normal and emergency venting for the primary tank and emergency venting only for the secondary tank / containment basin in accordance with UL 142 requirements.[Provide an overflow or return line between the fuel day tank and storage tank in accordance with NFPA 37.]

b. Float Switches for Day Tanks: Provide tank-top mounted or external float cage, single-pole, single-throw type designed for use on fuel oil tanks. Arrange high level float switches to close on rise of liquid level, and low level float switches to close on fall of liquid level. Mount float cage units with isolating and drain valves. Contacts must be suitable for the station battery voltage.

(1) Critical low level float switch which must activate at 5 percent of normal liquid level must shut engine off.

(2) Low-low level float switch which must activate alarm at 30 percent of normal liquid level.

(3) Low level float switch which must open the fuel oil solenoid valve and start the [remote] fuel transfer pump at 75 percent of normal liquid level.

(4) High level float switch which must close the fuel oil solenoid valve and stop the [remote] fuel transfer pump at 90 percent of normal liquid level.

(5) Critical high level float switch which must activate alarm at 95 percent of normal liquid level.

c. Leak Detector Switch for All Tanks: Actuates when fuel is detected in containment basin, stops fuel transfer pump, and closes the fuel oil solenoid valve.

d. Control Panel for All Tanks: Provide NEMA ICS 6, Type [1] [_____], enclosed control panel for each day tank. Control panel must include the following accessories.

(1) Power available LED (green).

(2) Critical low fuel alarm contacts for shut down of engine.

(3) Low-low level fuel alarm LED.

(4) Low-low level fuel alarm contracts for remote annunciator.

(5) Critical high level fuel alarm LED.

(6) Leak detecting alarm LED.

(7) Alarm horn.

e. Tank Gages for All Tanks: Provide buoyant force type gages for fuel tanks with dial indicator not less than 100 mm 4 inches in size and arranged for top mounting. Calibrate each reading dial or scale for its specific tank to read from empty to full, with intermediate points of 1/4, 1/2, and 3/4.

f. Integral Base Tanks Used as Primary Tank: Provide a 2 inch opening at the tank fill port, fitted an overfill prevention valve (OPV). Additionally, the fill opening must be perpendicular to the tank in order to allow operation of the OPV. Integral base tank must be sized and configured such that the filling and venting nozzles are outside the generator cabinet for ease of accessibility, inspection, and maintenance. Level gage must be in the line of sight from the fill port.

g. Integral Base Tanks Located Inside Buildings. The tank vents must discharge outside the building in accordance with NFPA 30 and NFPA 37. The fill pipe must terminate outside the building. The fill pipe connection point must be housed in a sealed spill box. High level alarms or level gauges used as overfill protection mechanisms must annunciate at the fill connection point. Provide an overfill prevention valve (OPV) at the tank with a check valve mounted on the fill line in the spill box. The fill connection point must be labeled with tank contents and capacity.

h. External tanks (all non-integral base tanks) are specified in Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.6.4.1 Fuel Transfer Pump[s]

****

NOTE: Delete this paragraph when remote fuel transfer pump(s) are provided. Select duplex pumps for facilities complying with UFC 4-510-01, "Design: Medical Military Facilities."

****

Fuel transfer pumps may be mounted on the day tank. Pump[s] must be [duplex,] horizontal, positive displacement. Direct-connect pump to motor through a flexible coupling. Equip each pump with a bypass relief valve, if not provided with an internal relief valve. Provide motor and controller in accordance with the paragraphs ELECTRIC MOTORS and MOTOR CONTROLLERS, respectively.

2.6.4.2 Capacity

Each tank must have capacity [as shown] [to supply fuel to the engine for an uninterrupted [4-hour][_____] period] at 100 percent rated load without being refilled.

2.6.4.3 Local Fuel Fill

Each local fuel fill port on the day tank must have a screw-on cap.

2.6.4.4 Fuel Level Controls

Provide tanks with a float-switch assembly to perform the following functions:

a. Activate the "Low Fuel Level" alarm at 70 percent of the rated tank capacity.

b. Activate the "Overfill Fuel Level" alarm at 95 percent of the rated tank capacity.

2.6.4.5 Arrangement

Integral tanks may allow gravity flow into the engine. Gravity flow tanks and any tank that allows a fuel level above the fuel injectors must have an internal or external factory installed valve located as near as possible to the shell of the tank. The valve must close when the engine is not operating. Provide integral day tanks with any necessary pumps to supply fuel to the engine as recommended by the generator set manufacturer. The fuel supply line from the tank to the manufacturer's standard engine connection must be welded pipe.

2.6.5 Day Tank

****

NOTE: Delete this paragraph if an integral main fuel storage tank is used.

See NFPA 99 and NFPA 110 for guidance on fuel tank sizes.

See NFPA 37 restrictions on allowable day tank sizes and enclosures. Select either self-supporting or

integral day tank. Select the first option below for applications where fuel is returned to the day tank. Select the second option below for applications where fuel is returned to the main tank. Integral day tanks allow for 1 to 8 hours of operation. Consult generator set manufacturer for the proper hours of operation for the application of integral day tanks. Standby applications for use with fire pumps will have day tanks sized for 8 hours duration. Select day tank capacity for either prime or standby application. The day tank can be sized by the designer or the Contractor. The size of the day tank should be based on a fuel flow rate that is equal to the value of a typical engine manufacturer for the indicated engine generator size. A value of 200 percent of the expected fuel consumption of the engine is not unusual for the flow rate of the main fuel pump. The excess fuel may be returned to the day tank or main fuel tank. The designer should also consider the impact of heat buildup when sizing the day tank. If a fuel oil cooler is not used or if fuel is returned to the day tank, the day tank size may need to be increased to properly dissipate the heat absorbed by the fuel.
****

Provide engine with [a separate self-supporting] [integral] day tank. Submit calculations for the capacity of each day tank, including allowances for recirculated fuel, usable tank capacity, and duration of fuel supply. Provide connections for fuel supply line, [fuel return line, fuel overflow line, local fuel fill port, gauge, vent line, drain line, and float switch assembly for control for each day tank. Provide a fuel return line cooler as recommended by the manufacturer and assembler. The temperature of the fuel returning to the day tank must be below the flash point of the fuel. Install a temperature sensing device in the fuel supply line], [fuel overflow line, local fuel fill port, gauge, vent line, drain line, and float switch assembly for control]. Mount the day tank within the enclosure for each engine-generator set with weatherproof enclosures. The fuel fill line must be accessible without opening the enclosure.

2.6.5.1 Capacity, Prime

Provide day tank with the capacity [as shown] [to supply fuel to the engine for an uninterrupted [8-hour] [_____] period at 100 percent rated load without being refilled, plus any fuel which may be returned to the main fuel storage tank. Submit calculations for the capacity of each day tank, including allowances for recirculated fuel, usable tank capacity, and duration of fuel supply. The calculation of the capacity of each day tank must incorporate the requirement to stop the supply of fuel into the day tank at a "High" level mark of 90 percent of the ultimate volume of the tank].

2.6.5.2 Capacity, Standby

Provide day tank with the capacity [as shown] [to supply fuel to the engine for an uninterrupted [4-hour] [_____] period at 100 percent rated load without being refilled, plus any fuel which may be returned to the main fuel storage tank. Submit calculations for the capacity of each day tank, including allowances for recirculated fuel, usable tank capacity, and duration of fuel supply. The calculation of the capacity of each day tank must incorporate the requirement to stop the supply of fuel into the day tank at 90 percent of the ultimate volume of the tank].

2.6.5.3 Drain Line

Each day tank drain line must be accessible and equipped with a shutoff valve. Arrange self-supporting day tanks to allow drainage into a 305 mm 12 inch tall bucket.

2.6.5.4 Local Fuel Fill

Each local fuel fill port on the day tank must have a screw-on cap.

2.6.5.5 Fuel Level Controls

Provide day tank with a float-switch assembly to perform the following functions:

a. [When the main storage tank is located higher than the day tank, open the solenoid valve located on the fuel supply line entering the day tank and start the supply of fuel into the day tank] [Start the supply of fuel into the day tank] when the fuel level is at the "Low" level mark, 75 percent of the rated tank capacity.

b. [When the main storage tank is located higher than the day tank, stop the supply of fuel into the day tank and close the solenoid valve located on the fuel supply line entering the day tank] [Stop the supply of fuel into the day tank] when the fuel level is at 90 percent of the rated tank capacity.

c. Activate the "Overfill Fuel Level" alarm at 95 percent of the rated tank capacity.

d. Activate the "Low Fuel Level" alarm at 70 percent of the rated tank capacity.

e. Activate the automatic fuel supply shut-off valve located on the fill line of the day tank and shut down the fuel pump which supplies fuel to the day tank at 95 percent of the rated tank capacity. Stop the flow of fuel before any fuel can be forced into the fuel overflow line.

2.6.5.6 Fuel Oil Solenoid Valve

UL 429. Provide electric solenoid type control valve for each day tank. Solenoid must be rated for starting battery voltage. Valve body must have a minimum working pressure rating of 1033 kPa 150 psig at 93 degrees C 200 degrees F. Valve must be capable of passing 0 to 0.63 L/s 0 to 10 gpm of fuel oil. Valves must be two-way, direct acting, normally closed (open when energized, closed when de-energized), with stainless steel body and resilient seat material. Solenoid enclosures must be NEMA ICS 6, Type 1. Body connections must be same size as connecting piping. Valve must be in line before the fuel pump.

2.6.5.7 Arrangement

****

NOTE: Select between integral and self-supporting day tanks. Also, select between applications where

the main fuel storage tank is located above the day tank and applications where the main fuel storage tank is located below the day tank. The location of all tanks, piping, and valves should also be indicated on the drawings.

****

[Integral day tanks may allow gravity flow into the engine. Provide gravity flow tanks with an internal or external valve located as near as possible to the shell of the tank. The valve must close when the engine is not operating. Provide integral day tanks with any necessary pumps to supply fuel to the engine as recommended by the generator set manufacturer. Arrange the overflow connection and the fuel supply line for integral day tanks which do not rely upon gravity flow so that the highest possible fuel level is below the fuel injectors.] [Arrange self-supporting day tanks so that the fuel level in the day tank remains above the suction port of the engine driven fuel pump or be provided with a transfer pump to provide fuel to the engine driven pump. Arrange the overflow connection and fuel supply line so that the highest possible fuel level is below the fuel injectors.] [When the main fuel storage tanks are located below the day tank, provide a check valve in the fuel supply line entering the day tank.] [When the main fuel storage tanks are located above the day tank, install a solenoid valve in the fuel supply line entering the day tank. The solenoid valve must be in addition to the automatic fuel shut off valve.] The fuel supply line from the day tank to the manufacturer's standard engine connection must be welded pipe.

2.6.6 Fuel Supply System

Provide the fuel supply from the main storage of fuel to the day tank as specified in Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.6.7 Strainer

****

NOTE: Select the options for duplex filters when changing of the filter will be required while the engine-generator set is operating. Do not provide duplex filters when the engine-generator set is to be installed in an enclosure or provided with an engine-driven radiator.

****

[Simplex][Duplex] strainers must comply with Section 33 52 10 SERVICE PIPING, FUEL SYSTEMS.

2.6.8 Fuel Oil Meters

****

NOTE: Provide fuel oil meters when required by the using activity.

****

Fuel oil meter must comply with Section 33 52 10 SERVICE PIPING, FUEL SYSTEMS.

2.6.9 Fuel Oil Cooler

Provide an air cooled fuel oil cooler if the temperature of the fuel returned to the tank from the engine will cause overheating of the tank fuel above the maximum fuel temperature allowed by the engine manufacturer when operating at maximum rated generator power output and low fuel level in the tank. The fuel oil cooler must be furnished by the engine manufacturer for the application and the installation must be complete including piping and power requirements.

2.7 LUBRICATION

****

NOTE: Delete the adjustable requirement for pressure regulation on sets smaller than 1000 kW. Sets larger than 500 kW will utilize a pressure-relief valve on the crankcase. Show crankcase vent piping for indoor installations.

****

Provide engine with a separate lube-oil system conforming to NFPA 30 and NFPA 37. Pressurize each system by engine-driven pumps. Regulate system pressure as recommended by the engine manufacturer. Provide a pressure relief valve on the crankcase for closed systems. Vent the crankcase in accordance with the manufacturer's recommendation. Do not vent the crankcase to the engine exhaust system. Crankcase breathers, if provided on engines installed in buildings or enclosures, must be piped to vent to the outside. The system must be readily accessible for service such as draining, refilling, etc. Each system must permit addition of oil and have oil-level indication with the set operating. The system must utilize an oil cooler as recommended by the engine manufacturer.

2.7.1 Lube-Oil Filter

Provide one full-flow filter for each pump. The filter must be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. Mark inlet and outlet connections.

2.7.2 Lube-Oil Sensors

Equip each engine with lube-oil pressure sensors located downstream of the filters and provide signals for required indication and alarms. Submit two complete sets of filters, required for maintenance, supplied in a suitable storage box. Provide these filters in addition to filters replaced after testing.

2.7.3 Precirculation Pump

Provide a motor-driven precirculation pump powered by the station battery, complete with motor starter, if recommended by the engine manufacturer.

2.8 COOLING SYSTEM

****

NOTE: Coordinate with paragraph SYSTEM REQUIREMENTS.

****

Provide each engine with its own cooling system to operate automatically while its engine is running. The cooling system coolant must use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified. The maximum temperature rise of the coolant across each engine must not exceed that recommended below. Submit a letter which certifies that the engine-generator set and cooling system function properly in the ambient temperature specified, stating the following values:

a. The maximum allowable inlet temperature of the [coolant fluid][cooling air].

b. The minimum allowable inlet temperature of the [coolant fluid through the engine][cooling air across the engine].

c. The maximum allowable temperature rise in the [coolant fluid through the engine][cooling air across the engine].

d. The minimum allowable inlet fuel temperature.

2.8.1 Coolant Pumps

****
NOTE: Delete raw-water pump for closed-loop systems.
****

Provide centrifugal coolant pumps. Each engine must have an engine-driven primary pump. Provide secondary pumps that are electric motor driven and have automatic controllers. Control raw-water circulating pump by manual-off-automatic controllers and must be [electric motor] [engine] driven.

2.8.2 Heat Exchanger

Provide heat exchanger with the size and capacity to limit the maximum allowable temperature rise in the coolant across the engine to that recommended and submitted for the maximum summer outdoor design temperature and site elevation. Submit manufacturer's data to quantify heat rejected to the space with the engine generator set at rated capacity. Provide heat exchangers that are corrosion resistant, suitable for service in ambient conditions of application.

2.8.2.1 Fin-Tube-Type Heat Exchanger (Radiator)

****
NOTE: Retain this paragraph and remove the next one as required by the project.
****

Heat exchanger may be factory coated with corrosion resistant film, provided that corrective measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Provide internal surfaces that are compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Provide heat exchangers that are pressure type incorporating a pressure valve, vacuum valve and a cap. Design caps for pressure relief prior to removal. Provide heat exchanger and cooling system that is capable of withstanding a minimum pressure of 48 kPa 7 psi and protect with a strong grille or screen guard. Provide heat exchanger with at least two tapped holes; equip one tapped hole with a drain cock, and plug the rest.

****
NOTE: Generally utilize the engine sub-base

radiator as the less expensive option. In cases where insufficient cooling air or space or additional reliability is necessary (requiring cross-connecting of radiators), provide remote radiators.

****

****

NOTE: At the text below, use the maximum dry-bulb temperature of the site plus 8 degrees C 15 degrees F for the first temperature, but not less than 43 degrees C 110 degrees F. Use minus 18 degrees C 0 degrees F, except where minimum dry-bulb temperature permits use of a higher temperature.

****

Provide for each engine-generator set, as standard with the manufacturer.

a. Design Conditions: Each radiator unit must have ample capacity to remove not less than the total kW Btu per hour of heat rejected by its respective engine at 100 percent full-rated load to the jacket water, fuel oil, and lubricating oil system, and intercooler. Radiator capacity must be rated at optimum temperature of coolant leaving the engine and intercooler as recommended by the engine manufacturer with an ambient dry bulb air temperature outside the enclosure of [_____] degrees C [_____] degrees F maximum, and [_____] degrees C [_____] degrees F minimum at the site elevation specified in the paragraph SITE CONDITIONS, and with the coolant mixture specified in the paragraph ENGINE CAPACITY. Pressure drop through the radiator must not exceed 41.34 kPa 6 psi when circulating the maximum required coolant flow. Radiator air velocity must be a maximum of 7.6 meters per second 1500 feet per minute.

b. Engine Mounted Radiator Construction: Radiator fan must direct airflow from the engine outward through the radiator. Fan must be V-belt driven directly from the engine crankshaft. Radiator fan must have sufficient capacity to meet design conditions against a static restriction of [_____] Pa [_____] inch of water. Fan static capacity must be adjusted to suit the ductwork furnished. Cooling section must have a tube and fin-type core consisting of copper or copper base alloy tubes with nonferrous fins. Select engine-driven fans for quiet vibration-free operation. Make provision for coolant expansion either by self-contained expansion tanks or separately mounted expansion tanks, as standard with the manufacturer. Provide suitable guards for each fan and drive.

****

NOTE: Radiator fan cycling controls should be considered for engines to be operated above 500 hours per year.

****

c. Remote Radiator Construction: Provide radiators as described above, except radiators must be remotely piped and provided with electric motor driven fan. Drive must be multiple V-belt or reduction gears. Expansion tanks must be separately mounted. Air flow must be vertical or horizontal as indicated. Interlock fan with engine operation such that fan must operate when engine operates when recommended by engine manufacturer.[Provide controls and control devices complete which must cycle fan on and off based upon coolant temperature.] Provide motors and controllers in accordance with the paragraphs ELECTRIC MOTORS and MOTOR CONTROLLERS, respectively. Motors, controllers, contactors, and disconnects must conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

d. Coolant solution must be a mixture of clean water and ethylene glycol, 50 percent by volume each. Provide an anti-freeze solution tester suitable for the mixture.

****

NOTE: Include the following paragraph when providing cooling system with a remote radiator.

****

Field installed jacket coolant water piping must conform to the following:

a. Piping: Provide seamless steel pipe, Schedule 40, conforming to ASTM A53/A53M, Grade A.

b. Fittings and Flanges: Fittings, 40 mm 1 1/2 inches or smaller, must be malleable iron conforming to ASME B16.3 for Class 300 threaded type. Fittings, 50 mm 2 inches and larger, must be steel butt welding conforming to ASME B16.9. Utilize either ASME B16.1 or Class A of ASTM A126 for Class 125 cast-iron flanged fittings. Flanges must be Class 150 slip-on forged steel welding flanges in accordance with ASME B16.5, with material in accordance with ASTM A181/A181M, Grade I. Provide flat face flanges for connecting to Class 125 standard cast-iron valves, fittings, and equipment connections.

c. Valves

(1) Gate Valves: For valves, 40 mm 1 1/2 inches and smaller, provide double disk, rising stem, inside screw, union bonnet type, Class 125 bronze material conforming to MSS SP-80. For valves, 50 mm 2 inches and larger, provide double-disk, parallel seat type, hydraulic-rated, Class 125, outside screw and yoke type with flanged ends and bronze trim conforming to MSS SP-70. Provide stem packing of material compatible with the system coolant.

(2) Globe Valves: For valves, 40 mm 1 1/2 inches and smaller, provide rising stem, inside screw, union bonnet type, Class 125 bronze valves conforming to MSS SP-80. For valves, 50 mm 2 inches and larger, provide Class 125 cast iron, flanged ends, bronze trim globe valves conforming to MSS SP-85. Valves must have renewable composition or cast iron discs compatible with the system coolant.

(3) Check Valves: MSS SP-71 or MSS SP-80, swing check type.

d. Hangers and Supports: MSS SP-58.

****

NOTE: Include on the drawings a detail of the cooling piping penetrations through walls and roofs showing the piping sleeve and exterior flashing.

****

e. Piping Sleeves: Provide where piping passes through masonry or concrete walls, floors, roofs, and partitions. Place sleeves during construction. Unless indicated otherwise, pipe sleeves must comply with following requirements: Sleeves in outside walls below and above grade, in floor, or in roof slabs, must be standard weight zinc coated steel pipe. Sleeves in partitions must be zinc coated sheet steel having a nominal weight of not less than 4.4 kg per square meter 0.90 pound per square foot. Space between piping insulation and the sleeve must be not less than 6 mm 0.25 inch. Sleeves must be held securely in proper position and location during construction. Sleeves must be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs must extend 50 mm 2 inches above the finished floor. Space between the pipe and the sleeve must be firmly packed with insulation and caulked at both ends of the sleeve with plastic waterproof cement.

2.8.2.2 Shell and U-Tube Type Heat Exchanger

****

NOTE: Retain this paragraph and remove the one above as required by the project.

****

Provide multiple pass shell, U-tube type heat exchanger. Exchanger must operate with low temperature water in the shell and high temperature water in the tubes. Provide exchangers that are constructed in accordance with ASME BPVC SEC VIII D1 and certified with ASME stamp secured to the unit. Provide U-tube bundles that are completely removable for cleaning and tube replacement and free to expand with the shell. Construct shells of seamless steel pipe or welded steel. Tubes must be cupronickel or inhibited admiralty, constructed in accordance with ASTM B395/B395M, suitable for the temperatures and pressures specified. Tubes less than 19 mm 3/4 inch unless otherwise indicated are not acceptable. Design shell side and tube side for 1.03 MPa 150 psig working pressure and factory tested at 2.06 MPa 300 psig. Locate high and low temperature water and pressure relief connections in accordance with the manufacturers standard practice. Water connections larger than 75 mm 3 inches must be ASME Class 150 flanged. Water pressure loss through clean tubes must be as recommended by the engine manufacturer. Minimum water velocity through tubes must be 300 mm/sec 1 fps and assure turbulent flow. Provide one or more pressure relief valves for each heat exchanger in accordance with ASME BPVC SEC VIII D1. The aggregate relieving capacity of the relief valves must be not less than that required by the above code. Install discharge from the valves indicated. Install the relief valves on the heat exchanger shell. Install a drain connection with 19 mm 3/4 inch hose bib at the lowest point in the system near the heat exchanger. Install additional drain connection with threaded cap or plug wherever required for thorough draining of the system.

2.8.3 Expansion Tank

****

NOTE: Delete this paragraph if a shell and U-tube type heat exchanger is not needed.

****

The cooling system must include an air expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those components. The tank must be suitable for operating temperature of 121 degrees C 250 degrees F and a working pressure of 0.86 MPa 125 psi. Provide welded steel tank , tested and stamped in accordance with ASME BPVC SEC VIII D1 for the stated working pressure. Do not use a bladder type tank. Support the tank by steel legs or bases for vertical or steel saddles for horizontal installation.

2.8.4 Thermostatic Control Valve

Provide a modulating type, thermostatic control valve in the coolant system to maintain the coolant temperature range submitted in paragraph SUBMITTALS.

2.8.5 Ductwork

Provide ductwork in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION, except use a flexible connection to connect the duct to the engine radiator. Material for the connection must be wire-reinforced glass. Provide airtight connection.

2.8.6 Temperature Sensors

Equip each engine with coolant temperature sensors. Provide temperature sensors with signals for pre-high and high indication and alarms.

2.9 SOUND LIMITATIONS

****

NOTE: The designer must perform an analysis in accordance with UFC 3-450-01 NOISE AND VIBRATION CONTROL. The designer must consider air intake, exhaust, and diesel generator casing noise. The designer must also coordinate with the architect for proper material selections for the sound transmittance characteristics of the mechanical equipment room and adjacent areas. The designer should consider sound within the equipment room, adjacent areas and building exterior. Acceptable sound levels will vary depending on the function of the space. As a minimum the design should comply with the following OSHA safety requirements; however, more stringent sound restrictions may be required to meet the functional requirements of the occupied spaces.

Frequency Band (Hz)	**Maximum Acceptable Sound Level (Decibels)**	
	Industrial	**Residential**
20-75	**87**	**81**
75-150	**77**	**71**
150-300	**70**	**64**
300-600	**64**	**58**

Frequency Band (Hz)	**Maximum Acceptable Sound Level (Decibels)**	
	Industrial	**Residential**
600-1,200	**61**	**55**
1,200-2,400	**60**	**54**
2,400-4,800	**60**	**54**
4,800-10,000	**62**	**56**

Typically, the generator manufacturer can provide information concerning the noise generated by the generator in a free field environment. The manufacturer does not have control over any other building parameters or additional mechanical equipment noise. Therefore the designer should indicate the required sound limits for each of the indicated octave bands for the sound pressure level of the generator set operating at 100 percent load in a free field. The designer should develop these numbers based on the desired sound levels that should exist at various locations after the generator is installed. This information should be based on the values used in the acoustical analysis and verified by coordination with equipment manufacturers during design. In some cases, a sound attenuated enclosure may be needed to achieve the desired result.

The designer should also indicate the desired sound pressure levels that will be measured in the field. The pressure levels should be based on the acoustical analysis and should consider the specified operating conditions of the generator operating in a free field, other mechanical equipment, the building's sound absorption characteristics, OSHA requirements, and the building's functional requirements. The location of the measurement points for the installed generator should be coordinated with the SAFETY RUN TEST paragraph. Modify the radial distance requirement from the engine,exhaust, and air-intake to account for obstructions, variations in site conditions, building configurations or indicate points on the contract drawings at which measurements are to be made.

****

Submit sound power level data for the packaged unit operating at 100 percent load in a free field environment. The data should demonstrate compliance with the sound limitation requirements of this specification. Submit certification from the manufacturer stating that the sound emissions meet the specification. Do not exceed the following sound pressure levels in any of the indicated frequencies when measured in a free field at a radial distance of 22.9 feet 7 meters at 45 degrees apart in all directions when operating at 100 percent load.

Frequency Band (Hz)	Maximum Acceptable Sound Level (Decibels)
31	[_____]
63	[_____]
125	[_____]
250	[_____]
500	[_____]
1,000	[_____]
2,000	[_____]
4,000	[_____]
8,000	[_____]

2.10 AIR INTAKE EQUIPMENT

Locate filters and silencers in locations that are convenient for servicing. Provide high-frequency filter type silencers and locate in the air intake system as recommended by the engine manufacturer. Provide silencer to reduce the noise level at the air intake so that the indicated pressure levels specified in paragraph SOUND LIMITATIONS will not be exceeded. A combined filter-silencer unit meeting requirements for the separate filter and silencer items may be provided. Provide [copper] [rubber] expansion elements in air-intake lines.

Provide intake filter assemblies for each engine of the oil bath or dry type, as standard with the manufacturer. Filters must be capable of removing a minimum of 92 percent of dirt and abrasive 3 microns and larger from intake air. Size filters to suit engine requirements at 100 percent of rated full load. Design unit for field access for maintenance purposes.

2.11 EXHAUST SYSTEM

****

NOTE: Include on the drawings a detail of the exhaust piping that penetrates construction such as walls or roof.

****

Provide a separate and complete system for each engine. Support piping to minimize vibration. Where a V-type engine is provided, use a V-type connector, with necessary flexible sections and hardware, to connect the engine exhaust outlets.

2.11.1 Flexible Sections and Expansion Joints

Provide a flexible section at each engine and an expansion joint at each muffler. Provide flexible sections and expansion joints that have flanged connections. Provide flexible sections made of convoluted seamless tube without joints or packing. Provide bellows type expansion joints. Provide stainless steel expansion and flexible elements suitable for engine exhaust gas at the maximum exhaust temperature that is specified by the engine manufacturer. Provide expansion and flexible elements that are capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2.11.2 Exhaust Muffler

****

NOTE: Muffler locations and mountings should be shown on the drawings.

****

Provide a chamber type exhaust muffler. Provide welded steel muffler designed for [outside] [inside] [vertical] [horizontal] mounting. Provide eyebolts, lugs, flanges, or other items as necessary for support in the location and position indicated. Do not exceed the engine manufacturer's recommended pressure drop. Outside mufflers must be zinc coated or painted with high temperature 204 degrees C 400 degrees F resisting paint. The muffler and exhaust piping together must reduce the noise level to less than the maximum acceptable level listed for sound limitations in paragraph SOUND LIMITATIONS. Provide muffler with a drain valve, nipple, and cap at the low-point of the muffler.

****

NOTE: The normal values given in the table for exhaust sound reduction are for installations in residential applications. If the installation is in a critical environment (such as a hospital), more stringent criteria must be applied, including engine noise dampening, and the attenuation values in the table for critical class should be selected.

****

A[residential class][critical class] silencer must be provided for each engine which will reduce the exhaust sound spectrum by the following listed values at a 23 m 75 foot radius from the outlet, with generator set loaded to rated capacity and clear weather. Inlet and outlet connections must be flanged.

Octave Band Center Frequency (Hertz)								
Minimum Silencer Attenuation Decibels	63	125	250	500	1000	2000	4000	8000
[Residental Class]	[10]	[25]	[32]	[30]	[25]	[25]	[24]	[23]
[Critical Class]	[15]	[32]	[37]	[36]	[30]	[36]	[37]	[37]

2.11.3 Exhaust Piping

****

NOTE: Exhaust piping will be sized at a gas velocity of less than 25.4 meters per second 5000 fpm. Show piping on the drawings.

****

Slope horizontal sections of exhaust piping downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction must be long radius. Insulate exhaust piping, mufflers and silencers installed inside any building in accordance with paragraph THERMAL INSULATION and covered to protect personnel. Provide vertical exhaust piping with a hinged, gravity-operated, self-closing, rain cover.

****

NOTE: Include the following paragraph when the engine-generator set is installed internal to a building in lieu of in a self-contained outdoor enclosure. The designer is responsible for ensuring that:

1. External loads from the exhaust system, such as weight and thermal expansion do not exceed the engine manufacturer's maximum allowed forces and moments on the turbocharger, and;

2. The exhaust piping system pressure loss is coordinated with the visible emission limits of the engine-generator set when air pollution permitting is required.

****

Field installed exhaust piping must conform to the following:

a. Exhaust Piping: Provide flanges for connections to engines, exhaust mufflers, and flexible connections. Provide steel pipe conforming to ASTM A53/A53M for each engine complete with necessary fittings, flanges, gaskets, bolts, and nuts. Exhaust piping must be Schedule 40 pipe for 300 mm 12 inches and smaller, standard weight for sizes 350 mm 14 inches through 600 mm 24 inches, and 6 mm 0.25 inch wall thickness for sizes larger than 600 mm 24 inches. Flanges must be Class 150 slip-on forged steel welding flanges in accordance with ASME B16.5, with material in accordance with ASTM A181/A181M, Grade I. Fittings must be butt welding conforming to ASTM A234/A234M, with wall thickness same as adjoining piping. Fittings must be of same material and wall thickness as pipe. Built-up miter welded fittings may be used. Miter angles of each individual section must not exceed 22.5 degrees total and not more than 11.25 degrees relative to the axis of the pipe at any one cut. Gaskets for exhaust piping must be of high temperature asbestos-free material suitable for the service and must be ASME B16.21, composition ring, 1.6 mm 0.0625 inch thick. Bolting material for exhaust flanges must be alloy-steel bolt-studs conforming to ASTM A193/A193M, Grade B7 bolts and alloy-steel nuts conforming to ASTM A194/A194M, Grade 7. Bolts must be of sufficient length to obtain full bearing on the nuts and must project not more than two full threads beyond the nut. Provide stainless steel counterbalance type rain caps at termination of each exhaust pipe.

****

NOTE: Select option for liners in expansion joints when required to reduce exhaust pressure drop.

****

b. Expansion (Flexible) Joints: Provide sections of multiple corrugated stainless steel expansion joints [with liners] in the engine exhaust piping for each engine to absorb expansion strains and vibration transmitted to the piping. Flexible joints must be suitable for operation at 93 degrees C 200 degrees F above normal exhaust gas temperature at 100 percent load, 10,000 cycles, minimum. Joints must be flanged and located between engine exhaust manifold and exhaust piping, must be the same size as exhaust piping size, and must be designed and constructed for engine exhaust service.

c. Hangers and Supports: MSS SP-58.

****

NOTE: Include on the drawings a detail of the exhaust piping penetrations through walls and roofs showing the piping sleeve and exterior flashing.

****

d. Piping Sleeves: Provide where piping passes through masonry or concrete walls, floors, roofs, and partitions. Sleeves must be placed during construction. Unless indicated otherwise, pipe sleeves must comply with following requirements: sleeves in outside walls below and above grade, in floor, or in roof slabs, must be standard weight zinc coated steel pipe. Sleeves in partitions must be zinc coated sheet steel having a nominal weight of not less than 4.4 kg per square meter 0.90 pound per square foot. Space between piping insulation and the sleeve must not be less than 6 mm 0.25 inch. Sleeves must be held securely in proper position and location during construction. Sleeves must be sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs must extend 50 mm 2 inches above the finished floor. Space between the pipe and the sleeve must be firmly packed with insulation and caulked at both ends of the sleeve with plastic waterproof cement.

e. Piping Insulation: Provide exhaust piping insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.12 PYROMETER

****

NOTE: For sets smaller than 200 kW delete this paragraph. Pyrometers with individual thermocouples are not normally available and should not be specified for units smaller than 1000 kW.

****

Provide a pyrometer, [multi-point selector switch, and individual thermocouples] [and thermocouple] with calibrated leads to show the temperature [in each engine cylinder and the combined exhaust] [of the combined exhaust]. For a supercharged engine, provide additional points, thermocouples and leads to show the temperature in the turbocharger exhaust gas outlet and combustion air discharge passages. Graduated scale length less than 150 mm 6 inches is not acceptable. Provide double pole selector switch with an "off" position, one set of points for each thermocouple, and suitable indicating dial. Calibrate the pyrometer, thermocouples, leads and compensating devices to show true exhaust temperature within plus or minus 1 percent above the highest temperature encountered at 110 percent load conditions.

2.13 EMISSIONS

****

NOTE: The designer will coordinate emissions requirements with the installation (base/post) environmental office and provide a listing of the requirements. The identification of environmental requirements should be identified at the beginning of the project as a special study effort which requires funding separate from the normal design.

****

The finished installation must comply with Federal, state, and local regulations and restrictions regarding the limits of emissions, as listed here: [_____]. Submit certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. At a minimum this certification must include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and for hazardous air pollutants (HAPs).

2.14 STARTING SYSTEM

****

NOTE: Either electrical or pneumatic starting system should be used and the other paragraphs deleted. Electrical starting will be used for most applications. Engines up to 750 kW should be equipped for electric starting. Starting battery system must be 24-volt dc for engine-generator sets greater than 100 kW and 12-volt dc for engine-generator sets rated 100 kW and less. See manufacturers literature to determine availability for sizes above 750 kW. For units used in emergency applications, select the first option and delete all other starting system paragraphs.

****

Provide starting system for [standby engine generator sets used in emergency applications in accordance with NFPA 99 and NFPA 110and as follows.] [engine generator sets used in non-emergency applications as follows.]

2.14.1 Controls

Provide an engine control switch with functions including: run/start (manual), off/reset, and, automatic mode. Provide start-stop logic for adjustable cycle cranking and cool-down operation. Arrange the logic for [manual starting] [and] [fully automatic starting in accordance with paragraph AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION]. Provide electrical starting systems with an adjustable cranking limit device to limit cranking periods from 1 second up to the maximum duration.

2.14.2 Capacity

Provide starting system with sufficient capacity, at the maximum [outdoor] [indoor] summer temperature specified to crank the engine without damage or overheating. The system must provide a minimum of three cranking periods with 15 second intervals between cranks. Each cranking period must have a maximum duration of 15 seconds. Starting must be accomplished using an adequately sized dc starter system with a positive shift solenoid to engage the starter motor and to crank the engine continuously for 60 seconds without overheating.

2.14.3 Electrical Starting

Manufacturers recommended dc system, utilizing a negative circuit ground. Starting motors must be in accordance with SAE ARP892.

2.14.3.1 Battery

****

NOTE: The ambient temperature selected must be the lowest temperature at which the engine might be cranked. Battery configuration must be two parallel sets of two 12-volt batteries for engine-generator sets rated 750 kW and above. Select nickel-cadmium only when the battery temperature cannot be maintained above minus 6 degrees C 22 degrees F.

****

Provide a starting battery system including the battery, battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. Provide battery in accordance with SAE J537. Size critical system components (rack, protection, etc.) to withstand the seismic acceleration forces specified. Provide [lead-acid] [nickel-cadmium] battery with sufficient capacity, at the minimum [outdoor] [indoor] and maximum [outdoor] [indoor] temperature specified, to provide the specified cranking periods. Valve-regulated lead-acid batteries are not acceptable.

Provide maintenance free, sealed, lead-acid, SAE Type D engine starting batteries.[Battery configuration must be two parallel sets of two 12-volt batteries.] Batteries must have sufficient capacity to provide 60 seconds of continuous cranking of the engine in an ambient temperature of [_____] degrees C [_____] degrees F.

2.14.3.2 Battery Charger

Provide a current-limiting battery charger, conforming to UL 1236, that automatically recharges the batteries. Submit battery charger sizing calculations. The charger must be capable of an equalize charging rate [for recharging fully depleted batteries within [24] [_____] hours] [which is manually adjustable in a continuous range] and a floating charge rate for maintaining the batteries at fully charged condition. Provide an ammeter to indicate charging rate. Provide a voltmeter to indicate charging voltage. Provide a timer for the equalize charging-rate setting. A battery is considered to be fully depleted when the output voltage falls to a value which will not operate the engine generator set and its components.

Provide [120] [_____] volt ac, enclosed, automatic equalizing, dual-rate, solid-state, constant voltage type battery charger with automatic ac line compensation. DC output must be voltage regulated and current limited. Charger must have two ranges, float and equalize, and must provide continuous taper charging. The charger must have a continuous output rating of not less than 10 amperes and must be sized to recharge the engine starting batteries in a minimum of 8 hours while providing the control power needs of the engine-generator set. Enclosure must be NEMA ICS 6, Type [1] [_____]. The following accessories must be included:

a. DC ammeter

b. DC voltmeter

c. Equalize light

d. AC on light

e. Low voltage light

f. High voltage light

g. Equalize test button/switch

h. AC circuit breaker

i. Low dc voltage alarm relay

j. High dc voltage alarm relay

k. Current failure relay

l. AC power failure relay

2.14.4 Storage Batteries

Provide storage batteries of suitable rating and capacity to supply and maintain power for the remote alarm annunciator for a period of 90 minutes minimum without the voltage applied falling below 87.5 percent of normal. Provide a [120] [_____] volt ac automatic battery charger.

2.14.5 Pneumatic

****

NOTE: Pneumatic starting should be used on sets 750 kW and larger.

The complete compressed air system should be shown on the drawings. Two receivers, redundant piping, and two compressors may be required so that starting capability is not lost when tank maintenance is required. Valve arrangement must permit any receiver to be removed from service, drained, repaired, or replaced without loss of starting air from the system. The designer must analyze the starting scenarios and determine the necessity to provide a gasoline or diesel-engine-driven compressor for a "black-plant" (no electrical sources available) startup.

Size each compressor to restore in 15 minutes the air used in one engine start.

Size each receiver to provide sufficient capacity to crank the largest engine for 60 seconds at an ambient temperature of 21 degrees C 70 degrees F

without recharging.

Recommended working pressures are 2068.5 kPa (gauge) 300 psig for cylinder injection or, 1034.2 kPa (gauge) 150 psig for air-motor starting.

Either motors or cylinder injection should be used and the other type deleted.
****

Provide a pneumatic starting system. Provide compressed air system as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE, for a working pressure of [2.07 MPa 300 psi] [1.03 MPa 150 psi].

2.14.5.1 Air Driven Motors

Provide air driven motors complete with solenoid valve, strainer, and lubricator.

2.14.5.2 Cylinder Injection

Perform starting by admitting compressed air into two or more engine cylinders through a timing valve, or through a distributor into a sufficient number of cylinders to assure successful starting regardless of piston positions.

2.14.6 Starting Aids

****
NOTE: Jacket coolant and/or lube-oil heaters are normally provided for most applications to aid starting. Some manufacturers may require glow plugs for combustion air temperatures significantly below 0 degrees C 32 degrees F. Consult manufacturers for availability in the application size range.
****

Provide one or more of other following methods to assist engine starting.

2.14.6.1 Glow Plugs

Design glow plugs to provide sufficient heat for combustion of fuel within the cylinders to guarantee starting at an ambient temperature of -32 degrees C -25 degrees F.

2.14.6.2 Jacket-Coolant Heaters

Mount a thermostatically controlled electric heater in the engine coolant jacketing to automatically maintain the coolant within plus or minus 1.7 degrees C 3 degrees F of the control temperature. The heater must operate independently of engine operation so that starting times are minimized. Power for the heaters must be [_____] volts ac. Include necessary equipment, piping, controls, wiring, and accessories.

2.14.6.2.1 Prime Rated Sets

The control temperature must be the higher of the manufacturer's recommended temperature or the minimum coolant inlet temperature of the engine recommended in paragraph SUBMITTALS.

2.14.6.2.2 Standby Rated Sets

The control temperature must be the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.14.6.3 Lubricating-Oil Heaters

Mount a thermostatically controlled electric heater in the engine lubricating-oil system to automatically maintain the oil temperature within plus or minus 1.7 degrees C 3 degrees F of the control temperature. The heater must operate independently of engine operation so that starting times are minimized. Power for the heaters must be [_____] volts ac.

2.14.7 Exerciser

****

NOTE: Coordinate the need for an exerciser with the user. The plant exerciser is required for stand-by rated sets only, so delete this paragraph for prime applications. Ensure that the exerciser is compatible with the automatic transfer scheme (see reset provisions). It is usually desirable to utilize system loads for genset exercise loads. Coordinate requirement with the user. The designer must ensure that the design provides warning signs in areas where the engine generator can start automatically.

****

Provide exerciser in accordance with Section 26 36 23 AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH.

2.15 GOVERNOR

****

NOTE: Coordinate with paragraph ENGINE GENERATOR PARAMETER SCHEDULE.

****

Provide a forward acting type engine speed governor system. Steady-state frequency band and frequency regulation (droop) must be in accordance with the operating limit values of the performance class specified in the paragraph PERFORMANCE CLASS.

Provide engine with a governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100 percent of rated output capacity. Configure the governor for safe manual adjustment of the speed/frequency during operation of the engine-generator set, without special tools, from 90 to 110 percent of the rated speed/frequency, over a steady state load range of 0 to 100 percent or rated capacity. Submit two complete sets of special tools required for maintenance (except for electronic governor handset). Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. Provide a suitable tool box for tools. Provide one handset for each electronic governor when required to indicate and/or change governor response settings. [Maintain the midpoint of the frequency bandwidth at the same value for steady-state loads over the range of zero to 100 percent of rated output capacity for isochronous governors.] [Maintain the midpoint of the frequency bandwidth linearly for steady-state loads over the range of zero to 100 percent of rated output capacity, [with 3 percent droop] [configured for safe, manual, external adjustment of the droop from zero to [7] [_____] percent] for droop governors.]

2.16 GENERATOR

****

NOTE: Armature and field winding insulation classes are specified based on the allowable temperature rise (the temperature in the windings above the temperature of the air used to cool the windings). See NEMA MG 1 for a discussion of the classes with respect to size range, elevation, method of measurement, and ambient temperature. Select the class insulation for each application based on operating conditions. Class F is considered industry standard. If a different class is required for different machines, specify the one for each application in the Parameter Schedule for the respective engine-generator.

****

Provide synchronous type, one or two bearing, generator conforming to the performance criteria in NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Submit calculations of the engine and generator output power capability, including efficiency and parasitic load data. Provide [Class H] [Class F] insulation.

a. Select NEMA MG 1, Part 16, standby duty, and temperature rise of 130 degrees C for engine-generator sets which are expected to operate for less than 300 hours per year. Select NEMA MG 1, Part 22, continuous duty, and temperature rise of 105 degrees C for engine-generator sets expected to operate 300 hours or greater per year or rated 300 kW and above.

b. Select 2/3 pitch design option for engine-generator sets rated 300 kW and above.

c. Select 10-12 lead re-connectable for engine-generator sets rated 300 kW to 800 kW.

d. For applications requiring high SCR loading or in harsh environments laden with salts and chemicals, select vacuum pressure impregnation (VPI) insulated coils. When engine-generator sets are rated 800 kW and larger, also select form wound coils.

e. Provide salient-pole type, ac, brushless-excited, revolving field, air-cooled, self-ventilated, [drip-proof guarded,] coupled type, synchronous generator conforming to NEMA MG 1, Part [16] [22], and IEEE C50.12. Generator must be rated for [standby] [continuous] duty at 100 percent of the power rating of the engine-generator set as specified in paragraph ENGINE-GENERATOR SET RATINGS AND PERFORMANCE. Temperature rise of each of the various parts of the generator must not exceed[130][105] degrees C as measured by resistance, based on a maximum ambient temperature of 40 degrees C. Winding insulation must be Class H.

f. Stator: Stator windings must be [2/3 pitch design] [,] [10-12 lead re-connectable] [with VPI insulated [and form wound] coils].

g. Rotor: The rotor must have connected amortisseur windings.

h. Generator Space Heater: Provide [120] [_____] volt ac heaters. Heater capacity must be as recommended by the generator manufacturer to aid in keeping the generator insulation dry.

i. Grounding: Provide non-corrosive steel grounding pads located at two opposite mounting legs.

j. Filters: Provide manufacturer's standard generator cooling air filter assembly.

k. Design generator to protect against mechanical, electrical and thermal damage due to vibration, 25 percent overspeeds, or voltages and temperatures at a rated output capacity of 110 percent for prime applications and 100 percent for standby applications.

l. Provide generator ancillary equipment meeting the short circuit requirements of NEMA MG 1. Select drip-proof guarded option for generators without weatherproof enclosures.

m. Submit manufacturer's standard data for each generator (prototype data at the specified rating or above is acceptable), listing the following information:

    (1) Direct-Axis sub-transient reactance (per unit).

    (2) The generator kW rating and short circuit current capacity (both symmetric and asymmetric).

2.16.1 Current Balance

At 100 percent rated output capacity, and load impedance equal for each of the 3 phases, the permissible current difference between any 2 phases must not exceed 2 percent of the largest current on either of the 2 phases. Submit certification stating that the flywheel has been statically and dynamically balanced and is capable of being rotated at 125 percent of rated speed without vibration or damage.

2.16.2 Voltage Balance

At any balanced load between 75 and 100 percent of rated output capacity, the difference in line-to-neutral voltage among the 3 phases must not exceed 1 percent of the average line-to-neutral voltage. For a single phase load condition, consisting of 25 percent load at unity power factor placed between any phase and neutral with no load on the other 2 phases, the maximum simultaneous difference in line-to-neutral voltage between the phases must not exceed 3 percent of rated line to neutral voltage. The single-phase load requirement must be valid utilizing normal exciter and regulator control. The interpretation of the 25 percent load for single phase load conditions means 25 percent of rated current at rated phase voltage and unity power factor.

2.16.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced rated output capacity must not exceed 10 percent. The RMS of all harmonics must be less than 5.0 percent and that of any one harmonic less than 3.0 percent of the fundamental at rated output capacity. Design and configure engine-generator to meet the total harmonic distortion limits of IEEE 519.

2.17 EXCITER

Provide brushless generator exciter. Provide semiconductor rectifiers that have a minimum safety factor of 300 percent for peak inverse voltage and forward current ratings for all operating conditions, including 110 percent generator output at 40 degrees C 104 degrees F ambient. The exciter and regulator in combination must maintain generator-output voltage within the limits specified.

****

NOTE: Select all options for engine-generator sets rated 300 kW and above.

****

Provide a brushless excitation system consisting of an exciter and rotating rectifier assembly [, and permanent magnet generator] integral with the generator and a voltage regulator. Insulation class for parts integral with the generator must be as specified in paragraph GENERATOR. System must provide a minimum short circuit of 300 percent rated engine-generator set current for at least 10 seconds. Steady state voltage regulation must be in accordance with the operating limit values of the performance class specified in the paragraph PERFORMANCE CLASS.

a. Exciter and Rotating Rectifier Assembly: Rectifiers must be provided with surge voltage protection.

b. Permanent Magnet Generator: Provide a voltage spike suppression device for permanent magnet generator (PMG) excitation systems.

c. Voltage Regulator: Voltage regulator must be solid state or digital, automatic, three-phase sensing, volts per hertz type regulator. Regulator must receive its input power from a PMG. Voltage variation for any 40 degree C change over the operating temperature range must be less than plus or minus 1.0 percent. Operating temperature must be minus 40 degree C to plus 70 degree C. Voltage adjust range must be plus to minus 5.0 percent of nominal. Inherent regulator features must include over excitation shutdown.

2.17.1 Electromagnetic Interference (EMI) Suppression

****

NOTE: Include electromagnetic interference (EMI) suppression for engine-generator set installations in the proximity of sensitive electronic equipment.

****

Provide as an integral part of the generator and excitation system, EMI suppression complying with MIL-STD-461.

2.18 VOLTAGE REGULATOR

****

NOTE: Delete reactive droop/differential compensation for non-parallel configuration.

****

Provide a solid-state voltage regulator, separate from the exciter, for each generator. Maintain the voltage within a bandwidth of the rated voltage, over a steady-state load range of zero to 100 percent of rated output capacity. Configure regulator for safe manual adjustment of the engine-generator voltage output without special tools, during operation, from 90 to 110 percent of the rated voltage over the steady state load range of 0 to 100 percent of rated output capacity. Regulation drift exceeding plus or minus 0.5 percent for an ambient temperature change of 20 degrees C 68 degrees F is not acceptable. Reactive droop compensation or reactive differential compensation must load share the reactive load proportionally between sets during parallel operation. Provide voltage regulator with a maximum droop of 2 percent of rated voltage over a load range from 0 to 100 percent of rated output capacity and automatically maintain the generator output voltage within the specified operational bandwidth.

2.19 GENERATOR ISOLATION AND PROTECTION

****

NOTE: Generator protection should be based on the application and size of the generator and should comply with the recommendations of IEEE 242 and IEEE Standard 446 for both generator breaker features and protection schemes. See AFMAN 32-1077 for recommended protection schemes for Air Force projects. The designer must perform a power system coordination study (reference UFC 3-520-01, Coordinated Power System Protection) to specify the breaker ratings, breaker trip unit features and settings, relay protection scheme, and relay settings for coordination for each engine-generator installed. The configuration should always include a disconnecting means for isolation of the generator for maintenance purposes. If the scope of protection is small the designer may elect to incorporate the appropriate Section 26 05 73 POWER SYSTEM STUDIES, paragraphs in this section. Show panelboard, switchboard, and switchgear ratings on the contract drawings for each engine-generator. Rating information should include voltage, phase, bus continuous capacity (amperes), and bus withstand capacity (amperes) (see NEMA PB 1 and NEMA PB 2 for necessary rating information). Show breaker frame, trip, and interrupting ratings on the contract drawings.

Surge capacitors and surge arresters should be provided when the sets are to be connected to exposed overhead lines directly or through transformers, even though connection may be only for transfer of load without service interruption. Surge arrester protection is not required for

separately derived sets which serve single buildings isolated from overhead lines by automatic or manual transfer switches, where provision has been made to prevent simultaneous connection to both sources.
The designer will specify the surge arrester rating.
****

Provide necessary devices for electrical protection and isolation of each engine-generator set and its ancillary equipment. The generator circuit breaker (IEEE Device 52) ratings must be consistent with the generator rated voltage and frequency, with continuous, short circuit withstand, and interrupting current ratings to match the generator capacity. Provide [manually operated] [electrically operated] [operated as indicated] generator circuit breaker. Mount a set of surge capacitors at the generator terminals. Provide monitoring and control devices as specified in paragraph GENERATOR PANEL.

The generator circuit breaker must comply with UL 489 requirements for molded case, adjustable thermal magnetic trip type circuit breaker. The circuit breaker continuous current rating must be adequate for the power rating of the engine-generator set and the circuit breaker must be rated to withstand the short circuit current provided by the generator set. Provide circuit breaker in a NEMA ICS 6, Type [1] [_____] enclosure mounted on the engine-generator set.

2.19.1 Switchboards

Provide free-standing, metal-enclosed, general purpose, 3-phase, 4-wire, [600] [_____] volt rated, with neutral bus and continuous ground bus, switchboards conforming to NEMA PB 2 and UL 891. Neutral bus and ground bus capacity must be [as shown] [full capacity]. Provide panelboards conforming to NEMA PB 1. Provide enclosure designs, construction, materials and coatings [as indicated] [suitable for the application and environment]. Bus continuous current rating must be [at least equal to the generator rating and correspond to the UL listed current ratings specified for panelboards and switchboards] [as indicated]. Current withstand (short circuit rating) must be [equal to the breaker interrupting rating] [as indicated]. Provide copper buses.

2.19.2 Devices

Provide switches, circuit breakers, switchgear, fuses, relays, and other protective devices as specified in Section 26 05 73 POWER SYSTEM STUDIES.

Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects must conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical connections under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide controllers and contactors with maximum of 120-volt control circuits, and auxiliary contacts for use with controls furnished. When motors and equipment furnished are larger than size indicated, the cost of providing additional electrical service and related work must be included under this section.

2.20 SAFETY SYSTEM

Provide and install devices, wiring, remote panels, and local panels, etc., as a complete system to automatically activate the appropriate signals and initiate the appropriate actions. Provide a safety system with a self-test method to verify its operability. Provide alarm signals that have manual acknowledgment and reset devices. The alarm signal systems must reactivate for new signals after acknowledgment is given to any signal. Configure the systems so that loss of any monitoring device will be dealt with as an alarm on that system element.

2.20.1 Audible Signal

****

NOTE: High dB levels are required for alarms located near engine. Specify over 100 dB for engine room application and show alarm location.

****

Provide audible alarm signal sound at a frequency of [70] [_____] Hz at a volume of [_____] [75] dB at 3.1 m 10 feet. The sound must be continuously activated upon alarm and silenced upon acknowledgment. Locate signal devices as shown.

2.20.2 Visual Signal

The visual alarm signal must be a panel light. The light must be normally off, activated to be blinking upon alarm. The light must change to continuously lit upon acknowledgement. If automatic shutdown occurs, the display must maintain activated status to indicate the cause of failure and must not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms must be red; all other alarms must be amber.

2.20.3 Alarms and Action Logic

2.20.3.1 Shutdown

Accomplish simultaneous activation of the audible signal, activation of the visual signal, stopping the engine, and opening the generator main circuit breakers.

2.20.3.2 Problem

Accomplish activation of the visual signal.

2.20.4 Safety Indications and Shutdowns

****

NOTE: The designer must provide design features in accordance with the requirements of NFPA 70 and NFPA 99 for medical facilities. The designer must provide design features in accordance with the requirements of NFPA 70 and NFPA 110 for emergency and standby applications. For emergency and standby applications select either Level 1 or Level 2. Level 1 defines the most stringent equipment performance requirements for applications where the failure of the equipment to perform could result in loss of human life or serious injury. Level 2 defines equipment performance where failure of the equipment to operate is less critical to human life. Edit the table to include all required shutdowns and alarms. Delete optional alarms which are not required. Delete all columns except the

first column and the appropriate code reference column. Add necessary parameters to define critical limits for alarms or shutdown.

For example, references to day tanks should be removed if integral main fuel storage tanks are used.

Provide a local alarm panel with the following shutdown and alarm functions [as indicated] [in accordance with [NFPA 99] [NFPA 110 level [1] [2]]] mounted either on or adjacent to the engine generator set.

****

NOTE: Depending on the application, a remote alarm panel may also be required. The Remote Alarm Panel should be shown on the drawings. Delete remote alarm panel where not required. Select the first option if the application is prime power plant. For prime power units provide panel elevations depicting desired configurations, together with a listing of alarms and instruments. Select the second option for engine generator sets utilized on emergency or standby applications. The designer must provide design features in accordance with the requirements of NFPA 70, and NFPA 99 for medical facilities. The designer must provide design features in accordance with the requirements of NFPA 70 and NFPA 110 for emergency and standby applications. A remote panel is required for NFPA 99 and NFPA 110, Level 1 applications. A remote panel is not required for NFPA 110, Level 2 applications. Edit the table to include all required alarms. Delete optional alarms which are not required. Delete all columns except the first column and the appropriate code reference column. Add necessary parameters where required to define critical limits for alarms.

****

A remote alarm panel is [is not] required for audible alarms, e.g., in the control room.

Indicator Function (at battery voltage)	NFPA 99 Level 1 CV S RA	NFPA 110 Level 1 CV S RA	NFPA 110 Level 2 CV S RA
Overcrank	X X X	X X X	X X O
Low water temperature	X NA X	X NA X	X NA O
High engine temperature pre-alarm	X NA X	X NA X	O NA NA
High engine temperature	X X X	X X X	X X O
Low lube oil pressure pre-alarm	X NA X	NA NA NA	NA NA NA

Indicator Function (at battery voltage)	NFPA 99 Level 1 CV S RA	NFPA 110 Level 1 CV S RA	NFPA 110 Level 2 CV S RA
Low lube oil pressure	X X X	X X X	X X O
Overspeed	X X X	X X X	X X O
Low fuel main tank	X NA X	X NA X	O NA O
Low coolant level	X O X	X O X	X O X
EPS supplying load	X NA NA	X NA NA	O NA NA
Control switch not in automatic position	X NA X	X NA X	X NA X
High battery voltage	X NA NA	X NA NA	O NA NA
Low cranking voltage	X NA X	X NA X	O NA NA
Low voltage in battery	X NA NA	X NA NA	O NA NA
Battery charger ac failure	X NA NA	X NA NA	O NA NA
Lamp test	X NA NA	X NA NA	X NA NA
Contacts for local and remote common alarm	X NA X	X NA X	X NA X
Audible alarm silencing switch	NA NA X	NA NA X	NA NA O
Low starting air pressure	X NA NA	X NA NA	O NA NA
Low starting hydraulic pressure	X NA NA	X NA NA	O NA NA
Air shutdown damper when used	X X X	X X X	X X O
Remote emergency stop	NA X NA	NA X NA	NA X NA

Indicator Function (at battery voltage)	NFPA 99 Level 1 CV S RA	NFPA 110 Level 1 CV S RA	NFPA 110 Level 2 CV S RA
Symbology: CV: Control panel-mounted visual. S: Shutdown of EPS indication. RA: Remote audible. Symbology: CV: Control panel-mounted visual. S: Shutdown of EPS indication. RA: Remote audible. X: Required. O: Optional. NA: Not applicable.			

2.20.5 Time-Delay on Alarms

For startup of the engine-generator set, install time-delay devices bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. Submit the magnitude of monitored values which define alarm or action set points, and the tolerance (plus and/or minus) at which the devices activate the alarm or action for items contained within the alarm panels. The lube-oil time-delay device must return its alarm to normal status after the engine starts. The coolant time-delay device must return its alarm to normal status 5 minutes after the engine starts.

2.21 SYNCHRONIZING PANEL

****

NOTE: Delete the Synchronizing Panel if no parallel service is intended. All panels except the remote panel can be combined into a single panel paragraph.

****

Provide panel as specified in paragraph PANELS and provide controls, gauges, meters, and displays to include:

a. Frequency meters, dial type, with a range of 90 to 110 percent of rated frequency. Do not use vibrating-reed type meters . One must monitor generator output frequency ("Generator Frequency Meter") and the other must monitor the frequency of the parallel source ("Bus Frequency Meter").

b. Voltmeters, ac, dial type, 3-phase, with 4-position selector switch for the generator output ("Generator Volt Meter") and for the parallel power source ("Bus volt meter").

c. Automatic synchronizer.

d. Manual synchronizing controls.

e. Indicating lights for supplementary indication of synchronization.

f. Synchroscope.

g. Wattmeter, indicating.

2.22 PANELS

****

NOTE: All panels except the remote panel can be combined into a single panel paragraph.

Provide a panel-mounting location and detail for panels not mounted on the engine-generator base. The designer may elect other locations such as adjacent to engine-generator set, in the generator enclosure, in or on the exciter-regulator cabinet, or in or on the switchgear enclosure. Provide panel nameplate and instrument nameplate unique identifiers or user preferred identifiers. Provide sizes, materials and attachment preferences.

Delete either the "analog" or "electronic instruments" paragraph.

****

Each panel must be of the type and kind necessary to provide specified functions. Mount panels [on the engine-generator set base by vibration/shock absorbing type mountings] [as shown]. Mount instruments flush or semiflush. Provide convenient access to the back of panels to facilitate maintenance. Calibrate instruments using recognized industry calibration standards. Provide a panel identification plate identifying the panel function. Provide a plate identifying the device and its function for each instrument and device on the panel. Provide switch plates identifying the switch-position function.

2.22.1 Enclosures

Design enclosures for the application and environment, conforming to NEMA ICS 6. Locking mechanisms [are optional.] [must be keyed alike.]

Provide for each engine-generator set and fabricate from zinc coated or phosphatized and shop primed 16 gage minimum sheet steel in accordance with the manufacturer's standard design. Provide a complete, weatherproof enclosure for the engine, generator, and auxiliary systems and equipment. Support exhaust piping and silencer so that the turbocharger is not subjected to exhaust system weight or lateral forces generated in connecting piping that exceed the engine manufacturer's maximum allowed forces and moments. The housing must have sufficient louvered openings to allow entrance of outside air for engine and generator cooling at full load. Design louvered openings to exclude driving rain and snow. Provide properly arranged and sized, hinged panels in the enclosure to allow convenient access to the engine, generator, and control equipment for maintenance and operational procedures. Provide hinged panels with spring type latches which must hold the panels closed securely and will not allow them to vibrate. Brace the housing internally to prevent excessive vibration when the set is in operation

2.22.2 Analog

Provide analog electrical indicating instruments in accordance with UL 1437 with semi-flush mounting. Switchboard, switchgear, and control-room panel-mounted instruments must have 250 degree scales with an accuracy of not less than 99 percent. Unit-mounted instruments must [be the manufacturer's standard] [have 100 degree scales] with an accuracy of not less than 98 percent. The instrument's operating temperature range must be minus 20 to plus 65 degrees C minus 4 to plus 158 degrees F. Distorted generator output voltage waveform of a crest factor less than 5 must not affect metering accuracy for phase voltages, hertz and amps.

2.22.3 Electronic

Electronic indicating instruments must be true RMS indicating instruments, 100 percent solid state, state-of-the-art, microprocessor controlled to provide specified functions. Provide control, logic, and function devices that are compatible as a system, sealed, dust and water tight, and that utilize modular components with metal housings and digital instrumentation. Provide an interface module to decode serial link data from the electronic panel and translate alarm, fault and status conditions to set of relay contacts. Instrument accuracy less than 98 percent for unit mounted devices and 99 percent for control room, panel mounted devices, throughout a temperature range of minus 20 to plus 65 degrees C minus 4 to 158 degrees F is not acceptable. Provide LED or back lit LCD data display. Additionally, the display must provide indication of cycle programming and diagnostic codes for troubleshooting. Numeral height must be [13 mm 0.5 inch] [_____].

2.22.4 Parameter Display

Provide indication or readouts of the tachometer, lubricating-oil pressure, ac voltmeter, ac ammeter, frequency meter, and safety system parameters. Specify a momentary switch for other panels.

2.23 SURGE PROTECTION

Electrical and electronic components must be protected from, or designed to withstand the effects of surges from switching and lightning.

2.24 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION

****

NOTE: Automatic operation is for standby. For hospital emergency/standby requirements, an emergency power plant of sufficient capacity to handle the essential load must be provided, arranged to operate automatically with the failure or restoration of normal current. Delete automatic paralleling and loading where not required. Adapt to fit application and provide desired actuation sequence.

****

Provide fully automatic operation for the following operations: engine-generator set starting and load transfer upon loss of [normal] [preferred] source; retransfer upon restoration of the [normal] [preferred] source; sequential starting; paralleling, and load-sharing for multiple engine-generator sets; and stopping of each engine-generator set after cool-down. Devices must automatically reset after termination of their function.

2.24.1 Automatic Transfer Switch

Provide automatic transfer switches in accordance with Section 26 36 23 AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH.

2.24.2 Monitoring and Transfer

Provide devices to monitor voltage and frequency for the [normal] [preferred] power source and each engine-generator set, and control transfer from the [normal] [preferred] source and retransfer upon restoration of the [normal] [preferred] source. Describe functions, actuation, and time delays as described in Section 26 36 23 AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH.

2.24.3 Automatic Paralleling and Loading of Engine-Generator Sets

Provide an automatic loading system to load and unload engine-generator sets in the sequence indicated. Monitor the system load and cause additional engine-generator sets to start, synchronize, and be connected in parallel with the system bus with increasing load. Actuation of the additional engine-generator set start logic must occur when the load exceeds a percentage set-point of the operating set's rating for a period of approximately 10 seconds. Provide an adjustable set-point range from 50 to 100 percent. When the system load falls below the percentage set-point of the operating set's rating for a period of approximately [_____], the controller must unload and disconnect engine-generator sets from the system, stopping each engine-generator set after cool-down.

2.25 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION

****

NOTE: Delete synchronization for non-parallel operation.

****

Provide complete facilities for manual starting and testing of each set without load, loading and unloading of each set, and synchronization of each set with an energized bus.

2.26 STATION BATTERY SYSTEM

****

NOTE: The station battery system should be shown on the drawings.

Delete this requirement when not needed. A station battery is required only when dc-operated devices other than engine starting motors are provided. The station battery and starting battery may be combined where all dc-operated devices are the same voltage level and are not affected by the voltage drop caused by engine starting. Because lead calcium batteries are more economical and require less maintenance, nickel cadmium batteries should be specified only where very high discharge rate with constant voltage over a short period of time is required, or for applications where the battery temperature cannot be maintained above minus 6 degrees C 22 degrees F. Slush does not begin to

form in lead acid batteries until the temperature reaches minus 29 degrees C minus 20 degrees F, but the battery voltage output and current capacity fall below useful values at minus 6 degrees C 22 degrees F. The designer should provide measures to maintain battery temperature between 16 and 32 degrees C 60 and 90 degrees F; 25 degrees C 77 degrees F is the target temperature for optimum service life and performance. The engine starting battery for smaller size sets is sufficient for dc requirements and a station battery is not required.

Define loads which are to be served by the station battery.

Calculations of battery capacity utilize a median temperature of 25 degrees C 77 degrees F. If the predominate battery operating temperature varies by more than plus or minus 2.5 degrees C plus or minus 5 degrees F from 25 degrees C 77 degrees F, specify the median operating temperature.

****

Provide a station battery system including the battery, battery rack, spacers, automatic battery charger and distribution panelboard with overcurrent protection, metering and relaying. Size components to withstand the seismic acceleration forces specified. Provide batteries that have a rated life of 20 years and a manufacturer's 5-year, no cost replacement guarantee.

2.26.1 Battery

Provide [lead-acid] [nickel-cadmium] battery sized in accordance with IEEE 485 and conforming to the requirements of IEEE 484. Valve-regulated lead-acid batteries are not acceptable. Provide battery environment temperature range between [_____] and [_____] degrees. The battery must be rated for at least [_____] ampere hours at the 8-hour rate.

2.26.2 Battery Capacity

****

NOTE: Delete loads which are not to be served from the Station Battery System. Add the following load for engine-generators 1000 kW and larger: precirculating lube-oil pumps for diesels for [_____] minutes.

****

The battery must be rated for at least [_____] ampere hours at the 8-hour rate, and must have sufficient capacity to serve the following loads without recharging for a period of [_____] hours. At the end of the discharge period, the battery must have the capacity to simultaneously close and trip all the circuit breakers provided, based on a 1-minute load to final voltage of [_____] volts per cell.

a. Diesel-generator safety circuits.

b. Switchgear indicating lights, control relays, protective relays, and other switchgear dc components as required for 24 hours.

c. Voltage regulator (dc power supplies).

d. Emergency-lighting and power load at [_____] watts for [_____] hours.

2.26.3 Battery Charger

Furnish a current-limiting, [_____]-volt battery charger to automatically recharge the batteries. Provide a charger that is capable of an equalize charging rate [for recharging fully depleted batteries within [8] [_____] hours] [which is continuously adjustable] and a floating-charge rate for maintaining the batteries in a fully charged condition. Equip the charger with a low-voltage alarm relay, 0- to 24-hour equalizing timer, an ammeter to indicate charging rate, and necessary circuit breakers. The charger must conform to the requirements of UL 1236. A battery is considered to be fully depleted when the voltage falls to a level incapable of operating the equipment loads served by the battery.

2.27 BASE

Provide a steel base. Design the base to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base must permit skidding in any direction during installation and must withstand and mitigate the affects of synchronous vibration of the engine and generator. Provide base with [suitable holes for anchor bolts] [[_____] diameter holes for anchor bolts] and jacking screws for leveling.

2.28 THERMAL INSULATION

Provide thermal insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.29 PAINTING AND FINISHING

Clean, prime and paintthe engine-generator set in accordance with the manufacturer's standard color and practice.

2.30 FACTORY INSPECTION AND TESTS

Submit [six] [_____] complete reproducible copies of the factory inspection result on the checklist format specified below. Perform the factory tests on each engine-generator set. The component manufacturer's production line test is acceptable as noted. Run each engine-generator set for at least 1 hour at rated output capacity prior to inspections. Complete inspections and make all necessary repairs prior to testing. Use engine generator controls and protective devices that are provided by the generator set manufacturer as part of the standard package for factory tests. When controls and switchgear are not provided as part of the generator set manufacturer's standard package, the actual controls and protective devices provided for the project are not required to be used during the factory test. The Contracting Officer may provide one or more representatives to witness inspections and tests.

2.30.1 Factory Inspection

****

NOTE: Delete inapplicable inspection items.

****

Perform inspections prior to beginning and after completion of testing of the assembled engine-generator set. Look for leaks, looseness, defects in components, proper assembly, etc. and note any item found to be in need of correction as a necessary repair. Use the following checklist for the inspection:

INSPECTION ITEM	GOOD	BAD	NOTES
Drive belts			
Governor and adjustments			
Engine timing mark			
Starting motor			
Starting aids			
Coolant type and concentration			
Radiator drains			
Block coolant drains			
Coolant fill level			
All coolant line connections			
All coolant hoses			
Combustion air filter			
Combustion air silencer			
Lube oil type			
Lube oil sump drain			
Lube-oil filter			
Lube-oil-level indicator			
Lube-oil-fill level			
All lube-oil line connections			
All lube-oil lines			
Fuel type and amount			
All fuel-line connections			

INSPECTION ITEM	GOOD	BAD	NOTES
All fuel lines			
Fuel filter			
Coupling and shaft alignment			
Voltage regulators			
Battery-charger connections			
All wiring connections			
Instrumentation			
Hazards to personnel			
Base			
Nameplates			
Paint			
Exhaust-heat recovery unit			
Switchboard			
Switchgear			

2.30.2 Factory Tests

****

NOTE: For dual fuel units, choose the fuel type to be used for the factory test. Decision should be based on providing satisfactory operation with the fuel which has the lowest heat value or on the fuel which presents the factors critical to satisfactory operation.

Delete Voltage Waveform tests for general purpose and commercial application categories.

Delete the Frequency and Voltage Stability and Transient Response Test for general-purpose and commercial-type applications. Perform this test either as a factory test or a field test (delete it from either the factory or field testing). This is not a standard manufacturer's test and requires most manufacturers to procure additional equipment (large reactive load banks) to test engine-generators over 1000 kW. Perform as a field test where required to ensure system operability using project loads. Revise the test steps to delete steps where the Maximum Step Increase is larger than final load to be placed on the engine-generator.

Voltage Unbalance with Unbalanced Load Test is not a standard manufacturer's test. Delete the test for applications where only balanced three phase loads are served.

Delete parallel operation where not required.
****

Submit a letter giving notice of the proposed dates of factory inspections and tests at least 14 days prior to beginning tests, including:

a. A detailed description of the manufacturer's procedures for factory tests at least [14] [_____] days prior to beginning tests.

b. [Six] [_____] copies of the Factory Test data described below in 216 by 279 mm 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Separate sections by heavy plastic dividers with tabs. Provide full size (216 by 279 mm 8-1/2 by 11 inch minimum) data plots showing grid lines, with full resolution.

    (1) A detailed description of the procedures for factory tests.

    (2) A list of equipment used, with calibration certifications.

    (3) A copy of measurements taken, with required plots and graphs.

    (4) The date of testing.

    (5) A list of the parameters verified.

    (6) The condition specified for the parameter.

    (7) The test results, signed and dated.

    (8) A description of adjustments made.

On engine-generator set tests where the engine and generator are required to be connected and operated together, the load power factor must be [the power factor specified in the engine generator set parameter schedule] [[_____] power factor]. For engine-generator set with dual-fuel operating capability, perform the following tests using [the primary fuel type] [[_____] type fuel]. Perform electrical measurements in accordance with IEEE 120. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation must be in accordance with IEEE 1. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Tests specifically for the generator may be performed utilizing any prime mover.

a. Insulation Resistance for Stator and Exciter Test, IEEE 115 and IEEE 43, to the performance criteria in NEMA MG 1, Part 22. Generator manufacturer's production line test is acceptable.

b. High Potential Test, in accordance with IEEE 115 and NEMA MG 1, test voltage in accordance with NEMA MG 1. Generator manufacturer's production line test is acceptable.

c. Winding Resistance Test, Stator and Exciter, in accordance with IEEE 115. Generator manufacturer's production line test is acceptable.

d. Phase Balance Voltage Test, to the performance criteria specified in paragraph GENERATOR. This test can be performed with any prime mover. Generator manufacturer's production line test results are acceptable.

(1) Start and operate the generator at no load.

(2) Adjust a regulated phase voltage (line-to-neutral) to rated voltage.

(3) Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(4) Apply 75 percent rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(5) Apply rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(6) Calculate average line-neutral voltage and percent deviation of individual line-neutral voltages from average for each load condition.

e. Current Balance on Stator Winding Test, by measuring the current on each phase of the winding with the generator operating at 100 percent of Rated Output Capacity, with the load impedance equal for each of the three phases: to the performance criteria specified in paragraph GENERATOR.

f. Voltage Waveform Deviation and Distortion Test in accordance with IEEE 115 to the performance criteria specified in paragraph GENERATOR. Use high-speed recording instruments capable of recording voltage waveform deviation and all distortion, including harmonic distortion. Include appropriate scales to provide a means to measure and interpret results.

g. Voltage and Frequency Droop Test. Verify that the output voltage and frequency are within the specified parameters as follows:

(1) With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency. Record the generator output frequency and line-line and line-neutral voltages.

(2) Increase load to Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

(3) Calculate the percent droop for voltage and frequency with the following equations:

$$\text{Voltage droop percent} = \frac{(\text{No-Load Volts}) - (\text{Rated Capacity Volts})}{(\text{Service-Load Volts})} \times 100$$

$$\text{Frequency droop percent} = \frac{(\text{No-Load Hertz}) - (\text{Rated Capacity Hertz}) \times 100}{(\text{Service-Load Hertz})}$$

(4) Repeat steps 1 through 3 two additional times without making any adjustments.

h. Frequency and Voltage Stability and Transient Response. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Include the following tabular data:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Frequency (before and after load changes).

(5) Generator output power (before and after load changes).

(6) Graphic representations must include the actual instrument trace of voltage and frequency showing: charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

(a) Perform and record engine manufacturer's recommended pre-starting checks and inspections.

(b) Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

(c) With the unit at no load, apply the Maximum Step Load Increase.

****

NOTE: For applications where the Maximum Step Load Increase is 100 percent, delete steps 4., 5., and 6.

****

(d) Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

(e) Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.

(f) Apply the Maximum Step Load Increase.

(g) Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

(h) Repeat steps (c) through (g).

i. Test Voltage Unbalance with Unbalanced Load (Line-to-Neutral) to the performance criteria specified in paragraph GENERATOR. Prototype test data is acceptable in lieu of the actual test. Submit manufacturer's standard certification that prototype tests were performed for the generator model proposed. This test may be performed using any prime mover.

(1) Start and operate the generator set at rate voltage, no load, rated frequency, and under control of the voltage regulator. Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(2) Apply the specified load between terminals L_1-L_2, L_2-L_0, and L_3-L_0 in turn. Record all instrument readings at each line-neutral condition.

(3) Express the greatest difference between any two of the line-to-line voltages and any two of the line-to-neutral voltages as a percent of rated voltage.

(4) Compare the largest differences expressed in percent with the maximum allowable difference specified.

PART 3 EXECUTION

****

NOTE: Provide an equipment layout on the plans, which provides the clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Include requirements for a staging/laydown area for disassembly or removal and replacement of major parts of the engine-generator. Additionally, it is advisable to provide access to remove the unit and/or major parts of equipment from the room and building either through doors/passageways or equipment hatches.

****

3.1 EXAMINATION

After becoming familiar with all details of the job, perform a Site Visit to verify the information shown on the drawings, before performing any work. Submit a letter stating the date the site was visited and listing discrepancies found. Notify the Contracting Officer in writing of any discrepancies.

3.2 GENERAL INSTALLATION

Provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Submit a copy of the manufacturer's installation procedures and a detailed description of the manufacturer's recommended break-in procedure. Install pipe, duct, conduit, and ancillary equipment to facilitate easy removal and replacement of major components and parts of the engine-generator set.

3.3 PIPING INSTALLATION

Weld piping. Provide flanged valve connections. Provide flanged connections at equipment. Provide threaded connections to the engine if the manufacturers standard connection is threaded. Except where otherwise specified, use welded flanged fittings to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Make connections to equipment with vibration isolation-type flexible connectors. Support and align piping and tubing to prevent stressing of flexible hoses and connectors. Flash pipes extending through the roof. Install piping clear of windows, doors and openings, to permit thermal expansion and contraction without damage to joints or hangers, and install a 13 mm 1/2 inch drain valve with cap at each low point.

The installation of gas engines must conform to the requirements of NFPA 37 and its references therein, including NFPA 54, NFPA 58, and ASME B31.3.

3.3.1 Support

Provide hangers, inserts, and supports to accommodate any insulation and conforming to MSS SP-58. Space supports no more than 2.1 m 7 feet on center for pipes 50 mm 2 inches in diameter or less, no more than 3.6 m 12 feet on center for pipes larger than 50 mm 2 inches but smaller than 100 mm 4 inches in diameter, and not more than 5.2 m 17 feet on center for pipes larger than 100 mm 4 inches in diameter. Provide supports at pipe bends or change of direction.

3.3.1.1 Ceiling and Roof

Support exhaust piping with appropriately sized Type 41 single pipe roll and threaded rods; support all other piping with appropriately sized Type 1 clevis and threaded rods.

3.3.1.2 Wall

Make wall supports for pipe by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

3.3.2 Flanged Joints

Provide flanges that are Class 125 type, drilled, and of the proper size and configuration to match the equipment and engine connections. Provide gasketed flanged joints that are square and tight.

3.3.3 Cleaning

After fabrication and before assembly, piping interiors must be manually wiped clean of debris.

3.3.4 Pipe Sleeves

Fit pipes passing through construction such as ceilings, floors, or walls with sleeves. Extend each sleeve through and fasten in its respective structure and cut flush with each surface. Build the structure tightly to the sleeve. The inside diameter of each sleeve must be minimum 13 mm 1/2 inch, and where pipes pass through combustible materials 25 mm 1 inch larger than the outside diameter of the passing pipe or pipe insulation/covering.

3.4 ELECTRICAL INSTALLATION

Perform electrical installation in compliance with NFPA 70, IEEE C2, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. For vibration isolation, provide flexible fittings for conduit, cable trays, and raceways attached to engine-generator sets; provide flexible stranded conductor for metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set; and provide crimp-type terminals or lugs for terminations of conductors on the engine generator set.

3.5 FIELD PAINTING

****

NOTE: For Air Force work, add that the exterior of all equipment must be finished in the base standard color.

****

Perform field painting as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6 ONSITE INSPECTION AND TESTS

****

NOTE: Include the bracketed option below for projects located outside the continental United States (OCONUS).

****

Perform and report on factory tests and inspections prior to shipment. Provide certified copies of manufacturer's test data and results. Test procedures must conform to ASME, IEEE, [IEC,] and ANSI standards, and to ISO requirements on testing, as appropriate and applicable. The manufacturer performing the tests must provide equipment, labor, and consumables necessary for tests and measuring and indicating devices must be certified to be within calibration. Tests must indicate satisfactory operation and attainment of specified performance. If satisfactory, equipment tested will be given a tentative approval. Equipment must not be shipped before approval of the factory test reports for the following tests.

Submit a letter giving notice of the proposed dates of onsite inspections and tests at least [14] [_____] days prior to beginning tests.

a. Submit a detailed description of the Contractor's procedures for onsite tests including the test plan and a listing of equipment necessary to perform the tests at least [_____] days prior to beginning tests.

b. Submit [six] [_____] copies of the onsite test data described below in 216 by 279 mm 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Separate sections by heavy plastic dividers with tabs. Provide full size (216 by 279 mm 8-1/2 by 11 inch minimum) data plots showing grid lines, with full resolution.

(1) A detailed description of the procedures for onsite tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

(4) The date of testing.

(5) A list of the parameters verified.

(6) The condition specified for the parameter.

(7) The test results, signed and dated.

(8) A description of adjustments made.

3.6.1 Test Conditions

3.6.1.1 Data

Make and record measurements of all parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, make adjustments, replacements, or repairs and repeat the step until satisfactory results are obtained. Unless otherwise indicated, record data in 15 minute intervals during engine-generator set operation and include: readings of all engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set. Perform electrical measurements in accordance with IEEE 120. Definitions of terms are in accordance with IEEE 100. Provide temperature limits in the rating of electrical equipment and for the evaluation of electrical insulations in accordance with IEEE 1.

3.6.1.2 Power Factor

Submit the generator capability curve showing generator kVA output capability (kW vs. kvar) for both leading and lagging power factors ranging from 0 to 1.0. For all engine-generator set operating tests the load power factor must be [the power factor specified in the engine-generator set parameter schedule] [[_____] power factor].

3.6.1.3 Contractor Supplied Items

Provide equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors.

3.6.1.4 Instruments

Verify readings of panel gauges, meters, displays, and instruments provided as permanent equipment during test runs, using test instruments of greater precision and accuracy. Test instrument accuracy must be within the following: current plus or minus 1.5 percent, voltage plus or minus 1.5 percent, real power plus or minus 1.5 percent, reactive power plus or minus 1.5 percent, power factor plus or minus 3 percent, frequency plus or minus

0.5 percent. Calibrate test instruments by a recognized standards laboratory within 30 days prior to testing.

3.6.1.5 Sequence

Provide the sequence of testing as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Perform field testing in the presence of the Contracting Officer. Schedule and sequence tests in order to optimize run-time periods; however, follow the general order of testing: Construction Tests; Inspections; Pre-operational Tests; Safety Run Tests; Performance Tests; and Final Inspection.

3.6.2 Construction Tests

****

NOTE: Coordinate the construction test requirements with the other specification sections to eliminate redundant tests and provide additional reference to necessary tests.

****

Perform individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer prior to connection to the engine-generator set.

3.6.2.1 Piping Test

a. Flush lube-oil and fuel-oil piping with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.

b. Test fuel piping which is external to the engine-generator set in accordance with NFPA 30. Pressure all remaining piping which is external to the engine-generator set with air pressure at 150 percent of the maximum anticipated working pressure, but not less than 1.03 MPa 150 psi, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, perform the test before the insulation is applied.

3.6.2.2 Electrical Equipment Tests

****

NOTE: Delete ground resistance tests where covered by other project specifications, or where no grounds are installed.

****

a. Perform low-voltage cable insulation integrity tests for cables connecting the generator breaker to the [automatic transfer switch] [panelboard] [main disconnect switch] [distribution bus] [_____]. Test low-voltage cable, complete with splices, for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. Apply a test voltage of 500 volts dc for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. Provide the minimum value of insulation as follows:

(1) R in meg-ohms = (rated voltage in kV plus 1) x 304.8/(length of cable in meters)

(2) R in meg-ohms = (rated voltage in kV plus 1) x 1000/(length of cable in feet)

(3) Each cable failing this test must be repaired or replaced. The repair cable must be retested until failures have been eliminated.

b. Perform medium-voltage cable insulation integrity tests for cables connecting the generator breaker to the [generator switchgear] [main disconnect switch] [distribution bus]. After installation and before the operating test or connection to an existing system, perform a high potential test on the medium-voltage cable system. Apply direct-current voltage on each phase conductor of the system by connecting conductors as one terminal and connecting grounds of metallic shields or sheaths of the cable as the other terminal for each test. Prior to making the test, isolate the cables by opening applicable protective devices and disconnecting equipment. Conduct the test with all splices, connectors, and terminations in place. Provide the method, voltage, length of time, and other characteristics of the test for initial installation in accordance with [NEMA WC 74/ICEA S-93-639] [_____] for the particular type of cable installed, except provide 28kV and 35kV insulation test voltages in accordance with either AEIC CS8 or AEIC CS8 as applicable, and do not exceed the recommendations of IEEE 404 for cable joints and IEEE 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, make necessary repairs or replace cables as directed. Retest repaired or replaced cables.

c. Ground-Resistance Tests. Measure the resistance of [each grounding electrode] [each grounding electrode system] [the ground mat] [the ground ring] using the fall-of-potential method defined in IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. Take measurements in normally dry weather, not less than 48 hours after rainfall. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance. The combined resistance of separate systems may be used to meet the requirements resistance, but the specified number of electrodes must still be provided as follows:

(1) Single rod electrode - [25] [_____] ohms.

(2) Multiple rod electrodes - [_____] ohms.

(3) Ground mat - [_____] ohms.

d. Examine and test circuit breakers and switchgear in accordance with the manufacturer's published instructions for functional testing.

3.6.3 Inspections

Perform the following inspections jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Submit a letter certifying that all facilities are complete and functional; that each system is fully functional; and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use. Perform checks applicable to the installation. Document and submit the results of those which are physical inspections (I) in accordance with paragraph SUBMITTALS. Present manufacturer's data for the inspections designated (D) at the time of inspection. Verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Provide manufacturer's statements to certify provision of features which cannot be verified visually.

Drive belts	I
Governor type and features	I
Engine timing mark	I
Starting motor	I
Starting aids	I
Coolant type and concentration	D
Radiator drains	I
Block coolant drains	I
Coolant fill level	I
Coolant line connections	I
Coolant hoses	I
Combustion air filter	I
Intake air silencer	I
Lube oil type	D
Lube oil sump drain	I
Lube-oil filter	I
Lube-oil level indicator	I
Lube-oil fill level	I
Lube-oil line connections	I
Lube-oil lines	I
Fuel type	D

Fuel level	I
Fuel-line connections	I
Fuel lines	I
Fuel filter	I
Access for maintenance	I
Voltage regulator	I
Battery-charger connections	I
Wiring and terminations	I
Instrumentation	I
Hazards to personnel	I
Base	I
Nameplates	I
Paint	I
Exhaust-heat system	I
Exhaust muffler	I
Switchboard	I
Switchgear	I
Access provided to controls	I
Enclosure is weather resistant	I
Engine and generator mounting bolts (application)	I

3.6.4 Engine Tests

Perform customary commercial factory tests in accordance with ISO 3046 on each engine and associated engine protective device, including, but not limited to the following:

a. Perform dynamometer test at rated power. Record horsepower at rated speed and nominal characteristics such as lubricating oil pressure, jacket water temperature, and ambient temperature.

b. Test and record the values that the low oil pressure alarm and protective shutdown devices actuate prior to assembly on the engine.

c. Test and record values that the high jacket water temperature alarm and protective shutdown devices actuate prior to assembly on the engine.

3.6.5 Generator Tests

****
NOTE: Include the bracketed option below for projects located outside the continental United States (OCONUS).
****

Tests must be performed on the complete factory assembled generator prior to shipment. Conduct tests in accordance with IEEE 115[, IEC 60034-2A], and NEMA MG 1.

3.6.5.1 Routine Tests

Perform the following routine tests on the generators and their exciters:

a. Resistance of armature and field windings.

b. Mechanical balance.

c. Phases sequence.

d. Open circuit saturation curve and phase (voltage) balance test.

e. Insulation resistance of armature and field windings.

f. High potential tes.t

3.6.5.2 Design Tests

Submit the following design tests made on prototype machines that are physically and electrically identical to the generators specified.

a. Temperature rise test

b. Short circuit saturation curve and current balance test

3.6.6 Assembled Engine-Generator Set Tests

****
NOTE: Select the first option for engine-generator sets rated up to 250 kW. Select the second option for engine-generator sets rated greater than 250 kW.
****

[Submit the following tests made on prototype machines that are physically and electrically identical to the engine-generator set specified.][Perform the following tests on the assembled engine-generator set.]

3.6.6.1 Initial Stabilization Readings

Operate the engine-generator set and allow the set to stabilize at rated kW at rated power factor, rated voltage, and rated frequency. During this period record instrument readings for output power (kW), terminal voltage, line current, power factor, frequency (rpm) generator (exciter) field voltage and current, lubricating oil pressure, jacket water temperature, and ambient temperature at minimum intervals of 15 minutes. Adjust the load, voltage, and frequency to maintain rated load at rated voltage and frequency. Adjustments to load, voltage, or frequency controls must be recorded on the data sheet at the time of adjustment. Stabilization must be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

3.6.6.2 Regulator Range Test

Remove load and record instrument readings (after transients have subsided). Adjust voltage to the maximum attainable value or to a value just prior to actuation of the overvoltage protection device. Apply rated load and adjust voltage to the minimum attainable value or a value just prior to activation of the under-voltage protection device. The data sheets must indicate the voltage regulation as a percent of rated voltage and the maximum and minimum voltages attainable. Voltage regulation must be defined as follows:

$$\frac{\text{Percent Regulation} = ((\text{No-Load Voltage}) - (\text{Rated-Load Voltage})) \times 100}{(\text{Rated-Load Voltage})}$$

3.6.6.3 Frequency Range Test

Adjust the engine-generator set frequency for the maximum attainable frequency at rated load. Record instrument readings. Adjust the engine-generator set frequency for the specified minimum attainable frequency at rated load. Record instrument readings. Reduce the load to zero and adjust the engine-generator set frequency for the maximum attainable frequency. Record instrument readings. Adjust the engine-generator set frequency for the minimum attainable frequency. Record instrument readings. The data sheet must show the maximum and minimum frequencies attained at rated load, and at no load.

3.6.6.4 Transient Response Test

Drop the load to no load and re-apply rated load three times to ensure that the no load and rated load voltage and frequency values are repeatable and that the frequency and voltage regulation is within the limits specified. Record generator terminal voltage and frequency using a high speed strip chart recorder. The data sheet must show the following results:

a. Frequency

    (1) Stability bandwidth or deviation in percent of rated frequency.

    (2) Recovery time.

    (3) Overshoot and undershoot.

b. Voltage

    (1) Stability bandwidth or deviation in percent of rated voltage.

    (2) Recovery time.

    (3) Overshoot and undershoot.

3.6.7 Pre-operational Tests

****

NOTE: Specify the protective devices to be tested. Devices which shut down the engine because of an abnormal electrical or generator condition should be detailed under Safety Run Tests. Delete current transformer tests when none are to be installed.

****

3.6.7.1 Protective Relays

****

NOTE: Delete the protective devices coordination study reference if the project does not require one. See UFC 3-520-01 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 05 73 POWER SYSTEM STUDIES, for guidance.

****

Visually and mechanically inspect, adjust, test, and calibrate protective relays in accordance with the manufacturer's published instructions. Include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Implement relay settings in accordance with the installation coordination study. Manually or electrically operate relay contacts to verify that the proper breakers and alarms initiate. Field test relaying current transformers in accordance with IEEE C57.13.1.

3.6.7.2 Insulation Test

Test generator and exciter circuits insulation resistance in accordance with IEEE 43. Take stator readings including generator leads to [switchgear] [switchboard] at the circuit breaker. Record results of insulation resistance tests. Readings must be within limits specified by the manufacturer. Verify mechanical operation, insulation resistance, protective relay calibration and operation, and wiring continuity of [switchgear] [switchboard] assembly. Do not damage generator components during test.

3.6.7.3 Engine-Generator Connection Coupling Test

When the generator provided is a two-bearing machine, inspect and check the engine-generator connection coupling by dial indicator to prove that no misalignment has occurred. Use the dial indicator to measure variation in radial positioning and axial clearance between the coupling halves. Take readings at four points, spaced 90 degrees apart. Align solid couplings and pin-type flexible couplings within a total indicator reading of 0.012 to 0.025 mm 0.0005 to 0.001 inch for both parallel and angular misalignment. For gear-type or grid-type couplings, 0.05 mm 0.002 inch will be acceptable.

3.6.8 Safety Run Test

****

NOTE: For the sound level tests, modify the radial distance requirement from the engine intake and exhaust to account for obstructions, variations in site conditions, building configurations, or

indicate points on the contract drawings at which measurements are to be made. Add item x. to the list below when a test for over/under frequency alarms are provided. Coordinate the requirement with paragraph Alarm Panels. Item x. should be included as follows:

x. Manually adjust the governor to speed up the engine to a level beyond the over frequency alarm set-point and record the frequency when the audible alarm sounds. Return the speed to the rated value. Shut down the engine-generator set.

****

For the following tests, repeat the associated safety tests if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

c. Activate the manual emergency stop switch and verify that the engine stops.

d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine-generator set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If either temperature reading exceeds the value required for an alarm condition, activate the manual emergency stop switch.

f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine generator-set at no load until the output voltage and frequency stabilize.

i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

k. Operate the engine generator-set for at least 2 hours at 75 percent of Service Load.

l. Verify proper operation and set-points of gauges and instruments.

m. Verify proper operation of ancillary equipment.

n. Manually adjust the governor to increase engine speed past the over-speed limit. Record the RPM at which the engine shuts down.

o. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.

p. Manually adjust the governor to increase engine speed to within 2 percent of the over-speed trip speed previously determined and operate at that point for 5 minutes. Manually adjust the governor to the rated frequency.

q. Manually fill the day tank to a level above the overfill limit. Record the level at which the overfill alarm sounds. Verify shutdown of the fuel transfer pump. Drain the day tank down below the overfill limit.

r. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine.

s. Attach a manifold to the engine oil system (at the oil pressure sensor port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. Move the engine's oil pressure sensor from the engine to the manifold. Open the manifold shutoff valve and close the bleed valve.

t. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.

u. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.

v. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100 percent of Service

Load. Record the maximum sound level in each frequency band at a distance of [22.9] [_____] m [75] [_____] feet from the end of the exhaust and air intake piping directly along the path of intake and discharge for horizontal piping; or at a radius of [22.9] [10.7] [_____] m [75] [35] [_____] feet from the engine at 45 degrees apart in all directions for vertical piping. [If a sound limiting enclosure is provided, modify or replace the enclosure, the muffler, and intake silencer must be modified or replaced as required to meet the sound requirements contained within this specification] [If a sound limiting enclosure is not provided, the muffler and air intake silencer as required to meet the sound limitations of this specification. If the sound limitations can not be obtained by modifying or replacing the muffler and air intake silencer, notify the Contracting Officers Representative and provide a recommendation for meeting the sound limitations.]

w. Manually drain off fuel slowly from the day tank to empty it to below the low fuel level limit and record the level at which the audible alarm sounds. Add fuel back to the day tank to fill it above low level alarm limits.

3.6.9 Performance Tests

****

NOTE: The onsite tests have been developed from MIL-STD 705 methods with input from many sources including industry. Each designer must verify the adequacy of the tests that are needed for each application. Modifications to these specifications may be necessary beyond the removal of brackets.

Delete the Frequency and Voltage, Stability and Transient Response Test and the Voltage Regulator and Governor Range Test for general-purpose and commercial-type applications. Perform this test either as a factory test or a field test (delete it from either the factory or field tests). Perform as a field test where required to ensure system operability using project loads. Revise the test steps to delete steps where the Maximum Step Increase is larger than final load to be placed on the engine-generator.

If possible, specify an ambient temperature for the load run test which is typical for the average maximum temperature. This is most strenuous operating condition. Specify a month which typically provides the most restrictive operating condition.

Delete all 110 percent load references from testing requirements for standby applications.

****

In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. For the following tests, repeat the associated tests if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries.

3.6.9.1 Continuous Engine Load Run Test

Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, repeat the entire test. Accomplish the engine load run test during daylight hours, with an average ambient temperature of [_____] degrees C F, during the month of [_____]. After each change in load in the following test, measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range. Take data taken at 15 minute intervals and include the following:

Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.

Pressure: Lube-oil.

Temperature: Coolant, Lube-oil, Exhaust, Ambient.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.

c. Operate the engine generator-set for 2 hours at 75 percent of Service Load.

d. Increase load to 100 percent of Service Load and operate the engine generator-set for 4 hours.

e. For prime rated units, increase load to 110 percent of Service Load and operate the engine generator-set for 2 hours.

f. Decrease load to 100 percent of Service Load and operate the engine generator-set for 2 hours or until all temperatures have stabilized.

g. Remove load from the engine-generator set.

3.6.9.2 Voltage and Frequency Droop Test

For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. Record the generator output frequency and line-line and line-neutral voltages following each load change.

a. With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency.

b. Increase load to 100 percent of Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

c. Calculate the percent droop for voltage and frequency with the following equations.

$$\text{Voltage droop percent} = \frac{\text{No-load volts - rated output capacity volts}}{\text{Rated output capacity volts}} \times 100$$

$$\text{Frequency droop percent} = \frac{\text{No load hertz - rated output capacity hertz}}{\text{Rated output capacity volts}} \times 100$$

d. Repeat steps a. through c. two additional times without making any adjustments.

3.6.9.3 Voltage Regulator Range Test

a. While operating at no load, verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.

b. Increase load to 100 percent of Rated Output Capacity. Verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.

3.6.9.4 Governor Adjustment Range Test

a. While operating at no load, verify that the governor adjusts from 90 to 110 percent of rated frequency.

b. Increase load to 100 percent of Rated Output Capacity. Verify that the governor adjusts from 90 to 110 percent of rated frequency.

3.6.9.5 Frequency and Voltage Stability and Transient Response

****

NOTE: For applications where the Maximum Step Load Increase is 100 percent, delete steps d, e, and f.

****

Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Include the following tabular data:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Frequency (before and after load changes).

(5) Generator output power (before and after load changes.

(6) Include the actual instrument trace of voltage and frequency in graphic representations showing:

Charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

c. With the unit at no load, apply the Maximum Step Load Increase.

d. Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

e. Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.

f. Apply the Maximum Step Load Increase.

g. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

h. Repeat steps c. through g.

3.6.10 Parallel Operation Test

****

NOTE: Delete the generator paralleling/load sharing test if parallel sets are not intended. This test must be performed at a power factor other than unity to verify proportional reactive power sharing.

****

Test the capability of each engine-generator set to parallel and share load with other generator sets, individually and in all combinations. This test must be performed with the voltage regulator and governor adjustment settings used for the Frequency and Voltage Stability and Transient Response test. If settings are changed during the performance of this test, a voltage and frequency stability and transient response test must be performed for each engine generator set using the setting utilized in this test. During operations record load-sharing characteristics of each set in parallel operation. Include the following data:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Power division and exchange between generator sets.

(5) Real power (watts) and reactive power (vars) on each set.

3.6.10.1 Combinations

Connect each set, while operating at no load, parallel with one other set in the system, operating at service load, until all possible combinations have been achieved. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive loads. Document stabilization of voltage and frequency within specified bandwidth, the active power division, active power exchange, reactive power division, and voltage and frequency stability and transient response in the following steps for each combination.

a. Divide the load proportionally between the sets and operate in parallel for 15 minutes.

b. Increase the load, in steps equal to the Maximum Step Increase, until each set is loaded to its service load.

c. Decrease the load, in steps equal to the Maximum Step Decrease, until each set is loaded to approximately 25 percent of its service load.

d. Increase the load, in steps equal to the Maximum Step Increase, until each set is loaded to approximately 50 percent of its service load Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive load.

e. Reduce the sum of the loads on both sets to the output rating of the smaller set.

f. Transfer a load equal to the output rating of the smaller of the 2 sets to and from each set. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive load.

g. Document the active power division, active power exchange, reactive power division, and voltage and frequency stability and transient response.

3.6.10.2 Multiple Combinations

Connect each set, while operating at no load, parallel with all multiple combinations of all other set in the system, while operating at service load, until all multiple combinations of parallel operations have been achieved.

3.6.11 Parallel Operation Test (Commercial Source)

****

NOTE: Delete the parallel to commercial source test if sets are not to be paralleled with the commercial power source.

****

Connect each set parallel with the commercial power source. Operate in parallel for 15 minutes. Verify stabilization of voltage and frequency within specified bandwidths. Record the output voltage, frequency, and loading to demonstrate ability to synchronize with the commercial power source.

3.6.12 Automatic Operation Tests

****

NOTE: Delete automatic operation test where not required. Adapt this paragraph based on the number of engine-generator sets, the desired starting order, and load sequencing. The designer will provide the sequence of operation (load sequences for load acquisition and load shedding) in the design documents.

****

Test the automatic operating system to demonstrate [automatic starting,] [loading and unloading,] [the response to loss of operating engine-generator sets,] and paralleling of each engine-generator set. Utilize [load banks at the indicated power factor] [and actual loads to be served] for this test, and the loading sequence is the indicated sequence. Record load-sharing characteristics during all operations. Perform this test for a minimum of two successive, successful tests. Include the following data:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Generator output frequency (before and after load changes).

(5) Power division and exchange between generator sets.

(6) Real and reactive power on each set.

a. Initiate loss of the preferred power source and verify the specified sequence of operation.

b. Verify resetting of automatic starting and transfer logic.

3.6.13 Automatic Operation Tests for Stand-Alone Operation

****

NOTE: Substitute manual operation and transfer for automatic operation where automatic operation is not required by the project. Delete automatic loading system where not required. The designer will provide the sequence of operation (load sequences for load acquisition and load shedding) in the design documents.

****

Test the automatic loading system to demonstrate [automatic starting,] [and] [loading and unloading] of each engine-generator set. Utilize the actual loads to be served for this test, and the loading sequence is the indicated sequence. Perform this test for a minimum of two successive, successful tests. Include the following data:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Generator output frequency (before and after load changes).

a. Initiate loss of the primary power source and verify automatic sequence of operation.

b. Restore the primary power source and verify sequence of operation.

c. Verify resetting of controls to normal.

3.7 GROUNDING

****

NOTE: Where rock or other soil conditions prevent obtaining a specified ground value, other methods of grounding should be specified. Where it is impractical to obtain the indicated ground resistance values, make every effort within reason to obtain ground resistance values as near as possible to the indicated values.

****

NFPA 70 and IEEE C2, except that grounding systems must have a resistance to solid earth ground not exceeding 5 ohms.

3.7.1 Grounding Electrodes

Provide driven ground rods as specified in [Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION] [and] [Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION]. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.7.2 Engine-Generator Set Grounding

Provide separate copper grounding conductors and connect them to the ground system as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" must apply.

3.7.3 Connections

Make joints in grounding conductors by exothermic weld or compression connector. Exothermic welds and compression connectors must be installed as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION paragraph regarding GROUNDING.

3.7.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.8 START-UP ENGINEER

Provide the services of a qualified factory trained start-up engineer, regularly employed by the engine-generator set manufacturer. The start-up services must include conducting preliminary operations and functional acceptance tests. The start-up engineer must be present at the engine generator set installation-site, full-time, while preliminary operations and functional acceptance tests are being conducted.

3.9 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the engine-generator set and auxiliary equipment.

3.9.1 Piping Tests

Complete as specified in Section 33 52 10 SERVICE PIPING, FUEL SYSTEMS.

3.9.2 Performance of Acceptance Checks and Tests

The acceptance checks and tests must be accomplished by the testing organization as described in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

3.9.3 Generator Sets

Complete as specified in the paragraph ACCEPTANCE CHECKS AND TESTS.

3.9.3.1 Automatic Transfer Switches

Complete acceptance checks and tests as specified in Section 26 36 23 AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH.

3.9.4 Preliminary Operations

The start-up engineer must conduct manufacturer recommended start-up procedures and tests to verify that the engine-generator set and auxiliary equipment are ready for functional acceptance tests. Give the Contracting Officer 15 days' advance notice that preliminary operations will be conducted. After preliminary operation has been successfully conducted, the start-up engineer will notify the Contracting Officer in writing stating the engine-generator set and auxiliary equipment are ready for functional acceptance tests.

3.9.5 Preliminary Assembled Operation and Maintenance Manuals

Preliminary assembled operation and maintenance manuals must have been submitted to and approved by the Contracting Officer. Manuals must be prepared as specified in the paragraph ASSEMBLED OPERATION AND MAINTENANCE MANUALS.

3.9.6 Functional Acceptance Test Procedure

Test procedure must be prepared by the start-up engineer specifically for the engine-generator set and auxiliary equipment. The test agenda must cover the requirements specified in the paragraph FUNCTIONAL ACCEPTANCE TESTS. The test procedure must indicate in detail how tests are to be conducted. A statement of the tests that are to be performed without indicating how the tests are to be performed is not acceptable. Indicate what work is planned on each workday and identify the calendar dates of the planned workdays. Specify what additional technical support personnel is needed such as factory representatives for major equipment. Specify on which testing workday each technical support personnel is needed. Data recording forms to be used to document test results are to be submitted with the proposed test procedure. A list of test equipment and instruments must also be included in the test procedure.

3.9.7 Test Equipment

Test equipment and instruments must be on hand prior to scheduling field tests or, subject to Contracting Officer approval, evidence must be provided to show that arrangements have been made to have the necessary equipment and instruments on-site prior to field testing.

3.10 FIELD QUALITY CONTROL

****

NOTE: Include the bracketed option below for NAVFAC projects. Coordinate Echelon III Reach-back Support with NAVFAC LANT CI44 Office or NAVFAC PAC CI44 Office during the design stage of the specific project.

****

Give Contracting Officer [NAVFAC [_____], Code [_____]] 30 days' notice of dates and times scheduled for tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The Contractor must be responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The Contractor must provide labor, equipment, fuel, test load, and consumables required for the specified tests. The test load must be a cataloged product. Calibration of measuring devices and indicating devices must be certified. Refer to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, for requirements for a cataloged product. Perform the following field tests.

3.10.1 Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.10.1.1 Circuit Breakers - Low Voltage Insulated Case/Molded Case

a. Visual and Mechanical Inspection

   (1) Compare nameplate data with specifications and approved shop drawings.

   (2) Inspect circuit breaker for correct mounting.

   (3) Operate circuit breaker to ensure smooth operation.

   (4) Inspect case for cracks or other defects.

   (5) Verify tightness of accessible bolted connections and cable connections by calibrated torque-wrench method. Thermo-graphic survey is not required.

   (6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

   (1) Perform contact-resistance tests.

   (2) Perform insulation-resistance tests.

   (3) Adjust breaker(s) for final settings in accordance with engine-generator set manufacturer's requirements.

3.10.1.2 Current Transformers

a. Visual and Mechanical Inspection

   (1) Compare equipment nameplate data with specifications and approved shop drawings.

   (2) Inspect physical and mechanical condition.

   (3) Verify correct connection.

   (4) Verify that adequate clearances exist between primary and secondary circuit.

   (5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermo-graphic survey is not required.

   (6) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

   (1) Perform insulation-resistance tests.

   (2) Perform polarity tests.

   (3) Perform ratio-verification tests.

3.10.1.3 Metering and Instrumentation

a. Visual and Mechanical Inspection

   (1) Compare equipment nameplate data with specifications and approved shop drawings.

   (2) Inspect physical and mechanical condition.

   (3) Verify tightness of electrical connections.

b. Electrical Tests

   (1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

   (2) Calibrate watt-hour meters according to manufacturer's published data.

   (3) Verify all instrument multipliers.

(4) Electrically confirm that current transformer secondary circuits are intact.

3.10.1.4 Battery Systems

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermo-graphic survey is not required.

(4) Measure electrolyte specific gravity and temperature and visually check fill level.

(5) Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical Tests

(1) Set charger float and equalizing voltage levels.

(2) Verify all charger functions and alarms.

(3) Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.

(4) Perform a capacity load test.

3.10.1.5 Engine-Generator Set

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect for correct anchorage and grounding.

b. Electrical and Mechanical Tests

(1) Perform an insulation-resistance test on generator winding with respect to ground. Calculate polarization index.

(2) Perform phase rotation test to determine compatibility with load requirements.

3.10.1.6 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

    (1) Perform ground-impedance measurements utilizing the fall-of-potential method defined in IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. Take measurements in normally dry weather, not less than 48 hours after rainfall. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.10.2 Functional Acceptance Tests

****

NOTE: Include the bracketed option below for NAVFAC projects.

****

The tests must be performed by the start-up engineer. Upon successful test completion, the start-up engineer must provide the Contracting Officer with a written test report within 15 calendar days showing the tests performed and the results of each test. The report must include the completed approved test data forms and certification from the start-up engineer that the test results fall within the manufacturer's recommended limits and meet the specified requirements performance. The report must be dated and signed by the start-up engineer, and submitted for approval by the Contracting Officer. The Contracting Officer [and NAVFAC [_____], Code [_____]] will witness final acceptance tests. Testing must include, but not be limited to, the following:

a. Verify proper functioning of each engine protective shutdown device and pre-shutdown alarm device. Testing of the devices must be accomplished by simulating device actuation and observing proper alarm and engine shutdown operation.

b. Verify proper functioning of the engine over-speed trip device. Testing of the over-speed trip device must be accomplished by raising the speed of the engine-generator set until an over-speed trip is experienced.

c. Verify proper functioning of the crank cycle/terminate relay. Testing of the relay must be accomplished by engaging the starter motor with the engine being prevented from running. Observe the complete crank/rest cycle as described in the paragraph STARTING SYSTEM.

d. Verify proper functioning of the following automatic and manual operations. Testing must include, but not be limited to, the following:

    (1) Loss of Utility: Initiate a normal power failure with connected test load of rated kW at 1.0 power factor. Record time delay on start, cranking time until engine starts and runs, time to come up to operating speed, voltage and frequency overshoot, and time to achieve steady state conditions with all switches transferred to emergency position.

    (2) Return of Utility: Return normal power and record time delay on retransfer for each automatic transfer switch, and time delay on engine cool-down and shutdown.

    (3) Manual starting.

(4) Emergency stop.

e. Operate the engine-generator set at rated current (amperes) until the jacket water temperature stabilizes. Stabilization will be considered to have occurred when three consecutive temperature readings remain unchanged. Continue to operate the generator set for an additional 2 hours. Record instrument readings for terminal voltage, line current, frequency (Hz), engine speed rpm, lubricating oil pressure, jacket water temperature, and ambient temperature at 5 minute intervals for first 15 minutes and at 15 minute intervals thereafter.

****

NOTE: Include the following paragraph when verification of engine emission limits are required by air pollution permit.

****

[f. Emissions Tests. Provide on-site testing by a certified testing organization of each engine-generator set. Testing must be in accordance with an EPA approved method, 40 CFR 60, (Appendix, Method 7, 7A, 7B, 7C, 7D or 7E). Emissions at rated full load must be within the limits specified in the paragraph ENGINE EMISSIONS LIMITS.]

3.11 DEMONSTRATION

Upon completion of the work and at a time approved by the Contracting Officer, the Contractor must provide instructions by a qualified instructor to the Government personnel in the proper operation and maintenance of the equipment. [_____]Government personnel must receive training comparable to the equipment manufacturer's factory training. The duration of instruction must be for not less than one 8 hour working day for instruction of operating personnel and not less than one 8 hour working day for instruction of maintenance personnel.

3.11.1 Instructor's Qualification Resume

Instructors must be regular employees of the engine-generator set manufacturer. The instruction personnel provided to satisfy the requirements above must be factory certified by the related equipment manufacturer to provide instruction services. Submit the name and qualification resume of instructor to the Contracting Officer for approval.

3.11.2 Training Plan

Submit training plan 30 calendar days prior to training sessions. Training plan must include scheduling, content, outline, and training material (handouts). Content must include, but not be limited to, the following:

3.11.2.1 Operating Personnel Training

This instruction includes operating the engine-generator set, auxiliary equipment including automatic transfer switches in all modes, and the use of all functions and features specified.

3.11.2.2 Maintenance Personnel Training

Training must include mechanical, hydraulic, electrical, and electronic instructions for the engine-generator set and auxiliary equipment including automatic transfer switches.

a. Mechanical Training: Must include at least the following:

    (1) A review of mechanical diagrams and drawings.

    (2) Component location and functions.

    (3) Troubleshooting procedures and techniques.

    (4) Repair procedures.

    (5) Assembly/disassembly procedures.

    (6) Adjustments (how, when, and where).

    (7) Preventive maintenance procedures.

    (8) Review of flow diagram.

    (9) Valve locations and function.

    (10) Valve and hydraulic equipment adjustment and maintenance procedures.

    (11) Hydraulic system maintenance and servicing.

    (12) Lubrication points, type, and recommended procedures and frequency.

b. Electrical and Electronic Maintenance Training: Must include at least the following:

    (1) A review of electrical and electronic systems including wiring diagrams and drawings.

    (2) Troubleshooting procedures for the machine and control systems.

    (3) Electrical and electronic equipment servicing and care.

    (4) Use of diagnostics to locate the causes of malfunction.

    (5) Procedures for adjustments (locating components, adjustments to be made, values to be measured, and equipment required for making adjustments).

    (6) Maintenance and troubleshooting procedures for microprocessor or minicomputer where applicable.

    (7) Circuit board repair procedures where applicable (with schematics provided).

    (8) Use of diagnostic tapes.

    (9) Recommended maintenance servicing and repair for motors, switches, relays, solenoids, and other auxiliary equipment and devices.

3.12 ONSITE TRAINING

****
NOTE: Delete videotaping if not required.
****

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total [_____] hours of normal working time and must start after the system is functionally completed but prior to final acceptance.

a. Submit a letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the digital video recording to be provided. The course instructions must cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as major elements of the operation and maintenance manuals. Additionally, the course instructions must demonstrate routine maintenance procedures as described in the operation and maintenance manuals.

b. Submit a digital video recording of the [entire training session] [manufacturers operating and maintenance training course].

c. One full size reproducible Mylar ach drawing must accompany the booklets. Mylars must be rolled and placed in a heavy cardboard tube with threaded caps on each end. The manual must include step-by-step procedures for system startup, operation, and shutdown; drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems together with their controls, alarms, and safety systems; the manufacturer's name, model number, and a description of equipment in the system. The instructions must include procedures for interface and interaction with related systems to include [automatic transfer switches] [fire alarm/suppression systems] [load shedding systems] [uninterruptible power supplies] [_____]. Each booklet must include a CD containing an ASCII file of the procedures.

d. Provide approved operation and maintenance manuals for the training course. Post approved instructions prior to the beginning date of the training course. Coordinate the training course schedule with the using service's work schedule, and submit for approval 14 days prior to beginning date of proposed beginning date of training.

3.13 INSTALLATION

Installation must conform to the applicable requirements of IEEE C2, NFPA 30, NFPA 37, and NFPA 70.

3.14 FINAL TESTING AND INSPECTION

a. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

b. Increase the load in steps no greater than the Maximum Step Load Increase to 100 percent of Service Load, and operate the engine-generator set for at least 30 minutes. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.

c. Remove load and shut down the engine-generator set after the recommended cool down period.

d. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Verify any corrective action for effectiveness by running the engine for 8 hours at Service Load, then re-examine the oil and filter.

e. Remove the fuel filter and examine the filter for trash, abrasive foreign particles, etc.

f. Visually inspect and check engine and generator mounting bolts for tightness and visible damage.

g. Replace air, oil, and fuel filters with new filters.

3.15 MANUFACTURER'S FIELD SERVICE

The engine generator-set manufacturer must furnish a qualified representative to supervise the installation of the engine generator-set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment.

3.16 POSTED DATA AND INSTRUCTIONS

****

NOTE: The designer should check with the customer to determine if framed instructions can be placed in the project area (requires wall space), and where they are to be placed. Select the 216 X 279 mm 8 1/2 X 11 inch notebook option where instructions will have to be placed in the engine-generator enclosure or a switchgear cubicle (or other suitable enclosure).

****

Post Data and Instructions prior to field acceptance testing of the engine generator set. [Provide two sets of instructions/data, typed and framed under weatherproof laminated plastic, and post side-by-side where directed. Include a one-line diagram, wiring and control diagrams and a complete layout of the system in the first set. Include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions in the second set. Submit posted data including wiring and control diagrams showing the key mechanical and electrical control elements, and a complete layout of the entire system.

a. Include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches).] [Provide two sets of typed instructions/data in 216 X 279 mm 8-1/2 x 11 inch format, laminated in weatherproof plastic, and placed in three-ring vinyl binders. Place the binders as directed by the Contracting Officer. Provide the instructions prior to acceptance of the engine generator set installation.

b. Include a one-line diagram, wiring and control diagrams and a complete layout of the system in the first set. Include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions in the second set. Include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches).]

c. Submit instructions including: the manufacturers pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches). Provide weatherproof instructions, laminated in plastic, and post where directed.

3.17 ACCEPTANCE

Submit drawings which accurately depict the as-built configuration of the installation, upon acceptance of the engine-generator set installation. Revise layout drawings to reflect the as-built conditions and submit them with the as-built drawings. Final acceptance of the engine-generator set will not be given until the Contractor has successfully completed all tests and all defects in installation material or operation have been corrected.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-26 33 53 (May 2019)**

Preparing Activity: USACE **Superseding**
UFGS-26 32 33.00 10 (October 2007)
UFGS-26 33 53.00 20 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 33 53

STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS)

05/19

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-26 33 53 (May 2019)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 33 53

STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS)

05/19

****

NOTE: This guide specification covers the requirements for static UPS to provide continuous ac power to critical loads and/or to improve the quality of ac power to critical loads. The specification is intended to cover three-phase systems starting with the smallest unit at 20 kVA. The upper end for a single module is around 750 kVA; however, parallel systems can have a larger total output. This guide specification is intended to be used with individual UPS units which contain a single module, parallel systems of the same size module, and scalable modular UPS systems. Single phase systems are not addressed. This specification covers UPS with electro-chemical batteries. Electro-mechanical (stored energy) UPS are not addressed. White paper TSEWG TP-19 is on Static Uninterruptible Power Supplies and should be reviewed while editing this specification. See https://www.wbdg.org/ffc/dod/supplemental-technical-criteria/tsewg-tp-19 **This specification supercedes previous versions of UFGS-26 32 33.00 10 Static Uninterruptible Power Supply (UPS) and UFGS-26 33 53.00 20 Uninterruptible Power Supply (UPS).**

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for

this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: For Air Force projects only: UPS specifications, criteria, and purchases are to be approved by the Power Conditioning and Continuation Interfacing Equipment (PCCIE) Group Manager at Ogden Air Logistics Center (OO-ALC/LGHC). Contact the PCCIE Product Group Manager, 500 CBSS/GBLD, Building 1207-N, 6029 Wardleigh Road, Hill AFB, UT 84056-5838. If you have access to the Air Force portal, then search PCCIE.

****

****

NOTE: Show the following information on the project drawings:

1. Location of equipment

2. Single-line diagrams, elevations, limiting dimensions, and equipment ratings which are not covered in the specifications

3. Remote indicating requirements.

4. Maintenance bypass switching cabinet and configuration.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

ASTM INTERNATIONAL (ASTM)

ASTM B173	(2017) Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 450	(2020) Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications
IEEE 485	(2020) Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
IEEE C2	(2023) National Electrical Safety Code
IEEE C57.110	(2008) Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems-

Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA PE 1	(2012; R 2017) Uninterruptible Power Systems (UPS) - Specification and Performance Verification

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 1778	(2014; Reprint Apr 2023) UL Standard for Safety Uninterruptible Power Systems

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a G to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

UPS Drawings; G, [_____]

[UPS Installation; G, [_____]]

SD-03 Product Data

UPS Module; G, [_____]

Technical Requirements UPS System

Energy Star Label for Battery Charging Systems and AC-DC/AC-AC Power Supply Products; S

****

NOTE: Delete submittal for spare parts on Navy projects.

****

[Spare Parts; G, [_____]]

SD-06 Test Reports

Work Plan; G, [_____]

Factory Test Plan; G, [_____]

Factory Test Report; G, [_____]

SD-09 Manufacturer's Field Reports

Initial Inspection and Tests; G, [_____]

Performance Tests; G, [_____]

Performance Test Plan; G, [_____]

Performance Test Report; G, [_____]

SD-10 Operation and Maintenance Data

UPS Operation and Maintenance, Data Package 5; G, [_____]

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

Installation

1.4 OPERATION AND MAINTENANCE MANUALS

1.4.1 Additions to UPS Operation and Maintenance Manuals

In addition to requirements of SD-10 Data Package 5, include the followings on the actual UPS system provided:

a. An outline drawing, front, top, and side views.

b. Prices for spare parts and supply list.

c. Routine and field acceptance test reports.

d. Date of Purchase.

e. Corrective maintenance procedures.

1.4.2 Spare Parts

****

NOTE: Army Only. Do not provide spare parts for Navy projects.

****

Furnish the following spare parts, of the same material and workmanship, meeting the same requirements, and interchangeable with the corresponding original parts.

a. Fuses: Two of each type and rating.

b. Circuit boards: One circuit board for each critical circuit.

c. Air Filters: One set of filters, when used on the UPS unit.

d. Special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment: One complete set.

1.5 QUALITY ASSURANCE

The manufacturer must have a documented quality assurance program including:

a. Inspections of incoming parts, modular assemblies and final product.

b. Final test procedure for the product including proof of performance specifications.

c. The on-site test procedure includes an inspection of controls and indicators after installation of the equipment.

d. ISO 9001 quality certification.

1.5.1 UPS Drawings

Drawings are to include the following: Detail drawings consisting of a complete list of equipment and materials, manufacturer's descriptive and technical literature, battery sizing calculations per IEEE 485, installation instructions, single-line diagrams, elevations, layout drawings, and details required to demonstrate that the system has been coordinated and will function properly as a unit.

a. One-line diagram.

b. Outline drawings including front elevation, section views, footprints, and overall dimensions.

c. Manufacturer's descriptive and technical literature.

d. Markings and NEMA nameplate data.

e. Battery sizing calculations per IEEE 485.

f. Wiring and control diagrams with terminals identified, and indicating prewired interconnections between items of equipment and interconnection between the items.

g. Complete list of materials and equipment covering major components. Ensure the bill of material and the schematic have a direct correlation between items in order to easily identify the various components.

h. Details required to demonstrate that the system has been coordinated and will function properly as a unit.

1.5.2 UPS Installation

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams are to identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings are to indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals include the nameplate data, size, and capacity. Submittals also include applicable federal, military, industry, and technical society publication references.

1.5.3 Work Plan

Submit schedules of dates for factory tests, installation, field tests, and operator training for the UPS system. Furnish a list of instrumentation equipment for factory and field test reports.

1.5.4 Factory Test Plan

Submit factory test plans and procedures at least [21][_____] calendar days prior to the tests being conducted. Provide detailed description of test procedures, including test equipment and setups, to be used to ensure the UPS meets the performance specification and explain the test methods to be used. Provide test procedures that include the test required under the paragraph entitled "Factory Testing."

1.5.5 Factory Test Report

Submit a factory test report within [21][_____] calendar days after completion of tests. Receive approval of test prior to shipping unit. Factory test reports are to be signed by an official authorized to certify on behalf of the UPS manufacturer of that the system meets specified requirements in accordance with the requirements set forth in paragraph entitled "Factory Testing". Provide test reports in booklet form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports are to state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.5.6 Performance Test Plan

Submit test plans and procedures at least [15][_____] calendar days prior to the start of field tests. Provide detailed description and dates and times scheduled for performance of tests, and detailed description of test procedures, including test equipment (list make and model and provide functional description of the test instruments and accessories) and setups of the tests to be conducted to ensure the UPS meets the performance specification. Explain the test methods to be used. Provide test procedures that include the tests required under the paragraph entitled "Performance Tests."

1.5.7 Performance Test Report

Submit report of test results as specified by paragraph entitled "Performance Tests" within [15][_____] calendar days after completion of tests. Field test reports are to be signed by an official authorized to certify on behalf of the UPS manufacturer that the system meets specified requirements in accordance with the requirements set forth in paragraph entitled "Performance Tests". Provide test reports in in booklet form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports are to state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.5.8 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.8.1 Reference Standard Compliance

Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.

1.5.8.2 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate is to state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.9 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

d. The service organization is to be, in the opinion of the Contracting Officer, reasonably convenient to the site.

e. Provide new parts and materials comprising the UPS system from the current manufacture, of a high grade and free of defects and imperfections, and has not been in prior service except as required during aging and factory testing.

1.5.9.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.9.2 Material and Equipment Manufacturing Date

Products manufactured more than 6 months prior to date of delivery to site are not acceptable.

1.6 INSPECTION

Inspection before shipment is required. The manufacturer must notify the

Government at least 2 weeks before shipping date so that an inspection can be made.

1.7 DELIVERY AND STORAGE

Protect equipment placed in storage from humidity and temperature variations, moisture, water intrusion, dirt, airborne corrosives, or other contaminants. In harsh environments where temperatures exceed non-operational parameters established within this specification, provide an environmentally controlled equipment storage facility to ensure temperature parameters are within equipment specification. Provide documentation of same to the Government when storage is implemented.

1.8 PROJECT/SITE CONDITIONS

****

NOTE: Army Only. This paragraph and its associated subparagraphs is used by the Army. Delete for other projects.

****

1.8.1 Environmental Conditions

The UPS and battery system must be capable of withstanding any combination of the following external environmental conditions without mechanical or electrical damage or degradation of operating characteristics.

****

NOTE: Designer must show approximate elevation above sea level for project location if it exceeds 1,000 meters 3,300 feet. UPS system including batteries must be derated if 50 degrees C 122 degrees F operating temperature is required.

****

a. Operating altitude: Sea level to 1,000 meters 3,300 ft. (Systems applied at higher altitudes are to be derated in accordance with the manufacturer's instructions).

b. Non-operating altitude: Sea level to 11,000 meters 36,000 ft.

c. Operating ambient temperature range: 0 to 40 degrees C 32 to 104 degrees F. Range for batteries is 20 to 25 degrees C 68 to 77 degrees F. Provide batteries that are capable of operating in a larger ambient temperature range of 10 to 30 degrees C 50 to 86 degrees F, but some degradation of life span is understood when operating outside the range of 20 to 25 degrees C 68 to 77 degrees F.

d. Non-operating and storage ambient temperature range: Minus 20 to plus 50 degrees C Minus 4 to plus 122 degrees F. Range for batteries or UPS modules with internal batteries: 10 to 30 degrees C 50 to 86 degrees F.

e. Operating relative humidity: 0 to 95 percent, without condensation.

1.8.2 Sound Pressure Levels

****

NOTE: UPS modules rated up to 125 kVA should have a dB rating of 65 dBA or lower at 1 meter 39 inches.

UPS modules rated above 125 kVA should have a dBA rating of 75 dB or lower at 1.5 meters 5 feet.
****

Sound pressure levels produced by the UPS, when operating under full rated load, at a distance of[1.5 meters 5 feet][1 meter 39 inches][_____] in any direction from the perimeter of the unit, must not exceed [75][65][_____] dB as measured on the A scale of a Type 1 sound level meter at slow response conforming to ASA S1.4.

1.8.3 Verification of Dimensions

The Contractor is to become familiar with details of the work, verify dimensions in the field, and is to advise the Contracting Officer of any discrepancy before performing the work. Do not proceed until the discrepancy or unsatisfactory condition(s) have been corrected.

PART 2 PRODUCTS

[2.1 SYSTEM DESCRIPTION
****

NOTE: Connect alternate power source to bypass/maintenance bypass for systems requiring dual input. Edit for the configuration used in this project. There are other configurations that the UPS system can be configured, but these are the more common ones.

Note: Delete system cabinet when specifying a single module UPS system.
****

Provide continuous duty, three-phase, solid state, on-line double conversion reverse transfer static UPS(s). The UPS by means of solid state conversion techniques, must provide continuous regulated AC power to its output terminals, while operating from an input power source, cabinet or rack-mounted direct current (DC) storage battery or other approved means. The performance of the UPS must not be degraded when operating without a system battery, provided the input AC source is within tolerance. Provide an UPS system that conforms to UL 1778 and consists of UPS module, battery system, battery protective device, [system cabinet,]static bypass transfer switch, controls and monitoring, system protective devices, means of isolating the UPS system from the critical load, and remote monitoring interfaces. Connect input ac power the normal source ac input of the UPS module. [Connect alternate power source bypass/maintenance bypass.]Connect battery to the dc input of the UPS module through the battery protective device. The following configuration is used:
****

NOTE: Three main choices: Non-Redundant, Redundant System, and Scalable Units. The Redundant system herein is strictly various parallel configurations, where a N+1 as a minimum is to be achieved.

Scalable units are becoming the standard, since they allow modularity and reduce the number of UPS models for a manufacturer. Scalable units in a Redundant configuration would also need to indicate the Redundant System configuration.
****

[a. Non-Redundant.

(1) Single Module. On-line, single module UPS configuration capable of supplying power to the total load, with bypass availability.

(2) Parallel Multi-Module. Two or more UPS modules, of the same size, on-line, operating in parallel, with enough capacity to supply the total load.

][b. Redundant System.

[(1) Isolated Redundant System (Segmented Redundant or Hot Standby). One unit on-line supporting the load, while the other unit is operating to provide the bypass source.

][(2) Parallel Redundant System. Two or more UPS modules, of the same size, on-line, operating in parallel, with more capability than is required to support the total load. If any unit fails, the remaining unit or units is able to support the critical load.

][(3) Split Bus System. Two parallel redundant systems that may be operated separately or through a tie breaker for increased redundancy. Each UPS system on either side of the split bus is able to support the total critical load.

][(4) Distributed Redundant System. Distributed redundant configurations is also called tri-redundant. The basis of this design uses three or more UPS modules with independent input and output feeders. The independent output buses are connected to the critical load via multiple PDUs.

]]c. Scalable Units.

****

NOTE: Scalable units are rack or cabinet mounted UPS power modules of the same size, which have scalable architecture to allow expansion/contraction to a different kVA size within the same vertical rack or cabinet lineup. The kVA is achieved by adding or subtracting power modules to achieve the desired kVA rating. Each power module, depending on the manufacturer, has a rectifier, inverter and battery converter. There is an UPS system module that works with these power modules to form the UPS. Scalable Units can be specified to have be non-redundant or be redundant. An explanation for each configuration is below.

****

][(1) Scalable Unit Non-Redundant. Non-redundant:scalable unit consists of a UPS system module with one or more power modules. The power modules provided are all required to handle the critical load.

][(2) Scalable Unit Internal Redundant. Internal Redundant: scalable unit consists of a UPS system module with more than one power module. There is at least one additional power module that is not required to handle the load within the system. The additional power module or power modules can be sized to handle only part of the critical load or all the critical load. This is not a true parallel redundant system system since it still uses one UPS system module.

][(3) Scalable Unit Redundant. Redundant:scalable unit consists of a UPS system module with one or more power modules. The number of power modules can be to just support the load or also have at least one extra power module to internal redundancy. This UPS system module is parallel with a matching scalable unit previously discussed under "Redundant System".

]

]2.2 MODES OF OPERATION

2.2.1 Normal

The UPS module rectifier/charger must convert the incoming ac input power to dc power for the inverter and for float charging the battery. The inverter continuously coverts the dc power to ac power to supply the critical load. The inverter output must synchronize with the bypass ac power source, provided that the bypass ac power source is within the specified voltage and frequency range.

2.2.2 Battery - Emergency Operation (Loss or deviation of AC Input Power)

Whenever the ac input power source deviates from the specified tolerances including complete failure, the inverter must draw power from the battery system and supply AC power to the critical load without any interruption or switching transient. The battery system must supply power to the inverter for the specified protection time or until return of ac input source. Provide an audible alarm to indicate the UPS is on battery and provide provisions for a remote alarm signal to be sent via the communication network and a relay output, allowing startup of a secondary power source or orderly shutdown of the critical load.

2.2.3 Failure of AC Input Power to Return

If the ac input power fail to return before the battery voltage reaches the discharge limit, then the UPS system must disconnect from the critical load to safeguard the battery.

2.2.4 Recharge

Upon restoration of normal power to the UPS unit, the input converter and output inverter must simultaneously recharge the batteries and provide regulated power to the critical load.

2.2.5 Transfer to Static Bypass AC Power Source

****

NOTE: Choose the first paragraph for non-redundant systems, i.e. single module, parallel multi-module, or scalable unit non-redundant UPS. Choose the second paragraph for redundant systems to include scalable unit internal redundant and scalable unit redundant.

****

[When the UPS controller senses an overload, two or more inverter shutdown signals or degradation of the inverter output, the static bypass switch automatically transfers the critical load from the inverter output to the bypass ac power source without an interruption of power. If the static bypass ac power source is outside of specified tolerance limits, the UPS and the critical load shut down. Transfer to static bypass can also be done manually (requested bypass). Transfer to bypass does not take place under these conditions: 100% stepload; and, loss or return of input power, momentary sags, surges or spikes on the input to the UPS.

][When the UPS controller senses an overload, two or more inverter shutdown signals or degradation of the inverter output, the static bypass switch automatically transfers the critical load from the inverter output to the bypass ac power source without an interruption of power only if the connected load exceeds the capacity of the remaining on-line modules. If the static bypass ac power source is outside of specified tolerance limits, the UPS and the critical load shut down. Transfer to static bypass can also be done manually (requested bypass). Transfer to bypass does not take place under these conditions: 100% stepload; and, loss or return of input power, momentary sags, surges or spikes on the input to the UPS.]

2.2.6 Transfer to Inverter

Provide a static bypass switch that is capable of automatically transferring the load back to the inverter output after the inverter overload condition has returned to normal conditions. Transfer only occurs once the two sources are synchronized. UPS system logic is to monitor the number of retransfer's within any one-hour period and is to allow 1 to 3 transfers in order to prevent cyclical transfers caused by overloads.

[2.2.7 Maintenance Bypass

****

NOTE: The majority of systems should provide an external maintenance bypass in order to isolate the UPS for maintenance. Internal switches still provide a benefit, but do not provide complete isolation when doing maintenance (arc flash hazard still exist). The configuration on the maintenance bypass is covered more fully later in paragraph 'MAINTENANCE BYPASS CIRCUIT'.

****

Provide the system with an external make-before-break maintenance bypass cabinet/panel to electrically isolate the UPS during routine maintenance and service. Manual transfer to the maintenance bypass circuit transfers the critical load from the inverter output to the bypass ac power source without disturbing the critical load bus.

][2.2.8 Off-Battery (Battery Maintenance)

Provide a battery protective device which disconnects the battery from the rectifier/charger and inverter for maintenance. The device may be located external to the UPS cabinet. The UPS module continues to function and meet the performance criteria specified except for the battery back-up time function.

][2.2.9 Failure of a Module

****

NOTE: Delete for non-redundant systems, i.e. single module, parallel multi-module, or scalable unit non-redundant UPS.

****

In a redundant configuration, failure of one module causes that module to be disconnected from the system critical load bus by its internal protective devices and its individual output protective device. Remaining module(s) are to continue to carry the load.

][2.2.10 UPS Module Servicing

****

NOTE: Delete for non-redundant systems, i.e. single module, parallel multi-module, or scalable unit non-redundant UPS..

****

Provide a means the manually disconnect the UPS modules from the critical load bus for maintenance without disturbing the critical load bus.

]2.2.11 Component Performance

Do not exceed 75% of the working voltage and current ratings as established by the manufacturer on solid-state power components and electronic devices. Do not exceed 75% of the operating temperature of solid-state component sub-assemblies. Use computer grade electrolytic capacitors and operate at no more than 95% of the voltage rating at the rectifier charging voltage.

2.3 GENERAL UPS SYSTEM COMPONENTS AND FABRICATION

2.3.1 Semiconductor Fusing

Protect power semiconductors with fast-acting fuses to prevent cascaded or sequential semiconductor failures. Bolt fuses at both ends to bus bars to ensure mechanical and electrical integrity. Indicator lamp or display panel denoting blown fuse conditions must be readily observable by the operator without removing panels or opening cabinet doors.

2.3.2 EMI/RFI Protection

Provide an UPS that complies with and is labeled compliant, with FCC Part 15, Subclass B, Class A.

2.3.3 Internal Wiring

Wiring practices, materials, and coding must be in accordance with the requirements of NFPA 70, OSHA, UL 1778, and other applicable standards. Protect wire runs in a manner which separates power and control wiring. Provide control cabling that is at least No. 16 AWG extra-flexible stranded copper. Logic-circuit wiring may be smaller. Provide ribbon cables that are at least minimum No. 22 AWG. Provide control wiring with permanently attached wire numbers.

2.3.4 Internal Assembly

The printed circuit board (PCB) subassemblies are to be mounted in pull-out swing-out trays where feasible. Provide cable connections to the trays that are sufficiently long to allow easy access to all components. Where not feasible to mount PCB subassemblies in pull-out or swing-out trays, then mount them firmly mounted inside the enclosure. Monitor every PCB subassembly. Include self-test and diagnostic circuitry in the logic circuits such that a fault can be isolated down to the PCB subassembly level. When used, control logic cards are to have test points or logic indicators on the front edge of the control logic card and be labeled.

2.3.5 Cable Lugs and Terminations

2.3.5.1 Cable Lugs

Provide appropriate compression type lugs or pre-drilled bus bars on all ac and dc power connections to the UPS system and battery as required. Aluminum or bare copper cable lugs are not suitable.

2.3.5.2 Terminations

Supply terminals for making power and control connections. Provide terminal block for field wiring terminals. Provide terminal blocks that are the heavy-duty, strap-screw type or screw terminals that are integrated into removable plugs. Locate terminal blocks for field wiring in one place in each module. Extend control wiring to the terminal block location. Any terminal point is limited to land a maximum of two wires. Where control wiring is attached to the same point as power wiring, Provide a separate terminal where control wiring is attached to the same point as power wiring, . If bus duct is used, provide bus stubs where bus duct enters cabinets.

2.3.6 Cabinets

****

NOTE: UPS units are normally made to be handled by a fork lift.

****

Install the UPS system in cabinets of heavy-duty structure meeting the NEMA PE 1 standards for floor mounting. Provide a structurally adequate UPS module that can be forklift handled and lifted. [Provide removable lifting eyes on top of each cabinet.] Provide the UPS module cabinet with hinged and key lockable doors on the front only and with assemblies and components accessible from the front. Provide dead-front construction behind the door for those UPS module cabinets that are not lockable. Operating controls are to be located outside the locked doors. Install input, output, and battery cables through the top or bottom of the cabinet.

[2.3.6.1 Cabinet Finish

****

NOTE: On Army projects choose the bracketed option; otherwise delete. Designer needs to coordinate with the requirements found in UFC 3-560-01 for arc-flash signage requirements.

****

Provide an equipment cabinet that is cleaned, primed and painted in the manufacturer's standard colors, in accordance with accepted industry standards. Cabinets are to be labeled in accordance with NFPA 70 and NFPA 70E.

]2.3.6.2 Factory Applied Finish

Provide electrical equipment with a factory-applied painting systems which, as a minimum, meets the requirements of NEMA 250 corrosion-resistance test.

[2.3.6.3 Drawout Assemblies

****

NOTE: Drawout applies to large units for removing

inverter modules, static switches assemblies, etc. This is not a standard option even on larger units. Delete for units smaller than 500 kVA.
****

Provide a means of lifting, either and overhead device or a hoisting device for drawout assemblies weighing 23 kg 50 lbs or more. Device can either be part of the UPS or a separate portable device that can be used to perform the lifting.

]2.3.7   Manufacturer's Nameplates

Provide a nameplate for each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.3.8   Field Fabricated Nameplates

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Provide an inscription on each nameplate that identifies the name of the item, calculated short circuit rating with date, and source of power e.g. 'Panel A in Electrical Room 103'. Provide nameplates that are made of melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core. Provide the nameplate with a surface that is matte finished and that has square corners.. Accurately align lettering and engrave into the core. Provide nameplates that are at least 25 by 65 mm 1.0 by 2.5 inches with a minimum lettering size of 6.35 mm 0.25 inch high normal block style.

2.3.9   Safety

Provide UPS with instruction plates including warnings and cautions, suitably located, and describing any special or important procedures to be followed in operating and servicing the equipment. Provide control panel displays, which also provide warning messages prior to performing a critical function.

2.3.9.1   Maintenance Isolation

All energized terminals, both AC and DC, and control voltage exposed points are to be insulated or enclosed to ensure the safety of maintenance personnel. Provide the system with the ability to isolate the static switch to enable repair when the UPS is bypassed.

2.3.9.2   Remote Emergency Power Off (REPO) Switch

Provide a remote emergency power off switch that is separate from the UPS. Provide a red, pushbutton with a cover with a label indicating "UPS Emergency Power Off". The switch disconnects all breakers or contactors including battery, input, output, and bypass breakers when activated.

2.4   TECHNICAL REQUIREMENTS UPS SYSTEM RATINGS

Unless stated otherwise, the parameters listed are under full output load over the range of0.9 lagging power factor to 0.9 leading power factor, with batteries fully charged and floating on the dc bus and with nominal input voltage.

2.4.1 UPS SYSTEM LOAD PROFILE

****

NOTE:
The UPS may exhibit load interface problems with certain types of ac load. The items which present the greatest problems are motors, transformers, electric discharge lighting, and SCR and mag-amp power supplies. Problems with these loads are caused by either load nonlinearity or inrush currents required for their operation. The Contractor will be better able to accommodate specific applications if well-defined load data is available.

****

Provide an UPS system that is compatible with the load characteristics defined in the LOAD PROFILE below and load configuration. The UPS system is to provide compensation for UPS/load interaction problems resulting from nonlinear loads or transformer and motor inrush.

LOAD PROFILE

Type of load:

Data processing equipment. Size of load: [_____][kVA][kW], [_____]voltage, [[_____]power factor].

****

NOTE: If known, provide the actual nameplate full load amps and the locked rotor code letter. If not known, delete the option.

****

Motors - type [_____]. Size of load: [_____]horsepower, [_____]voltage[, [_____] full load amps, [_____] locked rotor code letter].

Electric Discharge Lighting. Size of load: [_____][kVA][kW], [_____]voltage, [[_____]power factor].

****

NOTE: Variable Frequency Drives that are powered from an UPS, need to be specified with input inductors.

****

Variable Frequency Drive(s). Size of load: [_____]horsepower, [_____]voltage

Load switching pattern: [unswitched][cycled daily][cycled hourly][operated by thermostat][building management system control][_____].

****

NOTE: Coordinate this with the UPS System Load Profile paragraph. Power factors have been improving and it is becoming common to have 0.9 lagging or higher power factor.

****

Steady-state characteristics: [0.9 lagging][_____] power factor.

Special factors: [harmonic characteristics - Total Harmonic Distortion [_____] percent][high elevation][nonstandard input and output voltages][_____].

2.4.2 System Requirements

****

NOTE: Typical capacities in kVA are 10, 15, 20, 30, 40, 50, 80, 100, 125, 150, 225, 250, 275, 300, 500 and 750.

****

****

NOTE: System capacity for single module UPS is same as module capacity. Paralleling can be for capacity or for redundancy. Parallel redundant UPS typically provide on additional module that can be down while still carrying the entire load.

****

****

NOTE: Scalable Unit sizes listed can vary from manufacturer to manufacturer as well as the number that can be paralleled. If paralleling more than 4 modules, check with the main manufacturers for availability.

****

The UPS is to support and maintain full battery charging under the following conditions: indicated environmental conditions, a.c input voltage range, air filters blocked up to 50% and a single failed fan. The UPS size and configuration is indicated below.

[Single Module (non-redundant). Provide one UPS sized for [_____] kVA and [_____] kW.
]

[Parallel System is comprised of [_____] UPS system-level redundancy. The parallel system is sized for [_____] kVA and [_____] kW.]

****

NOTE: Scalable units are flexible so there are several choices. The power module are the units that provide the load and can provide internal redundancy if desire. The total load is the estimated demand for the critical load. The UPS system module is the overall controlling module. Example: One can have a system module at 60 kVA and have two 20 kVA power modules to allow for future expansion.

****

[Scalable Units. Each UPS power module is rated [10][20][25][_____] kVA. Provide at least [_____] UPS power modules to handle the system load. [Provide one additional UPS power modules for internal redundancy] The total load is [_____] kVA and [_____] kW. The UPS system module is sized for [_____] kVA and [_____] kW.
]

2.4.3 Battery Capacity

****

NOTE: Typical battery discharge times are 5, 10, 12, 15, and 30 minutes. If no emergency source is available, longer battery discharge time may be

required.

IEEE 450 defines end of life to be at 80% of the initial capacity. The industry standard is to size an end of life battery for 125% of initial capacity. Choose 125% unless another value is required.

****

Discharge time to end voltage: [10][15][30][_____] minutes, at 25 degrees C 77 degrees F. Provide a battery that is capable of delivering [125][_____] percent of full rated UPS kW load at 0.9 power factor at initial start-up.

2.4.4 Static Switch

****

NOTE: The static switch or static disconnect is a solid-state disconnect device used to apply or disconnect ac power. The interrupting capacity requirements must be determined for each project distribution system. Typical interrupting capacities are 30,000 AIC and 50,000 AIC. Interrupting capacities are normally found on the single line diagram or in the short circuit calculations provided with the drawings.

****

[____] amperes (continuous duty)

2.4.5 Short Circuit Withstand Rating

Braced for at least [____] amperes symmetrical interrupting capacity.

2.4.6 AC Input

****

NOTE: Be certain that units having foreign voltages are clearly specified since they are not standard for U.S. manufactured products.

****

a. Voltage [208][240][480][_____] volts line-to-line.

****

NOTE: Scalable unit systems do not come with an output transformer, so the input and output voltage needs to be the same when editing. Transformerless help with the efficiency of the UPS unit and keeps the foot-print smaller. Single unit UPS are still available with step-down output transformers

****

b. Number of phases: Three-phase[+ neutral] + ground configuration..

c. Voltage Range: Plus 10 percent, minus 15 percent nominal (no battery discharge), without affecting battery float voltage or output voltage.

****

NOTE: Use 50 Hz for units shipped or purchased in Europe.

****

d. Frequency: [60][50] Hz, plus or minus 5 percent.

****

NOTE: For scalable units choose the second bracketed option. For other type units, choose the first bracketed option.

****

e. Power walk-in: [20 percent to 100 percent input current over 10 to 15 seconds.] [0 percent to 100 percent input current over 10 to 15 seconds with an adjustable setting that can be set from 5 seconds to 30 seconds.]

****

NOTE: Total harmonic current distortion (THD) is usually 5 percent. If UPS will be supplied from a generator, the generator capacity must be at least twice the UPS capacity if THD exceeds 5 percent.

****

f. Total harmonic current distortion (THD) reflected into the primary line: [5][10] percent maximum at full load.

g. Sub-cycle magnetizing inrush: [2 to 3][_____] times full load current for modules without an isolation transformer.

h. Input surge protection: per IEEE C62.41.1 and IEEE C62.41.2, meeting IEEE C62.41 requirement of Category B3 6kV, 100k Hz ring wave and 6kV, combined wave.

i. Input power factor: Lagging from 1-100 percent load.

****

NOTE: Delete transformer inrush paragraph if input isolation transformer is not required. For transformer sub-cycle inrush, selecting a lower value like 6 or 4 in lieu of the range (4 to 8) is better for coordination of UPS feeder protection but might add some cost and extra components. If the range is selected than upstream breaker should have instantaneous current adjustment.

****

[j. Transformer sub-cycle magnetizing inrush: [5 to 8][_____] times full load current with optional isolation transformer and optional input filter.

]

2.4.7 AC Output

****

NOTE: If the output voltage is 208Y/120 V and the same voltage is not available for the static bypass and maintenance bypass, a transformer will be required in the bypass distribution system.

NOTE: Scalable units do not come with an output transformer, so the input and output voltage needs to be the same when editing. These scalable, expandable module systems are typically 208V, 480V, and 600V. Transformerless designs help with the efficiency of the UPS unit and keeps the foot-print

smaller. Single unit UPS are still available with step-down output transformers.

****

a. Voltage [208][220][240][480][_____] volts line-to-line[, [120][127][277][_____] volts line-to-neutral].

b. Number of phases: Three-phase[+ neutral] + ground configuration.

c. Voltage regulation:

(1) Balanced load: Plus or minus 1.0 percent.

(2) 50 percent load imbalance, phase-to-phase: Plus or minus 2 percent.

(3) 100 percent load imbalance, phase-to-phase Plus or minus 3 percent.

(4) Voltage drift: Plus or minus 1 percent over any 30 day interval (or length of test) at stated ambient conditions found in paragraph Environmental Conditions.

d. Voltage adjustment: Plus or minus 5 percent.

e. Frequency: [60][50] Hz.

f. Frequency regulation: Plus or minus 0.1 percent, when on internal oscillator. Internal oscillator is to be temperature compensated.

g. Frequency drift: Plus or minus 0.1 percent over any 24 hour interval (or length of test) at stated ambient conditions when on internal oscillator.

h. Harmonic content (RMS voltage): Provide a system that meets the following voltage THD levels: maximum of 4% RMS total,2 percent total with 100 percent on any single harmonic (linear load) and 5 percent RMS total for up to 100 percent nonlinear load.

****

NOTE: The load factor range can vary with the presence of a transformer. choose the first set of brackets in "i" when the UPS does not have a transformer and choose the second set of brackets when there is a transformer or provide own values. The load factor range is the range the UPS can operate at without derating.

****

i. Load power factor operating range (without derating): [0.9 leading to 0.9 lagging][0.95 leading to 0.9 lagging][______].

j. Phase angle displacement/imbalance:

(1) Balanced load: 120 degrees plus or minus [0.5][1] degree of bypass input.

(2) 50 percent load imbalance phase-to-phase: 120 degrees plus or minus 3 degrees of input.

k. Inverter overload capability (at full voltage with plus or minus 2 percent regulation) (excluding battery):

****

NOTE: Designer needs to determine the overload requirements against protection for the load. Any number can be used that falls within the range for each percent overload. Default values are 10 minutes for 125 percent and 60 seconds for 150 percent.

****

(1) 125 percent load for [10 minutes][30 seconds][60 seconds][______].

(2) 150 percent load for [60 seconds][40 ms].

(3) Fault clearing. Provide an UPS that is able to maintain output current during a fault condition for 20 cycles if bypass is unavailable or 1 cycle with bypass available. If the fault is not cleared and a bypass is available, the UPS is to transfer to bypass without interruption to clear the fault.

l. Load sharing of parallel modules: Plus or minus 5 percent at full rated system load.

m. Bypass Overload Capability.

****

NOTE: For scalable units choose the second option. Choose the first option for all others.

****

[(1) 0 percent load for 15 seconds.

][(2) Expandable units. 125 percent continuous at rated output voltage (phase-to-phase). 1000 percent for 1000 milliseconds.

]

2.4.8 Transient Response

2.4.8.1 Voltage Transients

a. 100 percent load step: Plus or minus 5 percent.

b. Loss or return of ac input: Plus or minus [1][5] percent.

c. Automatic transfer of load from UPS to bypass: Plus or minus 1 percent.

d. Manual retransfer of load from bypass to UPS: Plus or minus 5 percent.

****

NOTE: The default value is 20 milliseconds unless a faster recovery time is required. For scalable units, use 50 milliseconds.

****

e. Response time: Recovery to 1 percent of nominal within [20][50][16] milliseconds where there was a maximum deviation from nominal system output of volts plus or minus 5 percent.

2.4.8.2 Frequency

a. Transients: Plus or minus 0.6 Hz maximum.

****

NOTE: If there is a generator in the project, which will power the UPS during a utility power outage, then choose the second option.

****

b. Slew Rate: under all conditions of operation, [provide 0.4 to 1.0 Hz per second][0.25 to 0.8 Hz per second].

2.4.9 Efficiency

****

NOTE: Efficiencies do vary some with the size of the UPS; however, the variance between lower rated UPS and higher rated UPS have narrowed. Almost all sizes in double-conversion mode will meet 94%. The higher double-conversion efficiency is 97%. UPS systems loaded to 50 percent will typically see a reduction of 1-2 percentage in efficiency. Units with a transformer could have a lower efficiency.

Delete system efficiency requirements for single module UPS systems.

Energy Star only covers the battery charging systems and the AC-DC/AC-AC power supplies. Energy Star does not cover all components of the complete UPS System. Energy Star UPSs cannot be one of the following types:
(a) Products that are internal to a computer or other end load.
(b) Industrial UPSs designed to protect critical control, manufacturing or production processes.
(c) Utility UPSs that are part of electrical transmission and distribution
(d) Cable TV UPSs designed to power cable distribution systems.
(e) UPSs designed to comply with specific UL safety standards for safety-related applications e.g. emergency lighting, medical diagnostic equipment
(f) UPSs designed for mobile, ship board, marine or airborne applications.

****

[a. Minimum Single-Module Efficiency: [94][_____] percent at full load kW and [92][____] percent at 50 percent load.

][b. Minimum System Efficiency: 93 percent at full system load kW.
]
[c. Provide Energy Star labeled battery charging systems and AC-DC/AC-AC power supplies. Provide proof of Energy Star label for battery charging systems and AC-DC/AC-AC power supply products.
]
[2.4.10 Energy Saving Mode

****

NOTE: The UPS industry has developed various energy saving methods. If this is desired then edit appropriately; otherwise, delete. Smaller units may not have this option available. There are some issues that need to be considered since energy saving methods typically do not regulate the voltage

or the frequency, Areas with unstable power may not consider this appropriate. UPS installations that require the double-conversion to filter (clean-up) the incoming power should not enable an energy saving mode that allows facility power to the critical load. If the UPS unit is powering IT equipments (such as a data center), choose 2 milliseconds; otherwise 13 milliseconds is acceptable.
****

Provide the UPS with an energy saving mode that operates by having the inverter charged and batteries on at all times, while the main power to the output is through the static bypass switch. When a power problem is sensed, the system is to operate in double-conversion mode and revert to energy saving mode after a pre-set period of time. Maximum transition time is [2][13] miliseconds.

]2.5 UPS MODULE

2.5.1 General Description

****
NOTE: This part is for Scalable units only. If a scalable unit is not desired, then delete this part.
****

UPS module consists of an input converter, output converter, with associated transformers, synchronizing equipment, protective devices, surge suppression, and accessories as required for operation.

2.5.1.1 Interchangeability

The subassemblies in one UPS module are to be interchangeable with the corresponding modules within the same UPS, and from one UPS system to another of identical systems.

2.5.1.2 Rectifier/Charger Unit

Scalable, expandable modular input converts for the system are to be housed within removable power modules. Input converters control the power from the mains input of the system, provide the necessary UPS power for precise regulation of the DC bus voltage, battery charging, and main inverter regulated output power.

2.5.1.2.1 Input Protective Device

****
NOTE: Calculate/verify AIC on the single line diagram at input of the UPS.
****

Provide the rectifier/charger unit with an input protective device. Size the protective device to accept simultaneously the full-rated load and the battery recharge current. Provide a protective device that is capable of shunt tripping and has an amperes symmetrical interrupting rating of [_____]. Provide the protective device with an under-voltage release to open automatically when the control voltage is lost.

[2.5.1.2.2 Input Isolation Transformer

****

NOTE: An input isolation transformer is not normally required. Delete unless specifically required to be part of the UPS. Also, delete when requiring scalable, expandable modular UPS systems. Isolation transformers provide isolation of line induced EMI, common mode noise and dc offsets. Some of the UPS manufacturers require a separate cabinet for the transformer.

UPS industry is transitioning away from transformers being part of the UPS. Having the transformer separate can save space, reduce cooling, improve energy efficiency, reduce weight and cost. In general, those unit smaller than 200 kW will benefit more by not having a transformer as part of the UPS. The threshold level of 200 kW is increasing as more manufacturers go to "transformerless" designs.

Transformers rated 500 kVA and higher typically have the transformer connections on the backside.

****

The rectifier unit is to use a dry-type, isolated-winding power transformer. The transformer's hottest spot winding temperature must not exceed the temperature limit of the transformer insulation material when operating at full load. Provide a transformer with Class H, 150 degrees C rise insulation. [Transformer connections are to be accessible from the front.] If there is a separate transformer cabinet, it is is to match the UPS cabinet and attach to it.[Provide a Department of Energy CSL-3 transformer.]

]2.5.1.2.3 Power Walk-In

Input convert is to have an adjustable soft-start (either by manufacturer or owner), capable of limiting the input current form 0 percent to 100 percent of the input over a default 10 second period when returning to ac input bus from battery operation. The change in current over time is to be done in a linear manner.

2.5.1.2.4 Sizing

Size the rectifier/charger unit for the following two simultaneous operating conditions:

a. Supplying the full rated load current to the inverter.

b. Recharging a fully-discharged battery to 90 percent of rated ampere-hour capacity within ten times the discharge time after normal ac power is restored.

2.5.1.2.5 AC Input Current Limiting

Provide a circuit to the input converter that controls and limits the current draw form utility to 130 percent of the rated UPS output. During conditions where input current limit is active, the UPS system is to be able to support 100 percent of the load, charge the batteries at 10 percent of the UPS output rating, and provide voltage regulation with mains deviation of +15/-5 percent.

****

NOTE: Delete second step current limiting option if the UPS system will not be supplied with ac power from an auxiliary generator system or if the generator has been sized to accommodate the higher input current.

****

[Second step current limiting: Provide the rectifier/charger unit with a second-step input current limit. Provide a separately adjustable second-step current limit that is adjustable from 85 percent to 125 percent of the maximum discharge current with initial setting at 100 percent. Activate the second-step current-limit circuit by a dry contact signal from the generator.

]2.5.1.2.6 Battery Charging Current

a. Primary current limiting: Battery-charging current is to be voltage regulated and current limited. Provide a separately adjustable battery-charging current limit that is adjustable from 1 percent to 20 percent of the maximum discharge current. Set the limit at the factory to 10 percent. After the battery is recharged, the rectifier/charger unit maintains the battery at full float charge until the next operation under input power failure. Battery charger is capable of providing equalizing charge to the battery.

****

NOTE: Delete second step current limiting if the UPS system (paragraph below) will not be supplied with ac power from an auxiliary generator system or if the generator has been sized to accommodate the recharge current of the battery. Second step current limit is usually found in larger units of 150kVA and above.

****

[b. Second step current limiting: The rectifier/charger unit is also to have a second-step battery current limit. Provide a separately adjustable second-step current limit that is adjustable from 0 percent to 20 percent of the maximum discharge current with initial setting at [1][10][__] percent. The second-step current-limit circuit is activated by a dry contact signal from the generator set controls and it will prevent normal rate battery recharging until utility power is restored.

]2.5.1.2.7 DC Ripple (Output Filter)

Rectifier/charger unit is to minimize ripple current and voltage supplied to the battery; the ripple voltage into the battery is not to exceed 1 percent RMS of the float voltage. Ensure the AC ripple voltage of the rectifier DC output does not exceed 0.5 percent of the float voltage.

[2.5.1.2.8 DC Voltage Adjustment

****

NOTE: Delete this requirement on units smaller than 50 kVA.

****

Provide a manual means at the rectifier/charger unit that allows for adjusting the dc voltage for battery equalization in order to provide voltage within plus 10 percent of nominal float voltage.

]2.5.1.2.9 Battery Isolation Protective Device

Provide the module or external battery system with a dc protective device to isolate the module from the battery system. The protective device size and interrupting rating are as required by system capacity and is to incorporate the trip required by circuit design. Provide the protective device with a provision for locking in the "off" position.

[2.5.1.2.10 Battery Equalize Charge

****

NOTE: Delete this requirement on units smaller than 50 kVA.

****

Equalize charge timer is to provide an equalizing charge automatically to the battery after a 30 second or longer utility outage. The equalize charging time is to be adjustable form 0-72 hours. Provide a manual override for the automatic equalize circuit.

]2.5.2 General Description

****

NOTE: This option applies to single-module and, in some remote cases, multi-module UPS systems that are not specifically required to be scalable. Most applications do not require an isolation transformer as part of the UPS, so delete unless required.

****

UPS module consists of a rectifier/charger unit and a 3-phase inverter unit with their associated transformers, synchronizing equipment, protective devices, surge suppression, [input isolation transformer,] and accessories as required for operation.

2.5.2.1 Interchangeability

The subassemblies in one UPS module are to be interchangeable with the corresponding modules within the same UPS, and from one UPS system to another of identical systems.

2.5.2.2 Rectifier/Charger Unit

Provide a solid state rectifier/charger unit that converts alternating current to direct current, and provides regulated direct current to the dc bus, supplying power to the inverter and charging the battery plant.

2.5.2.2.1 Input Protective Device

****

NOTE: Calculate/verify AIC on the single line diagram at input of the UPS.

****

Provide the rectifier/charger unit with an input protective device. Size the protective device to accept simultaneously the full-rated load and the battery recharge current. Provide a protective device that is capable of shunt tripping and has an amperes symmetrical interrupting rating of [_____]. Provide the protective device with an under-voltage release to open automatically when the control voltage is lost.

[2.5.2.2.2 Input Isolation Transformer

****

NOTE: An input isolation transformer is not normally required. Delete unless specifically required to be part of the UPS. Also, delete when requiring scalable, expandable modular UPS systems. Isolation transformers provide isolation of line induced EMI, common mode noise and dc offsets. Some of the UPS manufacturers require a separate cabinet for the transformer.

UPS industry is transitioning away from transformers being part of the UPS. Having the transformer separate can save space, reduce cooling, improve energy efficiency, reduce weight and cost. In general, those unit smaller than 200 kW will benefit more by not having a transformer as part of the UPS. The threshold level of 200 kW is increasing as more manufacturers go to "transformerless" designs.

Transformers rated 500 kVA and higher typically have the transformer connections on the backside.

****

The rectifier unit is to use a dry-type, isolated-winding power transformer. The transformer's hottest spot winding temperature must not exceed the temperature limit of the transformer insulation material when operating at full load. Provide a transformer with Class H, 150 degrees C rise insulation. [Transformer connections are to be accessible from the front.] If there is a separate transformer cabinet, it is is to match the UPS cabinet and attach to it.[Provide a Department of Energy CSL-3 transformer.]

]2.5.2.2.3 Power Walk-In

Protect the rectifier/charger unit with a power walk-in feature such that when ac power is returned to the ac input bus, the total initial power requirement will not exceed 20 percent of the rated full load current. This demand is to gradually increase to 100 percent of the rated full load current plus the battery charging current over the specified time interval.

2.5.2.2.4 Sizing

Size the rectifier/charger unit for the following two simultaneous operating conditions:

a. Supplying the full rated load current to the inverter.

b. Recharging a fully-discharged battery to 90 percent of rated ampere-hour capacity within ten times the discharge time after normal ac power is restored.

2.5.2.2.5 AC Input Current Limiting

Provide a circuit on the rectifier/charger to limit AC input current to an adjustable level of 100 percent to 125 percent with a factory setting at [100][115] percent.

****

NOTE: Delete second step current limiting option if the UPS system will not be supplied with ac power from an auxiliary generator system or if the generator has been sized to accommodate the higher input current.

****

[Second step current limiting: Provide the rectifier/charger unit with a second-step input current limit. Provide a separately adjustable second-step current limit that is adjustable from 85 percent to 125 percent of the maximum discharge current with initial setting at 100 percent. Activate the second-step current-limit circuit by a dry contact signal from the generator.

]2.5.2.2.6 Battery Charging Current

a. Primary current limiting: Battery-charging current is to be voltage regulated and current limited. Provide a separately adjustable battery-charging current limit that is adjustable from 1 percent to 20 percent of the maximum discharge current. Set the limit at the factory to 10 percent. After the battery is recharged, the rectifier/charger unit maintains the battery at full float charge until the next operation under input power failure. Battery charger is capable of providing equalizing charge to the battery.

****

NOTE: Delete second step current limiting if the UPS system (paragraph below) will not be supplied with ac power from an auxiliary generator system or if the generator has been sized to accommodate the recharge current of the battery. Second step current limit is usually found in larger units of 150kVA and above.

****

[b. Second step current limiting: The rectifier/charger unit is also to have a second-step battery current limit. Provide a separately adjustable second-step current limit that is adjustable from 0 percent to 20 percent of the maximum discharge current with initial setting at [1][10][__] percent. The second-step current-limit circuit is activated by a dry contact signal from the generator set controls and it will prevent normal rate battery recharging until utility power is restored.

]2.5.2.2.7 DC Ripple (Output Filter)

Rectifier/charger unit is to minimize ripple current and voltage supplied to the battery; the ripple voltage into the battery is not to exceed 1 percent RMS of the float voltage. Ensure the AC ripple voltage of the rectifier DC output does not exceed 0.5 percent of the float voltage.

[2.5.2.2.8 DC Voltage Adjustment

****

NOTE: Delete this requirement on units smaller than 50 kVA.

****

Provide a manual means at the rectifier/charger unit that allows for adjusting the dc voltage for battery equalization in order to provide voltage within plus 10 percent of nominal float voltage.

]2.5.2.2.9   Battery Isolation Protective Device

Provide the module or external battery system with a dc protective device to isolate the module from the battery system. The protective device size and interrupting rating are as required by system capacity and is to incorporate the trip required by circuit design. Provide the protective device with a provision for locking in the "off" position.

[2.5.2.2.10   Battery Equalize Charge

****

NOTE: Delete this requirement on units smaller than 50 kVA.

****

Equalize charge timer is to provide an equalizing charge automatically to the battery after a 30 second or longer utility outage. The equalize charging time is to be adjustable form 0-72 hours. Provide a manual override for the automatic equalize circuit.

]2.5.3   Inverter Unit

****

NOTE: Choose the first option for all systems except for scalable unit UPS systems. Second option is for scalable unit UPS systems.

****

[Provide a solid-state inverter with sinusoidal output deriving its power from the dc bus (rectifier or battery source) and providing ac power within specified limits to the critical load. Inverter is to utilize microprocessor controlled solid state Pulse Width Modulation (PWM) controlled insulated gate bipolar transistor (IGBT) power transistor technology to shape the ac output.
][Provide an output converter that constantly develops the UPS output voltage waveform by converting the dc voltage to ac voltage through a set of semiconductor power converters. In both normal operation and battery operation, the output inverters are creating and output voltage independent of the mains input voltage. Input anomalies such as brown-outs, spikes, surges, sags and outages do not affect the amplitude or sinusoidal nature of the output voltage sine wave of the inverters.

]

****

NOTE: Keep this option/paragraph when there is a generator available to supply power to the UPS.

****

[Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.]

2.5.3.1   Output Overload

****

NOTE: Choose the first option for all systems except for scalable unit UPS systems. Second option is for scalable unit UPS systems.

****

[Provide an inverter that is able to sustain an overload as specified across its output terminals. The inverter is to remain on and continue to operate

within rated parameters, with inverse-time overload shutdown protection. If the overload condition persists beyond the rated parameters of the inverter, the load is to be transferred to the bypass source where the inverter disconnects automatically from the critical load bus. If the bypass source is not available and the overload/fault condition continues, the inverter is to current limit for the time as determined by the manufacturer and then shut down to protect the internal components.
][Provide the output inverter with overload capabilities that allows steady state overload conditions of up to 150 percent of system capacity to be sustained by for 30 seconds in normal and battery operation. If the overload condition persists beyond the rated parameters of the inverter, the load is to be transferred to the bypass source where the inverter disconnects automatically from the critical load bus.]

2.5.3.2 Output Protective Device

Provide an output protective device that is capable of opening on an applied control signal and has the proper frame size and trip rating to supply overload current as specified. Provide the external output protective device with provision for locking in the "off" position. The inverter output protective device works in conjunction with the bypass protective device for both manual and automatic load transfers to and from bypass power.

[2.5.3.3 Output Transformer

****

NOTE: Delete the output transformer unless required or when the design output voltage is different then the normal UPS output voltage. Some of the UPS manufacturers require a separate cabinet for the transformer. The preferred option is a harmonic mitigating transformer instead of a K rated transformer.

UPS industry is transitioning to transformerless UPS modules. Having the transformer separate can save space, reduce cooling, improve energy efficiency, reduce weight and cost. In general, those units smaller than 200 kW will benefit more by not having a transformer as part of the UPS. The threshold level of 200 kW is increasing as more manufacturers go to "transformerless" designs.

****

The inverter output transformer is [harmonic mitigating transformer type.] [or] [capable of handling up to [K-13][_____] nonlinear loads as described in IEEE C57.110].[Provide a transformer that meets the requirements for Department of Energy CSL-3.]

]2.5.4 External Protection

Provide the UPS module with built-in self-protection against undervoltage, overvoltage, overcurrent and surges introduced on the ac input source and/or the bypass source. Provide the UPS with built-in self-protection against overvoltage and voltage surges introduced at the output terminals by paralleled sources, load switching, or circuit breaker operation in the critical load distribution system.

2.5.5 Internal Protection

Provide the UPS module with the ability to be self-protected against overcurrent, sudden changes in output load and short circuits at the output terminals. Provide the UPS module with output reverse power detection which causes the module to be disconnected from the critical load bus when output reverse power is present. Provide the UPS module with built-in protection against permanent damage to itself and the connected load for predictable types of failure within itself and the connected load. At the end of battery discharge limit, the module shuts down without damage to internal components.

2.5.6 Battery Protection

Provide the inverter with monitoring and controls circuits to protect the battery system from damage due to excessive discharge. Inverter shutdown is be initiated when the battery has reached the end of discharge voltage. Manufacturer is to calculate the end-of-discharge voltage and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on discharge time is not acceptable.

[2.5.7 Modular Inverter Isolation

****

NOTE: Delete for single module UPS system.

****

Provide each inverter in the UPS system with fault sensing and static isolation as well as an output protective device, to remove a faulted module from the system without affecting the critical load bus beyond the stated limits.

][2.5.8 Parallel Operation

****

NOTE: Delete for single module UPS system.

****

For parallel operation, ensure the protection system has control logic capable of isolating only the faulted module, and does not shut down the entire UPS system upon a fault in one module. Open protective devices are to be indicated by an alarm and indicator light.

]2.6 STATIC BYPASS TRANSFER CIRCUIT

****

NOTE: Circuit breaker can be fixed or drawout type. In units 500 kVA and larger, the breaker will typically be drawout.
150 kVA or larger units may need to use fuses for the protection of the static switch

****

Provide the control logic with an automatic transfer circuit that senses the status of the inverter logic signals and alarm conditions and provides an uninterrupted transfer of the load to the static bypass ac power source, without exceeding the transient limits specified herein, during times when maintenance is required, when a malfunction occurs in the UPS or when an external overload condition occurs. [The power section of the static bypass transfer circuit consists of a plug-in type assembly to facilitate maintenance.] The static bypass transfer circuit is to be used to connect the input bypass ac power source to the critical load when required. Provide the static bypass transfer circuit with the following features:

2.6.1 Construction

****

NOTE: Last sentence on "modular" is only for the scalable unit UPS systems.

****

Provide a static with a continuous duty rating of at least 100 percent of the UPS output rating. Provide a static bypass transfer circuit as an integral part of the UPS that consists of a static switch, made up of two reverse-paralleled SCRs (silicon-controlled rectifiers) per phase conductor, and a bypass protective device, made up of a [circuit breaker][circuit breaker and fuses]. The bypass protective device is to be in series with the static switch. The inverter output protective device disconnects and isolates the inverter from the bypass transfer circuit. [Provide a static switch that is of a modular design.]

2.6.2 Automatic Uninterrupted Transfer

The static bypass transfer switch automatically causes the bypass ac power source to assume the critical load without interruption when the bypass control logic senses one of the following conditions and the UPS inverter output is synchronized to the bypass ac power source:

a. Inverter overload exceeds unit's rating.

b. Battery protection period is expired and bypass is available.

c. System failure.

d. Inverter output undervoltage or overvoltage.

2.6.3 Interrupted Transfer

If an overload occurs and the UPS inverter output is not synchronized to the bypass ac power source, the UPS inverter output current-limits for 200 milliseconds minimum. The inverter then turns off and an interrupted transfer to the bypass ac power source is made.

If the bypass ac power source is beyond the conditions stated below, an interrupted transfer is made upon detection of a fault condition:

a. Bypass voltage greater than plus or minus 10 percent from the UPS rated output voltage.

b. Bypass frequency greater than plus or minus 0.5 Hz from the UPS rated output frequency.

c. Phase differential of ac bypass voltage to UPS output voltage greater than plus or minus 3 degrees.

2.6.4 Manual Load Transfer

It must be possible to make a manually-initiated static transfer from the system status and control panel by turning the UPS inverter off or by initiating it through the UPS display interface. The transfer is to make-before-break utilizing the UPS output and system bypass circuit breakers. Do not use the static switch for manual transfer unless there isn't a parallel by-pass circuit breaker or contactor.

2.6.5 Automatic Uninterrupted Forward Transfer

Automatic transfer of the load back to the inverter is to take place when the transfer was caused by an overload and only after the load has returned to a level within the inverter souse. Provide the ability to allow 1 to 3 transfers within any one-hour period to prevent cyclical transfers caused by overloads.

2.6.6 Forced Transfer

Provide control logic circuitry with the means of making a forced or reverse transfer of the static bypass transfer circuit on an interrupted basis. Minimum interruption is 200 milliseconds when the UPS inverter is not synchronized to the bypass ac power source.

2.6.7 Overload Ratings

****

NOTE: Select choice "c" for scalable unit UPS systems.

****

The static bypass transfer switch is to withstand the following overload conditions:

a. 1000 percent of UPS output rating for one cycle.

b. 125 percent of UPS output rating for 1 minute.

[c. 110 percent of UPS output continuously.
]

2.6.8 System Protection

Incorporate into the static bypass circuit back-feed protection per UL 1778. To achieve back-feed protection, provide a back-feed protection breaker/mechanical contactor upstream and in series with the bypass switch that is controlled by the UPS/static switch, to open immediately upon sensing a condition where back-feeding of the static switch by any source connected to the critical output bus of the system is occurring.

[2.6.9 Static Bypass Switch Disconnect

****

NOTE: Delete if the static switch is of the draw-out type or if the UPS module is 30 kVA or smaller.

Delete last option if a maintenance by-pass system is not provided/used.

****

Incorporate a static switch disconnect that can be used to isolate the static bypass transfer switch assembly so it can be removed for servicing. [Equip the device with auxiliary contacts and provisions for padlocking in either the "on" or "off" position.]

]2.7 MAINTENANCE BYPASS CIRCUIT

2.7.1 General

****

NOTE: See the TP-19, Static Uninterruptible Power Supply for full discussion on maintenance bypass circuit configurations. UPS units typically come standard with certain internal circuit breakers or switches and these include: one ahead of the rectifier, one on the output of the rectifier, and one ahead of the static switch. In addition, the maintenance bypass switch can be internal to the UPS or external and typically consists of a circuit breaker(s). UPS units up to 500 kVA can have an internal maintenance bypass switch.

Multi-module UPS systems that have UPS modules rated 500 kVA (typically) and higher can have a different configuration. Each module can consist of a rectifier/battery/inverter without an internal maintenance bypass switch or a static switch. In this case, there is a centralized static switch that is sized for the entire load and has its own dedicated feeder. The maintenance by-pass cabinet will typically have two breakers and a single feed. The output of the UPS modules, centralized static switch are in a system control cabinet that connects to the maintenance bypass cabinet. Edit appropriately for multi-module systems.

****

Provide a maintenance bypass switch or arrangement of switch devices [in a matching NEMA 250, type 1 cabinet adjacent to the UPS cabinet][in a wall-mounted NEMA 250, type 1 enclosure][in a free-standing floor-mounted NEMA 250, type 1 enclosure]. [Provide a maintenance bypass enclosure configured as indicated.] [Provide a [two][three][four]switch maintenance bypass enclosure.][Provide a two switch maintenance bypass with an input switch for each module.]

2.7.2 Interlock

****

NOTE: Choose the last sentence option for scalable unit UPS systems.

****

Electrically and mechanically interlock the switch(es) to prevent interrupting power to the load when switching to bypass mode. Key interlock requires unlocking bypass/isolating switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking. [Provide auxiliary contacts for the purpose of relaying status information of each circuit breaker/switch actuator to the UPS and static bypass.]

2.7.3 Load Transfer

The maintenance bypass switch provides the capability of transferring the critical load from the UPS static bypass transfer switch to maintenance bypass and then back to the UPS static bypass transfer switch with no interruption to the critical load.

[2.7.4 Load Bank Protection Device

****

NOTE: Delete if the ability to load bank test the UPS system if not required. It is not recommended under normal circumstances for units smaller than 225 kVA.

****

Provide a load bank protective device that allows the UPS system to be tested using a portable load bank. The load bank protective device is connected on the line side of the maintenance bypass switch isolation protective device. Provide a [full system load bank][partial system load bank] sized at[_____].

][2.7.5 [Voltage Matching][Isolation Transformer]

****

NOTE: Delete if the input and output voltages are the same and an isolation transformer is not required.

UPS industry is transitioning away from transformers being part of the UPS. Having the transformer separate can save space, reduce cooling, improve energy efficiency, reduce weight and cost. In general, those unit smaller than 200 kW will benefit more by not having a transformer as part of the UPS. The threshold level of 200 kW is increasing as more manufacturers go to "transformer less" designs.

****

The maintenance bypass cabinet contains [a voltage matching transformer][an isolation transformer] as required to match the output voltage requirements.Ensure the transformer and UPS are phase matched.

]2.8 DISPLAY,CONTROLS AND ALARMS

****

NOTE: The first paragraph is for non-redundant systems, i.e. single module, parallel multi-module, or scalable unit non-redundant UPS. The second paragraph is for redundant systems to include scalable unit internal redundant and scalable unit redundant.

****

[Provide the UPS module with a microprocessor-controlled display unit located on the hinged door on the front of the system. Provide a LCD color alphanumeric display that operated by touchscreen to access the various information. Controls, meters, alarms and indicators for operation of the UPS module are to be on this panel. Provide a menu driven graphical user interface for browsing the screens. All three-phases of three-phase parameters are to be displayed simultaneously.

][Provide the modules with separate, optically isolated, communication paths to the power and static switch modules. Provide redundant power supplies, each having a separate AC and DC input and output for the logic power for the control modules. Provide a microprocessor-controlled display unit with alphanumeric display with back or side lighting. Controls, meters, alarms and indicators for operation of the UPS module are to be on this panel. Provide a menu driven graphical user interface for browsing the screens. All three-phases of three-phase parameters are to be displayed simultaneously.]

****

NOTE: Delete the output kilowatt hour meter information unless required. This option is rarely available with an UPS and if needed it would be better to consider a separate meter on the load.

****

2.8.1 Module Meters

2.8.1.1 Monitored Functions

Display the actual value along with the ability to show the peak, average and low values over various periods of time. Monitor and display the following functions:

a. Input voltage, phase-to-phase (all three phases).

b. Input current, all three phases.

c. Input frequency.

d. Bypass voltage, phase-to-phase and phase-to-neutral (all three phases).

e. Bypass frequency.

f. Battery voltage.

g. Battery current (charge/discharge).

h. Output voltage, phase-to-phase and phase-to-neutral (all three phases).

i. Output current, all three phases.

j. Output frequency.

k. Input power factor.

l. Maintenance bypass voltage, phase-to-phase and phase-to-ground (all three phases)

[m. Output kilowatts or kilovoltamps.
]

****

NOTE: This option is available on all systems. .

****

[n. Bypass voltage, phase-to-phase and phase-to-ground (all three phases).

]

2.8.1.2 Meter Construction

Display alphanumeric parameters based on true RMS metering with 2 percent accuracy at full scale(minimum 4 significant digits) at the display panel.

2.8.2 Module Controls

Provide a module or equivalent features via touchscreen with the following controls:

a. Silence audible alarm..

b. Display or set the date and time.

c. Adjust setpoints on various alarms.

d. Alarm test/reset pushbutton.

e. Battery protective device trip pushbutton[, with guard].

f. Emergency off pushbutton, with guard. Provide a hard-wired pushbutton even if touchscreen system is provided.

g. DC voltage adjustment potentiometer, with locking guard or AC output voltage adjustment potentiometer. Provide potentiometer that is accessible only by authorized personnel.

h. Control power off switch.

i. Transfer load to and from static bypass circuit.

j. Display control pushbuttons: up, down, select.

****

NOTE: Delete UPS/bypass transfer switch reference except for parallel redundant or parallel multi-module systems. The parallel redundant multi-module configuration must also be specified to have a system control cabinet instead of having individual (distributed) bypass parallel system, so only keep if specified and used.

****

[k. UPS/bypass transfer selector switch.

]

****

NOTE: Module input and output protective device trip pushbuttons are only available when an Emergency Power Off feature is provided.

****

[l. Module input protective device trip pushbutton.

m. Module output protective device trip pushbutton.

]777

2.8.3 Module or System Alarm Indicators

Provide the module with indicators for the following alarm items. Any one of these conditions is to turn on an audible alarm and the appropriate summary indicator. The system is to register each new alarm without affecting any previous alarm. Provide a processor that time-date stamps each event.

a. Input ac power source failure.

b. Input protective device open.

c. Input power out of tolerance.

d. Overload.

e. Overload shutdown.

f. DC overvoltage/shutdown.

g. DC ground fault.

h. Low battery.

i. Battery discharged.

j. Battery protective device open.

k. Blower fan failure or overtemperature.

l. Overtemperature shutdown.

m. Hardware shutdown.

n. Equipment overtemperature.

o. Fuse blown with annunciation..

p. Control power failure.

q. Charger off/problem.

r. Inverter fault/off.

s. Emergency power off.

t. External shutdown (Remote Emergency Power Off) activated.

u. Output protective device open.

v. Operating on internal oscillator

w. UPS on battery

x. Critical load on static bypass.

y. Static bypass transfer switch disabled/failure.

z. Inverter output overvoltage.

aa. Inverter output undervoltage.

ab. Inverter output overfrequency.

ac. Inverter output underfrequency.

ad. Bypass source overvoltage.

ae. Bypass source undervoltage.

af. Bypass source overfrequency.

ag. Bypass source underfrequency.

ah. Bypass source to inverter out of synchronization.

****

NOTE: The following additional alarms are only required when the system is scalable unit UPS system; otherwise, delete.

****

[ai. Load no longer above alarm threshold.

aj. Intelligent module inserted or removed.

ak. Redundancy restored.

al. Need battery replacement.

am. Bad battery module.

an. Bad power module.

ao. Redundant intelligent module installed and failed.

ap. Load above alarm threshold.

]

2.8.4 Module Emergency OFF Button

Provide an emergency off pushbutton with a protective cover. Pressing the emergency off button causes the module input, output, and battery circuit breakers or contactors to open, completely isolating the UPS system from sources of power and transfer of the load to bypass.

System Mimic Panel

Provide a mimic panel in the format of a single-line diagram that graphically depicts whether the load is supplied from the inverter, bypass, or battery. Provide on status on the following:

a. Module on-line, one per UPS module.

b. UPS output protective device status, one for closed (red), one for open (green), and one for withdrawn (amber).

c. Static bypass protective device status, one for closed (red), one for open (green), and one for withdrawn (amber).

d. Static switch status, one for connected (red), and one for disconnected (green).

e. Status on the AC input circuit breaker, battery circuit breaker, and inverter circuit breaker. Connected (red) and disconnected (green).

[2.9 SYSTEM CONTROL CABINET

****

NOTE: This section is for multi-module UPS systems that has a system control cabinet that contains a

single bypass static switch that handles the entire load provided by the multi-modules. Delete for single module UPS Systems and for scalable unit UPS systems.
****

2.9.1 General Description

Provide the multi-module UPS system with a separate control cabinet for system output that contains; bus bar connections to collect the output from each module, the static switch and its bypass breaker, the UPS system output protective device, and the UPS output switchgear.

2.9.2 UPS Output Switchgear

The UPS output switchgear consists of a main protective device feeding the UPS output switchgear critical load bus, a load bank protective device (connected on the line side of the main protective device), a maintenance bypass protective device and associated feeder protective devices for the critical loads.

2.9.2.1 Interlocking

****
NOTE: Delete references to load bank protective device if not used.
****

[The main protective device and the load bank protective device are interlocked to prevent both being closed at the same time.]The maintenance bypass protective device is interlocked with the UPS system output protective device and the static bypass switch. The maintenance bypass protective device is not capable of closing until the static bypass switch is closed and the UPS system output protective device is open. Once the maintenance bypass protective device is closed, the UPS output switchgear main protective device is capable of opening to isolate the critical loads from the UPS output.[The load bank protective device as well as the UPS system output protective device is then capable of closing to permit load bank testing.]

2.9.2.2 Switchgear

****
NOTE: Army only. This is only used on Army projects.
****

Provide the UPS output switchgear in accordance with Section 26 05 73 POWER SYSTEM STUDIES.

][2.10 SELF-DIAGNOSTIC CIRCUITS

****
NOTE: Delete if self-diagnostic circuits are not required. These circuits are normally required in high reliability applications where it becomes critical to identify the faulty circuit card in the shortest time possible. This option is not normally available in off the shelf UPS units.

****

Provide control logic with status indicators for trouble-shooting the control circuits. These indicators are mounted on the circuit card edge or face such that they will be visible without repositioning the card, and are labeled with the function name.

][2.11 REMOTE MONITORING PANEL

****

NOTE: Delete if a remote monitoring panel is not required.

****

Provide a remote monitoring panel to monitor system status. Wall mount the panel near the critical load or as indicated.

2.11.1 Indicators

Provide indicators for the following (minimum):

a. Load on UPS.

b. Battery discharging.

c. Load on bypass.

d. Low battery.

e. Overload.

f. summary alarm.

g. New alarm (to alert the operator that a second summary alarm condition has occurred).

2.11.2 Audible Alarm

Any single indicator turns on the audible alarm. An audible alarm test/reset button and lamp test/reset button is to be included. The alarm on the module is not affected nor reset by the reset button.

]2.12 COMMUNICATIONS AND DATA ACQUISITION

****

NOTE: Delete the communication and data options that are not required. RS-485 port is not supported by some of the UPS manufacturers.

****

Provide an [RS 232][Internet Protocol (IP)][RS 485] communications and data acquisition port. This port allows the system parameters, status, alarm indication and control panel functions specified to be remotely monitored and controlled.

Additionally, provide additional ports for use with the following:

a. Provide the following Form C contacts for remote indication:

    (1) UPS on battery.

(2) UPS on-line.

(3) UPS load on bypass.

(4) UPS in alarm condition.

(5) UPS off (maintenance bypass closed).

b. Provide four spare Form C contacts rated at 120V, 0.5A.

[c. Provide a SNMP (Simple Network Management Protocol) adapter to communicate UPS monitoring via a network or direct connection to [a personal computer (PC)][MODBUS][BACnet].
]
[d. Provide a standard Web Browser adapter to remotely view and monitor UPS functions over the Internet.
]
Provide communication ports and contacts that are capable of simultaneous communication.

[2.12.1 Emergency Control Contacts

****

NOTE: Include this paragraph only when the UPS will be installed in conjunction with a generator/alternate source.

****

Provide normally open contacts to signal when power is supplied to the UPS from engine generators or alternate source. The signal connects to an automatic transfer switch.

]2.13 TEMPERATURE CONTROL

2.13.1 General

****

NOTE: Default is to have the exhaust go out the top. If rack mounted UPS is specified, then choose the option to have a rear exhaust.

****

Ensure cabinet and enclosure ventilation is adequate to operate the components within their ratings. Forced-air cooled rectifier, inverter, and control unit will be acceptable. If UPS input power is lost, then the cooling fans are to continue to operate. Provide redundancy that ensures failure of one fan or associated circuit breaker does not cause an overheat condition. Cooling air is to enter the lower front of the cabinets and exhaust at the [top][rear]. Provide visual and audible alarms on the control panel that indicate blower power failure. Provide replaceable filters on air inlets, which may be located on the inside of the cabinet doors and are easily accessible for replacement.

2.13.2 Blower Power Source

****

NOTE: Select 'output side' for 10-225kVA; select 'input and output sides' for over 225kVA.

****

Provide a blower power source that is internally derived from the [output side] [input and output sides] of UPS module, with automatic transfer arrangement.

2.13.3 Temperature Sensors

Provide temperature sensors to monitor the air temperature. Provide a sensor or sensors to monitor the temperature of rectifier and inverter heat sinks. [Provide separate sensors to monitor the transformer temperature.] Provide critical equipment over-temperature indication that starts a timer that shuts down the UPS system if the temperature does not return below the setpoint level recommended by the UPS manufacturer.

2.14 BATTERY SYSTEM

****

NOTE: Ventilation of storage battery areas is required by NFPA 70. A safe environment for such areas exists where the concentration of gaseous hydrogen does not exceed 2 percent accumulation per unit volume. Factors used to determine this condition are the size and type of battery to be charged; room volume; maximum volume of hydrogen gas emitted during charging; and ventilation rate. Approximately 0.016 cubic foot per hour of hydrogen gas is produced from each fully charged wet cell per charging ampere. Valve-regulated cells typically produce considerably less. Once sufficient ventilation is produced, no need exists for explosion-proof wiring, vapor-proof fixtures, or other special provisions. Mechanical ventilation (an exhaust fan) should be provided in accordance with the battery manufacturer's recommendations.

Battery Room Temperature. Battery system performance may be affected by battery room temperatures above or below the nominal range of 23 degrees C (74 deg. F) to 27 degrees C (80 deg. F). Battery capacity is reduced at lower temperatures and battery life expectancy is reduced at sustained temperatures greater than 30 degrees C (86 deg. F). Batteries should be derated if battery room temperatures are expected to vary more than plus or minus 2 degrees from the standard 25 degrees C.

****

****

NOTE: Refer to UFC 3-520-01, "Interior Electrical System"s for battery types and selection information. UPS systems either use two basic types: wet cell (also called flooded cell) or valve-regulated lead-acid (VRLA). There are two types of VRLA: gel and absorbed glass mat(AGM). Provide AGM type for UPS applications when choosing between gel and AGM.

****

2.14.1 General

****

NOTE: Valve regulated lead acid (VRLA) batteries are predominately lead calcium and should be chosen for most applications. VRLA batteries that are pure lead have longer life when compared to lead

calcium. If considering pure lead, a cost analysis should be performed. Wet cells can be lead calcium, lead antimony or lead selenium with lead calcium the most common. Lead antimony and lead selenium are better for deep cycle applications and should only be considered in areas where there are very frequent power outages e.g. in areas where the battery is normally on a stand-by do not use lead antimony or lead selenium. Lead selenium, or sometimes called low antimony batteries, have a higher cycle capability when compared to lead calcium (5+ times), but not as good a lead antimony batteries (about 70%). Note that lead selenium typically requires less maintenance when compared with lead antimony. If designer wants lead antimony or lead selenium, the choice needs to be added to the wet cell paragraph.

****

****

NOTE: Wet cell batteries require a dedicated room. Small UPS units will typically use the valve-regulated lead-acid type battery. Wet cells can last up to 20 years with proper maintenance. There are two "grades" of VRLA: one for 10 years and one for 20 years. Note that 10 yr batteries typically only get 5-6 years of life in UPS application. If a 20 year VRLA is desired, then a life cycle cost analysis should be performed since the cost can be significantly more than a 10 year VRLA. Refer to UFC 3-520-05, "Stationary Battery Areas" for guidance governing the architectural, mechanical, plumbing and electrical requirements for design of stationary secondary battery installations.

****

****

NOTE: The last option is for modular, expandable scalable cabinet mounted type UPS unit with their associated battery plant.

****

Battery system contains the battery cells, [cabinets,][racks,] battery disconnect, [and battery monitor]. Provide a storage battery with sufficient ampere-hour rating to maintain UPS output at full capacity for the specified duration for each UPS module. Provide a battery that is heavy-duty, industrial design suitable for UPS service. Provide the cells with flame arrestor vents, intercell connectors and cables, cell-lifting straps, cell-numbering sets, and terminal grease. Size intercell connectors to maintain terminal voltage within voltage window limits when supplying full load under power failure conditions. Provide cell and connector hardware that is the type of stainless steel capable of resisting corrosion from the electrolyte used. The battery plant is to consist of the following:

[a. Provide a [lead calcium][pure lead] battery that is of the float-type, absorbed glass mat (AGM) valve-regulated, lead-acid, sealed, non-gassing, recombinant type (VRLA) that is rated for [10][20] years. [Battery is factory assembled in an isolated compartment of the UPS cabinet complete with battery disconnect switch.][Battery is factory assembled in a separate matching cabinet, complete with battery disconnect switch.]

]

[b. Provide a [lead calcium][_____] battery that is of the wet cell (flooded) type. Provide heavy-duty industrial units in styrene acrylonitrile containers suitable for rack mounting. Assembly includes battery disconnect switch, hydrometer syringe, and thermometer with specific gravity-correction scales.

][c. Provide a lead calcium battery that is of the float-type, absorbed glass mat (AGM) valve-regulated, lead-acid, sealed, non-gassing, recombinant type (VRLA) that is rated for 10 years. Provide the UPS battery plant of modular construction made up of replaceable, hot-swappable, fused, battery modules.

]

[2.14.2 Battery Cabinet

****

NOTE: Delete if a battery cabinet is not required. Cabinet or rack could be used for VRLA type batteries. Cabinets are the preferred method when VRLA are used. Racks are used for wet cell type batteries.

****

Furnish the battery pack assembly in a battery cabinet matching the UPS cabinet. Design the battery cabinet to allow for checking the torque on the connections in the battery system and to provide adequate access for annual housekeeping chores. Provide an external wiring interface through the bottom or top of the assembly. Provide a high temperature alarm that annunciates detection of high temperature within the battery cabinet.

][2.14.3 Battery Rack

****

NOTE: Delete if a battery rack is not required. Three tier racks should be used only where floor space is limited. They increase floor loading and make maintenance more difficult. Use battery rack for wet cell batteries.

****

Provide a suitable number of [two-tier][three-tier] racks to fit the room layout shown for the number of batteries provided. Provide a steel battery rack that is protected with electrolyte-resistant paint. Ship the battery rack unassembled with all necessary hardware for assembly. Provide each rack with a complete set with bus bars to accommodate cables from UPS module. Provide bus bar connectors for battery-to-battery connections and high-flex multi-stranded copper cable (ASTM B173 stranding class H) with proper cable supports for connecting top row of batteries to bottom row of batteries at rack ends. Cut end sections to length to prevent wasting floor space.

][2.14.4 Cell-Terminal Covers

****

NOTE: Cell-terminal covers are only for wet cells.

****

Provide acid-resistant transparent cell-terminal covers not exceeding 1.83 meters 6 feet in length and with vent holes drilled on top where needed.

]2.14.5 Battery Disconnect

Provide each battery string with a [circuit breaker][or][fused disconnect switch] provided in a NEMA 250, type 1 enclosure, finished with acid-resistant paint and located in line with the assembly. Provide each switch with line side and load side bus bars for connection to battery cells. Rate each switch [500][_____] V dc, [ampere rating per manufacturer][_____ amperes], 3-pole with interrupting rating as required by system capacity, and provide an external operator that is lockable in the "off" position. [Provide either a wall mounted disconnect or a cabinet mounted disconnecting means for cabinet mounted batteries. Disconnect is allowed to be in the battery cabinet.]

[2.14.6 Modular Battery Enclosures

****

NOTE: Paragraph is for scalable unit UPS systems only. For all other delete.

****

Provide battery enclosures that house draw-out battery cartridges. Battery cartridges are to interlock in place within the battery enclosure to ensure proper contact.

][2.14.7 Seismic Requirements

****

NOTE: Do not use this paragraph for Navy projects. When directed to meet Seismic Requirements, 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT must be edited to suit the project and be included in the contract documents. Edit the following paragraph and include it in the project specification. When a Government designer is the Engineer of Record, provide seismic requirements on the drawings.

****

.Provide a seismic-restraint design for the battery [racks][cabinets], assemblies, subassemblies, and components to include fasteners, supports, mounting and anchorage devises [that conforms to UFC 3-301-01, Section 13 48 73, SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and to Section 26 05 48, SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT][as indicated].

]2.14.8 Battery Monitor

****

NOTE: Provide a battery internal resistance monitoring system on and temperature-compensated charging only on mission critical systems.

For the scalable units UPS systems choose the battery module in the first sentence and for all other systems choose the "string in the system". Also, for the scalable unit UPS system choose the temperature-compensated charging option.

****

Provide a battery monitor for each battery [string in the system][battery module]. Monitor the following minimum parameters by the device:

a. Total system voltage.

b. Ambient room temperature.

c. Minimum of 120 days activity history.

d. Programmable alarm functions..

[e. Battery internal resistance.
]
[f. Temperature-compensated charging. Provide a battery temperature sensing unit to automatically reduce the float charge in response to increases in battery temperature. Set the response per the manufacturer's requirements. Monitor is to only indicate when the temperature compensation circuit is active.
]
[g. Provide a remote monitoring panel.
]
The monitor is to record the total accumulated discharge minutes and accumulated battery system discharge kW hours.

[2.15 BATTERY MONITOR - DISCHARGE

****

NOTE: This monitoring option is available on units that are 225 kVA and larger. If UPS system is smaller than 225 kVA then delete this option.

****

The UPS is to have a specialized battery monitor system that collects and stores data related to discharging the UPS battery. The information is to be displayed on a separate screen available through a menu selection. The system is to collect and retain (minimum of 50 events) the following information for each discharge cycle:

a. System time and date.

b. Duration of cycle.

c. DC bus voltage range.

[d. kW carried by batteries at the start of the event.]

]2.16 HYDROGEN GAS MONITORING SYSTEM

****

NOTE: This system is recommended even when valve-regulated lead-acid batteries are used. These batteries can release high amounts of hydrogen outside the battery if there is a malfunction to the battery charging system and functions as a backup in case the charger does not take itself off line during a malfunction.

****

Provide a hydrogen gas monitoring system to monitor the hydrogen levels in the room. The system is to consist of a [remote monitoring panel,]hydrogen sensor and monitor/control panel. Provide a single gas detector/sensor located to be located [near the UPS batteries][as shown]. When a sensor detects hydrogen gas at a level of 1 percent, the system is to initiate an exhaust fan operation and provide a warning on the control panel[and remote monitoring panel]. When a sensor detects hydrogen gas at a level of 2 percent, the system is to initiate an audible alarm and provide an alarm on the control panel[and remote monitoring panel].

2.17 FACTORY TESTING

****

NOTE: Edited as required for a single module system. The designer should carefully evaluate the UPS application and the user's mission to determine critical tests for the UPS that will ensure UPS/load compatibility. These tests should be conducted at the factory and the results validated prior to shipment to the site. The required UPS/load interaction can be achieved by requesting the following tests plus any other tests the designer deems necessary:

a. Tests to ensure that the UPS rated power factor is verified;

b. Tests to ensure that the UPS system will operate in total accord and support the rated load;

c. Tests to ensure that the UPS system can deal with load anomalies (odd harmonics, etc.) associated with the user's equipment load.

****

Factory test the UPS system to meet the requirements specified using a test battery (not the battery to be supplied with the system) or D.C. simulator. Factory load test the UPS module as an independent assembly with 3-phase ac input power and with battery power for a minimum of 8 hours, with meter readings taken every 30 minutes. Balance the load at rated kVA and rated power factor.

a. Submit a detailed description of proposed factory test and field test procedures, including proposed dates and steps outlining each test, how it is to be performed, what it accomplishes, and its duration, not later than [1][_____] months prior to the date of each test.

b. Run the factory test for each UPS module under full load that is witnessed by the Government. Should a malfunction occur, correct the problem and repeat the test. As a minimum, the factory tests are to include the parameters described in paragraphs ac Input, ac Output, Transient Response and Efficiency. Tests are to encompass all aspects of operation, such as module failure, static bypass operation, battery failure, input power failure and overload ratings.

c. Notify the Government in writing at least 2 weeks before testing. Do not use factory-test time for system debugging and/or checkout. Perform such work prior to notifying the Government that the system is ready for testing. Perform factory tests during normal business hours. Interconnect and test the system for an additional 8 hours to ensure proper wiring and performance.

d. Submit factory and field test reports in booklet form tabulating factory and field tests and measurements performed, upon completion and testing of the installed system. An official authorized to certify on behalf of the manufacturer of the UPS system that the system meets specified requirements will sign the factory and field test reports. Date each report after the award of this contract, which states the Contractor's name and address, name the project and location, and list the specific requirements, which are being certified.

2.17.1 Transient Tests

Conduct transient tests using high-speed oscillograph type recorders to demonstrate the operation of the components to the satisfaction of the Government. These tests consist of 50 percent to 100 percent load changes, manual transfer, manual retransfer, low dc bus initiated transfer and low ac output bus transfer. Use a recording instrument equipped with an event marker.

2.17.2 Efficiency Tests

Perform testing for efficiency at zero output up to 100 percent of stated kW output in 25 percent steps with battery fully charged and floating on the dc bus, with nominal input voltage, and with module connected to represent actual operating conditions.

PART 3 EXECUTION

3.1 INSTALLATION

Conform electrical installations to IEEE C2, NFPA 70, and to requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise. Set the UPS system in place that is wired and connected in accordance with the approved shop drawings and manufacturer's instructions.

3.1.1 Control Cable

****

NOTE: UPS sizes 200 KVA and above are shipped in sections. Control wiring between module sections will be connected by the UPS manufacturer's technical representative.

****

Install UPS control wiring in individual separate rigid steel conduits, unless connections are made between side by side matching cabinets of UPS. Tag control wires with numeric identification tags corresponding to the terminal strip location to where the wires are connected. In addition to manufacturer's requirements, provide four additional spare conductors between UPS module and remote alarm panel in same conduit. When routing control cables inside UPS module, maintain a minimum 155 mm 6 inches separation from power cables.

3.1.2 Grounding

3.1.2.1 Grounding Conductor Title

Provide a separate grounding conductor that is separate from the electrical system neutral conductor in feeder and branch circuits. Ground battery racks and battery breaker cabinets with a separate equipment grounding conductor to the UPS cabinet.

3.1.2.2 Separately Derived

If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic pipe.

3.1.3 UPS Output Conductors

Isolate the UPS output conductors from the UPS cabinet to the critical load panels and from other conductors by installing in separate conduit.

[3.1.4 DC Power Conductors

****

NOTE: Include this paragraph only when batteries are remote from the UPS cabinet.

****

When installed in conduits, place dc power conductors from the UPS cabinet to the battery circuit breaker such that each conduit contains an equal number of positive and negative conductors, for example, two positive and two negative conductors in each conduit. Size conductor for a maximum of 2 percent voltage drop at full discharge.

][3.1.5 Seismic Protection

****

NOTE: Do not use this paragraph for Navy projects. When directed to meet Seismic Requirements, 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT must be edited to suit the project and be included in the contract documents. Edit the following paragraph and include it in the project specification. When a Government designer is the Engineer of Record, provide seismic requirements on the drawings.

****

Provide seismic details[conforming to[Section 13 48 73, SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT][and to][Section 26 05 48, SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]][as indicated].

]3.1.6 Conduit Entries

Ensure conduit entries use the available conduit areas shown on manufacturer's installation drawings. Do not make conduit entries through the front, side or rear panels of the UPS[or Maintenance Bypass Cabinet][or battery cabinet][or battery disconnect enclosure].

[3.1.7 Battery Rack Assembly

****

NOTE: Choose this paragraph if racks are required for the batteries. This is typically required when the batteries are wet cell type.

****

Battery racks are typically shipped dismantled in separate rail, frame, and brace packages. Ensure that manufacturer furnished assembly hardware is used to assemble battery racks. Conform battery rack installation to the manufacturer's instructions.

][3.1.8 Battery Cabinet Assembly

****

NOTE: Choose this paragraph when VRLA batteries are required. Battery cabinets are typically factory assembled on units up to 500 kVA. Battery cabinets for larger units may require assembly at the site.

****

Conform battery rack installation to the manufacturer's instructions.

][3.1.9 Battery Installation

****

NOTE: Delete paragraph and subparagraphs for smaller UPS units that have batteries installed in the unit cabinet by the manufacturer at the factory.

****

Conform battery cabinet installation to the manufacturer's instructions.

]3.2 FIELD QUALITY CONTROL

****

NOTE: The UPS manufacturer's technical representative is required to inspect the completed UPS and battery installation. The representative's visit to the site must be scheduled by the Contractor.

****

Notify the Contracting Officer in writing at least 30 calendar days prior to completion of the UPS system installation. At this time the Contractor, will schedule the UPS manufacturer's technical representative to inspect the completed installation. Provide instruction for activity personnel by the UPS technical representative as specified in paragraph titled "DEMONSTRATION".

3.2.1 Installation Preparation

Completely install the following items by the Contractor and be operational prior to the arrival of the UPS representative for inspection, unit start-up and testing:

a. Ventilation equipment in the UPS and battery rooms.

****

NOTE: In subparagraph b.choose the appropriate item based on what was previously specified.

****

b. Battery [cabinets][racks][modules] and cells.

c. Battery connections including cell-to-cell, tier-to-tier, and rack-to-rack connections, with correct polarity;

d. DC power and control connections between UPS and battery circuit breaker, with correct polarity;

e. DC power connection between battery circuit breaker and battery, with correct polarity;

f. Clockwise phase rotation of ac power connections;

g. AC power to rectifier input bus;

h. AC power to UPS bypass input bus;

i. AC power to UPS maintenance bypass circuit breaker;

j. AC power from UPS output to UPS maintenance bypass output circuit breaker;

k. Remote monitors and control wiring;

l. UPS system and battery system properly grounded;

[m. Emergency shower and eye wash;

][n. Control connections between UPS and emergency engine generator signal contacts;

]

****

NOTE: In subparagraph o. delete the bracketed statement when the project does not require a UPS maintenance bypass cabinet.

****

o. Control connections between UPS module [and UPS maintenance bypass cabinet];

p. Clean and vacuum UPS and battery room floors, battery cells, and UPS equipment, both inside and outside

q. Ensure that shipping members have been removed.

****

NOTE: Provide this option for IEEE 450 certification when wet cell ventilated batteries are used.

****

[r. Provide IEEE 450 battery installation certification.

]

3.2.2 Initial Inspection and Tests

The UPS technical representative and the Contracting Officer, in the presence of the Contractor, will inspect the completed installation. The Contractor is responsible to correct construction or installation deficiencies as directed. Perform acceptance checks in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections, performed in accordance with NETA ATS.

a. UPS Unit visual and mechanical inspection

    (1) Compare equipment nameplate data with drawings, specifications and approved shop drawings.

    (2) Inspect physical and mechanical condition. Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware. Inspect the displays for scratches, dark pixels or uneven brightness.

(3) Inspect anchorage, alignment, grounding, and required clearances.

(4) Verify that fuse sizes and types correspond to drawings.

(5) Verify the unit is clean inside and out.

(6) Test all electrical and mechanical interlock systems for correct operation and sequencing.

(7) Inspect bolted electrical connections for high resistance using one of the following methods:

(a) Use a low-resistance ohmmeter.

(b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(c) Perform thermographic survey.

(8) Verify operation of forced ventilation.

(9) Verify that vents are clear and new clean filters are installed.

(10) Inspect batteries and chargers according to requirements in NETA ATS

b. UPS Batteries visual and mechanical inspection

(1) Compare equipment nameplate data with drawings, specifications and approved shop drawings.

(2) Inspect physical and mechanical condition. Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware. Inspect the displays for scratches, dark pixels or uneven brightness.

(3) Inspect anchorage, alignment, grounding, and required clearances.

(4) Verify that fuse sizes and types correspond to drawings.

(5) Verify the unit is clean inside and out.

(6) Verify the application of an oxide inhibitor on battery terminal connections.

(7) Inspect bolted electrical connections for high resistance using one of the following methods:

(a) Use a low-resistance ohmmeter.

(b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(c) Perform thermographic survey.

3.2.3 Performance Tests

Provide equipment, test instruments, power, load bank, materials and labor required for tests. Contracting Officer will witness all tests and the tests are subject to his approval. Perform tests in accordance with the manufacturer's recommendations and include the following electrical tests.

3.2.3.1 UPS Unit Performance Tests

Upon completion of battery activation procedures, Contractor is to connect load bank to UPS output. Size load bank to the full kW rating of the system.

Performance test is to be run under the supervision of the UPS technical representative. Operate UPS unit under full kW load for a minimum of one hour. Operation of the feeder and bypass power feeder breakers during testing of the UPS is the responsibility of the Contractor.

a. Electrical Tests

  (1) Test static transfer from inverter to bypass and back. Use normal load, if possible.

  (2) Test dc undervoltage trip level on inverter input breaker/relay. Set according to manufacturer's published data.

  (3) Test alarm circuits.

  (4) Verify synchronizing indicators for static switch and bypass switches.

  (5) Perform electrical tests for UPS system breakers.

  (6) Perform electrical tests for UPS system batteries.

    (a) Measure negative post temperature.

    (b) Measure charger float and equalizing voltages.

    (c) Verify all charge functions and alarms.

b. Test Values

Verify bolt-torque levels.

c. Maintenance Bypass Panel/Cabinet

Verify interlocks (Kirk-Key or other means) operate properly. Verify that the breaker arrangement operates in the manner required for the number of possible combinations.

[d. Load Test

****

NOTE: Edit as required, depending upon whether a temporary or permanent load bank is to be provided or if a load bank is required. Small UPS systems are normally not required to have a load bank test.

****

[Provide a load bank that stays with the system.]Load test the installed system for a continuous 24 hour period by means of resistive load banks. Continuously test the system at 1/2 load for 8 hours, 3/4 load for 8 hours and full load for 8 hours. Provide variable load banks sized to the full kW load of system to facilitate startup under load conditions, and to conduct load tests described above. Record instrument readings every half hour for the following:

(1) Input voltage (all three phases).

(2) Input current (all three phases).

(3) Input frequency.

(4) Battery voltage.

(5) Output voltage (all three phases).

(6) Output current (all three phases).

(7) Output kilowatts.

(8) Output frequency.

][e. Full Load Burn In Test

****

NOTE: Delete emergency/alternative source testing requirements if no emergency/alternative source is available. This paragraph may be deleted for small UPS system.

****

Provide an additional full load burn-in period of 24 continuous hours for the installed system. If a failure occurs during the burn-in period, repeat the tests. Record instrument readings every half hour as above. Perform the following tests during the burn-in period:

(1) With the UPS carrying maximum continuous design load and supplied from the normal source, switch [100 percent load][50 percent load] on and off a minimum of three times within [the burn-in period] [_____].

(2) [(2) With the UPS carrying maximum continuous design load and supplied from the emergency source, repeat the switching operations described in step (1). Also, verify that the UPS module rectifier charger unit(s) go into the second-step current limit mode.]

(3) With the UPS carrying maximum continuous design load and operating on battery power, repeat the switching operations described in step (1) above.

(4) Continue operation on battery power for 1 minute, then restore normal power.

Furnish a high-speed dual trace oscillograph to monitor ten or more cycles of the above tests at the ON and OFF transitions and two typical steady-state periods, one shortly after the load is energized (at 30 to 60 seconds) and one after operation has stabilized (at 8 to 10 minutes). Deliver four copies of the traces to the Contracting Officer.

][f. Battery Discharge Test

****

NOTE: This paragraph may be deleted for small UPS system.

****

Allow UPS 24 hrs to recharge batteries and an additional 24 hrs cool down prior to commencing this test, if other tests such as the full load test were performed. With the UPS carrying maximum continuous design load and the battery fully charged, the system is to undergo a complete battery discharge test to full depletion and a recharge to nominal conditions. Record instrument readings every minute during discharge for the following:

(1) Battery voltage.

(2) Battery current.

(3) Output voltage (all three phases).

(4) Output current (all three phases).

(5) Output kilowatts.

(6) Output frequency.

][3.2.3.2 Generator Operation

****

NOTE: Include this paragraph only when the UPS will be installed in conjunction with a generator.

****

Test UPS to observe operation with generator service. UPS technical representative is to verify UPS battery current limiting feature functions properly.

][3.2.3.3 Battery Performance Test (Constant kW)

****

NOTE: This paragraph is applicable for large wet-cell type battery systems. Delete for sealed (valve regulated) battery system.

****

Furnish all labor, material and test equipment necessary to conduct performance test under the direction of UPS technical representative. Accomplish the following:

a. Install a calibrated voltmeter across the battery terminals to measure voltage, and provide current transformers to measure the current from each string.

b. Record temperature of pilot cells in battery immediately prior to start of discharge performance test.

c. Read and record total battery voltage and battery current at start of discharge and every minute during discharge test.

d. Record minutes and seconds when battery voltage drops below minimum discharge voltage. On initial discharge test, a battery may be expected to deliver 95 percent of its rated capacity. This will increase to 100 percent after several complete discharge cycles or after 12 months of float charge service.

e. Should battery fail to meet the requirements of the first discharge performance test, place battery on equalizing charge as defined by the specific battery manufacturer's recommendations. Measure and record time and battery voltage. Run a second discharge performance test.

]3.3 DEMONSTRATION

****

NOTE: Delete recording references if not required.

****

3.3.1 Instructing Government Personnel

Furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors are to be thoroughly familiar with all parts of the installation and be trained in operating theory as well as practical operation and maintenance work. Provide instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. Provide [8][_____] hours of instruction for [_____] personnel.[When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.][record the field training with the recording left with the Contracting Officer.][Provide a factory training video or [on-line training] as part of the training materials.]

3.4 FINAL ADJUSTMENTS

a. Remove load bank and reconnect system for normal operation.

b. Equalize battery per manufacturer instructions.

****

NOTE: Delete this paragraph if battery is sealed (valve regulated) type.

****

[c. Bring electrolyte level of all cells up to the bottom of the high level line by adding original filling gravity electrolyte.

] d. Resume charging battery at normal float voltage as defined by battery manufacturer recommendations.

e. Prior to charging, check battery connections are properly torque to manufacturer's specifications. Take and record, for cell-to-cell and terminal connections, detailed micro-ohm resistance readings. Remake connections having a resistance of more than 10 percent above the average.

f. Deliver all manufacturer's data and operation manuals, which are an integral part of, and shipped with UPS, to Contracting Officer.

3.5 NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.6 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting is to comply with Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 35 43 (August 2021)**
Change 1 - 05/24

Preparing Activity: NAVFAC **Superseding**
UFGS-26 35 43 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC | **UFGS-26 35 43 (August 2021)**
Change 1 - 05/24

Preparing Activity: NAVFAC | **Superseding**
UFGS-26 35 43 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 35 43

400-HERTZ (HZ) SOLID STATE FREQUENCY CONVERTER

08/21, CHG 1: 05/24

****

NOTE: This guide specification covers the requirements for the procurement, installation, and testing of 400 Hz solid state frequency converters.

1) Combination converters (having both "400 Hz and 28 VDC" power outputs) are no longer permitted on Navy projects. When a combination converter is required for a specific Army project, edit the title of the specification to "COMBINATION 400 HERTZ AND 28 VDC SOLID STATE CONVERTER", and select the appropriate bracketed options throughout the remainder of the specification.

2) Previous versions of this specification referred to equipment sized only in kVA at 0.8 lagging power factor. The specification now has the requirement to use kW instead of kVA as the unit of power measurement for converters here and on the project drawings. This is a significant change in equipment designation, intending to ensure that our equipment meets the full required load range, including full power at unity power factor. It has been made to eliminate the problems that have been occurring with existing equipment in the field, and to accommodate the increasing nonlinear load characteristics of Military equipment. NAVAIR documents, including their Facilities Requirements Documents (FRD)s, are being revised to coordinate with this change to kW. Army documents are in the review process.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: These converters are used to supply 400 Hz electrical power to aircraft and ships in shore facility environments. Typical applications include aircraft operating in flight line conditions or in hangars, avionics shops, laboratories, training buildings, flight simulators, and computer rooms.

This specification is not to be used for procurement of power converters installed on board aircraft or ships without specific authorization from Naval Air Warfare Center Aircraft Division (NAWCAD Power and Energy Division (AB43) at (301) 342-4161), and from the Naval Sea Warfare Command (contact the Technical Warrant Officer for the appropriate ship classification).

This specification is not intended for medium-voltage applications.

****

****

NOTE: For Navy projects, incorporate the special SUBMITTAL REVIEW PROCESS paragraph in the SUBMITTALS section. Coordinate with NAVAIR, NAVFAC, and the Activity to see whether the "review and approval", or the "surveillance only" options are required.

1) If "review and approval" (reach-back support) is desired, for a specific NAVFAC project, the technical representative (electrical engineer) editing this document for that project must contact the NAVFAC Atlantic (LANT), Code DC 44 - Electrical Criteria Manager at (757) 322-4327 for consultation during the design stage of the project, prior to including the requirement in the specification.

2) If "surveillance only" is agreed to, it requires the submittal information to be sent to NAVAIR and NAVFAC LANT for review and comment at the same time as the information is being sent to the Designer of Record for Review and Approval. The surveillance mode would give NAVAIR or NAVFAC LANT the opportunity to confirm compliance, without inadvertently holding up the project if the appropriate personnel are not available to do the review in a timely manner.

The Electrical Designer of Record must also insure that the Division 1, Section 01 33 00 SUBMITTAL

PROCEDURES, paragraphs FORWARDING SUBMITTALS REQUIRING GOVERNMENT APPROVAL and SUBMITTALS RESERVED FOR NAVFAC [_____] APPROVAL of the project document are edited to identify the agreed upon special process.

****

****

NOTE: Coordination is required between this section and the project power systems study to determine which of the standardized Arc Flash Warning labels are required on the equipment. These labels (Graphics) are available in metric (SI) and U.S. Customary (IP) system dimensions. Use these files to develop project specific drawings.

File Name	**Description**
ARCFLASH	**Arc Flash Warning Label**

NOTE: To download UFGS Forms, Graphics, and Tables, go to: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Go to the specification section number, select the appropriate Electrical .ZIP file(s) and extract the desired details.

Do not include list of details, or details themselves, in project specifications. Insert the appropriate details on drawings and modify optional and blank items.

****

****

NOTE: The following information must be shown on the project drawings:

1. Show location of all equipment including converter, paralleling controls when required, and remote monitoring and control panels.

2. Provide functional block diagram, single line diagrams, power, and control wiring interconnection diagrams, wiring diagrams, conduit entry diagrams, equipment elevations, maintenance envelope, limiting dimensions, and equipment ratings which are not covered in the specifications.

3. Design equipment rooms with working spaces as required by NFPA 70 and manufacturers extra limitations. Provide ventilation for equipment rooms based on 400 Hz and 28 VDC components heat load generated when operating at 100 percent load. Provide 60 Hz convenience receptacles.

****

****

NOTE: Ensure that the 400 Hz distribution system is

properly coordinated including the ratings of the power cables, ground cables, circuit breakers, transformers, filters, rectifiers, and control equipment. Provide calculations in Basis of Design per UFC 3-501-01, Electrical Engineering, including voltage drops, which can be very critical in 400 Hz systems. When replacing a motor generator set with a solid state converter ensure that the existing feeders circuit protective devices will operate properly without damage to electrical devices, including the solid state converter.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 519	(2022) Standard for Harmonic Control in Electrical Power Systems
IEEE 1159	(2019) Recommended Practice on Monitoring Electric Power Quality
IEEE C2	(2023) National Electrical Safety Code

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60947-4-1	(2023) Low-voltage Switchgear and Controlgear, Part 4-1: Contactors and Motor Starters - Electromechanical Contactor and Motor Starters

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA Z535.4	(2023) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AS5756	(2021; Rev C) Cable, Power, Electrical, Portable
SAE AS5756/6	(2013; Rev A; Stabilized (S) 2013) Cable, 3-Phase Power, Electric, Portable, Multiconductor, 90 Degree C, 600V, Ozone Resistant, Split Phase
SAE AS7974	(2010; Rev A) Cable Assemblies and Attachable Plugs, External Electrical Power, Aircraft

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-32180	(2004) Cable Assembly, Aircraft Electrical Service

MIL-STD-704	(2016; Rev F; Change 1; Notice 3 2021) Aircraft Electric Power Characteristics
MIL-STD-1399-300	(2018) Low Voltage Electric Power, Alternating Current - Part 1

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers
UL 1012	(2010; Reprint Apr 2016; Rev Mar 2021) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

[1.2 RELATED REQUIREMENTS

****

NOTE: Include this optional reference to Section 26 08 00 APPARATUS INSPECTION AND TESTING when it is already being used and referred to for other electrical equipment on the project. Coordinate with optional paragraph in PART 3.

Coordinate converter equipment with Government's cybersecurity requirements and interpretations. Include this optional reference to Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS if the 400 Hz system includes remote control or remote access capability.

****

Section [26 08 00 APPARATUS INSPECTION AND TESTING][and 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS] applies to this section, with the additions and modifications specified herein.

]1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Ensure the optional bracketed "28 VDC Aircraft Power Cable Assembly", and "Remote Monitoring and Control Panel" are not included when those items of equipment are not included in the body of the specification.

****

SD-02 Shop Drawings

Converter Drawings; G, [_____]

SD-03 Product Data

Converter; G, [_____]

Aircraft Power Cable Assembly; G, [_____]

[28 VDC Aircraft Power Cable Assembly; G, [_____]

][Remote Monitoring and Control Panel; G, [_____]

] SD-06 Test Reports

Work Plan; G, [_____]

Routine Factory Test Plan; G, [_____]

Special Factory Test Plan; G, [_____]

Factory Test Schedule; G, [_____]

Routine Factory Tests Certification; G, [_____]

Special Factory Tests Certification; G, [_____]

SD-07 Certificates

Qualifications of Manufacturer; G, [_____]

Nationally Recognized Testing Laboratory (NRTL) Listing; G, [_____]

SD-09 Manufacturer's Field Reports

Field Test Plan; G, [_____]

Field Test Schedule; G, [_____]

Field Test Certification; G, [_____]

Training Syllabus; G, [_____]

SD-10 Operation and Maintenance Data

****

NOTE: Coordinate with options under paragraph OPERATION AND MAINTENANCE MANUALS.

****

Converter O&MM, Data Package 5; G, [_____]

Preliminary Converter O&MM, Data Package 5; G, [_____]

[Remote Monitoring and Control Panel, Data Package 5; G, [_____]

] **

NOTE: On Navy projects, include at least one of the bracketed options below. The first option is for surveillance only, and the second option is for complete approval where "reach-back support" has already been coordinated with either NAVAIR or NAVFAC LANT per the third introductory Technical Note. Add the appropriate information in Section 01 33 00 SUBMITTAL PROCEDURES to coordinate with the special requirements.

****

[1.4.1 Government Submittal Review

[NAWCAD Air Vehicle Electrical Power Systems Group (AB43), (301) 342-4161 [and Code CI44, NAVFAC LANT, Naval Facilities Engineering Systems Command] will provide surveillance. If they have comments or concerns, they will contact and coordinate resolution of their comments with the appropriate approving agent.

] [(NAWCAD Air Vehicle Electrical Power Systems Group (AB43), (301) 342-4161][Code CI44, NAVFAC LANT, Naval Facilities Engineering Systems Command][_____] will review and approve all submittals in this section requiring Government approval.

]1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 5 years prior to bid opening. The 5-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 5-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.2.1 Alternative Qualifications

Products having less than a 5-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.2.2 Material and Equipment Manufacturing Date

Products manufactured more than one year prior to date of delivery to site must not be used, unless specified otherwise.

1.5.3 Converter Drawings

****

NOTE: Provide a detail on the drawings that identifies the location, mounting and permitted maintenance access areas for each converter.

For Navy projects, include the bracketed options that require surface mounting against the wall, and prohibits rear access to converter.

****

Furnish scaled drawings of enclosure outline including front, top, side views, and overall dimensions. Include "maintenance envelope" dimensions confirming space limitations identified on the drawings[, and surface mounting flush against the wall.[Rear access for maintenance and repair purposes is prohibited]]. The "maintenance envelope" drawings must also indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Provide external power and control wiring, cabling, connector, and backplane interconnect drawings. Provide single line, schematic, and wiring diagrams. Drawings must include details of input and output circuit breakers, contactors, rectifiers, surge protectors, control devices and conduit entry and exit locations. If parallel operation is included, provide an interconnection diagram. Submittals must include the nameplate data, size, and capacity.

1.5.4 Qualifications of Manufacturer

****

NOTE: The experience clause in this section has been approved by a Level I Contracting Officer in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS). NFAS can be found at the following link:

https://www.navfac.navy.mil/products_and_services/sb/opportunities/guidelines/navfac.html

This clause may be used without further approval or request for waiver.

****

Submit a certification stating that the manufacturer has a minimum of five years' experience in the design, manufacturing, and testing of 400 Hz solid state frequency converters at the equivalent or greater kW and voltage ratings for direct connection to aircraft electrical loads. When specifications require multiple converters operating in parallel, the manufacturer must provide specific experience with equal or greater kW rated converters.

Experience in manufacturing motor generator sets does not qualify as equivalent. Experience in manufacturing portable engine-driven 400-hertz power units does not qualify as equivalent. The manufacturer must be experienced in producing units for installation in permanent buildings in environmentally closed spaces or in weatherproof enclosures as applicable. The manufacturer must also document that converters are designed for connection to non-linear loads typically encountered in the aircraft and shipbuilding industries. The manufacturer must furnish documented experience with converters in various environmental conditions including exterior flight line, hangar, and environmentally enclosed spaces within buildings.

1.5.5 Work Plan

Submit a written work plan with the initial shop drawing submittal, which consists of a schedule of dates of the routine and special factory tests, installation of equipment, field tests, and operator training for the system. Furnish a list of the test instrumentation equipment complete with the documented calibration program, for the factory and the field tests.

1.5.6 Routine Factory Test Plan

****
NOTE: Coordinate calendar day requirements with Activity and with special review requirements.
****

Submit test plan and procedures at least [21][_____] calendar days prior to the tests being conducted. Provide detailed description of test procedures, including test equipment and setups complete with their current calibration dates, to be used to ensure the converter meets this specification and explain the test methods used. As a minimum, include the tests required under the paragraph ROUTINE FACTORY TESTS.

1.5.7 Special Factory Test Plan

Submit the Special Factory Test Plan and procedures with the Routine Factory Test Plan. Provide detailed description of test procedures, including test equipment and setups complete with their calibration dates, used to ensure the converter meets this specification and explain the test methods used. As a minimum, include the tests required under the paragraph SPECIAL FACTORY TESTS.

1.5.8 Field Test Plan

****
NOTE: Coordinate calendar day requirements with Activity and with special review requirements. For Navy projects, use 30 days to coordinate with NAVAIR requirement to have time to arrange attendance.
****

Submit test plan and procedures at least [30][15][_____] calendar days prior to the start of field tests. Provide detailed description and dates and times scheduled for performance of tests, and detailed description of test procedures, including test equipment and setups of the tests to be conducted to ensure the system meets this specification. List make, model, and current calibration dates, and provide functional description of the test instruments and accessories. Explain the test methods to be used. As a minimum, include the tests required under the paragraph FIELD QUALITY CONTROL. Test reports must include power quality measurement data collected in accordance with IEEE 1159.

1.5.9 Nationally Recognized Testing Laboratory (NRTL) Listing

****
NOTE: Choose the bracketed "Combination" option only for Army projects, and only when the converter also has a separate 28 VDC Power output.
****

[Frequency][Combination] converters must be identified with a nationally recognized testing laboratory (NRTL) label or UL label prior to shipping.

1.5.9.1 Currently Listed Products

Submit NRTL or UL certification or UL file number for the actual [frequency][combination] converter to be shipped with the initial submittal to verify compliance of equipment.

1.5.9.2 Proposed Listed Products

Submit NRTL or UL certification or UL file number for same or similar rating or product size range of like design unit with the initial submittal to verify compliance of equipment.

1.5.10 Routine Factory Tests Certification

****

NOTE: Coordinate calendar day requirements with Activity and with special review requirements. Choose the bracketed "Combination" option only for Army projects and only when the converter also has a separate 28 VDC Power output.

****

Submit within [45][_____] calendar days after completion of tests. Receive approval of test prior to shipping unit. Certify tests were conducted on each [combination] converter in accordance with the requirements set forth in paragraph ROUTINE FACTORY TESTS and certify converter satisfactorily operated within specified limits. Include copies of the test procedures,test configuration diagrams and schematics, test data, and results.

1.5.11 Special Factory Tests Certification

****

NOTE: For Army projects, choose the bracketed "Combination" option only when the converter also has a separate 28 VDC Power output.

****

Certify tests were conducted on a [combination] converter of the same design, construction, kW rating, and voltage rating to be provided. Tests must be in accordance with the requirements set forth in paragraph SPECIAL FACTORY TEST and certify converter operated without malfunctioning within specified limits. Include copies of the test procedures, test configuration diagrams and schematics, test data, and results.

1.5.12 Field Test Certification

****

NOTE: Coordinate calendar day requirements with Activity and with special review requirements. Choose the bracketed "Combination" option only when the converter also has a separate 28 VDC Power output.

****

Submit report of test results as specified by paragraph FIELD QUALITY CONTROL within [15][_____] calendar days after completion of tests. Certify tests were conducted on each [combination] converter in accordance with the paragraph FIELD QUALITY CONTROL and certify converter satisfactorily operated within specified limits. Include copies of the test procedures, test configuration diagrams and schematics, test data, and results.

1.6 OPERATION AND MAINTENANCE MANUALS

****

NOTE: Choose the bracketed "Combination" option only on Army projects and only when the converter also has a separate 28 VDC Power output. Coordinate the 28 VDC options throughout the specification based on the actual equipment required and specified.

****

Submit [frequency][combination] converter Operation and Maintenance Manuals (O&MM) in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.1 Additions to Converter O&MM

****

NOTE: Include the paralleling bracketed option when paralleling has been included as a requirement of the equipment.

****

In addition to requirements of Data Package 5, include the following on the actual converter provided:

a. A "one-line diagram" from the building service entrance panel to the converter and out to the end utilization point(s).

b. A concise, duplicatable, single page data sheet with operating instructions for each unit including startup[, paralleling,] and shutdown procedures.

c. Routine and field test reports.

d. NRTL or UL certification or UL file number.

e. A list of all code required identification and warning signage and labels that have been provided on the converter.

1.6.2 Preliminary Converter O&MM

Prior to scheduling Field Tests, 2 bound copies of a Preliminary O&MM must be submitted to and approved by the Contracting Officer.

1.6.3 Spare Parts Information

Furnish recommended manufacturer's spare parts list, quantities, lead time to receive after ordering, and a schedule of prices,(guaranteed for one year after warranty expires), for each type of converter and other equipment specified in this section. Include the following:

a. Fuses

b. Human Machine Interface (HMI)

c. Indicator lamp/LED

d. Output switching modules

e. Plug-in logic cards

f. Power filter capacitors

g. Power semi-conductors

h. Ventilation system filters

i. 400 Hz Aircraft Power Cable Assembly

[j. 28 VDC Aircraft Power Cable Assembly

]1.7 WARRANTY

The equipment items must be supported by service organizations which are most convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 [FREQUENCY][COMBINATION] CONVERTER

****

NOTE: Do NOT edit this paragraph to specify the internal architecture of the converter (e.g. type of power supply, rectifier type or switching technology to be utilized). Specifying this type of technology may make this a sole source specification which requires justification and approval per federal contract law.

For the options: Choose the bracketed "Combination" option only for Army projects and only when the converter also has a separate 28 VDC Power output. Choose 50 or 60 Hz based on the exterior power distribution system at the project location. Choose 24,000 for the MTBF unless the project has documented, more stringent requirements.

****

Provide [frequency][combination] converter consisting of modular construction solid-state components for [50][60] Hz to 400 Hz [and 28 VDC] conversion, input/output devices, and ancillary control devices. Converter must be a standard product of the manufacturer and the manufacturer's latest design that complies with the specification requirements. The converters provided under this contract must be products of the same manufacturer. Each unit must have a calculated Mean Time Between Failures (MTBF) exceeding [24,000][_____] hours as calculated when the converter is provided with yearly servicing and maintenance. Provide converter with NRTL or UL listing complying with UL 1012. The converter must have minimum 12 pulse, active input rectification circuit or a demonstrated design achieving equal or better performance characteristics. Circuit breakers operating at 400 Hz [and 28 VDC] must be designed and UL tested for [50][60] Hz operation and derated for 400 Hz operation[and 28 VDC operation, as appropriate]. Provide startup and shutdown instructions posted on the front of the unit using engraved plastic or aluminum plate. Provide a plastic encapsulated schematic diagram attached to the inside of the unit in clear view of maintenance personnel.

2.1.1 Electrical Characteristics

2.1.1.1 Input Voltage

****

NOTE: For units 15 kW and below, the input voltage should be 208 volts. For units over 15 kW, the preferred input voltage is 480 volts. Using input voltage other than 480 volts will increase the cost and weight and decrease the efficiency of the converter. Show input voltage on the construction drawings.

Choose 50 or 60 Hz based on the exterior power distribution system at the project location. Choose 10 percent voltage variation unless specific project documents require a higher percentage input variation to be permitted.

A voltage changing transformer is not permitted at the input of the converter unit on any new facilities. Adding a voltage changing transformer at the input is only permitted in the rare case when retrofitting an existing facility and there is no other voltage available. In this exception, remove the last sentence in the section below.

****

[480][208][380][_____] V, three phase, three wire, grounded, [60][50] Hz. Converter must provide rated output voltage when input voltage is varied plus or minus [10][_____] percent. A voltage changing transformer is not permitted at the input of the converter unit

2.1.1.2 Input Power Factor

Between 0.8 lagging and unity, under all conditions of steady state line and load variations specified herein.

2.1.1.3 Surge Protection

****

NOTE: Select Location Category C for outdoor locations only.

****

Provide converter capable of sustaining an input surge described in and tested in accordance with UL 1449, and IEEE C62.41.1 and IEEE C62.41.2, Location Category [B][C], and continue to operate with no alarms within the specified tolerance.

2.1.1.4 Inrush Current

The inrush current must not exceed 100 percent of the rated full load input current.

2.1.1.5 Input Current Distortion

****

NOTE: Where total connected frequency converter load is a small percentage (less than 40 percent) of the total connected facility load, use 12 percent Total Harmonic Distortion (THD) and 8 percent individual. For large frequency converters (e.g. existing systems with 312 kW or larger) or where total connected frequency converter load is a significant percentage of the total connected facility load, use 5 percent THD and 3 percent individual. For installation in shipboard environments using Type 1 power (60 hertz per MIL Std 1399), use 5 percent THD and 3 percent individual.

Note that per NAVAIR request, the converter Special Tests paragraph requires data to be provided at the 25, 50, 75 and 100 percent load points. This is intentionally more stringent than the "full load" requirement below, and is intended for data acquisition only. It will be used to help develop a resolution to known field problems.

****

Input current Total Harmonic Distortion (THD) must not exceed [12][5] percent of the fundamental frequency with nominal input voltage at full load. Individual harmonic content must not exceed [8][3] percent of the fundamental frequency.

2.1.1.6 Output Voltage

****

NOTE: 1) Choose the first bracketed optional paragraph unless a combination unit is required on an Army project.

(a) Select the voltage requirement based on the Activity's location.

(b) Use MIL-STD-704, when 400 Hz power is required to power aircraft avionic equipment. Aircraft equipment is normally operated 200Y/115 V, three-phase, 400 Hz, grounded. Aircraft power monitors are only compatible with 200Y/115 Volts.

(c) If the voltage drop calculations (because of a required location of avionics shop units) are excessive, manufacturers upon request, are able to provide an avionics shop unit with 120/208 VAC output.

(d) Use MIL-STD-1399-300, Part 1 when 400 Hz power is required to power laboratory test benches simulating shipboard environments. Shipboard equipment in simulated shore laboratory environments is normally operated on a 440 V, three-phase, 400 Hz, ungrounded system.

(e) Select the "A-B-C" phase rotation option for MIL-STD-704, and the "AB-BC-CA" option for

MIL-STD-1399-300.

2) Choose the second bracketed "Combination" option only for Army projects when the converter also has a separate 28 VDC Power output.
****

[Provide a frequency converter with a [200Y/115 V, three phase, 400 Hz, grounded][440 V, three phase, 400 Hz, delta connected ungrounded] system, adjustable to plus or minus 10 percent of the rated voltage.

[a. The power characteristics must be within the requirements of MIL-STD-704 with the following clarifications:

(1) The voltage and frequency must be in accordance with the envelope of normal operating range of Figures 3 and 5, not just the limits of Figures 4 and 6.

(2) The steady state voltage must additionally be in accordance with the external power requirements as defined in the MIL-STD-704 Section 4.3, "External Power Source Requirement".

][b. The power characteristics must be within the requirements of MIL-STD-1399-300, Part 1, Type III power.

c. The phase rotation of the output voltage must be [A-B-C][AB-BC-CA] (per Figure 2 in MIL-STD-704, spinning in a counterclockwise direction).

]][Provide a combination converter with both 400 Hz and 28 VDC voltages deliverable simultaneously from the converter on individual outputs.

a. The 400 Hz output must be a 200Y/115 V, three phase, 400 Hz, grounded system, adjustable to plus or minus 10 percent of the rated voltage.

b. The 28 VDC, must be adjustable between 24 and 32 VDC.

[c. The power characteristics must be within the requirements of MIL-STD-704 with the following clarifications:

(1) For the 400 Hz output, the voltage and frequency must be in accordance with the envelope of normal operating range of Figures 3 and 5, not just the limits of Figures 4 and 6.

(2) For the 28 VDC output, the voltage must be in accordance with the envelope of normal operating range of Figure 13, not just the limits of Figure 14.

(3) The steady state voltage must additionally be in accordance with the external power requirements as defined in the MIL-STD-704 Section 4.3, "External Power Source Requirement".

(4) The 28 VDC must additionally be in accordance with the requirements as defined in the MIL-STD-704 Section 5.3.2.4, "Electric Starting".

][d. The power characteristics must be within the requirements of MIL-STD-1399-300, Part 1 Type III power.

] e. The phase rotation of the output voltage must be [A-B-C][AB-BC-CA] (per

Figure 2 in MIL-STD-704, spinning in a counterclockwise direction).

]2.1.1.7 Power Output

****

NOTE: Previous versions of this specification referred to equipment sized only in kVA at 0.8 lagging power factor. The specification now has the requirement to use kW instead of kVA as the unit of power measurement for converters here and on the project drawings. This is a significant change in equipment designation, intending to ensure that our equipment meets the full required load range, including full power at unity power factor. It has been made to eliminate the problems that have been occurring with existing equipment in the field, and to accommodate the increasing nonlinear load characteristics of Military equipment. NAVAIR documents, including their Facilities Requirements Documents (FRD)s, are being revised to coordinate with this change to kW. Army documents are in the review process.

Size units that provide power for aircraft based on the type and number of aircraft to be supplied. Point of Use converters are required.

For Navy Projects, choose the first bracketed option. Use 90 kW for all fixed wing aircraft and use 45 kW for all rotary wing aircraft unless there are specific project design requirements approved by NAVFAC and NAVAIR. (One example, may be the direct replacement of an existing, larger kW converter.)

For Army projects, use the first bracketed option except when a combination converter is required.

****

[Provide a frequency converter rated at [_____] kW at unity power factor.] [Provide a combination converter rated for continuous, simultaneous outputs of [_____] kW of 400 Hz at unity power factor and [_____] amps at 28 VDC. Combination converter must have a [_____] amp 28 VDC starting capacity for one minute.]

2.1.1.8 Load Range

****

NOTE: The intent of the load description below with the 15 percent current THD is to portray a 50 percent linear and 50 percent non-linear load, with a nonlinear load designed to emulate a six pulse rectifier supplying a resistive load. See UFC 3-555-01 App "xx" (Draft in Progress) for an example of the non-linear loadbank schematic. This loadbank would be used to validate factory testing requirements.

****

Converter must operate into a linear load with a power factor between 0.5

lagging and 0.7 leading and into a non-linear load with not less than 15 percent current THD, composed of not less than 6 percent of the 3rd harmonic and not less than 7 percent of the 5th harmonic.

2.1.1.9 Efficiency

****

NOTE: Use the table below to fill in the kW and the minimum efficiency.

Minimum Percent Efficiency		
Rating (kW)	**50 Percent Load**	**100 Percent Load**
5 - 14	**80**	**90**
15 - 39	**86**	**90**
40 - 99	**87**	**91**
100 - up	**89**	**92**

Electromagnetic Interference (EMI) filtering is rarely required, and has been removed from this specification. However, if EMI is needed for a specific project, and is added back into the specification, then for units with power rating larger than 15 kW, reduce the minimum efficiency by 2 percent.

In the rare case when a project is "permitted by exception" to have a voltage changing transformer at the input of the converter, reduce the specified efficiencies by 2 percent.

****

Provide [_____] kW units with a minimum efficiency of [_____] percent at 50 percent load and [_____] percent at 100 percent load.

2.1.1.10 No Load Input Losses

****

NOTE: Above 30 kW, use 7 percent. Below 30 kW, use 9 percent.

In the rare case when a project is "permitted by exception" to have a voltage changing transformer at the input of the converter, increase the specified no load input losses by 2 percent.

****

Provide frequency converter with no-load input losses no greater than [7] [9][_____] percent of the output kW rating.

2.1.1.11 Overload

****

NOTE: For the Navy, include the bracketed 300 percent overload requirement in the table. However, units strictly for avionics shop use do not need the 300 percent requirement.

****

Satisfactory overload operating time is based on no more than one overload of the same or longer conditions, within the following specified time between overloads.

Percent of Full Load	Satisfactory Operating Time	Time Between Overloads
110 percent	60 minutes	4 hours Note: Unit must still be capable of withstanding any of the other conditions for their respective operating times. e.g. Unit can still do 125 percent for less than 5 minutes, before tripping, etc.
125 percent	5 minutes	10 minutes
150 percent	2 minutes	10 minutes
200 percent	20 seconds	5 minutes
[300 percent	4 seconds	5 minutes]

After minimum operating time is achieved, unit must interrupt output power. Unit must be capable of sustaining the overload without damage until the protective device interrupts the overload.

2.1.1.12   Short Circuit

When a bolted line-to-line fault or a bolted three phase fault is applied to the unit, unit must be capable of sustaining the short circuit current without damage until the protective device interrupts the fault.

2.1.1.13   Crest Factor

The voltage crest factor must be between 1.31 and 1.51 over the entire load range in accordance with MIL-STD-704. The crest factor is the ratio of the peak value to the root mean square (RMS) value for each half cycle of the voltage waveform measured over a one second period under steady state conditions. Provide the crest factor for each condition in the paragraph LOAD RANGE.

2.1.1.14   Output Voltage THD

****

NOTE: The values indicated below meet MIL Std 704 requirements. Specifying lower percentages of THD requires more stringent power quality, may be a significant cost addition, and should only occur when a specific installation has different documented power quality requirements.

****

a. Balanced load:

(1) Output voltage THD: Not to exceed [3][_____] percent line-to-line and line-to-neutral for linear loads as specified in the paragraph LOAD RANGE.

(2) Output voltage THD: Not to exceed [5][_____] percent line-to-line and line-to-neutral for non-linear loads as specified in the paragraph LOAD RANGE.

(3) Maximum single harmonic distortion: Not to exceed [2][_____] percent of the fundamental at the nominal voltage for linear loads as specified in the paragraph LOAD RANGE.

(4) Maximum single harmonic distortion: Not to exceed [3][_____] percent of the fundamental at the nominal voltage for non-linear loads as specified in the paragraph LOAD RANGE.

b. Unbalanced load: Output voltage THD not to exceed 4 percent, line-to-neutral with 15 percent unbalanced linear load.

2.1.1.15 Output Voltage Amplitude Modulation

Provide output voltage amplitude modulation not exceeding 1/2 percent of nominal voltage at no load to full load.

[2.1.1.16 Voltage Regulation for Combination Converters with Multiple Outputs

****

NOTE: Combination Converters and Dual output converters are not permitted for Navy Projects. Navy requirement is for individual Point of Use Converters (PUCs).

For Army projects:

1) Dual output 400 Hz converters are no longer permitted.

2) When a combination converter (400 Hz and 28 VDC) is specified, verify with the Activity whether the converter will have a "simultaneous" or a "non-simultaneous" rating.

Include this voltage regulation option when the unit is required to simultaneously provide individually regulated power to each of the different voltage outputs (400 Hz and 28 VDC). It may add significant cost and size to the converter.

(a) Simultaneous regulation ensures that the voltage at the end of output A does not change if: Output B is turned on or off; or if there is an increase or a decrease in the load on output B. This would not apply to system overloads and short duration transients.

(b) "Non-simultaneous" regulation applies where

either the rated 400 Hz Output or the 28 VDC output is available and regulated, but not both at the same time.

****

For combination converter systems that provide 400 Hz and 28 VDC power each output must have isolated voltage regulation. The output voltage measured at the end of one servicing cable must not rise or fall as a result of any change in status of additional outputs (e.g. second output goes from ON to OFF, OFF to ON, or increase/decrease in applied load.) Voltage fluctuations as a result of short duration transients (non-steady state limits/times in accordance with MIL-STD-704) are exempt from this requirement.

]2.1.1.17   Frequency Stability

Control output frequency of the 400 Hz converter within plus or minus 0.5 percent for all operating conditions, including maximum and minimum specified input voltages, ambient temperature and relative humidity. The frequency regulation must operate independent of supply frequency and load changes.

2.1.1.18   Phase Angle Regulation

Displacement angle between adjacent voltage phases must be 120 degrees plus or minus 2 degrees with balanced load and plus or minus 4 degrees with three phase 15 percent unbalanced load. A 15 percent unbalanced load is defined as any combination of phasing where:

a. Phase A at full rated single phase load.

b. Phase B at 85 percent of Phase A.

c. Phase C at 85 percent of Phase A.

2.1.1.19   Transient Output Voltage Recovery

****

NOTE: Use MIL-STD-704, when 400 Hz power is required to power aircraft avionic equipment.

Use MIL-STD-1399-300, when 400 Hz power is required to power shipboard equipment.

****

[In accordance with MIL-STD-704.][In accordance with MIL-STD-1399-300 for Type III power.]Monitor and record output voltage at the load end of the cable.

2.1.2   Environmental Rating

****

NOTE: Select 55 degrees C 130 degrees F (ambient temperature rating unless in areas subject to extreme temperatures (e.g. Middle East or desert environments). Use 0-95 percent relative humidity unless extreme condensation such as in a jungle climate.

Use 915 meters 3000 feet level unless location of installation will be at higher elevations.
****

The converter must be rated for continuous operation from no load to rated full load under the following conditions:

a. Ambient temperatures ranging from -20 to [55][60][65] degrees C. -4 to [130][140][150] degrees F.

b. Relative humidity from [0 to 95] [_____] percent noncondensing.

c. Ambient pressures from sea level to [915] [_____] meters [3,000] [_____] feet.

2.1.3 Monitoring and Control Panel

Provide converter with a control panel that is equipped with the following controls, indicators, instrumentation, data logging, diagnostics, and alarm functions.

2.1.3.1 Controls

Controls must be mounted on the front of the control panel, accessible without opening any doors or covers. Specific sequencing, or the requirement for simultaneous pushbutton operation, is not acceptable for any input or output control.

****
NOTE: Include the remote control panel option when unit is platform mounted or located out of sight of aircraft.
****

a. Start/stop pushbutton for input device control (circuit breaker or contactor).

b. Lamp/light emitting diode (LED) test - A push-to-test button or switch to test indicator lamps/LEDs. If panel lights all blink as part of the startup Built-in-Test (BIT) sequence, then a separate push to test button is not required.

c. Emergency power off - A separate pushbutton for emergency power off.

d. Output device ON/OFF.

e. Alarm silence and "silence" indicator - A switch that must disable the audible alarm without clearing the alarm codes.

f. Additional individual controls for the following functions (Note - these may be included as part of the Human-Machine Interface (HMI) as described in paragraph HUMAN MACHINE INTERFACE REQUIREMENTS):

g. - Output voltage adjust

h. - Alarm reset - resets and clears the silenced audible alarm.

2.1.3.2 Indicators

a. The following are mandatory indicators. They must be included on the control panel on the exterior of the unit[, and on the exterior of the remote control panel] in addition to any that are included in the HMI:

b. - Input power available - Lamp/LED to indicate that the supply voltage is available.

c. - Output power On/Off - Lamp/LED to indicate that the converter output voltage is available.

d. - Output device "ON".

e. - Audible alarm.

f. - Aircraft interlock bypass - Lamp/LED to indicate that the Aircraft Interlock has been bypassed.

g. In addition, include the following additional indicators, if they are not included in the HMI:

h. - System alarm - Lamp/LED to indicate that a fault has been detected. This indicator must be latched in the "ON" position whenever an alarm condition described in paragraph ALARM ANNUNCIATOR, is detected and must remain "ON" until the alarm reset pushbutton is pressed.

i. - Indicating lamp/LED to indicate that the alarm silence switch is in the disable position.

j. - Elapsed time meter in hours; (may be internal or visible externally).

2.1.3.3 Human Machine Interface (HMI) Requirements

****

NOTE: For rarely used delta output frequency converters, delete the phase-to-neutral voltage requirement below.

****

Provide an HMI with a minimum of four by twenty (4 x 20) character backlit LED display for presenting the digital instrumentation, diagnostic system, and fault indicating system data. The HMI must be rated for harsh environments.

a. Digital Instrumentation. Provide true RMS, plus/minus one percent accuracy, microprocessor-based readings that include the following functions:

(1) Output phase-to-phase voltage.

(2) Output phase-to-neutral voltage.

(3) Output phase current.

(4) Output frequency.

(5) Inverter temperature. This function is desired for field diagnostics, but is not mandatory.

b. Alarm Annunciator. The unit must be capable of detecting and displaying the following abnormal conditions:

   (1) Input overvoltage.

   (2) Input undervoltage.

   (3) Output undervoltage.

   (4) Output overvoltage.

   (5) Output overload.

   (6) System alarm.

   (7) Control logic failure.

   (8) Over-temperature.

   (9) Logic power supply failure.

2.1.4 Input/Output Devices

****

NOTE: Coordinate 50 Hz vs 60 Hz requirement with Activity. Provide appropriate short circuit ratings in accordance with Basis of Design Calculations per UFC 3-501-01, "Electrical Engineering".

****

Provide fully-rated, three-pole, UL approved devices for control of [60][50] Hz input and 400 Hz output from the converter. Derate devices and cables operating at 400 Hz in accordance with IEEE 519.

2.1.4.1 Input Device

Provide converter with a UL listed input device (circuit breaker conforming to requirements of UL 489 or contactor) as an integral part of the converter. Device must be operable from the front of the converter. Device must have a short-circuit current rating of [_____] amperes symmetrical minimum.

2.1.4.2 Output Contactor

****

NOTE: Include option for IEC on Oconus projects.

****

Provide converter output with an automatic magnetically-held contactor with interlock circuit. Output contactor must have sufficient capacity to handle rated load, overload, and available short circuit current. Contactor must open when any circuit identified in the paragraph SAFETY FUNCTIONS causes the system to shut down. Electrically interlock contactor with ON/OFF circuitry so that when the frequency converter is shut down, the contactor opens immediately and remains open.[Conform to the requirements of IEC 60947-4-1.]

[2.1.4.3 Output Circuit Breaker

****

NOTE: Only add an output circuit breaker, (and delete the OUTPUT CONTACTOR paragraph above), if the converter is supplying a downstream distribution panelboard (such as in a shop or laboratory), or multiple outputs with distribution internal to the converter. Include the 28 VDC bracketed option only on Army projects with combination converters.

****

Provide converter output(s) with non-automatic manual circuit breaker(s), with appropriate frame size and a shunt trip coil derated for 400 Hz [and 28 VDC] operation. Trip circuit breaker by the unit's OFF circuit [local or remotely activated] and when any circuit identified in the paragraph SAFETY FUNCTIONS causes the system to shut down. Output breaker(s) must be operable from the front of the unit.

]2.1.4.4 Aircraft Interlock Circuit

****

NOTE: Coordinate with paragraph AIRCRAFT POWER CABLE ASSEMBLY.

1) For all new installations, use the first bracketed option; "Provide a Split F Type safety insertion interlock ..." in the first paragraph, and use the Split F option in item b.(1) "Normal...". See UFC 3-555-01 (Draft in Progress) and MIL-DTL-32180 for technical information and typical details and schematics on the operation of the interlock.

2) When the aircraft cable specification is used for existing converters, coordinate with the Activity to ensure they understand the new safety requirements in the UFC 3-555-01 (Draft in Progress) and have appropriate Standard Operating Procedures (SOPs) in place, per UFC 3-560-01, Operational and Maintenance: Electrical Safety" for the remainder of their existing equipment.

3) The 1997 NATO document "STANAG 7073", (titled Connectors for Aircraft Electrical Servicing Power) requires the EF pin to be jumpered in the ground servicing cable connector. The use of the Split F Insertion Interlock will meet that requirement.

For the Air Force: When involved with certain "Legacy" Air Force Aircraft, they may use the "STANAG" Alternate connection circuit, and the 28 VDC may need to be changed to utilize one of the 115 V, 400 Hz phases instead. Coordinate with the Activity to confirm requirements.

****

[Provide a Split F Type safety insertion interlock system (with the contacts integral to the cable head) in accordance with MIL-DTL-32180.

Utilize a control signal established by the converter to determine whether the servicing cable connector is installed to the aircraft or not. The converter control system must prevent the output control device from closing if the 28 VDC signal is not present. If the converter output control device is closed when the 28 VDC signal is lost, the converter control system must remove the 400 Hz power from the output servicing cable connector within 100 milliseconds. This 28 VDC control signal must not be referenced to the aircraft and cannot affect components on the aircraft.

][Provide interlock system that determines the presence or absence of the 28 VDC feedback signal from the aircraft. If the 28 VDC signal is not present within 5 seconds after initially closing the output disconnect, open the output disconnect. Once the interlock signal is received and the system is in operation, if the interlock signal is lost, the converter control system must remove the 400 Hz power from the output servicing cable connector within 100 milliseconds.

] a. Converter must contain terminal block points for the connection of two wires from the aircraft cable assembly for the interlock circuit (sized to accept No. 18 and No. 12 AWG). Interlock circuit must not draw more than 20 milliamperes from the aircraft's 28 VDC circuit.

b. For field testing purposes, provide a switch inside the converter with two positions:

  (1) Normal - [Converter relying on signal from Split F connecter][For aircraft loads].

  (2) Bypass - For testing with dummy load or no load, or for use with aircraft with no 28 VDC. This switch needs to be "Inside" or "located within the HMI functions". It must be out of sight except for specific maintenance purposes.

2.1.5 Safety Functions

2.1.5.1 400 Hz Power Source

The 400 Hz power source internal buss must automatically discharge to below 30 VAC within 5 seconds after the following:

a. 400 Hz power source has been turned off.

b. Whenever any access panel is opened on the equipment. Under this condition, the interlock circuitry must open the input device and the 400 Hz output device, and not allow the input or output device to close. For maintenance purposes, provide an internal bypass switch to defeat the interlock circuitry.

c. Detection of system fault that results in a converter shut down condition, including the following:

  (1) Input undervoltage.

  (2) Input overvoltage.

  (3) Loss of phase (input or output).

  (4) Loss of input power.

2.1.5.2 400 Hz Output Cable

The 400 Hz power must be removed from the output cable within 100 milliseconds after one of the following occurs:

a. Receiving a stop command.

b. Loss of 28 VDC control signal.

c. Detection of a fault that results in an output shut down, including the following:

    (1) Output overvoltage - Protect by tripping output devices for instantaneous overvoltage of 30 percent or more and for 10 to 30 percent overvoltage lasting more than 0.25 seconds.

    (2) Output undervoltage - Protect by preventing the closing of the output disconnect until the output voltage is 95 percent of the rated output. If, after closing, the voltage decreases to below 90 percent for longer than 5 seconds, provide relaying to trip output devices utilizing a field-adjustable time-delayed circuit with a range of 4 to 10 seconds.

    (3) Output frequency - Protect by tripping output devices for frequency change in excess of plus or minus 5 percent of the rated output frequency (400 Hz).

    (4) Output overload.

    (5) Converter overtemperature protection.

2.1.6 Automatic Line Drop Compensation

Provide automatic line drop compensation from zero to ten percent; adjustable internally.

[2.1.7 Paralleling

****

NOTE: This is an additional cost item and should not be specified unless specifically requested by the user. Coordinate with the Activity on desired load sharing percentages, and on whether or not the manual paralleling bracketed option is needed.

****

Provide frequency converters capable of being paralleled. Paralleled units must be the same manufacturer and model number. Regulate and control units operated in parallel by a master unit. Design controls associated with paralleling of the units such that each frequency converter can operate as a stand alone unit, or as either a slave or master unit in a parallel system. Units must parallel and synchronize within a 50 millisecond recovery time. Share the total load equally within plus or minus [5][_____] percent by each unit. If paralleling for redundancy, failure of one system must not affect the other system(s).[Provide manual paralleling which permits a paralleled unit to be added or removed from the system without interrupting the operation of other units.]

][2.1.8 Auto Restart

****
NOTE: Auto restart should be considered when the converter is installed in a remote location that is not readily accessible to operating personnel and maintaining 400 Hz power is critical to operations. Use of auto restart should be studied carefully to ensure that it does not create a potential personnel safety hazard.

This is an additional cost item and should not be specified unless specifically requested by the user.
****

After a total input power outage the unit must be capable of automatically restarting and re-energizing loads upon restoration of normal power. Provide units with a manual/auto restart switch and with backup battery power supply if it is needed to meet the auto restart requirement. When interlock circuit has been interrupted or when interlock is in the maintenance position (manual restart), the system should not restart.

][2.1.9 Built-In Test Equipment

****
NOTE: Built-in test equipment (BIT) should be considered when the converter is installed in a remote location that is not readily accessible to operating personnel and maintaining 400 Hz power is critical to operations. It may also be needed when high reliability is a defined concern.

This may be an additional cost item and although some manufacturers include it at no cost, it should not be required unless specifically requested by the user.
****

Frequency converter must include Built-in test equipment(BIT), which monitors both primary circuits and protection circuits of the unit. Provide visual indication to assist diagnosis of unit failures to a modular level. Provide visual indication of converter status using cabinet mounted light emitting diodes and Human Machine Interface (HMI). As a minimum the indicator lights must include a "machine on" light, and an "output faulted" indicator light that comes on when the unit has shut down.

]2.1.10 Magnetic Components

****
NOTE: Magnetic components are used within the converter unit. Do not delete this information. It is not included to imply permission to utilize transformers for modifying the input voltages to the converter.
****

Provide Class 180 power magnetic transformer and inductors in accordance with NEMA ST 20 and UL 506. The limits of Class 180 must not be exceeded at the maximum specified ambient temperature and at 100 percent load.

2.1.11 Acoustical Noise

****

NOTE: The following table serves as a guide for establishing the maximum allowable sound pressure level for each kW rating. The designer should take into consideration that converters are inherently noisy when physically locating the unit. Per manufacturers, 72 dBa is standard across the range of converters we specify.

Specifying one of the optional "Manufacturers Lowest Attainable - Maximum Acoustical Noise Values", which per the table below is possible, will have an additional cost associated with it.

Acoustical Noise Table

Rating (kW)	Mfrs Standard - Maximum Acoustical Noise Values (dBa)	Mfrs Lowest Attainable - Maximum Acoustical Noise Values (dBa)
5 - 14	72	65
15 - 39	72	65
40 - 99	72	68
100 - 249	72	72
250 - up	72	

NOTE: Do not go below the table values, unless specifically required by the Activity because of the location of the frequency converter, and unless the new values have been confirmed by multiple manufacturers as attainable.

If any value different than 72 dBa is used, include the "optional Acoustical Noise Test" in paragraph SPECIAL FACTORY TESTS, to verify that the equipment furnished meets the more stringent requirement. The test parameters (height and range) are included in that paragraph.

****

Provide unit with a maximum continuous acoustical noise level less than [72][_____] dBa (A weighted scale).

2.1.12 Assembly Construction

****

NOTE: Per manufacturers, all converter enclosures require ventilation. Per NEMA 250 Tables 1 and 2, only NEMA Types 1,2,3R and 3RX are permissible to be ventilated. Verify availability by multiple

manufacturers before using other enclosure types.

When location is outdoors, include the appropriate outdoor location coating and painting options.

When location is indoors, in item a:
- For Navy and Air Force, choose first option requiring flush wall mounting.
- For Army, choose second option and identify if pedestal mounted in hangars or floor mounted in lab or other locations.

****

Provide enclosures suitable for [indoor][outdoor][corrosive][_____] environments in accordance with NEMA 250, Type [1][2][3R][3RX]. Arrange to provide required louvers, cooling air, entry and exit provisions for equipment within enclosures.

a. [Units must be mounted flush against the wall, must not require back access for maintenance, and must comply with the "Maintenance Envelopes" identified on the drawings.][Units must be [pedestal][floor] mounted as indicated and comply with the "Maintenance Envelopes" identified on the drawings.]

b. Construct unit(s) so that components, with the exception of control and monitoring components, are totally enclosed within the enclosure. Electronic circuits including power circuits must be modular construction readily accessible for maintenance, repair and module replacement from the front of the enclosure.[For units installed outdoors or in corrosive environments, [provide a conformal (rust-inhibiting) coating for the printed circuit boards][enclose electronic circuits in a sealed electronics compartment that is not provided with direct cooling ventilation or forced air cooling].]

c. Provide permanent identification tags for wiring. Uniquely identify each wire. Use the same identification system in the wiring diagrams in the Operation and Maintenance Manual. Enclosures must be painted in accordance with paragraph FACTORY APPLIED FINISH and as specified herein. Provide each enclosure with a finish coat over a rust inhibiting substrate or a substrate that has been provided with a rust inhibiting treatment.[For outdoor enclosures, if the unit is not painted using the powder coating process, provide two finish coats on the unit.]

d. Provide units with a Mean Time To Repair (MTTR) of 30 minutes from the time of the diagnosed failure based on documented manufacturer's historical data for the average time of repair for their top ten faults. Provide the supporting data with the equipment submittal.

2.2 AIRCRAFT POWER CABLE ASSEMBLY

****

NOTE: Coordinate with paragraph AIRCRAFT INTERLOCK CIRCUIT. Banded cables are not permitted for 400 Hz systems due to excessive phase unbalance and voltage drop.

NOTE: For the Army:

1) Coordinate the cable amperage and length for the aircraft on the project.

2) Include the bracketed 28 VDC cable option when a combination converter, with an additional 28 VDC output, is part of the project.

NOTE: For the Navy:

1) Use the 260 Amp and 32 meters 105 feet length options for all cable assemblies with the 90 kW converters, and the 180 Amp 32 meters 105 feet length for all 45 kW converters, unless the project requirements given to the designer of record specifically identify that the 27 meters 90 feet feet length is sufficient.

2) Delete the 28 VDC option. Combination 400 Hz and 28 VDC Converters are no longer permitted. Individual 28 VDC Converters are required. Contact NAVFAC Atlantic, Code DC 44 - Criteria Manager at (757) 322-4327, for a draft 28 VDC specification that can be modified for the specific project.

****

Comply with SAE AS7974. For 400 Hz wiring at 200Y/115 volts, provide 7-conductor type cable configured as 6 phase conductors (2xA, 2xB, 2xC) tightly wound around the center located neutral, twisted and single jacketed in accordance with SAE AS5756/6. Rate cable for [260] [180] amperes. Cable length must be [32 meters] [27 meters] [_____] [105 feet][90 feet] [_____]. Provide control cabling included within the jacket for interlock circuit. Terminate control wiring on accessible terminal blocks in unit. Provide cable assembly with integrally molded 400 Hertz connector capable of connecting to the aircraft 6 pole receptacle. Provide cable/connector assembly suitable for severe duty, with crimped contact terminations. Banded cables are not permitted.

[2.2.1 28 VDC Aircraft Power Cable Assembly

For 28 VDC wiring provide 2-conductor cable assembly, banded in 600 mm 2 feet intervals maximum, in accordance with SAE AS5756. Provide cable assembly with integrally molded 28 VDC female connector aircraft plug in accordance with SAE AS7974.

][2.3 REMOTE MONITORING AND CONTROL PANEL

****

NOTE: Delete this paragraph unless plans clearly indicate requirement for remote monitoring and control panel.

****

Provide remote monitoring and control panel and circuitry. Connect to clearly and permanently labeled terminal blocks located inside the converter's enclosure. Provide the circuitry such that indicator lamp/LED information and control function(s) can be extended from the terminals to a remote location in the future.

a. Pushbutton or switch for de-energizing the output terminals.

b. Indicator lamp/LED showing the unit status (energized or not energized).

c. Indicator lamp/LED showing the output control device position (open or closed).

d. System alarm.

]2.4 MANUFACTURER'S NAMEPLATE

Each frequency converter, each major component within the frequency converter, and each item of other equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.5 FACTORY APPLIED FINISH

****

NOTE: This paragraph covers only the basic painting requirements for most electrical equipment. Include any special finishes for high or low temperatures and extremely corrosive atmospheres. Use manufacturer's standard color unless the Activity requires a special color.

****

Electrical equipment must have factory-applied painting systems which must, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements as specified herein. Interior and exterior steel surfaces of equipment enclosures must be thoroughly cleaned and then receive a rust-inhibitive phosphatizing treatment, a primer powder coat, or equivalent treatment prior to painting. Exterior surfaces must be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces must receive not less than one coat of corrosion-resisting paint or powder coating process in accordance with the manufacturer's standard practice. When enclosure is aluminum, interior may optionally be coated with rust inhibiting treated film. Exterior surfaces must be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish, or finished with a powder coating process.[Color must be the manufacturer's standard color.][Equipment located indoors must be ANSI Light Gray,[and equipment located outdoors must be ANSI[Light Gray][Dark Gray]].] Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.6 SOURCE QUALITY CONTROL

2.6.1 Factory Test Schedule

****

NOTE: For the Army: Choose the bracketed "Combination" option (throughout the specification) only when the converter also has a separate 28 VDC Power output.

****

The Government reserves the right to witness tests and reserves the right to request the raw data from the tests whether witnessed or not. Provide the [frequency][combination] converter test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

Test Instrument Calibration.

a. The manufacturer must have a documented calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. The accuracy must be directly traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule must not exceed 12 months for both test floor instruments and leased specialty equipment.

d. Provide dated calibration labels, that are visible on all test equipment.

e. Calibrating standard must be of higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

    (1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

    (2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.6.2 Routine Factory Tests

****

NOTE: Include the bracketed option, "As an exception..." when there are multiple, identically sized (in kW) converters on the same contract. Intent is to only do the "automatic line drop compensation test" on the first converter.

In item c, the aircraft power cable assembly is normally included in the project. If for some reason it is not part of the contract, modify the item and provide additional appropriate cable information (e.g. length and type) that the manufacturer should use for tests.

****

Perform routine tests by the manufacturer at the factory, on each of the actual [frequency][combination] converter(s) prepared for this project to ensure that the design performance is maintained in production.[As an exception, test automatic line drop compensation on only one unit on multiple unit orders of the same kW rating. If there are multiple units with different kW ratings, then testing one of each of the kW ratings is acceptable.] Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Include a list of the current test equipment calibration dates. Required tests, test conditions, and testing sequence is as follows:

a. For tests which require full load, use 1.0 power factor unless otherwise noted.

b. All measurements must be true RMS measurements. Obtain measurements in accordance with IEEE 1159. Monitor and record all data at the load end of the cable.

c. Connect loads to the converter with the specified aircraft power cable assembly.

d. No adjustments to the frequency converter are allowed between load tests.

2.6.2.1 Test Conditions

Tests must include the following conditions:

a. Initial Safety Verification: Perform tests and checks to validate the safe and timely shutdown for each condition (for the power source and the output cable) identified in paragraph SAFETY FUNCTIONS.

b. Input current and power factor: Operate converter at low, nominal and high input voltage at full load. Measure and record input voltage, input power factor and input current in each phase.

****

NOTE: The non-linear load tests below are based on the requirements in the paragraph LOAD RANGE. The intent of the required 15 percent current THD in LOAD RANGE is to portray a 50 percent linear and 50 percent non-linear load, with a nonlinear load designed to emulate a six pulse rectifier supplying a resistive load. See UFC 3-555-01 Specialty Power Systems (Draft in progress) for additional information.

****

c. Output voltage, output voltage THD, output current, output power factor, and voltage regulation. Operate converter at nominal input voltage unless otherwise specified.

    (1) 50 percent of rated capacity with 0.8 lagging power factor linear load.

    (2) 100 percent of rated capacity with 0.5 lagging power factor, 0.8 lagging power factor, 1.0 power factor, and 0.7 leading power factor linear loads.

    (3) 50 percent of rated capacity with the non-linear load as specified in the paragraph LOAD RANGE.

    (4) 100 percent of rated capacity at low and high input voltage.

    (5) 100 percent of rated capacity with the non-linear load as specified in the paragraph LOAD RANGE.

(6) Note - Operate for not less than 10 minutes at each test condition in (1), (2), (3) and (4) above, and for not less than 30 minutes at test condition in (5) above.

(7) Note - Monitor and record each of the following at the beginning and end of each test condition: output voltage, output voltage waveform, output voltage THD, output voltage distortion spectrum, output voltage crest factor, output current, output current waveform, output current distortion spectrum, output power factor and frequency. Verify output remains within specified regulation limits.

d. Efficiency: Operate at nominal input voltage at half load and full load at 1.0 power factor. Measure and record input voltage, input current, input power factor, output voltage, output current, and output power factor. Calculate the unit efficiency.

e. No load losses: Operate at no load and nominal input voltage. Measure and record input voltage, input current, input power, input power factor, and output voltage. Calculate the no load losses.

f. Overload: Operate at nominal input voltage and output voltage with loads and in sequence listed below:

****

NOTE: For the Navy:

1) Include the bracketed 300 percent overload requirement in the table. However, converters strictly for avionics shop use do not need the 300 percent requirement.

2) Coordinate with NAVAIR (POC information is at front of specification), to see if the NAVAIR Digital File Information has been completed before including the bracketed documentation option.

****

Percent of Full Load	Time	Time Between Overloads	Iterations
[300 percent	4 seconds	5 minutes	3]
200 percent	20	5 minutes	1
150 percent	2 minutes	10 minutes	1
125 percent	5 minutes	10 minutes	1
110 percent	60 minutes	4 hours	1

g. Monitor output to confirm there is no 400 Hz power interruption. After minimum operating time is achieved, unit must interrupt output power. Provide voltage and current waveforms [in accordance with NAVAIR Digital File Information] documenting the unit's response for each test.

****

NOTE: Utilize the identified burn-in hours, unless a validated reason has been identified by the Activity (such as a requirement for a higher uptime confidence limit) to either reduce or increase the number of hours.

The last sentence in the BURN-IN TEST paragraph permits not using the Aircraft power cable assembly that has been mandated for all the other tests. This exception has been added because the specified cable may not withstand the current draw for this length of time without overheating.
****

h. Burn-in Test: Before delivery, burn-in all units[under full load conditions at 1.0 power factor for at least [24][_____] hours][by cycling units [6][_____] hours "ON" under full load conditions and [3][_____] hours "OFF" at no load conditions for at least [4][_____] complete "ON" cycles]. Perform burn-in test with the converter enclosure doors closed, load connected directly to the output terminals, and all ventilation in the final operating condition. The specified aircraft cable is not required to be used for this test.

****
NOTE: For the Army: Choose the bracketed option including the "frequency range of the individual harmonic occurrence".
****

i. Include harmonic frequency spectrum analysis depicting harmonic order across the range of individual harmonic occurrence,[and harmonic magnitude][harmonic magnitude, and frequency range of individual harmonic occurrence] for each load condition in the test reports. Conduct tests at the unit's input terminals (to the 37th harmonic), and at the units output terminals (to the 37th harmonic) per IEEE standards.

j. Automatic line drop compensation: Operate converter at nominal voltage and verify specified performance of the line drop compensation at the following loads.

(1) No-load.

(2) 50 percent of rated capacity with a 0.8 lagging power factor linear load.

(3) 50 percent of rated capacity with the specified non-linear load.

(4) 100 percent of rated capacity with a 0.8 lagging power factor linear load.

(5) 100 percent of rated capacity with the specified non-linear load.

k. Post Routine Test Safety Verification: Repeat tests conducted under item a. Initial Safety Validation to confirm safety features were not affected by previous tests.

2.6.3 Special Factory Tests (Design Tests)

****
NOTE: Include the bracketed option "each of" when there are multiple sizes of converters in the project.
****

Submit special factory test (design test) reports (complete with test data, explanations, formulas, results, setup and cable information, and the list of the calibration dates of the test equipment used), in the same submittal package as the catalog data and drawings for [each of] the specified frequency converter(s). Tests must be certified and signed by a registered professional engineer or by a "company certified professional designee" within the manufacturers' organization. Submit designee's credentials with the initial design test report for approval. Tests must be on file based on a production model of converters of the same design, construction and kW rating provided.

****

NOTE: Include the first bracketed option below, "As an exception..." unless there are more than 5 units on the project, or the units are going to a severe or hard to reach environment / strategic location. When choosing the second option instead of the first, coordinate with the Activity to determine the number of "production units" that must be tested.

The "As an exception..." sentence has always permitted the Special Factory Tests to be done on one of the first units produced, at the same time scheduled for the Routine Tests. However it was rarely used, since it only applies when the manufacturer already meets the experience requirements in the QUALIFICATIONS OF MANUFACTURER paragraph in Part 1 of this specification, but was building a slightly different unit without the specific design tests already on file.

With the new change to "kW vs kVA" requirements, this exception may become more frequently used since test data indicating the kW ratings specifically, may not be on file. The manufacturer still has to meet the QUALIFICATIONS OF MANUFACTURER paragraph, and all of the Special Factory Tests will still be subject to being witnessed by the government with the Routine tests.

****

[As an exception, when the manufacturer does not have the special factory tests for the specific unit characteristics already on file, the manufacturer may conduct the special factory tests on the first "production unit" along with the routine tests.][The manufacturer must test [one] [_____] unit[s] at the same time scheduled for routine tests, of each rating and size converter.]To assure compliance with the specification, these tests are also subject to government witnessing at the same time as the routine tests. For all tests which require full load, use 1.0 power factor unless otherwise noted. For all tests that are "not already on file", connect loads to the converter with an aircraft power cable assembly, 32 meters 105 feet long, similar to the specified project aircraft power cable assembly. Monitor and record all data at the load end of the cable, unless otherwise noted. The tests conducted on the unit must include the following:

****

NOTE: Select Location Category C for outdoor locations only.

****

a. Initial Safety Verification: Perform tests and checks to validate the safe and timely shutdown for each condition (for the power source and the output cable) identified in paragraph SAFETY FUNCTIONS.

b. Surge protection: Apply input surges in accordance with IEEE C62.41.1 and IEEE C62.41.2, Location Category [B][C] and monitor output. Conduct a minimum of three consecutive successful tests on each unit listed. Confirm there is no interruption to 400 Hz output power and voltage stays within specified regulation tolerances. Surge protection tests must be applicable on all frequency converter units utilizing same surge protection device by manufacturer and part number regardless of frequency converter kW size.

c. Input current: Perform the following tests at nominal input voltage. Conduct each test a minimum of three times. Monitor the input and output power to demonstrate the duration of the transients until the converter reaches steady state. Provide copies of waveforms and analysis in test report.

    (1) Measure inrush current when initially turning on machine with no load.

    (2) After applying power and unit is at steady state, conduct load application test, going from 0 to full load to measure affect on input.

d. Input current distortion: Operate at nominal input voltage at 0, 25, 50, 75, and 100 percent of rated full load. Measure and record the input current THD for the current in each phase.

****

NOTE: For the Navy:

1) Include the bracketed 300 percent overload requirement in the table. However, units strictly for avionics shop use do not need the 300 percent requirement.

2) Coordinate with NAVAIR (POC information is at front of specification), to see if the NAVAIR Digital File Information has been completed before including the bracketed documentation option. Include bracketed option once NAVAIR has established a defined version of Digital File Requirements (still in progress). Verify at that time if need to add requirement for both input and output waveforms / data on the 300 percent test.

****

e. Overload: Operate at nominal input voltage and output voltage with loads as listed below:

Percent of Full Load	Satisfactory Operating Time	Time Between Overloads	Iterations
110 percent	60 minutes	4 hours	3
125 percent	5 minutes	10 minutes	3

Percent of Full Load	Satisfactory Operating Time	Time Between Overloads	Iterations
150 percent	2 minutes	10 minutes	3
200 percent	20 seconds	5 minutes	3
[300 percent	4 seconds	5 minutes	5]

f. Monitor output to confirm there is no 400 Hz power interruption. After minimum operating time is achieved, unit must interrupt output power. Provide voltage and current waveforms[in accordance with NAVAIR Digital File Information] documenting the unit's response for each test.

g. Short-circuit: Apply a bolted line-to-line fault and a bolted three phase fault directly to the output terminals of the unit. Conduct a minimum of three consecutive successful tests on each unit. Provide unit capable of carrying the fault current until the integral system protective devices interrupts the fault with no damage to the unit. Provide waveforms of short circuit current during short circuit tests.

h. Output voltage THD: Operate at nominal input voltage at full load with balanced and 15 percent unbalanced load. A 15 percent unbalanced load is defined as follows:

(1) Phase A at full rated single phase load.

(2) Phase B at 85 percent of Phase A

(3) Phase C at 85 percent of Phase A

i. Measure and record the output voltage THD for the line-to-neutral voltage of each phase.

j. Phase angle regulation: Operate at full load with balanced and 15 percent unbalanced loads. Measure and record output voltage and current, and identify RMS phase voltages and displacement angles between adjacent output voltage phases. A 15 percent unbalanced load is defined as follows:

(1) Phase A at full rated single phase load.

(2) Phase B at 85 percent of Phase A.

(3) Phase C at 85 percent of Phase A.

k. Transient recovery: Operate at the following load steps: 0 to 100 percent, 0 to 50 percent, 100 to 0 percent and 50 to 0 percent. Measure and record recovery time and output voltage deviation limits. Provide recordings or display of output voltage during transient recovery test.

****

NOTE: Delete bracketed acoustical noise test unless frequency converter is installed in special locations such as test laboratories or other confined spaces and a lower than 72 dBa value is specified.

The test parameters (Height and Range) identified

below, meet the ANSI SI 4 requirements. However the standard is not referenced because it "allows units to be averaged over a certain production range /quantity", whereas we want each unit to be individually compliant.

****

[l. Acoustical noise: Operate at no load, 50 percent and 100 percent of full load. Measure continuous steady sound pressure level 1525 mm 5 feet horizontally from the center of each side of the converter at a point 1525 mm 5 feet above the floor. Decibels (dB) are referenced to 20 micropascal.

]

****

NOTE: Delete optional paralleling test unless paralleling requirement is specified with the equipment.

****

[m. Paralleling: Operate at nominal input voltage at 50 percent and 100 percent of full load at 0.8 lagging power factor. Measure and record the output voltage, output current and power factor provided by each individual unit.

n. Post Special Test Safety Verification: Repeat tests conducted under item a. Initial Safety Verification to confirm safety features were not affected by previous tests.

]2.7 ARC FLASH WARNING LABEL

****

NOTE: Include the Arc Flash Warning Label detail on the drawings. See the technical notes at the beginning of this section to obtain the AutoCAD drawing file of the label.

****

Provide arc flash warning labels for arc flash protection in accordance with NFPA 70E and NEMA Z535.4 for the enclosures of electrical equipment that are likely to require examination, adjustment, servicing, or maintenance while energized. Locate this self-adhesive warning label on the outside of the equipment compartment doors warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated. The marking must be clearly visible to everyone, including qualified persons, before examination, adjustment, servicing, or maintenance of the equipment.

2.8 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings. Provide note on panelboard schedules to indicate where other than black center core labels are required.

****

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 by 65 mm 1 by 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.9 GROUNDING AND BONDING

****

NOTE: Include the reference to Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION when equipment is also being provided outside.

****

UL 467. Provide grounding and bonding as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM[and for exterior work, in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

[2.10 CAST-IN-PLACE CONCRETE

****

NOTE: Include concrete requirements when equipment is also being provided outside on concrete pads.

****

Provide concrete associated with electrical work for other than encasement of underground ducts rated for 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

]PART 3 EXECUTION

3.1 INSTALLATION

Install products to operate at 400 Hz in the same manner as specified in other sections of this specification for products operating at [50] [60] Hz, unless indicated or specified otherwise. Conform to the requirements of NFPA 70 and IEEE C2 and to manufacturer's instructions and recommendations.

3.2 EQUIPMENT

3.2.1 Floor Mounted

Provide proper floor mounting channels and install in accordance with the manufacturer's drawings and instructions and as indicated. Align, level, and bolt units to channels to allow easy withdrawal or insertion of removable components and to permit proper operation and maintenance of equipment. When in a Class 1, Division 2 area, mount units at least 18 inches above finished floor.

[3.2.2 Wall Mounted

****

NOTE: Wall mount units 5 kW or less. Floor mount all other units.

****

Bracket mount, but otherwise install as required for floor-mounted units.

][3.2.3 Maintenance Platform Mounted

****

NOTE: When used, verify drawings identify:

1) An appropriate maintenance platform with safety details including the maintenance envelope.

2) The location of the remote control panel and interconnecting conduit and wiring.

****

Install as required for floor-mounted units.

]3.2.4 Grounding and Bonding

In accordance with NFPA 70 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

[3.2.5 Grounding and Bonding - Exterior Equipment

****

NOTE: When equipment in the project is located outdoors, include the optional grounding and foundation (concrete pad) requirements. Use 25 ohms unless the project requires more stringent requirements.

****

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms.

3.2.5.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.5.2 Pad-Mounted Equipment Grounding

****

NOTE: Ensure plans show the pad details and ground connections matching how this paragraph is edited. Converter is to have a ground ring and the normal number of ground rods is two. The one ground rod option should only be chosen if required by local installation requirements.

****

Provide a ground ring around the equipment pad with 4/0 AWG bare copper.[Provide two ground rods in the ground ring at opposite corners.][Provide one ground rod in the ground ring with the ground rod located in the equipment cabinet.] Install the ground rods at least 3000 mm 10 feet apart from each other. Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.5.3 Connections

Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors. Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.6 Foundation for Equipment and Assemblies

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the requirement is located. Include construction requirements for concrete slab only if slab is not detailed on drawings.

****

Mount equipment on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 200 mm 8 inches thick, reinforced with a 152 by 152 mm MW19 by MW19 6 by 6 inches - W2.9 by W2.9 mesh placed uniformly 100 mm 4 inches from the top of the slab.

b. Place slab on a 150 mm 6 inch thick, well-compacted gravel base.

c. Install slab such that top of concrete slab is approximately 100 mm 4 inches above the finished grade with gradual slope for drainage.

d. Provide edges above grade with 15 mm 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 200 mm 8 inches beyond the equipment.

Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with equipment cable training areas.

3.2.6.1 Cast-In-Place Concrete

Provide cast-in-place concrete work in accordance with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

[3.2.6.2 Sealing

****

NOTE: Require sealing of cable wells (windows) in the concrete pad if rodent intrusion is a problem.

****

When the installation is complete, seal all entries into the equipment enclosure with an approved sealing method. Provide seals of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

]]3.2.7 Wiring and Conduit

****

NOTE: Designers of Record must provide calculations and derate conductors, circuit breakers (50 Hz / 60 Hz), and devices operating at 400 Hz and at 28 VDC. Do not use ferrous (steel) conduit for 400 Hz wiring.

Use of a distributed 400 Hz power system (instead of a Point of Use system), is prohibited on new projects, and is limited to making modifications to existing systems. If used, a distributed system requires additional special calculations to accommodate for unbalance in the system, which may also require the use of the bracketed option for the special 7-conductor, 6 around 1 cable in conduit.

See UFC 3-555-01 (Draft in progress) for additional information.

Circuit Breakers	
	Derating Factor
QO (< 50 A)	**0.927**
H, J, & L Frame (,400 A)	**0.8 to .9**
J Frame (600 A)	**0.82**
K Frame (1200 A)	**0.74**

Cable	
AWG	**Derating Factor**
#2	**0.9877**
#1	**0.9675**
#1/0	**0.9481**
#2/1	**0.9167**
#3/0	**0.8831**
#4/0	**0.8483**

****

Provide wiring and conduit as specified in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. Use copper conductors [type XHHW, 7-conductor, 6 around 1, twisted] for 400 Hz systems. Use aluminum conduit for exposed 400 Hz feeders. Do not install aluminum conduit underground or encased in concrete. Use aluminum fittings and boxes with aluminum conduit. Use PVC conduit and fittings for underground or concrete encased 400 Hz feeders.

3.2.8 Manufacturer's Representative

The manufacturer's representative must place the system in operation and make necessary adjustments to ensure optimum operation of the equipment.

The manufacturer's representative must have at least 2 years of practical experience in the installation and testing of 400 Hz solid state frequency converters.

3.3 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.5 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.6 FIELD QUALITY CONTROL

3.6.1 Field Test Schedule

****

NOTE: Include the bracketed options below on Navy projects where "reach-back support" has already been coordinated with NAVAIR / NAVFAC LANT per the third introductory Technical Note at the beginning of this specification section.

****

Give Contracting Officer[and (NAWCAD Air Vehicle Electrical Power Systems Group (AB43) (301) 342-4161] 30 days notice of dates, times and scheduled tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity[and NAVAIR / NAVFAC LANT,] and schedule a time that will eliminate or minimize interruptions and interference with the activity operations.

3.6.2 Instruments

Provide test instruments capable of measuring and recording or displaying test data at a higher resolution and greater accuracy than specified for the converter's performance. The test instruments used in the field tests must have current valid calibration stickers issued by an approved calibration laboratory. Verify calibration and adjustments of converter instruments provided prior to field tests. Calibrate instruments for 400 Hz operation when measuring 400 Hz signals.

3.6.3 Initial Inspection and Tests

****

NOTE: Include the bracketed option for the NETA ATS Representative when Section 26 08 00 APPARATUS INSPECTION AND TESTING is included in the project. Ensure that the list of identified specification sections that the NETA inspector is responsible for includes this section (see bracketed options in

Section 26 08 00 APPARATUS INSPECTION AND TESTING).
****

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests.[In addition, coordinate with the NETA ATS representative to witness, document, and validate the converter Field Quality Control.]

a. Compare equipment nameplate information with specifications and approved shop drawings.

b. Inspect physical and mechanical condition. Inspect cables and wiring harnesses for damage and strain relief.

c. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey. Perform thermographic survey while the unit is at full load during the loadbank test.

d. Perform specific inspections and mechanical tests as recommended by manufacturer.

e. Verify correct equipment grounding.

3.6.4 Field Performance Checks and Tests

****
NOTE: For the Navy, designers must coordinate with the Activity during the initial design phase. If the Activity has a reactive load bank on base that can be used during the field testing phase of the project, then:

1) Include the bracketed option to utilize the base equipment and perform the additional reactive load tests in the field.

2) Descriptions of the existing Activity owned loadbank, as well as information on where and how to obtain it, who is responsible to run it, and who has the liability for it, must also be included in the project documents, in Section 01 11 00 SUMMARY OF WORK.
****

Conduct converter field checks and tests under the supervision of the manufacturer's representative. Provide labor, equipment, test instruments, and incidentals required for the tests including resistive load banks, except the Government will furnish the electricity. For all electrical load tests, use 1.0 power factor unless otherwise noted.[As an additional exception, utilize the Government furnished reactive load bank as specified in Section 01 11 00 SUMMARY OF WORK, under paragraph, GOVERNMENT FURNISHED EQUIPMENT, and additionally repeat the routine factory tests that address lagging and leading power factors, in the field.]

All tests must be performed with the load connected to the load end of the specified aircraft cable assembly. The cable must be laid out / uncoiled to provide heat dissipation. No adjustment to the converter is allowed between tests. Successfully complete the safety verification, preliminary operation, and the control and protective devices check prior to performing load and transient tests. Load tests must be performed with the converter doors closed. If the converter fails to operate within the specified limits during any of the tests, discontinue the test, make necessary repairs to correct the failure, and restart testing of the converter. Repeat all previously completed tests and document the respective failed test data and new data.

3.6.4.1 Initial Safety Verification

Perform tests and checks to validate the safe and timely shutdown for each condition (for the power source and the output cable) identified in paragraph SAFETY FUNCTIONS. As an exception, a representative fault test will be sufficient at this time.

3.6.4.2 Preliminary Operation

****

For the Navy: NAVAIR is working on and will provide the requirements for a "digital manual" / type of "Data Acquisition system." All Manufacturers should also already have one of their own. The future goal is to include the standardized requirement as part of the specification so that NAVAIR will have the various manufacturer's equipment information, in a consistent format, submitted and then on file in the NAVAIR Database system for maintenance and problem solving. At that time, we will determine whether it will be possible to include as an attachment / sample in the specification or possibly as a reference to a UFC Appendix.

****

Inspect the converter and make adjustments necessary to assure proper operation in accordance with the manufacturer's instructions. Operate converter at 0, 25, 50, 75, and 100 percent of rated full load. On both the input and the output, measure and record the voltage, current, frequency, and THDs (voltage and current) at each load. Calculate output voltage regulation. Verify converter is operating within specified limits at each load level.

Test data must include voltage and current harmonic distortion amplitudes of all individual harmonics presented in a spectrum analysis format up to the 15th order at the 50 percent and 100 percent load points.

3.6.4.3 Control and Protective Device Checks

Operate each control, switch, input/output device that is capable of being operated manually a minimum of three times, demonstrating satisfactory operation each time. Perform operation test on each protective device to ensure that devices function properly. After each operation measure and record the converter output frequency, voltage and current. Verify converter is operating within specified limits.

3.6.4.4 Load (Burn-in) Test

****

NOTE: Include the bracketed option "For converters

used ..." only when one of the frequency converters, on a multi converter project, will not be connected to the aircraft cable assembly when in service; e.g. used in a lab setting instead.

In the rare condition, where there is only the one converter in a lab setting, then delete the entire sentence before the bracketed option as well.

****

Operate each unit continuously a minimum of 1 hour at 100 percent rated full load. Measure and record the converter output frequency, voltage and current at beginning, 30 minutes, and 1 hour. Verify converter is operating within specified limits. Load test must be performed with the converter doors closed and the test load connected to the converter at the cable head with specified aircraft cable assembly.[For converters used to supply test bench loads, perform load tests with the converter doors closed at the output of the converter.]

3.6.4.5 Post Load Test Verification

Repeat tests identified in paragraph PRELIMINARY OPERATION, to validate converter was not affected by the Load test. However apply loads in the reverse order (e.g. 100, 75, 50, 25, and 0 percent of the rated full load).

Conduct tests on each converter with the load connected to the load end of the specified aircraft power cable assembly. No adjustment to the converter is allowed between load tests. Monitor and record output voltage at the load end of the cable. Verify specified performance of the converter including the line drop compensation.

3.6.4.6 Final Safety Verification

Repeat tests conducted under paragraph INITIAL SAFETY VERIFICATION to confirm safety features were not affected by previous tests.

3.6.5 Grounding System

Inspect grounding system for compliance with contract plans and specifications.

3.7 DEMONSTRATION

3.7.1 Instructing Government Personnel

****

NOTE: For Navy: Include bracketed option requiring coordination with NAVAIR and coordination with Activity on availability of aircraft for conducting training.

****

Provide field training to Government personnel on the operation and maintenance of the converter provided at the same time as the Field Acceptance Testing.[For Navy projects contact NAWCAD Air Vehicle Electrical Power Systems Group (AB43) at (301) 342-4161 to obtain the name and e-mail of the NAVAIR point-of-contact so they can attend the training. Coordinate with the Activity to establish availability and non-availability to train on actual aircraft.] Include up to a maximum of 2 hours of instruction on operation and up to a maximum of 4 hours of repair and maintenance of the converters. The instructor must be approved by the manufacturer of the unit provided. Submit training syllabus including each topic of training and a brief outline of each topic to the Contracting Officer at least 4 weeks prior to training for approval.

Training must be approved by the Contracting Officer at least 2 weeks in advance. The Government may record, video and audio, the training sessions and use these recordings to train personnel on the operation and maintenance of the converter system. Provide two copies of video or audio DVDs, and of any supplemental information and examples covered in the training sessions, to the Contracting Officer.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 35 44 (August 2021)**
Change 1 - 05/24

Preparing Activity: NAVFAC **Superseding**
UFGS-26 35 44.00 20 (February 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-26 35 44 (August 2021)**

Change 1 - 05/24

Preparing Activity: NAVFAC **Superseding**

UFGS-26 35 44.00 20 (February 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 35 44

270 VDC SOLID STATE CONVERTER

08/21, CHG 1: 05/24

****

NOTE: This guide specification has been specifically limited to cover the requirements for the procurement, installation, and testing of 72 kW, 270 VDC solid state converters.

For Navy projects, the use of any other size converter is no longer authorized. If a different size unit is required for a specific project, contact NAVFAC Atlantic (LANT), Code DC 44 - Electrical Criteria Manager at (757) 322-4327 for authorization, and for the additional requirements necessary to appropriately modify this specification.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: These converters are used to supply 270 VDC and limited amounts of 28 VDC electrical power to aircraft in shore facility environments. Typical applications include aircraft operating in flight line conditions or in hangars, avionics shops, laboratories, training buildings, flight simulators, and computer rooms.

This specification is not to be used for procurement of power converters installed on board aircraft or ships without specific authorization from Naval Air Warfare Center Aircraft Division (NAWCAD Power and Energy Division (AB43) at (301) 342-4161), and from the Naval Sea Warfare Command (contact the Technical Warrant Officer for the appropriate ship classification).

This specification is not intended for medium-voltage applications.
****

****
NOTE: For Navy projects, incorporate the special SUBMITTAL REVIEW PROCESS paragraph in the SUBMITTALS section. Coordinate with NAVAIR, NAVFAC, and the Activity to see whether the "review and approval", or the "surveillance only" options are required.

1) If "review and approval" (reach-back support) is desired, for a specific NAVFAC project, the technical representative (electrical engineer) editing this document for that project must contact NAVFAC LANT for consultation during the design stage of the project, prior to including the requirement in the specification. Point of Contact (POC) information is included in the first introductory technical note.

2) If "surveillance only" is agreed to, it requires the submittal information to be sent to NAVAIR and NAVFAC LANT for review and comment at the same time as the information is being sent to the Designer of Record for Review and Approval. The surveillance mode would give NAVAIR or NAVFAC LANT the opportunity to confirm compliance, without inadvertently holding up the project if the appropriate personnel are not available to do the review in a timely manner.

The Electrical Designer of Record must also insure that the Division 1, Section 01 33 00 SUBMITTAL PROCEDURES, paragraphs FORWARDING SUBMITTALS REQUIRING GOVERNMENT APPROVAL and SUBMITTALS RESERVED FOR NAVFAC [_____] APPROVAL of the project document are edited to identify the agreed upon special process.
****

****
NOTE: Coordination is required between this section and the project power systems study to determine which of the standardized Arc Flash Warning labels are required on the equipment. These labels (Graphics) are available in metric (SI) and U.S. Customary (IP) system dimensions. Use these files to develop project specific drawings.

File Name	Description
ARCFLASH	Arc Flash Warning Label

NOTE: To download UFGS Forms, Graphics, and Tables, go to: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Go to the specification section number, select the appropriate Electrical.ZIP file(s) and extract the desired details.

Do not include the Arc Flash Warning Labels in the project specifications. Insert the appropriate details on drawings and modify optional and blank items.

****

****

NOTE: To the Project Specification Editors: The following two Attachments are included with the pdf version of this specification section and are referenced several times.

File Name	Description	
Figure 263544-1	Transient Voltage Recovery Limits for 270 VDC	Rev 07 26 21
Figure 263544-2	Transient Voltage Recovery Limits for 28 VDC	Rev 07 26 21

When developing your final project documents, you must download and attach the pdf versions of both figures to the end of this edited Section 26 35 44 270 VDC SOLID STATE CONVERTER.

NOTE: To download UFGS Forms, Graphics, and Tables, go to: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Go to the specification section number, select Figure 263544 -1 and Figure 263544-2 and download.

****

****

NOTE: The following information must be shown on the project drawings:

1. Show location of all equipment including converter, paralleling controls when required, and remote monitoring and control panels.

2. Provide functional block diagram, single line diagrams, power, and control wiring interconnection diagrams, wiring diagrams, conduit entry diagrams, equipment elevations, maintenance envelope, limiting dimensions, and equipment ratings which are not covered in the specifications.

3. Design equipment rooms with working spaces as required by NFPA 70 and manufacturers extra limitations. Provide ventilation for equipment rooms based on converter components heat load generated when operating at 100 percent load. Provide 60 Hz convenience receptacles.

****

****

NOTE: Ensure that the 270 VDC distribution systems are properly coordinated including the ratings of the power cables, ground cables, circuit breakers, transformers, filters, rectifiers, and control equipment. Provide calculations in Basis of Design per UFC 3-501-01, Electrical Engineering, including voltage drops, which can be critical in DC systems.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 519	(2022) Standard for Harmonic Control in

	Electrical Power Systems
IEEE 1159	(2019) Recommended Practice on Monitoring Electric Power Quality
IEEE C2	(2023) National Electrical Safety Code
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60947-4-1	(2023) Low-voltage Switchgear and Controlgear, Part 4-1: Contactors and Motor Starters - Electromechanical Contactor and Motor Starters

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA Z535.4	(2023) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AS7974	(2010; Rev A) Cable Assemblies and Attachable Plugs, External Electrical Power, Aircraft
SAE AS7974/5	(2017; Rev A) Cable Assembly, External Electrical Power, Aircraft, Single-Jacketed 270 VDC, 90 KW

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-704	(2016; Rev F; Change 1; Notice 3 2021)

	Aircraft Electric Power Characteristics

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers
UL 1012	(2010; Reprint Apr 2016; Rev Mar 2021) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

[1.2 RELATED REQUIREMENTS

****

NOTE: Include this optional reference to Section 26 08 00 APPARATUS INSPECTION AND TESTING when it is already being used and referred to for other electrical equipment on the project. Coordinate with optional paragraph in PART 3.

Coordinate converter equipment with Government's cybersecurity requirements and interpretations. Include this optional reference to Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS if the 270 VDC system includes remote control or remote access capability.

****

Section [26 08 00 APPARATUS INSPECTION AND TESTING] [and 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS] applies to this section, with the additions and modifications specified herein.

]1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Ensure the optional bracketed "Remote Monitoring and Control Panel" is not included when that equipment is not included in the body of the specification.

****

SD-02 Shop Drawings

Converter Drawings; G, [_____]

SD-03 Product Data

Converter; G, [_____]

270 VDC Aircraft Power Cable Assembly; G, [_____]

28 VDC Interlock; G, [_____]

[Remote Monitoring and Control Panel; G, [_____]

] SD-06 Test Reports

Work Plan; G, [_____]

Routine Factory Test Plan; G, [_____]

Special Factory Test Plan; G, [_____]

Factory Test Schedule; G, [_____]

Routine Factory Tests Certification; G, [_____]

Special Factory Tests Certification; G, [_____]

SD-07 Certificates

Qualifications of Manufacturer; G, [_____]

Nationally Recognized Testing Laboratory (NRTL) Listing; G, [_____]

SD-09 Manufacturer's Field Reports

Field Test Plan; G, [_____]

Field Test Schedule; G, [_____]

Field Test Certification; G, [_____]

Training Syllabus; G, [_____]

SD-10 Operation and Maintenance Data

****

NOTE: Coordinate with options under paragraph OPERATION AND MAINTENANCE MANUALS.

****

Converter O&MM, Data Package 5; G, [_____]

Preliminary Converter O&MM, Data Package 5; G, [_____]

[Remote Monitoring and Control Panel, Data Package 5; G, [_____]

] **

NOTE: On Navy projects, include at least one of the bracketed options below. The first option is for surveillance only, and the second option is for complete approval where "reach-back support" has already been coordinated with either NAVAIR or NAVFAC LANT per the third introductory Technical Note. Add the appropriate information in Section 01 33 00 SUBMITTAL PROCEDURES to coordinate with the special requirements.

****

[1.4.1 Government Submittal Review

[NAWCAD Air Vehicle Electrical Power Systems Group (AB43), (301) 342-4161 [and Code DC 44, NAVFAC LANT, Naval Facilities Engineering Systems Command] will provide surveillance. If they have comments or concerns, they will contact and coordinate resolution of their comments with the appropriate approving agent.

] [(NAWCAD Air Vehicle Electrical Power Systems Group (AB43), (301) 342-4161][Code DC 44, NAVFAC LANT, Naval Facilities Engineering Systems

Command][_____] will review and approve all submittals in this section requiring Government approval.

]1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 5 years prior to bid opening. The 5-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 5-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.2.1 Alternative Qualifications

Products having less than a 5-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site must not be used, unless specified otherwise.

1.5.3 Converter Drawings

****

NOTE: Provide a detail on the drawings that identifies the location, mounting and permitted maintenance access areas for each converter.

For Navy projects, include the bracketed options that require surface mounting against the wall, and prohibits rear access to converter.

****

Furnish scaled drawings of enclosure outline including front, top, side views, and overall dimensions. Include "maintenance envelope" dimensions confirming space limitations identified on the drawings[, and surface mounting flush against the wall.[Rear access for maintenance and repair purposes is prohibited]]. The "maintenance envelope" drawings must also indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Provide external power and control wiring, cabling, connector, and backplane interconnect drawings. Provide single line, schematic, and wiring diagrams. Drawings must include details of input and output circuit breakers, contactors, rectifiers, surge protectors, control devices and conduit entry and exit locations. If parallel operation is included, provide an interconnection diagram. Submittals must include the nameplate data, size, and capacity.

1.5.4 Qualifications of Manufacturer

****

NOTE: The experience clause in this section has been approved by a Level I Contracting Officer in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS). NFAS can be found at the following link:

https://www.navfac.navy.mil/products_and_services/sb/opportunities/guidelines/navfac.html

This clause may be used without further approval or request for waiver.

****

Submit a certification stating that the manufacturer has a minimum of five years' experience in the design, manufacturing, and testing of a 270 VDC solid state converter at the equivalent or greater kW and voltage ratings for direct connection to aircraft electrical loads. When specifications require multiple converters operating in parallel, the manufacturer must provide specific experience with equal or greater kW rated converters.

Experience in manufacturing motor generator sets does not qualify as equivalent. Experience in manufacturing portable engine-driven 28 VDC power units does not qualify as equivalent. The manufacturer must be experienced in producing units for installation in permanent buildings, in environmentally closed spaces, or in weatherproof enclosures as applicable. The manufacturer must furnish documented experience with converters in various environmental conditions including exterior flight line, hangar, and environmentally enclosed spaces within buildings.

1.5.5 Work Plan

Submit a written work plan with the initial shop drawing submittal, which consists of a schedule of dates of the routine and special factory tests, installation of equipment, field tests, and operator training for the system. Furnish a list of the test instrumentation equipment complete with the documented calibration program, for the factory and the field tests.

1.5.6 Routine Factory Test Plan

****

NOTE: Coordinate calendar day requirements with Activity and with special review requirements.

****

Submit test plan and procedures at least [21][_____] calendar days prior to the tests being conducted. Provide detailed description of test procedures, including test equipment and setups complete with their current calibration dates, to be used to ensure the converter meets this specification and explain the test methods used. As a minimum, include the tests required under the paragraph ROUTINE FACTORY TESTS.

1.5.7 Special Factory Test Plan

Submit the Special Factory Test Plan and procedures with the Routine Factory Test Plan. Provide detailed description of test procedures, including test equipment and setups complete with their calibration dates, used to ensure the converter meets this specification and explain the test methods used. As a minimum, include the tests required under the paragraph SPECIAL FACTORY TESTS.

1.5.8 Field Test Plan

****

NOTE: Coordinate calendar day requirements with Activity and with special review requirements. For Navy projects, use 30 days to coordinate with NAVAIR requirement to have time to arrange attendance.

****

Submit test plan and procedures at least [30][15][_____] calendar days prior to the start of field tests. Provide detailed description and dates and times scheduled for performance of tests, and detailed description of test procedures, including test equipment and setups of the tests to be conducted to ensure the system meets this specification. List make, model, and current calibration dates, and provide functional description of the test instruments and accessories. Explain the test methods to be used. As a minimum, include the tests required under the paragraph FIELD QUALITY CONTROL. Test reports must include power quality measurement data collected in accordance with IEEE 1159.

1.5.9 Nationally Recognized Testing Laboratory (NRTL) Listing

270 VDC converters must be identified with a nationally recognized testing laboratory (NRTL) label or UL label prior to shipping.

1.5.9.1 Currently Listed Products

Submit NRTL or UL certification or UL file number for the actual converter to be shipped with the initial submittal to verify compliance of equipment.

1.5.9.2 Proposed Listed Products

Submit NRTL or UL certification or UL file number for same or similar rating or product size range of like design unit with the initial submittal to verify compliance of equipment.

1.5.10 Routine Factory Tests Certification

****

NOTE: Coordinate calendar day requirements with Activity and with special review requirements.

****

Submit within [45][_____] calendar days after completion of tests. Receive approval of test prior to shipping unit. Certify tests were conducted on each converter in accordance with the requirements set forth in paragraph

ROUTINE FACTORY TESTS and certify converter satisfactorily operated within specified limits. Include copies of the test procedures, test configuration diagrams and schematics, test data, and results.

1.5.11 Special Factory Tests Certification

Certify tests were conducted on a converter of the same design, construction, kW rating, and voltage rating to be provided. Tests must be in accordance with the requirements set forth in paragraph SPECIAL FACTORY TEST and certify converter operated without malfunctioning within specified limits. Include copies of the test procedures, test configuration diagrams and schematics, test data, and results.

1.5.12 Field Test Certification

****

NOTE: Coordinate calendar day requirements with Activity and with special review requirements.

****

Submit report of test results as specified by paragraph FIELD QUALITY CONTROL within [15][_____] calendar days after completion of tests. Certify tests were conducted on each converter in accordance with the paragraph FIELD QUALITY CONTROL and certify converter satisfactorily operated within specified limits. Include copies of the test procedures, test configuration diagrams and schematics, test data, and results.

1.6 OPERATION AND MAINTENANCE MANUALS

Submit converter Operation and Maintenance Manuals (O&MM) in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.1 Additions to Converter O&MM

****

NOTE: Include the paralleling bracketed option when paralleling has been included as a requirement of the equipment.

****

In addition to requirements of Data Package 5, include the following on the actual converter provided:

a. A "one-line diagram" from the building service entrance panel to the converter and out to the end utilization point(s).

b. A concise, duplicatable, single page data sheet with operating instructions for each unit including startup[, paralleling,] and shutdown procedures.

c. Routine and field test reports.

d. NRTL or UL certification or UL file number.

e. A list of all code required identification and warning signage and labels that have been provided on the converter.

1.6.2 Preliminary Converter O&MM

Prior to scheduling Field Tests, two bound copies of a Preliminary O&MM must be submitted to and approved by the Contracting Officer.

1.6.3 Spare Parts Information

Furnish recommended manufacturer's spare parts list, quantities, lead time to receive after ordering, and a schedule of prices,(guaranteed for one year after warranty expires), for each type of converter and other equipment specified in this section. Include the following:

a. Fuses

b. Human Machine Interface (HMI)

c. Indicator lamp/LED

d. Output switching modules

e. Plug-in logic cards

f. Power filter capacitors

g. Power semi-conductors

h. Ventilation system filters

i. 270 VDC Aircraft Power Cable Assembly

j. 28 VDC Aircraft Power Cable Assembly

1.7 WARRANTY

The equipment items must be supported by service organizations which are most convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 270 VDC CONVERTER

****

NOTE: Do NOT edit this paragraph to specify the internal architecture of the converter (e.g. type of power supply, rectifier type or switching technology to be utilized). Specifying this type of technology may make this a sole source specification which requires justification and approval per federal contract law.

For the options: Choose 50 or 60 Hz based on the exterior power distribution system at the project location. Choose 24,000 for the MTBF unless the project has documented, more stringent requirements.

****

Provide converter consisting of modular construction solid-state components for [50][60] Hz to 270 VDC conversion, input/output devices, and ancillary control devices. Converter must be a standard product of the manufacturer and the manufacturer's latest design that complies with the specification requirements. The converters provided under this contract must be products of the same manufacturer. Each unit must have a calculated Mean Time Between Failures (MTBF) exceeding [24,000][_____] hours as calculated when the converter is provided with yearly servicing and maintenance. Provide converter with NRTL or UL listing complying with UL 1012. The converter must have minimum 12 pulse, active input rectification circuit or a demonstrated design achieving equal or better performance characteristics. Circuit breakers operating at 270 VDC and 28 VDC must be designed and UL tested for [50][60] Hz operation [and derated] for the applicable VDC operation, as appropriate. Provide startup and shutdown instructions posted on the front of the unit using engraved plastic or aluminum plate. Provide a plastic encapsulated schematic diagram attached to the inside of the unit in clear view of maintenance personnel.

2.1.1 Electrical Characteristics

The 270 VDC output and the associated 28 VDC Interlock voltage, measured at the aircraft end of the servicing cable, must be in accordance with MIL-STD-704, must be controlled to the voltage regulation requirements within this document throughout all loadings defined, and must comply with the additional modifications identified herein.

2.1.1.1 Input Voltage

****

NOTE: Using input voltage other than 480 volts (US) or 380 volts (European) will increase the cost and weight and decrease the efficiency of the converter. Show input voltage on the construction drawings.

Choose 60 or 50 Hz based on the exterior power distribution system at the project location. Choose 10 percent voltage variation unless specific project documents require a higher percentage input variation to be permitted.

A voltage changing transformer is not permitted at the input of the converter unit on any new facilities. Adding a voltage changing transformer at the input is only permitted in the rare case when retrofitting an existing facility and there is no other voltage available. In this exception, remove the last sentence in the section below.

****

[480][380][_____] V, three phase, three wire, grounded, [60][50] Hz. Converter must provide rated output voltage when input voltage is varied plus or minus [10][_____] percent. A voltage changing transformer is not permitted at the input of the converter unit.

2.1.1.2 Input Power Factor

Between 0.8 lagging and unity, under all conditions of steady state line and load variations specified herein.

2.1.1.3 Surge Protection

****

NOTE: Select Location Category C for outdoor locations only.

****

Provide converter capable of sustaining an input surge described in and tested in accordance with UL 1449, and IEEE C62.41.1 and IEEE C62.41.2, Location Category [B][C], and continue to operate with no alarms within the specified tolerance.

2.1.1.4 Inrush Current

The inrush current must not exceed 100 percent of the rated full load input current.

2.1.1.5 Input Current Distortion

****

NOTE: Where total connected converter load is a small percentage (less than 40 percent) of the total connected facility load, use 12 percent Total Harmonic Distortion (THD)and 8 percent individual. For large converters (e.g. 312 kW or larger) or where total connected converter load is a significant percentage of the total connected facility load, use 5 percent THD and 3 percent individual.

For installation in shipboard environments using Type 1 power (60 hertz per MIL-Std-1399-300, Part 1 (2018) Low Voltage Electric Power, Alternating Current), use 5 percent THD and 3 percent individual.

Note that per NAVAIR request, the converter Special Tests paragraph requires data to be provided at the 25, 50, 75 and 100 percent load points. This is intentionally more stringent than the "full load" requirement below, and is intended for data acquisition only. It will be used to help develop a resolution to known field problems.

****

Input current Total Harmonic Distortion (THD) must not exceed [12][5] percent of the fundamental frequency with nominal input voltage at full load. Individual harmonic content must not exceed [8][3] percent of the fundamental frequency.

2.1.1.6 Output Voltage

As an exception to the requirements of MIL-STD-704, the 270 VDC converter must simultaneously provide and regulate (when measured at the cable head) to the following steady state voltage limits:

a. 270 VDC (plus or minus 3 VDC).

b. 28 VDC (plus 1 VDC or minus 2 VDC).

2.1.1.7 Power Output

The 270 VDC converter must have a power output rating of:

a. 270 VDC: 267 amperes (72 kW) with overload / transient capability as defined herein.

b. 28 VDC: 15 amperes (0.42 kW) with overload / transient capability as defined herein.

2.1.1.8 Load Range

The 270 VDC converter must be capable of meeting the following load ranges:

a. 270 VDC: 0 to 72 kW of any combination of resistive and constant power loads with overload / transient capability as defined herein, in parallel with up to 2,500 microfarads of capacitance, with a minimum current demand rate of 200 Amperes per millisecond.

b. 28 VDC: 0 to 0.42 kW of any combination of resistive and constant power loads with overload / transient capability as defined herein, in parallel with up to 100 microfarads of capacitance, with a minimum current demand rate of 60 Amperes per millisecond.

2.1.1.9 Efficiency

****

NOTE: For the Navy, the use of any size converter other than 72 kW is no longer authorized. If a different size is required for a specific project, contact NAVFAC LANT for approval and for the appropriate efficiency modifications. The POC information is located at the beginning of this specification.

****

Provide 72 kW units with a minimum efficiency of 89 percent at 50 percent load and 92 percent at 100 percent load.

2.1.1.10 No Load Input Losses

Provide converter with no-load input losses no greater than 7 percent of the output kW rating.

2.1.1.11 Overload

The converter outputs, both 270 VDC and 28 VDC, must have overload capabilities in accordance with the following table. The satisfactory overload operating time is based on no more than one overload of the same or longer conditions, within the following specified time between overloads.

Percent of Full Load (Rated Output)	Satisfactory Operating Time	Time Between Overloads
110 percent	30 minutes	2 hours Note: Unit must still be capable of withstanding any of the other conditions for their respective operating times. e.g. Unit can still do 150 percent for less than 10 seconds, before tripping, etc.
125 percent	5 minutes	10 minutes
150 percent	10 seconds	10 minutes
200 percent	2 seconds	5 minutes
250 percent	100 milliseconds	5 minutes

After minimum operating time is achieved, unit must interrupt output power. Unit must be capable of sustaining the overload without damage until the protective device interrupts the overload.

2.1.1.12 Short Circuit

When a bolted positive to negative fault is applied to the unit, unit must be capable of sustaining the short circuit current without damage until the protective device interrupts the fault. The output transient voltage recovery time and thresholds are more stringent than those required by MIL-STD-704, and must comply with the following:

a. During a bolted fault the current output must be regulated between 485 and 550 Amps for 5 seconds. If the fault condition clears in less than 5 seconds, the power source must recover to the voltage range of 250 to 280 volts within 40 milliseconds, and then settling out to the regulated voltage levels of 270 VDC (plus or minus 3 VDC) within 10 milliseconds, as shown in Figure 263544-1: Transient Voltage Recovery Limits for 270 VDC.

b. During this 270 VDC bolted fault condition, as well as for any high di/dt load or overload condition (e.g. over voltage, over current, under voltage, ripple), the 28 VDC interlock power output must not be disrupted and power quality must remain as defined in Figure 263544-2: Transient Voltage Recovery Limits for 28 VDC, throughout the fault isolation event.

2.1.1.13 Ripple Amplitude

Ripple amplitude is the maximum absolute value of the difference between the steady state and the instantaneous DC voltage. The maximum allowable ripple amplitude for the 270 VDC output is more stringent than what is required by MIL-STD-704. The maximum allowable ripple amplitude for the 28 VDC output must be in accordance with MIL-STD-704 These must comply with the following:

a. 270 VDC output: 1.5V (peak to mean).

b. 28 VDC output: 1.5V (peak to mean).

2.1.1.14 Distortion Spectrum

The converter output distortion spectrum must meet the following requirements:

a. 270 VDC: MIL-STD-704 Figure 18, inclusive of the fundamental voltage ripple component.

b. 28 VDC: MIL-STD-704 Figure 15.

2.1.1.15 Distortion Factor

The DC distortion factor is the ratio of the DC distortion to the DC steady state voltage. The maximum allowable distortion factor for the 270 VDC converter must be as follows per Table IV of MIL-STD-704:

a. 270 VDC output: 0.015.

b. 28 VDC output: 0.035.

2.1.1.16 Transient Output Voltage Recovery

The transient output voltage recovery time and thresholds are more stringent than those required by MIL-STD-704. Monitor and record output voltage at the load end of the cable. Comply with the following:

a. The 270 VDC output must remain within the range of 220 to 330 VDC for any step load change as defined in paragraph LOAD RANGE herein.

b. The 270 VDC output must begin recovery from the worst case transient excursion within 10 milliseconds and must be recovered to within the steady-state operating range specified in paragraph OUTPUT VOLTAGE within 40 milliseconds per Figure 263544-1: Transient Voltage Recovery Limits for 270 VDC.

c. The 28 VDC output must remain within a range of 26 to 40 VDC for any step load change as defined in paragraph LOAD RANGE herein. The voltage must not drop below 26 VDC for more than 50 microseconds.

d. The 28 VDC output must begin recovery from the worst case transient excursion within 15 milliseconds and must be recovered to within the steady-state operating range specified in paragraph OUTPUT VOLTAGE within 100 milliseconds per Figure 263544-2: Transient Voltage Recovery Limits for 28 VDC.

2.1.2 Environmental Rating

****

NOTE: Select 55 degrees C 130 degrees F for the ambient temperature rating unless in areas subject to extreme temperatures (e.g. Middle East and desert environments.). Use 0-95 percent relative humidity unless extreme condensation such as in a jungle climate.

Use 915 meters 3000 feet level unless location of installation will be at higher elevations.
****

The converter must be rated for continuous operation from no load to rated full load under the following conditions:

a. Ambient temperatures ranging from -20 to [55][60][65] degrees C. -4 to [130][140][150] degrees F.

b. Relative humidity from [0 to 95] [_____] percent noncondensing.

c. Ambient pressures from sea level to [915] [_____] meters [3,000] [_____] feet.

2.1.3 Monitoring and Control Panel

Provide converter with a control panel that is equipped with the following controls, indicators, instrumentation, data logging, diagnostics, and alarm functions.

2.1.3.1 Controls

Controls must be mounted on the front of the control panel, accessible without opening any doors or covers. Specific sequencing, or the requirement for simultaneous pushbutton operation, is not acceptable for any input or output control.

****
NOTE: Include the remote control panel option when unit is platform mounted or located out of sight of aircraft.
****

a. Start/stop pushbutton for input device control (circuit breaker or contactor).

b. Lamp/light emitting diode (LED) test - A push-to-test button or switch to test indicator lamps/LEDs. If panel lights all blink as part of the startup Built-in-Test (BIT) sequence, then a separate push to test button is not required.

c. Emergency power off - A separate pushbutton for emergency power off.

d. Output device ON/OFF.

e. Alarm silence and "silence" indicator - A switch that must disable the audible alarm without clearing the alarm codes.

f. Additional individual controls for the following functions (Note - these may be included as part of the Human-Machine Interface (HMI) as described in paragraph HUMAN MACHINE INTERFACE REQUIREMENTS):

g. - Output voltage adjust

h. - Alarm reset - resets and clears the silenced audible alarm.

2.1.3.2 Indicators

a. The following are mandatory indicators. They must be included on the control panel on the exterior of the unit[, and on the exterior of the remote control panel] in addition to any that are included in the HMI:

b. - Input power available - Lamp/LED to indicate that the supply voltage is available.

c. - Output power On/Off - Lamp/LED to indicate that the converter output voltage is available.

d. - Output device "ON".

e. - Audible alarm.

f. - Aircraft interlock bypass - Lamp/LED to indicate that the Aircraft Interlock has been bypassed.

g. In addition, include the following additional indicators, if they are not included in the HMI:

h. - System alarm - Lamp/LED to indicate that a fault has been detected. This indicator must be latched in the "ON" position whenever an alarm condition described in paragraph ALARM ANNUNCIATOR, is detected and must remain "ON" until the alarm reset pushbutton is pressed.

i. - Indicating lamp/LED to indicate that the alarm silence switch is in the disable position.

j. - Elapsed time meter in hours; (may be internal or visible externally).

2.1.3.3 Human Machine Interface (HMI) Requirements

Provide an HMI with a minimum of four by twenty (4 x 20) character backlit LED display for presenting the digital instrumentation, diagnostic system, and fault indicating system data. The HMI display must be viewable in direct sunlight and the HMI must be rated for harsh environments.

a. Digital Instrumentation. Provide true RMS, plus/minus one percent accuracy, microprocessor-based readings that include the following functions:

    (1) Output voltage.

    (2) Output current.

    (3) Inverter temperature. This function is desired for field diagnostics, but is not mandatory.

b. Alarm Annunciator. The unit must be capable of detecting and displaying the following abnormal conditions:

    (1) Input overvoltage.

    (2) Input undervoltage.

    (3) Output undervoltage.

(4) Output overvoltage.

(5) Output overload.

(6) System alarm.

(7) Control logic failure.

(8) Over-temperature.

(9) Logic power supply failure.

2.1.4 Input/Output Devices

****

NOTE: Coordinate 50 Hz vs 60 Hz requirement with Activity. Provide appropriate short circuit ratings in accordance with Basis of Design Calculations per UFC 3-501-01, Electrical Engineering.

****

Provide fully-rated, UL approved devices for control of [60][50] Hz input and for control of DC outputs from the converter. Derate devices and cables operating at 270 VDC in accordance with IEEE 519.

2.1.4.1 Input Device

Provide converter with a UL listed input device (circuit breaker conforming to requirements of UL 489 or contactor) as an integral part of the converter. Device must be operable from the front of the converter. Device must have a short-circuit current rating of [_____] amperes symmetrical minimum.

2.1.4.2 Output Contactor

****

NOTE: Include option for IEC on Oconus projects.

****

Provide converter output with an automatic magnetically-held contactor with interlock circuit. Output contactor must have sufficient capacity to handle rated load, overload, and available short circuit current. Contactor must additionally be rated for make / break operation into a 2,500 microfarads capacitance without damage to the converter.

Contactor must open when any circuit identified in the paragraph SAFETY FUNCTIONS causes the system to shut down. Electrically interlock contactor with ON/OFF circuitry so that when the converter is shut down, the contactor opens immediately and remains open.[Conform to the requirements of IEC 60947-4-1.]

[2.1.4.3 Output Circuit Breaker

****

NOTE: Only add an output circuit breaker, (and delete the OUTPUT CONTACTOR paragraph above), if the converter is supplying a downstream distribution panelboard (such as in a shop or laboratory), or multiple outputs with distribution internal to the

converter.

****

Provide converter output(s) with non-automatic manual circuit breaker(s), with appropriate frame size and a shunt trip coil rated for DC operation. Trip circuit breaker by the unit's OFF circuit [local or remotely activated] and when any circuit identified in the paragraph SAFETY FUNCTIONS causes the system to shut down. Output breaker(s) must be operable from the front of the unit.

]2.1.4.4 Aircraft Interlock Circuit

The 270 VDC output power contactors must be interlocked with the unit's fault indicators, alarms, and the 28 VDC interlock power circuit. When the 28 VDC interlock power source is "broken" (e.g. when the power cord is removed from the aircraft receptacle), the 270 VDC output power source must be disabled.

2.1.5 Safety Functions

2.1.5.1 270 VDC Power Source

The 270 VDC power source internal 270 VDC buss must automatically discharge to below 12 VDC within 2 seconds after the following:

a. 270 VDC power source has been turned off.

b. Whenever any access panel is opened on the equipment. Under this condition, the interlock circuitry must open the input device and the 270 VDC output device, and not allow the input or output device to close. For maintenance purposes, provide an internal bypass switch to defeat the interlock circuitry.

c. Detection of system fault that results in a converter shut down condition, including the following:

(1) Input undervoltage.

(2) Input overvoltage.

(3) Loss of input phase.

(4) Loss of input power.

2.1.5.2 270 VDC Output Cable

The 270 VDC power must be removed from the output cable within 100 milliseconds after one of the following occurs:

a. Receiving a stop command.

b. Loss of 28 VDC interlock power.

c. Detection of a fault that results in an output shut down, including the following:

(1) Output overvoltage - Protect by tripping output devices for instantaneous overvoltage of 30 percent or more and for 10 to 30 percent overvoltage lasting more than 0.25 seconds.

(2) Output undervoltage - Protect by preventing the closing of the output disconnect until the output voltage is 95 percent of the rated output. If, after closing, the voltage decreases to below 90 percent for longer than 5 seconds, provide relaying to trip output devices utilizing a field-adjustable time-delayed circuit with a range of 4 to 10 seconds.

(3) Output overload.

(4) Converter overtemperature protection.

2.1.6 Automatic Line Drop Compensation

Provide automatic line drop compensation (ALDC) from zero to ten percent adjustable internally. Separate ALDC functions are required for the 270 VDC power source and for the 28 VDC interlock power source.

[2.1.7 Auto Restart

****

NOTE: Auto restart should be considered when the converter is installed in a remote location that is not readily accessible to operating personnel and maintaining 270 VDC power is critical to operations. Use of auto restart should be studied carefully to ensure that it does not create a potential personnel safety hazard.

This is an additional cost item and should not be specified unless specifically requested by the user.

****

After a total input power outage the unit must be capable of automatically restarting and re-energizing loads upon restoration of normal power. Provide units with a manual/auto restart switch and with backup battery power supply if it is needed to meet the auto restart requirement. When interlock circuit has been interrupted or when interlock is in the maintenance position (manual restart), the system should not restart.

][2.1.8 Built-In Test Equipment

****

NOTE: Built-in test equipment (BIT) should be considered when the converter is installed in a remote location that is not readily accessible to operating personnel and maintaining 270 VDC power is critical to operations. It may also be needed when high reliability is a defined concern.

This may be an additional cost item and although some manufacturers include it at no cost, it should not be required unless specifically requested by the user.

****

Converter must include Built-in test equipment(BIT), which monitors both primary circuits and protection circuits of the unit. Provide visual indication to assist diagnosis of unit failures to a modular level.

Provide visual indication of converter status using cabinet mounted light emitting diodes and Human Machine Interface (HMI). As a minimum the indicator lights must include a "machine on" light, and an "output faulted" indicator light that comes on when the unit has shut down.

]2.1.9 Magnetic Components

****

NOTE: Magnetic components are used within the converter unit. Do not delete this information. It is not included to imply permission to utilize transformers for modifying the input voltages to the converter.

****

Provide Class 180 power magnetic transformer and inductors in accordance with NEMA ST 20 and UL 506. The limits of Class 180 must not be exceeded at the maximum specified ambient temperature and at 100 percent load.

2.1.10 Acoustical Noise

****

NOTE: Converters are inherently noisy. Manufacturers standard for a 72 kW converter is 72 dBa, and their lowest attainable value is 68 dBa. If 68 dBa is specifically required by the Activity because of the location of the converter, include the "optional Acoustical Noise Test" in paragraph SPECIAL FACTORY TESTS, to verify that the equipment furnished meets the more stringent requirement. The test parameters (height and range) are included in that paragraph.

If a different size converter is required for a specific project, contact NAVFAC LANT for approval and for the appropriate acoustical noise modifications. The POC information is located at the beginning of this specification.

****

Provide unit with a maximum continuous acoustical noise level less than [72][68] dBa (A weighted scale).

2.1.11 Assembly Construction

****

NOTE: Per manufacturers, all converter enclosures require ventilation. Per NEMA 250 Tables 1 and 2, only NEMA Types 1,2,3R and 3RX are permissible to be ventilated. Verify availability by multiple manufacturers before using other enclosure types.

When location is outdoors, include the appropriate outdoor location coating and painting options.

When location is indoors, in item a:
- For Navy and Air Force, choose first option requiring flush wall mounting.
- For Army, choose second option and identify if

pedestal mounted in hangars or floor mounted in lab or other locations.
****

Provide enclosures suitable for [indoor][outdoor][corrosive][_____] environments in accordance with NEMA 250, Type [l][2][3R][3RX]. Arrange to provide required louvers, cooling air, entry and exit provisions for equipment within enclosures.

a. [Units must be mounted flush against the wall, must not require back access for maintenance, and must comply with the "Maintenance Envelopes" identified on the drawings.][Units must be [pedestal][floor] mounted as indicated and comply with the "Maintenance Envelopes" identified on the drawings.]

b. Construct unit(s) so that components, with the exception of control and monitoring components, are totally enclosed within the enclosure. Electronic circuits including power circuits must be modular construction readily accessible for maintenance, repair and module replacement from the front of the enclosure.[For units installed outdoors or in corrosive environments, [provide a conformal (rust-inhibiting) coating for the printed circuit boards][enclose electronic circuits in a sealed electronics compartment that is not provided with direct cooling ventilation or forced air cooling].]

c. Provide permanent identification tags for wiring. Uniquely identify each wire. Use the same identification system in the wiring diagrams in the Operation and Maintenance Manual. Enclosures must be painted in accordance with paragraph FACTORY APPLIED FINISH and as specified herein. Provide each enclosure with a finish coat over a rust inhibiting substrate or a substrate that has been provided with a rust inhibiting treatment.[For outdoor enclosures, if the unit is not painted using the powder coating process, provide two finish coats on the unit.]

d. Provide units with a Mean Time To Repair (MTTR) of 30 minutes from the time of the diagnosed failure based on documented manufacturer's historical data for the average time of repair for their top ten faults. Provide the supporting data with the equipment submittal.

2.2 AIRCRAFT POWER CABLE ASSEMBLY

****
NOTE: Coordinate cable assembly requirements with unit voltage requirements, aircraft requirements, and with paragraph AIRCRAFT INTERLOCK CIRCUIT. Point of use systems are required. Distributing through pits is not permitted on new installations. Distributing through other areas that increase total length beyond 43 meters 140 feet is not permitted on new installations.

For the Navy:

1) Use the 333 Amperes option and the 25 meters 83 feet length for all cable assemblies.

2) If a different amperage is specifically identified in the project requirements, or a longer

length is required due to a specific aircraft layout, approval must be obtained from NAVFAC LANT. The POC information is located at the beginning of this specification.

****

Provide a single-jacketed 270 VDC aircraft power cable assembly in compliance with SAE AS7974 and SAE AS7974/5. The 270 VDC output cable assembly must be constructed and tested to meet the power requirements of this specification, to minimize cross coupling, to meet current demand rates and to ensure power regulation, ripple, distortion, and transient voltage recovery, as defined herein, is not exceeded.

Rate cable for [333][_____] amperes. Cable length must be [43][_____]meters [83][_____]feet. Provide control cabling included within the jacket for interlock circuit. Terminate control wiring on accessible terminal blocks in unit. Provide cable assembly with integrally molded 270 VDC connector capable of connecting to the aircraft receptacle. Provide cable/connector assembly suitable for severe duty, with crimped contact terminations. Banded cables are not permitted. In addition, the assembly must comply with the following:

a. The 270 VDC and 28 VDC returns must be tied together only on the aircraft side of the on-aircraft external power receptacle.

b. The 28 VDC interlock output positive will be on pin "1" and output negative voltage will be on pin "2".

c. Pins "3" and "4" must be internally connected within the cable connector end to provide a "jumper" for interlock control (less than 0.1 ohms).

d. The contact section of the molded aircraft servicing connector must be capable of being repaired in the field. The contact section must be a one-piece, molded, replacement section or have individually replaceable pins and a molded one-piece cover. Installation of the replacement contact section must restore watertight integrity to the molded aircraft servicing connector. Repair must not include replacement of the entire aircraft servicing connector.

2.2.1 28 VDC Interlock

The 28 VDC interlock power must be within MIL-STD-704 "Normal Operating Limits", be available on power initiation, and must remain present throughout the duration of connection of power to the aircraft.

a. The 28 VDC interlock power must provide at least 15 amps of power capacity for aircraft equipment use.

b. The 270 VDC output must only be enabled when the 28 VDC interlock is present.

c. Power must only be available when the plug is fully seated in the aircraft receptacle.

d. The sensing back of the 28 VDC interlock from the aircraft must indicate a proper connection of the receptacle.

[2.3 REMOTE MONITORING AND CONTROL PANEL

****

NOTE: Delete this paragraph unless plans clearly indicate requirement for remote monitoring and control panel.

****

Provide remote monitoring and control panel and circuitry. Connect to clearly and permanently labeled terminal blocks located inside the converter's enclosure. Provide the circuitry such that indicator lamp/LED information and control function(s) can be extended from the terminals to a remote location in the future.

a. Pushbutton or switch for de-energizing the output terminals.

b. Indicator lamp/LED showing the unit status (energized or not energized).

c. Indicator lamp/LED showing the output control device position (open or closed).

d. System alarm.

]2.4 MANUFACTURER'S NAMEPLATE

Each frequency converter, each major component within the frequency converter, and each item of other equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.5 FACTORY APPLIED FINISH

****

NOTE: This paragraph covers only the basic painting requirements for most electrical equipment. Include any special finishes for high or low temperatures and extremely corrosive atmospheres. Use manufacturer's standard color unless the Activity requires a special color.

****

Electrical equipment must have factory-applied painting systems which must, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements as specified herein. Interior and exterior steel surfaces of equipment enclosures must be thoroughly cleaned and then receive a rust-inhibitive phosphatizing treatment, a primer powder coat, or equivalent treatment prior to painting. Exterior surfaces must be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces must receive not less than one coat of corrosion-resisting paint or powder coating process in accordance with the manufacturer's standard practice. When enclosure is aluminum, interior may optionally be coated with rust inhibiting treated film. Exterior surfaces must be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish, or finished with a powder coating process.[Color must be the manufacturer's standard color.][Equipment located indoors must be ANSI Light Gray,[and equipment located outdoors must be ANSI[Light Gray][Dark Gray]].] Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.6 SOURCE QUALITY CONTROL

2.6.1 Factory Test Schedule

The Government reserves the right to witness tests and reserves the right to request the raw data from the tests whether witnessed or not. Provide the converter test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

Test Instrument Calibration.

a. The manufacturer must have a documented calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. The accuracy must be directly traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule must not exceed 12 months for both test floor instruments and leased specialty equipment.

d. Provide dated calibration labels, that are visible on all test equipment.

e. Calibrating standard must be of higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

    (1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

    (2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.6.2 Routine Factory Tests

****

NOTE: Include the bracketed option, "As an exception..." when there are multiple, identically sized (in kW) converters on the same contract. Intent is to only do the "automatic line drop compensation test' on the first converter.

In item c, the aircraft power cable assembly is normally included in the project. If for some reason it is not part of the contract, modify the item and provide additional appropriate cable information (e.g. length and type) that the manufacturer should use for tests.

****

Perform routine tests by the manufacturer at the factory, on each of the actual converter(s) prepared for this project to ensure that the design performance is maintained in production.[As an exception, test automatic line drop compensation on only one unit on multiple unit orders of the same kW rating. If there are multiple units with different kW ratings, then testing one of each of the kW ratings is acceptable.] Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Include a list of the current test equipment calibration dates. Required tests, test conditions, and testing sequence is as follows:

a. For tests which require full load, use the nameplate full load kW of the unit being tested unless otherwise noted.

b. All measurements must be true RMS measurements. Obtain measurements in accordance with IEEE 1159. Monitor and record all data at the load end of the cable.

c. Connect loads to the converter with the specified aircraft power cable assembly.

d. No adjustments to the frequency converter are allowed between load tests.

2.6.2.1 Test Conditions

Tests must include the following conditions:

a. Initial Safety Verification: Perform tests and checks to validate the safe and timely shutdown for each condition (for the power source and the output cable) identified in paragraph SAFETY FUNCTIONS.

b. Input current and power factor: Operate converter at low, nominal and high input voltage at full load. Measure and record input voltage, input power factor and input current in each phase.

c. Output voltage, output current, and voltage regulation. Operate converter at nominal input voltage unless otherwise specified.

   (1) 50 percent of rated capacity.

   (2) 100 percent of rated capacity.

   (3) 50 percent of rated capacity with the loads as specified in the paragraph LOAD RANGE.

   (4) 100 percent of rated capacity at low and high input voltage.

   (5) 100 percent of rated capacity with the loads as specified in the paragraph LOAD RANGE.

   (6) Note - Operate for not less than 10 minutes at each test condition in (1), (2), (3) and (4) above, and for not less than 30 minutes at test condition in (5) above.

   (7) Note - Monitor and record each of the following at the beginning and end of each test condition: output voltage, output voltage waveform, output voltage ripple (peak-to-peak, distortion factor and distortion spectrum), output current, output current waveform, output current ripple (peak-to-peak, distortion factor and

distortion spectrum). Verify output remains within specified regulation limits at each load level by overlaying the graphs of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data.

d. Efficiency: Operate at nominal input voltage at half load and full load. Measure and record input voltage, input current, output voltage, and output current. Calculate the unit efficiency.

e. No load losses: Operate at no load and nominal input voltage. Measure and record input voltage, input current, input power, input power factor, and output voltage. Calculate the no load losses.

f. Overload: Operate at nominal input voltage and output voltage with loads and in sequence listed below:

****

NOTE: For the Navy: Coordinate with NAVAIR (POC information is at front of specification), to see if the NAVAIR Digital File Information has been completed before including the bracketed documentation option.

****

Percent of Full Load	Time	Time Between Overloads	Iterations
250 percent	50 milliseconds	5 minutes	3
200 percent	2 seconds	5 minutes	1
150 percent	10 seconds	10 minutes	1
125 percent	5 minutes	10 minutes	1
110 percent	30 minutes	2 hours	1

(1) Monitor output to confirm there is no 270 VDC power interruption.

(2) Provide graph showing current magnitude over time[in accordance with NAVAIR Digital File Information] for each condition above.

(3) Provide graph showing Output Voltage Response is in accordance with paragraph TRANSIENT OUTPUT VOLTAGE RECOVERY time and thresholds.

(4) After minimum operating time is achieved, unit must interrupt output power.

****

NOTE: Utilize the identified burn-in hours, unless a validated reason has been identified by the Activity (such as a requirement for a higher uptime confidence limit) to either reduce or increase the number of hours.

The last sentence in the BURN-IN TEST paragraph permits not using the Aircraft power cable assembly that has been mandated for all the other tests. This exception has been added because the specified cable may not withstand the current draw for this

length of time without overheating.
****

g. Burn-in Test: Before delivery, burn-in all units[under full load conditions for at least [24][_____] hours][by cycling units [6][_____] hours "ON" under full load conditions and [3][_____] hours "OFF" at no load conditions for at least [4][_____] complete "ON" cycles]. Perform burn-in test with the converter enclosure doors closed, load connected directly to the output terminals, and all ventilation in the final operating condition. The specified aircraft cable is not required to be used for this test.

h. Include harmonic frequency spectrum analysis depicting harmonic order across the range of individual harmonic occurrence, and harmonic magnitude for each load condition in the test reports. Conduct tests at the unit's input terminals (to the 37th harmonic) per IEEE standards. Output voltage distortion spectrum analysis must be measured out to 16,000 Hz.

i. Automatic line drop compensation: Operate converter at nominal voltage and verify specified performance of the line drop compensation at the following loads.

(1) No-load.

(2) 50 percent of rated capacity.

(3) 100 percent of rated capacity.

j. 28 VDC Interlock. Perform each of the above tests (a through h) at 50 percent and 100 percent of full 28 VDC load. Verify operation within specified limits. However, the burn-in test (item g) must be performed only at full load, and not at 50 percent load of 28 VDC.

k. Post Routine Test Safety Verification: Repeat tests conducted under item a. Initial Safety Validation to confirm safety features were not affected by previous tests.

2.6.3 Special Factory Tests (Design Tests)

****
NOTE: Include the bracketed option "each of" when there are multiple sizes of converters in the project.
****

Submit special factory test (design test) reports (complete with test data, explanations, formulas, results, setup and cable information, and the list of the calibration dates of the test equipment used), in the same submittal package as the catalog data and drawings for [each of] the specified converter(s). Tests must be certified and signed by a registered professional engineer or by a "company certified professional designee" within the manufacturers' organization. Submit designee's credentials with the initial design test report for approval. Tests must be on file based on a production model of converters of the same design, construction and kW rating provided.

****
NOTE: Include the first bracketed option below, "As

an exception..." unless there are more than 5 units on the project, or the units are going to a severe or hard to reach environment / strategic location. When choosing the second option instead of the first, coordinate with the Activity to determine the number of "production units" that must be tested.

The "As an exception..." sentence has always permitted the Special Factory Tests to be done on one of the first units produced, at the same time scheduled for the Routine Tests. However it was rarely used, since it only applies when the manufacturer already meets the experience requirements in the QUALIFICATIONS OF MANUFACTURER paragraph in Part 1 of this specification, but was building a slightly different unit without the specific design tests already on file.

With the new requirements in this specification, this exception may become more frequently used since test data may not be on file. The manufacturer still has to meet the QUALIFICATIONS OF MANUFACTURER paragraph, and all of the Special Factory Tests will still be subject to being witnessed by the government with the Routine tests.

****

[As an exception, when the manufacturer does not have the special factory tests for the specific unit characteristics already on file, the manufacturer may conduct the special factory tests on the first "production unit" along with the routine tests.][The manufacturer must test [one][_____] unit[s] at the same time scheduled for routine tests, of each rating and size converter.] To assure compliance with the specification, these tests are also subject to government witnessing at the same time as the routine tests. For all tests which require full load, use the nameplate full load kW of the unit being tested, unless otherwise noted. For all tests that are "not already on file", connect loads to the converter with an aircraft power cable assembly, 43 meters 140 feet long, similar to the specified project aircraft power cable assembly. Monitor and record all data at the load end of the cable, unless otherwise noted. The tests conducted on the unit must include the following:

****

NOTE: Select Location Category C for outdoor locations only.

****

a. Initial Safety Verification: Perform tests and checks to validate the safe and timely shutdown for each condition (for the power source and the output cable) identified in paragraph SAFETY FUNCTIONS.

b. Surge protection: Apply input surges in accordance with IEEE C62.41.1 and IEEE C62.41.2, Location Category [B][C] and monitor output. Conduct a minimum of three consecutive successful tests on each unit listed. Confirm there is no interruption to 270 VDC output power and voltage stays within specified regulation tolerances. Surge protection tests must be applicable on all converter units utilizing same surge protection device by manufacturer and part number regardless of converter kW size.

c. Input current: Perform the following tests at nominal input voltage. Conduct each test a minimum of three times. Monitor the input and output power to demonstrate the duration of the transients until the converter reaches steady state. Provide copies of waveforms and analysis in test report.

  (1) Measure inrush current when initially turning on machine with no load.

  (2) After applying power and unit is at steady state, conduct load application test, going from 0 to full load to measure affect on input.

d. Input current distortion: Operate at nominal input voltage at 0, 25, 50, 75, and 100 percent of rated full load. Measure and record the input current THD for the current in each phase.

e. Input current and power factor: Operate converter at low, nominal and high input voltage at full load. Measure and record input voltage, input power factor and input current in each phase and neutral if the neutral conductor is connected to the converter input.

f. Output voltage, output current, and voltage regulation. Operate converter at nominal input voltage unless otherwise specified.

  (1) 50 percent of rated capacity.

  (2) 100 percent of rated capacity.

  (3) 50 percent of rated capacity with the loads as specified in the paragraph LOAD RANGE.

  (4) 100 percent of rated capacity at low and high input voltage.

  (5) 100 percent of rated capacity with the loads as specified in the paragraph LOAD RANGE.

  (6) Note - Operate for not less than 10 minutes at each test condition in (1), (2), (3) and (4) above, and for not less than 30 minutes at test condition in (5) above.

  (7) Note - Monitor and record each of the following at the beginning and end of each test condition: output voltage, output voltage waveform, output voltage ripple (peak-to-peak, distortion factor and distortion spectrum), output current, output current waveform, output current ripple (peak-to-peak, distortion factor and distortion spectrum). Verify converter is operating within specified regulation limits at each load level by overlaying the graph of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data.

g. Include harmonic frequency spectrum analysis depicting harmonic order across the range of individual harmonic occurrence, and harmonic magnitude for each load condition in the test reports. Conduct tests at the unit's input terminals (to the 37th harmonic) per IEEE standards. Output voltage distortion spectrum analysis must be measured out to 500,000 Hz per MIL-STD-704.

****

NOTE: For the Navy: Coordinate with NAVAIR (POC information is at front of specification), to see if the NAVAIR Digital File Information has been completed before including the bracketed documentation option. Include bracketed option once NAVAIR has established a defined version of Digital File Requirements (still in progress).

****

h. Overload: Operate at nominal input voltage and output voltage with loads as listed below:

Percent of Full Load	Satisfactory Operating Time	Time Between Overloads	Iterations
110 percent	30 minutes	2 hours	3
125 percent	5 minutes	10 minutes	3
150 percent	10 seconds	10 minutes	3
200 percent	2 seconds	5 minutes	3
250 percent	50 milliseconds	5 minutes	3

i. Monitor output to confirm there is no 270 VDC power interruption. After minimum operating time is achieved, unit must interrupt output power. Provide voltage and current waveforms [in accordance with NAVAIR Digital File Information] documenting the unit's response for each test.

j. Short-circuit: Apply a bolted positive to negative fault directly to the output terminals of the unit. Conduct a minimum of three consecutive successful tests on each unit. Provide unit capable of carrying the fault current until the integral system protective devices interrupts the fault with no damage to the unit. Provide waveforms of short circuit current during short circuit tests.

k. Transient Output Voltage Recovery: Operate at the following load steps: 0 to 100 percent, 0 to 50 percent, 100 to 0 percent and 50 to 0 percent. Measure and record recovery time and output voltage deviation limits. Provide recordings or display of output voltage during transient recovery test. Verify converter is operating within specified regulation limits at each load level by overlaying the graph of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data.

****

NOTE: Delete bracketed acoustical noise test unless converter is installed in special locations such as test laboratories or other confined spaces and a lower than 72 dBa value is specified.

The test parameters (Height and Range)identified below, meet the ANSI SI 4 requirements. However the standard is not referenced because it "allows units to be averaged over a certain production range /quantity", whereas we want each unit to be individually compliant.

The optional paralleling test has been removed from this version of the specification. If it is required because of a critical location, approval and specific verbiage must be obtained from NAVFAC LANT. The POC information is located at the beginning of this specification.

****

[l. Acoustical noise: Operate at no load, 50 percent and 100 percent of full load. Measure continuous steady sound pressure level 1525 mm 5 feet horizontally from the center of each side of the converter at a point 1525 mm 5 feet above the floor. Decibels (dB) are referenced to 20 micropascal.

] m. Post Special Test Safety Verification: Repeat tests conducted under item a. Initial Safety Verification, to confirm safety features were not affected by previous tests.

2.7 ARC FLASH WARNING LABEL

****

NOTE: Include the Arc Flash Warning Label detail on the drawings. See the technical notes at the beginning of this section to obtain the AutoCAD drawing file of the label.

****

Provide arc flash warning labels for arc flash protection in accordance with NFPA 70E and NEMA Z535.4 for the enclosures of electrical equipment that are likely to require examination, adjustment, servicing, or maintenance while energized. Locate this self-adhesive warning label on the outside of the equipment compartment doors warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated. The marking must be clearly visible to everyone, including qualified persons, before examination, adjustment, servicing, or maintenance of the equipment.

2.8 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings. Provide note on panelboard schedules to indicate where other than black center core labels are required

****

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 by 65 mm 1 by 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.9 GROUNDING AND BONDING

****

NOTE: Include the reference to Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION when equipment is also being provided outside.

****

UL 467. Provide grounding and bonding as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM[and for exterior work, in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

[2.10 CAST-IN-PLACE CONCRETE

****

NOTE: Include concrete requirements when equipment is also being provided outside on concrete pads.

****

Provide concrete associated with electrical work for other than encasement of underground ducts rated for 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

]PART 3 EXECUTION

3.1 INSTALLATION

Install products to operate at 270 VDC in the same manner as specified in other sections of this specification for products operating at [50] [60] Hz, unless indicated or specified otherwise. Conform to the requirements of NFPA 70 and IEEE C2 and to manufacturer's instructions and recommendations.

3.2 EQUIPMENT

3.2.1 Floor Mounted

Provide proper floor mounting channels and install in accordance with the manufacturer's drawings and instructions and as indicated. Align, level, and bolt units to channels to allow easy withdrawal or insertion of removable components and to permit proper operation and maintenance of equipment. When in a Class 1, Division 2 area, mount units at least 18 inches above finished floor.

[3.2.2 Wall Mounted

****

NOTE: Wall mount units 5 kW or less. Floor mount all other units.

****

Bracket mount, but otherwise install as required for floor-mounted units.

][3.2.3 Maintenance Platform Mounted

****

NOTE: When used, verify drawings identify:
1) An appropriate maintenance platform with safety

details including the maintenance envelope.
2) The location of the remote control panel and interconnecting conduit and wiring.
****

Install as required for floor-mounted units.

]3.2.4 Grounding and Bonding

In accordance with NFPA 70 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

[3.2.5 Grounding and Bonding - Exterior Equipment

****
NOTE: When equipment in the project is located outdoors, include the optional grounding and foundation (concrete pad) requirements. Use 25 ohms unless the project requires more stringent requirements.
****

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms.

3.2.5.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.5.2 Pad-Mounted Equipment Grounding

****
NOTE: Ensure plans show the pad details and ground connections matching how this paragraph is edited. Converter is to have a ground ring and the normal number of ground rods is two. The one ground rod option should only be chosen if required by local installation requirements.
****

Provide a ground ring around the equipment pad with 4/0 AWG bare copper.[Provide two ground rods in the ground ring at opposite corners.][Provide one ground rod in the ground ring with the ground rod located in the equipment cabinet.] Install the ground rods at least 3000 mm 10 feet apart from each other. Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.5.3 Connections

Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors. Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.6 Foundation for Equipment and Assemblies

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the requirement is located. Include construction requirements for concrete slab only if slab is not detailed on drawings.

****

Mount equipment on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 200 mm 8 inches thick, reinforced with a 152 by 152 mm MW19 by MW19 6 by 6 inches - W2.9 by W2.9 mesh placed uniformly 100 mm 4 inches from the top of the slab.

b. Place slab on a 150 mm 6 inch thick, well-compacted gravel base.

c. Install slab such that top of concrete slab is approximately 100 mm 4 inches above the finished grade with gradual slope for drainage.

d. Provide edges above grade with 15 mm 1/2 inch chamfer.

e. Provide slab of adequate size to project at least 200 mm 8 inches beyond the equipment.

Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with equipment cable training areas.

3.2.6.1 Cast-In-Place Concrete

Provide cast-in-place concrete work in accordance with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

[3.2.6.2 Sealing

****

NOTE: Require sealing of cable wells (windows) in the concrete pad if rodent intrusion is a problem.

****

When the installation is complete, seal all entries into the equipment enclosure with an approved sealing method. Provide seals of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

]]3.2.7 Wiring and Conduit

****

NOTE: Designers of Record must provide calculations and ratings for conductors, circuit breakers (50Hz / 60Hz), and devices operating at 270 VDC and at 28 VDC.

Use of a distributed 270 VDC power system (instead of a Point of Use system), is prohibited on new

projects, and is limited to making modifications to existing systems. If used, a distributed system may require additional special calculations.

See UFC 3-555-01 (Draft in progress) for additional information.
****

Provide wiring and conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Use copper conductors for DC systems.

3.2.8 Manufacturer's Representative

The manufacturer's representative must place the system in operation and make necessary adjustments to ensure optimum operation of the equipment. The manufacturer's representative must have at least 2 years of practical experience in the installation and testing of 270 VDC solid state converters.

3.3 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.5 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.6 FIELD QUALITY CONTROL

3.6.1 Field Test Schedule

****
NOTE: Include the bracketed options below on Navy projects where "reach-back support" has already been coordinated with NAVAIR / NAVFAC LANT per the third introductory Technical Note at the beginning of this specification section.
****

Give Contracting Officer[and (NAWCAD Air Vehicle Electrical Power Systems Group (AB43) (301) 342-4161] 30 days notice of dates, times and scheduled tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity[and NAVAIR / NAVFAC LANT,] and schedule a time that will eliminate or minimize interruptions and interference with the activity operations.

3.6.2 Instruments

Provide test instruments capable of measuring and recording or displaying test data at a higher resolution and greater accuracy than specified for the converter's performance. The test instruments used in the field tests must have current valid calibration stickers issued by an approved calibration laboratory. Verify calibration and adjustments of converter instruments provided prior to field tests. Calibrate instruments for 270 VDC operation when measuring 270 VDC signals.

3.6.3 Initial Inspection and Tests

****

NOTE: Include the bracketed option for the NETA ATS Representative when Section 26 08 00 APPARATUS INSPECTION AND TESTING is included in the project. Ensure that the list of identified specification sections that the NETA inspector is responsible for includes this section (see bracketed options in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

****

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests.[In addition, coordinate with the NETA ATS representative to witness, document, and validate the converter Field Quality Control.]

a. Compare equipment nameplate information with specifications and approved shop drawings.

b. Inspect physical and mechanical condition. Inspect cables and wiring harnesses for damage and strain relief.

c. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey. Perform thermographic survey while the unit is at full load during the loadbank test.

d. Perform specific inspections and mechanical tests as recommended by manufacturer.

e. Verify correct equipment grounding.

3.6.4 Field Performance Checks and Tests

Conduct converter field checks and tests under the supervision of the manufacturer's representative. Provide labor, equipment, test instruments, and incidentals required for the tests including load banks, except the Government will furnish the electricity.

All tests must be performed with the load connected to the load end of the specified aircraft cable assembly. The cable must be laid out / uncoiled to provide heat dissipation. No adjustment to the converter is allowed between tests. Successfully complete the safety verification, preliminary operation, and the control and protective devices check prior to performing load and transient tests. Load tests must be performed with the converter doors closed and the 28 VDC at full load. If the converter fails to operate within the specified limits during any of the tests, discontinue the test, make necessary repairs to correct the failure, and restart testing of the converter. Repeat all previously completed tests and document the respective failed test data and new data.

3.6.4.1 Initial Safety Verification

Perform tests and checks to validate the safe and timely shutdown for each condition (for the power source and the output cable) identified in paragraph SAFETY FUNCTIONS. As an exception, a representative fault test will be sufficient at this time.

3.6.4.2 Preliminary Operation

****

For the Navy: NAVAIR is working on and will provide the requirements for a "digital manual" / type of "Data Acquisition system." All Manufacturers should also already have one of their own. The future goal is to include the standardized requirement as part of the specification so that NAVAIR will have the various manufacturer's equipment information, in a consistent format, submitted and then on file in the NAVAIR Database system for maintenance and problem solving. At that time, we will determine whether it will be possible to include as an attachment / sample in the specification or possibly as a reference to a UFC Appendix.

****

Inspect the converter and make adjustments necessary to assure proper operation in accordance with the manufacturer's instructions. Operate converter at 0, 25, 50, 75, and 100 percent of rated full load. On the input measure and record the voltage, current, frequency, and THDs (voltage and current) at each load. On both the 270 VDC and the 28 VDC outputs, measure and record the voltage, current, DC ripple, distortion spectrum, and distortion factor at each load. Verify converter is operating within specified regulation limits at each load level by overlaying the graph of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data. Verify the operation of the 28 VDC Interlock Power.

Test data must include input voltage and current harmonic distortion amplitudes of all individual harmonics presented in a spectrum analysis format up to the 15th order at the 50 percent and 100 percent load points. Output voltage distortion spectrum analysis must be measured out to 6,000 Hz.

3.6.4.3 Control and Protective Device Checks

Operate each control, switch, input/output device that is capable of being operated manually a minimum of three times, demonstrating satisfactory operation each time. Perform operation test on each protective device to ensure that devices function properly. After each operation measure and record the converter output voltage and current. Verify converter is operating within specified limits.

3.6.4.4 Load (Burn-in) Test

****

NOTE: Include the bracketed option "For converters used ..." only when one of the converters, on a multi converter project, will not be connected to the aircraft cable assembly when in service; e.g. used in a lab setting instead.

In the rare condition, where there is only the one converter in a lab setting, then delete the entire sentence before the bracketed option as well.

****

Operate each unit continuously a minimum of 1 hour at 100 percent rated full load. Perform a concurrent load (burn in) test for the 270 VDC and the 28 VDC loads. Measure and record the converter output voltage and current (both 270 VDC and the 28 VDC Interlock Power), at beginning, 30 minutes, and 1 hour. Verify converter is operating within specified limits. Load test must be performed with the converter doors closed and the test load connected to the converter at the cable head with specified aircraft cable assembly.[For converters used to supply test bench loads, perform load tests with the converter doors closed at the output of the converter.]

3.6.4.5 Post Load Test Verification

Repeat tests identified in paragraph PRELIMINARY OPERATION, to validate converter was not affected by the Load test. However apply loads in the reverse order (e.g. 100, 75, 50, 25, and 0 percent of the rated full load).

Conduct tests on each converter with the load connected to the load end of the specified aircraft power cable assembly. No adjustment to the converter is allowed between load tests. Monitor and record output voltage at the load end of the cable. Verify converter is operating within specified regulation limits at each load level by overlaying the graph of Figure 263544 - 1 with the 270 VDC test data, and Figure 263544 - 2 with the 28 VDC test data. In addition, verify specified performance of the line drop compensation.

3.6.4.6 Final Safety Verification

Repeat tests conducted under paragraph INITIAL SAFETY VERIFICATION to confirm safety features were not affected by previous tests.

3.6.5 Grounding System

Inspect grounding system for compliance with contract plans and specifications.

3.7 DEMONSTRATION

3.7.1 Instructing Government Personnel

****

NOTE: For Navy: Include bracketed option requiring coordination with NAVAIR and coordination with Activity on availability of aircraft for conducting training.

****

Provide field training to Government personnel on the operation and maintenance of the converter provided at the same time as the Field Acceptance Testing.[For Navy projects contact NAWCAD Air Vehicle Electrical Power Systems Group (AB43) at (301) 342-4161 to obtain the name and e-mail of the NAVAIR point-of-contact so they can attend the training. Coordinate with the Activity to establish availability and non-availability to train on actual aircraft.] Include up to a maximum of 2 hours of instruction on operation and up to a maximum of 4 hours of repair and maintenance of the converters. The instructor must be approved by the manufacturer of the unit provided. Submit training syllabus including each topic of training and a brief outline of each topic to the Contracting Officer at least 4 weeks prior to training for approval.

Training must be approved by the Contracting Officer at least 2 weeks in advance. The Government may record, video and audio, the training sessions and use these recordings to train personnel on the operation and maintenance of the converter system. Provide two copies of video or audio DVDs, and of any supplemental information and examples covered in the training sessions, to the Contracting Officer.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 36 23 (May 2020)**
Change 1 - 08/21

Preparing Activity: USACE **Superseding**
UFGS-26 36 00.00 10 (October 2007)
UFGS-26 36 23.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH

05/20, CHG 1: 08/21

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 36 23 (May 2020)**
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References are in agreement with UMRL dated January 2025

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SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH
05/20, CHG 1: 08/21

****

NOTE: This guide specification covers the requirements for low voltage applications (600V or less) of automatic transfer switches (ATS) and ATS with by-pass/isolation switches. See TSEWG TP-09 Automatic Transfer Equipment white paper at https://www.wbdg.org/ffc/dod/supplemental-technical-criteria/tsewg-tp-09**See TSEWG TP-19 Static Uninterruptible Power Supply (UPS) white paper at** https://www.wbdg.org/ffc/dod/supplemental-technical-criteria/tsewg-tp-19 **This specification supersedes previous versions of UFGS-26 36 00.00 10 Automatic Transfer Switch and By-Pass/Isolation Switch and UFGS-26 36 23.00 20 Automatic Transfer Switches.**

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification is for use when the nature of electrical loads indicates a need for automatic transfer between two power sources. Terminology used depends on the application. "Preferred" and "alternate" should be used when this

specification applies to a stand-by generator system as defined in NFPA 70. The same terminology should be used when switching between different sets of service entrance conductors or between feeders supplied by different transformers. "Normal" and "emergency" should be used for the emergency system application described in NFPA 70.

This specification covers conventional, standard, commercially available equipment appropriate for most Department of Army/Air Force/Navy applications. Special applications may require synchronized, closed-transition transfer, or withdrawal features to facilitate rapid maintenance or repair. Manufacturers of standard ATS may be able to provide ATS for special applications.

Fire pumps may utilize an automatic transfer switch. NFPA 20 describes Arrangement I and Arrangement II. Arrangement I is the most common and it is where the ATS is part of the fire pump controller and Section 21 30 00 FIRE PUMPS is to be used instead of this specification. Arrangement II is a separate ATS from the controller. This is not as common since the switch has to be listed for electric-motor driven fire pump service and there are only a few manufacturers that have this listing.

****

****

NOTE: The following system design requirements are to be adhered to when providing automatic transfer switches:

1. The neutral conductor for each source of supply, including the neutral on separately derived systems, must be switched by the transfer switch.

2. Service rated automatic transfer switches are available (ATS and service entrance breaker included in one enclosure). In many cases it is more cost effective to include the service overcurrent protection internal to the enclosure in addition to the ATS and this is the recommended approach. Designer should consider cost savings due to elimination of additional cable and installation labor. If this is not possible or practical, then specify a service rated transfer switch with the appropriate integrated overcurrent protection as part of the transfer switch.

3. Do not use open type transfer switches installed in other equipment such as switchboards. Consideration should be made regarding overall installation cost and minimizing footprint.

****

****

NOTE: Use the following related guide

specifications for power distribution equipment:

--Section 26 08 00 APPARATUS INSPECTION AND TESTING
--Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM
--Section 26 23 00 LOW-VOLTAGE SWITCHGEAR

Do not use the following related guide specifications except for Army Civil Works projects. They have not been unified:

--Section 26 22 00.00 10 480-VOLT STATION SERVICE SWITCHGEAR AND TRANSFORMERS
--Section 26 28 00.00 10 MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS

****

****

NOTE: Show the following information on the project drawings:

1. The available fault current at the bus feeding the automatic transfer switch.

2. The rating of the overcurrent device protecting the automatic transfer switch.

3. Identify automatic transfer switches to be provided with By-pass/Isolation Switches, when applicable.

4. Identify control type, i.e., Utility-Generator, Preferred Utility Source, or Generator-Generator, for each automatic transfer switch.

5. Identify automatic transfer switches to be provided with "transfer time delay"/"time delay transition" or "in-phase monitor" features, where applicable.

6. Identify automatic transfer switches to be used for fire pump service, when applicable.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 602	(2007) Recommended Practice for Electric Systems in Health Care Facilities - White Book

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 20	(2025) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 99	(2024) Health Care Facilities Code
NFPA 110	(2025) Standard for Emergency and Standby

Power Systems

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 1008	(2022) UL Standard for Safety Transfer Switch Equipment
UL 1066	(2022) UL Standard for Safety Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.2 RELATED REQUIREMENTS

****

NOTE: Include this paragraph on Navy projects; otherwise, delete.

****

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and Section 26 08 00 APPARATUS INSPECTION AND TESTING, applies to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Automatic Transfer Switch Drawings; G, [_____]

SD-03 Product Data

Automatic Transfer Switches; G, [_____]

[By-Pass/Isolation Switch (BP/IS); G, [_____]

][Remote Annunciator Panel; G, [_____]

][Remote Annunciator and Control System Panel; G, [_____]

] SD-06 Test Reports

Acceptance Checks and Tests; G, [_____]

Functional Acceptance Tests; G, [_____]

Factory Testing; G, [_____]

Factory Test Reports; G, [_____]

[Factory Testing -Medical Facilities; G, [_____]

] SD-07 Certificates

Proof of Listing; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual, Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, Data Package 5; G, [_____]

1.4 OPERATION AND MAINTENANCE MANUAL

Assemble and bind manuals in durable, hard-covered, water resistant binders. Assemble and index the manuals per the following table of contents:

a. Manufacturer's O&M per "SD-10 Operation and Maintenance Data".

b. Catalog data required by "SD-03 Product Data"

c. Drawings required by "SD-02 Shop Drawings".

1.4.1 Additions to Operation and Maintenance Manuals

In addition to requirements of SD-10 Data Package 5, include the followings on the actual equipment provided:

a. An outline drawing, front, top, and side views.

b. Prices for spare parts and supply list.

c. Date of Purchase.

d. Corrective maintenance procedures.

e. Operating manual outlining step-by-step procedures for system startup, operation, and shutdown.

f. Include simplified wiring and control diagrams in the manual for system as installed.

g. Provide typical contact voltage drop readings under specified conditions for use during periodic maintenance. Provide instructions for determination of contact integrity.

[1.4.2 Spare Parts

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NOTE: Do not provide spare parts for Navy projects.

****

Furnish the following the following minimum spare parts and any other spare parts required in one-year operation, of the same material and workmanship, meeting the same requirements, and interchangeable with the corresponding original parts.

a. Fuses: Two of each type and rating.

]1.5 QUALITY ASSURANCE

1.5.1 Proof of Listing

Submit proof of listing by UL 1008.

1.5.2 Automatic Transfer Switch Drawings

Include the following as a minimum:

a. An outline drawing, including front, top, and side views.

b. Provide a nameplate of corrosion-resistant material with not less than 3 mm 1/8 inch tall characters showing manufacturer's name and equipment ratings. Mount nameplate to front of enclosure and meet the nameplate requirements of NEMA ICS 2.

c. Provide detail drawings that include manufacturer's name and catalog number, electrical ratings, total system transfer statement, reduced normal supply voltage at which transfer to the alternate supply is initiated, transfer delay times, short-circuit current rating, wiring diagram, description of interconnections, testing instructions, acceptable conductor type for terminals, tightening torque for each wire connector, and other required UL 1008 markings.

d. Submit interface equipment connection diagram showing conduit and wiring between ATS and related equipment. Provide diagrams showing interlocking provisions and cautionary notes, if any.

e. Drawings are to indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.5.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated

1.5.4 Standard Product

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4.1 Alternative Qualifications

Products having less than a 2-year field service record are acceptable if the manufacturer has been regularly engaged in the design and production of automatic transfer switches and if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 years prior to date of delivery to site are not acceptable.

1.6 DELIVERY AND STORAGE

Protect equipment placed in storage from humidity and temperature variations, moisture, water intrusion, dirt, dust, or other contaminants. In harsh environments where temperatures exceed non-operational parameters established within this specification, provide an environmentally controlled equipment storage facility to ensure temperature parameters are within equipment specification. Provide documentation of same to the

Government when storage is implemented.

1.7 ENVIRONMENTAL CONDITIONS

****

NOTE: Do not use this paragraph and subparagraphs for the Navy.

****

Provide an ATS that is suitable for prolonged performance under following service conditions:

a. Operating altitude: Sea level to 1,000 meters 3,300 ft. (Systems applied at higher altitudes are to be derated in accordance with the manufacturer's instructions).

b. Operating ambient temperature range:-[-4][_____] to [40][_____] degrees C [40][_____] to [104][_____] degrees F.

c. Operating relative humidity: 0 to 90 percent, without condensation.

[1.8 SEISMIC REQUIREMENTS

****

NOTE: Do not use this paragraph for Navy projects. When directed to meet Seismic Requirements, 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT must be edited to suit the project and be included in the contract documents. Edit the following paragraph and include it in the project specification. When a Government designer is the Engineer of Record, provide seismic requirements on the drawings.

****

Provide seismic details[conforming to[Section 13 48 73, SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT][and to][Section 26 05 48, SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]][as indicated].

]PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCHES

****

NOTE: Withstand closing current ratings listed in UL 1008 should be used when fault currents are less than withstand closing current rating listed. However, in no case should withstand current rating be less than 10,000 amperes.

Where closed-transition transfer is required, coordinate system design requirements with power supplier.

Delete BP/IS requirements if not applicable. Delete reference to IEEE 602 if not applicable.

****

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NOTE: UFC 3-520-01 Interior Electrical Systems requires the neutral to be switched for grounded systems. The alternate power source is considered a separately derived system when the neutral is switched per the National Electrical Code.

Sizing of neutral bus, pole, contacts, and terminations should consider harmonic currents. Harmonic currents tend to have a high zero phase sequence component, which are additive in neutral circuit. Neutral ampere rating may need to be higher than phase contacts.

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NOTE: Select the following options for switches to be installed in facilities complying with UFC 4-510-01, Design: Military Medical Facilities located at : (a) Switches utilizing circuit breakers are not acceptable; (b) "Automatic Transfer Switches are to be provided with drawout construction. Verify requirements with latest version.

NOTE: Option "Switches utilizing circuit breakers are not acceptable for critical applications." If not a medical facility, this is a choice by the designer.

****

Each automatic transfer switch must be rated and marked for total system transfer and have the current and voltage ratings as indicated. Provide a switch operating mechanism that is electrically operated, have quick-make, quick-break, load break contacts, and be mechanically held in both positions. [Switches utilizing circuit breakers are not acceptable.] Provide an ATS that is UL listed. ATS must be manufactured and tested in accordance with applicable requirements of NEMA ICS 2, UL 1008 and UL 1066. ATS must conform to NFPA 110. Provide the ATS with the following characteristics:

a. Voltage: [_____] volts [ac][dc].

b. Amperage: [_____] amps [ac][dc]. Provide an ATS with a continuous load current rating of the switch rating.

c. Number of Phases: [Three][One].

d. Number of Wires: [Four][Three][Two].

e. Frequency: [60][50] Hz.

f. Poles: [Four switched][Three switched][Two switched]. [One of the poles is the neutral.]

g. ATS Withstand Current Rating: ATS must be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals. The ATS must be listed in accordance with UL 1008 for 3 [18] [30] cycle close and withstand ratings. Minimum UL listed close and withstand ratings at 208 VAC [480 VAC] must be 30 [42] [65] [100]

[200] kA.

h. Nonwelding Contacts: Provide contacts that are nonwelding at the available fault current rating. Contacts must be suitable for repetitive power transfer switching. Switches rated 800 amps and above must have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

****

NOTE: It is standard to have the ATS with contacts rated at the same value as the main contacts. Requesting a 200 per cent contacts for the neutral is an option, but can increase the cost and size of the transfer switch. Increasing the neutral needs to be considered where the majority of the load is non-linear, which can result in increased neutral current.

****

i. [Phase and Neutral] [Phase] Contacts: Provide contacts with silver alloy composition. [Provide neutral contacts with the same continuous current rating as main or phase contacts.] [Provide neutral contacts with 200 percent the current rating of the phase contacts.]

****

NOTE: Per NFPA 70, emergency, legally required standby, and critical operations power systems require the ATS to be listed for emergency use.

****

j. Configuration. Provide an ATS for use in [emergency systems][legally required standby system][optional standby systems][critical operations power systems] described in NFPA 70. [Provide an ATS that is listed for emergency use.]

****

NOTE: Open transition is the default choice. Closed transition may be required with some UPS. Closed transition requires coordination with the local utility. See UFC 3-540-01 Engine-Driven Generator Systems for Prime and Standby Power Applications.

****

k. ATS Configuration. [Provide an open transition ATS.][Neutral is to break and make with the phase contacts.][Phase contacts are to break and make, but the neutral is to make before break (overlap).][Provide a closed transition ATS.]

****

NOTE: The circuit breaker should be rated for 100 percent. Switches rated below 2500 amps may have the breaker rated for 80 percent. Default is 100 percent

****

[l. Service Entrance Rated. Provide an integrated circuit breaker and automatic transfer switch. Provide a separate deadfront compartment for the circuit breaker on switches 600 amp and larger. Provide label indicating that the ATS is the service disconnect. Provide a circuit breaker that is rated for [100 percent][80 percent] of the switch contact current rating. All components, except as noted herein, are to have a continuous load rating.

]

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NOTE: Provide this option for Medical Facilities. This is not a common option.

****

[m. Viewing Ports. Provide contacts that are viewable from the front of the device when the door is open. Comply with the requirements found in IEEE 602 and NFPA 99

]

****

NOTE: Choose only if a NFPA 20 rated ATS is required for the fire pump

****

[n. Fire Pump Service. Provide a manual operating means that is externally operable without opening the enclosure on transfer switches for fire pump service. The manual means is to open and close the switch contacts at the same rate of speed as that caused by the automatic operation of the switch. The ATS is to meet the requirements found in NFPA 20.

]

2.1.1 Undervoltage Sensing - Normal/Preferred Source

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NOTE: Where utility type power source is used and application is standard, monitoring devices should drop out at 85 percent of nominal value and pick up at 90 percent. Where precise power is monitored, protection should be specified with monitoring devices set to drop out at 90 percent of nominal and pick up at 95. In applications requiring closer regulation, solid state or microprocessor arrangement may be used with pickup and dropout response adjusted as close as 2 percent differential. However, for these applications a redundant uninterruptible power supply should be considered.

****

Undervoltage Sensing - Normal Source. Provide undervoltage sensing for each phase in the normal/preferred source. Sense low phase-to-ground voltage on each phase. Provide sensing circuit with adjustable dropout, 75-98 percent of nominal value and adjustable pickup, 85-100 percent of nominal value. Factory set dropout value to [85][90][80][_____]percent. Factory set pickup value to [90][95][_____]percent.

2.1.2 Adjustable Time Delay - Override Transfer

****

NOTE: ATS operation should not be initiated during low voltage conditions attributed to a fault or to momentary dips or excursions (transients) in normal or preferred power source. Time delay before monitored source override should exceed associated circuit breaker tripping time and normal system voltage instability periods. Minimum of 1 second

is recommended.

****

Adjustable Time Delay - Override Transfer. For override of normal-source voltage sensing to delay transfer[and engine starting] signals. Engine starting control contacts with adjustable commit-to-start delay circuit, 0.0-6.0 seconds. Factory set at [1][0.5][_____]second[s].

2.1.3 Voltage/Frequency Lockout Relay - Alternate/Emergency Source

Voltage/Frequency Lockout Relay. [Single-][Three-]phase sensing must be provided on the normal and emergency source. Prevent premature transfer to alternate/emergency source. Provide pickup voltage that is adjustable from 85-100 percent of nominal. Factory set for pickup at [90][_____] percent. Provide pickup frequency that is adjustable from 90-97 percent of nominal. Factor set frequency pickup for [95][_____] percent.

2.1.4 Adjustable Time Delay - Transfer to Alternate/Emergency Power Source

****

NOTE: Provide transfer to emergency or alternate source time delay for the transfer switches requiring delayed-automatic operation. For an emergency power source choose 0 seconds.

Use nonzero setting where multiple ATS require staggered application of load steps to alternate or emergency source.

****

Adjustable Time Delay - Transfer to Alternate Power Source. Transfer to alternate power source time delay for transfer switches as indicated, adjustable 0-5 minutes. Factory set to [0][_____] seconds. ATS is to monitor the frequency and voltage of alternate power source and transfer when frequency and voltage are stabilized.

2.1.5 Adjustable Time Delay- Re-transfer to Normal/Preferred Source

****

NOTE: Typical factory setting is 10 minutes.

****

Adjustable Time Delay- Transfer to Source. Re-transfer to normal source time delay, adjustable 0-30 minutes. Factory set at [10][_____] minutes. Time delay is automatically defeated upon loss or sustained undervoltage of alternate power source, provided that normal source has been restored.

[2.1.6 Engine-Generator Exerciser

****

NOTE: Use this paragraph when automatic system exercising is required by nature of loads and desired reliability. Automatic system exerciser is recommended when diesel engine driven generator set is used, but only if automatic feature is manually initiated and can be manually overridden during exercise period to return ATS to normal or preferred source.

Consult ATS manufacturers' literature for feature availability, timing interval range, and pickup and dropout settings. Insert proper values for application.

****

Exerciser. Solid-state, programmable-time switch exerciser to allow automatic starting of the generator set, subsequent load transfer, retransfer of load and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from on a daily, weekly, bi-weekly or monthly basis.. Running periods are adjustable from 10-30 minutes. Factory settings are for 7-day exercise cycle, 20 minute running period and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer or dual independent exercisers that allow for unloaded and loaded schedule testing.

b. Push-button programming control with digital display of settings.

c. Integral battery operation of time switch when normal control power is not available.

][2.1.7 Engine Shutdown Time Delay

****

NOTE: Omit this paragraph if there is no generator in transfer scheme. Recommended values for normal applications are shown in brackets but may be changed for other design conditions. Where values are not shown or different settings are required, specify values and settings.

****

Engine Shutdown. Provide time delay that is adjustable from [0][_____] to [5][_____] minutes and is factory set at [5][_____] minutes.

][2.1.8 Engine Starting Contacts

****

NOTE: The standard is one normally closed and one normally open contact. Choose the others values if additional contacts are required.

****

Provide [1][2][3][4] isolated normally closed and [1][2][3][4] isolated normally open contact that is rated 5 A at 250 VAC/30 VDC minimum.

][2.1.9 Controls for Fire Pump Service Automatic Transfer Switch

****

NOTE: The following paragraph is intended for use when the automatic transfer switch is to be used for fire pump service where the ATS is not part of the fire pump controller.

****

Provide the following additional controls features:

Phase reversal of the normal source is to initiate transfer to the emergency/alternate source.

][2.1.10 Delayed Transition With Time Delay Neutral

****

Transferring large motor or other inductive loads such as transformers requires special consideration. The motor will act like a generator momentarily and a transformer needs to have its magnetic field collapse. If a transfer happens, the transformer or motor may not be in-phase with the new power source. There are two general methods to address this issue: a contact transfer time delay (neutral position delay or timed transition) and in-phase monitor. The time delay allows the residual voltage of the motors to decay to a safer level. In-phase monitor allows transfer when the phase angle between the load and the source are within the preset parameters and provides minimum service interruption; however, this approach is not recommended. Instead, i the extra time is a factor, then the motor loads should be separately disconnected by the ATS and restarted in sequence after the transfer. See TSEWG TP-9 for more information.

Wound-rotor motors are not suitable for in-phase or the time delay approach. These motors should be isolated and restarted.

****

Provide an adjustable time delay transition for indicated transfer switches to allow safe transfer of highly inductive loads between two non-synchronized sources. This transfer between loads has a programmed neutral position arranged to provide a midpoint between the two working positions, with an intentional time-controlled pause at midpoint during transfer. Pause is adjustable from 1 to 300 seconds. Factory set time delay at [0.5][1][2][5] seconds. Time delay occurs for both transfer directions. Manufacturer is to provide recommendations for establishing the length of the time delay.

][2.1.11 Motor Disconnect And Timing Relay

****

NOTE: If the delayed transition with time delay neutral is too long for other critical loads, then this option allows sending a signal to the motor controller to prevent coming on line with the alternate/emergency source. Then signal is sent to sequence these loads on the new source. Delete if not required.

****

Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

][2.1.12 Make Before Break Neutral

****

NOTE: If the project has a transformerless UPS, then this option needs to be considered. Some manufacturers for transformerless UPS 60 kVA and below require the neutrals to be briefly connected during the transfer. The default value is 50 ms. Since this varies with manufacturer, the first choice requires the Contractor to coordinate this item. The second choice if for when it is known. See TSEWG TP-19 Static Uninterruptible Power Supply (UPS) white paper at https://www.wbdg.org/ffc/dod/supplemental-technical-criteria/tsewg-tp-19

****

[Contractor is required to coordinate with UPS manufacturer to determine if the unit being procured requires the neutral to be interconnected. If not required, then break before make neutral contacts are allowed. If required, then provide the ATS with make before break neutral contacts.][Provide the ATS with a make before break neutral. Phase contacts are to break before make.] The neutrals are to make for [50][_____] ms.

][2.1.13 Auxiliary Contact for Uninterruptible Power Supply

****

NOTE: Projects with a generator as an alternate power source that will be powering an Uninterruptible Power Supply may want to have a signal sent to the UPS from the ATS. This signal would have the UPS limit the charging current to a lower level, so as not to potentially increase the generator size. Other factors such a size of UPS compared to the entire load and expected length of generator runtime should be taken into account.

****

Provide a contact that closes when transferred to the alternate power source.

]2.1.14 Unassigned Auxiliary Contacts

****

NOTE: Provide at least three contacts for each position on Medical Facilities and for all other facilities provide at least two contacts. The standard is 10 amps at 240 volts. Edit appropriately for the project.

****

Provide [two][three][_____] normally open and [two][three][_____] normally closed, single-pole, double-throw auxiliary contacts for each switch position rated at [10][15][_____] amperes at [240][120][480][_____] volts.

2.1.15 Front Panel Devices

Provide devices mounted on cabinet front consisting of:

a. Mode selector switch with the following positions and associated functions. Selector switch can be part of the microprocessor controller consisting of an LCD screen with a graphical interface or as a stand-alone test switch.

  (1) TEST - Simulates loss of normal/preferred source system operation.

  (2) NORMAL - Transfers system to normal/preferred source bypassing re-transfer time delay.

b. Switch position indicating lights or graphical LCD display. Indicate source to which load is connected.

c. Source-Available Monitor. Provide source-available indicating lights or graphical LCD display monitor that is labeled to show when one or both sources of power are available. If indicating lights are used, then the preference is to have Green be normal/preferred power and Red be for alternate/emergency power; however, other color schemes are allowed if clearly marked.

****

NOTE: The transfer override switch is typically an option on an standard ATS. Overrides transfer back to the power source regardless of the condition of the power source.

****

d. Provide a transfer override switch. Provide automatic transfer switch microprocessor based controller, which offers field selectable/adjustable inputs and outputs for transfer switch operation. Override switch must bypass automatic transfer controls so ATS will transfer and remain connected to [alternate][emergency][generator][_____] power source, regardless of condition of normal/preferred source. Provide an indicating light to show override status. [If [alternate][emergency] source fails and [normal][preferred] source is available, ATS is to automatically retransfer to [normal] [preferred] source.]

e. Lamp test button.

[2.1.16 Voltage Unbalance

****

NOTE: If the power system has a large number of motors then consider adding this requirement.

****

Provide automatic transfer switch controller or control logic to include positive and negative sequence voltage detection to identify a phase loss condition that can adversely effect motor loads.

][2.1.17 Closed-Transition Transfer Switch

****

NOTE: The typical transfer switch operates in an open-transition manner; however, there are times the closed-transition makes sense. See TSEWG TP-19 Static Uninterruptible Power Supply (UPS) white paper at https://www.wbdg.org/ffc/dod/supplemental-technical-criteria/tsewg-tp-19 for a discussion on the topic. Delete if not required.

****

Include the following functions and characteristic for an automatic transfer switch that is to operate in a closed-transition manner.

a. Fully automatic make-before-break operation.

b. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms, but no less than 50 ms.

c. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    (1) Initiation occurs without active control of generator.

    (2) Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

d. Failure of power source serving load initiates automatic break-before-make transfer.

][2.1.18 In-Phase Monitor

****

NOTE: A Closed-transition type ATS needs to have the in-phase monitor option.

In addition, UFC 4-510-01 Design: Military Medical Facilities needs to be consulted for its requirements. The current version requires an ATS feeding high efficiency motors rated 25 hp or larger to be provided with an in-phase monitor.

****

Provide an in-phase monitor that consists of a factory-wired, internal relay that controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 5 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage Manufacturer is to provide information regarding what conditions a transfer cannot be accomplished.

][2.2 BY-PASS/ISOLATION SWITCH (BP/IS)

****

NOTE: Include by-pass/isolation switches only where the nature of the loads make continuance of power essential when the associated ATS switch is

disconnected for repairs, preventive maintenance, or testing. Consult UFC 4-510-01 Design: Military Medical Facilities and UFC 3-540-01 Engine-Driven Generator Systems for Prime and Standby Power Applications for when a by-pass/isolation switches for automatic transfer switches to be provided. Delete reference to generator starting where a generator is not used as alternate source.
****

Include non-load-break by-pass/isolation switches for the indicated automatic transfer switches. Designs which disconnect or interrupt the load when bypassing are not acceptable. Include the following features for each combined by-pass/isolation switch and automatic transfer switch:

a. Bypass/isolation switch (BP/IS) and associated ATS are to be made by the same manufacturer and must be completely interconnected and tested at factory and at project site as specified.

b. ATS is to be manufactured, listed and tested in accordance with paragraph AUTOMATIC TRANSFER SWITCH. BP/IS switch current, voltage, closing, and short-circuit withstand closing ratings are to be equal or exceed comparable ratings specified for ATS and have the same phase arrangement and number of poles.

c. Provide externally operated and arranged selector switch or handle so designed and constructed not to stop in an intermediate or neutral position during operation and that one person can safely bypass the ATS. Accomplish isolation of the ATS externally by one person. Bypass and isolation handles must be permanently affixed and operable without opening the enclosure door. Provide interlocks that ensure ATS is disconnected from source and load during isolation. Interlocks prevent ATS operation, except for testing and maintenance, while isolated. BP/IS operation is to be accomplished without disconnecting switch load terminal conductors. Equipment which require separate tools, keys, or other devices to operate the bypass/isolation mechanism which may not be present during an emergency is not acceptable.

d. Provide drawout transfer switch that provides physical separation from bypass switch and live parts and accessibility for testing and maintenance operation.

e. Provide contacts that have the same contact temperature that do not exceed those of the ATS contacts when carrying rated load. Provide contacts as specified for associated ATS, including provisions for inspection of contacts without disassembly of BP/IS or removal of entire contact enclosure. Provide manufacturer instructions for determining contact integrity in order To facilitate maintenance.

f. The ATS controls remain functional with the ATS isolated or in bypass mode to permit monitoring of the normal power source [and automatic starting of the generator in the event of a loss of the normal power source]. In the isolated mode, the bypass section is capable of functioning as a manual transfer to transfer the load to either power source for maintenane purposes or when automatic control has failed. Equipment that requires automatic controls to be functional to operate the bypass switch is not acceptable.. The ATS can be completely removed from the enclosure, if required for maintenance or repair, while the bypass section continues to power the load.

g. Construct Bypass/isolation switch for convenient removal of parts from front of switch enclosure without removal of other parts or disconnection of external power conductors.

h. Achieve load by-pass to the source with no load interruption. Bypass/isolation equipment that breaks the load is not accpetalbe.

****

NOTE: Optional operational items. Chose those required for project. Drawout bypass is normally available on those with 150 amp or greater ratings.

****

[i. Provide drawout bypass switch that provides physical separation from ATS and live parts and accessibility for testing and maintenance operation. [Provide automatic shutters that closed to isolate the bus.]

][j. Provide a means to ensure the switch is transferred to the alternate or emergency power source when normal power source becomes unavailable.

]2.2.1 Markings

Mark isolation handle positions with engraved plates or other approved means to indicate position or operating condition of associated ATS, as follows:

a. Provide an indication that shows that BP/IS section is providing power to the load.

b. Provide indication of ATS isolation/test position.

c. Provide suitable control labels and instruction signs describing operating instructions.

d. Indicating lamps or LCD screen for indicating that shows the source availability, bypass switch position, transfer switch position, and isolation handle position. If indicating lights are used, provide a lamp test button that turns the indicating lights on, but does not cause any function to take place.

2.2.2 Interconnection

Interconnect BP/IS and associated ATS with suitably sized copper bus bars silver-plated at each connection point, and braced to withstand magnetic and thermal forces created at withstand current rating specified for associated ATS.

]2.3 ENCLOSURE

****

NOTE: Designer must provide normal power source to ATS when specifying enclosure heater.

If ATS assembly is provided, equipment should be installed in free-standing, floor-mounted enclosure as specified, except when manufacturer incorporates switch specified in wall-mounted enclosure as standard construction. However, in some

applications it is advisable to specify that ATS or BP/IS components be mounted in separate switchboard, switchgear, motor control center, or other enclosure. Investigate conditions and options and specify accordingly.

****

Provide an enclosure that meets the following:

****

NOTE: The option on providing screened and filtered intake and exhaust vents are not available by all manufacturer, even by an option. Choose only if required by the site conditions for the ATS.

****

a. Provide ATS and accessories in a [free-standing, floor-mounted][wall-mounted], [ventilated][unventilated] NEMA 250, Type [1][3R][3RX][4][4X][12], smooth sheet metal enclosure constructed in accordance with applicable requirements of NEMA ICS 6, UL 508, UL 1066, and UL 1008. [Provide screened and filtered intake vents. Provide screened exhaust vents.] [Provide door with suitable hinges, locking handle latch, and gasketed jamb.] Provide at least No. 14 metal gauge.

b. Factory wiring within enclosure and field wiring terminating within enclosure must comply with NFPA 70. Provide wire that is permanently tagged or marked near terminal at each end with wire number shown on approved detail drawing, when wiring is not color coded. Conform terminal block to NEMA ICS 4. Arrange terminals for entrance of external conductors from [top and bottom][top][bottom] of enclosure as shown. Main switch terminals, including neutral terminal if used, must be pressure type suitable for termination of external [copper] [aluminum] conductors shown.

****

NOTE: The option on a controlled heater is typically only available on those units which require a NEMA 3R or similar enclosure.

****

[c. Provide thermostatically controlled heater within enclosure to prevent condensation over temperature range stipulated in paragraph SERVICE CONDITIONS.

]2.3.1 Construction

Construct enclosure for ease of removal and replacement of ATS components and control devices from front without disconnection of external power conductors or removal or disassembly of major components.

2.3.2 Cleaning and Painting

Protect both the inside and outside surfaces of an enclosure, including means for fastening against corrosion by enameling, galvanizing, plating, powder coating, or other equivalent means. Protection is not required for metal parts that are inherently resistant to corrosion, bearings, sliding surfaces of hinges, or other parts where such protection is impractical. Provide manufacturer's standard finish material, process, and color that is free from runs, sags, peeling, or other defects. An enclosure marked Type

1, 3R, 4 or 12 is acceptable if there is no visible rust at the conclusion of a salt spray (fog) test using the test method in ASTM B117, employing a 5 percent by weight, salt solution for 24 hours. Type 4X enclosures are acceptable following performance of the above test with an exposure time of 200 hours.

2.3.3 Field Fabricated Nameplates

Nameplate is to comply with ASTM D709. Provide laminated plastic nameplates for each equipment enclosure as specified or as indicated on the drawings. Provide an inscription on each nameplate that identifies the name of the equipment, sources of power, calculated short circuit with date and the location e.g. 'SWB-1 Electrical Room 103'. Provide nameplates that are made of melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core. Provide the nameplate with a surface that is matte finished and that has square corners.. Accurately align lettering and engrave into the core. Provide nameplates that are at least 25 by 65 mm 1.0 by 2.5 inches with a minimum lettering size of 6.35 mm 0.25 inch high normal block style.

[2.4 REMOTE ANNUNCIATOR PANEL

****

NOTE: This option is for a remote annunciator without any means of control. If this is required do not choose the 'Remote annunciator Controller'. There are two types of panels indicated: one is a simple panel with indicating lights and switches, the other is a touchscreen panel. Touchscreen is becoming more common.

****

[Provide remote annunciation with LED indicating lights, an audible alarm with silence switch as well as all appropriate labeling.][or][Provide a remote annunciator panel that utilizes a touchscreen human machine interface (HMI). Minimum screen size is 175 mm7 inches.] The annunciator is to be configured to handle [1][2][_____] transfer switches. Provide a surface mounted cabinet. Provide built-in power supply that accepts either 24 VDC or 120VAC or [_____]. Provide communications module to support monitoring of ATS. Module must provide status, analog parameters, event logs, equipment settings, and configurations over embedded webpage, open protocol, and automated email while utilizing AES 128-bit encryption. Provide a remote annunciation panel to annunciate the following conditions for the indicated transfer switch(es).

a. Sources available

b. Switch position.

c. Switch in test mode.

d. Failure of communication link.

][2.5 REMOTE ANNUNCIATOR AND CONTROL SYSTEM PANEL

****

NOTE: This option is for a combination remote annunciator and control system panel. If this is chosen be sure to delete the previous 'Remote

Annunciator Panel' option.
****

Provide a remote annunciator and control system that utilizes a touchscreen human machine interface (HMI) with the ability to remotely monitor and control multiple transfer switches from a single panel. Minimum screen size is 7 inches175 mm. Provide password protection and date/time stamped alarm history. The controller is to have internal battery backup. In the event of a communication link failure, the system is to automatically revert to stand-alone, self-contained operation. Automatic transfer switch sensing, controlling or operating function is not to depend on remote panel for proper operation. Provide a surface mounted cabinet. Communication is to be by a [Modbus] RS-485 connection. The annunciator controller is to be configured to monitor and control [1][2][_____] transfer switches.

2.5.1 Monitor

Monitor the following:

a. Sources available

b. Switch position.

c. Switch in test mode.

d. Overvoltage

e. Failure of communication link.

****
NOTE: Delete option if none of the sources are a generator.
****

[f. Engine test or exercise.
]

2.5.2 Alarm Screen

Alarm for the following conditions:

a. Alternate source closed

b. Undervoltage

c. Lockout.

2.5.3 Control Functions

Provide a means to perform the following functions from the controller: an alarm silence button in addition to monitoring the following items:

a. Control of switch-test initiation.

b. Control of switch operation in either direction.

c. Control of time-delay bypass for transfer to normal source.

d. Control to perform an engine test.

****

NOTE: This option can be beneficial to allow remote changes, but it can also be a concern with the security.

****

[e. Provide a means to remotely configure transfer switch controller setpoints. The means to perform these changes must be password protected.

]

****

NOTE: Provide if a large system and want to be able to remotely control the various ATSs.

****

[f. Manage up to eight (8) transfer switches from a single remote annunicator and control panel

]

]2.6 FACTORY TESTING

Submit a description of proposed field test procedures, including proposed date and steps describing each test, its duration and expected results, not less than [_____] weeks prior to test date. Submit certified factory and field test reports, within 14 days following completion of tests. Provide reports that are certified and dated and that demonstrate that tests were successfully completed prior to shipment of equipment.

2.6.1 Prototype Factory Testing

A prototype of specified ATS is to be factory tested in accordance with UL 1008. In addition, perform factory tests on each ATS as follows:

a. Insulation resistance test to ensure integrity and continuity of entire system

b. Main switch contact resistance test.

c. Visual inspection to verify that each ATS is as specified.

d. Mechanical test to verify that ATS sections are free of mechanical hindrances.

e. Electrical tests to verify complete system electrical operation and to set up time delays and voltage sensing settings.

2.6.2 Factory Test Reports

Provide three certified copies of factory test reports from the manufacturer.

[2.7 FACTORY TESTING -MEDICAL FACILITIES

****

NOTE: The factory tests sequence listed below is required for Medical Facilities only. This testing is normally above and beyond the standard factory test performed on an ATS.

****

The factory tests for ATS and By-Pass/Isolation switches used in medical facilities must be conducted in the following sequence:

a. General

b. Normal

c. Overvoltage

d. Undervoltage

e. Overload

f. Endurance

g. Temperature Rise

h. Dielectric Voltage-Withstand

i. Contact Opening

j. Dielectric Voltage-Withstand (Repeated)

k. Withstand

l. Instrumentation and Calibration of High Capacity

m. Closing

n. Dielectric Voltage-Withstand (Repeated)

o. Strength of Insulating Base and Support

]PART 3 EXECUTION

3.1 INSTALLATION

Installation must conform to the requirements of NFPA 70 and manufacturer's recommendation.

3.2 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the automatic transfer switch.

3.2.1 Performance of Acceptance Checks and tests

Complete as specified in paragraph entitled "Acceptance Checks and Tests". The Acceptance Checks and Tests are to be accomplished by the Testing organization as described in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

3.2.2 Manufacturers O&M Information

The manufacturers O&M information required by the paragraph entitled "SD-10 Operation and Maintenance Data", is to be submitted to and approved by the Contracting Officer.

3.2.3 Test Equipment

Ensure all test equipment and instruments is on hand prior to scheduling field tests, or subject to Contracting Officer's approval, evidence must be provided to show that arrangements have been made to have the necessary equipment and instruments on site prior to field testing.

3.3 FIELD QUALITY CONTROL

****

NOTE: Use of 26 20 00 is only required on Navy projects.

****

Give Contracting Officer 15 days notice of dates and times scheduled for tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The contractor is responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The contractor provides labor, equipment, apparatus, including test load, and consumables required for the specified tests. Calibration of all measuring devices and indicating devices must be certified. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and start-up of the equipment specified under this section. The manufacturer's representative is to provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly components contained herein. [Provide a test load that is a cataloged product in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.] Perform the following field tests in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.3.1 Automatic Transfer Switch Acceptance Checks and Tests

a. Visual and Mechanical Inspection

   (1) Compare equipment nameplate data with specifications and approved shop drawings.

   (2) Inspect physical and mechanical condition.

   (3) Confirm correct application of manufacturer's recommended lubricants.

   (4) Verify that manual transfer warnings are attached and visible.

   (5) Verify tightness of all control connections.

   (6) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey is not required.

   (7) Perform manual transfer operation.

   (8) Verify positive mechanical interlocking between normal and alternate sources.

b. Electrical Tests

  (1) Measure contact-resistance. Correct values that exceed 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

  (2) Perform insulation-resistance on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole for one minute. Perform tests in both source positions.

  (3) Verify settings and operations of control devices.

  (4) Calibrate and set all relays and timers.

[(5) Test ground-fault protective device.

]3.3.2 Functional Acceptance Tests

****

NOTE: Edit for the appropriate generator specification, if the project has a generator.

****

Functional Acceptance Tests must be coordinated with Section 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES.[Functional Acceptance Test must be coordinated with Section 21 30 00 FIRE PUMPS.] Include simulating power failure and demonstrating the following operations for each automatic transfer switch. Demonstrate in service that the automatic transfer switches are in good operating condition, and function not less than five times.

a. Perform automatic transfer tests:

  (1) Simulate loss of normal/preferred power.

  (2) Return to normal/preferred power.

  (3) Simulate loss of emergency/alternate power.

  (4) Simulate all forms of single-phase conditions.

b. Verify correct operation and timing of the following functions:

  (1) Normal source voltage-sensing relays.

  (2) Engine start sequence.

  (3) Time delay upon transfer.

(4) Alternate source voltage-sensing relays.

(5) Automatic transfer operation.

(6) Interlocks and limit switch function.

(7) Time delay and retransfer upon normal power restoration.

[(8) By-pass/isolation functional modes and related automatic transfer switch operations.

]3.3.3 Infrared Scanning

After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after acceptance.

b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

c. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 TRAINING

Provide 4 hours of training to maintenance personnel on the proper operation, maintenance and adjustment of the automatic transfer switch.[Coordinate this training with that of the generator equipment.]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS 26 37 13 (February 2024)**

Preparing Activity: USACE **New**

MICROGRID CONTROL SYSTEM

References are in agreement with UMRL dated January 2025
****

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02/24

PART 1 GENERAL

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS 26 37 13 (February 2024)**

Preparing Activity: USACE **New**

MICROGRID CONTROL SYSTEM

References are in agreement with UMRL dated January 2025
****

SECTION 26 37 13

MICROGRID CONTROL SYSTEM
02/24

PART 1 GENERAL

****
NOTE: This guide specification covers the requirements of a Microgrid Control System (MCS) in accordance with UFC 3-550-04 Installation Microgrid Design and IEEE 2030.7. The MCS may consist of a central controller or distributed control logic executed among multiple discrete devices.

This specification covers only the microgrid control system, and does not include specification for connected Distributed Energy Resources, controlled loads and devices, or external communication systems. Coordination of the requirements selected or edited within this guide specification is required with connected, controlled, or integrated components and equipment defined elsewhere within the UFGS. Refer to the further designer notes regarding these sections in the REFERENCES portion of this guide specification.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR). CCRs for this specification can be submitted through the Whole Building Design Guide page for this section:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-

****

****
NOTE: This guide specification makes use of the SpecsIntact tailoring options for service-specific requirements for the Air Force, Army, and Navy as well as a 'Service Generic' tailoring option for use on other projects. In order for this specification

to be properly tailored one (and only one) of the services tailoring options (Air Force, Army, Navy, Service Generic) must be selected.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

****

1.1 SUMMARY

****

NOTE: Ensure the MCS defined by this specification complies with UFC 3-550-04. Critical design elements that must be provided by the Designer of Record to inform and supplement this specification include but are not limited to:

*** Load Analysis; using highest resolution data available**
*** In-rush and startup load analysis**
*** Grid modeling**
*** Short Circuit and Arc Flash Study for new and modified components**
*** Grounding system analysis (with consideration given to ground path in all modes of operation)**
*** Protection analysis, including verification of island mode short circuit current in relation to minimum current required to activate protective devices.**
*** List of devices and device IDs**
*** Communication pathways and conduits; often microgrid controllers require communication with physically distant equipment.**

****

The Microgrid Control System defined herein monitors and controls the operation of the microgrid equipment. This specification refers only to that control system and does not include specification of the connected equipment which comprises the microgrid such as Distributed Energy Resources (DERs), controlled loads, distribution or utilization circuits, low, medium, or high-voltage protective devices, or other similar components specified elsewhere.

1.1.1 System Requirements

****

NOTE: Select the appropriate text in the type specific communication system requirements to indicate whether or not the IP network will be Government furnished. If the IP network is *not* Government furnished be sure to include complete requirements for the IP network in the contract

package. This specification does not provide sufficient requirements for the procurement of an IP network.

Use "[an IP network as specified in [_____] and]" only if the contractor is expected to install an IP network. In this case provide the information on the specification for the IP network in the "[_____]" provided.

For Army, coordinate with the installation (DPW and NEC) but the default selection will be "[the Government furnished IP network]"

****

Provide an electrical Microgrid Control System (MCS) as specified and indicated, and in accordance with the following characteristics:

1.1.1.1 General MCS Requirements

****

NOTE: Select the appropriate bracketed options in order to define the larger functions of the MCS in relation to the microgrid. The selected options should be coordinated with the design drawings accompanying this specification.

****

a. Scope of Control: The MCS controls the microgrid system. The microgrid is defined as [a bounded electrical system with a single point of interconnection][a bounded electrical system with multiple points of interconnection] with an external grid. The system includes DERs, distribution devices, dispatchable and non-dispatchable loads, controls, and communication systems.

b. Fault Management: MCS supervisory monitoring and control functions include but are not limited to automated fault detection, microgrid isolation from the external electrical grid, and internal system reconfiguration capabilities to maintain critical load supply.

c. Component Standards: Provide components and technology which are commercial, warrantied, and intended for permanent installation. Materials and equipment must be standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products. Units of the same type of equipment must be products of a single manufacturer. Items of the same type and purpose must be identical and supplied by the same manufacturer, unless replaced by a new version approved by the Government.

d. Island Mode Operation: Ensure the Microgrid Control system operates the microgrid in island mode, paralleling either one or more than one disparate source of generation, with at least one grid-forming DER [with][without] droop control.

e. Black Start Capability: Equip the MCS to manage the microgrid black start procedure. Initiate the startup of [one][more than one] firm-generation grid-forming DER asset(s) after an unplanned external grid outage.

f. Load Management: Incorporate functionality within the MCS to dispatch DER and direct load shedding, ensuring the islanded system generation meets the critical load within the system boundary.

g. Operational Modes: Equip the MCS with functionality to direct transitions between operational modes, including but not limited to black start in island mode, automatic transition from grid-connected to islanded mode, resynchronization and reconnection to grid-connected mode from islanded mode, and system balancing. Manage energy to optimize both real and reactive power generation and consumption for microgrid-connected load resilience, [operational efficiency,][economic benefits,][optimal external grid resilience,][decarbonization] purposes[, and][support of the grid,][participation in the energy market,][and utility system demand response] through DER and load dispatch.

h. Critical Load Uptime: For critical loads supplied by the microgrid, equip the MCS with functionality to support a minimum uptime of [99.9%][99.99%][99.999%][99.9999%] as defined and required by [UFC 3-520-02][Office of the Under Secretary of Defense Memo "Metrics and Standards for Energy Resilience at Military Installations"].

i. System Interface: Ensure the MCS is arranged and interconnected such that it serves as the single point of interface with all microgrid DERs, DER Management System (DERMS), or UMCS. If necessary, allow the microgrid control system to perform UMCS functions required to dispatch microgrid resources.

****

NOTE: Only allow for remote breaker operation where the facility has both qualified personnel regularly staffed and written standard operating procedure for remote operation. Confirm with Government before including.

****

j. Monitoring and Control: Equip the MCS with supervisory monitoring and control functions, including but not limited to: [Point of Common Coupling (PCC) monitoring and control,][frequency control,][load shedding,][anti-islanding,][low- or high- voltage or frequency ride-through,][voltage (reactive power) control,][remote breaker control and monitoring in accordance with facility SOP,][synchronization,]and power quality monitoring.

k. Grid Interface: Coordinate the microgrid and microgrid system controller to present to the larger grid as [a single entity][____] with [a single point][multiple points] of electrical interconnection and a single control and communication interface between the microgrid and external grid. Ensure all MCS control and reporting functions appear as a single entity to all external devices. Execute functions defined herein from that single point of interconnection.

l. Human Machine Interface: System includes human-machine interface with graphical interface into the MCS.[Incorporate a primary interface position where all described microgrid control and HMI functions are accessible.] The HMI must allow for graphical navigation between systems, graphical representations of systems and interconnection, access to real-time data for systems, ability to override points in a system, and access to all supervisory monitoring and control functions.

m. Control Workstation: [The Government will provide the] [Provide a standard desktop computer or a laptop meeting the following minimum requirements for the] Computer Workstation Hardware (workstation) in accordance with this specification.

n. Software Licenses: Provide all necessary software documentation, configuration information, configuration tools, programs, drivers, and other software. Ensure they are licensed to and remain with the Government so that the Government or their agents can repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor. Software licenses must [not require periodic fees and be valid in perpetuity][be valid for a period of not less than [three (3)][five (5)][_____] years].

o. Documentation: Supply sufficient documentation and data, including rights to documentation and data, enabling the Government or their agents to execute work to repair, replace, upgrade, expand, and cyber-secure the system without subsequent or future dependence on the Contractor.

1.1.1.2 Symbols, Definitions, and Abbreviations

Use symbols, definitions, and engineering unit abbreviations indicated in the contract drawings for displays, submittals and reports. For symbols, definitions and abbreviations not in the contract drawings use terms conforming at a minimum to IEEE Standards Dictionary as applicable.

1.1.1.3 System Units and Accuracy

Use [metric (SI)][English (inch-pound)] units for displays, print-outs and calculations. Ensure calculations have an accuracy of at least three significant figures and present values on displays and printouts to at least three significant figures.

1.2 RELATED SECTIONS

****

NOTE: A number of these referenced sections will require updating to coordinate with the contents of the microgrid controller as specified. Ensure each section also includes a reference to this section where the other equipment will interface with the microgrid control system.

****

UFGS 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS

1.2.1 Cybersecurity Requirements

****

NOTE: If Section 25 05 11 has been renumbered and/or renamed use the blank brackets to indicate the appropriate section, otherwise keep the reference to Section 25 05 11.

Designers refer to UFC 4-010-06 for cybersecurity

design and coordination requirements with Government. Potential interconnections to other control systems or infrastructure owned and operated by activities outside of the DoD are coordinated and approved by the Government prior to procurement and installation by the contractor.

Do not edit these requirements (beyond selection of bracketed text). These default requirements should only be used in lieu of technology-specific requirements in the preceding paragraphs. If these default requirements are inappropriate, ensure that the preceding paragraphs provide appropriate technology-specific requirements.

****

Cybersecurity requirements related to this Section are specified in [25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS][a separate cybersecurity specification derived from UFGS 25 05 11][_____].

For NAVY Projects include 25 08 11.00 20 RISK MANAGEMENT FRAMEWORK FOR FACILITY-RELATED CONTROL SYSTEMS in addition to requirements found in 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. SECTION 25 08 11.00 20 covers the Navy requirements to support the Risk Management Framework (RMF) Authority to Operate (ATO) Process for Facility-Related Control Systems.

1.2.2 Distributed Energy Resources

****

NOTE: Coordinate the operational modes of the microgrid with relevant air quality standards in relation to carbon emitting generation assets. Where the microgrid will allow parallel or grid-supporting operation of these assets, ensure the generator's specification, typically 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES is coordinated with the applicable requirements.

****

****

NOTE: Where ESS utilize lithium-ion battery technology, additional fire protection and alarm requirements must be provided per UFC 3-600-01. Refer also to UFGS for the specified equipment, whether provided under this project or existing.

****

[a. Evaluate reciprocating gensets in the microgrid for their operational mode as [parallel to the utility grid][, and][prime/continuous][standby/emergency]. Where carbon-emitting gensets operate in parallel to the utility, ensure compliance with [EPA Tier 1][EPA Tier 2][EPA Tier 3][EPA Tier 4] emission guidelines. Determine if the utility contract [permits][permits momentarily][prohibits] parallel operation. [Refer to Section 26 05 73 POWER SYSTEM STUDIES.]]

[b. Ensure turbine gensets, when serving as prime power sources, adhere to EPA tier emission guidelines if operating in parallel with the utility grid. Confirm the utility contract or interconnection agreement [permits][permits momentarily][prohibits] parallel operation.]

[c. Ensure the microgrid control system interfaces with, providing control and communication as outlined throughout this specification for [existing solar photovoltaic arrays][solar photovoltaic arrays provided under this contract] using compatible [string][central][micro-]inverter technology. If necessary, ensure inverters can control real and reactive power and comply with grid interconnection standards, including IEEE 1547[and UL 1741].[Refer to [48 14 00 SOLAR PHOTOVOLTAIC SYSTEMS][______].]]

[d. Integrate Energy storage systems (ESS) into the microgrid control system for purposes such as load leveling, peak shaving, and backup power. Ensure the ESS can control both charge and discharge, with real and reactive power capabilities. Specify the storage capacity based on the microgrid's operational objectives and ROI considerations. [Refer to Section [_____]].]

[e. Incorporate wind generation systems into the microgrid control system. Choose electrical connection technology types from [Type 3 (Doubly Fed Induction Generator)][Type 4 (Full Converter)]. Ensure the wind generation system controls real and reactive power and adheres to grid interconnection standards. [Refer to 48 15 00 WIND GENERATOR SYSTEM]]

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID (Reference ID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1547	(2018) Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
IEEE 1613	(2023) Environmental and Testing Requirements for Devices with Communications Functions used with Electric Power Apparatus

IEEE 2030.7	(2017) The Specification of Microgrid Controllers
IEEE 2030.8	(2008) The Testing of Microgrid Controllers
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.90.2	(2004; R 2010) Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60068-2-1	(2007) Environmental testing - Part 2-1: Tests - Test A: Cold
IEC 60068-2-2	(2007) Environmental testing - Part 2-2: Tests - Test B: Dry heat
IEC 60068-2-30	(2005; ED 3.0) Environmental Testing - Part 2-30: Tests - Test Db: Damp Heat, Cyclic (12 H + 12 H Cycle)
IEC 60068-2-78	(2012) Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state
IEC 60255-1	(2022) Measuring relays and protection equipment - Part 1: Common Requirements
IEC 60255-21-1	(1988) Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section One: Vibration tests
IEC 60255-21-2	(1988) Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section Two: Shock and bump tests
IEC 60255-21-3	(1993; ED 1.0) Electrical Relays - Part 21: Vibration, Shock, Bump And Seismic Tests On Measuring Relays And Protection Equipment - Section 3: Seismic Tests

IEC 60255-26	(2023) Measuring relays and protection equipment – Part 26: Electromagnetic compatibility requirements
IEC 61000-4-4	(2012) Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
IEC 61000-4-8	(2009) Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test
IEC 61131-3	(2013) Programmable Controllers - Part 3: Programming Languages
IEC 61850	(2021) Communication networks and systems for power utility automation

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 5.2	(1976; R1992) Binary Logic Diagrams for Process Operations
ISA 18.2	(2016) Management of Alarm Systems for the Process Industries
ISA 101.01	(2015) Human Machine Interfaces for Process Automation Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 262	(2023) Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-3071	(2023) Tactical Microgrid Communications and Control

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC EMC	(2002) FCC Electromagnetic Compliance Requirements
FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 1741	(2010; Reprint Jan 2015) UL Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
UL 60950	(2000; Reprint Oct 2007) Safety of Information Technology Equipment

1.4 ACRONYMS

Acronym	Term
ARC	Communication Architecture
ATS	Automatic Transfer Switch
DER	Distributed Energy Resource
DERMS	DER Management System
DFD	Data Flow Diagram
DMS	Distribution Management System
FAT	Factory Acceptance Test
HIL	Hardware in the Loop
HMI	Human Machine Interface
IBR	Inverter-Based Resource
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISE	Interconnection System Equipment
IT	Information Technology
LAN	Local Area Network
MCS	Microgrid Control System
MEMS	Micro-Electro-Mechanical Systems
NEC	National Electric Code (NFPA 70)
NEMA	National Electric Manufacturers Association
NFPA	National Fire Protection Association
OT	Operational Technology

Acronym	Term
PCC	Point of Common Coupling
POI	Point of Interface
PV	Photovoltaic
RPM	Revolutions Per Minute
ROI	Return on Investment
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SER	Sequential Events Recorder
SOE	Sequence of Events
SOP	Standard Operating Procedure
UL	Underwriters Laboratory
UPS	Uninterruptible Power Suppl

1.5 DEFINITIONS

1.5.1 IEEE Stds Dictionary

For terms not explicitly defined in this section, refer to the IEEE Stds Dictionary.

1.5.2 ASTM E772

For terms related to solar energy, refer to ASTM E772 for definitions and standard terminology.

1.5.3 Anti-Islanding

A safety mechanism that detects when a microgrid has been separated from the main grid and ensures that the microgrid does not continue to feed power back into the disconnected grid.

1.5.4 Automatic Transfer Switch (ATS)

A switch that automatically transfers a power supply from its primary source to a backup source when it senses a failure or outage in the primary source.

1.5.5 Base Load Power DER

A DER that provides a constant output to meet minimum load requirements.

1.5.6 Black Start

The process of restoring a disabled or shut down microgrid to operation without relying on the external electric power transmission network.

1.5.7 Distributed Energy Resource Management System (DERMS)

A control system that allows for the centralized control of DERs within the microgrid, often integrated into the microgrid control system.

1.5.8 Firm Electrical Output DER

A DER capable of providing a guaranteed level of output under specified conditions.

1.5.9 Grid Following

A mode of operation where the DER adjusts its output based on grid conditions but cannot independently maintain grid voltage and frequency.

1.5.10 Grid Forming

A mode of operation where the DER can independently control voltage and frequency within a microgrid, effectively forming a grid.

1.5.11 Grid Forming DER

A DER capable of operating in a grid-forming mode, independently controlling voltage and frequency within a microgrid.

1.5.12 Human-Machine Interface (HMI)

The user interface that connects an operator to the controller in an industrial system, often a part of the microgrid control system.

1.5.13 Inverter-Based DER

A DER that uses an inverter to convert its output to alternating current (AC) for grid interconnection.

1.5.14 Islanding

Condition in which a microgrid operates independently and electrically isolated from the external grid.

1.5.15 Load Following DER

A DER that adjusts its output in real-time to match fluctuations in load demand.

1.5.16 Microgrid

A localized energy system consisting of DERs and loads capable of operating in parallel with, or independently from, the main power grid.

1.5.17 Point of Common Coupling (PCC)

The demarcation point between the owned electrical system of the microgrid and the utility distribution system.

1.5.18 Power Quality Correcting DER

A DER that provides ancillary services to improve power quality, such as voltage and frequency regulation.

1.6 ADMINISTRATIVE REQUIREMENTS

****

NOTE: The subparts below are specific to each installation location and project. As the designer, provide additional information required to understand the context of the project being specified.

****

The contractor is responsible for the complete installation, testing, and commissioning of the Microgrid Control System (MCS) in accordance with the project's Division 01 Specification. The contractor must also coordinate with other trades and disciplines to ensure seamless integration of the MCS with other systems, including but not limited to DERs, UMCS, and existing utility infrastructure.

1.6.1 Pre-Installation Meeting

In accordance with UFC 1-300-02, a pre-installation meeting is required be held to discuss plans, procedures, responsibilities, and the impact on existing facilities. The meeting must include, but is not limited to, the following:

1.6.1.1 Coordination with Other Trades

[Discussion of coordination requirements with other trades to ensure seamless integration of the MCS into the larger project infrastructure.]

1.6.1.2 Phasing Plan

Prepare and submit a Phasing Plan that includes listing for duration and estimated start date for any and all outages of existing assets impacted by the installation of the MCS. Include outages or simulated outages related to testing as specified in Part 3..

Include in the submitted equipment phasing plan an Integration Plan for MCS with existing or planned assets, a detailed Phasing Plan outlining outages and coordination, and Risk Mitigation Strategies.

1.6.1.3 Related Project Coordination

[Discussion of interface with concurrent, prior, or subsequent projects which may interface with the microgrid or microgrid control system.]

1.7 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Utility Interconnection Agreement; G[, [_____]]

Phasing Plan; G[, [_____]]

SD-02 Shop Drawings

Contractor Design Drawings; G[, [_____]]

Draft As-Built Drawings; G[, [_____]]

Microgrid Control System HMI Graphical Mockup; G[, [_____]]

SD-03 Product Data

Product Data Sheets; G[, [_____]]

Computer Hardware Specifications; G[, [_____]]

Computer Software Specifications; G[, [_____]]

SD-04 Samples

Enclosure Keys; G[, [_____]]

SD-05 Design Data

Power System Studies; G[, [_____]]

Microgrid System Architecture Diagram; G[, [_____]]

SD-06 Test Reports

Comprehensive Execution Plan; G[, [_____]]

Site Assessment Survey; G[, [_____]]

Factory Test Procedures; G[, [_____]]

Factory Test Report; G[, [_____]]

PVT Testing Procedures; G[, [_____]]

PVT Phase I Testing Report; G[, [_____]]

PVT Phase II Testing Report; G[, [_____]]

PVT Phase III Testing Report; G[, [_____]]

Startup Testing Plan; G[, [_____]]

Startup Testing Report; G[, [_____]]

Factory Acceptance Test Reports; G[, [_____]]

Pre-construction QC checklist; G[, [_____]]

Post-construction QC checklist; G[, [_____]]

SD-07 Certificates

Regulatory Compliance Documentation; G[, [_____]]

ISO 9001 Compliance Certificate; G[, [_____]]

Installer Qualifications; G[, [_____]]

Utility Interconnect Contract

SD-10 Operation and Maintenance Data

Emergency Response Plan; G[, [_____]]

Training Documentation; G[, [_____]]

Operation And Maintenance Instructions; G[, [_____]]

SD-11 Closeout Submittals

****

NOTE: The Enclosure Keys are needed by the project site DPW.

****

Enclosure Keys; G, [_____]

Closeout QC Checklist; G[, [_____]]

Microgrid System Model; G[, [_____]]

1.8 DATA PACKAGE AND SUBMITTALS REQUIREMENTS

****

NOTE: Coordinate the review of all submittals with the project site. The site may have a System Integrator or other individual/office that should review all submittals before acceptance of the system.

The acquisition of all technical data, data bases and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Defense Acquisition Regulation Supplement (DFARS). Those regulations as well as the Services implementations thereof should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost. Specifically, DFARS 252.227-7013 Rights in Technical Data - Noncommercial Items as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS.

In addition, the appropriate DD Form 1423 Contract Data Requirements List, will be filled out for each distinct deliverable data item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, will be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to ensure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government.

Include with the request for proposals a completed DD Form 1423, Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified, both description and quantity being required.

****

Technical data packages consisting of computer software and technical data (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered shop drawings under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and must be delivered with unrestricted rights.

1.9 PROJECT SEQUENCING

****

NOTE:Table I provides bracketed text in which the number of days between items may be specified. In many cases this information will be specified elsewhere. When project schedule is specified elsewhere remove bracketed text and Table I will provide sequencing but not specific intervals. If time intervals are to be specified here keep the bracketed text and enter the number of days in the space provided.

****

Table I outlines the sequencing of submittals as detailed in the SUBMITTALS paragraph (indicated by an 'S' in the 'TYPE' column) and activities as described in PART 3 EXECUTION (marked by an 'E' in the 'TYPE' column).

1.9.1 Sequencing for Submittals

The sequencing for submittals indicates the final date by which the submittal must be provided. After submission, the Government will review as outlined in 01 33 00 SUBMITTAL PROCEDURES. If the Government doesn't accept the submittal, revise the submittal and resubmit within [14][_____] days of receiving the rejection notification. Each re-submission will undergo an additional Government review, and this process will continue until the Government accepts the submittal.

1.9.2 Sequencing for Activities

The sequencing specified for activities indicates the earliest activity may begin.

****

NOTE: Table I provides bracketed text in which the number of days between items may be specified. In many cases this information will be specified elsewhere. When project schedule is specified elsewhere remove bracketed text and Table I will provide sequencing but not specific intervals. If time intervals are to be specified here keep the bracketed text and enter the number of days in the space provided.

****

****

NOTE: If requiring a Factory Test in PART 3 EXECUTION, keep "Acceptance of Factory Test Report" in the Description column for item 1. If NOT requiring factory test keep "Notice to proceed" or edit to indicate other starting condition. Use Table I to specify the sequencing of submittals and activities. If the the project schedule has been specifiedelsewhere, remove the bracketed text, and

Table I will only indicate sequencing without specific intervals. If time intervals are specified here, retain the bracketed text and input the number of days in the provided space.

****

TABLE I - PROJECT SEQUENCING

ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
		Commercial contracts and Pos in place	[_____]
		Resource plan	[_____]
		Project schedule	[_____]
		Monthly progress reports	[_____]
		Kick-off meetings	[_____]
		Internal/External audit review meetings	[_____]
		Detailed functional design specification	[_____]
		Schematic Single Line Diagram	[_____]
		Equipment layout drawings	[_____]
		Studies completed and validated	[_____]
		Factory Acceptance Plan	[_____]
1		[Acceptance of Factory Test Report][Notice to proceed][_____]	[_____]
2	S	Existing Conditions Report (site assessment survey)	[_____] days after #1
3	S	Contractor Design Drawings	[_____] days after #1
4	S	Product Data Sheets and Certificate of Networthiness Documentation	[_____] days after #1
5	S	MCS IP Network Bandwidth Usage Estimate	[_____] days after #1
6	S	Pre-construction QC Checklist	[_____] days after #1
		Isolation, commissioning, testing, and restoration plans for system	[_____]
		Site readiness checklist	[_____]
7	E	Install MCS	AAO #2 thru #6
8	E	Start-Up Procedures and Start-Up Testing	ACO #7
9	S	Post-Construction QC Checklist	[_____] days ACO #8
10	S	Computer Software	[_____] days ACO #8
11	S	Start-Up and Start-Up Testing Report	[_____] days ACO #8
12	S	Draft As-Built Drawings	[_____] days ACO #8

ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
13	S	PVT Phase I Procedures	[_____] days before scheduled start of #14 and AAO #11
14	E	PVT Phase I AAO #13 and #12	[_____]
15	S	PVT Phase I Report	[_____] days
16	S	Preventive Maintenance Work Plan	AAO #11
17	S	O&M Instructions	AAO #11
18	S	Basic Training Documentation	AAO #11 and [_____] days before scheduled start of #19
19	E	Basic Training (PVT Phase II)	AAO #16, #17 and #18
20	S	PVT Phase II Report	[_____] days ACO #19
21	S	Final As-Built Drawings	[_____] days AAO #20
22	S	Advanced Training Documentation	[_____] days before schedule start of #23 and AAO #18
23	E	Advanced Training ACO #19	[_____] days AAO #22, and no later than [60] days ACO #19
24	S	Refresher Training Documentation	[_____] days before #25 and AAO #18and #22
25	E	Refresher Training between	[_____] and [_____] days ACO#19 and AAO #24
26	S	Closeout QC Checklist	ACO #23
		Contract closure meeting	[_____]

In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

1.10 STANDARD MATERIALS AND PRODUCTS

****

NOTE: If the microgrid control system offers remote control or access, even if separate from an energy management control system, choose this option. Implement a Risk Management Framework (RMF) for cybersecurity. Refer to Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS and UFC 4-010-06 Cybersecurity of Facility-Related Control Systems for guidance on integrating cybersecurity into the control system and for insights on the RMF process for control systems. Ensure equipment certification aligns with the Government's cybersecurity standards and interpretations.

****

[Provide certification that control systems are designed and tested in accordance with DoD Instruction 8500.01, DoD Instruction 8510.01, and as required by individual Service Implementation Policy.]

1.11 QUALITY ASSURANCE AND QUALITY CONTROL

Every manufacturer of the microgrid control system and its components must implement a documented quality assurance program (QAS), which includes an inspection test plan (ITP). All suppliers, including sub-suppliers, must provide QAS and ITP documentation for all deliverables. The QAS must encompass established process control documents, either as formal procedures or work instructions. Suppliers must ensure the availability of all relevant procedures and work instructions at every work location.

Supplier's adherence to their QMS and its effectiveness will be evaluated by:

a. Ongoing output quality verifications

b. Internal and External "Hold", "Witness" "Observation" and "Review" points

c. Inspection reports of incoming parts, modular assemblies and final product

d. Company involvement in the 'non-conformance' process

e. Periodic independent quality audits

f. Performing quality inspections and tests by third parties

1.11.1 Inspection Reports

Submit inspection reports created following the ITP procedures. Provide ITP documentation to the designated authority before [planned inspection meetings][site delivery].

1.11.2 Traceability and Markings

Within the Product Data Sheets submittals, report the country of origin for all materials and equipment in the submitted traceability documentation. All test reports and certificates must clearly indicate the origin of all software and the manufacturing location of relevant goods or materials. Ensure every item, component, software, and sub-component is traceable to its origin for both software development and manufacturing.

Submit this traceability documentation within the applicable Product Data Sheets submittals. Mark all goods and materials and trace their associated certifications throughout all processes, from engineering to construction. Ensure traceability of all sub-components through their markings to their origin and document this traceability.

1.11.3 Proof of Performance

Provide evidence of adherence to customer expectations, performance specifications, QAS requirements, IEEE 2030.8 standards, and other testing prerequisites within ITP, inclusive of [FAT][SAT][both FAT and SAT].

1.11.4 Documented ISO 9001 Compliance

Submit documentation verifying ISO 9001 Compliance Certificate for all entities in the supply chain, including engineering design firms, commissioning teams, and manufacturing teams.

1.11.5 Qualifications

Engineering and manufacturing companies participating in this microgrid must submit Installer Qualifications including evidence of having previously completed [three][five][___] projects of similar size and complexity of microgrid projects.

1.11.6 Documentation

Maintain and make accessible for review by the designated authority all QAS and ITP documentation, including changes and revisions. Including but not limited to, design documents, test reports, and quality records.

1.12 REGULATORY REQUIREMENTS

****

NOTE: Clearly define and allocate the scope of work for regulatory compliance to the contractor and construction management team in the contract documents. Recognize that this will entail effort, cost, and time.

****

Comply with all utility, local, state, and federal regulatory requirements related to this microgrid. Submit Regulatory Compliance Documentation demonstrating compliance with all utility interconnect contract stipulations. Ensure that no installation or testing done before the final SAT invalidates any warranties. Submit a table listing all regulatory requirements and confirmations of compliance. Update this list [annually][bi-annually][as required] and make it available for review when asked.

Where the microgrid couples to an external electrical grid, equip the microgrid control system with functionality required to meet the control and communication requirements of that external grid. Secure certification from the connected external grid provider or operator during the interconnect application process.

1.12.1 [Utility Interconnect Contract]

[Submit completed and approved evidence of meeting all Utility Interconnect Contract requirements. Including but not limited to [technical specifications][safety protocols][metering and telemetry][power quality standards][liability and indemnification clauses].]

1.13 DELIVERY, STORAGE, AND HANDLING

1.13.1 General Requirements

Deliver all equipment and materials in the manufacturer's original, unopened, undamaged containers with identification labels intact. Store all materials in a secure, clean, dry space in accordance with the manufacturer's instructions.

1.13.2 Handling

Handle all materials and equipment in a manner to prevent damage, adulteration, and soiling, and in accordance with the manufacturer's recommendations.

1.13.3 Storage

Store all materials and equipment off the ground and covered to protect them from weather, humidity, and temperature extremes.

1.14 SAFETY REQUIREMENTS

****

NOTE: As microgrids often integrate generation on the load side of facility transformers and operate independently from the external grid, special design consideration must be given to islanded operational states requiring dedicated grounding and protection configurations. Prior to integrating microgrids into existing installation systems, evaluate if:

Existing installation distribution equipment and switchgear are integrated.

Dedicated or modified grounding during certain conditions of operation are required.

Any islanded operational states require dedicated grounding or updated protections at any location.

****

1.14.1 Grounding and Bonding

The microgrid includes [fixed][variable] grounding system topology to accommodate various operational states. It is designed to include [a single point][multiple points] of system bonding within the microgrid boundary. Within this boundary, the grounded conductors (neutrals) are [switched][and][unswitched]. The switching mechanisms, which are [manually operated][automatically controlled], are capable of isolating the grounded conductor [at the point of common coupling][within the microgrid boundary]. [The MCS must include [monitoring][and][control] of these switching mechanisms and cease operation if grounded conductors become un-bonded to the grounding electrode system.]

1.14.2 Anti-Islanding Protection

Incorporate anti-islanding protection mechanisms in the microgrid control system (MCS) to safeguard both microgrid components and personnel. Ensure the MCS detects and disconnects the microgrid from the main grid during a grid outage, preventing unintentional islanding.

Equip the MCS with multiple methods to detect islanding conditions. These methods include, but are not limited to: [Active Frequency Drift: Monitor the system frequency and comparing it against predefined thresholds.] [Voltage Unbalance Detection: Monitor voltage levels to identify imbalances indicating an islanding condition.] [Rate of Change of Frequency (ROCOF): Track the rate of system frequency changes over time.]

Initiate a disconnect sequence within [10][20] milliseconds upon detecting an islanding condition to ensure system safety and prevent equipment damage. Do not reconnect to the main grid after an islanding event until verifying grid stability. Set a reconnection delay of at least [5][10][_____] minutes.

Coordinate anti-islanding protection with other microgrid protection mechanisms, such as over/under voltage, over/under frequency, and phase imbalance protections.

1.15 PROJECT AND SITE CONDITIONS

1.15.1 Environmental Conditions

Install the MCS [indoors][outdoors in a NEMA Type [3R][4][4X] enclosure]. Ensure each system component operates effectively in its designated environment. For MCS data communications equipment in unconditioned spaces, ensure operation within ambient temperatures of [0 and 49] [_____] degrees C [32 and 120][_____] degrees F and ambient relative humidity between 10 percent and 90 percent noncondensing. Comply with NFPA 70, UL 60950, NFPA 262, FCC EMC, and FCC Part 15 standards.

Equipment located outdoors, not provided with climate-controlled enclosure, must be capable of operating in the ambient temperature range. Electrical equipment must conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM INTERIOR DISTRIBUTION SYSTEM. Equipment and wiring must be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification

1.15.2 Utility Interconnection Requirements

****

NOTE: Use this section where the microgrid will interconnect and provide power to an external electrical Distribution System Operator (DSO).

****

a. Ensure the microgrid control system adheres to relevant grid codes and/or the interconnection agreement with the distribution system operator (DSO).

b. Adhere to the criteria set by the interconnection agreement, which establishes the following:

    (1) The conditions under which a connection is allowed and the requirements imposed on the microgrid control system.

    (2) The financial arrangements regarding energy and power demand imports from and exports to the distribution grid, and the compensation for ancillary services provided by the microgrid.

    (3) The information required by the distribution management system (DMS) and/or the DERMS (DERMS) for monitoring and control of the microgrid.[

    (4) Provide MCS functionality to provide grid support at the point of interconnection (POI) as required by the DSO.][

    (5) Provide MCS functionality to coordinate with the DMS and/or DERMS during steady state operation and during connection, disconnection, and reconnection processes.]

    (6) Allowable parallel operation of DERs.

    (7) Allowable power and reactive power [power factor] limitations.

c. Provide required studies for Utility interconnection support. Including, but not limited to:

    (1) Prior to Construction

        (a) Neutral Ground Bonding, aka 'Effective Grounding & Grounding Bank Study, this to show there will be no neutral inversion under all operational modes and transitions.

        (b) Transient Stability showing transition of PV from grid connected to island operation, showing the curtailment and partial shutdown of the PV during islanded operation.

        (c) Equipment sizing to ensure correct sizing of transformers, conductors, gensets, circuit breakers

    (2) Prior to construction:

        (a) Transient stability model- showing large microgrid disturbance & DER transient response during transitions island/grid and PV paralleling

        (b) Undervoltage/overvoltage ride-through

        (c) Underfrequency/over-frequency ride-through

        (d) Voltage stability grid connected showing Q./PF dispatch during grid connection

        (e) Power dispatch during grid connection

        (f) Fault study and Protective Device Coordination

(g) Clear explanation of grid connected dispatch, reconnection sequence to grid, aka 'modes of operation'

(3) Prior to energization:

(a) Validation of transient models after genset/transformer/IBR factory tests.

(b) HIL Testing with PCC, DER, and MC control and protection hardware.

(c) Factory Acceptance Test Reports demonstrating compliance with IEEE 2030.7, IEEE 2030.8, and IEEE 1547, and Interconnected Utilityrequirements.

(d) Open Phase Analysis

1.15.3 Utility Privatization Ownership Requirements

****

NOTE: If the utility assumes ownership of the final constructed microgrid, either directly or through third-party privatization, require the contractor to adhere to the following requirements.

****

1.15.3.1 Ownership

Upon initial turn-over, the microgrid and microgrid control system is anticipated to be [owned][leased][operated] by [the Government][a private entity][a public-private partnership]. Determine all ownership rights, including intellectual property associated with the microgrid control system, to be [retained by the Government][transferred to the private entity][shared between the Government and the private entity].

1.15.3.2 Coordination

Coordinate utility privatization efforts with [the local utility][and][the Government]. Ensure alignment for [interconnection][and][metering] according to [local][state][federal] regulations.

1.15.4 Existing Conditions

****

NOTE: For projects where the specified microgrid control specification will connect to existing equipment, this section is intended to be completed by the project designer of record, who is required to provide detailed information on the existing conditions relevant to the microgrid. The designer must refer to UFC 3-550-04 for technical requirements, UFC 1-300-01 for general formatting, UFC 1-300-02 for organizational structure, and IEEE 2030.7 for microgrid control systems.

Ensure that all existing conditions are thoroughly assessed and documented. This information is crucial for the contractor to understand the scope and

requirements of the project.

****

1.15.4.1 External Utility Distribution System

****

NOTE: Provide details on the existing external utility distribution system, including voltage levels, fault current ratings, and any other pertinent information. Refer to UFC 3-550-04 for guidance on technical aspects.

****

[_____]

1.15.4.2 Point of Interconnection Equipment

****

NOTE: Describe the existing point of interconnection (POI) equipment, including type, ratings, and condition. This information is critical for ensuring compatibility with the new microgrid.

****

[_____]

1.15.4.3 [Description of Existing Equipment]

****

NOTE: List and describe all existing equipment that will interact with or be affected by the new microgrid. Include information such as make, model, and condition.

****

[_____]

1.15.4.4 [Description of Existing Electrical Interconnection Means]

****

NOTE: Describe the existing electrical interconnection means, including wiring, switchgear, and protection devices. Through design phase modeling:

- Validate short circuit rating of POI and downstream equipment is sufficient for fault current available under all parallel source scenarios. Ensure that the short-circuit ratings at the POI and downstream are validated for all parallel source scenarios as per UFC 3-550-04

- Confirm that the fault current available during island mode operation is sufficient to activate the protection mechanisms at the POI and downstream, in accordance with IEEE 2030.7.

****

[_____]

1.16 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide MCS Operation and Maintenance Instructions which include:

a. Procedures for the MCS system start-up, operation and shut-down.

b. Final As-Built Drawings.

c. Routine maintenance checklist, arranged in a columnar format: The first column listing all installed devices, the second column stating the maintenance activity or stating that no maintenance required, the third column stating the frequency of the maintenance activity, and the fourth column providing any additional comments or reference.

d. Qualified service organization list including points of contact with phone numbers.

e. Start-Up and Start-Up Testing Report.

f. Performance Verification Test (PVT Phases I, II, & III) Procedures and Reports.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION AND OPERATIONAL REQUIREMENTS

****

NOTE: The specific microgrid topology should be based on either a distributed or central-plant architecture as outlined in UFC 3-550-04. Consider the trade-offs between leveraging existing capital asset investments and the communications intensity of the chosen architecture.

****

2.1.1 Microgrid System Architecture

The microgrid and associated MCS is designed as a [Distributed Generation Architecture with geographically disparate DERs networked at a single point of interconnection with the external distribution system][Distributed Generation Architecture with geographically disparate DERs networked at multiple points of interconnection to the external distribution system][Central-Plant Type Architecture with co-located DERs networked together and connected to the distribution system at a single point of common coupling].

Submit a detailed schematic Microgrid System Architecture Diagram that displays the layout and interconnections of all MCS components, DERs, and other interfacing systems to be connected to or controlled by the MCS. Account for the interconnection of communication networks belonging to the Government and third parties. If external grid operators require interconnection, [use redundant devices isolated from the MCS communication network][include devices within the MCS] to supply the necessary data. Communication between the MCS and third-party communications systems is [prohibited][permitted].

For each component and equipment indicated on the System Architecture

Diagram, provide technical Product Data Sheets for all hardware components of the Microgrid Control System, including but not limited to controllers, Human-Machine Interface (HMI) devices, and communication equipment.

2.1.2 Microgrid Equipment

****

NOTE: As noted in UFC 3-550-04, the following considerations represent best practice and should be included as project scope allows, and elaborated further within this specification section:
*** Redundant networked sources of generation**
*** Energy Storage**
*** Bi-directional soft, Blinkless transition; From grid to island, and re-synchronized transition from island to grid**
*** Grid connected support, with capability for demand response, and ancillary services such as frequency support voltage management, and black start.**
*** Redundant (min. 2) grid-forming assets capable of supporting life safety and critical loads requiring startup time measured in seconds**
*** Redundant (min. 2) HMI visualization front-ends**
*** Redundant (min. 2) independent black start sources**
*** Load shedding capability**

****

****

NOTE: Read closely and edit the following paragraph and section describing the microgrid system interconnection and operation. Where the microgrid system is arranged such that there are multiple points of interconnection, a ring configuration for the microgrid system, or other system topology differing from that described, the following paragraph should be replaced with a system description matching the design drawings.

****

2.1.2.1 [Utility Service; Point of Common Coupling (Point of Interconnection)]

The microgrid is designed to interface with the utility grid at the designated PCC. The PCC is designed as equipped with [bi-directional metering,][fault detection relays,][and automatic reclosers] to facilitate grid interaction and ensure safety. [The MCS [must][does not] control the automatic reclosers directly.][Reclosers are controlled by the protection system. Requests for open/close are made by the MCS, and executed by the protection system.]

2.1.2.2 Power Generating Assets

****

NOTE: Refer to UFC 3-550-04 for additional guidance on selecting and configuring power generating assets. Ensure compliance with anti-islanding and other safety requirements.

****

Asset Type & ID	Firm Power Asset	Grid-Connected Operation	Island Operation	Nameplate Generation
[Diesel Generator DG-1]	[Yes][No]	[D][S][/E]	[D][S][/F[(___)	[_____]
[Solar PV SPV-1]	[Yes][No]	[D][S][/E]	[D][S][/F[(___)	[_____]
[Wind WG-1]	[Yes][No]	[D][S][/E]	[D][S][/F[(___)	[_____]
[BESS BESS-1]	[Yes][No]	[D][S][/E]	[D][S][/F[(___)	[_____]
[_____]	[Yes][No]	[D][S][/E]	[D][S][/F[(___)	[_____]
[_____]	[Yes][No]	[D][S][/E]	[D][S][/F[(___)	[_____]

POWER GENERATING ASSET TABLE LEGEND:

Grid-Connected Operation:
D - Disabled; Will not generate power while in grid-connected mode
S - Supporting; Grid-following Power provided in parallel to external distribution network, only when total microgrid generation is less than microgrid connected load. No power export.
P - Power Factor Correction
E - Exporting; Permitted to Export power to the external distribution network

Island Operation:
D - Disabled; Asset will not operate in island mode
F(1) - Grid-forming; optional preference indication for primary, alternate grid-forming
S - Supporting; Grid-following power provided in parallel to grid-forming asset(s)

2.1.2.3 Controlled Switches, Breakers, and Devices

****

NOTE: Refer to UFC 3-550-04 for additional guidance on the selection and configuration of controlled switches, breakers, and devices. Ensure that all devices are compatible with the MCS and meet the requirements for data acquisition, control, and safety.

****

Asset Type & ID	Asset Location	Functional Requirements	Supported Condition(s)	Connected Load (W)
[Recloser UTIL-1]	[_____]	[O][M][D]	[E][S][D][N]	[_____]

Asset Type & ID	Asset Location	Functional Requirements	Supported Condition(s)	Connected Load (W)
[Breaker HVAC-1]	[_____]	[O][M][D]	[E][S][D][N]	[_____]
[BESS BESS-1]	[_____]	[O][M][D]	[E][S][D][N]	[_____]

LEGEND:

Functional Requirements:
  O - Operable Open and close via signal from MCS
  M - Metered data provided to microgrid control system
  D - Dispatchable Load; either able to increase or decrease as outlined further elsewhere

Supported Conditions
  E - Essential load; supported under all modes of operation
  S - Supported Load; served by microgrid, though may be shed based on programming
  D - Discretionary Load; Able to be served by microgrid. Within microgrid boundary
  N - Not located within the microgrid boundary

2.1.3   Functional Requirements and Design Parameters

The microgrid control system is to enable the bounded microgrid to meet the following minimum requirements. Unless stated otherwise, the MCS must fulfill these requirements. For equipment requiring control and connected to the MCS, coordinate with the connection and communication standards detailed in this specification.

2.1.3.1   Autonomy

Ensure the MCS provides essential islanding and interconnection functions, independent of external power sources and communication networks. While economic dispatch, demand forecasting, and other optimization models can utilize external networks or services, the microgrid system controller must have fallback logic to command generation that satisfies the designated critical load.

2.1.3.2   Supported Load Profile

The microgrid is designed to be capable of serving a peak critical load of [_____] [kW][MW] during both normal and peak mission activity. Incorporate [one][multiple] grid-forming DDER asset(s) in the system to sustain this load during islanded operations, as detailed in this specification. Direct each grid-forming DER asset with variable startup instructions.

2.1.3.3   Off-grid (Island) System Endurance

The microgrid system is designed to maintain off-grid endurance for a duration of [24 hours][48 hours][3 days][7 days][_____] without the need for commercial power restoration[or DER refueling]. Integrate components such as [battery storage][fuel cells][diesel generators] to achieve this endurance requirement.

****

NOTE: Special consideration must be given to the

potential reduction in fault current from the DERs in comparison to the external grid. The available current may be insufficient to appropriately clear a fault where minimal DERs are online. A design coordination study is required to ensure proper operation, and a construction-phase study will be required to confirm the design assumptions using data from selected equipment. The design must include updated coordination settings (possibly for existing to remain protection devices) at the system and device level to isolate or clear faults, preventing damage to equipment or loads. Refer to UFC 3-550-04 for additional information and requirements.

****

2.1.3.4 Energy Surety and Redundancy

Designer option - define the level of redundancy required by mission. In terms of load and redundant grid-forming or generating assets to support the critical load.

2.1.3.5 Load Shedding Requirements

[An automated load shedding strategy must be implemented to maintain the integrity of both critical and non-critical loads within the microgrid boundary. The automated load shedding must occur during specified anomalies observed [external to][or][within] the microgrid system. Load shedding must be executed under conditions such as [under-frequency,][over-frequency,][under-voltage,][over-voltage,][imbalance conditions,][DER failure,][protection system activation,][manual startup,][___].

Loads are categorized into priority levels [as indicated on the [contract][design] documents], which are defined as [Level 1: Life-Safety Systems,][Level 2: Mission-Critical Systems,][and Level 3: Non-Critical Systems]. Shedding strategies must be executed in descending order based on these levels, beginning with the least critical. Post load shedding, the MCS must automatically restore the shed loads in ascending order of priority levels, once grid stability is re-established. The restoration must be completed within [1][5][10] minutes. If sufficient generation capacity exists in island mode, either through dispatchable firm generation assets or non-dispatchable generation assets, the MCS must automatically restore shed loads based on available capacity.

The MCS must employ [deterministic][adaptive][rule-based][machine learning-based] algorithms to make shedding decisions. These algorithms must be capable of acting within [100 ms][200 ms][500 ms] from the detection of the specified anomaly.

Provide manual override function, accessible through the Human-Machine Interface (HMI), allowing for the [enabling][disabling] of load shedding and alteration of priority levels during emergencies.

Upon initiation and restoration of load shedding, designated personnel must be notified through [email][SMS][HMI alerts].][The microgrid resources are sufficient for operation of all connected loads. Automated load shedding is not required for microgrid operation.]

2.1.3.6 Restoration and Resynchronization

The MCS must restore power to critical loads within [5][10][15][20] minutes following an unplanned outage. This includes the sequence of [islanding][grid-forming] at all points of interconnection, [synchronizing][paralleling] generation assets, and [powering][restoring] designated critical loads. The restoration time is to be measured from the moment of [anomaly detection][islanding initiation] to the [restoration of the last critical load][first critical load].

Upon detecting the return of utility power at the primary side of the PCC, the system must initiate a [predefined][configurable] waiting period of [15 minutes][30 minutes][two hours][four hours][_____]. After confirming the stability of the external grid, the MCS begins execution of a soft transition, closing the [point][points] of common coupling back to the grid. Total transition duration must be no longer than [1][5][10][15] seconds. The transition must employ phase-locking and frequency matching techniques to synchronize the microgrid's [phase][frequency] with the utility's [phase][frequency]. Synchronization and connection of the soft transition is managed by the [the MCS][the protection system specified in Section 26 05 73 POWER SYSTEM STUDIES].

Provide a manual override function, available through the Human-Machine Interface (HMI) to [enable][disable] soft transitions and to alter restoration time settings. Notifications must be sent to designated personnel through [email][SMS][HMI alerts][all of the above] when transitions are initiated and when normal operations are restored.

2.1.3.7 Power System Studies

****

NOTE: The contract documents must include section 26 05 73 Power System Studies, referenced from within this paragraph. The additional requirements of those studies pertaining to the microgrid installation are included here, but may be transferred to section 26 05 73 at the designer's discretion.

****

Provide microgrid system model created using software and methods in accordance with [UFC 3-550-04][26 05 73 POWER SYSTEM STUDIES]. Studies are intended to validate performance metrics of the provided equipment. In addition to the studies outlined by 26 05 73 POWER SYSTEM STUDIES, provide study and reports for microgrid control system in relation to voltage regulation, frequency stability, and fault response analyses.

Incorporate into the model all DERs, load profiles, and grid interaction points, such that the model is capable of simulating [steady-state][transient][both steady-state and transient] conditions. Incorporate into the model [detailed component models][simplified aggregate models][both detailed and simplified models] for DERs and loads.

Submit Power System Studies including modeled analyses reports such as [Short Circuit Study,][Coordination Study,][Arc Flash Study,][Grounding Study,][Load Flow Study,][Harmonic Analysis,][Voltage Drop Calculations,][Transient Stability Study,][and Reliability Analysis]. Validate and provide documentation of the model accuracy and performance through [field measurements][historical data][both field measurements and historical data], and discrepancies must be addressed in subsequent updates.

Upon substantial completion the microgrid system model, including all library files in their native format, unlocked and editable, must be submitted to the Government for future system analysis and upgrades.

2.1.3.8 Expandability

****

NOTE: Engineer of record is to give careful consideration to the mission and project scope goals with relation to phasing and future expansion. The microgrid system is likely to be expanded and modified over time. Consult with the Government stakeholders to determine the tolerance for outages and cost impacts as those expansions and replacements occur. In accordance with UFC 3-550-04, a modular approach will allow expansion and replacement/upgrade with minimal impact to the operations compared to a system which is installed at its maximum size and without modularity.

****

The Microgrid Control System (MCS) must be provided with a modular architecture to facilitate future expandability and scalability. This includes the ability to integrate additional DER, loads, and control algorithms without requiring a complete system overhaul.

Provide MCS hardware components, including controllers, sensors, and Human-Machine Interface (HMI) devices, such that the system is readily scalable by addition of supplemental components. Provide the complete MCS system to accommodate additional hardware through modular expansion units or through software updates. Software updated must be via [automatic][or][manual] installation [only]to improve system performance, security, and to add new features. All systems capable of upgrade must include a rollback feature, capable of reverting to previous software versions [in case of update failures]. Provide a manual override function available through the Human-Machine Interface (HMI) to [enable][disable] system expandability features during specific scenarios.

[Provide an MCS capable of integrating new DERs, including but not limited to [solar PV][wind turbines][fuel cells][battery storage][diesel generators], in a plug-and-play manner. The system must automatically recognize and configure new DERs based on pre-defined or user-configured templates.]

[The system must allow for the addition of new loads, both critical and non-critical, without requiring significant reconfiguration of the existing load management algorithms. New loads must be categorized into existing priority levels or new levels as defined by the user.]

[The MCS must support the integration of new control algorithms or updates to existing algorithms. This includes [deterministic][adaptive][rule-based][machine learning-based] algorithms for load shedding, DER optimization, and other control functions.]

[Provide an MCS system compatible with standard communication protocols such as [Modbus][DNP3][IEC 61850][OPC UA] to ensure seamless integration with new equipment and systems. Any updates or changes to communication protocols must be executed without disrupting ongoing operations.]

2.1.3.9 Real-time Data Export

The Microgrid Control System (MCS) must be capable of feeding real-time data to designated engineering analysis tools centralized within the SCADA system. The data required to be available includes, but is not limited to, system status, DER performance metrics, load profiles, and fault events. Design the MCS to support standard data exchange protocols such as [OPC UA][Modbus][DNP3] for seamless integration with the analysis tools.

2.1.3.10 Bi-Directional 'Blinkless' Transitions

Provide MCS capability to execute bi-directional "blinkless" transitions between grid-connected and islanded operational modes. Transitions are to be completed within a time window not exceeding [50 ms][100 ms][200 ms], thereby ensuring zero interruption to critical and sensitive loads.

The MCS must employ advanced control algorithms to manage the rapid disconnection and reconnection processes. These algorithms must utilize real-time measurements of voltage, frequency, and phase angle to achieve seamless transitions. Incorporate [phase-locking techniques][frequency matching techniques][both phase-locking and frequency matching techniques] to synchronize the microgrid's electrical parameters with those of the utility grid or the islanded DERs.

During the transition, the MCS must manage the ramp rates of DER to avoid sudden changes in output that could destabilize the system. The ramp rates are to be configurable and must not exceed [2%][5%][10%] of the rated power per second.

Provide a manual override function to be accessible through the Human-Machine Interface (HMI) to [enable][disable] the automated transition process. This function must be password-protected and accessible only to authorized personnel.

Upon successful completion of each transition, the MCS must log the event, capturing key parameters such as transition time, DERs involved, and any deviations from set points. Notifications are to be sent to designated personnel through [email][SMS][HMI alerts].

2.1.3.11 Demand Response and Ancillary Services

Provide MCS functionality to be capable of executing demand response actions, [both][automated][and][manual,] to modulate electrical load within the microgrid boundary in response to external grid signals or internal setpoints. The MCS is to be capable of receiving demand response commands via [OpenADR 2.0b][IEC 61850 GOOSE messages].

Provide MCS capabilities including:

[a. Load curtailment: Implementing pre-configured load shedding schemes to reduce electrical consumption upon receiving a demand response signal.]

[b. Load shifting: Temporally reallocating non-critical loads to off-peak hours.]

[c. Frequency Regulation: Continuously adjust DER output to maintain system frequency within [0.1][0.2] Hz of the nominal frequency.]

[d. Voltage Support: Control reactive power output of DERs to maintain bus voltage within [1%][2%] of nominal voltage levels.]

2.1.3.12 Island-mode Black Start Capability

The Microgrid has been designed with the capability for [operator initiated][and] [MCS automatic initiation] of a black start in island-mode operation to restore power to critical and essential loads in the absence of external grid power. The MCS is to coordinate the black start process with designated DDERs capable of self-starting without external electrical supply. These DERs include [battery energy storage systems][fuel cells][diesel generators][gas turbines].

Provide MCS capable of employing advanced control algorithms to manage voltage and frequency during the black start process. These algorithms must be capable of stabilizing the microgrid within [30 seconds][1 minute][2 minutes] from the initiation of the black start. Voltage and frequency must be maintained within [±1%][±3%][±5%] of nominal values during the entire black start process.

Provide a manual override function to be accessible through the Human-Machine Interface (HMI) to [enable][disable] the automated black start process. This function must be password-protected and accessible only to authorized personnel.

The MCS must be tested to validate its black start capability under various load and DER conditions. Select the testing to be in accordance with this specification and [IEEE 1547][IEEE 2030.8][both IEEE 1547 and IEEE 2030.8] standards.

2.1.3.13 Control System Resilience and Redundancy

Integrate resiliency and redundancy to within the MCS control algorithms and components to ensure uninterrupted operation under various failure scenarios. The system must be designed for maximum reliability, safety and integrity while maintaining an availability of [99.9%][99.99%][99.999%] or better. Notifications must be sent to designated personnel through [email][SMS][HMI alerts] upon the activation of any redundancy or failover mechanisms.

Provide the MCS such that fault tolerance is implemented at multiple levels, including but not limited to, hardware, software, and network communication. Hardware components such as controllers, data acquisition systems, and communication devices are to be configured in a redundant setup. Provide architecture supporting hot-swappable components and capable of automatic failover within [100 ms][200 ms][500 ms].

[Redundant communication paths are to be established using [ring topology][star topology][mesh topology]. In case of a communication link failure, the system is to reroute data through an alternate path within [10 ms][20 ms][50 ms].][Data integrity must be maintained through the use of [checksums][hash functions][both checksums and hash functions]. Mirror real-time data in [dual][triple] redundant databases to prevent data loss.]integrity must be maintained through the use of [checksums][hash functions][both checksums and hash functions]. Real-time data is to be mirrored in [dual][triple] redundant databases to prevent data loss.

2.1.3.14 Operational Mode Prioritization

Provide within the MCS, the ability to prioritize between efficient and resilient operational modes. The prioritization is to consider the installation location, mission requirements, and other external factors. Prioritize operational modes based on a hierarchy that aligns with mission objectives and operational constraints. This prioritization is to be configurable and adaptable to real-time conditions.

2.1.3.15 Communication with Protection System

Provide capability within MCS to maintain real-time communication with the protection system. It must be capable of sending and receiving signals related to fault detection, isolation, and system restoration. Establish seamless and secure communication between the MCS and the protection system. This communication is to be in real-time and adhere to industry-standard protocols such as IEC 61850, DNP3, or Modbus. The chosen protocol must support [unidirectional][bidirectional] data flow and be capable of transmitting both analog and digital signals.

Upon detection of a fault condition by the protection system, immediate notification must be sent to the MCS. Subsequently, the MCS must execute pre-configured actions such as load shedding, DER reconfiguration, or mode transition. All events detected by the protection system that result in a change of state or action by the MCS must be logged.

[In the event of a communication failure between the MCS and the protection system, automatically activate a backup communication channel. This backup channel must be tested periodically to ensure its functionality.]

2.1.4 Microgrid Control System Multi-Level Architecture

This section outlines the multi-level logic architecture of the Microgrid Control System (MCS), detailing the various control levels, interface components, and external communication connections. The MCS is structured into primary, secondary, and tertiary control levels, each with distinct functionalities and responsibilities. The interaction of these logic functions with the microgrid forms the basis of the MCS state control and sequences of operation and control.

2.1.4.1 MCS Primary Control (High-Speed Communications)

2.1.4.1.1 Power Flow Management

Responsible for real-time control of power flows within the microgrid, ensuring stability and reliability.

2.1.4.1.2 Fault Detection & Isolation

Detects and isolates faults within the microgrid to prevent cascading failures.

2.1.4.1.3 Operational Safety

Ensures the safe operation of all microgrid components, including adherence to safety protocols and standards.

2.1.4.1.4 Utility Requests

Handles requests from the utility for load shedding, curtailment, or other grid-supportive actions requiring immediate response.

2.1.4.1.5 State Transition Management

Manages the transitions between different operational states of the microgrid.

2.1.4.1.6 Emergency Response

Coordinates actions during emergency situations, such as natural disasters or equipment failures.

2.1.4.2 Low-Speed Communications and Control - Secondary Control

2.1.4.2.1 Load Shedding

Manages the disconnection of non-essential loads during peak demand, during faults, or for island-mode endurance in accordance with sequences of control.

2.1.4.2.2 Economic Dispatch

Near real-time optimization through the dispatch of generation resources to meet demand at the lowest cost.

2.1.4.2.3 Reactive Control

Manages the reactive power in the system to maintain voltage levels within specified limits.

2.1.4.2.4 Load Shaping

Controls load patterns to optimize energy usage and costs.

2.1.4.2.5 Voltage Control

Maintains the voltage levels within the microgrid at optimal levels by directing dispatchable generation, reactive power capable DERs, and shedding of loads.

2.1.4.3 Low-Speed Communications and Control - Tertiary Control (optimization)

2.1.4.3.1 Energy Optimization

Optimizes the energy resources to reduce costs and emissions, optimize renewable energy utilization, and ensure system resilience, through optimizing storage charging/discharging schedules, demand response, and predictive optimization based on economic or weather forecasts.

2.1.4.3.2 Grid Interaction

Manages the interactions between the microgrid and the main grid.

2.1.4.3.3 Demand Response

Coordinates with external systems for demand response events.

2.1.4.3.4 Fuel Management

Optimizes fuel usage among dispatchable generation resources.

2.1.4.3.5 Curtailment Requests

Handles requests for renewable energy curtailment.

2.1.4.3.6 HMI & Visualization

Provides human-machine interface capabilities for monitoring and control. Provides access to real-time and historical data.

2.1.4.3.7 Real-time Analytics

Performs real-time analysis of microgrid performance metrics.

2.1.4.3.8 Renewable Energy Forecasting

Predicts the availability of renewable energy resources.

2.1.4.4 MCS Physical Interface Level

2.1.4.4.1 DER Firewall

Provides cybersecurity measures to protect the MCS and interconnected systems.

2.1.4.4.2 Data Concentrators

Aggregates data from multiple sources such as remote DERs for analysis and control.

2.1.4.4.3 Protocol Converter

Converts communication protocols to ensure interoperability among different devices and systems.

2.1.4.5 MCS Connection to External Communications Systems

2.1.4.5.1 UMCS

Utility Management Control System primarily for HVAC system control, energy management, and demand response coordination.

2.1.4.5.2 SCADA

Supervisory Control and Data Acquisition system for real-time monitoring and control.

2.1.4.5.3 External Grid Operator

Coordinates with the larger grid for import/export of power and other grid services.

2.1.4.5.4 Distributed Energy Resource Management System (DERMS)

Manages the distributed energy resources within the microgrid.

2.1.4.6 Protection & Metering Interfaced with MCS

2.1.4.6.1 Remote I/O

****

NOTE: Select the design option where remote monitoring is permitted. Segregation of control and remote monitoring prevents attacks paths to the microgrid control loop from remote monitoring stations if control is not mandatory.

****

Remote input/output modules for data acquisition and control. [For remote monitoring purposes an out-of-bounds monitoring must be installed physically isolated from the control loop metering.]

2.1.4.6.2 Meters, PQM

Power Quality Meters for monitoring voltage, current, and other electrical parameters.

2.1.4.6.3 Protective Relays

Devices that detect faults and trigger circuit breakers.

2.1.4.7 Microgrid Assets Controlled by MCS

2.1.4.7.1 External Grid PCC

Point of Common Coupling with the external grid.

2.1.4.7.2 Grid-Forming DER(s)

DERs capable of forming a grid. Typically, firm-generation assets.

2.1.4.7.3 Grid-Following DER(s)

Distributed Energy Resources that follow the grid. Typically, inverter-based assets.

2.1.4.7.4 ESS

Energy Storage Systems for storing excess energy.

2.1.4.7.5 Dispatchable Load(s)

Loads that can be controlled or shed as needed.

2.1.4.7.6 Controllable Load(s)

Loads that can be modulated or shifted for demand response or other grid services.

Operational States and State Sequences of Control (Control Algorithms)
Provide MCS capable of managing the following operational states at a

minimum. For each state, in order to execute the listed sequences of control, the MCS is responsible for closed loop control of the [generating assets,][DERs,][breakers and switches,][reclosers,][generation and load dispatch,][and sending and receiving control signals and data for external systems].

2.1.4.8 State I: Normal Operation (Grid-Tie Mode, Standby)

In this state, the MCS must maintain grid-connected operations while on standby for contingency scenarios. Ensure the system is prepared for immediate transition to other operational states as programmed or directed.

2.1.4.8.1 MCS Primary Control (high-speed)

a. Power Flow Management: Continuously monitor and control power flows to maintain grid stability.
b. Can initiate soft transition to Island Mode (SOO-101).
c. Can initiate Peak Shaving (SOO-101).
d. Fault Detection & Isolation: Continuously monitor for electrical faults and be prepared to isolate faulted sections.
e. Can initiate Fault Isolation (SOO-002).
f. Operational Safety: Ensure all safety protocols are active and operational.
g. Can initiate Emergency Shutdown (SOO-003).
h. Utility Requests: Standby to receive and act upon utility requests for grid services.
i. Can trigger Demand Response (SOO-004).
j. Can initiate Grid Support Services (SOO-102).
k. State Transition Management: Maintain readiness for state transitions based on system conditions or external commands.
l. Responsible for executing all state transitions (SOO-001).
m. Responsible for initiating Blackout Response (SOO-006)
n. Allowable State Transition Sequence: Grid-Tie to Island Forming (SOO-1x2)
o. Allowable State Transition Sequence: Grid-Tie to Testing (SOO-1x6)
p. Allowable State Transition Sequence: Grid-Tie to Blackout (SOO-1x3)
q. Emergency Response: Standby for emergency response activation, including natural disasters or equipment failures.
r. Can initiate Emergency Response Protocol (SOO-005).
s. Can initiate Communications Failure Response (SOO-007)

2.1.4.8.2 MCS Secondary Control (low-speed)

a. Load Shedding: Monitor load levels and be prepared for non-essential load shedding.
b. Can initiate Grid-tied Load Shedding Protocol (SOO-103).
c. Can initiate Peak Shaving (SOO-104).
d. Economic Dispatch: Maintain an optimized dispatch schedule for generation resources.
e. Reactive Control: Monitor reactive power levels and control VAR compensation devices.
f. Load Shaping: Monitor and control load patterns for optimal energy usage.
g. Voltage Control: Monitor and maintain voltage levels within specified limits.
h. Can initiate Voltage Regulation (SOO-105).

2.1.4.8.3 MCS Tertiary Control (long-term optimization)

a. Energy Optimization: Standby to optimize energy resources based on predictive algorithms.
b. Can trigger Energy Optimization Protocol (SOO-106).
c. Grid Interaction: Monitor the status of the main grid and be prepared for transitions.
d. Can initiate Grid Support Services (SOO-102).
e. Demand Response: Standby for demand response events from the utility or other external systems.
f. Can initiate Demand Response (SOO-108).
g. Fuel Management: Monitor fuel levels for dispatchable generators.
h. Curtailment Requests: Standby to receive and act upon renewable energy curtailment requests.
i. Can initiate Renewable Curtailment (SOO-109).
j. HMI & Visualization: Ensure real-time and historical data are available for monitoring.
k. Perform real-time analytics for system performance.
l. Provide Renewable Energy Forecasting: Standby with updated renewable energy forecasts.

2.1.4.8.4 MCS Physical Interface Level

a. DER Firewall: Ensure cybersecurity measures are active.
b. Data Concentrators: Aggregate data from DERs for system analysis.
c. Protocol Converter: Ensure all communication protocols are operational for device interoperability.

2.1.4.8.5 MCS Connection to External Communications Systems

a. UMCS: Standby for HVAC control and energy management commands.
b. Can trigger HVAC Optimization (SOO-110).
c. SCADA: Ensure real-time data is being sent to and received from the SCADA system.
d. External Grid Operator: Standby for commands or data exchange with the external grid operator.
e. DERMS: Ensure DERs are being managed according to set parameters.

2.1.4.8.6 Protection & Metering Interfaced with MCS

a. Remote I/O: Ensure data acquisition and control signals are operational.
b. Meters, PQM: Continuously monitor power quality parameters.
c. Protective Relays: Monitor status for connected protective relays; ensure they remain operational and ready to act upon fault conditions.
d. Can initiate Fault Isolation (SOO-003).

2.1.4.8.7 Microgrid Assets Controlled by MCS

a. External Grid PCC: Monitor the point of common coupling with the external grid for any anomalies.
b. Grid-Forming DER(s): Ensure grid-forming DERs are operational and synchronized.
c. Grid-Following DER(s): Ensure grid-following DERs are operational and synchronized.
d. ESS: Monitor the state of charge and health of energy storage systems.
e. Can initiate Energy Storage Dispatch (SOO-006).
f. Dispatchable Load(s): Ensure dispatchable loads are controllable and monitor their status.
g. Controllable Load(s): Monitor and control controllable loads for demand

response or other grid services.

h. Can be part of Demand Response (SOO-004).

2.1.4.9 State 2: Isolation from External Utility (Islanding; Transient State)

Upon detection of an external utility failure or other triggering events, the MCS must initiate the transition to islanding mode. Breakers or reclosers at the point(s) of common coupling (PCCs) must be opened, and system boundaries established.

2.1.4.9.1 MCS Primary Control (high-speed)

a. Power Flow Management: Responsible for real-time control of power flows within the islanded microgrid, ensuring stability and reliability. Temporarily suspends non-urgent control actions; focuses on stabilizing power flows during the transition.
b. Initiates Black Start Protocol (SOO-201)
c. Fault Detection & Isolation: Detects and isolates faults within the islanded microgrid to prevent cascading failures.
d. Operational Safety: Validates safety protocols specific to the transition to island mode.
e. Utility Requests: Suspends handling of new utility requests; maintains ongoing actions.
f. State Transition Management: Actively manages the transition to island mode.
g. Completes ongoing state transitions (SOO-001).
h. Allowable State Transition Sequence: Islanding to MG Formation (SOO-2x3).
i. Emergency Response: Continues to monitor for emergency situations that may arise during the transition. Coordinates actions during emergency situations specific to the islanded state.

2.1.4.9.2 MCS Secondary Control (low-speed)

a. Load Shedding: Prepares for potential load shedding; suspends non-urgent shedding actions. [Manages the disconnection of non-essential loads for island-mode endurance.]
b. Initiates Island Load Shedding (SOO-202) to maintain stability of mirogrid system
c. Economic Dispatch: Temporarily suspends optimization
d. Reactive Control: Manages the reactive power in the islanded system to maintain voltage levels.
e. Load Shaping: Suspends load shaping activities.
f. Voltage Control: Prepares for voltage control in island mode; suspends non-urgent actions. Maintains the voltage levels within the islanded microgrid by directing dispatchable generation and reactive power capable DERs.

Initiates Generation Synchronization (SOO-203).

2.1.4.9.3 MCS Tertiary Control (long-term optimization)

a. Energy Optimization: Suspends long-term optimization activities.
b. Grid Interaction: Prepares for disconnection from the main grid.
c. Demand Response: Suspends new demand response events; maintains ongoing events.
d. Fuel Management: Pauses economic fuel optimization actions.
e. Curtailment Requests: Suspends new curtailment requests; maintains ongoing curtailments.

2.1.4.9.4 MCS Physical Interface Level

a. DER Firewall: Maintains current cybersecurity measures; prepares for island-specific measures.
b. Data Concentrators: No functional change.
c. Protocol Converter: No functional change.

2.1.4.9.5 MCS Connection to External Communications Systems

a. UMCS: Suspends new HVAC control actions; maintains ongoing actions.
b. SCADA: Prepares for island-mode operation; maintains essential real-time data exchange.

2.1.4.9.6 Protection & Metering Interfaced with MCS

a. Remote I/O: Maintains essential data acquisition; suspends non-urgent control signals.
b. Meters, PQM: Focuses on essential power quality parameters; suspends detailed monitoring.
c. Protective Relays: Maintains current operational status; prepares for island-specific settings.

2.1.4.9.7 Microgrid Assets Controlled by MCS

a. External Grid PCC: Monitors for safe disconnection; prepares for island mode. Monitors for reconnection readiness.
b. Grid-Forming DER(s): Prepares for grid-forming operations; provides synchronization coordination for connected DERs. .
c. Grid-Following DER(s): Suspends new actions; maintains current operational status for soft transition. [Directs grid-following DERs offline for black start]
d. ESS: Prepares for island-mode dispatch; maintains current state of charge.
e. Dispatchable Load(s): Prepares for potential shedding or control; maintains current status based on load forming logic.
f. Controllable Load(s): Suspends new control actions; maintains current operational status based on load shedding logic.

2.1.4.10 State 3: Microgrid Formation (Soft Transition or Black Start)

In the event of unplanned grid failure with no energized generation resources, the MCS must initiate a black start. Initialize the system process to synchronize all resources uniformly to a defined reference frequency.

2.1.4.10.1 MCS Primary Control (high-speed)

a. Power Flow Management: Finalizes transition to island mode; ensures stable power flows.
b. Initiates Soft Transition Completion (SOO-301) or Black Start Completion (SOO-302) as applicable.
c. Fault Detection & Isolation: Resumes full fault detection and isolation capabilities.
d. Operational Safety: Validates and enforces island-mode safety protocols.
e. Utility Requests: Resumes handling of utility requests in island mode. If Island mode entered at utility request, monitors for change in state of request.
f. State Transition Management: Confirms successful transition to island

mode.
g. Can initiate State Transition to Island Mode (SOO-001).
h. Allowable State Transition Sequence: MG Formation to Island Mode (SOO-3x4)
i. Allowable State Transition Sequence: MG Formation to Grid-Connect (SOO-3x5) (typically following black start where external grid source is available.)
j. Emergency Response:

2.1.4.10.2 MCS Secondary Control (low-speed)

a. Load Shedding: Resumes normal load shedding protocols specific to island mode.
b. Initiates Island Load Confirmation (SOO-303).
c. Economic Dispatch: Resumes economic dispatch optimized for island mode.
d. Reactive Control: Resumes full reactive power control.
e. Load Shaping: Resumes load shaping activities optimized for island mode.
f. Voltage Control: Resumes full voltage control capabilities.
g. Initiates Island Voltage Stabilization (SOO-304).

2.1.4.10.3 MCS Tertiary Control (long-term optimization)

a. Energy Optimization: Resumes long-term optimization activities specific to island mode.
b. Grid Interaction: Monitors for potential reconnection to the main grid.
c. Demand Response: Resumes demand response activities optimized for island mode.
d. Fuel Management: Resumes fuel optimization activities.
e. Curtailment Requests: Resumes handling of curtailment requests in island mode.

2.1.4.10.4 MCS Physical Interface Level

a. ER Firewall: Activates island-specific cybersecurity measures.
b. Data Concentrators: Resumes full data aggregation capabilities.
c. Protocol Converter: Activates island-specific communication protocols.

2.1.4.10.5 MCS Connection to External Communications Systems

a. UMCS: Resumes full HVAC control and energy management activities.
b. SCADA: Resumes full real-time data exchange capabilities.

2.1.4.10.6 Protection & Metering Interfaced with MCS

a. Remote I/O: Resumes full data acquisition and control capabilities.
b. Meters, PQM: Resumes full monitoring of power quality parameters.
c. Protective Relays: Activates island-specific settings and resumes full operational status.

2.1.4.10.7 Microgrid Assets Controlled by MCS

a. External Grid PCC: Confirms successful disconnection and monitors for reconnection criteria.
b. Grid-Forming DER(s): Confirms successful transition to grid-forming operations.
c. Grid-Following DER(s): Resumes normal operations in island mode.
d. ESS: Confirms state of charge and resumes normal dispatch activities.
e. Dispatchable Load(s): Resumes full controllability.
f. Controllable Load(s): Resumes normal control activities optimized for

island mode.

2.1.4.11 State 4: Islanded Operation (Optimized Operation for Resilience and Endurance)

Once full load is served, the MCS must optimize operation by managing load factors of paralleled generation, paralleling inverter-based generation devices, and shedding discretionary loads to increase system endurance.

2.1.4.11.1 MCS Primary Control (high-speed)

a. Power Flow Management: Maintains stable power flows within the islanded microgrid.
b. Initiates Load Balancing (SOO-401).
c. Fault Detection & Isolation: Continuously monitors for electrical faults and isolates faulted sections.
d. Initiates Island Fault Isolation (SOO-402).
e. Operational Safety: Enforces island-mode safety protocols.
f. Utility Requests: Not applicable in island mode.
g. State Transition Management: Monitors conditions for potential reconnection to the main grid.
h. Initiates Reconnection Pre-check (SOO-403).
i. Allowable State Transition Sequence: Island Mode to Grid Connect (SOO-4x5)
j. Emergency Response: Maintains readiness for emergency scenarios specific to island mode.

2.1.4.11.2 MCS Secondary Control (low-speed)

a. Load Shedding: Manages load shedding specific to island mode.
b. Initiates Island Load Shedding (SOO-404).
c. Economic Dispatch: Optimizes dispatch of generation resources within the island.
d. Reactive Control: Manages reactive power to maintain voltage levels.
e. Load Shaping: Controls load patterns to optimize energy usage in island mode.
f. Voltage Control: Maintains voltage levels within specified limits.
g. Initiates Island Voltage Regulation (SOO-405).

2.1.4.11.3 MCS Tertiary Control (long-term optimization)

a. Energy Optimization: Optimizes energy resources based on island-mode constraints.
b. Initiates Island Energy Optimization (SOO-406).
c. Grid Interaction: Not applicable in island mode.
d. Demand Response: Manages demand response events within the island.
e. Initiates Island Demand Response (SOO-407).
f. Fuel Management: Optimizes fuel usage among dispatchable generation resources.
g. Initiates Island Fuel Management (SOO-408).
h. Curtailment Requests: Manages renewable energy curtailment within the island.
i. Initiates Island Renewable Curtailment (SOO-409).

2.1.4.11.4 2.1.6.11.4 MCS Physical Interface Level

a. DER Firewall: Maintains island-specific cybersecurity measures.
b. Data Concentrators: Aggregates data for island-mode analysis and control.

c. Protocol Converter: Maintains island-specific communication protocols.

2.1.4.11.5 MCS Connection to External Communications Systems

a. UMCS: Manages HVAC and energy in island mode.
b. SCADA: Ensures real-time data exchange within the island.

2.1.4.11.6 Protection & Metering Interfaced with MCS

a. Remote I/O: Maintains data acquisition and control signals.
b. Meters, PQM: Continuously monitors power quality parameters in island mode.
c. Protective Relays: Operates with island-specific settings.

2.1.4.11.7 Microgrid Assets Controlled by MCS

a. External Grid PCC: Monitors for reconnection criteria to the main grid.
b. Grid-Forming DER(s): Operates to maintain grid stability.
c. Grid-Following DER(s): Follows the grid-forming DERs.
d. ESS: Manages state of charge and dispatch activities.
e. Dispatchable Load(s): Manages controllability based on island-mode requirements.
f. Controllable Load(s): Manages control activities specific to island mode.

2.1.4.12 State 5: Re-Synchronization Back to External Utility (Soft Transition Only; Transient State)

Upon detecting the return of stable utility power, the MCS must wait for a predefined period to confirm utility stability before initiating a soft transition back to commercial power.

2.1.4.12.1 MCS Primary Control (high-speed)

a. Power Flow Management: Prepares the system for reconnection by aligning voltage, frequency, and phase.
b. Initiates Reconnection Pre-check (SOO-501).
c. Fault Detection & Isolation: Ensures no faults exist that would prevent reconnection.
d. Initiates Reconnection Safety Check (SOO-502).
e. Operational Safety: Validates that all safety protocols for reconnection are met.
f. Initiates Safety Confirmation (SOO-503).
g. Utility Requests: Awaits clearance from the utility for reconnection.
h. State Transition Management: Executes the reconnection sequence.
i. Initiates Reconnection Sequence (SOO-504).
j. Allowable State Transition Sequence: Re-sync to Grid-Tie Mode (SOO-5x1)
k. Allowable State Transition Sequence: Re-sync to Island Mode (SOO-5x4) (upon resync failure)
l. Emergency Response: Stands by for any emergency scenarios during reconnection.

2.1.4.12.2 MCS Secondary Control (low-speed)

a. Load Shedding: Prepares for potential load adjustments upon reconnection.
b. Economic Dispatch: Plans for dispatch adjustments that occur post-reconnection.
c. Reactive Control: Prepares reactive power compensation for reconnection.

d. Load Shaping: Plans for load adjustments upon reconnection.
e. Voltage Control: Aligns voltage levels for reconnection.

2.1.4.12.3 MCS Tertiary Control (long-term optimization)

a. Energy Optimization: Plans for energy resource adjustments post-reconnection.
b. Grid Interaction: Prepares for interactions with the main grid post-reconnection.
c. Demand Response: Prepares for potential demand response events post-reconnection.
d. Fuel Management: Plans for fuel usage adjustments post-reconnection.

2.1.4.12.4 MCS Physical Interface Level

a. DER Firewall: Validates cybersecurity protocols for reconnection.
b. Data Concentrators: Aggregates data for reconnection analysis and control.
c. Protocol Converter: Validates communication protocols for reconnection.

2.1.4.12.5 MCS Connection to External Communications Systems

a. UMCS: Prepares for HVAC and energy management post-reconnection.
b. SCADA: Validates real-time data exchange capabilities for post-reconnection.

2.1.4.12.6 Protection & Metering Interfaced with MCS

a. Remote I/O: Validates data acquisition and control signals for reconnection.
b. Meters, PQM: Validates power quality parameters for reconnection.
c. Protective Relays: Validates settings for reconnection.

2.1.4.12.7 Microgrid Assets Controlled by MCS

a. External Grid PCC: Validates criteria for reconnection to the main grid.
b. Grid-Forming DER(s): Prepares for transition to grid-following mode.
c. Grid-Following DER(s): Prepares for synchronization with the main grid.
d. ESS: Prepares for state of charge and dispatch activities post-reconnection.
e. Dispatchable Load(s): Prepares for controllability adjustments post-reconnection.
f. Controllable Load(s): Prepares for control activities post-reconnection.

2.1.4.13 State 6: Testing and Diagnostic State

This mode supports regularly scheduled loaded testing, device testing, and troubleshooting. The MCS must be capable of transitioning to this state for diagnostic and testing purposes. Individual components may be taken out of service for testing as operations and safety procedures allow. Protective functions must never be permitted to be taken out of service while the devices remain energized without a local failsafe controller. At a minimum, testing state must provide for testing of microgrid control system components and functions without interruption to regular operations.

[Loaded Testing: _____]
[Device Testing: _____]
[Isolation Testing: _____]

2.1.5 Microgrid Control System Sequences of Control

This section outlines the Sequences of Control (SOCs) that govern the behavior of the Microgrid Control System (MCS) under various conditions and operational states. The sequences of control defined are included to communicate design intent for functionality and operation and do not explicitly cover each interaction of grid components, features of the necessary communication, timing required, or the means of executing the functions described.

The SOCs are categorized based on their function and the operational state from which they are typically initiated:

a. Sequences beginning with '0' (e.g., SOC-001, SOC-002, etc.): These are general sequences that typically may be executed from any operational state.
b. Sequences with a leading numeral '1-6' (e.g., SOC-102, SOC-203, etc.): These sequences are typically initiated from the operational state represented by the leading numeral. For example, SOC-102 would generally be initiated from operational state '1', Normal Grid-Tie Operation.
c. Sequences with an 'x' in the second position (e.g., SOC-1x2, SOC-2x1, etc.) are state transition sequences, guiding the system from one operational state to another in a controlled manner.

2.1.5.1 SOC-001: State Transition

A macro sequence of operation; the Microgrid Control System (MCS) transitions between various operational states such as grid-connected, islanded, and testing modes as outlined above. The transition logic is based on real-time data and pre-defined conditions. The MCS must be capable of execute the state transitions based on [manual operator input][automated logic][pre-set schedules].

2.1.5.2 SOC-002: Fault Isolation

In this sequence, the Microgrid Control System (MCS) transitions between various operational states such as grid-connected, islanded, and emergency modes. The transition logic is based on real-time data and pre-defined conditions. The MCS must execute this sequence based on [manual operator input][automated logic][pre-set schedules].

2.1.5.3 SOC-003: Emergency Shutdown

In extreme conditions requiring immediate shutdown, the MCS must execute a controlled shutdown sequence to protect both hardware and personnel. This includes [disconnecting non-essential loads][shutting down generation units][activating emergency response protocols].

2.1.5.4 SOC-004: Demand Response

The MCS must adjust generation and load profiles in real-time to meet demand-side management objectives. This could be triggered by [utility signals][peak pricing periods][manual operator input].

2.1.5.5 SOC-005: (External) Emergency Response

In the event of an emergency such as a natural disaster, the MCS must switch to a pre-defined emergency response mode. This involves [prioritizing critical loads,][prioritizing island mode endurance,][isolating faulted or impacted system components,][utilizing generation sources to meet mission requirements,][_____].

2.1.5.6 SOC-006: Blackout Response

In this sequence of operation, the microgrid has been subjected to a planned or unplanned utility outage and loss of utility power. [Immediately after the loss of utility,][The MCS must wait for a delay of [_____] seconds for the return of a stable utility source, after which] the MCS must [automatically] begin the Black-Start Microgrid Formation Sequence of Operation.

2.1.5.7 SOC-007: Communications Failure Response

Upon loss of communication with the central control, the MCS must switch to a fail-safe mode, maintaining essential services using local control logic. This could involve [manual control][pre-loaded algorithms][local sensor data].

2.1.5.8 SOC-100: Normal Grid-tie Mode Stable Operation

The microgrid is operating in a stable, grid-connected mode. The MCS must manage the generation assets and loads to maintain optimal power quality and system efficiency. This involves [real-time monitoring][load forecasting][reactive power compensation].

2.1.5.9 SOC-101: Soft transition to Island Mode

[The microgrid system controller must not perform a seamless, loaded transition from grid-connected to island mode.][The microgrid system controller will perform a seamless transition of [only essential][all connected] loads from grid-connected to island mode. Prior to opening the [switch(es)][recloser(s)][breaker(s)] at the point of common coupling to transition into island mode, all non-essential loads exceeding the generation and step capacity of the microgrid firm power generation assets must be shed.]

May be initiated by the monitoring losing faith in the connected external grid; parameters outside IEEE 1547.8 requirements for anti-islanding, minimum voltage ride-through, under and over-voltage trip time.

2.1.5.10 SOC-102: Grid Support Services

During this Sequence of Operation (SOC), the Microgrid Control System (MCS) actively engages in supporting the stability and reliability of the connected utility grid. The MCS must [continuously monitor][periodically scan] grid parameters such as frequency, voltage, and phase angle. Based on real-time analytics and pre-defined setpoints, the MCS must [automatically adjust][request operator confirmation to adjust] the output of grid-forming DERs to provide ancillary services. These services include [frequency regulation,][voltage support,][reactive power compensation,][and demand response]. [The MCS may also engage in [demand response][energy arbitrage][frequency regulation] [as directed by an external DERMS][based on real-time grid conditions].]

[a. Frequency Regulation: The MCS must [automatically][manually] adjust the output of grid-forming DERs to maintain grid frequency within specified limits.]

[b. Voltage Support: Utilizing advanced control algorithms, the MCS must [dynamically adjust][maintain] the reactive power output of DERs to support grid voltage levels.]

[c. Reactive Power Compensation: The MCS must [automatically compensate][provide options to human operator for compensating] reactive power imbalances in the grid by controlling the VAR output of DERs.]

[d. Demand Response: Upon receiving signals or setpoints from the utility or an authorized entity, the MCS must execute pre-defined load shedding or load shifting strategies.]

2.1.5.11 SOC-103: Grid-tied Load Shedding

When the main grid is under stress, the MCS must execute a load-shedding sequence to alleviate the strain by [prioritizing essential loads,][disconnecting non-essential loads,][modulating grid-parallel generation,][_____].

2.1.5.12 SOC-104: Peak Shaving

During peak demand periods, the MCS must optimize the generation and load profile to minimize peak demand charges by means of [utilizing energy storage][demand-side management][load shifting].

2.1.5.13 SOC-105: Voltage Regulation

The MCS is requried to continuously monitor the voltage levels within the microgrid and exert control and direction for components within the microgrid boundary, ensuring the utilization voltage remains within the acceptable range defined by IEEE 1547.

2.1.5.14 SOC-106: Energy Optimization

In this sequence, the MCS must optimize the energy flow within the microgrid to achieve maximum efficiency and reliability based on [signals from DERMS external to the MCS,][real-time pricing data,][historical and projected load profiles,][renewable or dispatchable generation availability].

2.1.5.15 SOC-108: Demand Response

Upon receiving a utility load shed request, the MCS must prioritize loads based on predefined criteria and execute a shedding sequence to reduce total system load.

As directed by the system ['s participation in Voluntary Protection Program][operator] [automated logic], the MCS begins the process to transition from grid-tied mode to island mode. Where the islanded microgrid is insufficient to support all connected and powered loads with dispatchable generation resources and firmed renewable generation, the excess loads are disconnected from the distribution system by the MCS. After stabilization and paralleling of a Grid-forming asset, the MCS directs the breaker(s) or recloser(s) at the point of common coupling to open forming the boundaries of the microgrid. Upon transition, the microgrid control system enters island mode operation and exerts control over all devices, energy resources, and loads.

2.1.5.16 SOC-109: Renewable Curtailment

Upon receipt of a renewable curtailment request from the utility, the MCS must adjust the output of renewable generation sources to meet the requested curtailment levels.

2.1.5.17 SOC-110: HVAC Optimization

2.1.5.18 SOC-111: Directed Grid Disconnect

As directed by the system ['s participation in Voluntary Protection Program][operator] [automated logic], the MCS begins the process to transition from grid-tied mode to island mode. Where the islanded microgrid is insufficient to support all connected and powered loads with dispatchable generation resources and firmed renewable generation, the excess loads are disconnected from the distribution system by the MCS. After stabilization and paralleling of a Grid-forming asset, the MCS directs the breaker(s) or recloser(s) at the point of common coupling to open forming the boundaries of the microgrid. Upon transition, the microgrid control system enters island mode operation and exerts control over all devices, energy resources, and loads.

2.1.5.19 SOC-201: Black Start

Typically initiated following a planned or unplanned outage of the external grid, the MCS orchestrates a black start procedure to energize the microgrid. Leveraging black start-capable DER(s), the MCS ensures that the initial voltage and frequency are within acceptable limits before permitting additional resources online. The MCS also validates that the renewable sources, if any, adhere to IEEE 1547 Clause 8 requirements for anti-islanding and ride-through capabilities.

2.1.5.20 SOC-202: Island Load Shedding

Operating in Island-forming state, and upon detecting an imbalance between generation and load, the system immediately [engages in load shedding protocols][and directs dispatchable generation startup or ramp-up]. Priority is given to maintaining power to critical infrastructure, as per pre-defined load hierarchies.

2.1.5.21 SOC-203: Generation Synchronization

The MCS executes phase alignment algorithms to synchronize all active generators. This ensures cohesive operation and minimizes phase imbalances. If renewable energy sources are part of the generation mix, their variable output is stabilized to align with other generators. Operations are returned to the originating state upon completion of this SOC.

2.1.5.22 SOC-301: Soft Transition Completion

Transitioning into the 'Microgrid Formation' state from a Grid-Tie state, the MCS adjusts the microgrid's phase, frequency, and voltage to stabilize the islanded microgrid. This soft transition aims to minimize any disruptions to connected loads during the islanding process.

2.1.5.23 SOC-302: Black Start Completion

Once a successful black start is achieved, the MCS validates the stability and readiness of all connected resources. It then transitions the system to an 'Islanded Operation' state, ensuring that the microgrid is fully capable of supporting the designated critical load.

2.1.5.24 SOC-400: Island Mode Stable Operation

In this state the [Diesel generator(s)][_____] operates [in parallel] to provide the grid-forming voltage and frequency. During normal Island Mode [excess generation must be diverted to the ESS][excess generation must be curtailed. The MCS must provide direction to curtail production to the connected DERs][, and the MCS will direct breakers and switches supporting non-essential loads to open based upon available generation and load management]. The MCS must direct non-essential loads be shed where the demand load exceeds the firm generation capacity.

2.1.5.25 SOC-401: Load Balancing

Operating in Island mode, the MCS Utilizes real-time data to dynamically direct or connect/disconnect loads and provide direction to various dispatchable DERs and energy storage systems or connect/disconnect them based on their current capacity and efficiency. This sequence is occurring and repeating.

2.1.5.26 SOC-402: Island Fault Isolation

Should a fault occur within the islanded microgrid, automated fault detection sequence must initiate automatically. The MCS must isolate the faulty sections and reroute power to maintain microgrid stability, intended on preventing cascading failures and maintaining support of critical loads.

2.1.5.27 SOC-403: Reconnection Pre-check

Before initiating the reconnection to the main grid, a series of checks are conducted on both the microgrid and utility source. These include utility stability analysis for a specified duration, microgrid-to-utility phase matching, voltage matching, and frequency sync. Only after successful completion and evaluation within acceptable parameters, the MCS is to proceed with the reconnection sequence.

2.1.5.28 SOC-404: Island Load Shedding

To prevent overloading of DERs, the MCS is requried to engage automated load-shedding algorithms. Non-critical loads must be disconnected based on priority levels, ensuring that essential services remain uninterrupted.

2.1.5.29 SOC-405: Island Voltage Regulation

Voltage levels are continuously monitored. If any deviation from the specified limits is detected, the MCS must [activate capacitor banks,][direct on-load tap changers,][command ESS to charge or discharge as reactive power source or sink,][direct dispatchable or sheddable loads,][and][control reactive power from inverters] to maintain stable voltage levels.

2.1.5.30 SOC-406: Island Energy Optimization

Beginning in Island Mode, the MCS immediately assesses the current power flow, including generation assets, storage status, and load profiles. It then prioritizes renewable energy sources, directing them to operate at their maximum efficiency levels. Concurrently, the MCS adjusts the charge or discharge rates of Energy Storage Systems (ESS) to either store excess energy or release stored energy to meet demand. If renewables and ESS are insufficient, the MCS must provide direction to ramp up dispatchable generation assets, [gas turbines][and][diesel generators][___][] to meet demand. The MCS also [engages in real-time load forecasting to anticipate future energy needs][receives signals from external DERMS based on real-time load projection], adjusting generation and storage operations accordingly. Throughout this sequence, the MCS continuously monitors the state of charge of the ESS and the fuel levels of dispatchable generators to ensure long-term endurance to meet mission requirements.

2.1.5.31 SOC-407: Island Demand Response, Dispatchable Generation & Consumption

The MCS, referencing the defined and programmed categorization of loads into [critical,][essential,][and non-essential], and prepares to shed loads in inverse priority if necessary. Simultaneously, the MCS sends signals to dispatchable loads and generation assets, instructing them to either ramp up or down based on current needs. [Alternatively, it may instruct dispatchable generators to increase output.]

2.1.5.32 SOC-408: Island Fuel Management

Fuel levels and consumption rates for non-renewable DERs are closely monitored. Should fuel levels approach critical limits, the MCS must trigger alerts and may switch to alternative sources to maintain power supply.

2.1.5.33 SOC-409: Island Renewable Curtailment

When supply from renewable sources exceeds demand, the MCS must curtail the excess generation. This is crucial for maintaining microgrid stability and preventing potential damage to infrastructure.

2.1.5.34 SOC-501: Reconnection Pre-check

Before initiating the reconnection to the main grid, a series of checks are conducted on both the microgrid and utility source. These include utility stability analysis for a specified duration, microgrid-to-utility phase matching, voltage matching, and frequency sync. Only after successful completion and evaluation within acceptable parameters, the MCS is to proceed with the reconnection sequence.

2.1.5.35 SOC-502: Reconnection Safety Check

Prior to closing the point of common coupling circuit, the MCS directs a series of final checks [and simulations] [and directs protection system updates, shifting from island mode to grid-tie mode protection settings].

2.1.5.36 SOC-503: Safety Confirmation

In this sequence, the MCS sends a safety confirmation signal to both local operators and the utility grid control center. This serves as the final go/no-go decision point for reconnection. The MCS waits for an acknowledgment signal from the utility grid control center, confirming that it is safe to proceed with the reconnection. If the acknowledgment is not received within a predefined time, the MCS aborts the reconnection and reverts to island mode, ensuring the safety and integrity of the microgrid.

2.1.5.37 SOC-504: Reconnection Sequence

With all safety checks complete and confirmations received, the MCS initiates the final reconnection sequence. It first synchronizes the microgrid's voltage, frequency, and phase angle with those of the external grid. Once synchronized, the MCS closes the PCC breakers, effectively transitioning the microgrid from island mode to grid-tied operation. The MCS then gradually ramps down or shuts off internal generation assets as it begins to draw power from the external grid. Finally, the MCS performs a post-connection assessment to ensure that all systems are stable and operating as expected, completing the transition back to grid-tied mode.

2.1.6 Control Power

Power microprocessor-based devices integral to microgrid control from DC sources conforming to [24V][48V][125V] standard voltage levels. Devices requiring DC power encompass [controllers,][computers,][switches][, routers,][grid-connected inverters for battery storage,][generator set controllers,][inverter controllers,][firewalls,][gateways,][protection devices, meters,][and monitors].

In scenarios where AC power is lost, uninterrupted operation of communication, control, and monitoring functions is mandatory. For AC outages exceeding [_____][10 minutes][30 minutes], equipment must [enter a low-power state][or][disconnect from the DC bus] to conserve battery life for potential black start conditions.

Monitoring and alarming of DC backup batteries and associated charging circuits must be continuous on the MCS. Minimum monitored parameters must include [DC voltage][and][charger online status].

For enhanced DC bus reliability during prolonged AC outages, circuits and relays must be configured to [select AC power from a single source][select AC power from multiple sources]. In high-reliability locations, [single][redundant] DC power sources must be provided to critical electronics through [single diode arrangements][multiple diode arrangements]. During battery servicing or replacement, critical electronics must [remain connected to the DC bus][be disconnected from the DC bus] through [battery bypass circuits][chargers capable of providing DC voltage without a battery].

Engine starting batteries for generator sets may serve as [primary][backup] DC sources. Electronics must withstand a [3-second][5-second] voltage dip of [50%][40%] during engine starts.

Use of AC Uninterruptible Power Supplies (UPS) is [permitted][discouraged][not permitted].

2.1.7 Protection and Control Integration

Data pertaining to alarms, targets, health status, metering, and IEEE 2030.8 compliance on the AC power system must be transmitted from protective relays to the MCS. Upon detection of a faulted, open, or erroneous circuit condition by the relays, control systems governing dispatch, voltage, frequency, power, and reactive power must cease operation in a controlled manner.

Mandatory data collection in accordance with IEEE 2030.8 data table C.1

must encompass protective relays at the point of utility coupling and all DER, including [generator sets,][inverters,][photovoltaic systems,][and Battery Energy Storage Systems (BESS).]

All required data from protective relays must be displayed on the MC HMI, including:

a. Alarms and Targets required from relays include but are not limited to: Trip, Lockout 86, ESTOP, circuit breaker bell alarm, breaker status, local/remote, permissive to close/synchronize.
b. Health status required from relays include but are not limited to: protection enable/offline status, trip status, communication status.
c. Metering required from relays include but are not limited to: 3 phase power, 3 phase reactive power, frequency on both sides of all DER and PCC breakers, phase-phase voltages on both sides of all DER and PCC breakers, current, power factor.
d. IEEE 2030.8 data required from relays to be stored for the life of the microgrid must include but are not limited to: P, Q, V, F at every DER and PCC.
e. Required controls to the relays include but are not limited to: CB open/close, motor operated disconnect open/close, tap change raise/lower.

All required DER data from must be displayed on the MC HMI, including:

f. Alarms and Targets required from DER include but are not limited to: Trip, Lockout 86, ESTOP, circuit breaker bell alarm, breaker status (DC and AC), local/remote, permissive to close/synchronize/commutate.

g. Health status required from DER include but are not limited to: enable/offline status, major and minor alarms, communication status.

h. Metering required from DER include but are not limited to:3 phase power, 3 phase reactive power, frequency, phase-phase voltages on both sides of breakers, current, power factor, and applicable temperatures, oil pressures, levels, and fire alarm status.

i. IEEE 2030.8 data required from DER to be stored for the life of the microgrid must include but are not limited to: P,Q,V,F at every DER

j. Required controls to the DER include but are not limited to: frequency/power reference, voltage/reactive power reference, enable commutation, breaker open/close.

2.1.8 Energy Management Functions

2.1.8.1 Dispatch Requirements

All microgrid control systems are to be provided with several minimal requirements for dispatching all DER inclusive of gensets, battery inverters, PV inverters, or other energy producing DER.

The following forms of dispatch are mandatory:

a. DER offline. Each individual DER can be shut down into a mode they do not produce or consume current.
b. DER manual dispatch. Each individual DER can be started and follow a user entered setpoint set by the user at the MC HMI.
c. Grid Connected Resiliency dispatch. In this mode the system is connected to the utility and DER are dispatched to provide the best opportunity for a seamless islanding should the utility go out of

service. To be used when the base is about to experience an attack or a storm.

d. Grid Connected Economic Dispatch. In this mode the system is connected to the utility and DER are dispatched to achieve the desired economic objective for the system. User objectives may include least operational cost, Demand limiting at a point of common coupling, real time price optimization, or other. Equipment health, maintenance condition, fuel prices, project investment objectives, or other are to be prioritized and met.
e. Islanded Resiliency dispatch. In this mode the system is disconnected from the utility and all reliable genset must be operated without regard for operational costs such as fuel. Intermittent energy such as PV, wind, or other must be curtailed or shutdown. Battery systems must be paralleled and commutating but only produce or consume power to assist reliable gensets. This is the most resilient and costly form of islanded dispatch used specifically during blackstarting or should the facility be under attack or in a storm.
f. [Grid Connected External dispatch. All DER setpoints are set by an upstream 'nested' microgrid, a SCADA operations facility, or another control system. All controls of DER manual dispatch must be made available to an upstream system.]
g. [Islanded Economic Dispatch. In this mode the system is disconnected from the utility and the system is dispatched in a manner that prolongs base resources (such as fuel). Intermittent energy such as PV, wind, or other are to be curtailed as required to prevent gensets or batteries from tripping offline. This is the least costly form of islanded dispatch used specifically for prolonged utility outages.]
h. [Maintenance modes such as wet stack mitigation, monthly genset testing, or other.]

2.1.8.2 Blackstarting Requirements

Blackstarting a power system means bringing the power back only with all DER initially offline and systems de-energized. This is normally because the local utility is unavailable. The MC must provide a blackstarting system with the following minimal requirements:

a. Initiation and shutdown of the sequence must be user initiated. Auto initiation is acceptable, but optional. Blackstart sequence must automatically end and alert user of the status of success/failure of the attempt.
b. The sequence must cease should power system fault be detected.
c. The sequence must adapt to loss of monitoring or control of circuit breakers.
d. Long term (reserve margins) and short term (incremental reserve margins) of DER must be continuously abided; i.e., no loads are to be allowed to overrun the total system of DER ability to supply RM or IRM.
e. Magnetic inrush of transformers and motors must be considered prior to closing every breaker.
f. Cold load inrush associated with kinetic energy spin-up of motors and power electronic DC bus energization must be considered prior to closing every breaker.
g. Delayed load start such as building HVAC or ATS re-transfers must be considered prior to closing every breaker. Sufficient RM must be reserved should these systems come online several minutes after energization.
h. Gensets must not be damaged during starting without auxiliary AC power. DC lube oil pumps are preferred for blackstarting.
i. Engine response times must be adequate to pickup loads without

excessive frequency deviations; for example lean burn natural gas gensets are much slower and smaller IRM than same sized diesels.

2.1.8.3 Restoration Requirements

Grid Restoration means bringing the power back with a healthy local utility. The MC must provide a restoration system with the following minimal requirements:

a. Initiation and shutdown of the sequence must be user selectable as manual or automatic.
b. Sequence must automatically end and alert user of the status of success/failure of the attempt.
c. The sequence must cease should power system fault be detected.
d. The sequence must adapt to loss of monitoring or control of circuit breakers.
e. Consider protection trip setpoints, cold load inrush, magnetic inrush before closing breakers.

2.1.8.4 DER Mode Selection

DER that load share without communication are strongly preferred such as GFMD and RPM control with metered power droop.

The following table shows the preferred, acceptable, and un-acceptable modes of DER primary control for the microgrid during grid connected operation.

Mode	Genset	BESS IBR	PV IBR
Preferred	RPM control with metered power droop Voltage control with metered VAR droop	Grid forming with Droop	Grid following
Acceptable	Power and VAR control with or without droop	Grid following with or without droop	
Unacceptable	Isochronous	Grid forming	

The following table shows the preferred, acceptable, and un-acceptable modes of DER primary control for the microgrid during islanded operation (no utility).

Mode	Genset	BESS IBR	PV IBR
Preferred	RPM control with metered power droop Voltage control with metered VAR droop	Grid forming with Droop	Grid following
Acceptable	Power and VAR control with or without droop	Grid forming	
Acceptable	Isochronous	Grid following with or without droop	
Unacceptable	Power and VAR control	Grid following with or without droop	

2.1.8.5 Load Shedding

The following forms of acceptable load shedding may be specified for the microgrid control system. These do not require an HIL test, but they do require a load shedding coordination study.

a. Utility requested load reduction, per an interconnect contract. Utility commands come from SCADA either verbally or via a DNP3 communication line.

b. Utility coordinated load reduction, per an interconnect contract. Trips happen based on under-frequency thresholds and timers set in protective relays throughout the microgrid.

c. Islanded under-frequency load reductions. Trips happen based on under-frequency thresholds and timers set in protective relays throughout the microgrid. These setpoints may be either time or threshold coordinated with the utility load reductions, or they may be enabled with an islanding status from the PCC.

d. Islanded Overload load reductions. Loads are tripped when gensets and inverters approach a current or power overload.

e. Islanded Event load reduction. Loads are tripped when relays at PCC, gensets, BESS, or other detect an unexpected breaker opening. Also called contingency or fast schemes.

The following table identifies which type of load shedding are applicable for several common types of microgrids:

Type of Microgrid	Allowable Load Shedding	Comments
Utility Grid Connected	- Utility requested load reduction - Utility coordinated load reduction	Set per utility Contract

Type of Microgrid	Allowable Load Shedding	Comments
Islanded without gensets or synchronous condensor/flywheel. BESS in GFMD.	- Islanded under-frequency load reduction - Islanded Overload load reductions - Islanded Event load reduction	BESS which droop frequency on loading might allow frequency load shedding to work.
Islanded without gensets or synchronous condense r/flywheel. BESS in GFM no droop.	- Islanded Overload load reductions - Islanded Event load reduction	Frequency is not a good indication of overload on these types of microgrids.
Islanded with gensets or synchronous condenser/flywheel.	- Islanded under-frequency load reduction - Islanded Overload load reductions - Islanded Event load reduction	Kinetic energy storage allows reliable usage of more kinds of load shedding.

The following forms of load shedding require a full hardware in the loop test of the solution:

f. Under voltage based load shedding schemes.
g. Rate of change of frequency load shedding schemes.
h. Any type of load shedding not specifically called out in list of acceptable load shedding schemes.

2.1.9 Energy Reporting and Monitoring

The microgrid control system (MCS) must provide energy reporting and monitoring capabilities for effective and accurate collection and reporting for energy management and historical trending. The MCS must provide the following data at a minimum:

a. Real-time energy consumption data for all microgrid components, including generation, storage, and loads.

b. Historical energy consumption data for all microgrid components.

c. Energy production data for all microgrid generation sources.

d. Energy storage data for all microgrid storage devices.

e. Energy export/import data for the microgrid as a whole.

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NOTE: The required points or data to be read or passed to the UMCS system must be coordinated with specification section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION and included in the necessary UMCS points schedules required within the construction document set. Interoperability may support aspects of microgrid

design including communication with, or control of, primary assets of the Utility Control Systems (UCS) as described in UFC 3-470-01.

The corresponding input and output requirements for the microgrid control system are listed out below, or indicated in the drawing set.

Where either the UMCS or MCS requires action or procedure based on input from the other system, the internal function is required to be defined within the appropriate contract document. The MCS specification will not be used to dictate the action taken by the UMCS, and the UMCS specification will not be used to dictate the action taken by the MCS. Each will act on the signals and data received according to the internal system logic.

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2.1.9.1 [UMCS Integration]

The microgrid control system must include hardware and software required for integration into the UMCS system. Coordinate with UMCS points schedule in the document set and 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

[The microgrid control system must output to the UMCS the signals and data points [indicated on the design drawings][as follows:]]

[The microgrid control system must receive as input from the UMCS the signals and data points [indicated on the design drawings][as follows:]]

2.1.10 Fault Management and Isolation

Cover how the MCS identifies, isolates, and manages faults within the microgrid and at the point of common coupling. Focused on the MCS functions, and does not duplicate the functionality of an external protection scheme or equipment. Primary function described is MCS and microgrid operation, rather than protection.

2.1.11 Data Security and Encryption

Specifically addresses how data is secured. Largely referential to the cyber security spec and heading under section 1.

2.1.12 Time Synchronization

Covers the requirement for accurate time synchronization between discrete components, DER controllers, and the MCS. Describe the protocols and accuracy levels required using industry standard references.

2.1.13 Communication Standards

2.1.14 Failover and Redundancy

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NOTE:Using UFC 3-550-04 as a reference, consider the

requirements for controller or controller component failover, network redundancy, and backup power for the microgrid control system (separate from the microgrid itself).

Microgrid specifier is to call out which types of redundancy are allowed. The following list is sorted in order of value; i.e., least cost/best performance.

****

[a. Local/Remote. Each DER, PCC, and circuit breaker to have both a remote microgrid control system, and local controls including Human machine interface visualization, DER dispatch, breaker open/close.

][b. Network. RSTP or SDN must be configured to provide continuous communication between DERs and the MC in the case of a communication cable breakage or switch/router outage.

][c. Dual Primary MC. In this method two MC must be provided with duplicate code that is running real time and racing to make a decision such as load shedding.

][d. Hot Standby MC. In this method two MC must be provided with duplicate code; one is running and the other is powered up but disabled.

][e. Cold Standby. Spare parts that are wired but not powered up provide redundancy.

]2.1.15 Data Storage

Capture the following IEEE 2030.8 data for the life of the microgrid for future root cause analysis.

Table 2.1: IEEE 2030.8-2018 Table C.1, Minimum data collection

Type of data collection	Minimum time synchronized accuracy	Minimum sample rate	Minimum amplitude accuracy	Required data to collect	Required to meet IEEE 2030.7
Sequence of events (SOE) records	One quarter power system cycle (0.004166 s for a 60 Hz system)	One quarter power system cycle.	N/A	Digital data only. Examples are: Switching device (breaker, recloser, and switch) open and close status, commands, protection elements, control outputs and interlocks	Yes
Event oscillograph (OSC)	One quarter power system cycle	One quarter power system cycle	1% of nominal voltage and 20 times nominal current	Voltage and current of all phases	Yes
Continuous data collection (CDC)	One quarter power system cycle	100 ms	1% of nominal voltage and 20 times nominal current	Voltage and current of all phases	Yes

All microgrids must provide field data collection at Level 3, per the IEEE standard section C.2 repeated below.

Level 1 - Data must be collected at and on both sides the POI for any microgrid with one DER.

Level 2 - Data must be collected at every DER and POI for any microgrid with two or more DER.

Level 3 - Data must also be collected at the load(s) and the DER for any load greater than 50% of the largest DER and for any single load larger than 10% of the maximum total power consumed by the microgrid.

2.1.16 Utility Interconnect

2.1.16.1 Utility Interconnection Agreement

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NOTE: Typically, the designer should begin the utility interconnection agreement, and this specification assumes that process has been . As such, specifications should be crafted to account for and address the complexities that arise from these arrangements, ensuring clear delineation of responsibilities and requirements for all parties involved, including the contractor and utility providers.

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Submit for record, a finalized utility interconnection agreement required to have the following attributes:

A signed legal Contract which defines the parameters and requirements for the following minimum items:

a. Energy Rates (kWh) for both import and export

b. Power demand charges (kW)

c. Any other recurring charges

d. Reverse power (32) limitations

e. Frequency ride-through requirements (Hz and time in seconds or milliseconds)

f. Voltage ride-through requirements (Volts and time in seconds or milliseconds)

g. Equipment ownership delineation, including who is responsible for settings and testing every electronic device as the interconnect.

h. Linkages to the engineering protection requirements (standards), including but not limited to overcurrent elements, directional elements, distance, direct transfer trips, lockouts, anti-islanding, or other related protection requirements.

i. Deadbus arbitration requirements including all synchronization requirements.

j. Any regulatory requirements enforced by local, regional, state, or federal entities such as the EPA, NERC, or other.

k. Data recording requirements including fault recording, SOE recording, synchrophasor collection, or other.

l. Any required sequence of operations, such as paralleling or isolation from a utility owned asset.

m. Description of premises access such as behind locked gates or doors Cyber requirements including but not limited to applicable standards and all required documentation.

n. Identify any engineering processes, checklists, or reviews that must be completed.

o. Lowest and highest symmetrical and asymmetrical fault currents the utility can provide.

p. Utility Thevenin equivalence during normal operation.

q. Utility changes to their infrastructure which case the steady state Thevenin equivalent of the utility (impedance) or fault currents to change more than 5% must be shared with base 6 months in advance.

2.1.16.2 Protection System Interface & Coordination

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NOTE: Designer is required to coordinate the MCS with the protection system. Recommendations for protection system operation with relation to the MCS and microgrid can be found in UFC 3-550-04. Supplemental recommendations below:

MCS is required to have the ability to isolate from the grid without utility permission; i.e., at least one circuit breaker is required to be under the microgrid control systems purview in addition to any utility-controlled PCC equipment.

Breaker status, close premissive, warning, trips, and targets are required to be identified on the MPCC relay, and not on the MCS.

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a. Reverse power (32) elements are required to be coordinated with the slowest on-site DER.

b. Reverse directional fault detection (67) elements are required to be disabled should there be insufficient conventional synchronous generators or condensers in the microgrid.

c. Should 67 be viable, faults detected on the microgrid side are required to be isolated and require the microgrid blackstart and islanding features to be disabled.

d. Should 67 be viable, faults on the utility side must not inhibit microgrid islanding or blackstart.

e. All utility side neutral ground bonding is required to be identified to the MCS and incorporated into the HMI.

f. All CB open and close commands are required to be routed through the associated microprocessor relay; i.e., no direct close or open commands are allowed to be wired to the CB from the MCS.

g. All load shedding associated with the PCC opening is required to be capable of being inhibited (shut down) at the PCC protection relay.

h. Status of a synchronization attempt including a synchroscope, in operation, and failed status is required to be annunciated at the PCC relay.

i. All deadbus and synchronization logic is to reside in the PCC relay and not within the MCS.

j. Auto reconnection (re-transfer) functions of the PCC to the utility is required to be available and can be turned off/on at the PCC relay.

k. All remote commands including close and open from the MCS are required to be disabled by a local/remote pushbutton or switch at the PCC relay.

l. Live and deadbus indication must be annunciated on the PCC relay and to the MCS.

2.2 MICROGRID CONTROL SYSTEM COMPONENT DEVICE REQUIREMENTS

The following is a minimum set of criteria required for all microprocessor (intelligent) devices used on the microgrid:

a. Spares either readily available for purchase or purchased and placed in storage, and may be powered up to maintain equipment health.

b. All configurations/ settings/code on every device must be stored in a single engineering workstation or server.

c. All processes of setting up spares or replacement parts must be documented and the process must be tested.

d. All configurations/ settings/code must be tested to be easily uploaded/downloaded to spares and placed into service with no ill effect.

e. No annual licenses, software licenses, configuration licenses, data access licenses are allowed. Electronic equipment and their configurations must be purchased in perpetuity without further fees. A single use license on software/ hardware/algorithms is acceptable to preserve supplier intellectual property however no fees past initial purchase are allowed.

f. Supplier must supply cyber and functionality based service bulletins alerting the owners of potential vulnerabilities and or defects in the product.

g. Defects in software/configurations must be warranted for a minimum of 1 year.

h. Hardware/firmware must be warranted for a minimum of 10 years.

i. All electronics must operate in conditions -30 to +75 Celsius.

j. Intelligent and Secure Components. All electronic equipment must continuously self-test and report internal errors.

k. Devices taking part in microgrid control must include an integrated IEC 61131-3 programming environment.

l. Devices taking part in microgrid protection must include some form of free form logic programmability.

m. Devices must incorporate independent user-based security with strong passwords.

n. All devices must provide a mechanism to map security related system tags into a report or communicated data stream for the user to monitor.

o. All devices must support some form of human-machine interface or LED annunciation which allows the user to determine the health of the equipment.

p. All devices must support some form of time synchronization which keeps all CPU clocks within 8 milliseconds throughout the microgrid.

q. There must be an alarm contact output to signal internal errors and malfunctions.

r. Control, communication, and networking equipment must meet IEEE 1613:2003.

s. Protective devices must meet IEC 60255-21-1, IEC 60255-21-2, IEC 60255-21-3, IEC 60255-26, IEC 61000-4-4, and IEEE C37.90.1.

t. Utilize non-volatile memory available for user programmable retained variables.

u. Engineering Access must be available [over secured network][or][and][locally by direct connection].

v. All electronic boards must be conformal coated.

w. Minimum mean time between failure (MTBF) of 200 years.

2.2.1 Product Certifications

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NOTE: FCC part 15 does not apply to many of the computing devices used for industrial applications. Title 47 Part 15 provides for exemption of unintentional radiators considered "digital devices used exclusively as an electronic control" or power system utilized by a public utility or in and industrial plant.

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NOTE: Note: FCC Part 15 does not apply to many of the computing devices used for industrial applications. Title 47 Part 15 provides for exemption of unintentional radiators considered "digital devices used exclusively as an electronic control" or power system utilized by a public utility or in and industrial plant.

All electronic product certifications must be provided on product data sheets. Conformance is required the following minimum requirements:

a. Designed and manufactured by an ISO 9001 US based certified manufacturer
b. UL Listed to U.S. and Canadian safety standards
c. Time synchronization to better than 4 ms

d. MTBF minimum of 300 years.
e. Meet or exceed IEEE 1613
f. IEEE 1613 + A1-2011 Service Conditions IEC 60068-2-1, -40°C, 16 hours
g. IEEE 1613 + A1-2011 Service Conditions IEC 60068-2-2, 85°C, 16 hour
h. IEC 60068-2-30 25°-55°C, 6 cycles, 95% relative humidity, or equivalent.
i. Section IEEE C37.90.1, Impulse Section Severity Level: 0.5 J, 5 kV, or equivalent.
j. Electrostatic Discharge Immunity: IEEE 1613 + A1-2011 IEEE 1613 ESD, or equivalent.
k. Magnetic Field Immunity: IEC 61000-4-8 1000 A/m for 3 seconds, 100 A/m for 1 minute, or equivalent.
l. Power Supply Immunity
m. Radiated RF Immunity: IEEE C37.90.2, 35 V/m, or equivalent.
n. Digital Radio Telephone RF Immunity: ENV 50204:1995 10 V/m at 900 MHz and 1.89 GHz, or equivalent.
o. Minimum protocols of the MC controllers and gateways must be: [Modbus RTU,][Modbus TCP,][DNP/IP,][DNP/RTU,][Modbus,][MIL-STD-3071,][NTP,][LDAP].

2.2.2 Product Sourcing

All intelligent electronic devices must be sourced exclusively from the US. This includes board production, board population, firmware creation, code storage, firmware download, microprocessor production, and final assembly. See the Quality Control section for further traceability requirements of sub-assemblies. Non intelligent devices need only meet the traceability requirements.

2.2.3 General Requirements

NERC/CIP user authentication, logging, and port control requirements.

Mean time between failures of minimum 10 years per device. MTTF must be measured not calculated based upon customer product returns.

All status and control traffic between MC, DERS, POI, PCC and load devices able to be shed must be MIL-STD-3071 compliant. Remainder of system must be integrated via other protocols to protective devices, genset controllers, tap changer controllers, intelligent circuit breakers, UMCS, SCADA, and other devices as required.

2.2.4 Nameplates and Identification

All electronic devices must have nameplate indicating part number, serial number, and product manufacturer and country of origin. Per the ITP, all products must be traceable via their serial number.

2.2.5 Warning Labels

Product instruction manual must alert users of dangerous conditions. Labels must be installed in panels, on door, etc. as required for all location with human contact with said dangerous conditions.

2.2.6 Product Data Sheets

Product data sheets must be available on the supplier's corporate website.

2.2.7 Firmware and Software Updates

2.2.8 Environmental Ratings

(detail the environmental ratings requirements for the MCS equipment; IP ratings, NEMA enclosure rating requirements, etc. based on installed location and whether the space is normally conditioned, or conditioned by equipment powered by the microgrid in islanded operation)

2.3 CONTROL HARDWARE

All Facility Related Controls Systems (FRCS), which includes the SCADA System, must meet current Control Systems Platform Enclave/Navy Utilities Monitoring Control Systems (CSPE/NUMCS) Authority to Operate (ATO) requirements.

2.3.1 General Requirements

The Microgrid Control System (MCS) must be connected to electrical equipment for control, monitoring, and data gathering as part of the microgrid control system. The MCS must be micro-processor based, capable of receiving discrete and analog inputs, and, through programming, must be able to control discrete and analog output functions, perform data handling operations and communicate with external devices.

2.3.2 MCS Modules

Provide MCS modules that are field expandable design allowing the system to be tailored to the control application. The system must be expandable through the use of additional hardware and/or user software. As a minimum, the MCS must include a power supply module, central processing unit (CPU) module, communications module, and input/output (I/O) module, including discrete I/O modules. The MCS must include non-volatile memory to be saved on a loss of power.

The MCS must be a self-contained, microprocessor-based unit that provides time of day, scanning, application program execution, PID control with manual and self-tuning capabilities, custom function blocks, storage of application programs, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self-diagnostics. Programming must be IEC-61131 compliant. The control firmware must whitelist all applications and have self-diagnostic checks.

Communications must allow peer-to-peer communication with other relays and controllers and must allow the MCS to communicate with any existing control system equipment, or workstation computer. Communication modules must support [serial and Ethernet][Ethernet] architecture and protocols. Programming of the MCS to be done locally or remotely with software that meets minimal NERC/CIPs requirements.

2.3.3 Power Supply Module

One or more power supply modules must be provided as necessary to power other modules installed in the same cabinet. Auxiliary power supplies may be used to supply power to remote cabinets or modules . Power supplies must produce either DC or AC as required or the MCS and other ancillary electronics. Power supplies can be either external or internal to the MCS.

a. The power supply module must monitor the DC or AC supply and alarm if the voltage falls out of spec. The MCS must have sufficient ride through to sustain 10 minutes of AC outage. This can be done with batteries or capacitive energy storage. Direct DC battery connected solutions are preferred as UPS solutions are a costly maintenance item.
b. Every device must be capable of being powered off with a fuse, circuit breaker, or switch.
c. All electronic devices must annunciate the health of their status on front mounted, easily viewable LEDs.
d. Health of all DC or AC UPS buses is to be annunciated to the MCS HMI, including voltage level.

2.3.4 MCS Program Storage/Memory Requirements

The MCS must utilize nonvolatile memory for the operating system. The controller must have both nonvolatile and volatile memory that can be programmed. The memory capacity must be sized such that, when the system is completely programmed and functional, no more than 20 percent of the memory is used for real time processing of logic. No more than 50 total percent of the memory may be used, inclusive of all operating systems, code, protocols, data archiving, etc. CPU total processor burden must not be above 50% during normal operation.

2.3.5 MCS Input/Output Characteristics

Provide analog input, analog output, discrete input and discrete output. These can be either wired to the local or remote IO modules and or relays. The number and type of inputs and outputs for the system must be as shown on the drawings and must comply with the sequence of control. The system capacity must include a minimum of 20 percent spare input and output points (no less than two points) for each point type provided.

2.3.6 MCS Wiring Connections

Wiring terminals within the MCS to central controllers, distributed controllers, relays, and IO modules must be [in accordance with 40 60 00 PROCESS CONTROL][as follows:

a. All CT connections must accept 12 AWG with crimped ring terminal terminations.
b. All PT connections must accept 14 AWG with crimped ring terminal or compression terminations.
c. Digital outputs inclusive of dry contacts, sourcing, or sinking type must accept two 16 AWG with crimped ring terminal or compression terminations.
d. Digital inputs sourcing or sinking type must accept two 16 AWG with crimped ring terminal or compression terminations.
e. Analog inputs and outputs must accept two 16 AWG with crimped ring terminal or compression terminations.]

2.3.7 MCS Diagnostics

Implement diagnostic routines in firmware. The MCS must continuously perform self-diagnostic routines that provide information on the configuration and status of the MCS, memory, communications and input/output. The diagnostic routines must be regularly performed during normal system operation. All faults must be annunciated at the MCS/HMI and any existing control system head end.

All serial and Ethernet communication channels must have LED annunciating the Transmit and Receive hardware line status of their respective port.

2.3.8 Interface with DER

The microgrid control system must be capable of integrating with various DER, such as solar photovoltaic systems, wind turbines, energy storage systems, and gensets . It must enable real-time monitoring and control through bi-directional communication with DER devices.

To optimize DER management, the microgrid control system must include features such as load shedding, demand response, curtailment, and peak shaving. Dispatch algorithms must autonomously adjust DER output and/or load based on equipment health, grid topology, DER health, DER fuel levels, DER capability curves, load conditions, grid conditions, demand patterns, and [optionally weather forecasts].

The controller and/or a Historian must collect data from all DER, PCC, and load devices per IEEE 2030.8 standards Table C.1 repeated below. Historical data may be used to evaluate performance and enhance energy optimization. The historian must use open industry-standard communication time-stamped protocols such as MIL-STD-3071,IEEE 37.118, IEC-61850 GSSE, DNP, or other. Non time stamped data must not be allowed in a historian nor allowed to be used in a microgrid optimization algorithm.

Table 2.2: IEEE 2030.8 Table C.1, Minimum data collection

Type of data collection	Minimum time synchronized accuracy	Minimum sample rate	Minimum amplitude accuracy	Required data to collect	Required to meet IEEE 2030.7
Sequence of events (SOE) records	One quarter power system cycle (0.004166 s for a 60 Hz system)	One quarter power system cycle.	N/A	Digital data only. Examples are: Switching device (breaker, recloser, and switch) open and close status, commands, protection elements, control outputs and interlocks	Yes

Type of data collection	Minimum time synchronized accuracy	Minimum sample rate	Minimum amplitude accuracy	Required data to collect	Required to meet IEEE 2030.7
Event oscillograph (OSC)	One quarter power system cycle	One quarter power system cycle	1% of nominal voltage and 20 times nominal current	Voltage and current of all phases	Yes
Continuous data collection (CDC)	One quarter power system cycle	100 ms	1% of nominal voltage and 20 times nominal current	Voltage and current of all phases	Yes

2.3.9 Protocols

The microgrid control system must support industry-standard communication protocols to ensure efficient data exchange and integration with connected devices. Microgrid proven protocols include the following:

2.3.9.1 Modbus (Modicon Communication Protocol)

This protocol is very commonly used for communication with compatible devices such as inverters, genset controllers, gateways, relays, I/O modules, meters, and battery management systems. Modbus is widely used in the industry for monitoring and controlling distributed assets.

2.3.9.2 MIL-STD-3071

This standard describes a structured Data Distribution Service (DDS) data model adequate for all scales of micrograds. This standard also includes control system and data sets build specifically for microgrids, with designs for real time and non-realtime and high and low priority data sets. This allows the microgrid to interoperate/communicated with tactical/portable equipment such as tanks, trucks, and emergency portable gensets for rapid microgrid deployments.

2.3.9.3 IEC 61850

This standard includes a real time GOOSE and non-realtime MMS protocol. IEC 61850 GOOSE is designed for sub-millisecond level control and monitoring between controllers. MMS is a non real time protocol used for SCADA annunciation.

2.3.9.4 DNP 3.0

This is the north American de-facto standard for intercommunication with all electric utilities and SCADA systems.

2.3.9.5 ANSI C37.118

This is the North American de-facto standard for power system historians. Data is time stamped at the lowest level and re-aligned for historians and controllers.

2.3.9.6 Coordination

Coordinate and confirm that the microgrid control system fully supports the applicable communication protocols allowing for smooth interoperability and efficient operation with a wide range of devices and systems within the microgrid network. The implementation of these protocols must be thoroughly tested and validated during commissioning to guarantee reliable and secure data exchange throughout the system.

2.3.10 Data Concentrators

The microgrid control system must include data concentrators to efficiently aggregate data from connected devices and sensors within the microgrid. These concentrators must minimize network traffic and ensure smooth communication throughout the system.

The data concentrators must act as gateways, enabling bidirectional communication with various devices and sensors across the microgrid. They must support different data formats and industry-standard protocols to promote interoperability.

The microgrid control system's data concentrators must possess advanced data processing capabilities, facilitating real-time analysis and filtering. This optimization is to ensure streamlined data flow to the controller, reducing latency and enhancing overall system responsiveness.

Emphasizing reliability and security, the data concentrators must implement robust cybersecurity measures to protect data integrity and confidentiality.

The microgrid control system must support scalable data concentrators, allowing for integration of new devices and system expansions. Thorough testing and verification of functionality must be conducted to ensure successful integration within the microgrid.

2.3.11 Gateways

Gateways (also known as front end processors) must be provided to allow monitoring data to be interfaced directly with lower tier LANS and their electronics. Gateways must be provided with sufficient quantity of RS-232, RS-485 serial , and RJ45 Ethernet ports to accomplish the mission. Gateways can be configured as uni- or bi-directional protocol translators and must be configurable from a central engineering workstation(s). The gateways must operate from the same power sources described for the MCS.

The microgrid control system may incorporate gateways to facilitate efficient data transmission among microgrid components, DER devices, and the central monitoring system (SCADA). These gateways must support both real time and non real time data.

Gateways must be capable of supporting various communication protocols and networking technologies, promoting seamless integration with different devices and systems within the microgrid.

Emphasizing cybersecurity, the gateways must implement robust encryption and authentication mechanisms to safeguard data during transmission.

The microgrid control system's gateways must be designed for scalability, accommodating future expansions and new DER devices without compromising performance.

Comprehensive testing and validation of the gateway functionality must be conducted to verify its operation within the microgrid.

2.3.12 Ethernet Switches

2.3.12.1 Product Description

The microgrid control system may utilize Ethernet switches, capable of configuration and monitoring, to support a reliable and resilient communication network. Network switches must provide communication between network devices using 10/100/1000 MB Traffic over Copper and Fiber optic media. All network switches must support [software defined networks (SDN)][rapid spanning tree protocol (RSTP)]. Network switches must permit online network changes without disturbing network devices. Malfunctioning network devices must be automatically removed from service without shutting down the network.

2.3.12.2 Environmental Requirements

The switches must operate within a temperature range of -40°C to 85°C without the need for fans, ensuring reliability in harsh environments.

2.3.12.3 Power Supply

The switches must be equipped with integrated [optional - redundant] and high mean time between failure (MTBF) power supplies to ensure continuous operation and avoid single points of failure.

2.3.12.4 Encryption

The switches must implement industry-standard SSH/SSL encryption with a minimum key length of 128-bit to safeguard data transmission and protect against unauthorized access.

2.3.12.5 Passwords

The switches must support multi-level passwords to enable role-based access control, ensuring authorized personnel can access and configure the switches while maintaining security. These passwords must be provided to the government for record and on-going operation.

2.3.12.6 Port Security

Managed switches utilizing RSTP must implement MAC-based port security and support network access control 802.1x to enhance the overall network security. SDN switches natively provide port security through deny by default configuration.

2.3.12.7 Traffic Shaping

This must isolate high and low priority/latency traffic, and to prevent unnecessary traffic burden and fast system reconfiguration during failures.

RSTP switches must utilize VLANs and RTSP to shape traffic. SDN switches natively shape and prioritize traffic.

2.3.12.8 Ports

The switches must include various types of ports, including but not limited to single mode gigabit 1000LX SFP uplink ports, 100BASE-FX multimode fiber ports, and copper RJ45 Ethernet ports, ensuring compatibility with different connected devices. Network switches may include, but are not limited to the following physical characteristics:

10/100/1000 Base-T ports
1000 Base-LX ports
1000 Base-LX and 100 Base-FX downlink ports
Support the protocol utilized in the microgrid control system
Small form factor pluggable (SFP) downlink ports optional
Rack/panel or backplane mounted options
LED indicators for each port for network monitoring status
Twenty percent spare ports must be provided for all network switches

2.3.13 Network Design

Networks designed to facilitate the communication requirements for Microgrid Control Systems must be coordinated with local installation telecommunication providers to determine both outside telecommunication plant dependencies and local cybersecurity interconnection requirements. Cybersecurity design requirements for Microgrid Control Systems should refer to 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. The following list are suggested designs to help the user achieve ATO, but it is by no means a complete or definitive list.

2.3.13.1 Firewalls

Firewalls must be placed between OT/IT interfaces, or at jurisdictional interfaces such as at UMCS or Utility SCADA systems. Dual firewalls and/or gateways at critical interfaces are acceptable.

2.3.13.2 Remote Engineering Access

****

NOTE: Remote engineering access is typically forbidden. Confirm prohibition or allowance with Government prior to selection in this specification section.

****

[Remote Engineering Access is prohibited. Equipment with hardware allowing remote engineering access is prohibited. Disabling via software only is not acceptable.]

[Upon written permission from the Government remote engineering acess may be enabled. At all times when engaged, qualified staff must be in attendance at all times this remote access is powered on. Remote access must be powered off and air gapped if not under immediate supervision of qualified staff.]

2.3.13.3 Remote Control and Monitoring Access

Provide means for temporary facilities control system, utility SCADA, or building management system to remotely monitor and control the MCS. The remote control inteface must include a manually activated cut-out switch preventing remote control and allowing for lock out and tag out of the remote control interface. Allow for remote control of setpoints such as demand limit, demand response signals, or periodic maintenance functions; monitoring points such as energy, power, power factor, and voltage flow for the microgrid and each connected and controlled DER or load. For this interface, firewalls and protocol gateways are to be used to build a DMZ. Only approved protocols may pass through this DMZ; see prior list of approved MCS protocols.

2.3.13.4 Remote Internet Access

Internet connections are forbidden on all DoD microgrids.

If a project must have a remote Internet access for a forecasting algorithm, then a strict usage of a transmit-only serial channel imitating a traditional UART data diode is required.

2.3.13.5 On-site LAN

The microgrid controller must support on-site Local Area Network (LAN) gateway functionality to facilitate communication within the microgrid and local devices.

[2.3.13.6 Dedicated ADSL

Where external network communciation is required and has been permitted by the Government in writing, the microgrid controller may include a dedicated Asymmetric Digital Subscriber Line (ADSL) gateway to enable secure communication with external networks, such as remote monitoring and control systems. This must abide by the Remote Control and Monitoring practices outlined above.

]2.3.14 Supervisory Dispatch Controllers

The microgrid control system may incorporate advanced supervisory dispatch algorithms to efficiently oversee and coordinate the seamless operation of all local and remote microgrid components and DER devices. These algorithms may perform a number of functions, including but not limited to: optimize power flow within the microgrid, ensuring optimal performance, meeting a return on investment, optimizing grid stability/resiliency, or other. These supervisory dispatch algorithms may be centralized or distributed controls.

Leveraging real-time data, the supervisory algorithms may dynamically adjust and optimize the microgrid's electrical power generation, energy storage, load curtailments, and consumption patterns based on load demand, fuel prices, fore-casts, present weather conditions, equipment health, maintenance cycles, and more.

2.3.15 Human Machine Interface (HMI)

The microgrid control system must provide a user-friendly Human-Machine Interface (HMI) for efficient interaction with the microgrid control system. Design and implement HMIs in accordance with ISA 101.01, "Human Machine Interfaces for Process Automation Systems." Ensure that all aspects of HMI design, including layout, user interaction, information display, and system feedback, comply with the best practices and guidelines established in this standard. Submit Microgrid Control System HMI graphical mockup prior to or alongside related microgrid control system product data submittals.

2.3.15.1 HMI Layout and Organization

Organize HMI interfaces to emphasize clarity, ease of use, and effective communication. Organize interface layouts intuitively to facilitate quick understanding and efficient operation, following ISA-101.01 guidelines for hierarchical display structuring.

Identify control areas within the microgrid where operators have direct influence. Use intuitive, accessible color schemes and labeling for quick recognition.

Provide Level 1 display as defined by ISA 101.01 indicating operator's realm of control and microgrid status. Control may not be performed from the Level 1 display. Ensure only one Level 1 display is available for each operational state, with contextual links to appropriate Level 2, 3, and 4 displays. The Level 1 display must provide quick and easy access to additional information, leading to Level 2 displays.

Show current microgrid operational state, major equipment status (e.g. connected or offline for DERs, and open/closed for controlled breakers and switches), and highlights anything which requires immediate attention such as a high priority alarm, SOC failure status, or indications of abnormal status.

Include a high-level one-line diagram of the microgrid, including generation sources, storage, and load centers, focusing on clarity and ease of interpretation. Display real-time status indicators for critical components, including power generation units (solar panels, wind turbines, generators), storage systems (batteries), and main switches. Indicators must reflect operational status (on/off), fault conditions, and maintenance alerts.

Include a dynamic energy flow diagram showing the direction of power flow between generation, storage, loads, and the main grid. This diagram helps in understanding the current operational mode of the microgrid (islanded, grid-tied, charging, or discharging).

Integrate a section for system alerts and alarms, highlighting any abnormal conditions or operational issues that require immediate attention.

Include intuitive navigation options to detailed screens for in-depth monitoring and control of specific microgrid components.

Develop multiple Level 2 displays for the microgrid control system as defined by ISA 101.01. These displays are the primary interfaces for operator interaction, designed to align with operators’ mental models of the microgrid and its operations. Level 2 displays illustrate detailed insights and controls for specific operational states, such as startup, normal operation, transitions, and shutdown.

Integrate essential performance metrics related to the microgrid's operational efficiency, such as energy generation, consumption, storage levels, and grid interaction.

Provide direct controls necessary for managing the microgrid, including interfaces for adjusting generation sources, storage, and load management. Where space is limited, provide easy access to Level 3 and 4 displays, control panels, and detailed control interfaces.

Display relevant alarms for the microgrid’s operational state, prioritizing them based on severity and relevance to the current display. Ensure visibility of high-priority alarms and indicate the presence of additional alarms.

Provide a direct link to the Level 1 overview display, enabling operators to quickly shift to a macro-perspective of the microgrid’s status. Highlight abnormal conditions in the microgrid or Level 2 sub-system displayed, clearly indicating their severity and the related options for operator action.

For each parameter or datum displayed, provide links to the data historian for real time and historical trends of critical parameters such as state of charge, power, reactive power, frequency, and voltage as all defined by IEEE 2030.8 Table C.1 continuous data collection.

Include links to other applications or natively display the IEEE 2030.8 Table C.1 SOE and oscillography data.

Group related components logically for easy navigation and comprehension.

Displayed Information must indicate the quality of service; i.e., indicate if the tag is stale or the communication source is offline.

Real-Time Data Visualization:

a. Utilize graphical representations including but not limited to charts, historical and real-time trends, dials, X-Y plots, polar plots, or similar graphs to visualize data, facilitating operators' ability to make informed decisions rapidly.

b. Implement color-coding and visual cues to signify different states of microgrid components and alarms, effectively drawing attention to critical conditions. All color coding to be shaded and annotated sufficiently to allow color blind personnel to effectively use the HMI.

2.3.15.2 Alarm and Event Management

****

NOTE: As the connected equipment sizes, types, locations, and available alarm parameters will vary greatly between designs, the designer must review and supplement the alarm points listed below to suit the details of the microgrid and MCS under design.

****

Incorporate into the HMI a clear and distinguishable alarm system that provides audible and/or visual alerts for abnormal microgrid conditions and events. Display alarm details, such as severity, equipment, location, and timestamp, to help operators identify the cause and prioritize responses effectively. Use intelligent alarming techniques in accordance with ISA 18.2, Management of Alarm Systems for the Process Industries.

Timestamping must be in accordance with IEEE 2030.8 Table C1.

Alarm Acknowledgment and Management: The HMI must allow operators to acknowledge and manage alarms, providing options to silence audible alarms, acknowledge issues, and review historical alarms. Time stamped SOE data in accordance with IEEE 2030.8 are preferred for alarming.HMI include discrete display and logging of high priority alarms for each connected equipment and device. Specific requirements include but not are not limited to:

[a. PCC/POI Alarms: [_____]
  (1) Power quality out of range Harmonics, Flicker
  (2) Grid synchronization failure
  (3) Frequency out of range
    [(4) Voltage out of range]
    [(5)_____]]

[b. Connected DER Alarms: [_____]
    [(1) Inverter fault]
    [(2) Communications failure]
    [(3) Battery storage critical reserve level]
    [(4) Start/run failure]
    [(5) Generator Fuel Critical level]
    [(6) Generator Fuel system leak or malfunction]
    [(7) Generator high temperature]]

[c. Sequence of Operation Failure Alarms:
    [(1) Islanding failure]
    [(2) Load shed failure]
    [(3) Load restoration failure]
    [(4) Breaker or Switch operational failure]
    [(5) Communication loss for DERMS]
    [(6) Sequence deviation]]

[d. General Condition Alarms:
  (1) Bus under and over-voltage
  (2) Production shortfall; automatic load shed
  (3) Bus phase imbalance
  (4) Internal microgrid fault
  (5) Protective relay system tripping
  (6) Emergency stop engaged; manual or automatic
  (7) Communications fault
  (8) Communications system fallback engaged
    [(9)_____]]

[e. Additional Alarms: [_____]
    [(1) Remote access to MCS initialized]
    [(2) Fire alarm system, alarm condition reported]
    [(3) Connected equipment trouble or maintenance alerts]
    [(4)_____]]

Control and Setpoint Adjustment:

f. Equip Level 3 displays with intuitive for adjusting setpoints, operational modes, and control strategies, based on changing load conditions and the availability of DER.

g. Implement password-protected access for sensitive control functions to ensure only authorized personnel can make critical changes.

Data Logging and Historical Trending: Include data logging and historical trend visualization features in the HMI, enabling operators to analyze past performance, identify patterns, and optimize microgrid operations over time.

User Help and Support:

h. The HMI must include context-sensitive help and guidance to assist operators in utilizing its features effectively and understanding specific functions at each screen.
Provide documentation links or tooltips for complex features to enhance usability.

Responsiveness and Compatibility: Design the HMI to be responsive and compatible with various devices, including desktops and tablets to facilitate remote monitoring and control.

Local and Remote: Local controllers/relays may have HMI with subsets of the primary HMI, thus providing a cyber-secure backup system.

Multiple instances of the Microgrid Control System HMI may be provided for geographic convenience.

2.3.16 Workstation Hardware (Desktop and Laptop)

****

NOTE: Coordinate with the project site to determine if the workstation(s) will be contractor supplied or Government Furnished, or a mix where some workstations are Government furnished and others are contractor supplied: "Replace Brackets" instructions 1) Government furnished only : Keep first bracketed text and remove the [as indicated]. 2) Contractor supplied only: Keep the second bracketed text. 3) Combination of Government furnished and Contractor supplied: Keep all bracketed text. When keeping bracketed text (Contractor supplied or combination of Government and Contactor supplied) note that computer technology changes quickly and these requirements should be edited to reflect current products. Default requirements (current as of 2012) have been provided in brackets.

****

[The Government will provide the][Provide a standard desktop computer or a laptop meeting the following minimum requirements for the] Computer Workstation Hardware (workstation) [as indicated].

2.3.16.1 Processor

2.3.16.1.1 Desktop

Quad-core processor designed for desktop applications. Processor speed must be at least 75 percent of the speed of the fastest Intel desktop processor commercially available.

2.3.16.1.2 Laptop

Quad-core processor designed for laptop applications. Processor speed must be at least 50 percent of the speed of the fastest Intel laptop processor commercially available.

2.3.16.2 Random Access Memory (RAM)

[____][300 percent of the recommended requirements of the software to be installed on the server[and no less than 8GB].]

2.3.16.3 Communications Ports

2.3.16.3.1 Desktop

[____][Six USB ports.]

2.3.16.3.2 Laptop

[____][Two USB ports, plus a PCMCIA card slot or an additional USB port, plus an integral RS-232 serial port or an additional USB port and a USB to RS-232 serial adapter.]

2.3.16.4 Hard Drive and Controller

[2.3.16.4.1 Desktop

[____][1.5TB] or larger with a SATA-3 controller.

][2.3.16.4.2 Laptop

[____][250GB] or larger solid state drive.

]2.3.16.5 Optical Drive

[____][DVD-RW drive]

2.3.16.6 Video Output

2.3.16.6.1 Desktop

[____][32-bit color with dual monitor support minimum resolutions of 1920 by 1080 at minimum refresh rates of 70 Hz and dual DVI or display port outputs.]

2.3.16.6.2 Laptop

[____][32-bit color with a minimum resolution of 1920 by 1080 at minimum refresh rates of 70 Hz and VGA or HDMI output.]

2.3.16.7 Network Interface

2.3.16.7.1 Desktop

[____][Integrated 1000Base-T Ethernet with RJ45 connector.]

2.3.16.7.2 Laptop

[____][Integrated 1000Base-T Ethernet with RJ45 connector and an integrated IEEE 802.11b/g/n wireless interface. The Laptop must have a physical switch for activation and deactivation of the wireless interface.]

2.3.16.8 Monitor

2.3.16.8.1 Desktop

[____][Dual widescreen flat panel LCD monitors sized as indicated but no less than600 mm 24 inch nominal with minimum resolutions of 1920 by 1080 pixels and a minimum refresh rate of 70Hz.]

2.3.16.8.2 Laptop

[____][LCD Screen sized as indicated but no less than 325 mm 13 inch nominal with a maximum supported resolution of no less than 1600 by 900 pixels.]

2.3.16.9 Keyboard and Smart Card Reader

2.3.16.9.1 Desktop

[____][101 key wired USB keyboard having a minimum 64 character standard ASCII character set based on ANSI INCITS 154 and an integral smart card reader compatible with a Department of Defense Common Access Card (CAC).]

2.3.16.9.2 Laptop

[____][Standard laptop keyboard. Internal smart card reader compatible with a Department of Defense Common Access Card (CAC).]

2.3.16.10 Mouse

2.3.16.10.1 Desktop

[____][2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.]

2.3.16.10.2 Laptop

[____][Integrated touch-pad plus a 2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.]

2.3.16.11 Printers

Provide local or network printers as indicated. Provide local printers which have a USB interface. Provide network printers which have a 100Base-T or faster interface with an RJ45 connection and a firmware print spooler compatible with the Operating System print spooler.

2.3.16.11.1 Alarm Printer

Provide alarm printers which use sprocket-fed fanfold paper with adjustable sprockets for paper width up to 280 mm 11 inches. Alarm printers must have programmable control of top-of-form. [Provide floor stands with paper racks for alarm printers.]

2.3.16.12 Operating System (OS)

****

NOTE: Coordinate with the project site to determine if the OS license will be contractor supplied or Government Furnished.

****

****
NOTE: This subpart uses tailoring options to indicate the Gold Master version to use.
****

Provide the latest version of the Army [DISA][____] Gold Master Windows Operating System. The Operating System media will be furnished by the Government. [Provide][The Government will provide] the Operating System license.

2.3.16.13   Virus Protection Software

****
NOTE: Coordinate with the project site to determine if the Virus Protection Software will be contractor supplied or Government Furnished.
****

[Provide Virus Protection Software consisting of the project site's standard virus protection software complete with a virus definition update subscription] [Virus Protection Software will be furnished by the Government].

2.3.16.14   Disk Imaging (Backup) Software

****
NOTE: Coordinate with the project site to determine SECTION 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION if the Disk Imaging (Backup) Software will be contractor supplied or Government Furnished.
****

[Provide Disk imaging (backup) software capable of performing a bare-metal restore (imaging and restoring to a new blank hard drive such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software).] [Provide Disk imaging (backup) software consisting of the project site's standard disk imaging software.] [Disk imaging (backup) software will be furnished by the Government.]

2.3.16.15   Supported Field Control Protocols

****
NOTE: one of the integration methods for legacy systems is to use a protocol driver (a 'software gateway') in the M&C software to integrate the legacy system, and these requirements permit the M&C Software to support protocols other than those specifically required in this specification.
****

Provide M&C Software which supports field control protocols as follows:

2.3.17 Remote Access Hardware

[Remote access outside of the installation is strictly prohibited. Remote access is permitted only from within the installation boundaries].

2.3.17.1 Hardware Requirements

Remote access hardware must be compliant with cybersecurity protocols and standards. This hardware must facilitate secure communication channels for remote monitoring, control, and maintenance activities.

2.3.17.1.1 Firewalls

Deploy advanced firewalls to segregate the MCS network from unauthorized access.

2.3.17.1.2 VPN Gateway

A Virtual Private Network (VPN) gateway must be installed to ensure encrypted communication.

2.3.17.1.3 Multi-Factor Authentication

Implement multi-factor authentication mechanisms for all remote access points.

2.3.17.2 Redundancy and Failover

For mission-critical operations, redundant hardware configurations must be employed. Failover capabilities must be automatic and tested to ensure seamless transition during hardware or network failures.

2.3.17.3 Remote Access Protocols

Secure remote access protocols must be used, including but not limited to SSH, HTTPS, and SNMPv3. These protocols must be configurable to meet specific project requirements.

2.3.17.4 Data Encryption

Data in transit must be encrypted using algorithms that meet or exceed industry standards. Options for encryption algorithms include [AES][RSA].

2.3.17.5 Hardware Maintenance

Regular maintenance schedules must be established for all remote access hardware. Firmware updates must be applied in a timely manner and in accordance with manufacturer recommendations.

2.3.17.6 Logging and Monitoring

All remote access activities must be logged and monitored in real-time. Alerts for unauthorized or suspicious activities must be configured to notify designated personnel immediately.

2.3.17.7 Compliance and Certification

Hardware and software components must be compliant with relevant industry standards and certifications, including but not limited to [NIST].

Additionally, all remote access hardware must obtain an Authority to Operate (ATO) in accordance with the cybersecurity specification outlined in the project documentation. Compliance with this specification is mandatory for system deployment and operation.

2.3.18 Data Logging and Event Recording

2.3.18.1 Types of Data to be Logged

The system must log the following types of data:

a. Voltage, current, and power factor at all critical nodes
b. Frequency at the PCC and DER
c. Status of all circuit breakers and disconnects
d. Alarms and fault conditions
e. Energy production and consumption metrics
f. Control signals sent and received
g. System mode and state transitions

2.3.18.2 Data Logging Frequency

Data must be logged at varying frequencies depending on the parameter:

a. Electrical parameters such as voltage, current, and frequency: Every [1 second][5 seconds]
b. System status and mode: Every [10 seconds][30 seconds]
c. Alarms and fault conditions: Instantaneously

2.3.18.3 Data Storage Duration

Logged data must be stored for a minimum duration based on its type:
a. Electrical parameters: [30 days][90 days]
b. System status and mode: [7 days][30 days]
c. Alarms and fault conditions: [1 year][2 years]

2.3.18.4 Data Backup and Redundancy

Data must be backed up in a secondary storage medium and must be retrievable for [3 months][6 months].

2.3.18.5 Event Recording

All significant system events, including but not limited to, fault conditions, mode transitions, and manual interventions, must be recorded with a timestamp. These records must be stored for a minimum of [1 year][2 years].

2.3.18.6 Access to Logged Data

Logged data must be accessible through the MCS Human-Machine Interface (HMI) and must also be exportable in [CSV][XML] format for further analysis.

2.3.18.7 Data Security

Logged data must be encrypted and secured in compliance with relevant cybersecurity standards, ensuring data integrity and confidentiality.

2.4 COMPUTER HARDWARE

Computers used as microgrid controllers must meet the microgrid Computer Hardware Specifications outlined herein. Computers used for visualization and historian purposes may have significant data storage and visualization requirements that few MC hardware platforms can meet. Therefore, computers with lower performance criteria than the MC are selected here. All computers used on a microgrid must abide by the following minimum requirements:

a. Designed and manufactured by an ISO 9001 US based certified manufacturer
b. UL Listed to U.S. and Canadian safety standards
c. Rack- or panel-mount
d. Error-correcting code (ECC) memory
e. No moving parts
f. MTBF minimum of 10 years.
g. Meet or exceed IEEE 1613
h. Operating System with minimum of 10 years remaining support
i. Time synchronization to better than 4 ms, optional IRIG-B
j. Two or more DVI-D ports with support for up to 3 monitors
k. PCIe expansion slots
l. SSD hard drive, sized to accommodate 10 years of data storage or IEEE 2030.8, whichever is longer.
m. Dual power supplies, powered to the same DC standards as the MCS controller above
n. Two or more Ethernet RJ45 ports
o. Alarm contact for annunciation
p. Optional RAID for hot swap data storage
q. Optional Conformal coating for harsh environments.
r. Cold, Operational: IEC 60068-2-1, Severity Level: 16 hours at -40°C
s. Cold, Storage: IEC 60068-2-1. Severity Level: 16 hours at -40°C
t. Damp Heat, Cyclic: IEC 60068-2-30, Severity Level: 12 + 12-hour cycle 25° to 55°C, 6 cycles, >93% relative humidity
u. Damp Heat, Steady: IEC 60068-2-78, Severity Level: 40°C, 240 hours, >93% relative humidity
v. Dry Heat, Operational: IEC 60255-1, Severity Level: 16 hours at 60°C (E3-1505M CPU), 16 hours at 75°C (E3-1505L CPU)
w. Dry Heat, Storage: IEC 60255-1, Severity Level: 16 hours at 85°C
x. Vibration: IEC 60255-21-1, Severity Level: Endurance Class 2

2.5 COMPUTER SOFTWARE

All software used on the Computer Software Specifications must have the following attributes:

a. Backup installation on storage media outside the computer, such as USB or other storage device.
b. License information and purchase warranty clearly documented.
c. Product service bulletins and service patches free of charge.
d. No mandatory service fees for continuity of service.
e. Be provided by a long standing reputable company with a history of supporting their software.
f. A obsolescence plan must be provided, including the viable software alternatives should the primary software company go out of business.
g. Configuration/settings/ or code must be provided for all software integrated into the microgrid control system.

2.5.1 Web Services - API access

Public web access is strictly prohibited on DoD microgrid systems. Refer to 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS for additional requirements

2.6 RACKS AND ENCLOSURES

2.6.1 Enclosures

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NOTE: NOTE: In outdoor applications specify Type 3 unless hosedown of the enclosure is anticipated, in which case specify Type 4.

For retrofit projects in older mechanical rooms or where hosedown of the enclosure is anticipated specify Type 4 enclosures. Type 4 provides a greater degree of protection in dirty and wet environments than does Type 2.

****

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

2.6.1.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 [Type 3][Type 4] requirements.

2.6.1.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 [Type 2][Type 4] requirements.

2.6.1.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6.2 Equipment Racks

Provide standard 482 mm 19 inch equipment racks compatible with the electronic equipment provided. Racks must be either aluminum or steel with bolted or welded construction. Steel equipment racks must be painted with a flame-retardant paint. Guard rails must be included with each equipment rack and have a copper grounding bar installed and grounded to the earth.

PART 3 EXECUTION

Provide QA/QC control documents including an explanation of their audit points, both internal and external. All phases of the project must be included and the documents must include pre-construction QC checklist, post-construction QC checklist and closeout QC checklist. The Contractor's QC Representative must verify each item in the Checklist and initial in the provided area to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government. QC checklists must indicate quality control checks of major system functionality.

3.1 PLANNING

Prior to commencement of any work, prepare and submit a Comprehensive Execution Plan delineating the approach, methodology, and sequence of all activities necessary to execute the project in accordance with the specified requirements and schedule. All elements of the project, including but not limited to design, procurement, installation, integration, testing, and commissioning are included in the plan. Ensure that all requisite permits, approvals, and notifications have been obtained in a timely manner. Coordination is required with all relevant stakeholders, including the Government, utility companies, and other contractors, to ensure that all work is executed in a harmonized and orderly manner, minimizing disruptions and optimizing resource utilization.

3.2 DEVELOPMENT

Following approval of the detailed design, proceed with the procurement of all necessary materials, equipment, and services in accordance with the approved BOM and in compliance with the specified standards and requirements. Execute the installation, integration, and testing of the supplier specific system in accordance with the approved plans, designs, and testing plan. Ensure that all work is executed by qualified personnel in accordance with the best practices, and that all necessary measures are taken to ensure the safety, quality, and integrity of the system and surrounding installations. Upon successful completion of all testing and verification activities, coordinate with the Government and Commissioning Authority for the formal commissioning and handover of the supplier specific system, ensuring that all necessary documentation, training, and support are provided as required.

3.3 FACTORY TESTING

Conduct the Factory Test at a location and time approved by the Government. The Government will witness the factory test. If the system fails a portion of a test, the Government will determine whether the entire test or only the portion that failed must be repeated.

Perform factory testing of the MCS as specified. Provide personnel, equipment, instrumentation, and supplies necessary to perform required testing. Provide written notification of planned testing to the Government at least [21] [ ] days prior to testing, and do not give this notice until after receiving written Government approval of the specific Factory Test Procedures.

3.3.1 FACTORY TESTING COMPLIANCE

Factory testing procedures must be in compliance with IEEE 2030.8, IEEE Standard for the Testing of Microgrid control systems. Normative (enforceable) language within this specification requires a number of mandatory tests, as in the Tables below.

Table 3.1: IEEE 2030.8 Table 1, steady state grid connected scenarios

Initial Conditions	Initiating Events	Measures
POI breaker is closed Dispatch orders and objectives Power system state; this includes the breaker statuses, power flow conditions, and unbalance loads Expected minimum, average, and maximum export and import of P and Q Expected minimum, average, and maximum load levels Combinations of dispatchable and non-dispatchable DER	Power system disturbances including upstream or microgrid open or short circuit conditions Trip of DERs Setpoint step change Start and stop of largest load Action of all voltage control devices	V, f, P, Q, settling time, overshoot, and SS values within contractual requirements and equipment limitations.

Table 3.2: IEEE 2030.8 Table 2, steady state islanded scenarios

Initial Conditions	Initiating Events	Measures
POI breaker is open Dispatch orders and objectives Power system state; this includes the breaker statuses, power flow conditions, and unbalance loads Expected minimum, average, and maximum load levels Combinations of dispatchable and non-dispatchable DER	Power system disturbances including microgrid open or short circuit conditions Trip of DERs Setpoint step change Start and stop of largest load Action of all voltage control devices Total P and Q load decreased/increased or DER contributions increased/ decreased to the point at which each DER is forced to anticipated minimum/ maximum production levels	V, f, P, Q, settling time, overshoot, and SS values within contractual requirements and equipment limitations.

Table 3.3: IEEE 2030.8 Table 3, planned islanding transition scenarios

Initial Conditions	Initiating Events	Measures
POI breaker is closed Dispatch orders and objectives Power system state; this includes the breaker statuses, power flow conditions, and unbalance loads Expected minimum, average, and maximum export and import of P and Q Expected minimum, average, and maximum load levels Combinations of dispatchable and non-dispatchable DER	Receive planned islanding command	V, f, P, Q, settling time, overshoot, and SS values within contractual requirements and equipment limitations.

Table 3.4: IEEE 2030.8 Table 4, Unplanned islanding transition scenarios

Initial Conditions	Initiating Events	Measures
POI breaker is closed Dispatch orders and objectives Power system state; this includes the breaker statuses, power flow conditions, and unbalance loads Expected minimum, average, and maximum export and import of P and Q Expected minimum, average, and maximum load levels Open circuit, short circuit, or system voltage or frequency deviations from contractual ride-through requirements. Combinations of dispatchable and non-dispatchable DER	Unplanned POI disconnection	V, f, P, Q, settling time, overshoot, and SS values within contractual requirements and equipment limitations.
POI breaker is open System de-energized in all cases Start with all DER available or constrained (see NOTE 2) All loads connected or disconnected	Black start requested	V, f, P, Q, settling time, overshoot, and SS values within contractual requirements and equipment limitations.

Table 3.5: IEEE 2030.8 Table 5, Reconnection test scenarios

Initial Conditions	Initiating Events	Measures
POI breaker is open Dispatch orders and objectives Power system state; this includes the breaker statuses, power flow conditions, and unbalance loads Expected minimum, average, and maximum export and import of P and Q Expected minimum, average, and maximum load levels Combinations of dispatchable and nondispatchable DER Frequency and voltage difference across the POI out of specification Live/live, live/dead, dead/dead bus scenarios to be tested Start with constrained DER capacity (ramp rate or other constraints making the reconnection difficult.) All non-dispatchable DERs set at the highest and lowest power needs for the test. Use time varying loads or DER in some cases Microgrid load greater than total DER capacity	Reconnection signal received	V, f, P, Q, settling time, overshoot, and SS values within contractual requirements and equipment limitations.

Normative (enforceable) language within this specification requires a specific set of data collection for each test, as in the Tables below.

Table 3.6: IEEE 2030.8 Table C.1, Minimum data collection

Type of data collection	Minimum time synchronized accuracy	Minimum sample rate	Minimum amplitude accuracy	Required data to collect	Required to meet IEEE 2030.7
Sequence of events (SOE) records	One quarter power system cycle (0.004166 s for a 60 Hz system)	One quarter power system cycle.	N/A	Digital data only. Examples are: Switching device (breaker, recloser, and switch) open and close status, commands, protection elements, control outputs and interlocks	Yes
Event oscillograph (OSC)	One quarter power system cycle	One quarter power system cycle	1% of nominal voltage and 20 times nominal current	Voltage and current of all phases	Yes
Continuous data collection (CDC)	One quarter power system cycle	100 ms	1% of nominal voltage and 20 times nominal current	Voltage and current of all phases	Yes

All testing must adhere to normative field data collection at Level 3, per the IEEE standard section C.2 repeated below.

Level 1 - Data must be collected at and on both sides the POI for any microgrid with one DER.

Level 2 - Data must be collected at every DER and POI for any microgrid with two or more DER.

Level 3 - Data must also be collected at the load(s) and the DER for any load greater than 50% of the largest DER and for any single load larger than 10% of the maximum total power consumed by the microgrid.

3.3.2 FACTORY TEST SETUP

Perform a Factory Test to demonstrate the capability of the proposed control system solution to meet the requirements of project specifications.

Design the Factory Test Setup to represent the system as it will be fielded and to demonstrate the capability of the system to meet the requirements of the project specification.

Perform the Factory Test using equipment and software of the same manufacturer, model and revision as will be used for the specified project. At a minimum:

a. Include at least one of each model of electronic instrumentation, metering, control, relay, IO, gateway, router, and control device to be used on the project.
b. Include at least one network of each type to be used on the project.
c. All electronics must be programmed as close as possible to how they are intended to be installed.
d. Include hardware in the loop simulation that emulates some portion of the facilities. Include testing of overload, islanding, short circuit faults, open circuit faults, restoration, load acceleration, frequency collapse, voltage collapse, black starting, dispatch, load shedding, loss of DER, loss of load feeder, load swings, PV shading, and more. Black start modeling must show both cold load pickup and transformer inrush analysis. Data collection and testing sequences will be sufficient to self-certify compliance with IEEE 2030.8.
e. Include a representative set of project points as shown on the project design points schedules.
f. Demonstrate a minimum [20%, 80%] of the design Sequences of operation and control.
g. Demonstrate black start within parameters of "Island-Mode Black Start Capability" as specified in this section.

3.3.3 Factory Test Procedures

Submit Factory Test Procedures Include the following information, at a minimum, to document the factory test setup:

a. System one-line block diagram of equipment used in the factory test identifying computers (servers and workstations), network hardware, processor or controller hardware, and other instrumentation including, but not limited to, sensors, actuators, test signal generators, and meters.
b. System communication architecture diagram of the setup. If the test setup differs from the field, then a summary of the differences between the factory and field communication architectures.
c. System data flow diagram of the setup. If the test setup differs from the field, then a summary of the differences between the factory and field communication data flow diagrams.
d. System timing riser diagram identifying timing distribution and signal converters to include [IRIG-B][NTP][ ].
e. System hardware description used in the factory test.
f. System software description used in the factory test.
g. Points Schedules for each controller showing the configuration to be used during the test. Points Schedules must include the following information at a minimum: device address, point descriptions, network point names and types, hardware point types, settings and ranges including units.
h. Required passwords for each operator access level.
i. List of other test equipment.

j. Test procedures. The test procedures must consist of detailed instructions for test setup, execution, and evaluation of test results. Within the procedures define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required.

3.3.4 Factory Test Report

Upon completion of the Factory Test provide a Factory Test Report documenting the Factory Test. Include a copy of the Factory Test Procedure, and copies of the executed test procedures separated by test. For each test, include date performed and identify the Government representative who witnessed and approved the test. If a portion of any test failed, document the failure and corrective action.

Submit the Factory Test Report within 7 calendar days after completing the tests. Obtain approval for the test before shipping the unit. Ensure factory test reports bear the signature of an official authorized to certify on behalf of the MCS manufacturer that the system meets the specified requirements as outlined in the "Factory Testing" paragraph. Present test reports in booklet form, tabulating factory tests and measurements performed upon the system's installation and testing. The reports must state the Contractor's name and address, the project name and location, and list the specific requirements being certified.

Document and submit all nonconformances and track them to ensure they are resolved acceptably. The documentation method will vary based on the nonconformance type, detection point, and detection method.

Document and submit serious, critical, and/or major nonconformances through a formal inspection, testing, and validation procedure. Submit these procedures before conducting inspections, testing, or validation.

The supplier must within submitted reports indicate whether the withstand certification is based on actual testing of assembled components or on calculation. Additionally, the supplier must validate and endorse the design documentation and implementation technically.

3.4 Real Time Hardware in the Loop (HIL) Testing

Real time hardware in the loop factory testing [is/is not] required for the project. High risk, complex, or large microgrid projects [may][is not permitted to] be tested while attached to an operational microgrid used by [the customer][government facilities][mission]. To include:

HIL Simulation of the power system, DERs, breakers, transformers, inverters, and LTC/OLTC must be completed for each operational state. Each test must include the following fidelity:

[a. Full fidelity: 80 microsecond or faster update interval solution of the multiple difference equations solving the electromagnetic equations. This to show accurate results in faults, protection, mechanical equipment, inverter dynamics, exciter saturation, inrush phenomena, Power flow solutions.][Partial fidelity: 500 millisecond or faster update interval. This to show accurate results only in power flow solution.]

b. Relays, I/O modules, and controllers connected to the HIL model including metering, status, and control signals.

c. Real time models must be validated in a report. Validation to include proof of accurate response of mechanical and electrical characteristics of a power system.
d. Real time HIL models must show the MCSS in full operation under conditions such as overload, islanding, short circuit faults, open circuit faults, restoration, load acceleration, frequency collapse, voltage collapse, black starting, dispatch, load shedding, loss of DER, loss of load feeder, load swings, PV shading, and more.
e. Black start modeling must show both cold load pickup and transformer inrush analysis.
f. Data collection and testing sequences will be sufficient to self-certify compliance with IEEE 2030.8.

3.5 EXISTING CONDITIONS

Prior to the installation of the microgrid controller system, a comprehensive Site Assessment Survey must be conducted and a site assessment survey submitted to evaluate the existing conditions and infrastructure. The assessment aims to provide essential information for designing and implementing the microgrid controller system in a manner that optimally integrates with the site's existing infrastructure.

3.6 ASSESSMENT CONSIDERATIONS

The site assessment survey is to include, but not be limited to, the following key factors:

a. Electrical Infrastructure: A thorough evaluation of the existing electrical infrastructure, including the condition of switchboards, distribution equipment, transformers, and interconnection points that must be controlled by the microgrid control system. Any necessary upgrades or modifications required for the integration of the microgrid control system must be identified.
b. Utility Interconnection: Examination of the utility interconnection point and assessment of its compatibility with the microgrid control system. Coordination with the utility provider, as needed, to ensure a seamless interface.
c. Environmental Conditions: Assessment of environmental conditions, including climate, temperature extremes, humidity, and exposure to elements and possible impact of these conditions on the microgrid control system's components as well as protection measures must be provided.
d. Structural Readiness: Evaluation of the structural readiness of buildings or support structures where microgrid components are intended to be installed. This includes structural integrity assessments and any necessary modifications to accommodate the system.
e. Safety Compliance: Verification of compliance with safety codes and regulations for existing electrical infrastructure, ensuring that safety standards are met when integrating the microgrid control system.
f. Access and Clearance: Assessment of access routes, clearance requirements, and space availability for equipment installation. Any obstructions or constraints that may affect the installation process are to be identified and addressed.

3.6.1 Documentation and Reporting

The findings of the site assessment are documented and reported in the site assessment survey. The documentation must include, but not be limited to, the following:

a. Site Assessment Report: A detailed report outlining the existing conditions, including photographs, measurements, and descriptions of the site's electrical infrastructure, environmental conditions, structural readiness and other noteworthy findings.
b. Recommendations: Recommendations for necessary modifications, upgrades, or adjustments to the existing conditions to facilitate the seamless integration of the microgrid control system.
c. Safety Compliance Report: A report confirming the compliance of the existing electrical infrastructure with safety codes and regulations. If non-compliance issues are identified, a plan for bringing the infrastructure into compliance must be included.
d. Clearance and Space Requirements: Documentation specifying the required access routes, clearance areas, and space allocations for equipment installation.

The Assessment report is submitted within [21][ ] days of the assessments.

3.7 FUTURE EXPANSION CAPABILITIES

The MCSS design documents must show the following attributes associated with future expansion.

Microgrid designer must select technology that is ready for incremental design, procurement, installation, commissioning, test, and maintenance. The following attributes are required:

a. Incremental design. Future DER of any sort (generator, inverter, renewable, storage, etc) and configured within acceptable operational modes (See DER mode selection chapter) must be shown to operate islanded and grid connected while simultaneously paralleled to any DER proposed by the present design. Protocol capability of the specified microgrid control system must use established standard protocols which are expected to be supported by future DER including Modbus or MIL-STD-3071.
b. Incremental procurement. DER, switchgear, controllers, relays, and any equipment with microprocessors must be designed in packages that can be purchased separately at different times/years and with backwards compatible guarantees of interoperability.
c. Incremental installation. DER, switchgear, controllers, relays, and any equipment with microprocessors procured incrementally must be capable of being installed without dependency on other equipment and must have backwards compatible guarantees of interoperability.
d. Incremental commissioning. DER, switchgear, controllers, relays, and any equipment with microprocessors installed incrementally must be capable of being commissioned without dependency on other equipment and must have backwards compatible guarantees of interoperability.
e. Incremental test. DER, switchgear, controllers, relays, and any equipment with microprocessors commissioned incrementally must be capable of being tested without dependency on other equipment and must have backwards compatible guarantees of interoperability.
f. Incremental maintenance. DER, switchgear, controllers, relays, and any equipment with microprocessors commissioned incrementally must be capable of being maintained without dependency on other equipment and must have backwards compatible guarantees of interoperability.

3.8 DRAWINGS AND CALCULATIONS

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NOTE: Two types of system communication architecture diagrams are mandatory for all microgrids. These are required for the audit, performance validation, maintenance, testing, and RMF.

A system communication architecture (aka 'architecture') diagram. This is a detailed block diagram or system architecture diagram illustrating the overall structure and hierarchy of the microgrid control system to include all physical ports (e.g. RJ45 or DB9) and all communication cables in the system. Clouding of network infrastructure is not allowed.

A data flow diagram (DFD) illustrating all virtual connections and the intent of the physical layer communications architecture to include protocols used and a summary of the data transmitted on each communication channel. IO point lists further elaborate on the contents of these DFD channels.

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3.8.1 Network Bandwidth and Usage Calculations

Provide MCS Network, RI/O and HMI networks Bandwidth Usage Calculations for a normally loaded and a heavily loaded control system. Provide Calculations for network traffic at the HMI Server and master PLCs. A heavily loaded network is characterized as one performing the following activities simultaneously:

a. Trending a number of points equal to the specified minimum monitoring and control software trending capacity at 15-minute intervals.
b. Trending (for loop tuning) 20 points at 2 second intervals.
c. Viewing 500 points via workstations with a 5 second update interval.
d. Transmitting load shed commands to 2,000 devices in a 1 minute interval.
e. Viewing of 10 system display graphic screens of 50 points each via browsers. A normally loaded network is characterized as one performing the following activities simultaneously:
f. Trending 500 points equal at 15-minute intervals.
g. Viewing 100 points via workstations with a 5 second update interval.
h. Transmitting load shed commands to 200 devices in a 1 minute interval.
i. Viewing of 2 system display graphic screens of 50 points each via browsers.

3.8.2 Draft As-Built Drawings

Provide Draft As-Built Drawings consisting of Points Schedule drawings for the entire MCS and an updated Contractor Design Drawings including details of the actual installed system as it is at the conclusion of Start-Up and Start-Up Testing.

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NOTE: The design documents must include the design version of the drawings listed below. The intent is

to require the contractor to update the documents as necessary based on the specific components selected.
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The Contractor Design Drawings required to include, at a minimum:

a. Electrical Layout Diagram illustrating the major components within the microgrid boundary and how they are interconnected both electrically and via communication networks. It includes the layout of all DERs and their connections.

b. Electrical Schematics including detailed single-line and three-line system diagrams that provide a comprehensive view of the electrical distribution system, depicting how each component is electrically connected within the microgrid.

c. Control Logic Diagrams outlining the logic used to control the operation of the microgrid, highlighting the flow of control signals among different devices and systems.Diagrams must be in accordance with ISA 5.2.

d. Functional Block Diagrams which show the basic functions of the microgrid system and how they interact, breaking down complex system behaviors into simpler, functional parts.

e. Panel Layouts as detailed diagrams showing the layout of control panels, including the arrangement of components such as controllers, meters, and protective devices, as well as the location of HMI components.

f. Cable and Conduit Routing Plans that specify the paths for electrical cables and conduits, ensuring that all components are properly connected and that the routing complies with safety and operational requirements.

g. DER Integration Plans documenting how various existing and new DERs are integrated into the microgrid, including considerations for interoperability, control, and energy management.

h. Communication Interconnection Diagram including a visual representation of the communication network within the microgrid, detailing how different devices and systems communicate with one another.

i. Communication Functional Block Diagrams per standard IEC 61131-3 which depict the functional aspects of communication within the microgrid, showing the flow of data and control signals between devices.

j. Data Flow Diagram illustrating how data moves through the microgrid system, identifying the sources, paths, and destinations of data, and how it is used for control and decision-making.

k. System IO Points List for all points monitored and interfaced.

In addition to the details shown in the design drawings, the as-built drawing must include:

a. IP address(es) as applicable for each piece of network hardware.
b. IP address for each server, workstation, and printer.
c. Network identifier (name) for each printer, computer server and computer workstation.
d. CEA-709.1D address (domain, subnet, node address) for each CEA-709.1D TP/FT-10 to IP Router.

Provide Draft As-Built Drawings upon the completion of Start-Up and Start-Up Testing, and Final As-Built Drawings upon completion of PVT Phase II.

3.9 INSTALLATION REQUIREMENTS

3.9.1 General

Start installation after Government acceptance of the Product Data and Shop Drawings. Install system components as shown and specified in accordance with the manufacturer's instructions and provide necessary interconnections, services, and adjustments required for a complete and operable system. Communication equipment and cable grounding installed to preclude ground loops, noise, and surges from adversely affecting system operation. Fiber Optic cables and wiring in exposed areas, including low voltage wiring but not including network cable in telecommunication [racks][rooms], installed in metallic raceways as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Adjust or replace devices not conforming to the required accuracies. Factory sealed devices are replaced (rather than adjusted).

3.9.2 Isolation, Penetrations, Clearance

The MCS must be completely installed and ready for operation, as specified and shown. Dielectric isolation must be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in any building exteriors must be made watertight. Holes in concrete, brick, steel and wood walls must be drilled or core drilled with proper equipment; conduits installed through openings must be sealed with materials which are compatible with existing materials. The MCS installation must provide clearance for control-system maintenance by maintaining access space between coils, and other access space required to calibrate, remove, repair, or replace control-system devices. The control-system installation must not interfere with the clearance requirements for any other system maintenance such as electrical or mechanical devices.

3.10 INSTALLATION OF EQUIPMENT

Install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational control system.

3.10.1 Vibration and Seismic Control

All equipment and the installation of equipment covered by this specification must comply with the seismic requirements as specified in 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT

3.10.2 Wire and Cable

System components and appurtenances must be installed in accordance with

NFPA 70, manufacturer's instructions and as shown in drawing set. The raceways shown in the drawings are diagrammatic and must be coordinated with equipment being installed. Additional raceways not shown in the drawings but required for proper system operation must be provided and installed. Utilize separate raceways to segregate cables for redundant equipment and systems. Raceway sizes may be increased to accommodate manufacturer's cables or to accommodate supplied cables that have different outside diameter than cables specified. Costs associated with raceway changes must be borne by the Contractor. Cables must comply with the equipment manufacturer's requirements. Should specified cables not meet manufacturer's requirements, install appropriate cable complying with manufacturer's requirements. Costs associated with cable substitution based on manufacturer's requirements must be borne by Contractor. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system must be provided. Components must be labeled in accordance with TIA-606.

Conduits, outlets and raceways must be installed in accordance with 26 20 00 INTERIOR DISTRIBUTION SYSTEM. The wiring must be installed in accordance with TIA/EIA-568.1-D and as specified in 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wiring, and terminal blocks and outlets must be marked in accordance with TIA-606. Cables must be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables. Cables not installed in conduit or wireways must be properly secured and neat in appearance.

3.10.2.1 LAN Cables and Connecting Hardware

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NOTE: Include in the project specification any of the following UFGS for the appropriate BTC: Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM, Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

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Provide data transmission systems for communication [between PLCs][and][between PLCs and the central station][and][server] as specified in [Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM][Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP)] and as indicated.

3.10.2.2 Unshielded Twisted Pair Patch Panels

Patch panels must be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 10 [20] percent spares. Cable guides must be provided above, below and between each panel.

3.10.2.3 Fiber Optic Patch Panels

Patch panels must be mounted in equipment racks with sufficient ports to accommodate the installed cable plus 10 [20] percent spares. A slack loop of fiber must be provided within each panel. Loop must be 3 feet in length. The outer jacket of each cable entering a patch panel must be secured to the panel using clamps or brackets specifically manufactured for the purpose of preventing movement of the fibers within the panel. DIN rail mounted patch panels must also be installed where building fiber enters MCS enclosures or switchgear.

3.10.2.4 Equipment Racks

Equipment racks/cabinets must be provided and installed in accordance with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

3.10.2.5 Rack Mounted Equipment

Equipment to be rack mounted must be securely fastened to racks by means of the manufacturers recommended fasteners.

3.10.2.6 Termination

Cables and conductors must sweep into termination areas; cables and conductors must not bend at right angles. The manufacturer's minimum bending radius must not be exceeded. When there are multiple system type drops to individual panels, relative position for each system must be maintained on each system termination block or patch panel.

3.10.2.7 Unshielded Twisted Pair Cable

Each pair must be terminated on appropriate outlets, terminal blocks or patch panels. No cable is allowed to be unterminated or contain unterminated elements. Pairs must remain twisted together to within the proper distance from the termination. Conductors must not be damaged when removing insulation. Wire insulation must not be damaged when removing outer jacket.

3.10.2.8 Shielded Twisted Pair Cables

Each cable must be terminated on panel-mounted connectors. Cables must be grounded at patch panels using manufacturer's recommended methods. Shield braid is to be continuous to connector braid terminator. Wire insulation must not be damaged when removing shield.

3.10.2.9 Fiber Optic Cable

Each fiber must have connectors installed. The pull strength between the connector and the attached fiber must not be less than 25 pounds. The mated pair loss, without rotational optimization, must not exceed 1.0 db.

3.10.3 Pathways

Shop drawings must provide a comprehensive plan for the establishment of pathways within the microgrid control system. This plan must include:

Cable Routing: A detailed layout of cable routing throughout the system, ensuring that cables are organized, secured, and protected from potential damage.
Conduit and Tray Systems: Conduit and cable tray systems, including materials, sizes, and installation methods, to accommodate various cables and wires.
Separation of Services: Clear separation of power and communication cables to prevent interference and ensure safety.
Support Structures: Provision for support structures, such as cable trays, ladder racks, and mounting brackets, to securely fasten cables and prevent sagging or stress on the cables.
Conduit Sealing: Proper sealing of conduits to prevent the entrance of moisture, dust, or contaminants.
Cable Management Devices: Utilization of cable ties, clamps, and routing

accessories to maintain cable organization and prevent tangling.

Cable Guards: Installation of cable guards or covers to protect cables from physical damage or accidental contact.

EMI/RFI Shielding: Shielding measures to protect sensitive communication cables from electromagnetic and radio frequency interference.

3.10.4 Identification

All cables and microgrid control equipment within the microgrid control system must be appropriately identified and labeled for easy maintenance. Labels must include cable/equipment type, function, and any other relevant information to facilitate troubleshooting and system management.

3.10.5 Grounding and Bonding

Signal distribution system ground must be installed in accordance with TIA-607 and 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Equipment racks must be connected to the electrical safety ground.

3.10.6 Reference Voltages

Equipment racks and equipment contained within must be securely connected to the electrical safety ground to maintain a safe reference voltage.

3.10.7 Grounding

Design documents must provide detailed calculations and designs of system grounding, lightning grounds, static grounding, equipment grounding, safety grounding, as appropriate.

System grounds on microgrids are primarily designed to prevent equipment overvoltage. Microgrid systems without a system ground reference commonly experience overvoltage conditions due to single phase loads, faults, switching transients, or unbalanced capacitive coupling between phases and earth ground. In a three phase system not designed for ungrounded operation and with no reference to ground the phases can achieve damaging voltage levels. Overvoltage conditions cause surge arrestors, lightning arrestors, or insulation flash over in primary equipment. Once the first phase finds ground during this flash over, the other phases can rise to 173% of nominal voltage.

Although a microgrid may only have one perceived island, for grounding systems the design engineer must identify two types of isolated ground islands.

Electrically (galvanically) isolated grid sections such as when a circuit breaker is open. Be advised that in most four wire systems the neutral stays in service with three pole disconnection means, e.g., circuit breakers and disconnects.

Magnetically isolated grid sections such as occur at every transformer with certain transformer configurations.

Designs must show each ground island, either galvanically or magnetically formed, to have their own system ground(s).

Grounding must adhere to one or more of the following code standards:

NEC (NFPA 70) rules apply to system grounding below 1000V.

Above 1000V, grounding systems are subject to utility jurisdiction. Designer to base their 1000 V and above designs on the local utility standards. In the absence of utility standards, designs must comply with IEEE standards C62.92.

3.10.8 Surge Protection

Equipment connected to ac circuits must be protected against or withstand power-line surges. Equipment protection must meet the requirements of IEEE C62.41.1 and IEEE C62.41.2. Fuses are not to be used for surge protection.

Digital and analog inputs and outputs must be protected against surges induced on control and sensor wiring installed outdoors. The inputs and outputs must be tested in both the normal and common mode using the following two waveforms: The first waveform must be 10 microseconds by 1000 microseconds with a peak voltage of 1500 volts and a peak current of 60 amperes. The second waveform must be 8 microseconds by 20 microseconds with a peak voltage of 1000 volts and a peak current of 500 amperes.

3.11 APPLICATION

Provide MCS capable of for real-time monitoring, control, optimization, and dispatch of DER in both grid-connected and islanded modes. The controller must provide advanced functionalities to interface with a wide range of DERs, ensuring safe, secure, and resilient operation of the microgrid.

3.12 INTEGRATION OF FIELD CONTROL SYSTEMS

3.12.1 Install Control Hardware

All hardware components of the microgrid control system, including processors, I/O modules, communication devices, and interface units, must be installed in compliance with manufacturer recommendations and IEEE 2030.8 requirements. .

3.12.2 Add Field Control System

Integration with the field control systems of various DERs must be performed through standardized communication protocols such as Modbus, IEC 61850, and DNP3. Suitable gateway devices or protocol converters may be employed if direct integration is not feasible.

3.12.3 Configure Software

The microgrid control system software must be configured to match the specific requirements of the project, including DER types, ratings, communication settings, and desired operational modes. Necessary database parameters like DER setpoints, limits, and grid interconnection requirements must be accurately entered.

3.13 FIELD QUALITY CONTROL

3.13.1 Tests

3.13.1.1 Dispatch Functions

Validate the dispatch capability of each DER by sending appropriate control commands. Confirm ramp rate controls, start/stop sequences, and setpoint adjustments as per design.

3.13.1.2 Transition Functions

Test transition between grid-connected and islanded modes and vice versa. Validate the smooth switchover without power interruptions or excessive transients.

3.13.1.3 Grid-Following Synchronization

Using the external grid as reference, each DER in unison or in tandem, as outlined in the sequence of control, must synchronize, and connect either at the point of interconnection, or the point of connection for each DER.

For a central-plant type architecture, define the sequence of operation with regard to powering the connected loads (via external grid or via DER before interconnection).

Ensure that the voltage waveforms of the DERs are in phase with the external grid to allow for proper synchronization and connection. Ensure that the connection type (delta or wye) of the DERs matches that of the external grid to ensure proper synchronization and connection.

3.13.1.4 Islanded Grid-Forming Synchronization

During islanded operations designate a primary DER as the grid-forming unit and validate its ability to form the grid. All other DERs must be checked for synchronization capability to this primary source. In alternative designs where all DERs are grid-forming with droop characteristics, test and validate each DER's capability to operate in this mode.

3.13.1.5 Load-Following, Load-Shedding, and Energy Management

Validate the controller's capability to adjust DER dispatch in response to real-time load variations. Test and confirm the load-shedding schemes, ensuring prioritized shedding of non-critical loads during supply shortages. The controller must also demonstrate efficient energy management, optimizing DER dispatch for economic operations.

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NOTE: Consideration should be given to the possible power quality, fault current, and voltage drop issues based on which DER is selected as primary during island mode. As the power flow varies based on load and generation, the system may be required to dynamically adjust the protection.

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3.13.2 Examination and Inspection

Prior to commissioning, complete the following examinations and inspections:

a. Initial Inspection: Prior to commissioning, conduct an initial inspection to ensure that all system components, including hardware and software, are installed correctly and securely.

b. Safety Checks: Ensure that all safety protocols and mechanisms are in place and functioning as intended. This includes emergency shutdown procedures, overcurrent protection, fault detection, and isolation measures.

c. Cybersecurity Testing: Ensure cybersecurity standards are met for the system to ensure resilience against cyber threats in accordance with 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, paragraph CYBERSECURITY AUDITING.

d. Data Logging and Reporting: Verify data logging and reporting mechanisms, ensuring that the system records and reports relevant operational data accurately.

e. Redundancy and Failover Testing: Confirm the functionality of redundancy and failover mechanisms, guaranteeing seamless operation in the event of component failures or disruptions.

f. Environmental Testing: Assess the system's ability to withstand environmental conditions and ensure compliance with environmental standards.

g. Documentation Review: Review all documentation related to the system's configuration, settings, and operational procedures to ensure completeness, accuracy for reference during commissioning process.

3.13.3 Manufacturer Field Startup and Service

Obtain the services of a MCS manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjusting, and testing of the equipment. At a minimum, the services of manufacturer's representatives for the MCS equipment, central station, HMI, software, and data collection/report generation software must be provided.

3.14 STARTUP TESTING

Test all equipment and perform all other tests necessary to ensure the system is installed and functioning as specified. Prepare and submit a Startup Testing Plan prior to testing and Startup Testing Report documenting all tests performed and their results and certifying that the system meets the requirements specified.

Do not begin the startup testing until after receipt of written permission by the Government representative for base maintenance, based on Government approval of the startup testing Plan and Draft As-Built Drawings.

Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568-C.1, TIA-568-C.2, and TIA-568-C.3. Submit telecommunications cabling testing report for any cables requiring testing.

3.14.1 Testing Wire and Cable

Materials and documentation to be furnished under this specification are subject to inspections and tests. Terminate all components prior to testing. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

3.14.1.1   Unshielded Twisted Pair Testing

Test all metallic cable parts that have not been put into operation previously for proper identification and continuity. All opens, shorts, crosses, grounds, and reversals are to be corrected. Verify correct color coding and termination of each pair in the control system cabinets and at the end-device. Test horizontal wiring from end-to-end, including the termination device and including any modular jacks. Test backbone wiring end-to-end, including termination devices, from terminal block to terminal block. Complete these tests, and correct all errors, before starting any other tests.

3.14.1.2   Category 5E Circuits Testing

Test all Category 5E circuits that have not been put into operation previously using a test set that meets the Class II accuracy requirements of TIA/EIA-TSB-67. Use the Basic Link Test procedure of TIA/EIA-TSB-67. Cables which contain failed circuits must be replaced and retested to verify the standard is met.

3.14.1.3   Shielded Twisted Pair Wiring Testing

Test configurations that have not been put into operation previously or have been labeled as spare. Test for continuity, opens, shorts, correct pin configuration. Verify DC resistance for both pair-to-pair and wire-to-shield types. Verify all cable lengths. Test near end crosstalk from 722 kHz to 300 MHz.

3.14.1.4   Fiber Optic Cable Testing

Perform optical fiber field inspection tests via attenuation measurements on any existing or new cable to be utilized that has not been put into operation previously or has been previously labeled as spare. Provide test results where applicable. Remove failed cables from project site upon attenuation test failure.

3.14.1.5   Inspection

Visually inspect UTP and optical fiber jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color code for T568A or T568B pin assignments. Inspect cabling connections to confirm compliance with TIA-568-C.1, TIA-568-C.2, and TIA-568-C.3. Visually confirm Category 5E, marking of outlets, cover plates, outlet/connectors, and patch panels.

3.14.1.6   Final Verification Tests

Perform verification tests for UTP and optical fiber systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

Data Tests. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

3.14.2   Protective Relays Communications Testing

Verify software for communications and programming of protective relays to operate correctly in accordance with the manufacturer's published instructions. Include verification of time signal to relays, local and remote access to relay settings, and SER and ER functionality verification.

3.14.2.1 Points List Testing

All input and output points indicated on the typical points schedule must be tested for proper operation from the HMI and head-end workstation to the end. Test the following:

a. All devices with discrete (digital) output are checked for all energized and response states. The device outputs are confirmed and documented in an energized state and a de-energized state. Any changes in output status are documented.
b. All trouble and fault alarms with discrete (digital) outputs must be confirmed as normally closed, open on alarm.
c. All devices requiring a change in mechanical signal input must be checked and calibrated to provide the correct discrete (digital) output.

For analog transducers, calibration is required. Calibration for digital devices is not required if the factory test report shows calibration has been completed. Calibrate each analog instrumentation device connected to the control system control network by making a comparison between the reading at the device and the display at the HMI and head end workstation, using a standard at least twice as accurate as the device to be calibrated. Analog points must be tested at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of full scale.

Verify operation of systems in the specified failure modes upon MCS network failure or loss of power and verify that systems return to control system control automatically upon a resumption of control system network operation or return of power.

Verify system automatically performs a cold start (with the head end and controllers off-line) upon application of power and is in full operation as specified within [ ] [five minutes].

Verify system automatically performs a warm start (with head end off-line and controllers on-line) upon application of power without human intervention and is in full operation as specified within 15 minutes. Verify the head end servers review and enable programs that must be running at that time, including the restart of any automatic control programs resident at the head end servers.

Verify system recovers from power failure. When a power failure occurs at the head end or field panel, the system must automatically start upon restoration of power and the programs are to be restarted in a manner to assure an orderly resumption. Include a restart program based on detection of power failure at the head end MCS controller and distributed controllers. Upon restoration of power to the head end MCS controller and distributed controllers, verify the controllers obtain time of day from the system's real time clock, restart properly, and restore loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. Include start time delays between successive commands to prevent demand surges or overload trips.

Energize all equipment with motors to confirm proper operation, rotation (phasing), inrush currents, full load current.

Provide a startup testing report documenting all startup tests describing results of functional tests, diagnostics, calibrations, and commissioning procedures including written certification to the Government that the installed complete system has been calibrated, tested, adjusted, and commissioned and is ready to begin the PVT. The report must also include a copy of the approved PVT procedure.

3.15 PERFORMANCE VERIFICATION TESTING (PVT)

Refer to following specifications for details: 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM TESTING. Provide a PVT Procedure using the test procedures in this section, modifying the procedures and adding tests as appropriate to develop procedures that test all requirements of the project specifications. The test procedures must consist of detailed instructions for test setup, execution, and evaluation of test results. When developing additional procedures, provide the same information and fields as shown in the Test Template. The PVT must be performed in three phases:

Phase I Testing (Standalone Test)
Phase II Testing (Integration Test)
Phase III Testing (Endurance Test)

Provide a PVT Plan including system documentation and PVT Procedures. Include the following system documentation in the PVT Plan:

a. Copies of the most recent draft as-built drawings for the system, including but not limited to one-line drawings and Points Schedules [as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC] showing device address, point descriptions, network point names and types, hardware point types, settings and ranges including units.
b. Copies of manufacturer's product data sheets when needed to demonstrate compliance with project requirements. For example, provide data sheets showing that surge protection requirements have been met.
c. Operation or user manuals for all software and all DDC Hardware to be tested.
d. List of test equipment.

Submit the PVT Testing Procedures, including a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration. At a minimum this is expected to include primary or secondary current injections test kits.

Provide PVT testing procedures using the test procedures in this Section, modifying the procedures and adding tests as appropriate to develop procedures that test all requirements of the project specifications. Include detailed instructions for test setup, execution, and evaluation of test results.

****

NOTE: Coordinate with the project site to determine if government witness of PVT is required, or if there is a third party commissioning agent acting on behalf of the Government.

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Do not start the PVT until after receipt of written permission by the Government representative for base maintenance, based on Government approval of the PVT Procedure and Draft As-Built drawings. [The Government will witness each phase of PVT.][The Government's third-party commissioning agent will witness each phase of PVT]

PVT Phase I demonstrates compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems fully and correctly implement the sequences of operation and control. PVT for surge protection is not required to include introducing a surge to the equipment; surge protection may instead be demonstrated through product documentation.

Conduct testing during the most electrically demanding season, whether that be peak summer or peak winter, based on locality. At the completion of PVT Phase I, Phase II, and Phase III testing, and in accordance with the project schedule and project sequencing, provide reports documenting all PVT testing including all approved test procedures with test results indicated on the procedures, and a record of all actions taken to address PVT test failures.

3.15.1 Phase I Testing (Standalone Test)

Operational tests must to be completed and include testing device operation within the intended subsystem. All states included in the subsystem must be tested. All failover states must be documented. All communications within the subsystem must be tested. All tests are to be documented.

Unit tests are to be completed on each MCS device and include testing device operation as a standalone device. The devices must be tested energized.

Performing a sequence of operations test to the extent possible in the given subsystem must include all sequences specified. All failover states must be tested within each standalone subsystem.

At the completion of PVT Phase I, and in accordance with the project schedule and project sequencing, submit the PVT Phase I Testing Report documenting test procedures, failures and repair actions taken during PVT Phase I.

3.15.2 Phase II Testing (Integration Test)

Once the MCS has been tested as a standalone system, an Integration test must be performed. The integration test must include a re-performance of the entire sequence of operation, testing of all logic, communications testing, verification of accuracy and functioning of all graphics within the HMI, confirmation of the integrity of the control structure, and confirmation of all inputs and outputs. The integration test must be performed to the extent of verifying the full functional performance of the microgrid control system meets all design criteria and functionality specified here, in the drawing package and the sequence of operations.

At the completion of PVT Phase II, and in accordance with the project schedule and project sequencing, submit the PVT Phase II Testing Report documenting test procedures, failures and repair actions taken during PVT Phase II.

3.15.3 Phase III Testing (Endurance Test)

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NOTE: The intent of the Endurance Test is to ensure

the microgrid control system is burned in and able to operate without internal component failure. The test can be operated in island mode, grid mode, or black start mode.

Coordinate the off-grid testing requirements with the equipment provided (and specified elsewhere in the UFGS). Where carbon-emitting generators are used, coordinate EPA ratings and emissions requirements.

****

Complete an endurance test as part of the PVT in which the system is operated continuously for [24-hours][48-hours][one-week][___] without failure. The test can be operated in island mode, grid mode or black start mode. During the endurance test trend all points shown as requiring a trend on the Points Schedule for the entire duration of the endurance test. If insufficient buffer or storage capacity exists to trend the entire endurance test, offload trend logs during the course of the endurance test to ensure that no trend data is lost. If the control system specification includes bandwidth requirements for bandwidth usage on a non-IP network, measure and record the network bandwidth usage on each non-IP channel during the endurance test.

If the system experiences any failures during the endurance test portion of the PVT, repair the system and repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period. At the completion of PVT Phase III, and in accordance with the project schedule and project sequencing, submit the PVT Phase III Testing Report documenting test procedures, failures and repair actions taken during PVT Phase III.

3.16 TRAINING

3.16.1 General

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NOTE: Select the video record option where site and security allows.

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Conduct Operators and Maintenance training courses for designated personnel in the Operation and Maintenance of the system as specified. The training must be oriented to the specific system being installed under this contract. Deliver training manuals for each trainee with [two] [ ] additional copies for archival at the project site. [Record training sessions to video and deliver digital video files to Governmetn on CD after completion of Training program.]Furnish all audiovisual equipment and all other training documentation and supplies. Copies of any training materials must be delivered to the Government either as a part of the printed training manuals or on the same media as that used during the training sessions. Training materials must also be included in the O&M instructions. A training day is defined as [eight][] hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime or night shift in effect at the training facility. For guidance in planning the required instruction, assume that attendees have a high school education or equivalent, and are familiar with utility systems. Approval of a planned training schedule must be obtained from the Government at least 30 days prior to the training. Submit all

Training Documentation for record at project closeout.

3.16.2 Operators Training

The first course must be taught at the project site for a minimum of three 8-hour training days during or after field testing, but before commencing the PVT. A maximum of 6 [ ] personnel will attend the course. No one single part of the training given during this course is allowed be counted toward completion of the PVT. The course must be include instruction on the specific hardware configuration of the installed system and specific instructions for operating the installed system. Upon completion of this course, each student must be able to start the system, operate the system, recover the system after a failure, and describe the specific hardware architecture and operation of the system.

This course must include guided practical demonstrations for:

a. Instructional overview of system operation.

b. Detailed instruction for each mode of operation, demonstrating steady state operation and monitoring via HMI, and initiation of each SOC accessible from that state in accordance with the paragraph "MIcrogrid Control System Sequences of Control"

c. Control system management instruction to train users on the complete HMI. Demonstrate each distinct screen and provide written guide for what each displayed element represents and the funtions executed by selecting them.

d. Safety Procedures including essential safety protocols, review of alarm types and reporting methods, and recovery or restart demonstration for each category of alarm.

e. Maintenance and troubleshooting demonstration as outlined in paragraph "TROUBLESHOOTING AND DIAGNOSTICS".

3.16.3 Maintenance Training

The maintenance course must be taught at the project site within thirty days after completion of the PVT for a period of one training day. A maximum of 6 [ ] personnel will attend the course. The training must include:

a. Physical layout of each piece of hardware.

b. Thorough understanding of the microgrid control system and various modes of operations.

c. Troubleshooting and diagnostics procedures.

d. Repair instructions.

e. Preventive maintenance procedures and schedules.

f. Calibration procedures.

3.17 MAINTENANCE AND SERVICE

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NOTE: The maintenance and service to be provided by the Contractor for the duration of the IDIQ or maintenance contract is specified in this

paragraph. The Maintenance and Service may need to be a separate bid item funded by O&M funds.

Some/many of these Maintenance and Service requirements may not apply if the UMCS networking equipment and supporting infrastructure is Government furnished equipment and maintained by the Government.The requirements here generally assume that the contractor is permitted access to the system and equipment, but the applicability of this assumption will vary site-by-site. It's critical to coordinate with the project site to determine to what extent the contractor will be responsible for system and equipment maintenance. Some notes have been included with bracketed text to provide general guidance, but careful editing of this entire subpart is needed.

Requirements should be coordinated with "WARRANTY MANAGEMENT" in Section 01 78 00 CLOSEOUT SUBMITTALS
****

Perform inspection, testing, cleaning, and part or component replacement as specified and as required to maintain the new or existing warranty. Furnish labor, supervision, tools, materials, equipment, transportation, and management necessary to provide maintenance, service and repair for the MCS in accordance with the requirements as specified. Maintain, and repair devices connected to and used by the MCS in accomplishing its control and monitoring functions. This work includes inspection, testing, cleaning, lubrication, adjustment, calibration, and part or component replacement as specified. Work includes providing necessary preventive and unscheduled maintenance and repairs to keep the MCS operating as specified, and accepted by the Government, and other services as specified during the duration of work. Work must comply with manufacturer's recommendations and industry standards. Provide technical support via telephone during regular working hours.

3.17.1 Work Coordination

Coordinate all work activities related to the microgrid control system with other trades and parties involved in the project to ensure smooth and efficient installation and operation. This coordination must include regular communication with subcontractors and suppliers, coordination of installation, testing, and commissioning schedules, and collaboration with facility operators and managers to minimize disruptions during work.

3.17.2 Work Control

Maintain a clean and safe working environment throughout the installation and testing of the microgrid control system. Specific requirements including regular cleanup of work areas and removal of debris, protection of equipment and components from environmental factors, dust, and debris and implementation of safety measures to protect personnel during construction and testing.

3.17.3 Working Hours

Adhere to working hours and schedules defined in the project plan and in accordance with any state or local laws. Any deviation from the established working hours must be communicated and approved in advance to ensure minimal disruption to the facility's operation.

[3.17.4 Equipment Repairs

****

NOTE: Coordinate with the project site to determine if equipment (computers and control hardware) repair will be done by the contractor or by local staff, and to what extent. If the equipment is Government furnished then the contractor may not be allowed access to some/all of the equipment for repair. Address Information Assurance (IA) or other equipment access requirements in "Access To UMCS Equipment" below.

Select repair times below.

****

Initiate and complete equipment repairs within the following time periods, where time periods are measured as actual elapsed time from first notification, including working and non-working hours:

a. for non-redundant computer server hardware, initiate within [4] [_____] hours and complete within [8] [_____] hours.

b. for non-redundant computer workstation hardware, initiate within [4] [_____] hours and complete within [8] [_____] hours.

c. for redundant computer server hardware, initiate within [36] [_____] hours and complete within [5] [_____] days.

d. for redundant computer workstation hardware, initiate within [2] [_____] days and complete within [5] [_____] days.

e. for active (powered) control hardware, initiate within [4] [_____] hours and complete within [6] [_____] hours.

f. for cabling and other passive network hardware, initiate within [16] [_____] hours and complete within [5] [_____] days.

Repair is the restoration of a piece of equipment, a system, or a facility to such condition that it may be effectively used for its designated purposes. Repair may be overhaul, reprocessing, or replacement of nonfunctional parts or materials or replacement of the entire unit or system.

]

3.17.5 Replacement, Modernization, Renovation

Provide options and recommendations for the replacement, modernization, or renovation of microgrid control system equipment and components as needed, ensuring the continued efficiency and reliability of the system over time.

3.17.6 Access to MCS Equipment

Provide clear guidelines and procedures for authorized personnel to access microgrid control system equipment for maintenance, inspection, and repairs. Security measures and access control must be implemented to safeguard sensitive equipment.

3.17.7 Records, Logs, Progress Reports

Maintain detailed records, logs, and progress reports throughout the construction and testing phases, documenting work activities, test results, and project milestones. These records must be included in the O&M Instructions.

3.17.8 Periodic Maintenance and Inspection

Outline requirements for periodic maintenance and inspection of the microgrid control system to ensure its ongoing functionality and reliability. Comprehensive O&M Instructions must be compiled to guide facility personnel in these tasks.

3.17.9 Preventive Maintenance Requirements

****

NOTE: If the contractor will not be responsible for Preventive Maintenance keep only the bracketed text requiring a plan "detailing" preventive maintenance (note this may include software maintenance as well as hardware maintenance). Otherwise remove "[detailing]" and keep the other bracketed text.

Delete the requirement for written requests to reschedule maintenance if not required by the project site.

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[Perform maintenance procedures as described below, or more often if required by the equipment manufacturer.] [Prepare a Preventive Maintenance Work Plan included in the Operations and Maintenance submittal as specified.]

3.17.9.1 Preventive Maintenance Work Plan

Prepare a Preventive Maintenance Work Plan [to schedule] [detailing] all required preventive maintenance. Obtain Government approval of the Work Plan as specified in paragraph PROJECT SEQUENCING.[Strictly adhere to the approved work plan to facilitate Government verification of work.][If it is necessary to reschedule maintenance, make a written request to the Government detailing the reasons for the proposed change at least five days prior to the originally scheduled date. Scheduled dates will be changed only with the prior written approval of the Government.]

[3.17.9.2 Semiannual Maintenance

****

NOTE: Coordinate with the project site to determine whether or not to include the requirements for Semiannual Maintenance. See also above notes regarding maintenance of Government furnished

equipment and access requirements.
****

Perform the following Semiannual Maintenance as specified:

a. Perform data backups on all Server Hardware.

b. Run system diagnostics and correct diagnosed problems.

c. Perform fan checks and filter changes for MCS hardware.

d. Perform all necessary adjustments on printers.

e. Resolve all outstanding problems.

f. Install new ribbons, ink cartridges and toner cartridges into printers, and ensure that there is at least one spare ribbon or cartridge located at each printer.

][3.17.9.3 Maintenance Procedures

****
NOTE: Coordinate with the project site to determine whether or not to include the Maintenance Procedures requirement (in whole or in part). See also above notes regarding maintenance of Government furnished equipment and access requirements.

Select whether notice must be given for maintenance that will result in downtime (off-line) or for any maintenance that MAY result in downtime. A selection of 'will' is recommended unless the project site requests otherwise.

Select appropriate down-times and notice times.
****

3.17.9.3.1 Maintenance Coordination

Coordinate any scheduled maintenance event that [will][may] result in component downtime with the Government as follows, where time periods are measured as actual elapsed time from beginning of equipment off-line period, including working and non-working hours:

a. For non-redundant computer server hardware, provide [14] [_____] days notice, components must be off-line for no more than [8] [_____] hours.

b. For non-redundant computer workstation hardware, provide [7] [_____] days notice, components must be off-line for no more than [8] [_____] hours.

c. for redundant computer server hardware, provide [7] [_____] days notice, components must be off-line for no more than [36] [_____] hours.

d. For redundant computer workstation hardware, provide [4] [_____] days notice, components must be off-line for no more than [48] [_____] hours.

e. For active (powered) control hardware, provide [14] [_____] days notice, components must be off-line for no more than [6] [_____] hours.

f. For cabling and other passive network hardware, provide [21] [_____] days notice, components must be off-line for no more than [12] [_____] hours.

3.17.9.3.2 Software/Firmware

Software/firmware maintenance includes [____] [operating systems,]application programs, and files required for the proper operation of the MCS regardless of storage medium. User (project site) developed software is not covered by this contract, except that the MCS software/firmware must be maintained to allow user creation, modification, deletion, and proper execution of such user-developed software as specified. Perform diagnostics and corrective reprogramming as required to maintain total MCS operations as specified. Back up software before performing any computer hardware and software maintenance. Do not modify any parameters without approval from the Government. Properly document any approved changes and additions, and update the appropriate manuals.

[3.17.9.3.3 Network

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NOTE: Network maintenance should only be required for Contractor furnished networks. If using a Government furnished network delete the requirement.

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Network maintenance includes testing transmission media and equipment to verify signal levels, system data rates, errors and overall system performance.

]]3.17.10 Service Call Reception

Establish procedures for receiving and processing service calls related to the microgrid control system. These procedures must ensure timely response to service requests and efficient troubleshooting.

3.17.11 Service Call Work Warranty

The contractor must provide a warranty for service call work performed on the microgrid control system. The terms and conditions of this warranty must be detailed in the contract documents.

3.17.12 Warranties and Guarantees

Provide a warranty for service including service call availability to support work performed on the microgrid control system. The terms and conditions of this warranty must be detailed in the contract documents. Work is to be warrantied for a period of 1 year from on-site startup and must perform repairs to the system at no cost to the Government during this period. Include a copy of the warranty for service in the O&M Instructions.

3.18 EMERGENCY RESPONSE PLAN

Develop and submit an Emergency Response Plan that outlines procedures for responding to critical situations and ensuring the safety and reliability of the microgrid control system in emergencies. This plan must be integrated into the O&M Instructions. The emergency response plan must include procedures and responsibilities in the event of a system failure, natural disasters, or other emergencies.

3.19 TROUBLESHOOTING AND DIAGNOSTICS

Provide a comprehensive guide for troubleshooting and diagnosing issues related to the microgrid control system. Include general and specific troubleshooting procedures and incorporate into the O&M Instructions.

3.20 AS-BUILT DOCUMENTS

Prepare thorough as-built documents, submitted at the draft phas as Draft As-Built documents prior to construction, and as Final As-Built Documents included in the O&M package. The as-built documentation must provide a comprehensive record of the final installation, including precise locations of all components, wiring diagrams, cable routing, control/ladder logic, and all final as-built drawings. For each piece of equipment, include detailed specifications, manufacturer information, and relevant certification documents. This information ensures clarity during future maintenance or upgrades. The as-built documents must incorporate records of all testing and inspection activities performed during the installation and commissioning phases. For systems with software components, the as-built documentation must include detailed configurations, settings, and any custom Programming Software or Configuration Software developed or implemented. This ensures that software can be effectively maintained and updated.

3.21 ON-GOING MAINTENANCE MATERIALS

Provide any additional materials necessary to support the long-term operation and maintenance of the microgrid control system. Supply a list of recommended spare parts for the system. This list must encompass critical components, ensuring rapid replacement when necessary. Outline the availability of technical support services, including emergency contact information and response times. Procedures for acquiring and installing software and firmware updates for the microgrid control system must be provided, including recommendations for testing and implementing updates. Include the On-Going Maintenance Materials in the O&M Instructions.

3.22 PORTALS, CLOSED, OR TRANSFERRED TO GOVERNMENT

This section defines the process for closing or transferring access portals or control systems to government control. Close unneeded access portals to the microgrid control system, which may include disabling user accounts, revoking privileges, and securing the system against unauthorized access. When transferring ownership to the government, include the transfer of credentials, access control, and administrative responsibilities.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 41 00 (August 2023)**

Preparing Activity: NAVFAC

Superseding
UFGS-26 41 00 (November 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 26 41 00

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08/23

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NOTE: This guide specification covers the requirements for lightning protection systems for non-ordnance facilities. Modify this guide specification as needed to address unique requirements for ordnance-related facilities. Follow requirements in UFC 3-575-01, "Lightning and Static Electricity Protection Systems" and contact the service-specific ordnance organization for guidance.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Show the following information on the project drawings:

1. Location and height of air terminals.
2. Location of down conductors, including locations where down conductors are subject to physical damage and require additional protection.
3. Location of ground rods.

4. Location of ground ring electrodes or alternate methods for grounding electrodes (if any).
5. Location of test wells.
6. Fence and gate bonding details.
7. For additions to lightning protection systems on existing facilities, show locations of tie-in points.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

U.S. AIR FORCE (USAF)

DAFMAN 32-1065	(2020) Grounding and Electrical Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-575-01	(2012; with Change 1, 2021) Lightning and Static Electricity Protection Systems

UL SOLUTIONS (UL)

UL 96	(2016; May 2023) UL Standard for Safety Lightning Protection Components
UL 96A	(2023) UL Standard for Safety Installation Requirements for Lightning Protection Systems
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL Electrical Construction	(2012) Electrical Construction Equipment Directory

1.2 RELATED REQUIREMENTS

1.2.1 Verification of Dimensions

Confirm all details of work, verify all dimensions in field, and advise Contracting Officer of any discrepancy before performing work. Obtain prior approval of Contracting Officer after engineering approval and before making any departures from the design.

1.2.2 System Requirements

****

NOTE: This specification is based on compliance with NFPA 780 as specified in UFC 3-575-01, "Lightning and Static Electricity Protection Systems."

NFPA 780 requires surge protective devices (SPDs) at all service entrances as part of a lightning protection system. Include Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM to specify SPD requirements.

****

Provide a system furnished under this specification consisting of the latest products of a manufacturer regularly engaged in production of lightning protection system components. Products must be UL listed for use on lightning protection systems unless this rating does not exist for items in question.

Comply with NFPA 70, NFPA 780, UL 96, and UFC 3-575-01.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

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NOTE: Modify submittals paragraphs to ensure that an appropriate submittal is required for each item in the project.

****

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NOTE: For the Air Force, modify Division 1 paragraphs to require submission of lightning protection shop drawings, test reports and certificates to the Base Civil Engineer and to the Designer of Record via the Contracting Officer for approval. The Base Civil Engineer retains final site approval authority.

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SD-06 Test Reports

Lightning Protection and Grounding System Test Plan; G, [_____]

Grounding Systems Testing; G, [_____]

SD-07 Certificates

Component UL Listed and Labeled; G, [_____]

Lightning Protection System Inspection Certificate; G, [_____]

Roof Manufacturer's Warranty; G, [_____]

1.4 QUALITY ASSURANCE

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" or "must" has been substituted for "should," wherever it appears. Interpret references that require LPS expertise in these standards to mean Base Civil Engineer (BCE) or BCE-designated representative with LPS training certification.

1.4.1 Component UL Listed and Labeled

Submit proof of compliance that components are UL Listed and Labeled for use on lightning protection systems. Listing alone in UL Electrical Construction, which is the UL Electrical Construction Directory, is not acceptable evidence. In lieu of Listed and Labeled, submit written certificate from an approved, nationally-recognized testing organization equipped to perform such services, stating that items have been tested and conform to requirements and testing methods of Underwriters Laboratories (UL).

1.4.2 Lightning Protection and Grounding System Test Plan

Provide lightning protection system and grounding system test plans in compliance with NFPA 780[and DAFMAN 32-1065 chapters 8 and 10, and Attachment 7].[Identify (by number or letter, at the preference of the base - 1.2.3. or a.b.c.) the system test points/locations along with a listing or description of the item to be tested and the type of test to be conducted.][DAFMAN 32-1065, Attachment 7, contains a Sample Visual Inspection Form (Figure A7.6) and a Sample 24-month Resistance/Continuity Test/Visual Inspection of LPS and Grounding System (Figure A7.7). Substitute-Forms may be used, but those forms created or substituted by the base must include the same contents and information as the samples provided in Attachment 7, Figures A7.6 and A7.7.] As a minimum, include a sketch of the facility and surrounding lightning protection system as part of the specific test plan for each structure. Include the requirements as "Testing of [Integral][Catenary][Mast] Lightning Protection System" in the test plan. For explosives facilities, the rolling sphere must be superimposed in elevation drawings, on all three of these types of lightning protection systems for installations with a high strike density as indicated in the NOAA Strike Density Maps. This may be accomplished by Computer Aided Design (CAD). Integral systems are discouraged on explosives and communications facilities because it has the potential to bring lightning closer to what is being protected. For explosives facilities, record drawings with materials description (wire size, air terminal material, etc.) is required by the base Weapons Safety Office. Testing of Surge Protective Devices must comply with UL 1449 and annual inspection of Surge Protective Devices should be included on Figures A7.6 and A7.7.

1.4.3 Lightning Protection System Inspection Certificate of Qualifications

Provide an approved third-party inspector who meets training certification requirements for final acceptance of the LPS. Inspection and certification of the LPS must be completed and certified in writing, before occupancy of the building. Compliance requirements are in UFC 3-575-01[and DAFMAN 32-1065, paragraphs 4.2 and 4.3]. Signed Certificate of Qualifications must be placed in the LPS records.

[Optional certification (also described in UFC 3-575-01 and DAFMAN 32-1065): If available, base may provide LPS third-party qualified personnel via BCE-designated base individual who 1) routinely maintains and tests the lightning protection system and 2) has had advanced training, with a Certificate or Qualification signed and provided by the trainer, for LPS records. This option removes the requirement for a project-included third-party inspector to certify the LPS prior to LPS system acceptance.

] Note that the Contracting Officer may not accept the LPS system without a recommendation from a qualified person identified in the project documents.

1.5 SITE CONDITIONS

Confirm all details of work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before starting any work, if known at that time, or when it becomes known while performing work. Obtain prior approval of the BCE or BCE-designated representative with LPS training certification before design changes are made.

PART 2 PRODUCTS

2.1 MATERIALS

See NFPA 70, NFPA 780, UFC 3-575-01[, DAFMAN 32-1065]. Do not use a combination of materials that forms an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, provide conductors with protective coatings, such as tin or lead, or oversize conductors. Where a mechanical hazard is involved, increase conductor size to compensate for the hazard or protect conductors. When metallic conduit or tubing is provided, electrically bond conductor to conduit or tubing at the upper and lower ends by clamp type connectors or welds (including exothermic). All lightning protection components, such as bonding plates, air terminals, air terminal supports and braces, chimney bands, clips, connector fittings, and fasteners are to comply with the requirements of UL 96 classes, as applicable.

2.1.1 Main and Bonding Conductors

****

NOTE: NFPA 780 - Class I are ordinary building 23 m 75 ft or less in height and Class II are ordinary buildings over 23 m 75 ft in height.

****

Main and Bonding Conductors should be NFPA 780 and UL 96 Class I or Class II materials, as applicable. For explosives, Class II materials are in accordance with NFPA 780, Chapter 8.

2.1.2 Conductors

Provide copper or aluminum conductors, as applicable. See NFPA 780, UFC 3-575-01[, DAFMAN 32-1065].

2.2 COMPONENTS

2.2.1 Air Terminals on Integral Systems

Provide solid air terminals. Tubular air terminals are not permitted. Support air terminals more than 600 mm 24 inches in length by suitable brace, supported at not less than one-half the height of the terminal.

2.2.2 Ground Rods

****

NOTE: The designer will determine the type and number of ground rods to be used based on local conditions and earth resistivity data. NFPA 780 allows copper-clad steel, solid copper, or stainless steel ground rods for multiple ground rod applications.

Specify copper clad steel rods for normal conditions. The use of other materials such as galvanized coated steel will require written authorization in accordance with the MIL-STD-3007F, Paragraph 5.1.7, "Waivers and Exemptions."

In high resistivity soils, 3000 mm 10 foot sectional rods may be used to obtain the required resistance to ground; however, where rock is encountered, additional rods, a ground ring electrode, or ground grid may be necessary. Coordinate and standardize rod selection for individual facilities with other specification sections.

****

Provide ground rods conforming to NFPA 780. Provide ground rods that are not less than 16 mm 5/8 inch in diameter and 2440 mm 8 feet in length. Do not mix ground rods of copper-clad steel and solid copper on the job.

2.2.3 Connections and Terminations

Provide connectors for splicing conductors that conform to UL 96, class as applicable. Conductor connections can be made by compression clamps or welds (including exothermic). Provide style and size connectors required for the installation.

2.2.4 Connector Fittings

Provide connector fittings for "end-to-end", "Tee", or "Y" splices that conform to NFPA 780 and UL 96.

PART 3 EXECUTION

3.1 LIGHTNING PROTECTION SYSTEMS

****

NOTE: This specification is based on compliance with NFPA 780 as specified in UFC 3-575-01, "Lightning and Static Electricity Protection Systems."

****

Provide a lightning protection system that meets the requirements of NFPA 780 and UFC 3-575-01.

3.1.1 Integral Lightning Protection System

The integral type lightning protection system consists of air terminals, roof conductors, down conductors, ground connections, grounding electrodes and ground ring electrode conductor for the purpose of carrying lightning current from a direct strike to ground in a manner that will protect assets and personnel. Expose all conductors on the structures except where exterior down conductors are required to be in protective sleeves for prevention of mechanical damage (1830 mm 6 feet above grade level). Integral systems are the least preferred, especially for explosives and communications facilities. When use of integral systems is determined by the designer or site conditions to be necessary, do not run down conductors inside columns or other methods which will prevent visual access for required inspections. Visual access is required by NFPA 780[and DAFMAN 32-1065] so that the annual visual inspection may be performed on all LPS components.

Make interconnections within side-flash distances between down conductors and metallic equipment mounted on the exterior or interior of a facility, at or below the level of the grounded metallic parts. Calculate side-flash distances in accordance with NFPA 780. Be aware of side flashes that may occur through exterior walls.

Note that integral systems should be avoided as LPS for Explosives and Communications facilities and is discouraged for general facilities. Installation and maintenance costs of an integral system are excessive and this method is maintenance intensive. The complexity and number of test points dictates frequent interruption to missions and daily operations for required annual inspections and testing. Integral systems require fall protection and maintenance of that fall protection system. For fall protection, maintain NFPA 780-compliant separation distance between the integral system and metallic fall protection.

3.1.1.1 Roof-Mounted Components

Coordinate with the roofing manufacturer and provide certification that the roof manufacturer's warranty is not violated by the installation methods for air terminals and roof conductors. Adhesive fasteners may be used on the roof if the installation is observed by base-qualified personnel to be compliant with manufacturer's instructions. Installation must be observed until the observer is satisfied that the proper methods for preparing the surface are being performed. These fasteners will be added and considered a test point in Base records and must be part of the annual inspection. Observer must date and sign the test record.

No connection or physical attachment is allowed to any coping system on the roof as this violates the integrity and warranty of the coping system.

3.1.1.2 Air Terminals

Use of adhesive fasteners, when installing air terminals on "rubber" (EPDM) type roofs, should be in accordance with adhesive and roof manufactures’ recommendations. See paragraph ROOF-MOUNTED COMPONENTS.

3.1.1.3 Roof Conductors

Roof conductors should comply with NFPA 780[and DAFMAN 32-1065].

3.1.2 Catenary Lightning Protection System

A catenary lightning protection system consists of at least two wooden poles or metallic masts with overhead wires (cross conductors). Install air terminals on wooden masts at least 254 mm 10 inches higher than the top of the wooden pole, or use steel saddles on top of the wooden pole for conductor placement if saddle is at least 152 mm 6 inches above the wooden pole. Provide at two paths to ground for an overhead ground wire (cross conductor) and down conductors, to transport the current from a direct strike to grounding electrodes that are 16 mm by 2440 mm 5/8 in. by 8 ft. The class (diameter at the top of the pole and the pole height) of wooden pole must be designed to withstand the horizontal force of the cross conductor and any ice loading it could be subject to. Metallic masts used in a catenary lighting protection system do not require air terminals, but must be rated for use on electrical distribution or transmission lines because of horizontal forces that must be considered when sizing and selecting the metallic mast manufacturer. Consider resonant frequency in the design, if applicable, and use appropriate damping designed by the mast manufacturer. A rolling sphere proof of protection is a required submittal that must be approved prior to sizing or ordering the masts. This system shall comply with NFPA 780. Note that for randomly-shaped facilities (non-rectangular facilities), a catenary system is not required to be symmetrical. To maintain symmetry on the widest part of the building, the overhead ground wire (cross conductor) length sometimes drives the height of the masts by several sizes to compensate for added weight of the cross conductor and the fact that it could be laden with ice during winter, in some areas of a country. This system shall comply with NFPA 780 and UFC 3-575-01[, and DAFMAN 32-1065].

3.1.3 Mast Lightning Protection System

A mast lightning protection system consists of one or more individual masts not interconnected to each other, and isolated from the building, that provide sufficient protection for the structure contents. These masts may be wooden or metallic. Wood poles (masts) require air terminals on top that are at least 254 mm 10 inches higher than the top of the mast, down conductors that provide at least two paths to ground (as close to 180 degrees apart on the pole perimeter as possible), to transport the current from a direct strike directly to grounding electrodes (ground) that are 16 mm by 2440 mm 5/8 inches by 8 feet. Metallic masts do not require air terminals and are not required be rated for use on electrical distribution or transmission lines because only vertical forces are experienced by the mast. If lights or other items are mounted on the top of the masts, guy wires and proper bonding of the guy wires are required. The base of a metallic mast should have connections to two separate ground rods, 16 mm by 2440 mm 5/8 inches by 8 feet, unless equivalent protection is provided (designed within) in the footer or some other documented manner. Paths to ground must possess a visible test point. A rolling sphere diagram showing proof of protection is a required submittal that must be approved prior to sizing or ordering the masts. This system shall comply with NFPA 780 and UFC 3-575-01[, and DAFMAN 32-1065].

A lightning protection system may consist of a mixture of these three systems, in order to limit cost of the system while still providing protection. For instance, an irregularly shaped building that uses a catenary system may use a single mast to cover an area that is just outside the zone of protection created by the catenary, as indicated by a rolling sphere diagram.

3.1.4 Down Conductors

A minimum of two paths to ground shall be provided on any system. This may be by two down conductors or with a down conductor in combination with other metallic connections to ground. Protect exposed down conductors from physical damage from ground level up to 1830 mm 6 feet. If this protection is a metal conduit, both ends must be bonded to the down conductor passing through it. For Schedule 80 conduit providing this protection, no bonding at both ends is necessary. Schedule 80 conduit or metallic conduit may be painted to match the surrounding surface. NO CONNECTIONS OR FASTENERS OF ANY LIGHTNING PROTECTION SYSTEM MAY BE PAINTED because this affects the ease with which lightning current can pass to ground.

3.1.5 Ground Connections

Attach each down conductor and ground ring electrode to a ground rod below grade by exothermic weld for all buried connections and exothermic weld or compression connectors for connections inside test wells. Terminate all down conductors to a grounding electrode inside a test well. Test connections and record resistances and continuity readings prior to covering.

Accessible connections above ground level and in test wells can be grounded with mechanical clamping, meeting installation requirements in NFPA 780.

3.1.6 Installation of Grounding Electrodes (Ground Rods)

****

NOTE: Where soil conditions indicate definitely that a ground ring electrode will not be required, all references to a ground ring electrode should be deleted from the specifications.

If required by soil conditions, select an alternate method for grounding electrodes in shallow soil. Utilize NFPA 780 or an alternate method meeting the intent of NFPA 780. Validate by calculations or historical data for site conditions. Modify the wording below as necessary to specify the system design.

****

Extend driven ground rods vertically into the existing undisturbed earth for a distance of not-less-than 2400 mm 8 feet if exothermic welds are used for bonds. Inside test wells, the 16 mm by 2400 mm 5/8 in. by 8 ft rod may be driven to a point above the base of the test well, that will provide working/testing access to the mechanically-fastened bond. Set ground rods not less than 915 mm 3 feet nor more than 1830 mm 6 feet (see NFPA 780) from the structural foundation, and at least 915 mm 3 feet beyond the drip line for the facility. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE 81. Maximum allowed resistance of a single driven ground rod is 25 ohms (NFPA 70). If resistance-to-ground of a single ground rod for the lightning protection system exceeds 25 ohms and another ground rod is driven in accordance with NFPA 780, 25 ohms does not apply to this test point. See

NFPA 70 exception to Article 250.53.

[For explosives facilities: For a ground ring electrode, provide continuous No. 1/0 (minimum) bare stranded copper cable (NFPA 780-2023, Chapter 8, *Explosives Facilities*).

]3.2 APPLICATIONS

3.2.1 Personnel Ramps and Covered Passageways

****

NOTE: Personnel ramps and covered passageways that are in the zone of protection of a lightning protection system, as defined by NFPA 780, do not need additional lightning protection. Protect personnel ramps and covered passageways that are outside the zone of protection with lightning protection conforming to the requirements for buildings of similar construction.

****

Lightning Protection is required in accordance with NFPA 780 and UFC 3-575-01.

3.3 INTERFACE WITH OTHER STRUCTURES

3.3.1 Fences

****

NOTE: Coordinate with Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION for additional electrical distribution system requirements. Coordinate with Section 32 31 13 CHAIN LINK FENCES AND GATES for fence grounding requirements.

****

Bond metal fence and gate systems to the lightning protection system at the point where the fence, any fence post, or gate is within 1830 mm 6 feet of any part of the lightning protection system (usually a down conductor) in accordance with ANSI C2 and NFPA 780 and UFC 3-575-01.

3.4 RESTORATION

Where sod has been removed, replace sod as soon as possible after completing the backfilling. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work, to original condition. Overfill the trench to accommodate for settling. Include necessary topsoil, fertilizing, liming, seeding, sodding, sprigging or mulching in any restoration, to match existing. Maintain disturbed surfaces and replacements until final acceptance. Return to site after six months to fill in compacted surface.

3.5 FIELD QUALITY CONTROL

3.5.1 Lightning Protection Systems Testing

A 100 percent test point test and inspection is required by all services. Identify test points for lightning protection system connections and bonds. Provide a sketch (NTS) with identified test points as part of the contract acceptance. Number points in a manner consistent with the installation (Base or Post) nomenclature for existing lightning protection systems; for example, use letters or numbers to track the test results. Test each lightning protection system connection to ensure continuity across each connection or bond is 1 ohm or less, and record the value indicated on a copy of the test form located at the back of DAFMAN 32-1065, Attachment 7.

a. LPS testing must also be accomplished on smaller projects, such as roofing and HVAC projects, where lightning protection systems are installed on any facility with existing LPS, to ensure the LPS is not damaged or reconfigured during construction.

b. Comply with UL 96A. A third-party inspector (not the designer and not the installer) must be present for the 100 percent inspection and data documentation by the contractor. This is to take place prior to project acceptance. Note that in many cases Air Force personnel have been trained to inspect and accept projects as the third-party inspector. Verify this before contract award.

3.5.2 Grounding Systems Testing

****

NOTE: Use 25 ohms unless the specific facility, such as a telecommunications facility, requires a lower value.

****

A 100 percent test point resistance test and inspection is required. Identify all test points for grounding system connections and bonds. Provide a sketch (NTS) with identified test points as part of the contract acceptance. Number points in a manner consistent with the installation (Base or Post) nomenclature for existing grounding systems; for example, use letters or numbers to track the test results. Test each grounding system connection or bond to ensure resistance-to-ground is 25 ohms or less or as excepted by NFPA 70 or NFPA 780. Record the resistance measurement on a copy of the test form located at the back of DAFMAN 32-1065 for Air Force or a similar form provided by the Army or Navy. Test the ground rod for resistance to ground before making connections to the rod. Tie the grounding system together and test for resistance to ground. Make resistance measurements in dry weather, and not earlier than 48 hours after rainfall. Include in the written report: locations of test points, measured values for continuity and ground resistances, and soil conditions at the time that measurements were made. Submit results of each test to the Contracting Officer.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 42 13 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-26 42 13 00 20 (April 2006)
UFGS-26 42 14 00 10 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 42 13

GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM

05/21

PART 1 GENERAL

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 42 13 (May 2021)**

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Preparing Activity: USACE **Superseding**
UFGS-26 42 13 00 20 (April 2006)
UFGS-26 42 14 00 10 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 42 13

GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM

05/21

****

NOTE: This guide specification covers the requirements for a cathodic protection system utilizing continuous flow direct current from galvanic anodes.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and must be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: The requirements for the cathodic protection systems must be determined by a corrosion engineer following the criteria, design, and installation recommendations included in the National Association of Corrosion Engineers (NACE) Standard SP0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems and others listed in the specification.

****

****

NOTE: This specification covers a cathodic protection system for metal surfaces against corrosion by producing a continuous flow of direct current from sacrificial anodes to the metal to be protected. The anodes must be of sufficient size and quantity to protect the buried metal items for a specified number of years before replacement. The U.S. Department of Transportation has issued regulations requiring the application of cathodic protection to natural gas pipelines, liquid natural gas pipelines, petroleum pipelines, petroleum products pipelines, liquid petroleum gas pipelines, and petroleum storage facilities. Title 49 of the Code of Federal Regulations, Parts 191, 192, 193 and 195 must be consulted for applicable cathodic protection requirements for specific applications.

****

****

NOTE: The following information must be on the drawings:

1. Location of all underground pipes and structures.

2. Locations of all anodes and test stations.

3. Locations of all flanges and unions.

4. Installation details for anodes and test stations.

5. Location of equipment.

6. Single-line diagrams elevations, limiting dimensions, and equipment ratings which are not covered in the specification.

7. Remote indicating or control requirements.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B3	(2013; R 2024) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B418	(2016a; R2021) Standard Specification for Cast and Wrought Galvanic Zinc Anodes
ASTM B843	(2018) Standard Specification for Magnesium Alloy Anodes for Cathodic

	Protection
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D2028/D2028M	(2015; R 2021) Cutback Asphalt (Rapid-Curing Type)
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction
ASTM F1182	(2007; R 2023) Anodes, Sacrificial Zinc Alloy

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 15589-2	(2012) Petroleum, Petrochemical and Natural Gas Industries - Cathodic Protection of Pipeline Transportation Systems - Part 2: Offshore Pipelines

NACE INTERNATIONAL (NACE)

NACE SP0106	(2018) Control of Internal Corrosion in Steel Pipelines and Piping Systems
NACE SP0176	(2007) Corrosion Control of Submerged Areas of Permanently Installed Steel Offshore Structures Associated with Petroleum Production
NACE SP0177	(2019) Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
NACE SP0186	(1986; R 2007) Application of Cathodic Protection for External Surfaces of Steel Well Casings
NACE SP0188	(2024) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE SP0193	(2016) Application of Cathodic Protection to Control External Corrosion of Carbon Steel On-Grade Storage Tank Bottoms
NACE SP0196	(2020) Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks

NACE SP0200	(2014) Standard Practice Steel-Cased Pipeline Practices
NACE SP0285	(2021) External Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
NACE SP0286	(1997; R 2007) Standard Practice Electrical Isolation of Cathodically Protected Pipelines
NACE SP0388	(2018) Impressed Current Cathodic Protection of Internal Submerged Surfaces of Carbon Steel Water Storage Tanks - Item No. 21040
NACE SP0607	(2007) Petroleum and Natural Gas Industries — Cathodic Protection of Pipeline Transportation Systems — Part 2: Offshore Pipelines
NACE SP21424	(2018) Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation and Monitoring
NACE TPC 11	(2008) A Guide to the Organization of Underground Corrosion-Control Coordinating Committees

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA RN 1	(2018) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-18001	(1993) Anodes, Sacrificial Zinc Alloy
MIL-I-1361	(1985; Rev C; Notice 1 1991; Notice 2 2021) Instrument Auxiliaries, Electrical Measuring: Shunts, Resistors and Transformers

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2024) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings

1.2 DEFINITIONS

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Cathodic Protection is a method used to control corrosion.

1.2.1 Cathodic Protection

Cathodic Protection (CP) is an electrochemical (half electrical and half chemical) method used to control corrosion of buried or submerged metallic structures. It prevents corrosion by making the protected structure a cathode by installing a more anodic metal (sacrificial or galvanic) anode or a metallic (impressed current) anode connected to a Direct Current (DC) power source. When the proper amount of current is applied to the structure, it becomes a cathode. Since all corrosion occurs at the anode, the structure no longer corrodes. The electrons move in the metallic path (electrical). Reduction (chemical) reactions occur at the surface of the cathode resulting in a hydrogen coating and more alkaline environment. Oxidation (chemical) reactions occur at the surface of the anode resulting in corrosion and a more acidic environment. After a CP system is installed and adjusted to provide adequate protection, the hydrogen coats the defects in the coating and polarizes in the negative direction (to a copper/copper sulfate reference electrode) over time the current and potentials remain relatively stable; changes in currents or potentials indicate a problem. An error-free measurement of negative 850 millivolts DC or more negative to the copper/copper-sulfate reference electrode proves the structure is a cathode and corrosion has been mitigated.

1.2.2 Corrosion

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Some of the eight forms of corrosion are unique, but all of them are more or less interrelated.

The eight forms of corrosion are: (1) Uniform Attack, (2) Galvanic or Two-Metal Corrosion, (3) Crevice Corrosion, (4) Pitting Corrosion, (5) Intergranular Corrosion, (6) Selective Leaching, (7) Erosion Corrosion, and (8) Stress Corrosion Cracking. This listing is arbitrary but covers practically all corrosion failures and problems. The forms are not listed in any particular order of importance. Below, the eight forms of corrosion are discussed in terms of their characteristics, mechanisms, and preventive measures. Hydrogen damage, although not a form of corrosion, often occurs indirectly as a result of corrosive attack and is, therefore, included in this discussion.

1.2.3 Alternating Current (AC) Corrosion

AC corrosion occurs when there is a source of AC current, typically from a high voltage overhead AC (OHAC) power-line, when there is a low soil resistivity - typically less than 5,000 ohm-cm and there is a very small coating holidays. The AC corrosion pits typically have a tubercle of corrosion product at the pit. AC interference study modeling software can determine the mitigation solution to solve this problem. Typically, AC Corrosion mitigation is done in conjunction with high AC potentials and fault current mitigation.

1.2.4 AC Interference

AC interference occurs when a pipeline parallels a high-voltage overhead AC (OHAC) power-line. An interference study is required when this situation occurs as AC interference can cause high AC potentials along the pipeline (safety), can cause a fault condition between the pipeline and power-line and could cause AC corrosion to occur. The pipeline coating when exposed can have blisters/bubbles caused by the excessive AC. The interference study will use modeling software to determine what combination of interference may be occurring (if any) and provide the mitigation solution to solve the problem.

1.2.5 Uniform Attack

Uniform attack is the most common form of corrosion. It is normally characterized by a chemical or electrochemical reaction that proceeds uniformly over the entire exposed surface or over a large area. The metal becomes thinner and eventually fails. For example, a piece of steel or zinc immersed in dilute sulfuric acid normally dissolves at a uniform rate over its entire surface. A sheet iron roof shows essentially the same degree of rusting over its entire outside surface.

Uniform attack, or general overall corrosion, represents the greatest destruction of metal on a tonnage basis. This form of corrosion, however, is not of great concern from a technical standpoint, because the life of equipment can be accurately estimated on the basis of comparatively simple tests. Merely immersing specimens in the fluid involved is often sufficient. Uniform attack can be prevented or reduced by (1) materials, such as coatings, that reduce contact between metal and electrolytes, (2) inhibitors, or (3) CP.

1.2.6 Galvanic or Two-Metal Corrosion

A potential difference usually exists between two dissimilar-metals when they are immersed in a corrosive or conductive solution. If these metals are placed in contact (or otherwise electrically connected), this potential difference produces electron flow between them. Corrosion of the less corrosion-resistant metal is usually increased, and attack of the more resistant material is decreased, compared to the behavior of these metals when they are not in contact. The less resistant metal becomes anodic and the more resistant metal becomes cathodic. Usually the cathode or cathodic metal corrodes very little or not at all in this type of couple. Because of the electric currents and dissimilar-metals involved, this form of corrosion is called galvanic, bi-metallic or two-metal, corrosion. Galvanic corrosion is restricted to electrochemical corrosion caused by dissimilar-metal effects. It is electrochemical corrosion, but this document must restrict the term galvanic to dissimilar-metal effects for purposes of clarity.

1.2.7 Crevice Corrosion

Intense localized corrosion frequently occurs within crevices and other shielded areas on metal surfaces exposed to corrosives. This type of attack is usually associated with small volumes of stagnant solution caused by holes, gasket surfaces, lap joints, surface deposits, and crevices under bolt and rivet heads. As a result, this form of corrosion is called crevice corrosion or, sometimes, deposit or gasket corrosion.

1.2.8 Pitting Corrosion

Pitting is a form of extremely localized attack that results in holes in the metal. These holes may be small or large in diameter, but in most cases they are relatively small. Pits are sometimes isolated or so close together that they look like a rough surface. Generally a pit may be described as a cavity or hole with the surface diameter about the same as or less than the depth. Pitting is one of the most destructive and insidious forms of corrosion. It causes equipment to fail because of perforation with only a small percent weight loss of the entire structure. It is often difficult to detect pits because of their small size and because the pits are often covered with corrosion products. In addition, it is difficult to measure quantitatively and compare the extent of pitting because of the varying depths and numbers of pits that may occur under identical conditions. Pitting is also difficult to predict by laboratory tests. Sometimes the pits require a long time (several months or a year) to show up in actual service. Pitting is particularly vicious because it is a localized and intense form of corrosion, and failures often occur with extreme suddenness.

1.2.9 Intergranular Corrosion

Grain boundary effects are of little or no consequence in most applications or uses of metals. If a metal corrodes, uniform attack results since grain boundaries are usually only slightly more reactive than the matrix. However, under certain conditions, grain interfaces are very reactive and intergranular corrosion results. Localized attack at and adjacent to grain boundaries, with relatively little corrosion of the grains, is intergranular corrosion. The alloy disintegrates (grains fall out) or loses its strength. Intergranular corrosion can be caused by impurities at the grain boundaries, enrichment of one of the alloying elements, or depletion of one of these elements in the grain-boundary areas. Small amounts of iron in aluminum, wherein the solubility of iron is low, have been shown to segregate in the grain boundaries and cause intergranular corrosion. It has been shown that, based on surface tension considerations, the zinc content of a brass is higher at the grain boundaries. Depletion of chromium in the grain-boundary regions results in intergranular corrosion of stainless steels.

1.2.10 Selective Leaching

Selective leaching is the removal of one element from a solid alloy by corrosion processes. The most common example is the selective removal of zinc in brass alloys (dezincification). Similar processes occur in other alloy systems in which aluminum, iron, cobalt, chromium, and other elements are removed. Selective leaching is the general term to describe these processes, and its use precludes the creation of terms such as de-aluminumification, de-cobaltification. Parting is a metallurgical term that is sometimes applied, but selective leaching is preferred.

1.2.11 Erosion Corrosion

Erosion corrosion is the acceleration or increase in rate of deterioration or attack on a metal because of relative movement between a corrosive fluid and the metal surface. Generally, this movement is quite rapid, and mechanical wear effects or abrasion are involved. Metal is removed from the surface as dissolved ions, or it forms solid corrosion products, which are mechanically swept from the metal surface. Sometimes, movement of the environment decreases corrosion, particularly when localized attack occurs under stagnant conditions; this is not erosion corrosion because deterioration is not increased. Erosion corrosion is characterized in appearance by grooves, gullies, waves, rounded holes, and valleys and usually exhibits a directional pattern. In many cases, failures because of erosion corrosion occur in a relatively short time, and they are unexpected largely because evaluation corrosion tests were run under static conditions or because the erosion effects were not considered.

1.2.12 Stress-Corrosion Cracking

Stress-corrosion cracking refers to cracking caused by the simultaneous presence of tensile stress and a specific corrosive medium. Many investigators have classified all cracking failures occurring in corrosive media as stress-corrosion cracking, including failures due to hydrogen embrittlement. However, these two types of cracking failures respond differently to environmental variables. To illustrate, CP is an effective method for preventing stress-corrosion cracking; however, hydrogen-embrittlement may be caused when excessive current is applied, especially on stainless steel. Hence, the importance of considering stress-corrosion cracking and hydrogen embrittlement as separate phenomena is obvious. During stress-corrosion cracking, the metal or alloy is virtually unattacked over most of its surface, while fine cracks progress through it. This cracking phenomenon has serious consequences, since it can occur at stresses within the range of typical design stress.

1.2.13 Exothermic Welding

Exothermic welding is used in CP to connect a copper wire to a metallic structure, usually steel or cast-iron. It is a pyrotechnic composition of copper oxide, aluminum powder and magnesium powder. The magnesium powder is ignited with a spark gun or electronic ignition equipment. The aluminum powder serves as fuel, and melts the copper oxide, which bonds the wire to the structure. Although not explosive, it can create brief bursts of heat and high temperature in a small area.

1.2.14 Error-Free

Potential measurement error due to a voltage drop caused by current flowing through a resistor (the electolyte) between the reference electrode and the protected structure.

1.3 ADMINISTRATIVE REQUIREMENTS

After award of the contract, but prior to commencement of any work at the site, meet with the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Develop a mutual understanding relative to the administration of the value engineering, the safety program, preparation of the schedule of prices or the earned value report. Review shop drawings, and other submittals, scheduling programming, execution of the work, and clear expectations of the "Interim Department of Defense (DD) Form 1354" submittal. Major subcontractors who will engage in the work must also attend.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preconstruction Survey

SD-02 Shop Drawings

Drawings; G, [_____]

Isolation flange kits

Anode junction boxes, bonding boxes, and test stations

Joint bonds

Contractor's Modifications; G, [_____]

SD-03 Product Data

Qualifications

Equipment; G, [_____]

Anodes; G, [_____]

Anode junction boxes, bonding boxes, and test stations

Dielectric unions

Wires

Cable and wire

Casings, isolation, and seals

Shunts

Permanent reference electrodes; G, [_____]

Spare Parts

SD-06 Test Reports

Tests and Measurements; G, [_____]

Contractor's Modifications; G, [_____]

SD-10 Operation and Maintenance Data

Cathodic Protection System; G, [_____]

Training Course; G, [_____]

Cathodic Protection System, Data Package 5; G, [_____]

SD-11, Closeout Submittals

Initial Cathodic Protection System Field Testing; G, [_____]

One Year Warranty Period Cathodic Protection System Field Test Report; G, [_____]

Final Cathodic Protection System Field Test Report; G, [_____]

1.4.1 Material and Equipment Manufacturer Data

DATE	ISSUE NO.	REQUEST	REQUESTED BY	REQUEST REF. NO.
MANUFACTURER NAME				
DESCRIPTION OF EQUIPMENT				

1.5 MAINTENANCE MATERIAL SUBMITTALS

1.5.1 Spare Parts

After approval of shop drawings, furnish spare parts data for each different item of material and equipment specified. The data must include a complete list of parts, special tools, and supplies, with current unit prices and source of supply.

After approval of shop drawings, furnish revised spare parts for any changes made from original submittal. One spare anode of each type must be furnished. In addition, supply information for material and equipment replacement for all other components of the complete system, including anodes, cables, splice kits and connectors, corrosion test stations, and any other components not listed above. Furnish [one reference electrode on a hand reel with 120 meters 350 feet of conductor], [one digital voltmeter that can be used in the maintenance of this CP system]. Demonstrate use of furnished equipment in actual tests during the training course. Provide a description of equipment of the pipe-to-soil protected structure and foreign structures at electrical isolation between the utility supplier and the facility piping.

1.5.2 Extra Materials

Furnish [one reference electrode on a hand reel with 120 meters 350 feet of conductor], [one high-input-impedance digital multimeter that can be used in the maintenance of this CP system]. Demonstrate use of furnished equipment in actual tests during the training course. Provide a description of equipment of the pipe-to-soil protected structure and foreign structures at electrical isolation between the utility supplier and the facility piping. Include a description of the equipment and measurement of the pipe-to-soil potentials, anode voltage, anode current and soil condition.

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

Obtain the services of a corrosion expert to supervise, inspect, and test the installation and performance of the cathodic protection system. The term "corrosion expert" refers to a person, who by thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried or submerged metallic structures.

1.6.2 Qualifications

The corrosion expert must be accredited or certified by NACE International, as a CP-4 CP Specialist or be a NACE International certified Corrosion Specialist or a registered professional engineer who has certification or licensing that includes education and experience in CP of the type of CP system being installed. The corrosion expert must have not less than [three] [five] [_____] years of experience in the type of CP for buried or submerged metallic structures under this contract. Submit evidence of qualifications of the corrosion expert including their name and qualifications certified in writing to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager prior to the start of construction. Certification must be submitted giving the name of the firm, the number of years of experience, and a list of not less than five of the firm's installations, three or more years old, that have been tested and found satisfactory.

1.6.3 Services of Corrosion Expert

The "corrosion expert" must make a minimum of three visits to the project site. The first of these visits will include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the contractor the type of CP required (GACP or ICCP). Once the submittals are approved and the materials delivered, the "corrosion expert" will revisit the site to verify the materials meet submittal requirements, ensure the contractor understands installation practices and that the contractor is capable and qualified to complete the installation.

The "corrosion expert" will be available (but not necessarily be onsite the entire time) during the installation of the CP system to answer questions, approve any changes or additions required during construction, or to provide recommendations as required. The third visit is to complete the training and demonstrations to applicable personnel on proper testing and maintenance techniques and to complete testing the installed CP systems to ensure it has been installed properly and meets adequate CP criteria. An additional visit is required if the One-Year-Warranty-Period-Testing is required.

1.7 DELIVERY, STORAGE AND HANDLING

Storage area for corrosion materials will be designated by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. If materials are not stored in a building, tarps or similar protection must be used to protect material from inclement weather. Resack and add backfill to packaged anodes that are damaged as a result of improper handling or exposure to rain.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

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NOTE: The environmental requirements with which the contractor must comply must be developed during the design process, included in the bidding documents, and made a part of the contract.

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1.8.2 Existing Conditions

Prior to start of any onsite construction activities, perform a Preconstruction Survey of the project site with the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager, and take photographs showing existing environmental conditions in and adjacent to the site. Submit a report for the record. Include in the report a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the contractor's assigned storage area and access route(s), as applicable. The Contractor and the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager will sign this survey report upon mutual agreement regarding its accuracy and completeness. Protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference that their preservation may cause to the work under the Contract.

1.9 WARRANTY

Provide equipment items that are supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Corrosion Control System Description

A corrosion control system consists of several systems which work together to mitigate corrosion on buried or submerged metallic structures. Failure to comply with the requirements of any one of these systems may result in inadequate corrosion control and premature failure of the structure being protected. Each system's guide specifications must be included in the design and installation of a complete corrosion control system and must be adhered to in the design and execution of the corrosion control of a structure being protected. Determination of Need for CP must be made by government requirements and policy directives.

a. Construction Design Requirements (CDR) for protected structures are found in the UFGS for the structure being protected. For water storage tanks refer to Section 33 16 15 WATER STORAGE STEEL TANKS, NACE SP0388, and NACE SP0196, underground storage tanks NACE SP0285, aboveground storage NACE SP0193, fuel storage piping Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT), aviation fuel piping Section 33 52 43.13 AVIATION FUEL PIPING, leak detection systems Section 33 01 50.31 LEAK DETECTION FOR FUELING SYSTEMS, offshore pipelines NACE SP0607 and ISO 15589-2, offshore structures and NACE SP0176, pipeline casings structures (railroad, highway and water crossing) NACE SP0200 and for well casings NACE SP0186.

b. Coating Systems (CS) are a critical factor in performance of a GACP system. All coatings, including coatings in structure guide specifications and Green Seal (GS) coatings, must be compatible with the structure and the CP system, and have high disbondment capabilities. A high resistance to cathodic disbondment is critical for long term service life of coatings on buried or submerged metallic structures under CP. For paints and coatings refer to Section 09 90 00 PAINTS AND COATINGS, and for discontinuity (Holiday) testing of new protective coatings on conductive substrates refer to NACE SP0188.

c. Mechanical Damage Systems (MDS) such as bedding and rock control barriers normally included in Structure GS may be required by design for some locations. Electrical Isolation is required for all galvanic anode CP systems. For an Electrical Isolation System (EIS) refer to NACE SP0286.

d. An Electrical Continuity System (ECS) of the protected structure is critical to the operation of the CP system. The types of joints such as bonding and couplings are normally included in Structure GS, this is particularly important to nonwelded pipelines to allow sufficient CP current to conduct to the entire structure.

e. Stray Current (Interference) Systems must be considered in design, monitored during construction, and interference testing must be completed during the final testing. Design must consider all other cathodic protection systems which may affect other systems or systems which may affect the project, including foreign systems. All foreign systems must be contacted for information and notification and any joint testing which may be required. Corrosion Coordinating Committees may exist. Reference NACE TPC 11.

f. Pipelines that parallel overhead high voltage AC transmission power systems are subject to induced AC. Induced AC has several potential adverse impacts on the safety of personnel and pipeline integrity. Assuming that these conditions exist, there are several measures that can be taken to mitigate the induced AC present on a pipeline. These induced AC mitigation strategies are detailed in various international standards including NACE SP0177.

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NOTE: Any AC test voltage over 15 AC must be mitigated.

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g. Galvanic Anode CP Monitoring System is a solution for remote monitoring (and optionally controlling) different kinds of galvanic anode CP applications, mainly to protect underground pipelines used in oil and gas distribution systems, but the same system can be used to monitor other galvanic anode CP applications like tank farms and oil platforms. These Monitoring Systems are detailed in various international standards including NACE TPC 11.

h. When a project is connecting to an existing infrastructure with CP the design must be compatible with the existing structure(s) CP system. Existing structures may have Impressed Current CP (ICCP) Anode Systems using Remote Anode Systems, Deep Anode Systems, Linear Anode Systems, or Distributed Anode Systems. Existing structures may also have Galvanic CP (GACP) Systems which may be distributed or remote. Existing structures might not have CP. They may use alternative methods of corrosion mitigation instead of CP such as Inhibitor System/Internal Corrosion Control. For control of internal corrosion in steel pipelines and piping systems refer to NACE SP0106. Due to the limited voltage and current of galvanic anodes the protected structure must be coated and isolated from other structures.

i. A highly dielectric bonded coating is required to attain adequate CP. Unbonded coatings block the protective current from the pipeline or structure and must not be used with CP. Failure to isolate other metallic structures will result in loss of protection. Isolation from other metallic structures must be maintained.

j. Continuity of the structure with low resistance is crucial to proper operation of a galvanic anode system. All joints must be continuous or be bonded to both sides of the joint.

k. A conductive electrolyte is required to allow current flow from the galvanic anodes. Use of galvanic anode systems are normally restricted to electrolytes with resistivities below 30,000 ohm-cm. Small well coated structures such as coated valves, tees and elbows have very high resistance to earth in high resistance soils. Galvanic anodes in electrolytes over 30,000 ohms also have very high resistance to earth. High circuit resistance with the low voltage of galvanic anodes will not allow sufficient current to meet instant off or depolarization criteria. Additional anodes under these conditions will not noticeably increase the current applied to the structure. Reference SP0169 for criteria in high resistance electrolytes.

2.1.2 Design Requirements

2.1.2.1 Electrical Isolators

Isolators are required to isolate the [protected structure] [pipes] [_____] from any other structure. Provide isolators at all locations where the indicated [protected structure] [pipes] [_____] contact any other metallic structure. Provide locations and detailed drawings of required installations. Include any requirements for lightning protection, test stations, surge protection, or other requirements and include locations and details in design drawings.

2.1.2.2 Anode and Bond Wires

Provide a minimum of [5] [8] [25] [_____] magnesium anodes with an unpackaged weight of [_____] kg pounds at uniform distances along the metallic pipelines. Use a minimum of [3] [5] [10] [_____] test stations for these anodes. Provide these anodes in addition to anodes for the pipe under concrete slab and casing requirements. For each cathodic system, provide metallic components and structures that are electrically continuous by installing bond wires between the various structures. Bonding of existing buried structures may also be required to preclude detrimental stray current effects and safety hazards. Return stray current to its source without damaging structures intercepting the stray current. Provide electrical isolation of underground facilities in accordance with acceptable industry practice. All tests must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

2.1.2.3 Surge Protection

Install approved zinc grounding cells or sealed weatherproof lightning and surge arrestor devices across isolation flanges or fittings installed in underground piping as indicated on the drawings. Provide gapless, self-healing, solid state type arrestor. Provide zinc anode composition conforming to ASTM B418, Type II. Provide number 4 AWG copper lead wires with High Molecular Weight Polyethylene (HMWPE) insulation. Zinc grounding cells must be prepackaged in backfill install as detailed on the drawings. Lightning arrestors or zinc grounding cells are not required for isolation flanges on metallic components used on non-metallic piping systems.

2.1.2.4 Non-metallic Pipe System

In the event pipe other than metallic pipe is approved and used in lieu of metallic pipe, protect all metallic components of this pipe system with CP. Submit detailed drawings of CP for each component to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager for approval within 45 days after date of receipt of notice to proceed, and before commencement of any work.

2.1.2.5 Coatings

Provide coatings for metallic components as required for metallic fittings. Complete and test protective coating on each metallic component (such as valves, hydrants and fittings). Provide coating as required for underground metallic pipe. Each test must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Select, apply, and inspect coatings as specified in these specifications. The use of non-metallic pipe does not change other requirements of the specifications. Submit any deviations due to the use of non-metallic pipe for approval.

2.1.2.6 Tracer Wire

When a non-metallic pipeline is used to extend or add to an existing metallic line, exothermic-weld No. 8 AWG copper wire with THHN insulation to the existing metallic line and run the length of the new non-metallic line. Use this wire as a locator tracer wire and to maintain continuity to any future extensions of the pipeline.

2.1.2.7 Drawings

Submit [six] [_____] copies of detail drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, contractor's modifications, results of system design calculations including soil-resistivity, installation instructions and certified test data showing location of anodes and stating the maximum recommended anode current output density. Include in the detail drawings complete wiring and schematic diagrams, isolation fittings, test stations, permanent reference electrodes and bonding and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. Reference locations to two permanent facilities or mark points. Provide [one] [_____]electronic [digital] [PDF] [_____] copy and digital photos of the completed installation.

2.1.2.8 Summary of Services Required

Include the following scope of services:

a. Close-interval potential surveys,

b. CP Installation System,

c. System testing,

d. Casing corrosion control,

e. Interference testing,

f. Training,

g. Operating and maintenance manual,

h. Isolation testing and bonding testing,

i. Coating and holiday testing.

2.1.2.9 Tests of Components

Perform a minimum of four tests at each metallic component in the piping system. Two measurements must be made directly over the anodes and the other two tests must be over the outer edge of the component, but at the farthest point from the anodes. Provide a field drawing showing the component, the structure, all components of the CP system and their relationship to each other. Also provide a narrative describing how the CP system will work and the testing at each component. Components requiring CP must include but not be limited to the following:

a. Pipes beneath the floor slab or foundations.

b. Post Indicator Valve (PIV).

c. Shutoff valves.

d. Metallic pipes extended from aboveground locations.

e. Connectors or change-of-direction devices.

f. Metallic pipe components or sections.

g. Backflow preventers.

h. Culverts.

i. Casings.

2.1.2.10 Electrical Potential Measurements

Make all potential tests at a minimum of 3 meter 10 foot intervals witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Provide submittals identifying test locations on separate drawings, showing all metal to be protected and all CP equipment. Distinguish and identify test points, equipment, and protected metal.

2.1.2.11 Typical Metallic Components on Non-metallic Systems

2.1.2.11.1 Metallic Components

As a minimum, protect each metallic component with two galvanic anodes. This number of anodes is required to achieve minus 850 millivolts "instant off" potential on the metallic area and at the same time not provide overvoltage above 1200 millivolts "instant off." As a minimum, the galvanic anode unpackaged weight must be [4.1] [7.7] [_____] kg [9] [17] [_____] pounds. Locate the galvanic anodes on each side of the metallic component and route through a test station.

2.1.2.11.2 Fire Hydrants

Provide fire hydrant pipe components with a minimum of two anodes. These galvanic anodes must have an unpackaged weight of[_____] kg[_____] pounds.

2.1.2.11.3 Pipe Beneath Concrete Slab

Pipe beneath concrete slab must have a minimum of [2] [3] [_____] galvanic anodes. These galvanic anodes must have an unpackaged weight of [4.1] [7.7] [_____] kg [9] [17] [_____] pounds. Pipe beneath concrete slab must have [1] [2] [_____] permanent reference electrodes located beneath the slab. Locate one permanent reference electrode where the pipe enters the concrete slab. Route all conductors to a test station.

2.1.2.11.4 Valves

Protect each valve with [1] [2] [_____] galvanic anodes. The galvanic anode must have an unpackaged weight of [4.1] [7.7] [_____] kg [9] [17] [_____] pounds.

2.1.2.11.5 Metallic Pipe Component or Section

Protect each section of metallic pipe with [2] [3] [_____] galvanic anodes. The galvanic anodes must have an unpackaged weight of [4.1] [7.7] [_____] kg [9] [17] [_____] pounds.

2.1.2.11.6 Connectors or Change-of-Direction Devices

Protect each change-of-direction device with [2] [3] [_____] galvanic anodes. The galvanic anode must have an unpackaged weight of [4.1] [7.7] [_____] kg [9] [17] [_____] pounds.

2.1.2.12 Metallic Component Coating

Coatings for metallic components will be required for metallic fittings as indicated. These metallic fittings will include fire hydrants, tees, elbows, and valves. Coatings must be selected, applied, and inspected as specified in the coating specifications referenced and be compatible with the structure being protected. All coatings must be in accordance with all applicable Federal, State, and local regulations. Unbonded coatings must not be used with CP.

2.1.2.13 Location of Test Stations

Provide test stations of the type and location shown and [curb box] [post] [wall] mount. Provide buried isolation joints with test wire connections brought to a test station. Reference all test stations with GPS coordinates. Unless otherwise shown, locate other test stations as follows:

a. At 300 m 1,000-foot intervals or less.

b. Where the pipe or conduit crosses any other metal pipe.

c. At both ends of casings under roadways and railways.

d. Where both sides of an isolation joint are not accessible above ground for testing purposes.

2.1.2.14 Electrical Isolation of Structures

****

NOTE: The CP system will fail unless full consideration is given to specifications for electrically isolating pipe joints, electrically conductive pipe joints, and casing cradles and seals. Mechanical and electrical specifications must reference paragraphs "Electrically Isolating Pipe Joints" and "Electrically Conductive Couplings."

****

As a minimum, provide isolating flanges or unions at the following locations:

a. Connection of new metallic piping or components to existing piping.

b. Pressure piping beneath floor slab to a building.

Provide isolation at metallic connection of all lines to existing system and where connecting to a building. Additionally, provide isolation between [water] [_____] or [gas] [_____] [forced main] line; and foreign pipes that cross the new lines within 3.05 m 10 feet. Install isolation fittings, including isolating flanges and couplings, aboveground or in a concrete pit.

2.1.2.14.1 Gas Distribution Piping

Provide electrical isolation at each building riser pipe to the pressure regulator, at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings.

2.1.2.14.2 Isolation Joint Testing

An isolator checker or insulation tester will be used for isolation or insulating joint (flange or dielectric) electrical testing.

2.1.2.14.3 Underground Structure Coating

This coating specification takes precedence over any other project specification and drawing notes, whether stated or implied, and also applies to the pipeline or tank supplier. Variance in coating quality is not allowed by the contractor or Base Construction Representative without the written consent of the designer. All underground metallic pipelines and tanks to be cathodically protected must have a high quality factory-applied coating. This includes all carbon steel, cast-iron and ductile-iron pipelines or vessels. Select, apply, and inspect coatings as specified. If non-metallic pipelines are installed, coat all metallic fittings on pipe sections in accordance with this specification section.

a. The nominal coating thickness for the metallic pipe joint or other component coating must be [0.2][0.4][0.6][1.0][1.5][_____] mm [8][16][24][40][60][_____] mils, plus or minus 5 percent.

b. Apply pipe and joint coating for factory applied or field repair material as recommended by the manufacturer. Coating must be one of the following:

    (1) Continuously extruded polyethylene and adhesive coating system.
    (2) Polyvinyl chloride pressure-sensitive adhesive tape.
    (3) High density polyethylene/bituminous rubber compound tape.
    (4) Butyl rubber tape.
    (5) Coal tar epoxy.

2.1.2.14.4 Field Joints

Coat all field joints with materials compatible with the pipeline coating compound. Apply the joint coating material to an equal thickness as the pipeline coating. Do not use unbonded coatings for these buried metallic components. This includes the elimination of all unbonded polymer wraps or tubes. Once the pipeline or vessel is set in the trench, conduct an inspection of the coating. This inspection must include electrical holiday detection. Repair any damaged areas of the coating. The Contracting Officer or the Contracting Officer's Representative, Technical Expert or Project Manager must be asked to witness inspection of the coating and testing using a holiday detector.

2.1.2.14.5 Inspection of Pipe Coatings

Any damage to the protective coating during transit and handling must be repaired before installation. After field coating has been applied, inspect the entire pipe using an electric holiday detector in accordance with NACE SP0188 using a full-ring, spring-type coil electrode. The holiday detector must be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Upon detection, immediately repair all holidays in the protective coating. Occasional checks of holiday detector, operation will be made by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager to determine suitability of the detector. Provide all labor, materials, and equipment necessary for conducting the inspection.

2.1.2.14.6 Protective Coating for Aboveground Piping System

Provide finish painting conforming to the applicable paragraph of Section 09 90 00 PAINTS AND COATINGS and as follows:

2.1.2.14.7 Ferrous Surfaces

Touch-up shop-primed surfaces with ferrous metal primer. Solvent-clean surfaces that have not been shop-primed. Surfaces that contain loose rust, loose mill scale, and other foreign substances must be mechanically-cleaned by power wire-brushing and primed with ferrous metal primer. Finish primed surface with two coats of exterior oil paint and vinyl paint.

2.1.3 Performance Requirements

The design must allow for synchronized interruption of all applied current.

2.1.3.1 Criteria of Cathodic Protection

The design must allow for synchronized interruption of all applied current. All galvanic anode leads, or header cables, must be connected to the protected structure through test stations or junction boxes and must never be connected directly to the protected structure.

****

NOTE: Refer to applicable current NACE International Standard Practice NACE SP0169, NACE 0186, NACE 0193, NACE 0196, NACE SP0285, and NACE 0607 or other applicable NACE Standards for the type of metal and the type of metallic structure being protected to determine the appropriate criteria. Not all criteria may be applicable to the type of CP system(s) and structure being designed, and the designer or the contractor's corrosion engineer may select the applicable criteria with approval of the government. If no other criteria are applicable to the structure, use SP0169 Section 6, Criteria.

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a. Determination of the on and polarized (instant off) potentials must be made with the protective current applied to the [structure] [tank] [pipeline] [coupon] for a minimum of [1] [2] [4] [_____] [days]. Polarized potentials may be determined using a coupon test station (Error-Free (IR Free) test station). Polarized potentials must be determined by interrupting all the current being applied to the structure or coupon.

b. The potential measurements for the native measurement and the polarized potential must be made with the reference electrode at the same exact location. The polarization decay measurements must also be made with the reference electrode at the same exact location as the polarization potential.

c. The polarization decay measurements will be the difference between the polarized potential and a voltage measurement made [24] [48] [_____] hours after the interruption of protective current.

****

NOTE: Galvanic anodes are not recommended for use

in soil resistivities greater than 30,000 ohm-cm. When galvanic anodes are used to protect well coated metallic components such as isolated valves, hydrants, and other isolated pipe fittings in exceptionally high soil resistivities the circuit resistance to earth of the fitting will be in the hundreds or easily over a thousand ohms. The 0.9 driving voltage of the galvanic anode does not provide sufficient current to meet any criteria for protection, especially considering the anode resistance to earth may be well over 400 ohms. Pipelines and tanks have virtually no resistance to earth, even in high soil resistivities. If galvanic anodes are used for this application, (especially in soil resistivities over 100,000 ohm-cm), galvanic anode output current is virtually zero. Adding additional anodes does not increase the amount of current. The corrosion rate in this environment is low over 30,000 ohm-cm and non-corrosive over 100,000 ohm-cm. If Potentials are taken, they must be taken with the reference electrode as remote as possible to the anode, and as near to the metallic component as possible. On potentials at or more negative than negative 850 mV indicates the Anode is dominate in the circuit and the extremely low corrosion is on the anode. This must be determined by the contractor's corrosion engineer and approved by the government.

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NOTE: Refer to NACE SP0169 Paragraph 6.2.1.3.1.2.3 Evaluating the physical and electrical characteristics of the pipe and its environment, such as type of electrolyte, electrolyte resistivity, pH, dissolved oxygen content, moisture content, degree of aeration, differences in pipe metallurgy and installation dates, and variations in coating types and condition.

****

2.1.3.1.1 Steel

A negative polarized potential of 0.85 volts (850 millivolts) or more negative. The voltage must not be more negative than a negative polarized potential of 1.200 volts (1200 millivolts).

2.1.3.1.2 Aluminum

Aluminum underground component must not be protected to a potential more negative than minus 1200 millivolts, measured between the underground component and a saturated copper/copper sulfate reference electrode contacting the earth, directly over the metallic component. Resistance, if required, must be inserted in the anode circuit within the test station to reduce the potential of the aluminum to a value which will not exceed a potential more negative than minus 1200 millivolts. Voltage shift criterion must be a minimum negative polarization shift of 100 millivolts measured between the metallic component and a saturated copper/copper sulfate reference electrode contacting the earth, directly over the metallic component. The polarization voltage shift must be determined as outlined for iron and steel.

2.1.3.1.3 Copper Piping

For copper piping, the following criteria must apply: A minimum of 100 millivolts of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The polarization voltage shift must be determined as outlined for iron and steel.

2.2 EQUIPMENT

2.2.1 Remote Monitoring

Remote monitoring equipment must be designed, manufactured and procured specifically for cathodic protection use and must be provided as per design and drawings to monitor [potential (requires permanent reference electrode)] [bond(s)] [interference bond] [test station(s) shunts] [_____] and must match or be compatible with previously installed remote monitoring equipment in use at the installation.

2.2.2 Corrosion Rate Monitoring

Corrosion probes must be designed, manufactured and procured specifically for the application and matched to the structure being protected. Manufacturer must match or be compatible with previously installed rate monitoring equipment in use at the installation.

2.2.3 Polarization Cell Replacement (PCR) and (PCRH) for Hazardous Locations

PCRs and PCRHs must be designed, manufactured, and procured specifically for the application and must exceed the modeled AC steady-state current and fault conditions. For Hazardous locations, the PCRH model must be used.

Characteristic	**PCR**	**PCRH**
AC steady-state current, rms	45A, 80A	45A
AC fault current, rms. at 0.5s	3.7 kA to 15 kA	3.7 kA to 15 kA
Lightning current, 8x20 micros, peak	100 kA	100 kA
Hazardous location certification	Division 2, Zone 2	Division 1, Zone 1
Rain Proof, IP66	Yes	Yes
Submersible, IP68 or NEMA 6P	Optional	No

PCRs must be installed with a protective ground-based enclosure to secure the cable connections and prevent electrical hazards. The PCRH must be installed with an explosion-proof enclosure and must be [flange] [pole]

[wall] mounted. Structure and Grounding conductors must be properly sized for the application.

AC Fault Current Rating	Minimum Wire Size (AWG)	Minimum Wire Size (Metric)
1.2 kA, 2kA, 3.7 kA	#6	$16mm^2$
5kA 9kA 10kA	#2	$35mm^2$
14kA 15kA	#2/0	$70mm^2$

2.2.4 Solid State Decoupler (SSD)

SSDs must be designed, manufactured, and procured specifically for the application and must exceed the modeled AC steady-state current and fault conditions. For Hazardous locations, the PCRH model must be used. SSDs must be installed with a protective ground-based enclosure to secure the cable connections and prevent electrical hazards.

Characteristic	SSD
AC steady-state current, rms	45A
AC fault current, rms. at 0.5s	1.2 to 5 kA
Lightning current, 8x20micros, peak	75-100 kA
Hazardous location certification	Division 2, Zone 2
Rain Proof, IP66	Yes
Submersible, IP68 or NEMA 6P	Yes

2.3 COMPONENTS

2.3.1 Test Stations

2.3.1.1 Flush Mounted

NEMA ICS 6. Metallic or non-metallic with terminal board, [5] [8] [_____] terminal posts [and lockable lid]. A non-metallic enclosure must be molded of glass filled polycarbonate and urethane coated or Acrylonitrile Butadiene Styrene (ABS) plastic [and mounted on a 500 mm 18 inch length of

PVC conduit]. The unit must be of standard design, manufactured for use as a CP test station, complete with cover, terminal board, shunts, and brass or Type [304] [316] stainless steel hardware. The terminal board must be removable for easy access to wires. [Provide traffic valve box capable of withstanding [H-20] [_____] traffic loads.] The cover must have a cast in legend "CP TEST."

2.3.1.2 Post Top Mounted

NEMA ICS 6. Metallic or non-metallic with terminal board, [5] [8] [_____] terminal posts and lockable lid. A non-metallic enclosure must be high impact strength molded plastic. The unit must be of standard design, manufactured for use as a CP test station, complete with cover, terminal board, shunts, and brass or Type [304] [316] stainless steel hardware. The terminal board must be removable for easy access to wires. The test station must be mounted atop 1830 mm 6 foot long polyethylene conduit with anchor. Terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes).

2.3.1.3 Wall Mounted

NEMA ICS 6, Type [3R] [4X] [_____] enclosure with [clamped cover] [Type [304] [316] stainless steel hinges and [clamped] [latched] cover] [and padlocked hasp]. Enclosure will be of [galvanized steel] [painted steel] [aluminum] [fiberglass] [non-metallic] construction with terminal board and labeled with nameplate. Provide nameplate in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Enclosure mounting posts must be [galvanized steel pipe, schedule [40] [80] [_____]], [wood post, full length pressure treated with pentachlorophenol] [as indicated]. Mount enclosure 1066 mm 42 inches above finished grade [as indicated]. Terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes).

2.3.1.4 IR-Free Test Station

Must be [flush] [post top] [wall] mounted test station to include coupon of the same material as the structure, [shunt], [permanent reference electrode] with means of momentary isolation of the coupon with provided circuitry designed, manufactured and procured exclusively for CP instant off testing of a cathodically protected structure. Must be waterproof if used in flush test stations.

2.3.2 Shunts for Test Stations and Junction Boxes

[MIL-I-1361.] [0.1] [0.01] [_____] ohm, [2] [8] ampere, accuracy plus or minus one percent, polycarbonate circuit board type, color coded for value recognition [red for 0.1 ohm shunt] [yellow for 0.01 ohm shunt] with nickel-plated brass posts and standard [64] 6.35 mm 0.25 inch inch holes on [2.54] cm [1] inch centers to fit test stations and terminal boards [0.01 ohm 6] ampere, accuracy plus or minus one percent, manganin wire type.

2.3.3 Junction Box Enclosures

NEMA ICS 6, Type [3R] [4X] [_____] enclosure with [clamped cover] [Type [304] [316] stainless steel hinges and [clamped] [latched] cover] [and padlocked hasp]. Enclosure must be of [galvanized steel] [painted steel] [aluminum] [fiberglass] [non-metallic] construction with terminal board.

Knockout for conduit must be the size and location as per design drawings.

2.3.3.1 Nameplates

Provide nameplate in accordance with Section26 20 00 INTERIOR DISTRIBUTION SYSTEM and ASTM D709. Provide laminated plastic nameplates for each enclosure as specified or as indicated on the drawings. Each nameplate inscription must identify the function. Nameplates will be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface will be matte finish. Corners will be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 635 mm 25 inch by 65 mm 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.3.4 Terminal Boards

Provide terminal boards for anode junction boxes, bonding boxes, and test stations made of phenolic plastic [3] [6] [_____] mm [1/8] [1/4] [_____] inch thick with dimensions as indicated. Insulated terminal boards must have the required number of terminals (one terminal required for each conductor). Install solderless copper lugs and copper buss bars, shunts, and variable resistors on the terminal board as indicated. Test station terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, reference electrodes and coupons).

2.3.5 Anode Junction Boxes

2.3.5.1 Enclosure

NEMA ICS 6, Type [3R] [4X] [_____] enclosure with [clamped cover] [Type [304] [316] stainless steel hinges and [clamped] [latched] cover] [and padlocked hasp]. Enclosure must be of [galvanized steel] [painted steel] [aluminum] [fiberglass] [non-metallic] construction with terminal board and labeled with nameplate. Provide nameplate in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.3.5.2 Terminal Boards

Provide terminal boards for anode junction boxes, bonding boxes, and test stations made of phenolic plastic [3] [6] [_____] mm [1/8] [1/4] [_____] inch thick with dimensions as indicated. Insulated terminal boards must have the required number of terminals (one terminal required for each conductor). Install solderless copper lugs and copper buss bars, shunts, and variable resistors on the terminal board as indicated. Test station terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes).

2.4 MATERIALS

2.4.1 Galvanic Anodes

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NOTE: The actual compositions required must be determined to provide adequate and economical service. The anode material composition must be submitted for approval in accordance with "Submittals Procedures." Any deviation from chemical

compositions listed must be approved by the government.

****

2.4.1.1 Dimensions and Weights

****

NOTE: The following dimensions and weights of anodes are not all inclusive, additional sizes not included in the following tables may be available from various manufacturers.

****

Bare anode weight [4.1] [7.72] [9.7] [14.53] [_____] kg [9] [17] [20] [32] [_____] pounds not including core.

2.4.1.2 [High Potential] [Standard] Magnesium Anodes

Install a minimum of [2] [3] [10] [12] [_____] anodes on the [Pipe] [Tank] [_____] system. See Paragraph METALLIC COMPONENTS ON NON-METALLIC SYSTEMS AND TYPICALS for additional anodes under slab.

2.4.1.2.1 Anode Composition

Anodes must be of high-potential magnesium alloy, made of primary magnesium obtained from sea water or brine, and not made from scrap metal. Magnesium anodes must conform to ASTM B843 and to the following analysis (in percent) otherwise indicated:

Aluminum	0.010 percent
Manganese	0.50 to 1.30 percent max
Zinc	0.05 percent max
Silicon	0.05 percent max
Copper	0.02 percent max
Nickel	0.001 percent max
Iron	0.03 percent max
Other impurities	0.05 each or 0.3 percent max total
Magnesium	Remainder

Furnish spectrographic analysis on samples from each heat or batch of anodes used on this project.

2.4.1.2.2 Dimensions and Weights

The following dimensions and weights of anodes are not all inclusive and are presented as examples, various manufacturers may have additional sizes not included in the following table:

a. Bare anode weight: [4.1] [7.72] [9.7] [14.53] [_____] kg [[9] [17] [20] [32] [_____] pounds] [not including core].

Typical Magnesium Anode Size (may be round, square, or D shaped)

Nominal Weight Bare		Approximate Size						Packaged Weight		Nominal Packaged Dimensions			
		Width		Height		Length				Diameter		Length	
kg	lbs	mm	inch	mm	inch	mm	inch	kg	lbs	mm	inch	mm	inch
0.5	1	44	1.75	44	1.75	203	8	2.3	5	83	3.25	229	9
1.4	3	89	3.5	95	3.75	127	5	3.6	8	152	6	254	10
2.3	5	89	3.5	95	3.75	216	8.5	7.7	17	152	6	305	12
4.1	9	70	2.75	76	3	686	27	15.9	35	140	5.5	813	32
4.1	9	89	3.5	95	3.75	356	14	12.2	27	152	6	432	17
7.7	17	70	2.75	70	2.75	1276	50.25	27.2	60	152	6	1397	55
7.7	17	89	3.5	102	4	654	25.75	20.4	45	165	6.5	737	29
9.1	20	70	2.75	95	3.75	1518	59.75	31.8	70	127	5	1676	66
14.5	32	89	3.5	95	3,75	1149	45.25	41.3	91	165	6.5	1346	53
14.5	32	140	5.5	127	5	521	20.5	31.8	70	203	8	711	28
18.1	40	89	3.5	95	3.75	1518	59.75	43.5	96	165	6.5	1676	66
21.8	48	140	5.5	146	5.75	787	31	45.4	100	203	8	965	38
27.2	60	102	4	102	4	1524	60	56.7	125	178	7	1626	64

2.4.1.2.3 Packaged Anodes

Provide anodes in packaged form with the anode surrounded by specially-prepared quick-wetting backfill and contained in a water permeable cloth or paper sack. Anodes must be centered by means of spacers in the backfill material.

The backfill material will have the following composition, unless otherwise indicated:

Material	Approximate Percent by Weight
Gypsum	75
Bentonite	20
Sodium Sulfate	5
Total	100

2.4.1.3 [Cast] [Wrought] Zinc Anodes

[ASTM B418, Type [I] [II].] [ASTM F1182.] [MIL-A-18001] Bare anode weight: [2.2] [13.62] [_____] kg [5] [30] [_____] pounds [not including core].

Bare Weight		Width		Height		Length		Total Packaged Weight	
kg	pounds	mm	inches	mm	inches	mm	inches	kg	pounds
2.3	5	36	1.4	36	1.4	254	10	9.1	20
5.4	12	36	1.4	36	1.4	610	24	18.1	40
6.8	15	36	1.4	36	1.4	762	30	22.7	50
6.8	15	51	2.0	51	2.0	381	15	16.3	36
8.2	18	36	1.4	36	1.4	914	36	24.9	55
13.6	30	36	1.4	36	1.4	1524	60	39.0	86
13.6	30	51	2.0	51	2.0	762	30	30.4	67
20.4	45	51	2.0	51	2.0	1143	45	45.4	100
27.2	60	51	2.0	51	2.0	1524	60	54.4	120

2.4.1.3.1 Anode Composition

Chemical composition as follows:

Zinc	[4.5] [_____] percent maximum
Indium	[0.02] [_____] percent maximum
Silicon	[0.01] [_____] percent maximum
Aluminum	Remainder

2.4.1.4 Aluminum Anodes

2.4.1.4.1 Anode Composition

Chemical composition as follows:

Zinc	[4.5] [_____] percent maximum
Indium	[0.02] [_____] percent maximum
Silicon	[0.01] [_____] percent maximum
Aluminum	Remainder

2.4.1.4.2 Dimensions and Weights

Anode Weight [_____] kg [_____] pounds not including core.

2.4.1.4.3 Anode Core

Iron [galvanized steel] rod [pipe] [strap] [_____], [3] [6.35] [12.7] mm diameter [_____] by [_____] [1/8] [1/4] [1/2] inch diameter [_____] by [_____].

2.4.2 Wire and Cable

****

NOTE: Any pinhole, cut, scratch or other damage to the anode cable exposing bare copper to the electrolyte or reducing the insulation thickness will result in early failure of the CP system. For this reason, special, extra heavy-duty insulation is used on anode wires and cable exposed to the electrolyte. While it is often expedient to use the same type wire for the structure (negative) cable, to avoid a mix-up in the field, lesser insulation can be used since the structure cable is not subject to anodic failure.

****

2.4.2.1 Anode Lead Wire

Wire must be No. [12] [10] [_____] AWG solid copper wire, not less than 3 m 10 feet long, without any splices, complying with NFPA 70, Type Thermoplastic Heat and Water-resistant Nylon-coated (THHN) [THHN] Rubber Heat (resistant) Wire (RHW) [RHW-USE] insulation. [Connecting wires for magnesium anodes will be factory installed with the place or emergence from the anode in a cavity-sealed flush with a dielectric sealing compound.] [Connecting wires for zinc anodes must be factory installed with the place of connection to the protruding steel core completely sealed with a dielectric material.]

2.4.2.2 [Bolted] [Welded] Connected Anodes

[UL 83, Type [THWN] [THHN]] [ASTM D1248, Type HMWPE] [UL 44, Type RHW], [solid] [stranded] copper conductors, not less than [No. 12] [_____] AWG, [3050] [6100] [_____] mm [10] [20] [_____] feet long, [of sufficient length to extend to the accompanying junction box without splicing]. Anode lead wire will be factory installed. [Silver solder the lead wire to the anode core, and seal the soldered connection and recessed end of the anode with an [asphaltic] [epoxy] dielectric sealing compound.] [Silver solder the lead wire to the protruding anode core, and completely seal the soldered connection with an [asphaltic] [epoxy] dielectric material.] Dielectric material must extend past the connection and cover the lead wire insulation by not less than 15 mm 1/2 inch. [Cover the connection with heat-shrinkable tubing.]

2.4.2.3 Anode Header Cable

Cable for anode header and distribution will be No. [_____] AWG stranded copper wire with type CP HMWP, 2.8 mm 7/64 inch thick insulation, 600-volt rating.

2.4.2.4 Structure (Negative) Cable

Structure connecting wire must be No. [4][2][_____] AWG stranded copper wire with type [THHN] [THWN] [PVC] [TW] [RHW] [polyethylene] [CP high molecular weight insulation, 2.8 mm 7/64 inch thick] [polyethylene] insulation, 600 volt rating. Copper conductors conforming to ASTM B3 and ASTM B8.

2.4.2.5 Test Wires

Test wires must be No. 12 AWG stranded copper wire with NFPA 70 Type Thermoplastic Wire (TW) or RHW or polyethylene insulation. Copper conductors conforming to ASTM B3 and ASTM B8.

2.4.2.6 Joint and Continuity Bond Cables

Provide bonds across joints or any electrically discontinuous connections in the piping, and other pipes and structures with other than welded or threaded joints included in this CP system. Unless otherwise specified, bonds between structures and across joints in pipe with other than welded or threaded joints must be with No. 4 AWG stranded copper cable with polyethylene insulation. Bonds between structures must contain sufficient slack for any anticipated movement between structures. Bonds across pipe joints must contain a minimum of 100 mm 4 inch of slack to allow for pipe movement and soil stress. Bonds must be attached by exothermic welding. Exothermic weld areas must be insulated with coating compound and approved by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Continuity bonds must be installed as necessary to reduce stray current interference. Additional joint bonding must be done where determined during construction or testing or as directed. Joint bonding must include excavation and backfilling. There must be a minimum of 2 continuity bonds between each structure and other than welded or threaded joints. Electrical continuity must be tested across joints with other than welded or threaded joints and across metallic portions of sewage lift stations and water booster stations. Copper conductors conforming to ASTM B3 and ASTM B8.

2.4.2.7 Resistance Bond Wires

Resistance bonds must be adjusted for minimum interference while achieving the criteria of protection. Alternate methods may be used when approved.

2.4.2.8 Polyethylene Insulation

Polyethylene insulation must comply with the requirements of ASTM D1248 and of the following types, classes, and grades:

2.4.3 Cable and wire Identification Tags

[Laminated plastic material with black letters on a yellow background] [[Brass] [Stainless steel] material with engraved letters]. Print letters and numbers a minimum of 5 mm 3/16 inch in height. Provide identifier legend [in accordance with the drawings] [_____].

2.4.4 Anode Connection

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NOTE: Type RHW-2-USE-2 insulation must be used under hot asphalt.

****

2.4.4.1 End-Connected Anode

[Drill] [Cast] a recess [150] [_____] mm [6] [_____] inches deep in one end of the anode. Attach the lead wire to the anode with an anchor device. Not more than 10 mm 1/2 inch of bare wire must protrude from the anchor device. Attachment must withstand a 1446 Newton 325 pound pull without loosening the wire or anchor device. Fill the recess with an epoxy sealing compound [, leaving sufficient space for a plug]. [Provide non-metallic plug flush with the anode end surface.] [Install a heat-shrinkable anode cap over the attachment. Cap must extend not less than 65 mm 2 1/2 inches on the lead wire and 75 mm 3 inches on the anode.] Cable-to-anode contact resistance must not exceed 0.02 ohms.

2.4.4.2 Center-Connected Anode

Attach the lead wire to the center of the anode with an anchor device suitably fastened to the wire. Not more than 20 mm one inch of bare wire must protrude from the anchor device. Encapsulate [each side of] the connection point with [a minimum of 152 mm 6 inches [_____] of] high voltage insulating compound mastic and 102 mm 4 inches [_____] of epoxy resin. Attachment must withstand [4000] [6675] [_____] N [900] [1500] [_____] pounds pull without loosening the wire or anchor device. Provide a non-metallic [plug flush with the anode end] [end cap] to prevent chaffing of the anode lead wire. Cable-to-anode contact resistance must not exceed 0.02 ohms.

2.4.5 AC Mitigation Materials

If required, AC mitigation materials typically consist of a mitigation material either zinc ribbon or copper cable, interconnecting coated copper cables, solid state decouplers to control the AC current flow and test stations.

2.4.6 Backfill Material

The backfill material must have the following composition, unless otherwise indicated:

Material	**Approximate Percent by Weight**
Gypsum	75
Bentonite	20
Sodium Sulfate	5
Total	100

2.4.7 Permanent Reference Electrodes

Permanent reference electrodes must be [copper/copper-sulfate] [silver silver-chloride] [zinc] [Hydrocarbon-Proof Palladium (Pd/$PdCl_2$)] specifically manufactured for [underground] [submersible] [_____] use, [32] [_____] mm [1 1/4] [_____] inch diameter, by [203] [255] [_____] mm [8] [10] [_____] inches long, [plastic [_____] tube with an ion trap to minimize contamination of the electrode] [, and a minimum surface sensing area of [_____] square centimeters[_____] square inches]. Must never need recharging, maintenance, or recalibration. Must have impregnated membrane which keeps electrode electrolytes from drying out or getting the reference electrode electrolyte contaminated. Must have ion trap to prevent reference electrode damage from hydrogen sulfide or excess chloride ions. [The electrode will be prepackaged by the manufacturer with a backfill material as recommended by the manufacturer.] Provide electrodes with No. [10] [12]

[_____] AWG, [RHW] [THHN] [_____] cable of sufficient length to extend to the [test station] [junction box] [rectifier] without splicing. Reference electrodes will have a minimum 20-year life, stability of plus or minus 5 millivolts under 3 microamp load. The manufacturer must calibrate the PRE to 316 mV plus or minus 10mV referenced to a standard hydrogen electrode (SHE) and provide a calibration certificate detailing the results of the calibration. Procedures for evaluating the accuracy annually must be included in the Operation and Maintenance Manual.

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NOTE: Refer to NACE TM0113-2013 Standard Test Method for Evaluating the Accuracy of Field-Grade Reference Electrodes and NACE TM0211-2011 Standard Test Method for Durability Test for Copper/Copper Sulfate Permanent Reference Electrodes for Direct Burial Applications for information for evaluating the accuracy or durability of the PRE.

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2.4.8 Pavement Inserts

Pavement insert must be a non-metallic flush type test station without terminal board, and must allow a copper/copper sulfate reference electrode to contact the electrolyte beneath the pavement surface. [Provide traffic valve box capable of withstanding [H-20] [_____] traffic loads.]

2.4.9 Coupons

Coupons must match the material of the structure, with [1] [2] integrated connection(s) with electrical wire(s) and be designed, manufactured and procured for use as a corrosion coupon, IR-Free reference electrode, or AC reading electrode.

2.4.10 Zinc Grounding Cells

Two Zinc [Type II] [Type I] anodes separated with 24.5 mm 1 inch isolating spacers. Minimum 10 feet of #6 AWG HMWPE CP cable crimped securely to each anode. Both anodes centered in one cloth bag and surrounded with low resistance backfill mixture consists of 75 percent hydrated gypsum, 20 percent bentonite, and 5 percent sodium sulfate.

Element	**Content Percent**	
	MIL-A-18001 ASTM B418 Type I	**ASTM B418 Type II**
Al	0.1 - 0.5 percent	0.005 percent max
Cd	0.02 - 0.07 percent	0.003 percent max
Fe	0.005 percent max	0.0014 percent max
Pb	0.006 percent max	0.003 percent max
Cu	0.005 percent max	0.002 percent max
Zinc	Remainder	Remainder

Bare Weight		**Width**		**Height**		**Length**		**Total Packaged Weight**	
kg	**pounds**	**mm**	**inches**	**mm**	**inches**	**mm**	**inches**	**kg**	**pounds**
2.3	5	36	1.4	36	1.4	254	10	9.1	20
5.4	12	36	1.4	36	1.4	610	24	18.1	40
6.8	15	36	1.4	36	1.4	762	30	22.7	50
6.8	15	51	2.0	51	2.0	381	15	16.3	36
8.2	18	36	1.4	36	1.4	914	36	24.9	55
13.6	30	36	1.4	36	1.4	1524	60	39.0	86
13.6	30	51	2.0	51	2.0	762	30	30.4	67
20.4	45	51	2.0	51	2.0	1143	45	45.4	100
27.2	60	51	2.0	51	2.0	1524	60	54.4	120

2.4.11 Isolation Flange Kits

****

NOTE: On projects having piping installed by Division 2, SITEWORK or Division 15, MECHANICAL, coordinate the requirements for flanges and unions with the appropriate section(s).

****

Provide full-faced gaskets, isolating sleeves and washers, and steel washers. Provide isolation flange kits rated for operation at the rated pressure and temperature.

2.4.11.1 Gaskets

****

NOTE: Do not use asbestos materials.

****

ASME B16.21. [Neoprene faced phenolic] [Laminated phenolic] material for operation at [_____] KPa, [232] [_____] degrees C [_____] psi, [450] [_____] degrees F.

2.4.11.2 Isolating Washers and Sleeves

Two sets 3 mm 1/8 inch [laminated phenolic] [_____] for operation at [232] [_____] degrees C [450] [_____] degrees F. Isolating washers must fit within the bolt facing on the flange over the outside of the fabric reinforced phenolic sleeve.

2.4.11.3 Washers

Steel, cadmium plated, to fit within the bolt facing on the flange.

2.4.12 Steel Flanges and Bolting

2.4.12.1 Steel Flanges

ASME B16.5, [668 N] [1335 N] [150 lb.] [300 lb.].

2.4.12.2 Bolting

ASTM A307, Grade B for bolts; ASTM A194/A194M, Grade 2 for nuts. Dimensions: ASME B18.2.1 for bolts, ASME B18.2.2 for nuts. Threads: ASME B1.1, Class 2A fit for bolts, Class 2B fit for nuts. Bolts must extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at the roof of threads.

2.4.13 Dielectric Unions

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NOTE: On projects having piping installed by Division 2, SITEWORK or Division 15, MECHANICAL, coordinate the requirements for flanges and unions with the appropriate section(s).

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ASME B16.39, Class [1] [2] for dimensional, strength, and pressure requirements. Insulation barrier must limit galvanic current to one percent of the short-circuit current in a corresponding metallic joint. Provide insulating material impervious to [water] [oil] [gas].

2.4.14 Isolation and End Seals

2.4.14.1 Casing Isolator/Centralizer

[High density (linear), injection molded virgin Polyethylene] [Polycarbonate Hi-Temp isolators/spacers rated for service at least 138 degrees C 280 degrees F [or more]] [High Grade Thermoplastic] positive electrical isolation, high abrasion resistance and low coefficient of friction.

2.4.14.2 End Seals

Ethylene Propylene Diene Monomer (EPDM) Neoprene rubber end seals, thickness of 3175 micrometer 1/8 inch or more, with [2] [4] Stainless Steel Pipe Clamps per end seal, 3175 micrometer 1/8 inch thick and 12700 micrometer 1/2 inch wide or more.

2.5 ACCESSORIES

2.5.1 Conduit

[UL 6, rigid galvanized steel], [Outlet boxes: UL 514A and fittings UL 514B, threaded hubs]. [Metallic conduit and fittings to be PVC coated in accordance with NEMA RN 1, Type A40], [NEMA TC 2, Type EPC-40-PVC]. Non-metallic conduit must conform to NEMA TC 2.

2.5.2 Joint, Patch, Seal, and Repair Coating

Sealing and dielectric compound must be a black, rubber based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Compound will be applied as recommended by the manufacturer, but not less than 13 mm 1/2-inch thick. Coating compound must be [cold-applied coal-tar base mastic] [hot-applied coal-tar enamel]. Pressure-sensitive vinyl plastic electrical tape and rubber insulated tape must conform to UL 510.

2.5.3 Underground Splices

Provide splices with a compression connector on the conductors, and insulation and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

2.5.3.1 Cast-Type Splice

Provide cast-type splice insulation by means of molded casting process employing a thermosetting epoxy resin insulating material applied by a gravity poured method or pressure injected method. Provide component materials of the resin insulation in a packaged form ready for convenient mixing without removing from the package.

2.5.3.2 Gravity-Poured Splice

Gravity-poured method must employ materials and equipment contained in and approved commercial splicing kit which includes a mold suitable for the cables to be spliced. When the mold is in place around the joined conductors, prepare the resin mix and pour into the mold.

2.5.3.3 Heat Shrinkable Splice

Provide [heavy wall] heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which must be applied by a clean burning propane gas torch.

2.5.4 Electrical Isolation of Structures

2.5.4.1 Electrically Isolating Pipe Joints

Electrically isolating pipe joints will be of a type that is in regular factory production.

2.5.4.2 Electrically Isolating Couplings

Electrically isolating couplings will be of a type that has a published maximum electrical resistance rating given in the manufacturer's literature. Cradles and seals will be of a type that is in regular factory production made for the purpose of electrically isolating the carrier pipe from the casing and preventing the incursion of water into the annular space.

2.5.5 Electrical Insulating Coating

[Heat-shrinkable tape] [Conformable watertight sealant having dielectric strength not less than 15 kV for a 3 mm 1/8 inch thick layer].

2.5.6 Buried Cable Warning and Identification Tape

Polyethylene tape, manufactured for warning and identification of buried cable and conduit. Tape must be [75] [_____] mm [3] [_____] inches wide, [Yellow] [_____] in color and read "Caution Buried Cable Below" or similar. Color and lettering must be permanent and unaffected by moisture or other substances in backfill materials.

2.5.7 Electrical Connection to Structures

2.5.7.1 Exothermic Welds

Electrical connections to metallic structures must be made using exothermic welds in strict accordance with the manufacturer's recommendations.

2.5.7.2 Electrical-Shielded Arc Welds

Electrical-shielded arc welds must be approved for use on steel pipe by shop drawing submittal action.

2.5.7.3 Brazing

Brazing will be as specified by manufacturer using specialized equipment designed for that purpose.

2.5.8 Electrical Tape

Pressure-sensitive vinyl plastic electrical tape and rubber insulated tape must conform to UL 510.

2.5.9 Exothermic Weld Kits

Exothermic weld kits specifically designed by the manufacturer for exothermic welding wires to metallic surfaces. Molds must be for specific type of metallic structure (steel, cast iron), specific diameter of pipe or metallic surface and specific size (AWG)and type of wire (solid, stranded).

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

2.6.1 Non-Destructive Testing of Anodes

Contractor must perform the tests in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. One anode of each type will be chosen at random for non-destructive testing and will be submerged in a container of fresh water for about 30 minutes. Contractor must then measure the anode-to-water potential difference between a calibrated copper/copper sulfate reference electrode. Potential differences must generally be within the following ranges:

Anode Type	**DC Volts to Calibrated Cu/CuSO4 Reference Electrode**
High Potential Magnesium	More Negative than Negative 1.65 Volts DC
Standard Magnesium	More Negative than Negative 1.4 Volts DC
Zinc	More Negative than Negative 1.0 Volts DC
Aluminum	More Negative than Negativee 1.0 Volts DC

Failure of the test anode to conform to this specification can be cause for rejecting all anodes from the same lot as the test anode. The contractor must mark all rejected anodes on the ends with a 150 millimeter 6 inch high "X" using yellow spray paint. Failed anodes must be removed from the job site by the end of the day. The contractor must replace any rejected anodes at the contractor's expense. The destructive testing provision must also apply to replacement anodes as well.

2.6.2 Destructive Testing of Anodes

Contractor must perform the tests in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Contractor must include the cost of an additional anode [of each different type] with the longest lead wire for the destructive test in the contractor's bid. One completed [prepackaged] anode of each type with lead wires will be chosen at random for destructive testing and must be submitted to a static pull test. Anode wire connections must have sufficient strength to withstand a minimum tensile load of [136] [_____] kg [300] [_____] pounds. [The anode must be cut into sections or broken with a sledgehammer to verify conformance with this specification. Such items as anode-to-wire connection, complete encapsulation of the wire connector, and wire to anode electrical resistance must be checked.] [Failure of the test anode to conform to this specification can be cause for rejecting all anodes from the same lot as the test anode. The contractor must mark all rejected anodes on the ends with a 150 millimeter 6 inch high "X" using yellow spray paint. Failed anodes must be removed from the job site by the end of the day. The contractor must replace any rejected anodes at the contractor's expense. The destructive testing provision will also apply to replacement anodes as well.]

PART 3 EXECUTION

3.1 SAFETY PRECAUTIONS AND HAZARDOUS LOCATIONS

Any personnel performing operations that will generate heat, sparks, or flame in hazardous locations must first perform adequate safety precautions. A trained responsible person must ensure the area is safe to perform the operation. Required actions include ensuring adequate ventilation before work starts, air monitoring, and a fire watch must be provided and remain for 30 minutes after the operation is completed. A minimum of 20 pound ABC type fire extinguisher must be available and must be inspected before each use. Equipment being used must be inspected and used in accordance with manufacturer recommendations. Combustibles that are in the work area(s) must be moved or if they cannot be moved, be covered with fire retardant welding blankets. When performing exothermic welding, properly sized charges and inspection of the structure condition must be accomplished to ensure a safe operation.

3.2 INSTALLATION

3.2.1 Excavation and Trenching

Perform trenching and backfilling in accordance with [Section 31 00 00 EARTHWORK] [_____]. In the areas of the anode beds, all trees and underbrush will be cleared and grubbed to the limits shown or indicated. In the event rock is encountered in providing the required depth for anodes, determine an alternate approved location and, if the depth is still not provided, submit an alternate plan to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Alternate techniques and depths must be approved prior to implementation.

3.2.2 Anode Excavation

a. Excavate hole to a minimum 75 mm 3 inches larger than the packaged anode diameter, [_____] mm [_____] feet deep.

3.2.3 Lead Wire Trench

b. Excavate lead wire trench to [610] [_____] mm [24] [_____] inches deep, [_____] mm [_____] inches wide.

3.3 ANODES AND LEAD WIRE

3.3.1 Anode Installation

Unless otherwise authorized, installation must not proceed without the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Anodes of the size specified must be installed to the depth indicated and at the locations shown. Locations may be changed to clear obstructions with the approval of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Anodes will be installed in sufficient number and of the required type, size, and spacing to obtain a uniform current distribution over the surface of the structure. The anode system will be designed for a life of 25 years of continuous operation. Anodes must be installed as indicated in a dry condition after any plastic or waterproof protective covering has been completely removed from the water permeable, permanent container housing the anode metal. The anode connecting wire must not be used for lowering the anode into the hole. The annular space around the anode must be backfilled with fine earth in 150 mm 6 inch layers and each layer must be hand tamped.

3.3.1.1 Single Anodes

Single anodes, spaced as shown, will be [connected] [connected through a test station] to the pipeline, allowing adequate slack in the connecting wire to compensate for movement during backfill operation.

3.3.1.2 Group of Anodes

Groups of anodes, in quantity and location shown, must be connected to an anode header cable. The anode header cable must make contact with the structure to be protected only through a test station. Anode lead connection to the anode header cable must be made by an approved crimp connector or exothermic weld and splice mold kit with appropriate potting compound.

3.4 INSTALLATION DETAILS

3.4.1 Anode Installation

Do not lift or support anode by the lead wire. Where applicable, remove manufacturer's plastic wrap/bag from the anode. Exercise care to preclude damaging the cloth bag and the lead wire insulation. Center the packaged anode in the hole with native soil in layers not exceeding 150 millimeters 6 inches. Hand tamp each layer to remove voids taking care not to strike the anode lead wire. When the backfill is 150 millimeters 6 inches above the top of the anode, pour at least ten gallons of water into the hole to saturate the anode backfill and surrounding soil. Anodes must not be backfilled prior to inspection and approval by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

3.4.2 Lead Wire Installation

Cover the lead wire trench bottom with a 75 mm 3 inch layer of sand or stone free earth. Center wire on the backfill layer. Do not stretch or kink the conductor. Place backfill over wire in layers not exceeding 150 mm six inches deep. Compact each layer thoroughly. Do not place tree roots, wood scrap, vegetable matter and refuse in backfill. Place cable warning tape within [450] [_____] mm [18] [_____] inches of finished grade, above cable and conduit.

3.4.2.1 Lead Wire Connections

Connect anode lead wire(s) [to the test station terminal board(s)] [directly to the protected structure(s) by use of exothermic weld kit(s). Clean the structure surface by scraping, filing or wire brushing to produce a clean, bright surface. Weld connections using exothermic welding kit(s) in accordance with the kit manufacturer's instructions. Check and verify adherence of the bond to the substrate for mechanical integrity by striking the weld with a 908 gram 2 pound hammer. Cover connections with an electrically insulating coating [which is compatible with the existing coating on the structure]]. The coating must be completely cured before backfilling. Allow sufficient slack in the lead wire to compensate for movement during backfilling operation.

3.4.2.2 Field Drawing

Complete a field drawing of each anode installation showing location of anode, [test station], depth of anode, color and size of anode lead wire and any other pertinent details. Submit copy with daily report to the government.

3.4.2.3 Metallic Underground Pipeline Connection

To facilitate periodic electrical measurements during the life of the sacrificial anode system and to reduce the output current of the anodes, if required, all anode lead wires must be connected to a test station and buried a minimum of 610 mm 24 inches in depth. The cable must be No. 10 AWG, stranded copper, polyethylene or RHW-USE insulated cable. The cable must make contact with the structure only through a test station. Resistance wire must be installed between the cable and the pipe cable, in the test station, to reduce the current output, if required. Anode connections, except in the test station, must be accomplished by exothermic welding, and must be insulated by means of at least three (3) layers of electrical tape; and all lead wire connections must be installed in a moisture-proof splice mold kit and filled with epoxy resin. Lead wire-to-structure connections must be accomplished by an exothermic welding process. All welds must be in accordance with the manufacturer's recommendations. A backfill shield filled with a pipeline mastic sealant and material compatible with the coating must be placed over the weld connection and be of such diameter as to cover the exposed metal adequately. Anodes must be installed at a minimum of 2.5 meters 8 feet and a maximum of 3 meters 10 feet from the structure to be protected.

Contractor must take proper safety precautions prior to and during welding to live pipelines [tanks]. Contractor must notify the activity Fuel Office via the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of three days before performing exothermic welding to live lines. Exothermic welding must be conducted with product flowing through the pipeline to eliminate vapor spaces within the pipe and to dissipate the heat on the pipe. Exothermic weld charges for connections to live lines must be limited to a maximum 15 gram charge to prevent burning through the pipe wall. Exothermic weld connections must be spaced a minimum of 150 millimeters 6 inches apart. In the event of an unsuccessful weld, the new weld location must be located a minimum of 150 millimeters 6 inches from the unsuccessful weld and any other existing welds. Contractor must obtain the services of a certified safety professional [to monitor the construction site during exothermic welding work and certify that the area is free of flammable vapors and otherwise safe for work.] [to approve the contractor's exothermic welding safety procedures. Results of this consultation must be included in the Contractor's Daily Report.]

3.4.3 Underground Pipe Joint Bonds

Underground pipe having other than welded or threaded coupling joints must be made electrically continuous by means of a bonding connection installed across the joint.

3.4.4 Anode Junction Boxes

Provide junction boxes and mark each of the wires terminating in each box.

3.4.5 Bonding Boxes

Provide structure bonding boxes in locations [as indicated] [where the protected structure crosses or comes into close proximity to other metal structures that are unprotected or protected by its own electrically isolated CP system(s)].

3.4.6 Test Stations and Permanent Reference Electrodes

Test stations will be of the type and location shown and will be [curb box] [post] [wall] mounted. Provide buried isolation joints with test wire connections brought to a test station. Reference all test stations with GPS coordinates. Unless otherwise shown, locate other test stations [and permanent reference electrodes] [as indicated.] as follows:

a. At [305] [_____] meters [1000] [_____] foot intervals.

b. At all isolation joints.

c. At both ends of casings.

d. Where the pipe crosses any other metal pipes.

e. Where the pipe connects to an existing piping system.

f. Where the pipe connects to a dissimilar-metal pipe.

Do not fill the bottom of the test station with concrete unless otherwise specified. Do not place rubbish, scrap or other debris into the test station.

3.4.7 Permanent Reference Electrode Verification

Verify permanent reference electrodes against a calibrated portable electrode in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager before installation. Verify in a non-metallic container of water. Permanent electrode must measure a reference potential agreeing with that measured by the portable electrode within plus or minus 0.010 volts when the sensing windows of the two electrodes being compared are not more than 2 mm 1/6 inch apart but not touching. Remove permanent reference electrodes not within this potential range from the construction site by the end of the day and replace at the contractor's expense. The testing provision applies to replacement permanent reference electrodes as well.

3.4.7.1 Field Drawings

Complete a field drawing of [each anode installation showing location of anode, depth of anode, color and size of anode lead wire and any other pertinent details] [test station location and diagram] [Underground Pipe Joint bond locations and details] [Anode Junction Box Location and details] [Bonding Box location and details] [Permanent Reference Electrode locations] [Location of all Electrical Isolations]. Submit copy with daily report to the government.

3.5 ELECTRICAL ISOLATION OF STRUCTURES

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NOTE: The CP system will fail unless full engineering considerations are applied to selection, location and installation of electrically conductive joints and electrically isolating joints including the use of underground type dielectric coatings (not paint). Adequate electrical conductivity of a pipe joint made by means other than welding must be determined by a "corrosion expert." The "corrosion expert" must be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified CP Specialist or be a registered professional engineer who has certification or licensing that includes education and experience in corrosion control. Allowable electrical resistance depends on the cross sectional area of the pipe metal, the resistivity of the pipe metal, and the effectiveness of the coating on the pipe.

Effectively coated pipe underground requires only a fraction of the electrical conductivity at joints needed for bare (uncoated) pipe. Shop painted pipe is considered to be the same as bare (uncoated) pipe and is not to be confused with pipe coated with an underground type dielectric coating.

The type of electrical isolating pipe joint to be used requires engineering design consideration. In general, the dielectric parts of an isolating joint will not withstand structural or environmental stresses as well as an all-metal type of joint. If the pipe on the cathodically protected side of the underground electrically isolating pipe joint, including the joint, is not effectively coated,

interference type corrosion may occur unless other measures are taken. Factors to be considered include:

a. Deflection stresses.

b. Pull-out stresses.

c. Expansion-contraction due to temperature changes.

d. Is function as a union joint necessary?

e. Is field assembly of critical parts practical?

f. Hazardous locations to be avoided.

g. Accessibility if above ground.

h. Location of test box if below ground.

i. Importance of coating the adjacent pipe if below ground.

j. Vulnerability to short circuiting.

Factor of safety on pull-out strength required has to be engineered for the specific conditions involved since no blanket provisions are fully applicable to all cases. The requirement for isolating flanges unions or couplings must be based on a study of the conditions. If the new piping is a short extension to an existing old piping system not under cathodic protection, an isolating fitting must be installed at the point of connection, since the new piping will be anodic to the older system. If the older system is under CP, no isolating fitting must be used.

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3.5.1 Isolation Fittings

Isolating fittings, including isolating flange kits, dielectric unions and couplings, must be installed aboveground, or within manholes, wherever possible. Where isolating joints must be covered with soil, they must be fitted with a proper joint cover specifically manufactured for covering the particular joint, and the space within the cover filled with hot coal-tar enamel or hot petrolatum wax. Isolating fittings in lines entering buildings must be located at least 305 mm 12 inch above grade of floor level, when possible. Isolating joints must be provided with grounding cells to protect against over-voltage surges or approved surge protection devices. The cells must provide a low resistance across isolating joint without excessive loss of cathodic current.

3.5.2 Dielectric Unions

[Cut pipe ends square, remove fins and burrs, cut taper pipe threads in accordance with ASME B1.20.1.] Provide isolation unions as indicated. Work piping into place without springing or forcing. Apply joint compound or thread tape to male threads only. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed. [Cover unions with an electrically insulating coating.]

3.5.3 Gas Distribution Piping

Electrical isolation will be provided at each building riser pipe to the pressure regulator, at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings. If an isolating joint is located inside a vault, the pipe must be sleeved when entering and leaving the vault. A non-metallic sleeve is to be used.

3.5.4 Joint Bonds

Provide joint bonds on metallic pipe to and across buried flexible couplings, mechanical joints, flanged joints [except at places where isolation joints are specified] and joints not welded or threaded to provide electrical continuity. Connect bond wire(s) to the structure(s) by use of exothermic weld kit(s). Clean the structure surface by scraping, filing or wire brushing to produce a clean, bright surface. [Weld connections using exothermic kits in accordance with the kit manufacturer's instructions.] Check and verify adherence of the bond to the substrate for mechanical integrity by striking the weld with a 908 gram 2 pound hammer. Cover connections with an electrically insulating coating [which is compatible with the existing coating on the structure].

3.5.5 Casings, Isolation, and Seals

Where the pipeline is installed in a casing under a roadway or railway, isolate the pipeline from the casing, and seal the annular space against intrusion of water.

3.6 FIELD QUALITY CONTROL

Field tests must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager or their designated representative. Advise the Contracting Officer or Contracting Officer's Representative [5] [_____] days prior to performing each field test. Quality control for the cathodic protection system must consist of the following:

a. Initial field testing by the contractor upon construction.

b. Government Field Testing after contractor initial field test report submission.

c. Warranty period field testing by the contractor.

d. Final field testing by the contractor after one year of service.

****

NOTE: Additional testing may be required based upon the specific project or design. All tests listed below may not be required. Designer must consider the project requirements for selection of test procedures. Specify 30 days notice for large systems to allow the government corrosion engineer to be on-site during the initial and final field

testing of the cathodic protection systems.
****

3.6.1 Tests and Measurements

3.6.1.1 Native Potentials

Notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of five (5) working days prior to each test. Base potential tests: At least [one week] [24 hours] [_____] after [backfilling of the pipe] [installation of structure to be protected] [initial operation of structures containing fluids] and installation of the anodes, but before connection of anodes to the structure, measure base (native) structure-to-electrolyte potentials of the [pipe [and casings]] [structure]. Perform measurements at anode junction boxes, test stations and other locations suitable for test purposes (such as service risers or valves), at intervals not exceeding [30] [120] [_____] meters [100] [400] [_____] feet [with readings at each end point and the midpoints as a minimum]. The locations of these measurements must be identical to the locations specified for potential measurements with anodes connected. Use the same measuring equipment that is specified for measuring protected potential measurements.

3.6.1.2 Protected Potentials

Systems must be tested and inspected by the contractor's corrosion engineer in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager corrosion protection engineer or an approved representative. Notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of five working days prior to each test. At least [one week] [24 hours] [_____] after native potential testing and connection of anodes to the structure, measure protected structure-to-electrolyte potentials. The locations of these measurements must be identical to the locations specified for native potential measurements. [For underground storage tanks, take a minimum of three measurements with the reference electrode located as follows: Directly over the longitudinal and transverse centerlines of the tank at intervals not exceeding the diameter of the tank and to a distance from the tank of two times the tank diameter.] Use the same measuring equipment that is specified for measuring protected potential measurements. Record test data, including date, time, and locations of testing and submit report to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Contractor must correct and retest, at the contractor's and Technical Expert's expense, deficiencies in the materials and installation observed by these tests and inspections.

3.6.1.3 Isolation Testing

Before the anode system is connected to the [pipe] [tank], an isolation test must be made at each isolating joint or fitting. This test will demonstrate that no metallic contact, or short circuit exists between the two isolated sections of the [pipe] [tank]. Any isolating fittings installed and found to be defective must be reported to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

3.6.1.4 Isolation Tester

An Isolation Tester designed and manufactured for use in CP, using the continuity check circuit, must be used for all isolating joint (flange) electrical testing. Testing must conform to the manufacturer's operating instructions. Test must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. An isolating joint that is good will read full scale on the meter. If an isolating joint is shorted, the meter pointer will be deflected or near zero on the meter scale. Location of the fault will be determined from the instructions, and the joint must be repaired.

3.6.1.5 Anode Output

As the anodes or groups of anodes are connected to the [pipe] [tank] [_____], current output will be measured with an approved clamp-on milliammeter, calibrated shunt with a suitable millivoltmeter or multimeter, or a low resistance ammeter. (Of the three methods, the low-resistance ammeter is the least desirable and most inaccurate. The clamp-on milliammeter is the most accurate.) The values obtained and the date, time, and location must be recorded.

3.6.1.6 Reference Electrode Potential Measurements

Upon completion of the installation and with the entire CP system in operation, electrode potential measurements must be made using a copper/copper sulfate reference electrode and a potentiometer-voltmeter, or a direct-current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements must be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements must be recorded. No less than eight (8) measurements will be made over any length of line or component. Additional measurements will be made at each distribution service riser, with the reference electrode placed directly over the service line.

3.6.1.7 Casing Tests

Before final acceptance of the installation, the electrical isolation of carrier pipe from casings must be tested and any short circuits corrected.

3.6.1.8 Holiday Test

Any damage to the protective coating during transit and handling must be repaired before installation. After field-coating has been applied, the entire pipe must be inspected by an electric holiday detector with impressed current in accordance with NACE SP0188 using a full-ring, spring-type coil electrode. The holiday detector will be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective coating must be repaired upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection must be furnished by the contractor. The coating system must be inspected for holes, voids, cracks, and other damage during installation.

3.6.1.9 Stray Current Measurements

****
NOTE: Stray current may effect foreign pipelines or other metallic structures.
****

Before final acceptance of the installation, stray current tests must be performed on any foreign [pipes] [tanks][other metallic structures] in close proximity to the installed anodes. A full report of the tests giving all details must be made.

3.6.1.10 Induced AC Testing

****
NOTE: Induced AC may affect pipelines or other metallic structures when near high AC Voltage infrastructure. NACE SP0177 and NACE SP21424.
****

Before final acceptance of the installation, induced AC Voltage tests must be performed on the [pipes] [tanks] [other metallic structures] near high AC Voltage infrastructure and where crossing above ground and underground AC transmission systems. A full report of these tests must be included in the final testing reports with all details and data taken. The touch potential of any testing over 5 volts must be reported to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Any touch potential over 10 Volts must be mitigated by effective mitigation techniques. Refer to NACE SP0177 and NACE SP21424.

3.6.1.11 Interference Tests

****
NOTE: Interference from other structures CP current may adversely affect the structure and the structure CP current may adversely affect other metallic structures.
****

Before final acceptance of the installation, interference tests will be made with respect to any foreign [pipes] [tanks] in cooperation with the owner of the foreign [pipes] [tanks]. A full report of the tests giving all details must be made. Stray current measurements must be performed at all isolating locations and at locations where the new pipeline crosses foreign metallic pipes; results of stray current measurements must also be submitted for approval. The method of measurements and locations of measurements must be submitted for approval. As a minimum, stray current measurements must be performed at the following locations:

a. Connection points of new pipeline to existing pipeline.

b. Crossing points of new pipeline with other existing metallic pipelines.

3.6.1.12 Initial Cathodic Protection System Field Testing

Initial field testing must be completed by the contractor upon completion of construction. Field testing must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager or their designated representative. Advise the Contracting

Officer or Contracting Officer's Representative [5] [_____] days prior to performing each field test. Field testing must include native and protected potentials, and anode current testing.

****

NOTE: Additional testing may be required based upon the specific project or design. Other tests may include isolation testing, casing testing, permanent reference electrode testing, stray current testing, interference testing, and induced AC testing.

****

The contractor must submit an initial field test report of the cathodic protection system. All structure-to-electrolyte measurements, including initial potentials, anode outputs, and other required testing must be recorded on applicable forms. Identification of test locations, test station and anode test stations will coordinate with the as-built drawings and be provided on system drawings included in the report. The contractor must locate, correct, and report to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager any short circuits encountered during the checkout of the installed CP system.

****

NOTE: The requirements of paragraph entitled "Government Field Testing" are required for cathodic protection projects in either the Army, Navy, Air Force or Marines area. The designer must verify their applicability to projects outside the area with the appropriate Engineering Field Division (EFD) corrosion program manager.

****

3.6.1.13 Government Field Testing

The government corrosion [engineer] [program manager] must review the contractor's initial field testing report. Approximately four weeks after receipt of the contractor's initial test report, the system will be tested and inspected in the contractor's presence by the government corrosion [engineer] [program manager]. The contractor must correct, at the contractor's expense, materials and installations observed by these tests and inspections to not be in conformance with the plans and specifications. The contractor will pay for all retesting done by the government engineer made necessary by the correction of deficiencies.

****

NOTE: For cathodic protection projects in either the Army, Navy, Air Force or Marines area, select the appropriate options for paragraphs entitled "One Year Warranty Period Testing."

****

3.6.1.14 One-Year-Warranty-Period-Testing

The contractor must inspect, test, and adjust the cathodic protection system [quarterly] [semi-annually] [_____] for one year, [4] [2] [_____] interim inspections total, to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon the completion of all cathodic protection work, including changes required to correct deficiencies identified during initial testing, and preliminary acceptance of the cathodic protection system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the One Year Warranty Period Cathodic Protection System Field Test Report, including field data, and certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or Contracting Officer's Representative, the activity, and the geographic EFD corrosion [engineer] [program manager] [Contracting Officer] [Contracting Officer's Representative] [Technical Expert] [Project Manager].

3.6.1.15 Final Acceptance Field Testing

Conduct final field testing of the cathodic protection system utilizing the same procedures specified under, "Initial Field Testing of the Galvanic Cathodic Protection Systems". The contractor will inspect, test, and adjust the cathodic protection system after one year of operation to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon preliminary acceptance for the cathodic protection system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the Final Cathodic Protection System Field Test Report, certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager and the geographic EFD corrosion [engineer] [program manager] for approval, and as an attachment to the operation and maintenance manual in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. The government corrosion [engineer] [program manager] must review the contractor's final field testing report.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Reconditioning of Surfaces

3.7.1.1 Concrete

Concrete must be 20 MPa 3000 psi minimum ultimate 28-day compressive strength with 25 mm one inch minimum aggregate conforming to [ASTM C94/C94M] [Section 03 30 00 CAST-IN-PLACE CONCRETE].

3.7.1.2 Restoration of Sod

Restore unpaved surfaces disturbed during the installation of anodes and wires to their original elevation and condition. In areas where grass cover exists, it is possible that sod can be carefully removed, watered, and stored during construction operations, and replaced after the operations are completed since it is estimated that no section of pipeline must remain uncovered for more than two (2) days. Where the surface is disturbed in a newly seeded area, re-seed the area with the same quality and formula of seed as that used in the original seeding. Seeding must be done as directed, in all unsurfaced locations where sod and topsoil could not be preserved and replaced. The use of sod in lieu of seeding will require approval by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

3.7.1.3 Restoration of Pavement

Repair pavement, sidewalks, curbs, and gutters where existing surfaces are removed or disturbed for construction. Saw cut pavement edges. Graded aggregate base course must have a maximum aggregate size of 40 millimeters 1 1/2 inches. Prime base course with [liquid asphalt, ASTM D2028/D2028M, Grade RC-70] [_____] prior to paving. Match base course thickness to existing but must not be less than 150 millimeters 6 inches. Asphalt aggregate size must be 15 mm 1/2 inch [_____], asphalt cement must [conform to ASTM D3381/D3381M, Grade AR-2000] [_____]. Match asphalt concrete thickness to existing but must not be less than 50 millimeters 2 inches. Repair Portland cement concrete pavement, sidewalks, curbs, and gutters using 20.67 MPa 3,000 psi concrete conforming to [ASTM C94/C94M] [Section 03 30 00 CAST-IN-PLACE CONCRETE.] Match existing pavement, sidewalk, curb, and gutter thicknesses.

3.7.1.4 Cleanup

The contractor is responsible for cleanup of the construction site. All paper bags, wire clippings, must be disposed of as directed. Paper bags, wire clippings and other waste will not be put in bell holes or anodes excavation.

3.7.2 Training

3.7.2.1 Instruction to Government Personnel

****

NOTE: There are restrictions on the type and extent of training. Training is usually on-site, 2 days or less. Factory representatives or others provide basic instructions to facility maintenance and operation personnel. If more extensive training is required, e.g., student travel, special consultants, consult the Contract Division Director and the head of the Comptroller Department for assistance.

****

During the warranty testing or at a time designated by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager, make available the services of a technician regularly employed or authorized by the manufacturer of the Cathodic Protection System for instructing government personnel in the proper operation, maintenance, safety, and emergency procedures of the Cathodic Protection System. The period of instruction must be not less than [two] [four] [_____] hour[s] and not more than [two] [_____] 8-hour working day[s]. Conduct the training at the jobsite or at another location mutually satisfactory to the government and the contractor. The field instructions will cover all of the items contained in the operation and maintenance manual.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 42 15 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-26 42 15.00 10 (February 2013)
UFGS-26 42 22.00 20 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 26 - ELECTRICAL

SECTION 26 42 15

CATHODIC PROTECTION SYSTEM FOR THE INTERIOR OF STEEL WATER TANKS

05/21

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PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-26 42 15 (May 2021)**

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SECTION 26 42 15

CATHODIC PROTECTION SYSTEM FOR THE INTERIOR OF STEEL WATER TANKS
05/21

****
NOTE: This guide specification covers the requirements for steel water tank cathodic protection systems using either galvanic or impressed current systems (impressed current or galvanic anodes).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and must be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Each Service has a specialized facilities engineering activity: Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) for the Navy and Marine Corps, Engineering Research and Development Center (ERDC) for the Army, and Air Force Civil Engineering Corps (AFCEC) for the Air Force, has significant experience and technical expertise in the area of field testing and commissioning of new systems. If Reach-Back support is required, the technical representative (electrical engineer) editing this document for a specific project must contact the NAVFAC EXWC Design and Construction Department" and the relevant ERDC and AFCEC departments for consultation during the

design stage of the project and include the bracketed option in the 'Submittals' section.
****

****
NOTE: One of the major factors influencing selection of the type of cathodic protection system is the resistivity of the water involved. When the water resistivity is higher than 10,000 ohm-cm, impressed current systems are usually used. Other considerations include availability of electric power and the costs of installation, operation and maintenance. Where relatively large currents are required and reasonable access to power is available, the impressed current system will generally be found to be more economical. The requirements for the cathodic protection systems should be determined by a corrosion engineer following the criteria, design, and installation recommendations included in the National Association of Corrosion Engineers Standard; SP-0388, "Impressed Current Cathodic Protection of Internal Submerged Surfaces of Steel Water Tanks", and SP0-196, "Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks".
****

****
NOTE: The following information must be shown on the drawings:

1. Dimensions of tank, including riser (if tank is elevated), structural supports and overflow.

2. Locations of all equipment, including anodes, reference electrodes, junction boxes, test boxes, rectifiers, power connections (with branch circuit source), wire conduit, and remote monitoring equipment.

3. Installation details for anodes, test stations and rectifiers.

4. Electrical single-line diagrams, elevations, limiting dimensions, and equipment ratings which are not covered in the specification.

4. Single-line diagrams elevations, limiting dimensions, and equipment ratings which are not covered in the specification.

5. Remote indicating or control requirements.

6. Grounding (riser diagrams).
****

PART 1 GENERAL

****

NOTE: The requirements for the cathodic protection systems must be determined by a corrosion engineer following the criteria, design, and installation recommendations included in the National Association of Corrosion Engineers (NACE) Standard Practice NACE SP0388(2018) Impressed Current Cathodic Protection of Internal Submerged Surfaces of Carbon Steel Water Storage Tanks, NACE SP0196,(2015) Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks, and others listed in the specification.

****

****

NOTE: The following information must be on the drawings:

1. Installation details for anodes and test stations.

2. Location of equipment.

3. Single-line diagrams elevations, limiting dimensions, and equipment ratings which are not covered in the specification.

4. Remote indicating or control requirements.

5. Grounding.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA D104	(2011) Automatically Controlled, Impressed-Current Cathodic Protection for the Interior Submerged Surfaces of Steel Water Storage Tanks

ASTM INTERNATIONAL (ASTM)

ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A518/A518M	(1999; R 2022) Standard Specification for Corrosion-Resistant High-Silicon Iron Castings
ASTM B3	(2013; R 2024) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B418	(2016a; R2021) Standard Specification for Cast and Wrought Galvanic Zinc Anodes
ASTM B843	(2018) Standard Specification for Magnesium Alloy Anodes for Cathodic Protection
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D2028/D2028M	(2015; R 2021) Cutback Asphalt (Rapid-Curing Type)
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction
ASTM F1182	(2007; R 2023) Anodes, Sacrificial Zinc Alloy

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2023) National Electrical Safety Code
IEEE C135.30	(1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

NACE INTERNATIONAL (NACE)

NACE SP0188	(2024) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE SP0193	(2016) Application of Cathodic Protection to Control External Corrosion of Carbon Steel On-Grade Storage Tank Bottoms
NACE SP0196	(2020) Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks
NACE SP0388	(2018) Impressed Current Cathodic Protection of Internal Submerged Surfaces of Carbon Steel Water Storage Tanks - Item No. 21040

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
NEMA BI 50009	(2024) Low Voltage Cartridge Fuses
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA RN 1	(2018) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

NEMA ST 1	(1988; R 1994; R 1997) Specialty Transformers (Except General Purpose Type)
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-18001	(1993) Anodes, Sacrificial Zinc Alloy
MIL-I-1361	(1985; Rev C; Notice 1 1991; Notice 2 2021) Instrument Auxiliaries, Electrical Measuring: Shunts, Resistors and Transformers

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2024) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Mar 2024) UL Standard for

	Safety Conduit, Tubing and Cable Fittings
UL 854	(2020; Reprint Jul 2024) Standard for Service-Entrance Cables

1.2 DEFINITIONS

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Cathodic Protection is a method used to control corrosion.

1.2.1 Cathodic Protection

Cathodic Protection (CP) is an electrochemical (half electrical and half chemical) method used to control corrosion of buried or submerged metallic structures. It prevents corrosion by making the protected structure a cathode by installing a more anodic metal (sacrificial or galvanic) anode or a metallic (impressed current) anode connected to a Direct Current (DC) power source. When the proper amount of current is applied to the structure, it becomes a cathode. Since all corrosion occurs at the anode, the structure no longer corrodes. The electrons move in the metallic path (electrical). Reduction (chemical) reactions occur at the surface of the cathode resulting in a hydrogen coating and more alkaline environment. Oxidation (chemical) reactions occur at the surface of the anode resulting in corrosion and a more acidic environment. After a CP system is installed and adjusted to provide adequate protection, the hydrogen coats the defects in the coating and polarizes in the negative direction (to a copper/copper sulfate reference electrode) over time the current and potentials remain relatively stable; changes in currents or potentials indicate a problem. An error-free measurement of negative 850 millivolts DC or more negative to the copper/copper-sulfate reference electrode proves the structure is a cathode and corrosion has been mitigated.

1.2.2 Corrosion

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Some of the eight forms of corrosion are unique, but all of them are more or less interrelated.

The eight forms of corrosion are: (1) Uniform Attack, (2) Galvanic or Two-Metal Corrosion, (3) Crevice Corrosion, (4) Pitting Corrosion, (5) Intergranular Corrosion, (6) Selective Leaching, (7) Erosion Corrosion, and (8) Stress Corrosion Cracking. This listing is arbitrary but covers practically all corrosion failures and problems. The forms are not listed in any particular order of importance. Below, the eight forms of corrosion are discussed in terms of their characteristics, mechanisms, and preventive measures. Hydrogen damage, although not a form of corrosion, often occurs indirectly as a result of corrosive attack and is, therefore, included in this discussion.

1.2.3 Alternating Current (AC) Corrosion

AC corrosion occurs when there is a source of AC current, typically from a high voltage overhead AC (OHAC) power-line, when there is a low soil resistivity - typically less than 5,000 ohm-cm and there is very small coating holidays. The AC corrosion pits typically have a tubercle of corrosion product at the pit. AC interference study modeling software can determine the mitigation solution to solve this problem. Typically, AC Corrosion mitigation is done in conjunction with high AC potentials and fault current mitigation.

1.2.4 AC Interference

AC interference occurs when a pipeline parallels a high-voltage overhead AC (OHAC) power-line. An interference study is required when this situation occurs as AC interference can cause high AC potentials along the pipeline (safety), can cause a fault condition between the pipeline and power-line and could cause AC corrosion to occur. The pipeline coating when exposed can have blisters/bubbles caused by the excessive AC. The interference study will use modeling software to determine what combination of interference may be occurring (if any) and provide the mitigation solution to solve the problem.

1.2.5 Uniform Attack

Uniform attack is the most common form of corrosion. It is normally characterized by a chemical or electrochemical reaction that proceeds uniformly over the entire exposed surface or over a large area. The metal becomes thinner and eventually fails. For example, a piece of steel or zinc immersed in dilute sulfuric acid normally dissolves at a uniform rate over its entire surface. A sheet iron roof shows essentially the same degree of rusting over its entire outside surface.

Uniform attack, or general overall corrosion, represents the greatest destruction of metal on a tonnage basis. This form of corrosion, however, is not of great concern from a technical standpoint, because the life of equipment can be accurately estimated on the basis of comparatively simple tests. Merely immersing specimens in the fluid involved is often sufficient. Uniform attack can be prevented or reduced by (1) materials, such as coatings, that reduce contact between metal and electrolytes, (2) inhibitors, or (3) cathodic protection.

1.2.6 Galvanic or Two-Metal Corrosion

A potential difference usually exists between two dissimilar-metals when they are immersed in a corrosive or conductive solution. If these metals are placed in contact (or otherwise electrically connected), this potential difference produces electron flow between them. Corrosion of the less corrosion-resistant metal is usually increased, and attack of the more resistant material is decreased, compared to the behavior of these metals when they are not in contact. The less resistant metal becomes anodic and the more resistant metal becomes cathodic. Usually the cathode or cathodic metal corrodes very little or not at all in this type of couple. Because of the electric currents and dissimilar-metals involved, this form of corrosion is called galvanic, bi-metallic or two-metal, corrosion. Galvanic corrosion is restricted to electrochemical corrosion caused by dissimilar-metal effects. It is electrochemical corrosion, but this document must restrict the term galvanic to dissimilar-metal effects for purposes of clarity.

1.2.7 Crevice Corrosion

Intense localized corrosion frequently occurs within crevices and other shielded areas on metal surfaces exposed to corrosives. This type of attack is usually associated with small volumes of stagnant solution caused by holes, gasket surfaces, lap joints, surface deposits, and crevices under bolt and rivet heads. As a result, this form of corrosion is called crevice corrosion or, sometimes, deposit or gasket corrosion.

1.2.8 Pitting Corrosion

Pitting is a form of extremely localized attack that results in holes in the metal. These holes may be small or large in diameter, but in most cases they are relatively small. Pits are sometimes isolated or so close together that they look like a rough surface. Generally a pit may be described as a cavity or hole with the surface diameter about the same as or less than the depth. Pitting is one of the most destructive and insidious forms of corrosion. It causes equipment to fail because of perforation with only a small percent weight loss of the entire structure. It is often difficult to detect pits because of their small size and because the pits are often covered with corrosion products. In addition, it is difficult to measure quantitatively and compare the extent of pitting because of the varying depths and numbers of pits that may occur under identical conditions. Pitting is also difficult to predict by laboratory tests. Sometimes the pits require a long time (several months or a year) to show up in actual service. Pitting is particularly vicious because it is a localized and intense form of corrosion, and failures often occur with extreme suddenness.

1.2.9 Intergranular Corrosion

Grain boundary effects are of little or no consequence in most applications or uses of metals. If a metal corrodes, uniform attack results since grain boundaries are usually only slightly more reactive than the matrix. However, under certain conditions, grain interfaces are very reactive and intergranular corrosion results. Localized attack at and adjacent to grain boundaries, with relatively little corrosion of the grains, is intergranular corrosion. The alloy disintegrates (grains fall out) or loses its strength. Intergranular corrosion can be caused by impurities at the grain boundaries, enrichment of one of the alloying elements, or depletion of one of these elements in the grain-boundary areas. Small amounts of iron in aluminum, wherein the solubility of iron is low, have been shown to segregate in the grain boundaries and cause intergranular corrosion. It has been shown that, based on surface tension considerations, the zinc content of a brass is higher at the grain boundaries. Depletion of chromium in the grain-boundary regions results in intergranular corrosion of stainless steels.

1.2.10 Selective Leaching

Selective leaching is the removal of one element from a solid alloy by corrosion processes. The most common example is the selective removal of zinc in brass alloys (dezincification). Similar processes occur in other alloy systems in which aluminum, iron, cobalt, chromium, and other elements are removed. Selective leaching is the general term to describe these processes, and its use precludes the creation of terms such as de-aluminumification, de-cobaltification. Parting is a metallurgical term that is sometimes applied, but selective leaching is preferred.

1.2.11 Erosion Corrosion

Erosion corrosion is the acceleration or increase in rate of deterioration or attack on a metal because of relative movement between a corrosive fluid and the metal surface. Generally, this movement is quite rapid, and mechanical wear effects or abrasion are involved. Metal is removed from the surface as dissolved ions, or it forms solid corrosion products, which are mechanically swept from the metal surface. Sometimes, movement of the environment decreases corrosion, particularly when localized attack occurs under stagnant conditions; this is not erosion corrosion because deterioration is not increased. Erosion corrosion is characterized in appearance by grooves, gullies, waves, rounded holes, and valleys and usually exhibits a directional pattern. In many cases, failures because of erosion corrosion occur in a relatively short time, and they are unexpected largely because evaluation corrosion tests were run under static conditions or because the erosion effects were not considered.

1.2.12 Stress-Corrosion Cracking

Stress-corrosion cracking refers to cracking caused by the simultaneous presence of tensile stress and a specific corrosive medium. Many investigators have classified all cracking failures occurring in corrosive media as stress-corrosion cracking, including failures due to hydrogen embrittlement. However, these two types of cracking failures respond differently to environmental variables. To illustrate, CP is an effective method for preventing stress-corrosion cracking; however, hydrogen-embrittlement may be caused when excessive current is applied, especially on stainless steel. Hence, the importance of considering stress-corrosion cracking and hydrogen embrittlement as separate phenomena is obvious. During stress-corrosion cracking, the metal or alloy is virtually unattacked over most of its surface, while fine cracks progress through it. This cracking phenomenon has serious consequences, since it can occur at stresses within the range of typical design stress.

1.2.13 Exothermic Welding

Exothermic welding is used in CP to connect a copper wire to a metallic structure, usually steel or cast-iron. It is a pyrotechnic composition of copper oxide, aluminum powder and magnesium powder. The magnesium powder is ignited with a spark gun or electronic ignition equipment. The aluminum powder serves as fuel, and melts the copper oxide, which bonds the wire to the structure. Although not explosive, it can create brief bursts of heat and high temperature in a small area.

1.2.14 Error-Free

Potential measurement error due to a voltage drop caused by current flowing through a resistor (the electolyte) between the reference electrode and the protected structure.

1.3 ADMINISTRATIVE REQUIREMENTS

After award of the contract, but prior to commencement of any work at the site, meet with the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Develop a mutual understanding relative to the administration of the value engineering, the safety program, preparation of the schedule of prices or the earned value report. Review shop drawings, other submittals, scheduling programming, execution of the work, and clear expectations of the "Interim Department of Defense (DD) Form 1354" submittal. Major subcontractors who will engage in the work must also attend.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Submit all detail drawings at one time, as a single submittal, to demonstrate that the items have been properly coordinated and will function properly as a unit. Make a notation on each shop drawing submitted as to the item's specific use, either by a particular number referenced on the drawings or in the specifications, or by a description of its specific location.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preconstruction Survey

SD-02 Shop Drawings

Drawings; G, [_____]

Wiring and Schematic Diagram

Anode junction boxes

Contractor's Modifications; G, [_____]

SD-03 Product Data

Qualifications

Equipment; G, [_____]

Components; G, [_____]

Rectifiers; G, [_____]

Remote Monitoring Equipment; G, [_____]

Anodes; G, [_____]

Permanent reference electrodes; G, [_____]

Anode junction boxes

Cable and wire

Shunts

Extra Materials; G, [_____]

Spare Parts

SD-05 Design Data

Contractor's Modifications; G, [_____]

SD-06 Test Reports

Anode Connecting Cables

Rectifier Testing

SD-10 Operation and Maintenance Data

Cathodic Protection System; G, [_____]

Training Course;; G, [_____]

Contractor's Modifications; G, [_____]

SD-11, Closeout Submittals

Initial Cathodic Protection System Testing; G, [_____]

One Year Warranty Period Cathodic Protection System Field Test Report; G, [_____]

Final Acceptance Field Testing; G, [_____]

1.4.1 Material and Equipment Manufacturer Data

DATE	ISSUE NO.	REQUEST	REQUESTED BY	REQUEST REF.
MANUFACTURER NAME				
DESCRIPTION OF EQUIPMENT				

1.5 MAINTENANCE MATERIAL SUBMITTALS

1.5.1 Spare Parts

After approval of shop drawings, furnish spare parts data for each different item of material and equipment specified. The data must include a complete list of parts, special tools, and supplies, with current unit prices and source of supply.

After approval of shop drawings, furnish revised spare parts for any changes made from original submittal. One spare anode of each type must be furnished. In addition, supply information for material and equipment replacement for all other components of the complete system, including anodes, cables, splice kits and connectors, corrosion test stations, and any other components not listed above. Furnish [one reference electrode on a hand reel with 120 meters 350 feet of conductor], [one digital voltmeter that can be used in the maintenance of this CP system]. Demonstrate use of furnished equipment in actual tests during the training course. Provide a description of equipment of the pipe-to-soil protected structure and foreign structures at electrical isolation between the utility supplier and the facility piping.

1.5.2 Extra Materials

Furnish [one submersible reference electrode on a reel with enough wire to reach the bottom of the tank, or the bottom of the riser as required] and [one high input impedance multimeter that can be used in the maintenance of this CP system]. Demonstrate equipment in actual tests during the training course. Include a description of the equipment and measurement of the tank-to-water potentials, anode voltage, anode current and water level.

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

Obtain the services of a corrosion expert to supervise, inspect, and test the installation and performance of the CP system. The term "corrosion expert" refers to a person, who by thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried or submerged metallic structures.

1.6.2 Qualifications

The corrosion expert must be accredited or certified by NACE International, as a CP-4 CP Specialist or be a NACE International certified Corrosion Specialist or a registered professional engineer who has certification or licensing that includes education and experience in CP of the type of CP system being installed. The corrosion expert must have not less than [three] [five] [_____] years of experience in the type of CP for buried or submerged metallic structures under this contract. Submit evidence of qualifications of the corrosion expert including their name and qualifications certified in writing to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager prior to the start of construction. Certification must be submitted giving the name of the firm, the number of years of experience, and a list of not less than five of the firm's installations, three or more years old, that have been tested and found satisfactory.

1.6.3 Services of Corrosion Expert

The corrosion expert must make a minimum of three visits to the project site. The first of these visits will include obtaining water/electrolyte resistivity data, acknowledging the type of tank coatings to be used and reporting to the contractor the type of CP required (GACP or ICCP). Once the submittals are approved and the materials delivered, the corrosion expert will revisit the site to verify the materials meet submittal requirements, ensure the contractor understands installation practices and that the contractor is capable and qualified to complete the installation.

The "corrosion expert" will be available (but not necessarily be onsite the entire time) during the installation of the CP system to answer questions, approve any changes or additions required during construction, or to provide recommendations as required. The third visit is to complete the training and demonstrations to applicable personnel on proper testing and maintenance techniques and to complete testing the installed CP systems to ensure it has been installed properly and meets adequate CP criteria. An additional visit is required if the One-Year-Warranty-Period-Testing is required.

1.7 DELIVERY, STORAGE AND HANDLING

Storage area for corrosion material will be designated by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and

Project Manager. If materials are not stored in a building, tarps or similar protection must be used to protect materials from inclement weather.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

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NOTE: The environmental requirements with which the contractor must comply must be developed during the design process, included in the bidding documents, and made a part of the contract.

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1.8.2 Existing Conditions

Prior to start of any onsite construction activities, perform a Preconstruction Survey of the project site with the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager, and take photographs showing existing environmental conditions in and adjacent to the site. Submit a report for the record. Include in the report a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the contractor's assigned storage area and access route(s), as applicable. The Contractor and the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager will sign this survey report upon mutual agreement regarding its accuracy and completeness. Protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference that their preservation may cause to the work under the Contract.

1.9 WARRANTY

Provide equipment items that are supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Corrosion Control System Description

Coating Systems (CS) are a critical factor in performance of all CP systems. All coatings, including coatings in structure guide specifications and Green Seal (GS) coatings, must be compatible with the structure and the CP system, and have high disbondment capabilities. A high resistance to cathodic disbondment is critical for long term service life of coatings on buried or submerged metallic structures under CP. Due to the limited voltage and current of galvanic anodes, a highly dielectric bonded coating is required to attain adequate protective current distribution using galvanic CP systems. For paints and coatings refer to Section 09 97 13.16 INTERIOR COATING OF WELDED STEEL WATER TANKS. For discontinuity (Holiday) testing of new protective coatings on conductive substrates refer to NACE SP0188. Discontinuity (Holiday) Testing of New

Protective Coatings on Conductive Substrates.

a. Construction Design Requirements (CDR) for the interior of steel water tanks are found in the UFGS. Section 33 16 15 WATER STORAGE STEEL TANKS NACE SP0196 and NACE SP0388, External CP of On-Grade Carbon Steel Tank Bottoms NACE SP0193.

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NOTE: Some state and local health agencies have listings of acceptable paint materials to be used for the interior of potable water tanks and to be used on the exterior of structures. As an example, the State of California will not allow vinyl paints to be applied due to air emission restrictions. The designer must contact the appropriate state and local authorities to determine if the paint systems are acceptable. If these systems are not acceptable, the designer must determine the best acceptable system and revise this specification accordingly. However, any deviation from this specification and American Water Works Association (AWWA} Standards must be submitted with justification to Civil Emergency Management Program (CEMP-ET) for approval.

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NOTE: Any AC test voltage over 15 VAC must be mitigated.

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NOTE: This specification covers a CP system for metal surfaces against corrosion by producing a continuous flow of direct current from impressed current or galvanic anodes to the metal to be protected. The anodes should be of sufficient size and quantity to protect the submerged metal items for a specified number of years before replacement.

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NOTE: Provide impressed current CP and protective coatings for the interior submerged surfaces of potable water storage tanks, including bolted panel tanks in accordance with NSF/ANSI/CAN 61 and UFC 3-570-01. Galvanic Anodes are not allowed in potable water tanks, Reference: NSF/ANSI/CAN 61.

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NOTE: Construction Design Requirements (CDR) for the interior of steel water tanks are found in the UFGS for water storage tanks Section 33 16 15 WATER STORAGE STEEL TANKS and NACE SP0388, Impressed Current CP of Internal submerged Surfaces of Steel Water Storage Tanks or NACE SP0196 Galvanic CP of Internal submerged Surfaces of Steel Water Storage Tanks.

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NOTE: This UFGS is for internal CP of Submersed Surfaces of Steel Water Storage Tanks. For the external CP of On-Grade Carbon Steel Tank Bottoms refer to UFGS for impressed current or galvanic CP for buried or submerged metallic structures and NACE SP0193.

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2.1.2 Design Requirements

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NOTE: The following information must be shown on the drawings: Dimensions of tank, including riser (if tank is elevated), structural supports and overflow. Locations of all anodes, reference electrodes, junction boxes, test boxes, rectifiers, power connections, wire and conduit. Installation details for anodes and rectifiers. Electrical single-line diagrams, elevations, limiting dimensions, and equipment ratings which are not covered in the specification. Remote indicating or control requirements.

****

2.1.2.1 Drawings

Submit [six] [_____] copies of detail drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, contractor's modifications, results of system design calculations including water/electrolyte-resistivity, installation instructions and certified test data showing location of anodes and stating the maximum recommended anode current output density. Include in the detail drawings complete wiring and schematic diagrams, permanent reference electrodes and bonding and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. Reference locations to two permanent facilities or mark points. Provide [one] [_____] electronic [digital] [PDF] [_____] copy and digital photos of the completed installation.

2.1.2.2 Summary of Services Required

Include the following scope of services:

a. CP Installation System requirements,

b. System testing,

c. Training,

d. Operating and maintenance manual,

e. Coating and holiday testing.

Take potential test measurements on all permanent reference electrodes, witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

Provide submittals identifying test locations on separate drawing, showing all metal to be protected and all CP equipment. Distinguish and identify test points equipment and protected metal.

2.1.3 Performance Requirements

The design must allow for synchronized interruption of all applied current.

2.1.3.1 Criteria of Cathodic Protection

The design must allow for synchronized interruption of all applied current. Criteria for adequate CP must be identified by the designer or the contractor's corrosion engineer and approved by the Government corrosion engineer. The method of voltage drop consideration must also be identified by the contractor's corrosion engineer and approved by the Government. Use of the 100 mV shift criteria is not applicable to bi-metallic structures.

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NOTE: Refer to applicable current NACE International Standard Practice NACE SP0388 Impressed Current Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks or NACE International Standard Practice NACE SP0196 Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks to determine the appropriate criteria. Other criteria may not be applicable to this type of CP system(s) and structure being designed. The designer or the contractor's corrosion engineer may select the applicable criteria with approval of the Government.

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a. The measurements for the native potential measurement must be made before the CP system is energized. If CP has previously been applied, use the polarized potentials or the polarization decay potentials to determine if adequate CP has been achieved.

b. Determination of the on and polarized (instant off) potentials must be made with the protective current applied to the [structure] [tank] for a minimum of [2] [4] [7] [_____] [days].

c. The polarization decay (off) potentials must be made with the protective current off for a minimum of [24] [48] [_____] hours.

d. Polarized (instant off) potentials and polarization decay potentials must be made with the reference electrode at the same location.

e. The polarization decay will be the difference between the polarized potential and the polarization decay (off) potential made after the interruption of protective current.

2.1.3.1.1 Maximum Potential

The polarized potential between a copper/copper sulfate reference electrode and the tank [riser pipe] at any point must not be more negative than a negative 1.1 volts (with the protective current interrupted instantaneously or modulated). Do not use on potentials to determine maximum allowed potentials.

2.1.3.1.2 Tanks Subject to Icing Conditions

Suspend anodes in a manner similar to that in non-icing climates, except provisions must be made to prevent the anodes and suspending cables from being damaged by freezing or falling ice or by suspended floating flexible anode rings from the tank walls.

2.2 EQUIPMENT

2.2.1 Remote Monitoring

Remote monitoring equipment must be designed, manufactured and procured specifically for CP use and must be provided as per design and drawings to monitor [potential (requires permanent reference electrode)] [bond(s)] [interference bond] [test station(s) shunts] [_____] and must match or be compatible with previously installed remote monitoring equipment in use at the installation.

2.2.2 Corrosion Rate Monitoring

Corrosion probes must be designed, manufactured and procured specifically for the application and matched to the structure being protected. Manufacturer must match or be compatible with previously installed rate monitoring equipment in use at the installation.

2.2.3 Rectifiers

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NOTE: Below about 500 volt-amperes of dc rating output, single phase selenium rectifiers cost less to acquire and operate than silicon rectifiers. Above 1000 volt-amperes silicon rectifiers are more economical for both single phase and three phase. Silicon rectifiers are more economical to repair.

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2.2.3.1 Air Cooled Enclosure

NEMA ICS 6 Type [3] [3R] [3X] [4X] Air Cooled enclosure suitable for [wall] [post] [pad] mounting. Enclosures must be of 3.1 mm (11 gauge) steel or heavier. Enclosure must include front hinged door with [padlock hasp] [key lock, provide [three] [_____] keys.] [locks keyed alike.] [left side door] [right side door] fit with screened openings to provide for cooling by natural convection. Provide holes, conduit knockouts and threaded hubs of sufficient size and location. The cabinet and mounting support must be [painted][hot-dipped galvanized] [aluminum] [stainless] steel [according to the manufacturer's standards].

2.2.3.2 Oil Cooled Enclosure

NEMA ICS 6 Type 11-Oil Immersed Enclosure, suitable for pad mounting. Enclosure must include top hinged door with [padlock hasp] [key lock, provide [three] [_____] keys.] [locks keyed alike.] Enclosures must be of 3.1 mm 11 gauge steel or heavier, with an accessible drain plug. The oil level must be clearly marked. The lid must be hinged and have quick release clamps to secure it in the closed position. A stop must limit the swing of the lid when opened. A compressible, oil resistant, positive sealing gasket must be provided. The gasket must return to its original shape upon release of lid pressure. The gasket attached to the tank or lid and joints must be free of gaps. Base mounting using 102 mm 4 inch high channels provided. Conduits entering the enclosure must be internally sealed and enter or exit above the oil fill line.

2.2.3.3 Explosion Proof Enclosure

NEMA ICS 6 Type 7 Explosion Proof Enclosure suitable for pad mounting. Enclosure must include top hinged lid with [padlock hasp] [key lock, provide [three] [_____] keys.] [locks keyed alike.] Enclosures must be of 3.1 mm 11 gauge steel or heavier, with an accessible drain plug. The oil level must be clearly marked. The lid must have quick release clamps to secure it in the closed position. A stop must limit the swing of the lid when opened. A compressible, oil resistant, positive sealing gasket must be provided. The gasket must return to its original shape upon release of lid pressure. The gasket attached to the tank or lid and joints must be free of gaps. Base mounting using 102 mm 4 inch high channels provided. Conduits entering the enclosure must be internally sealed and enter or exit above the oil fill line.

2.2.3.4 Cabinet Paint System

[The cabinet and mounting support must be [painted] [hot dipped galvanized] [aluminum] [stainless steel] with the manufacturer's standard painting system.] [The mounting support for the fiberglass cabinet must be [painted] [hot dipped galvanized] [aluminum] [stainless steel] with the manufacturer's standard painting system.]

****

NOTE: Below about 500 volt-amperes of dc rating output, single phase selenium rectifiers cost less to acquire and operate than silicon rectifiers. Above 1000 volt-amperes silicon rectifiers are more economical for both single phase and three phase. Silicon rectifiers are more economical to repair.

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2.2.3.5 Transformers

UL 506 and NEMA ST 1, as applicable.

2.2.3.6 Electrical Ratings

Electrical ratings as follows: Input voltage at 60 Hz: [[115] [208] [230] volts single phase] [[208] [230] [460] volts three phase].

a. Output voltage, dc: [9] [12] [18] [24] [_____] volts [as indicated].

b. Output current, dc: [8] [16] [24] [32] [_____] amperes [as indicated].

The rectifier must be capable of supplying continuous full rated output at an ambient temperature of 44 degrees C 112 degrees F in full sunlight with expected life of 10 years minimum.

2.2.3.7 Rectifying Elements

Provide silicon diode rectifying elements, connected in such manner as to provide full-wave rectification. [Protect silicon diodes with selenium cells or varistors against overvoltage surges and by current limiting devices against overcurrent surges.]

2.2.3.8 Wiring and Schematic Diagram

Provide a complete wiring and schematic diagram of the power unit showing both the ac and the dc connections to anodes on the inside of the cabinet door. Show and label components.

2.2.3.9 Overload and Short Circuit Protection

Provide UL 489, single-pole, flush-mounted molded case circuit breaker, [magnetic] [thermal-magnetic] type, in the primary circuit of the rectifier supply transformer.

2.2.3.9.1 Circuit Breaker(s)

A [single] [double] [three]-pole, flush-mounted, fully magnetic, properly rated non-terminal type circuit breaker must be installed in the primary circuit of the rectifier supply transformer.

2.2.3.9.2 Fuses

Cartridge-type fuses conforming to NEMA BI 50009. Provide suitable fuse holders in each leg of the D.C. circuit.

2.2.3.9.3 Surge Protection

Protect silicon diodes by use of AC and DC lightning arresters or metal oxide varistors against overvoltage surges and by current-limiting device against overcurrent surges.

2.2.3.10 DC Output Control

Provide adjustable DC output voltage by [transformer taps] [automatic controls].

2.2.3.10.1 Transformer Taps

****

NOTE: A minimum of five coarse and five fine taps is recommended to provide sufficient voltage adjustment. Variacs must not be used where subjected to corrosive or marine air atmospheres.

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[Transformer taps, [5] [_____] coarse, [5] [_____] fine.] [Variac.] [_____].

2.2.3.10.2 Automatic Controls

Provide a control system capable of maintaining a preselected tank-to-water potential, within plus or minus 0.025 volt regardless of changes in water chemistry, temperature, or water level in the tank. [Provide separate dc output circuits, means of adjustment, reference electrodes, and metering for the tank bowl and riser pipe.] Make provisions for readily changing the range and limits of the operating potential. Refer to AWWA D104 Automatically Controlled Impressed-Current Cathodic Protection for the Interior Submerged Surfaces of Steel Water Storage Tanks.

2.2.3.11 Meters

Provide separate panel voltmeter and ammeter, not less than 63.5 mm 2 1/2 inch [round] [rectangular] 2 percent full scale accuracy at 30 degrees C 80 degrees F, temperature stability above and below 30 degrees C 80 degrees F of at least 1 percent per 5 degrees C 10 degrees F. Provide toggle switch for each meter.

2.2.3.12 Grounding Provisions

Grounding provisions must [be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.] [comply with NFPA 70 and UL 467 including a ground terminal in the cabinet.] The grounding conductor from the terminal to the earth grounding system must be solid or stranded copper not smaller than No. 6 AWG. Provide an earth grounding system consisting of one or more rods. Ground rods must be [copper-clad steel conforming to UL 467] [zinc-coated steel conforming to IEEE C135.30] [solid stainless steel] not less than [16] [19] mm [5/8] [3/4] inch in diameter by [2.4] [3.1] m [8] [10] feet in length. Drive rods full length into the earth. Sectional type rods may be used.

2.2.3.13 Resistance to Ground

****

NOTE: Remove this paragraph if not required in the project.

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Measure the resistance to ground using the fall-of-potential method described in IEEE 81. The maximum resistance of driven ground must not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, [_____] additional rods not less than 1.8 m 6 feet on centers, or if sectional type rods are used, [_____] additional couple sections and drive with the first rod. In high-ground-resistance, use UL listed chemically charged ground rods. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager immediately. Exothermically weld all connections below grade. Exothermically weld connections above grade or use UL 467 approved connectors.

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NOTE: Exothermic welding is not recommended for splicing since it is a higher resistance splice that also degrades the conductivity of the conductors. The most recent mechanical or hydraulic-crimp splice results in no degradation of the conductivity of the conductors and is not dependent on the ambient conditions.

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2.2.3.14 Efficiency

Overall efficiency of [65 percent] [90 percent] [_____] minimum when operated at full output.

2.2.3.15 Optional Rectifier Special Required Features

[1. An efficiency filter (choke) (may be required to improve the rectifiers efficiency). [capacitor] (A capacitor may also be required to be used in conjunction with the filter to further improve the efficiency and minimize noise.)

][2. Convenience Outlet mounted on Faceplate

][3. Safety shield panel covering Taps or all energized conductors on faceplate

][4. Stainless Steel Perforated screens on Air Cooled Rectifiers

][5. Heavy duty Draw-pull Stainless steel cabinet latch

][6. Separate Slide-out equipment racks for Transformer and Stack

][7. Additional [_____]coarse or [_____] fine voltage control link bar taps

][8. Quick-change, heavy-duty knobs for changing tap link bars Minimum 5/16" diameter

][9. Soldered tap changing studs 3/16" Grade XX

][10. Phenolic front panel

][11. Nickel Plated and double-nutted or soldered connections

][12. Terminal block for AC input wires

][13. Terminal block for Remote Monitoring Connections

][14. Primary tap change panel for dual input voltages (Single Phase models only)

]

2.2.3.16 Potable Water Storage Tanks

Provide CP and protective coatings for the interior submerged surfaces of potable water storage tanks, including bolted panel tanks in accordance with NSF/ANSI/CAN 61. Include requirements in the contract specifying that the contractor is responsible for providing an interior coating system and ensuring that the coating system is compatible with an impressed current CP (ICCP) system, if specified, and NSF/ANSI/CAN 61. For bolted panel storage tanks, require the contractor to ensure all panels of a bolted panel storage tank are electrically continuous.

2.2.3.17 Fire Protection Water Storage Tanks

Fire protection water storage tanks are mission critical facilities and must be properly protected against corrosion. Provide an ICCP system for the interior submerged surfaces of all fire protection water storage tanks, including bolted panel tanks. When the backfill beneath an on-grade tank is corrosive, provide an ICCP system for the exterior bottom of the on-grade tank. Refer to UFGS Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM, NACE International SP0193 External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms. Include requirements in the contract specifying that the contractor is responsible for providing an interior coating system and ensuring that the coating system is compatible with the ICCP system. For bolted panel storage tanks, require the contractor to ensure all panels of a bolted panel storage tank are electrically continuous.

For Navy projects, allow ICCP or galvanic anode (GCP) systems for fire protection water storage tanks. See above references and UFGS Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM.

2.3 COMPONENTS

2.3.1 Junction Box Enclosures (Access and Physical Protection)

NEMA ICS 6, Type [3R] [4X] [_____] enclosure with [clamped cover] [Type [304] [316] stainless steel hinges and [clamped] [latched] cover] [and padlocked hasp]. Enclosure must be of [galvanized steel] [painted steel] [aluminum] [fiberglass] [non-metallic] construction with terminal board. Knockout for conduit must be the size and location as per design drawings.

2.3.2 Shunts for Junction Boxes

[MIL-I-1361.] [0.1] [0.01] [_____] ohm, [2] [8] ampere, accuracy plus or minus one percent, polycarbonate circuit board type, color coded for value recognition [red for 0.1 ohm shunt] [yellow for 0.01 ohm shunt] with Nickel plated brass posts and standard [64] 6.35 mm 0.25 inch holes on 2.54 cm 1 inch centers to fit test stations and terminal boards 0.01 ohm 6 ampere, accuracy plus or minus one percent, manganin (Trade Mark/alloy).

2.3.2.1 Nameplates

Provide nameplate in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and ASTM D709. Provide laminated plastic nameplates for each enclosure as specified or as indicated on the drawings. Each nameplate inscription must identify the function. Nameplates will be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface will be matte finish. Corners will be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 635 mm 25 inch by 65 mm 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.3.3 Terminal Boards

Provide terminal boards for anode junction boxes, bonding boxes, and test stations made of phenolic plastic [3] [6] [_____] mm [1/8] [1/4] [_____] inch thick with dimensions as indicated. Insulated terminal boards must have the required number of terminals (one terminal required for each conductor). Install solderless copper lugs and copper buss bars, shunts, and variable resistors on the terminal board as indicated. Test station terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, reference electrodes and coupons).

2.4 MATERIALS

2.4.1 Anodes

****

NOTE: The actual compositions required must be

determined to provide adequate and economical service. The anode material composition must be submitted for approval in accordance with "Submittals Procedures." Any deviation from chemical compositions listed must be approved by the government.

****

****

NOTE: Choose from anodes listed below. The chemical composition listed are examples only. The actual compositions required must be determined to provide adequate and economical service, and conform to the standards established by NACE.

****

2.4.1.1 Dimensions and Weights

****

NOTE: The following dimensions and weights of anodes are not all inclusive, additional sizes not included in the following tables may be available from various manufacturers.

****

Bare anode weight [4.1] [7.72] [9.7] [14.53] [_____] kg [9] [17] [20] [32] [_____] pounds not including core.

2.4.1.2 High-Silicon Chromium Bearing Cast Iron

****

NOTE: High-silicon cast iron anodes are rugged, long lasting, and commonly used in icing and non-icing climates. They are generally classified as relatively non-sacrificial having a consumption rate between 227 to 454 grams 0.5 to 1.0 pounds per ampere-year in most fresh waters.

****

ASTM A518/A518M. Provide cast iron anodes with the following characteristics:

a. Electrical resistivity: 72 micro-ohm-centimeter at minus 6.6 degrees C 20 degrees F (maximum).

b. Physical properties (nominal):

Tensile strength	103.4 MPa 15,000 psi
Compressive strength	689.4 MPa 100,000 psi
Brinell hardness	520
Density	7.0 grams per cubic centimeter
Melting point	1260 degrees C 2300 degrees F

c. Coefficient of expansion from zero to 100 degrees C 32 to 212 degrees F:

0.132 micrometers per degree C 0.733 micrometers per degree F.

2.4.1.2.1 Chemical Composition (Nominal)

Element	Percent by Weight Grade 2
Silicon	14.20-14.75
Manganese	1.50 Max.
Carbon	0.75-1.15
Chromium	3.25-5.00
Iron	Balance

2.4.1.2.2 Electrical Resistivity

Seventy-two microhm-centimeter at minus 7 degrees C 20 degrees F.

2.4.1.2.3 Physical Properties (Nominal)

Tensile strength	103.4 MPa 15,000 psi
Compressive strength	689.5 MPa 100,000 psi
Brinell hardness	520
Density	7.0 grams per cubic centimeter
Melting Point	1260 degrees C 2300 degrees F
Coefficient of expansion from 0 to 100 degrees C 32 to 212 degrees F	132 nanometer per degree C 0.733 micrometer per degree F

2.4.1.2.4 Anode Connecting Cables

Anodes must have connecting cables installed at the factory.

2.4.1.3 Aluminum Anodes

****

NOTE: Aluminum anodes are used in cases where annual or frequent replacement is required due to ice damage, and routine cleaning of the tank makes it possible to remove any expended or broken pieces of anode stock from the tank before they accumulate. Also, see the technical note for "Precious Metal Anodes" regarding alternative anode systems for icing conditions. The designer must consider system maintainability impacts when selecting the anode system.

****

Provide aluminum anodes with composition and size conforming to NACE mandated requirements.

2.4.1.4 Precious Metal Anodes

****

NOTE: At installations where icing conditions exist and the scaling index of water is less than 20,000 (i.e., low hardness water), the designer must consider using precious metal anodes, such as platinized niobium, platinized titanium, or mixed metal oxide for CP systems. The consumption rate of precious metal anodes is less than that of other relatively non-sacrificial anodes. However, precious metal anodes are more vulnerable to damage and loss particularly during cleaning and reconditioning of the tank.

Selection of the configuration must be left to the designer of the system. Long, continuous wire from lengths of precious metal anodes may have an attenuating effect. This can be overcome by using an anode header cable connected to lengths of precious metal anodes at a common junction box. Such precious metal anode assemblies must be assembled with factory sealed and tested electrical connections to the anodes.

****

Provide [precious metal anodes] [_____], [solid] [composite] [wire] [rod] [expanded mesh] [ribbon] in form. Anode core must be [copper] [niobium] [titanium] with [platinum] [mixed metal oxide] [_____] coating with thickness of [_____] [millimeters] [mils].[Precious metal anode assemblies must have factory sealed and tested electrical connections to the anodes.] Size and length as indicated by engineering design drawings.

****

NOTE: mils is an abbreviated dimension in inches; millimeters is a metric dimension.

****

2.4.1.5 Mixed Metal Oxide (MMO) Anodes

Titanium Wire anodes with a mixed metal oxide crystalline electrically conductive coating with [1.5 mm 0.062 inches] [3.0 mm 0.118 inches] diameter.

Nominal Wire Size		**Diameter Tolerance**		**Titanium**		**Active Surface Area**		**Weight**	
mm	**inches**	**mm**	**inches**	**Percent by Weight**	**Percent by Volume**	**m^2/m of Length**	**ft^2/ft of Length**	**g/m**	**lbs/ft**
1.5	0.062	+0.062 -0.00	+0.007 -0.00	36.1	52.7	0.0051	0.017	13.7	0.009
3.0	0.118	+0.062 -0.00	+0.010 -0.00	17.1	29.0	0.010	0.033	0.042	0.042

Titanium Rod anodes with a mixed metal oxide crystalline electrically conductive coating with [3.175 mm 0.125 inches STD] [3.175 mm 0.125 inches XL] [6.35 mm 0.25 inches STD] [13.97 mm 0.55 inches] [19.05 mm 0.75 inches STD] diameter and [60.96 mm 24 inches XL] [121.92 mm 48 inches XL] length for use in [freshwater or brackish water] [seawater]. STD is standard MMO coating thickness, XL is extended life (greater MMO coating thickness). Titanium tubular anodes with a mixed metal oxide crystalline electrically conductive coating with [___] diameter, [___] length.

Anodes	Diameter		Length		Surface Area		Weight	
mm	cm	inches	cm	inches	m^2	ft^2	kg	lbs
1.6 x 100	1.6	0.063	100	39.4	0.050	0.78	0.21	0.47
2.5 x 50	2.5	1.00	50	19.7	0.039	0.42	0.18	0.40
2.5 x 100	2.5	1.00	100	39.4	0.079	0.84	0.35	0.77
3.1 x 76	3.1	1.22	76	30.0	0.076	0.82	0.32	0.70
3.1 x 122	3.1	1.22	122	48.0	0.121	1.30	0.50	1.10

****

NOTE: Wire, rod or tubular MMO anodes may be used underground with selected backfill, in deep anode beds, and are available in cannisters with selected backfill for use underground.

****

2.4.1.6 Platinized Niobium [Titanium] Anode

Standard platinized niobium anode must be [20 percent][40 percent] niobium by cross-sectional area with a copper core and [single][double] platinum thickness. The following table shows examples of platinized niobium anodes. Other platinized niobium anodes and platinized titanium may be specified.

20 Percent Niobium				
Diameter	Niobium Thickness	Resistance	Platinum Thickness	
inches	inches	micro-ohm/ft	u-in.	u-in.
0.75	0.038	22	300	600
0.5	0.025	50	200	400
0.375	0.019	89	150	300
0.25	0.013	201	100	200
0.188	0.009	356	75	150
0.125	0.006	806	50	100
40 Percent Niobium				
0.375	0.038	113	150	300
0.25	0.025	256	100	200
0.188	0.019	453	75	150
0.125	0.013	1025	50	100

20 Percent Niobium				
Diameter	**Niobium Thickness**	**Resistance**	**Platinum Thickness**	
inches	**inches**	**micro-ohm/ft**	**u-in.**	**u-in.**
0.093	0.01	1822	38	75
0.063	0.007	4102	25	50

2.4.1.7 Anode Life Test

The anode wire material must sustain current densities of 100 amperes per square meter 9.29 amperes per square feet in an oxygen-generating electrolyte for 20 years. The manufacturer must certify that a representative sample taken from the same lot used to construct the anode, has been tested and meets the following criteria. The test cell must sustain a current density of 10,000 amperes per square meter 9.29 amperes per square feet in a 15-weight percent sulfuric acid electrolyte at 66 degrees C 150 degrees F without an increase in anode to cathode potential of more than 1 volt. The cell containing the anode is to be powered with a constant current power supply for the 30-day test period. The representative sample must include a minimum of 125 mm 5 inch in length taken from the lot of wire that is to be used for the anode.

2.4.2 Galvanic Anodes

2.4.2.1 Magnesium

[ASTM B843] Chemical composition as mandated by NACE.

Bare anode weight: [7.71] [9.07] [14.51] [_____] kg [17] [20] [32] [_____] pounds [not including core].

2.4.2.2 Zinc

[ASTM B418, Type [I] [II].] [ASTM F1182.] [MIL-A-18001] Bare anode weight: [2.2] [2.27] [6.8] [13.61] [_____] kg [5] [15] [30] [_____] pounds [not including core].

Typical Zinc Bare Anode Sizes and Packaged Weight							
Bare Weight		**Width**		**Height**		**Length**	
kg	**pounds**	**mm**	**inches**	**mm**	**inches**	**mm**	**inches**
2.3	5	36	1.4	36	1.4	254	10
5.4	12	36	1.4	36	1.4	610	24
6.8	15	36	1.4	36	1.4	762	30
6.8	15	51	2.0	51	2.0	381	15

Typical Zinc Bare Anode Sizes and Packaged Weight

Bare Weight		**Width**		**Height**		**Length**	
kg	**pounds**	**mm**	**inches**	**mm**	**inches**	**mm**	**inches**
8.2	18	36	1.4	36	1.4	914	36
13.6	30	36	1.4	36	1.4	1524	60
13.6	30	51	2.0	51	2.0	762	30
20.4	45	51	2.0	51	2.0	1143	45
27.2	60	51	2.0	51	2.0	1524	60

2.4.3 Anode Wires and Cable

2.4.3.1 Anode Connecting Wire

****

NOTE: Any pinhole, cut, scratch or other damage to the anode cable exposing bare copper to the electrolyte will result in early failure of the CP system. For this reason, special, extra heavy insulation is used on anode cable. While it is often expedient to use the same type wire for the cathodic (negative) cable in order to avoid a mix-up in the field, the cathode cable is not subject to anodic failure and lesser insulation can be used.

****

Anode connecting wire must be No. [8] [_____] AWG stranded copper wire with type CP High Molecular Weight Polyethylene (HMWP) insulation, 2.8 mm 7/64 inch thick, 600 volt rating. Cable-to-anode contact resistance must be 0.003 ohms maximum.

2.4.3.2 Anode Header Cable

Cable for anode header and distribution must be No. [_____] AWG stranded copper wire with type [CP HMWP, 2.8 mm 7/64 inch thick insulation] [HMWPE protective jacketed cable with a fluoropolymer inner or primary insulation], 600-volt rating.

2.4.3.3 Polyethylene Insulation

Polyethylene insulation must comply with the requirements of ASTM D1248 and of the following types, classes, and grades:

2.4.3.3.1 HMWP

HMWP must be Type I, Class C, Grade E5.

2.4.3.3.2 High Density Polyethylene (HDPE)

HDPE must be Type III, Class C, Grade E3.

2.4.3.4 Attachment of Anode Lead Wire

Install anode lead wires at factory.

2.4.3.5 End-Connected Anode

[Drill] [Cast] a recess [150] [_____] mm [6] [_____] inches deep in one end of the anode. Attach the lead wire to the anode with an anchor device. Not more than 10 mm 1/2 inch of bare wire must protrude from the anchor device. Attachment must withstand a 1446 Newton 325 pound pull without loosening the wire or anchor device. Fill the recess with an epoxy sealing compound [, leaving sufficient space for a plug]. [Provide non-metallic plug flush with the anode end surface.] [Install a heat shrinkable anode cap over the attachment. Cap must extend not less than 65 mm 2 1/2 inches on the lead wire and 75 mm 3 inches on the anode.] Cable-to-anode contact resistance must not exceed 0.02 ohms.

2.4.3.6 Center-Connected Anode

Attach the lead wire to the center of the anode with an anchor device suitably fastened to the wire. Not more than 20 mm one inch of bare wire must protrude from the anchor device. Encapsulate [each side of] the connection point with [a minimum of 152 mm 6 inches [_____] of] high voltage insulating compound mastic and 102 mm 4 inches [_____] of epoxy resin. Attachment must withstand [4000] [6675] [_____] N [900] [1500] [_____] pounds pull without loosening the wire or anchor device. Provide a non-metallic [plug flush with the anode end] [end cap] to prevent chaffing of the anode lead wire. Cable-to-anode contact resistance must not exceed 0.02 ohms.

2.4.3.7 Mixed-Metal-Oxide-Anode Lead Wires

[[Solidly crimp] [and solder] the connection between the anode rod or ribbon and the lead wire. Seal the connection [with two layers of half lapped mastic tape covered with a heat shrinkable sleeve] [in cast epoxy].] [Tin and anneal the copper wire and hydraulically swage the tubular anode onto copper bushings in contact with the wire. Place a 28 mm 1 1/8 inch copper sleeve, inner diameter slightly larger than the tubular anode outer diameter, over the tube prior to swaging.] Cable to anode contact resistance must not exceed 0.02 ohms.

2.4.4 Permanent Reference Electrodes

Permanent reference electrodes must be [copper/copper-sulfate] [silver silver-chloride] [zinc] [Hydrocarbon-Proof Palladium (Pd/PdCl$_2$)] specifically manufactured for submersible use, [32] [_____] mm [1 1/4] [_____] inch diameter, by [203] [255] [_____] mm [8] [10] [_____] inches long, [plastic] [_____] tube with a minimum surface sensing area of [_____] [_____] square centimeters[_____] square inches. Must never need recharging, maintenance, or recalibration. Must have impregnated membrane which keeps electrode electrolytes from drying out or getting the reference electrode electrolyte contaminated. Must have ion trap to prevent reference electrode damage from hydrogen sulfide or excess chloride ions. Provide electrodes with No. [10] [12] [_____] AWG, Rubber Heat (resistant) Wire (RHW) [RHW] Thermoplastic Heat and Water-resistant Nylon-coated (THHN)

[THHN] [_____] cable of sufficient length to extend to the [rectifier] [junction box] without splicing. No splices are allowed below the high-water level. Reference electrodes will have a minimum 20-year life, stability of plus or minus 5 millivolts under 3 microamp load. The manufacturer must calibrate the PRC to 316 mV plus or minus 10mV referenced to a standard hydrogen electrode (SHE) and provide a calibration certificate detailing the results of the calibration. Procedures for evaluating the accuracy annually must be included in the Operation and Maintenance Manual.

****

NOTE: Refer to NACE TM0113-2013 Standard Test Method for Evaluating the Accuracy of Field-Grade Reference Electrodes and NACE TM0211-2011 Standard Test Method for Durability Test for Copper/Copper Sulfate Permanent Reference Electrodes for Direct Burial Applications for information for evaluating the accuracy or durability of the PRE.

2.5 ACCESSORIES

2.5.1 Shunt Resistors

[0.01] [_____] ohm, [6] [_____] amp, with an accuracy of plus or minus one percent. [Shunts must conform to MIL-I-1361 [rating as shown]].

2.5.2 Conduit

[UL 6, rigid galvanized steel.] [Outlet boxes: UL 514A and Fitting: UL 514B, threaded hubs.] [Metallic conduit and fittings to be polyvinyl-chloride coated in accordance with [NEMA RN 1, Type A40] [NEMA TC 2, Type EPC-40-PVC]]. Provide non-metallic conduit conforming to NEMA TC 2. Provide conduit support in accordance with NFPA 70.

2.5.3 Wires and Cables (other than Anodes)

****

NOTE: Refer to paragraph 2.4.3 Anode Wires and Cable for anode lead wires.

****

Provide copper wire conforming to ASTM B3 and ASTM B8. Wires terminating in a rectifier, junction box or test station must have a cable identification tag.

2.5.3.1 AC Power Supply Wiring

[UL 83, Type [THW] [THWN] [THHN]] [UL 44, Type RHW,] [UL 854, Type USE], stranded [solid] copper conductors, gauge (AWG) and color coded as indicated.

2.5.3.2 Reference Electrode Wire

[UL 83, Type [THW] [THWN] [THHN]] [UL 44, Type RHW,] stranded [solid] copper conductors, gauge (AWG) and color coded as indicated.

2.5.4 Wire Connectors

Safety Standard for Wire Connectors must conform to UL 486A-486B.

2.5.5 Splices

[Splices are not permitted in submerged sections of anode lead wire or anode header cable.] Provide splices with a compression connector on the conductor, and insulation and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

(1) Provide cast-type splice insulation by means of molded casting process employing a thermosetting epoxy-resin-insulating material applied by a gravity-poured method or pressure-injected method. Provide component materials of the resin insulation in a packaged form ready for convenient mixing without removing from the package.

(2) Gravity poured method must employ materials and equipment contained in and approved commercial splicing kit which includes a mold suitable for the cables to be spliced. When the mold is in place around the joined conductors, prepare the resin mix and pour into the mold.

(3) Provide [heavy wall] heat-shrinkable splice insulation by means of a thermoplastic adhesive sealant material which must be applied with a clean burning propane gas torch per manufacturer's instructions.

2.5.6 Insulating Tape

Safety Standard for Insulating Tape must conform to UL 510.

2.5.7 Bolting

ASTM A307, Grade B for bolts; ASTM A194/A194M, Grade 2 for nuts. Dimensions: ASME B18.2.1 for bolts, ASME B18.2.2 for nuts. Threads: ASME B1.1, Class 2A fit for bolts, Class 2B fit for nuts. Bolts must extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at the roof of threads.

2.5.8 Cable and Wire Identification Tags

[Laminated plastic material with black letters on a yellow background] [[Brass] [Stainless steel] material with stamped or engraved letters.] Print letters and numbers a minimum 5 mm 3/16 inch in size. Provide identifier legend [in accordance with the drawings] [_____].

2.5.9 Clevis Assemblies

Provide clevis assemblies, 6.35 mm 1/4 inch flat steel with a spool opening of 53.975 mm 2 1/8 inch, 114.3 mm 4 1/2 inch long to the centerline of the spindle. Provide porcelain spools, with an outside diameter of 57.15 mm 2 1/4 inch and an overall height of 53.975 mm 2 1/8 inch.

2.5.10 Pin Insulators

Provide pin insulator assemblies, 100 mm 4 inches long overall and 6.35 mm 1/4 inch diameter aluminum bolt 19 mm 3/4 inch long attached to the flat end with an aluminum nut and lock washer. Provide porcelain insulator of non-conducting material with hard glazed finish. Provide insulator with a hole through the bottom at least 13 mm 1/2 inch diameter.

2.5.11 Hand-hole Assemblies

Provide aluminum hand-hole covers, 175 mm 7 inches in diameter and 1.588 mm 1/16 inch thick and connected to insulating rubber gasket, 175 mm 7 inches in diameter and 3.175 mm 1/8 inch thick. Cut handholes 150 mm 6 inches in diameter. Provide hand-hole assemblies with 12.7 mm 1/2 inch bolts and 6.35 mm 1/4 inch plate clamping bars.

****

NOTE: The interiors and exteriors of bolted tanks are factory-coated. Electrical continuity must be verified and ensured across the bolted joints to ensure proper CP system operation.

****

2.5.12 Exothermic Weld Kits

Provide exothermic weld kits specifically designed by the manufacturer for welding the types of materials and shapes provided.

2.5.13 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.5.14 Field Fabricated Nameplates

****

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings.

****

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device, as specified or as indicated on the drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 by 65 mm one by 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.5.15 Cathodic Protection System Operation and Maintenance Manual

A Cathodic Protection System Operation and Maintenance Manual must outline the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. The manual must list routine maintenance procedures, recommendations for maintenance testing, possible breakdowns and repairs, and troubleshooting guides. The manual must include single line diagrams for the system as installed, instructions in making tank-to-reference electrode potential measurements and frequency of monitoring. The instructions must include precautions to ensure safe conditions during troubleshooting and repair of the CP system.

****
NOTE: Information must meet or exceed applicable sections in UFC 3-570-06, Operation and Maintenance: Cathodic Protection Systems. Applicable sections include Chapter 3.2.6 for water tank calibration for all tanks and chapter 3.2.1 for rectifier operational inspection for tanks with rectifiers.
****

PART 3 EXECUTION

3.1 SAFETY PRECAUTIONS AND HAZARDOUS LOCATIONS

Any operations that will generate heat, sparks, or flame include, but are not limited to, grinding, soldering, welding, cutting, brazing and exothermic welding. Ensure that hot work equipment is in good repair and used according to manufacturer's recommendations. A thorough safety inspection of the area must be conducted. Remove flammable gasses and liquids from the area. Combustibles in the work area must be moved or covered with fire-retardant blankets. One or more 20-pound ABC-type fire extinguisher(s) must be inspected before each planned use, and be readily available. A qualified fire watch must be present and remain 30 minutes after completion of the task(s). If work is being conducted in an area where explosive vapors could accumulate, adequate ventilation must be provided and air monitoring must be conducted.

3.2 INSTALLATION

3.2.1 Anode Installation

****
NOTE: Proprietary systems of anode installations are available for areas where icing is expected. For such areas, paragraph 3.2.1.1 "Icing Climate Requirements" should be included.
****

[IEEE C2] [NFPA 70].

3.2.1.1 Icing Climate Requirements

Suspend anodes in a manner similar to that in non-icing climates, except provisions must be made to prevent the anodes and suspending cables from being damaged by freezing or falling ice or by suspended floating flexible anode rings from the tank walls.

3.2.1.2 Anode Placement

Arrange anodes in the tank [and riser pipe] as shown in the drawings [so that protection can be provided to surfaces without exceeding potentials [in the vicinity of the anodes] that will be detrimental to coatings]. Suspend anodes from [roof] [wall] [plate] [structure] by means of factory-installed connecting wire designed to support the anodes in air [before submergence] without failure of the electrical wire insulation or the electrical conductors. Prevent contact between anode and tank surfaces such as man-access hatches, ladders, heater pipes, and stay rods.

3.2.1.3 Anode Hangers

Anode hangers must electrically insulate the anode suspending wire from the tank steel.

3.2.1.4 Handholes

Provide a handhole having a diameter of 150 mm 6 inches in the tank roof for each anode string to permit replacement or inspection of anodes.

3.2.2 Anode Connection

****

NOTE: A single split-bolt will work loose when wires it connects are moved. Minimum of two split bolts will prevent this from happening. In water tanks, split bolts are used (above water line only) because working space is limited and hydraulic or mechanical compression tools may be cumbersome and hazardous to use. At ground level or in trenches, compression tools can be used conveniently, and swedged sleeve connection produced by such tools is more reliable than split bolts.

****

3.2.2.1 Anode Lead Wires

Electrically connect anodes to the positive D.C. header cable with compression connectors or split bolts, or the header cable may terminate in a junction box for connection with all anode cables. Use a minimum of two split bolts for each connection if split bolts are used. Mark each of the wires terminating in the junction box.

3.2.2.2 Anode Header Cable

Provide header cable on the [underside of the roof] [wall] with electrically insulating hangers which enter the tank near the roof line from an externally mounted junction box. External wiring must be in conduit. Mark each of the wires terminating in the junction box.

3.2.2.3 Splices and Terminations

****

NOTE: Splices are not allowed below water level.

****

Locate under-roof electric wire splices above the high water line and seal water-tight using cast-type splice, gravity-poured method or heat shrinkable splice insulation as described in Section 2. Splices are not permitted in submerged sections of the anode lead wire or anode header cable.

3.2.3 Rectifiers

****

NOTE: For impressed current systems only.

****

3.2.3.1 Rectifier Installation

Location and mounting as indicated. Assemble and attach equipment enclosures to [wall] [post] [pad] in accordance with the manufacturer's instructions. Handle wires to prevent stretching or kinking the conductors or damaging the insulation. Use lubricants when pulling wires into conduits. Bond the equipment enclosures to a grounding electrode.

3.2.3.2 Rectifier Grounding

Locate ground rod(s) as indicated in drawings. Measure resistance to earth. If resistance to earth is more than 25 ohms, install additional ground rod(s) at a distance of 3.65 meters 12 feet or more and retest. Repeat if required. Low-resistance backfill, certified for use in grounding systems, may be required in exceptionally high soil resistivities using manufacturer's recommendations.

3.2.3.3 Wire-To-Tank Connections

Connect the structure wire to the tank [_____] [by use of an exothermic weld kit] [by brazing]. Clean the structure surface by scraping, filing, or wire brushing to produce a clean, bright surface. [Weld connections using the exothermic weld kits in accordance with the manufacturer's instructions. Test the integrity of the weld, prior to coating, by striking with a 908 gram 2 pound hammer.] [Cover connections and surrounding cleaned surface with an electrically insulating coating compatible with the existing coating.]

3.2.4 Permanent Reference Electrodes

3.2.4.1 Permanent Reference Electrode Verification

Verify permanent reference electrodes against a portable electrode in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager before installation. Verify in a non-metallic container of water with the same composition as the tank to be protected. Permanent electrode must measure a reference potential agreeing with that measured by the portable electrode within plus or minus 0.010 volt when the sensing windows of the two electrodes being compared are not more than 2 mm 0.07 inch apart but not touching. Remove permanent reference electrodes not within this potential range from the construction site by the end of the day and replace at the contractor's expense. The testing provision applies to replacement permanent reference electrodes as well.

3.2.4.2 Installation

Provide permanent reference electrodes at points in the tank [and riser pipe] which monitor minimum and maximum [tank] [/riser]-to-water [potentials], regulate the automatic control system [_____], and maintain continuous immersion. Sensing windows of reference electrodes must be equidistant to and located within 25 mm one inch of the steel tank/riser pipe surface and be fixed in position, preventing contact with tank wall or appurtenances.

3.3 BOLTED AND RIVETED TANKS

Ensure electrical continuity of joining components.

3.4 GASEOUS EVOLUTION

Provide for possible evolution of gases from anode reaction and ventilation requirements.

3.5 FIELD QUALITY CONTROL

Field tests must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager or their designated representative. Advise the Contracting Officer or Contracting Officer's Representative [5] [_____] days prior to performing each field test. Quality control for the cathodic protection system must consist of the following:

a. Initial field testing by the contractor upon construction.

b. Government field testing after contractor has submitted initial field test report.

c. Warranty period field testing by the contractor.

d. Final field testing by the contractor after one year of service.

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NOTE: Additional testing may be required based upon the specific project or design. All tests listed below may not be required. Designer must consider the project requirements for selection of test procedures. Specify 30-day notice for large systems to allow the Government corrosion engineer to be on-site during the initial and final field testing of the CP systems.

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3.6 TESTS AND MEASUREMENTS

3.6.1 Native Potentials

Notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of five (5) working days prior to each test. Base potential tests: At least [one week] [24 hours] [_____] after [installation of structure to be protected] [initial operation of structures containing fluids] and installation of the anodes, but before connection of anodes to the structure, measure base (native) structure-to-electrolyte potentials of the [structure]. Perform measurements at anode junction boxes, test stations and other locations suitable for test purposes. The locations of these measurements must be identical to the locations specified for potential measurements with anodes connected. Use the same measuring equipment that is specified for measuring protected potential measurements.

3.6.2 Protected Potentials

Systems must be tested and inspected by the contractor's corrosion engineer in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager corrosion protection engineer or an approved representative. Notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of five working days prior to each test. At least [one week] [24 hours] [_____] after native potential testing and connection of anodes to the structure, measure protected structure-to-electrolyte potentials. The locations of these measurements must be identical to the locations specified for native potential measurements. Use the same measuring equipment that is specified for measuring protected potential measurements. Record test data, including date, time, and locations of testing and submit report to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Contractor must correct and retest, at the contractors and Technical Experts expense, deficiencies in the materials and installation observed by these tests and inspections.

3.6.3 Reference Electrode Potential Measurements

Upon completion of the installation and with the entire CP system in operation, electrode potential measurements must be made using a copper/copper sulfate reference electrode and a potentiometer-voltmeter, or a direct-current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements must be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements must be recorded. No less than eight (8) measurements will be made.

3.6.4 Holiday Test

Any damage to the protective coating during installation must be repaired before completion. After repair-coating has been applied, the entire structure, tank, wall or pipe must be inspected by an electric holiday detector with impressed current in accordance with NACE SP0188. The holiday detector will be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective coating must be repaired upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection must be furnished by the contractor. The coating system must be inspected for holes, voids, cracks, and other damage during installation.

3.6.5 Rectifier Testing (impressed current systems only)

The purpose of the rectifier operational inspection is to determine the serviceability of all components required to impress current to the anodes of the impressed current system. The inspection must be thorough to ensure dependable current until the next inspection.

a. Before energizing the rectifier, visually check all rectifier components, shunt box components, safety switches, circuit breakers, and other system power components.

b. Tighten all accessible connections and check temperature of all the components.

c. Ensure all permanent reference electrode caps are removed and placed inside the rectifier cabinet for verification of removal and for use during tank cleaning.

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NOTE: Do not increase the amount of current by requiring the S/E potential not to be more negative than -1150 mV with respect to a CSE of the tank. Excessive current may dis-bond the coating.
****

d. Startup testing of the rectifier must include voltage and current testing at all tap settings up to the level of protection or maximum of the rectifier rated current, whichever is the lowest. Do not apply excessive current to the tank. For automatic rectifiers, record each tap setting (if available) before switching to automatic potential control.

e. Using a dependable hand-held meter, measure the output voltage and current, and calibrate the rectifier meters, if present. For rectifiers with more than one circuit, measure the output voltage and current for each circuit using a dependable hand-held meter, and calibrate the rectifier meters, if present.

f. For systems with permanent reference electrodes, using a calibrated reference electrode, measure the potential difference to each installed permanent reference electrode by placing both electrodes together in the electrolyte with CP current off (may be tested before installation). If the difference is more than 10 mV, replace the permanent reference electrode. For rectifiers with potential voltmeters, using a dependable hand-held meter, measure the potentials for each voltmeter, and calibrate that rectifier meter.

g. Calculate the CP system circuit resistance of each circuit by dividing the rectifier DC voltage output of each circuit by the rectifier DC ampere output for that circuit.

h. Calculate the rectifier efficiency.

3.6.6 Initial Cathodic Protection System Testing

Initial field testing must be completed by the contractor upon completion of construction. Field testing must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager or their designated representative. Advise the Contracting Officer or Contracting Officer's Representative [5] [_____] days prior to performing each field test. Field testing must include native and protected potentials, anode current testing and permanent reference electrode testing.

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NOTE: Additional testing may be required based upon the specific project or design.
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The contractor must submit an initial field test report of the CP system. Tank-to-electrolyte measurements, including initial potentials, protected potentials, anode outputs, rectifier and other required testing must be recorded on applicable forms. Identification of test locations, test station and anode test stations will coordinate with the as-built drawings and be provided on system drawings included in the report. The contractor must locate, correct, and report to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager any short circuits encountered during the checkout of the installed CP system.

3.6.7 Government Field Testing

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NOTE: The requirements of paragraph entitled "Government Field Testing" are required for CP projects in either the Army, Navy, Air Force or Marines area. The designer must verify their applicability to projects outside the area with the appropriate Engineering Field Division (EFD) corrosion program manager.

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The government corrosion [engineer] [program manager] must review the contractor's initial testing report. Approximately four weeks after receipt of the contractor's initial test report, the system will be tested and inspected in the contractor's presence by the government corrosion [engineer] [program manager]. The contractor must correct, at the contractor's expense, materials and installations observed by these tests and inspections to not be in conformance with the plans and specifications. The contractor will pay for all retesting done by the government engineer made necessary by the correction of deficiencies.

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NOTE: For CP projects in either the Army, Navy, Air Force or Marines area, select the appropriate options for paragraphs entitled "One Year Warranty Period Testing."

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3.6.8 One-Year-Warranty-Period-Testing

The contractor must inspect, test, and adjust the CP system [quarterly] [semi-annually] [_____] for one year, [4] [2] [_____] interim inspections total, to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon the completion of all CP work, including changes required to correct deficiencies identified during initial testing, and preliminary acceptance of the CP system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the One Year Warranty Period Cathodic Protection System Field Test Report, including field data, and certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or Contracting Officer's Representative, the activity, and the geographic EFD corrosion [engineer] [program manager] [Contracting Officer] [Contracting Officer's Representative] [Technical Expert] [Project Manager].

3.6.9 Final Acceptance Field Testing

Conduct final acceptance field testing of the CP system utilizing the same procedures specified under the Initial Field Testing of the CP systems. The contractor will inspect, test, and adjust the CP system after one year of operation to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon preliminary acceptance for the CP system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the Final Cathodic Protection System Test Report, certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager and the geographic EFD corrosion [engineer] [program manager] for approval, and as an attachment to the Operation and Maintenance Manual in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. The government corrosion [engineer] [program manager] must review the contractor's final field testing report.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Reconditioning of Surfaces

3.7.1.1 Concrete

Concrete must be 20 MPa 3000 psi minimum ultimate 28-day compressive strength with 25 mm one inch minimum aggregate conforming to [ASTM C94/C94M] [Section 03 30 00 CAST-IN-PLACE CONCRETE].

3.7.1.2 Restoration of Sod

Restore unpaved surfaces disturbed during the installation to their original elevation and condition. In areas where grass cover exists, it is possible that sod can be carefully removed, watered, and stored during construction operations, and replaced after the operations are completed. Where the surface is disturbed in a newly seeded area, re-seed the area with the same quality and formula of seed as that used in the original seeding. Seeding must be done as directed, in all unsurfaced locations where sod and topsoil could not be preserved and replaced. The use of sod in lieu of seeding will require approval by the Contracting Officer or the Contracting Officer’s Representative, Technical Expert and Project Manager.

3.7.1.3 Restoration of Pavement

Repair pavement, sidewalks, curbs, and gutters where existing surfaces are removed or disturbed for construction. Saw cut pavement edges. Graded aggregate base course must have a maximum aggregate size of 40 millimeters 1 1/2 inches. Prime base course with [liquid asphalt, ASTM D2028/D2028M, Grade RC-70] [_____] prior to paving. Match base course thickness to existing but must be atleast 150 millimeters 6 inches. Asphalt aggregate size must be 15 mm 1/2 inch [_____], asphalt cement must [conform to ASTM D3381/D3381M, Grade AR-2000] [_____]. Match asphalt concrete thickness to existing but must not be less than 50 millimeters 2 inches. Repair Portland cement concrete pavement, sidewalks, curbs, and gutters using 20.67 MPa 3,000 psi concrete conforming to [ASTM C94/C94M] [Section 03 30 00 CAST-IN-PLACE CONCRETE.] Match existing pavement, sidewalk, curb, and gutter thicknesses. Final surface must be the same level as the existing surface.

3.7.1.4 Cleanup

The contractor is responsible for cleanup of the construction site. All paper bags, wire clippings, must be disposed of as directed. Paper bags, wire clippings and other waste will not be put in bell holes or anodes excavation.

3.7.2 Training

3.7.2.1 Instruction to Government Personnel

During the warranty testing or at a time designated by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager, make available the services of a technician regularly employed or authorized by the manufacturer of the CP system for instructing Government personnel in the proper operation, maintenance, safety, and emergency procedures of the CP system. The period of instruction must be atleast [two] [four] [_____] hour[s] and at most [two] [_____] 8-hour working day[s]. Conduct the training at the jobsite or at another location mutually satisfactory to the government and the contractor. The field instructions will cover all of the items contained in the Operation and Maintenance Manual.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 42 17 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-26 42 17.00 10 (November 2008)
UFGS-26 42 19.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM

05/21

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 42 17 (May 2021)**

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References are in agreement with UMRL dated January 2025

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SECTION 26 42 17

IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM

05/21

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NOTE: This guide specification covers the requirements for a cathodic protection system using Impressed Current anodes.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and must be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: The requirements for the cathodic protection systems must be determined by a corrosion engineer following the criteria, design, and installation recommendations included in the applicable National Association of Corrosion Engineers (NACE) Standard for the type of structure being protected as listed in the references.

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NOTE: This specification covers a cathodic protection system for metal surfaces against corrosion by producing a continuous flow of direct

current from Impressed Current anodes to the metal to be protected. The anodes must be of sufficient size and quantity to protect the buried metal items for a specified number of years before replacement. The U.S. Department of Transportation has issued regulations requiring the application of cathodic protection to natural gas pipelines, liquid natural gas pipelines, petroleum pipelines, petroleum products pipelines, liquid petroleum gas pipelines, and petroleum storage facilities. Title 49 of the Code of Federal Regulations, Parts 191, 192, 193 and 195 must be consulted for applicable cathodic protection requirements for specific applications.

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NOTE: The following information must be on the drawings:

1. Locations of all underground pipes and structures.

2. Locations of all anode, anode wires, and structure wires.

3. Locations of all flanges and unions.

4. Locations of all equipment and components.

5. Installation details for structure connections, junction boxes, anodes and test stations.

6. Single-line diagrams elevations, limiting dimensions, and equipment ratings which are not covered in the specification.

7. Remote indicating or control requirements.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project

specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A518/A518M	(1999; R 2022) Standard Specification for Corrosion-Resistant High-Silicon Iron Castings
ASTM B3	(2013; R 2024) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors,

	Hard, Medium-Hard, or Soft
ASTM B418	(2016a; R2021) Standard Specification for Cast and Wrought Galvanic Zinc Anodes
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D2028/D2028M	(2015; R 2021) Cutback Asphalt (Rapid-Curing Type)
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2023) National Electrical Safety Code
IEEE C135.30	(1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 15589-2	(2012) Petroleum, Petrochemical and Natural Gas Industries - Cathodic Protection of Pipeline Transportation Systems - Part 2: Offshore Pipelines

NACE INTERNATIONAL (NACE)

NACE SP0106	(2018) Control of Internal Corrosion in Steel Pipelines and Piping Systems
NACE SP0176	(2007) Corrosion Control of Submerged Areas of Permanently Installed Steel Offshore Structures Associated with Petroleum Production
NACE SP0177	(2019) Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
NACE SP0186	(1986; R 2007) Application of Cathodic Protection for External Surfaces of Steel Well Casings

NACE SP0188	(2024) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE SP0193	(2016) Application of Cathodic Protection to Control External Corrosion of Carbon Steel On-Grade Storage Tank Bottoms
NACE SP0196	(2020) Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks
NACE SP0200	(2014) Standard Practice Steel-Cased Pipeline Practices
NACE SP0285	(2021) External Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
NACE SP0286	(1997; R 2007) Standard Practice Electrical Isolation of Cathodically Protected Pipelines
NACE SP0388	(2018) Impressed Current Cathodic Protection of Internal Submerged Surfaces of Carbon Steel Water Storage Tanks - Item No. 21040
NACE SP0607	(2007) Petroleum and Natural Gas Industries — Cathodic Protection of Pipeline Transportation Systems — Part 2: Offshore Pipelines
NACE SP21424	(2018) Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation and Monitoring
NACE TPC 11	(2008) A Guide to the Organization of Underground Corrosion-Control Coordinating Committees

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA RN 1	(2018) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-18001	(1993) Anodes, Sacrificial Zinc Alloy
MIL-I-1361	(1985; Rev C; Notice 1 1991; Notice 2 2021) Instrument Auxiliaries, Electrical Measuring: Shunts, Resistors and Transformers

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2024) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings
UL 854	(2020; Reprint Jul 2024) Standard for Service-Entrance Cables

1.2 DEFINITIONS

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Cathodic Protection is a method used to control corrosion.

1.2.1 Cathodic Protection

Cathodic Protection (CP) is an electrochemical (half electrical and half chemical) method used to control corrosion of buried or submerged metallic structures. It prevents corrosion by making the protected structure a cathode by installing a more anodic metal (sacrificial or galvanic) anode or a metallic (Impressed Current) anode connected to a Direct Current (DC) power source. When the proper amount of current is applied to the structure, it becomes a cathode. Since all corrosion occurs at the anode, the structure no longer corrodes. The electrons move in the metallic path (electrical). Reduction (chemical) reactions occur at the surface of the cathode resulting in a hydrogen coating and more alkaline environment. Oxidation (chemical) reactions occur at the surface of the anode resulting in corrosion and a more acidic environment. After a CP system is installed and adjusted to provide adequate protection, the hydrogen coats the defects in the coating and polarizes in the negative direction (to a copper/copper sulfate reference electrode) over time the current and potentials remain relatively stable; changes in currents or potentials indicate a problem. An error-free measurement of negative 850 millivolts DC or more negative to the copper/copper-sulfate reference electrode proves the structure is a cathode and corrosion has been mitigated.

1.2.2 Corrosion

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Some of the eight forms of corrosion are unique, but all of them are more or less interrelated.

The eight forms of corrosion are: (1) Uniform Attack, (2) Galvanic or Two-Metal Corrosion, (3) Crevice Corrosion, (4) Pitting Corrosion, (5) Intergranular Corrosion, (6) Selective Leaching, (7) Erosion Corrosion, and (8) Stress Corrosion Cracking. This listing is arbitrary but covers practically all corrosion failures and problems. The forms are not listed in any particular order of importance. Below, the eight forms of corrosion are discussed in terms of their characteristics, mechanisms, and preventive measures. Hydrogen damage, although not a form of corrosion, often occurs indirectly as a result of corrosive attack and is, therefore, included in this discussion.

1.2.3 Alternating Current (AC) Corrosion

AC corrosion occurs when there is a source of AC current, typically from a high-voltage overhead AC (OHAC) power-line, when there is a low soil resistivity (typically less than 5,000 ohm-cm) and there is a very small coating holiday. The AC corrosion pits typically have a tubercle of corrosion product at the pit. AC interference study modeling software can determine the mitigation solution to solve this problem. Typically, AC Corrosion mitigation is done in conjunction with high AC potentials and fault current mitigation.

1.2.4 AC Interference

AC interference occurs when a pipeline parallels a high-voltage overhead AC (OHAC) power-line. An interference study is required when this situation occurs as AC interference can cause high AC potentials along the pipeline (safety), can cause a fault condition between the pipeline and power-line and could cause AC corrosion to occur. The pipeline coating when exposed can have blisters/bubbles caused by the excessive AC. The interference study will use modeling software to determine what combination of interference may be occurring (if any) and provide the mitigation solution to solve the problem.

1.2.5 Uniform Attack

Uniform attack is the most common form of corrosion. It is normally characterized by a chemical or electrochemical reaction that proceeds uniformly over the entire exposed surface or over a large area. The metal becomes thinner and eventually fails. For example, a piece of steel or zinc immersed in dilute sulfuric acid normally dissolves at a uniform rate over its entire surface. A sheet iron roof shows essentially the same degree of rusting over its entire outside surface.

Uniform attack, or general overall corrosion, represents the greatest destruction of metal on a tonnage basis. This form of corrosion, however, is not of great concern from a technical standpoint, because the life of equipment can be accurately estimated on the basis of comparatively simple tests. Merely immersing specimens in the fluid involved is often sufficient. Uniform attack can be prevented or reduced by (1) materials, such as coatings, that reduce contact between metal and electrolytes, (2) inhibitors, or (3) cathodic protection.

1.2.6 Galvanic or Two-Metal Corrosion

A potential difference usually exists between two dissimilar-metals when they are immersed in a corrosive or conductive solution. If these metals are placed in contact (or otherwise electrically connected), this potential difference produces electron flow between them. Corrosion of the less corrosion-resistant metal is usually increased, and attack of the more resistant material is decreased, compared to the behavior of these metals when they are not in contact. The less resistant metal becomes anodic and the more resistant metal becomes cathodic. Usually the cathode or cathodic metal corrodes very little or not at all in this type of couple. Because of the electric currents and dissimilar-metals involved, this form of corrosion is called galvanic, bi-metallic or two-metal, corrosion. Galvanic corrosion is restricted to electrochemical corrosion caused by dissimilar-metal effects. It is electrochemical corrosion, but this document must restrict the term galvanic to dissimilar-metal effects for purposes of clarity.

1.2.7 Crevice Corrosion

Intense localized corrosion frequently occurs within crevices and other shielded areas on metal surfaces exposed to corrosives. This type of attack is usually associated with small volumes of stagnant solution caused by holes, gasket surfaces, lap joints, surface deposits, and crevices under bolt and rivet heads. As a result, this form of corrosion is called crevice corrosion or, sometimes, deposit or gasket corrosion.

1.2.8 Pitting Corrosion

Pitting is a form of extremely localized attack that results in holes in the metal. These holes may be small or large in diameter, but in most cases they are relatively small. Pits are sometimes isolated or so close together that they look like a rough surface. Generally a pit may be described as a cavity or hole with the surface diameter about the same as or less than the depth. Pitting is one of the most destructive and insidious forms of corrosion. It causes equipment to fail because of perforation with only a small percent weight loss of the entire structure. It is often difficult to detect pits because of their small size and because the pits are often covered with corrosion products. In addition, it is difficult to measure quantitatively and compare the extent of pitting because of the varying depths and numbers of pits that may occur under identical conditions. Pitting is also difficult to predict by laboratory tests. Sometimes the pits require a long time (several months or a year) to show up in actual service. Pitting is particularly vicious because it is a localized and intense form of corrosion, and failures often occur with extreme suddenness.

1.2.9 Intergranular Corrosion

Grain boundary effects are of little or no consequence in most applications or uses of metals. If a metal corrodes, uniform attack results since grain boundaries are usually only slightly more reactive than the matrix. However, under certain conditions, grain interfaces are very reactive and intergranular corrosion results. Localized attack at and adjacent to grain boundaries, with relatively little corrosion of the grains, is intergranular corrosion. The alloy disintegrates (grains fall out) or loses its strength. Intergranular corrosion can be caused by impurities at the grain boundaries, enrichment of one of the alloying elements, or depletion of one of these elements in the grain-boundary areas. Small amounts of iron in aluminum, wherein the solubility of iron is low, have been shown to segregate in the grain boundaries and cause intergranular corrosion. It has been shown that, based on surface tension considerations, the zinc content of a brass is higher at the grain boundaries. Depletion of chromium in the grain-boundary regions results in intergranular corrosion of stainless steels.

1.2.10 Selective Leaching

Selective leaching is the removal of one element from a solid alloy by corrosion processes. The most common example is the selective removal of zinc in brass alloys (dezincification). Similar processes occur in other alloy systems in which aluminum, iron, cobalt, chromium, and other elements are removed. Selective leaching is the general term to describe these processes, and its use precludes the creation of terms such as de-aluminumification, de-cobaltification. Parting is a metallurgical term that is sometimes applied, but selective leaching is preferred.

1.2.11 Erosion Corrosion

Erosion corrosion is the acceleration or increase in rate of deterioration or attack on a metal because of relative movement between a corrosive fluid and the metal surface. Generally, this movement is quite rapid, and mechanical wear effects or abrasion are involved. Metal is removed from the surface as dissolved ions, or it forms solid corrosion products, which are mechanically swept from the metal surface. Sometimes, movement of the environment decreases corrosion, particularly when localized attack occurs under stagnant conditions; this is not erosion corrosion because deterioration is not increased. Erosion corrosion is characterized in appearance by grooves, gullies, waves, rounded holes, and valleys and usually exhibits a directional pattern. In many cases, failures because of erosion corrosion occur in a relatively short time, and they are unexpected largely because evaluation corrosion tests were run under static conditions or because the erosion effects were not considered.

1.2.12 Stress-Corrosion Cracking

Stress-corrosion cracking refers to cracking caused by the simultaneous presence of tensile stress and a specific corrosive medium. Many investigators have classified all cracking failures occurring in corrosive media as stress-corrosion cracking, including failures due to hydrogen embrittlement. However, these two types of cracking failures respond differently to environmental variables. To illustrate, CP is an effective method for preventing stress-corrosion cracking; however, hydrogen-embrittlement may be caused when excessive current is applied, especially on stainless steel. Hence, the importance of considering stress-corrosion cracking and hydrogen embrittlement as separate phenomena is obvious. During stress-corrosion cracking, the metal or alloy is virtually unattacked over most of its surface, while fine cracks progress through it. This cracking phenomenon has serious consequences, since it can occur at stresses within the range of typical design stress.

1.2.13 Exothermic Welding

Exothermic welding is used in CP to connect a copper wire to a metallic structure, usually steel or cast-iron. It is a pyrotechnic composition of copper oxide, aluminum powder and magnesium powder. The magnesium powder is ignited with a spark gun or electronic ignition equipment. The aluminum powder serves as fuel, and melts the copper oxide, which bonds the wire to the structure. Although not explosive, it can create brief bursts of heat and high temperature in a small area.

1.2.14 Error-Free

Potential measurement error due to a voltage drop caused by current flowing through a resistor (the electolyte) between the reference electrode and the protected structure.

1.3 ADMINISTRATIVE REQUIREMENTS

After award of the contract, but prior to commencement of any work at the site, meet with the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Develop a mutual understanding relative to the administration of the value engineering, the safety program, preparation of the schedule of prices or earned value report. Review shop drawings, other submittals, scheduling programming, execution of the work, and clear expectations of the "Interim Department of Defense (DD) Form 1354" submittal. Major subcontractors who will engage in the work must also attend.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal

items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preconstruction Survey

SD-02 Shop Drawings

Drawings; G, [_____]

Anode junction boxes, bonding boxes, and test stations

Joint bonds

Contractor's Modifications; G, [_____]

SD-03 Product Data

Qualifications

Equipment; G, [_____]

Anodes; G, [_____]

Anode junction boxes, bonding boxes, and test stations

Isolation flange kits

Dielectric unions

Wires

Cable and wire

Casings, isolation, and seals

Shunts

Permanent reference electrodes; G, [_____]

Spare Parts

SD-06 Test Reports

Tests and Measurements; G, [_____]

Contractor's Modifications; G, [_____]

SD-10 Operation and Maintenance Data

Cathodic Protection System; G, [_____]

Training Course; G, [_____]

Cathodic Protection System, Data Package 5; G, [_____]

SD-11, Closeout Submittals

Initial Cathodic Protection System Field Testing; G, [_____]

One Year Warranty Period Cathodic Protection System Field Test Report; G, [_____]

Final Cathodic Protection System Field Test Report; G, [_____]

1.4.1 Material and Equipment Manufacturer Data

DATE	**ISSUE NO.**	**REQUEST**	**REQUESTED BY**	**REQUEST REF.**
MANUFACTURER NAME				
DESCRIPTION OF EQUIPMENT				

DATE	ISSUE NO.	REQUEST	REQUESTED BY	REQUEST REF.

1.5 MAINTENANCE MATERIAL SUBMITTALS

1.5.1 Spare Parts

After approval of shop drawings, furnish spare parts data for each different item of material and equipment specified. The data must include a complete list of parts, special tools, and supplies, with current unit prices and source of supply.

After approval of shop drawings, furnish revised spare parts for any changes made from original submittal. One spare anode of each type must be furnished. In addition, supply information for material and equipment replacement for all other components of the complete system, including anodes, cables, splice kits and connectors, corrosion test stations, and any other components not listed above. Furnish [one reference electrode on a hand reel with 120 meters 350 feet of conductor], [one digital voltmeter that can be used in the maintenance of this CP system]. Demonstrate use of furnished equipment in actual tests during the training course. Provide a description of equipment of the pipe-to-soil protected structure and foreign structures at electrical isolation between the utility supplier and the facility piping.

1.5.2 Extra Materials

Furnish [one reference electrode on a hand reel with 120 meters 350 feet of conductor], [one high-input-impedance digital multimeter that can be used in the maintenance of this CP system]. Demonstrate use of furnished equipment in actual tests during the training course. Provide a description of equipment of the pipe-to-soil protected structure and foreign structures at electrical isolation between the utility supplier and the facility piping. Include a description of the equipment and measurement of the pipe-to-soil potentials, anode voltage, anode current and soil condition.

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

Obtain the services of a corrosion expert to supervise, inspect, and test the installation and performance of the CP system. The term "corrosion expert" refers to a person, who by thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried or submerged metallic structures.

1.6.2 Qualifications

The corrosion expert must be accredited or certified by NACE International, as a CP-4 CP Specialist or be a NACE International certified Corrosion Specialist or a registered professional engineer who has certification or licensing that includes education and experience in CP of the type of CP system being installed. The corrosion expert must have not less than [three] [five] [_____] years of experience in the type of CP for buried or submerged metallic structures under this contract. Submit evidence of qualifications of the corrosion expert including their name and qualifications certified in writing to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager prior to the start of construction. Certification must be submitted giving the name of the firm, the number of years of experience, and a list of not less than five of the firm's installations, three or more years old, that have been tested and found satisfactory.

1.6.3 Services of Corrosion Expert

The "corrosion expert" must make a minimum of three visits to the project site. The first of these visits will include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the contractor if Impressed Current Cathodic Protection (ICCP) or Galvanic Anode Cathodic Protection (GACP) is required. Once the submittals are approved and the materials delivered, the "corrosion expert" will revisit the site to verify the materials meet submittal requirements, ensure the contractor understands installation practices and that the contractor is capable and qualified to complete the installation.

The "corrosion expert" will be available (but not necessarily be onsite the entire time) during the installation of the CP system to answer questions, approve any changes or additions required during construction, or to provide recommendations as required. The third visit is to complete the training and demonstrations to applicable personnel on proper testing and maintenance techniques and to complete testing the installed CP systems to ensure it has been installed properly and meets adequate CP criteria. An additional visit is required if the One-Year-Warranty-Period-Testing is required.

1.7 DELIVERY, STORAGE AND HANDLING

Storage area for corrosion material will be designated by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. If material are not stored in a building, tarps or similar protection must be used to protect material from inclement weather. Resack and add backfill to packaged anodes that are damaged as a result of improper handling or exposure to rain.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

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NOTE: The environmental requirements with which the contractor must comply must be developed during the design process, included in the bidding documents, and made a part of the contract.

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1.8.2 Existing Conditions

Prior to start of any onsite construction activities, perform a Preconstruction Survey of the project site with the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager, and take photographs showing existing environmental conditions in and adjacent to the site. Submit a report for the record. Include in the report a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the contractor's assigned storage area and access route(s), as applicable. The contractor and the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager will sign this survey report upon mutual agreement regarding its accuracy and completeness. Protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference that their preservation may cause to the work under the Contract.

1.9 WARRANTY

Provide equipment items that are supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Corrosion Control System Description

A corrosion control system consists of several systems which work together to mitigate corrosion on buried or submerged metallic structures. Failure to comply with the requirements of any one of these systems may result in inadequate corrosion control and premature failure of the structure being protected. Each system's guide specifications must be included in the design and installation of a complete corrosion control system and must be adhered to in the design and execution of the corrosion control of a structure being protected. Determination of Need for CP must be made by government requirements and policy directives.

a. Construction Design Requirements (CDR) for protected structures are found in the UFGS for the structure being protected. For water storage tanks refer to Section 33 16 15 WATER STORAGE STEEL TANKS, NACE SP0388, and NACE SP0196, underground storage tanks NACE SP0285, aboveground storage NACE SP0193, fuel storage piping Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT), aviation fuel piping Section 33 52 43.13 AVIATION FUEL PIPING, leak detection systems Section 33 01 50.31 LEAK DETECTION FOR FUELING SYSTEMS, offshore pipelines NACE SP0607 and ISO 15589-2, offshore structures and NACE SP0176, pipeline casings structures (railroad, highway and water crossing) NACE SP0200 and for well casings NACE SP0186.

b. Coating Systems (CS) are a critical factor in performance of an ICCP system. All coatings, including coatings in structure guide specifications and Green Seal (GS) coatings, must be compatible with the structure and the CP system, and have high disbondment capabilities. A high resistance to cathodic disbondment is critical for long term service life of coatings on buried or submerged metallic structures under CP. For paints and coatings refer to Section 09 90 00 PAINTS AND COATINGS, and for discontinuity (Holiday) testing of new protective coatings on conductive substrates refer to NACE SP0188.

c. Mechanical Damage Systems (MDS) such as bedding and rock control barriers normally included in Structure GS may be required by design for some locations. Electrical Isolation is required for all galvanic anode CP systems. For an Electrical Isolation System (EIS) refer to NACE SP0286.

d. An Electrical Continuity System (ECS) of the protected structure is critical to the operation of the CP system. The types of joints such as bonding and couplings are normally included in Structure GS, this is particularly important to nonwelded pipelines to allow sufficient CP current to conduct to the entire structure.

e. Stray Current (Interference) Systems must be considered in design, monitored during construction, and interference testing must be completed during the final testing. Design must consider all other cathodic protection systems which may affect other systems or systems which may affect the project, including foreign systems. All foreign systems must be contacted for information and notification and any joint testing which may be required. Corrosion Coordinating Committees may exist. Reference NACE TPC 11.

f. Pipelines that parallel overhead high-voltage AC transmission power systems are subject to induced AC. Induced AC has several potential adverse impacts on the safety of personnel and pipeline integrity. Assuming that these conditions exist, there are several measures that can be taken to mitigate the induced AC present on a pipeline. These induced AC mitigation strategies are detailed in various international standards including NACE SP0177 and NACE SP21424.

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NOTE: Any AC test voltage over 15 VAC must be mitigated.

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g. An Impressed Current CP Monitoring System is a solution for remote monitoring (and optionally controlling) different kinds of CP installations. Normally provides for measuring AC voltage input, DC voltage and current output. Optionally may be used to include potentials with permanent reference cells. Remote monitoring systems may be set to provide notifications of high and low alarms on any of the monitored inputs/outputs. Automated recording of all measurements may be scheduled and provide a historical database. Remote monitoring is widely used for underground pipelines used in oil and gas distribution systems, remote facilities such as missile launch facilities, for resistance bonds and remote test stations. These Monitoring Systems are detailed in various NACE international technical papers.

h. When a project is connecting to an existing infrastructure with CP the design must be compatible with the existing structure(s) CP system. Existing structures may have Impressed Current CP (ICCP) Anode Systems using Remote Anode Systems, Deep Anode Systems, Linear Anode Systems, or Distributed Anode Systems. Existing structures may also have Galvanic Cathodic Protection (GACP) Systems which may be distributed or remote. Existing structures might not have CP. They may use alternative methods of corrosion mitigation instead of CP such as Inhibitor System/Internal Corrosion Control. For control of internal corrosion in steel pipelines and piping systems refer to NACE SP0106. Due to the limited voltage and current of galvanic anodes the protected structure must be coated and isolated from other structures.

i. A highly dielectric bonded coating is required to attain adequate CP. Unbonded coatings block the protective current from the pipeline or structure and must not be used with CP. Failure to isolate other metallic structures will result in loss of protection. Isolation from other metallic structures must be maintained.

j. Continuity of the structure with low resistance is crucial to proper operation of a galvanic anode system. All joints must be continuous or be bonded to both sides of the joint.

k. A conductive electrolyte is required to allow current flow from the galvanic anodes. Use of galvanic anode systems are normally restricted to electrolytes with resistivities below 30,000 ohm-cm. Small well-coated structures such as coated valves, tees and elbows have very high resistance to earth in high resistance soils. Galvanic anodes in electrolytes over 30,000 ohms also have very high resistance to earth. High circuit resistance with the low voltage of galvanic anodes will not allow sufficient current to meet instant off or depolarization criteria. Additional anodes under these conditions will not noticeably increase the current applied to the structure. Reference SP0169 for criteria in high resistance electrolytes.

2.1.2 Design Requirements

2.1.2.1 Electrical Isolators

Isolators are required to isolate the [protected structure] [pipes] [_____] from any other structure. Provide isolators at all locations where the indicated [protected structure] [pipes] [_____] contact any other metallic structure. Provide locations and detailed drawings of required installations. Include any requirements for lightning protection, test stations, surge protection, or other requirements and include locations and details in design drawings.

2.1.2.2 Anode and Bond Wires

For each CP system, bond metallic components and structures that are not electrically continuous by installing bond wires between the various structures. Bonding of existing buried structures may also be required to preclude detrimental stray current effects and safety hazards. Return stray current to its source without damaging structures intercepting the stray current. Provide electrical isolation of underground facilities in accordance with acceptable industry practice. All tests must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

2.1.2.3 Surge Protection

Install approved zinc grounding cells or sealed weatherproof lightning and surge arrestor devices across isolation flanges or fittings installed in underground piping as indicated on the drawings. Provide gapless, self-healing, solid state type arrestor. Provide zinc anode composition conforming to ASTM B418, Type II. Provide number 4 AWG copper lead wires with High Molecular Weight Polyethylene (HMWPE) insulation. Zinc grounding cells prepackaged in backfill are acceptable; install as detailed on the drawings. Lightning arrestors or zinc grounding cells are not required for isolation flanges on metallic components used on non-metallic piping systems.

2.1.2.4   Non-metallic Pipe System

In the event pipe other than metallic pipe is approved and used in lieu of metallic pipe, protect all metallic components of this pipe system with CP. Submit detailed drawings of CP for each component to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager for approval within 45 days after date of receipt of notice to proceed, and before commencement of any work.

2.1.2.5   Coatings

Provide coatings for metallic components as required for metallic fittings. Complete and test protective coating on each metallic component (such as valves, hydrants and fittings). Provide coating as required for underground metallic pipe. Each test must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Select, apply, and inspect coatings as specified in these specifications. The use of non-metallic pipe does not change other requirements of the specifications. Submit any deviations due to the use of non-metallic pipe for approval.

2.1.2.6   Tracer Wire

When a non-metallic pipeline is used to extend or add to an existing metallic line, thermit-weld No. 8 AWG copper wire with Thermoplastic Heat and Water-resistant Nylon-coated (THHN) insulation to the existing metallic line and run the length of the new non-metallic line. Use this wire as a locator tracer wire and to maintain continuity to any future extensions of the pipeline.

2.1.2.7   Drawings

Submit [six] [_____] copies of detail drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, results of system design calculations including soil-resistivity, installation instructions and certified test data showing location of anodes and stating the maximum recommended anode current output density. Include in the detail drawings complete wiring and schematic diagrams, isolation fittings, test stations, permanent reference electrodes and bonding and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. Reference locations to two permanent facilities or mark points. Provide [one] [_____]electronic [digital] [PDF] [_____] copy and digital photos of the completed installation.

2.1.2.8   Summary of Services Required

Include the following scope of services:

a. Close-interval potential surveys,

b. CP Installation System,

c. System testing,

d. Casing corrosion control,

e. Interference testing,

f. Training,

g. Operating and maintenance manual,

h. Isolation testing and bonding testing,

i. Coating and holiday testing.

2.1.2.9 Contractor's Modifications

The specified system is based on a complete system with [galvanic in GACP] [Impressed Current in ICCP] & [Galvanic or Impressed Current (as applicable) in SWT] anodes. The contractor may modify the CP system after review of the project, site verification, and analysis, if the proposed modifications include the anodes specified and will provide better overall system performance.

a. Submit [six] [_____] copies of detail drawings showing proposed changes in location, scope of performance indicating any variations from, additions to, or clarifications of contract drawings. Show proposed changes in anode arrangement, anode size and number, anode materials and layout details, conduit size, wire size, mounting details, wiring diagram, method for electrically-isolating the structure, and any other pertinent information for proper installation and performance of the system. Reference locations to two permanent facilities or mark points. Include in the detail drawings complete wiring and schematic diagrams, permanent reference electrodes and bonding and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. The modifications must be fully described and must be approved by the Contracting Officer. Provide [one] [_____] electronic [digital] [PDF] [_____] copy and digital photos of the completed installation.

b. The proposed system must achieve performance requirements found in section 2.1.3 Performance Requirements, meet the criteria of CP and be verified by testing requirements in section 3.6.1 Tests and Measurements.

2.1.2.10 Tests of Components

Perform a minimum of four tests at each metallic component in the piping system. Two measurements must be made directly over the anodes and the other two tests must be over the outer edge of the component, but at the farthest point from the anodes. Provide a field drawing showing the component, the structure, all components of the CP system and their relationship to each other. Also provide a narrative describing how the CP system will work and the testing at each component. Components requiring CP must include but not be limited to the following:

a. Pipes under the floor slab or foundations.

b. Post Indicator Valve (PIV).

c. Shutoff valves.

d. Metallic pipes extended from aboveground locations.

e. Connectors or change-of-direction devices.

f. Metallic pipe components or sections.

g. Backflow preventers.

h. Culverts.

i. Casings.

2.1.2.11 Electrical Potential Measurements

Make all potential tests at a minimum of 3 m 10 foot intervals witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Provide submittals identifying test locations on separate drawings, showing all metal to be protected and all CP equipment. Distinguish and identify test points equipment and protected metal.

2.1.2.12 Typical Metallic Components on Non-metallic Systems

2.1.2.12.1 Metallic Components

As a minimum, protect each metallic component with two galvanic anodes. This number of anodes is required to achieve minus 850 millivolts "instant off" potential on the metallic area and at the same time not provide overvoltage above 1200 millivolts "instant off." As a minimum, the galvanic anode unpackaged weight must be [4.1] [7.7] [_____] kg [9] [17] [_____] pounds. Locate the galvanic anodes on each side of the metallic component and route through a test station.

2.1.2.12.2 Fire Hydrants

Provide fire hydrant pipe components with a minimum of two anodes. These magnesium anodes must have an unpackaged weight of 7.7 kg 17 pounds.

2.1.2.12.3 Pipe Under Concrete Slab

Pipe under concrete slab must have a minimum of [2] [3] [_____] magnesium anodes. These magnesium anodes must have an unpackaged weight of [4.1] [7.7] [_____] kg [9] [17] [_____] pounds. Pipe under concrete slab must have [1] [2] [_____] permanent reference electrodes located under the slab. Locate one permanent reference electrode where the pipe enters the concrete slab. Route all conductors to a test station.

2.1.2.12.4 Valves

Protect each valve with [1] [2] [_____] magnesium anodes. The magnesium anode must have an unpackaged weight of [4.1] [7.7] [_____] kg [9] [17] [_____] pounds.

2.1.2.12.5 Metallic Pipe Component or Section

Protect each section of metallic pipe with [2] [3] [_____] magnesium anodes. The magnesium anodes must have an unpackaged weight of [4.1] [7.7] [_____] kg [9] [17] [_____] pounds.

2.1.2.12.6 Connectors or Change-of-Direction Devices

Protect each change-of-direction device with [2] [3] [_____] magnesium anodes. The magnesium anode must have an unpackaged weight of [4.1] [7.7] [_____] kg [9] [17] [_____] pounds.

2.1.2.13 Metallic Component Coating

Coatings for metallic components will be required for metallic fittings as indicated. These metallic fittings will include fire hydrants, tees, elbows, and valves. Coatings must be selected, applied, and inspected as specified in the coating specifications referenced and be compatible with the structure being protected. All coatings must be in accordance with all applicable Federal, State, and local regulations. Unbonded coatings must not be used with CP.

2.1.2.14 Location of Test Stations

Provide test stations of the type and location shown and [curb box] [post] [wall] mount. Provide buried isolation joints with test wire connections brought to a test station. Reference all test stations with GPS coordinates. Unless otherwise shown, locate other test stations as follows:

a. At 300 m 1,000-foot intervals or less.

b. Where the pipe or conduit crosses any other metal pipe.

c. At both ends of casings under roadways and railways.

d. Where both sides of an isolation joint are not accessible above ground for testing purposes.

2.1.2.15 Electrical Isolation of Structures

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NOTE: The CP system will fail unless full consideration is given to specifications for electrically isolating pipe joints, electrically conductive pipe joints, and casing cradles and seals. Mechanical and electrical specifications must reference paragraphs "Electrically Isolating Pipe Joints" and "Electrically Conductive Couplings."

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As a minimum, provide isolating flanges or unions at the following locations:

a. Connection of new metallic piping or components to existing piping.

b. Pressure piping under floor slab to a building.

Provide isolation at metallic connection of all lines to existing system and where connecting to a building. Additionally, provide isolation between [water] [_____] or [gas] [_____] [forced main] line; and foreign pipes that cross the new lines within 3.05 m 10 feet. Install isolation fittings, including isolating flanges and couplings, aboveground or in a concrete pit.

2.1.2.15.1 Gas Distribution Piping

Provide electrical isolation at each building riser pipe to the pressure regulator, at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings.

2.1.2.15.2 Isolation Joint Testing

An isolator checker or insulation tester will be used for isolation or insulating joint (flange or dielectric) electrical testing.

2.1.2.15.3 Underground Structure Coating

This coating specification takes precedence over any other project specification and drawing notes, whether stated or implied, and also applies to the pipeline or tank supplier. Variance in coating quality is not allowed by the contractor or Base Construction Representative without the written consent of the designer. All underground metallic pipelines and tanks to be cathodically protected must have a high quality factory-applied coating. This includes all carbon steel, cast-iron and ductile-iron pipelines or vessels. Select, apply, and inspect coatings as specified. If non-metallic pipelines are installed, coat all metallic fittings on pipe sections in accordance with this specification section.

a. The nominal thickness of the metallic pipe joint or other component coating must be [0.2][0.4][0.6][1.0][1.5][_____] mm [8][16][24][40][60][_____] mils, plus or minus 5 percent.

b. Apply pipe and joint coating for factory applied or field repair material as recommended by the manufacturer. Coating must be one of the following:

    (1) Continuously extruded polyethylene and adhesive coating system.
    (2) Polyvinyl chloride pressure-sensitive adhesive tape.
    (3) High density polyethylene/bituminous rubber compound tape.
    (4) Butyl rubber tape.
    (5) Coal tar epoxy.

2.1.2.15.4 Field Joints

Coat all field joints with materials compatible with the pipeline coating compound. Apply the field joint coating material to an equal thickness as the pipeline coating. Do not use unbonded coatings for these buried metallic components. This includes the elimination of all unbonded polymer wraps or tubes. Once the pipeline or vessel is set in the trench, conduct an inspection of the coating. This inspection must include electrical holiday detection. Repair any damaged areas of the coating. The Contracting Officer or the Contracting Officer's Representative, Technical Expert or Project Manager must be asked to witness inspection of the coating and testing using a holiday detector.

2.1.2.15.5 Inspection of Pipe Coatings

Any damage to the protective coating during transit and handling must be repaired before installation. After field coating has been applied, inspect the entire pipe using an electric holiday detector in accordance with NACE SP0188 using a full-ring, spring-type coil electrode. The holiday detector must be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Upon detection, immediately repair all holidays in the protective coating. Occasional checks of holiday detector, operation will be made by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager to determine suitability of the detector. Provide all labor, materials, and equipment necessary for conducting the inspection.

2.1.2.15.6 Protective Coating for Aboveground Piping System

Provide finish painting conforming to the applicable paragraph of Section 09 90 00 PAINTS AND COATINGS and as follows:

2.1.2.15.7 Ferrous Surfaces

Touch-up shop-primed surfaces with ferrous metal primer. Solvent-clean surfaces that have not been shop-primed. Surfaces that contain loose rust, loose mil scale, and other foreign substances must be mechanically-cleaned by power wire-brushing and primed with ferrous metal primer. Finish primed surface with two coats of exterior oil paint and vinyl paint.

2.1.3 Performance Requirements

The design must allow for synchronized interruption of all applied current.

2.1.3.1 Criteria of Cathodic Protection

Criteria for adequate CP must be identified by the designer or the contractor's corrosion engineer and approved by the government corrosion engineer. The method of voltage drop consideration must also be identified by the contractor's corrosion engineer and approved by the government. The 100 mV shift criteria are not applicable to bi-metallic structures.

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NOTE: Refer to applicable current NACE International Standard Practice NACE SP0169, NACE 0186, NACE 0193, NACE SP0285, NACE 0388 and NACE 0607 or other applicable NACE Standards for the type of metal and the type of metallic structure being protected to determine the appropriate criteria. Not all criteria may be applicable to the type of CP system(s) and structure being designed, and the designer or the contractor's corrosion engineer may select the applicable criteria with approval of the government. If no other criteria are applicable to the structure, use SP0169 Section 6, Criteria.

****

a. Determination of the on and polarized (instant off) potentials must be made with the protective current applied to the [structure] [tank] [pipeline] [coupon] for a minimum of [1] [2] [4] [_____] [days]. Polarized potentials may be determined using a coupon test station (Error-Free (IR Free) test station). Polarized potentials must be determined by interrupting all the current being applied to the structure or coupon.

b. The potential measurements for the native measurement and the polarized potential must be made with the reference electrode at the same exact location. The polarization decay measurements must also be made with the reference electrode at the same exact location as the polarization potential.

c. The polarization decay measurements will be the difference between the polarized potential and a voltage measurement made [24] [48] [_____] hours after the interruption of protective current.

2.1.3.1.1 Steel

A negative polarized potential of 0.85 volts (850 millivolts) or more negative. The voltage must not be more negative than a negative polarized potential of 1.200 volts (1200 millivolts).

2.1.3.1.2 Aluminum

Aluminum underground components must not be protected to a potential more negative than 1200 millivolts, measured between the underground component and a saturated copper/copper sulfate reference electrode contacting the earth, directly over the metallic component. Resistance, if required, must be inserted in the anode circuit within the test station to reduce the potential of the aluminum to a value which will not exceed a potential more negative than minus 1200 millivolts. Voltage shift criterion must be a minimum negative polarization shift of 100 millivolts measured between the metallic component and a saturated copper/copper sulfate reference electrode contacting the earth, directly over the metallic component. The polarization voltage shift must be determined as outlined for iron and steel.

2.1.3.1.3 Copper Piping

For copper piping, the following criteria must apply: A minimum of 100 millivolts of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The polarization voltage shift must be determined as outlined for iron and steel.

2.2 EQUIPMENT

2.2.1 Remote Monitoring

Remote monitoring equipment must be designed, manufactured and procured specifically for CP use and should be provided as per design and drawings to monitor [potential (requires permanent reference electrode)] [bond(s)] [interference bond] [test station(s) shunts][_____] and must match or be compatible with previously installed remote monitoring equipment in use at the installation. Rectifier monitoring must include DC Current output(using rectifier shunt), DC Voltage Output,[AC voltage input][AC voltage input to stacks][_____]. Remote Monitoring must include ability to remotely control current interruption using a [solid state relay with surge suppressor][mercury switch] interrupting the [negative structure lead][AC Voltage to stacks] [AC Rectifier input]. [Software must be compatible with previously installed equipment and allow for group interruption.]

2.2.2 Corrosion Rate Monitoring

Corrosion probes must be designed, manufactured and procured specifically for the application and matched to the structure being protected.

Manufacturer must match or be compatible with previously installed rate monitoring equipment in use at the installation.

2.2.3 Rectifiers

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NOTE: Below about 500 volt-amperes of dc rating output, single phase selenium rectifiers cost less to acquire and operate than silicon rectifiers. Above 1000 volt-amperes silicon rectifiers are more economical for both single phase and three phase. Silicon rectifiers are more economical to repair.

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Rectifier will be [Air Cooled][Oil Immersed][Explosion Proof].

2.2.3.1 Air Cooled Enclosure

NEMA ICS 6 Type [3][3R][3X][4X] Air Cooled enclosure suitable for [wall] [post] [pad] mounting. Enclosures must be of 3.1 mm (11 gauge) steel or heavier. Enclosure must include front hinged door with [padlock hasp] [key lock, provide [three] [_____] keys.] [locks keyed alike.] [left side door] [right side door] fit with screened openings to provide for cooling by natural convection. Provide holes, conduit knockouts and threaded hubs of sufficient size and location. The cabinet and mounting support must be [painted][hot-dipped galvanized][aluminum][stainless] steel [according to the manufacturer's standards].

2.2.3.2 Oil Cooled Enclosure

NEMA ICS 6 Type 11-Oil Immersed Enclosure, suitable for pad mounting. Enclosure must include top hinged door with [padlock hasp] [key lock, provide [three] [_____] keys.] [locks keyed alike.] Enclosures must be of 3.1 mm 11 gauge steel or heavier, with an accessible drain plug. The oil level must be clearly marked. The lid must be hinged and have quick release clamps to secure it in the closed position. A stop must limit the swing of the lid when opened. A compressible, oil resistant, positive sealing gasket must be provided. The gasket must return to its original shape upon release of lid pressure. The gasket attached to the tank or lid and joints must be free of gaps. Base mounting using 102 mm 4 inch high channels provided. Conduits entering the enclosure must be internally sealed and enter or exit above the oil fill line.

2.2.3.3 Explosion Proof Enclosure

NEMA ICS 6 Type 7 Explosion Proof Enclosure suitable for pad mounting. Enclosure must include top hinged lid with [padlock hasp] [key lock, provide [three] [_____] keys.] [locks keyed alike]. Enclosures must be of 3.1 mm 11 gauge steel or heavier, with an accessible drain plug. The oil level must be clearly marked. The lid must have quick release clamps to secure it in the closed position. A stop must limit the swing of the lid when opened. A compressible, oil resistant, positive sealing gasket must be provided. The gasket must return to its original shape upon release of lid pressure. The gasket attached to the tank or lid and joints must be free of gaps. Base mounting using 102 mm 4 inch high channels provided. Conduits entering the enclosure must be internally sealed and enter or exit above the oil fill line.

2.2.3.4 Cabinet Construction

Cabinets are constructed of [not lighter than 1.56 mm 16 gauge [steel] [hot dipped galvanized steel] [stainless steel] [aluminum]] [molded fiberglass reinforced polyester], and provided with a full door. The enclosure must have oil-resistant gasket. The door must be hinged and have a hasp that will permit the use of a padlock. The cabinet must be fitted with screened openings of the proper size to provide for adequate cooling. Holes, conduit knockouts, or threaded hubs of sufficient size and number conveniently located.

2.2.3.5 Cabinet Paint System

[The cabinet and mounting support must be [painted] [hot dipped galvanized] [aluminum] [stainless steel] with the manufacturer's standard painting system.] [The mounting support for the fiberglass cabinet must be [painted] [hot dipped galvanized] [aluminum] [stainless steel] with the manufacturer's standard painting system.]

****

NOTE: The enclosure must not be used in areas prone to flooding unless required for hazardous locations. Provisions must be made for flooding.

****

2.2.3.6 Electrical Ratings

Electrical ratings as follows: Input voltage at 60 Hz: [[115] [208] [230] volts single phase] [[208] [230] [460] volts three phase].

a. Output voltage, dc: [9] [12] [18] [24] [_____] volts [as indicated].

b. Output current, dc: [8] [16] [24] [32] [_____] amperes [as indicated].

The rectifier must be capable of supplying continuous full rated output at an ambient temperature of 44 degrees C 112 degrees F in full sunlight with expected life of 10 years minimum.

2.2.3.7 Rectifier Stacks

Rectifying elements must be [silicon diodes] [selenium cells] connected to provide full-wave rectification. Silicon diodes must be protected by selenium surge cells or varistors against over-voltage surges, and by current-limiting devices against over-current surges.

2.2.3.8 Transformer

Transformer must conform to UL 506.

2.2.3.9 Circuit Breaker

A [single] [two] [three]-pole, flush-mounted, fully magnetic, properly rated non-terminal type circuit breaker must be installed in the primary circuit of the rectifier supply transformer. Properly rated secondary magnetic circuit breaker between rectifier supply transformer and stacks, two on three phase rectifiers.

2.2.3.10 Fuses

Cartridge-type fuses with suitable fuse holders must be provided in each leg of the DC circuit. Properly rated secondary fuse between rectifier supply transformer and stacks, two on three phase rectifiers.

2.2.3.11 Overload and Short Circuit Protection

Provide UL 489, single-pole, flush-mounted molded case circuit breaker, [magnetic] [thermal-magnetic] type, in the primary circuit of the rectifier supply transformer.

2.2.3.12 Surge Protection

Install approved sealed weatherproof lightning arrestor devices for the AC input and the DC output. The arrestor must be gapless, self-healing, solid state type.

2.2.3.13 Wiring

Install wiring in accordance with NFPA 70 utilizing type [THHN] [THWN] [PVC] Thermoplastic Wire (TW) [TW] Rubber Heat (resistant) Wire (RHW) [RHW] [polyethylene] insulation. Fittings for conduit and cable work must conform to UL 514A. Outlets and conduit must be of the threaded hub type with gasketed covers. Conduit must be securely fastened at 2.4 m 8 foot intervals or less. Splices made in outlet fittings only. Conductors must be color coded for identification. Wiring for anode header and distribution must be No. [2] [_____] AWG stranded copper wire with type [HMWPE] [Dular/Halar] [Dual Extrusion HALAR/HMWPE] [Dual Extrusion Kynar (PVDF)] Direct Burial Cable insulation.

2.2.3.14 Shunt Resistors

MIL-I-1361. Shunt must be located on the rectifier front panel and clearly marked with current and voltage for verification of panel ammeter. Install shunts calibrated in millivolts per amp with amp capacity at or slightly under rectifier output in series in the anode or the structure circuit between the stacks and the rectifier output.

2.2.3.15 DC Output Control

Provide adjustable DC output voltage by [transformer taps] [automatic controls] [Dial Potentiometer Control].

2.2.3.16 Output Voltage and Current Metering

Provide separate panel voltmeter and ammeter, not less than 63.5 mm 2 1/2 inch [round] [rectangular] 2 percent full scale accuracy at 30 degrees C 80 degrees F, temperature stability above and below 30 degrees C 80 degrees F of at least 1 percent per 5 degrees C 10 degrees F. Provide toggle switch for each meter.

2.2.3.17 Efficiency

Overall efficiency of [65 percent] [90 percent] [_____] minimum when operated at full output.

2.2.3.18 Filter Chokes and Capacitors

An efficiency filter (choke) may be required as an option to improve the rectifiers efficiency. A capacitor may also be required to be used in conjunction with the filter to further improve the efficiency and minimize noise.

2.2.3.19 Grounding Provisions

Grounding provisions must [be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.] [comply with NFPA 70 and UL 467 including a ground terminal in the cabinet.] The grounding conductor from the terminal to the earth grounding system must be solid or stranded copper not smaller than No. 6 AWG. The earth grounding system must consist of one or more ground rods. Ground rods must be of [copper-clad steel conforming to UL 467] [zinc-coated steel conforming to IEEE C135.30] [solid stainless steel] not less than [16] [19] mm [5/8] [3/4] inch in diameter by [2.4] [3.1] m [8] [10] feet in length. Rods are driven full length into the earth. Sectional type rods may be used.

2.2.3.20 Resistance to Ground

****

NOTE: Remove this paragraph if not required in the project.

****

The resistance to ground must be measured using the fall-of-potential method described in IEEE 81. The maximum resistance of driven ground is not to exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, [_____] additional rods not less than 1.8 m 6 feet on centers, or if sectional type rods are used, [_____] additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL-listed chemically-charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager immediately. Connections below grade must be fusion welded. Connections above grade must be fusion welded or must use UL 467 approved connectors.

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NOTE: Exothermic welding is not recommended for splicing since it is a higher resistance splice that also degrades the conductivity of the conductors. The most recent mechanical or hydraulic-crimp splice results in no degradation of the conductivity of the conductors and is not dependent on the ambient conditions.

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2.2.3.21 Wiring Diagram

A complete wiring diagram of the power unit showing both the AC supply and the DC connections to anodes located on the inside of the cabinet door. All components must be visible and labeled.

2.2.3.22 Optional Rectifier Special Required Features

[1. An efficiency filter (choke) (may be required to improve the rectifiers efficiency). [capacitor] (A capacitor may also be required to be used in conjunction with the filter to further improve the efficiency and minimize noise.)

][2. Convenience Outlet mounted on Faceplate

][3. Safety shield panel covering Taps or all energized conductors on faceplate

][4. Stainless Steel Perforated screens on Air Cooled Rectifiers

][5. Heavy duty Draw-pull Stainless steel cabinet latch

][6. Separate Slide-out equipment racks for Transformer and Stack

][7. Additional [_____]coarse or [_____] fine voltage control link bar taps

][8. Quick-change, heavy-duty knobs for changing tap link bars Minimum 5/16" diameter

][9. Soldered tap changing studs 3/16" Grade XX

][10. Phenolic front panel

][11. Nickel Plated and double-nutted or soldered connections

][12. Terminal block for AC input wires

][13. Terminal block for Remote Monitoring Connections

][14. Primary tap change panel for dual input voltages (Single Phase models only)

]

2.2.4 Polarization Cell Replacement (PCR) and (PCRH) for Hazardous Locations

PCRs and PCRHs must be designed, manufactured, and procured specifically for the application and must exceed the modeled AC steady-state current and fault conditions. For hazardous locations, the PCRH model must be used.

Characteristic	**PCR**	**PCRH**
AC steady-state current, rms	45A, 80A	45A
AC fault current, rms. at 0.5s	3.7 kA to 15 kA	3.7 kA to 15 kA
Lightning current, 8x20 micros, peak	100 kA	100 kA
Hazardous location certification	Division 2, Zone 2	Division 1, Zone 1
Rain Proof, IP66	Yes	Yes

Characteristic	**PCR**	**PCRH**
Submersible, IP68 or NEMA 6P	Optional	No

PCRs must be installed with a protective ground-based enclosure to secure the cable connections and prevent electrical hazards. The PCRH must be installed with an explosion-proof enclosure and must be [flange] [pole] [wall] mounted. Structure and Grounding conductors must be properly sized for the application.

AC Fault Current Rating	**Minimum Wire Size (AWG)**	**Minimum Wire Size (Metric)**
1.2 kA, 2kA, 3.7 kA	#6	16mm^2
5kA 9kA 10kA	#2	35mm^2
14kA 15kA	#2/0	70mm^2

2.2.5 Solid State Decoupler (SSD)

SSDs must be designed, manufactured, and procured specifically for the application and must exceed the modeled AC steady-state current and fault conditions. For hazardous locations, the PCRH model must be used. SSDs must be installed with a protective ground-based enclosure to secure the cable connections and prevent electrical hazards.

Characteristic	**SSD**
AC steady-state current, rms	45A
AC fault current, rms. at 0.5s	1.2 to 5 kA
Lightning current, 8x20micros, peak	75-100 kA
Hazardous location certification	Division 2, Zone 2
Rain Proof, IP66	Yes

Characteristic	**SSD**
Submersible, IP68 or NEMA 6P	Yes

2.3 COMPONENTS

2.3.1 Test Stations

2.3.1.1 Flush Mounted

NEMA ICS 6. Metallic or non-metallic with terminal board, [5] [8] [_____] terminal posts [and lockable lid]. A non-metallic enclosure must be molded of glass filled polycarbonate and urethane coated or Acrylonitrile Butadiene Styrene (ABS) plastic [and mounted on a 500 mm 18 inch length of PVC conduit]. The unit must be of standard design, manufactured for use as a CP test station, complete with cover, terminal board, shunts, and brass or Type [304] [316] stainless steel hardware. The terminal board must be removable for easy access to wires. [Provide traffic valve box capable of withstanding [H-20] [_____] traffic loads.] The cover must have a cast in legend "CP TEST."

2.3.1.2 Post Top Mounted

NEMA ICS 6. Metallic or non-metallic with terminal board, [5] [8] [_____] terminal posts and lockable lid. A non-metallic enclosure must be high impact strength molded plastic. The unit must be of standard design, manufactured for use as a CP test station, complete with cover, terminal board, shunts, and brass or Type [304] [316] stainless steel hardware. The terminal board must be removable for easy access to wires. The test station must be mounted atop 1830 mm 6 foot long polyethylene conduit with anchor. Terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes).

2.3.1.3 Wall Mounted

NEMA ICS 6, Type [3R] [4X] [_____] enclosure with [clamped cover] [Type [304] [316] stainless steel hinges and [clamped] [latched] cover] [and padlocked hasp]. Enclosure will be of [galvanized steel] [painted steel] [aluminum] [fiberglass] [non-metallic] construction with terminal board and labeled with nameplate. Provide nameplate in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Enclosure mounting posts must be [galvanized steel pipe, schedule [40] [80] [_____]], [wood post, full length pressure treated with pentachlorophenol] [as indicated]. Mount enclosure 1066 mm 42 inches above finished grade [as indicated]. Terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes).

2.3.1.4 IR-Free Test Station

[flush] [post top] [wall] mounted test station must include coupon of the same material as the structure, [shunt], [permanent reference electrode] with means of momentary isolation of the coupon with provided circuitry designed, manufactured and procured exclusively for CP instant-off testing

of a cathodically-protected structure. Must be waterproof if used in flush test stations.

2.3.2 Shunts for Test Stations and Junction Boxes

[MIL-I-1361.] [0.1] [0.01] [_____] ohm, [2] [8] ampere, accuracy plus or minus one percent, polycarbonate circuit board type, color coded for value recognition [red for 0.1 ohm shunt] [yellow for 0.01 ohm shunt] with nickel-plated brass posts and standard [64] 6.35 mm 0.25 inch inch holes on [2.54] cm [1] inch centers to fit test stations and terminal boards [0.01 ohm 6] ampere, accuracy plus or minus one percent, manganin wire type.

2.3.3 Junction Box Enclosures

NEMA ICS 6, Type [3R] [4X] [_____] enclosure with [clamped cover] [Type [304] [316] stainless steel hinges and [clamped] [latched] cover] [and padlocked hasp]. Enclosure must be of [galvanized steel] [painted steel] [aluminum] [fiberglass] [non-metallic] construction with terminal board. Knockout for conduit must be the size and location as per design drawings.

2.3.3.1 Nameplates

Provide nameplate in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and ASTM D709. Provide laminated plastic nameplates for each enclosure as specified or as indicated on the drawings. Each nameplate inscription must identify the function. Nameplates will be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface will be matte finish. Corners will be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 635 mm 25 inch by 65 mm 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.3.4 Terminal Boards

Provide terminal boards for anode junction boxes, bonding boxes, and test stations made of phenolic plastic [3] [6] [_____] mm [1/8] [1/4] [_____] inch thick with dimensions as indicated. Insulated terminal boards must have the required number of terminals (one terminal required for each conductor). Install solderless copper lugs and copper buss bars, shunts, and variable resistors on the terminal board as indicated. Test station terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, reference electrodes and coupons).

2.3.5 Anode Junction Boxes

2.3.5.1 Enclosure

NEMA ICS 6, Type [3R] [4X] [_____] enclosure with [clamped cover] [Type [304] [316] stainless steel hinges and [clamped] [latched] cover] [and padlocked hasp]. Enclosure must be of [galvanized steel] [painted steel] [aluminum] [fiberglass] [non-metallic] construction with terminal board and labeled with nameplate. Provide nameplate in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.3.5.2 Terminal Boards

Provide terminal boards for anode junction boxes, bonding boxes, and test stations made of phenolic plastic [3] [6] [_____] mm [1/8] [1/4] [_____]

inch thick with dimensions as indicated. Insulated terminal boards must have the required number of terminals (one terminal required for each conductor). Install solderless copper lugs and copper buss bars, shunts, and variable resistors on the terminal board as indicated. Test station terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes).

2.4 MATERIALS

2.4.1 Impressed Current Anodes

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NOTE: The actual compositions required must be determined to provide adequate and economical service. The anode material composition must be submitted for approval in accordance with "Submittals Procedures." Any deviation from chemical compositions listed must be approved by the government.

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NOTE: Options for anode materials include "High-Silicon Chromium Bearing Cast Iron," "Graphite," and "Mixed Metal Oxide Coated" anodes. Selection of material must be based upon the conditions and operating parameters for the intended use. Precious metal or other anode materials, packaging or connections may also be appropriate for use, as determined by the engineer. These materials, packaging, or connections must also be submitted for approval in accordance with "Submittals Procedures."

****

2.4.1.1 Dimensions and Weights

****

NOTE: The following dimensions and weights of anodes are not all inclusive, additional sizes not included in the following tables may be available from various manufacturers.

****

Bare anode weight [4.1] [7.72] [9.7] [14.53] [_____] kg [9] [17] [20] [32] [_____] pounds not including core.

2.4.1.2 High-Silicon Chromium Bearing Cast Iron

Cast-iron anodes must be of the size indicated and conform to the following requirements:

2.4.1.2.1 Chemical Composition (Nominal)

ASTM A518/A518M, Grade 3. Chemical composition as follows:

Carbon	0.70 to 1.10 percent
Manganese	1.5 percent maximum
Silicon	14.20-14.75 percent
Chromium	3.25 to 5.00 percent
Copper	0.50 percent maximum
Molybdenum	0.20 percent maximum
Iron	Remainder

Anode dimensions: [_____] mm by [_____] inches. [Centrifugally cast tubular anodes with uniform wall thickness, [_____] mm by [_____] inches outer diameter, [_____] mm by [_____] inches square meter feet surface area, and [_____] kb [_____] lb bare anode weight.]

2.4.1.2.2 Electrical Resistivity

Seventy-two microhm-centimeter at minus 7 degrees C 20 degrees F.

2.4.1.2.3 Physical Properties (Nominal)

Tensile strength	103.4 MPa 15,000 psi
Compressive strength	689.5 MPa 100,000 psi
Brinell hardness	520
Density	7.0 grams per cubic centimeter
Melting Point	1260 degrees C 2300 degrees F
Coefficient of expansion from 0 to 100 degrees C 32 to 212 degrees F	132 nanometer per degree C 0.00000733 centimeter per degree F

2.4.1.3 Graphite Anodes

****

NOTE: Maximum allowable current densities for anode surface area are as follows:
Seawater: 40.37 amps per square meter 3.75 amps per square foot,
Fresh water: 2.69 amps per square meter 0.25 amps per square foot,
Soil (anode placed in backfill): 10.76 amps per square meter 1.0 amps per square foot. Do not exceed the Manufacturer's allowable current for the specific anodes procured.

****

2.4.1.3.1 Chemical Composition (Nominal)

Impregnant	6.5 percent maximum
Ash	1.5 percent maximum
Moisture and Volatiles	0.5 percent maximum
Water Soluble Matter	1.0 percent maximum
Graphite	Remainder

Anode dimensions: [_____] mm [_____] inches

Bare graphite anodes must have a maximum electrical resistivity of 0.0011 ohm-centimeter.

2.4.1.3.2 Physical Properties

Tensile strength	103.4 MPa 15,000 psi
Compressive strength	689.5 MPa 100,000 psi
Brinell hardness	520
Density	7.0 grams per cubic centimeter
Melting Point	1260 degrees C 2300 degrees F
Coefficient of expansion from 0 to 100 degrees C 32 to 212 degrees F	132 nanometer per degree C 0.00000733 centimeter per degree F

2.4.1.4 Mixed Metal Oxide (MMO) Anodes

Titanium Wire anodes with a mixed metal oxide crystalline electrically conductive coating with [1.5 mm 0.062 inches] [3.0 mm 0.118 inches] diameter.

Nominal Wire Size		**Diameter Tolerance**		**Titanium**		**Active Surface Area**		**Weight**	
mm	**inches**	**mm**	**inches**	**Percent by Weight**	**Percent by Volume**	**m^2/m of Length**	**ft^2/ft of Length**	**g/m**	**lbs/ft**
1.5	0.062	+0.062 -0.00	+0.007 -0.00	36.1	52.7	0.0051	0.017	13.7	0.009
3.0	0.118	+0.062 -0.00	+0.010 -0.00	17.1	29.0	0.010	0.033	0.042	0.042

Titanium Rod anodes with a mixed metal oxide crystalline electrically conductive coating with [3.175 mm 0.125 inches STD] [3.175 mm 0.125 inches XL] [6.35 mm 0.25 inches STD] [13.97 mm 0.55 inches] [19.05 mm 0.75 inches STD] diameter and [60.96 mm 24 inches XL] [121.92 mm 48 inches XL] length for use in [freshwater or brackish water] [seawater]. STD is standard MMO coating thickness, XL is extended life (greater MMO coating thickness).

Titanium tubular anodes with a mixed metal oxide crystalline electrically conductive coating with [_____] diameter, [_____] length.

Anodes	Diameter		Length		Surface Area		Weight	
mm	cm	inches	cm	inches	m^2	ft^2	kg	lbs
1.6 x 100	1.6	0.063	100	39.4	0.050	0.78	0.21	0.47
2.5 x 50	2.5	1.00	50	19.7	0.039	0.42	0.18	0.40
2.5 x 100	2.5	1.00	100	39.4	0.079	0.84	0.35	0.77
3.1 x 76	3.1	1.22	76	30.0	0.076	0.82	0.32	0.70
3.1 x 122	3.1	1.22	122	48.0	0.121	1.30	0.50	1.10

****

NOTE: Wire, rod or tubular MMO anodes may be used underground with selected backfill, in deep anode beds, and are available in cannisters with selected backfill for use underground.

****

2.4.1.4.1 Conductive Material

Titanium substrate coated with an inert, dimensionally stable, electrically conductive coating with average composition of a 50/50 atomic percent mixture of iridium and titanium oxides, with a small amount of tantalum and ruthenium, 0.002 ohm-centimeter maximum resistivity, 50 MPa 7.25 ksi minimum adhesion or bond strength, and capable of sustaining a current density of 50 MPa 7.25 ksi adhesion or bond strength, and capable of sustaining a current density of 100 ampere per square meter 10.764 square feet in an oxygen generating electrolyte at 66 degrees C 150 degrees F for 20 years. Sinter the mixed metal oxide coating to the titanium surface as to remain tightly bound to the surface when bent 180 degrees onto itself.

2.4.1.4.2 Anode Life Test

The anode wire material must sustain current densities of 100 ampere per square meter 10.764 square feet in an oxygen generating electrolyte for 20 years. The manufacturer must certify that a representative sample taken from the same lot used to construct the anode, has been tested and meets the following criteria. The test cell sustains a current density of 10,000 ampere per square meter 10.764 square feet in a 15 weight percent sulfuric acid electrolyte at 66 degrees C 150 degrees F without an increase in anode to cathode potential of more than 1 volt. The cell containing the anode is to be powered with a constant current power supply for the 30 day test period. The representative sample must be 125 mm 5 inch in length taken from the lot of wire that is to be used for the anode.

2.4.2 Wire and Cable

****

NOTE: Any pinhole, cut, scratch or other damage to the anode cable exposing bare copper to the electrolyte or reducing the insulation thickness

will result in early failure of the CP system. For this reason, special, extra heavy-duty insulation is used on anode wires and cable exposed to the electrolyte. While it is often expedient to use the same type wire for the structure (negative) cable, to avoid a mix-up in the field, lesser insulation can be used since the structure cable is not subject to anodic failure.

****

2.4.2.1 Anode Lead Wire

Anodes must have lead wires installed at the factory. Anode connecting wire must be No. [8] [_____] AWG stranded copper wire with type CP HMWP insulation, 2.8 mm 7/64 inch thick, 600 volt rating. Cable-to-anode contact resistance must be 0.003 ohms maximum. In the toughest of environments, use wire specified for deep anode lead wire.

****

NOTE: The double insulated fluorocopolymer cable is intended for use in very harsh environments such as deep anode bed installations where chlorine and hydrogen gases are generated. This cable can be installed directly in soil or submerged in fresh, brackish, or salt waters. The CP HMWP cable is also a direct buried and submersible type cable suitable for harsh environments, but not as quiet as durable as the double insulated cable would be in the toughest of environments.

****

2.4.2.2 Deep Anode Lead Wire

For deep anodes, each anode must have a separate, continuous wire extending from the anode to the junction box with individual shunts. No spliced connections will be permitted in deep anode cables. No spliced connections will be permitted in deep anode cables. Chlorine gas resistant cable and shield connecting wire must be No. 8 [_____] AWG, stranded copper wire with [an inner jacket of 1 mm 40 mils of Halar insulation covered by an outer jacket of 1.6 mm 65 mils CP HMWP insulation] [HMWPE protective jacketed cable with a fluorocopolymer inner or primary insulation], [Dual Extrusion HALAR/HMWPE] [Dual Extrusion Kynar (PVDF)] Direct Burial Cable insulation with 600-volt rating. Cable-to-anode contact resistance must be 0.02 ohms maximum. For ceramic coated anodes, anode connecting wires must have molded multi-seal solder connections.

2.4.2.3 Anode Header Cable

Anode header cable must be No. [4][2][_____] AWG stranded copper wire with type CP HMWP insulation, 2.8 mm 7/64 inch thick 600 volt rating. Anode Header Cable aboveground in conduit must be No. [4][2][_____] AWG stranded copper wire with type [THHN] [THWN] [PVC] [TW] [RHW] [polyethylene] [CP high molecular weight insulation, 2.8 mm 7/64 inch thick][polyethylene] insulation, 600 volt rating.

2.4.2.4 Structure (Negative) Cable

Structure connecting wire must be No. [4] [2] [_____] AWG stranded copper wire with type [THHN] [THWN] [PVC] [TW] [RHW] [polyethylene] [CP high molecular weight insulation, 2.8 mm 7/64 inch thick] [polyethylene] insulation, 600 volt rating. Copper conductors conforming to ASTM B3 and ASTM B8.

2.4.2.5 Test Wires

Test wires must be No. 12 AWG stranded copper wire with NFPA 70 Type TW or RHW or polyethylene insulation. Copper conductors conforming to ASTM B3 and ASTM B8.

2.4.2.6 Joint and Continuity Bond Cables

Provide bonds across joints or any electrically discontinuous connections in the piping, and other pipes and structures with other than welded or threaded joints included in this CP system. Unless otherwise specified, bonds between structures and across joints in pipe with other than welded or threaded joints must be with No. 4 AWG stranded copper cable with polyethylene insulation. Bonds between structures must contain sufficient slack for any anticipated movement between structures. Bonds across pipe joints must contain a minimum of 100 mm 4 inch of slack to allow for pipe movement and soil stress. Bonds must be attached by exothermic welding. Exothermic weld areas must be insulated with coating compound and approved by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Continuity bonds must be installed as necessary to reduce stray current interference. Additional joint bonding must be done where determined during construction or testing or as directed. Joint bonding must include excavation and backfilling. There must be a minimum of 2 continuity bonds between each structure and other than welded or threaded joints. Electrical continuity must be tested across joints with other than welded or threaded joints and across metallic portions of sewage lift stations and water booster stations. Copper conductors conforming to ASTM B3 and ASTM B8.

2.4.2.7 Resistance Bond Wires

Resistance bonds must be adjusted for minimum interference while achieving the criteria of protection. Alternate methods may be used when approved.

2.4.2.8 AC Power Supply Wiring

[UL 83, Type [THW] [THWN] [TW]] [UL 44, Type RHW,] [UL 854, Type USE], stranded [solid] copper conductors, gauge (AWG) and color coded as indicated.

2.4.2.9 Polyethylene Insulation

Polyethylene insulation must comply with the requirements of ASTM D1248 and of the following types, classes, and grades:

2.4.2.9.1 HMWPE

HMWP must be Type I, Class C, Grade E5.

2.4.2.9.2 High Density Polyethylene (HDPE)

HDPE must be Type III, Class C, Grade E3.

2.4.2.10 Rectifier DC Negative (Structure) Cable(s)

ASTM D1248 HMWPE insulation, stranded copper conductors, gauge (AWG) as indicated.

2.4.3 Cable and Wire Identification Tags

[Laminated plastic material with black letters on a yellow background] [[Brass] [Stainless steel] material with engraved letters]. Print letters and numbers a minimum of 5 mm 3/16 inch in height. Provide identifier legend [in accordance with the drawings] [_____].

2.4.4 Anode Connection

****

NOTE: Type RHW-2-USE-2 insulation must be used under hot asphalt.

****

2.4.4.1 End-Connected Anode

[Drill] [Cast] a recess [150] [_____] mm [6] [_____] inches deep in one end of the anode. Attach the lead wire to the anode with an anchor device. Not more than 10 mm 1/2 inch of bare wire must protrude from the anchor device. Attachment must withstand a 1446 Newton 325 pound pull without loosening the wire or anchor device. Fill the recess with an epoxy sealing compound [leaving sufficient space for a plug]. [Provide non-metallic plug flush with the anode end surface.] [Install a heat-shrinkable anode cap over the attachment. Cap must extend not less than 65 mm 2 1/2 inches on the lead wire and 75 mm 3 inches on the anode.] Cable-to-anode contact resistance must not exceed 0.02 ohms.

2.4.4.2 Center-Connected Anode

Attach the lead wire to the center of the anode with an anchor device suitably fastened to the wire. Not more than 20 mm one inch of bare wire must protrude from the anchor device. Encapsulate [each side of] the connection point with [a minimum of 152 mm 6 inches [_____] of] high-voltage insulating compound mastic and 102 mm 4 inches [_____] of epoxy resin. Attachment must withstand [4000] [6675] [_____] N [900] [1500] [_____] pounds pull without loosening the wire or anchor device. Provide a non-metallic [plug flush with the anode end] [end cap] to prevent chaffing of the anode lead wire. Cable-to-anode contact resistance must not exceed 0.02 ohms.

2.4.4.3 Canister Contained Anodes

Canister contained anodes are to be packed at the factory in sheet metal canisters with calcined petroleum coke breeze. The coke must have a resistivity of 0.1 ohm-cm tested at 1034 kPa 150 psi. The coke must be 11244 kg/cubic meter 70 lbs/cubic foot or greater. The maximum particle size must be 1 mm 0.039 inch and the coke dust-free. The canisters must be capped with tight fitting end caps secured to the body of the canister. The canister must provide a minimum annular space of 75 mm 3 inch all around the anode. The connecting cable needs to pass through a hole in an end cap designed to be tight fitting with the cable and protected from sharp edges with a plastic or rubber grommet. The anodes must be centered in the canisters and the annular space filled with coke breeze compacted in place.

2.4.5 Coke Breeze

2.4.5.1 Calcined Petroleum Coke Breeze (Dry)

Coke Breeze must conform to the following requirements:

2.4.5.1.1 Electrical Resistivity

Resistivity is not to exceed 1 milliohm-meter (0.1 ohm-cm) Great Lake Carbon C 12 A Test Method.

2.4.5.1.2 General Backfill Specifications

Bulk Density - 1044 to 1204 kg/cubic meter 65 to 75 lbs/cubic foot
Fixed Carbon - 99.0 percent or greater
Volatiles - 0.2 percent or less
Sizing - 100 percent less than 13 mm 1/2 inch

2.4.5.2 Metallurgical Coke Breeze (Processed)

Coke Breeze must conform to the following requirements:

2.4.5.2.1 Electrical Resistivity (Nominal)

Nominal electrical resistivity must be:

a. 100 milliohm-meter (10 ohm-centimeter) Max., tightly compacted.

b. 100 milliohm-meter to 150 milliohm-meter, (10 to 15 ohm-centimeter,) lightly compacted.

c. 150 to 200 milliohm-meter, (15 to 20 ohm-centimeter,) loose.

2.4.5.2.2 General Backfill Specifications

Bulk density - 608 to 672 kg per cubic meter 38 to 42 pounds per cubic foot
Fixed Carbon - 80 percent or greater
Sizing - 100 percent less than .10 mm 3/8 inch

2.4.6 Permanent Reference Electrodes

Permanent reference electrodes must be [copper/copper-sulfate] [silver silver-chloride] [zinc] [Hydrocarbon-Proof Palladium (Pd/$PdCl_2$)] specifically manufactured for [underground] [submersible] [_____] use, [32] [_____] mm [1 1/4] [_____] inch diameter, by [203] [255] [_____] mm [8] [10] [_____] inches long, [plastic [_____] tube with an ion trap to minimize contamination of the electrode] [, and a minimum surface sensing area of [_____] square centimeters[_____] square inches]. Must never need recharging, maintenance, or recalibration. Must have impregnated membrane which keeps electrode electrolytes from drying out or getting the reference electrode electrolyte contaminated. Must have ion trap to prevent reference electrode damage from hydrogen sulfide or excess chloride ions. [The electrode will be prepackaged by the manufacturer with a backfill material as recommended by the manufacturer.] Provide electrodes with No. [10] [12] [_____] AWG, [RHW] [THHN] [_____] cable of sufficient length to extend to the [test station] [junction box] [rectifier] without splicing. Reference electrodes will have a minimum 20-year life, stability of plus or minus 5 millivolts under 3 microamp load. The manufacturer must calibrate the PRE to 316 mV plus or minus 10mV referenced to a standard hydrogen electrode (SHE) and provide a calibration certificate detailing the results of the calibration. Procedures for evaluating the accuracy annually must be included in the Operation and Maintenance Manual.

****

NOTE: Refer to NACE TM0113-2013 Standard Test Method for Evaluating the Accuracy of Field-Grade Reference Electrodes and NACE TM0211-2011 Standard Test Method for Durability Test for Copper/Copper Sulfate Permanent Reference Electrodes for Direct Burial Applications for information for evaluating the accuracy or durability of the PRE.

****

2.4.7 Pavement Inserts

Pavement insert must be a non-metallic flush type test station without terminal board, and must allow a copper/copper sulfate reference electrode to contact the electrolyte beneath the pavement surface. [Provide traffic valve box capable of withstanding [H-20] [_____] traffic loads.]

2.4.8 Coupons

Coupons must match the material of the structure, with [1] [2] integrated connection(s) with electrical wire(s) and be designed, manufactured and procured for use as a corrosion coupon, IR-Free reference electrode, or AC reading electrode.

2.4.9 Zinc Grounding Cells

Two Zinc [Type II] [Type I] anodes separated with 24.5 mm 1 inch isolating spacers. Minimum 10 feet of #6 AWG HMWPE CP cable crimped securely to each anode. Both anodes centered in one cloth bag and surrounded with low resistance backfill mixture consists of 75 percent hydrated gypsum, 20 percent bentonite, and 5 percent sodium sulfate.

Element	**Content Percent**	
	MIL-A-18001 ASTM B418 Type I	**ASTM B418 Type II**
Al	0.1 - 0.5 percent	0.005 percent max
Cd	0.02 - 0.07 percent	0.003 percent max
Fe	0.005 percent max	0.0014 percent max
Pb	0.006 percent max	0.003 percent max
Cu	0.005 percent max	0.002 percent max
Zinc	Remainder	Remainder

Bare Weight		Width		Height		Length		Total Packaged Weight	
kg	pounds	mm	inches	mm	inches	mm	inches	kg	pounds
2.3	5	36	1.4	36	1.4	254	10	9.1	20
5.4	12	36	1.4	36	1.4	610	24	18.1	40
6.8	15	36	1.4	36	1.4	762	30	22.7	50
6.8	15	51	2.0	51	2.0	381	15	16.3	36
8.2	18	36	1.4	36	1.4	914	36	24.9	55
13.6	30	36	1.4	36	1.4	1524	60	39.0	86
13.6	30	51	2.0	51	2.0	762	30	30.4	67
20.4	45	51	2.0	51	2.0	1143	45	45.4	100
27.2	60	51	2.0	51	2.0	1524	60	54.4	120

2.5 ACCESSORIES

2.5.1 Wire Connectors

Safety Standard for Wire Connectors must conform to UL 486A-486B.

2.5.2 Electrical Tape

Pressure-sensitive vinyl plastic electrical tape must conform to UL 510.

2.5.3 Cable Marker Tape

Traceable marker tape must be manufactured for the purpose and clearly labeled "Cathodic Protection Cable Buried Below".

2.5.4 Insulating Tape

Pressure-sensitive vinyl plastic electrical tape and rubber insulated tape must conform to UL 510.

2.5.5 Underground Splices

Provide splices with a compression connector on the conductors, and insulation and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

2.5.5.1 Cast-Type Splice

Provide cast-type splice insulation by means of molded casting process employing a thermosetting epoxy resin insulating material applied by a gravity poured method or pressure injected method. Provide component materials of the resin insulation in a packaged form ready for convenient mixing without removing from the package.

2.5.5.2 Gravity-Poured Splice

Gravity-poured method must employ materials and equipment contained in and approved commercial splicing kit which includes a mold suitable for the cables to be spliced. When the mold is in place around the joined conductors, prepare the resin mix and pour into the mold.

2.5.5.3 Heat Shrinkable Splice

Provide [heavy wall] heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which must be applied by a clean burning propane gas torch.

2.5.6 Buried Cable Warning and Identification Tape

Polyethylene tape, manufactured for warning and identification of buried cable and conduit. Tape must be [75] [_____] mm [3] [_____] inches wide, [Yellow] [_____] in color and read "CAUTION CATHODIC PROTECTION CABLE BURIED BELOW". Color and lettering must be permanent and unaffected by moisture or other substances in backfill materials.

2.5.7 Conduit

[UL 6, rigid galvanized steel], [Outlet boxes: UL 514A and fittings UL 514B, threaded hubs]. [Metallic conduit and fittings to be PVC coated in accordance with NEMA RN 1, Type A40], [NEMA TC 2, Type EPC-40-PVC]. Non-metallic conduit must conform to NEMA TC 2.

2.5.8 Resistance Wire

Resistance wire must be AWG No. [16 or No. 22] [_____] nickel-chromium wire.

2.5.9 Deep Anode Bed Casing

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NOTE: A metal casing must not be used except for a maximum of 1.5 meter 5 feet at the top for a well cap which also serves as a support for the suspension ropes. The drilling mud on the sides of the hole will usually keep the hole open until the anodes and coke breeze are installed. If a casing must be used, it must be fiberglass reinforced plastic (non-metallic) and must be located above the anode string.

****

Casing must be [_____] mm inch outside diameter, 3 mm 1/8 inch minimum wall thickness black steel pipe, conforming to ASTM A53/A53M, Type E or S, Grade B. The top casing must be [_____] mm inch outside diameter, 3 mm 1/8 inch minimum wall thickness black steel pipe, conforming to ASTM A53/A53M, Type E or S, Grade B. The metal casing must extend no more than [1.5] [_____] m [5] [_____] feet below the top of a well cap.

2.5.10 Anode Centering Device for Deep Anodes

Anode centering device must be metallic and capable of maintaining centering in the hole without interfering with other anode lead wiring, until coke breeze is packed in place. Centering device must have mechanical means of firmly attaching to vent pipe and anode.

2.5.11 Vent Pipes

All deep anodes must be vented in anode zones. Openings in the vent must not be larger than 0.1524 mm 0.006 inch.

2.5.12 Sealing and Dielectric Compound

Sealing and dielectric compound must be a black, rubber-based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Apply compound as recommended by the manufacturer, but not less than 3 mm 1/8 inch thick.

2.5.13 Protective Coating

Except as otherwise specified, protective coating for underground metallic components including pipe and fittings must be applied mechanically in a factory or field plant specially equipped for the purpose. Valves and fittings that cannot be coated mechanically must have the protective coating applied by hand, preferably at the plant. Joints must be coated by hand. Hand coating must produce a coating equal in thickness to the coating applied mechanically. Piping and components installed in valve boxes or manholes must also receive the specified protective coating.

2.5.13.1 Pipeline Metallic Components

Underground metallic pipelines and structures must have a good quality factory-applied coating. This includes carbon steel, cast iron and ductile-iron pipelines or vessels. If non-metallic pipelines are installed, metallic fittings or pipe sections must be coated as follows.

a. The nominal thickness of the metallic pipe joint or other component coating must be [0.2] [0.4] [0.6] [1.0] [1.5] [_____] mm [8] [16] [24] [40] [60] [_____] mils, plus or minus 5 percent.

b. Pipe and joint coating for factory-applied or field-repair material must be applied as recommended by the manufacturer and must be one of the following:

   (1) Fusion bonded epoxy.

   (2) Continuously-extruded polyethylene and adhesive coating system.

   (3) Polyvinyl chloride pressure-sensitive adhesive tape.

   (4) High-density polyethylene/bituminous rubber compound tape.

   (5) Butyl rubber tape.

   (6) Coal tar epoxy.

2.5.13.2 Field Joints

Coat field joints with material compatible with the existing pipeline coating compound. Apply the joint coating material to an equal thickness as the pipeline coating. Unbonded coatings must not be used on buried metallic piping. This prohibition includes unbonded wraps or tubes.

2.5.14 Preformed Sheaths

Preformed sheaths for encapsulating electrical wire splices to be buried underground must fit the insulated wires entering the spliced joint.

2.5.15 Epoxy Potting Compound

Epoxy potting compound for encapsulating electrical wire splices to be buried underground must be a two package system made for the purpose.

2.5.16 Backfill Shields

Backfill shields must consist of approved pipeline wrapping or fiberglass reinforced, coal-tar impregnated tape, or plastic weld caps, specifically made for the purpose.

2.5.17 Isolation Flange Sets/Kits

****

NOTE: On projects having piping installed by Division 2, SITEWORK or Division 15, MECHANICAL, coordinate the requirements for flanges and unions with the appropriate section(s).

****

Provide full-faced gaskets, isolating sleeves and washers, and steel washers. Provide isolation flange kits rated for operation at the rated pressure and temperature. Bolts must be replaced with similar type longer bolts if less than two threads extend beyond the end of both steel washers.

2.5.18 Dielectric Unions

****

NOTE: On projects having piping installed by Division 2, SITEWORK or Division 15, MECHANICAL, coordinate the requirements for flanges and unions with the appropriate section(s).

****

ASME B16.39, Class [1] [2] rated for dimensional, strength, and pressure requirements. Insulation barrier must limit galvanic current to one percent of the short-circuit current in a corresponding metallic joint. Provide insulating material impervious to [water] [oil] [gas].

2.5.19 Electrical Isolation of Structures

Isolating fittings, including isolating flanges and couplings, must be installed above ground or in a concrete hand hole. As a minimum, isolating flanges or unions must be provided at the following locations:

a. Connection of new piping to existing pipes.

b. Pressure piping under floor slab to a building.

c. Additionally, isolation must be provided between new pipe lines and foreign pipes that cross the new lines within 3 m 10 feet.

2.5.19.1 Gaskets

****
NOTE: Do not use asbestos materials.
****

ASME B16.21. [Neoprene faced phenolic] [Laminated phenolic] material for operation at [_____] KPa, [232] [_____] degrees C [_____] psi, [450] [_____] degrees F. Asbestos materials must not be used.

2.5.19.2 Isolation Washers and Sleeves

Two sets 3 mm 1/8 inch [laminated phenolic] [_____] for operation at [232] [_____] degrees C [450] [_____] degrees F. Isolating washers must fit within the bolt facing on the flange over the outside of the fabric reinforced phenolic sleeve.

2.5.20 Electrically Isolating Pipe Joints

****
NOTE: The CP system will fail unless full consideration is given to specifications for electrically isolating pipe joints, electrically conductive pipe joints, and casing cradles and seals. Mechanical and electrical specifications must reference this paragraph and paragraph "Electrically Conductive Couplings."
****

Electrically isolating pipe joints for above- or below-ground use must be [flexible, mechanical pipe couplings of an electrically isolating type consisting of bolted or compression design provided with electrically isolating joint harness if required to provide pull-out strength] [flexible, integral electrically isolating pipe couplings designed for field installation by means of a swaging system and providing pull-out strength with a factor of safety] [nonflexible flanged type electrically isolating pipe joints to be field assembled] [nonflexible factory assembled electrically isolating pipe joints designed with stub ends for installation by welding and providing pull-out strength with a factor of safety].

2.5.20.1 Threaded Fittings

Threaded type electrically isolating pipe joints must have molded plastic screw threads and be used above ground only. Machined plastic screw threads must not be used.

2.5.21 Electrically Conductive Couplings

Electrically conductive couplings must be of a type that is in regular factory production.

2.5.22 Stray Current Measurements

Perform stray current measurements as indicated. Alternate methods may be used when approved. The stray current test report must indicate location of test, type of pipes tested, method of testing, [_____].

2.5.23 Cast-In-Place Concrete

Concrete must be 20 MPa 3000 psi minimum ultimate 28-day compressive strength with 25 mm one inch minimum aggregate conforming to [ASTM C94/C94M] [Section 03 30 00 CAST-IN-PLACE CONCRETE].

2.5.24 Isolation and End Seals

2.5.24.1 Casing Isolator/Centralizer

[High density (linear), injection molded virgin Polyethylene] [Polycarbonate Hi-Temp isolators/spacers rated for service at least 280 degrees F. (138 degrees C) or more] [High Grade Thermoplastic] positive electrical isolation, high abrasion resistance and low coefficient of friction.

2.5.24.2 End Seals

Ethylene Propylene Diene Monomer (EPDM) Neoprene rubber end seals, thickness of 1/8 inch or more, with [2] [4] Stainless Steel Pipe Clamps per end seal, 1/8 inch thick and 1/2 inch wide or more.

2.5.25 Steel Flanges and Bolting

2.5.25.1 Steel Flanges

ASME B16.5, [668 N] [1335 N] [150 lb.] [300 lb.].

2.5.25.2 Bolting

ASTM A307, Grade B for bolts; ASTM A194/A194M, Grade 2 for nuts. Dimensions: ASME B18.2.1 for bolts, ASME B18.2.2 for nuts. Threads: ASME B1.1, Class 2A fit for bolts, Class 2B fit for nuts. Bolts must extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at the roof of threads.

2.5.26 Gravel

100 percent to pass a 25 mm 1 inch mesh.

2.5.27 Casing Isolation and Seals

Exothermic weld kits specifically designed by the manufacturer for exothermic welding wires to metallic surfaces. Molds must be for specific type of metallic structure (steel, cast iron), specific diameter of pipe or metallic surface and specific size (AWG)and type of wire (solid, stranded).

PART 3 EXECUTION

3.1 SAFETY PRECAUTIONS AND HAZARDOUS LOCATIONS

Any personnel performing operations that will generate heat, sparks, or flame in hazardous locations must first perform adequate safety precautions. A trained responsible person must ensure the area is safe to perform the operation. Required actions include ensuring adequate ventilation before work starts, air monitoring, and a fire watch must be provided and remain for 30 minutes after the operation is completed. A minimum of a 20 pound ABC type fire extinguisher must be available and must be inspected before each use. Equipment being used must be inspected and used in accordance with manufacturer recommendations. Combustibles that are in the work area(s) must be moved or if they cannot be moved, be covered with fire retardant welding blankets. When performing exothermic welding, properly sized charges and inspection of the structure condition must be accomplished to ensure a safe operation.

3.2 INSTALLATION

3.2.1 Anode Bed Installation

IEEE C2NFPA 70 Anode configuration and size must be as indicated in design drawings. A minimum of [one] [two] [three] [ten] [15] [_____] anodes must be installed in locations as specified in design drawings. Materials must meet these specifications. The corrosion expert must verify that the materials are in accordance with the approved submittals. Anode beds must be installed in remote earth or distributed around the structure being protected.

3.2.1.1 Shallow Anode Beds

Shallow ground beds must contain size and quantity of anodes designed to meet the design current requirement of the CP system at an initial operating current output density not exceeding [40] [50] [70] percent of manufacturers recommended current output density of the specific anodes being installed.

3.2.1.1.1 Horizontally Buried Bare Anodes

Horizontally buried bare anodes must be bedded on and covered with coke breeze as specified in a trench excavated for the purpose at depths, spacing and locations as shown in design drawings. Anodes must be completely surrounded by the backfill at bottom, sides, and top for a distance of not less than 100 mm 4 inch. Backfill must be compacted.

3.2.1.1.2 Vertically Buried Bare Anodes

Vertically buried bare anodes must be installed in vertical holes in the ground having a depth, spacing, and location shown. The holes in the ground must be sufficiently large to provide an annular space around the anode not less than 100 mm 4 inch. The anodes must be centered in the hole and backfilled with coke breeze. Backfill must be compacted.

3.2.1.1.3 Horizontally Buried Canister-Contained Anodes

Horizontally buried canister-contained anodes must be buried in a trench excavated for the purpose at depths, spacing, and locations shown.

3.2.1.1.4 Vertically Buried Canister-Contained Anodes

Vertically buried canister-contained anodes must be installed in vertical holes in the ground having depth, spacing, and locations shown. The holes in the ground must be sufficiently larger in diameter than the canisters to facilitate easy lowering into the hole and backfilling. The space between the canister and the wall of the hole must be completely backfilled with a wet slurry of earth free of stones.

3.2.2 Remote Anode Systems

Remote anode systems must consist of groups of anodes connected in parallel to a header cable, buried in the ground at depths, spacing, and locations shown. The anodes must be buried [horizontally] [vertically].

3.2.3 Distributed Anode Systems

Distributed anode systems must consist of a line or row of anodes connected in parallel to a header cable and buried in remote earth at depths, spacing, and locations shown. The anodes must be buried [horizontally] [vertically].

3.2.4 Linear Anode ICCP Systems

These systems are commonly used to protect long line structures, such as pipelines. This is usually the most economical choice when the pipeline due to poor or aged coating requires a continuous and close coupled current. This type of anode bed is used to protect pipelines with poor coating and can be installed up to several miles along a pipeline. The distance from the structure is normally 5 to 10 feet (1.5 to 3 meters). In most cases, the anode is installed with a separate header cable to minimize voltage drop. Mixed metal oxide anodes or polymer anodes are typically used for this type of installation.

3.2.5 Deep Anode Lead Wire

Each anode must have a separate, continuous lead wire, without splices, from the anode and terminating in an aboveground junction box equipped with individual anode current shunts.

3.2.5.1 Anode Centering

Anodes must be centered in the well by means of centering devices.

3.2.5.2 Casing

The casing must be to a depth and elevation indicated in design drawings.

3.2.6 Backfill

Backfill the well with specified coke breeze or metallurgical coke breeze surrounding the anodes by a method that does not leave voids or bridging. The recommended method is to pump the backfill from the bottom upward. The well must be over-filled with coke breeze allowing for settlement so that the settled level after a number of days is as high as the level shown. The number of days allowed for settling of the coke breeze will be determined by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. If the top level of coke breeze is below the level shown after settlement, put additional coke breeze in the well. The backfill used must not require tamping. The top portion of the well must be sealed for 8 m 25 feet to prevent surface water run-off. All vents must be vented above the high water mark and at a safe height.

3.2.7 Cable Marker Tape

Locate traceable marker tape in the same trench above CP cables including structure leads, anode leads, anode header cables, test station leads, bonding cables, and rectifier electrical power cables.

3.3 MISCELLANEOUS INSTALLATION

3.3.1 Rectifier Installation

Mounting must be as shown. [Pole or wall mounting must be equipped with a channel bracket, lifting eyes, and a keyhole at the top.] [Cross-arm brackets must accommodate a 102 by 102 mm 4 by 4 inch cross-arm.]

3.3.2 Test Stations

Provide test stations complete with an insulated terminal block having the indicated number of terminals; provided with a lockable cover and have a cast-in legend, "C.P. Test" and complete with an insulated terminal block having the required number of terminals. (One terminal required for each conductor). Provide sufficient test stations to monitor underground isolation points. Test-bond stations (potential measurement and stray current control) must be provided to monitor pipe-to-soil potential of proposed underground pipes or existing underground metallic structures which may conduct stray current from the new CP system. The location of the test-bond stations must ensure that the pipe-to-soil potential of metallic pipe not designated to be protected is not made less negative by the energization of the CP system. Test station terminal connections and the terminal conductor must be permanently tagged to identify each termination of the conductors (e.g. identify the conductors connected to the protected structures). Conductors must be permanently identified in the station by means of plastic or metal tags, or plastic sleeves to indicate termination. Each conductor must be color coded in accordance with the drawings. The station test facility, including permanent copper/copper-sulfate reference electrodes and test returns must be installed as indicated. Pavement inserts must be non-metallic and must allow copper/copper-sulfate reference electrode to contact the electrolyte beneath the pavement surface. Abbreviations must not be used. Welding of electrical connections must be as follows: Exothermic welds must be as specified. Use and selection of these materials and welding equipment must be in accordance with the manufacturer's recommendations.

3.3.3 Permanent Reference Electrodes

3.3.3.1 Permanent Reference Electrode Verification

Verify permanent reference electrodes against a calibrated portable electrode in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager before installation. Verify in a non-metallic container of water. Permanent electrode must measure a reference potential agreeing with that measured by the portable electrode within plus or minus 0.010 volts when the sensing windows of the two electrodes being compared are not more than 2 mm 1/6 inch apart but not touching. Remove permanent reference electrodes not within this potential range from the construction site by the end of the day and replace at the contractor's expense. The testing provision applies to replacement permanent reference electrodes as well.

3.3.4 Bonding Boxes

Provide structure bonding boxes in locations [as indicated] [where the protected structure crosses or comes into close proximity to other metal structures that are unprotected or protected by its own electrically isolated CP system(s)].

3.3.5 Joint Bonds

Provide joint bonds on metallic pipe to and across buried flexible couplings, mechanical joints, flanged joints [except at places where isolation joints are specified] and joints not welded or threaded to provide electrical continuity. Connect bond wire(s) to the structure(s) by use of exothermic weld kit(s). Clean the structure surface by scraping, filing or wire brushing to produce a clean, bright surface. [Weld connections using exothermic kits in accordance with the kit manufacturer's instructions.] Check and verify adherence of the bond to the substrate for mechanical integrity by striking the weld with a 908 gram 2 pound hammer. Cover connections with an electrically insulating coating [which is compatible with the existing coating on the structure].

3.3.6 Casings, Isolation, and Seals

Where a pipeline is installed in a casing under a roadway or railway, the pipeline must be electrically isolated from the casing, and the annular space sealed against incursion of water.

3.3.7 Wire Connections

3.3.7.1 Wire-To-Structure Connections

Lead wire to structure connections must be by exothermic welding process. Weld charges made specifically for use on cast iron must be used on cast iron pipe. A backfill shield filled with a pipeline mastic sealant or material compatible with the coating must be placed over the weld connection and must cover the exposed metal adequately. If other methods of connection are required, they must be approved by the corrosion expert and the Contract Officer or the Contracting Officer's Representative.

3.3.7.2 Cable Protection

Positive cable to the ground bed and negative cable to the [pipe] [tank] to be protected must be buried a minimum depth of 750 mm 30 inch except where above ground construction utilizing conduit is used.

3.3.7.3 Wire Splicing

Connecting wire splicing must be made with copper compression connectors or exothermic welds, following instructions of the manufacturer. Split-bolt type connectors must not be used.

3.3.8 Steel Surfaces

Connections to [ferrous pipe] [metal tanks] must be made by exothermic weld methods as manufactured by an approved manufacturer for the type of [pipe] [tank]. If other methods of connection are required, such as brazing, mechanical, electric-arc welding and other types of welded connections to ferrous pipe and structures, they must be approved by the corrosion expert and the Contracting Officer or the Contracting Officer's Representative before use.

3.3.9 Pipe Joints

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NOTE: This paragraph will be coordinated with and referenced in mechanical and electrical

specifications.
****

3.3.10 Electrical Continuity

Underground pipe must be electrically continuous except at places where electrically isolating joints are specified. Pipe joined by means other than welding must meet the following electrical continuity requirements:

a. Mechanical joints that are not factory designed to provide electrical continuity must be bonded by installing a metallic bond across the joint. The bonding connections must be made by the exothermic welding process.

b. Mechanical joints designed to provide electrical continuity may be used.

3.3.11 Electrical Isolation of Structures

Perform electrical isolation of structures as follows:

3.3.11.1 Gas Distribution Piping

Provide electrical isolation at each building riser pipe to the pressure regulator, both swivels on the pressure regulator, at all points where a short circuit to another structure or to a foreign structure may occur, and at other locations as indicated.

3.3.11.2 Locations of Electrical Isolation

[a. Steam piping

][b. High-temperature-water piping

][c. Chilled-water piping

][d. Line conduits

][e. Fuel-storage tanks

][f. Gasoline-storage tanks

][g. Fire-suppression tanks

]

Provide electrical isolation at each building entrance, and at other locations as indicated.

3.3.11.3 Copper Piping

Copper piping must be [electrically isolated at both ends of the pipe run] [coated with an approved coating and electrically isolated at both ends].

3.3.11.4 Underground Storage Tanks (UST)

Electrically isolate tanks from other metallic structures. Bond components protected with the tank such as pipes, vents, anchors, and fill pipes to the tank.

3.3.11.5 Dissimilar-Metals

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NOTE: This paragraph will be coordinated with and referenced in mechanical and electrical specifications.

****

Buried piping of dissimilar metals including new and old steel piping, excepting valves, must be electrically separated by means of electrically isolating joints at every place of connection. The isolation joint, including the pipes, must be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the joint.

3.3.12 Ferrous Valves

Dissimilar ferrous valves in a buried ferrous pipeline, including the pipe, must be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the valve.

3.3.13 Brass or Bronze Valves

Brass or bronze valves must not be used in a buried ferrous pipeline.

3.3.14 Metal Pipe Junction

If the dissimilar metal pipe junction, including valves, is not buried and is exposed to atmosphere only, the connection or valve, including the pipe, must be coated with an underground type dielectric coating for a minimum distance of 3 diameters on each side of the junction.

3.4 INSTALLATION DETAILS

3.4.1 Anode Installation

Unless otherwise authorized, installation must not proceed without the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Anodes of the size specified must be installed to the depth indicated and at the locations shown. Locations may be changed to clear obstructions with the approval of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Anodes will be installed in sufficient number and of the required type, size, and spacing to obtain a uniform current distribution over the surface of the structure. The anode system will be designed for a life of 25 years of continuous operation. Anodes must be installed as indicated in a dry condition after any plastic or waterproof protective covering has been completely removed from the water permeable, permanent container housing the anode metal. The anode connecting wire must not be used for lowering the anode into the hole. The annular space around the anode must be backfilled with fine earth in 150 mm 6 inch layers and each layer must be hand tamped.

3.4.2 Underground Pipe Joint Bonds

Underground pipe having other than welded or threaded coupling joints must be made electrically continuous by means of a bonding connection installed across the joint.

3.4.3 Anode Junction Boxes

Provide junction boxes and mark each of the wires terminating in each box.

3.4.4 Bonding Boxes

Provide structure bonding boxes in locations [as indicated] [where the protected structure crosses or comes into close proximity to other metal structures that are unprotected or protected by its own electrically isolated CP system(s)].

3.4.5 Test Stations and Permanent Reference Electrodes

Test stations will be of the type and location shown and will be [curb box] [post] [wall] mounted. Provide buried isolation joints with test wire connections brought to a test station. Reference all test stations with GPS coordinates. Unless otherwise shown, locate other test stations [and permanent reference electrodes] [as indicated.] as follows:

a. At [305] [_____] meters [1000] [_____] foot intervals.

b. At all isolation joints.

c. At both ends of casings.

d. Where the pipe crosses any other metal pipes.

e. Where the pipe connects to an existing piping system.

f. Where the pipe connects to a dissimilar metal pipe.

Do not fill the bottom of the test station with concrete unless otherwise specified. Do not place rubbish, scrap or other debris into the test station.

3.4.6 Permanent Reference Electrode Calibration and Installation

Calibrate permanent reference electrodes against a portable electrode in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager before installation. Calibrate in a test tank containing water with the same composition as the tank to be protected. Permanent electrode must measure a reference potential agreeing with that measured by the portable electrode within plus or minus 0.005 volt when the sensing windows of the two electrodes being compared are not more than 2 mm 0.07 inch apart but not touching. Remove permanent reference electrodes not within this potential range from the construction site by the end of the day and replace at the contractor's expense. The testing provision applies to replacement reference electrodes as well.

3.4.6.1 Field Drawings

Complete a field drawing of [each anode installation showing location of anode, depth of anode, color and size of anode lead wire and any other pertinent details] [test station location and diagram] [Underground Pipe Joint bond locations and details] [Anode Junction Box Location and details] [Bonding Box location and details] [Permanent Reference Electrode locations] [Location of all Electrical Isolations]. Submit copy with daily report to the government.

3.5 ELECTRICAL ISOLATION OF STRUCTURES

****

NOTE: The CP system will fail unless full engineering considerations are applied to selection, location and installation of electrically conductive joints and electrically isolating joints including the use of underground type dielectric coatings (not paint). Adequate electrical conductivity of a pipe joint made by means other than welding must be determined by a "corrosion expert." Allowable electrical resistance depends on the cross sectional area of the pipe metal, the resistivity of the pipe metal, and the effectiveness of the coating on the pipe. Factors to be considered include:

a. Deflection stresses.

b. Pull-out stresses.

c. Expansion-contraction due to temperature changes.

d. Is function as a union necessary?

e. Is field assembly of critical parts practical?

f. Hazardous locations to be avoided.

g. Accessibility if above ground.

h. Location of test box if below ground.

i. Importance of coating the adjacent structure if below ground.

j. Vulnerability to short circuiting.

Factor of safety on pull-out strength required has to be engineered for the specific conditions involved since no blanket provisions are fully applicable to all cases. The requirement for isolating flanges or couplings must be based on a study of the conditions. If the new piping is a short extension to an existing old piping system not under CP, an isolating fitting must be installed at the point of connection, since the new piping will be anodic to the older system. If the older system is under CP, no isolating fitting must be used.

****

3.5.1 Isolation Fittings

Isolating fittings, including isolating flange kits, dielectric unions and couplings, must be installed aboveground, or within manholes, wherever possible. Where isolating joints must be covered with soil, they must be fitted with a proper joint cover specifically manufactured for covering the particular joint, and the space within the cover filled with hot coal-tar enamel. Isolating fittings in lines entering buildings must be located at least 305 mm 12 inch above grade of floor level, when possible. Isolating joints must be provided with grounding cells to protect against over-voltage surges or approved surge protection devices. The cells must provide a low resistance across isolating joint without excessive loss of cathodic current.

3.5.2 Dielectric Unions

[Cut pipe ends square, remove fins and burrs, cut taper pipe threads in accordance with ASME B1.20.1.] Provide isolation unions as indicated. Work piping into place without springing or forcing. Apply joint compound or thread tape to male threads only. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed. [Cover unions with an electrically insulating coating.]

3.5.3 Gas Distribution Piping

Electrical isolation will be provided at each building riser pipe to the pressure regulator, on both swivels on the pressure regulator, at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings. If an isolating joint is located inside a vault, the pipe must be sleeved with insulator when entering and leaving the vault.

3.5.4 Joint Bonds

Provide joint bonds on metallic pipe to and across buried flexible couplings, mechanical joints, flanged joints [except at places where isolation joints are specified] and joints not welded or threaded to provide electrical continuity. Connect bond wire(s) to the structure(s) by use of exothermic weld kit(s). Clean the structure surface by scraping, filing or wire brushing to produce a clean, bright surface. [Weld connections using exothermic kits in accordance with the kit manufacturer's instructions.] Check and verify adherence of the bond to the substrate for mechanical integrity by striking the weld with a 908 gram 2 pound hammer. Cover connections with an electrically insulating coating [which is compatible with the existing coating on the structure].

3.5.5 Casings, Isolation, and Seals

Where the pipeline is installed in a casing under a roadway or railway, isolate the pipeline from the casing, and seal the annular space against intrusion of water.

3.6 FIELD QUALITY CONTROL

Field tests must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager or their designated representative. Advise the Contracting Officer or Contracting Officer's Representative [5] [_____] days prior to performing each field test. Quality control for the cathodic protection system must consist of the following:

a. Initial field testing by the contractor upon construction.

b. Government Field Testing after contractor initial field test report submission.

c. Warranty period field testing by the contractor.

d. Final field testing by the contractor after one year of service.

****

NOTE: Additional testing may be required based upon the specific project or design. All tests listed below may not be required. Designer must consider the project requirements for selection of test procedures. Specify 30 days notice for large systems to allow the government corrosion engineer to be on-site during the initial and final field testing of the CP systems.

****

3.6.1 Tests and Measurements

3.6.1.1 Native Potentials

Notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of five (5) working days prior to each test. Base potential tests: At least [one week] [24 hours] [_____] after [backfilling of the pipe] [installation of structure to be protected] [initial operation of structures containing fluids] and installation of the anodes, but before connection of anodes to the structure, measure base (native) structure-to-electrolyte potentials of the [pipe [and casings]] [structure]. Perform measurements at anode junction boxes, test stations and other locations suitable for test purposes (such as service risers or valves), at intervals not exceeding [30] [120] [_____] meters [100] [400] [_____] feet [with readings at each end point and the midpoints as a minimum]. The locations of these measurements must be identical to the locations specified for potential measurements with anodes connected. Use the same measuring equipment that is specified for measuring protected potential measurements.

3.6.1.2 Protected Potentials

Systems must be tested and inspected by the contractor's corrosion engineer in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Project Manager corrosion expert or an approved representative. Notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of five working days prior to each test. At least [one week] [24 hours] [_____] after native potential testing and connection of anodes to the structure, measure protected structure-to-electrolyte potentials. The locations of these measurements must be identical to the locations specified for native potential measurements. [For underground storage tanks, take a minimum of three measurements with the reference electrode located as follows: Directly over the longitudinal and transverse centerlines of the tank at intervals not exceeding the diameter of the tank and to a distance from the tank of two times the tank diameter.] Use the same measuring equipment that is specified for measuring protected potential measurements. Record test data, including date, time, and locations of testing and submit report to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Contractor must correct and retest, at the contractor's expense, deficiencies in the materials and installation observed by these tests and inspections.

3.6.1.3 Isolation Testing

Before the anode system is connected to the [pipe] [tank], an isolation test must be made at each isolating joint or fitting. This test will demonstrate that no metallic contact, or short circuit exists between the two isolated sections of the [pipe] [tank]. Any isolating fittings installed and found to be defective must be reported to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

3.6.1.4 Isolation Tester

An isolation tester designed and manufactured for use in CP, using the continuity check circuit, must be used for all isolating joint (flange) electrical testing. Testing must conform to the manufacturer's operating instructions. Test must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. An isolating joint that is good will read full scale on the meter. If an isolating joint is shorted, the meter pointer will be deflected or near zero on the meter scale. Location of the fault will be determined from the instructions, and the joint must be repaired.

3.6.1.5 Anode Output

As the anodes or groups of anodes are connected to the [pipe] [tank] [_____], current output will be measured with an approved clamp-on milliammeter, calibrated shunt with a suitable millivoltmeter or multimeter, or a low resistance ammeter. (Of the three methods, the low-resistance ammeter is the least desirable and most inaccurate. The clamp-on milliammeter is the most accurate.) The values obtained and the date, time, and location must be recorded.

3.6.1.6 Reference Electrode Potential Measurements

Upon completion of the installation and with the entire CP system in operation, electrode potential measurements must be made using a copper/copper sulfate reference electrode and a potentiometer-voltmeter, or a direct-current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements must be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements must be recorded. No less than eight (8) measurements will be made over any length of line or component. Additional measurements will be made at each distribution service riser, with the reference electrode placed directly over the service line.

3.6.1.7 Casing Tests

Before final acceptance of the installation, the electrical isolation of carrier pipe from casings must be tested and any short circuits corrected.

3.6.1.8 Holiday Test

Any damage to the protective coating during transit and handling must be repaired before installation. After field-coating has been applied, the entire pipe must be inspected by an electric holiday detector with Impressed Current in accordance with NACE SP0188 using a full-ring, spring-type coil electrode. The holiday detector will be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective covering must be repaired upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection must be furnished by the contractor. The coating system must be inspected for holes, voids, cracks, and other damage during installation.

3.6.1.9 Rectifier Testing

The purpose of the rectifier operational inspection is to determine the serviceability of all components required to impress current to the anodes of the Impressed Current system. The inspection must be thorough to ensure dependable current until the next inspection.

a. Before energizing the rectifier, visually check all rectifier components, shunt box components, safety switches, circuit breakers, and other system power components.

b. Tighten all accessible connections and check temperature of all the components.

c. Ensure all permanent reference electrode caps are removed and placed inside the rectifier cabinet for verification of removal and for use during tank cleaning.

****

NOTE: The voltage should not exceed a negative polarized potential of 1.200 volts (1200 millivolts). This could result in excessive current being applied to the structure which could cause coating disbondment.

****

d. Startup testing of the rectifier must include voltage and current testing at all tap settings up to the level of protection or maximum of the rectifier rated current, whichever is the lowest. Do not apply excessive current to the tank. For automatic rectifiers, record each tap setting (if available) before switching to automatic potential control.

e. Using a dependable hand-held meter, measure the output voltage and current, and calibrate the rectifier meters, if present. For rectifiers with more than one circuit, measure the output voltage and current for each circuit using a dependable hand-held meter, and calibrate the rectifier meters, if present.

f. For systems with permanent reference electrodes, using a calibrated reference electrode, measure the potential difference to each installed permanent reference electrode by placing both electrodes together in the electrolyte with CP current off (may be tested before installation). If the difference is more than 10 mV, replace the permanent reference electrode. For rectifiers with potential voltmeters, using a dependable hand-held meter, measure the potentials for each voltmeter, and calibrate that rectifier meter.

g. Calculate the CP system circuit resistance of each circuit by dividing the rectifier DC voltage output of each circuit by the rectifier DC ampere output for that circuit.

h. Calculate the rectifier efficiency.

3.6.1.10 Stray Current Measurements

****
NOTE: Stray current may effect foreign pipelines or other metallic structures.
****

Before final acceptance of the installation, stray current tests must be performed on any foreign [pipes] [tanks][other metallic structures] in close proximity to the installed anodes. A full report of the tests giving all details must be made.

3.6.1.11 Induced AC Testing

****
NOTE: Induced AC may affect pipelines or other metallic structures when near high AC voltage infrastructure. Reference NACE SP0177 and NACE SP21424.
****

Before final acceptance of the installation, induced AC voltage tests must be performed on the [pipes] [tanks] [other metallic structures] near high AC voltage infrastructure and where crossing above ground and underground AC transmission systems. A full report of these tests must be included in the final testing reports with all details and data taken. The touch potential of any testing over 5 volts must be reported to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Any touch potential over 10 Volts must be mitigated by effective mitigation techniques.

3.6.1.12 Interference Tests

****
NOTE: Interference from other structures' CP current may adversely affect the structure and the structure CP current may adversely affect other metallic structures.
****

Before final acceptance of the installation, interference tests will be made with respect to any foreign [pipes] [tanks] in cooperation with the owner of the foreign [pipes] [tanks]. A full report of the tests giving all details must be made. Stray current measurements must be performed at all isolating locations and at locations where the new pipeline crosses foreign metallic pipes; results of stray current measurements must also be submitted for approval. The method of measurements and locations of measurements must be submitted for approval. As a minimum, stray current measurements must be performed at the following locations:

a. Connection points of new pipeline to existing pipeline.

b. Crossing points of new pipeline with other existing metallic pipelines.

3.6.1.13 Initial Cathodic Protection System Field Testing

Initial field testing must be completed by the contractor upon completion of construction. Field testing must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager or their designated representative. Advise the Contracting Officer or Contracting Officer's Representative [5] [_____] days prior to performing each field test. Field testing must include native and protected potentials, anode current and rectifier testing.

****

NOTE: Additional testing may be required based upon the specific project or design. Other tests may include isolation testing, casing testing, permanent reference electrode testing, stray current testing, interference testing, and induced AC testing.

****

The contractor must submit an initial field test report of the CP system. All structure-to-electrolyte measurements, including native potentials, protected potentials, anode current testing, rectifier testing, and other required testing must be recorded on applicable forms. Identification of test locations, test station and anode test stations will coordinate with the as-built drawings and be provided on system drawings included in the report. The contractor must locate, correct, and report to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager any short circuits encountered during the checkout of the installed CP system.

3.6.1.14 Government Field Testing

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NOTE: The requirements of paragraph entitled "Government Field Testing" are required for CP projects in either the Army, Navy, Air Force or Marines area. The designer must verify their applicability to projects outside the area with the appropriate Engineering Field Division (EFD) corrosion program manager.

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The government corrosion [engineer] [program manager] must review the contractor's initial field testing report. Approximately four weeks after receipt of the contractor's initial test report, the system will be tested and inspected in the contractor's presence by the government corrosion [engineer] [program manager]. The contractor must correct, at the contractor's expense, materials and installations observed by these tests and inspections not to be in conformance with the plans and specifications. The contractor will pay for all retesting done by the government engineer made necessary by the correction of deficiencies.

****

NOTE: For CP projects in either the Army, Navy, Air Force or Marines area, select the appropriate options for paragraphs entitled "One Year Warranty Period Testing" and "Final Field Testing."

****

3.6.1.15 One-Year-Warranty-Period-Testing

The contractor must inspect, test, and adjust the CP system [quarterly] [semi-annually] [_____] for one year, [4] [2] [_____] interim inspections total, to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon the completion of all CP work, including changes required to correct deficiencies identified during initial testing, and preliminary acceptance of the CP system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the One Year Warranty Period Cathodic Protection System Field Test Report, including field data, and certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or Contracting Officer's Representative, the activity, and the geographic EFD corrosion [engineer] [program manager] [Contracting Officer] [Contracting Officer's Representative] [Technical Expert] [Project Manager].

3.6.1.16 Final Acceptance Field Testing

Conduct final field testing of the CP system utilizing the same procedures specified under, "Initial Field Testing of the Galvanic Cathodic Protection Systems". The contractor will inspect, test, and adjust the CP system after one year of operation to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon preliminary acceptance for the CP system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the Final Cathodic Protection System Field Test Report, certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager and the geographic EFD corrosion [engineer] [program manager] for approval, and as an attachment to the Operation and Maintenance Manual in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. The government corrosion [engineer] [program manager] must review the contractor's final field testing report.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Reconditioning of Surfaces

3.7.1.1 Concrete

Concrete must be 20 MPa 3000 psi minimum ultimate 28-day compressive strength with 25 mm one inch minimum aggregate conforming to [ASTM C94/C94M] [Section 03 30 00 CAST-IN-PLACE CONCRETE].

3.7.1.2 Restoration of Sod

Restore unpaved surfaces disturbed during the installation of anodes and wires to their original elevation and condition. In areas where grass cover exists, it is possible that sod can be carefully removed, watered, and stored during construction operations, and replaced after the operations are completed since it is estimated that no section of pipeline must remain uncovered for more than two (2) days. Where the surface is disturbed in a newly seeded area, re-seed the area with the same quality and formula of seed as that used in the original seeding. Seeding must be done as directed, in all unsurfaced locations where sod and topsoil could not be preserved and replaced. The use of sod in lieu of seeding will require approval by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

3.7.1.3 Restoration of Pavement

Repair pavement, sidewalks, curbs, and gutters where existing surfaces are removed or disturbed for construction. Saw cut pavement edges. Graded aggregate base course must have a maximum aggregate size of 40 millimeters 1 1/2 inches. Prime base course with [liquid asphalt, ASTM D2028/D2028M, Grade RC-70] [_____] prior to paving. Match base course thickness to existing but must not be less than 150 millimeters 6 inches. Asphalt aggregate size must be 15 mm 1/2 inch [_____], asphalt cement must [conform to ASTM D3381/D3381M, Grade AR-2000] [_____]. Match asphalt concrete thickness to existing but must not be less than 50 millimeters 2 inches. Repair Portland cement concrete pavement, sidewalks, curbs, and gutters using 20.67 MPa 3,000 psi concrete conforming to [ASTM C94/C94M] [Section 03 30 00 CAST-IN-PLACE CONCRETE.] Match existing pavement, sidewalk, curb, and gutter thicknesses.

3.7.1.4 Cleanup

The contractor is responsible for cleanup of the construction site. All paper bags, wire clippings, must be disposed of as directed. Paper bags, wire clippings and other waste will not be put in bell holes or anodes excavation.

3.7.2 Training

3.7.2.1 Instruction to Government Personnel

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NOTE: There are restrictions on the type and extent of training. Training is usually on-site, 2 days or less. Contractor Representative or designee will provide basic instructions to facility maintenance and operation personnel. If more extensive training is required, e.g., student travel, special consultants, consult the Contract Division Director and the head of the Comptroller Department for assistance.

****

During the warranty testing or at a time designated by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager, make available the services of a technician regularly employed or authorized by the manufacturer of the CP system for instructing government personnel in the proper operation, maintenance, safety, and emergency procedures of the CP system. The period of instruction must be not less than [two] [four] [_____] hour[s] and not more than [two] [_____] 8-hour working day[s]. Conduct the training at the jobsite or at another location mutually satisfactory to the government and the contractor. The field instructions will cover all of the items contained in the Operation and Maintenance Manual.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 42 19.00 10 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-26 42 19.10 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-26 42 19.00 10 (November 2024)**

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SECTION 26 42 19.00 10

CATHODIC PROTECTION SYSTEMS (IMPRESSED CURRENT) FOR CIVIL WORKS STRUCTURES

11/24

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NOTE: This guide specification is tailored for impressed current cathodic protection (ICCP) systems for use in submerged environments (water). This specification can be utilized for civil works structures such as lock miter gates, tainter gates, sector gates, and sheet pile walls.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: The intent of this guide specification to require the Contractor to design, provide, test and place into service the complete cathodic protection system for submerged civil works structures. Cathodic Protection must be provided for all portions of the structures submerged at normal water levels. A complete system must consist of all equipment, wiring, and wiring devices necessary to produce a continuous flow of direct current from the anodes in the water electrolyte to the gate surfaces to protect the surfaces of the metal structures

adequately and efficiently against corrosion where the surfaces are in contact with the water. The metallic surfaces of the gates need only be protected to normal water levels. This is in addition to the protective coating on the gates.

This guide specification includes the technical requirements for the types of equipment normally provided in a cathodic protection system. The system must be designed by a qualified engineering firm hired by the Government. The engineering firm must provide the design services of a Corrosion Expert(s) to design, supervise, and inspect system installation and test, energize, and adjust the completed system installation. The Corrosion Expert is a person, who by reason of thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of Lock & Dam Miter and Tainter Gates and other submerged metallic appurtenances. Such person(s) must be accredited or certified by NACE International (formerly the National Association of Corrosion Engineers) as a Corrosion or Cathodic Protection (CP) Specialist or be a register professional engineer who has certification or licensing that includes education and experience in corrosion control of Lock & Dam Miter and Tainter Gates and other submerged metallic appurtenances. The names and qualifications of the Corrosion Expert(s) must be certified and submitted in writing to the Contracting Officer prior to the start of the cathodic protection system design.

The Contractor will provide detailed design calculations, bill of materials lists and drawings of the cathodic protection system. The drawings will detail the system installation including arrangement and locations of all anodes, terminal boxes, conduit routing and test facilities to be installed for corrosion control on the submerged surfaces of the gates. The Contractor provided materials list, design calculations and drawings must be approved by the Contracting Officer prior to purchasing, delivering, or installing any of the cathodic protection system. These specifications together with the approved materials list, design calculations and drawings provide the minimum requirements of this contract. The cathodic protection system will be provided complete and in operating condition as further defined later in this specification.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

ASTM INTERNATIONAL (ASTM)

ASTM A518/A518M	(1999; R 2022) Standard Specification for Corrosion-Resistant High-Silicon Iron Castings
ASTM D789	(2015) Determination of Relative Viscosity and Moisture Content of Polyamide (PA)
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

NACE INTERNATIONAL (NACE)

NACE SP0169	(2024) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FB 1	(2014) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable

NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ST 1	(1988; R 1994; R 1997) Specialty Transformers (Except General Purpose Type)
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

CERL Tech Rep FM-95/05	(1994) Field Evaluation of Cathodic Protection Systems Using Ceramic-Coated Anodes for Lock and Dam Gates
EM 1110-2-2704	(2021) Engineering and Design -- Cathodic Protection Systems (CPS) for Civil Works (CW) Structures

UL SOLUTIONS (UL)

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.2 DEFINITIONS

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Cathodic Protection is a method used to control corrosion.

1.2.1 Cathodic Protection

Cathodic Protection (CP) is an electrochemical (half electrical and half chemical) method used to control corrosion of buried or submerged metallic structures. It prevents corrosion by making the protected structure a cathode by installing a more anodic metal (sacrificial or galvanic) anode or a metallic (Impressed Current) anode connected to a Direct Current (DC) power source. When the proper amount of current is applied to the structure, it becomes a cathode. Since all corrosion occurs at the anode, the structure no longer corrodes. The electrons move in the metallic path (electrical). Reduction (chemical) reactions occur at the surface of the cathode resulting in a hydrogen coating and more alkaline environment.

Oxidation (chemical) reactions occur at the surface of the anode resulting in corrosion and a more acidic environment. After a CP system is installed and adjusted to provide adequate protection, the hydrogen coats the defects in the coating and polarizes in the negative direction (to a copper/copper sulfate reference electrode). Over time the current and potentials remain relatively stable.

1.2.2 Corrosion

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Some of the eight forms of corrosion are unique, but all of them are interrelated.

The eight forms of corrosion are: (1) Uniform Attack, (2) Galvanic or Two-Metal Corrosion, (3) Crevice Corrosion, (4) Pitting Corrosion, (5) Intergranular Corrosion, (6) Selective Leaching, (7) Erosion Corrosion, and (8) Stress Corrosion Cracking. This listing is arbitrary but covers practically all corrosion failures and problems. The forms are not listed in any order of importance. Below, the eight forms of corrosion are discussed in terms of their characteristics, mechanisms, and preventive measures. Hydrogen damage, although not a form of corrosion, often occurs indirectly because of corrosive attack and is, therefore, included in this discussion.

1.2.3 Alternating Current (AC) Corrosion

AC corrosion occurs when there is a source of AC current, typically from a high-voltage overhead AC (OHAC) powerline, when there is a low soil resistivity (typically less than 5,000 ohm-cm) and there is a very small coating holiday. The AC corrosion pits typically have a tubercle of corrosion product at the pit. AC interference study modeling software can determine the mitigation solution to solve this problem. Typically, AC Corrosion mitigation is done in conjunction with high AC potentials and fault current mitigation.

1.2.4 AC Interference

AC interference occurs when a pipeline parallels a high-voltage overhead AC (OHAC) powerline. An interference study is required when this situation occurs as AC interference can cause high AC potentials along the pipeline (safety), can cause a fault condition between the pipeline and powerline, and could cause AC corrosion to occur. The pipeline coating when exposed can have blisters/bubbles caused by the excessive AC. The interference study will use modeling software to determine what combination of interference may be occurring (if any) and provide the mitigation solution to solve the problem.

1.2.5 Uniform Attack

Uniform attack is the most common form of corrosion. It is normally characterized by a chemical or electrochemical reaction that proceeds uniformly over the entire exposed surface or over a large area. The metal becomes thinner and eventually fails. For example, a piece of steel or zinc immersed in dilute sulfuric acid normally dissolves at a uniform rate over its entire surface. A sheet iron roof shows essentially the same degree of rusting over its entire outside surface.

Uniform attack, or general overall corrosion, represents the greatest destruction of metal on a tonnage basis. This form of corrosion, however, is not of great concern from a technical standpoint, because the life of equipment can be accurately estimated based on comparatively simple tests. Merely immersing specimens in the fluid involved is often sufficient. Uniform attack can be prevented or reduced by (1) materials, such as coatings, that reduce contact between metal and electrolytes, (2) inhibitors, or (3) cathodic protection.

1.2.6 Galvanic or Two-Metal Corrosion

A potential difference usually exists between two dissimilar metals when they are immersed in a corrosive or conductive solution. If these metals are placed in contact (or otherwise electrically connected), this potential difference produces electron flow between them. Corrosion of the less corrosion-resistant metal is usually increased, and attack of the more resistant material is decreased, compared to the behavior of these metals when they are not in contact. The less resistant metal becomes anodic, and the more resistant metal becomes cathodic. Usually, the cathode or cathodic metal corrodes very little or not at all in this type of couple. Because of the electric currents and dissimilar-metals involved, this form of corrosion is called galvanic, bi-metallic or two-metal, corrosion. Galvanic corrosion is restricted to electrochemical corrosion caused by dissimilar-metal effects. It is electrochemical corrosion, but this document must restrict the term galvanic to dissimilar-metal effects for purposes of clarity.

1.2.7 Crevice Corrosion

Intense localized corrosion frequently occurs within crevices and other shielded areas on metal surfaces exposed to corrosives. This type of attack is usually associated with small volumes of stagnant solution caused by holes, gasket surfaces, lap joints, surface deposits, and crevices under bolt and rivet heads. As a result, this form of corrosion is called crevice corrosion or, sometimes, deposit or gasket corrosion.

1.2.8 Pitting Corrosion

Pitting is a form of extremely localized attack that results in holes in the metal. These holes may be small or large in diameter, but in most cases, they are relatively small. Pits are sometimes isolated or so close together that they look like a rough surface. Generally, a pit may be described as a cavity or hole with the surface diameter about the same as or less than the depth. Pitting is one of the most destructive and insidious forms of corrosion. It causes equipment to fail because of perforation with only a small percent weight loss of the entire structure. It is often difficult to detect pits because of their small size and because the pits are often covered with corrosion products. In addition, it is difficult to measure quantitatively and compare the extent of pitting because of the varying depths and numbers of pits that may occur under identical conditions. Pitting is also difficult to predict by laboratory tests. Sometimes the pits require a long time (several months or a year) to show up in actual service. Pitting is particularly vicious because it is a localized and intense form of corrosion, and failures often occur with extreme suddenness.

1.2.9 Intergranular Corrosion

Grain boundary effects are of little or no consequence in most applications or uses of metals. If a metal corrodes, uniform attack results since grain boundaries are usually only slightly more reactive than the matrix. However, under certain conditions, grain interfaces are very reactive and intergranular corrosion results. Localized attack at and adjacent to grain boundaries, with relatively little corrosion of the grains, is intergranular corrosion. The alloy disintegrates (grains fall out) or loses its strength. Intergranular corrosion can be caused by impurities at the grain boundaries, enrichment of one of the alloying elements, or depletion of one of these elements in the grain-boundary areas. Small amounts of iron in aluminum, wherein the solubility of iron is low, have been shown to segregate in the grain boundaries and cause intergranular corrosion. It has been shown that, based on surface tension considerations, the zinc content of a brass is higher at the grain boundaries. Depletion of chromium in the grain-boundary regions results in intergranular corrosion of stainless steels.

1.2.10 Selective Leaching

Selective leaching is the removal of one element from a solid alloy by corrosion processes. The most common example is the selective removal of zinc in brass alloys (dezincification). Similar processes occur in other alloy systems in which aluminum, iron, cobalt, chromium, and other elements are removed. Selective leaching is the general term to describe these processes, and its use precludes the creation of terms such as de-aluminumification, de-cobaltification. Parting is a metallurgical term that is sometimes applied, but selective leaching is preferred.

1.2.11 Erosion Control

Erosion corrosion is the acceleration or increase in rate of deterioration or attack on a metal because of relative movement between a corrosive fluid and the metal surface. Generally, this movement is quite rapid, and mechanical wear effects or abrasion are involved. Metal is removed from the surface as dissolved ions, or it forms solid corrosion products, which are mechanically swept from the metal surface. Sometimes, movement of the environment decreases corrosion, particularly when localized attack occurs under stagnant conditions; this is not erosion corrosion because deterioration is not increased. Erosion corrosion is characterized in appearance by grooves, gullies, waves, rounded holes, and valleys and usually exhibits a directional pattern. In many cases, failures because of erosion corrosion occur in a relatively short time, and they are unexpected largely because evaluation corrosion tests were run under static conditions or because the erosion effects were not considered.

1.2.12 Stress-Corrosion Cracking

Stress-corrosion cracking refers to cracking caused by the simultaneous presence of tensile stress and a specific corrosive medium. Many investigators have classified all cracking failures occurring in corrosive media as stress-corrosion cracking, including failures due to hydrogen embrittlement. However, these two types of cracking failures respond differently to environmental variables. To illustrate, CP is an effective method for preventing stress-corrosion cracking; however, hydrogen-embrittlement may be caused when excessive current is applied, especially on stainless steel. Hence, the importance of considering stress-corrosion cracking and hydrogen embrittlement as separate phenomena is obvious. During stress-corrosion cracking, the metal or alloy is virtually unaffected over most of its surface, while fine cracks progress through it. This cracking phenomenon has serious consequences, since it can occur at stresses within the range of typical design stress.

1.2.13 Exothermic Welding

Exothermic welding is used in CP to connect a copper wire to a metallic structure, usually steel or cast-iron. It is a pyrotechnic composition of copper oxide, aluminum powder and magnesium powder. The magnesium powder is ignited with a spark gun or electronic ignition equipment. The aluminum powder serves as fuel, and melts the copper oxide, which bonds the wire to the structure. Although not explosive, it can create brief bursts of heat and high temperature in a small area.

1.2.14 Error-Free

Potential measurement error due to a voltage drop caused by current flowing through a resistor (the electrolyte) between the reference electrode and the protected structure.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Drawings; G, [_____]

Contractor's Modifications; G, [_____]

SD-03 Product Data

Materials and Equipment; G, [_____]

Protective Angle Irons; G, [_____]

SD-05 Design Data

Calculations; G, [_____]

SD-06 Test Reports

Factory Test Data

Tests and Measurements; G, [_____]

SD-07 Certificates

Qualifications; G, [_____]

SD-10 Operation and Maintenance Data

Cathodic Protection System; G, [_____]

Training; G, [_____]

SD-11 Closeout Submittals

Initial Cathodic Protection System Field Testing; G, [_____]

Final Cathodic Protection System Field Test Report; G, [_____]

One Year Warranty Period Cathodic Protection System Field Test Report; G, [_____]

1.4 MATERIAL AND EQUIPMENT MANUFACTURER DATA

DATE	ISSUE NO.	REQUEST	REQUESTED BY	REQUEST REF.
MANUFACTURER NAME				

DATE	ISSUE NO.	REQUEST	REQUESTED BY	REQUEST REF.
DESCRIPTION OF EQUIPMENT				

1.5 MAINTENANCE MATERIAL SUBMITTALS

1.5.1 Spare Parts

After approval of shop drawings, including spare parts for any modifications or changes made from original submittal, provide spare parts data for each different item of materials and equipment specified. The data must include a complete list of parts, special tools, and supplies, with current unit prices and source of supply.

1.5.2 Extra Materials

a. Provide spare rod, sausage, and button-type anodes (the type used in the original installation) to the Contracting Officer with a minimum of five of each type of installation component required for the original installation of the sausage and button anodes. Provide sufficient neoprene gaskets, mounting hardware, and epoxy cement for installation of the silicon button anodes. Supply a minimum of two of each type of anode rod or string assemblies each for the upstream and downstream gates (anode assembly complete with factory attached 100 ft anode lead cable and a minimum of five disk or button anodes with 100 ft of factory attached cable). Supply cement, epoxy, polychloroprene gaskets, and any other material needed for installation in sufficient quantity to install these spare components.

b. Provide a complete set of special tools, provided in a steel or plastic toolbox, for use in installing all types of anodes used in the installation. Tools used in making the original installation, provided they are in good working condition, will be acceptable. Ensure one tool is a torque wrench device capable of 40 psi.

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

Obtain the services of a corrosion expert to supervise, inspect, and test the installation and performance of the CP system. The term "corrosion expert" refers to a person, who by thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of submerged metallic structures of the type under this contract.

1.6.2 Qualifications

The corrosion expert must be accredited or certified by Association for Materials Protection and Performance (AMPP) as a CP-4 Cathodic Protection Specialist, be a AMPP certified Corrosion Specialist, or a registered professional engineer who has certification or licensing that includes education and experience in CP of the type of CP system being installed. The corrosion expert must have not less than [three] [five] [____] years of experience in the type of CP for submerged metallic structures under this contract. Submit evidence of qualifications of the corrosion expert including their name and qualifications certified in writing to the Contracting Officer prior to the start of construction. Certification must be submitted giving the name of the firm, the number of years of experience, and a list of not less than five of the firm's installations, three or more years old, that have been tested and found satisfactory.

1.6.3 Services of Corrosion Expert

Conduct a pre-installation meeting with the Contractor's project superintendent and Contracting Officer's Representative at the project site office. Hold this meeting after all pre-construction submittals have been made and approved by the Contracting Officer prior to the start of any work on this project. Include discussions of Safety, Communication and Work Plans, as well as any other issues which arise from the submittal review.

Once the submittals are approved and the materials delivered, verify all materials meet submittal requirements, ensure the contractor understands installation practices and that the contractor is capable and qualified to complete the installation. The "corrosion expert" will be available (but not necessarily be onsite the entire time) during the installation of the CP system to answer questions, approve any changes or additions required during construction, or to provide recommendations as required.

Upon completion of the installation, the "corrosion expert" will inspect, energize, and commission the CP system to ensure it has been installed properly and meets adequate CP criteria. Perform training and demonstrations to applicable personnel on proper testing and maintenance techniques of the installed CP systems. Perform additional interim inspections as required in paragraph ONE-YEAR-WARRANTY-PERIOD-TESTING, to ensure the system's continued conformance with the criteria outlined in this specification.

1.7 DELIVERY, STORAGE, AND HANDLING

Storage area for corrosion material will be designated by the Contracting Officer. If materials are not stored in a building, tarps or similar protection must be used to protect material from inclement weather. Repackaged equipment and materials that are damaged due to improper handling or exposure to rain for return.

1.8 PROJECT/SITE CONDITIONS

The cathodic protection system design is based on a water resistivity of [_____], a total area, in square meters feet, of [_____], a minimum coating efficiency of 50 percent, a minimum current density requirement for effective cathodic protection of [_____] amperes/bare square meter foot of submerged steel and a 20-year life expectancy.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

Provide a complete cathodic protection system for the structure(s) consisting of all equipment, wiring, and wiring devices necessary to produce a continuous flow of direct current from the anodes in the water electrolyte to the structure surfaces to, adequately and efficiently, protect the surfaces of the metal structures against corrosion where the surfaces are in contact with the water. This system is in addition to the protective coating on the structures. The system must meet the performance requirements in paragraph DESIGN REQUIREMENTS and the testing requirements in paragraph FIELD QUALITY CONTROL.

a. Submit [six] [_____] copies of detailed drawings consisting of a complete list of equipment and material, manufacturer's descriptive and technical literature, catalog cuts, results of system design calculations including water-resistivity, installation instructions and certified test data showing location of anodes and stating the maximum recommended anode current output density. Include in the detail drawings complete wiring and schematic diagrams, anode mounting details, reference cell mounting details (if applicable), terminal cabinets, conduit routing, and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. Provide [one] [_____] electronic [digital] [PDF] [_____] copy and digital photos of the completed installation.

b. The Contractor's provided equipment and materials list, design calculations, and drawings are subject to approval by the Contracting Officer prior to purchasing, delivering, or installing any of the cathodic protection system. These specifications together with the approved materials list, design calculations and drawings provide the minimum requirements of this contract.

2.1.2 Performance Requirements

Test and adjust the system such that the cathodic protection system is providing corrosion control for the submerged surfaces of the structure(s) in accordance with one of the two criterion in the following paragraphs taken from Section 6 of NACE SP0169

2.1.2.1 First Criterion

A negative (cathodic) voltage of at least a minus 850 millivolts "instant-off" potential, as measured with respect to a calibrated, saturated copper-copper sulfate reference electrode (CSE) over 90 percent of each structure face, and at least minus 800 millivolts "instant-off" at all other locations. [Apply the second criterion below for areas within 2 ft of the sill, quoin, and miter of each gate (refer to Paragraph 1.3.3.2 of NACE SP0169).]Achieve the above criteria without the "instant-off" potential exceeding minus 1100 millivolts at any location. Determine this voltage with the cathodic protection system in operation. Make correction for IR drop using "instant-off" potential measurements (interrupt all operating cathodic protection systems simultaneously). If digital meters are used to obtain these measurements, interpret the second reading displayed on the digital voltmeter after interruption of the rectifier current as the "instant-off" reading.

2.1.2.2 Second Criterion

The second criterion is a minimum cathodic polarization voltage decay of 100 millivolts provided that a potential of at least minus 750 millivolts "instant-off" potential as measured with respect to a calibrated, saturated copper-copper sulfate reference electrode (CSE) is also obtained. [Make polarization shift measurements within 1 ft of the sill plate at the quoin, at 2 ft intervals along the gate bottom, and at the miter on each gate leaf face.] This criterion cannot be used until the criterion in paragraph 1.3.3.1 of NACE SP0169 for the remaining structure submerged surfaces has been maintained for a minimum period of one week. Measure "instant-off" potential between the structure surface and a saturated copper-copper sulfate reference cell immersed in the electrolyte directly adjacent to the structure. Determine this polarization voltage shift by interrupting the protective current and measuring the polarization decay thereafter. When the protective current is initially interrupted, an immediate voltage shift will occur. Record and use the second voltage reading observed after the immediate voltage shift as the base reading from which to measure polarization decay. Then take readings each 10 minutes thereafter and record the voltage readings and time intervals. The total time for achieving this decay is 4 hours or less.

2.1.3 Contractor's Modifications

Do not modify the design of the cathodic protection system as specified and shown on the Contractor's approved drawings except with the express written approval of the Contracting Officer. Fully describe and identify proposed modifications or changes as a "MODIFICATION" or "CHANGE" and submit to the Contracting Officer for approval within 15 days after the need for such modification or change is determined.

a. Submit [six] [_____] copies of detailed drawings showing proposed modifications in location, scope of performance indicating any variations from, additions to, or clarifications of contract drawings. Show proposed changes in anode arrangement, anode size and number, anode materials and layout details, conduit size, wire size, mounting details, wiring diagram, and any other pertinent information for proper installation and performance of the system. Include in the detail drawings complete wiring and schematic diagrams, anode mounting details, reference cell mounting details (if applicable), terminal cabinets, conduit routing, and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. Provide [one] [_____] electronic [digital] [PDF] [_____] copy and digital photos of the completed installation.

b. The modified cathodic protection system must be in accordance with the performance requirements in paragraph PERFORMANCE REQUIREMENTS and the testing requirements in paragraph FIELD QUALITY CONTROL.

2.2 MATERIALS AND EQUIPMENT

Ensure all cathodic protection system materials and equipment provided is designed for a minimum 20-year service life when operating at the system maximum rated output. Use components that are based on the Contractor's Cathodic Protection System Specialist's design which is in accordance with these specifications. Submit a complete list in triplicate of materials and equipment to be incorporated in the work, within [30] [45] [90] [_____]

days after date of receipt of notice to proceed, and before commencement of installation of any materials or equipment. Include cuts, diagrams, and such other descriptive data as may be required by the Contracting Officer. Partial lists submitted from time to time will not be considered. Submit, as a minimum, the following:

a. Water resistivity as measured on site.

b. As a minimum, provide complete system design calculations as provided in Appendix "K" of CERL Tech Rep FM-95/05 including calculations for total current required for each structure side, each anode circuit resistance, rectifier current and voltage output requirements and life of each anode type and location within the system.

c. Complete list of materials for all cathodic protection system components including all replaceable components in the rectifier units, terminal boxes and anodes materials with mounting equipment including part numbers and source name, address and phone number for each component.

d. Conductor types and sizes including copper grade, number of strands, insulation, and resistance for each wire type and size to be used.

e. Anodes, layout of anodes, and detailed description of anode installation procedure.

f. Layout of rectifiers and anode terminal boxes, rectifier and terminal box details including method of control including wiring diagram and schematic, output measurement means, cabinet materials and construction, ammeters and voltmeters, shunt resistors, variable resistors, and AC & DC lightning and surge protection.

g. All connections, supports, and seals for conductors, conduit, and plastic and steel protector pipes, pipe caps, angle iron, [_____].

h. All watertight connections and connection protection means.

i. Resistor and anode terminal cabinet details and mounting locations. Show identified connections and conductors in the terminal cabinet on a drawing.

j. Certified experience and qualification data of installing firm, as specified in paragraph QUALIFICATIONS.

2.3 CABLES AND CONDUITS

2.3.1 Direct Current Cables

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NOTE: Low-density, high-molecular-weight, polyethylene (HMWPE) insulation conforming to ASTM D1248, Type I, Class C, Grade 5, Grades E-5 and J-1, should be specified for all exposed cable or cable to be installed in conjunction with rod or string anode protective conduit. High-density polyethylene is not recommended because it is subject to stress cracking. Polyvinyl chloride (PVC) insulation is not recommended because it is a relatively soft and

easily damaged insulation and does not have the required tight fit on the wire, which can provide a path for moisture ingress and corrosion attack on the wire.

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2.3.1.1 Anode Lead Cables

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NOTE: Select first paragraph for use with High Silicon Cast Iron anodes.

Select second paragraph for use with EMMO anodes. Select the first bracket when removable underwater connectors are needed for installation. This would apply for extended cable lengths exceeding 150 feet. Select the second bracket for permanently connected cables from the manufacturer. This is the preferred option due to reliability.

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[Provide direct current cable from the terminal cabinet to each anode disk, ribbon, button, or rod assembly consisting of 7-strand No. 8 AWG stranded copper wire with type CP high molecular weight polyethylene insulation (HMWPE), 7/64 inch thick, 600-volt rating, in accordance with ASTM D1248, Type I, Class C, Grades E-5 and J-1. Each anode lead must be continuous without splices from its point of connection in the terminal cabinet to the anode disk, ribbon, button, or rod assembly. Assemble cable-to-anode connection by the manufacturer and the seal area with a waterproof epoxy. Ensure cable-to-anode contact resistance is 0.003 ohm maximum. Also assemble HSCI string anode assemblies (assembled in link sausage manner to the anode cable lead) by the manufacturer. Ensure conductor for the HSCI sausage strings only are 7-strand, No. 4 AWG copper wire with CP high molecular weight polyethylene insulation (HMWPE), 7/64 inch thick, 600-volt rating, in accordance with ASTM D1248, Type I, Class C, Grades E-5 and J-1, and do not cut or splice within the anode or assembly and route without splicing to the anode terminal box. The cable HMWPE insulation does not adhere well to some epoxies, rough in the sealant area prior to application of the sealant to the anode connections. Mark anode leads, terminal board connections, and corresponding jumpers on the front of the terminal board with the anode number, as specified.]

[Provide direct current cable from the rectifier cabinet to each EMMO strip, disk, rod or wire anode consisting of [27 strand T/C, minimum size No. 10 AWG, copper wire with 45 mil wall flame-retardant, low smoke irradiated cross linked polyolefin (XLPO) insulation, and 2 kV rating.] [27 strand, minimum size No. 10 AWG, copper wire with 15 mil wall, 2 kV rating, Diesel Locomotive Cable with Ethylene Propylene Diene Monomer Rubber (EPDM) insulation, Chlorinated Polyethylene (CPE) jacket rated for continuous wet/dry exposure and resists oils, acids, alkali's, heat, and flame.] Each anode lead must be continuous without splices from its point of connection in the rectifier cabinet to each EMMO strip, disk, rod or wire anode. All Cable-to-connector and Cable-to-anode connections must be made by the manufacturer in the factory.]

2.3.1.2 Rectifier and Terminal Cabinets Connection Cables

Provide soft drawn copper conductors and have the number of conductors as shown on the drawings. Cables connecting the terminal cabinet to the ac power outlet and cables between the ac power outlet and the rectifier dc terminals must be No. 10 AWG insulated copper wire with a neoprene jacket. Provide cables between the resistor and anode terminal cabinets consisting of 7-strand No. 8 AWG stranded copper wire with type CP HMWPE, 7/64 inch thick, 600-volt rating, in accordance with ASTM D1248, Type I, Class C, Grades E-5 and J-1. Include one conductor for each dc plus circuit and one conductor for each negative connection. Make each cable continuous without splices from its point of connection in one terminal cabinet to its point of connection in the other terminal cabinet.

2.3.2 Cable in Conduit

Provide cables that meet or exceed the requirements specified above. Make flexible cable connections between the ac power outlet and the ac input terminals of the rectifier with minimum No. 10 AWG copper conductors in flexible portable power cables, UL type SO.

2.3.3 Nonmetallic Conduit

Nonmetallic conduit must be type 80, extra heavy-wall, PVC, rigid-plastic conduit. Provide conduit conforming to the requirements of NEMA TC 2. PVC conduit utilized as rod or string anode protective pipe is the only PVC conduit allowed by these specifications. Design the plastic pipe such that its inside diameter (I.D.) is at least 2 inch greater than the anode outside diameter (O.D.). Provide perforated pipe on the side opposite the angle iron protective channel except for the area within 2 inches of the pipe couplings at each girder web which must not be perforated. The total open area provided by these perforations must be at least equal to the surface area of the anode material contained within the PVC pipe.

2.3.4 Rigid Metal Conduit

Provide rigid metal conduit conforming to the requirements of ANSI C80.1, and of the size indicated on the drawings. Galvanize conduit both inside and outside using the hot-dip method.

2.3.5 Conduit Fittings and Outlets

Provide conduit fittings and outlets for rigid metal conduit conforming to the requirements of NEMA FB 1.

2.4 IMPRESSED CURRENT ANODES AND MATERIALS

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NOTE: NOTE: For details on various types of anodes, anode designs and typical anode configurations for preparation of project drawings, refer to EM 1110-2-2704 and CERL Tech Rep FM-95/05.

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2.4.1 Ceramic Precious Metal Oxide Coated Anodes

Provide ceramic precious metal oxide coated anodes conforming to the following requirements:

2.4.1.1 Conductive Precious Metal Oxide Ceramic Coating

Use electrically conductive ceramic coating that contains a mixture consisting primarily of iridium, tantalum, and titanium oxides. Although the exact composition of the conducting layer can vary, the average composition must generally be a 50/50 atomic percent mixture of iridium and titanium oxides with small amounts of tantalum. Use coating resistivity certified by the manufacturer to have an electrical resistivity of less than 0.002 ohm-centimeters, a bond strength to the substrate metal greater than 50 MPa, and a current capacity of 100 DC amperes per square meter of anode surface area when operated in an oxygen-generating electrolyte at 65.5 degrees C 150 degrees F for 20 years.

2.4.1.2 Anode Substrate Material

Fabricate anode substrate from high purity alloy titanium.

2.4.2 Hi-Silicon Cast-Iron Anodes

Provide hi-silicon cast-iron anodes conforming to the following requirements:

2.4.2.1 Chemical Composition (Nominal)

ELEMENT	PERCENT BY WEIGHT
Silicon	14.20 - 14.75
Manganese	1.50 Max
Carbon	0.75 - 1.15
Chromium	3.25 - 5.00
Iron	Balance

2.4.2.2 Electrical Resistivity

Electrical Resistivity must be 72 micro-ohm-centimeter at -7 degrees C 20 degrees F maximum.

2.4.2.3 Physical Properties (Nominal)

PROPERTY	VALUE
Tensile Strength	1.05 kg/m^{2}15,000 psi
Compressive Strength	7.04 kg/m^{2}100,000 psi
Brinnell Hardness	520
Density	7.0 g/cm^{3}0.253 lb/cu in.
Melting Point	1,260 deg C2,300 deg F
Coefficient of Expansion Between 0 deg C and 100 deg C 32 deg F and 212 deg F	0.00000733 cb/deg C0.00000289 in/deg F

2.4.3 Ceramic Coated Titanium Anodes (Disk Type)

2.4.3.1 General

Ceramic coated titanium disk anodes must be conductive ceramic coated titanium disks similar to that shown in Figure 2, "Typical Ceramic Coated Flat Disk Anode" of CERL Tech Rep FM-95/05, November, 1994. Provide anodes conforming to the requirements in paragraph SYSTEM DESCRIPTION, that are suitable for cathodic protection use, highly resistant to corrosion, and with good electrical properties. Ensure anodes disk is at least 127 mm 5 inch diameter factory mounted in a 305 mm 12 inch diameter FRP reinforced Polyurethane protective shield to prevent shorting of the anode to the skin plate and over voltage damage to the adjacent coating. Provide it with an integral titanium mounting rod with gold plated connector socket. Provide each disk anode with a gold plated connector plug and PVC cable connector that is assembled by the manufacturer. Submit certified Factory Test Data on anode connections showing anode-to-contact resistance. Provide a measured resistance of less than 0.003 ohm (or redo the connection). Provide a certified report on these factory tests within two weeks after fabrication by the manufacturer.

2.4.3.2 Impact Protection for Disk Anode Cables

Weld a 152.4 mm 6 inch diameter by 203.2 mm 8 inch long steel schedule-40 pipe with threaded pipe cap to the structure in back of each disk anode. Drill a hole in the side of this pipe and weld a thread-o-let fitting to the 152.4 mm 6 inch diameter pipe at this point to receive the anode lead wire and conduit routed to the anode terminal box at the top of the structure. The pipe and conduit are provided for impact protection of the anode cables and the anode bolt. Galvanize and paint the pipes with 0.1778 mm 7 mil of paint.

2.4.3.3 Number of Ceramic Coated Titanium Disk Anodes

Provide the actual number of ceramic coated titanium disk anodes in accordance with the corrosion engineer's approved design calculations based on the system circuit resistance, current requirements ,current distribution and anode life, in accordance with EM 1110-2-2704 and Appendix "A" in CERL Tech Rep FM-95/05, "Detailed Cathodic Protection Design Procedures for Pike Island Auxiliary Lock" as long as the minimum number of button anodes provided must equal or exceed one each for every 18.58 square meters 200 square feet of submerged steel surface area (for some typical anode configurations, refer to Figures 4, 5, 6, 7, C3, and F2 in CERL Tech Rep FM-95/05). The minimum number of anodes and an indication of their mounting locations should be shown in the design drawings.

2.4.4 Hi-Silicon Cast Iron Button Anodes

2.4.4.1 General

Provide high-silicon cast iron anodes conforming to ASTM A518/A518M.

2.4.4.2 High-Silicon, Cast-Iron Anodes (Button Type)

Provide high-silicon, cast-iron "button-type" anodes consisting of an alloy of silicon, carbon, manganese, and iron. Ensure anodes are similar in all respect to the Button anode design shown in Figure 1, "HSCBCI "Sausage" and "Button" Anode Designs of CERL Tech Rep FM-95/05. Ensure anodes conform to the requirements in paragraph IMPACT PROTECTION FOR RODS AND SAUSAGE-STRING

ANODES and are suitable for cathodic protection use, are highly resistant to corrosion, and have good electrical properties. Provide anodes button castings with a nominal weight of 8.16 kg 18 lb and a size of 152.4 mm 6 inch diameter by 76.2 mm 3 inch deep and provide with a 19.05 mm 3/4 inch diameter by 50.8 mm 2 inch deep conical terminal connection cavity in the back of the anode and 25.4 by 50.8 mm 1 by 2 inch stepped mounting hole provision through the center of the anode as shown in above referenced Figure 1. Install a polychloroprene or neoprene gasket material behind the button anode no less than 3.175 mm 1/8 inch thick by 203.2 mm 8 inch diameter. Use gasket adhesive consisting of 100 percent silicone waterproof caulking material similar to GE 100 percent Silicone Caulk suitable for continuous immersion service. Mold or fabricate plastic seal plugs from an approved polystyrene. Fabricate flanged sleeve from nascent oxygen and chlorine resistant rigid plastic material. Button anodes and assemble cable by the manufacturer.

2.4.4.3 Anodes Number

Provide the actual number high-silicon, cast-iron "button-type" anodes in accordance with the corrosion engineer's approved design calculations based on the system circuit resistance, current requirements, current distribution and anode life, in accordance with EM 1110-2-2704 and Appendix "A" in CERL Tech Rep FM-95/05, "Detailed Cathodic Protection Design Procedures for Pike Island Auxiliary Lock" as long as the minimum number of button anodes provided equals or exceeds one each for every 18.58 square meters 200 square feet of submerged steel surface area (for some typical anode configurations, refer to Figures 4, 5, 6, 7, C3, and F2 in CERL Tech Rep FM-95/05. The minimum number of anodes and an indication of their mounting locations should be shown in the design drawings.

2.4.4.4 Assembly

The manufacturer is responsible for assembling the conductor to the anode after the conductor has been tinned. Make connections with caulked tellurium lead, and then sealed with epoxy around the connection. Cover all tinned wire completely by lead. Reference Figure 1, "HSCBCI "Sausage" and "Button" Anode Designs of CERL Tech Rep FM-95/05 for mounting component details.

2.4.4.5 Impact Protection for Button Anode Cables

Weld a 152.4 mm 6 inch diameter by 203.2 8 inch long steel schedule-40 pipe with threaded pipe cap to the structure in back of each button anode. Drill a hole in the side of this pipe and weld a thread-o-let fitting to the 152.4 mm 6 inch diameter pipe at this point to receive the anode lead wire and conduit routed to the anode terminal box at the top of the structure. The pipe and conduit are provided for impact protection of the anode cables and the anode bolt. Galvanize pipes and paint with 0.1778 mm 7 mil of paint.

2.4.5 Ceramic Coated Titanium Segmented Rod Anodes

a. Provide conductive ceramic coated titanium rods similar to that shown in Figure 3, "Typical Ceramic Coated Flat Disk Anode" of CERL Tech Rep FM-95/05. Provide anodes conforming to the requirements in paragraph SYSTEM DESCRIPTION, that are suitable for cathodic protection use, highly resistant to corrosion, and with good electrical properties. Each anode rod must be solid titanium and at least 3.175 mm 1/8 inch diameter by 1.2192 m 48 inch long with integral factory fabricated 12.7 mm 1/2 inch diameter ceramic coated titanium screw couplings at each end. Provide one anode for each assembled length with a screw coupled sealed PVC cable connector which is assembled by the manufacturer. Provide each such connector/cable assembly with sufficient lead length so that no splices are necessary between the anode/cable connector and the anode terminal box.

b. Provide the actual number of segmented rod assemblies and the number of strings per chamber in accordance with the corrosion engineer's approved design calculations based on the current required for protection in accordance with EM 1110-2-2704 and Appendix "A" in CERL Tech Rep FM-95/05, "Detailed Cathodic Protection Design Procedures for Pike Island Auxiliary Lock" as long as the number of segmented rod anode assemblies provided equals or exceeds 305 mm 1 linear foot of 3.175 mm 1/8 inch diameter (minimum) ceramic coated titanium rod material for each 9.29 square meters 100 square feet of submerged steel surface area and at least one full height assembly in each chamber (for some typical anode configurations, refer to Figures 4, 5, 6, 7, C3, and F2 in CERL Tech Rep FM-95/05). Extend each assembly at least 152.4 mm 6 inch above the normal highest water line to within 152.4 - 304.8 mm 6 - 12 inch of the bottom most girder plate.

2.4.6 Hi-Silicon Cast Iron Sausage Anode Strings

a. Provide high-silicon, cast-iron anodes consisting of an alloy of silicon, carbon, manganese, and iron conforming to ASTM A518/A518M. Ensure anodes are similar in all respect to the "Sausage" anode design shown in Figure 1, "HSCBCI "Sausage" and "Button" Anode Designs of CERL Tech Rep FM-95/05. Provide anodes that are suitable for cathodic protection use, are highly resistant to corrosion, and with good electrical properties. Provide "Sausage" anode castings with a nominal weight of 2.95 kg 6-1/2 lb each and with an irregular surface terminal connection cavity in the center interior of the tubular shaped anode as in CERL Tech Rep FM-95/05. Provide anodes that are 52.39 mm 2-3/16 inches in diameter by 305 mm 12 inch long, designed for tandem mounting in "link-sausage" manner on the anode lead cable. Connect cable and anodes all in a manner similar to the "Sausage" anode design shown in the above referenced Figure 1. Provide anode strings assembled by the manufacturer and do not splice the anode lead cable in the anode. Assemble anode by removing insulation from the anode cable and connecting the anode to the cable inside the anode.

b. Provide the actual number and spacing of the individual "sausage" segments and the number of strings per chamber in accordance with the corrosion engineer's approved design calculations based on the current required for protection in accordance with EM 1110-2-2704 and Appendix "A" in CERL Tech Rep FM-95/05, "Detailed Cathodic Protection Design Procedures for Pike Island Auxiliary Lock" as long as the number of "sausage" anodes provided equals or exceeds one each for every 18.59 square meters 200 square feet of submerged steel surface area and at least one string in each chamber (for some typical anode configurations, refer to Figures 4, 5, 6, 7, C3, and F2 in CERL Tech Rep FM-95/05). Extend each assembly from 152.4 mm 6 inch above the normal highest water line to within 152.4 - 304.8 mm 6 - 12 inches of the bottom most girder plate.

2.4.7 Enhanced Mixed Metal Oxide (EMMO) Strip Anodes

a. The EMMO anodes are the newest generation of MMO anodes and far exceed the limitations of the MMO anodes. The EMMO anodes were originally designed for the interior of a USACE hydropower turbine unit and have proven very successful in this application. Since then, the EMMO anode has been utilized on other structures in USACE.

b. EMMO anodes possess excellent abrasion resistance and dimensional stability from the ceramic plasma spray processing technology and inherent inertness from the active catalyst, Iridium. The EMMO dielectric anode shield can be molded in different shapes, configurations, and to the curvature (radius) of the structure to be mounted to.

c. EMMO strip anodes must be made of Iridium/Tantalum based mixed metal oxide, catalyst arc-plasma spray EMMO ceramic anode coating. The EMMO coating must have a coating tensile bond strength >40 MPa per ASTM 633 and an average thickness of at least 900 micro inches (min: 500 micro-inch, max:1500 micro-inch). The anodes are to have a minimum current rating of 20 years at 8 Amperes in seawater, a maximum voltage rating of 92 Volts, and a minimum current density of 13,574 mA/square-foot. Contruct the anode shield out of dielectric PVC and have a minimum thru wall capacity of 1 inch with at least 6 recessed holes to mount the anode housing to the structure using welded studs. The PVC housing are to have a nominal tensile strength of at least 10,000 psi and be molded to the curvature (radius) of the structure for which the anodes will be installed on. Determine the size and quantity in the CPS design.

2.5 IMPACT PROTECTION FOR RODS AND SAUSAGE-STRING ANODES

2.5.1 PVC Pipe and Metal Couplings

Install PVC pipe, to be used for protection of the rod and sausage-string anodes, through each girder web in the center of each chamber which has an inside diameter (I.D.) that is at least 38.1 mm 1-1/2 inch greater than the anode outside diameter (O.D.). Provide pipe that is Schedule 80 PVC minimum and perforate on the side opposite the angle iron except for the area within 50.8 mm2 inch of the pipe couplings at each girder web. Ensure total open area provided by these perforations is at least equal to the surface area of the anode material contained within the PVC pipe. Install metal couplings through the girder webs on the compartment side of the structure (and where compartments are used on the skin plate side), where the PVC pipe penetrates the web. The steel coupling selected should have an I.D. that will allow the plastic pipe and its associated couplings to pass through the coupling. Align these steel couplings vertically for each anode string to serve as vertical troughs for the plastic pipes. Solvent weld full sections of the plastic pipe together end to end. Drill holes in the plastic pipe as shown on the drawings. Prepare steel coupling, angle iron, channel iron and all areas affected by the welding for painting and coat with the same paint system as the adjacent structure surfaces, in accordance with Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

2.5.2 Protective Angle Irons

Submit anode disk, button, strip, rod and string details including ice and debris damage protection means for each anode type and alternative location.

2.5.2.1 PVC Piping

The protective PVC piping is subject to damage from floating ice and/or driftwood. Therefore, install protective angle irons in front of the protective PVC pipe. Ensure these angle iron sections are at least 6.35 mm 1/4 inch thick with angle legs whose height equals to at least 75 percent but no more than 100 percent of the plastic pipe coupling outside diameter. Weld this angle iron to each girder passage pipe coupling from the top of the highest girder to the bottom most girder plate. At each girder, which is penetrated by the PVC pipe, also weld the angle irons to the girder to reduce stress concentrations in the girder web caused by this penetration. Install entire assembly, consisting of the perforated PVC pipe containing the sausage anodes and the angle irons, as shown on the drawings. When plastic pipes only are used for sausage anode protection, ensure the girder penetration is the same, but install the angle iron in the impact area only.

2.5.2.2 Painting

Prepare steel couplings, angle iron, and channel iron for painting and coat with the same paint system as the adjacent structure surfaces, in accordance with Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES. Each component must have the same minimum mil thickness (where 1 mil = 0.0254 mm 0.001 inch) of paint after couplings, angle irons, and channels are welded to the structure. Clean welded area to bare metal and paint in this same manner. Use paint that is the same type used on the structure.

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NOTE: Select first set of brackets for RECTIFIERS AND AUXILIARY EQUIPMENT for standard analog system. Select second set of brackets for RECTIFIERS AND AUXILIARY EQUIPMENT for digitally controlled system.

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[2.6 RECTIFIERS AND AUXILIARY EQUIPMENT - STANDARD ANALOG SYSTEM

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NOTE: Air-cooled rectifiers are used for most applications. Oil immersion cooled units are normally used in highly corrosion atmospheres.

The rectifier cabinet may be located in the control house to avoid problems caused by moisture, insects, dust, vandalism, etc., when these are a factor. When outside placement of the rectifier is indicated, the rectifier must be securely mounted or fastened to the structure (see Alternate 2 below). When high-water flooding is likely, the rectifier should be mounted on wheels for easy removal (see Alternate 1 below). It is left to the designer to provide detailed drawings for either type rectifier installation. Adequate drainage must be provided in all terminal cabinets since flooding will in most cases cause sand and water to accumulate in the terminal cabinet. Eventually, this will cause the appearance that anodes are failing when, in fact, contacts in the terminal cabinets, or rectifier contacts, are causing failure and outages to the

cathodic protection systems. Alternatively, watertight sealed terminal cabinets can be used. The rectifier cabinet referenced in these documents is for the air-cooled type transformer and rectifier unit. If the designer selects the oil-immersed type unit, then the specifications will have to be revised accordingly.
****

2.6.1 System Description

Provide a rectifier unit for [each upstream and downstream face of each gate leaf] [each of the four gate leaves of the lock][ ]. Provide cathodic protection system power circuit consisting of a step-down transformer with secondary taps for output adjustment, primary circuit breaker, rectifier transformer, rectifier, secondary fuses, and rectifier terminal panel. Locate rectifier units [in the control houses] [outside at the specified locations]. Design units [for removal during periods when flood waters overtop the lock wall] [to be free-standing].

2.6.2 Cabinets

Provide rectifier cabinet to house the rectifier transformer, rectifier stacks, circuit breaker, terminals, and the control and instrument panel. In installations requiring the use of a step-down transformer, design the cabinet such that the rectifier equipment specified above can be installed in the lower section of the cabinet with the step-down transformer in the upper portion. Provide [convection air cooled] [oil immersed cooled] cabinets constructed of 1.894 mm 14-gauge minimum sheet stainless steel, ASTM grade [304][316]. Design the cabinets for use outdoors; NEMA 250, enclosure 3R, and use appropriate structural shapes in the construction of the cabinet to provide rigidity and to prevent bending or flexing of the cabinet while being transported. Provide louvers for air-cooled units in the hinged doors and on the sides of the cabinets for ventilation. Cover all ventilation openings with ASTM grade [304][316] stainless steel insect screen arranged so as to be easily replaceable. Hinge all doors using post hinges designed to allow easy removal of all doors for unit servicing and provide with a hasp and lock for padlocking. Use locks that are keyed alike such that all cabinets can be opened with one key. Provide the keys and turn them over to the Contracting Officer.

2.6.3 Wheeled Rectifier Cabinets (Alternate 1)

Mount rectifier cabinet on wheels and provide with handles for moving during floods. Ensure wheels, axles, and bearings have sufficient capacity to support a weight of at least three times the weight of the complete rectifier. Weld studs for the clamps to be used for securing the rectifier to the pipe rail, as shown on the drawings, to a reinforced back section of the cabinet at the factory before finishing. All components must be ASTM grade [304][316] SS or equal.

2.6.4 Stationary Cabinets (Alternate 2)

Mount rectifier cabinet on structures as shown on the drawings. Accomplish welding of ASTM grade 304 SS or equal clamps, brackets, or cabinet-back reinforcement at the factory before finishing.

2.6.5 Circuit Breakers

Install a 120/240-volt, [10] [_____] ampere-interrupting-capacity, double-pole, molded-case circuit breaker conforming to UL 489 in the primary circuit of the rectifier transformer and disconnect both conductors. Provide breaker with instantaneous and inverse time trips. Provide [10] [_____] ampere cartridge-type fuses conforming to NEMA FU 1 with suitable fuse holders in each leg of the dc circuit.

2.6.6 Step-down Transformers

Provide step-down transformers of the two-winding, insulating dry type conforming to NEMA ST 20 rated for 480-120/240 volts, single-phase, 60-Hertz. Provide transformers with 2 to 5 percent full capacity primary taps below rated voltage. Ensure transformers rated for no less than a temperature rise of 80 degrees C 176 degrees F above a 40 degrees C 104 degrees F ambient and provide with Class B or H insulation.

2.6.7 Rectifier Transformers

Provide two-winding, [convection air-cooled] [oil immersed cooled] rectifier transformer, with a primary operating voltage of 120/240 volts, single phase, and conforming to the requirements of NEMA ST 1. Provide transformer secondary with five "coarse" and five "fine" taps on each dc circuit, to permit variations of the dc output voltage in 25 uniform increments of the rated output voltage, from zero to a maximum rated voltage of [_____] volts. Adjust voltage steps by rotating solid brass tap bars. Identify each control by suitable permanent, engraved marking such as "coarse" or "fine" with an arrow to indicate the type and direction of adjustment. Mark individual steps of adjustment with numbers in consecutive order for fine control and with letters in alphabetical order for coarse control. Mount all primary alternating current terminals behind the panel. Dip coils of all transformers manufactured for cathodic protection use in preheated varnish and bake dry for maximum moisture and corrosion resistance.

2.6.8 Rectifiers

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NOTE: Silicon rectifier stacks are usually recommended for the rectifier and these specifications reflect their use; however, the designer has the option to select either selenium or silicon stacks. When the specification writer selects selenium, the specifications should be revised accordingly. The advantages and disadvantages for the two types of rectifier stacks are as follows:

Silicon stacks (diodes): These stacks are more economical in higher voltage output circuits and in higher current circuits.

Advantages:

a. Cost-effective in high current ratings.
b. More efficient in higher voltage ratings.
c. Replacement cells are easily stocked.
d. Higher efficiency

Disadvantages:

a. Must be surge protected with selenium.
b. Cannot withstand extreme surges.

Selenium stacks (cells): These stacks may be more economical in lower voltage output circuits where current requirements are lower.

Advantages:

a. Can withstand surges caused by lightning much better than silicon without additional protecting devices.
b. Are cost-effective in lower voltage and lower current ratings.
c. Can withstand severe short-term overloads

Disadvantages:

a. Expensive in high voltage and high current ratings.
b. Cannot be easily replaced
c. May be difficult to obtain.
d. Replacement stacks can be expensive to stock.
e. Relatively low efficiency

Recent studies by the US Army Corps of Engineers indicate that remote monitor of these systems can greatly improve the reliability of effective monitor and maintenance of these systems and eliminate the need for meters in the units:

"Demonstration of Remote Monitoring Technology for Cathodic Protection Systems" FEAP-TR 97/76 (April 1997), http://owww.cecer.army.mil/TechReports/Vancatho/Vancatho.pdf

"Demonstration of Remote Monitoring Technology for Cathodic Protection Systems: Phase II" FEAP-TR 98/82 (May 1998), http://owww.cecer.army.mil/techreports/van_cpr2/van_cpr2.flm.post.pdf

"Remote Monitoring Equipment for Cathodic Protection Systems" FEAP User Guide 97/75 (April 1997), http://owww.cecer.army.mil/TechReports/Vancprem/Vancprem.pdf

"User Guide for Remote Monitoring Equipment for Cathodic Protection Systems: Phase II" FEAP User Guide 98/77 (May 1998), http://owww.cecer.army.mil/techreports/VANFUG2.CPR/vanfug2.cpr.post.pdf

The designer should investigate the cost, reliability and availability of these remote monitoring systems.
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Provide [air-cooled] [oil-immersed] units, consisting of silicon stacks to provide full-wave, bridge-type rectification, within the manufacturer's ratings. The rectifier must be suitable for operation over an ambient temperature range of -18 to 49 degrees C 0 to 120 degrees F. Use output ratings as designed by the Corrosion Expert and for continuous duty operation.

2.6.9 Ammeter and Voltmeter

Provide a dc ammeter and voltmeter of the semi flush, 89 mm 3-1/2 inch round or rectangular panel board type, conforming to the applicable requirements of ANSI C39.1, in each dc circuit, or as otherwise indicated on the drawings. Provide sealed, taught band type instruments with a guaranteed accuracy of 1 percent of full-scale deflection, zero adjustment, and a minimum scale length of 61 mm 2.4 inch. Indicate full load reading by means of a red mark on the meter scale and incorporate at least 80 percent of the meter scale length. Provide each meter with a momentary contact switch, either integral with the meter or separately mounted, for momentary reading. A single meter having dual scales may be provided in lieu of separate meters, provided that the scales are distinct and easily read, and that a switch is provided to select the desired function and to prevent simultaneously energizing more than one function.

2.6.10 Current Monitoring Shunt

Provide a separate current monitoring shunt resistor on the rectifier unit face plate to facilitate using an external digital milli-voltmeter to confirm the current output displayed by the unit ammeter. This shunt resistor must have a calibrated accuracy of plus or minus 1 percent and a 1 ampere/millivolt drop rating.

2.6.11 Ammeter and Voltmeter Switches

Use switches for switching the meters in and out of the dc circuit that are lever action sealed toggle, quick make-or-break type switches. Ensure switches are [[single-pole] [double-throw]] [[double-pole] [double-throw]] and wired not to interrupt the output circuit.

2.6.12 Control and Instrument Panel

Provide dead-front type control and instrument panel and install in the rectifier cabinet. Make primary connection by means of a panel-mounted terminal block with screw connection protected by a removable metal or molded plastic cover. Terminate incoming power lines in such a manner as to prevent accidental contact by personnel using the rectifier.

2.6.12.1 Tap Bars

Permanently identify tap bars serving the rectifier transformer secondary adjustment by means of engraving on the non-metallic control panel face plate denoted "coarse" and "fine" and identify the individual tap positions by letters, such as "A," "B," "C," and numerals, such as "1," "2," "3," respectively.

2.6.12.2 DC Output Terminals

Identify rectifier dc output terminals by means of engraving on the non-metallic control panel face plate indicating polarity of the terminal and point of connection to the system, i.e., "+ANODES" and "-STRUCTURE."

2.6.12.3 Components Identification

Identify all other components on the rectifier panel face plate by means of engraving on the non-metallic control panel face plate.

2.6.13 Anode Cable Leads

Identify anode cable leads at the resistor and anode terminal cabinet by means of plastic sleeves or tags showing the anode lead number as indicated on the drawings. Ensure they are of sufficient length so that splicing between the anode and the anode terminal box is not necessary. No splices of the anode lead wires will be permitted between the anode and the anode terminal box.

2.6.14 Surge Arresters

Provide MOV surge arresters for all AC and DC power circuits. In addition, for AC voltages above 120-volt, use a single pole valve-type surge arrester for each input line. Locate it ahead of the ac breaker feeding the rectifier transformer. Use surge arresters rated for continuous load currents up to [10] [_____] amps minimum and limit the voltage to 200 volts peak. The response clamping activation time is 5 nanoseconds maximum.

2.6.15 Wiring Diagram

Encase s complete wiring diagram of the rectifier unit showing both the ac supply and the dc outputs to the resistor and anode terminal cabinets in clear rigid plastic and mount on the inside of the rectifier cabinet door. Show and label all components.

][2.7 RECTIFIERS AND AUXILIARY EQUIPMENT - DIGITALLY CONTROLLED SYSTEM

2.7.1 System Description

Provide a rectifier unit for [each upstream and downstream face of each gate leaf] [each of the four gate leaves of the lock] [   ]. Locate rectifier units [in the control houses] [outside at the specified locations]. Design units [for removal during periods when flood waters overtop the lock wall] [to be free-standing].

2.7.2 Rectifier Description

Each rectifier must be a minimum four (4) mode automatic rectifier with full feedback control and consist of a minimum of four independent channels (isolated circuits) with a controller that monitors the output voltage and current of each circuit. The rectifier controller also must obtain feedback from permanently installed dual reference electrodes and adjust the rectifier according to presets selected in the controller.

2.7.3 Operating Modes

The rectifier must have multiple operating modes which can be set independently for each circuit, including "automatic constant current", "constant voltage", "constant potential", and "I/R Free". An adjustable DC output interrupter for IR free manual testing must be integral to the rectifier.

2.7.4 Operation Characteristics

The rectifier must receive and display the polarization status of each dual reference electrode, regulate the current within predetermined windows of operation via set points and limits, and record and store the data at preset intervals.

2.7.5 User Interface Display, Connectivity, and Download Capabilities

The controller must allow for all set points and parameters to be defined by the operator through a color, touch screen panel with NEMA 4X rating. The rectifier must utilize industry standard connectivity and connectors that allow for remote control monitoring, optional rectifier remote control, and long-term data storage modules. The rectifier controller must allow downloading of the cathodic protection performance data over time and graphically represent a combination of rectifier voltage and current; anode voltage and current; on potentials; instant off potentials; native potentials; etc. The graphical representation of the anode voltage and current over time is critical for detecting coating degradation over time.

2.7.6 Rectifier Power Requirements

Rectifier power requirements must be rated for DC output per CPS design calculations and AC input per facility voltage/phase availability. Rating of rectifier cabinet must be a minimum NEMA 3R cabinet.

]2.8 RESISTOR AND ANODE TERMINAL CABINETS

Provide terminal cabinets for each rectifier output circuit. Provide NEMA type 4X cabinets consisting of weather-resistant construction. Construct cabinets of ASTM grade [304][316] stainless steel. Provide cabinets of ample size to accommodate all anode and power input lead wires and [_____] standard brass or copper heavy duty screw terminals to facilitate individual connection of each anode assembly lead wire through a 0.01 ohm type RS shunt resistor to a common copper bus bar. Mount all terminals, bus bars, shunts, and other DC conducting components to an extra strong, non-metallic panel. Identify all conductors in the cabinet by means of plastic or metal tags or plastic sleeves to indicate the anode number. Identify each terminal with permanent engraved identification of the anode number, or other corresponding conductor numbers, or function. [Mount cabinets securely on the top of the corresponding gate in the manner proposed by the Contractor and approved by the Contracting Officer.]Provide a removable, hinged front door facing a direction after installation that is easily accessible.

2.8.1 Resistor and Anode Terinal Cabinet Wiring Diagram

Provide a complete wiring diagram showing the anode numbers in the terminal cabinets and a complete wiring diagram of the entire cathodic protection system. Identify each conductor and each termination.

2.9 PERMANENT DUAL REFERENCE ELECTRODES

Reference electrodes specifically designed for the applicable flow rates and long-term stability requirements are to be employed to monitor the effectiveness of the ICCP System. Each reference electrode housing must contain dual electrodes for redundancy and incorporate stability filters as required. The reference electrode must be constructed of dielectric PVC and have a minimum thru wall capacity of 1 inch capacity with at least four (4) recessed holes to mount the reference electrode housing to the structure with welded studs. The PVC housing must have a nominal tensile strength of at least 10,000 psi. If applicable and required, the PVC housing must be molded to the curvature (radius) of the structure for which the dual reference electrodes will be installed on. Feedback from these electrodes to the rectifier controller will regulate the current for optimal control. Combinations of copper/copper-sulfate and zinc reference electrodes must be considered in brackish water or when salinity of water changes frequently.

2.9.1 Impact Protection for Permanent Dual Reference Electrodes

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NOTE: In areas with the problem of floating ice and/or driftwood, consideration should be given to the use of the more flexible ceramic coated titanium rod installed in PVC schedule 80 pipes with holes drilled in the pipe. These anodes should be used on the compartment side of the gate leaf, which is usually downstream. Alternatively, in areas subject to substantial floating ice and/or excessive driftwood, either Ceramic Coated Disk Anodes or High Silicon, Cast-Iron Button anodes may be used exclusively on both sides of the gate although this is usually a more expensive option.

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Weld a 6 inch diameter by 8 inch long minimum steel schedule-40 pipe with threaded pipe cap to the structure in back of each reference electrode housing. Drill a hole in the side of this pipe and weld a thread-o-let fitting to the 6 inch diameter pipe at this point to receive the connection wire and conduit routed to the terminal box at the top of the structure. The pipe and conduit are provided for impact protection of the anode cables and the. Paint the 6 inch diameter pipe at the same time as the structure (after all welding) with the same application standards and coating system that is applied to the structure surface.

2.10 MARKINGS

2.10.1 Manufacturer's Nameplate

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.10.2 Rectifier Cabinets

Identify rectifier cabinets by means of suitable stainless steel plates attached to the outside of the rectifier cabinet by means of bolts or screws.

PART 3 EXECUTION

3.1 EXAMINATION

Visit the premises and thoroughly become familiar with all details of the work and working conditions, verify existing conditions in the field, note the exact locations for materials and equipment to be installed on the structures for cathodic protection, and advise the Contracting Officer of any discrepancies before performing any work.

3.2 INSTALLATION

Provide all materials, equipment, and labor necessary to provide a complete and workable cathodic protection system conforming to the drawings and specifications. Provide all electrical work and materials conforming to NFPA 70 and requirements specified herein. Provide 150 mm 6 inchdiameter Schedule 40 steel pipe. Provide fittings for rigid metal conduit conforming to NEMA FB 1. Use straight conduit; no kinks or bends will be permitted. Ensure conduit is RGS except the 152.4 mm 6 inch pipe required for protecting the HSCI button anodes and PVC schedule-80 perforated protective pipe used to protect the ceramic rod and HSCI sausage string anodes.

3.3 WIRING INSTALLATION

3.3.1 Rectifier in Control Room

Install cables, of the type specified in paragraph DIRECT CURRENT CABLES, between the rectifier cabinet located in the control room and the dc receptacle located adjacent to each structure. Install this cable in conduit conforming to the requirements of paragraph CONDUIT AND FITTINGS.

3.3.2 Rectifier on the Structure

Run Type SO cable exposed from the ac receptacle on the lock wall to the rectifier cabinet and from this cabinet to the dc receptacle. Also run Type SO cable exposed from the dc receptacle to the watertight bushing on the structure. Provide watertight insulating bushings with a cable seal fitting that makes a watertight conduit connection and a watertight seal between the cable jacket or insulation and the fitting. At all locations at which a conduit penetrates a watertight member, install a watertight packing gland constructed as shown on the drawings.

3.3.3 Wiring on the Structure

Provide all dc circuit wiring and anode lead wiring on the structures in rigid galvanized steel conduit, except sausage anode strings which must be shown on the drawings and as specified. [Where possible, install conduit on the gate structure in the recesses of the gate and flush with the wall skin plate to reduce the probability of physical damage from floating debris.]Provide each anode with sufficient lead length, without splice, to reach the terminal cabinets located on the top of each structure. Provide watertight insulating bushings with a cable seal fitting to seal between the cable jacket or insulation and the fitting. At all locations at which a conduit penetrates a watertight member, provide a watertight packing gland constructed as shown on the drawings. Prior to installation perform continuity testing utilizing a high impedance meter between the anode material surface and the anode lead wire end (that will be terminated at rectifier location), and insulation testing utilizing a Megger insulation tester. Replace all anodes and/or lead wires, including spares, that are found to be faulty or do not meet manufacturer suggested test results. After the cathodic protection system is installed, but prior to rewatering, the same two tests must be utilized to confirm that anodes and lead wires meet manufacturer suggested test results.

3.3.4 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves.

3.4 ROD AND SAUSAGE ANODE INSTALLATION

3.4.1 Metal Pipe Couplings for PVC Pipee

Weld metal pipe couplings (guides for PVC pipe used with sausage anodes) permanently on the structure. Do not use rod or Sausage-type anodes without these PVC pipe guides. Install PVC schedule-80 pipe (with holes) containing the sausage anode strings through the couplings with the holes oriented away from the protective steel angle channel (toward the back of the chambers). Use anode rod or string assembliescapable of being withdrawn at any time for inspection and repair. Install metal pipe couplings used for PVC pipe guides plumb, with an alignment tolerance of plus or minus 6.35 mm 1/4 inch over the entire height of the structure. When in place, weld the metal pipe couplings to the girder. Position protective angle irons at the previously specified locations to protect the PVC pipe and anode strings contained therein, exposing as much anode surface area as possible.

3.4.2 Assembly of Titanium Rod Anode

Sequentially assemble ceramic coated titanium rod anode as it is lowered into the PVC pipe by screw coupling each to the next anode element. Tighten coupling to a torque equal to that specified by the anode manufacture. Attach factory fabricated anode-to-cable connector to topmost element in a similar manner. The HSCI sausage anode assemblies are lowered into place inside the plastic pipe. Take care in handling these HSCI anode strings since the material is very brittle and subject to cracking if dropped or bounced against a hard surface. If any single anode element in the HSCI "sausage" string is cracked, replace the entire string with a new string. Do not install cracked anodes in the system. Install anode centering devices on each rod or string anode element to assure that the anode in maintained in a centered position within the pipe in a manner so that no portion of the anode is closer than 12.7 mm 1/2 inch of the pipe interior surface. Ensure each anode lead is continuous without splices from its point of connection to the anode to the terminal cabinet on the structure. Mark anode leads with anode string or anode number at the point of connection to the terminal box. Coil a minimum of 152.4 mm 6 inch of excess cable in the anode terminal box before cutting and connection the cable to the corresponding anode terminal in the terminal box. Coat this connection with a suitable oxidation preventing electrical contact paste.

3.4.3 Suspension of Anode Rod or String Assemblies

Provide support for each anode rod or string in a manner to permit easy raising, lowering, removal and/or reinstallation of the anode strings in the anode guides. Suspend anode assemblies from anode connecting cables using "Kellum" or equal grips to provide uniform and non-deforming gripping of the wire insulation.

3.5 DISK AND BUTTON ANODE INSTALLATION

3.5.1 General

Install the Disk or Button-type anodes at the locations shown on the approved Contractor's corrosion engineer design drawings.

3.5.2 Impact Protection Pipes Installation

Install impact protection pipes for the disk or button anode connection cables prior to installation of the anodes. Fully seal weld a 152.4 mm 6 inch diameter by 203.2 mm 8 inch long galvanized steel schedule-40 pipe with threaded pipe cap to the structure in back of each button anode. Drill a hole in the side of this pipe and weld a thread-o-let fitting to the 152.4 mm 6 inch diameter pipe at this point to receive the anode lead wire and conduit routed to the anode terminal box at the top of the structure. The pipe and conduit provide impact protection of the anode cables and the anode support means. Prepare pipes for painting and coat with the same paint system as adjacent structure surfaces, in accordance with Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.5.3 Disk Anode Installation

Deleiver the disk anode as a complete assembly by the manufacturer. Drill a 28.58 mm 1-1/8 inch diameter hole through the skin plate at each disk anode location shown on the approved system design drawings. Remove the FRP nut and washer from the disk support shaft. Apply 100 percent silicone waterproof caulk to the skin plate side of the anode composite shield in sufficient quantity to completely seal the shield at its outer perimeter and adjacent to the shaft where it passes through the skin plate. Then insert the disk through the structure and hold firmly in place while the washer and nut are placed on the support shaft from the opposite side of the structure and tighten using an automatic torque wrench set to 33.9 N-m 25 ft-lb of torque. Then attach cable connector to the integral threaded socket on the end of the anode support shaft and tighten to the torque specified by the manufacturer. Route this cable through the pipe protecting thread-o-let fitting and then via conduit to the anode terminal box. Ensure each disk anode lead is continuous without splices from its point of connection to the anode to the terminal cabinet on the structure. Mark anode leads with anode string or anode number at the point of connection to the terminal box. Coil a minimum of 152.4 mm 6 inch of excess cable in the anode terminal box before cutting and connection of the cable to the corresponding anode terminal in the terminal box. Coat this connection with a suitable oxidation preventing electrical contact paste.

3.5.4 Button Anode Installation

a. Provide polychloroprene or neoprene gasket material that is no less than 3 mm 1/8 inch in thickness and provide a minimum of 500,000 ohms of resistance between the button anode and the structure. Provide plastic plugs, molded or fabricated from an approved polystyrene to fit securely in the anode opening, in accordance with the approved submittal drawings. After assembly, insulate the anode support bolt completely on the button side of the structure by forcing epoxy cement through a passage provided for that purpose, around the insulating sleeve, into the bolt-head cavity, and out the vent hole in the plastic plug. Place the plastic plug in the bolt-head cavity such that the vent hole is at the highest point.

b. Provide epoxy cement of an approved type, with a suitable dielectric strength, that is water-resistant, and does not generate enough heat to damage or react with the plastic plug, the insulating bushings, or the gaskets. The epoxy must provide a minimum electrical resistance of 10 megohms between the anode and the structure.

c. Fabricate flanged sleeves from nylon conforming to the requirements of ASTM D789, or a similar approved rigid plastic material. It must be of proper size and length so that it will penetrate the skin plate enough to provide electrical isolation between the anode and skin plate. The sleeve must enter the skin plate at least 1.59 mm 3/16 inch. Refer to CERL Tech Rep FM-95/05 - Figure 1, "HSCBCI "Sausage" and "Button" Anode Designs for mounting component details.

d. Also isolate the bolt from the anode and skin plate. Use a metal washer behind the skin plate to connect the bolt to the structure so that the bolt will receive cathodic protection and not corrode. Apply the epoxy cement (resin) to provide a watertight seal in all areas of the bolt and anode bolt cavity. This will isolate the anode from the structure.

e. Sandblast the surfaces of the structure to be covered by the polychloroprene or neoprene gasket and the anode to clean metal to provide a bonding surface for the epoxy cement. The metal washer must not exceed the flange diameter of the nylon sleeve and the nylon flanges must be at least 3 mm 1/8 inch in diameter smaller than the diameter of the button anode hole bolt-head cavity. Provide anchoring bolt with slots that are large enough and adequate to transfer epoxy. Machine bolts and drill holes to transfer epoxy. Use bolt of sufficient length to allow threads to be visible past the nut. Consider structural thickness. Attach neoprene gasket to the structure and the anode using an approved cement to make a watertight seal. Use bolt to torque the anode to a watertight seal on the structure. Do not over-torque bolt, causing the metal anode to contact the structure or the polychloroprene gasket to turn out from the skin plate. Do not handle or carry anodes by the conductor. Ensure each anode lead is continuous without splices from its point of connection to the anode to the terminal cabinet on the structure. Mark anode leads with anode string or anode number at the point of connection to the terminal box. Coil a minimum of 152.4 mm 6 inch of excess cable in the anode terminal box before cutting and connection of the cable to the corresponding anode terminal in the terminal box. Coat this connection with a suitable oxidation preventing electrical contact paste.

3.6 RECTIFIER CABINET INSTALLATION

Secure wheeled rectifier cabinets, when provided, to the lock wall pipe rails using the clamp provided as a part of the rectifier. Secure stationary rectifier cabinets to the structures as shown on the approved submittal drawings.

3.7 RESISTOR AND ANODE TERMINAL CABINETS INSTALLATION

Install resistor and anode terminal cabinets at locations convenient for maintenance and testing purposes and to provide ready access to the terminals therein. Securely mount the cabinets to the structure with welded angle iron supports holding the cabinet in place.

3.8 REPAIR OF EXISTING WORK

Carefully lay work out in advance, and where cutting, channeling, chasing, or drilling of the structure or girder web, or other surfaces is necessary for the proper installation, support, or anchorage of the cabinets, conduit, raceways, or other electrical work, peerform this work carefully, and repair any damage to the structure or equipment by skilled mechanics of the trades involved, at no additional cost to the Government.

3.9 FIELD QUALITY CONTROL

3.9.1 Tests and Measurements

3.9.1.1 Insulation Testing

After installation of the button anode on the structure, but prior to connection to the rectifier and submergence, make an insulation test to demonstrate that no metallic contact or short circuit exists between the anode and the structure. Make these tests using a Megger apparatus or other device specifically designed for this purpose. Replace insulation found to be shorted. Ensure each button anode has a minimum resistance of 500,000 ohms isolation from the structure. If the button anode fails to indicate 500,000 ohms isolation, make the necessary corrections and/or modifications to the anode installation to achieve the minimum reading.

3.9.1.2 System Component Circuit Resistance Measurements

Within 1 week following the filling of the lock, measure and record the resistance of each anode, reference electrode, system ground, and reference ground using four separate test lead wires and a Nilsson Model 400 AC impedance meter or other similar AC impedance instrument acceptable to the Contracting Officer. Make the measurement by disconnecting the component lead at the appropriate terminal in the terminal box and connecting two of the four AC impedance test leads individually to the lead wire. Connect the other two AC impedance test leads individually to the structure component to which the component is mounted or connected. Should the resistance between the lead wire and the structure (immerse anode and reference elements in water) be less than 50 percent or more than 200 percent of the calculated (expected) resistance, make the necessary corrections and/or modifications necessary to achieve the anticipated value(s).

3.9.1.3 Structure-to-Reference Cell Potential Measurements

Following completion of the installation of the cathodic protection system and prior to placing the impressed current cathodic protection system in operation, make structure-to-reference cell potential measurements. Use testing equipment consisting of a calibrated copper-copper sulfate reference electrode with waterproof connector to insulated test lead wire suitable for immersion testing and of suitable length so that no splices are necessary in the test lead wire and a high-resistance digital voltmeter, Fluke Models 865 or 867 or equal. The copper-copper sulfate reference electrodes must contain a saturated reagent copper sulfate in distilled water. Prior to first system energization, record native "OFF" potential measurement using the same meter and calibrated reference electrode to be used during system energization and adjustment. Measure and record these native "OFF" potentials at all the specified locations.

3.9.2 Initial Cathodic Protection System Field Testing

Initial field testing must be completed by the contractor upon completion of construction. Field testing must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager or their designated representative. Advise the Contracting Officer or Contracting Officer's Representative [5] [_____] days prior to performing each field test. Field testing must include native and protected potentials, anode current and rectifier testing.

The contractor must submit an initial field test report of the CP system. All system component circuit resistances, structure-to-electrolyte measurements, including native potentials, protected potentials, anode current testing, rectifier testing, and other required testing must be recorded on applicable forms. Identification of test locations in reference to anode locations will coordinate with the as built drawings and be provided on system drawings included in the report. The contractor must locate, correct, and report to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager any unusual data, problems, or short circuits encountered during the checkout of the installed CP system.

3.9.2.1 Rectifier Adjustments

Accomplish rectifier adjustment as follows:

a. Adjust the output of the rectifier so that the structure-to-water potential measured using a reference cell indicates that the negative potential has stabilized and is at least minus 850 millivolts and not more than 1200 millivolts. Make these measurements with current applied. Make corrections for IR drop. Accomplish this by adjusting the rectifier to obtain the aforementioned "instant-off" potentials. Make this IR drop correction by interrupting the current output of the rectifier either manually or automatically using a 90 percent minimum "ON" and 10 percent maximum "OFF". If more than one rectifier is energized at the same time, interrupt all such rectifiers simultaneously. The "OFF" time must not exceed 1 second. During this "OFF" period, use the Fluke 865/867 meter to automatically read the minimum DC voltage that is the polarized protective potential on the structure.

b. Perform a complete structure-to-water potential survey structure face.

3.9.2.2 Locations of Structure-to-Reference Cell

Locate the reference cell in the water, 0.5 to 3 inches from the structure. Connect reference cell with a waterproof screw coupled connector to a conductor on a reel. Lower cell to depths in the water as indicated below. Connect reference cell conductor to the positive terminal of the digital voltmeter. Connect a second conductor from the structure (rectifier structure terminal) to the voltmeter negative terminal. Repeat and record measurement procedure for each measurement location. Make measurements every 3 ft vertically (minimum) from normal water elevation to the bottom of the structure. Make these same measurements at a minimum of five locations across the width of the submerged structure. [In addition, make one set of measurements at the quoin end and one at the miter end on both sides of the structure.]

3.9.2.3 Polarization Decay

a. Polarization decay measurements are only necessary if the structure fails to meet the above criteria of providing negative protection potential of at least minus 850 millivolts.

b. Measure a minimum negative (cathodic) polarization voltage shift of 100 millivolts between the structure surface and the reference electrode cell contacting the electrolyte. This polarization voltage shift is to be determined by interrupting the protective current and measuring the polarization decay. When the current is initially interrupted, an immediate voltage shift will occur. Use the second voltage reading displayed after the immediate shift as the base reading from which to measure polarization decay. Make polarization measurements at minimum 10-minute intervals for a maximum of 4 hours. This measurement

c. Location of the structure with respect to the reference cell for polarization decay measurements must be 1 ft from the bottomand at 2 ft intervals along the bottom of the structure. Make measurements on all surfaces contacting the electrolyte.

3.9.3 Government Review of Initial Field Testing

The government corrosion [engineer] [program manager] must review the contractor's initial field-testing report. The contractor must correct, at the contractor's expense, material and installation deficiencies not to be in conformance with the plans and specifications. The contractor will pay for all retesting necessary by the correction of deficiencies.

3.9.4 Final Acceptance Field Testing

Conduct final field testing of the CP system utilizing the same procedures specified under, "Initial Cathodic Protection Field Testing". The contractor will inspect, test, and adjust the CP system after one year of operation to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon preliminary acceptance for the CP system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the Final Cathodic Protection System Field Test Report, certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager and the geographic EFD corrosion [engineer] [program manager] for approval, and as an attachment to the Operation and Maintenance Manual in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. The government corrosion [engineer] [program manager] must review the contractor's final field testing report.

[3.9.5 One-Year-Warranty-Period-Testing

The contractor must inspect, test, and adjust the CP system [quarterly] [semi-annually] [_____] for one year, [4] [2] [_____] interim inspections total, to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon the completion of all CP work, including changes required to correct deficiencies identified during initial testing, and preliminary acceptance of the CP system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the One Year Warranty Period Cathodic Protection System Field Test Report, including field data, and certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or Contracting Officer's Representative, the activity, and the geographic EFD corrosion [engineer] [program manager] [Contracting Officer] [Contracting Officer's Representative] [Technical Expert] [Project Manager].

]3.10 CLOSEOUT SUBMITTALS

Submit Weekly, Monthly and Annual Test Procedure to be part of the operations and maintenance instruction manual. This test plan must conform to all applicable AMPP recommended practices.

3.10.1 Operating Instructions

Provide the Contracting Officer six (6) complete copies of operating instructions detailing the step-by-step procedures required for system start-up and adjustment of the rectifier to achieve the criteria of protection. Include native system and component test data (data before system energization), test set up, test equipment diagrams showing voltmeter and reference cell connections, test locations, and a description of the procedure for measuring "on" and "off" potentials. Provide detailed steps that show use of the equipment used in the training course and cover test and measurement of the cathodic protection systems for each structure. Submit the Operation and Maintenance manual to the Contracting Officer for approval 30 days prior to the training course. Include the manufacturer's name, model number, service manual, parts list, and a brief description of all equipment and its basic operating features.

3.10.2 Maintenance Instructions

Provide the Contracting Officer six (6) complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides. Include diagrams for the system as installed, instructions in making structure-to-reference electrode measurements, and frequency of monitoring.

3.11 TRAINING

3.11.1 Government Personnel Training

Provide training for [_____] Government Personnel at a time designated by the the Contracting Officer. The training must be provided by a technician regularly employed or authorized by the manufacturer of the CP system for instructing government personnel in the proper operation, maintenance, safety, and emergency procedures of the CP system. The period of instruction must be not less than [eight] [_____] hour[s] and not more than [two] [_____] 8-hour working day[s]. Conduct the training at the jobsite or at another location mutually satisfactory to the government and the contractor. The field instructions will cover all the items contained in the Operation and Maintenance Manual and include demonstrations of the procedure for measuring the minus 850 millivolts "off" potentials and AMPP protection criteria of a minimum negative (cathodic) polarization voltage shift of 100 millivolts. Provide a digital voltmeter (Fluke 865 or similar and approved equal) and an insulated cable (minimum 100 ft length) on a reel with a saturated copper-copper sulfate reference cell attached by a factory assembled waterproof connector for these demonstrations. This equipment will become the property of the Government and turn over to the Contracting Officer upon completion of the training.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 51 00 (May 2020)**
Change 2 - 11/21

Preparing Activity: NAVFAC **Superseding**
UFGS-26 51 00 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 26 - ELECTRICAL

SECTION 26 51 00

INTERIOR LIGHTING

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PART 1 GENERAL

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USACE / NAVFAC / AFCEC | **UFGS-26 51 00 (May 2020)**
Change 2 - 11/21

Preparing Activity: NAVFAC | **Superseding**
UFGS-26 51 00 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 26 51 00

INTERIOR LIGHTING

05/20, CHG 2: 11/21

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NOTE: This guide specification covers lighting and lighting control system requirements for interior installations.

This specification does not cover all possible methods or requirements for interior lighting; therefore, designer should add special information required to suit a specific project. Industry publications and websites exist to aid the designer in choosing the best lighting system for the project. These include, but are not limited to, the Illuminating Engineering Society (IES) 'Lighting Handbook, 10th Edition' and 'RP-1-12 - American National Standard Practice for Office Lighting'; National Fire Protection Association (NFPA) 101 - 'Life Safety Code'; the DesignLights Consortium (DLC); US Department of Energy's Federal Energy Management Program (FEMP) and ENERGY STAR program.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: For supplemental information regarding

Section 26 51 00, including PDF and CAD downloads of luminaire plates, go to:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-

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NOTE: This section contains the following luminaire plates (also referred to as 'sketches' or 'details'.) These are available in metric (SI) and U.S. Customary (IP) system dimensions. Plate titles and style numbers are unchanged for both units.

Do not include list of plates, or plates themselves, in project specifications. Use luminaire plates as details on drawings whenever possible. If special features are required for a project, do not modify plates, but indicate these changes on notes in luminaire schedule. The "NL" style numbers and dates must remain on the drawing details. If additional luminaire types are needed that are not covered in plates, provide additional sketches or details on drawings, but do not label as NL plate type.

Luminaire list is now divided into 2004 sketches and 2016 sketches. Use the 2016 sketches instead of the 2004 unless use of legacy technology is strictly necessary. Indicate on luminaire schedule if the luminaire is from the 2016 or 2004 list if the same sketch number is used.

2016 PLATE NUMBER	**TITLE**
NL-1	**DIRECT/INDIRECT LED LUMINAIRE**
NL-2	**FLAT LENS LED LUMINAIRE**
NL-3	**SURFACE LED WRAPAROUND**
NL-4	**LINEAR LED SLOT**
NL-5	**ROUND LED LUMINAIRE**
NL-6	**DIRECT/INDIRECT LED PENDANT**
NL-7	**DIRECT WAL-MOUNTED LINEAR**
NL-8	**INDIRECT WALL MOUNT**
NL-9	**RECESSED LINEAR WALL WASH**
NL-10	**INDIRECT COVE LIGHT**
NL-11	**ADJUSTABLE RECESSED DOWNLIGHT**
NL-12	**FIXED RECESSED DOWNLIGHT**
NL-13	**WALLWASH RECESSED DOWNLIGHT**
NL-14	**LED TRACK LIGHTING**
NL-15	**LED UNDERCABINET LIGHT**
NL-16	**LED ROUND CEILING SURFACE MOUNT**
NL-17	**LED DECORATIVE ACCENT PENDANT**

2016 PLATE NUMBER	TITLE
NL-18	LED DECORATIVE WALL SCONCE
NL-19	LED UP/DOWN WALL SCONCE
NL-20	LED FOOD SERVICE LIGHT
NL-21	LED HIGH ABUSE LIGHT
NL-22	LED HAZARDOUS LOCATION LIGHT
NL-23	LED INDUSTRIAL LIGHT
NL-24	LED INDUSTRIAL HIGH-BAY
NL-25	LED INDUSTRIAL LOW-BAY
NL-26	LED EMERGENCY LIGHTING UNIT (ELU)
NL-27	EDGE-LIT EXIT SIGN
NL-28	EXIT SIGN
NL-29	LED NICHE POOL LUMINAIRE
NOTE: Do not include this index in project specification.	

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NOTE: Include the following information on the project drawings:

1. Luminaire schedule indicating luminaire symbol; luminaire type; NL plate number and type designation; light source; voltage; input watts; delivered lumen output; efficacy; CCT; CRI; LED driver; dimming; mounting; BUG rating if applicable; and any other applicable options or notes.

2. Location and mounting height of all luminaires (including normal and emergency) for each given area or room.

3. Referenced NL plate number or detail (if no NL plate is available) for each luminaire type provided.

4. All accessories required, such as mounting hardware, emergency battery back-up inverters, remote LED drivers, sensors and control equipment, and central emergency system components.

5. Occupancy, vacancy, and photosensor locations, mounting, and technology type. For occupancy and vacancy control, note if the sensor is Passive Infrared, Ultrasonic, or Dual-Tech. For photosensor, note if the sensor is open-loop or closed-loop.

6. Control strategy description for each given area

or room. If the lighting controls manufacturer will not be providing shop drawings showing sensor locations and mounting heights, provide this information on the project plans.

7. Manual control wall stations, switches, and dimmers.

8. EMI filters, surge suppression, or shielding required.

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NOTE: Demolition work that involves disposal of fluorescent and HID lamps and ballasts will require the use of Section 02 84 16 HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY.

****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by

	the Hot-Dip Process
ASTM A1008/A1008M	(2024) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM D4674 REV A	(2002; R 2010) Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 20	(2019) Appliance Efficiency Regulations / Public Utilities and Energy Division 2. State Energy Resources Conservation and Development Commission
CEC Title 24	(2016) Building Energy Efficiency Standards For Residential and Nonresidential Buildings

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79	(2019) Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
ANSI/IES LM-80	(2020) Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
ANSI/IES LS-1	(2020) Lighting Science: Nomenclature and Definitions for Illuminating Engineering
ANSI/IES TM-15	(2020) Technical Memorandum: Luminaire Classification System for Outdoor Luminaires
ANSI/IES TM-21	(2021) Technical Memorandum: Projecting Long-TermLuminous, Photon, and Radiant Flux Maintenance of LED Light Sources
ANSI/IES TM-30	(2020) Technical Memorandum: IES Method

	for Evaluating Light Source Color Rendition
IES Lighting Library	IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C78.54	(2019) Specification Sheet for Tubular Fluorescent Replacement and Retrofit LED Lamps
NEMA 77	(2017) Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2024) Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77-10	(2020) Harmonic Emission Limits - Related Power Quality Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA SSL 1	(2016) Electronic Drivers for LED Devices, Arrays, or Systems
NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination
NEMA SSL 7A	(2015) Phase-Cut Dimming for Solid State Lighting: Basic Compatibility
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 7	(2011; R 2016; R 2021) Occupancy Motion Sensors Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 101	(2024) Life Safety Code
NFPA 110	(2025) Standard for Emergency and Standby Power Systems

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UL SOLUTIONS (UL)

UL 20	(2018; Reprint May 2023) UL Standard for Safety General-Use Snap Switches
UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 844	(2012; Reprint Oct 2021) UL Standard for Safety Luminaires for Use in Hazardous (Classified) Locations
UL 916	(2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment
UL 917	(2006; Reprint Aug 2013) UL Standard for Safety Clock-Operated Switches
UL 924	(2016; Reprint Dec 2022) UL Standard for Safety Emergency Lighting and Power Equipment
UL 1472	(2015) UL Standard for Safety Solid-State Dimming Controls
UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires
UL 1598C	(2014) Standard for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits
UL 1993	(2017) Self-Ballasted Lamps and Lamp Adapters
UL 2043	(2023) Fire Test for Heat and Visible

	Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 8750	(2020; Reprint Aug 2024) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

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NOTE: For the purpose of this document, interior luminaires include those in the interior portion of buildings or facilities, luminaires attached to the exterior of a building, and luminaires mounted in parking garages. Luminaires that are not attached to the exterior of a building and that are intended to illuminate exterior areas are specified in Section 26 56 00 EXTERIOR LIGHTING.

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Materials not considered to be luminaires, luminaire accessories, or lighting equipment are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires and accessories that are mounted in exterior environments and not attached to the exterior of the building are specified in Section 26 56 00 EXTERIOR LIGHTING. Cybersecurity requirements are specified in Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. Commissioning requirements are specified in Section 01 91 00.15 BUILDING COMMISSIONING.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications and on the drawings, must be as defined in IEEE 100 and ANSI/IES LS-1.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in ANSI/IES LM-80.

c. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

d. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Luminaire shop drawings are required for custom luminaires, luminaires specified to a specific custom length, or linear luminaires with lengths greater than 2.5 meters 8 feet.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G, [_____]

Occupancy/Vacancy Sensor Coverage Layout; G, [_____]; S

Lighting Control System One-Line Diagram; G, [_____]

Sequence of Operation for Lighting Control System; G, [_____]

SD-03 Product Data

Luminaires; G, [_____]

Light Sources; G, [_____]

LED Drivers; G, [_____]

Luminaire Warranty; G, [_____]

Lighting Controls Warranty; G, [_____]

Local Area Controller; G, [_____]

Lighting Relay Panel; G, [_____]

Lighting Control Panel; G, [_____]

Gateway; G, [_____]

Lighting Contactor; G, [_____]

Switches; G, [_____]

Digital Switch Timers; G, [_____]

Wall Box Dimmers; G, [_____]

Scene Wallstations; G, [_____]

Occupancy/Vacancy Sensors; G, [_____]

Photosensors; G, [_____]

Time Clocks; G, [_____]

Power Packs; G, [_____]

Power Hook Luminaire Hangers; G, [_____]

Mini Inverters; G, [_____]

Exit Signs; G, [_____]

Emergency Drivers; G, [_____]

Energy Star Label For Residential Luminaires; S

Linear LED Lamps; G, [_____]

[SD-04 Samples

Luminaire Samples; G, [_____]

] SD-05 Design Data

Luminaire Design Data; G, [_____]

Photometric Plan; G, [_____]

SD-06 Test Reports

ANSI/IES LM-79 Test Report; G, [_____]

ANSI/IES LM-80 Test Report; G, [_____]

ANSI/IES TM-21 Test Report; G, [_____]

ANSI/IES TM-30 Test Report; G, [_____]

Occupancy/Vacancy Sensor Verification Test; G, [_____]

Photosensor Verification Test; G, [_____]

SD-07 Certificates

LED Driver and Dimming Switch Compatibility Certificate; G, [_____]

SD-10 Operation and Maintenance Data

Lighting System, Data Package 5; G, [_____]

Lighting Control System, Data Package 5; G, [_____]

Maintenance Staff Training Plan; G, [_____]

End-User Training Plan; G, [_____]

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES Lighting Library as applicable, for the lighting system specified.

1.5.1 Luminaire Drawings

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NOTE: Aiming diagrams are required for applications with directional luminaires, such as art lighting, track lighting, and wallwash applications.

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Include dimensions, accessories installation details, and construction details. Photometric data, including CRI, CCT, LED driver type,[aiming diagram,] zonal lumen data, and candlepower distribution data must accompany shop drawings.

1.5.2 Luminaire Design Data

a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified in accordance with the NFPA 70. Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

b. Provide long term lumen maintenance projections for each LED luminaire in accordance with ANSI/IES TM-21. Data used for projections must be obtained from testing in accordance with ANSI/IES LM-80.

1.5.3 ANSI/IES LM-79 Test Report

Submit test report on manufacturer's standard production model of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data in IES format as outlined under "14.0 Test Report" in ANSI/IES LM-79.

1.5.4 ANSI/IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "8.0 Test Report" in ANSI/IES LM-80.

1.5.5 ANSI/IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in ANSI/IES TM-21.

1.5.6 ANSI/IES TM-30 Test Report

Submit color vector graphic in accordance with ANSI/IES TM-30 on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Include spectral distribution of test LED light source.

1.5.7 LED Driver and Dimming Switch Compatibility Certificate

Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices without flickering and to specified dimming levels.

1.5.8 Photometric Plan

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NOTE: Require photometric plans and design criteria to be submitted if the project is a Design-Build project and will not have a engineer or designer producing photometrics during design.

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1.5.8.1 Computer-generated Photometric Plans

Computer-generated photometric plans for each space are required to verify proposed luminaires and locations meet the required performance criteria of the design using the applicable light loss factor (LLF).

Target illumination levels are provided for each Interior Application. Depending on the application and the recommendations provided by the IES, values are given as one of the following:

a. Minimum: No values anywhere on the calculation grid may be less than this value, within a 10 percent margin of error.

b. Minimum Average: An average, taken over the entire task area for the application, may not be less than this value, within a 10 percent margin of error.

c. Maximum: No values anywhere on the calculation grid may be greater than this value, within a 10 percent margin of error.

d. Maximum Average: An average, taken over the entire task area for the application, may not be greater than this value, within a 10 percent margin of error.

e. Uniformity: Unless otherwise noted, uniformity is calculated as a ratio of the average calculated illuminance over the minimum calculated illuminance of the calculation grid.

1.5.8.2 Schematic Photometric Plan Calculations

Schematic photometric plan calculations must include:

a. Horizontal illuminance measurements at workplane or other designated height above finished floor, taken at a maximum of every 305 mm one foot across the task area.

b. Average maintained illuminance level.

c. Minimum and maximum maintained illuminance levels.

d. Lighting power density (Watts per square meter) (Watts per square foot).

e. LLF. Recommended LLF is 0.81 for LED luminaires but LLF varies based on environment and application.

1.5.8.3 Final Photometric Plan Calculations

Final photometric plan calculations must include:

a. Horizontal illuminance measurements at workplane or other designated height above finished floor, taken at a maximum of every 305 mm one foot across the task area.

b. Where applicable, vertical illuminance measurements at designated surface, taken at a maximum of every 305 mm one foot across task area.

c. Minimum and maximum maintained illuminance levels.

d. Average maintained illuminance level.

e. Average to minimum and maximum to minimum ratios for horizontal illuminance.

f. Lighting power density (Watts per square meter) (Watts per square foot).

g. LLF. Recommended LLF is 0.81 for LED luminaires but LLF varies based on environment and application.

1.5.9 Occupancy/Vacancy Sensor Coverage Layout

Provide floor plans showing coverage layouts of all devices using manufacturer's product information.

1.5.10 Test Laboratories

Test laboratories for the ANSI/IES LM-79 and ANSI/IES LM-80 test reports must be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program for both LM-79 and LM-80 testing.

b. One of the qualified labs listed on the Department of Energy - LED Lighting Facts Approved Testing Laboratories List for LM-79 testing.

c. One of the EPA-Recognized Laboratories listed for LM-80 testing.

1.5.11 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated. Provide luminaires and assembled components that are approved by and bear the label of UL for the applicable location and conditions unless otherwise specified.

1.5.12 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products must have been in satisfactory commercial or industrial use for six months prior to bid opening. The six-month period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the six-month period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.12.1 Alternative Qualifications

Products having less than a six-month field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.12.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of delivery to site, unless specified otherwise.

1.6 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 Luminaire Warranty

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NOTE: In applications where color rendition and color detection are a high priority, require

warranty for color maintenance.
****

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

  (1) Finish warranty must include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

  (2) Material warranty must include:

    (a) All LED drivers and integral control equipment.

    (b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

[(c) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) show a color shift greater than 0.003 delta u'v' from the zero hour measurement stated in the ANSI/IES LM-79 Test Report.

] b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.

c. Provide replacements that are promptly shipped, without charge, to the using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and assembly.

1.6.2 Lighting Controls Warranty

Provide and transfer to the government the original lighting controls manufacturers standard commercial warranty for each different lighting controls manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Warranty service must be performed by a factory-trained engineer or technician.

a. Unless otherwise noted, provide a written five year minimum warranty on the complete system for all systems with factory commissioning. Provide warranty that covers 100 percent of the cost of any replacement parts and services required over the five years which are directly attributable to the product failure. Failures include, but are not limited to, the following:

  (1) Software: Failure of input/output to execute switching or dimming commands.

  (2) Damage of electronic components due to transient voltage surges.

(3) Failure of control devices, including but not limited to occupancy sensors, photosensors, and manual wall station control devices.

b. Provide a written five year minimum warranty on all input devices against defect in workmanship or materials provided by device manufacturer.

c. Provide a written five year minimum warranty on all control components attached to luminaires against defect in workmanship or materials.

1.7 OPERATION AND MAINTENANCE MANUALS

1.7.1 Lighting System

Provide operation and maintenance manuals for the lighting system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting system for the building. Additional O&M Manual requirements for the Army are provided in Section 01 78 24.00 10 FACILITY DATA REQUIREMENTS. Additional requirements for the Navy are provided in Section 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW). Include the following:

a. Manufacturers' operating and maintenance manuals.

b. Luminaire shop drawings for modified and custom luminaires.

c. Luminaire Manufacturers' standard commercial warranty information as specified in paragraph LUMINAIRE WARRANTY.

1.7.2 Lighting Control System

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NOTE: Lighting control panel schedules are not required for localized control systems.

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Provide operation and maintenance manuals for the lighting control system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting control system for the building. Include the following:

a. Lighting control system layout and wiring plan.

b. Lighting control system one-line diagram.

c. Product data for all devices, including installation and programming instructions.

d. Occupancy/vacancy sensor coverage layout.

e. Training materials, such as videos or in-depth manuals, that cover basic operation of the lighting control system and instructions on modifying the lighting control system. Training materials must include calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

f. Sequence of operation descriptions for each typical room type, including final programming, schedules, and calibration settings.

[g. "As-built" lighting control panel schedules.

]PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

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NOTE: For luminaires used in residential applications, include requirements for Energy Star Label. If building-mounted exterior luminaires are specified on this project, require compliance with BUG rating as indicated in the luminaire schedule.

****

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule and NL plates or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the driver and light source provided.

[Provide luminaire with Energy Star Label For Residential Luminaires in accordance with Energy Star.

][2.2.1 Luminaire Samples

****

NOTE: Only require the acquisition of samples for luminaire installations that warrant mock-ups, such as wall grazing unique materials, for custom luminaires, or for applications where aesthetics are of high priority.

****

Submit one sample of each luminaire type [_____], complete with light source, LED driver rated for 120 V operation, and 2 meters 6 feet pigtail with 3-prong Edison plug. Sample will be returned to the Contractor for installation in the project work.

]2.2.2 Luminaires

****

NOTE: Provide design information including delivered lumen output, L70 lumen maintenance data, and luminaire efficacy in the luminaire schedule on project plans.

Luminaires attached to the exterior of the building are included in this interior lighting specification. For any interior project with exterior building-mounted luminaires, select the requirements for exterior luminaires, including BUG rating.

If there are any recessed luminaires that are in contact with insulation, require those luminaires to be IC-rated. If the project is located in the City of Chicago or a jurisdiction that has adopted

Chicago amendments to the NEC, select Chicago Plenum requirements.

****

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

a. Complete system with LED drivers and light sources.

b. Housings constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.

c. ANSI/IES TM-21, ANSI/IES LM-80. Minimum L70 lumen maintenance value of 50,000 hours unless otherwise indicated in the luminaire schedule. Luminaire drive current value must be identical to that provided by test data for luminaire in question.

d. Minimum efficacy as specified in the luminaire schedule. Theoretical models of initial lamp lumens per watt are not acceptable. If efficacy values are not listed in the luminaire schedule, provide luminaires that meet the following minimum values:

Luminaire Style	Minimum Luminaire Efficacy
Recessed 1 by 4, 2 by 4, and 2 by 2	100 LPW
Recessed Downlight (fixed, adjustable, wallwash)	80 LPW
Linear, Accent (undercabinet, cove)	45 LPW
Linear, Ambient (indirect wall mount, linear pendent)	100 LPW
High Bay, Low Bay, and Industrial Locations	100 LPW
Food Service and Hazardous Locations	60 LPW
Other (track, residential diffusers)	50 LPW
Exterior Wall Sconce	50 LPW
Steplight	30 LPW
Parking Garage Luminaire	100 LPW

e. UL listed for dry or damp location typical of interior installations.[Any luminaire mounted on the exterior of the building must be UL listed for wet location typical of exterior installations.]

f. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.

g. Lenses constructed of heat tempered borosilicate glass, UV-resistant acrylic, or silicone.[Provide polycarbonate vandal-resistant lenses as indicated.] Sandblasting, etching and polishing must be performed as indicated in the luminaire description.

[h. ANSI/IES TM-15. Provide exterior building-mounted luminaires that do not exceed the BUG ratings as listed in the luminaire schedule. If BUG ratings are not listed in the luminaire schedule, provide luminaires that meet the following minimum values for each application and mounting conditions:

Lighting Application	Mounting Conditions	BUG Rating
Exterior Wall Sconce	Above 1.2 meters 4 feet AFF	B1-U0-G2
Exterior Wall Sconce	Below or at 1.2 meters 4 feet AFF	B4-U0-G4
Steplight	Above 1.2 meters 4 feet AFF	B1-U1-G2
Steplight	Below or at 1.2 meters 4 feet AFF	B4-U1-G4
Parking Garage Luminaire	Ceiling mounted	B4-U4-G3

][i. For all recessed luminaires that are identified to be in contact with insulation, provide luminaires that are IC-rated.

][j. For all recessed luminaires that are to be installed in air plenums, require housings that are Chicago Plenum rated.

]2.2.2.1 Luminaire Conversion Kits

****

NOTE: Provide LED luminaire conversion kits to replace non-LED light sources in renovation or energy conservation projects, only where entire luminaires are not replaced.

****

Provide luminaire conversion kits that meet UL 1598C Standard for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits.

2.2.3 Luminaires for Hazardous Locations

In addition to requirements stated herein, provide LED luminaires for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated.

2.3 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type, delivered lumen output, and wattage as indicated in the luminaire schedule on project plans.

2.3.1 LED Light Sources

****

NOTE: A color temperature of 3500 K is standard for most applications. When specifically desired by the designer, a nominal color temperature of 2700 K, 3000 K, or 4000 K may be selected. The highest allowable CCT is 4100 K.

In applications where color rendition and color detection are a high priority, require that LED

light sources meet the recommended fidelity and gamut indices as determined by ANSI/IES TM-30. Additionally, select color maintenance requirements.

For projects in the state of California, require compliance with CEC Title 20.

Refer to UFC 3-530-01 for CRI allowances in maintenance and recreational spaces.

****

[CEC Title 20.]Provide LED light sources that meet the following requirements:

a. NEMA ANSLG C78.377. Emit white light and have a nominal CCT of [3000][2700][3500][4000] Kelvin.

b. Minimum Color Rendering Index (CRI) of [80][90][95 with an R9 value of 95].[Fidelity index greater than or equal to 80, gamut index between 97 and 110, determined in accordance with ANSI/IES TM-30.]

c. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

d. Light source color consistency by utilizing a binning tolerance within a 3-step McAdam ellipse.

[e. Color maintenance value of no greater than 0.003 (delta u'v') at 6000 hours as listed in ANSI/IES LM-79 Test Report.

][2.3.1.1 Linear LED Lamps

****

NOTE: Minimum beam angle of 270-degrees is preferred over 180-degrees, but is less common. If target light levels and optical performance of linear LED lamp is critical for the specified application, select 270-degree beam angle.

Provide linear LED Lamps to replace fluorescent light sources in renovation or energy conservation projects, only where entire luminaires are not replaced or LED conversion kits are not available. Do not use UL 1993 Type B, UL 1993 Type C, or any hybrid Linear LED Lamps.

****

Provide linear LED Lamps that are compatible with existing instant-start or programmed-start ballasts, and meet the following additional requirements:

a. UL 1993 UL Type A linear LED lamp.

b. Power Factor greater than or equal to 0.90 at full input power and across specified dimming range.

c. Maximum Total Harmonic Distortion (THD) less than or equal to 20 percent at full input power and across specified dimming range.

d. Lumen per watt efficacy no less than 120.

e. Minimum beam angle of [270][180] degrees.

f. Lamp datasheet complies with ANSI C78.54. Manufacturer must provide list of all ballasts that are compatible for use with lamp.

]2.4 LED DRIVERS

****
NOTE: Dimmable LED drivers should be specified with dimming down to at least 10 percent. Dimmable drivers with a dimming range down to 1 percent should be specified for applications where audio/visual presentations are common such as conference and meetings rooms, and hospitality.
****

NEMA SSL 1, UL 8750. Provide LED drivers that are electronic, UL Class 1 or Class 2, constant-current type and that comply with the following requirements:

a. The combined driver and LED light source system does not exceed the minimum luminaire efficacy values as listed in the luminaire schedule provided.

b. Operates at a voltage of [120-277][120][277] volts at 50/60 hertz, with input voltage fluctuations of plus/minus 10 percent.

c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.

d. Maximum Total Harmonic Distortion (THD) less than 20 percent at full input power and across specified dimming range.

e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

f. Withstands Category A surges of 2 kV without impairment of performance. Provide surge protection that is integral to the driver.

g. Integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.

h. 47 CFR 15. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

i. Class A sound rating.

j. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

k. Provide dimming capability as indicated in the luminaire schedule on project plans.[Dimmable drivers must dim down to [10][5][1] percent. Dimmable drivers must be controlled by a [Class 2 low voltage 0-10VDC controller] [Digital Addressable Lighting Interface (DALI)] dimming signal protocol unless otherwise specified. LED drivers of the same family/series must track evenly across multiple luminaires at all light levels.]

[2.4.1 Remote LED Drivers

****

NOTE: Do not allow use of remote drivers unless specifically noted on the lighting plate and luminaire schedule.

****

Provide remote LED Drivers that are UL listed for dry locations typical of interior installations. Provide LED driver in junction box or housing with mounting plate. Housing must allow for field connections to occur inside the housing or must contain mechanical connections.

]2.5 LIGHTING CONTROLS

****

NOTE: Include a version of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS edited specifically for the lighting control system where a control system is specified.

****

Provide network certification for all networked lighting control systems and devices in accordance with the requirements of Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. Provide lighting control systems that do not switch off battery-operated or emergency backup luminaires or exit signs in path of egress. Provide system with override of lighting control devices controlling luminaires in path of egress with activation of fire alarm system.

2.5.1 System

Provide lighting control system that operates the lighting system as described in the lighting control strategies in the project plans. Submit Sequence of Operation for Lighting Control System describing the operation of the proposed lighting control system and devices. Sequence of Operation must provide the strategies identified in the lighting control strategies.

2.5.1.1 Localized Control Systems

Provide room or area-wide lighting control system capable of manual control, time-based control, and receiving input from photosensors and occupancy/vacancy sensors.

2.5.1.1.1 Local Area Controller

****

NOTE: Select requirement for daylight harvesting capabilities for all regularly-occupied spaces with access to daylight. Task oriented areas such as offices, conference rooms, and classrooms require continuous dimming of electric lighting per UFC 3 530 01.

When using receptacle load control in private offices, allow capability for receptacle load control via the localized control system. Only use

receptacle load control for areas with non-critical loads such as computer monitors, task lights, or personal convenience devices.

Select Item g. if Local Area Controller is connected to luminaires in the path of egress.
****

Provide controller designed for single area or room with the following requirements:

a. Operates at a voltage of [120-277][120][277] volts at 50/60 hertz.

b. [2][_____] zone, with [1][2][_____] relay[s] rated 20 amps[each] with one manual [switch][dimmer] per zone.

c. Provide inputs for occupancy/vacancy sensors, photosensors, and low-voltage wall switches.

[d. Provide daylight harvesting capability with full-range dimming control with input from photosensor.

][e. Provide capability for receptacle load control from occupancy sensors.

][f. Provide full 'OFF' function with input from external time clock input.

][g. Capable of 0-10V dimming.

][h. AV interface via [RS-232][RS-485][ethernet and CAT5].

][i. Provide override 'ON' function with input from Fire Alarm Control Panel for all emergency lighting. Controller must not turn off power to emergency batteries or exit signs.

]2.5.1.2 Centralized Control Systems

Provide a centralized lighting control system capable of manual control, time-based control, receiving input from photosensors and occupancy/vacancy sensors, with the capabilities of controlling, monitoring, and programming changes from one centralized on-site location, and integration with other building systems.

2.5.1.2.1 Lighting Relay Panel

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NOTE: Select NEMA 1 enclosure for indoor use with normal conditions, NEMA 3R for indoor or outdoor use when weather resistance is necessary, and NEMA 4 if a watertight enclosure is necessary.
****

UL 924. Enclose panel hardware in a [surface][flush]-mounted, NEMA [1][3R][4], painted, steel enclosure with lockable access door and ventilation openings. Internal low-voltage compartment must be separated from line-voltage compartment of enclosure with only low-voltage compartment accessible upon opening of door. Provide additional remote cabinets that communicate back to main control panel as required. Provide Lighting Control Panels that meet the following criteria:

a. Input voltage of [120][277][120-277] at 50/60 Hz, with internal low voltage power supply as required.

b. [8][16][32][_____] single-pole latching relays rated at [20][30] amps, [120-277][120][277] volts. Provide provision for relays to close upon power failure. Provide relays designed for 10 years of use at full rated load.

c. Relay control module operates at 24 VDC and is rated to control a minimum of [8][16][32][_____] relays.

[d. Capable of 0-10V dimming.

]2.5.1.2.2 Lighting Control Panel

****

NOTE: Select NEMA 1 enclosure for indoor use with normal conditions, NEMA 3R for indoor or outdoor use when weather resistance is necessary, and NEMA 4 if a watertight enclosure is necessary.

When providing a control panel that interfaces with the building automated control system, reference IES Technical Memorandum IES TM-23-11 for technical information on various protocols, architectures and topologies for such systems. Include Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION for UMCS and integration requirements.

For projects in the state of California, require compliance with CEC Title 24.

****

UL 916, 47 CFR 15[, CEC Title 24]. Provide an electronic, programmable lighting control panel complete with microprocessor, capable of providing lighting control with input from internal programming, digital switches,[time clocks,] and other control devices.

Enclose panel hardware in a [surface][flush]-mounted, NEMA [1][3R][4], painted, steel enclosure with lockable access door and ventilation openings. Internal low-voltage compartment must be separated from line-voltage compartment of enclosure with only low-voltage compartment accessible upon opening of door. Provide additional remote cabinets that communicate back to main control panel as required. Provide Lighting Control Panels that meet the following criteria:

a. Input voltage of [120][277][120-277] at 50/60 Hz, with internal low-voltage VDC power supply as required.

b. Solid-state, microprocessor-based, internal astronomical time clock. Microprocessor must have nonvolatile memory and must reset automatically after power interruptions of up to 90 days.

c. Interface for providing local programming and control capability, with physical key-locked cover or programmed security access code to prevent unauthorized use.

d. Dimming modules capable of [0-10V][DALI] dimming.

e. Modules and control panels include multichannel output with [_____] channels, with multiple inputs for manual control, photosensors, and occupancy/vacancy sensors.

[f. Control processor is configured to interface with [BACnet in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][LONworks in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] compliant network via [native compatibility][gateway].

][g. Outputs that require line-voltage switching are provided by relays which are designed for 10 years of use at full rated load.

][h. Control processor indicates failure of normal power and which circuits are supplied by alternative power source if connected to emergency lighting units.

][i. Provide building automation system write access points to lighting control system for [manual override][building schedules][utility demand response events].

][j. Provide building automation read access points to lighting control system for [occupancy status per room or area][current lighting load in kilowatts][calculated energy use in kilowatt-hours][utility demand response priorities].

]2.5.1.2.3 Gateway

****

NOTE: When specifying BAS interface, coordinate with HVAC specifier to ensure the requirements are described in both specifications. Include Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION for UMCS and integration requirements.

****

Provide gateway in accordance with Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION. Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports. Provide [BACnet][LONworks][_____] communication interface that enables remote control and monitoring of lighting from a workstation according to read access points and write access points listed in this section. Control features and monitoring points displayed locally at lighting panel must be available through the Gateway. Provide Gateway that meets the following requirements:

a. Microprocessor-based communications device that perform bi-directional protocol translation.

b. Support full bi-directional communication and translation.

c. Contain its own microprocessor, RAM, battery, communication ports, and power supply.

[d. Support an additional 5 percent points for future expansion.

]2.5.1.2.4 Lighting Contactor

NEMA ICS 2, NEMA ICS 6. Provide an electrically[mechanically]-held lighting contactor housed in a NEMA [1][12][3R][4][4X][_____] enclosure. Provide contactor with one [_____] [normally-open(NO)][normally closed(NC)], single[double] pole contacts, rated 600 volts, 30 amps. Provide coil operating voltage of [24][120][277][480][_____] volts.

2.5.2 Devices

2.5.2.1 Switches

Provide line-voltage toggle switches as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. When used for non-digital loads, devices must be rated at 20 Amps inductive load, and be compatible with the lighting control systems.

2.5.2.2 Digital Switch Timers

Provide line-voltage toggle switches that allow manual control to ON and automatically switches lighting load to OFF. Device operates with the use of paddle, button, or toggle, and operates at [120-277][120][277] volts. Device allows for programming of auto off timer from [2][5][10] minutes to [1][6][12] hours.

2.5.2.3 Wall Box Dimmers

****

NOTE: Coordinate dimming range with LED driver specifications.

The majority of dimmers for LED light sources use 0-10V technology to dim light sources. If a Digital Addressable Lighting Interface (DALI) system is specified, then all dimmers and drivers must be compatible with a DALI system.

****

UL 1472, UL 20, IEEE C62.41, NEMA 77, NEMA SSL 7A. Dimmers must provide flicker-free, continuously variable light output throughout the dimming range of [10][5][1] percent to 100 percent. Devices must be capable of operating at their full rated capacity regardless of being single or ganged-mounted, and be compatible with three-way and four-way switching scenarios.

Provide wall-box dimmers that meet the following requirements:

a. Device operates as [part of a lighting control system][an independent control device].

b. Device operates with the use of a vertical slider, paddle, rotary, button, or toggle with adjacent vertical slider.

c. Finish of device matches switches and outlets in the same area.

d. Back box in wall has sufficient depth to accommodate body of switch and wiring.

e. Dimmer is capable of controlling [0-10 volt][DALI] LED drivers.

Dimmers and the drivers they control must be provided from the same manufacturer or tested and certified as compatible for use together.

f. Radio frequency interference suppression is integral to device.

2.5.2.4 Scene Wallstations

Provide scene wallstations that are compatible with the other components of the lighting control system and capable of Class 1 or 2 wiring methods in accordance with the NEC and local codes. Provide devices that contain on/off group, preset scene functions, or dim up/dim down interface through front panel. Programming of new scenes or zone assignments must be accomplished by authorized personnel from the space being controlled. Provide labeling for each button, including laminated sheet with scene descriptions to be posted near each scene controller.

2.5.2.5 Occupancy/Vacancy Sensors

****

NOTE: Indicate whether sensor layouts are shown on project plans or on manufacturer shop drawings. If indicating that manufacturer will provide shop drawings for sensor locations, provide sequence of operations in project documentation.

In general, use sensors that are wallbox mounted, wall-mounted, ceiling-mounted, or integral to luminaire for most interior applications. Keep in mind wallbox mounted sensors may be ineffective when obstructions such as partitioned workstations and storage shelving exist. Use high-bay sensors or wall-mounted sensors for areas with ceilings higher than 3.6 meters 12 feet. Ceiling-mounted sensors are not recommended in locations where pendent-mounted luminaires are within 1.2 meters 4 feet of the sensor.

Maximum and minimum load requirements depend on the operating voltage of the sensor. If low voltage sensors are specified, select low voltage in Item A, and the maximum load requirement in Item E.

Select the paragraph describing the characteristics of PIR sensors if PIR sensors are used. Select the paragraph describing the characteristics of ultrasonic sensors if ultrasonic sensors are used. Select both paragraphs and the section discussing dual tech if dual tech sensors are used.

For projects in the state of California, require compliance with CEC Title 24 and CEC Title 20.

****

IEEE C62.41, NEMA WD 1, UL 94, UL 916, UL 508, ASTM D4674 REV A, NEMA WD 7 [, CEC Title 24, CEC Title 20]. Provide occupancy/vacancy sensors with coverage patterns as indicated on [project plans][manufacturer shop drawings].[Provide no less quantity of sensors as shown on plans, but add additional sensors when required to fulfill coverage requirement for the specific model of sensor provided.][Provide sensor types as described in the sequence of operations. Sensor locations and quantities are shown in shop drawings provided by the lighting control system manufacturer.][Provide occupancy sensor operation that requires movement to activate luminaires controlled and turns luminaires off after a set time of inactivity.][Provide vacancy sensor operation that requires manual control to activate luminaires and turns luminaires off after a set time of inactivity.] Provide ceiling or wall-mounted occupancy/vacancy sensors that meet the following requirements:

a. Operating voltage of [12-24][120-277][120][277] volts.

b. Time delay of 30 seconds to 30 minutes with at least four intermediate time delay settings.

c. Sensors are [ceiling mounted][wall-box mounted][wall mounted][integral to luminaire].

d. [Does not exceed a maximum load requirement of 20mA at 24VDC.][No minimum load requirement and be capable of switching from zero to 800 W at 120 VAC, 50/60 Hz and from zero to 1200 W at 277 VAC, 50/60 Hz.][Networked sensor with no minimum or maximum load. Sensor is programmed to control zones.]

e. Shielded or controlled by internal logic to adjust sensitivity to avoid false triggering due to ambient temperature, air temperature variations or HVAC air movement.

f. Sensor is equipped to automatically energize the connected load upon loss of normal power when located in a means of egress.

g. Occupancy and vacancy operation is field-adjustable and [programmable via lighting control system processor.][programmable with push-button or dip switch on the sensor device.]

h. No leakage current to load when in the off mode.

i. Utilize zero-crossing circuitry to prevent damage from high inrush current and to promote long life operation.

[j. Allow the adding or deleting of specific luminaires or zones to the assigned sensor without the use of ladders.[Provide sensors that allow for remote control adjustments of operational parameters (sensitivity, time delay), and that are be able to transmit, receive, and store system information through the lighting control system processor.]

][k. Provide an isolated relay for integrating control of HVAC or other automated systems.

]2.5.2.5.1 Passive Infrared Sensors

Provide Passive Infrared Sensors (PIR) sensors that detect occupancy by sensing heat and movement in the area of coverage. Provide sensors are constructed of a housing of high-impact, injection-molded thermoplastic. Provide PIR sensors that are temperature compensated, with a dual element sensor and a multi-element fresnel lens of POLY IR4 material.

2.5.2.5.2 Ultrasonic Sensors

Provide ultrasonic sensors that detect occupancy by sensing a change in pattern of reflected ultrasonic waves in the area of coverage. Provide sensors that are constructed of a housing of high-impact, injection-molded thermoplastic. Provide ultrasonic sensors that operate at 40 kHz.

2.5.2.5.3 Dual Technology Sensors

Provide dual technology sensors that meet the requirements for PIR sensors and ultrasonic sensors indicated above. If either the PIR or ultrasonic sensing registers occupancy, the luminaires must remain on.

2.5.2.5.4 High Bay Sensors

Provide occupancy/vacancy sensors specifically designed for high-bay mounting applications for all [ceiling-mounted sensors][sensors integral to luminaires] mounted above 10 meters 35 feet using PIR technology. Provide high-bay sensors with interchangeable lenses for 360 degree open area coverage or narrow rectangular warehouse aisle coverage.[Provide sensors that are designed to mount directly to or adjacent to high- or low-bay luminaires.]

2.5.2.5.5 Integrated Sensors

****

NOTE: If integrated sensors are used independently of any other lighting control system component, then the sensors do not need to communicate to a local area controller or lighting control panel.

****

Provide integrated occupancy/vacancy sensors that mount directly to the luminaires as indicated in project plans.[Sensor mounts to standard junction box or directly to luminaire using a [straight][drop] nipple mount.][Provide sensors that communicate to [lighting control panel][local area controller] via [RJ45][SPDT relay][_____].]

2.5.2.5.6 Power Packs

****

NOTE: For projects in the state of California, require compliance with CEC Title 24.

****

UL 2043[, CEC Title 24]. Provide power packs to provide power to lighting control sensors as required in accordance with the manufacturer's specifications. Provide power packs that meet the following requirements:

a. Operate at an input voltage of [120][277][120-277] VAC, with an output voltage [12-24][12][24] VDC at 225 mA.

b. Constructed of plenum-rated, high-impact thermoplastic enclosure.

c. Utilizes zero-crossing circuitry to prevent damage from inrush current.

d. Maximum load rating of 16 [_____] amps for electronic [_____] lighting loads.

e. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

2.5.2.6 Photosensors

****

NOTE: Open-loop photosensors are recommended in spaces where occupant interference is frequent or when reflectances may shift over time.

For projects in the state of California, require compliance with CEC Title 24 and CEC Title 20.

****

[CEC Title 24, CEC Title 20.]Provide photosensors that meet the following requirements:

a. Detect changes in ambient lighting level and enable dimming as required by sequence of operation by operating in [an open-loop][a closed-loop] system.

b. Contain a detection cone, where the base of the cone may be circular or an elongated shape, and where the smallest angle between the edge and the axis of the cone is between 20 and 50 degrees. The cone axis may be tilted to the vertical when installed to give the sensor preferred directionality.

c. Sensors are [ceiling-mounted][wall-box-mounted][wall-mounted][mounted integral to luminaire] with sensitivity, filtering, range and viewing angle to meet requirements of sequence of operation, scope of work and construction documents.

d. Time delay that is adjustable from 1 to 30 seconds ON delay, and 1 to 30 minutes OFF delay to prevent cycling, with deadband adjustment of 25 percent to 100 percent above lower setpoint.

e. Output dimming signal is linear to light level with less than 1 percent variation. Cadmium sulfide photo-resistors are not acceptable.

f. Sensor is not combined in the same housing or location with occupancy or vacancy sensors if the proper location for one function compromises the successful operation of the other function, or in any way reduces the system's ability to meet the design intent.

2.5.2.7 Time Clocks

****

NOTE: Choose astronomic time clocks if any areas to be controlled by the time clock receive daylight. If the building schedule or use changes depending on the day of the week, select a 7 day time clock.

****

UL 917, NEMA ICS 6. House time clock in a surface-mounted, lockable, NEMA [1][3R][4] enclosure constructed of painted steel or plastic polymer. Provide electronic type time clock that meets the following criteria:

a. [Astronomic][24 hour][7 day][365 day] programming function, providing a total of [56][96][2000][4000] on/off set points.

b. [24 hour][12 hour AM/PM] type digital clock display format.

c. Power outage back-up for time clock utilizing [a capacitor][alkaline batteries][lithium battery] which provides coverage for a minimum of [seven][four][_____] days.

d. Capable of controlling a minimum of [1][2][4][8][12][16][_____] channels or loads.

e. Contacts are rated for [30] [_____] amps at 120-277 VAC resistive load in a [SPST][DPST][SPDT][DPST] [normally open (NO)][normally closed (NC)] configuration.

f. Contains [function that allows automatic control to be skipped on certain selected days of the week][manual bypass or remote override control][daylight savings time automatic adjustment][EEPROM memory module][momentary function for output contacts][ability for photosensor input].

2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT

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NOTE: Select a central emergency control system if the building contains an emergency backup generator for critical loads other than egress lighting.

****

2.6.1 Exit Signs

****

NOTE: For Navy projects, provide LED exit signs with battery backup unless specifically instructed otherwise. Normal mode of power to these signs must be the branch circuit serving normal lighting in the same area, ahead of any local switching. The emergency mode of power is the exit sign's self-contained emergency battery pack. Provide remote-powered exit signs only when providing centrally distributed AC or DC emergency power system.

****

UL 924, NFPA 101. Provide wattage as indicated in the luminaire schedule on project plans. Provide LED Exit Signs that meet the following criteria:

a. [Housing constructed of [UV-stable, thermo-plastic][clear polycarbonate housing][painted, die-cast aluminum][painted steel].][Edge-lit type with clear acrylic, edge-lit face and aluminum trim having [clear aluminum][white][chrome][brass][_____] finish.]

b. UL listed for [damp][wet] location.

c. Configured for [universal][ceiling][wall][end] mounting.

d. 150 mm 6 inch high, 19 mm 3/4 inch stroke [red][green] lettering on face of sign with chevrons on either side of lettering to indicate direction.

e. Single or double face as indicated in project plans and luminaire schedule.

2.6.1.1 Exit Signs with Battery Backup

Equip with automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free nickel-cadmium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1-1/2 hours. LEDs must have a minimum rated life of 10 years.[Provide self-diagnostic circuitry integral to emergency LED driver.] In lieu of battery, can use a nonradioactive photoluminescent plate.

2.6.1.2 Remote-Powered Exit Signs

Provide exit sign that contains provision for [120-277 VAC][120 VAC][277 VAC][6-48 VDC] input from remote source.

2.6.2 Emergency Lighting Unit (ELU)

UL 924, NFPA 101. Provide emergency lighting units (ELUs) completely assembled with wiring and mounting devices, ready for installation at the locations indicated. Provide in [UV-stable, thermo-plastic] [painted, die-cast aluminum] [painted steel] housing with [UL damp label] [UL wet label] as indicated. Emergency lighting units must be rated for 12 volts, except units having no remote-mounted light sources and having no more than two unit-mounted light sources may be rated six volts. Equip units with brown-out sensitive circuit to activate battery when input voltage falls to 75 percent of normal. Equip with [two] [_____] LED light sources, automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free [lead-calcium] [nickel-cadmium] [_____] type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 90 minutes. LEDs must have a minimum rated life of 10 years.[Provide self-diagnostic circuitry integral to emergency LED driver.]

2.6.3 LED Emergency Drivers

****

NOTE: Provide information on minimum total power in watts of LED(s) in emergency mode to satisfy requirements of NFPA 101, Life Safety Code.

****

UL 924, NFPA 101. Provide LED emergency driver with automatic power failure detection, test switch and LED indicator (or combination switch/indicator) located on luminaire exterior, and fully-automatic solid-state charger, battery and inverter integral to a self-contained housing.[Provide self-diagnostic function integral to emergency driver.] Integral nickel-cadmium[lead-calcium][_____] battery is required to supply a minimum of 90 minutes of emergency power at [5][7][10][_____] watts, [10-50][_____] VDC[compatible with LED forward voltage requirements], constant output. Driver must be RoHS compliant, rated for installation in plenum-rated spaces and damp locations, and be warranted for a minimum of five years.

2.6.4 Self-Diagnostic Circuitry for LED Drivers

UL 924, NFPA 101. Provide emergency lighting unit with fully-automatic, integral self-testing/diagnostic electronic circuitry. Circuitry must provide for a one minute diagnostic test every 28 days, and a 30 minute diagnostic test every six months, minimum. Any malfunction of the unit must be indicated by LED(s) visible from the exterior of the luminaire. A manual test switch must also be provided to perform a diagnostic test at any given time.

2.6.5 Mini Inverters

UL 924, NFPA 101. Provide mini inverters that are designed to provide power to emergency luminaires. Provide mini inverters that are suitable for [dry] [damp] [wet] installations, operate at a voltage of [120-277] [120] [277] volts at 50/60 hertz, and are capable of operating 0-10V dimming override. Provide mini inverters that supply a minimum of 90 minutes of emergency power.

2.6.6 Central Emergency Lighting System

UL 924, NFPA 101, NFPA 110 level 1, NFPA 70. Provide a central power system providing emergency power at [277] [120] volts, 60 hertz, for a minimum period of [90] [_____] minutes. Design the system to handle surges during loss and recovery of the voltage, and to deliver its full rated output to the designated lamp load. Provide [batteries] [backup ac source] for power.

2.6.6.1 Operation

Provide system such that when the lighting system loses normal supply voltage, it automatically disengages itself from the normal input line, and switches to a self-contained inverter with built-in protection when the output is shorted or overloaded. Ensure that, when normal line voltage resumes, the emergency system automatically switches back to normal operation. Size the transfer switch for this function to handle [125] [_____] percent of full load. Provide the battery system with self-contained inverters with overload protection.

2.6.6.2 Charger

Provide a completely automatic battery charger that maintains the batteries in a fully charged condition and recharges the batteries to full capacity within [24] [_____] hours after full discharge in accordance with UL 924.

2.6.6.3 Batteries

Provide sealed [lead-acid] [nickel-cadmium] batteries, maintenance-free for a period of not less than [10] [_____] years under normal operating conditions.

2.6.6.4 Accessories

Provide visual indicators to indicate normal power, inverter power, and battery-charger operation. Provide a low-voltage test switch to simulate power failure by interrupting the input line, voltage meter, electrolyte level detector to automatically disable the charging circuit in the event of a fault, and low-voltage cutoff to prevent extreme battery power dissipation.

2.6.6.5 Enclosure

Provide a free-standing cabinet with floor stand and constructed of [2.7] [_____] millimeter [12] [_____]-gage sheet steel with baked-on enamel finish and a locking latch.

2.7 LUMINAIRE MOUNTING ACCESSORIES

2.7.1 Suspended Luminaires

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NOTE: Coordinate pendent sway bracing details with the architect where required for seismic mitigation. The architect may prefer to provide pendent sway bracing details in locations where appearance is important. Specify shock absorbing hangers for luminaires in certain hazardous locations if indicated.

****

a. Provide hangers capable of supporting twice the combined weight of luminaires supported by hangers.

b. Hangers must allow luminaires to swing within an angle of 45 degrees. Brace pendents 1.2 meters 4 feet or longer to limit swinging.[Provide with swivel hangers to ensure a plumb installation for rigid stem pendents. Provide cadmium-plated steel with a swivel-ball tapped for the conduit size indicated.]

c. Single-unit suspended luminaires must have [cable][twin-stem] hangers. Multiple-unit or continuous row luminaires with a separate power supply cord must have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end.

d. Provide all linear pendent and surface mounted luminaires with two supports per four-foot section or three per eight-foot section unless otherwise recommended by manufacturer.

[e. Provide rods in minimum 4.57 mm 0.18 inch diameter.

]2.7.2 Recess and Surface Mounted Luminaires

Provide access to light source and LED driver from bottom of luminaire. Provide trim [and lenses]for the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications. Luminaires recessed in ceilings which have a fire resistive rating of one hour or more must be enclosed in a box which has a fire resistive rating equal to that of the ceiling. For surface mounted luminaires with brackets, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the luminaire rigidly in design position. Flanged part of luminaire stud must be of broad base type, secured to outlet box at not fewer than three points.

2.7.3 Luminaire Support Hardware

2.7.3.1 Wire

ASTM A641/A641M. Galvanized, soft tempered steel, minimum 2.7 mm 0.11 inches in diameter, or galvanized, braided steel, minimum 2 mm 0.08 inches in diameter.

2.7.3.2 Wire for Humid Spaces

****

NOTE: Select stainless steel or nickel copper alloy wire for facilities where high humidity can be expected such as large kitchens and dishwashing areas. Use nickel copper alloy when hangers are used in indoor pool environments. When spacing of hangar wires exceeds 1.2 meters 4 feet or when heavy luminaires are supported, specify eight or 10 gauge wire.

****

ASTM A580/A580M. Composition 302 or 304, annealed stainless steel, minimum 2.7 mm 0.11 inches in diameter.

ASTM B164. UNS NO4400, annealed nickel-copper alloy, minimum 2.7 mm 0.11 inches in diameter.

2.7.3.3 Threaded Rods

Threaded steel rods, 4.76 mm 3/16 inch diameter, zinc or cadmium coated.

2.7.3.4 Straps

Galvanized steel, 25 by 4.76 mm one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

2.7.4 Power Hook Luminaire Hangers

UL 1598. Provide an assembly consisting of through-wired power hook housing, interlocking plug and receptacle, power cord, and luminaire support loop. Power hook housing must be cast aluminum having two 19 mm 3/4 inch threaded hubs. Support hook must have safety screw. Luminaire support loop must be cast aluminum with provisions for accepting 19 mm 3/4 inch threaded stems. Power cord must include 410 mm 16 inches of 3 conductor No. 16 Type SO cord. Assembly must be rated 120 volts or 277 volts, 15 amperes.

2.8 EQUIPMENT IDENTIFICATION

2.8.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.8.2 Labels

UL 1598. All luminaires must be clearly marked for operation of specific light sources and LED drivers. The labels must be easy to read when standing next to the equipment, and durable to match the life of the equipment to which they are attached. Note the following light source characteristics in the format "Use Only _____":

a. Correlated Color Temperature (CCT) and Color Rendering Index (CRI) for all luminaires.

b. Driver and dimming protocol.

All markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.9 FACTORY APPLIED FINISH

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NOTE: This paragraph covers only the basic painting requirements for most electrical equipment. Include any special finishes for high or low temperatures and corrosive atmospheres.

****

NEMA 250. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum, meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

IEEE C2, NFPA 70.

3.1.1 Light Sources

When light sources are not provided as an integral part of the luminaire, deliver light sources of the type, wattage, lumen output, color temperature (CCT), color rendering index (CRI), and voltage rating indicated to the project site and install just prior to project completion, if not already installed in the luminaires from the factory.

3.1.2 Luminaires

****

NOTE: The electrical designer must coordinate these requirements with architectural plans and specifications. Ensure requirements for antiterrorism/force protection for luminaires in suspended ceilings are included in and coordinated with Section 09 51 00 ACOUSTICAL CEILINGS by referencing ASTM E580 seismic requirements in that section.

Luminaires for facilities located in earthquake

zones must have additional supports and restraining devices as described in UFC 1-200-01, "DoD Building Code (General Building Requirements)" and UFC 3-310-04, "Seismic Design for Buildings".

Coordinate pendent sway bracing details with the architect. The architect may prefer to provide pendent sway bracing details in locations where appearance is important.

****

Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires and secure in accordance with manufacturers' directions and approved drawings. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed. Provide wires, straps, or rods for luminaire support in this section. Install luminaires with vent holes free of air blocking obstacles.

3.1.2.1 Suspended Luminaires

Measure mounting heights from the bottom of the luminaire for ceiling-mounted luminaires and to center of luminaire for wall-mounted luminaires. Obtain architect approval of the exact mounting height on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Support suspended luminaires from structural framework of ceiling or from inserts cast into slab.

a. Provide suspended luminaires with 45 degree swivel hangers so that they hang plumb and level.

b. Locate so that there are no obstructions within the 45 degree range in all directions.

c. The stem, canopy and luminaire must be capable of 45 degree swing.

d. Rigid pendent stem, aircraft cable, rods, or chains 1.2 meters 4 feet or longer excluding luminaire must be braced to prevent swaying using three cables at 120 degree separation.

e. Suspended luminaires in continuous rows must have internal wireway systems for end to end wiring and must be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces.

f. Utilize aligning splines on extruded aluminum luminaires to assure minimal hairline joints.

g. Support steel luminaires to prevent "oil-canning" effects.

h. Match supporting pendents with supported luminaire. Aircraft cable must be stainless steel.

i. Match finish of canopies to match the ceiling, and provide low profile canopies unless otherwise shown.

j. Maximum distance between suspension points must be 3.1 meters 10 feet or as recommended by the manufacturer, whichever is less.

3.1.2.2 Recessed and Semi-Recessed Luminaires

a. Support recessed and semi-recessed luminaires independently from the building structure by a minimum of two wires, straps or rods per luminaire and located near opposite corners of the luminaire. Secure horizontal movement with clips provided by manufacturer. Ceiling grid clips are not allowed as an alternative to independently supported luminaires.

b. Support round luminaires or luminaires smaller in size than the ceiling grid independently from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around.

c. Do not support luminaires by acoustical tile ceiling panels.

d. Where luminaires of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support each independently and provide at least two 19 mm 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the luminaire.

e. Luminaires installed in suspended ceilings must also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

f. Adjust aperture rings on all applicable ceiling recessed luminaires to accommodate various ceiling material thickness. Coordinate cut-out size in ceiling to ensure aperture covers cut-out entirely. Install aperture rings such that the bottom of the ring is flush with finished ceiling or not more than 1.6 mm 1/16 inch above. Do not install luminaires such that the aperture ring extends below the finished ceiling surface.

[g. For luminaire recessed in plaster ceilings, provide plaster frames for setting. Install setting such that the bottom of the frame is flush with finished ceiling. Support luminaires with plaster frames utilizing yokes or leveling lugs. Do not mount luminaires or support elements to ducts or pipes. Yokes must support a luminaire by no fewer than two bolts each.

]3.1.2.3 Field Applied Painting

****

NOTE: Use and coordinate paint and coating requirements with Section 09 90 00 PAINTS AND COATINGS when provided in the job. If Section 09 90 00 PAINTS AND COATINGS is not provided or when requirements are beyond what is specified in Section 09 90 00 PAINTS AND COATINGS, specify the requirements in this paragraph.

****

Provide field applied painting for luminaire type [_____]. Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1.3 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

[3.1.3.1 Remote LED Drivers

Locate Remote LED Drivers within the maximum distance allowed to minimize voltage drop. Do not locate remote LED drivers further from the light source than specified by the manufacturer. Locate remote LED drivers in dry, well-ventilated, and accessible location, above accessible ceilings or behind a removable wall or ceiling panel. Mount housing or junction box so that it is rigidly and securely fastened in place. Install LED drivers such that components are not in contact with combustible materials unless listed for such condition. Remote LED drivers must be grounded in accordance with NFPA 70.

Provide separate compartments for Class 2 wiring connections and for Class 1 wiring connections. Separation must be barrier-type within the same box or separate boxes with close connector conduit fittings. Field connections must be inside housing or junction box or secured by a quick disconnect wire connector.

]3.1.4 Exit Signs

****

NOTE: Select the second paragraph if a central emergency system is specified.

****

NFPA 101. Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area.

[Connect exit signs on separate circuits and serve from [an emergency panel][a separate circuit breaker][a fused disconnect switch]. Provide only one source of control, which would be [the circuit breaker in the emergency panel][the separate circuit breaker][the fused disconnect switch]. Paint source of control red and provide lockout capability.

]3.1.5 Lighting Controls

****

NOTE: Include a version of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS edited specifically for the lighting control system where a lighting control system is specified.

****

Refer to Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS for additional lighting control installation requirements.

3.1.5.1 Scene Wallstations

Submit labeling templates for all scene wallstations, ganged faceplates and other manual control cover plates. Label each scene control button with approved scene description.

3.1.5.2 Occupancy/Vacancy Sensors

****

NOTE: Include sensor testing requirement here when project does not include a separate commissioning specification. When it does, provide sensor testing requirements in the commissioning specification. Coordinate commissioning requirements with Section 01 91 00.15 BUILDING COMMISSIONING.

****

a. Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage must provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways.

b. Locate ceiling-mounted sensors no closer than 2 meters 6 feet from the nearest HVAC supply or return diffuser.

c. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations.

3.1.5.3 Photosensors

****

NOTE: Include sensor testing requirement here when project does not include a separate commissioning specification. When it does, provide sensor testing requirements in the commissioning specification. Coordinate commissioning requirements with Section 01 91 00.15 BUILDING COMMISSIONING.

****

Locate and aim sensor as indicated and in accordance with the manufacturer's recommendations. Adjust sensor set-point in accordance with the manufacturer's recommendations and for the indicated light level of the area of coverage, measured at the work plane.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

3.2.1.1 Lighting Control Verification Tests

Verify lighting control system and devices operate according to approved sequence of operations. Verification tests are to be completed after commissioning.

a. Verify occupancy/vacancy sensors operate as described in sequence of operations. Provide testing of sensor coverage, sensitivity, and time-out settings in all spaces where sensors are placed. This is to be completed only after all furnishings have been installed. Submit occupancy/vacancy sensor verification test.

b. Verify photosensors operate as described in sequence of operations. Provide testing of sensor coverage, aiming, and calibration in all spaces where sensors are placed. This is to be completed only after all furnishings have been installed. Submit photosensor verification test.

c. Verify wall box dimmers and scene wallstations operate as described in sequence of operations.

3.2.1.2 Emergency Lighting Test

Interrupt power supply to demonstrate proper operation of emergency lighting. If adjustments are made to the lighting system, re-test system to show compliance with standards.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Commissioning

****

NOTE: Coordinate commissioning requirements with Section 01 91 00.15 BUILDING COMMISSIONING.

****

NFPA 101. Commission all components of the lighting system and lighting control system in accordance with Section 01 91 00.15 BUILDING COMMISSIONING. Factory Trained Field Service Technician is responsible for calibration and programming sequences for input devices and systems in accordance with the requirements described in the sequence of operation.

3.3.2 Training

3.3.2.1 Maintenance Staff Training

Submit a Maintenance Staff Training Plan at least 30 calendar days prior to training session that describes training procedures for Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide on-site training which demonstrates full system functionality, assigning schedules, calibration adjustments for light levels and sensor sensitivity, integration procedures for connecting to third-party devices, and manual override including information on appropriate use. Provide protocols for troubleshooting, maintenance, repair, and replacement, and literature on available system updates and process for implementing updates.

3.3.2.2 End-User Training

Submit an End-User Training Plan at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide users with a list of control devices located within user-occupied spaces, such as photosensors and occupancy and vacancy sensors, including information on the proper operation and schedule for each device. Provide demonstration for each type of interface. Provide users with the building schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

Provide laminated instructions to the user at each scene wallstation. Provide only instructions relevant to the functionality of the specific scene wallstation. Provide a description of each labeled scene control button. If the room utilizes occupancy/vacancy sensors or photosensors, include a description of this functionality on the instruction sheet.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 55 53 (November 2023)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-26 55 53.00 40 (August 2023)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 26 55 53

SECURITY LIGHTING

11/23

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USACE / NAVFAC / AFCEC **UFGS-26 55 53 (November 2023)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-26 55 53.00 40 (August 2023)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 55 53

SECURITY LIGHTING
11/23

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NOTE: This guide specification covers the requirements for lighting for security and closed circuit television (CCTV) area illumination.

Use and coordinate UFGS Section 26 56 00 EXTERIOR LIGHTING for pole or standard, including mounting and base accessories of exterior fixtures with this section.

Use and coordinate UFGS Section 26 56 00 EXTERIOR LIGHTING for roadway and street lighting with this section.

Use UFGS Section 26 56 00 EXTERIOR LIGHTING for facility and grounds flood lighting.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: This guide specification does not include provision for high-mast roadway and parking lot

lighting (poles over 18.3 meters (60 feet)). Add requirements for materials and procedures for special or unusual design as necessary for specific projects. Standard details, and quality of illumination will conform to HREF=http://www.wbdg.org/ccb/DOD/UFC/ufc_3_550_01.pdf>UFC 3-550-01, "Exterior Electrical Power Distribution" **and may be modified to suit project conditions.**

Do not use Incandescent lamps, Fluorescent lamps, and Mercury Vapor Lamps for CCTV area illumination, nor tungsten lamps other than infrared lamps.

Two types of infrared luminaires are currently available: fixtures with special lamps utilizing optical dichroic mirror coatings that produce only infrared light, and fixtures that use conventional lamps that pass the light output through infrared filters. Special lamps have the advantage of operating cooler and not requiring a cooling fan, thus operating quieter and requiring less maintenance.

The major disadvantages are high lamp replacement cost due to short bulb life (2000 to 4000 hours) and special lamp design. The 2000 hour lamps produce more infrared light energy and are preferred over the 4000 hour lamps. Another disadvantage is the limited variety of wattages available, but this is normally resolved by fixture placement during site lighting system design. Conventional lamps utilizing special power supplies and infrared filters have the advantages of low bulb replacement cost and bulb life ranging from 1700 to 18000 hours. (Note: Special power supplies reduce current flow to the bulb and allow it to operate at a lower filament temperature to shift light output more into the near infrared (NIR) light spectrum and requires less filtering. This has the additional advantage of extending bulb life.) A variety of bulb sizes are available and no special bulbs are required. The main disadvantage of using a conventional bulb is the heat generated utilizing an infrared filter which requires cooling by a cooling fan. Fans require maintenance and the loss of the fan will destroy the filter. Filters are expensive.

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1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A576	(2023) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B2	(2013) Standard Specification for Medium-Hard-Drawn Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES RP-8	(2018; Addenda 1 2020; Errata 1-2 2021) Recommended Practice for Design and Maintenance of Roadway and Parking

Facility Lighting

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2023) National Electrical Safety Code
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C135.1	(1999) Standard for Zinc-Coated Steel Bolts and Nuts for Overhead Line Construction
IEEE C135.30	(1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI ANSLG C78.42	(2009; S 2022) For Electric Lamps: High-Pressure Sodium Lamps
ANSI C78.40	(2011) American National Standard for Mercury Lamps--Specifications
ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C82.4	(2017; R 2022) Lamp Ballasts - Ballasts for High- Intensity-Discharge and Low-Pressure Sodium Lamps
ANSI C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI C136.2	(2015) American National Standard for Roadway and Area Lighting Equipment: Luminaires Voltage Classification
ANSI C136.3	(2020) Roadway and Area Lighting Equipment - Luminaire Attachments
ANSI C136.6	(2004) American National Standard for Roadway Lighting Equipment - Metal Heads and Reflector Assemblies - Mechanical and Optical Interchangeability
ANSI C136.9	(2003) American National Standard for Roadway and Area Lighting Equipment -

	Socket Support Assemblies for Metal Heads - Mechanical Interchangeability
ANSI C136.11	(2011; R 2016; STBL 2021) Roadway Lighting Equipment - Multiple Parallel Wired Sockets
ANSI C136.15	(2020) American National Standard for Roadway and Area Lighting Equipment - Luminaire Field Identification
ANSI/ANSLG C78.43	(2013) American National Standard for Electric Lamps - Single-Ended Metal-Halide Lamps
ANSI/NEMA OS 1	(2013; R 2020) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA RN 1	(2018) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 6 & 8	(2020) Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
NEMA TC 9	(2020) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-232	(1997f; R 2012) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 98	(2016; Reprint Jan 2022) UL Standard for Safety Enclosed and Dead-Front Switches
UL 467	(2022) UL Standard for Safety Grounding

	and Bonding Equipment
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers
UL 514A	(2024) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Apr 2024) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 651A	(2023; Reprint Jan 2024) UL Standard for Safety Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit
UL 854	(2020; Reprint Jul 2024) Standard for Service-Entrance Cables
UL 870	(2016; Reprint Nov 2023) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 1029	(1994; Reprint Oct 2024) UL Standard for Safety High-Intensity-Discharge Lamp Ballasts
UL 1203	(2023; Reprint May 2024) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lighting System[; G, [_____]]

Detail Drawings[; G, [_____]]

SD-03 Product Data

Equipment and Materials[; G, [_____]]

Spare Parts[; G, [_____]]

LED Lighting[; G, [_____]]

Interface Lighting System And Power Distribution[; G, [_____]]

Aerial Cable Hardware[; G, [_____]]

Cable Boxes[; G, [_____]]

Manholes, Handholes, And Pullboxes[; G, [_____]]

Cable Splices And Connectors[; G, [_____]]

Conduit, Ducts And Fittings[; G, [_____]]

Fixtures[; G, [_____]]

Transformers[; G, [_____]]

Wireway, Raintight, Support[; G, [_____]]

Nameplates[; G, [_____]]

Tamper Provisions[; G, [_____]]

Cable[; G, [_____]]

Electrical Enclosures[; G, [_____]]

Illumination[; G, [_____]]

Lamps, Incandescent[; G, [_____]]

Lamps, Fluorescent[; G, [_____]]

Luminaire Components[; G, [_____]]

Photometric Distribution Classification[; G, [_____]]

Luminaires, Floodlighting[; G, [_____]]

SD-06 Test Reports

CCTV Assessment Lighting[; G, [_____]]

Operating Test[; G, [_____]]

Ground Resistance Measurements[; G, [_____]]

SD-07 Certificates

CCTV Assessment Lighting Test Procedures[; G, [_____]]

Operating Test Procedures[; G, [_____]]

SD-10 Operation and Maintenance Data

Operations and Maintenance Manuals[; G, [_____]]

SD-11 Closeout Submittals

Record Drawings[; G, [_____]]

1.3 QUALITY CONTROL

1.3.1 Standard Products

Provide materials and equipment which are the standard products of manufacturer regularly engaged in the manufacture of such products, and which essentially duplicate equipment that has been in satisfactory use at least two years prior to bid opening.

1.4 PROJECT/SITE CONDITIONS

Lighting equipment that is usable in their original configuration without modification may be reused with Government approval. Perform a field survey, including testing and inspection of existing lighting equipment and control lines intended to be incorporated into the lighting system, and furnish a report to the Government. For those items considered nonfunctioning, provide specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency with the report. As part of the report, include the scheduled need date for connection to all existing equipment.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Lighting System

Provide all lighting system components. Include all fixtures, hardware, poles, cables, connectors, adapters and appurtenances needed to provide a fully functional lighting system.

[a Design Requirements for CCTV Assessment Lighting

****

NOTE: Coordinate the type of CCTV light fixture used with the spectral sensitivity of the CCTV camera installed at each assessment zone. Provide a sufficient lighting level to meet the minimum faceplate illumination requirements of each camera. Provide a light ratio of not greater than 6 to 1 (highlight to shadow) between the perimeter fences or in the CCTV assessment zone. In addition, the security at some sites may require lighting in areas not normally viewed by the CCTV cameras.

Omit this paragraph if the lighting system is not used for CCTV assessment.

****

Configure the CCTV Assessment Lighting system as specified and shown. Ensure equipment conforms to NFPA 70 and IEEE C2. Provide sufficient light for optimum CCTV assessment of each zone in the configuration. Include all fixtures, hardware, poles, cables, connectors, adapters, and appurtenances needed to provide a fully functional lighting system.

]2.1.1.1 Electrical Requirements

Provide equipment which operates from a voltage source as shown; plus or minus 10 percent, and at 60 Hz, plus or minus 2 percent.

a. Power Line Surge Protection

****

NOTE: Indicate circuits requiring additional transient voltage surge suppression. Provide requirements on the drawings or in a table.

****

Provide transient voltage surge suppressors for all electronic equipment, meeting the requirements of IEEE C62.41.1 and IEEE C62.41.2, and UL listed as tested in accordance with UL 1449. Select surge suppressor ratings [as indicated] [[_____] volts rms, operating voltage; [50] [60] Hz; [1-phase] [3-phase]; [2] [3] [4] wire with ground; transient suppression voltage (peak let-through-voltage) of [_____] volts]. Do not use fuses as surge suppression.

b. Interface CCTV Lighting and CCTV System

****

NOTE: Delete this paragraph if infrared lights are not used for CCTV assessment.

****

Interface infrared lights to the CCTV system and provide automatic, alarm actuated call-up of the light associated with the alarm zone.

[2.1.1.2 Unusual Service Conditions

****

NOTE: If normal service conditions prevail, omit this subparagraph. Unusual service conditions for altitude start above 1 kilometer (3300 feet) for most apparatus. Ambient temperature is generally 40 degrees C, although in some cases 30 degrees C applies. Frequency is generally 60 Hz, although 50 Hz may also be standard. Take any unusual service conditions or atmospheres into consideration and adjust the specifications accordingly.

****

Provide equipment and materials furnished under this section suitable for the following unusual service conditions: altitude [_____] m feet, ambient temperature [_____] degrees C F.

][2.1.1.3 Hazardous Locations

****

NOTE: Designer identifies hazardous areas and shows them on the drawings. Delete this paragraph if there are no hazardous issues involved in the project.

****

[Provide wiring conforming to NFPA 70 for Class [I] [II] [III], Division [1] [2] hazardous locations, and suitable equipment for [Group [_____]] [operating temperature of [_____] degrees C F].] [Provide wiring and equipment of the classes, groups, divisions indicated, and suitable for the indicated operating temperature.]

]2.1.2 System Design

Submit detail drawings for the complete system and for [poles,] [lighting fixtures,] [bracket arms,] [cable boxes,] [handholes,] [transformers,] [controllers,] [and] [_____]. [Detail drawings for precast handholes include a design analysis to determine that strength is equivalent to indicated cast-in-place concrete handholes.] [Indicate in drawings bonding method for concrete encasement.] [Include in drawings design calculations showing adequate strength of screw foundations.] [For CCTV lighting, include in date:

a. Infrared light call-up response time.

b. Lamp strike and restrike times.

c. System startup and shutdown operations.

d. Manuals for CCTV Assessment Lighting equipment.

e. A typical zone layout showing light locations, isolux patterns, and lighting ratios.]

Submit data published by the manufacturer of each item on the list of equipment and material, to permit verification that the item proposed is of the correct size, properly rated or applied, or is otherwise suitable for the application and fully conforms to the requirements specified.

2.2 EQUIPMENT

2.2.1 Interface Lighting System and Power Distribution

****

NOTE: Include the secondary power panel only for a backup generator as specified in another section. Determine the site requirements for a backup generator.

****

Provide conductors [including all conductors extending from the load side of the primary and secondary power panels that serve assessment lighting equipment] [and] [as indicated].

2.2.2 Aerial Cable Hardware

****

NOTE: Include this paragraph only when aerial cable is being used.

****

Provide zinc coated aerial cable hardware conforming to IEEE C135.1, with steel hardware material conforming to ASTM A575 and ASTM A576, hot-dip galvanized in accordance with ASTM A153/A153M.

2.2.3 Cable Splices and Connectors

Provide cable splices and connectors conforming to UL 486A-486B. Provide underground splices and connectors conforming to the requirements of ANSI C119.1.

2.2.4 Cable Boxes

Provide cable boxes and covers made of cast iron with zinc coated or aluminized finish, of the sizes indicated on drawings. Provide minimum inside dimensions of not less than 304.8 mm 12 inches square by 152.4 mm 6 inches deep and not less than required to house the cable splice. Install a suitable gasket between the box and cover for a watertight seal. Install a sufficient number of screws to hold the cover in place along the entire surface of contact. Provide grounding lugs.

2.2.5 Manholes, Handholes, and Pullboxes

****

NOTE: Actual strength figures may need to be adjusted to accommodate various manufacturers of glass reinforced polymer boxes.

Cast iron should generally be specified for wheel loadings up to 7,258 kPa (16,000 pounds); cast steel may be used at the Contractor's option. Handhole covers and frames will generally conform to the details of HREF=http://www.wbdg.org/ccb/DOD/UFC/ufc_3_550_01.pdf>UFC 3-550-01, "Exterior Electrical Power Distribution" **Specify cast steel for areas that require heavier loadings, such as airports or other concentrated load applications. When cast steel is required, revise the specification to indicate the wheel load, tire or wheel contact area, and tire pressure.**

Use tamperproof bolts for handholes that are in a non-secure area but serve security and CCTV lighting systems.

****

Provide manholes, handholes, pullboxes,and related frames and covers as indicated, with strengths conforming to the requirements of IEEE C2. Provide precast concrete manholes with the required strength established by ASTM C478. Provide frames and covers for manholes made of [gray cast iron] [or] [cast steel]. Provide a machine-finished seat to ensure a matching joint between frame and cover. Cast iron is to comply with ASTM A48/A48M, Class 30B, minimum. Provide handholes for low voltage cables installed in parking lots, sidewalks, and turf areas made from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least [69] [_____] MPa [10,000] [_____] psi and a flexural strength of at least [34.5] [_____] MPa [5,000] [_____] psi. Provide pullbox and handhole covers in parking lots, sidewalks, and turf areas of the same material as the box. [Provide concrete pullboxes consisting of precast reinforced concrete boxes, extensions, bases, and covers.] [Install a sufficient number of tamperproof bolts to hold the cover firmly in place along the entire surface of contact; and include a tool for the tamperproof bolts.]

2.2.6 Conduit, Ducts and Fittings

2.2.6.1 Conduit, Rigid Steel

Provide rigid steel conduit conforming to ANSI C80.1 and UL 6.

2.2.6.2 Conduit Coatings

Coat underground metallic conduit and fittings with a plastic resin system conforming to NEMA RN 1, Type 40. Epoxy systems may also be used.

2.2.6.3 Conduit Fittings and Outlets

a. Boxes, Metallic Outlets

ANSI/NEMA OS 1 and UL 514A.

b. Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers

ANSI/NEMA OS 1 and UL 514C.

c. Boxes, Outlet for Use in Hazardous (Classified) Locations

UL 1203.

d. Boxes, Switch (Enclosed), Surface Mounted

UL 98.

e. Fittings for Conduit and Outlet Boxes

UL 514B.

f. Fittings for Use in Hazardous (Classified) Locations

UL 1203.

g. Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

2.2.6.4 Non-Metallic Duct

****

NOTE: Only polyvinyl chloride and high-density polyethylene conduits are presently covered by UL 651, which includes a temperature rating clause. Other plastic materials are covered by NEMA Standards, which do not provide a temperature rating clause. All options will be permitted and the temperature certification required until these materials are covered by an industry temperature rating clause.

****

Provide non-metallic duct lines and fittings utilized for underground installation suitable for the application, consisting of thick-wall, single, round-bore type, using material of one type. Provide acrylonitrile-butadiene-styrene (ABS) duct conforming to NEMA TC 6 & 8 and NEMA TC 9, with high-density conduit conforming to UL 651A. Provide Schedule 40 polyvinyl chloride (PVC) conforming to UL 651. Provide schedule 40 polyvinyl chloride (PVC) conforming to UL 651.

Provide all plastic utility duct and fittings manufactured without a UL label or listing with a certification as follows: "The materials are suitable for use with 75 degree C 167 degree F wiring. No reduction of properties in excess of that specified for materials with a UL label or listing will be experienced if samples of the finished product are operated continuously under the normal conditions that produce the highest temperature in the duct."

2.2.7 Fixtures

****

NOTE: Carefully review and select fixtures from

Standard Detail No. 40-06-04. Then enter sheet numbers which show the fixture types selected in this paragraph.

****

Provide standard fixtures as detailed on [Standard Detail No. 40-06-04, Sheet Nos. [_____]][_____] which accompany and form a part of this specification. Provide special fixtures as indicated on the drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar design, equivalent light distribution and brightness characteristics, equal finish and quality is acceptable as approved.

2.2.7.1 Accessories

Provide accessories such as straps, mounting plates, nipples, or brackets for proper installation.

2.2.7.2 Special Fixtures

The types of special fixtures are designated by letters and numbers. For example, SP-1 denotes special Type 1.

2.2.7.3 In-Line Fuse

Provide an in-line fuse for each fixture, consisting of a fuse and a UL approved waterproof fuse holder rated [at 30 amperes, 600 volts] [as indicated], with insulated boots. Provide a fuse rating of [600 volts] [as indicated].

2.2.8 Transformers

****

NOTE: In corrosive atmospheres, specify transformers with PVC coating on exterior metallic surfaces. Consult transformer manufacturers about derating that might result from the application of additional protective coatings.

****

Provide transformers conforming to UL 506. Provide rust-inhibiting treatment and standard finish by the manufacturer on all exterior transformer cases.

2.2.8.1 Outdoor Dry-Type Lighting Transformers

****

NOTE: Provide transformers in the security lighting system to serve 120 volt incandescent or quartz lamps from distribution systems of higher voltages.

****

Provide single phase, 60 Hz, two winding, with two wire secondary and with a [240] [480] [_____] volt primary to 120 volt secondary, [1] [_____] kVA transformers.

2.2.8.2 Buck-Boost Transformers

****

NOTE: Select a kVA rating for the buck-boost transformer of not less than 125 percent of the required load (as determined by multiplying the current by the boost voltage). In order to keep conductor size to a minimum, use buck-boost transformers in security and CCTV lighting circuits that have excessive voltage drop due to the circuit lengths. See American Electrician's Handbook, Ninth Edition, for diagrams.

****

Provide transformers suitable for outdoor installation, with a 150 degree C 302 degree F insulation system for an 80 degree C 176 degree F rise; 60 Hz with 4 windings, 2 for primary and 2 for secondary, with all leads brought out to permit parallel or series connections of primary and secondary windings. Provide voltage ratings, kVA ratings, percent of boost and/or buck, and connections as indicated on drawings.

2.2.9 Wireway, Raintight, Support

Provide raintight wireway conforming to UL 870. When used for supporting floodlights on wood poles, provide[[101.6 by 101.6] [_____] mm [4 by 4] [_____] inches wide by [1.8] [_____] m [6] [_____] feet long] wireway[as indicated].

2.2.10 Nameplates

Provide each major component of equipment with a nonferrous metal or engraved plastic nameplate which shows, as a minimum, the manufacturer's name and address, the catalog or style number, the electrical rating in volts, and the capacity in amperes or watts.

2.2.11 Spare Parts

Submit spare parts data for each different item of material and equipment specified, after approval of detail drawings for materials and equipment, and not later than 4 months before the date of beneficial occupancy. Include in data a complete list of parts, special tools, and supplies, with current unit prices and sources of supply.

2.3 COMPONENTS

2.3.1 Protection of Security Lighting System Components

2.3.1.1 Components and Conductors

****

NOTE: Bury Security and CCTV lighting system conductors in areas where the likelihood of damage to the conductors is slight. In areas where subsurface utilities are congested and in areas where the chance of accidental or intentional damage is great, place the security and CCTV lighting system conductors in ducts.

****

Protect Security lighting system conductors from damage. Install lighting system conductors in raceways or by means of direct burial, as shown. Where the conductors leave the underground systems, encase the conductors in rigid steel conduit of the indicated size. Provide wire guards to protect security lighting luminaries mounted below 6.1 m 20 feet. House exterior group-located electrical equipment such as time switches, safety switches, and magnetic contactors in a NEMA ICS 6, Type 4 enclosure. Provide an individual enclosure where only one piece of equipment is provided at a location.

[2.3.1.2 Tamper Provisions

****

NOTE: When an Intrusion Detection System (IDS) is to be provided or is already in place, tamper switches or welded covers are required. When an IDS is not required, delete this paragraph.

****

Provide enclosures, cabinets, housings (other than luminaire housings), boxes, raceways, conduits, and fittings having hinged doors or removable covers, and which contain any part of the security lighting system (including power sources), with corrosion-resistant tamper switches, connected to an Intrusion Detection System (IDS), that initiates an alarm signal when the door or cover is opened or moved. Make tamper switches inaccessible until the switch is activated. Conceal switch leads and mounting hardware from the exterior of the enclosure. For pull or junction boxes which contain no splices or connections the covers may be protected by 6.4 mm1/4 inch tack welds on four sides of each cover rather than by tamper switches. Affix labels to indicate they contain no connections. Do not indicate on labels that the box is part of the security system.

]2.3.2 Cable

Provide all wire and cable not indicated as government furnished equipment, capable of withstanding the jobsite environment for a minimum of 20 years.

2.3.2.1 Insulated Cable

****

NOTE: Select insulation thickness of column B when approximately 0.381 to 0.508 mm 15 to 20 mils more insulation is desired and column A when even thicker insulation is necessary. Do not specify for small installations or for limited amounts of one AWG size on large installations, since cable is manufactured to order.

****

Provide USE type cable conforming to UL 854, with copper conductors and type RHW or XHHW insulation conforming to UL 44, including green ground conductor. Provide cable with insulation of a thickness not less than that given in column [A] [B] of TABLE 15.1 of UL 854, rated 600 volts. Provide parts of the cable system, such as splices and terminations, rated not less than 600 volts. The size and number of conductors and the number of cables are as indicated. Strand conductors larger than No. 8 AWG.

[2.3.2.2 Messenger Cable

****

NOTE: Include this paragraph only for aerial cable. Coordinate with the site to determine acceptable locations and heights for aerial cables. For security reasons, aerial cables do not cross perimeter fencing.

****

Provide a messenger cable system to support aerial cable, including guys, hardware and appurtenances needed to install the messenger cable, and capable of supporting the weight of the lighting system cable with the required messenger cable tensioning without exceeding 30 percent of its breaking strength under 16 degrees C 60 degrees F conditions of no ice and no wind. Size the messenger so that ice and wind loading normally encountered at the site does not cause the messenger to exceed 50 percent of its breaking strength. Size appurtenances, guys, and hardware to exceed the rated breaking strength of the messenger cable. Provide galvanized zinc coated steel or aluminum clad steel messenger cables.

]2.3.2.3 Bare Copper Conductors

Provide medium-hard-drawn copper conductors conforming to ASTM B2 and ASTM B8.

2.3.3 Electrical Enclosures

****

NOTE: Show on the drawings which specific type of enclosure is needed.

****

Provide metallic enclosures as needed to house the [security] [and] [CCTV] lighting equipment conforming to NEMA ICS 6 and NEMA 250. Provide enclosures with lockable or padlock handles. Deliver keys for lockable enclosures to the Contracting Officer. Provide enclosures as specified or as shown on the drawings.

[2.3.3.1 Interior Enclosures

Provide enclosures to house lighting equipment in an interior environment meeting the requirements of a NEMA 12 enclosure as defined in NEMA 250.

][2.3.3.2 Exposed-to-Weather Enclosures

Provide enclosures to house lighting equipment in an outdoor environment meeting the requirements of a NEMA 4 enclosure as defined in NEMA 250.

][2.3.3.3 Corrosion Resistant Enclosures

Provide enclosures to house lighting equipment in a corrosive environment meeting the requirements of a NEMA 4X enclosure as defined in NEMA 250.

][2.3.3.4 Hazardous Environment Enclosures

Install equipment within a hazardous environment as described in paragraph Hazardous Locations.

]2.3.4 Illumination

****

NOTE: Insert appropriate sheets from CE Standard Detail 40-06-04 into these specifications. Add references used in 40-06-04 to paragraph REFERENCES. Delete paragraphs not required.

****

2.3.4.1 General Lighting

Provide luminaires, ballasts, lamps, and control devices required for [general area] [and] [_____] lighting [, including floodlighting] in accordance with [sheet] [sheets] [_____] of Standard Detail No. 40-06-04, attached to these specifications.

2.3.4.2 Roadway Lighting

Provide luminaires, ballasts, lamps, and control devices required for roadway lighting in accordance with [sheet] [sheets] [_____] of Standard Detail No. 40-06-04, attached to these specifications.

2.3.5 Lamps and Ballasts, High Intensity Discharge (Hid) Sources

****

NOTE: Production of required lumen output within 3 minutes after primary or emergency power is applied is required of lighting system.

Incandescent lamps may be used to provide required light output during periods of restart.

****

2.3.5.1 High-Pressure Sodium

Provide lamps conforming to ANSI ANSLG C78.42, and ballasts conforming to ANSI C82.4, or UL 1029. Provide clear high-pressure sodium lamps.

2.3.5.2 Mercury Vapor

****

NOTE: To save energy, only use mercury vapor fixtures when matching existing fixtures.

****

Provide lamps conforming to ANSI C78.40, and ballasts conforming to ANSI C82.4.

2.3.5.3 Metal-Halide

Provide lamps made by a manufacturer with not less than 5 years experience in making metal-halide lamps, conforming to ANSI/ANSLG C78.43, with ballasts conforming to ANSI C82.4 or UL 1029.

2.3.6 Lamps, Incandescent

Provide incandescent lamps conforming to UL 1598 and rated for 120 volt operation unless otherwise specified.

2.3.7 Lamps, Fluorescent

Provide fluorescent lamps with standard cool-white color characteristics which do not require starter switches. Provide rapid-start type lamps.

2.3.8 LED Lighting

Provide LED lighting of the wattage and type indicated. LED luminaries are to have a minimum service life of 20,000 hours of operation. Provide LED lamps with [2700K] [3000K] [4000K] [5000k] color temperature. Provide [floodlights] [wall packs] [canopy lights] [pole mounted parking lot lights] as indicated in the drawings. Housings are to be [anodized aluminum] [powder coated aluminum] [powder coated steel] [manufacturers standard finish]. Provide all mounting poles, brackets, wiring and hardware for a complete, functioning installation.

[2.3.9 Luminaire Components

****

NOTE: Include the following paragraph if UFGS Section 26 56 00 EXTERIOR LIGHTING is not included in the project.

****

Provide luminaire components conforming to the following:

a. Attachments, ANSI C136.3;

b. Voltage classification, ANSI C136.2;

c. Field identification marking, ANSI C136.15;

d. Interchangeability, ANSI C136.6 and ANSI C136.9; and

e. Sockets, ANSI C136.11.

]2.3.10 Photometric Distribution Classification

Provide photometrics conforming to ANSI/IES RP-8.

2.3.11 Luminaires, Floodlighting

2.3.11.1 HID and Incandescent

Provide HID lighting fixtures conforming to UL 1598. Provide incandescent lighting fixtures conforming to UL 1598.

2.3.11.2 Fluorescent

Provide fluorescent lamps conforming to [_____].

2.3.12 Searchlights

Provide special type [_____] searchlights [304.8 mm 12-inch] [457.2 mm 18-inch] [609.6 mm 24-inch] nominal size, and built with weatherproof, dust-tight, corrosion-resistant construction. Include with each searchlight a housing and hinged door, two reflectors, a receptacle, a trunnion, and a base. Provide searchlights which operate at [120 Vac] [[_____] Vdc].

Provide each searchlight with a range for observing objects the size of an automobile at [243.8] [365.8] [457.2] [609.6] m [800] [1200] [1500] [2000]-feet on a clear night. Searchlights are to be [hand-controlled, with pedestal base and slip rings] [pilot-house controlled, with low base and slip rings]. Provide with housing and hinged door made of nonferrous metal. Provide gaskets and mount, to form a weatherproof seal, a heat-resistant, clear, smooth cover glass tempered to withstand sudden changes in temperature to the door. Mount a parabolic reflector of silver-mirrored glass or aluminum approximately 6.4 mm 1/4-inch thick at the back of the housing, and also mount a spherical auxiliary reflector designed to permit relamping in front of the lamp, with a permanent, non-tarnishing, nonabsorptive aluminum oxide reflecting surface. Provide receptacle of proper size to receive the lamp and install in a manner to ensure accurate positioning of the light center. Arrange searchlights for horizontal and vertical adjustment. Provide standard, two-conductor, weatherproof, flexible cable out of the housing through a weatherproof entrance bushing. Optically arrange searchlights to provide a horizontal and vertical beam spread of [2.5] [3.5] [4.5] [5.5] [6.5] [7.5] [8.5] [_____] degrees. Make provisions for tilting searchlights to any position within 45 degrees above and below the horizontal. Provide the searchlights with slip rings to permit continuous horizontal rotation. [Include with each searchlight installation a [_____] 12 volt [_____] kVA transformer conforming to UL 506.]

[Searchlight installation on guard towers Nos. [_____] is also to include a manually operated, two-pole, enclosed transfer switch, a 200 ampere-hour, 12 volt, lead-acid, flat pasted positive plate design storage battery, and an automatic battery charger. Provide a silicon type, full wave battery charger, with high and low charging rate, arranged to go on high rate after resumption of power and emergency discharge, and return to low rate automatically when battery has reached full charge. Provide an ammeter in the charging circuit to indicate rate of charge.

]2.3.13 Fresnel-Lens Luminaires

Provide special type [_____] luminaires consisting of mounting bracket, head, socket, reflector, and fresnel-lens assembly for multiple circuit, with weatherproof, dust tight, and insect proof luminaire. Provide a mounting bracket for [crossarm] [[38.1] [50.8] mm [1-1/2] [2] in slip fitter] [wood-pole] [pipe] mounting. Provide readily accessible means to permit horizontal adjustment and locking of the luminaire within a 30 degree arc each side of the center, and tilting and locking the luminaire within a 30 degree arc each side of vertical. Make the length of the mounting bracket such that the center of the luminaire, when hanging vertically, is not less than 200 mm 8-inches nor more than 600 mm 2-feet from the surface of the pole or cross-arm. [Provide luminaire with a 300 watt incandescent lamp that produces an average candela not less than 3000.] [Provide luminaire with a 500 watt incandescent lamp that produces an average candela of not less than 5000.] Provide the unit with an auxiliary reflector of white glossy-type porcelain enamel or aluminum reflecting surface. Provide a completed assembly, consisting of a 180 degree cylindrical fresnel lens and a semicylindrical reflector housing, which produces a horizontal beam spread of approximately 180 degrees, and a vertical beam spread of approximately 15 to 25 degrees.

2.4 MATERIALS

2.4.1 Corrosion Protection

2.4.1.1 Aluminum Materials

[Do not use aluminum material if in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, use fittings conforming to UL 486A-486B.] [Do not use aluminum.]

2.4.1.2 Ferrous Metal Materials

a. Hardware

Provide hot-dip galvanized ferrous metal hardware in accordance with ASTM A153/A153M and ASTM A123/A123M.

b. Equipment

****

NOTE: Specify a 120 hour test in a non-corrosive environment and a 480 hour test in a corrosive environment.

****

Provide equipment and component items, including but not limited to metal poles and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, with corrosion-resistant finishes which withstand [120] [480] hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm 1/16-inch from the test mark, with a scribed test mark and test evaluation rated not less than 7 in accordance with TABLE 1, (procedure A) of ASTM D1654.

Coat cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel with a zinc rich paint conforming to the manufacturer's standard.

2.4.1.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory, are as specified in Section 09 90 00 PAINTS AND COATINGS.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Current Site Conditions

Verify that site conditions are in agreement with the design package. Report all changes to the site or conditions that will affect performance of the system to the Government. Do not take any corrective action without written permission from the Government.

3.1.2 Existing Equipment

Connect to and utilize existing lighting equipment and devices as shown. Make written requests and obtain approval prior to disconnecting any control lines and equipment, and creating equipment downtime. Proceed with such work only after receiving Government approval of these requests. If any device fails after work has commenced on that device, diagnose the failure and perform any necessary corrections to the equipment. The Government is responsible for maintenance and repair of Government equipment.

3.2 INSTALLATION

Install all system components, including government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2, and contract documents. Furnish necessary hardware, fixtures, cables, wire, connectors, interconnections, services, and adjustments required for a complete and operable system.

3.2.1 Enclosure Penetrations

Make enclosure penetrations from the bottom unless the system design requires penetrations from other directions. Seal all penetrations of interior enclosures involving transitions of conduit from interior to exterior, and penetrations on exterior enclosures with rubber silicone sealant to preclude the entry of water. Terminate the conduit riser in a hot-dipped galvanized metal cable terminator. Fill the terminator with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

3.2.2 Prevention of Corrosion

3.2.2.1 Aluminum

Do not use aluminum in contact with earth or concrete, and where connected to dissimilar metal, protect with approved fittings and treatment.

3.2.2.2 Steel Conduits

Do not install steel conduits within concrete slabs-on-grade. Field wrap steel conduits installed underground or under slabs-on-grade, or penetrating slabs-on-grade, with 254 micrometers 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlap, or provide with a factory-applied plastic resin, epoxy coating. Zinc coating may be omitted from steel conduit which has a factory-applied epoxy coating.

3.2.2.3 Cold Galvanizing

Coat field welds and/or brazing on factory galvanized boxes, enclosures, conduits, etc. with a cold galvanized paint containing at least 95 percent zinc by weight.

3.2.3 Cable Installation

****

NOTE: Bury security and CCTV lighting system conductors in areas where the likelihood of damage to the conductors is slight. In areas where subsurface utilities are congested and in areas where the chance of accidental or intentional damage is great, place the security and CCTV lighting system conductors in ducts.

****

Provide cable and all parts of the cable system, such as splices and terminations, rated not less than 600 volts, with the size and number of conductors and the number of cables as indicated. Provide stranded conductors if larger than No. 8 AWG. Identify each circuit by means of fiber or nonferrous metal tags, or approved equal, in each [handhole] [and] [junction box,] and at each terminal.

3.2.3.1 Splices

Make splices below grade with nonpressure-filled resin systems using transparent, interlocking, self-venting, longitudinally split plastic molds. Make splices above grade with sealed insulated pressure connectors and provide insulation and jacket equal to that of the cable. In order to prevent moisture from entering the splice, cut back jackets to expose the required length of insulation between the jacket and the tapered end of the insulation.

3.2.3.2 Installation in Duct Lines

Install [ground] [ground and neutral] conductors in duct with the associated phase conductors. Make cable splices in handholes only.

3.2.4 Direct Burial

Provide minimum cover depth from top of cable to finished grade 750 mm 30-inches for direct buried cable, but not less than the depth of the frost line.

3.2.4.1 Trenching

****

NOTE: Where soil does not contain rocks or abrasive material, delete the requirements for placing protection over the cable. Delete planks if not required.

****

Excavate trenches to the depths required to provide the minimum cable cover, with the bottom of the trench smooth and free of stones and sharp objects. Where the bottom of the trench consists of material other than sand or earth, remove an additional 75 mm 3-inch layer and replace with a 75 mm 3-inch layer of sand or stone-free earth compacted to the approximate density of the surrounding firm soil. Unreel the cables unreeled in place along the side of or in the trench and carefully placed on the sand or earth bottom. Pulling cables into a direct-burial trench from a fixed reel position is not permitted. Where cables cross, provide a separation of at least 75 mm 3-inches, unless the cables are protected by nonmetallic conduit sleeves at the crossing. Make the radius of bends in cables not less than 12 times the diameter of the cable. Do not leave the cables under longitudinal tension. Install the first layer of backfill, 150 mm 6-inches thick, consisting of sand or stone-free earth. Place one-inch untreated planks, not less than 200 mm 8-inches in width, or approved equal protection, end to end along the cable run, approximately 75 mm 3 inches above the cable. Place a 0.127 mm 5-mil, brightly colored plastic tape not less than 75 mm 3-inchesin width and suitably inscribed at not more than 3 m 10-feet on centers, or other approved dig-in warning indication, approximately 300 mm 12-inches below finished grade levels of trenches. Provide selected backfill of sand or stone-free earth to a minimum depth of

75 mm 3-inches above cables.

3.2.4.2 Requirements for Installation in Duct

Where indicated on drawing, install cable in duct lines. Install ground and neutral conductors in duct with the associated phase conductors. Install segments of direct-burial cable that cross under new railroad tracks, roads, or paving exceeding 1.5 m 5 feet in width, in plastic, or rubber duct encased in concrete in accordance with paragraph DUCT LINES. Pulling of cable into conduit from a fixed reel position is not permitted. At interfaces with direct-burial cable, center the direct-burial cable in the entrance to the duct, using an approved waterproof, nonhardening mastic compound to facilitate the centering. Where crossing existing railroad tracks, install coated rigid steel conduit under the tracks, in lieu of concrete-encased duct, in accordance with paragraph DUCT LINES in accordance with NFPA 70 and the regulations of the railroad.

3.2.4.3 Location of Cable Splices

Splices in direct-burial cable are not permitted in runs of 150 m 500 feet or less or at intervals of less than 150 m 500 feet in longer runs except as required for taps. Where cable splices in shorter intervals are required to avoid obstructions or damage to the cable, the location is as approved. Install cable splices in cable boxes or concrete handholes.

3.2.4.4 Markers

****

NOTE: Markers will be detailed on drawings in accordance with HREF=http://www.wbdg.org/ccb/DOD/UFC/ufc_3_550_01.pdf>UFC 3-550-01, "Exterior Electrical Power Distribution".

****

Locate cable and cable splice markers near the ends of cables, at each cable splice, approximately every 120 m 400 feet along the cable run, and at changes in direction of the cable run. Markers need not be placed along cables laid in relatively straight lines between lighting poles that are spaced less than 120 m 400 feet apart. Place markers approximately 600 mm 2 feet to the right of the cable or cable splice when facing the longitudinal axis of the cable in the direction of the electrical load. Provide concrete markers with a 28 day compressive strength of 17 MPa 2500 psi in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Impress the letter "C" in the top of each marker.

3.2.4.5 Warning Tape

Place direct burial cable below a plastic warning tape buried in the same trench or slot. Place a 0.127 mm 5 mil brightly colored plastic tape, not less than 75 mm 3 inches in width and suitably inscribed at not more than 3 m 10 feet on centers with a continuous metallic backing and a corrosion-resistant 0.0254 mm 1 mil metallic foil core to permit easy location of the buried cable, approximately 300 mm 12 inches below finished grade.

3.2.5 Messenger Cable

3.2.5.1 Installation

****
NOTE: Verify local electrical installation requirements to determine if new grounding conductors and electrodes are required at each messenger cable ground connection.
****

Attach messenger to poles with approved clamps,with not less than 15.9 mm 5/8 inch through bolts. Do not exceed 30 percent of messenger cable rated tensioning rated breaking strength under 16 degrees C 60 degrees F conditions of no ice and no wind. Stress messengers to a tension higher than the final tension in order to prestretch the cable, so that when the messenger is dead-ended under its final tension and sag, there is minimum variation from the calculated values.

3.2.5.2 Grounding and Bonding Connections

Ground messengers and guy at corners, dead-ends, and entrances to each facility. Ground at intervals not exceeding 300 m 1000 feet. [Provide new grounding conductors and electrodes at each ground connection.] [Where grounding connections are made in the vicinity of existing grounding conductors and electrodes, the grounding connection may be made by a bolted or welded connection to the existing grounding conductor.] Fusion weld connections below grade. Fusion weld connections above grade or use UL 467 approved connectors.

3.2.5.3 Grounding Conductors and Electrodes

Provide soft drawn copper ground conductors, having a current capacity of at least 20 percent of that of the messenger to which it is connected, no smaller than No. 6 AWG. Connect the ground conductor to a ground rod of [copper clad steel conforming to UL 467] [zinc coated steel conforming to IEEE C135.30] [solid stainless steel] not less than [15.9] [19.1] mm [5/8] [3/4] inch in diameter by [2.4] [3.1] m [8] [10] feet in length. After installation is completed, ensure that the top of the ground is approximately 300 mm 1 foot below finished grade. Protect the ground conductor by half-round wood, plastic, or fiber molding from the ground to a point at least 2.4 m 8 feet above the ground.

3.2.5.4 Ground Resistance Testing

Measure the resistance to ground using the fall-of-potential method described in IEEE 81. The ground resistance must be 25 ohms or less under normally dry conditions. Whenever the required ground resistance is not met provide additional electrodes, [interconnected with grounding conductors] [as indicated], to achieve the specified ground resistance. Provide additional electrodes [up to three [[2.4] [3] m [8] [10] [20] feet] long spaced a minimum of [3 m 10 feet apart for 10 foot long rods] [6 m 20 feet for 20 foot long rods]] [as a single extension type rod, [[15.9] [19.1] mm [5/8] [3/4] inch] in diameter, up to 9.1 m 30 feet long [driven perpendicular to grade] [coupled and driven with the first rod]]. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.

3.2.6 Aerial Cable Splices

Make splices in aerial cable within 900 mm 3 feet of a pole and place inside a watertight enclosure. Form drip loops at the cable entrance to the enclosure. Place lashing clamps within 300 mm 12 inches of the enclosure.

3.2.7 Lashing Wire

Wind lashing wire tightly around both the communication cable and the messenger cable by machine methods, with a minimum of one turn per 355.6 linear mm 14 linear inches and not less than the number of turns per linear meterfoot that is recommended by the cable manufacturer for the distance between cable support points and the combined ice and wind loading and extreme wind loading shown or normally encountered for the installed location. Place lashing clamps at all poles and splices.

3.2.8 Stress Loops

Form loops in the aerial cable at all points of connection and at all poles to prevent damage from thermal stress and wind loading. Protect aerial cable from chafing and physical damage with the use of spiral cut tubing and PVC tape, or plastic sleeves.

3.2.9 Connections to Buildings

****

NOTE: Where this guide specification is used for installation of a security and CCTV lighting system in an existing facility, delete the reference to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and incorporate pertinent paragraphs from the referenced guide specification.

****

Extend cables into the various buildings as indicated and properly connect to the indicated equipment. [Provide empty] [Empty] conduits to the indicated equipment from a point 1.5 m 5 feet outside the building wall and 600 mm 2 feet below finished grade [are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM]. After installation of cables, seal conduits to prevent moisture or gases from entering the building.

3.2.10 Duct Lines

3.2.10.1 Requirements

Provide the numbers and size of ducts as indicated, laying duct lines with a minimum slope of 100 mm/30 m 4 inches/100 feet. Depending on the contour of the finished grade, the high point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short radius manufactured 90 degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius is 450 mm 18 inches for ducts of less than 80 mm 3 inches in diameter, and 900 mm 36 inches for duct 80 mm 3 inches or greater in diameter; for long sweep bends use a minimum radius of 7.6 m 25 feet for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends,with a maximum curve of 30 degrees using manufactured bends. Provide ducts with end bells when duct lines terminate in manholes or handholes.

3.2.10.2 Treatment

Keep ducts clean of concrete, dirt, or foreign substances during construction. Make field cuts requiring tapers with proper tools and match factory tapers. Use a coupling recommended by the duct manufacturer when an existing duct is connected to a duct of different material or shape. Store ducts to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Thoroughly clean ducts before installation. Store plastic ducts on a flat surface and protected from the direct rays of the sun.

3.2.10.3 Concrete Encasement

****

NOTE: For crossings of existing railroads and airfield pavements greater than 15.2 m 50 feet in length, use the pre-drilling method or the jack-and-sleeve method.

****

Provide ducts requiring concrete encasements in compliance with NFPA 70, except for electrical duct bank configurations for ducts 150 mm 6 inches in diameter, which are determined by calculation and as shown on the drawings. Provide monolithic construction of duct line encasements. Where a connection is made to a previously poured encasement, bond or dowel the new encasement to the existing encasement. At any point, except railroad and airfield crossings, make tops of concrete encasements not less than the cover requirements listed in NFPA 70. At railroad and airfield crossings, encase duct lines with concrete and reinforce as indicated to withstand specified surface landings. Make tops of concrete encasement not less than 1.5 m 5 feet below tops of rails or airfield paving unless otherwise indicated. Where ducts are jacked under existing pavement, install rigid steel conduit. To protect the corrosion-resistant conduit coating, pre-drilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 15 m 50 feet in length, use the pre-drilling method or the jack-and-sleeve method. Use separators or spacing blocks of steel, concrete, plastic, or a combination of these materials placed not more than 1.2 m 4 foot on centers. Securely anchor ducts to prevent movement during the placement of concrete, and stagger joints at least 150 mm 6 inches vertically.

3.2.10.4 Non-encased Direct-Burial

****

NOTE: Specify cover requirements in accordance with NFPA 70 and ANSI C2. Specify frost line depth.

****

Install top of duct lines below the frost line depth of [_____] mm inches, but not less than [_____] mm inches below finished grade and install with a minimum of 75 mm 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 300 mm 12 inches of earth is required. Grade bottom of trenches toward manholes or handholes, smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches are comprised of materials other than sand, place a 75 mm 3 inch layer of sand first and compact to approximate densities of surrounding firm soil before installing ducts. Vertically stagger joints in adjacent tiers of duct at least 150 mm 6 inches, with the first 150 mm 6 inch layer of backfill cover of compacted sand as previously specified. Backfill and compact the rest of the excavation in 75 to 150 mm3 to 6 inch layers. Hold duct banks in alignment with earth; however, use a wooden frame or equivalent forms to hold ducts in alignment prior to backfilling for high tiered banks.

3.2.10.5 Installation of Couplings

Make joints in each type of duct in accordance with the manufacturer's recommendation for the particular type of duct and coupling selected and as approved. Make duct joints by brushing a plastic solvent on insides of plastic coupling fittings and on outsides of duct ends, then slip each duct and fitting together with a quick 1/4 turn to set the joint tightly.

3.2.10.6 Concrete

Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE, with plain concrete strength of, 17 MPa 2500 psi at 28 days, and reinforced concrete strength of 21 MPa 3000 psi at 28 days. Provide monolithic duct line encasement construction. Where a connection is made to an existing duct line, bond the concrete encasement or dowel to the existing encasement.

3.2.10.7 Duct Line Markers

Provide duct line markers [as indicated] [at the ends of long duct line stubouts or for other duct locations that are indeterminate because of duct curvature or terminations at completely below-grade structures]. In addition to markers, place a 0.127 mm 5 mil brightly colored plastic tape, not less than 75 mm 3 inches in width and suitably inscribed at not more than 3 m 10 feet on centers with a continuous metallic backing and a corrosion-resistant 0.0254 mm 1 mil metallic foil core to permit easy location of the duct line, approximately 300 mm 12 inches below finished grade levels of such lines.

3.2.11 Handholes

Determine the exact locations after carefully considering the locations of other utilities, grading, and paving. Secure approval of exact before construction is started.

3.2.11.1 Construction

Construct handholes as indicated on drawings, including appurtenances, with top, walls, and bottom consisting of reinforced concrete. Provide monolithic walls and bottom. Provide 21 MPa 3000 psi concrete at 28 days. Precast concrete handholes having the same strength and inside dimensions as cast-in-place concrete handholes may be used. In paved areas, make the top of entrance covers flush with the finished surface of the paving. In unpaved areas, set the top of entrance covers approximately 13 mm 1/2 inch above the finished grade. Where finished grades are in cut areas, install unmortared brick between the top of handhole and entrance frame to temporarily elevate the entrance cover to existing grade level. Where duct lines enter walls, the sections of duct may be cast in the concrete or may enter the wall through a suitable opening. Caulk the openings around entering duct lines tight with lead wool or other approved material.

3.2.11.2 Appurtenances

Provide the following appurtenances for each handhole.

3.2.11.3 Cable Pulling-in Irons

Install a cable pulling-in iron in the wall opposite each duct line entrance.

3.2.11.4 Ground Rods

In each handhole, at a convenient point close to the wall, drive a ground rod conforming to paragraph GROUNDING CONDUCTORS AND ELECTRODES, into the earth before the floor is poured; with approximately 100 mm 4 inches of the ground rod extending above the floor after pouring. When precast concrete units are used, the top of the ground rod may be below the floor; bring a No. 1/0 AWG copper ground conductor inside through a watertight sleeve in the wall.

3.2.12 Lighting

****

NOTE: Following a power outage, a minimum of 10.8 lux (1 foot candle) at grade within 30 seconds is required. Requirement may be met by including dual re-strike element lamps for instant re-strike, using incandescent fixtures for backup lighting or by 5 minute UPS to allow standby power to pickup lighting loads. When the asset being protected justifies the additional cost, consider interleaving of power circuits for additional security and reliability. When interleaving is used, the loss of any one circuit should not significantly reduce the visual detection of intruders. Interleaving may also be useful in reducing the power demand for backup power sources.

****

3.2.12.1 Lamps

Deliver lamps of the proper type, wattage, and voltage rating to the project in the original containers and install in the fixtures just before completion of the project.

3.2.12.2 Fixture Installation

Install standard fixtures as detailed on Standard Detail No. 40-06-04, Sheet Nos. [_____] [_____][, which accompany and form a part of this specification]. Provide special fixtures as indicated on drawings. Illustrations shown [on these sheets or] on the drawings are indicative of the general type desired and are not intended to restrict selection of fixtures to any particular manufacturer. Fixtures of similar design, equivalent light-distribution and brightness characteristics, and equal finish and quality are acceptable as approved.

a. Accessories

Install accessories such as straps, mounting plates, nipples, or brackets as required for proper installation.

b. In-Line Fuses

Provide an in-line fuse for each fixture.

c. Special Fixtures

The types of special fixtures are designated by letters and numbers. For example, SP-1 denotes special type 1.

3.2.13 Transformer Installation

Install transformers for lighting fixtures on [aluminum] [or steel] [or concrete] poles in the transformer base. Provide a transformer base for poles that require transformers. Securely mount transformers to steel supporting plates and bolt to wood poles.

3.2.14 CCTV Alarm Interface

****

NOTE: Delete this paragraph if assessment infrared lights are not used. Determine the number of alarm inputs needed for the alarm interface. Calculate the percentage of expansion for future needs, and determine if 10 percent is adequate.

****

Furnish and install an alarm interface with the lighting control system, compatible with the CCTV alarm annunciation system. Monitor alarm closures for processing by the system CPU with the alarm. Provide alarm inputs to the alarm interface by relay contact or through an TIA-232 interface, modular and allowing for system expansion. Configure the alarm interface to be installed at the site to handle [_____] alarm points, with an expansion capability of not less than [10] [_____] percent. Provide an output to actuate a video recorder.

3.3 FIELD QUALITY CONTROL

3.3.1 Test for CCTV Assessment Lighting

****

NOTE: Omit this paragraph if the lighting is not used for CCTV Assessment.

****

Submit CCTV assessment lighting test procedures and reports. After receipt by the Contractor of written approval of the test procedures, schedule the tests. Deliver the final test procedures report after completion of the tests.

Perform site testing and adjustment of the completed CCTV lighting, in conjunction with Section 28 10 05 ELECTRONIC SECURITY SYSTEM ACCEPTANCE TESTING. Provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Give written notification of planned testing to the Government at least 14 days prior to the test. In the test procedures, explain, in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. Do not give notice until after receiving written approval of the specific test procedures. Use the test reports to document results of the tests. Deliver the reports to the Government within 7 days after completion of each test.

3.3.2 Operating Test

Submit operating test procedures and reports for the operating test to the Contracting Officer for approval. After receipt of written approval of the test procedures, schedule the tests. Deliver the final Operating Test procedures report after completion of the tests.

After the installation is completed and at such time as the Contracting Officer may direct, conduct an operating test for approval, in the presence of the Contracting Officer. Demonstrate that the equipment operates in accordance with the requirements specified. Furnish instruments and personnel required for the test The Government will furnish the necessary electric power.

3.3.3 Ground Resistance Measurements

Submit the measured resistance to ground of each separate grounding installation,in writing, indicating the location of the rods, the resistance of the soil in ohms per millimeter and the soil conditions at the time the measurements were made.

Measure the resistance to ground by the fall-of-potential method described in IEEE 81.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Operations and Maintenance Manuals

Submit a draft copy of the operation and maintenance manuals, prior to beginning the tests for use during site testing. Submit final copies of the manuals as specified bound in hardback, loose-leaf binders, within 30 days after completing the field test. Update the draft copy used during site testing with any changes required, prior to final delivery of the manuals. Identify each manual's contents on the cover. Include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. Provide the manuals with a table of contents and tab sheets. Place tab sheets at the beginning of each chapter or section and at the beginning of each appendix. Include, upon delivery of the final copies, modifications made during installation checkout and acceptance.

3.4.2 Record Drawings

Maintain and keep up to date, a separate set of drawings, elementary diagrams and wiring diagrams of the lighting to be used for "record" drawings, showing all changes and additions to the lighting system. In addition to being complete and accurate, keep this set of drawings separate and do not use for installation purposes. Upon completion of the record drawings, a representative of the Government will review the as-built work with the Contractor. If the as-built work is not complete, the Contractor will be so advised and complete the work as required.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 55 80 (November 2020)**

Preparing Activity: NAVFAC

Superseding
UFGS-26 55 80.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 26 - ELECTRICAL

SECTION 26 55 80

SURGICAL, PROCEDURE AND EXAM LIGHTING FIXTURES

11/20

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SECTION 26 55 80

SURGICAL, PROCEDURE AND EXAM LIGHTING FIXTURES
11/20

****
NOTE: This guide specification covers the requirements for surgical lighting fixtures and similar related specialties.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATION FOR THE ADVANCEMENT OF MEDICAL INSTRUMENTATION (AAMI)

ANSI/AAMI ES60601-1	(2005; R 2012) Medical Electrical Equipment - Part 1: General Requirements for Basic Safety and Essential Performance

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60601-2-41	(2013) Medical Electrical Equipment – Part 2-41: Particular Requirements for the Basic Safety and Essential Performance of Surgical Luminaires and Luminaires for Diagnosis

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 99	(2024) Health Care Facilities Code

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy

and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Structural Support; G, [_____]

[Structural Shop Drawings; G, [_____]

] SD-03 Product Data

Light Fixtures; G, [_____]

Fixture Arm Supports; G, [_____]

Wall Controls; G, [_____]

SD-09 Manufacturer's Field Reports

Installation Report; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual; G, [_____]

1.3 OPERATION AND MAINTENANCE MANUAL

Include the following information for each light fixture in the operation and maintenance manual:

a. Vendor/manufacturer product data

b. Assembly information

c. Mounting details: structural support, wiring, transformers, all accessories and co-ordination with architectural features and finishes

d. Wiring diagram(s)

e. Recommended maintenance

f. Infection control measures, [sterile removable fixture covers][or][removable sterilizable handles]

g. Replacement parts list

[h. Structural support shop drawings and supporting calculations

]1.4 QUALITY CONTROL

1.4.1 Structural Support[and Structural Shop Drawings]

Coordinate structural support with vendor/manufacturer, building structural system and other MEP services.[Use[prefabricated] supporting frames with welded joints to the greatest extent possible.] Comply with 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT. Include the following information for the structural support submittal for each light fixture:

a. Vendor/manufacturer's structural design data.

b. Structural shop drawings indicating the construction method, materials, arrangement and attachment to the building structure and the light fixture arm[signed and sealed by a registered engineer].

[c. Structural calculations signed and sealed by a registered engineer.

]1.5 DELIVERY, STORAGE, AND HANDLING

Deliver equipment, components, and materials in original packaging, labeled with the manufacturer/vendor, brand name and part number(s) as appropriate. Inspect equipment, components, and materials upon receipt. Remove and replace damaged items. Comply with manufacturers/vendors instructions and recommendations for storage and handling of all equipment, components, and materials. Protect materials and components from deleterious environments including weather, direct sunlight, temperature, moisture, contamination, corrosion, and construction traffic.

PART 2 PRODUCTS

2.1 LIGHT FIXTURES

Submit the following for each light fixture:

a. Vendor/manufacturer product data.

b. Assembly information, including wiring, transformers, all accessories and coordination with architectural features and finishes.

c. Mounting details including structural support.

d. Wiring diagrams for power and communication.

e. Infection control measures.

2.1.1 Design Requirements

Provide surgical lighting fixtures for use in surgical operating rooms, with the following characteristics:

a. Comply with IEC 60601-2-41 and ANSI/AAMI ES60601-1.

b. Electrical service: [120][120-240] volts, [60][50/60] Hz, single-phase, three-wire grounded circuits.

c. Maximum allowable fixture current leakage 0.1 milliampere, measured between metal parts and ground.

d. Restricted frequency ranges for ballasts, drivers, and controls: 20KHz to 25KHz, 32KHz to 39KHz, and above 60KHz. Avoid interference with medical devices.

e. Infection control: [sterile removable fixture covers][or][removable sterilizable handles].

[2.1.2 Surgical Light Fixtures[- JSN [_____]]

Ceiling mounted with [one][two][three] light head[s][and [one][two] flat screen displays on radial arm(s)]. Radial arms to provide [minimum of 330][360][_____] degree rotation[with limit stop]. [LED][_____] light source with illumination level of [160,000][_____] lux at working distance of [32-47][39.37][_____] inches with a[n adjustable] pattern size between [6.5-9.5][_____] inches, and shadow reduction capability. Provide color temperature [between][of][3500-5000][4000][4500][5000][, adjustable] with a color rendering index (Ra) of [96][_____] (minimum) and (R9) of [90][_____] (minimum). Minimum service life [40,000][_____] hours. Provide [recessed][surface mount] wall controller[with ____].[Configure [each][_____] light head for camera installation.]

][2.1.3 Surgical Light Fixtures - Minor Surgery and Procedure Room[- JSN [_____]]

[Ceiling mounted][_____] with [one][two] light head[s][and flat screen display on radial arm]. Radial arm(s) to provide [minimum 330][_____] degree rotation[with limit stop]. [LED][_____] light source with illumination level of [50,000][80,000][125,000][_____] lux at working distance of [at least 12][39.37][_____] inches, with a[n adjustable] pattern size [of at least 6][_____] inches[and shadow reduction capability]. Provide color temperature [between][of][3500-5000][4500][5500][, adjustable] with a color rendering index (Ra) of [at least 95][96][_____] and (R9) of [90][_____] (minimum). Minimum service life [40,000][_____] hours. Provide [recessed][surface mount] wall controller[with [on/off control with dimming][_____]].[Configure[each] light head for camera installation.]

][2.1.4 Exam Light Fixtures[- JSN [_____]]

[Wall Mounted][Ceiling mounted][_____] with one light head. Radial arm to provide [minimum 330][_____] degree rotation[with limit stop]. [LED][_____] light source with illumination level of [20,000][50,000][_____] lux at working distance of [at least 12][_____] inches, with a[n adjustable] pattern size [of at least 4][_____] inches[and shadow reduction capability]. Provide color temperature [between 3600-5500][of ___][with a color rendering index (Ra) of [at least 95][_____]] and (R9) of [90][_____] (minimum). Minimum service life [40,000][_____] hours. Provide [switch mounted on light head][touchless on/off][wall controller][_____].

][2.1.5 Labor and Delivery Light Fixtures[- JSN M7440]

Recessed, ceiling mounted fixture with [one][two] light head[s][, with each light head in a recessed enclosure]. [LED][_____] light source with an illumination level of [43,000][_____] lux with[remote] rotation adjustment of [25][30][_____] degrees. Provide color temperature [between

3600-5500][4400][with a color rendering index (Ra) of [at least 95][_____]] and (R9) of [90][_____]. Minimum service life [40,000][_____] hours. Provide wall controller to control light intensity and light head position.

]2.2 FIXTURE ARM SUPPORTS

Mount lighthead[s][and flat screen display(s)] on an arm assembly. Configure the lighthead[s][and flat screen display(s)] to rotate within a clearance circle of [15 1/2][_____] feet. Provide vertical height adjustment to allow positioning of fixture[s][and displays] between [3 feet 11 inches][_____] and [7 feet 6 inches][_____] above the floor. Provide control for fixture within[and outside of] sterile field. Enable free, smooth, and silent movement of each arm assembly throughout its range of maneuverability without drifting, regardless of its position.[Provide fully independent repositioning throughout the full range of movement for each arm on a single multi-fixture mount, bypassing other components.]

2.3 WALL CONTROLS

[Recessed][or][Surfaced] mounted. Include[overcurrent protection,] on/off switch located outside the sterile field and indicator light.

PART 3 EXECUTION

3.1 INSTALLATION

Reference section 11 70 00 GENERAL REQUIREMENTS FOR MEDICAL AND DENTAL EQUIPMENT, NFPA 99 and NFPA 70. Install [surgical][,][exam][,][and][labor and delivery] light assembly and fixture arm supports in accordance with the approved installation drawings and manufacturer's instructions and recommendations for each assembly.

3.1.1 Wiring Methods

Provide conduit, wiring, and rough in for each light assembly[and any future add-on option(s)] in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2 FIELD QUALITY CONTROL

3.2.1 Installation Report

For each assembly submit a [vendor/manufacturer][factory-authorized installer] installation report confirming each light fixture and associated equipment has been properly installed, adjusted and tested, and meets the manufacturer's installation requirements.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-26 56 00 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 56 00 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-26 56 00 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-26 56 00 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 26 56 00

EXTERIOR LIGHTING

08/21

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NOTE: This guide specification covers lighting and lighting control system requirements for exterior installations.

This specification does not cover all possible methods or requirements for exterior lighting; therefore, designer should add special information required to suit a specific project. Industry publications exist to aid the designer in choosing the best lighting system for the project. Publications include, but are not limited to, the Illuminating Engineering Society (IES) 'Lighting Handbook, 10th Edition' and RP-8, 'Recommended Practice for Roadway Lighting.'

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: For supplemental information regarding UFGS 26 56 00, including PDF and CAD downloads of luminaire plates, go to:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-

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NOTE: This section contains the following luminaire plates (also referred to as 'sketches' or 'details'.) These are available in metric (SI) and U.S. Customary (IP) system dimensions. Plate titles and style numbers are unchanged for both units.

Do not include list of plates, of plates themselves, in project specifications. Use luminaire plates as details on drawings whenever possible. If special features are required, do not modify plates, but indicate these changes as notes in luminaire schedule. The "XL" style numbers and dates must remain on the drawing details. If additional luminaire types are needed that are not covered in plates, provide additional sketches or details on drawings, but do not label as XL plate type.

PLATE NUMBER	Title
XL-1	LED ROADWAY LUMINAIRE
XL-2	LED AREA LUMINAIRE
XL-3	LED PEDESTRIAN LUMINAIRE
XL-4	LED ILLUMINATED BOLLARD
XL-5	LED PARKING LOT LUMINAIRE
XL-6	LED PARKING GARAGE LUNINAIRE
XL-7	LED EXTERIOR STEP LIGHT
XL-8	LED EXTERIOR WALL SCONCE
XL-9	LED EXTERIOR DECORATIVE WALL SCONCE
XL-10	LED WALL PACK
XL-11	EXTERIOR RECESSED DOWNLIGHT
XL-12	LED LINEAR WALL WASH
XL-13	AVIATION OBSTRUCTION LUMINAIRE
XL-14	LED FLOOD LUMINAIRE
XL-15	DIRECT-SET FIBERGLASS POLE
XL-16	DIRECT-SET CONCRETE POLE
XL-17	DIRECT-SET STEEL/ALUMINUM POLE
XL-18	ANCHOR BASE FIBERGLASS POLE

PLATE NUMBER	Title
XL-19	ANCHOR BASE STEEL/ALUMINUM POLE
XL-20	ANCHOR BASE CONCRETE POLE
XL-21	ANCHOR BASE POLE FOUNDATION
XL-22	DIRECT SET POLE GROUNDING DETAIL
XL-23	LUMINAIRE MOUNTING ARM DETAILS
XL-24	LUMINAIRE MOUNTING ARM DETAILS
XL-25	LUMINAIRE MOUNTING BRACKET DETAILS
XL-26	LUMINAIRE MOUNTING BRACKET DETAILS
NOTE: Do not include this index in project specification.	

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NOTE: Include the following information on the project drawings:

1. Luminaire schedule indicating luminaire symbol; luminaire type; XL plate number and type designation; light source; voltage; input watts; delivered lumen output; efficacy; CCT; CRI; LED driver; dimming; mounting; NEMA distribution if applicable; BUG rating if applicable; and any other applicable options or notes.

2. Location and mounting height of all luminaires and required accessories such as, mounting brackets and poles.

3. Referenced XL plate number or detail (if no XL plate is available) for each luminaire type provided.

4. All accessories required, such as mounting hardware, mounting brackets, arms, NEMA 7-pin receptacles, remote drivers, emergency back-up, sensors and control equipment, and central emergency system components.

5. Control strategy description for each given area.

6. Extent and location of the work to be accomplished with wiring and equipment necessary for a complete installation.

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NOTE: Demolition work that involves disposal of fluorescent and HID light sources and ballasts will require the use of Section 02 84 16 HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

ATIS ANSI O5.1	(2017) Wood Poles -- Specifications & Dimensions

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LTS	(2013; Errata 2013) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA U1	(2024) Use Category System: User

Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1089	(2013) Standard Specification for Spun Cast Prestressed Concrete Poles
ASTM G154	(2023) Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24	(2016) Building Energy Efficiency Standards For Residential and Nonresidential Buildings

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79	(2019) Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
ANSI/IES LM-80	(2020) Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
ANSI/IES LP-11	(2020) Lighting Practice: Environmental Considerations for Outdoor Lighting
ANSI/IES LS-1	(2020) Lighting Science: Nomenclature and Definitions for Illuminating Engineering
ANSI/IES RP-8	(2018; Addenda 1 2020; Errata 1-2 2021) Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting
ANSI/IES TM-15	(2020) Technical Memorandum: Luminaire

	Classification System for Outdoor Luminaires
ANSI/IES TM-21	(2021) Technical Memorandum: Projecting Long-TermLuminous, Photon, and Radiant Flux Maintenance of LED Light Sources
IES Lighting Library	IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C136.3	(2020) Roadway and Area Lighting Equipment - Luminaire Attachments
ANSI C136.13	(2020) Roadway and Area Lighting Equipment - Metal Brackets for Wood Poles
ANSI C136.21	(2014) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
ANSI C136.41	(2013) Roadway and Area Lighting Equipment-Dimming Control Between an External Locking Type Photocontrol and Ballast or Driver
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2024) Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77-10	(2020) Harmonic Emission Limits - Related Power Quality Requirements
NEMA C136.10	(2023) American National Standard for Roadway and Area Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles--Physical and Electrical Interchangeability and Testing
NEMA C136.20	(2012; R 2021) Roadway and Area Lighting Equipment - Fiber Reinforced Composite (FRC) Lighting Poles
NEMA C136.31	(2023) Roadway and Area Lighting Equipment - Luminaire Vibration

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA IEC 60529	(2004) Degrees of Protection Provided by Enclosures (IP Code)
NEMA SSL 1	(2016) Electronic Drivers for LED Devices, Arrays, or Systems
NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination
NEMA WD 7	(2011; R 2016; R 2021) Occupancy Motion Sensors Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS Bull 1728F-700	(2011) Specification for Wood Poles, Stubs, and Anchor Logs

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UL SOLUTIONS (UL)

UL 773	(2016; Reprint Jul 2020) UL Standard for Safety Plug-In, Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2016; Reprint Jan 2024) UL Standard for Safety Nonindustrial Photoelectric Switches for Lighting Control
UL 916	(2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment
UL 924	(2016; Reprint Dec 2022) UL Standard for Safety Emergency Lighting and Power Equipment
UL 1310	(2018; Reprint Jun 2022) UL Standard for Safety Class 2 Power Units
UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires
UL 8750	(2020; Reprint Aug 2024) UL Standard for Safety Light Emitting Diode (LED)

Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

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NOTE: Select applicable tri-service, Army, Navy, Air Force specification section reference(s).

For the purpose of this document, exterior luminaires include luminaires mounted in exterior environments that are not attached to the building. Luminaires attached to the exterior of the building are specified in Section 26 51 00 INTERIOR LIGHTING.

****

Materials not considered to be luminaires, luminaire accessories, or lighting equipment are specified in Section(s) [33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION] [33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION]. Luminaires and accessories installed in interior of buildings or attached to the exterior of a building are specified in Section 26 51 00 INTERIOR LIGHTING. Cybersecurity requirements are specified in Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. Commissioning requirements are specified in Section 01 91 00.15 BUILDING COMMISSIONING.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications and on the drawings must be as defined in IEEE 100 and ANSI/IES LS-1.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in ANSI/IES LM-80.

c. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

d. Total Harmonic Distortion (THD) is the Root Mean Square (RMS) of all the harmonic components divided by the total fundamental current.

e. The "Groundline Section" of wood poles is that portion of the pole between 305 mm one foot above, and 610 mm 2 feet below the groundline.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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NOTE: Luminaire shop drawings are required for custom luminaires, luminaires specified to a specific custom length, or linear luminaires with lengths greater than 2.5 meters 8 feet.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G, [_____]

Pole Drawings; G, [_____]

Control System One-Line Diagram; G, [_____]

Sequence of Operation for Exterior Lighting Control System; G, [_____]

SD-03 Product Data

Luminaires; G, [_____]

Light Sources; G, [_____]

LED Drivers; G, [_____]

Luminaire Warranty; G, [_____]

Lighting Controls Warranty; G, [_____]

Pole Warranty; G, [_____]

Dimming Panel; G, [_____]

Motion Sensors; G, [_____]

Photosensors; G, [_____]

Time Clock; G, [_____]

Lighting Contactor; G, [_____]

Poles; G, [_____]

Brackets

Obstruction Marker Luminaires; G, [_____]

[SD-04 Samples

Luminaire Samples; G, [_____]

] SD-05 Design Data

Luminaire Design Data; G, [_____]

Photometric Plan; G, [_____]

SD-06 Test Reports

ANSI/IES LM-79 Test Report; G, [_____]

ANSI/IES LM-80 Test Report; G, [_____]

ANSI/IES TM-21 Test Report; G, [_____]

Pressure Treated Wood Pole Quality; G, [_____]

Tests for Fiberglass Poles; G, [_____]

SD-08 Manufacturer's Instructions

Poles

SD-10 Operation and Maintenance Data

Lighting System, Data Package 5; G, [_____]

Exterior Lighting Control System, Data Package 5; G, [_____]

Maintenance Staff Training Plan; G, [_____]

End-User Training Plan; G, [_____]

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES Lighting Library as applicable, for the lighting system specified.

1.5.1 Drawing Requirements

1.5.1.1 Luminaire Drawings

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NOTE: EPA and weight must be included in the luminaire drawings for pole-mounted luminaires.

Aiming diagrams are required for applications with directional luminaires, such as adjustable landscape and tree lighting, sports lighting, and wallwash applications.

****

Include dimensions,[effective projected area (EPA), weight,] accessories, and installation and construction details. Photometric data, including CRI, CCT, TM-15-11 BUG rating, LED driver type,[aiming diagram,] zonal lumen data, and candlepower distribution data per LM-79 must accompany shop drawings.

1.5.1.2 Pole Drawings

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NOTE: Wind loads for roadway luminaires are defined by AASHTO LTS. For other non-roadway poles, use ASCE 7-16.

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Include dimensions, wind load determined in accordance with [AASHTO LTS][ASCE 7-16], pole deflection, pole class, and other applicable information.[For concrete poles, include: section and details to indicate quantities and position of prestressing steel, spiral steel, inserts, and through holes; initial prestressing steel tension; and concrete strengths at release and at 28 days.]

1.5.2 Luminaire Design Data

a. Provide distribution data according to IES classification type as defined in IES Lighting Library and ANSI/IES RP-8.

b. B.U.G. rating for the installed position as defined by ANSI/IES TM-15 and shielding as defined by ANSI/IES RP-8.

c. Provide safety certification and file number for the luminaire family. Include listing, labeling and identification in accordance with NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

d. Provide long term lumen maintenance projections for each LED luminaire in accordance with ANSI/IES TM-21. Data used for projections must be obtained from testing in accordance with ANSI/IES LM-80.

e. Provide wind loading calculations for luminaires mounted on poles. Weight and effective projected area (EPA) of luminaires and mounting brackets must not exceed maximum rating of pole as installed in particular wind zone area.

1.5.3 ANSI/IES LM-79 Test Report

Submit test report on manufacturer's standard production model of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "14.0 Test Report" in ANSI/IES LM-79.

1.5.4 ANSI/IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "8.0 Test Report" in ANSI/IES LM-80.

1.5.5 ANSI/IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in ANSI/IES TM-21.

1.5.6 Tests for Fiberglass Poles

a. Ultraviolet resistance tests: Perform according to ASTM G154 using a UV-B light source having a 313 nanometer wavelength, operated at 54 degrees C 130 degrees F, cycling the light source on for 4 hours and off for 4 hours for a total test period of 1500 hours minimum with the following results:

Fiber exposure:	None
Crazing:	None
Checking:	None
Chalking:	None
Color:	May dull slightly

b. Flexural strength and deflection test: Test loading must be as a cantilever beam with pole butt as fixed end and a force simulating wind load at the free end.

1.5.7 Pressure Treated Wood Pole Quality

Ensure the quality of pressure treated wood poles. Furnish an inspection report (for wood poles) of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with AWPA U1 and RUS Bull 1728F-700 standards. The RUS approved Quality Mark "WQC" on each pole will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

[1.5.8 Photometric Plan

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NOTE: Require photometric plans and design criteria to be submitted if the project is a Design-Build project and will not have an engineer or designer producing photometrics during design.

Select ANSI/IES RP-8 for roadway and parking facilities photometric plans and ANSI/IES LP-11 for all other exterior environment scenarios.

For roadway designs, require average maintained luminance.

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For [roadways][parking lots][intersections][_____] include computer-generated photometric analysis of the "designed to" values in accordance with [ANSI/IES RP-8][ANSI/IES LP-11] for the "end of useful life" of the luminaire installation using a light loss factor of 0.81. Provide photometric plans that meet criteria in the Basis of Design in the project plans. Include the following in the submittal:

a. Horizontal illuminance measurements at finished grade, taken at a maximum grid size of 3050 mm 10 feet by 3050 mm 10 feet.

b. Vertical illuminance measurements at 1500 mm 5 feet above finished grade at all sidewalks and crosswalks, taken at a maximum of 3050 mm 10 feet.

c. Minimum and maximum lux footcandle levels.

d. Average maintained lux footcandle level.

e. Maximum to minimum ratio for horizontal illuminance only.

[f. Average maintained luminance in candela per square meter.

]]1.5.9 Test Laboratories

Test laboratories for the ANSI/IES LM-79 and ANSI/IES LM-80 test reports must be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program.

b. One of the qualified labs listed on the Department of Energy - Energy Efficiency & Renewable Energy, Solid-State Lighting web site.

c. One of the EPA-Recognized Laboratories listed at for LM-80 testing.

1.5.10 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory provisions of NFPA 70 unless more stringent requirements are specified or indicated. Provide luminaires and assembled components that are approved by and bear the label of UL for the applicable location and conditions unless otherwise specified.

1.5.11 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for six months prior to bid opening. The six-month period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the six-month period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.11.1 Alternative Qualifications

Products having less than a six-month field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.11.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of delivery to site, unless specified otherwise.

1.6 DELIVERY, STORAGE, AND HANDLING OF POLES

1.6.1 Aluminum Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.6.2 Steel Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.6.3 Wood Poles

Do not store poles on ground. Stack poles stored for more than 2 weeks on decay-resisting skids arranged to support the poles without producing noticeable distortion. Store poles to permit free circulation of air; the bottom poles in the stack must be at least 305 mm one foot above ground level and growing vegetation. Do not permit decayed or decaying wood to remain underneath stored poles. Do not drag treated poles along the ground. Do not use pole tongs, cant hooks, and other pointed tools capable of producing indentation more than 25 mm one inch in depth in handling the poles. Do not apply tools to the groundline section of any pole.

1.6.4 Fiberglass Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.6.5 Concrete Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation.

1.7 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7.1 Luminaire Warranty

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

    (1) Finish warranty must include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

    (2) Material warranty must include:

        (a) All LED drivers and integral control equipment.

        (b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.

c. Provide replacements that are promptly shipped, without charge, to the using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and installation.

1.7.2 Lighting Controls Warranty

Provide and transfer to the government the original lighting controls manufacturers standard commercial warranty for each different lighting controls manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Warranty service must be performed by a factory-trained engineer or technician.

a. Unless otherwise noted, provide a written five year minimum warranty on the complete system for all systems with factory commissioning. Provide warranty that covers 100 percent of the cost of any replacement parts and services required over the five years which are directly attributable to the product failure. Failures include, but are not limited to, the following:

(1) Software: Failure of input/output to execute switching or dimming commands.

(2) Damage of electronic components due to transient voltage surges.

(3) Failure of control devices, including but not limited to photosensors and motion sensors.

b. Provide a written five year minimum warranty on all input devices against defect in workmanship or materials provided by device manufacturer.

c. Provide a written five year minimum warranty on all control components attached to luminaires against defect in workmanship or materials.

1.7.3 Pole Warranty

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NOTE: Three year pole warranty is preferred.
Select one year when three years is not available.
****

Provide and transfer to the government the original pole manufacturers standard commercial warranty for each different pole manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Provide a written [3] [one] year minimum replacement warranty for material, luminaire finish, and workmanship. Warranty service must be performed by a factory-trained engineer or technician.

1.8 OPERATION AND MAINTENANCE MANUALS

1.8.1 Lighting System

Provide operation and maintenance manuals for the lighting system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting system. Additional O&M Manual requirements for the Army are provided in Section 01 78 24.00 10 FACILITY DATA REQUIREMENTS. Additional requirements for the Navy are provided in Section 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW). Include the following:

a. Manufacturers' operating and maintenance manuals.

b. Luminaire shop drawings for modified and custom luminaires.

c. Luminaire Manufacturers' standard commercial warranty information as specified in paragraph LUMINAIRE WARRANTY.

1.8.2 Exterior Lighting Control System

Provide operation and maintenance manuals for the exterior lighting control system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the exterior lighting control system. Include the following:

a. Control System One-Line Diagram

b. Product data for all devices, including installation and programming instructions.

c. Training materials, such as videos or in-depth manuals, that cover basic operation of the lighting control system and instructions on modifying the control system. Training materials must include calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

[d. Motion sensor coverage layout.

]PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

****

NOTE: Only require the acquisition of samples for luminaire installations that warrant mock-ups, such as wall grazing unique materials, or for applications where aesthetics are of high priority.

****

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule and XL plates or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the LED driver and light source provided.

[2.2.1 Luminaire Samples

****

NOTE: Only require the acquisition of samples for luminaire installations that warrant mock-ups, such as wall grazing unique materials, for custom luminaires, or for applications where aesthetics are of high priority.

****

Submit one sample of each luminaire type [_____], complete with light source and LED driver rated for 120 V operation, and 2 meters 6 feet pigtail with 3-prong Edison plug. Sample will be returned to the Contractor for installation in the project work.

]2.2.2 Luminaires

****

NOTE: 40 degrees C 104 degrees F is "standard" upper level rating of most LED luminaires. Choose higher 50 degrees C 122 degrees F rating when an installation location warrants a higher ambient temperature rating and the additional cost it incurs.

Provide design information including delivered lumen output, L70 lumen maintenance data, and luminaire

efficacy in luminaire schedule on project plans.
****

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

a. Complete system with LED drivers and light sources.

b. Housing constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.

c. ANSI/IES TM-21, ANSI/IES LM-80. Minimum L70 lumen maintenance value of 50,000 hours unless otherwise indicated in the luminaire schedule. Luminaire drive current value must be identical to that provided by test data for luminaire in question.

d. Minimum efficacy as specified in the luminaire schedule. Theoretical models of initial lamp lumens per watt are not acceptable. If efficacy values are not listed in the luminaire schedule, provide luminaires that meet the following minimum values:

Luminaire Style	Minimum Luminaire Efficacy
Area and Roadway (pole mounted, arm mounted)	119 LPW
Pedestrian Post-Top (pole mounted, arm mounted)	97 LPW
Bollard	45 LPW
Accent (adjustable landscape, sign lighting)	35 LPW
Linear Accent (facade, wallwash)	80 LPW
Exterior Wall Sconce	50 LPW
Steplight	30 LPW
Parking Garage Luminaire	113 LPW

e. Product rated for operation within an ambient temperature range of minus 30 degrees C minus 22 degrees F to[40 degrees C 104 degrees F][50 degrees C 122 degrees F].

f. UL listed for wet locations.[Optical compartment for LED luminaires must be sealed and rated a minimum of IP65 per NEMA IEC 60529.]

g. IES Lighting Library. Light distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans.

h. Housing finish that is baked-on enamel, anodized, or baked-on powder coat paint. Finish must be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.

i. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.

j. ANSI/IES TM-15. Does not exceed the BUG ratings as listed in the luminaire schedule. If BUG ratings are not listed in the luminaire schedule, provide luminaires that meet the following minimum values for each application and mounting conditions:

Lighting Application	Mounting Conditions	BUG Rating
Area and Roadway	All	B3-U0-G3
Pedestrian Post-Top	All	B2-U1-G1
Exterior Wall Sconce	Above 1.2 meters 4 feet AFF	B1-U0-G2
Exterior Wall Sconce	Below or at 1.2 meters 4 feet AFF	B4-U0-G4
Steplight	Above 1.2 meters 4 feet AFF	B1-U1-G2
Steplight	Below or at 1.2 meters 4 feet AFF	B4-U1-G4
Parking Garage Luminaire	Ceiling mounted	B4-U4-G3

k. Fully assembled and electrically tested prior to shipment from factory.

l. Finish color is as indicated in the luminaire schedule or detail on the project plans.

m. Lenses constructed of [clear][frosted] tempered glass or UV-resistant acrylic.[Provide polycarbonate vandal-resistant lenses.]

n. All factory electrical connections are made using crimp, locking, or latching style connectors. Twist-style wire nuts are not acceptable.

o. NEMA C136.31. Comply with 3G vibration testing.

[p. Luminaire arm bolts constructed from 304 stainless steel or zinc-plated steel.

][q. Wiring compartment on pole-mounted, street and area luminaires is accessible without the use of hand tools to manipulate small screws, bolts, or hardware.

][r. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, LED drivers, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

][s. ANSI C136.3. For all roadway and area luminaires, provide products with an integral tilt adjustment of plus or minus 5 degrees to allow the unit to be leveled.

][2.2.3 Obstruction Marker Luminaires

****

NOTE: Do not use LED obstruction luminaires for Air Force projects. See Air Force ETL 11-29 "Use of Light-Emitting Diode (LED) Fixtures in Airfield Lighting Systems on Air Force Installations and

Enduring/Contingency Locations" for more information.

****

Provide obstruction marker luminaires for facilities as required by the FAA and in accordance with Section 26 56 20 AIRFIELD AND HELIPORT LIGHTING AND VISUAL NAVIGATION AIDS.

]2.3 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type, lumen rating, and wattage as indicated in luminaire schedule on project plans.

2.3.1 LED Light Sources

****

NOTE: A color temperature of 3000 K is standard for most applications. When specifically desired by the designer, a nominal color temperature of 2700 K, 3500 K, or 4000 K may be selected. The highest allowable CCT is 4100 K.

For area and roadway projects where color detection is not of high importance, select a CRI of 70.

****

Provide LED light sources that meet the following requirements:

a. NEMA ANSLG C78.377. Emit white light and have a nominal Correlated Color Temperature (CCT) of [3000][2700][3500][4000] Kelvin.

b. Minimum Color Rendering Index (CRI) of [80][70].

c. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

d. Light source color consistency by utilizing a binning tolerance within a 4-step McAdam ellipse.

2.4 LED DRIVERS

****

NOTE: 40 degrees C 104 degrees F is "standard" upper level rating of most LED luminaires. Choose higher 50 degrees C 122 degrees F rating when an installation location warrants a higher ambient temperature rating and the additional cost it incurs.

Require a dimmable driver for all exterior lighting that will be reduced at curfew in accordance with the lighting control strategies in the project plans.

****

NEMA SSL 1, UL 1310. Provide LED Drivers that are electronic, UL Class 1 or Class 2, constant-current type and meet the following requirements:

a. The combined LED driver and LED light source system is greater than or equal to the minimum luminaire efficacy values as listed in the luminaire schedule provided.

b. Operate at a voltage of [120-277][120][277] volts at 50/60 hertz, with input voltage fluctuations of plus or minus 10 percent.

c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.

d. Maximum Total Harmonic Distortion (THD) less than or equal to 20 percent at full input power and across specified dimming range.

e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

f. Meets the "Elevated" (10kV/10kA) requirements per IEEE C62.41.2 -2002. Manufacturer must indicate whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire. Provide surge protection that is integral to the LED driver.

g. Contains integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.

h. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

i. Class A sound rating for all drivers mounted under a covered structure, such as a canopy, or where otherwise appropriate.

j. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

k. UL listed for wet locations typical of exterior installations.

l. [Dimmable, and compatible with a standard dimming control circuit of 0 - 10V][Non-dimmable].

m. Rated to operate between ambient temperatures of minus 30 degrees C minus 22 degrees F and 40 degrees C 104 degrees F[50 degrees C 122 degrees F].

2.4.1 Remote LED Drivers

****

NOTE: Do not allow use of remote drivers unless specifically noted on the lighting plate and luminaire schedule.

****

Provide remote LED Drivers that are [UL listed for wet locations typical of exterior installations][located in an IP68 direct burial enclosure listed for wet location].

2.5 LIGHTING CONTROLS

****

NOTE: Include a version of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS edited specifically for the lighting control system where a control system is specified.

****

[Provide a control system interface within each luminaire that is compatible with the energy management or control system used by the utility department in charge of the project area for control of site lighting.]Provide network certification for all networked lighting control systems and devices in accordance with the requirements of Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

2.5.1 System

Provide exterior lighting control system that operates the exterior lighting system as described in the exterior lighting control strategies in the project plans. Submit Sequence of Operation for Exterior Lighting Control System describing the operation of the proposed exterior lighting control system and devices. Sequence of Operation must provide the strategies identified in the exterior lighting control strategies.

2.5.1.1 Relay Panel

****

NOTE: Select NEMA 1 enclosure if panel will be located indoors with normal conditions, NEMA 3R for indoor or outdoor use when weather resistance is necessary, and NEMA 4 if a watertight enclosure is necessary.

****

Enclose panel hardware in a [surface][flush]-mounted, NEMA [1][3R][4], painted, steel enclosure with lockable access door and ventilation openings. Internal low-voltage compartment must be separated from line-voltage compartment of enclosure with only low-voltage compartment accessible upon opening of door. Provide additional remote cabinets that communicate back to main control panel as required. Provide relay panel that meets the following criteria:

a. Input voltage of [120][277][120-277] at 50/60 Hz, with internal low voltage power supply as required.

b. UL 924. [8][16][32][_____] single-pole latching relays rated at [20][30] amps, [120-277][120][277] volts. Provide provision for relays to close upon power failure. Provide relays designed for 10 years of use at full rated load.

c. Relay control module operates at 24 VDC and is rated to control a minimum of [8][16][32][_____] relays.

2.5.1.2 Dimming Panel

****

Select NEMA 1 enclosure if panel will be located indoors with normal conditions, NEMA 3R for indoor or outdoor use when weather resistance is necessary, and NEMA 4 if a watertight enclosure is necessary.

For projects in the state of California, require compliance with CEC Title 24.

****

UL 916, 47 CFR 15[, CEC Title 24]. Provide dimming panel that is designed as a [a standalone][an automated control system interface] type. Provide panel that meets the following criteria:

a. Consists of a single NEMA [1][3R][4] [flush][surface]-mounted enclosure with two separate interior sections; one for Class 1 (branch circuit) and one for Class 2 (low voltage) wiring.

b. Panel enclosure is constructed of [16][14] gauge cold-rolled steel with baked-on enamel finish.

c. Class 1 section contains the load side of all relays and the incoming branch circuit wiring.

d. Class 2 section contains a 24 VDC control power transformer, relays, relay control modules, and control wiring[, and [BACnet compatibility in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [LONworks compatibility in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] field-programmable application controller for panels connected to the facility automated control system].

e. Contains inputs for signals from photosensors, time clocks, and motion sensors.

f. Capable of 0-10V dimming.

2.5.1.3 Networked Lighting Control System

****

NOTE: When providing a control panel that interfaces with the building automated control systems, reference IES Technical Memorandum ANSI/IES LP-6-20 for technical information on various protocols, architectures and topologies for such systems. Include Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION for UMCS and integration requirements. Coordinate read access points and write access points with BAS specifier.

Select requirements for a wired system if possible. If a wired control system is not available, select requirements for a wireless system. If a wireless system is not a viable option due to security concerns, a powerline carrier system may be used.

****

Provide a networked exterior lighting control system that meets the following requirements:

a. [Wired network][Wireless mesh network][Powerline carrier] system.

b. ANSI C136.41. [Communicates via gateway with [_____] nodes per gateway and a maximum of [_____] meters feet between gateways.] [Gateway-less system with wireless node compatible with 7-pin dimming receptacle. Wireless node must have a communication frequency of [_____][kHz][MHz][GHz] and must be located no greater than [_____]

meters feet apart.]

c. Capable of [0-10V][DALI] dimming.

d. Capable of astronomic time clock functions, programmable luminaire grouping, [motion detection][programmable motion detection grouping], light source monitoring, LED driver monitoring, energy monitoring in kilowatt-hours, [remote monitoring with read-only access][remote control and programming with read and write access].

2.5.1.4 Gateway

****

NOTE: When specifying BAS interface, coordinate with HVAC specifier to ensure the requirements are described in both specifications. Include Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION for UMCS and integration requirements.

****

Provide gateway in accordance with Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION. Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports. Provide [BACnet communication interface in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][LONworks communication interface in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][_____] that enables remote control and monitoring of lighting from a workstation according to read access points and write access points listed in the paragraph NETWORKED LIGHTING CONTROL SYSTEM. Control features and monitoring points displayed locally at lighting panel must be available through the Gateway. Provide Gateway that meets the following requirements:

a. Microprocessor-based communications device that perform bi-directional protocol translation.

b. Support full bi-directional communication and translation.

c. Contain its own microprocessor, RAM, battery, communication ports, and power supply.

[d. Support an additional 5 percent points for future expansion.

]2.5.2 Devices

2.5.2.1 Time Clock

NEMA ICS 6. House time clock in a surface-mounted, lockable NEMA [1][3R] enclosure constructed of painted steel or plastic polymer. Provide electronic type time clock that meets the following criteria:

a. [24 hour][7 day][astronomic] programming function, providing a total of 56 [_____] on/off set points.

b. [12 hour AM/PM][24 hour] type digital clock display format.

c. Power outage back-up for switch utilizing [a capacitor][alkaline batteries][lithium battery] which provides coverage for a minimum of [seven days][three years][eight years].

d. Capable of controlling a minimum of [1][2][4][_____] channels or loads.

e. Contacts are rated for [30] [_____] amps at 120-277 VAC resistive load in a [SPST][DPST][SPDT][DPST] [normally open (NO)][normally closed (NC)] configuration.

f. Contains [function that allows automatic control to be skipped on certain selected days of the week][manual bypass or remote override control][daylight savings time automatic adjustment][EEPROM memory module][momentary function for output contacts][ability for photosensor input].

2.5.2.2 Photosensors

****

NOTE: Silicon diode sensors are a solid state device and more resistant to higher temperatures and environmental contamination. Silicon diode type are usually specified when mounting directly to luminaires.

****

UL 773, UL 773A. Provide Photosensors that meet the following requirements:

a. Hermetically sealed, [cadmium sulfide][silicon diode] light sensor type, rated at [_____] watts, [_____] volts, 50/60 Hz with single-pole, [single][double]-throw contacts.

b. Turns ON at 10 to 30 lux 1 to 3 footcandles and turns OFF at 30 to 150 lux 3 to 15 footcandles.

c. Designed to fail to the ON position.

d. Housing is constructed of [polycarbonate][die cast aluminum][UV stabilized polypropylene], rated to operate within a temperature range of minus 40 to 70 degrees C minus 40 to 158 degrees F.

e. Time delay that prevents accidental switching from transient light sources.

[f. Directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.

] g. Designed for 20-year service to match life expectancy of long-life LED fixtures and exceed 15,000 operations at full load. Provide photosensors with zero-cross technology to withstand severe in-rush current and extend relay life.

[h. [Fixed][Swivel] base type housing with 12.7 mm 1/2 in threaded base for mounting to a junction box or conduit.

][i. NEMA C136.10. Twist-lock receptacle type. Provide with solid brass prongs and voltage markings and color coding on exterior of housing.

][j. Provide photosensors with metal oxide varistor (MOV) type surge protection.

]2.5.2.3 Motion Sensors

****

NOTE: Select requirement for motion sensors to work with bi-level controllers if required by the Sequence of Operations.

****

NEMA WD 7, UL 773A. Provide sensors that meet the following requirements:

a. Operating voltage of [12-24][120-277][120][277] volts.

b. [Passive infrared][Microwave][Dual technology passive infrared/microwave] type sensors with [270][_____] degree coverage.

c. Time delay that can be adjusted from 15 seconds to 15 minutes.

d. Default state is "Fail to ON position."

e. Sensors installed integral to the luminaire must be provided by the luminaire manufacturer.

f. Sensor contains an integral light level sensor that does not allow luminaires to operate during daylight hours

g. [Equipped with a threaded base for mounting to a weatherproof junction box][Mounted directly to luminaire].

[h. Operates in conjunction with bi-level controllers that reduce the connected lighting power by 50 percent.

]2.5.2.4 Lighting Contactor

NEMA ICS 2. Provide a [mechanically][electrically]-held lighting contactor [housed in a NEMA [1][3R][4][_____] enclosure conforming to NEMA ICS 6]. Contactor must have [2][4][6][_____] poles, configured as [normally open (NO)][normally closed (NC)]. Contacts must be rated [600] [_____] volts, [30][_____] amperes for a resistive load. Coil operating voltage must be [24][120][277][_____] volts. Contactor must have silver cadmium oxide double-break contacts [and coil clearing contacts for mechanically held contactors] and must require no arcing contacts.[Provide contactor with hand-off-automatic [on-off] selector switch.][Provide contactor as specified above along with [disconnect switch][circuit breaker] in integral NEMA [1][3R][_____] enclosure with flange-mounted handle to satisfy requirement for a "combination lighting contactor" when specified.]

2.6 POLES

****

NOTE: This specification does not cover decorative poles or high-mast lighting systems. Poles, luminaire mounting assemblies, and lowering mechanisms for high-mast lighting are specially fabricated and should be individually designed to suit a specific project. Pole specifications for high-mast system should, as a minimum, include wind loading and ultimate strength meeting the loading requirements of AASHTO LTS. Do not specify embedded

type metal poles for Army facilities.

Wind loads for roadway luminaires are defined by AASHTO LTS. For other, non-roadway poles, use ASCE 7-16.

****

[AASHTO LTS][ASCE 7-16]. Provide round [straight][tapered] poles designed for wind loading of [161][_____] km/hr [100][_____] miles per hour while supporting luminaires and all other appurtenances indicated. The effective projected areas (EPA) of luminaires and appurtenances used in calculations must be specific for the actual products provided on each pole. Provide poles that are[embedded][anchor]-base type designed for use with[underground][overhead] supply conductors.[Poles[, other than wood poles,] must have oval-shaped hand hole having a minimum clear opening of 80 by 130 mm 3 by 5 inches. Secure hand hole covers by stainless steel captive screws.][Provide metal poles with an internal grounding connection accessible from the hand hole near the bottom of each pole. Install a means of wire disconnection accessible from the hand hole.] Do not install square poles. Provide poles from a Manufacturer with a standard provision for protecting the finish during shipment and installation. Do not install scratched, stained, chipped, or dented poles.

2.6.1 Aluminum Poles

Provide aluminum poles with [uniform satin][anodized][_____] finish unless otherwise noted in luminaire schedule on project plans. Do not paint aluminum poles. Provide poles that meet the following requirements:

a. AASHTO LTS. Manufactured of corrosion resistant aluminum alloys for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3,5) for cast alloys.

b. Seamless extruded or spun seamless-type with minimum 4.8 mm 0.188 inch wall thickness.

c. Top of shaft is fitted with a round or tapered cover.

d. ASTM B108/B108M. Pole base is mounted by anchor bolts, made of cast 356-T6 aluminum alloy. Base must be machined to receive the lower end of shaft.

e. Joint between shaft and base is welded.

f. ASTM B108/B108M. Base cover is cast 356-T6 aluminum alloy.

g. All hardware other than anchor bolts are either 2024-T4 anodized aluminum alloy or stainless steel.

h. Grounding connection is designed to prevent electrolysis when used with copper ground wire.

2.6.2 Steel Poles

Provide steel poles with[hot-dipped galvanized in accordance with ASTM A123/A123M][iron-oxide primed] factory finish. Provide poles that meet the following requirements:

a. Minimum 11-gage steel with minimum yield/strength of 331 MPa 48,000 psi

b. Pole is [mounted by anchor bolts][direct set].

c. Consists of tapered tubular members, either round in cross section or polygonal.

d. Pole shaft is one piece and is of welded construction with no bolts, rivets, or other means of fastening except as specifically approved.

e. Base covers are of structural quality hot-rolled carbon steel plate, with a minimum yield of 248 MPa 36,000 psi.

f. Markings are approximately 900 to 1270 mm 3 to 4 feet above grade and includes manufacturer, year of manufacture, top and bottom diameters, and length.

g. Grounding connection is designed to prevent electrolysis when used with copper ground wire.

2.6.3 Wood Poles

****

NOTE: Other wood species which are covered by ATIS ANSI 05.1 and AWPA may be specified, provided they are available at the project location. Indicate pole class and height on the drawings.

****

ATIS ANSI O5.1, RUS Bull 1728F-700. Provide wood poles of[Southern Yellow Pine][Douglas Fir][_____]. Provide poles that meet the following requirements:

a. AWPA U1. RUS Bull 1728F-700. Treated full length with chromated copper arsenate (CCA) or ammoniacal copper arsenate (ACA). Poles must be gained, bored, and roofed before treatment.

b. Branded by manufacturer with manufacturer's mark and date of treatment, height and class of pole, wood species, preservation code, and retention. Place the brand so that the bottom of the brand or disc is 3050 mm 10 feet from the pole butt for poles up to 15250 mm 50 feet long[and 4270 mm 14 feet from the butt for poles over 15250 mm 50 feet long].

2.6.4 Fiberglass Poles

NEMA C136.20. Provide fiberglass poles with resin color of [dark bronze][_____] with uniform pigment coloration throughout entire wall thickness. Provide poles that meet the following additional requirements:

a. Poles are designed specifically for supporting luminaires and have factory-formed cable entrance and hand hole.

b. Finish surface is pigmented polyurethane having a minimum dry film thickness of 0.038 mm 1.5 mils. Polyurethane may be omitted if the surface layer of the pole is inherently ultraviolet inhibited.

c. Minimum fiberglass content is 65 percent with resin and pigment comprising the other 35 percent material content.

2.6.5 Concrete Poles

ASTM C1089. Cross-sectional shape must be round.

2.6.5.1 Steel Reinforcing

Provide prestressed concrete pole shafts that are reinforced with steel prestressing members. Provide internal longitudinal loading by either pre-tensioning or post-tensioning longitudinal reinforcing members.

2.6.5.2 Tensioned Reinforcing

Primary reinforcement steel used for a prestressed concrete pole shaft must be tensioned between 60 to 70 percent of its ultimate strength. The amount of reinforcement must be such that when reinforcement is tensioned to 70 percent of its ultimate strength, the total resultant tensile force does not exceed the minimum section compressive strength of the concrete.

2.6.5.3 Coating and Sleeves for Reinforcing Members

Where minimum internal coverage cannot be maintained next to required core opening, such as hand holes and wiring inlet, protect reinforcing with a vapor proof noncorrosive sleeve over the length without the 1/2 inch concrete coverage. Apply a nonmigrating slipper coating to each steel reinforcing member which is to be post-tensioned prior to the application of concrete to ensure uniformity of stress throughout the length of each member.

2.6.5.4 Strength Requirement

As an exception to the requirements of ASTM C1089, provide poles that are naturally cured to achieve a 28-day compressive strength of 48.23 MPa 7000 psi. Poles must not be subjected to severe temperature changes during the curing period.

2.6.5.5 Shaft Preparation

Provide completed prestressed concrete pole shaft with a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost, and must be clean, smooth, and free of surface voids and internal honeycombing. Do not install poles within 15 days of manufacture.

2.6.6 Brackets and Supports

ANSI C136.3, ANSI C136.13, and ANSI C136.21. Provide pole brackets that are not less than 31.75 mm 1 1/4 inch[galvanized steel pipe][aluminum] secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets must be coordinated to luminaires provided, and brackets for use with one type of luminaire must be identical. Brackets for pole-mounted street lights must correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 7320 mm 24 feet above street. Provide special mountings or brackets as indicated and of metal which will not promote galvanic reaction with luminaire head.

2.6.7 Pole Foundations

Provide anchor bolts consisting of a steel rod with a minimum yield strength of 344.5 MPa 50,000 psi; the top 305 mm 12 inches of the rod must be galvanized in accordance with ASTM A153/A153M. Concrete must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7 EQUIPMENT IDENTIFICATION

2.7.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.7.2 Labels

UL 1598. Luminaires must be clearly marked for operation of specific light sources and drivers according to proper light source type. Note the following luminaire characteristics in the format "Use Only _____":

a. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

b. Driver and dimming protocol.

Markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.8 FACTORY APPLIED FINISH

****

NOTE: This paragraph covers only the basic painting requirements for most electrical equipment. Include any special finishes for high or low temperatures and corrosive atmospheres.

****

NEMA 250. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Luminaires

****

NOTE: Require luminaires to be installed per aiming diagram in applications with directional luminaires, such as adjustable landscape and tree lighting, sports lighting, and wallwash applications.

****

Install all luminaires in accordance with the luminaire manufacturer's written instructions. Install all luminaires at locations and heights as indicated on the project plans. Level all luminaires in accordance to manufacturer's written instructions.[Aim all luminaires in accordance with aiming diagram.]

[3.1.2 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

[3.1.2.1 Remote LED Drivers

Locate Remote LED Drivers within the maximum distance allowed to reduce voltage drop. Do not locate remote LED drivers further from the light source than specified by the manufacturer. Locate remote LED drivers in dry, well-ventilated, and accessible location, or in accessible IP68-rated enclosure. Provide separate compartments for Class 2 wiring connections and for Class 1 wiring connections. Separation must be barrier-type within the same box or separate boxes with close connector conduit fittings. Field connections must be inside housing or junction box or secured by a quick disconnect wire connector suitable for wet-location. Remote LED drivers must be electronically grounded in accordance with NFPA 70.

]]3.1.3 Field-Applied Painting

****

NOTE: Use and coordinate paint and coating requirements with Section 09 90 00 PAINTS AND COATINGS when provided in the job. If Section 09 90 00 PAINTS AND COATINGS is not provided or when requirements are beyond what is specified in Section 09 90 00 PAINTS AND COATINGS, specify the requirements in this paragraph.

****

Provide field applied painting for luminaire type [_____]. Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1.4 Wood Poles

****

NOTE: Poles set in swampy or rocky soil will require different settings or foundations than those set in average bearing soils. Consult pole manufacturer and structural engineer for proper setting or foundation requirements for these and other unusual soil conditions.

Delete setting information for pole lengths not required.

****

Pole holes must be at least as large at the top as at the bottom and must be large enough to provide 100 mm 4 inches of clearance between the pole and the side of the hole.

a. Setting depth: Provide pole setting depths as follows:

Length of Pole (mm)	Setting in Soil (mm)
6100	1575
7625	1575
9150	1575
10675	1830
12200	1830
13725	1985
12250	2135
16775	2285
18300	2440

Length of Pole (feet)	Setting in Soil (feet)
20	5.0
25	5.5
30	5.5
35	6.0
40	6.0
45	6.5
50	7.0
55	7.5
60	8.0

b. Soil setting: "Setting in Soil" depths must apply where pole holes are in soil, sand, or gravel or any combination of these.[At corners, dead ends and other points of extra strain, poles 12,200 mm 40 feet long or more must be set 150 mm 6 inches deeper.]

c. Setting on sloping ground: On sloping ground, measure the depth of the hole from the low side of the hole.

d. Backfill: Tamp pole backfill for the full depth of the hole and mound the excess fill around the pole.

3.1.5 Concrete Poles

****

NOTE: Poles set in swampy or rocky soil will

require different settings or foundations than those set in average bearing soils. Consult pole manufacturer and structural engineer for proper setting or foundation requirements for these and other unusual soil conditions.

****

Install according to pole manufacturer's instructions.

3.1.6 Fiberglass Poles

****

NOTE: Poles set in swampy or rocky soil will require different settings or foundations than those set in average bearing soils. Consult pole manufacturer and structural engineer for proper setting or foundation requirements for these and other unusual soil conditions.

****

Install according to pole manufacturer's instructions.

3.1.7 Aluminum and Steel Poles

****

NOTE: Poles set in swampy or rocky soil will require different settings or foundations than those set in average bearing soils. Consult pole manufacturer and structural engineer for proper setting or foundation requirements for these and other unusual soil conditions.

****

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end. Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit bells, and ground rods must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.[After installation, paint exposed surfaces of steel poles with two finish coats of[exterior oil paint of a color as indicated][aluminum paint]. Install according to pole manufacturer's instructions. Alterations to poles after fabrication will void manufacturer's warranty and is not allowed.]

3.1.8 Pole Setting

[Set pole to depth as indicated.][Poles in straight runs must be in a straight line. Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 150 mm 6 inch maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.]

3.1.9 Lighting Controls

****

NOTE: Include a version of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS edited specifically for the lighting control system where a control system is specified.

****

Refer to Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS for additional lighting control installation requirements.

3.1.9.1 Photosensors

Aim photosensor according to manufacturer's recommendations.[Mount sensor on or beside each luminaire when switch is provided in cast weatherproof aluminum housing with swivel arm.][Set adjustable window slide for [_____] lux footcandles photosensor turn-on.]

3.1.9.2 Motion Sensors

Locate sensors in accordance with the manufacturer's recommendation. Locate sensors to achieve coverage of areas as indicated on project plans. Coverage patterns must be derated as recommended by manufacturer based on mounting height of sensor and any obstructions such as trees. Do not use gross rated coverage in manufacturer's product literature.

3.1.10 Grounding

Ground noncurrent-carrying parts of equipment including[metal poles,] luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

****

NOTE: Coordinate commissioning requirements with Section 01 91 00.15 BUILDING COMMISSIONING.

****

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Perform initial operational test, consisting of the entire system energized for 72 consecutive hours without any failures of any kind occurring in the system. All circuits must test clear of faults, grounds, and open circuits.

3.2.1.1 Lighting Control Verification Test

Verify lighting control system and devices operate according to approved sequence of operations. Verification tests are to be completed after commissioning.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Training

Provide on-site training to the Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide training that includes calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

3.3.1.1   Maintenance Staff Training

Submit a Maintenance Staff Training Plan at least 30 calendar days prior to training session that describes training procedures for Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide on-site training which demonstrate full system functionality, assigning schedules, calibration adjustments for light levels and sensor sensitivity, integration procedures for connecting to third-party devices, and manual override including information on appropriate use. Provide protocols for troubleshooting, maintenance, repair, and replacement, and literature on available system updates and process for implementing updates.

3.3.1.2   End-User Training

Submit a End-User Training Plan at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide demonstration for each type of user interface. Provide users with the curfew schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-26 56 20 (February 2019)**

Preparing Activity: USACE

Superseding
UFGS-26 54 21.00 10 (October 2007)
UFGS-26 56 20.00 10 (October 2007)
UFGS-34 43 00.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 56 20

AIRFIELD AND HELIPORT LIGHTING AND VISUAL NAVIGATION AIDS

02/19

PART 3   EXECUTION

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-26 56 20 (February 2019)**

Preparing Activity: USACE **Superseding**

UFGS-26 54 21.00 10 (October 2007)

UFGS-26 56 20.00 10 (October 2007)

UFGS-34 43 00.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 26 56 20

AIRFIELD AND HELIPORT LIGHTING AND VISUAL NAVIGATION AIDS

02/19

****

NOTE: This guide specification covers the requirements for lighting and visual navigation aids for airfields and heliports. When editing this specification, follow the requirements of UFC 3-535-01. For Navy projects NAVAIR 51-50AAA-2 is the governing design document and is referenced in UFC 3-535-01.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Show locations of all lights, signs, markers, and other visual navigation aids on the contract drawings.

****

****

NOTE: Depending on the specific application, additional technical sections will probably have to be added to the project specification. The construction drawings and specifications establish

the scope for the construction project. Electrical drawings must include: a legend dedicated to the airfield lighting fixtures; an airfield map depicting runways, and electrical vaults; demolition plans, single line electrical riser diagrams, schematic diagrams for fixture wiring, conduit and duct bank schedules; cable schedule, and a fixture schedule; and construction installation details for each airfield lighting fixture.Where an option is given for military and FAA specifications, the electrical designer of the specific project must determine if the project requires a military specification component without option for the FAA specification. Where the words "as indicated," "as specified," "unless specified otherwise," "when specified," or similar words are used, the designer must ensure that the appropriate requirements are included in the project drawings or specifications. The drawings should show new portions of the work on existing airfields and should indicate clearly the existing wires, cables, ducts, and equipment as applicable. For Navy or Marine Corps airfields the designer should refer to the NAVAIR 51-50AAA-2, "General Requirements for Shore Based Airfield Marking and Lighting." Electrical Designer must specify Primary type I or Secondary type II Class A or Class B electrical cable system. Designer must specify FAA style for the cable/receptacle system. Connectors must be certified by ETL.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the

basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A447/A447M	(2011; R 2021) Standard Specification for Steel Castings, Chromium-Nickel-Iron Alloy (25-12 Class), for High-Temperature Service
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 71/ICEA S-96-659	(2014; R 2022) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V

NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA PB 1	(2011) Panelboards
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70B	(2023) Recommended Practice for Electrical Equipment Maintenance

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 1	(2015) Solvent Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS5351	(1987; Rev F; R 2006) Steel Castings, Sand, Corrosion and Moderate Hear Resistant, 13Cr, Normalized and Tempered

U.S. DEPARTMENT OF AGRICULTURE (USDA)

REA Bull 1753F-205	(1993) Filled Telephone Cables (PE-39)

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-L-26764	(2018; Rev C; Notice 1 2023) Light, Marker, Airport Approach, High Intensity, Type MB-2
MIL-L-29575	(1989) Light, Wave-Off, Flashing, Capacitance-Discharge
MIL-STD-108	(1966; Rev E; Am 1 1985; Notice 2 1990; Notice 3 2020) Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment
UFC 3-535-01	(2017; with Change 4, 2023) Visual Air Navigation Facilities

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(2016; Rev L; Change 2) Obstruction Marking and Lighting

FAA AC 150/5345-3	(2007; Rev F) Specification for L-821 Panels for Control to Airport Lighting
FAA AC 150/5345-5	(2006; Rev B) Specification for Airport Lighting Circuit Selector Switch
FAA AC 150/5345-7	(2013; Rev F) Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
FAA AC 150/5345-10	(2014; Rev H) Specification for Constant Current Regulators Regulator Monitors
FAA AC 150/5345-12	(2005; Rev E) Specification for Airport and Heliport Beacon
FAA AC 150/5345-13	(2007; Rev B) Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits
FAA AC 150/5345-26	(2021; Rev E) FAA Specification for L-823 Plug and Receptacle, Cable Connectors
FAA AC 150/5345-27	(2021; Rev F) FAA Specification for Wind Cone Assemblies
FAA AC 150/5345-28	(2005; Rev F) Precision Approach Path Indicator (PAPI) Systems
FAA AC 150/5345-42	(2024; Rev K) Specification for Airport Light Bases, Transformer Housings, Junction Boxes and Accessories
FAA AC 150/5345-43	(2019; Rev J) Specification for Obstruction Lighting Equipment
FAA AC 150/5345-44	(2024; Rev L) Specification for Runway and Taxiway Signs
FAA AC 150/5345-45	(2007; Rev C) Low-Impact Resistant (LIR) Structures
FAA AC 150/5345-46	(2016; Rev E; Errata 1 2023) Specification for Runway and Taxiway Light Fixtures
FAA AC 150/5345-47	(2005; Rev B) Specification for Series to Series Isolation Transformers for Airport Lighting Systems
FAA AC 150/5345-51	(2005; Rev A) Specification for Discharge-Type Flashing Light Equipment
FAA AC 150/5345-53	(2012; Rev D) Airport Lighting Equipment Certification Program
FAA AC 150/5345-56B	(2011; Rev B) Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS)

FAA AC 150/5370-10	(2018; Rev H; Errata 1 2019) Standard Specifications for Construction of Airports
FAA E-982	(2003; Rev J) PAR-56 Lampholder
FAA E-2159	(2004; Rev E) Runway End Identifier Lighting System (REIL)
FAA E-2519	(1972; Rev A) Types I and II
FAA E-2628	(1979; Rev B) Sequenced Flashing Lighting System, Elevated and Semiflush with Dimming and Monitoring
FAA E-2690	(2000; Rev A) Isolation Transformer (1500 watt) for High Intensity Approach Lighting Systems
FAA E-2702	(2007; Rev A)Low Impact Resistant (LIR) Structures
FAA FO 6850.19	(1978) Frangible Coupling

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 360	(2013; Reprint Jan 2024) UL Standard for Safety Liquid-Tight Flexible Metal Conduit
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 773	(2016; Reprint Jul 2020) UL Standard for Safety Plug-In, Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2016; Reprint Jan 2024) UL Standard for Safety Nonindustrial Photoelectric Switches for Lighting Control
UL 797	(2007; Reprint Apr 2023) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL Electrical Construction	(2012) Electrical Construction Equipment Directory

1.2 DEFINITIONS

****

NOTE: Provide definitions for specific project related terms not included in this guide specification.

****

[_____].

1.3 SYSTEM DESCRIPTION

Provide airfield [and heliport] lighting and visual navigation aids as indicated.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Modify submittals paragraphs to ensure that an appropriate submittal is required for each item in the project.

****

SD-01 Preconstruction Submittals

Protection plan; G

Training; G

SD-02 Shop Drawings

Lighting and visual navigation aids; G

Composite drawings showing coordination of work of one trade with that of other trades and with structural and architectural elements of the work. Provide sufficient detail to show overall dimensions of related items, clearances, and relative locations of work in allotted spaces. Indicate where conflicts or clearance problems exist between the various trades.

[Wave-off system; G]

[Landing signal officer (LSO) control panel; G]

[Approach Lighting Frangible Towers; G]

[Wind Cone Indicator Assembly Connection; G]

Posted instructions; G

SD-03 Product Data

When equipment or materials are specified to conform to the standards or publications and requirements of AASHTO, ANSI, ASTM, AEIC, ETL, IEEE, IES, NEMA, NFPA, or UL, or to an FAA, FS, or MS, include proof that the items furnished under this section conform to the specified requirements. The label or listing in UL Electrical Construction or ETL or the manufacturer's certification or published catalog specification data statement that the items comply with applicable specifications, standards, or publications and with the manufacturer's standards will be acceptable evidence of such compliance. Provide manufacturer prepared certificates when the manufacturer's published data or drawings do not indicate conformance with other requirements of these specifications.

Simulated carrier deck lighting system components, complete; G

Pilot relay panel; G

Control transfer panel; G

Airfield lighting control and monitoring system components, complete; G

Approach lighting systems components, complete; G

Type L-823 Connectors; G

Precision approach path indicator system; G

Chase helicopter approach path indicator system

Runway edge lights; G

Runway threshold and end lights; G

Runway centerline lights, tailhook operations; G

Runway centerline lights, non-tailhook operations; G

Runway touchdown zone lights, tailhook operations; G

Taxiway edge lights; G

Taxiway centerline lights, each type; G

Runway hold position lights, each type; G

Guidance signs; G

Runway distance remaining signs; G

Arresting gear markers; G

Obstruction lighting; G

Wheels-up system components, complete; G

Wave-off system components, complete; G

Light bases, each type; G

Wind direction indicator; G

Airfield rotating beacon; G

Helipad/heliport beacon

List of airfield lighting materials and equipment with the FAA AC 150/5345-53 Appendix C review date.

Airfield identification/code beacon; G

Isolation transformers; G

Encapsulated isolation transformers; G

Isolation transformers for frangible towers; G

Constant current regulators, each size; G

Circuit selector switch; G

Control cable; G

Frangible couplings; G

Type P-605 Sealant; G

Type P-606 Sealant; G

Materials and equipment; G

SD-06 Test Reports

Visual inspection; G

[Photometric testing; G]

[Airfield guidance signs; G]

Discharge-type flashing light equipment; G

[PAPIs; G]

Progress testing for series lighting circuits; G

Counterpoise system test and inspection; G

Operating test; G

Distribution conductors, 600-volt class; G

Electrical acceptance tests; G

Low-voltage continuity tests; G

High-voltage insulation resistance tests; G

Constant current regulators, each size; G

SD-07 Certificates

Qualifications of contractor; G

Certified documentation of qualifications, as specified.

[Qualifications of photometric tester; G]

Special tools; G

List of special tools and test equipment required for installation, maintenance and testing of the products supplied by the Contractor. Items to be listed include, but are not limited to, the following:

4-Jack positioning jig, for in-pavement light bases.; G

Elevated light level; G

Crimping tool; G

Cable penciler

List of parts; G

A list of parts and components for the system by manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair necessary to ensure continued operation with minimal delays.

SD-08 Manufacturer's Instructions

Posted instructions; G

Submit proposed disgrams, instructions, and other sheets prior to posting.

SD-10 Operation and Maintenance Data

Constant current regulators, Data Package 5; G

Airfield rotating beacon, Data Package 3; G

Approach lighting systems components, Data Package 3; G

[Wave-off system, Data Package 5; G]

Maintenance and repair instructions; G

Instructions necessary to check out, troubleshoot, repair, and replace components of the systems, as specified.

Posted operations and maintenance instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

As-built drawings

[1.5 MAINTENANCE MATERIAL SUBMITTALS

1.5.1 Spare Parts

Provide spare parts as indicated in this specification as part of this contract. The spare parts must be provided at the end of construction. They must be in addition to any items consumed during construction or in testing.

]1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "must" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Contracting Officer.

1.6.1.1 Code Compliance

Comply with the requirements and recommendations of NFPA 70 and IEEE C2 and local codes where required.

1.6.2 Standard Products

****

NOTE: For a monthly listing of approved equipment (by manufacturer) go to website and refer to the latest Addendum to AC 150/5345-53, Airport Lighting Equipment Certification Program

****

a. Use only approved equipment listed in FAA AC 150/5345-53 with addendum for the date of delivery the exception of Air Force threshold lights and Army heliport fixture colors and intensities. Inspect wire and cable for date of manufacture. Materials must be certified and listed as "Approved Airport Lighting Equipment" downloadable from: http://www.faa.gov/arp/pdf/534553ad.pdf. Do not use wire and cable manufactured more than one year before delivery to job site.

b. Provide materials and equipment listed by FAA, UL, or ETL, when such equipment is listed or approved. Do not use askarel, tetrachlorethylene and insulating liquids containing polychlorinated biphenyls (PCBs) in equipment.

c. Material and equipment must be a standard product of a manufacturer regularly engaged in the manufacture of the product and essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

d. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be products of the same manufacturer unless stated in this section.

1.6.3 Qualifications of Contractor

a. Provide documentation that the aviation lighting equipment contractor and installation electricians are experienced in installing, testing and maintaining aviation lighting systems of a similar complexity. Similar complexity, in increasing complexity, are the following: elevated edge lights and signs, in-pavement lights, and approach light systems. Include a list of government projects and 3 years of experience in constructing similar projects. Include written certification that systems have performed satisfactorily for not less than 18 months. Provide a list of airfield lighting schools or seminars attended in the last 5 years.

b. Submit certification containing the names and the qualifications of persons recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. Indicate that any person recommended to perform actual splicing and termination has been adequately trained in the proper techniques and has had at least 3 recent years of experience in splicing and terminating the same or similar types of cables approved for installation. Any person recommended by the Contractor may be required to perform a dummy or practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage power or series lighting cables. If that additional requirement is imposed, provide short sections of the approved types of cables with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

[1.6.4 Qualifications of Photometric Tester

****

NOTE: Photometric testing is highly recommended for all runway lighting construction. The designer should verify with the airfield manager that the cost of testing has been included in project funding.

Photometric testing is not required for Navy projects.

****

Submit [three][_____] copies of certification containing the names and the qualifications of persons recommended to perform Field Photometric Testing of Airfield Lighting Fixtures. The general goal of the field photometric testing is to test the airfield lighting fixtures in the field as constructed with respect to FAA AC 150/5345-46. Perform testing utilizing an independent, third-party firm unaffiliated with any lighting manufacturer or construction contractor. This firm must have demonstrated capability for the field measurement of the photometric performance of airfield lighting fixtures in comparison to FAA and UFC standards by having performed work similar to this contract successfully at no less than ten (10) air carrier airports (in the United States) in the past five (5) years.

Submit a list of equipment to be used for the photometric testing with a record of experience of similar projects with references for contact. Additionally, submit a list of equipment used to calibrate the photometric sensors as well as proof of the last date of calibration. The equipment must be calibrated within six months prior to commencement of testing.

]1.6.5 Protection Plan

Submit detailed procedures to prevent damage to existing facilities or infrastructures. If damage does occur, the procedures must address repair and replacement of damaged property at the Contractor's expense.

1.6.6 Prevention of Corrosion

1.6.6.1 Metallic Materials

Protect metallic materials against corrosion as specified. Do not use aluminum in contact with earth or concrete. Do not use aluminum conductors.

1.6.6.2 Ferrous Metal Hardware

Ferrous metal hardware must be hot-dip galvanized in accordance with ASTM A123/A123M and ASTM A153/A153M.

1.7 DELIVERY, STORAGE, AND HANDLING

The Contractor must deliver, store and secure all airfield lighting materials an equipment in accordance with the manufacturers' requirements.

1.8 PROJECT/SITE CONDITIONS

Items furnished under this section must be specifically suitable for the following unusual service conditions:

1.8.1 Altitude

Any equipment must be suitable for operation up to an altitude of[3,000 m 10,000 feet][_____].

1.8.2 Other

Material or equipment to be installed [underground]; [in handholes, manholes, or underground vaults]; [or] [in light bases], [_____] must be suitable for submerged operation.

1.8.3 Environmental Requirements

The airfield for this project has the following requirements:

Location - [_____]
Altitude - [_____] m[_____] feet above mean sea level.
Maximum Exterior Temperature - [_____] degrees C[_____] degrees F.
Minimum Exterior Temperature - [_____] degrees C[_____] degrees F.
Maximum Relative Humidity - [_____] percent non-condensing.
Maximum Indoor Temperature - [_____] degrees C[_____] degrees F.
Minimum Indoor Temperature - [_____] degrees C[_____] degrees F.

1.8.4 Existing Airfield Lighting Systems

****

NOTE: When modification, additions, or any other work is be performed on an existing airfield lighting system, the designer must add a carefully worded paragraph to cover maintenance of airfield lighting circuits and operations. Local conditions and the specifics of the Contract will affect this paragraph. An example of this paragraph follows:

"Existing airfield lighting systems must remain in operating condition and interruptions must be held to a minimum. Where interruptions are ncessary, they must be scheduled as approved in writing by the Contracting Officer. Prior to the scheduled time for each interruptions, all necessary materials and a sufficient labor force must be assembled to permit completing the work within the scheduled time interval. Under no circumstances must any of the existing airfield lighting circuits be left inoperative without making provisions for suitable temporary connections in the affected area or areas. All airfield lighting circuits covered under this Contract must be replaced in such a manner that they will be operational at dusk each day. The Contractor must submit to the Contracting Officer a plan for outages and maintaining lighting and lighting control."

****

[_____].

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide airfield lighting and visual navigation aids as indicated on contract drawings.

2.1.1 Design Requirements

****
NOTE: Various FAA requirements are described in this specification and are a part of the requirements of this project.
****

2.2 AIRFIELD LIGHTING CONTROL AND MONITORING SYSTEM (AFLCMS)

****
NOTE: For Navy projects, coordinate with Activity and Space and Naval Warfare Systems Command (SPAWAR). If SPAWAR system is used delete the following paragraph. Normally, airfield lighting control systems are provided by SPAWAR Charleston. Designer must indicate on drawings for contractor and Construction Manager to coordinate with SPAWAR.
****

****
NOTE: For conventional control systems refer to FAA AC 150/5345-3 for type, class, and style. For PC or PLC based control and monitoring systems refer to FAA AC 150/5345-56B for type. Edit and retain one of the following paragraphs.

Provide security clearance requirements of certified installers for termination to DoD networks.
****

The FAA has determined that acceptable airfield lighting control and monitoring systems can be configured in three levels of features. They include personal computer (PC) based systems, programmable logic controller (PLC) based systems, and systems configured with pilot relay panels or basic PLC systems.

2.2.1 Pilot Relay Panel

****
NOTE: Type I pilot relay panel has 24 double-pole, single-throw relays and is used for systems including the approach lighting systems. Specify a Type II relay panel if 16 double-pole, single-throw relays and 8 double-pole, double-throw relays are required for a system. Specify L-841 panel only if 48 V dc control is required.

****

[Utilize one of more pilot relay panels as indicated or compliant with NEMA 250, NEMA ICS 2, and NEMA PB 1 for 120-volt control systems;] or [FAA AC 150/5345-13, Type L-841, for 48-V dc control systems.]

2.2.2 Control Transfer Panel

[Transfer panel, 120-volt, 60 Hz, with eight-pole, double-throw, continuous-duty, industrial control type relays, in NEMA Type 1 enclosure. Provide relay contacts with a rating of not less than 10 amp for continuous non-inductive loads.] [Transfer panel, 48-volt, dc, with double-pole, double throw relays in accordance with FAA AC 150/5345-13, Type L-841.]

2.2.3 Control Panel

****

NOTE: Specify class for airfield lighting systems indicated as follows: Class I covers basic airfield lighting systems including beacons, obstruction lighting, wind direction indicators, approach, runway, and taxiway lights; Class II includes Class I plus runway centerline, touchdown zone, and taxiway centerline lighting; and Class III includes Class II plus optical landing system and approach flash monitor lights. Use Type I for conventional panels, Type II for facsimile panels and Type III for mimic or PLC based panels. Use Class F for flush mounted panels, Class S for surface mounted panels or Class W for a wall mounted panel. Use Style 1 for an unlighted panel, Style 2 for a backlighted panel and Style 3 for a touchscreen. Refer to FAA AC 150/5345-3 for type, class, and style.

****

[FAA AC 150/5345-3, Type L-821, Type [_____], Class [_____], Style [_____]]. Quantity and color of lenses must conform to FAA AC 150/5345-3 and must correspond to the actual circuits indicated.

2.2.4 Airfield Lighting Control and Monitoring System

2.2.4.1 Computer Based (PC) Technology

Utilize computer based (PC) technology control systems as indicated on the drawings, compliant with FAA AC 150/5345-56B, L-890 Type [_____]. Include touchscreen type control panel. For the essential system PCs provide the following characteristics: 483 mm19 inch rack mount form factor, fully enclosed metal housing, redundant hot-swappable solid state software and data storage devices, redundant hot-swappable cooling system, redundant hot-swappable power supplies. Incorporate uninterruptible power supplies (UPS) for primary power to all system components required for normal operation for a duration of fifteen minutes.

2.2.4.2 Programmable Logic Controller (PLC) Technology

[Utilize Programmable Logic Controller (PLC) technology, compliant with FAA AC 150/5345-56B, L-890, Type [_____]. Include touchscreen type control panel.]

2.3 APPROACH LIGHTING SYSTEMS

****

NOTE: Design the Approach Lighting System to include an emergency power supply to transfer lighting load within fifteen seconds of a power outage for a CAT I runway and one second for a CAT II runway.

****

2.3.1 High Intensity Approach Lighting System

****

NOTE: High-intensity approach systems may be either ALSF-1, ALSF-2, SALS or SSALSR lights.

****

Provide approach, centerline, crossbar, threshold bar, side row barrette, centerline barrette, bar lights, sequenced flashing lights, approach lighting frangible towers, and associated equipment and interconnecting wiring to provide a complete system as indicated on construction drawings.

2.3.1.1 Elevated High-Intensity Steady Burning Fixtures

****

NOTE: Light Plane Elevation Limits for the slope of this plane must not exceed 2 percent up or 1.5 percent down.

****

Provide FAA E-982 unidirectional frangible mounted lights with PAR-56 [200 W] [300 W] [and] [500 W] lamps, and [without] [with aviation red] filters at cross bar, centerline bars, and side row barrettes.

2.3.1.2 In-Pavement, High-Intensity Steady Burning Approach Lights

Use in-pavement, high-intensity, base-mounted lights in the overrun area and paved areas with traffic. Use fixtures conforming to FAA AC 150/5345-46 [Type L-850E for unidirectional quartz lights with lamps,] [Type L-850E(L) for unidirectional LED lights] with filters and transformers as indicated. Mounting must conform to the details indicated. Mount bases level and recess as required by thickness of fixture to provide installation in accordance with manufacturer's instructions.

[2.3.1.3 Hook Resistant Lights for Simulated Carrier Deck Lighting System

Provide fixtures as required for simulated carrier deck lighting system as specified except with 65-watt lamps and green filters.

]2.3.1.4 [Voltage][Current] Powered Sequenced Flashing Light (SFL) for High Intensity Approach Light System

FAA E-2628. Provide as a complete and integrated part of the approach system including individual power supply units, elevated flashing units, master timer, remote control and monitor units, interconnecting wiring, and support structures. Include master timer cabinet that provides timed flashing signals to 21-lamp power supplies. System must monitor individual lamp flashes and report via normally open contacts a condition of two, three, or more malfunctioning lamps or power supplies. The master timer cabinet can be a solid-state type. Provide the system with major components that are the product of a single manufacturer. Install junction boxes as indicated on concrete foundations and on the platform of elevated structures. Install conduit tappings in the bottom and top of the junction boxes as required to accommodate the incoming and outgoing power and control circuits for the flashing lights. Provide terminal strips in each junction box as indicated for termination and connection of the power and control circuits. Provide signal and monitor cables as recommended by the system manufacturer. [Provide current transformers for current powered system.]

2.3.1.5 Economy Approach REIL

FAA AC 150/5345-51[Type L-849V voltage powered][Type L-849V current powered].

2.3.2 Medium-Intensity Approach Lighting Systems with Runway Alignment Indicator Lights (MALSR)

2.3.2.1 Elevated, Medium-Intensity, Steady-Burning Fixtures

Utilize FAA E-2325 PAR 38 lampholders with [150 watt] [_____] PAR-38 spotlight lamps frangibly mounted on [light bases] [steel stakes] [and/or] [low-impact-resistant supports] [frangible supports]. The peak intensity of the main beam, at 120V input, must not be less than 5,000 candelas and the intensity must not be less than 1,000 candelas at any angle up to 15 degrees from the beam axis.

2.3.2.2 In-Pavement, Medium-Intensity, Steady-Burning Fixtures

****

NOTE: In-pavement fixtures are only authorized for installation in pavement subject to aircraft operations.

****

The peak intensity must be not less than 5,000 candelas within the main beam, and not less than 2500 candelas +/-5 degrees horizontally and +/-3.5 degrees vertically from the main beam axis, and not less than 500 candelas at +/-7 degrees horizontally and +/-5.5 degrees vertically from the main beam axis.

2.3.2.3 Encapsulated Stepdown Transformer

Provide 200-watt, 240-volt/30.3-volt transformer approved by the fixture manufacturer. Use connectors that comply with Type L-823 as indicated.

2.3.2.4 Voltage Powered Sequence Flashing Lights (SFL) for Medium Intensity Lights

These elevated SFL fixtures (RAIL) must meet the requirements of [FAA E-2159] [FAA AC 150/5345-51, Type L-849] with [eight] [_____] lights and must be as indicated on the contract drawings as an integrated part of the approach system. The SFL system must include the fixtures, the individual power supplies, master timer and power supply, remote control [and monitor] [support structures], and interconnecting wiring. The SFL must flash twice per second in sequence towards the runway threshold.

2.3.3 Omnidirectional Approach Lighting System (ODALS)

The ODALS fixtures must meet the requirements of FAA AC 150/5345-51, Type L-859 Style F. The ODALS must include the [7] [_____] fixtures, the individual power supplies, the master timer and power supply, remote control, [support structures] and interconnecting wiring. The ODALS must flash twice per second in sequence towards the runway threshold.

2.3.4 Glide Slope Indicator System

[Consists of four light units mounted in the area of the ground point of intercept of the glide slope and aimed in the direction of the approach.

]2.3.4.1 Precision Approach Path Indicator System (PAPI)

FAA AC 150/5345-28 [Type L-880 non-LED][Type L-880(L) LED]. Connect the four light units to [6.6 ampere series current circuit (Style B) via appropriate isolation transformers][240 volts ac constant voltage circuit (Style A)]. Provide tilt switches and relays to de-energize all light units when one unit exceeds tilt requirements.

2.3.4.2 Chase Helicopter Approach Path Indicator System (CHAPI)

FAA AC 150/5345-28 [Type L-881 non-LED][Type L-881(L) LED] with a filter that will provide a two-degree wide green sector in the center of the white over red beam. Connect the two light units to [6.6 ampere series current circuit (Style B) via appropriate isolation transformers][240 volts ac constant voltage circuit (Style A)]. Provide tilt switches and relays to de-energize all light units when one unit exceeds tilt requirements.

2.3.5 Low-Impact-Resistant (LIR) Frangible Supports

****

NOTE: Designer to provide structural foundation design by registered professional engineer.

****

Fiberglass reinforced conforming to [FAA E-2702] [FAA AC 150/5345-45]. Provide anchor bolts, lowering devices and fixture mounting accessories as required by tower manufacturer.

2.4 RUNWAY LIGHTING SYSTEM

****

NOTE: The designer must insure compatibility if FAA listed LED type fixtures are to be served by existing regulators. In such cases, indicate the existing regulator manufacturer and model number on the drawings.

****

[Include runway edge lights, runway threshold lights, [runway centerline lights,] [runway touchdown zone lights,] [runway distance remaining signs [and arresting gear] markers], mounting structures, controls, and the associated equipment and interconnecting wiring to provide complete runway lighting systems as indicated.] Use in-pavement light fixtures that withstand a minimum static single wheel load of 22,680 kg 50,000 pounds. [Where LED fixtures are used, provide fixtures that are compatible with the associated constant current regulators.] [Existing regulator manufacturer and model number is as indicated on drawings.]

2.4.1 Runway Edge Lights

FAA AC 150/5345-46, [[Type L-862][Type L-862(L) LED], elevated high-intensity] [[Type L-861][Type L-861(L) LED], elevated medium-intensity, airfield and heliport] [[Type L-850C][Type L-850C(L) LED], in-pavement, high-intensity] [[Type L-852E][Type L-852E(L) LED], in-pavement medium-intensity,] white lights.

2.4.2 Runway Threshold and End Lights

[FAA AC 150/5345-46, [[Type L-862][Type L-862(L) LED], elevated high-intensity, bidirectional]], [[Type L-861 SE][Type L-861(L) LED], elevated, medium-intensity, bidirectional] [[Type L-861][Type L-861(L) LED], elevated, medium-intensity, omnidirectional] [[Type L-852E][Type L-852(L) LED], in-pavement, medium-intensity, omnidirectional] [[Type L-850D][Type L-850D(L) LED], in-pavement, high-intensity, bidirectional] [[Type L-850C][Type L-850C(L) LED], in-pavement, high-intensity, unidirectional] [FAA E-982, PAR-56, elevated unidirectional outboard of runway edges,] [airfield and heliport lights as indicated]. For threshold lights use aviation green filter and for end lights use aviation red filters. Combine these lights in a single bidirectional fixture with the appropriate color filters as indicated.

2.4.3 Runway Centerline Lights, Tailhook Operations

****

NOTE: Runway centerline lights for tailhook operations are medium intensity and are spaced at 7.5 m 25 feet on center. The fixtures are identified as compliant with NAVAIR 51-50AAA-2 and conform to FAA AC 150/5345-46 Type L-852. These fixtures have an extra strength stainless steel top conforming to Rockwell hardness of C40 to resist damage from aircraft tailhooks.

****

****

NOTE: Type V is a fixture that is very shallow and is glued directly into the pavement that has been cored to make an 200 mm8 inch diameter by 29 to 32 mm 1.125 to 1.25 inch deep opening. The low voltage wires are installed in saw kerfs and are directly connected to fixture leads before setting the fixture. If the pavement is re-surfaced, it appears that new fixtures are needed, unless they can be un-glued.

Type VI is a fixture that is shallow and is bolted down to a shallow base. The shallow base is glued directly into the pavement that has been cored to make an 200 mm8 inch diameter opening as deep as the shallow base. The wires are installed in saw kerfs and are routed into the shallow base and then connected to fixture leads before setting the fixture. If the pavement is re-surfaced, the fixture can be removed, spacer rings added and the fixture re-installed.

Type VII is a fixture that is bolted down to a 250 mm 10 inch diameter L-868 base can that has standard conduit and cable connections. The fixture has an L-823 secondary connector to connect to the isolation transformer in the base can. Spacer rings can be used for pavement re-surfacing.

Type VIII is a fixture that is bolted down to a 300 mm12 inch diameter L-868 base can that has standard conduit and cable connections. The fixture has an L-823 secondary connector to connect to the isolation transformer in the base can. Spacer rings can be used for pavement re-surfacing.
****

Provide fixtures similar to FAA AC 150/5345-46, [Type L-852][Type L-852(L) LED], and identified as Class N (Navy). Use unidirectional, narrow beam, Type VIII, [with shorting device for failed lamp,] fixtures modified to resist damage from aircraft tailhooks. The stainless steel top assembly must conform to ASTM A447/A447M with a Rockwell hardness of C40 plus or minus 5. Height of fixture must be 12.7 mm 1/2 inch above pavement in lieu of 9.5 mm 3/8 inch. Secure optical assembly with ceramic/metallic/fluorocarbon polymer coated steel bolts.

2.4.4 Runway Centerline Lights, Non-Tailhook Operations

FAA AC 150/5345-46, [Type L-850A][Type L-850A(L) LED], Class 2. Provide filters as indicated and that conform to the requirements of fixture specifications.

2.4.5 Runway Touchdown Zone Lights, Tailhook Operations

FAA AC 150/5345-46, [Type L-852][Type L-852(L) LED], Class N (Navy), bidirectional, narrow beam, Type [V][VI][VII][VIII], [with shorting device for failed lamp,] modified to resist damage from aircraft tailhooks. Modify fixture as follows to resist damage from aircraft tailhooks. Stainless steel for top assembly must conform to SAE AMS5351 with Rockwell hardness of C40 plus or minus 5. Provide casting thickened from 9.52 to 12.7 mm 3/8 to 1/2 inch, and optical plate thickened as required to maintain flushness. Height of fixture must be 12.7 mm 1/2 inch above pavement in lieu of 9.52 mm 3/8 inch. Light channel width must be 25 mm 1 inch at the lens, with a divergence of 14 degrees on each side. Secure optical assembly with ceramic/metallic/fluorocarbon polymer coated steel bolts.

2.4.6 Runway Touchdown Zone Lights, Non-Tailhook Operations

[FAA AC 150/5345-46, [Type L-850B][Type L-850B(L) LED], with top casting having extra rib for protection against damage from aircraft tailhooks.]

2.5 TAXIWAY LIGHTING SYSTEMS

Include edge lights, [centerline lights], hold position lights, and all associated equipment, power supplies and controls, mounting devices, and interconnecting wiring to provide complete systems. If LED fixtures are used, provide fixtures that are compatible with the associated constant current regulators. [Existing regulator manufacturer and model number is as indicated on drawings.]

2.5.1 Taxiway Edge Lights

[FAA AC 150/5345-46, [Type L-861T][Type L-861T(L) LED] for elevated taxiway edge lights with 45-watt, 6.6A lamp and blue lens or yellow lens or LED as indicated][and][FAA AC 150/5345-46, [Type L-852E][Type L-852E(L) LED], Class [1][2] for semiflush taxiway edge lights with a 115-watt, 6.6A lamp and blue filter.]

****

NOTE: The designer must insure compatibility if FAA listed LED type fixtures are to be served by existing regulators. In such cases, indicate the existing regulator manufacturer and model number on the drawings.

****

2.5.2 Taxiway Centerline Lights

****

NOTE: Taxiway centerline lights are required only for Category III operation. They are optional for Category II and should only be installed with Activity concurrence. Delete this paragraph if not required.

****

FAA AC 150/5345-46, Type [L-852][L-852(L) LED], in-pavement fixtures.

2.5.3 Straight Centerline Sections

FAA AC 150/5345-46, [Type L-852C][Type L-852C(L) LED] with green/green or green/yellow filters as indicated.

2.5.4 Curved Centerline Sections

FAA AC 150/5345-46, [Type L-852D][Type L-852D(L) LED] with green/green or green/yellow filters as indicated.

2.5.5 Taxiway Intersections

FAA AC 150/5345-46, [Type L-852F][Type L-852F(L) LED] with yellow filter.

2.5.6 Taxiway Hold Lights

FAA AC 150/5345-46, [Type L-852G][Type L-852G] unidirectional with yellow filter toward the taxiway.

2.5.7 Runway Hold Position Lights

FAA AC 150/5345-46, [Type L-804][Type L-804(L) LED], elevated, or [Type L-852G][Type L-852G(L) LED], in-pavement, unidirectional, with aviation yellow filter and aimed toward the taxiway approach to the runway.

2.5.8 Limit Lights

FAA AC 150/5345-46, [Type L-861][Type L-861(L) LED] with red globes and 45-watt lamps or LEDs. Frangibly mount the lights on FAA AC 150/5345-42, Type L-867 light bases.

2.6 AIRFIELD GUIDANCE SIGN SYSTEMS

****

NOTE: The designer must insure compatibility if FAA listed LED type signs are to be served by existing regulators. In such cases, indicate the existing regulator manufacturer and model number on the drawings.

****

[2.6.1 General

****

NOTE: For most applications select Mode 3, 483 kph 300 mph rated markers. For bases that do not serve C-17 aircraft select Mode 2, 322 kph 200 mph rated markers. If not known verify with airfield manager.

****

Provide guidance signs compatible with all L-828/L-829 regulators.

]2.6.2 Photometric Requirements

Guidance signs must meet FAA minimum luminance requirements.

2.6.3 Taxiway Guidance Signs

FAA AC 150/5345-44, [[Type L-858Y][Type L-858Y(L) LED] for information] [and] [[Type L-858R][Type L-858R(L) LED] for mandatory signs]. Provide signs of the size and with the information indicated. Sign must operate on a [multistep 6.6 amp circuit][5.5 amp single stopcircuit].

2.6.4 Runway Distance Remaining Signs

****

NOTE: It is recommended that runway distance remaining signs be Style 5 (5.5A) and connected to a dedicated runway sign circuit. Style 3 signs are designed for 5-step 2.8 to 6.6 ampere CCRs. The associated L-828 or L-829 constant current regulator is adjusted to operate at 5.5A and as one-step (on-off). The signs are less expensive and operate more efficiently if they do not have to operate at the lower current levels of the runway circuit. Signs must have white numerals. Existing installations may have yellow numerals and it is recommended that the panels be changes to conform to FAA standards.

****

FAA AC 150/5345-44, Type L-858B, Size 4, Style [3][5], with white numerals on a black background. Provide internally illuminated markers with illumination of the face not less than 50 percent of that at rated current when the series lighting circuit is operated at the lowest brightness step.

2.6.5 Arresting Gear Markers

****

NOTE: This is not a standard FAA sign configuration. Markers are similar to L-858B except the legend is yellow (instead of white) on a black background.

****

Provide arresting gear markers that are the same as Runway Distance Remaining Signs, except arresting gear markers must have a 990.6 mm 39 inch translucent yellow circle in place of numerals as specified above.

2.7 HELIPAD LIGHTING SYSTEMS

2.7.1 Helipad Perimeter Lights

****

NOTE: The standard configuration uses yellow lights as shown in Figure 7-1, in UFC 3-535-01. The hospital configuration uses yellow and green lights as shown in Figure 7-2.

****

2.7.1.1 Elevated Lights

FAA AC 150/5345-46, [Type L-861][Type L-861(L) LED] with aviation yellow [or green] globes, as indicated. Frangibly mount lights on FAA AC 150/5345-42, Type L-867 bases.

2.7.1.2 In-Pavement Lights

FAA AC 150/5345-46, [Type L-852E][Type L-852E(L) LED] with aviation yellow [or green] filters. Mount fixtures on FAA Type L-868 bases.

2.7.2 Helipad Floodlighting

****

NOTE: Reference UFC 3-535-01 Chapter 7 for Air Force and Army helipad flood lights and NAVAIR 51-50AAA-2 Work Package 007 06 for Navy helipad flood lights information.

****

Use helipad floodlights as indicated.

2.7.3 Helipad Landing Direction Lights

FAA AC 150/5345-46, [Type L-861][Type L-861(L) LED] with aviation yellow globes. For landing direction lights located in paved areas subject to aircraft or vehicular surface traffic, use FAA AC 150/5345-46, [Type L-852E][Type L-852E(L) LED] fixtures with aviation yellow filters.

2.7.4 Helipad Approach Direction Lights, Visual Meteorological Conditions

FAA AC 150/5345-46, [Type L-861][Type L-861(L) LED] fixtures with aviation white globes. For approach direction lights located in paved areas subject to aircraft or vehicular surface traffic, use FAA AC 150/5345-46, [Type L-852E][Type L-852E(L) LED] fixtures without filters.

2.7.5   Helipad Approach Direction Lights, Instrument Meteorological Conditions

FAA E-982 lampholder for Type PAR-56 lamps without filters.

2.8   HOVERLANE LIGHTS

[FAA AC 150/5345-46, [Type L-861][Type L-861(L) LED] for elevated lights with aviation yellow or aviation green globes] [as indicated on the contract drawings]. For hoverlane lights located in paved areas subjected to aircraft or vehicle traffic, the fixtures must be [FAA AC 150/5345-46, [Type L-852E][Type L-852E(L) LED] with aviation yellow or aviation green filters].

2.9   RUNWAY END IDENTIFIER LIGHTS (REIL)

FAA AC 150/5345-51, [Type L-849][Type L-849(L) LED], Style E-Unidirectional, three brightness steps. Include the master and slave fixture, the power supply, remote control, frangible mounts, and interconnecting wiring. The REIL units must flash in unison twice per second.

2.10   OBSTRUCTION LIGHTING AND MARKING

****

NOTE: At the time of this writing, questions are being raised about the ability of a pilot, using night vision goggles, to see LED-based obstruction lights. For the time being, do not use LED-based obstruction lights on military facilities.

Do not use the first bracketed option for Navy projects.

****

2.10.1   Obstruction Lights

[Mark obstructions on or near the [airfield] [heliport] and/or lighted as indicated.]Use obstruction marker lights emitting aviation red [flashing] [steady burning] [flashing and/or steady burning] light. Use [multiple-socket assembly] [series socket assembly] FAA AC 150/5345-43, [Type L-810] [Type L-864] light fixtures. For multiple flashing lights on a circuit, flash the lights in unison. Use [single-unit type] [double-unit type] [single- or double-unit type] obstruction marker lights as indicated. Energize the obstruction lights [multiple] [series] [series or multiple] circuits as indicated.

Do not use LED-based obstruction lights on military facilities.

2.10.2   Solid State Flasher

Provide zero voltage switching, at zero point of sine wave, to regulate the on-off cycle of red hazard beacons. Provide flasher which supplies [one][two][three] circuits[as indicated].

[2.11   WHEELS-UP SYSTEM

****

NOTE: The Wheels-Up Light Fixtures are for some

Navy airfields. Reference NAVAIR 51-50AAA-2 Work Package 006 03 for information on this system.
****

Include wheels-up lights, handholes, equipment vault, control panel, and the associated equipment and interconnecting wiring to provide a complete system as indicated and as specified herein.

2.11.1 Wheels-Up Light Fixtures

FAA E-982 or MIL-L-26764 Type MB-2 for 120-volt, 500-watt lamp (Q500-PAR56/MFL). Include a positioning arrangement to adjust light with a locked position after installation. Provide lamps as indicated. Provide a clear filter to protect lamp from direct contact with rain.

2.11.2 Light Dimmer

As indicated and as specified below. Provide a single NEMA Type 4X housing for assembly, above-ground on frangible supports to a 0.9 m 3 foot head. Enclosure must have limiting dimensions of 0.76 by 0.76 by 1.22 m 2 1/2 by 2 1/2 by 4 feet in height. Provide enclosure finish in accordance with the manufacturer's standard practice for the intended service. Provide dimmer designed for continuous full-load operation in an ambient temperature of 40 degrees C 104 degrees F. Dimmer must control rated circuit load from full bright to blackout, 12 volts or less, on any load from 3 to 100 percent of rated circuit load. Provide output voltage not less than 120 volts at maximum controller setting and at maximum rated circuit load. For an input variation of plus or minus 10 percent, output voltage must vary within plus or minus 5 percent. Provide dimmer capable of handling suddenly applied cold tungsten lamp loads of full circuit load rating at maximum dimmer output setting without failure or without degradation of components. When equipped with branch circuit protection, dimmer must handle a short circuit on load terminals without failure or degradation of components. Use a dimmer that employs the principle of a variable transformer with output voltage continuously adjustable from zero to maximum proportionately over the full range. Provide motor driven unit with built-in limit switches, controlled from a lever action, spring return to "off" switch. Solid-state controls or equipment are prohibited.

2.11.3 Wheels Watch Control Panel

Construct as indicated on drawings and conform to UL 50. Provide cabinet and hinged cover of 14 gage sheet steel, zinc coated by the hot-dip process, and NEMA Type 4 suitable for outdoor use. Provide cabinet and cover treated, primed, and finish painted with color as directed and suitable for the intended service. Provide weatherproof receptacle on cabinet with threaded cap and chain as indicated on drawings. Where controls are on the face of the panel, provide clearly identified engraved nameplates. Provide panel with components necessary for complete operation of the lighting system as indicated.

][2.12 WAVE-OFF SYSTEM

****
NOTE: The Wave-off strobe light fixtures are for some Navy airfields. Reference NAVAIR 51-50AAA-2 Work Package 006 03 for information on this system.
****

Include wave-off strobe lights (flash head), equipment pad, control panel, transformers, safety switches, panelboard and the associated equipment and interconnecting wiring to provide a complete wave-off system as indicated on drawings.

2.12.1 Wave-off Strobe Lights

Provide capacitance-discharge, flashing lights (strobe) for wave-off lighting system. Each light includes a flash head (FH) optical assembly unit, a power converter unit (PCU), and the interconnecting cable.

a. MIL-L-29575

2.12.2 Wave-Off Control Cabinet

Provide cabinet with components necessary for complete operation of the lighting system as indicated.

a. Enclosure

  (1) a. UL 50

  (2) b. 14 gage, sheet steel, NEMA [3R][_____], enclosure per NEMA ICS 6, with hinged cover

  (3) c. Hot-dip, zinc coated

  (4) d. Solvent clean per SSPC SP 1. If the galvanized metal has been "passivated" or "stabilized", the coating must be completely removed by brush-off abrasive blast or other treatment, or the surface must be primed with a primer which is specifically recommended by the paint manufacturer for use on passivated or stabilized galvanized steel.

  (5) e. Immediately after cleaning, coat surfaces with a pretreatment coating or a crystalline phosphate coating.

  (6) f. As soon as practicable after the pretreatment coating has dried, prime treated surfaces with a coat of zinc-chromate primer and one coat of synthetic exterior gloss green enamel paint. The color must be [Munsell 7GY3.29/1.5 green per ASTM D1535][_____].

b. Nameplates

  (1) . Provide nameplates for controls as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

c. Terminal Board

  (1) . NEMA ICS 4

d. Relays

  (1) . Provide as indicated.

  (2) . Coil: [120][277][_____] Volt, 60 Hz.

  (3) . Contacts: [10][_____] Amperes

e. Receptacle

   (1) . UL listed for use in wet locations.

   (2) . Weatherproof on cabinet with threaded cap and chain as indicated.

2.12.3 Pad-mounted Transformer, [15][_____] kVA, [1][3]-Phase, Low Profile

[As specified in Section 26 12 21, SINGLE-PHASE PAD-MOUNTED TRANSFORMERS.]

[As specified in Section 26 12 19, PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS.]

2.12.4 Safety Switches, Panelboard, and Transformer

a. Provide as specified in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM.

b. Provide enclosure as specified for Wave-Off Control Panel.

2.12.5 Photo-Electric Switch

a. UL 773 or UL 773A

b. Hermetically sealed cadmium-sulfide cell

c. Single-throw contacts

d. On below 3 footcandles, off 3 - 10 footcandles

e. Time delay to prevent switching from transient light sources.

f. Directional lens to prevent turnoff condition from fixed lights.

2.12.6 Equipment Pad

Provide as indicated on construction drawings.

][2.13 SIMULATED CARRIER DECK LIGHTING SYSTEM

****

NOTE: The Simulated Aircraft Carrier Deck Lighting System is for some Navy airfields. Reference NAVAIR 51-50AAA-2 Work Package 006 04 for information on this system.

****

Include deck edge lights, deck centerline lights, athwartship and ramp lights, isolating transformers, control panels, the associated equipment and interconnecting wiring to provide a complete system as indicated on drawings.

2.13.1 Light Fixtures

****

NOTE: Type L-852N fixture shorting device is only used where multiple fixtures will be on a single isolation transformer. See description of Type V, VI, VII, and VIII light fixtures in designer note

for runway centerline lights, tailhook operations.
****

FAA AC 150/5345-46, Type L-852, Class N (Navy), unidirectional, narrow beam, Type [VIII][VII][VI][V], [with shorting device for failed lamp,] modified to resist damage from aircraft tailhooks. Modify fixture as follows to resist damage from aircraft tailhooks. Stainless steel for top assembly must conform to SAE AMS5351 with Rockwell hardness of C40 plus or minus 5 with casting thickened from 9.53 to 12.7 mm 3/8 to 1/2 inch, and optical plate thickened as required to maintain flushness. Provide fixture height of 12.7 mm 1/2 inch above pavement in lieu of 9.53 m 3/8 inch. Provide light channel width one inch at the lens, with a divergence of 14 degrees on each side. Secure the optical assembly with ceramic-metallic/fluorocarbon polymer coated bolts.

2.13.2 Landing Signal Officer (LSO) Control Panel

Portable and suitable for use on paved area adjacent to the LSO handhole. Provide control panel, cabinet, and cover of 3.18 mm 1/8 inch aluminum alloy 5052-H32 conforming to ASTM B209 and constructed as indicated. Rigidly construct entire assembly spraytight in accordance with MIL-STD-108. Provide a hinged cover with two or more positive closing latches to protect panel face when not in use, with cover arranged so that it can be opened to all positions. Identify controls on panel face clearly by engraved nameplates. Panel must contain components and controls necessary for complete operation of lighting systems indicated. Provide receptacles as indicated and in accordance with the referenced Military Standards. Provide panel in close-fitting cabinet, removable from front.

2.13.3 Encapsulated Stepdown Transformer

Provide 200-watt, 6.6A/6.6A transformer approved by the fixture manufacturer. Connectors must comply with Type L-823 as specified.

]2.14 LIGHT BASES

****
NOTE: Use FAA AC 150/5345-42 Type L-867 bases for applications not subject to aircraft or vehicle loading. Use Type L-868 for applications subjected to aircraft or vehicle loading.
****

FAA AC 150/5345-42 Type L-867 or L-868 [_____]. Use steel bases, Class 1, Size [B] [C] [D] [A] as indicated or as required to accommodate the fixture or device installed. Use Size C where more than one distributed control module is installed in the light base. Where used as pull boxes in (single or multiple) can plazas use L-867D bases. Provide base plates, cover plates, and adapter plates to accommodate various sizes of fixtures.

Furnish each base with internal and external one-hole ground lugs for attaching ground or counterpoise cables.

****
NOTE: For Navy projects delete the following sentences.
****

[Furnish each base with a 1.2 m 4 foot braided, 25 square mm #6 AWG equivalent ground strap with one-hole lug compression fittings. Utilize straps made for the purpose of grounding the light fixture to the base can interior grounding lug.]

2.15 SNOW PLOW RINGS

Provide cast ductile iron [unidirectional] [bi-directional] snow plow rings for in-pavement light fixtures, as indicated. The rings must be suitable for the light fixture and L-868 light base cans indicated. Rings must have [four stainless steel spring pins and] black powder coat finish. Ring must be provided with a silicone rubber O-ring and six ceramic fluoropolymer coated bolts and 2-piece locking washers.

2.16 WIND DIRECTION INDICATOR

FAA AC 150/5345-27, Type [L-806, low mass supporting structure, size 1, 2438 mm 8 feet] [L-807, rigid supporting structure], [size 1, 2438 mm 8 feet][size 2, 3657 mm 12 feet], [Style (I-lighted] [II-unlighted], Size [0.3 to 2.44 m 1 to 8 feet] [0.61 to 3.66 m 2 to 12 feet]. Provide wind cones of the size and color as indicated, including wind cone indicator assembly connection, including wind cone indicator assembly connection..

FAA AC 150/5345-27, Type L-807, with a frangible support assembly, lighted with four lamps, and [an orange][a white] 3660 mm 12 foot fabric cone. Provide wiring and controls. Supplemental wind cones, where used, must be Type L-806.

2.17 BEACON

The rotating beacons for airfield and heliport beacons are omnidirectional and color coded and are provided by rotating the beams in sequence to provide the color and intensity. For military facilities the beacon has a double-peaked white beam. Use beacons with flashes visible through 360 degrees.

2.17.1 Airfield Rotating Beacon

****

NOTE: For operation down to 30 degrees C -22 degrees F, a Class 1 beacon must be provided. For operation down to 50 degrees C -58 degrees F, specify a Class 2 beacon with a low temperature heater package.

****

FAA AC 150/5345-12F, Type L-802M, Class [1] [2] for fixed wing aircraft. Provide a duplex type beacon with double-peaked white beam in a repeating white/white/green pattern. Use NEMA ICS 6 Type [3R] [_____] enclosure of zinc-coated steel. [Provide beacon with a low temperature heater package for use in temperatures below minus 30 degrees C 86 degrees F.]

2.17.1.1 Power Supply

Provide weatherproof circuit-breaker panelboard having four single-pole 120-volt circuits, a ground bus and a solid neutral bus to provide separately protected circuits for the beacon lamps, motor, [heater circuit] and obstruction lights. Provide cabinet with a NEMA Type [3R][_____] enclosure of zinc-coated steel. Locate panelboard at working height at ground level. Provide disconnect switches at the maintenance platform level

2.17.2 Helipad/Heliport Beacon

FAA AC 150/5345-12, Type L-801H, Class 2, with double-peaked white flash. The beacon must flash the colors [white, aviation green, and aviation yellow for a non-medical facility helipad] [white, aviation green, and aviation red for a medical facility helipad.] The beacon flashes must be visible throughout 360 degrees horizontally, and the effective intensity of the flashes must be not less than 25,000 candelas for vertical angles between 2 and 8 degrees and not less than 12,500 candelas for vertical angles between 0 and 10 degrees. The flashes must be uniformly spaced with the three-color sequence flashing 10 to 15 times per minute.

[2.17.3 Airfield Identification/Code Beacon

****

NOTE: This type of beacon is very seldom used. Validate requirement with airfield manager.

****

FAA AC 150/5345-43, Type L-866 with green filters and code flashing device. Use beacons with flashes visible through 360 degrees. The effective intensity of the green flash must be not less than 2,000 candelas. Use the code as indicated and flash 6 to 8 codes per minute.

]2.18 LAMPS AND FILTERS

Provide lamps of the size and type indicated, or as required by fixture manufacturer for each lighting fixture required. Include filters of colors as indicated and conforming to the specification for the light concerned or to the standard referenced.

2.19 EXPLOSION-PROOF FIXTURES FOR HAZARDOUS LOCATIONS

****

NOTE: Only fixtures that are listed by U.L. or an equivalent lab are authorized for use in explosion-hazardous locations. The listing must reflect the installed configuration.

****

For explosive hazardous locations, use fixtures that meet the requirements of and be listed by UL Electrical Construction or ETL as defined in NFPA 70 for the hazard and application.

2.20 ISOLATION TRANSFORMERS

2.20.1 Encapsulated Isolation Transformers

FAA AC 150/5345-47, Type (G) L-830. Provide each transformer with rating as indicated. Insulation Level Primary voltage rating 5000 volts RMS, Secondary 600 V RMS. Operating Temperature range minus 55 degrees C 131 degrees F to plus 65 degrees C 149 degrees F. Resistant to UV exposure and ozone. Suitable for areas contaminated with oils, aircraft fuels, soil acids, alkalis, and deicing fluids. Compatible with FAA Style 2 and Style 9 connectors.

2.20.2 Isolation Transformers for Frangible Towers

FAA E-2690. Encapsulated, submersible type with lifting handles and rating of 1500 watts, [_____] volts, 20 amp primary, [6.6][20] amp secondary, [as indicated,] single phase, 60 Hz. Primary and secondary leads conforming to FAA AC 150/5345-7, Type L-824.

2.21 SURGE ARRESTERS

Provide surge arresters in accordance with IEEE C62.11, IEEE C62.41.1 and IEEE C62.41.2 as applicable with ratings as indicated. Provide surge arresters on the line side of the constant current regulator (CCR). Provide series circuit surge arresters for locations with a lightning flash density of 8 or more flashes per square kilometer per year.

2.22 SURGE PROTECTIVE DEVICES

As required in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM.

2.23 CONSTANT CURRENT REGULATORS

****

NOTE: The following FAA L-828/929 regulators are not allowed for new construction:

1. 20 A output current in sizes 50 and 70 KW.

2. 2400 V input regulators.

However, with Activity concurrence, they may be permitted for minor additions or upgrade for existing installations. Additionally, 240V input regulators also require Activity concurrence.

For Navy regulators check control voltage with SPAWAR.

****

2.23.1 Regulators

FAA AC 150/5345-10, [Type L-828, without monitoring] [Type L-829 with monitoring] dry-type system and with current rating or [6.6A][20A][6.6A and 20A][5.5A][_____]. Use regulators of ferrorescnant design to reduce EMI, increase efficiency, and provide a power factor not less than 0.95. Provide regulators that operate on [60] [50] Hz, have internal primary switch [included] [excluded], have input voltage of [480][_____] and be controlled by [120 VAC][48VDC][_____] external control voltage. Provide [5][3][or][1] [_____] brightness steps, as indicated. [Provide monitors as indicated.] [Provide regulators with digital power meters.] [Provide regulators with insulation resistance monitoring systems.] [Provide regulators with integral or unit-mounted series circuit cutouts.] [Use stackable switchgear style regulators with a series circuit cutout cabinet.] Insure that constant current regulators are compatible with signs, [LED light fixtures] and other connected loads.

2.23.2 Basic Impulse Level (BIL)

Provide 60-kV series circuit BIL except that 4-kW, 7.5-kW and 10-kW regulator series circuits may have a BIL of 25 kV.

2.24 CIRCUIT SELECTOR SWITCH

****
NOTE: Circuit selector switches were previously referred to as circuit selector cabinets or distribution boxes and may be provided to select one of two circuits or to select any combination of up to four circuits.
****

FAA AC 150/5345-5, Type L-847, for [one] [two] [three] [four] circuit control [as indicated], Class [A, indoor] [B, outdoor], Rating [1, for 6.6 amperes] [2, for 20 amperes].

2.25 MATERIALS AND HARDWARE

2.25.1 Wire and Cable

Use copper conductors installed in conduit. Do not provide or install wire and cable manufactured more than one year before delivery to the job site.

2.25.1.1 Conductor Sizes

Conductor size conforming to American Wire Gage (AWG) or metric trade size. Use stranded conductors for sizes larger 10 square mm #8 AWG. Unless otherwise indicated 10 square mm #8 AWG and smaller may be solid or stranded.

2.25.1.2 Low Voltage Wire and Cable

****
NOTE: Type THW insulation can only be obtained in large quantity. Use of this type insulation is not recommended for small projects. Wire with "W" in the type is usually acceptable for wet locations. Revise to add guidance on when to use each type.
****

a. [UL 83, Type [_____][THWN-2] UL 44 Type XHHW-2 [_____].]

b. [UL 83, Type [_____][THWN-2]] [UL 44, Type [XHHW-2] [_____] must be used for secondary series lighting circuits to be installed in pavement.]

2.25.1.3 Wire and Cable for Series Lighting Circuits

****
NOTE: FAA AC 150/5345-7 covers Type B ethylene-propylene) and Type C (crosslinked polyethylene) cable. Each type has 600 volt and 5000 volt ratings with single and multiple conductors. Type B has an overall jacket while Type C only has the overall jacket for the multiple conductor cables. Type C is recommended for single conductor cable.
****

a. FAA AC 150/5345-7, Type L-824 for [crosslinked polyethylene Type C] [Type B] [600] [5000]-volt cable. Use unshielded cable for series airfield and heliport lighting.

****
NOTE: Provide safety equipment ground per NEC.
****

2.25.1.4 Safety (Equipment) Grounding System

Safety (Equipment) Grounding System for constant voltage (parallel) circuits: minimum 16 square mm #6 AWG bare stranded copper, annealed or soft drawn.

2.25.1.5 Sequence Flashing Trigger Circuits

[REA Bull 1753F-205] [_____] compliant cables.

2.25.1.6 Control Cable

[Multiconductor type for 120 V ac control, rated 600 volts, 4 square mm #12 AWG, and conforming to the following unless indicated or specified otherwise. Insulate each conductor with a thickness of not less than 0.762 mm 30 mils and rate for continuous operation at 90 degrees C 194 degrees F. Conductors must be color coded. An overall jacket of [heavy-duty neoprene][_____] rated for direct burial must be included. Cable must conform to NEMA WC 70for rubber insulation, ANSI/NEMA WC 71/ICEA S-96-659 for cross-linked polyethylene insulation, or NEMA WC 74/ICEA S-93-639 for ethylene-propylene rubber insulation.][Multiconductor type for 48 V dc control, rated 300 volts, 19 square mm #19 AWG, conforming to REA Bull 1753F-205.]

[2.25.1.7 Cable Tags

Install cable tags for each cable or wire at duct entrances entering or leaving manholes, handholes, and at each terminal within the lighting vault, and in all base cans. Use stainless steel, bronze or copper strip cable tags, approximately 1.59 mm 1/16 inch thick or hard plastic 3.18 mm 1/8 inch thick suitable for immersion in salt water and impervious to petroleum products. Use sufficient material length for imprinting the legend on one line using raised letters. Permanently mark or stamped with letters not less than 6.4 mm 1/4 inch in height as indicated. Two-color laminated plastic is acceptable. When providing plastic tags utilize white colored with markings of black color to provide contrast so that identification can be easily read. Use nylon or stainless steel ties must be of a type that will not deteriorate when exposed to water with a high saline content and to petroleum products.

]2.25.1.8 Cable Connectors and Splices

FAA AC 150/5345-26, Item L-823 for connections and splices appropriate for FAA Type L-824 cable.

2.25.2 Conduit, Conduit Fittings, and Boxes

2.25.2.1 Rigid Metal Conduit (RMC) or Electrical Metallic Tubing (EMT) and Fittings

UL 6 and UL 797.

2.25.2.2 Liquid-tight Flexible Metal Conduit (LFMC)

UL 360 liquid-tight flexible metal conduit. See Sections 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.25.2.3 Outlet Boxes for use with RMC, EMT, of LFMC

See 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.25.2.4 Plastic Duct for Concrete Encasement

Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.25.2.5 Plastic Conduit for Direct Burial

Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.25.2.6 High Density Polyethylene (HDPE) Electrical Conduit for Directional Bore

Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.25.2.7 Frangible Couplings and Adapters

FAA FO 6850.19 and FAA E-2519. Provide upper section of frangible coupling with one of the following:

a. Unthreaded for slip-fitter connections.

b. 61.1 mm 2-13/32 inch 16N-1A modified thread for nut and compression ring to secure 53 mm 2 inch EMT.

c. 53 mm 2 inch 11-1/2-N.P.T. (tapered) with 5.6 mm 7/32 inch nominal wall thickness to accept rigid conduit coupling.

d. Frangible Couplings for specialized applications as approved.

e. Electrical Metallic Tubing UL 797, where indicated for use with frangible couplings and adapters.

2.25.3 Electrical Tape

Provide as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.25.4 Ground Rods

As specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.25.5 Bolts and Hardware

2.25.5.1 Locking Type Washers

Use locking washers of the two-piece wedge-lock design to prevent damage to the fixture. Do not use split-ring, serrated or star type lock washers.

2.25.5.2 Anti-Seize Compound

Use anti-seize compounds for elevated light fixtures with stainless steel bolts but not for ceramic-metallic/fluorocarbon polymer coated bolts for in-pavement light fixtures. Use as recommended by the fixture manufacturer to provide the required clamping force except as indicated in Part 3 of this specification.

2.25.5.3 Ceramic-Metallic/Fluorocarbon Polymer Coated Bolts

Ceramic-metallic/fluorocarbon polymer coated bolts must be used for in-pavement light fixtures or may be used where recommended by the fixture manufacturer in lieu of using an anti-seize compound.

2.25.5.4 Stainless Steel Bolts for Elevated Fixtures

Use anti-seize lubricating compound.

2.25.6 Sealants for Fixtures and Wires in Drilled Holes or Saw Kerfs

****

NOTE: Keep this paragraphand only if paragraph "ENCLOSURES IN SAW KERFS AND DRILLED HOLES" in PART 3 is kept.

****

FAA AC 150/5370-10, Type P-605 and P-606, for use in asphaltic concrete (AC) or Portland cement concrete (PCC) pavement compatible with AC pavement and having a minimum elongation of 50 percent. Do not use formulations of Type P-606 which are compatible with PCC pavement only.

2.25.7 Manufacturer's Nameplates

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.25.8 Field Fabricated Nameplates

Provide field fabricated nameplates as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.25.9 Spare Airfield Lighting Equipment Materials

[

****

NOTE: Spare materials are optional for Air Force and Army projects, and not recommended for Navy projects. Coordinate quantities of spare materials with users.

****

Contractor must provide the following equipment and materials:

a. Lamps - Type and Quantity

b. Isolation Transformers - Type and Quantity

c. Constant Current Regulators - Type and Quantity

d. FAA L-823 Connectors - Type and Quantity

e. Control Cable - Type and Quantity

f. FAA L-824 Cable - Type and Quantity

g. Lamps for Airfield Lighting Fixtures and Signs

h. Refractors and Filters for Airfield Lighting Fixtures - Type and Quantity

i. Light Bases - Type and Quantity

j. Frangible Couplings - Type and Quantity

k. Sequenced Flashing Light System - Provide a spare part trunk with parts.
]

2.26 ACCESSORIES

2.26.1 Special Tools

List of special tools and test equipment required for installation, maintenance of testing of the products supplied by the Contractor. Items to be listed include, but are not limited to, the following:

4-Jack Positioning Jig, used to install the light base to ensure correct orientation and leveling of in-pavement fixtures.

Crimping Tool

Cable Penciler

Elevated Light Level

PART 3 EXECUTION

3.1 LIGHT FIXTURE INSTALLATION REQUIREMENTS

[3.1.1 Existing Airfield Lighting Systems

****

NOTE: When modifications, additions, or any other work is to be performed on an existing airfield lighting system, the designer must add a carefully worded paragraph to cover maintenance of airfield lighting circuits and operations. Local conditions and the specifics of the Contract will affect this paragraph. The paragraph must be coordinated with Division 1 specifications. An example of this paragraph follows:

"Existing airfield lighting systems must remain in operating condition and interruptions must be held to a minimum. Where interruptions are necessary, they must be scheduled as approved in writing by the Contracting Officer. Prior to the scheduled time

for each interruption, all necessary materials and a sufficient labor force must be assembled to permit completing the work within the scheduled time interval. Under no circumstances must any of the existing airfield lighting circuits be left inoperative without making provisions for suitable temporary connections in the affected area or areas. All airfield lighting circuits covered under this Contract must be replaced in such a manner that they will be operational at dusk each day. The Contractor must submit to the Contracting Officer a plan for outages and maintaining lighting and lighting control."

****

[_____].

]3.1.2 General Installation Requirements

[Conform to IEEE C2, NFPA 70, NFPA 70B, and requirements specified herein. Circuits installed underground must conform to the requirements of Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION], except as required herein. Steel conduits installed underground must be installed and protected from corrosion in conformance with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical metallic tubing (EMT) must not be installed underground or encased in concrete. Except as covered herein, perform excavation, trenching, and backfilling in accordance with the requirements of Section 31 00 00 EARTHWORK and Section 32 11 23.23 BASE COURSE DRAINAGE LAYERS.

3.1.3 Airfield Light Fixture Installation

****

NOTE: For all projects do not use anti-seize compounds on runway/taxiway centerline or runway touchdown zone lights.

****

Use 2-part locking type washers for the installation of all airfield light fixtures. Tighten bolts to washer manufacturers recommended torque based on bolt type used. Use only adjustable torque limiting tools.

Where stainless steel bolts are used for elevated fixture installation use an anti-seize lubricating compound.

Where ceramic-metallic/fluorocarbon polymer coated bolts are used for in-pavement fixture installation do not use anti-seize lubricating compounds.

3.1.4 Light Base Installation

3.1.4.1 Installation in Cored Pavement

****

NOTE: Provide details on the project drawings showing the installed light fixture with reference to the finished pavement.

****

Wipe down the sides and bottom of each light base immediately prior to installation. For bored hole installations cover the inside faces of bored hole and bottom and sides of light base with a coating of compatible P-606 sealant that will completely fill the void between concrete and base. Use a jig or holding device when installing each light fixture to ensure positioning to the proper elevation, alignment, level control, and azimuth control. Orient the light fixture with the light beams parallel to the runway or taxiway centerline and facing in the required direction. Outermost edge of fixture must be level with the surrounding pavement. Remove surplus sealant or flexible embedding material. The holding device must remain in place until sealant has reached its initial set. Properly arrange fixture lead wires with respect to their connecting position. Block the wireway entrance into the light recess to retain the sealant material during curing.

3.1.4.2 Installation in Concrete Bed

Where light base can is partially embedded in concrete with jig or holding devices, leave device in place for minimum 24 hours. Let base can set for an additional 48 hours before remaining concrete is placed to the top of the light base.

3.1.5 Frangible Requirements

Install frangible supports, couplings, and adapters as indicated or specified. At the 300 m 1000 foot cross bar and beyond, mount approach lights up to 1.83 m 6 feet above concrete foundation on threaded frangible couplings and 53 mm 2 inch electrical metallic tubing (EMT). For mounting heights greater than 1.8 m 6 feet, mount approach lights on low-impact resistant frangible towers as indicated. The elevation of approach lights must be as indicated on drawings.

3.1.6 Elevated Light Fixtures

Elevated lights must be frangibly mounted, not to exceed 350 mm 14 inches in height except where higher mounting is permitted in snow accumulation areas. For equipment exceeding 350 mm 14 inches in height, frangibly mount as indicated. Use a 4-jack positioning jig to install the light base to ensure correct orientation and leveling. The individual setting the jig must fully understand reference marks that are provided by the surveyor. Check azimuth by survey before the concrete anchor is placed and again before paving. [A factory representative of the light base manufacture must be on-site when the first light base is being installed and verify that the installation crew understands proper azimuth and elevation required for the light base.]Do not place the near light base edge closer than two feet from a planned pavement joint. If conflict occurs, immediately notify the Contracting Officer Representative of the conflict.

3.1.6.1 Elevated Light Level

Level elevated light fixture using manufacturers system required for fixture type.

3.1.7 In-Pavement Airfield and Heliport Lights

****

NOTE: Coordinate light fixtures with concrete joint to maintain the proper pattern. Reference Section 32 13 11 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER

HEAVY-DUTY PAVEMENTS MORE THAN 10,000 CUBIC YARDS for PCC requirements. See UFC 3-535-01 Figure 4-11, Runway Centerline Light Configuration Note 2 for longitudinal tolerance that light bases my be offset from the pavement joint by up to 0.60 m2 feet.
****

Remove water, debris, and other foreign substances prior to installing in-pavement light base and light. Use a 4-jack positioning jig, obtained from the L-868 base manufacturer, to install the light base to ensure correct orientation and leveling. The individual setting the jig must fully understand reference marks that are provided by the surveyor. Check azimuth by survey before the concrete anchor is placed and again before paving. [A factory representative of the light base manufacture must be on-site when the first light base is being installed and verify that the installation crew understands proper azimuth & elevation required for the light base.]Do not place the near light base edge closer than two feet from a planned pavement joint. If conflict occurs, immediately notify the Contracting Officer Representative of the conflict.

3.1.7.1 In-Pavement Light Installation

For in-pavement installations, pavement around the light base must be level with the surrounding pavement; dished or mounded pavement near the light base is not acceptable.

3.1.7.2 Snow Plow Ring Installation

For in-pavement fixtures that require snow plow rings, coordinate the light base can, light fixture and snow plow ring to meet the installation tolerances shown in the paragraph Light Fixture Installation Tolerances. The Contractor may need to provide spacer rings to meet these tolerances. The top edge of the snow plow ring must be slightly higher than the top of the light fixture. Install the silicone rubber O-ring to seal the light base can. Install the ceramic fluoropolymer coated bolts to attach the light fixture and snow plow ring to the light base can.

3.1.8 Light Fixture Installation Tolerances

	IN-PAVEMENT	ELEVATED
ELEVATION (relative to finished pavement surface)	+0 mm+0 inch, -1.59 mm -1/16 inch (fixture edge on low side in snow areas or on high side in non-snow areas)	+6.35 mm, -0 mm +1/4 inch, -0 inch
AZMUTH (*) (w/respect to line parallel to RW/TW centerline)	+/- 1/2 degree	+/- 1/2 degree
LEVEL	+/- 1/2 degree	+/- 1/2 degree

	IN-PAVEMENT	ELEVATED
STATIONING (in line parallel to RW/TW centerline)	+/- 2 inch	+/- 50.8 mm+/- 2 inch
OFFSET (perpendicular to RW/TW centerline)	+/- 1/4 inch	+/- 6.35 mm+/- 1/4 inch

(*)For omni-directional fixtures the Azimuth does not apply.

[3.1.9 Enclosures in Saw Kerfs and Drilled Holes

3.1.9.1 Holes for Light Fixtures

Bore holes in existing pavement to the dimensions indicated with a diamond-edged bit to provide a smooth, straight cut. Bottom of hole must be flat or slightly concave, except that an area at least 25 mm 1 inch wide around the perimeter must be flat. Fill surfaces deeper than the prescribed depth with sealant to the level of the flat area and allow sealant to cure before further placement.

3.1.9.2 Holes for Transformer Enclosures

Drill or excavate holes through concrete pavement and remove loose material. Fill hole with concrete to depth indicated. Provide a minimum of 75 mm 3 inches of concrete at bottom of hole.

3.1.9.3 Saw Kerfs and Splice Chambers

Cut saw kerfs and splice chambers in pavements where indicated. Saw cuts must be in straight lines with vertical sides. Width and depth of saw cuts must be adequate for the required number of wires. Chamfer the vertical edges of saw kerfs at intersections. Where a saw kerf crosses a construction joint, increase the depth sufficiently to allow for slack wire under the joint. Enclose the wire in flexible tubing which extends not less than 0.60 m 2 feet each side of the joint.

3.1.9.4 Sandblasting

Sandblast saw kerfs, grooves, and holes to remove foreign or loose material. Use approved equipment maintained in good working order. Utilize the proper size and quality of sand necessary to perform the work. Use nozzles of the proper size in relation to the groove or holes to be cleaned. Replace nozzles enlarged by wear as necessary. Sandblast air pressure must be not less than 620 kPa 90 psi.

3.1.9.5 Cleaning

Immediately prior to installation of wire or light fixtures, flush saw kerfs and holes with a high velocity water jet or steam, and then clean and dry with a high velocity air jet to remove dirt, water, and foreign material.

]3.1.10 Isolation Transformers

Conform to FAA AC 150/5345-26 for transformer lead connections. Plug transformer secondary connectors directly into a mating connector on the transformer secondary leads. During installation, cover mating surfaces of connectors until connected and clean when plugged together. At joint where connectors come together, install heat shrinkable tubing with waterproof sealant or with two half-lapped layers of tape over the entire joint. Joint must prevent entrapment of air which might subsequently loosen the joint.

3.2 CABLES

3.2.1 Cable Installation

In addition to the requirements of Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, use kit type connectors to splice 5 kV single-conductor series lighting cables. During installation, keep mating surfaces of connectors covered until connected and clean when plugged together. At joint where connectors come together, install heat shrinkable tubing with waterproof sealant. [Alternately, provide two half lapped layers of tape over the entire joint.]Joint must prevent entrapment of air which might subsequently loosen the joint.

3.2.2 Low Voltage Cables

For splices in wires 10 square mm #8 AWG single conductor cable, use [FAA AC 150/5345-26 Type L-823 connectors] [noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A-486B, and covered with an insulation and jacket material equivalent to the conductor insulation and jacket.] Splices below grade or in wet locations must be sealed type conforming to NEMA C119.1 or must be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

Cable must be rated 600 volts, except that secondaries of isolation transformer to in-pavement lights installed in pavement saw kerf and 48 volt DC control cables may be 300 volts. Other parts of cable systems such as splices and terminations must be rated at not less than 600 volts. Splices in wires 16 square mm #10 AWG and smaller must be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A-486B. Splices in wires 10 square mm #8 AWG single conductor cable must be made with [FAA AC 150/5345-26 Type L-823 connectors] [noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A-486B. They must then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.] Splices below grade or in wet locations must be sealed type conforming to NEMA C119.1 or must be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

3.2.3 Airfield 5kV Series Lighting Cables

3.2.3.1 Connectors

Use kit type connectors to splice 5 kV single-conductor series lighting cables. During installation and prior to covering with earth, cover mating surfaces of connectors until connected and clean when plugged together. At joint where connectors come together, install heat shrinkable tubing with waterproof sealant with two half-lapped layers of tape over the entire joint. Joint must prevent entrapment of air which might subsequently loosen the joint.

3.2.3.2 Crimping Tool

Use only splice kit manufacturer's crimping tool on splice connectors for all primary and secondary airfield cable splices. Crimping tool must have an embossed die with gauge marks for gauge of cable being used.

3.2.3.3 Cable Penciler

Airfield cable insulation must only be removed using cabling penciler made specifically for airfield cable.

[3.2.4 Installation of Circuit Wires in Saw Kerfs

****

NOTE: Wherever practical, install cables in approved underground duct. Direct installation in saw kerfs is only permitted in existing pavements. Ensure the cable is constrained below the pavement surface and protected from damage resulting from differential expansion or movement. Delete this paragraph if no shallow-based fixtures are being installed in existing pavement.

****

Place wires in saw kerfs and anchor them at bottom by means of rubber or plastic wedges or noncorrosive metal clips placed every 0.60 to 0.90 m 2 or 3 feet or as often as necessary to hold the wire down. Encase wires crossing existing joints in a 600 mm 24 inch length of flexible tubing of polyethylene material conforming to ASTM D1248, Type II or Type III, to break the bond between the wires and the sealing material. Center flexible tubing on the joint and ensure the tubing is of sufficient size to accommodate the wires to allow for movement of the wires as the joint opens and closes. Wrap ends of tubing with tape to prevent entrance of sealing materials. The adjacent joint area must be packed temporarily with roving material, such as hemp, jute, cotton or flax, to prevent sealing material from flowing into the open joint. Carefully mix and apply sealing materials in accordance with the manufacturer's instructions and at the recommended temperature. Remove surplus or spilled material.

3.2.4.1 Splicing Fixtures to the Wires in Pavement Saw Kerfs

****

NOTE: Delete this paragraph if paragraph "Installation of Circuit Wires in Pavement" is not kept.

****

Use preinsulated watertight connector sleeves crimped with a tool that requires a complete crimp before tool can be removed. Tape splice with plastic insulating tape.

]3.2.5 Cable Markers

Provide cable markers or tags for each cable at duct entrances entering or leaving manholes or handholes and at each termination within the lighting vault. Provide not less than two tags per cable in in each manhole or handhole, one near each duct entrance hole. Immediately after cable installation, permanently attached tags to cables and wires so that they cannot be accidentally detached.

3.2.6 Maximum Allowable Non-Armored Cable Pulling Tension, Using Dynamometer

Cable	Tension LB Kg
2 - 1/C #8 solid	275 125
3 - 1/C #8 solid	367 167
4 - 1/C #8 solid	550 250
2 - 1/C #6 stranded	420 191
3 - 1/C #6 stranded	630 286
4 - 1/C #6 stranded	840 382
1 - 2/C #8 stranded	305 139
1 - 3/C #8 stranded	395 180
1 - 4/C #8 stranded	585 266
1 - 2/C #6 stranded	455 207
1 - 3/C #6 stranded	685 311
1 - 4/C #6 stranded	880 400
1 - 6/C #12 stranded	315 143
1 - 12/C #12 stranded	630 286
1 - 12 pair #19 solid	230 105
1 - 25 pair #19 solid	541 246
1 - 50 pair #19 solid	1061 482
1 - 100 pair #19 solid	2000 909

3.3 COUNTERPOISE

****

NOTE: For Navy projects connect the counterpoise to the external ground lug of each fixture base and the ground rod spacing is 600 m 2000 feet. For Army and Air Force projects only connect the counterpoise to in-pavement fixture bases in full strength pavement (i.e. where they are subject to routine air craft traffic). Edit the following paragraphs as required.

****

Install counterpoise above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete cone of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise conductors above the conduits must be adequate to provide a cone of protection measured 22 1/2 degrees each side of vertical. Install one continuous length of conductor, except where distance exceeds the length usually supplied. Install the counterpoise approximately 150 mm 6 inches above single duct lines that are not adjacent to pavement. Where trenches or duct lines intersect, electrically interconnect the counterpoise wires. Connect the counterpoise conductor to a ground rod at every 600 m 2,000feet of cable run, at lighting vault(s) (but not to vault equipment), and at feeder connection to light circuit(s). Install the counterpoise conductor in a separate duct under roads, railroads and paved areas, above the highest duct containing electrical or communications circuits.

****

NOTE: Retain this paragraph for Army and Air Force projects.

****

For in-pavement light fixtures, [connect the counterpoise to the exterior one-hole ground lug on fixture bases installed in pavement subject to routine aircraft traffic (runway touchdown zone lights, runway centerline lights, runway guard lights and taxiway centerline lights). Where fixture bases are installed in pavement not subject to routine aircraft traffic (runway and taxiway edge lights) do not connect the counterpoise to fixture bases. In such cases, install the counterpoise at a location half way between the fixture line and the defined runway or taxiway edge. Use exothermic welding for all counterpoise connections.] Provide counterpoise ground rods at maximum 600 m 2,000 foot spacing.

****

NOTE: Retain this paragraph for Navy projects.

****

[The counterpoise must be connected to the exterior one-hole ground lug on fixture bases. Use bolted ground clamps when bases are supplied with ground lug. Bolts and fasteners must be bronze or stainless steel. Torque to manufacturer's recommendation.]

3.4 SAFETY (EQUIPMENT) GROUNDING SYSTEM

****

NOTE: The Army and Air Force preferred method of grounding is to have safety (equipment) ground separate and not connected to the counterpoise. The light fixtures, equipment and buildings are connected to the safety ground.

****

The purpose of the safety ground is to protect personnel from possible contact with an energized light base that may result from a shorted power cable or isolation transformer. Install and connect a 16 square mm #16 AWG conductor by one of the following methods from base to a ground rod

a. Connect each fixture base to a dedicated ground rod located outside the base on the side opposite the counterpoise.

b. Bond a group of adjacent fixture bases to a common safety ground conductor.

Connect the safety ground conductor to ground rods by exothermic welding and bolted connections. A safety ground is not required for in-pavement fixture bases where a counterpoise is connected to the exterior ground lug. In all cases connect the light fixture, whether in-pavement or elevated, to the base interior ground lug by means of a braided ground strap specified in paragraph "Light Bases".

3.5 DUCT LINES

****

NOTE: For all projects with underground electrical work, use 33 71 02, UNDERGROUND ELECTRICAL DISTRIBUTION. When editing the appropriate, communication lines run elsewhere will be provided with the type of wall thickness that is in accordance with the appropriate communication agency's policy. Electrical metallic tubing will not be installed underground or encased in concrete.

****

Duct lines as required in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and as indicated. Ducts must be installed in trench for 24 hours before trench is backfilled to allow ducts to reach final ground temperature.

3.6 MANHOLES AND HANDHOLES

****

NOTE: When editing the appropriate project specification, the designer will edit the guide specification as necessary to suit the specific airfield or heliport installation. Note that airfield type manholes, vaults, handholes, and their associated frames and covers, located in areas subject to aircraft operation (including paved shoulders), require a design for a maximum single wheel load of 75,000 pounds 34,000 kg at a contact pressure of 250 psi 1,724 kPa. Where located in unpaved shoulders require a design for a maximum single wheel load of 50,000 pounds 22,667 kg at a contact pressure of 250 psi 1,724 kPa. Use steel conforming to ASTM A 36/A 36M, for covers to airfield manholes, vaults, and handholes. Use ductile iron for frames conforming to ASTM A 536, grade 65-45-12.

****

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NOTE: For Navy projects use airfield rated handholes for low voltage and constant current circuits. Manholes can only be used with NAVFAC or FEAD approval. Delete references to manholes as required.

****

The manholes and handholes as required in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.6.1 [Manholes and]Handholes Within Paved Areas

[Manholes and h][H]andholes within paved areas must have their top surface flush with grade, -0 to +6.35 mm -0 to +1/4 inch.

3.6.2 [Manholes and]Handholes Within Unpaved Areas

[Manholes and h][H]andholes within unpaved areas must have their top surface

+/-25.4 to +50.8 mm +1 to +2 inches above grade.

3.7 MARKING AND LIGHTING OF AIRWAY OBSTRUCTIONS

****

NOTE: If Section 09 90 00, PAINTS AND COATINGS is included, painting requirements should be transferred to it. Local conditions may necessitate modification to the following paragraph. Refer to FAA AC 70/7460-1 for further information on marking of obstructions.

****

Mark and light all towers, poles, smokestacks, buildings of certain shapes and sizes, and other obstructions in accordance with FAA AC 70/7460-1 and as indicated.

3.7.1 Painting of Airway Obstructions

Conform with FAA AC 70/7460-1 and as indicated for patterns and colors to mark obstructions.

3.7.2 Obstruction Marker Lights

Install obstruction marker lights on radio towers, elevated water tanks, smokestacks, buildings, and similar structures with 27 mm 1 inch zinc-coated rigid steel conduit stems using standard tees and elbows, except that lowering devices, when required, must be installed in accordance with equipment manufacturer's recommendations.

3.8 APPROACH LIGHTING SYSTEMS

Install approach lighting system as indicated. Provide nameplates for equipment, controls, devices, and for each lighting circuit.

3.8.1 Frangible Requirements

At the 300 m 1,000 foot crossbar and beyond, mount overrun lights up to 1.8 m 6 feet above concrete foundations on threaded frangible couplings and 53 mm 2 inch RMC or EMT conduit. For mounting heights greater than 1.8 m 6 feet, install light on low impact-resistant (LIR) frangible supports. When rigid towers, trestles, and similar structures are required, install the light unit at least 6 m 20 feet above the rigid structure with this support unit being frangible.

3.8.2 Alignment of Lights

Align lights in azimuth, with beams axes parallel to the approach lighting system centerline. Aim elevated lights vertically at a point on the glide path with the angular elevation of each light as indicated. In-pavement lights have a preset vertical aiming angle and require alignment in azimuth only.

3.9 ROTATING BEACONS

3.9.1 Airfield Rotating Light Beacon

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NOTE: Provide foundation and supports drawings for

the beacon.
****

Install beacon in accordance with the manufacturer's instructions and other contract requirements including cleaning, lubrication, adjustment, and other special instructions. Provide foundations and supports as indicated.

3.9.1.1 Beam Adjustment

Adjust beam during hours of darkness. Aim beam to provide a minimum of 5.5 degrees above the horizontal, but not higher than necessary to clear principal obstructions.

3.9.1.2 Power Supply and Wiring

Install panelboard at working height at ground level with lockable panel cover and disconnects at top of structure to provide separately protected circuits for beacon lamps, heaters, motor, and obstruction lights. Install cabinet on side of platform opposite ladder. Conduit riser must be installed on tower in a corner angle and not near ladder.

3.9.2 Heliport Light Beacon

****
NOTE: Provide foundation and support drawings for the beacon.
****

Install beacon in accordance with the manufacturer's instructions and other contract requirements including cleaning, lubrication, and adjustment.

Provide foundations and supports as indicated.

3.9.2.1 Beam Adjustment

Adjust beam during hours of darkness. Aim beam to provide a minimum of 5.5 degrees above the horizontal, but not higher than necessary to clear principal obstructions.

3.9.3 Power Supply and Wiring

Install panelboard at working height at ground level with lockable panel cover and disconnects at top of structure to provide separately protected circuits for beacon lamps, [heaters,]motor, and obstruction lights. Install cabinet on side of platform opposite ladder. Install conduit riser on tower in a corner angle and must not be located near ladder. The terminal cabinet must be in accordance with NEMA ICS 6 Type 3R or as indicated on drawings.

3.10 WIND DIRECTION INDICATORS

Include in the installation a black circle constructed on a concrete pad the ground with center at center of the base. Guy the wind cone direction indicator as indicated on drawings. Energize the wind cone illumination lights and obstruction lights from [multiple] circuits as indicated.

3.11 CONSTANT CURRENT REGULATORS

Install as indicated in strict accordance with manufacturer's instructions.

3.12 CIRCUIT SELECTOR SWITCHES

Install as indicated and in strict accordance with manufacturer's instructions.

3.13 SIMULATED CARRIER DECK LIGHTING SYSTEM

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NOTE: The following paragraph is specific to Navy training installations. Delete if not required.

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[3.13.1 Light Fixtures

Install in runway pavement as indicated, with centerline of unidirectional light beam aimed toward the nearer runway threshold and parallel to runway centerline.

3.13.2 Isolation Transformers

Except where indicated otherwise, provide a transformer for each group of four 45-watt lights and install in handhole or manhole as indicated.

3.13.3 Equipment in Control Tower, Vault, Manhole, and Handholes

Provide nameplates to match and fit existing lighting control panels in locations as directed. Provide equipment, wiring, and nameplates in runway field lighting vault, in system brightness control manhole, and in handholes as indicated.

3.13.4 Wire and Connectors

Provide THWN-2 insulation for secondary conductors between isolation transformers and simulated carrier deck fixtures. Provide two-pin connectors in accordance with FAA AC 150/5345-26.

]3.14 APPLICATION

3.14.1 Exothermic Welding

Utilize only personnel who are experienced in and regularly engaged in this type of work to make these connections. Prior to any installations in the field, provide documentation that the welding kits, materials and procedures to be used for welded connections are satisfactory. Comply with the manufacturer's recommendations and the following:

****

NOTE: Delete item c. for Navy projects.

****

a. Remove all slag from welds.

b. The light fixture base cans should be provided with internal and external one-hole ground lugs that are coated with hot dipped galvanizing, the same as the rest of the base cans. The external ground lug should be bolted to a separate ground lug that is exothermically welded to a 21 square mm #4 AWG stranded bare copper grounding cable. That is connected to a ground rod for Air Force or

Army projects or the counterpoise for Navy projects.

c. [c. All direct buried welds must be thoroughly coated 6 mil of 3M "Scotchkote", or approved equivalent, or coated with coal tar bitumastic material to prevent surface exposure to corrosive soil or moisture.]

3.14.2 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.14.3 Equipment for Silicone Sealant

Equipment for silicone sealant must be air-powered pump, components, and hoses as recommended by the sealant manufacturer. Hoses and seals must be lined to prevent moisture penetration and withstand pumping pressures. Equipment must be free of contamination from previously used other type sealant.

[3.14.4 Painting

As specified in Section 09 90 00 PAINTS AND COATINGS.

]3.14.5 Concrete

Concrete used in underground structures, such as manholes, handholes, pull boxes and foundations must have minimum 28-day strength of 27.56 MPa 4000 psi. Similar structures in areas where freeze/thaw conditions are common, must have minimum 28-day strength of 31.00 MPa 4500 psi. Concrete used for non-structural items, such as equipment pads, must have minimum 28-day strength of 13.78 MPa 2000 psi.

3.14.6 Grounding

Ground non-current carrying metallic parts associated with electrical equipment as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.15 FIELD QUALITY CONTROL

Notify the Contracting Officer [five][_____] working days prior to [each] [_____] test. Correct all deficiencies and repeat tests. Field test reports must be written, signed and provided as each circuit or installation item is completed. Include resistance-to-ground and resistance between conductors field tests, and continuity measurements for each circuit. For each series circuit measure the input voltage and output current of the constant current regulator at each intensity. For multiple circuits measure the input and output voltage of the transformer for each intensity setting. Provide report documenting the visual inspection of the [lights operation] [markings appearance] [installed fixtures or units].

3.15.1 Visual Inspection

Inspection reports must be prepared and provided as each stage of installation is completed. Identify the activity by contract number, location, quantity of material placed, and compliance with requirements.

3.15.2 Operating Test

Upon completion of tests, show by demonstration in service that circuits, control equipment, and lights covered by the contract are in good operating condition. Operate each switch in the control tower lighting panels so that each switch position is engaged at least twice. During this process, observe lights and associated equipment to determine that each switch controls properly corresponding circuit. Provide telephone or radio communication between the operator and the observers. Repeat tests from the alternate control station, from the remote control points, and again from the local control switches on the regulators. Test each lighting circuit by operating the lamps at maximum brightness for not less than 30 minutes. Visually examine at the beginning and at the end of this test to ensure that the correct number of lights are burning at full brightness. Conduct [one][_____] day and [one][_____] night operating test for the Contracting Officer.

Provide performance test reports, upon completion and testing of the installed system, in booklet form showing all field tests performed to adjust each component and all field tests performed to provide compliance with the specified performance criteria. For each test, indicate the final position of controls.

3.15.3 Distribution Conductors, 600-Volt Class

Using an instrument which applies a voltage of approximately 500 volts providing a direct reading in resistance, performing testing to verify that no short circuits or accidental grounds exist.

3.15.4 Counterpoise System Test and Inspection

At accessible locations, visually inspect counterpoise system to ensure continuity of counterpoise system. Test continuity of counterpoise system to the vault grounding system in manhole closest to the vault.

3.15.5 Progress Testing for Series Lighting Circuits

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NOTE: Progress testing should be specified when replacing or modifying existing series airfield and heliport lighting circuits since interruption time is usually critical; however, progress testing on completely new series airfield and heliport lighting circuits is not normally necessary.

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Conduct a megger test on each section of circuit or progressive combinations of sections as they are installed. Test each section or progressive combination of sections with a megohmmeter providing a voltage of approximately 1000 volts, a direct reading in resistance. Document all results. Eliminate faults found by these tests, and re-test before proceeding with the circuit installation.

3.15.6 Electrical Acceptance Tests

Perform acceptance tests for series and multiple airfield and heliport lighting circuits only on complete lighting circuits. Each series and multiple lighting circuit must receive a high voltage insulation test. Check that cable insulation resistance to ground is not less than 50 megohms per FAA-C-1391, Installation and Splicing of Underground Cable.

3.15.7 Low-Voltage Continuity Tests

Test each series circuit for electrical continuity. Eliminate faults indicated by this test and perform retest before proceeding with the high-voltage insulation resistance test.

3.15.8 High-Voltage Insulation Resistance Tests

Subject each series lighting circuit to a high-voltage insulation resistance test by measurement of the insulation leakage current with a suitable high-voltage test instrument which has a steady, filtered direct current output voltage and limited current. High-voltage tester must include an accurate voltmeter and microammeter for reading voltage applied to the circuit and resultant insulation leakage current. Do not exceed voltage test values specified below.

a. Test Procedure: Disconnect both leads from regulator output terminals and support so that air gaps of at least 75 mm 3 inches or as defined by FAA AC 150/5345-7 Table 1 exists between bare conductors and ground. Clean and dry cable sheaths for a distance of 25 m 1 feet from ends of cables and exposed insulation at ends of cables. Connect ends of both conductors of the circuit together and to high-voltage terminals of test equipment, and test voltage applied as specified in the following tabulation between conductors and ground for a period of 5 minutes.

Test Voltage, DC		
	First Test on New Circuits	Test on Existing Circuits
High Intensity Series Lighting Circuits (5,000 volt leads, 500 and 200 watt transformers)	9000	5000
Medium Intensity Series Lighting Circuits (5,000 volt leads, 30/45 watt transformers)	6000	3000
600-Volt Circuits	900	600

When additions are made to existing circuits, test only new sections in accordance with "First Test on New Circuits" in table above. To ensure reliable operation, test complete circuit at reduced voltages indicated above.

b. Leakage Current: Measure and record insulation leakage current for each circuit after a 1 minute application of the test voltage. If leakage current exceeds values specified below, sectionalize the circuit and retest, and repair or replace defective parts. Leakage current limits include allowances for the normal number of connectors and splices for each circuit as follows:

(1) . Three microamperes for each 300 m 1000 feet of cable.

(2) . Two microamperes for each isolation transformer.

(3) . If measured value of insulation leakage current exceeds calculated value, sectionalize the circuit and test as specified for each section. Repair or replace defective components until repeated tests indicate an acceptable value of leakage current for the entire circuit.

c. Resistance Values versus Cable Length

An alternate test procedure for circuit validation is to use a megohmeter. Use 5000V test for new circuits and 3000V test for existing circuits. If the minimum resistance values are not achieved then use the leakage current test indicated above.

Circuit Length in Feet Meters	Minimum Resistance to Ground (Megohms)
10,000<3,000	50
10,000-20,0003,000-6,000	40
>20,0006,000	30

3.16 PHOTOMETRIC TESTING

****

NOTE: Photometric testing of light fixtures is optional but highly recommended for all runway lighting. It is also highly recommended that all newly installed airfield guidance signs and PAPIs be tested. Verify with the Activity that the costs can be included in the project funding. If photometric testing is included see paragraph "Qualifications of Photometric Tester" for possible contacts.

Delete this paragraph for Navy project or if not required.

****

[3.16.1 Inspection

Provide test reports from an FAA approved, third-party, certification body to insure full compliance with the photometric requirements. Submit for approval for each type of light fixtures to the Contracting Officer prior to final acceptance of the installation. Include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.Items to be tested include, but are not limited to, the following:

a. Airfield Guidance Signs

b. Discharge-Type Flashing Light Equipment

c. LED Fixtures or PAPIs

3.16.2 Test Instrument Calibration

a. Use a photometric tester that has a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. The accuracy must be directly traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule must not exceed 12 months.

d. Dated calibration labels must be visible on all test equipment.

e. Calibrating standard must be of higher accuracy than that of the instrument tested.

f. Up-to-date records which indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

    (1) . Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

    (2) . Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

3.16.3 Pre-Testing Requirements

a. Verify Constant Current Regulator (CCR) Performance. When the CCR is energized at the highest brightness intensity and at the middle brightness intensity, measure the following electrical characteristics for each CCR powering the light fixtures:

    (1) . Input Current.

    (2) . Input Voltage.

    (3) . Input Power Factor.

    (4) . Input Voltage Harmonic Distortion.

    (5) . Input Current Harmonic Distortion.

    (6) . Output Voltage.

    (7) . Output Current.

    (8) . Output Power Factor.

    (9) . Output Voltage Harmonic Distortion.

    (10) . Output Current Harmonic Distortion.

Analyze the data, and perform any adjustments or calibration required.

b. Clean Light Fixture. Clean all of the light fixtures to be tested one day prior to commencement of photometric testing. Perform the photometric testing at night. At the end of each night the photometric testing firm must provide a list of the deficient fixtures to the Contractor for corrections. A minimum 10% spare lamps and/or fixtures, transformers, and other accessories required to correct possible deficiencies must be available so that any corrections can be made daily and retested the following night.

c. Use photometric testing equipment that has an array of photometric sensors capable of taking simultaneous readings along the main photometric beam of the light output in direct correlation with Tables 1, 2, and 3 of the current edition FAA AC 150/5345-46 and the appropriate UFC requirements. The number and angles of measurement as well as sensor location and placement must be in accordance with Paragraphs 4.3.1 and 4.3.3 and the above-mentioned tables of the current edition FAA AC 150/5345-46 which provide specific requirements for photometric testing. Compare the average photometric intensity to the horizontal and vertical requirements detailed in Tables 1, 2, and 3 of the current edition FAA AC 150/5345-46. Include the measurement of each light fixture in both directions. All of the sensor readings for the light fixture being evaluated must be displayed simultaneously for operator and Airport representative review and evaluation. All sensor readings must be recorded automatically through the computer. Hand written data recording will not be accepted. Measure the chromaticity (x, y) or color of 5 percent of the light fixtures to ensure compliance with MIL-C-25050A, "Aviation Colors". Measure the chromaticity along one point in the center of the main photometric ellipse.

d. The testing firm must submit initial reports daily to the Contractor during the progress of the work so that corrective measures can be taken as required. A list of the deficient fixtures and the photometric output for each fixture must be provided in a field report to the Contractor prior to the testing firm leaving the job-site. Document the final results in a Final Report, with six (6 copies) submitted to the Airport. The final report must present an evaluation of each fixture tested, including proposed or performed corrective measures, such as cleaning or replacement of lenses, re-aiming of fixture, repair or replacement of fixture, for those fixtures that do not meet the performance requirements. Tabulate the photometric test data for each fixture with the following information:

Fixture Number - Provided by Airport.
Light Direction -Direction of light beam (ex. North, South, East, West).
Fixture type - FAA Fixture Type (ex. L-852C).
Lens Color - Color of lens on fixture being tested.
Max CD - Maximum candela output in a point along the main beam.
Avg CD - Average candela output of main beam.
Max/Avg - Ratio of max. candela output over the ave. output.
FAA Min Level - FAA specified output for type of fixture.
Chromaticity - x, y color coordinates of the sample fixture.

3.16.4 Photometric Testing of Airfield Guidance Signs

Evaluate the performance of the guidance signs with respect to RAA criteria (reference test methods in FAA AC 150/5345-44):

****
NOTE: Luminance requirements indicated below are higher than FAA minimum standards.
****

a. Uniformity: Make photometric measurements on a 75 mm 3 inches grid over the entire face of the sign, with no measurement being closer than 75 mm 3 inches to the sign frame. Adjacent measurements must not exceed a 1.5:1 ratio.

b. Discernability: The sign must be discernable from 240 m 800 feet away.

c. Contrast: For L-858R signs the ratio of average luminance between white legend and red background must be no greater than 10:1 and no less than 5:1.

Test all new airfield guidance panels or signs at night. Test the signs at their highest rated input current. Evaluate the photometric performance of the signs using digital color images. Convert these images to gray-scale images that can be analyzed directly for photometric output. To provide calibration and control for the evaluation of the gray-scale image, direct photometric readings of the light output in foot-lamberts (FL) must be taken at several locations on the face of the sign using a calibrated photometer. Only light emitted from the sign is permitted to reach the photometer.

To document compliance with FAA requirements, present the following information and data for each color for each sign tested in the Final Report:

a. Sign Designation & Date Sign was tested.

b. Digital & Gray-Scale Image of Sign.

c. Step - The step intensity of the regulator controlling the sign.

d. Arithmetic average of luminance levels.

e. Maximum luminance level on sign face and/or message.

f. Minimum luminance level sign face and/or message.

g. Ratio of Maximum luminance to Minimum luminance.

h. Uniformity. The maximum ratio of the average luminance levels of adjacent 75 mm 3 inches areas over the face of the sign.

i. Visual Discernability of the Sign including comments.

j. Statements whether or not sign meets the specified luminance criteria.

Take photometric measurements of the red background on mandatory signs (white message on red background) to evaluate the sign's red to white contrast.

3.16.5 Photometric Testing of Discharge-Type Flashing Light Equipment

To evaluate the equipment performance with respect to the criteria in FAA AC 150/5345-51, paragraph 3.4, perform photometric testing of the discharge-type lights. Conduct tests per FAA-E-1100, Photometric Test Procedures for Condenser Discharge Lights. Include in test results a graph showing the isocandela curve of effective intensity for each brightness setting and oscilloscope photographs or digital image files (e.g., TIF, JPG, BMP) of the discharge pulse shape.

3.16.6 Photometric Testing of PAPIs

Using photometric testing, evaluate the photometric intensity of the PAPI system and verify that the center of the light beams are aimed at the appropriate vertical and horizontal angle. Provide support to adjust the PAPI while it is flight tested by the government.

a. Prior to performing the test measure the electrical characteristics of the CCR, if applicable, powering the PAPI or APAPI circuit. Include the measurement of the Volt-Amperes, Current, Voltage, and Harmonic Distortion for each intensity settings on the both the output and input to the CCR.

b. Sensors. Utilize sensors that are accurate to 5 percent as traceable to the National Institute of Standards and Technology (NIST) secondary standard or approved equal. Sensor must be color corrected to account for the different white and red lens associated with the system.

c. Measurement Points. Test on a one-degree horizontal interval and one-degree vertical interval inside the photometric ellipse indicated in Figure 3-12, UFC 3-535-01.

d. Measurement distance from lighting system. Take measurements at a minimum of 3 m 10 feet from the edge of the lenses.

e. Measurement Duration. Each measurement point must last a minimum of 30 seconds. To minimize stray light which may enter the lens, intentensity measurements at each point must be the average measurement over the 30 second time span.

f. Test Results. Compare measured light intensity values to the minimum values established in Figure 3-12, UFC 3-535-01. The angular difference for successive light units in a light bar must comply with paragraph 3-7.3.1, UFC 3-535-01.

]3.16.7 Constant Current Regulators

3.16.7.1 Visual Examination

Examine each constant current regulator to ensure that porcelain bushings are not cracked, no shipping damage has occurred, internal and external connections are correct, switches and relays operate freely and are not tied or blocked, fuses, if required, are correct, and oil level of oil-filled regulators is correct. Remove relay panel covers only for this examination; it is not necessary to open the main tank of oil-filled regulators. Accomplish the instructions on the plates attached to the regulators. Replace covers tightly after completing examinations and tests.

3.16.7.2 Electrical Tests

Ensure that supply voltage and input tap correspond. With load disconnected, energize regulator and observe the open circuit protector to ensure that it de-energizes the regulator within 3 seconds. After testing circuits for open connections and grounds and after determining that lamps are good and in place, apply circuit load to the regulator and measure the voltage and current simultaneously on brightness taps. Voltmeter and ammeter must have an accuracy of plus or minus one percent. Record readings and make readings during the day and night in order to obtain the average supply voltage. Output current on each brightness tap must be within plus or minus 2 percent of the nameplate values after making necessary correction in the supply voltage. Late model regulators have automatic supply voltage correction in lieu of input taps, and output current does not change as supply voltage varies. When output current on tap 5 deviates from nameplate value by more than 2 percent, and regulator is not overloaded, check internal adjustment as described on regulator instruction plate. Since adjustment may be rather delicate, allow a deviation of up to plus or minus 5 percent on taps 1 through 4 before attempting to readjust the regulator.

3.17 FINISHING

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory must be as required in Section 09 90 00 PAINTS AND COATINGS.

3.18 CLOSEOUT ACTIVITIES

3.18.1 Demonstration

After completion of installations and the above tests, circuits, control equipment, and lights covered by the contract must be demonstrated to be in acceptable operating condition. Each switch in the control tower lighting panels must be operated so that each switch position is engaged at least twice. During this process, lights and associated equipment must be observed to determine that each switch properly controls the corresponding circuit. Telephone or radio communication must be provided between the operator and the observer. Tests must be repeated from the alternate control station, from the remote control points, and again from the local control switches on the regulators. Each lighting circuit must be tested by operating the lamps at maximum brightness for not less than 30 minutes. At the beginning and at the end of this test the correct number of lights must be observed to be burning at full brightness. [One][_____] day and [one][_____] night operating test must be conducted for the Contracting Officer.

3.18.2 Training

Submit requirements of training [four][_____] weeks before training is scheduled to begin. Submit information describing training to be provided, training aids to be used, samples of training materials, and schedules; instructions necessary to checkout, troubleshoot, repair, and replace components of the systems, including integrated electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting after acceptance of the system.

a. Provide training on the proper operation and maintenance procedures for the system. Submit a list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor.

b. Submit [six][_____] copies of operation for the equipment furnished. One complete set must be furnished prior to performance testing and the remainder must be furnished upon acceptance. Operating manuals must detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals must include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features.

c. Submit [six][_____] copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals must include conduit and equipment layout and simplified wiring and control diagrams of the system as installed.

3.18.3 As-Built Drawings

Submit as-built drawings that provide current factual information including deviations from, and amendments to the drawings and changes in the work, concealed and visible, as instructed. The as-built drawings must show installations with respect to fixed installations not associated with the systems specified herein. Cable and wire must be accurately identified as to direct-burial or in conduit and must locate the connection and routing to and away from bases, housings, and boxes.

3.18.4 Posted Instructions

Submit a typed copy of the proposed posted instructions showing wiring, control diagrams, complete layout and operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system.

3.19 MAINTENANCE

3.19.1 List of Parts

A list of parts and components for the system by manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair necessary to ensure continued operation with minimal delays.

3.19.2 Maintenance and Repair Instructions

Instructions necessary to check out, troubleshoot, repair, and replace components of the systems, as specified.

3.19.3 Posted Operations and Maintenance Instructions

Submit proposed diagrams, instructions, and other sheets prior to posting.

3.20 SCHEDULES

Refer to Section 01 35 13 SPECIAL PROJECT PROCEDURES for construction outage plan requirements.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-27 05 13.43 (May 2020)**

Preparing Activity: NAVFAC

Superseding
UFGS-27 05 14.00 10 (April 2006)
UFGS-27 41 16.00 10 (April 2006)
UFGS-27 54 00.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 27 - COMMUNICATIONS

SECTION 27 05 13.43

TELEVISION DISTRIBUTION SYSTEM

05/20

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-27 05 13.43 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-27 05 14.00 10 (April 2006)
UFGS-27 41 16.00 10 (April 2006)
UFGS-27 54 00.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 27 05 13.43

TELEVISION DISTRIBUTION SYSTEM
05/20

****
NOTE: This guide specification covers the requirements for procurement and testing of a television distribution system for housing units and for other jobs where the local cable television company provides service to the facility.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: This guide specification covers the usual methods and frequently used alternatives for providing conventional television distribution systems for all types of facilities, including medical facilities. It does not include unusual methods or alternatives which may be required for special applications. The documentation is intended to be used in conjunction with other guide specifications required by the design. This specification includes provisions for a television distribution system with the headend amplifier provided by the Contractor. Coordinate with the

local television serviceprovider as to who will provide the headend amplifier. Modify this specification accordingly if the headend amplifier is provided by the local television service provider.

Use Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, for empty conduit television distribution systems instead of this section. Include the backboard, outlet, faceplate, and other special requirements in that section.

****

****

NOTE: This UFGS must be used in conjunction with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM to specify conduit, boxes, outlets, and backboards.

****

****

NOTE: As a minimum, the Designer shall provide the television distribution system loss and tilt compensation calculations using manufacturer's data and including the amplifier sizes and system requirements to the EFA/EFD. Project drawings shall show the cable system, grounding, homeruns, and passive and active devices in a one-line diagram. Where television mounting brackets are required on a job, provide bracket requirements and details in architectural drawings and specifications.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-83-596	(2021) Indoor Optical Cable

NATIONAL CABLE AND TELECOMMUNICATIONS ASSOCIATION (NCTA)

NCTA RP	(1989) NCTA Recommended Practices for Measurements on Cable Television Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.3	(2022e) Optical Fiber Cabling Components Standard

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 76.605	Technical Standards

UL SOLUTIONS (UL)

UL 969	(2017; Reprint May 2023) UL Standard for Safety Marking and Labeling Systems
UL 1581	(2019; Reprint Nov 2023) UL Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 1666	(2007; Reprint Sep 2021) UL Standard for Safety Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

1.2 DEFINITIONS

1.2.1 Television Distribution System

The television distribution system system, commonly referred to as cable television, is a network of cables, headend, electronic and passive components that process and amplify television (TV) signals for distribution of adequate signals to each receiver from the headend equipment to the individual television outlets and provides distortion-free signal to TV sets by isolating each receiver from the system an providing the proper amount of signal to each set.

1.2.2 Headend

The connection point between television distribution system equipment and equipment provided by the local television service provider.

1.2.3 Distribution System

Distribution system transports and delivers adequate signals to each receiver. Provides distortion-free signal to TV sets by isolating each receiver from the system and by providing proper amount of signal to each set.

1.2.4 Cable

****

NOTE: Delete the first bracketed item for single housing units and small systems where trunk and feeder cables are not used. Edit the last sentence accordingly.

****

[Trunk and feeder cables are low-loss cables used to transport the desired signal from the headend equipment to the telecommunications room in the area to be served. These cables are used to transport signal from the [telecommunications room][headend equipment] into close proximity to a number of user locations in excess of 60 meters 200 feet from the [telecommunications room][headend equipment].]Drop cables are used to transport the desired signal used from the [telecommunications closet room][headend equipment] to the wall outlet.

1.3 SYSTEM DESCRIPTION

1.3.1 Headend

Contractor shall provide interior equipment up to headend [and including the main amplifier] located at the interior television distribution system [backboard][cabinet][rack].

1.3.2 Distribution System

****

NOTE: Choose the bracketed item corresponding to the television distribution system design.

****

[[Distribution system shall be star topology with each outlet connected to a telecommunications room with a feeder cable or a drop cable and each telecommunications room connected to the headend equipment with a [coaxial][fiber optic] trunk cable][Distribution system shall be star topology with each outlet connected to headend equipment with the drop cable].

][Distribution system shall be a star topology utilizing a coaxial trunk cable and category [6] UTP drop cables with the exception of low voltage patient television outlets. Low voltage patient television outlets shall be connected with coaxial drop cables.

]1.3.3 Cable

****

NOTE: Delete the first bracketed item for single housing units and for small systems where trunk and feeder cables are not used. Edit the last sentence accordingly.

****

[Provide trunk cables to transport the desired signal from the headend equipment to the telecommunications room in the area to be served.][Provide [trunk] [feeder] cables to transport signal from the [headend equipment][telecommunications room] to user locations for cable lengths in excess of 60 meters 200 feet from the [headend equipment][telecommunications room].]Provide drop cables to transport the desired signal from the [telecommunications room][headend equipment] to the outlet.

1.3.4 System Components

****

NOTE: Delete the first bracketed item for medical projects

****

System shall provide high quality TV signals to all outlets[with a return path for interactive television and cable modem access]. Provide any combination of items specified herein to achieve required performance, subject to approvals, limitations, acceptance test, and other requirements specified herein. System shall include amplifiers, splitters, combiners, line taps, cables, outlets, tilt compensators and all other parts, components, and equipment necessary to provide a complete and usable system.

1.3.4.1 System Bandwidth

a. Downstream: 50-1000 MHz minimum.

b. Upstream 5-40 MHz minimum.

1.3.5 System Performance

System shall be in compliance with 47 CFR 76.605.

1.3.5.1 Receiver Termination Signal Level

Each termination for a TV receiver must have a minimum signal level of 0 decibel millivolts (dBmV) (1000 microvolts) at 55 MHz and of 0 dBmV (1000 microvolts) at 1000 MHz and a maximum signal of 15 dBmV or a level not to overload the receiver for the entire system bandwidth.

1.3.5.2 Distribution System

a. Modulation distortion at power frequencies: 4 percent or less hum distortion;

b. Composite third order distortion for:

    (1) CW carriers: 53 dB.

(2) Modulated carriers: 59 dB.

c. Subscriber terminal isolation: 18 dB or greater.

d. Carrier to second order beat ratio: 60 dB.

e. Amplitude characteristic:within a range of plus or minus 2 decibels from 0.75 MHz to 5.0 MHz above the lower boundary frequency of the cable television channel, referenced to the average of the highest and lowest amplitudes within these frequency boundaries.

f. Visual, aural carrier level, 24-hour variation: 47 CFR 76.605, subpart (a), rules (4), (5), and (6).

g. Frequency determination: 47 CFR 76.605, subpart (a), rules (1),(2), and (3).

1.3.5.3 System Tolerance

The system must not show a serious loss of carrier to noise when the system levels are lowered 3 dB below normal or a significant distortion when the levels are increased 3 dB above normal, as observed on a TV set located at the far end extremities of the system.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Television Distribution System Wiring Diagrams And Installation Details; G, [_____]

Television Distribution System Components; G, [_____]

SD-03 Product Data

Attenuators; G, [_____]

[Amplifiers, including [Headend,]Trunk, Bridging, and Distribution; G, [_____]

] Cables, including [Trunk, Feeder, and]Drop; G, [_____]

Terminators; G, [_____]

Splitters/Combiners; G, [_____]

[Fiber Optic Couplers; G, [_____]

] Line Taps; G, [_____]

Coaxial Outlets; G, [_____]

Coaxial Connectors; G, [_____]

Tilt Compensator; G, [_____]

[Distribution Hubs; G, [_____]

][Baluns; G, [_____]

][Grounding Block; G, [_____]

] Submittals for each manufactured item must be the current manufacturer's descriptive literature of catalog products, equipment drawings, diagrams, performance and characteristics curves, and catalog cuts.

SD-05 Design Data

Television Distribution System Loss Calculations; G, [_____]

SD-06 Test Reports

Operational Test Plan; G, [_____]

Operational Test Procedures; G, [_____]

System Pretest; G, [_____]

Acceptance Tests; G, [_____]

SD-08 Manufacturer's Instructions

Connector Installation; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

Submit Data Package 5 for each component in accordance with requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5 QUALITY ASSURANCE

1.5.1 Wiring Diagrams and Installation Details

Illustrate how each item of equipment functions in the system and include an overall system schematic indicating the relationship of television distribution system units on one diagram. Drawings must include wiring diagrams and installation details of equipment indicating proposed locations, layout and arrangements, and other items that must be shown to ensure coordinated installation.

1.5.2 Television Distribution System Loss Calculations

****

NOTE: Use second bracketed option in the first sentence for systems that include amplifiers.

****

Calculations must verify that the system does not exceed the loss values specified in dBmV at the [receiver terminations][input of all active devices and the receiver terminations]. Provide a drawing displaying all distribution network calculations. The drawing should accurately show taps, splitters, outlets, and the type and length of all [trunk, feeder, and]drop cables. The drawing must show how many taps, splitters, or outlets are served by each tap or splitter.

1.5.3 Operational Test Plan

****

NOTE: The test methods in Parts I and II of the NCTA recommended practices are used to establish proper operating parameters during initial setup and alignment. They are also used to verify proper operation of a unit following a needed repair. Only a few of the tests can be used during normal operations of a television distribution system without interruption to the system or the specific channel under test.

****

Test plan must define tests required to ensure that the system meets technical, operational, and performance specifications. Test plan must be based on NCTA RP and be in accordance with FCC proof of performance requirements. Test plan must include plan for testing for signal leakage. Provide test requirements and guidelines.

1.5.4 Operational Test Procedures

Use test plan and design documents to develop test procedures. Procedures must consist of detailed instructions for a test setup, execution, and evaluation of test results.

1.5.5 Connector Installation

Provide manufacturer's instructions for installing connectors.

PART 2 PRODUCTS

****

NOTE: This specification is written for bidirectional devices operating from 5 to 40 MHz and from 50 to 1000 MHz. The lower end, 5 to 40 MHz provides an active return path and allows ordering of pay-per-view, cable modem and communication back to the television system service provider. The 50 to 1000 MHz provides one-way communication to the user's service. Passive devices are rated 1000 MHz since they require more work if upgrading of the system is required in the future. Coordinate with the television service provider to ensure these specifications meet their minimum requirements for television service.

****

2.1 ELECTRONIC EQUIPMENT

Electronic components of similar type must be produced and designed by the same manufacturer as major components of the equipment and must have the manufacturer's name and model permanently attached. Equipment must function properly as a complete integrated system. Equipment must be shielded. The system must be designed to operate within 5 to 1000 MHz bandwidth using 1000 MHz passive devices and a minimum of 1000 MHz active devices.

2.2 HEADEND EQUIPMENT

****

NOTE: Use the headend equipment paragraphs when the headend equipment is provided by the Contractor. Delete when provided by local cable television company.

****

2.2.1 Headend Amplifiers

****

NOTE: Broadband amplifiers are used to amplify a number of TV channels. Single-channel amplifiers are used to amplify a single TV channel.

****

****

NOTE: Delete first bracketed option for medical projects.

****

Provide broadband distribution amplifiers. Amplifiers must amplify broadband signals from 40 to 1000 MHz[and provide an amplified return path for signals from 5 to 40 MHz for 75 ohms impedance]. Amplifiers must be bidirectional with variable slope and gain control.

2.2.2 Attenuators

Provide attenuators to equalize signal levels, when required. Variable attenuators are not permitted.

2.2.3 Power Supplies

Power supplies must contain a current limiter circuit to protect against short circuits on the radio frequency (RF) line. Provide overvoltage protection to protect solid state equipment from line surges and induced voltages, in accordance with IEEE C62.41.1 and IEEE C62.41.2.

2.3 DISTRIBUTION EQUIPMENT

****

NOTE: Delete paragraphs for distribution amplifiers when design calculations indicate they are not required.

****

[2.3.1 Distribution Amplifiers

****

NOTE: Delete bracketed option in last sentence for medical projects.

****

Distribution amplifiers shall be equipped for 75 ohms input and output impedance. Electronic equipment exposed to weather shall be equipped with weatherproof housings. Amplifiers shall be bidirectional with variable slope and gain control and shall amplify broadband signals from 50 to 1000 MHz[and provide an amplified return path for signals from 5 to 40 MHz for 75 ohms impedance].

2.3.1.1 Trunk Amplifiers

Trunk amplifiers shall have automatic level and slope control features.

2.3.1.2 Bridging Amplifiers

Bridging amplifiers shall be used to connect feeder cables to trunk cables.

[2.3.1.3 Fiber Optic Amplifiers

****

NOTE: Include the following paragraphs as needed when specifying a fiber optic trunk distribution system to a coaxial sub-distribution system.

****

Provide fiber optic amplifiers in fiber optic backbone distribution systems as required to provide required optical power to fiber optic receivers.

][2.3.1.4 Fiber Optic Receiver Distribution Amplifier

Provide fiber optic receiver with integrated broadband distribution amplifier to receive the fiber optic video signal and distribute it to the coaxial cable sub-distribution system.

]]2.3.2 Cables and Associated Hardware

****

NOTE: For cable subject to moisture from flooding or to atmospheric contamination such as cable near coastal areas or in cities with significant air pollution, specify the same cable be protected by a black polyethylene jacket with a flooding or other water migration deterrent compound between the jacket and the aluminum shield. When this type of cable is required, add the requirement to the item specifying the jacket and insulation in the applicable cable paragraph(s).

For systems under 90 meters 295 feet from headend equipment to telecommunications room or from telecommunications room to communication closet, provide RG-11 coaxial trunk cable. For systems exceeding 90 meters 295 feet from headend equipment to telecommunications room or from telecommunications room to telecommunications room, consideration should be given to utilizing 625 series cable to reduce system losses. Edit paragraphs for type of cable required in job. Delete paragraphs for trunk and feeder cable for single family housing units and for small systems where only drop cables are used.

****

Cabling shall be UL listed for the application and shall comply with NFPA 70. Provide a labeling system for cabling as required by UL 969. Cabling manufactured more than 12 months prior to date of installation shall not be used.

2.3.2.1 Trunk Cable

[UL 1666. Provide trunk cable with an NFPA 70 rating of CATVR.

a. Provide RG-11 coaxial cable with the following characteristics:

(1) 14 AWG copper-clad steel center conductor.

(2) Gas injected foam polyethylene dielectric with nominal 7.11 mm 0.28 inches outer diameter.

(3) Bonded foil inner-shield and 60 percent aluminum braid[or quad shield].

(4) 75 ohms impedance.

(5) 82 to 85 percent nominal velocity of propagation.

(6) Black PVC jacket

(7) Maximum attenuation characteristics:

MHz	DB/100 m ft
5	1.25 0.38
55	3.15 0.96
300	7.38 2.25
350	7.94 2.42
450	9.02 2.86
500	9.51 2.90
600	10.43 3.18
750	11.97 3.65
1000	14.27 4.35

b. Provide 625 Series cable with an NFPA 70 rating of CATVR and the following characteristics:

(1) Copper-clad aluminum center conductor

(2) Seamless aluminum tubing shield

(3) Expanded polyethylene dielectric

(4) 75 ohms impedance

(5) Nominal diameter over outer conductor: 15.88 mm 0.625 inches.

(6) Maximum attenuation at 20 degrees C and 1000 MHz: 6.79 dB/100m 2.07 dB/100 feet

(7) Black medium density polyethylene jacket

(8) Nominal 87 percent velocity of propagation

][Provide fiber optic trunk cable as indicated and in accordance with ICEA S-83-596, TIA-568.3, UL 1666 and NFPA 70. Provide the number of strands indicated, (but not less than 6 strands between the main telecommunication room and each of the other telecommunication rooms), of single-mode, tight buffered fiber optic cable as recommended by the television distribution system manufacturer.

][2.3.2.2 Feeder Cable

****

NOTE: CATVP is plenum rated cable. Provide type

CATVP plenum rated cabling in ducts, plenums and other air-handling spaces. Choose the first bracketed option for CATV cable and the second bracketed option for CATVP cable throughout. Delete feeder cable paragraphs for single family housing units and for small systems where only drop cables are used.
****

UL 1581, provide RG-11 coaxial trunk cable with an NFPA 70 rating of [CATV][CATVP] and the following characteristics:

a. 14 AWG copper-clad steel center conductor.

b. [Gas injected foam polyethylene][Foam FEP] dielectric with 7.11 mm .28 inches nominal outer diameter.

c. Bonded foil inner-shield and a minimum of 60 percent aluminum braid[or quad shield].

d. 75 ohms impedance.

e. 81 to 84 percent nominal velocity of propagation.

f. [Black PVC][PVC low smoke polymer or FEP] jacket.

g. Maximum attenuation characteristics:

[

CATV	
MHz	DB/100 m ft
50	3.1 .95
100	4.2 1.3
200	5.7 1.9
400	8.85 2.7
700	11.0 3.9
1000	14.26 4.8

][

CATVP	
MHz	DB/100 m ft
50	3.9 1.2
100	5.6 1.7
200	8.2 2.5
400	11.5 3.5

CATVP	
MHz	DB/100 m ft
700	115.1 4.6
900	117.4 5.3
1000	18.4 5.6

]][2.3.2.3 Drop Cable

****

NOTE: CATVP is plenum rated cable. Provide type CATVP plenum rated cabling in ducts, plenums and other air-handling spaces. Choose the first bracketed option for CATV cable and the second bracketed option for CATV cable throughout.

****

UL 1581. Provide RG 6 coaxial cable with an NFPA 70 rating of [CATV][CATVP] and with the following characteristics:

a. No. 18 AWG copper-clad steel center conductor.

b. Bonded foil inner-shield and 90 percent aluminum braid.

c. Characteristic impedance of 75 ohms.

d. [Gas injected foam polyethylene][Foam FEP] dielectric

e. Nominal capacitance, conductor to shield, of 53 pf per 100 m 16.2 pf per 100 ft .

f. Maximum operating voltage of 350 V RMS.

g. Maximum attenuation:

[

CATV	
MHz	DB/100 m ft
10	2.59 0.81
50	5.08 1.46
100	7.19 2.05
200	10.17 2.83
400	14.38 4.0
500	15.48 4.53

CATV	
MHz	DB/100 m ft
700	19.02 6.0
1000	22.74 7.3

][

CATVP	
MHz	DB/100 m ft
10	2.3 0.7
50	4.9 1.5
100	6.9 2.1
200	10.2 3.1
400	14.8 4.5
500	19.7 6.0
700	22.6 6.9
1000	23.9 7.3

] h. [Black polyvinyl chloride (PVC)][PVC low smoke polymer or FEP] jacket.

i. 100 percent sweep testing from 5 MHz to a minimum of 1000 MHz.

][2.3.2.4 Low Voltage Patient Television Drop Cable

****

NOTE: CATVP is plenum rated cable. Provide type CATVP plenum rated cabling in ducts, plenums and other air-handling spaces. Choose the first bracketed option for television distribution cable and the second bracketed option for CATVP cable throughout.

****

****

NOTE: Delete this paragraph if low voltage patient televisions are not included in the project.

****

UL 1581. Provide RG 6 coaxial cable with an NFPA 70 rating of [CATV][CATVP] and with the following characteristics:

a. No. 18 AWG solid copper center conductor.

b. Aluminum/Polyesetr/Aluminum tape 100 percent coverage inner-shield and tinned copper outer braid with 60 percent coverage.

c. Characteristic impedance of 75 ohms.

d. [Gas injected foam polyethylene][Foam FEP] dielectric

e. Nominal capacitance, conductor to shield, of 53 pf per m 16.2 pf per ft.

f. Maximum operating voltage of 300 V RMS.

g. Maximum attenuation:

[

CATV	
MHz	DB/100 m ft
10	2.3 0.70
50	4.9 1.5
100	6.58 2.0
200	9.2 2.8
400	13.1 4.0
700	17.43 5.3
900	20.07 6.1
1000	21.3 6.5
1500	27.3 8.3

][

CATVP	
MHz	DB/100 m ft
10	2.3 0.70
50	4.9 1.5
100	6.58 2.0
200	9.2 2.8
400	13.1 4.0
700	17.43 5.3
1000	21.3 6.5
1500	27.3 8.3

] h. [Black polyvinyl chloride (PVC)][PVC low smoke polymer or FEP] jacket.

i. 100 percent sweep testing from 5 MHz to a minimum of 1000 MHz.

]2.3.3 Category 6 Drop Cable

Provide as indicated on the drawings and 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.3.4 Category 6 Patch Cords

Provide patch cords, as complete assemblies, with matching connectors as specified in 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. Patch cords shall meet minimum performance requirements specified in 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM for cables, cable length and hardware specified.

2.3.5 Terminators

Coaxial terminators shall be rated for 75 ohms and 1/4 watt.[Category 6 port terminators shawl be plug-in hub type and shall have integral 8-pin modular connector.]

2.3.6 Splitters/Combiners

****

NOTE: Slope is the straight line of the average response between 54 MHz and 450 MHz. Return loss is a measure of impedance matching.

****

Use splitters/combiners with characteristics equal to or exceeding the characteristics listed in this paragraph over the entire operating band. All unused outlets must be terminated with 75-ohm terminators.

a. Peak to Valley: Not to exceed 1 dB across bandwidth of device.

b. Return loss: 18 dB minimum.

c. Bandwidth: 5-1000 Mh

[2.3.7 Fiber Optic Couplers

****

NOTE: Include this paragraph when specifying a fiber optic backbone distribution system.

****

Use fiber optic couplers to split fiber optic light sources equal to or exceeding the characteristics listed in this paragraph.

a. Number of inputs: 1

b. Wavelength: 1310 and 1550 nm

****

NOTE: Select number of outputs as required. Provide a minimum of two spare outputs for each fiber optic coupler required.

****

c. Number of Outputs: [2 with insertion loss of 3.3 dB, uniformity of greater than 0.7 dB, and directivitiy of greater than 50 dB][4 with insertion loss of 6.3 dB, uniformity of greater than 1.4 dB, and directivitiy of greater than 50 dB][8 with insertion loss of 9.5 dB, uniformity of greater than 2.1 dB, and directivitiy of greater than 50 dB][16 with insertion loss of 12.6 dB, uniformity of greater than 2.8 dB, and directivitiy of greater than 50 dB]

]2.3.8 Line Taps

Line taps shall have 18 dB minimum isolation from each tap to the thru-line. Pressure tapoffs are not permitted. Taps shall be rated from 5 to 1000 MHz and shall have a peak to valley not to exceed 1 dB to 1 GHz.

****

NOTE: Designer has the option to provide a combination convenience receptacle and CATV outlet in one outlet box. If used, provide detail on drawings indicating combined outlet with isolation barrier between power and communication sections.

****

2.3.9 Coaxial Outlets

Provide flush mounted, 75-ohm, F-type connector outlets rated from 5 to 1000 MHz in standard electrical outlet boxes[with isolation barrier].

2.3.10 Coaxial Connectors

****

NOTE: Delete trunk and feeder cable connectors for housing units and when trunk cable and feeder cable are not used in job.

****

Provide one piece connectors. [Trunk and feeder cable connectors shall be pin type.]Drop cable connectors shall be feed thru type.

2.3.11 Tilt Compensator

Provide tilt compensators as required.

[2.3.12 Distribution Hubs

Rack-mountable passive distribution hubs with 16 front mounted modular 8-pin jacks for connection to UTP 4-pair category 6 cabling, and “F” fitting on rear panel for connection to coaxial trunk cable. Hubs shall be tested compliant with FCC Part 15 requirements. Bandwidth: 5 – 860 MHz. Hubs shall be supplied with quantities of plug-in terminators to terminate all unused ports. Provide quantities of hubs as indicated.

][2.3.13 Baluns

Provide single-port converters (for use at TV outlet locations). Converter shall convert balanced line signal to coaxial unbalanced signal for connection to coaxial inputs of television receiver/monitors. Converter shall be equipped with integral 8-pin modular jack on one end and male “F” fitting on the opposite end. Provide quantities as indicated

]2.4 GROUNDING AND BONDING

Provide ground rods and connections in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

****

NOTE: Include this paragraph only when a telecommunications grounding system is not being specified in other sections.

****

[2.4.1 Grounding Block

Provide [corrosion-resistant] grounding block suitable for [outdoor][indoor] installation.

][2.5 BACKBOARDS

****

NOTE: Include this paragraph only when backboards are not included in other specification sections.

****

Provide void-free, fire rated interior grade plywood, 19 mm 3/4 inch thick, [1200 by 2400 mm][4 by 8 feet][as indicated]. Backboards shall be painted with a gray, nonconductive fire-resistant overcoat. Do not cover the fire stamp on the backboard.

]PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Distribution System

****

NOTE: Show cable routing and equipment locations on the drawings.

****

Distribution system shall conform to requirements specified herein. Installation shall be in accordance with IEEE C2 and NFPA 70.

3.1.1.1 Raceway

****

NOTE: Use the bracketed option when conduit stubout is provided for the local cable television company.

****

Provide cable installed in raceways such as conduit and cable trays in compliance with NFPA 70. Raceway shall comply with Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM.[Provide 78 mm 3 inch, minimum, PVC from interior headend location to exterior television service provider connection location. Coordinate location and requirements with the local cable television service provider.]

[3.1.1.2 Grounding System

****

NOTE: Include this paragraph only when a telecommunications grounding system is not being specified in other sections.
****

****
NOTE: Show location of grounding blocks on drawings. Grounding blocks may be used either inside or outside. Since they are intended to protect equipment from foreign currents, they are most frequently placed inside, close to the cable entrance.
****

Provide the grounding block [at the main television distribution backboard][_____]. Ground this device according to the requirements of IEEE C2 and NFPA 70.

]3.1.1.3 Trunk, Feeder, and Drop Cable

****
NOTE: Delete Trunk and Feeder from the title for housing units and when trunk and feeder cable are not used in the job.
****

Provide cable to grounding blocks, to line taps, and to outlets.

3.1.1.4 Splitters, Directional Couplers, Attenuators, Amplifiers

Install in accordance with manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

3.2.1 System Pretest

****
NOTE: Use the first bracketed item requiring the Contractor to align and balance the system, where amplifiers are provided. For single family housing units, delete second bracketed item requiring testing at 151 and 547 MHz. Testing at these frequencies is required for other applications.

Use option for testing at each outlet instead of random sampling and at furthest outlet when a small number of outlets are provided in the job.
****

Upon completing installation of the television distribution system, the Contractor [shall align and balance the system and]shall perform complete pretesting. During the system pretest, Contractor, utilizing the approved spectrum analyzer or signal level meter, shall verify that the system is fully operational and meets all the system performance requirements of the specification. Contractor shall test the signal loss in dBmV at 55[, 151, 547,] and 1000 MHz. The signal levels shall be 0 dBmV (1000 microvolts), minimum. The signal shall not exceed 15 dBmV over the entire system bandwidth. Any deficiencies found shall be corrected and revalidated by follow up testing. Contractor shall measure and record the video and audio carrier levels at each of the frequency levels specified at each of the following points in the system:

a. Furthest outlet from[each communications room][service entrance point of connection].

b. A random sampling of 25 percent of the[outlets[from each communications room]][housing units].

[c. At each outlet.

][d. [Headend and]Distribution amplifier inputs and outputs.

]3.2.2 Acceptance Tests

****

NOTE: Use option for testing at each outlet instead of random sampling and at furthest outlet when a small number of outlets are provided in the job.

****

Contractor shall notify the Contracting Officer of system readiness 10 days prior to the date of acceptance testing. Contractor shall also coordinate with the local television service provider and allow them to attend witness tests. The television distribution system shall be tested in accordance with the approved test plan in the presence of the Contracting Officer's representative to certify acceptable performance. System test shall verify that the total system meets all the requirements of the specification and complies with the specified standards. Contractor shall verify that no signal leakage exists in conformance with NCTA RP and 47 CFR 76.605. System leakage shall also be tested at the headend location with signal applied to system. Deficiencies revealed by the testing shall be corrected on the [housing units][outlets] sampled as well as on the [units][outlets] not sampled and revalidated by follow-up testing. Contractor shall conduct testing at each of the following points in the system:

a. Furthest outlet from [each communications room][service entrance point of connection].

b. A random sampling of 25 percent of the [outlets[from each telecommunications room]][housing units] as designated by the Contracting Officer.

[c. At each outlet.

][d. [Headend and]Distribution amplifier inputs and outputs.

]3.3 OPERATION AND MAINTENANCE MANUALS

Submit commercial, off-the-shelf manuals for operation, installation, configuration, and maintenance of products provided as a part of the cable television premises distribution system.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-27 05 29.00 10 (August 2011)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 27 05 29.00 10

PROTECTIVE DISTRIBUTION SYSTEM (PDS) FOR SIPRNET COMMUNICATION SYSTEMS

08/11

PART 1 GENERAL

PART 2 PRODUCTS

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-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-27 05 29.00 10 (August 2011)**

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****

SECTION 27 05 29.00 10

PROTECTIVE DISTRIBUTION SYSTEM (PDS) FOR SIPRNET COMMUNICATION SYSTEMS
08/11

****
NOTE: This guide specification covers the requirements for a protective distribution system used in conjunction with SIPRNET communication systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of

the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.3	(2020) American National Standard for Electrical Metallic Tubing (EMT)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NATIONAL SECURITY TELECOMMUNICATIONS AND INFORMATION SYSTEMS SECURITY (NSTISS)

NSTISSAM TEMPEST/2-95	(1995; Am A 2000) RED/BLACK Installation Guidance
NSTISSI-7003	(1996) Protective Distribution Systems (PDS)

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Conditions

Notify the Contracting Officer if it is impossible to install SIPRNET PDS that complies with this section and references.

1.3.2 Construction Methods

Methods of construction that are not specifically described or indicated in the Contract will be subject to the control and approval of the Contracting Officer.

1.3.3 PDS Design

Include separate plans, elevations, sections, details, and attachments to other work. Indicate PDS carrier route, PDS carrier mounting height above finished floor, user drop box mounting height, and user drop box locations. Submit the PDS design to the cognizant Central TEMPEST Technical Authority (CTTA), for a technical review prior to the acquisition of material, through the installation Network Enterprise Center (NEC) or Directorate of Information Management (DOIM).

1.3.4 PDS Design Technical Review

Coordinate with the installation NEC/DOIM and submit PDS design for technical review to CTTA. Provide PDS carrier shop drawings, List of Material (LOM), and any other documentation required 90-days prior to PDS carrier installation (see NSTISSI-7003, Appendix C).

1.3.5 PDS Design Approval Request

PDS design approving authority is the installation NEC/DOIM Designated Approving Authority (DAA). Submit PDS design and CTTA technical review to the installation NEC/DOIM to obtained PDS design approval from the DAA prior to installation.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

PDS Design; G, [_____]
PDS Design Technical Review; G, [_____]
PDS Design Approval; G, [_____]

SD-03 Product Data

PDS Hardened Carrier

SD-04 Samples

PDS Carrier Surface Mounted
Pull Boxes
Fittings

SD-11 Closeout Submittals

User Drop Box
Other Enclosures

1.5 QUALITY ASSURANCE

1.5.1 Manufacturer's Qualifications

Use firms regularly engaged in manufacture of secure raceway systems, boxes, and fittings of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.5.2 Installer's Qualifications

Installer is required to obtain certification from the manufacturer of secure raceway system and install secure raceway system in accordance with manufacturer's instructions.

1.5.3 Equipment

Provide PDS Hardened Carrier meeting or exceeding guidelines as defined by NSTISSI-7003 and approved for use by DHS, U.S. Army, U.S. Marine Corps, U.S. Navy, and U.S. Air Force. Submit manufacturer's descriptive data.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver secure raceways, conduit, fittings and components in factory labeled packages. Store and handle in strict compliance with manufacturer's written instructions and recommendations. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 PRODUCTS

2.1 PDS CARRIER CONFIGURATION

****

NOTE: Use Secure Raceway carrier system in office environments, for SIPRNET PDS, unless the installation NEC/DOIM specifically specifies a Conduit Carrier system. Conduit carrier may be used in non-office environments, such as hangars,

maintenance facilities, warehouse, BCTC, etc.
****

Use secure raceway carrier system in office environments, Use conduit carrier in Non-office environments, such as hangars, maintenance facilities, warehouse, training areas, industrial areas.

2.1.1 Secure Raceway Carrier

Provide secure raceway, fittings and components manufactured from ferrous material. Submit three 150 mm 6-inch lengths of exposed type PDS carrier surface mounted conduit material, including component and fitting samples from the manufacturer, along with a LOM to the NEC/DOIM. Show finishes available (if applicable). PDS carrier that is comprised of Secure Raceway systems must be:

a. Square or rectangular design with removable top covers or solid construction

b. [50 by 50 mm 2 by 2 inch raceway][50 by 100 mm2 by 4 inch] raceway for horizontal backbone and vertical riser runs

c. [25 by 25 mm 1 by 1 inch][12 by 25 mm1/2 by 1 inch] raceway for vertical user drops from horizontal backbone

d. Utilize elbows, couplings, fittings and connectors constructed from the same type of ferrous material as the secure raceway

e. Do not exceed 70 percent cable fill capacity of secure raceway with removable top cover in horizontal runs. TIA-569 cable fill standards do not apply.

f. Do not exceed 60 percent fill capacity of secure raceway of solid construction. TIA-569 cable fill standards do not apply.

2.1.1.1 Fittings and Components

Fittings and components include flat internal and external elbows, tees, couplings for joining raceway sections, nipples, wire clips, blank end fittings, and device mounting brackets and plates as applicable. Provide full capacity corner elbows and fittings to maintain a controlled 50 mm 2-inch cable bend radius that meet the TIA-569 specification for Fiber Optic and UTP cabling and exceeding the requirements for communications pathways.

2.1.1.2 Mounting Accessories

Mount secure raceways to the wall partition using 25 mm 1-inch stand-off mounting brackets or spacers. Do not mount the secure raceways flush with the wall partition.

2.1.1.3 Through Wall Penetrating

a. Use trim plates threaded rigid pipe and locking rings on both the inside and outside of the raceway to secure the thru-wall penetration.

b. Provide dielectric breaks when penetrating secure room wall partitions.

c. Seal space between wall partition and through wall penetration using fire-stop material.

d. Fire-stop vertical risers and through wall penetrations of fire rated wall partitions after pulling cabling. Annotate firewall penetrations on PDS design.

2.1.1.4 Pull Points

a. Provide a pull point for secure raceway with removable top cover every 270 degree change in direction. Provide additional pull points in accordance with the manufacturer's instructions.

b. Provide a pull point for secure raceway of solid construction every 180 degree change in direction. Provide additional pull points in accordance with the manufacturer's instructions.

2.1.2 Conduit Carrier

Provide electrical metallic tubing (EMT) manufactured from ferrous material that meets ANSI C80.3. Use fittings, couplers, and connectors manufactured from ferrous material. Use of EMT, fittings, couplers, and connectors construction from non-ferrous material is not acceptable. TIA-569 cable fill standards do not apply. Do not exceed 60 percent cable fills capacity in horizontal or vertical runs.

2.1.2.1 Conduit

Use [25] [50] [75] [100] mm [1] [2] [3] [4]-inch EMT conduit for horizontal backbone or vertical riser runs; [19] [25] mm [3/4] [1]-inch EMT conduit for vertical runs from horizontal runs to secure user drop box. Use components (e.g. couplers, connectors, condulette, fittings, pull boxes, enclosures) constructed from ferrous metallic material. Use of components constructed from non-ferrous metallic material is not acceptable.

2.1.2.2 Mounting Brackets

Surface mount PDS conduit carrier on interior walls using [12] [25] mm [1/2] [1]-inch stand-off mounting brackets. Use of non-metallic pipe hangers is acceptable to mount PDS conduit carrier to wall partitions.

2.1.2.3 Fittings

****

NOTE: Condulettes do not provide a 50 mm 2 inch bend radius except in larger sizes and listed as Mogul Pulling Elbows.

****

PDS conduit carrier fittings include; flat internal and external elbows; tees; condulette; pulling elbows; couplings for joining conduit sections; wire clips; blank end fittings; device mounting brackets; trim plates as applicable.

a. Provide full capacity corner elbows and fittings to maintain a controlled 50 mm 2-inch cable bend radius that meets the TIA-569 specification for Fiber Optic and UTP/STP cabling for communications pathways.

b. Use EMT conduit compression fittings and couplers to connect EMT conduit carrier sections, fittings and components together. Use of set screw connectors or set screw couplers to connect EMT conduit sections together is prohibited.

2.1.2.4 Through Wall Penetrating

a. Provide dielectric breaks when penetrating secure room wall partitions.

b. Seal space between wall partition and PDS conduit using appropriate fill material or fire-stop material.

c. Fire-stop vertical risers and through wall penetrations of fire rated wall partitions after pulling cabling. Annotate firewall penetrations on PDS design.

2.1.2.5 Pull Points

Provide a pull point with a pull string between every pair of adjacent access/pull locations; for every 180 degree bends in EMT conduit carrier; and every 100 feet of continuous conduit run.

a. Size pull boxes according to the size of the conduit, not the number of cables or conduits that enter/exit the pull box. NFPA 70 conduit fill standards do not apply.

b. Leave pull string in place throughout the conduit carrier, even after cable is pulled, in each horizontal and vertical run.

2.2 USER DROP BOX

Provide User Drop Box (UDB) (aka Secure User Workstation Enclosure, Drop Box, or Lockbox) that is at least 175 mm 7-inch high by 150 mm 6-inch wide by 100 mm 4-inch deep, tamper-resistant design constructed from 16 gauge steel with welded internal hinges, without pre-punched knockouts; and has a single door that has a built-in steel hasp that accepts a GSA approved changeable combination padlock. UDB must accommodate a complete line of open connectivity outlets; modular inserts for Category 6 UTP or STP cable; fiber optic cabling with matching faceplates. Provide STP cabling consisting of shielded connectors, jacks, and patch panels. UDB with exterior hinges, pre-punched knockouts, and built-in locks are not acceptable.

2.3 ENCLOSURES

Provide equipment and pull-box enclosures constructed from 16 gauge steel; have a single door with a built-in steel hasp or multi-point security hasp that accepts a GSA approved changeable combination padlock; without pre-punched knockouts; and a tamper-resistant design with welded internal hinges.

PART 3 EXECUTION

3.1 EXAMINATION

Examine the route and mounting locations of the raceways, boxes, distribution systems, supporting structure and accessories, to determine if conditions exist that will inhibit or prevent proper PDS installation. Notify the Contracting Officer in writing of conditions detrimental to proper completion of the work (i.e. that would render the distribution system non-compliant with governing security regulations). Do not proceed with work until unsatisfactory conditions are corrected.

3.2 PDS CARRIER ROUTING

3.2.1 General

Route the PDS carrier in a tree type fashion.

a. Start the PDS horizontal backbone at the TR (SIPRNET TR or at IPS container location) with a single raceway or conduit sized accordingly (70 percent cable fill for secure raceway with removable top cover, 60 percent cable fill for EMT conduit and solid construction secure raceway) to contain CAT6 UTP, CAT6 STP, or fiber optic cable runs.

b. Extend the PDS carrier from the PDS horizontal backbone throughout the facility to areas where SIPRNET access is required. Branch off the PDS horizontal backbone with a horizontal run to an area where the UDB is located.

c. Use vertical carrier runs from the horizontal run to the UDB. TIA-569 change in direction standard does not apply.

d. Use standard under-floor cable distribution methods to distribute SIPRNET cabling within Secure Room and SCIF spaces with raised flooring.

e. Maintain RED/BLACK cable separation in accordance with NSTISSAM TEMPEST/2-95.

f. Remove all burrs from carrier segments prior to installation.

3.2.2 Distribution Topology

Use a distributed topology when designing the PDS carrier. Locating a small secondary network switch in an equipment enclosure mounted in an Uncontrolled Access Area (UAA) space or in a relay or equipment rack within a Controlled Access Area (CAA) space (i.e. SCIF, NOC/BOC, etc.) that has a high concentration of users is acceptable. Interconnect network switches using single-mode fiber optic cable. Increase the capacity of the network switch to provide service to adjacent spaces as required.

3.2.3 Mounting Location Considerations

a. Route the PDS carrier so that it does not cross windows or doorway openings; does not cross ceiling or wall mounted lighting fixtures; does not obscure EXIT signs or fire alarms; and maintains a minimum 1000 mm 3-foot separation from fire sprinkler heads.

b. Bend (saddle or offset) conduit to follow wall contours and avoid wall obstacles (columns, pipes, etc.).

c. Use offset raceway to route secure raceway systems around columns and other wall partition obstacles.

d. Route PDS carrier so that it is surface mounted on interior walls wherever possible. Obtain exceptions from NEC/DOIM prior to installation to mount PDS carrier on exterior wall partitions.

e. Route PDS carrier to maximized cable fills in horizontal runs and reduce the number of horizontal runs within the same space.

f. Use all-thread rod to mount the PDS carrier to true ceiling structure when routing across open areas (e.g. large hallways, open office areas, large rooms) that exceed 2400 mm 8 feet. Mounting the PDS carrier directly from suspended ceiling framework is not acceptable.

3.2.4 Adjacent Infrastructure Considerations

Keep conduit a minimum of 150 mm 6 inches from parallel runs of flues and steam or hot water pipes. A minimum separation of 150 mm 6-inches is required between the PDS carrier and water pipes, electrical wires, electrical pipes, plumbing, air conditioning, etc.

3.3 INSTALLATION

Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and compliance with project site manager and NEC/DOIM.

3.3.1 Mounting PDS Carrier

Surface mount PDS Conduit on the wall using conduit clamps, brackets, or mounts with 12 to 25 mm 0.5 to 1-inch offset spacer from the wall surface. Mount PDS carrier to a wall partition every 1500 mm 5 feet and/or within 450 mm 18 inches of a section or component connection. Do not mount the PDS Carrier directly to the wall surface.

a. Where wall mounting is unavailable, use appropriately sized all thread rods to mount PDS carrier to ceiling structure.

b. Do not mount PDS carrier to acoustical tile ceiling (ATC) framework.

c. Fasten PDS carrier and component items to building wall partitions using appropriate anchor and fastener for wall partition type.

d. Mount PDS carrier so that is is level and plumb along its route. The top edge of the carrier is horizontally level. Whenever possible maintain a minimum of 50 mm 2-inches below the suspended ceiling line or the true ceiling line, whichever is lower.

e. Use appropriate hanger type to mount PDS Conduit carrier from ceiling structure.

f. Struts are not allowed to be used to mount secure raceway or conduit to wall partitions.

g. No more than 6 mm 1/4 inch play is allowed on TOP CAP (top cover) and span cut per segment span.

h. Install the PDS carrier to permit visual inspections of its entire run.

i. Do not block doorways or access to emergency exits and do not inhibit the operation of windows.

j. Do not paint or cover the PDS carrier with wallpaper or other covering unless the paint is applied by the carrier manufacturer.

k. Bond PDS carrier to TGB or TMGB at point of origin.

3.3.2 Enclosures

Use of enclosures with pre-punched knockouts or external hinges is not acceptable. Fasten UDB, pull boxes, and enclosures to the wall partition using fasteners appropriate for the wall partition type.

3.3.2.1 User Drop Box (UDB)

****

NOTE: Up to 6 cable connections may be terminated within the drop box as long as it is within 3.6 m 12 feet of the classified workstations and/or printers located in the same room.

****

a. Indicate UDB locations in the PDS Plan and on as-built drawings.

b. Size the UDB to terminate up to 6 cables.

c. Coordinate drop box location with furniture, fixtures and equipment that will be used in the vicinity[(provided by others)]. Surface mount drop boxes on the wall partition approximately 1.2 to 1.5 m 4 to 5 feet above final floor line depending on room furniture height and layout.

3.3.2.2 Other Enclosures

Indicate enclosure type (user drop box, equipment, or pull-box) on shop and as-built drawings.

3.3.3 Mechanical Security

Comply with site specific epoxy standards obtained from the installation NEC/DOIM. Apply a continuous bead of epoxy at all component, coupling, and fitting connection joints of an EMT conduit PDS carrier system. Seal pull box covers to the pull boxes around the mating surfaces after installation if they cannot be secured with GSA approved changeable combination padlock.

3.3.4 Carrier Support

Support carrier with mounting brackets at intervals [not to exceed 1.5 m 5 feet] [in accordance with manufacturer's installation sheets].

3.4 FIELD QUALITY ASSURANCE

3.4.1 Physical Inspection

Physically inspect all interfaces to ensure that they are tight and cannot turn. Also, physically inspect lock covers to ensure that the lock cap is properly sealed inside the locking mechanism.

3.4.2 Magnetic Test

Perform magnet test on all components (e.g. carrier conduit, carrier raceway, pull boxes, enclosures, conduit bodies, cover plates, etc) and fittings used to construct the carrier. Place a magnet on the carrier component or fitting to verify that construction is from ferrous material.

Some alloys will fail the magnet test (e.g. 309 stainless steel) but meet the ferrous material requirements. Provide alloy material property list for components that fail magnet test to the Contracting Officer for approval. Use of components and fittings that fail the magnet test and are not made from ferrous material is not acceptable.

3.5 CLEANING AND PROTECTION

Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer. Protect raceways and boxes until acceptance.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-27 10 00 (August 2011)**

Preparing Activity: NAVFAC **Superseding**
UFGS-27 10 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 27 - COMMUNICATIONS

SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM

08/11

PART 1 GENERAL

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-27 10 00 (August 2011)**

Preparing Activity: NAVFAC **Superseding**

UFGS-27 10 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM
08/11

****

NOTE: This guide specification covers requirements for building telecommunications cabling systems using a physical star network topology for transporting telecommunications signals within a building. Telecommunications cabling systems include the copper and optical fiber horizontal and interior building backbone systems and cable media, patch panels, connecting blocks, firestopping, grounding, cable support, hardware, communications outlets, connectors, and associated hardware; station wiring, work area station outlets (adapters); and distribution terminals. This specification covers telecommunication cabling systems supporting customer's voice, data, video, audio, security, digital imaging and environmental control for transporting information throughout modern buildings using twisted pair and optical fiber cables.

Telecommunications pathways are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Coordinate electrical, grounding, and HVAC requirements with the associated disciplines.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be

submitted as a Criteria Change Request (CCR).

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NOTE: The designer shall provide single line schematic type diagrams of the telecommunications system, site plans, and floor plans showing overhead or underground service entrances, maintenance holes, handholes, conduit sizes, conductor size and type, number of pairs and fibers, and physical locations and layouts of telecommunication entrance facility, telecommunications equipment rooms, campus distributor, building distributors, floor distributors, and telecommunications outlets.

****

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NOTE: UFC 3-580-01, "Telecommunications Building Cabling Systems Planning and Design" provides requirements for interior telecommunications cabling systems for DoD. It is currently being revised to accommodate the USAISEC Technical Criteria for Installation Information Infrastructure Architecture (I3A) and the UFC 3-580-10, "Navy And Marine Corps Intranet (NMCI) Standard Construction Processes". When UFC 3-580-01 is complete, these documents will no longer be valid.

Until then, the Army ECB 2007-22, "Army Installation Information Infrastructure Architecture (I3A) Guide", available electronically, invokes the I3A, and the I3A provides the criteria for Army telecommunications cabling systems.

Similarly, UFC 3-580-01 and UFC 3-580-10, "Navy And Marine Corps Intranet (NMCI) Standard Construction Processes" provides design requirements for Navy sites.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-83-596	(2021) Indoor Optical Cable
ICEA S-90-661	(2021) Category 3 and 5E Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communications Wiring Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA/BICSI 568	(2006) Standard for Installing Building Telecommunications Cabling

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 66	(2019) Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pairs

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-21	(1988a; R 2012) FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices
TIA-526-7	(2015a; R 2022) Measurement of Optical Power Loss of Installed Single-Mode Fiber

	Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures - Part 4-2: Installed Cable Plant - Single-Mode Attenuation and Optical Return Loss Measurement
TIA-526-14	(2023d) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-568.0	(2020e) Generic Telecommunications Cabling for Customer Premises
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2024e) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2022e) Optical Fiber Cabling Components Standard
TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces
TIA-570	(2024e) Residential Telecommunications Infrastructure Standard
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-1152	(2016; R 2021) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
TIA/EIA-598	(2014D; Add 2 2018) Optical Fiber Cable Color Coding
TIA/EIA-604-2	(2004b; R 2014) FOCIS 2 Fiber Optic Connector Intermateability Standard
TIA/EIA-604-3	(2004b; R 2014) Fiber Optic Connector Intermateability Standard (FOCIS), Type SC and SC-APC, FOCIS-3
TIA/EIA-604-10	(2002a) FOCIS 10 Fiber Optic Connector Intermateability Standard - Type LC
TIA/EIA-604-12	(2000) FOCIS 12 Fiber Optic Connector Intermateability Standard Type MT-RJ

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 68	Connection of Terminal Equipment to the Telephone Network (47 CFR 68)

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 444	(2017; Reprint Jun 2021) UL Standard for Safety Communications Cables
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 514C	(2014; Reprint Apr 2024) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 969	(2017; Reprint May 2023) UL Standard for Safety Marking and Labeling Systems
UL 1286	(2022; Reprint Mar 2024) UL Standard for Safety Office Furnishings
UL 1666	(2007; Reprint Sep 2021) UL Standard for Safety Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
UL 1863	(2004; Reprint Oct 2019) UL Standard for Safety Communication Circuit Accessories

1.2 RELATED REQUIREMENTS

****

NOTE: Ensure that design provides for adequate telecommunications spaces using TIA/EIA-569-A as a minimum requirement.

Network type, size and configuration must be coordinated with the user's representative, if known. The same cable pathways and spaces are normally used for both telephone and data (including local area network) systems.

For Military Construction projects, telephone instruments and other equipment are procured and installed using procurement funding outside of the construction contract. Other types of projects, such as Army and Navy Reserve, DoD and work for others, may require that telephone instruments and other specified equipment be added to this section

detailing what must be procured and installed as part of the construction contract.

****

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and Section 33 82 00 TELECOMMUNICATIONS, OUTSIDE PLANT (OSP), apply to this section with additions and modifications specified herein.

1.3 DEFINITIONS

****

NOTE: Use Definitions from HEADQUARTERS AIR FORCE MEDICAL SUPPORT AGENCY DESIGN AND IMPLEMENTATION GUIDELINES MEDICAL SYSTEMS INFRASTRUCTURE MODERNIZATION PROGRAM (2001) for Air Force Medical projects. In this section the terms cover plate, device plate and faceplate refer to the same item and are used interchangeably. In this section the terms outlet/connector and adapter are used to designate the "jack" or female portion of intermateable interconnection components and connectors are used to designate the "plug" or male portion of intermateable interconnection components.

****

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568.1, TIA-568.2, TIA-568.3, TIA-569, TIA-606 and IEEE 100 and herein.

1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect (MC).)

1.3.2 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

1.3.3 Floor Distributor (FD)

A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).)

1.3.4 Telecommunications Room (TR)

An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

1.3.5 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including wireless) including the entrance point at the building wall and continuing to the equipment room.

1.3.6 Equipment Room (ER) (Telecommunications)

An environmentally controlled centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.7 Open Cable

Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

1.3.8 Open Office

A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

1.3.9 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

****

NOTE: Use Section 33 82 00 TELECOMMUNICATIONS, OUTSIDE PLANT (OSP) to specify exterior distribution and interbuilding cables and include bracketed sentence.

For the Navy: Coordinate with the Base Communications Officer (BCO) for the Navy and with the G6 for the Marine Corps and edit the last bracketed sentences appropriately. The Navy and Marine Corps Intranet (NMCI) contract has been replaced by a "continuation of Services Contract (COSC)". This will eventually be replaced by "next Generation" (NGEN) Contract. These contracts are being handled differently for the Navy and the Marine Corps.

For the Air Force: Project development and design requires coordination with the Installation Communications Squadron, regardless of the planned design method or the execution method (DB, DBB, other). The Installation Communications Squadron shall be one of the approving organizations for project development, design, and construction.

****

The building telecommunications cabling and pathway system shall include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, service entrance facilities, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building. The horizontal system shall be wired in a star topology from the telecommunications work area to the floor distributor or campus distributor at the center or hub of the star. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware. The intrabuilding backbone provides connectivity from the floor distributors to the building distributors or to the campus distributor and from the building distributors to the campus distributor as required. The backbone system shall be wired in a star topology with the campus distributor at the center or hub of the star.[The interbuilding backbone system provides connectivity between the campus distributors and is specified in Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).] Provide telecommunications pathway systems referenced herein as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.[The telecommunications contractor must coordinate with the NMCI/COSC/NGEN contractor concerning access to and configuration of telecommunications spaces. The telecommunications contractor may be required to coordinate work effort within the telecommunications spaces with the NMCI/COSC/NGEN contractor.]

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications Drawings; G, [_____]

Telecommunications Space Drawings; G, [_____]

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Telecommunications Cabling (backbone and horizontal); G, [_____]

Patch Panels; G, [_____]

Telecommunications Outlet/Connector Assemblies; G, [_____]

Equipment Support Frame; G, [_____]

[Connector Blocks; G, [_____]

] **

NOTE: Delete submittal for spare parts on Navy projects. Spare parts requirements are provided in Section 01 78 23 OPERATION AND MAINTENANCE DATA on Navy projects.

****

[Spare Parts; G, [_____]

] Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Telecommunications Cabling Testing; G, [_____]

SD-07 Certificates

Telecommunications Contractor Qualifications; G, [_____]

Key Personnel Qualifications; G, [_____]

Manufacturer Qualifications; G, [_____]

Test Plan; G, [_____]

SD-09 Manufacturer's Field Reports

Factory Reel Tests; G, [_____]

SD-10 Operation and Maintenance Data

Telecommunications Cabling and Pathway System Data Package 5; G, [_____]

SD-11 Closeout Submittals

Record Documentation; G, [_____]

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

In exception to Section 01 33 00 SUBMITTAL PROCEDURES, submitted plan drawings shall be a minimum of 279 by 432 mm 11 by 17 inches in size using a minimum scale of 1 mm per 100 mm 1/8 inch per foot[, except as specified otherwise]. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Drawings

****

NOTE: The Army and Navy require RCDD approved drawings for all A/E designed projects.

On government designed (in-house design) projects, the government designer shall make sure that the bid documents require an RCDD stamp on the contractor's telecommunications drawings submitted for approval.

For small scale projects, limited to adding drops to existing telecommunications rooms, an RCDD stamp is not required provided the work is being accomplished under the technical authority of an RCDD or the government telecommunications manager.

Activity Specific Telecommunications Manager: Throughout this document, the term "telecommunications manager " refers to the following:
"   For Army, the Network Enterprise Center (NEC).
"   For Navy, the Base Communications Officer (BCO)
"   For Marine Corps, the G6
"   For Air Force, the Base/Installation Communications Squadron, Commander's Representative.

****

Provide[registered communications distribution designer (RCDD) approved,] drawings in accordance with TIA-606. The identifier for each termination and cable shall appear on the drawings. Drawings shall depict final telecommunications installed wiring system infrastructure in accordance with TIA-606. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the EF telecommunications and ER telecommunications, CD's[, BD's], and FD's to the telecommunications work area outlets.[Provide a plastic laminated schematic of the as-installed telecommunications cable system showing cabling, CD's, BD's, FD's, and the EF and ER for telecommunications keyed to floor plans by room number. Mount the laminated schematic in the EF telecommunications space as directed by the Contracting Officer.] The following drawings shall be provided as a minimum:

a. T1 - Layout of complete building per floor - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.

b. T2 - Serving Zones/Building Area Drawings - Drop Locations and Cable Identification (ID’S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.

c. T4 - Typical Detail Drawings - Faceplate Labeling, Firestopping, Americans with Disabilities Act (ADA), Safety, Department of Transportation (DOT). Detailed drawings of symbols and typicals such as faceplate labeling, faceplate types, faceplate population installation procedures, detail racking, and raceways.

1.6.1.2 Telecommunications Space Drawings

Provide T3 drawings in accordance with TIA-606 that include telecommunications rooms plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and [cabinet][, rack][, backboard][and] wall elevations. Drawings shall show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 or T2 drawings.

1.6.2 Telecommunications Qualifications

****

NOTE: BICSI Cabling Installer, Technician Level certification is preferred for supervisors and installers in lieu of documentation of three years experience. Contractors have the option to submit either BICSI certification or experience documentation.

****

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years of similar scope and size. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

1.6.2.2 Key Personnel

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.

In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of [3][_____] years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using [optical fiber and]copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

1.6.2.3 Minimum Manufacturer Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of [3] [_____] years experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568.1, TIA-568.2 and TIA-568.3.

1.6.3 Test Plan

Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the components and accessories for each cable type specified, [60][_____] days prior to the proposed test date. Include procedures for certification, validation, and testing.

1.6.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.5.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.5.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 DELIVERY AND STORAGE

Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.

1.8 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of 0 to 60 degrees C 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.10 MAINTENANCE

1.10.1 Operation and Maintenance Manuals

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system, Data Package 5. Submit operations and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein not later than [2] [_____] months prior to the date of beneficial occupancy. In addition to requirements of Data Package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION. Ensure that these drawings and documents depict the as-built configuration.

1.10.2 Record Documentation

****

NOTE: TIA-606 describes the necessary data fields and reports for hard copy, spreadsheet and electronic media as well as cable management software requirements. Check with activity to determine if cable management software is currently employed at the activity and provide necessary data input to the existing system to include information associated with project installation.

****

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA-606. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. T5 drawings shall be provided[in hard copy format][on electronic media using Windows based computer cable management software.][A licensed copy of the cable management software including documentation, shall be provided.] Provide the following T5 drawing documentation as a minimum:

a. Cables - A record of installed cable shall be provided in accordance with TIA-606. The cable records shall [include only the required data fields][include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility]in accordance with TIA-606. Include manufacture date of cable with submittal.

b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with TIA-606. Documentation shall include the required data fields[as a minimum][only] in accordance with TIA-606.

[1.10.3 Spare Parts

****

NOTE: Delete this paragraph for Navy projects.

****

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

]PART 2 PRODUCTS

2.1 COMPONENTS

****

NOTE: Service entrance and pathway requirements are provided in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP) provides requirements for campus backbone cable systems.

For specialized circuits, such as pay phones, coordinate with the local telephone company. Provide electrical and telephone outlets installed per the ADA to accommodate TTD's and other devices.

****

Components shall be UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

2.2 TELECOMMUNICATIONS PATHWAY

Provide telecommunications pathways in accordance with TIA-569 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide system furniture pathways in accordance with UL 1286.

2.3 TELECOMMUNICATIONS CABLING

****

NOTE: Cables shall be terminated within telecommunications rooms, telecommunications equipment rooms, and work areas. Cross-connect jumpers may be provided as part of the contract if required to provide the customer a complete and usable facility. Optical fiber and copper patch cords shall be provided by the Contractor when patch panels are installed. Optical fiber media may be single-mode, multimode, or hybrid combination. For information on optical fiber local area network system, visit www.fols.org.

Air Force Medical Facilities are installed and labeled in accordance with HEADQUARTERS AIR FORCE MEDICAL SUPPORT AGENCY DESIGN AND IMPLEMENTATION GUIDELINES MEDICAL SYSTEMS INFRASTRUCTURE MODERNIZATION PROGRAM (2001) for Air Force medical projects. All other projects are labeled in accordance with TIA-606.

When systems furniture is provided as part of the construction contract, ensure that systems furniture specifications require compliance with TIA-568.0, TIA-568.1, TIA-568.2, and TIA-568.3 cabling standards as applicable.

NFPA 70 provides detailed information for optical fiber cables and communications circuits in various spaces and locations. Article 770, table 770-154(a), provides application of optical fiber cables and article 800, Table 800.154(a), provides application for communications circuits (copper).

Table 770.179 provides the following definitions for optical fiber cable:

OFNP	**Nonconductive optical fiber plenum cable**
OFCP	**Conductive optical fiber plenum cable**
OFNR	**Nonconductive optical fiber riser cable**
OFCR	**Conductive optical fiber riser cable**
OFNG	**Nonconductive optical fiber general-purpose cable**
OFCG	**Conductive optical fiber general-purpose cable**
OFN	**Nonconductive optical fiber general-purpose cable**
OFC	**Conductive optical fiber general-purpose cable**

Table 800.179 provides the following definitions for communications circuits:

CMP Communications plenum cable
CMR Communications riser cable
CMG Communications general-purpose cable
CM Communications
general-purpose cable
CMX Communications cable, limited use
CMUC Undercarpet communications wire and cable
****

****
NOTE: In passive optical network (PON) topologies, specify single mode fiber since it is currently the only viable cabling solution. PON technology is not supported by all current networks and must be coordinated with the agency specific telecommunications manager (NEC, BCO, G6) and additionally for the Navy, with the NMCI/COSC/NGEN Contractor.
****

Cabling shall be UL listed for the application and shall comply with TIA-568.0, TIA-568.1, TIA-568.2, TIA-568.3 and NFPA 70. Provide a labeling system for cabling as required by TIA-606 and UL 969. Ship cable on reels or in boxes bearing manufacture date for for unshielded twisted pair (UTP) in accordance with ICEA S-90-661[and optical fiber cables in accordance with ICEA S-83-596] for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

[2.3.1 Backbone Cabling

****
NOTE: 150 ohm shielded twisted pair (STP)is not allowed for new construction. Backbone cable lengths shall not exceed guidelines of TIA-568.1, TIA-568.2, and TIA-568.3. STP 100 ohm backbone and horizontal cable may be required for EMI isolation in complex buildings.

Use fiber optic cable for backbone data service, unless expanding an existing site where other backbone cable types are required or requested by user.
****

[2.3.1.1 Backbone Copper

****
NOTE: TIA-568.1 recognizes Category 3 rated cable as the minimum backbone transmission media. Use of cables rated higher than Category 3 are not required since the copper backbone cable is only used for voice systems. Choose the first bracketed jacket color for the preferred color code for cable jackets. Coordinate with activity and choose the second bracketed jacket color option to specify an

activity preferred color. Color coding for conductors within the 25 pair bundles is covered by the reference to industry standards.

ICEA S-90-661 specifies a different cable marking interval for copper cables when marked in SI versus empirical units. This standard requires: "Length marking shall appear at intervals not to exceed 1 meter 3.3 feet and the word "METER" shall appear after each length marking. If specified by the user, length marking shall be provided in feet and shall appear at intervals not to exceed 0.6 meters 2 ft. The word "FEET" shall appear after each length marking".

****

Copper backbone cable shall be solid conductor, 24 AWG, 100 ohm, [100] [_____]-pair, Category 3, UTP, in accordance with ICEA S-90-661, TIA-568.1, TIA-568.2 and UL 444, formed into 25 pair binder groups covered with a[gray][____] thermoplastic jacket[and overall metallic shield]. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular length marking intervals in accordance with ICEA S-90-661 . Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG)communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70.

][2.3.1.2 Backbone Optical Fiber

****

NOTE: In a fiber optic communication cable a buffer is one type of component used to encapsulate one or more optical fibers for the purpose of providing such functions as mechanical isolation, protection from physical damage and fiber identification. The buffer may take the form of a miniature conduit, contained within the cable and called a loose buffer, or loose buffer tube, in which one or more fibers may be enclosed, often with a lubricating gel. A loose buffer is typically used in outside plant applications. A tight buffer consists of a polymer coating in intimate contact with the primary coating applied to the fiber during the manufacturing process. A tight buffer is typically used for interior distribution.

Indicate the proper color coding of optical fiber cabling on design drawings. TIA/EIA-598 color coding scheme for cordage jackets used on military projects is as follows:

Fiber type and class	**Fiber diameter m**	**Jacket color**
Multimode	**50/125 Laser Optimized (OM3)**	**Aqua**
	50/125 (OM2)	**Orange**
	62.5/125 (OM1)	**Slate**
Single-mode	**OS1 (ranges between 8 and 10)**	**Yellow**

****

NOTE: The Army Installation and Campus Area Network (ICAN) Guide standard dictates the use of single mode fiber cables for building backbones on Army projects.

For Navy projects provide single mode fiber cables (OS1) for building backbones on all new projects to future proof the network and standardize the backbone. Additionally, this permits the option of flattening the network via direct connection to switches in TRs other than the main TR.

In existing facilities with multimode cables and switches, coordinate with the activity and the NMCI/COSC/NGEN contractor to determine whether the switch optics will be changed to utilize the single mode backbone, or if multimode cable must also be provided in addition to the single mode. If using multimode, OM3 (which permits data rates up to 10 Gig) is first choice. OM2 and OM1 should only be used to supplement existing systems.

For Air Force projects, coordinate fiber cable requirements with the Installation Communications Squadron.

****

Provide in accordance with ICEA S-83-596, TIA-568.3, UL 1666 and NFPA 70. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 1 meter 40 inches.

Provide the number of strands indicated, (but not less than 12 strands between the main telecommunication room and each of the other telecommunication rooms), of single-mode(OS1), tight buffered fiber optic cable.

[Provide tight buffered fiber optic multimode, [50/125-um diameter laser optimized(OM3)] [50/125-um diameter(OM2)] [62.5/125-um diameter(OM1)] cable as indicated.

] Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be in accordance with TIA/EIA-598.

Provide plenum (OFNP) riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be in accordance with TIA/EIA-598.

]]2.3.2 Horizontal Cabling

****

NOTE: Coordinate project requirements and use of fiber optic cable for horizontal cabling.

****

Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568.1.

2.3.2.1 Horizontal Copper

****

NOTE: Choose the first bracketed jacket color for the preferred color code for cable jackets. Coordinate with activity and choose the second bracketed jacket color option to specify an activity preferred color.

ICEA S-90-661 specifies a different cable marking interval for copper cables when marked in SI versus empirical units. This standard requires "Length marking shall appear at intervals not to exceed 1 meter 3.3 feet and the word "METER" shall appear after each length marking. If specified by the user, length marking shall be provided in feet and shall appear at intervals not to exceed 0.6 meters 2 feet. The word "FEET" shall appear after each length marking."

Screened twisted pair cable (ScTP) may be required OCONUS. Coordinate with Activity for specific requirements and applicable reference standards.

****

Provide horizontal copper cable, UTP, 100 ohm in accordance with TIA-568.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661 . Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6, with a [blue] [_____] thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG) communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs shall be UL listed and labeled for wet locations in accordance with NFPA 70.[Provide residential Category 6 cabling in accordance with TIA-570.]

[2.3.2.2 Horizontal Optical Fiber

****

NOTE: When using fiber to the work area outlet, the

most common method is to use the multimode fiber for horizontal cabling. If using multimode, OM3 (which permits data rates up to 10 Gig) is first choice. OM2 and OM1 should only be used to supplement existing systems.

Centralized cabling provides connection from the work areas to the centralized cross connect by allowing the use of pull through cable, an interconnect, or a splice in the TR or ER. Although this is using the same cable as horizontal, the industry standard permits runs up to 300 meters. In this topology, longer distances corresponds to a lower date rate.

In passive optical network (PON) topologies, specify single mode fiber since it is currently the only viable cabling solution. PON technology is not supported by all current networks and must be coordinated with the agency specific telecommunications manager (NEC, BCO, G6) and additionally for the Navy, with the NMCI/COSC/NGEN Contractor.

- **For horizontal cabling, 62.5/125 µm or 50/125 µm multimode optical fiber is recommended for:**
  - **Distances up to 90 m 295 ft.**
  - **Data rates up to 2.5 Gb/s.**
- **For centralized cabling, 62.5/125 µm or 50/125 µm multimode optical fiber is recommended for:**
  - **Distances up to 300 m 984 ft.**
  - **Data rates up to 1.25 Gb/s.**

****

Provide optical fiber horizontal cable in accordance with ICEA S-83-596and TIA-568.3. Cable shall be tight buffered, [multimode, 50/125-um diameter laser optimized, OM3][,][multimode, 50/125-um diameter, OM2][multimode, 62.5.125-um diameter, OM1][single-mode, 8/125-um diameter, OS1]. Cable shall be imprinted with manufacturer, flammability rating and fiber count at regular intervals not to exceed 1 meter 40 inches.

Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70.Cables installed in conduit within and under slabs be UL listed and labeled for wet locations in accordance with NFPA 70. The cable jacket shall be of single jacket construction with color coding of cordage jacket, fiber, unit, and group in accordance with TIA/EIA-598.

][2.3.3 Work Area Cabling

****

NOTE: This type cabling is seldom provided on projects and is normally the responsibility of the activity. Coordinate with the activity and local design agency for requirements concerning work area cabling.

****

2.3.3.1 Work Area Copper

****
NOTE: Choose the first bracketed jacket color for the preferred color code for cable jackets. Coordinate with activity for alternate color coding and choose the second bracketed jacket color option to enumerate activity preferred color code. Coordinate work area cabling color code with work area adapter color code.
****

Provide work area copper cable in accordance with TIA-568.2, with a [blue,] [_____] thermoplastic jacket.

[2.3.3.2 Work Area Optical Fiber

Provide optical work area cable in accordance with TIA-568.3.

]]2.4 TELECOMMUNICATIONS SPACES

****
NOTE: For projects that do not include Section 33 82 00 TELECOMMUNICATIONS, OUTSIDE PLANT (OSP) for termination of interbuilding cables, copy paragraph BUILDING PROTECTOR ASSEMBLIES and PROTECTOR MODULES from Section 33 82 00 and paste the paragraphs into this section as part of the telecommunications spaces.

Navy projects adhere to color coding standards in accordance with the following colors from TIA-606.

Cross-Connect Field Color Codes

Color	**Identifies**
Orange	**Demarcation point (e.g., central office terminations).**
Green	**Network connections (e.g., network and auxiliary equipment).**
Purple	**Common equipment, private branch exchange (PBX), local area network (LANs),multiplexers (e.g., switching and data equipment).**
White	**First-level backbone (e.g., CD (MC) to an FD (HC) or to a BD (IC)).**
Gray	**Second-level backbone (e.g., BD (IC) to an FD (HC)).**
Blue	**Horizontal cable (e.g., horizontal connections to telecommunications outlets).**
Brown	**Interbuilding backbone (campus cable terminations).**

Cross-Connect Field Color Codes	
Color	**Identifies**
Yellow	**Miscellaneous (e.g., auxiliary, alarms, security).**
Red	**Reserved for future use (also, key telephone systems).**
NOTE: Brown takes precedence over white or gray for interbuilding runs.	

****

Provide connecting hardware and termination equipment in the telecommunications entrance facility[and telecommunication equipment room[s]] to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with TIA-606.

2.4.1 Backboards

Provide void-free, interior grade A-C plywood 19 mm 3/4 inch thick [1200 by 2400 mm] [4 by 8 feet] [as indicated]. Backboards shall be fire rated by manufacturing process. Fire stamp shall be clearly visible.[Paint applied over fire retardant backboard shall be UL 723 fire retardant paint. Provide label including paint manufacturer, date painted, UL listing and name of Installer. When painted, paint label and fire stamp shall be clearly visible.] Backboards shall be provided on a minimum of two adjacent walls in the telecommunication spaces.

[2.4.2 Equipment Support Frame

****

NOTE: Provide equipment support frames only when patch panels or cabinet/rack mounted interconnecting equipment are provided. In most applications, a rack in locked communications room is sufficient. Provide lockable cabinets in locations where additional security is required. Use wall-mounted brackets for small systems where only a few patch panels are required. Use 482.6 mm 19 inches equipment support frames for Navy projects.

Provide adequate space in telecommunications spaces to facilitate tenant owned telecommunications system support equipment requirements in tenant installed free standing cabinets or racks.

****

Provide in accordance with ECIA EIA/ECA 310-E and UL 50.

[a. Bracket, wall mounted, 8 gauge aluminum. Provide hinged bracket compatible with [482.6 mm] [584 mm] [19 inches] [23 inches] panel mounting.

][b. Racks, floor mounted modular type, [16 gauge steel][or][11 gauge aluminum] construction, minimum, treated to resist corrosion. Provide rack with vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug[and a surge protected power strip with 6 duplex 20 amp receptacles]. Rack shall be compatible with [482.6 mm] [584 mm] [19 inches] [23 inches] panel mounting.

][c. Cabinets, freestanding modular type, [16 gauge steel][or][11 gauge aluminum] construction , minimum, treated to resist corrosion. Cabinet shall have removable and lockable side panels, front and rear doors, and have adjustable feet for leveling. Cabinet shall be vented in the roof and rear door. Cabinet shall have cable access in the roof and base and be compatible with [482.6 mm] [584 mm] [19 inches] [23 inches] panel mounting. Provide cabinet with grounding bar[,][[rack][roof] mounted 15 cu. m 550 CFM fan with filter][and][a surge protected power strip with 6 duplex 20 amp receptacles].[All cabinets shall be keyed alike.]

][d. Cabinets, wall-mounted modular type, [16 gauge steel][or][11 gauge aluminum] construction , minimum, treated to resist corrosion. Cabinet shall have have lockable front[and rear] door[s], louvered side panels,[7 cu. m 250 CFM [roof][rack] mounted fan,] ground lug, and top and bottom cable access. Cabinet shall be compatible with [482.6 mm] [584 mm] [19 inches] [23 inches] panel mounting.[All cabinets shall be keyed alike.][A [duplex AC outlet][surge protected power strip with 6 duplex 20 amp receptacles] shall be provided within the cabinet.]

]][2.4.3 Connector Blocks

****

NOTE: Type 66 blocks are not permitted for new construction.

****

Provide insulation displacement connector (IDC) Type 110 for Category 6 systems. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 25 percent spare.

][2.4.4 Cable Guides

****

NOTE: Delete this paragraph for single family residential installations.

****

Provide cable guides specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on[[482.6][584] mm [19][23] inches equipment[racks][cabinets]][and][telecommunications backboards]. Cable guides of ring or bracket type devices[mounted on [rack][cabinet] panels][backboard] for horizontal cable management and individually mounted for vertical cable management. Mount cable guides with screws,[and][or]nuts and lockwashers.

][2.4.5 Patch Panels

Provide ports for the number of horizontal and backbone cables terminated on the panel plus [25][_____] percent spare. Provide pre-connectorized [optical fiber][and][copper] patch cords for patch panels. Provide patch cords, as complete assemblies, with matching connectors as specified.[Provide fiber optic patch cables with crossover orientation in accordance with TIA-568.3]. Patch cords shall meet minimum performance requirements specified in TIA-568.1, TIA-568.2 [and TIA-568.3] for cables, cable length and hardware specified.

2.4.5.1 Modular to 110 Block Patch Panel

****

NOTE: Provide individual patch panels with a maximum of 48 adapter ports per patch panel for Navy projects. Larger patch panel cross-connect fields are more difficult for cable and administrative management. Army projects allow the use of 96 port adapter patch panels.

Wire 8-pin modular ports to T568A configuration unless specifically requested and approved by the authority having jurisdiction.

****

Provide in accordance with TIA-568.1 and TIA-568.2. Panels shall be third party verified[and shall comply with EIA/TIA Category 6 requirements]. Panel shall be constructed of 2.2 mm 0.09 inches minimum aluminum and shall be [cabinet][rack][wall] mounted and compatible with an ECIA EIA/ECA 310-E [482.6 mm] [584 mm] [19 inches] [23 inches] equipment[cabinet][rack]. Panel shall provide [48][_____] non-keyed, 8-pin modular ports, wired to [T568A][T568B]. Patch panels shall terminate the building cabling on Type 110 IDCs and shall utilize a printed circuit board interface. The rear of each panel shall have incoming cable strain-relief and routing guides. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.

[2.4.5.2 Fiber Optic Patch Panel

****

NOTE: Provide individual patch panels and distribution panels with 12 duplex LC, SC or MT-RJ adapters or 24 ST adapters maximum. Larger patch panels are more difficult to manage.

Sleeves are used in adapters to align the fibers and reduce insertion loss. Zirconia ceramic split sleeves are more expensive but provide higher durability than phosphor bronze split sleeves.

Do not use ST or MT-RJ fiber optic adapters and connectors for new construction unless specifically required for interface with existing equipment reused on installations. Check with activity for specific requirements for ST and MT-RJ adapters and connectors.

****

Provide panel for maintenance and cross-connecting of optical fiber cables. Panel shall be constructed of[[16][18] gauge steel][or][11 gauge aluminum] minimum and shall be [cabinet][rack][wall] mounted and compatible with a ECIA EIA/ECA 310-E [482.6 mm] [584 mm] [19 inches] [23 inches] equipment rack. Each panel shall provide [12][_____] [multimode][single-mode] adapters as [duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,] [duplex SC in accordance with TIA/EIA-604-3 with zirconia ceramic][MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic][ST in accordance with TIA/EIA-604-2 with metallic] alignment sleeves. Provide dust cover for unused adapters. The rear of each panel shall have a cable management tray a minimum of 203 mm 8 inches deep with removable cover, incoming cable strain-relief and routing guides. Panels shall have each adapter factory numbered and be equipped with laminated plastic nameplates above each adapter.

]][2.4.6 Optical Fiber Distribution Panel

[Cabinet][Rack][Wall] mounted optical fiber distribution panel (OFDP) shall be constructed in accordance with ECIA EIA/ECA 310-E utilizing[[16][18] gauge steel][or][11 gauge aluminum] minimum. Panel shall be divided into two sections, distribution and user. Distribution section shall have strain relief, routing guides, splice tray and shall be lockable, user section shall have a cover for patch cord protection. Each panel shall provide[[12][_____] multimode][and][[12][_____] single-mode] pigtails and adapters. Provide adapters as [duplex LC with zirconia ceramic] [duplex SC with zirconia ceramic][MT-RJ with thermoplastic][ST with metallic] alignment sleeves. Provide dust covers for adapters. Provide patch cords as specified in the paragraph PATCH PANELS.

]2.5 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

****

NOTE: When a building has elevators, a four-pair copper cable with an eight-position modular outlet adapter shall be installed for each elevator. The exact location of the outlet assembly should be verified with the elevator installer or Contractor.

Conduit bend radius shall be coordinated with cable bend radius. Conduit entries at outlet and junction boxes shall be arranged so that cables passing through the box shall enter and exit at opposite sides of the box. Provide grounding and bonding as required by TIA-607.

Wire 8-pin modular outlet/connectors to T568A configuration unless specifically requested and approved by the authority having jurisdiction. The term RJ-45 refers to 8-pin modular adapters/connectors wired to T568A or T568B configurations. Ensure drawings indicate work area outlet adapter color code functionality if color coding of adapters is a requirement of the project.

****

2.5.1 Outlet/Connector Copper

****

NOTE: Coordinate outlet/connector color with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS.

****

Outlet/connectors shall comply with FCC Part 68, TIA-568.1, and TIA-568.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and shall be third party verified[and shall comply with TIA-568.2 Category 6 requirements].

Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A and T568B wiring. Each outlet/connector shall be wired [T568A][or][T568B][as indicated]. UTP outlet/connectors shall comply with TIA-568.2 for [200] [_____] mating cycles.[UTP outlet/connectors installed in outdoor or marine environments shall be jell-filled type containing an anti-corrosive, memory retaining compound.]

2.5.2 Optical Fiber Adapters(Couplers)

****

NOTE: LC style adapters and connectors are the default standard for new construction due to smaller form factor (size) allowing higher density at both the patch panel and the outlets. However, SC style connectors/adapters are the minimum TIA-568.3 requirement.

Do not use ST or MT-RJ fiber optic adapters and connectors for new construction unless specifically required for interface with existing equipment reused on installations. Check with activity for specific requirements for ST and MT-RJ adapters and connectors.

Sleeves are used in adapters to align the fibers and reduce insertion loss. Zirconia ceramic split sleeves are more expensive but provide higher durability than phosphor bronze split sleeves.

****

Provide optical fiber adapters suitable for[duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,][duplex SC in Accordance with TIA/EIA-604-3 with zirconia ceramic alignment sleeves,] [MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic alignment sleeves,][and][ST in accordance with TIA/EIA-604-2 with metallic alignment sleeves] as indicated. Provide dust cover for adapters. Optical fiber adapters shall comply with TIA-455-21 for [500][_____] mating cycles.

2.5.3 Optical Fiber Connectors

****

NOTE: Do not use ST style connectors for new construction unless specifically required for interface with existing equipment reused on installations. Check with activity for specific requirements for ST connectors. Use bracketed option for crimp style ST type connectors. Select 850 or 1300 nm for multimode fiber optic cable and 1310 or 1550 nm for single-mode fiber optic cable.

****

Provide in accordance with TIA-455-21.[Optical fiber connectors shall be[duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,] [duplex SC in accordance with TIA/EIA-604-3 with zirconia ceramic][MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic][ST in accordance with TIA/EIA-604-2 with metallic] ferrule, epoxyless[crimp style] compatible with[[62.5/125][50/125] multimode][8/125 single-mode] fiber. The connectors shall provide a maximum attenuation of 0.3 dB at[850][1300][1310][1550] nm with less than a 0.2 dB change after 500 mating cycles.]

2.5.4 Cover Plates

****

NOTE: Coordinate cover plate color with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS.

****

Telecommunications cover plates shall comply with UL 514C, and TIA-568.1, [TIA-568.2], [TIA-568.3]; [flush][or][oversized] design constructed of [high impact thermoplastic material [[ivory][white][brown] in color][to match color of receptacle/switch cover plates specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM]][302 stainless material][or][brass material]. Provide labeling in accordance with the paragraph LABELING in this section.

[2.6 MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

****

NOTE: Multi-User Telecommunications Outlet Assemblies (MUTOAs) are termination devices used for open office cabling. The use of multi-user telecommunications outlet assemblies allows horizontal cabling to remain intact when the open office plan is changed. Work area cables originating from the MUTOA should be routed through work area pathways (e.g., furniture pathways). The work area cables shall be connected directly to work station equipment without the use of any additional intermediate connections. MUTOAs should be located in an open office area so that each furniture cluster is served by at least one MUTOA. The MUTOA should be limited to serving a maximum of twelve work areas. Maximum work area cable length requirements shall also be taken into account. Spare capacity should also be considered when sizing the MUTOA.

****

Provide MUTOA(s) in accordance with TIA-568.1.

][2.7 TERMINAL CABINETS

****

NOTE: Install wiring and labeling in Air Force medical facilities in accordance with HEADQUARTERS AIR FORCE MEDICAL SUPPORT AGENCY DESIGN AND IMPLEMENTATION GUIDELINES MEDICAL SYSTEMS INFRASTRUCTURE MODERNIZATION PROGRAM (2001) for Air Force Medical projects. Label other projects in accordance with TIA-606.

****

Construct of zinc-coated sheet steel,[915 by 610 by 150 mm 36 by 24 by 6 inches deep][as indicated]. Trim shall be fitted with hinged door and locking latch. Doors shall be maximum size openings to box interiors.

Boxes shall be provided with 16 mm 5/8 inch backboard with two-coat varnish finish. Match trim, hardware, doors, and finishes with panelboards. Provide label and identification systems for telecommunications wiring and components consistent with TIA-606.

]2.8 GROUNDING AND BONDING PRODUCTS

****

NOTE: Indicate grounding and bonding components and conductor sizes on drawings. Use Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

****

Provide in accordance with UL 467, TIA-607, and NFPA 70. Components shall be identified as required by TIA-606. Provide ground rods, bonding conductors, and grounding busbars as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.9 FIRESTOPPING MATERIAL

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NOTE: Firestopping material requirements are specified in Section 07 84 00 FIRESTOPPING.

****

Provide as specified in Section 07 84 00 FIRESTOPPING.

2.10 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.11 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm 0.125 inches thick, white with [black] [_____] center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm one by 2.5 inches. Lettering shall be a minimum of 6.35 mm 0.25 inches high normal block style.

2.12 TESTS, INSPECTIONS, AND VERIFICATIONS

2.12.1 Factory Reel Tests

Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with TIA-568.1, TIA-568.2, TIA-568.3[, TIA-526-7 for single mode optical fiber][, and TIA-526-14 for multimode optical fiber] cables.

PART 3 EXECUTION

3.1 INSTALLATION

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NOTE: Delete last sentence associated with cabling guides for single family residential installations.

****

Install telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with NECA/BICSI 568, TIA-568.1, TIA-568.2, [TIA-568.3,]TIA-569, NFPA 70, and UL standards as applicable. Provide cabling in a star topology network.[Provide residential cabling in a star wiring architecture from the distribution device as required by TIA-570.] Pathways and outlet boxes shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling.[Cabling shall be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.]

3.1.1 Cabling

****

NOTE: Do not exceed cable manufacturer's specific minimum bend radius or manufacturer's maximum pull tension (tensile) rating.

****

Install [UTP,][and][optical fiber] telecommunications cabling system as detailed in TIA-568.1, [TIA-568.2,] [TIA-568.3][and TIA-570 for residential cabling]. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 110 N 25 pounds pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain unterminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

[3.1.1.1 Open Cable

****

NOTE: Provide cabling in a wireway/raceway pathway system only for Navy projects. Delete bracketed sentences associated with cabling not in wireway and pathway, structural member routing, cable placement and coiling of cables for Navy projects.

****

Use only where specifically indicated on plans for use in cable trays, or below raised floors. Install in accordance with TIA-568.1, TIA-568.2[[and]TIA-568.3]. Do not exceed cable pull tensions recommended by the manufacturer.[Copper cable not in a wireway or pathway shall be suspended a minimum of [200][_____] mm [8][_____] inches above ceilings by cable supports no greater than [1.5][_____] m [60][_____] inches apart. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 300 mm 12 inches shall be maintained when such placement cannot be avoided.]

Plenum cable shall be used where open cables are routed through plenum areas. Cable routed exposed under raised floors shall be plenum rated. Plenum cables shall comply with flammability plenum requirements of NFPA 70. Install cabling after the flooring system has been installed in raised floor areas.[Cable [1.8][_____] meters [6][_____] feet long shall be neatly coiled not less than [300][_____] mm [12][_____] inches in diameter below each feed point in raised floor areas.]

]3.1.1.2 Backbone Cable

a. Copper Backbone Cable. Install intrabuilding backbone copper cable, in indicated pathways, between the campus distributor, located in the telecommunications entrance facility or room, the building distributors and the floor distributors located in telecommunications rooms and telecommunications equipment rooms as indicated on drawings.

b. Optical fiber Backbone Cable. Install intrabuilding backbone optical fiber in indicated pathways. Do not exceed manufacturer's recommended bending radii and pull tension. Prepare cable for pulling by cutting outer jacket 250 mm 10 inches leaving strength members exposed for approximately 250 mm 10 inches. Twist strength members together and attach to pulling eye. Vertical cable support intervals shall be in accordance with manufacturer's recommendations.

3.1.1.3 Horizontal Cabling

Install horizontal cabling as indicated on drawings Do not untwist Category 6 UTP cables more than 12 mm one half inch from the point of termination to maintain cable geometry. Provide slack cable in the form of a figure eight (not a service loop) on each end of the cable, 3 m 10 feet in the telecommunications room, and 304 mm 12 inches in the work area outlet.

3.1.2 Pathway Installations

****

NOTE: Do not use metal flex conduit for telecommunications wiring.

****

Provide in accordance with TIA-569 and NFPA 70. Provide building pathway as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

[3.1.3 Service Entrance Conduit, Overhead

Provide service entrance overhead as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS.

][3.1.4 Service Entrance Conduit, Underground

Provide service entrance underground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

]3.1.5 Cable Tray Installation

Install cable tray as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Only [CMP][and][OFNP] type cable shall be installed in a plenum.

3.1.6 Work Area Outlets

3.1.6.1 Terminations

Terminate UTP cable in accordance with TIA-568.1, TIA-568.2 and wiring configuration as specified.[Terminate fiber optic cables in accordance with TIA-568.3.]

3.1.6.2 Cover Plates

As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

3.1.6.3 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of 304 mm 12 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

3.1.6.4 Pull Cords

Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed.

[3.1.6.5 Multi-User Telecommunications Outlet Assembly (MUTOA)

Run horizontal cable in the ceiling or underneath the floor and terminate each cable on a MUTOA in each individual zone. MUTOAs shall not be located in ceiling spaces, or any obstructed area. MUTOAs shall not be installed in furniture unless that unit of furniture is permanently secured to the building structure. MUTOAs shall be located in an open work area so that each furniture cluster is served by at least one MUTOA. The MUTOA shall be limited to serving a maximum of twelve work areas. Maximum work area cable length requirements shall also be taken into account. MUTOAs must be labeled to include the maximum length of work area cables. MUTOA labeling is in addition to the labeling described in TIA-606, or other applicable cabling administration standards. Work area cables extending from the MUTOA to the work area device must also be uniquely identified and labeled.

]3.1.7 Telecommunications Space Termination

Install termination hardware required for [Category 6][and][optical fiber] system. An insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.

[3.1.7.1 Connector Blocks

Connector blocks shall be [cabinet][rack][wall] mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Install in accordance with industry standard wire routing guides in accordance with TIA-569.

]3.1.7.2 Patch Panels

Patch panels shall be mounted [in equipment [cabinets]][racks][on the plywood backboard] with sufficient ports to accommodate the installed cable plant plus [25][_____] percent spares.

[a. Copper Patch Panel. Copper cable entering a patch panel shall be secured to the panel [with cable ties][as recommended by the manufacturer] to prevent movement of the cable.

][b. Fiber Optic Patch Panel. Fiber optic cable loop shall be [[900][_____] mm [3][_____] feet in length][provided as recommended by the manufacturer]. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

][3.1.7.3 Equipment Support Frames

Install in accordance with TIA-569:

[a. Bracket, wall mounted. Mount bracket to plywood backboard in accordance with manufacturer's recommendations. Mount rack so height of highest panel does not exceed 1980 mm 78 inches above floor.

][b. Racks, floor mounted modular type. Permanently anchor rack to the floor in accordance with manufacturer's recommendations.

][c. Cabinets, freestanding modular type. When cabinets are connected together, remove adjoining side panels for cable routing between cabinets.[Mount rack mounted fan in [roof][base] of cabinet.]

][d. Cabinets, wall-mounted modular type. Mount cabinet to plywood backboard in accordance with manufacturer's recommendations. Mount cabinet so height of highest panel does not exceed 1980 mm 78 inches above floor.

]]3.1.8 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00 FIRESTOPPING.

3.1.9 Grounding and Bonding

Provide in accordance with TIA-607, NFPA 70 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2 LABELING

3.2.1 Labels

****

NOTE: Install and label Air Force medical facilities in accordance with HEADQUARTERS AIR FORCE MEDICAL SUPPORT AGENCY DESIGN AND IMPLEMENTATION GUIDELINES MEDICAL SYSTEMS INFRASTRUCTURE MODERNIZATION PROGRAM (2001). Label other projects in accordance with TIA-606 using a mechanical device for printing.

****

Provide labeling in accordance with TIA-606. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using[thermal ink transfer process][laser printer] [_____].

3.2.2 Cable

Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA-606.

3.2.3 Termination Hardware

Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with TIA-606.

3.3 FIELD APPLIED PAINTING

****

NOTE: Use and coordinate paint and coating requirements with Section 09 90 00 PAINTS AND COATINGS when provided in the job. When requirements are beyond what is specified in Section 09 90 00, specify the requirements in this paragraph.

****

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3.1 Painting Backboards

If backboards are required to be painted, then the manufactured fire retardant backboard must be painted with fire retardant paint, so as not to increase flame spread and smoke density and must be appropriately labeled. Label and fire rating stamp must be unpainted.

3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 TESTING

3.5.1 Telecommunications Cabling Testing

Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568.1, [TIA-568.2], [TIA-568.3]. Test equipment shall conform to TIA-1152. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.

3.5.1.1 Inspection

Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments, and inspect cabling connections to confirm compliance with TIA-568.1, TIA-568.2, [TIA-568.3], [and][TIA-570 for residential cabling]. Visually confirm [Category 6,] marking of outlets, cover plates, outlet/connectors, and patch panels.

3.5.1.2 Verification Tests

UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but prior to being cross-connected.

****

NOTE: Two methods for measuring the installed optical fiber cable plant loss are described in EIA TIA/EIA-526-7 (single-mode cable). Method A uses optical power measurement equipment. Method B uses an Optical Time Domain Reflectometer (OTDR). Method B is not recommended for cable plants containing branching devices and/or isolators. EIA TIA/EIA-526-14A (multimode cable) does not recommend the use of an OTDR for testing. BICSI recommends using Method A for all testing and implementing Method B testing to isolate optical disparities in fiber links that fail Method A testing.

****

[[For multimode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568.3 and TIA-526-14 using [Method A, Optical Power Meter and Light Source] [Method B, OTDR] for multimode optical fiber.][For single-mode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568.3 and TIA-526-7 using [Method A, Optical Power Meter and Light Source][Method B, OTDR] for single-mode optical fiber.]Perform verification acceptance tests.

]3.5.1.3 Performance Tests

Perform testing for each outlet and MUTOA as follows:

[a. Perform Category 6 link tests in accordance with TIA-568.1 and TIA-568.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.

][b. Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with TIA-568.3.

]3.5.1.4 Final Verification Tests

****

NOTE: Use bracketed options for Voice Tests and Data Tests on Navy projects only.

****

Perform verification tests for UTP[and optical fiber] systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

[a. Voice Tests. These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and DSN telephone call.

][b. Data Tests. These tests assume the Information Technology Staff has a network installed and are available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-27 41 00 (November 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 27 - COMMUNICATIONS

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AUDIO-VISUAL SYSTEMS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-27 41 00 (November 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 27 41 00

AUDIO-VISUAL SYSTEMS
11/21

****
Note: This guide specification covers the general requirements for most audio-visual system projects. This specification does not cover detailed, project specific, design requirements. The system designer will need to address these specific requirements in the SYSTEM DESCRIPTION and EQUIPMENT LIST AND SPECIFICATIONS paragraphs and on any related drawings or supplemental documents. An independent system designer may be required for this purpose. In this case, the design process should follow the requirements of ANSI/INFOCOMM 2M-2010 and ANSI/BICSI 001 2017, with the lead system designer having a CTS-D certification.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AUDIOVISUAL AND INTEGRATED EXPERIENCE ASSOCIATION (AVIXA)

ANSI/INFOCOMM 2M	(2010) Standard Guide for Audiovisual Design and Coordination Processes
ANSI/INFOCOMM 10	(2013) Audiovisual Systems Performance Verification
ANSI/INFOCOMM A102.01	(2017) Audio Coverage Uniformity in Listener Areas
AVIXA F502.01	(2018) Rack Building for Audiovisual Systems
AVIXA F502.02	(2020) Rack Design for Audiovisual Systems
INFOCOMM F501.01	(2015) Cable Labeling for Audiovisual Systems

BICSI International Standards Program (BICSI)

ANSI/BICSI 001	(2017) Information and Communication Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities
ANSI/BICSI N1	(2019) Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure
ANSI/BICSI N3	(2020) Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

EXTRON ELECTRONICS (EE)

EE GUI Design Guide	(2020; 4th Edition) Graphical User Interface Design Guide

MIDDLE ATLANTIC PRODUCTS (MA)

MA Whitepaper	(2018) Controlling the Temperature Inside Equipment Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.0	(2020e) Generic Telecommunications Cabling for Customer Premises
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2024e) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2022e) Optical Fiber Cabling Components Standard
TIA-568.4	(2022e) Broadband Coaxial Cabling and Components Standard
TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

U.S. Code (USC)

19 USC 13	Trade Agreements Act of 1979
41 USC 83	Buy American Act

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8100.04	(2010) DOD Unified Capabilities (UC)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

UL SOLUTIONS (UL)

UL 2043	(2023) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 62368-1	(2019) UL Standard for Audio/Video, Information, and Communication Technology Equipment - Part 1: Safety Requirements

1.2 RELATED DOCUMENTS

a. Drawings and general provisions of the Contract including General and Supplementary Conditions and UFGS Division 01 Specification Sections.

b. UFGS Division 26 Specification for Communications cabling, cabling pathways, termination and physical mounting of cable hangers and cable trays.

c. UFGS Division 26 Specification Sections for room lighting fixtures, dimmers, power receptacle outlets, and interconnecting wiring for these circuits.

d. UFGS Division 27 Specification Sections for all telecommunications requirements - including LAN connections, analog and digital telephone lines, digital data circuits, high speed internet access and building horizontal cabling.

e. Section 27 05 13.43 TELEVISION DISTRIBUTION SYSTEM for CATV Systems.

f. Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

g. UFGS Division 23 Specification Sections for Heating, Ventilation and Air Conditioning.

h. Audiovisual drawings and equipment lists.

i. If system design services are required, provide designs in accordance with ANSI/INFOCOMM 2M and ANSI/BICSI 001.

1.3 SCOPE OF WORK

****

NOTE: Delete items i., j., and k. below if not included in the Scope of Work.

****

This Specification Section outlines the minimum requirements and installation methods for the integrated audiovisual System, hardware, software, cables, accessories, and acceptance testing. System refers to the complete and functional assemblage of equipment required to achieve the specified functionality, performance, and design intent. This includes but is not limited to:

a. Audio equipment: Speakers, mixers, amplifiers, microphones, signal processing equipment, and source equipment.

b. Video equipment: Displays, signal routing and processing equipment, and source equipment.

c. Video projection screens

d. Remote control equipment including touch panels, control processors, software, and programming.

e. Equipment racks and associated hardware such as rack screws, power distribution products, cooling products, and blank panels.

f. Cables, snakes, connectors, plates, and wiring.

g. Other similar parts that may be required for normal operation such as projector bulbs and lenses.

h. Mounts, rigging, and required hardware such as all-thread, unistrut, chains, and cables.

[i. Floor boxes

][j. Display wall boxes

][k. AV lecterns and credenzas

] l. System commissioning

m. Training

n. Documentation

o. Communication and coordination with all team members and trades to fulfill the requirements of this Specification.

1.4 EXCLUDED SCOPE OF WORK

****

NOTE: Delete items c., d., and e. below if included in the paragraph SCOPE OF WORK.

****

a. Cutting and patching

b. Painting, refinishing and finishes

[c. Floor boxes

][d. Display wall boxes

][e. AV lecterns and credenzas

] f. Work specified in other UFGS Specification Sections.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications; G

Bid Pricing; G

SD-02 Shop Drawings

Shop Drawings; G

SD-09 Manufacturer's Field Reports

Status Reports and Meeting Minutes; G

SD-10 Operation and Maintenance Data

Record Drawings; G

Operation and Maintenance (O&M) Manuals, G

1.6 CYBERSECURITY

****

NOTE: Coordinate any audio-video networking requirements with facility needs and cybersecurity requirements.

****

Coordinate any network security requirements related to this Specification in accordance with Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

1.7 QUALIFICATIONS

1.7.1 General

a. Comply with all UFGS Division 1 (General Requirements) standards to include Section 01 14 00 WORK RESTRICTIONS.

b. The Government reserves the right to accept or reject the System Contractor or Manufacturer based upon qualifications and ability to conform to specified technical or licensing requirements of this Section. System Contractors, Installers and Manufacturers that do not have the specified qualifications will not be acceptable and will not be allowed to perform the work of this Section.

c. The Government will determine the acceptability of any proposed System Contractor, Installer and Manufacturer based on submitted and verified documentation that substantiates that the proposed System Contractor, Installer and Manufacturer have the qualifications specified in this Section.

d. Submit documented verification of the specified qualifications as part of the Data Qualifications submittal. The Government maintains the right to request, inspect and verify references and resumes of all technical and managerial personnel assigned to the project.

1.7.2 System Contractor Qualifications

The System Contractor must:

a. Be licensed in the project jurisdiction as required to perform the work included in this Specification.

b. Be regularly engaged in the system application design, documentation, installation, testing, training, and maintenance of the type of system specified in this Section.

c. Have a minimum of five [_____] years of experience providing these services for systems having the same level of features and functions as the system being provided.

d. Submit [five] [_____] references with contact names and valid telephone numbers regarding similar projects successfully completed within the last [3] [_____] years.

e. Be capable of providing manufacturer-specified installation, programming, training, maintenance, and repair for all equipment provided.

f. Have an office within a [120] [_____] mile radius of the project site that can provide all specified service and support.

g. Be responsible for any required low voltage permits.

h. Use a Project Manager with a [CTS] [CTS-I] [CTS-D] [RCDD] [RTPM] [PMP] [_____] certification.

i. Use a Lead Installer with a [CTS] [CTS-I] [CTS-D] [RCDD] [_____] certification.

j. Use a Control System and Digital Signal Processor (DSP) Programmer certified by the manufacturer(s) of the product(s) used in the project.

k. Submit names and resumes of key personnel that will be assigned to the project. As a minimum, these personnel must include the Project Salesman, Project Manager, Lead Installer, Control System Programmer, and Digital Signal Processor Programmer. The same person may be utilized for multiple project responsibilities. Once approved, these personnel are expected to work on the project through the duration. Any replacement personnel must be approved by the Contracting Officer. The approved Lead Installer, Control System Programmer, and Digital Signal Processor Programmer must be present during system commissioning.

1.7.3 Manufacturer Qualifications

Each product manufacturer must:

a. Have a minimum of [5] [_____] years' experience in producing the products and type of system included in this Specification Section.

b. Guarantee the availability of the replacement parts for the designed system for a minimum of [3] [_____] years from the date of final acceptance of the system by the Contracting Officer.

1.8 BID PRICING

****

NOTE: Remove this paragraph if the project does not require bid pricing to be submitted.

****

Submit the following in conjunction with the System Contractor Qualifications information:

a. Complete and accurate listing of all equipment to be used in assembling the system(s).

b. Itemized pricing for all equipment. Include sales tax where applicable.

c. Itemized costs for all pertinent labor/installation categories.

d. Itemized costs for any optional items such as Add/Deduct Alternates and Extended Warranties.

[e. Any proposed Handing and Administration Rates (HAR) are not to exceed 5 percent. This fee will account for all administrative costs, overhead, bonding fees, administration of subcontracts, profit, and any other costs associated with and related to the coordination and processing of the procurement and installation of the equipment. The proposed HAR percentage will be incorporated into the contract award and will not be adjusted regardless of fluctuations from the estimate amount for the FF&E. The proposed HAR is a fixed rate.

]1.9 SHOP DRAWINGS

Submit the following prior to the purchase, assembly, or installation of any equipment:

a. Drawing Index and Title Page.

b. Symbols Legend showing all devices, cable types, labelling scheme and any other information required to decipher symbols in the submittal package.

c. Floor Plans, Reflected Ceiling Plans, and Sectional View drawings as required to completely document all devices, dimensional locations, and infrastructure requirements.

d. System wiring diagrams showing make and model of equipment, logical wire traces, cable types, and any other identifying labels for wiring or ancillary devices.

e. Rack Elevations showing rack identifiers, equipment location within each rack, per-outlet power distribution details, and any rack accessories.

f. Plate and Panel drawings showing connections, size, finish, color, engraving, and any other information required to document fit and finish of wall plates or floor boxes.

g. Riser drawings showing cable routing between wall plates, floor boxes, ceiling devices, racks, and any other devices as required.

h. Additional drawings as required -including but not limited to custom furniture and millwork, custom display details and equipment mounting.

i. Patch Panel and/or Network Switch Layouts that show port numbering schemes and IP information as required.

j. Product data sheets for equipment and cabling, organized logically by system type and indexed for reference. Any parts used but not approved may be rejected at any time.

k. Material samples as required.

l. Project schedule including key milestones including but not limited to submittal packages, material procurement, rack fabrication and shop testing, installation milestones as applicable, acceptance testing, and completion.

m. Images of proposed touch panel layouts, with functional descriptions of buttons and pages. The Contractor will make up to two iterative edits based on comments from the Contracting Officer at no additional cost.

1.10 STATUS REPORTS AND MEETING MINUTES

a. Provide [weekly] [daily] status reports outlining progress on the project to the Contracting Officer. These reports must include information on the work completed during the [week] [day], the work to be completed during the upcoming [week] [day] and any potential scheduling issues.

b. Provide minutes for any meetings directly related to this project. Minutes are to be completed within one [week] [day] of the meeting.

1.11 DELIVERY, STORAGE, AND HANDLING

a. All costs for shipping to the site, and of any unusual storage requirements, are to be a part of this Specification.

b. Make appropriate arrangements, and coordinate with authorized personnel at the site, for the proper acceptance, handling, protection, and storage of equipment so delivered.

c. Until site conditions are ready for installation of the AV equipment, some AV equipment must be received and stored offsite in suitable environmental conditions for sensitive electronic equipment. This equipment must be made available to the Government for inspection as required.

PART 2 PRODUCTS

2.1 GENERAL

a. All materials must be new, free from defects and not less than the quality specified. Materials must be designed to ensure satisfactory operation and operational life in the environmental conditions which will prevail where they are being installed.

b. At the time of submittal, supply the latest model for each piece of equipment.

c. All products used must be manufactured no more than one year prior to installation.

d. All products must be provided with the latest version of all software/firmware.

e. All equipment must be UL 62368-1 or equivalent listed or industry standard and comply with the NEC NFPA 70.

f. Equipment installed in air handling spaces must be UL 2043 listed

g. Where indicated as relevant to this project, all equipment must be 19 USC 13 compliant, 41 USC 83 compliant, and approved prior to purchase.

h. Where indicated as relevant to this project, all equipment must be DISA compliant and on the DODI 8100.04 DoDIN Approved Products List.

i. No Substitutions or Variances are allowed without the written consent of the Contracting Officer or their approved representative.

j. Substitute equipment must meet or exceed the performance specifications of the basis of design equipment and be at no additional cost.

k. Substitute equipment must not impact the existing architectural, mechanical or electrical designs.

l. Submit equipment pricing based on the specified equipment herein. Any substitute equipment or new proposed equipment necessary to fulfill the design intent, must be clearly categorized and priced individually on a separate page as an alternate to the specified equipment. Pricing for the original specified equipment must still be provided.

[2.2 SPARE PARTS

****

NOTE: Remove this paragraph if not applicable to the project. If applicable, the system designer must update this paragraph based on the actual project requirements.

****

Provide spare parts/attic stock as identified below:

a. XLRM to XLRF microphone cable, 7.6 meter 25-foot, black. QTY. 2

b. Cat6 patch cable, 0.9 meter 3-foot, white. QTY.6

c. Rechargeable battery for wireless microphone. QTY. 2

]2.3 SYSTEM DESCRIPTION

****

NOTE: The system designer must update this paragraph based on the actual project requirements. This sample paragraph is based on the design used in the Technical Paper.

****

2.3.1 Large Conference Room

a. A wall-mounted flat panel display is required for local presentations and video conferencing. The display will be sized to allow appropriate viewing from the furthest point at the conference table based on mixed media (video and graphics) content and basic decision-making calculations. The display will include a tilting wall mount. An in-wall storage box will be located behind the display to recess a surge protection AC power outlet and any accessory devices.

b. Sources to the display will include an in-house CATV feed (provided and installed by others), a Government provided room computer located in the credenza, a wired laptop input at the credenza (with both HDMI and VGA connections), and a wireless presentation device.

c. The Government provided computer will include a wireless keyboard and mouse and will be configured with software as required to allow web conferencing.

d. The wireless presentation device will allow connectivity from Windows, Android, OSX and iOS devices. It will also be used for basic digital signage and emergency notifications.

e. A high definition (1080P) USB web camera with pan/tilt/zoom capability will be provided to allow capture of room participants seated at the conference table. The camera will allow all seated participants to be viewed at once or allow along with the ability to zoom in on individual participants or smaller groups of participants. The output of the camera will be extended to the room computer.

f. Pendant ceiling microphones will be located above the conference table to capture participant voices from a seated position at the conference table. The microphones will include tracking technology to allow them to focus on participants speaking. These microphones will feed the room PC (via a USB interface) for web conferencing. Local voice reinforcement is not required.

g. Ceiling speakers will be provided for program audio playback.

h. The room will also include integrated VoIP audio conferencing using the built-in room microphones and speakers. VoIP service will be provided by others.

i. A wireless touch screen, with a docking station at the credenza, will be provided for room control. Refer to paragraph REMOTE CONTROL SYSTEM PROGRAMMING for control system functionality. The system will interface with the room lights and shades if programmable lighting and shading systems are provided.

j. A room scheduling panel will be located outside of the room. This panel will be PoE powered and connect to the Government LAN. It will interface with Office 365 to allow scheduling of the room through a standard Outlook Calendar invitation. Coordinate the configuration of this touch panel with the Contracting Officer. The panel will include indicator lights that turn from green to red when the room becomes unavailable.

k. Rack mounted equipment will be installed in a small cabinet in the room credenza. The rack and credenza will be designed to allow adequate ventilation.

2.4 EQUIPMENT LIST AND SPECIFICATIONS

****

NOTE: The system designer must update this paragraph based on the actual project requirements. This list should include all required types, and quantities of equipment by room, along with their pertinent specifications. For ease of formatting and overall management of the large number of products that may be specified, it is recommended that this equipment list be prepared as a separate spreadsheet and inserted into this Specification as an Attachment or included on the design drawings. See example based on the Conference Room document in the Technical Paper.

****

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with the details of the work and working conditions, verify dimensions and equipment locations in the field, and advise the Contracting Officer of any discrepancies before performing the work.

3.2 GENERAL INSTALLATION STANDARDS

a. Coordinate the installation of all equipment, wiring, and associated hardware to be compatible with the work of other trades and with the overall construction completion schedule. Coordinate all access and work with the Government in advance.

b. Protect all finishes, furniture, and equipment, and maintain a clean work environment while working and when finished each day.

c. Perform installation in strict accordance with AVIXA standards and best practices, general industry standards and best practices, the National Electrical Code, and any other governing codes.

d. Keep a complete and accurate set of installation drawings at the job site. Note any changes made during installation on the drawings. Include a final set of as-built drawings with the Operation and Maintenance manuals.

e. Install all equipment following the manufacturers' recommendations and broadcast standards. Adjust and test to assure that all components are functioning properly by themselves and in conjunction with their associated components.

f. Install all equipment in appropriate cabinets or consoles at the locations designated in this document or on the associated contract drawings.

g. Apply no advertising to racks, equipment, and accessories. Where possible, [and requested by the Contracting Officer,] remove all visible manufacturer name badges from equipment mounted in public areas.

h. Cleanup and dispose of all waste materials daily. Wherever possible, materials must be properly recycled.

3.3 MOUNTING, RIGGING AND SEISMIC RESTRAINT

a. Design and build equipment racks in accordance with AVIXA F502.01, AVIXA F502.02, and ECIA EIA/ECA 310-E.

b. Mount equipment in accordance with 36 CFR 1191.

c. Securely fasten all equipment in place unless requirements of portability dictate otherwise. Fastenings and supports must be adequate to support their loads with a safety factor of at least five.

d. Provide seismic protection, including supports and hangers, as required by applicable code.

e. Install all boxes and equipment plumb and square per the manufacturer's recommended mounting practice.

f. Securely fasten and support all equipment without hindering equipment operation.

g. Provide shaft locks or security covers on all non-user-operated equipment having front panel controls.

h. Provide structural/rigging calculations for mounting equipment more than [227 Kilograms] [500 pounds] [_____]. Mounting details may require review and approval by the project's Structural Engineer.

i. Equipment racks will be designed to ensure proper thermal management. Maximum constant operating temperature of equipment should not exceed 85 degrees Fahrenheit. Where cooling fans are provided in racks located in sensitive areas, select fans to minimize the noise impact in the area. Refer to MA Whitepaper.

3.4 GROUNDING AND SHIELDING

a. Install grounding in accordance with NFPA 70, TIA-607, ANSI/BICSI N3 and all Division 26 Specification Sections.

b. As a minimum, provide individual equipment racks with a rack grounding stud or bus bar and a #12 stranded (minimum) bonding jumper connected to the grounding and bonding stud on the primary power distribution unit that is plugged into the power receptacle serving the rack. Isolate the rack from the floor with plastic or rubber wheels/leveling feet.

c. Verify the integrity of grounding systems prior to connection of equipment.

3.5 GENERAL WIRING STANDARDS

a. Provide, install, terminate, and test all cabling in accordance with TIA-568.0, TIA-568.1, TIA-568.2, TIA-568.3, TIA-568.4, TIA-569, ANSI/BICSI N1, AVIXA F502.01, AVIXA F502.02 and other industry best practices.

b. All wiring runs must be unspliced where possible. Splices are not permitted in conduit, outside of listed splice boxes.

c. Cable routed in conduits or equipment racks to have non-plenum (PVC) rated jacket. All other cables to have a plenum rated jacket.

d. Cables routed above ceilings must be suspended above the ceiling tiles in J-hooks or cable tray.

e. Provide outdoor-rated, direct burial, or other similar specialty rated cable types where required based on installation conditions and applicable codes.

f. The following denotes the most common cabling types and the minimum performance requirements. The Contractor is required to verify all cabling specifications based on the actual equipment provided.

(1) Microphone and Line Audio Cable:

    (a) 22 AWG (7x30) stranded twisted shielded pair with overall shield
    (b) Nominal Capacitance (Conductor to Conductor): less than or equal to 35 pF/ft
    (c) Nominal Capacitance (Conductor to Conductor and Shield): less than or equal to 67 pF/ft

(2) Low Impedance Loudspeaker Cable:

    (a) 14 AWG (19x27) stranded twisted pair
    (b) Nominal Capacitance (Conductor to Conductor): less than or equal to 36 pF/ft

(3) Low Impedance Loudspeaker Cable:

    (a) 12 AWG (19x25) stranded twisted pair
    (b) Nominal Capacitance (Conductor to Conductor): less than or equal to 36 pF/ft

(4) Low or High Impedance Loudspeaker Cable

    (a) 16 AWG (19x29) stranded pair
    (b) Nominal Capacitance (Conductor to Conductor): less than or equal to 36.5 pF/ft

(5) High Impedance Loudspeaker Cable (70V / 100V)

    (a) 18 AWG (7x26) stranded pair
    (b) Nominal Capacitance (Conductor to Conductor): less than or equal to 34 pF/ft

(6) Antenna Cables - RG58 - Wireless Microphone and Assisted Listening

    (a) 50 ohm RG-58 19 AWG solid center conductor
    (b) Nominal Capacitance (Conductor to Shield): less than or equal to 27 pF/ft
    (c) Nominal Attenuation at 900MHz: less than or equal to 12.5 dB/100 ft

(7) Antenna Cables - RG213 - Wireless Microphone and Assisted Listening

    (a) 50 ohm RG-213 13 AWG solid center conductor
    (b) Nominal Capacitance (Conductor to Shield): less than or equal to 31 pF/ft
    (c) Nominal Attenuation at 900MHz: less than or equal to 6.5 dB/100 ft

(8) Antenna Cables - RG8/U - Wireless Microphone and Assisted Listening

    (a) 50 ohm RG-8/U 10 AWG solid center conductor

    (b) Nominal Capacitance (Conductor to Shield): less than or equal to 25 pF/ft

    (c) Nominal Attenuation at 900MHz: less than or equal to 4 dB/100 ft

(9) Video Tie Line Cable:

    (a) RG59/U coaxial cable 20 AWG solid bare copper

    (b) Nominal Capacitance (Conductor to Shield): less than or equal to 16.5 pF/ft

    (c) Nominal Attenuation at 3000MHz: less than or equal to 22 dB/100 ft

(10) Video Tie Line Cable:

    (a) RG6/U coaxial cable 18 AWG solid bare copper

    (b) Nominal Capacitance (Conductor to Shield): less than or equal to 16.5 pF/ft

    (c) Nominal Attenuation at 3000MHz: less than or equal to 18 dB/100 ft

(11) Video Tie Line Cable:

    (a) RG11/U coaxial cable 14 AWG solid bare copper

    (b) Nominal Capacitance (Conductor to Shield): less than or equal to 16.5 pF/ft

    (c) Nominal Attenuation at 3000MHz: less than or equal to 10.5 dB/100 ft

(12) Video Tie Line Cable Five (5) Conductor - Mini High-Res:

    (a) 5 x 26 AWG coaxial cable with overall jacket

    (b) Nominal Capacitance (Conductor to Shield): less than or equal to 17 pF/ft

    (c) Nominal Attenuation at 1000MHz: less than or equal to 21.5 dB/100 ft

(13) Video Tie Line Cable Five (5) Conductor - RG59:

    (a) 5 x 24 AWG coaxial cable with overall jacket

    (b) Nominal Capacitance (Conductor to Shield): less than or equal to 17.5 pF/ft

    (c) Nominal Attenuation at 1000MHz: less than or equal to 13.5 dB/100 ft

(14) Digital Video SUTP Tie Line Cable

    (a) 4 x 26 AWG solid bare copper, shielded twisted pair

    (b) Nominal Capacitance (Conductor to Shield): less than or equal to 25 pF/ft

    (c) Nominal Attenuation at 500MHz: less than or equal to 20.5 dB/100 ft

(15) Data Tie Line Cable:

    (a) Refer to telecommunications specifications for project-standard data cabling information.

(16) RS-232 Control Cable

    (a) 22 AWG (7X30) Two pair twisted, individually shielded with drain wire

    (b) Nominal Capacitance (Conductor to Conductor): less than or equal to 17 pF/ft

(17) Specialty Control Cable - AXLINK, CRESNET:

    (a) 22 AWG (7X30) shielded twisted pair with drain wire and 18 AWG unshielded pair in single jacket

    (b) Nominal Capacitance (Conductor to Conductor): less than or equal to 14 pF/ft

(18) Multimode Optical Fiber:

    (a) 50/125 micron as required per transmission equipment manufacturer recommendation. If transmission equipment does not support 50/125 micron, 62.5/125 micron shall be permitted.

    (b) Strand count per functional drawings; minimum of two strands for each run outside the main equipment cabinet.

    (c) Shall support 10Gbps transmission speed for length of run

    (d) Each optical fiber strand shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification and all TIA-568.3 performance parameters.

(19) Single-Mode Optical Fiber:

    (a) 8.3/125 micron

    (b) Each optical fiber strand shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification and all TIA-568.3 performance parameters.

(20) Unshielded Ethernet:

    (a) 4Px24 AWG UTP

(b) Cat6 with a minimum TIA-568.2 standard rating

(21) Shielded Ethernet:

(a) 4Px24 AWG STP

(b) Cat6 with a minimum TIA-568.2 standard rating

g. Use digital video cable as specified by the product manufacturer to obtain a signal at the maximum capable system resolution (minimum 1080P, 60Hz) that is free from all artifacts at each display from each source location. Use shielded cabling and connectors as required. Where multiple cabling options are provided by a manufacturer, use the option resulting in the greatest performance.

h. All Category cabling and connectors are to be rated at CAT6 or greater with a minimum TIA-568.2 standard rating.

i. All Category cabling and connectors to be terminated to the T568A standard unless otherwise required.

j. Use color-coded ruggedized and lockable (Neutrik EtherCON or similar) shielded panel connectors and shielded inline connectors for all Contractor provided signal distribution equipment that requires RJ-45 style connectors at wall panel or floor box panel connections, except for those connecting a piece of AV equipment to the LAN. Maintain all cable shielding as required.

k. Each digital AV over RJ-45 receptacle, permanently installed cable, equipment cord, and patch panel will be of a color or have markings that are non-standard with the voice/data system, and be plainly and permanently labeled "AV Only".

l. Arrange, route, and isolate wiring according to signal level to minimize crosstalk, hum, or spurious signals. Wiring categories must consist of: microphone level (minus 80 dBm to minus 20 dBm), line level (minus 20 dBm to plus 30 dBm), loudspeaker level (plus 30 dBm and above), AC power, and DC control or emergency power.

m. Select cable color according to signal type. Submit color scheme to Contracting Officer for approval as a part of the Shop Drawing submission package.

n. Install all cabling in an orderly and professional manner. Provide service loops to allow access to the rear of equipment.

3.6 LABELING

a. Label all cables and equipment in accordance with TIA-606 and INFOCOMM F501.01.

b. Use white labeling with black text unless requested otherwise by the Contracting Officer.

c. Provide the wire run list as an Excel spreadsheet and include as a part of the Operation and Maintenance Manuals.

d. Clearly and logically label external devices such as audio mixers, wireless microphones, belt packs, and assistive listening receivers.

e. Label relevant inputs and outputs on switchers, matrices, and mixers. This includes digital/virtual labelling of audio channels and video inputs and outputs.

f. Label telephone numbers, ISDN numbers and IP addresses of pertinent devices.

g. Label cabling wherever it is exposed in junction or pull boxes.

3.7 REMOTE CONTROL SYSTEM PROGRAMMING

a. Design graphical user interfaces in accordance with industry standards such as noted in EE GUI Design Guide.

b. As a minimum, the remote-control systems (where provided) will be programmed for the following general functionality as appropriate for each room:

(1) Power sequencer: Rack power on/off.

(2) Projection screen: Up/down. Screen must automatically lower when the projector is turned on and automatically raise when the projector is turned off.

(3) Projector lift: Up/down. Provide the following lift preset positions: projector off (fully up), show position (projector in normal operating position), and service position (fully down).

(4) Displays: Power on/off, input source select, video mute, lamp life monitoring. Automatic power on when a source is selected for display.

(5) Video matrices: Source routing.

(6) Video cameras: Pan/tilt/zoom, preset store and select.

(7) CATV/Satellite TV tuner: Manual channel select, preset channel store and recall.

(8) Media player: Standard transport and menu controls.

(9) Recorder: Standard transport and menu controls, record source select.

(10) Audio matrix: Dialing, privacy, local and remote volume up/down/mute, pick up/hang up.

(11) Video codec: Dialing, privacy, volume up/down/mute, pick up/hang up, camera controls, menu navigation, source send select.

c. Where all room video sources are portable, use video sync sensing to automatically power on the room display system upon connection of a video source and automatically power off the display upon disconnection of a video source.

d. Provide separate Program and Microphone audio level controls with mute function. Include a technician's page with access to individual microphone level controls. Include a preset button to recall default levels.

****

NOTE: If the Audiovisual system is not monitored, item e. can be deleted.

****

[e. UPS: System monitoring. Provide a technician page for the monitoring of the UPS. Feedback will be provided to monitor the following conditions as available by the UPS: Utility Voltage, Output Voltage, Current Load, Load Percentage, Wattage Load, Battery Capacity, Battery Voltage, Remaining Battery Time, Remaining Charging Time, and Cabinet Temperature. Provide alerts for the detection of any system faults, warnings, or abnormal conditions as available.

] f. Lighting system: Preset 1-4 recall, all lights on, all lights off, individual lighting zone raise/lower, all lights raise/lower.

g. Shades: Open, close, stop. Provide individual controls for each shade zone and type (such as sun control and blackout).

[h. Room combining: In room combined mode, all video sources must be made available to all video destinations and all microphone sources must be made available to all audio destinations. The audio from the last routed video source is to become the local program audio source. One control system touch panel is to become the master (or multiple touch panels can track together). In rooms with operable partition sensors, use the sensors to automatically recall the room combination presets.

][i. In the absence of pre-defined touch panel templates, propose draft touch panel pages for review and approval by the Government prior to programming. A minimum of one meeting must be provided to present these pages. Provide modifications as necessary based on comments resulting from the meeting.

]

****

NOTE: Powering off an Audiovisual system may not be recommended in certain applications. If not desired, item j. can be removed.

****

[j. Program the control system to automatically power down the AV systems each day at a time specified by the Contracting Officer. Fully power off (or place in stand-by mode) all non-critical equipment.

] k. Where applicable, provide web browser-based control of each room in addition to the room touch panels.

l. Coordinate all required control system LAN settings with the Contracting Officer.

m. Include [eight] [_____] hours of additional programming time as a part of this Specification for any requested control system modifications after initial system acceptance but prior to the expiration of the warranty period.

3.8 SYSTEM TESTING AND ADJUSTMENT

a. Perform in accordance with ANSI/INFOCOMM 10.

b. Demonstrate that all audio system coverage is in accordance with ANSI/INFOCOMM A102.01.

c. Demonstrate that the entire scope of work defined is complete and fully functional per the scope of this specification and drawings, as well as any additional approved modifications and revisions.

d. Prior to conducting Commissioning with the Government, complete an internal quality review including a minimum of the following:

   (1) Verify that all equipment has been delivered and installed per specifications. Provide a detailed equipment list sorted by room number and rack complete with make, model and serial number.

   (2) Verify that all other trades have completed the work associated with the functioning of the audiovisual systems and that any installed third-party devices such as screens, shades, and lights work properly with the AV systems.

   (3) Power on all equipment and verify the intended functions.

   (4) Verify signal paths and cable continuity/integrity for all field terminated wiring.

   (5) Adjust and align all displays for color, contrast, and geometry.

   (6) Verify all communications services such as POTS, ISDN, and Ethernet.

   (7) Configure and test the functionality of all audio and video conferencing systems.

   (8) Load and test all DSP and control system software and provide button by button testing of all control system touch panels.

e. Provide documentation to the Contracting Officer that the systems are substantially complete at least [one week] [_____] in advance of Commissioning with the Government.

3.9 TEST EQUIPMENT

Provide all test equipment and test materials relative to the scope of the project to include legal copies of all source media in all appropriate formats and blank recordable media in all appropriate formats.

3.10 COMMISSIONING

a. Perform in accordance with ANSI/INFOCOMM 10.

b. After preliminary system installation and adjustment, conduct a Commissioning Test with representatives from the Government present.

c. Schedule testing to ensure the availability of all required personnel and rooms.

d. During the commissioning, demonstrate the operation of each individual piece of equipment in the system, and the system as a whole. Also demonstrate that equipment functions according to manufacturer's specifications, industry standards, and as stated in this Specification.

e. This demonstration must include a minimum of the following:

   (1) A physical inventory of all equipment

   (2) An evaluation of general workmanship and construction quality

   (3) A mechanical check of all system components

   (4) The physical operation of all system equipment (audio, video, control, and network) including button-by-button control system testing

   (5) The placement of audio and video test calls

3.11 SYSTEM TRAINING AND OPERATION ASSISTANCE

a. Conduct a training program for a nominal [_____] staff members as designated by the Contracting Officer to instruct on overall system and individual equipment operation, basic preventative maintenance, and basic system troubleshooting. Provide a nominal [____] hours of training which may be scheduled at the Government's request at any time up to one year following system acceptance.

b. The training program will include a minimum of two [video recorded] sessions. The first session must occur immediately after the acceptance of the systems and cover the basic operation of each system. Provide the second training session within [_____] weeks from the first session. The operation and maintenance manuals for the equipment must be completed and presented at this time. This training session will be used to train additional people and/or to answer questions/resolve issues developed within the first weeks of system use.

c. Notify the Contracting Officer at least [14] [_____] days prior to the start of each course.

3.12 RECORD DRAWINGS

a. Submit as-built documentation upon completion, including but not limited to, the following:

   (1) All information contained in the Shop Drawings submittal package as detailed above and edited to reflect final conditions.

   (2) Documentation of equipment serial numbers and network/phone/ISDN addressing scheme.

   (3) Software files for touch panel interfaces, source code, DSP, and equipment settings, both compiled and un-compiled code for future system modification.

   (4) Manufacturer product guides and instruction manuals

   (5) Warranty information and product registration as applicable.

3.13 OPERATION AND MAINTENANCE (O&M) MANUALS

a. As-built documentation must also contain a custom-generated system operation guide that details the proper setup and usage of each system in all its normal functions and common usage scenarios as defined by the Contracting Officer. This "Step-by-Step" operation guide must contain information such as a general description of the overall system(s), instructions for general system operation such as turning the system on and off, selecting various video sources for display, routing various audio sources to the speaker systems, setting up audio bridge calls, room combining, making VTC calls, using camera presets, etc. The intent is for this manual to provide simple "how-to" instructions on operating the system. This manual must also be a supplement to the system training specified above.

b. The operations guide must include screen captures of each touch panel page (where applicable) with descriptions of the functionality of each button.

c. Submit revisions of manuals that include changes based on feedback from prior training sessions, other government comments, errors in documentation, or any altered control interface programming prior to the second training session.

d. Complete the operation guide prior to the second training session system and use it for the training.

e. Post one copy of system specific equipment interconnection drawings (laminated or in a plastic bag to prevent damage) inside the front or rear door of the main equipment for each individual audiovisual system.

f. All control system software will become the property of the Government and the Government will have the right to make any desired modifications after the expiration of the system warranty.

g. At the end of the warranty period, provide an updated copy of the above to account for any modifications that may have occurred during the warranty period.

3.14 WARRANTY AND MAINTENANCE

a. Guarantee the system for a period of [one] [_____] year[s] from the date of final system acceptance against defective materials, design, workmanship, and improper adjustment. Repair or replace any defective material at no expense to the Government. During the warranty period, respond to any service calls within [24] [_____] hours [excluding Saturdays, Sundays, and holidays]. Where possible, provide substitute equipment to maintain system operation during repair.

b. Provide [two] [_____] service calls after the acceptance of the system at months [six] [_____] and [12] [_____] to perform routine system maintenance and adjustment.

c. The above warranty must not void warranties issued by individual equipment manufacturers. Individual warranties valid for greater than one year must remain in full effect.

d. The above warranty must not void any rights guaranteed by law to the Government.

e. The above warranty does not pertain to Government provided equipment.

[3.15 LIVE SUPPORT

Provide [one] [_____] service technician for [eight] [_____] man-hours starting on the first scheduled use date. For a period of [one] [_____] week(s) after this period, provide necessary support to ensure a [two] [_____]-hour response time for issues that arise.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-27 51 16 (May 2020)**
Change 1 - 05/22

Preparing Activity: USACE **Superseding**
UFGS-27 51 16 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC | **UFGS-27 51 16 (May 2020)**
Change 1 - 05/22

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UFGS-27 51 16 (April 2006)

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****

SECTION 27 51 16

PUBLIC ADDRESS SYSTEMS

05/20, CHG 1: 05/22

****

NOTE: This guide specification covers the requirements for public address systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification is to be used in conjunction with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

If there is a requirement to integrate a Personnel Alerting System (to alert building occupants of eminent threat) to the PA system, assure that the necessary inputs and interfaces are included in this specification.

****

1.1 RELATED SECTIONS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

[Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.]
[Section 07 84 00 FIRESTOPPING for additional work related to firestopping.]

[1.2 SUMMARY

****

NOTE: This paragraph is intended to be used when a perfomance based IP Networked Public Address System is used where the contractor is responsible for design of the system. Include SUMMARY paragraph and all sub-paragraphs only if specification includes IP Networked Public Address System.

****

1.2.1 Scope

****

NOTE: Modify scope to clearly include desired capabilities of the public address system.

****

a. This work includes design and providing a new, complete, public address system as [required and as]described herein for the [building name]. Provide a turnkey system capable of receiving, processing, and transmitting indicated input signals including the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, amplifiers, microphones, speakers, mounting hardware and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide system[s] complete and ready for operation. See paragraph titled SYSTEM DESCRIPTION for additional requirements.

[b. The system layout on the drawings show the intent of coverage and are shown in suggested locations. Submit plan view drawing showing all component locations, cable routing, junction boxes, other related equipment, conduit routing, and wire counts for all floors.]

]1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2020) American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 800-82	(2015; Rev 2) Guide to Industrial Control Systems (ICS) Security

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1778	(2014; Reprint Apr 2023) UL Standard for Safety Uninterruptible Power Systems

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

System Layout; G, [_____]

[System Design; G, [_____]]

SD-03 Product Data

Spare Parts

[SD-05 Design Data

Design Analysis and Calculations; G, [_____]]

SD-06 Test Reports

Approved Test Procedures; G, [_____]

Acceptance Tests

Accreditation; G, [_____]

SD-07 Certificates

Components

SD-10 Operation and Maintenance Data

Public Address System; G, [_____]

Submit Data Package 5 for each component in accordance with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.

****

NOTE: Include the following paragraph if specification includes IP Networked Public Address System.

****

[1.5 SYSTEM DESCRIPTION

1.5.1 Design Requirements

Provide a Public Address System, capable of distributing the indicated audio signals from equipment including LAN controllers, communication links, cabling, battery backup, power line surge protection and all other necessary components to make a complete and operational system. Complete coverage will be provided for all interior public spaces and other spaces as indicated on the drawings.

Provide a zoned system capable of evenly distributing live [and pre-recorded] paging and music program sources. Provide balanced and highly intelligible distributed sound free of noise and distortion. Provide capability of both individual and simultaneous paging all separate paging zones. Intelligibility must meet the requirements of Modified Rhyme Test (MRT) of ASA S3.2

Provide all headend interface, amplification components, conditioners and any other equipment necessary. Provide system capable of interfacing with the GFGI telephone system for zone paging.

Provide all materials and labor needed for a complete and operational system for the services in this specification plus the additional system capabilities as indicated. This includes but not limited to all necessary equipment, interfaces, jumpers, terminations, cabling, amplifiers, conditioners, power supplies, battery backup, software and all components required for system operation.

1.5.2 System Application Design

Provide the system application design required to provide a public address system that complies with and satisfies all of the requirements specified in this Section [and indicated on the Telecommunications Drawings] for this application and project.

1.5.3 Standard Products

Provide an application design that utilizes standard system components that are the product of a Manufacturer regularly engaged in the manufacture of networked public address system, and that have been in satisfactory use for at least six months. Provide all major components from the same manufacturer. The System must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the facility. Do not deliver material to the project site more than six months prior to the scheduled date of installation.

Provide hardware, software, and installation of a complete and engineered system. Provide a submitted design that is properly engineered for the operational requirements. Include all components required to meet this specification section in the design, other than a change in, or in addition to the operational frequencies identified herein.

1.5.4 Local Products

Incorporate local materials to the greatest extent possible. All proposed local products must meet all applicable hardware and software requirements set forth in these specifications.

1.5.5 Minimum Requirements

Specifications are minimum requirements. If the provided system requires enhanced specifications that exceed those specified herein in order to satisfy the specified design, configuration, capability, and performance requirements, then a provide a system with the enhanced specifications.

1.5.6 Current State-of-the-Art Technology

Provide application design and products that utilize current state-of-the-art products that provide the enhanced capability and performance specified herein. Provide design and products representing the latest manufacturer make and model.

1.5.7 Design Analysis and Calculations

Include in the design analysis and calculations, at a minimum, the following:

a. Power supply requirements for each component and each separate speaker zone of the system in accordance with the manufacturer's instructions. Provide power consumption and dissipation data under normal and maximum operating conditions.

b. Cable types and sizes.

c. Interfaces with all other systems such as the fire alarm and mass notification system for muting of public address system upon fire alarm or mass notification announcement.

1.5.8 Environmental Requirements

Provide equipment to be used indoors rated for continuous duty operation under ambient environmental conditions of 1.7 to 49 degrees C 35 to 120 degrees F dry bulb and 10 to 95 percent reflective humidity, noncondensing. Provide all other equipment rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

1.5.9 Electrical Requirements

105 VAC to 130 VAC at 60 Hz operating voltage range, plus or minus 2 percent.

1.5.10 Power supplies

Provide power supplies that provide sufficient power for worst-case conditions of system operation that could occur without signal loss or perceptible degradation.

1.5.11 Power Line Surge Protection

Provide power line surge protection for all equipment connected to AC power. Provide surge protection integral to the equipment or installed as an accessory item in accordance to manufacturer's recommendations. Do not use fuses for surge protection.

1.5.12 Shielding and Grounding

Provide shielding and grounded as required by the system design, Manufacturer's instructions, FCC Part 15 listing, and regulatory requirements.

1.5.13 System Capability and Configuration

1.5.13.1 System Capability

Provide a public address system with capabilities to support [VoIP interface,][zone paging,][background music,][all-call,][priority paging,][messaging processors,][software,][input modules,][controllers,][interface modules,] [and] [_____].

1.5.14 Performance Requirements

1.5.14.1 System Initiation and Operation

No user controlled features are permitted on this system. System is to be active on power up and perform as specified without any form of manual control.

1.5.14.2 Priority

****

NOTE: Indicate paging priorities on the drawings or in this specification section.

****

Provide paging priorities as indicated.

][1.6 CYBERSECURITY

****

NOTE: Coordinate public address integration requirements with facility needs and cybersecurity requirements. Simple public address system may be segregated from the facility network and greatly reduce the cost of cybersecurity compliance.

****

a. The Risk Management Framework (RMF) is the process by which information systems are accredited for operation by a designated official from the Using Military Department. It is the standard process under which all DoD information systems must achieve and maintain their Authority To Operate. The Cyber Security process is documented in DOD 8510.01 and NIST SP 800-82. Refer to UFC 4-010-06 for additional requirements.

b. All systems that are IP addressable or interface with the Assured Network must be certified to operate. Coordinate with the Government to initiate and complete the accreditation process.

c. Cybersecurity requires input from the system vendor or provider and support from the local IMD. The local IMD-IA office is the point of contact for all Cybersecurity requirements. The local CMIO is the point of contact for all clinical and functional system requirements.

]1.7 QUALIFICATIONS

1.7.1 General Qualification Requirements

a. The System Contractor, Installer and Manufacturer must each have the minimum qualifications specified, related to the type of system specified for this project.

b. The Government reserves the right to accept or reject the System Contractor, Installer or Manufacturer based upon qualifications and ability to conform to specified technical or licensing requirements of this Section. System Contractors, Installers and Manufacturers that do not have the specified qualifications will not be acceptable and will not be allowed to perform the work of this section.

c. The Government will determine the acceptability of any proposed System Contractor, Installer and Manufacturer based on submitted and verified documentation that substantiates that the proposed System Contractor, Installer and Manufacturer have the qualifications specified in this Section.

d. Submit documented verification of the specified qualifications as part of the Data Qualifications submittal. The Government maintains the right to request, inspect and verify references and resumes of all technical and managerial personnel assigned to the project.

e. Include qualification documentation, but not limited to the information outlined below:

  (1) A list of projects performed by the System Contractor and Installer during the last five years explicitly involving the type of system specified in this section, including:

(a) Name of facility where work was completed.

(b) Name, title, address and telephone number of a point of contact for the listed facility.

(c) The make and model of the system provided and total scope of work for the facility.

(d) Restrict list to the facilities where the same type of system was installed for the same purpose provided.

1.7.2 System Contractor Qualifications

a. Contractor qualifications must include the following:

(1) The Contractor is regularly engaged in the system application design, documentation, installation, testing, training, and maintenance of the type of system specified in this section.

(2) The Contractor has a minimum of five years experience providing these services for systems having the same level of features and functions as the system being provided.

(3) The Contractor has a minimum of five years as the manufacturer or an authorized distributor and service organization for the manufacturer of the system provided.

b. Contactor personnel qualifications must:

(1) Be factory trained or certified for the make and model of the system provided.

(2) Have a minimum of five years experience performing the services specified in this specification section.

(3) Maintain a full compliment of spare parts for the provided system with the ability to furnish on-call maintenance 24 hours per day, 365 days per year.

1.7.3 Installer Qualifications

a. The installer personnel must be regularly engaged in the installation of the type of system in this specification section.

b. The installation supervisor must be factory trained or certified for the make and model of the system provided.

c. The installation supervisor must have a minimum of five years experience providing services having the same level of features and functions for the system included in this specification section.

d. The installation personnel must have a minimum of three years experience providing services having the same level of features and functions for the system included in this specification section.

1.7.4 Manufacturer Qualifications

The system manufacturer must:

a. Have a minimum of five years experience in producing the products and type of system included in this specification section.

b. Produce a system that satisfies all specified features, functions and product requirements.

c. Guarantee the availability of the replacement parts for the designed system for a minimum of seven years from the date of final acceptance of the system by the Contracting Officer.

1.8 DELIVERY, STORAGE, AND HANDLING

Equipment placed in storage until installation must be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.9 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [2] [_____] months prior to the date of beneficial occupancy. The data must include a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The public address system must consist of an audio distribution network to include amplifiers, mixers, microphones, speakers, cabling, and ancillary components required to meet the required system configuration and operation. Submit Data Package 3 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

2.1.1 Multi-Channel System with Paging

The system must include microphones, microphone outlet receptacles, microphone inputs with preamplifiers, inputs for [digital music,] [telephone,] [and] [_____] program sources, [single] [all] channel paging, control for each input, power amplifying equipment, and accessories required to output the public address and paging audio signals through selected portions of the audio distribution network as indicated. The paging signal must be replaced [by zones] [channel [_____]] [all channels] of the system output, when the paging function is activated.

2.1.2 Single-Channel System

The system must control and amplify an audio program for distribution within the areas indicated. Components of the system must include a [mixer-preamplifier,] [mixer-amplifier,] [mike input expander,] [power amplifier,] [microphone,] [speaker system,] cabling and other associated hardware.

2.1.3 System Performance

The system must provide even sound distribution throughout the designated area, plus or minus 3 dB for the 1/1 octave band centered at 4000 Hz. The system must provide uniform frequency response throughout the designated area, plus or minus 3 dB as measured with 1/3-octave bands of pink noise at locations across the designated area selected by the Contracting Officer. The system must be capable of delivering 75 dB average program level with additional 10 dB peaking margin sound pressure level (SPL) in the area at an acoustic distortion level below 5 percent total harmonic distortion (THD). Unless otherwise specified the sound pressure reference level is 20 micro Pascal (0.00002 Newtons per square meter).

2.1.4 Detail Drawings

Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical speakers. Check the layout based on the actual speakers to be installed and make necessary revisions in the detail drawings. Detail drawings must also contain complete point to point wiring, schematic diagrams and other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings must show proposed layout of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

[2.1.5 Network IP System Design

Submit system design consisting of a design analysis, calculations, and drawings as described in paragraph titled Detail Drawings. In the design analysis, describe all components, equipment, and appurtenances required for a fully functional system. Also include a detailed description of system operation to include paging priorities, interfaces with other systems, telephone interface for paging, all system inputs, and paging zones.

]2.2 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products, and that essentially duplicate material and equipment that have been in satisfactory use at least 2 years. All components used in the system must be commercial designs that comply with the requirements specified. Submit copies of current approvals or listings issued by UL, or other nationally recognized testing laboratory for all components. Equipment must be supported by a service organization that is within [_____] miles of the site.

2.2.1 Identical Items

Items of the same classification must be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2.2.2 Nameplates

Each major component of equipment must have the manufacturer's name, address, model and catalog number, and serial number on a plate secured to the equipment.

****

NOTE: Chose digital IP based system or analog type system. For analog type system, show all components

on drawings to include riser diagram showing all required components.

Digital IP based system must be by performance specification. Show headend location on drawings to include required mounting racks. Show all speaker locations to include speaker zone assignments. Include system operation description on the drawings to describe required features and specific operational requirements.

Digital IP system must not reside on Government networks. Performance specification must include all active networking components and wiring necessary for system operation. At a minimum, include block diagrams on the drawings to include required functional components such as required inputs, microphones, interfaces with other systems, telephone interface modules, speakers, and volume controls. Define paging priorities on the drawings.
****

[2.3 IP NETWORKED PUBLIC ADDRESS SYSTEM

Provide complete digital IP based audio network as required to deliver high quality audio signals to paging speakers as indicated on the drawings. Provide amplifiers of sufficient power to drive speakers indicated based on the defined paging zones. Provide additional amplifiers or modules as required for indicated paging zones.

2.3.1 System Components

Provide all system components as required for a complete and operational system to include the following minimum components.

2.3.1.1 Headend Equipment

Provide floor mounted equipment rack to house all headend equipment.

2.3.1.2 Auxiliary Inputs

****

NOTE: Include specific inputs as required by project specific requirements.

****

Provide rack space and input modules for a minimum of two auxiliary inputs. Input sources are [_____].

2.3.2 Distribution Equipment

Provide all distribution equipment necessary to process and distribute paging and music to zones as indicated on the drawings.

2.3.2.1 Monitor Panel

Provide system monitor panel with speaker and zone selection capability to check each output, voice input, and zone selection.

2.3.2.2 Loudspeaker System

****

NOTE: Show all speaker locations and associated speaker zones on the construction drawings. Space corridor ceiling speakers at a maximum of twice the ceiling height where ceiling heights do not exceed 3 m 10 feet above finished floorin order to provide maximum uniform coverage. Space speakers in other locations as recommended by the speaker manufacturer for maximum coverage at low volume levels.

NOTE: Show individual room volume control locations on the contract drawings to meet project specific requirements. Indicate specific rooms that require all-call bypass feature on the contract drawings.

****

Provide low power loudspeakers for uniform sound distribution at low volume levels. Space speakers [as indicated on the drawings][_____]. Provide separate volume control for individual rooms as indicated on the drawings. [In rooms designated on the drawings, provide volume control with bypass feature to allow for all-call paging to bypass the local volume control and be audible at normal system volume.]

Provide speakers that are designed to provide even sound dispersion over the 20 Hz to 20 kHZ frequency range within the entire area the speaker covers.

2.3.2.3 Indoor Loudspeaker Assemblies

Provide cone type speakers with wall or ceiling enclosures and baffles as indicated on the drawings.

2.3.2.4 Outdoor Loudspeaker Assemblies

Provide weather resistant cone speakers with enclosures and baffles for outdoor ceiling locations. Provide horn type loudspeakers for outdoor wall mounted locations.

[2.3.2.5 IP Addressable PoE Loudspeakers

****

NOTE: Delete if not using IP network type system.

NOTE: IP Addressable PoE Loudspeakers must not reside on Government networks without prior permission nor without meeting RMF requirements.

****

Provide PoE speakers with integral amplifiers to provide a maximum of 8 Watts of power from the PoE connection. Provide all networking components, PoE switches, cabling, and termination equipment to be an integral part of the public address system.

]2.3.2.6 Microphones

****

NOTE: Show microphone locations on the contract drawings as required to meet project specific requirements. Microphones are normally only provided at the headend equipment for testing purposes in medical facilities. All other paging input is via the telephone system.

****

Provide types and quantities of microphones as indicated on the drawings.

2.3.3 System Configuration

2.3.3.1 All Call

Provide all call paging capability. All call paging will have priority over all other paging zones. Provide access to all call paging via a microphone, telephone, or both. Microphone access will have priority over telephone access for all paging zone types.

2.3.3.2 Zone Paging

****

NOTE: Show all paging zones on the contract drawings. Coordinate paging zones with project specific requirements.

NOTE: Show zone volume control locations on the contract drawings.

****

Provide local paging zones as indicated on the drawings. Provide access to local zones using the telephone system[, microphones,][or both]. All call paging will have priority over all local paging zones. Provide zone volume control at a controlled access location as indicated on the drawings.

****

NOTE: Include the following paragraph only in medical facilities that contain combined medical and dental clinics.

**[

2.3.3.3 Medical and Dental Clinic Zoning

Provide separate wide area zone for the medical clinic areas and separate wide area zone for dental clinic areas as indicated on the drawings. These wide area zones are in addition to all call for the entire facility. All call will have priority over wide area zones.

]

****

NOTE: Include the following paragraph only in medical facilities that contain an auditorium equipped with an auditorium AV system.

****

[2.3.3.4 Auditorium Zone

Provide all call paging in the auditorium only. Do not include auditorium within a local or wide area paging zone.

]2.3.4 System Performance

Provide system that evenly distributes sound throughout loudspeaker zones at plus or minus 3 dB for the 1/1 octave band centered at 4,000 Hz. Provide system that has uniform frequency response throughput loudspeaker zones of plus or minus 3 DB as measured with 1/3 octave bands of pink noise at locations as selected by the Contracting Officer. Provide system capable of delivering 75 dB average program level with additional 10 dB peaking margin sound pressure level without causing the associated amplifier to exceed normal operating specifications for power or distortion. Reference sound pressure level is 20 micropascal, unless otherwise indicated. Minimum audio sound pressure level must be at least +15 dB in all areas. System must not produce audible hum, noise, buzz, or rattles at any loudspeaker. Electoral/acoustic signal-to-noise ratio for the entire system must be at least 66 dB.

[2.3.5 Electrical Power

****

NOTE: Include this paragraph for all medical facilities. Include for other facilities as necessary to meet project specific requirements.

NOTE: For medical facilities with a Type I or Type II essential, connect the public address system to the essential system life safety branch. Coordinate with project electrical engineer. Public address equipment must be connected to dedicated circuit breakers that serve no other loads.

****

Provide uninterruptable power supply (UPS) units that will support AC powered equipment for a minimum of 15 minutes of full power during an AC power failure. Provide UPS units that comply with UL 1778 and FCC Part 15

]][2.4 ANALOG AUDIO SYSTEM

2.4.1 MIXER-PREAMPLIFIER

****

NOTE: Verify that the designated number of inputs is sufficient to meet the requirements of the design and increase the number of inputs if required.

Consideration should be given to the use of a mixer-amplifier instead of a mixer-preamplifier/power-amplifier combination. Mixer-amplifiers may not be available for power outputs of 200 watts or greater.

****

Mixer-preamplifier must as a minimum conform to the following specifications:

Rated Output	18 dB
Frequency Response	Plus or Minus 1 dB, 20 - 20,000 Hz

Distortion	Less than 0.5 percent, 20 - 20,000 Hz
Signal to noise	Microphone - 60 dB
	Aux - 70 dB
Inputs	5 independent balanced low-impedance transformer-isolated
Input Sensitivity	Microphone - 0.003 volts
	Aux - 0.125 volts
	Magnetic Cartridge - 0.0005 volts
Input Channel Isolation	80 dB minimum
Tone Controls	Plus or Minus 10 dB range at 50 and 15,000 Hz
Power Requirement	110-125 Vac 60 Hz

2.4.2 POWER AMPLIFIERS

****

NOTE: The required wattage rating will be inserted in the blank. This wattage may be computed as follows: Allow 1 watt for each loudspeaker. Use 1.4 multiplier for reserve power. Auditorium systems will have an output of not less than 20 watts or not less than 10 watts per 100 seats, whichever is greater. Special consideration will be given to acoustics, speaker placement, and the functions for which the system will be used, particularly for large auditoriums where music will be reproduced or amplified.

****

Power amplifiers as a minimum conform to the following specifications:

Rated power output	[60] [125] [250] [_____] watts RMS
Frequency Response	Plus or Minus 3 dB, 20-20,000 Hz
Distortion	Less than 2 percent at RPO, 600-13,000 Hz
Input Impedance	50 k ohm unbalanced
Output Impedance	Balanced 4 and 8 ohms
Output voltage	25 and 70.7 volts
Power Requirement	110-125 Vac 60 Hz

2.4.3 MIXER AMPLIFIER

****

NOTE: Verify that the designated number of inputs are sufficient to meet the requirements of the design and increase the number of inputs if required.

Consideration should be given to the use of a mixer-amplifier instead of a mixer-preamplifier/power-amplifier combination. Mixer-amplifiers may not be available for power outputs of 200 watts or greater.

The required wattage rating will be inserted in the blank. This wattage may be computed as follows: Allow 1 watt for each loudspeaker. Use 1.4 multiplier for reserve power. Auditorium systems will have an output of not less than 20 watts or not less than 10 watts per 100 seats, whichever is greater. Special consideration will be given to acoustics, speaker placement, and the functions for which the system will be used, particularly for large auditoriums where music will be reproduced or amplified.

****

Mixer amplifier must as a minimum conform to the following specifications:

Rated Power Output (RPO)	[35] [60] [125] [_____] watts RMS
Frequency Response	Plus or Minus 3 dB, 20-20,000 Hz
Distortion	Less than 1 percent at RPO, 60 - 13,000 Hz
Inputs	2 microphones (high impedance or low-impedance unbalanced 2 Aux. (high-impedance)
Output Impedance	Balanced 4 and 8 ohms
Output Voltage	25 and 70.7 volts
Power Requirement	110-125 Vac 60 Hz

2.4.4 MICROPHONE INPUT MODULES

****

NOTE: Verify that the designated number of inputs are sufficient to meet the requirements of the design and increase the number of inputs if required.

****

Microphone input modules must as a minimum conform to the following specifications:

Rated Outputs	0.25 volts into 10,000 ohms
	1.0 volts into 10,000 ohms
Frequency Response	Plus or Minus 2 dB, 20 - 20,000 Hz
Distortion	Less than 0.5 percent 20 - 20,000 Hz
Inputs	4 transformer - coupled balanced 150 ohm
Input Sensitivity	0.003 volts
Input Channel Isolation	70 dB minimum

2.4.5 MICROPHONES

2.4.5.1 Desk Microphone

Microphones must as a minimum conform to the following specifications:

Element	Dynamic
Pattern	Cardioid
Frequency Response	50 - 12,000 Hz
Impedance	Low impedance mic (150-400 ohms)
Front-to-back Ratio	20 dB
Selector switches	Selector switches for zone must be be [integral microphone] or [Separate console adjacent to microphone]

2.4.5.2 Gooseneck Microphone

Gooseneck microphone must meet the minimum requirements of the desk microphone. Microphone must have push to talk button. Gooseneck tube length must be [305] [406] [_____] mm [12] [16] [_____] inch.

2.4.5.3 Microphone Jack

Each outlet for microphones must consist of a standard outlet box, flush-mounted, and fitted with a three-pole, polarized, locking-type, female microphone jack and a corrosion resistant-steel device plate.

]2.5 LOUDSPEAKERS

****

NOTE: Indicate on drawings type of speaker and location. Horn Speaker must be specified only in areas with high ambient noise or outdoors. High output speaker enclosures must be restricted to large open spaces i.e. gymnasiums, auditoriums or commons

****

2.5.1 Cone Speaker

The cone speaker must as a minimum conform to the following specifications:

Application	[Wall baffle] [Ceiling]
Frequency range	60 to 12,000 Hz
Power Rating	Normal - [7] [_____] watts
	Peak - [10] [_____] watts
Voice Coil Impedance	8 ohms
Line Matching Transformer Type	25/ 70.7 volt line
Capacity	4 watts
Magnet	10 ounces or greater
Primary Taps	0.5, 1, 2 and 4 watts
Primary Impedance	25 volts - 1250, 625, and 312 ohms
	70.7 volts - 10k, 5k, and 2.5k ohms
Frequency Response	30 - 20,000 Hz
Insertion Loss	Less than 1 dB

2.5.2 Horn Speaker

The horn speaker must as a minimum conform to the following specifications:

Application	[Indoor] [Outdoor] [Weatherproof]
Frequency Response	400 - 14,000 Hz
Power Taps	70 volt line - .9, 1.8, 3.8, 7.5, and 15 watts
Impedance	5000, 2500, 1300, 670, 330, 90, and 45 ohms
	Normal - [7] [_____] watts
	Peak - [15] [_____] watts
Dispersion	110 degrees

2.5.3 Dual Horn Speaker

The dual horn speaker must meet the minimum requirements of horn speaker except the dispersion must be 100 degrees.

2.5.4 High Output Speaker Enclosures

High Output speaker enclosures must be of the tuned-port design for precise balancing and tuning of the speaker. The enclosures must be constructed throughout of 19.1 mm 3/4 inch high density board, with screwed and glued joints, durably braced, and padded with fiberglass where acoustically required. Speaker enclosures must have a [25] [45] degree [_____] vertical dispersion and [90] [120] degrees [_____] horizontal dispersion. The effective length of throw must be a minimum of [15] [40] [60] [_____]m [50] [130] [200] [_____] feet.

2.5.5 Wall Baffle Speaker Enclosures

The wall baffle speaker must be of [particle board construction covered with [walnut laminate]][full steel construction painted [off-white][_____] [_____] and complete with [black] [_____] cloth grille]. Baffle must feature 9.5 [12.5] degree slope to provide directional sound dispersion offset in the direction of radiation. Wall baffle enclosure must come equipped with a wall mounting bracket designed to assure a rigid mounting to any flat surfaces.

2.5.6 Ceiling Speaker Enclosures

Ceiling speaker enclosure must be constructed of heavy gauge cold steel with interior undercoating and 38 mm 1-1/2 inch thick high density fiberglass 24 kg/cu. m 1-1/2 lbs/cu. ft. The unit must be [round] [square] and designed for [recessed] [surface] installations which will be accomplished via [standard screw] [torsion spring] [flange mount] mounting. Recessed models must have a rust-preventive, [textured black coating] [_____] and the surface mount unit finished in textured [white] [_____]. Enclosure must include four triple compound conduit knockouts.

2.6 SPEAKER SWITCHING PANEL

****

NOTE: Delete if paging function is not required.
Show zone boundaries on the drawings.

****

2.6.1 Selector Switches

Zone control must be provided for the paging function. The speaker switching panel must contain at least [_____] double-pole, [[4-] [3-] position] [push button] selector switches and must be [rack-mounted] [desk mounted] [selector switches built in microphone]to activate priority relays. Selector switches labeling must be provided to identify the zones.

2.6.2 System Power supply

Power supply must be provided for priority relays and controls, rack-mounted and sized for a capacity equal to 200 percent of the as-built control system, and must operate at 24 Vdc. Input and output must be protected to permit Class 2 wiring in accordance with NFPA 70.

2.7 PRIORITY RELAYS AND CONTROLS

Provide priority relays and controls required to accomplish operations specified. Relays must be completely enclosed with a plastic dust cover for maximum protection against foreign matter, and must be plug-in type. Relays must be provided with a diode wired across the relay coil for transient suppression and must be installed utilizing factory-prewired, rack-mounted receptacle strips. Coil must be maximum 24 volts dc.

2.8   SWITCHES AND CONTROLS

2.8.1   Remote Loudspeaker ON/OFF Switches

****

NOTE: If more than one switch is required, indicate in a schedule on the drawing.

****

Remote switches must be [key-operated] [toggle switch] 2-pole, wall-mounted, single gang type with engraved switch plates finished to match the approved finish of electrical wall switches. Low-voltage priority override relays must be provided as part of the switches with all wiring to the racks to allow override of the ON/OFF switches for priority announcements.

2.8.2   Remote Loudspeaker Volume Controls

****

NOTE: If more than one control is required, indicate in a schedule on the drawing.

****

Remote volume controls must be an auto transformer type with detented 3 dB steps and an OFF position. The controls must be wall-mounted in single-gang outlet boxes and furnished with engraved switching plates finished to match approved finish of electrical wall switches. Insertion loss of the controls must not exceed 0.6 dB and the power-handling capacities of the control must be [10] [35] [75] [_____] watts. Low-voltage priority override relays must be furnished as part of these controls with all wiring to the racks to allow override of the volume controls for priority announcements.

2.9   EQUIPMENT RACKS AND CABINETS

****

NOTE: For low powered systems i.e. only paging systems,specify perforations or louvers for cooling through convection currents. Systems with total amplifier capacity exceeding 400 watts use top rack mounted fan option.

****

Equipment must be mounted on[482.6 mm 19 inch racks] [swing wall mounted cabinets with hinged front removable and reversible door and [right hand] [left hand] hinged rear section that provides access to equipment with 482.6 mm 19 inch mounting rails] [and] [floor mounted cabinets with 482.6 mm 19 inch mounting rails] as indicated on the drawings UL listed andin accordance with ECIA EIA/ECA 310-E and located as shown on drawings. Ventilated rear panels, solid side panels, and solid top panels must be provided for cabinets. Equipment cabinets must be provided with lockable front panels that limit access to equipment. The lockable front must not cover items that require operator access. Cabinet cooling must be through [perforations or louvers in front panels to ensure adequate ventilation of equipment] [top cabinet mounted fan]. The racks and cabinets must be factory finished with a uniform baked enamel over rust inhibiting primer.

2.10 CABLES

2.10.1 Speaker Cable

Cables must be of the gauge required depending upon the cable run length. In no case are cables to be used which is smaller than 18 AWG. Insulation on the conductors must be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.2 mm 0.009 inch. Cables must be jacketed with a [PVC] [Fluoropolymer] compound. The jacket thickness must be 0.5 mm 0.02 inch minimum.

2.10.2 Microphone Cable

Cable conductor must be stranded copper 20 AWG. Insulation on the conductors must be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.2 mm 0.009 inch. Cable must be shielded 100 percent of aluminum polyester foil with a bare 22 gauge stranded soft copper drain conductor. Cables must be jacketed with a [PVC] [Fluoropolymer] compound. The jacket thickness must be 0.5 mm 0.02 inch minimum.

2.11 TERMINALS

Terminals must be [solderless, tool-crimped pressure] [or] [_____] type.

2.12 SURGE PROTECTION

2.12.1 Power Line Surge Protection

Major components of the system such as power amplifiers, mixer-preamplifiers, and tuners, must have a device, whether internal or external, which provides protection against voltage spikes and current surges originating from commercial power sources in accordance with IEEE C62.41.1/IEEE C62.41.2 B3 combination waveform and NFPA 70. Fuses must not be used for surge protection. The surge protector must be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground). Surge protection device must be UL listed and labeled as having been tested in accordance with UL 1449.

2.12.2 SIGNAL SURGE PROTECTION

Major components of the system must have internal protection circuits which protects the component from mismatched loads, direct current, and shorted output lines. Communication cables/conductors must have surge protection installed at each point where it exits or enters a building.

2.13 TELEPHONE INTERFACE MODULE

****

NOTE: Telephone Interface module may be used to access PA system from telephone in conjunction or lieu of microphone. If there is a requirement to integrate Telephone Interface module to the PA system, assure that the necessary inputs and interfaces are included in this specification.

****

[2.13.1 Analog Interface Module

Telephone Interface module must provide one way all call paging access from telephone to PA system. Paging must be accomplished by the building telephone system instruments interconnected to the PA system via an interface module to allow telephone dial up access to the paging amplifier. Telephone interface module must as a minimum conform to the following specifications:

Impedance	600 ohms
Frequency response	100Hz to 10Khz
70V Input Impedance	200K ohms
Output level	400mV rms
Input Power Requirement	12-24Vdc (from power supply)
Access requirement	Electronic (analog) or IA2 line key (line card required) PABX loop or ground-start trunk port, or dedicated single-line phone

][2.13.2 VoIP Interface Module

Provide paging interface module suitable for use with VoIP telephone systems.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with the details of the work and working conditions, verify dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work.

3.2 INSTALLATION

Install equipment as indicated and specified, and in accordance with the manufacturer's recommendations except where otherwise indicated. Equipment mounted out-of-doors or subject to inclement conditions must be weatherproofed.

3.2.1 Equipment Racks

****

NOTE: Racks be located adjacent to walls. If a mechanical rack/floor attachment is required, controls must not be lower than 762.0 mm (30 inches nor higher than 1.7 m 66 inches above floor.

****

Mount racks side-by-side and bolt together. Group items of the same function together, either vertically or side-by-side. Arrange controls symmetrically at a height as indicated. Make audio input and interconnections with approved shielded cable and plug connectors; output connections may be screw terminal type. All connections to power supplies must utilize standard male plug and female receptacle connectors with the female receptacle being the source side of the connection. Inputs, outputs, interconnections, test points, and relays must be accessible at the rear of the equipment rack for maintenance and testing. Each item must be removable from the rack without disturbing other items or connections. Empty space in equipment racks must be covered by blank panels so that the entire front of the rack is occupied by panels.

3.2.2 Wiring

Install wiring in rigid steel conduit, intermediate metal conduit, cable trays, or electric metallic tubing as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wiring for microphone, grounding, line level, speaker and power cables must be isolated from each other by physical isolation and metallic shielding. Shielding must be terminated at only one end.

3.3 GROUNDING

All grounding practices must comply with NFPA 70. Equipment must be grounded to the serving panelboard ground bus through a green grounding conductor. Metallic conduits serving the equipment must be isolated on the equipment end with an insulating bushing to prevent noise from being transferred to the circuit. Equipment racks must be grounded to the panelboard ground bus utilizing a 8 AWG conductor. Grounding conductor must be terminated to the rack using connector suitable for that purpose.

3.4 TRAINING

Conduct a training course for [_____] members of the operating and maintenance staff as designated by the Contracting Officer. The training course will be given at the installation during normal working hours for a total of [_____] hours and must start after the system is functionally complete but prior to final acceptance tests. The field instructions must cover all of the items contained in the approved operating and maintenance manuals, as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to the start of the training course.

3.5 ACCEPTANCE TESTS

Submit test reports in booklet form showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The reports must include the manufacturer, model number, and serial number of test equipment used in each test. Each report must indicate the final position of controls and operating mode of the system. After installation has been completed, conduct acceptance tests, utilizing the approved test procedures, to demonstrate that equipment operates in accordance with specification requirements. Submit test plan and test procedures for the acceptance tests. The test plan and test procedures must explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedure must also explain methods for simulating the necessary conditions of operation to demonstrate system performance. Notify the Contracting Officer [14] [_____] days prior to the performance of tests. In no case will notice be given until after the Contractor has received written Contracting Officer approval of the test plans as specified.

3.5.1 Testing Requirements

Include the following minimum testing:

a. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

b. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

   (1) Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.

   (2) Repeat test for each separately controlled zone of loudspeakers.

   (3) Minimum acceptance ratio is 50 dB

c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.

d. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.

e. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

****

NOTE: Include the following paragraph where UPS units are included for the public address system.

****

[f. Power Outage Test: Turn off AC power at the circuit breaker for AC powered components connected to a UPS unit to ensure components continue to operate for a minimum of 15 minutes.]

g. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

Public address system will be considered defective if it does not pass any of the required individual tests and inspections listed above.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-27 51 23 (November 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-27 21 00.00 20 (April 2006)
UFGS-27 21 00.00 40 (February 2016)
UFGS-27 51 23.10 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 27 - COMMUNICATIONS

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11/21

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-27 51 23 (November 2021)**

Preparing Activity: NAVFAC

Superseding
UFGS-27 21 00.00 20 (April 2006)
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UFGS-27 51 23.10 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 27 51 23

INTERCOMMUNICATION SYSTEM

11/21

****

NOTE: This guide specification covers the requirements for electronic intercommunication systems, including master and remote stations of the wired and wireless types.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification covers intercommunication systems and lists desirable features of electronic systems; however, not all manufacturers produce products with all the listed features. Consult manufacturers as to the availability of features desired and the availability of those features. Additional features, requirements, etc., may be made to this specification. Where intercommunication systems are to be used with other communication devices, consider the electromagnetic compatibility of the

intercommunication system in accordance with AR 5-12 - Army Use of the Electromagnetic Spectrum. This intercommunication system guide specification does not include all features and design parameters which are available. Do not specify exact equipment configuration or design parameters that are unnecessarily restrictive.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2020) American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.0	(2020e) Generic Telecommunications Cabling for Customer Premises
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard

TIA-568.2	(2024e) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2022e) Optical Fiber Cabling Components Standard

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 RELATED REQUIREMENTS

Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS applies to this section.

Section 27 51 16 PUBLIC ADDRESS SYSTEMS.

1.3 SYSTEM DESCRIPTION

****

NOTE: Public address systems are covered in specification 27 51 16 PUBLIC ADDRESS SYSTEMS and not in this specification; this guide specification covers the requirements for three different types of intercommunication systems, select those appropriate to the project and remove those not applicable to the project.

For brig facilities, a 2-way public address system for paging and monitoring must be provided in addition to the intercom system; use specification 27 51 16 PUBLIC ADDRESS SYSTEMS for the 2-way public address system. The various types are as follows:

Type 1 systems are hardwired, single-master systems with selector switches at the master station allowing for a single 2-way conversation with a remote station at a time. This system also allows for calls to the master station from a remote station, allows the master station to make a one-way announcement to one, several, or all remote stations at one time. Remote stations typically consist of a single speaker, a call button, and a visual indicator to show that the master station is connected to the particular remote station. This system typically cannot provide a video option. This type of system is applicable for relatively small systems (maximum quantity of remote stations approximately 30). If there is a requirement for annunciation at more than one location, multiple master stations, a large number of remote stations,or a requirement for multiple conversation

paths, the use of a Type 1 system might not be appropriate; consider a Type 2 or 3 system instead.

Type 2 systems are typically microprocessor-based, and hardwired or multiplexed with one or more multiple master stations; the master station typically utilizes a telephone-type instrument. This system allows for calls to the master station from a remote station, calls from master station to master station, and allows each master station to make a one-way announcement to one, several, or all of its remote stations at one time. A multiplexed version of this system could be appropriate for a facility with multiple remote stations distributed in various wings, such as in a BEQ, detention facility, or other building where it is not desirable to provide an individual cable from the master station to each remote station. Remote stations can be connected to a local electronic (not necessarily an IP Ethernet switch) switch and each switch connected to the master station by a single cable. Some of these systems allow for a designated master station to take control from another master station such as in a correctional facility where central control might need to take over the master station in a particular block in case of an emergency. These systems do not have to be IP-based, although addition of video will often require an IP system.

Type 3 systems are similar to Type 2 systems except that they can communicate among multiple buildings and sites and are IP-based to allow communications over local and wide area networks.

****

Provide Data Package 5 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Provide an Intercommunication System that is solid state, modular in design, and as indicated.[Stations must have capacity for later expansion to [[_____] master] [and] [[_____] remote] stations [with [_____] handset] [and][or] [with hands free operation] without sacrificing any equipment or feature of performance.][When both wired and wireless circuitry are used, such interface must not present a reduction of function or quality.][System must provide one-way video from the remote stations to the master stations where video-type remote stations are indicated].

1.3.1 Sound Reproduction

Provide system with normally acceptable speech intelligibility, defined as a score of at least 75 percent obtained utilizing the phonetically balanced monosyllabic work intelligibility test in accordance with ASA S3.2.

Provide an intercommunication system to provide an audio output of no less than 10 dBA above ambient at [900] [_____] mm [3] [_____] feet from the surface of each receiving stations over the frequency range of [200] [_____] to [5000] [_____] Hz, when driven by a sound pressure level at the calling station of at least 70 dBA at the face of the transducer enclosure. All sound pressure levels are referenced to 1 pascal equals 94 dB. The entire system must have a dynamic range of at least 40 dB. The root-mean-square (rms) extraneous noise (e.g. hum) level introduced by the intercommunication system must be at least [30] [_____] dB below the nominal signal level. Distortion, including envelope delay, intermodulation, cross talk, and other nonlinear sources, must not exceed 5 percent.

[1.3.2 Video Capability

Provide intercom stations with video in addition to audio. Master stations must be able to view individuals at remote stations equipped with video, but remote stations must not be able to view video from the master station(s). Provide video equipped remote stations where indicated and provide master stations with video feature.

Video Master Stations must have the following features:

a. Color touch screen with a diagonal size of at least 170 mm 7 inches.

b. Hands-free (VOX) and handset communications.

c. Pan, tilt, zoom,contrast, and brightness controls.

d. Automatic camera pan, tilt, and zoom setting specific to the remote stations when communicating with a remote station.

e. Audio and video storage of at least twenty calls of at least five minutes each on removable SD or SDHC media. Include software for viewing and listening on a standard PC if files are a proprietary format.

f. Low voltage power supply requirement complete with AC power adapter.

[g. Door release function.

]]1.3.3 System Operation And Service Features

1.3.3.1 Control and Power Requirements

Provide the system with a power switch and an associated visual indicator for ON and OFF operations. Provide a volume control at each station to regulate listening volume. System must operate on [110-125 Vac] [220-250 Vac], single phase, [60] [50] Hz.

[a. Remote stations must utilize Power over Ethernet (PoE). Include all necessary PoE switches, equipment and PoE injectors.

][b. Provide an IP-based system[utilizing Power over Ethernet (PoE)]. Include all necessary PoE switches, equipment and injectors.

]1.3.3.2 Call-In Indication

Master stations must have an audible and visual call-in indicator to provide indication of incoming calls from remote stations. Indication must identify the specific calling station and status, and remain actuated until the call is answered by a master station. Visual call-in indicators must be clearly visible at off-center angles of at least 45 degrees.

1.3.3.3 Identification Plates

In addition to the manufacturer's standard identification plates, provide engraved laminated acrylic plastic identification plates for each component, connection, and terminal. Identification labels must be 3-layered white on black, engraved to show black letters on a white background. Warning and caution labels must be 3-layered white on red, engraved to show white letters on red background. Control switches and knobs must be clearly marked with their function and status. Identification strips for station selector switches must be located to clearly identify remote and master stations and must be protected by transparent plastic inserts. Lettering must be no smaller than 6.35 mm 1/4 inch high, normal block style.

1.3.3.4 Combination Speaker-Handset Stations

At combination speaker-handset stations, lifting the handset must automatically cut out the loudspeaker in the station and all conversation must be carried through the handset.

1.3.3.5 Privacy Switch

****

NOTE: Where ambient noise does not exceed 55 dBA, specify hands-free operation from distances up to 4.5 m 15 feet. In areas where the noise occasionally exceeds 55 dB, a talk-listen switch that overrides the hands-free operation should be specified. Where a high noise environment exists (above 80 dBA), delete hands-free operation and specify only a talk-listen switch.

General Noise Level Guidelines Library 30 dBA, Quiet Private Office 40 dBA, General Open Office 50 dBA, face-to-face conversation 60 dBA; full symphony 90 dBA.

****

Provide privacy switch at [each] [each indicated] remote station that prevents listening to that station when activated. Activation of the privacy switch must provide a initial temporary audible indication at the master station along with a constant visual indication of the specific station that activated its privacy switch. The visual indication at the master station must only be turned off by resetting the privacy switch at the remote station.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: Submit detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, catalog cuts, manufacturer's data, materials and equipment lists, and operational and general maintenance instructions, including the overall system and for each major component. Indicate the quantities of stations and provided spare capacity, including amplifier and power supply spare capacity; amplifer headroom must not be considered part of the spare capacity. Illustrate on the drawings how each item of equipment has been coordinated to function properly in the system. Include on detail drawings an overall system schematic indicating relationship of intercommunication units on one diagram and showing power source, system controls, impedance matches, plus number, size, and maximum lengths of interconnecting wires and indicate clearances required for maintenance and operation. Provide calculations for power requirements of equipment to show that the proper power levels, including headroom, are provided for the specified equipment.

[Submit details of interface with Electronic Security System when providing door control via the intercom system.]

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G

SD-03 Product Data

All-Call Amplifier; G, [_____]

Cone-Type Loudspeakers; G, [_____]

Horn-Type Loudspeakers; G, [_____]

Intercommunication Amplifier; G, [_____]

Master Station; G, [_____]

[Remote Audio and Video Station; G, [_____]

] Remote Audio-Only Station; G, [_____]

Speaker Enclosures; G, [_____]

Spare Parts; G, [_____]

SD-06 Test Reports;

Acceptance Tests; G, [_____]

SD-10 Operation and Maintenance Data

All-Call Amplifier; G, [_____]

Intercommunication Amplifier; G, [_____]

Master Station; G

[Remote Audio and Video Station; G, [_____]

] Remote Audio-Only Station; G, [_____]

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.6 EXTRA MATERIALS

After approval of detail drawings and not later than [2] [_____] months prior to the date of beneficial occupancy, furnish spare parts data for each different item of equipment and component in the system. Include with the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

****

NOTE: Project drawings should clearly indicate the

exact location of all stations, conduit, wiring, and junction boxes. If no drawings of the locations of master stations, remote stations, junction boxes, etc., are furnished with the specification, the number and type of stations and junction boxes and the distance between them must be included as a part of the project specification.

****

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate equipment that have been in satisfactory use at least 2 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Product Data

Submit Product Data including, but not limited to, capabilities, technical data, operating parameters, operating instructions, and installation instruction for Intercommunication System equipment and components requiring submittals.

2.1.3 Identical Items

Items of the same classification must be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2.1.4 Nameplates

Each major component of equipment must have the manufacturer's name, model number, serial number, and markings for all required code, compliant, and conformant certification on plates mechanically attached to the equipment.

2.1.5 Common Equipment Requirements

2.1.5.1 Intercommunication Amplifier

The system intercommunication amplifier must, as a minimum, conform to the following specifications:

Rated Output Power	10 watts rms minimum
Total Harmonic Distortion	Less than 5 percent at rated output power with a load equivalent to one station connected to output terminals
Signal-To-Noise Ratio	60 dB or greater at rated output
Frequency Response	Plus or minus 3 dB from 150 Hz to 12,000 Hz

Input Sensitivity	Matched to input circuit and providing full-rated output with sound-pressure level of not more than 70 dBA impinging on master stations, speaker microphones, or handset transmitters.

2.1.5.2 All-Call Amplifier

All-call amplifier must, as a minimum, conform to the following specifications:

Rated Output Power	Minimum of 2 watts rms for each station, but no less than 20 watts.
Total Harmonic Distortion	Less than 5 percent at rated output power with a load equivalent to the quantity of stations connected to it in all-call mode of operation
Signal-To-Noise Ratio	60 dB or greater at rated output
Frequency Response	Plus or minus 2 dB from 200 Hz to 10,000 Hz
Output Regulation	Maintains output level within 2dB from full to no load
Input Sensitivity	Compatible with master stations and central equipment so amplifier delivers full-rated output with sound pressure level of less than 10 dynes/sq. cm 0.000145 psi impinging on master station, speaker microphone or hand set transmitter.
External Microphone Input	Balanced low-impedance with switchable 48VDC phantom power
Amplifier Protection	Prevent damage from shorted and open circuits

2.1.5.3 Power Line Surge Protection

Provide a permanently-mounted (not a portable power strip) UL 1449 Type 3 Listed Surge Protective Device for all amplifiers. The surge protector must have a Maximum Continuous Operating Voltage of 150 volts for 120 VAC supply voltage and 300 volts for a 230 or 240 VAC supply voltage. The maximum Voltage Protection Rating must not exceed 600 VAC line-to-neutral, 700 VAC line-to-ground, and 600 VAC neutral-to-ground for a 120 VAC supply voltage or 1200 VAC line-to-neutral, 1500 VAC line-to-ground, and 1200 VAC neutral-to-ground for a 230 or 240 VAC supply voltage. Surge protection device must be UL listed and labeled as having been tested in accordance with UL 1449, 4th Edition.

2.1.5.4 Signal Circuit Protection

All amplifiers must have internal protection circuits that protect the internal components from mismatched loads, direct current and shorted output lines. Communication conductors must have surge protection installed at each point where it exits or enters a building.

2.1.5.5 Remote Audio-Only Station

[Desk] [Surface wall] [Recessed wall]-mounted remote station must have [stainless steel] [anodized aluminum] faceplate with tamper proof mounting screws and [galvanized steel] [aluminum] backbox. The remote station must have:

a. A speaker with a minimum sensitivity of 90 dB on axis at 1200 mm 4 feet from the speaker when driven at one watt rms.

b. A call announcement visual indicator that illuminates when there are incoming calls. Visual announcement indicators must be clearly visible at off-center angles of at least 45 degrees.

c. A recurring momentary tone that announces incoming calls.

d. Call Switch that permits a call to the master station.

e. Provide a privacy switch at each remote station. When in the ON position, the switch must prevent any transmission of sound from the remote station. When in the OFF position, persons must be able to respond to incoming call without manual intervention.

[f. A handset with hook switch, telephone type, arranged to disconnect the speaker when the handset is lifted. The cord must be 450 mm 18 inches long and [permanently coiled] [metallic jacketed].

][g. NEMA 4X IP66 rating.

][2.1.5.6 Remote Audio and Video Station

Wall-mounted remote station must have [stainless steel] [anodized aluminum] faceplate with tamper proof mounting screws and [galvanized steel] [aluminum] backbox. The remote audio-video station must have the following features:

a. A speaker with a minimum sensitivity of 90 dB on axis at 1200 mm 4 feet from the speaker when driven at one watt rms.

b. A call announcement indicator that illuminates when there are incoming calls. Visual announcement indicators must be clearly visible at off-center angles of at least 45 degrees.

c. A recurring momentary tone that announces incoming calls.

d. Call Switch that permits a call to the master station.

e. A fixed-focal length, recessed color camera with the following features:

    (1) Sufficient depth of field to provide clear images with no discernable difference in sharpness for subjects between 300 to 1800 mm 12 inches to 84 inches from the camera lens surface.

    (2) An angle of view between 80 and 115 degrees.

    (3) Resolution of at least one megapixel.

    (4) Full color video when the vertical illumination on the subject's face is as low as 20 lux 2 footcandles.

(5) Effective frame rate of at least 20 frames per second.

(6) Dynamic range of at least 100 to 1.

(7) H.264 or H.265 compressed video output.

(8) Integral white LED to illuminate subject to maintain above specifications when ambient light level is below 20 lux 2 footcandles.

(9) Scratch-resistant multicoated clear or neutral-tinted optical cover.

(10) Operating temperature of minus 30 to plus 55 degrees Celsius minus 20 to plus 130 degrees Fahrenheit with no discernable loss of performance.

(11) Operation over IPv4 and IPv6 network protocol.

[(12) NEMA 4X IP66 rating.

]]2.1.5.7 Cone-Type Loudspeakers

****

NOTE: Larger diameter speakers will typically have better low-frequency response than smaller diameter speakers, but is not as important for intercom use. Smaller diameter speakers typically have a wider dispersion angle than larger diameter speakers and can often be placed further apart than larger diameter speakers for the same coverage.

****

Cone-type loud speakers, not integral with a remote station, must be enclosed in a [steel housing] [back boxes] and must be acoustically dampened with a front face of at least 1.21 mm 0.0478 inches steel. The whole assembly must be rust proofed and factory primed complete with mounting assembly.[Baffle for flush speakers must be a minimum thickness of 0.8128 mm 0.032 inches aluminum [brushed to a satin sheen and lacquered] [with textured white finish] [_____]].[Vandal-proof high strength baffles for flush mounted speakers must be cast aluminum with tensile strength of 3,093 kg/sq. cm 44,000 psi and a minimum thickness of 0.635 mm 0.025 inch. The mounting screws must be heat-treated alloy.] The cone-type loudspeakers must comply with the following specifications:

Axial Sensitivity	Minimum of [90][_____] dB with one watt input measured at 1 meter 4 feet
Frequency Response	Within plus or minus 6 dB from [70][180] to 15,000 Hz
Minimum Power Rating	8 watts
Minimum Dispersion Angle	[100][135] degrees

Line Transformers Power Rating	At least 4 watts with at least four taps with insertion loss of no more than 0.5 dB
Speaker Size	[200][100] mm [8][4] inches with 25 mm 1 inch voice coil and minimum 142 grams 5 oz ceramic magnet
Speaker Cone	Resistant to fracture and delamination.
Speaker Cone Surround	Provide sealer on cone surround to minimize environmental effects and aging degradation.

2.1.5.8 Horn-Type Loudspeakers

****

NOTE: A round horn speaker might have a dispersion angle of 95 to 130 degrees in all directions. Rectangular horns might control the dispersion pattern 70 x 95 degrees or, for a sectoral horn, 60 x 80 degrees. Specify the type of horn speaker based on the area of coverage, weather resistance, and whether an explosion proof speaker is needed.

****

Horn-type loudspeakers must be all metal [weather proof] construction complete with universal mounting brackets.[Horn-type loudspeakers must be suitable for Class [1, Groups C and D] [1, Groups B, C, and D] [2, Groups E, F and G] hazardous locations and equipped with 13 mm 1/2 inch threaded conduit entry]. The horn type loudspeakers must be provided with an internally mounted, factory installed line transformers and must as a minimum conform to the following specifications:

Minimum Power Rating	[25][_____] watts
Horizontal Dispersion Angle	[57][70][90][115][_____]
Vertical Dispersion Angle	[57][90][115][_____]
Axial Sensitivity	Minimum of [110][_____] dB with one watt input measured at 1 meter 4 feet
Line Transformers Power Rating	At least 4 watts with at least four taps with insertion rate of 0.5 dB

2.1.5.9 Master Station Capacity

Master Stations and associated equipment, regardless of system type, must have an as-installed spare capacity of at least [25] [____] percent to allow this amount of remote stations to be added without additional system, software, or hardware additions or modifications except for the added remote stations and their connection to their immediate upstream device.

[2.2 TYPE 1 SYSTEM

****

NOTE: Delete this System unless specifying a Type 1 System.

****

A manually switched direct connected keyed intercommunication system that must accommodate at least [_____] remote stations. Remote stations must be provided in the quantities indicated. The master station must selectively communicate with any remote station by actuation of an appropriate selector switch.[The master station must be capable of initiating a message to all remote stations simultaneously or in groups of not less than 10 stations per group.]

2.2.1 Master Station

[Desk] [Surface wall] [Recessed wall] [Rack]-mounted master stations must have:

a. Station-selector switches and talk-listen switches with heavy duty type gold plated contacts rated for at least five million operations.

b. Volume Control to regulate incoming call volume.

c. A light annunciation that identifies the calling stations and stations in use. The light must remain on until the call is answered.

d. A tone annunciator with a momentary audible tone signal that announces incoming calls.

[e. A handset with hook switch, telephone type, arranged to disconnect the speaker when the handset is lifted. The cord must be permanently coiled and have a length between 450 and 1500 mm 18 and 60 inches when extended.

] f. A lockable, ventilated metallic central control cabinet complying with ECIA EIA/ECA 310-E. The cabinet must house terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment.

][2.3 TYPE 2 SYSTEM

****

NOTE: Delete this Type unless specifying a Type 2 System.

****

A microprocessor switched single conversation path, central control intercommunication system must include[an annunciator panel,] a master station, automatic switching equipment, remote stations and all amplifiers, control equipment and ancillary devices required to provide features specified. The master station must selectively communicate with any remote station by actuating the number assigned to that remote station.[The master station must be designed to communicate with all remote stations simultaneously or in groups of not less than 10 stations by actuating an assigned "all-call" number.] Only the selected remote station must be able to listen or talk to the master station. A non-selected remote station must not be able to hear or interfere with any portion of conversation between a master station and the selected remote station. Hanging up the master station handset must reset the system for next call. The quantity and location of remote stations must be as indicated on the drawings. The system must be programmable and password protected and allow access to be granted or denied to various stations on an individual basis for each master station.

2.3.1 Master Station

[Desk-top] [Surface wall] [Recessed wall] [Rack-mounted] type master station equipped with:

a. A 12 digit keypad selector to transmit calls to other stations and initiate commands for programming operations.

b. Volume control to regulate incoming call volume.

c. Visual annunciation to identify calling stations and stations in use. The light must remain on until a call is answered. Visual indicators must be clearly visible at off-center angles of at least 45 degrees.

d. Tone annunciation with a momentary audible tone signal that announces incoming calls.

e. Reset controls that cancels calls and resets system for the next call.

[f. A handset with hook switch, telephone type, arranged to disconnect the speaker when the handset is lifted. The cord must be permanently coiled and have a length between 450 and 1500 mm 18 and 60 inches when extended.

] g. A metallic central control cabinet that must comply with ECIA EIA/ECA 310-E. The cabinet must house terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment. It must be lockable and ventilated.

****

NOTE: Not all systems require door release. Determine if the controlled door should be monitored and possibly also controlled by the Electronic Security System. Not having this interface could mean that unauthorized access to an area could occur with no security personnel response. Coordinate the requirements with Government security.

****

h. Door release feature to allow activation of electric strikes and electric latches from the video master station. Coordinate with the electronic security system design and Section 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS).

][2.4 TYPE 3 SYSTEM

****

NOTE: Delete this Type unless specifying a type 3 system.

****

A microprocessor switched multiple conversation path central control intercommunication system must be provided. The system must be capable of communicating with other master stations and remote stations selectively or in any combination thereof over local and wide-area networks. Each master station must selectively communicate with any other master station or any remote station by entering a number assigned to the called station.[Each master station must also be designed to initiate a message to all other master stations and all remote stations simultaneously or in groups of not less than 10 stations.] Station quantities must be as indicated on drawings. The system must be programmable and password protected and allow access to be granted or denied to various stations on an individual basis for each master station.

2.4.1 Master Station

[Desk-top] [Surface wall] [Recessed wall] [Rack-mounted] master stations equipped with:

a. A 12 digit keypad selector to transmit calls to other stations and initiate commands for programming operations.

b. Volume control to regulate incoming call volume.

c. Light annunciation to identify calling stations and stations in use. The light must remain on until a call is answered.

d. Tone annunciation with a momentary audible tone signal that announces incoming calls.

e. Reset controls that cancels calls and resets system for the next call.

[f. A handset with hook switch, telephone type, arranged to disconnect the speaker when the handset is lifted. The cord must be permanently coiled and have a length between 450 and 1500 mm 18 and 60 inches when extended.

] g. A metallic central control cabinet that must comply with ECIA EIA/ECA 310-E. The cabinet must house terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment. It must be lockable and ventilated.

h. Door release feature to allow activation of electric strikes and electric latches from the video master station. Coordinate with the electronic security system design and Section 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS).

]2.5 SPEAKER ENCLOSURES

Speaker enclosures must be compatible with the speakers specified and comply with UL 50.

2.6 TERMINALS

Terminals must be [solderless, tool-crimped pressure] [or] [_____] type.

2.7 COMMUNICATIONS WIRING

Type of signal and control circuit wire and number of conductors must be provided as recommended by the intercommunication system manufacturer, and as necessary to provide a complete and operable system. Where required, cable must be UL classified low smoke and low flame for use in air plenums in accordance with NFPA 70.

a. Unless manufacturer, voltage drop, or attenuation requirements are more stringent, multi-conductor cables not used with modular connectors must contain only stranded conductors of minimum 22 AWG gauge, insulated with minimum 105-degree Celsius-rated insulation. Cable jacket must be rated at minimum of 105 degrees Celsius.

b. Balanced twisted-pair telecommunications cables must be rated as above, except that conductors must be minimum 24 AWG; cables including modular connectors must be rated at least Category [5e] [_____].

c. Comply with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM when utilizing IP-based systems.

2.8 SURGE PROTECTION

Major components of the system such as Master Stations, Amplifiers, and Remote Stations, must have devices, either internal or external, that must provide protection against voltage spikes and current surges.

****

NOTE: Consider fiber-optic transmission media, without any metallic elements to connect far away remote intercom stations. An example of this is a remote station at a vehicle gate hundreds of feet from the connection to the system. This can provide better protection from the differential voltage which can occur between the two locations in case of a lightning strike in the vicinity. Do not run any metallic conductors or raceways for signal, power, or data between those locations.

****

a. Signal, Data, and low-voltage power: Continuous voltage rating of surge protective devices internal to the units must be between 120 and 140 percent of the nominal circuit voltage, maximum leakage current must be less than one milliampere, and the unit must be able to absorb at least one hundred 1,000-ampere 8x 20 microsecond pulses without appreciable degradation.

b. External surge protective devices for incoming AC line-voltage protection must be UL 1449-listed Type 3 with a maximum Voltage Protective Rating (VPR) of 330 volts for nominal line voltages of 120 VAC and a VPR of 600 volts for nominal line voltages above 120 volts when tested in accordance with UL 1449.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with the details of the work and working conditions, verify locations and dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work.

3.2 INSTALLATION

****

NOTE: State precisely what is to be shown in detail drawings. State also the calculations that need to be a part of the submittal.

****

Install all system components and appurtenances in accordance with the manufacturer's instructions and as specified and shown. Units to be mounted outside or subject to inclement conditions must be weatherproof or be mounted in weatherproof enclosures.

3.2.1 Signal and Control Circuits Wiring

Install signal and control circuits in accordance with NFPA 70, TIA-568.0, TIA-568.1, TIA-568.2, TIA-568.3, and as indicated. The conductors must be separated as recommended by the equipment manufacturer.

a. Size conductors to maintain voltage drop in power circuits to no more than 3-percent and loss in signal circuits to no more than 0.5 dB. Comply with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM for IP-based systems. Include boosters, additional power supplies, amplifiers, switches, etc. as necessary to maintain these requirements.

b. Run conductors and cables from unit to unit without splicing.

c. Cables that do not use modular connectors can use terminal strips and junction boxes to extend the cable if in conformity with manufacturer recommendations.

d. Provide data switches to extend cable length as necessary for IP-based systems when cable run would otherwise exceed requirements.

e. Follow applicable portions of Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM when utilizing IP-based systems.

f. Locate switches and other consolidation points in Telecommunications Rooms.

3.2.2 Conduit, Cable Tray and Tubing Systems

Install wiring in rigid conduit, intermediate metal conduits, cable trays, or electric metallic tubing as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.3 WARRANTY

Provide a [5] [_____]-year warranty for all units, parts,and assemblies and a [2] [_____]-year warranty on all labor. Include travel and expense costs associated with repair and supervisory persons such that owner is not charged for these when warranty labor is provided.

3.4 GROUNDING

Perform the connection of interfacing components through the use of transformers and the tying of interconnecting lines to a unit ground bus at one end only.

3.5 TRAINING

Conduct a training course for [_____] members of the operating staff and for [______] members of the maintenance staff as designated by the Contracting Officer. The training course must be given at the installation during normal working hours for a total of [2] [_____] hours for the operating staff and [4] [_____] hours for the maintenance staff, and must start after the system is functionally complete but prior to final acceptance tests. The field instructions must cover all of the items contained in the approved operating and maintenance instructions, as well as the demonstration of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to the start of the training course.

3.6 ACCEPTANCE TESTS

After installation has been completed, conduct an acceptance test, using the approved test plan, to demonstrate that the equipment operates in accordance with specification requirements. Submit test plan and procedures for the acceptance test explaining in detail step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedures must also explain methods for simulating the necessary conditions of operation to demonstrate system performance. Notify the Contracting Officer [_____] days prior to the performance of tests. In no case must notice be given until after the written approval of the test plans. The acceptance tests must include as a minimum the following tests:

3.6.1 Operational Test

Test originating station-to-station, and all call at each intercommunication station. Verify proper routing and volume levels and that the system is free of noise and distortion. Test available message path from each station on system.[Test for proper video displays and automatic display of pre-preprogrammed video views.]

3.6.2 Frequency Response Test

Determine frequency response of two transmission paths, including all-call, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.

3.6.3 Signal-to-Noise Ratio Test

Measure signal-to-noise ratio of complete system at normal gain setting as follows:

a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000 Hz signal. Measure signal-to-noise ratio at intercom station speakers.

b. Repeat test for 10-percent of the speaker microphones, but no less than one speaker-microphone.

c. Minimum acceptable ratio is 35 dB.

3.6.4 Distortion Test

Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each all-call amplifier, and a minimum of two selected intercommunication amplifiers. For each frequency, measure distortion in the all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.

3.6.5 Video Tests

Verify that video from all remote stations appears at all master stations with proper resolution, focus, and color balance meeting the manufacturer's published specifications.

3.6.6 Test Reports

Submit test reports in booklet form, upon completion and testing of the installed system, showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria. Include in each test report the final position of controls and operating mode of the system. Include the manufacturer, model number, and serial number of test equipment used in each test.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-27 52 24 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-27 52 24 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-27 52 24 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-27 52 24 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 27 52 24

NURSE CALL SYSTEM
11/20

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NOTE: This specification covers the requirements for requirements for nurse call systems in medical treatment facilities.

Adhere to UFC 1-300-02**. Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update

the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 99	(2024) Health Care Facilities Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems
UFC 4-510-01	(2023; with Change 3, 2023) Design: Military Medical Facilities

UL SOLUTIONS (UL)

UL 1069	(2024) UL Standard for Safety Hospital Signaling and Nurse Call Equipment

1.2 DEFINITIONS

Use UL 1069, NFPA 99, UFC 4-510-01, and TIA-569 for definitions, abbreviations and acronyms unless noted otherwise. In the case of discrepancies UL 1069 takes preference. UFC 4-510-01 takes preference over TIA-569.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wiring Diagrams; G, [_____]

System Riser Diagrams; G, [_____]

SD-03 Product Data

Master Station - Tone-Visual; G, [_____]

Master Station - Audio-Visual; G, [_____]

Nurse Call Control Cabinet; G, [_____]

Battery Backup or Uninterruptible Power Supply; G, [_____]

Nurse Call Controller; G, [_____]

Pull Cord; G, [_____]

Pull Cord - with Audio; G, [_____]

Patient Station; G, [_____]

Patient Station - Audio; G, [_____]

Patient Station - Behavioral Health; G, [_____]

Staff Emergency Station; G, [_____]

Staff Station; G, [_____]

Staff Station - Audio; G, [_____]

Staff Station - Behavioral Health; G, [_____]

Central Code Annunciation Station; G, [_____]

Cord Sets; G, [_____]

Bed Interface Outlet Station; G, [_____]

Cancel Station; G, [_____]

Code Blue Station; G, [_____]

[Infant Distress Code Station; G, [_____]

] Dome Light; G, [_____]

Zone Light; G, [_____]

Corridor Light; G, [_____]

Duty Station; G, [_____]

Equipment Alarm Station; G, [_____]

Nurse Call - Lighting Interface; G, [_____]

Nurse Call - TV Interface; G, [_____]

Call Logging Workstation; G, [_____]

Maintenance Workstation; G, [_____]

SD-06 Test Reports

Acceptance Test Plan; G, [_____]

Acceptance Test Report; G, [_____]

Operational Test Report; G, [_____]

Corrective Action Results; G, [_____]

Warranty Period Inspection And Testing Plan; G, [_____]

Warranty Period Inspection And Test Report; G, [_____]

SD-07 Certificates

System Contractor Qualifications; G, [_____]

Lead Installer Qualifications; G, [_____]

Manufacturer Qualifications; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Data; G, [_____]

Software Service Agreement; G, [_____]

SD-11 Closeout Submittals

As-Built System Drawings; G, [_____]

Equipment Spare Parts List; G, [_____]

1.4 MAINTENANCE MATERIAL SUBMITTALS

1.4.1 Extra Materials

****

NOTE: Do not ordinarily include extra materials in Navy Projects.

****

Furnish the spare parts to the facility as itemized below, after the successful completion of system acceptance testing.

Quantity	Items
[_____]	Each type of Station
[_____]	Patient Station
[_____]	[Dome Light]
[_____]	[Push Button Cord Sets]
[_____]	[Zone Light]
[_____]	[Corridor Light]
[_____]	[Pneumatic Cord Sets]
[_____]	[Pillow Speaker Cord Sets]
[_____]	[Sets of Main Terminal/Equipment Panel plug-in modules]
[_____]	[_____]
[_____]	[_____]

1.5 QUALITY CONTROL

1.5.1 Regulatory Requirements

Conform to UL 1069, UFC 4-510-01, and NFPA 99. Nurse call system components listed by UL or a nationally recognized testing laboratory (NRTL).

1.5.1.1 Cybersecurity

Comply with the cybersecurity requirements identified in UFC 4-010-06, Section 25 05 11, and NFPA 99 while maintaining compliance with UL 1069. Document compliance of cybersecurity requirements for the fundamental nurse call system(s) and all proposed integrations of supplemental systems.

1.5.2 Product Standardization

Provide standard product[s] for the nurse call system from a single manufacturer/vendor, designed to integrate together and operate as a complete system.

1.5.3 Service Organization

****

NOTE: Generally a 4-hour response time is appropriate. Consult with facility for special circumstances including remote locations.

****

Support from a factory-authorized service organization within a [4][_____]-hour window, from notification to arrival at site.

1.5.4 Qualifications

1.5.4.1 System Contractor Qualifications

Authorized vendor/contractor and service organization for the manufacturer of the nurse call system, with a minimum of five years regularly engaged in performing services for projects with similar level of complexity, features and functions including system application, design, integration, installation, testing, training, and maintenance.

Ensure system contractor personnel are factory trained or certified for the make and model of the system(s) provided.

1.5.4.2 Lead Installer Qualifications

Factory trained or certified on the type of system(s) provided. Minimum of five years regularly engaged in the installation of systems for projects with similar level of complexity, features, and functions.

1.5.4.3 Manufacturer Qualifications

Minimum of five years regularly engaged in the manufacture of UL 1069 -listed nurse call systems and equipment, of the same level of complexity, features and functions.

1.6 STORAGE AND PROTECTION

Deliver equipment, components, and materials in original packaging, labeled with the manufacturer/vendor name, part name and part number as appropriate. Inspect equipment, components, and materials upon receipt. Replace damaged items.

Comply with manufacturer's instructions and recommendations for storage and handling of all equipment, components, and materials. Protect materials and components from deleterious environments including weather, direct sunlight, moisture, contamination, corrosion, and construction traffic.

[1.7 SOFTWARE SERVICE AGREEMENT

Submit a proposal for maintenance, licensing, and any other running costs associated with the nurse call system for the next [5][_____] years, divided into annual costs. Coordinate proposal with the Using Services and DHA.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION AND REQUIREMENTS

2.1.1 General Requirements

Provide a complete and fully functional nurse call system in compliance with UL 1069, UFC 4-510-01, and NFPA 99. Compliance to include all aspects of the nurse call system and subsystems including components and cabling, and the selection, arrangement, and connection of materials and circuits.

Supply and install all necessary equipment required, whether or not enumerated, to provide a complete and operating nurse call system. Include the following capabilities:

a. Simultaneously process and signal all calls regardless of the priority level within the nurse call system. When several different priority level calls are present on the system at one time, precedence is given to the highest priority level for call tones and visual indicators.

b. Electronically supervise all call initiation and notification devices, and associated wiring in accordance with UL 1069. Report station failure to designated console[, PC], e-mail, and wireless device.[Provide integral diagnostics able to quickly locate the source of the problem.][Provide network monitoring tool to ensure network reliability.]

c. Support the routing of patient calls to any annunciator[, wireless/telephone network/hands-free/personally assignable communications devices][, pager,] or other annunciating device anywhere in the facility, or to any combination of the above regardless of the location of the calling station. Process calls based on location, room assignment, priority or combination thereof.

d. Perform resetting or canceling of a call with a priority of level #3 or higher only at the initiating station or device within the originating room.

e. Accomplish all programming and firmware changes on a working system without interruption to the normal operation of the system. In the event of an error or failure in the update process, revert to the previous firmware. Test and approve for installation all security patches prior to implementation to prevent interruption in service.

f. Minimum [99][_____] different event types may be defined in the nurse call network to facilitate work flow within and outside of normal nurse call activity (i.e. environmental services, facilities, transportation, lab, pharmacy, etc.).

g. Provide separate, dedicated nurse call network to accomplish all fundamental nurse call operations.[Provide gateways to enable nurse call system integration(s) via the facility network(s).]

h. Provide battery backup or uninterruptible power supply capable of operating the nurse call system(s) at full power for 15 minutes upon AC power failure.

i. Provide the nurse call network to support at least [990][_____] call processes to facilitate work flow and call escalations to various staff or groups.

[2.1.1.1 Integration/Coordination

****

NOTE: Each system integrated will add cost and difficulty in achieving the goals of the cybersecurity approval process.

****

Integrate the nurse call system with the following[existing] systems, by use of agnostic and non-proprietary software. Provide middleware that allows for system integration and provides for interoperability of other systems. Where facility has both tone-visual and audio-visual systems, integrate all subsystems into a combined, fully-functioning nurse call system. Obtain cybersecurity approval for integrations and middleware, while maintaining UL 1069 listing.

[a. Wireless/networked-telephone, hands-free, personally-assignable communication device

][b. Closed circuit television (CCTV)

][c. Hospital-grade televisions

][d. Admit, discharge and transfer system

][e. Patient entertainment system

][f. Infant protection system

][g. Electronic medical records / Electronic health records systems

][h. Patient education system

][i. Access control system

][j. Patient room lighting control

][k. Shade control

][l. Bed exit system

][m. Equipment monitoring[, including [____]]

][n. Real time location services

][o. Staff assignment

][p. Radio paging

][q. Network time synchronization

][r. Call logging workstation

][s. [____]

][t. [____]

][Coordinate patient's control units (headwall[,][and][pillow speaker][, and][bed side-rails]) to provide remote control of devices such as lighting and television, which are not part of the nurse call system.

]][2.1.1.2   Expansion Capability

Provide nurse call system with capability for future expansion. Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and main trunk cable conductor quantities adequate to increase the number of stations in the future by [25][_____] percent above those indicated without adding internal or external components or main trunk cable conductors.

Provide ability to change any individual room without reprogramming by the manufacturer.

][2.1.1.3   Existing System Compatibility

****

NOTE: Integration to an existing system will be outside of the new systems UL 1069 listing, and may require middleware to communicate between the two systems.

****

Maintain UL 1069[and cybersecurity approval] through additions or modifications to the existing nurse call system.

]2.1.1.4   Call Annunciation Priorities

Sequence the annunciation of all call types in a four level priority matrix, with the highest priority of Level 1 and the lowest priority of Level 4. Coordinate the call type names, meanings and priority levels with facility.

Priority Level	Call Type	Lamp Color
#1 Code	Code Blue Code Call	[Blue][Purple][Color coordinated with facility]
#2 Emergency	Emergency Bed Exit Alarm Staff Assist Failure Alarm [Medical Device Emergency Alarm]	[Red][Color coordinated with facility]
#3 Priority	Patient Priority Call Cord Disconnected Bed Cable Disconnected	[Yellow][White][Color coordinated with facility]

Priority Level	Call Type	Lamp Color
#4 Routine	Patient Routine [Medical Device Routine Alarm] [Voice Intercom - Staff and Duty Stations (Audio Only)]	[Green][Color coordinated with facility]

2.1.2 System Shop Drawings

2.1.2.1 System Riser Diagrams

Submit system riser diagram for the overall system, including any integration, and for each subsystem. Identify systems integrated with the nurse call system, and provide description and details for the integration of each system. Identify the level of responsibility of the nurse call system provider for each integration, including provision of interface or gateway modules.

2.1.2.2 Wiring Diagrams

Submit wiring diagrams for the overall system and each subsystem. Indicate wiring type and size, as well as conduit or raceway size for each section of the nurse call system. Ensure system wiring reflects the required expansion capability.

2.1.3 Nurse Call Tone-Visual (NCTV) System

2.1.3.1 Operational Requirements

Provide NCTV system with capability to meet UL 1069 fundamental nurse call functions utilizing alert tones, visual indicators, selectable voice annunciation, and alphanumeric text displays.

2.1.3.2 Master Station - Tone-Visual

LED or monitor display meeting UL 1069. Provide tone-visual annunciation of calls, service requests, staff registration, with ability to display events from any device in the nurse call system network. Call-in priorities are differentiated through unique tone signals and call-in LED flash patterns. Tone may be muted at annunciator, but automatically re-engage if another call is received.

2.1.3.3 Nurse Call Control Cabinet

Wall or rack mounted cabinet for nurse call system head-end equipment including power supplies, battery backup or uninterruptible power supply, [Ethernet switch,]and other ancillary equipment.

2.1.4 Nurse Call Audio-Visual (NCAV) System

2.1.4.1 Operational Requirements

Provide NCAV system with capability to meet UL 1069 fundamental nurse call functions utilizing alert tones, visual indicators, selectable voice annunciation, alphanumeric text displays, and full duplex voice intercom. Full duplex audio communications capability on all handsets and all loud-speaking devices including patient, staff, duty, and master stations.

2.1.4.2 Master Station - Audio Visual

****

NOTE: Association with a VoIP network requires an integration beyond fundamental UL 1069 requirements. Use caution in requiring integrations, unless directed.

****

a. Provide a master station console display that meets the system manufacturer's minimum specifications, utilizing [touch screen][or][keypad][or][standard mouse] control.[Provide an automated service reminder when selecting a call or log item.][While in audio contact with the patient, display all user defined information, such as caregiver assigned[, and pertinent patient information] in an enriched display.][When a PC is "associated" with a VoIP console, provide user with easy to follow on-screen functions, such as display of call priority, room and patient information.]

b. Display calls on the master station in order of their priority level, and then in the order of call placement.

c. Provide the following additional functions at each one of these users' screens:

(1) Full display of all calls, including corridor light color sequence.

(2) Text message to multiple devices such as pagers, wireless phone displays, handsfree devices, and personally assignable communication devices.

[(3) Display calls in a centralized display format (i.e. Centralized Code Blue display).

] (4) Display and route calls in a de-centralized workflow environment.

[(5) Display all staff information, staff status, wireless extension and their location.

]

2.1.4.3 Nurse Call Controller

a. Provide a nurse call network controller in each nursing unit or service with an audio-visual system, capable of non-blocking, duplex communications between consoles and rooms, duty stations, staff stations, sub stations, and master stations.

b. Provide controller as life safety grade meaning that it does not require regular rebooting for continued basic functions of system. Maintain fundamental nurse call operations upon loss of facility's communication network. A PC may not be used as a nurse call controller.

2.2 MATERIAL AND EQUIPMENT

****

NOTE: Refer to UFC-4-510-01 for operation of devices and required locations.

****

2.2.1 Pull Cord

An emergency call device activated by pulling cord. Provide pendant attached to the end of the cord, within patient reach. Provide with call assurance LED[, second, unique call-in priority button,] and cancel button. Provide water-resistant device where installed in wet area.

2.2.2 Pull Cord - with Audio

****

NOTE: Pull cord with audio stations are available from limited manufacturers. Only provide if requested by and coordinated with the using department. Remove pull cord with audio for projects seeking competitive bids.

****

An emergency call device activated by pulling cord. Provide pendant attached to the end of the cord, within patient reach. Provide with call assurance LED,[second unique call-in priority button,] cancel button, and speaker/microphone. Provide water-resistant device where installed in wet area.

2.2.3 Patient Station

Call placed lamp, reset pushbutton, and polarized receptacle matching cord set plug, mounted in a single faceplate. Provide each patient bed with a cord set plug, call placed lamp and unique system address where patient station serves two adjacent patient beds.

2.2.4 Patient Station - Audio

****

NOTE: Keep second paragraph of Patient Stations for systems where the patient station rather than the dome light functions as the hub for the devices in the patient room.

****

a. Call placed lamp, reset pushbutton, speaker/microphone, and polarized receptacle matching cord set plug, mounted in a single faceplate. Provide each patient bed with a cord set plug, call placed lamp and unique system address where patient station serves two adjacent patient beds.

[b. Where the patient station functions as a system hub, provide support of up to [13][_____] call in stations, [3][_____] of which can have audio capability. Provides annunciation at associated console and visible annunciation at device, for calls originating from connected call stations.

]2.2.5 Patient Station - Behavioral Health

Provide tamper-proof pushbutton call device. Pull cords are prohibited. Provide water-resistant device where installed in wet area. Provide each patient bed with a pushbutton and unique system address where patient station serves two adjacent patient beds.

2.2.6 Staff Emergency Station

Call station with the ability to place a staff emergency call. Provide station with a call assurance LED and a cancel button, mounted in a single faceplate.

2.2.7 Staff Station

Provide with call button, call assurance LED, and cancel button mounted in a single faceplate.

2.2.8 Staff Station - Audio

Provides two-way intercom capability. Provide with call button, call assurance LED, cancel button, and speaker/microphone mounted in a single faceplate.

2.2.9 Staff Station - Behavioral Health

Provide two-way intercom capability via ceiling-mounted speakers and microphone. Include call-assurance LED.

2.2.10 Central Code Annunciation Station

Provides central annunciation of code calls from any code station.

2.2.11 Cord Sets

Listed by UL or a NRTL and compatible with the nurse call system listing. Provide a cord set wall bracket with each cord set to hold device when not in use.

2.2.11.1 Cord Set - Push-Button

Sufficient length of cord for patient reach; compatible with medical gas environment; equipped with momentary-action, call button switch; sterilizable; washable cord.

2.2.11.2 Cord Set - Geriatric Call-Button

Sufficient length of cord for patient reach; compatible with medical gas environment; equipped with momentary-action, light-pressure switch in soft outer jacket; sterilizable; washable cord.

2.2.11.3 Cord Set - Squeeze-Bulb Switch

Sufficient length of cord for patient reach; compatible with medical gas environment; equipped with neoprene squeeze bulb activator and plug-mounted momentary contact switch; sterilizable; washable cord.

2.2.11.4 Cord Set - Breath Call Cord

Flexible PVC jacketed cable; momentary contact air-pressure sensitive switch; sufficient length of cord for patient reach; adjustable arm included for clamping; suitable for use in oxygen-enriched atmosphere; include 12 replacement straws; sterilizable; washable cord.

2.2.11.5 Cord Set - Pillow Speaker

Eight-conductor, DIN, flexible PVC jacketed cable. Contains nurse-call button, volume control, separate lighting control for room and reading lights, speaker, and channel control in molded flame-retardant ABS housing. Sufficient length of cord for patient reach with sheet clip; washable cord.

2.2.12 Bed Interface Outlet Station

37-pin receptacle, with dummy plug or dust cap and stainless steel wall plate, supervise and annunciate calls originating from the bed rails on the nurse call system and enable auxiliary functions.

2.2.13 Cancel Station

Cancel button, with flexible programming for cancellation of some or all call priorities, located in the same room as the originating call devices, mounted in a single faceplate.

2.2.14 Code Blue Station

Call station with the singular function to place a code call. Provide station with call assurance LED and cancel button.

[2.2.15 Infant Distress Code Station

****

NOTE: Not all facilities have a separate response team for infant code calls. Coordinate with facility.

****

Call station with the singular function to place a infant distress code call. Provide station with a call assurance LED and a cancel button.

]2.2.16 Dome Light

****

NOTE: For some manufacturer's, dome lights, corridor lights, and zone lights are the same device. Retain all device descriptions to identify performance requirements of system.

****

a. [Four][_____] segment light with integral tone device, with each segment capable of indicating a call in [white, blue, purple, red, yellow, green, orange, and pink][white, blue, red, yellow, and green][_____]. Fully programmable LED lights for the following criteria: colors, patterns, and flash rates.

2.2.17 Zone Light

Provide visual indication with integral tone device of calls by mimicking associated dome light tone, patterns, and flash rates. Provide device capable of producing the same colors as the dome light.

2.2.18 Corridor Light

Provide visual indication with integral tone device of calls by mimicking associated dome light tone, patterns, and flash rates. Provide device capable of producing the same colors as the dome light.

2.2.19 Duty Station

Provides visual and audible notification of calls. Contains [4][_____] LEDs to provide visual indication by mimicking dome light display. Provide device capable of producing the same colors as the dome light. Contains call-in button and speaker/microphone.

2.2.20 Equipment Alarm Station

[Two][_____] isolated inputs for auxiliary alarms with call assurance LEDs and cancel button, compatible with 6 mm 1/4 inch jack medical instruments. Supervise inputs to initiate a call if a cord is removed.

2.2.21 Nurse Call - Lighting Interface

****

NOTE: The 1 level selection is for on/off control of a single light. The 2 level selection is typically used for a reading/ambient/exam light. Coordinate with lighting controls to ensure intended functionality is present. Most nurse call systems will provide momentary contact inputs into the lighting control system rather than controlling the lights directly.

****

Provide [on-off control][full range dimming] for [1][2][______] zone(s) of lighting from the pillow speaker or bed rail. Lighting interface listed by UL or a NRTL.

2.2.22 Nurse Call - TV Interface

Provides control of hospital grade TV, including power, channel selection, channel up/down, volume up/down, closed caption, and mute from the pillow speaker or bed rail. TV interface listed by UL or a NRTL.

[2.2.23 Call Logging Workstation

Provide workstation to monitor, collect, process, store and archive call logs, and prepare analytical reports on the nurse call system and applicable integrations. Coordinate reports required with the Using Services.

][2.2.24 Maintenance Workstation

Provide workstation for remote monitoring, diagnostics, testing, and troubleshooting of nurse call system failures.

]PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: This specification is suited primarily for new building construction.. Modify as appropriate if used for a remodeling or retrofit type project. In retrofit projects, the designer should become familiar with as-built conditions, and maximize the use of existing conduits and raceway components. Use extreme care in retrofit specifications to avoid proprietary statements.

****

Provide a complete and operational nurse call system, with subsystems, in compliance with NFPA 70, NFPA 99, UL 1069, UFC 4-510-01, and TIA-569. Install equipment and accessory items to suit manufacturer's instructions and recommendations, plans and specifications. Provide insulated conductors in electrical metallic tubing and cable tray as the wiring method.

3.1.1 System Installation

a. Use water-resistant devices in wet areas, such as toilet rooms and showers.

b. [Surface mount main terminal/equipment panels][Rack][Cabinet]-mount the system LAN, server, and battery back-up equipment in the [server room][room approved by DHA to house servers]. Mounting of the panels and equipment in any other room, area or above-finished ceilings is not acceptable. Mark panels with the nurse call subsystem number and function served.

c. Master Station equipment that does not require attendant access for programming or call activities (such as the battery back-up) may be wall mounted in a protected area under the counter top at the master station location. If the under counter mounted equipment can be kicked and damaged by staff sitting at the counter, provide a protective shield for the equipment.

d. Firmly secure mounted equipment in place, plumb, square, and level.

e. Locate equipment to provide adequate ventilation and equipment access for service and repair.

f. Mount dome lights, corridor lights, zone lights so they are visible for the entire length of the corridor or room in which they are installed.

g. Develop zone light operational matrix, to ensure zone lights operate to notify and direct staff to the associated dome light and annunciated call device. Incorporate operational matrix into the system shop drawings.

h. Incorporate facility's final room naming convention and room numbering into the programming of the nurse call system. Provide permanent label for each new panel and equipment.

i. Install cabling in raceway and cable trays. Segregate cabling in separate raceways or cable tray as required per wiring diagrams. Install cable tray and raceway parallel and perpendicular to structural members, concealed from view except where specifically noted per drawings.

j. Install cables without damaging conductors or jacketing, pulling cables within manufacturer's recommended pulling tension.

k. For nurse call devices in behavioral health areas, provide tamper-proof screws, pushbutton devices, ceiling mount speakers, ability to limit calls from patient devices, and ability to mute calls from the master station.

3.2 FIELD QUALITY CONTROL

3.2.1 Periodic Inspection and Testing

All work and workmanship is subject to inspection and testing as requested by the Contracting Officer at any and all times during preparation and installation. The Contracting Officer, in his or her sole discretion, may reject defective work and workmanship and require its correction. The Government's right to inspect, test, and reject, or its failure to exercise such right, as provided herein, in no way diminishes the system Contractor's duty to inspect and reject work as necessary to comply fully with the requirements of the contract documents.

3.2.2 Final Inspection and Acceptance Testing

Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3.2.2.1 Inspection

a. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Verify that the system and individual devices are installed in accordance with manufacturer's instructions.

b. Notify the Contracting Officer when the installation of [each phase of]the system is completed and operating in accordance with specifications and ready for final inspection.

c. After installation [of each phase]has been completed, and the system components installed [during the phase]have been final inspected, checked out, and approved by the Contracting Officer, conduct acceptance tests in accordance with the approved Acceptance Test Plan.

3.2.2.2 Acceptance and Operational Testing

a. Develop an Acceptance Test Plan, to include step-by-step actions and the expected results to demonstrate system compliance. Include tests defined in the Manufacturer's installation instructions; list of all test equipment, including data indicating that calibration of the test equipment is current; test data sheets; and names and qualifications of the person(s) who will perform the tests.[For project's with phased construction schedules, identify acceptance test criteria for each phase in the test plan.]

b. Conduct acceptance tests in accordance with the approved Acceptance Test Plan upon approval of final inspection [of each phase]by the Contracting Officer.

c. Operational Test: After completion of the acceptance testing, perform an operational system test to demonstrate proper operations as defined in UL 1069. Test each station capable of originating calls by activating a call from the station and observing the proper sequence of operation. Demonstrate each call type and priority for stations capable of placing multiple types or priorities of calls. Perform tests that include originating station-to-station messages and pages at each nurse-call station. Verify proper routing, volume levels, and freedom from noise and distortion. Simulate power outage to demonstrate operation on battery back-up source and transition to the essential electrical system. Submit an Operational Test Report to document results.

d. Upon successful completion of [all phased]final acceptance tests, and 30 calendar days of consecutive operationwithout the occurrence of any major malfunctions, submit the final acceptance test report, including certificates of compliance stating that all requirements and conditions have been satisfied. Submit test reports in both electronic media form and hard copy booklet form. Indicate in the field reports all field tests performed to adjust each component and to prove compliance with the performance criteria.

e. Indicate in each test report the final position of controls and operating mode of the system, and the manufacturer, model number, and serial number of the test equipment used in each test. The effective date of final system acceptance is the date when the system has satisfied 30 days of operation without a major malfunction.

f. Submit as-built system drawings in accordance with Section 01 78 00.

3.2.2.3 Corrective Action for Rejected Work

Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets the system requirements and complies with applicable standards. Report corrective action results in writing.

3.2.2.4 Warranty Period Inspection and Testing

At the end of 3rd and 7th months of operation, observe the system in operation and conduct tests to assure system performance. Include interviews of users to determine if the system is satisfying requirements and that training is adequate. Coordinate this service with the Contracting Officer. During the [11][____]th month of operation conduct an inspection and test of the system to identify and correct any deficiencies before the end of warranty period. Conduct this inspection and testing in the presence of a medical facility representative to witness this procedure and certify that all necessary corrective actions have been taken. Submit the warranty period inspection and test report to the Contracting Officer. Submit warranty period inspection and testing plan, including contact information and dates of proposed warranty period inspection prior to final system acceptance.

3.3 TRAINING

****

NOTE: Designer to coordinate timing of refresher course with the facility. Eleven months is intended to ensure the refresher training occurs as close to the end of the warranty period as possible, to allow

the facility to develop experience with the systems to thereby improve the effectiveness of the training.
****

[Engage a factory-authorized service representative to train][Train] Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment. Provide training for each role assignable in the nurse call system. Coordinate number of roles with using services. Provide minimum two training sessions for system users and minimum two training sessions for maintenance personnel scheduled to accommodate shift work. [Eleven][____] months after [the system is installed][beneficial occupancy], provide a refresher course for each group of trainees.

3.4 MAINTENANCE

Submit Data Package 5 operation and maintenance data for the installed nurse call system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

a. Utilize systems and devices in accordance with the UL 1069 listing of the nurse call system and the Cybersecurity approvals noted in this Section. Coordinate with Government to establish a plan of action for approval and dissemination of required Information Assurance Vulnerability Alert (IAVA) patches as well as software and security updates. Provide perpetual licenses for the nurse call system.

b. Provide equipment spare parts list for all spare parts furnished.

****
NOTE: Requiring software upgrade after project completion will add substantial cost to nurse call system. Use caution when selecting this option.
****

[c. Upgrade Service: Update software to latest version at project completion. [Install and program software upgrades that become available within [two][_____] years from date of Substantial Completion.]Upgrade operating system if required to support software upgrade. Provide new or revised licenses to enable use of upgraded software. Ensure cybersecurity approval is maintained through the upgrade(s).

][d. [c][d]. Technical Support: Beginning with Substantial Completion, provide software support for [two][___] years. Follow the DHA Business to Business (B2B) process, or other process as coordinated with the Using Services to provide connectivity to support remote repair, maintenance, and sustainment of the system.

][e. [c][d][e]. Provide [30][___] days notice to Using Service to allow scheduling and access to system and to allow Using Service to upgrade computer equipment if necessary.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-27 53 19.13 (May 2020)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 27 - COMMUNICATIONS

SECTION 27 53 19.13

FIRST RESPONDER DISTRIBUTED ANTENNAE SYSTEMS (DAS)

05/20

PART 1 GENERAL

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-27 53 19.13 (May 2020)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 27 53 19.13

FIRST RESPONDER DISTRIBUTED ANTENNAE SYSTEMS (DAS)
05/20

****
NOTE: This guide specification covers the requirements for distributed antenna systems (DAS).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
1. On telecommunications floor plans, show location of headend equipment and other active components.

2. On electrical floor plans, show branch circuits for all active components. In healthcare occupancies, connect all active components to the life safety branch of the essential electrical system.
****

1.1 RELATED SECTIONS

[Section 07 84 00 FIRESTOPPING for additional work related to firestopping.]

1.2 SUMMARY

1.2.1 Scope

****

NOTE: Modify scope to clearly include desired capabilities of the distributed antenna system.

NOTE: Types of DAS are generally classified into three different categories. These categories are passive DAS, active DAS, and hybrid DAS. Coupling two solutions together in the same space or facility is not recommended because they could interfere with each other.

NOTE: Passive DAS is typically used for buildings 125,000 square feet or less and in a building that does not have a large amount of metal, masonry, or concrete wall materials that block the RF signals. Passive DAS uses only coaxial cable to distribute the signals. It is the smallest, simplest, and often the least expensive DAS solution. Passive DAS is inherently limited in bandwidth and is only suitable for very small service frequency requirements. A Passive DAS is only allowed were permitted by the using military departnemt and is not allowed in military medical facilities.

NOTE; Active DAS is a solution used for larger spaces and spaces with more barrier materials that block the RF signals from traveling through the interior space. Active solutions use fiber optic cabling which changes the RF signals into light for distribution, and then back into usable signals at the desired locations. An active DAS is the preferred solution for military medical facilities. Specify an active system for all medical facilities.

NOTE: A hybrid DAS solution includes a combination of both active and passive DAS. Do not specify a hybrid DAS solution.

****

a. This work includes design and providing a new, complete, [passive] [active] distributed antenna system (DAS) as required and as described herein for the [building name]. Provide a turnkey system capable of receiving, processing, and transmitting indicated radio signals including the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, active components, passive components, mounting hardware and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide system[s] complete and ready for operation. See paragraph titled SYSTEM DESCRIPTION for additional requirements.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required provisions of NFPA 72 [and NFPA 1221].

c. [c. The system layout on the drawings show the intent of coverage and are shown in suggested locations. Submit plan view drawing showing all component locations, cable routing, junction boxes, other related equipment, conduit routing, and wire counts for all floors.]

****

NOTE: Include project specific frequencies in the brackets.

****

d. Provide a DAS capable of receiving, processing, and transmitting first responder[, military and local emergency medical services (EMS),][radio paging,] [and][required [UHF][and VHF]] frequencies. Provide initial system capable of processing services of frequencies from [_____] to [_____]. Provide a system that is upgradeable to allow future additional frequencies as required by NFPA 1221.

e. Provide letters of permission for all used frequencies for which the Government does not already have a license.

1.3 1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 99	(2024) Health Care Facilities Code
NFPA 780	(2023) Standard for the Installation of

	Lightning Protection Systems
NFPA 1221	(2019; TIA 21-1) Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 800-82	(2015; Rev 2) Guide to Industrial Control Systems (ICS) Security

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-329.1-D	(2009; R 2013) Minimum Standards for Communication Antennas Base Station Antennas
TIA-455-13	(1996a; R 2012) FOTP-13 Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies
TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC EMC	(2002) FCC Electromagnetic Compliance Requirements
FCC Part 15	Radio Frequency Devices (47 CFR 15)
FCC Part 95	Personal Radio Services (47 CFR 95)

UL SOLUTIONS (UL)

UL 924	(2016; Reprint Dec 2022) UL Standard for Safety Emergency Lighting and Power Equipment

1.4 DEFINITIONS

1.4.1 System Integrator

A person or organization that specializes in distributed antenna systems in bringing together component subsystems in to a complete system and ensuring that those subsystems function together as a complete system. The system integrator is responsible for the system design, installation, testing including all warranties required by this specification.

1.5 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications; G, [_____]

SD-02 Shop Drawings

System Description; G, [_____]

System Layout; G, [_____]

Detail Drawings; G, [_____]

Coordination Drawings; G, [_____]

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Material and Equipment; G, [_____]

Uninterruptible Power Supply; G, [_____]

Warranty; G, [_____]

SD-05 Design Data

Design Analysis and Calculations; G, [_____]

SD-06 Test Reports

Acceptance Test Plan; G, [_____]

Acceptance Test Procedure; G, [_____]

Acceptance Test Report; G, [_____]

SD-07 Certificates

Accreditation; G, [_____]

Certificates of Compliance; G, [_____]

SD-08 Manufacturer's Instructions

Installation; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

Submit Data Package 5 for each component in accordance with requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Training Plan; G, [_____]

SD-11 Closeout Submittals

As-built System Drawings; G, [_____]

Closeout Documentation; G, [_____]

1.6 SYSTEM DESCRIPTION

1.6.1 Design Requirements

Provide a Distributed Antenna System (DAS), capable of distributing first responder radio signals from equipment including [Government Furnished, Government Installed (GFGI) wireless (802.11a/b/g/n) and LAN controllers,] communication links, antenna systems, bi-directional amplifiers, [coaxial cabling,] [broadband repeaters] in necessary bandwidths to support desired frequencies, couplers, decouplers, battery backup, power line surge protection and all other necessary components to make a complete and operational system. Provide a complete and operational system to distribute system two-way radio service from the first response radio system.

Complete coverage in accordance with NFPA 1221 will be provided for all interior spaces including [mechanical areas,] [open stairwells,] [and] [storage areas][_____].

Provide all headend interface, antenna interfaces and amplification components, conditioners and any other equipment necessary.

Provide system features that include, at a minimum, frequency conditioners, auto isolation detection (Uplink/Downlink) and auto turn on-off (Downlink) functions to ensure that the repeater unit is optimally positioned and safe guarded at all times. It will also have LED displays to show uplink and downlink connection, as well as LED lights for power and uplink and downlink alarms.

Provide all materials and labor needed for a complete and operational system for the services in this specification plus the additional system capabilities as indicated. This includes but not limited to all necessary equipment, interfaces, jumpers, terminations, cabling, antennas, amplifiers, conditioners, power supplies, battery backup, software and all components required to attach access points to the system.

1.6.2 System Application Design

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NOTE: At a minimum, include the following on the telecommunications drawings: System block diagrams showing major components, a system riser showing relative locations of major equipment, telecommunications room layouts showing locations of major equipment, roof conduit penetrations and antenna mounting details, and cable riser and major pathway locations.

****

Provide the system application design required to provide a DAS that complies with and satisfies all of the requirements specified in this Section[and as indicated on the Telecommunications Drawings] for this application and project.

1.6.3 Standard Products

Provide an application design that utilizes standard system components that are the product of a Manufacturer regularly engaged in the manufacture of DAS, and that have been in satisfactory use for at least six months. The System must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the facility.

Provide hardware, software, and installation of a complete and engineered system. Provide a submitted design that is properly engineered for the operational requirements. Include all components required to meet this specification section in the design, other than a change in, or in addition to the operational frequencies identified herein.

1.6.4 Local Products

Incorporate local materials to the greatest extent possible. All proposed local products must meet all applicable hardware and software requirements set forth in these specifications.

1.6.5 Minimum Requirements

Specifications are minimum requirements. If the provided system requires enhanced specifications that exceed those specified herein in order to satisfy the specified design, configuration, capability, and performance requirements, then provide a system with the enhanced specifications.

1.6.6 Current State-of-the-Art Technology

Provide DAS application design and products that utilize current state-of-the-art products that provide the enhanced capability and performance specified herein. Provide DAS design and products representing the latest manufacturer make and model.

1.6.7 Continuous Duty Design

Provide equipment designed for 24 hours per day, 365 days per year continuous 100 percent duty operation.

1.6.8 Design Analysis and Calculations

Provide a comprehensive design analysis and calculations to i, at a minimum, the following:

a. Power supply requirements for each component of the system in accordance with the manufacturer's instructions and the worst-case loading conditions for power supplies that are not part of the component. Provide power consumption and dissipation data under normal and maximum operating conditions.

b. Cable type, size, and attenuation calculations for all cables connecting the components of the system according to manufacturer's instructions.

c. Definition of all interface protocols and specific preparation and application items including coordination issues.

d. Signal calculations and anticipated signal strength for various areas of the buildings.

e. Frequencies of operation and the transmission characteristics throughout the facility.

f. Amount of concurrent users per frequency and service.

g. Uninterruptible power supply meeting the secondary power source requirements of NFPA 1221 and UL 924.

h. System monitoring meeting the requirements of NFPA 1221 for Two-Way Radio Communications Enhancement Systems.

1.6.9 Environmental Requirements

Provide equipment to be used indoors rated for continuous duty operation under ambient environmental conditions of 35 to 120 degrees F1.7 to 49 degrees C dry bulb and 10 to 95 percent reflective humidity, noncondensing. Provide all other equipment rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

1.6.10 Electrical Requirements

105 VAC to 130 VAC at 60 Hz operating voltage range, plus or minus 2 percent.

1.6.11 Power supplies

Provide primary and secondary power supplies in accordance with NFPA 1221 that provide sufficient power for worst-case conditions of system operation that could occur without signal loss or perceptible degradation. Provide power supply monitoring in accordance with NFPA 1221.

1.6.12 Power Line Surge Protection

Provide power line surge protection for all equipment connected to AC power. Provide surge protection integral to the equipment or installed as an accessory item in accordance to manufacturer's recommendations. Do not use fuses for surge protection.

1.6.13 Antenna Line Surge Protection

Provide power line surge protection for all equipment connected to a radio antenna. Provide surge protection in accordance to manufacturer's recommendations. Do not use fuses for surge protection.

1.6.14 Shielding and Grounding

Provide shielding and grounded as required by the system design, Manufacturer's instructions, FCC Part 15 listing, and regulatory requirements.

1.6.15 System Capability and Configuration

1.6.15.1 System Capability

Provide a DAS to support all indicated frequencies and services.

Coordinate requirements for interfacing with the trunked radio system which supports fire and police departments and emergency personnel with the Contracting Officer.

1.6.15.2 System Configuration and Major Functional Components

Provide system of automatically controlled bi-directional amplifiers (BDA), antennas, decoupling cavities, coaxial cables, fiber optic cables, related filtering devices engineered into one tuned system that will accomplish the specified functionality on all specified frequencies.

1.6.16 Performance Requirements

Provide DAS coverage within the facility in accordance with NFPA 1221 and as follows:

****

NOTE: Include comprehensive list of all locations where 99 percent floor area radio coverage is required. Included this list in this

specification. Consult with using military department during construction document design for required areas.
****

a. 99 percent floor area radio coverage for critical areas such as the [emergency command center,] [fire pump rooms,] exit passageways, [elevator lobbies,] [standpipe cabinets,] fire suppression valve locations, [_____] and other areas deemed critical by the Contracting Officer.

b. 90 percent floor area radio coverage for general building areas.

1.6.16.1 System Initiation and Operation

No user controlled features are permitted on this system. System is to be active on power up and perform as specified without any form of manual control.

1.6.16.2 Signal Processing Rates

System processing rates are real time and occur without interference. Include proper engineering to remove intermodulation effects, interference within system components, echo, delay or disparity reception caused by active or passive components or by the transmission media. System must be capable of supporting a large amount of users per frequency.

1.6.16.3 Priority

All devices coexist on the system without channel control within the system.

1.6.16.4 Signal Strength

Provide minimum signal strength in accordance with NFPA 1221 throughout the coverage areas.

1.6.16.5 Reception

Provide complete reception and transmission within the facility without shadows or dead spots.

1.7 QUALITY ASSURANCE

1.7.1 Cybersecurity

****
NOTE: Coordinate DAS integration requirements with facility needs and cybersecurity requirements. Simple DAS may be segregated from the facility network and greatly reduce the cost of cybersecurity compliance.
****

a. The Risk Management Framework (RMF) is the process by which information systems are accredited for operation by a designated official from the Using Military Department. It is the standard process under which all DoD information systems must achieve and maintain their Authority To Operate. The Cyber Security process is documented in DOD 8510.01 and NIST SP 800-82. Refer to UFC 4-010-06 for additional requirements.

b. All systems that are IP addressable or interface with the Assured Network must be certified to operate. Coordinate with the Government to initiate and complete the accreditation process.

c. Cybersecurity requires input from the system vendor or provider and support from the local IMD. The local IMD-IA office is the point of contact for all Cybersecurity requirements. The local CMIO is the point of contact for all clinical and functional system requirements.

1.7.2 Shop Drawings

In exception to Section 01 33 00 SUBMITTAL PROCEDURES, submitted plan drawings must be a minimum of 279 by 432 mm 11 by 17 inches in size using a minimum scale of one mm per 100 mm 1/8 inch per foot[, except as specified otherwise]. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on the wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity. Also include applicable federal, military, industry, and technical society publication references.

1.7.2.1 Detail Drawings

Provide drawings certified by the qualified system integrator. Include drawings specifically prepared to indicate the work for this project. Generic drawings are not acceptable. Submit drawings to include:

a. System block diagram, riser diagrams, wiring and schematic diagrams, run sheets including number of conductors and wire number (ID), custom assembly details, installation details, location of donor antennae and maps showing donor equipment sites and signal strength at the construction site for each donor system. Provide a drawing that indicates all RF emitting elements, antennae or radiating cable within the system, differentiated from all interconnecting cables and or elements, and the location and value of any non RF emitting terminations, stubs or loads.

b. Riser diagrams that indicate the identification number (ID) for all equipment components.

c. Installation details that indicate layout and mounting of equipment, equipment relationship to other parts of the work, including clearances required for maintenance and operation, and plan and elevation details that indicate the exact and totally coordinated physical location and size of each individual item of equipment.

d. Installation details for equipment and cabling that is mounted within or on the ceiling, ceiling grid, or hard ceiling structure and that includes the make and model of the surface or recess mounted boxes and wireways, and details for any mounting hardware.

e. Details for the custom assembly of equipment that indicate the assembly configuration, elevations and dimensions. Typical custom assembly details include equipment panels, and equipment mounted in a rack or cabinet.

f. Legend of graphic symbols used.

[g. Details that indicate anchoring and bracing provided for seismic protection in accordance with the requirements of the Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]

1.7.2.2 Coordination Drawings

Submit coordination drawings to include:

a. The details of all electronic and physical interfaces between the DAS System and all interfaced telecommunications systems and other systems, including the exact point and type of demarcation.

b. The layout and mounting of all DAS equipment, and the routing and mounting of cabling in telecommunications rooms and the communications equipment room as coordinated with the layout of all other systems equipment in these rooms.

c. The layout, routing, and mounting details of all equipment, cables and apparatus located in ceilings, passageways, or other areas not indicated as communications spaces, and to coordination of those items with ductwork, plumbing, lighting and other materials so located in those respective areas.

1.7.3 Qualifications

1.7.3.1 General Qualification Requirements

a. The System Integrator and Installer must each have the minimum qualifications specified, related to the type of system specified for this project. All system components must meet the minimum requirements of this specification.

b. The Government reserves the right to accept or reject the System Integrator or Installer based upon qualifications and ability to conform to specified technical or licensing requirements of this Section. System Integrator, Installers that do not have the specified qualifications will not be accepted.

c. The Government will determine the acceptability of any proposed System Integrator or Installer based on submitted and verified documentation that substantiates that the proposed System Contractor, Installer and Manufacturer have the qualifications specified in this Section.

d. Submit documented verification of the specified qualifications as part of the Data Qualifications submittal. The Government maintains the right to request, inspect and verify references and resumes of all technical and managerial personnel assigned to the project.

e. Include qualification documentation, but not limited to the information outlined below:

    (1) A list of projects performed by the System Integrator and Installer during the last five years explicitly involving the type of system specified in this section, including:

    (a) Name of facility where work was completed.

    (b) Name, title, address and telephone number of a point of contact for the listed facility.

    (c) The make and model of the system provided and total scope of work for the facility.

    (d) Restrict list to the facilities where the same type of system was installed for the same purpose provided.

(2) An organizational chart of the DAS System Integrator and Installer project team that will perform the work included in this specification section.

(3) List and resumes of the principle personnel that will be assigned to the work on this project to include responsibility and relationship to the project management structure. For each individual, include education, certification of factory training, and experience relevant to work assignments for this project. Do not include unrelated experience with other systems. Include the following personnel:

    (a) System project manager

    (b) System Application Designer

    (c) [CAD][BIM] staff that will prepare submittal drawings

    (d) Installation technician and supervisory personnel

    (e) Acceptance Testing Personnel

    (f) Training Personnel

(4) Define the work and services that will be performed at locations other than on the project site, and provide points of contact, the address and telephone number of the locations where such off-site work is to be done. Include the following, at a minimum:

    (a) Project management

    (b) System application and design and documentation

    (c) Testing and training plans

    (d) Repair and maintenance services

    (e) Maintenance supplies warehouse

    (f) Training personnel

(5) Telephone number that will be answered by staff 24 hours per day, 365 days per year, to obtain repair parts and maintenance service.

(6) The System Integrator and Installer qualifications relative to the the type of system specified in this Section.

(7) A letter from the System Integrator stating that system being

provided satisfies all functional and product requirements specified in this Section.

(8) . A letter from the System Integrator guaranteeing the availability of parts as specified.

1.7.3.2 System Integrator Qualifications

a. System Integrator qualifications must include the following:

  (1) The System Integrator is regularly engaged in the system application design, documentation, installation, testing, training, and maintenance of the type of system specified in this section.

  (2) The System Integrator has a minimum of five years experience providing these services for systems having the same level of features and functions as the system being provided.

  (3) The System Integrator has a minimum of five years as the manufacturer or an authorized distributor and service organization for the manufacturer of the system provided.

b. System Integrator personnel qualifications must:

  (1) Be factory trained or certified for the make and model of the components used in the system provided.

  (2) Have a minimum of five years experience performing the services specified in this specification section.

  (3) Maintain a full compliment of spare parts for the provided system with the ability to furnish on-call maintenance 24 hours per day, 365 days per year.

1.7.3.3 Installer Qualifications

a. The installer personnel must be regularly engaged in the installation of the type of system in this specification section.

b. The installation supervisor must be factory trained and certified or licensed for the type of the system provided.

c. The installation supervisor must have a minimum of five years experience providing services having the same level of features and functions for the system included in this specification section.

d. The installation personnel must have a minimum of three years experience providing services having the same level of features and functions for the system included in this specification section.

1.7.3.4 Manufacturer Qualifications

The system manufacturer must:

a. Have a minimum of five years experience in producing the products and type of system included in this specification section.

b. Produce a system that satisfies all specified features, functions and product requirements.

c. Guarantee the availability of the replacement parts for the designed system for a minimum of seven years from the date of final acceptance of the system by the Contracting Officer.

1.7.4 Regulatory Requirements

1.7.4.1 Products

Provide products which comply with FCC Part 15

1.7.4.2 Design and Installation Work

Provide design and installation work compliant with FCC Part 95, UL 924, NFPA 70, and TIA-569

1.7.4.3 Electromagnetic Interference (EMI)

a. Comply with FCC EMC and the EMI standards specified in FCC Part 15 for EMI caused by electronics devices.

b. Provide a system that does not generate nor is susceptible to any harmful electromagnetic emission, radiation, or induction that degrades, obstructs, or interrupts the operation of the installed system, any computer system, [or] life safety system[, medical equipment] [or patient monitoring system].

c. In the event that any part of the system is certified by the FCC, and subject to CFR technical rules and standards, and are different or in addition to those set forth herein, the standard relating to these parts apply.

d. Comply with current CFR standards that are applicable to the system at the time of system acceptance testing.

e. In the event of a breach of representations or warranties, the System Integrator or Installer, and its own expense, is responsible to put the offending system into compliance with the current applicable CFR standards or replace the offending system with an acceptable system.

1.8 DELIVERY, STORAGE, AND HANDLING

1.8.1 Protection

Store all products delivered and placed in storage protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.8.2 Delivery Coordination

Coordinate deliveries with the Contracting Officer to insure a timely installation.

1.8.3 Loss Liability

The System Integrator or Installer is liable for any loss due to delivery and storage problems.

1.8.4 Delivery Restrictions

a. Do not deliver products or installation material the project site more than one month prior to commencement of its installation.

b. System products must not leave the factory prior to six months before the time that the facility is ready for installation of the products. Obtain prior written approval of the shipping date from the Contracting Officer.

1.8.5 System Integrator Responsibility

The System Integrator or Installer is responsible for all handling and control of products provided under this contract.

1.9 SEQUENCE AND SCHEDULING

a. Install each part of the system and phase into operation as required by the project schedule.

b. Schedule and coordinate work with all other trades and suppliers whose work is critical to the successful installation of the system.

c. Furnish and install all required items for a complete and operating installation so as to cause no delay in work by others, or completion of the project.

d. Perform final inspection and acceptance testing of each system after the system installation has been completed and all pre-testing, [and commissioning] have been successfully completed.

1.10 WARRANTY

Provide equipment items that are supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Warranty the operational and physical integrity of the provided system, including a warranty against all defects in design, equipment, materials, software, workmanship, and improper installation and adjustments, for a period of at least one year from the date of final acceptance of the work. If the System Integrator or Manufacturer warranty is for a period longer than one year, the longest warranty period governs. Include a warranty document with the Product Data submittal.

During the warranty period any maintenance, make adjustments or repairs in accordance with the Warranty Maintenance specifications herein. Warranty repair of minor malfunctions desired by the Government at other than normal working hours may be charged at current labor rates for the premium portion of time.

1.11 MAINTENANCE

1.11.1 Operation and Maintenance Manuals

Furnished commercial off the shelf manuals for operation, installation, configuration, and maintenance of products. Submit operations and maintenance data in accordance with Section 01 78 23 OPERATION AND

MAINTENANCE DATA and as specified herein not later than [2] [_____] months prior to the date of beneficial occupancy. In addition to requirements of Data Package 5, include the requirements of paragraphs DETAIL DRAWINGS, and COORDINATION DRAWINGS. Ensure that these drawings and documents depict the as-built configuration.

1.11.2 Extra Materials

1.11.2.1 Off-The-Shelf Maintenance Parts

Provide guarantee that a stock of the subsystem component parts required for maintenance service will be available off-the-shelf from the system integrator, and can be express shipped to the Facility if not available locally within a 150 mile driving radius of the Facility. Parts that must be ordered from the Manufacturer for the repair of a major malfunction, as defined herein, must be express shipped for delivery within one day after the major malfunction has been identified. Parts that must be ordered from the Manufacturer for the repair of a minor malfunction, as defined herein, must be express shipped for delivery two days after the minor malfunction has been identified.

1.11.2.2 Installation Spare Parts

The System Integrator is required to keep an adequate quantity of installation spare parts onsite to preclude work stoppages and to meet other contingencies that might arise prior to the final inspection and acceptance of the system.

1.11.2.3 Post Acceptance Spare Parts

a. After the system has been in acceptance by the Government, recommend and provide one of the minimum quantity and type of onsite spare parts as necessary to maintain the full operation of the system in case of failure.

b. System Integrator is required to maintain spare parts on-site during the warranty period to facilitate quick repair through plug-in module replacement of key system components, then replenished and turned over to the Government at the end of warranty period.

c. Provide recommendation of any additional onsite spare parts deemed necessary by the Manufacturer and or the System Integrator. Furnish to the Contracting Officer the cost of recommended additional spare components as a separate line item.

1.11.2.4 Special Tools and Equipment

Provide any special maintenance tools, equipment and software are defined as those items that are uniquely required, due to Manufacturer make or model of the provided products, to install, setup, initialize, program, and maintain any component or function of the system such. Provide, after final inspection and acceptance, one set of any special tools, equipment and software necessary.

1.11.3 Maintenance Service

a. Perform warranty maintenance service on the system using qualified maintenance personnel that have been trained for the system being serviced.

b. System Integrator is required to offer a Service Agreement to the [medical] facility. Include a copy of the proposed Service Agreement with the Product Data Submittal.

c. As authorized by the [medical] facility, the contractor may utilize [medical] facility maintenance personnel that have been factory trained for maintenance of the provided system for the first level of response to a call for service.

d. If available at the project location, provide and on-line diagnostic maintenance support capability as specified herein.

1.11.4 Service Availability and Response Time

a. Provide maintenance service on a 24 hour per day, 7 days per week, 365 days per year basis for on-premises maintenance within 8 hours after notification of a major malfunction. Maintenance service must include a 24 hour answering service available to receive after hour maintenance requests and to dispatch on-call service personnel within the required response time.

b. All major repair malfunctions must be accomplished within 8 hours of the reported failure. A major malfunction is defined as failure of one of the following major functional components:

  (1) Complete failure of any headend or remote equipment.

  (2) Failure of a power supply, exclusive of loss of utility power feed.

  (3) Failure of 20 percent or more of all antenna locations in the facility.

c. Repair of a minor malfunction is any failure other than a major malfunction. Minor malfunctions must be repaired within 48 hours.

PART 2 PRODUCTS

2.1 2.1 MATERIAL AND EQUIPMENT

2.1.1 New Products

Provide products, components, and devices that are new and free of defects. Coordinate floor space requirements and electrical branch circuits for all equipment requiring 120 VAC. Any special cabinetry or shielded enclosures are the responsibility of the System Integrator or Installer and are to be provided and installed as part of this system.

2.1.2 Unspecified Products

If the provided system requires additional products that are not specified or indicated on the Telecommunications Drawings in order to satisfy the specified performance requirements for the system, then provide additional component.

2.1.3 Product Modifications

Modification of products that nullifies the UL listing or other agency approval is not permitted.

2.1.4 Identical Products

Provide identical make and model for products such as component equipment, modules, assemblies, parts and materials of the same classification.

2.1.5 Nameplates and Equipment Markings

a. Provide nameplate and equipment marking for each major equipment component to include the Manufacturer's name, model, and serial number on a plate secured to the equipment. Also, include all compliance with regulatory requirements, such as UL and CFR on the nameplate or on adjacent labels.

b. Plainly and permanently label all controls with the identification of the function served. Stick on marker tapes are not acceptable.

[c. Markings on any exposed surfaces must be resistant to housekeeping solutions normally used in medical facilities.]

2.1.6 Mounting Alignment Capability

Provide wall mounted components with capability for adjustable mounting alignment to compensate for improperly aligned back boxes and to insure a plumb, square, and level installation.

2.1.7 Model and Enhancements

a. Provide products and components that are the manufacturer's latest model, design, version, and quality in production at time of delivery and installation.

b. Notify the Contracting Officer of any product enhancements that become available after delivery and installation, and up to time of system acceptance, must be brought to the attention of the Contracting Officer upon announcement by the Manufacturer and make enhancements available to the Government. If such enhancements customarily are provided at no additional cost, the Government must automatically be entitled to such enhancements. If such enhancements customarily are provided at additional cost, the Contracting Officer may chose to accept or reject such enhancements.

c. Submit a letter to the Contracting Officer from the Manufacturer guaranteeing that the Manufacturer will inform the Government of, and make available to the Government, all commercially available enhancements to the System at the then current price. Include the letter with the Data Submittal.

d. Substitutions, modifications, or improvements to a System are permissible provided that such substitution, modifications, or improvements will not reduce or degrade the performance or product requirements, nor violate regulatory requirements. No such substitutions, modifications, or improvements can be made without the written consent of the Manufacturer and Contracting Officer. Such consent must not be unreasonably withheld or delayed.

2.1.8 Software and License

a. Issue to the Government a nonexclusive, fully paid perpetual license to use the software provided.

b. Provide software maintenance that is offered to all other customers without charge to the Government without charge.

2.2 BIDIRECTIONAL AMPLIFIERS

a. The primary bidirectional amplifiers will be located in the [headend equipment room] [_____].

[b. Locate Any additional amplifiers required by the System Application Design in [telecommunications rooms][_____].]

2.3 ACTIVE AND PASSIVE EQUIPMENT

Locate all active equipment in [headend equipment room] and [telecommunications room] [_____] as may be required by system application design. Coordinate all mounting locations with the Contracting Officer. Provide all mounting materials as part of this system. Install any passive or other components, excluding coaxial cables and antenna, that are installed in the facility at locations other than the telecommunications rooms or equipment rooms in locked steel cabinets, keyed alike and provided and installed as part of this system.

2.4 ENCLOSURES

****

NOTE: In accordance with NFPA 1221, all repeater, transmitter, receiver, signal booster components, external filters, and battery systems must be contained in NEMA 4 or NEMA 4X type enclosures

****

Provide NEMA Type 4 enclosures in interior spaces where located in clean, dry environments. Provide NEMA Type 4X for enclosures located outdoors.

2.5 OPERATING FREQUENCIES

All RF emitting devices used must be certified by the radio licensing authority to achieve the required radio coverage. Any frequencies for which the facility does not have a license to retransmit must not be amplified nor retransmitted. All RF emitting devices must have the certification of the radio licensing authority and be suitable for public safety use prior to installation in accordance with NFPA 1221.

a. Provide capability to process required communications signals from outside the facility to include transmitted frequencies of:

****

NOTE: Include specific required frequencies in the specification. Coordinate frequencies in this paragraph with paragraph 1.2 Scope.

****

[(1) Military Band First Responder Trunked Radio Frequencies]

b. Coordinate any additional frequencies with the contracting officer.

[c. Receive and transmit frequencies for military and public EMS. Re-transmit frequencies unaltered. Coordinate frequencies with the installation frequency manager via the Contracting Officer.]

2.6 TRANSMISSION LINE

Provide all required cables and associated passive components in accordance with the system application design. Provide plenum rated feeder and riser cables in accordance with NFPA 1221that meet all performance requirements, fire and environmental regulations as installed by the specific design for this project.

2.7 DONOR ANTENNAS

a. Provide Antenna and antenna structure that conform to TIA-329.1-D. Engineer the antennas to the proper system performance for the TIA-455-13operating frequencies indicated in this specification.

b. Provide all required cables in accordance with the system application design and engineered to the correct performance of the system.

c. Antennas must not interfere with [medical equipment][_____] or any other system in accordance with this specification.

d. Provide lightning protection and equipment for separate grounding of the antenna mast as required by NFPA 780.

e. Provide isolation between donor antenna and all inside antennas to a minimum of 20dB under all operating conditions in accordance with NFPA 1221.

2.8 PORTABLE EQUIPMENT

No portable receivers, transmitters, or radio devices are to be provided as part of this system.

2.9 UNINTERRUPTIBLE POWER SUPPLY (UPS)

a. Volt-Amp capacity must be at least 130 percent of the total volt-amp load of the equipment connected to the UPS. UPS must provide of runtime required by NFPA 1221 under the highest system load possible. Include power requirement calculations with design data submittal to verify power requirements.

b. Upon an ac power line outage, the UPS must automatically transfer to battery power within 4.2 milliseconds of sensing ac power line loss, and provide at least 15 minutes of full power for operation of the equipment connected to the UPS. On-battery output voltage must be 115 VAC, plus or minus 5 percent.

c. The UPS must use sealed, maintenance free type batteries that have an expected life of at least three years. Power batteries from a constant voltage or "float type" battery charger. Recharge time to 90 percent capacity after discharge to 50 percent capacity must not exceed 10 hours.

d. Surge energy rating must be at least 320 joules. Surge peak current capability must be at least 26 ka.

e. UPS visual indicators on the UPS front panel must indicate on-line operation, output overload, low battery, and replace battery. [Provide network reporting of UPS functions and warnings.]

PART 3 EXECUTION

3.1 EXAMINATION

Perform a site survey to verify all field conditions, become familiar with the details of the work and working conditions, verify dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work.

3.2 BUILDING UTILITY AND SUPPORT

****

Note: Indicate mounting space locations, electrical power connections, grounding system, and associated HVAC on the construction drawings.

Note: Provide pathway survivability in accordance with NFPA 72 and NFPA 1221. Pathway survivability normally includes 2-hour rated rooms that house the first responder DAS equipment and 2-hour rated riser pathways. Stacked telecommunications rooms that are 2-hour rated provide a 2-hour rated riser pathway.

****

Locate equipment and connect to branch circuits and grounding system and utilize pathways as indicated on the drawings. Where additional space, branch circuiting, grounding, or pathways are necessary to support the system as designed, notify the Contracting Officer of additional support needed.

3.3 PREPARATIONS

As part of the project planning and system application design, and prior to the submittal of documents and plans, gather the data required to design and install the system, and plan the work. Include the data listed below, at a minimum.

3.3.1 User Room Numbers and Names

Obtain from the Contracting Officer a listing of facility User room numbers and room names cross referenced to the architectural room numbers and names indicated on the contract documents. Use the facility User room numbers and room names for all system functions, applications software, and as-built documentation.

3.3.2 Interfaces and Interconnections

a. Coordinate and define the details of all interfaces and interconnections with other systems and equipment as specified herein. Include a detailed definition of all electronic and physical interface requirements, interface protocols, and physical demarcation points, donor frequencies, donor signal levels and injection levels for directly coupled systems. Provide details as part of Drawings and Data submittals.

b. Include the following interfaces and connections:

(1) First Responder Trunked Radio

3.3.3 Certificates and Authorizations

Provide certificate of authority and/or operational authority from the licensee of all individual services utilizing this System. Include the FCC station identification information, details of frequency, power, and modulation, and a specific authority to operate a distribution and/or rebroadcast system on said frequency at the project location, any restrictions in operating conditions, levels, emissions or other conditions, and issued in the name of the facility with a point of contact at the Licensee.

3.4 INSTALLATION

3.4.1 General

a. Provide installation as indicated and specified, and in accordance with acknowledged industry and professional standards and practices, and the Manufacturer's instructions.

b. Comply with the requirements of NFPA 70, [NFPA 72,] [NFPA 1221,] [NFPA 99,] and TIA-569.

c. Only the Installer as qualified in Paragraph QUALITY ASSURANCE, subparagraph Installer Qualifications, is permitted install and connect all equipment and system cabling.

d. Maintain onsite a supervisor during the entire installation as qualified in Paragraph QUALITY ASSURANCE, subparagraph Installer Qualifications.

e. Provide all tools and equipment needed to install the system.

[f. Comply with the requirements of Section 26 05 48 SEISMIC PROTECTION OF ELECTRICAL SYSTEMS.]

3.4.2 Equipment Installation

a. Provide appropriate waterproof gaskets for equipment installations in exposed areas.

b. Locate equipment where indicated on the drawings or where indicated in this specification section. Mounting of system components in any room other than a Comm Room or above finished ceilings is not acceptable without written authorization by the Contracting Officer.

c. Rack mount system components. Floor mounted equipment is prohibited.

d. Install equipment firmly secured in place, plumb, square, and level.

e. Provide adequate equipment ventilation and adequate equipment accessibility for service and repair.

****

Note: Indicate antenna locations and conduit pathway on the contract drawings.

****

f. Provide roof conduit penetration for antenna pathways[, including GFGI antenna pathways]. [Locate penetrations at antenna locations as indicated on the drawings.]

3.4.3 System Cabling Installation

Install system cabling using the approved qualified installer in accordance with NFPA 70. Install cables without kinks, sharp bends or deformations or abrasions as recommended by the cable manufacturer. Install cable in cable trays, conduits, and boxes as indicated. Coordinate the system cable routing with other cable routing of other systems to ensure that there will be no interference that will adversely affect the performance of this system of any other specified or GFGI system. The System Integrator is responsible to notify the Contracting Officer of any routing conflicts prior to placement of cable. Provide firestopping where penetrations are required in rated floors, walls, or ceilings in accordance with Section 07 84 00 FIRESTOPPING

3.4.4 Grounding

Ground equipment enclosures and all other non-current carrying exposed metal parts of electric equipment.

3.5 AC POWER CONNECTIONS

****

Note: Coordinate electrical circuit requirements with the project electrical engineer. For medical facilities, coordinate branch circuit connection requirements with UFC 4-510-01, NFPA 70 Article 517, and NFPA 99. Show all branch circuit connections on the electrical drawings.

****

AC power for all equipment must be circuited to the [electrical system] [emergency system] [life safety branch] in accordance with NFPA 70 [,] [NFPA 72,] [and] [NFPA 99].

[Connect the system to the essential electrical system life safety branch as indicated on the drawings.][The System Integrator is responsible for coordinating that the active system components are provided with required branch circuits.] The System Integrator is responsible coordinating any other power requirements to active devices with the Contracting Officer as necessary where adequate circuits are not indicated on the contract drawings.

3.6 TRANSMISSION LINE

****

Note: Indicate conduit pathway to roof on the contract drawings.

****

Install transmission line(s) to the roof in the indicated pathway, with the outer conductor and lighting arrestor grounded to the indicated grounding system in accordance with NFPA 70 and NFPA 780. Provide any additional grounding required.

3.7 INSTALLATION SETUP

Make all adjustments as necessary to setup the system to function in accordance with specific user requirements for the overall system.

3.8 FIELD QUALITY CONTROL

3.8.1 Inspection, Testing and Validation

a. Prepare and submit an Acceptance Test Plan that includes the requirements of this Section. Include step-by-step procedures and the expected results to demonstrate system compliance with the requirements of this specification. Include tests defined in the Manufacturer's installation instructions; list of all test equipment to be used, including data indicating that calibration of the test equipment is current; test data sheets; and names and qualifications of the person(s) who will perform the tests. [Coordinate the Test Plan with the Commissioning Plan as specified.]

b. Furnish required test equipment, tools, consumable supplies, and technically qualified and licensed personnel to perform inspections, testing and validation of the installed system. All test equipment must be in current calibration and must have a current calibration certification.

c. The Contracting Officer reserves the right to approve the System Contractor's choice of testing personnel, and, upon rejection of any testing personnel by the Contracting Officer at any time, the System Contractor is required to replace such testing personnel as soon as reasonably possible. Upon request, provide the Contracting Officer the opportunity to review the qualifications of each person proposed for testing work.

d. Conduct all inspections and testing in accordance with submitted and approved quality control, testing [and commissioning plans] and procedure, and requirements specified herein.

e. Notify Contracting Officer at least 30 days prior of any planned inspection and testing, but in no case prior the System Integrator having received written Government approval of the submitted test plans, including procedures.

f. Conduct inspection and testing during normal working hours with prior notice to the Contracting Officer so as not to interfere with orderly work processes.

g. Allow inspection by the Contracting Officer of all work and workmanship, and witnessing of System Integrator performed inspections, system readiness checks, integrated performance testing, and acceptance testing.

h. Expose any work that is enclosed or concealed before being inspected and tested and restore to the original condition after inspection and testing.

i. Submit results of each inspection and test in electronic and hard copy format to the Contracting Officer.

3.8.2 Periodic Inspection and Testing

The Contracting Officer reserves the right to inspect and test all work and workmanship at any and all times during preparation and installation. The Contracting Officer, in his or her sole discretion, may reject defective work and workmanship and require its correction. The Government right to inspect, test, and reject, or its failure to exercise such right, as provided herein, must in no way diminish the System Integrator's duty to inspect and reject work as necessary to comply fully with the requirements of the contract documents.

Licensee's who have granted permissions are responsible for their frequencies operating within their license. Licensee's are responsible for inspections for their operating signals and have the right to revoke permissions at any time.

3.8.3 System Readiness Checks

Place the system into complete working order in full compliance with specified requirements, system application design, and all setup requirements, including requirements listed in the Licensee's Authority to the Facility, programming and adjustments prior to the start of system testing and validation. Perform system readiness checks to certify that the system is ready for testing and validation.

3.8.4 Integrated Performance Testing

Perform all necessary performance testing of interoperability of the telecommunications systems with each other, and with other building systems. Such testing is to demonstrate full integration and/or interface of systems and to demonstrate they function as a comprehensive system where necessary.

3.8.5 Final Inspection and Acceptance Testing

3.8.5.1 General Requirements

a. After installation has been completed, and system readiness checks and integrated performance testing have been successfully completed, notify the Contracting Officer that the system is ready for final inspection and acceptance testing. Conduct final inspection and acceptance tests in accordance with the approved Test Plan [and Commissioning Plan], and the project schedule.

b. Draft as-built system drawings, and operating and maintenance manuals must be made available by the System Integrator for use during performance of final inspection and acceptance testing. Final inspection or acceptance testing will not be scheduled nor performed without this documentation.

c. Upon successful completion of final acceptance tests, and 30 calendar days of consecutive operation in accordance with specified requirements without the occurrence of any major malfunctions, submit the final acceptance test report, including certificates of compliance and certificate(s) of Licensee Authority with Licensee inspection report stating that all specified requirements and conditions have been satisfied. The effective date for completion of the final system acceptance will be the date when the system has satisfied the 30 days of operation without a major malfunction as specified above.

3.8.5.2 Acceptance Test Procedure

a. Provide final acceptance tests that demonstrate that the system operates in full accordance with all specified requirements, system application design, and user setup requirements for the system. Demonstrate that each system operating mode performs as required by operation of each individual system component under normal or simulated normal system conditions.

b. Include the following tests, at a minimum:

   (1) Operation under ac power failure conditions. Include demonstration of UPS capability under normal power loading conditions, and operation under emergency power conditions.

   (2) Signal quality under worst-case loading conditions of low voltage power supplies.

   (3) Operation of electronic supervision circuitry.

   (4) Operation of 100 percent of all components.

   (5) All interface functions.

   (6) Place and test devices from inside the facility to other mobile devices within the facility. Place and test devices from inside the facility to other mobile devices outside the facility. Place and test other devices from outside the facility to other mobile devices inside the facility. Perform each inside/outside test a minimum of ten times from various points selected by the Contracting Officer to demonstrate complete coverage throughout the facility.

   (7) A test will be considered as passed if the device successfully connects and message is transferred without error. A pass rate of 100 percent is required.

   (8) Sweep test all coaxial cables for all frequencies the system is capable of transmitting whether or not in service.

c. Include testing equipment for frequency and signal strength testing.

3.8.6 Corrective Action for Rejected Work

a. Correct all deficiencies and another re-test as necessary to demonstrate compliance with all requirements to the Contracting Officer.

b. Complete all corrective action within a reasonable time consistent with project schedules and acceptable to the Contracting Officer.

c. If, after 30 calendar days from the start of acceptance testing, the system or any equipment component thereof fails to demonstrate complete and proper performance, the Government reserves the right to return the total system or any equipment component to the System Integrator. The System Integrator is required refund all costs thereof to the Government and to indemnify the Government from damages, costs, and expenses incurred in connection with such activity.

d. The Government retains absolute control of the actual date of return of any rejected system or equipment component. The Government reserves the right to continue to utilize such system and equipment until the actual date of removal.

3.8.7 Acceptance Test Report

Provide test reports in booklet form with witness signatures verifying execution of tests. Include physical routing and a test report for each cable from the installed outlet to the main termination point. Submit test report within 14 days after completion of the testing.

3.8.8 Warranty Period Inspection and Testing

Observe the system in operation at the end of the 4th and 9th months after the time of acceptance and re-conduct acceptance tests to demonstrate that system is continuing to perform as specified. Coordinate with the Contracting Officer. The Contracting Officer and a Customer Representative reserve the right to participate in this activity. Include interviews of users to determine if the system is satisfying specified requirements and that training is adequate. Provide written report of results to the Contracting Officer. During the 11th month of operation, re-inspect and retest the system to identify and correct any deficiencies prior to the end of the warranty period. A [medical] facility Government representative reserves the right to witness this procedure. Make all correction actions necessary. Provide written report of results to the Contracting Officer.

3.9 CLOSEOUT ACTIVITIES

3.9.1 Training Plan

a. Develop and submit a Training Plan for approval by the Contracting Officer. The training plan must describe the training to be provided. The Training Plan must include, but not be limited to the following items:

    (1) Describe the operation and maintenance training programs, and instructional materials to be provided.

    (2) As coordinated with the user, define the number of staff members that will be expected to attend each training session, and the classrooms to be used for on-site training.

    (3) Furnish the identity and qualification of training instructors, and the instructional schedules for all classes.

b. Provide training to the Facility staff in accordance with the approved Training Plan.

3.9.2 General Preparations

During the week prior to the start of training for any system, check the system to assure that it has been successfully commissioned and acceptance tested, and is in full-specified operation condition.

3.9.3 Training Personnel

a. Furnish qualified factory trained or certified instructors to train designated Facility staff in the operation and maintenance of the provided system.

b. The Contracting Officer reserves the right to approve the System Integrator's choice of training personnel, and, upon rejection of a trainer by the Contracting Officer at any time, the System Integrator must immediately replace such trainers. Upon request, the System Integrator will provide the Contracting Officer the opportunity to review the qualifications of each proposed trainer.

3.9.4 Training Instructions

Include all specified performance and capabilities of the system in the training instructions, and all of the items contained in the operation and maintenance manuals. In addition, include preventive maintenance, routine maintenance, repair and troubleshooting procedures.

3.9.5 Training Materials and Recordings

Furnish all training materials and handouts. Provide the quantity needed for all of the Facility maintenance technicians, operations and user staff that will receive training. Provide [Six][_____] copies of all standard training media, such as video recordings, CDs, and DVDs, that are available from the Manufacturer to the Contracting Officer. [Provide four copies of video recordings of onsite training sessions to the Contracting Officer. This will be a coordinated effort between the System Integrator training staff and the Facility education department staff.]

3.9.6 Onsite Training Programs and Requirements

Provided all training onsite to all Facility staff as required throughout the contract and warranty period to train operations and maintenance staff for the provided system. Include two training courses, one for maintenance technicians, and one for user and operations staff. Include classroom training and field training. Field training for Facility staff will take place in the area where the staff will be working. Coordinate classroom training with the Contracting Officer. Conduct multiple instructional units for each onsite course on a three shift, seven days a week basis as required to train all staff during their normal on-duty working hours. The Contracting Officer will designate qualified personnel to be instructed in the operation and maintenance of each system, schedule instructional sessions, and provide suitable onsite instruction facilities.

3.9.7 User and Operational Staff Training

Comments user and operational staff training at a time acceptable to the Contracting Officer and near the time the system is scheduled for operational use by the Facility staff. Provide classroom instructions for all Major Functional Components of the system, and field instructions in each area where equipment is installed. Nine months after the system is installed and accepted by the Government, provide refresher coerce to the user and operational staff.

3.9.8 Technician Training

Before the system is turned over to the Government for operational use, provide training for maintenance technicians designated by the Contracting Officer. Provide the number of instructional hours necessary to cover all aspects of system setup, programming, operations, preventive maintenance, routine maintenance, routine repair, and troubleshooting procedures for the system as installed. Nine months after the system is installed and accepted by the Contracting Officer, provide a comprehensive refresher course covering the final configuration for the system. Provide technician training on site and focus on failure diagnosis and field repair.

3.9.9 PROTECTION

Do not permanently install items that can be easily stolen, such as desktop computer and monitor equipment, until such time as the System Integrator has been notified by the Contracting Officer that the facility is secured.

3.9.10 CLOSEOUT DOCUMENTATION

a. Prepare and submit all documents as required.

b. Maintain a record of all maintenance and repair, including subsequent field strength readings, performed during the warranty period and submit the record at the end of the warranty period.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-28 08 10 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-28 08 10 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 28 08 10

ELECTRONIC SECURITY SYSTEM ACCEPTANCE TESTING

08/23

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USACE / NAVFAC / AFCEC **UFGS-28 08 10 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-28 08 10 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 28 08 10

ELECTRONIC SECURITY SYSTEM ACCEPTANCE TESTING
08/23

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NOTE: This guide specification covers the requirements for acceptance testing of electronic security systems. An electronic security system includes all equipment, components, control systems, devices, and associated software used to secure facilities and assets through intrusion detection, access control, and video surveillance systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR)**..**

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PART 1 GENERAL

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NOTE: When this specification is used, it will be in conjunction with UFGS 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS).

For Air Force projects, use this specification in conjunction with applicable Air Force testing policy and standards.

****

1.1 SUMMARY

This specification defines the process and procedures for initial acceptance testing of electronic security systems (ESS) to include intrusion detection, access control and video as well as associated power and communications. Requirements to plan, conduct, and document all testing activities are covered along with the Government responsibility to witness testing and review and approve submittals. During the course of the acceptance test, demonstrate that, without exception, the completed and integrated ESS complies with the contract requirements.

1.2 DEFINITIONS

The Government Representative is a qualified individual given specific authority to witness system acceptance testing and evaluate the results.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-05 Design Data

Test Plan; G, [_____]

SD-06 Test Reports

Final Test Report; G, [_____]

Pre-Acceptance Test Certification; G, [_____]

SD-07 Certificates

Qualifications

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

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NOTE: Adjust years of experience required for the Test Director, Operator, and Technician to reflect the size and complexity of the ESS.

Government personnel may be allowed to participate in the role of Operator.

****

1.4.1.1 General

The Test Director, Operator, and Technician must have prior experience with the specific equipment, hardware and software installed under the contract.

1.4.1.2 Test Director

The Test Director must have at least [five] [_____] years of hands-on ESS experience to include any combination of design, installation, testing and maintenance.

1.4.1.3 Operator

The Operator must have at least [two] [_____] years of hands-on experience installing and maintaining ESS workstations to include both hardware and software. The Operator must be capable of demonstrating all workstation features and capabilities.

1.4.1.4 Technician

The technician must have at least [two] [_____] years of hands-on experience installing and maintaining ESS field equipment to include sensors, card readers, cameras, local processors, and communications equipment. The Technician must be capable of demonstrating all features and capabilities of ESS field equipment. Qualifications may be met by the individual experience of one technician or by the combined experience of a team of technicians.

[1.4.1.5 Test Intruder

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NOTE: Include the qualifications for a test

intruder only if the project includes intrusion sensors that are activated by: 1) an intruder moving through a volumetric or linear detection pattern or 2) an intruder climbing a fence. These sensors include passive infrared, active infrared, microwave, buried ported coaxial cable, and fence-mounted sensors. Insert the allowable height and weight range to match the design basis threat for the project. Be aware of the security classification of the design basis threat. If intruder height and weight are classified, do not include these values in this specification. Provide classified information to the Contractor through authorized channels.

If there is no design basis threat for the project, use the default height and weight range which corresponds to the average height and weight of a 20 - 29 year old male in the host nation where the site is located.

For Army projects, contact the Electronic Security System Mandatory Center of Expertise (ESS MCX) for assistance in determining requirements for the Test Intruder. ESS MCX email address is AskESSMCX@usace.army.mil

****

The purpose of the test intruder is to activate intrusion sensors in a realistic and repeatable manner. The test intruder must be between 1780 to 1830 mm [70] [_____] and [72][____] inches tall and weigh between 80 to 85 kg [175] [____] and [190] [_____] pounds. The test intruder must possess sufficient physical strength, agility, and endurance to perform movements required for intrusion testing. These movements may include, but are not limited to, walking, running, crawling, jumping, and climbing.

]PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 TEST PLAN

The Government will witness all system acceptance testing and endurance testing. Obtain written permission from the Government before proceeding with testing. Clearly establish the scope for ESS testing prior to beginning testing. Submit a Test Plan that addresses all testing requirements to include the following topics:

3.1.1 Personnel

Identify the Test Director, Operator, Technician, [Test Intruder], and any other personnel that will be performing test activities.

3.1.2 Equipment

List all equipment that is required to support testing. State the purpose of each piece of equipment. Describe equipment that will be used to enable voice communications between the monitoring location and the field.

3.1.3 Procedures

Provide a step-by-step procedure for conducting each functional test. Describe actions and expected results. Ensure that functional test procedures address performance standards described in contract specifications especially any probability of detection (Pd) and nuisance and false alarm rate (NAR/FAR) requirements. Pd and NAR/FAR are not typically a concern for interior sensors installed per manufacturers specifications. For exterior sensors NAR/FAR needs to be verified but Pd may not need to be verified if installed IAW manufacturers or service specific guidance.

****

NOTE: Example ESS functional test procedures may be downloaded from
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms
These are intended to aid the Contractor in preparing test plans.

For Air Force Projects, follow the Electronic Security Equipment (ESE) Master Installation Acceptance Test and Turnover Plan, ESE-TP-0023.

****

Download example procedures from
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-
and review for applicability and completeness. Adapt example procedures to meet specific project requirements and develop additional ones as needed. Follow TEST-MASTERTP0023-005 for Air Force projects.

3.1.4 Special Provisions

Discuss any special test provisions such as facility access, safety, integration with existing systems, and coordination with other work.

3.1.5 Test Logs

Provide logs for recording all data from functional testing and burn-in testing.

****

NOTE: Example ESS test logs may be downloaded from
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms
These are intended to aid the Contractor in preparing test plans.

****

Download example logs from
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-
and review for applicability and completeness. Adapt example logs to identify each component by location to meet specific project components and system test requirements. Develop additional logs as needed.

3.1.6 Schedule

Provide an overall schedule that includes all testing milestones.

3.2 PRE-ACCEPTANCE TESTING

****

NOTE: Perform pre-acceptance based on the sponsoring activity requirements. The contractor must confirm system readiness prior to scheduling the system acceptance test.

****

Conduct a complete test of all field equipment, workstations, and central system hardware and software in accordance with the approved Test Plan. The Test Director must be on site to conduct a pre-test inspection and oversee all testing activities. Prior to testing, visually inspect all ESS components and correct workmanship and neatness deficiencies as needed. During the pre-test inspection, verify the accuracy of redline drawings and update drawings as needed. Verify and document performance of each device and system feature to include sensor nuisance and false alarm rates. Review all positioning and field of view adjustments for each camera view in day and night operation.

Prepare and submit Pre-Acceptance Test Certification detailing the results of the testing. Refer to paragraph FINAL TEST REPORT for required content. Include a cover letter signed by the Test Director stating that pre-acceptance testing has been completed and that the system is ready for acceptance testing.

3.3 SYSTEM ACCEPTANCE

Test the ESS in accordance with the approved Test Plan in the presence of the Government Representative to certify acceptable performance. Verify that the total system meets all requirements of the specification and complies with the specified standards.

a. Demonstrate that the completed system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project must be demonstrated and shown. The SAT, as specified, is not to be started until after receipt by the Contractor of written permission from the Government.

b. Begin acceptance testing upon arrival of the Government Representative at the project site. Place the ESS in normal operating mode and evaluate system performance during the testing period. Immediately report any deficiencies observed during testing to the Government Representative and discuss possible causes and corrective measures. Obtain Government approval prior to making any adjustments, repairs or modifications. The Government retains the right to terminate testing at any time the ESS is found to be incomplete or fails to perform as specified. Such termination of acceptance testing constitutes a FAILED system acceptance test.

c. Upon termination of testing by the Government or by the Contractor, commence an assessment period as described in paragraph Test Termination Assessment Period.

d. Upon successful completion of the system acceptance test, deliver test reports and other documentation as specified to the Government prior to commencing the endurance test.

3.3.1 Test Termination Assessment Period

Identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. Ensure that the report explains in detail the nature of each failure, corrective action taken, results of tests performed, and recommend the point at which testing should be resumed. After delivering the written report, convene a test review meeting to present the results and recommendations to the Government. Schedule the test review meeting at least 5 business days after receipt of the report by the Government. As a part of this test review meeting, demonstrate that all failures have been corrected by performing appropriate portions of the system acceptance test. Based on the Contractor's report and the test review meeting, the Government will determine the restart date, or may require that the entire test be repeated.

3.3.2 Preparation

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NOTE: Adjust the notification requirement as needed to accommodate the scheduling needs of the Government Representative. Consider travel planning if the Government Representative's normal duty location is not the project site. Foreign travel may require several weeks advance notice.

****

Notify the Contracting Officer of system readiness [15] [_____] days prior to the expected start date of acceptance testing. Prior to acceptance testing, complete all clean-up and patch work requirements. Ensure that security equipment closets and similar areas are free of accumulation of waste materials or rubbish caused by prior installation work.

3.3.3 Personnel

Ensure that the following personnel are on site to perform test activities: Test Director, Operator, Technician[, and Test Intruder]. Ensure that the Quality Control Manager is on site during acceptance testing.

3.3.4 Visual Inspection

Assist the Government Representative in conducting a visual inspection of ESS equipment and wiring. This inspection will focus on the general neatness and quality of workmanship and compliance with applicable codes and manufacturers' recommended installation methods. Provide a comprehensive listing of installed equipment and software, sorted by location, along with a complete set of ESS red line drawings to be used during the inspection. Document deficiencies identified during the inspection.

3.3.5 Phased Testing

3.3.5.1 Functional Testing

During the functional testing, verify system performance in accordance with the approved Test Plan. Record results in approved Test Logs and provide a written explanation of each failure to include cause, corrective action, and retest result. Continue functional testing until all tests have been successfully completed with no unresolved failures. Comply with requests from the Government Representative to repeat functional tests performed previously. The Government reserves the right to request the Contractor to repeat all functional tests or a representative sampling thereof as a means of performance verification. Document all test results on approved Test Logs.

3.3.5.2 System Activity Reports

Retrieve archived data from the system and provide unaltered activity reports as requested by the Government Representative. Reports may address any type of activity to include alarms, portal transactions, and video archives. Assist with analyzing reports to identify trends and anomalies.

3.3.5.3 Corrective Actions

Correct any deficiencies in coordination with the Government Representative. Maintain a punch list and review status at the end of each day. Work diligently to complete corrective actions the same day that deficiencies are observed. Add deficiencies not corrected on the same day to the rework items list maintained by the Quality Control Manager. Failure to resolve punch list items to the satisfaction of the Government constitutes a FAILED system acceptance test.

3.3.5.4 Endurance Testing

****

NOTE: Consider the size, technology types, and complexity of the ESS installation project when specifying the duration of endurance testing. Consider a 24-hour burn-in testing duration only for a very simple ESS installation involving no more than 25 discrete components. Consider a burn-in testing duration greater than 120 hours for a project with a large number of IDS zones, especially outdoor perimeter zones for which nuisance and false alarms are a concern. Suggested time frames for endurance testing based on technology type are listed below.

1. Video System (no Analytics/ Artificial Intelligence (AI)): 3 to 5 days

2. Video System with Analytics/AI = 5 to 10 days

3. ACS (small) < 20 readers: 3 to 5 days

4. ACS (large)20 < readers < 100: 5 to 10 days

5. Interior IDS (Small) < 7 intrusion zones: 5 days

6. Exterior IDS sensors (Any size): > 9 days

1)Endurance testing for interior IDS should not be less than 5 days, unless the system is very small based on the number of intrusion zones.

2) Endurance testing for exterior IDS should not be less than 7 days

8. Enterprise IDS/ACS/CCTV = > 9 days

****

Following the successful completion of the functional test and completion of all corrective actions, monitor all components for a continuous period of [24] [72] [120] [_____] hours [5] [7] [10] [_____] days upon written approval from the government representative. Active monitoring will take place for a total of [24 hours per day] [8 hours per day and staggered throughout duty hours to sample normal operational and environmental site conditions during daytime and nighttime hours]. All events, anomalies, and alarms will be reviewed, assessed in real time, and documented. Date and time of each activation will be recorded, assessed for cause, and noted. [Events that occur outside the 8-hour window will be assessed during the following work period.] All cameras are to be reviewed for operability and clarity of view, day, and night.

a. The endurance test must demonstrate system reliability and operability. The endurance test will not be started until the Government notifies the Contractor, in writing, that the system acceptance test is satisfactorily completed, and correction of all outstanding deficiencies has been satisfactorily completed.

b. Provide 1 operator to operate the system 24 hours per day in addition to any Government personnel that may be made available. The Government may terminate testing at any time if the system fails to perform as specified.

c. Upon termination of testing by the Government or by the Contractor, commence an assessment period as defined in paragraph Test Termination Assessment Period. Verify the operation of each terminal device during the last day of the test. Upon successful completion of the endurance test, deliver test reports and other documentation as specified to the Government prior to acceptance of the system.

d. The endurance test for sensors is required to demonstrate the configuration meets the requirements of Section 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS) paragraphs False Alarm Rate and Nuisance Alarm Rate. The Government Representative must be directly notified if any section of the fence exceeds the requirement. Upon coordination, re-calibrate the failed section, repeat functional test, and restart the endurance test period for that section.

3.4 FINAL TEST REPORT

Submit a Final Test Report following the successful completion of acceptance testing to include all failures, remediation, and resolution of all punch list items. Address the following topics in the Final Test Report:

3.4.1 Summary

Provide a chronological summary of all testing. Describe test activities and results in narrative form.

3.4.2 Personnel

Provide a list of all Contractor and Government personnel who participated in the testing.

3.4.3 Test Logs

Provide all completed test logs along with a test log verification signed by the Test Director.

3.4.4 False and Nuisance Alarm Rates

Provide a tabulated and summarized listing of all events based on the system activity reports. Categorize every alarm as one of four types: 1) Valid/Actual, 2) False, 3) Nuisance, or 4) Test/Authorized Alarm.

3.4.4.1 Valid or Actual Alarm

An alarm received due to an actual intruder attempting to enter or entering a protected area or attempting to cross or crossing a line of detection.

3.4.4.2 False Alarm

An alarm received for which no cause can be determined. Typically, false alarms are due to aging or malfunctioning equipment and communications pathways that the alarm monitor cannot assess. False alarms in excess of established rates will cause complacency and lead to unsecure protected areas.

3.4.4.3 Nuisance Alarm

An alarm received due to an influence for which the sensor was designed to detect but which is not related to an intrusion attempt. The influence that caused the alarm must be clearly identifiable. These alarms fall into three categories: preventable, mitigatable, and unpreventable. Preventable nuisance alarms typically include personnel using improper entry/exit procedures, or an unauthorized incursion into the sensor zone. Preventable nuisance alarms must be included in the nuisance alarm rate. Mitigatable nuisance alarms can include: an animal entering into the sensor zone; a weather event typical/normal to the area, a noise event (i.e., a jet taking off in afterburner, a training explosion from the base range, etc.), or a seismic event (large vehicle vibrations from regular traffic in the area). Steps must be taken to reduce mitigatable events such as critter/animal control fences or animal abatement, bird abatement programs such as Bird/wildlife Aircraft Strike Hazard (BASH) or reprograming the system to filter out certain vibrations/noises. Mitigatable nuisance alarms must be included in the nuisance alarm rate. Unpreventable nuisance alarms can include a weather event not typical/normal to the area (i.e., thunderstorm, hurricane, typhoon, etc.) or other atypical events to the area and will not be included in the nuisance alarm rate. Nuisance alarms in excess of established rates will cause complacency and lead to unsecure protected areas.

3.4.4.4 Test or Authorized Alarm

An alarm received due to authorized personnel performing required testing on the ESS. Tests can include daily, weekly, or monthly operational checks as well as acceptance, quarterly, semi-annual, or annual system functional checks.

3.5 Probability of Detection and Confidence Level

If Probability of Detection (Pd) requirements need to be validated, then Pd testing must be completed. The binomial table below uses a statistical method to determine Pd and Confidence level based on the number of sequential annunciated alarms due to test intrusions. Regulatory or contractual requirements will define the Pd and Confidence Level needed for specific zones or lines of detection. If the number of successive detections cannot be met without a missed detection, then adjustments to detection sensor coverage and sensitivity must be made.

Probability of Detection	0.9	0.9	0.95	0.95	Number of Misses Allowed
Confidence Level	90%	95%	90%	95%	
Number of Intrusion Attempts	22	29	45	59	0
	38	46	77	93	1
	52	61	105	124	2
	65	76	132	153	3
	78	89	158	181	4
	91	103	184	208	5

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-28 10 05 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-28 10 05 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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ELECTRONIC SECURITY SYSTEMS (ESS)

05/24

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USACE / NAVFAC / AFCEC **UFGS-28 10 05 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-28 10 05 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 28 10 05

ELECTRONIC SECURITY SYSTEMS (ESS)

05/24

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NOTE: This guide specification covers the requirements for Electronic Security Systems (ESS) consisting of commercial off-the-shelf equipment which is limited to:

1. Intrusion Detection System (IDS)
2. Access Control System (ACS)
3. Video Surveillance System (VSS)
4. Medical Facility System
5. Security Command Center
6. Security Lighting
7. Infant Protection Alarm System (IPAS)

System requirements must conform to UFC 4-021-02, "Electronic Security Systems". Consult the appropriate governing authority - the US Naval Facilities Engineering Command, the US Army Corps of Engineers, the US Air Force Civil Engineering Support Agency, or the National Aeronautics and Space Administration - for questions concerning system design. Coordinate requirements with the Project Manager, Base/Regional Security Personnel, and the Accrediting Official. ESS is typically provided for the protection of designated assets.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for

this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: This section will be used in conjunction with Sections: 26 20 00 INTERIOR DISTRIBUTION SYSTEM; 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM; 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION; 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION; 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP); 28 08 10 ELECTRONIC SECURITY SYSTEM ACCEPTANCE TESTING; Section 34 75 13.13 CRASH RATED ACTIVE VEHICLE BARRIERS AND CONTROLS; and any other guide specification sections required by the design.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ASC/X9 X9.52	(1998) Triple Data Encryption Algorithm Modes of Operation

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM B32	(2020) Standard Specification for Solder Metal

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.23	(2010) Electromagnetic Locks

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2022) Ethernet
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTELLIGENCE COMMUNITY STANDARD (ICS)

ICS 705-1	(2010) Physical and Technical Security Standard for Sensitive Compartmented Information Facilities

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ANSI ISO/IEC 7816	(R 2009) Identification Cards - Integrated Circuit Cards

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 140-2	(2001) Security Requirements for Cryptographic Modules
NIST FIPS 197	(2001) Advance Encryption Standard
NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors
NIST SP 800-116	(2018; Rev 1) Guidelines for the Use of PIV Credentials in Facility Access

OPEN NETWORK VIDEO INTERFACE FORUM (ONVIF)

ONVIF	(2017) Core Specification Version 17.06

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-222	(2018H; Add 1 2019) Structural Standard for Antenna Supporting Structures and Antennas and Small Wind Turbine Support Structures
TIA-568.2	(2024e) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-HDBK-419	(1987; Rev A) Grounding, Bonding, and Shielding for Electronic Equipments and Facilities Volumes 1 of 2 Basic Theory
MIL-STD-188-124	(1998; Rev B; Notice 2 1998; Notice 3 2000; Notice 4 2013) Grounding, Bonding and Shielding for Common Long Haul/Tactical Communications Systems, Including Ground Based Communications - Electronics Facilities and Equipments

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

21 CFR 1020	Performance Standards for Ionizing Radiation Emitting Products
47 CFR 15	Radio Frequency Devices

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment,

	Non-Environmental Considerations
UL 294	(2023) UL Standard for Safety Access Control System Units
UL 437	(2013; Reprint Jan 2022) UL Standard for Safety Key Locks
UL 634	(2007; Reprint Mar 2015) Connectors and Switches for Use with Burglar-Alarm Systems
UL 636	(2018) UL Standard for Safety Holdup Alarm Units and Systems
UL 639	(2007; Reprint Jun 2024) Standard for Intrusion Detection Units
UL 681	(2014; Reprint Jan 2021) UL Standard for Safety Installation and Classification of Burglar and Holdup Alarm Systems
UL 796	(2020; Reprint Oct 2023) UL Standard for Safety Printed Wiring Boards
UL 969	(2017; Reprint May 2023) UL Standard for Safety Marking and Labeling Systems
UL 972	(2006; Reprint Nov 2020) UL Standard for Safety Burglary Resisting Glazing Material Type
UL 1037	(2016; Reprint Aug 2023) UL Standard for Safety Antitheft Alarms and Devices
UL 1076	(2018; Reprint Feb 2021) UL Standard for Safety Proprietary Burglar Alarm Units and Systems
UL 1610	(2016; Reprint Apr 2021) UL Standard for Safety Central-Station Burglar-Alarm Units
UL 2050	(2003; 4th Edition) Standard for National Industrial Security Systems for the Protection of Classified Materials (limited distribution publication, direct purchase request with justification to UL)
UL 2802	(2013; Reprint Apr 7 2020) UL Standard for Safety Performance Testing of Camera Image Quality
UL 62368-1	(2019) UL Standard for Audio/Video, Information, and Communication Technology Equipment - Part 1: Safety Requirements

1.2   SUBMITTALS

****

NOTE: Review submittal description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

[[The [_____] will review and] [[_____] Division], [Naval Facilities Engineering Command] [_____] will approve submittals requiring special review in this section.

] SD-02 Shop Drawings

ESS Components; G, [_____]

Access Control System (ACS); G, [_____]

Security Hardware Door Schedule; G, [_____]

Overall System Schematic; G, [_____]

Video Surveillance System (VSS) Schedule; G, [_____]

SD-03 Product Data

****

NOTE: The product data list is not all inclusive.

****

Premise Control Unit; G, [_____]

Detection Sensors; G, [_____]

Access Control Unit; G, [_____]

Access Control Devices; G, [_____]

Cameras; G, [_____]

Camera Lenses; G, [_____]

Camera Housing and Mounts; G, [_____]

Thermal Imaging System; G, [_____]

Video Recording; G, [_____]

Printers; G, [_____]

Communications Interface Devices; G, [_____]

Radio Frequency Link; G, [_____]

Network Switch; G, [_____]

Video and ESS Transmission; G, [_____]

Infant Protection Alarm System (IPAS) Major Components; G, [_____]

Uninterruptible Power Supply (UPS); G, [_____]

Batteries; G, [_____]

Component Enclosure; G, [_____]

Equipment Rack; G, [_____]

SD-05 Design Data

Backup Battery Capacity Calculations; G, [_____]

Video Surveillance System (VSS) Storage Calculations; G, [_____]

Error and Throughput Rates; G, [_____]

SD-07 Certificates

Contractor Qualifications; G, [_____]

Instructor Qualifications; G, [_____]

Contact Card Readers; G, [_____]

Contactless Card Readers; G, [_____]

Data Encryption; G, [_____]

Wire And Cable; G, [_____]

Bonding, Grounding, And Shielding; G, [_____]

SD-10 Operation and Maintenance Data

ESS Components; G, [_____]

ESS Software, Data Package 4; G, [_____]

ESS Training; G, [_____]

ESS Training Outline; G, [_____]

Submit data package in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA

SD-11 Closeout Submittals

As-Built Drawings; G, [_____]

Warranty; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Regulatory Requirements

The advisory provisions in each of the publications referred to in this specification are mandatory. Interpret these publications as though the word "must" has been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer.

Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.3.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening and have been utilized in applications of equipment and materials under similar circumstances and of similar size.

b. Have been available on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer.

d. Provide commercial off-the-shelf (COTS) products in which the manufacturer allows a network of qualified distributors to sell, install, integrate, maintain, and repair the hardware and software products that make up the system. All products are to be NDAA and FAR subpart 4.21 compliant.

1.3.2.1 Alternative Qualifications

Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.3.2.2 Material and Equipment Manufacturing Date

Products manufactured more than one year prior to date of delivery to the site are not acceptable.

1.3.2.3 Product Safety

System components are to conform to applicable rules and requirements of NFPA 70. Equip system components with instruction stickers including warnings and cautions describing physical safety, and special or important procedures to be followed in operating and servicing system equipment.

1.3.3 Shop Drawings

1.3.3.1 ESS Components

Submit the ESS Components, Data Package 4 with the ESS Software submittal package in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit drawings that clearly and completely indicate each ESS component function that includes:

a. Termination device points

b. Interconnections required for system operation

c. Interconnections between modules and devices

d. Component and device wiring diagrams.

e. Proposed wireway or conduit systems to be used including:

   (1) Locations

   (2) Sizes

   (3) Types

f. Drawings showing:

   (1) Device locations and spacing

   (2) Mounting and positioning details

   (3) Riser Diagrams with cable sizes and types

   (4) Bill of Materials (Device make, model and quantities)

   (5) Alarm and access control zones

   (6) Video Surveillance System (VSS) and sensor coverage areas

(7) Spare capacity

(8) Tables with (Security Hardware Door Schedule) identifying security devices requirements per building, room, and door

(9) Overall system schematic diagram(s).

1.3.4 Evidence of Experience and Qualifications

1.3.4.1 Contractor Qualifications

Contractor or its subcontractor(s) must be a Value Added Resaler (VAR)/Authorized Dealer (AD) of the manufacturer line of products being installed. Provide manufacturer certificate showing current dealership status. Technicians working the project must provide certificates of training for the requirements of the manufacturer, and those certificates must be from the manufacturer or approved by the manufacturer.

Submit experience and certified qualifications data prior to installation. Show that specific installers who will perform the work have a minimum of [2] [_____] years of experience successfully installing ESS of the same type and similar design as specified. Include the names, locations, and points of contact of at least two installations of similar type and design as specified in this document where the installer has installed such systems. Indicate the type of each system installed. Certify that each system has performed satisfactorily in the manner intended for a period of at least [12] [_____] months.[Installation and maintenances of IDS for the protection of classified information to be performed by US citizens who have been subject to a trustworthiness determination.]

1.3.4.2 Instructor Qualifications

Submit the instructor's experience and certified qualifications data prior to installation. Show that the instructor has received a minimum of 24 hours of ESS training from the manufacturer of the product being installed, and 2 years experience in installing the specified ESS type.

1.4 ENVIRONMENTAL CONDITIONS

1.4.1 Interior Conditions

Equipment installed in environmentally protected interior areas must meet performance requirements specified for the following ambient conditions:

1.4.1.1 Temperature

0 to 50 degrees C.32 to 120 degrees F. Components installed in unheated security protected areas must meet performance requirements for temperatures as low as minus 17 degrees C 0 degrees F

1.4.1.2 Pressure

Sea level to 4573 m 15,000 feet above sea level

1.4.1.3 Relative Humidity

5 to 95 percent

1.4.1.4 Fungus

Components must be constructed of non-fungus nutrient materials or be treated to inhibit fungus growth

1.4.1.5 Acoustical Noise

Components must be suitable for use in high noise areas above 100 dB, without adversely affecting their performance

1.4.2 Exterior Conditions

Components in enclosures must meet performance requirements when exposed to the following ambient conditions:

1.4.2.1 Temperature

[Minus 32 to 60] [_____] degrees C [Minus 25 to 140] [_____] degrees F

1.4.2.2 Pressure

Sea level to [4573] [_____] m [15,000] [_____] feet above sea level

1.4.2.3 Solar Radiation

Six [_____] hours of solar radiation per day at dry bulb temperature of 60 [   ] degrees C 120 [_____] degrees F including 4 hours of solar radiation at 0.00112 [   ] watts per square mm 104 [_____] watts per square foot

[1.4.2.4 Sand and Dust

Wind driven for up to [9.6] [_____] km per hour (kmph) [6] [_____] miles per hour (mph) in accordance with UL 294 and UL 639.

]1.4.2.5 Rain

50 mm 2 inches per hour and 125 mm 5 inches per hour cyclic with wind plus one period of 300 mm 12 inches per hour in accordance with UL 294 and UL 639.

1.4.2.6 Humidity

5 to 95 percent

[1.4.2.7 Fungus

Warm, humid atmosphere conducive to the growth of heterotrophic plants

][1.4.2.8 Salt Fog

Salt atmosphere with [5] [_____] percent salinity

][1.4.2.9 Snow

Snow loading of 234 kg per square m 48 (psf) per hour; blowing snow of 22.5 kg per square m 4.6 psf per hour. Blowing snow from any angle (falling vertically to horizontal blowing from any azimuth) must not penetrate ESS equipment.

][1.4.2.10 Ice Accretion

Up to 12.7 mm 1/2 inches of radial ice

]1.4.2.11 Wind

Continual velocity up to 80 kmph 50 mph with gusts to 106 kmph 66 mph, except that fence sensors must detect intrusions up to 56 kmph 35 mph

1.4.2.12 Acoustical Noise

Visual alert device and components should be used in high noise areas above 110 dB without adversely affecting their performance. Examples areas include flight lines, run-up pads, and generator sites.

1.5 SYSTEM CALCULATIONS AND ANALYSIS

1.5.1 Backup Battery Capacity Calculations

Submit calculations showing that backup battery capacity exceeds sensor operation, communications supervision, and alarm annunciation power requirements for proposed equipment plus 25 percent spare capacity. In environments regularly exposed to conditions of 0 degrees C 32 degrees F provide 50 percent spare capacity. In environments regularly exposed to conditions of 49 degrees C 120 degrees F provide resistance to thermal runaway for lithium based batteries.

1.5.2 Video Surveillance System (VSS) Storage Calculations

Submit calculations showing the required storage capacity for each video storage device. Calculations must be based on the recording parameters specified by the end user/customers operational requirements.

1.6 ESS SOFTWARE, DATA PACKAGE 4

Submit the ESS software, Data Package 4 with the ESS Components submittal package in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Describe the functions of all software in the software manual and include:

a. All information necessary to enable proper loading, testing, and operation

b. Terms and functions definitions

c. Use of system and application software

d. Procedures for system initialization, start-up and shutdown

e. Alarm reports

f. Reports generation

g. Database format and data entry requirements

h. Directory of all files

i. All communication protocol descriptions, including data formats, command characters, and a sample of each type of data transfer

j. Interface definition

k. List of software keys

l. Backup and restore procedures and instructions on how to archive reports and video footage on DVD for forensics investigations.

1.7 AS-BUILT DRAWINGS

****

NOTE: Designer must verify CAD version with Contracting Officer and clearly state the requirement.

****

Maintain a separate set of drawings, elementary diagrams, and wiring diagrams of the system to be used for as-built drawings. Keep this set accurately and neatly up to date with all changes and additions. This set is not to be used for installation purposes.

Finish the final drawings submitted with the endurance test report in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS for as-built requirements.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Use the following for ESS guidance as applicable:

For SCIF and SAPF fill in the first bracketed option with: Intelligence Community Standards (ICD/ICS) 705 Physical and Technical Security Standards for Sensitive Compartmented Information Facilities. (NOTE: Do not identify "SCIF" or SAPF in Request for Proposal (RFP) or construction drawings. With accrediting official's approval, areas may be identified as "secure area" or "controlled area.")

For Secret, Top Secret or Controlled Access Areas (CAA), fill in the first bracketed option with the appropriate Service instruction: SECNAV M-5510.36A Department of Navy Information Security Program; Army Regulation AR 380-5 Department of the Army Information Security Program; or Air Force Instruction AFI 31-401 Department of the Air Force Information Security Program.

For Arms, ammunition or explosives (arms rooms, armories, and magazines), fill in the first bracketed option with the appropriate Service instruction: OPNAV Instruction 5530-13C Department of the Navy Physical Security Instruction for Conventional Arms, Ammunition, and Explosives; MCO 5530.14A Marine Corps Physical Security Program Manual; AR 190-11 Department of the Army Physical

Security of Arms, Ammunition and Explosives; or AFMAN 91-201 Department of the Air Force Explosive Safety Standards

For Air Force non-nuclear assets, ensure system utilizes the Air Force Non-Nuclear IDS Approved Equipment List. Contact AFSFC/S5G at afsfc.ibdss@us.af.mil for a copy of the letter or with any questions concerning these items.

For Army projects, contact the Electronic Security System Mandatory Center of Expertise (ESS MCX) for assistance in specifying requirements for IDS zones that will connect to an existing Integrated Commercial Intrusion Detection System (ICIDS). ESS MCX e-mail address is AskESSMCX@usace.army.mil

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Provide a complete and integrated electronic security system (ESS) that meets the requirements of [_____]. ESS must be compatible with the Installation's central monitoring system and monitored [within the secure/protected area] [_____] [and] [at the Installation central monitoring station]. [[Installation's][_____] central monitoring system is manufactured by [______], model number [_____].] ESS consisting of the following subsystems and features:

a. Intrusion Detection System (IDS)

b. Access Control System (ACS)

c. Video Surveillance System (VSS)

d. Security Command Center (SCC)

e. Communications System

f. Security Lighting Systems

[g. Medical Facility Systems

] Include materials not normally furnished by the manufacturer with the ESS equipment as specified in:

[a. Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION

]b. Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION

][c. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

]2.2 PERFORMANCE REQUIREMENTS

Integrate the installed and operating subsystems into the overall ESS system to detect intrusion, control access, video surveillance, visual verification, and perform as an entity, as specified below. Provide electronic equipment that complies with 47 CFR 15 and are suitable for the environment where they will be installed.

2.2.1 Growth Capability

Provide capability for modular ESS expansion of inputs, outputs, card readers, and remote-control stations with minimal equipment modification. Software must be able to handle design requirements plus 25 [_____] percent spare capacity. Growth capability is not to be limited by the provided products.

2.2.2 Hazardous Locations

****

NOTE: Do not locate alarm reporting and display equipment within a hazardous area. If point sensors and volumetric sensors are required in hazardous areas, clearly identify their location on the plans. Delete this paragraph if no hazardous areas exist in this project.

****

When located in areas where fire or explosion hazards exist, provide system components rated and installed according to Chapter 5 of NFPA 70.

2.2.3 Maintainability

Provide components that can be maintained using commercially available tools and equipment. Arrange and assemble components to be readily accessible to maintenance personnel without compromising system defeat resistance and with no degradation in tamper protection, structural integrity, EMI or RFI attenuation, or line supervision after maintenance when it is performed in accordance with manufacturer's instructions.

2.2.4 Availability

Provide components rated for continuous operation. Provide solid-state electronic components mounted on printed circuit boards, conforming to UL 796. Provide boards that are plug-in, quick-disconnect type. Do not impede maintenance with densely packed circuitry. Provide power-dissipating components with safety margins of not less than 25 percent with respect to dissipation ratings, maximum voltages, and current-carrying capacity. Provide heat sinks or other heat dissipation devices on appropriate components and assemblies. Provide solid-state type or hermetically sealed electromechanical type light duty relays and similar switching devices.

2.2.5 Fail-Safe Capability

Provide fail-safe capability in critical elements of the ESS including, but not be limited to, the capability to monitor communication link integrity and to provide self-test. Provide fault annunciation when diminished functional capabilities are detected. Annunciate fail-safe alarms to clearly distinguish from other types of alarms.

2.2.6 Line Supervision

Provide the same geographic resolution for fault isolation at the systems level as provided for intrusion detection. Provide either a static or dynamic system with active mode for line supervision of communication links of the ESS.

a. The static system must represent "no-alarm" always by the same signal, which is different than the originally transmitted signal.

b. The dynamic system must represent "no-alarm" with a signal which continually changes with time.

2.2.7 Power Loss Detection

****

NOTE: Verify if the Uninterruptible Power Supply (UPS) is detecting the loss of power to the critical component.

****

Detect AC and DC power loss and generate an alarm when a critical component of the system experiences temporary or permanent loss of power. Annunciate the alarm in [the Secured Area] [_____] [and] [the Security Command Center] to clearly identify the component experiencing power loss.

2.2.8 Controls and Designations

Provide controls and designations in accordance with NEMA ICS 1.

2.2.9 Special Test Equipment

Provide all special test equipment, special hardware, software, tools, instructions, and programming or initialization equipment needed to start or maintain any part of the system and its components. Special test equipment is defined as any test equipment not normally used in an electronics maintenance facility.

2.2.10 Electromagnetic Interference (EMI)

Configure and provide ESS components employing electromagnetic radiation constructed to provide minimal vulnerability to electronic countermeasures.

2.2.11 Electromagnetic Radiation (EMR)

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NOTE: National Post Telephone and Telegraph is normally the approving authority for EMR components overseas.

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Provide only ESS communication components which are [Federal Communications Commission (FCC)] [_____] licensed and approved. Provide system components which are electromagnetically compatible.

2.2.12 Interchangeability

Use off-the-shelf components which are physically, electrically, and functionally interchangeable with equivalent components as complete items. Equivalent, replacement components must not require new or other component modification. Do not use custom designed or one-of-a-kind items. Interchangeable components or modules must not require trial and error matching in order to meet integrated system requirements, system accuracy, or restore complete system functionality.

2.2.13 Date and Time Generator

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NOTE: Provide a time server for larger systems.

****

The ESS system date and time are to originate from [the ESS network time server] [GPS synchronization system with GPS satellite antenna][_____].

2.3 INTRUSION DETECTION SYSTEM (IDS)

The IDS primary function is to detect intrusion into secured areas. Utilize a single database for all IDS programming data that seamlessly integrates with the ESS under a single operating environment. The IDS events must be viewable as separate or as a combined list of all ESS events. Control the IDS alarm monitoring through software control from the ESS.

a. Provide both supervised and non-supervised alarm point monitoring.

b. [Arm or disarm] [Secure or access] alarm points both manually and automatically by time of day, day of week or by operator command.

[c. For classified assets, IDS installation related components and monitoring stations must comply with UL 2050.

]

2.3.1 IDS Components

Provide components:

a. Premise Control Units (PCU)

b. Detection Sensors

c. Tamper Switches

d. Arm/Disarm Keypads

2.3.2 Detection Sensitivity

The sensitivity of the IDS must allow for the following:

a. Locating intrusions [within [100] [_____] meters 300 [______] feet zones along a line or perimeter] [to one side of the [facility] [building]]

b. Locating intrusions at individually protected assets or at an individual portal

c. Locating intrusions within the coverage on a single volumetric sensor

d. Locating failures or tampering at individual sensors

2.3.3 Detection Alarm and Reporting Capacity

****

NOTE: Select system capacity parameters based on the specific facility design requirements. System capacity should be expressed as a binary number.

Include a 25 percent expansion factor to accommodate changes in design caused by reconfiguration of equipment within interior spaces or renovation. The designer should select arming/disarming for Army projects and select secure/access for Air Force and Navy projects.
****

Collect, communicate, and display up to [12] [32] [64] [128] [256] [_____] sensor zone alarms [and to enable control of [one] [two] [_____] [card reader] [card reader with integral keypad] for [arming and disarming] [secure and access] [inside of the protected area with a delayed alarm] [outside of the protected area with instant alarm]].

Identify individual sensors in alarm if the sensor zone is a multiple alarm source combination. Annunciate a single alarm within [1] [2] [_____] seconds maximum, after sensor transducer or other detection device activation [except that alarms transmitted by radio frequency signaling must communicate in less than 3 seconds].

2.3.4 False Alarm Rate

The false alarm rate for each interior IDS zone must not exceed one false alarm per 30-day period. The false alarm rate for each exterior IDS zone must not exceed one false alarm per 24-hour period.

2.3.5 Nuisance Alarm Rate

The nuisance alarm rate for each interior IDS zone must not exceed three nuisance alarms per 30-day period. The nuisance alarm rate for each exterior IDS zone must not exceed three nuisance alarms per 24-hour period.

2.3.6 Premise Control Unit (PCU)

Install the PCU command processor in a tamper resistant enclosure that is specified in paragraph COMPONENT ENCLOSURE. Package the following with the PCU:

a. Power transformer

b. Battery(s)

c. Network connection cable

d. Keypad(s)

e. Keypad connection cable(s)

f. Additional components as required for full functionality

2.3.6.1 PCU Capabilities

Provide the PCU at a minimum but not limited to, the following capabilities;

a. Expansion to a total of at least [10,000] [_____] user codes with [99] [_____] user profile definitions.

b. Support [4] [8] [16] [_____] keypads with alphanumeric display. Each keypad must be capable of [arming and disarming] [securing and accessing] any system area based on a pass code or access control card and or key FOB authorization. Provide keypad alphanumeric display with complete prompt messages during all stages of operation and system programming and display all relevant operating and test data.

c. Four [4] [_____] shift schedules per area.

d. A total of at least [100] [_____] programmable output relay schedules.

e. [32] [64] [_____] individual reporting areas.

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NOTE: For installation where dial-up is the only feasible line, two lines of communication are to be used.

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f. Data line supervision [or two separate lines of communication].

g. Two-man access code or credentials.

h. Support programming to require the same or different access code entered within a programmed delay time of [1 to 15] [_____] minutes after disarming before activating a silent ambush alarm.

i. Support area programming that disables schedule and time-of-day changes while system is armed so that area can only be disarmed during scheduled times.

j. Provide a minimum of a [4,000] [_____] event log buffer per PCU. Record and hold alarm activity information in the log buffer until the ESS is connected and receives the information. Provide a software-configurable warning log buffer filling notification for PCU(s) configured with network switch capabilities.

k. Support a Network Interface Card (NIC) plug-in module with built in network router capable of 128 Bit AES Rijndael Encryption process certified by NIST (National Institute of Standards and Technology).

2.3.6.2 Overcurrent Protection and Indication

When overcurrent more than it is rated for is detected by the PCU, communication bus(es) and keypad(s) are to be shut down and an overcurrent notification LED lit to indicate the situation.

2.3.6.3 Manual and Self-Test

All alphanumeric keypad to include testing for: standby battery, alarm bell or siren, and communication to the Security Command Center (SCC). Include provisions for an automatic, daily, weekly, 30 day, or up to 60 day communication link test from the PCU installation site to the SCC. Include a provision for displaying the internal system power and wiring conditions.

Include the following for internal monitoring points:

a. The bell circuit

b. AC power

c. Battery voltage level

d. Charging voltage

e. Panel box tamper

f. Phone trouble line 1

g. Phone trouble line 2

h. Transmit trouble

i. Network trouble

A battery test must be automatically performed to test the integrity of the standby battery by disconnecting the standby battery from the charging circuit and placing a load on the battery. Perform this test at an interval no greater than 180 days.

2.3.7 Detection Sensors

****

NOTE: Certain assets may require a higher probability of detection (Pd) than the 0.9 value provided below. Consult the applicable security policy for the asset being protected to determine the actual Pd value required. Remote test capability should be used only when required by governing regulations or when sensors are installed in hard to reach areas.

****

a. Sensors are to detect facility perimeter or protected zone penetrations by unauthorized personnel or intruders and transmit an alarm signal to the alarm annunciation system upon change detection. Accomplish this with a probability of detection (PD) of [[0.9], [0.95]] with a [[90], [95]] percent confidence level and conforming to UL 639 where applicable.

Probability of Detection	0.9	0.9	0.95	0.95	Number of Misses Allowed
Confidence Level	90 Percent	95 Percent	90 Percent	95 Percent	
Number of Intrusion Attempts	22	29	45	59	0
	38	46	77	93	1
	52	61	105	124	2
	65	76	132	153	3
	78	89	158	181	4
	91	103	184	208	5

b. Required sensor power is 12 VDC unless otherwise specified.

c. An interior IDS zone is a room or space within a building that can be [armed and disarmed] [secured and accessed] independently from all other zones.

d. Provide line supervision for all sensors with an end-of-line resistor at the sensor or within a tampered junction box with conduit from the junction box to the sensor.

e. Provide sensors and components rated for operation in the installed environment. The sensors must transmit an alarm signal to the alarm annunciation system upon change detection. Provide all sensors with a tamper switch and elements housed in a tamper-alarmed enclosure in accordance of paragraph COMPONENT ENCLOSURE.

2.3.7.1 Interior Sensors

2.3.7.1.1 High Security Switch (HSS)

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NOTE: High security switch (HSS) as specified in (a) are for High security applications, refer to ICS 705-1. Use of recessed HSS is recommended during new installations. Coordinate with Architect to ensure proper door hardware (electric strike, hinges, etc.) is provided.

Use level 2 high security HSS in SCIF and SAPF areas. Use level 1 or level 2 in all other locations. The level required is dependent on the asset and risk level.

****

Mount the HSS inside the secure location and on the opening side of the door. HSS sensors do not have the capability to incorporate an end-of-line (EOL) resistor.

2.3.7.1.1.1 Level 1 Switch

UL 634. Level 1 High Security

2.3.7.1.1.2 Level 2 Switch

UL 634. Level 2 High Security

2.3.7.1.2 Glass Break Detection

UL 639.

2.3.7.1.2.1 Window-Mounted Glass Break Shock Sensor

Provide sensors with an LED for adjusting sensitivity.

Provide sensor with an exterior label to protect tape from direct sunlight. Seismic vibrations or other ambient stimuli are not to initiate an alarm. [Test glass breakage sensors by using test units supplied by the manufacturer which simulate glass breakage.]

2.3.7.1.2.2 Ceiling Or Wall-Mounted Dual Technology Glass Break Sensor

Provide a sensor that eliminates occupant-generated false alarms by combining a passive infrared motion detector (PIR) with glass break sensing. The combination will extend coverage to occupied areas, allowing the sensors to be armed while people are present.

2.3.7.1.2.3 Ceiling or Wall-Mounted Recessed Glass Break Sensor

Provide a sensor employing pattern recognition technology that listens for the actual pattern of breaking glass. The sensor is to be able to detect the difference from breaking glass and normal room sounds by listening across the glass break frequency spectrum. Provide a range of 7.6 meters 25 feet to cover the area to be protected.

2.3.7.1.3 Vibration Vault Sensor

Provide a sensor that senses short duration, large amplitude signals like those produced in attacks from explosions, hammering or chiseling and also detect long duration, small amplitude signals like those produced in attacks from torches, thermic lances, drills, grinders, or cutting discs.

Provide sensor equipped with a manual and an automatic test alarm output with test indicator not visible or audible during normal operations. The test indicator is to annunciate when the sensor detects an intruder when active. The alarm indication may be located within the sensor or as a separate device.

2.3.7.1.4 Fiber Optic Mesh Sensors

Fiber optic mesh sensors are to be comprised of a web of optical fiber cables which are deployed within:

a. Building walls

b. Partitions

c. Flexible structures

d. Water-side installations

e. Mobile facilities

f. Mobile container shells

2.3.7.1.5 Utility Inlet Opening Protection

****

NOTE: Utility inlet openings are protected in a variety of methods, the correct one being dependent on two variables: the nature of the intrusion threat (i.e., physical penetration, electrical, electro-optical, etc.) and the characteristics of the utility inlet opening (i.e., discharge water from a nuclear plant, office air duct, electric conduit, etc.). Subsequent to such analysis, almost any of the intrusion detection sensors described herein could provide the necessary protection. Normally a breakwire trap sensor is used for this application.

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Provide protection by a sensor of the [breakwire] [wire trap] type consisting of up to 26 AWG hard-drawn copper wire with a tensile strength of 17.8 N 4 pounds maximum interlaced throughout the opening such that no opening between wires is larger than 100 mm 4 inches on center.

[Conceal] [Tamper protect] terminated sensors so that any attempts to cut the wire or enlarge openings between wires cause an alarm.

2.3.7.1.6 Passive Infrared Sensors

UL 639.

2.3.7.1.7 Microwave Sensors

UL 639.

2.3.7.1.8 Dual Technology Sensors

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NOTE: In subparagraph, writer should specify whether the dual technology detection would require both phenomenological (i.e., "AND" mode) or a single phenomenology (i.e., "OR" mode) for reporting of an alarm. If dual technology sensors are placed in SCIF, SAPF, or classified open storage, then the sensor must be configured in the "OR" mode.

****

UL 639. Provide sensor combining passive infrared (PIR) and microwave sensors configured and manufactured specifically to be mounted in a single tamper alarmed enclosure. The sensor must provide ["AND" logic for alarm indication] [selectable "AND" logic or "OR" logic for alarm indication configured in the "OR" logic state]. Provide sensors that have a local means of indicating detection for use during installation and calibration with a means of disabling the indication.

The sensor is to have an LED walk test indicator which is not visible during normal operations. When visible, the walk test indicator will light when the sensor detects an intruder. Provide a sensor equipped with a manual control, located within the sensor's housing, to enable and disable the test indicator or with the test indicator located within the sensor housing so that it can only be seen when the housing is open or removed.

2.3.7.1.9 Photoelectric Sensors

UL 639. The sensor is to detect opaque bodies and not allow an intruder to disable detection by shining another light source into the receiver.

Provide sensor with a local means of indicating detection for use during installation and calibration with a means of disabling the indication.

2.3.7.2 Exterior Sensors

2.3.7.2.1 Wide Gap High Security Switch (HSS)

Provide UL 634 approved wide gap HSS for all exterior applications (gates, etc.) that cannot operate within the close tolerances of standard HSS sensors. Ensure the application tolerances are within the HSS limitations set by the manufacturer for optimum operation. Wide gap HSS should have a minimum gap tolerance of [_____] mm [_____] inches and a maximum gap tolerance of [_____] mm [_____] inches between switch and magnet.

2.3.7.2.2 Fence Mounted Sensors

Sensors are fiber optic or strain-sensitive cable sensors as indicated which initiate an alarm when an intruder attempts to scale, cut through, lift the fabric of, or lean climbing devices on to the entire length of a standard chain link fence or physical barrier. Provide sensors that are either tamper alarmed or self-protecting. House exterior components in rugged, corrosion-resistant enclosures, as specified in paragraph COMPONENT ENCLOSURE.

Provide fence cable support hardware that is weather-resistant.

2.3.7.2.2.1 Fiber Optic Sensor

The sensor consists of an ultraviolet resistant fiber optic transducer cable with a microprocessor based dual zone signal processor that is capable of monitoring different styles of metal fabric fencing including chain-link, expanded-metal or welded-mesh fence. The sensor detects intruders by utilizing signals generated by the minute flexing of the fiber optic transducer cable, caused by attempting to cut, climb, or raise the fence fabric.

The signal processor analyzes the signals from the fiber optic transducer cable and detects minute vibrations in the fabric of the fence. The signal processor supports [single] [dual] zones with each zone supporting a maximum 500 m 1640 feet of sensing cable. The processor utilizes adaptive algorithms, ambient signal compensation and selectable common-mode rejection, to discriminate between actual, false and nuisance alarms, without lowering the probability of detection. The processor identifies, by type, a cut intrusion and a climb intrusion. Provide sensors with independent adjustments and thresholds for each type of intrusion and have the capability to completely mask climb or cut alarms. Alarms caused by power failure, low input voltage, cable fault (cable cut or high loss due to physical stress), or internal electronic fault are to be identified as supervisory alarms. Equip the sensor with a test indicator if it is an integral sensor signal processor function.

2.3.7.2.2.2 Strain-Sensitive

a. Provide a complete fence line protection with no dead zones where an intruder can penetrate the fence. Through sensor electronics the fence line protection must be divided into zones. Sensing unit of sensor must achieve specified performance with transducer cable either by attachment directly to the fence fabric by plastic cable every 300 to 455 mm 12 to 18 inches or by installation inside RGS conduit mounted on the fence. Provide sensing units with equal adjustable sensitivity throughout the entire length.

b. Use only conventional waterproof coaxial cable connectors for connections of the sensing unit to permit installation in extreme EMI environments with no loss of detection capability. Entire sensor system must be capable of detecting tampering within each system portion by sensor zone.

c. Provide capability for alarm threshold sensitivity adjustment to permit compensation by zone for winds up to [40] [56] [_____] kmph [25] [35] [_____] mph while maintaining the same level of detection performance as under ambient conditions.

d. Sensor zone control unit must provide an analog audio output for interface to an external audio amplifier to permit remote audio assessment regardless of sensor alarm status. Sensor zone control unit alarm output interface is to be a separately supervised relay contact normally open or normally closed, with [an adjustable intrusion alarm pulse width of 0.5 second adjustable and a] continuous (until corrected) tamper alarm.

2.3.7.2.2.3 Gate Units

Provide gate units in accordance with specific fence sensor manufacturer's recommendations to ensure continuous fence sensor zone protection for the entire protected perimeter. Provide a gate unit for each fence portal.

Provide separately zoned HSS gate sensors when gate units are not provided by the fence sensor manufacturer. HSS sensors perform as specified in paragraph WIDE GAP BALANCED MAGNETIC SWITCH.

2.3.7.2.3 Electrostatic Field Sensors

a. Initiate an alarm when an intruder attempts to approach or scale a fence or physical barrier. Electrostatic field sensors generate an electric field around one or more horizontal wires and sense the induced signal in parallel sensing wires to detect human presence. Provide sensors that monitor the induced signal for changes that result from the presence of a conductive body or a body with a high dielectric constant.

b. Use mounting and support hardware as provided by the equipment manufacturer.

c. Provide spring tension-mounted wire on end-of-line terminators to detect cutting, shorting, or breaking of the wires. Select sensor configuration such that an intruder cannot crawl under the bottom wire, through the wires, or over the top wire without being detected and be divided into sensor zones.

d. Sensors must be capable of following irregular contours and barrier bends without degrading sensitivity below the specified detection level. Adjacent zones must provide continuous coverage to avoid a dead zone and be configured to prevent crosstalk interference.

e. Provide filtering on signal processing circuitry to distinguish nuisance alarms. Sensor configuration is to incorporate balanced, opposed field construction to eliminate far field noise.

f. House exterior components in rugged corrosion-resistant enclosures, protected from environmental degradation and provided with tamper switches. Use underground cables to interface between exterior units. Use stainless steel or galvanized exterior support hardware. Use stainless steel sensor and field wires.

g. Follow manufacturer's specifications for wire spacing of various configurations.

h. Provide adjustable sensor sensitivity which is inaccessible to operating personnel.

2.3.7.2.4 Taut-Wire Sensors

a. Incorporate perimeter intrusion detection sensors into a [barbed] [barbless] wire security fence. Detect intrusion of cutting of any single wire or the deflecting, as by climbing, of any wire by more than 80 mm 3.1 inches. A sensor zone includes one or more [61] [_____] m [200] [_____] feet maximum sections of [2100] [_____] mm [7] [_____] foot high parallel fence with each sector consisting of [13] [_____] horizontal tensioned wires attached to the taut-wire fence posts, and three strands as outriggers, plus an "anti-ladder" trip wire supported by rods extending from the outriggers for a total vertical height of approximately [2440] [_____] mm [8] [_____] feet.

b. Mount displacement switches for each horizontal wire within a prewired channel fastened to the fence post at the midpoint of each section. Outrigger barbed wire and tripwire may share the same switch. Mount each taut-wire fence post to the normal security fence (chain link) fabric posts or other barrier via standoffs to position the taut-wire approximately 150 mm 6 inches from the fence fabric or other barrier.

c. Mount freestanding taut-wire fence posts in concrete to support the taut-wire fence system. Pretension and clamp each [barbed] [barbless] wire strand to the lever arm of the displacement switch, such that the lever is in the neutral (off) position; therefore, the forces applied by the [barbed] [barbless] wires are balanced equal in opposite directions. Pretension tripwires in a like manner. Line tripwires to the top switch in the sensor switch channel by a special subassembly that includes a rod which transfers tripwire movement as a lever to the end of the actuating sensor switch's lever arm.

d. Initiate an alarm upon abnormal switch lever displacement. This would result from cutting or deflecting its attached wire, as by climbing on or through fence strands. Provide sensor with a damping mechanism which reduces alarm threshold due to slowly changing phenomena including ground shifting, daily and seasonal temperature variations, and winds up to 56 kmph 35 mph.

e. Sensor switch must provide electrical contact closure as the means for initiating an alarm, whenever the wire clamped to the vertical center bolt is pulled laterally in any direction by an amount not over 19 mm 0.75 inch.

f. Housing for switch assembly must be covered by a neoprene cap to retain the center bolt (lever arm). This bolt translates attached horizontal wire movement into the contact closure. The bolt functions as the fulcrum for the lever when the neoprene cap is firmly seated on the cup-shaped polycarbonate housing.

g. Provide threaded upper exposed end of the lever to accommodate clamping to the horizontal wire. The lower end of the lever, which is fashioned to serve as the movable electrical contact, must be held suspended in a small cup-shaped contact that floats in a plastic putty material. The plastic putty is to retain a degree of elasticity under varying temperature conditions and provide the sensor switch with a self-adjusting property. This provides the switch with a built-in compensating mechanism that ignores small, very slow changes in lever alignment (which may result from environmental changes including extreme temperature variations and ground creepage due to weather conditions) and to react to fast changes only, as caused by manual deflection or cutting of the wires.

h. Provide metal slider strips having slots through which the barbed wires pass with rivets that prevent the wires from leaving the slots. The slider strip must translate horizontal displacement forces normal to the barbed wire to the sensor. Install one slider strip pair, upper and lower, on every fence post except where sensor posts or anchor strips are installed. Provide maximum separation between slider elements along the fence of [3000] [_____] mm [10] [_____] feet.

i. Attach [barbed] [barbless] wires to installed fence anchor posts, located equidistant on both sides of sensor posts and at ends of sensor zone run. Install fastening plates on an anchor strip. Weld strip or otherwise attach the strip to anchor post and ends of tensed barbed wires wrapped around the fastening plates. Fastening plates are to break off when climbed upon or on the attached [barbed] [barbless] wires creating an alarm and making it impossible to defeat the system by climbing at the anchor post.

j. Use [barbed] [barbless] wire suitable for installation under a preload of approximately 392 N 88 pounds tension and be flexible enough for convenient manipulation during tensioning. The minimum acceptable double-strand barbed wire gage is 15-1/2.

k. Sensor zone control unit must monitor up to [10] [_____] zones.

l. Provide sensor with relay outputs to interface alarm outputs with the overall ESS. Input power is [120] [230] VAC.

2.3.7.2.5 Dual Technology Sensors

a. Provide dual technology sensor that combines Microwave and Dual PIR into one single all-weather detector. Use the sensor in extreme outdoor conditions to provide the maximum amount of coverage in a horizontal plane.

b. The sensor must come mounted in an industrial-grade housing as specified in paragraph COMPONENT ENCLOSURE. Provide pan-tilt swivel bracket with swivel within 100 degrees of range and tilt within 10 degrees. The swivel bracket is to allow for calibration into 1-degree segments for adjustment to any environment.

c. The sensor must provide either wide angle or long-range detection by change of optical mirrors. Wide angle coverage must detect intrusion out to 15 [_____] m [49] [_____] feet and long-range coverage out to [40] [_____] m [130] [_____] feet. Provide sensors that allow adjustment masks for wildlife immunity for animals up to [10] [20] [30] [45] [_____] kg [22] [44] [66] [99] [_____] pounds.

2.3.7.2.6 Bistatic Microwave Sensor

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NOTE: Within the U.S., the FCC regulates the operating frequencies of all microwave sensors. Other countries have their own frequencies. The designer must request approval from U.S Government agency or country agency having authority for approval of the frequency of the product selected in the design.

****

a. Provide sensor equipped with circuitry that produces an alarm signal when the sensor's receiver is captured by another microwave transmitter. Multiple sensors must be able to operate in adjacent zones without interfering with each other. Provide sensors with adjustable sensitivity controls within the sensor that are not accessible when the sensor housing is in place. Provide sensors that can be adjusted in order to obtain the designed coverage pattern.

b. The bistatic microwave sensor is to consist of a separate transmitter and receiver. The sensor detects changes from a standard intruder's movement in the received microwave signal sensor's detection pattern. The sensor transmits an alarm signal to the alarm annunciation system upon detecting such changes. The sensor must detect a standard intruder moving perpendicular through the sensor's detection pattern at a speed of 0.06 to 7.6 m per second 0.2 to 25 fps.

c. Equip the sensor with an LED walk test indicator which is not visible during normal operations. When visible, the walk test indicator is to light when the sensor detects an intruder. Provide sensors equipped with a manual control, located within the sensor's housing, to enable and disable the test indicator or with the test indicator located within the sensor housing so that it can only be seen when the housing is open or removed.

2.3.7.2.7 Monostatic Microwave Sensor

a. Multiple sensors must be able to operate in adjacent zones without interfering with each other. Provide sensors with adjustable sensitivity controls within the sensor that are not accessible when the sensor housing is in place. The sensor must be adjustable to obtain the coverage pattern shown and have range cut off capabilities of field selected distance 30 to 122 m 100 to 400 feet.

b. The monostatic microwave sensor must consist of an integrated transceiver. The sensor detects changes from a standard intruder in the received microwave signal sensor's detection pattern. The sensor must transmit an alarm signal to the alarm annunciation system upon detecting such changes. The sensor must detect a standard intruder moving perpendicular through the sensor's detection pattern at a speed of 0.06 to 7.6 m per second 0.2 to 25 fps.

c. The sensor is to be equipped with an LED walk test indicator which is not visible during normal operations. When visible, the walk test indicator is to light when the sensor detects an intruder. Provide sensors equipped with a manual control, located within the sensor's housing, to enable and disable the test indicator or with the test indicator located within the sensor housing so that it can only be seen when the housing is open or removed.

2.3.7.2.8 Passive Infrared Sensor (Exterior)

a. UL 639. The passive infrared sensor must detect movement from a standard intruder in the ambient level of infrared emissions within the sensors' field of view.

b. The sensor is to detect a change in temperature of at least 1.1 degrees C 2 degrees F and detect an intruder traveling within the sensor's detection pattern at a speed of 0.2 to 15 m per second 0.6 to 50 fps across 2 adjacent segments of the field of view. The sensor must have a detection range of at least 92 m 300 feet. Emissions monitored by the sensor must be in the 8 to 14 micron range.

c. Provide sensors that can be adjusted to obtain the designed coverage pattern. The sensor is to be equipped with a temperature compensation circuit.

d. The sensor is to be equipped with an LED walk test indicator which is not visible during normal operations. When visible, the walk test indicator is to light when the sensor detects an intruder. Provide sensors equipped with a manual control, located within the sensor's housing, to enable and disable the test indicator or with the test indicator located within the sensor housing so that it can only be seen when the housing is open or removed.

2.3.7.2.9 Buried Ported Cable

The buried ported cable to monitor for changes in the electromagnetic field between the leaky coax transmit and receive cables within the sensor's detection pattern to detect standard intruder movement. The sensor must transmit an alarm signal to the alarm annunciation system upon detecting such changes. Provide sensors that detect a standard intruder moving through the sensor detection pattern at a speed of 0.06 to 7.6 m per second 0.2 to 25 fps.

Provide ported coaxial transmission and receive cables rated for direct burial. Provide sensors to obtain the designed coverage pattern with adjustable sensitivity to 1 m 3 feet length by controls within the sensor signal processor. Controls must not be accessible when the sensor signal processor's housing is in place. Equip the sensor with a test indicator if it is an integral sensor signal processor function.

2.3.7.2.10 Active Infrared Sensor (Exterior)

a. The active infrared sensor detects a light beam interruption that links the transmitter and receiver caused by an intruder moving at a speed of less than 2.92 m per second 7.5 fps through the beam. The sensor must transmit an alarm signal to the alarm annunciation system upon detecting such an interruption.

b. The sensor must use a pulsed infrared light source. Multiple sensors must be able to operate within the same zone without interfering with each other. Provide sensors to obtain the designed coverage pattern with adjustable sensitivity with controls located within the sensor signal processor and not accessible when the sensor signal processor's housing is in place.

c. The sensor is to be equipped with an LED walk test indicator which is not visible during normal operations. When visible, the walk test indicator is to light when the sensor detects an intruder. Provide sensors equipped with a manual control, located within the sensor's housing, to enable and disable the test indicator or with the test indicator located within the sensor housing so that it can only be seen when the housing is open or removed.

d. The sensor may incorporate remote test if it is an integral sensor function.

2.3.7.2.11 Video Motion Sensor (Exterior)

Provide a video motion sensor to detect changes in the video signal within a user defined detection zone as described in paragraph VIDEO ANALYTICS (VA). The system must detect changes in the video signal corresponding to a standard intruder moving within the defined detection zone and wearing clothing with a reflectivity that differs from that of the background scene by a factor of 2. Provide signal processing techniques to eliminate non-alarm background motion including light changes, trees blowing, and birds. Provide sensor with controls and method needed by the operator to define and adjust the sensor detection zone within the video picture.

Video motion sensor system must operate using [digital cameras] [thermal cameras] [or digital and thermal cameras]. The number of detection zones, the size of the detection zones, and the sensitivity of the detection zones are to be user definable. Provide sensors that accommodate multiple video inputs and have the capability of modular growth. The video inputs must accept composite video. The sensor must not require external sync for operation. Provide one alarm output for each video input. Provide number of video inputs and alarm outputs as required for an operable system. Rack-mount sensor equipment in a standard rack as described in paragraph EQUIPMENT RACK with hardware includes as required to mount the sensor components.

2.3.7.2.12 Radar

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NOTE: Radar should be used in conjunction with other detection and assessment systems such as VSS, to provide capability to extend the zone of protection to maximum standoff distances. The

designer should contact the manufacturer of the product to determine that product's particular capabilities during design.

****

The radar system must provide intruder detection to [700] [_____] m [2300] [_____] feet. Provide monostatic type unit in which the transmitter and receiver are encased within a single housing unit (transceiver). The radar is to be equipped with a signal processor that is programmed to recognize reflected energy from the normal environmental surroundings and eliminate those objects relative to alarm. Provide unit with the capability of preprogramming specific parameters, size and speed, above which an alarm signal is generated.

The system is to provide alarm information to the ESS to identify specific zones of concern to include range and azimuth information, as a minimum. The information must have the capability of integrating with [VSS] [video motion sensor] systems, to "call" the cameras to a particular view for alarm verification. The system is to be able to retrofit with existing VSS or other detection systems. After radar system installation, post warning signs indicating radiation hazard as recommended by the manufacturer.

2.3.7.3 Duress Alarms (Hold Up Switch)

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NOTE: The designer will show type and location of duress alarm switches. Duress alarm switches must meet requirements in UL 636.

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UL 636. Duress alarm switches must provide the means for an individual to covertly notify the alarm annunciation system that a duress situation exists with no visible or audible signal in the secure area.

2.3.7.3.1 Hardwire Duress Alarms

Alarms must be capable of being secretly activated by the foot or hand of an average adult in both standing and seated positions. Upon activation the alarm signal is to lock-in until manually reset with a key or similar device and be readily identifiable by the ESS.

Provide sensors that are easy to operate and configured to minimize the possibility of accidental activation. Hardwire duress alarms must be rated for a minimum lifetime of 50,000 operations. Securely mount sensors in rugged, corrosion-resistant housing.

2.3.7.3.2 Wireless Duress Alarms

Wireless duress alarm switches to consist of portable alarm transmitters easily worn on the body or clothing. Alarm activation is to be by hand-operated switch protected from accidental activation, yet easily activated by hand when worn at the waist on body or clothing which transmits a unique identification code to one or more receivers located within a protected zone. The receivers, in-turn, are to transmit an alarm signal to the ESS system. [Sensor activation is to be automatic when mounted on a body or clothing and the wearer is in a horizontal position for longer than [one] [5] [15] [_____] minutes, adjustable. Operations personnel must not be able to adjust time interval activation.]

Provide switches rated for a minimum lifetime of 50,000 operations and have a range of at least 762 m 2500 feet. Wireless switches must be fully supervised, where the transmitter automatically transmits (checks in) to the receiver on a regular basis to test the system for low battery, tamper, and inactive status.

2.3.7.4 Tamper Switches

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NOTE: For Army projects, the designer should confirm with USACE Electronic Security Systems Mandatory Center of Expertise if the maintenance position is required. For Air Force and NAVFAC projects, include the requirement for a maintenance position switch.

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a. Corrosion-resistant tamper switches are required for the following IDS and VSS equipment with hinged doors or removable covers that contain open circuits:

  (1) Enclosures

  (2) Cabinets

  (3) Housings

  (4) Boxes

  (5) Raceways

  (6) Fittings

  (7) Sensors

b. Tamper switches are to initiate an alarm signal when the door or cover is moved as little as 6 mm 1/4 inch from the normally closed position. Mechanically mount tamper switches to maximize defeat time when enclosure covers are opened or removed. One second is the minimum amount of time required to depress or defeat the tamper switch after opening or removing the cover. Enclosure and tamper switch must prevent direct line of sight to internal components and prevent switch or circuit tampering. Conceal mounting hardware so switch cannot be observed from enclosure exterior.

c. Tamper switches on doors which are opened to make normal maintenance adjustments to the system and to service power supplies must [not] have a maintenance position. [Provide two positions tamper switches.]

2.3.7.4.1 Tamper Switch Performance Requirements

Tamper switches are to be:

a. Inaccessible until switch is activated.

b. Under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating.

c. Annunciated to be clearly distinguishable from intrusion detection alarms and exempt from being disarmed, shunted, or silenced.

d. Spring-loaded and held in the closed position by the door, or cover protected.

e. Wired to break the circuit when the door or cover is disturbed.

f. Wired so that each sensor and device is annunciated [individually] [by zone] at the central reporting processor.

2.3.8 Intrusion Detection System Date and Time

Provide system date and time per paragraph DATE AND TIME GENERATOR.

2.4 ACCESS CONTROL SYSTEM (ACS)

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NOTE: The designer must ensure that the Access Control System components are compatible with Common Access Cards (CAC). CAC is the principal identity credential of the Government.

Obtain clear requirements for separate and stand-alone ACS and separate and stand-alone IDS or a system that is capable of both ACS and IDS capability.

For HSPD-12 access control projects, ensure system utilizes the GSA FIPS 201 Evaluation Program Approved Products List.

****

Provide an access control system based upon a modular distributed microprocessor architecture complete with access control cards and ready for operation.

a. The ACS card credentials are required to be Common Access Cards (CAC), and CAC cards are being provided by the Government. [Interface system with and provide alarm and other status to the overall ESS.] [Provide system monitoring and control for the ESS.] Provide ACS that meets the communications requirements of UL 1076 and UL 294 and has the capability of controlling up to [4] [8] [16] [_____] card readers and keypads per card reader controller, [128] [256] [512] [_____] alarm inputs, or [128] [256] [512] [_____] relay outputs or any components combination.

b. System is to grant or deny access or exit based upon:

    (1) Keypad identification data

    (2) [Common Access Card (CAC)] [Personal Identity Verification (PIV)] card identification data

    (3) Video

    (4) Biometric reader identification data

    (5) Smart card identification data

(6) Identification technologies combination

(7) Input through the access control devices compared to data stored within the system

(8) Time of day, day of week, and special day and holiday scheduling with card validation override.

c. Decision to grant or deny access or exit is to be based upon authorization for such data to be input at a specific location for the current duration. [Access decisions for high security areas are to be based upon two identification technology combinations: card and keypad or card and biometric.]

d. Provide ACS that supports the configuration and simultaneous monitoring of multiple access control devices when TCP/IP communication interfaces are used between the ESS and the primary Access Control Unit (ACU). The events of the ACS are to be viewable as separate or as a combined list of all ESS events. Provide overall control of the ACS, alarm monitoring, and photo identification through software control of the ESS.

e. Access control, photo imaging, and programming data must reside on a single database and instantly accessible to every networked PC workstation connected to the ESS.

f. Provide both supervised and non-supervised alarm point monitoring.

g. Provide the capability to arm or disarm alarm points both manually and automatically by time of day, day of week or by operator command and the capability to disarm alarm points based on a valid access event.

[h. When used for elevator control, the ACS is to grant access to elevator floors based on a valid credential, or by schedule.]

i. Provide programmable 'delay' setting for all alarm points. The alarm points are not to report an ENTRY type alarm until the delay setting has expired and not report a dwell type alarm condition until the alarm has been active for the full delay period.

j. Provide the capability to place ACU(s) in an off-line mode. In the off-line mode, the ACU(s) must retain a historical summary of all ACU activity transactions, up to the maximum capacity of the ACU memory buffer. Provide the ability for manual operator control of system output relays with the manual functions to energize, de-energize, enable or disable.

[k. Provide the ability to display a stored 'video image' of the cardholder based on card activity and switch real-time VSS camera to the card reader location for specific card usage. The card reader must not activate the door lock until positive operator acknowledgment from the SCC.]

[2.4.1 ACS Badging Requirements

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NOTE: The designer must show justification for including badging. CAC cards will be provided offsite and are not part of this contract.

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Include fully integrated badging capabilities, including image capture, image editing, badge design, and badge printing. Allow for each cardholder to be assigned to both a badge design formatted for badge printing and a dossier design formatted for standard paper printing. The system must permit the storage of four different images:

a. Main photograph

b. Alternate photograph

c. Signature

d. Fingerprint

Provide for interfacing with external badge programs, in which stored photo images are displayed in a cardholder information window, but other badge features are supported by the external program. Include one or more networked PC workstations with the photo imaging components at which all the required image capture equipment has been installed.

]2.4.2 ACS Programming

Provide software capable of, but not limited to, the following programming:

2.4.2.1 Time Schedules

Provide up to [256] [_____] user-definable time schedules. These time schedules are to determine the day(s) and times that access will be granted, or a scheduled event is to occur. Any and all of the time schedules are to be available for defining access privileges and scheduled events. Provide ALWAYS and NEVER schedules that cannot be altered or removed from the system. Each user-defined time schedule must have the option of reacting or not reacting to user-defined special days, with the ability to react uniquely to each type of special day.

2.4.2.2 Special Days

Provide an unlimited number of user definable special days to be used for configuring exceptions to the normal operating rules, typically for specifying holiday operating rules. Allow for each special day to be assigned to a user-defined type.

2.4.2.3 ACU Daylight Savings Time Adjustment

Provide a software-configurable, user defined adjustment for Daylight Savings Time. The ACU must not need to be connected to a PC workstation for the adjustment to occur.

2.4.2.4 Scheduled Events

Any access-controlled reader is to be capable of scheduled unlock periods to allow for card-free access. The access-controlled reader is to also be capable of requiring one valid access event before beginning a scheduled unlock period.

Any access control point is to be capable of requiring a valid card as well as a PIN code via keypad on a scheduled basis for high security areas. The use of PIN via keypad functions must not reduce the number of card readers or alarm points available in the ACU(s). Any designated alarm input must be able to be scheduled [Armed and Disarmed] [Secured and Accessed]. Any relay output must be capable of scheduled ON and OFF periods to allow for automatic input and output system control.

2.4.2.5 Maximum User Capability

Up to [64,000] [_____] individual users may be given access cards or codes and have their access controlled and recorded.

2.4.2.6 Access Groups

Each system user must be assignable to a maximum of [4] [_____] of [256] [_____] possible access groups. An access group is defined as one or more people who are allowed access to the same areas at the same days and time periods.

2.4.2.7 Active and Expire Dates

Any card or user may be configured with activation and expiration dates. The card can be assigned to any valid access group and will be activated and expired according to the specified dates.

2.4.2.8 Maximum Use Settings

Any card or user may be configured with maximum number of uses for that card. The card can be assigned to any valid access group and will be expired according to the specified number of card uses.

2.4.2.9 Door Outputs

Provide each access control reader with [one] [two] [_____] dedicated relay outputs. Both relays are to provide Normally Open and Normally Closed contacts. Use the first relay for electric lock control while the second is software configurable to activate for door forced open, door left open too long, duress, passback violations, invalid access attempts and valid unlock conditions. Allow for both relays to be separately programmable for energize times from [1] [_____] second to [10] [_____] minutes. The second relay must allow a delay time to be specified, causing its activation to be delayed after an activating condition occurs.

[2.4.2.10 Anti-Passback

Provide global anti-passback capability. Any door on the system can be linked to one of [256] [_____] user defined passback areas or two [2] [_____] pre-defined areas. Each door may be set up to automatically forgive passback entries at one of the following intervals:

(1) Never

(2) Midnight

(3) Every 12 hours (Midnight and Noon)

(4) Every 6 hours

(5) Every 2 hours

(6) Each hour

(7) Every 30 minutes

Each door can be configured to deny or grant access for passback violations and individual users can be exempt to the passback rules. The anti-passback features must be a global function and operate completely independent of the ACS software, except configuring the passback rules. Additionally, the operator is to have the ability to manually forgive an individual user or all users by command from the ACS.

][2.4.2.11 Two Person Rule

Any access control reader on the system is to have the ability via software programming to require two valid cards for access. Any access control reader on the system that includes a keypad is to also have the ability to require a valid PIN number associated with each of the two valid cards.

]2.4.2.12 User List or Who's In (Muster Reports)

Provide the capability to generate dynamic lists of users in certain access-controlled areas, based either upon selected users or selected areas. The lists must have the option of automatically refreshing after a user-selected interval of time.

2.4.2.13 Crisis Mode

Provide support for a "crisis mode", in which user-selected alarm point activations cause changes to user access privileges. The changes to user access privileges must be configurable to restrict normal access to no access or limited access.

2.4.2.14 Door Groups

Allow up to [256] [_____] door groups to be configured. Doors belonging to the same group are capable of being locked, unlocked, disabled, and enabled on command from the ACS.

2.4.2.15 Door Interlocking

Allow a group of doors to be software configured so that if any door in the group is unsecure, all other doors are automatically disabled. This feature is also known as a "mantrap" configuration. The interlocking features must not require the ACS to be on-line for proper operation.

2.4.2.16 PIN Required

Provide support for the required use of a keypad code, in addition to a valid credential during user-selected schedules.

2.4.2.17 Remote Door Control

Provide the ESS operator the capability of manually controlling any access point by issuing a simple command from the ACS. Provide the operator the ability to lock, unlock, enable, and disable any door or Door Group in this manner. This activity is to cause an entry to be logged displaying the door name, number and time that it was performed.

2.4.2.18 Key Control

When interfaced with an approved key-control system, the system is to allow users to deny access to certain doors for any users who have keys in their possession.

[2.4.2.19 Guard Tour

Provide support for user-defined guard tours configurable in a set pattern of tour points or following a mode in which all tour points can be visited in any order within an allotted time. Allow for a tour to be started by ACS command, by use of a selected card at a selected reader, or by use of a selected keypad code at a selected keypad. Detect guard late-to-point, point missed, and point out-of-sequence events. Generate a report at tour completion.

]2.4.2.20 Reader Disable

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NOTE: If it is a project requirement, provide camera coverage of the card readers.

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Provide support for disabling readers in reaction to a user-selected number of invalid access attempts. [Locate a camera to view the card reader and interface to record the events of invalid access attempts.]

2.4.2.21 Disable Event Messages

Allow users to disable user-selected event messages (Door Forced Open, Door Open Too Long, Door Closed, Request to Exit) for user-selected doors. Allow users to disable certain messages (Door Forced Open, Door Open Too Long) according to a user-selected schedule.

2.4.2.22 Input and Output Groups

Allow for up to [256] [_____] user-defined (input and output) groups to be defined. Each Input device is to be able to be linked to these groups for arming, disarming, shunting and unshunted as well as output control.

2.4.2.23 Delays

Each alarm device must allow a delay to be specified which is either an entry type or a dwell type. An entry-type delay is to prevent the input from issuing an alarm event until the delay elapses. If unarmed during the delay period, the alarm is to be ignored. A dwell-type delay requires the input to remain in the alarm state for the full delay duration before issuing an alarm.

[2.4.2.24 Remote Input Control

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NOTE: Remote access is not allowed for certain security locations such as SCIF and SAPF areas.

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[Provide the operator the capability of manually controlling any alarm, input point, alarm partition or group by issuing a simple command from the SCC on the ACS allowing the ability to shunt, unshunt, disable and restore any input in this manner. This activity must cause an entry to be logged displaying the input name and time that it was performed. The arm and disarm, shunt and unshunt any alarm partition or group from the SCC must not be permissible in ICS 705-1 applications.] [The operator cannot have the capability to shunt or disable a tamper alarm.]

]2.4.2.25 Output Configuration

Allow each output relay to be software configurable as:

(1) Follows

(2) Latch

(3) Timeout

(4) Scheduled

(5) Timeout Re-triggerable

(6) Limit

(7) Counter

Allow for a time schedule to automatically control the activation and de-activation of the Scheduled type with all other types configured to activate based on input and output group conditions. Additionally, a time schedule must be specified to configure when the output is to actively monitor the input and output groups.

2.4.2.26 Remote Output Control

Provide the operator the capability of manually controlling any output point by issuing a simple command from the SCC. Based upon the output type, provide the ESS operator the ability to ENABLE, DISABLE, turn ON and turn OFF any output in this manner. A FOLLOWS type output must not be capable of being turned OFF or ON. Log an entry when this activity is performed displaying the output name and time performed. Manual control of outputs are not permissible in ICS 705-1 applications.

2.4.2.27 Remote Reset Command

Provide the capability for any ACU to reset manually or by command issued from the ACS with the option of simulating the ACU reset settings or forcing a reset type as specified by the user. The remote reset command is not to cause the ACU to degrade its level of protection to any access points defined.

2.4.2.28 Time Zone

Allow the user to select the time zone in which the ACU is located, so that event times displayed for that ACU will match the local time where the ACU is located.

2.4.2.29 User-Selected LED Behavior

Allow the user to select different behaviors for the LEDs of each access-controlled reader.

2.4.2.30 Traced Cards

Provide the capability of selecting any number of cardholders for the purpose of limiting reports to only traced users displaying all traced cardholder events in a user-selected alternate color.

[2.4.2.31 Badge Print Tracking

Support setting a print limit for any badge. The software will track the number of times any badge has been printed, as well as display the date and time of the most recent printing.

]2.4.3 Error and Throughput Rates

Rates must be portal to portal performance averages obtained when processing individuals one at a time. Features are not to reduce capability to meet throughput requirements when serial verification techniques or multiple attempts are required to satisfy error performance requirements.

A Type I error denies access to an authorized enrolled individual. A Type II error grants access to an unauthorized individual. Subsystem Type I and Type II error rates must both be less than [0.1] [_____] percent. At the error rates, subsystem access throughput rate must be minimum of [12] [_____] individuals per minute through one card reader and keypad access control device.

2.4.4 Access Control System Central Processing

a. Provide serial management and control of system processing. Provide a microprocessor control device able to monitor and control units and up to [32] [_____] card reader and keypad access control devices. Central processor must interrogate and receive responses from each ACU within 100 milliseconds. Failure to respond to an interrogation is to cause an alarm.

b. Provide the central processor with a [Ethernet] [USB] [_____] interface port to communicate with the printer. Provide an operator interface to control system operating functions. Provide the central processor with a facility-tailorable data base for a minimum of [1000] [_____] cardholders with by-name alphanumeric printout, and for automated [subsystem] [IDS] monitoring, management, and control functions.

c. Provide enrollment equipment as required in paragraph ENROLLMENT CENTER EQUIPMENT.

d. Provide system configuration controls and electronic diagnostic aids for subsystem setup and troubleshooting with the central processor. Components are not to be accessible to operations personnel and must be tamper alarmed.

2.4.5 Access Control Unit(ACU)

Provide micro-processor based ACU with all access and input and output decisions to be made by the individual ACU(s). Provide modular solution which will allow for present security requirements and the capability to expand. Configure all field ACU panels to intercommunicate via [RS-422/485] or [RS-232 hardwired] or [TCP/IP]. Equip all field ACU(s) with a tamper contact.

Designate one ACU as "Primary", responsible for all ACS-to-ACU communications. All other ACU(s) up to a maximum of [16] [32] [64] [256] [_____] are to be designated as "Secondary" and communicate with the "Primary" via an [RS-422/485 hardwire], [TCP/IP network] or [fiber-optic configuration]. Provide ACU capable of, but not limited to, the following:

a. Built-in surge suppression circuitry on plug-in modular circuit boards with surge suppression, configured as an integral component of the system and self-sacrificing in the event of extreme surges or spikes.

b. Capable of supporting at least [2] [_____] ports and be expandable in increments of two ports up to a maximum of [4] [8] [16] [_____] ports per ACU.

c. Each port configured by ACS to support any one of the following peripheral devices:

    (1) Card reader

    (2) Alarm Monitoring Module

    (3) Output Relay Module

    (4) Elevator Reader

    (5) Elevator Output Module

    Any device combination can be supported on each ACU, up to a total of [2] [4] [8] [16] [_____] devices per ACU.

d. Capability of supporting multiple card reader technologies simultaneously, including:

    (1) Keypad

    (2) Card and Keypad

    (3) [CAC] [PIV] compatible

    (4) Biometrics

    This capability must be an integral part of the ACU and will not require special external equipment. See NIST SP 800-116.

e. Built-in battery back-up of programmed information sustainable for a period of at least 90 days.

f. Powered by a [12] [24] [____] VDC power source rated at a minimum of [2] [_____] amperes with a battery back-up for complete system operation in the event of power failure. Provide battery backup for all ACU(s) to sufficiently power the ACU for [8] [_____] hours continuous service.

g. Electric strikes, other locking devices and ancillary peripherals on a separate power supply with battery back-up for continued operation in the event of power failure as specified in paragraph BACKUP POWER.

h. A minimum of a [10,300] [_____] event log buffer per ACU to record and hold access and alarm activity information until the ACS is connected and receives the information. Provide a software-configurable warning log buffer filling notification for ACU(s) configured with network switch capabilities.

2.4.6 Access Control Devices

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NOTE: The Common Access Credential (CAC) cards are only supplied by the Government and must meet the requirements in UFC 4-021-02. Provide a card reader with an integrated keypad for portals where the added security of credential plus code access is required.
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NOTE: This paragraph may be removed by the designer if encryption is not required by the project.
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UL 294. The card, card reader, and panels must meet encryption requirements that are specified in paragraph DATA ENCRYPTION. Devices are to be tamper alarmed, tamper and vandal resistant, and solid state, containing no electronics which could compromise the access control subsystem should the subsystem be attacked.

2.4.6.1 Card Readers

Provide [surface], [semi flush], [pedestal], or [weatherproof mountable] card readers as indicated for each individual location. Provide contactless [contactless w/keypad] [contact/contactless w/keypad] [contact/contactless w/keypad and fingerprint] type card readers capable of reading [Keypad] [[CAC] [PIV] and Keypad] [[CAC] [PIV] cards] [Biometric] type of access control cards.

Keypads must contain an alphanumeric and special symbols keyboard with symbols [arranged in ascending ASCII code ordinal sequence] [scramble type]. Provide keypad [as a stand-alone device] [or] [integrated into the card reader].

2.4.6.1.1 Contact Card Readers

Provide contact card readers that can read credential [PIV] [CAC] cards whose characteristics of size and technology meet those defined by ANSI ISO/IEC 7816 and meet NDAA Compliance and NIST FIPS 201-2 Approval Letter for ACS Products.

Provide readers with "flash" download capability to accommodate card format changes and the capability of reading the card data and transmitting the data, or a portion thereof, to the ESS control panel.

2.4.6.1.2 Contactless Card Readers

Provide contactless card readers that can read credential [PIV] [CAC] cards whose characteristics of size and technology meet those defined by ANSI ISO/IEC 7816 in close proximity to the card reader and meet NDAA Compliance and NIST FIPS 201-2 Approval Letter for ACS Products.

Provide readers with "flash" download capability to accommodate card format changes and the capability of reading the card data and transmitting the data, or a portion thereof, to the ESS control panel.

2.4.6.1.3 Card Readers With Integral Keypad and Biometric Reader

Equip contact and contactless card readers with integral keypads and biometric readers as specified in paragraph KEYPADS and as in FINGERPRINT ANALYSIS SCANNER.

2.4.6.1.4 Card Readers with Integral Keypad

Equip contact and contactless card readers with integral keypads as specified in paragraph KEYPADS.

2.4.6.1.5 Card Reader Display

Provide card readers with an LED or other visual indicator display which indicate power ON and OFF and whether user passage requests have been accepted or rejected.

2.4.6.1.6 Card Reader Response Time

The card reader is to respond to passage requests by generating a signal to the local processor.

2.4.6.1.7 Card Reader Power

Power the card reader from the source as shown on the drawings. The card reader must not dissipate more than 5 Watts.

2.4.6.1.8 Card Reader Mounting Method

Provide card readers suitable for [surface], [semi-flush], [pedestal], or [weatherproof] mounting as required.

2.4.6.2 Keypads

****

NOTE: The designer will specify the type of keypad needed for the site. The scrambled keypad should be specified for very high security needs. If a scrambled keypad is specified, the designer will specify the reduced viewing angle feature. The designer will specify whether visual and audible prompts are needed.

****

Entry control keypads are to use unique alphanumeric and other symbol combinations as an identifier. Keypads must contain an integral alphanumeric and special symbols keyboard with symbols arranged in [ascending ASCII code ordinal sequence] [random scrambled order]. Communications protocol is to be compatible with the local processor.

2.4.6.2.1 Keypad Display

Keypads are to include an LED or other type of visual indicator display and provide [visual] [visual and audible] status indications indicating power ON and OFF and whether user passage requests have been accepted or rejected.

The maximum horizontal and vertical viewing angles are to be limited by the keypad display or enclosure. The maximum horizontal viewing angle must be no more than plus and minus 5 degrees off a vertical plane perpendicular to the plane of the face of the keypad display. The maximum vertical viewing angle must be no more than plus and minus 15 degrees off a horizontal plane perpendicular to the plane of the face of the keypad display.

2.4.6.2.2 Keypad Response Time

The keypad is to respond to passage requests by generating a signal to the local processor.

2.4.6.2.3 Keypad Power

Power the keypad from the source as shown on the drawings. The keypad must not dissipate more than 5 Watts.

2.4.6.2.4 Keypad Mounting Method

Provide keypads suitable for [surface], [semi-flush], [pedestal], or [weatherproof] mounting as required.

2.4.6.2.5 Keypad Duress Codes

Provide a means for users to indicate a duress situation by entering a special code into the keypad.

2.4.6.3 Access Control Cards

****

NOTE: Determine the format, logo, and wording for the cards from the using activity before final design. A unique facility code may only be available with the purchase of 5000 cards or more. CAC cards will be provided by the Government.

****

Provide cards with the capability of modification and lamination during enrollment process without readability reduction for use as a picture and identification badge. Cards must contain binary coded data arranged in a scrambled pattern as a unique identification code stored on or within the card and of the type readable by the subsystem card readers. Include a non-duplicated unique facility access control subsystem identification code common to access control cards within the card binary data. [Configure cards for use as a photo identification card suitable for lamination.]

PIV cards must be be listed on the "FIPS 201 Approved Products List - PIV Card" found on the www.idmanagement.gov website.

2.4.6.3.1 Credential Card Modification

Provide entry control cards that can be modified by lamination or direct print process during the enrollment process for use as a picture and identification badge as needed for the site without readability reduction. Credential cards must allow adding at least one slot or hole for a clip affixing the credential card to the type of badge holder used at the site.

2.4.6.3.2 Card Size and Dimensional Stability

****

NOTE: Specify the standard card size of 54 x 85 mm 2-1/8 x 3-3/8 inch unless a different size card is needed. If a non-standard size card is specified, the designer must make certain that the card size specified will work with the photo badging system and the card reader specified.

****

Provide credential cards that are [54 x 85] [_____] mm [2-1/8 x 3-3/8] [_____] inches. The credential card material must be dimensionally stable so that an undamaged card with deformations resulting from normal use is readable by the card reader.

2.4.6.3.3 Card Materials and Physical Characteristics

Provide credential cards that are abrasion resistant, non-flammable, and present no toxic hazard to humans when used in accordance with manufacturer's instructions. The credential card is to be impervious to solar radiation and the effects of ultra-violet light.

2.4.6.3.4 Card Construction

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NOTE: Specify whether additional security enhancements are needed. Choose which security enhancement is needed. Specify card lamination and assembly equipment if needed at the site.

****

Provide credential cards of core and laminate or monolithic construction. Hot stamp into material or direct print onto lettering, logos and other markings. [Incorporate [holographic images] [phosphorous ink] as a security enhancement.] [Provide a means to allow onsite assembly and credential cards lamination by Government.]

2.4.6.3.5 Card Durability and Maintainability

The credential cards must yield a useful lifetime of at least 5 years. The credential card must be able to be cleaned by wiping the credential card with a sponge or cloth wet with a soap and water solution.

2.4.6.3.6 Warranty

Include a minimum 3-year warranty.

[2.4.6.4 Personal Identity Verification Equipment

Entry control personnel identity verification equipment must use a unique personal characteristic or unique personal physiological measurement to establish the identity of authorized, enrolled personnel. Provide a means to construct individual templates or profiles based upon measurements taken from the person to be enrolled. This template is to be stored as part of the System Reference Database Files. The stored template is to be used as a comparative base by the personnel identity verification equipment to generate appropriate signals to the associated local processors.

2.4.6.4.1   Hand Geometry

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NOTE: The designer will specify if audible status indication is required.
****

a. Hand geometry devices are to use unique human hand measurements to identify authorized, enrolled personnel. The device is to incorporate positive measures to establish that the hand being measured by the device belongs to a living human being. Provide alignment system which allows the user's hand to remain in full view of the user at all times.

b. During the scan process the hand geometry device is to make 3 dimensional measurements of the size and shape of the user's hand. The hand geometry device is to automatically initiate the scan process once the user's hand is properly positioned by the alignment system. Either left or right hands are to be able to be used for enrollment and verification. User hand geometry template must not require more than 50 eight-bit bytes of storage media space.

c. Hand geometry devices must include an LED or other type of visual indicator display and provide [visual] [visual and audible] status indications and user prompts. The display is to indicate power ON and OFF and whether user passage requests have been accepted or rejected.

2.4.6.4.1.1   Template Update and Acceptance Tolerances

Hand geometry devices are not to automatically update a user's profile. Significant changes in an individual's hand geometry are to require re-enrollment. Provide an adjustable acceptance tolerance or template match criteria under the system manager or operator control. The hand geometry device is to determine when multiple attempts are needed for hand geometry verification, and automatically prompt the user for additional attempts up to a maximum of three. Three failed attempts are to generate an entry control alarm.

2.4.6.4.1.2   Average Verification Time

The hand geometry device is to respond to passage requests by generating signals to the local processor. The verification time must be 1.5 seconds or less from the moment the hand geometry device initiates the scan process until the hand geometry device generates a response signal.

2.4.6.4.1.3   Modes

a. Provide an enrollment mode, recognition mode, and code or credential verification mode that is selectable by the system manager or operator from the SCC.

b. The enrollment mode is to create a hand template for new personnel and enter the template into the entry control database file created for that person. Template information must be compatible with the system application software.

c. The hand geometry device allows passage when the hand scan data from the verification attempt matches a hand geometry template stored in the database files when operating in recognition mode.

d. The hand geometry device allows passage when the hand scan data from the verification attempt matches the hand geometry template associated with the identification code entered into a keypad or matches the hand geometry template associated with credential card data read by a card reader when operating in code or credential verification mode.

2.4.6.4.1.4 Reports

The hand geometry device is to create and store template match scores for all transactions involving hand geometry scans. The template match scores are to be stored in the matching personnel data file in a file format compatible with the system application software and be used for report generation.

2.4.6.4.1.5 Electrical

The hand geometry device must not dissipate more than 45 Watts from the source indicated.

2.4.6.4.1.6 Mounting Method

Provide hand geometry devices suitable for [surface], [flush], or [pedestal] mounting as required.

2.4.6.4.1.7 Communications Protocol

The communications protocol between the hand geometry device and the local processor must be compatible.

2.4.6.4.2 Fingerprint Analysis Scanner

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NOTE: The designer will specify if audible status indication is required.

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a. Fingerprint analysis scanners are to use a unique human fingerprint pattern to identify authorized, enrolled personnel. The device is to incorporate positive measures to establish that the fingers being measured by the device belong to a living human being. Provide alignment system which allows the user's fingers to always remain in full view of the user.

b. The fingerprint analysis scanner is to perform an optical or other type of scan of the user's fingers during the scan process. The fingerprint analysis scanner is to automatically initiate the scan process provided the user's fingers are properly positioned. Each user fingerprint template must not require more than 1250 eight-bit bytes of storage media space.

c. Include an LED or other type of visual indicator display and provide [visual] [visual and audible] status indications and user prompts. The display is to indicate power ON and OFF, and whether user passage requests have been accepted or rejected.

2.4.6.4.2.1 Template Update and Acceptance Tolerances

Fingerprint analysis scanners are not to automatically update an user's profile. Significant changes in an individual's fingerprints require re-enrollment. Provide an adjustable acceptance tolerance or template match criteria under system manager or operator control. The fingerprint analysis scanner is to determine when multiple attempts are needed for fingerprint verification, and automatically prompt the enrollee for additional attempts up to a maximum of 3. Three failed attempts are to generate an entry control alarm.

2.4.6.4.2.2 Average Verification Time

The fingerprint analysis scanner is to respond to passage requests by generating signals to the local processor. The verification time must be 2.0 seconds or less from the moment the fingerprint analysis scanner initiates the scan process until the fingerprint analysis scanner generates a response signal.

2.4.6.4.2.3 Modes

a. Provide an enrollment mode, recognition mode, and code or credential verification mode that is selectable by the system manager or operator from the SCC.

b. The enrollment mode is to create a fingerprint template for new personnel and enter the template into the system database file created for that person. Template information must be compatible with the system application software.

c. The fingerprint analysis scanner is to allow passage when the fingerprint data from the verification attempt matches a fingerprint template stored in the database files when operating in recognition mode.

d. The fingerprint analysis scanner allows passage when the fingerprint data from the verification attempt matches the fingerprint template associated with the identification code entered into a keypad or matches the fingerprint template associated with credential card data read by a card reader when operating in code or credential verification mode.

2.4.6.4.2.4 Reports

The fingerprint analysis scanner is to store template transactions involving fingerprint scans. The template match scores are to be stored in the matching personnel data file in a file format compatible with the system application software, and to be used for report generation.

2.4.6.4.2.5 Electrical

The fingerprint analysis scanner must not dissipate more than 45 Watts from the source indicated.

2.4.6.4.2.6 Mounting Method

Provide fingerprint analysis scanners suitable for [surface], [flush], or [pedestal] mounting.

2.4.6.4.2.7 Communications Protocol

The communications protocol between the fingerprint analysis scanner and its associated local processor must be compatible.

2.4.6.4.3 Iris Scan Device

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NOTE: The designer will specify if audible status indication is required.

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The iris scan identification device is to use the unique patterns found in the iris of the human eye to identify authorized, enrolled personnel. The device is to use ambient light to capture an image of the iris of a person presenting themselves for identification. The resulting video image is to be compared against a stored template that was captured during the enrollment process. The device authenticates the presenting individual as identified when the presented image is sufficiently similar to the stored image template. Provide the ability to adjust the threshold of similarity.

Users who wear contact lenses or eyeglasses are not to adversely affect the efficiency and accuracy of the device. Facial contact with the device is not to be required for identification. Provide a manual push-button to initiate the scan process when the user has aligned their eye in front of the device. Provide adjustments to accommodate differences in user height.

2.4.6.4.3.1 Display Type

Include an LED or other type of visual indicator display and provide [visual] [visual and audible] status indications and user prompts. The display is to indicate power ON and OFF and whether user passage requests have been accepted or rejected.

2.4.6.4.3.2 Template Update and Acceptance Tolerances

Iris scanners are not to automatically update a user's template. Significant changes in an individual's eye requires re-enrollment. Provide an adjustable acceptance tolerance or template match criteria under system manager or operator control. The iris scanner is to determine when multiple attempts are needed to verify the iris being scanned, and automatically prompt the enrollee for additional attempts up to a maximum of three. Three failed attempts generates an entry control alarm.

2.4.6.4.3.3 Average Verification Time

The iris scanner is to respond to passage requests by generating signals to the local processor. The verification time must be 1.5 seconds or less from the moment the eye scanner initiates the scan process until the eye scanner generates a response signal.

2.4.6.4.3.4 Modes

a. Provide an enrollment mode, recognition mode, and code or credential verification mode that is selectable by the system manager or operator from the Security Command Center.

b. The enrollment mode is to create an iris template for new personnel and enter the template into the system database file created for that person. Template information must be compatible with the system application software.

c. The iris scanner is to allow passage when the iris scan data from the verification attempt matches the iris scan template stored in the database files when operating in recognition mode.

d. The iris scanner allows passage when the iris scan data from the verification attempt matches the iris scan template associated with the identification code entered into a keypad or matches the iris scan template associated with credential card data read by a card reader when operating in code or credential verification mode.

2.4.6.4.3.5 Reports

The iris scanner is to store template transactions involving iris scans. The template match scores are to be stored in the matching personnel data file in a file format compatible with the system application software and be used for report generation.

2.4.6.4.3.6 Electrical

The eye scanner must not dissipate more than 45 Watts from the voltage source indicated.

2.4.6.4.3.7 Mounting Method

Provide eye scanners suitable for [surface], [flush], or [pedestal] mounting.

2.4.6.4.4 Facial Scanner

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NOTE: The designer will specify if audible status indication is required.

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a. Facial recognition scanners are to use a unique human facial patterns to identify authorized, enrolled personnel. The device is to incorporate positive measures to establish that the face being measured by the device belong to a living human being. Provide alignment system which allows the user's face to always remain in full view of the user.

b. The facial recognition scanner is to perform an optical or other type of scan of the user's face during the scan process. The facial recognition scanner is to automatically initiate the scan process provided the user's face is properly positioned.

c. Include an LED or other type of visual indicator display and provide [visual] [visual and audible] status indications and user prompts. The display is to indicate power ON and OFF, and whether user passage requests have been accepted or rejected.

2.4.6.4.4.1 Template Update and Acceptance Tolerances

Facial recognition scanners are not to automatically update an user's profile. Significant changes in an individual's face require re-enrollment. Provide an adjustable acceptance tolerance or template match criteria under system manager or operator control. The facial recognition scanner is to determine when multiple attempts are needed for data verification, and automatically prompt the enrollee for additional attempts up to a maximum of 3. Three failed attempts are to generate an entry control alarm.

2.4.6.4.4.2 Average Verification Time

The facial recognition scanner is to respond to passage requests by generating signals to the local processor. The verification time must be 2.0 seconds or less from the moment the facial recognition scanner initiates the scan process until the facial recognition scanner generates a response signal.

2.4.6.4.4.3 Modes

a. Provide an enrollment mode, recognition mode, and code or credential verification mode that is selectable by the system manager or operator from the SCC.

b. The enrollment mode is to create a facial template for new personnel and enter the template into the system database file created for that person. Template information must be compatible with the system application software.

c. The facial recognition scanner is to allow passage when the facial data from the verification attempt matches a facial template stored in the database files when operating in recognition mode.

d. The facial recognition scanner allows passage when the facial data from the verification attempt matches the facial template associated with the identification code entered into a keypad or matches the facial template associated with credential card data read by a card reader when operating in code or credential verification mode.

2.4.6.4.4.4 Reports

The facial recognition scanner is to store template transactions involving facial scans. The template match scores are to be stored in the matching personnel data file in a file format compatible with the system application software, and to be used for report generation.

2.4.6.4.4.5 Electrical

The facial recognition scanner must not dissipate more than 45 Watts from the source indicated.

2.4.6.4.4.6 Mounting Method

Provide facial recognition scanners suitable for [surface], [flush], or [pedestal] mounting.

2.4.6.4.4.7 Communications Protocol

The communications protocol between the facial recognition scanner and its associated local processor must be compatible.

2.4.6.4.5 Palm Scanner

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NOTE: The designer will specify if audible status indication is required.

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a. Palm scanners are to use a unique human hand pattern to identify authorized, enrolled personnel. The device is to incorporate positive measures to establish that the palm being scanned by the device belongs to a living human being. Provide alignment system which allows the user's hand to always remain in full view of the user.

b. The palm scanner is to perform an optical or other type of scan of the user's hand during the scan process. The palm scanner is to automatically initiate the scan process provided the user's hand is properly positioned. Each user's hand template must not require more than 1250 eight-bit bytes of storage media space.

c. Include an LED or other type of visual indicator display and provide [visual] [visual and audible] status indications and user prompts. The display is to indicate power ON and OFF, and whether user passage requests have been accepted or rejected.

2.4.6.4.5.1 Template Update and Acceptance Tolerances

Palm scanners are not to automatically update a user's profile. Significant changes in an individual's hand requires re-enrollment. Provide an adjustable acceptance tolerance or template match criteria under system manager or operator control. The palm scanner is to determine when multiple attempts are needed for data verification, and automatically prompt the enrollee for additional attempts up to a maximum of 3. Three failed attempts are to generate an entry control alarm.

2.4.6.4.5.2 Average Verification Time

The palm scanner is to respond to passage requests by generating signals to the local processor. The verification time must be 2.0 seconds or less from the moment the palm scanner initiates the scan process until the palm scanner generates a response signal.

2.4.6.4.5.3 Modes

a. Provide an enrollment mode, recognition mode, and code or credential verification mode that is selectable by the system manager or operator from the SCC.

b. The enrollment mode is to create a hand template for new personnel and enter the template into the system database file created for that person. Template information must be compatible with the system application software.

c. The palm scanner is to allow passage when the hand data from the verification attempt matches a hand template stored in the database files when operating in recognition mode.

d. The palm scanner allows passage when the hand data from the verification attempt matches the hand template associated with the identification code entered into a keypad or matches the hand template associated with credential card data read by a card reader when operating in code or credential verification mode.

2.4.6.4.5.4 Reports

The palm scanner is to store template transactions involving hand scans.

The template match scores are to be stored in the matching personnel data file in a file format compatible with the system application software, and to be used for report generation.

2.4.6.4.5.5 Electrical

The palm scanner must not dissipate more than 45 Watts from the source indicated.

2.4.6.4.5.6 Mounting Method

Provide palm scanners suitable for [surface], [flush], or [pedestal] mounting.

2.4.6.4.5.7 Communications Protocol

The communications protocol between the palm scanner and its associated local processor must be compatible.

]2.4.6.5 Portal Control Devices

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NOTE: Portal Control Devices must be designed in accordance with NFPA 101, Means of Egress.

If ESS is to be integrated with the Fire Alarm System provide appropriate signage in accordancewith NFPA 101.

The designer must meet the requirements in Section 08 71 00 DOOR HARDWARE.

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Portal control devices must meet the requirements in Section 08 71 00 DOOR HARDWARE.

2.4.6.5.1 Push-Button Switches

a. Provide momentary contact, back lit push buttons and stainless-steel switch enclosures for each push button. Provide switch enclosures suitable for [flush] [surface] mounting as required and push buttons suitable for flush mount in the switch enclosures. The push button switches are to meet the requirements of NEMA 250 for the area in which they are to be installed.

b. Where multiple pushbuttons are housed within a single switch enclosure stack vertically with each push button switch labeled with 7 mm 1/4 inch high text and symbols. The push button switches are to be connected to the local processor associated with the portal to which they are applied and operate the appropriate electric strike, electric bolt or other facility release device.

c. The continuous current of the IDS circuit is to be no more than 50 percent of the continuous current rating of the device supplied. Provide push button switches with double-break silver contacts that will make 720 VA at 60 amperes and break 720 VA at 10 amperes.

2.4.6.5.2 Panic Bar

Include panic bar emergency exit hardware on emergency exit doors as indicated. Provide an alarm shunt signal from the panic bar emergency exit hardware to the appropriate local processor. Provide panic bar compatible with [mortise-] [rim-] mount door hardware and operate by retracting the bolt.

2.4.6.5.2.1 Emergency Egress With Alarm

[Include a conspicuous warning sign with 25 mm 1 inch high, red lettering notifying personnel that an alarm will be annunciated if the panic bar is operated.

] Panic bar hardware operation is to generate an intrusion alarm [and local alarm annunciation]. The panic bar must depend upon a mechanical connection only and not depend upon electric power for operation, except for local alarm annunciation and alarm communications.

2.4.6.5.2.2 Normal Egress

Panic bar hardware operation is not to generate an intrusion alarm. The panic bar must depend upon a mechanical connection only when exiting. Provide the exterior, non-secure side of the door with an electrified thumb latch or lever to provide access after the credential I.D. authentication by the ESS.

Signal Switches: Strikes/bolts are to include signal switches indicating to the system when the bolt is not engaged, or the strike mechanism is unlocked. The signal switches are to report a forced entry to the system.

2.4.6.5.2.3 Delay Egress With Alarm

Include a conspicuous warning sign with 25 mm 1 inch high, red lettering notifying personnel that an alarm will be annunciated if the panic bar is operated.

Delay operation [15] [_____] seconds after initiation for portal control devices.

2.4.6.5.3 Electric Door Strikes and Bolts

****

NOTE: The designer will specify whether the electric strike or lock will fail open, fail secure, or other configuration (such as fail security for entry into higher security area, while failing open for egress from the area). The designer must coordinate this with requirements of the site safety and fire personnel. The designer will determine if signal switches are required for the site.

****

Configure electric door strikes and bolts to [release automatically] [remain secure] in case of power failure using DC power to energize the solenoids. Incorporate end-of-line resistors to facilitate line supervision by the system. Install metal-oxide varistors (MOVs) to protect the controller from reverse current surges if not incorporated into the electric strike or local controller. Electric strikes must have a minimum forcing strength of 101 kN 2300 pounds.

2.4.6.5.3.1 Solenoid

The actuating solenoid for the strikes and bolts furnished must not dissipate more than 12 Watts and operate on [12] [24] VDC. The inrush current must not exceed 1 ampere and the holding current must not be greater than 500 milli-amperes. The actuating solenoid must move from the fully secure to fully open positions in not more than 500 milliseconds.

2.4.6.5.3.2 Signal Switches

Strikes and bolts are to include signal switches indicating to the system when [the bolt is not engaged] [the strike mechanism is unlocked]. The signal switches are to report a forced entry to the system.

2.4.6.5.3.3 Tamper Resistance

The electric strike and bolt mechanism is to be encased in hardened guard barriers to deter forced entry.

2.4.6.5.3.4 Size and Weight

Electric strikes and bolts are to be compatible with standard door frame preparations.

2.4.6.5.3.5 Mounting Method

Provide electric strikes and bolts suitable for use with single and double door installations, with [mortise-] [rim-] type hardware as indicated, and compatible with right- or left-hand mounting.

2.4.6.5.3.6 Astragals

See Section 08 71 00 DOOR HARDWARE for Astragal lock guards.

2.4.6.5.4 Electrified Mortise Lock

****

NOTE: The electrified mortise locks provide an excellent solution for stairwell doors that require positive latching when unlocked. The doors should be built with a raceway within the door for the power and signal wire. A wire transfer hinge or other device is required to get the wire from the door to the door frame for connection with the access control system.

****

Configure electrified mortise locks to [release automatically] [remain secure] in case of power failure using DC power to energize the solenoids. Provide solenoids rated for continuous duty. Incorporate end-of-line resistors to facilitate line supervision by the system. Install metal-oxide varistors (MOVs) to protect the controller from reverse current surges if not incorporated into the electric strike or local controller.

2.4.6.5.4.1 Solenoid

The actuating solenoid for the mortise locks furnished must not dissipate more than 12 Watts and operate on [12] [24] VDC. The inrush current must not exceed 1 ampere and the holding current must not be greater than 500 milli-amperes. The actuating solenoid must move from the fully secure to fully open positions in not more than 500 milliseconds.

2.4.6.5.4.2 Signal Switches

The mortise locks are to include signal switches indicating to the system when the locks are not engaged. The signal switches are to report a forced entry to the system.

2.4.6.5.4.3 Power Transfer

Provide an electric power transfer with each mortise lock to get power and monitoring signals from the lockset to the door frame.

2.4.6.5.4.4 Size and Weight

Electrified mortise locks are to be compatible with standard door preparations.

2.4.6.5.4.5 Mounting Method

Provide electrified mortise locks suitable for use with single and double door installations. The lock would be in the active leaf and the fixed leaf would be monitored in double door installations.

2.4.6.5.5 Electromagnetic Lock

Electromagnetic locks are to contain no moving parts and depend solely upon electromagnetism to secure a portal by generating at least 5.3 kN 1200 pounds of holding force. Interface the lock with the local processors without external, internal, or functional local processor alteration. Incorporate an end-of-line resistor to facilitate line supervision by the system. Install MOVs to protect the controller from reverse current surges if not incorporated into the electromagnetic lock or local controller. Provide in accordance with ANSI/BHMA A156.23.

2.4.6.5.5.1 Armature

The electromagnetic lock is to contain internal circuitry to eliminate residual magnetism and inductive kickback. The actuating armature must operate on [12] [24] VDC and not dissipate more than 12 Watts. The holding current must be not greater than 500 milli-amperes. The actuating armature must take not more than 300 milli-seconds to change the status of the lock from fully secure to fully open or fully open to fully secure.

2.4.6.5.5.2 Tamper Resistance

The electromagnetic lock mechanism is to be encased in hardened guard barriers to deter forced entry.

2.4.6.5.5.3 Mounting Method

Provide electromagnetic lock suitable for use with single and double door installations with [mortise-] [rim-] type hardware as indicated, and compatible with right- or left-hand mounting.

2.4.6.5.6 Entry Booth

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NOTE: The designer will choose either keypads or card readers as needed. The outside dimensions of the entry booth will not exceed the site limitations required for the proper installation and functionality of the booth.

If a project requirement, the entry booth must have the capability to be used for egress.

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a. Entry booths are to be constructed as an integral part of the physical structure of the boundary for the area or facility to which entry is being controlled. The entry booth is to automatically lock the high security side door's [electric strike and bolt] [electrified mortise lock] [electromagnetic lock] or other facility interface release device and automatically open the low security side door's electric strike or other facility interface release device in case of power failure.

b. Connect entry booths to the SCC and include a local processor. The entry booth local processor subsystem is to support paired card readers on a single entry booth for anti-pass back functions.

[c. Provide the entry booth with egress capabilities.

]

2.4.6.5.6.1 Local Alarm Annunciation

Provide local alarm annunciation for all system equipment located within the entry booth itself and its associated portals or zones and terminal devices and a means to enable and disable this feature from the SCC under operator control.

2.4.6.5.6.2 Terminal and Facility Interface Device Support

The entry booth local processor subsystem is to support the full range of system terminal and facility interface devices as specified.

2.4.6.5.6.3 Response Times

The entry booth local processor subsystem must respond to a SCC interrogation within 100 milliseconds. The entry booth local processor is to respond to valid passage requests from its associated terminal devices by generating a signal to the appropriate [electric strike and bolt] [electrified mortise lock] [electromagnetic lock] within 100 milliseconds after verification.

2.4.6.5.6.4 Autonomous Local Control

In the event of a communication loss, the entry booth local processor subsystem must automatically convert to autonomous local control and monitoring of its associated card readers, keypads, [electric strike and bolt] [electrified mortise lock] [electromagnetic lock] and automatically revert to central control upon communication restoration. Transactions occurring during the communications outage are to be recorded and retained in local memory and reported to the central database files upon communication restoration within 10 seconds.

2.4.6.5.6.5 Entry Booth Local Processor Subsystem Capacities

As a minimum, the entry booth local processor subsystem is to have sufficient capacity to control and monitor a combination of 6:

a. Card readers

b. Keypads

[c. Electric strikes and bolts

][d. Electrified mortise lock

][e. Electromagnetic lock

] All entry control identification decisions and controls are to be performed by the local processor subsystem. The entry booth local processor subsystem must provide a local transaction history file with capacity to store at least 1000 entry control transactions without losing any data.

2.4.6.5.6.6 Diagnostics

Provide built-in diagnostics implemented in software, firmware, or hardware. The booth is to automatically execute a series of built-in tests and report equipment malfunctions, configuration errors, and inaccuracies to the SCC each time the entry booth local processor subsystem is started up or re-booted. The system must annunciate a fail-safe alarm if the local processor fails the built-in diagnostics. Provide diagnostic aids within the entry booth local processor subsystem to aid in system set-up, maintenance, and troubleshooting.

2.4.6.5.6.7 Memory Type and Size

Data entered is to be stored for a minimum of 1 year in the absence of power from external source to the entry booth.

2.4.6.5.6.8 Tamper Protection

The local processor subsystem is to monitor all service entry panels for tamper. Tamper lines must not be accessible except through tamper protected entry panels. Provide entry panels with key locks. Provide the capability to take the booth off-line for service.

2.4.6.5.6.9 Entry Booth Configuration

Provide a closed-in structures suitable for occupancy by 1 person with a personnel passage area, equipment storage, a low security entry or exit door and a high security entry or exit door. Configure with paired [card readers] [keypads], 1 each, on the high security entry or exit door and low security entry or exit door; a key release switch outside the low security door; a glass break type emergency release switch. Both doors to the entry booth are to be normally secured.

2.4.6.5.6.10 Entry Booth Operation

a. Configure to allow passage requests to be initiated from only 1 door at a time. During emergency situations both doors must have the capability to able to be opened at the same time. The person is to be allowed entry to the booth by presenting valid credential card to the card reader or keypad identification code data to the keypad device. An unsuccessful attempt to enter the booth are to generate an entry denial alarm.

b. Incorporate a personal identity verification device as specified and grant the person egress from the booth after successful personal identity verification. The entry booth is to confine the person and generate an entry control alarm if the person fails the personal identity verification test. The local processor is to grant the person's passage request if all provided data is valid.

c. The person is to be confined if a tamper alarm is generated by any of the equipment associated with the subject entry booth while a person is inside. Operating the glass break type emergency release switch is to command the entry door [electric strike and bolt] [electrified mortise lock] [electromagnetic lock] release to the fully open position or with a delay after the egress door has been confirmed secured. The person may exit through the door used for entry once inside the entry booth and prior to personal identity verification test initiation.

2.4.6.5.6.11 Display Type

Include an LED or other type of visual indicator display and provide visual status indications and person prompts. The display is to indicate power on/off, and whether enrollee passage requests have been accepted or rejected. Provide 3 status lights outside each door indicating entry booth status by marking:

a. Green light indicates READY

b. Amber light indicates BUSY

c. Red light indicates INOPERATIVE

2.4.6.5.6.12 Lighting

Provide lights recessed above an acrylic light diffuser in the ceiling of the entry booth. Provide a separate light source within the overhead lighting fixture assembly to provide emergency lighting in case of a power failure.

2.4.6.5.6.13 Heating and Ventilation Equipment

Include built-in heating and cooling equipment to sustain the specific operating temperature range for the electronic equipment installed.

2.4.6.5.6.14 Entry Booth Wall and Frame Construction

Provide a rigid structure with the strength of the walls greater than or equal to 12-gauge steel with 25 mm 1 inch standing seams. All glass is to be at least 8 mm 5/16 inch laminated, annealed glass and meeting UL 972 certification requirements. The entry booth must meet flame spread rating 25 or less, fuel contribution of 50 or less, smoke development of 50 or less, in accordance with test method ASTM E84.

Provide entry booths constructed to minimize the heating effects of solar radiation, by using the manufacturer's standard clear, tinted, or bronzed glass with over-hanging roofs or other structural means to shade the windows.

2.4.6.5.6.15 Entry Booth Doors

Doors must be at least 889 mm wide, by 2.0 m high 35 inches wide, by 79 inches high with glass panels at least 788 mm wide, by 1.9 m high 31 inches wide, by 74 inches high. Provide door hinges and closers with adjustments for vertical, horizontal, and torque. Provide an inside push bar, and an outside mechanical pull handle. Aluminum parts are to be anodized finish.

2.4.6.5.6.16 Entry Booth Floor Construction

Provide entry booth with a rigid floor covered by a rubber mat or indoor or outdoor carpeting. The rubber mat or carpet must be at least 1.6 mm 1/16 inch thick and provide a continuous floor covering without seams.

2.4.6.5.6.17 Electrical Requirements

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NOTE: The designer will specify whether the electric strike or lock will fail open, fail secure, or other configuration (such as fail secure for entry into higher security area, while failing open for egress from the area). The designer must coordinate this with requirements of the site safety and fire personnel. Life safety will be designed in accordance with NFPA 101, Life Safety Code.

****

The entry booth, including associated terminal and facility interface and other type of devices housed within the entry booth must not dissipate more than 1500 Watts. Provide booth with an integral battery back-up system. The battery back-up system must power the entry control devices and [electric strike and bolt] [electrified mortise lock] [electromagnetic lock] for at least 30 minutes. The doors to the booth are to be [secured] [opened], and the booth must go into an inoperative status if AC power is not restored to the booth within 30 minutes. Upon AC power restoration, the booth is to upload all entry transactions from the local processor subsystem to the SCC.

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NOTE: The designer will specify the equipment and features for the booth configuration and eliminate the subparagraphs not needed.

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2.4.6.5.6.18 VSS Camera

Design and configure the VSS camera for continuous operation and transmit video information to the [SCC] [and] [local video recorder] as specified and designed.

2.4.6.5.6.19 Weight Check Monitor

Provide a weight check monitor which continuously monitors the weight of the booth plus any occupant. The weight check monitor is to consist of synchronized, matched, electronic load cells located at the base of the entry booth and be connected to the local processor subsystem. The weight check monitor must be accurate to within plus or minus 2.3 kg 5 pounds. Configure the entry booth to compensate for side loading to prevent damage to the load cells by the passage of equipment through the booth. Include individual weights for each user in the reference database files as part of the enrollment process. Provide a method to enter a custom, predefined tolerance on valid weights of authorized persons.

Automatically update each person's weight profile based upon the last three uses of entry control booths. Generate an entry control alarm for any passage attempt for which the person's weight does not agree with system reference database file data and confine the person. The weight check monitor is not to increase the portal door threshold height by more than 6 mm 1/4 inch.

2.4.6.5.6.20 Double Occupancy Sensor

Incorporate a sensor connected to the local processor subsystem which monitors the entire occupant area to detect attempts at double occupancy. A double occupancy sensor activation is to generate a system alarm and confine the enrollees.

2.4.6.5.6.21 Intercom

Provide three combination speaker and microphones to provide 2-way communications at each speaker and microphone location. The speakers must be at least 100 mm 4 inches in diameter. Locate two of the speakers and microphones at the high and low security entry or exit doors, behind louvered panels, to provide communications for people outside the booth. The third speaker and microphone are to be located inside the booth behind a perforated metal screen above the personal identity verification device to provide communications for people inside the booth. Connect each of the speakers and microphones to the operator console at the SCC and to the voice prompt system as indicated.

2.4.6.5.6.22 Voice Prompts

Include a voice prompt system using human voice commands to speed up the entry control process and improve throughput rate. This audible prompt system is to respond to the next sequential activity requirement as each employee accesses the booth. All commands are to be stored in electrically programmable read only memory chips located in the local processor subsystem. The voice prompts are to only be directed to the speaker and microphone nearest the employee. Use the voice prompts only if the employee does not perform the next step in the entry booth entry control process within a 5 second time window. The SCC must be able to enable and disable of voice prompts and adjustment of the time window under operator control.

[2.4.6.5.7 Vehicle Gate Operator

Provide vehicle gate operators suitable for connection to, monitoring, and control by the system's local processors and include all additional equipment and wiring to be an operable system. Provide a hand crank for the manual vehicle gate operator and a solenoid actuated brake operation to prevent gate coasting.

Provide an auto reverse time delay of at least 1 second and not more than 3 seconds to minimize shock loads on vehicle gate operator drive components. Include a contactor type motor starter that is appropriate for the gate operator motor.

2.4.6.5.7.1 Input Power

Provide vehicle gate operator that operates from the voltage source as shown on the drawings. Include manual reset type thermal and electrical overload devices.

2.4.6.5.7.2 Audible Warning

Provide an audible warning system to signal personnel in the vicinity of the vehicle gate operator that an opening or closing is about to commence. The audible warning must sound at least 2 seconds and no more than 5 seconds before movement begins.

2.4.6.5.7.3 Maximum Run Timer

The vehicle gate operator must incorporate an internal maximum run timer which limits the motor run time. The maximum run time is to be operator adjustable for at least the maximum amount of time gate opening or closing takes during normal operation.

2.4.6.5.7.4 Adjustable Load Monitor for Obstruction Sensing

Provide operator adjustable load monitor that senses obstructions in the path of the gate and automatically reverses the vehicle gate operator drive motor. Do not allow the gate to open once the gate has reached the limit switch.

2.4.6.5.7.5 Operator Override Controls

Provide the vehicle gate operator with an interface to a three pushbutton control station located within an entry-controlled area. The three pushbutton switches are to be labeled and function as Open, Close, and Stop controls, and meet the requirements of paragraph PUSH-BUTTON SWITCHES.

2.4.6.5.7.6 Limit Switches

Provide adjustable limit switches to define the range of gate travel and provide a means to securely lock the switches in place after adjustment.

2.4.6.5.7.7 Type of Gate

Provide the vehicle gate operators to be compatible with cantilever, roller, v-track, overhead, slide, and swing gates.

2.4.6.5.7.8 Safety

Provide safety compatible with paragraph TYPE OF GATE for entrapment protection.

]2.4.6.6 Active Barrier Interface

Provide active barrier interface in accordance with Section 34 75 13.13 CRASH RATED ACTIVE VEHICLE BARRIERS AND CONTROLS suitable for connection to, monitoring, and control by the system's local processors and include all additional equipment and wiring to be an operable system.

2.4.7 Elevator Control

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NOTE: The designer will determine if floor tracking is appropriate for the site, see item b below.

If the ESS design includes Medical Facilities the elevator control must interface with Infant Protection Alarm System (IPAS).

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2.4.7.1 Control Elevator Operation with Entry Control Terminal Devices

The elevator's standard control equipment, components, and actuators must serve as the facility interface. System components and subsystems must interface with standard elevator control equipment without elevator control equipment modification. The system is to provide a means to define access-controlled floors of a facility, deny access to these floors by unauthorized individuals, and implement all other system functions as specified.

2.4.7.2 Floor Tracking

Deploy the elevator control system in such a manner as to provide "floor tracking" reports where the system records the individual's floor selection when elevator control is in effect.

2.4.8 Access Control System Date and Time

Provide system date and time per paragraph DATE AND TIME GENERATOR.

2.5 VIDEO SURVEILLANCE SYSTEM (VSS)

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NOTE: Scene illumination must be even across the field of view of the camera, with a maximum light to dark ratio of 8 to 1.

For visual assessment of alarms use a minimum of two monitors. Specify the optimum number of monitors for the number of cameras required. It is difficult to view and respond to too many monitors. Typically, for 16 cameras or less, use one monitor.

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Select system components that conform to the Open Network Video Interface Forum (ONVIF) specification. Provide compatible [UL 62368-1] [and] [UL 2802] listed VSS components to provide visual assessment of ESS alarms automatically upon alarm or upon SCC operator selection. Otherwise, the subsystem is to continuously display the coverage area. Display alphanumeric camera location ID on all monitors. Provide the number of alarm monitors as required. The scene from each camera must appear clear, crisp, and stable on the respective monitor during both daytime and nighttime operation. Provide component equipment that minimizes both preventive and corrective maintenance. Provide components from a single manufacturer or justify mixing manufacturer components and demonstrate compatibility in submittal information.

2.5.1 Cameras

2.5.1.1 VSS Camera

Provide Internet Protocol (IP) cameras of fixed, pan-tilt-zoom (PTZ), or panoramic type as indicated on the drawings.

a. Day-Night [Color] [B&W] fixed, PTZ or panoramic cameras are to be used in all outdoor environments. Standard fixed, PTZ, or panoramic cameras are to be used for all indoor applications except when backlighting issues are observed. Use Day-Night cameras or standard cameras with backlighting compensation for backlighting or high contrast applications.

b. Provide PTZ cameras with a direct drive motor assembly. Belt driven PTZ camera units are not acceptable. Equip PTZ cameras with a slip ring assembly having an optical interface and be rated for continuous duty. PTZ cameras must be fully integrated units. The pan-tilt mechanism must be an integral part of the camera. The PTZ control system from the [joystick] [and] [mouse] to the camera to the viewed image must operate in real-time with no impact to operational accuracy of pan tile zoom function.

c. Provide cameras that operate over a voltage range of [12 VDC] [24 VDC] [12] [24] VAC at [50] [60] Hz Power over Ethernet (PoE) IEEE 802.3.

d. All cameras must be constructed to provide rigid support for electrical and optical systems so that unintentional changes in alignment or microphonic effects do not occur during operation, movement, or lens adjustments.

e. Video Frame Rate: [30] [60] [120] frames per second (fps)

f. Cameras without on-board SD card recording may be used.

g. Cameras with on-board SD card recording must be addressed in the system programming regarding the use of SD card recording. Network outages must be addressed regarding the upload procedure for the SD card data. Audio recording (if used) must be addressed also, including proper signage per all applicable laws.

2.5.1.1.1 Sensitivity

Minimum Illumination: 0.7 lux 0.07 foot-candles at F1.4 color mode; 0.09 lux 0.009 foot-candles at F1.4 in the B&W mode.

2.5.1.1.2 Signal-To-Noise Ratio

Show a signal-to-noise ratio of not less than 50 decibels (dB) at Automatic Gain Control (AGC) "Off", weight "On".

2.5.1.1.3 Resolution

Provide a minimum of [2.1] [_____] megapixel resolution. The imager must have a minimum of 1080P picture in progressive scan format. Resolution is to be maintained over the specified input voltage and frequency range, and not vary from minimum specification over the specified operating temperature range.

2.5.1.1.4 Synchronization

Provide cameras that have internal and line lock.

2.5.1.1.5 Low Light Level

Provide Day-Night cameras that have a B-W mode that may be automatically engaged on low light level and permit the use of integrated or external infrared illuminator. Electronic removal of the color signal is not acceptable. The camera must have an infrared cut filter capable of being removed automatically upon low light threshold or manually.

2.5.1.2 Camera Lenses

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NOTE: The designer will provide drawings of the lens field of view labeled with the correct lens focal length for each camera, or a table that references the camera location and the required lens focal length in order to support this paragraph.

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Camera lenses are to be all glass with coated optics. Provide lens mount that is [C or CS mount], [compatible with the cameras selected] [integrated with the cameras]. Provide lens with the camera that have a maximum f-stop opening of f/1.2 or the maximum available for the focal length specified. The lens is to have an auto-iris mechanism unless otherwise specified. Lenses having auto iris, manual iris, or zoom and focus functions are to be supplied with connectors, wiring, receiver and driver units, and controls as needed to operate the lens functions. Provide lenses with sufficient circle of illumination to cover the image sensor evenly. Lenses are not to be used on a camera with an image format larger than the lens is configured to cover. Provide lens with focal lengths as indicated or specified in the manufacturer's lens selection tables.

2.5.1.3 Camera Housing and Mounts

The camera and lens are to be enclosed in a tamper resistant housing installed on a camera support. Any ancillary housing mounting hardware needed to install the housing at the camera location is to be provided as part of the housing. The camera support must be capable of supporting the mounted equipment and withstanding wind and ice loads normally encountered at the site.

2.5.1.3.1 Environmentally Sealed Camera Housing

The housing is to provide an environment needed for camera operation and be condensation free; dust and watertight; keep the viewing window free of fog, snow, and ice, and be fully operational in 100 percent condensing humidity. Provide housing equipped with a sunshield. Both the housing and sunshield are to be white in color. Housing must be purged of atmospheric air and pressurized with dry nitrogen, equipped with a fill valve, overpressure valve, and include a humidity indicator visible from the exterior. Housing must not have a leak rate greater than 13.8 kPa 2 psi at sea level within a 90 day period. Housing must resist influx of rain or snow from vertical to wind driven horizontal directions.

Provide housing equipped with supplementary camera mounting blocks or supports needed to position the camera and lens to maintain the proper optical centerline. All electrical and signal connections required for camera and lens operation are to be supplied. Provide a mounting bracket as part of the housing which allows weight adjustment to center the weight of the assembly.

2.5.1.3.2 Indoor Camera Housing

Provide housing with a tamper resistant enclosure for indoor camera operation and with the proper mounting brackets for the specified camera and lens. The housing and appurtenances color are not to conflict with the building interior color scheme.

2.5.1.3.3 Interior Mount

Provide camera mount suitable for either wall or ceiling mounting and have an adjustable head for mounting the camera. The wall mount and head must be constructed of aluminum or steel with a corrosion-resistant finish. Provide adjustable head with 360 degrees of pan and plus or minus 90 degrees of tilt.

2.5.1.3.4 Low Profile Ceiling Mount

Provide tamperproof ceiling housing which is low profile and suitable for use in 610 by 610 mm 2- by 2-foot ceiling tiles. The housing must be equipped with a camera mounting bracket and allows a 360-degree viewing setup.

2.5.1.3.5 Interior Dome Housing

The dome housing is to be capable of being mounted by pendant, pole, ceiling, surface, or corner as shown on the drawings. The lower dome is to be black opaque acrylic and have a light attenuation factor of not more than 1 f-stop. Provide housing with:

a. Integral pan-tilt complete with wiring

b. Wiring harnesses

c. Connectors

[d. Receiver-driver

][e. Pan-tilt control system

][f. Pre-position cards

][g. Heavy duty bearings

][h. Hardened steel gears

] i. Permanent lubrication

j. Motors that are thermally or impedance protected against overload damage.

k. Any other hardware and equipment as needed to provide a fully functional pan-tilt dome. Provide pan movement of 360 degrees and tilt movement of at least plus or minus 90 degrees. Pan speed must be at least 20 degrees per second and tilt speed be at least 10 degrees per second.

2.5.1.3.6 Exterior Dome Housing

Provide dome housing capable of being mounted by pendant, pole, ceiling, surface, or corner as shown on the drawings and constructed to be dust and watertight, and fully operational in 100 percent condensing humidity. Purge the housing of atmospheric air and pressurize with dry nitrogen. Provide a fill valve and overpressure valve with a pressure indicator visible from the exterior. The housing is to be equipped with supplementary camera mounting blocks or supports as needed to position the specified camera and lens to maintain the proper optical centerline.

Provide all electrical and signal connections required for camera and lens operation. The housing is to provide the environment needed for camera operation. The lower dome is to be black opaque acrylic with a light attenuation factor of not more than 1 f-stop. Provide housing with:

a. Integral pan-tilt complete with wiring

b. Wiring harnesses

c. Connectors

[d. Receiver-driver

][e. Pan-tilt control system

][f. Pre-position cards

][g. Heavy duty bearings

][h. Hardened steel gears

] i. Permanent lubrication

j. Motors that are thermally or impedance protected against overload damage.

k. Any other hardware and equipment as needed to provide a fully functional pan-tilt dome. Provide pan movement of 360 degrees and tilt movement of at least plus or minus 90 degrees. Pan speed must be at least 20 degrees per second and tilt speed be at least 10 degrees per second.

2.5.1.3.7 Exterior Wall Mount

Provide exterior camera wall mount that is [406.4] [609.6] [914.4] [____] mm [16] [24] [36] [_____] inches long and has an adjustable head for mounting the camera. The wall mount and head must be constructed of aluminum, stainless steel, or steel with a corrosion-resistant finish. Provide adjustable head for at least plus and minus 90 degrees of pan, and at least plus and minus 45 degrees of tilt. If to be used in conjunction with a pan-tilt, provide bracket without the adjustable mounting head, and a bolt hole pattern to match the pan-tilt base. Wind speeds up to [27] [   ] m/s [60] [_____] mph must not change alignment of the camera nor affect the PTZ operation.

2.5.1.3.8 Pan-Tilt Mount

a. Provide pan-tilt mount capable of supporting the camera, lens, and housing specified that is weatherproof and sized to accommodate the camera, lens and housing weight plus maximum wind loading encountered at the installation site if the pan-tilt is to be mounted outdoors. Provide pan-tilt with:

   (1) Heavy duty bearings

   (2) Hardened steel gears

   (3) Externally adjustable limit stops for pan and tilt

   (4) Mechanical, dynamic, or friction brakes

   (5) Permanent lubrication

   (6) Motors that are thermally or impedance protected against overload damage.

b. Provide pan movement of 360 degrees pan rotation, a minimum tilt movement of plus and minus 90 degrees. Manual pan speed must be a minimum of [0 to 80 degrees per second] [_____], and a minimum tilt speed of [10 degrees per second] [_____]. A minimum automatic pan speed of [280 degree per second] [_____] and tilt speed of [160 degree per second] [_____].

c. The pan-tilt is to be supplied complete with wiring, wiring harnesses, connectors, receiver-driver, pan-tilt control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan-tilt mount to fulfill the site design requirements.

2.5.1.3.9 Explosion Proof Housing

The explosion proof housing must meet the requirements in paragraph COMPONENT ENCLOSURE for hazardous locations, see paragraph HAZARDOUS LOCATIONS. Configure housing to provide a tamper resistant enclosure and supply with the proper mounting brackets for the specified camera and lens.

2.5.2 Thermal Imaging System

IP Thermal Cameras

a. Provide an integrated thermal imaging device in an environmental enclosure.

b. Provide a native digital image from the image sensor to the IP video stream.

c. Provide of an uncooled, sun-safe amorphous silicon micro bolometer, long-wavelength infrared (LWIR) camera capable of 640 x 480 and 384 x 288 resolution formats.

d. Provide a temporal Noise Equivalent Temperature Difference (NETD) below 50mK at f/1.0 capable of multiple display formats including white hot, black hot, and rainbow.

e. Allow for input voltage of [24 VAC], [24 VDC], [or] [a selectable power source of [120] [230] VAC].

f. Provide a built-in heater and defroster and sun shroud in accordance with paragraph COMPONENT ENCLOSURE.

g. Support two simultaneous, configurable video streams. MJPEG and H.264 compression formats that are available for primary and secondary streams with selectable Unicast and Multicast protocols. The streams are to be configurable in a variety of frame rates, bit rates, and group of pictures (GOP) structures.

h. Use a standard Web browser interface for remote administration and camera parameter configurations.

i. Provide a [100Base-TX] [_____] network port for live streaming to a standard Web browser.

j. Provide built-in video analytics.

2.5.3 Video Analytics (VA)

2.5.3.1 Software

Provide capability range from basic activity detection to the search through databases to pre-empt serious incidents. The VA is to provide graphic identified movement identification, user-selectable monitored areas, compensation for environmental movement, and other features specified when provided as a capability of the NVR. Provide the following features:

2.5.3.1.1 Basic Motion Detection

a. Adaptive Motion

b. Abandoned Object

c. Object Removal

d. Camera Sabotage

e. Directional Motion

f. Object Counting

g. Loitering Detection

h. Stopped Vehicle

2.5.3.1.2 Advanced VA

2.5.3.1.2.1 Intruder Identification

This refers to identifying unauthorized humans in specified areas within the field of view.

2.5.3.1.2.2 Environmental Compensation

Recognizing and ignoring wind-blown debris, animals, background traffic, and so on.

2.5.3.1.2.3 Counting

This refers to recognizing a quantity of a particular object moving or activity performed.

2.5.3.1.2.4 Directional Identification

This refers to the ability to ignore objects moving in one direction, while alarming for objects moving in unauthorized directions.

2.5.3.1.2.5 Item Recognition

This refers to activation when specific user-selected items are removed from, placed in, or passed through the field of view.

2.5.3.1.2.6 Subject Tracking

Highlighting and following a specific person or item as it moves about the field of view, or from the field of view of one camera to another.

2.5.3.1.2.7 Multiple Subject Tracking

Highlighting and following multiple persons or items simultaneously as they move about the field of view, or from the field of view of one camera to another.

2.5.3.1.2.8 Object Left Behind

This refers to the ability to detect objects left behind or added within the field of view in a scene.

2.5.3.2 Embedded VA

2.5.3.2.1 Intelligent Video Analysis

a. Provide camera capable of processing and analyzing video within the camera itself, with no extra hardware required.

b. The camera is to be capable of detecting and sending alarms for abnormal events.

c. The camera is to be configurable to analyze up to 10 different scenes for one or more of the following events:

  (1) Line Crossing

  (2) Loitering

  (3) Idle Object

  (4) Removed Object

  (5) Conditional Change

  (6) Trajectory Tracking

  (7) Filters

d. The camera is to allow users to set up to 10 separate profiles and switch profiles based on a day, night, or holiday schedule.

e. The camera is to support scene tours that automatically reposition the camera to each scene for a specified duration.

f. The camera is to incorporate an Alarm Rule Engine, enabling abnormal events that VA detects to prompt the camera to take one or more actions:

(1) Trigger a relay connected to an alarm siren, strobe, or both.

(2) Trigger a visual alert to be displayed on the operator's screen.

(3) Go to a specified scene (preset position).

g. Camera must provide [100] [_____] horizontal and [80] [_____] vertical pixels per foot at desired distance for License Plate Recognition. Camera must also provide [24] [_____] frames per second for License Plate Recognition.

2.5.3.2.2 Motion Tracking with PTZ Cameras

a. The camera is to offer Intelligent Tracking to continuously track an object using pan, tilt, and zoom actions.

b. The camera is to provide automatic motion tracking using intelligent video analytics.

c. Provide camera with the ability to follow an object continually when passing behind a privacy mask.

d. Provide camera with the ability to restart tracking if a target starts moving in the same area where the initial target stopped moving or if the camera detects an object moving along the last known trajectory.

e. The camera is to allow an operator to select an object to track in the live image view.

2.5.4 Color Computer Monitors

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NOTE: Certain display unit types may not be acceptable for use by the Activity. Verify with the SSO/CTTA for your project for acceptable formats.

****

Except as specified, provide computer monitors that:

a. Are rated for continuous operation.

b. LED flat panel computer monitor with [HDMI] [and] [DP] [USB-C] [DVI] input.

c. Have a [16:9][16:10] aspect ratio nominally measures [685][1066][1397][1651][_____] mm [27][42][55][65][_____] inches for LED displays.

2.5.4.1 Mounting

a. Mount monitors with compatible wall mount or manufacturer provided desk top stand.

2.5.4.2 Video and Signal Input

****

NOTE: Certain display input types may not be acceptable for use by the Activity. Verify with the SSO/CTTA for your project for acceptable formats.

****

Monitors are to operate with video input requiring a one [HDMI] [DVI-D] [DP] [USB-C] switchable to either loop-through or internal 75-ohm terminating impedance.

Signal input connectors must be [HDMI] [DVI-D] [DP] [USB-C] type.

2.5.5 Ancillary Equipment

Equipment is to consist of the items specified below:

2.5.5.1 Video System Date and Time

Provide system date and time per paragraph DATE AND TIME GENERATOR and paragraph VIDEO RECORDING PERFORMANCE.

2.5.5.2 Camera Identifiers

Label video signal from each camera using alphanumeric identifiers. Camera alphanumeric identifiers may originate from either the camera or the video recorder.

2.5.5.3 Video Recording

2.5.5.3.1 Analog to IP Video Converter

For new construction projects or new installation of new cameras on an existing site analog cameras are not allowed. For existing analog cameras that must remain in service, provide an analog (base band video) to IP converter to allow the camera images to be recorded in the IP based system.

2.5.5.3.2 IP Based Video Recording Device/System

a. Provide video recording device/system with an integral video management software (VMS). Dedicated VSS monitors and authorized computers networked to the video recording device/system are to be capable of viewing recorded and live video from the network. The video recording device/system is to be able to record and transmit video with minimum 24 fps at maximum camera resolution. The video recording device/system is to network with and utilize smaller, non-server computers at off-site camera locations as local recorders.

b. Provide video recording device/system with the capability to de-warp live and recorded images.

c. The storage memory capacity of the video recording device/system is to be sufficient to store a minimum of [7] [14] [30] [_____] days of video at [3] [6] [9] [15] [_____] fps, [2.1] [_____] megapixel resolution and be expandable for an increased capacity of [_____] [GB] [TB] and be capable of including Redundant Array of Independent Disc (RAID) arrays [0] [1] [5] [6] [10] [_____].

d. The video recording device/system must have the capacity to address and process up to [8] [16] [24] [32] [64] [128] [256] [512] [_____] dual-streaming cameras. The video recording device/system must record all cameras onto a hard drive and allow remote network viewing via [internet] [intranet] browser. Hard drive capability must be sized to store all cameras recording 24 hours a day 7 days a week at [3] [6] [9] [15] [_____] frames per second per camera for [1] [2] [4] [ ] weeks.

2.5.5.3.3 Video Recording Performance

The video recording performance is to be as follows:

a. The NVR [video server] is to use modular hard disk media, with a digital format capacity of [2TB] [_____] per module.

b. Provide a [1000Base-T] [_____] connection for record review and camera view and control that is compatible for a PC workstation equipped with latest [Microsoft Windows [_____] Professional operating system software], [Internet Browser Software].

c. PC workstation Viewing: Include direct access from the ESS PC workstations to each NVR [video server] via a internet web browser. All necessary descriptive bookmarks and shortcuts are to be prepared on each PC workstation to allow this direct access. All functions are to be accessible through HTML commands from a user's web browser interface. Pictures are to be available for attachment via a user-provided SMTP-based e-mail transport system and included capability for 16 users and 3 user access levels (admin, control and user).

d. Include sampling at 720(H) by 480(V) and 320(H) by 240(V) (Pixel Memory) with [_____] frames per second and 3-D scan conversion to enable jitter-free stabilized pictures in a single frame. Modes include:

    (1) Emergency

    (2) Event

    (3) Schedule

    (4) Manual Recording

e. Each camera is to support individual Recording Rate and Image Quality settings for each mode (Emergency, Event, Schedule, and Manual Recording). This array of Camera Recording Rate and Image Quality settings by the Recording Modes is to form one of four Program Actions. The Program Action is to be assignable to a timetable to form one of 16 Independent Recording Profiles. Allow each Recording Profile to be manually activated, activated via RS-232C interface, automatically activated by timetable, or activated by separate alarm or emergency inputs.

f. Provide system date and time per paragraph DATE AND TIME GENERATOR.

System Date and time to be digitally displayed on the monitor and also clearly shown on digitally stored recordings. The following information is to be included as part of the date and time stamps:

(1) Year

(2) Month

(3) Day

(4) Hour

(5) Minute

(6) Second

(7) Alphanumeric camera location ID up to 8 characters. The NVR [video server] is to feature video loss detection on all channels.

g. Pre-event recording: Pre-event recording should match the configuration in software to record [0.50 second] [1 minute] [3 minutes] or [_____ minutes] pre-event.

h. Motion-based Recording: Advanced integrated VMD is to be used to detect a specific area, direction and motion duration for each camera channel, independently and simultaneously. Motion Search may be executed for a single camera channel for a selected area on the image.

i. Disk Partitioning: Provide within the NVR [video server]an automated disk management and a RTOS (real-time operating system) platform to include a minimum of [4.8] [_____] TB of digital video storage on a single partition.

The video recording system is to provide a choice of Physical Partitioning as RAID [0] [1] [5] [6] [10] [_____] to provide a redundant array of independent discs to increase performance and redundancy. Raid levels should be coordinated with user requirements. Allow the operator to be able to partition the available recording areas in a Virtual Partition by Regular, Event, and Copy Partitions. Manually and scheduled recorded video information is to be assigned to a Regular Recording Partition, which may be overwritten. Event and Emergency Recording Data is to be assignable to an Event Partition, where image overwriting is be prohibited. Any copied data is to be able to be assigned to the Copy Partition, which may be overwritten or saved as required.

j. Playback: Permit direct camera selection for recording playback of any of [4] [9] [16] [_____] video sources at the same time as multiscreen viewing and multiplexed camera encoding (triplex multiplexer capability).

k. Multiplexer Functions: Include an integral, software based IP switching capability that automatically switches multiple camera images to enable sequential spot monitoring and simultaneous field recording. The unit must have full screen, [4] [7] [9] [10] [13] [16] multiscreen monitoring modes.

l. Outputs

(1) Provide via HDMI female connections [4] [9] [16] [_____] outputs for all video source connections to external monitoring systems including multiscreen and spot monitor video outputs.

(2) Provide virtual camera number programming capability to support [64] [128] [256] [512] [_____] camera channels on a single system.

m. All camera selection buttons are to have Tri-State Indication, corresponding to Recording, Viewing and Control functions in the NVR [video server] software. Furnish the following indicators:

(1) Alarm

(2) Alarm Suspend

(3) Operate

(4) HDD1, Hard drive identifier

(5) Timer and Error indicators

(6) Camera Selection

(7) Iris

(8) Preset

(9) Camera Automatic Mode

(10) Pan-Tilt

(11) Set

(12) Jog Dial

(13) Shuttle Dial

(14) Setup-Esc

(15) Record

(16) Search

(17) Play-Pause

(18) Pan-Tilt Slow

(19) Stop

(20) Pan-Tilt Go to Last

(21) Zoom-Focus

(22) A-B

(23) Repeat

(24) Shift

(25) Alarm Reset Buttons

n. Networking: All NVR [video server] recording, review, playback, camera control and setup are to be available via the internally mounted Network Interface. A [1000Base-T] [_____] connection for record review and camera view and control will be required on a personal computer equipped with Internet Browser Software and an Ethernet 1000Base-T connection. Permit direct camera selection for recording playback of any of [4] [9] [16] [_____] video sources at the same time as multiscreen viewing and multiplexed camera encoding (triplex multiplexer mode). Support a minimum of [8] [_____] simultaneous clients viewing and [2] [ ] simultaneous FTP sessions.

o. Power: The video recording equipment must have a power source of [120] [230] VAC at [50] [60] Hz.

2.5.5.3.4 Recording Audio With Video

Recording audio with video is acceptable provided all applicable laws are followed. Audio recording is not allowed under any circumstances in certain areas per the law, and if allowed often has strict signage requirements.

2.5.5.4 Camera Control

Provide access to camera functions and real time control for all cameras via the video management software for all camera control, set-up and alarm functions, including preset sequence, digital motion detector mask set, and back light compensation set-up. Controllable camera functions are to be accessible via front panel controls or the optional system controller controls to be accomplished by [joystick] [mouse]. These functions are to include:

(1) Direct access of preset position

(2) Zoom (near/far)

(3) Focus (near/far)

(4) Iris (open/close)

(5) Pan (left/right)

2.5.6 Camera Mounting Structures

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NOTE: Show footing details on drawings. For a camera pole, installation must meet the requirements as specified in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION. For self-supporting towers, footings must be designed in accordance with UFC 3-301-01.

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Provide camera mounting structures designed specifically for VSS cameras. The structure is to accommodate appropriate wiring pathways for power and communication as well as proper grounding and surge protection. Design loads for the camera mounting structure must conform to TIA-222 and all applicable addendums of the TIA standard. Allowable pole deflection is determined from the point of the camera mount and must not exceed 0.5 percent of the pole height under adjusted maximum wind load conditions. Adjusted maximum wind load conditions for deflection calculations must be 48 km per hour 30 miles per hour (mph) or 35 percent of the basic wind speed as determined by TIA-222, whichever is greater. Confirm compliance to TIA standards by structure manufacturer data or by analysis. Provide additional measures as required to stabilize the camera if placed in an environment that is subject to induced vibrations such as heavy winds or excessive traffic.

2.5.7 Video Surveillance System (VSS) Schedule

Provide a spreadsheet describing each individual camera installation location including the following items:

a. Unique camera location identifier.

b. Make/model/type (PTZ, fixed, fixed IR, etc.)/part-number of camera.

c. Make/model/part-number of camera mount.

d. Intended camera field of view.

e. Any additional information pertinent to that unique location.

2.6 SECURITY COMMAND CENTER (SCC)

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NOTE: The specific size and speed of the computers is directly related to the size and complexity of the installation along with the ESS software. The following minimum requirements are developed for IDS, ACS, and VSS workstations, enrollment center equipment (badging station), administrative workstation, and an Enterprise server.

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The SCC must integrate all subsystems and communications and provide operator control interface to the ESS system. The components are as follows:

a. ESS Software

b. Monitoring Display Software

c. Graphical Map Software

d. Printers

e. Controls and Display Integration

f. Enrollment Center Equipment

2.6.1 ESS Software

a. Provide commercial off-the-shelf ESS software that utilizes a single database for the subsystem integrations provided under a single operating environment. The system is to archive all events in a database stored either on a local hard drive or a networked database server. The software has to support configuration and simultaneous monitoring of all subsystems.

b. Allow the networked PC workstation configurations connected via a TCP/IP network. Administrative tasks including configuration, monitoring, schedules, report generation and graphic display are provided from any PC workstation on the network. All system programming data must be instantly accessible to every PC Workstation connected to the network. The system is to utilize a non-proprietary SQL-based, ODBC-compliant database, managed by Sybase Adaptive Server Anywhere, Microsoft SQL Server, or Oracle.

c. Utilize a preemptive multi-tasking operating system, such as the latest Microsoft Windows [_____] Professional environment, that is multitasking, with many processes running at the same time without interference with each other and with higher priority tasks taking precedence over lower priority tasks.

d. Provide capabilities to define visual exclusion areas.

[e. Provide de-warping software for panoramic cameras.

]2.6.1.1 Alarm Call up

Support responses to alarms entering the system with each alarm capable of initiating one or more of the following actions:

a. Sending alarm commands to a VSS system interface

b. Triggering event recording

c. Activating output devices

d. Playing PC audio files

e. Controlling doors

f. Display graphical maps associated with the alarm device

Provide mode of system operation that requires an operator to acknowledge any alarm. While alarm is still active, the alarm cannot be cleared.

2.6.1.2 Programming

Provide the capability of, but not limited to, the following programming and functionality:

2.6.1.2.1 Daylight Savings Time Adjustment

The ACU(s) and PCU(s) must not need to be connected to the ESS in order for the adjustment to occur.

2.6.1.2.2 Operator Privileges

Support an unlimited number of system operators, each with a unique login and password combination. Operators are to be assigned privileges based on the loops, commands, or programmed features that are available to each individual operator.

2.6.1.2.3 Alarm Priorities

Provide the ability for each alarm device to be user configured to belong to one of [10,000] [_____] priority levels which are assigned to an alarm based on alarm importance. These priorities are to define which alarm events to display on individually specified ESS workstations.

2.6.1.2.4 Reports

Include integrated reporting capabilities as well as the ability to run [Crystal Report] [_____] templates.

2.6.1.2.5 User Interface

The ESS programming is to be menu-driven, with "wizards" to assist with software configuration, and include 'Help' information.

2.6.1.2.6 Messages

Permit the use of user-selected colors for event messages.

2.6.1.2.7 Graphics

Provide the capability to display a floor-plan graphic for card activity and alarm events as part of the ESS integration.

2.6.1.2.8 Device Status

Provide the capability to display the dynamic status of a user-selected list of devices, including doors, inputs, and outputs.

2.6.1.2.9 Diagnostics

Include diagnostic software tools that interface and query the hardware for information and to issue commands.

2.6.1.2.10 Mandatory Data Fields

Require any cardholder data field to be selected by the user as mandatory.

2.6.1.2.11 User Defined Data Fields

Provide [20] [_____] unassigned data fields for storing user-defined data that support user-defined labels, and are user-configurable as plain text fields or drop-down selection lists.

2.6.1.2.12 Archive Database

Include a connection to an archive database which stores purged events and deleted programming which can be accessed for reporting.

2.6.1.2.13 Programmable Database Backup

Include the capability of performing user-scheduled database backups without the use of third-party backup software.

2.6.1.2.14 Programmable Database Purging

Include the capability of performing user-scheduled database purging, moving selected events to an archive database when the events have aged a user-specified number of days.

2.6.1.2.15 Database Importing

Include the capacity to import user data from an ODBC data source (Access, Excel, text).

2.6.1.2.16 Data Exporting

Include the capacity to export data from any table in the database to either a [text] [HTML] [Excel] [Access] file in any user-selected order.

2.6.1.2.17 Event Log Output

Include the capacity to send a continuous stream of user-selected types of event messages to a text file, serial port, or TCP/IP address.

2.6.1.2.18 Data Audit Trail

Record changes to programming, recording the date and time stamp of the change, the name of the operator making the change, and the nature of the change. This data audit is to be available in history for reporting.

2.6.1.2.19 Alarm Forwarding

Provide the capability to forward alarms to cellular telephones via dedicated applications or text message to be utilized by authorized system personnel when they are away from the SCC.

2.6.2 ESS Monitor Display Software

ESS Monitor display software is to provide for text and graphic map displays that include zone and device status integrated into the display. Different colors are to be used for the various components and real time data. Colors must be uniform on all displays. Follow the color coding as follows.

a. FLASHING RED to alert an operator that a zone has gone into an alarm or that primary power has failed.

b. RED to alert an operator that a zone is in alarm and that the alarm has been acknowledged.

c. YELLOW to advise an operator that a zone is in access.

d. GREEN to indicate that a zone is secure or that power is on.

2.6.3 Graphical Interactive Map Software

a. ESS graphical map software is to show the [graphic and] visual data of all subsystem devices. Use a [480] [533][762] [1066] [_____] mm [19] [21] [30] [42] [_____] inches, LED flat screen display with messages displayed in the English language. Provide graphical maps showing a layout of all the protected facilities. Highlight zones corresponding to those monitored by the ESS on the graphical maps. Display status of each zone using graphical icons as required within each designated zone.

b. Provide capability for graphical maps to be linked together using a layered tree structure. For example, a top-level map might be a top view of the site and its buildings, the next level the individual buildings floor, followed by a map of the area on a floor containing the device in alarm. Allow for [3] [6] [_____] layers of maps to be defined for any given ESS device. To speed an incident location, each map level contains a clearly visible indicator as to which sub map the operator should select next to find the device that is in alarm.

c. The ESS may also be configured to display a map automatically on a new alarm presentation, providing the operator with prompt visual indication that an alarm has occurred.

d. The status of intrusion devices, access control readers, doors, auxiliary monitor points, and auxiliary outputs is to be able to be requested from any map by simply selecting the icon representing the device and its current state will be displayed. VSS camera control, digital video review, alarm panel transactions and intercom requests are to be available for inclusion on the map with the associated management module installed.

e. Allow for SCC operators to change a current setting by pressing the right mouse button anywhere on the screen or on a specific system device icon. Pressing the right mouse button is to cause the appropriate command options list to appear for selection. Confirmation is provided by reflecting the change in status on the display after a command is selected.

f. The display of intrusion or auxiliary door alarms may be automatically enabled or disabled by the use of timed commands, either by device or by a group of devices. This may be used, for example, to disable all door alarms on internal doors, during normal office hours.

g. Create maps using standard office tools allowing drawings to be imported in Jpeg, Bitmap, Windows metafile, PDF or DXF file formats to provide maximum flexibility.

2.6.4 Printers

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NOTE: A shared printer can be used for reports and alarms. If a project requirement includes the badge printer a separate badge printer is required.

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2.6.4.1 Report Printer

Provide a laser text printer to generate reports that is a [USB] [wired network (RJ45)] interface dry-type laser process printer. Provide a printer with the capability of holding a minimum of 500 pages. The unit must print a minimum of 30 pages per minute at 600 dpi resolution.

2.6.4.2 Alarm Printer

Provide an alarm printer interconnected to the SCC equipment with a minimum print rate of 30 characters per second to produce hard copy of system events. Printer must meet requirements per paragraph REPORT PRINTER.

[2.6.4.3 Badge Printer

Provide a dye-sublimation or resin thermal transfer type image printer for Badge Identification credentials that is capable of printing two sides, edge to edge, directly onto a white-unfinished 0.030 PVC, PVH or PVCH card at a rate of approximately 80 seconds per card. [Provide an encoder to be an integral part of the printer with encoding conforming to ABA Track II and ANSI specifications].

]2.6.5 Control and Display Integration

Integrate human engineer SCC controls so the entire SCC can be operated by a single or multiple operator(s). Integrate switching and monitoring components of the assessment subsystem with the SCC so that SCC operator(s) can effectively monitor, assess alarms, and control the ESS. [Method of system integration must be as a single console. Provide chassis, and modules required for console SCC configuration.]

2.6.6 Enrollment Center Equipment

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NOTE: The designer will calculate if 25 percent is adequate for future use. If it is not, the designer will specify the correct percentage.

SCIF and SAPF enrollment equipment must be inside the SCIF or SAPF areas.

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Provide enrollment stations to enroll personnel into, and disenroll personnel from, the system database. The enrollment equipment is to only be accessible to authorized entry control enrollment personnel.[Provide a quantity of credential cards equal to or greater than the number of personnel to be enrolled at the site plus an extra [25] [_____] percent for future use.] The enrollment equipment is to include subsystem configuration controls and electronic diagnostic aids for subsystem setup and troubleshooting with the SCC. Provide a [CAC] [PIV] [proximity] card reader at the enrollment station.[Also provide a [fingerprint reader] [palm scanner] [facial scanner] and [keypad] at the enrollment station.][Provide a printer for the enrollment station which meets the requirements of paragraph REPORT PRINTER.]

2.6.6.1 Enrollment Client Accessories

a. Provide a steel desk-type console and equipment racks. The console is to be in accordance with ECIA EIA/ECA 310-E and as indicated.

b. Rack mount all equipment in the console and equipment racks, except for printer. Color coordinate the console and equipment racks and cabinets, obtaining approved by the Contracting Officer.

[c. Provide a locking cabinet approximately 1.8 m 6 feet high, 900 mm 3 feet wide, and 600 mm 2 feet deep with three adjustable shelves, and two storage racks for storage of CDs, DVDs, printouts, printer paper, ink/toner, manuals, and other documentation.

]2.6.6.2 Enrollment Center I.D. Production

a. Equip the enrollment client with a high-resolution digital camera structurally mounted or provided with a reliable tripod. The camera model is to be as recommended by the manufacturer of the ESS. Provide commercial off-the-shelf components.

b. Design and provide a lighting system sufficient for quality, still-video capture.

c. Equip the enrollment client with a dye-sublimation [_____] printer capable of printing directly to the access control or I.D. credential. Provide printer toner kits and other printing supplies to complete the initial enrollment by 200 percent.

2.6.6.3 Enrollment Client Software

Provide database management functions for the system and allow an operator to change and modify the data entered in the system as needed. The enrollment station is not to have any alarm response or acknowledgment functions as a programmable system function. Multiple, password-protected access levels are to be provided at the enrollment station. Database management and modification functions are to require a higher operator access level than personnel enrollment functions. Provide a means for disabling the enrollment station when it is unattended to prevent unauthorized use.

Provide a method to enter personnel identifying information into the entry control database files through enrollment stations to include a credential unit in use at the installation. In the case of personnel identity verification subsystems, this data is to include biometric data. Allow entry of this data into the system database files using simple menu selections and data fields. The data field names are to be customized to suit user and site needs. All personnel identity verification subsystems selected for use with the system are to fully support the enrollment function and be compatible with the entry control database files.

2.7 COMMUNICATIONS

a. Communications are to link together subsystems of the ESS and be in accordance with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. Interfaces between subsystems cannot be accomplished by use of an electro-mechanical relay assembly. Communications links must be supervised. Provide common communications interface devices throughout the ESS. Provide the sensor to control unit interface as a dry contact relay that is normally open (NO) or normally closed (NC), except as specified otherwise.

b. Use digital, asynchronous, or multiplexed data control unit for central alarm reporting and display processor interface. Group individual data bits into word format and transmit as coded messages. Implement interface with network switches which function as a communications controller, perform data acquisition and distribution, buffering message handling, error checking, and signal regeneration as required to maintain communications.

c. Provide totally automatic status changes communication, commands, field-initiated interrupts, and any other communications required for proper system operation. Do not require system communication operator initiation or response. System communication is to return to normal after any partial or total network interruption including power loss or transient upset. Automatically annunciate communication failures to the operator with communication link identification that has experienced a partial or total failure.

2.7.1 Link Supervision

2.7.1.1 Hardwire Direct Current Line Supervision

Provide only for the sensor to control unit links which are within the ESS protected area. Supervise circuits by monitoring changes in the current that flows through the detection circuit and a terminating resistor of at least 2.2 K ohms. Supervision circuitry is to initiate an alarm in response to opening, closing, shorting, or grounding of conductors by employing Class C standard line security. Class C circuit supervisor units are to provide an alarm response in the annunciator in not more than one second because of the following changes in normal transmission line current:

a. Five percent or more in normal line signal when it consists of direct current from 0.5 through 30 milliamperes.

b. Ten percent or more in normal line signal when it consists of direct current from 10 microamperes to 0.5 milliamperes.

c. Five percent or more of an element or elements of a complex signal upon which security integrity of the system is dependent. This tolerance will be applied for frequencies up to 100 Hz.

d. Fifteen percent or more of an element or elements of a complex signal upon which the security integrity of the system is dependent. This tolerance will be applicable for all frequencies above 100 Hz.

2.7.1.2 Hardwire Alternating Current Supervision

Supervision is not to be capable of compromise by use of resistance, voltage, or current substitution techniques. Use this method on circuits which employ a tone modulated frequency-shift keying (FSK), interrogate-and-reply communications method. Supervisory circuit are to be immune to transmission line noise, crosstalk, and transients. Terminate detection circuit by complex impedance. Maintain line supervision by monitoring current amplitude and phase. Size complex impedance so that current leads or lags the driving voltage by 0.785 plus or minus 0.087 rad 45 plus or minus 5 degrees.

Alarm when rms current changes by more than 5 percent, or phase changes by more than 0.087 rad 5 degrees for supervision current of 0.5 to 30 milliamperes rms. Alarm when rms current changes by more than 10 percent, or phase changes by more than 0.139 rad 8 degrees for lines with supervision currents of 0.01 to 0.5 milliamperes. Identified line supervision alarm must be communicated within one second of the alarm.

2.7.1.3 Hardwire Digital Supervision

Local processors are to exchange digital data to indicate secure or alarm at least every 2 seconds. Alarm if data is missed for more than one second for passive supervisory circuits. Coding used for data cannot be decipherable by merely viewing data on an oscilloscope. Supervisory circuits are to asynchronously transmit bursts of digital data for transponder schemes. Data pattern is to be random in nature. Remote detectors are to receive data and encode a response based on a proprietary coding scheme.

Provide a unique encoding scheme; [an industry-wide or vendor standard is not acceptable.] Transmit encoded response back to supervisory circuit. Supervisory circuit is to compare the response to an anticipated response. Alarm on failure of the detector to return a data burst or return an incorrect response.

2.7.2 Hardwire

2.7.2.1 Electrical Conductor Lines

a. Use electrical conductor lines for hardwire that rely on current path except for electrical wires; neutral conductors of electrical distribution systems cannot be used as signal transmitters.

b. Conductors outside the protected area are to be [shielded cable] [buried] [[installed in Galvanized Rigid Steel Conduit (GRC, RMC)] [installed in Electrical Metallic Tubing (EMT)] in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM]. Supervision circuitry is not to initiate nuisance alarms in response to normal line noise, transients, crosstalk, or in response to normal parametric changes in the line over a temperature range of minus 35 to 52 degrees C 30 to 125 degrees F.

c. Ambient current levels chosen for line supervision must be sufficient to detect tampering and be within the normal operating range of electrical components. Report line supervision and tamper alarms regardless of mode of operation.

d. Provide hardwire links in accordance with UL 1076 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM for interior applications with additions and modifications specified. Conductors are to be copper. Conductors for links which also carry AC voltage, are to be No. 12 AWG minimum; single conductors for low-voltage DC links are to be No. [14] [16] AWG minimum. Conductors are to be color coded. Conceal wiring in finished areas of new construction and wherever practical in existing construction if not otherwise precluded by the Government.

e. Identify conductors within each enclosure where a tap, splice, or termination is made. Identify conductors by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Connect sensors, control units, and communication devices so that removal will cause a tamper alarm to sound. Pigtail or "T" tap connections are not acceptable. Each conductor used for identical functions is to be distinctively color-coded. Each circuit color-coded wire is to remain uniform throughout circuit. Tamper switches meet requirements of paragraph TAMPER SWITCHES.

2.7.2.2 Communication Link

a. Provide a dedicated circuit communication link from sensor to control unit. Opening or closing a relay contact will indicate an alarm. Convert analog signals to digital values or a relay closure or opening within 76 m 250 feet of the sensing point. Communications from control unit to central alarm reporting and display processor are to operate in a continuous interrogation and response mode, using time-multiplexed digital communications techniques at a data rate of [5.12] [10.24] [_____] kilobaud.

b. Interrogation and response communications between the control unit and central processor is to be half-duplex and bidirectional on one dual twisted pair cable (one pair for interrogation and one for response), which may have one or more parallel branches. Individual control unit lines are to be at least 22 AWG wire. Connect control wires in parallel to the hardwire link. Communication system is to provide as many as [255] [_____] control unit connections.

c. The communication system must maintain specified performance over a link length of 2287 m 7500 feet when operating without line repeaters or other signal regenerating or amplifying devices. The communications system must maintain specified performance over a link length of 22,865 m 75,000 feet when operating with signal-regenerating line repeaters.

d. Control unit to central alarm reporting and display processor communications link is to also be capable of operating over a maximum of [two] [four] [_____] standard voice grade telephone leased or proprietary lines. Link is to be capable of operating half-duplex over a Type 3002 data transmission pair and be capable of modular expansion. Telephone lines will be provided by the Government. Coordinate and check out system operation. General characteristics and telephone line service are to be as follows:

e.

Connections	Two- or four-wire
Impedance at 1000 Hz	600 ohms
Transmitting level	0 to 12 dBm
Transmitting level adjustment	3 dB increments
Type	Data
Direction	Two-way alternate (half-duplex)
Maximum speed	[1.2] [5.12] [10.24] [_____] kilobaud
Maximum loss at 1000 Hz	33 dB

2.7.3 Radio Frequency Link

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NOTE: Radio frequency links may not be allowed on some of Government facilities. Recommended usage for RF links is as backup to hardwire links or to a remote location lacking telephone lines. As soon as possible, but no later than schematic design, the designer must contact the area radio frequency coordinator (usually the base radio officer) to determine the availability of radio frequencies and to ensure that the using activity submits a DD Form 1494, "Application for Frequency Allocation," for a Stage 1 ("Conceptual Development") allocation (see DD Form 1494 Preparation Guide). Stage 1 allocation authority (i.e., approval) must be obtained prior to advertisement of the contract.

The 138 to 150.8 MHz band is the preferred range since specific frequencies in this range are reserved for DODI use. Frequencies in the 162 to 174 MHZ and 450 to 470 MHz bands are shared with other users on a first-come, first-served basis. In order to avoid potential contract delays, the frequency assignment should be included in the specification when possible. For additional information, contact the base radio officer or local/regional contact responsible for frequency allocation.
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a. Provide a full-duplex, supervised RF, polling system specifically used for alarm data communications with components manufactured by one manufacturer operating in the VHF, [134 to 154 MHz] [_____] band. System is to interface directly with ESS hardwire data link from control unit to central alarm reporting and display location and is to translate (reduce) the data rate for RF transmission, modulate and demodulate the data signal, and transmit and receive ESS data.

b. Provide a factory-tested complete RF link which both automatically and upon operator command transmits a signal with a unique identification from the central alarm monitoring location to the control unit locations. Message receipt at control unit location is to be ignored by all units except the addressee. Unit with the correct address is to decode the interrogation signal and respond to the interrogation with the status of the reporting sensors. Re-interrogate when the addressee fails to respond. Alarm upon failure to respond a second time.

c. Remote units in the RF system are to be individually polled in turn. Polling response time and transmission data rate, data error rate, and equipment reliability is to ensure that overall, ESS alarm annunciation time reliability and Pd is not degraded.

d. Provide RF transmitters, receivers, or transceivers in sufficient quantities to meet specified requirements. RF link transmissions are to be on one or more of the frequencies within the specified band as required to meet specified requirements and neither interfere with other ESS components nor any facility electronic components. Provide transmitters which are in accordance with applicable requirements of 47 CFR 15.

e. Message types and content are to be identical to those transmitted by other portions of the ESS data communications subsystem. ESS alarms sent by RF link are not to fail and are to be transmitted by the RF link due to event occurrence during "off air" periods. RF link is to provide message transmission priority in the following order:

(1) Intrusion alarms

(2) Tamper alarms

(3) Access denial alarms

(4) Other alarms on a first-in, first-out basis including loss of communication signal, fail-safe, low battery, and power loss.

f. Provide [omnidirectional, coaxial, half-wave dipole] [_____] antennas for alarm transmitters and transceivers with a driving point impedance to match transmission output. Provide antennas and antenna mounts that are corrosion resistant and able to withstand wind velocities of [160] [_____] km per hour [100] [_____] mph and physical damage caused by vandalism. Antennas cannot be mounted directly to any facility fence or roofing system.

g. Provide antennas from the same manufacturer as the rest of the RF link. Provide coaxial cable in lengths as required. Cables are to use PL-type fittings or connectors, properly protected against moisture. Cables must match transmitter output impedance.

2.7.4 Data Encryption

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NOTE: Data encryption should be used when required by governing regulations or when it has been determined that unauthorized persons may have access to system intercommunications. The designer must indicate which DTS circuits require data encryption to include card reader to control panel circuits when appropriate. The designer should choose which encryption is required. AES is the strongest but may not be available from all manufacturers, TDES next, and DES is the lowest level of data encryption. Data encryption must be in accordance with NIST FIPS 140-2.

****

Incorporate data encryption equipment on data transmission circuits as shown on the drawings. The algorithm used for encryption must be the [Advanced Encryption Standard (AES) algorithm described in NIST FIPS 197] of [TDES], ASC/X9 X9.52, as a minimum. Data encryption must be in accordance with NIST FIPS 140-2.

2.7.5 Network Switch

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NOTE: Designer to determine the hierarchy of the network such as star, self-healing ring, etc. Layer 3 switches should be considered for use throughout the design to accommodate future network requirements. Verify the existing environmental conditions to make sure the switch temperature range is compliant. Determine if multimode fiber or single mode fiber is required for Outside Plant (OSP) and Inside Plant (ISP) to accommodate future network requirements.

Verify network switch with local activity telecommunications manager.

For Army projects reference UFC 3-580-01.

****

[For Department of Defense projects network switches must comply with DISA APL.]The small form-factor pluggable (SFP) is to provide full-duplex 1000/100/10-Mbps connectivity between switches over [multimode fiber (MMF)] [single mode (SM)] infrastructures. Provide mounting accessories for a typical [field distribution box] [cabinet] [rack]. Rack requirements as specified in paragraph EQUIPMENT RACK.

2.7.5.1 Inside Plant

Provide a network switch for ESS system with [8] [12] [24] [48] [64] [_____] SFP Ethernet ports. Allow dynamic port base security and rapid spanning tree protocol with VLAN assignments for specific users regardless of where the switch is connected. The switch will use AC input voltage nominal of [120] [230] VAC at [50] [60] Hz. The switch is to be less than 2 Rack Units (RU) and Layer 3 capable. The switch is to have the capability of commanding a self-healing ring configuration. 1000Base-LX SFP Fast Ethernet Interface Converter is to be a hot swappable device that plugs into a Gigabit fiber SFP uplink port on the switch. The switch is to be a fully managed power over Ethernet (PoE) to all ports. Provide switch capable of using a Layer 3 (routed) port to connect to a LAN gateway port for Internet and web base access. The Mean Time Between Failure (MTBF) must be greater than 210,000 hours.

2.7.5.2 Outside Plant

Provide hardened managed Ethernet switch with a minimum of [6] [8] [12] 10/100/1000 switched RJ-45 ports and two 1000 Mb fiber ports designed for unconditioned outdoor applications. The switch is to be sealed, conduction cooled, use a rugged case with no fans and no air vent openings. The ambient operating temperature range is -40 to 75 degree C 40 to 170 degree F. The software includes SNMP, QoS, Telnet, Security, STP, VLAN, BootP / DHCP.

2.7.6 Video and ESS Transmission

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NOTE: Include industry standard for each cable type on cable data sheets at the end of section.

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Transmission is to be by optical fiber dedicated to the associated circuit. Video and ESS transmission cables must conform to the industry standards in [Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM] [Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP)].

Install interior cable in [Rigid Metal Conduit (RMC)] [Electrical Metallic Tubing (EMT)] conduit unless indicated otherwise. Provide conduit and fittings in accordance with Section 26 20 00 INTERIOR DISTRIBUTION. Use only compression fittings for EMT conduit. No set screw fittings allowed. Cable is to be rated for the installation method intended. Install exterior cable underground installed in [Schedule 40] [Schedule 80] Polyvinyl chloride (PVC) conduits.

2.7.7 Wire and Cable

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NOTE: Designer to provide wire and cable data sheets for each wire and cable type. Refer to IC Tech Spec for IDC-ICS 705 and UFC 4-010-05 SCIF for for cables associated with SCIF environments.

****

Provide all wire and cable (including copper power cable, UTP data cable, optical fiber cable, and coaxial cable) not indicated as Government-furnished equipment. Wiring must meet NFPA 70 standards and as indicated in the Wire and Cable Data Sheets Attachment at the end of this section. Provide optical fiber test data and UTP test data for field connectorized cable, including any existing optical fiber cable and/or existing UTP which will be used to transmit data for any ESS items provided in the project..

2.7.8 Digital Data Interconnection Wiring

Interconnecting cables carrying digital data between equipment located at the SCC or at a secondary control and monitoring site is to be optical fiber cable. Interconnecting cables conform to the industry standards in [Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM] [Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP)].

2.7.9 Aboveground Sensor Wiring

Sensor wiring is to be 20 AWG minimum, twisted and shielded, 2, 3, 4, or 6 pairs to match hardware. Provide multiconductor wire with a PVC outer jacket.

2.7.10 Direct Burial Sensor Wiring

Sensor wiring is to be 20 AWG minimum, twisted and shielded, 2, 3, 4, or 6 pairs to match hardware.

2.7.11 Local Area Network (LAN) Cabling

Category 6 cabling must be in accordance with TIA-568.2. Provide permanent link testing and a test report for all Category 6 cabling.

2.7.12 Cable Construction

Provide all cable components that will withstand the environment in which the cable is installed for a minimum of 20 years.

[2.8 SECURITY LIGHTING INTERFACE

Provide an interface for control of the security lighting system in accordance with [Section 26 56 00 EXTERIOR LIGHTING] and as shown on the drawings.[Provide motion activation of lights for enhanced VSS performance.]

][2.9 MEDICAL FACILITY SYSTEM

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NOTE: If the ESS design includes Medical Facilities, the designer to include additional security features to meet the requirements in UFC 4-510-01 Medical Military Facilities.

If the ESS design includes Medical Facilities the elevator control must interface with IPAS.

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2.9.1 Infant Protection Alarm System (IPAS) Performance Requirements

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NOTE: The Hospital will have a method of notifying responders to Medical Emergencies such as Radio Page or other Wireless Personal Communications Device. Use the same system to notify the staff in the protected area and any on site security team designated by the facility users.

****

a. Fully integrate the IPAS with the ESS system. Infant abduction alarms (exit alarms and tag tamper alarms) from the IPAS are to be received and processed the same as all other alarms and concurrently routed in real time to all Operator Workstations. Send notifications via radio page or other wireless Personal Communications device to the security unit staff and paged to the nursing staff in the alarmed unit.

b. The IPAS is to detect and report alarms if an attempt is made to remove an infant tag from the secured nursing area (exit alarm) or of an unauthorized removal of a tag strap from an infant (tag tamper alarm).

c. Wireless readers are to adequately cover all areas of the secured nursing units.

2.9.2 Infant Protection Alarm System (IPAS) Major Components

Major components of the IPAS include:

a. Network Adapters

b. Infant Protection Workstations

c. RF Readers

d. Infant Tags

e. Tag Straps

f. External Relay Boxes

g. Door Position Switches

h. Dome Lights with Buzzer Device

i. Electromagnetic Locks & Power Supplies (part of Door Hardware)

j. Card Readers

    (1) Remote Display Units (RDU)

    (2) Infant Protection Software

2.9.3 Infant Protection Operator Workstations

a. Operation, management, and monitoring of the Infant Protection Alarm Systems are to be performed from Infant Protection Workstations located in the [Nurse Stations] [Labor and Delivery] [Mother Baby Units] for the patient care units served. Locate an additional monitoring workstation at the [Nurse Team Center] [_____] of the [Med Surge Unit] [_____]. Functions performed at these workstations include:

(1) Management of the subsystem for the protected unit

(2) Infant Tag inventory, activation and assignment, and deactivation

(3) Strap inventory and use

(4) Infant data, tag and strap assignment, and discharge

(5) Alarm event reporting and monitoring

(6) Activity and event reports

(7) Display of alarm receivers and status

(8) Video display of alarmed cameras

b. The infant protection operator workstations include:

(1) CPU

(2) Computer keyboard

(3) Mouse

(4) Two video monitors

(5) Printer

(6) Removable media storage unit that provides for offline storage and retrieval of event activity

2.9.4 Remote Display Unit

Locate a RDU and an associated card reader near the secure side of each designated [exit door] [and elevator] to allow authorized staff to quickly suspend an infant tag, so that an infant can be taken out of the secured nursing unit without generating an exit alarm. Allow authorized staff to reactivate the infant tag when the infant is returned to the secured nursing unit. The RDU is to be inoperative until activated by the associated card reader when the card reader senses an access control card from a staff member that is authorized to take the infant out of the secured nursing unit. The RDU is to remain active for a programmed short period of time to allow the transaction to occur and then the RDU is to automatically become inactive.

2.9.5 Operator Interface

The IPAS operator workstations are to enable the real-time display of any alarms on graphical floor plans. Provide graphical display with the ability to select the following views:

a. All tags in the system, or

b. A specific tag

The system operator interface is to enable tags to be easily added or deleted from the system, by either using a button press to identify the tag ID code, or by typing in the tag ID code.

2.9.6 Alarm Management

The IPAS is to support several different types of alarms for the tags, including:

2.9.6.1 Tamper Alarm

This indicates a strap attaching a baby tag has been tampered or disconnected. Display the tag's name, description, and location in the alarm line.

2.9.6.2 Near Exit Alarm

This indicates a tag has moved into the proximity of a monitored exit door or elevator. The tag name, description, and location is to be displayed within 0.5 seconds on the IPAS Operator Workstation, transmit the alarm to radio pagers carried by on-duty security and nursing staff, and transmit the alarm to the system database and system Operator Workstations.

The IPAS is to activate the electrical locks on the doors to the protected area. The doors will automatically unlock either upon the staff clearing the alarm, a power outage to the electrical lock control, an independent activation of the smoke alarm system, or water flow in the sprinkler system. The staff is to have the ability to unlock the doors at any time from inside the unit. The alarm event is to also activate a dome light and buzzer at the door until the alarm is acknowledged. Activation of IPAS will prevent the elevator from opening or stopping on the event floor.

2.9.6.3 Battery Alarm

This indicates the battery of a tag is low and should be replaced. Display the tag name, description, and its location in the alarm line.

2.9.6.4 Failed Communications Alarm

This indicates the network is not working or the database server has been shut down. No tag location or alarm can be performed while this alarm is active.

2.9.6.5 Lost Alarm

This indicates the tag cannot be detected by any reader in the system. Display the tag name, description, and its last-known location in the alarm line.

2.9.7 IPAS Area Wireless Tag Readers

The IPAS area wireless tag readers are to be able to be mounted either in the ceiling or on the walls. Provide readers with 360-degree coverage and an effective read range as required by the IPAS. The system is to assign the tag to the reader with the highest signal strength if more than one area wireless reader detects the tag signal. Multiple area wireless readers are to be able to be installed in a single room to narrow the location down to areas as small as a 10 foot radius using signal strength levels. The area wireless readers are to operate at an unlicensed radio frequency and have all necessary regulatory approvals.

2.9.8 IPAS Door Wireless Reader

The IPAS door wireless readers are to be able to be mounted either in the ceiling or walls. The readers are to transmit within an adjustable range (distance from and width of exit door) of each exit door to limit ifant tags detection within a very short distance of the exit door. The readers are to support wireless fields synchronization if multiple door wireless readers are used to cover a large entry area. The transmission field generated by the door wireless reader is to include an encrypted ID code that can be decoded by tags that enter the field.

2.9.9 Infant Tags and Straps

2.9.9.1 Tag Characteristics

Technology	Very low power wireless transmission
Power Battery	Rechargeable lithium battery with 5-year life
Transmission Rates	As required
LED Indication	Low battery, transmission
Tag ID	Unique factory programmed
Water Resistance	Waterproof and completely sealed housing

2.9.9.2 Tag Features

a. Automatically activate when attached to a baby

b. Manufactured with latex free adjustable strap made from skin safe material that includes a soft pad to prevent skin irritation

c. Have a re-adjustable strap to suit ankle shrinkage

d. Be easy to clean

e. Be manufactured with disposable parts, ensuring re-use of tag up to 1000 times without compromising hygiene level

f. Be rechargeable by placing them in a desktop charger that is supplied with the system. Multiple tags can be recharging simultaneously

2.9.10 IPAS Dome Lights

Mount a dome light configured with indicator lamps and a tone device over exit doors from areas equipped with an IPAS. A red light is to illuminate and the tone sound when an exit alarm is activated. The light and tone are to remain on until the exit alarm is acknowledged.

[2.9.11 Radio Page Interface

a. Unit is to interface with the radio page system capability of Section 27 52 24 NURSE CALL SYSTEM. This interface must be a hardwired connection to an input port on the radio page encoder.

b. Route all alarms to the radio page system for transmission to alphanumeric pagers carried by the security staff.

c. Transmitted alphanumeric alarm information is to include the type, location, date, and time of the alarm event.

d. Infant protection alarm event is to be radio paged to the nursing staff in the patient care area where the alarm originated.

]]2.10 SURVEILLANCE AND DETECTION EQUIPMENT

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NOTE: For Army projects, contact the Electronic Security System Mandatory Center of Expertise (ESS MCX) for assistance in determining requirements for these devices. The ESS MCX e-mail address is AskESSMCX@usace.army.mil

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2.10.1 Article Surveillance and X-Ray

Provide X-ray package search system suitable for [automated] [manual] detection and material density identification. The article surveillance is to function as a sensor or detector subsystem and connect to the local processors and alarm monitoring.

The article surveillance and X-ray device are to provide adjustable contrast and a surface area threshold setting. Incorporate a long-term image storage system to document subsystem operations. The article surveillance and X-ray device must have a minimum throughput rate of 600 packages per hour and be rated for continuous operation. The article surveillance and X-ray device must meet the requirements of 21 CFR 1020, Section 1020.40.

2.10.1.1 Size and Weight

The article surveillance and X-ray device is not to exceed 3.1 m long, by 1.02 m wide, by 1.5 m high 120 inches long, by 40 inches wide, by 60 inches high and not weigh more than 910 kg 2000 pounds.

2.10.1.2 Local Audible Alarms

Provide local audible alarm annunciation and automatic threat alert based upon an adjustable contrast and a surface area threshold setting. Immediately communicate to and annunciate alarms generated by the article surveillance and X-ray device at the SCC.

2.10.1.3 Maximum Package Size

Allow inspection of packages and other articles up to 380 mm tall, by 610 mm wide and 1.5 m long 15 inches tall, by 24 inches wide, and 60 inches long.

2.10.1.4 X-Ray Tube

Output from the X-ray tube is to be able to penetrate steel up to 3.2 mm 1/8 inch thick.

2.10.1.5 Electrical

The article surveillance and X-ray device is to operate from the power source as indicated.

2.10.1.6 Safety

Include dual lead-lined curtains at the entrance and exit to the conveyer system package scanning region. The radiation exposure to operator for each package inspection must be no more than 0.2 milli-roentgens. The article surveillance and X-ray device is not to adversely affect magnetic storage media as it is passed through the device.

2.10.1.7 Display

Use a standard 525 line [LCD] [LED] monitor to present X-ray data to the article surveillance and X-ray device operator. Configure the article surveillance and X-ray device to provide at least 64 gray scale shades or at least 64 distinct colors. The article surveillance and X-ray device is to provide:

a. Image enhancement

b. Zoom

c. Pan

d. Split screen

e. Freeze-frame capabilities

2.10.1.8 Conveyor

Provide article surveillance and X-ray device with a conveyor system with foot switch controls. The conveyor is to be reversible and suitable for intermittent operation with a minimum speed range of 0 to 0.18 m per second 0 to 35 feet per minute.

2.10.1.9 Material Identification and Resolution

The article surveillance and X-ray device is to be able to detect and identify the full range of ferrous and non-ferrous metals, plastics, and other contraband as required. The device resolution, including its display, is to be sufficient to identify a 30 AWG solid copper wire.

2.10.2 Metal Detector

a. The metal detector is to function as a sensor or detector subsystem and connect to the local processors and alarm monitoring. The metal detector is to be rated for continuous operation. The metal detector is to use an active pulsed or continuous wave induction detection field.

b. The metal detector is to create a field detection pattern with no holes or gaps from top to bottom and across the passage area and provide 100 percent Faraday shielding of the sensor coil. The metal detector is to incorporate measures to minimize false alarms from external sources. Provide a synchronization module to allow simultaneous multiple metal detection subsystem operation, with no sensitivity or function degradation, when separated by 1.5 m 5 feet or more.

c. The metal detector is not to adversely affect magnetic storage media.

d. When incorporated into an entry booth, the metal detector is to be physically compatible with the entry booth configuration and connected to the entry booth local processor subsystem.

2.10.2.1 Size and Weight

Freestanding metal detectors are not to exceed 1.0 m deep, by 1.3 m wide, by 2.3 m high 40 inches deep, by 50 inches wide, by 90 inches high and weigh 160 kg 350 pounds or less. Metal detectors to be used in entry control booths may have dimensions as needed to fit inside the entry control booth.

2.10.2.2 Local Alarms

Provide metal detector with local audible and visual alarm annunciation that are also immediately communicated to and annunciated at the SCC.

2.10.2.3 Material Identification and Sensitivity

Provide metal detector with a continuously adjustable sensitivity control which allows it to be set to detect 100 grams of ferrous or non-ferrous metal placed anywhere on or in an individual's body.

2.10.2.4 Traffic Counter

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NOTE: If traffic counters are not required, eliminate this paragraph.

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Include a built-in traffic counter with manual reset capability. The traffic counter is to be sensor actuated and automatically increment each time a person passes through the metal detector. The metal detector is also to provide visual prompts directing the individual to proceed through the metal detector at the proper time or to wait until the metal detector is reset and ready for another scan.

2.10.2.5 Electrical

The metal detector must not dissipate more than 250 Watts. Neither the metal detector's sensitivity nor its functional capability is to be adversely affected by power line voltage variations of plus or minus 10 percent or less from nominal values.

2.11 BACKUP POWER

a. Intrusion alarms are not to be generated because of power switching; however, Provide a power switching indication and on-line source at the alarm monitor.

b. The system is to automatically switch back to the primary source upon primary power restoration. Detect and report failure of an on-line battery as a fault condition. Power products must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

c. Provide backup power to the primary power by [backup batteries in each element or subsystem] [uninterruptible power supply (UPS)].

[2.11.1 Uninterruptible Power Supply (UPS)

Backup power required for uninterrupted ESS operation [until a diesel engine generator set can assume the full load] is to be provided by a UPS.

The UPS is to consist of a rectifier, battery and support racks, a static inverter, static switch transfer, and a manual bypass switch. Provide UPS with a continuous output to supply the maximum load requirements of the ESS. Size the battery to sustain the UPS at full rated load [for [8] [24] [_____] hours] [for 15 minutes] [until diesel engine generator set can assume the load] [_____]. [The UPS is to be in accordance with Section 26 33 53 STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS).]

][2.11.2 Batteries

Provide backup by dedicated batteries in remotely located system elements including individual sensors or control units. Batteries are to be an integral part of dispersed system elements when radio frequency (RF) operation is required. Batteries are to be capable of operation in any position and be protected against venting caustic chemicals or fumes within an equipment cabinet. Provide batteries capable of continuous operation for up to [8] [24] [_____] hours without recharge or replacement.

]2.12 SURGE SUPPRESSION DEVICES

Comply with requirements in Section 33 82 00 TELECOMMUNICATION OUTSIDE PLANT (OSP).

2.12.1 Powerline Surge Protection

Power Line Surge Protection Equipment connected to alternating current circuits must be protected from power line surges. Equipment protection must withstand surge test waveforms described in IEEE C62.41.1 and IEEE C62.41.2. Fuses must not be used for surge protection.

2.12.2 Powerline Sensor Device Wiring and Communication Circuit Surge Protection

Sensor Device Wiring and Communication Circuit Surge Protection Inputs must be protected against surges induced on device wiring. Outputs must be protected against surges induced on control and device wiring installed outdoors and as shown. Communications equipment must be protected against surges induced on any communications circuit. Cables and conductors, except fiber optics, which serve as communications circuits from console to field equipment, and between field equipment, must have surge protection circuits installed at each end. Protection must be furnished at equipment, and additional triple electrode gas surge protectors rated for the application on each wire line circuit must be installed within 1 m 3 feet of the building cable entrance. Fuses must not be used for surge protection. The inputs and outputs must be tested in both normal mode and common mode using the following two waveforms:

a. A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 Volts and a peak current of 60 Amperes.

b. An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 Volts and a peak current of 500 Amperes.

2.13 COMPONENT ENCLOSURE

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NOTE: Designer will show on the drawings which specific enclosure is needed. Show metallic enclosures for both standard installations and high security areas.

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Alarm enclosures with a tamper switch(es). Refer to paragraph TAMPER SWITCHES. Enclosures is to be formed and assembled to be sturdy and rigid. These include:

a. Consoles

b. Annunciator housings

c. Power supply enclosures

d. Sensor control and terminal cabinets

e. Control units

f. Wiring gutters

g. Other component housings

2.13.1 Interior Sensor

Provide sensors to be used in an interior environment with a housing that provides protection against dust, falling dirt, and dripping noncorrosive liquids. Refer to paragraph INTERIOR ENCLOSURES for enclosure ratings.

2.13.2 Exterior Sensor

Provide sensors to be used in an exterior environment with a housing that provides protection against windblown dust, rain and splashing water, and hose directed water. Sensors are not to be damaged by the ice formation on the enclosure. Refer to paragraph "Exposed-to-Weather Enclosures" and "Corrosion-Resistant Enclosures" for enclosure ratings.

2.13.3 Interior Enclosures

Enclosures to house equipment in an interior environment must be housed in a metallic enclosure and meet the requirements of NEMA 250 Type [12] [1] [____].

2.13.4 Exposed-to-Weather Enclosures

Enclosures to house equipment in an outdoor environment must be housed in a metallic enclosure and meet the requirements of NEMA 250 Type [3R] [4] [4X] [____].

2.13.5 Corrosion-Resistant Enclosures

Enclosures to house equipment in a corrosive environment must be housed in a metallic enclosure and meet the requirements of NEMA 250 Type 4X.

2.13.6 Hazardous Environment Equipment

All system electronics to be used in a hazardous environment must be housed in a metallic enclosure which meets the requirements of paragraph HAZARDOUS LOCATIONS.

2.13.7 Metal Thickness

Thicknesses of metal in cast and sheet metal enclosures of all types must be not less than those listed in Tables 8.1, 8.2, and 8.3 of UL 1610 for alarm components, and NEMA ICS 2 and NEMA ICS 6 for other enclosures. Sheet steel used in enclosure fabrication is to be at least 16 gauge; consoles are to be at least 18 gauge.

2.13.8 Doors and Covers

a. Doors and covers are to be flanged. Provide tight pin hinges or the ends of hinge pins are to be tack welded to prevent ready removal where doors are mounted on hinges with exposed pins.

b. Provide doors having a latch edge length of less than 600 mm 24 inches with a single lock. Provide the door with a three-point latching device with lock where latch edge of a hinged door is 600 mm 24 inches or more in length; or alternatively with two locks, one located near each end.

c. Covers of pull and junction boxes provided to facilitate initial installation of the system need not be provided with tamper switches if they contain no splices or connections, but must be protected by permanently affixing the covers in place or by tamper resistant security fasteners. Labels must be affixed to such boxes indicating they contain no connections.

2.13.9 Ventilation

Ventilation openings in enclosures and cabinets must conform to requirements of UL 1610.

2.13.10 Mounting

Sheet metal enclosures are to be rated for wall mounting with top hole slotted, unless otherwise indicated. Mounting holes are to be in positions which remain accessible when major operating components are in place and door is open and be inaccessible when door is closed.

2.13.11 Labels

Junction Boxes utilized for ESS and ESS system connections must be labeled with "ESS".

2.13.12 Test Points

Provide readily visible and accessible with minimum disassembly of equipment to test points, controls, and other adjustments inside enclosures. Test points and other maintenance controls must be readily accessible to operator personnel.

2.14 EQUIPMENT RACK

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NOTE: The designer will provide a drawing showing the amount of rack space needed for the rack mounted IDS, ACS,and VSS equipment, and placement of the equipment in the rack. Coordinate the IDS, ACS, and VSS equipment rack with actual equipment being installed.
****

Provide standard 483 mm 19 inch electronic rack cabinets conforming to UL 50 for the ESS system at the SCC and remote control and monitoring sites as shown on the drawings. Equipment rack must be in accordance with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.14.1 Labels

Provide a labeling system for cabling as required by TIA-606 and UL 969. Provide stenciled lettering for voice and data circuits using [thermal ink transfer process][laser printer] [_____].

2.15 LOCKS AND KEY LOCK

****
NOTE: Either round key or conventional key type locks are acceptable for use. Selection should be based on hardware availability at the time of design and the requirements for matching locks currently in use at the site. If the locks do not have to be matched to locks in use, and the designer has no preference, all brackets may be removed.
****

2.15.1 Lock

Provide locks on system enclosures for maintenance purposes that meet UL 437 and are [round-key type, with three dual, one mushroom, and three plain pin tumblers] [or] [conventional key type lock having a five-cylinder pin and five-point three position side bar combination]. Keys must be stamped "U.S. GOVT. DO NOT DUP.". Keys are only to be withdrawn when in the locked position. Key all maintenance locks alike and furnish only two keys for all of these locks.

2.15.2 Key-Lock Operated Switches

All key-lock-operated switches required to be installed on system components are to be UL 437, [with three dual, one mushroom, and three plain pin tumblers,] [or] [conventional key type lock having a five-cylinder pin and five-point three position side bar combination]. Keys must be stamped "U.S. GOVT. DO NOT DUP.". Key-lock-operated switches are to have two positions, with the key removable in either position. Key all key-lock-operated switches differently and furnish only two keys for each key-lock-operated-switch.

2.15.3 Construction Locks

Use a set of temporary locks during installation and construction. Do not include any of the temporary locks in the final set of locks installed and delivered to the Government.

2.16 FIELD FABRICATED NAMEPLATES

Nameplates must comply with ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device as specified or as indicated on the drawings. Each nameplate inscription is to identify the function and, when applicable, the position.

Nameplates are to be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface is to be matte finish. Corners are to be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 by 65 mm 1 by 2.5 inches. Provide lettering a minimum of 6.35 mm 0.25 inch high normal block style. Nameplates are not required for devices smaller than 25 x 75 mm 1 x 3 inches.

2.16.1 Manufacturer's Nameplate

Each item of equipment is to have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.17 FACTORY APPLIED FINISH

Electrical equipment is to have factory-applied painting systems which meets the requirements of the NEMA 250 corrosion-resistance test as a minimum.

PART 3 EXECUTION

3.1 INSTALLATION

Install the system in accordance with safety and technical standards NFPA 70, UL 681, UL 1037, and UL 1076. Configure components within the system with appropriate service points to pinpoint system trouble in less than 20 minutes.

****

NOTE: Electric metallic tubing (EMT) may be considered for use if it is used solely within the secure protected area.

****

Install all system components, including any equipment that is furnished by the Government, and appurtenances in accordance with the manufacturer's instructions, NFPA 70 and as shown on the drawings, and furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

3.1.1 Existing Equipment

Connect to and utilize existing equipment, control signal transmission lines, and devices as shown on the drawings. Any equipment and signal lines that are usable in their original configuration without modification may be reused with Government approval.

Make written requests and obtain approval prior to disconnecting any signal lines and equipment that creates equipment outage. Such work can proceed only after receiving Government approval of these requests. If any device fails after work has commenced on that device, signal, or control line, diagnose the failure and perform any necessary corrections to the equipment. The Government is responsible for maintenance and repair of Government equipment. The Contractor will be held responsible for repair costs due to negligence or abuse of Government equipment on their part.

3.1.2 Software Installation

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NOTE: Coordinate Software Installation with Government's cybersecurity requirements and interpretations.

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Load software as specified and required for an operational system, including databases and specified programs. Provide original and backup copies on [optic discs] [_____] of all accepted software, including diagnostics, upon successful endurance test completion.

3.1.3 Enclosure Penetrations

Enclosures are to be penetrated from the bottom unless shown otherwise. Penetrations of interior enclosures having transitions of conduit from interior to exterior, and penetrations of exterior enclosures are to be sealed with rubber silicone sealant to preclude the entry of water. Terminate conduit risers in a hot-dipped galvanized metal cable terminator that is filled with a sealant as recommended by the cable manufacturer, and in a manner that does not damage the cable.

3.1.4 Cable and Wire Runs

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NOTE: Design requirements must conform to NFPA 70, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and ICS 705-1.

****

Perform required cable and wire routings per NFPA 70 [and] [Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM,] [ICS 705-1], and as specified. Terminate conduits including flexible metal and armored cable in the sensor or device enclosure. Fit ends of conduit with insulated bushings. Exposed conductors at ends of conduits external to sensors and devices are not acceptable.

3.1.5 Soldering

Soldered electrical connections must use composition Sn60, Type AR or S, for general purposes; use composition Sn62 or Sn63, Type AR or S, for special purposes. Flux must conform to ASTM B32 when Type S solder is used for soldering electrical connections.

3.1.6 Galvanizing

Ferrous metal is to be hot-dip galvanized in accordance with ASTM A123/A123M. Provide screws, bolts, nuts, and other fastenings and supports that are corrosion resistant.

Field welds or brazing on factory galvanized boxes, enclosures, conduits, and so on, are to be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

3.1.7 Conduits

****

NOTE: Design requirements for interior conduits must conform to NFPA 70, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and ICS 705-1. Design requirements for exterior conduits must conform to NFPA 70, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and ICS 705-1.

****

Install interior conduits in accordance with NFPA 70, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and ICS 705-1. Install exterior conduits in accordance with NFPA 70, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and ICS 705-1.

3.1.8 Underground Cable Installation

Install underground conductors connecting protected structures and objects to the central alarm updating and display unit as direct burial or in conduit in accordance with Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Coaxial cable cannot be spliced.

3.1.9 Exterior Fences

****

NOTE: Coordinate this requirement with requirements of Section 32 31 13 CHAIN LINK FENCES AND GATES; 32 31 13.53 HIGH-SECURITY FENCES (CHAIN LINK AND ORNAMENTAL) AND GATES.

****

Prepare [existing fence] [new fence installation] to ensure a rigid fence system for fence-mounted detection system installation or a detection system where loose fence fabric might prove troublesome. A rigid fence and fence fabric must be provided to minimize nuisance alarms. Fences are to be additionally braced, provided with fabric ground anchors or curbs, tensioning devices, top or bottom rails or both, soft-seated gate latches, and re-anchored outriggers for barbed wire to ensure a vibration-free installation. Relocate large, fence-supported signs to separate support posts to preclude interference with fence detection systems.

3.1.10 Camera Housings, Mounts, and Poles

****

NOTE: Designer will specify correct Section numbers for concrete camera pole foundations, electrical work, and control signal cable.

****

a. Provide a foundation for each camera pole as specified and designed.

b. Provide a ground rod for each camera pole and connect the camera pole to the ground rod [as shown on the drawings] [in accordance with Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.]

3.1.11 Field Applied Painting

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting must be in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.1.12 Bonding, Grounding, and Shielding

Provide in accordance with TIA-607 and NFPA 70. Provide ground rods, bonding conductors, and grounding busbars in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

****

NOTE: General requirements for grounding, bonding and shielding are contained in MIL-STD-188-124B and MIL-HDBK-419A. Designer will ensure that proper grounding, bonding, and shielding is provided to all security equipment.

****

3.1.12.1 Grounding

Provide a ground system that consists of the earth electrode and lightning protection, surge protection, fault protection and signal reference subsystems.

3.1.12.1.1 Earth Electrode Subsystem

Provide an earth electrode subsystem that provides a path of low resistance to earth for lightning and power fault currents.

3.1.12.1.1.1 Ground Rod

Provide ground rods as needed. Ground rods must be [copper clad galvanized] [stainless steel], a minimum of [3.0] [_____] m [10] [_____] foot in length and not less than [19.1] [_____] mm [3/4] [_____] inch in diameter. Install ground rods vertically with the top at least [304.8] [_____] mm [12] [_____] inches below grade. The resistance to earth should not exceed 10 ohms for any ground rod location supporting an electronic sensor. Consider alternate methods for reducing the resistance to earth where 10 ohms cannot be obtained due to high soil resistivity, rock formations, etc.

3.1.12.1.1.2 Perimeter Fence

Ground perimeter animal control or security fences for personnel safety and to minimize the potential for equipment damage caused by lightning strikes. Ground sensored fences with ground rods at every sensor post supporting an electronic sensor. Ground fences with no electronic security equipment with ground rods at intervals of 198.12 meters 650 feet. Ground all fences on each side of all gates, at each corner, or change in fence direction, at points 45.72 meters 150 feet on each side of high tension wiring crossings, and at the closest approach to any building located within 15.24 meters 50 feet of the fence. For all fences, bond a #2 AWG copper wire to the fence post, bottom steel tension wire, and ground rod. Bonding will be in accordance with MIL-HDBK-419. Bond ground straps to posts and ground rods by exothermic welding or brazing. Bond hinged gates to gate posts. Ensure each bend in the copper cable is gradual and does not exceed a radius of 203.2 mm 8 inches. The angle of any bend will not be less than

90 degrees. The fence to earth ground will not exceed 10 ohms. Non-electronic, sensored fences may be grounded to 25 ohms.

3.1.12.1.1.3 Field Distribution Boxes (FDBs)

Ground each FDB with a grounding rod, which will be commonly bonded with power and sensor ground in the FDB on a common ground bus. Verify that all paint and or foreign substance that would preclude continuity of the signal path has been removed when securing a ground bus/strip. Attach the FDB ground wire to the grounding rod by exothermic welding.

3.1.12.1.1.4 Towers and Structures

****

NOTE: NFPA 70 and MIL-HDBK-419A provide design guidance on protection of structures and surge protection for equipment.

****

Provide security alarm monitoring facilities that contain major concentrations of security equipment such as consoles with a lightning protection system including air terminals, down conductors, surge arrestors and station grounds, all connected to a common counterpoise system.

3.1.12.2 Surge Protection Subsystem

3.1.12.2.1 Exterior Equipment

Provide lightning surge protection for exterior sensor equipment, Field Distribution Boxes, and camera equipment. Provide surge protection on input and output circuits of field equipment boxes to protect transponders and power supplies.

3.1.12.2.2 Interior Equipment

Ground interior sensor surge protection devices to an existing facility ground provided the ground is thoroughly checked for integrity. If a proper facility ground is not available, install a code compliant ground in accordance with the National Electric Code.

3.1.12.2.3 Fault Protection Subsystem

****

NOTE: The fault protection subsystem consists of a separate grounding conductor to provide protection to personnel and equipment from static charge buildup and electrical faults.

****

Install a fault protection subsystem that provides a conductive path between the earth electrode subsystem and all exposed metal parts of electrical enclosures. Provide fault protection for exterior and interior equipment by means of an equipment-grounding conductor routed from the equipment to the AC power distribution panel.

3.1.12.2.4 Signal Reference Subsystem

****

NOTE: This interior subsystem is that part of a

ground system that is used to provide a ground reference plane for all signal paths. It is used essentially to control noise.

****

Install a proper Signal Reference Subsystem for security systems in accordance with MIL-HDBK-419. Bond all security equipment cases or cabinets to the equipotential planes by the shortest and most direct route.

3.1.12.3 Bonding

****

NOTE: Bonding is essential in all circuits, both communications and power, as well as in lightning protection, where conductors must be joined. The engineer must specify bonding requirements per MIL-STD-188-124 and MIL-HDBK-419A.

****

Provide bonding by [welding] [brazing] [clamping] in accordance with MIL-STD-188-124 and MIL-HDBK-419.

3.1.12.4 Shielding

****

NOTE: Shielding prevents the security equipment or cabling from propagating interference and also protects it from similar effects by other electrical or electronic systems. It is the engineers' responsibility to specify the proper type of shielding to be used for security equipment and cabling, and to adhere to standards in MIL-HDBK-419A.

****

Provide [_____] shielding in accordance with the standards in MIL-HDBK-419.

3.1.13 Nameplate Mounting

Provide nameplate number, location, and letter designation as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or rivets.

3.2 ADJUSTMENT, ALIGNMENT, SYNCHRONIZATION, AND CLEANING

a. Clean each system component of dust, dirt, grease, or oil incurred during and after installation or accrued subsequent to installation from other project activities subsequent to installation.

b. Prepare for system activation by manufacturer's recommended procedures for adjustment, alignment, or synchronization.

c. Prepare each component in accordance with appropriate provisions of component installation, operations, and maintenance manuals.

d. Remove large vegetation that may sway in the wind and touch fencing.

e. Adjust sensors so that coverage is [overlapping and] maximized without mutual interference.

3.3 SYSTEM STARTUP

Do not apply power to the system until after:

a. Set up system equipment items and communications in accordance with manufacturer's instructions.

b. Conduct a system visual inspection to ensure that defective equipment items have not been installed and that there are no loose connections.

c. Test and verify system wiring as correctly connected.

d. Verify system grounding and transient protection systems as properly installed.

e. Verify the correct voltage, phasing, and frequency of the system power supplies.

Satisfaction of the requirements above does not relieve the contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as result of Contractor work or equipment.

3.4 SUPPLEMENTAL CONTRACTOR QUALITY CONTROL

****

NOTE: The Contractor quality control requirements for all electronic security projects, as stated in 01 45 00 QUALITY CONTROL, must be included in contracts, regardless of increase in project cost. Normally this Contractor quality control requirement is applicable to projects in excess of $1,000,000.

****

Provide the services of technical representatives who are familiar with all components and installation procedures of the installed system; and are approved by the Contracting Officer. These representatives are to be present on the job site during the preparatory and initial phases of quality control to provide technical assistance. These representatives are also to be available on an as needed basis to aid with follow-up phases of quality control. These technical representatives are to participate in the system testing and validation and provide certification that their respective system portions meet the contractual requirements.

The above requirements supplement the quality control requirements specified elsewhere in the contract.

3.5 ESS SYSTEM TESTING

All ESS Testing requirements are specified in Section 28 08 10 ELECTRONIC SECURITY SYSTEM ACCEPTANCE TESTING.

3.6 ESS TRAINING

Conduct training courses for [10] [_____] designated personnel in system maintenance and operation. Coordinate training with the Government. The training is to be oriented to the specific system being installed. Training content is to include training manuals and audio-visual materials. Deliver training manuals for each trainee with 2 additional copies delivered for archiving at the project site. The manuals are to include an agenda, defined objectives for each lesson, and a detailed subject matter description for each lesson.

Furnish audio-visual equipment and other training materials and supplies. Deliver copies of the audio-visual materials to the Government either as a part of the printed training manuals or on the same media as that used during the training sessions when course portions are presented using audio-visual material.

3.6.1 ESS Training Outline

****

NOTE: The designer will coordinate the training requirements with the installation and designate the number of persons to be trained.

****

Submit a training plan for the training phases, including type of training to be provided, outline of training manuals, training course agendas, and a list of reference material, for Government approval.

3.6.2 Typical Training Day

A training day is defined as:

a. Eight hours of classroom instruction, with

    (1) Two 15-minute breaks

    (2) One hour lunch break

b. Conducted:

    (1) Monday through Friday

    (2) During the daytime shift in effect at a government-provided training facility

For guidance in planning the required instruction, assume that attendees will have a high school education or equivalent, and are familiar with ESS. Approval of the planned training schedule is to be obtained from the Government at least 30 days prior to the training.

3.6.3 ESS Administrator Training

a. ACS and IDS Administrator Training includes:

    (1) [Two] [_____] eight-hour on-site training sessions

    (2) Operating system procedures and configuration

    (3) Operator functions

    (4) Database functions and setup

    (5) Card holder input and deletion procedures

    - (6) Report generation
    - (7) Applications programs (as applicable)
    - (8) Graphics generation and manipulation
    - (9) Items unique to the ACS and IDS interfaces with other systems
    - (10) System backup and restore

- b. VSS Administrator Training includes:
    - (1) [One] [_____] eight-hour session on site
    - (2) Training is to include all administrator and operator functions, and items unique to the installed VSS, and interfaces with other systems.

3.6.4 ESS Operator Training

Coordinate the operator training syllabus with the Government prior to conducting operator training.

- a. ACS and IDS Operator Training includes:
    - (1) [Four] [_____] (one-day) [8] [_____] hour on-site training sessions
    - (2) System operating procedures
    - (3) System configuration orientation
    - (4) Alarm acknowledgment
    - (5) Alarm response logging
    - (6) Graphics functionality
    - (7) Items unique to the ACS and IDS interfaces with other systems
- b. VSS Operator Training includes:
    - (1) [Two] [_____] (one-day) [8] [_____] hour on-site training sessions
    - (2) System operating procedures
    - (3) System configuration
    - (4) Video call-up
    - (5) Camera and monitor control
    - (6) Graphics functionality
    - (7) Basic device terminology and troubleshooting

3.6.5 Maintenance Personnel Training

The system maintenance course is to be taught at the project site after endurance test completion for a period of five training days. A maximum of

[five] [_____] personnel, designated by the Government, will attend the course. The training includes:

a. Physical layout of each piece of hardware.

b. Troubleshooting and diagnostics procedures of each piece of hardware.

c. Component repair and replacement procedures of each piece of hardware.

d. Maintenance procedures and schedules to include system testing after repair of each piece of hardware.

e. Calibration procedures of each piece of hardware. Upon course completion, the students are to be proficient in system maintenance.

f. Review of site-specific drawing package, device location, communication, topology, and flow.

3.6.6 Follow-up Training

a. Provide [One] [two] [_____] hour training session each month for [two] [_____] months after initial training.

b. Follow-up training is to begin one month after initial training.

c. Training is to include testing for system competence.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-28 20 02 (November 2008)**

Preparing Activity: USACE **Superseding**
UFGS-13729 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-28 20 02 (November 2008)**

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SECTION 28 20 02

CENTRAL MONITORING SERVICES FOR ELECTRONIC SECURITY SYSTEMS
11/08

****

NOTE: This guide specification covers the requirements for central monitoring services for electronic security systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification specifies monitoring facility criteria. This specification does not cover requirements pertaining to the installation of alarm systems at a protected site monitored by a central monitoring facility.

A monitoring facility, as used in this document, is a building, an office, or a suite of offices that houses the security system central station and monitoring personnel. In this type system, the operation of alarm devices and electrical circuits is automatically signaled to, recorded, maintained, and supervised from a central station with persons in attendance at all times. These persons monitor

the signals and dispatch the response force to any unauthorized entry into the protected area. Connection of alarm equipment to the central monitoring facility may be over leased telephone company lines.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEFENSE INTELLIGENCE AGENCY (DIA)

DIA DCID 6/9	(2002) Physical Security Standards for Sensitive Compartmented Information Facilities

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 5100.76-M	(2012; Change 1-2018; Change 2-2020) Physical Security of Sensitive Conventional Arms, Ammunition, and Explosives
DOD 5220.22-M	(2006; Change 1-2013; Change 2-2016) National Industrial Security Program Operating Manual (NISPOM)

UL SOLUTIONS (UL)

UL 827	(2022; Reprint Oct 2023)UL Standard for Safety Central-Station Alarm Services
UL 1981	(2014; Reprint Mar 2023) Standard for Central Station Automation Systems

UL 2050	(2003; 4th Edition) Standard for National Industrial Security Systems for the Protection of Classified Materials (limited distribution publication, direct purchase request with justification to UL)

1.2 SUMMARY

1.2.1 General System Description

Provide central monitoring services, including associated facilities, equipment, appurtenances and trained personnel for the service of remotely monitoring alarm systems and taking actions as appropriate. Furnish central monitoring facility capable of monitoring security related alarm systems and in compliance with UL 827 and UL 2050. Provide staff for central monitoring facility and operate at all times.

[1.2.2 Redundant Monitoring Facility

****

NOTE: A redundant monitoring facility is typically not necessary. Facilities meeting UL requirements, have redundancy on critical systems and are inherently reliable. However, requiring a redundant facility would allow signals to be rerouted in the event of a disaster at the primary monitoring facility with the break in the continuity of monitoring service being minimized. Requiring a redundant monitoring facility should be based on the importance of the protected site. Designer should confirm with the owner of the protected site as to whether a redundant monitoring facility is required.

Practices that are currently in use in the alarm industry would route alarm signals to a facility that is staffed and operating. Thus, it is unnecessary to permit an extensive break in the continuity of monitoring service. The designer should consider what length of time is acceptable for a break in the continuity of monitoring service based on the protected site being monitored.

****

Provide a redundant monitoring facility in addition to the primary monitoring facility in the event that the primary monitoring facility is disabled. In that case, reroute all alarm signals to the redundant monitoring facility such that there is [no] [less than a 15 minute] [less than a thirty minute] [_____] break in the continuity of monitoring service. When manned, meet the requirements covered in this specification for the primary monitoring facility.

]1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Hiring Practices Outline; G, [_____]

Central Station Operator Certificates; G, [_____]

In-House Training Outline; G, [_____]

Alarm History Report; G, [_____]

UL Certificate of Compliance; G, [_____]

Notarized Affidavit; G, [_____]

Proof of Insurance; G, [_____]

Operating Procedure Plan; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Monitoring Facility Personnel Hiring Practices

****

NOTE: Hiring practices are typically incorporated

that lead to employing upstanding and reliable personnel.

****

Demonstrate the existence of a pre-hire screening process. Satisfactory results for each segment of the screening process is a requirement for any employment opportunity. At a minimum, include the following segments in the process:

a. felony conviction screening
b. drug screening
c. previous employment statement verification
d. [a two-year degree]

Submit a hiring practices outline detailing the pre-hire screening practices currently in place.

1.4.2 Monitoring Facility Operator Qualifications

Provide qualified monitoring facility operators assigned to monitor alarms under this contract as specified in this section.

1.4.2.1 Central Station Operator Certificates

Demonstrate that monitoring facility operators are Security Industry Association (SIA) trained and certified as Central Station Operators. Submit the monitoring facility operators' current Central Station Operator Certificates verifying that each monitoring facility operator has completed and passed the SIA Central Station Operator course.

1.4.2.2 In-House Training

Train monitoring facility operators on facility specific equipment and policies. Submit an in-house training outline detailing facility specific training requirements that each monitoring facility operator must complete.

1.4.3 Regulatory Requirements

****

NOTE: UL 827, Central Station Alarm Services is the UL standard that covers central monitoring facilities. Under UL 827, three categories exist. Each category is identified by its UL Category Control Number (CCN). The categories and their respective CCN are as follows:

Protective Signal Services - Central Station (UUFX)
Burglar Alarm Systems - Central Station (CPVX)
Monitoring Station, Residential (CVSU)

Where the asset(s) to be monitored consist(s) only of one or any combination of the following three cases, omit the paragraph below and include paragraph titled: Central Monitoring of High Security Assets, below.

1. The asset(s) is(are) under the authority of the National Industrial Security Program.

2. The asset(s) is(are) Sensitive Compartmented Information.

3. The asset(s) is(are) Arms, Ammunition and Explosives.

****

All alarms monitored under this contract must be received and handled on systems and at facilities that are in compliance with regulatory requirements specified in this section.

1.4.3.1 Security Alarm Systems

Provide a monitoring facility that is in compliance with UL 827, Central Station Alarm Services. Determine compliance by a UL-Listing in any of the following three categories:

a. UUFX (Protective Signal Services - Central Station)
b. CPVX (Burglar Alarm Systems - Central Station)
c. CVSU (Monitoring Station, Residential)

Substantiate UL-Listing in any of the above categories by submitting the associated UL Certificate of Compliance.

1.4.3.2 Central Monitoring Facility Staffing

****

NOTE: UL reviews the actions taken in response to alarm signals generated by UL certificated alarm systems. UL does not review the handling of alarm signals that are not generated from UL certified alarm systems. UL only addresses alarm signals from non-certified alarm systems if they interfere with the handling of alarm signals from UL certified alarm systems. The handling of alarm signals is affected by the central monitoring facility staffing. Specify an alarm history report be submitted prior to selecting a central monitoring facility to verify that the monitoring facility is staffed such that all alarms have been acknowledged and a response to the alarm has been initiated within 45 seconds per UL 1981.

Select item "a." to require compliance to the 45 second staffing requirement. Select item "b." to exceed the 45 second staffing requirement and specify a new time in the blank space provided.

****

UL 1981 requires monitoring facility staffing be such that all alarm signals be acknowledged and the appropriate dispatch or verification action be initiated not more than 45 seconds after the monitoring facility receiver acknowledges to the alarm panel at the protected site that the alarm signal has been received (receiver kiss-off signal).

[a. Provide staffing at the central monitoring facility in compliance with UL 1981.]

[b. Provide staffing at the central monitoring facility exceeding requirements in UL 1981. Acknowlege all alarm signals be acknowledged and initiate the appropriate dispatch or verification action no more than [_____] seconds after the monitoring facility receiver acknowledges to the alarm panel at the protected site that the alarm signal has been received (receiver kiss-off signal).]

Submit an alarm history report listing all alarms received on [specify unannounced date here] between [specify start time here] and [specify end time here]. Include the date, time, and type (such as burglar, panic, trouble) of each received alarm signal as well as the date and time at which the operator initiated a response (such as verification or dispatch) in the report.

[1.4.3.3 Central Monitoring of High Security Assets

****

NOTE: Requirements related to equipment at the protected site as well as data transmission and response forces are not within the scope of this guide specification. The DCID 6/9, NISPOM and the AA&E manual provide requirements for all aspects of a security system including installation guidelines, maintenance, and testing of equipment installed at a protected site as well as requirements for monitoring facility operations and staffing.

Note that inclusion of the paragraph below does not require compliance with the selected government security document in its entirety (i.e. it does not invoke requirements related to equipment at the protected site). However, designer must ensure that the alarm equipment installed at the protected site complies with regulatory and UL 2050 requirements.

The paragraph below should only be included when it is mandatory that the monitoring facility meet requirements of the DCID 6/9, NISPOM, or the AA&E manual.

****

Submit a notarized affidavit attesting to compliance with either of the following referenced standards:

a. UL 827 and the requirements of UL 2050, section 7, and of [DIA DCID 6/9] [DOD 5220.22-M, NISPOM] [DOD 5100.76-M, AA&E Manual] as applicable to the monitoring facility only, or

b. UL 2050, section 6, and of [DIA DCID 6/9] [DOD 5220.22-M, NISPOM] [DOD 5100.76-M, AA&E Manual] as applicable to the monitoring facility only when the area being monitored is [under the authority of the National Industrial Security Program] [Sensitive Compartmented Information] [Arms, Ammunition and Explosives].

]1.4.4 Insurance

Contractor is required to carry not less than $1,000,000 in general liability insurance,including coverage for omissions and errors. Submit proof of insurance.

1.4.5 Procedure Development Conference

Hold a procedure development conference, prior to the start of alarm signal monitoring. The purpose of this conference is to establish a clear understating of step-by-step instructions for handling each type of alarm signal to be monitored under this contract. Include, at a minimum, a facility manager of the monitoring facility and appropriate Government personnel. Include the following topics for discussion: alarm signal types and the corresponding operator actions, the order in which operator actions are taken, Government contact information and alternate Government contact information. Other topics for discussion may include: when cancel codes are required, alarm log content, how often an alarm log will be submitted, what signals are to be flagged in the alarm log, what operator actions are to be taken if a signal fails to restore, and other topics deemed necessary by the attendees.

1.4.5.1 Scheduling and Location

Coordinate the scheduling and location of the procedure development conference. Provide notification of scheduling and location information to [the Government] [_____] [two weeks] [_____] prior to the conference date. Include the procedure development conference date, time, location, the attendees who will represent the Contractor, and their titles in notification information.

1.4.5.2 Operating Procedure Plan

****

NOTE: Select, in the paragraph below, the operating procedure plan submittal date relative to the start of alarm signal monitoring or relative to the procedure development conference.

****

[Prior to the start of alarm signal monitoring] [Within [_____] days following the procedure development conference], submit for review a comprehensive operating procedure plan detailing alarm signal types and the corresponding operator actions, the order in which the operator actions are to be taken, Government contact information, alternate Government contact information, and other relevant topics discussed at the procedure development conference.

1.4.5.3 Plan Verification

Verify [annually] [_____] with the Government, the information in the operating procedure plan, including Government contact and operating procedure information. Update and submit the verified plan to the Government.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

3.1 INTERFACE

3.1.1 Alarm Signal Format

****

NOTE: Listed below are several examples of the numerous possible alarm signal formats. Specify the alarm signal format(s) corresponding to the format(s) produced by the alarm system installed at the protected location.

****

Receive and process the following alarm signal [format] [formats].

a. [Ademco Contact ID]
b. [FBI Superfast]
c. [4+1]
d. [4+1 Extended]
e. [SIA]
f. [Radionics BFSK]

3.1.2 Communication Means

****

NOTE: Specify the primary communication means and, if used, the back-up communications means. In the blank spaces following the listed communication means indicate each as "primary" or "back-up", if used.

****

Receive alarm signals via the following communications means.

a. [dial-up network], [_____]
b. [cellular network], [_____]
c. [long-range radio network], [_____]
d. [Internet (TCP/IP)], [_____]
e. [leased line (DSL, T-1)], [_____]
f. [Local Area Network (LAN)], [_____]
g. [Wide Area Network (WAN)], [_____]

[3.2 AUDIO VERIFICATION

****

NOTE: Audio verification capabilities may be specified if an audio system will be used at the protected site.

****

Support audio alarm verification. In an alarm event, provide audio alarm verification support to establish [two-way communication with a protected site - similar to an intercom system.] [one-way communication with a protected site.] Provide audio alarm verification to determine what dispatch action(s) is (are) appropriate.

][3.3 VIDEO VERIFICATION

****

NOTE: Video verification capabilities may be specified if a video system will be used at the protected site. This specification assumes video data is not recorded at the central monitoring facility.

Presently, there are no standardized video alarm verification packages.

Use the first bracketed paragraph below if designer will specify information defining the video alarm verification package. Include information that will ensure compatibility between the protected site and the central monitoring facility.

Use the second bracketed paragraph below if Contractor is to determine video alarm verification compatibility between the central monitoring facility and the protected site.

****

Support video alarm verification. Provide video alarm verification support that transmits alarm triggered video media to the central station and used by an operator to assess pre-alarm and post-alarm video information. Use video alarm verification support to determine what dispatch action(s) is (are) appropriate. [Provide resources required to be capable of monitoring the following video alarm verification package:[_____]] [Determine compatibility with video alarm verification system to be used at the protected site.]

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-28 31 32 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-28 31 02.00 20 (February 2010)
UFGS-28 31 75.00 10 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 28 31 32

FIRE ALARM REPORTING SYSTEM, DIGITAL COMMUNICATOR TYPE

08/23

PART 1 GENERAL

PART 2 PRODUCTS

PART 3   EXECUTION

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC   **UFGS-28 31 32 (August 2023)**

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References are in agreement with UMRL dated January 2025
****

SECTION 28 31 32

FIRE ALARM REPORTING SYSTEM, DIGITAL COMMUNICATOR TYPE
08/23

****
NOTE: This guide specification covers the requirements for digital alarm communicator type fire alarm reporting systems. This section is written around the use of managed facilities-based voice network (MFVN) lines as the means of transmission. It is acknowledged that other transmission technologies are ever emerging, and sole reliance on MFVN lines is not a preferred approach under NFPA 72. Edit this specification and its contents to reflect those requirements applicable to the specific project and the chosen means of transmission.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

Interior building fire alarm systems are covered by Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE, Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE, Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, and Section 28 31 76 INTERIOR FIRE

ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE.

In 2022, discussions were held regarding which UFGS template specification sections should be developed or maintained related to fire alarm reporting systems. As a result of these discussions, the Department of Defense Fire Protection Engineering Working Group (FPEWG) determined that the technologies represented in Section 28 31 32 FIRE ALARM REPORTING SYSTEM, DIGITAL ALARM COMMUNICATOR TYPE and Section 28 31 33 FIRE ALARM REPORTING SYSTEM, RADIO TYPE were the most appropriate technologies for which to maintain template specification sections. Based on the rate at which the fire alarm reporting system industry is changing, the FPEWG decided that it was prudent to hold off on developing an additional UFGS section for other technologies (such as internet protocol type systems) until more evidence-based requirements can be developed based on real-world system experience and advancement of NFPA 72 to include more prescriptive guidance on systems using other communication technologies. This is not intended to convey that use of other technologies is discouraged or prohibited. If the Qualified Fire Protection Engineer editing this specification, in consultation with the Government's Designated Fire Protection Engineer (DFPE), determines that another communication technology is best suited to meet the needs of the project, it is recommended that he or she choose one of the two existing UFGS sections and edit that section to include all pertinent information related to the chosen alternative technology.

****

PART 1   GENERAL

1.1   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 11	(2024) Standard for Low-, Medium- and High- Expansion Foam
NFPA 12	(2025) Standard on Carbon Dioxide Extinguishing Systems
NFPA 12A	(2022) Standard on Halon 1301 Fire Extinguishing Systems
NFPA 13	(2024) Standard for the Installation of Sprinkler Systems
NFPA 17	(2024) Standard for Dry Chemical Extinguishing Systems
NFPA 17A	(2024) Standard for Wet Chemical Extinguishing Systems
NFPA 20	(2025) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 111	(2025) Standard on Stored Electrical Energy Emergency and Standby Power Systems
NFPA 170	(2024; ERTA 1 2023) Standard for Fire Safety and Emergency Symbols
NFPA 1225	(2025) Standard for Emergency Services Communications

NFPA 2001	(2025) Standard on Clean Agent Fire Extinguishing Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-570	(2024e) Residential Telecommunications Infrastructure Standard

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 514A	(2024) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings
UL 797	(2007; Reprint Apr 2023) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: Tailoring tags are used to add information specific to Computer-Aided Dispatch (CAD) systems when applicable.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

Supervisor's Qualifications; G, [_____]

Designer's Qualifications; G, [_____]

SD-02 Shop Drawings

Shop Drawings; G, [_____]

SD-03 Product Data

Digital Alarm Communicator Transmitter (DACT); G, [_____]

Digital Alarm Communicator Receiver (DACR); G, [_____]

Supervising Station Terminal; G, [_____]

Supervising Station Printer; G, [_____]

Uninterruptible Power Supply (UPS); G, [_____]

Peripheral Equipment; G, [_____]

Computer-Aided Dispatch (CAD) System; G, [_____]

SD-05 Design Data

Battery Calculations; G, [_____]

SD-06 Test Reports

Site Observation Report(s)

Test Procedures; G, [_____]

Request for Formal Inspection and Tests; G, [_____]

Final Test Report; G, [_____]

SD-07 Certificates

Current Listings or Approvals

SD-10 Operation and Maintenance Data

Operation And Maintenance Instructions; G, [_____]

SD-11 Closeout Submittals

Special Tools

Spare Parts Data

Spare Parts

As-Built Drawings; G, [_____]

Final QFPE Certification Letter

Training Certificates

Recordings

1.3 SUBMITTAL REQUIREMENTS

****

NOTE: Review Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) to ensure specific quantities and formats of submittals are included as desired. Coordinate with the DFPE and Contracting Officer on required quantities and formats to be provided.

****

Provide submittals in quantities, formats, and transmission means as dictated by Section 01 33 00 SUBMITTAL PROCEDURES. Draw floor plans to a scale no less than 1:100 1/8 inch equals 1 foot. Utilize NFPA 170 compliant symbols.

Submit Shop Drawings (SD-02), Product Data (SD-03), and Calculations (SD-05) simultaneously. Submit all Product Data as a single combined package. Partial submittals; SD-02, SD-03, and SD-05 submittals not submitted simultaneously; and submittals not fully complying with the requirements of applicable NFPA standards and this specification; are not acceptable and may be returned without review at the discretion of the Contracting Officer.

1.3.1   Submittal Schedule

Submit all Preconstruction Submittals (SD-01) within [14][_____] days following Notice to Proceed and before any other classification of submittal. Provide submittals for SD-02, SD-03,[SD-04,] and SD-05 no less than [21][_____] days prior to the proposed start of construction on the subject system. Provide other submittals as specified in other sections of this specification.

1.3.2   Shop Drawings

Provide shop drawings compliant with the Shop Drawings section of NFPA 72 and the following. Submit plan views showing system layout, including transmitting equipment, receiving equipment, interfacing equipment, terminal cabinet locations, junction boxes, other related equipment, raceway routing, wire color coding, wire counts, pathway identification in each raceway, pathway layouts, and end-of-line supervisory devices. Ensure drawings reflect the actual proposed wire and raceway routing as it will be installed in the field. Submit detailed point-to-point wiring diagrams showing all points of connection. Include connections between system devices, appliances, control panels, supervised devices, and all equipment that is activated or controlled by the panel in the diagrams. Provide mounting details for each type of transmitter. Show a single-line system riser diagram. Provide each transmitter and receiver on the riser with an identification number indicating its building number. Indicate connection of equipment by pathway runs or raceway runs.

Show data essential for proper installation of each system. Show details, plan views, elevations and sections of the systems. Submit plan view and cross-section of supervising station operations room, showing all [new and retained existing]equipment and furnishings, drawn in 1:50 1/4 inch equals 1 foot or larger scale.

1.3.2.1   Transmitter Information Table

Provide a table showing each transmitter location, telephone numbers, and the number of zones to be connected and their descriptions (for example: Bldg. 591, telephone numbers: 555-1212, 555-1213; Zone 1 - Manual Pull Station Alarm; Zone 2 - Smoke Detector Alarm; Zone 3 - Sprinkler Waterflow Alarm; Zone 4 - Sprinkler Valve Supervisory).

1.3.2.2   Receiver Capacity

Indicate the intended number of transmitters to be connected to each receiver, as well as the maximum number of transmitters that are permitted to be connected to each receiver based on system loading capacity as defined by NFPA 72.

1.3.3   Product Data

Provide manufacturer's product data sheets for each system component to be provided, including at least each item specified herein. Annotate product data sheets to indicate precise equipment that is to be provided, including an indication of all options selected.

1.3.4 Design Data

Submit battery calculations to substantiate battery capacity exceeds supervisory and alarm power requirements for digital alarm communicator transmitters (DACTs), digital alarm communicator receivers (DACRs), receiving terminals, printers, and interface panels (if provided).

1.3.5 Test Reports

Submit reports for inspections and tests specified under paragraphs titled "FIELD QUALITY CONTROL". Submit test reports in booklet form showing field tests performed to prove compliance with the specified performance criteria upon completion and testing of the installed system. Document readings, test results, and the final position of controls on each test report.

1.3.6 Certificates

Submit copies of current listings or approvals for all equipment furnished. Submit listing or approval documentation from a nationally recognized testing laboratory for transmitters, interface equipment, and receiving and control equipment showing that such equipment is listed or approved for use together as an integrated system.

1.3.7 Operation and Maintenance Manuals

Submit the Operation and Maintenance Instructions indexed and in booklet form as a single volume or in separate volumes. Inscribe the following identification on the cover: the words "FIRE ALARM REPORTING OPERATION AND MAINTENANCE MANUAL", the location of the building, the name of the Contractor, the system manufacturer, and the contract number. Provide instructions that are legible and easily read, with large sheets of drawings folded in. Provide submittals for SD-10 at least [21][_____] days prior to the proposed start of training. Do not provide training prior to approval of SD-10 submittals. Include the following in the Operation and Maintenance Instructions:

a. "Data Package Five" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and its basic operating features in each manual.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. Include raceway layout, equipment layout, and simplified wiring and control diagrams of the system as installed in each manual.

d. A list of parts and tools that should be kept in stock by the owner for routine maintenance, including the name of a local supplier and recommended service organization (including address and telephone number) for each item of equipment. Ensure that each service organization submitted is capable of providing [four-hour][[_____]-hour] on-site response to a service call on an emergency basis.

e. Complete procedures for system revision and expansion, detailing both equipment and software requirements.

f. Software for this project on Compact Disk (CD) or Digital Video Disk (DVD) media.

g. Printouts of configuration settings for all devices and appliances.

****

NOTE: Ensure that all data on routine maintenance checklist (devices, appliances, testing frequencies, etc.) complies with UFC 3-601-02: FIRE PROTECTION SYSTEMS INSPECTION, TESTING, AND MAINTENANCE.

****

h. Routine maintenance checklist arranged in a columnar format. List all installed devices and appliances in the first column, state the maintenance activity or state no maintenance required in the second column, state the frequency of the maintenance activity in the third column, and provide a fourth column for additional comments or reference.

1.3.8 As-Built Drawings

Show the system as installed, including deviations from both the Contract Drawings and the approved shop drawings. Ensure the accuracy of the as-built drawings is plus or minus 150 mm 6 inches for all devices, appliances, and equipment locations, and plus or minus 300 mm 12 inches for all raceway and wire runs.

a. Prepare the drawings in the same format, size, and layout as the approved shop drawings.

b. Include complete wiring diagrams showing connections between devices, appliances, and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices, appliances, and equipment.

1.4 SPECIAL TOOLS AND SPARE PARTS

Furnish special tools necessary for the maintenance of the equipment. Submit spare parts data for each different item of material and equipment specified, after approval of shop drawings, and not later than [60][_____] days prior to the anticipated date of beneficial occupancy. Include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after [one][_____] year[s] of service.

Furnish the following spare parts:

****

NOTE: Edit this list as desired by the contracting organization. Generally, spare parts are discouraged by UFC 1-300-02: UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS) FORMAT STANDARD, but some hard to replace or easily lost items may be

warranted for inclusion.
****

a. [Two][_____] DACTs of each configuration provided.

b. [Two][_____] DACRs of each configuration provided.

c. [Two][_____] DACT interface devices of each configuration provided.

d. [10][_____] sets of fuses of each type and size provided.

e. [Five][_____] lamps of each type provided.

f. [16][_____] reams of permanent record printing paper.

g. [10][_____] complete sets of system keys.

1.5 QUALITY ASSURANCE

1.5.1 Materials

[Provide materials and workmanship conforming to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, with the additions and modifications specified herein.]Include provision of all labor, material, tools, and equipment necessary for and incidental to the provision of a complete and usable digital alarm communicator type fire alarm reporting system.

****
NOTE: For OCONUS projects, use the blank brackets to insert local certification standards that are considered equivalent to United States (U.S.) Nationally Recognized Testing Laboratories (NRTLs) for your project.
****

Ensure all devices, appliances, and equipment for fire alarm service are listed by [a Nationally Recognized Testing Laboratory (NRTL)][_____] for their intended purpose.

1.5.2 Codes, Standards, and Manufacturer's Literature

Provide the system in accordance with NFPA 70, NFPA 72,[NFPA 1225,] and as specified herein. Interpret reference to "authority having jurisdiction" to mean the Contracting Officer.

Follow all recommended installation and start-up practices stated in the manufacturer's literature or documentation.

1.5.3 FCC Compliance

Ensure the system conforms to the Federal Communications Commission's rules and regulations concerning connection of telephone equipment, systems, and protective apparatus to the managed facilities-based voice network (MFVN).

1.5.4 Qualifications

1.5.4.1 Qualified Fire Protection Engineer (QFPE)

****

NOTE: For large and complex projects, it is advisable for the QFPE to be directly hired by the General Contractor as an integral part of the General Contractor's team for identifying and incorporating all of the fire protection and life safety requirements for the project. The General Contractor should clearly identify a single firm (or individual) designated as the QFPE for the project. The General Contractor should not separate the responsibilities of the QFPE, as established in UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES, among multiple subcontractors.

****

****

NOTE: It is strongly recommended that the specification writer coordinate closely with the DFPE regarding QFPE expectations to be included in this specification.

****

Provide the services of a Qualified Fire Protection Engineer (QFPE). A QFPE is an individual who is a licensed Professional Engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Ensure that the QFPE is an integral part of the construction team and is involved in every aspect of the system's submittals, installation, and testing. Submit the Qualified Fire Protection Engineer's Qualifications, including the name and documentation of qualifications of the proposed QFPE.

Ensure that the QFPE:

****

NOTE: UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES requires that shop drawings, calculations, and material data sheets bear the Review Stamp of the QFPE prior to submission to the Government for approval. For Army projects, the QFPE is also required to apply their Professional Engineer seal and signature to the shop drawings, calculations, and material data sheets prior to submission to the Government for approval.

****

a. Reviews all required shop drawings, material data, calculations, qualifications, test procedures, test reports, as-built drawings, and O&M manuals for completeness and compliance with the provisions of this Contract prior to submitting them to the Government. Ensure that construction (shop) drawings and calculations are prepared by, or prepared under the immediate supervision of, the QFPE. Affix the QFPE's [review stamp][and][Professional Engineer seal with signature] to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting them to the Government.

b. Provides a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and note any outstanding comments.

c. Performs in-progress construction surveillance prior to installation of ceilings (rough-in inspection)[or closure of trenches]. Performs at least [one][_____] interim site observation visit[s] prior to completion of installation, separate from the preliminary testing, to confirm that all systems are being installed in accordance with the Contract.

d. Witnesses and approves all preliminary and final functional performance testing and performs a final installation review.

e. Signs all certificates under SD-07.

f. Attends training sessions presented as a part of this project to answer questions that may arise.

1.5.4.2 Installer

****

NOTE: Consult with the DFPE for guidance on when to include the UL certification requirements for the Installer.

****

Provide an Installer that is qualified as required by the Personnel Qualifications section of NFPA 72 and the following. Submit the Installer's Qualifications including written certificate demonstrating that the Installer has been regularly engaged in the installation of digital alarm communicator type fire alarm reporting systems of the same type and design as specified herein for a minimum of three years immediately preceding commencement of this contract. Include proof of satisfactory performance on at least three projects similar to that required by these specifications, including the names and telephone numbers of using agency points of contact for each of these projects. Indicate the type of each system installed and include a written certificate that each system has performed satisfactorily in the manner specified for a period of not less than 18 months following completion.[Listing of the installer under "Protective Signaling Services - Local, Auxiliary, Remote Station Proprietary (UUJS)" or under "Protective Signaling Services - Central Station (UUFX)" of the UL Fire Prot Dir will be accepted as equivalent proof of compliance with the foregoing experience requirements.][Ensure that the installer is UL certified for the installation and testing of the fire alarm systems. Provide proof of this listing. Provide a list of installer's personnel as part of the submittal package under the subparagraph titled "Certificates".] Ensure Installer is able to provide service within 24 hours.

1.5.4.3 Supervisor

Provide the services of a qualified technician, factory trained, certified, and experienced in the installation and operation of the type of system being provided to supervise the installation, adjustment, preliminary testing and final testing of the system, and to provide instruction to Government maintenance and operating personnel.

Submit the Supervisor's Qualifications including name(s) of the Supervisor(s) who will oversee installation and testing of the system, and who will provide instruction to Government personnel, along with the manufacturer's certification of the qualifications of the named representative(s).

1.5.4.4 Designer

Provide a Designer that is qualified as required by the Personnel Qualifications section of NFPA 72 and the following. Prepare shop drawings, product data, design data, O&M manual(s), and as-built drawings by, or under the supervision of, a qualified technician. A qualified technician is an individual who is experienced with the types of work specified herein and is currently certified by the National Institute for Certification in Engineering Technologies (NICET) as an engineering technician with minimum Level [III][IV] certification in fire alarm systems, or holds an equivalent certification and training acceptable to the Contracting Officer. Submit the Designer's Qualifications including the name and documentation of certification of the proposed Designer.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

[1.7 CONTINUITY OF PROTECTION

Ensure no loss of function of the existing Installation fire alarm reporting system, or of the protected premises alarm[and fire suppression or fire extinguishing] system[s] connected thereto occurs during installation of this system. Ensure that transfer of protected premises system connections from the existing Installation fire alarm reporting system does not result in loss of signal transmitting or receiving capability. Temporary interruption of individual protected premises systems connections, not to exceed eight hours in duration, will be permitted with the approval of the Contracting Officer. No interruption of alarm or communications functions at the supervising station will be permitted.

][1.8 INTERCONNECTION WITH EXISTING COMPUTER-AIDED DISPATCH (CAD) SYSTEM

****

NOTE: Use this paragraph if there is an existing CAD system which is to be retained. Describe the existing system as precisely as possible. Otherwise, delete this paragraph.

****

1.8.1 Interconnection to Fire Alarm Reporting System

Provide interconnection of fire alarm receiving and decoding system with existing CAD system so that signals are automatically processed by the CAD system,[and] displayed on the CAD monitor screen[, and printed on the CAD printer] as they are received. The existing CAD system utilizes [_____] software, version [_____], and operates on a [_____] computer with [_____] MHz processor, [_____] hard drive, [_____] RAM[, [and][_____] floppy disc drive][, and [_____] CD ROM drive].[[_____] ports are available for this connection.]

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a complete, supervised, fire alarm reporting system complying with NFPA 70, NFPA 72,[NFPA 1225,] and this specification, consisting of remote

DACTs connected to each building fire alarm control unit and a DACR system at a supervising station. Provide spare DACRs at the supervising station in accordance with NFPA 72. Provide system connections to protected premises fire alarm system[and fire suppression or fire extinguishing system] control units.[New protected premises fire alarm systems are specified in Section [28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE].]

2.1.1 Operation

Ensure the receiving system is activated into the active signal mode when an abnormal condition occurs in any building fire alarm system. Ensure the receiving system remains in the active signal mode until the active signal is acknowledged and reset by the operator. Configure the fire alarm reporting system in accordance with NFPA 72. Ensure the transmitting equipment is compatible with receiving equipment.

2.1.2 Active Signal Functions

****

NOTE: Coordinate with the local fire department or other authority responsible for the fire alarm reporting system to determine which signal or signals are required to be transmitted to the supervising station.

****

Ensure that an alarm, trouble, or supervisory condition in any building which reports to the supervising station automatically initiates the following functions:

a. Transmission of a signal by the DACT. Ensure the DACT establishes or maintains communication pathways with the DACR at the supervising station, and transmits the message associated with the active signal.[Ensure that upon failure to connect with the DACR using the primary communication pathway, the DACT attempts to connect via the secondary communication pathway.]

b. Ensure that upon receipt of the signal at the supervising station the signal is decoded and status information is displayed on the supervising station visual display indicating the nature of the status change.

c. Sound an audible signal at the supervising station until the signal is acknowledged.

[d. Print the signal information on the system printer at the supervising station.

]2.2 STANDARD PRODUCTS

****

NOTE: The intent of this section is to ensure some level of standardization and reliability in equipment is provided to simplify maintenance and spare part inventory management. The intent is not to exclude the use of existing DACTs if they are

compatible with the new DACR.
****

Provide transmitting, receiving, and decoding equipment that are the current products of one[or more] manufacturer[s] regularly engaged in the manufacture of digital alarm communicator systems and that essentially duplicate items that have been in satisfactory use for at least two years prior to contract award. Provide all other materials and equipment that are the current products of one or more manufacturers regularly engaged in production of such materials and equipment. Provide solid state electronics. Provide equipment used to interconnect the fire alarm reporting system with protected premises fire alarm system [and fire suppression or fire extinguishing system]control units that is [NRTL][_____] listed for that service; or provide all equipment that is [NRTL][_____] listed as a Supervising Station Fire Alarm System. Provide electrical supervision for all pathways and for all components critical for system operation.

2.3 NAMEPLATES

Provide the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a corrosion-proof and non-heat-sensitive plate which is securely attached to all major components of equipment.[Provide the English translation on each label provided in any language other than English.]

2.4 DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACT)

****
NOTE: The requirement to provide printed circuit boards with a non-nutrient conformal coating should be considered based on the anticipated ambient conditions to which the circuit boards will be exposed. Consider whether these environmental conditions may be more easily offset by the use of a more robust enclosure. Historically, Navy and Marine Corps preference was to provide such coatings on all installations. Consult with the DFPE for project specific requirements.
****

Provide DACTs that are compatible with the Supervising Station DACR. Ensure each transmitter is the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Provide transmitters in accordance with applicable portions of NFPA 72. Ensure transmitter electronics modules are contained within the physical housing as an integral, removable assembly.[At the Contractor's option, and if listed, the transmitter may be housed in the same enclosure as the fire alarm control unit.] Ensure that the DACT is capable of seizing a telephone line at the protected premises and sending digital alarm, supervisory, and trouble information over the telephone network to a DACR.[Provide printed circuit boards in transmitters with a non-nutrient conformal coating for protection against moisture and fungus. Ensure that the coating is suitable for the climate in which the equipment is to operate and apply it at the factory in accordance with the coating manufacturer's specifications.][Provide interface device for DACT to be compatible with existing system.]

2.4.1 Transmitter Identity Code

Include a unique, field settable, identity code for each DACT as part of each transmission.[Set the specific code number for each DACT as shown on the Contract Drawings.][Submit in writing,[with the shop drawing submittal][within 30 days after award], the specific code number for each DACT.][Obtain the code numbers for each DACT from the Federal Fire Department.]

2.4.2 Functional Requirements

2.4.2.1 Connection to Fire Alarm Control Units

Provide DACTs that are capable of being connected to and receiving signal inputs from[existing][and][new] fire alarm control units.[Provide DACTs that are capable of monitoring a minimum of three normally open contacts from a building fire alarm control unit.] Provide DACTs that will support[Class A][,][and][Class X][,][and][Class B] pathway arrangements. Ensure that pathway connections to the DACT utilize manufacturer installed terminations. Do not field modify pathway terminals.

2.4.2.2 Memory

Provide a DACT with memory capability to store at least [50][_____] discrete events automatically in non-volatile memory such that multiple, simultaneous signals do not result in the loss of any messages, and such that the failure of a communication pathway does not result in the loss of any messages. Store messages until they are transmitted.

2.4.2.3 Signal Transmission

****

NOTE: Determine the availability and applicability of MFVN lines or local private branch exchange (PBX) service for use in each project. Telephone lines must be loop-start configuration to allow the DACT to operate properly. Telephone lines connected to the DACR must be configured for sequential hunting. Show the telephone lines to be used on the Contract Drawings.

****

****

NOTE: While this specification section is written around the use of plain old telephone system (POTS) lines, there are other transmission means available in the industry, and the editor of this specification may revise it to include requirements for those other technologies as deemed appropriate for the specific project.

****

Provide DACTs that initiate transmission using a loop-start format. Connect each DACT to two telephone lines, as shown on the Contract Drawings. Configure the DACT to seize the primary telephone line, disconnecting any telephones, obtain a dial tone and dial the DACR to initiate a transmission. Arrange the DACT such that upon failure to connect to the DACR after a minimum of five attempts, it attempts to connect to the DACR via the second telephone line. Report a trouble condition at the building fire alarm control unit and at the supervising station upon failure of one telephone line. Transmit the required alarm, supervisory, trouble, or test information when the DACT makes a connection to the DACR. Utilize repetition of the signal, parity checks, or equivalent checksum-type transmission to confirm the signal.

2.4.2.3.1 Messages

Transmit messages upon automatic actuation of the transmitter. Individually identify the building and zone causing actuation as part of this transmission. Ensure that the transmitter is capable of identifying and transmitting a minimum of the following status messages, as applicable for each respective building:

****

NOTE: The required list of signals that the system must be capable of sending should be edited to match the specific requirements of each project. There may be more or less detail required. The intent of this list is not to define how to program each of these devices or signals, but merely to list all of the messages that may need to be transmitted by the equipment.

****

(1) Primary Power Failure

(2) Primary Power Restoration

(3) Battery Fault

(4) Battery Restoration

(5) Communication Failure

(6) Communication Restoration

[(7) Manual Pull Station Alarm

][(8) General Smoke Sensor Alarm

][(9) Duct Type Smoke Sensor Supervisory

][(10) Damper Control Smoke Sensor Supervisory

][(11) Door Hold Open Release Smoke Sensor Supervisory

][(12) Sleeping Room Smoke Sensor Supervisory

][(13) Waterflow Switch Alarm

][(14) Carbon Monoxide Sensor Alarm

][(15) Gas Sensor Alarm

][(16) Aspirating Smoke Sensor Alert

(17) Aspirating Smoke Sensor Fire 1 Alarm

(18) Aspirating Smoke Sensor Fire 2 Alarm

(19) Aspirating Smoke Sensor Trouble

][(20) Fire Pump Running

(21) Fire Pump System Supervisory

][(22) Water Tank Low Level Supervisory

][(23) Water Tank Low Temperature Supervisory

][(24) Kitchen Hood Suppression System Activation Alarm

(25) Kitchen Hood Suppression System Trouble

][(26) Mass Notification Message Activated with Active Fire Alarm

][(27) Fire Suppression Containment Supervisory

][(28) Foam System Supervisory

(29) Foam System Disabled Supervisory

[(30) Manual Foam Release Start Station Alarm

][(31) Optical Flame Detector Alarm

][(32) Optical Flame Detector Inhibited Supervisory

][(33) Foam System Flow Switch Alarm

][(34) Foam Stop Station Active Supervisory

] (35) Foam System Trouble

(36) Foam System Release Alarm

][(37) Clean Agent System Alarm

(38) Clean Agent System Supervisory

(39) Clean Agent System Trouble

[(40) Clean Agent System Stop Station Active Supervisory

][(41) Clean Agent System Release Disabled Supervisory

][(42) Clean Agent System Release Alarm

]][(43) Smoke Control System Active

(44) Smoke Control System Fault

][(45) Valve Supervisory Switch Supervisory

] (46) General Alarm

(47) General Supervisory

(48) General Trouble

(49) Any Additional Signals Called for on the Contract Drawings

[(50) [_____]

] When the number of zone connections shown exceeds the maximum zone capacity furnished in a single transmitter, provide additional transmitters at that location to connect to all zones shown.

2.4.2.3.2 Message Priorities

Ensure that alarm messages take precedence over supervisory messages. Ensure that supervisory messages take precedence over trouble messages.

2.4.3 Enclosures

****

NOTE: NEMA 1 enclosures should provide the necessary protection for most indoor applications. Upgrading to NEMA 3R, 4, or 4X should only be required if warranted based on anticipated exposed conditions. If locations are deemed to require a NEMA type other than NEMA 1, they must be shown on the Contract Drawings.

****

Provide transmitters with enclosures of corrosion-resistant metal, conforming to NEMA ICS 6 classification in accordance with NFPA 70 for the environment in which they are installed as indicated on the Contract Drawings. If no NEMA type is indicated on the Contract Drawings, provide NEMA Type 1 enclosures. Design transmitter housings for universal mounting on walls, poles, or pedestals. Utilize [lag bolts][,][or][anchor bolts][,][or][stainless steel banding][,][or][mounting brackets][,][or][a shackle and bolt combination] for mounting. Provide enclosures with raceway entry points (minimum 21 mm 3/4 inch I.D.) at no less than one place near the top of the enclosure and one place near the bottom of the enclosure.[Protect internal components from vandalism by a tamper-proof lock on the transmitter housing.] Key locks for all transmitters of each configuration provided alike. Ensure that the housing allows access to all internal components for testing, servicing, and replacement at the installation site. Ensure access door(s) swing open through at least a 2.1 rad 120 degree arc. Factory paint the enclosure with a priming coat and not less than two coats of a durable weatherproof enamel or factory powder coat the enclosure. Ensure the finish color is Fire Engine Red, similar to color number 11105 under SAE AMS-STD-595A, except as otherwise specified herein for each individual transmitter configuration. Repaint all surfaces damaged during installation to match existing paint.[Securely affix a metallic or rigid plastic engraved code number plate to the front of the enclosure.][Monitor the housing for tampering and automatically transmit a tamper message when a tamper switch is tripped in the transmitter housing.]

2.4.4 Environmental Operating Requirements

****

NOTE: Check local conditions for design wind gust and ice loading. Lowest design wind speed is 160 km/hour 100 mph; typical design wind speed is 201

km/hour 125 mph.
****

Design transmitters not installed within climate-controlled spaces for reliable operation in an ambient temperature range of [-30][-40][_____] to [60][_____] degrees C [-22][-40][_____] to [140][_____] degrees F, a maximum ambient humidity of at least [85][_____] percent at [30][_____] degrees C[86][_____] degrees F, and under adverse climatic conditions including [201][125][_____] km per hour [125][100][_____] mph winds, ice, rain, and snow storms.

[2.4.5 DACT Interface Device

When direct connection between the building fire alarm control unit and the DACT is not possible, provide a means of converting the signals available from the local control equipment into a form that is compatible with the DACT inputs, while still maintaining electrical supervision of the entire system. Provide interface devices that are completely assembled, wired, tested at the factory, and delivered ready for installation and operation.

2.4.6 Interface Device Enclosure

When furnished as an independent self-contained device, incorporate the interface device into an enclosure conforming to NEMA ICS 6 or other national standard as required by its location.

2.4.7 Interface Device Indicators

Provide red alarm and amber trouble illuminating indicators to indicate alarm and trouble conditions. Ensure the indicators are visible during daylight hours and clearly indicate the reporting zone.

2.4.8 Interface Device Access

Ensure that switches and other controls are not accessible without the use of a key. Provide access to controls by unlocking and opening a panel or door.

2.4.9 Interface Device Housing Mounting

Design interface housings for universal mounting on walls, poles, or pedestals. Utilize[lag bolts][,][or][anchor bolts][,][or][stainless steel banding][,][or][mounting brackets][,][or][a shackle and bolt combination] for mounting.

2.4.10 Interface Device Inputs and Outputs

Provide at least the number of signal pathway inputs and outputs necessary to ensure a functional system in accordance with the Contract Documents at each interface panel. Arrange each input pathway so that the alarm signals override the supervisory and trouble signals.

]2.4.11 DACT Power Supply

****
NOTE: The voltage available at each building must be verified. If [100-120][200-240] VAC [60][50] Hz service is not available at certain buildings, the need for transformers must be noted on the Contract

Drawings.
****

Operate each transmitter from [100-120][200-240] Volt (V) Alternating Current (AC) [60][50] Hertz (Hz) power. In the event of [100-120][200-240] VAC power loss, automatically switch the transmitter to battery operation. Accomplish switchover with no interruption of protective service and automatically transmit a trouble message. Transmit a trouble message in no less than 200 seconds following loss of AC power for a duration longer than 60 seconds. Upon restoration of AC power, automatically transfer back to normal AC power supply and recharge the batteries. Ensure the battery charger is capable of restoring the batteries from full discharge to full charge within [48][_____] hours while the transmitter is operating under normal conditions. Install the converter or battery charger within the transmitter housing. Provide power supply transient voltage surge suppression. Provide transmitters with power supply filtering to prevent false message transmissions caused by transient or steady-state electrical disturbances.

2.4.11.1 Battery Power

Provide transmitter standby battery capacity sufficient to operate the transmitter[and interface device] in a normal standby status for a minimum of [48][_____] hours and be capable of transmitting signals during that period. Provide maintenance-free, [valve-regulated lead-acid][_____] type batteries. Submit substantiating battery calculations for supervisory and alarm power requirements. Include the ampere-hour requirements for each system component, each panel component, and the battery recharging period. Ensure that each fire alarm transmitter constantly monitors and supervises its own battery power supply. Report a low-battery condition when battery voltage falls below the minimum voltage prescribed by the manufacturer, or 85 percent of the rated voltage, whichever is higher.

2.4.12 Transmission Confirmation

Arrange each DACT such that an audible or visual indication that the transmitter is operating and a signal is being sent, whether the signal was automatically or manually initiated.

2.4.13 Automatic DACT Test

****
NOTE: Test signals should be sent at least once every hour for single communication path systems. Systems that use multiple communication paths may extend their time period between test signals to once every six hours per NFPA 72. DACTs utilizing two separate telephone lines are considered to be using multiple communication paths.
****

Provide transmitters which automatically transmit a test signal at least once in each [six][one]-hour period. Provide transmitters that also allow manual actuation of a test signal by a secured (not publicly accessible) means. Initiate automatic actuation by a solid state programmable electronic device. Ensure that stability of the electronic device is plus or minus one minute per month or better. Ensure that test time(s) are programmable without removing the transmitter from the enclosure.

2.4.14 DACT Supervision

2.4.14.1 Supervision of Communications

Supervise transmitter communications in accordance with NFPA 72. Provide supervision to ensure that all status changes, including communication channel failures, are transmitted within 200 seconds. Ensure that interface wiring is such that a trouble indication on the fire alarm control unit will not disrupt the transmission capability of alarm or supervisory messages. Ensure that status changes on monitoring zones occur within 60 seconds of fire alarm control unit activation. Ensure that all signals transmitted from the transmitter are received and recorded at the receiving station within 90 seconds.

2.4.14.2 Supervision of Pathways

Ensure that each transmitter monitors the integrity of pathways between the transmitter and the protected premises control unit(s). Ensure that disarrangement of the transmitter wiring which prevents proper operation of the transmitter, the abnormal position of any switch, or a ground-fault or a break (open condition) in any of the above pathways causes a trouble condition at the transmitter.

2.4.14.3 Trouble Indication

Provide transmitters with local audible trouble signal, visual amber trouble signal(s), and audible signal silencing switch. Ensure that lamps are the light emitting diode type. Lamps need not be visible with the access door closed. Upon occurrence of a trouble condition as defined in NFPA 72, ensure that the transmitter transmits a trouble signal, a local audible trouble signal sounds, and a visual trouble signal illuminates. When silencing switch is operated, silence the audible trouble signal, and ensure that the visual trouble signal(s) remain(s) lit. If the silencing switch is not a momentary-action-self-resetting type, upon correction of the trouble condition(s) sound the audible signal again until the silencing switch is returned to its normal position.

[2.4.15 Zone Disconnecting Means

Provide transmitters with switches to disconnect individual zone inputs from the transmitter without disconnecting wiring. Ensure that disconnecting a zone causes a trouble condition which initiates transmission of a trouble signal and actuation of local audible and visual trouble signals.

]2.5 DIGITAL ALARM COMMUNICATOR RECEIVER (DACR)

Provide [two][_____] identical Digital Alarm Communicator Receivers (DACRs).[Install [both][all]DACRs at the main supervising station.][Install [one][_____] DACR at the primary supervising station and [the other][_____] at the alternate supervising station.] Ensure that each DACR is completely assembled, wired, and tested at the factory, and delivered ready for installation and operation.

2.5.1 Design

Provide DACRs with a solid state design that perform the receipt, processing, and display of emergency and non-emergency messages transmitted by the DACTs specified herein, independently of any other DACR. Provide each DACR with a complete independent receiving system consisting of: a receiver, decoder, audible signaling appliances, audible signal silence switch, visual display, alarm reset switch, digital clock, printer connection, primary and emergency power supplies, power supply monitors, memory devices, personal computer connection, and interconnecting cables.

2.5.2 Polling Device

If the automatic DACT tests specified under paragraph titled "Automatic DACT Test" are initiated by a polling (interrogation) device located at the DACR, then provide each of the required DACRs with a polling device. Ensure that one such device is always active, with the other(s) in standby status. Ensure that failure of the active device automatically causes another device to take over the polling (interrogation) function, and initiates a trouble signal. Ensure this switch occurs within [30][_____] seconds of detection of failure of the active unit.

2.5.3 Telephone Line Connections

****

NOTE: "Telephone lines" as used in this paragraph may be POTS lines or they may be a different technology as used in a MFVN. See NFPA 72 for additional discussion on the current industry shift away from POTS lines and to ensure compliance with any applicable limitations of the code.

****

****

NOTE: Select the appropriate number of incoming telephone lines based upon the anticipated loading of the system. Note that the connection of supervised burglar alarms and guard's tour transmitters will reduce the available system capacity at a greater rate than connection of a DACT. Reference NFPA 72 for requirements surrounding maximum system loading and the impacts of connecting burglar alarm and guard's tour transmitters.

****

Provide the DACR with connections for a minimum of [four][_____] incoming telephone lines. Ensure connections are six-position, four-conductor, modular jacks as described in TIA-570.

2.5.4 Receiver Code Format

****

NOTE: There are many different types of code formats that can be used by digital alarm communicator type systems, including but not limited to 3X1, 4X2, Ademco Express, Contact ID, DMP, SIA, Modem IIe, Modem IIIa2, BFSK, and SK. Each code format has advantages and disadvantages. While the particular code format to be used is not specifically defined within this specification, it is imperative that the DACR be compatible with the DACTs that are sending it signals.

****

Provide DACRs capable of receiving and decoding any of the code formats used by the DACTs to be monitored.

2.5.5 Display

****

NOTE: Current industry trends are moving towards omitting displays on the actual DACRs and utilizing a supervising station terminal to display received signals. If a supervising station terminal is provided as a part of the project, consider removing the requirement for a local display on the DACR. Status indicator lights should still be required on the DACR regardless of whether a local display is included or not.

****

Configure each DACR to do the following:

a. Display incoming signals in alphanumeric format, by means of a[light emitting diode (LED)][or][liquid crystal display (LCD)] screen.

(1) Indicate the originating transmitter identity code, originating building name, originating building number, time, date, and type of signal. Ensure the DACR is capable of displaying at least the following signal designations:

****

NOTE: The required list of signals that the system must be capable of receiving should be edited to match the specific requirements of each project. There may be more or less detail required. The intent of this list is not to define how to program each of these devices or signals, but merely to list all of the messages that may need to be received by the equipment.

****

a. Primary Power Failure

b. Primary Power Restoration

c. Battery Fault

d. Battery Restoration

e. Communication Failure

f. Communication Restoration

g. Manual Pull Station Alarm

h. General Smoke Sensor Alarm

i. Duct Type Smoke Sensor Supervisory

j. Damper Control Smoke Sensor Supervisory

k. Door Hold Open Release Smoke Sensor Supervisory

l. Sleeping Room Smoke Sensor Supervisory

m. Waterflow Switch Alarm

n. Carbon Monoxide Sensor Alarm

o. Gas Sensor Alarm

[p. Aspirating Smoke Sensor Alert

q. Aspirating Smoke Sensor Fire 1 Alarm

r. Aspirating Smoke Sensor Fire 2 Alarm

s. Aspirating Smoke Sensor Trouble

][t. Fire Pump Running

u. Fire Pump System Supervisory

][v. Water Tank Low Level Supervisory

w. Water Tank Low Temperature Supervisory

][x. Kitchen Hood Suppression System Activation Alarm

y. Kitchen Hood Suppression System Trouble

] z. Mass Notification Message Activated with Active Fire Alarm

[aa. Optical Flame Detector Alarm

bb. Optical Flame Detector Inhibited Supervisory

][cc. Fire Suppression Containment Supervisory

][dd. Manual Foam Release Start Station Alarm

ee. Foam System Supervisory

ff. Foam System Disabled Supervisory

gg. Foam System Flow Switch Alarm

hh. Foam Stop Station Active Supervisory

ii. Foam System Trouble

jj. Foam System Release Alarm

][kk. Clean Agent System Alarm

ll. Clean Agent System Supervisory

mm. Clean Agent System Trouble

nn. Clean Agent System Stop Station Active Supervisory oo. Clean Agent System Release Disabled Supervisory

pp. Clean Agent System Release Alarm

][qq. Valve Supervisory Switch Supervisory

][rr. Smoke Control System Active

ss. Smoke Control System Fault

] tt. General Alarm

uu. General Supervisory

vv. General Trouble

ww. Any Additional Signals Called for on the Contract Drawings

[xx. [_____]

] (2) Include a message of a minimum of three lines of 20 characters each for each transmission. Ensure the message is operator-programmable into the memory through a provided keyboard.

(3) Configure the DACR to annunciate an error message any time a message is received that does not match the programmed DACT codes.

b. Include a means to manually clear and reset the display. If the display is not reset at the time additional alarms are received, retain the additional alarms in memory and activate a distinctive audible or visual indication to alert the operator that additional alarms are waiting to be acknowledged.

c. Ensure that the DACR will display and print a summary of DACTs that have transmitted a low-battery or trouble message or failed to transmit a message during the previous [six][one]-hour test period upon command. Ensure that any incoming DACT signal pre-empts the command display and printout function, and is processed and displayed.

2.5.6 Memory

Provide each DACR with a programmable memory capable of retaining at least [500][1500][3000][_____] transmitter codes, together with specific messages, total number of zones possible, and related information associated with each of the transmitters. If memory is operator-programmable, restrict access into the memory for the purpose of making additions or deletions by the use of a user specific access code to prevent unauthorized changes, and permanently record any such actions in this history log. Do not purge memory and ensure it is always current and available. Ensure memory is not lost in the event of a total loss of primary and emergency power supplies.

2.5.7 Digital Clock

Incorporate an electronic digital clock into each DACR. Ensure the clock displays the current time (expressed in 24-hour format) and date, and transmits to each interconnected printer the time and date that signals are received. Provide a manual means of resetting the clock.

[2.5.8 Self-Contained Printer

Provide the DACR with a self-contained printer that will output a minimum of 32 characters per line and record all displayed transaction information including time and date.

]2.5.9 Audible Appliance

Provide an audible appliance that produces a sound distinct from other audible signals to indicate the receipt of signals. Internally mount the appliance in the DACR and activate it upon receipt of an alarm, supervisory, or trouble signal. Ensure the audible sounds used to indicate trouble and supervisory signals are separate and distinct from the sound used to denote receipt of alarm signals. Ensure that the audible appliance continues to sound until acknowledged with the silence switch by the operator.

2.5.10 Power Supplies

Operate each DACR from [100-120][200-240] VAC [60][50] Hz power. Provide the primary power supply for each DACR [through a single dedicated circuit from the building's electric service][through a single connection into the line side of the building's regular AC service circuit][through a single connection into the building's emergency service circuit] with a lockable [breaker][fused disconnect switch] that is red in color and labeled "FIRE REPORTING". Provide a separate [breaker][disconnect switch] for each DACR. In the event of [100-120][200-240] VAC power loss, automatically switch the DACR to battery operation. Accomplish switchover with no interruption of protective service. Upon restoration of AC power, automatically transfer back to normal AC power supply and recharge the batteries. Install the converter or battery charger within the DACR housing. Provide power supply transient voltage surge suppression. Provide DACRs with power supply filtering to prevent false message transmissions caused by transient or steady-state electrical disturbances.

2.5.10.1 Emergency Power Source

****

NOTE: Ensure that the supervising station is provided with appropriate primary and secondary power according to its application. Edit the required UPS capacity period based upon the level of backup power provided to the supervising station.

****

Provide DACR standby battery capacity sufficient to operate the DACR in a normal standby status for a minimum of [four][24][_____] hours and be capable of receiving signals during that period. Provide maintenance-free, [valve-regulated lead-acid][_____] type batteries. Submit substantiating battery calculations for supervisory and alarm power requirements. Include the ampere-hour requirements for each system component, each panel component, and the battery recharging period. Ensure that each DACR constantly monitors and supervises its own battery power supply. Report a low-battery condition when battery voltage falls below the minimum voltage recommended by the manufacturer, or 85 percent of the rated voltage, whichever is higher.[Mount batteries on rack(s) designed for that purpose. Provide a termination cabinet as a part of the rack. Locate battery rack(s) where shown on the Contract Drawings.]

2.5.10.2 Manual Battery Test

Provide a self-contained or externally mounted switch to accommodate manually placing the DACR on emergency battery power for test purposes.

2.5.10.3 Battery Charger

Provide self-regulating battery chargers with the capacity to completely recharge its associated batteries from full discharge within [48][_____] hours with the DACR fully operational on primary AC power. Ensure the DACR remains operational on AC power with the batteries removed.

2.5.11 DACR Supervision

Ensure supervisory controls provide constant supervision of the operating condition of the DACR. Provide individual indicators for each major component, and produce an audible signal in the event of failure of any major component. Ensure this audible signal is distinctly different from the signal used to annunciate alarms. Provide a switch to silence the audible signal.

2.5.12 Electrical Connections

Provide DACRs designed with modular components to allow interchange of components for maintenance purposes. Provide primary power cables that incorporate positive twist-lock connections. Provide interconnecting cables and connectors that are compatible with computer quality signal data transmission.

2.5.13 Field Programming Capability

Provide field programming capability, including interconnecting cables, software, firmware, hardware, and manufacturer's licenses and passwords necessary to permit revisions to data stored in memory as follows: addition or deletion of transmitters, changes in zone numbers and identification, changes in signal type and displayed message, alphanumeric label changes, and password changes, to be made by the Government after contract completion.

2.6 SUPERVISING STATION TERMINAL

****

NOTE: Cybersecurity provisions must comply with the requirements of UFC 4-010-06: CYBERSECURITY OF FACILITY-RELATED CONTROL SYSTEMS and DAFGM2022-32-01: CIVIL ENGINEER CONTROL SYSTEMS CYBERSECURITY (if applicable).

****

2.6.1 Terminal Configuration

Provide a personal computer based supervising station terminal provided with an applications program to allow it to be connected to the receiving equipment.[Provide provisions for floor mounting of the central processing unit.][Extend the keyboard, monitors, mouse, and audible indicating appliance from the rack to the operator workstation.] Ensure that the hardware, software, and firmware are all compatible with the receiving equipment, and permit the site specific configurations prescribed herein. Configure the terminal to display additional information about the building from which a signal is received, detailed description of the current signal, and signal histories. Provide operator interface with the Fire Alarm Reporting System at the Installation, including with [new][and][existing]individual building fire alarm systems, through the terminal via wired QWERTY keyboard and wired mouse equipped with a scroll wheel.[Ensure that operation of the new terminal does not disrupt operation of, and works in conjunction with, the existing terminal.] Provide system capable of being backed-up and restored using a reliable media acceptable to the Government.

2.6.2 Terminal Cybersecurity

Ensure the system meets current requirements for cybersecurity as dictated by Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

2.6.3 Terminal Functions

****

NOTE: Determine if the Installation requires additional functionality out of the terminal and edit the specification accordingly. Also consider whether the terminal must be capable of serving multiple systems, such as the wide area mass notification system or computer aided dispatch system, and edit the specifications for each respective system consistently to convey the requirement for a multifunctional terminal. Alternatively, consider relocating the terminal requirements into a stand-alone specification section if the terminal is intended to serve multiple systems.

****

Provide all hardware and software required to permit an operator at the terminal to perform the following functions:

a. Signal acknowledgement, signal silence, and system reset.

b. Manual activation, de-activation, enabling, or disabling individual fire alarm system points.

c. Query building fire alarm system status.

d. Query building fire alarm system maintenance and sensitivity reports for devices.

e. Query building fire alarm system event history.

Configure terminal to initiate an audible notification to the operator any time a signal is received.

2.6.4 Terminal Display

Provide [liquid crystal display][_____] flat panel monitors no less than[480 mm 19 inch][584 mm 23 inch][686 mm 27 inch][813 mm 32 inch][[_____] mm [_____] inch]. Provide monitors capable of being[wall][or][desktop] mounted with manufacturer furnished hardware.

Provide displays capable of being manipulated to show four separate quadrants reflecting the following information:

a. List of Events: Display the address of the active device, device type, device description, and time of the event in a prioritized color-coded event list. Configure system such that operator selection of an independent event automatically displays a building floor plan zoomed to the location of the device.

b. Floor Plan: Display a color graphical view of the floor plan, zoomed to the location of the signal initiating device. Provide the operator with the ability to zoom in or zoom out of the floor plan via operation of the mouse scroll wheel. Do not use pre-set zoom levels.

c. Event Action: Display a customized set of written operator instructions for the active event. Configure system to add subsequent events to create a list of active signals. Provide the operator with the ability to scroll through all active signals via mouse or keyboard control. Ensure all events and operator actions are logged and time stamped in the receiving system history file.

d. Image: Display a stored image of the active device, such as that provided in the manufacturer's product data sheet.

2.7 SUPERVISING STATION PRINTER

****

NOTE: Consideration should be given to whether a supervising station printer is warranted based on system size and use.

****

Provide a supervising station printer of high speed, computer compatible, low noise design, that is [compatible with the supervising station terminal and]capable of printing all transaction information and history reports. Provide a printer that is a type and size compatible and listed with the receiving station.[Arrange the printer to print on paper the required visually displayed data, including the date and time received, upon reception of an alarm, trouble, or supervisory signal.] Provide standard size paper compatible with the printer for recording messages. Ensure the paper is commercially available from three or more manufacturers[and continuous feed].[Include paper take-up devices for storing printouts.] Print alarm, trouble, and supervisory signals in a manner to make them readily distinguishable from acknowledgments and routing messages by use of a different color, typeface, type size, or other distinguishable means.

2.8 SUPERVISING STATION POWER SUPPLIES

****

NOTE: Ensure that the supervising station is provided with appropriate primary and secondary power according to its application. Edit the required UPS capacity period based upon the level of backup power provided to the supervising station.

****

Provide each component of supervising station equipment with a self-contained power supply. Provide primary power from a dedicated 20A circuit. If a dedicated fire protection subpanel is provided, ensure the circuit originates from that panel. Ensure the dedicated breaker is red in color, lockable, and labeled "FIRE REPORTING".[Directly wire terminal and all associated components into the primary power circuit. Do not provide equipment with plug-in type power cords.] Provide an uninterruptible power supply (UPS) for equipment which does not have a self-contained battery backup[, such as the[terminal][and][printer]]. Ensure the UPS provides all power requirements for the connected equipment for a period of [four][24][_____] hours under maximum normal load. Provide UPS with a bypass switch for maintenance purposes. Provide self-regulating battery chargers with the capacity to completely recharge its associated batteries from full discharge within [48][_____] hours with the network fully operational on primary AC power. Ensure the system remains operational on AC power with the batteries removed.[Ensure the UPS is in accordance with Section 26 33 53 STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS).]

2.9 PERIPHERAL EQUIPMENT

[2.9.1 Surge Suppression

****

NOTE: Specify surge suppression for projects administered by NAVFAC Southeast and for all areas with high potential for lightning damage. Consult DFPE if additional guidance is needed.

****

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NOTE: Tailoring tags have been used to automatically add requirements related to CAD systems when applicable.

****

Provide line voltage[and low voltage] surge suppression devices to suppress all voltage transients which might damage system transmitter, CAD, and receiving and control system components. Mount suppressors in separate enclosures adjacent to each transmitter[, computer,] and receiving and control system unless suppressors are specifically [NRTL][_____] listed for mounting inside the transmitter or receiving and control system enclosures and approved for such use by the system manufacturer. Provide line voltage suppressors which are UL 1449 listed having a maximum 330 volt clamping level and a maximum response time of five nanoseconds. Ensure suppressors also meet IEEE C62.41.1 and IEEE C62.41.2 Category B tests for surge capacity. Provide multi-stage type suppressors which include inductors and silicon-avalanche or zener diodes. Provide suppressors with long-life indicating lamp (light emitting diode or neon lamp) which extinguishes upon failure of the protection components. Ensure fuses are externally accessible. Wire surge suppressors in series with the incoming power source ahead of the protected equipment, using screw terminations.

[Provide low voltage surge suppressors for all wired pathways which leave the building shell. When pathways connect two or more buildings, provide a suppressor at each pathway entrance to each building. Ensure suppressors are UL 497B listed with a maximum 30 volt clamping level and a maximum response time of five nanoseconds and multi-stage construction having both differential and common-mode protection.

]2.9.1.1 Communications Link Surge Protection

Provide communications link surge protection that meets the following two waveforms:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

]2.9.2 Raceway and Fittings

Provide raceway that complies with UL 6, UL 797, or UL 1242 and is no less than [13][19] mm [1/2][3/4] inch in diameter.

Provide outlet boxes and fittings that comply with UL 514A or UL 514B.

2.9.3 Wiring

Provide wiring in accordance with NFPA 70 and NFPA 72, and as specified herein. Ensure conductor for [100-120][200-240] VAC circuits is 4 square mm No. 12 AWG minimum solid copper. Ensure conductor for low voltage direct-current (DC) circuits is [1.5][2.5] square mm No. [14][16] AWG minimum [solid][or][stranded] copper. Provide 75 degrees C 167 degrees F minimum insulation with nylon jacket. Color code all wiring.

2.9.4 Ground Rods

****

NOTE: Designer must determine the size, type, and number of ground rods to be used based on local conditions, earth resistivity data, and the size and type of the electrical installation. Copper-clad steel rods should be specified for normal conditions. In high resistivity soils, 3048 mm 10 foot sectional rods may be used to obtain the required resistance to ground. Where rock is encountered, additional rods, a counterpoise, or ground grid may be necessary. Coordinate and standardize rod selection for individual facilities with other specification sections.

****

Provide grounding to building ground. Ensure maximum impedance to ground is [25][_____] ohms. If the maximum impedance to ground exceeds [25][_____] ohms, provide driven ground rods. If used, provide ground rods that conform to UL 467 and are of [copper-clad steel][solid copper][_____] not less than [19][_____] mm [3/4][_____] inch in diameter by [3048][_____] mm [10][_____] feet in length[and of the sectional type].

2.9.5 DACT Programmer

Provide a device for programming the required information in each DACT unless programming capability is an integral part of the DACT. Provide all required programming equipment, including the programmer, interconnect cables and adaptors, and power supply. Provide [six][_____] spare program chips if removable program chips are used.

[2.9.6 Protected Premises Control Units

****

NOTE: Survey each control unit to ensure that the necessary "dry" electrical contacts are available

for connection to the DACT; if not, the control unit must be modified in accordance with the recommendations of its manufacturer or replaced. Indicate on the Contract Drawings which units require modification or replacement under this contract and include Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE, Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE, Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, or Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE, as appropriate. Consult the DFPE for additional guidance as needed.

****

****

NOTE: Edit the following section to provide connection to fire alarm control units, suppression system control units, extinguishing system control units, and fire pump controllers, as appropriate. If all suppression and extinguishing system control units are connected to fire alarm systems in compliance with the applicable NFPA standards, separate connections between the suppression or extinguishing system and the DACT are not required. If fire pump controllers are connected to fire alarm systems in such a way that the three separate alarm signals required by NFPA 20: STANDARD FOR THE INSTALLATION OF STATIONARY PUMPS FOR FIRE PROTECTION can be transmitted to the supervising station, separate connections between the DACT and pump controller are not required.

****

****

NOTE: Indicate on the Contract Drawings the location of each control unit, how many separate signals (pathways) are to be connected to the DACT, and the designation of each pathway as it should be annunciated at the supervising station.

****

Fire alarm[and fire suppression or fire extinguishing system] control unit[and fire pump controller] alarm, trouble, and supervisory contacts are [existing][or][specified in other sections].

]2.10 COMPUTER-AIDED DISPATCH (CAD) SYSTEM

****

NOTE: Except for larger consolidated communication centers, select the single CAD system option. If a new CAD system is not desired, delete these paragraphs. Consult the Federal Fire Chief to determine the requirement for a CAD system and the historical and anticipated daily (average and peak) call loading.

****

****

NOTE: Cybersecurity provisions must comply with the requirements of UFC 4-010-06: CYBERSECURITY OF FACILITY-RELATED CONTROL SYSTEMS and

DAFGM2022-32-01: CIVIL ENGINEER CONTROL SYSTEMS CYBERSECURITY (if applicable).
****

In the supervising station, provide [one][two] CAD system[s] in compliance with NFPA 1225. Provide hardware, firmware, and software required for a complete, code compliant, and useable system. Ensure the system meets current requirements for cybersecurity as dictated by Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.[Ensure that operation of the new system does not disrupt operation of, and works in conjunction with, the existing system.] Provide a computer that utilizes a [Windows10][Windows11][_____] based operating system and has hard drive disk space sufficient to maintain records for no less than two years. Provide a keyboard, dual monitors, mouse, and audible indicating appliance.[Extend the keyboard, monitors, mouse, and audible indicating appliance from the rack to the operator workstation.] Provide monitors no less than[480 mm 19 inch][584 mm 23 inch][686 mm 27 inch][813 mm 32 inch][[_____] mm [_____] inch]. Provide system capable of being backed-up and restored using a reliable media acceptable to the Government. Provide standard, commercially available software loaded on the computer hard drive. Provide a system that is capable of accommodating an average load of [_____] calls per 24-hour day and a peak load of [_____] calls per hour.

2.10.1 Interconnection to Alarm System

Provide interconnection between CAD system[s][,][and] fire alarm receiving and decoding systems[,][and][existing wired box circuits][,][and][Enhanced 9-1-1 telephone system] so that signals are automatically displayed on the CAD monitor screen[and printed on the CAD printer] as they are received.

2.10.2 Printer

Provide color laser printer, capable of printing [six][_____] pages per minute in text mode, that utilizes standard 216 mm by 279 mm 8.5 inches by 11 inches[tractor-feed][or][loose-leaf] paper.

2.10.3 Automatic Display

Ensure the system displays[and prints] the following upon automatic receipt of a signal:

a. Transmitter number.

b. Zone number (when applicable).

c. Type of signal (alarm, supervisory, trouble).

d. Building name and number.

e. Street address.

f. Nearest street intersection.

g. Emergency response unit assignments by unit type and number for first, second, third, and subsequent alarms, including substitute unit(s) for normally assigned unit(s) previously entered into the system by the telecommunicator as being in a status which makes them not available to respond.

h. Pre-Incident Planning Information and special instructions for first-arriving units.

2.10.4 Manual Alarm Entry Capability

Provide system with manual alarm entry capability to enable the telecommunicator to enter alarm locations by any of the following: building name or number, transmitter number, street address, or nearest street intersection. When an alarm is manually entered, ensure the system displays[and prints] the information specified in paragraph entitled "Automatic Display".

2.10.5 Unit Status Tracking Capability

****

NOTE: Consult the Federal Fire Chief to determine the number of units that the system should be capable of tracking. Ensure anticipated department growth over the expected life of the system is factored into this quantity.

****

Provide system with unit status tracking capability to enable the telecommunicator to record changes in individual unit status (such as in-quarters, responding, on-scene) with no more than two keystrokes (not counting unit number) or mouse clicks. Ensure system is capable of tracking status of at least [_____] units simultaneously.

2.10.6 Pre-Incident Plan Retrieval

Provide system with pre-incident planning storage and retrieval capability to enable the telecommunicator to access pre-incident plans. For displayed alarm location, ensure that access to the pre-incident plan does not require more than two keystrokes or mouse clicks.

2.10.7 Hazardous Materials Data Retrieval

Provide system with hazardous materials data storage and retrieval capability to enable the telecommunicator to access stored hazardous material database information.

2.10.8 Power Source

Provide primary power for CAD system [through a connection into the line side of the building's regular AC service circuit][from the supervising station's emergency service circuit] through a dedicated, lockable, 20A breaker that is red in color and labeled "CAD".

2.10.8.1 Uninterruptible Power Supply (UPS)

****

NOTE: Specify type and class of Stored Emergency Power Supply System (SEPSS) based on requirements of NFPA 1225: STANDARD FOR EMERGENCY SERVICES COMMUNICATIONS and NFPA 72: NATIONAL FIRE ALARM AND SIGNALING CODE. A Type U SEPSS is primarily fed by utility power but instantly switches to UPS power upon utility power loss. A Type O SEPSS is

constantly powered through the UPS batteries. A Class 1 SEPSS will provide power for 60 minutes, and is the minimum allowable.
****

Provide a Type [U][O], Level 1, Class [1][4][_____] Stored Emergency Power Supply System (SEPSS) in compliance with NFPA 111 to provide power for operation of the CAD computer(s), monitors, and printer in the event of loss of power on the line side of the SEPSS.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Provide installation in accordance with the requirements of NFPA 70, NFPA 72, and the manufacturer's instructions, unless otherwise specified. Provide all necessary interconnections, services, and adjustments required for a complete and operational system. Unless indicated otherwise on the Contract Drawings, provide all new wiring and raceways. Dress out all transmitters[,][and] receivers[,][and][interface panels][,][and new wiring in existing panels,] in a neat manner with all wires running in a vertical or horizontal plane, cut to exact length, making all turns at 1.57 rad 90 degree angles, and tightly bundled and tie wrapped. Make all terminations under screw terminals. Pigtail or "T-tap" connections are prohibited. Use of crimped connectors is prohibited[, except that use of crimped connectors at termination points is required where stranded wire is used].

3.2.1 Wiring for Systems

Provide wiring for systems in rigid conduit, intermediate metallic conduit, or electric metallic tubing[, except surface mounted wiring in surface metal raceway in finished areas is permitted where indicated on the Contract Drawings]. Do not install the conductors for the fire alarm reporting system in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Ensure that the sum of the cross-sectional areas of individual conductors does not exceed 40 percent of the interior cross-sectional area of the raceway. Provide raceway in compliance with NFPA 70. Provide ample gutter space to accommodate necessary wiring. Paint all junction box covers red and provide them with permanent rigid engraved labels reading "FIRE REPORTING".

Install no more than one conductor under any screw terminal. Connect each pathway conductor entering or leaving any mounting box, outlet box enclosure, or cabinet to screw terminals with each terminal marked in accordance with the wiring diagram. Ensure that wiring within control equipment is readily accessible without removing component parts.

3.2.1.1 Conductor Identification

Distinctively color code each conductor used for the same specific function; ensure that each function color code remains consistent throughout.[Use colors as directed by the Contracting Officer to match the existing Installation fire alarm conductor color coding scheme.] Identify conductors at every termination, junction, and splice by means of plastic coated self-sticking printed markers or by heat-shrink type sleeves. Attach markers in a manner that will prevent accidental detachment. Furnish a printed schedule of conductor markings identifying each wire marker, and the purpose, the origin, and the termination of each conductor; also include this information on the as-built drawings.

3.2.1.2 Additional Installation Requirements

Pull all conductors splice-free. Provide insulated barrier type terminal strips at junction points. Use of wire nuts, crimped connectors, or twisting of conductors together is prohibited. Route raceway such that it does not enter the top of a transmitter, receiver, control panel, or interface panel. Provide raceway seals for all raceways terminating at a transmitter, receiver, control panel, or interface panel.

3.2.2 Overvoltage and Surge Protection

Protect equipment connected to alternating current circuits from surges in accordance with IEEE C62.41.1, IEEE C62.41.2, and NFPA 70. Provide cables and conductors which serve as communications links, except fiber optics, with surge protection devices installed at each end. Do not use fuses for surge protection.[Install additional triple electrode gas surge protectors, rated for the applications, on each wireline circuit within 910 mm 3 feet of the building entrance.]

3.2.3 Ground Rods

Ensure that ground rods do not protrude more than 150 mm 6 inches above grade. Ensure that non-current-carrying metallic parts associated with fire alarm reporting equipment have a maximum resistance to solid "earth" ground not to exceed [25][_____] ohms.

[3.2.4 Protected Premises Control Units

3.2.4.1 Fire Alarm Control Units

Provide connection to protected premises fire alarm control units in accordance with NFPA 72 and as specified herein. Provide separate alarm, supervisory, and trouble pathways between DACT and fire alarm control unit. Ensure that actuation of control unit alarm contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as an alarm signal. Ensure that actuation of control unit common supervisory contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as a supervisory signal. Ensure that actuation of control unit common trouble contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as a trouble signal.

[3.2.4.2 Fire Suppression or Fire Extinguishing System Control Units

****

NOTE: Select the NFPA standard(s) applicable to the systems to which direct connections from the DACT are to be made; delete standards not applicable. If all suppression and extinguishing system control

units are connected to fire alarm control units in compliance with the applicable NFPA codes and standards, separate connections between the suppression or extinguishing system and the DACT are not required. If all connections are through the building fire alarm system, delete the entire paragraph.
****

Provide connection to protected premises fire suppression or fire extinguishing system control units in accordance with[NFPA 11,][NFPA 12,][NFPA 12A,][NFPA 13,][NFPA 17,][NFPA 17A,] NFPA 72,[NFPA 2001,] and as specified herein. Provide separate alarm, supervisory, and trouble pathways between DACT and control unit. Ensure that actuation of control unit alarm contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as an alarm signal. Ensure that actuation of control unit common supervisory contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as a supervisory signal. Ensure that actuation of control unit common trouble contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as a trouble signal.

][3.2.4.3 Fire Pump Controllers

****
NOTE: NFPA 20: STANDARD FOR THE INSTALLATION OF STATIONARY PUMPS FOR FIRE PROTECTION requires the pump running alarm and two supervisory signals to be transmitted to a "constantly attended" location, which is usually the supervising station. If direct connections are to be provided from a pump controller to a DACT, consult the controller wiring diagram for availability of "remote alarm" contacts; if all connections are through building fire alarm systems, delete this paragraph.
****

Provide connection to fire pump controllers in accordance with NFPA 20, NFPA 72, and as specified herein. Provide separate alarm and supervisory pathways between DACT and pump controller. Ensure that actuation of controller "pump running" contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as an alarm signal. Ensure that actuation of other controller remote alarm contacts required by NFPA 20 cause transmission of distinctly identifiable signals that are displayed and annunciated by the receiving systems specified herein as supervisory signals.

]][3.3 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM

****
NOTE: Contact the Contracting Officer, Installation Fire Prevention Office, and Installation Maintenance Personnel to determine what action is appropriate for the salvaging of existing fire alarm reporting equipment.
****

Maintain existing fire alarm reporting equipment fully operational until the new equipment has been tested and accepted by the Contracting Officer. As new equipment is installed, label it "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Government, place it in service and connect it to the supervising station. Remove tags from new equipment and tag the existing equipment "NOT IN SERVICE" until removed from the building.

a. After acceptance of the new system by the Contracting Officer, remove existing equipment not connected to the new system, remove unused exposed raceway, and restore damaged surfaces. Remove the material from the site and dispose of it properly.

b. Disconnect and remove the existing fire alarm reporting systems where indicated.

c. Turn over disconnected and removed control units, devices, and appliances to the Contracting Officer.

d. Properly dispose of outlet and junction boxes, wiring, raceway, supports, and other such items.

]3.4 PROGRAMMING

****

NOTE: Tailoring tags are used to add information specific to CAD systems when applicable.

****

Field program each receiving and control system with all system transmitter identity codes, zones on each transmitter, and appropriate message and audible alerting tone associated with each active zone (for example: Transmitter 1234; Zone One - Waterflow (alarm tone), Zone Two - Pump Running (alarm tone), Zone Three - Valve Supervisory (supervisory tone), Zone Four - System Trouble (trouble tone)). Program transmitter automatic test times so that at least one test signal is received at the receiving and control system at not exceeding [five-minute][60-minute][_____] intervals. Field program each CAD computer with all data required for proper operation of CAD system as specified in the paragraph entitled "Computer-Aided Dispatch (CAD) System". Obtain emergency response unit type or number and pre-incident plan information for each location and transmitter number from the Federal Fire Chief.

3.5 FIELD QUALITY CONTROL

3.5.1 Interim Construction Observation Visit[s]

Perform interim construction observation visit[s] when construction is[sufficiently underway to provide sufficient evidence of installation practices being followed, but not so far along as to cause major schedule delays to correct any deficiencies observed][approximately[25 percent][,][50 percent][,][and][75 percent] complete]. Document each site observation visit with a separate site observation report documenting what was observed and any corrective actions required as a result of the visit. Submit site observation report(s) within [14][_____] days of conclusion of respective site observation visit.

3.5.2 Test Procedures

Submit detailed test procedures at least [30][______] days prior to proposed start of performing system tests. List all components of the installed system such as batteries, transmitting and receiving equipment, power sources and supply, interface equipment, and transient voltage (surge) suppressors. Include sequence of testing, time estimate for each test, and sample test data forms. Provide test data forms in a check-off format (pass or fail with space to add applicable test data; similar to the format in NFPA 72) and use them for the preliminary testing and the final testing. Provide test data forms that record the test results and:

a. Identify each test required by NFPA 72 Test Methods and herein to be performed on each component, and describe how this test must be performed.

b. Identify each component and pathway as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan and site plan sheets showing each component location, test location, and alphanumeric identity.

c. Identify all test equipment and personnel required to perform each test.

d. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.5.3 Test Stages

3.5.3.1 Preliminary Testing

Conduct preliminary tests to ensure that equipment and pathways are functioning properly. Meet the requirements of paragraph entitled "Minimum System Tests". If deficiencies are found, make corrections and retest the system to ensure that they are resolved. After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable with the Request for Formal Inspection and Tests. State in the letter that panel functions were tested and operated properly. Provide a print-out of the system history log from the testing performed as an attachment to the letter. Include the names and titles of the witnesses to the preliminary tests in the letter. Ensure that the QFPE, as well as the Supervisor, are in attendance at the preliminary testing and sign off on the letter. Submit request for final test at least [30][_____] calendar days prior to the proposed test date.

3.5.3.2 Final Testing

Conduct final tests to ensure that equipment and pathways are functioning properly. Meet the requirements of paragraph entitled "Minimum System Tests". If deficiencies are found, make corrections and retest the system to ensure that they are resolved. Costs for witnessing of retesting incurred by the Government and their representatives may be charged to the Contractor at the discretion of the Contracting Officer. Ensure that the final tests are witnessed by the DFPE and the QFPE. At this time, repeat any and all required tests at their discretion.

Do not schedule final testing until the following are provided at the job site:

a. Marked-up red line drawings of the system as actually installed.

b. Complete program printout including input and output addresses.

3.5.3.2.1 Final Test Report

Provide a letter certifying that the installation is complete and fully operable with the Final Test Report. State in the letter that panel functions were tested and operated properly. Provide a print-out of the system history log from the testing performed as an attachment to the letter. Include the names and titles of the witnesses to the final tests in the letter. Ensure that the QFPE, as well as the Supervisor, are in attendance at the final testing and sign off on the letter.

3.5.3.3 System Acceptance

Following acceptance of the system, deliver as-built drawings and operation and maintenance instructions (O&M Manuals) to the Contracting Officer for review and acceptance. Submit the drawings within [two][_____] weeks after the final testing of the system. Provide at least one set of as-built (marked-up) drawings at the time of, or prior to, the final testing.

3.5.4 Minimum System Tests

****

NOTE: Tailoring tags are used to add information specific to CAD systems when applicable.

****

Test the system in accordance with the procedures outlined in NFPA 72. Include at least the following tests:

a. Test to ensure there are no grounded, shorted, or open pathways. Measure the resistance of each connection to ground and ensure it does not exceed five ohms.

b. Check each cable at the transmitter or receiver connection for continuity, shorts, and grounds on the conductor and on the shield prior to connection to equipment. Do not connect assemblies failing these tests to equipment.

c. Test each input to and output from each DACT, including transmission of trouble, supervisory, and alarm signals across both the first and second telephone lines at each location, and verify proper reception at the supervising station.

d. [d. Test operation of each interface device.

e.]e. Test operation of each protected premises control unit zone.

f. Test operation of supervisory features.

g. Test operation of all features of each fire alarm receiving and control system component and each supervising station fire alarm receiving and control system as a whole.

h. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

i. Determine that the system is operable under trouble conditions as specified.

j. Visually inspect wiring.

k. Test the battery charger and batteries.

l. Verify that red-line as-built drawings are accurate.

m. Test all functions of the CAD system to verify proper programming and operation.

3.6 CLOSEOUT ACTIVITIES

[3.6.1 Final QFPE Certification Letter

****

NOTE: The final QFPE Certification Letter is intended to be provided when a single QFPE has been hired to oversee all fire protection and life safety components of a given project. The letter should not be submitted until all fire protection and life safety systems have been completely installed and tested, not just the fire alarm reporting system. This paragraph is likely more appropriate to place in a division 01 specification section rather than each individual fire protection or life safety component section.

****

Following successful completion of all acceptance testing, including resolution of all punch list items, provide a certification letter from the QFPE, bearing his or her Professional Engineer seal and signature, attesting to the proper installation and successful testing of all fire protection and life safety systems in the [building][project]. Submit the Final QFPE Certification Letter no later than [seven][_____] days after the successful completion of final acceptance testing and resolution of all punch list items.

]3.6.2 Training

3.6.2.1 Instruction of Operating Personnel

****

NOTE: Consult the Federal Fire Chief regarding the number of shifts and number of personnel to be trained.

****

****

NOTE: Tailoring tags are used to add information specific to CAD systems when applicable.

****

Train personnel who receive, process, and retransmit alarms at each supervising station and emergency response facility which houses a digital alarm communicator type receiving system provided under this Contract. Train personnel who receive, process, and retransmit alarms at each supervising station and emergency response facility which houses a CAD system workstation provided under this Contract. Provide this instruction for [two][three] alternating shifts, minimum of [four][eight][_____] hours per shift, and include at least the following:

a. Overview of functions of individual system components and the system as a whole.

b. Proper responses to the various types of messages which can be displayed.

c. Procedures for startup, operation, and shutdown of transmitting, receiving, and control system.

d. Procedures for startup, operation, and shutdown of CAD system.

e. Procedures for diagnosing and correcting operator-correctable malfunctions.

f. Procedures for restarting system after total power (primary and backup) failure.

g. Procedures for manually initiating system tests.

h. Train supervisory personnel on each shift, as designated by the Contracting Officer, in procedures for adding and deleting transmitters and changing zone-specific messages.

i. Train supervisory personnel on each shift, as designated by the Contracting Officer, in procedures for loading CAD data.

Perform training by the manufacturer's technical representative(s) on-site using the equipment provided under this Contract. At the conclusion of this training, provide training certificates to certify by name that each operator trained is qualified to operate the digital alarm communicator type receiving system equipment provided under this Contract. At the conclusion of this training, provide training certificates to certify by name that each operator trained is qualified to operate the CAD system provided under this Contract.

3.6.2.2 Instruction of Maintenance Personnel

Instruct Government-designated maintenance personnel for a minimum of [16][_____] total hours covering at least the following for all items of equipment provided under this Contract:

a. Theory of operation.

b. Procedures for start-up, operation, and shutdown of each item of equipment.

c. Maintenance instructions.

d. Safety precautions.

e. Test procedures.

f. Field troubleshooting and diagnostic procedures.

g. Repair procedures for field repairs that can be made by replacing plug-in components.

Provide instruction by the manufacturer's technical representative at the project site using the documents specified in the paragraph entitled "Operation and Maintenance (O&M) Instructions".

3.6.2.3 Recordings

Record all training presented on-site utilizing recording equipment acceptable to the Contracting Officer. Perform recording such that all visual aids are clearly visible and all discussion is clearly understandable. Provide record copies of the recordings to the Contracting Officer within [14][_____] days following completion of training.

[3.6.2.4 Advanced Maintenance Training

****

NOTE: Advanced Maintenance Training is intended for those Installations where the government personnel are going to be responsible for making programming changes to the equipment or installing new equipment without the involvement of a manufacturer's representative. This training is intended to provide those individuals with manufacturer's certification level training to enable them to be competent to make such changes.

****

Within one year of contract completion, provide [one][two][_____] Government-designated maintenance personnel assigned to the site a complete technical repair training session of [40][_____] hours covering repair of the digital alarm communicator system equipment. Include in the training an in-depth explanation and review of the theory of operation, function, description, and troubleshooting of all equipment provided down to the component level. Include a review of manuals, drawings, and parts lists, together with any clarifications required. Ensure that at least one period of eight hours is spent troubleshooting equipment with actual faults being introduced for training purposes. Provide instructional personnel that are certified by the related equipment manufacturer to provide technical instruction services. Transportation, lodging, and meals for Government personnel attending this off-site training is not the responsibility of the Contractor.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-28 31 33 (August 2023)**

Preparing Activity: USACE

Superseding
UFGS-28 31 33.00 10 (November 2008)
UFGS-28 31 33.13 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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08/23

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USACE / NAVFAC / AFCEC **UFGS-28 31 33 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-28 31 33.00 10 (November 2008)
UFGS-28 31 33.13 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 28 31 33

FIRE ALARM REPORTING SYSTEM, RADIO TYPE

08/23

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NOTE: This guide specification covers the requirements for radio transmitted fire alarm reporting systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions, and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

Interior building fire alarm systems are covered by Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE, Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE, Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, and Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE.

In 2022, discussions were held regarding which UFGS template specification sections should be developed or maintained related to fire alarm reporting systems. As a result of these discussions, the Department of Defense Fire Protection Engineering Working Group (FPEWG) determined that the technologies represented in Section 28 31 32 FIRE ALARM REPORTING SYSTEM, DIGITAL COMMUNICATOR TYPE and Section 28 31 33 FIRE ALARM REPORTING SYSTEM,

RADIO TYPE were the most appropriate technologies for which to maintain template specification sections. Based on the rate at which the fire alarm reporting system industry is changing, the FPEWG decided that it was prudent to hold off on developing an additional UFGS section for other technologies (such as internet protocol type systems) until more evidence-based requirements can be developed based on real-world system experience and advancement of NFPA 72 to include more prescriptive guidance on systems using other communication technologies. This is not intended to convey that use of other technologies is discouraged or prohibited. If the Qualified Fire Protection Engineer editing this specification, in consultation with the Designated Fire Protection Engineer, determines that another communication technology is best suited to meet the needs of the project, it is recommended that he or she choose one of the two existing UFGS sections and edit that section to include all pertinent information related to the chosen alternative technology.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022; Supp 1 2023; Supp 2 2023) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 11	(2024) Standard for Low-, Medium- and High- Expansion Foam
NFPA 12	(2025) Standard on Carbon Dioxide Extinguishing Systems
NFPA 12A	(2022) Standard on Halon 1301 Fire Extinguishing Systems
NFPA 13	(2024) Standard for the Installation of Sprinkler Systems
NFPA 17	(2024) Standard for Dry Chemical Extinguishing Systems
NFPA 17A	(2024) Standard for Wet Chemical Extinguishing Systems
NFPA 20	(2025) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 111	(2025) Standard on Stored Electrical Energy Emergency and Standby Power Systems
NFPA 170	(2024; ERTA 1 2023) Standard for Fire Safety and Emergency Symbols
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems
NFPA 1225	(2025) Standard for Emergency Services Communications
NFPA 2001	(2025) Standard on Clean Agent Fire Extinguishing Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-222	(2018H; Add 1 2019) Structural Standard for Antenna Supporting Structures and Antennas and Small Wind Turbine Support Structures

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 96	(2016; May 2023) UL Standard for Safety Lightning Protection Components
UL 96A	(2023) UL Standard for Safety Installation Requirements for Lightning Protection Systems
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 514A	(2024) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings

UL 797	(2007; Reprint Apr 2023) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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NOTE: Tailoring tags are used to add information specific to CAD systems when applicable.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer's Qualifications; G, [_____]

Installer's Qualifications; G, [_____]

Supervisor's Qualifications; G, [_____]

Designer's Qualifications; G, [_____]

Structural Engineer's Qualifications; G, [_____]

SD-02 Shop Drawings

Shop Drawings; G, [_____]

SD-03 Product Data

Radio Fire Alarm Transmitter (Transceiver); G, [_____]

Transmitter Antenna; G, [_____]

Transmitter Antenna Cable; G, [_____]

Transmitter Interface Device; G, [_____]

Supervising Station Radio Fire Alarm Receiver (Transceiver); G, [_____]

Supervising Station Radio Fire Alarm Receiver (Transceiver) Antenna System; G, [_____]

Supervising Station Radio Fire Alarm Receiver (Transceiver) Antenna Supporting Structure; G[, [_____]]

Supervising Station Terminal; G, [_____]

Supervising Station Printer; G, [_____]

Uninterruptible Power Supply (UPS); G, [_____]

Fire Alarm Reporting System Peripheral Equipment; G, [_____]

Computer-Aided Dispatch (CAD) System; G, [_____]

SD-05 Design Data

Battery Calculations; G, [_____]

Foundation Data; G, [_____]

SD-06 Test Reports

Site Observation Report(s)

Test Procedures; G, [_____]

Request for Formal Inspection and Tests; G, [_____]

Final Test Report; G, [_____]

SD-07 Certificates

Current Listings or Approvals

SD-10 Operation and Maintenance Data

Operation And Maintenance Instructions; G, [_____]

SD-11 Closeout Submittals

Special Tools

Spare Parts Data

Spare Parts

As-Built Drawings; G, [_____]

Final QFPE Certification Letter

Training Certificates

Recordings

1.3 SUBMITTAL REQUIREMENTS

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NOTE: Review Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) to ensure specific quantities and formats of submittals are included as desired. Coordinate with DFPE and Contracting Officer on required quantities and formats to be provided.

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Provide submittals in quantities, formats, and transmission means as dictated by Section 01 33 00 SUBMITTAL PROCEDURES. Draw floor plans to a scale no less than 1:100 1/8 inch equals 1 foot. Utilize NFPA 170 compliant symbols.

Submit Shop Drawings (SD-02), Product Data (SD-03), and Calculations (SD-05) simultaneously. Submit all Product Data as a single combined package. Partial submittals; SD-02, SD-03, and SD-05 submittals not submitted simultaneously; and submittals not fully complying with the requirements of applicable NFPA standards and this specification; are not acceptable and may be returned without review at the discretion of the Contracting Officer.

1.3.1 Submittal Schedule

Submit all Preconstruction Submittals (SD-01) within [14][_____] days following Notice to Proceed and before any other classification of submittal. Provide submittals for SD-02, SD-03,[SD-04,] and SD-05 no less than [21][_____] days prior to the proposed start of construction on the subject system. Provide other submittals as specified in other sections of this specification.

1.3.2 Shop Drawings

Provide shop drawings compliant with the Shop Drawings section of NFPA 72 and the following. Submit plan views showing system layout, including transmitting equipment, receiving equipment, interfacing equipment, terminal cabinet locations, junction boxes, other related equipment, raceway routing, wire color coding, wire counts, pathway identification in each raceway, pathway layouts, and end-of-line supervisory devices. Ensure drawings reflect the actual proposed wire and raceway routing as it will be installed in the field. Submit detailed point-to-point wiring diagrams showing all points of connection. Include connections between system devices, appliances, control panels, supervised devices, and all equipment that is activated or controlled by the panel in the diagrams. Provide mounting details for each type of transmitter and antenna. Show a single-line system riser diagram. Provide each transmitter and receiver on the riser with an identification number indicating its building number. Indicate connection of equipment by pathway runs or raceway runs.

Show data essential for proper installation of each system. Show details, plan views, elevations and sections of the systems. Submit plan view and cross-section of supervising station operations room, showing all [new and retained existing]equipment and furnishings, drawn in 1:50 1/4 inch equals 1 foot or larger scale.

1.3.3 Product Data

Provide manufacturer's product data sheets for each system component to be provided, including at least each item specified herein. Annotate product data sheets to indicate precise equipment that is to be provided, including an indication of all options selected.

1.3.4 Design Data

Submit battery calculations to substantiate that the battery capacity provided exceeds supervisory and alarm power requirements for radio fire alarm transmitters[, interface units,] and receiving and control equipment.

Submit foundation data to substantiate that the foundation designs for supervising station radio fire alarm receiver (transceiver) antenna support structures are adequate to withstand the anticipated environmental conditions and equipment loads.

1.3.5 Test Reports

Submit reports for inspections and tests specified under paragraphs titled "INTERIM CONSTRUCTION OBSERVATION VISIT[S]" and "TESTING". Submit test reports in booklet form showing field tests performed to prove compliance with the specified performance criteria upon completion and testing of the installed system. Document readings, test results, and the final position of controls on each test report.

1.3.6 Certificates

Submit copies of current listings or approvals for all equipment furnished. Submit listing or approval documentation from a nationally recognized testing laboratory for transmitters, interface equipment, and receiving and control equipment showing that such equipment is listed or approved for use together as an integrated system.

1.3.7 Operation and Maintenance Data (O&M)

Submit the Operation and Maintenance Instructions indexed and in booklet form as a single volume or in separate volumes. Inscribe the following identification on the cover: the words "FIRE ALARM REPORTING OPERATION AND MAINTENANCE MANUAL", the location of the building, the name of the Contractor, the system manufacturer, and the contract number. Provide instructions that are legible and easily read, with large sheets of drawings folded in. Provide submittals for SD-10 at least [21][_____] days prior to the proposed start of training. Do not provide training prior to approval of SD-10 submittals. Include the following in the Operation and Maintenance Instructions:

a. "Data Package Five" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and its basic operating features in each manual.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. Include raceway layout, equipment layout, and simplified wiring and control diagrams of the system as installed in each manual.

d. A list of parts and tools that should be kept in stock by the owner for routine maintenance, including the name of a local supplier and recommended service organization (including address and telephone number) for each item of equipment. Ensure that each service organization submitted is capable of providing [four-hour][[_____]-hour] on-site response to a service call on an emergency basis.

e. Complete procedures for system revision and expansion, detailing both equipment and software requirements.

f. Software for this project on CD or DVD media.

g. Printouts of configuration settings for all devices and appliances.

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NOTE: Ensure that all data on routine maintenance checklist (devices, appliances, testing frequencies, etc.) complies with UFC 3-601-02: FIRE PROTECTION SYSTEMS INSPECTION, TESTING, AND MAINTENANCE.

****

h. Routine maintenance checklist arranged in a columnar format. List all installed devices and appliances in the first column, state the maintenance activity or state no maintenance required in the second column, state the frequency of the maintenance activity in the third column, and provide a fourth column for additional comments or reference.

1.3.8 As-Built Drawings

Show the system as installed, including deviations from both the Contract Drawings and the approved shop drawings. Ensure the accuracy of the as-built drawings is plus or minus 150 mm 6 inches for all device, appliance, and equipment locations, and plus or minus 300 mm 12 inches for all raceway and wire runs.

a. Prepare the drawings in the same format, size, and layout as the approved shop drawings.

b. Include complete wiring diagrams showing connections between devices, appliances, and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices, appliances, and equipment.

1.4 SPECIAL TOOLS AND SPARE PARTS

Furnish special tools necessary for the maintenance of the equipment. Submit spare parts data for each different item of material and equipment specified, after approval of shop drawings, and not later than [60][_____] days prior to the anticipated date of beneficial occupancy. Include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after [one][_____] year[s] of service.

Provide the following spare parts:

****

NOTE: Edit this list as desired by the contracting organization. Generally, spare parts are discouraged by UFC 1-300-02: UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS) FORMAT STANDARD, but some hard to replace or easily lost items may be warranted for inclusion.

****

a. [Two][_____] radio transmitters of each configuration provided.

b. [Two][_____] radio receivers of each configuration provided.

c. [Two][_____] radio transmitter interface devices of each configuration provided.

d. [Two][_____] radio transmitter antennas of each type provided.

e. [10][_____] sets of fuses of each type and size provided.

f. [Five][_____] lamps of each type provided.

g. [16][_____] reams of permanent record printing paper.

h. [10][_____] complete sets of system keys.

1.5 QUALITY ASSURANCE

1.5.1 Materials

[Provide materials and workmanship conforming to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, with the additions and modifications specified herein.]Include provision of all labor, material, tools, and equipment necessary for and incidental to the provision of a complete and usable radio fire alarm reporting system.

****

NOTE: For OCONUS projects, use the blank brackets to insert local certification organizations that are considered equivalent to United States (U.S.) Nationally Recognized Testing Laboratories (NRTLs) for your project.

****

Ensure all devices, appliances, and equipment for fire alarm service are listed by [a Nationally Recognized Testing Laboratory (NRTL)][_____] for their intended purpose.

1.5.2 Codes, Standards, and Manufacturer's Literature

Provide the system in accordance with NFPA 70, NFPA 72,[NFPA 1225,] and as specified herein. Interpret reference to "authority having jurisdiction" to mean the Contracting Officer.

Follow all recommended installation and start-up practices stated in the manufacturer's literature or documentation.

1.5.3 Qualifications

1.5.3.1 Qualified Fire Protection Engineer (QFPE)

****

NOTE: For large and complex projects, it is advisable for the QFPE to be directly hired by the General Contractor as an integral part of the General Contractor's team for identifying and incorporating all of the fire protection and life safety requirements for the project. The General Contractor should clearly identify a single firm (or individual) designated as the QFPE for the project. The General Contractor should not separate the responsibilities of the QFPE, as established in UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES, among multiple subcontractors.

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****

NOTE: It is strongly recommended that the specification writer coordinate closely with the Government's Designated Fire Protection Engineer (DFPE) regarding QFPE expectations to be included in this specification.

****

Provide the services of a Qualified Fire Protection Engineer (QFPE). A QFPE is an individual who is a licensed Professional Engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Ensure that the QFPE is an integral part of the construction team and is involved in every aspect of the system's submittals, installation, and testing. Submit the Qualified Fire Protection Engineer's Qualifications, including the name and documentation of qualifications of the proposed QFPE.

Ensure that the QFPE:

****

NOTE: UFC 3-600-01: FIRE PROTECTION ENGINEERING FOR FACILITIES requires that shop drawings, calculations, and material data sheets bear the Review Stamp of the QFPE prior to submission to the Government for approval. For Army projects, the QFPE is also required to apply their Professional Engineer seal and signature to the shop drawings, calculations, and material data sheets prior to submission to the Government for approval.

****

a. Reviews all required shop drawings, material data, calculations, qualifications, test procedures, test reports, as-built drawings, and O&M manuals for completeness and compliance with the provisions of this Contract prior to submitting them to the Government. Ensure that construction (shop) drawings and calculations are prepared by, or prepared under the immediate supervision of, the QFPE. Affix the QFPE's [review stamp][and][Professional Engineer seal with signature] to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting them to the Government.

b. Provides a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and note any outstanding comments.

c. Performs in-progress construction surveillance prior to installation of ceilings (rough-in inspection)[or closure of trenches]. Performs at least [one][_____] interim site observation visit[s] prior to completion of installation, separate from the preliminary testing, to confirm that all systems are being installed in accordance with the Contract.

d. Witnesses and approves all preliminary and final functional performance testing and performs a final installation review.

e. Signs all certificates under SD-07.

f. Attends training sessions presented as a part of this project to answer questions that may arise.

1.5.3.2 Installer

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NOTE: Consult with the DFPE for guidance on when to include the UL certification requirements for the Installer.

****

Provide an Installer that is qualified as required by the Personnel

Qualifications section of NFPA 72 and the following. Submit the Installer's Qualifications including written certificate demonstrating that the radio fire alarm reporting system Installer has been regularly engaged in the installation of radio fire alarm reporting systems meeting NFPA standards for a minimum of three years immediately preceding commencement of this contract. Include proof of satisfactory performance on at least three projects similar to that required by these specifications, including the names and telephone numbers of using agency points of contact for each of these projects. Indicate the type of each system installed and include a written certification that each system has performed satisfactorily in the manner specified for a period of not less than 18 months following completion.[Listing of the Installer under "Protective Signaling Services - Local, Auxiliary, Remote Station Proprietary (UUJS)" or under "Protective Signaling Services - Central Station (UUFX)" of the UL Fire Prot Dir will be accepted as equivalent proof of compliance with the stated experience requirements.][Ensure that the installer is UL certified for the installation and testing of the fire alarm systems. Provide proof of this listing. Provide a list of installer's personnel as part of the submittal package under the subparagraph titled "Certificates".] Ensure Installer is able to provide service within 24 hours.

1.5.3.3 Supervisor

Provide the services of a qualified technician, factory trained, certified, and experienced in the installation and operation of the type of system being provided to supervise the installation, adjustment, preliminary testing and final testing of the system, and to provide instruction to Government maintenance and operating personnel.

Submit the Supervisor's Qualifications including name(s) of the Supervisor(s) who will oversee installation and testing of the system, and who will provide instruction to Government personnel, along with the manufacturer's certification of the qualifications of the named representative(s).

1.5.3.4 Designer

Provide a Designer that is qualified as required by the Personnel Qualifications section of NFPA 72 and the following. Prepare shop drawings, product data, design data, O&M manual(s), and as-built drawings by, or under the supervision of, a qualified technician. A qualified technician is an individual who is experienced with the types of work specified herein and is currently certified by the National Institute for Certification in Engineering Technologies (NICET) as an engineering technician with minimum Level [III][IV] certification in fire alarm systems, or holds an equivalent certification and training acceptable to the Contracting Officer. Submit the Designer's Qualifications including the name and documentation of certification of the proposed Designer.

[1.5.3.5 Structural Engineer

Provide a registered professional Structural Engineer to design the supervising station radio fire alarm receiver (transceiver) antenna supporting structure to resist all environmental loads, including site-specific wind and seismic forces. Include the engineer's name, signature, and Professional Engineer number on all final design documents. Submit the Structural Engineer's Qualifications including the name and documentation of qualifications of the proposed Structural Engineer.

]1.6 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt, dust, and other contaminants.[Do not store poles on ground. Support poles so they are at least 300 mm 12 inches above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing the pole.]

[1.7 CONTINUITY OF PROTECTION

Ensure no loss of function of the existing Installation fire alarm reporting system, or of the protected premises alarm[and fire suppression or fire extinguishing] system[s] connected thereto occurs during installation of this system. Ensure that transfer of protected premises system connections from the existing Installation fire alarm reporting system does not result in loss of signal transmitting or receiving capability. Temporary interruption of individual protected premises systems connections, not to exceed eight hours in duration, will be permitted with the approval of the Contracting Officer. No interruption of alarm or communications functions at the supervising station will be permitted.

][1.8 INTERCONNECTION WITH EXISTING COMPUTER-AIDED DISPATCH (CAD) SYSTEM

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NOTE: Use this paragraph if there is an existing CAD system which is to be retained. Describe the existing system as precisely as possible. Otherwise, delete this paragraph.

****

1.8.1 Interconnection to Fire Alarm Reporting System

Provide interconnection of radio fire alarm receiving and decoding systems with existing CAD system so that signals are automatically processed by the CAD system,[and] displayed on the CAD monitor screen[, and printed on the CAD printer] as they are received. The existing CAD system utilizes [_____] software, version [_____], and operates on a [_____] computer with [_____] MHz processor, [_____] hard drive, [_____] RAM[, [and][_____] floppy disc drive][, and [_____] CD ROM drive].[[_____] ports are available for this connection.]

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a complete, supervised, radio-based fire alarm reporting system complying with NFPA 70, NFPA 72,[NFPA 1225,] and this specification, consisting of remote radio alarm transmitters connected to each building fire alarm control unit and a radio alarm receiver system at a supervising station. Provide spare radio alarm receivers at the supervising station in accordance with NFPA 72. Provide system connections to protected premises fire alarm system[and fire suppression or fire extinguishing system] control units.[New protected premises fire alarm systems are specified in Section [28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE][28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE][28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE][28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE].] System is permitted to use one-way or two-way (interrogation) communication, or both, to comply with the performance requirements specified herein. If a two-way system is provided, interpret the term "transmitter" as used in this section to mean "transmitter and receiver" or "transceiver".

2.1.1 Operation

Ensure the receiving system is activated into the active signal mode when an abnormal condition occurs in any building fire alarm system. Ensure the receiving system remains in the active signal mode until the active signal is acknowledged and reset by the operator. Configure the fire alarm reporting system in accordance with NFPA 72. Ensure the transmitting equipment is compatible with receiving equipment.

2.1.2 Active Signal Functions

****

NOTE: Coordinate with the local fire department or other authority responsible for the fire alarm reporting system to determine which signal or signals are required to be transmitted to the supervising station.

****

Ensure that an alarm, trouble, or supervisory condition in any building which reports to the supervising station automatically initiates the following functions:

a. Transmission of a signal by the radio alarm transmitter. Ensure the radio alarm transmitter establishes or maintains communication pathways with the radio alarm receiver at the supervising station, and transmits the message associated with the active signal.[Ensure that upon failure to connect with the radio alarm receiver using the primary communication pathway, the radio alarm transmitter attempts to connect via the secondary communication pathway.]

b. Ensure that upon receipt of the signal at the supervising station the signal is decoded and status information is displayed on the supervising station visual display indicating the nature of the status change.

c. Sound an audible signal at the supervising station until the signal is acknowledged.

[d. Print the signal information on the system printer at the supervising station.

]

2.2 STANDARD PRODUCTS

Provide radio transmitting, receiving, and decoding equipment that are the current products of one manufacturer regularly engaged in production of such equipment and that essentially duplicate items that have been in satisfactory use for at least two years prior to contract award. Provide all other materials and equipment that are the current products of one or more manufacturers regularly engaged in production of such materials and equipment. Provide solid state electronics. Provide equipment used to interconnect the fire alarm reporting system with protected premises fire alarm system [and fire suppression or fire extinguishing system]control units that is [NRTL][_____] listed for that service; or provide all equipment that is [NRTL][_____] listed as a Supervising Station Fire Alarm

System. Ensure that radio transmitters and receivers comply with all requirements for Federal Communications Commission (FCC) Type Acceptance, except that they must be capable of operation in the military frequency bandwidths and at the power output specified herein. Supervise and operate the radio communication link in accordance with NFPA 72. Provide electrical supervision for all pathways and for all components critical for system operation.

2.3 NAMEPLATES

Provide the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a corrosion-proof and non-heat-sensitive plate which is securely attached to all major components of equipment.[Provide the English translation on each label provided in any language other than English.]

2.4 RADIO FIRE ALARM TRANSMITTER (TRANSCEIVER)

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NOTE: The requirement to provide printed circuit boards with a non-nutrient conformal coating should be considered based on the anticipated ambient conditions to which the circuit boards will be exposed. Consider whether these environmental conditions may be more easily offset by the use of a more robust enclosure. Historically, Navy and Marine Corps preference was to provide such coatings on all installations. Consult with the DFPE for project specific requirements.

****

Provide Radio Fire Alarm Transmitters that are compatible with the Supervising Station Radio Fire Alarm Receiver (Transceiver). Ensure each transmitter is the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Provide transmitters in accordance with applicable portions of NFPA 72 and FCC 47 CFR 15. Ensure transmitter electronics modules are contained within the physical housing as an integral, removable assembly.[At the Contractor's option, and if listed, the transmitter may be housed in the same enclosure as the fire alarm control unit.][Provide printed circuit boards in transmitters with a non-nutrient conformal coating for protection against moisture and fungus. Ensure that the coating is suitable for the climate in which the equipment is to operate and apply it at the factory in accordance with the coating manufacturer's specifications.][Provide interface device for DACT to be compatible with existing system.]

2.4.1 Frequency

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NOTE: Department of Defense (DoD) Instructions require the submission of a DD Form 1494, APPLICATION FOR FREQUENCY ALLOCATION, and assignment of an operating frequency(ies) to be completed by the Government. This process is required to be completed prior to solicitation of a project for construction, and is preferred to have been completed during the planning phase of the project (prior to design). Each Agency has their own

process for submitting this form and obtaining frequency assignment(s). The editor of this specification must coordinate with the Contracting Officer to obtain this information.

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NOTE: In the U.S., the 138-150 MHz eight band is the preferred range since specific frequencies in this range are reserved for DoD use. Frequencies in the 162-174 MHz and 406-420 MHz bands are shared with other users on a first-come, first-served basis. Also the effectiveness of the 406-420 MHz band is limited to relatively short, line-of-sight transmissions, limiting its practicality at geographically larger Installations.

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NOTE: Do not assume that an existing system's frequency assignment will automatically carry over to a new system being installed. It is possible that an existing system is permitted to continue using a given frequency that has been traded away by the DoD as a legacy system, but the same Installation will not be permitted to use that same frequency for a new system.

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NOTE: For Installations outside U.S. territory, compliance with host nation requirements is also mandatory.

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Provide a narrowband radio transmitter with FCC certification for narrowband operation that meets the requirements of the National Telecommunications and Information Administration (NTIA) Manual of Regulations for Federal Radiofrequency Spectrum Management (MRPFRFM). Ensure transmitters operate on any frequency within the [138-150.8 or 162-174 MHz][406-420 MHz][_____] band and are operable within a 12.5 kHz channel. The specific frequency must be [[_____] MHz][as directed by the Contracting Officer, within [90][_____] days following submission of completed application for frequency allocation following contract award]. If two-way transmitter and receivers are provided to fulfill the requirements as specified herein for radio fire alarm transmitters, ensure they transmit and receive on separate frequencies. The second frequency must be [[_____] MHz][as directed by the Contracting Officer, within [90][_____] days following submission of completed application for frequency allocation following contract award].

2.4.2 RF Power Output

Provide transmitters with radio frequency (RF) power output required for reliable reception or one watt, whichever is greater.

2.4.3 Primary Power

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NOTE: The voltage available at each building must be verified. If [100-120][200-240] VAC [60][50] Hz service is not available at certain buildings, the

need for transformers must be noted on the Contract Drawings.

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Operate each transmitter from [100-120][200-240] Volt (V) Alternating Current (AC) [60][50] Hertz (Hz) power. In the event of [100-120][200-240] VAC power loss, automatically switch the transmitter to battery operation. Accomplish switchover with no interruption of protective service and automatically transmit a trouble message. Transmit a trouble message in no less than 200 seconds following loss of AC power for a duration longer than 60 seconds. Upon restoration of AC power, automatically transfer back to normal AC power supply and recharge the battery. Ensure the battery charger is capable of restoring the batteries from full discharge to full charge within [48][_____] hours while the transmitter is operating under normal conditions. Install the converter or battery charger within the transmitter housing. Power supply transient voltage surge suppression must be provided. Provide transmitters with power supply filtering to prevent false message transmissions caused by transient or steady-state electrical disturbances.

2.4.4 Battery Power

Provide transmitter standby battery capacity sufficient to operate the transmitter[and interface device] in a normal standby status for a minimum of [48][_____] hours and be capable of transmitting signals during that period. Provide maintenance-free, [valve-regulated lead-acid][_____] type batteries. Submit substantiating battery calculations for supervisory and alarm power requirements. Include the ampere-hour requirements for each system component, each panel component, and the battery recharging period. Ensure that each fire alarm transmitter constantly monitors and supervises its own battery power supply. Report a low-battery condition when battery voltage falls below the minimum voltage prescribed by the manufacturer, or 85 percent of the rated voltage, whichever is higher.

2.4.5 Environmental Operating Requirements

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NOTE: Check local conditions for design wind gust and ice loading. Lowest design wind speed is 160 km/hour 100 mph; typical design wind speed is 201 km/hour 125 mph.

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Design transmitters not installed within climate-controlled spaces for reliable operation in an ambient temperature range of [-30][-40][_____] to [60][_____] degrees C [-22][-40][_____] to [140][_____] degrees F, a maximum ambient humidity of at least [85][_____] percent at [30][_____] degrees C [86][_____] degrees F, and under adverse climatic conditions including [161][201][_____] km per hour [100][125][_____] mph winds, ice, rain, and snow storms.

2.4.6 Housing

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NOTE: NEMA 1 enclosures should provide the necessary protection for most indoor applications. Upgrading to NEMA 3R, 4, or 4X should only be required if warranted based on anticipated exposed conditions. If locations are deemed to require a

NEMA type other than NEMA 1, they must be shown on the Contract Drawings.

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Provide transmitters with enclosures of corrosion-resistant metal, conforming to NEMA ICS 6 classification in accordance with NFPA 70 for the environment in which they are installed as indicated on the Contract Drawings. If no NEMA type is indicated on the Contract Drawings, provide NEMA Type 1 enclosures. Design transmitter housings for universal mounting on walls, poles, or pedestals. Utilize [lag bolts][,][or][anchor bolts][,][or][stainless steel banding][,][or][mounting brackets][,][or][a shackle and bolt combination] for mounting. Provide enclosures with raceway entry points (minimum 21 mm 3/4 inch I.D.) at no less than one place near the top of the enclosure and one place near the bottom of the enclosure.[Protect internal components from vandalism by a tamper-proof lock on the transmitter housing.] Key locks for all transmitters of each configuration provided alike. Ensure that the housing allows access to all internal components for testing, servicing, and replacement at the installation site. Ensure access door(s) swing open through at least a 2.1 rad 120 degree arc. Factory paint the enclosure with a priming coat and not less than two coats of a durable weatherproof enamel or factory powder coat the enclosure. Ensure the finish color is Fire Engine Red, similar to color number 11105 under SAE AMS-STD-595A, except as otherwise specified herein for each individual transmitter configuration. Repaint all surfaces damaged during installation to match existing paint.[Securely affix a metallic or rigid plastic engraved code number plate to the front of the enclosure.][Monitor the housing for tampering and automatically transmit a tamper message when a tamper switch is tripped in the transmitter housing.]

2.4.7 Communication

a. Provide transmitters that are capable of being connected to and receiving signal inputs from[existing][and][new] fire alarm control units.

b. Provide transmitters that are a standard design which allows the immediate transmission of all initiated signals.

c. Provide transmitters with memory capability to store at least [50][_____] discrete events automatically in non-volatile memory such that multiple, simultaneous signals do not result in the loss of any messages. Store messages until they are transmitted.

d. Provide transmitters which produce an audible or visual indication that the transmitter is operating and a signal is being sent, whether the transmission is initiated automatically by an initiating condition or manually.

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NOTE: The quantity of transmitters or transceivers permitted to be connected to the receiving system is based on the Type of system as classified under NFPA 72.

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e. Ensure each transmitter transmits a distinct identity code as part of all signals emanating from the transmitter. Provide identity codes that support no less than [512][128][_____] transmitters per frequency in use. Ensure that setting the code is readily accomplishable in the field without the need to exchange or alter circuit boards.[Program the specific code for each transmitter as shown on the Contract Drawings.][Submit in writing, [with the shop drawing submittal][within 30 calendar days after award], the proposed specific code for each transmitter.][Obtain the code for each transmitter from the Federal Fire Department serving the Installation.]

f. Transmit messages upon automatic actuation of the transmitter. Individually identify the building and zone causing actuation as part of this transmission. Ensure that the transmitter is capable of identifying and transmitting a minimum of the following status messages, as applicable for each respective building:

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NOTE: The required list of signals that the system must be capable of sending should be edited to match the specific requirements of each project. There may be more or less detail required. The intent of this list is not to define how to program each of these devices or signals, but merely to list all of the messages that may need to be transmitted by the equipment.

****

(1) Primary Power Failure

(2) Primary Power Restoration

(3) Battery Fault

(4) Battery Restoration

(5) Communication Failure

(6) Communication Restoration

[(7) Manual Pull Station Alarm

][(8) General Smoke Sensor Alarm

][(9) Duct Type Smoke Sensor Supervisory

][(10) Damper Control Smoke Sensor Supervisory

][(11) Door Hold Open Release Smoke Sensor Supervisory

][(12) Sleeping Room Smoke Sensor Supervisory

][(13) Waterflow Switch Alarm

][(14) Carbon Monoxide Sensor Alarm

][(15) Gas Sensor Alarm

][(16) Aspirating Smoke Sensor Alert

(17) Aspirating Smoke Sensor Fire 1 Alarm

(18) Aspirating Smoke Sensor Fire 2 Alarm

(19) Aspirating Smoke Sensor Trouble

][(20) Fire Pump Running

(21) Fire Pump System Supervisory

][(22) Water Tank Low Level Supervisory

][(23) Water Tank Low Temperature Supervisory

][(24) Kitchen Hood Suppression System Activation Alarm

(25) Kitchen Hood Suppression System Trouble

][(26) Mass Notification Message Activated with Active Fire Alarm

][(27) Fire Suppression Containment Supervisory

][(28) Foam System Supervisory

(29) Foam System Disabled Supervisory

[(30) Manual Foam Release Start Station Alarm

][(31) Optical Flame Detector Alarm

][(32) Optical Flame Detector Inhibited Supervisory

][(33) Foam System Flow Switch Alarm

][(34) Foam Stop Station Active Supervisory

] (35) Foam System Trouble

(36) Foam System Release Alarm

][(37) Clean Agent System Alarm

(38) Clean Agent System Supervisory

(39) Clean Agent System Trouble

[(40) Clean Agent System Stop Station Active Supervisory

][(41) Clean Agent System Release Disabled Supervisory

][(42) Clean Agent System Release Alarm

]][(43) Smoke Control System Active

(44) Smoke Control System Fault

][(45) Valve Supervisory Switch Supervisory

] (46) General Alarm

(47) General Supervisory

(48) General Trouble

(49) Any Additional Signals Called for on the Contract Drawings

[(50) [_____]

] When the number of zone connections shown exceeds the maximum zone capacity furnished in a single transmitter, provide additional transmitters at that location to connect to all zones shown.

g. Provide transmitters with clearly distinguishable red alarm and amber trouble illuminating indicators to indicate the status of each initiating zone.

h. Supervise transmitter communications in accordance with NFPA 72. Provide supervision to ensure that all status changes, including communication channel failures, are transmitted within 200 seconds. Ensure that interface wiring is such that a trouble indication on the fire alarm control unit will not disrupt the transmission capability of alarm or supervisory messages. Ensure that status changes on monitoring zones occur within 60 seconds of fire alarm control unit activation. Ensure that all signals transmitted from the transmitter are received and recorded at the receiving station within 90 seconds.

****

NOTE: Test signals should be sent at least once every hour for single communication path systems. Systems that use multiple communication paths may extend their time period between test signals to once every six hours per NFPA 72.

****

i. Provide transmitters which automatically transmit a test signal at least once in each [one][six]-hour period. Provide transmitters that also allow manual actuation of a test signal by a secured (not publicly accessible) means. Initiate automatic actuation by a solid state programmable electronic device. Ensure that stability of the electronic device is plus or minus one minute per month or better. Ensure that test time(s) are programmable without removing the transmitter from the enclosure. Ensure that the test is initiated at the transmitter for one-way radio systems; and that the automatic test is part of the normal polling and interrogation function for two-way polling and interrogation systems.

j. Ensure that each transmitter monitors the integrity of pathways between the transmitter and the protected premises control unit(s). Ensure that a ground-fault or a break (open condition) in any of the above pathways causes a trouble condition at the transmitter. Provide transmitters capable of supporting [Class A][,][and][Class X][,][and][Class B] pathway arrangements. Ensure that pathway connections to the transmitter utilize manufacturer installed terminations. Do not field modify pathway terminals.

k. Provide transmitters with local audible trouble signal, visual amber trouble signal(s), and audible signal silencing switch. Ensure that lamps are the light emitting diode type. Lamps need not be visible with the access door closed. Upon occurrence of a trouble condition as defined in NFPA 72, ensure that the transmitter transmits a trouble signal, a local audible trouble signal sounds, and a visual trouble signal illuminates. When silencing switch is operated, silence the audible trouble signal, and ensure that the visual trouble signal(s) remain(s) lit. If the silencing switch is not a momentary-action-self-resetting type, upon correction of the trouble condition(s) sound the audible signal again until the silencing switch is returned to its normal position.

l. Ensure that alarm messages take precedence over supervisory messages.

m. Ensure that supervisory messages take precedence over trouble messages.

[2.4.8 Zone Disconnecting Means

Provide transmitters with switches to disconnect individual zone inputs from the transmitter without disconnecting wiring. Ensure that disconnecting a zone causes a trouble condition which initiates transmission of a trouble signal and actuates local audible and visual trouble signals.

]2.5 TRANSMITTER ANTENNA

Provide [omnidirectional, coaxial, halfwave dipole antennas][_____] for radio fire alarm transmitters with a driving point impedance to match transmitter output. Provide corrosion resistant antenna and antenna mounts designed to withstand wind velocities of [161][201][_____] km per hour [100][125][_____] mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage.

2.6 TRANSMITTER ANTENNA CABLE

Provide RG8U or RG58U, minimum 95 percent shielded coaxial cables utilizing PL-259 connectors, unless required otherwise by the manufacturer's written recommendations. Protect connectors against moisture. Provide no splices in any cable. Do not use crimp-type connectors. Run fire alarm reporting system cables alone in separate raceway from cable for other systems.

[2.7 TRANSMITTER INTERFACE DEVICE

When direct connection between the building fire alarm control unit and the transmitter is not possible, provide a means of converting the signals available from the local control equipment into a form that is compatible with the transmitter inputs, while still maintaining electrical supervision of the entire system. Provide interface devices that are completely assembled, wired, tested at the factory, and delivered ready for installation and operation.

2.7.1 Enclosure

When furnished as an independent self-contained device, incorporate the interface device into an enclosure conforming to NEMA ICS 6 or other national standard as required by its location.

2.7.2 Indicators

Provide red alarm and amber trouble illuminating indicators to indicate alarm and trouble conditions. Ensure the indicators are visible during daylight hours and clearly indicate the reporting zone.

2.7.3 Access

Ensure that switches and other controls are not accessible without the use of a key. Provide access to controls by unlocking and opening a panel or door.

2.7.4 Mounting

Design interface housings for universal mounting on walls, poles, or pedestals. Utilize [lag bolts][,][or][anchor bolts][,][or][stainless steel banding][,][or][mounting brackets][,][or][a shackle and bolt combination] for mounting.

2.7.5 Inputs and Outputs

Provide at least the number of signal pathway inputs and outputs necessary to ensure a functional system in accordance with the Contract Documents at each interface panel. Arrange each input pathway so that the alarm signals override the supervisory and trouble signals.

]2.8 SUPERVISING STATION RADIO FIRE ALARM RECEIVER (TRANSCEIVER)

Provide [two][_____] identical master radio fire alarm transceiver systems compatible with transmitter frequency.[Install [both][_____] transceivers at the main supervising station.][Install [one][_____] transceiver at the primary supervising station and [the other][_____] at the alternate supervising station.] Ensure that the systems are completely assembled, wired, tested at the factory, and delivered ready for installation and operation.

2.8.1 Design

Provide solid-state transceiver that uses frequency modulation.[Ensure that the transceiver is a single integrated unit.][The transceiver may be a single integrated unit, or it may consist of separate transmitter and receiver modules with a common power supply, amplifier, and control unit.] Ensure that each supervising station radio fire alarm receiving system performs the receipt, processing, and display of emergency and non-emergency signals transmitted by the radio fire alarm transmitters specified herein, independently of the other system. Provide each system as a complete and independent receiving system consisting of: a receiver (or transmitter and receiver for polling (interrogation) type systems), decoder, audible signaling appliances, audible signal silence switch, visual display, alarm reset switch, digital clock, printer connection, primary and emergency power supplies, power supply monitors, memory devices, personal computer connection, interconnecting cables, and antenna. Provide equipment in [desk-top console][vertical rack] configuration.

[If the radio fire alarm transmitters are polled by the radio fire alarm receiver, provide each of the required systems at the supervising station with its own polling device. Ensure that one such device is always active, with the other(s) in standby status. Ensure that failure of the active device automatically causes another polling device to take over the interrogation (polling) function, and initiates a trouble signal. Ensure this switch occurs within [30][_____] seconds of detection of failure of the active unit.

]2.8.2 Transmitter Section

Provide transmitter that operates on a frequency [of [_____] MHz][as directed by the Contracting Officer, within [90][_____] days following submission of completed application for frequency allocation following contract award]. Ensure frequency stability is within 1/100000 0.00025 percent over the operating temperature range. Provide transmitter designed to work into a 50-ohm load. Ensure frequency deviation is less than or equal to 5 kHz. Ensure audio response is within plus 1 dB and minus 3 dB over the 300 Hz to 3000 Hz range.

2.8.3 Receiver Section

Ensure the receiver antenna input impedance is 50 ohms. Tune the receiver to a frequency assignment [of [_____] MHz][as directed by the Contracting Officer, within [90][_____] days following submission of completed application for frequency allocation following contract award]. Ensure receiver has no more than five percent audio distortion measured at 1000 Hz. Ensure receiver has a noise level not greater than 50 dB below the signal level. Ensure receiver output is compatible with the associated device.

2.8.4 Transceiver Supervision

Ensure the supervisory system provides constant supervision and display of the operating condition of the radio transceiver and indicates an abnormal condition when a fire alarm transceiver carrier lasting more than 15 seconds is detected. Test the transceiver's ability to properly receive and decode an incoming signal at least once every five minutes.

2.8.5 Display

****

NOTE: Current industry trends are moving towards omitting displays on the actual receivers and utilizing a supervising station terminal to display received signals. If a supervising station terminal is provided as a part of the project, consider removing the requirement for a local display on the transceiver. Status indicator lights should still be required on the transceiver regardless of whether a local display is included or not.

****

Configure each transceiver to do the following:

a. Display incoming signals in alphanumeric format, by means of a[light emitting diode (LED)][or][liquid crystal display (LCD)] screen.

    (1) Indicate the originating transmitter identity code, originating building name, originating building number, time, date, and type of signal. Ensure the transceiver is capable of displaying at least the following signal designations:

****

NOTE: The required list of signals that the system must be capable of receiving should be edited to match the specific requirements of each project. There may be more or less detail required. The

intent of this list is not to define how to program each of these devices or signals, but merely to list all of the messages that may need to be received by the equipment.
****

a. Primary Power Failure

b. Primary Power Restoration

c. Battery Fault

d. Battery Restoration

e. Communication Failure

f. Communication Restoration

g. Manual Pull Station Alarm

h. General Smoke Sensor Alarm

i. Duct Type Smoke Sensor Supervisory

j. Damper Control Smoke Sensor Supervisory

k. Door Hold Open Release Smoke Sensor Supervisory

l. Sleeping Room Smoke Sensor Supervisory

m. Waterflow Switch Alarm

n. Carbon Monoxide Sensor Alarm

o. Gas Sensor Alarm

[p. Aspirating Smoke Sensor Alert

q. Aspirating Smoke Sensor Fire 1 Alarm

r. Aspirating Smoke Sensor Fire 2 Alarm

s. Aspirating Smoke Sensor Trouble

][t. Fire Pump Running

u. Fire Pump System Supervisory

][v. Water Tank Low Level Supervisory

w. Water Tank Low Temperature Supervisory

][x. Kitchen Hood Suppression System Activation Alarm

y. Kitchen Hood Suppression System Trouble

] z. Mass Notification Message Activated with Active Fire Alarm

[aa. Optical Flame Detector Alarm

bb. Optical Flame Detector Inhibited Supervisory

][cc. Fire Suppression Containment Supervisory

][dd. Manual Foam Release Start Station Alarm

ee. Foam System Supervisory

ff. Foam System Disabled Supervisory

gg. Foam System Flow Switch Alarm

hh. Foam Stop Station Active Supervisory

ii. Foam System Trouble

jj. Foam System Release Alarm

][kk. Clean Agent System Alarm

ll. Clean Agent System Supervisory

mm. Clean Agent System Trouble

nn. Clean Agent System Stop Station Active Supervisory

oo. Clean Agent System Release Disabled Supervisory

pp. Clean Agent System Release Alarm

][qq. Valve Supervisory Switch Supervisory

][rr. Smoke Control System Active

ss. Smoke Control System Fault

] tt. General Alarm

uu. General Supervisory

vv. General Trouble

ww. Any Additional Signals Called for on the Contract Drawings

[xx. [_____]

] (2) Include a message of a minimum of three lines of 20 characters each for each transmission. Ensure the message is operator-programmable into the memory through a provided keyboard.

(3) Configure the transceiver to annunciate an error message any time a message is received that does not match the programmed transmitter codes.

b. Include a means to manually clear and reset the display. If the display is not reset at the time additional alarms are received, retain the additional alarms in memory and activate a distinctive audible or visual indication to alert the operator that additional alarms are waiting to be acknowledged.

c. Ensure that the transceiver will display and print a summary of transmitters that have transmitted a low-battery or trouble message or failed to transmit a message during the previous [six][one]-hour test period upon command. Ensure that any incoming transmitter signal pre-empts the command display and printout function, and is processed and displayed.

2.8.6 Memory

Provide each transceiver with a programmable memory capable of retaining at least [500][_____] transmitter codes, together with specific messages, total number of zones possible, and related information associated with each of the transmitters. If memory is operator-programmable, restrict access into the memory for the purpose of making additions or deletions by the use of a user specific access code to prevent unauthorized changes, and permanently record any such actions in this history log. Do not purge memory and ensure it is always current and available. Ensure memory is not lost in the event of a total loss of primary and emergency power supplies.

2.8.7 Digital Clock

Incorporate an electronic digital clock into each transceiver. Ensure the clock displays the current time (expressed in 24-hour format) and date, and transmits to each interconnected printer the time and date that signals are received. Provide a manual means of resetting the clock.

[2.8.8 Self-Contained Printer

Provide the transceiver with a self-contained printer that will output a minimum of 32 characters per line and record all displayed transaction information including time and date.

]2.8.9 Audible Appliance

Provide an audible appliance that produces a sound distinct from other audible signals to indicate the receipt of signals. Internally mount the appliance in the transceiver and activate it upon receipt of an alarm, supervisory, or trouble signal. Ensure the audible sounds used to indicate trouble and supervisory signals are separate and distinct from the sound used to denote receipt of alarm signals. Ensure that the audible appliance continues to sound until acknowledged with the silence switch by the operator.

2.8.10 Primary Power

Operate each transceiver from [100-120][200-240] VAC [60][50] Hz power. Provide the primary power supply for each transceiver [through a single dedicated circuit from the building's electric service][through a single connection into the line side of the building's regular AC service circuit][through a single connection into the building's emergency service circuit] with a lockable [breaker][fused disconnect switch] that is red in color and labeled "FIRE REPORTING". Provide a separate [breaker][disconnect switch] for each transceiver. In the event of [100-120][200-240] VAC power loss, automatically switch the transceiver to battery operation. Accomplish switchover with no interruption of protective service. Upon restoration of AC power, automatically transfer back to normal AC power supply and recharge the battery. Install the converter or battery charger within the transceiver housing. Provide power supply transient voltage surge suppression. Provide transceivers with power supply filtering to prevent false message transmissions caused by transient or steady-state electrical disturbances.

2.8.11 Battery Power

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NOTE: Ensure that the supervising station is provided with appropriate primary and secondary power according to its application. Edit the required UPS capacity period based upon the level of backup power provided to the supervising station.

****

Provide transceiver standby battery capacity sufficient to operate the transceiver in a normal standby status for a minimum of [four][24][_____] hours and be capable of transmitting signals during that period. Provide maintenance-free, [valve-regulated lead-acid][_____] type batteries. Submit substantiating battery calculations for supervisory and alarm power requirements. Include the ampere-hour requirements for each system component, each panel component, and the battery recharging period. Ensure that each transceiver constantly monitors and supervises its own battery power supply. Report a low-battery condition when battery voltage falls below the minimum voltage recommended by the manufacturer, or 85 percent of the rated voltage, whichever is higher.[Mount batteries on rack(s) designed for that purpose. Provide a termination cabinet as a part of the rack. Locate battery rack(s) where shown on the Contract Drawings.]

2.8.12 Manual Battery Test

Provide a self-contained or externally mounted switch to accommodate manually placing the transceiver on emergency battery power for test purposes.

2.8.13 Battery Charger

Provide self-regulating battery chargers with the capacity to completely recharge its associated batteries from full discharge within [48][_____] hours with the transceiver fully operational on primary AC power. Ensure the transceiver remains operational on AC power with the batteries removed.

2.8.14 Transceiver Supervision

Ensure supervisory controls provide constant supervision of the operating condition of the transceiver. Provide individual indicators for each major component, and produce an audible signal in the event of failure of any major component. Ensure this audible signal is distinctly different from the signal used to annunciate alarms. Provide a switch to silence the audible signal.

2.8.15 Electrical Connections

Provide transceivers designed with modular components to allow interchange of components for maintenance purposes. Provide primary power cables that incorporate positive twist-lock connections. Provide interconnecting cables and connectors that are compatible with computer quality signal data transmission.

2.8.16 Field Programming Capability

Provide field programming capability, including interconnecting cables, software, firmware, hardware, and manufacturer's licenses and passwords necessary to permit revisions to data stored in memory as follows: addition or deletion of transmitters, changes in zone numbers and identification, changes in signal type and displayed message, alphanumeric label changes, and password changes, to be made by the Government after contract completion.

2.9 SUPERVISING STATION RADIO FIRE ALARM RECEIVER (TRANSCEIVER) ANTENNA SYSTEM

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NOTE: Refer to Article 810 of NFPA 70 (2023 edition). The antennas for dual transmitters and receivers must be installed with maximum vertical separation. The designer must check local conditions for design wind speed. Minimum design wind speed is 160 km per hour 100 mph; typical design wind speed is 201 km per hour 125 mph. This antenna is usually more robust than the individual building transmitter antennas provided.

****

Provide one antenna system for each radio fire alarm reporting system receiver, including all necessary components for proper operation. Mount antenna on TIA-222 compliant support structure. Provide either omni-directional or shaped-coverage antenna, selected based on the topography and anticipated coverage area. Ensure the antenna is capable of withstanding the environmental conditions of [201][_____] km per hour [125][_____] mph wind, and [13][_____] mm [1/2][_____] inch radial ice without failure. Provide lightning protection in accordance with NFPA 70, NFPA 780, and the manufacturer's instructions. Provide antenna cables in rigid conduit and protect from damage. Seal all conduits where they penetrate exterior walls. Ensure that antenna cables and ground wires are rated for the environmental conditions they will be exposed to.

2.9.1 Grounding Conductors

Provide antenna grounding conductors that are a minimum 32-strand, 10 square mm No. 8 AWG copper.

2.9.2 Surge Protection

Provide lightning arresters for supervising station radio fire alarm receiver (transceiver) antennas in accordance with NFPA 70. Ensure that supervising station radio fire alarm receivers (transceivers) do not exhibit mis-operation or failure when electrical transients of IEEE C62.41.1 and IEEE C62.41.2 Category B are applied to the AC power line.[Provide Metal Oxide Varistor (MOV) protection on all primary power circuits in accordance with IEEE C62.11.]

2.9.3 Communication Links

Provide transmission line between the transceiver and the antenna that is 50-ohm impedance rated for the transceiver output power. As a minimum, ensure cable exhibits an attenuation not exceeding 110 dB per 30500 mm 100 feet at 200 MHz.

2.10 SUPERVISING STATION RADIO FIRE ALARM RECEIVER (TRANSCEIVER) ANTENNA SUPPORTING STRUCTURE

Design the supporting structure for the structural loads listed in ASCE 7-22 and specified wind and seismic criteria. Size the supporting structure to accommodate the static and dynamic loads produced by the antenna system and all attachments.

****

NOTE: The following information should be provided by the project's Structural Engineer.

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Design system for a three-second wind speed of [60][_____] meters per second [135][_____] mph; Exposure [C][_____]. Use the following seismic criteria: Ss = [_____]g; S1 = [_____]g; Soil Site Class [_____]; Seismic Design Category [_____]; IE = [1.25][_____].

[2.10.1 Poles

Provide poles designed for specified wind and seismic criteria while supporting antenna and all other appurtenances indicated. Provide anchor-base type poles designed for use with underground supply conductors. Provide poles with oval-shaped handholes having a minimum clear opening of 100 mm by 300 mm 4 inches by 12 inches. Secure handhole cover by stainless steel captive screws. Provide metal poles with an internal grounding connection accessible from the handhole near the bottom of each pole.

Provide steel poles that are externally and internally galvanized. Ensure exposed carbon steel is hot dip galvanized per ASTM A123/A123M. Ensure exposed hardware and fasteners are stainless steel of 18-8 grade or better, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153/A153M (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). Enclose all wiring within the pole or electrical components enclosures. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Fit tops of shafts with a round or tapered cover. Provide base that is anchor bolt mounted and machined to receive the lower end of the shaft. Weld the joint between the shaft and the base. Provide unpainted pole and bracket for antenna with a uniform satin finish.

]2.10.2 Lightning Grounding

Provide lightning grounding as defined by NFPA 70 and NFPA 780. Ensure grounding is [NRTL][_____] listed per UL 96 and UL 96A. Integrate grounding via concrete encased electrode grounding system, or supply grounding electrodes, copper down conductors, and exothermic weld kits from the manufacturer. Size electrodes and conductors as required by NFPA 70 and NFPA 780.[Integrate new antenna lightning protection with existing building lightning protection system and ensure antenna does not go above the existing lightning protection system.][Coordinate antenna support structure grounding with Specification 26 41 00 LIGHTNING PROTECTION SYSTEM.]

[2.10.3 Aircraft Obstruction Lights

Provide obstruction marker luminaires for all antenna support structures as required by the Federal Aviation Administration (FAA) and in accordance with Section 26 56 20 AIRFIELD AND HELIPORT LIGHTING AND VISUAL NAVIGATION AIDS.

]2.10.4 Foundations

Provide reinforced concrete foundations designed by a Professional Engineer to suit the reactions from the specified loading and in accordance with manufacturer's recommendations. Submit Foundation Data in accordance with referenced standards in this section.

Provide concrete as specified in Division 03 - CONCRETE. Ensure anchor bolts are steel rod having a minimum yield strength of 344500 kPa 49,965.5 psi. Galvanize the top 300 mm 12 inches of the rod in accordance with ASTM A153/A153M.

2.11 SUPERVISING STATION TERMINAL

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NOTE: Cybersecurity provisions must comply with the requirements of UFC 4-010-06: CYBERSECURITY OF FACILITY-RELATED CONTROL SYSTEMS and DAFGM2022-32-01: CIVIL ENGINEER CONTROL SYSTEMS CYBERSECURITY (if applicable).

****

2.11.1 Terminal Configuration

Provide a personal computer based supervising station terminal provided with an applications program to allow it to be connected to the receiving equipment.[Provide provisions for floor mounting of the central processing unit.][Extend the keyboard, monitors, mouse, and audible indicating appliance from the rack to the operator workstation.] Ensure that the hardware, software, and firmware are all compatible with the receiving equipment, and permit the site specific configurations prescribed herein. Configure the terminal to display additional information about the building from which a signal is received, detailed description of the current signal, and signal histories. Provide operator interface with the Fire Alarm Reporting System at the Installation, including with [new][and][existing]individual building fire alarm systems, through the terminal via wired QWERTY keyboard and wired mouse equipped with a scroll wheel.[Ensure that operation of the new terminal does not disrupt operation of, and works in conjunction with, the existing terminal.] Provide system capable of being backed-up and restored using a reliable media acceptable to the Government.

2.11.2 Terminal Cybersecurity

Ensure the system meets current requirements for cybersecurity as dictated by Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

2.11.3 Terminal Functions

****

NOTE: Determine if the Installation requires additional functionality out of the terminal and

edit the specification accordingly. Also consider whether the terminal must be capable of serving multiple systems, such as the wide area mass notification system or computer aided dispatch system, and edit the specifications for each respective system consistently to convey the requirement for a multifunctional terminal. Alternatively, consider relocating the terminal requirements into a stand-alone specification section if the terminal is intended to serve multiple systems.
****

Provide all hardware and software required to permit an operator at the terminal to perform the following functions:

a. Signal acknowledgement, signal silence, and system reset.

b. Manual activation, de-activation, enabling, or disabling individual fire alarm system points.

c. Query building fire alarm system status.

d. Query building fire alarm system maintenance and sensitivity reports for devices.

e. Query building fire alarm system event history.

Configure terminal to initiate an audible notification to the operator any time a signal is received.

2.11.4 Terminal Display

Provide [liquid crystal display][_____] flat panel monitors no less than[480 mm 19 inch][584 mm 23 inch][686 mm 27 inch][813 mm 32 inch][[_____] mm [_____] inch]. Provide monitors capable of being[wall][or][desktop] mounted with manufacturer furnished hardware.

Provide displays capable of being manipulated to show four separate quadrants reflecting the following information:

a. List of Events: Display the address of the active device, device type, device description, and time of the event in a prioritized color-coded event list. Configure system such that operator selection of an independent event automatically displays a building floor plan zoomed to the location of the device.

b. Floor Plan: Display a color graphical view of the floor plan, zoomed to the location of the signal initiating device. Provide the operator with the ability to zoom in or zoom out of the floor plan via operation of the mouse scroll wheel. Do not use pre-set zoom levels.

c. Event Action: Display a customized set of written operator instructions for the active event. Configure system to add subsequent events to create a list of active signals. Provide the operator with the ability to scroll through all active signals via mouse or keyboard control. Ensure all events and operator actions are logged and time stamped in the receiving system history file.

d. Image: Display a stored image of the active device, such as that provided in the manufacturer's product data sheet.

2.12 SUPERVISING STATION PRINTER

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NOTE: Consideration should be given to whether a supervising station printer is warranted based on system size and use.

****

Provide a supervising station printer of high speed, computer compatible, low noise design, that is [compatible with the supervising station terminal and]capable of printing all transaction information and history reports. Provide a printer that is a type and size compatible and listed with the receiving station.[Arrange the printer to print on paper the required visually displayed data, including the date and time received, upon reception of an alarm, trouble, or supervisory signal.] Provide standard size paper compatible with the printer for recording messages. Ensure the paper is commercially available from three or more manufacturers[and continuous feed].[Include paper take-up devices for storing printouts.] Print alarm, trouble, and supervisory signals in a manner to make them readily distinguishable from acknowledgments and routing messages by use of a different color, typeface, type size, or other distinguishable means.

2.13 SUPERVISING STATION POWER SUPPLIES

****

NOTE: Ensure that the supervising station is provided with appropriate primary and secondary power according to its application. Edit the required UPS capacity period based upon the level of backup power provided to the supervising station.

****

Provide each component of supervising station equipment with a self-contained power supply. Provide primary power from a dedicated 20A circuit. If a dedicated fire protection subpanel is provided, ensure the circuit originates from that panel. Ensure the dedicated breaker is red in color, lockable, and labeled "FIRE REPORTING".[Directly wire terminal and all associated components into the primary power circuit. Do not provide equipment with plug-in type power cords.] Provide an uninterruptible power supply (UPS) for equipment which does not have a self-contained battery backup, such as the terminal[and printer]. Ensure the UPS provides all power requirements for the connected equipment for a period of [four][24][_____] hours under maximum normal load. Provide UPS with a bypass switch for maintenance purposes. Provide self-regulating battery chargers with the capacity to completely recharge its associated batteries from full discharge within [48][_____] hours with the system fully operational on primary AC power. Ensure the system remains operational on AC power with the batteries removed.[Ensure the UPS is in accordance with Section 26 33 53 STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS).]

2.14 FIRE ALARM REPORTING SYSTEM PERIPHERAL EQUIPMENT

****

NOTE: Check the terrain and distances to determine if a repeater(s) will be needed to transmit signals from a remote location to the main radio fire alarm

receiver.

****

2.14.1 Repeaters

Provide repeaters where indicated on the Contract Drawings or required to meet system requirements. Ensure the repeater receives on [[_____] MHz][a frequency as directed by the Contracting Officer, within [90][_____] days following submission of completed application for frequency allocation following contract award] and transmits on [[_____] MHz][a frequency as directed by the Contracting Officer, within [90][_____] days following submission of completed application for frequency allocation following contract award]. Provide receiver and transmitter sections conforming to the requirements specified for transceivers. Relay two-way data transmission between the supervising station radio fire alarm receiver (transceiver) and remote stations. Provide repeater(s) that utilize(s) a bandpass-type duplexer and one antenna, or multiple-bandpass cavity filters and multiple antennas. Ensure the duplexer or filter cavities isolate the receiver from transmitter spurious noise and prevent receiver desensitization. Ensure the duplexer or filter cavities are rated to handle the output power of the transmitter. Key the repeater with tone-encoded control pathway. Provide a transmitter time-out pathway to prevent system lockup.

2.14.2 Raceway and Fittings

Provide raceway that complies with UL 6, UL 797, or UL 1242 and is no less than [13][19] mm [1/2][3/4] inch in diameter.

Provide outlet boxes and fittings that comply with UL 514A or UL 514B.

2.14.3 Ground Rods

****

NOTE: Designer must determine the size, type, and number of ground rods to be used based on local conditions, earth resistivity data, and the size and type of the electrical installation. Copper-clad steel rods should be specified for normal conditions. In high resistivity soils, 3048 mm 10 foot sectional rods may be used to obtain the required resistance to ground. Where rock is encountered, additional rods, a counterpoise, or ground grid may be necessary. Coordinate and standardize rod selection for individual facilities with other specification sections.

****

Provide grounding to building ground. Ensure maximum impedance to ground is [25][_____] ohms. If the maximum impedance to ground exceeds [25][_____] ohms, provide driven ground rods. If used, provide ground rods that conform to UL 467 and are of [copper-clad steel][solid copper][_____] not less than [19][_____] mm [3/4][_____] inch in diameter by [3048][_____] mm [10][_____] feet in length[and of the sectional type].

2.14.4 Wiring

Provide wiring in accordance with NFPA 70 and NFPA 72, and as specified herein. Ensure conductor for [100-120][200-240] VAC circuits is 4 square mm

No. 12 AWG minimum solid copper. Ensure conductor for low voltage direct-current (DC) circuits is [1.5][2.5] square mm No. [14][16] AWG minimum [solid][or][stranded] copper. Provide 75 degrees C 167 degrees F minimum insulation with nylon jacket. Color code all wiring.

[2.14.5 Surge Suppression

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NOTE: Specify surge suppression for projects administered by NAVFAC Southeast and for all areas with high potential for lightning damage. Consult DFPE if additional guidance is needed.

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NOTE: Tailoring tags have been used to automatically add requirements related to CAD systems when applicable.

****

Provide line voltage[and low voltage] surge suppression devices to suppress all voltage transients which might damage system transmitter, CAD, and receiving and control system components. Mount suppressors in separate enclosures adjacent to each transmitter[, computer,] and receiving and control system unless suppressors are specifically [NRTL][_____] listed for mounting inside the transmitter or receiving and control system enclosures and approved for such use by the system manufacturer. Provide line voltage suppressors which are UL 1449 listed having a maximum 330 volt clamping level and a maximum response time of five nanoseconds. Ensure suppressors also meet IEEE C62.41.1 and IEEE C62.41.2 Category B tests for surge capacity. Provide multi-stage type suppressors which include inductors and silicon-avalanche or zener diodes. Provide suppressors with long-life indicating lamp (light emitting diode or neon lamp) which extinguishes upon failure of the protection components. Ensure fuses are externally accessible. Wire surge suppressors in series with the incoming power source ahead of the protected equipment, using screw terminations.

[Provide low voltage surge suppressors for all wired pathways which leave the building shell. When pathways connect two or more buildings, provide a suppressor at each pathway entrance to each building. Ensure suppressors are UL 497B listed with a maximum 30 volt clamping level and a maximum response time of five nanoseconds and multi-stage construction having both differential and common-mode protection.

]][2.14.6 Protected Premises Control Units

****

NOTE: Survey each control unit to ensure that the necessary "dry" electrical contacts are available for connection to the radio fire alarm transmitter; if not, the control unit must be modified in accordance with the recommendations of its manufacturer or replaced. Indicate on the Contract Drawings which units require modification or replacement under this contract and include Section 28 31 60 INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE, Section 28 31 66 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE, Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE, or Section 28 31 76 INTERIOR FIRE ALARM

AND MASS NOTIFICATION SYSTEM, ADDRESSABLE, as appropriate. Consult the DFPE for additional guidance as needed.

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NOTE: Edit the following section to provide connection to fire alarm control units, suppression system control units, extinguishing system control units, and fire pump controllers, as appropriate. If all suppression and extinguishing system control units are connected to fire alarm systems in compliance with the applicable NFPA standards, separate connections between the suppression or extinguishing system and the radio fire alarm transmitter are not required. If fire pump controllers are connected to fire alarm systems in such a way that the three separate alarm signals required by NFPA 20: STANDARD FOR THE INSTALLATION OF STATIONARY PUMPS FOR FIRE PROTECTION can be transmitted to the supervising station, separate connections between the radio fire alarm transmitter and pump controller are not required.

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NOTE: Indicate on the Contract Drawings the location of each control unit, how many separate signals (pathways) are to be connected to the radio fire alarm transmitter, and the designation of each pathway as it should be annunciated at the supervising station.

****

Fire alarm[and fire suppression or fire extinguishing system] control unit[and fire pump controller] alarm, trouble, and supervisory contacts are [existing][or][specified in other sections].

]2.15 COMPUTER-AIDED DISPATCH (CAD) SYSTEM

****

NOTE: Except for larger consolidated communication centers, select the single CAD system option. If a new CAD system is not desired, delete these paragraphs. Consult the Federal Fire Chief to determine the requirement for a CAD system and the historical and anticipated daily (average and peak) call loading.

****

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NOTE: Cybersecurity provisions must comply with the requirements of UFC 4-010-06: CYBERSECURITY OF FACILITY-RELATED CONTROL SYSTEMS and DAFGM2022-32-01: CIVIL ENGINEER CONTROL SYSTEMS CYBERSECURITY (if applicable).

****

In the supervising station, provide [one][two] CAD system[s] in compliance with NFPA 1225. Provide hardware, firmware, and software required for a complete, code compliant, and useable system. Ensure the system meets current requirements for cybersecurity as dictated by Section 25 05 11

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.[Ensure that operation of the new system does not disrupt operation of, and works in conjunction with, the existing system.] Provide a computer that utilizes a [Windows10][Windows11][_____] based operating system and has hard drive disk space sufficient to maintain records for no less than two years. Provide a keyboard, dual monitors, mouse, and audible indicating appliance.[Extend the keyboard, monitors, mouse, and audible indicating appliance from the rack to the operator workstation.] Provide monitors no less than[480 mm 19 inch][584 mm 23 inch][686 mm 27 inch][813 mm 32 inch][[_____] mm [_____] inch]. Provide system capable of being backed-up and restored using a reliable media acceptable to the Government. Provide standard, commercially available software loaded on the computer hard drive. Provide a system that is capable of accommodating an average load of [_____] calls per 24-hour day and a peak load of [_____] calls per hour.

2.15.1 Interconnection to Alarm System

Provide interconnection between CAD system[s][,][and] radio fire alarm receiving and decoding systems[,][and][existing wired box circuits][,][and][Enhanced 9-1-1 telephone system] so that signals are automatically displayed on the CAD monitor screen[and printed on the CAD printer] as they are received.

2.15.2 Printer

Provide color laser printer, capable of printing [six][_____] pages per minute in text mode, that utilizes standard 216 mm by 279 mm 8.5 inches by 11 inches[tractor-feed][or][loose-leaf] paper.

2.15.3 Automatic Display

Ensure the system displays[and prints] the following upon automatic receipt of a signal:

a. Transmitter number.

b. Zone number (when applicable).

c. Type of signal (alarm, supervisory, trouble).

d. Building name and number.

e. Street address.

f. Nearest street intersection.

g. Emergency response unit assignments by unit type and number for first, second, third, and subsequent alarms, including substitute unit(s) for normally assigned unit(s) previously entered into the system by the telecommunicator as being in a status which makes them not available to respond.

h. Pre-Incident Planning Information and special instructions for first-arriving units.

2.15.4 Manual Alarm Entry Capability

Provide system with manual alarm entry capability to enable the telecommunicator to enter alarm locations by any of the following: building name or number, transmitter number, street address, or nearest street intersection. When an alarm is manually entered, ensure the system displays[and prints] the information specified in paragraph entitled "Automatic Display".

2.15.5 Unit Status Tracking Capability

****

NOTE: Consult the Federal Fire Chief to determine the number of units that the system should be capable of tracking. Ensure anticipated department growth over the expected life of the system is factored into this quantity.

****

Provide system with unit status tracking capability to enable the telecommunicator to record changes in individual unit status (such as in-quarters, responding, on-scene) with no more than two keystrokes (not counting unit number) or mouse clicks. Ensure system is capable of tracking status of at least [_____] units simultaneously.

2.15.6 Pre-Incident Plan Retrieval

Provide system with pre-incident planning storage and retrieval capability to enable the telecommunicator to access pre-incident plans. For displayed alarm location, ensure that access to the pre-incident plan does not require more than two keystrokes or mouse clicks.

2.15.7 Hazardous Materials Data Retrieval

Provide system with hazardous materials data storage and retrieval capability to enable the telecommunicator to access stored hazardous material database information.

2.15.8 Power Source

Provide primary power for CAD system [through a connection into the line side of the building's regular AC service circuit][from the supervising station's emergency service circuit] through a dedicated, lockable, 20A breaker that is red in color and labeled "CAD".

2.15.8.1 Uninterruptible Power Supply (UPS)

****

NOTE: Specify type and class of Stored Emergency Power Supply System (SEPSS) based on requirements of NFPA 1225: STANDARD FOR EMERGENCY SERVICES COMMUNICATIONS and NFPA 72: NATIONAL FIRE ALARM AND SIGNALING CODE. A Type U SEPSS is primarily fed by utility power but instantly switches to UPS power upon utility power loss. A Type O SEPSS is constantly powered through the UPS batteries. A Class 1 SEPSS will provide power for 60 minutes, and is the minimum allowable.

****

Provide a Type [U][O], Level 1, Class [1][4][_____] Stored Emergency Power Supply System (SEPSS) in compliance with NFPA 111 to provide power for operation of the CAD computer(s), monitors, and printer in the event of loss of power on the line side of the SEPSS.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Provide installation in accordance with the requirements of NFPA 70, NFPA 72, and the manufacturer's instructions, unless otherwise specified. Provide all necessary interconnections, services, and adjustments required for a complete and operational system. Unless indicated otherwise on the Contract Drawings, provide all new wiring and raceway. Dress out all transmitters[,][and] receivers[,][and][interface panels][,][and new wiring in existing panels,] in a neat manner with all wires running in a vertical or horizontal plane, cut to exact length, making all turns at 1.57 rad 90 degree angles, and tightly bundled and tie wrapped. Make all terminations under screw terminals. Pigtail or "T-tap" connections are prohibited. Use of crimped connectors is prohibited[, except that use of crimped connectors at termination points is required where stranded wire is used].

3.2.1 Wiring for Systems

Provide wiring for systems in rigid conduit, intermediate metallic conduit, or electric metallic tubing[, except surface mounted wiring in surface metal raceway in finished areas is permitted where indicated on the Contract Drawings]. Do not install the conductors for the radio fire alarm reporting system in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Ensure that the sum of the cross-sectional areas of individual conductors does not exceed 40 percent of the interior cross-sectional area of the raceway. Provide raceway in compliance with NFPA 70. Provide ample gutter space to accommodate necessary wiring. Run antenna cables alone in separate galvanized rigid steel conduit. Paint all junction box covers red and provide them with permanent rigid engraved labels reading "FIRE REPORTING".

Install no more than one conductor under any screw terminal. Connect each pathway conductor entering or leaving any mounting box, outlet box enclosure, or cabinet to screw terminals with each terminal marked in accordance with the wiring diagram. Ensure that wiring within control equipment is readily accessible without removing component parts.

3.2.1.1 Conductor Identification

Distinctively color code each conductor used for the same specific function; ensure that each function color code remains consistent throughout.[Use colors as directed by the Contracting Officer to match the existing Installation fire alarm conductor color coding scheme.] Identify conductors at every termination, junction, and splice by means of plastic coated self-sticking printed markers or by heat-shrink type sleeves. Attach markers in a manner that will prevent accidental detachment. Furnish a printed schedule of conductor markings identifying each wire marker, and the purpose, the origin, and the termination of each conductor; also include this information on the as-built drawings.

3.2.1.2 Additional Installation Requirements

Pull all conductors splice-free. Provide insulated barrier type terminal strips at junction points. Use of wire nuts, crimped connectors, or twisting of conductors together is prohibited. Route raceway such that it does not enter the top of a transmitter, receiver, control panel, or interface panel. Provide raceway seals for all raceways terminating at a transmitter, receiver, control panel, or interface panel.

3.2.2 Overvoltage and Surge Protection

Protect equipment connected to alternating current circuits from surges in accordance with IEEE C62.41.1, IEEE C62.41.2, and NFPA 70. Provide cables and conductors which serve as communications links, except fiber optics, with surge protection devices installed at each end. Do not use fuses for surge protection.[Install additional triple electrode gas surge protectors, rated for the applications, on each wireline circuit within 910 mm 3 feet of the building entrance.]

[3.2.3 Poles

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 1.57 rad 90 degrees at the bottom end. Provide ornamental covers to match pole, and galvanized nuts and washers for anchor bolts. Provide concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for antenna location. Do not install scratched, stained, chipped, or dented poles.

]3.2.4 Grounding

Ground non-current-carrying parts of equipment including antenna, mounting arms, brackets, and metallic enclosures [in accordance with NFPA 70][as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION]. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

Ensure that ground rods do not protrude more than 150 mm 6 inches above grade. Ensure that non-current-carrying metallic parts associated with radio fire alarm reporting equipment have a maximum resistance to solid "earth" ground not to exceed [25][_____] ohms.

[3.2.5 Foundations

Construct foundations in accordance with approved design submittals and in accordance with Division 03 and Division 31 specifications.

][3.2.6 Protected Premises Control Units

3.2.6.1 Fire Alarm Control Units

Provide connection to protected premises fire alarm control units in accordance with NFPA 72 and as specified herein. Provide separate alarm, supervisory, and trouble pathways between radio fire alarm transmitter and fire alarm control unit. Ensure that actuation of control unit alarm contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as an alarm signal. Ensure that actuation of control unit common supervisory contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as a supervisory signal. Ensure that actuation of control unit common trouble contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as a trouble signal.

[3.2.6.2 Fire Suppression or Fire Extinguishing System Control Units

****

NOTE: Select the NFPA standard(s) applicable to the systems to which direct connections from the radio fire alarm transmitters are to be made; delete standards not applicable. If all suppression and extinguishing system control units are connected to fire alarm control units in compliance with the applicable NFPA codes and standards, separate connections between the suppression or extinguishing system and the radio fire alarm transmitter are not required. If all connections are through the building fire alarm system, delete the entire paragraph.

****

Provide connection to protected premises fire suppression or fire extinguishing system control units in accordance with[NFPA 11,][NFPA 12,][NFPA 12A,][NFPA 13,][NFPA 17,][NFPA 17A,] NFPA 72,[NFPA 2001,] and as specified herein. Provide separate alarm, supervisory, and trouble pathways between radio fire alarm transmitter and control unit. Ensure that actuation of control unit alarm contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as an alarm signal. Ensure that actuation of control unit common supervisory contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as a supervisory signal. Ensure that actuation of control unit common trouble contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as a trouble signal.

][3.2.6.3 Fire Pump Controllers

****

NOTE: NFPA 20: STANDARD FOR THE INSTALLATION OF STATIONARY PUMPS FOR FIRE PROTECTION requires the pump running alarm and two supervisory signals to be transmitted to a "constantly attended" location, which is usually the supervising station. If direct connections are to be provided from a pump controller to a radio fire alarm transmitter, consult the controller wiring diagram for availability of "remote alarm" contacts; if all connections are through building fire alarm systems, delete this paragraph.

****

Provide connection to fire pump controllers in accordance with NFPA 20, NFPA 72, and as specified herein. Provide separate alarm and supervisory pathways between radio fire alarm transmitter and pump controller. Ensure that actuation of controller "pump running" contact causes transmission of a distinctly identifiable signal that is displayed and annunciated by the receiving systems specified herein as an alarm signal. Ensure that actuation of other controller remote alarm contacts required by NFPA 20 cause transmission of distinctly identifiable signals that are displayed and annunciated by the receiving systems specified herein as supervisory signals.

]][3.3 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM

****

NOTE: Contact the Contracting Officer, Installation Fire Prevention Office, and Installation Maintenance Personnel to determine what action is appropriate for the salvaging of existing fire alarm reporting equipment.

****

Maintain existing fire alarm reporting equipment fully operational until the new equipment has been tested and accepted by the Contracting Officer. As new equipment is installed, label it "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Government, place it in service and connect it to the supervising station. Remove tags from new equipment and tag the existing equipment "NOT IN SERVICE" until removed from the building.

a. After acceptance of the new system by the Contracting Officer, remove existing equipment not connected to the new system, remove unused exposed raceway, and restore damaged surfaces. Remove the material from the site and dispose of it properly.

b. Disconnect and remove the existing fire alarm reporting systems where indicated.

c. Turn over disconnected and removed control units, devices, and appliances to the Contracting Officer.

d. Properly dispose of outlet and junction boxes, wiring, raceway, supports, and other such items.

]3.4 PROGRAMMING

****

NOTE: Tailoring tags are used to add information specific to CAD systems when applicable.

****

Field program each receiving and control system with all system transmitter identity codes, zones on each transmitter, and appropriate message and audible alerting tone associated with each active zone (for example: Transmitter 1234; Zone One - Waterflow (alarm tone), Zone Two - Pump Running (alarm tone), Zone Three - Valve Supervisory (supervisory tone), Zone Four - System Trouble (trouble tone)). Program transmitter automatic test times so that at least one test signal is received at the receiving and control system at not exceeding [five-minute][60-minute][_____] intervals. Field program each CAD computer with all data required for proper operation of CAD system as specified in the paragraph entitled

"Computer-Aided Dispatch (CAD) System". Obtain emergency response unit type or number and pre-incident plan information for each location and transmitter number from the Federal Fire Chief.

3.5 FIELD QUALITY CONTROL

3.5.1 Interim Construction Observation Visit[s]

Perform interim construction observation visit[s] when construction is[sufficiently underway to provide sufficient evidence of installation practices being followed, but not so far along as to cause major schedule delays to correct any deficiencies observed][approximately[25 percent][,][50 percent][,][and][75 percent] complete]. Document each site observation visit with a separate site observation report documenting what was observed and any corrective actions required as a result of the visit. Submit site observation report(s) within [14][_____] days of conclusion of respective site observation visit.

3.5.2 Test Procedures

Submit detailed test procedures at least [30][______] days prior to proposed start of performing system tests. List all components of the installed system such as batteries, transmitting and receiving equipment, power sources and supply, interface equipment, and transient voltage (surge) suppressors. Include sequence of testing, time estimate for each test, and sample test data forms. Provide test data forms in a check-off format (pass or fail with space to add applicable test data; similar to the format in NFPA 72) and use them for the preliminary testing and the final testing. Provide test data forms that record the test results and:

a. Identify each test required by NFPA 72 Test Methods and herein to be performed on each component, and describe how each test must be performed.

b. Identify each component and pathway as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan and site plan sheets showing each component location, test location, and alphanumeric identity.

c. Identify all test equipment and personnel required to perform each test.

d. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.5.3 Test Stages

3.5.3.1 Preliminary Testing

Conduct preliminary tests to ensure that equipment and pathways are functioning properly. Meet the requirements of paragraph entitled "Minimum System Tests". If deficiencies are found, make corrections and retest the system to ensure that they are resolved. After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable with the Request for Formal Inspection and Tests. State in the letter that panel functions were tested and operated properly. Provide a print-out of the system history log from the testing performed as an attachment to the letter. Include the names and titles of the witnesses to the preliminary tests in the letter. Ensure that the QFPE, as well as the

Supervisor, are in attendance at the preliminary testing and sign off on the letter. Submit request for final test at least [30][_____] days prior to the proposed test date.

3.5.3.2 Final Testing

Conduct final tests to ensure that equipment and pathways are functioning properly. Meet the requirements of paragraph entitled "Minimum System Tests". If deficiencies are found, make corrections and retest the system to ensure that they are resolved. Costs for witnessing of retesting incurred by the Government and their representatives may be charged to the Contractor at the discretion of the Contracting Officer. Ensure that the final tests are witnessed by the Government's Designated Fire Protection Engineer (DFPE) and the QFPE. At this time, repeat any and all required tests at their discretion.

Do not schedule final testing until the following are provided at the job site:

a. Marked-up red line drawings of the system as actually installed.

b. Complete program printout including input and output addresses.

3.5.3.2.1 Final Test Report

Provide a letter certifying that the system is complete and fully operable with the Final Test Report. State in the letter that panel functions were tested and operated properly. Provide a print-out of the system history log from the testing performed as an attachment to the letter. Include the names and titles of the witnesses to the final tests in the letter. Ensure that the QFPE, as well as the Supervisor, are in attendance at the final testing and sign off on the letter.

3.5.3.3 System Acceptance

Following acceptance of the system, deliver as-built drawings and operation and maintenance instructions (O&M Manuals) to the Contracting Officer for review and acceptance. Submit the drawings within [two][_____] weeks after the final testing of the system. Provide at least one set of as-built (marked-up) drawings at the time of, or prior to, the final testing.

3.5.4 Minimum System Tests

****

NOTE: Tailoring tags are used to add information specific to CAD systems when applicable.

****

Test the system in accordance with the procedures outlined in NFPA 72. Include at least the following tests:

a. Test to ensure there are no grounded, shorted, or open pathways. Measure the resistance of each connection to ground and ensure it does not exceed five ohms.

b. Check each antenna assembly and cable at the transmitter or receiver connection for continuity, shorts, and grounds on the conductor and on the shield prior to connection to equipment. Do not connect assemblies failing these tests to equipment.

c. Test radio emission frequency and band width of each transmitter to ensure proper operation on the assigned frequency.

d. Test the system for specified functions in accordance with the Contract Drawings, specifications, and the manufacturer's O&M manual.

e. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

f. Test all functions of each radio fire alarm transmitter.

[g. Test operation of each interface device.

] h. Test operation of each protected premises control unit zone.

i. Test operation of supervisory features.

j. Test operation of all features of each supervising station radio fire alarm receiving and control system component and each supervising station radio fire alarm receiving and control system as a whole.

k. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

l. Determine that the system is operable under trouble conditions as specified.

m. Visually inspect wiring.

n. Test the battery charger and batteries.

o. Verify that red-lined as-built drawings are accurate.

p. Test all functions of the computer-aided dispatch (CAD) system to verify proper programming and operation.

3.6 CLOSEOUT ACTIVITIES

[3.6.1 Final QFPE Certification Letter

****

NOTE: The final QFPE Certification Letter is intended to be provided when a single QFPE has been hired to oversee all fire protection and life safety components of a given project. The letter should not be submitted until all fire protection and life safety systems have been completely installed and tested, not just the fire alarm reporting system. This paragraph is likely more appropriate to place in a division 01 specification section rather than each individual fire protection or life safety component section.

****

Following successful completion of all acceptance testing, including resolution of all punch list items, provide a certification letter from the

QFPE, bearing his or her Professional Engineer seal and signature, attesting to the proper installation and successful testing of all fire protection and life safety systems in the [building][project]. Submit the Final QFPE Certification Letter no later than [seven][_____] days after the successful completion of final acceptance testing and resolution of all punch list items.

]3.6.2 Training

3.6.2.1 Instruction of Operating Personnel

****

NOTE: Consult the Federal Fire Chief regarding the number of shifts and number of personnel to be trained.

****

****

NOTE: Tailoring tags are used to add information specific to CAD systems when applicable.

****

Train personnel who receive, process, and retransmit signals at each supervising station and emergency response facility which houses a radio fire alarm receiving and control system provided under this Contract. Train personnel who receive, process, and retransmit alarms at each supervising station and emergency response facility which houses a computer-aided dispatch system workstation provided under this Contract. Provide this instruction for [two][three] alternating shifts, a minimum of [four][eight][_____] hours per shift, and include at least the following:

a. Overview of functions of individual system components and the system as a whole.

b. Proper responses to the various types of messages which can be displayed.

c. Procedures for start-up, operation, and shutdown of transmitting, receiving and control system.

d. Procedures for startup, operation, and shutdown of CAD system.

e. Procedures for diagnosing and correcting operator-correctable malfunctions.

f. Procedures for restarting system after total power (primary and backup) failure.

g. Procedures for manually initiating system tests.

h. Train supervisory personnel on each shift, as designated by the Contracting Officer, in procedures for adding and deleting transmitters and changing zone-specific messages.

i. Train supervisory personnel on each shift, as designated by the Contracting Officer, in procedures for loading CAD data.

Perform training by the manufacturer's technical representative(s) on-site using the equipment provided under this Contract. At the conclusion of this training, provide training certificates to certify by name that each operator trained is qualified to operate the radio fire alarm receiving and control equipment provided under this Contract. At the conclusion of this training, provide training certificates to certify by name that each operator trained is qualified to operate the CAD system provided under this Contract.

3.6.2.2 Instruction of Maintenance Personnel

Instruct Government-designated maintenance personnel for a minimum of [16][_____] total hours covering at least the following for all items of equipment provided under this Contract:

a. Theory of operation.

b. Procedures for start-up, operation, and shutdown of each item of equipment.

c. Maintenance instructions.

d. Safety precautions.

e. Test procedures.

f. Field troubleshooting and diagnostic procedures.

g. Repair procedures for field repairs that can be made by replacing plug-in components.

Provide instruction by the manufacturer's technical representative at the project site using the documents specified in the paragraph entitled "Operation and Maintenance (O&M) Instructions".

3.6.2.3 Recording

Record all training presented on-site utilizing recording equipment acceptable to the Contracting Officer. Perform recording such that all visual aids are clearly visible and all discussion is clearly understandable. Provide record copies of the recordings to the Contracting Officer within [14][_____] days following completion of training.

[3.6.2.4 Advanced Maintenance Training

****

NOTE: Advanced Maintenance Training is intended for those installations where the government personnel are going to be responsible for making programming changes to the equipment or installing new equipment without the involvement of a manufacturer's representative. This training is intended to provide those individuals with manufacturer's certification level training to enable them to be competent to make such changes.

****

Within one year of contract completion, provide [one][two][_____] Government-designated maintenance personnel assigned to the site a complete technical repair training session of [40][_____] hours covering repair of the radio fire alarm reporting system equipment. Include in the training an in-depth explanation and review of the theory of operation, function, description, and troubleshooting of all equipment provided down to the component level. Include a review of manuals, drawings, and parts lists, together with any clarifications required. Ensure that at least one period of eight hours is spent troubleshooting equipment with actual faults being introduced for training purposes. Provide instructional personnel that are certified by the related equipment manufacturer to provide technical instruction services. Transportation, lodging, and meals for Government personnel attending this off-site training is not the responsibility of the Contractor.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-28 31 60 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-28 31 00.00 10 (November 2008)
UFGS-28 31 49 (April 2006)
UFGS-28 31 63.00 20 (October 2007)
UFGS-28 31 64.00 10 (August 2009)
UFGS-28 31 74.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 28 31 60

INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE

08/20

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-28 31 60 (August 2020)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 28 31 60

INTERIOR FIRE ALARM SYSTEM, NON-ADDRESSABLE
08/20

****

NOTE: This specification covers the requirements for a non-addressable integrated fire detection, fire alarm system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: For OCONUS projects, this specification section should be edited for specific Host Nation requirements. Coordinate compliance with Host Nation requirements with the Designated Fire Protection Engineer (DFPE).

****

****

NOTE: For Family Housing projects at NAVFAC NE use regional guide specification section 28 31 46.00 22

(N-13854N) HOUSEHOLD FIRE WARNING EQUIPMENT to specify residential fire warning systems in lieu of this section.
****

****
NOTE: This specification section includes requirements from UFC 3-600-01 (change 43, 7 February 2020)
****

****
NOTE: This guide specification covers carbon monoxide alarm detectors for protection in indoor locations where fuel-burning appliances/equipment are used.
****

PART 1 GENERAL

****
1. On the drawings, show location of control unit, batteries and charger (if remotely mounted), supervising station transmitter, annunciator, primary power supply, remote annunciator, detectors, notification appliances (unless performance requirements are specified), and each alarm initiating device including fire extinguishing system switches.

2. Show single-line fire alarm systems riser diagram. Each device on the riser should be identified by type. Indicate connection of equipment.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2022) Safety Code for Elevators and Escalators

ASTM INTERNATIONAL (ASTM)

ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 170	(2024; ERTA 1 2023) Standard for Fire Safety and Emergency Symbols

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-601-02	(2021) Fire Protection Systems Inspection, Testing, and Maintenance
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

47 CFR 90	Private Land Mobile Radio Services

UL SOLUTIONS (UL)

UL 228	(2006; Reprint Mar 2022) UL Standard for Safety Door Closers-Holders, With or Without Integral Smoke Detectors
UL 268	(2023) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Aug 2023) Smoke Detectors for Duct Application
UL 464	(2023) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 521	(2024) UL Standard for Safety Heat Detectors for Fire Protective Signaling Systems
UL 864	(2023; Reprint Oct 2024) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1638	(2023) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Feb 2024) UL Standard for Safety Signaling Devices for the Deaf and Hard of Hearing
UL 2034	(2024; Reprint Aug 2024) UL Standard for Safety Single and Multiple Station Carbon Monoxide Alarms
UL 2075	(2013; Bul. 2019) UL Standard for Safety Gas and Vapor Detectors and Sensors
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 RELATED SECTIONS

Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

[Section 21 13 13 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION]
[Section 21 30 00 FIRE PUMPS]
[Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS]
[Section 21 13 16 DRY PIPE FIRE SPRINKLER SYSTEMS]
[Section 21 13 18 PREACTION FIRE SPRINKLER SYSTEMS]
[Section 21 13 19 DELUGE FIRE SPRINKLER SYSTEMS]
[Section 23 30 00 HVAC AIR DISTRIBUTION]
[Section 21 13 24.00 10 AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM]
[Section 21 13 25 HIGH-EXPANSION FOAM SYSTEM, FIRE PROTECTION]
[Section 21 21 01 CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS]
[Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS]
[Section 08 71 00 DOOR HARDWARE for [door release][door unlocking] and additional work related to finish hardware.]
[Section[s] [14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS] [14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS] [and] [14 24 13 HYDRAULIC FREIGHT ELEVATORS] [14 24 23 HYDRAULIC PASSENGER ELEVATORS] for additional work related to elevators.]
[Section 07 84 00 FIRESTOPPING for additional work related to firestopping.]

1.3 SUMMARY

1.3.1 Scope

a. This work includes designing and [providing a new, complete,][modifying the existing] fire alarm system as described herein and on the contract drawings[for the _____________]. Include system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, initiating devices, notification appliances, supervising station fire alarm transmitters, and other accessories and miscellaneous items required for a complete operational system even though each item is not specifically mentioned or described. Provide system[s] complete and ready for operation.[Existing interior fire alarm system was manufactured by [_____].] Design and installation must comply with UFGS 25 05 11 and UFC 4-010-06.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 72, except as modified herein. [The system layout on the drawings show the intent of coverage and suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.]

c. [c. Each remote fire alarm control unit must be powered from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.]

d. [d. Where a fire pump is provided, the fire alarm system must monitor and transmit the fire pump controller signals in accordance with the provisions of NFPA 72.]

e. [e. Where an emergency generator provides standby power supply for life safety system circuits, the generator must be monitored by the Fire Alarm Control Unit (FACU) and transmit emergency generator signals in accordance with NFPA 72.]

f. The fire alarm system must be independent of the building security, building management, and energy/utility monitoring systems other than for control functions.

1.3.2 Qualified Fire Protection Engineer (QFPE)

****

NOTE: UFC 3-600-01 requires that shop drawings must bear the Review Stamp and professional engineering stamp of the QFPE prior to submission to the Government for approval.

****

****

NOTE: The term Qualified Fire Protection Engineer (QFPE) should be considered interchangeable with the terms "Fire Protection Designer of Record (FPDOR)" and/or "Fire Protection QC Specialist" where referred to in other applicable contract documents. The intent of defining the QFPE roles and responsibilities here is NOT to require personnel in addition to the QFPE, FPDOR, and/or FPQC specialist referenced elsewhere in the applicable contract documents.

****

Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Construction (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Providing a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting any outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government [and final Government]functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions must be defined as follows:

1.4.1 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door where terminal strips are securely mounted inside the cabinet.

1.4.2 Designated Fire Protection Engineer (DFPE)

The DoD fire protection engineer that oversees that Area of Responsibility for that project. This is sometimes referred to as the "cognizant" fire protection engineer. Interpret reference to "authority having jurisdiction" and/or AHJ in referenced standards to mean the Designated Fire Protection Engineer (DFPE). The DFPE may be responsible for review of the contractor submittals having a "G" designation, and for witnessing final inspection and testing.

1.4.3 Qualified Fire Protection Engineer (QFPE)

A QFPE is an individual who is a licensed professional engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the fire alarm designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their registered professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE will be returned by the Government disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G, [_____]

Fire alarm system designer; G, [_____]

Supervisor; G, [_____]

Technician; G, [_____]

Installer; G, [_____]

Test Technician; G, [_____]

SD-02 Shop Drawings

Nameplates; G, [_____]

Instructions; G, [_____]

Wiring Diagrams; G, [_____]

System Layout; G, [_____]

Notification Appliances; G, [_____]

Initiating devices; G, [_____]

Battery Power; G, [_____]

Voltage Drop Calculations; G, [_____]

SD-03 Product Data

Fire Alarm Control Unit (FACU); G, [_____]

Remote Annunciator; G, [_____]

Manual Stations; G, [_____]

Smoke Detectors; G, [_____]

Duct Smoke Detectors; G, [_____]

[Projected Beam Smoke Detector; G, [_____]]

[Air sampling smoke detectors; G, [_____]]

Heat Detectors; G, [_____]

[Flame Detectors; G, [_____]]

[Multi-Criteria Detectors; G, [_____]]

Carbon monoxide detector; G, [_____]

Notification Appliances; G, [_____]

Batteries; G, [_____]

Battery Chargers; G, [_____]

[Supplemental Notification Appliance Circuit Panels; G, [_____]]

[Auxiliary Power Supply Panels; G, [_____]]

Surge Protective Devices; G, [_____]

Alarm Wiring; G, [_____]

[Back Boxes and Conduit; G, [_____]]

[Ceiling Bridges for Ceiling-Mounted Appliances; G, [_____]]

Terminal Cabinets; G, [_____]

Digital Alarm Communicator Transmitter (DACT); G, [_____]

[Automatic Fire Alarm Transmitters (including housing); G, [_____]]

[Radio Transmitter and Interface Panels; G, [_____]]

Electromagnetic Door Holders; G, [_____]

Environmental Enclosures or Guards; G, [_____]

[Firefighter Telephone; G, [_____]]

[Printer; G, [_____]]

Document Storage Cabinet; G, [_____]

SD-05 Design Data

[Air Sampling Smoke Detection System Calculations; G, [_____]
]

SD-06 Test Reports

Test Procedures; G, [_____]

SD-07 Certificates

Verification of Compliant Installation; G, [_____]

Request for Government Final Test; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, [_____]

Instruction of Government Employees; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings

Spare Parts

1.6 SYSTEM OPERATION

****

NOTE: Circuit wiring must be Class "B" unless Class "A" is required by the local installation and as permitted by NFPA 72 (IDC and NAC: "A" or "B").

Circuits and pathways must have survivability levels as defined by NFPA 72.

****

Fire alarm system components requiring power, except for the FACU(s) power supply, must operate on 24 volts DC unless noted otherwise in this section.

****

If an addition to an existing system is required, provide the make, model number, and other pertinent information on existing components that are to operate with the new equipment. Since new interfaces will have to be compatible with the existing system or to the central fire alarm reporting system, it may be necessary to edit major items out of this specification. If a new fire alarm unit is required, it has to be compatible with the existing central fire alarm reporting system.

****

Provide a fire alarm system that is a complete, supervised fire alarm reporting system. Activate the system into the alarm mode by actuation of any alarm initiating device. Remain in the alarm mode until the initiating device is reset and the fire alarm control unit is reset and restored to normal. Audible and visual appliances and systems must comply with NFPA 72. Operate fire alarm system components requiring power, except for the control unit power supply, on 24 Volts dc.

1.6.1 Alarm Initiating Devices and Notification Appliances (Visual, Audible)

a. Connect alarm initiating devices to initiating device circuits (IDC) [Class "A"][Class "B"] and installed in accordance with NFPA 72.

b. Connect notification appliances to notification appliance circuits (NAC) [Class "A][Class "B"].

1.6.2 Functions and Operating Features

The system must provide the following functions and operating features:

a. Power, annunciation, supervision, and control for the system.

b. Visual alarm notification appliances must be synchronized as required by NFPA 72.

c. Electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control unit.

d. An audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal must also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory control unit modules. After the system returns to normal operating conditions, the trouble signal must again sound until the trouble is acknowledged.

e. A trouble signal silence feature that must silence the audible trouble signal, without affecting the visual indicator.

f. Switches in a locked portion of the FACU to bypass the automatic notification appliance circuits, [fire reporting system][air handler shutdown][smoke control operation][elevator recall][door release][door unlocking] features. Operation of this action must indicate on the FACU display[and printer output] as a supervisory or trouble condition.[Notification appliance bypass must be selectable by floor.]

g. Alarm functions must override trouble or supervisory functions. Supervisory functions must override trouble functions.

h. There must be no limit, other than maximum system capacity, as to the number of zones that may be in alarm simultaneously.

i. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as [HVAC,][atrium exhaust,][smoke control,][elevator recall,][releasing service,]the fire alarm relay must be located in the vicinity of the emergency control device.

j. An alarm signal must automatically initiate the following functions:

    (1) Transmission of an alarm signal to [the fire department][a remote supervising station].

    (2) Visual indication of the device operated on the FACU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

    (3) [(3) Record the event on the system printer.]

    (4) Actuation of alarm notification appliances.

(5) [(6) Release of doors held open by electromagnetic devices.]

(6) [(7) Operation of the [smoke control system][atrium exhaust system].]

(7) [(8) Release of power to electric locks (delayed egress locks) on doors that are part of the means of egress.]

(8) [(9) Elevator recall as described in this section.]

****

NOTE: Use this paragraph only where a detector or detection system is to release a special fire extinguishing system.

****

(9) [(10) Operation of [_____] must release the [_____] fire extinguishing system after a [_____] second time delay.]

(10) [(11) Operation of a sprinkler waterflow switch serving an elevator machinery room or elevator shaft must operate shunt trip circuit breaker(s) to shut down power to the elevators in accordance with ASME A17.1/CSA B44.]

(11) [(12) Operation of an interface that operates vibrating pagers worn by hearing-impaired occupants.]

k. A supervisory signal must automatically initiate the following functions:

(1) Visual indication of the device operated on the FACU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

(2) [(2) Record the event on the system printer.]

(3) Transmission of a supervisory signal to [the fire department][a remote supervising station].

(4) Operation of a duct smoke detector must shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph and as allowed by NFPA 72.

l. A trouble condition must automatically initiate the following functions:

(1) Visual indication of the device operated on the FACU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

(2) [(2) Record the event on the system printer.]

(3) Transmission of a trouble signal to [the fire department][a remote supervising station].

m. [m. Activation of a carbon monoxide alarm initiating device must automatically initiate the following functions:

(1) Visual indication of the device operated on the ,[LCD, LED Display unit (VDU),][and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor and room number, device address, and device type.]

(2) Transmission of a carbon monoxide alarm signal to [the fire department][a remote supervising station].

(3) Activation of all strobes and the carbon monoxide alarm signal throughout the building.]

n. System control equipment must be programmed to provide a 60-minute to 180-minute delay in transmission of trouble signals resulting from primary power failure.

[1.6.3 Elevator Recall

****

NOTE: Delete this paragraph if no elevator work is included in the project.

****

Provide elevator recall in accordance with ASME A17.1/CSA B44, Section [14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS][14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS][14 24 13 HYDRAULIC FREIGHT ELEVATORS][14 24 23 HYDRAULIC PASSENGER ELEVATORS], and as specified herein. Activation of any smoke detector in an elevator shaft, machine room, or lobby (except at designated recall level) must cause all elevators associated with that shaft, machine room, or lobby to return nonstop to the designated level. Activation of a smoke detector in the lobby or machine room at the designated level must cause all elevators associated with that lobby to return nonstop to the assigned alternate level. Activation of a detector in an elevator shaft, machine room, or lobby must also cause illumination of elevator cab warning signal (fire hat) and complete operation of fire alarm system as specified in paragraph titled "Functions and Operating Features".

][1.7 EXISTING EQUIPMENT

****

NOTE: If an addition to an existing fire alarm system is required, the contract drawings or this section must include the make, model number, and other pertinent information of existing components that are to operate with the new equipment. Since new interfaces will have to be compatible with the existing system or to the central fire alarm reporting system, it may be necessary to edit major items out of this specification. If a new FACU is required, it has to be compatible with the existing central fire alarm reporting system. When an existing system is to be expanded, show the following information on the contract drawings:

1. Manufacturer and model of existing control unit.

2. Number of existing initiating circuits (zones), notification appliance circuits, and control circuits served by the control unit.

3. Number of existing alarm notification appliances on the system.

4. Total calculated current draw of all devices served by each existing standby battery under both supervisory (standby) and alarm conditions, including NAC/extender control units and subcontrol units.

5. Ampere-hour rating and type of each existing battery.
****

a. Equipment and devices must be compatible and operable with the existing fire alarmmass notification system and must not impair reliability or operational functions of existing supervising station fire alarm system.[The proprietary type supervising station (PSS) is located [in Building [_____].][_____].][The supervising equipment is existing and consists of the following brands and models: [supervising station control unit [_____].][_____][signal reporting components [_____]], [annunciator [_____]][_____]].

b. [b. Equipment and devices must be compatible and operable with the existing building fire alarm system. Equipment must not impair reliability or operational functions of the existing system. The existing building system control unit is [_____].]

]1.8 QUALITY ASSURANCE

1.8.1 Submittal Documents

1.8.1.1 Preconstruction Submittals

Within 36 days of contract award but not less than [14 days][_____] prior to commencing any work on site, the Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE must be returned disapproved without review. All resultant delays must be the sole responsibility of the Contractor.

1.8.1.2 Shop Drawings

Shop drawings must not be smaller than [ISO A1][ANSI D][the Contract Drawings]. Drawings must comply with the requirements of NFPA 72 and NFPA 170. Minimum scale for floor plans must be 1/8"=1'.

1.8.1.3 Nameplates

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

1.8.1.4 Wiring Diagrams

[_____] copies of point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FACU and remote FACU, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

1.8.1.5 System Layout

[_____] copies of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors. Indicate candela rating of each visual notification appliance. Indicate the addresses of all devices, modules, relays, and similar. Indicate if the environment for the FACU is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format similar to the "Typical Input/Output Matrix" included in the Annex of NFPA 72.

[For air sampling smoke detection systems, provide floor plan layouts indicating location of fire alarm control unit, air sampling piping (lengths of pipe) and sampling ports (sizes and locations). Floor plan must also indicate geographic monitor zone boundaries, location of display control unit, bar level annunciation panels if separate, and all other associated equipment that is required to provide a complete operational system.]

1.8.1.6 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.8.1.7 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least [25][_____] percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.8.1.8 Battery Power

Calculations and supporting data as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.8.1.9 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.8.1.10 Product Data

[_____] copies of annotated descriptive data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, and options that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

[1.8.1.11 Air Sampling Smoke Detection System Calculations

Submit air sampling detection system design analysis calculations consisting of battery capacity, loading calculations, and fan speed and air flow/transport calculations. Include schematic diagrams showing pipe segments, pipe diameters, lengths of pipe, node numbers, and sample port diameters to verify the requirements are met.

]1.8.1.12 Operation and Maintenance (O&M) Instructions

[Six][_____] copies of the Operation and Maintenance Instructions. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm System Operation and Maintenance Instructions must include the following:

a. "Manufacturer Data Package [five][_____]" as specified in [Section 01 78 23 OPERATION AND MAINTENANCE DATA][_____].

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. Complete procedures for system revision and expansion.

e. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices, testing frequencies, and similar) must comply with UFC 3-601-02.

f. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

1.8.1.13 As-Built Drawings

The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of the as-built (marked-up) drawings must be provided at the time of, or prior to the final Government test.

1.8.2 Qualifications

****

NOTE: NICET (National Institute for Certification in Engineering Technologies) establishes the qualifications of an individual as an Engineering Technologist with verification of experience by having a current NICET certification.

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1.8.2.1 Fire Alarm System Designer

The fire alarm system designer must be certified as a Level [III][IV] (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology or meet the qualifications for a QFPE.

1.8.2.2 Supervisor

[A NICET Level [III][or][IV] fire alarm technician must supervise the installation of the fire alarm system[, including the air sampling smoke detection system].][A fire alarm technician with a minimum of eight years of experience must supervise the installation of the fire alarm system.] The fire alarm technicians supervising the installation of equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.3 Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate fire alarm devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings[, and must be thoroughly experienced in the installation of air sampling detection systems].

1.8.2.4 Installer

[Fire alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm devices, cabinets and control units] [NICET Level II technician to assist in the installation of fire alarm devices, cabinets and control units]. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the fire alarm system system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.5 Test Technician

Fire alarm technicians with a minimum of eight years of experience and

NICET Level [III][or][IV]utilized in testing and certification of the installation of the fire alarm devices, cabinets and control units. The fire alarm technicians testing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment installed as part of this project.

1.8.2.6 Manufacturer

Components must be of current design and must be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as specified herein.

1.8.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation must be considered as mandatory requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.10 MAINTENANCE

1.10.1 Spare Parts

Furnish the following spare parts in the manufacturers original unopened containers:

a. [Five][_____] complete sets of system keys.

b. [Two][_____] of each type of fuse required by the system.

c. [One][_____] manual stations.

d. [d. [Two][_____] of each type of detector installed.]

e. [Two][_____] of each type of detector base and head installed.

[f. [One][_____] electromagnetic door holders.]

g. [g. One smoke detector manufacturer's test screen, card or magnet for each ten beam smoke detectors, or fraction thereof, installed in the system.]

h. [h. Two air sampling smoke detection system filter assemblies.]

i. [Two][_____] of each type of audible and visual alarm device installed.

j. [Two][_____] low voltage, [one][_____] [telephone][internet][ethernet], and [one][____] 120 VAC surge protective device.

k. [k. [Two][_____] spare reams of paper for the system printer, plus sufficient paper for testing.]

l. [l. [Two][_____] spare printer ribbons.]

m. [_____] spare zone modules for modular type control units in addition to those installed in the control unit.

1.10.2 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment must be furnished to the Contracting Officer, prior to the instruction of Government employees.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENT

All fire alarm equipment must be listed for use under the applicable reference standards.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory and listed for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least [2][_____] years prior to bid opening.

2.2.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FACU

Nameplates must be etched metal or plastic, permanently attached by screws to control units or adjacent walls.

2.2.3 Keys

Keys and locks for equipment, control units and devices must be identical. [Master all keys and locks to a single key as required by the [Installation Fire Department][_____]]. [Keys must be CAT [60][_____].]

2.2.4 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame.

[Install the instructions on the interior of the FACU.][Install the frame in a conspicuous location observable from the FACU.] The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.3 FIRE ALARM CONTROL UNIT

Fire Alarm Control Unit (FACU) must comply with the applicable requirements of UL 864. Unit must be modular, installed in a [flush][surface][semi-flush] mounted steel cabinet with hinged door and cylinder lock. Control unit must be clean, uncluttered, and orderly assembled containing components and equipment required to provide the specified operating and supervisory functions of the system. The unit must have prominent rigid plastic, phenolic or metal identification plates for LEDs, zones, controls, meters, fuses, and switches.

a. Each control unit must provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit must be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each control unit with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the FACU must be by liquid crystal display or similar means with a minimum of 80 characters.

c. Nameplates for fuses must also include ampere rating. Separate alarm and trouble LEDs must be provided for each zone alarm. These LEDs must be located on the exterior of the cabinet door or be visible through the cabinet door. Control unit switches must be within the locked cabinet.

d. A suitable means (single operation) must be provided for testing the control unit visual indicating devices (meters or LEDs). Meters and LEDs must be plainly visible when the cabinet door is closed. Signals and LEDs must be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Each IDC must be powered and supervised so that a signal on one zone does not prevent the receipt of signals from other zones.

e. Upon restoration of power, startup must be automatic, and must not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power must not affect the transmission of alarm, supervisory or trouble signals. Visual annunciators must be provided for each active zone and spare zone. [_____] spare zones must be provided [as shown on the drawing]. Each LED must provide specific identification of the zone by means of a permanently attached rigid plastic, phenolic, or metal sign with either raised or engraved letters.

f. Zone identification must consist of a word description of the zone.

g. Cabinets must be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the control unit equipment. If more than one modular unit is required to form a control unit, the units must be installed in a single cabinet large enough to accommodate units.

2.3.1 Cabinet

Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and [surface][semi-recessed] mounting provisions. The enclosure must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must say "Fire Alarm control unit" and must not be less than 25 mm 1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches.

2.3.2 Silencing Switches

2.3.2.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FACU that must silence the audible and visual notification appliances. Subsequent activation of initiating devices must cause the notification appliances to re-activate.

2.3.2.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch(es) that must silence the audible trouble and supervisory signal(s), but not extinguish the visual indicator. This switch must be overridden upon activation of a subsequent supervisory or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated if the supervisory or trouble condition still exists.

2.3.3 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Initiating devices must be manually reset by switch from the FACU after the initiating device or devices have been restored to normal.

2.3.4 Input/Output Modifications

The FACU must contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features must consist of a control unitswitch/button. Any bypass or modification to the system must indicate a trouble condition on the FACU.

2.3.5 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.4 REMOTE ANNUNCIATOR

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NOTE: Provide the annunciator at a location in accordance with NFPA 72. A suggested location should be near the door through which the first responders will enter the building as indicated in their pre-fire plan, typically the main entrance.

****

2.4.1 Remote Annunciator

****

NOTE: Locate annunciator at or near the building entrance to allow fire department quick access to the annunciator. When both a remote trouble sounder and remote annunciator are required, specify an annunciator with trouble sounder for dry indoor locations. Where a weatherproof enclosure is required, specify a separate trouble bell.

****

Remote annunciator must duplicate all requirements specified for the control unit annunciator, except that individual zone trouble lamps are not required. Lamps must be LED type, except lamps used in backlighted annunciators must be LED or neon type. Annunciator must have a lamp test switch. Zone identification must be by means of [permanently attached rigid plastic or metal plate(s)][or][silk-screened labels attached to the reverse face of backlighted viewing window(s)]. Annunciator must be of the [interior][weatherproof] type, [flush][surface][pedestal]-mounted. [Provide annunciator with an integral audible trouble sounder which must operate in conjunction with control unit audible sounder. Provide annunciator with trouble silence switch which must comply with the requirements for a trouble silencing switch as specified for the FACU.]

[2.4.2 Graphic Annunciator

****

NOTE: Graphic annunciators should be provided only when a large number of concealed devices are installed. Normally, exposed devices will be annunciated by zone only on the fire alarm control unit zone annunciator and remote zone annunciator. Edit accordingly. Locate graphic annunciator(s) at or near building entrance to allow fire department quick access to the annunciator.

****

Graphic annunciator must be of the [interior][weatherproof] type, [flush][surface][pedestal]-mounted. Annunciator must be provided with the [building][room] floor plan, drawn to scale, with alarm lamps mounted to represent the location of [each concealed detector][each initiating device]. Annunciator graphic must also show the locations of the annunciator and control unit, and must have a "you are here" arrow showing its location. Orient building floor plan on graphic to location of person viewing the graphic(i.e., the direction the viewer is facing must be toward the top of the graphic display). Provide a North arrow.[Principal rooms and areas shown must be labeled with room numbers or titles.] Detectors mounted above ceilings, [on ceilings,]and beneath raised floors and different types of initiating devices must have different symbols or lamps of different colors for identification. Lamps must illuminate upon activation of corresponding device and must remain illuminated until the system is reset. Annunciator must have a lamp test switch.

2.4.2.1 Materials

Construct the graphic annunciator face plate of [smoked

Plexiglas][non-glare matte finish][anodized bronze][anodized aluminum]. The face plate must be backlit with LEDs. Control equipment and wiring must be housed in a [recessed][semi-recessed][surface mounted] back box. The exposed portions of the back box must be [chrome plated][anodized bronze][anodized aluminum] without knockouts.

][2.4.3 Printer

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NOTE: If the printer will be located in a SCIF or similar area, specify "no stored memory".

****

a. Provide a system printer [with no stored memory] to record alarm, supervisory, and trouble conditions without loss of any signal or signals. Printout must be by circuit, device, and function as provided in the FACU. Printer must operate on a 120 VAC, 60 Hz power supply.

b. The printer must have at least 80 characters per line and have a 96 ASCII character set. The printer must have a microprocessor-controlled, bi-directional, logic seeking head capable of printing 120 characters per second utilizing a 9 by 7 dot matrix print head. Printer must not contain internal software which is essential for proper operation.

c. When the FACU receives a signal, the alarm, supervisory, and trouble condition must be printed. The printout must include the type of signal, the circuit or device reporting, the date, and the time of the occurrence. The printer must differentiate alarm signals from other printed indications. When the system is reset, this condition must also be printed including the same information concerning device, location, date, and time. Provide a means to automatically print a list of existing alarm, supervisory, and trouble conditions in the system. If a printer is off-line when an alarm is received, the system must have a buffer to retain the data and it must be printed when the printer is restored to service. The printer must have an indicator to alert the operator that the paper has run out.

]2.5 MANUAL STATIONS

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NOTE: Architectural Barriers Act (ABA) requires that manual alarm stations be mounted at a maximum of 1.1 m 44 inches above finished floor (AFF).

****

Provide metal or plastic, [semi-flush][flush][surface] mounted, [single][double]-action, manual stations, that are not subject to operation by jarring or vibration. Stations must be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations must be finished in red with molded raised lettering operating instructions of contrasting color. The use of a key must be required to reset the station.

2.6 SMOKE DETECTORS

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NOTE: Provide smoke detectors only in spaces where they are specifically required by UFC 3-600-01, DESIGN: FIRE PROTECTION ENGINEERING FOR FACILITIES.

Smoke detectors provided in elevator machinery rooms are to be provided per requirements of UFC 3-600-01. Coordinate with Section 14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS, Section 14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS and/or Section 14 24 13 HYDRAULIC FREIGHT ELEVATORS, Section 14 24 23 HYDRAULIC PASSENGER ELEVATORS.
****

2.6.1 Spot Type Detectors

Provide [photoelectric][ionization][laser] smoke detectors as follows:

a. Provide [photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268][smoke detectors that operate on the ionization principle and are actuated by the presence of visible or invisible products of combustion][laser smoke detectors utilizing laser diode and patented smoke sensing chamber, designed to amplify signals from smoke but diminish stray internal reflections and must, on command from the FACU, send data to the control unit representing the analog level of smoke density]. Smoke detectors must be listed for use with the FACU .

b. Provide self-restoring type detectors that do not require any readjustment after actuation at the FACU to restore them to normal operation. The detector must have a visual indicator to show actuation.

c. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases [with sounder that produces a minimum of 90 dBA at 3 m 10 feet] with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.

[2.6.2 Projected Beam Smoke Detector

Detectors must consist of [combined transmitter and receiver unit][separate transmitter and receiver units]. The transmitter unit must emit an infrared beam to the receiver unit [the use of a supplied reflector is required for the combined unit]. When the signal at the receiver falls below a preset threshold, the detector must initiate an alarm. The receiver must contain an LED status indicator that illuminates when an alarm condition exists. Long-term changes to the received signal caused by environmental variations must be automatically compensated. Detectors must incorporate features to assure that they are operational; a trouble signal must be initiated if the beam is obstructed for more than 3 seconds, the limits of the compensation circuit are reached, or the housing cover is removed. Detectors must have multiple sensitivity settings in order to meet UL listings for the different distances covered by the beam.

]2.6.3 Duct Smoke Detectors

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NOTE: The requirements for Duct Detectors will be coordinated with the HVAC requirements and Sections 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. All

required duct detectors will be shown on the contract drawings.
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Duct-mounted photoelectric smoke detectors must consist of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct.[It is not permitted to cut the duct insulation to install the duct detector directly on the duct.] Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the FACU.

a. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the FACU.

b. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote indicators must be provided where required by NFPA 72. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.

c. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Auxiliary contacts provide for this function must be located within 1 m 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

[2.7 AIR SAMPLING SMOKE DETECTION SYSTEM

The [addressable]air sampling smoke system must consist of a detector assembly housing an integral aspiration fan, filter, laser-based detection chamber and control, output and supervision circuitry.[Each sampling point must be capable of being independently addressable.] The system must consist of a piping or tubing distribution network that runs from the detector assembly(s) to the protected area(s) and is supported by air sampling smoke detection system calculations from a computer-based design modeling tool. The system must include configurable alarm and trouble relay outputs for interface to other systems where required.

a. System must be complete in all ways. It must include all engineering, and electrical installation, all detection and control equipment, auxiliary devices and controls, alarm interface, functional checkout and testing, training and all other operations necessary for a functional system.

b. System base detectors and modules must each accommodate up to [40 addressable][_____] microbore sampling tubes where each tube has a sampling point at the end. Additional modules may be used to provide up to [20 addressable][_____] sampling holes per system.

c. Program alarm thresholds to the following values unless the results of the pre-Government system tests indicate a clear need to change them. In the event that such a need is indicated, notify the Contracting Officer and provide complete documentation concerning the need to deviate from these values. Include within the deviation documentation request, information that complies with the paragraph entitled "Sensitivity Verification Test". Ensure initial threshold levels are approved prior to the Government test.

(1) Alarm Level 1: set ALERT at [_____][0.0250] percent obscuration/foot

(2) Alarm Level 2: set PRE-ALARM at [_____][0.0500] percent obscuration/foot

(3) Alarm Level 3: set FIRE 1 at [_____][0.1000] percent obscuration/foot

(4) Alarm Level 4: set FIRE 2 at [_____][0.2000] percent obscuration/foot

d. All air sampling smoke detection devices and associated components must be new, standard products or the manufacturer's latest design and suitable to perform the functions intended.

e. The laser detection chamber must be of the mass light scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method must be employed for the purposes of:

(1) Preventing large particles from affecting the true smoke reading.

(2) Monitoring contamination of the filter (for example, dust and dirt) to automatically notify when maintenance is required. The particle counting method must not be used for the purpose of smoke density measurement.

f. Detector(s) must be self-monitoring for filter contamination and provide indication through system fault when replacement is necessary. Detectors which allow automatic reset of filter status upon removal and re-insertion are not permitted.

g. Detector(s) must contain relays for alarm and fault conditions. The relays must be software programmable to the required functions.

h. Detector(s) must permit configuration by programmers that are either integral to the system, portable or PC based.

i. Detector(s) must allow programming of:

(1) Smoke threshold alarm levels; ALERT, PRE-ALARM, FIRE 1 and FIRE 2.

(2) Time delays. Ensure the display control unit contains individual adjustable alarm time delay features for each of the alarm threshold levels. Provide an adjustment range between 0 and 60 seconds. Program the alarm threshold time delays to 30 seconds for alarm levels 1 and 2, and 15 seconds for alarm levels 3 and 4.

(3) Faults, including airflow, detector, power, filter and network, as well as an indication of the urgency of the fault.

(4) Configuration of relay outputs for remote indication of alarm and fault conditions.

(5) General purpose input functionality.

]2.8 HEAT DETECTORS

****

NOTE: Heat detectors provided in elevator machinery rooms are strictly for the warning sign in the elevator cab and must not alarm the FACU. Coordinate with Section 14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS, Section 14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS and/or Section 14 24 13 HYDRAULIC FREIGHT ELEVATORS, Section 14 24 23 HYDRAULIC PASSENGER ELEVATORS.

****

2.8.1 Heat Detectors

Heat detectors must be designed for detection of fire by [fixed temperature][combination fixed temperature and rate-of-rise principle][rate-compensating principle] in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values.. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations [as defined by NFPA 70][and][as indicated], must be types approved for such locations.

[2.8.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-resetting. Detector must operate at [57.2][90] degrees C[135][194] degrees F. Detector must feature rate compensation. [Detectors rated to operate at 57.2 degrees C135 degrees F must not respond to momentary temperature fluctuations less than 16.7 degrees C30 degrees F per minute between 16 and 38 degrees C60 and 100 degrees F].[Detectors rated to operate at 90 degrees C194 degrees F must not respond to momentary temperature fluctuations less than 27.8 degrees C 50 degrees F per minute between 16 and 66 degrees C60 and 150 degrees F.][The detector assembly must be [weatherproof][and][explosionproof].]

][2.8.1.2 Rate Compensating Detectors

Detector backbox must be [surface][flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring and hermetically sealed.[The detector assembly must be [weatherproof][and][explosionproof].]

][2.8.1.3 Line-Type Fixed Temperature Detectors

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NOTE: Specify line-type heat detectors only with approval of the EFD/EFA Fire Protection Engineer.

****

Provide [thermostatic][or][thermistor] line-type heat detection cable [with weather-resistant outer covering] where indicated. Cable must be nominally rated for a temperature of [68][88][138] degrees C [155][190][280] degrees F and must operate on fixed temperature principle only.

][2.8.1.4 Fixed Temperature Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. The detectors must have a specific temperature setting [of [57.2][_____] degrees C [135][_____] degrees F][as shown].[The detector assembly must be [weatherproof][and][explosionproof].]

][2.9 FLAME DETECTORS

****

NOTE: Modify these paragraphs as necessary to indicate that detectors placed in an explosive environment will be approved for use in the appropriate class, division, and group environment as defined in NFPA 70 and as shown on drawings.

****

Detectors must be sensitive to the micron range best suited for their intended use. Detectors must operate over electrically supervised wiring circuits and the loss of power to the detector must result in a trouble signal. A self-test feature must be provided for each detector to be individually tested.

[2.9.1 Infrared (IR) Single Frequency Flame Detector

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NOTE: The single frequency IR flame detector has the advantage of a fast response and is moderately sensitive. Its disadvantages are being affected by temperature extremes and being subject to false alarms from a myriad of IR sources.

****

The detector must be sensitive in the range of [_____] to [_____] micrometers only.

][2.9.2 Infrared (IR) Multi Frequency Flame Detector

****

NOTE: The IR multi frequency flame detector has the advantages of a moderately fast response, moderate sensitivity, and a lower false alarm rate. Its disadvantage is being affected by temperature extremes.

****

The IR detector must consist of three or more IR sensors, each selected for a different IR frequency. The primary sensor must be sensitive in the range of [_____] to [_____] micrometers only. Secondary sensors are tuned to different IR wavelengths to null out the effect of black body radiation to the primary sensor.

][2.9.3 Ultraviolet (UV) Flame Detectors

****

NOTE: Ultraviolet (UV) flame detectors can be set

to respond accurately to UV wavelength light produced by flame from both indoors and outdoors. UV flame detectors operate on the Geiger-Muller principle. These gas-filled vacuum tubes respond in the UV portion of the spectrum but can ignore UV radiation from the sun because the upper response range of the detector falls below the range of UV radiation that reaches the earth.

Solid-state UV detectors are available, but their spectral response extends into the sun's UV range and are not recommended for external use.

UV detectors have an 80 to 90 degree cone of vision. The UV detector has a fast response time and usually is not affected by rain, wind, snow, high humidity, or temperature and pressure extremes. UV units will produce false alarms if they are exposed to arc welding or X-ray and gamma radiation. They can also be blinded by oil film or smoke. UV flame detectors that are used in dirty and dusty environments should be equipped with automatic self-test and self-cleaning devices. The cleaning device uses a stream of clean air across the lens surface to minimize the build-up of contaminants.

****

UV flame detector must be of the narrow band response type which operates on radiated ultraviolet energy and must be sensitive in the range of [_____] to [_____] micrometers only. The cone of vision must be 80 degrees or greater. Each detector must be completely insensitive to light sources in the visible frequency range.

][2.9.4 Combination UV/IR Flame Detector

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NOTE: Combination UV/IR flame detectors have been used both inside and outside to detect fires, but are slower to react than individual units.

****

The UV/IR detector must provide discrimination against false alarms by requiring both UV and IR flame detection before an alarm is sent. The UV sensor must be sensitive in the range of 0.185 to 0.265 micrometers only. The IR sensor must be sensitive in the range of [_____] to [_____] micrometers only. Detectors must be completely insensitive to light sources in the visible frequency range.

][2.10 MULTI-CRITERIA DETECTORS

****

The designer must select the sensor required to initiate a fire alarm condition.

****

Multi-criteria detectors must contain [fixed temperature [_____] degrees C F heat sensor], [rate-of-rise heat sensor], [photoelectric smoke detector], [_____] elements in a single housing.

]2.11 CARBON MONOXIDE DETECTOR

Carbon monoxide (CO) detectors must be listed to UL 2075 and set to respond to the sensitivity limits of UL 2034. Carbon monoxide detectors must be listed for use with fire alarm control units. Detectors must be [surface] [semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. For FACU with no listed compatible addressable CO detectors, provide listed 4-wire detectors.[Do not provide CO detectors with local alarms.] Detector must be provided with an LED status indicator.

a. Where 4-wire CO detectors are necessary, each 4-wire CO detector must be individually monitored via addressable interface modules for alarm and off normal/trouble conditions (including loss of power to the individual detector). Power circuits for 4-wire CO detectors must be dedicated to powering the CO detectors only. Battery powered and 120 VAC powered detectors are prohibited.

b. Wiring connections must be made by means of screw terminals and detectors must be equipped with trouble relays. Detectors must be able to mount a single-gang electrical box.

c. A trouble condition at an individual CO detector must not affect any other CO detectors. CO detectors must be powered by the FACU.

d. Detectors must be provided with a means to test CO gas entry into the CO sensing cell.

2.12 NOTIFICATION APPLIANCES

2.12.1 Audible Notification Appliances

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NOTE: The designer must layout speakers to achieve both the required dBA levels requires by NFPA 72.

NOTE: Where horns or bells are used for fire alarm notification, calculate the proper locations for these devices as detailed in "Designing Fire Alarm Audibility," which is contained in the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering. Submit the calculations at the 35-percent design review.

****

Audible appliances must conform to the applicable requirements of UL 464. Appliances must be connected into notification appliance circuits. Surface mounted audible appliances must be painted [red][white][_____]. Recessed audible appliances must be installed with a grill that is painted [red][white][_____][with a factory finish to match the surface to which it is mounted].

2.12.1.1 Horns

Horns must be [semi-flush mounted][surface-mounted, with the matching mounting backbox surface mounted vibrating type suitable for use in an electrically supervised circuit]. Horns must produce a sound rating of at least 85 dBA at 3.1 meters10 feet. Horns used in exterior locations must be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.[Horns must be [weatherproof][explosionproof].]

[2.12.1.2 Bells

Bells must be surface mounted with the matching mounting backbox [surface mounted][recessed]. Bells must be suitable for use in an electrically supervised circuit. Bells must be the underdome type producing a minimum output rating of [85] [_____] dBA at 3.1 m 10 feet. Bells used in exterior locations must be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles. Single stroke, electrically operated, supervised, solenoid bells must be used for coded applications.

][2.12.1.3 Chimes

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NOTE: Chimes are normally only used in hospitals and child development centers to alert the staff about a fire emergency without arousing the patients. Sound output is low and prevents them from being used in areas having even moderately low noise levels.

****

Chimes must be electrically operated, supervised, electronic type, with an adjustable frequency of 800 to 1200 Hertz. Chimes must have a minimum sound rating of [80][_____] dBA at 3 m 10 feet. Chimes must ring the bell codes, as indicated.

]2.12.2 Visual Notification Appliances

****

NOTE:
1. ABA requires that Visual Notification Appliances be provided in buildings and facilities in each of the following areas: restrooms, and any general usage area (e.g., meeting rooms), hallways, lobbies, and any other area for common use and other areas stated at www.access-board.gov. The Visual Notification Appliance must be mounted as required by ABA that directs compliance with NFPA 72. In addition, alarms in guest rooms required to provide communication features must comply with sections 18.5.5.7 of NFPA 72. Shop drawings must indicate location, dimensions, content, details, and other required information to indicate extent of complying with ABA requirements.

2. Currently NFPA 72 requires "clear color" strobes for Fire Alarm Notification. NFPA 72 requires the strobe must be marked "Fire" to clear identify the function.

****

Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED) and be marked "Alert" in letters of contrasting color. The light pattern must be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of [15][30][75][_____] candela based on the UL 1971 test. Strobe must be [surface][semi-flush] mounted.

2.13 ELECTRIC POWER

2.13.1 Primary Power

Power must be [120][_____] VAC [50][60] Hz service for the FACU from the AC service to the building in accordance with NFPA 72.

2.14 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.14.1 Batteries

Provide sealed, maintenance-free, [sealed lead acid][lead-calcium][gel cell] batteries as the source for emergency power to the FACU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.14.1.1 Capacity

Battery size must be the following capacity. This capacity applies to every control unit associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, and fire alarm transmitters.

a. Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.

2.14.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

    (1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit component, and compliance with UL 864.

    (2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

    (3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components. Calculations must be performed using the minimum

rated voltage of each component.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing device and/or appliances remote from the power sources.

2.14.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and must maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.15 SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage fire alarm control unit components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on any signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the FACU breaker is located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for fire alarm wiring. The base assembly must accept "plug-in" surge protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

    (1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

(2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

(3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

(4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.16 WIRING

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.16.1 Alarm Wiring

IDC wiring must be solid copper cable in accordance with the manufacturers requirements. Copper initiating device circuit field wiring must be No. [14][16][18][_____] AWG size conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 14 AWG size conductors at a minimum. Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors and/or appliances. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with NFPA 70.

2.17 AUTOMATIC FIRE ALARM TRANSMITTERS

****

NOTE: State the make and model number of existing proprietary supervising station receiving equipment. The choice of code transmitter, or radio transmitter depends upon the type of existing fire reporting system at the activity. Determine the type of activity reporting system (e.g., positive non interfering or shunt). In most cases a local energy-tripping device will be required. The facility Fire Dept. or Engineering office should be contacted to determine the type and amount of data to be supervised (monitored), e.g., -type: separate or common transmission of alarm, supervisory, and trouble type signals; -amount: all points, all zones, or the combined premises. Verify that existing monitoring equipment has sufficient capacity to support the additional premises or that it can be expanded as necessary to accommodate the new fire alarm system. Identify existing components.

****

[2.17.1 Radio Transmitter and Interface Panels

Transmitters must be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter must be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters must be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module must be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is [_____] and the transmitter must be fully compatible with this equipment. At the contractors option, and if listed, the transmitter may be housed in the same control unit as the FACU. The transmitter must be narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.

2.17.1.1 Operation

Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter must automatically switch to battery operation. Switchover must be accomplished with no interruption of protective service, and must automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply must also be automatic.

2.17.1.2 Battery Power

Transmitter standby battery capacity must provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.17.1.3 Transmitter Housing

Use NEMA Type 1 for housing. The housing must contain a lock that is keyed [identical to the fire alarm system for the building][identical to radio alarm transmitter housings on the Installation]. Radio alarm transmitter housing must be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.17.1.4 Antenna

Antenna must be [omnidirectional, coaxial, halfwave dipole antennas][_____] for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts must be corrosion resistant and designed to withstand wind velocities of 161 km/hour 100 mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage.

][2.17.2 Digital Alarm Communicator Transmitter (DACT)

Provide DACT that is compatible with the existing supervising station fire alarm system. Transmitter must have a means to transmit alarm, supervisory, and trouble conditions via a single transmitter. Transmitter must have a source of power for operation that conforms to NFPA 72. Transmitter must be capable of initiating a test signal daily at any selected time. Transmitter must be arranged to seize telephone circuits in accordance with NFPA 72.

]2.17.3 Signals to Be Transmitted to the Base Receiving Station

****

NOTE: The following paragraph is applicable only to existing installations for connections to an auxiliary (public) alarm system. Edit this for the installation specific criteria.

****

The following signals must be sent to the base receiving station:

[a. Sprinkler waterflow]

[b. Manual pull stations]

[c. Smoke detectors]

[d. Duct smoke detectors]

[e. Sleeping room smoke detectors]

[f. Carbon monoxide detectors]

[g. Heat detectors]

[h. Fire extinguishing system]

[i. Sprinkler valve supervision]

[j. Fire pump running]

[k. Fire pump supervision]

[l. Water supply level and temperature]

[m. Combustion engine drive fire pump running

    (1) Selector switch in position than automatic

    (2) Engine over-speed

    (3) Low fuel

    (4) Low battery

    (5) Engine trouble (for example, low oil, over temp)]

2.18 SYSTEM MONITORING

2.18.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves,[standpipe control valves,] sprinkler service entrance valve,[valves at fire pumps,] isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, must be electrically monitored to ensure its proper position. Provide each tamper switch with a separate zone[, unless they are within the same room, then a maximum of five can use the same zone].

[2.18.2 High/Low [Air][Nitrogen] Supervisory Switches

Provide monitoring of high and low supervisory [air][nitrogen] for [dry pipe][and][preaction] systems. Each air supervisory switch must have a separate address. Switches must be listed extinguishing system attachments. The device must contain double pole, double throw contacts. Operation of the switch must cause a supervisory signal to be transmitted to the FACU when [air][nitrogen] pressure in the system monitored sprinkler system increases more than 34.5 kPa5 psi above the normal system pressure or drops halfway from the normal pressure to the tripping point.

][2.18.3 Room Low Temperature Supervisory Switch

Provide [monitoring of the]listed supervisory air temperature switch for the [fire pump][sprinkler riser] room[s]. Switch must cause a supervisory signal to be transmitted to the FACU whenever the temperature in the room drops to below 4.4 degrees C40 degrees F. Device must reset when temperature rises above 4.4 degrees C40 degrees F.

][2.18.4 Electromagnetic Door Holders

Electromagnetic holding devices must operate on [120 VAC][24 VDC], and require not more than [3][_____] watts of power to develop 6.9 kPa25 psi of holding force. Under normal conditions, the magnets must attract and hold the doors open. Operation must be fail safe with no moving parts. Electromagnetic door hold-open devices must not be required to be held open during building power failure. The device must be listed based on UL 228 tests.

]2.19 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures must be provided to permit fire alarm components to be used in areas that exceed the environmental limits of the listing. The enclosure must be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the component is currently listed. Guards required to deter mechanical damage must be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

[2.20 FIREFIGHTER TELEPHONE COMMUNICATION SYSTEM

****

NOTE: Provide a master control station at the FACU with remote telephone stations in each stair at each floor landing, in each elevator lobby on each floor, and in elevator cabs. In addition, provide them at specific locations containing essential fire protection equipment, such as the fire pump room and outside the emergency generator room.

NOTE: In lieu of firefighter telephones radio repeater equipment compatible with responding fire department may be used if approved by the responding fire department.

****

2.20.1 General

Provide a firefighter telephone communication system with complete, common talk, closed circuits. The system must include, but not be limited to, a master control station mounted in the fire alarm control unit, a power supply and standby battery system, and remote telephone stations.

2.20.2 Features

The system must include the following features:

a. A master control station which must provide power, supervision, and control for wiring, components, and circuits. The act of lifting any remote telephone hand set from its cradle must cause both a visual and audible signal to annunciate at the master control station. Removing the hand set at the master control station and depressing a button at the remote telephone hand set must cause the automatic silencing of the audible signal.

b. Communication between the master control station hand set and any/or all remote hand sets must require the depressing of a push-to-talk switch located on any/all remote hand sets. During the time that the master control hand set is removed from its cradle it must be possible to communicate between five remote hand sets and the master control station.

c. Hand sets must be able to monitor any conversation in progress and join the conversation by pressing the push-to-talk button. It must not be possible to communicate between two or more remote hand sets with the master control station hand set in its cradle.

d. The master control station hand set must be red in color and equipped with a 1.5 m5-foot long strain-relieved coiled cord.

e. The master control station must monitor wire and connections for any opens, shorts, or grounds which would render the system inoperable or unintelligible.

f. The master control station must be equipped with a silencing switch and ring-back feature such that any audible trouble signal can be silenced and must be so indicated by the lighting of an amber LED. Once any trouble condition has been corrected, the amber LED must be extinguished.

g. The master control station must be equipped with a separate, LED annunciated switch for each telephone circuit. In addition, LEDs must provide for the annunciation of operating and supervisory power.

h. The loss of operating or supervisory power must cause an audible and visual indication at the master control station and must also cause the fire alarm trouble signal to sound on the FACU.

i. Switches, LEDs, and controls must be fully labeled.

2.20.3 Handsets

Handsets must have the following features:

a. Provide [surface][flush] mounted remote telephone stations.

b. Each station must be equipped with a hinged door that is magnetically locked.

c. Each hand set must be permanently wired in place with a coiled cord.

d. Each hand set must be red high-impact cycolac and must be equipped with a push-to-talk switch which, when operated, must signal the master control station and a switch-equipped, storage cradle.

e. Provide operating and supervising power from the same supply circuit(s) utilized for the FACU.

]PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

3.2.1 Fire Alarm Control Unit (FACU)

Locate the FACU [where indicated on the drawings][_____]. [Recess][Semi-recess][Surface mount] the enclosure with the top of the cabinet 2 m 6 feet above the finished floor or center the cabinet at [1.5][_____] m [5][_____] feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the FACU. Locate the document storage cabinet adjacent to the FACU unless the Contracting Officer directs otherwise.

3.2.2 Battery Cabinets

When batteries will not fit in the FACU, locate battery cabinets below or adjacent to the FACU. Battery cabinets must be installed at an accessible location when standing at floor level. Battery cabinets must not be installed lower than 300 mm12 inches above finished floor, measured to the bottom of the cabinet, nor higher than 900 mm36 inches above the floor, measured to the top of the cabinet. Installing batteries above drop ceilings or in inaccessible locations is prohibited. Battery cabinets must be large enough to accommodate batteries and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.The cabinet must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must indicate the control unit(s) the batteries power and must not be less than 25 mm1-inch high.

3.2.3 Manual Stations

Locate manual stations as required by NFPA 72[and as indicated on the drawings]. Mount stations so they are located no farther than [1.5][_____]

m [5][_____] feet from the exit door they serve, measured horizontally. Manual stations must be mounted at [1067][1117][_____] mm [42][44][_____] inches measured to the operating handle.

3.2.4 Notification Appliances

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NOTE: Locate strobes wall mounted in corridors no more than 4.5 m 15 feet from the end of a corridor with 30 m 100 feet maximum distance between strobes. Where there is an obstruction to the viewing path in the corridors, such as a cross-corridor door or ceiling elevation change, consider the obstruction as defining a new corridor. Provide ceiling mounted strobes in rooms accessible to the public, such as conference rooms, restrooms, courtrooms, cafeterias, and auditoriums in accordance with NFPA 72. In Child Development Centers only chimes must be used as the pre-alert tone prior to voice messages.

****

a. Locate notification appliance devices [as required by NFPA 72][where indicated] Where more than two visual notification appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring.[Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles plus or minus 50 mm2 inches.].

b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.

c. Speakers must not be located in close proximity to the FACU or LOC so as to cause feedback when the microphone is in use.

3.2.5 Smoke and Heat Detectors

Locate detectors [as required by NFPA 72 and their listing][as indicated on the drawings] on a 100 mm 4-inch mounting box. Install heat detectors not less than 100 mm 4 inches from a side wall to the near edge. Heat detectors located on the wall must have the top of the detector at least 100 mm 4 inches below the ceiling, but not more than 300 mm 12 inches below the ceiling. Smoke detectors are permitted to be on the wall no lower than 300 mm 12 inches from the ceiling with no minimum distance from the ceiling.[In raised floor spaces, install the smoke detectors to protect[21 square meters 225 square feet per detector][_____].] Install smoke detectors no closer than 1 m 3 feet from air handling supply diffusers. Detectors installed in acoustical ceiling tiles must be centered in the tiles plus or minus 50 mm2 inches.

3.2.6 Carbon Monoxide Detectors

Locate detectors [as required by NFPA 72 and their listings][as indicated on the drawings] on a 100-mm4-inch mounting box.[Carbon monoxide detectors must be installed separate from smoke and/or heat detectors.]

[3.2.7 Air Sampling Smoke Detector

Locate air sampling smoke detectors in accordance with the manufacturer's instructions. Air sampling smoke detectors must be installed as follows:

a. Air Sampling Smoke Detector Assembly:

   (1) Detector assembly must be mounted to a wall at a height between 48 to 60 inches1200 mm to 1800 mm to top of detector measured above the finished floor.

   (2) Mounting must be in a fully accessible and visible location.

   (3) Mounting or attachment to site equipment, cable trays, movable walls, other equipment or equipment supports is not permitted.

   (4) Piping network insertion into the detector inlet must not be glued.

   (5) Air sampling smoke detector assembly must be installed in accordance with this specification section and the manufacturer's installation and instruction manuals.

   (6) Flexible tubing for termination of the sampling pipe network into detector inlet is not permitted unless allowed by its listing.

   (7) Provide red background with white lettering labels that are plastic or phenolic type with a minimum of 0.25-inch6.4 mm block lettering to indicate detector and zone. For example: "AIR SAMPLING SOME DETECTOR No. 1-1 No. 5".

   (8) Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the ASD panel. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must be approved by the Contracting Officer before being posted.

b. Pipe and Sampling Tube Mounting:

   (1) The pipe and sampling tubing detection network must be mounted as per the design and manufacturer's specification. The hardware used for mounting will depend upon the design and site requirements.

   (2) To minimize flexing, pipes must be secured every 1.5 m5 feet.

   (3) Pipes must be suspended between 25 mm and 100 mm1 and 4 inches below the ceiling. In areas with a suspended ceiling, the pipe network must be installed above the ceiling utilizing the manufacturer's capillary sample port supported by the ceiling.

   (4) The sampling tubes must be of the same length or use the manufacturer's guidelines to run tubes of the required lengths.

   (5) When installing a pipe network in areas subject to high temperature fluctuations allow for the contraction and expansion of pipes.

(6) Where expansion or contraction of pipes is likely either after installation or on a continuous basis, do not place pipe clips adjacent to couplings and socket unions as these may interfere with the movement of the pipe.

(7) No bends are permitted within the first 450 mm18 inches from the detector inlet.

(8) The routing of the piping and sample tube network must be coordinated with potential obstructions, including cable trays, grounding bars, and HVAC ductwork.

(9) All changes in direction must be made with standard elbows or tees.

(10) All joints must be air-tight and made by using solvent cement, except at the entry to the detector assembly. Refer to ASTM F402.

(11) All pipes must be supported by mechanical hangers attached to the structure of the building. Not more than 300 mm1-foot of pipe must extend beyond the last hanger of each sampling pipe. The final installation must result in no noticeable deflection in the piping network.

(12) Attachment of air sampling pipes to cable trays, "gray iron", and telecommunications equipment is prohibited.

(13) Clearly label pipe network to distinguish the pipe from other facility pipe work or protective cabling enclosures. For example: "SMOKE DETECTION SAMPLING TUBE - DO NOT DISTURB". In open rooms and exposed areas, provide labels at no greater than 6.1-m20-foot intervals. Provide labels every 3 m10 feet where piping is installed above suspended ceilings and every 609 mm2 feet, centered in the floor panels, where piping is installed within the raised floor cavity.

(14) Placement of the sampling tube must take into consideration appropriate sampling point locations and spacing.

c. Air Sampling Points:

(1) Open area ceiling sampling points must be oriented downward and must be within 25 mm to 100 mm1 to 4 inches below the underside of the ceiling above where the ceiling is smooth.

(2) Label all air sampling points with a round red label, each with a center hole to match the diameter of the drilled sampling point. For example: "AIR SAMPLING POINT DIA 3.2 MM0.125 INCHES". Indicate fractional dimensions in decimal format with a minimum of three decimal places.

][3.2.8 Graphic Annunciator

Locate the graphic annunciator as shown on the drawings. Mount the annunciator, with the top 1830 mm 6 feet above the finished floor or center the annunciator at [1525][_____] mm [5][_____] feet, whichever is lower. [Locate the graphic annunciator as shown on the drawings. Surface-mount the annunciator, with the top 1830 mm 6 feet AFF or center the annunciator at [1525][_____] mm [5][_____] feet, whichever is lower.]

]3.2.9 Remote Annunciator

Locate the remote annunciator as shown on the drawings. Mount the annunciator, with the top 2 m 6 feet above the finished floor or center the annunciator at [1.5][_____] m [5][_____] feet, whichever is lower.

[3.2.10 Electromagnetic Door Holder Release

Doors must be held open at a minimum of 90 degrees so as not to impede egress from the space. Mount the armature portion on the door and have an adjusting screw for seating the angle of the contact plate. Wall-mount the electromagnetic release, with a total horizontal projection not exceeding 100 mm4 inches. Ensure all doors release to close upon first stage (pre-discharge) alarm. Electrical supervision of wiring external of control unit for magnetic door holding circuits is not required.

][3.2.11 Firefighter Telephones

Mount telephone[hand sets][jacks] on the wall in each stair at each floor landing, in each emergency generator room, in each fire pump room, in each elevator machine room, in each elevator lobby, and in each elevator cab 1200 mm 4 feet above the finished floor.

]3.2.12 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.3 SYSTEM FIELD WIRING

3.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and professional manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FACU and remote fire alarm control units, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.3.2 Terminal Cabinets

****

NOTE: Provide terminal cabinets on each floor where the fire alarm system supply riser is located and where the fire alarm return riser is located.

****

Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 200 mm by 200 mm 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "FIRE ALARM TERMINAL CABINET" with 50 mm 2-inch lettering, on the front of the terminal cabinet.

3.3.3 Alarm Wiring

****

NOTE: Do not penetrate SCIF perimeters with copper signal line circuits. SCIF penetrations should be either fiber optic cable or IDC. IDC circuits penetrating the SCIF must be filtered.

****

a. Voltages must not be mixed in any junction box, housing or device, except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the FACU.

c. [Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.][T-tapping using screw terminal blocks is allowed for Class "B" initiating device circuits.]

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the [_____] Designated Fire Protection Engineer (DFPE).

3.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 19 mm3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits [_____]6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

g. [g. For Class "A" or "X" circuits with conductor lengths of 10 feet3 meters or less, the conductors must be permitted to be installed in the same raceway in accordance with NFPA 72.]

3.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FACU, and remote FACU must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FACU, and remote FACU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12 point lettering minimum size, and mounted within each cabinet, control unit, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

[3.4 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM

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NOTE: Contact the Contracting Officer, Base Fire Prevention Office, and/or Base Maintenance Personnel to determine what action is appropriate for the salvaging of existing fire alarm equipment.

****

Maintain existing fire alarm equipment fully operational until the new equipment has been tested and accepted by the Contracting Officer. As new equipment is installed, label it "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Government, it must be placed in service and connected to the supervising station. Remove tags from new equipment and tag the existing equipment "NOT IN SERVICE" until removed from the building.

a. After acceptance of the new system by the Contracting Officer, remove existing equipment not connected to the new system, remove unused exposed conduit, and restore damaged surfaces. Remove the material from the site and dispose.

b. Disconnect and remove the existing fire alarm and smoke detection systems where indicated and elsewhere in the specification.

c. Control units and fire alarm devices and appliances disconnected and removed must be turned over to the Contracting Officer.

d. Properly dispose of fire alarm outlet and junction boxes, wiring, conduit, supports, and other such items.

3.5 CONNECTION OF NEW SYSTEM

The following new system connections must be made during the last phase of construction, at the beginning of the pre-Government tests. New system connections must include:

a. Connection of new relays to existing magnetic door hold-open devices.

b. Connection of new elevator recall relays to existing wiring and conduit.

c. Connection of new system transmitter to existing installation fire reporting system.

Once these connections are made, system must be left energized. Report immediately to the Contracting Officer, coordination and field problems resulting from the connection of the above components.

]3.6 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire-rated walls, partitions with fire-rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.7 PAINTING

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 19 mm3/4-inch wide at 3-meter10-foot centers and at each side of a floor, wall, or ceiling penetration.

c. Painting must comply with Section 09 90 00 PAINTS AND COATINGS.

3.8 FIELD QUALITY CONTROL

****

NOTE: Listed tests are minimum required. Coordinate with the local Authority Having Jurisdiction (AHJ) for minimum requirements in excess of the NFPA 72 minimums or those recommend

below. If additional tests are required, such tests must be added to the list.
****

3.8.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level [III][or][IV] Fire Alarm Technician, and the representative of the installing company, [and reviewed by the QFPE] [60][_____] days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, and surge protective devices. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forma in NFPA 72 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government testing. The test data forms must record the test results and must:

a. Identify the NFPA Class of all Initiating Device Circuits (IDC), and Notification Appliance Circuits (NAC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing. The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.8.2 Pre-Government Testing

3.8.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that devices and circuits are functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" as required by NFPA 72. The contractor and an authorized representative from each supplier of equipment must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 72 including all referenced annex sections and the test reports noted below.

a. NFPA 72 Record of Completion.

b. NFPA 72 Record of Inspection and Testing.

c. Fire Alarm and Emergency Communication System Inspection and Testing Form.

d. Audibility test results with marked-up test floor plans.

e. Documentation that all tests identified in the paragraph "Minimum System Tests" are complete.

3.8.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the [_____][Designated Fire Protection Engineer (DFPE)][Contracting Officer's Representative (COR)]. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation-wide fire reporting system has been completed and tested to confirm communications are fully functional. Submit request for test at least [15][_____] calendar days prior to the requested test date.

3.8.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. [b. The contractor's Qualified Fire Protection Engineer (QFPE).]

c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results

e. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

f. Audibility test results with marked-up floor plans.

Government Final Tests will be witnessed by the [_____], [Designated Fire Protection Engineer][Contracting Officer's Representative (COR)][, Qualified Fire Protection Engineer (QFPE)]. At this time, any and all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.9 MINIMUM SYSTEM TESTS

3.9.1 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final Government test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the pre-Government test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

e. Carbon Monoxide Detector Tests: Carbon monoxide detectors must be tested in accordance with NFPA 72 and the manufacturer's recommended calibrated test method.

f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

h. Determine that the system is operable under trouble conditions as specified.

i. Visually inspect wiring.

j. Test the battery charger and batteries.

k. Verify that red-line drawings are accurate.

l. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

m. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

n. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

o. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.9.2 Audibility Tests

Sound pressure levels from audible notification appliances must be a minimum of 15 dBa over ambient with a maximum of 110 dBa in any occupiable area. The provisions for audible notification (audibility and intelligibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

3.10 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the Final Government Test.

[a. The drawings must be prepared electronically and sized no less than the contract drawings.][Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation] [AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide Operation and Maintenance (O&M) Instructions.

[In existing buildings, the transfer of devices from the existing system to the new system and the permission to begin demolition of the old fire alarm system will not be permitted until the as-built drawings and O&M manuals are received.]

3.11 INSTRUCTION OF GOVERNMENT EMPLOYEES

3.11.1 Instructor

Provide the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the operation, inspection, testing, and maintenance of the system provided. The instructor must train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm system. The instructor must be thoroughly familiar with all parts of this installation. The instructor must be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

3.11.2 Required Instruction Time

Provide [8][16][_____] hours of instruction after final acceptance of the system. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training must allow for rescheduling for unforeseen maintenance and/or fire department responses.

[3.11.2.1 Technical Training

Equipment manufacturer or a factory representative must provide [1][3][_____] days of on site[and 5 days of technical training to the Government at the manufacturing facility]. Training must allow for classroom instruction as well as individual hands on troubleshooting and diagnostics exercises.[Factory training must occur within [6][12][_____] months of system acceptance.]

]3.11.3 Technical Training Manual

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training must familiarize designated government personnel with proper operation of the installed system. The maintenance training course must provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.12 EXTRA MATERIALS

3.12.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturer[s]. Installing fire alarm contractor is NOT responsible for any damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.12.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed system[s]. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the Government testing and must be accompanied by an inventory list.

3.12.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. All documentation required by SD-06.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-28 31 66 (August 2020)**

Preparing Activity: USACE

Superseding
UFGS-28 31 00.00 10 (November 2008)
UFGS-28 31 49 (April 2006)
UFGS-28 31 63.00 20 (October 2007)
UFGS-28 31 64.00 10 (August 2009)
UFGS-28 31 74.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 28 31 66

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE

08/20

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-28 31 66 (August 2020)**

Preparing Activity: USACE

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UFGS-28 31 00.00 10 (November 2008)
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SECTION 28 31 66

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, NON-ADDRESSABLE

08/20

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NOTE: This specification covers the requirements for a non-addressable integrated fire detection, fire alarm evacuation and mass notification system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: For OCONUS projects, this specification section should be edited for specific Host Nation requirements. Coordinate compliance with Host Nation requirements with the Designated Fire Protection Engineer (DFPE).

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NOTE: For Family Housing projects at NAVFAC NE use regional guide specification section 28 31 46.00 22

(N-13854N) HOUSEHOLD FIRE WARNING EQUIPMENT to specify residential fire warning systems in lieu of this section.

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NOTE: This specification section includes requirements from UFC 3-600-01 (change 43, 7 February 2020)

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NOTE: This guide specification covers carbon monoxide alarm detectors for protection in indoor locations where fuel-burning appliances/equipment are used.

****

PART 1 GENERAL

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1. On the drawings, show location of control unit, batteries and charger (if remotely mounted), supervising station transceiver, annunciator, primary power supply, remote annunciator, detectors, notification appliances (unless performance requirements are specified), and each alarm initiating device including fire extinguishing system switches.

2. Show single-line fire alarm/mass notification systems riser diagram. Each device on the riser should be identified by type. Indicate connection of equipment.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2020) American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2022) Safety Code for Elevators and Escalators

ASTM INTERNATIONAL (ASTM)

ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 170	(2024; ERTA 1 2023) Standard for Fire Safety and Emergency Symbols

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-601-02	(2021) Fire Protection Systems Inspection,

	Testing, and Maintenance
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices
47 CFR 90	Private Land Mobile Radio Services

UL SOLUTIONS (UL)

UL 228	(2006; Reprint Mar 2022) UL Standard for Safety Door Closers-Holders, With or Without Integral Smoke Detectors
UL 268	(2023) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Aug 2023) Smoke Detectors for Duct Application
UL 464	(2023) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 521	(2024) UL Standard for Safety Heat Detectors for Fire Protective Signaling Systems
UL 864	(2023; Reprint Oct 2024) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1480	(2023) UL Standard for Safety Speakers for Fire Alarm and Signaling Systems, Including Accessories
UL 1638	(2023) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Feb 2024) UL Standard for Safety Signaling Devices for the Deaf and

	Hard of Hearing
UL 2034	(2024; Reprint Aug 2024) UL Standard for Safety Single and Multiple Station Carbon Monoxide Alarms
UL 2075	(2013; Bul. 2019) UL Standard for Safety Gas and Vapor Detectors and Sensors
UL 2572	(2016; Bul. 2018) UL Standard for Safety Mass Notification Systems
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 RELATED SECTIONS

Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

[Section 21 13 13 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION]
[Section 21 30 00 FIRE PUMPS]
[Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS]
[Section 21 13 16 DRY PIPE FIRE SPRINKLER SYSTEMS]
[Section 21 13 18 PREACTION FIRE SPRINKLER SYSTEMS]
[Section 21 13 19 DELUGE FIRE SPRINKLER SYSTEMS]
[Section 23 30 00 HVAC AIR DISTRIBUTION]
[Section 21 13 24.00 10 AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM]
[Section 21 13 25 HIGH-EXPANSION FOAM SYSTEM, FIRE PROTECTION]
[Section 21 21 01 CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS]
[Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS]
[Section 08 71 00 DOOR HARDWARE for [door release][door unlocking] and additional work related to finish hardware.]
[Section[s] [14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS] [14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS] [and] [14 24 13 HYDRAULIC FREIGHT ELEVATORS] [14 24 23 HYDRAULIC PASSENGER ELEVATORS] for additional work related to elevators.]
[Section 07 84 00 FIRESTOPPING for additional work related to firestopping.]

1.3 SUMMARY

1.3.1 Scope

a. This work includes designing and [providing a new, complete,][modifying the existing] fire alarm and mass notification (MNS) system as described herein and on the contract drawings[for the _____________]. Include system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, initiating devices, notification appliances, supervising station fire alarm transmitters/mass notification transceiver, and other accessories and miscellaneous items required for a complete operational system even though each item is not specifically mentioned or described. Provide system[s] complete and ready for operation.[Existing interior fire alarm system was manufactured by [_____].] Design and installation must comply with UFGS 25 05 11 and UFC 4-010-06.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 72, except as modified herein. [The system layout on the drawings show the intent of coverage and suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.]

c. [c. Each remote fire alarm control unit must be powered from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.]

d. [d. Where a fire pump is provided, the fire alarm and mass notification system must monitor and transmit the fire pump controller signals in accordance with the provisions of NFPA 72.]

e. [e. Where an emergency generator provides standby power supply for life safety system circuits, the generator must be monitored by the FMCU and transmit emergency generator signals in accordance with NFPA 72.]

f. The fire alarm and mass notification system must be independent of the building security, building management, and energy/utility monitoring systems other than for control functions.

1.3.2 Qualified Fire Protection Engineer (QFPE)

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NOTE: UFC 3-600-01 requires that shop drawings must bear the Review Stamp and professional engineering stamp of the QFPE prior to submission to the Government for approval.

****

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NOTE: The term Qualified Fire Protection Engineer (QFPE) should be considered interchangeable with the terms "Fire Protection Designer of Record (FPDOR)" and/or "Fire Protection QC Specialist" where referred to in other applicable contract documents. The intent of defining the QFPE roles and responsibilities here is NOT to require personnel in addition to the QFPE, FPDOR, and/or FPQC specialist referenced elsewhere in the applicable contract documents.

****

Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Construction (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Providing a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting any outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government [and final Government]functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions must be defined as follows:

1.4.1 Local Operating Console (LOC)

A unit designed to allow emergency responders and/or building occupants to operate the MNS including delivery of recorded messages and/or live voice announcements, initiate visual, textual visual, and audible appliance operation and other relayed functions.

1.4.2 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door where terminal strips are securely mounted inside the cabinet.

1.4.3 Designated Fire Protection Engineer (DFPE)

The DoD fire protection engineer that oversees that Area of Responsibility for that project. This is sometimes referred to as the "cognizant" fire protection engineer. Interpret reference to "authority having jurisdiction" and/or AHJ in referenced standards to mean the Designated Fire Protection Engineer (DFPE). The DFPE may be responsible for review of the contractor submittals having a "G" designation, and for witnessing final inspection and testing.

1.4.4 Qualified Fire Protection Engineer (QFPE)

A QFPE is an individual who is a licensed professional engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of

the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the fire alarm designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their registered professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE will be returned by the Government disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G, [_____]

Fire alarm system designer; G, [_____]

Supervisor; G, [_____]

Technician; G, [_____]

Installer; G, [_____]

Test Technician; G, [_____]

SD-02 Shop Drawings

Nameplates; G, [_____]

Instructions; G, [_____]

Wiring Diagrams; G, [_____]

System Layout; G, [_____]

Notification Appliances; G, [_____]

Initiating devices; G, [_____]

Amplifiers; G, [_____]

Battery Power; G, [_____]

Voltage Drop Calculations; G, [_____]

SD-03 Product Data

Fire Alarm and Mass Notification Control Unit (FMCU); G, [_____]

Local Operating Console (LOC); G, [_____]

Amplifiers; G, [_____]

Tone Generators; G, [_____]

Digitalized voice generators; G, [_____]

Remote Annunciator; G, [_____]

Manual Stations; G, [_____]

Smoke Detectors; G, [_____]

Duct Smoke Detectors; G, [_____]

[Projected Beam Smoke Detector; G, [_____]]

[Air sampling smoke detectors; G, [_____]]

Heat Detectors; G, [_____]

[Flame Detectors; G, [_____]]

[Multi-Criteria Detectors; G, [_____]]

Carbon monoxide detector; G, [_____]

Notification Appliances; G, [_____]

Textual Display Sign Control Panel; G, [_____]

Textual Display Signs; G, [_____]

Batteries; G, [_____]

Battery Chargers; G, [_____]

[Supplemental Notification Appliance Circuit Panels; G, [_____]]

[Auxiliary Power Supply Panels; G, [_____]]

Surge Protective Devices; G, [_____]

Alarm Wiring; G, [_____]

[Back Boxes and Conduit; G, [_____]]

[Ceiling Bridges for Ceiling-Mounted Appliances; G, [_____]]

Terminal Cabinets; G, [_____]

Digital Alarm Communicator Transmitter (DACT); G, [_____]

[Automatic Fire Alarm Transmitters (including housing); G, [_____]]

[Radio Transmitter and Interface Panels; G, [_____]]

[Mass Notification Transceiver; G, [_____]]

Electromagnetic Door Holders; G, [_____]

Environmental Enclosures or Guards; G, [_____]

[Firefighter Telephone; G, [_____]]

[Printer; G, [_____]]

Document Storage Cabinet; G, [_____]

SD-05 Design Data

[Air Sampling Smoke Detection System Calculations; G, [_____]
]

SD-06 Test Reports

Test Procedures; G, [_____]

SD-07 Certificates

Verification of Compliant Installation; G, [_____]

Request for Government Final Test; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, [_____]

Instruction of Government Employees; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings

Spare Parts

1.6 SYSTEM OPERATION

****

NOTE: Circuit wiring must be Class "B" unless Class "A" is required by the local installation and as permitted by NFPA 72 (IDC and NAC: "A" or "B").

Circuits and pathways must have survivability levels as defined by NFPA 72.

****

Fire alarm system/mass notification system including textual display sign control panel(s), components requiring power, except for the FMCU(s) power supply, must operate on 24 volts DC unless noted otherwise in this section.

****

If an addition to an existing system is required, provide the make, model number, and other pertinent information on existing components that are to operate with the new equipment. Since new interfaces will have to be compatible with the existing system or to the central fire alarm reporting system, it may be necessary to edit major items out of this specification. If a new fire alarm unit is required, it has to be compatible with the existing central fire alarm reporting system.

****

Provide a fire alarm system that is a complete, supervised fire alarm reporting system. Activate the system into the alarm mode by actuation of any alarm initiating device. Remain in the alarm mode until the initiating device is reset and the fire alarm control unit is reset and restored to normal. Audible and visual appliances and systems must comply with NFPA 72. Operate fire alarm system components requiring power, except for the control unit power supply, on 24 Volts dc.

1.6.1 Alarm Initiating Devices and Notification Appliances (Visual, Voice, Textual)

a. Connect alarm initiating devices to initiating device circuits (IDC) [Class "A"][Class "B"] and installed in accordance with NFPA 72.

b. Connect notification appliances to notification appliance circuits (NAC) [Class "A][Class "B"].

1.6.2 Functions and Operating Features

The system must provide the following functions and operating features:

a. Power, annunciation, supervision, and control for the system.

b. Visual alarm notification appliances must be synchronized as required by NFPA 72.

c. Electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control unit.

d. An audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal must also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory control unit modules. After the system returns to normal operating conditions, the trouble signal must again sound until the trouble is acknowledged.

e. A trouble signal silence feature that must silence the audible trouble signal, without affecting the visual indicator.

f. Switches in a locked portion of the FMCU to bypass the automatic notification appliance circuits, [fire reporting system][air handler shutdown][smoke control operation][elevator recall][door release][door unlocking] features. Operation of this action must indicate on the FMCU display[and printer output] as a supervisory or trouble condition.[Notification appliance bypass must be selectable by floor.]

g. Alarm functions must override trouble or supervisory functions. Supervisory functions must override trouble functions.

h. There must be no limit, other than maximum system capacity, as to the number of zones that may be in alarm simultaneously.

i. Where the fire alarm/mass notification system is responsible for initiating an action in another emergency control device or system, such as [HVAC,][atrium exhaust,][smoke control,][elevator recall,][releasing service,]the fire alarm relay must be located in the vicinity of the emergency control device.

j. An alarm signal must automatically initiate the following functions:

    (1) Transmission of an alarm signal to [the fire department][a remote supervising station].

    (2) Visual indication of the device operated on the FMCU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

    (3) [(3) Record the event on the system printer.]

    (4) Actuation of alarm notification appliances.

    (5) [(5) Release of doors held open by electromagnetic devices.]

    (6) [(6) Operation of the [smoke control system][atrium exhaust system].]

    (7) [(7) Release of power to electric locks (delayed egress locks) on doors that are part of the means of egress.]

    (8) [(8) Elevator recall as described in this section.]

****

NOTE: Use this paragraph only where a detector or detection system is to release a special fire extinguishing system.

****

    (9) [(9) Operation of [_____] must release the [_____] fire extinguishing system after a [_____] second time delay.]

(10) [(10) Operation of a sprinkler waterflow switch serving an elevator machinery room or elevator shaft must operate shunt trip circuit breaker(s) to shut down power to the elevators in accordance with ASME A17.1/CSA B44.]

(11) [(11) Operation of an interface that operates vibrating pagers worn by hearing-impaired occupants.]

k. A supervisory signal must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

(2) [(2) Record the event on the system printer.]

(3) Transmission of a supervisory signal to [the fire department][a remote supervising station].

(4) Operation of a duct smoke detector must shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph and as allowed by NFPA 72.

l. A trouble condition must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

(2) [(2) Record the event on the system printer.]

(3) Transmission of a trouble signal to [the fire department][a remote supervising station].

m. [m. Activation of a carbon monoxide alarm initiating device must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU,[LCD, LED Display unit (VDU),][and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor and room number, device address, and device type.]

(2) Transmission of a carbon monoxide alarm signal to [the fire department][a remote supervising station].

(3) Activation of all strobes and the audible carbon monoxide message throughout the building.]

n. System control equipment must be programmed to provide a 60-minute to 180-minute delay in transmission of trouble signals resulting from primary power failure.

o. [o. Activation of a LOC pushbutton must activate the audible and visual alarms in the facility. The audible message must be the one associated with the pushbutton activated.]

[1.6.3 Elevator Recall

****

NOTE: Delete this paragraph if no elevator work is included in the project.

****

Provide elevator recall in accordance with ASME A17.1/CSA B44, Section [14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS][14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS][14 24 13 HYDRAULIC FREIGHT ELEVATORS][14 24 23 HYDRAULIC PASSENGER ELEVATORS], and as specified herein. Activation of any smoke detector in an elevator shaft, machine room, or lobby (except at designated recall level) must cause all elevators associated with that shaft, machine room, or lobby to return nonstop to the designated level. Activation of a smoke detector in the lobby or machine room at the designated level must cause all elevators associated with that lobby to return nonstop to the assigned alternate level. Activation of a detector in an elevator shaft, machine room, or lobby must also cause illumination of elevator cab warning signal (fire hat) and complete operation of fire alarm system as specified in paragraph titled "Functions and Operating Features".

][1.7 EXISTING EQUIPMENT

****

NOTE: If an addition to an existing fire alarm/mass notification system is required, the contract drawings or this section must include the make, model number, and other pertinent information of existing components that are to operate with the new equipment. Since new interfaces will have to be compatible with the existing system or to the central fire alarm reporting system, it may be necessary to edit major items out of this specification. If a new FMCU is required, it has to be compatible with the existing central fire alarm reporting system. When an existing system is to be expanded, show the following information on the contract drawings:

1. Manufacturer and model of existing control unit.

2. Number of existing initiating circuits (zones), notification appliance circuits, and control circuits served by the control unit.

3. Number of existing alarm notification appliances on the system.

4. Total calculated current draw of all devices served by each existing standby battery under both supervisory (standby) and alarm conditions, including NAC/extender control units and subcontrol units.

5. Ampere-hour rating and type of each existing battery.

****

a. Equipment and devices must be compatible and operable with the existing fire alarm/mass notification system and must not impair reliability or operational functions of existing supervising station fire alarm system.[The proprietary type supervising station (PSS) is located [in Building [_____].][_____].][The supervising equipment is existing and consists of the following brands and models: [supervising station control unit [_____].][_____][signal reporting components [_____]], [annunciator [_____]][_____]].

b. [b. Equipment and devices must be compatible and operable with the existing building fire alarm/mass notification system. Equipment must not impair reliability or operational functions of the existing system. The existing building system control unit is [_____].]

c. Equipment and devices must be compatible and operable with the existing installation-wide mass notification system and must not impair reliability or operational functions of the existing system. The installation-wide mass notification system utilizes [_____] transceivers.

]1.8 QUALITY ASSURANCE

1.8.1 Submittal Documents

1.8.1.1 Preconstruction Submittals

Within 36 days of contract award but not less than [14 days][_____] prior to commencing any work on site, the Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE must be returned disapproved without review. All resultant delays must be the sole responsibility of the Contractor.

1.8.1.2 Shop Drawings

Shop drawings must not be smaller than [ISO A1][ANSI D][the Contract Drawings]. Drawings must comply with the requirements of NFPA 72 and NFPA 170. Minimum scale for floor plans must be 1/8"=1'.

1.8.1.3 Nameplates

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

1.8.1.4 Wiring Diagrams

[_____] copies of point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote FMCU, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

1.8.1.5 System Layout

[_____] copies of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors. Indicate candela rating of each visual notification appliance. Indicate the wattage of each speaker. Indicate the addresses of all devices, modules, relays, and similar. Show/identify all acoustically similar spaces. Indicate if the environment for the FMCU is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format similar to the "Typical Input/Output Matrix" included in the Annex of NFPA 72.

[For air sampling smoke detection systems, provide floor plan layouts indicating location of fire alarm control unit, air sampling piping (lengths of pipe) and sampling ports (sizes and locations). Floor plan must also indicate geographic monitor zone boundaries, location of display control unit, bar level annunciation panels if separate, and all other associated equipment that is required to provide a complete operational system.]

1.8.1.6 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.8.1.7 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least [25][_____] percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.8.1.8 Amplifiers

Calculations and supporting data to indicate that amplifiers have sufficient capacity to simultaneously drive all notification speakers at tapped settings plus [25][_____] percent spare capacity. Annotate data for each circuit on the drawings.

1.8.1.9 Battery Power

Calculations and supporting data as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.8.1.10 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.8.1.11 Product Data

[_____] copies of annotated descriptive data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, and options that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

[1.8.1.12 Air Sampling Smoke Detection System Calculations

Submit air sampling detection system design analysis calculations consisting of battery capacity, loading calculations, and fan speed and air flow/transport calculations. Include schematic diagrams showing pipe segments, pipe diameters, lengths of pipe, node numbers, and sample port diameters to verify the requirements are met.

]1.8.1.13 Operation and Maintenance (O&M) Instructions

[Six][_____] copies of the Operation and Maintenance Instructions. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions must include the following:

a. "Manufacturer Data Package [five][_____]" as specified in [Section 01 78 23 OPERATION AND MAINTENANCE DATA][_____].

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. Complete procedures for system revision and expansion.

e. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices, testing frequencies, and similar) must comply with UFC 3-601-02.

f. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

1.8.1.14 As-Built Drawings

The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of the as-built (marked-up) drawings must be provided at the time of, or prior to the final Government test.

1.8.2 Qualifications

****

NOTE: NICET (National Institute for Certification in Engineering Technologies) establishes the qualifications of an individual as an Engineering Technologist with verification of experience by having a current NICET certification.

****

1.8.2.1 Fire Alarm System Designer

The fire alarm system designer must be certified as a Level [III][IV] (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology or meet the qualifications for a QFPE.

1.8.2.2 Supervisor

[A NICET Level [III][or][IV] fire alarm technician must supervise the installation of the fire alarm/mass notification system[, including the air sampling smoke detection system].][A fire alarm technician with a minimum of eight years of experience must supervise the installation of the fire alarm/mass notification system.] The fire alarm technicians supervising the installation of equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.3 Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings[, and must be thoroughly experienced in the installation of air sampling detection systems].

1.8.2.4 Installer

[Fire alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm/mass notification devices, cabinets and control units] [NICET Level II technician to assist in the installation of fire alarm/mass notification devices, cabinets and control units]. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the fire alarm system/mass notification system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.5 Test Technician

Fire alarm technicians with a minimum of eight years of experience and NICET Level [III][or][IV]utilized in testing and certification of the installation of the fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians testing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment installed as part of this project.

1.8.2.6 Manufacturer

Components must be of current design and must be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as specified herein.

1.8.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation must be considered as mandatory requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.10 MAINTENANCE

1.10.1 Spare Parts

Furnish the following spare parts in the manufacturers original unopened containers:

a. [Five][_____] complete sets of system keys.

b. [Two][_____] of each type of fuse required by the system.

c. [One][_____] manual stations.

d. [d. [Two][_____] of each type of detector installed.]

e. [Two][_____] of each type of detector base and head installed.

[f. [One][_____] electromagnetic door holders.]

g. [g. One smoke detector manufacturer's test screen, card or magnet for each ten beam smoke detectors, or fraction thereof, installed in the system.]

h. [h. Two air sampling smoke detection system filter assemblies.]

i. [Two][_____] of each type of audible and visual alarm device installed.

j. [One][_____] textual visual notification appliance.

k. [Two][_____] low voltage, [one][_____] [telephone][internet][ethernet], and [one][____] 120 VAC surge protective device.

l. [l. [Two][_____] spare reams of paper for the system printer, plus sufficient paper for testing.]

m. [m. [Two][_____] spare printer ribbons.]

n. [_____] spare zone modules for modular type control units in addition to those installed in the control unit.

1.10.2 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment must be furnished to the Contracting Officer, prior to the instruction of Government employees.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENT

All fire alarm and mass notification equipment must be listed for use under the applicable reference standards. Interfacing of UL 864 or similar approved industry listing with Mass Notification equipment listed to UL 2572 must be done in a laboratory listed configuration, if the software programming features cannot provide a listed interface control.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory and listed for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least [2][_____] years prior to bid opening.

2.2.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FMCU

Nameplates must be etched metal or plastic, permanently attached by screws to control units or adjacent walls.

2.2.3 Keys

Keys and locks for equipment, control units and devices must be identical. [Master all keys and locks to a single key as required by the [Installation Fire Department][_____]]. [Keys must be CAT [60][_____].]

2.2.4 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. [Install the instructions on the interior of the FMCU.][Install the frame in a conspicuous location observable from the FMCU.] The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must also include procedures for operating live voice microphones. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.3 FIRE ALARM AND MASS NOTIFICATION CONTROL UNIT

Fire Alarm and Mass Notification Control Unit (FMCU) must comply with the applicable requirements of UL 864. Unit must be modular, installed in a [flush][surface][semi-flush] mounted steel cabinet with hinged door and cylinder lock. Control unit must be clean, uncluttered, and orderly assembled containing components and equipment required to provide the specified operating and supervisory functions of the system. The unit must have prominent rigid plastic, phenolic or metal identification plates for LEDs, zones, controls, meters, fuses, and switches.

a. Each control unit must provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit must be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each control unit with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the FMCU must be by liquid crystal display or similar means with a minimum of 80 characters. The mass notification control unit must have the capability of temporarily deactivate the fire alarm audible notification messages while delivering voice messages.

c. Nameplates for fuses must also include ampere rating. Separate alarm and trouble LEDs must be provided for each zone alarm. These LEDs must be located on the exterior of the cabinet door or be visible through the cabinet door. Control unit switches must be within the locked cabinet.

d. A suitable means (single operation) must be provided for testing the control unit visual indicating devices (meters or LEDs). Meters and LEDs must be plainly visible when the cabinet door is closed. Signals and LEDs must be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Each IDC must be powered and supervised so that a signal on one zone does not prevent the receipt of signals from other zones.

e. Upon restoration of power, startup must be automatic, and must not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power must not affect the transmission of alarm, supervisory or trouble signals. Visual annunciators must be provided for each active zone and spare zone. [_____] spare zones must be provided [as shown on the drawing]. Each LED must provide specific identification of the zone by means of a permanently attached rigid plastic, phenolic, or metal sign with either raised or engraved letters.

f. Zone identification must consist of a word description of the zone.

g. Cabinets must be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the control unit equipment. If more than one modular unit is required to form a control unit, the units must be installed in a single cabinet large enough to accommodate units.

2.3.1 Cabinet

Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and [surface][semi-recessed] mounting provisions. The enclosure must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must say "Fire Alarm and Mass Notification control unit" and must not be less than 25 mm 1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches.

2.3.2 Silencing Switches

2.3.2.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FMCU that must silence the audible and visual notification appliances. Subsequent activation of initiating devices must cause the notification appliances to re-activate.

2.3.2.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch(es) that must silence the audible trouble and supervisory signal(s), but not extinguish the visual indicator. This switch must be overridden upon activation of a subsequent supervisory or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated if the supervisory or trouble condition still exists.

2.3.3 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Initiating devices must be manually reset by switch from the FMCU after the initiating device or devices have been restored to normal.

2.3.4 Input/Output Modifications

The FMCU must contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features must consist of a control unitswitch/button. Any bypass or modification to the system must indicate a trouble condition on the FMCU.

2.3.5 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.4 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS

Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 must be housed in a remote FMCU, terminal cabinet, or in the FMCU. Individual amplifiers must be 100 watts maximum.

2.4.1 Operation

The system must automatically operate and control all building speakers[except those installed in the stairs][and within elevator cabs].[The speakers in the stairs[and elevator cabs] must operate only when the microphone is used to deliver live messages.]

2.4.2 Construction

Amplifiers must utilize computer grade solid state components and must be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

2.4.3 Inputs

Equip each system with separate inputs for the tone generator, digitalized voice driver and control unit mounted microphone [Public Address Paging Function]. Microphone inputs must be of the low impedance, balanced line type. Both microphone and tone generator input must be operational on any amplifier.

2.4.4 Tone Generator

The tone generator must produce a three-pulse temporal pattern and must be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator must be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay. The tone generator must be provided with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces.

2.4.5 Protection Circuits

Each amplifier must be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component must cause illumination of a visual "amplifier trouble" indicator on the control unit, appropriate logging of the condition in the history log[and on the system printer], and other actions for trouble conditions as specified.

2.5 REMOTE ANNUNCIATOR

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NOTE: Provide the annunciator at a location in accordance with NFPA 72. A suggested location should be near the door through which the first responders will enter the building as indicated in their pre-fire plan, typically the main entrance.
****

2.5.1 Remote Annunciator

****
NOTE: Locate annunciator at or near the building entrance to allow fire department quick access to the annunciator. When both a remote trouble sounder and remote annunciator are required, specify an annunciator with trouble sounder for dry indoor locations. Where a weatherproof enclosure is required, specify a separate trouble bell.
****

Remote annunciator must duplicate all requirements specified for the control unit annunciator, except that individual zone trouble lamps are not required. Lamps must be LED type, except lamps used in backlighted annunciators must be LED or neon type. Annunciator must have a lamp test switch. Zone identification must be by means of [permanently attached rigid plastic or metal plate(s)][or][silk-screened labels attached to the reverse face of backlighted viewing window(s)]. Annunciator must be of the [interior][weatherproof] type, [flush][surface][pedestal]-mounted. [Provide annunciator with an integral audible trouble sounder which must operate in conjunction with control unit audible sounder. Provide annunciator with trouble silence switch which must comply with the requirements for a trouble silencing switch as specified for the FMCU.]

[2.5.2 Graphic Annunciator

****
NOTE: Graphic annunciators should be provided only when a large number of concealed devices are installed. Normally, exposed devices will be annunciated by zone only on the fire alarm control unit zone annunciator and remote zone annunciator. Edit accordingly. Locate graphic annunciator(s) at or near building entrance to allow fire department quick access to the annunciator.
****

Graphic annunciator must be of the [interior][weatherproof] type, [flush][surface][pedestal]-mounted. Annunciator must be provided with the [building][room] floor plan, drawn to scale, with alarm lamps mounted to represent the location of [each concealed detector][each initiating device]. Annunciator graphic must also show the locations of the annunciator and control unit, and must have a "you are here" arrow showing its location. Orient building floor plan on graphic to location of person viewing the graphic(i.e., the direction the viewer is facing must be toward the top of the graphic display). Provide a North arrow.[Principal rooms and areas shown must be labeled with room numbers or titles.] Detectors mounted above ceilings, [on ceilings,]and beneath raised floors and different types of initiating devices must have different symbols or lamps of different colors for identification. Lamps must illuminate upon activation of corresponding device and must remain illuminated until the system is reset. Annunciator must have a lamp test switch.

2.5.2.1 Materials

Construct the graphic annunciator face plate of [smoked Plexiglas][non-glare matte finish][anodized bronze][anodized aluminum]. The face plate must be backlit with LEDs. Control equipment and wiring must be housed in a [recessed][semi-recessed][surface mounted] back box. The exposed portions of the back box must be [chrome plated][anodized bronze][anodized aluminum] without knockouts.

][2.5.3 Printer

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NOTE: If the printer will be located in a SCIF or similar area, specify "no stored memory".

****

a. Provide a system printer [with no stored memory] to record alarm, supervisory, and trouble conditions without loss of any signal or signals. Printout must be by circuit, device, and function as provided in the FMCU. Printer must operate on a 120 VAC, 60 Hz power supply.

b. The printer must have at least 80 characters per line and have a 96 ASCII character set. The printer must have a microprocessor-controlled, bi-directional, logic seeking head capable of printing 120 characters per second utilizing a 9 by 7 dot matrix print head. Printer must not contain internal software which is essential for proper operation.

c. When the FMCU receives a signal, the alarm, supervisory, and trouble condition must be printed. The printout must include the type of signal, the circuit or device reporting, the date, and the time of the occurrence. The printer must differentiate alarm signals from other printed indications. When the system is reset, this condition must also be printed including the same information concerning device, location, date, and time. Provide a means to automatically print a list of existing alarm, supervisory, and trouble conditions in the system. If a printer is off-line when an alarm is received, the system must have a buffer to retain the data and it must be printed when the printer is restored to service. The printer must have an indicator to alert the operator that the paper has run out.

]2.6 MANUAL STATIONS

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NOTE: Architectural Barriers Act (ABA) requires that manual alarm stations be mounted at a maximum of 1.1 m 44 inches above finished floor (AFF).

****

Provide metal or plastic, [semi-flush][flush][surface] mounted, [single][double]-action, manual stations, that are not subject to operation by jarring or vibration. Stations must be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations must be finished in red with molded raised lettering operating instructions of contrasting color. The use of a key must be required to reset the station.

2.7 SMOKE DETECTORS

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NOTE: Provide smoke detectors only in spaces where they are specifically required by UFC 3-600-01, DESIGN: FIRE PROTECTION ENGINEERING FOR FACILITIES.

Smoke detectors provided in elevator machinery rooms are to be provided per requirements of UFC 3-600-01. Coordinate with Section 14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS, Section 14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS and/or Section 14 24 13 HYDRAULIC FREIGHT ELEVATORS, Section 14 24 23 HYDRAULIC PASSENGER ELEVATORS.

****

2.7.1 Spot Type Detectors

Provide [photoelectric][ionization][laser] smoke detectors as follows:

a. Provide [photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268][smoke detectors that operate on the ionization principle and are actuated by the presence of visible or invisible products of combustion][laser smoke detectors utilizing laser diode and patented smoke sensing chamber, designed to amplify signals from smoke but diminish stray internal reflections and must, on command from the FMCU, send data to the control unit representing the analog level of smoke density]. Smoke detectors must be listed for use with the FMCU.

b. Provide self-restoring type detectors that do not require any readjustment after actuation at the FMCU to restore them to normal operation. The detector must have a visual indicator to show actuation.

c. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases [with sounder that produces a minimum of 90 dBA at 3 m 10 feet] with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.

[2.7.2 Projected Beam Smoke Detector

Detectors must consist of [combined transmitter and receiver unit] [separate transmitter and receiver units]. The transmitter unit must emit an infrared beam to the receiver unit [the use of a supplied reflector is required for the combined unit]. When the signal at the receiver falls below a preset threshold, the detector must initiate an alarm. The receiver must contain an LED status indicator that illuminates when an alarm condition exists. Long-term changes to the received signal caused by environmental variations must be automatically compensated. Detectors must incorporate features to assure that they are operational; a trouble signal must be initiated if the beam is obstructed for more than 3 seconds, the limits of the compensation circuit are reached, or the housing cover is removed. Detectors must have multiple sensitivity settings in order to meet UL listings for the different distances covered by the beam.

]2.7.3 Duct Smoke Detectors

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NOTE: The requirements for Duct Detectors will be coordinated with the HVAC requirements and Sections 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. All required duct detectors will be shown on the contract drawings.

****

Duct-mounted photoelectric smoke detectors must consist of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct.[It is not permitted to cut the duct insulation to install the duct detector directly on the duct.] Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the FMCU.

a. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the FMCU.

b. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote indicators must be provided where required by NFPA 72. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.

c. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Auxiliary contacts provide for this function must be located within 1 m 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

[2.8 AIR SAMPLING SMOKE DETECTION SYSTEM

The [addressable]air sampling smoke system must consist of a detector assembly housing an integral aspiration fan, filter, laser-based detection chamber and control, output and supervision circuitry.[Each sampling point must be capable of being independently addressable.] The system must consist of a piping or tubing distribution network that runs from the detector assembly(s) to the protected area(s) and is supported by air sampling smoke detection system calculations from a computer-based design modeling tool. The system must include configurable alarm and trouble relay outputs for interface to other systems where required.

a. System must be complete in all ways. It must include all engineering, and electrical installation, all detection and control equipment, auxiliary devices and controls, alarm interface, functional checkout and testing, training and all other operations necessary for a functional system.

b. System base detectors and modules must each accommodate up to [40 addressable][_____] microbore sampling tubes where each tube has a sampling point at the end. Additional modules may be used to provide up to [20 addressable][_____] sampling holes per system.

c. Program alarm thresholds to the following values unless the results of the pre-Government system tests indicate a clear need to change them. In the event that such a need is indicated, notify the Contracting Officer and provide complete documentation concerning the need to deviate from these values. Include within the deviation documentation request, information that complies with the paragraph entitled "Sensitivity Verification Test". Ensure initial threshold levels are approved prior to the Government test.

    (1) Alarm Level 1: set ALERT at [_____][0.0250] percent obscuration/foot

    (2) Alarm Level 2: set PRE-ALARM at [_____][0.0500] percent obscuration/foot

    (3) Alarm Level 3: set FIRE 1 at [_____][0.1000] percent obscuration/foot

    (4) Alarm Level 4: set FIRE 2 at [_____][0.2000] percent obscuration/foot

d. All air sampling smoke detection devices and associated components must be new, standard products or the manufacturer's latest design and suitable to perform the functions intended.

e. The laser detection chamber must be of the mass light scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method must be employed for the purposes of:

    (1) Preventing large particles from affecting the true smoke reading.

    (2) Monitoring contamination of the filter (for example, dust and dirt) to automatically notify when maintenance is required. The particle counting method must not be used for the purpose of smoke density measurement.

f. Detector(s) must be self-monitoring for filter contamination and provide indication through system fault when replacement is necessary. Detectors which allow automatic reset of filter status upon removal and re-insertion are not permitted.

g. Detector(s) must contain relays for alarm and fault conditions. The relays must be software programmable to the required functions.

h. Detector(s) must permit configuration by programmers that are either integral to the system, portable or PC based.

i. Detector(s) must allow programming of:

    (1) Smoke threshold alarm levels; ALERT, PRE-ALARM, FIRE 1 and FIRE 2.

    (2) Time delays. Ensure the display control unit contains individual adjustable alarm time delay features for each of the alarm threshold levels. Provide an adjustment range between 0 and 60 seconds. Program the alarm threshold time delays to 30 seconds for alarm levels 1 and 2, and 15 seconds for alarm levels 3 and 4.

(3) Faults, including airflow, detector, power, filter and network, as well as an indication of the urgency of the fault.

(4) Configuration of relay outputs for remote indication of alarm and fault conditions.

(5) General purpose input functionality.

]2.9 HEAT DETECTORS

****

NOTE: Heat detectors provided in elevator machinery rooms are strictly for the warning sign in the elevator cab and must not alarm the FMCU. Coordinate with Section 14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS, Section 14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS and/or Section 14 24 13 HYDRAULIC FREIGHT ELEVATORS, Section 14 24 23 HYDRAULIC PASSENGER ELEVATORS.

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2.9.1 Heat Detectors

Heat detectors must be designed for detection of fire by [fixed temperature][combination fixed temperature and rate-of-rise principle][rate-compensating principle] in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values.. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations [as defined by NFPA 70][and][as indicated], must be types approved for such locations.

[2.9.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-resetting. Detector must operate at [57.2][90] degrees C[135][194] degrees F. Detector must feature rate compensation. [Detectors rated to operate at 57.2 degrees C135 degrees F must not respond to momentary temperature fluctuations less than 16.7 degrees C30 degrees F per minute between 16 and 38 degrees C60 and 100 degrees F].[Detectors rated to operate at 90 degrees C194 degrees F must not respond to momentary temperature fluctuations less than 27.8 degrees C 50 degrees F per minute between 16 and 66 degrees C60 and 150 degrees F.][The detector assembly must be [weatherproof][and][explosionproof].]

][2.9.1.2 Rate Compensating Detectors

Detector backbox must be [surface][flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring and hermetically sealed.[The detector assembly must be [weatherproof][and][explosionproof].]

][2.9.1.3 Line-Type Fixed Temperature Detectors

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NOTE: Specify line-type heat detectors only with approval of the EFD/EFA Fire Protection Engineer.

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Provide [thermostatic][or][thermistor] line-type heat detection cable [with weather-resistant outer covering] where indicated. Cable must be nominally rated for a temperature of [68][88][138] degrees C [155][190][280] degrees F and must operate on fixed temperature principle only.

][2.9.1.4 Fixed Temperature Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. The detectors must have a specific temperature setting [of [57.2][_____] degrees C [135][_____] degrees F][as shown].[The detector assembly must be [weatherproof][and][explosionproof].]

][2.10 FLAME DETECTORS

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NOTE: Modify these paragraphs as necessary to indicate that detectors placed in an explosive environment will be approved for use in the appropriate class, division, and group environment as defined in NFPA 70 and as shown on drawings.

****

Detectors must be sensitive to the micron range best suited for their intended use. Detectors must operate over electrically supervised wiring circuits and the loss of power to the detector must result in a trouble signal. A self-test feature must be provided for each detector to be individually tested.

[2.10.1 Infrared (IR) Single Frequency Flame Detector

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NOTE: The single frequency IR flame detector has the advantage of a fast response and is moderately sensitive. Its disadvantages are being affected by temperature extremes and being subject to false alarms from a myriad of IR sources.

****

The detector must be sensitive in the range of [_____] to [_____] micrometers only.

][2.10.2 Infrared (IR) Multi Frequency Flame Detector

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NOTE: The IR multi frequency flame detector has the advantages of a moderately fast response, moderate sensitivity, and a lower false alarm rate. Its disadvantage is being affected by temperature extremes.

****

The IR detector must consist of three or more IR sensors, each selected for a different IR frequency. The primary sensor must be sensitive in the range of [_____] to [_____] micrometers only. Secondary sensors are tuned to different IR wavelengths to null out the effect of black body radiation to the primary sensor.

][2.10.3 Ultraviolet (UV) Flame Detectors

****

NOTE: Ultraviolet (UV) flame detectors can be set to respond accurately to UV wavelength light produced by flame from both indoors and outdoors. UV flame detectors operate on the Geiger-Muller principle. These gas-filled vacuum tubes respond in the UV portion of the spectrum but can ignore UV radiation from the sun because the upper response range of the detector falls below the range of UV radiation that reaches the earth.

Solid-state UV detectors are available, but their spectral response extends into the sun's UV range and are not recommended for external use.

UV detectors have an 80 to 90 degree cone of vision. The UV detector has a fast response time and usually is not affected by rain, wind, snow, high humidity, or temperature and pressure extremes. UV units will produce false alarms if they are exposed to arc welding or X-ray and gamma radiation. They can also be blinded by oil film or smoke. UV flame detectors that are used in dirty and dusty environments should be equipped with automatic self-test and self-cleaning devices. The cleaning device uses a stream of clean air across the lens surface to minimize the build-up of contaminants.

****

UV flame detector must be of the narrow band response type which operates on radiated ultraviolet energy and must be sensitive in the range of [_____] to [_____] micrometers only. The cone of vision must be 80 degrees or greater. Each detector must be completely insensitive to light sources in the visible frequency range.

][2.10.4 Combination UV/IR Flame Detector

****

NOTE: Combination UV/IR flame detectors have been used both inside and outside to detect fires, but are slower to react than individual units.

****

The UV/IR detector must provide discrimination against false alarms by requiring both UV and IR flame detection before an alarm is sent. The UV sensor must be sensitive in the range of 0.185 to 0.265 micrometers only. The IR sensor must be sensitive in the range of [_____] to [_____] micrometers only. Detectors must be completely insensitive to light sources in the visible frequency range.

][2.11 MULTI-CRITERIA DETECTORS

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The designer must select the sensor required to

initiate a fire alarm condition.
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Multi-criteria detectors must contain [fixed temperature [_____] degrees C F heat sensor], [rate-of-rise heat sensor], [photoelectric smoke detector], [_____] elements in a single housing.

]2.12 CARBON MONOXIDE DETECTOR

Carbon monoxide (CO) detectors must be listed to UL 2075 and set to respond to the sensitivity limits of UL 2034. Carbon monoxide detectors must be listed for use with fire alarm control units. Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. For FMCU with no listed compatible addressable CO detectors, provide listed 4-wire detectors.[Do not provide CO detectors with local alarms.] Detector must be provided with an LED status indicator.

a. Where 4-wire CO detectors are necessary, each 4-wire CO detector must be individually monitored via addressable interface modules for alarm and off normal/trouble conditions (including loss of power to the individual detector). Power circuits for 4-wire CO detectors must be dedicated to powering the CO detectors only. Battery powered and 120 VAC powered detectors are prohibited.

b. Wiring connections must be made by means of screw terminals and detectors must be equipped with trouble relays. Detectors must be able to mount a single-gang electrical box.

c. A trouble condition at an individual CO detector must not affect any other CO detectors. CO detectors must be powered by the FMCU.

d. Detectors must be provided with a means to test CO gas entry into the CO sensing cell.

2.13 NOTIFICATION APPLIANCES

2.13.1 Audible Notification Appliances

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NOTE: The designer must layout speakers to achieve both the required dBA levels requires by NFPA 72 and also the required intelligibility required. See 3.7 for testing for intelligibility requirements that must be incorporated into the design.

****

Audible appliances must conform to the applicable requirements of UL 464. Appliances must be connected into notification appliance circuits. Surface mounted audible appliances must be painted [red][white][_____]. Recessed audible appliances must be installed with a grill that is painted [red][white][_____][with a factory finish to match the surface to which it is mounted].

2.13.1.1 Speakers

a. Speakers must conform to the applicable requirements of UL 1480.

Speakers must have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Interior speaker tap settings must include taps of 1/4, 1/2, 1, and 2 watt, at a minimum. Exterior speakers must also be multi-tapped with no more than 15 watt maximum setting. Speakers must incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 400 Hz to 4,000 Hz, and must have a sealed back construction. Speakers must be capable of installation on standard 100 mm 4-inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single [wall mounted] unit. All inputs must be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FMCU.

b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 1.519 mm 16 gage or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes must be ground and finished to provide a smooth and neat appearance for each plate. Each plate must be primed and painted.

c. Speakers must utilize screw terminals for termination of all field wiring.

2.13.2 Visual Notification Appliances

****

NOTE:
1. ABA requires that Visual Notification Appliances be provided in buildings and facilities in each of the following areas: restrooms, and any general usage area (e.g., meeting rooms), hallways, lobbies, and any other area for common use and other areas stated at www.access-board.gov. The Visual Notification Appliance must be mounted as required by ABA that directs compliance with NFPA 72. In addition, alarms in guest rooms required to provide communication features must comply with sections 18.5.5.7 of NFPA 72. Shop drawings must indicate location, dimensions, content, details, and other required information to indicate extent of complying with ABA requirements.

2. Currently NFPA 72 requires "clear color" strobes for Fire Alarm Notification. NFPA 72 requires the strobe must be marked "Fire" to clear identify the function.

****

Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED) and be marked "Alert" in letters of contrasting color. The light pattern must be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of [15][30][75][_____] candela based on the UL 1971 test. Strobe must be [surface][semi-flush] mounted.

2.13.3 Textual Display Signs

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NOTE: Provide remote LED Text display in locations where Hearing Impaired personnel might read instructions on the emergency. For Navy projects, the Text displays will be located over stairwell doors and major egress doors at the level of discharge.

****

Textual display signs must be [LED][LCD flat panel][LED scrolling] and must not exceed 400 mm long by 150 mm high by 75 mm deep 16 inches long by 6 inches high by 3 inches deep with a height necessary to meet the requirements of NFPA 72).The text display must spell out the word "EVACUATE" or "ANNOUNCEMENT" [and the remainder of the emergency instructions]as appropriate. The design of text display must be such that it cannot be read when not illuminated.

[LCD or LED scrolling text displays must meet the following requirements at a minimum:

a. Two lines of information for high priority messaging.

b. Minimum of 20 characters per line (40 total) displayed.

c. Text must be no less than height requirements and color/contrast requirements of NFPA 72.

d. 32K character memory.

e. Display must be wall or ceiling mounted.

f. Mounting brackets for a convenient wall/cubicle mount.

g. [g. During non-emergency periods, display date and time.]

h. The system must interface with the textual display sign control panel to activate the proper message.]

2.14 ELECTRIC POWER

2.14.1 Primary Power

Power must be [120][_____] VAC [50][60] Hz service for the FMCU from the AC service to the building in accordance with NFPA 72.

2.15 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.15.1 Batteries

Provide sealed, maintenance-free, [sealed lead acid][lead-calcium][gel cell] batteries as the source for emergency power to the FMCU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a solid state battery charger.

Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.15.1.1 Capacity

Battery size must be the greater of the following two capacities. This capacity applies to every control unit associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, fire alarm transmitters, and Base-wide mass notification transceivers. When determining the required capacity under alarm condition, visual notification appliances must include both textual and non-textual type appliances.

a. Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.

b. Sufficient capacity to operate the mass notification for 60 minutes after loss of AC power.

2.15.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

    (1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit component, and compliance with UL 864.

    (2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

    (3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components. Calculations must be performed using the minimum rated voltage of each component.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing device and/or appliances remote from the power sources.

2.15.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and must maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.16 SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage fire alarm control unit components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on any signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the FMCU breaker is located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for fire alarm wiring. The base assembly must accept "plug-in" surge protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

    (1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

    (2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

    (3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

    (4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.17 WIRING

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.17.1 Alarm Wiring

IDC wiring must be solid copper cable in accordance with the manufacturers requirements. Copper initiating device circuit field wiring must be No. [14][16][18][_____] AWG size conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 14 AWG size conductors at a minimum. Speaker circuits must be copper No. [16][_____] AWG size twisted and shielded conductors at a minimum.[Wiring for textual notification appliance circuits must be in accordance with manufacturer's requirements but must be supervised by the FMCU.] Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors and/or appliances. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with NFPA 70.

2.18 INTERFACE TO THE BASE-WIDE MASS NOTIFICATION NETWORK

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NOTE: Provide as required for connection to a remote Central Control/Monitoring Mass Notification System Command Center.

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[2.18.1 Fiber Optic

The fiber optic transceiver must be fully compatible with EIA standards for RS-232, RS-422 and RS-485 at data rates from 0 (DC) to 2.1 mbps (200 kbps for RS-232) in the low speed mode or from 10 kbps to 10 mbps in the high-speed mode. The fiber optic transceiver must be capable of simplex or full duplex asynchronous transmissions in both point-to-point systems and drop-and-repeat data networks. The fiber optic transceiver must be user configurable for the protocol, speed and mode of operation required. The fiber optic transceiver must be installed as a [stand-alone][card-cage] unit. The fiber optic transceiver must operate on [Multi-mode][Single-mode] fiber optic cable. The fiber optic transceiver must be supplied with [ST][or][FCPC] type optical connectors. Cabling: as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

][2.18.2 Radio

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Note: Receiving a new radio frequency assignment often takes a relatively long period of time. Be sure to request the frequency assignment early in the design process.

****

The mass notification transceiver must be bi-direction and meet all the requirements of paragraph, RADIO TRANSMITTER AND INTERFACE PANELS as specified in this Specification Section. The transceiver utilized in the mass notification system must be capable of the following:

a. Communication with the central control/monitoring system to provide supervision of communication link and status changes are reported by automatic and manual poll/reply/acknowledge routines.

b. All monitored points/status changes are transmitted immediately and at programmed intervals until acknowledged by the central control/monitoring system.

c. Each transceiver must transmits a unique identity code as part of all messages; the code is set by the user at the transceiver.

][2.18.3 Telephone

A modem must be provided for communication with the central control/monitoring system. The modem must be 56k, compatible with data mode V.90, utilizing Hayes compatible command codes. The modem must be capable of auto dialing a preset number based on preprogrammed events. The modem must auto answer and provide a secure password protection system. Cabling: as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

][2.18.4 Secure Radio System

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Note: Receiving a new radio frequency assignment often takes a relatively long period of time. Be sure to request the frequency assignment early in the design process.

****

2.18.4.1 Communications Network

The communications network provides two-way signals between central control units and autonomous control units (in individual building systems), and should include redundant (primary and backup) communication links. The system must incorporate technology to prevent easy interruption of the radio traffic for MNS alerting.

2.18.4.2 Radio Frequency Communications

Use of radio frequency-type communications systems must comply with National Telecommunications and Information Administration (NTIA) requirements. The systems must be designed to minimize the potential for interference, jamming, eavesdropping, and spoofing.

2.18.4.3 Licensed Radio Frequency Systems

An approved DD Form 1494 for the system is required prior to operation.

]2.19 AUTOMATIC FIRE ALARM TRANSMITTERS

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NOTE: State the make and model number of existing proprietary supervising station receiving equipment. The choice of code transmitter, or radio transmitter depends upon the type of existing fire reporting system at the activity. Determine the type of activity reporting system (e.g., positive non interfering or shunt). In most cases a local energy-tripping device will be required. The facility Fire Dept. or Engineering office should be contacted to determine the type and amount of data to be supervised (monitored), e.g., -type: separate

or common transmission of alarm, supervisory, and trouble type signals; -amount: all points, all zones, or the combined premises. Verify that existing monitoring equipment has sufficient capacity to support the additional premises or that it can be expanded as necessary to accommodate the new fire alarm system. Identify existing components.
****

[2.19.1 Radio Transmitter and Interface Panels

Transmitters must be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter must be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters must be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module must be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is [_____] and the transmitter must be fully compatible with this equipment. At the contractors option, and if listed, the transmitter may be housed in the same control unit as the FMCU. The transmitter must be narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.

2.19.1.1 Operation

Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter must automatically switch to battery operation. Switchover must be accomplished with no interruption of protective service, and must automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply must also be automatic.

2.19.1.2 Battery Power

Transmitter standby battery capacity must provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.19.1.3 Transmitter Housing

Use NEMA Type 1 for housing. The housing must contain a lock that is keyed [identical to the fire alarm system for the building][identical to radio alarm transmitter housings on the Installation]. Radio alarm transmitter housing must be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.19.1.4 Antenna

Antenna must be [omnidirectional, coaxial, halfwave dipole antennas][_____] for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts must be corrosion resistant and designed to withstand wind velocities of 161 km/hour 100 mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage.

][2.19.2 Digital Alarm Communicator Transmitter (DACT)

Provide DACT that is compatible with the existing supervising station fire alarm system. Transmitter must have a means to transmit alarm, supervisory, and trouble conditions via a single transmitter. Transmitter must have a source of power for operation that conforms to NFPA 72. Transmitter must be capable of initiating a test signal daily at any selected time. Transmitter must be arranged to seize telephone circuits in accordance with NFPA 72.

]2.19.3 Signals to Be Transmitted to the Base Receiving Station

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NOTE: The following paragraph is applicable only to existing installations for connections to an auxiliary (public) alarm system. Edit this for the installation specific criteria.

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The following signals must be sent to the base receiving station:

[a. Sprinkler waterflow]

[b. Manual pull stations]

[c. Smoke detectors]

[d. Duct smoke detectors]

[e. Sleeping room smoke detectors]

[f. Carbon monoxide detectors]

[g. Heat detectors]

[h. Fire extinguishing system]

[i. Sprinkler valve supervision]

[j. Fire pump running]

[k. Fire pump supervision]

[l. Water supply level and temperature]

[m. Combustion engine drive fire pump running

   (1) Selector switch in position than automatic

   (2) Engine over-speed

   (3) Low fuel

   (4) Low battery

   (5) Engine trouble (for example, low oil, over temp)]

2.20 SYSTEM MONITORING

2.20.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves,[standpipe control valves,] sprinkler service entrance valve,[valves at fire pumps,] isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, must be electrically monitored to ensure its proper position. Provide each tamper switch with a separate zone[, unless they are within the same room, then a maximum of five can use the same zone].

[2.20.2 High/Low [Air][Nitrogen] Supervisory Switches

Provide monitoring of high and low supervisory [air][nitrogen] for [dry pipe][and][preaction] systems. Each air supervisory switch must have a separate address. Switches must be listed extinguishing system attachments. The device must contain double pole, double throw contacts. Operation of the switch must cause a supervisory signal to be transmitted to the FMCU when [air][nitrogen] pressure in the system monitored sprinkler system increases more than 34.5 kPa5 psi above the normal system pressure or drops halfway from the normal pressure to the tripping point.

][2.20.3 Room Low Temperature Supervisory Switch

Provide [monitoring of the]listed supervisory air temperature switch for the [fire pump][sprinkler riser] room[s]. Switch must cause a supervisory signal to be transmitted to the FMCU whenever the temperature in the room drops to below 4.4 degrees C40 degrees F. Device must reset when temperature rises above 4.4 degrees C40 degrees F.

][2.20.4 Electromagnetic Door Holders

Electromagnetic holding devices must operate on [120 VAC][24 VDC], and require not more than [3][_____] watts of power to develop 6.9 kPa25 psi of holding force. Under normal conditions, the magnets must attract and hold the doors open. Operation must be fail safe with no moving parts. Electromagnetic door hold-open devices must not be required to be held open during building power failure. The device must be listed based on UL 228 tests.

]2.21 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures must be provided to permit fire alarm/mass notification components to be used in areas that exceed the environmental limits of the listing. The enclosure must be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the component is currently listed. Guards required to deter mechanical damage must be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

[2.22 FIREFIGHTER TELEPHONE COMMUNICATION SYSTEM

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NOTE: Provide a master control station at the FMCU with remote telephone stations in each stair at each floor landing, in each elevator lobby on each floor,

and in elevator cabs. In addition, provide them at specific locations containing essential fire protection equipment, such as the fire pump room and outside the emergency generator room.

NOTE: In lieu of firefighter telephones radio repeater equipment compatible with responding fire department may be used if approved by the responding fire department.

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2.22.1 General

Provide a firefighter telephone communication system with complete, common talk, closed circuits. The system must include, but not be limited to, a master control station mounted in the fire alarm control unit, a power supply and standby battery system, and remote telephone stations.

2.22.2 Features

The system must include the following features:

a. A master control station which must provide power, supervision, and control for wiring, components, and circuits. The act of lifting any remote telephone hand set from its cradle must cause both a visual and audible signal to annunciate at the master control station. Removing the hand set at the master control station and depressing a button at the remote telephone hand set must cause the automatic silencing of the audible signal.

b. Communication between the master control station hand set and any/or all remote hand sets must require the depressing of a push-to-talk switch located on any/all remote hand sets. During the time that the master control hand set is removed from its cradle it must be possible to communicate between five remote hand sets and the master control station.

c. Hand sets must be able to monitor any conversation in progress and join the conversation by pressing the push-to-talk button. It must not be possible to communicate between two or more remote hand sets with the master control station hand set in its cradle.

d. The master control station hand set must be red in color and equipped with a 1.5 m5-foot long strain-relieved coiled cord.

e. The master control station must monitor wire and connections for any opens, shorts, or grounds which would render the system inoperable or unintelligible.

f. The master control station must be equipped with a silencing switch and ring-back feature such that any audible trouble signal can be silenced and must be so indicated by the lighting of an amber LED. Once any trouble condition has been corrected, the amber LED must be extinguished.

g. The master control station must be equipped with a separate, LED annunciated switch for each telephone circuit. In addition, LEDs must provide for the annunciation of operating and supervisory power.

h. The loss of operating or supervisory power must cause an audible and visual indication at the master control station and must also cause the fire alarm trouble signal to sound on the FMCU.

i. Switches, LEDs, and controls must be fully labeled.

2.22.3 Handsets

Handsets must have the following features:

a. Provide [surface][flush] mounted remote telephone stations.

b. Each station must be equipped with a hinged door that is magnetically locked.

c. Each hand set must be permanently wired in place with a coiled cord.

d. Each hand set must be red high-impact cycolac and must be equipped with a push-to-talk switch which, when operated, must signal the master control station and a switch-equipped, storage cradle.

e. Provide operating and supervising power from the same supply circuit(s) utilized for the FMCU.

]PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

3.2.1 Fire Alarm and Mass Notification Control Unit (FMCU)

Locate the FMCU [where indicated on the drawings][_____]. [Recess][Semi-recess][Surface mount] the enclosure with the top of the cabinet 2 m 6 feet above the finished floor or center the cabinet at [1.5][_____] m [5][_____] feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the FMCU. Locate the document storage cabinet adjacent to the FMCU unless the Contracting Officer directs otherwise.

3.2.2 Battery Cabinets

When batteries will not fit in the FMCU, locate battery cabinets below or adjacent to the FMCU. Battery cabinets must be installed at an accessible location when standing at floor level. Battery cabinets must not be installed lower than 300 mm12 inches above finished floor, measured to the bottom of the cabinet, nor higher than 900 mm36 inches above the floor, measured to the top of the cabinet. Installing batteries above drop ceilings or in inaccessible locations is prohibited. Battery cabinets must be large enough to accommodate batteries and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.The cabinet must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must indicate the control unit(s) the batteries power and must not be less than 25 mm1-inch high.

3.2.3 Manual Stations

Locate manual stations as required by NFPA 72[and as indicated on the drawings]. Mount stations so they are located no farther than [1.5][_____] m [5][_____] feet from the exit door they serve, measured horizontally. Manual stations must be mounted at [1067][1117][_____] mm [42][44][_____] inches measured to the operating handle.

3.2.4 Notification Appliances

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NOTE: Locate strobes wall mounted in corridors no more than 4.5 m 15 feet from the end of a corridor with 30 m 100 feet maximum distance between strobes. Where there is an obstruction to the viewing path in the corridors, such as a cross-corridor door or ceiling elevation change, consider the obstruction as defining a new corridor. Provide ceiling mounted strobes in rooms accessible to the public, such as conference rooms, restrooms, courtrooms, cafeterias, and auditoriums in accordance with NFPA 72. In Child Development Centers only chimes must be used as the pre-alert tone prior to voice messages.

****

a. Locate notification appliance devices [as required by NFPA 72][where indicated][and to meet the intelligibility requirements]. Where more than two visual notification appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring.[Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles plus or minus 50 mm2 inches.].

b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.

c. Speakers must not be located in close proximity to the FMCU or LOC so as to cause feedback when the microphone is in use.

3.2.5 Smoke and Heat Detectors

Locate detectors [as required by NFPA 72 and their listing][as indicated on the drawings] on a 100 mm 4-inch mounting box. Install heat detectors not less than 100 mm 4 inches from a side wall to the near edge. Heat detectors located on the wall must have the top of the detector at least 100 mm 4 inches below the ceiling, but not more than 300 mm 12 inches below the ceiling. Smoke detectors are permitted to be on the wall no lower than 300 mm 12 inches from the ceiling with no minimum distance from the ceiling.[In raised floor spaces, install the smoke detectors to protect[

21 square meters 225 square feet per detector][_____].] Install smoke detectors no closer than 1 m 3 feet from air handling supply diffusers. Detectors installed in acoustical ceiling tiles must be centered in the tiles plus or minus 50 mm2 inches.

3.2.6 Carbon Monoxide Detectors

Locate detectors [as required by NFPA 72 and their listings][as indicated on the drawings] on a 100-mm4-inch mounting box.[Carbon monoxide detectors must be installed separate from smoke and/or heat detectors.]

[3.2.7 Air Sampling Smoke Detector

Locate air sampling smoke detectors in accordance with the manufacturer's instructions. Air sampling smoke detectors must be installed as follows:

a. Air Sampling Smoke Detector Assembly:

  (1) Detector assembly must be mounted to a wall at a height between 48 to 60 inches1200 mm to 1800 mm to top of detector measured above the finished floor.

  (2) Mounting must be in a fully accessible and visible location.

  (3) Mounting or attachment to site equipment, cable trays, movable walls, other equipment or equipment supports is not permitted.

  (4) Piping network insertion into the detector inlet must not be glued.

  (5) Air sampling smoke detector assembly must be installed in accordance with this specification section and the manufacturer's installation and instruction manuals.

  (6) Flexible tubing for termination of the sampling pipe network into detector inlet is not permitted unless allowed by its listing.

  (7) Provide red background with white lettering labels that are plastic or phenolic type with a minimum of 0.25-inch6.4 mm block lettering to indicate detector and zone. For example: "AIR SAMPLING SOME DETECTOR No. 1-1 No. 5".

  (8) Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the ASD panel. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must be approved by the Contracting Officer before being posted.

b. Pipe and Sampling Tube Mounting:

  (1) The pipe and sampling tubing detection network must be mounted as per the design and manufacturer's specification. The hardware used for mounting will depend upon the design and site requirements.

  (2) To minimize flexing, pipes must be secured every 1.5 m5 feet.

(3) Pipes must be suspended between 25 mm and 100 mm1 and 4 inches below the ceiling. In areas with a suspended ceiling, the pipe network must be installed above the ceiling utilizing the manufacturer's capillary sample port supported by the ceiling.

(4) The sampling tubes must be of the same length or use the manufacturer's guidelines to run tubes of the required lengths.

(5) When installing a pipe network in areas subject to high temperature fluctuations allow for the contraction and expansion of pipes.

(6) Where expansion or contraction of pipes is likely either after installation or on a continuous basis, do not place pipe clips adjacent to couplings and socket unions as these may interfere with the movement of the pipe.

(7) No bends are permitted within the first 450 mm18 inches from the detector inlet.

(8) The routing of the piping and sample tube network must be coordinated with potential obstructions, including cable trays, grounding bars, and HVAC ductwork.

(9) All changes in direction must be made with standard elbows or tees.

(10) All joints must be air-tight and made by using solvent cement, except at the entry to the detector assembly. Refer to ASTM F402.

(11) All pipes must be supported by mechanical hangers attached to the structure of the building. Not more than 300 mm1-foot of pipe must extend beyond the last hanger of each sampling pipe. The final installation must result in no noticeable deflection in the piping network.

(12) Attachment of air sampling pipes to cable trays, "gray iron", and telecommunications equipment is prohibited.

(13) Clearly label pipe network to distinguish the pipe from other facility pipe work or protective cabling enclosures. For example: "SMOKE DETECTION SAMPLING TUBE - DO NOT DISTURB". In open rooms and exposed areas, provide labels at no greater than 6.1-m20-foot intervals. Provide labels every 3 m10 feet where piping is installed above suspended ceilings and every 609 mm2 feet, centered in the floor panels, where piping is installed within the raised floor cavity.

(14) Placement of the sampling tube must take into consideration appropriate sampling point locations and spacing.

c. Air Sampling Points:

(1) Open area ceiling sampling points must be oriented downward and must be within 25 mm to 100 mm1 to 4 inches below the underside of the ceiling above where the ceiling is smooth.

(2) Label all air sampling points with a round red label, each with a center hole to match the diameter of the drilled sampling point. For example: "AIR SAMPLING POINT DIA 3.2 MM0.125 INCHES".

Indicate fractional dimensions in decimal format with a minimum of three decimal places.

][3.2.8 Graphic Annunciator

Locate the graphic annunciator as shown on the drawings. Mount the annunciator, with the top 1830 mm 6 feet above the finished floor or center the annunciator at [1525][_____] mm [5][_____] feet, whichever is lower. [Locate the graphic annunciator as shown on the drawings. Surface-mount the annunciator, with the top 1830 mm 6 feet AFF or center the annunciator at [1525][_____] mm [5][_____] feet, whichever is lower.]

]3.2.9 Remote REMOTE Annunciator

Locate the remote annunciator as shown on the drawings. Mount the annunciator, with the top 2 m 6 feet above the finished floor or center the annunciator at [1.5][_____] m [5][_____] feet, whichever is lower.

[3.2.10 Electromagnetic Door Holder Release

Doors must be held open at a minimum of 90 degrees so as not to impede egress from the space. Mount the armature portion on the door and have an adjusting screw for seating the angle of the contact plate. Wall-mount the electromagnetic release, with a total horizontal projection not exceeding 100 mm4 inches. Ensure all doors release to close upon first stage (pre-discharge) alarm. Electrical supervision of wiring external of control unit for magnetic door holding circuits is not required.

][3.2.11 Firefighter Telephones

Mount telephone[hand sets][jacks] on the wall in each stair at each floor landing, in each emergency generator room, in each fire pump room, in each elevator machine room, in each elevator lobby, and in each elevator cab 1200 mm 4 feet above the finished floor.

]3.2.12 Local Operating Console (LOC)

Locate the LOC(s) as required by NFPA 72 and as indicated. Mount the console so that the top message button and microphone is no higher than 1200 mm 4 feet above the floor and the bottom (lowest) message button and microphone is at least 1-meter3 feet above the finished floor.

3.2.13 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.3 SYSTEM FIELD WIRING

3.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and professional manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote fire alarm/mass notification control units, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.3.2 Terminal Cabinets

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NOTE: Provide terminal cabinets on each floor where the fire alarm system supply riser is located and where the fire alarm return riser is located.

****

Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 200 mm by 200 mm 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "FIRE ALARM TERMINAL CABINET" with 50 mm 2-inch lettering, on the front of the terminal cabinet.

3.3.3 Alarm Wiring

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NOTE: Do not penetrate SCIF perimeters with copper signal line circuits. SCIF penetrations should be either fiber optic cable or IDC. IDC circuits penetrating the SCIF must be filtered.

****

a. Voltages must not be mixed in any junction box, housing or device, except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the FMCU.

c. [Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.][T-tapping using screw terminal blocks is allowed for Class "B" initiating device circuits.]

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the [_____] Designated Fire Protection Engineer (DFPE).

3.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 19 mm3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits [_____]6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

g. [g. For Class "A" or "X" circuits with conductor lengths of 10 feet3 meters or less, the conductors must be permitted to be installed in the same raceway in accordance with NFPA 72.]

3.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FMCU[, and remote FMCU] and the LOC must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FMCU, and remote FMCU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12 point lettering minimum size, and mounted within each cabinet, control unit, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

[3.4 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM

****

NOTE: Contact the Contracting Officer, Base Fire Prevention Office, and/or Base Maintenance Personnel to determine what action is appropriate for the salvaging of existing fire alarm equipment.

****

Maintain existing fire alarm/mass notification equipment fully operational until the new equipment has been tested and accepted by the Contracting Officer. As new equipment is installed, label it "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Government, it must be placed in service and connected to the supervising station. Remove tags from new equipment and tag the existing equipment "NOT IN SERVICE" until removed from the building.

a. After acceptance of the new system by the Contracting Officer, remove existing equipment not connected to the new system, remove unused exposed conduit, and restore damaged surfaces. Remove the material from the site and dispose.

b. Disconnect and remove the existing fire alarm/mass notification and smoke detection systems where indicated and elsewhere in the specification.

c. Control units and fire alarm devices and appliances disconnected and removed must be turned over to the Contracting Officer.

d. Properly dispose of fire alarm outlet and junction boxes, wiring, conduit, supports, and other such items.

3.5 CONNECTION OF NEW SYSTEM

The following new system connections must be made during the last phase of construction, at the beginning of the pre-Government tests. New system connections must include:

a. Connection of new relays to existing magnetic door hold-open devices.

b. Connection of new elevator recall relays to existing wiring and conduit.

c. Connection of new system transmitter to existing installation fire reporting system.

Once these connections are made, system must be left energized. Report immediately to the Contracting Officer, coordination and field problems resulting from the connection of the above components.

]3.6 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire-rated walls, partitions with fire-rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.7 PAINTING

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 19 mm3/4-inch wide at 3-meter10-foot centers and at each side of a floor, wall, or ceiling penetration.

c. Painting must comply with Section 09 90 00 PAINTS AND COATINGS.

3.8 FIELD QUALITY CONTROL

****

NOTE: Listed tests are minimum required. Coordinate with the local Authority Having Jurisdiction (AHJ) for minimum requirements in excess of the NFPA 72 minimums or those recommend below. If additional tests are required, such tests must be added to the list.

****

3.8.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level [III][or][IV] Fire Alarm Technician, and the representative of the installing company, [and reviewed by the QFPE] [60][_____] days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, and surge protective devices. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forma in NFPA 72 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government testing. The test data forms must record the test results and must:

a. Identify the NFPA Class of all Initiating Device Circuits (IDC), and Notification Appliance Circuits (NAC), Voice Notification System Circuits (NAC Audio).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing. The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.8.2 Pre-Government Testing

3.8.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that devices and circuits are functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" as required by NFPA 72. The contractor and an authorized representative from each supplier of equipment must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 72 including all referenced annex sections and the test reports noted below.

a. NFPA 72 Record of Completion.

b. NFPA 72 Record of Inspection and Testing.

c. Fire Alarm and Emergency Communication System Inspection and Testing Form.

d. Audibility test results with marked-up test floor plans.

e. Intelligibility test results with marked-up floor plans.

f. Documentation that all tests identified in the paragraph "Minimum System Tests" are complete.

3.8.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the [_____][Designated Fire Protection Engineer (DFPE)][Contracting Officer's Representative (COR)]. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation-wide fire reporting system[and the installation-wide mass notification system have] been completed and tested to confirm communications are fully functional. Submit request for test at least [15][_____] calendar days prior to the requested test date.

3.8.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required

for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. [b. The contractor's Qualified Fire Protection Engineer (QFPE).]

c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results

e. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

f. Audibility test results with marked-up floor plans.

g. Intelligibility test results with marked-up floor plans.

Government Final Tests will be witnessed by the [_____], [Designated Fire Protection Engineer][Contracting Officer's Representative (COR)][, Qualified Fire Protection Engineer (QFPE)]. At this time, any and all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.9 MINIMUM SYSTEM TESTS

3.9.1 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final Government test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the pre-Government test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

e. Carbon Monoxide Detector Tests: Carbon monoxide detectors must be tested in accordance with NFPA 72 and the manufacturer's recommended calibrated test method.

f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

h. Determine that the system is operable under trouble conditions as specified.

i. Visually inspect wiring.

j. Test the battery charger and batteries.

k. Verify that red-line drawings are accurate.

l. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

m. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

n. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

o. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.9.2 Audibility Tests

Sound pressure levels from audible notification appliances must be a minimum of 15 dBa over ambient with a maximum of 110 dBa in any occupiable area. The provisions for audible notification (audibility and intelligibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

3.9.3 Intelligibility Tests

****

NOTE: Occasionally, large DoD buildings are designed to provide cavernous-type open areas to meet unique operational requirements. Such areas are typically designed with hard wall and ceiling surfaces (such as metal or concrete) without acoustical treatments, and this has been found to cause excessive sound reflections that prevent obtaining the normal, minimum required CIS value. In such facilities, the cavernous-type open area is permitted to have locations with a CIS value lower than the normal, minimum required CIS value when the following conditions are met:

The requirement for a deviation from the normal, minimum CIS criteria identified in the design phase.

Justification for the deviation from the normal, minimum CIS criteria is provided to the approving authority (i.e., the AHJ for the Navy and Marine Corps; the DoD installation in conjunction with the contracting officer for the Army and Air Force).

The justification must address all factors relevant to the request for deviation from normal, minimum CIS criteria, including, but not limited to: the operational requirements that restrict the installation of acoustical wall and ceiling treatments; the potential use of special speaker technologies such as directional speakers or stacked speaker systems; and, the availability of physically larger or higher-fidelity speakers even though such speakers might not be listed for fire alarm use.

Note: Deviation from normal, minimum CIS criteria should not be requested for the design of normal, large, open areas that are typically found in permanent DoD buildings, such as dining halls, theaters, and gymnasiums. The potential for deviation from normal criteria is intended to address the rare exception to normal criteria that is sometimes needed for DoD buildings with unique operational requirements.

Building occupants located in the large, cavernous area can adequately understand the message content in the voice signal being broadcast. Whether the voice message is adequately understood must be determined by the approving authority (i.e., the AHJ for the Navy and Marine Corps; the DoD installation in conjunction with the contracting officer for the Army and Air Force).

The CIS value is not less than 0.6 at any location within the large, cavernous area.

The building occupants in the large, cavernous area must walk no more than 30 m98 feet to find another location within the large, cavernous area having at least the normal, minimum required CIS value. Note: An STI score of 0.5 is considered equivalent to a CIS score of 0.7. An STI value of 0.7 is considered equivalent to a CIS value of 0.8.

All readings for Sound Pressure Level (SPL) and Intelligibility score must be recorded on the installation drawings next to the speaker symbol. The readings must then be added on the "as-Built" drawings to be submitted at the conclusion of the Final Government test.

****

Intelligibility testing of the System must be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, and ASA S3.2. Following are the specific requirements for intelligibility tests:

a. Intelligibility Requirements: Verify intelligibility by measurement after installation.

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NOTE: The minimum required value for Navy and Marine Corps is 0.7 CIS. The minimum required value for

Army and Air Force is 0.8 CIS, although rounding is permitted such that a value of 0.75 may be rounded to 0.8.

****

b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is [.7][.8]. Rounding of values is permitted.

****

NOTE: Edit the following paragraph as required for each specific project.

****

c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the DFPE, and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 10 m 33 feet to find a location with at least the minimum required CIS value within the same area.

****

NOTE: Edit the following paragraph as required for each specific project.

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d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 15 m 50 feet to a location with at least the minimum required CIS value within the same area.

e. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).

f. The distance the occupant must walk to the location meeting the minimum required CIS value must be measured on the floor or other walking surface as follows:

    (1) Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.

    (2) Curving around any corners or obstructions, with a 300 mm 12 inches clearance there from.

    (3) Terminating directly below the location where the minimum required CIS value has been obtained.

Use commercially available test instrumentation to measure intelligibility as specified by NFPA 72 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3.10 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the Final Government Test.

[a. The drawings must be prepared electronically and sized no less than the contract drawings.][Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation] [AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide Operation and Maintenance (O&M) Instructions.

[In existing buildings, the transfer of devices from the existing system to the new system and the permission to begin demolition of the old fire alarm system will not be permitted until the as-built drawings and O&M manuals are received.]

3.11 INSTRUCTION OF GOVERNMENT EMPLOYEES

3.11.1 Instructor

Provide the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the operation, inspection, testing, and maintenance of the system provided. The instructor must train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm system. The instructor must be thoroughly familiar with all parts of this installation. The instructor must be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

3.11.2 Required Instruction Time

Provide [8][16][_____] hours of instruction after final acceptance of the system. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training must allow for rescheduling for unforeseen maintenance and/or fire department responses.

[3.11.2.1 Technical Training

Equipment manufacturer or a factory representative must provide [1][3][_____] days of on site[and 5 days of technical training to the Government at the manufacturing facility]. Training must allow for classroom instruction as well as individual hands on troubleshooting and diagnostics exercises.[Factory training must occur within [6][12][_____] months of system acceptance.]

]3.11.3 Technical Training Manual

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training must familiarize designated government personnel with proper operation of the installed system. The maintenance training course must provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.12 EXTRA MATERIALS

3.12.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturer[s]. Installing fire alarm contractor is NOT responsible for any damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.12.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed system[s]. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the Government testing and must be accompanied by an inventory list.

3.12.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. All documentation required by SD-06.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-28 31 70 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-28 31 00.00 10 (November 2008)
UFGS-28 31 49 (April 2006)
UFGS-28 31 63.00 20 (October 2007)
UFGS-28 31 64.00 10 (August 2009)
UFGS-28 31 74.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-28 31 70 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-28 31 00.00 10 (November 2008)
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UFGS-28 31 74.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 28 31 70

INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE

08/20

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NOTE: This specification covers the requirements for an addressable integrated fire detection, fire alarm system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: For OCONUS projects, this specification section should be edited for specific Host Nation requirements. Coordinate compliance with Host Nation requirements with the Designated Fire Protection Engineer (DFPE).

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NOTE: For Family Housing projects at NAVFAC NE use regional guide specification section 28 31 46.00 22 (N-13854N) HOUSEHOLD FIRE WARNING EQUIPMENT to specify residential fire warning systems in lieu of this section.

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NOTE: This specification section includes requirements from UFC 3-600-01 (change 43, 7 February 2020)

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NOTE: This guide specification covers carbon monoxide alarm detectors for protection in indoor locations where fuel-burning appliances/equipment are used.

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PART 1 GENERAL

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1. On the drawings, show location of control unit, batteries and charger (if remotely mounted), supervising station transmitter, annunciator, primary power supply, remote annunciator, detectors, notification appliances (unless performance requirements are specified), and each alarm initiating device including fire extinguishing system switches.

2. Show single-line fire alarm systems riser diagram. Each device on the riser should be identified by type. Indicate connection of equipment.

3. A fire alarm operating matrix must be placed on the drawings. Show actions of input devices such as detectors, manual stations, waterflow switches, initiating devices, etc. on one axis and output functions such as door releases, smoke control fans, elevator relays, indicating/notification appliances etc. on the other. Entries which require descriptions, explanation of processes, sequences, interfaces, etc. can be flagged by symbols keyed to supplementary notes. Alternately provide a zone-by-zone sequence of operation or a schedule identifying all initiators, outputs, and interfaces.

4. Addressable Fire Alarm Systems generally utilize Signal Line Circuits (SLC) for communication between devices. Normally all devices are addressable or will have an addressable interface device installed integrally with the device. Initiating Device Circuits (IDC) should be provided for interfacing to existing IDC loops or connection between non-addressable devices and the SLC.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2022) Safety Code for Elevators and Escalators

ASTM INTERNATIONAL (ASTM)

ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 170	(2024; ERTA 1 2023) Standard for Fire Safety and Emergency Symbols

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-601-02	(2021) Fire Protection Systems Inspection, Testing, and Maintenance
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices
47 CFR 90	Private Land Mobile Radio Services

UL SOLUTIONS (UL)

UL 228	(2006; Reprint Mar 2022) UL Standard for Safety Door Closers-Holders, With or Without Integral Smoke Detectors
UL 268	(2023) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Aug 2023) Smoke Detectors for Duct Application
UL 464	(2023) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 521	(2024) UL Standard for Safety Heat Detectors for Fire Protective Signaling Systems
UL 864	(2023; Reprint Oct 2024) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems

UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1638	(2023) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Feb 2024) UL Standard for Safety Signaling Devices for the Deaf and Hard of Hearing
UL 2034	(2024; Reprint Aug 2024) UL Standard for Safety Single and Multiple Station Carbon Monoxide Alarms
UL 2075	(2013; Bul. 2019) UL Standard for Safety Gas and Vapor Detectors and Sensors
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 RELATED SECTIONS

Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

[Section 21 13 13 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION]
[Section 21 30 00 FIRE PUMPS]
[Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS]
[Section 21 13 16 DRY PIPE FIRE SPRINKLER SYSTEMS]
[Section 21 13 18 PREACTION FIRE SPRINKLER SYSTEMS]
[Section 21 13 19 DELUGE FIRE SPRINKLER SYSTEMS]
[Section 23 30 00 HVAC AIR DISTRIBUTION]
[Section 21 13 24.00 10 AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM]
[Section 21 13 25 HIGH-EXPANSION FOAM SYSTEM, FIRE PROTECTION]
[Section 21 21 01 CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS]
[Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS]
[Section 08 71 00 DOOR HARDWARE for [door release][door unlocking] and additional work related to finish hardware.]
[Section[s] [14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS] [14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS] [and] [14 24 13 HYDRAULIC FREIGHT ELEVATORS] [14 24 23 HYDRAULIC PASSENGER ELEVATORS] for additional work related to elevators.]
[Section 07 84 00 FIRESTOPPING for additional work related to firestopping.]

1.3 SUMMARY

1.3.1 Scope

a. This work includes designing and [providing a new, complete,][modifying the existing] fire alarm system as described herein and on the contract drawings[for the ______________]. Include system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, initiating devices, notification appliances, supervising station fire alarm transmitters, and other accessories and miscellaneous items required for a complete operational system even though each item is not specifically mentioned or described. Provide system[s] complete and ready for operation.[Existing interior fire alarm system was manufactured by [_____].] Design and installation must comply with UFGS 25 05 11 and UFC 4-010-06 .

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 72, except as modified herein. [The system layout on the drawings show the intent of coverage and suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.]

c. [c. Each remote fire alarm control unit must be powered from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.]

d. [d. Where a fire pump is provided, the fire alarm system must monitor and transmit the fire pump controller signals in accordance with the provisions of NFPA 72.]

e. [e. Where an emergency generator provides standby power supply for life safety system circuits, the generator must be monitored by the Fire Alarm Control Unit (FACU) and transmit emergency generator signals in accordance with NFPA 72.]

f. The fire alarm system must be independent of the building security, building management, and energy/utility monitoring systems other than for control functions.

1.3.2 Qualified Fire Protection Engineer (QFPE)

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NOTE: UFC 3-600-01 requires that shop drawings must bear the Review Stamp and professional engineering stamp of the QFPE prior to submission to the Government for approval.

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NOTE: The term Qualified Fire Protection Engineer (QFPE) should be considered interchangeable with the terms "Fire Protection Designer of Record (FPDOR)" and/or "Fire Protection QC Specialist" where referred to in other applicable contract documents. The intent of defining the QFPE roles and responsibilities here is NOT to require personnel in addition to the QFPE, FPDOR, and/or FPQC specialist referenced elsewhere in the applicable contract documents.

****

Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Construction (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Providing a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting any outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government [and final Government]functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions must be defined as follows:

1.4.1 Interface Device

An addressable device that interconnects hard wired systems or devices to an analog/addressable system.

1.4.2 Fire Alarm Control Unit (FACU)

A master control unit having the features of a fire alarm control unit (FACU).

1.4.3 Remote Fire Alarm Control Unit

A control unit, physically remote from the fire alarm control unit, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm and mass notification control unit.

1.4.4 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door where terminal strips are securely mounted inside the cabinet.

1.4.5 Control Module and Relay Module

Terms utilized to describe emergency control function interface devices as defined by NFPA 72.

1.4.6 Designated Fire Protection Engineer (DFPE)

The DoD fire protection engineer that oversees that Area of Responsibility for that project. This is sometimes referred to as the "cognizant" fire protection engineer. Interpret reference to "authority having jurisdiction" and/or AHJ in referenced standards to mean the Designated Fire Protection Engineer (DFPE). The DFPE may be responsible for review of the contractor submittals having a "G" designation, and for witnessing final inspection and testing.

1.4.7 Qualified Fire Protection Engineer (QFPE)

A QFPE is an individual who is a licensed professional engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the fire alarm designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of

Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their registered professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE will be returned by the Government disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G, [_____]

Fire alarm system designer; G, [_____]

Supervisor; G, [_____]

Technician; G, [_____]

Installer; G, [_____]

Test Technician; G, [_____]

Fire Alarm System Site-Specific Software Acknowledgement; G, [_____]

SD-02 Shop Drawings

Nameplates; G, [_____]

Instructions; G, [_____]

Wiring Diagrams; G, [_____]

System Layout; G, [_____]

Notification Appliances; G, [_____]

Initiating devices; G, [_____]

Battery Power; G, [_____]

Voltage Drop Calculations; G, [_____]

SD-03 Product Data

Fire Alarm Control Unit (FACU); G, [_____]

[Video Display Unit (VDU); G, [_____]]

LCD Annunciator; G, [_____]

Manual Stations; G, [_____]

Smoke Detectors; G, [_____]

Duct Smoke Detectors; G, [_____]

[Projected Beam Smoke Detector; G, [_____]]

[Air sampling smoke detectors; G, [_____]]

Heat Detectors; G, [_____]

[Flame Detectors; G, [_____]
]

[Multi-Criteria Detectors; G, [_____]]

Carbon monoxide detector; G, [_____]

Addressable Interface Devices; G, [_____]

Addressable Control Modules; G, [_____]

Isolation Modules; G, [_____]

Notification Appliances; G, [_____]

Batteries; G, [_____]

Battery Chargers; G, [_____]

[Supplemental Notification Appliance Circuit Panels; G, [_____]]

[Auxiliary Power Supply Panels; G, [_____]]

Surge Protective Devices; G, [_____]

Alarm Wiring; G, [_____]

[Back Boxes and Conduit; G, [_____]]

[Ceiling Bridges for Ceiling-Mounted Appliances; G, [_____]]

Terminal Cabinets; G, [_____]

Digital Alarm Communicator Transmitter (DACT); G, [_____]

[Automatic Fire Alarm Transmitters (including housing); G, [_____]]

[Radio Transmitter and Interface Panels; G, [_____]]

Electromagnetic Door Holders; G, [_____]

Environmental Enclosures or Guards; G, [_____]

[Firefighter Telephone; G, [_____]]

[Printer; G, [_____]]

Document Storage Cabinet; G, [_____]

SD-05 Design Data

[Air Sampling Smoke Detection System Calculations; G, [_____]
]

SD-06 Test Reports

Test Procedures; G, [_____]

SD-07 Certificates

Verification of Compliant Installation; G, [_____]

Request for Government Final Test; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, [_____]

Instruction of Government Employees; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings

Spare Parts

1.6 SYSTEM OPERATION

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NOTE: Circuit wiring must be Class "B" unless Class "A" or "X" is required by the local installation and as permitted by NFPA 72 (SLC: "A", "B", or "X"; IDC and NAC: "A" or "B").

Circuits and pathways must have survivability levels as defined by NFPA 72.

****

Fire alarm system components requiring power, except for the FACU(s) power supply, must operate on 24 volts DC unless noted otherwise in this section.

The interior fire alarm system must be a complete, supervised, noncoded, analog/addressable fire alarm system conforming to NFPA 72, and UL 864. Systems meeting UL 2017 only are not acceptable. The system must be activated into the alarm mode by actuation of an alarm initiating device. The system must remain in the alarm mode until the initiating device is reset and the control unit is reset and restored to normal.

1.6.1 Alarm Initiating Devices and Notification Appliances (Visual, Audible)

a. Connect alarm initiating devices to initiating device circuits (IDC) [Class "A"][Class "B"], or to signaling line circuits (SLC) Class ["A"]["B"]["X"] and installed in accordance with NFPA 72.

b. Connect notification appliances to notification appliance circuits (NAC) [Class "A][Class "B"].

1.6.2 Functions and Operating Features

The system must provide the following functions and operating features:

a. Power, annunciation, supervision, and control for the system. Addressable systems must be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

b. Visual alarm notification appliances must be synchronized as required by NFPA 72.

c. Electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control unit.

d. An audible and visual trouble signal to activate upon a single break or open condition, or ground fault[(or short circuit for Class "X")]. The trouble signal must also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory control unit modules. After the system returns to normal operating conditions, the trouble signal must again sound until the trouble is acknowledged. A smoke detector in the process of being verified for the actual presence of smoke must not initiate a trouble condition.

e. A trouble signal silence feature that must silence the audible trouble signal, without affecting the visual indicator.

f. Program capability via switches in a locked portion of the FACU to bypass the automatic notification appliance circuits, [fire reporting system][air handler shutdown][smoke control operation][elevator recall][door release][door unlocking] features. Operation of this programmed action must indicate on the FACU display[and printer output] as a supervisory or trouble condition.[Notification appliance bypass must be selectable by floor.]

g. Alarm functions must override trouble or supervisory functions. Supervisory functions must override trouble functions.

h. The system must be capable of being programmed from the control unit keyboard. Programmed information must be stored in non-volatile memory.

i. The system must be capable of operating, supervising, and/or monitoring non-addressable alarm and supervisory devices.

j. There must be no limit, other than maximum system capacity, as to the number of addressable devices that may be in alarm simultaneously.

k. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as [HVAC,][atrium exhaust,][smoke control,][elevator recall,][releasing service,]the addressable fire alarm relay must be located in the vicinity of the emergency control device.

l. An alarm signal must automatically initiate the following functions:

    (1) Transmission of an alarm signal to [the fire department][a remote supervising station].

    (2) Visual indication of the device operated on the FACU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

(3) [(3) Record the event on the system printer.]

(4) Actuation of alarm notification appliances.

(5) Recording of the event electronically in the history log of the FACU.

(6) [(6) Release of doors held open by electromagnetic devices.]

(7) [(7) Operation of the [smoke control system][atrium exhaust system].]

(8) [(8) Release of power to electric locks (delayed egress locks) on doors that are part of the means of egress.]

(9) [(9) Elevator recall as described in this section.]

****

NOTE: Use this paragraph only where a detector or detection system is to release a special fire extinguishing system.

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(10) [(10) Operation of [_____] must release the [_____] fire extinguishing system after a [_____] second time delay.]

(11) [(11) Operation of a sprinkler waterflow switch serving an elevator machinery room or elevator shaft must operate shunt trip circuit breaker(s) to shut down power to the elevators in accordance with ASME A17.1/CSA B44.]

(12) [(12) Operation of an interface that operates vibrating pagers worn by hearing-impaired occupants.]

m. A supervisory signal must automatically initiate the following functions:

(1) Visual indication of the device operated on the FACU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

(2) [(2) Record the event on the system printer.]

(3) Transmission of a supervisory signal to [the fire department][a remote supervising station].

(4) Operation of a duct smoke detector must shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph and as allowed by NFPA 72.

(5) Recording of the event electronically in the history log of the FACU.

n. A trouble condition must automatically initiate the following functions:

(1) Visual indication of the device operated on the FACU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by

floor, zone or circuit, and type of device.]

(2) [(2) Record the event on the system printer.]

(3) Transmission of a trouble signal to [the fire department][a remote supervising station].

(4) Recording of the event electronically in the history log of the FACU.

o. [o. Activation of a carbon monoxide alarm initiating device must automatically initiate the following functions:

(1) Visual indication of the device operated on the ,[LCD, LED Display unit (VDU),][and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor and room number, device address, and device type.]

(2) Transmission of a carbon monoxide alarm signal to [the fire department][a remote supervising station].

(3) Activation of all strobes and the carbon monoxide alarm signal throughout the building.

(4) Recording of the event electronically in the history log of the FACU.]

p. System control equipment must be programmed to provide a 60-minute to 180-minute delay in transmission of trouble signals resulting from primary power failure.

[1.6.3 Elevator Recall

****

NOTE: Delete this paragraph if no elevator work is included in the project.

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Provide elevator recall in accordance with ASME A17.1/CSA B44, Section [14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS][14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS][14 24 13 HYDRAULIC FREIGHT ELEVATORS][14 24 23 HYDRAULIC PASSENGER ELEVATORS], and as specified herein. Activation of any smoke detector in an elevator shaft, machine room, or lobby (except at designated recall level) must cause all elevators associated with that shaft, machine room, or lobby to return nonstop to the designated level. Activation of a smoke detector in the lobby or machine room at the designated level must cause all elevators associated with that lobby to return nonstop to the assigned alternate level. Activation of a detector in an elevator shaft, machine room, or lobby must also cause illumination of elevator cab warning signal (fire hat) and complete operation of fire alarm system as specified in paragraph titled "Functions and Operating Features".

]1.7 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The fire alarm system manufacturer must submit written confirmation of this contract provision as "Fire Alarm System Site-Specific Software Acknowledgement". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must also include the following:

a. Items identified in NFPA 72, titled "Site-Specific Software".

b. Identification of programmable portions of the system equipment and capabilities.

c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

d. Provision of operational software data on all modes of programmable portions for fire alarm .

e. Description of Fire Alarm Control Unit equipment operation.

f. Description of auxiliary and remote equipment operations.

g. Library of application software.

h. Operation and maintenance manuals.

[1.8 EXISTING EQUIPMENT

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NOTE: If an addition to an existing fire alarm system is required, the contract drawings or this section must include the make, model number, and other pertinent information of existing components that are to operate with the new equipment. Since new interfaces will have to be compatible with the existing system or to the central fire alarm reporting system, it may be necessary to edit major items out of this specification. If a new FACU is required, it has to be compatible with the existing central fire alarm reporting system. When an existing system is to be expanded, show the following information on the contract drawings:

1. Manufacturer and model of existing control unit.

2. Number of existing initiating circuits (zones), notification appliance circuits, and control circuits served by the control unit.

3. Number of existing alarm notification appliances on the system.

4. Total calculated current draw of all devices served by each existing standby battery under both supervisory (standby) and alarm conditions, including NAC/extender control units and subcontrol units.

5. Ampere-hour rating and type of each existing battery.

****

a. Equipment and devices must be compatible and operable with the existing fire alarmmass notification system and must not impair reliability or operational functions of existing supervising station fire alarm system.[The proprietary type supervising station (PSS) is located [in Building [_____].][_____].][The supervising equipment is existing and consists of the following brands and models: [supervising station control unit [_____].][_____][signal reporting components [_____]], [annunciator [_____]][_____]].

b. [b. Equipment and devices must be compatible and operable with the existing building fire alarm system. Equipment must not impair reliability or operational functions of the existing system. The existing building system control unit is [_____].]

]1.9 QUALITY ASSURANCE

1.9.1 Submittal Documents

1.9.1.1 Preconstruction Submittals

Within 36 days of contract award but not less than [14 days][_____] prior to commencing any work on site, the Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE must be returned disapproved without review. All resultant delays must be the sole responsibility of the Contractor.

1.9.1.2 Shop Drawings

Shop drawings must not be smaller than [ISO A1][ANSI D][the Contract Drawings]. Drawings must comply with the requirements of NFPA 72 and NFPA 170. Minimum scale for floor plans must be 1/8"=1'.

1.9.1.3 Nameplates

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

1.9.1.4 Wiring Diagrams

[_____] copies of point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FACU and remote FACU, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

1.9.1.5 System Layout

[_____] copies of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors. Indicate candela rating of each visual notification appliance. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, and similar. Indicate if the environment for the FACU is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format similar to the "Typical Input/Output Matrix" included in the Annex of NFPA 72.

[For air sampling smoke detection systems, provide floor plan layouts indicating location of fire alarm control unit, air sampling piping (lengths of pipe) and sampling ports (sizes and locations). Floor plan must also indicate geographic monitor zone boundaries, location of display control unit, bar level annunciation panels if separate, and all other associated equipment that is required to provide a complete operational system.]

1.9.1.6 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.9.1.7 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least [25][_____] percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.9.1.8 Battery Power

Calculations and supporting data as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.9.1.9 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.9.1.10 Product Data

[_____] copies of annotated descriptive data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, and options that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

[1.9.1.11 Air Sampling Smoke Detection System Calculations

Submit air sampling detection system design analysis calculations consisting of battery capacity, loading calculations, and fan speed and air flow/transport calculations. Include schematic diagrams showing pipe segments, pipe diameters, lengths of pipe, node numbers, and sample port diameters to verify the requirements are met.

]1.9.1.12 Operation and Maintenance (O&M) Instructions

[Six][_____] copies of the Operation and Maintenance Instructions. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm System Operation and Maintenance Instructions must include the following:

a. "Manufacturer Data Package [five][_____]" as specified in [Section 01 78 23 OPERATION AND MAINTENANCE DATA][_____].

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. Complete procedures for system revision and expansion, detailing both equipment and software requirements.

e. Software submitted for this project on CD/DVD media utilized.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices, testing frequencies, and similar) must comply with UFC 3-601-02.

h. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

1.9.1.13 As-Built Drawings

The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of the as-built (marked-up) drawings must be provided at the time of, or prior to the final Government test.

1.9.2 Qualifications

****

NOTE: NICET (National Institute for Certification in Engineering Technologies) establishes the qualifications of an individual as an Engineering Technologist with verification of experience by having a current NICET certification.

****

1.9.2.1 Fire Alarm System Designer

The fire alarm system designer must be certified as a Level [III][IV] (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology or meet the qualifications for a QFPE.

1.9.2.2 Supervisor

[A NICET Level [III][or][IV] fire alarm technician must supervise the installation of the fire alarm system[, including the air sampling smoke detection system].][A fire alarm technician with a minimum of eight years of experience must supervise the installation of the fire alarm system.] The fire alarm technicians supervising the installation of equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.9.2.3 Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate fire alarm devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings[, and must be thoroughly experienced in the installation of air sampling detection systems].

1.9.2.4 Installer

[Fire alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm devices, cabinets and control units] [NICET Level II technician to assist in the installation of fire alarm devices, cabinets and control units]. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the fire alarm system system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.9.2.5 Test Technician

Fire alarm technicians with a minimum of eight years of experience and NICET Level [III][or][IV]utilized in testing and certification of the installation of the fire alarm devices, cabinets and control units. The fire alarm technicians testing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment installed as part of this project.

1.9.2.6 Manufacturer

Components must be of current design and must be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as specified herein.

1.9.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation must be considered as mandatory requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.11 MAINTENANCE

1.11.1 Spare Parts

Furnish the following spare parts in the manufacturers original unopened containers:

a. [Five][_____] complete sets of system keys.

b. [Two][_____] of each type of fuse required by the system.

c. [One][_____] manual stations.

d. [d. [Two][_____] of each type of detector installed.]

e. [Two][_____] of each type of detector base and head installed.

[f. [One][_____] electromagnetic door holders.]

g. [g. One smoke detector manufacturer's test screen, card or magnet for each ten beam smoke detectors, or fraction thereof, installed in the system.]

h. [h. Two air sampling smoke detection system filter assemblies.]

i. [Two][_____] of each type of audible and visual alarm device installed.

j. [Two][_____] of each type of addressable monitor module installed.

k. [Two][_____] of each type of addressable control module installed.

l. [Two][_____] low voltage, [one][_____] [telephone][internet][ethernet], and [one][____] 120 VAC surge protective device.

m. [m. [Two][_____] spare reams of paper for the system printer, plus sufficient paper for testing.]

n. [n. [Two][_____] spare printer ribbons.]

1.11.2 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment must be furnished to the Contracting Officer, prior to the instruction of Government employees.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENT

All fire alarm equipment must be listed for use under the applicable reference standards.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory and listed for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least [2][_____] years prior to bid opening.

2.2.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FACU

Nameplates must be etched metal or plastic, permanently attached by screws to control units or adjacent walls.

2.2.3 Keys

Keys and locks for equipment, control units and devices must be identical. [Master all keys and locks to a single key as required by the [Installation Fire Department][_____]]. [Keys must be CAT [60][_____].]

2.2.4 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a

Lexan plastic or glass cover in a stainless steel or aluminum frame. [Install the instructions on the interior of the FACU.][Install the frame in a conspicuous location observable from the FACU.] The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.3 FIRE ALARM CONTROL UNIT

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NOTE: The control unit must be located in an air conditioned space where the ambient temperature is maintained between 15 and 27 degrees C 60 and 80 degrees F.

****

Provide a complete fire alarm control unit (FACU) fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care, maintenance, and use of the system must be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control unit, the unit cabinets must match exactly.[If more than a single unit is required, and is located in the lobby/entrance, notify the Contracting Officer's Designated Representative (COR), prior to installing the equipment.] The system must be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation.

a. Each control unit must provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit must be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each control unit with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the FACU must be by liquid crystal display or similar means with a minimum of 80 characters.

2.3.1 Cabinet

Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and [surface][semi-recessed] mounting provisions. The enclosure must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must say "Fire Alarm control unit" and must not be less than 25 mm 1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches.

2.3.2 Silencing Switches

2.3.2.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FACU that must silence the audible and visual notification appliances. Subsequent activation of initiating devices must cause the notification appliances to re-activate.

2.3.2.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch(es) that must silence the audible trouble and supervisory signal(s), but not extinguish the visual indicator. This switch must be overridden upon activation of a subsequent supervisory or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated if the supervisory or trouble condition still exists.

2.3.3 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Initiating devices must be manually reset by switch from the FACU after the initiating device or devices have been restored to normal.

2.3.4 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices must not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.3.5 Field Programmability

Provide control units and control units that are fully field programmable for both input and output of control, initiation, notification, supervisory, and trouble functions. The system program configuration must be menu driven. System changes must be password protected. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system must be provided as part of this contract.

2.3.6 Input/Output Modifications

The FACU must contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features must consist of a control unit mounted keypad[and a keyboard]. Any bypass or modification to the system must indicate a trouble condition on the FACU.

2.3.7 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.3.8 Walk Test

The FACU must have a walk test feature. When using this feature, operation of initiating devices must result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated in the history log[and on the system printer], but no other outputs occur.

2.3.9 History Logging

The control unit must have the ability to store a minimum of 400 events in a log. These events must be stored in a battery-protected memory and must remain in the memory until the memory is downloaded or cleared manually. Resetting of the control unit must not clear the memory.

2.3.10 Manual Access

An operator at the control unit, having a proper access level, must have the capability to manually access the following information for each initiating device.

a. Primary status.

b. Device type.

c. Present average value.

d. Present sensitivity selected.

e. Detector range (normal, dirty).

[2.3.11 Heat Detector Self-Test Routines

Automatic self-test routines must be performed on each detector that will functionally check detector sensitivity electronics and ensure the accuracy of the value being transmitted. Any detector that fails this test must indicate a trouble condition with the detector location at the control unit.

][2.4 VIDEO DISPLAY UNIT (VDU)

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NOTE: Contact the DFPE to determine if a VDU is to be provided.

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a. The VDU must be the secondary operator-to-system interface for data retrieval, alarm annunciation, commands, and programming functions. The desk mounted VDU must consist of a LCD monitor and a keyboard. The VDU must have a [300][430][_____]-mm [12][17][_____]-inch minimum [touch]screen, capable of displaying 25 lines of 80 characters each. Communications with the FACU must be supervised. Faults must be recorded in the history log[and on the printer]. Power required must be 120 VAC, 60 Hz from the same source as the FACU.

b. To eliminate confusion during an alarm situation, the screen must have dedicated areas for the following functions:

  (1) Alarm and return to normal.

  (2) Commands, reports, and programming.

  (3) Time, day, and date.

c. Use full English language throughout to describe system activity and instructions. Full English language descriptors defining system points must be 100 percent field programmable by factory trained personnel, alterable and user definable to accurately describe building areas.

d. Alarms and other changes of status must be displayed in the screen area reserved for this information. Upon receipt of alarm, an audible alarm must sound and the condition and point type must flash until acknowledged by the operator. Return to normal must also be annunciated and must require operator acknowledgment. The following information must be provided in full English:

    (1) Condition of device (alarm, trouble, or supervisory).

    (2) Type of device (for example, manual pull, waterflow)

    (3) Location of device plus numerical system address.

e. The system must have multiple levels of priority for displaying alarms to conform with UL 864. Priority levels must be as follows:

    (1) Level 1 - Fire Alarms Signals

    (2) Level 2 - Supervisory Signals

    (3) Level 3 - Carbon Monoxide Alarm Signals

    (4) Level 4 - Trouble Signals

f. Provide the system with memory so that no alarm is lost. A highlighted message must advise the operator when unacknowledged alarms are in the system.

g. Multiple levels of access must be provided for operators and supervisors via user-defined passwords. Provide the following functions for each level:

    (1) Operator level access functions:

        (a) Display system directory, definable by device.

        (b) Display status of an individual device.

        (c) Manual command (alarm device with an associated command must use the same system address for both functions).

        (d) Report generation, definable by device, output on the VDU[or printer], as desired by the operator.

        (e) Activate building notification appliances.

    (2) Supervisor level access functions:

        (a) Reset time and date.

        (b) Enable or disable event initiated programs[, printouts,] and initiators.

        (c) Enable or disable individual devices and system components.

h. The above supervisor level functions must not require computer programming skills. Changes to system programs must be [recorded on the printer and]maintained in the control unit as a trouble condition.

]2.5   REMOTE ANNUNCIATOR

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NOTE: Provide the annunciator at a location in accordance with NFPA 72. A suggested location should be near the door through which the first responders will enter the building as indicated in their pre-fire plan, typically the main entrance.

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[2.5.1   LCD Annunciator

Provide a [semi-recessed][flush] mounted annunciator that includes an LCD display. The display must indicate the device in trouble/alarm or any supervisory device. Display the device name, address[, and actual building location].

A building floor plan must be provided and mounted (behind Plexiglass or similar protective material) at the annunciator location. The floor plan must indicate all rooms by name and number including the locations of stairs and elevators. The floor plan must show all devices and their programmed address to facilitate identification of their physical location from the LCD display information.

][2.5.2   Graphic Annunciator

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NOTE: Graphic annunciators should be provided only when a large number of concealed devices are installed. Normally, exposed devices will be annunciated by zone only on the fire alarm control unit zone annunciator and remote zone annunciator. Edit accordingly. Locate graphic annunciator(s) at or near building entrance to allow fire department quick access to the annunciator.

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Graphic annunciator must be of the [interior][weatherproof] type, [flush][surface][pedestal]-mounted. Annunciator must be provided with the [building][room] floor plan, drawn to scale, with alarm lamps mounted to represent the location of [each concealed detector][each initiating device]. Annunciator graphic must also show the locations of the annunciator and control unit, and must have a "you are here" arrow showing its location. Orient building floor plan on graphic to location of person viewing the graphic(i.e., the direction the viewer is facing must be toward the top of the graphic display). Provide a North arrow.[Principal rooms and areas shown must be labeled with room numbers or titles.] Detectors mounted above ceilings, [on ceilings,]and beneath raised floors and different types of initiating devices must have different symbols or lamps of different colors for identification. Lamps must illuminate upon activation of corresponding device and must remain illuminated until the system is reset. Annunciator must have a lamp test switch.

2.5.2.1   Materials

Construct the graphic annunciator face plate of [smoked Plexiglas][non-glare matte finish][anodized bronze][anodized aluminum]. The face plate must be backlit with LEDs. Control equipment and wiring must be housed in a [recessed][semi-recessed][surface mounted] back box. The exposed portions of the back box must be [chrome plated][anodized bronze][anodized aluminum] without knockouts.

2.5.2.2 Programming

Where programming for the operation of the graphic annunciator is accomplished by a separate software program other than the software for the FACU, the software program must not require reprogramming after loss of power. The software must be reprogrammable in the field.

][2.5.3 Printer

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NOTE: If the printer will be located in a SCIF or similar area, specify "no stored memory".

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a. Provide a system printer [with no stored memory] to record alarm, supervisory, and trouble conditions without loss of any signal or signals. Printout must be by circuit, device, and function as provided in the FACU. Printer must operate on a 120 VAC, 60 Hz power supply.

b. The printer must have at least 80 characters per line and have a 96 ASCII character set. The printer must have a microprocessor-controlled, bi-directional, logic seeking head capable of printing 120 characters per second utilizing a 9 by 7 dot matrix print head. Printer must not contain internal software which is essential for proper operation.

c. When the FACU receives a signal, the alarm, supervisory, and trouble condition must be printed. The printout must include the type of signal, the circuit or device reporting, the date, and the time of the occurrence. The printer must differentiate alarm signals from other printed indications. When the system is reset, this condition must also be printed including the same information concerning device, location, date, and time. Provide a means to automatically print a list of existing alarm, supervisory, and trouble conditions in the system. If a printer is off-line when an alarm is received, the system must have a buffer to retain the data and it must be printed when the printer is restored to service. The printer must have an indicator to alert the operator that the paper has run out.

]2.6 MANUAL STATIONS

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NOTE: Architectural Barriers Act (ABA) requires that manual alarm stations be mounted at a maximum of 1.1 m 44 inches above finished floor (AFF).

****

Provide metal or plastic, [semi-flush][flush][surface] mounted, [single][double]-action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations must be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations must be finished in red with molded raised lettering operating instructions of contrasting color. The use of a key must be required to reset the station.

2.7 SMOKE DETECTORS

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NOTE: Provide smoke detectors only in spaces where they are specifically required by UFC 3-600-01, DESIGN: FIRE PROTECTION ENGINEERING FOR FACILITIES.

Smoke detectors provided in elevator machinery rooms are to be provided per requirements of UFC 3-600-01. Coordinate with Section 14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS, Section 14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS and/or Section 14 24 13 HYDRAULIC FREIGHT ELEVATORS, Section 14 24 23 HYDRAULIC PASSENGER ELEVATORS.

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2.7.1 Spot Type Detectors

Provide addressable [photoelectric][ionization][laser] smoke detectors as follows:

a. Provide analog/addressable [photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268][smoke detectors that operate on the ionization principle and are actuated by the presence of visible or invisible products of combustion][laser smoke detectors utilizing laser diode and patented smoke sensing chamber, designed to amplify signals from smoke but diminish stray internal reflections and must, on command from the FACU, send data to the control unit representing the analog level of smoke density]. Smoke detectors must be listed for use with the FACU.

b. Provide self-restoring type detectors that do not require any readjustment after actuation at the FACU to restore them to normal operation. The detector must have a visual indicator to show actuation.

c. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases [with sounder that produces a minimum of 90 dBA at 3 m 10 feet] with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.

e. The detector address must identify the particular unit, its location within the system[, and its sensitivity setting]. Detectors must be of the low voltage type rated for use on a 24 VDC system.

[f. Laser smoke detector must be listed for use with the FACU. Detector must be able to achieve sensitivities from 0.02 percent-per-foot to 2 percent-per-foot obscuration.

g. Laser smoke detector must provide point identification of the fire location through addressability, must experience no delay in response time due to smoke dilution or smoke transportation time, and must offer complete supervision of wiring and detector.]

[2.7.2 Projected Beam Smoke Detector

Detectors must consist of [combined transmitter and receiver unit] [separate transmitter and receiver units]. The transmitter unit must emit an infrared beam to the receiver unit [the use of a supplied reflector is required for the combined unit]. When the signal at the receiver falls below a preset threshold, the detector must initiate an alarm. The receiver must contain an LED status indicator that illuminates when an alarm condition exists. Long-term changes to the received signal caused by environmental variations must be automatically compensated. Detectors must incorporate features to assure that they are operational; a trouble signal must be initiated if the beam is obstructed for more than 3 seconds, the limits of the compensation circuit are reached, or the housing cover is removed. Detectors must have multiple sensitivity settings in order to meet UL listings for the different distances covered by the beam.

]2.7.3 Duct Smoke Detectors

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NOTE: The requirements for Duct Detectors will be coordinated with the HVAC requirements and Sections 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. All required duct detectors will be shown on the contract drawings.

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Duct-mounted addressable photoelectric smoke detectors must consist of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct.[It is not permitted to cut the duct insulation to install the duct detector directly on the duct.] Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the FACU.

a. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the FACU.

b. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote indicators must be provided where required by NFPA 72. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.

c. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Auxiliary contacts provide for this function must be located within 1 m 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

[2.8 AIR SAMPLING SMOKE DETECTION SYSTEM

The [addressable]air sampling smoke system must consist of a detector assembly housing an integral aspiration fan, filter, laser-based detection chamber and control, output and supervision circuitry.[Each sampling point must be capable of being independently addressable.] The system must consist of a piping or tubing distribution network that runs from the detector assembly(s) to the protected area(s) and is supported by air sampling smoke detection system calculations from a computer-based design modeling tool. The system must include configurable alarm and trouble relay outputs for interface to other systems where required.

a. System must be complete in all ways. It must include all engineering, and electrical installation, all detection and control equipment, auxiliary devices and controls, alarm interface, functional checkout and testing, training and all other operations necessary for a functional system.

b. System base detectors and modules must each accommodate up to [40 addressable][_____] microbore sampling tubes where each tube has a sampling point at the end. Additional modules may be used to provide up to [20 addressable][_____] sampling holes per system.

c. Program alarm thresholds to the following values unless the results of the pre-Government system tests indicate a clear need to change them. In the event that such a need is indicated, notify the Contracting Officer and provide complete documentation concerning the need to deviate from these values. Include within the deviation documentation request, information that complies with the paragraph entitled "Sensitivity Verification Test". Ensure initial threshold levels are approved prior to the Government test.

    (1) Alarm Level 1: set ALERT at [_____][0.0250] percent obscuration/foot

    (2) Alarm Level 2: set PRE-ALARM at [_____][0.0500] percent obscuration/foot

    (3) Alarm Level 3: set FIRE 1 at [_____][0.1000] percent obscuration/foot

    (4) Alarm Level 4: set FIRE 2 at [_____][0.2000] percent obscuration/foot

d. All air sampling smoke detection devices and associated components must be new, standard products or the manufacturer's latest design and suitable to perform the functions intended.

e. The laser detection chamber must be of the mass light scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method must be employed for the purposes of:

    (1) Preventing large particles from affecting the true smoke reading.

    (2) Monitoring contamination of the filter (for example, dust and dirt) to automatically notify when maintenance is required. The particle counting method must not be used for the purpose of smoke density measurement.

f. Detector(s) must be self-monitoring for filter contamination and provide indication through system fault when replacement is necessary. Detectors which allow automatic reset of filter status upon removal and re-insertion are not permitted.

g. Detector(s) must contain relays for alarm and fault conditions. The relays must be software programmable to the required functions.

h. Detector(s) must permit configuration by programmers that are either integral to the system, portable or PC based.

i. Detector(s) must allow programming of:

   (1) Smoke threshold alarm levels; ALERT, PRE-ALARM, FIRE 1 and FIRE 2.

   (2) Time delays. Ensure the display control unit contains individual adjustable alarm time delay features for each of the alarm threshold levels. Provide an adjustment range between 0 and 60 seconds. Program the alarm threshold time delays to 30 seconds for alarm levels 1 and 2, and 15 seconds for alarm levels 3 and 4.

   (3) Faults, including airflow, detector, power, filter and network, as well as an indication of the urgency of the fault.

   (4) Configuration of relay outputs for remote indication of alarm and fault conditions.

   (5) General purpose input functionality.

]2.9 HEAT DETECTORS

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NOTE: Heat detectors provided in elevator machinery rooms are strictly for the warning sign in the elevator cab and must not alarm the FACU. Coordinate with Section 14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS, Section 14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS and/or Section 14 24 13 HYDRAULIC FREIGHT ELEVATORS, Section 14 24 23 HYDRAULIC PASSENGER ELEVATORS.

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2.9.1 Heat Detectors

Heat detectors must be analog/addressable and designed for detection of fire by [fixed temperature][combination fixed temperature and rate-of-rise principle][rate-compensating principle] in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values.. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations [as defined by NFPA 70][and][as indicated], must be types approved for such locations.

[2.9.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-resetting. Detector must operate at [57.2][90] degrees C[135][194] degrees F. Detector must feature rate compensation. [Detectors rated to operate at 57.2 degrees C135 degrees F must not respond to momentary temperature fluctuations less than 16.7 degrees C30 degrees F per minute between 16 and 38 degrees C60 and 100 degrees F].[Detectors rated to operate at 90 degrees C194 degrees F must not respond to momentary temperature fluctuations less than 27.8 degrees C

50 degrees F per minute between 16 and 66 degrees C60 and 150 degrees F.][The detector assembly must be [weatherproof][and][explosionproof].]

][2.9.1.2 Rate Compensating Detectors

Detector backbox must be [surface][flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring and hermetically sealed.[The detector assembly must be [weatherproof][and][explosionproof].]

][2.9.1.3 Line-Type Fixed Temperature Detectors

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NOTE: Specify line-type heat detectors only with approval of the EFD/EFA Fire Protection Engineer.

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Provide [thermostatic][or][thermistor] line-type heat detection cable [with weather-resistant outer covering] where indicated. Cable must be nominally rated for a temperature of [68][88][138] degrees C [155][190][280] degrees F and must operate on fixed temperature principle only.

][2.9.1.4 Fixed Temperature Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. The detectors must have a specific temperature setting [of [57.2][_____] degrees C [135][_____] degrees F][as shown].[The detector assembly must be [weatherproof][and][explosionproof].]

][2.10 FLAME DETECTORS

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NOTE: Modify these paragraphs as necessary to indicate that detectors placed in an explosive environment will be approved for use in the appropriate class, division, and group environment as defined in NFPA 70 and as shown on drawings.

****

Detectors must be sensitive to the micron range best suited for their intended use. Detectors must operate over electrically supervised wiring circuits and the loss of power to the detector must result in a trouble signal. A self-test feature must be provided for each detector to be individually tested.

[2.10.1 Infrared (IR) Single Frequency Flame Detector

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NOTE: The single frequency IR flame detector has the advantage of a fast response and is moderately sensitive. Its disadvantages are being affected by temperature extremes and being subject to false alarms from a myriad of IR sources.

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The detector must be sensitive in the range of [_____] to [_____]

micrometers only.

][2.10.2 Infrared (IR) Multi Frequency Flame Detector

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NOTE: The IR multi frequency flame detector has the advantages of a moderately fast response, moderate sensitivity, and a lower false alarm rate. Its disadvantage is being affected by temperature extremes.

****

The IR detector must consist of three or more IR sensors, each selected for a different IR frequency. The primary sensor must be sensitive in the range of [_____] to [_____] micrometers only. Secondary sensors are tuned to different IR wavelengths to null out the effect of black body radiation to the primary sensor.

][2.10.3 Ultraviolet (UV) Flame Detectors

****

NOTE: Ultraviolet (UV) flame detectors can be set to respond accurately to UV wavelength light produced by flame from both indoors and outdoors. UV flame detectors operate on the Geiger-Muller principle. These gas-filled vacuum tubes respond in the UV portion of the spectrum but can ignore UV radiation from the sun because the upper response range of the detector falls below the range of UV radiation that reaches the earth.

Solid-state UV detectors are available, but their spectral response extends into the sun's UV range and are not recommended for external use.

UV detectors have an 80 to 90 degree cone of vision. The UV detector has a fast response time and usually is not affected by rain, wind, snow, high humidity, or temperature and pressure extremes. UV units will produce false alarms if they are exposed to arc welding or X-ray and gamma radiation. They can also be blinded by oil film or smoke. UV flame detectors that are used in dirty and dusty environments should be equipped with automatic self-test and self-cleaning devices. The cleaning device uses a stream of clean air across the lens surface to minimize the build-up of contaminants.

****

UV flame detector must be of the narrow band response type which operates on radiated ultraviolet energy and must be sensitive in the range of [_____] to [_____] micrometers only. The cone of vision must be 80 degrees or greater. Each detector must be completely insensitive to light sources in the visible frequency range.

][2.10.4 Combination UV/IR Flame Detector

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NOTE: Combination UV/IR flame detectors have been used both inside and outside to detect fires, but are slower to react than individual units.
****

The UV/IR detector must provide discrimination against false alarms by requiring both UV and IR flame detection before an alarm is sent. The UV sensor must be sensitive in the range of 0.185 to 0.265 micrometers only. The IR sensor must be sensitive in the range of [_____] to [_____] micrometers only. Detectors must be completely insensitive to light sources in the visible frequency range.

]][2.11 MULTI-CRITERIA DETECTORS

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The designer must select the sensor required to initiate a fire alarm condition.
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Multi-criteria detectors must contain [fixed temperature [_____] degrees C F heat sensor], [rate-of-rise heat sensor], [photoelectric smoke detector], [_____] elements in a single housing.

]2.12 CARBON MONOXIDE DETECTOR

Analog/addressable carbon monoxide (CO) detectors must be listed to UL 2075 and set to respond to the sensitivity limits of UL 2034. Carbon monoxide detectors must be listed for use with fire alarm control units. Detectors must be [surface] [semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. For FACU with no listed compatible addressable CO detectors, provide listed 4-wire detectors.[Do not provide CO detectors with local alarms.] Detector must be provided with an LED status indicator.

a. Where 4-wire CO detectors are necessary, each 4-wire CO detector must be individually monitored via addressable interface modules for alarm and off normal/trouble conditions (including loss of power to the individual detector). Power circuits for 4-wire CO detectors must be dedicated to powering the CO detectors only. Battery powered and 120 VAC powered detectors are prohibited.

b. Wiring connections must be made by means of screw terminals and detectors must be equipped with trouble relays. Detectors must be able to mount a single-gang electrical box.

c. A trouble condition at an individual CO detector must not affect any other CO detectors. CO detectors must be powered by the FACU.

d. Detectors must be provided with a means to test CO gas entry into the CO sensing cell.

2.13 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored must be configured as a [Class "A"][Class "B"] initiating device circuits. The module must be listed as compatible with the control unit. The module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED.[Existing fire alarm system initiating device circuits must be connected to a single module to supervise the circuit.] Modules must be listed for the environmental conditions in which they will be installed.

2.14 ADDRESSABLE CONTROL MODULES

The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders or initiate elevator fire service. The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as [Class B][Class A] notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and must prevent power from being applied to the circuit. The control model must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

[2.15 ISOLATION MODULES

a. Provide isolation modules to subdivide each signaling line circuit [into groups of not more than [20 addressable devices][_____]][each floor][in accordance with NFPA 72] between adjacent isolation modules.

b. Isolation modules must provide short circuit isolation for signaling line circuit wiring.

c. Power and communications must be supplied by the SLC and must report faults to the FACU.

d. After the wiring fault is repaired, the fault isolation modules must test the lines and automatically restore the connection.

]2.16 NOTIFICATION APPLIANCES

2.16.1 Audible Notification Appliances

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NOTE: The designer must layout speakers to achieve both the required dBA levels requires by NFPA 72.

NOTE: Where horns or bells are used for fire alarm notification, calculate the proper locations for these devices as detailed in "Designing Fire Alarm Audibility," which is contained in the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering. Submit the calculations at the 35-percent design review.

****

Audible appliances must conform to the applicable requirements of UL 464. Appliances must be connected into notification appliance circuits. Surface mounted audible appliances must be painted [red][white][_____]. Recessed audible appliances must be installed with a grill that is painted [red][white][_____][with a factory finish to match the surface to which it is mounted].

2.16.1.1 Horns

Horns must be [semi-flush mounted][surface-mounted, with the matching mounting backbox surface mounted vibrating type suitable for use in an electrically supervised circuit]. Horns must produce a sound rating of at least 85 dBA at 3.1 meters10 feet. Horns used in exterior locations must be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.[Horns must be [weatherproof][explosionproof].]

[2.16.1.2 Bells

Bells must be surface mounted with the matching mounting backbox [surface mounted][recessed]. Bells must be suitable for use in an electrically supervised circuit. Bells must be the underdome type producing a minimum output rating of [85] [_____] dBA at 3.1 m 10 feet. Bells used in exterior locations must be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles. Single stroke, electrically operated, supervised, solenoid bells must be used for coded applications.

][2.16.1.3 Chimes

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NOTE: Chimes are normally only used in hospitals and child development centers to alert the staff about a fire emergency without arousing the patients. Sound output is low and prevents them from being used in areas having even moderately low noise levels.

****

Chimes must be electrically operated, supervised, electronic type, with an adjustable frequency of 800 to 1200 Hertz. Chimes must have a minimum sound rating of [80][_____] dBA at 3 m 10 feet. Chimes must ring the bell codes, as indicated.

]2.16.2 Visual Notification Appliances

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NOTE:
1. ABA requires that Visual Notification Appliances be provided in buildings and facilities in each of the following areas: restrooms, and any general usage area (e.g., meeting rooms), hallways, lobbies, and any other area for common use and other areas stated at www.access-board.gov. The Visual Notification Appliance must be mounted as required by ABA that directs compliance with NFPA 72. In addition, alarms in guest rooms required to provide communication features must comply with sections 18.5.5.7 of NFPA 72. Shop drawings must indicate location, dimensions, content, details, and other required information to indicate extent of complying with ABA requirements.

2. Currently NFPA 72 requires "clear color" strobes for Fire Alarm Notification. NFPA 72 requires the strobe must be marked "Fire" to clear identify the function.

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Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED) and be marked "Alert" in letters of contrasting color. The light pattern must be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of [15][30][75][_____] candela based on the UL 1971 test. Strobe must be [surface][semi-flush] mounted.

2.17 ELECTRIC POWER

2.17.1 Primary Power

Power must be [120][_____] VAC [50][60] Hz service for the FACU from the AC service to the building in accordance with NFPA 72.

2.18 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.18.1 Batteries

Provide sealed, maintenance-free, [sealed lead acid][lead-calcium][gel cell] batteries as the source for emergency power to the FACU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.18.1.1 Capacity

Battery size must be the following capacity. This capacity applies to every control unit associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, and fire alarm transmitters.

a. Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.

2.18.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

    (1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each

system component and each control unit component, and compliance with UL 864.

(2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

(3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components. Calculations must be performed using the minimum rated voltage of each component.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing device and/or appliances remote from the power sources.

2.18.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and must maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.19 SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage fire alarm control unit components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on any signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the FACU breaker is located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for fire alarm wiring. The base assembly must accept "plug-in" surge protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

  (1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

  (2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

  (3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

  (4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.20 WIRING

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.20.1 Alarm Wiring

IDC and SLC wiring must be [fiber optic][, stranded copper][or][solid copper] cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. [14][16][18][_____] AWG size conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 14 AWG size conductors at a minimum. Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors and/or appliances. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with NFPA 70.

2.21 AUTOMATIC FIRE ALARM TRANSMITTERS

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NOTE: State the make and model number of existing proprietary supervising station receiving equipment. The choice of code transmitter, or radio transmitter depends upon the type of existing fire reporting system at the activity. Determine the type of activity reporting system (e.g., positive non interfering or shunt). In most cases a local energy-tripping device will be required. The facility Fire Dept. or Engineering office should be contacted to determine the type and amount of data to be supervised (monitored), e.g., -type: separate

or common transmission of alarm, supervisory, and trouble type signals; -amount: all points, all zones, or the combined premises. Verify that existing monitoring equipment has sufficient capacity to support the additional premises or that it can be expanded as necessary to accommodate the new fire alarm system. Identify existing components.
****

[2.21.1 Radio Transmitter and Interface Panels

Transmitters must be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter must be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters must be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module must be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is [_____] and the transmitter must be fully compatible with this equipment. At the contractors option, and if listed, the transmitter may be housed in the same control unit as the FAC. The transmitter must be narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.

2.21.1.1 Operation

Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter must automatically switch to battery operation. Switchover must be accomplished with no interruption of protective service, and must automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply must also be automatic.

2.21.1.2 Battery Power

Transmitter standby battery capacity must provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.21.1.3 Transmitter Housing

Use NEMA Type 1 for housing. The housing must contain a lock that is keyed [identical to the fire alarm system for the building][identical to radio alarm transmitter housings on the Installation]. Radio alarm transmitter housing must be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.21.1.4 Antenna

Antenna must be [omnidirectional, coaxial, halfwave dipole antennas][_____] for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts must be corrosion resistant and designed to withstand wind velocities of 161 km/hour 100 mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage.

][2.21.2 Digital Alarm Communicator Transmitter (DACT)

Provide DACT that is compatible with the existing supervising station fire alarm system. Transmitter must have a means to transmit alarm, supervisory, and trouble conditions via a single transmitter. Transmitter must have a source of power for operation that conforms to NFPA 72. Transmitter must be capable of initiating a test signal daily at any selected time. Transmitter must be arranged to seize telephone circuits in accordance with NFPA 72.

]2.21.3 Signals to Be Transmitted to the Base Receiving Station

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NOTE: The following paragraph is applicable only to existing installations for connections to an auxiliary (public) alarm system. Edit this for the installation specific criteria.

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The following signals must be sent to the base receiving station:

[a. Sprinkler waterflow]

[b. Manual pull stations]

[c. Smoke detectors]

[d. Duct smoke detectors]

[e. Sleeping room smoke detectors]

[f. Carbon monoxide detectors]

[g. Heat detectors]

[h. Fire extinguishing system]

[i. Sprinkler valve supervision]

[j. Fire pump running]

[k. Fire pump supervision]

[l. Water supply level and temperature]

[m. Combustion engine drive fire pump running

(1) Selector switch in position than automatic

(2) Engine over-speed

(3) Low fuel

(4) Low battery

(5) Engine trouble (for example, low oil, over temp)]

2.22 SYSTEM MONITORING

2.22.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves,[standpipe control valves,] sprinkler service entrance valve,[valves at fire pumps,] isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, must be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address[, unless they are within the same room, then a maximum of five can use the same address].

[2.22.2 High/Low [Air][Nitrogen] Supervisory Switches

Provide monitoring of high and low supervisory [air][nitrogen] for [dry pipe][and][preaction] systems. Each air supervisory switch must have a separate address. Switches must be listed extinguishing system attachments. The device must contain double pole, double throw contacts. Operation of the switch must cause a supervisory signal to be transmitted to the FACU when [air][nitrogen] pressure in the system monitored sprinkler system increases more than 34.5 kPa5 psi above the normal system pressure or drops halfway from the normal pressure to the tripping point.

][2.22.3 Room Low Temperature Supervisory Switch

Provide [monitoring of the]listed supervisory air temperature switch for the [fire pump][sprinkler riser] room[s]. Switch must cause a supervisory signal to be transmitted to the FACU whenever the temperature in the room drops to below 4.4 degrees C40 degrees F. Device must reset when temperature rises above 4.4 degrees C40 degrees F.

][2.22.4 Electromagnetic Door Holders

Electromagnetic holding devices must operate on [120 VAC][24 VDC], and require not more than [3][_____] watts of power to develop 6.9 kPa25 psi of holding force. Under normal conditions, the magnets must attract and hold the doors open. Operation must be fail safe with no moving parts. Electromagnetic door hold-open devices must not be required to be held open during building power failure. The device must be listed based on UL 228 tests.

]2.23 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures must be provided to permit fire alarm components to be used in areas that exceed the environmental limits of the listing. The enclosure must be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the component is currently listed. Guards required to deter mechanical damage must be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

[2.24 FIREFIGHTER TELEPHONE COMMUNICATION SYSTEM

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NOTE: Provide a master control station at the FACU with remote telephone stations in each stair at each floor landing, in each elevator lobby on each floor, and in elevator cabs. In addition, provide them at

specific locations containing essential fire protection equipment, such as the fire pump room and outside the emergency generator room.

NOTE: In lieu of firefighter telephones radio repeater equipment compatible with responding fire department may be used if approved by the responding fire department.

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2.24.1 General

Provide a firefighter telephone communication system with complete, common talk, closed circuits. The system must include, but not be limited to, a master control station mounted in the fire alarm control unit, a power supply and standby battery system, and remote telephone stations.

2.24.2 Features

The system must include the following features:

a. A master control station which must provide power, supervision, and control for wiring, components, and circuits. The act of lifting any remote telephone hand set from its cradle must cause both a visual and audible signal to annunciate at the master control station. Removing the hand set at the master control station and depressing a button at the remote telephone hand set must cause the automatic silencing of the audible signal.

b. Communication between the master control station hand set and any/or all remote hand sets must require the depressing of a push-to-talk switch located on any/all remote hand sets. During the time that the master control hand set is removed from its cradle it must be possible to communicate between five remote hand sets and the master control station.

c. Hand sets must be able to monitor any conversation in progress and join the conversation by pressing the push-to-talk button. It must not be possible to communicate between two or more remote hand sets with the master control station hand set in its cradle.

d. The master control station hand set must be red in color and equipped with a 1.5 m5-foot long strain-relieved coiled cord.

e. The master control station must monitor wire and connections for any opens, shorts, or grounds which would render the system inoperable or unintelligible.

f. The master control station must be equipped with a silencing switch and ring-back feature such that any audible trouble signal can be silenced and must be so indicated by the lighting of an amber LED. Once any trouble condition has been corrected, the amber LED must be extinguished.

g. The master control station must be equipped with a separate, LED annunciated switch for each telephone circuit. In addition, LEDs must provide for the annunciation of operating and supervisory power.

h. The loss of operating or supervisory power must cause an audible and visual indication at the master control station and must also cause the fire alarm trouble signal to sound on the FACU.

i. Switches, LEDs, and controls must be fully labeled.

2.24.3 Handsets

Handsets must have the following features:

a. Provide [surface][flush] mounted remote telephone stations.

b. Each station must be equipped with a hinged door that is magnetically locked.

c. Each hand set must be permanently wired in place with a coiled cord.

d. Each hand set must be red high-impact cycolac and must be equipped with a push-to-talk switch which, when operated, must signal the master control station and a switch-equipped, storage cradle.

e. Provide operating and supervising power from the same supply circuit(s) utilized for the FACU.

]PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

3.2.1 Fire Alarm Control Unit (FACU)

Locate the FACU [where indicated on the drawings][_____]. [Recess][Semi-recess][Surface mount] the enclosure with the top of the cabinet 2 m 6 feet above the finished floor or center the cabinet at [1.5][_____] m [5][_____] feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the FACU. Locate the document storage cabinet adjacent to the FACU unless the Contracting Officer directs otherwise.

3.2.2 Battery Cabinets

When batteries will not fit in the FACU, locate battery cabinets below or adjacent to the FACU. Battery cabinets must be installed at an accessible location when standing at floor level. Battery cabinets must not be installed lower than 300 mm12 inches above finished floor, measured to the bottom of the cabinet, nor higher than 900 mm36 inches above the floor, measured to the top of the cabinet. Installing batteries above drop ceilings or in inaccessible locations is prohibited. Battery cabinets must be large enough to accommodate batteries and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.The cabinet must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must indicate the control unit(s) the batteries power and must not be less than 25 mm1-inch high.

3.2.3 Manual Stations

Locate manual stations as required by NFPA 72[and as indicated on the drawings]. Mount stations so they are located no farther than [1.5][_____] m [5][_____] feet from the exit door they serve, measured horizontally. Manual stations must be mounted at [1067][1117][_____] mm [42][44][_____] inches measured to the operating handle.

3.2.4 Notification Appliances

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NOTE: Locate strobes wall mounted in corridors no more than 4.5 m 15 feet from the end of a corridor with 30 m 100 feet maximum distance between strobes. Where there is an obstruction to the viewing path in the corridors, such as a cross-corridor door or ceiling elevation change, consider the obstruction as defining a new corridor. Provide ceiling mounted strobes in rooms accessible to the public, such as conference rooms, restrooms, courtrooms, cafeterias, and auditoriums in accordance with NFPA 72. In Child Development Centers only chimes must be used as the pre-alert tone prior to voice messages.

****

a. Locate notification appliance devices [as required by NFPA 72][where indicated] Where more than two visual notification appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring.[Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles plus or minus 50 mm2 inches.].

b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.

c. Speakers must not be located in close proximity to the FACU or LOC so as to cause feedback when the microphone is in use.

3.2.5 Smoke and Heat Detectors

Locate detectors [as required by NFPA 72 and their listing][as indicated on the drawings] on a 100 mm 4-inch mounting box. Install heat detectors not less than 100 mm 4 inches from a side wall to the near edge. Heat detectors located on the wall must have the top of the detector at least 100 mm 4 inches below the ceiling, but not more than 300 mm 12 inches below the ceiling. Smoke detectors are permitted to be on the wall no lower than 300 mm 12 inches from the ceiling with no minimum distance from the ceiling.[In raised floor spaces, install the smoke detectors to protect[21 square meters 225 square feet per detector][_____].] Install smoke detectors no closer than 1 m 3 feet from air handling supply diffusers. Detectors installed in acoustical ceiling tiles must be centered in the tiles plus or minus 50 mm2 inches.

3.2.6 Carbon Monoxide Detectors

Locate detectors [as required by NFPA 72 and their listings][as indicated on the drawings] on a 100-mm4-inch mounting box.[Carbon monoxide detectors must be installed separate from smoke and/or heat detectors.]

[3.2.7 Air Sampling Smoke Detector

Locate air sampling smoke detectors in accordance with the manufacturer's instructions. Air sampling smoke detectors must be installed as follows:

a. Air Sampling Smoke Detector Assembly:

  (1) Detector assembly must be mounted to a wall at a height between 48 to 60 inches1200 mm to 1800 mm to top of detector measured above the finished floor.

  (2) Mounting must be in a fully accessible and visible location.

  (3) Mounting or attachment to site equipment, cable trays, movable walls, other equipment or equipment supports is not permitted.

  (4) Piping network insertion into the detector inlet must not be glued.

  (5) Air sampling smoke detector assembly must be installed in accordance with this specification section and the manufacturer's installation and instruction manuals.

  (6) Flexible tubing for termination of the sampling pipe network into detector inlet is not permitted unless allowed by its listing.

  (7) Provide red background with white lettering labels that are plastic or phenolic type with a minimum of 0.25-inch6.4 mm block lettering to indicate detector and zone. For example: "AIR SAMPLING SOME DETECTOR No. 1-1 No. 5".

  (8) Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the ASD panel. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must be approved by the Contracting Officer before being posted.

b. Pipe and Sampling Tube Mounting:

  (1) The pipe and sampling tubing detection network must be mounted as per the design and manufacturer's specification. The hardware used for mounting will depend upon the design and site requirements.

  (2) To minimize flexing, pipes must be secured every 1.5 m5 feet.

  (3) Pipes must be suspended between 25 mm and 100 mm1 and 4 inches

below the ceiling. In areas with a suspended ceiling, the pipe network must be installed above the ceiling utilizing the manufacturer's capillary sample port supported by the ceiling.

(4) The sampling tubes must be of the same length or use the manufacturer's guidelines to run tubes of the required lengths.

(5) When installing a pipe network in areas subject to high temperature fluctuations allow for the contraction and expansion of pipes.

(6) Where expansion or contraction of pipes is likely either after installation or on a continuous basis, do not place pipe clips adjacent to couplings and socket unions as these may interfere with the movement of the pipe.

(7) No bends are permitted within the first 450 mm18 inches from the detector inlet.

(8) The routing of the piping and sample tube network must be coordinated with potential obstructions, including cable trays, grounding bars, and HVAC ductwork.

(9) All changes in direction must be made with standard elbows or tees.

(10) All joints must be air-tight and made by using solvent cement, except at the entry to the detector assembly. Refer to ASTM F402.

(11) All pipes must be supported by mechanical hangers attached to the structure of the building. Not more than 300 mm1-foot of pipe must extend beyond the last hanger of each sampling pipe. The final installation must result in no noticeable deflection in the piping network.

(12) Attachment of air sampling pipes to cable trays, "gray iron", and telecommunications equipment is prohibited.

(13) Clearly label pipe network to distinguish the pipe from other facility pipe work or protective cabling enclosures. For example: "SMOKE DETECTION SAMPLING TUBE - DO NOT DISTURB". In open rooms and exposed areas, provide labels at no greater than 6.1-m20-foot intervals. Provide labels every 3 m10 feet where piping is installed above suspended ceilings and every 609 mm2 feet, centered in the floor panels, where piping is installed within the raised floor cavity.

(14) Placement of the sampling tube must take into consideration appropriate sampling point locations and spacing.

c. Air Sampling Points:

(1) Open area ceiling sampling points must be oriented downward and must be within 25 mm to 100 mm1 to 4 inches below the underside of the ceiling above where the ceiling is smooth.

(2) Label all air sampling points with a round red label, each with a center hole to match the diameter of the drilled sampling point. For example: "AIR SAMPLING POINT DIA 3.2 MM0.125 INCHES". Indicate fractional dimensions in decimal format with a minimum of

three decimal places.

][3.2.8 Graphic Annunciator

Locate the graphic annunciator as shown on the drawings. Mount the annunciator, with the top 1830 mm 6 feet above the finished floor or center the annunciator at [1525][_____] mm [5][_____] feet, whichever is lower.

]3.2.9 LCD REMOTE Annunciator

Locate the LCD annunciator as shown on the drawings. Mount the annunciator, with the top 2 m 6 feet above the finished floor or center the annunciator at [1.5][_____] m [5][_____] feet, whichever is lower.

[3.2.10 Electromagnetic Door Holder Release

Doors must be held open at a minimum of 90 degrees so as not to impede egress from the space. Mount the armature portion on the door and have an adjusting screw for seating the angle of the contact plate. Wall-mount the electromagnetic release, with a total horizontal projection not exceeding 100 mm4 inches. Ensure all doors release to close upon first stage (pre-discharge) alarm. Electrical supervision of wiring external of control unit for magnetic door holding circuits is not required.

][3.2.11 Firefighter Telephones

Mount telephone[hand sets][jacks] on the wall in each stair at each floor landing, in each emergency generator room, in each fire pump room, in each elevator machine room, in each elevator lobby, and in each elevator cab 1200 mm 4 feet above the finished floor.

]3.2.12 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.3 SYSTEM FIELD WIRING

3.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and professional manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FACU and remote fire alarm control units, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.3.2 Terminal Cabinets

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NOTE: Provide terminal cabinets on each floor where the fire alarm system supply riser is located and where the fire alarm return riser is located.

****

Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 200 mm by 200 mm 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "FIRE ALARM TERMINAL CABINET" with 50 mm 2-inch lettering, on the front of the terminal cabinet.

3.3.3 Alarm Wiring

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NOTE: Do not penetrate SCIF perimeters with copper signal line circuits. SCIF penetrations should be either fiber optic cable or IDC. IDC circuits penetrating the SCIF must be filtered.

****

a. Voltages must not be mixed in any junction box, housing or device, except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the FACU.

c. [Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.][T-tapping using screw terminal blocks is allowed for Class "B" signaling line circuits.]

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the [_____] Designated Fire Protection Engineer (DFPE).

3.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 19 mm3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits [_____]6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

g. [g. For Class "A" or "X" circuits with conductor lengths of 10 feet3 meters or less, the conductors must be permitted to be installed in the same raceway in accordance with NFPA 72.]

3.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FACU, and remote FACU must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FACU, and remote FACU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12 point lettering minimum size, and mounted within each cabinet, control unit, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

[3.4 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM

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NOTE: Contact the Contracting Officer, Base Fire Prevention Office, and/or Base Maintenance Personnel to determine what action is appropriate for the salvaging of existing fire alarm equipment.

****

Maintain existing fire alarm equipment fully operational until the new equipment has been tested and accepted by the Contracting Officer. As new equipment is installed, label it "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Government, it must be placed in service and connected to the supervising station. Remove tags from new equipment and tag the existing equipment "NOT IN SERVICE" until removed from the building.

a. After acceptance of the new system by the Contracting Officer, remove existing equipment not connected to the new system, remove unused exposed conduit, and restore damaged surfaces. Remove the material from the site and dispose.

b. Disconnect and remove the existing fire alarm and smoke detection systems where indicated and elsewhere in the specification.

c. Control units and fire alarm devices and appliances disconnected and removed must be turned over to the Contracting Officer.

d. Properly dispose of fire alarm outlet and junction boxes, wiring, conduit, supports, and other such items.

3.5 CONNECTION OF NEW SYSTEM

The following new system connections must be made during the last phase of construction, at the beginning of the pre-Government tests. New system connections must include:

a. Connection of new relays to existing magnetic door hold-open devices.

b. Connection of new elevator recall relays to existing wiring and conduit.

c. Connection of new system transmitter to existing installation fire reporting system.

Once these connections are made, system must be left energized. Report immediately to the Contracting Officer, coordination and field problems resulting from the connection of the above components.

]3.6 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire-rated walls, partitions with fire-rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.7 PAINTING

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 19 mm3/4-inch wide at 3-meter10-foot centers and at each side of a floor, wall, or ceiling penetration.

c. Painting must comply with Section 09 90 00 PAINTS AND COATINGS.

3.8 FIELD QUALITY CONTROL

****

NOTE: Listed tests are minimum required. Coordinate with the local Authority Having Jurisdiction (AHJ) for minimum requirements in excess of the NFPA 72 minimums or those recommend below. If additional tests are required, such tests must be added to the list.

****

3.8.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level [III][or][IV] Fire Alarm Technician, and the representative of the installing company, [and reviewed by the QFPE] [60][_____] days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, and surge protective devices. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forma in NFPA 72 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government testing. The test data forms must record the test results and must:

a. Identify the NFPA Class of all Initiating Device Circuits (IDC), and Notification Appliance Circuits (NAC), and Signaling Line Circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing. The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.8.2 Pre-Government Testing

3.8.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that devices and circuits are functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" as required by NFPA 72. The contractor and an authorized representative from each supplier of equipment must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 72 including all referenced annex sections and the test reports noted below.

a. NFPA 72 Record of Completion.

b. NFPA 72 Record of Inspection and Testing.

c. Fire Alarm and Emergency Communication System Inspection and Testing Form.

d. Audibility test results with marked-up test floor plans.

e. Documentation that all tests identified in the paragraph "Minimum System Tests" are complete.

3.8.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the [_____][Designated Fire Protection Engineer (DFPE)][Contracting Officer's Representative (COR)]. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation-wide fire reporting systemhas been completed and tested to confirm communications are fully functional. Submit request for test at least [15][_____] calendar days prior to the requested test date.

3.8.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. [b. The contractor's Qualified Fire Protection Engineer (QFPE).]

c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results.

e. Complete program printout including input/output addresses.

f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

g. Audibility test results with marked-up floor plans.

Government Final Tests will be witnessed by the [_____], [Designated Fire Protection Engineer][Contracting Officer's Representative (COR)][, Qualified Fire Protection Engineer (QFPE)]. At this time, any and all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.9 MINIMUM SYSTEM TESTS

3.9.1 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final Government test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the pre-Government test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

e. Carbon Monoxide Detector Tests: Carbon monoxide detectors must be tested in accordance with NFPA 72 and the manufacturer's recommended calibrated test method.

f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

h. Determine that the system is operable under trouble conditions as specified.

i. Visually inspect wiring.

j. Test the battery charger and batteries.

k. Verify that software control and data files have been entered or programmed into the FACU. Hard copy records of the software must be provided to the Contracting Officer.

l. Verify that red-line drawings are accurate.

m. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

n. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

o. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.

p. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

q. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.9.2 Audibility Tests

Sound pressure levels from audible notification appliances must be a minimum of 15 dBa over ambient with a maximum of 110 dBa in any occupiable area. The provisions for audible notification (audibility and intelligibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

3.10 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the Final Government Test.

[a. The drawings must be prepared electronically and sized no less than the contract drawings.][Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation] [AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide Operation and Maintenance (O&M) Instructions.

[In existing buildings, the transfer of devices from the existing system to the new system and the permission to begin demolition of the old fire alarm system will not be permitted until the as-built drawings and O&M manuals are received.]

3.11 INSTRUCTION OF GOVERNMENT EMPLOYEES

3.11.1 Instructor

Provide the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the operation, inspection, testing, and maintenance of the system provided. The instructor must train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm system. The instructor must be thoroughly familiar with all parts of this installation. The instructor must be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

3.11.2 Required Instruction Time

Provide [8][16][_____] hours of instruction after final acceptance of the system. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training must allow for rescheduling for unforeseen maintenance and/or fire department responses.

[3.11.2.1 Technical Training

Equipment manufacturer or a factory representative must provide [1][3][_____] days of on site[and 5 days of technical training to the Government at the manufacturing facility]. Training must allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises.[Factory training must occur within [6][12][_____] months of system acceptance.]

]3.11.3 Technical Training Manual

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training must familiarize designated government personnel with proper operation of the installed system. The maintenance training course must provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.12 EXTRA MATERIALS

3.12.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturer[s]. Installing fire alarm contractor is NOT responsible for any damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.12.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed system[s]. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the Government testing and must be accompanied by an inventory list.

3.12.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. Site-specific software data package

e. All documentation required by SD-06.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-28 31 76 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-28 31 00.00 10 (November 2008)
UFGS-28 31 49 (April 2006)
UFGS-28 31 63.00 20 (October 2007)
UFGS-28 31 64.00 10 (August 2009)
UFGS-28 31 74.00 20 (February 2010)
UFGS-28 31 76 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE

08/20

PART 2   PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-28 31 76 (August 2020)**

Preparing Activity: USACE

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References are in agreement with UMRL dated January 2025

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SECTION 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE

08/20

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NOTE: This specification covers the requirements for an addressable integrated fire detection, fire alarm evacuation and mass notification system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: For OCONUS projects, this specification section should be edited for specific Host Nation requirements. Coordinate compliance with Host Nation requirements with the Designated Fire Protection Engineer (DFPE).

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NOTE: For Family Housing projects at NAVFAC NE use regional guide specification section 28 31 46.00 22 (N-13854N) HOUSEHOLD FIRE WARNING EQUIPMENT to specify residential fire warning systems in lieu of this section.
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NOTE: This specification section includes requirements from UFC 3-600-01 (change 43, 7 February 2020)
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NOTE: This guide specification covers carbon monoxide alarm detectors for protection in indoor locations where fuel-burning appliances/equipment are used.
****

PART 1 GENERAL

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1. On the drawings, show location of control unit, batteries and charger (if remotely mounted), supervising station transceiver, annunciator, primary power supply, remote annunciator, detectors, notification appliances (unless performance requirements are specified), and each alarm initiating device including fire extinguishing system switches.

2. Show single-line fire alarm/mass notification systems riser diagram. Each device on the riser should be identified by type. Indicate connection of equipment.

3. A fire alarm operating matrix/mass notification system must be placed on the drawings. Show actions of input devices such as detectors, manual stations, waterflow switches, initiating devices, etc. on one axis and output functions such as door releases, smoke control fans, elevator relays, indicating/notification appliances etc. on the other. Entries which require descriptions, explanation of processes, sequences, interfaces, etc. can be flagged by symbols keyed to supplementary notes. Alternately provide a zone-by-zone sequence of operation or a schedule identifying all initiators, outputs, and interfaces.

4. Addressable Fire Alarm Systems generally utilize Signal Line Circuits (SLC) for communication between devices. Normally all devices are addressable or will have an addressable interface device installed integrally with the device. Initiating Device Circuits (IDC) should be provided for interfacing to existing IDC loops or connection between non-addressable devices and the SLC.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2020) American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A17.1/CSA B44	(2022) Safety Code for Elevators and Escalators

ASTM INTERNATIONAL (ASTM)

ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on

	Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 170	(2024; ERTA 1 2023) Standard for Fire Safety and Emergency Symbols

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-601-02	(2021) Fire Protection Systems Inspection, Testing, and Maintenance
UFC 4-010-06	(2023) Cybersecurity of Facility-Related Control Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices
47 CFR 90	Private Land Mobile Radio Services

UL SOLUTIONS (UL)

UL 228	(2006; Reprint Mar 2022) UL Standard for Safety Door Closers-Holders, With or Without Integral Smoke Detectors
UL 268	(2023) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Aug 2023) Smoke Detectors for Duct Application
UL 464	(2023) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 521	(2024) UL Standard for Safety Heat

	Detectors for Fire Protective Signaling Systems
UL 864	(2023; Reprint Oct 2024) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1480	(2023) UL Standard for Safety Speakers for Fire Alarm and Signaling Systems, Including Accessories
UL 1638	(2023) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Feb 2024) UL Standard for Safety Signaling Devices for the Deaf and Hard of Hearing
UL 2017	(2008; Reprint Jan 2024) UL Standard for Safety General-Purpose Signaling Devices and Systems
UL 2034	(2024; Reprint Aug 2024) UL Standard for Safety Single and Multiple Station Carbon Monoxide Alarms
UL 2075	(2013; Bul. 2019) UL Standard for Safety Gas and Vapor Detectors and Sensors
UL 2572	(2016; Bul. 2018) UL Standard for Safety Mass Notification Systems
UL Fire Prot Dir	UL Product IQ (updated online) at https://productiq.ulpropsector.com/en

1.2 RELATED SECTIONS

Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

[Section 21 13 13 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
][Section 21 30 00 FIRE PUMPS
][Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS
][Section 21 13 16 DRY PIPE FIRE SPRINKLER SYSTEMS
][Section 21 13 18 PREACTION FIRE SPRINKLER SYSTEMS
][Section 21 13 19 DELUGE FIRE SPRINKLER SYSTEMS
][Section 23 30 00 HVAC AIR DISTRIBUTION
][Section 21 13 24.00 10 AQUEOUS FILM-FORMING FOAM (AFFF) FIRE PROTECTION SYSTEM
][Section 21 13 25 HIGH-EXPANSION FOAM SYSTEM, FIRE PROTECTION

][Section 21 21 01 CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS
][Section 21 23 00 WET CHEMICAL FIRE EXTINGUISHING SYSTEMS
][Section 08 71 00 DOOR HARDWARE for [door release][door unlocking] and additional work related to finish hardware.
][Section[s] [14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS] [14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS] [and] [14 24 13 HYDRAULIC FREIGHT ELEVATORS] [14 24 23 HYDRAULIC PASSENGER ELEVATORS] for additional work related to elevators.
][Section 07 84 00 FIRESTOPPING for additional work related to firestopping.

]1.3 SUMMARY

1.3.1 Scope

a. This work includes designing and [providing a new, complete,][modifying the existing] fire alarm and mass notification (MNS) system as described herein and on the contract drawings[for the _____________]. Include system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, initiating devices, notification appliances, supervising station fire alarm transmitters/mass notification transceiver, and other accessories and miscellaneous items required for a complete operational system even though each item is not specifically mentioned or described. Provide system[s] complete and ready for operation.[Existing interior fire alarm system was manufactured by [_____].] Design and installation must comply with UFC 4-010-06.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 72, except as modified herein. [The system layout on the drawings show the intent of coverage and suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.]

[c. Each remote fire alarm control unit must be powered from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.

][d. Where a fire pump is provided, the fire alarm and mass notification system must monitor and transmit the fire pump controller signals in accordance with the provisions of NFPA 72.

][e. Where an emergency generator provides standby power supply for life safety system circuits, the generator must be monitored by the FMCU and transmit emergency generator signals in accordance with NFPA 72.

] f. The fire alarm and mass notification system must be independent of the building security, building management, and energy/utility monitoring systems other than for control functions.

1.3.2 Qualified Fire Protection Engineer (QFPE)

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NOTE: UFC 3-600-01 requires that shop drawings must bear the Review Stamp and professional engineering stamp of the QFPE prior to submission to the Government for approval.

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NOTE: The term Qualified Fire Protection Engineer (QFPE) should be considered interchangeable with the terms "Fire Protection Designer of Record (FPDOR)" or "Fire Protection QC Specialist" where referred to in other applicable contract documents. The intent of defining the QFPE roles and responsibilities here is NOT to require personnel in addition to the QFPE, FPDOR, or FPQC specialist referenced elsewhere in the applicable contract documents.

****

Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Construction (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Providing a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting any outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government [and final Government]functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions must be defined as follows:

1.4.1 Interface Device

An addressable device that interconnects hard wired systems or devices to an analog/addressable system.

1.4.2 Fire Alarm and Mass Notification Control Unit (FMCU)

A master control unit having the features of a fire alarm control unit (FACU) and an autonomous control unit (ACU) where these units are interconnected to function as a combined fire alarm/mass notification system. The FACU and ACU functions may be contained in a single cabinet or in independent, interconnected, and co-located cabinets.

1.4.3 Remote Fire Alarm and Mass Notification Control Unit

A control unit, physically remote from the fire alarm and mass notification control unit, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm and mass notification control unit.

1.4.4 Local Operating Console (LOC)

A unit designed to allow emergency responders or building occupants to operate the MNS including delivery of recorded messages or live voice announcements, initiate visual, textual visual, and audible appliance operation and other relayed functions.

1.4.5 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door where terminal strips are securely mounted inside the cabinet.

1.4.6 Control Module and Relay Module

Terms utilized to describe emergency control function interface devices as defined by NFPA 72.

1.4.7 Designated Fire Protection Engineer (DFPE)

The DoD fire protection engineer that oversees that Area of Responsibility for that project. This is sometimes referred to as the "cognizant" fire protection engineer. Interpret reference to "authority having jurisdiction" and AHJ in referenced standards to mean the Designated Fire Protection Engineer (DFPE). The DFPE may be responsible for review of the contractor submittals having a "G" designation, and for witnessing final inspection and testing.

1.4.8 Qualified Fire Protection Engineer (QFPE)

A QFPE is an individual who is a licensed professional engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES (or the particular specification section for submittal procedures in this project) and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving

authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the fire alarm designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their registered professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE will be returned by the Government disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G, [_____]

Fire alarm system designer; G, [_____]

Supervisor; G, [_____]

Technician; G, [_____]

Installer; G, [_____]

Test Technician; G, [_____]

Fire Alarm System Site-Specific Software Acknowledgement; G, [_____]

SD-02 Shop Drawings

Nameplates; G, [_____]

Instructions; G, [_____]

Wiring Diagrams; G, [_____]

System Layout; G, [_____]

Notification Appliances; G, [_____]

Initiating devices; G, [_____]

Amplifiers; G, [_____]

Battery Power; G, [_____]

Voltage Drop Calculations; G, [_____]

SD-03 Product Data

Fire Alarm and Mass Notification Control Unit (FMCU); G, [_____]

Local Operating Console (LOC); G, [_____]

Amplifiers; G, [_____]

Tone Generators; G, [_____]

Digitalized voice generators; G, [_____]

[Video Display Unit (VDU); G, [_____]

] LCD Annunciator; G, [_____]

Manual Stations; G, [_____]

Smoke Detectors; G, [_____]

Duct Smoke Detectors; G, [_____]

[Projected Beam Smoke Detector; G, [_____]

][Air sampling smoke detectors; G, [_____]

] Heat Detectors; G, [_____]

[Flame Detectors; G, [_____]

][Multi-Criteria Detectors; G, [_____]

] Carbon monoxide detector; G, [_____]

Addressable Interface Devices; G, [_____]

Addressable Control Modules; G, [_____]

Isolation Modules; G, [_____]

Notification Appliances; G, [_____]

Textual Display Sign Control Panel; G, [_____]

Textual Display Signs; G, [_____]

Batteries; G, [_____]

Battery Chargers; G, [_____]

[Supplemental Notification Appliance Circuit Panels; G, [_____]

][Auxiliary Power Supply Panels; G, [_____]

] Surge Protective Devices; G, [_____]

Alarm Wiring; G, [_____]

[Back Boxes and Conduit; G, [_____]

][Ceiling Bridges for Ceiling-Mounted Appliances; G, [_____]

] Terminal Cabinets; G, [_____]

Digital Alarm Communicator Transmitter (DACT); G, [_____]

[Automatic Fire Alarm Transmitters (including housing); G, [_____]

][Radio Transmitter and Interface Panels; G, [_____]

][Mass Notification Transceiver; G, [_____]

] Electromagnetic Door Holders; G, [_____]

Environmental Enclosures or Guards; G, [_____]

[Firefighter Telephone; G, [_____]

][Printer; G, [_____]

] Document Storage Cabinet; G, [_____]

SD-05 Design Data

[Air Sampling Smoke Detection System Calculations; G, [_____]

] SD-06 Test Reports

Test Procedures; G, [_____]

SD-07 Certificates

Verification of Compliant Installation; G, [_____]

Request for Government Final Test; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, [_____]

Instruction of Government Employees; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings

Spare Parts

1.6 SYSTEM OPERATION

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NOTE: Circuit wiring must be Class "B" unless Class "A" or "X" is required by the local installation and as permitted by NFPA 72 (SLC: "A", "B", or "X"; IDC and NAC: "A" or "B").

Circuits and pathways must have survivability levels as defined by NFPA 72.

****

Fire alarm system/mass notification system including textual display sign control panel(s), components requiring power, except for the FMCU(s) power supply, must operate on 24 volts DC unless noted otherwise in this section.

The interior fire alarm and mass notification system must be a complete, supervised, noncoded, analog/addressable fire alarm and mass notification system conforming to NFPA 72, UL 864, and UL 2572. Systems meeting UL 2017 only are not acceptable. The system must be activated into the alarm mode by actuation of an alarm initiating device. The system must remain in the alarm mode until the initiating device is reset and the control unit is reset and restored to normal. The system may be placed in the alarm mode by local microphones, LOC, FMCU, or remotely from authorized locations/users.

1.6.1 Alarm Initiating Devices and Notification Appliances (Visual, Voice, Textual)

a. Connect alarm initiating devices to initiating device circuits (IDC) [Class "A"][Class "B"], or to signaling line circuits (SLC) Class ["A"]["B"]["X"] and installed in accordance with NFPA 72.

b. Connect notification appliances to notification appliance circuits (NAC) [Class "A][Class "B"].

1.6.2 Functions and Operating Features

The system must provide the following functions and operating features:

a. Power, annunciation, supervision, and control for the system. Addressable systems must be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

b. Visual alarm notification appliances must be synchronized as required by NFPA 72.

c. Electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control unit.

d. An audible and visual trouble signal to activate upon a single break or open condition, or ground fault[(or short circuit for Class "X")]. The trouble signal must also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory control unit modules. After the system returns to normal operating conditions, the trouble signal must again sound until the trouble is acknowledged. A smoke detector in the process of being verified for the actual presence of smoke must not initiate a trouble condition.

e. A trouble signal silence feature that must silence the audible trouble signal, without affecting the visual indicator.

f. Program capability via switches in a locked portion of the FMCU to bypass the automatic notification appliance circuits, [fire reporting system][air handler shutdown][smoke control operation][elevator recall][door release][door unlocking] features. Operation of this programmed action must indicate on the FMCU display[and printer output] as a supervisory or trouble condition.[Notification appliance bypass must be selectable by floor.]

g. Alarm functions must override trouble or supervisory functions. Supervisory functions must override trouble functions.

h. The system must be capable of being programmed from the control unit keyboard. Programmed information must be stored in non-volatile memory.

i. The system must be capable of operating, supervising, and monitoring non-addressable alarm and supervisory devices.

j. There must be no limit, other than maximum system capacity, as to the number of addressable devices that may be in alarm simultaneously.

k. Where the fire alarm/mass notification system is responsible for initiating an action in another emergency control device or system, such as [HVAC,][atrium exhaust,][smoke control,][elevator recall,][releasing service,]the addressable fire alarm relay must be located in the vicinity of the emergency control device.

l. An alarm signal must automatically initiate the following functions:

(1) Transmission of an alarm signal to [the fire department][a remote supervising station].

(2) Visual indication of the device operated on the FMCU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

[(3) Record the event on the system printer.

] (4) Actuation of alarm notification appliances.

(5) Recording of the event electronically in the history log of the FMCU.

[(6) Release of doors held open by electromagnetic devices.

][(7) Operation of the [smoke control system][atrium exhaust system].

][(8) Release of power to electric locks (delayed egress locks) on doors that are part of the means of egress.

][(9) Elevator recall as described in this section.
]

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NOTE: Use this paragraph only where a detector or detection system is to release a special fire extinguishing system.

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[(10) Operation of [_____] must release the [_____] fire extinguishing system after a [_____] second time delay.

][(11) Operation of a sprinkler waterflow switch serving an elevator machinery room or elevator shaft must operate shunt trip circuit breaker(s) to shut down power to the elevators in accordance with ASME A17.1/CSA B44.

][(12) Operation of an interface that operates vibrating pagers worn by hearing-impaired occupants.

] m. A supervisory signal must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

[(2) Record the event on the system printer.

] (3) Transmission of a supervisory signal to [the fire department][a remote supervising station].

(4) Operation of a duct smoke detector must shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph and as allowed by NFPA 72.

(5) Recording of the event electronically in the history log of the FMCU.

n. A trouble condition must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU, [Video Display unit (VDU),] [and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor, zone or circuit, and type of device.]

[(2) Record the event on the system printer.

] (3) Transmission of a trouble signal to [the fire department][a remote supervising station].

(4) Recording of the event electronically in the history log of the FMCU.

[o. Activation of a carbon monoxide alarm initiating device must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU,[LCD, LED Display unit (VDU),][and on the [graphic][remote]annunciator].[Indication on the graphic annunciator must be by floor and room number, device address, and device type.]

(2) Transmission of a carbon monoxide alarm signal to [the fire department][a remote supervising station].

(3) Activation of all strobes and the audible carbon monoxide message throughout the building.

(4) Recording of the event electronically in the history log of the FMCU.

] p. System control equipment must be programmed to provide a 60-minute to 180-minute delay in transmission of trouble signals resulting from primary power failure.

[q. Activation of a LOC pushbutton must activate the audible and visual alarms in the facility. The audible message must be the one associated with the pushbutton activated.

][1.6.3 Elevator Recall

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NOTE: Delete this paragraph if no elevator work is included in the project.

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Provide elevator recall in accordance with ASME A17.1/CSA B44, Section [14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS][14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS][14 24 13 HYDRAULIC FREIGHT ELEVATORS][14 24 23 HYDRAULIC PASSENGER ELEVATORS], and as specified herein. Activation of any smoke detector in an elevator shaft, machine room, or lobby (except at designated recall level) must cause all elevators associated with that shaft, machine room, or lobby to return nonstop to the designated level. Activation of a smoke detector in the lobby or machine room at the designated level must cause all elevators associated with that lobby to return nonstop to the assigned alternate level. Activation of a detector in an elevator shaft, machine room, or lobby must also cause illumination of elevator cab warning signal (fire hat) and complete operation of fire alarm system as specified in paragraph titled "Functions and Operating Features".

]1.7 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The fire alarm system manufacturer must submit written confirmation of this contract provision as "Fire Alarm System Site-Specific Software Acknowledgement". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must also include the following:

a. Items identified in NFPA 72, titled "Site-Specific Software".

b. Identification of programmable portions of the system equipment and capabilities.

c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

d. Provision of operational software data on all modes of programmable portions for fire alarm and mass notification.

e. Description of Fire Alarm and Mass Notification Control Unit equipment operation.

f. Description of auxiliary and remote equipment operations.

g. Library of application software.

h. Operation and maintenance manuals.

[1.8 EXISTING EQUIPMENT

****

NOTE: If an addition to an existing fire alarm/mass notification system is required, the contract drawings or this section must include the make, model number, and other pertinent information of existing components that are to operate with the new equipment. Since new interfaces will have to be compatible with the existing system or to the central fire alarm reporting system, it may be necessary to edit major items out of this specification. If a new FMCU is required, it has to be compatible with the existing central fire alarm reporting system. When an existing system is to be expanded, show the following information on the contract drawings:

1. Manufacturer and model of existing control unit.

2. Number of existing initiating circuits (zones), notification appliance circuits, and control circuits served by the control unit.

3. Number of existing alarm notification appliances on the system.

4. Total calculated current draw of all devices served by each existing standby battery under both supervisory (standby) and alarm conditions, including NAC/extender control units and subcontrol units.

5. Ampere-hour rating and type of each existing battery.

****

a. Equipment and devices must be compatible and operable with the existing fire alarm/mass notification system and must not impair reliability or operational functions of existing supervising station fire alarm system.[The proprietary type supervising station (PSS) is located [in Building [_____].][_____].][The supervising equipment is existing and consists of the following brands and models: [supervising station control unit [_____].][_____][signal reporting components [_____]], [annunciator [_____]][_____]].

[b. Equipment and devices must be compatible and operable with the existing building fire alarm/mass notification system. Equipment must not impair reliability or operational functions of the existing system. The existing building system control unit is [_____].

] c. Equipment and devices must be compatible and operable with the existing installation-wide mass notification system and must not impair reliability or operational functions of the existing system. The installation-wide mass notification system utilizes [_____] transceivers.

]1.9 QUALITY ASSURANCE

1.9.1 Submittal Documents

1.9.1.1 Preconstruction Submittals

Within 36 days of contract award but not less than [14 days][_____] prior to commencing any work on site, the Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE must be returned disapproved without review. All resultant delays must be the sole responsibility of the Contractor.

1.9.1.2 Shop Drawings

Shop drawings must not be smaller than [ISO A1][ANSI D][the Contract Drawings]. Drawings must comply with the requirements of NFPA 72 and NFPA 170. Minimum scale for floor plans must be 1/8"=1'.

1.9.1.3 Nameplates

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

1.9.1.4 Wiring Diagrams

[_____] copies of point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote FMCU, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

1.9.1.5 System Layout

[_____] copies of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors. Indicate candela rating of each visual notification appliance. Indicate the wattage of each speaker. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, and similar. Show/identify all acoustically similar spaces. Indicate if the environment for the FMCU is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format similar to the "Typical Input/Output Matrix" included in the Annex of NFPA 72.

[For air sampling smoke detection systems, provide floor plan layouts indicating location of fire alarm control unit, air sampling piping (lengths of pipe) and sampling ports (sizes and locations). Floor plan must also indicate geographic monitor zone boundaries, location of display control unit, bar level annunciation panels if separate, and all other associated equipment that is required to provide a complete operational system.

]1.9.1.6 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.9.1.7 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least [25][_____] percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.9.1.8 Amplifiers

Calculations and supporting data to indicate that amplifiers have sufficient capacity to simultaneously drive all notification speakers at tapped settings plus [25][_____] percent spare capacity. Annotate data for each circuit on the drawings.

1.9.1.9 Battery Power

Calculations and supporting data as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.9.1.10 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.9.1.11 Product Data

[_____] copies of annotated descriptive data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, and options that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

[1.9.1.12 Air Sampling Smoke Detection System Calculations

Submit air sampling detection system design analysis calculations consisting of battery capacity, loading calculations, and fan speed and air flow/transport calculations. Include schematic diagrams showing pipe segments, pipe diameters, lengths of pipe, node numbers, and sample port diameters to verify the requirements are met.

]1.9.1.13 Operation and Maintenance (O&M) Instructions

[Six][_____] copies of the Operation and Maintenance Instructions. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions must include the following:

a. "Manufacturer Data Package [five][_____]" as specified in [Section 01 78 23 OPERATION AND MAINTENANCE DATA][_____].

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. Complete procedures for system revision and expansion, detailing both equipment and software requirements.

e. Software submitted for this project on CD/DVD media utilized.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices, testing frequencies, and similar) must comply with UFC 3-601-02.

h. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

1.9.1.14 As-Built Drawings

The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of the as-built (marked-up) drawings must be provided at the time of, or prior to the final Government test.

1.9.2 Qualifications

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NOTE: NICET (National Institute for Certification in Engineering Technologies) establishes the qualifications of an individual as an Engineering Technologist with verification of experience by having a current NICET certification.

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1.9.2.1 Fire Alarm System Designer

The fire alarm system designer must be certified as a Level [III][IV] (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology or meet the qualifications for a QFPE.

1.9.2.2 Supervisor

[A NICET Level [III][or][IV] fire alarm technician must supervise the installation of the fire alarm/mass notification system[, including the air sampling smoke detection system].][A fire alarm technician with a minimum of eight years of experience must supervise the installation of the fire alarm/mass notification system.] The fire alarm technicians supervising the installation of equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.9.2.3 Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings[, and must be thoroughly experienced in the installation of air sampling detection systems].

1.9.2.4 Installer

[Fire alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm/mass notification devices, cabinets and control units] [NICET Level II technician to assist in the installation of fire alarm/mass notification devices, cabinets and control units]. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the fire alarm system/mass notification system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.9.2.5 Test Technician

Fire alarm technicians with a minimum of eight years of experience and NICET Level [III][or][IV] utilized in testing and certification of the installation of the fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians testing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment installed as part of this project.

1.9.2.6 Manufacturer

Components must be of current design and must be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as specified herein.

1.9.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation must be considered as mandatory requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.11 MAINTENANCE

1.11.1 Spare Parts

Furnish the following spare parts in the manufacturers original unopened containers:

a. [Five][_____] complete sets of system keys.

b. [Two][_____] of each type of fuse required by the system.

c. [One][_____] manual stations.

[d. [Two][_____] of each type of detector installed.

] e. [Two][_____] of each type of detector base and head installed.

[f. [One][_____] electromagnetic door holders.

][g. One smoke detector manufacturer's test screen, card or magnet for each ten beam smoke detectors, or fraction thereof, installed in the system.

][h. Two air sampling smoke detection system filter assemblies.

] i. [Two][_____] of each type of audible and visual alarm device installed.

j. [One][_____] textual visual notification appliance.

k. [Two][_____] of each type of addressable monitor module installed.

l. [Two][_____] of each type of addressable control module installed.

m. [Two][_____] low voltage, [one][_____] [telephone][internet][ethernet], and [one][____] 120 VAC surge protective device.

[n. [Two][_____] spare reams of paper for the system printer, plus sufficient paper for testing.

][o. [Two][_____] spare printer ribbons.

]1.11.2 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment must be furnished to the Contracting Officer, prior to the instruction of Government employees.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENT

All fire alarm and mass notification equipment must be listed for use under the applicable reference standards. Interfacing of UL 864 or similar approved industry listing with Mass Notification equipment listed to UL 2572 must be done in a laboratory listed configuration, if the software programming features cannot provide a listed interface control.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory and listed for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least [2][_____] years prior to bid opening.

2.2.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FMCU

Nameplates must be etched metal or plastic, permanently attached by screws to control units or adjacent walls.

2.2.3 Keys

Keys and locks for equipment, control units and devices must be identical. [Master all keys and locks to a single key as required by the [Installation Fire Department][_____]]. [Keys must be CAT [60][_____].]

2.2.4 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. [Install the instructions on the interior of the FMCU.][Install the frame in a conspicuous location observable from the FMCU.] The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must also include procedures for operating live voice microphones. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.3 FIRE ALARM AND MASS NOTIFICATION CONTROL UNIT

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NOTE: The control unit must be located in an air conditioned space where the ambient temperature is maintained between 15 and 27 degrees C 60 and 80 degrees F.

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Provide a complete fire alarm and mass notification control unit (FMCU) fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care, maintenance, and use of the system must be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control unit, the unit cabinets must match exactly.[If more than a single unit is required, and is located in the lobby/entrance, notify the Contracting Officer's Designated Representative (COR), prior to installing the equipment.] The system must be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation.

a. Each control unit must provide power, supervision, control, and logic for the entire system, utilizing modular components, internally mounted and arranged for easy access. Each control unit must be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each control unit with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the FMCU must be by liquid crystal display or similar means with a minimum of 80 characters. The mass notification control unit must have the capability of temporarily deactivate the fire alarm audible notification appliances while delivering voice messages.

c. Provide secure operator console for initiating recorded messages, strobes and displays; and for delivering live voice messages. Provide capacity for at least eight prerecorded messages. Provide the ability to automatically repeat prerecorded messages. Provide a secure microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification, initiate/synchronize strobes and initiate textual visual notification appliances. Provide a complete set of self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file.

2.3.1 Cabinet

Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and [surface][semi-recessed] mounting provisions. The enclosure must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must say "Fire Alarm and Mass Notification control unit" and must not be less than 25 mm 1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches.

2.3.2 Silencing Switches

2.3.2.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FMCU that must silence the audible and visual notification appliances. Subsequent activation of initiating devices must cause the notification appliances to re-activate.

2.3.2.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch(es) that must silence the audible trouble and supervisory signal(s), but not extinguish the visual indicator. This switch must be overridden upon activation of a subsequent supervisory or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated if the supervisory or trouble condition still exists.

2.3.3 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Initiating devices must be manually reset by switch from the FMCU after the initiating device or devices have been restored to normal.

2.3.4 Audible Notification System

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NOTE: Use the proper bracketed item depending upon whether the fire alarm system is to cause total evacuation upon an alarm.

****

The Audible Notification System must comply with the requirements of NFPA 72 for Emergency Voice/Alarm Communications System requirements, except as specified herein. The system must be a one-way, multi-channel voice notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of recorded messages. Audible appliances must produce a three-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced. For carbon monoxide detector activation, audible appliances must produce a four-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced. Automatic messages must be broadcast through speakers throughout the building/facility but not in stairs or elevator cabs. A live voice message must override the automatic audible output through use of a microphone input at the control unit or the LOC.

a. When using the microphone, live messages must be broadcast [throughout a selected floor or floors,][selectable by zone,] or all call. The system must be capable of operating all speakers at the same time. [The Audible Notification System must support Public Address (PA) paging for the facility.][This must be accomplished with the provision of a separate microphone with a head unit that interfaces with the FMCU. The public address paging function must not override any fire alarm or mass notification functions. The microphone must be [desktop][hand-held][_____] style. Hand-held microphones must be housed in a separate protective cabinet. The cabinet must be accessible without the use of a key. The location of the microphone(s) must be approved by the [_____] Designated Fire Protection Engineer (DFPE).] Activation of the public address microphone must not initiate activation of visual notification appliances or LED text displays.

b. The microprocessor must actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative must automatically cause the three-pulse temporal pattern to take over all functions assigned to the failed unit in the event an alarm is activated.

2.3.4.1 Outputs and Operational Modules

All outputs and operational modules must be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form "C" contacts for system alarm and trouble conditions. Provide circuits for operation of auxiliary appliance during trouble conditions. During a Mass Notification event, the control unit must not generate nor cause any trouble alarms to be generated with the Fire Alarm system.

2.3.4.2 Mass Notification

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NOTE: The specification writer must comply with the requirements of UFC 4-021-01 and must use messages approved for each specific installation since risks are different at each and every installation.

These message that follow are suggestions for use in the event that installation specific messages are not available.

****

a. The system must have the capability of utilizing an LOC with redundant controls of the FMCU. Notification Appliance Circuits (NAC) must be provided for the activation of strobe appliances. Audio output must be selectable for line level. A hand-held microphone must be provided and, upon activation, must take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC circuit activation.

b. The Mass Notification functions must override the manual or automatic fire alarm notification,[and public address (PA) functions]. Other fire alarm functions including transmission of a signal(s) to the fire department must remain operational. When a mass notification announcement is disengaged and a fire alarm condition still exists, the audible and visual notification appliances must resume activation for alarm conditions. The fire alarm message must be of lower priority that all other messages (except any "test" messages) and must not override any other messages. If not manually ended, any mass notification announcement will automatically end after 10 minutes.

****

NOTE: Include ALL installation specific messages in this section.

****

[c. Messages must be recorded professionally utilizing standard industry methods, in a professional [male][female] voice. Message and tone volumes must both be at the same decibel level. Messages recorded from the system microphone must not be accepted. A 1000 Hz tone (as required by NFPA 72) must precede messages and be similar to the following unless Installation or Facility specific messages are required:

(1) "May I have your attention please. May I have your attention please. [Insert installation specific message here.]" (Provide a [2][_____] second pause.) "May I have your attention please, (repeat the tones and message [on a continuous loop][[_____] times]).

(2) Carbon Monoxide: "May I have your attention please. May I have your attention please. Carbon monoxide has been detected in the building. Please walk to the nearest exit and leave the building." (Provide a [2][_____] second pause.) "May I have your attention please, (repeat the tones and message [on a continuous loop][[_____] times])."

(3) Fire: "May I have your attention please. May I have your attention please. A fire emergency has been reported in the building. Please leave the building by the nearest exit[or exit stairway].[Do not use the elevators.]" (Provide a [2][_____] second pause.) "May I have your attention please, (repeat the tones and message on a continuous loop)."

(4) Test: "May I have your attention please. May I have your attention please. This is a test of the building mass notification system. Please continue your normal duties. This is only a test." (Provide a [2][_____] second pause.)

(5) All Clear: "May I have your attention please. May I have your attention please. An all clear has been issued, resume normal activities." (Provide a [2][_____] second pause.)

] d. Auxiliary Input Module must be designed to be an outboard expansion module to either expand the number of optional LOC's, or allow a telephone interface.

[2.3.4.3 Installation-Wide Control

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NOTE: Show on the contract drawings the manufacturer make and model number of any existing installation-wide control system to facilitate communications with the system being specified in this section.

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If an installation-wide control system for mass notification exists on the Base, the autonomous control unit must communicate with the central control unit of the Installation-wide system. The autonomous control unit must receive commands/messages from the central control unit and provide status information.

]2.3.5 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices must not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.3.6 Field Programmability

Provide control units and control units that are fully field programmable for both input and output of control, initiation, notification, supervisory, and trouble functions. The system program configuration must be menu driven. System changes must be password protected. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system must be provided as part of this contract.

2.3.7 Input/Output Modifications

The FMCU must contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features must consist of a control unit mounted keypad[and a keyboard]. Any bypass or modification to the system must indicate a trouble condition on the FMCU.

2.3.8 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.3.9 Walk Test

The FMCU must have a walk test feature. When using this feature, operation of initiating devices must result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated in the history log[and on the system printer], but no other outputs occur.

2.3.10 History Logging

The control unit must have the ability to store a minimum of 400 events in a log. These events must be stored in a battery-protected memory and must remain in the memory until the memory is downloaded or cleared manually. Resetting of the control unit must not clear the memory.

2.3.11 Manual Access

An operator at the control unit, having a proper access level, must have the capability to manually access the following information for each initiating device.

a. Primary status.

b. Device type.

c. Present average value.

d. Present sensitivity selected.

e. Detector range (normal, dirty).

[2.3.12 Heat Detector Self-Test Routines

Automatic self-test routines must be performed on each detector that will functionally check detector sensitivity electronics and ensure the accuracy of the value being transmitted. Any detector that fails this test must indicate a trouble condition with the detector location at the control unit.

]2.4 LOCAL OPERATING CONSOLES (LOC)

2.4.1 General

The LOC must consist of a remote microphone station incorporating a push-to-talk (PTT) hand-held microphone and system status indicators. The LOC must have the capability of being utilized to activate prerecorded messages. The unit must incorporate microphone override of any tone generation or recorded messages. The unit must be fully supervised from the FMCU. The housing for the LOC must not be lockable.[The LOC must have public address capability with the provision of a separate microphone. The PA paging function must not override any alarm or notification functions. The PA microphone must be [desktop][hand-held][_____] style. Hand-held microphones must be housed in a separate protective cabinet. The cabinet must be accessible without the use of a key. The location of the microphone[s] must be approved by the [_____] Designated Fire Protection Engineer (DFPE). Activation of the PA microphone must not initiate activation of visual notification appliances or LED text displays. The PA paging function must not override any alarm or notification functions.]

2.4.2 Multiple LOCs

When an installation has more than one LOC, the LOCs must be programmed to allow only one LOC to be available for paging or messaging at a time. Once one LOC becomes active, all other LOC's will have an indication that the system is busy (Amber Busy Light) and cannot be used at that time. This is to avoid two messages being given at the same time. It must be possible to override or lockout the LOC's from the FMCU.

2.5 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS

Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 must be housed in a remote FMCU, terminal cabinet, or in the FMCU. Individual amplifiers must be 100 watts maximum.

2.5.1 Operation

The system must automatically operate and control all building speakers[except those installed in the stairs][and within elevator cabs].[The speakers in the stairs[and elevator cabs] must operate only when the microphone is used to deliver live messages.]

2.5.2 Construction

Amplifiers must utilize computer grade components and must be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

2.5.3 Inputs

Equip each system with separate inputs for the tone generator, digitalized voice driver and control unit mounted microphone [Public Address Paging Function]. Microphone inputs must be of the low impedance, balanced line type. Both microphone and tone generator input must be operational on any amplifier.

2.5.4 Tone Generator

The tone generator must produce a three-pulse temporal pattern and must be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator must be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay. The tone generator must be provided with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces.

2.5.5 Protection Circuits

Each amplifier must be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component must cause illumination of a visual "amplifier trouble" indicator on the control unit, appropriate logging of the condition in the history log[and on the system printer], and other actions for trouble conditions as specified.

[2.6 VIDEO DISPLAY UNIT (VDU)

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NOTE: Contact the DFPE to determine if a VDU is to be provided.

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a. The VDU must be the secondary operator-to-system interface for data retrieval, alarm annunciation, commands, and programming functions.

The desk mounted VDU must consist of a LCD monitor and a keyboard. The VDU must have a [300][430][_____]-mm [12][17][_____]-inch minimum [touch]screen, capable of displaying 25 lines of 80 characters each. Communications with the FMCU must be supervised. Faults must be recorded in the history log[and on the printer]. Power required must be 120 VAC, 60 Hz from the same source as the FMCU.

b. To eliminate confusion during an alarm situation, the screen must have dedicated areas for the following functions:

  (1) Alarm and return to normal.

  (2) Commands, reports, and programming.

  (3) Time, day, and date.

c. Use full English language throughout to describe system activity and instructions. Full English language descriptors defining system points must be 100 percent field programmable by factory trained personnel, alterable and user definable to accurately describe building areas.

d. Alarms and other changes of status must be displayed in the screen area reserved for this information. Upon receipt of alarm, an audible alarm must sound and the condition and point type must flash until acknowledged by the operator. Return to normal must also be annunciated and must require operator acknowledgment. The following information must be provided in full English:

  (1) Condition of device (alarm, trouble, or supervisory).

  (2) Type of device (for example, manual pull, waterflow)

  (3) Location of device plus numerical system address.

e. The system must have multiple levels of priority for displaying alarms to conform with UL 864. Priority levels must be as follows:

  (1) Level 1 - Mass Notification Signals

  (2) Level 2 - Fire Alarm Signals

  (3) Level 3 - Carbon Monoxide Alarm Signals

  (4) Level 4 - Supervisory Signals

  (5) Level 5 - Trouble Signals

f. Provide the system with memory so that no alarm is lost. A highlighted message must advise the operator when unacknowledged alarms are in the system.

g. Multiple levels of access must be provided for operators and supervisors via user-defined passwords. Provide the following functions for each level:

  (1) Operator level access functions:

    (a) Display system directory, definable by device.

(b) Display status of an individual device.

(c) Manual command (alarm device with an associated command must use the same system address for both functions).

(d) Report generation, definable by device, output on the VDU[or printer], as desired by the operator.

(e) Activate building notification appliances.

(2) Supervisor level access functions:

(a) Reset time and date.

(b) Enable or disable event initiated programs[, printouts,] and initiators.

(c) Enable or disable individual devices and system components.

h. The above supervisor level functions must not require computer programming skills. Changes to system programs must be [recorded on the printer and]maintained in the control unit as a trouble condition.

]2.7 REMOTE ANNUNCIATOR

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NOTE: Provide the annunciator at a location in accordance with NFPA 72. A suggested location should be near the door through which the first responders will enter the building as indicated in their pre-fire plan, typically the main entrance.

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[2.7.1 LCD Annunciator

Provide a [semi-recessed][flush] mounted annunciator that includes an LCD display. The display must indicate the device in trouble/alarm or any supervisory device. Display the device name, address[, and actual building location]. The remote annunciator must duplicate functions of the FMCU for message display, fire alarm, supervisory alarm, and trouble conditions, visual and audible notification, and system reset functions. Remote annunciator must require the use of a key for accessing the reset, control and other functions.

A building floor plan must be provided and mounted (behind Plexiglass or similar protective material) at the annunciator location. The floor plan must indicate all rooms by name and number including the locations of stairs and elevators. The floor plan must show all devices and their programmed address to facilitate identification of their physical location from the LCD display information.

][2.7.2 Graphic Annunciator

****

NOTE: Graphic annunciators should be provided only when a large number of concealed devices are installed. Normally, exposed devices will be annunciated by zone only on the fire alarm control unit zone annunciator and remote zone annunciator.

Edit accordingly. Locate graphic annunciator(s) at or near building entrance to allow fire department quick access to the annunciator.

****

Graphic annunciator must be of the [interior][weatherproof] type, [flush][surface][pedestal]-mounted. Annunciator must be provided with the [building][room] floor plan, drawn to scale, with alarm lamps mounted to represent the location of [each concealed detector][each initiating device]. Annunciator graphic must also show the locations of the annunciator and control unit, and must have a "you are here" arrow showing its location. Orient building floor plan on graphic to location of person viewing the graphic(i.e., the direction the viewer is facing must be toward the top of the graphic display). Provide a North arrow.[Principal rooms and areas shown must be labeled with room numbers or titles.] Detectors mounted above ceilings, [on ceilings,]and beneath raised floors and different types of initiating devices must have different symbols or lamps of different colors for identification. Lamps must illuminate upon activation of corresponding device and must remain illuminated until the system is reset. Annunciator must have a lamp test switch.

2.7.2.1 Materials

Construct the graphic annunciator face plate of [smoked Plexiglas][non-glare matte finish][anodized bronze][anodized aluminum]. The face plate must be backlit with LEDs. Control equipment and wiring must be housed in a [recessed][semi-recessed][surface mounted] back box. The exposed portions of the back box must be [chrome plated][anodized bronze][anodized aluminum] without knockouts.

2.7.2.2 Programming

Where programming for the operation of the graphic annunciator is accomplished by a separate software program other than the software for the FMCU, the software program must not require reprogramming after loss of power. The software must be reprogrammable in the field.

][2.7.3 Printer

****

NOTE: If the printer will be located in a SCIF or similar area, specify "no stored memory".

****

a. Provide a system printer [with no stored memory] to record alarm, supervisory, and trouble conditions without loss of any signal or signals. Printout must be by circuit, device, and function as provided in the FMCU. Printer must operate on a 120 VAC, 60 Hz power supply.

b. The printer must have at least 80 characters per line and have a 96 ASCII character set. The printer must have a microprocessor-controlled, bi-directional, logic seeking head capable of printing 120 characters per second utilizing a 9 by 7 dot matrix print head. Printer must not contain internal software which is essential for proper operation.

c. When the FMCU receives a signal, the alarm, supervisory, and trouble condition must be printed. The printout must include the type of signal, the circuit or device reporting, the date, and the time of the occurrence. The printer must differentiate alarm signals from other printed indications. When the system is reset, this condition must also be printed including the same information concerning device, location, date, and time. Provide a means to automatically print a list of existing alarm, supervisory, and trouble conditions in the system. If a printer is off-line when an alarm is received, the system must have a buffer to retain the data and it must be printed when the printer is restored to service. The printer must have an indicator to alert the operator that the paper has run out.

]2.8 MANUAL STATIONS

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NOTE: Architectural Barriers Act (ABA) requires that manual alarm stations be mounted at a maximum of 1.1 m 48 inches above finished floor (AFF).

Designer to determine if single-action manual pull stations are permitted to be used when requested on a project

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Provide metal or plastic, [semi-flush][flush][surface] mounted,double-action, addressable manual stations, that are not subject to operation by jarring or vibration.[Provide separately addressed conventional single-action manual pull stations[in hazardous locations,][in wet and damp locations,][and][where indicated on plans].]Stations must be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations must be finished in red with molded raised lettering operating instructions of contrasting color. The use of a key must be required to reset the station.

2.9 SMOKE DETECTORS

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NOTE: Provide smoke detectors only in spaces where they are specifically required by UFC 3-600-01, DESIGN: FIRE PROTECTION ENGINEERING FOR FACILITIES.

Smoke detectors provided in elevator machinery rooms are to be provided per requirements of UFC 3-600-01. Coordinate with Section 14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS, Section 14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS , Section 14 24 13 HYDRAULIC FREIGHT ELEVATORS, Section 14 24 23 HYDRAULIC PASSENGER ELEVATORS.

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2.9.1 Spot Type Detectors

Provide addressable [photoelectric][ionization][laser] smoke detectors as follows:

a. Provide analog/addressable [photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268][smoke detectors that operate on the ionization principle and are actuated by the presence of visible or invisible products of combustion][laser smoke detectors utilizing laser diode and patented smoke sensing chamber, designed to amplify signals from smoke but diminish stray internal reflections and must, on command from the FMCU, send data to the control unit representing the analog level of smoke density]. Smoke detectors must be listed for use with the FMCU.

b. Provide self-restoring type detectors that do not require any readjustment after actuation at the FMCU to restore them to normal operation. The detector must have a visual indicator to show actuation.

c. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases [with sounder that produces a minimum of 90 dBA at 3 m 10 feet] with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.

e. The detector address must identify the particular unit, its location within the system[, and its sensitivity setting]. Detectors must be of the low voltage type rated for use on a 24 VDC system.

[f. Laser smoke detector must be listed for use with the FMCU. Detector must be able to achieve sensitivities from 0.02 percent-per-foot to 2 percent-per-foot obscuration.

g. Laser smoke detector must provide point identification of the fire location through addressability, must experience no delay in response time due to smoke dilution or smoke transportation time, and must offer complete supervision of wiring and detector.

][2.9.2 Projected Beam Smoke Detector

Detectors must consist of [combined transmitter and receiver unit] [separate transmitter and receiver units]. The transmitter unit must emit an infrared beam to the receiver unit [the use of a supplied reflector is required for the combined unit]. When the signal at the receiver falls below a preset threshold, the detector must initiate an alarm. The receiver must contain an LED status indicator that illuminates when an alarm condition exists. Long-term changes to the received signal caused by environmental variations must be automatically compensated. Detectors must incorporate features to assure that they are operational; a trouble signal must be initiated if the beam is obstructed for more than 3 seconds, the limits of the compensation circuit are reached, or the housing cover is removed. Detectors must have multiple sensitivity settings in order to meet UL listings for the different distances covered by the beam.

]2.9.3 Duct Smoke Detectors

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NOTE: The requirements for Duct Detectors will be coordinated with the HVAC requirements and Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. All required duct detectors will be shown on the contract drawings.

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Duct-mounted addressable photoelectric smoke detectors must consist of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct.[It is not permitted to cut the duct insulation to install the duct detector directly on the duct.] Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the FMCU.

a. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the FMCU.

b. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote indicators must be provided where required by NFPA 72. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.

c. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 00 to INSTRUMENTATION AND CONTROL FOR HVAC. Auxiliary contacts provide for this function must be located within 1 m 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

[2.10 AIR SAMPLING SMOKE DETECTION SYSTEM

The [addressable]air sampling smoke system must consist of a detector assembly housing an integral aspiration fan, filter, laser-based detection chamber and control, output and supervision circuitry.[Each sampling point must be capable of being independently addressable.] The system must consist of a piping or tubing distribution network that runs from the detector assembly(s) to the protected area(s) and is supported by air sampling smoke detection system calculations from a computer-based design modeling tool. The system must include configurable alarm and trouble relay outputs for interface to other systems where required.

a. System must be complete in all ways. It must include all engineering, and electrical installation, all detection and control equipment, auxiliary devices and controls, alarm interface, functional checkout and testing, training and all other operations necessary for a functional system.

b. System base detectors and modules must each accommodate up to [40 addressable][_____] microbore sampling tubes where each tube has a sampling point at the end. Additional modules may be used to provide up to [20 addressable][_____] sampling holes per system.

c. Program alarm thresholds to the following values unless the results of the pre-Government system tests indicate a clear need to change them. In the event that such a need is indicated, notify the Contracting Officer and provide complete documentation concerning the need to deviate from these values. Include within the deviation documentation request, information that complies with the paragraph entitled "Sensitivity Verification Test". Ensure initial threshold levels are approved prior to the Government test.

(1) Alarm Level 1: set ALERT at [_____][0.0250] percent

obscuration/foot

(2) Alarm Level 2: set PRE-ALARM at [_____][0.0500] percent obscuration/foot

(3) Alarm Level 3: set FIRE 1 at [_____][0.1000] percent obscuration/foot

(4) Alarm Level 4: set FIRE 2 at [_____][0.2000] percent obscuration/foot

d. All air sampling smoke detection devices and associated components must be new, standard products or the manufacturer's latest design and suitable to perform the functions intended.

e. The laser detection chamber must be of the mass light scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method must be employed for the purposes of:

(1) Preventing large particles from affecting the true smoke reading.

(2) Monitoring contamination of the filter (for example, dust and dirt) to automatically notify when maintenance is required. The particle counting method must not be used for the purpose of smoke density measurement.

f. Detector(s) must be self-monitoring for filter contamination and provide indication through system fault when replacement is necessary. Detectors which allow automatic reset of filter status upon removal and re-insertion are not permitted.

g. Detector(s) must contain relays for alarm and fault conditions. The relays must be software programmable to the required functions.

h. Detector(s) must permit configuration by programmers that are either integral to the system, portable or PC based.

i. Detector(s) must allow programming of:

(1) Smoke threshold alarm levels; ALERT, PRE-ALARM, FIRE 1 and FIRE 2.

(2) Time delays. Ensure the display control unit contains individual adjustable alarm time delay features for each of the alarm threshold levels. Provide an adjustment range between 0 and 60 seconds. Program the alarm threshold time delays to 30 seconds for alarm levels 1 and 2, and 15 seconds for alarm levels 3 and 4.

(3) Faults, including airflow, detector, power, filter and network, as well as an indication of the urgency of the fault.

(4) Configuration of relay outputs for remote indication of alarm and fault conditions.

(5) General purpose input functionality.

]2.11 HEAT DETECTORS

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NOTE: Heat detectors provided in elevator machinery rooms are strictly for the warning sign in the elevator cab and must not alarm the FMCU. Coordinate with Section 14 21 13 ELECTRIC TRACTION FREIGHT ELEVATORS, Section 14 21 23 ELECTRIC TRACTION PASSENGER ELEVATORS , Section 14 24 13 HYDRAULIC FREIGHT ELEVATORS, Section 14 24 23 HYDRAULIC PASSENGER ELEVATORS.

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2.11.1 Heat Detectors

Heat detectors must be analog/addressable and designed for detection of fire by [fixed temperature][combination fixed temperature and rate-of-rise principle][rate-compensating principle] in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values.. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations [as defined by NFPA 70][and][as indicated], must be types approved for such locations.

[2.11.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-resetting. Detector must operate at [57.2][90] degrees C[135][194] degrees F. Detector must feature rate compensation. [Detectors rated to operate at 57.2 degrees C135 degrees F must not respond to momentary temperature fluctuations less than 16.7 degrees C30 degrees F per minute between 16 and 38 degrees C60 and 100 degrees F].[Detectors rated to operate at 90 degrees C194 degrees F must not respond to momentary temperature fluctuations less than 27.8 degrees C 50 degrees F per minute between 16 and 66 degrees C60 and 150 degrees F.][The detector assembly must be [weatherproof][and][explosionproof].]

][2.11.1.2 Rate Compensating Detectors

Detector backbox must be [surface][flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring and hermetically sealed.[The detector assembly must be [weatherproof][and][explosionproof].]

][2.11.1.3 Line-Type Fixed Temperature Detectors

****

NOTE: Specify line-type heat detectors only with approval of the EFD/EFA Fire Protection Engineer.

****

Provide [thermostatic][or][thermistor] line-type heat detection cable [with weather-resistant outer covering] where indicated. Cable must be nominally rated for a temperature of [68][88][138] degrees C [155][190][280] degrees F and must operate on fixed temperature principle only.

][2.11.1.4 Fixed Temperature Detectors

Detectors must be [surface][semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. The detectors must have a specific temperature setting [of [57.2][_____] degrees C [135][_____] degrees F][as shown].[The detector assembly must be [weatherproof][and][explosionproof].]

][2.12 FLAME DETECTORS

****

NOTE: Modify these paragraphs as necessary to indicate that detectors placed in an explosive environment will be approved for use in the appropriate class, division, and group environment as defined in NFPA 70 and as shown on drawings.

****

Detectors must be sensitive to the micron range best suited for their intended use. Detectors must operate over electrically supervised wiring circuits and the loss of power to the detector must result in a trouble signal. A self-test feature must be provided for each detector to be individually tested.

[2.12.1 Infrared (IR) Single Frequency Flame Detector

****

NOTE: The single frequency IR flame detector has the advantage of a fast response and is moderately sensitive. Its disadvantages are being affected by temperature extremes and being subject to false alarms from a myriad of IR sources.

****

The detector must be sensitive in the range of [_____] to [_____] micrometers only.

][2.12.2 Infrared (IR) Multi Frequency Flame Detector

****

NOTE: The IR multi frequency flame detector has the advantages of a moderately fast response, moderate sensitivity, and a lower false alarm rate. Its disadvantage is being affected by temperature extremes.

****

The IR detector must consist of three or more IR sensors, each selected for a different IR frequency. The primary sensor must be sensitive in the range of [_____] to [_____] micrometers only. Secondary sensors are tuned to different IR wavelengths to null out the effect of black body radiation to the primary sensor.

][2.12.3 Ultraviolet (UV) Flame Detectors

****

NOTE: Ultraviolet (UV) flame detectors can be set to respond accurately to UV wavelength light produced by flame from both indoors and outdoors. UV flame detectors operate on the Geiger-Muller principle. These gas-filled vacuum tubes respond in the UV portion of the spectrum but can ignore UV radiation from the sun because the upper response

range of the detector falls below the range of UV radiation that reaches the earth.

Solid-state UV detectors are available, but their spectral response extends into the sun's UV range and are not recommended for external use.

UV detectors have an 80 to 90 degree cone of vision. The UV detector has a fast response time and usually is not affected by rain, wind, snow, high humidity, or temperature and pressure extremes. UV units will produce false alarms if they are exposed to arc welding or X-ray and gamma radiation. They can also be blinded by oil film or smoke. UV flame detectors that are used in dirty and dusty environments should be equipped with automatic self-test and self-cleaning devices. The cleaning device uses a stream of clean air across the lens surface to minimize the build-up of contaminants.

****

UV flame detector must be of the narrow band response type which operates on radiated ultraviolet energy and must be sensitive in the range of [_____] to [_____] micrometers only. The cone of vision must be 80 degrees or greater. Each detector must be completely insensitive to light sources in the visible frequency range.

][2.12.4 Combination UV/IR Flame Detector

****

NOTE: Combination UV/IR flame detectors have been used both inside and outside to detect fires, but are slower to react than individual units.

****

The UV/IR detector must provide discrimination against false alarms by requiring both UV and IR flame detection before an alarm is sent. The UV sensor must be sensitive in the range of 0.185 to 0.265 micrometers only. The IR sensor must be sensitive in the range of [_____] to [_____] micrometers only. Detectors must be completely insensitive to light sources in the visible frequency range.

][2.13 MULTI-CRITERIA DETECTORS

****

The designer must select the sensor required to initiate a fire alarm condition.

****

Multi-criteria detectors must contain [fixed temperature [_____] degrees C F heat sensor], [rate-of-rise heat sensor], [photoelectric smoke detector], [_____] elements in a single housing.

]2.14 CARBON MONOXIDE DETECTOR

Analog/addressable carbon monoxide (CO) detectors must be listed to UL 2075 and set to respond to the sensitivity limits of UL 2034. Carbon monoxide detectors must be listed for use with fire alarm control units. Detectors must be [surface] [semi-flush] mounted in the [vertical][horizontal] orientation and supported independently of wiring connections. Detectors must be self-restoring. For FMCU with no listed compatible addressable CO detectors, provide listed 4-wire detectors.[Do not provide CO detectors with local alarms.] Detector must be provided with an LED status indicator.

a. Where 4-wire CO detectors are necessary, each 4-wire CO detector must be individually monitored via addressable interface modules for alarm and off normal/trouble conditions (including loss of power to the individual detector). Power circuits for 4-wire CO detectors must be dedicated to powering the CO detectors only. Battery powered and 120 VAC powered detectors are prohibited.

b. Wiring connections must be made by means of screw terminals and detectors must be equipped with trouble relays. Detectors must be able to mount a single-gang electrical box.

c. A trouble condition at an individual CO detector must not affect any other CO detectors. CO detectors must be powered by the FMCU.

d. Detectors must be provided with a means to test CO gas entry into the CO sensing cell.

2.15 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored must be configured as a [Class "A"][Class "B"] initiating device circuits. The module must be listed as compatible with the control unit. The module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED.[Existing fire alarm system initiating device circuits must be connected to a single module to supervise the circuit.] Modules must be listed for the environmental conditions in which they will be installed.

2.16 ADDRESSABLE CONTROL MODULES

The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders or initiate elevator fire service. The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as [Class B][Class A] notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and must prevent power from being applied to the circuit. The control module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

[2.17 ISOLATION MODULES

a. Provide isolation modules to subdivide each signaling line circuit [into groups of not more than [20 addressable devices][_____]][each floor][in accordance with NFPA 72] between adjacent isolation modules.

b. Isolation modules must provide short circuit isolation for signaling line circuit wiring.

c. Power and communications must be supplied by the SLC and must report faults to the FMCU.

d. After the wiring fault is repaired, the fault isolation modules must test the lines and automatically restore the connection.

]2.18 NOTIFICATION APPLIANCES

2.18.1 Audible Notification Appliances

****

NOTE: The designer must layout speakers to achieve both the required dBA levels requires by NFPA 72 and also the required intelligibility required. See 3.7 for testing for intelligibility requirements that must be incorporated into the design.

****

Audible appliances must conform to the applicable requirements of UL 464. Appliances must be connected into notification appliance circuits. Surface mounted audible appliances must be painted [red][white][_____]. Recessed audible appliances must be installed with a grill that is painted [red][white][_____][with a factory finish to match the surface to which it is mounted].

2.18.1.1 Speakers

a. Speakers must conform to the applicable requirements of UL 1480. Speakers must have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Interior speaker tap settings must include taps of 1/4, 1/2, 1, and 2 watt, at a minimum. Exterior speakers must also be multi-tapped with no more than 15 watt maximum setting. Speakers must incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 400 Hz to 4,000 Hz, and must have a sealed back construction. Speakers must be capable of installation on standard 100 mm 4-inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single [wall mounted] unit. All inputs must be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FMCU.

b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 1.519 mm 16 gage or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes must be ground and finished to provide a smooth and neat appearance for each plate. Each plate must be primed and painted.

c. Speakers must utilize screw terminals for termination of all field wiring.

2.18.2 Visual Notification Appliances

****

NOTE:
1. ABA requires that Visual Notification Appliances be provided in buildings and facilities in each of the following areas: restrooms, and any general usage area (e.g., meeting rooms), hallways, lobbies, and any other area for common use and other areas stated at www.access-board.gov. The Visual Notification Appliance must be mounted as required by ABA that directs compliance with NFPA 72. In addition, alarms in guest rooms required to provide communication features must comply with sections 18.5.5.7 of NFPA 72. Shop drawings must indicate location, dimensions, content, details, and other required information to indicate extent of complying with ABA requirements.

2. Currently NFPA 72 requires "clear color" strobes for Fire Alarm Notification. NFPA 72 requires the strobe must be marked "Fire" to clear identify the function.

****

Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED) and be marked "Alert" in letters of contrasting color. The light pattern must be dispersed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of [15][30][75][_____] candela based on the UL 1971 test. Strobe must be [surface][semi-flush] mounted.

2.18.3 Textual Display Signs

****

NOTE: Provide remote LED Text display in locations where Hearing Impaired personnel might read instructions on the emergency. For Navy projects, the Text displays will be located over stairwell doors and major egress doors at the level of discharge.

****

Textual display signs must be [LED][LCD flat panel][LED scrolling] and must not exceed 400 mm long by 150 mm high by 75 mm deep 16 inches long by 6 inches high by 3 inches deep with a height necessary to meet the requirements of NFPA 72. The text display must spell out the word "EVACUATE" or "ANNOUNCEMENT" [and the remainder of the emergency instructions]as appropriate. The design of text display must be such that it cannot be read when not illuminated.

[LCD or LED scrolling text displays must meet the following requirements at a minimum:

a. Two lines of information for high priority messaging.

b. Minimum of 20 characters per line (40 total) displayed.

c. Text must be no less than height requirements and color/contrast requirements of NFPA 72.

d. 32K character memory.

e. Display must be wall or ceiling mounted.

f. Mounting brackets for a convenient wall/cubicle mount.

g. [g. During non-emergency periods, display date and time.]

h. The system must interface with the textual display sign control panel to activate the proper message.]

2.19 ELECTRIC POWER

2.19.1 Primary Power

Power must be [120][_____] VAC [50][60] Hz service for the FMCU from the AC service to the building in accordance with NFPA 72.

2.20 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.20.1 Batteries

Provide sealed, maintenance-free, [sealed lead acid][lead-calcium][gel cell] batteries as the source for emergency power to the FMCU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.20.1.1 Capacity

Battery size must be the greater of the following two capacities. This capacity applies to every control unit associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, fire alarm transmitters, and Base-wide mass notification transceivers. When determining the required capacity under alarm condition, visual notification appliances must include both textual and non-textual type appliances.

a. Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.

b. Sufficient capacity to operate the mass notification for 60 minutes after loss of AC power.

2.20.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

(1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit component, and compliance with UL 864.

(2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

(3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components. Calculations must be performed using the minimum rated voltage of each component.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing devices or appliances remote from the power sources.

2.20.2 Battery Chargers

Provide a fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and must maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.21 SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage fire alarm control unit components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on any signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the FMCU breaker is located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for fire alarm wiring. The base assembly must accept "plug-in" surge protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

(1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

(2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

(3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

(4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.22 WIRING

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.22.1 Alarm Wiring

IDC and SLC wiring must be [fiber optic][or][solid copper][or][stranded copper] cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. [14][16][_____] AWG size conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 16 AWG size conductors at a minimum. Speaker circuits must be copper No. [16][_____] AWG size twisted and shielded conductors at a minimum.[Wiring for textual notification appliance circuits must be in accordance with manufacturer's requirements but must be supervised by the FMCU.] Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors and appliances. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with NFPA 70.

2.23 INTERFACE TO THE BASE-WIDE MASS NOTIFICATION NETWORK

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NOTE: Provide as required for connection to a remote Central Control/Monitoring Mass Notification System Command Center.

****

[2.23.1 Fiber Optic

The fiber optic transceiver must be fully compatible with EIA standards for RS-232, RS-422 and RS-485 at data rates from 0 (DC) to 2.1 mbps (200 kbps for RS-232) in the low speed mode or from 10 kbps to 10 mbps in the high-speed mode. The fiber optic transceiver must be capable of simplex or full duplex asynchronous transmissions in both point-to-point systems and drop-and-repeat data networks. The fiber optic transceiver must be user configurable for the protocol, speed and mode of operation required. The fiber optic transceiver must be installed as a [stand-alone][card-cage] unit. The fiber optic transceiver must operate on [Multi-mode][Single-mode] fiber optic cable. The fiber optic transceiver must be supplied with [ST][or][FCPC] type optical connectors. Cabling: as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

][2.23.2 Radio

****

Note: Receiving a new radio frequency assignment often takes a relatively long period of time. Be sure to request the frequency assignment early in the design process.

****

The mass notification transceiver must be bi-direction and meet all the requirements of paragraph, RADIO TRANSMITTER AND INTERFACE PANELS as specified in this specification section. The transceiver utilized in the mass notification system must be capable of the following:

a. Communication with the central control/monitoring system to provide supervision of communication link and status changes are reported by automatic and manual poll/reply/acknowledge routines.

b. All monitored points/status changes are transmitted immediately and at programmed intervals until acknowledged by the central control/monitoring system.

c. Each transceiver must transmits a unique identity code as part of all messages; the code is set by the user at the transceiver.

][2.23.3 Telephone

A modem must be provided for communication with the central control/monitoring system. The modem must be 56k, compatible with data mode V.90, utilizing Hayes compatible command codes. The modem must be capable of auto dialing a preset number based on preprogrammed events. The modem must auto answer and provide a secure password protection system. Cabling: as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

][2.23.4 Secure Radio System

****

Note: Receiving a new radio frequency assignment often takes a relatively long period of time. Be sure to request the frequency assignment early in the design process.

****

2.23.4.1 Communications Network

The communications network provides two-way signals between central control units and autonomous control units (in individual building systems), and should include redundant (primary and backup) communication links. The system must incorporate technology to prevent easy interruption of the radio traffic for MNS alerting.

2.23.4.2 Radio Frequency Communications

Use of radio frequency-type communications systems must comply with National Telecommunications and Information Administration (NTIA) requirements. The systems must be designed to minimize the potential for interference, jamming, eavesdropping, and spoofing.

2.23.4.3 Licensed Radio Frequency Systems

An approved DD Form 1494 for the system is required prior to operation.

]2.24 AUTOMATIC FIRE ALARM TRANSMITTERS

****

NOTE: State the make and model number of existing proprietary supervising station receiving equipment. The choice of code transmitter, or radio transmitter depends upon the type of existing fire reporting system at the activity. Determine the type of activity reporting system (e.g., positive non interfering or shunt). In most cases a local energy-tripping device will be required. The facility Fire Dept. or Engineering office should be contacted to determine the type and amount of data to be supervised (monitored), e.g., -type: separate or common transmission of alarm, supervisory, and trouble type signals; -amount: all points, all zones, or the combined premises. Verify that existing monitoring equipment has sufficient capacity to support the additional premises or that it can be expanded as necessary to accommodate the new fire alarm system. Identify existing components.

****

[2.24.1 Radio Transmitter and Interface Panels

Transmitters must be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter must be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters must be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module must be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is [_____] and the transmitter must be fully compatible with this equipment. At the contractors option, and if listed, the transmitter may be housed in the same control unit as the FMCU. The transmitter must be narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency

Management.

2.24.1.1 Operation

Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter must automatically switch to battery operation. Switchover must be accomplished with no interruption of protective service, and must automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply must also be automatic.

2.24.1.2 Battery Power

Transmitter standby battery capacity must provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.24.1.3 Transmitter Housing

Use NEMA Type 1 for housing. The housing must contain a lock that is keyed [identical to the fire alarm system for the building][identical to radio alarm transmitter housings on the Installation]. Radio alarm transmitter housing must be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.24.1.4 Antenna

Antenna must be [omnidirectional, coaxial, halfwave dipole antennas][_____] for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts must be corrosion resistant and designed to withstand wind velocities of 161 km/hour 100 mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage.

][2.24.2 Digital Alarm Communicator Transmitter (DACT)

Provide DACT that is compatible with the existing supervising station fire alarm system. Transmitter must have a means to transmit alarm, supervisory, and trouble conditions via a single transmitter. Transmitter must have a source of power for operation that conforms to NFPA 72. Transmitter must be capable of initiating a test signal daily at any selected time. Transmitter must be arranged to seize telephone circuits in accordance with NFPA 72.

]2.24.3 Signals to Be Transmitted to the Base Receiving Station

****

NOTE: The following paragraph is applicable only to existing installations for connections to an auxiliary (public) alarm system. Edit this for the installation specific criteria.

****

The following signals must be sent to the base receiving station:

[a. Sprinkler waterflow

][b. Manual pull stations

][c. Smoke detectors

][d. Duct smoke detectors

][e. Sleeping room smoke detectors

][f. Carbon monoxide detectors

][g. Heat detectors

][h. Fire extinguishing system

][i. Sprinkler valve supervision

][j. Fire pump running

][k. Fire pump supervision

][l. Water supply level and temperature

][m. Combustion engine drive fire pump running

  (1) Selector switch in position than automatic

  (2) Engine over-speed

  (3) Low fuel

  (4) Low battery

  (5) Engine trouble (for example, low oil, over temp)

]2.25 SYSTEM MONITORING

2.25.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves,[standpipe control valves,] sprinkler service entrance valve,[valves at fire pumps,] isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, must be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address[, unless they are within the same room, then a maximum of five can use the same address].

[2.25.2 High/Low [Air][Nitrogen] Supervisory Switches

Provide monitoring of high and low supervisory [air][nitrogen] for [dry pipe][and][preaction] systems. Each air supervisory switch must have a separate address. Switches must be listed extinguishing system attachments. The device must contain double pole, double throw contacts. Operation of the switch must cause a supervisory signal to be transmitted to the FMCU when [air][nitrogen] pressure in the system monitored sprinkler system increases more than 34.5 kPa5 psi above the normal system pressure or drops halfway from the normal pressure to the tripping point.

][2.25.3 Room Low Temperature Supervisory Switch

Provide [monitoring of the]listed supervisory air temperature switch for the [fire pump][sprinkler riser] room[s]. Switch must cause a supervisory signal to be transmitted to the FMCU whenever the temperature in the room drops to below 4.4 degrees C40 degrees F. Device must reset when temperature rises above 4.4 degrees C40 degrees F.

][2.25.4 Electromagnetic Door Holders

Electromagnetic holding devices must operate on [120 VAC][24 VDC], and require not more than [3][_____] watts of power to develop 6.9 kPa25 psi of holding force. Under normal conditions, the magnets must attract and hold the doors open. Operation must be fail safe with no moving parts. Electromagnetic door hold-open devices must not be required to be held open during building power failure. The device must be listed based on UL 228 tests.

]2.26 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures must be provided to permit fire alarm/mass notification components to be used in areas that exceed the environmental limits of the listing. The enclosure must be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the component is currently listed. Guards required to deter mechanical damage must be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

[2.27 FIREFIGHTER TELEPHONE COMMUNICATION SYSTEM

****

NOTE: Provide a master control station at the FMCU with remote telephone stations in each stair at each floor landing, in each elevator lobby on each floor, and in elevator cabs. In addition, provide them at specific locations containing essential fire protection equipment, such as the fire pump room and outside the emergency generator room.

NOTE: In lieu of firefighter telephones radio repeater equipment compatible with responding fire department may be used if approved by the responding fire department.

****

2.27.1 General

Provide a firefighter telephone communication system with complete, common talk, closed circuits. The system must include, but not be limited to, a master control station mounted in the fire alarm control unit, a power supply and standby battery system, and remote telephone stations.

2.27.2 Features

The system must include the following features:

a. A master control station which must provide power, supervision, and control for wiring, components, and circuits. The act of lifting any remote telephone handset from its cradle must cause both a visual and audible signal to annunciate at the master control station. Removing the handset at the master control station and depressing a button at the remote telephone handset must cause the automatic silencing of the audible signal.

b. Communication between the master control station handset and any/or all remote handsets must require the depressing of a push-to-talk switch located on any/all remote handsets. During the time that the master control handset is removed from its cradle it must be possible to communicate between five remote handsets and the master control station.

c. handsets must be able to monitor any conversation in progress and join the conversation by pressing the push-to-talk button. It must not be possible to communicate between two or more remote handsets with the master control station handset in its cradle.

d. The master control station handset must be red in color and equipped with a 1.5 m5-foot long strain-relieved coiled cord.

e. The master control station must monitor wire and connections for any opens, shorts, or grounds which would render the system inoperable or unintelligible.

f. The master control station must be equipped with a silencing switch and ring-back feature such that any audible trouble signal can be silenced and must be so indicated by the lighting of an amber LED. Once any trouble condition has been corrected, the amber LED must be extinguished.

g. The master control station must be equipped with a separate, LED annunciated switch for each telephone circuit. In addition, LEDs must provide for the annunciation of operating and supervisory power.

h. The loss of operating or supervisory power must cause an audible and visual indication at the master control station and must also cause the fire alarm trouble signal to sound on the FMCU.

i. Switches, LEDs, and controls must be fully labeled.

2.27.3 Handsets

Handsets must have the following features:

a. Provide [surface][flush] mounted remote telephone stations.

b. Each station must be equipped with a hinged door that is magnetically locked.

c. Each handset must be permanently wired in place with a coiled cord.

d. Each handset must be red high-impact cycolac and must be equipped with a push-to-talk switch which, when operated, must signal the master control station and a switch-equipped, storage cradle.

e. Provide operating and supervising power from the same supply circuit(s) utilized for the FMCU.

]PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

3.2.1 Fire Alarm and Mass Notification Control Unit (FMCU)

Locate the FMCU [where indicated on the drawings][_____]. [Recess][Semi-recess][Surface mount] the enclosure with the top of the cabinet 2 m 6 feet above the finished floor or center the cabinet at [1.5][_____] m [5][_____] feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the FMCU. Locate the document storage cabinet adjacent to the FMCU unless the Contracting Officer directs otherwise.

3.2.2 Battery Cabinets

When batteries will not fit in the FMCU, locate battery cabinets below or adjacent to the FMCU. Battery cabinets must be installed at an accessible location when standing at floor level. Battery cabinets must not be installed lower than 300 mm12 inches above finished floor, measured to the bottom of the cabinet, nor higher than 900 mm36 inches above the floor, measured to the top of the cabinet. Installing batteries above drop ceilings or in inaccessible locations is prohibited. Battery cabinets must be large enough to accommodate batteries and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.The cabinet must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must indicate the control unit(s) the batteries power and must not be less than 25 mm1-inch high.

3.2.3 Manual Stations

Locate manual stations as required by NFPA 72[and as indicated on the drawings]. Mount stations so they are located no farther than [1.5][_____] m [5][_____] feet from the exit door they serve, measured horizontally. Manual stations must be mounted at [1067][1117][_____] mm [42][44][_____] inches measured to the operating handle.

3.2.4 Notification Appliances

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NOTE: Locate strobes wall mounted in corridors no more than 4.5 m 15 feet from the end of a corridor with 30 m 100 feet maximum distance between strobes. Where there is an obstruction to the viewing path in the corridors, such as a cross-corridor door or ceiling elevation change,

consider the obstruction as defining a new corridor. Provide ceiling mounted strobes in rooms accessible to the public, such as conference rooms, restrooms, courtrooms, cafeterias, and auditoriums in accordance with NFPA 72. In Child Development Centers only chimes must be used as the pre-alert tone prior to voice messages.
****

a. Locate notification appliance devices[as required by NFPA 72][where indicated][and to meet the intelligibility requirements]. Where two or more visual notification appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring.[Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles plus or minus 50 mm2 inches.]

b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.

c. Speakers must not be located in close proximity to the FMCU or LOC so as to cause feedback when the microphone is in use.

3.2.5 Smoke and Heat Detectors

Locate detectors[as required by NFPA 72 and their listing][as indicated on the drawings] on a 100 mm 4-inch mounting box. Install heat detectors not less than 100 mm 4 inches from a side wall to the near edge. Heat detectors located on the wall must have the top of the detector at least 100 mm 4 inches below the ceiling, but not more than 300 mm 12 inches below the ceiling. Smoke detectors are permitted to be on the wall no lower than 300 mm 12 inches from the ceiling with no minimum distance from the ceiling.[In raised floor spaces, install the smoke detectors to protect[21 square meters 225 square feet per detector][_____].] Install smoke detectors no closer than 1 m 3 feet from air handling supply diffusers. Detectors installed in acoustical ceiling tiles must be centered in the tiles plus or minus 50 mm2 inches.

3.2.6 Carbon Monoxide Detectors

Locate detectors[as required by NFPA 72 and their listings][as indicated on the drawings] on a 100-mm4-inch mounting box.[Carbon monoxide detectors must be installed separate from smoke and heat detectors.]

[3.2.7 Air Sampling Smoke Detector

Locate air sampling smoke detectors in accordance with the manufacturer's instructions. Air sampling smoke detectors must be installed as follows:

a. Air Sampling Smoke Detector Assembly:

  (1) Detector assembly must be mounted to a wall at a height between 48 to 60 inches1200 mm to 1800 mm to top of detector measured above the finished floor.

  (2) Mounting must be in a fully accessible and visible location.

(3) Mounting or attachment to site equipment, cable trays, movable walls, other equipment or equipment supports is not permitted.

(4) Piping network insertion into the detector inlet must not be glued.

(5) Air sampling smoke detector assembly must be installed in accordance with this specification section and the manufacturer's installation and instruction manuals.

(6) Flexible tubing for termination of the sampling pipe network into detector inlet is not permitted unless allowed by its listing.

(7) Provide red background with white lettering labels that are plastic or phenolic type with a minimum of 0.25-inch6.4 mm block lettering to indicate detector and zone. For example: "AIR SAMPLING SOME DETECTOR No. 1-1 No. 5".

(8) Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the ASD panel. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must be approved by the Contracting Officer before being posted.

b. Pipe and Sampling Tube Mounting:

(1) The pipe and sampling tubing detection network must be mounted as per the design and manufacturer's specification. The hardware used for mounting will depend upon the design and site requirements.

(2) To minimize flexing, pipes must be secured every 1.5 m5 feet.

(3) Pipes must be suspended between 25 mm and 100 mm1 and 4 inches below the ceiling. In areas with a suspended ceiling, the pipe network must be installed above the ceiling utilizing the manufacturer's capillary sample port supported by the ceiling.

(4) The sampling tubes must be of the same length or use the manufacturer's guidelines to run tubes of the required lengths.

(5) When installing a pipe network in areas subject to high temperature fluctuations allow for the contraction and expansion of pipes.

(6) Where expansion or contraction of pipes is likely either after installation or on a continuous basis, do not place pipe clips adjacent to couplings and socket unions as these may interfere with the movement of the pipe.

(7) No bends are permitted within the first 450 mm18 inches from the detector inlet.

(8) The routing of the piping and sample tube network must be coordinated with potential obstructions, including cable trays, grounding bars, and HVAC ductwork.

(9) All changes in direction must be made with standard elbows or tees.

(10) All joints must be air-tight and made by using solvent cement, except at the entry to the detector assembly. Refer to ASTM F402.

(11) All pipes must be supported by mechanical hangers attached to the structure of the building. Not more than 300 mm1-foot of pipe must extend beyond the last hanger of each sampling pipe. The final installation must result in no noticeable deflection in the piping network.

(12) Attachment of air sampling pipes to cable trays, "gray iron", and telecommunications equipment is prohibited.

(13) Clearly label pipe network to distinguish the pipe from other facility pipe work or protective cabling enclosures. For example: "SMOKE DETECTION SAMPLING TUBE - DO NOT DISTURB". In open rooms and exposed areas, provide labels at no greater than 6.1-m20-foot intervals. Provide labels every 3 m10 feet where piping is installed above suspended ceilings and every 609 mm2 feet, centered in the floor panels, where piping is installed within the raised floor cavity.

(14) Placement of the sampling tube must take into consideration appropriate sampling point locations and spacing.

c. Air Sampling Points:

(1) Open area ceiling sampling points must be oriented downward and must be within 25 mm to 100 mm1 to 4 inches below the underside of the ceiling above where the ceiling is smooth.

(2) Label all air sampling points with a round red label, each with a center hole to match the diameter of the drilled sampling point. For example: "AIR SAMPLING POINT DIA 3.2 MM0.125 INCHES". Indicate fractional dimensions in decimal format with a minimum of three decimal places.

][3.2.8 Graphic Annunciator

Locate the graphic annunciator as shown on the drawings. Mount the annunciator, with the top 1830 mm 6 feet above the finished floor or center the annunciator at [1525][_____] mm [5][_____] feet, whichever is lower.

]3.2.9 LCD REMOTE Annunciator

Locate the LCD annunciator as shown on the drawings. Mount the annunciator, with the top 2 m 6 feet above the finished floor or center the annunciator at [1.5][_____] m [5][_____] feet, whichever is lower.

[3.2.10 Electromagnetic Door Holder Release

Doors must be held open at a minimum of 90 degrees so as not to impede egress from the space. Mount the armature portion on the door and have an adjusting screw for seating the angle of the contact plate. Wall-mount the electromagnetic release, with a total horizontal projection not exceeding 100 mm4 inches. Ensure all doors release to close upon first stage (pre-discharge) alarm. Electrical supervision of wiring external of control unit for magnetic door holding circuits is not required.

][3.2.11 Firefighter Telephones

Mount telephone[handsets][jacks] on the wall in each stair at each floor landing, in each emergency generator room, in each fire pump room, in each elevator machine room, in each elevator lobby, and in each elevator cab 1200 mm 4 feet above the finished floor.

]3.2.12 Local Operating Console (LOC)

Locate the LOC(s) as required by NFPA 72 and as indicated. Mount the console so that the top message button and microphone is no higher than 1200 mm 4 feet above the floor and the bottom (lowest) message button and microphone is at least 1-meter3 feet above the finished floor.

3.2.13 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.3 SYSTEM FIELD WIRING

3.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and professional manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote fire alarm/mass notification control units, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.3.2 Terminal Cabinets

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NOTE: Provide terminal cabinets on each floor where the fire alarm system supply riser is located and where the fire alarm return riser is located.

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Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 200 mm by 200 mm 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "FIRE ALARM TERMINAL CABINET" with 50 mm 2-inch lettering, on the front of the terminal cabinet.

3.3.3 Alarm Wiring

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NOTE: Do not penetrate SCIF perimeters with copper signal line circuits. SCIF penetrations should be either fiber optic cable or IDC. IDC circuits penetrating the SCIF must be filtered.

****

a. Voltages must not be mixed in any junction box, housing or device, except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the FMCU.

c. [Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.][T-tapping using screw terminal blocks is allowed for Class "B" signaling line circuits.]

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the [_____] Designated Fire Protection Engineer (DFPE).

3.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 19 mm3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits, notification appliance circuits and signaling line circuits [_____]6 feet in length or less. Use liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

[g. For Class "A" or "X" circuits with conductor lengths of 10 feet3 meters or less, the conductors must be permitted to be installed in the same raceway in accordance with NFPA 72.

]3.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FMCU[, and remote FMCU] and the LOC must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FMCU, and remote FMCU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12 point lettering minimum size, and mounted within each cabinet, control unit, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

[3.4 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM

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NOTE: Contact the Contracting Officer, Base Fire Prevention Office, or Base Maintenance Personnel to determine what action is appropriate for the salvaging of existing fire alarm equipment.

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Maintain existing fire alarm/mass notification equipment fully operational until the new equipment has been tested and accepted by the Contracting Officer. As new equipment is installed, label it "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted by the Government, it must be placed in service and connected to the supervising station. Remove tags from new equipment and tag the existing equipment "NOT IN SERVICE" until removed from the building.

a. After acceptance of the new system by the Contracting Officer, remove existing equipment not connected to the new system, remove unused exposed conduit, and restore damaged surfaces. Remove the material from the site and dispose.

b. Disconnect and remove the existing fire alarm/mass notification and smoke detection systems where indicated and elsewhere in the specification.

c. Control units and fire alarm devices and appliances disconnected and removed must be turned over to the Contracting Officer.

d. Properly dispose of fire alarm outlet and junction boxes, wiring, conduit, supports, and other such items.

3.5 CONNECTION OF NEW SYSTEM

The following new system connections must be made during the last phase of construction, at the beginning of the pre-Government tests. New system connections must include:

a. Connection of new relays to existing magnetic door hold-open devices.

b. Connection of new elevator recall relays to existing wiring and conduit.

c. Connection of new system transmitter to existing installation fire reporting system.

Once these connections are made, system must be left energized. Report immediately to the Contracting Officer, coordination and field problems resulting from the connection of the above components.

]3.6 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire-rated walls, partitions with fire-rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.7 PAINTING

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 19 mm3/4-inch wide at 3-meter10-foot centers and at each side of a floor, wall, or ceiling penetration.

c. Painting must comply with Section 09 90 00 PAINTS AND COATINGS.

3.8 FIELD QUALITY CONTROL

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NOTE: Listed tests are minimum required. Coordinate with the local Authority Having Jurisdiction (AHJ) for minimum requirements in excess of the NFPA 72 minimums or those recommend below. If additional tests are required, such tests must be added to the list.

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3.8.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level [III][or][IV] Fire Alarm Technician, and the representative of the installing company, [and reviewed by the QFPE] [60][_____] days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, and surge protective devices. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 72 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government testing. The test data forms must record the test results and must:

a. Identify the NFPA Class of all Initiating Device Circuits (IDC), and Notification Appliance Circuits (NAC), Voice Notification System Circuits (NAC Audio), and Signaling Line Circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test including equipment necessary for smoke detector testing. The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.8.2 Pre-Government Testing

3.8.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that devices and circuits are functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" as required by NFPA 72. The contractor and an authorized representative from each supplier of equipment must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 72 including all referenced annex sections and the test reports noted below.

a. NFPA 72 Record of Completion.

b. NFPA 72 Record of Inspection and Testing.

c. Fire Alarm and Emergency Communication System Inspection and Testing Form.

d. Audibility test results with marked-up test floor plans.

e. Intelligibility test results with marked-up floor plans.

f. Documentation that all tests identified in the paragraph "Minimum System Tests" are complete.

3.8.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the [_____][Designated Fire Protection Engineer (DFPE)][Contracting Officer's Representative (COR)]. Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation-wide fire reporting system[and the installation-wide mass notification system have] been completed and tested to confirm communications are fully functional. Submit request for test at least [15][_____] calendar days prior to the requested test date.

3.8.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

[b. The contractor's Qualified Fire Protection Engineer (QFPE).

] c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results.

e. Complete program printout including input/output addresses.

f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

g. Audibility test results with marked-up floor plans.

h. Intelligibility test results with marked-up floor plans.

Government Final Tests will be witnessed by the [_____], [Designated Fire Protection Engineer][Contracting Officer's Representative (COR)][, Qualified Fire Protection Engineer (QFPE)]. At this time, any and all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.9 MINIMUM SYSTEM TESTS

3.9.1 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final Government test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the pre-Government test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

e. Carbon Monoxide Detector Tests: Carbon monoxide detectors must be tested in accordance with NFPA 72 and the manufacturer's recommended calibrated test method.

f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

h. Determine that the system is operable under trouble conditions as specified.

i. Visually inspect wiring.

j. Test the battery charger and batteries.

k. Verify that software control and data files have been entered or programmed into the FMCU. Hard copy records of the software must be provided to the Contracting Officer.

l. Verify that red-line drawings are accurate.

m. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

n. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

o. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.

p. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

q. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.9.2 Audibility Tests

Sound pressure levels from audible notification appliances must be a minimum of 15 dBa over ambient with a maximum of 110 dBa in any occupiable area. The provisions for audible notification (audibility and intelligibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

3.9.3 Intelligibility Tests

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NOTE: Occasionally, large DoD buildings are designed to provide cavernous-type open areas to meet unique operational requirements. Such areas are typically designed with hard wall and ceiling surfaces (such as metal or concrete) without acoustical treatments, and this has been found to cause excessive sound reflections that prevent obtaining the normal, minimum required CIS value. In such facilities, the cavernous-type open area is permitted to have locations with a CIS value lower than the normal, minimum required CIS value when the following conditions are met:

The requirement for a deviation from the normal, minimum CIS criteria identified in the design phase.

Justification for the deviation from the normal, minimum CIS criteria is provided to the approving authority (i.e., the AHJ for the Navy and Marine Corps; the DoD installation in conjunction with the contracting officer for the Army and Air Force). The justification must address all factors relevant to the request for deviation from normal, minimum CIS criteria, including, but not limited to: the operational requirements that restrict the installation of acoustical wall and ceiling treatments; the potential use of special speaker technologies such as directional speakers or stacked speaker systems; and, the availability of physically larger or higher-fidelity speakers even though such speakers might not be listed for fire alarm use.

Note: Deviation from normal, minimum CIS criteria should not be requested for the design of normal, large, open areas that are typically found in permanent DoD buildings, such as dining halls,

theaters, and gymnasiums. The potential for deviation from normal criteria is intended to address the rare exception to normal criteria that is sometimes needed for DoD buildings with unique operational requirements.

Building occupants located in the large, cavernous area can adequately understand the message content in the voice signal being broadcast. Whether the voice message is adequately understood must be determined by the approving authority (i.e., the AHJ for the Navy and Marine Corps; the DoD installation in conjunction with the contracting officer for the Army and Air Force).

The CIS value is not less than 0.6 at any location within the large, cavernous area.

The building occupants in the large, cavernous area must walk no more than 30 m98 feet to find another location within the large, cavernous area having at least the normal, minimum required CIS value. Note: An STI score of 0.5 is considered equivalent to a CIS score of 0.7. An STI value of 0.7 is considered equivalent to a CIS value of 0.8.

All readings for Sound Pressure Level (SPL) and Intelligibility score must be recorded on the installation drawings next to the speaker symbol. The readings must then be added on the "as-Built" drawings to be submitted at the conclusion of the Final Government test.
****

Intelligibility testing of the System must be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, and ASA S3.2. Following are the specific requirements for intelligibility tests:

a. Intelligibility Requirements: Verify intelligibility by measurement after installation.

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NOTE: The minimum required value for Navy and Marine Corps is 0.7 CIS. The minimum required value for Army and Air Force is 0.8 CIS, although rounding is permitted such that a value of 0.75 may be rounded to 0.8.
****

b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is [.7][.8]. Rounding of values is permitted.

****
NOTE: Edit the following paragraph as required for each specific project.
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c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the DFPE, and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 10 m 33 feet to find a location with at least the minimum required CIS value within the same area.

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NOTE: Edit the following paragraph as required for each specific project.

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d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 15 m 50 feet to a location with at least the minimum required CIS value within the same area.

e. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).

f. The distance the occupant must walk to the location meeting the minimum required CIS value must be measured on the floor or other walking surface as follows:

    (1) Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.

    (2) Curving around any corners or obstructions, with a 300 mm 12 inches clearance there from.

    (3) Terminating directly below the location where the minimum required CIS value has been obtained.

Use commercially available test instrumentation to measure intelligibility as specified by NFPA 72 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3.10 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the Final Government Test.

a. [The drawings must be prepared electronically and sized no less than the contract drawings.][Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of [MicroStation] [AutoCAD,]DXF and portable document formats of as-built drawings and schematics.]

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide Operation and Maintenance (O&M) Instructions.

[In existing buildings, the transfer of devices from the existing system to the new system and the permission to begin demolition of the old fire alarm system will not be permitted until the as-built drawings and O&M manuals are received.]

3.11 INSTRUCTION OF GOVERNMENT EMPLOYEES

3.11.1 Instructor

Provide the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the operation, inspection, testing, and maintenance of the system provided. The instructor must train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm system. The instructor must be thoroughly familiar with all parts of this installation. The instructor must be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

3.11.2 Required Instruction Time

Provide [8][16][_____] hours of instruction after final acceptance of the system. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training must allow for rescheduling for unforeseen maintenance and fire department responses.

[3.11.2.1 Technical Training

Equipment manufacturer or a factory representative must provide [1][3][_____] days of on site[and 5 days of technical training to the Government at the manufacturing facility]. Training must allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises.[Factory training must occur within [6][12][_____] months of system acceptance.]

]3.11.3 Technical Training Manual

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training must familiarize designated government personnel with proper operation of the installed system. The maintenance training course must provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.12 EXTRA MATERIALS

3.12.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the

Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturer[s]. Installing fire alarm contractor is NOT responsible for any damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.12.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed system[s]. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the Government testing and must be accompanied by an inventory list.

3.12.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. Site-specific software data package

e. All documentation required by SD-06.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 00 00 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-31 00 00 (August 2008)
UFGS-31 23 00.00 20 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 31 - EARTHWORK

SECTION 31 00 00

EARTHWORK

08/23

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PART 2   PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-31 00 00 (August 2023)**

Preparing Activity: USACE **Superseding**
UFGS-31 00 00 (August 2008)
UFGS-31 23 00.00 20 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 31 00 00

EARTHWORK
08/23

****
NOTE: This guide specification covers the requirements for earthwork activities for buildings, utilities, roadways, railroads, and airfields.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: Consult with an engineer while editing this section to determine specific requirements for each job.

The following information will be indicated on the project drawings:

1. Surface elevations, existing and new;

2. Location of underground obstructions and existing utilities;

3. Location and record of soil borings and test

pits. Include ground water observations and topsoil thickness encountered in boring, soil classifications, and properties such as moisture content and Atterberg limit determinations;

4. Location of borrow and disposal area if located on Government property;

5. Clearing stripping and grubbing limits, if different from clearing limits;

6. Areas to be seeded;

7. Hydrological data where available;

8. Shoring and sheeting required (trench protection is specified in Corps of Engineers Manual EM 385-1-1); and

9. Pipe trench excavation details;

10. Location and limits of hard material (obstructions or bedrock);

11. Details of special construction such as under railroad and highways right-of-way requirements for jacking and boring;

12. Details of sewage absorption trenches, absorption pits, and subsurface drains.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of

	Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2974	(2020; E 2020) Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
ASTM D4253	(2016; E 2019) Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	(2016) Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4829	(2021) Standard Test Method for Expansion Index of Soils
ASTM D4832	(2016; E 2018) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D5268	(2019) Topsoil Used for Landscaping Purposes
ASTM D6023	(2016) Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM)
ASTM D6103/D6103M	(2017; E 2021) Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D8167/D8167M	(2023) Standard Test Method for In-Place

	Bulk Density of Soil and Soil-Aggregate by a Low-Activity Nuclear Method (Shallow Depth)

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SW-846.3-3	(1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-203	(Rev C; Notice 3) Paper, Kraft, Untreated

1.2 DEFINITIONS

****

NOTE: Delete definitions that will not be used in the specification text or shown on the drawings for a specific project.

All materials called out in the project plan set must be defined in this section.

This list is not exhaustive, therefore will need to be tailored for each project.

****

1.2.1 Structural Fill

Soil material placed to support buildings, walls, pads, and other similar facilities.

1.2.2 Embankment Fill

Soil material placed to construct embankment.

1.2.3 Porous Fill

Free-draining material placed for subsurface drainage, as a capillary break, or another specific purpose.

1.2.4 Topsoil

Surface layer of primarily organic soil capable of supporting vegetation growth.

1.2.5 Utility Bedding Material

Fill placed to directly support pipes, conduits, cables, and appurtenant structures. Bedding may also be used to provide a cushion between utilities and bedrock, obstacles, obstructions and other unyielding materials.

1.2.6 Flowable Fill

Fill placed in a plastic or liquid form that flows to near its final placement location with limited assistance and subsequently cures or solidifies to provide a stable or impermeable barrier.

1.2.7 Satisfactory Materials

****

NOTE: Satisfactory material will be defined in accordance with locally available materials, design slopes, etc., and suitable classes, based on the geotechnical report, will be listed in the project specification in accordance with the Unified Soil Classification System, ASTM D2487. Maximum rock size will be determined based on how thick the fill is and how it is going to be accomplished. As a rule of thumb, it should be no larger than 1/2 the allowable lift thickness. Clay material should be checked for expansive characteristics and this section should be edited accordingly.

****

Satisfactory materials for fill, backfill, and/or any in-situ soils to remain in place comprise any materials classified by ASTM D2487 as [GW], [GP], [GM], [GP-GM], [GW-GM], [GC], [GP-GC], [GM-GC], [SW], [SP], [SM], [SW-SM], [SC],[SW-SC], [SP-SM], [SP-SC], [CL], [ML], [CL-ML], [CH], [MH]. Maximum particle size to be no greater than [one-half of the allowable lift thickness] [[_____] mm inches] in any dimension.

1.2.8 Unsatisfactory Materials

****

NOTE: Unsatisfactory material will be defined in accordance with locally available materials, design slopes, etc., and unsuitable classes will be listed in the project specifications as not being in accordance with ASTM D2487. This paragraph should be edited to delete inapplicable materials. Paragraphs UNSATISFACTORY MATERIALS and COHESIONLESS MATERIALS should only be utilized where are very limited variety of materials are to be used or where project soil parameter requirements are not necessary.

****

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; roots and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.

1.2.9 Cohesionless Materials

****

NOTE: When classification will be necessary during construction, determination of grain size for classification will be specified to be made in conformance with ASTM C117, ASTM C136/C136M, and

ASTM D1140. This paragraph should only be used where soil materials can be categorized as either cohesionless or cohesive without any other limiting parameters.

****

Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C117, ASTM C136/C136M and ASTM D1140.

1.2.10 Cohesive Materials

****

NOTE: When classification will be necessary during construction, determination of grain size for classification will be specified to be made in conformance with ASTM C117, ASTM C136/C136M, and ASTM D1140. This paragraph should only be used where soil materials can be categorized as either cohesionless or cohesive without any other limiting parameters.

****

Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesive only when the fines are plastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C117, ASTM C136/C136M and ASTM D1140.

1.2.11 Hard/Unyielding Materials

****

NOTE: Stones should generally not exceed 75 mm 3 inches in diameter. However, pipe manufacturer's criteria, if any, should be used.

****

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than [_____] mm inch in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.12 Unstable Material

Unstable materials are too weak to adequately support the utility pipe, conduit, equipment, or appurtenant structure. Satisfactory material may become unstable due to ineffective drainage, dewatering, becoming frozen, excessive loading.

1.2.13 Expansive Soils

****

NOTE: Additional laboratory testing and analysis might be needed to better define site specific expansive soils. If expansive soils are anticipated

at the construction site, this specification should be edited to ensure proper construction techniques are undertaken per UFC 3-220-01.
****

Expansive soils are defined as soils that have an expansion index greater than 20 when tested in accordance with ASTM D4829.

1.2.14 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding [0.375] [_____] cubic meter [1/2] [_____] cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.2.15 Capillary Water Barrier

A layer of clean, poorly graded crushed rock, stone, or natural sand or gravel having a high porosity which is placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below a slab.

1.2.16 Degree of Compaction (Proctor)

****
NOTE: ASTM D1557 will be used for maximum density determinations, unless soil borings indicate a gradation that may include coarse material where more than 30 percent is retained on the 19 mm 3/4 inch sieve; in that case, the Contractor will be required to use AASHTO T 180, Method D and corrected with AASHTO T-180-21 Annex A for the maximum density determinations. The designer should determine if AASHTO T 180 is appropriate for the existing soil gradation. If maximum density cannot be determined by either method, the specification may need to require a test section and the COR to determine the number of compaction coverages and equipment type.
****

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in [ASTM D1557] [ASTM D698] abbreviated as a percent of laboratory maximum density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 19.0 mm 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 19.0 mm 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180-21 paragraph 1.5, Note 1.

1.2.17 Degree of Compaction (Relative Density)

Degree of compaction required for soils with less than 5 percent passing the No. 200 sieve, is expressed as a relative percentage of the maximum index density/dry unit weight and minimum index density/dry unit weight, obtained by the test procedures in accordance with ASTM D4253 and ASTM D4254, respectively, abbreviated as a percent of laboratory relative density.

1.2.18 Overhaul

****

NOTE: This paragraph is to be deleted when the earthwork is to be paid for under a lump sum contract. The blank will be filled with the appropriate number of stations.

****

Overhaul is the authorized transportation of satisfactory excavation or borrow materials in excess of the free-haul limit of [_____] stations. Overhaul is the product of the quantity of materials hauled beyond the free-haul limit, and the distance such materials are hauled beyond the free-haul limit, expressed in station meters yards.

1.2.19 Borrow

Soil brought to the project site from an external location for the purposes of project construction.

1.2.20 Subgrade

Earth materials directly below foundations and directly below granular base materials in building slab and pavement areas including shoulders.

1.3 SUBSURFACE DATA

Subsurface soil boring logs are shown [in project plans] [in an Attachment to these specifications] [_____]. These data represent available subsurface information; however, variations may exist between boring locations.

1.4 CRITERIA FOR BIDDING

****

NOTE: For most projects, the scope of earthwork can accurately be determined. However, if earthwork is approximately known, a unit price for earth work should be provided in the Bid Schedule.

Measurement and Payment should be addressed with Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

Unit-price items are multiplied by the approximated and stated quantity giving a sum that is then added to the price for the rest of the work. The result is a lump sum bid with automatic provision for payment or credit due to variations in earthwork within 15 percent of that shown and bid upon.

Variations exceeding 15 percent of that shown and bid upon will become the subject of negotiations in accordance with FAR 52.211-18 Variation in Estimated Quantity.

****

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. [Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.][Ground water elevation is [_____] meters feet below existing surface elevation.]

d. Ground water elevation is [_____] meters feet below existing surface elevation.

e. Material character is indicated by the boring logs.

****

NOTE: Choose the following option if no boring information is available, or if the boring information is insufficient to permit a bidder to develop an accurate estimate of hard material or rock to be encountered. If hard material or rock is to be encountered, the following option should be modified to include a percent figure or an approximate depth at which hard material or rock will be encountered.

****

f. Hard materials[and rock] [will not] [will] be encountered[in [_____] percent of the excavations][at [_____] meters feet below existing surface elevations].

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Excavation and Trenching Plan; G, [_____]

[Borrow Plan; G, [_____]

][Dewatering Work Plan; G, [_____]

] Jacking, Boring, and Tunneling Plan; G, [_____]

[Rock Excavation Plan; G, [_____]

][Blasting Plan; G, [_____]

] Disposition of Surplus Materials; G, [_____]

Preconstruction Meeting; G

SD-03 Product Data

Flowable Fill Mix Design; G, [_____]

Geotextiles

SD-04 Samples

Geotextiles

SD-06 Test Reports

[Dewatering Performance Records; G, [_____]

] Material Test Report; G, [_____]

Borrow Site Testing; G, [_____]

Pipe Inspection Report; G, [_____]

Geotechnical Evaluation Report; G, [_____]

1.6 QUALITY CONTROL

1.6.1 Geotechnical Engineer

****

NOTE: Where site conditions require extensive monitoring of excavations and water levels, include the following requirement.

****

Provide a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for preparing and updating the Excavation and Trenching Plan and Dewatering Work Plan as construction progresses to reflect changing conditions and submit an updated plan if necessary. Submit a monthly Geotechnical Evaluation report, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Contractor is responsible for arranging meetings with the Geotechnical Engineer and Contracting Officer throughout the contract duration.

1.6.2 Qualified Technician

Provide a Qualified Technician to inspect, monitor, sample, and performing field testing. The technician qualifications need to be one of the following: a current National Institute for Certification in Engineering Technologies (NICET) Level II minimum certification in Construction Materials Testing Soils; a Geologist-in-Training with minimum one-year experience; an Engineer-in-Training with minimum one-year experience; a Registered Geologist; or a Professional Engineer.

1.6.3 Lab Validation

Perform testing by a Corps validated commercial testing laboratory or Contractor established testing laboratory meeting the requirements of Section 01 45 00 (or similar number) entitled QUALITY CONTROL and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until testing facilities have been inspected, Corps validated and approved by the Contracting Officer.

1.6.4 Preconstruction Meeting

Conduct a preconstruction meeting at the jobsite at least five business days prior to the start of earthwork operations on the project. The preconstruction meeting is to be arranged by the Contractor and is to follow the written agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Project Superintendent, earthwork subcontractor's Project Manager and Site Foreman, Contractor's Geotechnical Engineer and Testing Agency, Government Geotechnical Engineer and Civil Engineer, and Government Construction Manager and Engineering Technician.

The minutes of this meeting are to be recorded by the Contractor and published via email within 48 hours to all attendees. The minutes must be re-published within 48 hours via email pending any subsequent comments from the attendees.

PART 2 PRODUCTS

****

NOTE: All PRODUCTS included must have an associated definition in PART 1.

****

2.1 SOIL MATERIALS

****

NOTE: All SOIL MATERIALS included must have an associated definition in PART 1. Soil materials as described in this subpart should be called out where applicable on project plan sets. Soil materials should expand upon definition to include required classifications and parameters.

For example, the following is a list of material properties/criteria that could be considered for specific soil materials such as Embankment Fill:

a. Liquid limit less than [_____];
b. Plasticity index [greater than] [less than] [_____];
c. Hydraulic conductivity (ASTM D5084) to be [less than] [greater than] or equal to [_____]; and
d. Grain size analysis resulting in greater than [_____] percent of material [passing] [retained on] the [_____] sieve.

****

2.1.1 Structural Fill

Materials classified as [GW], [GP],[GM], [GC], [GW-GM], [GW-GC], [GP-GM], [GP-GC], [GC-GM], [SW], [SP], [SM], [SW-SM], [SC], [SW-SC], [SP-SM], [SP-SC], [CL], or [CH] in accordance with ASTM D2487. Select material type appropriate for the intended purpose.

2.1.2 Embankment Fill

Materials classified as [GW], [GP], [GM], [GC], [GW-GM], [GW-GC], [GP-GM], [GP-GC], [GC-GM], [SW], [SP], [SM], [SW-SM], [SC], [SW-SC], [SP-SM], [SP-SC], [CL], or [CH] in accordance with ASTM D2487. Select material type appropriate for the intended purpose.

2.1.3 Porous Fill

Materials containing less than 5 percent passing the No. 200 sieve. Provide the gradation as appropriate for the intended purpose.

2.1.4 Topsoil

****

NOTE: Additional requirements such as pH value and necessary soil conditioning, according to applicable

provisions of Sections 32 92 19 SEEDING through 32 92 26 SPRIGGING, should be inserted in this paragraph. The depth of the topsoil should be given in the text of the specification, preferably in this paragraph.

****

Material suitable for topsoil obtained from [offsite areas] [excavations] [areas indicated on the drawings] is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than 25 mm one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth.[Amend topsoil pH range to obtain a pH of [5.5 to 7] [_____].][Topsoil material will be in accordance with ASTM D5268.]

2.1.5 Capillary Water Barrier

Conform to ASTM C33/C33M for fine aggregate grading with a maximum of 3 percent by weight passing ASTM D1140, 75 micrometers No. 200 sieve,[or][37.5 mm 1-1/2 inch and no more than 2 percent by weight passing the 4.75 mm No. 4 size sieve][or coarse aggregate Size 57, 67, or 77].

2.1.6 Utility Bedding Material

Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with [AWWA C600] [ASTM D2321]. Install bedding for plastic piping to spring line of pipe.[Provide geotextile fabric below bedding layer where indicated.] Utility bedding material may include the following:

2.1.6.1 Class I

Angular, 6 to 40 mm 0.25 to 1.5 inch, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

2.1.6.2 Class II

Coarse sands and gravels with maximum particle size of 40 mm 1.5 inch, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

2.1.6.3 Sand

Clean, coarse-grained sand classified as [_____], [gradation [_____] of the [DOT] [State Standard] or [SW] [or] [SP] by ASTM D2487 for [bedding] [and] [backfill] [as indicated]].

2.1.6.4 Gravel and Crushed Stone

Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as [_____], [gradation [_____] of the [DOT] [State Standard]] or having a classification of [GW] [GP] in accordance with ASTM D2487 for [bedding] [and] [backfill] [as indicated].[Do not exceed maximum particle size of [75] [_____] mm [3] [_____] inches.]

2.2 FLOWABLE FILL

Design and submit flowable fill mix design to consist of Portland cement, fly ash, and/or slag cement and fine aggregate. Include the dry weights of cementitious material(s); quality and gradation of aggregates in the saturated surface-dry weights along with gradation tests; quantities, types, and names of admixtures; and quantity of water per cubic yard. The [minimum] [maximum] unconfined compressive strength to be [_____] [psi] [psf] at [_____] days in accordance with ASTM D4832. The aggregates in accordance with ASTM C33/C33M Fine Aggregates. Air-entrain fill in accordance with ASTM C260/C260M. The air content to be between [8 and 15 percent] in accordance with ASTM D6023. The flow to be between [17 to 25 mm] [8 and 12 inches] [_____] in accordance with ASTM D6103/D6103M. Portland cement to be Type I or II in accordance with ASTM C150/C150M. Fly ash to be Class C in accordance with ASTM C618. Provide slag cement in Grade 100 or 120 in accordance with ASTM C989/C989M.

2.3 BURIED WARNING AND IDENTIFICATION MARKERS

****

NOTE: Delete paragraph if tape is not required in the project. The use of a plastic warning tape for identification is mandatory for buried hazardous utilities such as electrical conduit, gas lines, fuel lines, high pressure nitrogen, high pressure water and steam lines, domestic sewage force mains, industrial waste force mains and industrial sewers carrying hazardous, explosive, or toxic waste. Coordinate color codes with other specification sections and conform, if possible, to local practice for identifying buried utilities.

****

Provide [polyethylene plastic] [and] [metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic] warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 75 mm 3 inches minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes	
Red	Electric
Yellow	Gas, Oil; Dangerous Materials
Orange	Telephone and Other Communications
Blue	Water Systems
Green	Sewer Systems
White	Steam Systems

Warning Tape Color Codes	
Gray	Compressed Air

2.3.1 Warning Tape for Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.08 mm 0.003 inch and a minimum strength of 10.3 MPa 1500 psi lengthwise, and 8.6 MPa 1250 psi crosswise, with a maximum 350 percent elongation.

2.3.2 Detectable Warning Tape for Non-Metallic Piping

Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.10 mm 0.004 inch, and a minimum strength of 10.3 MPa 1500 psi lengthwise and 8.6 MPa 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 920 mm 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.3.3 Detection Wire for Non-Metallic Piping

Insulate a single strand, solid copper detection wire with a minimum of 12 AWG.

2.4 MATERIAL FOR RIP-RAP

****

NOTE: Make sure there is no duplication of rip-rap requirements between this and other specification sections. In this paragraph refer to standard specifications for rip-rap if local specifications are satisfactory and available. Delete this paragraph or subparagraphs not required in the project. Large scale riprap applications should consider Section 35 31 19.40 STONE REVETMENTS or another similar specification where riprap placement is a major component of a project’s scope.

****

Provide [bedding material] [grout] [filter fabric] and rock conforming to [these requirements] [DOT] [_____ State Standard] for construction indicated.

2.4.1 Bedding Material

Provide bedding material consisting of sand, gravel, or crushed rock, well graded, [or poorly graded] with a maximum particle size of 50 mm 2 inches. Compose material of tough, durable particles. Allow fines passing the 75 micrometers No. 200 standard sieve with a plasticity index less than [6] [_____].

2.4.2 Grout

Provide durable grout composed of cement, water, an air-entraining admixture, and sand mixed in proportions of one-part Portland cement to

[two] [_____] parts of sand, sufficient water to produce a workable mixture, and an amount of admixture which will entrain sufficient air, as determined by the Contracting Officer. Mix grout in a concrete mixer. Allow a sufficient mixing time to produce a mixture having a consistency permitting gravity flow into the interstices of the riprap with limited spading and brooming.

2.4.3 Rock

****

NOTE: Adjust weights in brackets to fit application. Take local practice into consideration.

****

Provide rock fragments which ensure permanence in the structure and the environment in which it is to be used. Use rock fragments free from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. Provide fragments sized such that no individual fragment exceeds a weight of [68] [_____] kg [150] [_____] pounds and that no more than 10 percent of the mixture, by weight, consists of fragments weighing 0.91 kg 2 pounds or less each. Provide rock with a minimum specific gravity of [2.50] [_____]. Do not permit the inclusion of more than trace [1 percent] [_____] quantities of dirt, sand, clay and rock fines.

2.5 BORROW

Provide borrow materials from sources located [within] [and/or] [outside of Government] property meeting the requirements of paragraph [STRUCTURAL FILL] [EMBANKMENT FILL] [TOPSOIL].

2.6 GEOTEXTILE

****

NOTE: FILTER FABRIC should only be included for relatively small projects that have a scope limited such that a separate section is not warranted.

****

Provide a pervious sheet of polyester, nylon, glass or polypropylene ultraviolet resistant filaments woven, spun bonded, fused, or otherwise manufactured into a non-raveling fabric with uniform thickness and strength. Fabric must have manufacturer certified minimum average roll properties that conform with [_____]. Submit a sample and material product data for all Geotextiles utilized.

PART 3 EXECUTION

3.1 PROTECTION

****

NOTE: Include this paragraph when scope of work requires excavations which are greater than 1.5 m 5 feet or where it is known that in-situ soils lack the stability to hold near vertical faces. Where sufficient room is available, the Contractor may slope back trench walls rather than having to use a shoring system. However, the Contractor should not be given the opportunity to slope the faces of

excavations in lieu of providing shoring unless all the following conditions are met:

The excavation is less than 6 m 20 feet in depth.

There are no adjacent structures, roads, or pavements that will affect the excavation.

No equipment, stored material, or overlying material will affect the excavation.

Vibration from equipment, traffic, or blasting will not affect the excavation.

There will be no ground water problems.

Surcharges will not affect the excavation.

Operational considerations permit laying back the slopes of the excavation.

In conditions requiring engineering expertise to assess or design, include requirement for Geotechnical Engineer in paragraph QUALITY CONTROL.

****

Perform all work specified in accordance with applicable requirements of the Corps of Engineers publication EM 385-1-1 Safety and Health Requirements Manual.[Provide a Geotechnical Engineer to monitor construction activities and to prepare necessary work plans and reports; see paragraph QUALITY CONTROL.]

Use equipment of type and size appropriate for the site conditions (soil character and moisture content). Maintenance of exposed subgrades and fills is the responsibility of the Contractor. The Contractor is required to prevent damage by ineffective drainage, dewatering, and heavy loads and equipment by implementing precautionary measures. Repair or replace any defects or damage.

3.1.1 Underground Utilities

Location of the existing utilities indicated is approximate. Physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor is responsible for protecting utilities from damage during construction.

3.1.2 Drainage and Dewatering

****

NOTE: Sentence can be used instead of paragraphs DRAINAGE and DEWATERING for minor, low consequence situations related to impacts from surface or groundwater.

****

Provide for the collection and disposal of surface and subsurface water encountered during construction.

3.1.2.1 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity [and][or] provide temporary ditches, swales, and other drainage features and equipment as required to keep soils from becoming unstable, prevent erosion, or undermining of foundations. Remove unstable material from working platforms for equipment operation and soil support for subsequent construction features and provide new material as specified herein. It is the responsibility of the Contractor to assess the site conditions to employ necessary measures to permit construction to proceed.

3.1.2.2 Dewatering

****

NOTE: UFC 3-220-01 only requires 300 mm 12 inches for temporary dewatering during construction.

****

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches are not allowed within one meter 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Perform control measures by the time the excavation reaches the water level in order to maintain the integrity of the in-situ material. While the excavation is open, maintain the water level continuously, at least [_____] meters feet below the working level.[Submit a Dewatering Work Plan outlining procedures for accomplishing dewatering work.][Operate dewatering system continuously until construction work below existing water levels is complete. Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system. Submit dewatering performance records weekly.]

3.1.3 Shoring and Sheeting

Submit an Excavation and Trenching Plan to stabilize features, prevent undermining or unintended horizontal and vertical movement of adjacent structures, and prevent slippage or movement in banks or slopes adjacent to the excavation. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Drawings to include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations are to include data and references used.

3.1.4 Protection of Graded Surfaces

Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.2 BORROW

****

NOTE: Where a substantial quantity of borrow excavation is anticipated, the drawings and specifications will indicate the location or locations within the project site, and the conditions under which borrow may be obtained.
****

Select borrow material to meet the requirements and conditions of the fill or embankment for which it is to be used. Obtain borrow material from [the borrow areas shown] [within the limits of the project site, selected by the Contractor] [from approved private sources].[Submit a Borrow Plan that includes materials to be excavated, stockpile locations, proposed slopes, drainage, and closure.] Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval.

3.2.1 Government Furnished Borrow Area(s)

****
NOTE: Verify materials from Government furnished borrow are suitable for intended use. Alternatively, indicate that Contractor needs to determine suitability. Provide available information on material properties. Include in paragraph any Installation or Government requirements, conditions, and restrictions.

Utilize this paragraph where borrow site for the project will be furnished by the Government. Delete and utilize paragraph CONTRACTOR FURNISHED BORROW AREA(S) where borrow is furnished by the Contractor. In the event that a combination of multiple borrow sites is required for the project, maintain both paragraphs.
****

Obtain approved borrow materials from [_____]. The rights-of-way and earth materials for constructing the work have been furnished, without cost, to the Contractor at locations as [specified] [shown]. Submit a Borrow Plan to the Government of intention to use the specified Government-furnished borrow areas.

3.2.1.1 Stripping and Stockpiling Operations in Borrow Area

Strip in accordance with paragraph STRIPPING. Strip at least 1.5 meters 5 feet beyond the limits of the borrow excavation and any stockpiles of fill and embankment materials.

Stockpile materials within the borrow area work limits such that the stockpiles does not interfere with borrow operations. Stockpile borrow material awaiting transport in approved segregated piles. Maintain a minimum of 10 meters 30 feet between all stockpile toes and the top of the borrow cut.

3.2.1.2 Drainage of Borrow Excavations

Provide adequate drainage of borrow area. Ensure that borrow operations result in minimum detrimental effects on natural environmental conditions.

3.2.1.3 Borrow Area Closure

Complete borrow areas final grading, so that slopes are not steeper than [_____] vertical on [_____] horizontal, except as otherwise indicated. Avoid abrupt changes in grade. Distribute stripped material and stockpiles of unstable materials over the disturbed borrow area, as directed. Final grade the borrow area to drain.

3.2.2 Contractor Furnished Borrow Area(s)

****

NOTE: Utilize this paragraph where borrow site for project will be furnished by the Contractor. Delete and utilize paragraph GOVERNMENT FURNISHED BORROW AREA(S) where borrow is furnished by the Government. In the event that a multiple borrow sites are required for the project, maintain both paragraphs.

****

Obtain approved borrow materials from approved offsite sources. If a borrow source is selected that is not a commercial entity from which soil material is directly purchased, submit a Borrow Plan that includes the borrow source location, geotechnical test results showing the fill material meets the Contract requirements, environmental test results in accordance with paragraph ENVIRONMENTAL REQUIREMENTS FOR OFF-SITE SOIL, and any Federal, State, and local permits required for excavation and reclamation of the borrow area.

3.2.3 Environmental Requirements for Off-Site Soil

****

NOTE: Check with regional and local authorities as well as the facility/installation manager to determine actual requirements of bracketed items; values shown come from the Commonwealth of Virginia. Remove this paragraph if not required by the project.

Generally, Government Furnished Borrow Area(s)should be tested before contract award.

****

Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill may not contain concentrations above [appropriate State and EPA criteria, and for hazardous waste characteristics] [10] [_____] parts per million (ppm) of total petroleum hydrocarbons (TPH) and [10] [_____] ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and pass the TCLP test. Determine TPH concentrations by using [EPA Method 8015][applicable State TPH Testing Requirements]. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020/8260B. Perform TCLP in accordance with

EPA SW-846.3-3 Method 1311. Perform hazardous waste characteristic tests for ignitability, corrosivity, and reactivity in accordance with accepted standard methods. Perform PCB testing in accordance with accepted standard methods for sampling and analysis of bulk solid samples. Provide borrow site testing for petroleum hydrocarbons and BTEX from a grab sample of material from the area most likely to be contaminated at the borrow site (as indicated by visual or olfactory evidence), with at least one test from each borrow site. Provide borrow site testing for hazardous waste characteristics (TPH, BTEX and TCLP) from a composite sample of material, collected in accordance with standard soil sampling techniques. Do not bring borrow material to project site until Borrow Plan containing environmental test results has been received and approved by the Contracting Officer.

3.3 SURFACE PREPARATION

3.3.1 Clearing and Grubbing

[Clear and grub as specified in Section 31 11 00 CLEARING AND GRUBBING.

] Remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations. Remove stumps entirely. Grub out matted roots and roots over 75 mm 3 inches in diameter to at least 500 mm 18 inches below existing surface.

3.3.2 Stripping

****

NOTE: Topsoil will be separately excavated, stored, and used for surface finish in preparation for seeding, sodding, or other planting, only where topsoil is definitely superior for grass and plant growth as compared with the remainder of the excavated material. Surface soil that is a heavy clay, predominantly sandy, or is lean in grass- and plant-growth qualities, will not be saved. The hauling, spreading, smoothing, and maintenance of the topsoil in preparation for the seeding and planting operations are generally considered under a separate section, and therefore are not considered in this specification. The blank will be filled with the appropriate depth dimension.

****

Strip site where indicated on the plans. Strip existing surface materials to a depth of [100] [_____] mm [4] [_____] inches below the existing ground surface in areas designated as Clear and Grub on the plans. Strip existing surficial soils to a depth of [_____] mm inches in all other areas. Strip in all areas within the planned limits of disturbance. All stripped materials not suitable for reuse as topsoil will be wasted in specified disposal area. Screen all stripped soils to remove roots and organic materials prior disposal.

[Strip suitable soil from the site where excavation or grading is indicated and stockpile separately from other excavated material. Protect topsoil and keep in segregated piles until needed.

]3.3.3 Proof Rolling

****

NOTE: Specify proof rolling when the quality of the existing subgrade is questionable. Proof rolling can be used to verify that material in question is acceptable for constructing a project feature (no bid quantity required, location shown or specified) or to locate suspected areas where material is not acceptable for project features (indicate a bid quantity to be removed). Remove this paragraph if not required in the project.

****

Perform proof rolling on exposed subgrade that is unfrozen and free of surface water (wet conditions resulting from rainfall).[Notify the Contracting Officer a minimum of three days prior to proof rolling.][Perform proof rolling in the presence of the Contracting Officer.]

[After stripping, excavating, and rough grading to the planned elevation,]proof roll the existing subgrade of all building, pavement and embankment locations with six passes of a [loaded tandem axle dump truck] [15 ton, pneumatic-tired or smooth drum roller]. Operate the [roller] [truck] in a systematic manner to ensure the number of passes over all areas, and at speeds between 4 to 5.5 km per hour 2.5 to 3.5 miles per hour. Subgrade materials that exhibit excessive deflection and/or rutting during proof rolling need to be scarified, aerated, and re-compacted to specified density at [plus or minus] [2][_____] percent of optimum moisture content prior to being considered for remedial action by the Contracting Officer. When proof rolling under buildings, the building subgrade is considered to extend 1.5 meters 5 feet beyond the building lines, and make one-half of the passes with the roller in a direction perpendicular to the other passes.

3.3.4 Stockpiling Operations

****

NOTE: When spoil areas or borrow areas are within the limits of Government-controlled land, additional requirements based on the following, and as appropriate for the project, will be included in the contract document. Locations of areas will be indicated, or the approximate distances from the project site will be specified. Generally, unburned vegetative material and surplus excavated material will be disposed of in inconspicuous spoil areas where no future construction is planned. If economically justifiable, surplus suitable excavated material may be stockpiled or may be disposed of in areas where future construction is planned and where fill will be required. Spoil materials will be so placed and the worked portions of spoil areas and borrow areas will be so graded and shaped as to minimize soil erosion, siltation of drainage channels, and damage to existing vegetation.

****

Place and grade stockpiles of satisfactory [and unsatisfactory] [and wasted materials] as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. Do not create stockpiles that could obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.4 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Excavate soil disturbed or weakened by Contractor's operations, and soils softened or made unstable for subsequent construction due to exposure to weather. Use material removed from excavations meeting the specified requirements in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes to minimize surplus material and to minimize additional material to brought on site. Do not excavate below indicated depths except to remove unstable material as determined by the [Government] [Geotechnical Engineer] and confirmed by the Contracting Officer. Remove and replace excavations below the grades shown with appropriate materials as directed by the Contracting Officer.

If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock or as hard/unyielding material, uncover such material, and notify the Contracting Officer. Do not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow sufficient time for classification and delineation of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

3.4.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown. Do not excavate below grades shown. Backfill excessive excavation as directed by the Contracting Officer, with satisfactory, compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed. Do not allow material to be deposited within one meter 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.4.2 Trench Excavation Requirements

****

NOTE: The width of the trench below the top of the pipe will depend on the type of pipe used and soil conditions. The pipe manufacturer's installation manual should provide this information, and if so, it will be followed. In general, the width of trench will be 300 mm to 600 mm 12 inches to 24

inches, plus pipe O.D. for smaller pipe sizes, and 600 mm to 900 mm 24 inches to 36 inches plus pipe O.D. for larger pipe sizes. Sloping walls below the top of the pipe are allowed for certain types of pipe in special ground conditions.
****

Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope trench walls below the top of the pipe, or make vertical, and of such width as recommended by the manufacturer. Provide vertical trench walls where no manufacturer installation instructions are available. Do not exceed the trench width of 600 mm 24 inches below the top pipe plus pipe outside diameter (O.D.) for pipes of less than 600 mm 24 inches inside diameter, and do not exceed 900 mm 36 inches plus pipe outside diameter for pipe sizes larger than 600 mm 24 inches inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.

3.4.2.1 Bottom Preparation

****
NOTE: Stones 75 mm 3 inches or greater should be removed. However, pipe manufacturer's criteria, if any, should be used.
****

Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of [_____] mm inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3.4.2.2 Removal of Unyielding Material

****
NOTE: Minimum of 100 mm 4 inches should be removed to produce a suitable cushion for the pipe.
****

Where [overdepth is not indicated and]unyielding material is encountered in the bottom of the trench, notify the Contracting Officer. Following approval, remove such material [_____] mm inch below the required grade and replaced with suitable materials as provided in paragraph FILLING AND COMPACTION.

3.4.2.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with suitable material as provided in paragraph FILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Government.

3.4.2.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures [sufficient to leave at least 300 mm 12 inches clear between the outer structure surfaces and the face of the excavation or support members.] [of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown.]

3.4.2.5 Gas Distribution

Excavate trenches to a depth that will provide a minimum 450 mm 18 inches of cover in rock excavation and a minimum 600 mm 24 inches of cover in other excavation.

3.4.2.6 Water Lines

****

NOTE: Minimum depth of cover will be that required for frost penetration in the region and for safe operation of the utility. For fire protection yard mains, reference is made to NFPA 24 for recommended depth of cover.

****

Excavate trenches to a depth that provides a minimum cover of [_____] meters feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.[For fire protection yard mains or piping, an additional [_____] mm inch of cover is required.]

3.4.3 Jacking, Boring, and Tunneling

****

NOTE: Generally, Section 33 05 23 TRENCHLESS UTILITY INSTALLATION should be used instead. This section should only be considered for minor, low risk, and relatively simple situations.

In situations where utility lines must be installed more than 5 to 7 meters 15 to 20 feet below ground surface, through embankments, under minor roads or parking areas, or where surface conditions make it difficult or impractical to excavate open trenches, utility lines may be installed by jacking, boring, or tunneling as a Contractor option. Where operational requirements preclude installation by trenching, the use of jacking, boring, or tunneling should be specified as mandatory alternatives. This requirement will normally exist where utilities must cross railroads, highways, primary access roads and airfield pavements. Pipe and conduit smaller than 900 mm 36 inches in diameter will normally be installed in smooth steel pipe casing. Designing engineers must coordinate with installation facility engineers to identify and validate utility crossings where jacking, boring, or tunneling will be specified as mandatory.

Where the above conditions/requirements are not

present, and where the existing subsurface conditions would prove difficult and costly to bore/tunnel (e.g., large boulders/cobbles or shallow rock), delete this paragraph in its entirety.

****

Unless otherwise indicated, provide excavation by open cut except those sections requested and if, in the opinion of the Contracting Officer, can be safely and properly installed and backfill. Provide a Jacking, Boring, and Tunneling Plan, signed and sealed by a licensed Professional Engineer that includes a work site layout, methods and procedures, equipment, alignment control, monitoring, and contingency for responding to unplanned movements.

3.4.3.1 Pipeline Casing

Provide new smooth wall steel pipeline casing under [new] [existing] [railroad] [and] [pavement] [in a trench] [by the boring and jacking method of installation]. Provide each new pipeline casing, where indicated and to the lengths and dimensions shown, complete and suitable for use with the new piped utility as indicated.[Install pipeline casing by dry boring and jacking method as follows:]

3.4.3.2 Bore Holes

Mechanically bore holes and case through the soil with a cutting head on a continuous auger mounted inside the casing pipe. Weld lengths of pipe together in accordance with AWS D1.1/D1.1M. Do not use water or other fluids in connection with the boring operation.

3.4.3.3 Cleaning

Clean inside of the pipeline casing of dirt, weld splatters, and other foreign matter which would interfere with insertion of the piped utilities by attaching a pipe cleaning plug to the boring rig and passing it through the pipe.

3.4.3.4 End Seals

After installation of piped utilities in pipeline casing, provide watertight end seals at each end of pipeline casing between pipeline casing and piping utilities. Provide watertight [end seals as indicated.] [segmented elastomeric end seals.]

3.4.4 Underground Utilities

****

NOTE: Delete this paragraph in its entirety if no known utilities or subsurface construction is located below or adjacent to work covered in this specification.

****

[Perform work adjacent to utilities [as indicated] [in accordance with procedures outlined by utility owner].] [Excavation made with power-driven equipment is not permitted within [600] [_____] mm [2] [_____] feet of known utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer.] Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.4.5 Structural Excavation

****

NOTE: For projects requiring over-excavation and replacement of near-surface materials below building and/or pavement areas, retain and edit the bracketed text.

****

[Following general excavation and rough grading activities, excavate the entire building footprint area and at least 1.5 meters 5 feet beyond, to the deeper of [1200] [_____] mm [4] [_____] feet below existing grade or [600] [_____] mm [2] [_____] feet below bottom of footings. Scarify the exposed surface to a depth of [150 to 200 mm] [6 to 8 inches], moisture-condition, and compact to at least 95 percent of laboratory maximum density.][Do not excavate to final grade until just before concrete is to be placed. Roughen level surfaces. Cut sloped surfaces as indicated into rough steps or benches to provide a satisfactory bond for compacting materials.][For new pavement areas including exterior concrete pads, over-excavate to a minimum of 300 mm 12 inches below bottom of new pavement/pad base course, scarify, moisture-condition, and compact to at least 95 percent.]

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata.

Concrete placement is not allowed until footing subgrades have been inspected and approved by the Contracting Officer.

3.4.6 Pile Cap Excavation

[Stop the excavation at an elevation 150 to 300 mm 6 to 12 inches above the bottom of the footing before driving piles. After pile driving has been completed, complete the remainder of the excavation to the elevations shown.] [Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the Contracting Officer.] After the pile driving has been completed, remove loose and displaced material and complete excavation, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry. Backfill and compact over-excavations and changes in grade due to pile driving operations to 95 percent of [ASTM D698] [ASTM D1557] maximum density.

3.4.7 Rock Excavation and Blasting

Excavate rock encountered in the cut section to a depth of 150 mm 6 inches below finished grade and replace with [satisfactory material] [_____].[Submit a Rock Excavation Plan, prepared and sealed by a registered professional engineer.][Perform blasting in accordance with EM 385-1-1 and in conformance with Federal, State, and local safety regulations.

Submit notice 15 days prior to starting work. Submit a Blasting Plan, prepared and sealed by a registered professional engineer that includes calculations for overpressure and debris hazard. Provide blasting mats and use the non-electric blasting caps. Obtain written approval prior to performing any blasting and notify the Contracting Officer 24 hours prior to blasting. Include provisions for storing, handling and transporting explosives as well as for the blasting operations in the plan. The Contractor is responsible for damage caused by blasting operations.][Blasting will not be permitted.]

3.5 SUBGRADE PREPARATION

3.5.1 General Requirements

****

NOTE: Moisture content limits for compaction should be included in these paragraphs when necessary for obtaining strength and stability in embankments and fill, for controlling movement of expansive soils and when, in the opinion of the project geotechnical engineer, moisture control is required for the soils being used.

****

Shape subgrade to line, grade, and cross section as indicated. Remove unsatisfactory and unstable material in surfaces to receive fill or in excavated areas, [as determined by proof rolling,]and replaced with [satisfactory materials] [structural fill] [_____]. Do not place material on surfaces that are muddy, frozen, contain frost, or otherwise containing unstable material. Scarify the surface to a depth of 100 mm 4 inches prior to placing fill. Step or bench sloped surfaces steeper than 1 vertical to 4 horizontal prior to scarifying. Place 100 mm 4 inches of loose fill and blend with scarified material. When subgrade is part fill and part excavation or natural ground, scarify to a depth of 200 mm 8 inches.

3.5.2 Subgrade for Structures, Spread Footings, and Concrete Slabs

Do not excavate below depth shown for structures, spread footings, and concrete slabs. If over excavation occurs, [notify the Contracting Officer and remove, replace, and compact as directed.] [compact disturbed material to [95] [_____] percent of [ASTM D698] [ASTM D1557].] After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 15 mm 0.05 foot when tested with a 4 meter 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.5.3 Subgrade for Railroads

Compact subgrade for railroads to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials.

3.5.4 Subgrade for Pavements

Compact top 300 mm 12 inches of subgrade for pavements to at least 95 percent of [ASTM D698] [ASTM D1557]. After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 15 mm 0.05 foot when tested with a 4 meter 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.5.5 Subgrade for Shoulders

Compact the upper [150] [_____] mm [6] [_____] inches of subgrade for shoulders to at least [95][_____] percent of [ASTM D698] [ASTM D1557] for the [depth below the surface of shoulder shown] [full depth of the shoulder].

3.5.6 Subgrade for Airfield Pavements

****

NOTE: Refer to UFC 3-260-02 for specific requirements for compaction of Airfield Pavement subgrade and modify paragraph as necessary.

****

Compact top [_____] mm inches of subgrade, to [95] [_____] percent of ASTM D1557. After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 15 mm 0.05 foot when tested with a 4 meter 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.5.7 Subgrade Filter Fabric

Place filter fabric as indicated directly on prepared subgrade free of vegetation, stumps, rocks larger than 50 mm 2 inch diameter and other debris which may puncture or otherwise damage the fabric. Repair damaged fabric by placing an additional layer of fabric to cover the damaged area a minimum of one meter 3 feet overlap in all directions. Overlap fabric at joints a minimum of one meter 3 feet. Obtain approval of filter fabric installation before placing fill or backfill. Place fill or backfill on fabric in the direction of overlaps and compact as specified herein. Follow manufacturer's recommended installation procedures.

3.6 FILLING AND COMPACTION

****

It is imperative to specify a high degree of compaction in fills under structures to minimize settlement and to ensure stability of a structure. In addition to the criteria set forth in UFC 3-220-01, the following factors will be considered in establishing the specific requirements:

a. The sensitivity of the structure to total and differential settlement as related to the structural design. This is particularly true of structures to be founded partly on fill and partly on natural ground.

b. The ability of normal compaction equipment to produce the desired densities in existing or locally available materials within a reasonable range of molding moisture content. If considered essential, special equipment will be specified.

c. The compaction requirements for clean, cohesionless, granular materials will be generally higher than those for cohesive materials because

cohesionless materials readily consolidate when subjected to vibration. For structures with critical stability requirements and settlement limitations, the minimum density requirements may be altered. If only a cohesionless soil or only a cohesive soil is used, the inapplicable values will be deleted.

d. The exception to required high degree of compaction in fills and backfills is in expansive soils (see UFC 3-220-01). Where it is necessary to use materials having swelling characteristics, usually CL or CH classifications, the specified degree of compaction will be related to laboratory test results for swelling under a considerable range of molding moisture and compactive effort. In swelling soils, it is important to specify a density and molding moisture range that will enable the soil to stay stable, striking a reasonable balance between potential swell and excessive settlement under load, even at the expense of accepting a reduced bearing capacity. A maximum permissible density should be established to minimize swelling. If possible, soils with swelling characteristics will be classified as unsatisfactory material, particularly under critical stability structures.

e. ASTM D1557 is satisfactory for establishing moisture density characteristics of a material in most cases. However, other modifications may be necessary as discussed in this ASTM and under soil tests in DM 21.3/ UFC 3-260-02. The procedures and precautions in the subgrade compaction paragraphs of DM 21.3/UFC 3-260-02, will be considered in establishing minimum density requirements for a particular project.

Modifications will be made to meet the backfill requirements for deep-seated or subsurface structures as discussed in UFC 3-220-04FA.

****

Prepare ground surface on which backfill is to be placed and provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs for SUBGRADE PREPARATION. Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary [to plus or minus [_____] percent of optimum moisture] [to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used]. Fill and backfill to contours, elevations, and dimensions indicated. Compact and test each lift before placing overlaying lift.

3.6.1 Trench Backfill

****

NOTE: Most pressure tests require backfilling to at least 600 mm 2 feet over the pipe with the joints

and couplings left open for inspection.
****

Backfill trenches to the grade shown. [Backfill the trench to [_____] meters feet above the top of pipe prior to performing the required pressure tests. Leave the joints and couplings uncovered during the pressure test.] [Do not backfill the trench until all specified tests are performed.]

3.6.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with satisfactory material or initial backfill material.

3.6.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with satisfactory material placed in layers not exceeding 150 mm 6 inches loose thickness.

3.6.1.3 Bedding and Initial Backfill

****
NOTE: Bedding is provided to level out any irregularities in the foundation and to assure uniform support along the barrel of each pipe section. Bedding is also constructed to distribute the load bearing reaction, due to the weight of the backfill material, around the lower portion of the pipe. If the pipe or conduit is placed directly on a flat or shaped foundation, delete "bedding" from the title and from any reference in the paragraph. If bedding will be specified, determine type and thickness and show on the plans. Specify compaction to 95 percent maximum density for cohesionless soils, and 90 percent maximum density for cohesive soils.

Any locally available fine aggregate for concrete or asphalt mixtures will qualify as sand and may be specified by local gradation and specification number in lieu of "SW" or "SP." Drawings (details) should clearly show where sand backfill or bedding is required.

Locally available coarse aggregate for concrete will suffice and may be specified by local gradation and specification number in lieu of "GW" or "GP." Maximum size of aggregate should not be more than 25 mm per 300 mm one inch per foot of pipe diameter or 75 mm 3 inches maximum. Refer to pipe manufacturer's criteria for more stringent requirements, if any, on aggregate size and gradation. On drawings (details), clearly show where gravel backfill or bedding is required.
****

[Provide bedding of the type and thickness shown.]Place initial backfill material and compact it with approved tampers to a height of at least 300 mm one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except where shown or when specified otherwise in the individual piping section, provide bedding for buried piping in accordance with PART 2 paragraph UTILITY BEDDING MATERIAL. Compact backfill to top of pipe to [95 percent of ASTM D698 maximum density] [85 percent of ASTM D1557]. Provide plastic piping with bedding to spring line of pipe.

3.6.1.4 Final Backfill

Do not begin backfill until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Bring backfill to indicated finish grade. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 600 mm 2 feet above sewer lines and 300 mm one foot above other utility lines need to be free from stones larger than 25 mm one inch in any dimension. Heavy equipment for spreading and compacting backfill are not to be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; compact remaining area in layers not more than 100 mm 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Place backfill carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Do not place backfill against foundation walls prior to 7 days after completion of the walls. As far as practicable, bring backfill up evenly on each side of the wall and sloped to drain away from the wall.

Fill the remainder of the trench, except for special materials for buildings[, railroads][, airfields] and pavements with satisfactory material. Place backfill material and compact as follows:

3.6.1.4.1 Buildings[, Railroads][, Airfields] and Pavements

Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction. Compact as specified for Structural Fill.

3.6.1.4.2 Turfed or Seeded Areas and Miscellaneous Areas

Deposit backfill in layers of a maximum of 300 mm 12 inches loose thickness, and compact it to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils.[Allow water flooding or jetting methods of compaction for granular noncohesive backfill material. Do not allow water jetting to penetrate the initial backfill.][Do not permit compaction by water flooding or jetting.] Apply this requirement to all other areas not specifically designated above.

3.6.1.5 Heat Distribution System

Free initial backfill material of stones larger than 6.3 mm 1/4 inch in any dimension.

3.6.1.6 Electrical Distribution System

Provide a minimum cover of 600 mm 24 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.6.1.7 Sewage Absorption Trenches or Pits

****

NOTE: Delete these paragraphs when sewage absorption trenches or pits are not included in the project. Consult a geotechnical engineer and local standards in selecting bracketed information.

****

3.6.1.7.1 Porous Fill

Provide backfill consisting of porous fill material in the locations and thickness as shown on the drawings. No compaction is required.

3.6.1.7.2 Cover

****

NOTE: Select appropriate bracketed information to correspond to the design indicated on the drawings.

****

[Filter fabric][Concrete][Kraft paper conforming to CID A-A-203, Grade B, No. 2, 22.7 kg 50 pound weight][or a layer of straw at least 50 mm 2 inches thick]as indicated.

3.6.1.8 Displacement of Features

****

NOTE: The trench should be backfilled to at least 600 mm 2 feet.

****

After other required tests have been performed and the trench backfill compacted to [[_____] meters feet above the top of the pipe] [the finished grade surface], inspect the pipe to determine whether unexpected or damaging displacement has occurred. Conduct walk-through inspection of pipe sizes larger than 1200 mm 48 inches. Inspect pipes smaller than 1200 mm 48 inches using remote methods using closed circuit television, sonar, or hybrid that can provide a 360-degree inspection of the pipe. Prepare and submit a pipe inspection report consisting of digital video or photos. If, in the judgment of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost to the Government.

3.6.1.9 Buried Tape And Detection Wire

3.6.1.9.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 300 mm 12 inches below finished grade; under pavements and slabs, bury tape 150 mm 6 inches below top of subgrade.

3.6.1.9.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm 12 inches above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 0.9

meters 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over its entire length. Install wires at manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.6.2 Structural Fill Placement

Place fill and backfill beneath and adjacent to structures in successive horizontal layers of loose material not more than 200 mm 8 inches in depth, or in loose layers not more than 100 mm 4 inches in depth when using hand-operated compaction equipment. Do not place over wet or frozen materials. Compact to at least 90 percent of laboratory maximum density for cohesive materials or 95 percent of laboratory maximum density for cohesionless materials, except as otherwise specified. Perform compaction in such a manner as to prevent wedging action or eccentric loading upon or other damage to the structure. Moisture condition fill and backfill material to [a moisture content that will readily facilitate obtaining the specified compaction][within range of plus 2 or minus 2 percent of optimum moisture content at the time of compaction].

3.6.3 Backfill for Appurtenances

****

NOTE: The number of days the concrete is allowed to cure before backfilling the structure will depend on the type of mix and the concrete strength requirements specified. Three days would be considered as a minimum. Seven days is more common.

****

After the manhole, catchbasin, inlet, or similar structure has been constructed[and the concrete has been allowed to cure for [7][_____] days], place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.6.4 Porous Fill Placement

Provide under floor and area-way slabs on a compacted subgrade. Place in a single lift and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.6.5 Flowable Fill

Place fill in a manner to completely fill voids in the location indicated. Do not place when atmospheric temperatures are expected to be below one degree C 33 degrees F at any time during the 3 day period following placement.

3.6.6 Compaction

****

NOTE: In general for most projects, use ASTM D698 for compaction. Use ASTM D1557 for roads, airfields, and other heavily loaded areas or locations needing a greater density or compressive strength. Specify compaction in terms of one method

of compaction effort (ASTM D698 or ASTM D1557) for a contract, if possible. Use 90 percent of ASTM D698 or ASTM D1557 for general site compaction of cohesionless materials on Army projects and 85 percent for Navy projects. For airfield projects see UFC 3-260-02 for criteria and design guidelines.
****

3.6.6.1 General Site

Compact underneath areas designated for vegetation and areas outside the 1.5 meter 5 foot line of the paved area or structure to [85] [90] percent of [ASTM D698] [ASTM D1557].

3.6.6.2 Adjacent Areas

Compact areas within 1.5 meters 5 feet of structures to 95 percent of [ASTM D698] [ASTM D1557].

3.7 EMBANKMENTS

3.7.1 Earth Embankments

****
NOTE: Moisture content limits for compaction should be included in these paragraphs when necessary for obtaining strength and stability in embankments and fill, for controlling movement of expansive soils and when, in the opinion of the project geotechnical engineer, moisture control is required for the soils being used.

This paragraph should be omitted from projects where specialized earthwork controls not specified in EXCAVATION, SUBGRADE PREPARATION and FILLING AND COMPACTION.
****

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 75 mm 3 inches. Place the material in successive horizontal layers of loose material not more than 200 mm 8 inches in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise break up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Backfill and fill material are to be [within the range of minus 2 to plus 2 percent of optimum moisture] [to a moisture content that will readily facilitate obtaining the specified compaction].

Compaction requirements for the upper portion of earth embankments forming subgrade for pavements are identical with those requirements specified in paragraph SUBGRADE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.7.2 Rock Embankments

****

NOTE: The designer will determine the appropriate values for all blank spaces, except the last one, on the basis of recent experience on similar construction or of test results obtained from construction and testing of a test section. The specific method by which density will be determined in the laboratory and measured in the field will be described in the project specification. The total thickness of the pavement structure, including subbase, base, and pavement will be placed in the last blank space in this paragraph.

The first blank space applies to rock fill of small maximum dimension and maximum lift placement of 200 to 250 mm 8 to 10 inches. Coordinate maximum size with satisfactory material definition. If it is necessary to use larger rock and thicker lifts, the second expression in brackets is applicable. When thicker lifts are used, it may be necessary to specify a minimum number of passes of the compactor. Delete last sentence, unless the rock excavation is engineered to be used under pavements with sufficient fines to prevent consolidation of the embankment.

This paragraph should be omitted from projects where specialized earthwork controls not specified in EXCAVATION, SUBGRADE PREPARATION, and FILLING AND COMPACTION.

****

Construct rock embankments from material classified as rock excavation, as defined above, placed in successive horizontal layers of loose material not more than [_____] mm inch in depth. Do not use pieces of rock larger than [_____] mm inch in the greatest dimension. Spread each layer of material uniformly, completely saturate, and compact to a minimum density of [_____] kg/cubic meter pounds per cubic foot. Adequately bond each successive layer of material to the material on which it is placed. Finish compaction with vibratory compactors weighing at least [_____] metric tons tons, heavy rubber-tired rollers weighing at least [_____] metric tons tons, or steel-wheeled rollers weighing at least [_____] metric tons tons.[Do not use rock excavation as fill material for the construction of pavements.][In embankments on which pavements are to be constructed, do not use rock above a point [_____] mm inch below the surface of the pavement.]

3.8 RIP-RAP CONSTRUCTION

****

NOTE: Select information in brackets to best describe rip-rap construction. Provide detail or typical section through rip-rap on drawings as well as all dimensions necessary for estimating and construction. If DOT standard specifications are referenced for rip-rap construction, paragraphs PREPARATION through GROUTING may be deleted.

****

Construct rip-rap [on bedding material] [on filter fabric] [with grout] [in accordance with [DOT] [_____] State Standard, paragraph [_____]] in the areas indicated. Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 30 mm 0.1 foot.

3.8.1 Bedding Placement

Spread [filter fabric and] bedding material uniformly to a thickness of at least [75] [_____] mm [3] [_____] inches on prepared subgrade as indicated.[Compaction of bedding is not required. Finish bedding to present even surface free from mounds and windrows.]

3.8.2 Stone Placement

Place rock for rip-rap on prepared bedding material to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.[For grouted rip-rap, hand-place surface rock with open joints to facilitate grouting and do not fill smaller spaces between surface rock with finer material. Provide at least one "weep hole" through grouted rip-rap for every 4.65 square meters 50 square feet of finished surface. Provide weep holes with columns of bedding material, 100 mm 4 inches in diameter, extending up to the rip-rap surface without grout.]

[3.8.3 Grouting

Prior to grouting, wet rip-rap surfaces. Grout rip-rap in successive longitudinal strips, approximately 3 meters 10 feet in width, commencing at the lowest strip and working up the slope. Distribute grout to place of final deposit and work into place between stones with brooms, spades, trowels, or vibrating equipment. Take precautions to prevent grout from penetrating bedding layer. Protect and cure surface for a minimum of 7 days.

]3.9 FINISHING/FINISH OPERATIONS

****

NOTE: Special smoothness tolerances are not required for subgrades for railroads; therefore, both sets of brackets will be removed when writing specifications for preparation of railroad subgrade only. When writing specifications for preparation of roadway and/or airfield pavement subgrade, the brackets will be removed from the applicable sentences and the smoothness tolerances showing permissible deviations in fractions of a millimeter inch and the length of straightedge in meters feet will be inserted in the blanks as appropriate.

****

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, frozen or otherwise unstable subgrade.

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 30 mm 0.1 foot of the grades and elevations indicated except as indicated for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.9.1 Capillary Water Barrier

****

NOTE: The compacted thickness and locations requiring a capillary water barrier must be indicated on the drawings. The thickness will not be less than 100 mm 4 inches. The paragraph will be deleted where site conditions make the barrier unnecessary.

****

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.9.2 Grading Around Structures

Construct areas within 1.5 meters 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.9.3 Shoulder Construction

****

NOTE: Shoulder construction will form a part of the work to be performed under this section of the specifications except when shoulder construction is specified under the subbase, base-course, wearing course, or pavement sections of the specifications and is designated in the contract to be performed and paid for under one of these sections.

****

Construct shoulders of [satisfactory material] [_____]. Submit advanced notice on shoulder construction for rigid pavements. Construct shoulders immediately after adjacent paving is complete. In the case of rigid pavements, do not construct shoulders until permission of the Contracting Officer has been obtained. Compact the entire shoulder area to at least the percentage of maximum density as specified in paragraph SUBGRADE PREPARATION above, for specific ranges of depth below the surface of the shoulder. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Finish shoulder construction in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. Align the completed shoulders true to grade and shaped to drain in conformity with the cross section shown.

3.9.4 Grading

Finish grades as indicated within 30 mm one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.9.5 Topsoil and Seed

****

NOTE: Topsoil will be separated, excavated, stored, and used for surface finish in preparation for seeding, sodding, or other planting only where the topsoil is definitely superior for grass and other plant growth as compared to the balance of the excavated materials. Generally, topsoil will be spread after other operations have been completed. When topsoil spreading is covered under a separate section of the specifications, this paragraph will be deleted.

****

[Provide as specified in Section 32 92 19 SEEDING [32 92 23 SODDING].]

On areas to receive topsoil, prepare the compacted subgrade soil to a 50 mm 2 inches depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of [_____] mm inch and grade to the elevations and slopes shown. Do not spread topsoil when frozen or excessively wet or dry. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 50 mm 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. [Stockpile in locations indicated][Remove from the site]any surplus of topsoil from excavations and gradings. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from [offsite areas] [areas indicated].

3.10 DISPOSITION OF SURPLUS MATERIAL

****

NOTE: Coordinate with Installation POC for on-site disposition of materials. Ensure requirements are consistent with Environmental specification.

****

Remove from Government property all surplus or other soil material not required or not suitable for filling or backfilling, along with brush, refuse, stumps, roots, and timber. Properly disposed of in accordance with all applicable laws and regulations. Prepare plan for Disposition of Surplus Materials to include permissions document to dispose of nonsalable products.

3.11 TESTING

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NOTE: Modify Table 1 to identify each material type to be subject to quality control testing. List materials in paragraph DEFINITIONS. For each material type, list each test method and test frequency appropriate for required work. If numerous tests required for different materials, allowable to create separate tables for each material for clarity.

Density test frequency can vary from one test per 10 square meters 100 square feet for small areas up to one test per 900 square meters 10,000 square feet. The following table is to help establish test frequency for various situations:

Material Type	**Location of Material**	**Test Frequency**
Undisturbed native soil	**Structures**	**Two random tests in building footings and two tests on subgrade within building line**
Fills and backfills	**Structures (adjacent to)**	**One test per structure per 200 sq m 2000 sq ft taken 300 mm 1 foot below finished grade**
Subgrades	**Site (except airfields)**	**One test per 250 sq m 2500 sq ft**
Embankments or borrow	**Any**	**One test per lift per 400 cubic m 500 cubic yds placed**
Native soil subgrade other than structures and parking	**Any**	**One test or one test per 900 sq m 10,000 sq ft whichever is greater**
Borrow	**Any**	**One test per lift per 400 cubic m 500 cubic yds placed**

For projects having extensive amounts or a critical need for test data to verify design or other urgent needs, consider using Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION and require Contractor to submit data to specified Data Management system in addition normal submission requirements.

****

Perform testing as indicated in Table 1. Submit Material Test Reports within [24 hours] [7 days] of tests being completed.[In addition, submit test data in accordance with Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION.]

Material Type [list materials to be tested as identified in paragraph DEFINITIONS]	Location of Material	Test Method	Test Frequency
		Density - [ASTM D1556/D1556M] [ASTM D2167] [ASTM D6938] [ASTM D8167/D8167M]. [When ASTM D6938 or ASTM D8167/D8167M is used, check the calibration curves and adjust using only the sand cone method as described in ASTM D1556/D1556M.]	One test per [2000] [_____] square meters feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines. Double testing frequency for areas compacted by hand-operated machines. [If ASTM D6938 or ASTM D8167/D8167M is used, check in-place densities by ASTM D1556/D1556M as follows: One check test per lift for every [6] [10] tests.] [Where ASTM D8167/D8167M is used, provide water content
		Moisture Content - ASTM D2216	Two tests per day for each type of fill and backfill. Sample taken immediately prior to compaction after moisture conditioning.

Material Type [list materials to be tested as identified in paragraph DEFINITIONS]	Location of Material	Test Method	Test Frequency
		Moisture Density Relationship - [ASTM D698][ASTM D1557]	One representative test per [500][_____] cubic meters yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density. Sample to be taken from stockpile or location of placement.
		Relative Density - ASTM D4253 and ASTM D4254	One test per [2000] [_____] square meters feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines. Double testing frequency for areas compacted by hand-operated machines.

Material Type [list materials to be tested as identified in paragraph DEFINITIONS]	Location of Material	Test Method	Test Frequency
		Gradation - ASTM C136/C136M	One representative test per [500][_____] cubic meters yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density. Sample to be taken from stockpile or location of placement.
		Atterberg Limits - ASTM D4318	One representative test per [500][_____] cubic meters yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density. Sample to be taken from stockpile or location of placement.
		Organic Content Test - ASTM D2974, Method C	One representative test per [200] [_____] lineal [meters] [feet] of embankment.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 05 19.13 (February 2021)**

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Preparing Activity: USACE **Superseding without Revision**
UFGS-31 05 22 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 31 05 19.13

GEOTEXTILES FOR EARTHWORK

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USACE / NAVFAC / AFCEC **UFGS-31 05 19.13 (February 2021)**

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SECTION 31 05 19.13

GEOTEXTILES FOR EARTHWORK

02/21

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NOTE: This guide specification covers the requirements for furnishing, hauling, and placing the geotextile, complete, as specified and shown, and maintaining the geotextile until placement of the granular filter material, bedding material, and/or riprap cover is completed and accepted. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: This guide specification is to facilitate the preparation and review of specifications for procurement and installation of woven and nonwoven geotextiles as filter material. It is based on field performance and the laboratory testing of a limited number of geotextiles. Geotextiles possess greatly varying engineering properties and physical characteristics. Such variations require the designer to decide which testing method and what

test criteria are necessary for each application. The apparent opening size (AOS), percent open area (POA), geotextile permeability (Kg), and strength test described in the specifications that follow are physical property tests. While it is acceptable to specify minimum thickness value where it governs performance, it is inappropriate to use thickness to identify a geotextile. Result of these tests are used to judge the acceptability of a geotextile for a particular use. Prospective geotextile suppliers should furnish these test results before their geotextile will be considered for use, or before contract specifications are adjusted to permit the use of geotextiles whose properties are outside the limits imposed by this guide. For severe soil conditions and/or for a project using a large amount of geotextiles, the specifications should require that the applicable tests be run during construction, either at a specific frequency or upon demand of the Contracting Officer. For projects requiring small amounts of geotextiles under normal soil conditions the physical properties of the geotextile supported by written authentication from an authorized representative of the manufacturers may be accepted.

The actual life of geotextiles is not known, and their use in inaccessible areas must be considered carefully. Therefore geotextiles should not be used as filter material in toe drains, buried collector system, relief wells, or within any portions of embankments. Caution is advised in using geotextiles on the upstream face of earth dams or to wrap permanent piezometers.

Geotextiles are basically inert materials for typical civil engineering applications. However certain applications may expose the geotextile to chemical or biological activities that could drastically influence the filtration properties of the geotextile. Specific site conditions should be reviewed, and if such conditions exist, testing and specifications should be written to overcome it.

Geotextile strength requirements vary with intended use and construction procedures. Experience has shown that when a heavier non-woven geotextile is used, the bedding material can often be reduced in thickness or be completely eliminated. TABLE I in SI ENGLISH UNITS (1) presents the most important geotextile strength properties. It should be noted that the strength requirements listed are only a guideline to the minimum values required for survivability. Specific applications may require additional testing.

Filter design criteria for geotextiles are based on the apparent opening size (AOS, which is designated as EOS in the previous guide specification), percent

open area (POA, for woven only), geotextile permeability (Kg), and an appropriate percent passing size of the soil. For piping analysis computations, AOS must be expressed as an equivalent U.S. standard sieve opening in millimeters. To assure adequate resistance to reduction in permeability over time (clogging) and sufficient long term flow through the soil/woven geotextile system, POA criteria, as expressed in the next note, can be used.

TABLE I

RECOMMENDED GEOTEXTILE STRENGTH REQUIREMENTS IN METRIC UNITS (1)

GEOTEXTILE USE	STRENGTH REQUIREMENTS (MINIMUM VALUES)			
	ASTM D4632 TENSILE (N) (lbs)	ASTM D4355/D4355M UNTRAVIOLET DEGRADATION AT 500 HOURS	ASTM D6241 PUNCTURE (N) (lbs)	ASTM D4533/D4533M TEAR (N) (lbs)
RIPRAP SLOPE PROTECTION FILTER WITH GREATER THAN 100 mm 4 INCHES BEDDING	515115	50	18040	18040
RIPRAP SLOPE PROTECTION WITHOUT BEDDING	900200	50	36080	18040
DRAINAGE TRENCH	515115	50	18040	11025
SLAB DRAIN	515115	50	18040	11025
ARTICULATED MATTRESS OR INTERLOCKING BLOCK SLOPE PROTECTION FILTER	515115	50	18040	18040

(1) Strength values are for the weaker principal direction.

The designer must specify geotextile properties which will allow retention of the soil being protected, permit sufficient flow through the textile, and prevent clogging. The designer should select the AOS, POA, and Kg, based on criteria in TABLE II. The AOS requirement should be specified as a range, to allow for manufacturing tolerance. It is preferable to specify a geotextile with opening as large as allowed by the design criteria. The smallest sieve opening size of the AOS range should not be smaller than the 0.125 mm sieve U.S. Standard sieve size No. 120.

TABLE II GEOTEXTILE FILTER DESIGN CRITERIA

		COEFFICIENT OF PERMEABILITY (3)	
PROTECTED SOIL (1) (PERCENT PASSING 75 µm NO. 200 SIEVE)	SOIL PIPING (2)	WOVEN	NON-WOVEN
< 5	$0_{95}/D_{85} \le 1$	POA 10 percent	Kg 5Ks
5 to 50	$0_{95}/D_{85} \le 1$	POA 4 percent	Kg 5Ks
50 to 85	$0_{95}/D_{85} \le 1$ $0_{95} \le$ 0.212 mm No. 70 U.S. sieve)	POA 4 percent	Kg 5Ks
$0_{95}/D_{85} \le 1$	$0_{95} \le$ 0.125 No. 120 U.S. sieve)	Kg 5Ks	

(1) Recent experiences have indicated that 0_{95} (i.e. AOS) increased with increasing relative density, Dr, and it is higher for uniform soil than well graded soil of similar density and average particle size.

(2) If the protected soil contains appreciable quantities of material retained on the 4.75 mm No. 4 U.S. sieve use only the soil passing the 4.75 mm No. 4 U.S. sieve in selecting the 0_{95} of the geotextile.

(3) Kg is the permeability of the geotextile and Ks is the permeability of the protected soil.

Satisfactory geotextile performance is greatly dependent on the field preparation of the surface of the protected soil and the installation procedure.

The following information is related to TABLE 1. Geotextile calculations should be based on procedure from an accepted reference. Worst placement conditions should be considered since stresses generated during installation often exceed post construction stresses.

(1) The requirement of permittivity (as defined in ASTM D4491/D4491M) should be chosen in such a manner that the permeability of the geotextile should always be at least five times greater than the permeability of the adjacent soil during the life of the protected earth structure.

(2) The minimum seam strength listed in TABLE 1 is based on the tensile strength of the parent geotextile material. Seam strength can also be considered as not less than 90 percent of the unaged grab tensile strength of the geotextile in the applicable direction.

NOTE: TO DOWNLOAD UFGS GRAPHICS

Figures described below are available on-line for download. Go to http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms

Figure 1. Correct geotextile placement for current acting parallel to bank or for wave attack on the bank.

Figure 2. Placement of geotextile on bank subject to streamflow action. Revetment materials have not yet been placed on the geotextile.

Figure 3. Geotextile on bank subject to wave attack showing placement of vertical-wall key trench at toe and top bank. Revetment materials have not yet been placed on geotextile.

Figure 4. Key trench design used when soil conditions do not permit construction of vertical walls.

The Designer must comply with the requirements of the following Regulatory Requirements:

U.S. DEPARTMENT OF INTERIOR, BUREAU OF RECLAMATION - 7-2071 (6-48), (1992) Design Standard No. 13, "Embankment Dams", Chapter 19, "Geotextile"

U.S. DEPARTMENT OF INTERIOR, BUREAU OF RECLAMATION:

EM 1110-2-1601, (1991) "Hydraulic Design of Flood Control Channels"

EM 1110-2-1906, (1970) Laboratory Soil Testing, Appendix V, "Grain-Size Analysis", paragraph 2d "Procedure", subparagraph (1)(g)
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1.1 UNIT PRICES

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NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
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1.1.1 Payment

Payment will be made at the contract unit price and will constitute full compensation to the Contractor for providing all plant, labor, material, and equipment and performing all operations necessary for the complete and satisfactory installation of the geotextile. The following items are included in the contract unit price for Geotextiles and will not be counted a second time in the process of determining the extent of geotextile placed: Material and associated equipment and operation used in laps, seams, or extra length; securing pins and associated material, equipment, and operations; and material and associated equipment and operations used to provide cushioning layer of sand or gravel or both to permit increase in allowable drop height of stone. No payment will be made for geotextiles replaced because of waste, contamination, damage, repair, or due to Contractor fault or negligence.

1.1.2 Measurement

Installed geotextiles will be measured for payment in place to the nearest [_____] square meter feet of protected area as delineated in the drawings.

1.1.3 Unit of Measure

Unit of measure: [_____] square meter feet.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D123	(2015b; R 2017) Standard Terminology Relating to Textiles
ASTM D4354	(2012; R 2020) Sampling of Geosynthetics for Testing
ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M	(2017) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533/D4533M	(2015) Standard Test Method for Trapezoid

	Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2020) Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4873/D4873M	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D4884/D4884M	(2014a) Strength of Sewn or Thermally Bonded Seams of Geotextiles
ASTM D6241	(2014) Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1601	(1991; 1994 Change 1) Engineering and Design -- Hydraulic Design of Flood Control Channels

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL

PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Geotextiles

Minimum of [_____] [60] days prior to the beginning of installation of the same textile

SD-06 Test Reports

Geotextiles
Site Verification

SD-07 Certificates

Geotextiles
Needle Punched Geotextile

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver only approved geotextile [rolls][, panels,][_____] to the project site. Label, ship, store, and handle all geotextile in accordance with ASTM D4873/D4873M. Do not use hooks, tongs, or other sharp instruments for handling geotextile.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

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NOTE: Nonwoven geotextiles are suitable for filtering fine-grained soils whereas woven or nonwoven are suitable for well graded granular soils.
****

Provide geotextile that is a [woven][non-woven] pervious sheet of plastic yarn as defined by ASTM D123 matching or exceeding the minimum average roll values listed in TABLE 1. Strength values indicated in the table are for the weaker principal direction.

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
GRAB STRENGTH	N lb	[_____]	ASTM D4632/D4632M

SEAM STRENGTH	N lb	[_____]	ASTM D4632/D4632M
PUNCTURE	N lb	[_____]	ASTM D6241
TRAPEZOID TEAR	N lb	[_____]	ASTM D4533/D4533M
PERMEABILITY	cm/sec	[_____]	ASTM D4491/D4491M
APPARENT OPENING SIZE	U.S. SIEVE	[_____]	ASTM D4751
PERMITTIVITY	sec -1	[_____]	ASTM D4491/D4491M
ULTRAVIOLET DEGRADATION	Percent	50 at 500 Hrs	ASTM D4355/D4355M

2.1.2 Geotextile Fiber

Use fibers consisting of a long-chain synthetic polymer composed of at least 85 percent by weight of polyolefins, polyesters, or polyamides. Add stabilizers and/or inhibitors to the base polymer, if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Do not add reclaimed or recycled fibers or polymer to the formulation. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Finish the edges of the geotextile to prevent the outer fiber from pulling away from the geotextile.

2.1.3 Seams

****

NOTE: Most geotextiles are manufactured in widths of 1.8 to 5.5 m 6 to 18 feet, but to reduce the number of overlaps, wider sections may be produced by attaching narrow sections together. Pre-assembled sections of 11-m 36-foot widths or more are preferred to keep the number of overlaps to a minimum.

****

Sew the seams of the geotextile with thread of a material meeting the chemical requirements given above for geotextile yarn or bond the seams by cementing or by heat. Attach the sheets of geotextile at the factory or another approved location, if necessary, to form sections not less than [_____] meter [_____] feet wide. Test seams in accordance with method ASTM D4884/D4884M. Seam strength less than 90 percent of the required grab tensile strength of the unaged geotextile in any principal direction is not permitted.

2.1.4 Securing Pins

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NOTE: The use of security pins should be restricted as much as possible since holes in geotextile allow pin boils to form and remove material from beneath geotextile and cause failure of system.

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Secure the geotextile to the embankment or foundation soil by pins to prevent movement prior to placement of revetment materials. Other appropriate means to prevent movement such as staples, sand bags, and stone could also be used. Insert securing pins through both strips of overlapped geotextile along the line passing through midpoints of the overlap. Remove securing pins as placement of revetment materials are placed to prevent tearing of geotextile or enlarging holes. Maximum spacing between securing pins depends on the steepness of the embankment slope. Provide maximum pins spacing equal to or less than the values listed in TABLE 2. When windy conditions prevail at the construction site, increase the number of pins upon the demand of the Contracting Officer. Anchor terminal ends of the geotextile with key trench or apron at crest, toe of the slope and upstream and downstream limits of installation.

TABLE 2
MAXIMUM SPACING FOR SECURING PINS

EMBANKMENT	SPACING, meter feet
STEEPER THAN 1V ON 3H	0.62
1V ON 3H TO 1V ON 4H	1.03
FLATTER THAN 1V ON 4H	1.55

2.2 INSPECTIONS, VERIFICATIONS, AND TESTING

2.2.1 Manufacturing and Sampling

Provide geotextiles and factory seams meeting the requirements specified in TABLE 1.

2.2.1.1 Conformance Testing

Perform conformance testing in accordance with the manufacturers approved quality control manual. Submit manufacturer's quality control conformance test results.

2.2.1.2 Factory Sampling

Randomly sample geotextiles in accordance with ASTM D4354 (Procedure Method A). Sample factory seams at the frequency specified in ASTM D4884/D4884M. Provide all samples from the same production lot as will be supplied for the contract, of the full manufactured width of the geotextile by at least 3 m 10 feet long, except that samples for seam strength may be a full width sample folded over and the edges stitched for a length of at least 1.5 m 5 feet. Identify samples submitted for testing by manufacturers lot designation.

2.2.1.3 Needle Punched Geotextile

For needle punched geotextile, provide manufacturer certification that the geotextile has been inspected using permanent on-line metal detectors and does not contain any needles.

2.2.1.4 Manufacturer Certification

[Upon delivery of the geotextile, submit duplicate copies of the written certificate of compliance signed by a legally authorized official of the manufacturer. State that the geotextile shipped to the site meets the chemical requirements and exceeds the minimum average roll value listed in TABLE 1.] [All brands of geotextile and all seams to be used will be accepted on the basis of mill certificates or affidavits. Submit duplicate copies of the mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile. Attest that the geotextile meets the chemical, physical and manufacturing requirements stated in this specification.]

2.2.2 Site Verification and Testing

****

NOTE: The need for, and amount of, site verification testing should be based on the severity of site conditions and the amount of textile being placed.

****

Collect samples at approved locations upon delivery to the site [at the request of the Contracting Officer][in accordance with ASTM D4354 (Procedure Method B)][at a frequency of once per 9290 square meters 100,000 square feet]. Test samples to verify that the geotextile meets the requirements specified in TABLE 1. Identify samples by manufacturers name, type of geotextile, lot number, roll number, and machine direction. Perform testing at an approved laboratory. Submit test results from the lot under review for approval prior to deployment of that lot of geotextile. Immediately rewrap rolls which are sampled in their protective covering.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Prepare surface, on which the geotextile will be placed, to a relatively smooth surface condition in accordance with the applicable portion of this specification and must be free from obstruction, debris, depressions, erosion feature, or vegetation. Remove any irregularities so as to ensure continuous, intimate contact of the geotextile with all the surface. Remove loose material, soft or low density pockets of material; grade erosion features such as rills and gullies out of the surface before geotextile placement.

3.2 INSTALLATION OF THE GEOTEXTILE

****

NOTE: This paragraph describes installation in an open area and on generally planar surfaces. For installation of geotextiles in drainage systems or about collector pipes, additional specification requirements may need to be added. The use of geotextiles to wrap collector pipes should be avoided whenever possible.

Minimum overlaps should be specified at 300 to 450 mm 12 to 18 inches depending on the specified orientation of the overlap to the direction of wave attack, velocity, or seepage. For under-water placement, minimum overlap should be 900 mm 3 feet.

Geotextiles will bridge small surface features in the slope and allow erosion to occur beneath the geotextile. Surface drainage should be directed away from the top of slope to prevent erosion under the geotextile. Surface flow should be brought downslope at controlled points such as lined ditches.

****

3.2.1 General

Place the geotextile in the manner and at the locations shown. At the time of installation, reject the geotextile if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.

3.2.2 Placement

****

NOTE: The placement of the geotextile relative to this paragraph may follow the following general procedures. (FIGURES referenced in this note are available on-line, see the note above).

(1) For current acting parallel to the bank the geotextile will be placed with the long dimension parallel to the current (Fig. 1a). Geotextile placement must be started from the bottom up with upper strips overlapping lower strips, and the upstream strips must overlap the downstream strips. The overlaps at the end of strips will be staggered at least 1.5 m 5 feet. Revetment and geotextile materials should be extended at least below the mean low water to minimize erosion at the toe (Fig. 2). If construction schedule permits, a period of low streamflow should be selected for the geotextile installation.

(2) When revetment material and geotextile filter are selected to protect against wave attack, the geotextile strips must be placed vertical to the slope of the bank with the upper strips overlapping the lower strips (Fig. 1b). The geotextile must be keyed at the toe to prevent uplift or undermining (Fig. 3). The key trench should be located below the mean low water to prevent erosion of the soil adjacent to the trench. When it is not possible to maintain vertical trench walls, the geotextile must be keyed to an excavated trench with stable slopes (Fig. 4). A key at the top of the bank will be installed where there is an overbank drainage problem.

Allowing the geotextile to drape or be free of high tensile stress during placement will require larger quantities of geotextiles than the actual slope length.

****

Place the geotextile with the long dimension [parallel] [perpendicular] to the [centerline of the channel][shoreline][trench] and laid smooth and free of tension, stress, folds, wrinkles, or creases. Place the strips to provide a minimum width of [_____] mm inches of overlap for each joint. The placement procedure requires that the length of the geotextile be approximately [_____] percent greater than the slope length. Adjust the actual length of the geotextile used based on initial installation experience. Temporary pinning of the geotextile to help hold it in place until the [bedding layer][riprap] is placed will be allowed. Remove the temporary pins as the [bedding][granular material][riprap] is placed to relieve high tensile stress which may occur during placement of material on the geotextile. Design protection of riprap in compliance with EM 1110-2-1601. Perform trimming in such a manner that the geotextile is not damaged in any way.

3.3 PROTECTION

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NOTE: All geotextiles can be damaged if stone is dropped on it from a height greater than 900 mm 3 feet. Some geotextiles can be damaged with lesser drop heights. When stone is heavy and angular it may cause punctures in the geotextile even if dropped from a height of 300 mm 1 foot. Tension in the geotextile must be minimized to prevent puncture.

****

Protect the geotextile at all times during construction from contamination by surface runoff; remove any geotextile so contaminated and replaced with uncontaminated geotextile. Replace any geotextile damaged during its installation or during placement of [granular filter materials][bedding materials][riprap] at no cost to the Government. Schedule the work so that the covering of the geotextile with a layer of the specified material is accomplished within [_____][7] calendar days after placement of the geotextile. Failure to comply will require replacement of geotextile. Protect the geotextile from damage prior to and during the placement of riprap or other materials.[This may be accomplished by limiting the height of drop to less than 300 mm 1 foot, by placing a cushioning layer of sand or gravel on top of the geotextile before placing the material, or other methods deemed necessary. Care should be taken to ensure that the utilized cushioning materials will not impede the flow of water.] Before placement of riprap or other materials, demonstrate that the placement technique will not cause damage to the geotextile. Do not allow equipment on the unprotected geotextile.

3.4 PLACEMENT OF CUSHIONING MATERIAL

Perform placing of cushioning material in a manner to ensure intimate contact of the geotextile with the prepared surface and with the cushioning material. Do not damage the geotextile, including tear, puncture, or abrasion, during placement. On sloping surfaces place the cushioning material from the bottom of the slopes upward. During placement, the height of the drop of riprap material greater than 300 mm 12 inches is not permitted. Uncover any geotextile damaged beneath the cushioning material, as necessary, and replaced at no cost to the Government.

3.5 OVERLAPPING AND SEAMING

3.5.1 Overlapping

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NOTE: In general, overlapping is sufficient where the primary purpose is to hold the material in place during installation. However, where the design requires the geotextile to resist tensile stresses, seams should be sewn. A 300-mm 12-inch overlap specified in this section is considered minimum for all cases. The Contractor has the option of field sewing instead of overlapping.

****

The overlap of geotextile [rolls] [panels] [_____] must be [300][600][900][_____] mm [12][24][36][_____] inches. Appropriate measures will be taken to ensure required overlap exists after cushion placement.

3.5.2 Sewn Seams

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NOTE: The Designer must specify appropriate seam test requirements. ASTM D1683, the previously used test standard, has been discontinued with no replacement designated.

****

High strength thread should be used so that seam test conforms to ASTM D4884/D4884M. Provide thread meeting the chemical, ultraviolet, and physical requirements of the geotextile, and provide color different from that of the geotextile. Provide seam strength equal to the strength required for the geotextile in the direction across the seam. Overlapping J-type seams are preferable over prayer-type seams as the overlapping geotextile reduces the chance of openings to occur at the seam. Use double sewing, specially for field seams, to provide a safety factor against undetected missed stitches.

3.6 [FIELD TESTING

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NOTE: The need for field testing should be based on the size and importance of the project. Field testing should be performed if the geotextile will be in tension.

****

Field test geotextile[in tension].]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 10 00 (February 2021)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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DIVISION 31 - EARTHWORK

SECTION 31 10 00

SITE CLEARING

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USACE / NAVFAC / AFCEC **UFGS-31 10 00 (February 2021)**

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References are in agreement with UMRL dated January 2025

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SECTION 31 10 00

SITE CLEARING
02/21

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NOTE: This guide specification covers the requirements for furnishing all labor and equipment and performing all work required for clearing and disposal of trees, stumps, clearing fences, buildings, and other structures and disposal of debris, trash, and materials resulting from clearing operations. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

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NOTE: This guide specification has been prepared for use in reservoir clearing operations. It has two alternates, one which is concerned with the clearing of timber lands and the other one deals with the removal of man-made structures, debris, etc.

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1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

No paragraph covering partial payment has been included in this guide specification. If partial payment is to be made, it should be addressed in the contract at the appropriate place (e.g., Section 01 20 00 PRICE AND PAYMENT PROCEDURES. One method, which has been used, is described here in general terms and may be incorporated when necessary. To estimate the value of work completed during each period, the zones are divided into the class of clearing involved. Class A clearing includes, as nearly as can be determined from aerial photographs or other means, all the wooded area with the exception of scattered trees, fringe growth along roads and fences, etc. Class B clearing contains all of the open, cultivated or pasture lands and those relatively open areas containing scattered trees, fringe growth along roads and fences, etc. The numbers of hectares acreages in each class should be estimated in advance and tabulated under the partial payment clause of the specification and thenceforth not be subject to change even if it is discovered that the original classification may have been in error. The most difficult class is arbitrarily assigned ninety work units for clearing, disposal, and clean-up. The number of work units in the other classes are estimated by comparison with the base class. The final estimate might be as follows:

Class	**Zone**	**Areas (hectares acres)**	**Multiplication Factor**	**Work Units**
A	**1**		**60**	
B	**1**		**15**	
A	**2**		**90**	
B	**2**		**25**	
			Total work units	

The value of a work unit is determined by dividing the contract price by the above total. The value of the work completed during any period will be determined by multiplying the number of hectares acres of the various classes completed in each zone, as estimated by the Contracting Officer by

planimetering areas from Government progress maps, by the work units in that class, totaling these figures and multiplying this total by the value of an individual unit as determined above. The estimate of the Contracting Officer will be final. For the purpose of apportioning the classes of work completed during any period, the felling and decking ready for burning or removal is considered as 50 percent of the work required and the removal and/or burning and clean-up will be considered as the remaining 50 percent.
****

1.1.1 Clearing (Timber and Structure)

1.1.1.1 Payment

Payment will be made for costs associated with furnishing plant, labor, materials and equipments, and performing all operations necessary for clearing (timber and structures) as specified.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.2 DEFINITIONS

1.2.1 Trees

****
NOTE: Alternate 1.
****

The line of demarcation between brush and trees, for the purpose of distinguishing clearing requirements, is that trees, as used, will be considered as that woody growth not falling within the limits of brush as defined below.

1.2.2 Brush

****
NOTE: Alternate 1.
****

Brush is that growth which is less than 50 mm 2 inches in diameter measured 150 mm6 inches from the ground on the uphill side and is less than 2 m 6 feet in height measured from the ground on the uphill side.

1.2.3 Structures

****
NOTE: Alternate 2.
****

The term "structures" includes buildings or portions thereof, walls, silos, storm or root cellars, cisterns, wells, windmills, pit silos, water towers, etc. Remove or fill structures to the ground surface.

1.3 PROJECT/SITE CONDITIONS

1.3.1 Aesthetics and Pollution Control

****

NOTE: Alternate 1.

****

1.3.1.1 Ground Areas

All ground areas in the zone of normal pool level fluctuations which are disturbed by clearing operations and which would become subject to erosion will be protected or restored.

1.3.1.2 Construction Roads

****

NOTE: Insert type of cover crop and seeding rate, if applicable.

****

All construction roads proposed for use by the Contractor for removing salvaged timber or for access to the work area must be approved, as to location and alignment, prior to construction. Where such roads are determined to be of no value to project operation or will not serve recreational access needs after project construction, the areas occupied by these roads will be restored as nearly as possible to pre-construction conditions by reasonable grading and seeding [_____] [of a native cover crop] along with the planting of seedling trees if in a tree cover area.

1.3.2 Existing Conditions

****

NOTE: Paragraphs of Alternate 1 and 2 should be deleted if not applicable.

****

1.3.2.1 Boundaries

****

NOTE: Alternate 1.

When land lines or identifiable topographic features, such as roads, railroads, streams, etc., are used in place of or in addition to contours to designate zone boundaries, the descriptions indicated below should be so modified.

****

The area to be cleared under this [section] [contract] is divided into two (2) zones having the general limits as defined below and as indicated on the [drawings] [and] [maps] and [aerial photographs], which form a part of this contract.

1.3.2.1.1 Zone 1

Included in this zone is that portion of the reservoir area [bounded by][at a lower elevation than] the [_____] meter foot msl contour line.

1.3.2.1.2 Zone 2

****

NOTE: Use the contour elevation of Zone 1.

****

Included in this zone is that portion of the reservoir area above the [_____] meter foot msl contour line and below the [_____] meter foot msl contour line.

[1.3.2.2 Cemeteries

****

NOTE: Alternate 1.

****

Cemeteries are in the area to be cleared. Do not disturb or destroy any grave marker, or allow any vehicle to pass over a grave, or otherwise disturb the surface of the ground over any grave. Adequately mark the graves to insure that equipment does not work over the areas. Graves and headstones or markers will be relocated by others.

]1.3.2.3 Markings of Zones

****

NOTE: Alternate 1.

****

The [_____] and [_____] contour lines have been established in the field by the Government. The contour lines are identified by stakes on the lines or by painted bands on trees near the lines. The [_____] contour is marked with [_____] paint and the [_____] contour is marked with [_____] paint. [Other boundaries are marked by identifiable topographical features or by section or fractional section lines.]

1.3.2.4 Zones

****

NOTE: Alternate 2.

When Alternate 2 is used independently of Alternate 1, the boundaries should be completely described. Similarly, this section should be further modified to include all other applicable portions of Alternate 1.

****

The boundaries of the zones are as described in paragraph BOUNDARIES, subparagraphs ZONE 1 and ZONE 2.

1.3.2.5 Fences

1.3.2.5.1 Zone 1

No clearing of fences is required in Zone 1; however, the Contractor may, as an option, remove any or all fence materials from the area and dispose of such materials off the reservoir area.

1.3.2.5.2 Zone 2

Clear all fences in Zone 2, except in those areas where no timber clearing is required.

1.3.2.6 Structures

Burn combustible materials obtained from removal of structures in accordance with paragraph DISPOSAL OF MATERIAL or dispose of them off the reservoir area. Where filling of structures is required, fill to within 450 mm 18 inches of the ground surface and made with noncombustible materials such as masonry rubble, and other debris. When all available debris has been used in filling, all remaining unfilled portions, together with the above 450 mm 18 inches, completely fill to the ground surface with earth, borrowed as directed by the Contracting Officer. The top surfaces of fills must be neat in appearance and smooth enough not to constitute a hazard to persons or livestock.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

3.1 CLEARING REQUIREMENTS

****

NOTE: Alternate 1.

****

3.1.1 Brush

The cutting of brush in either zone is not required.

3.1.2 Zone 1

****

NOTE: Use the same elevation which determines the contour bounding Zone 1.

****

Remove all trees and stumps, not defined as brush, that extend above elevation [_____], except that no material will be required to be removed any nearer to the ground surface than is specified for Zone 2. Topping of trees and stumps to elevation [_____] will be permitted as a Contractor's option.

3.1.3 Zone 2

Remove all trees and stumps, not falling within the classification of brush, to a height not exceeding 150 mm 6 inches above the ground surface measured on the uphill side.

3.1.4 Equipment

A tree crushing machine may be used at the option of the Contractor in all clearing operations.

3.2 DISPOSAL OF MATERIAL

****

NOTES: This paragraph makes general provisions for the Contractors' responsibility for fire damage beyond the clearing area. Notwithstanding these requirements, substantial damage has occurred in reservoir areas above the clearing line, due to fire escaping from areas being cleared. Fires originating in this manner have destroyed timber, ruined choice public use areas, destroyed wildlife habitat, and adversely affected public relations in the areas. Every effort should be made to avoid unnecessary destruction of the natural resources of reservoir areas, including the following actions:

1. The Contracting Officer or the Contractor or both should maintain constant knowledge, by appropriate telephone or radio liaison with personnel of the State forest protection service, relative to the degree of fire hazard and promptly disseminate by appropriate means this information to all others concerned.

2. The Contractor should be required to patrol firebreaks around clearing operations during all periods when there is danger of fire spreading beyond the clearing areas.

3. The Contractor should be required to halt all burning during periods of high fire danger.

It is considered that the provisions of the guide specifications and contract documents give the Contracting Officer the authority to enforce the required safety precautions.

****

3.2.1 General

Completely remove material cleared from the areas by transporting from the Government property or burn within the cleared areas unless otherwise approved by the Contracting Officer. All timber from which saw logs, posts, ties or cordwood can be produced will become the property of the Contractor and in the interest of conservation it is required that the Contractor make a reasonable effort to dispose of material for these purposes. The Contractor may cut timber into convenient lengths at the site but approval must be secured prior to the operation of saw mills within the Government lands. Do not throw or leave cleared material in the creeks or river. After the felling operation has been completed, the timber to be burned must be decked for burning within [_____] days. Remove all felled timber. However, it is intended that all existing down timber in zones one (1) and two (2) will remain in place except dispose solid, floatable material that is larger than 100 mm 4 inches in diameter (regardless of length) and/or over 2.5 m 8 feet in length (regardless of diameter) in the manner prescribed for cleared material. Clean up floatable debris. The cutting of branches and debris remaining after clean-up, to reduce their length in order to avoid removal, will not be permitted.

3.2.2 Burning

****

NOTE: Specification provisions for burning of material from cleared areas should be written to comply with applicable statutory and regulatory requirements for Prevention, Control, and Abatement of Air Pollution by Federal Activities.

****

a. The material cleared may be burned within the contract area, and at any time within the contract period provided such burning does not interfere with inhabitants of the area by drastic changes in their accustomed environment, such as addition to air pollution or danger of fire. However, the specific time, location and manner of burning must be subject to approval from the viewpoints of air pollution, governing fire laws and safety.

b. In the interest of conservation, as an option, make available to the general public without charge, the material scheduled for burning. Do not conduct burning operations within 30 m 100 feet of any standing timber or flammable growth. The burning operations are subject to all public law governing such operations and the Contractor will be responsible for any damage to life and/or property resulting from fires that are started by its employees or as a result of its operations.

c. Furnish at the site adequate fire fighting equipment, such as back tanks, flaps, shovels, rakes, etc., to properly equip his personnel for fighting fires. Guard fires at all times and provide constant surveillance until they have burned out or have been extinguished.

d. Burn so thorough that the materials is reduced to ashes, except that occasional charred pieces of logs or branches not exceeding 100 mm 4 inches in diameter and/or 2.5 m 8 feet in length will be permitted to remain. Upon approval, charred material will be buried after it is determined that it could not be disposed of by methods used in the normal burning operation. Dispose material at approved locations and cover within a minimum of 450 mm 18 inches of earth.

3.2.3 Burial

In certain cases, such as along drainage channels in remote areas, cleared material may be disposed of by burial in areas designated for disposal of excess excavation or spoil. When this option is used, care will be taken to insure that all such cleared material will be buried under not less than 450 mm 18 inches of earth. Approval will be obtained for each area selected for debris disposal for burial prior to beginning such operations. Areas to be used for permanent roadways, levees or embankments will not be used for disposal of material from clearing operations. Areas for disposal of cleared materials by burial will not be located within 92 m 300 feet of public road crossings or of project areas to be regularly visited by the public.

3.2.4 Removal from Site

Except as otherwise provided, the Contractor will be permitted to remove felled and trimmed timber from the site of the work. The Contractor will be allowed to stockpile salvaged timber near contour line [_____] at approved locations. The Government will assume no responsibility for the protection and safekeeping of such material. All stockpiled timber must be removed from Government lands before final acceptance of the work will be made.

3.3 DEBRIS

****
NOTE: Alternate 2.
****

Dispose burn combustible debris in accordance with paragraph DISPOSAL OF MATERIAL. Dispose noncombustible debris in excess of that disposed of as set forth in paragraph STRUCTURES at such locations below elevation [_____] as designated by the Contracting Officer. Debris includes trash of all kinds.

3.4 MARKETABLE MATERIALS

Any of the cleared materials which the Contractor considers marketable becomes its property and remove from the reservoir area.

3.5 LOCATIONS

The locations of structures and debris to be cleared are tabulated below.

[_____]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 11 00 (November 2018)**

\-----------------------------------

Preparing Activity: USACE **Superseding**
UFGS-31 11 00 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 11 00

CLEARING AND GRUBBING

11/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC UFGS-31 11 00 (November 2018)

Preparing Activity: USACE Superseding
UFGS-31 11 00 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 31 11 00

CLEARING AND GRUBBING
11/18

****
NOTE: This guide specification covers the requirements for clearing and grubbing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: When this specification is used for hazardous waste site remediations, define what materials generated from clearing, grubbing, and tree removal are contaminated and what materials are non-contaminated. The decision on how to define contaminated and non-contaminated materials must be made by the appropriate regulatory authorities and documented in the design analysis.

The following information must be shown on the project drawings:

1. Limits of clearing

2. Limits of grubbing

3. Trees and shrubs to remain in area to be cleared

4. Trees to be removed in areas which are not to be cleared

5. Describe size, density, and type of trees to be cleared and grubbed.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 4150.07	(2019) DOD Pest Management Program

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Herbicide Application Plan

SD-03 Product Data

Herbicides; G, [_____]

SD-07 Certificates

Qualifications; G, [_____]

SD-11 Closeout Submittals

Pest Management Report

1.3 QUALITY CONTROL

1.3.1 Regulatory Requirements

****

NOTE: Herbicides are a type of pesticide. Contact regional pest management consultant to obtain service specific reporting requirements for the use of herbicides.

For Navy projects, contact the cognizant NAVFAC Applied Biologist. Contact information can be found at
https://hub.navfac.navy.mil/webcenter/faces/oracle/webcenter/page/scopedMD/sa0

For Army projects, contact the cognizant Army Applied Biologist. Contact information can be found at

http://www.aec.army.mil/services/conserve/pestmanagement.aspx.
****

Comply with DODI 4150.07 for requirements on Contractor's licensing, certification, and record keeping. Maintain daily records using the Pest Management Maintenance Record, DD Form 1532-1, or a computer generated equivalent. These forms may be obtained from the main web site: https://www.acq.osd.mil/eie/afpmb/docs/standardlists/dd1532-1.xlsm.

1.3.2 Qualifications

For the application of herbicides, use the services of an applicator who is commercially certified in the state where the work is to be performed as required by DODI 4150.07. Submit a copy of the pesticide applicator certificates.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

1.4.1 Storage

Storage of herbicides on the installation will not be permitted unless it is written into the contract.

1.4.2 Handling

Handle herbicides in accordance with the manufacturer's label and Safety Data Sheet (SDS), preventing contamination by dirt, water, and organic material. Protect herbicides from weather elements as recommended by the manufacturer's label and SDS. Spill kits must be maintained on herbicide control vehicles. Mixing of herbicides on the installation will not be permited unless it is written into the contract.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Herbicide

****
NOTE: The herbicide must be pre-approved by regional pest management consultant.
****

Provide herbicides currently registered by the EPA or approved for such use by the appropriate agency of the host county and approved by the Contracting Officer. Select a herbicide that is suitable for the climatic conditions at the project site. Submit manufacturer's label and SDS for herbicides proposed for use.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Herbicide Application Plan

Prior to commencing application of herbicide, submit a herbicide application plan with proposed sequence of treatment work including dates and times of application. Include the herbicide trade name, EPA registration number, chemical composition, formulation, application rate of active ingredients, method of application, area or volume treated, and amount applied. Include a copy of the pesticide applicator certificates.

3.1.2 Protection

3.1.2.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

3.1.2.2 Trees, Shrubs, and Existing Facilities

[Provide protection in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.] [Protect trees and vegetation to be left standing from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.]

3.1.2.3 Utility Lines

Protect existing utility lines that are indicated to remain from damage. Notify the Contracting Officer immediately of damage to or an encounter with an unknown existing utility line. The Contractor is responsible for the repair of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, notify the Contracting Officer in ample time to minimize interruption of the service. Refer to Section 01 30 00 ADMINISTRATIVE REQUIREMENTS and Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS for additional utility protection.

3.2 APPLICATION

3.2.1 Herbicide Application

Adhere to safety precautions as recommended by the manufacturer concerning handling and application of the herbicide.

3.2.1.1 Clean Up, Disposal, And Protection

Once application has been completed, proceed with clean up and protection of the site without delay. Clean the site of all material associated with the treatment measures, according to label instructions, and as indicated. Remove and dispose of excess and waste material off Government property.

3.2.1.1.1 Disposal of Herbicide

Dispose of residual herbicides and containers off Government property, and in accordance with the approved disposal plan, label instructions and EPA requirements.

3.3 CLEARING

****

NOTE: Any clearing which requires the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work should be indicated and specified in the Section 02 41 00 {DEMOLITION} {AND} {DECONSTRUCTION}.

When grubbing is included as part of the contract, delete requirements for herbicides.

Where loose rocks, boulders, or rock piles are present on the surface of the areas designated to be cleared, appropriate provisions will be inserted to provide for the disposal of such material. Where stone occurs that can be economically used in the project, provision will be made for the proper stockpiling of such stone in a designated area adjacent to the location of its intended use.

If only minor structures will be encountered, such work may be included. Where large structures are to be demolished, the requirements of this work will be covered in Section 02 41 00 {DEMOLITION} {AND} {DECONSTRUCTION}.

Herbicides intended for controlling vegetative growth should be specified and used with caution on hazardous waste sites to avoid contributing to site contamination.

****

Clearing consists of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. [Clearing also includes the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work.] Cut off flush with or below the original ground surface trees, stumps, roots, brush, and other vegetation in areas to be cleared, except such trees and vegetation as may be indicated or directed to be left standing. Trim dead branches that are 40 mm 1-1/2 inches or more in diameter on trees designated to be left standing within the cleared areas and trim all branches to the heights indicated or directed. Neatly cut close to the bole of the tree or main branches, limbs and branches to be trimmed. Apply herbicide [at the rate of [_____]] [in accordance with the manufacturer's label] to the top surface of stumps designated not to be removed.

3.3.1 Tree Removal

Where indicated or directed, remove trees and stumps that are designated as trees from areas outside those areas designated for clearing and grubbing. This work includes the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. Dispose of trees as specified in paragraph DISPOSAL OF MATERIALS.

[3.3.2 Pruning

[Prune] [Trim] trees designated to be left standing within the cleared areas of dead branches 38 mm 1-1/2 inches or more in diameter; and trim branches to heights and in a manner as indicated. Neatly cut limbs and branches to be trimmed close to the bole of the tree or main branches.

]3.3.3 Grubbing

****

NOTE: Delete the second sentence when this work is included under another section or sections of the project specification.

For hazardous waste sites, the amount of grubbing performed in contaminated areas should be minimized due to potential added costs for disposal of contaminated materials and health and safety concerns.

****

Grubbing consists of the removal and disposal of stumps, roots larger than 75 mm 3 inches in diameter, and matted roots from the designated grubbing areas. Remove material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, to a depth of not less than 455 mm 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Fill depressions made by grubbing with suitable material and compact to make the surface conform with the original adjacent surface of the ground.

3.4 DISPOSAL OF MATERIALS

****

NOTE: Coordinate disposal requirements with 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

****

Dispose of excess materials in accordance with the approved solid waste management permit and include those materials in the solid waste management report.

All wood or wood like materials, except for salable timber, remaining from clearing, prunning or grubbing such as limbs, tree tops, roots, stumps, logs, rotten wood, and other similiar materials is the property of the Contractor and dispose of as specified. All non-saleable timber and wood or wood like materials remaining from timber harvesting such as limbs, tree tops, roots, stumps, logs, rotten wood, and other similiar materials is the property of the Contractor and dispose of as specified.

[3.4.1 Saleable Timber

****

NOTE: Verify the most appropriate option with the natural resources office for the Installation.

When this specification is being used for the remediation of hazardous waste sites or when soil or

groundwater are contaminated by hazardous materials, timber removed from these areas is not normally havested due to liability concerns. When timber is havested in areas where hazardous materials are present,this paragraph should define how both contaminated and non-contaminated materials will be disposed of. Include requirements describing how both contaminated and non-contaminated materials will be handeled, stored and disposed of. These requiremnts must be coordinated with the Government Forester and Installation environmental staff.

****

[

****

NOTE: Use this paragraph when regional forestry program has a way of hauling or selling stockpiled harvested timber and the Contractor will be required to cut and stack saleable timber for the Government.

Applicable lengths for each class of forest products will vary by geographic region. Consult with the Government forester for the correct log lengths in a particular area. Coordinate with the Government regional forestry program to determine for the correct log lengths in a particular area..

****

Consider felled timber from which saw logs, pulpwood, posts, poles, ties, or fuelwood can be produced as saleable timber. Trim limbs and tops, and saw into saleable lengths of [_____] meters feet for saw logs, [_____] meters feet for pulpwood, [_____] meters feet for poles, [_____] meters feet for ties, and [_____] meters feet for fuelwood, and stockpile adjacent to the site. The stockpile timber will remain the property of the Government.

][

****

NOTE: Use this paragraph when the Government will harvest saleable timber prior to award of the contract.

****

The Government will, by separate contract, harvest all saleable timber from the project site.

][

****

NOTE: For Navy only, this option must be approved by NAVFAC legal counsel for NAVFAC projects.

****

****

NOTE: Use this paragraph when the Contractor will be required to pay the Government an appraised fair market value for the saleable timber on the project site. The fair market value must be determined by the Government forester.

Describe the boundaries for the tract of land.

****

All timber removed from the project site is the property of the Contractor .

Reimburse the Government for the fair market value of the timber which the Government has appraised at $[_____][on the tract of land described as follows [_____]]. Submit payment to the Contracting Officer by cashier's or certified check in the amount of the appraised value, made payable to [the U.S. Treasury] [_____] for deposit into the [Navy Forestry] or [______] account. Make payment within 30 days of the Notice to Proceed.

][

****

NOTE: Use this paragraph when the fair market value of the harvested timber does not exceed a nominal value. The fair market value must be determined by the Government forester. The timber will become the property of the contractor. The Contractor permitted to make use of the nonsaleable timber or to dispose of such timber in an approved manner.

****

All timber removed from the project site is the property of the Contractor.]

]

3.5 CLOSEOUT ACTIVITIES

3.5.1 Herbicides

Upon completion of this work, submit the Pest Management Report DD Form 1532, or an equivalent computer product, to the Integrated Pest Management Coordinator. This form identifies the type of operation, brand name and manufacturer of herbicide, formulation, concentration or rate of application used.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 21 00 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 21 00 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 31 - EARTHWORK

SECTION 31 21 00

OFF-GASSING MITIGATION

02/21

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PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-31 21 00 (February 2021)**

Preparing Activity: USACE

Superseding without Revision
UFGS-31 21 00 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 31 21 00

OFF-GASSING MITIGATION

02/21

****

NOTE: This guide specification covers the requirements for pipe systems for the transmission of gases and vapors.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: When it is determined that lump sum contract is advisable this paragraph will be deleted.

****

Measurement and payment will be based on completed work performed in accordance with the drawings, specifications, and the contract payment schedules. No payment will be made under this section for excavation, trenching, or backfilling. Payment for such work will be made under Section 31 00 00 EARTHWORK.

1.1.1 Measurement

The length of pipe lines to be paid for will be determined by measuring along the centerline of the various sizes of pipe furnished and installed. Pipe will be measured from center of fitting to center of fitting and from connection to connection to wells or treatment units. No deduction will be made for the space occupied by valves or fittings.

1.1.2 Payment

Payment will be made for off-gas piping at the contract unit price per linear meter linear foot for the various types and sizes of piping, and will be full compensation for pipes, joints, specials, and fittings, complete in place. Payment for valves, valve boxes, and standard valve manholes will be made at the respective contract unit price each for such items complete in place. Payment will include the furnishing of testing, plant, labor, and material and incidentals necessary to complete the work, as specified and as shown.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA ANSI B109.2	(2000) Diaphragm Type Gas Displacement Meters (500 cubic ft./hour Capacity and Over)
AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z400.1/Z129.1	(2010) Hazardous Workplace Chemicals – Hazard Evaluation and Safety Data Sheet

	and Precautionary Labeling Preparation

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.40	(2024) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
ASME B31.8	(2022; Supplement 2022) Gas Transmission and Distribution Piping Systems

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C218	(2023) Liquid Coatings for Aboveground Steel Water Pipe and Fittings

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B837	(2019) Standard Specification for Seamless Copper Tube for Natural Gas and Liquified Petroleum (LP) Gas Fuel Distribution Systems
ASTM C581	(2020) Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures, Intended for Liquid Service
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1598	(2015a) Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
ASTM D1693	(2015) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2513	(2018a) Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
ASTM D2517	(2018) Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2657	(2007; R 2015) Heat Fusion Joining

	Polyolefin Pipe and Fittings
ASTM D2672	(2014) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D2683	(2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D2774	(2021a) Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	(2020) Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
ASTM D2992	(2012) Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
ASTM D3035	(2022) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D3839	(2014; R 2019) Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3892	(2015) Standard Practice for Packaging/Packing of Plastics
ASTM E515	(2011; R 2022) Standard Practice for Leaks Using Bubble Emission Techniques
ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F442/F442M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC)

	Plastic Pipe (SDR-PR)
ASTM F656	(2021) Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F1055	(2016; R 2022a) Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX)Pipe and Tubing

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service

NACE INTERNATIONAL (NACE)

NACE SP0185	(2024) Extruded Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe
NACE SP0274	(1974; R 2011) High Voltage Electrical Inspection of Pipeline Coatings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code
NFPA 704	(2022) Standard System for the Identification of the Hazards of Materials for Emergency Response

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

UL SOLUTIONS (UL)

UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.3 SYSTEM DESCRIPTION

Provide off-gas piping system consisting of buried and above ground pipe, pipe supports, fittings, equipment and accessories. Submit Drawings containing graphical relationship of various components of the work, schematic diagrams of the systems, details of fabrication, layouts of particular elements, connections, clearance required for maintenance and operation, and other aspects of the work to demonstrate that the system has been coordinated and will properly function as a unit. Drawings to demonstrate that thermal expansion of plastic pipe exposed to ambient conditions has been incorporated into the design. Submit a written certificate from the testing agency stating that the items have been tested and that they conform to the applicable requirements of the specifications. Indicate the methods of testing used by the testing agency. In lieu of a certificate from a testing agency, published catalog specification data, accompanied by the manufacturer's certified statement that the items are in accordance with the applicable requirements of the specifications will be acceptable as evidence that the items conform with agency requirements.

1.3.1 Design Requirements

****

NOTE: Determine design wind speed from ASCE 7-16, and/or UFC 3-301-01 STRUCTURAL LOAD DATA. Use 161 km/h 100 miles per hour minimum. Use 1.2 kPa 25 psf snow load for most heavy snow climates; delete snow load where maximum snow is insignificant. In some cases, local climates and topography will dictate that a value greater than 197 Pa 25 psf be used for snow loading. This may be determined from ANSI A58.1, local codes, or by research and analysis of the effect of local climate and topography.

Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not included. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

****

Provide piping in accordance with 49 CFR 192. Ensure design for installation of plastic pipe above grade has provisions for movement due to thermal expansion and contraction. Provide seismic details in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS [as shown on the drawings].

a. Soil bearing capacity: [_____] MPa psf.

b. Seismic parameters: [_____].

c. Wind speed (maximum): [_____] km/h mph.

d. Ground snow load: [_____] kPa psf.

e. Ambient air temperature (maximum): [_____] degrees C F.

f. Ambient air temperature (minimum): [_____] degrees C F.

1.3.2 Performance Requirements

****

NOTE: Enter names and concentrations of organic chemicals in the blank provided and additional lines or provide a reference to another section of the specification as necessary to provide complete information. Conditions encountered during construction frequently differ from the design conditions and/or worst conditions. Plume migration affects the concentrations that will be encountered during startup and testing. Design velocity range for vapors, gases, and smoke is between 5.1 and 10 m/sec 1,004 and 1,970 ft/min in NFPA 91 Exhaust Systems for Air Conveying of Materials. Consider the requirements of ASTM D543 in selection of pipe materials.

Identify pipe runs on the drawings and fill in the blanks with the maximum positive and negative anticipated gauge pressures.

****

Provide capacity and design of the piping and accessories suitable for 24-hour full load service in an outdoor location. Calculate expansion of plastic pipe exposed to ambient conditions. Provide pipe materials compatible with each of the following off-gas properties.

a. Pipe segment [A-B] [B-C] [C-D] [D-E] [_____]:
b.

Pressure (gauge maximum	[_____] MPa psig
Pressure (gauge minimum)	[_____] MPa psig
Flow rate (maximum)	[_____] cubic m/s cubic ft/s
Flow rate (minimum)	[_____] cubic m/s cubic ft/s
Ambient temperature (maximum)	[_____] degrees C F
Ambient temperature (minimum)	[_____] degrees C F
Off-gas temperature (maximum)	[_____] degrees C F
Off-gas temperature (minimum)	[_____] degrees C F

c. Estimated chemical concentrations of [vapor] [off-gas]:
d.

	Minimum	Average	Maximum
pH	[_____]	[_____]	[_____]
Sulfide	[_____] mg/L	[_____] mg/L	[_____] mg/L
Ammonia	-----	[_____] mg/L	[_____] mg/L
[_____]	[_____]	[_____]	[_____]

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Off-Gas Piping System

SD-03 Product Data

Materials and Equipment

Safety Data Sheet

Statement of Satisfactory Installation

SD-06 Test Reports

Destructive Joint Tests

Bubble Tests

Pressure Testing

Leakage Testing

Vacuum Testing

Hanger Acceptance Testing

SD-07 Certificates

Off-gas Piping System

Manufacturer's Representative

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Contractor Qualifications

Have a minimum of [2] [3] [5] [_____] years of experience in the construction of piping systems for sour gas, condensable gas, off-gas or vapor.

1.5.2 Single Source Supplier

Assign to a single supplier full responsibility for the furnishing of the off-gas piping system. The designated single supplier, however, need not manufacture the system but must coordinate the selection, assembly, installation, and testing of the entire system as specified herein.

1.5.3 Welding

Provide qualifications of welding procedures, welders, and welding operators in accordance with welding and nondestructive testing procedures for pressure piping specified in Section 40 05 13.96 WELDING PROCESS PIPING. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

1.5.4 Jointing Plastic and Fiberglass Reinforced Pipe

Use manufacturer's prequalified joining procedures. Inspect joints by an inspector qualified in the joining procedures being used and in accordance with AGA XR0603. Ensure joiners and inspectors are qualified at the job site by a person who has been trained and certified by the manufacturer of the pipe, to train and qualify joiners and inspectors in each joining procedure to be used on the job. Training must include use of equipment, explanation of the procedure, and successfully making joints which pass tests specified in AGA XR0603. Notify the Contracting Officer at least 24 hours in advance of the date to qualify joiners and inspectors.

1.5.5 Pre-Installation Meeting

****

NOTE: Remove this paragraph when conference is not required.

****

[Partnering] [Pre-installation] meeting will be required. Ensure that involved subContractors, suppliers, and manufacturers are [notified] [represented]. Furnish date and time of the conference to the Contracting Officer for approval.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packaging

Pack, package and mark plastic pipe in accordance with ASTM D3892.

1.6.2 Cleaners, Solvents and Glues

A safety data sheet in conformance with ANSI Z400.1/Z129.1 must accompany each chemical delivered for solvents, solvent cements, or glues used in pipe connections or pipe installation. Handling must be in accordance with ASTM F402.

1.6.3 Storage

Classify and mark storage facilities in accordance with NFPA 704. Store materials with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) damage, or other damage. Handle and store pipe and fittings in accordance with the manufacturer's recommendations. Store piping bundles on a prepared surface and do not stack more than two bundles high.

1.7 SEQUENCING AND SCHEDULING

****

NOTE: Coordinate with Section Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM or Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM if steel pipe is allowed. Blowers and control valves are specified in Section 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS.

****

Perform installation as specified in Section 31 00 00 EARTHWORK, except as modified herein or required by ASTM D2774, ASTM D2855, ASTM D3839, or ASTM F402, as appropriate for the pipe material.

1.8 EXTRA MATERIALS

****

NOTE: This paragraph covers items to be furnished to the Government by the Contractor for future maintenance and repair. Insert text as required.

****

Provide extra material consisting of [_____]. Provide a special wrench for removal of locking covers for each valve box and for each pressure regulator box.

1.9 MAINTENANCE SERVICE

****

NOTE: This paragraph covers provisions for maintenance service as applicable to critical systems, equipment, and landscaping. Insert text as required or omit.

****

Maintenance service includes [_____].

PART 2 PRODUCTS

****

NOTE: If thermoplastic pipe is specified for above ground use, verify that the referenced standards allow use of the specified materials for vapor transport or note the exceptions. Thermoplastic pipe is specified and installed above grade for vacuum applications. The ASME B31.3 advises that "special precautions should be observed" when using thermoplastic pipe to transport compressed gases above ground. Recommendation B of the Plastic Pipe Institute recommends against the use of thermoplastic pipe to transport air or other compressed gases in exposed above ground locations, e.g. in exposed plant piping." The industry standards for use of thermoplastic pipe for transmission of gas, ASTM D2513 and ASTM D3839, both recommend only underground use.

Combustible and explosive properties of the vapor, accumulation of static electrical charge and changes in strength characteristics due to elevated temperatures should be considered in material selection. Consideration should be given to compatibility of the construction materials with the condensate that will accumulate in the system. Select materials to avoid softening and loss of physical properties due to polymer degradation by depolymerization; stiffening or embrittlement due to loss of plasticizers resulting from repeated usage; deterioration of mechanical properties due to swelling; and failure of adhesive or heat fused joints due to interaction with condensate or leachate and physical stress.

See EM 1110-1-4008 Liquid Process Piping for chemical resistivity information.

Delete inapplicable materials or equipment. Options for other material, such as ductile iron in iron pipe sizes, may be added for noncorrosive gases.

****

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment that are new and unused, except for testing equipment. Ensure components that serve the same function and that are the same size are identical products of the same manufacturer. Provide piping material and appurtenances suitable for the service intended as specified and as shown on the drawings. Submit manufacturer's descriptive data and technical literature for each piping system, including design recommendations, pressure and temperature ratings, dimensions, type, grade and strength of pipe and fittings, thermal characteristics (coefficient of expansion and thermal conductivity) and chemical resistivity for each chemical constituent in the off-gas stream. Manufacturer's recommended installation procedures including materials preparation, and installations.

2.1.1 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide pipe, valves, fittings and appurtenances supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Identification

Provide each piece of pipe bearing the ASTM designation and the ASTM markings required for that designation. Mark each valve in accordance with MSS SP-25 to identify the manufacturer, size, pressure rating, body disc and seat material. Securely attach a tag with the manufacturer's name, catalog number and valve identification.

2.2 DESIGN STRENGTH

Ensure design strength of piping is suitable for the operating pressure and temperature ranges indicated and/or shown. With the exception of vacuum pipe segments [A-B] [B-C] [D-E] [_____], do not use thermoplastic pipe to transport air or vapors in exposed above ground locations.

2.3 STEEL PIPE

****

NOTE: Verify that pipe wall thickness conforms to ASME B31.8 for larger sizes and high pressures.

For exposure potential to pressures less than 70 kPa 10 psig and temperatures less than 100 degrees C 212 degrees F and mild chemical exposure, blast surface in accordance with SSPC SP 6/NACE No.3.

For exposure potential to pressures greater than 70 kPa 10 psig and temperatures greater than 100

degrees C 212 degrees F and mild chemical exposure intermediate options may be appropriate.

For severe chemical exposure, the baked phenolic system should be used.

****

Provide Schedule 40 steel pipe conforming to [Grade A or B, Type E or S of ASTM A53/A53M,] [API Spec 5L,] [ASME B31.8,] [or] [NFPA 58]. Provide pipe threads conforming to ASME B1.20.2MASME B1.20.1. Use fittings for pipe 40 mm 1-1/2 inches and smaller conforming to ASME B16.11. Use buttweld fittings for pipe 40 mm 1-1/2 inches or less conforming to ASME B16.9. Provide joint sealing compound conforming to UL FLAMMABLE & COMBUSTIBLE, Class 20 or less. Use polytetrafluoroethylene tape conforming to ASTM D3308. Use weld neck flanges. Ensure connections conform to ASTM A181/A181M, Class 60, carbon steel. Coat carbon steel components with corrosion resistant [materials.] [materials suitable for exposure to condensates.] Ensure coatings and finishes are 100 percent holiday free.

2.3.1 Carbon Steel Located Above Grade

****

NOTE: Color must be specified only for the "-S" systems. The color is automatic (-A, Aluminum; -B, Black; -W, white) for the other systems.

****

[_____] coat surfaces of aboveground carbon steel components in accordance with AWWA C218 [three-coat alkyd system 1-91-A] [three-coat alkyd system 1-91-W] [three-coat alkyd system 1-91-S] [four-coat alkyd system 2-91-A] [four-coat alkyd system 2-91-W] [four-coat alkyd system 2-91-S] [three-coat alkyd/silicone alkyd system 3-91-W] [three-coat alkyd/silicone alkyd system 3-91-S] [three-coat epoxy/urethane system 4-91-W] [three-coat epoxy/urethane 4-91-S] [three-coat inorganic or organic zinc/epoxy/urethane 5-91-W] [three-coat inorganic or organic zinc/epoxy/urethane 5-91-S] [two- or three-coat epoxy/coal tar epoxy 6-91-B] [two or three- coat water reducible epoxy-polyamid 7-91-W] [two- or three-coat water reducible epoxy-polyamid 7-91-S] [three-coat water reducible acrylic or alkyd-modified acrylic emulsion 8-91-W] [three-coat water reducible acrylic or alkyd-modified acrylic emulsion 8-91-S] [two- or three-coat epoxy/high-build aliphatic polyurethane over existing coated substrates 9-95-W] [two- or three-coat epoxy/high-build aliphatic polyurethane over existing coated substrates 9-95-S].

2.3.2 Silicone Coating

Blast surfaces of carbon steel components in accordance with SSPC SP 6/NACE No.3. Provide surface with an alkyd primer 62.5 micrometers 2.5 mils dry film thickness followed by two alkyd modified silicone final coats.

2.3.3 Zinc Coating

Coat surfaces of carbon steel components with zinc in accordance with ASTM A123/A123M or ASTM A153/A153M.

2.3.4 Thermoplastic Resin Coating System

[Provide surfaces of carbon steel components with a minimum of [4] [5] [6] coats of phenolic type coatings applied [40] [50] micrometers [1.6] [2] mils minimum dry film thickness per coat. Bake each coat at 149 degrees C 300 degrees F for 10 minutes. Cure full coating system in oven at [190] [232] degrees C [375] [450] degrees F for 30 minutes.] [Ensure continuously extruded polyethylene and adhesive coating system materials conform to NACE SP0185 Type A.]

2.3.5 Cathodic Protection

Provide buried ferrous pipe systems with cathodic protection.

2.4 COPPER TUBING

Provide copper tubing conforming to ASTM B837.

2.5 POLYVINYL CHLORIDE (PVC) PIPING

Design and fabaricate below grade components of the off-gas piping system in accordance with ASTM D2513 except as modified herein.

2.5.1 PVC Pipe

****

NOTE: CPVC in accordance with ASTM F422 provides a heat protection factor that is important near blowers but is not generally necessary for buried piping.

****

Provide pipe in accordance with ASTM F442/F442M, ASTM D2241, SDR [26] [21] [17] [_____]. Provide materials conforming to ASTM D1784, Type IV, Grade 1, rigid (23447-B). Use maximum eccentricity of the inside and outside circumferences of the pipe walls of 12 percent. Provide pipe which does not fail, balloon, burst, or weep as defined in ASTM D1598.

2.5.2 PVC Joints

Provide pressure rated solvent cemented bell joints in accordance with ASTM D2672 except where flanged or threaded fittings are required at expansion joints, valves, flowmeter, equipment connections or otherwise shown. Join flanges to pipe by solvent cementing. Use primer conforming to ASTM F656. Use solvent cement conforming to ASTM D2564.

2.5.3 PVC Fittings

Provide fittings in accordance with [ASTM D2466] [ASTM D2467].

2.6 POLYETHYLENE (PE) PIPING

Design and fabricate below grade components of the off-gas piping system in accordance with ASTM D2513 except as modified herein.

2.6.1 PE Pipe

Provide pipe in accordance with ASTM D3035, Schedule [40] [80]. Ensure wall thickness is SDR [11] [_____]. Ensure melt flow is less than 1.5 g/10 min. with method ASTM D1248, Condition F. Ensure environmental stress crack resistance exceeds 1000 hours, ASTM D1693, Condition C.

2.6.2 PE Joints and Fittings

Provide pressure rated electrofusion fittings in accordance with ASTM F1055, butt heat fusion fittings in accordance with ASTM D3261 or socket-type fittings in accordance with ASTM D2683 except where flanged connections are required at expansion joints, valves, flowmeter, equipment connections or otherwise shown. Join flanges to pipe by heat fusion in accordance with ASTM D2657.

2.7 REINFORCED EPOXY RESIN PIPING

Design and fabricate below grade components of the off-gas piping system in accordance with ASTM D2992 except as modified herein.

2.7.1 Epoxy Resin Pipe

Provide pipe in accordance with ASTM D2517. Provide resin that is chemically resistant to condensates as determined by ASTM C581.

2.7.2 Epoxy Resin Joints and Fittings

Provide joints and fittings in accordance with ASTM D2517.

2.8 DUCT SYSTEMS

****

NOTE: Consult Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) for metal and PVC duct design and construction recommendations. Consult Thermal Insulation Manufacturers' Association (TIMA) for design and construction standards for fiberglass ducts.

****

Provide ductwork in compliance with Section 23 54 19 BUILDING HEATING SYSTEMS, WARM AIR.

2.9 FLANGED CONNECTIONS

2.9.1 Flanges

Provide Class [150] [_____], socket weld, flat face flanges in accordance with ASME B16.5. Ensure drilling and dimensions of flanges, bolts, nuts, and bolt patterns are in accordance with ASME B16.5, Class [150] [_____]. Provide bolts and nuts that [conform to ASTM A307] [are 304 stainless steel].

2.9.2 Gaskets

****

NOTE: Use gasket materials compatible with condensates. High temperature gaskets for above 160 degrees C 320 degrees F should be aramid fibers bonded with nitrile butadiene rubber (NBR) or glass fibers bonded with polytetrafluoroethylene. EPDM is

suitable for 100 degrees C 212 degrees F or less. Chloroprene rubber is suitable for 80 degrees C 176 degrees F or less. Florin rubber (i.e. Viton) and nitrile are suitable for 160 degrees C 320 degrees F) or less.

****

Provide gaskets consisting of full face, non-asbestos compressed material compatible with the expected condensates in accordance with ASME B16.21, [3] [1.6] mm [1/8] [1/16] inch minimum thickness, full face or self-centering flat ring type. Provide gaskets consisting of aramid fibers bonded with nitrile butadiene rubber (NBR) or glass fibers bonded with polytetrafluoroethylene suitable for [315] [_____] degrees C [600] [_____] degrees F service and meeting applicable requirements of [ASME B31.8] [NFPA 58]. [Provide high temperature gaskets which are suitable for above 160 degrees C 320 degrees F.] [Provide chloroprene rubber suitable for [80] [100] degrees C [176] [212] degrees F service.] [Provide EPDM suitable for 100 degrees C 212 degrees F service.] [Provide florin rubber (i.e. Viton) or nitrile rubber suitable for 160 degrees C 320 degrees F service.]

2.9.3 Sealants

Provide sealants conforming to ASTM C920.

2.10 EQUIPMENT AND APPURTENANCES

2.10.1 Manually Operated Valves

Provide ball valves in accordance with MSS SP-72. Provide gate, plug, ball, and check valves in accordance with API Spec 6D. Provide thermoplastic gas shutoffs and valves in accordance with ASME B16.40.

2.10.2 Relief Valves

Provide relief valve with manually adjustable pressure differential for each blower or vacuum pump. Ensure relief valve is [weighted] [spring] [pilot-operated diaphragm type] with a [_____] percent accumulation. Ensure relief valve diameter is line sized or as otherwise indicated and rated to relieve [_____] cubic meters/s cubic feet per minute at a set pressure of [_____] kPa psig or a vacuum of [_____] kPa inches Hg. Provide materials consisting of [aluminum] [bronze] [cast iron] [stainless steel] [_____] body, [bronze] [316 stainless steel] [_____] trim, and [Buna-N] [EPR] [nitrile] [Viton] [Teflon] [_____] elastomers. Provide maximum operating temperature and pressure of [_____] degrees C F and [_____] kPa psi.

2.10.3 Unloading Valves

Include unloading valves to minimize pump/motor overloading during start and stop operations. Provide [pilot-operated diaphragm type with auxiliary solenoid operator] [actuated butterfly valve control by blower system controls] unloading valve. Ensure unloading valve is rated to relieve [_____] cubic meters/s cubic feet/minute at a set pressure of [_____] kPa psi or a vacuum of [_____] mm Hg inches Hg. Provide materials consisting of [aluminum] [bronze] [stainless steel] body, [bronze] [316 stainless steel] trim, and [Buna-N] [EPR] [Viton] [Teflon] elastomers. Provide maximum operating temperature and pressure of [_____] degrees C F and [_____] kPa psig respectively.

2.10.4 Vacuum Breakers

Provide vacuum breakers to protect blowers and vacuum pumps from damage due to excessive vacuum surges. Provide [pilot-operated diaphragm type with auxiliary solenoid operator] [actuated butterfly valve control by blower system controls] vacuum breakers. Ensure valve is rated to relieve [_____] cubic m/s cfm at a set pressure of [_____] kPa psi or a vacuum of [_____] kPa inches Hg. Provide materials consisting of [aluminum] [bronze] [stainless steel] body, [bronze] [316 stainless steel] trim, and [Buna-N] [EPR] [Viton] [Teflon] elastomers. Provide maximum operating temperature and pressure of [_____] degrees C F and [_____] kPa psi.

2.10.5 Dielectric Fittings

Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains. Use dielectric fittings to prevent metal-to-metal contact of dissimilar metallic piping elements and suitable for the required working pressure.

2.10.6 Meters

Gas meters conforming to AGA ANSI B109.2.

2.10.7 Insulation

Provide insulation of above grade exterior pipe, fittings and valves as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.10.8 Supports for Aboveground Piping

****

NOTE: Pipe materials differ greatly in their respective changes in size as temperature changes. The thermal expansion coefficient of PE is three times that of PVC pipe. In a buried environment, where the temperature fluctuations should be minimal and the pipe is supported on all sides by soil, thermal expansion is of less concern. However, in systems where the collector pipes are above ground, thermal expansion and contraction must be considered.

****

Furnish pipe hangers and supports complete with necessary inserts, bolts, nuts, rods, washers, and accessories. Design and construction must be in accordance with MSS SP-58. Specific application must be in accordance with MSS SP-58. Provide hanger and supports capable of adjustment after placement of piping. Ensure hangers and supports are the product of one manufacturer. Hot dip galvanize hangers, supports and accessories in accordance with ASTM A123/A123Munless copper or plastic coated. Provide restrained joints and thrust protection. Provide concrete and metal cradles, collars, floor stands, supports, kickers, and block as recommended by manufacturer. Pipe cradle cushion material must be elastomer sheet strapped to pipe to prevent chafing at pipe support. Utilize elastomer sheet around top of pipe to prevent chafing of pipe strap.

2.10.9 Valve Boxes

Provide adjustable extension type valve boxes with screw or slide-type adjustments constructed of cast iron no less than 5 mm 3/16 inch thick. Provide valve boxes with locking covers that require a special wrench for removal and the word "gas" cast in the box cover.

2.11 FACTORY TESTS

Test [steel piping] [a representative unit of each diameter of steel piping] by the manufacturer or a nationally recognized testing agency in compliance with NACE SP0274.

PART 3 EXECUTION

****

NOTE: Operations required to accomplish construction of plastic piping systems will conform to the requirements of ASTM F402.

****

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 MANUFACTURER'S REPRESENTATIVE

Provide the services of a manufacturer's field service representative who is experienced in the installation of the materials and equipment furnished and who has complete knowledge of the proper operation and maintenance of the system. Submit the name and qualifications of the manufacturer's representative and written certification from the manufacturer that the representative is technically qualified.

3.3 CONDENSATE CONTROL

Slope off-gas piping uniformly between control elevations to enhance the removal of liquids. Make provisions to collect and drain liquids from [condensation] [mist accumulation] [_____] in each pipe run. Locate liquid removal sumps and traps in the piping systems.

3.4 PRESSURE REGULATOR AND METER INSTALLATION

Install a valve on each side of each meter or regulator for isolating the regulator for calibration, maintenance. and removal. Install an insulating joint constructed to prevent flow of electrical current between metallic pipe and the meter or regulator.

3.4.1 Pressure Regulators

****

NOTE: Delete inapplicable requirements. Remove reference to bypasses around pressure regulators unless continuity is imperative and the bypass is regulated to prevent possible over pressure of downstream lines.

****

Install pressure regulators [450 mm 18 inches above the ground on the riser] [where shown]. Provide a 10 mm 3/8 inch tapped fitting equipped with a plug on both sides of the regulator for installation of pressure gauges for adjusting the regulator. Install regulators and valves in rectangular reinforced concrete boxes. Use boxes large enough so that required equipment can be properly installed, operated, and maintained. Extend sidewalls above ground line. Provide boxes with [steel door] [cast iron manhole] covers with locking provisions and 100 mm 4 inch diameter vents.

3.4.2 Meters

Install meters in accordance with ASME B31.8.

3.4.3 Vents

Locate discharge stacks, vents, or outlet ports of devices where gas can be discharged into the atmosphere without undue hazard. Terminate vents in the outside air in rain and insect resistant fittings. [Locate the open end of the vent where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.] [Provide stacks and vents with fittings to preclude entry of water.]

3.5 INSTALLING PIPE UNDERGROUND

****

NOTE: Coordinate Section 31 00 00 EARTHWORK and details on the drawings to assure that pipe bedding materials are appropriate for the allowed pipe.

****

Perform installation as specified in Section 31 00 00 EARTHWORK, except as modified herein; and as required by ASTM F402 and ASTM D2855 for using solvents and cleaners, ASTM D2774 for polyvinyl chloride and polyethylene pipe, and ASTM D3839 for fiberglass pipe.

3.5.1 Cathodic Protection

****

NOTE: Cathodic protection is mandatory for underground ferrous pipelines. The type and design of cathodic protection will be in accordance with UFC 3-570-02A. Stations will be provided for testing the cathodic protection system.

****

Provide cathodic protection for ferrous piping installed underground as specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

3.5.2 Valve Boxes

Install valve boxes at each underground valve except where concrete or other type of housing is indicated. When the valve is located in a roadway, protect the valve box by a suitable concrete slab at least 1 square meter 3 square feet. When in a sidewalk, place the top of the box in a concrete slab 600 mm 2 feet square and set flush with the sidewalk. Support valve boxes separately, not resting on the pipe, so that traffic loads cannot be transmitted to the pipe.

3.5.3 Magnetic Tape

When non-metallic piping is installed underground, place foil backed magnetic tape above the pipe to permit locating with a magnetic detector.

3.5.4 Pipe Coatings

Repair any damage to the protective covering during transit and handling before installation.

3.6 INSTALLING PIPE ABOVEGROUND

With the exception of vacuum pipe segments [A-B] [B-C] [D-E] [_____] as indicated and/or shown, do not install thermoplastic pipe aboveground. Install vertical pipe plumb in all directions. Install perpendicular piping parallel to building walls. Piping at angles and 45 degree runs across corners will not be accepted unless specifically shown. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate piping to avoid ducts, equipment, and beams. Install piping to avoid obstructing corridors, walkways, work areas, and like spaces. Provide a minimum headroom clearance of 2.2 m 7 feet under piping, unless otherwise indicated. Provide temporary caps or plugs at pipe openings at the end of each day's work. Run piping in groups where practicable. Provide minimum clearance of 25 mm 1 inch between pipe and other work.

3.6.1 Hangers and Supports

Install pipe hangers and supports in accordance with MSS SP-58 at locations where pipe changes direction. Install hanger rods straight and vertical. Chain, wire, strap or perforated bar hangers will not be permitted. Do not suspend hangers from piping. Where proper hanger or support spacing does not correspond with joist or rib spacing, suspend pipe from structural steel channels attached to joists or ribs. Prevent contact between dissimilar metals when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless steel hangers or supports. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl. Use galvanized or stainless steel hangers and supports in basins or submerged locations. Provide maximum support spacing, unless otherwise shown or approved for standard weight steel pipe, as follows:

Pipe Size	Spacing
Less than 50 mm 2 inches	2 m6 feet
50 to 75 mm2 to 3 inches	3 m10 feet
Greater than 75 mm3 inches	4 m12 feet

Maximum support spacing for pipe other than standard weight steel must be two-thirds of the corresponding spacing for steel pipe unless otherwise shown or approved.

3.6.2 Insulation

Furnish and install insulation in accordance with Section 23 07 00 THERMAL

INSULATION FOR MECHANICAL SYSTEMS.

3.6.3 Coatings or Finishes

****

NOTE: Where the using service has specific requirements for color coding differing from the color specified, this paragraph will be modified accordingly and coordinated with paragraph, Identification and UFGS 09 97 02 PAINTING: HYDRAULIC STRUCTURES. Off-gases from landfills often consist of large quantities of Methane (CH4), Hydrogen Sulfide (H2S) and Carbon Dioxide (CO2) with a lesser amount of other organic compounds present. Phenolic or epoxy type coatings are generally recommended for this type of service.

****

Provide coatings and finishes in accordance with Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES. Repair damage to the factory covering during transit and handling before installation. Painting is not required where piping is insulated, stainless steel, galvanized steel or nonferrous. Clean factory painted items requiring touching-up in the field of foreign material and prime and top coat with the manufacturer's standard factory finish. Paint exposed ferrous surfaces with two coats of enamel paint. Solvent clean factory primed surfaces before painting. Prepare and prime surfaces that have not been factory primed in accordance with the enamel paint manufacturer's recommendations.

3.7 JOINTING PIPE

Join non-metallic piping by performance qualified joiners using qualified procedures in accordance with AGA XR0603. Inspect joints by an inspector qualified in the joining procedures being used and in accordance with AGA XR0603.

3.7.1 O-Ring Joints

Clean jointing surfaces and adjacent areas before making joint. Lubricate and adjust gaskets and "O"-rings in accordance with manufacturer's recommendations. Check each gasket for proper position around full circumference of the joint after "O"-rings are compressed and before pipe is brought fully home. Jointing pipe must be done in accordance with ASTM D3139 and manufacturer's recommendations.

3.7.2 Mechanical Joints

Center the plain end and push into the bell. Firmly press gasket evenly into the bell. Slip gland to the bell for bolting. Oil the bolt threads. Tighten bolts alternately 180 degrees opposite to each other to seat the gasket evenly. Apply bituminous coating to ferrous bolts and nuts before assembly. Use maximum torque on bolts as follows:

Bolt Size (mminch)	Applied Torque (Nmft-lb)
165/8	6850

Bolt Size (mminch)	Applied Torque (Nmft-lb)
193/4	10880
251 inch	12290
321-1/4	149110

3.7.3 Flanged Joints

Use hexagon head nuts and bolts. Limit bolt projection through the end of the nut to [6] [_____] mm [1/4] [_____] inch maximum. Follow manufacturer's rating and instructions for specified service.

3.7.4 Expansion Couplings

Provide expansion couplings in tension to facilitate their removal. Set stretcher bolts for maximum allowable elongation of expansion coupling as recommended by the manufacturer. Provide expansion couplings as shown and as recommended by the manufacturer.

3.7.5 Destructive Joint Tests

****

NOTE: Destructive tests are provided as a designer option. Destructive tests are considered useful in assuring that good joints will be made. Delete the paragraph if this option is not exercised.

****

Each day, prior to making [heat fusion] [adhesive] [or] [solvent welded] joints, make a joint of each size and type to be installed that day by each person assembling these joints that day and destructively test. Cut at least 3 longitudinal straps from each joint. Visually examine each strap. Ensure strap does not contain voids or discontinuities on the cut surfaces of the joint area, and is deformed by bending, torque, or impact, and if failure occurs, it must not initiate in the joint area. If a joint fails the visual or deformation test, ensure the qualified joiner who made that joint does not make further field joints in plastic pipe on this job until that person has been retrained and requalified. Record results of the destructive tests to include the date and time of the tests, size and type of the joints, ambient conditions, fusion iron temperature and names of inspectors and joiners.

3.8 CONNECTIONS

3.8.1 Transitions Between Types of Pipe

Provide necessary adapters, specials and connector pieces when connecting different types and sizes of pipe or pipe furnished by different manufacturers. Encase underground connecting joints with 150 [_____] mm [6] [_____] inches minimum, Class B concrete unless otherwise shown, or recommended by manufacturer. Make connections between piping and equipment, where required, using [approved] [proper] fittings to suit the actual conditions.

3.8.2 Connections to Off-Gas Source and Discharge Points

Connect the off-gas pipelines to the source and discharge locations. Notify the Contracting Officer, in writing, 10 days before final connections and activation of the system.

3.8.3 Connection to Equipment

****

NOTE: Coordinate the drawings and specifications for blowers and treatment equipment.

****

Provide connections to the equipment in accordance with approved procedures. Only isolate equipment [immediately on each side of the equipment] [at the valve location shown on the drawings].

3.8.4 Location of Existing Piping

Locations of existing piping shown should be considered approximate. Contractor is responsible for determining exact location of existing piping which may be affected by the work during earth moving operations.

3.8.5 Removing Existing Pipelines from Service

Do not remove pipelines from service unless specifically listed or approved by Contracting Officer. Notify the Contracting Officer at least [48] [_____] hours prior to removing each pipeline from service.

3.9 PRESSURE AND LEAKAGE TESTS

Perform tests on [pipe segments as shown] [the system as a whole] [sections that can be isolated]. Test joints in sections prior to backfilling when trenches have to be backfilled before the completion of other pipeline sections. Furnish labor, materials and equipment for conducting the tests which are subject to inspection during the tests. The Contractor is responsible for the cost of repair, replacement, and retesting required because of failure to meet testing requirements. Prior to testing the system, blow out the interior, clean and clear of foreign materials. Remove meters, regulators, and controls before blowing out and cleaning and reinstall after clearing of foreign materials. Maintain safety precautions for pressure testing during the tests. Notify Contracting Officer [_____] [48] hours in advance of pressure, leakage and/or vacuum testing. Conduct tests in the presence of the Contracting Officer unless otherwise directed. During the test, completely isolate the entire system from compressors and other sources of pressure. Perform testing with due regard for the safety of employees and the public during the test. Keep persons not working on the test operations out of the testing area while testing is proceeding. Conduct leakage test only after satisfactory completion of pressure test.

3.9.1 Bubble Tests

Test each joint in accordance with ASTM E515 prior to backfilling or concealing any work.

3.9.2 Pressure Testing

****

NOTE: Thermoplastic piping should not be pressure tested with air. Specify test pressure (including Class Location) to be used in accordance with ASME B31.8. Test pressure will not be less than 1.5 times the design pressure, but not exceeding 1.5 times the maximum rated pressure of the lowest-rated component in the system. Test pressures should recognize the weakest component of each segment tested for the design pressure and the maximum allowable operating pressure.

****

Place and compact backfill to at least the pipe centerline before testing. Allow concrete for blocking to reach design strength and backfill and compact to assure restraint by harnessed joints before testing. Fill section to be tested slowly with [air.] [water, and expell air. Install corporation cocks as necessary to remove air.] Apply test pressure for one hour and observe gauge pressure. Check leaks continuously while test pressure is being maintained. Test off-gas piping system after construction and before being placed in service using [water] [air] as the test medium. Continue pressure test for at least [24] [36] [48] hours from the time of the initial readings to the final readings of pressure and temperature. Do not make the initial test readings of the instrument for at least 1 hour after the pipe has been subjected to the full test pressure, and make neither the initial nor final readings at times of rapid changes in atmospheric conditions. Ensure temperatures are representative of the actual trench conditions. There must be no indication of reduction of the test pressure, [_____] kPa psig, applied at the lowest elevation of the pipeline section, during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship T(1)P(2)=T(2)P(1), in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial and final readings. Repair and retest lines which fail to hold specified test pressure or which exceed the allowable leakage rate.

3.9.3 Leakage Testing

Allow pipe to stand full of water at least 12 hours prior to starting leakage test. Examine exposed pipe, joints, fittings and valves. Stop visible leakage, and replace the defective pipe, fitting or valve. Refill the line under test to reach the required test pressure. Place the amount of water permitted as leakage in a container attached to the supply side of the test pump. Seal the container. Do not attach other source of supply to the pump or line under test. Pump water into the line with the test pump to hold [_____] kPa psig for [2] [4] [8] hours. Measure water remaining in the container and the amount used during the test and record on the test report. Consider test as failed upon exhaustion of supply and/or inability to maintain the required pressure.

3.9.4 Vacuum Testing

Perform test on [the entire system] [individual sections] as approved by the Contracting Officer. Seal openings in system or section to be tested. Pull vacuum [_____] kPa psig for one hour (isolating system from vacuum by closing valves). Allow system to normalize and then record the initial vacuum readings. Record vacuum at intervals of [15 minutes] [1 hour] [_____] for the duration of the [8] [_____] hour test. Repair and retest measurable leakage (loss of vacuum) after corrections have been made for changes in atmospheric conditions in conformity with the relationship

T(1)P(2)=T(2)P(1), in which T and P denote absolute temperature and total pressure, respectively, and the numbers denote initial and final readings.

3.9.5 Hanger Acceptance Testing

Bring pipe systems up to operating pressures and temperatures. Recycle systems to duplicate operating conditions. Submit reports of all inspections or tests, including analysis and interpretation of test results. Identify each report and test methods used, and record test results.

3.9.6 Demonstration

Upon completion of the work and before final acceptance, submit a Statement of Satisfactory Installation signed by the principal officer of the contracting firm stating that: the installation is satisfactory and in accordance with the contract plans and specifications; the manufacturer's prescribed procedures and techniques have been followed; and at a time designated by the Contracting Officer. Provide the services of a qualified engineer for a period of no less than [8] [_____] hours to instruct a representative of the Government in the contents of the operation and maintenance manuals for the equipment furnished under this Section. Submit [6] [_____] copies, in indexed booklet form, of site specific operation and maintenance manual for the piping system including system operation, system maintenance, equipment operation, and equipment maintenance manuals described below. If operation and maintenance manuals are provided in a common volume, ensure they are clearly differentiated and separately indexed. Ensure the field instructions cover the items contained in the bound instructions.

a. The System Operation Manual includes but is not limited to the following:

   (1) Maps showing piping layout and locations of system valves and line markers.

   (2) Step-by-step procedures required for system startup, operation, and shutdown. Index system components and equipment to the maps.

   (3) Isolation procedures and valve operations to shut down or isolate each section of the system. Index valves and other system components to the maps.

   (4) Descriptions of Site Specific Standard Operation Procedures including permanent and temporary pipe repair procedures, system restart and test procedures for placing repaired lines back in service, and procedures for abandoning piping and system components.

   (5) Descriptions of Emergency Procedures including: isolation procedures including required valve operations with valve locations indexed to the map, recommended emergency equipment, and checklist for major emergencies.

b. The Equipment Operation Manual includes but is not limited to detail drawings, equipment data, and manufacturer supplied operation manuals for equipment, valves and system components.

c. The System Maintenance Manuals include but are not limited to:

(1) Maintenance check list for entire system.

(2) Descriptions of site specific standard maintenance procedures.

(3) Maintenance procedures for installed cathodic protection systems.

(4) Piping layout, equipment layout, and control diagrams of the systems as installed.

(5) Identification of pipe materials and manufacturer by location, pipe repair procedures, and jointing procedures at transitions to other piping materials or piping from different manufacturer.

d. The Equipment Maintenance Manuals include but are not limited to the following:

(1) Identification of valves and other equipment by materials, manufacturer, vendor identification and location.

(2) Maintenance procedures and recommended maintenance tool kits for valves and equipment.

(3) Recommended repair methods, either field repair, factory repair, or whole-item replacement for each valve component or piece of equipment or component item.

(4) Routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 21 13 (November 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-31 21 13 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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-- End of Section Table of Contents --

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SECTION 31 21 13

RADON MITIGATION

11/18

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NOTE: This guide specification covers the requirements for constructing radon mitigation systems in new buildings, existing buildings and facilities, including constructing radon mitigation systems enclosures, when required.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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RADON MITIGATION FOR NEW CONSTRUCTION

NOTE: Consult the current EPA radon map and EPA documents for each state for additional information concerning radon zones.

For new construction in Zone 1 areas as defined on "EPA Map of Radon Zones", or when testing identifies radon concentrations equal to or greater than 4 pCi/L, passive radon mitigation systems should be incorporated into the original building design. The design should include provisions to permit installation of exhaust fans, if necessary, after testing the building under occupied conditions.

Criteria for radon mitigation in new construction is specified in EPA 625-R-92-016, (1994, Third Printing with Addenda) and the current version of "Radon Mitigation Standards for Schools and Large Buildings."

Materials (aggregate for capillary water barrier and poly(vinyl chloride) (PVC) pipe) currently in use for constructing new buildings, when properly arranged as indicated and specified in EPA 625-R-92-016, will provide a passive radon mitigation system. A separate specification section on radon mitigation for new construction seems unnecessary considering the materials are addressed in Division 02 and Division 15 sections and the installation will be shown on the drawings.

****

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NOTE: A simple, effective, efficient, and economical radon mitigation system is little more than a PVC vent pipe (one suction point) exhausted to the atmosphere without a fan (passive system). For large areas requiring mitigation, the system could include several vent pipes connected to a single outlet with an appropriately sized in-line fan (active system). Depending on the distances between suction points, several individual vent pipes with or without in-line fans may be more practical.

This guide specification provides criteria and material requirements for constructing radon mitigation systems, post mitigation testing and constructing gypsum wallboard enclosures to conceal the radon mitigation systems in occupied spaces.

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NOTE: The Designer should include unit price items to address post mitigation radon testing. Estimate the quantity and specify as unit price items in Section 00 21 13, INSTRUCTIONS TO BIDDERS or Section 01 20 00 Price and Payment Procedures per standard practice of the activity preparing the contract.

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NOTE: The work may involve a historic property. The designer must coordinate review of the proposed work with the appropriate cultural resources manager (CRM) and cultural resource laws and regulations, as part of the environmental review and permitting process. Consultation with stakeholders, including the state historic preservation office, may be required, and work involving historic properties will likely be required to confirm to the Secretary of the Interior's Standards for the Treatment of Historic Properties (usually at the REHABILITATION

level). See https://www.nps.gov/tps/standards/four-treatments/treatment-rehabilitation.htm

****

PART 1 GENERAL

1.1 SUMMARY

****

NOTE: For work in the continental United States, Alaska and Hawaii select picoCuries per liter (pCi/L) as the unit of measure. For work elsewhere in the world Bequerels per cubic meter (Bq/cu m) may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

****

Provide all work necessary to reduce and maintain radon concentration levels below [148 Bequerels per cubic meter (Bq/cu m)][4.0 picoCuries per liter (pCi/L)] in various buildings specified herein. Perform mitigation system installation, and perform post-mitigation testing and monitoring for radon.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AMERICAN ASSOCIATION OF RADON SCIENTISTS AND TECHNOLOGISTS (AARST)

ANSI/AARST MA-MFLB	Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily, School, Commercial and Mixed-Use Buildings
ANSI/AARST SGM-MFLB	(2023) Soil Gas Mitigation Standards for Existing Multifamily, School, Commercial and Mixed-Use Buildings

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	(2020) Specifications for Structural Concrete

ASTM INTERNATIONAL (ASTM)

ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C475/C475M	(2017; R 2022) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C645	(2024) Standard Specification for Nonstructural Steel Framing Members
ASTM C834	(2017; R 2023) Standard Specification for Latex Sealants
ASTM C840	(2024) Standard Specification for Application and Finishing of Gypsum Board
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1002	(2022) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C1047	(2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C1396/C1396M	(2024) Standard Specification for Gypsum Board
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

ASTM E2121	(2013) Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7	(2014) Compressed Air for Human Respiration; 6th Edition

GYPSUM ASSOCIATION (GA)

GA 216	(2016) Application and Finishing of Gypsum Panel Products

INTERNATIONAL CODE COUNCIL (ICC)

ICC IMC	(2024) International Mechanical Code

MASTER PAINTERS INSTITUTE (MPI)

MPI 50	(2015) Primer Sealer, Latex, Interior
MPI 114	(2012) Latex, Interior, Gloss (MPI GLoss Level 6)
MPI 139	(2016) Latex, Interior, High Performance Architectural, (MPI Gloss Level 3)
MPI 141	(2016) Latex, Interior, High Performance Architectural, Semi-Gloss (MPI Gloss Level 5)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules	(2021) Standard Grading Rules for Northeastern Lumber

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1378	(1995) Thermoplastic Duct (PVC) Construction Manual, 2nd Edition

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003	(2021) Standard Grading Rules for Southern Pine Lumber

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF THE NAVY (DON)

OPNAV M-5090.1	(2014) Environmental Readiness Manual

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 402-R-92-003	(1993) Protocols for Radon and Radon Decay Product Measurements in Homes
EPA 402-R-92-004	(1992) Indoor Radon and Radon Decay Product Measurement Device Protocols
EPA 402-R-92-014	(1993) Radon Measurement in Schools
EPA 402-R-93-078	(1993; R 1994) Radon Mitigation Standards
EPA 625-R-92-016	(1993; Am 1994) Radon Prevention in Design and Construction of Schools and Other Large Buildings
EPA 625-R-93-011	(1993) Radon Reduction Technique for Existing Detached Houses: Technical Guidance for Active Soil Depressurization Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1096	(2017) Ionizing Radiation
29 CFR 1926.59	Hazard Communication
29 CFR 1926.103	Respiratory Protection
42 CFR 84	Approval of Respiratory Protective Devices

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17	(2015; R 2018) Standard Grading Rules for West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5	(2021) Western Lumber Grading Rules

1.3 DEFINITIONS

1.3.1 Active Soil Depressurization (ASD)

A family of radon mitigation systems involving mechanically-driven soil depressurization, including sub-slab depressurization (SSD), sub-membrane depressurization (SMD), block wall depressurization (BWD) and crawl space depressurization (CSD).

1.3.2 Contract Documents

Documents furnished to prospective bidders/proposers containing information and specifying criteria and project requirements for diagnostic testing, design, construction and monitoring of multiple radon mitigation systems. The documents include this specification and the drawings listed in and accompanying this specification.

1.3.3 Long Term Radon Detectors

****

NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

****

Alpha track, electret ion chamber, or approved equivalent. Devices capable of sensing and recording the presences of radon during a time period of 91 days to 12 months which when analyzed provide a numeric value, measured in [Bq/cu m][pCi/L], for radon concentrations during the time exposed.

1.3.4 Pressure Differential Gauge

A tool used to measure the PFE created by an ASD system. Calibrate the gauge in accordance with national standards and the manufacturer's recommendations. The gauge must be capable of readings to 0.25 Pa 1/1000 in water column

1.3.5 Pressure Field Extension (PFE)

The distance that a pressure change, created by drawing soil-gas through a suction point, extends outward in a sub-slab gas permeable layer, under a membrane, behind a solid wall or in a hollow wall.

1.3.6 Qualified Mitigation Professional

Regardless of team composition, a "Qualified Mitigation Professional" for the purposes of this document is defined as: "An individual that has demonstrated a minimum degree of appropriate technical knowledge and skills specific to radon mitigation of schools and large buildings: a) as established in certification requirements of the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB); and b) as required by statute, state licensure or certification program, where applicable."

1.3.7 Short Term Radon Detectors

****

NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

****

Charcoal, electret ion chamber, or approved equivalent. Devices capable of sensing and recording the presences of radon during a time period of 48-hours to 90 days which when analyzed provide a numeric value, measured in [Bq/cu m][pCi/L], for radon concentrations during the time exposed.

1.3.8 Suction Hole

Location at which vacuum is created for sub-slab communication testing.

1.3.9 Suction Point

Vertical standpipe penetrating into the soil gas environment containing radon and serving as the conduit to exhaust radon gas to the atmosphere.

1.3.10 Test Hole

Location at which pressure readings are taken during sub-slab communication testing. Readings are used to evaluate potential effectiveness of a sub-slab depressurization system.

1.4 SYSTEM DESCRIPTION AND REQUIREMENTS

1.4.1 Performance Requirements

****

NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

****

Radon mitigation systems must reduce and maintain radon concentration levels below [148 Bq/cu m][4.0 pCi/L] in various buildings specified herein. Test and construct radon mitigation systems in accordance with ANSI/AARST SGM-MFLB, ANSI/AARST MA-MFLB,[ASTM E2121][OPNAV M-5090.1] EPA 402-R-93-078, EPA 402-R-92-003, EPA 402-R-92-004 and as specified herein. Additional guidance for testing and constructing radon mitigation systems is contained in EPA 625-R-92-016 and EPA 625-R-93-011.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Respirators; G, [_____]

Radon Mitigation Systems Components

Radon Mitigation Systems Enclosure Components

SD-06 Test Reports

Post Mitigation Testing; G, [_____]

SD-07 Certificates

Worker Protection Plan; G, [_____]

Medical Certification; G, [_____]

Worker Notification; G, [_____]

Respiratory Protection Program; G, [_____]

Contractor Qualifications; G, [_____]

Contractor Experience; G, [_____]

Testing Laboratory Certification; G, [_____]

Proof Of Current Calibration For Testing Devices; G, [_____]

Radon Mitigation System Inspection; G, [_____]

SD-08 Manufacturer's Instructions

Radon Mitigation Systems Components

Radon Mitigation Systems Enclosure Components

SD-10 Operation and Maintenance Data

Radon Mitigation Systems, Data Package 2; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Radon Detector Location Log; G, [_____]

Respirator Program Records; G, [_____]

1.6 RADON DETECTOR LOCATION LOG

Prepare and provide to the Contracting Officer a Radon Detector Location Log for each building detailing the identity and location of each short term and long term radon detector. Prepare the log using copies of the "Device Placement Log" contained in EPA 402-R-92-014, and provide the appropriate information as line items. In addition to the log, on a copy of the building floor plans, locate and identify each short term and long term detector.

1.7 WORKER HEALTH AND SAFETY

Comply with OSHA, state and local standards or regulations relating to worker safety and occupational radon exposure. Prepare a worker protection plan in accordance with 29 CFR 1910.1096,[OPNAV M-5090.1,][EM 385-1-1,] and EPA 402-R-93-078.

1.7.1 Worker Protection Plan

The worker protection plan must address, at a minimum occupational radon exposure, safe use of all job site equipment including safe practices when using ladders or scaffolding; safe procedures for crawl space work and avoidance of job site hazards; discussion of hantavirus symptoms; fire and life safety issues; confined space access; handling caustic solvents and bonding chemicals; appropriate use of personal protective equipment; respiratory protection program; suspected contaminants such as asbestos, lead paint, mold or other toxins that may exist; safety data sheets (SDS); ventilated work areas as required to reduce occupational radon exposure. Adhere to 29 CFR 1926.59 and provide the Contracting Officer with a copy of the SDS for all materials brought to the site.

1.7.2 Worker Exposure Records

Maintain records of worker exposure to radon sufficient to verify that workers are exposed to less than four working level months (WLM) in any 12-month period.

1.7.3 Medical Certification

Provide a written certification for each worker and supervisor, signed by a licensed physician indicating that the worker and supervisor has met or exceeded all of the medical prerequisites listed herein and in

29 CFR 1910.1096 and 29 CFR 1926.103 as prescribed by law. Submit certificates prior to the start of work.

1.7.4 Worker Notification

Train workers exposed to radon about the hazards of exposure to radon and the need to apply protective measures when working in areas with elevated radon concentrations. Training must comply with 29 CFR 1910.1096. Submit a notification signed by each worker acknowledging they have been properly trained regarding the hazards of radon exposure.

1.8 RESPIRATORY PROTECTION PROGRAM

Establish and implement a respirator program as required by 29 CFR 1910.1096, and 29 CFR 1926.103. Submit a written description of the program to the Contracting Officer. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.

1.8.1 Respirator Program Records

Submit records of the respirator program as required by 29 CFR 1926.103, and 29 CFR 1910.1096.

1.8.2 Respirator Fit Testing

Conduct a qualitative or quantitative fit test conforming to 29 CFR 1926.103 for each worker required to wear a respirator, and any authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test must be performed prior to initially wearing a respirator and every 12 months thereafter. If physical changes develop that will affect the fit, a new fit test must be performed. Functional fit checks must be performed each time a respirator is put on and in accordance with the manufacturer's recommendation.

1.8.3 Respirator Selection and Use Requirements

Provide respirators, and ensure that they are used as required by 29 CFR 1910.1096, 29 CFR 1926.103 and in accordance with CGA G-7 and the manufacturer's recommendations. Respirators must be approved by the National Institute for Occupational Safety and Health NIOSH, under the provisions of 42 CFR 84, for use in environments containing radon. For air-purifying respirators, the particulate filter must be high-efficiency particulate air (HEPA)/(N-,R-,P-100). The initial respirator selection and the decisions regarding the upgrading or downgrading of respirator type must be made by the Contractor's Designated IH based on the measured or anticipated airborne radon concentrations to be encountered.

1.8.3.1 Respirators

Provide personnel with respiratory protection as indicated in 29 CFR 1926.103. Breathing air must comply with CGA G-7.

1.9 QUALITY ASSURANCE

****

NOTE: Some states require only State listed mitigation contractors to perform radon mitigation work in their State. Determine the requirements for the State in which the work will be performed, and

include the bracketed text if such is the case, otherwise delete.
****

1.9.1 Contractor Qualifications and Experience

Within 15 days after award, submit written evidence or data demonstrating that the Contractor and one or more subcontractors employed by the Contractor possess the qualifications and experience specified below.

1.9.1.1 Contractor Qualifications

The person responsible for diagnostic testing, construction and on-site supervision, as required by the specifications, must have successfully completed the requirements of and maintaining a current certification issued by either the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB)as a qualified mitigation professional. Alternatively, in a State with legislation requiring mandatory credentialing for this work, compliance with the State legislation is acceptable. Evidence showing successful completion of the requirements of the NRPP or the NRSB must include copy of current certification document and documentation issued by the State.[Listing in the State of [_____] is required.]

1.9.1.2 Contractor Experience

Submit written evidence demonstrating that the Contractor has successfully designed and installed at least [two] [_____] radon mitigation systems of the same or similar to the type required herein. The Contractor must have [3][5][_____] years of experience installing radon mitigation systems. Experience proof must include but not be limited to:

a. The contract name and number, completion dates of the project and the total cost of the project;

b. The names, telephone numbers and fax number of the facility or installation for whom the radon mitigation system design, construction and testing were performed;

c. The name, telephone number and fax number of a supervisory level point of contact at each facility or installation who has knowledge of the Contractor's performance.

1.9.1.3 Qualified Mitigation Professional

A Qualified Mitigation Professional must be physically present or ensure a responsible person is present during onsite activities and immediately available to direct, instruct and oversee activities of other individuals, mitigation installers and other professionals engaged in installation activities for the mitigation system(s). The qualified mitigation professional must have [3][5][_____] years of experience installing radon mitigation systems.

1.9.2 Testing Laboratory

Submit testing laboratory certification as proof that the testing laboratory performing radon detector analysis has successfully completed the requirements of the National Radon Safety Board (NRSB)or the National Radon Proficiency Program, (NRPP) and is qualified and authorized to perform such analysis. Alternatively, in a State with legislation requiring mandatory credentialing for this work, compliance with the State legislation is acceptable.[Listing in the State of [_____] is required.]

1.9.3 Diagnostic Testing Equipment

Submit proof of current calibration for testing devices used in performing diagnostic testing.

1.9.4 On-Site Supervision

No work at the site will be permitted without the presence of a person possessing the qualifications specified elsewhere in this section, namely certification issued by either the National Radon Proficiency Program, (NRPP) or the National Radon Safety Board (NRSB)as a qualified mitigation professional, or the State equivalent, where applicable.

1.9.5 Preconstruction Conference

****

NOTE: Specify additional or modified requirements to be addressed in the preconstruction safety conference within the bracket if different from that described. Confer with the appropriate Construction Office and Safety and Occupational Health Office representatives to make this determination. For Army projects refer to EP 415-1-260, Chapter 9, Resident Engineers Management Guide. If this conference is addressed in another specification section, reference the appropriate section.

****

Conduct a safety preconstruction conference to discuss the details of the Worker Protection Plan, Accident Prevention Plan (APP) including the AHAs required in specification section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS [______]. The safety preconstruction conference must include the Contractor and their Qualified Mitigation Professional, Designated IH and Project Supervisor and the Contracting Officer. Deficiencies in the APP will be discussed. Onsite work must not begin until the APP has been accepted. [______]

1.10 DELIVERY, STORAGE AND HANDLING

1.10.1 Delivery of Products

Deliver materials to the site in an undamaged condition. Deliver proprietary items in manufacture's original unopened and undamaged containers of packages with manufacture's name and brand and other pertinent data such as specification number, type, and class, date of manufacture. Schedule deliveries of materials to coincide with scheduled installation.

1.10.2 Storage and Handling

Carefully store materials off the ground to provide proper ventilation, drainage and protection against weather and dampness. Protect materials from marring, staining, rust, damage and overload and from contaminants such as grease, oil and dirt. Store materials at temperatures recommended by the manufacturer. Handle material to avoid damage such as chipping and breaking. Replace damaged material.

1.11 PROJECT CONDITIONS

1.11.1 Building Descriptions

****

NOTE: Provide a general description for each building and address conditions which may affect the work or the cost of accomplishing the work. For each building, address the following as appropriate for the areas in which work is to be accomplished:

1. Type of construction for the exterior walls, interior walls and partitions and the floor in contact with or above soil containing radon gas. Indicate thickness of concrete slab and aggregate beneath the concrete slab.

2. Number of floors.

3. Type of roof, flat or pitched. If pitched roof, overhang size. Type of roof covering.

4. Do rooms/spaces have suspended ceilings? This could be shown on the drawings if not consistent throughout the building.

5. Will the building and individual rooms or spaces be occupied or unoccupied during construction? Will access to the building or individual room or spaces be restricted in any way which would delay the start of work each day?

6. Restrictions with respect to penetrations to the building exterior, such as no roof penetrations, if any.

7. Restrictions on penetrating the concrete floor slab with respect to what may be embedded in the concrete slab (i.e. rebar spacing, electrical grounding grid embedded in the concrete slab).

8. Restrictions with respect to routing vent pipe on the building interior or exterior, if any. Vents may not be desired on the exterior of a particular side of the building.

The sample paragraph below may be used as a starting point for each building description.

****

[Building No. [_____] is a three story, brick faced (CMU backed), slab-on grade structure with a partial basement on the southeast corner of the building. Concrete slab is approximately [_____] mm inches thick and the aggregate beneath the concrete slab is approximately [_____] mm inches thick. Interior partitions are gypsum wallboard on metal studs except where indicated otherwise on the drawings. The roof is flat and covered with single ply rubber membrane. Except for the basement, mechanical rooms and closets, all rooms have suspended acoustical ceilings located approximately 450 mm 18 inches below the structural floor or roof above. The building will[not] be occupied during the contract period.[Roof penetrations are not permitted and the south elevation must remain unchanged as a result of the work.][Penetrations to the building exterior must be through the roof only. All elevations must remain unchanged as a result of the work.]

]PART 2 PRODUCTS

2.1 RADON MITIGATION SYSTEMS

2.1.1 System Performance

****

NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

****

Radon mitigation systems must reduce and maintain radon concentration levels below [148 Bq/cu m][4.0 pCi/L] after activation of the mitigation systems.

2.1.1.1 System Piping

Route radon mitigation systems piping so as not to interfere with the daily operations and functions of the building occupants. Keep visibility of the systems to a minimum. Enclose each radon mitigation system in occupied spaces, however, all operating components must be accessible for maintenance and repair. All spaces must be considered to be occupied spaces except for mechanical and electrical rooms, warehouses, storerooms, janitor closets, crawl spaces, [_____] and attic spaces. Enclosures are not required for portions of systems installed above suspended acoustical ceilings.

2.1.1.2 System Outlet Location

****

NOTE: In climates where condensation is subject to freezing and ice build-up at the discharge point above the roof line, include the bracketed text, otherwise delete.

****

Mitigation system discharge points must be as specified in ANSI/AARST SGM-MFLB and EPA 402-R-93-078. Prevent foreign objects from entering the outlet.[Rain caps are not permitted.] Maintain water tight seal through all penetrations to the building exterior.

2.1.1.3 System Failure Warning Monitor

Provide a means to detect and announce each radon mitigation system failure. System failure is defined as:

a. System blockage: foreign debris.

b. Mechanical failure: fan or other mechanical failure.

c. System leakage: pipe breakage or crack.

Provide an audio or visual annunciator device to indicate system failure and locate the annunciator device in an occupied space. Conform to the requirements of ANSI/AARST SGM-MFLB and EPA 402-R-93-078.

2.1.1.4 Air Cleaners

Do not use air cleaners as a radon reduction method.

2.1.1.5 Ventilation Devices

Do not use devices that solely increase ventilation as a radon reduction method.

2.1.1.6 Back Drafting

Do not allow radon mitigation systems to cause back drafting of building chimneys.

2.1.2 Radon Mitigation Systems Components

Mechanical and electrical materials, fabrication, construction and installation must conform to the following industry standards:

a. Poly(vinyl chloride) (PVC) Piping: ASTM D2665, Schedule 40.

b. In-line Tubular Centrifugal Fans: AMCA 210 and UL listed.

c. Electrical Work: NFPA 70, NEMA MG 1, ANSI/AARST SGM-MFLB and EPA 402-R-93-078, No. 12 AWG minimum wire size, solid copper installed in EMT or surface metal raceway.

d. Mechanical Work: ICC IMC, SMACNA 1378, ANSI/AARST SGM-MFLB and EPA 402-R-93-078.

e. Sealants: ASTM C920, polyurethane, Type S, Grade P for horizontal application, Grade NS for vertical application, Class 25, Use T.

f. Crawl space soil-gas retarder membrane must be minimum [40][60] mils thick.

****

NOTE: Include mock downspouts and fittings only when round PVC piping is not acceptable for aesthetic reasons.

****

[g. Mock Downspouts and Fittings: Aluminum, ASTM B209M ASTM B209, minimum 0.81 mm 0.032 inch thick, color to match existing. Seal seams and joints. Use downspout only on the building exterior above the fan with appropriate round to downspout shape PVC adapter.

]2.2 RADON MITIGATION SYSTEMS ENCLOSURES

****

NOTE: Select the first bracketed paragraph for enclosure materials and construction when the project involves only radon mitigation work. Select the second bracketed paragraph when the project also involves building renovations which require project specification sections addressing the work listed in the second bracketed paragraph.

****

****

NOTE: When selecting the MPI painting/coating designations, determine whether an eggshell, semi-gloss or gloss finish is desired.

****

[Radon mitigation systems enclosure components, materials, fabrication, construction and installation must conform to the following industry standards:

a. Concrete: ACI 301.

b. Wood Studs and Furring: WWPA G-5, WCLIB 17, SPIB 1003 or NELMA Grading Rules Standard Light Framing, air dried or kiln dried lumber.

c. Metal Studs and Furring: ASTM C645, but not lighter than 25 gage.

d. Gypsum Wallboard Work: ASTM C1396/C1396M, ASTM C475/C475M, ASTM C514, ASTM C1002, ASTM C1047, ASTM C840 and GA 216. Wallboard must be minimum [12][15] mm [1/2][5/8] inch thick.

e. Sealants: ASTM C834.

f. Painting/Coating: MPI 50 and [[MPI 139] [MPI 141][MPI 114]], provide primer, intermediate and top coat. Match existing coating material. Match the adjacent surfaces color.

g. Hardware: Be of the type and size necessary for the project requirements. Sizes, types and spacing of fasteners for manufactured building materials must be as recommended by the product manufacturer. Hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs must be zinc coated.

][Radon mitigation systems enclosure components, materials, fabrication, construction and installation for concrete, wood studs and furring, metal studs and furring, gypsum wallboard, sealants and painting must conform to the requirements specified in the respective specification sections addressing this work contained in the project specification.

]PART 3 EXECUTION

3.1 RADON MITIGATION SYSTEMS INSTALLATION

3.1.1 Furnishings

****

NOTE: Choose one of the following options. In most projects, the Government will remove furniture and

equipment before the Contractor begins work. In this case the first paragraph should be used.
****

[Furniture [,(_____)] and equipment will be removed from the area of work by the Government before radon mitigation work begins.

][Furniture [,(_____)] and equipment will remain in the building. Cover and seal furnishings with 0.15 mm 6-mil plastic sheet or remove from the work area and store in a location on site approved by the Contracting Officer.

]3.1.2 Installation

a. Provide radon mitigation systems as indicated in the approved design drawings, as specified in ANSI/AARST SGM-MFLB, EPA 402-R-93-078 and as required by the specifications and standards referenced herein for the respective materials using workmen skilled in the trades involved. Install piping plumb and parallel to existing walls, partitions and ceilings as appropriate, slope horizontal runs to drain, and secure in place in a rigid and substantial manner.

b. Seal new and existing floor slab penetrations in accordance with EPA 402-R-93-078 and as specified herein. Prevent entry of soil gas into the building and exhausting of conditioned air via the radon mitigation system. Seal cracks and openings around floor slab penetrations with polyurethane sealant. Provide backer rod or comparable filler material as required. Insure that all penetrations to the building exterior are weathertight.

c. Lay work out in advance. Exercise care where cutting, channeling, chasing or drilling floors, walls, partitions, ceilings or other surfaces as necessary for proper installation, support or anchorage. Patch and repair damage to buildings, piping and equipment using workmen skilled in the trades involved.

d. Coordinate all work with the Contracting Officer.

3.1.3 Supervision

Installation of the radon mitigation systems must be supervised by a qualified mitigation professional.

3.1.4 Electrical Work

NFPA 70, ANSI/AARST SGM-MFLB and EPA 402-R-93-078, No. 12 AWG minimum wire size, solid copper installed in EMT or surface metal raceway. A source of electric power should be available within [15] [_____] meters [50] [_____] feet of each fan installation. Base bids on providing [15] [_____] meters [50] [_____] feet of wire and conduit or surface metal raceway for each fan.

3.1.5 Mechanical Work

ICC IMC, SMACNA 1378, ANSI/AARST SGM-MFLB, and EPA 402-R-93-078.

3.1.6 System Identification

****
NOTE: For NAVFAC projects include the bracketed text, otherwise delete.

****

Label all components of the radon mitigation systems including, but not limited to, piping (every 3 meters 10 feet), enclosures, fans, electrical conduit (every 3 meters 10 feet) and circuit breakers. Labels must read:

Radon Reduction System. Do Not Turn Off.
Public Works Office Phone [_____]

[or as specified by the Contracting Officer.

]3.2 RADON MITIGATION SYSTEM ENCLOSURES INSTALLATION

Provide enclosures as indicated in the approved design drawings and as required by the specifications and standards referenced herein for the respective materials using workmen skilled in the trades involved. Install enclosures plumb, level and parallel to existing walls, partitions and ceilings as appropriate, and secure in place in a rigid and substantial manner.

3.3 POST MITIGATION FUNCTIONAL EVALUATION/INSPECTION

3.3.1 ASD Systems

In conjunction with activating an ASD system, the suction in system piping must be measured and recorded along with at least one PFE measurement that is conducted under closed-building or normal operating conditions. It is recommended that both measurements be made under conditions that reflect normal building operation when significantly occupied and include consideration for worst-case conditions.

3.3.1.1 PFE Measurement

Obtain PFE measurements at more than one point distant from each suction point(s) to verify intended design using a differential pressure gauge capable of reading to 0.25 Pa 1/1000 in water column. Record PFE test location and close in a nonpermanent fashion to facilitate any future needs (e.g. diagnosing a system when radon tests do not indicate success in achieving mitigation goals).

3.3.2 Non-ASD Systems

Measurements of airflow volume, pressure and other system parameters that are applicable to the method chosen must be recorded after installation.

3.4 FIELD QUALITY CONTROL

3.4.1 Radon Mitigation System Inspection

Inspect and approve in writing by a qualified mitigation professional each radon mitigation system. Verify compliance with the design, ANSI/AARST MA-MFLB, ANSI/AARST SGM-MFLB and the presence of fire stops. Provide the Radon Mitigation System inspection to the Contracting Officer. Deficiencies identified in the inspection report must be corrected by the Contractor at no additional cost to the Government.

3.4.2 Post Mitigation Testing and Monitoring

Perform post mitigation radon testing in the buildings as specified in

ANSI/AARST SGM-MFLB, EPA 402-R-93-078 and herein.

3.4.2.1 Short Term

****

NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Consult with the Contracting Officer and use the unit of measure familiar to the prospective Contractors.

****

Test each radon mitigation system as described below.

a. Test each radon mitigation system for effectiveness no sooner than 24-hours nor later than 15 days after activation of the radon mitigation system. Perform all testing in accordance with ANSI/AARST MA-MFLB, ANSI/AARST SGM-MFLB and all local, state and Federal requirements. Provide short term radon detectors (charcoal, electret ion chamber or approved equivalent) at the rate of one detector per 186 square meters 2,000 square feet but not less than one detector per enclosed space, except for closets. On copies of the building floor plans, locate and identify each short term detector and provide short term detector data on copies of the "Device Placement Log" contained in EPA 402-R-92-014.

b. At the end of the testing period, collect the detectors and send the detectors to the testing laboratory for analysis. Provide radon test results of the effectiveness of the mitigation systems not later than 30 days after collecting the detectors. Radon test results must be sent from the testing laboratory directly to the Contracting Officer with one copy to the Contractor. Complete the line item information on the "Device Placement Log."

c. Radon test results above [148 Bq/cu m][4.0 pCi/L] require system redesign and installation modifications as necessary to achieve radon test results below [148 Bq/cu m][4.0 pCi/L]. Submit design modifications to the Government for review and approval. After approval of the design modifications, provide installation modifications to the radon mitigation system and retest for effectiveness. Repeat this short term test procedure until test results below [148 Bq/cu m][4.0 pCi/L] are achieved.

d. System modifications (as-built systems installations) must be reflected in the Contractor's design documents (drawings and design narrative).

3.4.2.2 Long Term

****

NOTE: For work in the continental United States, Alaska and Hawaii select pCi/L as the unit of measure. For work elsewhere in the world Bq/cu m may be the required unit of measurement. Use the unit of measure familiar to the prospective Contractors.

****

After acceptance of the radon mitigation systems, provide for long term testing (8 to 12 months), see below.

a. Perform all testing in accordance with ANSI/AARST MA-MFLB, ANSI/AARST SGM-MFLB and all local, state and Federal requirements. Provide long term radon detectors (alpha track, electret ion chamber or approved equivalent) at the rate of one detector per 186 square meters 2,000 square feet but not less than one detector per enclosed space, except for closets. Locate and identify each detector on copies of the building floor plans and in the Radon Detector Location Log. After installing the detectors, furnish the completed detector documentation and mailers to the Contracting Officer.

****

NOTE: Depending upon the resources available at the activity or facility, select the appropriate paragraph for collecting the long term detectors.

****

[b. At the end of the testing period, collect the detectors, request return of the detector documentation and mailers from the Contracting Officer and send the detectors to the testing laboratory for analysis. Radon test results must be sent from the testing laboratory directly to the Contracting Officer with one copy to the Contractor. Complete the line item information in the Radon Detector Location Log.

][c. At the end of the testing period, the Contracting Officer will collect and send the detectors to the testing laboratory for analysis. Radon test results must be sent from the testing laboratory directly to the Contracting Officer with one copy to the Contractor.

] d. Radon test results above [148 Bq/cu m][4.0 pCi/L] require system redesign and installation modifications as necessary to achieve radon test results below [148 Bq/cu m][4.0 pCi/L]. Submit design modifications to the Government for review and approval. After approval of the design modifications, provide installation modifications to the radon mitigation system and retest for effectiveness. Repeat the short term and long term test procedures specified herein until test results below [148 Bq/cu m][4.0 pCi/L] are achieved.

e. Payment for work required because long term testing results in readings above [148 Bq/cu m][4.0 pCi/L] will be made from the funds identified in the "Schedule of Prices" for the work required under this paragraph and defined under the paragraph POST MITIGATION TESTING - SCHEDULE OF PRICES DATA included herein. Payment of these funds will be made only after the Contracting Officer has received the radon testing results from the testing laboratory and the readings for the long term testing are below [148 Bq/cu m][4.0 pCi/L].

f. Final system modifications (as-built systems installations) must be reflected in the Contractor's design documents (drawings and design narrative).

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 23 00.00 (November 2021)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

USACE / NAVFAC / AFCEC **UFGS-31 23 00.00 (November 2021)**

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****

SECTION 31 23 00.00

TUNNEL EXCAVATION - BLASTING

11/21

****

NOTE: This guide specification covers the requirements for tunnel excavation for underground construction by blasting. Tunnel Excavation guide specifications for excavation using mechanical methods such as Tunnel Boring Machine (TBM) or roadheader presently do not exist but may be developed in the future. This specification is currently for use in tunnel excavation in bedrock conditions equivalent to at least two tunnel diameters below top of rock (i.e., ledge) only. For mixed-face or soft ground tunneling conditions (i.e., soil-like conditions), consider alternate mechanical excavation methods to account for anticipated ground conditions for appropriate equipment selection and methods of ground support and groundwater control. For localized ground conditions including fault zones or other specialized ground conditions, revise specification to account for potentially adverse rock characterization conditions identified in the Geotechnical Baseline Report or other geotechnical design documents. This section was originally developed for USACE Civil Works projects.

For projects on a naval facility, consult with local NAVFAC office, Naval Ordinance Safety and Security Activity (NOSSA), and NAVSEA on requirements. NAVSEA OP5 Ammunition and Explosive Safety Ashore manual dictates many of the requirements and NOSSA has the final determination on blasting on a Navy installation above or underwater. Reference NAVSEA OP5 manual and contact local Explosives Safety Officer and Planner for the base prior to revising the specification. Overall NOSSA approval process can take 12-18 months depending on the level of approval required.

Adhere to UFC 1-300-02 **Unified Facilities Guide**

Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: For USACE: Consult with Subject Matter Experts (SME) from the Geotechnical Engineering, Structural Engineering, Engineering Geology, and Materials Community of Practice or District Office that has most recently completed a similar type of underground construction project, while editing this section, to be appraised of recent, specific requirements, guidance, excavation methods or understandings for the subject project.

Consult with or have Specification reviewed by a Subject Matter Experts in Underground Construction for projects involving Tunnel Excavation as a primary component of a project, or where Underground Construction issues are particularly challenging.

There are likely decisions and/or requirements of other agencies, the Safety Manual, and/or internal offices/divisions/ branches, which could have an influence upon a project's underground construction specifications. Some of these issues may be: concerns from federal, state, and local jurisdictions and agencies; public use of nearby federal, state and/or local properties near or adjacent to the project; evaluations of acceptable construction vibrations, noise and/or pressures affecting individuals or reaching nearby structures; natural resource impact reviews, negotiations and/or requirements; constraints on the excavation means and methods; pre-construction inspections; special studies to facilitate lower cost of the bids or to encourage more bid submissions; the acquisition strategy for the payment; and, other concerns specific to the project.

This Tunnel Excavation guide specification covers the construction of underground facilities by means of blasting in rock and includes mucking. The details on excavation are typically covered by a

separate Rock Excavation specification.

The following minimum requirements for project information will be indicated on the project drawings:

1. Surface elevations, existing and new.

2. All utilities, whether trenched, buried, at the surface or overhead to distances well beyond the project's limits;

3. Spatial location and record of all soil and rock borings and test pits, instrumentation, and/or geophysical surveys including soil and rock classifications and the pertinent engineering properties. For example this data may include, but is not limited to, weathered rock, material strength, bit drops, circulation loss, voids, ground water observations, SPT, Recovery, RQD, RMR, lab testing results, permeability, stratigraphy, geologic features and structure, and topsoil thickness encountered in boring (NOTE: This is a list of examples of data pertinent to the tunnel design that may be provided in the project drawings or GBR/GDR but does not include all possible engineering properties or conditions of soil and rock that characterize a specific site.);

4. Reference to project Geotechnical Data Report (GDR), Geotechnical Interpretation Report (GIR) and/or Geotechnical Baseline Report (GBR) for additional site characterization information not contained on the project drawings.

5. Location and limits of hard material, whether rock or concrete, or other building materials;

6. Excavation or demolition limits, and clearing, stripping and grubbing limits, and tolerances of excavation;

7. Details of special limits that may require line drilling, presplitting, reduced subdrilling, and/or specialty blasting practices;

8. Location of borrow and disposal area, if located on Government property; or on site (as some sites may or may not remain government property, and disposal sites may be under control of project partners);

9. Hydrological, hydraulic and impoundment data, where applicable; and,

10. Details of all rights-of-way within the project boundaries.

****

****
NOTE: Typical Measurement and Payment language is to be inserted into the Measurement and Payment specification section. This is typical language used that will need to be tailored for the project needs.
****

1.1 METHOD OF MEASUREMENT

Tunnel support for the various support categories must be measured and paid by the individual components comprising each support category (e.g., Rock Bolts, Steel Arch Ribs, Shotcrete), under their respective specification or special provision section.

Tunnel Excavation must be measured by the[meter][cubic meter][linear foot][cubic yard] excavated in accordance with the 'B' line payment limit shown on the Drawings. Tunnel drainage must be measured and paid under Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

1.2 BASIS OF PAYMENT

The accepted quantities measured as specified above must be paid for at the contract unit price for the pay items listed below.

Pay Item Pay Unit

Tunnel Excavation[Meter][Cubic Meter][Linear Foot][Cubic Yard]

Payment for Tunnel Excavation must constitute full compensation for all excavation, scaling, scaling reports, support, blasting, blasting reports, removal, hauling and disposal of excavated materials, construction ventilation and illumination, control of water and groundwater inflow including groundwater testing, supply of potable water, and all other work necessary for completion of the tunnel in accordance with the Contract Documents.

****
NOTE: The coordination with other federal, state, and local jurisdictions and agencies, the public, and private entities must be completely resolved before finalizing the specifications. A project's excavation and/or foundation requirements, for which, dense materials are being removed, may require navigation, highway, structural and/or other regulations and codes to be followed. Depending upon the proximity of public-use areas, private residences or businesses, and the project's location within a county or township, various accommodations will need to be required for the protection of the public, and the safety of private entities regarding local laws, regulations, and ordinances. Avoiding natural resource impacts may overlay other measures and require: seasonal or daily time limitations of the initiation of the individual blast patterns; special observers for some or all the underground construction work; special studies or monitoring while blasting operations is being conducted; and, other potential considerations.

Agency coordination will vary by project. Be certain that all government stakeholders have been involved with planning of the project and approved of all requirements for the specifications. List those important navigation or safety stakeholders. When there are navigable waters near the excavation zone, list in the controlled navigation perimeter's distance during the warning period of a shot. While the distance is project specific, the minimum distance is typically 300 m 1,000 ft.

It is essential that the agency/service person, using these Guide Specifications to prepare Plans and Specifications coordinate with the planners and environmental compliance specialists within their agency/Service to ensure that all appropriate restrictions and mitigation measures for hazards associated with tunnel excavation and underground construction are incorporated into the Plans and Specifications. Failure to comply with the requirements of applicable Federal or state laws and regulations could result in project delays or stoppages, as well as the potential for increased project costs.

****

1.3 SCOPE

This work must consist of excavation and disposal of all material within the rock tunnel limits indicated on the plans, in accordance with these specifications and in conformity to the lines, grades, stations and tolerances shown on the plans or as established in the field by the Contracting Officer. Some general guidelines to maintain the inherent strength of the ground surrounding the tunnel opening have been included. In addition, the work also includes geotechnical instrumentation for monitoring rock displacement and water management in the tunnel; including but not limited to, furnishing, installing, and monitoring of optical survey targets in the tunnel, collection and interpretation of data and furnishing all other necessary material, equipment and labor incidental to such work, [furnishing of optical survey targets], including installation and monitoring of instruments in accordance with the specifications. The Contractor must monitor all geotechnical instrumentation and interpret the data obtained from them. The data must be made available to the Contracting Officer [upon request][within 24 hours of reading].

The breakage of rock and hard/unyielding materials may be conducted by any means unless otherwise stated herein. If the contractor elects to use drilling and blasting for breakage or displacement of units, this entire section is applicable and covers activities associated with drilling and blasting for rock excavation at the surface for portal and shaft construction, or underground tunneling operations. Contained herein are procedures for all activities relating to drilling; blasting and the transportation, storage and use of explosives; breakage and displacement of rock. The Contractor's blasting program and methods are those necessary to accomplish the excavation shown on the Contract drawings in accordance with the provisions specified herein. Contractor's blasting plan must address site-specific conditions affecting the control, quantity, and magnitude of explosives fired in all blasting operations to prevent injuries to persons and avoid damage to all structures, properties, governmental and nonprofit entities, commerce and businesses, and natural resources and their habitat.

1.4 RELATED WORK SPECIFIED ELSEWHERE

****

NOTE: These specifications for related work specified elsewhere are not all inclusive. Add and remove specifications as needed for the project.

List specifications that are related, such as Earthwork, Excavation, Soil and Rock Anchors, Temporary Environmental Controls, Shotcrete, Natural Resources, are typical specs related depending on the project.

The specifications without numbers listed below presently do not have a corresponding UFGS Guide Specification. The designer will need to write a project-specific specification to address those features of work

****

Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS
Section 01 33 00 SUBMITTAL PROCEDURES
Section 02 32 13 SUBSURFACE DRILLING AND SAMPLING
Section 03 30 00 CAST-IN-PLACE CONCRETE
Section 31 00 00 EARTHWORK
Section 31 23 06.00 BLASTING - SURFACE
Section 31 68 13 SOIL AND ROCK ANCHORS
Section 31 73 19 TUNNEL AND SHAFT GROUTING
Section XX XX XX GEOTECHNICAL DATA REPORT
Section XX XX XX SURVEYING AND LAYOUT
Section XX XX XX GEOTECHNICAL AND STRUCTURAL INSTRUMENTATION
Section XX XX XX TUNNEL AND SHAFT DEWATERING
Section XX XX XX GROUNDWATER TREATMENT SYSTEM
Section XX XX XX TEMPORARY LIGHT AND POWER
Section XX XX XX TEMPORARY ELECTRICAL SYSTEMS
Section XX XX XX TUNNEL EXCAVATION SUPPORT

1.5 REFERENCES

****

NOTE: Add and remove references as needed for the project. Reference the appropriate state and local laws, regulations and ordinances concerning blasting where the project is to occur.

This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D5434	(2012) Field Logging of Subsurface Explorations of Soil and Rock
ASTM D6032/D6032M	(2017) Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements
EM 1110-1-1804	(2001) Engineering and Design -- Geotechnical Investigations
EM 1110-2-1009	(2018) Engineering and Design -- Structural Deformation Surveying
EM 1110-2-2901	(1997) Engineering and Design -- Tunnels and Shafts in Rock

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.109	Explosives and Blasting Agents
29 CFR 1926-SUBPART U	Blasting and the Use of Explosives
49 CFR 177	Carriage by Public Highway

1.6 RELATED ATTACHMENTS AND SPECIFICATIONS

****

NOTE: Geotechnical Data Report (GDR) and Geotechnical Baseline Report (GBR) Importance. Project-specific site data should be presented in Geotechnical Data Report (GDR); design interpretations of the expected subsurface conditions and expected behavior should be presented in the Geotechnical Baseline Report (GBR). GDR/GBR data must be consistent with information presented

in the project specifications and drawings without conflict. Agencies may require different types of documents; there may be a Geotechnical Interpretive Report (GIR).

Location and record of all soil and rock borings and test pits, including soil and rock classifications and their properties, weathered rock, bit drops and voids, ground water observations, and topsoil thickness encountered in boring.

Location and limits of hard material, whether rock or concrete, or other building materials.
****

"Geotechnical Data Report" (GDR) dated [_____], prepared by [_____].

"Geotechnical Baseline Report" (GBR) dated [_____], prepared by [_____].

"Geotechnical Interpretive Report" (GIR) dated [_____], prepared by [_____].

1.7 DEFINITIONS

****
NOTE: Delete definitions that will not be used in the specification text for a specific project. A complete list of frequently used tunneling terms can be found in Appendix B of the EM 1110-2-2901, blasting definitions can be found in the GLOSSARY of the EM 1110-2-3800, and other references. Recommend only including definitions not already referenced in the EM and definitions to further define the work on the specific project in the specification. It may be necessary to add definitions depending on what the Earthwork and/or Excavation specifications for the project have terms for Rock, Weathered Rock, Sound Rock, Voids, Sediment, etc.
****

1.7.1 Controlled Blasting

****
NOTE: This section may be applicable for the shaft/portal blasting construction.
****

Controlled blasting refers to blasting techniques used to better distribute the explosive charge to minimize impacts such as fracturing and loosening of the rock beyond the design excavation line (overbreak) and limit vibration effects. This is accomplished by using small diameter, decoupled charges in closely spaced blastholes placed on the perimeter of an excavation. Methods including but not limited to line drilling, and pre-splitting (pre-shearing) cushion blasting, and buffer zone blasting.

1.7.2 Airblast

Airblast are the overpressure waveforms that move though air as audible and sub-audible sound waves. These are also called compression waves. Airblast is one of the three, primary adverse impacts from blasting.

1.7.3 Vibrations

****

NOTE: There are other impacts that may be related to blasting that should be considered, such as ground settlement, disruption to structures or activities, hazardous environments.

****

Vibrations are the second of the three, primary adverse impacts from blasting. The third primary adverse impact from blasting is flyrock. Vibrations are the result of various wave forms emanating from the detonation or deflagration of ignited materials from a shot pattern. Peak particle velocity (PPV) is defined as the maximum absolute value among the three ground vibration velocities measured in the vertical, longitudinal, and transverse directions over the period of a record. Peak, total vector-sum particle velocity is the peak value over the full-time history of each time-unit's value of the square-root sum of the squared, component velocities. Velocity units are expressed in centimeters per second (cps) or inches per second (ips).

1.7.4 Initial Support

Installed at and adjacent to the excavation face following a heading advance to minimize ground movement and loosening and to maintain stability of the opening prior to construction of the permanent lining. Initial support for the rock tunnel generally refers to all elements of rock support required to provide a safe, stable rock excavation at all times during construction. Elements of rock support include, but are not limited to, such items as steel ribs, timber blocking, spiling, rock dowels and anchors, steel straps, welded wire fabric or shotcrete.

1.7.5 Additional Initial Support

May include rock bolts and dowels, crib and lagging, steel straps, spot-holds, steel sets, steel liner plates, shotcrete and pre-reinforcement spiling in addition to the initial support types and quantities for the support categories as shown on the Contract Drawings. Additional ground support measures should be installed in a systematic or non-systematic manner, for local stabilization and safety during tunneling operations

1.7.6 Final Lining

****

NOTE: Tailor this paragraph to the type of final lining for the project, this may be a cast-in-place or precast reinforced concrete liner, steel liner that is backfilled with contact grout, or left unlined, maybe with shotcrete or reinforced (steel fiber) shotcrete or other.

****

[Cast-in-place reinforced concrete, steel] lining that is installed after the tunnel has been excavated and supported with initial support. Backfill concrete and contact grout are also included in the final lining.

1.7.7 Design (Excavation) Line

****

NOTE: This nomenclature should be defined during the development of the plans and specifications as it will be specific for each project.

****

A line within which no unexcavated material must remain. Only shotcrete, structural steel rib supports with limited blocking, rock dowels, including bearing plates and metal hardware, and tie rods may extend beyond the design line as shown on the Drawings. The minimum concrete cover over these elements is shown on the Drawings. Embedments shown on the Drawings within the design line must be placed as shown. The Contractor may select the size of the excavated opening provided that finished minimum excavation tolerances are maintained and the design line requirements and diameter constraints given in this section are satisfied.

1.7.7.1 A-line (Theoretical Excavation Line)

The A-line, shown in the contract drawings is the line within which unexcavated material must not be permitted to remain.

1.7.7.2 B-line (Pay Line)

The B-line shown in the contract drawings is the outside limit to which measurement for payment for excavation must be made. Measurement for payment must be made to this line regardless of whether the limits of the actual excavation are inside or outside of the B-line. Excavations beyond the B-line performed by the Contractor for purpose or reason except as shown on the Drawings or as may be ordered in writing by the Contracting Officer, must be at the expense of the Contractor.

1.7.8 Heading

A general term used to refer to the advancing (excavation) tunnel face.

1.7.9 Face

The position of the underground works that has been advanced the furthest for the respective section of the overall construction sequence adopted for the large span tunnels. Also referred to as "Working Face" or "Heading."

1.7.10 Forward Area

Is that area within which the initial ground support is to be installed behind the heading (depends on rock mass conditions, stand up time, and heading advance rate).

1.7.11 Initial Ground Support

****

NOTE: Other common terminology may include wood lagging and liner plate (gasketed and un-gasketed), splines, strapping, mesh, steel sets, steel-fiber reinforced shotcrete, expandable bolts.

****

****

NOTE: In addition, the initial support systems indicated on the Drawings for additional openings in the tunnel, must form part of the Permanent Support.
****

The support system installed after an excavation advance within the tunnel forward area to minimize ground deformation and loosening and to maintain stability and safety of the opening. Initial support measures include, but may not be limited to, rock bolts and dowels for rock reinforcement, shotcrete lining, steel ribs, and pre-reinforcement for the duration of construction and prior to installation of the permanent support.

1.7.12 Length of Advance Interval

Length of the unsupported span of ground exposed during one excavation advance increment (depends on rock mass conditions, stand up time, and heading advance rate).

1.7.13 Line Drilling

Line drilling may be applicable in and around tie-in structures where precise ground control is needed. Within tunnel blasting operations, perimeter holes, back holes or heading rounds may be line drilled for overbreak control along the rib, springline and through the crown. Typically line drilling is applied during shaft or portal construction.

1.7.14 Excessive Overbreak

The amount of ground unintentionally removed beyond the pay line, or B-Line. The Contractor should attempt to minimize overbreak.

1.7.15 Over-Excavation

Excavation of ground beyond the theoretical excavation line, or A-Line.

1.7.16 Probe Hole

An exploratory hole drilled in advance of an excavation to explore ground conditions or water infiltration conditions. Supplemental probe holes are those installed in addition to the probe holes shown on the Drawings or required herein and at the direction or approval of the Contracting Officer.

1.7.17 Scaling

Consists of barring, wedging, and picking to remove loose, shattered, or unstable pieces of rock around the heading advance. Individual pieces not in accordance with the specified tolerance must also be removed during scaling.

1.7.18 Shotcrete

Mortar or concrete conveyed through a hose and pneumatically projected at high velocity onto a surface.

1.7.19 Staged Excavation

****
NOTE: Advancing multiple headings is often performed in poor ground or for larger final tunnel

dimensions, where a top (left and/or right) heading is advanced, supported then the other heading or bench removed, potentially also removing the center support system separating the headings.

****

Sequence of excavation by which the final excavation is divided into a group of smaller drifts, also referred to as slashes and cuts, or top heading and bench.

1.7.20 Support Type

Method of excavation and initial support defined in the Drawings for use at a particular location.

1.7.21 Tights or Underbreak

Projections of rock in a tunnel inside the minimum excavation profile (A-line) that need to be removed prior to placement of lining.

1.7.22 Water Sheet or Panning and Drain Hose

PVC-sheet, PVC-pan and PVC-hose used to collect and drain off ground water from areas at either the excavated surface behind the shotcrete lining or to collect and drain seepage through the shotcrete lining.

1.7.23 Smooth Wall Blasting

****

NOTE: Smooth wall blasting can be used around openings and sensitive structures.

****

Refers to a technique involving perimeter holes drilled along the excavation limits which are lightly loaded to remove the final burden and are fired on the last delay of the detonation sequence. The objective is to obtain smooth walls with minimum overbreak and minimal damage to the rock outside the excavation limits.

1.7.24 Hangfire

Occurs where the explosive in the borehole begins burning and may eventually detonate when the fire reaches the area of the base charge of the failed detonator. This detonation may take place a few seconds after the blasting machine was fired or a few minutes later.

1.8 RESTRICTIONS

Tunnels must be excavated and supported using a continuous or incremental excavation- observation-support approach to provide the necessary and justifiable levels of ground control and permanent stabilization. The use of a staged excavation approach with integral, concurrent initial support and permanent stabilization of the tunnel periphery is fundamental to the successful execution of the project and recognizes that tunnel spans of different dimensions must be developed in variable and fractured rock mass conditions.

Do not begin underground tunnel blasting excavation operations until the following conditions have been met:

1. Do not begin tunnel excavation until all required submittals in paragraph SUBMITTALS have been submitted and the Contracting Officer has reviewed and approved the submittals.

2. Pre-construction inspections near the tunnel excavation have been completed by the Contracting Officer and pre-construction documents have been provided to Contractor.

3. Installation of geotechnical and structural instrumentation for monitoring surface structures near the tunnel excavation have been completed and initialized by the Contractor.

4. All issues related to health and safety have been met and all submittals have been made in accordance with OSHA requirements, EM 385-1-1, and other applicable codes and regulations of Federal, State, and local agencies having jurisdiction.

5. Required personnel with qualifications specified in paragraphs BLASTING PERSONNEL and TUNNELING PERSONNEL are available on site to perform work.

6. Temporary construction power substation has been installed and tested in accordance with the Division 16 specifications

7. Blasting will not be carried out without the prior approval of the Contracting Officer.

8. The Contractor must take all necessary precautions to prevent premature detonation of explosive charges.

9. The Contractor must be responsible for safe transportation, storage, security/guarding and use of explosives, blasting agents, primers, initiators, and ancillary equipment and materials in accordance with 29 CFR 1910.109, 29 CFR 1926-SUBPART U, and all applicable federal, state, and local Regulations. All cost associated with the transportation, storage, security/guarding and use of explosives must be considered incidental to the cost of tunnel excavation and included in their respective unit costs.

10. Vibration monitoring equipment must be installed, calibrated and operating before blasting begins.

11. Public notification and meeting held.

1.9 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****

NOTE: The following Submittal requirements are for tunnel excavation using excavation methods and should be included in all project specifications.

Several other considerations include Tunnel and Confined space rescue team training and setting up an independent emergency communication lines within the tunnel. If the local fire department is not trained in confined space tunnel or mine rescue, they may have to be trained in confined space tunnel/mine rescue procedures prior to excavation of tunnel or a private specialty company can be hired for rescue services as required by federal, state, and local work ordinances.

Haul routes for muck disposal can also be an issue in densely populated areas. Haul routes may need to be coordinated with local and state officials as required by local ordinances.

****

Tunneling Superintendent and Supervisors; G, [_____]

Drill and Blast Supervisors; G, [_____]

Geotechnical Engineer or Engineering Geologist; G, [_____]

Survey Control Plan; G, [_____]

Dust Suppression System; G, [_____]

Muck Handling Plan; G, [_____]

Ventilation System; G, [_____]

Blasting Consultant's Qualifications; G, [_____]

Blasting Specialist's Qualifications; G, [_____]

Blaster-In-Charge's Qualifications; G, [_____]

Vibration Monitoring Specialty Firm; G, [_____]

Structural Inspection/Evaluation Technician; G, [_____]

Blasting Safety Plan; G, SO

Master Blasting Plan; G, SO

Test-Blast Plan; G, AO

Pre-Blast Surveys; G, [_____]

Public Notice of Blasting Operations; G, [_____]

Tunnel Excavation Plan; G, [_____]

****

NOTE: The section below should be used when rock blasting excavation techniques are required.

****

SD-03 Product Data

Explosives; G, [_____]

Lightning Detection Device; G, [_____]

Seismographs; G, [_____]

SD-05 Design Data

Individual Shot Plan; G, [_____]

SD-06 Test Reports

Individual Shot Reports; G, [_____]

Post-Blast Surveys; G, [_____]

Drilling Logs

Daily Explosive Material Consumption

Daily As-built Survey; G, [_____]

SD-07 Certificates

Blasting Consultant; G, [_____]

Blasting Specialist; G, [_____]

Blaster-In-Charge; G, [_____]

Magazine Keeper; G, [_____]

Structural Inspection/Evaluation Technician; G, [_____]

Seismic Specialist; G, [_____]

1.10 COORDINATION

****

NOTE: The following paragraph can be used if working with multiple stakeholders/owners.

****

Underground construction employing blasting methods will be in the vicinity of the [existing lock, railroad, and highway, and river barge, train, hospital highway traffic, utilities and businesses] and their operation will not be impeded or delayed beyond that which has been coordinated with [TVA, U.S. Coast Guard, U.S. Army Corps of Engineers - [_____] District, [_____] environmental or natural resources offices, [_____] Department of Transportation, local government entities,] [[_____] Railroad, regional or local utilities, and/private businesses]. Include a coordination and traffic control sub-plan as part of the Blasting Safety Plan, with the appropriate authorities that mitigates navigation and traffic delays in the Master Blasting Plan.

Coordinate, through the Contracting Officer, with other Contractors working onsite to minimize work stoppages during blasting.

1.11 LIABILITY

****

NOTE: This section can be included in the front end documents (General Conditions) instead of here, consult with Contracting Officer.

****

Compliance with provisions in the contract will not relieve the Contractor of their responsibility for damages or injuries caused by, related to or arising out of blasting or associated blasting activities. The Contractor assumes all liability and hold and save the Government, its agents, officers, and employees harmless for all claims for personal injuries, property damage, or other claims arising out of or in connection with the handling of explosives or blasting under this contract.

PART 2 PRODUCTS

2.1 STORAGE AND USE OF EXPLOSIVES

2.1.1 General

****

NOTE: The specification writer may choose to list

reasons the Contracting Officer may restrict the use of various tunnel excavation methods such as blasting, but not always necessary. Confirm and follow applicable federal, state, and local regulations and guidance on the transport, storage and use of all Explosive materials and components. State and local agencies and/or authorities may not easily allow the receipt of Explosives in a timely manner. State and local agencies and/or authorities may have specific reporting, certifications, adverse impact concerns, or distance regulations from the blast zone to private properties governing the use of Explosives. The Agency/Service may wish to allow storage of Explosives on federal premises. The winning contractor should independently assess and cite in the Master Blasting Plan all applicable federal, state, and local laws, regulations, ordinances, or authorities that impact the transportation and storage of Explosives if authorized on the project.

****

Store, transport, handle, use, and otherwise secure explosives in accordance with best practices as approved by the Contracting Officer and in accordance with all Federal, State and Local laws and regulations. Comply with all special rules, regulations and ordinances that may be made by the authorities having jurisdiction, or by the Contracting Officer, regarding construction of, and storage in, magazines and precautions in handling and transporting explosives for blasting. Times and imposed restrictions concerning the use of explosives must be conducted in accordance with Federal State, and local regulations. The Contracting Officer reserves the right to establish further restrictions or time windows when blasting will not be allowed beyond the Federal State, and local requirements. The Contractor is responsible for all claims for damages and injuries caused by or arising out of blasting activities. Perform all blasting operations in accordance with the current edition of EM 385-1-1.

2.1.2 Blasting Products

****

NOTE: This paragraph may need to be adjusted, for some projects it is not appropriate to allow bulk explosives, such as in karst conditions because the bulk explosives could fill voids if care is not taken while loading to monitor the amount being added to each hole.

****

All blasting caps used on the project must be one year or less of age. Millisecond delay, [shock tube] initiators, must be used as the initiation system. To ensure the accuracy of firing times of blasting caps, it is required that each cap period come from one lot number. Mixing of lot numbers for one cap period is strictly prohibited. All explosives used on the project must be six months or less of age or no older than one half the shelf life shown on the explosives manufacturer's technical data sheet for that product. Cartridge [and bulk] explosives may be used in different sections of the project. Ammonium nitrate and fuel oil (ANFO) is not allowed in wet environments.

****

NOTE: In projects where controlled blasting techniques are required to produce final walls which require presplit blasting, only explosives designed for this application must be allowed. Ammonium nitrate and fuel oil (ANFO) is not to be allowed in wet environments. Consider requiring cartridge explosives within a specified distance from new structure which requires neat excavation lines, i.e., "Bulk explosives such as ANFO or bulk emulsion or emulsion blends will not be allowed for production blasts at the area within 60 meters 200 feet of it or within 15 meters 50 feet of presplit walls."

****

Explosives that do not meet the manufacturer's specifications must not be used. When, in the opinion of the Contracting Officer, blasting product is either of excessive age or appears to be in a deteriorated condition, all work must cease until the products age and quality can be determined. Blasting products without date and batch codes are / will not be permitted on site. The Contracting Officer may require products to be tested by an independent organization to determine its performance as compared to the manufacturer's data sheet. If product performance or composition deviates by more than 10 percent from the manufacturer's data sheet, that lot number will be rejected. The Contractor is responsible for required testing and no additional compensation will be made for product testing directed by the Contracting Officer.

2.1.3 Magazines

****

NOTE: Two paragraph options here first paragraph is for where explosives must be stored off site (off site magazine). The other covers the storage of explosives onsite. The designer will need to ensure these requirements are fully detailed and the appropriate regulations are followed.

****

Explosives must be stored offsite. Obtain all necessary Federal and State magazine permits. Magazines must be located at safe distances as defined by the Bureau of Alcohol, Tobacco and Firearms (ATF) in addition to the State of [_____] requirements. There must be no permanent explosive storage or overnight explosive storage on site. Procure off-site explosive storage and expect to have daily explosives deliveries to the site. Secure a permit to transport explosives from the [_____] Highway Patrol when the amount of explosives to be transported exceeds 454 kilograms 1000 pounds, and transport explosives in accordance with 49 CFR 177 when carried on public highways.

****

NOTE: If explosives will be stored in an onsite magazine, it will be required to follow the requirements in EM385-1-1, including a submittal for an Explosive Site Safety Plan and the following paragraph can be used.

****

Explosives may be stored onsite. Obtain all necessary Federal and State magazine permits. Magazines must be located at safe distances as defined by the Bureau of Alcohol, Tobacco and Firearms (ATF) in addition to the State of [_____] requirements. Secure a permit to transport explosives from the [_____] Highway Patrol when the total weight of explosives to be transported is less than 454 kilograms 1001 pounds, and transport explosives in accordance with 49 CFR 177 when carried on public highways.

2.1.4 Magazine Keeper

Each magazine keeper must be experienced and familiar with the laws and general practices concerning the handling, care, use, and storage of explosives and detonators. The magazine keeper is responsible for maintaining a cleared area around each magazine. The magazine keeper will not be required to perform duties that interfere with their duties as magazine keeper and being physically present at the magazines for every entry to the magazines for delivery, disbursement, and review of explosives at the magazines. If explosives are delivered and returned daily from the manufacturer or supplier to the project, the driver of the truck will serve as the magazine keeper.

2.2 SAFETY EQUIPMENT

****

NOTE: This section requires tailoring for the specific project design and geology.

****

a. Provide safety equipment and monitoring instruments according to requirements of Safety and Health Plan in accordance with Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS, to be included in the Materials Handling Plan as required in Section 01 33 00 SUBMITTAL PROCEDURES.

b. Provide personal protective equipment for protection against respirable dust, and all other protective measures that may be deemed necessary for dust control as per Federal Requirements. Submit the details of the Dust Suppression System.

c. All rock reinforcement, including spiling and other ground support in accordance with the requirements set forth in Section 31 68 13 SOIL AND ROCK ANCHORS and 03 37 13 SHOTCRETE.

d. Lattice girders and shotcrete lining must be in accordance with the requirements of Section XX XX XX GROUND SUPPORT SYSTEMS, and Section 03 37 13 SHOTCRETE.

e. Steel sets must be in accordance with the requirements of Section XX XX XX GROUND SUPPORT SYSTEMS, and Section XX XX XX REINFORCING STEEL.

f. Shotcrete materials must be in accordance with the requirements of Section 03 37 13 SHOTCRETE.

g. Water sheet and drain hoses as part of temporary construction measures to drain off local water inflows:

    (1) . PVC sheet, or approved equal by the Contracting Officer, for application at exposed ground surface or shotcrete surface.

(2) . Flexible PVC hose with end couplings as required

2.3 PROBEHOLE DRILLING EQUIPMENT

A continuous probe must be maintained at [_____] meters [_____] feet, or least [_____] tunnel diameters ahead of the tunnel face. If the probing results indicate the presence of poor ground requiring the installation of pre-reinforcement, the Contractor must make adjustments as necessary to achieve the required excavation profile prior to excavating through the anticipated poor ground. During the probing operation the Contractor must monitor and measure the amount of in-flowing water.

Probe hole drilling equipment must be capable of drilling a minimum [_____]-inch diameter holes through sound and decomposed rock and concrete. Provide all necessary core hole drilling personnel, equipment, and accessories.

****

NOTE: Designer of record to provide input on the flow pressures for packer tests. Consideration must be taken by reviewing other data such as other data (piezometers, pressure cells, rock mass features).

****

The drill must be suitable for drilling in wet ground conditions, highly sheared or fractured zones, and through fault gouge. The drilling equipment must be capable offsetting packers in the hole against a pressure of [_____] kg/cm^2 [_____] psi.

PART 3 EXECUTION

****

NOTE: Consult with a District Office that has most recently completed a similar type of blasting, while editing this section, to be appraised of recent, specific requirements, guidance, blasting and underground excavation developments or understandings for the subject project.

****

****

NOTE: This specification is for use for tunnel excavation. For mixed face tunneling conditions, revise specification to account for anticipated ground conditions. This specification requires a Geotechnical Baseline Report (GBR) that defines the ground properties, conditions, and behavior related to tunnel excavation, support, and constructability along the tunnel alignment, portals, or along separate tunnel segments that is expected. The Geotechnical Data Report (GDR) contains all the testing, and rock mass characterization data used to characterize the conditions and behavior of the ground along the tunnel alignment to establish the base line conditions for the project. The GBR defines what constitutes a differing site conditions for claim resolution per the frameworks of the contract.

****

3.1 GENERAL

****

NOTE: This paragraph should agree with the designations under paragraph SUBMITTALS, the Master Blasting Plan will always be for approval. The Individual Shot Plan may be approved ("G") or accepted ("FIO).

****

Obtain approval, or revise for approval, of the submitted Master Blasting Plan and Individual Shot Plans, acquire all required permits, and comply with all laws, regulations, ordinances, applicable safety code requirements, and regulations relative to the transportation, handling, storage, and use of explosives and the protection of life and property. Perform vibration and airblast monitoring at the Contracting Officer's specified locations to record blast effects. The peak particle velocity must be limited to the values in Paragraph BLAST EFFECTS MONITORING in these specifications. Minimize rock over-break and blast damages beyond the design excavation line. The Contracting Officer will, always, have the authority to prohibit or halt the blasting operations, if it is apparent that the required lines and grades and stable rock slopes are not being obtained with the methods being employed. Adhere to the general requirements as outlined below:

a. Care must be exercised to minimize overbreak, to prevent immediate or subsequent rock falls from within the tunnel or from portal areas and other rock slopes outside the tunnel, and to preserve the integrity of the rock outside the limits of tunnel excavation.

b. Clean working conditions must be always maintained inside the tunnel. All muck, slush, grout spills, and any other material not required for tunneling must be removed from the tunnel in a timely manner.

c. Detailed construction sequencing must be the responsibility of Contractor, consistent with the requirements of these Specifications, and those shown on the Contract Drawings.

d. Perform work in a manner that minimizes safety hazards and exposure of personnel and equipment to hazardous and potentially hazardous conditions in accordance with specified safety requirements and Contractor's Safety and Health Plan.

e. Minimize ground movement at the tunnel face and in the surrounding excavation, and prevent ground loss, subsidence, and movement in surface features, overlying structures, and utilities above and around the vicinity of the tunnel excavation.

f. Provide additional face and excavation stabilization by means of discretionary ground support wherever ground conditions dictate.

g. In case of stoppages, maintain qualified personnel on-duty to monitor conditions that may threaten stability of the heading.

h. If monitoring of ground vibrations and air blast indicate that vibration levels, or noise levels are exceeding response levels as defined under paragraph BLAST EFFECTS MONITORING, and Section XX XX XX

TUNNEL INSTRUMENTATION; adjust procedures for excavation and initial support installation in accordance with the accepted Contingency Plan to reduce the levels to within acceptable limits.

i. Maintain sufficient quantities of shotcrete materials at the tunnel face, ready for immediate application, during the entire excavation period. Excavation will not be permitted without this requirement being met or as approved by the Contracting Officer.

****

NOTE: The need to maintain sufficient quantities of tunnel support materials/equipment will vary per project. Define this quantity during design phase and incorporate in GBR. The Government will map the tunnel according to ASTM D4879.

****

j. As the excavation progresses, the Contracting Officer will perform inspection, photogrammetry, LiDAR scanning, and geologic mapping or other documentation of the exposed tunnel sections. This mapping will be accomplished after excavation and either before or in conjunction with support installation. The Contractor must provide cleaning of the heading and completed crown and sidewalls and a safe means of access to these areas to allow this mapping. Mapping of the crown and sidewalls will be conducted for documentation of the actual geologic conditions encountered and assessment of rock mass characteristics of the heading. The Contractor should assume that this inspection and mapping will be performed once each shift for a period of minimum [20 minutes] in each heading. Lighting and access will be provided for close inspection of the face. Where necessary the excavated surfaces may need to be cleaned by air or water jets to provide surfaces suitable for mapping, as directed by the Contracting Officer; provided, however, such cleaning will be minimal in areas where softer materials can be gouged out to depths greater than three inches. The Contractor must cease operations to the extent necessary to permit such mapping as directed by the Contracting Officer. Such work will be coordinated by the Contracting Officer in a manner to avoid undue disruption to Contractor's operations.

k. Establish and maintain surveyed tunnel station markers throughout both lined and unlined excavated tunnel. Placed station markers indicating the tunnel stationing at 50 feet intervals by spray painting the rock or shotcrete surface in a color to contrast with background. Intermediate station markers should be made at 10-foot intervals with visible paint marks located at or near tunnel spring-line

l. Sequence and Direction of Construction:

   (1) . Sequence and direction of tunneling to be as shown on the drawings and as reviewed by the Contracting Officer.

m. Temporary niches or adits, temporary or future pump sump pits and other temporary openings:

   (1) . Excavate these temporary openings conforming to excavation and support criteria of this Specification and as reviewed by the Contracting Officer.

   (2) . Seal all temporary openings with [4,000-psi] 28-day strength

concrete in accordance with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE when no longer needed, before installation of the final lining and Contract completion and as reviewed by the Contracting Officer.

n. Survey:

(1) . Contractor is responsible for the development and implementation of a surveying program capable of satisfying all survey and accuracy requirements. This program is subject to the review of the Contracting Officer prior to the commencement of the work. The review does not release the Contractor of liabilities associated with or dependent on this part of the work.

(2) . Design and implement a functional underground network and determine all required measurements and the required accuracy of each measurement including horizontal angles, zenith angles, azimuth angles, distances, and height differences. Include analysis of required redundancy and measure of internal reliability associated with each planned observation.

(3) . Design and implement a functional surface control network, stations, positions, measurements, and accuracies. Measurements may include Global Positioning System (GPS) vectors, horizontal angles, zenith angles, azimuth angles, distances, and height differences. Include analysis of required redundancy and measure of internal reliability associated with each planned observation.

(4) . Obtain survey information prior to completing the last [100] feet of the tunnel excavation. Adjustments to line and grade to the tunnel over the last [100] feet may be necessary to meet project requirements. The purpose of conducting the survey is to obtain the true centerline alignment in 3-dimensions to locate the connections as shown on the Drawings. Vertical and horizontal alignment should be taken along both invert/sidewall construction joints. The center point on the invert is assumed as the dividing line between both invert/sidewall joints.

(5) . Obtain start point alignment for the survey from the surface at [_____] data for alignment consisting of at least 2 benchmarks with known elevation and geographic coordinates enabling tie-in to [NGVD29, NAVD88] elevation and the [_____] State Plane Coordinate System, respectively.

(6) . Perform in-tunnel survey to an accuracy of ½-inch in the horizontal and vertical dimensions. Record sufficient survey points to enable the complete horizontal and vertical profile of tunnel alignment to be detailed. Some tunnel alignment curves may not necessarily be circular arcs; they may be based on complex parabola or other geometric shape forms.

(7) . Assume that station of [_____] are as indicated in historical documents. All new survey stationing must reference these stations.

(8) . A survey was completed on [_____]. This information is available and must be reviewed by the Contractor, prior to conducting the tunnel survey.

(9) . Shaft centerline is the basis of all tunnel stationing up and down station of the shaft centerline.

(10) . Calibration and data processing:

a. Calibrate all survey instrumentation as required and as recommended by instrument manufacturer.

b. Data reduction must incorporate calibrations and meteorological correction, and reduction of measurements to the ellipsoid and thence to the [_____] State Plane Coordinate System. Correct distance measurements by electro-optical distance measurement instrument (EODMI) for scale, cyclic error, zero error, and meteorological effects. Correct azimuth angles using the Laplace correction and include the deflection of the vertical components on angles and azimuth measurements.

c. Data regression processing must include least squares adjustments, as required. Employ data outlier detection. Determine horizontal and vertical confidence intervals.

3.2 TEMPORARY SYSTEMS

****

NOTE: Review applicable consideration in EM 385-1-1, Ch. 26 and/or consult with a Safety professional with tunneling background. Ensure groundwater conditions and overall regime through rock mass is well understood by tunnel reach and rock type.

****

a. Provide, operate, and maintain a complete groundwater control/ treatment system to collect water from within the tunnel and shaft and suitably treat it before discharge in accordance with the requirements of Section XX XX XX CONTROL OF WATER.

b. Water entering the tunnel from all sources must be controlled, managed, and disposed of in a manner to prevent damage to the tunnel and surrounding property and in accordance with all Federal, State, and local regulations.

c. Design, furnish, install, operate, and maintain a temporary lighting system in all underground and other working areas in strict compliance with all applicable Federal, State, and local regulations.

d. The system must provide a minimum light level in accordance with OSHA requirements and EM 385-1-1. In case of failure of the lighting system, provide an emergency lighting system in all work areas in strict compliance with all applicable Federal, State, and local regulations, and industry standards.

e. Design, furnish, install, operate, and maintain temporary ventilation during all phases of construction complying with all applicable Federal, State, local regulations, and industry standards. Operate and maintain the entire temporary ventilation system. Details of the Contractor's ventilation system must be presented to the Contracting Officer for agreement at least 60 days prior to its installation.

f. Two battery-operated handlamps of 20-Watts minimum power must be provided and maintained at each working face and portal for emergencies and inspection of the work.

g. Electric heaters or radiators having exposed coils or elements must not be allowed in the tunnels.

h. All main electrical cables installed within the tunnels must comply with all applicable Federal, State, and Local Requirements.

****

NOTE: Designer will need to ensure safety requirements in specification at a minimum follow OSHA/EM385/MSHA.

****

i. Provide additional floodlighting and ventilation locally as required at active ground support installation, shotcrete, and other locations, and provide portable floodlighting and ventilation equipment, as needed, for localized construction operations. Equipment for short-term use may be battery-operated

j. For Contract requirements regarding temporary construction power, refer to Section XX XX XX TEMPORARY LIGHT AND POWER and Section XX XX XX TEMPORARY ELECTRICAL SYSTEM.

k. In all parts of the Underground Works, the atmosphere inhaled by those present must contain not less than 19.5 percent and maximum of 22.0 percent of oxygen and must not contain a concentration of contaminates such as gases, vapors and dusts greater than is safe for the health of the construction personnel having regard to the effects of exposure time, temperature, humidity and the combined effects of several contaminants. The concentration of inflammable contaminants must not exceed 10 percent of the lower explosive limit (minimum explosive concentration).

l. Wet drilling should be used. Where possible, drilling should be carried out using hollow bits with continuous water feed to reduce dust. Always wear suitable protective equipment.

****

NOTE: The potential for contaminants or hazardous conditions must be defined by the project owner (in the GBR) and assumed by the Contractor. If the conditions differ, owner is responsible for conditions more adverse than the baseline for this condition.

****

m. The Contractor must be responsible for obtaining all information necessary to determine what concentrations of contaminants are harmless, without prejudice to the adoption of such lower figures as may be stated by competent authorities or directed by the Contracting Officer. The atmosphere inhaled by the workmen and other authorized persons in all parts of the tunnel must not contain more than 5 ppm of nitrous fumes (measured as NO2) for longer than 10 minutes after each blast, 30 ppm of nitrous fumes as an absolute maximum, 50 ppm of carbon monoxide as an absolute maximum, 5,000 ppm of carbon dioxide as an absolute maximum, or for other contaminants. The Safety Professional must field calibrate air quality monitoring instrumentation in accordance with manufacturer's recommendations.

n. In all parts of the Underground Works, throughout the period in which explosives or other materials producing contaminants are used, and at such time as may be necessary to maintain the standard of purity of air required in this subsection, clean fresh air must be supplied by forced ventilation, using an exhaust system at the face or other method as agreed by the Contracting Officer, at a rate not less than the greater of the following:

  (1) . [_____] cubic meters[_____] cubic feet per hour per person present in a tunnel;

  (2) . [_____] meters[_____] feet per hour per kilowatt of combustion-engine generated power operating simultaneously in the heading.

o. The Contractor must take special measures to minimize the effect of particular sources of fumes. These measures must include the use of efficient and properly maintained exhaust smoke washers (scrubbers) for all internal combustion engines in the tunnel. Gasoline engines must not be permitted in the tunnel.

p. The means of dealing with blasting fumes must include, but not be limited to water sprays on muck piles after blasting and ventilation of the Underground Works immediately after blasting for as long as necessary to restore the purity of the atmosphere.

q. Notwithstanding requirements of this subsection the method of ventilation and treatment of fumes, including blasting fumes, must be subject to whatever tests may be necessary in the opinion of the Contracting Officer. The Contractor must provide, maintain, and use as directed by the Contracting Officer, an instrument approved by the Contracting Officer to measure the velocity of air, and an approved gas detector. Maintenance of the gas detectors must include the supply of all detector tubes.

3.3 SAFETY PROCEDURES FOR DRILL AND BLAST UNDERGROUND EXCAVATION

****

NOTE: Use below for general blasting safety procedures for drill and blast tunnel construction. Consider other Tunnel H&S issues which are related to tunnel operations, equipment, slip-trip-fall, cave-ins.

****

3.3.1 General Blasting

Ensure all work completed under this Contract is executed safely. Follow the safety procedures outlined in EM 385-1-1. EM 385-1-1 will govern all activity unless more stringent safety requirements are specified here and in other applicable Federal, State, and local laws, regulations, and ordinances.

a. All blasting work must be carried out using controlled perimeter drilling and smooth wall blasting techniques to control the geometry of, and to minimize damage to, the final excavation profile and to minimize overbreak.

b. Only non-electric detonation systems must be used for tunnel blasting, unless another detonation system is approved by the Contracting Officer. Cap and fuse or safety fuse is prohibited. The Contractor will be allowed to use one electric blasting cap per round to initiate the shot. The electric blasting cap must not be tied into the blasting circuit until [traffic has been stopped and] the area has been secured.

c. The Contractor must carry out controlled blasting to achieve a blast surface that exhibits a regular fracture plane between perimeter holes with minimal overbreak. The excavation surface must be scaled to remove all loose and hollow sounding rock to leave a solid, intact surface. Special care must be required with such procedures in highly fractured rock.

d. If the methods of drilling and blasting do not produce a consistent, uniform profile with minimal overbreak within the tolerances specified, the Contractor must undertake further test blasts until a method is established that results in an excavation profile to the specified tolerances.

e. The blasting technique must be such as to ensure reproducibility of the blasting pattern, accurate positioning of drillholes and precision in drilling. It may include the use of a template, or other techniques as may be proposed by the Contractor, all of which must have the prior approval of the Contracting Officer, for setting out the blasting pattern.

f. During the progress of the excavation, this technique must be varied as necessary to suit rock conditions exposed and to obtain the best practicable excavation surface after blasting, to the satisfaction of the Contracting Officer.

g. All blasting rounds must incorporate smooth wall blasting techniques.

h. Blasting must not be carried out within [_____] hours of the application of shotcrete within [_____] meters [_____] feet of the face.

i. The shot firing and detonator delays pattern must be such that the peak particle velocity (PPV) must not exceed the requirements of paragraph BLAST EFFECTS MONITORING.

****

NOTE: The section below should be used when rock blasting excavation techniques are required.

****

3.3.2 Public Notice of Blasting Operations

At least thirty calendar days, and prior to blasting operations, prepare and submit to the Contracting Officer a public government notification letter of the proposed blasting activities. The Government will distribute copies of this notification letter by certified mail to law enforcement, local governments, public utilities, [public users of project recreational facilities,] and residents and commercial interests located within 0.8 kilometers one half mile of the blast site. This notification letter must contain at minimum:

a. Name, address, telephone number and e-mail address of the Contractor;

b. Plan maps identifying the specific areas in which blasting will take place, and major and secondary roads, geographic features and auxiliary features;

c. Proposed duration of blasting activities, and on which days of the week and hours of the day that blasts can be expected to occur;

[d. Vehicular and pedestrian traffic control measures to be taken;

] e. Methods to limit access to the blasting area; and,

f. Types, patterns and duration of audible warning and all clear signals to be used before and after blasting.

3.3.3 Public Meetings

****

NOTE: Communicate with the project manager and stakeholders about whether specific requirements for a meeting or multiple meetings are needed. It may be necessary to advertise the meeting in a local newspaper and specify the meeting room capacity.

****

Fifteen calendar days prior to commencing tunneling operations, provide for the approved Project Manager, Tunneling Superintendent, Seismic Specialist, Blasting Specialist and Blasting Consultant (as applicable) to attend a public information meeting to be conducted on an evening to be determined by the Contracting Officer. This meeting will inform the public about the anticipated tunneling and underground construction operations, including the need to use blasting (as applicable). The Project Manager and Tunneling Superintendent must make a short presentation on tunneling and underground construction and answer questions pertaining to concerns that may impact the public. The Blasting Specialist, Blasting Consultant and Seismic Specialist must make a short presentation of blasting operations and answer questions pertaining to public concerns dealing with the tunneling and blasting operations, the magnitude of ground vibrations, airblast and potential for flyrock that may impact the public. Distribute points of contact for the public and local entities in the event of concerns related to the blasting program.

3.3.4 Warnings and Signals

Establish a method of warning all employees on the job site of an impending blast following the guidance of the EM 385-1-1. The signal must consist of a five-minute warning signal to notify all in the area that a blast will be fired in five minutes. A second warning signal must be sounded one minute before the blast. After the blast is over, sound an all-clear signal, after the blast site has been inspected for misfires by the Blaster-In-Charge to provide notification to all personnel in the area that the blasting operation is finished. No personnel other than the Blaster-In-Charge must enter the blast area until it has been determined to be all clear.

3.3.5 Time Restrictions

****

NOTE: Research the specific State and local requirements. This paragraph will need to be tailored for the specific site conditions, for example, avoiding blasting during rush hours in the morning and afternoon. Most locations prohibit blasting on Sunday but may allow on Saturdays and some Holidays.

****

Blast only during daylight hours, one-half hour before sunrise and one-half hour after sunset, and between [_____] AM and [_____] PM, local time, on weekdays and only during the approved time periods each day and at the same time each day, in concert with the approved closure time for area roads. No blasting is allowed on Saturdays, Sundays, or official holidays recognized by the Federal Government or the State of [or Commonwealth of][_____] unless consent is granted by the [State Fire Marshal]. Drilling activities and blasthole loading are not time restricted, except as noted in Section 01 14 00 WORK RESTRICTIONS.

3.3.6 Lightning Detection Equipment and Safety

****

NOTE: This section is needed when conducting blasting at the surface for shaft or portal blasting.

****

Furnish, maintain, and operate Lightning Detection Device during the entire period of blasting operations and during the periods that explosives are used at the site. Equipment must provide real time audio and visual alarm/signal and detection based on combined detection of electromagnetic, electrostatic, light wave spectral and audio disturbances, or a commercial service based on these as a minimum as approved. Equipment must be capable of detecting lightning within 40 kilometers 25 miles, as minimum, of the blast area.

****

NOTE: Obtain technical feedback from the rest of the design team for minimum lightning detection distance.

****

When and where the lightning detection device indicates a blasting hazard potential, immediately evacuate personnel from all areas where drilling is being conducted or explosives are present. When a lightning detector indicates a blasting hazard, perform the following:

a. Clear the blasting area of all personnel. Place guards at all access points to the blast area.

b. Immediately notify the Contracting Officer of the potential hazards and precautions being taken.

c. Terminate the loading of holes and secure the unused explosives to an approved location.

d. When the hazard dissipates, inform the Contracting Officer that the drilling and loading of holes will continue.

3.3.7 Check for Misfires

****

NOTE: Federal, or local entities may have different regulations applicable to the minimum time required before entering blast site after firing the shot. The more stringent regulation must apply.

If a misfire is declared, then the appropriate regulations must be followed for wait time and handling the misfire.

****

The Blaster-In-Charge must closely inspect the entire blast area following a blast to check for misfires and guard against rock fall or cave-in before commencing work in the tunnel. It is the responsibility of the Blaster-In-Charge to go into the shot area and check all holes to make sure that all explosives have been detonated.

3.3.8 Misfire Handling Procedures

Should a visual inspection indicate that complete detonation of all charges did not occur, only critical personnel involved in the blasting operation or excavation of the unexploded material are allowed within the established blasting area. Restrict access to the blast site until the Blaster-In-Charge and the Blasting Specialist indicate the site is safe. If the misfire poses problems that cannot be safely corrected by the Blaster-In-Charge or the Blasting Specialist, a consultant, or an explosives company representative skilled in correcting misfires must be brought to site to resolve the problem. Compliance with this or any other provision in the Contract must not relieve the Contractor of responsibility for damages or injuries caused by, related to, or arising out of blasting or associated blasting activities. Detail the misfire procedures in the Blasting Safety Plan including the distance of the restricted area when a misfire is discovered.

3.4 BLASTING PERSONNEL

3.4.1 Blasting Consultant

****

NOTE: Depending on the scope of the project, it may not be necessary to require a Blasting Consultant. This will be determined during design, an Agency/Service Blasting SME or Government Blasting Consultant should be consulted to discuss this. Projects where slope blasting, away from sensitive structures minor and lightly used public areas may be a consideration to not including this requirement. One option is to still require a blasting consultant to be engaged but only for reviewing the Master Blasting Plan and engaged on very serious issues with the blasting (exceedance of vibration and/or airblast limits, misfires, flyrock, or excessive backbreak and/or overbreak). Excessive backbreak will need to be defined prior to issue of the specifications. This specification is geared

towards IFB (Invitation for Bid) where there is no mechanism to select contractors prior to award. If another contract mechanism is used it may be necessary to include the bracketed text requiring a letter of commitment from the consultant.
****

The Blasting Consultant, Blasting Specialist, Blaster-In-Charge, and Vibration Specialist cannot be the same person, unless a justifiable request is presented and approved by the Contracting Officer. Retain a recognized Blasting Consultant to assist in the blast design. The Blasting Consultant must be approved by the Contracting Officer prior to the submission of the Master Blasting Plan. Submit the Blasting Consultant's Qualifications including resume, experience, current blasting licenses, credentials and training and a formal letter of commitment from the consultant verifying their availability on an "as needed" basis for the duration of the Contract prior to the award of the Contract. The consultant must be an expert in the field of drilling and underground blasting who has derived their primary source of income by providing specialized underground blasting and underground blasting consulting services. The consultant must not be an employee of the Contractor, explosives manufacturer, or explosives distributor or other sub-contractor. There must be no additional cost to the Government for the Blasting Consultant's duties, even when required by the Government.

****
NOTE: The paragraph below should be used when controlled blasting techniques are required.
****

The Contractor's Blasting Consultant with the Blasting Specialist must develop controlled blasting techniques to be utilized in the areas specified in the drawings during the Test Blasting program. The Blaster-In-Charge is responsible for the technical application of the controlled blasting methods specified during and following the Test Blasting. The Blasting Consultant must modify controlled blasting methods, as necessary, to meet safety requirements, airblast and vibration limits, and protect rock to be left intact. Proposed controlled blasting methods must be submitted to the Contracting Officer for approval.

The Blasting Consultant must review the Master Blasting Plan and Individual Shot Reports, attend the public meetings and be available for consultation on an "as needed" basis, as determined by the Contractor, Contracting Officer, or both. The Blasting Consultant is not required to be on the job site for review of the Master Blasting Plan or Individual Shot Reports. The Blasting Consultant must submit a short, signed Blasting Consultant's Report each month stating that the Blasting Consultant has briefly reviewed the Individual Shot Reports including blast videos, and problems, concerns or errors in the reports were addressed. This report is due within [_____] days after the end of the month.

3.4.1.1 Blasting Consultant's Qualifications

The consultant must be able to demonstrate involvement in at least [15] projects with underground blasting. The consultant must have as a minimum the credentials and experience outlined below:

a. The consultant must have at least 20 [_____] years of experience in general construction blasting within [_____] meters [_____] feet of protected structures, [natural resource concerns and environmentally sensitive areas], final tunnel periphery, and presplit shaft or walls.

****

NOTE: "Natural resource concerns and environmentally sensitive" areas need to be defined elsewhere in this guide specification. Depending on the scope of the project and state requirement the number of short courses, seminars and conferences can be adjusted.

****

b. The consultant must be able to demonstrate that he has attended at least [15] short courses, seminars, or conferences on blasting technology, or university engineering class studies on blast design during the past [20] years including a complete understanding of blasting seismology with emphasis on vibration frequency, acceleration, and displacement (ground strain).

c. For the past 10 years the consultant must have derived their primary source of income from providing specialized blasting consulting services.

d. Project list will contain a description of the projects, details of the blast plans, and modifications made during the project.

e. The names and telephone numbers of at least three project owners with enough knowledge of the projects to verify the submitted information.

f. The Blasting Consultant must be approved by the Contracting Officer prior to the beginning of drilling and blasting work including submission of the Master Blasting Plan.

g. Hands-on experience as a blaster for at least three years.

3.4.1.2 Issues Requiring the Blasting Consultant

If problems with vibration, airblast, smooth wall blasting, or production blasting, or adverse impacts on natural resources occur the Contracting Officer will require the Contractor to immediately summon the approved Blasting Consultant and have their presence on site within 10 days after the problem develops for the following:

a. To approve the blasting plans for each individual blast.

b. To be present to review the blasthole layout on the ground before drilling begins.

c. Observe blasthole loading.

d. To sign each blasting plan and each Individual Shot Report, at no additional cost to the Government. The Blasting Consultant must have full authority to stop or delay blast they consider unsafe.

e. To submit and sign a written checklist that all necessary precautions were reviewed and followed by the drilling and blasting crews. The checklist must be as defined under the section on Individual Shot Reports. The signed checklist must be attached to each blasting report.

f. Submit Blasting Consultant's Reports after each site visit.

3.4.2 Blasting Specialist

Submit the Blasting Specialist's Qualifications including resume, experience, education, training, and valid blasting licenses of the Blasting Specialist for approval, at least 60 days before drilling and blasting operations commence. The Blasting Specialist must be approved before submission of the Master Blasting Plan. Detail the experience and training, which qualifies the specialist for work under this Contract. The duties of the Blasting Specialist are to prepare all necessary paperwork, to conduct quality control and to coordinate with the Contracting Officer on all issues dealing with underground blasting. The Blasting Specialist must be an employee of the Contractor on the job site each day.

a. The Blasting Specialist must have at least 10 years of verifiable experience utilizing underground controlled blasting techniques.

b. Within the last five years, the specialist must have completed at least five days of classroom training that has familiarized the specialist with the most current drilling and controlled blasting methods.

c. In the last five years he must have been responsible for the blast design or execution of large underground rock excavation projects similar in scope and complexity as this project.

****

NOTE: Include this sentence under paragraph a. if the project requires precision presplitting: [or projects where at least 30,500 meters 100,000 linear feet of Precision Presplitting was used].

****

d. Their credentials must include a list of the projects, including the location, duration, scope, description, geologic conditions, and the challenges that developed though the course of the projects and how the challenges were resolved.

e. Each project description must be accompanied with photos which exhibit the Blasting Specialist's competency and ability to create the designed tunnel periphery and shaft configuration if blasting at portals or shafts, to the specified tolerances. The list of projects must also contain the names and phone numbers of the project owner or their representative, Contracting Officer, or project engineers who has enough knowledge to verify the submitted information. The Contracting Officer will invalidate project submitted as reference that cannot be verified.

3.4.3 Blaster-In-Charge

****

NOTE: Some USACE projects may require an Alternate Blaster-In-Charge based on the frequency, size, and complexity of the blasting operations. The Alternate Blaster-In-Charge must meet the same qualification requirements as the Blaster-In-Charge.

****

Submit the Blaster-In-Charge's Qualifications including resume, experience, education, blasting licenses and training of the Blaster-In-Charge for approval, at least 60 days prior to the commencement of drilling and blasting. Also submit the Contractor's Federal ATF License. Detail the experience and training, which qualifies the Blaster-In-Charge for work under this Contract. The Blaster-In-Charge is responsible for preparing the Individual Shot Plans that will be approved by the Blasting Specialist. The Blaster-In-Charge is responsible for marking the blasthole locations for drilling, accounting for the relevant geology, loading the blastholes according to the Individual Shot Plans and firing the blast.

a. The Blaster-In-Charge must be a licensed blaster in the State of [_____] per that State's regulations or issuing agency.

b. The Blaster-In-Charge must have a minimum of 10 years of experience.

c. The Blaster-In-Charge credentials must include a list of the projects, including the location, duration, scope, description, geologic conditions, and the challenges that developed though the course of the projects and how the challenges were resolved. Each project description must be accompanied with photos, which exhibit the Blaster-In-Charge's competency and ability to design the blast.[Create the designed shaft configuration or tunnel periphery to the specified tolerances.] The list of projects must also contain the names and phone numbers of the project owner or their representative, Contracting Officer, or project engineers who has enough knowledge to verify the submitted information. The Contracting Officer will invalidate project submitted as reference that cannot be verified.

3.4.4 Magazine Keeper

Each magazine keeper must be experienced and familiar with the laws and general practices concerning the handling, care, use, and storage of explosives and detonators. The magazine keeper is responsible for maintaining a cleared area around each magazine. The magazine keeper will not be required to perform duties that will interfere with their duties as magazine keeper. If explosives are delivered daily from the manufacturer, the driver of the truck will serve as the magazine keeper.

3.4.5 Vibration Monitoring Specialty Firm

****

NOTE: This requirement is a new format from previous specifications. The firm is submitted for approval, having the appropriate experience and the firm must have on staff the Seismic Specialists and Seismograph Technicians, typically a firm is subcontracted by the Contractor and having multiple experienced people approved allows them to have flexibility on supporting the site work. The people coming to the project or responding to the work must be within the group approved but does not need to be a single person anymore.

****

Retain the services of a vibration monitoring specialty firm that specializes in the prediction, monitoring and control of ground vibration and airblasts applicable for tunneling. The firm must have experience conducting installation of seismographs for vibration monitoring, communicating vibration and airblast results, and developing and maintaining a site attenuation curve. The firm must have on staff at least two Seismic Specialists that specialize in vibration monitoring and analysis. The firm must have on staff at least four Seismograph Technicians that have five years or more experience with seismograph installation and vibration monitoring. Submit resumes for all personnel and for the firm for approval citing, in additional to other pertinent data, experience, training, and education, at least 60 days prior to the commencement of blasting. The Seismograph Technicians must be persons capable of setting up the seismographs at designated locations, effectively recording the blast, and appropriately interpreting results. The Seismic Specialists must interpret the seismograph records to ensure that the seismic data must be effectively utilized in the control of the blasting operations with respect to the existing structures. The Seismograph Technicians must supervise the placement, operation and maintenance of the seismographs. The Seismic Specialists must conduct the airblast and particle velocity regression analysis as described in this Section. The Contracting Officer may require the Seismic Specialists and Seismograph Technicians to be present during the test blast program, production blasting, or both.

3.4.6 Structural Inspection/Evaluation Technician

****

NOTE: This may be required for shaft/portal blasting/excavation. Depending on proximity of the tunnel it may be needed to document condition of structures in proximity to the work. Designers will need to determine project requirements/needs.

****

****

NOTE: Five years should be considered the minimum experience requirement. Depending on the project it might be necessary to increase the minimum if there is a special concern (i.e., complex ground conditions) or sensitive structures, consult with USACE SME to help determine appropriate experience requirements.

****

Pre and Post Blast structural inspections must be performed by technicians with at least [five] years' experience in pre-blast and post blast surveys in the State of [_____]. Submit a copy of the qualifications and certificates to the Contracting Officer.

3.5 TUNNELING PERSONNEL

3.5.1 Project Manager

Perform the work under the direct supervision of an experienced project manager with a minimum of 15 years (or as approved by the Contracting Officer) in civil and heavy construction of which a minimum of five years' experience (or as approved by the Contracting Officer) is in tunnel construction, including a minimum of two projects, or as directed by the Contracting Officer. Substitutions for the project manager during the Contract period should not be made without prior written acceptance by the Contracting Officer. Substitute personnel must have the same qualifications specified herein for the position to be held.

3.5.2 Tunneling Superintendent and Supervisors

****

NOTE: The nomenclature of tunneling "supervisors" could vary based on geographic location. Foreman or Shifters are common terms for supervisor.

****

Submit for approval the qualifications. Perform the work under the direct supervision of an experienced tunneling superintendent and tunneling supervisors with experience requirements in accordance with Section [_____], or as directed by the Contracting Officer. In addition, the Tunneling Superintendent's experience should include at least one project of a comparable size to this Project within the previous ten years (or as approved by the Contracting Officer). Duties of the tunneling superintendent and tunneling supervisors should include the requirements set forth in Section [_____]. Substitutions for the tunnel superintendent during the Contract period should not be made without prior written acceptance by the Contracting Officer. Substitute personnel must have the same qualifications specified herein for the position to be held.

****

NOTE: Use qualification criteria requirements for drill and blast tunnel superintendents and supervisors as described below.

****

Tunneling superintendents and supervisors must have a minimum of 15 years of comparable experience in supervising the excavation and support of tunnels in similar ground using the same construction methods and must have all necessary licenses and permits required by local agencies or others having jurisdiction. Supervisors and superintendents must have experience on at least two projects with full face hard rock drill and blast tunnel excavation. Tunneling must not be performed unless the tunneling superintendent, supervisors, drillers and miners meeting the above experience requirements are on site and in actual supervision of this portion of the work.

The following duties are also part of the responsibilities of tunneling supervisors and superintendents:

a. Supervising excavation to ensure safety and quality of construction.

b. Meeting daily [at the start of each shift] with the Contracting Officer at the tunnel face to discuss ground conditions encountered and corresponding excavation and support requirements including additional initial support and keeping records thereof.

c. Devising and implementing additional initial support measures as required by ground conditions or as directed by the Contracting Officer, coordinating remedial measures when ground loss at mined tunnel heading or instability of mined tunnel occurs, or appears likely to occur.

****

NOTE: It is standard practice to have drill and blast supervisors (in addition to Tunneling superintendents, Consultants, Blaster) in drill and blast tunnel construction. Nomenclature of these

positions may vary depending on geographic area.
****

3.5.3 Drill and Blast Supervisors

Drill and blast supervisors must have a minimum of 10 years of experience in designing, supervising, loading, and firing of blasts for shaft or tunnel excavations, as applicable, and must have all licenses and permits required by state and local agencies and others having jurisdiction. Submit for approval the qualifications

3.5.4 Geotechnical Engineer or Engineering Geologist

****
NOTE: A licensed professional must be used, that may vary on the state, since some do not license Engineering Geologists or Geotechnical Engineers. Tailor this section appropriately for your project needs.
****

Contractor's Geotechnical Engineer or Engineering Geologist must be a licensed Civil Engineer, Professional Geologist or Engineering Geologist in the State of [_____] with a minimum of 10 years' experience designing underground excavations and constructing such excavations, installing slope stabilization support, designing tunnel and underground support, evaluating rock mass properties, and groundwater conditions for large underground excavations.

The Geotechnical Engineer or Engineering Geologist must have worked on a minimum of two projects with full face hard rock drill and blast tunnel excavation. Tunneling must not be performed unless the Geotechnical Engineer or Engineering Geologist meeting the above experience requirements is on site and in actual supervision of this portion of the work. Submit for approval the qualifications.

The Contractor's Geotechnical Engineer or Engineering Geologist to provide inspection of excavations and evaluate rock and groundwater conditions during construction. The Geotechnical Engineer or Engineering Geologist must perform pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer or Engineering Geologist must update the excavation, dewatering plans, geologic mapping, rock support mapping, and rock mass characterization as construction progresses to reflect changing conditions and changes in contract rock support based on in-situ conditions observed. The Geotechnical Engineer or Engineering Geologist must submit a written Monthly Excavation Status Report that informs the Contractor and Contracting Officer of the status of the excavation and provide an accounting of the Contractor's adherence to the plans and address present or potential problems or issues with ongoing construction. The Geotechnical Engineer or Engineering Geologist must be available to meet with the Contracting Officer and Government representatives throughout the Contract duration.

3.6 PRE-CONSTRUCTION DOCUMENTS

****
NOTE: The section below should be used when rock blasting excavation techniques are required.

****

3.6.1 Tunnel Excavation Plan

The following documents must be submitted to the Contracting Officer at least 60 days prior to commencing excavation:

a. A drawing of proposed tunneling operations. The drawing must include detailed working drawings of mobilization, proposed methods, and sequence of excavating and disposing of materials for each portion of the work, drilling and blasting, ventilation, illumination, installation of ground support including placing of shotcrete, steel sets and rock reinforcement, dimensions for excavation and types of equipment to be used.

b. A method statement of the proposed tunneling operations. This method statement must include details of the Contractors proposed tunnel-logging system such as the NGI "Q" system or Rock Mass Rating (RMR) system for determining ground support, as defined in the GBR, in concert with guidelines provided in Chapter 7 Design of Initial Support, EM 1110-2-2901. The report must present details of proposed methods and sequences of excavating and disposing of materials for each portion of the work, probing ahead of the tunnel face, pre-grouting, drilling, and blasting, ventilation, illumination, placing Shotcrete, steel sets and rock reinforcement, surveying, monitoring, and construction equipment to be used.

c. Catalog cuts of drilling, mucking and transportation equipment to be used.

d. Contingency Plan for the excavation and support of the tunnels in the event that monitoring of blasting operations in accordance with Section [_____] and monitoring of ground deformations in accordance with Section [_____] TUNNEL INSTRUMENTATION. Refer to EM 1110-2-1009 for further guidance on instrumentation. Indicate vibrations or movements exceeding threshold values defined in the drawings.

e. The following Optical Survey Target Details must be submitted to the Contracting Officer for approval:

    (1) . Manufacturer's address, phone number and name of the contact person.

    (2) . List and description of special modifications if there are changes.

    (3) . Description of instrument's operational principle.

    (4) . Plans or diagrams of instrument.

    (5) . Maintenance requirements.

    (6) . Reading procedures, including sample data, and data processing calculations.

    (7) . Complete data on all tests done to calibrate instruments or verify accuracy.

f. Working Drawings - The following must be submitted in accordance with the specifications:

(1) . Drawings and details of the initial support of all excavations.

(2) . Procedures for the control [, treatment]and disposal of groundwater and water supplied for use during tunneling.

(3) . Methods and and equipment for measuring and recording groundwater inflow. Methods, equipment, guidelines, and criteria for the use of fissure grouting must be proposed by the Contractor in method statement as required in Section 31 73 19 TUNNEL AND SHAFT GROUTING.

g. Instruments for monitoring air quality.

h. The following records of work accomplished must be submitted to the Contracting Officer within 24-hours of the installation of geotechnical instrumentation measuring tunnel convergence:

(1) . A list of instruments installed, including instrument identification numbers, calibration, elevation, orientation, stationing, offset, and initial coordinates as applicable to each instrument or installation.

(2) . Drawings showing details of installed instruments. All dimensions and materials used must be fully identified.

(3) . A statement describing the procedure used for the installation of each instrument.

i. Complete working drawings and system description of proposed equipment, materials, and method for handling water within the tunnel, measurement of pumped water, and disposal methods.

3.6.2 Blasting

3.6.2.1 Master Blasting Plan

Submit a Master Blasting Plan at least [_____] days prior to commencing drilling and blasting operations that includes a section called Blasting Safety Plan for review and approval. The Master Blasting Plan must contain the full details of the typical drilling and blasting patterns [and control for line drilling and for the presplit, buffer and production blasting, in the situation where controlled blasting is required for the project]. The Master Blasting Plan must contain the following information, at a minimum:

a. Typical plan and section views drawn to scale of proposed drill patterns including free face, burden, blasthole spacing, relief hole data, [burn, v, fan] cut design, blasthole diameters, blasthole angles, lift height and subdrilling depth, where allowed except for the blast that will carry the excavation to foundation grade where subdrilling is restricted as specified in the article SUBDRILLING. Base the typical plan and section views on the geology and excavation plan for this project site, it cannot be a blast plan from a previous project.

b. Typical loading diagrams for each blast design being proposed showing type and amount of explosives, primers, boosters, decks, initiators and location and depth of stemming in each blasthole.

c. Typical initiator sequence of blastholes including delay times and delay system.

d. Predicted vibration and airblast amplitudes, and the mathematical equations used to calculate them. The Contractor must monitor the results of the test blasts and with the seismic data collected can determine the site-specific ground vibration equations and the site specific airblast equations for the project. After the first 10 blasts the Individual Shot Plans must use the site-specific estimates at the 95 percent confidence level.

****

NOTE: Some states or counties may have specific vibration amplitude and airblast equations for specific locations.

****

e. Manufacturer's data sheets, including Safety Data Sheet (SDS), for all explosives, primers, and initiators to be employed. Provide copies of SDS for all explosives and detonators and define specific details about hazard communication programs for employees and specify where copies of SDS will be kept.

f. The Master Blasting Plan submittal is for quality control and record keeping purposes. Approval of the Master Blasting Plan does not relieve the Contractor of responsibility for the accuracy and adequacy of the plan when implemented in the field. Retain the professional services of a Blasting Consultant to assist with the blast designs included in the Master Blasting Plan.

g. Provide the Test Blast Plan and procedures for test blasting and modifying shot plans during production blasting in the Master Blasting Plan. Also provide the expected results from each shot including, but not limited to, the likely maximum peak particle velocity and airblast levels at the nearest inhabited structures.

h. Indicate that the Individual Shot Report design and blast record documents must provide all the data of each blast in sufficient detail.

i. Include samples of all completed submittal forms and diagrams (Pre-Blast Surveys, Individual Shot Plan, Drilling Logs, Individual Shot Reports, Individual Shot Vibration Monitoring Report, Results of Vibration and Airblast Monitoring, and Individual Shot Video).

j. Manufacturer's specifications on equipment to be used including but not limited to drills, air compressors, drill bits, drilling equipment specifications, manufacturer's literature of the drill rods, bits, casing.

k. Plans for construction sequencing line drilling, presplitting, blasting, and mucking operations to complete the rock excavation within the limitations of the peak particle velocities. Describe the change in placement of the seismographs with regards to the progression of blasting and excavation. Provide the names of individuals responsible for the instruments, data retrieval, and analyses.

l. Single Sheet plan view showing location of all seismographs. This sheet must be amended and resubmitted whenever seismographs are moved.

m. Sample checklist that the Contractor will use to ensure that all required information is included in each blasting plan.

n. Survey Control Plan: Establish survey control as approved by the Contracting Officer for horizontal and vertical control of all line drill, presplit and production blasts. Assure that all blast holes are drilled on the specified pattern and at the location and the depths as detailed in the blast plan.

3.6.2.2 Blasting Safety Plan

In addition to the Master Blasting Plan, a Blasting Safety Plan must also be prepared, as specified, and outlined in EM 385-1-1, Section 29. All blasting work must be conducted in accordance with the requirements specified in EM 385-1-1.

****

NOTE: Minimum safe distance from blast point will vary with each project. Federal, state, and local regulations must be taken into consideration. Ensure NEPA, 408 permits, and environmental studies incorporated the blast safety radius.

****

The required minimum safe distance for shaft blasting or when blasting at portal is [_____] meters [_____] feet from the blast point. All the public[, including swimming and boating recreationists] must be excluded from the safety zone during blasts, including pre- and post-blast operations. The safety zone must be marked with an intrusion prevention barrier and high hazard warnings.[Patrol by boat before and during blasting to prevent the recreational public from entering the safety zone.]

The Blasting Safety Plan must provide a complete description of the clearing and guarding procedures that must be employed to ensure personnel, staff, visitors, and all other persons are at safe locations during blasting. A Blasting Safety Plan simply stating: "all regulations will be followed" is not acceptable and will be rejected. This plan must be developed and signed by the Contractor's Blasting Specialist with input from the Contractor's Site Safety and Health Officer (SSHO) with the intent to show how the Contractor's procedures and methods meet or exceed applicable rules, regulations and standards established by the Regulatory Agencies, codes and professional societies, and specifications listed herein. This information must include detailed descriptions and maps, when appropriate of traffic control, visible warning signs or flags, audible warning signals, method of determining blast areas (all areas affected by potentially harmful blast effects), access blocking methods, guard placement and guard release procedures, primary initiation method, and the system by which the Blaster-In-Charge must communicate with site security guards or other appropriate site supervisory personnel. The Blasting Safety Plan must be in accordance with and include items required in the EM 385-1-1, Section 29, 29 CFR 1910.109, 29 CFR 1926-SUBPART U.

The Blasting Safety Plan must state that explosive distributor will be delivering explosives on the day of the planned operation and recovering unused explosives at the end of the day. In the event of lightning detected at 16 kilometers 10 miles or less from the project site requirements for ceasing operations must be described. Provide a plan for controlling the temporary onsite storage of explosives or of securing an area of loaded holes until the threat has passed.

The Blasting Safety Plan must contain detailed descriptions of how and from where explosives will be transported and used at the various project work areas, and a map of the transportation route. The Blasting Safety Plan must explain how explosive transport vehicles will satisfy all applicable ATF, OSHA, Federal, State, and local regulations. The Blasting Safety Plan must also include the following:

a. Specific details about hazard communication programs for employees.

b. Equipment that will be used to monitor the approach of lightning in such event, the site evacuation and site security plans, and the criteria for determining if the site is safe to re-occupy.

c. Methods for preventing spills or losses of explosives, drilling fluids, oil, or other pollutants onto the ground during handling and blast hole loading operations. Include details of spill containment and contingency plans for quickly and effectively cleaning up spilled materials.

d. Method of safe and approved disposal of all explosive packaging materials.

e. Detailed contingency plans for detection and disposal of misfires resulting from cutoffs or other causes, hangfires, inadvertent initiator extraction, or accidental loss of downlines. A narrative describing in detail job steps, controls, and hazards associated with but not limited to hung or bridged powder, overloaded holes, cutoffs during placement of blast mats, failure of communication system during pre and post blasting protocols, recovery protocols for unexploded objects (UXO).

f. Misfire mitigation procedures, including but not limited to restrictions of entry, securing the area prior to investigating and inspection, additional safety measures, time-sequence of operations, and mitigation protocols.

g. Fire Prevention Plan details, including tobacco smoking policies, procedures and limitations for work involving open flames or sparks, description and location of firefighting equipment, and firefighting and evacuation plans.

h. Digital copies of a valid [state] blasting license for the Blaster-In-Charge, Blasting Specialist and all personnel required to have one.

i. State required certifications for the Contractor's explosives supplier's Federal, ATF Explosives license or permit.

j. Other required county or state permits required for explosive transportation, use and offsite storage.

k. Explosive transporters' commercial driver's licenses with HazMat endorsements.

l. When a misfire is declared the Blaster-In-Charge must wait 1 hour before inspecting site and provide proper safeguards for excluding employees from the danger zone except those necessary to do the work.

m. Submit updates, modifications, and additions to the Master Blasting Plan in an appropriate and timely manner.

n. Complete project team organization with duties, responsibilities and authorities clearly defined. This organizational outline must also include names, addresses, resumes, responsibilities, and qualifications of all personnel authorized to sign for, receive and use explosives on this Contract.

[o. Traffic Control Plan.

]3.6.2.3 Pre-Blast Surveys

****

NOTE: During design consult with the stakeholders to determine what Pre-Blast Survey needs to be conducted and whether access is allowed, or special considerations are needed. This needs to be outlined in the specifications for a proper bid to be made for the scope. It is important to include the entire Project Development Team in design to ensure all project features of importance are documented before blasting. Lessons learned on one lock where blasters caused damage and it was not realized until well after the work was completed. The Government had no means to prove the damage occurred from blasting because there was no Pre-Blast Survey of the structures damaged.

****

Prior to the commencement of blasting, conduct a Pre-Blast Survey of any nearby buildings, structures and utilities within [_____] meters [_____] feet from the blast area that may potentially be at risk of blasting damage to document pre-existing conditions. The survey extent and method used must be acceptable to both the Contractor's insurance company and the Contracting Officer. Provide a letter from the insurance company to the Contracting Officer certifying that the proposed survey extent and methods are acceptable. The Contractor is responsible for damages or injuries resulting from blasting. Submit all Pre-Blast Surveys 30 calendar days before the start of blasting. There will be no blasting allowed until the Pre-Blast Survey is submitted and approved by the Contracting Officer. Provide owners of surveyed features a copy of their feature's Pre-Blast Survey results before or with the notice of blasting commencement. Notify owners and occupants of local buildings prior to the commencement of blasting. Perform the following when conducting Pre-Blast Surveys:

a. Provide methodology to be used in conducting the Pre-Blast Survey and listing of structures, determined from the survey to be sensitive, with reasons for these structures being sensitive.

b. Each structure must be documented (including high resolution photography and digital video) as to its construction, foundation type, condition, and closest distance to excavation blasting. The general condition and all observable defects of each structure must be documented. This includes measurements of the defects.

c. The Commodity storage facilities that may be impacted by blasting must be addressed by the Contractor for safety and continued operation during the blasting program.

d. Freestanding structures (such as retaining walls) must be inspected on the exterior and on the interior as a room. All concrete walks, driveways, and structures must be inspected for cracks, level condition, holes, and defects.

e. Industrial structures, silo/elevators and special facilities, and office space must be described relative to their present conditions and tolerance to vibration. Besides the inspection of walls, columns and stairwells, the Contractor must survey the work areas and structures for distress.

f. An inspection of accessible structures must be made and a list of all structures, which could not be surveyed or refused to allow survey, must be completed. The dates of possible subsequent surveys and physical constraints prohibiting the survey must be documented. The requirement to perform Pre-Blast Surveys is not an indication of Right-of-Entry by the Contractor. Right-of-Entry associated with Pre-Blast Surveys, monitoring during blasting and Post-Blast surveys are the responsibility of the Contractor. In the event a property or properties identified as significant or intended to be included in the Surveys and monitoring are not included because access was denied, indicate this occurrence including the points of contact, dates contacted, and reasons provided for denial of access (if given.)

g. Certify that the survey was prepared prior to the start of blasting under this Contract. Submit a copy of the Pre-blast survey in conjunction with the Master Blasting Plan.

3.7 RECORD KEEPING

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NOTE: The paragraph below applies to all excavation techniques.

****

Daily records should be maintained as excavation progresses and one copy of such records must be submitted to the Contracting Officer [before 12:00 PM]of the following workday. Keep such other records as deemed necessary. The following data must be included in the daily record for each tunnel heading:

a. Station of tunnel heading faces at start and end of each work shift.

    (1) . Daily As-built Survey: While tunnel excavation is in progress, submit to the Contracting Officer a daily as-built survey record showing line, level, and grade of centerline of tunnel at the invert relative to the theoretical alignment and profile and actual excavated tunnel cross-sections compared to the theoretical cross-sections shown on the Contract Drawings.

b. Type, quantity, and location of initial support and additional initial support installed. Geologic mapping and excavation records that comply with EM 1110-1-1804 Appendix B and C.

c. Evaluation of in-tunnel monitoring results.

d. Probe hole records in accordance with paragraph DRILLING LOGS of this Section.

e. Number of workers employed per shift for each workday categorized by union trade, idle equipment, active equipment, and site visitors.

   (1) . Air quality and gas monitoring data. Line and grade survey reports.

   (2) . Water inflows, if encountered, with locations and estimates of rates.

   (3) . Overbreak.

   (4) . Other geological and unusual features such as faults, shears, crushed or soft zones, and raveling areas.

3.7.1 Individual Shot Plan

The Blasting Plan must be consistent with the general concepts, designs and layouts shown in the approved Master Blasting Plan. The number of rows of blastholes and the number of blastholes per row can be changed from one individual shot plan to the next. Provide reasons and technical justification for all significant changes from the Master Blasting Plan.

Submit a Blasting Plan for each blast at least [24] hours prior to the planned initiation of drilling. The results of the previous blast are to be jointly evaluated by the Contractor and Contracting Officer prior to the submission of the Individual Shot Plan. The Individual Shot Plan must contain but be not limited to the following:

a. Plan view, and at least two sectional views drawn to scale, of the shot pattern showing blasthole locations, inclinations and designations;

b. Individual blasthole depths, diameters, blasthole spacings, burden, depth intervals of stemming and depth of subdrill;

c. Type of shot, i.e. test, production, pre-split, line drilling or buffer and shot number;

d. Orientation and elevation of the collar and bottom of all blast holes;

e. Total volume of blasted material in cubic meters cubic yards;

f. Description of type of blast and indication if blast is on final slopes or inverts;

g. Amount, type, diameter and depth of explosives, stemming and delay in each hole, and amount, type, and location of boosters and centering devices and the lift elevation;

h. Plan view of blasthole shot pattern showing in-hole and surface delays and firing times of each blasthole or decked charge;

i. Anticipated time and date of blast;

j. Survey coordinates using State Plane coordinate system and, if appropriate, a local coordinate system;

k. Significant geologic features, and techniques planned for mitigating their influence upon results must be included in plan and section with appropriate elevations;

l. Estimated/anticipated peak particle velocities and maximum peak airblast predictions at seismographs located at protected structures using site specific data and regression analysis and the accurate distances from the blast to seismographs;

m. Name of Contractor;

n. Name, signature, and license number of the Blaster-In-Charge;

o. The maximum charge weight per delay, pattern and sequence of delays, and firing times for the blast;

p. Type of detonators, initiation and down hole lines;

q. Powder factors both in charge weight per cubic yard of material shot and in charge weight per meter per foot of total drillhole depth;

r. An elevation sketch of a typically loaded hole depicting each hole pattern, top of overburden elevation, top of rock elevation, bottom of hole elevation and diameter of hole, sub-drilling, decking charges, locations of explosives and stemming, and the locations of primers, boosters.

s. The location of the blast area on a scale plan map of the project indicating the location of the shot, and the distance and directional relationship between all seismic equipment and the nearest structure subject to damage using a scaled distance measured in a horizontal line from the blast site to the nearest building, structure, or facility.

t. A minimum of [_____] high resolution photos, taken with a camera with a resolution of at least twelve megapixels, of the entire blast area, preferably from above, of surface and open face, tunnel working face, tunnel crown, tunnel periphery, tunnel floor; of the shot and surrounding rock to document conditions prior to the shot.

u. Blastholes must not be drilled until the Individual Shot Plan for them is approved. Evaluate problems or impediments of the prior shot and implement solutions for those issues with the next Individual Shot Plan. Provide the Individual Shot Plan to the Contracting Officer electronically. The Contracting Officer will review the plan and send comments to the Contractor within 24 hours of receiving the plan if the plan is submitted between Monday and not later than close of business Thursday.

v. Include a tabular listing by hole in the ascending time order of delays by the describing: row and number within the row of the shot hole, total delay time, the total charge weight of explosive materials for the entire hole, top of sound rock elevation, bottom hole elevation, stemming elevations, and detonator, primer and booster elevations in the hole, by hole in the ascending total delay time order of delays by describing: row and number within the row of the shot; and for each seismic monitoring location the closest approach, the square-root scaled distance, the cube-root scaled distance, and the estimated PPV and airblast overpressure.

3.7.2 Drilling Logs

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NOTE: It may be necessary on sites with complex geology and blasting is occurring near very critical structures or rock outside of neat lines needs special protection, or neat line tolerances are especially important to consider the blaster or Contractor to have geologist(s) on staff to log blast holes or assist in logging blast holes, and aide the blaster in understanding the geology and for more accurate drilling logs. For rock excavation's objective(s); the project truly requires the designed tolerances and quality/stability of the remaining rock, which cannot be overcome at the Contractor's cost of dental clean-up, rock bolting, shotcrete or mass concrete placement; and, an experienced, agency (or third-party) geologist will be onsite for Quality Assurance of the logging & blasting & retained rock stability or damage. Logging may need to be in accordance with ASTM D2488, ASTM D5434, ASTM D6032/D6032M in some instances.

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The drillers are required to keep precise drilling logs on each blasthole to show the depth of the geological features. At minimum, each drilling log must include:

a. Blast number;

b. Blasthole designation and location station number, bench number and type of blast (production, presplit, buffer[, and other types]);

c. Blasthole depth, inclination and diameter;

d. Elevation of top of blasthole;

e. Subdrill depth as permitted in the article SUBDRILLING;

f. Depth(s) of geologic structural features, e.g., voids, gouge or mud seams, soft weathered or altered zones, rusty intervals, changes in rock chip color, and other features encountered in the blasthole pertinent to loading the hole;

g. Relative penetration rates;

h. Start and end times of drilling;

i. List blasthole misalignment; and

j. Soft seams within the rock and sudden feed pressure changes on the drill;

k. If qualitative descriptors are used (e.g., soft, moderately hard, hard, very hard, decomposed, highly weathered, moderately weathered, slightly weathered, unweathered), ensure consistency between drill operators in logging using these terms. Blasting Specialist and Blaster-In-Charge must ensure drillers are using consistent terminology between drillers.

[Log soil and rock in accordance with ASTM D2487, ASTM D5434, ASTM D6032/D6032M.] Submit an example of the Drilling Logs with the Master Blasting Plan. Copies, both hard and electronic PDFs, of these drilling logs must be provided to the Contracting Officer at least 24 hours prior to loading blastholes. The drilling logs must be used to determine the proper design and loading of blastholes and for locating the depths for use of stemming decks across intersected geological features to protect against blowout, flyrock and unusual or hazardous blasting effects.

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NOTE: The paragraph below may be necessary where preventing subdrilling and foundation damage is critical.

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[Survey the elevation at the collar of each production hole in the final blast to foundation grade to ensure that the production blastholes are not subdrilled below final foundation grade, except as permitted in article SUBDRILLING. The survey must be included in the Individual Shot Plan.

]3.7.3 Individual Shot Reports

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NOTE: The Contractor must plan on multiple tunnel headings so that production can be maintained on schedule. The GBR may include recommendations as to how many headings can be expected in the project.

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As a minimum, the Individual Shot Report must be the same form used in the Individual Shot Plan but provide all "as-built" information required for the blast plan. Furthermore, the Individual Shot Report must better describe part of the blasting operation that wasn't adequately described by the Individual Shot Plan including information on misfires, observed field conditions, and information how the Blaster-In-Charge compensated for compromising field conditions, such as increased stemming amounts, or stemming decks where voids, cracks, spalls or mud seams were identified and resolved. The Blasting Specialist is responsible for recording all explosives loaded in the blasthole and for accurate documentation of daily blasting activities. The Individual Shot Reports are for quality control and record keeping. Review of, and comments on, the blast reports by the Contracting Officer will not relieve the Contractor of responsibility for the accuracy and adequacy of the blast design. Submit the Individual Shot Report no later than 24 hours after the blast. No additional blast will be drilled or loaded in the immediate area of the completed blast until the previous day's Individual Shot Report is submitted to the Contracting Officer. The report must include at minimum the following information:

a. Blast number (i.e., R-L3-PS1);

b. Date and specific time the blast was initiated;

c. Blasthole designations, locations;

d. Amount, type and depth of explosives, decking, stemming, and delay in each hole;

e. Plan and section views, drawn to scale, of drill pattern including free face, burden, blasthole spacing, blasthole diameters, blasthole angles and azimuths, blasthole number, lift height, and subdrill depth. Show in-hole and surface delays, as well as actual firing times of each blasthole or decked charge. Use different symbols to distinguish the production, buffer, presplit and line-drilled blastholes. Include a north arrow, stationing, and scale on each plan view. Label the direction of the sections on the sections. Include section parallel to, and perpendicular to the blasthole rows. Show final grade and slope lines as appropriate in the sections. Show the location of the two video recorders on the plan in relation to the blast.

f. Drilling logs for presplit, line, buffer, and production blastholes. Each drill hole must be logged by the driller to provide additional information to the Blaster-In-Charge during loading operations. Drilling Logs must contain information pertinent to the rock characteristics and blast operations. At the minimum, drill logs must contain geological information on pertinent geologic structure, soft or weathered zones, voids, penetration rate changes, and driller's notes.

g. Loading diagram showing type, diameter, amount and depth interval of explosive, primers, initiators and location, depth, and type of stemming for each blasthole. Show the charge weight of each type of explosive and the total explosive load per delay or per hole.

h. Diagrams showing the delay system in the initiation sequence in each blasthole and the location and delay time of all surface delays of each blast. Indicate which blastholes are firing with a delay of less than 8 milliseconds.

i. Trade names and sizes of all explosives, primers, and initiators to be employed.

j. Daily, Weekly, and Monthly explosives material consumption record.

k. A description of all personal injuries and property damage caused by the blast; when the measured maximum peak particle velocity or airblast exceeded by 10 percent the anticipated values from the Blasting Plan; and, all problems with the Warning System and problematic results of the blast, such as overbreak or large fragmentation, or with the shot pattern, such as misfires.

l. The vibration and airblast report described in paragraph Vibration and Airblast Monitoring. Include a comparison of predicted and actual measured values.

m. Signature of the Blasting Specialist specifying that the Blasting Specialist has reviewed the Individual Shot Report for accuracy and completeness.

n. Signature of the Blaster-In-Charge.

o. Note if mats are used [or required by the Contracting Officer]then list the type of blasting mats or other protective covering used.

p. A brief weather description at or near the time of the detonation such as cloudy, clear, partly cloudy, and foggy, with approximate wind direction and velocity, and temperature.

q. Updated or "as-built" Plan drawings depicting the blast hole pattern and the delay pattern employed as well as pounds of explosives utilized, hazard incidents, and blast holes not loaded.

r. Copies of drilling records and originals of the blast monitoring data.

s. A plan view map [of each bench]showing the location of each completed blast.

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NOTE: A pre-blast photograph may be required for some project, if so then including them with the post-blast photographs in the shot report may be required.

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t. Include photos, after the shot, taken from the same locations and at the same resolution as the blasting plan photos. Include the blasting plan photos in the shot report.

u. Include an updated as-built tabular listing by hole in the ascending time order of delays by the describing: row and number within the row of the shot hole, total delay time, the total charge weight of explosive materials for the entire hole, top of sound rock elevation, bottom hole elevation, stemming elevations, and detonator, primer and booster elevations in the hole, by hole in the ascending total delay time order of delays by describing: row and number within the row of the shot; and for each seismic monitoring location the closest approach, the square-root scaled distance, the cube-root scaled distance, and the estimated PPV and airblast overpressure.

v. Include two log-peak particle velocity versus square root scaled distance as per RI8507 diagrams for each seismograph.[One diagram including all shots.][The second including only data from the last 10 shots.]

Include seismic records with peak displacement, velocity, and accelerations at their respective frequencies. Site curve modification may be required to ensure that vibration levels[structure of interest][are] acceptable.

If a recorded seismic value appears anomalous, the Contracting Officer may request that the vibrations monitoring specialist interpret all the collected seismic records from the seismographs for that blast and provide an explanation of the anomalous readings. Anomalous readings include, but are not limited to, unusually high or low particle velocities, failure of a seismograph to trigger, or atypical wave forms on the paper record. No additional blasting will be allowed until the issue is resolved to the Contracting Officer's satisfaction.

w. Signatures of the Blasting Specialist and Blaster-In-Charge will be considered as proof that the shot was laid out, drilled, loaded, and wired as designed.[Proof of the Blasting Specialist and Blaster-in Charge's qualification must include remaining below the allowable peak particle velocities at all structures.][Inability to remain below the allowable vibration levels may be cause for dismissal of either or both parties.]

The Blasting Specialist must oversee all loading operations and collect and keep accurate records of the information required for each Individual Shot

Report. Submit an example of an Individual Shot Report to the Contracting Officer for approval at least 30 days before commencement of blasting. Failure to submit satisfactory Individual Shot Reports must result in suspension of additional drilling and blasting until the Contractor complies with this requirement. The Blasting Specialist will make sure that the drilling logs are used by the blaster when blastholes are loaded to prevent overloading in soft or weak rock in the borehole. The Blasting Consultant must develop a checklist of tasks that must be completed and checked off by the Blasting Specialist for each blast. Complete the tasks in an orderly fashion before a blast is fired. Submit the draft checklist for approval. Submit the completed and signed daily checklist with the Individual Shot Report.

Supplement the Individual Shot Reports with the original digital copy of the printed results of vibration and airblast monitoring showing peak readings and frequencies for each blast to the Contracting Officer. This submittal must also include the distance from the blast to the seismograph in meters feet as well as the maximum kilograms pounds of explosive per delay. The seismograph locations must be clearly marked and located on a map in the blast report. Supplement the Individual Shot Report with the original, handwritten, field notes showing field changes on the approved blasting plan.

3.7.4 Daily Explosive Material Consumption

Accurate daily records must be kept and account for each piece of explosive, detonator, and equipment from the time of delivery at the site until its discharge and used. No explosives must be accepted until it is plainly labeled and delivered as new stock in sound condition. Dates of manufacture and lot numbers must be recorded for all explosives delivered to the site. Temporary containers for explosives must be approved in advance by the Contracting Officer. Remaining or unused explosives must be inventoried each day and discrepancies that would indicate a theft or loss of explosive material must be reported immediately as specified in Paragraph Report of Loss.

3.7.5 Report of Loss

Should a loss or theft of explosives occur, all circumstances and details of the loss or theft must be immediately reported to the nearest office of the Bureau of Alcohol, Tobacco, Firearms and Explosives and to the local law enforcement authorities and the Contracting Officer. The Blasting Specialist must prepare a memorandum describing and explaining problems in the accounting of explosives used.

3.7.6 Individual Shot Videos

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NOTE: Video size can be a point of discussion, larger files come out of the new high quality 1080 HD and 4K videos. It may be necessary to require a frames/second or use of HD/4K videos. It is likely technology will change faster than this guide specification. This paragraph can be updated by project. The use of sFTP allows for the larger files.

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When blasting at portal(s)[and shafts], record each blast with high resolution digital video cameras from two designated locations, approximately perpendicular to one another, that provide side, front and rear views of the blast and area above it. The Contractor should anticipate at least one designated video camera location when blasting underground[for each shot]. The video images must not contain other text than the shot number, date, and time. Include metadata consisting of the blast ID, date, and time of the blast. Index the two video recordings to properly identify each blast. Submit the proposed locations of the two video recorders on a map with the Individual Shot Plan for approval. Furnish electronic file copies of video recordings on the sFTP within 24 hours of a blast. If the Contracting Officer requests that a copy of the video be submitted earlier, then deliver a copy within one hour of the request. Maintain a digital video library of all blasts. All drilling and blasting activities must cease after the 24 hours from the previous blast if the video recordings of the previous blast are not furnished to the Contracting Officer.

3.7.7 Post-Blast Surveys

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NOTE: Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist would only be required if there are structures or facilities requiring such inspections. Eliminate the paragraphs referencing Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist if the project does not have a requirement for these inspections.

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Post-blast surveys must be conducted at locations, where a reasonable notice of damage from blasting has been provided. Post-blast surveys will be conducted by, or under the supervision of, the Structural Inspection/ Evaluation Specialist, who will also sign and date each survey. The survey extent and method used must be acceptable to both the Contractor's insurance company and the Contracting Officer. The post-blast surveys must be conducted within a week of the notice of damage from blasting. The Contractor is responsible for damages or injuries resulting from blasting. Submit a copy of all post-blast surveys within two business days of the on-premises surveys to both the structure's owner and the Contracting Officer.

3.7.8 Probe Hole Drilling

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NOTE: The design team must evaluate expected ground conditions including but not limited to: zones of intensely jointed rock mass due to faults, shears, etc., rock types, weathering profiles, groundwater regime, other pertinent geological information available from the site investigations to determine the adequate length of probing ahead of tunnel. This information must be included in the Geotechnical Baseline Report as a recommendation.

Insert gallons per minute (gpm) based upon results of packer tests performed, or other estimates of water inflow. In lieu of available project data, assume nominal amount of water on the order of 15-20

gpm. The inflow information must be included in the GBR and/or GDR.

The number of supplemental probe holes expected for the project must be determined during design phase and clearly listed as a recommendation in the GBR.

Typically these probe holes are incidental to the tunnel excavation pay item (cu.f.or cu.m), designer should ensure this is stated in the specification or include a CLIN for payment.

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a. The Contracting Officer must be informed 24 hours prior to probing activities in the tunnel so that the Government may be present during the probe hole drilling. The results of probing ahead along with proposed amendments to excavation profile, sequence or support must be submitted to the Contracting Officer[immediately upon][within [_____] hours of the] completion of the probing.

b. Probe holes must be drilled to provide advance warning of abnormal inflow of water or degradation in rock quality, which might occur. Probe hole locations and extent of hole drilling is shown on the Drawings and will be modified as needed in the field as approved by the Contracting Officer. The Contracting Officer may direct supplemental probe holes to be drilled based on ground conditions. Exploratory probe holes may also be required to explore the nature of subsurface formations or following grout operations to investigate the effectiveness of the grouting program.

c. If the inflow of water from the probe hole exceeds [_____] gpm, supplemental probe holes will be required, at the direction of the Contracting Officer, to probe the extent and character of the ground, and to drain the water, or for use as grout holes. If directed by the Contracting Officer, grout the face of the tunnel heading in accordance with Section 31 73 19 TUNNEL AND SHAFT GROUTING.

d. Probe holes must be drilled to a minimum of [_____] meters [_____] feet measured along the drilled hole and will overlap to maintain at least one hole a minimum of [_____] meters [_____] feet ahead of the plane of the tunnel face at all times. The Contracting Officer may reduce the drilling length based on ground conditions.

e. During probe hole drilling, the Contractor should stop at a minimum of each 3 meters 10 feet of hole advance to measure water flow and water pressure. The Contracting Officer waive this requirement on a hole-by-hole basis if little or no water is encountered.

f. Probe hole must be terminated [_____] meters [_____] feet beyond the first groutable feature, as determined by the Contracting Officer.

g. Probe holes must be sealed by grouting through a packer close to the first water producing feature to prevent water flows into the tunnel while the tunnel face is advanced.

h. If, in sections of the tunnel excavation, drilling is directed by the Contracting Officer for supplemental probe holes, other operations should be suspended or modified as may be necessary to permit such drilling; and the Contractor will not be entitled to compensation for delay nor will the Contractor be entitled to extension of time, such stopping of work being deemed an ordinary delay to be expected during construction operations.

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NOTE: A conservative estimate for the number of supplemental probe holes should be defined in the GBR. Define how these supplemental probe holes are to be paid.

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i. Follow format requirement in paragraph DRILLING LOGS.

3.8 BLAST EFFECTS MONITORING

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NOTE: The vibration and air blast monitoring are covered under Section 31 23 06.00 BLASTING - SURFACE; it must be included when conducting blasting work.

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3.8.1 Convergence Monitoring Construction Requirements

3.8.1.1 General Tolerance

The instruments must be installed as close as practicable to the locations [shown on the Drawings][or as established in the field by the Contracting Officer]. The Contractor must submit to the Contracting Officer for consent, all final instrument locations prior to their installation. Where instruments are shown on the contract drawings to be installed in clusters, the Contractor must install all instruments shown within a [_____] mm [_____] in. radius

3.8.1.2 Availability of Data

The Contractor must monitor all instruments and provide data obtained to the Contracting Officer within a maximum of [24 hours] after taking the readings unless otherwise directed by the Contracting Officer.

Instrument monitoring data must not be disclosed to third parties and must not be published without the prior written approval of the Contracting Officer.

3.8.1.3 Instrument Installation Sequence

Optical survey targets must be installed following scaling and within [_____] meters [_____] feet of the advancing tunnel face.

3.8.1.4 Installation Requirements

The Contractor must assign an instrument identification number to each instrument. Each instrument identification number must be permanently affixed to a suitable material, such as the stamping of a brass tag. The tag must be attached to the instrument or must be secured at the instrument location.

Optical survey targets must be installed as shown on the drawings.

3.8.1.5 Protection of Instruments

Full responsibility must be borne by the Contractor for protecting the instruments from damage caused by construction operations. Damaged instruments must be promptly replaced or repaired, as directed by the Contracting Officer, at the expense of the Contractor.

The instruments must be clearly marked and protected to avoid being covered by shotcrete. Access must be maintained to permit reading of instruments. Shotcrete applied around instruments must be removed immediately.

3.8.2 Rock Damage Control

The rock formations are known to contain geological features including variable weathering, alteration, fracturing and shearing, voids, weathered joints, and gouge seams. Rock cores recovered during drilling investigations disclose the site's geological conditions and are available for review by the Contractor. The Contractor is encouraged to review the [Geotechnical Data Report, Geotechnical Baseline Report, other reports provided with bid documents or made accessible], the drill core, drill core photographs, cut slopes, and all geotechnical and structural information available before planning and conducting blasting operations.

Use stemming decks across weak or open geological features to confine the energy into the hard rock and minimize explosive gas penetration into these features. No rock mass damage, uplift or shifting or significant overbreak will be tolerated. Control drilling accuracy and delay timing to provide proper relief toward the free face away from final rock slopes. Blasting damage or breakage into the excavation walls will be mitigated at the Contractor's expense. Damage is defined as the loosening of rock beyond the B-line, opening of joints in the final wall and rock block displacement in the final wall. If damage occurs to the final wall that requires remediation, it must be the responsibility of the Contractor to prove that the blasting method employed did not cause the damage.

3.9 TEST BLASTING

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NOTE: The test blasting may be highly specific for the project site. The designer may have a way to carry out the test blasting to have the Contractor demonstrate satisfactory results. Typically, the main reason for test blasting is to gain understanding of how the blasting on the site causes vibrations/air blast on monitored structures, develop a site attenuation curve to design future blasts with vibration in mind. The other is to demonstrate results, line drilling and presplitting that meets the specifications and no damage to final faces and foundation grade when blasting at portals or final tunnel or shaft periphery when blasting underground. Typically, the test blasting occurs in an area where there is room for failure, if a test presplit causes significant back break it won't be to a finished face and can be removed

The following is typical test blasting language.

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Submit the Test-Blast Plan for review and approval. Approval of the revised plan will not relieve the Contractor of their responsibility to produce safe and satisfactory results as set forth by these specifications.

Prior to commencing full-scale blasting operations in a different rock type, weathering grade or new bench elevation, demonstrate the adequacy and effectiveness of the proposed blasting plan by drilling, blasting, and excavating short test sections, not exceeding [15.3] meters [50] feet in length, to determine which combination of method, hole spacing, and explosive loads produces the proper split. If more than one presplit design is tested in one test blast, each presplit design section must be at least [6] meters [20] feet in length along the surface.

The first opening blast starting from a level plane that has only vertical relief (i.e., a sinking cut), must not be used as the production test blast. However, its results must be considered when designing the test blasts. The opening blast must be excavated to full depth if possible before drilling the blastholes for the test blast. The test blast must incorporate the planned methods of presplitting and must be near the center of the excavation and at least [4.5] meters [15] feet away from the final excavation walls [or invert]. The Contracting Officer has the option to adjust the location of the test blast areas to optimize for geology. Anticipate blasting up to 10 test sections with at least one test at each different geologic condition and underground blast design. The location of the test blast section must be approved in advance. The Contracting Officer may direct the Contractor to use test section lengths less than [15.2] meters [50] feet if field conditions warrant.

Unless otherwise directed, begin the presplit test blast with presplit holes spaced at [61] centimeters [24] inches center to center. Requirements for presplit and production blasting operations are covered elsewhere in this specification but apply to test blasts.

Do not drill ahead of the test shot area until the test section has been as fully excavated as possible and the results have been evaluated by the Contracting Officer. If the results of the test blast(s) are unsatisfactory, in the opinion of the Contracting Officer, the Contractor's Blasting Consultant must revise the blast design as necessary to achieve the specified results. Unsatisfactory test blast results include poor fragmentation beyond the indicated lines and grade, extensive overbreak, flyrock, ground vibration, airblast or violation of other requirements or these specifications. All costs incurred by the Contractor in adopting revised blasting methods necessary to produce acceptable test blast results will be borne by the Contractor.

If during the progress of the work, the methods of drilling and blasting do not produce the desired result of an undamaged rock slope or tunnel design excavation lines within the specified tolerances, perform additional test sections by drilling, blasting, and excavating short sections, not exceeding [15.2] meters [50] feet in length, until a technique is developed that produces the desired results. No additional compensation will be made for the additional test sections.

At the conclusion of the test blast program, produce a Post-Test Blast Evaluation Report which examines all reports, surveys, test data, and other pertinent information and conclusions reached. Submit a Test Blast Evaluation Report prepared by the Blasting Consultant and Blasting Specialist after testing blasting is completed.

3.10 BLASTHOLE DRILLING - PORTALS AND SHAFTS

Survey the elevation at the collar of each production hole in the final blast to foundation grade when at the portal excavation or to depth of advance when blasting in the tunnel to ensure that the production blastholes are not subdrilled below final foundation grade. The survey must be included in the Individual Shot Plan and must not be changed without prior approval from the Contracting Officer. Drill production blastholes according to the patterns in the approved Individual Shot Plan. Prior to commencement of drilling of production blastholeS, all holes must be located by survey and clearly marked and numbered. Drill the production blastholes within two blasthole diameters of the marked collar location. The blastholes must have no more than a plus or minus [_____] meter foot horizontal tolerance at the bottom. If holes are drilled outside of these tolerances, except for geologic reasons, fill the holes with crushed stone or neat grout and re-drill them at the approved location as directed by the Contracting Officer at no additional expense to the Government.

After drilling of blastholes at the portals, place approved, reusable plastic blasthole markers in each hole to identify all blasthole locations and keep material from falling into the holes. Check, measure and record the depth of all blastholes as soon as the drill is retracted from the blasthole. If a blasthole has become plugged or is unable to be fully loaded, re-drill or clean out those holes with air prior to commencement of loading operations. Check and measure the depth of all blastholes in a shot to ensure each blasthole is open to the original drilled depth prior to loading of holes. If a blasthole is found not be open to the drilled depth, re-drill the blast hole to the proper depth at the Contractor's expense. If holes are too deep, fill the holes to the proper depth with crushed stone. When drilling and blasting at the portal areas, blasthole loading and drilling may be ongoing concurrently in a shot area; nonetheless, drilling must be separated from loaded holes by a distance equivalent to at least the depth of the loaded hole but in no case less than 15.2 meters 50 feet.

When blasting for portal excavation, the Contracting Officer may require inclined boreholes to reduce toe burdens and backbreak.

3.11 PRODUCTION BLASTING

The Contractor must provide a detailed narrative for the proposed sequence of production blasting for the project in the Master Blasting Plan, to be evaluated and approved by the Contracting Officer. The proposed sequence must be tailored primarily towards conducting a safe blasting operation and overall responsible, prudent, and professional blast design in efforts to keep overbreak, flyrock, vibration and airblast levels to a minimum. If in the opinion of the Contracting Officer satisfactory results in the production blasts are not being produced, the Contracting Officer reserves the right to require changes in the blast design which could include variables such as burden, spacing, bench height, timing sequence and delays, subdrill depths, explosive loads, detonators, blast matting and the use of air decks or stemming in borehole bottoms. Such required revisions will be at no additional cost to the Government.

****

NOTE: The proposed language below can be used as guidance when both presplit, and production blasting are used in the project. THE PRODUCTION BLASTING

SECTION WILL BE HEAVILY TAILORED FOR THE PROJECT. THIS IS GENERAL TEXT THAT CAN BE ADJUSTED.

The drilling of presplit and production blastholes must be done one pattern at a time. Advanced drilling of adjacent presplit or production blastholes will not be permitted. The presplit wall conditions must be evaluated after each blast by both the Contractor and the Contracting Officer before the adjacent presplit blasting plan can be approved or drilled whenever possible.

The sequence of Production and Presplit blasting for a single blast must be as follows:

1. Submit an individual shot plan.
2. Individual shot plan approved, or revisions requested before approval.
3. Conduct drilling and submit Drilling Logs to Contracting Officer and Blaster-In-Charge.
4. Submit Individual Shot Report with Daily Drill logs, video recordings, and vibration and airblast monitoring results.
5. Conduct rock removal, scaling, and rock reinforcement Joint Evaluation of results by Contractor and Contracting Officer.
6. Submit an Individual Shot Plan for the subsequent blast in that work area.
7. Prepare enough planned blasting areas in advance to maintain the project schedule.

The presplit wall conditions must be evaluated by the Contractor and the Contracting Officer after the Contractor exposes a minimum of [2.4] meters [8] feet (vertical) of the wall. If [2.4] meters [8] feet of exposure is not sufficient to determine the condition of the presplit wall, reinforce the exposed wall as necessary, then expose a minimum additional [2.4] meters [8] feet (vertical) of wall. Repeat this downward to the toe of the presplit wall or until the Contracting Officer can determine if the presplit wall condition is adequate before approving the Individual Shot Plan for the adjacent presplit blast. Evaluate the effects of each production blast on the presplit and line drilled walls before submitting a blasting plan for the next blast.

The drilling tolerance must be evaluated and if drill tolerance exceeded the allowable tolerance then benches will be reduced in height to where the drilling tolerance was obtained on the subsequent blasts.

****

3.12 SUBDRILLING

****

NOTE: Subdrilling is typically not utilized in

underground blasting, however it may be a component required for shaft excavations for connecting surface blasting operations with the underground environment. If Section 31 23 06.00 BLASTING - SURFACE is being used, tailor that specification for the project or include language here.
****

[_____]

3.13 PRESPLITTING

****
NOTE: Presplitting is typically not utilized in underground blasting, however it may be a component required for shaft or portal excavation for surface blasting operations. If Section 31 23 06.00 BLASTING - SURFACE is being used, tailor that specification for the project or include language here. Precision presplitting may also be utilized in these situations. It is a form of presplitting with closer spaced holes with an even lighter explosive load.
****

[_____]

3.14 STEMMING

****
NOTE: Stemming may be used in shaft sinking operations using controlled blasting methods. Stemming is not typically used in tunnel heading advance. Depending on the geology of the project site this paragraph should be tailored to the project, for example in places with karst geologic conditions a more detailed procedure should be specified, or contractor required to submit a procedure for dealing with larger voids
****

Variations in rock hardness, structure, and other geological conditions encountered at depth will require the Contractor to stem the blast holes through soft weak areas, shears, open joints, and voids; therefore, close attention will be taken to classify the rock while drilling the blast holes. Where necessary, holes will be stemmed with dry, angular, well-graded crushed stone from .3-cm to 1-cm 1/8-inch to 3/8-inches in diameter without fines. The Blasting Consultant may submit a written, signed request to use drill cuttings for applications such as in presplit blastholes, must be submitted to the Contracting Officer for approval. Wet holes must not be stemmed with drill cuttings. No separate payment is made for stemming.

****
NOTE: Include tolerance for each proposed structure from the excavation lines. For example, "The tolerance for the perimeter walls is minus 100 cm/m 12 inches/foot from the design excavation line."
****

3.15 REQUIRED MUCKING

Required mucking operations should adhere to the details of the Muck Handling Plan. Prior to mucking operations, the Blaster-In-Charge and Tunneling Superintendent should perform an explosive safety check to ensure that all explosive materials have been detonated with the last tunnel heading advance. Undetonated explosive materials should be disposed of in advance of mucking operations in accordance with 29 CFR 1926-SUBPART U.

Muck and scaling follow each shot after firing for inspection of the heading, bottom of the shot lift, or foundation. Drilling and loading for the next shot must not be allowed before the required mucking of the previous shot. This requirement may be waived temporarily when in the opinion of the Contracting Officer, the Contractor's blasting is satisfactory (i.e., no backbreak, overbreak, vibration cracking, exceedance of vibration or airblast thresholds).

****

NOTE: The following paragraph should be tailored for the specific project, the GBR will provide recommendation on this distance. The Contracting Officer reserves the right to require additional ground support beyond that systematically required in the drawings.

****

Notwithstanding this requirement, the face must fully be dug out after every shot to a distance not less than [_____] meters [_____] feet prior to drilling and loading the next shot to allow inspection and evaluation of the shot face and allow for adjustments to the blast design for adjacent shots. Required mucking after each shot must be reinstated, when in the opinion of the Contracting Officer blasting is unsatisfactory. Excavation support deemed necessary by the Contractor[or Contracting Officer] for the safety of personnel in the excavation will be installed as the excavation proceeds. Blasting of the next heading advance or lift will not be permitted until the excavation has been accepted by the Contracting Officer.

The mucking system(s) must not restrict other operations including handling and erecting of initial support system materials.

For rail mucking systems, a track with ties and ballast or direct fixation system must be maintained for safe operation of trains. The head of the rails must not be submerged in water or covered with tunnel muck or other debris. Upon completion of excavation of the tunnel, remove all such trackwork prior to placement of final lining.

Submit for review at least [sixty (60)][______] days before the start of tunnel excavation the Muck Handling Plan, the methods, procedures, and details of the proposed mucking system. Submit for review the manufacturer's information for the proposed equipment including, but not limited to, specifications, drawings, details, maintenance procedures and requirements, operating procedures, and such other information as may be requested by the Contracting Officer.

3.16 SCALING

****

NOTE: Typically, a level of scaling is required for

each project to remove loose, unstable rock prior to mucking operations or prior to required bolting application or other methods of stabilization before carrying out additional excavation operations
****

A program of frequent inspection and scaling must be maintained in all portions of the tunnel. Immediately after each blast, the roof and walls of rock excavations must be inspected by experienced and suitably equipped scalers who must dislodge and scale down all loose and unstable rock. Scale loose and unstable or unsafe appearing material remaining on the tunnel periphery or rock slopes at the portal areas as the excavation proceeds. Perform scaling immediately after each blasting round. The removal must be accomplished by compressed air or water jetting, pry bars, rock picks, hoe-ramming, excavator bucket or other means as approved by the Contracting Officer. Drilling of the next blasting round will not be allowed until the current excavation has been properly scaled and all initial ground support has been installed as determined by the Contracting Officer. No separate payment will be made for scaling.

3.17 GROUTING

Conduct pre-excavation and post-construction grouting in accordance with Section 31 73 19 TUNNEL AND SHAFT GROUTING and as shown on the Contract Drawings.

If groundwater exceeds [____] liters per minute (lpm) gallons per minute (gpm) during probe hole advancement during tunnel construction the Contractor's Engineering Geologist or Geotechnical Engineer will submit a grouting and excavation plan or establish protocols for excavation if certain inflows exceed threshold lpm gpm values prior to tunnel excavation. The Contracting Officer must be informed of the implementation of the aforementioned grouting plan if groundwater inflows exceed excavation plan established inflow thresholds.

3.18 INITIAL SUPPORT

****
NOTE: A UFGS for TUNNEL EXAVATION SUPPORT is being developed. The designer will need to include Initial Support as listed here and Permanent support. Often the contractor will be responsible for designing their own initial ground support types, and may not be defined in the GBR or specs. Alternatively, the GBR may give conceptual initial support types (spacing, types, lengths, etc...) to bid on but give multiple support Types that may be applied along different alignment stationing depending on the geologic conditions. Tailor this section as appropriate.
****

3.18.1 Support Classes and Support Class Ranges

All stations indicating limits of typical support classes referenced herein or as shown on the Contract Drawings are only approximate and may vary due to the geological and hydrological conditions encountered in the field. Tunnel excavation support classes, as shown on the Contract Drawings, are the minimum to be installed and should be adjusted above and beyond the said minimum based on the actual ground conditions encountered and be determined in the field in consultation between Contractor and the Contracting Officer.

Each support class defines installation of a specific initial support system. The support elements are as specified in Section XX XX XX TUNNEL EXCAVATION SUPPORT and as shown on the Contract Drawings.

Initial support measures have been derived based on anticipated ground conditions and the need to provide stabilization of the tunnel openings for enlargements to cavern size openings under this Contract or future contracts.

Excavation and support measures delineated hereafter are typical and should be supplemented by additional initial support measures as required by ground conditions encountered or as directed by the Contracting Officer. To minimize ground movement; the initial support must be installed following each heading round blast and as close to the working face as practical in accordance with Section XX XX XX TUNNEL EXCAVATION SUPPORT.

****

NOTE: Verify that a Geotechnical Baseline Report has been prepared for the project and has been referenced in Section Related Attachments and Specifications.

****

a. Ground support guidelines for the tunnel excavation are shown on the Drawings and provided in the GBR. In addition to the ground support shown on the contract plans, the Contractor must install such ground support as necessary to always ensure the stability of the excavation and the safety of the construction personnel. Ground support installed by the Contractor without agreement or instruction from the Contracting Officer must be for the Contractors convenience and at the Contractor's expense.

b. The ground support must be installed as soon as practicable after tunnel excavation to minimize loosening or movement of the surrounding ground. The Contractor must be responsible for providing confirmation that the ground support system has produced a stable excavation. The support layouts shown on the contract drawings are a guide only and must be modified as required on the field during tunnel excavation.

c. The approval of the proposed excavation and support sequence by the Contracting Officer or failure to call attention upon improper or inadequate application of the related excavation sequence or tunnel support, pre-support, or face support or to require respective change must not relieve the Contractor of responsibility for the integrity of the tunnel support or the proper execution of the work.

[d. Lengths of excavation rounds shown on the contract drawings are maximum values and may have to be reduced due to the ground conditions encountered.

] e. Pneumatically projected concrete, either fiber reinforced Shotcrete or plain Shotcrete must comply with provisions set forth in Section 03 37 13 SHOTCRETE.

f. Rock reinforcement for tunnel excavation must comply with Section 31 68 13 SOIL AND ROCK ANCHORS.

g. Steel arch ribs, liner plates and additional ground support elements must comply with Section XX XX XX TUNNEL EXCAVATION SUPPORT.

3.19 EXCAVATION SEQUENCE FOR TUNNELS

Tunnel excavation must be accomplished in either a full face or top heading and bench format as indicated on the contract drawings. All initial support must be applied or installed prior to drilling subsequent rounds.

3.20 STABILIZATION TYPES

[_____] ground support categories have been developed for the stabilization of the main tunnels as defined in Section XX XX XX TUNNEL EXCAVATION SUPPORT.

An estimate has been made as to the lengths of each of the ground support categories required to stabilize the tunnel. The estimated lengths are shown on the contract drawings and presented in the Geotechnical Baseline Report (GBR). Actual stabilization requirements may vary from those estimated based on the geologic conditions encountered. In accordance with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS, the Contractor must be responsible for the safety of the work and for accomplishing the permanent stabilization of the tunnel opening.

3.21 EXCAVATION FOR TRENCHES AND SUMPS

Excavation for trenches and sumps must conform with Section 31 00 00 Earthwork and as shown on the contract drawings.

3.22 EXCESS EXCAVATION

****

NOTE: The type/class of shotcrete used to fill overbreak areas in the tunnel should be defined by the designer in early stages of the development of the bid documents. Similarly, the type of material used to fill overbreak in the tunnel invert must also be defined during early stages of the project design.

****

Excavation outside of the B-Line shown on the Drawings must be filled with Class I,II, III Shotcrete in accordance with Section 03 37 13 SHOTCRETE at the expense of the Contractor. Overbreak excavation in the tunnel invert must be filled with [compacted crushed rock, lean concrete].

3.23 TOLERANCES

The tunnels must be excavated in accordance with the A-line dimensions shown on the Drawings. No unexcavated rock or other material must protrude within the A-line.

3.24 CONTROL OF WATER

****

NOTE: This section will likely be incorporated into

a future UFGS for Tunnel Dewatering. This section will need to be heavily tailored for your project needs. Adhere to the current version of the ETL 1110-2-586 DEWATERING: Methods, Installation, and Performance Monitoring.
****

a. The Contractor is responsible for control of water in the tunnel during construction and must take all means necessary for such control. Control of water must include but not be limited to, furnishing, installing, operating, and maintaining pumps and other equipment including temporary measuring devices must as per (b) below, constructing temporary ditches and drains and keeping ditches and drains free to carry all water to sumps or other disposal areas; and disposal of all water, tested daily, draining or pumped from the tunnel. Disposal of water must conform to all applicable Federal, State, and local laws.

b. Automatic measuring devices must be furnished by the Contractor and must be employed to measure the flow rate of water coming out of the tunnel portals. Water piped in for construction operations and water exiting at the portals must be separately measured. The difference between the total flow rate out of and the total flow rate into the tunnel must be considered the rate of groundwater inflow to the tunnel. This rate of flow must be measured and recorded on a [daily basis][hourly basis] for information only.

c. Fissure grouting must mean grouting carried out in the rock mass surrounding the Underground Works to stem water flows emanating from fissures in the rock where if left un-stemmed the inflows could initiate instability. Pressure grouting must be carried out when instructed by the Contracting Officer and, where necessary the Contractor must carry out lugeon permeability tests to establish the extent of the fissure to delineate zones that will take grout. Further requirements are in SECTION 31 73 19 TUNNEL AND SHAFT GROUTING.

3.25 PERMANENT TUNNEL DRAINAGE

A drainage geotextile must be installed on the walls and crown of the excavation against the shotcreted surface at locations where actual flows of water are encountered and at other locations as shown on the Drawings or as may be required to the satisfaction of the Contracting Officer. The installation must comprise full coverage for ground support in accordance with Section XX XX XX TUNNEL EXCAVATION SUPPORT.

The drainage membrane must be fixed and sealed to the approval of the Contracting Officer so that the placing of shotcrete does not block or obstruct the drainage geotextile.

Geotextile must be installed in accordance with Section XX XX XX and Waterproof Membrane must be installed in accordance with Section XX XX XX.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 23 01 (February 2021)**
Change 1 - 11/21

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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Preparing Activity: USACE **New**

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References are in agreement with UMRL dated January 2025
****

SECTION 31 23 01

UNDERWATER BLASTING
02/21; CHG 1: 11/21

****
NOTE: This guide specification covers the requirements for underwater (from overwater vessels and platforms) blasting and blasting near a water body with adverse impacts for any use of blasting, most commonly submerged rock excavation and/or submerged structural demolition. If any of the materials being blasted and excavated are known to be, or during the contract period may possibly be, above water, also use Section 31 23 06.00 BLASTING - SURFACE. For projects on a naval facility, consult with local NAVFAC office, Naval Ordinance Safety and Security Activity (NOSSA), and NAVSEA on requirements. NAVSEA OP5 Ammunition and Explosive Safety Ashore manual dictates many of the requirements and NOSSA has the final determination on any blasting on a Navy installation above or underwater. Reference NAVSEA OP5 manual and contact local Explosives Safety Officer and Planner for the base prior to revising the specification. Overall NOSSA approval process can take 12-18 months depending on the level of approval required.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Consult with an office that has most recently completed a similar type of underwater or near-water blasting, while editing this section, to be appraised of recent, specific requirements, guidance, blasting developments or understandings for the subject project. Consult with, or have the specifications reviewed by, a subject matter expert in blasting for projects where blasting issues are particularly challenging or where protections to the public, structures/facilities, and/or natural resources will require project-specific designs or activities.

There are likely decisions and/or requirements of other agencies, the Safety Manual, and/or internal departments, which could have an influence upon a project's blasting specs. Some of these issues may be: navigational concerns and dealing with federal, state, and local jurisdictions and agencies; public use of nearby federal, state and/or local properties near the project; evaluations of acceptable vibrations and/or pressures affecting individuals or reaching nearby structures; natural resource (environmental) impact reviews, negotiations and/or requirements; cultural resource impact reviews for their considerations and/or requirements; constraints on the drilling or blasting procedures; pre-blast inspections; special studies to facilitate lower cost of the bids or to encourage more bid submissions; the acquisition strategy for the payment; and, other concerns specific to the project. If there are required natural resource protections, there will need to be resolutions concerning specialty firms or professions, including all of the appropriate references, designing the activity(-ies) for the project, and the Contractor's conduct of the activity(-ies), in full or part, or the Contractor's coordination with a government agency(-ies) or external office(s) conducting the activity(-ies).

The following information will be indicated on the project drawings:

1. Surface elevations, existing and new; Applicable datum for elevations and spatial coordinates will be stated clearly for reference.

2. All utilities, whether trenched, buried, at the surface or overhead to distances well beyond the project's limits;

3. Location and record of all soil and rock borings and test pits, including soil and rock

classifications and their properties, weathered rock, bit drops and voids, ground water observations, and topsoil thickness encountered in boring;

4. Location and limits of hard material, whether rock or concrete, or other building materials; with caveats as to uncertainty as appropriate;

5. Excavation or demolition limits with tolerances;

6. Details of any special limits that may require line drilling, presplitting, reduced subdrilling, and/or specialty blasting practices;

7. Location of borrow and disposal area, if located on Government property;

8. Hydrological, hydraulic and impoundment data, where applicable; and,

9. Details of all rights-of-way within the project boundaries.

****

1.1 SCOPE

The breakage of rock and hard/unyielding materials may be conducted by any means, unless otherwise stated herein. If the contractor elects to use drilling and blasting for breakage or displacement of any units, this entire section is applicable and covers activities associated with drilling and blasting for rock excavation at the surface. Contained herein are procedures for all activities relating to drilling; blasting and the transportation, storage and use of explosives; breakage and displacement of rock. The Contractor's blasting program and methods are those necessary to accomplish the excavation shown on the Contract drawings in accordance with the provisions specified herein. Control the quantity of explosives fired in all blasting to prevent injuries to persons and to avoid damage to all structures, properties, governmental and nonprofit entities, commerce and businesses, and natural resources and their habitat.

1.2 RELATED WORK SPECIFIED ELSEWHERE

****

NOTE: List any specifications that are related, such as Excavation, Earthwork, Demolition, Temporary Environmental Controls, Natural Resources, Shotcrete are typical specs related, depending on the project.

****

Section [_____]

1.3 REFERENCES

****

NOTE: Add and remove references as needed for the project. Reference the appropriate state and local laws, regulations and ordinances concerning blasting where the project is to occur.

This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISEE PSBS	(2017) ISEE Performance Specification for Blasting Seismographs

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 495	(2018) Explosives Materials Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements
EM 1110-2-3800	(2018) Engineering and Design -- Blasting for Rock Excavations

U.S. Code (USC)

16 USC 470	National Historic Preservation Act
16 USC 668	Bald and Golden Eagle Protection Act
16 USC 1361	Marine Mammal Protection Act
16 USC 1531	Endangered Species Act
16 USC 1801	Magnuson-Stevens Act
33 USC 1251	Clean Water Act
33 USC 1401	Marine Protection, Research and Sanctuaries Act
42 USC 4321	National Environmental Policy Act

42 USC 7401	Clean Air Act

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 177	Carriage by Public Highway

1.4 DEFINITIONS

****

NOTE: Delete definitions that will not be used in the specification text for a specific project. A complete list of blasting definitions can be found in the GLOSSARY of the EM 1110-2-3800. Recommend only using definitions not already in GLOSSARY in the EM and those definitions to further stipulate the work on the specific project in the specification. It may be necessary to add definitions depending on what the Earthwork and/or Excavation specifications for the project have terms for Rock, Weathered Rock, Sound Rock, Voids, Sediment, etc.

****

1.4.1 Controlled Blasting

Controlled blasting refers to blasting techniques used to better distribute the explosive charge to minimize adverse impacts. For underwater blasting, adverse impacts may be cited for the public's and contracted personnel's safety, lessening the fracturing of the rock being blasted, surrounding facilities' protection, and the avoidance of impacting natural resources or their habitats. Controlled blasting techniques must be deployed, such as careful loading to the pattern's design using the drilling log for each shot hole, stemming effectively the top of firm rock and any soft zones or voids, carefully observing maximum charge weight per delay, using delays between holes and rows of 25 milliseconds or greater, and avoiding rifling plumes by proper blasting techniques.

1.4.2 Flyrock

****

NOTE: Choose the distances for the project, the typical values are listed. Edit definition as needed for project site.

****

Flyrock is one of the three primary adverse impacts from blasting. Flyrock is defined as any airborne projectile flying the lesser distance of either 60 m 200 ft horizontally from the shot pattern or one-half the distance between the shot pattern and the Contractor work limits, whichever distance is the lesser.

1.4.3 Green Concrete

****

NOTE: If no concrete placement is expected on the project then delete this definition. If concrete placements will occur when blasting operation is

ongoing, further define green concrete here and include appropriate thresholds and monitoring for the green concrete in Part 3. There needs to be limits on vibrations when there is green concrete because of the strength loss due to vibrations while curing. Involve the Structural Engineer project development team members in these determinations.
****

Green concrete is recently placed concrete that has initiated setting but may have substantial strength reduction from strong vibrations before the concrete has fully cured. Green concrete also includes the materials of shotcrete or cementitious grouts. Each Individual Shot Plan is required to consider vibrations emanating from its blast pattern reaching the location of the reported newly placed concrete to remain below allowable vibration levels depending upon the age of the concrete. Note the paragraph GREEN CONCRETE.

1.4.4 Pressure Waves

Pressure Waves, both Airblast (or noise) and Underwater Pressure Waves, are one of the three, primary adverse impacts from blasting. Airblast and Underwater Pressure Waves are solely compression waves passing through the air or water, respectively. Their units of measure may be in terms of pressure, Pascals (Pa) or pounds per square inch (psi), or in terms of the logarithmic scale, Decibels (dB). Note that pressures in dB have different reference values for Airblast and Underwater Pressure Waves, so the pressure waves through air are of a lower magnitude than pressure waves through water with the same numeric dB value.

1.4.5 Rock, Hard/Unyielding Material, Weathered Rock, Voids (Bit Drops), Sediment

1.4.5.1 Rock

Rock is natural solid, interlocking material with firmly cemented, laminated, and crystalline fabric, foliated masses or conglomerate deposits, none of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of high-energy mechanical devices; and, so classified for this project as submerged large boulders, [masonry, or concrete other than pavement exceeding the capacity of the awarded contractor's underwater excavation capacity,] which may be the minimum volume of 0.38 cubic meter 0.50 cubic yard.

1.4.5.2 Hard/Unyielding Material

****
NOTE: Depending upon the acquisition strategy and measurement and payment, hard materials should typically be included in lump sum payment.
****

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 25.4 mm 1.0 inch in any dimension. These materials usually require the use of heavy excavation equipment or high-energy mechanical devices for breakage or displacement to remove the materials .

1.4.5.3 Weathered Rock

****

NOTE: Weather rock and voids are particularly important for the percussion drilling's logging to properly stem the zone where the weather rock and bit-drops are encountered.

****

Weathered rock, for underwater percussion-drilling logging, is any original rock unit that has been altered to a weaker state that will not retain stemming when explosives are loaded into that material.

1.4.5.4 Voids

Voids, for underwater percussion-drilling logging, is any rapid bit drop with little or no resistance to the downward drilling pressure. Voids may be water or sediment filled, which may possibly determine that the original rock unit has been altered to a weaker state that will not retain the gaseous detonation products when the explosives are shot.

1.4.5.5 Sediment

Sediment is both: the loose to firm material that may be dredged above the surface of weathered or firm rock, which cannot be easily dredged; and the infill of voids as solid particles.

1.4.6 Unstable Material

Unstable materials are loose, submerged sediment that are easily displaced by water flow or turbulence and by vibrations or incidental impact.

1.4.7 Vibrations

Vibrations are one of the three, primary adverse impacts from blasting. Vibrations are the result of various wave forms emanating from the detonation or deflagration of ignited materials from a shot pattern. Peak particle velocity (PPV) is defined as the maximum absolute value among the three ground vibration velocities measured in the vertical, longitudinal, and transverse directions over a time of a record. Peak, total vector-sum particle velocity is the peak value over the full, time history of each time-unit's value of the square-root sum of the squared, component velocities. Velocity units are expressed in centimeters per second (cps) or inches per second (ips).

1.5 SYSTEM DESCRIPTION

Boring logs are [shown on the drawings] [appended to the SPECIAL CONTRACT REQUIREMENTS or GDR]. Bottom-sounding surveys are provided as contoured maps, as precise to the vertical and lateral tolerance on the date of the survey.

The subsoil investigation report and samples of materials taken from subsurface investigations may be examined at [_____]. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.5.1 Classification of Excavation

****

NOTE: Inapplicable portions will be deleted. Other classifications of excavation may be utilized as required. For underwater blasting, resolve whether there is any potential for anthropogenic materials, such as concrete or pavement, or lost shipping debris that must be included in paragraph DEFINITIONS above and paragraph CLASSIFICATIONS herein.

If no consideration will be given to the nature of the materials, then all excavation will be designated as unclassified excavation. Otherwise, finish the specified excavation on a classified basis, in accordance with the following designations and classifications.

****

1.5.1.1 Common Submerged Excavation

Include common excavation with the satisfactory removal and disposal of all materials not classified as rock or hard/unyielding materials. Include the removal of any concrete or masonry structures or pavements that may be encountered in the submerged excavation zone under this classification.

1.5.1.2 Rock Excavation

Submit notification of encountering rock and/ or hard/unyielding materials in the project. Include rock excavation with blasting, excavating, grading, disposing of material classified as rock, and the satisfactory removal and disposal of boulders 1/2 cubic meter yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; firmly cemented conglomerate deposits possessing the characteristics of solid rock impossible to remove without systematic drilling and blasting; and hard materials as defined herein [requires inclusion of appropriate definition of hard materials for the project].

If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may not be classified as rock excavation, uncover such material, and notify the Contracting Officer. Do not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

1.5.2 Blasting

Drilling and blasting are not required activities for breakage of materials to allow excavation. Should the Contractor elect to conduct drilling and blasting, the Contractor must perform the blasting in accordance with this section. The Contractor is responsible for all claims for damages and injuries caused by, or arising out of, blasting activities and its adverse impacts, as noted in the FAR.

Perform blasting in accordance with EM 385-1-1 and in conformance with all Federal, State, and local laws, regulations, and ordinances. Submit notice 30 days prior to starting work. Submit a Master Blasting Plan for approval, prepared and signed by the Blasting Specialist that includes: a listing of all federal, state and local regulations and ordinances to conduct blasting at the project; the support documentation and certifications for all proposed blasting personnel; information and data sheets for all the explosives to be used at the project; the design approach to blasting; outlines of all required reports and formats for all the forms of the respective reports; and, the procedures to control all the adverse effects of blasting. Use the non-electric blasting caps for all underwater blasting. Obtain written approval prior to performing any blasting and notify the Contracting Officer 24 hours prior to blasting. Include provisions for storing, handling, and transporting explosives as well as for the blasting operations in the plan.

1.6 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Master Blasting Plan; G, SO

Blasting Safety Plan; G, SO

Navigation Control Plan; G, AO

Test-Blast Plan; G, AO

Certified Marine Survey; G, AO

Pre-Blast Surveys; G, [_____]

Blasting Consultant's Qualifications; G, [_____]

Blasting Specialist's Qualifications; G, [_____]

Blaster-In-Charge Qualifications; G, [_____]

Blaster Qualifications; G, [_____]

Blasting Administrator's Qualifications; G, [_____]

Vibration Monitoring Specialty Firm; G, [_____]

Public Notice Of Blasting Operations; G, [_____]

Structural Inspection/Evaluation Specialist; G, [_____]

Natural Resource Subcontractor; G, [_____]

SD-03 Product Data

Explosives and Blasting Equipment; G, [_____]

Lightning Detection Device; G, [_____]

Seismographs; G, [_____]

SD-05 Design Data

Individual Shot Plan

SD-06 Test Reports

Test-Blast Evaluation Report

Individual Shot Reports; G, [_____]

Drilling Logs

Individual Shot Vibration Monitoring Report

Individual Shot Videos

Daily Blasting And Removal Log

Blasting Consultant's Report

Post-Blast Surveys; G, [_____]

Reports of Required Safety, Protective, and Natural Resource Programs

SD-07 Certificates

Blasting Licenses and Credentials; G, [_____]

Seismic Specialist; G, [_____]

Seismograph Technicians; G, [_____]

Magazine Keeper; G, [_____]

1.7 COORDINATION

****

NOTE: The following paragraph can be used if working with multiple stakeholders/owners.

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Blasting will be in the vicinity of the [existing lock, railroad, and highway, and river barge, train, highway traffic, utilities and businesses] and their operation will not be impeded or delayed beyond that which has been coordinated with [TVA, U.S. Coast Guard, U.S. Army Corps of Engineers - [_____] District, [_____] environmental or natural resources offices, [_state_] Department of Transportation, [_____], [_____] Railroad, regional or local utilities, and/private businesses]. A coordination plan, with the appropriate authorities that mitigates [navigation and traffic delays], in the Master Blasting Plan.

Coordinate, through the Contracting Officer, with other Contractors working onsite to minimize work stoppages during blasting.

1.8 LIABILITY

Compliance with provisions in the contract will not relieve the Contractor of their responsibility for any damages or injuries caused by, related to, or arising out of blasting or associated blasting activities. Notwithstanding federal, state, and local laws, regulations and ordinances, the Contractor assumes all liability and hold and save the Government, its agents, officers, and employees harmless for any and all claims for personal injuries, property damage, or other claims arising out of or in connection with the handling of explosives or blasting under this contract.

PART 2 PRODUCTS

2.1 TRANSPORTATION, STORAGE AND USE OF EXPLOSIVES

****

NOTE: Confirm and follow federal, state, and local regulations and guidance on the transport, storage and use of all Explosives. State and local agencies and/or authorities may not easily allow the receipt

of Explosives in a timely manner. State and local agencies and/or authorities may have specific reporting, certifications, adverse impact concerns, or distance regulations from the blast zone to private properties governing the use of Explosives. The Agency/Service may wish to allow storage of Explosives on federal premises. The winning contractor should independently assess and cite in the Master Blasting Plan all federal, state, and local laws, regulations, ordinances, or authorities that impact the transportation and storage of Explosives. Consider requiring cartridge explosives for water sensitive explosive materials or allowing the use of those bulk explosive that are not water sensitive, i.e., "Bulk explosives such as ammonium nitrate and fuel oil (ANFO) or bulk emulsion or emulsion blends will not be permitted."

****

2.1.1 General

Store, transport, handle, use, and otherwise secure explosives in accordance with best practices as approved by the Contracting Officer and in accordance with all Federal, State and Local laws and regulations. Comply with all special rules and regulations that may be made by the authorities having jurisdiction, or by the Contracting Officer, regarding construction of, and storage in magazines and precautions in blasting. Times and imposed restrictions concerning the use of explosives must be conducted in accordance with local, State, and Federal regulations. The Contracting Officer reserves the right to establish restrictions or time windows when blasting will not be allowed.

2.1.2 Blasting Products

2.1.2.1 Requirements

All explosive materials to be used on site must be proposed for approval in the Master Blasting Plan. Cartridged and bulk explosives may be used in different sections of the project. All explosive materials used on the project must be six months or less of age or no older than one half the shelf life shown on the explosives manufacturer's technical data sheet for that product. Millisecond delay, shock-tube initiators, must be used as the initiation system. To ensure the accuracy of firing times of blasting caps, it is required that each cap period come from one lot number. Mixing of lot numbers for any single cap delay period within a shot pattern is strictly prohibited. For underwater blasting's ability to displace rock against the water load, the minimum delay both between shot holes and shot rows will be 25 milliseconds.

2.1.2.2 Prohibited Explosive Materials

Explosives that do not meet the manufacturer's specifications must not be used. When, in the opinion of the Contracting Officer, any explosive materials is either of excessive age or appears to be in a deteriorated condition, all work must cease until the products age and quality can be determined. Blasting products without date batch codes will not be permitted on site. The Contracting Officer may require any explosive materials to be tested by an independent organization to determine its performance as compared to the manufacturer's data sheet. If explosive materials' performance or composition deviates by more than 10 percent in any manner from the manufacturer's data sheet, that lot number will be rejected. The Contractor is responsible for any required testing and no additional compensation will be made for any product testing directed by the Contracting Officer.

Bulk explosives, which are water sensitive, are strictly prohibited.

Detonation Cord is strictly prohibited for initiation transmission through the air and water to the shot holes. An approved non-electric shock tubing, proposed in the Master Blasting Plan, must be used to transmit the firing initiation to each shot hole. Detonation cord may be used within the shot hole by proper connection to the shock tubing beneath the highest elevation of firm-rock stemming.

2.1.3 Magazines

****

NOTE: Determine whether not allowing onsite explosive storage magazines will be an adverse impact that will limit bidders. If the project has sufficient area of restricted open property, explosive magazines may be allowed onsite. For example, a rural federal project may have sufficient property to accommodate the stand-off distances from the magazine to other residential or essential structures to easily allow an onsite magazine, especially if the adjacent non-federal property owners might not wish to have a magazine on their property. Recognize that there will be at least two daily trips with appropriate explosive-transport vehicles between the magazine and the coming shot pattern. Delete the first paragraph, "No explosives … explosive magazines.", if onsite magazines will be allowed.

****

[No explosives will be stored onsite. There must be no permanent explosive storage or overnight explosive storage onsite. The Contractor will either obtain daily deliveries of the explosives to the site from a manufacturer or supplier or secure offsite explosive magazines.

] When the Contractor will maintain the explosive magazines, obtain all necessary Federal and State magazine permits for the magazines. Magazines must be located at safe distances as defined by the Bureau of Alcohol, Tobacco and Firearms (ATF), in addition to the State of [_____]'s requirements. Procure off-site explosive storage and expect to transport the daily volume of explosives to the site. Secure a permit to transport explosives from the State of [_____]'s Highway Patrol when and if required, and transport explosives in accordance with 49 CFR 177 when carried on public highways.

The Contractor must have two temporary magazines on board the drilling and loading barge of sufficient volume to hold the largest day's use of explosives and initiators separately. These temporary magazines must meet all ATF requirements and all regulations and ordinances of state and local government. No explosives may remain overnight in the temporary magazines. A daily-use log of explosives delivered, loaded by shot hole through the day, and removed at the last shift must account for the use of all explosives.

2.1.4 Magazine Keeper

Each magazine keeper must be experienced and familiar with the laws and general practices concerning the handling, care, use, and storage of explosives and detonators. The magazine keeper is responsible for maintaining a cleared area around each magazine. The magazine keeper will not be required to perform any duties that will in any way interfere with their duties as magazine keeper and being physically present at the magazines for every entry to the magazines for delivery, disbursement, and review of explosives at the magazines.

If explosives are delivered and returned daily from the manufacturer or supplier to the project, the driver of the truck will serve as the magazine keeper.

PART 3 EXECUTION

3.1 GENERAL EXCAVATION AND REMOVAL

****

NOTE: Delete inapplicable sections. The coordination with other federal, state, and local jurisdictions and agencies, the public, and private entities must be completely resolved before finalizing the specifications.

While it is not typical to have low tolerances for the horizontal variation of submerged walls or for the vertical variation of submerged pay grades, some projects may require limited control of the walls and grades in underwater blasting. Before resolving the project's underwater tolerances, determine an easy and effective means to survey the submerged walls and grades, and further assess to what precision such surveys may accurately estimate horizontal and vertical variations over short distances.

Presplitting would be an unusual requirement for underwater blasting, even in shallow water, because of the accuracy of knowing the exact horizontal location of the Top of Firm Rock. In projects where controlled blasting techniques are required to produce final walls which require presplit blasting, only explosives designed for this application must be allowed.

Specific underwater blasting impacts' requirements, negotiated or specified with environmental agencies and offices, must be fully determined, and in some cases designed, for the project before the specs may be finalized. Some requirements, like seasonal restrictions on underwater blasting or the prohibition of detonation cord in the open air and water, may easily be included. Other requirements, such as the required use of a bubble curtain, should be avoided if possible, because of its difficulty in

its proper use, maintenance, and storage, but when required will need to be designed by an appropriate experienced professional for inclusion of the designed element in the specifications.

****

Perform the excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Dredging, breakage, displacement, and excavation of all the materials will be accomplished by appropriate techniques and with special care, such that no individuals, cited natural resources, structures, navigation and other sensitive features, and activities suffer any adverse effects from blasting. Perform the submerged removal in accordance with the typical sections shown and the tolerances specified in paragraph SUBMERGED MATERIAL DISPOSAL.

The Contractor's blasting program and methods will be those controlled blasting techniques necessary to accomplish the excavation shown on the contract drawings in accordance with the procedures specified in this section. Make necessary plans, examinations, surveys, and test blasts to determine the quantity of explosives that can be fired to accomplish the breakage (or displacement) and removal of materials without injuries to persons, and aquatic wildlife (or other natural resources), or damage to personal or public property. Test blasts will be performed to slowly build to acceptable loading and timing of production shot patterns, to verify that the monitoring network performs as designed, to begin to assemble monitoring data collection, and to resolve that the submerged material is adequately broken or displaced for removal. Use the test blasting results to optimize remainder of work. The blasting program must abide by all applicable Federal, state, and local laws, regulations, and ordinances established for the project's location.

Process any and all claims of public entities, companies and private citizens arising from the transportation, storage, and use of explosives promptly in an acceptable time period set by the Contracting Officer Representative (COR); in particular, all injury and property damage claims must be acknowledged by the Contractor, or their representative, and be submitted immediately as directed by the COR to the Contracting Officer providing name of claimant, location, time and description of alleged injury, and damage, and estimated value. The claimed injury or damage will be evaluated and inspected by an appropriate specialist within 48 hours following initial notification, and processed to a conclusion (honored, denied, or compromised) within 90 days after cessation of all blasting on the contract; but, in no case will the claims remain unresolved for a period exceeding 6 months (180 calendar days). Submit evaluation and inspection results and actions taken to the Contracting Officer on a weekly basis.

3.1.1 Removal of Submerged Materials

****

NOTE: Determine whether varied submerged materials being excavated may be placed in other submerged low-elevation zones that allows undifferentiated placement of the excavated volumes to the pay grade. There may be requirements to place certain materials in specific locations by the submerged material's type. Different projects may require disposal only above water or only below water.

****

3.1.1.1 Sediment Within the Project Limits for Removal Displacement

Sediment vertically above the project limits for removal may be excavated, removed, or displaced by any means, including dredging, prior to action upon deeper materials. Sediment may be left in place for removal by mechanical means after the breakage of deeper materials allows those materials to be removed. Unless the Disposal of Materials requires differentiation of materials below or above the water surface, the sediment may be removed and placed in the disposal zone before or after the excavation of deeper materials.

3.1.1.2 Breakage of Rock and Hard/Unyielding Materials for Excavation and Disposal

****

NOTE: Determine whether the sentence below, "The lateral dimensions … azimuthal direction." is required. If it is necessary for specific project, determine the lateral distances the azimuthal directions that meet the project's needs. If it is not necessary for specific project, delete the sentence.

****

Blasting may be conducted to break or displace the rock and hard/underlying materials into sizes that may be removed by dredging or excavation equipment. Test blasting will be conducted to determine the parameters for the following production blasting. Care must be taken to prevent damage to any of the remaining specified materials, features or structures noted in the drawings; and avoid adverse effects from blasting to personnel, the public, natural resources, structures, and features. The lateral dimensions of any blast plan must not exceed [_____] m [_____] ft horizontally in any azimuthal direction. The Contractor must curtail blasting activities in designated areas when, in the opinion of the Contracting Officer, damage to in-place units or adverse impacts may have occurred. Blasting will be curtailed in these designated areas until both remediation, as directed by the Contracting Officer, has been completed, and the Contractor has resolved a means to conduct the blasting without the damage or adverse impacts.

3.1.2 Disposal of Materials Within the Project Limits

****

NOTE: The Guide Spec presumes that all dredged and/or excavated materials below the water surface may be placed below a specified elevation(s) in submerged, low-elevation zones already surveyed and provided in drawings. If any materials must be removed from the project area and/or will be placed by material type and/or within certain tolerances, compaction requirements and/or by having been dewatered, additional disposal sections and references to those locations of placement or disposal will be required to be added.

****

Transport and place all dredged, displaced, or excavated materials within the limits of the disposal zones below the specified elevations, according to the requirements specified in paragraph SUBMERGED MATERIAL DISPOSAL.

3.2 SAFETY PROCEDURES

3.2.1 General

Ensure all work completed under this Contract is executed safely. Follow the safety procedures outlined in EM 385-1-1. EM 385-1-1 will govern all activity unless more stringent safety requirements are specified in other applicable Federal, State, and local laws, regulations, and ordinances.

****

NOTE: Additional narrative may need to be added on coordination with other federal, state, or local entities before acceptance of the Master Blasting Plan for critical items and required limitations, which have been included within paragraphs SAFETY PROCEDURES, OPERATIONAL REQUIREMENTS, and IMPACT MONITORING. There may be compliance obligations for the Contractor, the Contracting Officer and/or other entities regarding those critical items and required limitations. For example, if a Marine Mammal Watch Program is required to avoid blasting while marine mammals are near the loaded, underwater shot array, then the CO, the Contractor and the entity requiring the watch program should schedule and meet both to discuss and to have a mutual understanding relative to project of the Marine Mammal Protection Plan.

****

3.2.2 Weekly Coordination Meeting

Coordinate all blasting schedules with the Resident Engineer's Office and Contracting Officer at least one week in advance and hold a weekly blasting coordination meeting with the Resident Office. Provide an agenda for the blasting coordination meeting that lists project's prior week's shots, the forecasted shot schedule, and displays a scale site plan showing the locations of the schedule shots. The Blasting Specialist, Blaster in Charge, and Seismic Specialist are required to participate in discussion of agenda items and lessons learned.

3.2.3 Public Notice of Blasting Operations

Thirty days, prior to any blasting operations, prepare and submit to the Contracting Officer a public government notification letter of the proposed blasting activities. The Government will distribute copies of this notification letter by certified mail to local governments, law enforcement, public utilities, public users of project recreational facilities, and residents and commercial interests located within 0.8 kilometers one half mile of the blast site. This notification letter must contain at minimum:

a. Name, address, telephone number and e-mail address of the Contractor;

b. Plan maps identifying the specific areas in which blasting will take place, and major and secondary roads, geographic features and auxiliary features;

c. Duration of blasting activities, and on which days of the week and hours of the day that blasts can be expected to occur;

d. Vehicular and pedestrian traffic control measures to be taken;

e. Methods to limit access to the blasting area; and,

f. Types, patterns and duration of audible warning and all-clear signals to be used before and after blasting.

3.2.4 Public Meetings

****

NOTE: Communicate with the project manager and all stakeholders about whether specific requirements for a meeting or multiple meetings are needed. It may be necessary to advertise the meeting in a local newspaper and specify the meeting room capacity.

****

Fifteen calendar days prior to any blasting operations, provide the approved Blasting Specialist, Blasting Consultant, and Seismic Specialist to attend a public-relations meeting to be conducted on an evening to be determined by the Contracting Officer. This meeting will inform the public about the anticipated blasting operations. The Blasting Specialist, Blasting Consultant, and Seismic Specialist must each make a short presentation of blasting operations and answer any questions pertaining to public concerns dealing with the blasting operations, the magnitude of vibrations, airblast and potential for flyrock that may impact the public, and the project's required natural resource activities. Distribute points of contact should the public and local entities have an event of concern related to the blasting program.

3.2.5 Warnings and Signals

Establish a method of warning all employees on the job site of an impending blast following the guidance of EM 385-1-1. The signals must consist of a five-minute warning signal to notify all in the area that a blast will be initiated in five minutes. A second warning signal must be sounded one-minute before the blast. After the blast is over, sound an all-clear signal, once the blast site has been inspected for misfires by the Blaster in Charge to notify all in the area that the blasting operation is finished. No personnel other than the Blaster in Charge must enter the blast area, until it has been determined to be all clear.

3.2.6 Notification to Navigation

****

NOTE: Use the following paragraphs when working in or near navigable waters or navigation lock. The notice may need to be coordinated with multiple federal, state, or local agencies, which could include the U.S. Coast Guard, a Corps of Engineers' District Office, an entity of a District Office (e.g., a Lock), a state agency, a local agency for a harbor or its police or fire department, and other offices.

****

Notify the [_____] a minimum of [14] [_____] calendar days prior to the commencement of blasting operations to allow for sufficient time to send out navigation notices. The information to be supplied will include the dates and time window of blasting operations.

3.2.7 Navigation Control During Drilling, Loading, and Blasting Operations

****

NOTE: Determine the number of patrol vessels required for the specific project. At least one patrol vessel should be required unless the AO totally controls the water surface far beyond the size of the excavation zone. Correct the second and third paragraphs with such determination for the specific project.

Placement of buoys in the third paragraph is also project specific. Resolve whether buoys are required and the distance beyond the shot pattern or excavation zone that the buoys should be positioned.

****

Notify the Coast Guard 24 hours prior to a scheduled blast and 2 hours prior to the actual blast's initiation. Contact should be made with: US Coast Guard's contact, whose name and an alternate's name will be provided at time of contract award.

Operate [two] patrol vessel[s] during blasting operations equipped with a visible yellow flashing light, audible horn, and radio with a hailer, whose sole function will be to monitor and maintain security in the blast area. Use patrol vessels during all blasting operations. Inspect and insure there is no vessel traffic within the work area prior to the firing of the blasting caps and until such time as the Contractor has sounded the "All-Clear Signal".

Establish and maintain a warning system as required by EM 385-1-1 and as stated in paragraph WARNINGS AND SIGNALS. Equip and maintain the floating plant with radio equipment capable of communications with the Coast Guard. The Contractor, after each blast, upon inspecting the area, notify the Coast Guard and Contracting Officer if all clear or misfire is noted. Buoy the area with warning signs. The warning signs are to be legible from a distance of [_____] m [_____] ft and contain the message "DANGER - EXPLOSIVES IN USE" visible on either side of the sign. Station patrol vessels at the drill barge and remain in the blasting area during all blasting operations. Land oriented access control and visual observation locations will be determined and approved by the Contracting Officer.

3.2.8 Lightning Detection Device

Furnish, maintain, and operate lightning detection equipment during the entire period of blasting operations and during the periods that explosives are used at the site. Equipment must provide real time audio and visual alarm/signal and detection based on combined detection of electromagnetic, electrostatic, light wave spectral and audio disturbances, or a commercial service based on these, as a minimum for approved. Equipment must be capable of detecting lightning within 40 kilometers 25 miles as a minimum of the blast area. Provide the equipment after approval. When and where the lightning detection device indicates a blasting hazard potential, immediately evacuate personnel from all areas where drilling is being conducted or explosives are present. When a lightning detector indicates a blasting hazard, perform the following actions.

a. Clear the blasting area of all personnel. Place guards at all access points to the blast area.

b. Immediately notify the Contracting Officer of the potential hazards and precautions being taken.

c. Terminate the loading of holes and secure the unused explosives to an approved location.

d. When the hazard dissipates, inform the Contracting Officer that the drilling and loading of holes will continue.

3.2.9 Drill-Boat or Barge Safety

All onboard day magazines must be permanently secured to the deck as required by the Coast Guard. No high explosives will be stored on the boat or barge deck in the open except for the one case that is to be loaded immediately into the shot holes. Any explosives remaining on deck must be returned to the day magazine prior to the firing of any blast. The firing line reel or spool will be mounted on the rig in a manner that it cannot be lost overboard. An approved blasting machine will be used for detonation regardless of the number of caps used. No electric blasting system can be used. The amount of explosives permitted aboard the drill boat or barge at any one time will be subject to the approval of the Contracting Officer, but in no case will such amount exceed the amount permitted by appropriate codes and regulations.

Make necessary arrangements to prevent damage to any vessel, moored or underway, building or structure and to preserve the crew or occupants thereon from exposure to injury because of the Contractor's operations. Automatic fire extinguishers of an appropriate type must be installed on air compressors and in all engine compartments abroad vessels (drill boats, barges) where explosives are stored, handled, and used. The Contracting Officer may require additional arrangements. Have a Certified Marine Survey of all floating plant proposed for underwater blasting work on this contract performed prior to starting any work and provide the results to the Contracting Officer. Remote fuel shut-offs and fire-signaling devices must be provided aboard the drill boat.

3.2.10 Inspection for the All-Clear Signal

The Blaster in Charge must thoroughly inspect the entire blast area for a minimum of five minutes following a blast. The five-minute delay between blasting and commencing work is needed to ensure that no misfires have occurred. Details of the misfire procedures were provided in the Blasting Safety Plan, including the distance of the restricted area when a misfire is discovered.

3.2.10.1 Check for Misfires

During the five-minute delay, it is the responsibility of the Blaster in Charge to enter and inspect the shot-pattern area and verify for all loaded shot holes that all explosives have been detonated.

3.2.10.2 Misfire-Handling Procedures

Should an inspection indicate that complete detonation of all charges did not occur, only critical personnel involved in the blasting operation or excavation of the unexploded material are allowed within the established shot-pattern area. Restrict the site until the Blaster in Charge or the Blasting Specialist indicate the site is safe. If the misfire poses problems that cannot be safely corrected by the Blaster in Charge or the Blasting Specialist, a consultant, or an explosives company representative skilled in correcting misfires must be called to resolve the problem. Provide within 60 minutes of the recognition of a misfire, a notice to the Contracting Officer and all applicable agencies and offices for public safety. Compliance with this or any other provision in the Contract will not relieve the Contractor of responsibility for any damages or injuries caused by, related to, or arising out of blasting or associated blasting activities.

Provide the details of the misfire and the correction measures in the Individual Shot Report for shot with the misfire to the Contracting Officer and the emailed addressees the next business day.

3.2.11 Natural Resource Protection (Environmental Resource Protection)

****

NOTE: During the planning process for projects requiring underwater blasting, the agency/Service responsible for construction would have conducted an environmental impact analysis of the project, including blasting impacts, and coordinated with applicable Federal and state Natural Resource agencies, under the authorities of a number of environmental laws. For example, an Environmental Assessment (EA) or Environmental Impact Statement (EIS) would have been completed per the requirements of the National Environmental Policy Act. Often mitigation is suggested or required by the reviewing agencies. These mitigation techniques could be as simple as the design of well stemmed shot-holes to reduce pressure entering the water column or the use of small repelling charges to scare fish from the blasting zone. The responsible, reviewing agencies could also require extensive planning and design for such mitigation techniques as post-blast monitoring studies or the design and use of an effective bubble curtain system to reduce blast pressures. If marine mammals are in the project area, the Marine Mammal Act comes into play. Depending on the project, the National Marine Fisheries Service (NMFS) has required the use of Marine Mammal Watch Programs to ensure that marine mammals are not within a specified distance from the blast prior to detonation. These distances (in the form of pressure limits) are often provided by the NMFS and the monitoring is conducted by specialized companies with specialists in the identification of marine mammals. The NMFS has also required near-field pressure monitoring to confirm Watch Program distances and far-field acoustic monitoring to ensure that sound levels are below levels causing

auditory damage. The major environmental laws that may require mitigation or place restrictions on project blasting are listed under paragraph REFERENCES. (If there are no requirements under an environmental law, then the no mitigation would be required under that law and the reference should be deleted). However, additional Federal and state laws may also apply, depending on the project. Coordination with other federal, state, and local agencies and jurisdictions, the public, and private entities must be completely resolved before finalizing the Specifications. It is essential that the agency/service person, using these Guide Specifications to prepare Plans and Specifications. coordinate with the planners and environmental compliance specialists within their agency/Service to ensure that all the blasting restrictions and mitigation measures are incorporated into the Plans and Specifications. Failure to comply with the requirements of Federal or state laws and regulations could result in project delays or stoppages.

****

The Contractor is required to utilize the following to avoid and minimize techniques designed to mitigate the impacts of underwater blasting that have been developed, in coordination with other Federal agencies, in compliance with the federal, state, and local environmental laws and regulations and with applicable regulations and requirements of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. All activities requiring the Contractors' action or coordination are included in paragraph NATURAL RESOURCE ASSESSMENTS, Mitigation and Monitoring. The Contractor has full responsibility for not violating all the mitigation requirements. Associated fines for violations will be borne by the Contractor.

[3.2.11.1 National Environmental Policy Act

Write detailed description of work to be performed by the Contractor here. If there is no required work under 42 USC 4321 then the section should be deleted and renumbered.

][3.2.11.2 Endangered Species Act

Write detailed description of work to be performed by the Contractor here. If there is no required work under 16 USC 1531 then the section should be deleted and renumbered.

][3.2.11.3 Marine Mammal Protection Act

Write detailed description of work to be performed by the Contractor here. If there is no required work under 16 USC 1361 then the section should be deleted and renumbered.

][3.2.11.4 Bald and Golden Eagle Protection Act

Write detailed description of work to be performed by the Contractor here. If there is no required work under 16 USC 668 then the section should be deleted and renumbered.

][3.2.11.5 Marine Protection, Research and Sanctuaries Act

Write detailed description of work to be performed by the Contractor here. If there is no required work under 33 USC 1401 then the section should be deleted and renumbered.

][3.2.11.6 Magnuson-Stevens Act

Write detailed description of work to be performed by the Contractor here. If there is no required work under 16 USC 1801 then the section should be deleted and renumbered.

][3.2.11.7 Clean Air Act

Write detailed description of work to be performed by the Contractor here. If there is no required work under 42 USC 7401 then the section should be deleted and renumbered.

][3.2.11.8 Clean Water Act

Write detailed description of work to be performed by the Contractor here. If there is no required work under 33 USC 1251 then the section should be deleted and renumbered.

][3.2.11.9 National Historic Preservation Act

Write detailed description of work to be performed by the Contractor here. If there is no required work under 16 USC 470 then the section should be deleted and renumbered.

][3.2.11.10 Additional Federal Environmental Laws

Write detailed description of work to be performed under Federal environmental laws by the Contractor that are not listed in paragraph REFERENCES. If there is no required work under this Federal law, then the section should be deleted and renumbered.

][3.2.11.11 State and Local Environmental Laws and Regulations

Write detailed description of work to be performed by the Contractor here. If there is no required work under an applicable state and local laws and regulations, then the section should be deleted and renumbered.

]3.3 OPERATIONAL REQUIREMENTS

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NOTE: The coordination with other federal, state, and local jurisdictions and agencies, the public, and private entities must be completely resolved before finalizing the specifications. A project's excavation and/or foundation requirements, for which submerged, dense materials are being removed, may require navigation, highway, structural and/or other regulations and codes to be followed. Depending upon the proximity of public-use areas, private residences or businesses, and the project's location within a county or township, various accommodations will need to be required for the protection of the public, and the safety of private entities regarding

local laws, regulations, and ordinances. Avoiding natural-resource impacts may overlay other measures and require seasonal or daily time limitations of the initiation of the individual blast patterns; special observers for some or all the blasting; special studies or monitoring while the blasting is being conducted; and other potential considerations.

Agency coordination will vary by project. Be certain that all government stakeholders have been involved with planning of the project and approved of all requirements for the specifications. List those important navigation or safety stakeholders in 3.3.2. When there are navigable waters near the excavation zone, list in 3.3.2 the controlled navigation perimeter's distance during the warning period of a shot. While the distance is project specific, the minimum distance is typically 300 m 1,000 ft.

****

3.3.1 Coordination

3.3.1.1 Schedules

Coordinate schedules for blasting with the proper authorities, federal, state, local. No blasting will be conducted unless the Contractor is notified by the appropriate parties that blasting may proceed. In addition, if channel restrictions of navigable waters are required for drilling and blasting, the Contractor will coordinate with the U.S. Coast Guard.

3.3.1.2 Permits

Obtain all necessary permits from the state and local authorities to transport explosives and all blasting agents necessary, and to perform blasting operations on site. The Contracting Officer will be notified in writing that all permits have been obtained and will be furnished copies of all permits.

3.3.2 Navigational, Lock or Vessel Control During Excavation and Removal

Various agencies and offices, [_____], must be notified of the scheduled blasting times for coordination. The Contractor must assure that no vessels are within, nor on a heading and speed to be within, [_____] m [_____] ft of the shot pattern during the 5-minute warning.

3.3.3 Work Restrictions

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NOTE: While it is not typical to have low tolerances for the horizontal variation of submerged walls or for the vertical variation of submerged pay grades, some projects may require limited control of the walls and grades in underwater blasting. Before resolving the project's underwater tolerances, determine an easy and effective means to survey the submerged walls and grades, and further assess to what precision such surveys may estimate horizontal

and vertical variations over short distances. Presplitting would be an unusual requirement for underwater blasting, even in shallow water, because of the precision of knowing the horizontal location and vertical relief of the presplit walls. In projects where controlled blasting techniques are required to produce final walls which require presplit blasting, only explosives designed for this application must be allowed.

List all the restrictions for blasting agreed to by various agencies and offices in the sentence of the first paragraph, "The restrictions include: [_____]." Such restrictions may need to be detailed elsewhere in the specs, and may include any or all or the following: public notices; vessel traffic control by patrolling and through the Coast Guard; blast initiation only during daylight hours; prohibiting the use of bulk explosives; assuring confined detonations within sound rock; limiting the maximum charge weight of explosives per delay; assuring that airblast and vibration remain below acceptable levels; recording all shots with videography and blast seismographs; seasonal restrictions to lessen the likelihood of a species in the blasting area; and, the use of fish-repelling noise immediately preceding every shot. Some specialty requirements will require careful consideration for their need and will require the design input of experienced specialists. These specialty requirements include, but are not limited to, underwater pressure wave monitoring or mitigation by use of an air curtain. The design or limitation of the action is stated in these paragraphs. The Contractor's actions or coordination of required Natural Resource activities are listed in paragraph NATURAL RESOURCE ASSESSMENTS, MITIGATION AND MONITORING.

****

There are a variety of restrictions upon blasting to assure that there are no adverse impacts to the public and upon commerce, and to avoid harm to surrounding structures and to the natural resources and their habitats. The restrictions include: [_____]. Several restrictions that are not fully detailed elsewhere within this chapter are noted in this paragraph.

3.3.3.1 Confined Detonations

The rock excavation after blasting will be more effective if each loaded drill hole is well confined by stemming within sound rock. The intent is to confine the gaseous detonation products of each shot hole, such that no rifling plumes, the visual result, are produced in any shot patterns. The premature release of the gaseous products reduces or eliminates effective fracturing and displacement and causes large water-borne pressures potentially damaging to natural resources. Drill-hole logging is required to recognize the depth of firm rock and voids, and to adjust the designed Individual Shot Plan loading of each shot hole with explosives and stemming according to the position of sound rock relative to the paid elevation of removal. Video recording of each blast will detail the effectiveness of avoiding rifling plumes.

3.3.3.2 Temporal, Weekly and Seasonal Restrictions for Blasting

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NOTE: Determine the times, days, and dates that blasting is permitted. Typically, blasting is only allowed during business hours on business days and Saturdays, particularly when there may be vibratory blasting impacts at residential, business and/or commercial structures. Specialty or critical facilities may require other temporal and vibratory restrictions. Usually, blasting is restricted from being conducted on Sundays and federal holidays. There may need to be date restrictions for specific local or regional events. In coordination with state and local entities, revise the paragraphs for your specific project.

****

Blast initiation is permitted: during daylight, business hours on business days; on Saturdays to [_____]; and, on Sundays and federal holidays to [_____]. Regardless of the season, blast initiation is only permitted, during the period from one-hour after sunrise to one-hour before sunset. The Contractor will not be constrained by weather conditions, except for lightning, for underwater blasting in depths of water greater than 0.9 m 3.0 ft for which airblast is often negligible. Drilling and blasting will not be permitted during the following seasonal periods: [_____].

3.3.3.3 Allowable Vibration

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NOTE: Vibration monitoring is required for every blasting project. The paragraph's narrative is a generic description for most projects, where the nearest structure/facility is: Standard Construction Timber Frame, Brick, and Concrete Buildings; Lock Monoliths; Powerhouse Switchyard; Highway and Railroad Bridges; Buried Utilities; and Wells and Aquifers. Some projects may require assessment by a trained experienced blasting specialist or structural engineer of lower allowable vibration criteria at critical or historic or special structures or facilities or structures with continuous occupants. Vibrations can cause the occupants of structures to become physically uncomfortable at levels well below the allowable vibration levels to avoid damage to the structure itself. Projects a with a Powerhouse and Electrical Power Relay Equipment or Pipelines, besides those with continuous occupants, should be evaluated for lower allowable vibration criteria. Some projects could utilize the assessment by a trained experienced blasting specialist or structural engineer to include higher allowable vibration criteria for those projects where typical structures/facilities are more than twice the distance of the closest approach of blasting to: Steel and Reinforced-Concrete Structures; Mass

Concrete Monoliths; and Cured Shotcrete.

Alternate language and charts for this section:

TABLE 1 below gives standards for allowable peak particle velocities as they relate to a variety of common construction materials. Do not exceed these vibration limits.

These vibration limits must not be incorporated in the blast design. Many projects have been constructed utilizing a fraction of these allowable values. Properly design the blasts, set allowable vibration limits, and maintain proper control throughout the duration of construction. The Contractor is responsible for all damages caused directly by, or as a result of the blasting operations. Compliance with this or any other provisions in the Contract must not relieve the Contractor of responsibility for any damages or injuries caused by, related to, or arising out of blasting or associated blasting activities.

Here are two examples of vibration tables. The first is more generic and should be used the section shows for a specific project also requiring an initial peak particle velocity for test blasting ramp up.

TABLE 1: VIBRATION LIMITS FOR STRUCTURES		
STRUCTURE TYPE	**ALLOWABLE PPV (ips)**	**ALLOWABLE PPV (cps)**
Standard Construction Timber Frame, Brick, and Concrete	**2.0**	**5.0**
Reinforced Concrete Structures (not Mass Concrete)	**4.0**	**10.0**
Steel Structures	**4.0**	**10.0**
Buried Utilities	**2.0**	**5.0**
Wells and Aquifers	**2.0**	**5.0**
Steel Pipelines	**5.0**	**12.7**
Mass Concrete Monoliths (Cured Concrete) Shotcrete	**10.0**	**25.4**

Or similar, adjust these for projects:

Features	**Initial**	**Initial**	**Product**	**Product**
Lock Control Room	**0.5**	**1.2**	**2.0**	**5.0**

Features	**Initial**	**Initial**	**Product**	**Product**
Powerhouse Lower Level	**0.2**	**0.6**	**1.0**	**2.5**
Powerhouse Control Room 69kV Relay	**0.4**	**1.0**	**1.0**	**2.5**
Powerhouse Switchyard	**2.0**	**5.0**	**2.0**	**5.0**
Transmission Tower	**3.0**	**7.6**	**3.0**	**7.6**
Existing Lock Monoliths	**2.0**	**5.0**	**2.0**	**5.0**
Segmental and Cellular Cofferdam	**2.0**	**5.0**	**4.0**	**10.0**
Downstream Highway and Railroad Bridges	**1.0**	**2.5**	**2.0**	**5.0**

Note that older deteriorated structures or utilities and structures housing computers or other sensitive equipment may require lower peak particle velocity limits than those provided in Table 1. Also, buried pipelines owned by private utility companies or bridge structures owned by other agencies may be subject to lower limiting values imposed by the owner. The safe vibration limits and charge weights per delay to achieve these vibration limits must be established by the Seismic Specialist and the Blasting Consultant. Vibration limits for all non-government owned structures must conform to the laws of the State of [_____]. The text below can be used referring to the graph in NFPA 495 in lieu of site specific developed for the project.

****

The Contractor must conduct all the required monitoring as noted in paragraph IMPACT MONITORING. The Contractor must conduct all blasting by controlled blasting methods to avoid exceeding the allowable vibration in applicable federal, state, and local laws, regulations and ordinances at all structures and facilities, as monitored by blast seismographs.

The allowable vibration at any structure or facility must not exceed the maximum PPV of 5.0 centimeters/second (cm/s) 2.0 inches/second (ips), nor exceed the PPV amplitude in the Frequency versus Particle Velocity Graph Figure in NFPA 495 (Figure 11.2.1) for the frequency of the half-cycle amplitude.

****

NOTE: The section pertaining to Green Concrete may be removed and its definition removed, if the concern for newly placed concrete, shotcrete and/or cementitious grouts is not applicable. The period of hours is broad, because neither the exact time of the blast nor of the material placement will be known exactly. Values of allowable PPV have not been included greater than 2.0 ips, because above 2.0 ips will adversely affect ordinary structures

and individuals within those structures. Further, most concrete structures should be limited to allowable PPV at or below 4.0 ips.

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3.3.3.4 Limiting Blast-Induced Vibrations at Green Concrete

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NOTE: Some guidelines for peak particle velocities related to time intervals after placing mass concrete/shotcrete/grout curtains are given in Tables 2 and 3 should be considered when designing a blast. The specification writer must include a limitation of the allowable vibration when there is green concrete expected on the project. Table 2 has two option, one is more conservative, designer should make engineering decision which to use or adjust based on data. There are other potential charts that can be used:

TABLE 2: VIBRATION LEVELS FOR GREEN MASS CONCRETE/SHOTCRETE/GROUT

TIME AFTER PLACEMENT	ALLOWABLE PPV (ips)	ALLOWABLE PPV (cps)
0 - 4 Hours	2.0	5.0
4 - 24 Hours	3.0	7.6
1 - 3 Days	5.0	12.7
4 - 7 Days	7.0	17.7
8 - 10 Days	9.0	22.8
Over 10 Days	10.0	25.4

TABLE 3: VIBRATION LEVELS FOR GREEN CONCRETE/SHOTCRETE

TIME AFTER PLACEMENT	ALLOWABLE PPV (ips)	ALLOWABLE PPV (cps)
0 - 10 Hours	0.1	0.2
10 - 24 Hours	2.0	5.0
24 - 48 Hours	3.0	7.6
2 - 3 Days	4.0	10.0
4 - 7 Days	6.0	15.2
8 - 10 Days	8.0	20.3
Over 10 Days	10.0	25.4

****

During the performance period, other construction activities may be placing concrete at varied locations on or near the project. The Contractor will coordinate with other project contractors or will be informed on the prior business day by the Contracting Officer concerning the likely placement of concrete near the project.

a. The Contractor will assure that a seismograph is monitoring vibrations from blasting at a location, which is closer to the blast pattern than the Green Concrete. Seismic monitoring must be conducted near the concrete placement from prior to placement until 72 hours after placement.

b. The table below indicates that maximum allowable peak particle velocity (PPV) permitted, relative to the age of the recently-place concrete, as measured at an acceptable location or within 15 m 50 ft of the most recently placed concrete on the side of closest approach to the blast.

Age of Concrete (hours)	less than 12	12 to 24	24 to 72
PPV (inch/second)	0.1	1.0	2.0

c. Adjust all blasting to conform to the table's maximum allowable PPV at the seismograph near the Green Concrete. See paragraph IMPACT MONITORING.

3.3.3.5 Allowable Airblast

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NOTE: Airblast is rarely a concern with underwater blasting. Some provision for allowable airblast should be provided within this paragraph. Air blast limits should follow most stringent regulation as some states have a threshold more stringent than some agencies.

****

The Contractor must conduct all the required monitoring as noted in paragraph IMPACT MONITORING. The Contractor must conduct all blasting by controlled blasting methods to avoid exceeding the allowable airblast in applicable federal, state, and local laws, regulations and ordinances at all structures and facilities, as monitored by blast seismographs. Peak airblast overpressure must be held below [133 dB (linear peak scale), 100. Pascals (Pa) 0.015 pounds/square inch (psi)] at the nearest residential or inhabited structure or other designated location.

3.4 BLASTING PERSONNEL

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NOTE: Depending on the scope and duration of the project, it may be prudent to require the Contractor to provide a named and approved alternate for some positions. Several positions are required to continuously perform blasting responsibilities, even when one individual is not available onsite for that role's responsibilities.

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3.4.1 Blasting Consultant

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NOTE: Depending on the scope of the project, it may not be necessary to require a Blasting Consultant. This will be determined during design, a USACE Blasting SME should be consulted to discuss this. Projects with few critical blasting limitations, far from sensitive structures or from heavily used public areas, or with few Natural Resource issues

may not need a Blasting Consultant. One option is to still require a blasting consultant to be engaged, but only for reviewing the Master Blasting Plan and engaged on serious blasting issues with the blasting (misfires, shot hole rifling loss of confinement, exceedance of vibration and/or airblast limits, approaching Natural Resource limitations without being able to properly break and displace rock) as and if the issues develop.

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The Blasting Consultant, Blasting Specialist, Blasting Administrator, Blaster in Charge, and Vibration Specialist cannot be the same person. Retain a recognized Blasting Consultant to assist both with the project's blast design and with the resolution of any blasting issues for the project. The Contractor must submit the Blasting Consultant's expertise submission within [15] [_____] days of the Notice to Proceed. The Blasting Consultant must be approved by the Contracting Officer's Representative two weeks prior to the submission of the Master Blasting Plan.

3.4.1.1 Blasting Consultant's Responsibilities

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NOTE: The paragraph below should be used when controlled blasting techniques are required.

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The Contractor's Blasting Consultant must be available to review the Master Blasting Plan, assist with controlled blasting techniques, and resolve difficult or complex issues with blasting for the project. The Blasting Consultant will recommend controlled blasting methods, as necessary, to meet safety and natural resource requirements, retain airblast and vibration within the allowable limits, and protect the rock foundation. Proposed controlled blasting methods must be submitted in the Master Blasting Plan.

The Blasting Consultant must provide advice for, and review, the Master Blasting Plan, attend the public meeting(s), and be available for consultation on an "as needed" basis, as determined separately by the Contractor or by the Contracting Officer. The Blasting Consultant is not required to be at the project site for review of the Master Blasting Plan or of any specific shot plans or records. The Blasting Consultant must be present at the project site for any required shot issue or, if requested, for the subsequent shot following a misfire or significant exceedance of any onsite blasting issues.

The Blasting Consultant must provide a written summary of all site visits and special assignments within [2] [_____] business days of performing such actions to both the Contractor and the Contracting Officer's representative.

The Blasting Consultant must submit a short, signed Blasting Consultant's Report each month stating that he/she has briefly reviewed the individual shot documents, including blast videos, and has collaborated with the Contractor on all issues, concerns, or errors in the individual shot documents. This report is due within [3] [_____] business days after the end of the month.

If problems with vibration, airblast, rifling of a shot hole producing a water column plume, or production blasting occur, the Contracting Officer will require the Contractor to immediately summon the approved Blasting Consultant and have their presence on site within 10 days after the problem develops to:

a. Approve each Individual Shot Plan;

b. Observe in person shot-hole drilling, logging, revision to that hole's plan, and loading with the full authority to stop or delay any blast he/she considers unsafe;

c. Review and sign each Individual Shot Record at no additional cost to the Government; and,

d. Submit and sign a written checklist that all necessary precautions were reviewed and followed by the drilling and blasting crews.

The checklist must be as defined under the section on Individual Shot Reports. The signed checklist must be attached to each Individual Shot Report.

3.4.1.2 Blasting Consultant's Expertise

The consultant must be able to demonstrate involvement in at least 15 projects with controlled blasting. The consultant must provide, as a minimum, the credentials and experience for each outlined following items:

a. The consultant must have at least 10 years of experience in construction blasting within 75 m 250 ft of protected structures, and had consultation on three underwater blasting programs;

b. The consultant must be able to demonstrate that he has attended at least 15 short courses, seminars, or conferences on blasting technology, or university engineering class studies on blast design during the past 20 years, including a complete understanding of blasting seismology with emphasis on vibration frequency, acceleration, and displacement (ground strain);

c. For the past 10 years the consultant must have derived their primary source of income from providing specialized blasting consulting services;

d. A list of recent projects containing a description of the projects' details, summarize the blasting plans, and any modifications made during the projects from your consulting;

e. Provide the names and telephone numbers of contacts, who have sufficient stature with, and knowledge of, their individual project to verify the submitted information in competency and ability, for at least three recent projects;

f. Hands-on experience as a blaster for at least 3 years; and,

g. The Blasting Consultant, Blasting Specialist, Blaster in Charge, and Seismic Specialist cannot be the same person.

3.4.1.3 Blasting Consultant's Qualifications Submissions

Submit the resume, education, experience, current blasting licenses and credentials, and training of the proposed Blasting Consultant, and a formal letter of commitment from the consultant verifying their availability on an "as needed" basis for the duration of the Contract. The consultant must be a drilling and blasting expert, who has derived their primary source of income by providing specialized blasting and blasting consulting services. The provided consultation must have included at least three, large underwater blasting projects. The consultant must not be an employee of the Contractor, an explosives manufacturer, an explosives distributor, or any other sub-contractor. There must be no additional cost to the Government for the Blasting Consultant's duties, even when required by the Government.

3.4.2 Blasting Specialist

The Blasting Specialist is the Contractor's employee most responsible for the project's blasting and conducting all coordination and providing all documentation for the underwater blasting. The Blasting Specialist must coordinate with the Contracting Officer on all issues dealing with blasting. The Blasting Specialist must be on the job site each day. The Contractor must submit the Blasting Specialist's expertise submission within [15] [_____] days of the Notice to Proceed. The Blasting Specialist must be approved by the Contracting Officer's Representative two weeks prior to the submission of the Master Blasting Plan.

3.4.2.1 Blasting Specialist's Responsibilities

The Blasting Specialist is responsible for the project's blast design, preparing and submitting all necessary blasting documentation, and conducting quality control. The Contractor may employee a documentation assistant to aid the Blasting Specialist with all the blasting documentation creation and submissions. The Blasting Specialist is solely responsible for the accuracy and timely submission of all blast documentation.

3.4.2.2 Blasting Specialist's Expertise

The Blasting Specialist must be able to demonstrate involvement in at least three projects with underwater blasting. The Blasting Specialist must provide, as a minimum, the credentials and experience for each outlined following items:

a. The proposed individual must have at least 10 years of verifiable experience utilizing controlled blasting techniques and have had conducted controlled blasting on three underwater projects;

b. Within the last five years, the proposed individual must have completed at least five days of classroom training that has familiarized the person with the most current drilling and controlled blasting methods;

c. The proposed individual must be a licensed blaster in the State of [_____] and hold all credentials that may be required by local jurisdictions;

d. In the last five years the proposed individual must have been responsible for the blast design or execution of underwater rock excavation projects, similar in scope and complexity as this project;

e. The names and telephone numbers of contacts, who have sufficient stature with, and knowledge of, their individual project to verify the submitted information in competency and ability, for at least three underwater blasting projects; and,

f. The Blasting Consultant, Blasting Specialist, Blaster in Charge, and Seismic Specialist cannot be the same person.

3.4.2.3 Blasting Specialist's Qualifications Submission

Submit the resume, education, experience, current blasting licenses and credentials, and training of the proposed Blasting Specialist. Their credentials must include a list of the projects, including the location, duration, scope, description, geologic conditions, and the challenges that developed though the course of the projects and how the challenges were resolved.

3.4.3 Blaster in Charge

The Blaster in Charge may create the Individual Shot Plan for approval by the Blasting Specialist. The Blaster in Charge, in the absence of the Blasting Specialist, is the Contractor's employee responsible for on-deck supervision of all underwater blasting activities and its documentation. The Contractor must submit the Blaster-in-Charge's expertise submission within [15] [_____] days of the Notice to Proceed. The Blaster in Charge must be approved by the Contracting Officer's Representative two weeks prior to the submission of the Master Blasting Plan.

3.4.3.1 Blaster-in-Charge's Responsibilities

The Blaster in Charge, in the absence of the Blasting Specialist, is responsible for on-deck supervision of the drilling, shot-hole logging, possible revisions of the Individual Shot Plan, loading or abandoning of individual shot holes, and firing the blast. The Blaster in Charge is responsible for: the accurate placement of the shot holes' locations for drilling; conducting the drilling and shot-hole logging accurately; accounting for the relevant geology within each shot-hole's log; assuring the careful recording of every shot-hole's log and their submission with the Individual Shot Report; loading the blastholes according to the Individual Shot Plan or the revision thereto based on the shot-hole's log; coordinating the likely time of the blast pattern's initiation; coordinating all notices of imminent blasting and providing the signaling before and after the shot; initiating the blast; performing the post-blast inspection; providing the All-Clear signal or instituting the notices and actions for a misfire; and, providing the documentation for, and signing, the Individual Shot Report.

3.4.3.2 Blaster-in-Charge's Expertise

The Blaster in Charge must be able to demonstrate involvement in at least two projects with underwater blasting. The Blaster in Charge must provide, as a minimum, the credentials and experience for each outlined following items:

a. The proposed individual must have verifiable experience in equivalently responsible roles for controlled blasting projects for at least 3 years and with underwater projects;

b. Within the last 5 years, the proposed individual must have completed at least five days of classroom training that has familiarized the person with the most current drilling and controlled blasting methods;

c. The proposed individual must be a licensed blaster in the State of [_____] and hold all credentials that may be required by local jurisdictions; and,

d. The Blasting Consultant, Blasting Specialist, Blaster-in-Charge, and Seismic Specialist cannot be the same person.

3.4.3.3 Blaster-in-Charge Qualifications Submission

Submit the resume, experience, current blasting licenses and credentials, and training of the proposed Blaster-in-Charge. Their credentials must include a list of the projects, including the location, duration, scope, description, geologic conditions, and the challenges that developed though the course of the projects and how the challenges were resolved.

3.4.4 Blasters

The Contractor may elect to employ multiple Blasters. Each Blaster is a Contractor's employee responsible for on-deck, underwater drilling and blasting activities under the supervision of the on-deck, Blasting Specialist or Blaster in Charge, whoever is present. The Blaster in Charge or a Blaster will log each shot hole, as the hole is being drilled. Each Blaster must be approved by the Contracting Officer's Representative after the submission of the Master Blasting Plan.

Blaster qualifications require each Blaster must be able to demonstrate prior experience with drilling and blasting. The proposed individuals must be a licensed or certified blaster in the State of [_____] and hold all credentials that may be required by local jurisdictions. Submit the resume, experience, current blasting licenses and credentials, and training of each proposed Blaster with the Master Blasting Plan.

3.4.5 Blasting Administrator

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NOTE: For smaller projects this position may not be necessary. The Blasting Administrator was added for large projects to aid the Blasting Specialist with paperwork.

****

The duties of the Blasting Administrator are to be the direct assistant of the Blasting Specialist in preparing all necessary paperwork, and in performing quality control on all issues dealing with blasting. The primary function is to assist the Blasting Specialist in the preparation and completion of submittals, prepare the detailed post blast report, and the individual shot videos for submittal to the Contracting Officer, and submit the drilling logs with the post blast report. The Blasting Administrator cannot sign any paperwork. The Blasting Administrator must be approved by the Contracting Officer.

Blasting Administrator's qualifications require the Blasting Administrator to possess the following minimum qualifications and experience:

a. Holds a current Blaster's license;

b. Have prior experience in underwater blasting;

c. Must have completed at least five days of classroom training within the last five years that has equipped the person with the most current knowledge in blasting procedures; and the software to be used on the project; and,

d. Have proven proficiency with blasting software and spreadsheets.

3.4.6 Vibration Monitoring Specialty Firm

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NOTE: This is requirement is a new format from previous specifications. The firm is submitted for approval, having the appropriate experience and the firm must have on staff the Seismic Specialists and Seismograph Technicians, typically a firm is subcontracted by the Contractor and having multiple experienced people approved allows them to have flexibility on supporting the site work. The people coming to the project or responding to the work must be within the group approved but does not need to be a single person anymore.

****

Retain the services of a vibration monitoring specialty firm that specializes in the prediction, monitoring, and control of ground vibration and airblasts. The firm must have experience conducting installation of seismographs for vibration monitoring, communicating vibration and airblast results, and developing and maintaining a site attenuation curve. The firm must have on staff at least two Seismic Specialists that specialize in vibration monitoring and analysis. The firm must have on staff at least four Seismograph Technicians that have five years or more experience with seismograph installation and vibration monitoring. Submit resumes for all personnel and for the firm for approval citing, in additional to other pertinent data, experience, training, and education, at least 60 days prior to the commencement of blasting. The Seismograph Technicians must be persons capable of setting up the seismographs at designated locations, effectively recording the blast, and appropriately interpreting results. The Seismic Specialists must interpret the seismograph records to ensure that the seismic data must be effectively utilized in the control of the blasting operations with respect to the existing structures. The Seismograph Technicians must supervise the placement, operation, and maintenance of the seismographs. The Seismic Specialists must conduct the airblast and particle velocity regression analysis as described in this Section. The Contracting Officer may require the Seismic Specialists and Seismograph Technicians to be present during the test blast program, production blasting, or both.

3.4.7 Seismic Specialist

The Contractor will retain the services of an independent, seismic-monitoring firm with employees capable of monitoring, assessing, and predicting vibrations and airblast due to blasting. The Seismic Specialist must be an employee of the independent, seismic-monitoring firm, and must not be an employee of the Contractor. The Seismic Specialist will conduct, or assure the actions are being taken to obtain, the required blast seismograph monitoring for the project. The Seismic Specialist will supervise all Seismograph Technicians deployed to the project to deploy and maintain all the seismographs for recording vibrations and airblast, and to properly retain, store and submit all seismic records of the blasting. The Contractor must submit the independent, seismic-monitoring firm's, Seismic Specialist's expertise submission within [15] days of the Notice to Proceed. The firm and Seismic Specialist must be approved by the Contracting Officer's Representative two weeks prior to the submission of the Master Blasting Plan.

3.4.7.1 Seismic Specialist's Responsibilities

The Seismic Specialist must be a person able to deploy blast seismographs, effectively record and transmit the seismic data, comprehensively assess, and interpret seismic data regarding the monitored blast's parameters, and remotely supervise the firm's Seismograph Technicians. The Seismic Specialist must also interpret the seismic records to ensure that the seismic data will be effectively utilized in the control of the blasting operations with respect to the existing structures and conduct of an optimized blasting program.

3.4.7.2 Seismic Specialist's Expertise

The Seismic Specialist must be able to demonstrate monitoring deployment, seismic data assessment and interpretation, prediction of vibration and airblast from blasting, and remote supervision of field personnel for five blasting projects. The Seismic Specialist must provide, as a minimum, the credentials and experience for each outlined following items:

a. The proposed individual must have verifiable experience in equivalently responsible roles for controlled blasting projects for at least 3 years;

b. Within the last five years, the proposed individual must have completed at least five days of classroom training concerning seismic monitoring equipment, data telemetry, and seismic data interpretation;

c. The Blasting Consultant, Blasting Specialist, Blaster in Charge, and Seismic Specialist cannot be the same person. The proposed Seismic Specialist and Structural Inspection/Evaluation Specialist may be the same person.

3.4.7.3 Seismic Specialist Qualifications' Submission

Submit the credentials of the proposed seismic-monitoring firm with documentation for the Seismic Specialist. Submit the firm's history for this office, if there are multiple offices, years under the present office's leadership, the regional extent of clients, the approximate number of projects in the past year, and the number of present employees at this office. Submit the resume, education, experience, credentials, and training of the proposed Seismic Specialist. Their credentials must include a list of the projects, including the location, duration, scope, description, and the monitoring challenges that developed though the course of the projects and how the challenges were resolved. The documentation must provide experience and capability for the proposed Seismic Specialist to provide remote blast monitoring and supervision of support personnel while the individual is not on site.

3.4.8 Seismograph Technicians

The approved, independent, seismic-monitoring firm may provide Seismograph Technicians to assist the Seismic Specialist with the project's vibration and airblast monitoring. Each Seismograph Technician must be approved by the Contracting Officer's Representative after the submission of the Master Blasting Plan.

Each Seismograph Technician must be able to demonstrate prior experience with blast seismic monitoring on a prior project of equivalent size and similar telemetry requirements. The proposed individuals must have the required training and hold all credentials that may be required by local jurisdictions. Submit the resume, experience, credentials, and training of each proposed Seismograph Technician with the Master Blasting Plan.

3.4.9 Structural Inspection/Evaluation Specialist

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NOTE: Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist would only be required if there are structures or facilities requiring such inspections. Eliminate the paragraphs referencing Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist if the project does not have a requirement for these inspections. The Structural Inspection/Evaluation Specialist must be experienced in both pre- and post-blast inspections. While there may be an advantage to this person being a registered professional engineer, it is more important that the specialist have experience in evaluating potential blasting effects by post-blast inspections. Consider whether a registered professional engineer is a requirement, as the most experienced persons may not be registered professional engineers or may be difficult for a bidder to acquire for some projects

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Pre- and Post-Blast structural inspections must be performed by specialists with at least five years' experience in pre-blast and post-blast surveys.[The Structural Inspection/Evaluation Specialist must be a Registered Professional Engineer in the State of [_____], who is qualified to conduct structural evaluations.] Submit the resume, education, experience, credentials, and training of the proposed Structural Inspection/Evaluation Specialist to the Contracting Officer with the Master Blasting Plan. The proposed Seismic Specialist and Structural Inspection/Evaluation Specialist may be the same person.

3.4.10 Magazine Keeper

The Magazine Keeper and an Alternate are the Contractor's employees responsible for explosive magazines and its record keeping. The position of Magazine Keeper is required only if the Contractor elects to have explosives' magazines under his control. The Magazine Keeper must be approved by the Contracting Officer's Representative after the submission of the Master Blasting Plan.

The Magazine Keeper must be familiar with the laws and general practices concerning the handling, care, use, and storage of explosives and detonators. The Magazine Keeper must be responsible for maintaining a cleared area around each magazine, and accounting for by record the throughput of explosives and detonators. The Magazine Keeper must be present for any transfer of explosives and detonators into or out of the magazines. The Magazine Keeper must not be required to perform any duties that will in any way interfere with his or her duties as Magazine Keeper.

The Magazine Keeper must be able to demonstrate prior experience explosives' magazines. The proposed individual must hold all credentials that may be required by the State of [_____] and local jurisdictions. Submit the resume, experience, credentials, and training of the proposed Magazine Keeper with the Master Blasting Plan.

3.5 RECORD KEEPING

3.5.1 Pre-Blast Surveys

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NOTE: Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist would only be required if there are structures or facilities requiring such inspections. Eliminate the paragraphs referencing Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist if the project does not have a requirement for these inspections. The lateral distance to the nearest structures by azimuth may vary by project. Typically, only those nearest structures to the excavation zone requiring blasting in a general azimuthal direction are surveyed. Example, if there are many structures within 1,000 feet (if that is the resolved lateral distance) for a specific project, only the closest structures at ~700 feet to the south and at -850 feet to the east would need to be surveyed. For the example project those structures within 1,000 feet of the excavation zone are protected by the pre-blast surveys of the structures closer to the excavation zone on the same azimuth. If any of the structures or facilities are critical or sensitive features or if there is some public or governmental concern, it may be prudent to conduct the pre-blast surveys for all the structures within 1,000 ft, not just the closest by azimuth. The lateral distance also may need to be increased for certain projects. The Agency may seek rights-of-entry for these structures proposed for surveys with the announcement of the Public Meeting. Those owners, who decline the right-of-entry, miss their opportunity to document that there were no prior defects, so that Post-Blast Surveys could document the damage but would not have a Pre-Blast Survey to show there was no previously existing damage given the owner's claim of new blasting damage.

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Prior to the commencement of blasting, conduct a pre-blast survey of nearest buildings, structures, and utilities within 300 m 1,000 ft from the blast area by azimuth about the blasting zone to document pre-existing conditions. The pre-blast surveys will be conducted by, or under the supervision of, the Structural Inspection/Evaluation Specialist, who will also sign and date each survey. The survey extent and method used must be acceptable to both the Contractor's insurance company and the Contracting Officer. Submit a copy of all pre-blast surveys at least two weeks prior to the first Test Blast. Provide owners of surveyed structures a copy of their Pre-Blast Survey before, or with the notice of, blasting commencement. Notify owners and occupants of local buildings 10 days prior to the commencement of blasting.

Perform the following when conducting pre-blast survey.

a. Provide methodology to be used in conducting the pre-blast survey and listing of structures, determined from the survey to be sensitive, with reasons for these structures being sensitive.

b. Each structure must be documented (including photography and video recordings) as to its construction, foundation type, condition, and closest distance to excavation blasting. The general condition and all observable defects of each structure must be documented.

c. The Commodity storage facilities that may be impacted by blasting must be addressed by the Contractor for safety and continued operation during the blasting program.

d. Freestanding structures (such as retaining walls) must be inspected on the exterior and on the interior as a room. All concrete walks, driveways, etc. must be inspected for cracks, level condition, holes, and defects.

e. Industrial structures, silo/elevators and special facilities, and office space must be described relative to their present conditions and tolerance to vibration. Besides the inspection of walls, columns and stairwells, the Contractor must survey the work areas and structures for distress.

f. An inspection of accessible structures must be made and a list of all structures, which could not be surveyed or refused to allow survey, must be completed. The dates of possible subsequent surveys and physical constraints prohibiting the survey must be documented.

g. Certify that the survey was prepared prior to the start of any blasting under this Contract.

3.5.2 Post-Blast Surveys

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NOTE: Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist would only be required if there are structures or facilities requiring such inspections. Eliminate the paragraphs referencing Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist if the project does not have a requirement for these inspections.

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Post-blast surveys are not typically required. Post-blast surveys must be conducted at any location, where a reasonable notice of damage from blasting has been provided. Post-blast surveys will be conducted by, or under the supervision of, the Structural Inspection/ Evaluation Specialist, who will also sign and date each survey. The survey extent and method used must be acceptable to both the Contractor's insurance company and the Contracting Officer. The post-blast surveys must be conducted within a week of the notice of damage from blasting. Submit a copy of all post-blast surveys within two business days of the on-premises surveys to both the structure's owner and the Contracting Officer.

3.5.3 Daily Explosives' Magazine Inventory and Daily Explosives' Accounting

Accurate daily records must be kept by the Magazine Keeper, who must account for each piece of explosive, detonator, and equipment from the time of delivery at the magazine until its discharge in use or return to the magazine. If explosive products will be delivered and returned daily, the records of the driver must agree with the amount used in the day and a copy of each driver's record must be provided with the Daily Blasting and Removal Log submission. No explosive can be accepted until it has been plainly labeled and delivered as new stock in sound condition. Dates of manufacture and lot numbers will be recorded for all explosives delivered to the site. No explosive material older than 1 year will be used. Containers for explosives must be approved in advance by the Contracting Officer. Remaining inventory must be checked each day and any discrepancies must be immediately reported, regardless of the potential of accounting error, loss, or theft of explosive material.

Should a loss or theft of explosives occur, all circumstances and details of the loss or theft must be immediately reported to the nearest office of Alcohol, Tobacco and Firearms, as well as to the local law enforcement authorities and the Contracting Officer's representative.

3.6 BLASTING DOCUMENTS

3.6.1 Master Blasting Plan

The Master Blasting Plan must be submitted for approval by the Contracting Officer 45 days before the first anticipated Test Blast. No blasting may be conducted prior to the approval of the Master Blasting Plan. No deviation from the Master Blasting Plan will be conducted by the Contractor. Any request for change or revision to the Master Blasting Plan must be provided in writing and approved by the Contracting Officer before such change or revision can be performed. The Contractor will submit a Test Blasting Plan within the Master Blasting Plan that includes calculations for all noted adverse impacts. Non-electric blasting caps must be used for all underwater shots. The Master Blasting Plan must contain provisions for storing, handling, and transporting explosives, as well as for the blasting operations. The means of surveying and locating the shot-hole positions horizontally and vertically must be described in detail within the Master Blasting Plan. Provide a signed statement by the Blasting Consultant that the plan represents a safe and efficient set of means and methods with which to achieve the goals of the work. The Master Blasting Plan must be submitted with the signature and date of the Blasting Specialist. The Contracting Officer will have a minimum of 30 calendar days review of the revised plan. The Contractor may elect, or may be required, to revise and resubmit the Master Blasting Plan or a portion thereof; additional time will be allotted for review by the Contracting Officer.

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NOTE: Add or delete sections of the Master Blasting Plan, as appropriate. Include within the Master Blasting Plan.

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3.6.1.1 Proposed Blasting Personnel

Submit all the approved and proposed blasting personnel and their required information from paragraph BLASTING PERSONNEL. List and copies of licenses, permits, and clearances required, including permit numbers, when applied for, and date of approval or anticipated approval by Federal, State, and local concerns. Provide their police records for every approved and proposed blasting individual. Submit the complete Project Team Organization with duties, responsibilities and authorities clearly defined. Identify the on-site Safety Officer and include a listing of all personnel authorized to sign for, receive and use explosives on this contract.

3.6.1.2 Explosives and Blasting Equipment

Submit all the explosives, their use, and their data sheets for the project. Data sheets, which include the products' specific gravity and water resistance, for all explosives and blasting agents that may be used.

3.6.1.3 Blasting Safety Plan

Submit Blasting Safety Plan, that is in accordance with EM 385-1-1, Section 29, and all other Federal, state, and local regulations. Implement all other applicable safety requirements in addition to that required below. Include, as a minimum, the following items.

a. Permanently secure all onboard magazines to the deck as required by all applicable Code of Federal Regulations.

b. Do not store explosives on the boat or barge deck in the open except for the one case that is to be loaded immediately into the shot holes. Return explosives remaining on deck to the day magazine prior to the firing of any blast. Clearly identify the location of the day magazine in the 'Blasting Safety Plan'.

c. Mount the non-electric, shock tubing spool on the rig in a manner that it cannot be lost overboard. Use an approved blasting machine for detonation regardless of the number of caps used. Do not use an electric blasting system.

d. Limit the amount of explosives aboard the drill boat at any one time to be in accordance with the amount permitted by appropriate codes and regulations. Do not exceed the amount permitted.

e. Make arrangements to prevent damage to any vessel, moored or underway, building or structure and preserve the crew or occupants thereon from exposure to injury as a result of the Contractor's operations. The Contracting Officer may require additional arrangements.

f. Perform a certified marine survey of all floating plant proposed for underwater blasting work on this contract prior to starting any work.

g. Install automatic fire extinguishers of an appropriate type on air compressors and in all engine compartments aboard vessels including but not limited to (drill boats, barges) where explosives are stored, handled, and used.

h. Provide remote fuel shut-offs and fire signaling devices aboard the drill boats.

i. Coordination Plans with the local Coast Guard office to provide notice of blasting and for vessel traffic control.

j. Alert sequence signals and public notice of blasting and all clear. See paragraph PUBLIC NOTICE OF BLASTING OPERATIONS in this section.

3.6.1.4 Navigation Control Plan

Submit the Navigation Control Plan in accordance with EM 385-1-1, Section 29, and all other Federal, state, and local laws and regulations. Implement all other applicable safety requirements in addition to that are required below.

Develop a Navigation Control Plan, which is incorporated into the Master Blasting Plan, that will provide the procedures required to maintain safe passage of all vessels within [_____], during the project. The Contractor will maintain a 1/2 channel to a depth of [_____] m ft below the low water datum for [_____] for all marine traffic through [_____] during the project. The 1/2 channel will always be maintained, except during blasting events.

The Contractor will buoy the area with floating warning signs. The warning signs will be legible from a distance of 60 m 200 ft and must contain the message "DANGER - EXPLOSIVES IN USE" visible on either side of the sign.

Operate two or more patrol vessels during blasting operations equipped with a visible yellow flashing light, audible horn, and radio with a hailer, whose sole function will be to monitor and maintain security in the blast area. A patrol vessel will be stationed at the drill barge and remain in the blasting area during all blasting operations. Land oriented access control and visual observation locations should be determined and approved by the Contracting Officer. Inspect and insure there is no vessel traffic within the buoyed work area prior to providing the Shot's Warning Signals and until such time as the "All Clear Signal" has sounded. Establish and maintain a warning system as required by the Corps of Engineers Safety Manual. Equip and maintain floating plant with radio equipment capable of communications with the Coast Guard. After each blast, upon inspecting the area, immediately notify the U.S. Coast Guard and the Contracting Officer of the all clear or of a misfire.

Maintain the work areas that are not completed and accepted by the Corps to a depth of [_____] m ft below the low water datum for [_____]. In addition, for work located along the channel centerline, remove immediately obstructions that have impacted the main channel above a depth of [_____] m ft below the low water datum for [_____], prior to the "All Clear Signal," for marine traffic to resume.

The Corps of Engineers will provide clearance surveys, following rock blasting activities along the centerline of the main channel. The clearance surveys will be conducted immediately following a blast, to ensure that no rock material has fallen into the 1/2 channel used for marine traffic.

3.6.1.5 Production Blasting Design

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NOTE: Have an experienced person, who is provided with the work restrictions, determine the maximum

charge weight per delay, when potential natural-resource impacts are being considered or have been accepted/negotiated. In absence of potential natural-resource impacts, the maximum charge weight per delay will not specifically be resolved. The allowable PPV at specific monitoring locations will govern the charge weight per delay designed for each shot pattern. The monitoring data for smaller charge weights per delay will be assembled from the Test-Blasting program.

Include within the Master Blasting Plan the detailed design of all required safety, protective, and natural-resource actions required of the Contractor or the engagement of a specialty subcontractor by the Contractor. Some of these safety, protective, and natural-resource actions for a project may include: special monitoring of a critical or essential facility or of a government or commercial structure; a fish repelling charge sequence prior to firing every shot pattern; an aviarian or mammalian watch program for assurance that a shot is not initiated at a time when the cited species is present; underwater pressure wave monitoring; and/or, an air-curtain mitigation program.

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No blasting, including the Test Blasting, may differ from the approved Master Blasting Plan. Shot-hole drilling must not begin until the Master Blasting Plan is approved in writing. Reflect changes to the blasting or monitoring procedures, equipment, plant, products or personnel in a revised Master Blasting Plan or portion thereof. Obtain approval from the Contracting Officer, in writing, prior to implementation of any Master Blasting Plan changes or revisions.

Confine the loaded charge with angular, granular stemming materials, placed within competent rock, to perform the most work and to avoid a rifling plume from occurring within any shot hole. See paragraph STEMMING. The shortest delay period both between two adjacent shot holes and between two adjacent shot rows in the shot pattern is 25 milliseconds (ms). The maximum charge weight per delay may not exceed [_____] kg [_____] pounds of all combined explosives and blasting agents in each 25-ms delay period.

Include in the Production Blasting Design Section, as a minimum, the following items.

a. Proposed method of transportation, storage, and handling of explosives.

b. Procedure for monitoring the blast operations and handling misfires.

c. Plan showing the intended layout of the shot-hole patterns, timing and sequence, anticipated burden dimensions and depth of sub-drilling for a specified maximum charge weight per delay. Identify each drill hole by a unique, sequential identifier.

d. Typical size, depth, and spacing of blast holes; methodology to assure loading of explosives is only within sound rock; the maximum load density (in pounds per foot of drill hole length) and the maximum powder factor (in pounds of explosive per cubic yard of rock shot);

type of explosive and method of loading and detonating; procedure to confine the charge with stemming; and maximum number of holes to be detonated for a production shot pattern. Initiation system to be deployed and the means to assure each shot hole fires on its own delay.

e. Sequencing of delays for each shot hole that will be employed during blasting and the maximum explosive loading in pounds of explosive per delay.

f. Indication as to whether decking or boosters will be used.

g. Type and number of drill frames, including drill hole diameter, and expected production rates/day.

h. Type of blast seismographs to be used, manufacturer, and when last calibrated or certified, and types of video cameras.

i. The formats of all logs and reports to be used throughout the life of the project designed to record pertinent data before, during, and after the blasting operation. Pertinent information includes, but not be limited to, those items specified in paragraphs detailing the submittals.

j. Names, office mailing addresses and phone numbers of Contractor's representatives (Blasting Consultant, Blasting Specialist, Blaster in Charge, and Seismic Specialist) to which any informational inquiries may be addressed.

k. Location plan, manufacturer's literature, and parameters to be used in site selection for the blast seismographs and video cameras. The location of any other monitoring equipment, when used.

l. The methods that will be used to prevent all cited adverse impacts during the blasting activities, including protection of natural resources.

m. Complete list of floating plant involved in production blasting operations.

n. Within the blasting plan consider the multiple types of commercial vessels that will be on the water over the period of the excavation and removal program. Notify the sail/yacht clubs, etc., of plans to blast in advance and what traffic control and proximity restrictions will be implemented.

o. Submit the means and methods to be used to recover and dispose of all shock cord/tubing and initiation transmission-line debris immediately following each shot.

3.6.1.6 Test-Blast Plan

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NOTE: Have an experienced person, who is provided with the work restrictions, determine the first test shot's number of shot holes, the initial maximum charge weight per delay for the test blasting, and the second test blast's number of shot holes. For some underwater blasting projects, the restrictions may be so limiting that the initial charge weight

per delay will be quite low, perhaps kg, 5 lb per 25 ms delay. Other large projects with few natural-resource concerns and great lateral distances to non-federal structures may have a large initial charge weight per 25 ms delay. The former projects may have a production blasting allowable maximum charge weight per delay.
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Test Blasting is the initial blasting for the project starting with lower explosive loading in shot holes and fewer shot-holes in each initial shot pattern. The purpose of the Test Blasting is to safely build to the level of Production Blasting and to accumulate data to avoid shot-hole rifling and the cited adverse effects from blasting. An Individual Shot Plan must be provided for each Test Blast.

A minimum of three shots are required for the Test Blasting. Increase the number of shot holes loaded and the maximum charge weight per delay of subsequent test and production shot patterns only if the prior test shot was apparently successful. An apparently successful shot pattern is defined as a properly fired pattern without riffling plumes that has seemed to have been effective prior to excavation and has remained below the maximum, peak particle velocity values, as prescribed in paragraph ALLOWABLE VIBRATION. For the next immediate test shot pattern, use a smaller number of loaded drill holes and a smaller maximum charge weight per delay, if (1) the prior shot pattern had a rifling plume [and][or] (2) underestimated the recorded, PPV by 25 percent at any monitoring location [and][or] (3) had any type of misfire, damage or injury or accident or claim thereof.

a. Limit the first test shot to [3] [_____] total drilled shot holes in a single row and have a maximum charge weight per delay of [_____] kg [_____] lb of explosive materials per 25-ms delay.

b. Limit the second test shot to [7] [_____] total shot holes in a single row of the shot pattern of the Contractor's choosing and to a maximum charge weight per delay of double the first shot's maximum charge weight per delay, if the first test shot was completely satisfactory.

c. The third and any further test shot patterns may use double the number of the shot holes of the preceding satisfactory shot, included within two or more shot rows, and double maximum charge weight per delay of the preceding satisfactory shot[to the production-shot maximum allowable charge weight per delay of [_____] kg [_____] lb of explosive materials per 25-ms delay].

A Test-Blast Evaluation Report must be provided within two business days to the Contracting Officer's representative in writing and by e-mail to the cited e-mail address listing once the last Test Blast has reached the explosive load per shot hole and the number of shot holes and rows to conduct Production Blasting.

3.6.2   Individual Shot Plans

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NOTE: The Master Blasting Plan must provide the format of the Individual Shot Plan for approval with the Master Blasting Plan. Include within list item 3.6.2 b.(6) all special duties and/or actions

required for the project that have been established for protection of individuals, natural resources, and/or structures.

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The Contractor must submit an Individual Shot Plan 24 hours prior to any subsequent drilling and blasting for that shot pattern. The format may utilize a spreadsheet for ease data entry but requires an actual signature and handwritten date for its submission.

Prior to each blast, including Test Blasts, the Contractor must submit for the Contracting Officer's documentation a plan detailing all the data required in the Individual Shot Plan's format of the approved Master Blasting Plan. The plan will provide all the pertinent aspects of the blast design including, but not limited to, the loading, firing, delay sequence, and special considerations. The Individual Shot Plan will provide the location and depth of holes, inclination of all holes that will not be vertical, the proposed depth and the spacing of the blast holes, amount, and strength of explosives per hole and per pattern, the proposed sequence of firing and time delays, and estimated time and day for the pattern's initiation. Each proposed shot pattern will be designed by the Contractor's Blasting Specialist with changes being determined by observation of the way the rock breaks as the operations progress. The Contractor must take such precautions as are necessary to prevent displacement, cracking or damaging the rock outside the prescribed limits of dredging or excavation. The rock outside the limits of the dredging must be left in as sound and undamaged a condition as possible.

a. Submit an Individual Shot Plan to the Contracting Officer, with the anticipated plan for the next shot pattern prior to drilling the shot holes.   Furnish each submitted Individual Shot Plan as a signed paper copy and in digital form to the e-mail listing required by the Contracting Officer. The Individual Shot Plan may be developed in a format that easily provides data that remains the same for the actual shot information in the Daily Blasting and Removal Log and the Individual Shot Report with its included reports.

b. The Individual Shot Plan includes, as a minimum, the following items:

    (1) The shot pattern's name/number, coordinate locations of the outermost holes of the shot pattern, any specific purpose for the shot, the anticipated time, date, weather conditions, and the water conditions and its elevation at the anticipated time of the shot;

    (2) The total number of holes to be shot, the shot-hole diameter, the total weight of explosives, number of delays, load density and powder factor for the shot, the maximum charge weight per delay, the closest approach, scaled distance and estimated PPV and airblast overpressures at each monitoring location;

    (3) A large-scale plan map depicting the proposed layout of shot hole pattern, timing and delay sequence;

    (4) An elevation sketch showing a typical hole's loading from the water surface to the bottom of the drill hole with an elevation scale, including the elevation of the removal grade, the top of sound rock, the top and bottom elevation of stemming, the top and bottom position of explosive materials, and the position of all

detonators, boosters and primers in the hole;

(5) A tabular listing, which may be a printed spreadsheet page, by hole in the ascending total delay time order by the describing: row and number within the row of the shot hole, total delay time, the total charge weight of explosive materials for the entire hole, the largest charge weight of any deck within a hole on a separate 25-ms delay if any, top of sound rock elevation, bottom hole elevation or the top of stemming elevation at the bottom of a shot hole that was over-drilled in depth and backfilled, stemming elevations, and detonator, primer and booster elevations in the hole;

(6) The estimated PPV and airblast overpressure at each seismograph location and the lateral close approach distance from the shot pattern to each seismograph;

(7) the means to remove and dispose of all shock cord/tubing and/or initiation transmission-line debris immediately following the shot;

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NOTE: Complete the required Natural Resource activities that the Contractor must either conduct or initiate the shot with coordination of other offices for them to conduct the required Natural Resource activities of paragraph NATURAL RESOURCE ASSESSMENT.

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[(8) The Contractor must employ a Natural Resource Subcontractor, submitted to the Contracting Officer to [list activities] and the Contractor must conduct the shot in coordination with other offices as they perform [list activities]; and

] (9) The name, title, and signature of the Blasting Specialist providing the form with the date of the signature.

3.6.3 Test-Blast Evaluation Report

Provide a report summarizing the Test Blasting and submit the report with the Individual Shot Report of the first apparently successful production shot.

3.6.4 Individual Shot Reports

The Contractor must submit an Individual Shot Reports, both in writing to the Contracting Officer and by e-mail distribution to the required e-mail addresses, on the next business day and prior to any subsequent drilling and blasting for the next shot pattern. The supporting reports related to each shot pattern, which was not included with the Individual Shot Report, must be provided with their required data by the submission date of each supporting submission. The Individual Shot Report may utilize the spreadsheets, maps, and sketches of that shot's Individual Shot Plan, which have been corrected or revised for the actual shot-hole use, loading, timing firing, and observed or recorded impacts.

The Contractor must submit for the Area Office's documentation a specific set of reports of all the actual information from an initiated shot pattern, including Test Blasts, required in the Individual Shot Report's format of the approved Master Blasting Plan. The record will provide all the pertinent aspects of the blast design including, but not limited to: the time, date and weather conditions at the blast's initiation; proposed shot holes that were abandoned; the actual shot holes' positions and elevations of stemming, loading, decking, its delay and firing sequence, and special considerations; the total weight of explosives and the maximum charge weight per delay for the pattern; all pertinent factors about signaling and providing the all-clear signal; the peak particle velocity of all seismographs; and, any delays to shot initiation and all blast impediments, including by not limited to, shot-hole rifling plumes, observed impacts from blasting, misfiring, and reports of damage from blasting. The Individual Shot Report will include or be followed with all the supporting reports from the shot pattern. Each Individual Shot Report will be signed by the Contractor's Blasting Specialist or Blaster in Charge, whoever initiated the shot pattern's firing. The Contractor must take such precautions as are necessary to prevent displacement, cracking or damaging the rock outside the prescribed limits of dredging or excavation. The rock outside the limits of the dredging must be left in as sound and undamaged a condition as possible.

a. The Individual Shot Report may be developed in a format that easily provides data that remains the same from the proposed design of the Individual Shot Plan and the actual shot information for the shot's supporting reports and in the Daily Blasting.

b. The Individual Shot Record includes, as a minimum, the following items:

    (1) The shot pattern's name/number, coordinate locations of the outermost holes of the shot pattern, any specific purpose for the shot, the anticipated time, date, weather conditions, water conditions and its elevation at the time of the shot;

    (2) The total number of holes to be shot, the shot-hole diameter, the total weight of explosives, number of delays, load density and powder factor for the shot, the maximum charge weight per delay, the closest approach, scaled distance and recorded PPV and airblast overpressures at each monitoring location;

    (3) A large-scale plan map depicting the layout of shot hole pattern, timing, and delay sequence;

    (4) A tabular listing, which may be a printed spreadsheet page, by the loaded shot hole in the ascending total delay time order by the describing: row and number within the row of the shot hole, total delay time, the total charge weight of explosive materials for the entire hole, the largest charge weight of any deck within a hole on a separate 25-ms delay if any, top of sound rock elevation, bottom hole elevation or the top of stemming elevation at the bottom of a shot hole that was over-drilled in depth and backfilled, stemming elevations, and detonator, primer and booster elevations in the hole;

    (5) The recorded PPV and airblast overpressure at each seismograph location and the lateral close approach distance from the shot pattern to each seismograph;

    (6) The removal and disposal of all shock cord/tubing and initiation transmission-line debris immediately following the shot[; each required safety, protective, and natural-resource action conducted

for the initiated shot with their supporting data];

(7) A short narrative of any peculiarities or impediments or adverse impacts or accident/misfire with the shot, if any;

(8) The name, title, and signature of the Blasting Specialist providing the form with the date of the signature.

3.6.4.1 Drilling Logs

The Blaster in Charge or a Blaster with the assistance of the driller will log each shot hole, as the hole is being advanced. No drilling will be initiated without the Blaster in Charge or a Blaster to log the hole by a measurement means of drill bit's depth, the downward rig pressure, advancement rate of drilling, and air-water return of cutting with the driller's full assistance. The log must record the material encountered at the drill bit's depth to a precision of 0.03 m 0.1 ft. The drilling for each shot hole must be assessed to determine, and the log must record, the vertical depth/elevation of encountering sediment, weathered rock, the Top of Firm Rock, and voids to the total drilled depth. The shot-hole logs for all the shot holes in a shot pattern must be provided at the same time as the Individual Shot Report. An acceptable sample drilling log is provided in EM 1110-2-3800.

3.6.4.2 Individual Shot Vibration Monitoring Report

After each shot, submit an Individual Shot Vibration Monitoring Report, which will require the use of blast seismographs, to measure the vibration created from the blasting activities. Submit the Individual Shot Vibration Report to the Contracting Officer by or before Noon of the second business day following the shot, which is being reported. Submit each Individual Shot Vibration Report as a signed paper copy and in digital form to the e-mail listing required by the Contracting Officer. This will be provided at the pre-construction meeting.

Direct the specialty firm providing the seismic specialist, with approval of the Contracting Officer, to place blast seismographs, consisting of three component seismographs, (1) at important structures, and (2) other locations designated by the Contracting Officer. At least [three] [_____] seismograph locations will be required for every blast during this project.[Place additional seismographs at each specified monitoring locations.]

Samples of possible Individual Shot Vibration Report formats are in EM 1110-2-3800, pp B-9 and B-10. The minimum required information to be submitted in the Individual Shot Vibration Report includes:

a. Date and time of recording from each seismograph;

b. Type (brand and model) of three-component seismographs used, serial #, and position name;

c. Who performed, and the date of, the most recent calibration of each seismograph, and its sensitivity;

d. The firm and employee who placed the blast seismograph;

e. Seismograph installation procedures to prevent disturbance during monitoring, vandalism, and damage, and whether the seismic data is being telemetered or downloaded individually;

f. Set trigger levels;

g. Maximum for each of the three, component PPV in units of centimeters per second (cps) inches per second (ips), the maximum total vector-sum peak particle velocity in units of centimeters per second (cps) inches per second (ips), and a log-log graph of all maximum total vector-sum peak particle velocity versus square-root scaled distance in units of sqr meter/kilogram (sqr m/kg) sqr feet/pound (sqr ft/lb) for all seismic records of all prior shots for this project;

h. A graph of the PPV versus frequency for each seismograph location that triggered;

i. The maximum airblast overpressures in units of kilopascals (kPa) pounds per square inch (psi) at any triggered monitoring location and the results from noise tests before blasting in the first report;

j. A narrative description of any peculiarities or impediments or adverse impacts or accident/misfire for the shot; and,

k. The name, title, and signature of the Seismic Specialist processing and interpreting the data and providing the report with the date of the signature.

3.6.4.3 Individual Shot Videos

The Contractor will make a video recording of each shot pattern in a clear and consistent manner. Video recording must include date, time, and location. The digital video file must be furnished with the Individual Shot Report in a format noted within the Master Blasting Plan and approved by the Contracting Officer. The submission must be made to the Project Office and to all on the e-mail address listing. A library of blast videos will be maintained for all blasts and will be readily cross referenced with individual blast plans and post blast evaluations.

3.6.4.4 Reports of Required Safety, Protective, and Natural Resource Programs

Specify the data submission for required safety, protective, and natural-resource actions. A summary report must be submitted by noon [2] [_____] business days after the shot of the [special monitoring of a critical or essential facility or of a government or commercial structure, [and][or] an avian or mammalian watch program for assurance that a shot is not initiated at a time when the cited species is present, [and][or] underwater pressure wave monitoring, [and][or] other agreed/negotiated program].

3.6.5 Daily Blasting and Removal Log

The Contractor must submit a Daily Blasting and Removal Log, both in writing to the Contracting Officer and by e-mail distribution to the required e-mail addresses, on the next business day. The Daily Blasting and Removal Log summaries all the drilling and blasting activities, surveying, dredging [and][or] removal of spoils, and disposal operations for any day that one or more of those operations were conducted. The Daily Blasting and Removal Log will be signed by the designated representative of the Contractor, approved in the Master Blasting Plan.

3.7 DRILLING AND BLASTING

3.7.1 Underwater Shot Holes

No drilling will be initiated without the Blaster in Charge or a Blaster to log the hole and confirm the proper positioning of the shot hole. For underwater blasting, the Contractor must be prepared to: drill; log the hole; resolve the units encountered in drilling; reassess the Shot Plan's intent for that particular shot hole; load explosives, boosters, initiators and delays, place stemming in sound rock; and raise the firing line. If a shot hole cannot be drilled or cleaned out, the Contractor will be required to re-drill that shot hole or properly correct the shot design to delete that hole.

3.7.2 Shot Hole Logging

The Blaster in Charge or a Blaster will log each drilled hole, as the hole is being drilled. The Blaster in Charge or a Blaster will log the shot hole by a measurement means of drill bit's elevation, the downward rig pressure, advancement rate of drilling, and air-water return of cutting with the driller's full assistance. The shot holes must be logged during drilling and measured upon completion with a weighted tape for its full depth before any explosives are loaded into any of the holes.

If any holes are too deep, then these holes will be filled to the proper depth with stemming. Repeated, significant voids, 0.2 m 0.5 ft or larger, must be reported to the Contracting Officer. The Blasting Consultant may need to assess the issue of voids. Should voids become confinement issue blasting will be delayed until the Contracting Office is satisfied that potential problems related to blasting around the void have been properly addressed.

3.7.3 Stemming

All shot holes must have appropriately sized stemming material of the proper vertical placement length to optimize the blast design. Loss of explosive confinement can be due to improper stemming material type and poorly placed stemming. Tamped stemming must be placed from the top of firm rock (or hard material), as determined from the drilling log, to the top of the explosive charge. Stemming must also be used to fill voids, if any, as noted on the drilling log of that shot hole.

3.7.3.1 Stemming Material

Stemming must consist of well-graded, crushed, angular stone without fines. The gradation of the crushed, angular stone is between 3.0 mm 1/8 inch and 10.0 mm 3/8 inch in diameter. No soil or drill cuttings or rounded particles of the noted grading may be used as stemming material.

3.7.3.2 Length of Stemming

The minimum vertical length of tamped stemming within rock, or hard materials, of a shot hole must be the greater of 0.60 m 2.0 ft or eight times the shot hole's diameter. This minimum length of stemming must be placed in firm rock, or hard materials, to contain the gaseous products of detonation both below the top of firm rock and on either side of (above or below) voids, if any, with an explosive charge.

3.7.4 Loading Shot Holes

Stemming, decking, shot hole explosives' loading, and shot plan revisions for each shot hole must be made upon completion of drilling to the total depth from the logging of that underwater shot hole. Resolve whether to abandon the shot hole or load the hole from the Shot Plan's intent and the information resolved by the shot hole's log.

3.8 IMPACT MONITORING

Monitoring of the blasting may be required for public safety or natural-resource protection. The Contractor will be responsible for the payment and services of one or more, independent, third-party firms to conduct the required monitoring. The Contractor will make available the schedule and blasting documents to coordinate with other specialists monitoring issues for: the public's safety; environmental concerns for air, water, and property; natural resource protection; and the safety of structures and features.

****

NOTE: Delete inapplicable sections. The coordination with other federal, state, and local jurisdictions and agencies, the public, and private entities must be completely resolved before finalizing the specifications.

****

3.8.1 Public-Use Area Effects

The Contractor will provide personnel, patrolling vessels or vehicles, and the signage necessary to assure safe distances from all shot patterns are maintained and physically monitored at public-use areas on land or on water, and at occupied structures or highways or other features requiring control.

3.8.2 Airblast and Seismic Monitoring

****

NOTE: Determine the number of seismographs required for the project by the nearer structures or features to protect and their general azimuthal direction. Every blasting program should have at least three blast seismographs deployed. More seismographs may be needed at the project temporarily for green concrete or other temporary considerations or by the request of the Contracting Officer. While airblast is rarely a concern for underwater blasting, airblast should be recorded at a minimum of three seismograph locations in different azimuthal directions.

****

Airblast and vibration monitoring must conform to current industry standards and use equipment developed for blast monitoring. The Contractor will hire a subcontracted specialty firm, independent of the Contractor's firm and other sub-contractors to locate, maintain, and record the airblast and vibrations from every shot. The subcontracted seismic firm through their employee, the Seismic Specialist, will monitor the [three] seismic positions shown on the plans or accepted by the Contracting Officer. Additional seismographs may be required temporarily for (green) concrete placement or other temporary considerations or as required by the Contracting Officer for specific airblast or vibration issues due to blasting suspected at locations without seismographs. The seismic records and the Individual Shot Vibration Monitoring Reports will inform the Contractor of the actual airblast and vibration parameters from every shot and assure the government that the blasting has remained within the allowable airblast and vibration levels.

Provide 3 blast Seismographs capable of sampling rates of 15,000 samples per second or higher that meets ISEE PSBS. The 15,000 samples per second accuracy is required to acquire reproducible vibration readings. Each seismograph provided to the project must have been calibrated by the manufacturer within six months of its installation. No seismograph may be used at the project may have manufacturer's calibration longer than eleven months prior to its date of use. The units must be self-contained except for external geophones and microphones. The seismographs without erasing the stored data must be capable of telemetering the digital data or downloading the digital data to a portable device. The units must be programmed with specific data for each site of seismograph placement, which includes seismograph location, geophone burial or mounting method, calibration signal, date, and time of the record. The seismographs must be housed in protective enclosures, if vandalism or high-traffic concerns or weather or other conditions could limit the continuous, proper recording by the seismographs.

The blast seismographs must not be placed inside of a structure, unless required for the designated purpose and authorized by the Contracting Officer. The seismographs should not be placed near a structure unless the intent is to measure that particular structure's specific response to the blast. The microphone must be positioned to avoid wave reflections of the airblast from the vertical, front or side of a structure, wall or rock face. The microphone should be placed at a height of 0.91 m 3.0 ft. The geophone for each seismograph must appropriate for buried in soil or for being physically secured to rock or sidewalk or pavement or a concrete foundation.

The seismographs must be operated continuously beginning [seven] days before the first anticipated Test Blast. All The airblast and vibration amplitudes' maximal, frequencies of those amplitudes, repeated occurrences, and other parameters for the first period of operation before the first Test Blast will be reported as the project's background conditions in the first Individual Shot Vibration Monitoring Report.

The seismographs must be operated continuously until the excavation has been approved by the Contracting Officer. The seismograph may be removed from the project and replaced after their initial deployment, if there will be no blasting for a period of seven days or longer and if there will be no explosives stored onsite during that period.

3.8.3 Individual Shot Videos

Record every shot pattern's blast with Full High Definition, 1080p, digital video recordings with a minimum of 30 frames per second from two designated locations, approximately perpendicular to one another, that provide side and front or rear views of the blast and area above it. The video images must not contain any other text than the shot number. Include metadata consisting of the blast ID, date, and time of the blast. Index the two video recordings to properly identify each blast. Submit the proposed locations of the two video recorders on a map with the Individual Shot Plan. Furnish electronic file copies of video recordings on the sFTP within 24 hours of a blast. If the Contracting Officer requests that a copy of the video be submitted earlier, then deliver a copy within one hour of the request. Maintain a digital video library of all blasts.

3.8.4 Air, Water or Land Protections

The Contractor will assure that all escaping or released gases, fluids, and solids are within applicable limits of all federal, state, and local laws, regulations, ordinances, and guidelines. Any releases of fluids or solids that are not such limits will be immediately reported, mitigated, retained, and removed from the project.

****

NOTE: This section should emphasize the importance of recovering all shock tube. Additional details could include typical methods of recovery and best practices for the containment of shock tube.

****

The Contractor will remove all shock cord/tubing and initiation transmission-line debris immediately following each shot. Submit means and methods for removal in Master Blasting Plan.

****

NOTE: Delete inapplicable NATURAL RESOURCE ASSESSMENTS, MITIGATION AND MONITORING paragraphs that are not required by coordination with other federal, state, and local jurisdictions and agencies, the public, and private entities, which must be completely resolved before finalizing the specifications. Each of the paragraphs for Natural Resources will require a design by a qualified professional(s), who has experience with such activity(ies). The activity's paragraph text for the Contractor's action must be written for the specific project and unique Natural Resource requirements. None of these activities or other possible required actions or coordination by the Contractor have generic or standard approaches, much less narratives. The Contractor may be required to hire a specialty contractor to perform the designed assessment, mitigation, or monitoring, or to coordinate the blasting with an external organization responsible for the activity.

****

3.8.5 Natural Resource Assessments, Mitigation and Monitoring

[_____]

3.8.5.1 Fish-Repelling Noise

[_____]

3.8.5.2 Watch Program

[_____]

3.8.5.3 Post-Blast Fish Surveys

[_____]

3.8.5.4 Air-Curtain Mitigation

[_____]

3.8.5.5 Underwater Overpressure Monitoring

[_____]

3.9 EXCAVATION VERIFICATION

****

NOTE: This Blasting Section presumes that the excavation(s) will fully achieve the required vertical and lateral limits. This paragraph references the location of the verification procedures by its section in the specifications.

****

Conduct the verification of the completed excavation, as specified in Section [EXCAVATION], Paragraph [SURVEYS].

3.10 SUBMERGED MATERIAL DISPOSAL

****

NOTE: The Guide Spec presumes that material disposal will properly place any onsite material disposal. This paragraph references the location of the material disposal procedures by its section in the specifications.

****

Transport and place all dredged, displaced, or excavated materials within the limits of the disposal zones below the specified elevations, as specified in Section [DISPOSAL].

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 23 06.00 (February 2021)**
Change 1 - 11/21

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 23 06.00

BLASTING - SURFACE

02/21, CHG 1: 11/21

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-31 23 06.00 (February 2021)**
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Preparing Activity: USACE **New**

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References are in agreement with UMRL dated January 2025

****

SECTION 31 23 06.00

BLASTING - SURFACE

02/21, CHG 1: 11/21

****

NOTE: This guide specification covers the requirements for blasting at the ground surface and the avoidance of adverse impacts for any use of blasting, most commonly rock excavation. If during the contract period any of the materials being blasted and excavated are known to be, or may possibly be, near a water body or below water, also refer to Section 31 23 01 UNDERWATER BLASTING. For projects on a naval facility, consult with local NAVFAC office, Naval Ordinance Safety and Security Activity (NOSSA), and NAVSEA on requirements. NAVSEA OP5 Ammunition and Explosive Safety Ashore manual dictates many of the requirements and NOSSA has the final determination on any blasting on a Navy installation above or underwater. Reference NAVSEA OP5 manual and contact local Explosives Safety Officer and Planner for the base prior to revising the specification. Overall NOSSA approval process can take 12-18 months depending on the level of approval required.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Consult with a District Office that has most recently completed a similar type of blasting, while editing this section, to be appraised of recent, specific requirements, guidance, blasting developments or understandings for the subject project.

Consult with or have Specification reviewed by a Subject Matter Expert in Blasting for projects involving Blasting as a primary means of removing materials or where Blasting issues are particularly challenging.

There are likely decisions and/or requirements of other agencies, the Safety Manual, and/or internal offices/divisions/ branches, which could have an influence upon a project's blasting specs. Some of these issues may be: concerns from federal, state, and local jurisdictions and agencies; public use of nearby federal, state and/or local properties near the project; evaluations of acceptable vibrations and/or pressures affecting individuals or reaching nearby structures; natural resource impact reviews, negotiations and/or requirements; constraints on the drilling or blasting procedures; pre-blast inspections; special studies to facilitate lower cost of the bids or to encourage more bid submissions; the acquisition strategy for the payment; and, other concerns specific to the project.

This blasting guide specification covers the blasting of rock and including mucking. The details on excavation are typically covered by a separate Rock Excavation specification.

The following information will be indicated on the project drawings:

1. Surface elevations, existing and new;

2. All utilities, whether trenched, buried, at the surface or overhead to distances well beyond the project's limits;

3. Location and record of all soil and rock borings and test pits, including soil and rock classifications and their properties, weathered rock, bit drops and voids, ground water observations, and topsoil thickness encountered in boring;

4. Location and limits of hard material, whether rock or concrete, or other building materials;

5. Excavation or demolition limits, and clearing,

stripping and grubbing limits, and tolerances of excavation;

6. Details of any special limits that may require line drilling, presplitting, reduced subdrilling, and/or specialty blasting practices;

7. Location of borrow and disposal area, if located on Government property; or on site (as some sites may or may not remain government property, and disposal sites may be under control of project partners);

8. Hydrological, hydraulic and impoundment data, where applicable; and,

9. Details of all rights-of-way within the project boundaries.

****

****

NOTE: The coordination with other federal, state and local jurisdictions and agencies, the public, and private entities must be completely resolved before finalizing the specifications. A project's excavation and/or foundation requirements, for which, dense materials are being removed, may require navigation, highway, structural and/or other regulations and codes to be followed. Depending upon the proximity of public-use areas, private residences or businesses, and the project's location within a county or township, various accommodations will need to be required for the protection of the public, and the safety of private entities in regard to local laws, regulations and ordinances. Avoiding natural resource impacts may overlay other measures and require: seasonal or daily time limitations of the initiation of the individual blast patterns; special observers for some or all the blasting; special studies or monitoring while the blasting is being conducted; and, other potential considerations.

Agency coordination will vary by project. Be certain that all government stakeholders have been involved with planning of the project and approved of all requirements for the specifications. List those important navigation or safety stakeholders. When there are navigable waters near the excavation zone, list in the controlled navigation perimeter's distance during the warning period of a shot. While the distance is project specific, the minimum distance is typically 300 m 1,000 ft.

It is essential that the agency/service person, using these Guide Specifications to prepare Plans and Specifications coordinate with the planners and environmental compliance specialists within their agency/Service to ensure that all the blasting

restrictions and mitigation measures are incorporated into the Plans and Specifications. Failure to comply with the requirements of Federal or state laws and regulations could result in project delays or stoppages.

****

1.1 SCOPE

The breakage of rock and hard/unyielding materials may be conducted by any means unless otherwise stated herein. If the contractor elects to use drilling and blasting for breakage or displacement of any units, this entire section is applicable and covers activities associated with drilling and blasting for rock excavation at the surface. Contained herein are procedures for all activities relating to drilling; blasting and the transportation, storage and use of explosives; breakage and displacement of rock. The Contractor's blasting program and methods are those necessary to accomplish the excavation shown on the Contract drawings in accordance with the provisions specified herein. Control the quantity of explosives fired in all blasting to prevent injuries to persons and to avoid damage to all structures, properties, governmental and nonprofit entities, commerce and businesses, and natural resources and their habitat.

1.2 RELATED WORK SPECIFIED ELSEWHERE

****

NOTE: List any specifications that are related, such as Earthwork, Excavation, Rock Bolts, Temporary Environmental Controls, Shotcrete, Natural Resources, are typical specs related depending on the project.

****

Section 01 33 00 SUBMITTAL PROCEDURES

1.3 REFERENCES

****

NOTE: These publications are not all inclusive, and it must remain the responsibility of the Contractor to obtain, know, and comply with applicable Federal, State, and Local regulations not included in the references. In case of a conflict between the regulations and specifications, the Contracting Officer will determine which applies.

Add and remove references as needed for the project. Reference the appropriate state regulations on blasting for where the project is to occur.

This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D5434	(2012) Field Logging of Subsurface Explorations of Soil and Rock
ASTM D6032/D6032M	(2017) Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISEE PSBS	(2017) ISEE Performance Specification for Blasting Seismographs

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.109	Explosives and Blasting Agents
29 CFR 1926-SUBPART U	Blasting and the Use of Explosives
49 CFR 177	Carriage by Public Highway

1.4 DEFINITIONS

****

NOTE: Delete definitions that will not be used in the specification text for a specific project. A complete list of blasting definitions can be found in the GLOSSARY of the EM 1110-2-3800 and other references. Recommend only using definitions not already in GLOSSARY in the EM and definitions to further the define the work on the specific project in the specification. It may be necessary to add definitions depending on what the Earthwork and/or Excavation specifications for the project have terms

for Rock, Weathered Rock, Sound Rock, Voids, Sediment, etc.

****

1.4.1 Blast Site

The area where explosive material is handled during the loading of blastholes, including 15.2 m 50 feet in all directions from the perimeter formed by loaded holes. A minimum of 9.1 m 30 feet may replace the 15.2 m 50 feet requirement if the perimeter of loaded holes is marked and separated from non-blast site areas by a barrier. The 15.2 m 50 feet or 9.1 m 30 feet distance requirements, as applicable, apply in all directions along the full depth of the blasthole.

1.4.2 Blast Area

The area of a blast within the influence of flying rock and eject gases, and concussion that may cause injury to persons or property.

1.4.3 Buffer Zone

Buffer Zone is defined as a designated section of rock between a slope to be formed by line drilling or pre-splitting during excavation and the production blast. The explosives in each blast hole and the burden in the buffer zone must be reduced to prevent damage to the final rock slopes.

****

NOTE: Choose one of the following sentences depending on when to shoot the buffer holes, sometimes it is appropriate to shoot them as a separate shot in order to further control the excavation and prevent backbreak.

****

[The buffer zone blastholes must be fired in sequence after the adjacent production blastholes.

][The buffer zone blastholes must be fired as a separate blast, after the adjacent production shot.

]

1.4.4 Controlled Blasting

Controlled blasting refers to blasting techniques used to better distribute the explosive charge to minimize impacts such as fracturing and loosening of the rock beyond the design excavation line (overbreak). This is accomplished by using small diameter, decoupled charges in closely spaced blastholes placed on the perimeter of an excavation. Methods including but not limited to line drilling, and pre-splitting (pre-shearing) cushion blasting, and buffer zone blasting.

1.4.5 Flyrock

****

NOTE: Choose the distances for the project, the typical values are listed. Edit definition as needed for project site.

****

Flyrock is defined as any airborne rock flying more than 61 meters 200 feet horizontally or 12 meters 40 feet vertically from the blast or if flyrock travels more than one-half the distance between the blast and the Contractor work limits, whichever distance is the lesser.

1.4.6 Green Concrete

****

NOTE: If no concrete placement is expected on the project then delete this definition. If concrete placements will occur when blasting operation is ongoing, further define green concrete here and include appropriate thresholds and monitoring for the green concrete in Part 3. There needs to be limits on vibrations when there is green concrete because of the strength loss due to vibrations while curing. Involve the Structural Engineer project development team members in these determinations.

****

Concrete that has undergone initial setting but has not hardened to design strength. Green concrete also includes the materials of shotcrete or cementitious grouts. Each Individual Shot Plan is required to consider vibrations emanating from its blast reaching the location of the reported newly placed concrete to remain below allowable vibration levels depending upon the age of the concrete. Note the paragraph Green Concrete.

1.4.7 Line Drilling

Line drilling is defined as a controlled excavation technique consisting of a series of closely spaced holes (spacing minimum of twice the hole diameter) that are either not loaded with explosives or lightly loaded and are drilled along the excavation line. The line drill hole spacing must be no greater than twice the hole diameter.

1.4.8 Pre-Splitting

Pre-splitting is defined as a method of controlled blasting utilizing a row of closely spaced, (typically 30 centimeters 12 inches or larger), lightly loaded blastholes placed on the perimeter of the excavation and fired before the production blast. The purpose of the pre-split blast is to form a crack between blastholes without serious damage, overbreak, heaving or cracking of the final wall.

1.4.9 Precision Pre-Splitting

****

NOTE: The loading density for precision pre-splitting holes needs to be evaluated and selected based on project design. The value may be reduced accordingly.

****

Precision pre-splitting is defined as a special pre-splitting method which utilizes closely spaced blastholes (61 centimeters24 inches or less center to center) with light explosives loads (no more than 0.5 kilograms 0.2 pounds of explosive per .3 meter foot of blasthole) to supply only sufficient energy to shear the web of rock between holes without any damage to the Presplit wall.

1.4.10 Airblast

Airblast are the overpressure waveforms that move though air as audible and sub-audible sound waves. These are also called compression waves.

1.4.11 Vibrations

Vibrations are one of the three, primary adverse impacts from blasting. Vibrations are the result of various wave forms emanating from the detonation or deflagration of ignited materials from a shot pattern. Peak particle velocity (PPV) is defined as the maximum absolute value among the three ground vibration velocities measured in the vertical, longitudinal and transverse directions over the period of a record. Peak, total vector-sum particle velocity is the peak value over the full-time history of each time-unit's value of the square-root sum of the squared, component velocities. Velocity units are expressed in centimeters per second (cps) or inches per second (ips).

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Blasting Consultant's Qualifications; G, [_____]

Vibration Monitoring Specialty Firm; G, [_____]

Structural Inspection/Evaluation Technician; G, [_____]

Blasting Safety Plan; G, SO

Master Blasting Plan; G, [_____]

Survey Control Plan; G, [_____]

Test-Blast Plan; G, [_____]

Pre-Blast Surveys; G, [_____]

Public Notice Of Blasting Operations

SD-03 Product Data

Seismographs; G, [_____]

Lightning Detection Device; G, [_____]

SD-05 Design Data

Individual Shot Plan; G, [_____]

SD-06 Test Reports

Individual Shot Reports; G, [_____]

Post-Blast Surveys

Individual Shot Videos

Drilling Logs

Individual Shot Monitoring Report

SD-07 Certificates

Blasting Consultant; G, [_____]

Blasting Specialist; G, [_____]

Blaster In Charge; G, [_____]

Blasting Administrator; G, [_____]

Magazine Keeper; G, [_____]

Structural Inspection/Evaluation Technician; G, [_____]

Seismic Specialist; G, [_____]

1.6 COORDINATION

****

NOTE: The following paragraph can be used if working with multiple stakeholders/owners.

****

Blasting will be in the vicinity of the [existing lock, railroad, and highway, and river barge, train, hospital highway traffic, utilities and businesses] and their operation will not be impeded or delayed beyond that which has been coordinated with [TVA, U.S. Coast Guard, U.S. Army Corps of Engineers - [_____] District, [_____] environmental or natural resources offices, [_____] Department of Transportation, local government entities, [[_____] Railroad, regional or local utilities, and/private businesses]]. Include a coordination and traffic control sub-plan as part of the Blasting Safety Plan, with the appropriate authorities that mitigates navigation and traffic delays in the Master Blasting Plan.

Coordinate, through the Contracting Officer, with other Contractors working onsite to minimize work stoppages during blasting.

1.7 LIABILITY

Compliance with provisions in the contract will not relieve the Contractor of their responsibility for any damages or injuries caused by, related to or arising out of blasting or associated blasting activities. The Contractor assumes all liability and hold and save the Government, its agents, officers, and employees harmless for any and all claims for personal injuries, property damage, or other claims arising out of or in connection with the handling of explosives or blasting under this contract.

PART 2 PRODUCTS

2.1 STORAGE AND USE OF EXPLOSIVES

2.1.1 General

****

NOTE: The specification writer may choose to list reasons the Contracting Officer may restrict blasting but not always necessary. Confirm and follow federal, state and local regulations and guidance on the transport, storage and use of all Explosives. State and local agencies and/or authorities may not easily allow the receipt of Explosives in a timely manner. State and local agencies and/or authorities may have specific reporting, certifications, adverse impact concerns, or distance regulations from the blast zone to private properties governing the use of Explosives. The Agency/Service may wish to allow storage of Explosives on federal premises. The winning contractor should independently assess and cite in the Master Blasting Plan all federal, state and local laws, regulations, ordinances or authorities that impact the transportation and storage of Explosives.

****

Store, transport, handle, use, and otherwise secure explosives in accordance with best practices as approved by the Contracting Officer and in accordance with all Federal, State and Local laws and regulations. Comply with all special rules, regulations and ordinances that may be made by the authorities having jurisdiction, or by the Contracting Officer, regarding construction of, and storage in, magazines and precautions in handling and transporting explosives for blasting. Times and imposed restrictions concerning the use of explosives must be conducted in accordance with local, State, and Federal regulations. The Contracting Officer reserves the right to establish further restrictions or time windows when blasting will not be allowed beyond the Local, State, and Federal requirements; these windows may include times of day of high traffic volumes, times when school traffic is present, or during funerals. The Contractor is responsible for all claims for damages and injuries caused by or arising out of blasting activities. Perform all blasting operations in accordance with the current edition of EM 385-1-1.

2.1.2 Blasting Products

****

NOTE: This paragraph may need to be adjusted, some projects it is not appropriate to allow bulk explosives, such in karst because the bulk explosives could fill voids if care is not taken while loading to monitor the amount being added to each hole.

****

All blasting caps used on the project must be one year or less of age. Millisecond delay, [shock tube] initiators, must be used as the initiation system. To ensure the accuracy of firing times of blasting caps, it is required that each cap period come from one lot number. Mixing of lot numbers for any one cap period is strictly prohibited. All explosives used on the project must be six months or less of age or no older than one half the shelf life shown on the explosives manufacturer's technical data sheet for that product. Cartridged [and bulk] explosives may be used in different sections of the project. Ammonium nitrate and fuel oil (ANFO) is not allowed in wet environments.

****

NOTE: In projects where controlled blasting techniques are required to produce final walls which require presplit blasting, only explosives designed for this application must be allowed. Ammonium nitrate and fuel oil (ANFO) is not to be allowed in wet environments. Consider requiring cartridge explosives within a specified distance from any new structure which requires neat excavation lines; i.e. "Bulk explosives such as ANFO or bulk emulsion or emulsion blends will not be allowed for production blasts at the area of the Labyrinth Weir foundation or within 61 meters 200 feet of it or within 15.2 meters 50 feet of presplit walls."

****

Explosives that do not meet the manufacturer's specifications must not be used. When, in the opinion of the Contracting Officer, any blasting product is either of excessive age or appears to be in a deteriorated condition, all work must cease until the products age and quality can be determined. Blasting products without date and batch codes will not be permitted on site. The Contracting Officer may require any product to be tested by an independent organization to determine its performance as compared to the manufacturer's data sheet. If product performance or composition deviates by more than 10 percent in any manner from the manufacturer's data sheet, that lot number will be rejected. The Contractor is responsible for any required testing and no additional compensation will be made for any product testing directed by the Contracting Officer.

2.1.3 Magazines

****

NOTE: Two paragraph options here first paragraph is for where explosives must be stored off site (off site magazine). The other covers the storage of explosives onsite. The designer will need to ensure these requirements are fully detailed and the appropriate regulations are followed.

****

Explosives must be stored offsite. Obtain all necessary Federal and State magazine permits. Magazines must be located at safe distances as defined by the Bureau of Alcohol, Tobacco and Firearms (ATF) in addition to the State of [_____] requirements. There must be no permanent explosive storage or overnight explosive storage on site. Procure off-site explosive storage and expect to have daily explosives deliveries to the site. Secure a permit to transport explosives from the [_____] Highway Patrol when the amount of explosives to be transported exceeds 454 kilograms 1000 pounds, and transport explosives in accordance with 49 CFR 177 when carried on public highways.

****

NOTE: If explosives will be stored in an onsite magazine, it will be required to follow the requirements in EM385-1-1, including a submittal for an Explosive Site Safety Plan and the following paragraph can be used.

****

Explosives may be stored onsite. Obtain all necessary Federal and State magazine permits. Magazines must be located at safe distances as defined by the Bureau of Alcohol, Tobacco and Firearms (ATF) in addition to the State of [_____] requirements. Secure a permit to transport explosives from the [_____] Highway Patrol when the total weight of explosives to be transported is less than 454 kilograms 1001 pounds, and transport explosives in accordance with 49 CFR 177 when carried on public highways.

2.1.4 Magazine Keeper

Each magazine keeper must be experienced and familiar with the laws and general practices concerning the handling, care, use, and storage of explosives and detonators. The magazine keeper is responsible for maintaining a cleared area around each magazine. The magazine keeper will not be required to perform any duties that will in any way interfere with their duties as magazine keeper, and being physically present at the magazines for every entry to the magazines for delivery, disbursement and review of explosives at the magazines. If explosives are delivered and returned daily from the manufacturer or supplier to the project, the driver of the truck will serve as the magazine keeper.

PART 3 EXECUTION

3.1 GENERAL

****

NOTE: This paragraph should agree with the designations under paragraph SUBMITTALS, the Master Blasting Plan will always be for approval. The Individual Shot Plan may be approved ("G") or accepted ("FIO").

****

Obtain approval, or revise for approval, of the submitted Master Blasting Plan and Individual Shot Plans, acquire all required permits, and comply with all laws, regulations, ordinances, applicable safety code requirements, and regulations relative to the transportation, handling, storage, and use of explosives and the protection of life and property. Perform vibration and airblast monitoring at the Contracting Officer's specified locations to record blast effects. The peak particle velocity must be limited to the values in Paragraph BLAST EFFECTS MONITORING in these specifications. Minimize rock over-break and blast damages beyond the design excavation line. The Contracting Officer will, always, have the authority to prohibit or halt the blasting operations, if it is apparent that the required lines and grades and stable rock slopes are not being obtained with the methods being employed.

3.2 SAFETY PROCEDURES

3.2.1 General

Ensure all work completed under this Contract is executed safely. Follow the safety procedures outlined in EM 385-1-1. EM 385-1-1 will govern all activity unless more stringent safety requirements are specified here and in other applicable Federal, State, and local laws, regulations, and ordinances.

3.2.2 Weekly Coordination Meeting

Coordinate all blasting schedules with the Resident Engineer's Office at least one week in advance and hold a weekly blasting coordination meeting with the Resident Office. Provide an agenda for the blasting coordination meeting that lists the prior week's shots, the forecasted shot schedule and displays a scale site plan showing the locations of the scheduled shots. The Blasting Specialist, Blaster in Charge, and Seismic Specialist are required to participate in discussion of agenda items and lessons learned.

3.2.3 Public Notice of Blasting Operations

At least thirty calendar days, and prior to any blasting operations, prepare and submit to the Contracting Officer a public government notification letter of the proposed blasting activities. The Government will distribute copies of this notification letter by certified mail to law enforcement, local governments, public utilities, public users of project recreational facilities, and residents and commercial interests located within 0.8 kilometers one half mile of the blast site. This notification letter must contain at minimum:

a. Name, address, telephone number and e-mail address of the Contractor;

b. Plan maps identifying the specific areas in which blasting will take place, and major and secondary roads, geographic features and auxiliary features;

c. Proposed duration of blasting activities, and on which days of the week and hours of the day that blasts can be expected to occur;

d. Vehicular and pedestrian traffic control measures to be taken;

e. Methods to limit access to the blasting area; and,

f. Types, patterns and duration of audible warning and all clear signals to be used before and after blasting.

3.2.4 Public Meetings

****

NOTE: Communicate with the project manager and stakeholders about whether specific requirements for a meeting or multiple meetings are needed. It may be necessary to advertise the meeting in a local newspaper and specify the meeting room capacity.

****

Fifteen calendar days prior to any blasting operations, provide the approved Seismic Specialist, Blasting Specialist and Blasting Consultant to attend a public relations meeting to be conducted on an evening to be determined by the Contracting Officer. This meeting will inform the public about the anticipated blasting operations. The Blasting Specialist, Blasting Consultant and Seismic Specialist must make a short presentation of blasting operations and answer any questions pertaining to public concerns dealing with the blasting operations, the magnitude of seismic vibrations, airblast and potential for flyrock that may impact the public. Distribute points of contact for the public and local entities in the event of concerns related to the blasting program.

3.2.5 Warnings and Signals

Establish a method of warning all employees on the job site of an impending blast following the guidance of the EM 385-1-1. The signal must consist of a five-minute warning signal to notify all in the area that a blast will be fired in five minutes. A second warning signal must be sounded one minute before the blast. After the blast is over, sound an all-clear signal, after the blast site has been inspected for misfires by the Blaster in Charge to provide notification to all personnel in the area that the blasting operation is finished. No personnel other than the Blaster in Charge must enter the blast area until it has been determined to be all clear.

3.2.6 Time Restrictions for Blasting

****

NOTE: Research the specific State requirements. This paragraph will need to be tailored for the specific site conditions, for example, avoiding blasting during rush hours in the morning and afternoon. Most locations prohibit blasting on

Sunday but may allow on Saturdays and some Holidays.
****

Blast only during daylight hours, one-half hour before sunrise and one-half hour after sunset, and between 7 AM and 7 PM, local time, on weekdays and only during the approved time periods each day and at the same time each day, in concert with the approved closure time for area roads. No blasting is allowed on Saturdays, Sundays, or official holidays recognized by the Federal Government or the State of [_____] unless consent is granted by the State Fire Marshal. Drilling activities and blasthole loading are not time restricted, except as noted in Section 01 14 00 WORK RESTRICTIONS.

3.2.7   Traffic Control During Blasting

****
NOTE: This section should be edited for the specific project sites traffic control issues. Communicated with stakeholders and local utilizes, DOTs, Railroads, businesses during design phase to capture any special needs the Government will need to specify for the Contractor to carry out during blasting. This Paragraph is an example.
****

During blasting operations traffic may need to be temporarily halted to allow safe execution of blasting and possible removal of rock fragments and debris. Traffic control, including such delays must be the sole responsibility of the Contractor. Traffic control must be in close coordination with the [_____] Department of Transportation[and the town of [_____]]. Include the traffic control plans with the Blasting Safety Plan.

It is not anticipated that blasting activities will impact traffic due to the distance of the blasting from the road. The Contractor will need to coordinate with [_____] for blasting [_____]. In addition, use protective blasting mats for all shots [_____], unless otherwise directed by the Contracting Officer to minimize any fly rock near [_____] may be required, if, in the opinion of the Contracting Officer, flyrock becomes an issue. If traffic stoppages are warranted, coordinate with the Contracting Officer. A sentinel boat must be stationed [_____] of the work area to prevent any boaters from entering the blast area.

Recreational boats, swimmers, fisherman and the public, on land or in the water must be prohibited access within 762 meters 2500 feet of the blasting area. Station sentinel boats to prevent any boaters from entering the blast area.

3.2.8   Notification to Navigation

****
NOTE: Use the following paragraph when working in or near navigable waters or navigation lock.
****

Notify the lockmaster at [_____] Lock, the US Army Corps of Engineers, [_____] District, Navigation Branch a minimum of [14] calendar days prior to the commencement of blasting operations to allow for sufficient time to send out navigation notices. The information to be supplied will include the dates and time window of blasting operations.

3.2.9 Lightning Detection Equipment and Safety

Furnish, maintain and operate Lightning Detection Device during the entire period of blasting operations and during the periods that explosives are used at the site. Equipment must provide real time audio and visual alarm/signal and detection based on combined detection of electromagnetic, electrostatic, light wave spectral and audio disturbances, or a commercial service based on these as a minimum as approved. Equipment must be capable of detecting lightning within 40 kilometers 25 miles as minimum of the blast area.

****

NOTE: Obtain technical feedback from the rest of the design team for minimum lightning detection distance.

****

Provide the equipment after approval of lightning detection device. When and where the lightning detection device indicates a blasting hazard potential, immediately evacuate personnel from all areas where drilling is being conducted or explosives are present. When a lightning detector indicates a blasting hazard, perform the following:

a. Clear the blasting area of all personnel. Place guards at all access points to the blast area.

b. Immediately notify the Contracting Officer of the potential hazards and precautions being taken.

c. Terminate the loading of holes and secure the unused explosives to an approved location.

d. When the hazard dissipates, inform the Contracting Officer that the drilling and loading of holes will continue.

3.2.10 Check for Misfires

The Blaster in Charge must closely inspect the entire blast area for a minimum of five minutes following a blast to guard against rock fall before commencing work in the cut. The five-minute delay between blasting and commencing work is needed to ensure that no misfires have occurred. During the five-minute delay, it is the responsibility of the Blaster in Charge to go into the shot area and check all holes to make sure that all explosives have been detonated.

3.2.11 Misfire Handling Procedures

Should a visual inspection indicate that complete detonation of all charges did not occur, only critical personnel involved in the blasting operation or excavation of the unexploded material are allowed within the established blasting area. Restrict the site until the Blaster in Charge and the Blasting Specialist indicate the site is safe. If the misfire poses problems that cannot be safely corrected by the Blaster in Charge or the Blasting Specialist, a consultant or an explosives company representative skilled in correcting misfires must be called to resolve the problem. Compliance with this or any other provision in the Contract must not relieve the Contractor of responsibility for any damages or injuries caused by, related to, or arising out of blasting or associated blasting activities. Detail the misfire procedures in the Blasting Safety Plan including the distance of the restricted area when a misfire is discovered.

3.3 BLASTING PERSONNEL

3.3.1 Blasting Consultant

****

NOTE: Depending on the scope of the project, it may not be necessary to require a Blasting Consultant. This will be determined during design, an Agency/Service Blasting SME or Government Blasting Consultant should be consulted to discuss this. Projects where slope blasting, away from sensitive structures minor and lightly used public areas may be a consideration to not including this requirement. One option is to still require a blasting consultant to be engaged but only for reviewing the Master Blasting Plan and engaged on very serious issues with the blasting (exceedance of vibration and/or airblast limits, misfires, flyrock, or excessive backbreak and/or overbreak). Excessive backbreak will need to be defined prior to issue of the specifications. This specification is geared towards IFB (Invitation for Bid) where there is no mechanism to select contractors prior to award. If another contract mechanism is used it may be necessary to include the bracketed text requiring a letter of commitment from the consultant.

****

The Blasting Consultant, Blasting Specialist, Blasting Administrator, Blaster in Charge, and Vibration Specialist cannot be the same person. Retain a recognized Blasting Consultant to assist in the blast design. The Blasting Consultant must be approved by the Contracting Officer prior to the submission of the Master Blasting Plan. Submit the Blasting Consultant Qualifications including resume, experience, current blasting licenses, credentials and training of the proposed Blasting Consultant[, and a formal letter of commitment from the consultant verifying their availability on an "as needed" basis for the duration of the Contract prior to the award of the Contract]. The consultant must be an expert in the field of drilling and blasting who has derived their primary source of income by providing specialized blasting and blasting consulting services. The consultant must not be an employee of the Contractor, explosives manufacturer, or explosives distributor or any other sub-contractor. There must be no additional cost to the Government for the Blasting Consultant's duties, even when required by the Government.

****

NOTE: The paragraph below should be used when controlled blasting techniques are required.

****

The Contractor's Blasting Consultant with the Blasting Specialist must develop controlled blasting techniques to be utilized in the areas specified in the drawings during the Test Blasting program. The Blaster in Charge is responsible for the technical application of the controlled blasting methods specified during and following the Test Blasting. The Blasting Consultant must modify controlled blasting methods, as necessary, to meet safety requirements, airblast and vibrations limits, and protect the rock foundation. Proposed controlled blasting methods must be submitted to the Contracting Officer for approval.

The Blasting Consultant must review the Master Blasting Plan and Individual Shot Reports and attend the public meeting and be available for consultation on an "as needed" basis, as determined by the Contractor, Contracting Officer, or both. The Blasting Consultant is not required to be on the job site for review of the Master Blasting Plan or Individual Shot Reports. The Blasting Consultant must submit a short, signed Blasting Consultant's Report each month stating that the Blasting Consultant has briefly reviewed the Individual Shot Reports including blast videos, and any problems, concerns or errors in the reports were addressed. This report is due within [_____] days after the end of the month.

3.3.1.1 Blasting Consultant's Qualifications

The consultant must be able to demonstrate involvement in at least 15 projects with blasting. The consultant must have as a minimum the credentials and experience outlined below:

a. The consultant must have at least 20 [_____] years of experience in construction blasting within [_____] meters [_____] feet of protected structures, [natural resource concerns and environmentally sensitive areas], final presplit slopes or walls.

****

NOTE: "Natural resource concerns and environmentally sensitive" areas need to be defined elsewhere in this guide specification.

****

b. The consultant must be able to demonstrate that he has attended at least 15 short courses, seminars, or conferences on blasting technology, or university engineering class studies on blast design during the past 20 years including a complete understanding of blasting seismology with emphasis on vibration frequency, acceleration, and displacement (ground strain).

c. For the past 10 years the consultant must have derived their primary source of income from providing specialized blasting consulting services.

d. Project list will contain a description of the projects, details of the blast plans, and any modifications made during the project.

e. The names and telephone numbers of at least three project owners with enough knowledge of the projects to verify the submitted information.

f. The Blasting Consultant must be approved by the Contracting Officer prior to the beginning of any drilling and blasting work including submission of the Master Blasting Plan.

g. Hands-on experience as a blaster for at least three years, and

h. The Blasting Consultant, Blasting Specialist, Blaster in Charge, and Vibration Specialist cannot be the same person.

3.3.1.2 Issues Requiring the Blasting Consultant

If problems with vibration, flyrock, airblast, presplitting, or production blasting, or adverse impacts on natural resources occur the Contracting Officer will require the Contractor to immediately summon the approved Blasting Consultant and have their presence on site within 10 days after the problem develops for the following:

a. To approve the blasting plans for each individual blast.

b. To be present to review the blasthole layout on the ground before drilling begins.

c. Observe blasthole loading.

d. To sign each blasting plan and each Individual Shot Report, at no additional cost to the Government. The consultant must have full authority to stop or delay any blast the Blasting Consultant considers unsafe.

e. To submit and sign a written checklist that all necessary precautions were reviewed and followed by the drilling and blasting crews. The checklist must be as defined under the section on Individual Shot Reports. The signed checklist must be attached to each blasting report.

f. Submit Blasting Consultant's Reports after each site visit.

3.3.2 Blasting Specialist

Submit the Blasting Specialist's Qualifications including resume, experience, education, training, and valid blasting licenses of the Blasting Specialist for approval, at least 60 days before drilling and blasting operations commence. Detail the experience and training, which qualifies the specialist for work under this Contract. The duties of the Blasting Specialist are to prepare all necessary paperwork, to conduct quality control and to coordinate with the Contracting Officer on all issues dealing with blasting. The Blasting Specialist must be an employee of the Contractor on the job site each day.

a. The Blasting Specialist must have at least 10 years of verifiable experience utilizing controlled blasting techniques.

****

NOTE: Include this sentence under paragraph a. if the project requires precision presplitting: [and Precision Presplitting methods to create uniform presplit faces in mixed rock types like the bedrock strata present at the project site].

****

b. Within the last five years, the specialist must have completed at least five days of classroom training that has familiarized the specialist with the most current drilling and controlled blasting methods.

c. In the last five years he must have been responsible for the blast design or execution of large rock excavation projects similar in scope and complexity as this project.

****

NOTE: Include this sentence under paragraph a. if the project requires precision presplitting: [or projects where at least 30,500 meters 100,000 linear feet of Precision Presplitting was used].
****

d. Their credentials must include a list of the projects, including the location, duration, scope, description, geologic conditions, and the challenges that developed though the course of the projects and how the challenges were resolved.

e. Each project description must be accompanied with photos which exhibit the Blasting Specialist's competency and ability to create the designed cut slope configuration to the specified tolerances. The list of projects must also contain the names and phone numbers of the project owner or their representative, Contracting Officer, or project engineers who has enough knowledge to verify the submitted information. The Contracting Officer will invalidate any project submitted as reference that cannot be verified.

3.3.3 Blaster in Charge

****
NOTE: Some USACE projects may require an Alternate Blaster in Charge based on the frequency, size, and complexity of the blasting operations. The Alternate Blaster in Charge must meet the same qualification requirements as the Blaster in Charge.
****

Submit the Blaster in Charge's Qualifications including resume, experience, education, blasting licenses and training of the Blaster in Charge for approval, at least 60 days prior to the commencement of drilling and blasting. Also submit the Contractor's Federal ATF License. Detail the experience and training, which qualifies the Blaster in Charge for work under this Contract. The Blaster in Charge is responsible for preparing the Individual Shot Plans that will be approved by the Blasting Specialist. The Blaster in Charge is responsible for marking the blasthole locations for drilling, accounting for the relevant geology, loading the blastholes according to the Individual Shot Plans and firing the blast.

a. The Blaster in Charge must be a licensed blaster in the State of [_____] per that State's regulations or issuing agency.

****
NOTE: If presplitting, precision presplitting, or both, is included in the project, include paragraph below as an additional requirement for the Blaster in Charge.
****

b. Blaster in Charge will have at least [_____] years of verifiable experience utilizing controlled blasting techniques [and at least [_____] years of experience with "Precision Presplitting" to create uniform presplit faces with blasthole spacing at 61 centimeters 24 inches or less in variably weathered and fractured rock similar to the bedrock strata present at the project site].

c. Within the last five years, the Blaster in Charge must have completed at least five days of classroom training that has familiarized the Blaster in Charge with the most current controlled blasting methods.

d. Blaster in Charge must have been responsible for at least [_____] large rock excavation projects similar in scope and complexity as this project

****

NOTE: Include this sentence under paragraph d. if the project requires precision presplitting: [The projects must have included experience totaling at least [_____] linear meters [_____] linear feet of drilled blastholes for "Precision Presplitting".].

****

e. The Blaster in Charge credentials must include a list of the projects, including the location, duration, scope, description, geologic conditions, and the challenges that developed though the course of the projects and how the challenges were resolved. Each project description must be accompanied with photos, which exhibit the Blaster in Charge's competency and ability to design the blast.[Create the designed cut slope configuration to the specified tolerances.] The list of projects must also contain the names and phone numbers of the project owner or their representative, Contracting Officer, or project engineers who has enough knowledge to verify the submitted information. The Contracting Officer will invalidate any project submitted as reference that cannot be verified.

3.3.4 Blasting Administrator

****

NOTE: For smaller projects this position may not be necessary. The Blasting Administrator was added for large projects to aid the Blasting Specialist with paperwork.

****

The duties of the Blasting Administrator are to be the direct assistant the Blasting Specialist to prepare all necessary paperwork, and quality control on all issues dealing with blasting. The primary function is to assist the Blasting Specialist in the preparation and completion of submittals, prepare the detailed post blast report, and the individual shot videos for submittal to the Contracting Officer, and submit the drilling logs with the post blast report. The Blasting Administrator cannot sign any paperwork. The Blasting Administrator must be approved by the Contracting Officer. Submit the Blasting Administrator's Qualifications.

The Blasting Administrator will possess the following minimum qualifications and experience:

a. Hold a current Blaster's license;

****

NOTE: If the Blasting Administrator will not be performing blasting duties (handling explosives in the field) this requirement may be waived but will have to be evaluated on a project specific basis.

****

b. Have at least [5] [_____] years of credible and verifiable experience in the industry utilizing controlled drilling and blasting techniques;

****
NOTE: If presplitting is required in the project, include "c" below, if not, delete.
****

[c. Have at least five years of specialized experience with presplitting techniques;

] d. Must have completed at least five days of classroom training within the last five years that has equipped the Blasting Administrator with the most current knowledge in controlled blasting or perimeter control techniques.

e. Have proven proficiency with blasting software and spreadsheets.

3.3.5 Magazine Keeper

Each magazine keeper must be experienced and familiar with the laws and general practices concerning the handling, care, use, and storage of explosives and detonators. The magazine keeper is responsible for maintaining a cleared area around each magazine. The magazine keeper will not be required to perform any duties that will in any way interfere with their duties as magazine keeper. If explosives are delivered daily from the manufacturer, the driver of the truck will serve as the magazine keeper.

3.3.6 Vibration Monitoring Specialty Firm

****
NOTE: This is requirement is a new format from previous specifications. The firm is submitted for approval, having the appropriate experience and the firm must have on staff the Seismic Specialists and Seismograph Technicians, typically a firm is subcontracted by the Contractor and having multiple experienced people approved allows them to have flexibility on supporting the site work. The people coming to the project or responding to the work must be within the group approved but does not need to be a single person anymore.
****

Retain the services of a vibration monitoring specialty firm that specializes in the prediction, monitoring and control of ground vibration and airblasts. The firm must have experience conducting installation of seismographs for vibration monitoring, communicating vibration and airblast results, and developing and maintaining a site attenuation curve. The firm must have on staff at least two Seismic Specialists that specialize in vibration monitoring and analysis. The firm must have on staff at least four Seismograph Technicians that have five years or more experience with seismograph installation and vibration monitoring. Submit resumes for all personnel and for the firm for approval citing, in additional to other pertinent data, experience, training, and education, at least 60 days prior to the commencement of blasting. The Seismograph Technicians must be persons capable of setting up the seismographs at designated locations, effectively recording the blast, and appropriately interpreting results. The Seismic Specialists must interpret the seismograph records to ensure that the seismic data must be effectively utilized in the control of the blasting operations with respect to the existing structures. The Seismograph Technicians must supervise the placement, operation and maintenance of the seismographs. The Seismic Specialists must conduct the airblast and particle velocity regression analysis as described in this Section. The Contracting Officer may require the Seismic Specialists and Seismograph Technicians to be present during the test blast program, production blasting, or both.

3.3.7 Structural Inspection/Evaluation Technician

****

NOTE: Five years is the minimum requirement experience, depending on the project it might be necessary to increase the minimum if there is a special concern or sensitive structures, consult with USACE SME to help determine.

****

Pre and Post Blast structural inspections must be performed by technicians with at least [five] years' experience in pre-blast and post blast surveys in the State of [_____]. Submit a copy of the qualifications and certificates to the Contracting Officer.

3.4 PRE-CONSTRUCTION DOCUMENTS

3.4.1 Master Blasting Plan

Submit a Master Blasting Plan at least [_____] days prior to commencing drilling and blasting operations that includes a section called Blasting Safety Plan for review and approval. The Master Blasting Plan must contain the full details of the typical drilling and blasting patterns [and control for line drilling and for the presplit, buffer and production blasting, in the situation where controlled blasting is required for the project]. The Master Blasting Plan must contain the following information, at a minimum:

a. Typical plan and section views drawn to scale of proposed drill patterns including free face, burden, blasthole spacing, blasthole diameters, blasthole angles, lift height and subdrilling depth, where allowed except for the blast that will carry the excavation to foundation grade where subdrilling is restricted as specified in the article SUBDRILLING. Base the typical plan and section views on the geology and excavation plan for this project site, it cannot be a blast plan from a previous project.

b. Typical loading diagrams for each blast design being proposed showing type and amount of explosives, primers, boosters, decks, initiators and location and depth of stemming in each blasthole.

c. Typical initiator sequence of blastholes including delay times and delay system.

d. Predicted vibration and airblast amplitudes, and the mathematical equations used to calculate them. The Contractor must monitor the results of the test blasts and with the seismic data collected can determine the site-specific ground vibration equations and the site specific airblast equations for the project. After the first 10 blasts the Individual Shot Plansmust use the site-specific estimates at the 95 percent confidence level.

****
NOTE: Some states or counties may have specific vibration amplitude and airblast equations for specific locations.
****

e. Manufacturer's data sheets, including Safety Data Sheet (SDS), for all explosives, primers, and initiators to be employed. Provide copies of SDS for all explosives and detonators and define specific details about hazard communication programs for employees and specify where copies of SDS will be kept.

f. The Master Blasting Plan submittal is for quality control and record keeping purposes. Approval of the Master Blasting Plan does not relieve the Contractor of responsibility for the accuracy and adequacy of the plan when implemented in the field. Retain the professional services of a Blasting Consultant to assist with the blast designs included in the Master Blasting Plan.

g. Provide the Test Blast Plan and procedures for test blasting and modifying shot plans during production blasting in the Master Blasting Plan. Also provide the expected results from each shot including, but not limited to, the likely maximum peak particle velocity and airblast levels at the nearest inhabited structures

h. Indicate that the Individual Shot Report design and blast record documents must provide all the data of each blast in sufficient detail; for example, the exact same blast design data conduct by anyone else from the Individual Shot Plan provided with no other information would produce similar blast results and impacts.

i. Include samples of all completed submittal forms and diagrams (Pre-Blast Surveys, Individual Shot Plan, Drilling Logs, Individual Shot Reports, Individual Shot Vibration Monitoring Report, Results of Vibration and Airblast Monitoring, and Individual Shot Video).

j. Manufacturer's specifications on equipment to be used including but not limited to drills, air compressors, drill bits, drilling equipment specifications, manufacturer's literature of the drill rods, bits, casing, etc..

k. Plans for construction sequencing line drilling, presplitting, blasting, and mucking operations to complete the rock excavation with the limitations of the peak particle velocities. Describe the change in placement any of the seismographs with regards to the progressing blasting and excavation. Provide the names of individuals responsible for the instruments, data retrieval, and analyses.

l. Single Sheet plan view showing location of all seismographs. This sheet must be amended and resubmitted whenever seismographs are moved.

m. Sample checklist that the Contractor will use to ensure that all required information is included in each blasting plan.

n. Survey Control Plan: Establish survey control as approved by the Contracting Officer for horizontal and vertical control of all line drill, presplit and production blasts. Assure that all blast holes are drilled on the specified pattern and at the location and the depths as detailed in the blast plan.

3.4.2 Blasting Safety Plan

In addition to the Master Blasting Plan, a Blasting Safety Plan must also be prepared, as specified and outlined in EM 385-1-1, Section 29. All blasting work must be conducted in accordance with the requirements specified in EM 385-1-1.

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NOTE: Minimum safe distance from blast point will vary with each project. Local, state, county and federal regulations must be taken into consideration. Ensure NEPA, 408 permits, and environmental studies incorporated the blast safety radius.

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The required minimum safe distance is [_____] meters [_____] feet from the blast point. All the public, including swimming and boating recreationists must be excluded from the safety zone during blasts, including pre- and post-blast operations. The safety zone must be marked with an intrusion prevention barrier and high hazard warnings. Patrol by boat before and during blasting to prevent the recreational public from entering the safety zone.

The Blasting Safety Plan must provide a complete description of the clearing and guarding procedures that must be employed to ensure personnel, staff, visitors, and all other persons are at safe locations during blasting. A Blasting Safety Plan simply stating: "all regulations will be followed" is not acceptable and will be rejected. This plan must be developed and signed by the Contractor's Blasting Specialist with input from the Contractor's Site Safety and Health Officer (SSHO) with the intent to show how the Contractor's procedures and methods meet or exceed applicable rules, regulations and standards established by the Regulatory Agencies, codes and professional societies, and specifications listed herein. The guarding procedures must also consider aircraft and water vehicles that may enter the danger zone. This information must include detailed descriptions and maps, when appropriate of traffic control, visible warning signs or flags, audible warning signals, method of determining blast areas (all areas affected by any potentially harmful blast effects), access blocking methods, guard placement and guard release procedures, primary initiation method, and the system by which the Blaster in Charge must communicate with site security guards or other appropriate site supervisory personnel. The Blasting Safety Plan must be in accordance with and include items required in the EM 385-1-1, Section 29, 29 CFR 1910.109, 29 CFR 1926-SUBPART U.

The Blasting Safety Plan must state that explosive distributor will be delivering explosives on the day of the planned operation and recovering unused explosives at the end of the day. In the event of lightning detected at 16 kilometers 10 miles or less from the project site requirements for ceasing operations must be described. Provide a plan for controlling the temporary onsite storage of explosives or of securing an area of loaded holes until the threat has passed.

The Blasting Safety Plan must contain detailed descriptions of how and from where explosives will be transported and used at the various project work areas, and a map of the transportation route. The Blasting Safety Plan must explain how explosive transport vehicles will satisfy all applicable

ATF, OSHA, Federal, State, County, and local regulations. The Blasting Safety Plan must also include the following.

a. Specific details about hazard communication programs for employees.

b. Equipment that will be used to monitor the approach of lightning or dust storms and in such event, the site evacuation and site security plans, and the criteria for determining if the site is safe to re-occupy.

c. Methods for preventing spills or losses of explosives, drilling fluids, oil, or any other pollutants onto the ground during handling and blast hole loading operations. Include details of spill containment and contingency plans for quickly and effectively cleaning up spilled materials.

d. Method of safe and approved disposal of all explosive packaging materials.

e. Detailed contingency plans for detection and disposal of misfires resulting from cutoffs or other causes, hangfires, inadvertent initiator extraction, or accidental loss of downlines. A narrative describing in detail job steps, controls, and hazards associated with but not limited to hung or bridged powder, overloaded holes, cutoffs during placement of blast mats, failure of communication system during pre and post blasting protocols, recovery protocols for unexploded objects (UXO), etc.

f. Misfire mitigation procedures, including but not limited to restrictions of entry, securing the area prior to investigating and inspection, additional safety measures, time-sequence of operations, and mitigation protocols.

g. Fire Prevention Plan details, including tobacco smoking policies, procedures and limitations for work involving open flames or sparks, description and location of firefighting equipment, and firefighting and evacuation plans.

h. Digital copies of a valid [state] blasting license for the Blaster in Charge, Blasting Specialist and all personnel required to have one.

i. State required certifications for the Contractor's explosives supplier's Federal, ATF Explosives license or permit.

j. Other required county or state permits required for explosive transportation, use and offsite storage.

k. Explosive transporters' commercial driver's licenses with HazMat endorsements.

l. A reference in Attachment II (under misfire) when a misfire is declared the Blaster in Charge must wait 1 hour before inspecting site and provide proper safeguards for excluding employees from the danger zone except those necessary to do the work.

m. Submit updates, modifications and additions to the Master Blasting Plan in an appropriate and timely manner.

n. Complete project team organization with duties, responsibilities and authorities clearly defined. This organizational outline must also include names, addresses, resumes, responsibilities, and qualifications of all personnel authorized to sign for, receive and use explosives on this Contract.

o. Traffic Control Plan.

3.4.3 Pre-Blast Surveys

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NOTE: During design consult with the adjust businesses/stakeholders to determine what Pre-Blast Survey needs to be conducted and whether access is allowed, or special considerations are needed. This needs to be outlined in the specifications for a proper bid to be made for the scope. It is important to include the entire Project Development Team in design to ensure all project features of importance are documented before blasting. Lessons learned on one lock where blasters caused damage and it was not realized until well after the work was completed, the Government had no means to prove the damage occurred from blasting because there was no Pre-Blast Survey of the structures damaged.

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Prior to the commencement of blasting, conduct a Pre-Blast Survey of any nearby buildings, structures and utilities within [_____] meters [_____] feet from the blast area that may potentially be at risk of blasting damage to document pre-existing conditions. The survey extent and method used must be acceptable to both the Contractor's insurance company and the Contracting Officer. The Contractor is responsible for any damages or injuries resulting from blasting. Submit all Pre-Blast Surveys 30 calendar days before the start of blasting. There will be no blasting allowed until the Pre-Blast Survey is submitted and approved by the Contracting Officer. Provide owners of surveyed features a copy of their feature's Pre-Blast Survey results before or with the notice of blasting commencement. Notify owners and occupants of local buildings prior to the commencement of blasting. Perform the following when conducting Pre-Blast Surveys:

a. Provide methodology to be used in conducting the Pre-Blast Survey and listing of structures, determined from the survey to be sensitive, with reasons for these structures being sensitive.

b. Each structure must be documented (including high resolution photography and videotaping) as to its construction, foundation type, condition, and closest distance to excavation blasting. The general condition and all observable defects of each structure must be documented. This includes measurements of the defects.

c. The Commodity storage facilities that may be impacted by blasting must be addressed by the Contractor for safety and continued operation during the blasting program.

d. Freestanding structures (such as retaining walls) must be inspected on the exterior and on the interior as a room. All concrete walks, driveways, etc. must be inspected for cracks, level condition, holes, and defects.

e. Industrial structures, silo/elevators and special facilities, and office space must be described relative to their present conditions and tolerance to vibration. Besides the inspection of walls, columns and stairwells, the Contractor must survey the work areas and structures for distress.

f. An inspection of accessible structures must be made and a list of all structures, which could not be surveyed or refused to allow survey, must be completed. The dates of possible subsequent surveys and physical constraints prohibiting the survey must be documented. The requirement to perform Pre-Blast Surveys is not an indication of Right-of-Entry by the Contractor. Any Right-of-Entry associated with Pre-Blast Surveys, monitoring during blasting and Post-Blast surveys are the responsibility of the Contractor. In the event a property or properties identified as significant or intended to be included in the Surveys and monitoring are not included because access was denied, indicate this occurrence including the points of contact, dates contacted and any reasons provided for denial of access (if given.)

g. Certify that the survey was prepared prior to the start of any blasting under this Contract. Submit a copy of the Pre-blast survey in conjunction with the Master Blasting Plan.

3.5 RECORD KEEPING

3.5.1 Individual Shot Plan

The Blasting Plan must be consistent with the general concepts, designs and layouts shown in the approved Master Blasting Plan. The number of rows of blastholes and the number of blastholes per row can be changed from one individual shot plan to the next. Provide reasons and technical justification for all significant changes from the Master Blasting Plan.

Submit a Blasting Plan for each blast at least [24] hours prior to the planned initiation of drilling. The results of the previous blast are to be jointly evaluated by the Contractor and Contracting Officer prior to the submission of the Individual Shot Plan. The Individual Shot Plan must contain but be not limited to the following:

a. Plan view, and at least two sectional views drawn to scale, of the shot pattern showing blasthole locations, inclinations and designations;

b. Individual blasthole depths, diameters, blasthole spacings, burden, depth intervals of stemming and depth of subdrill;

c. Type of shot, i.e. test, production, pre-split, line drilling or buffer and shot number;

d. Orientation and elevation of the collar and bottom of all blast holes;

e. Total volume of blasted material in cubic meters cubic yards;

f. Description of type of blast and indication if blast is on final slopes or inverts;

g. Amount, type, diameter and depth of explosives, stemming and delay in each hole, and amount, type, and location of boosters and centering devices and the lift elevation;

h. Plan view of blasthole shot pattern showing in-hole and surface delays and firing times of each blasthole or decked charge;

i. Anticipated time and date of blast;

j. Survey coordinates using State Plane coordinate system and, if appropriate, a local coordinate system;

k. Any significant geologic features, and techniques planned for mitigating their influence upon results must be included in plan and section with appropriate elevations;

l. Estimated/anticipated peak particle velocities and maximum peak airblast predictions at seismographs located at protected structures using site specific data and regression analysis and the accurate distances from the blast to seismographs;

m. Name of Contractor;

n. Name, signature, and license number of the Blaster in Charge;

o. The maximum charge weight per delay, pattern and sequence of delays, and firing times for the blast;

p. Type of detonators, initiation and down hole lines;

q. Powder factors both in charge weight per cubic yard of material shot and in charge weight per meter per foot of total drillhole depth;

r. An elevation sketch of a typically loaded hole depicting each hole pattern, top of overburden elevation, top of rock elevation, bottom of hole elevation and diameter of hole, sub-drilling, decking charges, locations of explosives and stemming, and the locations of primers and boosters; and

s. The location of the blast area on a scale plan map of the project indicating the location of the shot, and the distance and directional relationship between all seismic equipment and the nearest structure subject to damage using a scaled distance measured in a horizontal line from the blast site to the nearest building, or structure, berthing facility.

t. A minimum of ten high resolution photos, taken with a camera with a resolution of at least eight megapixels, of the entire blast area, preferably from above, of surface and open face of the shot and surrounding rock to document conditions prior to the shot.

u. No blastholes must be drilled until the Individual Shot Plan for them is approved. Evaluate any problems or impediments of the prior shot and implement solutions for those issues with the next Individual Shot Plan. Provide the Individual Shot Plan to the Contracting Officer electronically. The Contracting Officer will review the plan and send comments to the Contractor within 24 hours of receiving the plan if the plan is submitted between Monday and not later than close of business Thursday.

v. Include a tabular listing by hole in the ascending time order of delays by the describing: row and number within the row of the shot hole, total delay time, the total charge weight of explosive materials for the entire hole, top of sound rock elevation, bottom hole elevation, stemming elevations, and detonator, primer and booster elevations in the hole; and for each seismic monitoring location the closest approach, the square-root scaled distance, the cube-root scaled distance, and the estimated PPV and airblast overpressure.

3.5.2 Drilling Logs

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NOTE: It may be necessary on sites with complex geology and blasting is occurring near very critical structures or rock outside of neat lines needs special protection, or neat line tolerances are especially important to consider the blaster or Contractor to have geologist(s) on staff to log blast holes or assist in logging blast holes, and aide the blaster in understanding the geology and for more accurate drilling logs. For rock excavation's objective(s); the project truly requires the designed tolerances and quality/stability of the remaining rock, which cannot be overcome at the Contractor's cost of dental clean-up, rock bolting, shotcrete or mass concrete placement; and, an experienced, agency (or third-party) geologist will be onsite for Quality Assurance of the logging & blasting & retained rock stability or damage. Logging may need to be in accordance with ASTM D2487, ASTM D5434, ASTM D6032/D6032M in some instances.

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The drillers are required to keep precise drilling logs on each blasthole to show the depth of the geological features. At minimum, each drilling log must include:

a. Blast number;

b. Blasthole designation and location station number, bench number and type of blast (production, presplit, buffer, etc.);

c. Blasthole depth and diameter;

d. Elevation of top and diameter of blasthole;

e. Subdrill depth as permitted in the article SUBDRILLING;

f. Depth(s) of geologic structural features, e.g., voids, gouge or mud seams, soft weathered or altered zones, rusty intervals, changes in rock chip color, and other features encountered in the blasthole pertinent to loading the hole;

g. Relative penetration rates;

h. Start and end times of drilling;

i. List any blasthole misalignment; and

j. Soft seams within the rock and sudden feed pressure changes on the rig;

k. If qualitative descriptors are used (e.g., soft, moderately hard, hard, very hard, decomposed, highly weathered, moderately weathered, slightly weathered, unweathered). Ensure consistency between drill operators in logging using these terms. Blasting Specialist and Blaster in Charge must ensure drillers are using consistent terminology between drillers. [Log soil and rock in accordance with ASTM D2487, ASTM D5434. ASTM D6032/D6032M.] Submit an example of the Drilling Logs with the Master Blasting Plan. Copies, both hard and electronic PDFs, of these drilling logs must be provided to the Contracting Officer at least 24 hours prior to loading any blastholes. The drilling logs must be used to determine the proper design and loading of blastholes and for locating the depths for use of stemming decks across intersected geological features to protect against blowout, flyrock and any unusual or hazardous blasting effects.

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NOTE: The paragraph below may be necessary where preventing subdrilling and foundation damage is critical.

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[Survey the elevation at the collar of each production hole in the final blast to foundation grade to ensure that the production blastholes are not subdrilled below final foundation grade, except as permitted in article SUBDRILLING. The survey must be included in the Individual Shot Plan.

]3.5.3 Individual Shot Reports

As a minimum, the Individual Shot Report must be the same form used in the Individual Shot Plan but provide all "as-built" information required for the blast plan. Furthermore, the Individual Shot Report must better describe any part of the blasting operation that wasn't adequately described by the Individual Shot Plan including information on misfires, observed field conditions, and information how the Blaster in Charge compensated for compromising field conditions, such as increased stemming amounts, or stemming decks where voids, cracks, spalls or mud seams were identified and resolved. The Blasting Specialist is responsible for recording all explosives loaded in the blasthole and for accurate documentation of daily blasting activities. Submit the Individual Shot Report no later than 24 hours after the blast. No additional blast will be drilled or loaded in the immediate area of the completed blast until the previous day's Individual Shot Report is submitted to the Contracting Officer. The Contractor must plan on multiple work areas so that production can be maintained on schedule. The report must include at minimum the following information:

a. Blast number (i.e., R-L3-PS1);

b. Date and specific time the blast was initiated;

c. Blasthole designations, locations;

d. Amount, type and depth of explosives, decking, stemming, and delay in each hole;

e. Plan and section views, drawn to scale, of drill pattern including free face, burden, blasthole spacing, blasthole diameters, blasthole angles and azimuths, blasthole number, lift height, and subdrill depth. Show in-hole and surface delays, as well as actual firing times of each blasthole or decked charge. Use different symbols to distinguish the production, buffer, presplit and line-drilled blastholes. Include a north arrow and scale on each plan view. Label the direction of the sections on the sections. Include section parallel to, and perpendicular to the blasthole rows. Show final grade and slope lines as appropriate in the sections. Show the location of the two video recorders on the plan in relation to the blast.

f. Drilling logs for presplit, line, buffer and production blastholes. Each drill hole must be logged by the driller to provide additional information to the Blaster in Charge during loading operations. Drilling Logs must contain information pertinent to the rock characteristics and blast operations. At the minimum, drill logs must contain geological information on pertinent geologic structure, soft or weathered zones, voids, penetration rate changes, and driller's notes.

g. Loading diagram showing type, diameter, amount and depth interval of explosive, primers, initiators and location, depth and type of stemming for each blasthole. Show the charge weight of each type of explosive and the total explosive load per delay and per hole.

h. Diagrams showing the delay system in the initiation sequence in each blasthole and the location and delay time of all surface delays of each blast. Indicate which blastholes are firing with a delay of less than 8 milliseconds.

i. Trade names and sizes of all explosives, primers, and initiators to be employed.

j. Daily explosives material consumption record.

k. A description of all personal injuries and property damage caused by the blast; when the measured maximum peak particle velocity or airblast exceeded by 10 percent the anticipated values from the Blasting Plan; and, all problems with the Warning System and problematic results of the blast, such as overbreak or large fragmentation, or with the shot pattern, such as misfires.

l. The vibration and airblast report described in paragraph Vibration and Airblast Monitoring. Include a comparison of predicted and actual measured values.

m. Signature of the Blasting Specialist specifying that the Blasting Specialist has reviewed the Individual Shot Report for accuracy and completeness.

n. Signature of the Blaster in Charge.

o. Note if mats are used or required by the Contracting Officer then list the type of blasting mats or other protective covering used.

p. A brief weather description at or near the time of the detonation such as cloudy, clear, partly cloudy, and foggy, with approximate wind direction and velocity, and temperature.

q. Updated or "as-built" Plan drawings depicting the borehole pattern and the delay pattern employed as well as pounds of explosives utilized, hazard incidents, and blast holes not loaded.

r. Copies of drilling records and originals of the blast monitoring data.

s. A plan view map of each bench showing the location of each completed blast.

t. Include photos, after the shot, taken from the same locations and at the same resolution as the blasting plan photos.

u. Include an updated as-built tabular listing by hole in the ascending time order of delays by the describing: row and number within the row of the shot hole, total delay time, the total charge weight of explosive materials for the entire hole, top of sound rock elevation, bottom hole elevation, stemming elevations, and detonator, primer and booster elevations in the hole, by hole in the ascending total delay time order of delays by describing: row and number within the row of the shot; and for each seismic monitoring location the closest approach, the square-root scaled distance, the cube-root scaled distance, and the estimated PPV and airblast overpressure.

Include two log-peak particle velocity versus square root scaled distance as per RI8507 diagrams for each seismograph. One diagram including all shots. The second including only data from the last 10 shots.

Include seismic records with peak displacement, velocity and accelerations at their respective frequencies. Site curve modification may be required to ensure that vibration levels at the control room remain acceptable.

If a recorded seismic value appears anomalous, the Contracting Officer may request that the vibrations monitoring specialist interpret all of the collected seismic records from the seismographs for that blast and provide an explanation of the anomalous readings. Anomalous readings include, but are not limited to, unusually high or low particle velocities, failure of a seismograph to trigger, or atypical wave forms on the paper record. No additional blasting will be allowed until the issue is resolved to the Contracting Officer's satisfaction.

Signatures of the Blasting Specialist and Blaster in Charge will be considered as proof that the shot was laid out, drilled, loaded, and wired as designed. Proof of the Blasting Specialist and Blaster-in Charge's qualification must include remaining below the allowable peak particle velocities at all structures. Inability to remain below the allowable vibration levels may be cause for dismissal of either or both parties.

The Blasting Specialist must oversee all loading operations and collect and keep accurate records of the information required for each Individual Shot Report. Submit an example of an Individual Shot Report to the Contracting Officer for approval as least 30 days before commencement of any blasting. Failure to submit satisfactory Individual Shot Reports must result in suspension of any additional drilling and blasting until the Contractor complies with this requirement. The Blasting Specialist will make sure that the drilling logs are used by the blaster when blastholes are loaded to prevent overloading in soft or weak rock in the borehole.

The Individual Shot Reports are for quality control and record keeping. Review of, and comments on, the blast reports by the Contracting Officer will not relieve the Contractor of his responsibility for the accuracy and adequacy of the blast design.

Supplement the Individual Shot Reports with the original digital copy of the printed results of vibration and airblast monitoring showing peak readings and frequencies for each blast to the Contracting Officer. This submittal must also include the distance from the blast to the seismograph in meters feet as well as the maximum kilograms pounds of explosive per delay. The seismograph locations must be clearly marked and located on a map in the blast report.

Supplement the Individual Shot Report with the original, handwritten, field notes showing any field changes on the approved blasting plan.

The Blasting Consultant must develop a checklist of tasks that must be completed and checked off by the Blasting Specialist for each blast. Complete the tasks in an orderly fashion before a blast is fired. Submit the draft checklist for approval. Submit the completed and signed daily checklist with the Individual Shot Report.

3.5.4 Individual Shot Videos

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NOTE: Video size can be a point of discussion, larger files come out of the new high quality 1080 HD and 4K videos. It may be necessary to require a frames/second or use of HD/4K videos. It is likely technology will change faster than this guide specification. This paragraph can be updated by project. The use of sFTP allows for the larger files.

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Record each blast with high resolution digital video cameras from two designated locations, approximately perpendicular to one another, that provide side, front and rear views of the blast and area above it. The video images must not contain any other text than the shot number. Include metadata consisting of the blast ID, date, and time of the blast. Index the two video recordings to properly identify each blast. Submit the proposed locations of the two video recorders on a map with the Individual Shot Plan for approval. Furnish electronic file copies of video recordings on the sFTP within 24 hours of a blast. If the Contracting Officer requests that a copy of the video be submitted earlier, then deliver a copy within one hour of the request. Maintain a digital video library of all blasts. All drilling and blasting activities must cease after the 24 hours from the previous blast if the video recordings of the previous blast are not furnished to the Contracting Officer.

3.5.5 Post-Blast Surveys

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NOTE: Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist would only be required if there are structures or facilities requiring such inspections. Eliminate the paragraphs referencing Pre- and Post-Blast Inspections and the Structural Inspection/Evaluation Specialist if the project does not have a requirement for these inspections.

****

Post-blast surveys must be conducted at any location, where a reasonable notice of damage from blasting has been provided. Post-blast surveys will be conducted by, or under the supervision of, the Structural Inspection/ Evaluation Specialist, who will also sign and date each survey. The survey extent and method used must be acceptable to both the Contractor's insurance company and the Contracting Officer. The post-blast surveys must be conducted within a week of the notice of damage from blasting. The Contractor is responsible for any damages or injuries resulting from blasting. Submit a copy of all post-blast surveys within two business days of the on-premises surveys to both the structure's owner and the Contracting Officer.

3.6 BLAST EFFECTS MONITORING

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NOTE: Depending on the project, this section will vary and need to be tailored for the monitoring locations and thresholds specifically. The designer should engage any subject matter expert for various disciplines - Structural for concrete, Mechanical/Electrical for related equipment (powerhouses, locks, etc.).

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3.6.1 Vibration and Airblast Monitoring

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NOTE: Vibration monitoring is required for every blasting project. Consult with the Structural, Mechanical, and Electrical Engineers on the project in developing the vibration and airblast thresholds. The paragraph's narrative is a generic description for most projects, where the nearest structure/facility is: Standard Construction Timber Frame, Brick, and Concrete Buildings; Lock Monoliths; Powerhouse Switchyard; Highway and Railroad Bridges; Buried Utilities; and, Wells and Aquifers. The Figure below in the notes is Figure 8-19 of EM 1110-2-3800. Some projects may require assessment by a trained experienced blasting specialist or structural engineer of lower allowable vibration criteria at critical or historic or special structures or facilities or structures with continuous occupants. Vibrations can cause the occupants of structures to become physically uncomfortable at levels well below the allowable vibration levels to avoid damage to the structure itself. Projects a with a Powerhouse and Electrical Power Relay Equipment or Pipelines, besides those with continuous occupants, should be evaluated for lower allowable vibration criteria. Some projects could utilize the assessment by a trained experienced blasting specialist or structural engineer to include higher allowable vibration criteria for those projects where typical structures/facilities are more than twice the distance of the closest approach of blasting to: Steel and Reinforced-Concrete Structures; Mass Concrete Monoliths; and, Cured Shotcrete. The specification writer must include a limitation of the allowable vibration.

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Vibration monitoring must conform to current industry standards and use equipment developed for that purpose. Peak particle velocity must be used as the unit of measure. Begin seismic vibration monitoring at least four weeks prior to the commencement of any blasting to determine vibration background levels on adjacent roads, and the [_____]. Permanently mount the seismograph to record seismic events for a 24-hour period daily. Submit the background vibration monitoring reports and the baseline vibrations levels determined from the data for approval at least two weeks prior to the commencement of blasting. When blasting commences, analyze all events shown on the seismograph including normal background or blast induced vibrations. Monitor all blasts for vibration. Control ground vibration levels always using properly designed delay sequences and allowable charge weights per delay. Base allowable charge weights per delay on vibration levels recorded during the test and production blasting that produced no adverse impacts. Monitor each blast with an approved seismograph located between the blast area and the closest structure(s) of interest. The seismograph used must be capable of recording particle velocities for three mutually perpendicular direction components of vibration in the range generally found with controlled, cautious blasting. The peak particle velocity of each component must not be allowed to exceed current local, State and Federal vibration limits, whichever is more stringent, and never exceed the safe limits of the nearest structure subject to vibration damage.

Report peak particle velocity, peak acceleration and peak displacement in the Individual Shot Monitoring Report. The Individual Shot Monitoring Report must include the summary report from each seismograph which will include the peak particle velocity and frequency of the peak, peak particle displacement, peak acceleration, distance from the blast, map location of each seismograph and the blast, and charge weight per delay. A single delay includes the weight of all charges fired within 8 milliseconds of each other. Compile all vibration data in an up to date database of distance, charge weight per delay and measured peak particle velocity. The Seismic Specialist must conduct a linear regression of the particle velocities to determine the equation of the 95 percent confidence level propagation. Use the equation to predict the expected vibration in the next blast. Show the time history of the particle velocity in the vibration report.

The seismograph must also record airblast. This data must also be added to the Individual Shot Monitoring Report. The report must include the airblasts measured at each seismograph. Compile all airblast data in and up to date database with the Individual Shot Monitoring Report data. The Seismic Specialist must conduct a linear regression of the airblasts to determine the equation of the 95 percent confidence level airblast propagation. The equation must be used to predict the expected airblast in the next blast. Provide the linear regression data to the Contracting Officer in digital form to become part of the Individual Shot Monitoring Report.

****

NOTE: The following are the limitation of the allowable vibrations:

TABLE 1 below gives standards for allowable peak particle velocities as they relate to a variety of common construction materials. Do not exceed these

vibration limits.

These vibration limits must not be incorporated in the blast design. Many projects have been constructed utilizing a fraction of these allowable values. Properly design the blasts, set allowable vibration limits, and maintain proper control throughout the duration of construction. The Contractor is responsible for all damages caused directly by, or as a result of the blasting operations. Compliance with this or any other provisions in the Contract must not relieve the Contractor of responsibility for any damages or injuries caused by, related to or arising out of blasting or associated blasting activities.

Here are two examples of vibration tables. The first is more generic and should be used the section shows for a specific project also requiring an initial peak particle velocity for test blasting ramp up.

TABLE 1: VIBRATION LIMITS FOR STRUCTURES

STRUCTURE TYPE	ALLOWABLE PPV (ips)	ALLOWABLE PPV (cps)
Standard Construction Timber Frame, Brick, and Concrete Buildings	2.0	5.0
Reinforced Concrete Structures (not Mass Concrete)	4.0	10.0
Steel Structures	4.0	10.0
Buried Utilities	2.0	5.0
Wells and Aquifers	2.0	5.0
Steel Pipelines	5.0	12.7
Mass Concrete Monoliths (Cured Concrete) Shotcrete	10.0	25.4

Or similar, adjust these for project:

Features	Initial Peak Particle Velocity (ips)	Initial Peak Particle Velocity (cps)	Production Particle Velocity, ips	Production Particle Velocity, cps
Lock Control Room	0.5	1.2	2.0	5.0
Powerhouse Lower Level	0.2	0.6	1.0	2.5
Powerhouse Control Room 69kV relay	0.4	1.0	1.0	2.5
Powerhouse Switchyard	2.0	5.0	2.0	5.0
Transmission Tower	3.0	7.6	3.0	7.6

Features	**Initial Peak Particle Velocity (ips)**	**Initial Peak Particle Velocity (cps)**	**Production Particle Velocity, ips**	**Production Particle Velocity, cps**
Existing Lock Monoliths	**2.0**	**5.0**	**2.0**	**5.0**
Segmental and Cellular Cofferdam	**2.0**	**5.0**	**4.0**	**10.0**
Downstream Highway and Railroad Bridges	**1.0**	**2.5**	**2.0**	**5.0**

Note that older deteriorated structures or utilities and structures housing computers or other sensitive equipment may require lower peak particle velocity limits than those provided in Table 1. Also, buried pipelines owned by private utility companies or bridge structures owned by other agencies may be subject to lower limiting values imposed by the owner. The safe vibration limits and charge weights per delay to achieve these vibration limits must be established by the Seismic Specialist and the Blasting Consultant. Vibration limits for all non-government owned structures must conform to the laws of the State of [_____].

Blast vibrations measured 30.5 meters 100 feet or less from final walls must not exceed 12.7 cm/s 5 ips. If any damage occurs to benches or final slopes above the blast area, the blast vibration levels may be reduced at the option of the Contracting Officer. The vibration limits will be subject to approval by the Contracting Officer.

****

3.6.2 Blasting Near Green Concrete, Grouting, and Shotcrete

Blasting operations are typically ongoing in one section of a project while placing concrete or applying shotcrete in another.

****

NOTE: The following are the limitations on allowable vibration:

Some guidelines for peak particle velocities related to time intervals after placing mass concrete/shotcrete/grout curtains are given in Tables 2 and 3 should be considered when designing a blast. The specification writer must include a limitation of the allowable vibration when there is green concrete expected on the project. Table 2 has two option, one is more conservative, designer should make engineering decision which to use or adjust based on data.

TABLE 2: VIBRATION LEVELS FOR GREEN MASS CONCRETE/SHOTCRETE/GROUT		
TIME AFTER PLACEMENT	**ALLOWABLE PPV (ips)**	**ALLOWABLE PPV (cps)**
0 - 4 Hours	**2.00**	**5.0**
4 - 24 Hours	**3.00**	**7.6**
1 - 3 Days	**5.00**	**12.7**
4 - 7 Days	**7.00**	**17.7**
8 - 10 Days	**9.00**	**22.8**
Over 10 Days	**10.00**	**25.4**

TABLE 3: VIBRATION LEVELS FOR GREEN CONCRETE/SHOTCRETE		
TIME AFTER PLACEMENT	**ALLOWABLE PPV (ips)**	**ALLOWABLE PPV (cps)**
0 - 10 Hours	**0.10**	**0.2**
10 - 24 Hours	**2.00**	**5.0**
24 - 48 Hours	**3.00**	**7.6**
2 - 3 Days	**4.00**	**10.0**
4 - 7 Days	**6.00**	**15.2**
8 - 10 Days	**8.00**	**20.3**
Over 10 Days	**10.00**	**25.4**

****

3.6.3 Measuring and Recording Instruments

Submit seismographs for approval. Provide up to [_____] blasting seismographs capable of sampling rates of 15,000 samples per second or higher that meets ISEE PSBS. The 15,000 samples per second accuracy is required to acquire reproducible vibration readings. The units must be self-contained except for external geophones and microphones. The seismograph must be capable of providing a printout of each blast or downloading the data to a portable device for off-site printing. The units must be programmed with specific data for each site of seismograph placement, which includes seismograph location, geophone burial or mounting method, calibration signal, date, time and closest distance to the blast area. The seismic record must also indicate the maximum charge weight of explosives per delay in the blast. The seismographs must not be placed inside of a structure, unless required for the designated purpose and authorized by the Contracting Officer. The seismographs and geophones must be placed on and secured to sound bedrock or virgin soil, or mass concrete foundations. The seismographs should not be placed near a structure, unless the intent is to measure that structure's specific response to the blast. Include the raw data values from the seismograph of vibration and airblast.

3.6.4 Seismograph Locations

****

NOTE: This paragraph will vary depending on the project, the designer should determine what structures need to be monitored. It may be necessary to require one or two extra seismographs that are placed at the Contracting Officer's direction.

****

Install seismographs at the following locations:

a. Closest point on the existing main dam and auxiliary dam.

b. Main dam powerhouse or as otherwise directed by the Contracting Officer.

c. Three other locations selected by the Contractor with the agreement of the Contracting Officer.

These locations are subject to change as the project progresses.

3.6.5 Individual Vibration Monitoring Report

Provide the original digital results of vibration monitoring in the form of peak readings and frequencies for each blast prior to conducting any subsequent blasts, provide the Contracting Officer with access to the online data available immediately after the shot. Submit the vibration monitoring reports with the individual shot reports. Data recorded for each shot must include the following:

a. Identification of instrument used and location.

b. Name of qualified observer and interpreter.

c. Distance and direction of recording station from blast area.

d. Maximum pounds of explosive per delay period.

e. Type of ground at recording station and material on which the instrument is sitting.

f. How the geophone is anchored, if peak acceleration is greater than 0.2 g to prevent decoupling of the sensor.

g. Maximum particle velocity in each component direction.

h. A dated and signed copy of seismic records with their supporting information.

i. Regression analysis of seismic data measured at each seismograph for each blast. The Seismic Specialist must conduct an independent regression analysis for each seismic location after each blast. The regression analysis is necessary to understand vibration transmission throughout the site and must be used to accurately predict the vibration levels generated on the next blast design.

j. Airblast results.

Take all necessary precautions to assure that the peak particle velocity readings available from the blast record are accurate to the maximum extent possible, as defined by the manufacturer of the equipment. The equipment must be calibrated annually.

3.6.6 Airblast Monitoring

****

NOTE: The peak overpressure threshold should be 133 dB in accordance with the EM385-1-1, some state regulations set a lower dB threshold. The designer must research state, county or local requirements and decide if the most stringent must be selected.

****

Take every precaution to minimize airblasts from all blasts. Install an airblast monitoring system between the main blasting area and the nearest structure subject to blast damage or annoyance. The equipment used to make the airblast measurements must be specifically manufactured for that purpose. Peak overpressure must be held below [133] dB (linear peak scale), 100 Pa 0.015 psi at the nearest residential or inhabited structure or other designated location. Appropriate blasthole patterns, detonation systems, and stemming must be used to prevent venting of blasts and to minimize airblast and noise levels produced by the blasting operations. A dated record of the peak overpressure measurements signed by the Seismic Specialist must be furnished to the Blasting Specialist immediately after each blast unless a variance is given by the Contracting Officer. Provide the Contracting Officer with access to the online data available immediately after the shot. Include the airblast data in the Individual Vibration Monitoring Report.

3.6.7 Flyrock Control

****

NOTE: Use of blasting mats may be required in specific areas depending on the project needs and risks.

****

Before firing any blast in areas where flying rock may result in personal injury or any damage to property or the work area, the rock to be blasted must be covered with approved blasting mats, or other equally serviceable material, to prevent flyrock. The Contractor must ensure that enough blasting mats are available at the project site to cover the blast area. If flyrock occurs all blasting must cease until the Blasting Consultant files a report explaining the cause of the flyrock and methods that must be employed on all subsequent blasts to prevent flyrock. Submit this report to the Contracting Officer for review before any additional blasts are detonated. No additional compensation will be given to the Contractor for work stoppage after a flyrock incident.

3.6.8 Rock Damage Control

****

NOTE: Tailor this paragraph to the specific site issues that may affect blasting.

****

The rock formations are known to contain geological features including variable weathering, alteration, fracturing and shearing, voids, weathered joints and gouge seams. Rock cores recovered during drilling investigations disclose the site's geological conditions and are available for review by the Contractor. The Contractor is encouraged to review the [Geotechnical Data Report, Geotechnical Baseline Report, other reports provided with bid documents], the drill core, drill core photographs, cut slopes, and all geotechnical and structural information available before planning and conducting blasting operations.

Use stemming decks across weak or open geological features to confine the energy into the hard rock and minimize explosive gas penetration into these features. No rock mass damage, uplift or shifting or significant overbreak will be tolerated. Control drilling accuracy and delay timing to provide proper relief toward the free face away from final rock slopes. Any blasting damage or breakage into the excavation walls will be mitigated at the Contractor's expense. Damage is defined as the loosening of rock behind final lines and grades, opening of joints in the final wall and rock block displacement in the final wall. If any damage occurs to the final wall that requires remediation, it must be the responsibility of the Contractor to prove that the blasting method employed did not cause the damage.

3.7 TEST BLASTING

****

NOTE: The test blasting will may be highly specific for the project site. The designer may have a way to carry out the test blasting in order to have the Contractor demonstrate satisfactory results. Typically, the main reason for test blasting is to gain understanding of how the blasting on the site causes vibrations/air blast on monitored structures, develop a site attenuation curve to design future blasts with vibration in mind. The other is to demonstrate results, line drilling and presplitting that meets the specifications and no damage to final faces and foundation grade. Typically the test blasting occurs in an area where there is room for failure, if a test presplit causes significant back break it won't be to a finished face and can be removed. The designer must also keep in mind that a poorly design shot can result in blast damage, such as induced cracks or even opening of rock joints, and can extend beyond the blast area more than 30 meters 100 feet. Typically an area that would be removed with full production blasting. Test blasting will be reviewed by the Contractor's consultant and the Government's consultant (if retained), blasting Subject Matter Expert (SME) within USACE.

The following is typical test blasting language.

****

Submit the Test-Blast Plan for review and approval. Allow 21 days for review after submittal. Allow 14 days for Government review after submitting the revised plan. Approval of the revised plan will not relieve the Contractor of their responsibility to produce safe and satisfactory results as set forth by these specifications.

Prior to commencing full-scale blasting operations in a different rock type, weathering grade or new bench elevation, demonstrate the adequacy and effectiveness of the proposed blasting plan by drilling, blasting, and excavating short test sections, not exceeding 15.3 meters 50 feet in length, to determine which combination of method, hole spacing, and explosive loads produces the proper split. If more than one presplit design is tested in one test blast, each presplit design section must be at least 6 meters 20 feet in length along the surface.

The first opening blast starting from a level plane that has only vertical relief (i.e. a sinking cut), must not be used as the production test blast. However, its results must be considered when designing the test blasts. The opening blast must be excavated to full depth if possible before drilling the blastholes for the test blast. The test blast must incorporate the planned methods of presplitting and must be near the center of the excavation and at least 4.5 meters 15 feet away from the final excavation walls [or invert]. The Contracting Officer has the option to adjust the location of the test blast areas to optimize for geology. Anticipate blasting up to 10 test sections with at least one test at each different geologic condition. The location of the test blast section must be approved in advance. The Contracting Officer may direct the Contractor to use test section lengths less than 15.2 meters 50 feet if field conditions warrant.

Unless otherwise directed, begin the presplit test blast with presplit holes spaced at 61 centimeters 24 inches center to center. Requirements for presplit and production blasting operations are covered elsewhere in this specification but apply to test blasts.

Do not drill ahead of the test shot area until the test section has been as fully excavated as possible and the results have been evaluated by the Contracting Officer. If the results of the test blast(s) are unsatisfactory, in the opinion of the Contracting Officer, the Contractor's Blasting Consultant must revise the blast design as necessary to achieve the specified results. Unsatisfactory test blast results include an excessive amount of fragmentation beyond the indicated lines and grade, extensive overbreak, flyrock, ground vibration, airblast or violation of other requirements or these specifications. All costs incurred by the Contractor in adopting revised blasting methods necessary to produce acceptable test blast results will be borne by the Contractor.

If at any time during the progress of the work, the methods of drilling and blasting do not produce the desired result of an undamaged rock slope within the specified tolerances, perform additional test sections by drilling, blasting and excavating short sections, not exceeding 15.2 meters 50 feet in length, until a technique is developed that produces the desired results. No additional compensation will be made for the additional test sections.

At the conclusion of the test blast program, produce a Post-Test Blast Evaluation Report which examines all reports, surveys, test data, and other pertinent information and conclusions reached. Submit a Test Blast Evaluation Report prepared by the Blasting Consultant and Blasting Specialist after testing blasting is completed.

3.8 BLASTHOLE DRILLING

Survey the elevation at the collar of each production hole in the final blast to foundation grade to ensure that the production blastholes are not subdrilled below final foundation grade, except as permitted in paragraph SUBDRILLING. The survey must be included in the Individual Shot Plan and must not be changed without prior approval from the Contracting Officer. Drill production blastholes according to the patterns in the approved Individual Shot Plan. Prior to commencement of drilling of any production blasthole, all holes must be located by survey and clearly marked and numbered. Drill the production blastholes within two blasthole diameters of the marked collar location. The blastholes must have no more than a plus or minus [_____] meter foot horizontal tolerance at the bottom. If holes are drilled outside of these tolerances, except for geologic reasons, fill these holes with crushed stone or neat grout and re-drill them at the approved location as directed by the Contracting Officer at no additional expense to the Government.

After drilling of blast holes, place approved, reusable plastic blasthole markers in each hole to identify all blasthole locations and keep material from falling into the holes. Check, measure and record the depth of all blastholes as soon as the drill is retracted from the blasthole. If any blasthole has become plugged or is unable to be fully loaded, re-drill or clean out those holes with air prior to commencement of loading operations. Check and measure the depth of all blastholes in a shot to ensure each blasthole is open to the original drilled depth prior to loading of any holes. If any blasthole is found not be open to the drilled depth, re-drill the shot holes to the proper depth at the Contractor's expense. If any holes are too deep, fill the holes to the proper depth with crushed stone. Blasthole loading and drilling may be ongoing concurrently in a shot area; nonetheless, drilling must be separated from loaded holes by a distance equivalent to at least the depth of the loaded hole but in no case less than 15.2 meters 50 feet.

The Contracting Officer may require inclined boreholes to reduce toe burdens and backbreak.

3.9 PRODUCTION BLASTING

The Contractor must provide a detailed narrative for the proposed sequence of production blasting for the project in the Master Blasting Plan, to be evaluated and approved by the Contracting Officer. The proposed sequence must be tailored primarily towards conducting a safe blasting operation and overall responsible, prudent, and professional blast design in efforts to keep overbreak, flyrock, vibration and airblast levels to a minimum. If in the opinion of the Contracting Officer satisfactory results in the production blasts are not being produced, the Contracting Officer reserves the right to require changes in the blast design which could include variables such as burden, spacing, bench height, timing sequence and delays, subdrill depths, explosive loads, detonators, blast matting and the use of air decks or stemming in borehole bottoms. Such required revisions will be at no additional cost to the Government.

****

NOTE: The proposed language below can be used as guidance when both presplit and production blasting are used in the project. THE PRODUCTION BLASTING SECTION WILL BE HEAVILY TAILORED FOR THE PROJECT. THIS IS GENERAL TEXT THAT CAN BE ADJUSTED.

The drilling of presplit and production blastholes must be done one pattern at a time. Advanced

drilling of adjacent presplit or production blastholes will not be permitted. The presplit wall conditions must be evaluated after each blast by both the Contractor and the Contracting Officer before the adjacent presplit blasting plan can be approved or drilled whenever possible.

The sequence of Production and Presplit blasting for any single blast must be as follows:

1. Submit an individual shot plan.
2. Individual shot plan approved or revisions requested before approval.
3. Conduct drilling and submit Drilling Logs to Contracting Officer and Blaster in Charge.
4. Submit Individual Shot Report with Daily Drill logs, video recordings, and vibration and airblast monitoring results.
5. Conduct rock removal, scaling and rock reinforcement Joint Evaluation of results by Contractor and Contracting Officer.
6. Submit an Individual Shot Plan for the subsequent blast in that work area.
7. Prepare a sufficient number of planned blasting areas in advance to maintain the project schedule.

The presplit wall conditions must be evaluated by the Contractor and the Contracting Officer after the Contractor exposes a minimum of 2.4 meters 8 feet (vertical) of the wall. If 2.4 meters 8 feet of exposure is not sufficient to determine the condition of the presplit wall, reinforce the exposed wall as necessary, then expose a minimum additional 2.4 meters 8 feet (vertical) of wall. Repeat this downward to the toe of the presplit wall or until the Contracting Officer can determine if the presplit wall condition is adequate before approving the Individual Shot Plan for the adjacent presplit blast. Evaluate the effects of each production blast on the presplit and line drilled walls before submitting a blasting plan for the next blast.

The drilling tolerance must be evaluated and if drill tolerance exceeded the allowable tolerance then benches will be reduced in height to where the drilling tolerance was obtained on the subsequent blasts.

****

3.9.1 General Blasting Considerations and Limitations

In order to help control the effects of vibration, flyrock and airblast, maintain a burden distance that is not more than one-half the bench height and the burden must be between 25 to 35 times the diameter of the explosive charges in the blastholes. Deck loading must be placed across joints and seams that may direct energy and gases into the final walls. "Mud capping" for secondary blasting or blasting to reduce oversize rock fragments of blocks is prohibited.

****

NOTE: The language below is suggested example for projects requiring presplit as a controlled blasting method for a new spillway. Consult with USACE Blast Consultant or Blasting SME during design phase for suggested blasting considerations and limitations tailored to the project.

Production blasts must advance from the center of the spillway cut toward the left and right final cut slopes. The final shot for the left and right cut slopes must be a buffer shot. Blasting may be conducted on the upstream and downstream ends of the spillway at the same time.

Perform all production blasting, including that carried out in conjunction with the test blast section requirements, in accordance with the following general requirements.

Drill Production blastholes according to the patterns in the approved Individual Shot Plan. Bulk blasting agents will be permitted in specified locations. The use of cartridged explosives is required at locations described in paragraph 2.1.2 Blasting Products.

Set a buffer zone where the row of production blast holes in the row that is immediately adjacent to the presplit line are drilled on a plane approximately parallel to the plane of the presplit line. Drill the line of 3-inch diameter buffer holes no closer than one meter three feet to the design excavation line and with a hole spacing no closer than one meter three feet. The explosive loads in buffer holes must not exceed 50 percent of the full explosive load that is placed in a 3-inch production blastholes.

Detonation of the buffer holes must be on a delay sequence towards a free face and fired in sequence after the adjacent production blastholes. Detonation of production holes must be on a delay sequence toward a free face. The delay between adjacent rows parallel to the final face must be sufficiently long to minimize blast damage to the final face. Other than for sinking cuts, all blasts within 15.2 meters 50 feet of the final walls must be designed such that the open face is parallel to the excavation walls to reduce excessive pressure on the presplit final walls.

The true burden of blasts along the final walls, must be designed to be perpendicular to the final walls.

Take all necessary precautions in the production blasting so as to prevent blast damage to the

presplit or line drill face. If presplit results are not satisfactory and production or buffer blasts damage the presplit or line drill face (as evidenced by back-break or opening of joints beyond the presplit line, uplifted rock blocks at the presplit line or damage to the perimeter as determined by the Contracting Officer or Blasting Consultant), the Contractor may be directed to add another line of buffer holes on a parallel plane adjacent to the presplit holes for some or all of the successive buffer zone blasts.

Lift Height and Explosive Cartridge Diameter: Follow this specification for explosive diameter as a function of bench height. This may require the use of mixed drilling for maximum production efficiency. Tamping of explosive cartridges or cartridge compression will not be allowed.

Lifts up to 10 Feet Deep: Production blastholes that are designed for lifts or hole depths of 10 feet or less must be loaded with explosive cartridges no larger than 1.25-inches in diameter. The final lift above the design excavation line must be 10 feet high and use these small diameter charges at the Labyrinth Weir and within 200 feet of the Labyrinth Weir. Short blastholes along final cut slopes of 0.25H:1.0V or shallower must also use 1.25-inch diameter explosives. Tamping of explosive cartridges or cartridge compression will not be allowed.

Lifts from 10 to 15 Feet Deep: Load production blastholes designed for lifts of 10 to 15 feet deep with explosive cartridges no larger than 2-inches in diameter. Tamping of explosive cartridges or cartridge compression will not be allowed.

Lifts Greater Than 15 Feet Deep or within 50 Feet of Final Walls: Load production blastholes that are designed for lifts of 15 or more feet deep or within 50 feet of final walls with explosive cartridges no larger than 2.5-inches in diameter. Tamping of explosive cartridges or cartridge compression will not be allowed.

Lifts Between 20 and 35 Feet Deep and Greater than 50 Feet from Final Walls or Farther than 200 Feet from the Labyrinth Weir: Bulk explosives may be used in the area 200 feet beyond the Labyrinth Weir, and 50 feet beyond the final excavation walls. The blastholes may be up to 3.5 inches in diameter and bulk loaded with bulk blasting agents.

In the area less than 200 feet from the Labyrinth Weir, and/or less than 50 feet from the excavation walls, tamping of explosive cartridges or cartridge compression will not be allowed.

When blasthole alignment restrictions can be met and geological conditions permit, the lift depth may be increased to a maximum of 35 feet at the option of the Contracting Officer.

****

3.10 PRESPLIT BLASTING

****

NOTE: Delete paragraph if presplit blasting is NOT to be used in the project.

****

Perform all presplit blasting, including presplit test blasts, in accordance with the following requirements:

Unless otherwise permitted by the Contracting Officer, completely remove all loose and decomposed rock along the top of the excavation floor for a distance of at least 9 meters 30 feet beyond the end of the production hole drilling limits or to the edge of the excavation cut slope to reduce the possibility of flyrock before drilling any presplit blastholes.

The presplit blastholes must be 7.6 centimeters 3 inches in diameter.

****

NOTE: Use the suggested paragraph when requiring precision presplitting methods.

Use the precision presplitting methods defined in paragraph Precision Presplitting, for all presplit blasting on this project. Presplit blasthole spacing must be 61 centimeters 24 inches on centers.

****

The Contracting Officer reserves the right to determine whether blasting results are satisfactory after evaluating the final rock slopes. Successful demonstration of presplit blasting including blasthole spacing and the ability to meet allowable tolerances must be completed using test blasts during the beginning of blasting operations and when there is a change in rock materials character and bench elevations as outlined in the blasting test section of the specifications.

Use proper equipment and techniques to control drilling operations and ensure that no hole deviates from the plane of the planned final face by more than 6 inches normal to the slope or 15.2 centimeters 6 inches from its planned position along the slope. Presplit blastholes deviating more than these limits will not be paid for unless, if in the Contracting Officer's opinion, satisfactory rock slopes are being obtained.

Drill presplit blastholes along a line that is within 7.6 centimeters 3 inches of the design excavation line. If the presplit holes are outside of the tolerance given in Subpart c, fill the holes with crushed stone or neat grout and re-drill at the correct location. Use electro-mechanical or electronic devices installed on all equipment for drilling the presplit holes to accurately measure the angle at which the drill steel enters the rock. Presplit blasthole drilling will not be permitted if these devices are not being used. The drill rig used must have the ability to change feed, impact, and rotation pressures on demand to adjust for the varying rock conditions and maintain presplit hole alignment. If problems maintaining the blast hole tolerances persist, use an approved device, to determine blasthole orientation before the holes are loaded.

****

NOTE: Use this subpart if specific areas need more alignment control.

****

Measure the blasthole orientation of all presplit blastholes drilled at the [location(s) where this method is needed] using an approved device to check borehole alignment.

The row of presplit holes must extend 9 meters 30 feet beyond the limits of the production blast.

Measure and record the blasthole depth on the drilling log after drilling is completed. Place protection over each blasthole before moving the drill to the next blasthole location. The Blaster in Charge must also measure the blasthole depth to determine that it is free of obstructions for its entire depth before loading the blasthole. The Blasting Specialist must record the depths on the Individual Shot Report. Exercise all necessary precautions so that placing the charges does not cause caving of material from the walls of the holes. Blasthole conditions may vary from dry to partially to filled with groundwater. The depth of water in each blasthole must be recorded in the Individual Shot Report. The maximum diameter of explosives used in presplit holes must not be greater than one-half the diameter of the presplit hole. Perform presplitting before the production blast.

Line drilling along final walls may be required at corners where presplit lines meet.

Blastholes exceeding the allowable tolerances for location and alignment must be refilled with crushed stone or lean grout (at the option of the Contracting Officer) and re-drilled at the proper location and alignment.

Use only standard cartridge explosives manufactured specifically for presplitting or detonating cord in presplit holes. Do not use continuous columns of presplit explosives in the presplit holes. Use lighter loads composed of fractional cartridges affixed to detonating cord with inert spacers between charges or detonating cord in the blastholes. Firmly affix the cartridges to the detonating cord in such a manner that the cartridges will not slip down the detonating cord nor bridge across the hole.

****

NOTE: Add this sentence if using precision presplitting.

****

Use "Precision Presplitting" methods as defined in paragraph DEFINITIONS.

Spacing between the fractional cartridges along the detonating cord must not exceed 91.4 centimeters 36 inches center to center and must be adjusted to give the desired results. Fractional sticks of presplit explosive must be assembled and affixed to the detonating cord in accordance with the explosive manufacturer's instructions, a copy of which must be furnished to the Contracting Officer. The "air deck" method of presplitting is not allowed. The bottom charge of a presplit hole may be larger than the line charges but must not be greater than one pound or so large as to cause overbreak or damage to the toe of the slope. Place the column charge of the presplit hole far enough below the collar, and reduce the upper charge(s) sufficiently to avoid overbreak and heaving of rock at the collar of the hole.

Place stemming in the upper portion of all presplit blastholes, extending from the uppermost charge to the hole collar. Stemming material must not extend more than 76.2 centimeters 30 inches below the collar of the hole. If test blasts produce unsatisfactory results adjustments must be made. Stemming material for presplit blastholes must consist of dry sand or drill cuttings supported by a stemming plug. Cover the presplit blasts as well as an adjoining production blast with blasting mats, if required to prevent flyrock.

If required to reduce ground vibrations or noise, presplit holes may be delayed, providing the hole-to-hole delay is no more than 25 milliseconds.

The presplit face must not deviate more than 15.2 centimeters 6 inches either side of a plane passing through adjacent drill holes, except where the character of the rock is such that, as determined by the Contracting Officer, irregularities are unavoidable. The geologic conditions affecting rock character include joints, shears, voids, gouge seams and variable weathering/alteration zones of various thicknesses and orientations. Design the blasts in such a manner to keep explosives gases from entering these planes and zones of weakness. Use of the Daily Drill Logs during explosive loading to identify the depth of weak zones and install stemming decks across them. The stemming decks must be filled with dry, angular, well graded crushed stone with the gradation specified in paragraph STEMMING.

****

NOTE: Typically cushion or trim blasting are not used on Civil Works projects. Exceptions must be decided early in the project design phase.

****

3.11 CUSHION OR TRIM BLASTING

Do not use cushion or trim blasting on this project.

****

NOTE: Note: Use the following paragraph templates if needing for precision Presplitting of specific areas of the excavation or project:

Precision Presplitting of Foundation Excavations at Service Spillway: For presplitting of excavations for concrete wall foundations at the Service Spillway, the Contractor must use a spacing between blastholes not to exceed 18 inches. The explosive load cannot exceed 0.04 pounds per square foot of face created for the column load. The bottom charge in these precision presplit blastholes cannot exceed 0.5 pounds.

Precision Presplitting at Main Dam Right Wall: Explosives must not be permitted for precision presplitting to form final cut slope surfaces at the Main Dam Right Wall. The Contractor must use

non-explosive demolition agent to fracture bedrock. Presplit hole spacing must range from eight to 18 inches, center to center. Hole diameter, final hole spacing and grout mixing, and proportions must be in accordance with manufacturer's recommendations for bedrock conditions encountered. The Contractor must take care to assure proper temperature and other environmental considerations meet the manufacturer's recommendations prior to use. Nonexplosive demolition agent must be use in such a manner to shear the web of rock between holes without any damage to the presplit final wall.

****

3.12 LINE DRILLING

Perform all line drilling in accordance with the following requirements:

****

NOTE: Line drilling spacing is typically twice to four times the diameter of the drill hole size, it could be varied depending on the project.

****

a. The line drill holes must be 7.2 centimeters 3 inches in diameter and drilled with a spacing of 15.2 centimeters 6 inches on center.

b. Use proper equipment and techniques to control drilling operations and ensure that no line drill hole must deviate from the plane of the planned slope by more than 7.2 centimeters 3 inches normal to the slope or 7.2 centimeters 3 inches from its planned position along the slope plane. Line drill holes deviating more than these limits will not be paid for unless, in the Contracting Officer's opinion, satisfactory rock slopes are being obtained.

c. Drill line drill holes within [_____] centimeters [_____] inches of the marked collar location. If the line drill holes are outside of the 7.2-centimeters 3-inch tolerance, fill them with crushed stone or lean grout and re-drill at the correct location.

d. Locate line drill hole collars along a line that is within 7.2 centimeters 3 inches of the design excavation line. Line drilling will not be permitted if electro-mechanical or electronic devices are not being used to accurately determine the angle at which the drill steel enters the rock. The drill rig should have the ability to change feed, impact and rotation pressures on demand to meet the varying rock conditions and to maintain hole alignment. If problems maintaining the drill hole tolerance persist, use an approved device to determine blasthole orientation before the holes are loaded.

****

NOTE: Include the following paragraph if need to extend line drilling beyond lengths of cut:

****

Lined drill holes in those areas where located must extend a minimum of 9 meters 30 feet beyond the limits of the production holes to be detonated, or to the end of the cut, as applicable.

3.12.1 Line Drilling Locations

Line drilling must be performed at the following locations:

****

NOTE: Depending on the project geology and structure, it may be appropriate to lengthen the distances line drilling is to be conducted at corners, the bracketed lengths here should be considered a minimum. The orientation of the jointing/fractures/foliation may dictate this length.

****

a. [3][_____] meters [10][_____] feet on either side of outside corners with an angle equal to or less than 120 degrees.

b. [1.5][_____] meters [5][_____] feet on either side of inside corners with an angle equal to or less than 90 degrees.

****

NOTE: Use the following if project is in karst or areas of large cavities.

****

If cavities are encountered during presplit drilling, that section of presplit line must be lined drilled in order to prevent presplit gases from entering the cavity.

3.13 STEMMING

****

NOTE: Depending on the geology of the project site this paragraph should be tailored to the project, for example in places with karst a more detailed procedure should be specified or contractor required to submit a procedure for dealing with larger voids.

****

Variations in rock hardness, structure, and other geological conditions encountered at depth will require the Contractor to stem the blast holes through soft weak areas, shears, open joints, and voids; therefore, close attention will be taken to classify the rock while drilling the blast holes. Where necessary, holes will be stemmed with dry, angular, well-graded crushed stone from .3-cm to 1-cm 1/8-inch to 3/8-inches in diameter without fines. The Blasting Consultant may submit a written, signed request to use drill cuttings for applications such as in presplit blastholes, must be submitted to the Contracting Officer for approval. Wet holes must not be stemmed with drill cuttings. No separate payment is made for stemming.

3.14 SUBDRILLING

****

NOTE: Depending on the project features it may be necessary to further specify where subdrilling is allow and to what depth. Describe depth range of subdrilling in the Master Blasting Plan. There may be places where subdrilling is prohibited or limited as in the case where structures are to be

constructed on the blasted surface and anchored - as subdrilling can complicate and significantly alter planned anchorage.

****

Subdrilling of blastholes below the design excavation line of the foundation is restricted to limited areas of the excavation. Use precise survey control to attain accurate drill blasthole depths and locations in accordance with the approved Master Blasting Plan. The methods of controlling blasthole depths and locations are subject to approval. Describe in the Master Blasting Plan the depth range of subdrilling planned in areas where it is allowed.

If test blasts on higher benches in the same geologic material as that above foundation grade demonstrate that subdrilling with no explosive placed in the hole below grade (air or water cushion in subdrill) causes no cracking below the grade, a request to use the subdrilling procedure may be submitted for approval.

Backfill any blastholes that are not in compliance with these requirements with crushed stone to the appropriate depth at the Contractor's expense.

3.15 FRAGMENT SIZE DISTRIBUTION AND TOLERANCES

****

NOTE: This section should be written with direct coordination from the project designer of record, who will provide input on maximum rock size/gradation based on project (embankment fill zones, etc.). Large stones (riprap, armor stone, derrick stone) may be required in the project and the blast must be adequately designed to produce this large stone. Some projects will not need this paragraph. CAUTION: requiring stone gradation may imply that the stone may be conducive to that gradation - which may not be the case.

****

Produce rock fragmentation from blasts such that [_____] percent of the fragments are [_____] centimeters [_____] inches or less in diameter for placement into the rock crusher and into the rock fill zones of the embankments. Reduce oversize material from blasting to meet the size range specified above. Predictive methods involving photo comparison and image analyses such as Wipfrag or Motion Metrics are encouraged to analyze size distribution of fragmented rock. Any secondary blasts of oversize fragments must be covered with blasting mats, and use a charge diameter no greater than 3 centimeters 1.25 inches.

****

NOTE: Include tolerance for each proposed structure from the excavation lines. For example, "The tolerance for the perimeter walls is minus 30.5 cm/ft 12 inches/foot from the design excavation line. The tolerance for the invert in the area of the Labyrinth Weir foundation and within 61 meters 200 feet downstream from the Weir is minus 31 centimeters 12 inches from the design excavation line. Elsewhere, the tolerance for the invert is plus or minus 31 centimeters 12 inches from the design

excavation line."

****

3.16 REQUIRED MUCKING

Muck and scale following each shot after firing for inspection of the slopes, bottom of the shot lift, or foundation. Drilling and loading for the next shot must not be allowed before the required mucking of the previous shot. This requirement may be waived temporarily when in the opinion of the Contracting Officer, the Contractor's blasting is satisfactory (i.e. no backbreak, overbreak, vibration cracking, exceedance of vibration or airblast thresholds etc.). Notwithstanding this requirement, the face must fully be dug out after every shot to a distance not less than 6 meters 20 feet prior to drilling and loading the next shot to allow inspection and evaluation of the shot face and allow for adjustments to the blast design for adjacent shots. Required mucking after each shot must be reinstated, when in the opinion of the Contracting Officer blasting is unsatisfactory. Any excavation support deemed necessary by the Contractor or Contracting Officer for the safety of personnel in the excavation will be installed as the excavation proceeds. Blasting of the next lower lift will not be permitted until the slope has been accepted by the Contracting Officer.

3.17 SCALING

****

NOTE: Typically a level of scaling is required for each project, an excavation spec may have more detail on this, or require bolting or other methods of stabilization before carrying down an excavation with more blasting.

****

Scale any loose and unstable or unsafe appearing material remaining on the rock slopes after blasting and as the excavation is carried down. Perform scaling immediately after each lift of the rock mass is removed by production blasting. The scaling must be accomplished by methods approved by the Contracting Officer. Drilling of the next lift will not be allowed until a rock slope has been properly scaled and rock reinforcement installed as determined by the Contracting Officer. No separate payment is made for scaling.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 31 16.13 (August 2022)**
Change 1 - 11/23

Preparing Activity: NAVFAC **Superseding**
UFGS-31 31 16.13 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 31 31 16.13

CHEMICAL TERMITE CONTROL

08/22, CHG 1: 11/23

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USACE / NAVFAC / AFCEC	**UFGS-31 31 16.13 (August 2022)** **Change 1 - 11/23**

Preparing Activity: NAVFAC	**Superseding** **UFGS-31 31 16.13 (August 2016)**

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****

SECTION 31 31 16.13

CHEMICAL TERMITE CONTROL

08/22, CHG 1: 11/23

****

NOTE: This guide specification covers the requirements for termiticide treatment measures for subterranean termite control.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Termite infestation exists throughout the United States and overseas areas with the exception of Alaska. Soil treatment will be specified for all types of construction where termites are likely to establish colonies and make concealed access to wood construction, including wood doors, windows, finish, and trim, or to wood-product, cloth, or cellulose storage in buildings. Soil treatment will also be required for structures constructed of or containing wood-preservative-treated items or containing electronic equipment (e.g., hydraulic digital interfaces, medical equipment) that will be damaged due to nuisance swarms of termites that may occur due to untreated soil. Soil treatment is not

required for power plants, central-heating plants, water or sewer treatment plants, incinerators, pump houses, and structures of similar nature which have neither electronic equipment that could be damaged due to nuisance swarms, wood in their construction nor wood or cellulose items stored within, and which have little chance of conversion to alternative uses.

Modification of this section, including materials, concentrations, or rates of application, which are considered necessary because of climatic conditions, porosity of soil to be treated, type of termite, or heavy infestation of termites, will be as recommended by the cognizant Pest Management Consultant. Modifications will be in accordance with the guidance contained in the installation integrated pest management plan. Army Regulation 210-50, Housing Management, paragraph SPECIAL CONDITIONS, prohibits termiticide treatment through or under concrete slabs where HVAC ducts or vents are within or beneath the slab. Information is also available from state and local agriculture agencies and from the EPA National Pesticide Telephone Network at 1-800-858-7378.

When termites are known to be present on the project site, any crawl space on the ground level needs to be designed for a concrete cover to be placed over the soil after treatment by a termiticide. Because the crawl space remains accessible to people and animals, it requires the concrete cover and signage.

For maximum termite protection, new structures should be designed and constructed using pressure treated lumber EPA registered wood preservatives, especially for foundation members. Untreated lumber in existing structures may be treated with EPA registered wood treatment chemicals which can be applied to untreated wood.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 4150.07	(2019) DOD Pest Management Program

1.2 ADMINISTRATIVE REQUIREMENTS

Coordinate work related to final grades, landscape plantings, foundations, or any other alterations to the finished construction which might alter the condition of treated soils.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Termiticide Application Plan; G, [_____]

SD-03 Product Data

Termiticides

SD-05 Design Data

Mixing Formulation

SD-06 Test Reports

Soil Moisture

Calibration Test

SD-07 Certificates

Qualifications; G, [_____]

Foundation Exterior

Utilities and Vents

Crawl and Plenum Air Spaces

List of Equipment

SD-08 Manufacturer's Instructions

Termiticides

SD-11 Closeout Submittals

Verification of Measurement

Warranty

Pest Management Report

1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

****

NOTE: Contact regional pest management consultant to obtain service specific reporting requirements.

****

Comply with DODI 4150.07 for requirements on Contractor's licensing, certification, and record keeping. Maintain daily records using the Pest Management Maintenance Record, DD Form 1532-1, or a computer generated equivalent, and submit copies of records when requested by the Contracting Officer. These forms may be obtained from the main web site:

https://www.esd.whs.mil/Directives/forms/fmo_poc/

1.4.2 Qualifications

For the application of pesticides, use the services of an applicator whose principal business is pest control. The applicator must be commercially certified in the state where the work is to be performed as required by DODI 4150.07. No contractor personnel may work under the supervision of a certified person even where this is permitted practice in those States or host nations in which the DOD property is located. Termiticide applicators must also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control. Submit a copy of the pest control business license and pesticide applicator certificates to the Contracting Officer prior to any applications.

1.4.3 Safety Requirements

Formulate, apply, and dispose of termiticides and their containers in accordance with label directions. Draw water for formulating only from sites designated by the Contracting Officer, and fit the filling hose with a backflow preventer meeting local plumbing codes or standards. Maintain an air gap between the filling hose and tank. Perform filling operations under the direct and continuous observation of a contractor's representative to prevent overflow. Secure pesticides and related materials under lock and key when unattended. Ensure that proper protective clothing and equipment are worn and used during all phases of termiticide application. Dispose of used pesticide containers off Government property.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver termiticide material to the site in the original unopened containers bearing legible labels indicating the EPA registration number, manufacturer's registered uses and in new or otherwise good condition as supplied by the manufacturer or formulator.

1.5.2 Inspection

Inspect termiticides upon arrival at the job site for conformity to type and quality in accordance with paragraph TERMITICIDES. Each label must bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended or under appropriate regulations of the host county. Inspect other materials for conformance with specified requirements. Remove unacceptable materials from the job site.

1.5.3 Storage

Storage of pesticides on the installation will not be permitted unless it is written into the contract.

1.5.4 Handling

Handle and mix termiticides in accordance with the manufacturer's label and SDS, preventing contamination by dirt, water, and organic material. Protect termiticides from weather elements as recommended by the manufacturer's label and SDS. Spill kits must be maintained on pest control vehicles and must be available at the mixing site. Conduct termiticide mixing in an area that has been approved by the Integrated Pest Management Coordinator (IPMC) or Contracting Officer, and with adequate spill containment that can contain at least 110 percent of the volume of the tank.

1.6 SITE CONDITIONS

The following site conditions determine the acceptable time of application.

1.6.1 Soil Moisture

Test soils to be treated immediately before application. Test soil moisture content to a minimum depth of 75 mm 3 inches. The soil moisture must be as recommended by the termiticide manufacturer. Application of the termiticide is not permitted when soil moisture content exceeds manufacturer's recommendations.

1.6.2 Runoff and Wind Drift

Application of termiticide will not be permitted during or immediately following heavy rains, when conditions may allow runoff, when it may create an environmental hazard or when average wind speed exceeds 16 km 10 miles per hour. Termiticide is not permitted to enter water systems, aquifers, or endanger humans or animals.

1.7 WARRANTY

****

For Navy projects, modifications must be approved by the cognizant NAVFAC Applied Biologist.

For Army projects, contact information can be found at https://aec.army.mil/index.php?cID=432

****

Provide a 5 year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions constructed under this contract. Include in the warranty annual inspections of the buildings or building additions during the warranty period. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim:

a. Re-treat the site and perform other treatment as may be necessary for elimination of subterranean termite infestation;

b. Repair damage caused by termite infestation; and

c. Reinspect the building approximately 180 days after the re-treatment.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Chemical termite control uses liquid termiticide treatments applied to the soil to form a continuous chemical barrier in the soil around both sides of the foundation. The application can be surface applied or rodded and trenched. This barrier prevents foraging termites from reaching the foundation and piers. Only the soil adjacent to these foundation elements is treated. For slab construction (including foundations, patios and garages), the entire soil (or gravel) surface is treated before the vapor barrier is installed and the slab poured over it. Soil treatment is coordinated with all building activities from foundation construction through final grading of the soil around the building's exterior. In order for the treatment to be effective, the final phase of the application must be done after final grading and sometimes after landscaping is completed so that the treated soil is not disturbed.

2.2 MATERIALS

2.2.1 Termiticides

Provide termiticides currently registered by the EPA or host country. Termiticides must be approved by the Contracting Officer and the Pest Management Consultant prior to use. Select non-repellent termiticides (active ingredient: chlorantraniliprole, chlorfenapyr, fipronil, or imidacloprid) for maximum effectiveness and duration after application. Select a termiticide that is suitable for the soil and climatic conditions at the project site and apply at the highest labeled rate. Submit manufacturer's label and Safety Data Sheet (SDS) for termiticides proposed for use.

PART 3 EXECUTION

3.1 PREPARATION

Before termiticide application begins, remove all cellulose containing materials from the site such as wood debris from clearing and grubbing and post construction wood scraps, such as ground stakes, form boards, cardboard paper, and scrap lumber from the site.

3.1.1 Verification

Before work starts, verify that final grades are as indicated and smooth grading has been completed in accordance with Section 31 00 00 EARTHWORK. Finely grade soil and remove particles larger than 25 mm 1 inch. Compact soil particles to eliminate soil movement.

3.1.2 Foundation Exterior

If the exterior perimeter treatment is applied before major construction is completed it will be damaged or removed. The exterior foundation perimeter treatment will have to occur in phases during completion of any pads, porches, aprons, sidewalks, final grading, or landscape plantings adjacent to the building foundation. These treatment areas should be coordinated after all major construction but before any pads, porches, or other items requiring special consideration are poured adjacent to the foundation walls. Submit written verification that final grading, landscape planting, and other items adjacent to the foundation will not disturb treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures.

3.1.3 Utilities and Vents

Turn off and block HVAC ducts and vents located in the treatment area prior to application to protect people and animals from termiticide. Submit written verification that the HVAC ducts and vents, water and sewer lines, and plumbing have been turned off or blocked prior to applying termiticide.

3.1.4 Crawl and Plenum Air Spaces

Submit written verification that crawl and plenum air spaces have been located and identified prior to applying termiticide.

3.1.5 Application Plan

Prior to commencing application of termiticide, submit a Termiticide Application Plan addressing the following items:

a. proposed sequence of treatment work including dates and times of application

b. termiticide trade name

c. EPA registration number

d. chemical composition

e. concentration of original and diluted material

f. formulation

g. manufacturer's recommended application rates

h. regional requirements

i. application rate of active ingredients

j. method of application

k. area or volume to be treated

l. amount to be applied

m. copy of the pest control business license

n. copy of the pesticide applicator certificates

3.2 APPLICATION

For areas to be treated, establish complete and unbroken vertical and horizontal soil chemical barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Make applications to crawl spaces in accordance with label directions. Applications to crawl space areas that are used as plenum air spaces will not be permitted.

3.2.1 Equipment Calibration and Tank Measurement

Submit a list of equipment to be used. Conduct calibration test on the application equipment to be used immediately prior to commencement of termiticide application. Measure the volume and contents of the application tank. Testing must confirm that the application equipment is operating within the manufacturer's specifications and meets the specified requirements. Submit written certification of the equipment calibration test results within one week of testing. Where results from the equipment calibration and tank measurements tests are unsatisfactory, re-treatment will be required.

3.2.2 Mixing and Application

Perform all work related to formulating, mixing, and application in the presence of the Contracting Officer, a DOD certified pesticide applicator, Pest Management Quality Assurance Evaluator (QAE)/Performance Assessment Representative (PAR), or IPMC. Applications must be made at the highest rate or concentration allowed by the label. Submit mixing formulation:

a. Quantity of pesticide used.

b. Rate of dispersion.

c. Percent of use.

d. Total amount used.

A closed system is recommended as it prevents the termiticide from coming into contact with the applicator or other persons. Only use water from designated locations. Fit filling hoses with a backflow preventer meeting local plumbing codes or standards. Maintain an air gap between filling hoses and tanks. Prevent overflow during the filling operation. Spill kits must be maintained on pest control vehicles and must be available at the mixing site. Termiticide mixing must be conducted in an area that has been designated by the IPMC or Contracting Officer and that has adequate spill containment. Inspect the application equipment prior to each day of use for leaks, clogging, wear, or damage. Immediately perform repairs on the application equipment to prevent or eliminate leaks and clogging.

3.2.2.1 Application Method

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NOTE: Termiticide may be applied as a surface spray or by rodding and trenching.

****

[3.2.2.1.1 Surface Application

Use surface applications for establishing horizontal barriers. Apply termiticide as a coarse spray and provide uniform distribution over the soil surface. Termiticide must penetrate a minimum of 25 mm 1 inch into the soil, or as recommended by the manufacturer. If soils are treated to a depth less than specified or approved, repeat work performed to the depth specified at no additional cost to the Government.

][3.2.2.1.2 Rodding and Trenching

Use rodding and trenching for establishing vertical soil barriers. Trenching must be to the depth of the foundation footing. Width of trench must be as recommended by the manufacturer, or as indicated. Rodding or other approved method may be implemented for saturating the base of the trench with termiticide. Backfill the trench immediately after termiticide has reached maximum penetration as recommended by the manufacturer. If maximum penetration is not achieved, as recommended by the manufacturer, repeat work performed to maximum penetration as recommended by the manufacturer at no additional cost to the Government. Backfill in 150 mm 6 inch rises or layers. Treat each rise or layer with termiticide.

]3.2.3 Sampling

The Contracting Officer may draw samples for analysis, at any time and without prior notice, from stocks at the job site to determine if the amount of active ingredient specified on the label is being applied. When analysis, performed by the Government, indicates samples contain less than the amount of active ingredient specified on the label, repeat work performed with pesticides conforming to this specification at no additional cost to the Government.

3.2.4 Vapor Barriers and Waterproof Membranes

Apply termiticide prior to placement of a vapor barrier or waterproof membrane.

3.2.5 Placement of Concrete

Place concrete covering treated soils after the termiticide has reached maximum penetration into the soil as recommended by the manufacturer. Cover treated areas with plastic if slab is not to be poured immediately following termiticide application.

3.2.6 Clean Up, Disposal, and Protection

Once application has been completed, proceed with clean up and protection of the site without delay.

3.2.6.1 Clean Up

Clean the site of all material associated with the treatment according to label instructions, and as indicated. Remove and dispose of excess and waste material off Government property.

3.2.6.2 Disposal of Termiticide

Dispose of residual termiticides and containers off Government property, and in accordance with label instructions and EPA criteria.

3.3 FIELD QUALITY CONTROL

3.3.1 Verification of Measurement

Once termiticide application has been completed, measure tank contents to determine the remaining volume. The total volume measurement of used contents for the application must equal the application rate established in the application plan. Submit written verification that the volume of termiticide used meets the application rate established in the application plan.

3.3.2 Inspection

3.3.2.1 Technical Representative

Provide a technical representative who is a DOD certified pesticide applicator, Pest Management QAE/PAR, or IPMC. The technical representative must be present at all meetings concerning treatment measures for subterranean termites and during treatment application. Contact the IPMC prior to starting work.

3.4 CLOSEOUT ACTIVITIES

Upon completion of this work, submit the Pest Management Report DD Form 1532, or an equivalent computer product, to the IPMC. This form identifies the target pest, type of operation, brand name and manufacturer of pesticide, formulation, concentration or rate of application used.

3.5 PROTECTION

3.5.1 Protection of Treated Area

Immediately after the application, protect the area from other use by erecting barricades as required or directed. Provide signage in accordance with Section 10 14 00.10 EXTERIOR SIGNAGE. Place signage inside the entrances to crawl spaces and identify the space as treated with termiticide and not safe for children or animals.

3.5.2 Disturbance of Treated Soils

Re-treat soil and fill material disturbed after treatment before placement of slabs or other covering structures.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 31 16.19 (August 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-31 31 16.19 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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USACE / NAVFAC / AFCEC **UFGS-31 31 16.19 (August 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-31 31 16.19 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 31 31 16.19

TERMITE CONTROL BARRIERS
08/22

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NOTE: This guide specification covers the requirements for termite control barriers, including both steel mesh and basaltic sand barriers. Project requirements and local conditions will dictate which barrier system is to be used.

This section is tailored for STEEL MESH and BASALTIC SAND termite barrier systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: This specification consists of furnishing and installing a complete stainless steel mesh barrier system or graded basaltic barrier sand at all penetrations, joints, and perimeter foundations as a physical barrier below the concrete slabs and foundations of a structure to prevent the entry of Formosan and other ground termites into wood components of the structure, similar to laying down a chemical barrier of soil termiticide treatments.

The use of these materials does not preclude the use

of other preventive measures, such as chemical treatment and pressure treated lumber for construction, to provide maximum protection to the structure. In fact, it is recommended that these materials be used in conjunction with chemical treatment at all vulnerable areas, such as penetration areas around electrical conduits and plumbing pipes that penetrate the slab, as well as the foundation perimeter and shoulder portions of the barrier. These termite barriers must comply with all codes. It is also recommended that pressure treated lumber be used to provide maximum protection to the structure.

****

****

NOTE: For Air Force, termite control barriers are not recommended by the Air Force Civil Engineer Center as a cost-effective method of termite prevention or control for Air Force real property. Instead use Section 31 31 16.13, CHEMICAL TERMITE CONTROL.

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NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

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PART 1 GENERAL

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NOTE: Termite infestation exists throughout the United States and overseas areas with the exception of Alaska. Steel mesh termite barriers or graded basaltic sand can be prescribed for installation at all sites where termites are likely to establish colonies and make concealed entries to wood construction, when it is deemed appropriate and cost effective.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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****

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ASTM INTERNATIONAL (ASTM)

ASTM A478	(1997; R 2019) Standard Specification for Chromium-Nickel Stainless Steel Weaving and Knitting Wire
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Meetings

Convene a pre-installation meeting at least one week prior to beginning installation to review conditions of preparation, storage and handling, installation procedures, sequencing, protection, and coordination with other related work. The project superintendent, installer, installer's crew leader, and representatives of the trades affected by this work are required to attend. Notify the Contracting Officer at least 10 calendar days before the meeting.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Steel Mesh Shop Drawings; G, [_____]

Basaltic Sand Shop Drawings; G, [_____]

SD-03 Product Data

Steel Mesh Materials

Accessories

Steel Mesh System

Written Warranty

SD-04 Samples

Steel Mesh Materials; G, [_____]

SD-06 Test Reports

Basaltic Sand; G, [_____]

SD-07 Certificates

System Installers

Steel Mesh Materials

Written Verification

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instruction Manual

Manufacturer's Guidance

Manufacturer's Installation Instructions

SD-09 Manufacturer's Field Reports

Site Conditions

SD-11 Closeout Submittals

Written Warranty

1.4 QUALITY CONTROL

1.4.1 Qualifications

1.4.1.1 Steel Mesh Barrier System

a. Only employee system installers trained in the behavior of termites and installation techniques of the mesh barrier, and accredited by the system's manufacturer. Submit certification that system installers meet the requirements specified and for the effective time period of accreditation.

b. Only employ workers trained and accredited at the appropriate level by the system's manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site in original, unbroken packaging and containers, with original labels in place, to include any U.S. Environmental Protection Agency (EPA) designation. Store materials in conformance with system manufacturer's recommendations.

Store and handle the material so as to prevent contamination by dirt, water, and organic material.

1.6 SITE CONDITIONS

1.6.1 Environmental Requirements

In addition to the manufacturer's installation instructions and before placing material, ensure project site is free from standing water.

1.7 WARRANTY

****

NOTE: Choose the first sentence for minimum 1-year written warranty for existing building repair or renovation projects. Choose the second sentence for 5-year written warranties on new building or addition projects.

****

[Provide a minimum 1-year written warranty against infestations or reinfestation by subterranean termites of existing buildings with barrier installed during repair or renovation.][Furnish a 5-year written warranty against infestations or reinfestation by subterranean termites of the buildings or building additions constructed under this contract.] Written warranty must be jointly signed by an officer of the Contractor and the supplier. Perform annual inspections of the building[s] or building addition[s]. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and building conditions have not been altered in the interim, take the following actions:

a. Correct defective steel mesh basaltic sand installation and perform other treatment as may be necessary to eliminate subterranean termite infestation.

b. Repair damage caused by termite infestation.

c. Reinspect the building approximately 180 calendar days after the repair.

PART 2 PRODUCTS

****

NOTE: Check with local agencies to determine the local building code requirements and specifications to ensure conformance where required.

****

2.1 SYSTEM DESCRIPTION

2.1.1 Steel Mesh System Description

A complete termite control barrier system encompasses a fine steel mesh placed across all termite entry points to the building. Principal entry points include all cracks, joints, penetrations, and other termite entry points within the concrete slabs and cavities in walls. The steel mesh and fastening system physically prevents the termites from entering the building. The mesh is too fine for the termites to pass through, too hard to chew through, and highly corrosion resistant against future break down.

2.1.2 Basaltic Sand System Description

A complete termite control barrier system composed of a graded basaltic sand as a physical barrier below the concrete slab or foundation of a structure to prevent the entry of Formosan ground termites into wood components of the structure, similar to laying down a chemical barrier of soil termiticide. The use of this preventive measure does not preclude the use of other preventive measures such as chemical treatment, steel mesh barrier system, and pressure treated lumber to provide maximum protection to the structure. It is recommended that this material be used in conjunction with chemical treatments of vulnerable areas such as around electrical conduits, plumbing pipes that penetrate the slab, and the shoulder portions of the barrier and with pressure treated lumber to provide maximum protection to the structure.

2.2 MATERIALS

2.2.1 Asbestos Prohibition

No asbestos containing materials or equipment are permitted at the job site. Ensure materials proposed for the project are asbestos free.

2.2.2 Steel Mesh Materials

Provide stainless steel mesh that conform to ASTM A478 and ASTM A580/A580M, Type A1AA marine grade 316 stainless steel mesh of 0.18 mm 0.007 inches diameter wire with mesh openings of 0.66 by 0.465 mm 0.026 by 0.018 inches.

2.2.2.1 Steel Mesh Material Submittals

Submit statements signed by responsible officials of the manufacturer of material attesting that material meets specification requirements. These statements must be dated after award of the project contract and clearly name the project.

Submit samples of steel mesh materials. Provide 102 by 102 mm 4 by 4 inch samples of steel mesh to be used in this work.

2.2.3 Accessories

Provide parging adhesives, bonding cement, high grade stainless steel clamps, ties, and other accessories as recommended by system's manufacturer.

2.2.4 Basaltic Sand

Provide clean, dry sand material manufactured from crushed basalt rock that meets the following requirements.

a. Material gradation, ASTM C136/C136M.

Sieve Size	Percent Passing
4.75 mmNo. 4	100
2.36 mmNo. 8	95-100
2 mmNo. 10	75-95
1.7 mmNo. 12	35-50
1.18 mmNo. 16	1-10

b. Specific gravity, ASTM C128, 2.80.

c. Silica (S102) content, 45 percent.

d. Abrasion loss, after 500 revolutions, 20 percent, when tested in accordance with ASTM C131/C131M.

PART 3 EXECUTION

****

NOTE: Provide stainless steel mesh graded basaltic

sand in a manner to provide maximum protection to the dwelling. The material provides a physical barrier against termites, thus, preventing entry. A range of techniques and material widths may be required to meet site conditions. The designer is required to determine the extent of openings to be covered to provide quantity estimates for the material installed.
****

****
NOTE: The stainless steel mesh must be installed in a manner to provide maximum protection to the dwelling. The material provides a physical barrier to the termites, thus, preventing entry. A range of techniques and material widths may be required to meet site conditions. The designer is required to determine the extent of openings to be covered to provide quantity estimates for the material installed.
****

3.1 EXAMINATION

Examine the substrates and conditions under which work of this section will be performed. Coordinate with this specification all work related to final grades, landscape plantings, foundations, or any other alternations to finished construction that might alter the condition of the site. Do not proceed until any unsatisfactory conditions detrimental to timely and proper completion of the work have been corrected. Submit written verification that site conditions are as required and other site work will not disturb the installation.

3.2 PREPARATION

In addition to the manufacturer's requirements and before placing material, remove any visible plant roots, construction wood scraps such as ground stakes, form boards, scrap lumber, and standing water from the excavated area. Inspect the utility trenches to ensure they are sufficiently wide to permit adequate cover under, around, and over pipes and conduit that will be encapsulated with the basaltic sand materials. In addition, inspect the foundation perimeter to ensure there is sufficient room between the sides of the excavations and the edges of the foundations to provide the required barrier depth and width.

Provide finished or temporary site grading to remove standing water from the project site (i.e., excavated areas or adjacent areas). Grading must provide positive drainage towards temporary, new or existing drainage features. Grading must not result in low spots that hold water or direct water towards new or existing facilities.

3.2.1 Surface Preparation

Perform work related to final grades, landscape plantings, foundations, or any other operations that might alter the condition of the site, in accordance with this specification. Before installing the steel mesh, ensure that the following have been completed:

a. Eliminate termite food sources by removing wood debris, such as ground stakes, form boards, scrap lumber, and any cellulose containing material from the work area.

b. The work area has been filled with finely graded soil consisting of particle sizes no larger than 25 mm 1 inch and compacted to eliminate soil movement. Ensure the site conditions meet the manufacturer's recommendations for installing the steel mesh.

c. Footings, foundations, and outer forms are in place.

d. Penetrating pipes for communications, electrical, and plumbing are in place.

e. Submit site conditions certificate documenting that the site conditions are acceptable for the steel mesh barrier system.

3.3 INSTALLATION

Install a basaltic sand system in accordance with the manufacturer's installation instructions.

Submit basaltic sand shop drawings of the basaltic sand installation at all interior and perimeter foundations, joints, and penetration conditions to the Contracting Officer for approval before installation.

3.3.1 Steel Mesh Instructions

Strictly follow the manufacturer's instructions published in Manufacturer's Installation Instruction Manual. In addition to the system manufacturer's instructions, place the stainless steel mesh across all openings, joints, penetrations, and other termite entry points to the building (including all shrinkage cracks in concrete slabs and built penetrations in slabs and walls that termites may use for access points)and in accordance with manufacturer's recommendations. Clamp, parge adhere, bond, or embed the steel mesh to the material surrounding the opening in accordance with the manufacturer's recommendations. Install with no gaps, penetrations, or damage to the mesh system. Submit steel mesh shop drawings of the termite steel mesh installation at all perimeter foundations, joints, and penetration conditions to the Contracting Officer for approval before installation.

To avoid an electrolytic reaction, do not place dissimilar metals in contact with the steel mesh.

3.3.1.1 Installation Sequence

a. Install the steel mesh barrier in accordance with the manufacturer's recommendations. Fit and clamp the mesh around all pipe penetrations, and terminate the mesh at the perimeters, as appropriate for the building construction and as described in the manufacturer's installation manual. Lap joint the mesh 10 to 15 mm 0.39 to 0.59 inches and the joint may be strengthened by using bonding cement for a minimum distance of 500 mm 20 inches along the joint.

b. Install special fittings that are appropriate to the construction, as described in manufacturer's installation manual.

c. Following installation of mesh and vapor barrier, install reinforcing steel and concrete, as specified under other sections. Seal penetrations and shrinkage cracks through concrete slabs in accordance with manufacturer's recommendations.

d. To maintain resistance to termites, complete the system and do not disturb, penetrate, or damage during the remaining contract time period.

3.3.1.2 Steel Mesh Integration

Where required, integrate mesh into subsequent construction, as described in manufacturer's installation manual.

3.3.2 Placement

Place the basaltic sand barrier under slabs, in utility trenches, along edges of concrete pavement, in concrete masonry unit (CMU) cells, along retaining walls, and other areas that termites may use for access points and in accordance with manufacturer's recommendations.

Place material in one lift for thicknesses of 150 mm 6 inches or less and in successive lifts of 100 to 150 mm 4 to 6 inches where the indicated thickness is greater than 150 mm 6 inches. Compact each lift prior to placing successive lifts. Use power driven, vibrating-plate type tampers for large areas and rod-and-plate type hand tampers for small areas such as utility trenches and foundation and walk edges.

3.3.2.1 Slab on Grade

****

NOTE: Show the required depths on the drawings. 100 mm Four inches depth is the minimum required. For areas where capillary action is a problem, consult a soils engineer if the depth should be increased or other capillary prevention measures are required.

****

Provide a barrier of the depth indicated. Rake smooth and machine tamp, making at least three passes over the entire area. Hand tamp around pipe and conduit risers.

3.3.2.1.1 Utility Trenches

Place the required depth of material for bedding in the trenches prior to placing pipes and conduits and hand tamp the material. For pipes 75 mm 3 inches and larger in diameter: after placing the pipe, bring material up to the top of the pipe and carefully hand tamp the material. Then, bring the material up to the top of the trench and tamp. For pipes smaller than 75 mm 3 inches in diameter and for conduit: bring material up to the top of the trench and tamp.

3.3.2.1.2 Edges

After concrete is placed and the form is removed, remove any dirt, loose concrete, and other debris and hand place and tamp additional material to the existing grade

3.3.2.2 CMU Block Walls

Place the material in non-grouted cells at a height of at least one course above grade of the wall.

3.3.2.3 Fence Posts and Utility Poles

Line the designated hole with a geotextile or similar material before proceeding with the work.

Once the geotextile is in place, put a 100 to 150 mm 4 to 6 inch layer of the basaltic sand at the bottom of the hole. Hand tamp the material. After positioning the fence post or utility pole in the middle of the hole, fill around the sides, compacting the material after successive lifts of 150 to 300 mm 6 to 12 inches until the hole is completely filled. Ensure that a 100 to 150 mm 4 to 6 inch basaltic sand barrier exists around the perimeter of the post or pole.

3.3.2.4 Retaining Walls

Place the required amount of material below the footing and up to the grade level of the wall. Place lifts of 100 to 150 mm 4 to 6 inches with compaction of each lift prior to placing successive lifts.

3.4 FIELD QUALITY CONTROL

3.4.1 Inspection

Provide Manufacturer's Guidance for performing a visual inspection of the installed mesh to ensure the steel mesh provides the designed termite physical barrier.

3.4.2 Manufacturer Field Services

Before installing the steel mesh, verify that final grades are as indicated and smooth grading has been completed. Provide written verification that the site conditions under the proposed slabs are proper for the installation of the termite barrier system in accordance with the manufacturer's recommendations.

3.5 PROTECTION

Protect the installed steel mesh system, attachments, and accessories before, during, and after the work of all trades, as required by the system manufacturer or as directed by the Contracting Officer.

In the event that subsequent trades on the site move or damage the mesh, clamps, or parging mix, immediately contact the mesh installer for a recommendation of the necessary repairs.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 32 19.13 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 05 20 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-31 32 19.13 (February 2021)**

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****

SECTION 31 32 19.13

GEOGRID SOIL STABILIZATION
02/21

****

NOTE: This guide specification covers the requirements for geosynthetic drainage layers including both geonets and geocomposites.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

****

NOTE: Delete this paragraph when lump sum bidding is used.

****

Measure the total surface area in square meters feet covered by geosynthetic drainage layer. Base final quantities on as-built conditions. Allowance will be made for geosynthetic drainage layer in anchor and/or drainage trenches but no allowance will be made for waste, overlap, or materials used for the convenience of the Contractor. Geosynthetic drainage layer accepted by the Contracting Officer will be paid for at the respective contract unit price in the bidding schedule.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1505	(2018) Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	(2020) Carbon Black Content in Olefin Plastics
ASTM D4218	(2020) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M	(2017) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533/D4533M	(2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4716/D4716M	(2008; R 2013) Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D4751	(2020) Standard Test Method for Determining Apparent Opening Size of a

	Geotextile
ASTM D4833/D4833M	(2007; R 2020) Standard Test Method forIndex Puncture Resistance of Geomembranes and Related Products
ASTM D5035	(2011) Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D5199	(2012) Measuring Nominal Thickness of Geosynthetics
ASTM D5261	(2010; R 2018) Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
ASTM D7005	(2003; R 2008) Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sampling and Testing

Penetrations

Construction Quality Control (QC) Laboratory

SD-04 Samples

Geosynthetic Drainage Layer

Seams and Overlaps

SD-06 Test Reports

Sampling and Testing

Geosynthetic Drainage Layer

1.4 QUALITY ASSURANCE

Provide a construction quality control (QC) laboratory that has also performed quality assurance (QA) testing, if required, of geosynthetic drainage layers for at least five completed projects, having a total minimum area of [186,000] [_____] square meters [2] [_____] million square feet. Submit qualifications of laboratory carrying current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests it will be required to perform.

1.5 DELIVERY, STORAGE, AND HANDLING

The QC inspector must be present during delivery and unloading of the geosynthetic drainage layer. Ensure the drainage layer material has not been damaged during shipping, storage, or handling. Repair or replace any drainage layer material found to be damaged. Accept delivery of material only after the required submittals have been approved. Label each roll with the manufacturer's name, product identification, lot number, roll number, and roll dimensions. Wrap rolls that have attached geotextiles individually in plastic. Store the rolls in a level and dry area.

PART 2 PRODUCTS

2.1 GEOSYNTHETIC DRAINAGE LAYER

****

NOTE: The flow capacity required for the geosynthetic drainage layer should be determined using a procedure such as the one described in GRI Report Number 19 - The Design of Drainage Systems Over Geosynthetically Lined Slopes. Appropriate global safety factors and reduction factors should be applied to transmissivity values reported by manufacturers. A global factor of safety of 2 is typically used. Guidance on reduction factors for intrusion, creep, chemical clogging, and biological

clogging are provided in Designing with Geosynthetics by Dr. Robert Koerner and GRI Standard-GC8 Determination of the Allowable Flow Rate of a Drainage Geocomposite.

If high long term normal stresses are anticipated (e.g. 192 kPa 4000 psf or greater), requirements for maximum allowable creep strain should be included in Table 1. Creep strain requirements for geosynthetic drainage layers are determined using test method GRI GS 4 - Time Dependent (Creep) Deformation Under Normal Pressure. Typically, a normal stress of 2 to 3 times the design stress for a period of at least 10000 hours is used for creep strain testing.

Delete paragraphs and sentences which describe geotextile material and construction requirements if geotextiles will not be attached to the geonet.

****

Use polyethylene polymer, which is clean and free of any foreign contaminants, to manufacture the geonet component of the geosynthetic drainage layer. Submit one properly identified 610 by 610 mm 24 by 24 inch minimum size geosynthetic drainage layer sample; fasteners proposed for use; and the method of seaming and overlapping. Submit manufacturer's quality control test results. Use regrind material which consists of edge trimmings and other scraps to manufacture the geonet; however, do not use post-consumer recycled materials. Conform the geosynthetic drainage layer to the property requirements listed in Table 1. Component criteria for the geonet alone and geotextile alone are also listed in Table 1. Cover the geonet on [one] [both] sides with nonwoven geotextile. Create geocomposite by heat bonding geotextile to the geonet. Do not bond the geotextile to the drainage net within 150 mm 6 inches of the edges of the rolls. Where applicable, Table 1 property values represent minimum average roll values (MARV). The value for AOS represents the maximum average roll value (MaxARV).

TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
GEONET COMPONENT			
Thickness, minimum avg, Note	ASTM D5199	5 mm200 mil	9300 sq m100,000 sq ft
Polymer Density, minimum avg	ASTM D1505	0.940 g/cc	9300 sq m100,000 sq ft
Carbon Black Content	ASTM D1603 ASTM D4218	1-3 percent	9300 sq m100,000 sq ft
Tensile Strength, minimum avg, Note	ASTM D5035	7884 N/m45 lbs/inch	9300 sq m100,000 sq ft
GEOTEXTILE COMPONENT			
Mass/Unit Area, MARV	ASTM D5261	0.2 kg/sq m6.0 oz/SY	9300 sq m100,000 sq ft
Grab Strength, MARV	ASTM D4632/D4632M	698 N157 lbs	9300 sq m100,000 sq ft

TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES			
PROPERTY	TEST METHOD	TEST VALUE	MINIMUM MQC TESTING FREQUENCY
Grab Elongation, MARV	ASTM D4632/D4632M	50 percent	9300 sq m100,000 sq ft
Tear Strength, MARV	ASTM D4533/D4533M	245 N55 lbs	9300 sq m100,000 sq ft
Puncture Strength, MARV	ASTM D4833/D4833M	245 N55 lbs	9300 sq m100,000 sq ft
Permittivity, MARV	ASTM D4491/D4491M	.2/sec	46,500 sq m 500,000 SF
AOS(O95), MaxARV	ASTM D4751	.25 mm	46,500 sq m 500,000 SF
UV Stability, percent retained (500 hours)	ASTM D4355/D4355M	50 percent	Note 3
GEOCOMPOSITE			
Transmissivity, min, including attached geotextiles, Note	ASTM D4716/D4716M	[_____] gal/min-foot	18,600 sq m 200,000 sq ft
Geonet/Geotextile Adhesion, minimum avg, Note 5	ASTM D7005	0.5 lbs/inch	9300 sq m100,000 sq ft
Note 1: The diameter of the presser foot must be 56 mm 2.22 inches and the pressure must be 20 kPa 2.9 psi. For other thickness options, see manufacturer's literature.			
Note 2: This is the average peak value for five equally spaced machine direction tests across the roll width.			
Note 3: Manufacturer's historical data.			
Note 4: Measure manufacturing quality control transmissivity tests using a gradient of [0.1] [_____] under a normal pressure of [10] [100] [_____] kPa [1.45] [14.5] [_____] psi. Use a minimum seating period of 15 minutes. Perform the test between rigid end platens.			
Note 5: Average of five tests across the roll width. Discounting the outer 305 mm 1 foot of each side of the roll, collect samples at the 10, 30, 50, 70, and 90 percent positions across the roll width. Test both sides for double sided geocomposites.			

2.2 SAMPLING AND TESTING

2.2.1 Manufacturing Quality Control Testing

Provide manufacturing quality control test methods and frequencies in accordance with Table 1 unless otherwise approved. Submit manufacturer's quality control manual and construction quality control test results.

2.2.2 Construction Quality Control Testing

****

NOTE: One or more additional performance type transmissivity tests are often required to be performed by the Contractor's quality control laboratory. These tests should be performed at gradients and normal stresses that model site conditions. The type of material in contact with the geosynthetic drainage layer affects the flow properties of the drainage layer. Performance tests should use site specific soils and geosynthetics when such materials are known.

Typically, normal loads for CQC transmissivity tests are seated on the geosynthetic drainage layer for 100 hours prior to testing to account for long-term intrusion and creep. A reduction factor for intrusion should be used if a seating period of less than 100 hours is used.

The transmissivity requirement for the construction quality control transmissivity tests will generally be lower than the value shown in Table 1 for the manufacturing quality control tests.

****

Perform a minimum of [one] [_____] construction quality control transmissivity test in accordance with the requirements of this paragraph. Measure transmissivity using a gradient of [_____] under a normal pressure of [_____] kPa psf. Attach geotextile to the geonet in the same configuration as will be used in the field. Sandwich the drainage layer between [_____] on the bottom and [_____] on the top. Use a minimum seating period of [100][_____] hours. Achieve a minimum transmissivity of [_____].

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Surface Preparation

Prior to placement of the geosynthetic drainage layer, provide a subgrade that is smooth and free of all materials which could damage the drainage layer.

3.1.2 Placement

Do not damage the geosynthetic drainage layer during placement. Unroll the drainage layer in the direction of maximum slope, keeping the net flat against the subgrade to minimize wrinkles and folds. Do not drag the drainage layer across textured geomembrane if a geotextile is attached to the surface facing the geomembrane. Place adequate ballast (e.g. sandbags) to prevent uplift by wind prior to covering.

3.1.3 Seams and Overlaps

3.1.3.1 Geonet Side Seams

Overlap geonet side seams a minimum of 100 mm 4 inches. Space side seam fasteners a maximum of 1.5 m 5 feet. In anchor trenches, space fasteners a maximum of 305 mm 1 foot.

3.1.3.2 Geonet End Seams

****

NOTE: Flow capacity of the geosynthetic drainage layer must be adequate to ensure all flow remains in the drainage layer and head does not build up in the cover soils above the drainage layer. For this reason, consideration must be given to flow capacity of end seams on slopes. If end seam flow capacity is a concern, end seams can be prohibited on side slopes or they can be configured such that water can flow from one geonet to another without passing through any geotextile layers.

****

Overlap geonet end seams a minimum of 305 mm 1 foot. Space end seam fasteners spacing a maximum of 305 mm 1 foot. Make overlaps in the direction of flow.

3.1.3.3 Geonet Fasteners

Tie geonet rolls together with plastic fasteners. Use fasteners that are a contrasting color from the geonet and attached geotextiles. Metallic fasteners will not be allowed.

3.1.3.4 Geotextile Seams

The geotextile component of the geocomposite must be [overlapped in the direction of flow] [thermally bonded using approved methods] [sewn using approved methods].

3.1.3.5 Geotextile Cap Strips

Place geotextile cap strips over any exposed edges of geocomposite. Provide cap strips that are a minimum of 610 mm 2 feet in width and thermally bond to the geotextile component of the geocomposite.

3.1.4 Stacked Geosynthetic Drainage Layers

When geosynthetic drainage layers are to be stacked, stagger roll ends and edges so that joints do not lie above one another.

3.1.5 Corners

In the corners of landfill liner side slopes, install an extra layer of drainage layer material from the top to the bottom of the slope.

3.1.6 Penetrations

Submit penetration details. Mechanically attach a geotextile apron to pipes and other appurtenances penetrating through the drainage layer so that soil is prevented from getting into the drainage layer. Extend the apron of the attached geotextile out from the pipe or appurtenance a minimum of 610 mm 2 feet. Thermally bond the apron geotextile to the geotextile [component of the geocomposite.][overlying the geonet.]

3.2 REPAIRS

3.2.1 Geonet Damage

Make repairs by placing a patch of the geosynthetic drainage layer over the damaged area. Extend the patch a minimum of 610 mm 2 feet beyond the edge of the damage. Use approved fasteners, spaced every 150 mm 6 inches around the patch, to hold the patch in place. If more than 25 percent of the roll width is damaged, approval must be obtained to repair or replace the damaged roll.

3.2.2 Geotextile Damage

Repair damaged geotextile by placing a patch of geotextile over the damaged area with a minimum of 305 mm 12 inches of overlap in all directions. Thermally bond the geotextile patch in place.

3.3 PROTECTION AND BACKFILLING

Cover the geosynthetic drainage layer with the specified materials within [14] [_____] days of acceptance. Place cover soil from the bottom of the slope upward and do not drop directly onto the drainage layer from a height greater than 915 mm 3 feet. Push the cover soil out over the geosynthetic drainage layer in an upward tumbling motion so that wrinkles in the drainage layer do not fold over. Do not operate equipment on the top surface of the geosynthetic drainage layer without permission from the Contracting Officer. Provide an initial loose soil lift thickness of 305 mm 12 inches. Use equipment with ground pressures no greater than 50 kPa 7 psi to place the first lift of soil. Maintain a minimum of [460] [610] [915] [_____] mm [18] [24] [36] [_____] inches of soil between construction equipment with a ground pressure greater than 50 kPa 7 psi and the drainage layer. Cover soil compaction and testing requirements are described in Section 31 00 00 EARTHWORK.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 32 19.16 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 05 19 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATION

References are in agreement with UMRL dated January 2025

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GEOTEXTILE SOIL STABILIZATION

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USACE / NAVFAC / AFCEC **UFGS-31 32 19.16 (February 2021)**

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UFGS-31 05 19 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATION

References are in agreement with UMRL dated January 2025
****

SECTION 31 32 19.16

GEOTEXTILE SOIL STABILIZATION
02/21

****
NOTE: This guide specification covers requirements for geotextiles.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: The "Geotextile Engineering Manual" by the Federal Highway Administration and "Designing with Geosynthetics" by Robert M. Koerner provide information on design criteria and example calculations used for the design of geotextiles.
****

1.1 MEASUREMENT

****
NOTE: Delete paragraphs MEASUREMENT and PAYMENT when lump sum bidding is used.
****

Measure the as-built surface area, covered by geotextile, in square meters yards. Allowance will be made for geotextile in anchor and/or drainage trenches but no allowance will be made for waste, overlaps, damaged materials, repairs, or materials used for the convenience of the Contractor.

1.2 PAYMENT

Geotextile installed and accepted will be paid for at the respective contract unit price in the bidding schedule. This unit price will include the cost of materials, equipment, installation, testing, and other costs associated with placement of the geotextile.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4354	(2012; R 2020) Sampling of Geosynthetics for Testing
ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M	(2017) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533/D4533M	(2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2020) Standard Test Method for Determining Apparent Opening Size of a Geotextile

ASTM D4759	(2011; R 2018) Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4873/D4873M	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D6241	(2014) Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Thread
Manufacturing Quality Control Sampling and Testing

SD-04 Samples

Quality Assurance Samples and Tests

SD-07 Certificates

Geotextile

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle geotextile in accordance with ASTM D4873/D4873M.

1.5.1 Delivery

Notify the Contracting Officer a minimum of 24 hours prior to delivery and unloading of geotextile rolls packaged in an opaque, waterproof, protective plastic wrapping. Do not remove the plastic wrapping until deployment. If quality assurance samples are collected, immediately rewrap rolls with the plastic wrapping. Repair or replace as directed, geotextile or plastic wrapping damaged during storage or handling. Label each roll with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

1.5.2 Storage

Protect rolls of geotextile from construction equipment, chemicals, sparks and flames, temperatures in excess of 71 degrees C 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, either elevate rolls off the ground or place them on a sacrificial sheet of plastic in an area where water will not accumulate.

1.5.3 Handling

Handle and unload geotextile rolls with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Do not drag rolls along the ground, lift by one end, or drop to the ground.

PART 2 PRODUCTS

2.1 RAW MATERIALS

A minimum of [7] [_____] days prior to scheduled use, submit manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. For needle punched geotextiles, certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. Provide the certificate of compliance attested to by a person having legal authority to bind the geotextile manufacturer.

2.1.1 Geotextile

****

NOTE: This note contains information from Standard Specifications for Transportation Materials and

Methods of Sampling and Testing, Part I - Specifications, Copyright 1999 by the American Association of State Highway and Transportation Officials (AASHTO), Washington, D.C. AASHTO has given permission to use this information.

Values for grab strength, seam strength, tear strength, and puncture strength for various applications can be obtained from the AASHTO M 288 - Standard Specification for Geotextiles. The most recent version of M 288 should be used as a reference. The table in M 288 is divided into three geotextile classes. The severity of installation conditions for the application generally dictates the required geotextile class.

The following values for permittivity and apparent opening size (AOS) are from AASHTO M 288. Values for permittivity and maximum AOS should be compared to actual values of commonly manufactured products to assure there are a sufficient number of manufacturers who can meet specifications.

AASHTO M288 PERMITIVITY AND A0S REQUIREMENTS

SOIL TO BE FILTERED	**MINIMUM PERMITIVITY**	**MAXIMUM A0S**
TEST METHOD	**ASTM D4491/D4491M**	**ASTM D4751**
UNITS	**(1/SECONDS)**	**(mm)**
LESS THAN 15 PERCENT PASSING 75 µm NO. 200	**0.5**	**0.43 NO. 40 SIEVE**
15 TO 50 PERCENT PASSING 75 m NO. 200	**0.2**	**0.25 NO. 60 SIEVE**
GREATER THAN 15 PERCENT PASSING 75 m NO. 200	**0.1**	**0.22 NO. 70 SIEVE**

The values listed above provide general guidance only. A site specific geotextile design should be performed especially if one or more of the following problematic soil environments are encountered: unstable or highly erodible soils such as non-cohesive silts; gap graded soils; alternating sand/silt laminated soils; dispersive clays; or rock flour. For cohesive soils with a plasticity index greater than 7, the geotextile maximum average roll value for AOS should be 0.30 mm No. 50 sieve.

Compatibility testing should be considered in situations where the geotextile will be exposed to chemicals which could degrade its physical properties. Refer to ASTM D5322 - Practice for Immersion Procedures for Evaluating the Chemical

Resistance of Geosynthetics to Liquids for additional guidance on compatibility testing.

Geotextiles may also be used to provide puncture protection for geomembranes. Needle-punched nonwoven geotextiles are commonly used to provide puncture protection. GRI Report Number 13 - A Design Methodology for the Puncture Protection of Geomembranes provides guidance on the design of geotextile cushion layers. Typical index properties for a 350 g/square meter geotextile are shown below:

MINIMUM REQUIREMENTS FOR PROTECTION GEOTEXTILE

PROPERTY	**UNITS**	**ACCEPTABLE VALUES**	**TEST METHOD**
GRAB STRENGTH	**N**	**1420**	**ASTM D4632/D4632M**
PUNCTURE	**N**	**930**	**ASTM D6241**
TRAP TEAR	**N**	**555**	**ASTM D4533/D4533M**
MASS/ UNIT AREA	**G/SQ M**	**350**	**ASTM D4751**
UV DEGRADATION	**PERCENT**	**50 AT 500 HRS**	**ASTM D4355/D4355M**

****

Provide geotextile that is a [woven] [nonwoven] pervious sheet of polymeric material consisting of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Add stabilizers and/or inhibitors to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile. Post-consumer recycled material [may also] [must not] be used. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD

TABLE 1 MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE			
GRAB STRENGTH	NLBS	[700][160] [_____]	ASTM D4632/D4632M
SEAM STRENGTH	NLBS	[_____]	ASTM D4632/D4632M
PUNCTURE	NLBS	[250][55] [_____]	ASTM D6241
TRAPEZOID TEAR	NLBS	[250][55] [_____]	ASTM D4533/D4533M
APPARENT OPENING SIZE	U.S. SIEVE	[_____]	ASTM D4751
PERMITTIVITY	SEC -1	[_____]	ASTM D4491/D4491M
ULTRAVIOLET DEGRADATION	PERCENT	50 AT 500 HRS	ASTM D4355/D4355M

2.1.2 Thread

A minimum of [7] [_____] days prior to scheduled use, submit proposed thread type for sewn seams along with data sheets showing the physical properties of the thread. Construct sewn seams with high-strength polyester, nylon, or other approved thread type. Provide thread with ultraviolet light stability equivalent to the geotextile and color that contrasts with the geotextile.

2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. A minimum of [7] [_____] days prior to scheduled use, submit manufacturer's quality control manual. Provide documentation describing the quality control program upon request. Perform manufacturing quality control sampling and testing in accordance with the manufacturer's approved quality control manual. As a minimum, randomly sample geotextiles for testing in accordance with ASTM D4354, Procedure A. Acceptance of geotextile must be in accordance with ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

PART 3 EXECUTION

3.1 QUALITY ASSURANCE SAMPLES AND TESTS

****

NOTE: The need for and amount of quality assurance testing should be based on site conditions and the amount of geotextile being placed. EPA/600/R-93/182 indicates that a frequency of testing of once per 10,000 square meters 100,000 square feet has been used in the past for some large waste containment

facilities.
****

3.1.1 Quality Assurance Samples

Provide assistance to the Contracting Officer in the collection of quality assurance samples for quality assurance testing; assign [7] [_____] days in the schedule to allow for testing. Collect samples upon delivery to the site [at the request of the Contracting Officer.] [in accordance with ASTM D4354, Procedure B. Consider the lot size for quality assurance sampling to be the shipment quantity of the product or a truckload of the product, whichever is smaller. The unit size is considered one roll of geotextile.] [at a frequency of one per 10,000 square meters 100,000 square feet]. Identify samples with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. Note the date and a unique sample number on the sample. Discard the outer layer of the geotextile roll prior to sampling a roll. Collect samples by cutting the full-width of the geotextile sheet a minimum of 1 meter 3 feet long in the machine direction. Immediately reseal rolls which are sampled in their protective covering.

3.1.2 Quality Assurance Tests

[Provide] [The Contracting Officer will provide] quality assurance samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements specified in Table 1. Do not perform test method ASTM D4355/D4355M on the collected samples. Base geotextile product acceptance on ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

3.2 INSTALLATION

3.2.1 Subgrade Preparation

****
NOTE: Reference the appropriate sections for compaction requirements if the geotextile will be placed on a soil subgrade.
****

The surface underlying the geotextile must be smooth and free of ruts or protrusions which could damage the geotextile. Provide subgrade materials and compaction requirements in accordance with Section [_____].

3.2.2 Placement

****
NOTE: For collection ditches, geotextile placed in the direction of flow should be wide enough to cover the entire width of the ditch. If this is not possible, the geotextile should be placed perpendicular to the direction of flow and shingled in the down-gradient direction.
****

Notify the Contracting Officer a minimum of 24 hours prior to installation of geotextile. Repair or replace geotextile rolls which are damaged or contain imperfections as directed. Lay the geotextile flat and smooth so that it is in direct contact with the subgrade. The geotextile must also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, lay the geotextile with the machine direction of the fabric parallel to the slope direction.

3.3 SEAMS

****

NOTE: Overlapped seams are commonly used for geotextile not placed in tension. Geotextile seams can also be produced by sewing or the application of thermal energy. Contact the geotextile manufacturer for installation instructions using thermal methods. ASTM D4886 should be referenced for heat seamed geotextiles.

For geotextile placed in tension, seams should be sewn and the stitch type should be based on the manufacturer's recommendations.

****

3.3.1 Overlap Seams

****

NOTE: Seams are typically overlapped a minimum of 300 mm 12 inches. The specified seam overlap should be greater than 300 mm 12 inches for soft subgrades or where large amounts of differential settlement are anticipated. The maximum overlap is typically 1 meter 36 inches. For soils with a CBR value of less than 1, seams are typically sewn. Refer to AASHTO M 288 for additional guidance on overlaps for soft subgrade conditions.

****

Continuously overlap geotextile panels a minimum of [300] [_____] mm [12] [_____] inches at all longitudinal and transverse joints. Where seams must be oriented across the slope, lap the upper panel over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

3.3.2 Sewn Seams

****

NOTE: The plans and/or specifications should indicate which seams must be sewn.

Seam strength can be specified based on ASTM D4632/D4632M for applications where the geotextile will not be placed in tension. In this case, seam strength is typically measured in accordance with ASTM D4632/D4632M and is typically specified to be equal to or greater than 85 to 90 percent of the grab strength of the geotextile. If seam strength testing will be required, add seam strength requirements to Table 1.

The need for quality assurance testing needs to be determined on a site specific basis and should be based on how critical the project is and the consequences of failure.

If the geotextile is designed to be in tension, strength testing should be required and ASTM D4884/D4884M should be used to determine seam strength. Quality assurance and quality control testing should be performed on all seams that are designed to be in tension.
****

Sew factory and field seams [on all slopes steeper than 1 vertical on [4][_____] horizontal] [at the locations shown on the drawings.] Use a 401 locking chain stitch or a stitch recommended by the manufacturer. [For field and factory seams which are sewn, provide at least a 2-meter sample of sewn seam before the geotextile is installed. For seams that are field sewn, sew the seams using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, provide samples of seams from both directions.] [Provide Quality Assurance seam samples to the Government at the request of the Contracting Officer]. Provide seam strength meeting the minimum requirements specified in Table 1. Tie off the thread at the end of each seam run to prevent unraveling. Sew skipped stitches or discontinuities with an extra line of stitching with a minimum of 450 mm 18 inches of overlap.

3.4 PROTECTION

****
NOTE: The use of staples or pins to hold geotextiles in place should not be allowed in applications where the geotextile will be located adjacent to other geosynthetic layers which could be damaged.

The purpose of limiting exposure time prior to covering geotextiles is to minimize damage due to UV radiation and to prevent direct contact by vehicles, humans, and animals. To prevent UV degradation, exposure time of polypropylene geotextile should be limited to 14 to 28 days. Polyester geotextile is more resistant to UV degradation and may be exposed to UV radiation for at least 28 days without damage.
****

Protect the geotextile during installation from clogging, tears, and other damage. Repair or replace damaged geotextile as directed. Use adequate ballast (e.g. sand bags) to prevent uplift by wind. Do not leave the geotextile uncovered for more than [14] [_____] days after installation.

3.5 REPAIRS

Repair torn or damaged geotextile. Remove clogged areas of geotextile. Perform repairs by placing a patch of the same type of geotextile over the damaged area. Extend the patch a minimum of 300 mm 12 inches beyond the edge of the damaged area. Continuously fasten patches using approved methods. Align the machine direction of the patch with the machine direction of the geotextile being repaired. Remove and replace geotextile rolls which cannot be repaired. Perform repairs at no additional cost to the Government

3.6 PENETRATIONS

Construct engineered penetrations of the geotextile [as shown on the drawings] [by methods recommended by the geotextile manufacturer].

3.7 COVERING

****

NOTE: This paragraph should be modified if the geotextile will be covered by another geosynthetic layer.

If large stones or riprap will be placed over the geotextile, the drop height of the stones should be addressed in the specifications. At some projects, the Contractor is required to construct a small test fill to verify his placement techniques will not damage the geotextile and to determine the maximum allowable drop height.

****

Do not cover geotextile prior to inspection and approval by the Contracting Officer. Place cover soil in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, place soil backfill from the bottom of the slope upward. Do not drop cover soil onto the geotextile from a height greater than 1 m 3 feet. Do not operate equipment directly on top of the geotextile without approval of the Contracting Officer. Use equipment with ground pressures less than 50 kPa 7 psi to place the first lift over the geotextile. Maintain a minimum of [300][_____] mm [12][_____] inches of soil between full-scale construction equipment and the geotextile. Cover soil material type, compaction, and testing requirements are described in Section 31 00 00 EARTHWORK. Do not use equipment for placing cover soil that stops abruptly, makes sharp turns, spins their wheels, or travels at speeds exceeding [2.2] [_____] m/s [5] [_____] mph.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 32 39 (August 2008)**

Preparing Activity: USACE **Superseding**
UFGS-31 32 39 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-31 32 39 (August 2008)**

Preparing Activity: USACE **Superseding**
UFGS-31 32 39 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 31 32 39

BIOENGINEERING PRACTICES FOR STREAM BANK AND SHORELINE STABILIZATION
08/08

****

NOTE: This guide specification covers the requirements for bioengineering practices for stream bank and shoreline stabilization. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification covers bioengineering practices as related to stabilizing stream banks and shorelines using natural vegetation by itself or in conjunction with stone, rock, dead vegetation structures, or organic erosion control matting. The methods may also be applied to small tributaries, gullies, canals, and drainage channels. The use of the term bioengineering refers to soil bioengineering in this specification. Soil bioengineering is a method of stabilizing soils using living and dead plant material and biodegradable manufactured products. Bioengineered structures should not at anytime be constructed on

embankments, levees, or flood control structures where there is a risk of failure of the project from a single event or a storm with a recurrence interval of 10 years.

This specification focuses only on stream banks and shorelines at or near the edge of water. This specification is not for coastal protection. This specification does not include requirements for hard or dead vegetation structures that are for erosion control or habitat restoration. This specification does not include the use of geosynthetic materials, metal, or requirements for traditional stone or rock hardened structures for bank protection. The designer should be cognizant that the structures described in this specification often must be augmented with the establishment or enhancement of vegetative zones on the landward portions of the banks or shores. Refer to TR-EL-97-8 Bioengineering for Stream Bank Erosion Control Report 1 Guidelines for guidance.

The designer should use caution in the selection of bioengineering methods for bank stabilization. Many bioengineering methods provide improved erosion resistance to stream banks or shorelines. However, bioengineering methods are not designed to repair inherently unstable stream banks or shorelines, which require engineering design, soil improvement, or extensive soil removal prior to vegetation efforts. Bioengineering methods will not prevent bank failures due to poor soil conditions, over steepened or undercut slopes, rapid draw down or drop of water levels, or where flow velocities exceed bioengineering established tolerances. Improved stability due to the development of root mats in the soil may take two or more years to be realized. Therefore, the desired bioengineering methods or bioengineered structures must be selected based on-site specific conditions, realistic expectations of performance, and consultation with soil, hydraulic, and structural engineers and environmental resource personnel.

The designer should compare bioengineered structures to more traditional stabilization methods, such as stone revetments or concrete channel lining, in terms of cost and performance before final selection of stabilization methods. Traditional stabilization methods may be better suited and more economical and provide greater protection at lower costs than bioengineered structures. The designer should review case histories on the performance and maintenance of existing bioengineered structures during selection and design. It is important to anticipate possible future failures of banks due to toppling of large mature vegetation, changes in vegetation species, and impact on the structure and vegetation by animal and human activities. Hard

structures may be preferred at locations where the risk of loss of life or property is apparent or where rapid changes in land use may pose such a risk in the future.

This specification is applicable to semiarid and temperate regions. The construction of bioengineered structures in arid regions requires special attention to the selection of appropriate plant species, water supply, irrigation, and maintenance for successful completion and performance. Other bank protection alternatives may be more cost effective than bioengineered structures in arid regions.

The construction of bioengineered structures in cold climates requires additional design efforts to reduce or prevent damage. Structures may be damaged by the impact of ice flows or ice blocks in the stream or river. The development of ice at the stream bank that incorporates the vegetation of the structure may result in vegetation loss or increased forces on the structure. Consult with a hydraulic engineer on methods to minimize damage to the structure. The percent of damage and mortality to vegetation may be higher due to frost or severe cold. Free draining soils should be used to reduce the amount of frost heave on structural components. Structures may not be suitable in climates with deep frost depths where surficial soil may be subject to flow when disturbed during the spring thaw. Bioengineering methods may not be suitable in cold regions where plant development and growth are stunned due to the climate and where root development, which is required for performance of the structure, may require more than 2 years. Consult with regional experts when planning bioengineered structures in these regions.

Planning of the bioengineered structure requires a multidisciplinary team approach. The designer should consult at a minimum with personnel in soil mechanics, structural design, hydraulic engineering, biological sciences, botany, regulatory, cost estimating, contracting, and construction during the initial development of conceptual designs, comparison of alternatives, and throughout project execution as required. Clear objectives for the selection, performance, and risk of the structure must be developed early in the planning phase. Sponsors and the public must be advised about the cost, performance, safety, benefits, and risks of the selected structure during the early stages of design. The designer should be aware of the need for construction oversight during installation to ensure quality.

The designer should include the long-term costs of maintenance in cost estimates and the amount of

maintenance required for adequate and safe performance of the structure. Monitoring or after care of the structure may be necessary for 2 to 10 years after the structure is completed to ensure the vegetation becomes established and the structure is meeting performance requirements. The impact of changes to site conditions should be evaluated during planning for safety and maintenance requirements. The effect of loss, damage, and change of vegetation species on structure performance should be discussed. The effect of disease, fire, harvesting, or removal related to plants in the structure and impact on performance must be elevated. Requirements for vegetation replenishment, pruning, selective cutting, and replacement should be included in maintenance planning. Repair to the soil, backfill, or hard materials in the structure must be addresses. The accretion of sediment on stream banks due to the trapping of sediment by vegetation should be evaluated for loss of stream conveyance and decreased slope stability due to the increased weight of accreted sediment. Damage due to wave action from storms, navigation, or boats should be determined.

Clear acceptance criteria should be defined for the project as well as warranty requirements. Acceptance and warranty requirements may be more stringent and require longer periods of time than traditional bank stabilization projects due to the need for vegetation to become established.

The following stream flow velocities are recommended for maximum limits on the selected methods of stream bank or channel stabilization.

Vegetative protection 2.5 m/s 8 feet per second (fps) Structural and bioengineering
Woody material, 2.5 m/s 8 fps
Woody material and herbaceous species, 1.5 m/s 5 fps
Herbaceous alone, 1 m/s 3 fps
(USDA TN Plant Materials No 23, Technical Notes, September 1993)
Flow velocities greater than 2.5 m/s 8 fps may require reinforced matting or hard structures.

Bioengineering methods require construction techniques and materials, which are described by other existing specifications. The following specifications should be included with this specification in the bid package depending on site conditions and design objectives.

Minor clearing and grubbing of vegetation is provided in this specification with an emphasis on salvaging cleared or grubbed material for the construction of the bioengineered structure. For

extensive clearing and grubbing of vegetation for site construction or access, refer to Section 31 11 00 CLEARING AND GRUBBING.

Minor earthworks may be required for the construction of the bioengineered structure. In addition, select fill or backfill materials may be needed. This specification only includes the requirements for the minimal earthworks necessary for key trench installation and surface roughening. For slope reduction, benching, and material specification, refer to Section 31 00 00 EARTHWORK.

The construction of bioengineered structures often results in the exposure of soils that require protection from erosion. This specification mentions the need for erosion control products but does not provide the specifications or installation methods for these products.

Bioengineering methods may incorporate stone or rock. For the requirements for hard armor, refer to Section 35 31 19.40 STONE REVETMENTS.

Seeding is an important component for many bioengineered structures. To specify the requirements for the installation procedures for seeding, refer to Section 32 92 19 SEEDING.

Fencing may be required during and after construction to protect bioengineered structures and associated vegetation from damage due to human and animal activities. For the requirements for fencing, refer to Section 32 31 13 CHAIN LINK FENCES AND GATES or 32 31 26 WIRE FENCES AND GATES.

Bioengineered structures are commonly placed in or adjacent to bodies of water. Employ Best Management Practices for storm water pollution prevention in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

Portions of this specification may not be consistent with sections in the construction contract. The designer will delete unnecessary paragraphs of this specification or provide full requirements to portions in this specification that may conflict with or contradict other sections in the contract. These conflicts, contradictions, or lack of requirements will be resolved between this section and other specifications and the construction contract before the design package is released for review.

For additional information concerning bioengineering practices, methods, structures, construction, and performance, see the following publications:

United States Department of Agriculture, December

1996, Engineering Field Handbook, Chapter 16, Stream Bank and Shoreline Protection.

United States Department of Agriculture, October 1992, Engineering Field Handbook, Chapter 18, Soil Bioengineering for Upland Slope and Erosion Reduction.

Muhlberg, K, Gayh, A, and Moore, Nancy J., 1998, Stream Bank Revegetation and Protection, A Guide for Alaska, Alaska Department of Fish and Game, Technical Report No. 98-3, 75 p.

Schiechtl, H. M., and Stern, R., 1997, Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection; Blackwell Science Ltd, London, 186 p.

TN Plant Materials No. 2, USDA, September 1993, How to Plant Willows and Cottonwoods for Riparian Rehabilitation.

The publications listed above are a small sample of the numerous publications available with related guidance for bioengineering practices. The designer is encouraged to obtain and review local and State publications that are specific to the region of project work. These publications generally contain useful information on suitable plant species, soil and stream conditions, and regulations. Insert project specific references as needed. Numerous guidance and case history publications on bioengineering by the USACE may be reviewed at http://libweb.wes.army.mil.

Publications may contain drawings of proposed structures that are of value for reference and incorporation in design documents. It is strongly recommended that the designer obtain and review drawings of the various bioengineering methods and structures during the preparation of this specification. These drawings lend considerable clarity to the descriptive text about the structures. These drawings should be included in the specification package as attachments to this specification and should be modified to reflect site-specific conditions and restraints.

****

1.1 SUMMARY

****

NOTE: Provide requirements that are specific to the work and that the Contractor will be responsible for completing.

The Contractor should submit sufficient drawings to clearly define site layout, structure, details, site conditions, extents of features, and the like to

allow adequate planning and cost estimating. The designer will delete or add drawings that are necessary to meet project needs.
****

The work by the Contractor consists of furnishing and installing bioengineered features and structures. Submit design, details, cross sections and profiles of site engineered structures to enhance [stream bank] [and] [shoreline] stability within project limits and in areas outside the project limits where the soil surface is disturbed from work under this contract [and as noted on the drawings]. Include in this work all necessary evaluation, design, materials, labor, supervision, and equipment for installation of a complete system and after construction maintenance. Submit a list of all equipment and tools that will be used for the construction of the bioengineered structure. Include information on products used in equipment such as fuel, hydraulic fluids, and the like. Coordinate this section with the requirements of Section [31 11 00 CLEARING AND GRUBBING] [and] [31 00 00 EARTHWORK] [and] [35 31 19.40 STONEREVETMENTS][and][32 31 13 CHAIN LINK FENCES AND GATES][32 31 26 WIRE FENCES AND GATES] [and] [32 92 19 SEEDING] [and all other specifications or requirements as necessary].

1.2 MEASUREMENT AND PAYMENT

****
NOTE: Add or delete products and measurement and payment as require for project specific needs.
****

1.2.1 Binder

Measure the standard binder by the linear meter foot placed.

1.2.2 Live or Dead Cuttings

Measure live or dead cuttings by number and type of individual cuttings. No payment will be made for cuttings not required for use in the structure, defective, or that are trimmed from cuttings. Include all harvesting, soaking, transportation, and preparation in the measurement for payment.

1.2.3 Materials

Measure soil and rock by the [cubic meter yard] [metric 2000 pound ton].

1.3 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D6765	(2012) Standard Practice for Live Staking

U.S. ARMY CORPS OF ENGINEERS (USACE)

TR-EL-97-8	(1997) Bioengineering for Streambank Erosion Control; Report 1, Guidelines

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

The designer should ensure adequate time is allowed for the review of submittals before the start of work. The designer will clearly note the time for submittals, where required. Insert the number of

copies required as needed.

The submittals listed below are for general bioengineering projects. The designer will edit this section to tailor the submittals to the project needs and requirements and include submittals not listed below as necessary.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Existing Site Conditions

Site Evaluation Plan

Permits and Regulations

Construction Work Sequence Schedule

Seed Establishment Period

Dewatering; G, [_____]

SD-02 Shop Drawings

Staging area

Structures; G, [_____]

Vegetation

Harvest Site Restoration

SD-03 Product Data

Materials

Stakes

Binders

Fertilizer

Sealing of Harvest Cuts

Painting of Stakes and Poles

Lumber

Logs, Trunks, and Brush

Equipment

Harvesting and Soaking Records

SD-04 Samples

Soil

Excavated Sediments

Surface Water

Groundwater

SD-06 Test Reports

Material Testing

SD-07 Certificates

Installer's Qualification

Personnel Qualifications

Seed

Vegetation

Binders

SD-10 Operation and Maintenance Data

Maintenance Instructions; G, [_____]

SD-11 Closeout Submittals

Maintenance Records

Final Project Report

1.5 QUALITY ASSURANCE

Ensure all Contractor and subcontractor personnel are fully qualified to perform the specified work and provide the Contracting Officer with such documentation no less than [30] [_____] days before the notice to proceed. Do not start work until the Contracting Office is satisfied that the Contractor meets or exceeds all required qualifications. All Contractor records, documents, and work may be inspected by the Contracting Officer or designated representative at any time. Replace or repair immediately items not meeting quality requirements at no cost to the Government.

1.5.1 Regulatory Compliance

Perform the specified work in accordance with all applicable Federal, State, and local regulations.

1.5.2 Pre-Installation Conference

Coordinate and conduct meetings with the USACE and all subcontractors prior to the start of any work to ensure all work requirements are fully understood and will be performed. All of these meetings must take place in the presence of the Contracting Officer.

1.5.3 Substitutions

Substitutions will not be allowed.

1.5.4 Qualifications

1.5.4.1 Installer's Qualification

Submit the installer's company name and address; training and experience and or certification. The installer must be certified by the manufacturer for any special training and/or experience required for installation.

1.5.4.2 Personnel Qualifications

Submit a list of personnel working on the project including name, title, and statements of their current positions and previous experiences. Use selected personnel that have been involved in bioengineering design and construction efforts similar to the proposed site work within the last 2 years.

1.6 DELIVERY, STORAGE, AND HANDLING

****

NOTE: Provide specific information on required delivery procedures, inspection requirements and methods, special storage needs, and specific handling methods.

Edit this section to include materials that are specific to the project work. Add or delete materials or products as required.

Sediment samples should be collected for mechanical and chemical analyses. Rock and stone should be tested for toughness, durability, chemical stability, and freeze and thaw at a minimum. Vegetation to be used in construction should be tested for health and presence of disease. All analyses must be preformed by analytical laboratories that are certified by the USACE. The designer will add or delete sample and testing requirements to this section as needed. Specify the specific tests and methods adjacent to the sample or refer to the accompanying specification in which this information is contained.

****

Submit a list of nonvegetative materials to be used in the construction of bioengineered feature or structure. Include manufacturer's literature regarding physical characteristics, limitations, and application or installation instructions. Store materials in designated areas as recommended by the manufacturer and that are protected from direct exposure to the elements, moisture, and any potential damage. Do not drop containers from trucks. Provide material free of defects that would void required performance or warranty. Deliver manufactured items in the manufacturer's original sealed containers and stored in a secure area.

Prior to delivery of materials, submit certificates of compliance attesting that materials meet the specified requirements. Include the following for items listed in this section:

a. Certification of recycled content or,
b. Statement of recycled content.
c. Certification of origin including the name, address and telephone number of manufacturer.
d. Certification for binders showing EPA registered uses, toxicity levels, and application hazards.

1.6.1 Erosion Control Blankets

Furnish erosion control blankets in rolls with suitable wrapping to protect against moisture and extended ultraviolet exposure prior to placement. Label erosion control blanket rolls to provide identification sufficient for inventory and quality control purposes.

1.6.2 Seed

Inspect seed upon arrival at the job site for conformity to species and quality. Reject seed that is wet, moldy, or bears a test date five months or older. Store seed in a cool dry area protected from moisture.

1.6.3 Lumber

Inspect lumber for straightness and defects. Reject warped, damaged, or used lumber. Do not store lumber directly on the ground and protect from moisture until the time of installation.

1.6.4 Vegetation

Inspect vegetation cuttings, herbaceous plants, and clump plantings for species, size, health, and preparation. Reject diseased, improperly sized, and incorrect species. Specific requirements for storage and handling are provided below.

1.6.5 Earth Materials

Provide select fill, top soil, stone, rock, aggregate, and sand meeting design specifications. Store excavated sediments and fill in well drained areas, separated from the ground by a non contaminating isolation barrier. Reject material not meeting specifications or with contained physical or chemical contaminates.

1.6.6 Logs, Trunks and Brush

Use logs, trunks, and brush of the size and quality specified. Place materials in organized manner in stock piles near the work site ensuring they were not damaged during delivery, storage, or installation. Do not rest materials directly on the ground or expose to precipitation if they are to remain at the storage site for longer than [4] week before installation. Use coverings for the logs, trunks, or brush that do not promote mold or rotting.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Environmental Requirements

****

NOTE: Include information on the physical and environmental characteristics and limitations at the work site e.g. temperature, illumination, slope, water depth, etc.

****

[_____]

1.7.2 Existing Site Conditions

****

NOTE: Include information on site conditions, references to documents and reports about site conditions, and requirements for the Contractor to obtain all literary information available for site planning and design. This paragraph should include the need for surface mapping, subsurface exploration, hydraulic analyses of streams or lakes, and all other information necessary for successful design and construction that is not provided by the Government. Also note that lack of supply of such information by the Government does not relieve the Contractor of any such necessary research or studies.

****

Submit a detailed description of the existing site conditions prior to construction work including but not limited to literary references, site visits, public or private reports, studies (engineering, ecological, environmental, etc.) and topographic or other maps. Submit [_____] copies of this survey to the Contracting Officer [_____] days before the start of work.

1.7.3 Site Evaluation Plan

****

NOTE: Consider the following items during site evaluation and project planning to improve the success of the bioengineered structure. The items below are not all inclusive for every site. Other evaluation factors may be relevant based on site specific conditions.

Do not construct bioengineered structures:

- **where soil or water is contaminated with compounds or elements that may damage live vegetation or where disturbance may result in expansion of the area of contamination,**
- **at locations with unstable slopes that can not be mitigated as part of construction,**
- **where robust stabilization structures are required for protection of navigation structures, levees, or embankments,**
- **where damage of the structure could pose a risk to**

loss of life or property,
- where long-term maintenance and after care of the structure and vegetation is not desired,
-where climate or hydraulic conditions may threaten establishment of vegetation,
- where the streambed is degrading and where such degradation can not be stopped by altering hydraulic conditions of the stream or by the use of hard armor,
- along stream banks or shorelines subjected to high wave action from storms or watercraft,
- in areas subject to shade from other plant species that may hinder growth of the selected plant species for the structure,
- in areas where the structure may not be secured from undesired animal or human traffic and subsequent damage.

Check with local, State, and Federal agencies to ensure all regulations are understood and followed. Do not alter wetland areas.

Know the mean, mean low, mean high, minimum, and maximum water elevations of the stream, river, or lake. The definitions of water levels may be defined in terms of hydrologic analyses or by observation of stream geomorphic features.

- The maximum water elevation should be the highest water possible at the site due to storm surges, waves, floods, or water storage. The elevation of debris associated with flood events or storm waves on the high bank may be used for recent high water elevations.
- The mean high water elevation is the average high water level over 19 years. This elevation is typically located where trees and brush are established on the high bank of the channel.
- The mean water elevation is the average height of water over 19 years. This elevation typically corresponds to the area where reeds and small shrubs are present on the low bank adjacent to the stream channel or shore.
- The mean low water elevation is the average height of the low water over 19 years. This water level is characterized by the upper extent of aquatic plants on the bank or swash zone at the toe of the bank or shore.
- The minimum water elevation may correspond to the minimal flow in the stream channel or lowest elevation of a lake due to drought or human activities such as irrigation or water storage. The minimal water elevation may be the bottom of the stream channel or lake if these water bodies may be completely drained.

The designer is advised to modify these definitions and water level elevations based on the growing and dormant seasons for species of vegetation used in construction to ensure establishment, performance,

and survivability. Determine the amount and rate of change of water elevations due to natural or human activities.

Determine the possible height of waves, direction, and frequency due to storms or navigation operations.

Determine the changes in current velocities and flow direction due to different stages, seasons, or storm events.

Known the sediment load, composition, size, and rates of deposition or erosion at the site.

Know the climate of the work area. Severe flooding, drought, or cold during construction or in the future may damage the structure.

Determine the requirements for regular monitoring and maintenance of the structure to ensure plant survival and structure performance.

Specify the need for and the role and responsibilities of a multidisciplinary team for design and planning, construction, and after care.

The site evaluation plan may require literary searches; subsurface and surface exploration, sampling, and testing; surface topographic, geological, biological mapping; hydraulic engineering studies; assessment of the of site in relation to residences, commercial property, and biological communities; and impact of navigation or water storage projects on the site. The report should contain sufficient information to determine if the site is viable for the proposed structure and sufficient information for structure deign and planning.

****

Furnish a site evaluation plan stating clear and concise project objectives and assessment criteria of the viability of the proposed structure based on the physical, chemical, biological, political, and social site conditions and aspects. Submit the contents of the plan developed by the Contracting Officer and the Contractor in [_____] copies of this plan to the Contracting Officer [_____] days before the start of work. The plan should contain supporting documentation and studies, which include but are not limited to climate, geological, geotechnical, hydraulic, botanical, geomorphic, project cost estimates, and regulatory and permitting requirements. Include a review of case histories of bank stabilization methods at other similar sites, reconnaissance report on site conditions and suitability for bioengineering structures or methods, design alternatives, potential problems, and recommendations for the types and methods of bioengineered structures if applicable to site conditions and uses. Include lists of all applicable permits and regulations and methods of compliance related to construction. Submit list and copies of all required and approved permits for site work and of all regulations that pertain to site work to the Contracting Officer [_____] days before the start of work. Include a report identifying the species of vegetation and plants that will be used for construction. Refer to TR-EL-97-8 for site evaluation and planning guidance. The report includes but is not limited to:

Supply of vegetation,
Harvest area and procedures,
Retention of existing vegetation,
Short and long-term interaction of selected species with existing vegetation,
Interaction of species with existing structures,
Retention or elimination of nonnative or invasive species,
Performance of selected vegetation in the proposed structure,
Maintenance and replacement.

1.8 SEQUENCING AND SCHEDULING

****

NOTE: Most bioengineered structures must be completed during the period of dormancy of plant growth unless otherwise noted. Structures completed outside of this dormant season will not be accepted by the Government unless provided with specific information on the need for such schedule and survivability of plant species used for construction. Local requirements may limit construction periods and must be fully complied with and adhered to unless granted waiver rights by the appropriate regulatory authorities. See paragraph TIME OF PLANTING in PART 3 for additional information.

****

Conduct all work [during the period of plant dormancy] [as stated below] and in accordance with all Federal, State, and local requirements for in-stream or near stream construction. The construction sequence must result in successful completion of the structure. Submit a construction work sequence schedule, detailing the work tasks and order of completion, to the Contracting Officer for approval a minimum of [90] [_____] days prior to the start of construction. Do not commence work without the approval of the schedule and construction sequence by the Contracting Officer. Construction must not occur if climatic conditions threaten the survivability of plants or worker safety. Construction sequence schedule .

1.9 WARRANTY

****

NOTE: The designer should consult with the manufacturer to ensure proper application and installation techniques for the site specific project conditions. Warranties vary with different materials and may be void if proper technical advice is not obtained. Seed germination is not covered under the warranty.

****

The structure and all manufactured materials will be under Contractor warranty for a period of [2] years including vegetation and earthworks. Stone and rock will be under warranty from decomposition for [5] years.

1.10 MAINTENANCE

****

NOTE: Bioengineered structures require observation and maintenance for up to 5 years after installation to ensure the vegetation becomes established. Observation should be done on a weekly basis for the first year and bimonthly thereafter for the second year at a minimum. A minimal level of acceptable survival of plants should be established. The Contractor should be required to replace plants that die above the allotted percentage and area of concentration that may adversely effect structure performance.

****

1.10.1 General

Include in maintenance eradicating weeds; protecting embankments and ditches from surface erosion; maintaining the performance of the erosion control materials and mulch; replacement of dead or non-viable plants; repair of soil, stone, rock, or hard structures, and protecting installed structures from human and animal activities.

1.10.2 Maintenance Instructions

Furnish written instructions containing drawings and other necessary information to the Contracting Officer, describing the care of the installed material; and including when and where maintenance should occur and the procedures for material replacement. Submit instruction for year-round care of installed products including schedule, materials, and tasks. Describe the methods for specific maintenance activities and equipment and tools required for such efforts. Include requirements on safety and regulations and permits.

PART 2 PRODUCTS

****

NOTE: Consult local codes and regulations for additional information that may effect the project before design work begins. The choice of methods and materials will be project specific and will be at the discretion of the designer. Edit the specification choices of products to best suit the needs of the project.

****

2.1 BINDERS

Submit certification for binders showing EPA registered uses, toxicity levels, and application hazards. Prior to delivery of materials, submit certificates of compliance attesting that materials meet the specified requirements and certified copies of the material certificates. Ensure all binders are biodegradable and untreated hemp or coir rope or fasteners, which are able to withstand 2 years minimum exposure to the environment of placement without significant degradation in strength or quality. Do not use steel or plastic binders or fasteners.

2.2 EROSION CONTROL ITEMS

****

NOTE: Several structures require the application or integration of erosion control products. These products include but are not limited to mulch, straw, hay, shredded bark, coir, mulch control netting, and erosion control mats. Products selected for use should be biodegradable and non-damaging to the environment in which they are placed. Sediment retention products may also be required as part of construction efforts. Mention the specific needs and types of products below.

****

Provide [erosion control products] [and] [sediment control structures or products]. Install materials and structures according to manufacturer's recommendations based on [actual site conditions] [and] [as shown in the drawings].

2.3 SEED

****

NOTE: State-certified seed is more stringently monitored than State-approved seed, and therefore, more expensive.

****

Provide seed in accordance with Section 32 92 19 SEEDING. Provide [state-certified] [state-approved] seed of the latest season's crop in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Use labels in conformance with AMS Seed Act and applicable State seed laws. Provide classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested. Submit the Seed Establishment Period calendar time for seed establishment. When there is more than one seed establishment period, describe the boundaries of the seeded area specific for each period. Proportion permanent seed species and mixtures by weight as follows:

Mixture Percent by Weight	Percent Pure Live Seed	Botanical Name	Common Name
[_____]	[_____]	[_____]	[_____]

2.4 PERMANENT VEGETATION SPECIES AND MIXTURES

****

NOTE: Live or dead cuttings from locally harvested stock should be specified in this section. Nursery stock may also be used for design purposes or in areas with limited supplies of cuttings at or near the work site. Nursery stock has a higher chance of survival due to developed root systems but may add cost to the project.

The selection of the appropriate vegetation species

for the site should be made by consultation with a qualified geotechnical engineer, hydraulic engineer, biologist, and botanist based on site conditions, stability requirements, desired habitat creation, and blending ability with surrounding vegetation. The soil types, hydraulic conditions and requirements, and ability of the selected species to survive in the work area must be determined and considered in species selection. Selected species should improve or enhance slope stability and should be flexible and of low height at maturity to allow maximum conveyance of water in the channel.

At some sites, nonnative species may be more appropriate due to changed site conditions or alterations by natural or human activities. Native species may not be able to survive in such alternated settings. For restoration projects, non-native or intrusive species may need to be removed before planting native species to reduce competition for resources and to improve the survivability of the native plants. Plant species should be collected from the same watershed and near the work site to prevent the import of differing genetic stains into the project area.

Woody vegetation that matures to have trunk diameters greater than four inches should not be used. Such species when mature pose a threat of scour to the bank down stream of the trunk during high flow events. In addition, these species may develop extensive root system that may damage the structure when the tree dies and rotates into the stream or lake. In this case, the root wad typically removes a large amount of soil as it is pulled from the bank. The resulting hole may be subject to scour and result in structure damage or failure during moderate or high flow events.

Sedimentation types and depositional rates should be determined. Some streams may transport sediment that may abrade or break vegetation. Alternatively, large amounts of sediment may be deposited at the site and cover vegetation. The combined effect of the trapping of large amounts of sediment by the selected vegetation species may result in the accretion of sediment onto the bank. While this accretion of material provides additional bank protection in the short term, the long term effects may be large bank failures due to the added weight of the sediment on the bank. The structure may be damaged or destroyed if the failure plane cuts the structure. Therefore the vegetation species in such areas should allow adequate water flow through the vegetation to reduce the amount of sediment that accumulates at the site.

On banks down stream of water storage project, selected vegetation should be able to survive or

recover rapidly in the event water levels must remain at elevated levels for an extended period of time due to flood or navigation releases.

Provide specifics on quality requirements.
****

Submit classification, botanical name, common name, harvest location, plant heath, and date tested, (live or dead cuttings, nursery stock, plants). Provide permanent vegetation type and planting plan, species and mixtures for [live and dead cuttings] [and] [nursery stock] [and] [herbaceous plants] as follows:

Mixture Percent by Volume	Percent Live and Dead	Botanical Name	Common Name
[_____]	[_____]	[_____]	[_____]

Provide weed seed or noxious plants that are a maximum of 1 percent by weight of the total seed mixture. [Undesired], [non native] [and] [or] invasive vegetation species are not be allowed. Ensure all live cuttings and containerized plantings are capable of growth and rooting and free of disease or defects at the time of installation.

2.5 STAKES

Provide stakes consisting of 100 percent biodegradable materials and designed to safely and effectively secure erosion control blankets, coir logs, fascines, and other bioengineered structures for temporary or permanent applications. Ensure the biodegradable stakes are fully degradable by biological activity [within 2 years]. The stakes must exhibit ample rigidity to enable being driven into hard ground, with sufficient flexibility to resist shattering.

2.6 STAPLES

Do not use metal or plastic staples.

2.7 SYNTHETIC GRID AND SHEET SYSTEMS

Do not use synthetic grid and sheet systems.

2.8 CRUSHED ROCK, GRAVEL, SAND, STONE, RIPRAP, and BACKFILL

Provide quality of rock, gravel, sand, stone, riprap, and backfill in accordance with requirements in Section 31 00 00 EARTHWORK and Section 35 31 19.40 STONE REVETMENTS. Reject materials not meeting specified requirements and immediately replace by suitable material at no cost to the Government.

2.9 WATER

Water for irrigation, soaking of plants and cuttings, and dust control is the responsibility of the Contractor. Water must be clean, free of contaminates, and have a turbidly of less than 20 NTU. Use water from [a public source of know quality] [local surface water source] [groundwater well] near the work site. [Test water obtained from non public sources for quality in accordance with paragraph MATERIAL TESTING REQUIREMENTS.]

2.10 FENCING

****
NOTE: Permanent or temporary fencing may be required around work sites to prevent vandalism and damage to newly planted vegetation by livestock, animal, or human activities. Fencing may be temporary or permanent. Specify temporary fencing such as plastic construction fence, snow fence, or rental fence below. Use Section 32 31 26 WIRE FENCES AND GATES or 32 31 13 CHAIN LINK FENCES AND GATES to specify permanent wire and chain link fabric fences and gates if required.
****

[All fencing must be in accordance with Section [32 31 26 WIRE FENCES AND GATES][32 31 13 CHAIN LINK FENCES AND GATES].] Fencing must be temporary and consist of [_____] fence. Secure fencing to [wood] [metal T-poles] that are driven 600 mm 2 feet into the ground and extend 1.2 m 4 feet above the finish grade. Install fencing [at the start of work] [after construction]. Allow fencing to remain in place [until vegetation is established] [for 3 years].

2.11 IRRIGATION

****
NOTE: Sites may require extended periods of irrigation to ensure vegetation establishment. Irrigation systems may be on the surface or underground. Water retention in the structure in arid regions may be aided by the use of super absorbent polymers. Edit this specification for products that may be used with open trench irrigation.

Some sites may be remote and may not have electrical or water supplies available. In this case, the designer should include products for solar power, water tanks, or methods such as daily watering by water truck.
****

[All underground irrigation must conform to Section 32 84 24 IRRIGATION SPRINKLER SYSTEMS or as approved by the Government.] Provide the following products and materials for irrigation.

Product	Manufacturer	Quantity	Purpose
[_____]	[_____]	[_____]	[_____]

2.12 FERTILIZER, PESTICIDE, HERBICIDE

****
NOTE: Edit this paragraph as required. Fertilizer, pesticide, and herbicide may be required for the construction, establishment, and maintenance of

bioengineered structures. The designer will consult with a qualified botanist, biologist, landscape engineer, and regulatory agencies before selecting the use of or type of fertilizer, pesticide, or herbicide for application at the site. Products, if selected for use, should not pose a threat to water quality or the environment. Pesticides and herbicides will only be used when absolutely necessary. Use of biological methods for pest or plant control is encouraged. Provide specific product names, manufacturer, method and concentration of application, and other required product information below.

****

Provide the following products and materials.

Product	Manufacturer	Quantity/ Application	Purpose
[______]	[______]	[______]	[______]

2.13 MATERIAL TESTING

****

NOTE: Edit this section as required. Provide specific methods, procedures, sample numbers, test, and the like.

The Contractor should collect samples of select fill and site soils for physical and chemical analyses to ensure these materials are appropriate for growth of the selected plant species. Refer to specific soil requirements needed for healthy plant growth to complete this section. Imported soil or select fill must be tested to ensure the material is free of seeds or root stocks of non native or invasive species or detrimental biological organisms.

Soil samples from the surface and subsurface of the site should be collected for geotechnical and chemical analyses. Geotechnical test parameters should be at a minimum grain size with hydrometer, moisture content, density, and Atterberg limits as required. Testing of site soils and select fill for permeability, consolidation, and soil strength may also be required depending of site conditions and selected structure. Soil samples should be collected to confirm that soils at the site are not contaminated with hazardous, toxic, or radioactive compounds that would require special handling.

Samples of surface and groundwater should be collected to verify that seepage into the stream or water body at the work site is not contaminated with compounds that will endanger plant survival or pose a hazard to human health and the environment. Water that is not obtained from a public source should be

tested for biological and chemical contaminates.

Specify analytical laboratories for analyses, turn around time for samples, and holding times for chemical samples.

The soil and water samples must be collected and analyzed a minimum of 120 days before the start of construction. The analytical results must be reviewed by the Contracting Officer before work continues at the site. If hazardous compounds or chemicals are discovered, then the work will be terminated. All testing must be performed by USACE validated laboratories.

Several different types of samples and tests may be required depending on structure design, construction, and location. Soil samples should be collected for geotechnical analyses for grain size, moisture content, density, Atterberg limits, compaction, shear strength, and pH. Soil at the site and fill that may be imported should also be tested for these parameters. The chemistry of the soil should be tested to ensure the soil will support vegetation growth and is free of contaminates. Soil should be tested for deleterious microorganisms that could increase plant mortality. Surface and groundwater should be sampled for chemistry and quality.

****

Submit certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Properly identify each report. Describe test methods used and compliance with recognized test standards. Collect samples of soil and water at and for use at the site, collected at the locations as shown in the drawings and at source locations for the materials or water. Collect these samples and test as specified below.

Sample	Location	Number	Test Method	Collection Method
[_____]	[_____]	[_____]	[_____]	[_____]

PART 3 EXECUTION

3.1 SITE VERIFICATION OF CONDITIONS

Coordinate, through the work schedule, the timing of land disturbing activities with the provision of erosion control measures. An erosion control plan will be required in accordance with applicable Federal, State, or local requirements. Perform erosion control operations under favorable weather conditions. When excessive moisture, frozen ground, or other unsatisfactory conditions prevail, stop the work as directed. When special conditions warrant a variance to earthwork operations, submit a revised construction schedule for approval. Do not apply bioengineering materials in adverse weather conditions, which could affect their performance. Complete all tasks necessary for the required submittals.

3.2 SITE PREPARATION

3.2.1 Temporary Construction Facilities

****

NOTE: Access roads or paths may need to be permanent to allow ease in future monitoring and maintenance. If such access is required, provide requirements or references to appropriate specifications below.

****

Establish access routes to the construction site prior to the start of work and show them on the drawings. Provide all temporary construction facilities in accordance with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS. Provide access to the work site and harvest area by [temporary] [permanent] [roads] [and] [paths] designed for [motorized vehicles] [and] [pedestrian access] if acceptable and in accordance with regulations and property owner restrictions and permission. Select access methods that have the least impact on existing site conditions and that may be easily removed and restored upon the completion of work. Provide strict access control to the work and harvesting sites to prevent access by non-authorized personnel. Install [access gates] [barricades] at the entrances of temporary [roads] [paths] to the sites. [Secure these gates with a keyed lock and keep closed at all times when personnel are not present at the gates for access. Provide duplicate keys for the lock to the Contracting Office, landowner, authorized regulatory personnel, and fire and law enforcement as required.] [Place appropriate signage on the gates that clearly specify site access is restricted.]

3.2.2 Clearing and Grubbing

Clear access route and construction site of vegetation necessary for the construction of the bioengineered structure or staging area in accordance with Section 31 11 00 CLEARING AND GRUBBING. Efforts will be made to salvage vegetation suitable for use in the bioengineered structure.

3.2.3 Erosion and Sediment Control

Install erosion and sediment control measures prior to active construction efforts to prevent erosion of soil and offsite releases of sediment.

3.2.4 Earthwork

****

NOTE: Minor or extensive earthwork may be required as part of the construction of the bioengineered structure. This specification only includes the requirements for minor earthworks for trench excavations and soil roughening. Dimensions for minor earthworks are provided in the specific bioengineering method sections below. Site grading, shaping, or trenching for drains and utilities, and material types and gradations should be included in Section 31 00 00 EARTHWORK.

****

Slope and grade the [stream bank] [shoreline] [in accordance to Section 31 00 00 EARTHWORK] [and] [as shown on the drawings].

3.2.4.1 Trenches

Unless otherwise stated, make trenches to the depth, width, and line as shown on the drawings. Make side slopes, unless otherwise indicated, at the angle of repose. [Use material removed from the trench as backfill.] [Remove material that is removed from the trench from the site.] [Backfill trenches with select fill]. [Compact the floor of the trench to 90 percent maximum dry density and smooth.] Place backfill in 150 mm 6 inch lifts compacted [to 80 to 90 percent maximum dry density] [sufficiently to improve soil density but not impede vegetation root growth]. [Key trenches into the stream bank for a distance of 3 feet]. [Install shoring [if the trench exceeds 1 m 3 feet in depth] [as required by regulations]]. [The Contractor is responsible for dewatering of trenches for construction purposes.]

3.2.4.2 Finished Grade

Provide smooth finish grade and as shown on the drawings and in accordance with Section 31 00 00 EARTHWORK.

3.2.4.3 Surface Roughening

****

NOTE: Surface roughening should be performed on all slopes with exposed earth that are greater than 3H:1V. Surface roughening reduces surface runoff velocities and provides depressions that collect sediment, seed, and water, thereby improving vegetation establishment on the slope. Roughening may be accomplished by traversing the surface with track-mounted equipment, manual efforts such as hand raking, or terracing of the slope during excavation or the placement of fill. The method of roughening may vary depending if the slope is a new cut or fill surface or an existing or graded slope. Surface roughening should not create ridges or depression that hinder the mowing of slopes that are 3H:1V or less.

****

Roughen surfaces of all barren slopes related to work efforts by [equipment] [and] [manual efforts] to reduce erosion and promote trapping of seed, water, and sediment. Compact all lifts as specified in Section 31 00 00 EARTHWORK. [Cover surfaces of the lifts with loosely compacted soil to a depth of 100 mm 4 inches.] [Use track-mounted equipment to traverse the slope from the toe to the crest to place track imprints parallel to the contours of the slope.]

a. [Roughen slopes on new cut faces greater than 3H:1V by stair-step cuts installed during construction. Ensure the faces of the steps do not exceed 600 mm 2 feet in height in soft material or 900 mm 3 feet in height in hard material. Make horizontal spacing between the vertical faces no less than the vertical height of the step.]

b. [Roughen slopes on new fill greater than 3H:1V by the installation of lifts of compacted soil that does not exceed 200 mm 8 inches in thickness.]

c. [Roughen existing slope of graded areas by tilling, disking, harrowing and seeding, or other suitable method or equipment to produce ridges and depressions in the surface of the slope, which are parallel to the contours of the slope. Ensure these ridges and depressions do not exceed 25 mm 1 inch in depth or height above the grade surface and space no more than 250 mm 10 inches apart.]

d. Do not smooth the final roughened surface by blading or scraping. Break all large soil clumps into small clumps no more than 50 mm 2 inches in diameter and disperse on the immediate surface. Cut or fill mounds or depressions of soil that are greater in height or depth than those produced by the method of roughening with suitable material to grade and roughen to match the adjacent surface. Backfill depressions of depth greater than 150 mm 6 inches with compacted suitable material until reaching the design grade of the slope and roughened. Do not compact sand or silty sand to a density that may prevent vegetation planting and growth. Seed, plant, or cover roughened areas with erosion control products [immediately after roughening] [within [_____] days after completion of roughening].

3.3 FIRE PREVENTION

Take all efforts possible to prevent fire at the work site and harvest area as a direct result of work efforts. Provide fire prevention or suppression equipment to personnel at the work and harvest sites. Provide all equipment in compliance with applicable regulations and maintain in working condition at all times and within no more than 5 m 15 feet distant from the active work areas.

3.4 SANITATION

Provide adequate portable sanitation facilities for persons at the construction and harvest sites that are in compliance with all Federal, State, and local requirements.

3.5 HARVESTING OF VEGETATION

****

NOTE: Most plants for bioengineering structures constructed near water are wetland plants except for species used for the vegetation of high bank areas. Woody plants or herbaceous plants may be used and should be somewhat flood tolerant. Harvesting may include the collection of woody plants, herbaceous plants, or single or clump plantings. Vegetation should be harvested from local sources and native plant species near the construction site. The need to obtain vegetation from distant sources should be evaluated in terms of cost and the risk of introducing foreign genetic material into the watershed in which work occurs. Vegetation should be obtained when at all possible from the same watershed in which the work will occur. Other stabilization methods may be more appropriate for the site due to high transportation and handling costs.

Site harvesting requires the cutting of existing vegetation for live and dead stakes, poles, or

cuttings, collection of roots or tubers, or excavation of plants with root mats intact. The harvest site must not be over harvested and must be restored as much as reasonably possible after harvest work is completed. Determine the number and location of the vegetation that may be harvested before construction by a qualified botanist or forest engineer.

****

3.5.1 Harvesting of Woody Plants

****

NOTE: Woody plants consist of stem cuttings that quickly sprout roots and stems from the parent stem. These plants are typically willow and perhaps some species of dogwood and alder. Nursery stock with established roots may also be used.

The length of the harvested vegetation will vary with site conditions and structure design. In general, stakes and poles should extend at least 300 mm 1-foot above the top of structure. Cuttings should extend at least 300 mm 1-foot beyond the edge of a structure or 600 mm 2 feet above the ground surface. Base the actual lengths of the stakes or poles on the depth of soil from the surface to the mid summer capillary zone or water table. For guidance, the minimum length is three feet. The diameters for the base of cuttings and stakes may range from 19 to 38 mm 3/4 to 1.5 inches and should be of sufficient diameter to resist buckling when driven into the streambed or bank. Live poles may range from 50 to 100 mm 2 to 4 inches. Live or dead logs used for crib walls should be at least 100 mm 4 inches in diameter for gullies and 200 mm 8 inches in diameter for use in streams or rivers. To improve survivability, live stakes and poles must be of sufficient length to penetrate the soil 600 mm 2 feet below the bioengineered structure or to within the capillary zone of moisture in the soil.

****

Harvest [stakes] [,] [poles] [,] [and] [cuttings] from local sources of selected species. Only import species of plants foreign to the ecosystem environment at the work site if they pose minimal threat to interfering with the native vegetation, are accepted by regulatory and environmental management, and are able to survive at the specific site. Unless otherwise stated below, provide [cuttings] [and] [stakes] that are 19 to 38 mm 0.75 to 1.5 inches in diameter and at least 1 m 3 feet in length. Use [stakes] [poles] with a diameter of 50 to 75 mm 2 to 3 inches and minimum length of 1.5 m 5 feet for insertion into armored stream bank structures. Cut [stakes] [and] [cuttings] [and] [poles] as straight as possible from healthy plants. Ensure plants for harvest are a minimum of one-year-old, preferable 2 to 5 years in age. Do not use suckers or current year growth. Ensure all cuts are clean and free of splits or excessive peeling of bark. Ensure at least two bud scars are visible on the [cutting] [stake] [pole] above the surface of the ground or structure when installed. [Stakes] [Poles] with deviations or curvatures greater than 13 mm 0.5 inch from vertical per 200 mm 1-foot of length will not be accepted. [Trim all branches emanating from the [stake] [pole] as close as possible to the surface of the stake without damage to the bark.] [Cut the bottom end of the [stake] [pole] at an angle of 60 degrees to the horizontal. Cut the top of the [stake] [pole] normal to its length.] [Harvest live cuttings from branches and include the growth tips of the branch. Cut the butt of the cutting at an angle to the vertical to aid in placing into soil.] If trunks of vegetation remain after cutting, ensure these trucks have a sufficient number of healthy branches remaining to allow survival.

3.5.2 Harvesting of Herbaceous Plants

****

NOTE: Edit this section as required. Consult a qualified botanist for harvesting, handling, growing, and transplanting requirements if herbaceous plants are to be used. Herbaceous plants may be emergent aquatic plants such as reeds, rushes, and sedges or may be non aquatic plants such as grasses or other forbs that require moisture during some portion of the year. Harvesting of these plants requires the collection of seeds, roots, or tubers. The roots or tubers may be transplanted directly to the site. Plants from the roots may be grown in a nursery and subsequently transplanted to the site. Plants or roots collected in the field must be placed in containers filled with water and kept cool until being transplanted to growing media at a nursery. Exposure of the harvested plants to wind or dry and hot conditions should be avoided. Consult a wetlands expert for methods for collecting and growing of wetland plants.

****

[_____]

3.5.3 Harvesting of Reeds or Clump Plantings

****

NOTE: Edit this section as required. Consult a qualified botanist for harvesting and transplanting requirements of reed or clump plantings. Single plants or groups of plants may be harvested, which include the root mass in soil plugs. Large clump plantings require the removal of vegetation with the root mass and surrounding soil intact. These larger plantings may be extracted by hand and shovel methods or the use of light or heavy equipment.

****

[_____]

3.5.4 Sealing of Harvest Cuts

Trim all harvest cuts on trunks or branches of the host vegetation of loose wood or bark and sealed with an approved sealant to prevent desiccation and disease or infestation at the end of the workday without exception.

3.5.5 Harvest Site Restoration

Restore the harvest site to preexisting conditions as best as possible after harvesting is completed. Restoration includes but is not limited to removal of aggregate or wood chip roads or access paths, access gates, and ruts or depression, or other items or features related to work activities.

3.5.6 Disposal of Excess Vegetation

Excess cut vegetation from harvesting must be [thinly distributed on site] [collected and removed from the site] [staked on-site and [burned] [left in place]] [collected and transported to the work site for incorporation in the designed structure].

3.6 TIME OF PLANTING

****

NOTE: Edit this section as needed for site specific conditions. Provide specific dates for the planting window below.

Woody plants and nursery stock should be planted in the dormant season. These plants are dormant when buds are set in the fall after the first hard freeze until the time when the buds begin to swell in the early spring. If planting can not be done during the dormant season, then the cuttings may be stored in a cold environment at -2 degrees C 28 degrees F until planting is possible.

Herbaceous plants may be planted during the dormant or non dormant seasons. If planted in the non dormant season, these plants should be placed as early as possible in the spring to allow the greatest amount of time for root development and growth. Herbaceous plants should not be planted during hot or dry weather if at all avoidable.

The time of planting is also dependent on site climatic and hydrologic conditions. The best time to plant is when the stream or lake is at mean water level. Planting should occur in the fall at sties where the water levels are expected to be low from the fall to the spring and if the plants may experience some growth and establishment before spring floods. Planting at sites where water levels fluctuate during the winter due to flooding or where frost heaving of soil occurs should be delayed until late spring. Late fall plantings may be preferable at locations subject to winter flooding and summer droughts. Fall planting is not recommended for areas where late season droughts or frost heaving occurs below the root level. The designer should consult a hydraulic engineer to determine water levels and flow velocities at the site during the planting and initial growth periods. Clump planting of shrubs or reeds should occur in the spring or early summer.

****

Start planting in the [spring] [fall] [summer] no earlier than [_____] and complete no later than [_____].

3.7 TRANSPORTATION OF HARVESTED VEGETATION

a. Submerge all freshly harvested and prepared live woody vegetation immediately in clean uncontaminated water and do not allow to dry out. Transport cut vegetation to the work staging area submerged in water. If site conditions prohibit direct access to storage bins filled with water, then wrap the freshly cut live vegetation in cloth, which is thoroughly saturated with water, and transport to a storage bin filled with water within no more than one hour from the time of cutting.

b. Transport live vegetation from the staging area to the work site in containers fully covered with clean water. Remove vegetation from the containers and immediately place in the ground. In the event that access to the installation site is limited, remove vegetation from the soaking tanks and wrap in bundles that are completely covered with at least three layers of saturated highly absorbent cloth or saturated biodegradable paper product with high saturated strength. Place cloth and bundles in plastic liners for greater ease in transportation to the work site.

c. Do not leave cut vegetation uninstalled at the work site and exposed to air or heat or excessive cold for any reason. Do not soak dead [cuttings] [stakes] [poles] unless the design requires this vegetation to be flexible. Cut live vegetation that is exposed to air for longer than 15 minutes during harvesting, transportation, installation, or which were not collected or transported as specified above are not acceptable. Do not accept damaged live vegetation and replace at no expense to the Government.

d. [Transport [herbaceous plants] [nursery stock] to the work site in covered vehicles. Do not subject plants to cold or excessive heat or drying during transport. Carefully unload plants at the staging area and place in a shaded area. Water plants and maintain in healthy condition until the time of installation. Transport plants to the work site [by hand] [push cart] [vehicles] and immediately install at the site. Do not accept damaged, wilted, diseased, or dead [plants] [nursery stock] and immediately replace at no expense to the Government.]

3.8 SOAKING AND PAINTING OF LIVE WOODY VEGETATION

****

NOTE: Make all possible efforts to prevent the harvested live vegetation from losing moisture from the time of cutting to insertion into the ground. Soaking of the live vegetation greatly improves the ability of the plants to survive transplant into the bioengineered structure.

****

a. Soak all harvested live vegetation in clean water for 3 to 5 days before installation into the ground. Place live vegetation in clean, leak proof, large plastic storage containers or similar, which are at least 300 mm 12 inches longer in length than the cut vegetation. Do not use reused or new metal drums or drums used for the containment of hazardous wastes or chemicals. Place containers in organized lines in a shaded location separated by a sufficient distance to allow access of a vehicle to the containers for the placement and removal of the vegetation. Give each container a unique identification number or series of numbers and letters that is clearly visible at the end of the container that will be approached for the placement or the removal of vegetation. Record identification numbers and reference relation to the contained vegetation for quality control and construction purposes.

b. Check water levels in the containers twice daily and add water as needed to ensure the containers are filled with sufficient water to completely cover the contained vegetation with a minimum of 50 mm 2 inches of water. Rust proof weights or clean cobbles or boulders may be used to weight down the vegetation and retain it under the water surface. Do not crush or damage the vegetation. Replace water in the containers completely with fresh and clean water every 3 days without exception. Vegetation that remains in water that has not been replaced as required will be deemed defective and will not be accepted by the Government. Water replacement schedule may be adjusted to compensate for weekends and holidays with the notification and approval of the Contracting Officer.

3.8.1 Mixing of Live Vegetation

Do not comingle vegetation of a specific species with another species during cutting, soaking, or transportation.

3.8.2 Painting of Stakes and Poles

****

NOTE: The painting of the tops of the live stakes and poles will reduce desiccation of the cuttings, potential for disease mortality, and allow ease in locating once installed. Perform all painting after soaking. Stakes or poles made of lumber may be painted at the option of the designer to improve visibility.

****

Paint the top ends of the [stakes] [and] [poles] with a latex paint diluted with water at a ratio of one part paint to one part water. The tops of the [stakes] [and] [poles] must be [dipped in the dilute paint mixture to a depth of 75 mm 3 inches after soaking] [painted immediately after planting by [brush] [spray applicator]]. The color of the paint must be [caution yellow] [safety orange]. The top ends of dead [stakes] [and] [poles] must [not] be painted.

3.8.3 Harvesting and soaking records

Prepare daily logs documenting the activities of plant harvesting, transportation, and soaking. Ensure these records contain at a minimum: name, date, weather conditions, company, location of harvest area, location of soaking area, site rehabilitation, species harvested, number of cuttings harvested, number of cuttings placed in soaking tanks, damage to cuttings, problems, and solutions to problems encountered. Clearly indicate the health of the primary vegetation from which the cuttings are obtained, diameter of cuttings and primary vegetation, length of cuttings, trimming procedures, time of cutting, time of placement in transportation bins, handling procedures, sealing of harvest cuts, time the live vegetation is delivered and transferred to soaking tanks, and identification label of the tank in which the cuttings are placed. Include the duration of soaking of the vegetation, water quality and time and amounts of water added to the tank during soaking, time of removal of the cuttings from the tanks, time of planting of the cuttings, and procedures used for removal, transportation, and planting of the vegetation at the construction site. Ensure records are signed by the lead harvest person or person in charge of soaking and planting and provide to the on-site manager at the end of each day. Provide records to the Contracting Officer within [24] [_____] hours of completion.

3.9 STAGING AREA

****

NOTE: A staging area for operations may be required. This staging area should be level and of sufficient size for the positioning of numerous bins for the soaking of live vegetation before installation. The staging area should also be of sufficient size to allow parking, storage of equipment, construction of bioengineering components, work trailer, sanitation, and water tanks if necessary.

****

Construct a staging area at the work site for the storage of equipment, work trailer, portable sanitation, water tanks, parking, and all other materials and equipment required to complete the work. The site should have a level portion for the placement of soaking tubs for the live vegetation. [Secure staging area by an eight feet high chain link security fence to prevent vandalism or unauthorized access to the staging area.] Perform adequate surface preparation to prevent excessive settlement, ponding of water, or rutting. Show location and design of the staging area in the drawings.

3.10 SITE DRAINAGE

****

NOTE: The designer should specify the site specific requirements for temporary and permanent drainage in this section. Work and harvest sites should be well drained at all times to prevent the ponding of water. Runoff water may need to be stored in retention or settling ponds before release to surface water bodies or channels. Remove all temporary drainage features and structures and restore to preexisting or design conditions at the end of work. Drainage may be a requirement for structure stability and for final grade of the work site. Some structure may require internal drainage of groundwater to improve stability. The requirements for internal drainage design should be stated in the requirement paragraph of the selected structure. Employ Best Management Practices in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

****

[_____]

3.11 DEWATERING

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NOTE: Excavations may need to be dewatered to allow construction. Failure to due necessary site investigation or characterization may result in construction delays, unsafe working conditions, and cost claims.

It is important to understand the subsurface groundwater conditions, surface drainage, and precipitation in the area of the work during the selection and design of a structure. Water in excavations may delay work efforts, interfere with proper soil placement and compaction, and damage vegetation. Structures that incorporate large amounts of woody vegetation may be damaged due to buoyant forces if these excavations fill with water before sufficient material or binders have been placed to hold the vegetation in place. Water removed from excavations may require treatment before release.

Excavations adjacent to tidally influenced water bodies offer challenges in water control and drainage of excavation in terms of construction timing. Time of construction and dewatering may need to be adjusted to match tidal events and require work during time periods other than normal working hours. Similarly, work schedule and dewatering of excavations may need special attention adjacent to rivers or streams that fluctuate seasonally or daily due to water releases from water storage or hydropower projects. In areas where water levels fluctuate, precautions should be taken to ensure the structure will not be damaged by buoyant forces or by currents.

Dewatering of excavations can be expensive due to planning, equipment, labor, and disposal efforts. Alternative designs, locations, or foundations should be considered to reduce project costs if required. Groundwater should be tested for chemical contamination before the start of work. The cost of dewatering and treatment of such water may be high.

****

Submit overall plan for dewatering and any required diversion of water. Completely address in the plan installation and removal of the required systems and features. Dewater for construction, obtain and review all necessary information to ensure dewatering efforts are in compliance with regulations, and ensure the designed dewatering efforts are adequate based on site conditions and climate and other variables that may effect dewatering efforts. [Submit a technical memorandum detailing all dewatering requirements, locations, methods, and disposal procedures to the Contacting Officer at least [60] days before the start of work.] Information provided by the Government regarding dewatering requirements and site conditions in no way relieve the Contractor of full responsibility for all dewater planning, efforts, and costs. Ensure the structure will not be damaged by buoyant forces or by currents should water enter the excavation or during the removal of this water. Ensure dewatering efforts do not impact adjacent structures or property, result in instability of the excavation floor or slopes, produce unsafe working conditions, or damage to animals or the environment.

3.12 BIOENGINEERED STRUCTURES

****

NOTE: The most common types of bioengineered structures are described below. These structures may be categorized as common, transverse, deflector, or longitudinal. Common structures are generic bioengineered structures applicable to gullies, stream banks, and lake shores. Transverse structures are constructed across stream channels that are less than 4.5 m 15 feet wide and 3 m 10 feet deep. Deflector structures are constructed from the bank into a stream or river to deflect flow away from the bank. Longitudinal structures are constructed parallel to stream banks or lake shores. Bioengineered structures may be used separately or in combination for bank protection and stabilization depending on the geotechnical and hydraulic site conditions, physical setting, desired habitat, and supply of construction materials. Structures not pertinent to the proposed design should be deleted from this specification. Structures described below are:

Common Structures
Permanent seeding
Live Staking
Joint planting
Pole planting
Live fascine
Siltation structures
Brush mat
Clump planting
Transverse Structures (streams less than 4.5 m 15 feet wide, gullies, small tributaries)
Palisade
Brush and stone sill
Wattle fence sill
Vegetated crib wall or wood sill
Vegetated dry stone barrier
Brush works or brush packing
Live fascine sill
Deflectors (Streams wider than 9 m 30 feet, stream bank protection)
Vegetated deflector (groins, dikes, spurs)
Live brush sill
Brush transverse
Brush grid
Longitudinal Structures
Single or clump reed planting
Live stone revetment
Brush layered revetment

Longitudinal live fascine
Longitudinal brush packing
Live crib wall

The specific names for bioengineered structures have not been standardized. The names of the structures listed above are not inclusive of all structures mentioned in literary sources and only represent a general compilation of the most commonly referenced names assigned to the structures. Therefore, individuals may have a different understanding of the function and deign of a structure when provided with only a name. A diagram of the proposed structure is recommended for inclusion in this specification to provide clarity in the description and intent of the requirements. The designer may obtain these drawings from numerous literary sources, private venders, or State resource agencies. It is recommended that the designer review these drawings during the selection of the structures for use and that the designer should provide these drawings to other personnel involved in the deign and planning of the project to reduce confusion in design objectives and requirements. These drawings may be edited for site specific conditions as needed and should be included in or attached to this specification.

The following paragraphs provide the general types of information that are required for the description of requirements for the structures. The designer must edit the selected requirements to meet project objectives and performance criteria based on actual site conditions.

****

3.12.1 Common Structures

3.12.1.1 Permanent Seeding

****

NOTE: Permanent seeding is a simple method of stream bank stabilization that may be used along low velocity streams or channels with peak flows less than 0.08 cubic meter per second 3 cubic feet per second. Seeding must be combined with erosion control stabilization methods to prevent or reduce soil erosion during germination and the first several years of vegetation growth. Selected species of grasses and/or plants should be native to the area, resilient, provide a dense root mat, and be able to withstand being submerged in water for extended periods. The placement of rock or woody debris may be required at the toe of the bank to reduce undercutting.

****

Select seed conforming to all required regulations and requirements and perform all seeding in accordance with Section 32 92 19 SEEDING. Place seed before installation of erosion control mats or the application of other erosion control materials or products.

3.12.1.2 Live Staking

****

NOTE: Live staking is the insertion of living stakes of vegetation into the ground. Live staking may be used to cover large areas of stream banks and to infill areas between other bioengineered structures. Live poles may also be used in lieu of stakes if deeper ground penetration is required. In this event, the method should be referred to as live pole staking. Combining live stakes with dead stakes may be feasible where the trapping of debris on the bank is desired or where there is a limited supply of local live vegetation.

****

Drive live stakes into the ground in a row parallel to the stream bank with the stakes spaced 1 meter 3 feet apart. Install rows of stakes starting from the toe of the bank and progressing landward and space 1 meter 3 feet apart. Offset successive rows of stakes from the preceding row by one half the spacing distance between the stakes. Perform construction in accordance with ASTM D6765 Standard Practice for Live Staking.

3.12.1.3 Joint Planting

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NOTE: Joint planting is a variation of live staking in which live stakes or poles are driven between the joints of large natural stone, rip rap, or other forms of bank armor. This method may be used to add vegetation to stretches of stream bank, which are protected by barren armor to improve habitat and add areas of shade. Vegetation will improve bank stability due to the development of root mats. The vegetation will also decrease the velocity of water adjacent to the bank during high flow events. Caution is advised to check the stability and condition of the armor before using these methods on existing protected banks. The amount of sediment that may accumulate on the back as a result of the vegetation should be considered in long term design performance since the deposition of large amounts of sediment may overload the bank and result in failure.

****

Install live [stakes] [poles] in rows parallel to the stream bank with the [stakes] [poles] driven into joints between the [stones] [rocks] of the bank armor. Drive [stakes] [poles] a minimum of 600 mm 2 feet into the soil behind the armor and space 1 meter 3 feet apart. Incline [stakes] [poles] at 15 to 45 degrees from horizontal. Install rows starting at the toe of the bank and progressing landward and space 1 meter 3 feet apart. Offset [stakes] [poles] in successive rows from the [stakes] [poles] in the preceding row by half the spacing distance. Extend tops of the [stakes] [poles] at least 0.5 m 1.5 feet but no more than 1 meter 3 feet above the top of the armor.

3.12.1.4 Pole Planting

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NOTE: Pole planting is the placement of vertical live or dead poles in multiple rows along the toe of a stream bank. The poles may trap debris between the poles and between the poles and the bank. The accumulation of debris should reduce the flow velocity adjacent to the bank and encourage the deposition of sediment and thus promote the aggradation of the bank over time. The structures will not provide immediate erosion protection, habitat, or bank stability. Erosion protection and habitat should develop as debris is trapped and the vegetation begins to grow. The stability of the bank should improve over time as new bank is formed and vegetation and root mats become established in the new bank material. Pole planting may be used in areas with steep or vertical banks or in areas with a limited supply of the vegetation that is necessary for the construction of other types of bioengineered structures. Pole plantings may be combined with brush mats or brush grids. Pilot holes may need to be drilled to allow the installation of the poles in coarse alluvial streambeds. Pole planting is not recommended for use in stream channels that contain large boulders or where bedrock may be within a few feet of the channel bottom. The depth to scour must be known to ensure the poles will not be lost due to degradation of the stream bottom during a flood event.

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Drive live poles vertically into the stream bed to a minimum depth of 1 m 3 feet. [Extend no more than one-half the length of the pole below grade above the ground.] [Drive poles to refusal.] [Drill pilot holes at the locations where the poles are installed using a steel rod or mechanized drilling machine. Place poles into the holes and compact loose sediment around the poles in place. Add additional sediment as needed to fill any space between the pole and the inner wall of the pilot hole until the hole is filled to the existing surface.]

a. Ensure poles are straight and at least 100 mm 4 inches in diameter. Shape driving tip to a point to aid in installation. Branches must [not] be stripped from the pole [where exposed above grade after installation]. Cut the top of each pole normal to its length.

b. Install poles in rows parallel to the stream bank at a nominal spacing of 1 m 3 feet. Install rows starting at the toe of the bank and progressing towards the stream channel to the mean low water level. Offset poles in successive rows from the poles in preceding rows by one half the spacing distance. Ensure tops of the poles are at a uniform elevation [of 1 m 3 feet] above the mean low water level along the bank.

3.12.1.5 Live Fascine

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NOTE: Live fascines are long bundles of live or dead branch cuttings tied together in tubular

sections from 1 to 10 m 4 to 30 feet in length and up to 300 mm 1-foot in diameter. Smaller diameters and lengths of fascines are advantageous in areas where access by vehicles is not possible and materials must be provided to the site by manual labor. Fascines are recommended for sites close to large supplies of vegetation. Fascines are advantageous in stabilizing slopes of long length and for protecting the toes of banks. The structures are effective in reducing erosion on sloped banks that are subjected to bank scour or high surface runoff. The horizontal arrangement of fascines will reduce erosion and trap sediment and seed on the slope. The structures will deflect and insulate the bank from the stream current.

The stability of the bank will improve as the live vegetation develops root systems. Steep or undercut banks must be reduced in slope to provide a stable slope for construction and installation of the fascines. Banks that have experienced sloughing or rotational failures must be repaired by the removal of the failed material and the reconstruction of a stable surface before the installation of the fascine structures.

Fascines require large amounts of live vegetation for construction. Therefore, these structures are best suited for temperate regions where there is a significant supply of available and suitable vegetation near the work site. Staggered fascine structures are recommended in areas with limited supplies of vegetation or as a means to reduce project costs. Fascines are suitable to protect the toes of banks when used in combination with other bioengineering methods on the slopes. Fascines may be used at transition areas between different types of erosion or stabilization structures such as between erosion control mats and live siltation structures at the toe of a stream bank, or with brush mats or layered structures.

Fascines may be refereed to as horizontal or vertical structures. Horizontal fascines are placed parallel to the stream channel. These fascines will reduce bank erosion by scour and surface runoff. The recommended spacing between horizontal fascines based on bank slope are:

Slope	Slope Distance Between Trenches (mft)	Maximum Slope Length (mft)
1H:1V to 1.5H:1V	0.9-1.23-4	4.515
1.5H:1V to 2H:1V	1.2-1.54-5	620
2H:1V to 2.5H:1V	1.5-1.85-6	930

Slope	Slope Distance Between Trenches (mft)	Maximum Slope Length (mft)
2.5H:1V to 3H:1V	1.8-2.46-8	1240
3H:1V to 4H:1V	2.4-2.78-9	15.250
4H:1V to 5H:1V	2.7-39-10	18.360

Vertical fascines are placed normal to the stream channel. These fascines may be used to serve as drainage conduits between the key trenches of horizontal fascines and are recommended in temperate regions and banks composed of poorly drained soils. Vertical fascines may be used to protect the bank from scour. Determine the spacing of the vertical fascines by site conditions, but should be close enough to prevent scour of the bank between the vertical bundles.

The trenches for the horizontal fascines may extend the full width of the work area or may be of shorter length and staggered to reduce the amount of material and labor required for the project. Key trenches must be installed at the toes of banks for horizontal fascine structures. The key trenches may be filled with natural stone and live and/or dead fascines up to three bundles in height. The ends of all trenches should be keyed into the bank or protected with large natural stone to prevent scour.

The trenches for vertical fascines should extend from the crest to the toe of the bank if these fascines are used without other structures on the slope. The trenches for the vertical fascines may extend between the trenches of horizontal fascines if used in combination. In this case, the vertical fascine trenches should connect the lowest portions of the horizontal fascine trenches to allow drainage. Trenches for both horizontal and vertical fascines may be installed landward of the crest of the bank if additional protection is desired and sufficient room for these trenches is available.

Fascines composed of live cuttings may be placed on bank slopes to the mean high water level of the stream. Live cuttings capable of growth under saturated conditions may be placed in the stream and in key trenches to elevations below the mean water level. Dead cuttings may be used for fascines placed in saturated conditions or may be interwoven with live cuttings to provide added resiliency to live fascines. Fascines composed of dead cuttings may also be used separately at the toe or on the bank slopes where erosion and scour protection are desired and other bioengineered or hard structures are used for bank stability. Fascines should be wrapped with erosion control matting when installed

in fine-grained cohesionless soil to reduce erosion of backfill.

Fascines should not be constructed on the ground. Elevated tables or braces should be used for assembly. All fascines bundles should be constructed by laying live cuttings parallel to one another with all growth tips oriented in the same direction. The cuttings should have a minimum of 300 mm 1-foot of overlap on successive layers. The live vegetation cuttings should be secured into a bundle using biodegradable binders spaced every 450 to 600 mm 1.5 to 2 feet along the length of the bundle. The fascines should be carried to the installation site in a manner that prevents excessive bending or breakage. Fascines with broken or loose cuttings due to excessive bending or the failure of binders must be repaired or replaced at no expense to the Government.

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3.12.1.5.1 Horizontal Fascines

Install all trenches parallel to the direction of the bank contours. All trenches must be 450 mm 18 inches wide and no more than 50 mm 2 inches deeper than the diameter of the fascine bundles.

a. Excavate a key trench [at the toe of the bank] [at the mean [high] water level] [at the location shown on the drawings] [to a depth of 1 m 3 feet below the mean high water level] and extend the full length of the working area. Make trenches up slope of the key trench [the same length as the key trench] [3 m 10 feet in length and separate by a spacing of 3 m 10 feet longitudinally. The midpoints of the trenches placed up slope must coincide with the midpoints of the spaces between the down slope trenches]. Space trenches 1.2 m 4 feet apart. Install a trench at the toe and at two feet below the crest of the bank regardless of spacing interval. Extend these trenches the full length of the work site. [Place at least [2] [_____] trenches landward of the crest of the slope at a spacing of 1.2 m 4 feet.] Ensure all trenches are [keyed into the bank slope] [and] [filled for a distance of 1 m 3 feet with large natural stone at the up stream and down stream ends of the trenches].

b. Place the fascine bundle in the center of the trench with at least 50 mm 2 inches of the bundle exposed above the top of the existing grade of the stream bank. The junction between the ends of adjacent fascine bundles in the same trench must be [offset side-by-side] [interwoven with each other] for a distance of 300 mm 1-foot. Anchor fascine bundle in the trench with [live] [and] [dead] [stakes] [and] [poles] that are at least 50 mm 2 inches [square] [in diameter] at the top, 700 mm 2.5 feet in length, and taper from the top to the base. Drive [stakes] [poles] vertically through the fascine until flush with the top of the bundle starting 1-foot from the end of each fascine and space every 1 m 3 feet thereafter. Drive a terminal [stake] [pole] 300 mm one-foot from the end of the fascine regardless of spacing interval. Do not drive [stakes] [poles] through or within 150 mm 6 inches of the binders. Drive live [stakes] [poles] into the slope on the downhill side of the fascine bundle at an angle not to exceed 45 degree from vertical. Place [stakes] [poles] at the midpoint between the anchor [stakes] [poles] and contact the underside of the fascine, but do not penetrate the fascine. Extend at least 75 mm 3 inches of these downhill live [stakes] [poles] above the ground surface. Place soil and lightly tamp into place around the fascine and brush into the voids in the fascine until only the top of the bundle is partially exposed. Slope top of the backfill towards the back of the fascine trench to prevent overtopping by runoff and to retain water and sediment.

c. [Place a single fascine in the key trench.] [Stack up to [3] [_____] fascines on top of one another in the key trench.] Drive live poles vertically into the ground to a minimum depth of 600 mm 2 feet to secure the [stacked] fascine bundle(s) in the key trench. Extend these poles at least 600 mm 2 feet above the top of the upper most bundle. Backfill key trenches with compacted [removed sediment] [select fill] to match the [existing] [final grade of the] surface.

3.12.1.5.2 Vertical Fascines

Install trenches normal to the bank contours and space 3 m 10 feet apart starting from the up stream end of the work site. Place a trench at the down stream end of the work site regardless of spacing interval. Extend trenches [from the [toe of the bank] [key trench]] to [[the crest of the bank] [3 m 10 feet landward of the crest of the bank]] [between the horizontal fascine trenches. Offset vertical trenches by 1.5 m 5 feet between horizontal trenches to prevent through flow of drainage]. Make all trenches 450 mm 18 inches wide and no more than 50 mm 2 inches deeper than the diameter of the fascine bundles. [Excavate a key trench parallel to the bank contours at the [toe of the bank] [mean high water level] and extend the full length of the working area. Fill key trench with horizontal fascine bundles as specified above in paragraph HORIZONTAL FASCINES].

a. Place fascine bundle in the center of the trench with at least 50 mm 2 inches of the bundle exposed above the top of the existing grade of the stream bank. The junction between the ends of adjacent fascine bundles in the same trench must be [offset side-by-side] [interwoven with each other] for a distance of 300 mm 1-foot. Anchor fascine bundle in the trench with [live] [and] [dead] [stakes] [and] [poles] that are least 50 mm 2 inches [square] [in diameter] at the top, 700 mm 2.5 feet in length, and taper from the top to the base.

b. Drive [stakes] [poles] vertically through the fascine until flush with the top of the bundle starting 300 mm 1-foot from the end of each fascine and space every 1 m 3 feet thereafter. Drove a terminal [stake] [pole] 300 mm one-foot from the end of the fascine regardless of spacing interval. Do not drive [stakes] [poles] through or within 150 mm 6 inches of the binders. Drive live [stakes] [poles] into the slope on the up stream and down stream sides of the fascine bundle at an angle not to exceed 45 degree from vertical. Place [stakes] [poles] at the midpoint between the anchor [stakes] [poles] and contact the underside of the fascine, but do not penetrate the fascine. Extend at least 75 mm 3 inches of the up stream and down stream live [stakes] [poles] above the ground surface.

c. Place soil and compact into place around the fascine and brush into the voids in the fascine until only the top of the bundle is partially exposed. Roughen, seed, and cover the top of the backfill with erosion control matting to prevent the loss of soil.

3.12.1.6 Siltation structures

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NOTE: Siltation structures are composed of live or dead cuttings that are placed parallel to the toe of a stream bank at or below the mean high water elevation of the stream. These structures provide immediate erosion protection, fish habitat during high flow events, and trap sediment that results in bank aggradation. The structures deflect the current in the stream away from the toe of the bank to prevent scour and undercutting. The stability of the bank is improved as root systems develop.

Siltation structures are recommended for sites with low flow velocities such as the insides of meander bends, side channels, and in areas of bank scour behind obstructions. The structures are well suited for locations where the development of new bank is desired. Siltation structures should be combined with large natural stone, coir logs, root wads, or other hard structures if used in areas subject to high flow velocities and scour.

The structures may be constructed of live or dead cuttings. Live cuttings should be 1 to 2 m 3 to 6 feet in length, flexible, and from species of plants with do not mature to heights greater than 3 m 10 feet. Side branches may remain on the cuttings. Live cutting structures should be placed at the mean high water elevation of the stream to allow growth of vegetation unless the selected species is capable of root generation under saturated conditions.

Dead cuttings may be incorporated into a live structure to improve its resiliency and resistance to abrasion by sediment and debris. The dead cuttings may be from any locally available species of vegetation. Structures composed completely of dead cuttings are suitable for areas were temporary bank aggradation and erosion protection are desired. Dead cutting structures may be placed above or below the mean high water level of the stream. If the dead structure is placed below the mean high water level, it is recommended that large natural stone be placed on the cuttings to reduce floating of the cuttings. More than one row of live or dead siltation structures may be placed along a stream bank to increase the width of coverage.

Siltation structures may be placed on the stream bank normal to the toe of the bank and oriented up to 15 degrees down stream from the perpendicular to the toe. Theses structures are recommended for low slope banks to reduce erosion of low banks, improve bank stability due to root development, and for areas where sedimentation is desired. The spacing between these structures should be determined based

on actual field conditions and flow velocities to prevent scour between the structures. Live stakes or poles may be placed between the siltation structures.

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a. The siltation structure must [be [parallel] [normal]] [consist of segments parallel and normal] to the contours of the bank. Compose the structure of [live] [dead] [live and dead cuttings, comprising [80 percent] [and] [20 percent] of the structure, respectively]. Provide cuttings that are 1 to 2 m 3 to 6 feet in length [and flexible] with side branches attached.

b. Place cuttings in a trench that is excavated [at the toe of the bank] [1 m 3 feet from the toe of the bank towards the stream channel] [as shown on the drawings]. The trench must [be parallel to the bank contours and at the mean high water elevation.] [extend the entire length of the work site.] [[normal] [inclined at 15 degrees down stream to the bank contours.]] [Extend the trench from the toe of the bank to the mean water elevation of the stream.] Ensure all trenches are 600 mm 2 feet deep with a 'V' shaped cross section. [Space trenches 1 m 3 feet apart.] [Key all trenches 1 m 3 feet into the stream bank.]

c. Push ends of the cuttings vertically into the bottom of the trench along the centerline with the growth tips extending 450 mm 1.5 feet above the top of the trench. Place cuttings to form a layer that is 150 mm 6 inches thick with at least [15] [_____] cuttings per 300 mm linear foot of trench. Place large natural stone on either side of the bases of the cuttings and place backfill to infill between the stones to the top of the existing [design] grade. [Protect the stream side portion of the structure and the toe of the bank with [coir logs] [exposed dead fascines] [large natural stone with joint plantings of [live] [and] [dead] [poles] [stakes] [root wads]]]. Protect the ends of the structure with large natural stone placed on the up stream side of structure where it ties into the stream bank.

3.12.1.7 Brush Mat

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NOTE: A brush mat is composed of live or dead cuttings that are placed on the stream bank to form a densely packed layer of cuttings. These structures provide immediate erosion protection, habitat for fish during high flow events, and the rapid establishment of extensive root systems in the bank. Brush mats are well suited for erosion protection of banks damaged by flooding. The growth of the vegetation composing the mat structure may be improved by placing an initial lift of brush and covering it with soil and then placing a second lift of brush to the design surface. The mat is held in place by anchor stakes or poles and further secured to the slope by rope or binding products that are laced between the anchor poles. Erosion control matting may be installed beneath the brush mat to reduce erosion of slope soil, especially if this soil is poorly compacted or easily eroded.

Brush mats require large quantities of vegetation

and labor for construction. If an insufficient supply of live cuttings is available, then dead cuttings may be intermixed with the live cuttings in approximately equal portions. Dead cuttings should be flexible to allow construction and interweaving with the live cuttings. The base of the mat at the toe of the bank should be secured with rock or longitudinal bioengineered structures to prevent erosion or damage of the mat. The cuttings for the mat may be placed in small trenches cut into the face of the bank or pushed directly into the slope without the excavation of trenches.

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a. Provide [live] [and] [dead] cuttings that are generally straight, supple, 1.5 m 5 feet long, and with lateral branches still attached. Shape cut ends of the cuttings to sharp tips for penetration into the stream bank. Place cuttings in rows parallel to the contours of the bank starting 1 m 3 feet below the bank crest. Space rows every 600 mm 2 feet thereafter down slope to the toe of the bank. Extend all rows the full length of the work site.

b. Push cut ends of the cuttings into the bank at the same contour elevation for each row with the growth tips toward the top of the bank. Orient the cuttings [normal] [at an angle of 15 degrees down stream from normal] to the bank toe. Place at least 15 cuttings per 300 mm liner foot in each row. Use a light roller and foot pressure to push the cuttings of subsequent rows against the bank over the cuttings of preceding rows to achieve a mat thickness of 100 mm 4 inches. [Place up to 15 percent of the cuttings parallel to the slope of the bank and interwoven with the cuttings that are placed with the growth tips toward the top of the bank. Use these parallel cuttings to reinforce the brush mat. Orient the growth tips of the parallel cuttings down stream.] Continue process of placing and compressing cuttings down slope until the toe of the bank is reached. Place a row of cuttings along the toe of the bank regardless of spacing interval.

c. Protect toe of the bank by [large natural stones] [[live] [dead] fascines] [coir logs] that overlie the base of the cuttings of the row at the toe of the bank. [Install an erosion control mat on the prepared grade of the bank slope before the placement of the cuttings.] [Extend ends of the mat 1.2 m 4 feet over unprepared bank.]

d. Drive [live] [dead] anchor stakes that are 50 mm 2 inches in diameter through the mat and 600 mm 2 feet into the stream bank. Do not extend the tops of these stakes more than 300 mm 1-foot above the top of the mat. Place stakes in rows parallel to the bank contours starting at the crest of the bank with the stakes spaced 1 m 3 feet apart. Space subsequent down slope rows every 1 m 3 feet to the toe of the bank. Install a row of stakes along the toe of the bank regardless of spacing interval to anchor the base of the mat. Notch the top of each anchor stake with a 13 mm 1/2-inch deep triangular cut that is normal to the length of the stake and 25 mm 1 inch below the top of the mat when compressed by foot pressure adjacent to the stake.

e. Secure the up stream and down stream ends of the mat with anchor stakes that are placed with a spacing interval equal to one half the above specified spacing distance of stakes in the rows. Extend the one half distance spacing of stakes for 1 m 3 feet towards the center of the structure from the up stream and down stream ends of the mat and extend from the base to the top of the mat at these locations.

f. Secure mat to the slope using binding ropes. Lace ropes across the mat in a diagonal. Secure a single length of rope to a stake in the row of stakes at the toe of the bank. Secure rope to each stake that is oriented diagonally to this stake in a single direction from the toe of the bank to the crest of the bank. Tie together ropes that cross between stakes . Secure ropes parallel and normal to the slope along the rows of stakes and to the stakes that lie in a line from the crest to the toe of the bank. Tie these ropes together where they meet between stakes. Secure all ropes to the stakes with non raveling knots. Allow no more than 150 mm 6 inches of rope to remain at the ends of the rope lengths after they are installed.

g. Brush [removed soil] [select fill] into the mat to within 50 mm 2 inches of the top of the structure.

3.12.1.8 Clump Planting

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NOTE: Clump planting requires the excavation, transport, and placement of live vegetation with root wads and attached soil. This planting method is recommended for establishing vegetation on steep banks of limited height and on the upper banks or floodplains of a stream where the plants will not be subjected to long periods of inundation by water and where adequate moisture is available. Plantings should not be subjected to erosion, flooding, animal traffic or grazing, dry conditions, or high winds during the first several years after installation. Minor earthwork is recommended to reduce vertical faces or remove undercut slopes from the bank to limit the loss of plant clumps due to scour or flooding. Selected woody vegetation should not grow to large mature trees, which could induce scour and loss of the bank due to obstruction of the stream flow or the rotation of the tree into the stream channel and creation of a large hole as the root wad is pulled from the bank. Heavy equipment may be required if plant clumps or root wads are too large to be easily moved by manual efforts. The toe of the stream bank should be protected from erosion by the placement of large natural stone, erosion control matting, or construction of longitudinal bioengineered structures. Irrigation and fencing may be required to ensure the survivability of the plants.

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a. Prepare stream bank for clump planting by excavating 600 mm 2 feet deep holes with floors that slope into the bank and that are at least 150 mm 6 inches longer and wider than the same dimensions of the removed clumps. Ensure the floors of these holes are not within 150 mm 6 inches of the groundwater table. The excavations must be [spaced at 2 m 6 feet and separated by 1 m 3 feet of existing bank] [1 m 3 feet in width, continuous, and separated by 1 m 3 feet of existing bank] along the extent of the work site. Use removed soil as backfill. [Remove excess soil from the excavations from the site.] [Thinly spread excess soil from the excavations on the upper bank landward of the clump plantings.] Roughen and seed exposed surface of the backfill [and cover with erosion control products].

b. Locate suitable species for transplant in the vicinity of the work site. Do not allow plant species to mature to heights greater than 4.5 m 15 feet or trunk diameters exceeding 100 mm 4 inches. Ensure clumps of plants do not exceed the width of the removal equipment. If clumps are removed by hand, ensure these clumps do not exceed 1 m 3 feet in any dimension. Remove clumps with existing soil and as many shallow roots as possible to aid in growth and survival, and transport immediately to the work site and place.

c. Prior to placement, flood the excavation with water to moisten the soil and aid in plant survival. Place plant clumps with vegetation [standing vertically] [slightly inclined towards the stream] and firmly push into the soil at the base of the excavation to prevent rafting. Drive at least [[3] [_____]] [dead stakes] [or] [live poles] driven through each clump to secure it to the bank. Place biodegradable coir net with a minimal life of 2 years on top of the soil of the clump and extend 1 m 3 feet onto the bank beyond the limits of the excavation.

3.12.2 Transverse Structures

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NOTE: Transverse structures consist of live vegetation or a combination of live vegetation and hard material (dead vegetation, logs, rock, and natural stone) that are constructed normal to and across small stream or river channels or narrow gullies. These structures are recommended for streams with low flow, intermittent streams, or dry gullies subject to flow after precipitation events. The harder structures may be used in narrow channels that experience infrequent or seasonally torrential flows.

The transverse structures function as weirs and drop structures, which reduce the velocity of stream flow, bed degradation, and may result in the transformation of the channel profile to a stepped profile due to the retention of sediment and debris. The reduction in flow velocity aids in reducing bank erosion. In addition, these structures may be placed at the toe and parallel to the stream bank, thus directly improving bank stability and reducing undercutting and erosion especially in areas with banks composed of low cohesive materials. Structures should be placed with key trenches into the banks to improve stability and to prevent the by pass of the structure due to lateral erosion of the bank.

Advantages of transverse structures are ease of construction at remote sites using locally available materials and the establishment of habitat with time. A primary disadvantage of these structures is that they may obstruct fish passage and may reduce

the conveyance of the channel resulting in local flooding. Therefore, the structures should be designed to allow fish passage and constructed of supple vegetation that matures to minimal height. Some transverse structures require significant amounts of manual labor and may not be economical in areas of limited vegetation supply. Periodic maintenance may be required to remove excessive amounts of trapped debris to prevent possible flooding, fire dangers, build up of decomposing plant material, or heath hazards caused by habitation of the debris by insects or vermin or trapping of dead fish or animals. These structures may be combined with other forms of live and dead bioengineered structures and hard structures such as gabions, or riprap.

Stagnant water may become present behind transverse structures depending on site conditions. These areas of stagnate water may become breeding grounds for mosquitoes or other insects and undesirable aquatic plants and animals. The designer will include adequate drainage features in the design to remove water from behind the structure, such as open channels, drainage pipes, or passive subsurface drains.

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3.12.2.1 Palisade

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NOTE: A live palisade is a weir composed of live poles, which develops into a transverse zone of vegetation that crosses the stream channel. These structures may be installed rapidly, are easy to construct, and provide shade to the stream channel as the vegetation matures. Palisades are best suited for small gullies or streams in low-lying areas that are less than 10 m 30 feet wide and 4 m 12 feet deep. The streambed should consist of loose sand, silt, or soft clay to allow easy installation of the poles used in the construction of the palisade. A steel rod may be required to install pilot holes for the driving of the poles in medium to hard clay, dense sand, sand with fine gravel, and medium dense silt. Palisades may be installed in coarse alluvial streams if placed in a trench excavated in the streambed. These structures in coarse alluvial systems should be viewed as temporary and expendable since they may be damaged by bed load and large debris transported during periods of high flow.

A palisade may be constructed entirely of dead poles if the project objective is the temporary stabilization of the stream channel. These structures will not become reinforced with time by root structures and will deteriorate. However, depending on the site conditions, these structures

may be adequate for the retention of sediment on which native grasses and vegetation may take root, thus resulting in the evolution of the dead structure to a live transverse brush sill. Dead palisades may be used in coarse alluvial streams since the establishment of a vegetated structure is not expected and may not be desired.

The live or dead poles should be driven a minimum of 600 mm 2 feet into the streambed for poles under 1.5 m 5 feet in length. Poles over 1.5 m 5 feet in length should be driven a minimum of 1 m 3 feet into the streambed. The poles should be harvested from local vegetation and should be a minimum of 38 mm 1.5 inches in diameter. The bottoms of the poles should be formed to sharp points to aid in the driving of the poles into the streambed.

The strength of the palisade may be increase by attaching a cross beam to the structure. A cross beam is recommended for palisades with widely spaced or thin poles and that have a height greater than one-foot above the streambed. The cross beams should be at the same height and inclination on both sides of the palisade. The beams are attached to the palisade with binders composed of untreated coir or hemp rope that is capable of withstanding several years of exposure. The binder must be looped and tied around the cross beams and the adjacent poles in a manner that tightly secures the members together. The binders should not unravel if a portion of the binder or structure is lost or damaged. Cross beams may be composed of untreated dimensional lumber or straight poles of similar diameter as the palisade poles.
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a. Provide live poles that are 1 m 3 feet long, 38 to 100 mm 1.5 to 4 inches in diameter, and cut the bottom ends of the poles to form sharp drive points. Drive poles vertically into the streambed to a minimum depth of 600 mm 2 feet and place across the channel in a [straight row] [row that is deflected down stream by 15 degrees] ['V'-shaped row pointing down stream with the apex at the center of the channel]. Space poles no less than 50 mm 2 inches but no greater than 150 mm 6 inches. [Extend center poles of the structure a maximum of [300] [600] mm [1] [2]-foot above the existing grade of the streambed.] [Use dead poles for center poles and place for a distance of 1 m 3 feet about the centerline of the structure.] [Compose central span of the structure of large natural stone keyed 600 mm 2 feet into the streambed with a top elevation 300 mm 1 foot above the existing streambed. Extend the stone 600 mm 2 feet on each side of the centerline of the structure and tightly butt with [live] [dead] poles of the palisade structure.] [The tops of the poles must increase in height outward from the center of the structure by no more than 15 mm 0.05-foot for each adjacent pole to form a notch at the center of the structure.] [The tops of the poles must be at the same elevation.] Place ends of the structure in key trenches that extend 1 m 3 feet into the stream bank.

b. Attach cross beam members of untreated [straight 25 by 100 mm 1 by 4 inch dimensional lumber] [long straight poles at least 50 mm 2 inches in diameter] to the palisade with binding products; wrap at least two times around the cross beam and adjacent pole. Install binding products to prevent raveling of the binder in the event of the loss of a portion of the binder or structure. Place [horizontal] [inclined] cross beam members at the same elevation on each side of the palisade and extend the entire width of the structure. Use beams that are 600 mm 2 feet greater in length than the structure and place the ends of the beams in key trenches in the bank. Excavate key trenches to the depth and width necessary for the placement of the ends of the cross beams and backfill with soil removed by excavation.

c. Compact sediment in the streambed around each pole using a tamping bar. [Place sediment removed from the streambed for the installation of the poles as compacted backfill around the poles.] Place dead cuttings and excess live cuttings in a criss-cross pattern on the up stream and down stream sides of the structure for a distance of 600 mm 2 feet and pack tightly against the stream bank at the ends of the structure to a thickness of 150 mm 0.5-foot for 600 mm 2 feet beyond the limits of backfill exposed at the key trenches.

3.12.2.2 Brush [and Stone] Sill

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NOTE: Brush sills are transverse structures similar to palisades, but composed of live or dead cuttings. These structures reduce stream channel degradation, are easy to construct, and may be combined with natural stone to improve performance. Selected vegetation should mature to low height, remain supple with time, and be capable of good root mat development. Live or dead cuttings may be used for the structure and the cuttings may retain small branches and do not need to be straight. Sills may also be placed along the toes of stream banks separately or adjacent to the transverse brush sills. Sills do not trap large amounts of sediment or debris since the vegetation used in construction is pushed against the stream channel during high flow events and does not form an obstruction to flow. Therefore, these structures are suitable for channels where minimal changes to the stream profile are desired. Sills may be constructed in most types of alluvial material and will function in coarse alluvial streams. Backfill and the buried portions of cuttings should be wrapped in several layers of coir mat if the sill is constructed in a stream channel subject to infrequent torrential flows. The width of the construction trench may be increased up stream of the vegetation and filled with large natural stone to reduce damage to the structure by bed load in high flow channels. Live stakes may be planted between the joints of the stone.

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Excavate a 600 mm 2 feet deep trench normal to and across the entire width of the stream channel. Place live cuttings in a criss cross manner with 20 cuttings per 1 meter 3 linear feet of trench on the down stream face of the trench. [Place cuttings in the same pattern and concentration as in the trench for the sill on the stream side faces of trenches excavated at the toes of the banks for a distance of 4.5 meters 15 feet up stream and down stream of the ends of the sill structure]. Push cut ends of the cuttings into the bottom of the trench to [refusal] [150 mm 6 inches] and extend the growth tips 600 mm 2 feet above the top of the existing streambed. Place large natural stone on top of the cut ends of the cuttings [to the top of the existing streambed to fill the entire trench] and tamp into the streambed to secure the stones in place. Place removed sediment in the voids between the natural stone [and place over the lower stone work to fill the entire trench]. Thinly spread excess sediment up stream of the structure. Place large natural stone at the ends of the structure against the bank [and at the upstream and down stream ends of the trenches excavated parallel to the banks]. Drive [live stakes] [and] [dead cuttings] up to 600 mm 2 feet in length into the [sediment backfill on 150 mm 6 inch centers] [between the joints in the natural stone] across the entire width of the trench and 1 m 3 feet up each bank from the toe of the bank. Space sills [15 m 50 feet apart] [as shown on the drawings].

3.12.2.3 Wattle fence sill

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NOTE: Wattle fence sills are recommended for narrow and slow flowing streams, small gullies, agricultural drainage ditches, or open channel drains. These sills are best suited for streams or drainage systems with coarse-grained bed load, which will be trapped by the weaves of the fence. The sills may not trap fine-grained sediment or reduce erosion in fine-grained alluvial streams since the fine sediment may pass through the structure. These fence structures may be constructed of live or dead vegetation. The use of live poles and cuttings should result in the establishment of a row of vegetation across the stream channel with time. Cross beams are recommended for structures over two feet in height. These sills may be combined with brush sills and brush layer structures.

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a. Excavate a trench 600 mm 2 feet deep and 300 mm 1 foot wide normal to and extend across the entire width of the stream channel. [Live] [Dead] poles must be 1 m 3 feet long with a minimum and maximum nominal diameters of 38 and 100 mm 1.5 and 4 inches, respectively. Cut bottom ends of the poles to form sharp drive points. Drive poles vertically into the streambed to a minimum depth of 600 mm 2 feet and place across the channel in a [straight row] ['V'-shaped row pointing down stream with the apex at the center of the channel with the poles] at a spacing of 600 mm 2 feet. Extend poles a maximum of [300] [600] mm [1] [2]-foot above the existing grade of the streambed. [Use dead poles for center poles and place for a distance of 1 m 3 feet about the centerline of the structure.]

b. Extend wattle fence from the bottom of the trench to the tops of the poles. The top of the fence must be [at the same elevation] [sloped to the center of the channel]. Construct fence of flexible [live] [and] [dead] cuttings that are 2 meters 6 feet in length and from 19 to 38 mm 3/4 to 1.5 inches in diameter. Ensure cuttings are [laced horizontally between the poles in an alternating woven pattern with the cuttings being placed on the up stream and down stream sides of adjacent poles across the structure starting from the steam bank] [placed on the up stream side of the poles and tightly packed and interwoven to form a braided vertical structure]. Overlap ends of the cuttings 300 mm 1-foot with adjacent cuttings. Secure cuttings of the fence to the poles with binding products. Install binders to prevent raveling of the binders in the event of the loss of a portion of the binders or structure.

c. [Place sediment removed from the trench in the excavation as compacted backfill around the poles and lower fence.] [Place live stakes at 300 mm 1-foot spacings in the backfill.] [Place large natural stone at the bottom of the trench along the up stream and down stream toes of the fence [and extend to the top of the existing streambed]. [Tamp stones into place and use sediment to fill voids between the stones.] [Place live stakes in the joints between the stones.]] Thinly spread excess sediment up stream of the structure.

d. Place [cross beam members of untreated [straight 25 by 100 mm 1 by 4 inch dimensional lumber] [long straight poles at least 50 mm 2 inches in diameter] on the down stream side of the poles and overlie the fence on the up stream side of the structure. Attach beams to the structure with binding products wrapped at least two times around the cross beam and adjacent pole and lace through the wattle fence cuttings.] [Place cross beams horizontal and at the same elevation on each side of the structure and extend the entire width of the structure.] [Extend both ends of the structure into a key trench that is excavated 600 mm 2 feet in the banks.] [Extend both ends of the structure to the existing stream banks and cover on both sides with large natural stone placed from the channel bottom to the top of the structure. Rest stone on the stream bank, at least 600 mm 2 feet thick, and extend 1.5 m 5 feet away from the structure in the up stream and down stream directions.]

3.12.2.4 Vegetated Crib Wall or Wood sill

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NOTE: A vegetated crib wall consists of a hollow box-like structure of timber or logs filled with earth and live cuttings. A wood sill is a vertical open wall composed of timber or logs that forms the front header, which is not tied to a similar structure, or rear header, up stream by stretchers as is the case with the crib wall. The crib wall is more stable than the wood sill. These structures may last 20 to 30 years depending on the type of timber used, are quick to construct, and may use locally available materials. The live cuttings take over the function of the crib wall as the cuttings grow and mature and the timber decays. These structures should not exceed 1.5 m 5 feet in height and are well suited for gullies with fine-grained sediment bed load and narrow streams less than 4.5 m 15 feet wide with steep gradients.

Crib walls or wood sills may be combined with brush sills, brush mats, or large natural stone on the up stream or down stream sides of the structure to reduce erosion. Stability of the structure may be improved using a double crib design composed of front and back rails. Backfill should be free

draining material with less than 10 percent fines. However, if such backfill material is not readily available, removed sediment may be placed as compacted backfill. Timber used for the crib wall may be untreated manufactured 100 mm 4-inch square posts, locally harvested vegetation with trunk diameters greater than 100 mm 4-inch, or a combination of these materials. Treated lumber will not be used.
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a. Excavate a trench that is 1.5 m 5 feet wide and 600 mm 2 feet deep and extends normal to and across the entire width of the stream channel. Slope the floor of the trench at 15 degrees up stream and [manually compact using a tamping bar weighing at least 18 kg 40 pounds] [compact using a small motorized tamping machine] until the bottom of the trench is dense and provides a solid base for the crib wall [wood sill]. The floor of the trench must be [as shown in the drawings] [of uniform grade across the trench width]. Fill depressions in the trench floor with compacted material to raise these areas to grade and reduce positive areas above the floor design elevation to grade. Key trench into the stream banks for a distance of 1 m 3 feet. Use material removed from the key trenches as compacted backfill in the key trenches. [Remove sediment removed from the trench in the stream channel from site and replace with select fill.] [Use sediment removed from the trench in the stream channel as compacted backfill].

b. Frame [crib wall] [wood sill] with [untreated, straight 100 mm 4-inch square by 2.5 m 8 feet long posts] [100 to 150 mm 4 to 6 inch diameter by 2.5 m 8 feet long straight logs harvested from local sources. Cut logs normal to the trunks with all branches stripped from the trucks]. Place down stream header [parallel to the bottom of the trench and extend the full width of the trench] [along the alignment shown in the drawings]. [Place up stream header parallel and 1.5 m 5 feet up stream of the down stream header.] Place splices between members end-to-end and in line. Drive wood posts that are at least 100 mm 4 inches in diameter vertically 150 mm 6 inches from the splices on the up stream and down stream sides of the headers. Drive wood post on both sides of the headers at the midpoints between the splices. Place members at the ends of the structure firmly against the faces of the key trenches. Drive wood posts on both sides of the headers at the toes of the banks and the toes of the key trenches.

c. Stretchers [for wood sills must be 1.2 m 4 feet] [for live crib walls must be 2 m 6 feet] in length. Place stretcher between the vertical splice poles and normal to the down stream header. Space stretchers every 1.2 m 4 feet between the poles and have a minimum of 100 mm 4 inches extending down stream of the header face. Place rear butt of the stretcher [firmly against the upstream face of the trench] [on top of the up stream header]. Attach stretcher to the header(s) with binding products wrapped three times around the stretcher and header in a criss cross pattern and secure with a non-raveling knot. Drill a 13 mm 1/2-inch diameter hole vertically through the stretcher and header. Drive a 16 mm diameter by 300 mm 5/8 inch diameter by 12 inch long [non-galvanized steel spike] [steel rebar] [hard wood dowel] into the hole and set flush to the top of the stretcher.

d. Backfill the open area between the down stream header and the upstream [trench face] [header and the portion of the trench upstream of the upstream header] with compacted [sediment removed from the trench excavation] [select fill] to an elevation that is at the middle of the stretchers. Place live cuttings that are 19 to 38 mm 3/4 to 1.5 inch in diameter and 2.4 m 8 feet long in a criss cross manner on top of the compacted backfill with the cut ends pushed into the up stream face of the trench. Ensure at least 600 mm 2 feet of growth tips of the cuttings extend beyond the face of the down stream header. Place backfill and lightly compact on top of the cuttings to the top of the stretchers. Place additional lifts of headers, stretchers, backfill, and cuttings until only the final lift remains. Offset centerlines of the down stream headers 50 mm 2 inches upstream of the lower headers to provide an incline to the down stream face of the structure.

e. The top down stream header must be 100 mm 4 inches larger in diameter than the headers used for wall construction to reduce sediment loss due to scour. Cut vertical poles on both sides of the headers flush with the top of the final down stream header [and the top rear header]. Place a header at the midpoint between the top down stream and up stream headers and secure with binders and [spikes] [rebar] [dowels] to the underlying stretchers. Fill the lift of backfill immediately below the completion headers with a tightly packed brush mat composed of live [and dead] cuttings that are placed in an alternating pattern perpendicular and parallel to the wall. Ensure each layer of cuttings is 100 mm 4 inches thick and cover with a thin layer of lightly compacted backfill. Place [rounded clean natural stone from 200 to 300 mm 8 to 12 inches in diameter] [excavated sediment] from the top of the packed brush to the top of the down stream header and grade up stream to match the existing slope of the stream channel up gradient of the work site. [Drive live stakes vertically on 600 mm 2 feet centers into the backfill at the top of the structure.] [Place large natural stone armor 600 mm 2 feet thick at the ends of the structure and on the slopes of the banks for a distance of 2 m 6 feet upstream and down stream from the structure. Plant live stakes in the joints between the stones.] Fill trench down stream of the structure with [large natural stone] [a brush [and stone] sill] [a brush mat].

3.12.2.5 Vegetated Dry Stone Barriers

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NOTE: Vegetated dry stone barriers are constructed of large natural stone with interlayered live cuttings. These structures may be built to heights of 4.5 m 15 feet and serve as weirs or drop structures in high gradient streams with torrential flows and heavy coarse bed load. Stone barriers may also be constructed to slightly above the existing elevation of the stream channel to prevent bed degradation. The largest stones that may be moved by manual efforts should be used. Construction of barriers adjacent to existing large boulders may reduce the amount of work required.

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Excavate a trench that is 1.2 m 4 feet wide and 1 m 3 feet deep normal to and across the entire width of the stream channel and key 1 m 3 feet into the stream banks. Slope the bottom of the trench at 15 percent in the up stream direction and compact using a manual tamping bar weighing at least 18 kg 40 pounds. Place large stone of similar size on the entire floor of the trench with a minimum of voids between the stones. Cover stones by [fine sediment] [select fill] and work into the voids between the stones until only the tops of the stones are visible. Place live cuttings that are 2 m 6 feet long and up to 38 mm 1.5 inches in diameter on top of the stones in a criss cross pattern with the butts of the cuttings in contact with the up stream face of the trench. Orient growth tips of the cuttings down stream and extend 0.5 m 1.5 feet beyond the farthest down stream placed stones. Place additional lifts of stone, fill, and cuttings on the lower lifts until the design height of the structure is reached. Place stones of each successive lift to interlock with the tops of the stones of the lower lift. Place live cuttings at the top of the structure in between the stones and incline slightly down stream. [Drive live stakes that are 600 mm 2 feet long between the joints of the stones at the top of the structure on 600 mm 2 feet centers and for a distance of 1 m 3 feet up the stream banks.] Cover top stones with a 100 mm 4 inch thick layer of [fine sediment] [select fill].

3.12.2.6 Brush Work or Brush Packing

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NOTE: Brush work or brush packing uses live and dead cuttings to fill a section of a gully or stream channel to reduce erosion of stream banks. These structures provide erosion protection to the channel by covering the channel with a mat of brush and are recommended for intermittent streams with fine-grained sediment. Brush works refers to brush mats placed across the stream channel with growth tips pointing up stream and which extend up the stream banks. Construction of brush work starts at the upstream limit of the work site and progresses down stream with each new layer of cuttings overlying the immediately up stream layer of cuttings. Brush packing refers to thickly packed layers of brush placed with the growth tips inclined slightly down stream that fill a gully or small stream channel. Brush packing starts at the down stream limit of the work site and progresses upstream with each new layer of cuttings overlying the immediately down stream layer of cuttings. Bank stability is improved as the vegetation grows and develops root systems in the lower bank. The cuttings may be anchored in the channel by cross logs secured to vertical poles driven into the streambed.

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a. [Start brush work construction at the upstream end of the work site and progress down stream with each down stream layer of cuttings overlying the layer of cuttings immediately upstream.] [Start brush packing construction at the down stream end of the work site and progress upstream with each upstream layer of cuttings overlying the layer of cuttings immediately down stream.]

b. Excavate trenches that are 300 mm 1-foot deep normal to and across the entire stream channel [and extend 1.5 m 5 feet up the stream banks]. Space trenches 1.5 m 5 feet apart. Place live cuttings that are 2 m 6 feet in length in the trench in a herringbone pattern at an angle of 30 degrees from the centerline of the channel with the growth tips pointing [upstream] [inclined down stream at an angle of 45 degrees from vertical]. The cuttings must [not] extend up the stream banks. Push cut ends of the cuttings firmly into the streambed. Place [removed sediment] [select fill] and compact over the cut ends of the cuttings to the elevation of the existing channel. Repeat this procedure for the specified length of channel at the work site.

c. Place cross logs normal to the channel and on top of the cuttings every 1 meter 3 feet. Ensure logs are 100 mm 4 inches in diameter and extend the full width of the channel. [Place cross logs parallel to the slope of the bank on top of the brush [work] [pack] layers that extend up the stream banks. Shape ends of the cross logs at the toes of the banks to sharp tips and drive the logs 500 mm 1.5 feet into the streambed at the angle of the slope of the stream bank.] Drive [live] [dead] poles vertically into the streambed on the down stream sides of the cross logs. Space poles at 600 mm 2 feet intervals and ensure the tops of the poles are not greater than 150 mm 6 inches above the tops of the cross logs. Drive poles at the toes of the stream banks regardless of spacing interval. Tie poles and cross logs together using binders that are wrapped around the logs and poles in a manner to prevent raveling.

3.12.2.7 Live Fascine Sill

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NOTE: Live fascine sills are more resilient and less prone to damage by scour than brush sills. However, heavy coarse bed load and large woody debris transported during high flow events may damage the fascines. Fascine sills may be used to form low drop structures to prevent streambed degradation in narrow streams with low flow velocities and minimal coarse bed load. Sills may be combined with other bioengineering methods for channel stabilization of high gradient or torrential flow streams. Fascines have the advantage of being flexible and therefore may be placed to conform to the existing profiles of the stream channel and may be easily extended up the banks of the channel. The diameter and strength of the fascine may be increased by adding dead branches and gravel or cobbles to the fascine. Fascines should be placed in trenches that are normal to the stream channel and that are at least 50 to 75 percent the diameter of the fascine in depth. Live fascines may be placed on top of one another to form step sills. Step sills are constructed by placing a down stream fascine in a trench and positioning a fascine directly up stream of the down stream fascine. The up stream fascine should rest on the upper one quarter of the exposed down stream fascine.

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Each fascine must be 300 mm 12 inches in diameter and 3 m 10 feet in length and constructed of live cuttings that are from 19 to 38 mm 3/4 to 1.5 inches in diameter. Up to 35 percent dead branches [and 15 percent rounded gravel or cobbles] must be interwoven with the live cuttings. Excavate a 200 mm 8-inch deep by 0.5 m 1.5 feet wide trench normal to and across the entire width of the stream channel [and at least 1.5 m 5 feet up the faces of the stream banks]. Place fascine in the trench. The junction between fascine bundles in the same trench must be [offset side-by-side] [interwoven] for a distance of 300 mm 1-foot. Anchor fascine in the trench with 700 mm 2.5 feet long [live] [dead] stakes that are at least 50 mm 2 inches [in diameter] [square] at the top and taper from the top to the base. Drive stakes vertically through the fascine until flush with the top of the bundle starting 300 mm 1-foot from the end of the fascine and space every 1 meter 3 feet thereafter. Drive a terminal stake 300 mm one-foot from the end of the fascine regardless of spacing interval. Drive [live] [dead] stakes at a 45-degree angle on the down stream side of the fascine but do not penetrate the bundle. Secure fascine to the stakes with binders wrapped around the fascine and secure to the stakes. Tie binders to prevent ravel in the event of damage. Use removed sediment as backfill and place and compact on the up stream and down stream sides of the fascine and brush into the fascine structure until only the top of the fascine is visible. [Space fascine sills 8 m 25 feet apart starting from the down stream end of the work site.] [Place fascine sills at the locations shown on the drawings.]

3.12.2.8 Vegetated Deflector

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NOTE: Vegetated deflectors are traditional hard structures composed of rock (groins, dikes, spurs) or timber (log or pile revetments) that incorporate live vegetation and which provide excellent long-term bank protection with the added benefits of shade and habitat enhancement. These structures protect the banks of large streams and rivers, which are subjected to high velocity flows, by deflecting the energy of the current away from the banks. The incorporated vegetation improves the strength of the structure and the quality of habitat over time. A key component for the establishment of vegetation on these structures is the retention of fine-grained material and the exposure of the hardened structure above the mean water level of the stream or river. Only vegetation that matures to trees or brush of less than 2 m 6 feet in height and which remains flexible should be used. Species that may mature to tall tress with extensive root systems may not be used, since these trees may damage the hard structures.

For existing structures, fine-grained material may be placed in open voids and live posts driven into these voids in the structure. For new construction, the interior of the structure may be composed of fine-grained material capable of supporting root growth. This core should be covered with rock of suitable size to resist transport by the stream or river. The cover armor must be anchored along the perimeter of the structure in a key trench below the scour depth of the high flow events. Additional stability of the armor may be gained by inserting dead stakes between stones in areas below the mean water level. Live poles may be driven into the joints of the armor above the mean water level.

Retention of fine-grained material in the core of the structure may be improved by placing this

material in untreated sand bags composed of natural fibers. The lifetime of the sand bags should be sufficient to prevent the loss of fines until the roots of the live poles lock this material in place. The surface of the sand bag core may be covered with a coir erosion mat prior to the placement of armor. To reduce the number of sand bags, the core may be constructed of compacted material overlain by a three-bag thick layer of sand bags, which is in turn overlain by the stone armor. A layer of well-graded fine gravel and coarse sand may be placed beneath the stone armor to form a filter layer and thus further reduce the loss of fines from the core. Other deflector alternatives include the use of logs or wood structures as cores surrounded by fine-grained material with exterior stone armor. These structures may be used to assist in trapping sediment behind rock groins or dikes to in fill large scour areas in a stream or river banks.

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a. Excavate a trench [4.5 m 15 feet wide, 1 m 3 feet in depth below the lowest elevation of expected scour, that extends from the toe of the high bank to 3 m 10 feet into the stream below the mean low water elevation. The trench must be [keyed 1.5 m 5 feet into the bank.] [as shown on the drawings]. [Place live cuttings against the face of the trench from the mean water level to the high bank. Extend these cuttings at least 450 mm 1.5 feet above grade and push the cut ends of the cuttings firmly into the bottom of the trench and cover with a thin layer of [sediment] [select fill]]. Place [natural stone] [quarry rock] at least 1 m 3 feet in the minimal dimension against the outer perimeter face of the trench and maintain as much contact with adjacent stones as possible. [Place [stone] [rock] to a height of 600 mm 2 feet above the high mean water level of the stream]. Slope the outer face of the [stone] [rock] at [2H:1V] while the face towards the center of the trench is at the angle of repose. Brush [sediment removed from the trench] [select fill] into the voids between the [stones] [rocks] until the soil is even with the tops of the [stones] [rocks]. Place live cuttingson top of the outer [stones] [rocks] with the cut ends of the cuttings firmly pushed into the bottom of the inside trench. Cover the ends of the cuttings with a thin layer of sediment that is overlain by [backfill] [sandbags]. [Drive live poles between the [stones] [rocks] to a depth of at least 1.2 m 4 feet.] Fill the core of the structure lying inside the larger outer [stones] [rocks] with [removed sediment] [select fill] [in untreated biodegradable sand bags that are placed tightly end to end and in vertical overlapping pattern] [compacted cohesive sediment removed from the trench separated from the outer [stones] [rocks] by a 600 mm 2 feet thick layer of select fill contained in untreated biodegradable sand bags].

b. Place successive lifts of armor [stone] [rock] on top of the completed lifts to the design slopes and grades of the structure. Place live cuttings on the top of each lift. Raise the core of the structure concurrently with the lifts of armor material. The final lift must consist of interlocked [stone] [rock] that extends across the entire top of the structure. Brush [removed sediment][select fill] into the voids between the [stones] rocks]. Plant live stakes in the joints between the [stones] [rocks] with a spacing of 1 m 3 feet. The top of the rock structure must be 300 mm 1 foot above the top of the original elevation of the high bank.

3.12.2.9 Live Brush Sill

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NOTE: Live brush sills are structures composed of live vegetation that extend perpendicular from the toe of the bank into the stream channel. These structures may extend landward to the high bank. The sills trap sediment and debris, reduce scour, and are useful in establishing vegetation on point bars of barren flat expanses of low bank. These structures are inexpensive, easy to construct, and may reduce the amount of rock or stone armor required for bank protection. The development of root systems and the growth of vegetation improve bank stability and develop riparian habitat. Dead cuttings may be used in these structures to improve their resistance to erosion and damage due to currents or debris. Sills composed entirely of dead cutting may be placed below the mean high water elevation separately or between harden transverse structures. These dead brush sills trap debris, sediment, and result in bank aggradation. Live sills, or other live bioengineered structures, may be placed on the new bank created by the dead sills at a future date to promote improved stability and habitat development.

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Excavate a 600 mm 2 feet deep trench with a 'V' shaped cross section normal to the toe of the stream bank from [the mean high water level] for a distance of [3 m 10 feet into the stream channel [from the mean high water level]] [and] [6 m 20 feet landward of the toe of the bank.] [to the edge of existing vegetation] [as shown on the drawings]. Place live cuttings in the trench with the cut ends pushed firmly into the bottom of the trench with the growth tips extending at least 600 mm 2 feet above the top of the existing grade. Place at least 20 cuttings per 300 mm linear foot of trench and rest all cuttings against the down stream side of the trench. Place large stone up to 150 mm 6 inches in diameter on the bottom of the trench against the cut ends of the cuttings and cover with loosely compacted [sediment] [soil] [select fill] to the existing surface. [Mound excess material removed from the trench that is to remain on site around the base of the sill at the surface.] Space sills 1.5 m 5 feet apart.

3.12.2.10 Brush Transverse

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NOTE: Brush transverses are stone structures augmented with live or dead brush cuttings that are easy to construct and inexpensive. These structures are useful in deflecting high velocity flows away from stream banks to prevent scour and erosion and may be used to aid in the repair of scoured or failing areas of stream banks. The live vegetation will develop root systems that will strengthen the structure and provide shade and habit. The stone structure deflects and dissipates the stream velocity away for the bank thereby creating areas of

still water down stream of the structures in which sediment may be deposited. The brush cuttings assist in sediment trapping during periods of high flow. This vegetation matures with time and will eventually completely cover the scour area. Brush transverses may be combined with brush grids to repair areas of bank scour in high flowing rivers.

Brush transverse structures are not suitable for use in streams with torrential flows and heavy clastic bed load. Installation trench depth and width must be based on hydraulic analyses of stream velocities and bed load transport. The structure may be normal to the stream bank or inclined at an acute angle to the stream bank in the down stream direction. The use of subrounded large natural stone from the immediate area of work is preferred for construction. If such material is in limited supply, then the available natural stone may be used as cover stone and the core of the structure may be constructed of angular to subangular quarry rock. In areas that lack natural stone, local durable quarry rock may be used for the entire structure.

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a. Excavate a trench 600 mm 2 feet deep by 1.5 m 5 feet wide from [the face of the high bank] [edge of the stream bank] to [3 m 10 feet beyond the low mean water elevation of the stream] [the new bank alignment as shown on the drawings]. [Key trench into the stream bank for a distance of 1 m 3 feet.] Firmly compact the base of the trench. Place live [and] [dead] cuttings that are at least 1.5 m 5 feet in length and that have side branches attached on the down stream side of the trench. Place the cuttings with a concentration of at least 20 cuttings per 300 mm linear foot of trench to form a layer with a thickness of 100 mm 4 inches. Push cut ends of the cuttings firmly into the streambed with a minimum of 1 m 3 feet of the growth tips extending above grade and incline in the down stream direction. Cover cut ends of the cuttings with a 75 mm 3 inch layer of moderately compacted [fine-grained sediment] [select fill] and extend from surface grade to the base of the trench at the angle of repose.

b. Place durable [large natural stone] [quarry rock] that is 450 mm 1.5 feet in minimal dimension along the up stream side of the trench, against the fill covering the cut ends of the cuttings, and completely fill the key trench. Place [natural stone] [quarry rock] ranging from 150 to 450 mm 0.5 to 1.5 feet in minimal diameter to cover the floor of the trench and firmly tamp into place to provide the greatest contact with adjacent [stones] [rocks]. [Brush] [Wash][fine sediment] [select fill] into the voids between the [stones] [rocks] until only the tops of the [stones] [rocks] remain exposed. Place successive layers of [stone] [rock] on lower lifts in a pattern that allows the greatest amount of interlocking of [stones] [rocks] and fill the voids between the [stones] [rocks] with [fine sediment] [select fill] to the top of the structure. Construct the end of the structure that projects into the stream of [large stone] [rock] that is 1 m 3 feet in minimal dimension for a distance of 2 m 6 feet. [Place excess sediment removed from the trench along the up stream and down stream toes of the structure.] Place the farthest up stream structure in the work area at an angle of 30 degrees to the direction of stream flow to deflect the current towards the center of the channel. Construct subsequent down stream structures at right angles to the stream bank with a spacing of the average length of the structure.

3.12.2.11 Brush Grid

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NOTE: A brush grid consists of layers of brush laid out in a rectilinear pattern with each successive lift being placed normal to the lower lift. The structures are well suited for the repair of severely scoured or sloughing areas on banks in streams with high flow velocities and large range or frequent changes in water level. These structures may be used on portions of the streambed from the toe of the high bank to the edge of the mean low water level of the stream. For large scour areas, a brush grid may be constructed at the up stream end of the scour hole between the stream bank and a brush traverse or vegetated groin or dike. The remaining portion of the scour area may be filled with widely spaced brush transverse structures. The areas between the transverses may be filled with brush sills. A brush grid requires significant manual labor and a large supply of brush. The amount of labor and materials may be reduced by combining the grid with brush sills, vegetated dikes, gabions, or by constructing a widely spaced grid work of brush instead of a complete cover of brush.

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a. [Extend an excavation that is 4.5 m 15 feet wide and 1 m 3 feet deep from the edge of the high bank 6 m 20 feet into the stream channel. Slope the floor of the excavation towards the bank at 2H:1V and make smooth and compact. Extend the side slopes beyond the above specified dimensions and at the angle of repose. Key trench 1.5 m 5 feet into the stream bank.] [Excavate sediment to form a level floor at the installation area to the grades and dimensions shown on the drawings.][Drive live] [dead] poles composed of [untreated manufactured lumber] [straight sections cut from local trees] vertically 1 m 3 feet into the streambed [along the alignment of the proposed bank] [as shown on the drawings] [in a straight row that is 4.5 m 15 feet from the edge of the high bank]. Place additional poles between the new alignment of poles and the stream bank on 1.5 m 5 feet centers. The poles must be 100 mm 4 inches in diameter. The length of the poles must be such to allow 600 mm 2 feet of pole to extend above the mean water level. Shape bottoms of the poles to sharp tips to facilitate driving them into the streambed. Cut tops of the poles normal to the lengths of the poles. The top elevations of the poles must be the same for all poles. [Drill pilot holes, slightly larger in diameter than the poles, into the streambed using a [steel punch rod] [mechanical drill] in coarse alluvial sediment]. Stand the poles erect without support after installation in the streambed. Install loose or nonvertical poles. Replace poles damaged during installation at no expense to the Government.

b. Provide base layer of the structure consisting of 150 mm 6 inch diameter by 6 m 20 feet long trunks of trees with their branches still attached. Do not attach root wads to the trunk. Pack these trunks tightly between the poles with the growth tips extending 600 mm 2 feet into the stream beyond the new bank alignment. Place trunks horizontally in the excavation with the cut ends placed [in the key trench] [firmly butted against] the stream bank.

c. Place [removed sediment] [select fill] over the trunks until only to tops of the trunks are exposed. Place live cuttings up to 50 mm 2 inches in diameter vertically in rows spaced 1 m 3 feet apart parallel to the base layer of trees with a minimum of 5 cuttings per 300 mm linear foot of row. Push cut ends of the cuttings through gaps between the base logs and into the streambed. The top of the growth tips of the cuttings must be at the same elevation as the top of the vertical poles and inclined at a slight angle down stream. Place a layer of live cuttings consisting of 1 m 3 feet wide rows that are up to 300 mm 12 inches thick horizontal on top of the first lift of trunks and pull around the upright live cuttings and poles. Extend the growth tips 600 mm 2 feet beyond the new alignment into the stream. Separate the rows from the vertical posts by a distance of 300 mm one-foot. Place sediment n top of the cuttings to fill all voids until only the top of the rows are exposed. Place a lift of cuttings normal to the first lift of cuttings with the growth tips extending 600 mm 2 feet beyond the down stream edge of the structure. Place sediment on top of this lift of cuttings the same as the lower lift. Place lifts of rows of cuttings in this alternating manner until the structure reaches a minimal height of 1 m 3 feet above the mean low water level. Place large natural stone along the outer perimeter of the structure to protect it from scour. Secure top of the structure with [a layer of natural stone] [sand bags filled with select fill] placed on top of the horizontal cuttings and around the vertical live cuttings and poles.

3.12.3 Longitudinal structures

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NOTE: Longitudinal structures or plantings are placed parallel to stream banks or lake shores and may be used in conjunction with hard engineered structures to provide habitat, shade, and to obscure the hard structures from view thus allowing a more natural appearance to the protected bank.

****

3.12.3.1 [Single] [Clump] Reed Planting

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NOTE: Reed planting involves the planting of singe reeds or clumps of reeds along a stream bank or lake shore. This method is well suited for low flowing streams, lakes, canals, and stagnate areas of water that are protected from wave action or strong currents. Such sites may include exposed banks at or slightly below the mean low water level, tidal flats, or areas of low relief shoreline that extends some distance into a water body. The reeds dissipate energy of the water acting on the shore area and reduce erosion while root structures improve the strength of the bank. Planting should begin at the wet shoreline and progress landward. This planting method is simple to implement and

complete, but must be accomplished during the first months of summer to allow the plants to become established.

The method does not provide immediate erosion protection to the bank nor will the plants tolerate shade. The effect of the plantings may not be realized until two to three years after planting. Reed planting will not reduce failure of unstable banks or shorelines. Clump planting refers to the planting of a large group of reeds contained in a large soil and root mat in a hole excavated at the site.

****

Plant reeds during the active growing period. Deliver reeds to the site in bundles in saturated cloth. Plant [single reeds] [reed clumps] on a grid with a spacing of 600 mm 2 feet starting at the shoreline and progressing landward [for a distance of 16 m 50 feet] [to the existing reed line]. The stems of the reeds must be slightly above grade and vertical. Protect shoreline edge of the planting area by [a line of natural stone] [coir log] [log] [_____]. [Ensure placed between stone armor at the water line are placed between the stones in narrow trenches backfilled with fine-grained sediment.]

3.12.3.2 Live stone revetment

****

NOTE: Live stone revetments are traditional stone or rock armor revetments placed on banks for stabilization and erosion protection with the addition of live cuttings placed in the joints between the armor stones. These structures are well suited for sites where extensive areas of bank must be protected along high flowing streams with heavy bed load or lake shore subject to wave action. Saplings may be placed between the rock joints if topsoil is placed to fill the interstitial voids between the armor stones. Construction must occur in the dormant season for live cutting revetments and in the spring or autumn for transplanted saplings. Expect 30 to 50 percent mortality rate with cuttings, particularly in drier climates. Driving cuttings or live poles deeper into the stream bank and irrigation of the site may improve plant survivability.

The designer is encouraged to review existing references on stone revetment function, performance, and construction. Also, the designer should consider the impact the construction of a hard structure may have to the surrounding banks and channel such as the shifting of erosion to adjacent or cross stream locations that are not protected.

****

a. Prepare bank by reducing the slope to [2H:1V] [as shown in the drawings]. Smooth and compact the surface of the bank. Excavate a key trench at the toe of the stream bank and extend [1 m 3 feet below the mean low water level] [600 mm 2 feet below the lowest elevation of estimated scour]. Overlay bank by a 100 mm 4 inch thick layer of 75 mm 3-inch minus compacted fill that contains less than 5 percent fines to serve as a filter blanket between the outer armor stone and the bank soil.

b. Place large stone with a nominal diameter of 1 m 3 feet in the key trench. Place armor stone up bank from the key stones to the bank crest [and extend 1.5 m 5 feet landward of the bank crest]. Place each stone to interlock with down slope stones to form a rock mass that covers 100 percent of the exposed bank. Place the stones by [hand] [heavy equipment with placing bucket]. Do not dump stones in mass from the top of the bank. Push the stones into the bank once the stone is placed. Place [top soil] [excavated bank material] on top of the stone and brush over the surface of the stone to fill the voids between the stones. Drive live [cuttings] [stakes] [poles] between the joints of the rock at least 600 mm 2 feet into the bank soil below the base of the armor stone. Place up to 10 live poles per square yard of area. Place cuttings on the entire structure from the mean low water level to the landward end of the revetment.

c. Key ends of the structure into the stream bank. Excavate key trenches 1.5 m 5 feet into the stream bank at the up stream and down stream ends of the structure. These trenches must be 1.5 mm 5 feet deep and the faces of these trenches must be the same slope as the face of the prepared bank. Fill trenches with large [stone] [rock] that is pushed into the bottom and sides of the trench. Fill voids between the [stones] [rocks] with soil removed from the trench. Extend the [stone] [rock] to the surface and wrap in a continuous mass into the armor [stone] [rock] on the face of the bank.

3.12.3.3 Brush Layered Revetment

****

NOTE: Brush layer revetments are constructed of alternating layers of live brush cuttings and rock. These structures are easier to construct and of lower cost than live revetments and are suitable for protecting long stretches of stream banks or lake shores. The live brush will cover the armor rock with time and obscure it from view. Angular quarry stone or rip rap may be used with this method.

****

a. Prepare bank by reducing the slope to [2H:1V] [as shown in the drawings]. The surface of the bank must be smoothed and compacted. Excavate a key trench at the toe of the stream bank and extend [600 mm 2 feet below the mean low water level] [600 mm 2 feet below the lowest elevation of estimated scour]. Overlay the bank by a 100 mm 4 inch thick layer of 75 mm 3-inch minus compacted fill that contains less than 5 percent fines to serve as a filter blanket between the outer armor stone and the bank soil.

b. Place live cuttings in the trench against the stream side wall of the trench. Push the cuttings into the streambed and cover the cut ends with a thin layer of [sediment] [select fill]. Place large stone with a nominal diameter of 1 m 3 feet in the key trench. Rest the large stone on the ends of the cuttings and anchor them in place. Place armor stone up the bank from the key stones to the bank crest [and extend 1.5 m 5 feet landward of the bank crest]. Place each stone to interlock with down slope stones to form a rock mass the covers 100 percent of the exposed bank. Place the stones by [hand] [heavy equipment with a placing bucket]. Do not dump stones in mass from the top of the bank. Push stones into the bank using suitable heavy equipment once the stone is placed. [Brush] [Wash] [sediment] [select fill] into the voids between the rocks as the rocks are placed.

c. Place stone in lifts not to exceed 1 m 3 feet in height. The top of the lift must be within 150 mm 0.5-foot of the same elevation across the surface of the lift [and parallel to the water surface of the stream]. Place a layer of loosely compacted topsoil at least 150 mm 6 inches thick on the top of the rock lift. Place live cuttings in a criss cross manner with 20 cuttings per 1 m 3 linear feet on top of the topsoil layer with the cut ends pushed at least 300 mm 1-foot into the bank beneath the filter layer and with growth tips extending 150 mm 1.5 feet beyond the face of the armor rock. Cover cuttings with 100 mm 4 inches of moderately compacted topsoil. Place the next lift of rock on top of the compacted top soil and push these rocks into the topsoil until refusal due to contact with the rocks of the underlying lift. Continue process of alternating layers of rocks, cuttings, and topsoil to the [design height] [top of bank].

d. Key ends of the structure into the stream bank. Excavate key trenches 1.5 m 5 feet into the stream bank at the up stream and down stream ends of the structure. These trenches must be 1.5 m 5 feet deep and the faces of these trenches must be the same slope as the face of the prepared bank. Fill trenches with large [stone] [rock] that is pushed into the bottom and sides of the trench. Fill voids between the [stones] [rocks] with soil removed from the trench. Extend [stone] [rock] to the surface and wrap in a continuous mass into the armor [stone] [rock] on the face of the bank.

3.12.3.4 Longitudinal Live Fascine

****

NOTE: Longitudinal live fascines consist of live fascines combined with brush layers and possible bank toe armor stone along the length of a stream bank or lake shore. These structures provide immediate protection of the toe of the bank from current or wave erosion. These structures are inexpensive and easy to construct and suitable for low banks. The method may be used as toe protection for stable high banks if the upper portions of the banks are protected by other bioengineered or hard structures.

****

Compose fascines of live cuttings and construct in accordance with paragraph "Live Fascines" in PART 3. [Excavate a trench at the mean low water level of the stream with a floor that slopes at 15 degrees towards the bank.] [Excavate a key trench between the fascine trench and the mean low water line. This trench must be 600 mm 2 feet deep and 1 m 3 feet wide. Terminate the face of the key trench at the lip of the trench for the fascine. Fill trench with [quarry rock] [large natural stone] [rock and brush fascines anchored with dead stakes].] Place a layer of live cuttings in the bottom of the fascine trench in a criss cross manner with the cut ends of the cuttings in contact with the face of the trench and the growth tips extending 150 mm 1.5 feet beyond the lip of the trench. Place a minimum of 20 cuttings per linear foot. Cover cuttings with a layer of compacted soil. Place fascine the trench and anchor in place by live poles. The poles must be 1.2 m 4 feet in length and drive 10 mm 2.5 feet into the bottom of the trench through the fascine. Space the poles every 1 m 3 feet along the length of the fascine. Place backfill around the fascine to the [grade of the original bank] [design grade].

3.12.3.5 Longitudinal Brush Packing

****

NOTE: Longitudinal brush packing is a method suited for the repair or protection of near vertical or under cut banks subject to erosion. These structures provide immediate protection to the bank from erosion or wave action. The stability of the bank should improve over time as vegetation becomes established dependent on the properties of the soils that compose the bank. The structures are suited for low to fast flowing streams or active lake shores. They are simple and easy to construct but may require large amounts of fill and vegetation. The structure consists of lifts of soil and brush that are wrapped by erosion control products. Do not use geosynthetic or plastic netting unless absolutely necessary and in this case only for the lower lifts of the structure.

****

a. The slope of the bank must be reduced to [2H:1V] [steps that are 300 mm 12 inches high and 600 mm 24 inches deep from the toe to the crest of the bank] [as shown on the drawings]. Excavate a key trench at the toe of the design slope. This slope must be of the same grade as the adjacent undamaged stream bank. The key trench must be 1.2 m 4 feet wide and 600 mm 2 feet deep and extend the length of the work site. Fill trench with [large natural stone] [quarry rock] that has a nominal diameter of 600 mm 2 feet and that is well graded with 100 percent greater than 100 mm 4 inches. Place [stone] [rock] to form a triangular topped dike with side slopes of 2H:1V. The [stone] [rock] must be tamped into place.

b. Place a 100 mm 4 inch layer of [select fill] [removed sediment] on top of the landward face of the rock dike and compact. Cover [fill] [sediment] layer with erosion control fabric composed of [coir netting] [_____]. Extend fabric from the face of the bank to at least 1.2 m 4 feet beyond the top of the rock dike. Secure netting to the soil layer with [staples] [stones] [stakes]. Ensure fabric is free of wrinkles and extend the full length of the rock dike.

c. Place live cuttings [with 25 percent dead branches] on top of the fabric layer in a herringbone pattern. Push cut ends of the cuttings into the streambed to refusal. Place cuttings at a density of 20 cuttings per 300 mm linear foot to a thickness of 100 mm 4 inches. The growth tips of the cuttings must extend 150 mm 1.5 feet beyond the top of the crest of the rock dike into the stream channel. Brush [select fill] [removed sediment] into the voids between the cuttings. Place a 100 mm 4 inch layer of [select fill] [removed sediment] on top of the cuttings and compact. The fabric that extends over the rock dike must be [cut and removed] [tightly rolled and anchored at the base of the cuttings on top of the rock dike].

d. Cover the top of the [fill] [sediment] layer placed on top of the first layer of cuttings with a layer of erosion control fabric composed of [coir netting] [_____]. The fabric must cover the top of the lower lift. At least 1.5 m 5 feet of fabric must remain above the contact of the lower lift and the slope of the bank. Stake this portion of fabric temporarily to the bank slope. At least 2 m 6 feet of fabric must extend beyond the top of the design slope. Place a 300 mm 12 inch layer of [select fill] [removed sediment] on top of the fabric and compact to 90 percent dry density. Place the ends of the fabric on top of the compacted material. Place the fabric near the face of the bank on top of the compacted material and pull free of wrinkles. Place the portion of fabric towards the stream channel across the face of the compacted material and pull tight and secure to the top of compacted material with staples. Install staples flush with the top of the lift.

e. Place live on top of the lift of compacted material in the same manner as the cuttings on the first lift. Cover these cuttings by a 100 mm 4 inch layer of compacted [select fill] [removed sediment]. Continue process of wrapping lifts of compacted soil with erosion control fabric and the placement of layers of cuttings to the [design height of the structure] [top of the bank]. Adjust the height of the soil lift nearest to the top of the structure in thickness to meet the design grade. Do not cover the top of the structure with cuttings. [Place live cuttings across the top of the structure on 600 mm 2 feet centers for a distance of 2 m 6 feet landward of the top of the bank and for 2 m 6 feet upstream and down stream of the ends of the structure on the original stream bank.]

f. Key the structure into the bank on the up stream and down stream sides of the structure. The key trenches must be 1.2 m 4 feet deep. Wrap lifts of the structure into the trenches and butt the ends of the lifts against the face of the key trench.

3.12.3.6 Live Crib Wall

****

NOTE: Live Crib walls are robust structures suited for stabilization and protection of banks or shores subjected to high flow or moderate wave action. These structures provide immediate erosion protection and possible habitat during high flow events dependent upon design. The structure provides a hard frame that dissipates current or wave energy. Bank stability and habitat improve as the vegetation matures and develops extensive root systems and shade along the bank. These structures typically require earthworks and large equipment for bank preparation and backfilling. Large amounts of vegetation and labor are required. Crib walls may be used to increase the width of a stream by replacing the natural sloped banks with the near vertical walls of the structure. Crib walls may be used to repair severely scoured banks by placing the structure in the stream at the new bank alignment and backfilling the void between the structure and the existing bank.

The structure may be combined with brush sills, brush mats, or large natural stone on the up stream or down stream sides of the structure to reduce erosion. Stability of the structure may be improved using a double crib design composed of front and back headers. Backfill should be free draining material. Timber used for the crib wall may be untreated manufactured 300 mm 12-inch square posts, locally harvested vegetation with truck diameters greater than 300 mm 12 inches, or combination of these materials.
****

a. Reduce stream bank to the required slope and design grade. Excavate a trench that is 600 mm 2 feet deep and extends parallel to the toe of the slope. This trench must extend the full length of the work site and must extend [for a distance of 4.5 m 15 feet into the stream channel from the toe of the slope] [in the stream channel to the distance and dimensions shown on the drawings]. Slope the floor of the trench at 15 degrees towards the bank and [manually compact using a tamping bar weighing at least 18 kg 40 pounds] [compact using a small motorized tamping machine] until the bottom of the trench is dense and provides a solid base for the crib wall. Ensure the floor of the trench is [as shown in the drawings] [of uniform grade across the trench width]. Key trench into the stream bank for a distance of 2 m 6 feet. Use material removed from the key trenches as compacted backfill in the key trenches. Sediment excavated from the trench must be [removed from the site and replaced with select fill] [used as compacted backfill]. Fill depressions in the trench floor with compacted material to raise these areas to design grade and reduce areas above grade to the design grade.

b. Frame crib wall with [untreated straight 300 mm 12-inch square by 2.5 m 8 feet long beams] [200 to 300 mm 8 to 12 inch diameter by 2.5 m 8 feet long straight logs harvested from local sources. Cut these logs normal to the trunk and strip all branches from the trucks]. Place the header adjacent to the stream parallel to the toe of the slope at the design alignment of the wall and extend the full width of the trench. Place tje header adjacent to the bank parallel to and 2 m 6 feet from the stream side header in the direction of the bank. Place headers end-to-end and in line at splices between the members. Drive wood posts vertically into the streambed 150 mm 6 inches from the splices on both sides of the header.

c. Provide stretchers that are 2 m 6 feet in length. Place each stretcher normal to the headers and between the vertical poles at the splices between the headers. Space stretchers [every 1.2 m 4 feet] [mid distance] between the vertical poles and extend a minimum of 100 mm 4 inches beyond the outer edge of the stream side header face. Place rear butt of the stretcher on top of the header near the bank and [extend 100 mm 4 inches beyond the outer face of the header] [firmly place against the exposed bank]. Attach stretcher to the header with binding products wrapped three times in a criss cross pattern and secure with a non-raveling knot. Drill a 13 mm 1/2-inch diameter hole vertically through the stretcher and header. Drive a 600 mm 24 inch long, 16 mm 5/8-inch diameter [non-galvanized steel spike] [steel rebar] [hard wood dowel] into the hole and set flush to the top of the stretcher. Backfill the open area between the inner face of the stream side header and the inner face of the landward header with compacted [sediment removed from the trench excavation] [select fill] to the middle of the stretchers. Place live cuttings 19 to 38 mm 3/4 to 1.5 inches in diameter in a criss cross manner on the top of the compacted backfill with the cut ends pushed into the backfill near the landward header. The growth tips of the cuttings must extend 600 mm 2 feet beyond the face of the stream side header. Place backfill and lightly compact on top of the cuttings to the top of the stretchers. Place additional headers, stretchers, backfill, and cuttings until only the final lift remains. The centerlines of stream side headers must be off set 50 mm 2 inches towards the bank relative to the lower headers to provide an incline to the face of the structure. Place select fill in the area between the face of the landward header and the slope of the bank. Place the fill in lifts of the same thickness as the lifts on backfill in the interior of the structure. Compact each fill to at least 90 percent dry density.

d. The top stream side headers must be 100 mm 4 inches larger in diameter than the headers used for wall construction. Cut vertical poles flush with the top of the final headers. Place a header at the midpoint between the outer headers and secured with binders and [spikes] [rebar] [dowels] to the underlying stretchers. Fill the lift of backfill immediately below the completion headers with a tightly packed brush mat composed of live [and dead] cuttings that are placed in an alternating rectilinear grid pattern. Cover each layer of brush with a thin layer of lightly compacted backfill. [Rounded clean natural stone from 300 to 600 mm 12 to 24 inches in diameter] Place [excavated sediment] from the top of the packed brush to the top of the final headers [to the grade shown in the drawings]. [Drive live stakes vertically on 600 mm 2 feet centers into the backfill at the top of the structure.] [Place large natural stone armor 600 mm 2 feet thick on the banks and against the ends of the structure for a distance of 3 m 10 feet upstream and down stream from the structure. Plant live stakes in the joints between the stones.] Fill key trenches with [large natural stone] [quarry rock] to the design grade.

3.13 IRRIGATION

Start irrigation of the structure immediately after installing erosion control products and vegetation. Apply water to supplement rainfall at a sufficient rate to ensure moist soil conditions to a minimum 300 mm 12-inch depth. Prevent run-off and puddling. Do not drive watering trucks over turf areas, unless otherwise directed. Watering of other adjacent areas or plant material not related to work efforts must be [prevented] [as specified by the Contracting Officer]. Apply water to trenches immediately before placement of live vegetation. Place water on the completed structure at the end of each day, as needed to control dust and to prevent excessive drying of vegetation, and at the completion of the structure. [Irrigate the structure after installation for 3 months until the end of the first year growing season.] [Irrigate structures in arid climates for a period of 3 years.] [Daily irrigation of the structure and work site must not exceed 20 minutes [each day] [twice a day] [3 times per week] and must be sufficient to support the survival and growth of planted vegetation. Do not exceed limits of irrigation that could impair the stability of the structure and adjust irrigation to compensate for additions or deficits to soil moisture caused by precipitation or evaporation.]

3.14 FERTILIZER, PESTICIDE, HERBICIDE

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NOTE: Edit this section as required. Fertilizer, pesticide, and herbicide may be required for the construction, establishment, and maintenance of bioengineered structures. Provide methods for application, frequency of use, safety precautions for humans and the environment in the section below.

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3.15 FIELD QUALITY CONTROL

The Contracting Officer will inspect the work site prior to final acceptance of work. A punch list noting deficiencies will be compiled by the Contracting Officer and provided to the Contractor. Perform, repair, adjust, align, or otherwise comply with the specified work on the punch list to the satisfaction of the Contracting Officer. Notify the Contracting Officer at least 14 days prior to the inspection that work is ready for inspection. Work will not be accepted until all punch list items are resolved and all work meets or exceeds contract requirements. Final acceptance of work will not be provided by the Contracting Officer until all defects or deficiencies are corrected. Final Acceptance will occur only after all corrective actions and supplemental viable plantings are complete and the structure meets performance standards and all contract requirements. Comply with necessary repairs to the structure and vegetation as stated in the warranty.

3.16 CLEAN-UP

Dispose of excess material, debris, and waste materials offsite at an approved landfill or recycling center. Clear adjacent paved areas. Restore the site to preexisting conditions to the extent reasonably possible and to the satisfaction of the Contracting Officer.

3.17 PROTECTION

Immediately upon the start of the installation in an area, protect the area against traffic or other use by erecting barricades and providing signage as required, or as directed. Provide signage [in accordance with Section 10 14 00.10 EXTERIOR SIGNAGE] [as shown on the drawings]. Protect the work site and vegetation from damage and vandalism and free of trash and debris until final acceptance by the Contracting Officer.

3.18 DOCUMENTATION

Establish and maintain documentation for bioengineering practices to record the desired information and to assure compliance with contract requirements, including, but not limited to, the following:

3.18.1 Maintenance Records

Visit, inspect, and document site conditions after the completion of construction every week for the first year and every two weeks thereafter until the end of the second year. Include written reports on site structure and vegetation conditions, damage, plant loss, and the like, to fully describe site conditions at the time of the visits and changes observed since previous visits. Obtain photographs of the site and areas of growth, defects, or damage and include with the records. Submit records to the Contracting Officer within [48] [_____] hours after the completion of the site visit.

3.18.2 Final Project Report

Specify and summarize all construction activities and problems plus information included in the construction and maintenance records as submitted throughout the project. Summarize the work rather than repeat the items in the individual reports.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 33 20 (November 2024)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 31 33 20

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SECTION 31 33 20

VOID AND PERMEATION GROUTING

11/24

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NOTE: This guide specification has been prepared as a construction guide specification to address permeation grouting, void grouting, and grouting in unconsolidated deposits, such as breakwaters, alluvial/colluvial deposits, and soil/fill using both cementitious and solution grouts with high to moderate mobility. This specification is intended for minimally disruptive grouting techniques specific to cases where soil grouting may be needed for seepage control or structural support at lower grouting pressures. Large voids and cavities in cohesive soils are more appropriately treated through Limited Mobility Grouting using techniques not covered within this specification. Soil grouting must never be used in any USACE dam or levee without approval from the appropriate Major Subordinate Command (MSC) and the Dam Safety Modification Mandatory Center of Expertise.

This guide specification covers the requirements for advancing cased and uncased boreholes in soil for the purpose of grouting. This specification includes requirements for drilling, grouting, furnishing, handling, transporting, storing, mixing and injecting the grouting materials; care and disposal of drill cuttings, wastewater and waste grout; and clean-up of areas as necessary to complete the work.

This specification may be reworded for adaptation to various applications, such as foundation treatments, cutoff trenches, breakwater protection, etc. Edit this guide specification for project-specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information. Remove nonessential information whether or not brackets are present. Seepage requirements must be removed if the grouting

is intended for structural support.
****

PART 1 GENERAL

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This guide specification may be included in combination with other UFGS grouting specifications for a complete soil and rock grouting program. Limited - mobility grouting and compaction grouting in soil is addressed in Specification 31 33 30. Foundation grouting in rock is addressed under Specification 31 33 10. Foundation grouting advanced within galleries or through concrete structures is addressed in Specification 31 43 13.13. Tunnel and shaft grouting is addressed in Specification 31 73 19.

This specification may be used as a general outline for cement grouting, chemical grouting (here after referred to as "solution grouting", or other specialty grouting applications by insertion of the proper equipment, materials, and procedures in the appropriate paragraphs and by modification and deletion of other paragraphs. Engineer Manuals 1110-2-3504, "Chemical Grouting", and 1110-2-3506, "Grouting Technology", should be consulted as guidance documents as appropriate for the grouting techniques under consideration. There may be occasions when the engagement of a consultant would be appropriate and advantageous to assist in the planning, selecting, and evaluating of a system under consideration.

Caution must be exercised to not prohibit the use of a material or technique that may otherwise satisfy the project scope. Specific products or manufacturers must not be specified within this specification. The use of performance criteria defining the problem, soil conditions, desired strength and/or permeability must be specified to allow manufacturers and Contractors to submit a suitable material that both meets this specification and the intended purpose of the grouting. Consideration must be given to conducting laboratory and field tests and evaluations of the system or systems being considered for a given application, including sieve analyses, unit weight, strength, and permeability tests. Manufacturer of systems and products must be contacted during design efforts to verify a suite of products exist which can meet the performance requirements established as part of the project. Specific products or manufacturers should not be sole sourced within this specification without a Justification and Approval document from the Office of Counsel.

If grouting is anticipated during extreme temperatures, alteration of certain field procedures

may be necessary and must be included in the specifications. Generally, for cold weather cementitious grouting, the grout must be maintained at temperatures above 50 degrees F until injected, and storage of the grouting materials must be at temperatures above freezing.Insulation, heated enclosures, water heaters or other equipment or procedures may be required. Grouting in extremely hot weather may also require extra precautions.

Methods for listing subdivided items are described in Paragraph "Variations in Estimated Quantities-Subdivided Items" of Army Federal Acquisition Regulation Supplement (AFARS) 5152.211-9001. Subdivided items are recommended for all jobs unless there are extenuating circumstances for small jobs having less than 10 holes.

****

1.1 SYSTEM DESCRIPTION

****

NOTE: Provide a brief summary of the project scope and any prudent references applicable to the layout, depths, and orientation required for the grouting. Include any special restrictions or coordination required. Include relevant bracketed types of foundation features that may be encountered and specify where they are found in the blank brackets.

****

[Historic seepage,] [sand boils and piped sand,] [depressions,] [settlement,] [open voids] have been encountered at [_____] project at the [_____] location. [Loose unconsolidated deposits,] [open work [sands][gravels] with large void capacity,] [engineered structures having open graded materials with large void capacity,] [_____] are known to exist at [_____] project at the [_____] location.

****

NOTE: Choose the type of grouting to be performed, reference the proper plan sheets in the empty brackets. Specify the number of boreholes, and/or the length of grouting in the desired units. Fill in the additional quantities as needed in the last blank bracket.

****

Perform [Void] [Permeation] grouting as described in these specifications[and where indicated in the [plans on sheet [_____]]]. A total of [_____ boreholes,] [[_____] meters [_____] feet of grouting] are required in the base contract with additional [_____] quantities to be assigned based on the initial grouting results. Estimated grout quantities are detailed in the Bid Schedule. Perform installation, monitoring, and testing of grout, and provide all planning, labor, materials, tools, equipment, supervisory personnel, monitoring equipment, and quality control personnel and processes required to install grout in accordance with this specification. Verify closure through [verification cores] [falling head permeability tests] for [[_____] number full depth holes] [[_____] meters feet total to be assigned by the Contracting Officer]. Install ground movement monitoring equipment and system to monitor and record [structure] [structure and] ground movement during grouting operations at [location 1,] [location 2,] [location 3].

1.2 UNIT PRICES

****

NOTE: The following unit prices can be adapted to the grouting techniques specified. If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) must be deleted from this section and the remaining appropriately edited subparagraphs below must be inserted into Section 01 20 00.

****

1.2.1 Mobilization and Demobilization

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NOTE: This provision applies for inclusion in instances where grouting is the primary feature of work.

****

1.2.1.1 Payment

Payment is made for costs associated with assembling all plant and equipment at the site, preparatory activities prior to initiating the work, and for removal and clean-up of the site once the drilling and grouting program has been completed. Sixty percent of the contract lump-sum price for mobilization and demobilization will be paid following on-site assembly to working order of all equipment, and the materials necessary to perform the required drilling and grouting operations. The remaining forty percent of the contract lump-sum price will be paid when all equipment has been removed from the site and all site restoration requirements have been fulfilled.

1.2.1.2 Unit of Measure

Unit of measure: Job.

1.2.2 Casing Installation

1.2.2.1 Payment

All incidental costs associated with the performance of work in this section are included in the contract price for this item. Payment will be made for costs associated with advancing [vertical] [10 degree] [20 degree] [30 degree] [____ degree] boreholes with casing, including multiple port sleeve pipe (MPSP) (Tube-A-Manchette (TAM)), as specified. Casing length projecting above the top of ground is not measured for payment and is incidental to the work. The payment item includes but is not limited to: equipment set up on the proposed borehole location; [advancement] [drilling] of the hole; installing permanent casing or installing and then removing temporary casing; care and disposal of drilling wastes; clean-up of the site; and furnishing all equipment, labor, and supplies necessary and incidental to the work, including all records associated with this item. [Payment will be made for installation of the required number of

MPSPs.] Grout will be paid for under the appropriate grouting pay item. The Government will make no additional separate payment for items included herein. [Overburden and embankment drilling that is intended to limit the potential for hydrofracture must be performed per ER 1110-1-1807.]

1.2.2.2 Measurement

Measurement for payment is by linear length of properly placed casing as measured from the ground surface to the bottom of the pipe - any length of casing projecting above the ground surface is considered incidental to the work and will not be measured for payment. Grout pipe and casing can be the same material. The total linear footage of properly installed casing must be subdivided into "initial quantity" and "over initial quantity".

1.2.2.3 Unit of Measure

Unit of measure: Linear meter foot.

1.2.3 Grout and Grout Placement

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NOTE: If the designer requires a restrictive flow rate less than 2 gallons per minute, grouting time must be considered as a separate measurement and payment item due to the prolonged duration required to complete a single hole.

****

1.2.3.1 Payment

All incidental costs associated with the performance of work in this section are included in the contract price. Payment will be made for costs associated with furnishing all equipment, labor, and supplies necessary for grout hole setups, grout hole connections, and satisfactorily placing grout in grout holes. This includes injecting the grout at the required stages, pressures, rates, and volumes. Incidental work includes, but is not limited to, costs for all equipment, labor, and supplies associated with furnishing the various grout mixes specified herein; including but not limited to furnishing, handling, transporting and storing of grout materials; proportioning the mixes; mixing; quality control of grout; and storage, transportation of grout cubes, testing of grout cubes, and reporting of laboratory test results. Records and data required are incidental to this item. Payment for grout must only be made for grout installed and accepted by the Government in accordance with the plans and specifications. No payment will be made for time lost due to fault or negligence of the Contractor or due to defective equipment furnished by the Contractor. The Government will make no additional separate payment for items included herein. Required quality Control testing is incidental to this item.

1.2.3.2 Measurement

Injection of grout must be measured for payment by the volume in [liter (L)] [gallon (gal)] of liquid grout properly mixed and injected. The grout mixes will be measured for payment on the basis of the volume of each grout mix satisfactorily placed in grout holes. Grouting and grout placement must be subdivided into "initial quantity" and "over initial quantity".

1.2.3.3 Unit of Measure

Unit of measure: [liter (L)][gallon (gal)].

[1.2.4 Grout Containment

****

NOTE: Consider this item if working below water or in an otherwise sensitive area where additional controls may be needed for environmental compliance. Delete this section if the Contract addresses these concerns through stormwater protection or other means as part of the general site work. This section must be edited to the meet requirements of local, state, federal, and other jurisdictions, including downstream considerations, which may be impacted by the project.

****

1.2.4.1 Payment

All incidental costs associated with grout containment, including but not limited to containment barriers, the placement of cover materials, checking water quality for the presence of grout outside of the approved working area, and general environmental compliance are included in the contract price for this item. Payment will be made for costs associated with furnishing all equipment, labor, and supplies necessary for this item.

****

NOTE: Containment barriers can consist of washed aggregate fill to be placed on the surface immediately prior to grouting to aid in the containment of grout exiting from breakwaters. Limit the placement area to areas being grouted within 24 hours to avoid wave wash erosion of the containment barrier prior to grouting.

Coordinate water quality requirements, including any monitoring while placement of grout or water used for grout production, with stormwater pollution requirements established for the site.

****

1.2.4.2 Measurement

Measurement is based on successful installation of required systems and compliance to appropriate regulations and restrictions as required in the Contract.

1.2.4.3 Unit of Measure

Unit of measure: [Job] [Each]

]1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 13B-1	(2009; R 2016) Recommended Practice for Field Testing Water-Based Drilling Fluids
API Spec 13A	(2010; Errata 1 2014; Errata 2-3 2015) Specification for Drilling-Fluid Materials

ASTM INTERNATIONAL (ASTM)

ASTM C40/C40M	(2020) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C70	(2020) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C87/C87M	(2023) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement

ASTM C191	(2021) Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C403/C403M	(2023) Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C937	(2023) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C939/C939M	(2022) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C940	(2022) Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1797	(2023) Standard Specification for Ground Calcium Carbonate and Aggregate Mineral Fillers for use in Hydraulic Cement Concrete
ASTM D4219	(2022) Standard Test Method for Short-Term Unconfined Compressive Strength Index of Chemically Grouted Soils
ASTM D4380	(2020) Standard Test Method for Determining Density of Construction Slurries
ASTM D4832/D4832M	(2023) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

ASTM D6910/D6910M	(2019) Standard Test Method for Marsh Funnel Viscosity of Construction Slurries

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 112	(1969) Method of Test for Surface Moisture in Aggregate by Water Displacement
COE CRD-C 120	(1994) Test Method for Flat and Elongated Particles in Fine Aggregate
COE CRD-C 661	(2006) Specification for Antiwashout Admixtures for Concrete
EM 1110-1-1804	(2001) Engineering and Design -- Geotechnical Investigations
EM 1110-2-3506	(2017) Engineering and Design -- Grouting Technology
ER 1110-1-1807	(2014) Drilling in Earth Embankment Dams and Levees
ER 1110-1-8100	(1997) Laboratory Investigations and Testing

1.4 DEFINITIONS

****

NOTE: Definitions may be included by reference to engineering manuals if the exact definition in the reference is to be used in the Contract. If definitions are edited for the project, then they must be included in this section.

****

[1.4.1 Automated Grouting Data Collection System (AGDCS)

A computerized system for receiving, translating, recording, storing, and displaying pressure grouting data. The system is capable of viewing results in real time or at any time after the stage is grouted. The system can also produce graphic and numerical outputs for grouting data in real-time with digital transmittable files, including but not limited to, PDF, excel, spreadsheets, and raw data files.

]1.4.2 Cement Grout

****

NOTE: Chemical or cement grouts can be used for permeation or void grouting. Solution grouting may have advantages in soils with higher fines percentages or in locations where seepage may be present. The designer may select cementitious or solution grout, or allow both, per the project

scope. Most seepage related projects should require at least 2 grout mixes.
****

A fluid cementitious material used to reduce the permeability and improve the stability or modulus of coarse-grained materials. Grout can be composed of portland cement, slag cement, (or micro fine cement) and water, and may contain additives such as clay, bentonite, dispersant, retarders, silica fume, fly ash, pozzolan, anti-washout agents, and/or accelerators as appropriate.

1.4.3 Centipoise (cP)

For solution grouts, a common unit of measurement for viscosity allowing for a direct comparison to the viscosity of water. Water has a viscosity of 1 cP at 20 degrees Celsius 68 degrees Fahrenheit.

1.4.4 Closure

The completion of all grouting within a section such that refusal criteria is met, and no additional split spaced holes are required to achieve the objective of the grouting. For permeation grouting, the residual permeabilities following grouting are measured in verification holes for each completed section. For void filling, closure is assessed by verification holes verifying strength for each completed section.

1.4.5 Communication

The passage of water or grout from one hole to another or to any opening/observation point during drilling and/or grouting.

1.4.6 Downstage Grouting

A protocol involving drilling a zone and grouting of that zone before proceeding to the next deeper zone within the same borehole. It involves the placement of a grout by repeated drilling and grouting in successive stages in the downward direction in each hole.[In USACE's Engineering Manual EM 1110-2-3506, this is defined as "Stage Grouting".]

1.4.7 Effective Pressure

The sum of all head losses and head gains in the injection system and the ground.

1.4.8 Exploratory Hole

Exploratory holes are drilled, grouted, and backfilled to investigate subsurface conditions.

1.4.9 Final Set

A degree of stiffening of a cementitious grout mixture indicating the time in hours and minutes required to stiffen sufficiently to resist the penetration of a weighted test needle (Vicat needle). Also called 'Final Set Time' or 'Time of Final Set'.

1.4.10 Gel Time

The time or period after mixing for a liquid solution grout to exhibit measurable shear strength, or the onset of change from the liquid to plastic state.

1.4.11 Grout Take

The volume of grout placed. This can be for a specific grout stage, specific grout hole, a grout line, or treatment interval for the entire job.

1.4.12 Grout Verification Hole

A grout verification hole is drilled to verify the grouting results at the conclusion of grouting. All holes in a section must have reached refusal before a verification hole is initiated.

1.4.13 Hydrofracture / Hydrofracturing

The fracturing of an embankment or underground stratum by pumping water, drilling fluid, air, or grout under a pressure in excess of the tensile strength and minor principal stress.

1.4.14 Initial Set

The time required for freshly mixed cementitious grout to achieve initial set.

1.4.15 Permeation Grouting

A grouting technique that injects the appropriate grout to reduce the effective porosity in the soil/material matrix in the area specified without causing excessive movement or fracturing of the formation, accomplished by solution (chemical) or cementitious grout.

1.4.16 Primary Hole

The first series of holes to be drilled and grouted, usually at the maximum allowable spacing. Grouting of primary holes is completed prior to secondary holes being drilled.

1.4.17 Refusal

The point during grout injection where little or no grout is accepted per the refusal criteria

1.4.18 Refusal Criteria

When conditions are met to stop grouting within a stage, hole, or other established treatment zone that may include parameters such as pressure, flow, volume, grout communication, ground movement, or a prescribed combination of criteria.

1.4.19 Restoration

The correction by repair or replacement of any structure or area damaged, removed, or altered by construction activities under this section.

1.4.20 Secondary Hole

The second series of holes to be drilled and grouted, spaced midway between previously grouted primary holes. Secondary holes must be completed prior to drilling tertiary holes.

1.4.21 Section

A reach along the grout lines, not more than [_____] meters [_____] feet in length in which grouting operations are not to be permitted at the same time that drilling is in progress.

1.4.22 Solution Grout

A grout that is typically composed of chemical materials combined to form a liquid solution that hardens into a solid material composed of (1) matrix forming base materials, (2) reactants, and (3) accelerators or retarders.

1.4.23 Split Spacing

The procedure of locating an additional grout hole midway between two previously drilled and grouted holes that failed to reach refusal.

1.4.24 Split Space Criteria

The criteria by which split spacing is performed, based on whether a hole or stage meet refusal criteria. The split space criteria also includes occurrences of grout communication between holes, hole collapse, equipment failure, premature termination, or any interruption of grouting activities. The split space criteria may vary depending on the stage, zone, series, or grout line under consideration.

1.4.25 Stage

One complete operational cycle of pressure grouting, over a predefined length and within a pre-defined depth interval of the grout hole.

1.4.26 Stop

A pre-determined depth or elevation at which the expanding plug or packer is positioned.

1.4.27 Succeeding Series

Each of the succeeding series of holes is located based on the split space criteria. Succeeding series holes may be located as directed by the Contracting Officer based upon conditions and prior grouting results.

1.4.28 Tertiary Hole

The third series of holes to be drilled and grouted, spaced midway between previously grouted primary and secondary holes.

1.4.29 Upstage Grouting

Upstage grouting involves drilling a grout hole to its final depth and grouting from the bottom up in stages.

1.4.30 Void Grouting

****

NOTE: Many products for void grouting are available with variations in viscosity, reaction time,

reaction with water, expansion characteristic and flexibility of the reacted grout. Products can be single or multi-component grouts and can react when coming in contact with water or require a reactant. The use of low mobility grouts requires special equipment and procedures and is covered under the low mobility grouting specification.

****

A grouting technique performed by injection of appropriate solution or cementitious grout to fill specific voids in the subsurface or structure. A casing pipe is advanced and the grout is injected at specified flow rates and depths to fill the void, and not damage the structure. Casing can be a permanent multiple port sleeve pipe or temporary casing that is withdrawn as the grouting proceeds. The process primarily fills most voids for structural support.

1.4.31 Zone

A pre-determined subdivision of the overall depth of grout treatment defined in the Contract. A single zone may make up the full depth of treatment, or the depth of treatment may be divided into several zones.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications; G, [_____]

Ground Movement Monitoring Plan; G, [_____]

Drilling and Grouting Work Plan; G, [_____]

Automated Grouting Data Collection System (AGDCS); G, [_____]

Laboratory Accreditation; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Daily Records; G, [_____]

Drilling Logs; G, [_____]

Grouting Equipment

Equipment Calibration and Certifications; G, [_____]

SD-05 Design Data

Grout Mix Design; G, [_____]

Demonstration Section; G, [_____]

SD-06 Test Reports

Field QA/QC Procedures; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings and Grouting Profiles; G, [_____]

Completion Report; G, [_____]

1.6 DELIVERY, STORAGE, AND HANDLING

****

NOTE: Grouting constituent components may pose health hazards. Some components of solution grouts may require special health/environmental considerations. Verify grout products meet local, state, and federal laws and regulation, and that appropriate health and safety precautions are considered during design and implemented during

construction.
****

Material must be stored in accordance with the manufacturer's recommendation. Store a sufficient quantity of grout material at or near the work site to ensure grouting operations are not delayed by a shortage of materials. Protect all materials from inclement weather, including rain, snow, and freezing conditions. The use of suitable enclosures to prevent the degradation of the various materials prior to use is required. [Store chemicals and materials in metal tanks, and suitably protect from accidental discharge by valving and other necessary means.]

The use of bulk cement is permitted if methods of handling, transporting, and storage are approved by the Contracting Officer in writing. Submit methods in the Drilling and Grouting Work Plan submittal for approval. Otherwise, only use cement furnished in fabric or paper bags. [In the event the cement is found to contain deleterious lumps, as determined by the Contracting Officer, either screening through a standard [1.18] mm [No. 16] mesh screen, or replacement is required. No payment will be made for such screening or replacement of material.]

Storage capacity for each constituent component must be sufficient to supply at least 1 week [1 month's] volume of grouting materials so as not to interrupt the work in the event of delivery delays.

1.7 PROJECT/SITE CONDITIONS

The grouting program detailed in the plans and specifications is based on currently available information. Examine the site conditions and available surface and subsurface data, including the boring logs, foundation plans, utility plans, and site plans to successfully prepare a suitable work plan to complete the work. Review site conditions and the objectives for the proposed work and propose any necessary changes as part of the work plan. Conditions encountered during construction may require adjustments to the grouting program. Once the work plan is approved, field changes to grout mixes, injection pressures, injection rates, and the sequence in which the holes are drilled and grouted will require approval from the Contracting Officer.

[Previous investigations and work completed at the project include [____].] [Perform any necessary site investigations in accordance with EM 1110-1-1804.]

****
NOTE: Coordinate with property owners, utility providers, facilities, and other stakeholders as necessary to understand potential risks to personal property and infrastructure from grouting operations. The Government must assist with Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) and Water Quality Permitting.
****

1.7.1 Permits and Approvals

Obtain necessary permits and approvals based on application, site conditions, and project scope in a manner that is in compliance with all local, state, and federal laws and regulations.

[
The following permits are [obtained by the Contractor] [provided by the Government]; National Pollutant Discharge Elimination System (NPDES), [401 Water Quality], [_____].]

1.7.2 Underground Utilities

Prior to the submission of the Drilling and Grouting Work Plan, verify the location, type, diameter, and depth of all underground utility lines in the work area, and mark on the ground surface prior to the onset of drilling. Determine and comply with any additional underground utility location, marking and/or potholing requirements by local jurisdictional agencies. Notify the Contracting Officer of any conflicts between the underground utility lines and the proposed Drilling and Grouting Work Plan.

1.8 CONTRACTOR QUALIFICATIONS

Meet the following criteria.

a. The grouting program, including installation of grout pipes, must be performed by a specialist Grouting Contractor with at least [five years] [3 projects] of documented successful experience in permeation grouting. The project list must include a description of the project, relative size, and customer point of contact for the work.

b. Include resumes for the [Professional Engineer] [Professional Geologist], Grouting Manager, Project Superintendent, and Project Foreman meeting the following requirements:

[(1) A Professional Engineer or Professional Geologist currently licensed in the State of [_____]. Required experience includes work on at least two projects where they successfully designed and supervised similar grouting applications, and performed responsible supervision of ground treatment design and execution. This engineer will be responsible for signing and sealing drawings, computations, and reports.

] (2) A Grouting Manager who is full-time, on-site, and whose duties are limited to responsibility for grouting operations. Required experience includes at least [5] [10] years of experience in the successful design and field application of grouting technology similar to the requirements specified for this project. Provide complete documentation of applicable experience.

(3) The superintendent must have at least [5] [10] years of successful experience in permeation grouting. Provide complete documentation of applicable experience.

1.9 DRILLING AND GROUTING WORK PLAN

****

NOTE: Provide the subsurface information to the Contractor and allow flexibility for variations in the submitted work plan based on the Contractor's experience and site specific conditions. Remain flexible during construction to balance contract administration with the need to tweak the grouting operations to most effectively achieve the project goals.

****

Design the program to meet all applicable criteria and ensure grouting objectives are fulfilled. Submit the following items for approval at least [60] days prior to the start of grouting (except where specific time requirements are stated with the item):

a. Produce a detailed layout drawing of the working area, including the batch plant layout[, and grout hole layout. Show the presence of all utilities as described in the paragraph "UNDERGROUND UTILITIES" within [_____] meters [_____] feet of any planned drilling location].

b. Submit a detailed description of grouting work procedures, including methodology and equipment to be used, and installation of a [structure and] ground movement monitoring system in accordance with paragraph "GROUND MOVEMENT AND MONITORING PLAN". Detail the installation/removal of casing, [installation of MPSP], sequence of grouting operations for each hole, sequences for multiple holes, and field monitoring activities to successfully accomplish the work. [Include the procedure and equipment used to contain grout, and prevent grout from exiting the working area.] Discuss how work will be coordinated to ensure it is in compliance with all work restrictions and requirements.

c. For the submittal, assume at least [_____] meters feet of casing, [MPSP] [and] [_____] cubic meters yards of grouting. Address variations in these quantities in accordance with the applicable FAR Clauses for variations in standard quantities, or as otherwise directed by the Contracting Officer.

d. An explanation of the suitability of the grout materials and procedures proposed, and why they are ideal for successful grouting in the subsurface conditions of the site (see paragraph "DEMONSTRATION SECTION"). Provide applicable supporting data.

e. Describe delivery, storage, and handling procedures for all constituent components of the grout mix design. [Use of bulk cement must be approved.]

f. If grouting operations may be impacted by the presence of underground or other utilities, discuss where, how, and the planned procedure for mitigating these impacts. Detail all applicable local jurisdictional agency requirements and resulting work. Indicate which agency verified the utilities present, and the date verified.

g. A list of personnel and details for each titled role including responsibilities.

h. Discuss closure verification methods and frequency.

i. Produce Detail Drawings and submit [15][_____] days prior to beginning work. For each borehole, include the anticipated volume, pressure, and flow rate for each grout stage, per depth.

[1.10 RESTRICTIONS

****

NOTE: List any restrictions to the working area, means/methods, or other site constraints. Delete any unneeded examples or brackets. Tailor to the

project.

****

[No grouting work may commence [between the following] [dates,] [times,] [weather conditions] without written approval from the Contracting Officer.][Access the site from[street][access point][pier][dock][_____] as shown on the drawings.][Special restrictions exist at the project which limit the use of[diesel equipment,][gasoline equipment,][electrical equipment][_____].]

]1.11 LABORATORY ACCREDITATION

All laboratories submitting testing results for this contract must be accredited by Engineering Regulation ER 1110-1-8100. Submit written proof of accreditation for each laboratory utilized within [30][_____] days prior to the start of work. If the accreditation expires during the contract period, submit the accreditation renewal at least 5 business days prior to the expiration. Submit each laboratory accreditation separately.

PART 2 PRODUCTS

2.1 GROUT MIX DESIGN

****

NOTE: Section GROUT MIX DESIGN applies to the general grouting submittal. Additional requirements that are part of this submittal are in brackets in the proceeding sections based on whether solution or cementitious grout is preferred.

NOTE: In general, for permeation grouting, cementitious grouts, cementitious/bentonite grouts, and polyurethane grouts are only appropriate to grout open-graded gravels and poorly-graded coarse sands with a minimum particle size of 1.0 mm. Microfine and ultrafine cement grout is appropriate for treating gravels, coarse, and medium to fine sand having less than 15 percent non-plastic fines. Acrylates and Acrylamide grouts can be used in fine sands and silts with particle sizes less than 0.01 mm.

****

Submit a mix design for the project at least [15] [30] [60] days prior to the start of work. Detail the types of grout materials and source suppliers. Include mix proportions, and material test data[from previous projects] including compressive strength. The grout mixes must be approved by the Contracting Officer prior to use. After approved, future changes must be recommended by the [Professional Engineer] [Professional Geologist] and approved by the Contracting Officer. Any modification must be based on an evaluation of grout takes and site conditions.

Deliver, store and handle bulk and bagged cement and pozzolans in accordance with paragraph "DELIVERY, STORAGE, AND HANDLING". Grout mix designs must meet the requirements for cementitious or solution grouts as required in paragraph CEMENTITIOUS GROUT MIX DESIGN and paragraph SOLUTION GROUT MIX DESIGN. Grout pressures must be adjusted to consider effective pressure acting on the grout stage.

[2.1.1 Cementitious Grout Mix Design

Furnish balanced and stable cementitious grout. The use of a site-batched grout is required and must conform to the following:

a. Dry weight of each solid component and weight of water on a per cubic meter yard basis in accordance with ASTM C128. Show conversion to liters gallons.

b. [7][28]-day unconfined compressive strength test results exceed [690][1034][2068] kPa [100][150][300] psi in accordance with ASTM D4832/D4832M.

c. Batch volume is as proposed by the Contractor in the Work Plan.

d. Required mixing time as proposed by the Contractor in the Work Plan.

e. Reduce the permeability to below the target permeability, based on the soil stratum selected for treatment [_____] cm/s [_____] in/s.

f. Temperature is between 10-32 degrees C 50-90 degrees F.

g. Bleed tests must be in accordance with ASTM C940. Grout bleed must not exceed [1][2] percent after 2 hours.

h. Conduct pressure filtration test in accordance with API Method API RP 13B-1, low-pressure/low-temperature or [ASTM D4380].

i. Set Time is between 8-24 hours in accordance with ASTM C191, method 'A'.

j. Measure viscosity using a Marsh funnel. Determine which viscosity is appropriate for your project and perform Marsh Funnel testing in accordance with ASTM D6910/D6910M:
Mix A between 27-40 seconds [Mix B between 40-55 seconds][Mix C between 55-70 seconds].
[
Due to flowing water conditions, prepare a thicker grout mix based on the flow cone test per ASTM C939/C939M: Mix D between 20-40 seconds.]

k. Test results establishing the working time and set time of the mix design at [30-60 minutes][45-90 minutes][60-120 minutes] in accordance with [ASTM C191, Method A][ASTM C403/C403M].

2.1.1.1 Portland Cement

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NOTE: Avoid specifying the use of air entrainment, except on rare occasions when grout may be exposed to severe freezing and thawing conditions.

****

Cement used in grout must conform to the requirements of ASTM C150/C150M Type [I][II][III][,and][V]. The Grout Mix Design submittal must include the source(s) of cement, [6 month][1 year][2 years] of mill tests, and an ASTM C150/C150M compliance certificate.

2.1.1.2 Blended Hydraulic Cement

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NOTE: Blended hydraulic cements are becoming more common, and in some areas, the only cement products that are available. The industry will continue to grow and develop new cement products to limit the carbon footprint by the industry. Alternate mix designs may be acceptable if field demonstrated to meet the intent of the design.

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Blended hydraulic cement is a combination of portland cement, and one or more pozzolans or limestone. Blended hydraulic cements must conform to ASTM C595/C595M. ASTM C595/C595M recognizes four types of blended cements: Type IS (X), Type IP (X), Type IL (X), and Type IT. The "X" in the name refers to the percentage of secondary ingredient in the blend. Type IS (X) has slag as the secondary component, Type IP (X) has pozzolan, typically fly ash, as the secondary component. Type IL cement has limestone as the secondary component, and Type IT(PX)(PY) has two types of pozzolans. For example, Type IP (15) would contain 15-percent pozzolan. All four types of blended cements are permissible for use in grout.[Verify fresh and hardened grout properties through trial batching and field demonstrations].

When using blended hydraulic cement, the grout mixes must contain at least 30-percent portland cement by dry weight of the mixture. Test blended cement with limestone to determine the chemical composition of the lime using ASTM C1797. The Grout Mix Design Submittal must include the source(s) of cement, [6 month][1 year][2 years] of mill tests, and an ASTM C595/C595M compliance certificate.

2.1.1.3 Mixing Water

Furnish the water used in grout. The water must be fresh, clean and free from deleterious amounts of sewage, oil, acid, alkali, salts, or organic matter. [Non-potable water is available on site and testing is required to confirm the acceptability of the water. Perform water testing quarterly to ensure that the water does not cause a deleterious effect on the grout.] Perform tests in accordance with ASTM C1602/C1602M, and submit to the Contracting Officer within 24 hours of completion. Withdrawing water from the [lake] [river] requires a permit from the [_____].[Potable water suitable for use in the work is furnished by the Government.][Provide any necessary connections and extensions to the provided supply line.]

2.1.1.4 Pozzolans

Transport, handle, and store all pozzolans so as to avoid damage, waste, or absorption of moisture.

a. Fly ash [or other raw or calcined natural pozzolans], if used, must conform to ASTM C618. Fly ash may be furnished in paper sacks or in bulk. Reclaimed ash and alternatives to Class F and Class C ash are not permitted for use.

b. Ground-Granulated Blast Furnace Slag (GGBFS), if used, must conform to ASTM C989/C989M, [grade 100][grade 120].

c. Silica Fume, if used, must conform to ASTM C1240. Pelletized silica fume is not permitted for use.

2.1.1.5 Admixtures

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NOTE: For USACE projects the bracketed text in subpart b should be included.

****

Ship, handle, and store materials a way that prevents deterioration, contamination, damage, or waste. Reject and replace any admixtures allowed to freeze without cost to the Government. Add admixtures to the grout immediately before or during mixing, and use an appropriate combination of one or more of the following: water reducers, superplasticizers, fluidifiers, anti-washout additives[, as approved in the Grout Mix Design submittal]. All admixtures must be compatible with other components of the grout. Alternatives may be proposed as part of the work plan. Deviations from the work plan must be approved by the Contracting Officer. No time extension will be given by the Government for review time required due to submitted alternative materials.

a. Water Reducing Admixtures, if used, must meet the requirements of ASTM C494/C494M, type A.

b. A Superplasticizer is a high-range water reducer possessing characteristics that reduce the water demand by at least 12 percent. Superplasticizer, if used, must meet the requirements of ASTM C494/C494M, type F.[Use Naphthalene sulphonate or polycarboxylate with the ability to coat grout particles in the suspension with a film having a negative charge.]

c. Fluidifier is a compound possessing characteristics which increase the flowability of the mixture, assist in dispersal of the cement grains, and neutralize the setting shrinkage of the grout. If used, fluidifier must meet the material quality requirements specified in ASTM C937.

d. Viscosity Modifier is a natural, soluble, copolymer having a high molecular weight which enhances the stability of the suspension grouts. If used, the material quality must meet the requirements of API Spec 13A (such as welan gum or diutan gum). Viscosity Modifier may also be classified as conforming to ASTM C494/C494M Type S.

e. Anti-Washout Admixtures, if used, must meet the requirements of ASTM C494/C494M Type S and COE CRD-C 661. Consult with the anti-washout admixture manufacturer to ensure compatibility with other grout mix ingredients.

f. Retarders, if used, must meet the requirements of ASTM C494/C494M, Type B.

[2.1.1.6 Sand

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NOTE: Modern grout mixes may be able to produce low viscosity mixes for plugging holes without the use of sand. Be flexible during construction if a submitted mix design can meet the requirements of a sanded mix without the use of sand.

****

a. Sand for grout must be clean and consist of hard, tough, durable, uncoated particles with no more than [5] percent passing the [0.075] mm [No. 200] sieve. The shape of the particles must be generally rounded or cubical [and must not contain more than [_____] percent of flat or elongated pieces having a maximum dimension in excess of five times the minimum dimension]. When coarse sand is used, the sand must be well graded from fine to coarse per ASTM C136/C136M with 100 percent passing the [2.36] mm [No. 8] sieve.

b. Test the sand to determine its acceptability. Perform these tests at no additional expense to the Government. Sample sand in accordance with the applicable sampling provisions contained in COE CRD-C 100, or as directed by the Contracting Officer. Perform the following tests:

(1) Table 1: Sand Properties

Property	Standard	Criteria
Specific Gravity	ASTM C128	[greater or equal to 2.55]
Absorption	ASTM C128	[less than or equal to 2.0]
Flat and Elongated	COE CRD-C 120	[less than 25 percent]
Clay Lumps and Friable Particles	ASTM C142/C142M	[less than 1%]
Organic Impurities	ASTM C40/C40M and if fails then ASTM C87/C87M	[3 maximum or minimum, 95 percent strength retention]

c. The percentage of surface moisture of the saturated surface-dried sand must be determined in accordance with ASTM C70, ASTM C566, COE CRD-C 112, or other approved method giving comparable results.

d. Store sand a manner that prevents the inclusion of any foreign materials in the grout. All sand must remain in free draining storage bins for at least 72 hours prior to use.

e. The Grout Mix Design submittal must include the source(s) of sand and all required test results.

]]2.1.2 Solution Grout Mix Design

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NOTE: Acrylic grouts will not substantially strengthen/densify soils. They are primarily used for seepage control.

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NOTE: Polyurethane grout can be used for seepage control in boulders, cobbles,and open graded stone. These grouts can strengthen these soils.

NOTE: Sodium silicates are only recommended for short term applications.

NOTE: Remove any sections that are not applicable to the scope to be executed.

****

Furnish solution grout composed of reactant, hardener, accelerator, resin, and water. Structural solution grouts must provide a permanent and irreversible gel with a controlled gel time. The volume change of the grout must not exceed [10][20][50][100] percent of the initial volume.

Provide solution grout with the following properties:

a. Batch weight of each solid component and weight of water on a per [liter][cubic meter] [gallon][cubic yard] basis in accordance with ASTM C127. If using cubic yards, also show conversion to gallons.

b. Select viscosity for compatibility with the material to be grouted. The materials to be be grouted consist of [strata of] [Silt,] [Sand,] [Gravel]. The anticipated hydraulic conductivity of the layer to be grouted is [_____].

****

NOTE: Reduce strength requirements if permeability reduction is the intended goal for the project. For voids or for structural support, the strength should be equivalent to the in-situ soil conditions, or slightly stronger.

****

c. [7] [28]-day unconfined compressive strength exceeding [34] [172] [345] kPa [5] [25] [50] psi in accordance with ASTM D4219.

d. Test results establishing the working time/gel time of the mix design at [5/30 minutes] [30/50 minutes] [in accordance with manufacturer's recommendations and field demonstrated] [Verify gel time in the field with "cup tilting test" where product is poured from one cup to another until it gels.] Cure time for all grouts must be [0.5-10] hours.

e. All solution grouts must be non-toxic and non-flammable during and after grouting, and non-toxic in the set form.

f. Batch volume as proposed by the Contractor in the Work Plan..

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NOTE: Note for viscosity requirements in Part g, below. These requirements are site specific and should be informed by a site investigation to fully capture the conditions anticipated on site. In general viscosity requirements should generally be:

Less than 2 cP for hydraulic conductivities less than 1E-4 cm/s 4E-5 in/s.

Between 2-5 cP for hydraulic conductivities between 1E-4 cm/s 4E-5 in/s and 1E-3 cm/s 4E-4 in/s.

Between 5-12 cP for for hydraulic conductivities between 1E-3 cm/s 4E-4 in/s and 1E-2 cm/s 4E-3 in/s.

If an acrylamide/acrylate grout is used, the grout must have a specific gravity between 1 and 1.5.

****

g. For seepage control applications the grout must be less permeable than 1x10-6 cm/s 3.9x10-7 in/s and viscosity requirements must be submitted as part of the work plan.
[
Viscosity requirements must be less than [_____ cP] for hydraulic conductivities less than [_____].]
[
Viscosity requirements must be [between] [_____ cP and _____ cP] for hydraulic conductivities between [_____ and _____].]

h. If a polyurethane grout is used for void filling, the grout must have a specific gravity between 1 and 1.4. The viscosity requirements must be submitted as part of the work plan [must be less than [40 cP][100 cP][500 cP][1,000 cP].]

[i. Sodium Silicate Grouts (Chemical Grout for temporary strengthening and seepage control) must not be used for permanent applications as the only grouting product). The minimum sodium silicate concentration must be forty percent of the mix by volume. The sodium silicate must be delivered in sealed containers or certified tank truck, and must be accompanied by the supplier's certificate of origin. Provide the supplier's certificate of origin to the Contracting Officer. Sodium silicate in non-gelled liquid form, while not considered toxic, is strongly alkaline and must be handled by authorized personnel only. Injected or pluviated sand-grout samples must exhibit less than [1][2] percent shrinkage. Grout gel and/or grouted material must not exhibit objectionable odors such as ammonia. Sodium bicarbonate, sodium aluminate and other reactants that produce a temporary grout will not be allowed. The accelerator, if required, must be technical grade, water soluble calcium chloride or other approved metal salt.]

[2.1.3 Containment Barriers

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NOTE: If containment barriers are required to prevent unwanted grout loss, either include this requirement in the Drilling and Grouting Work Plan to be submitted by the Contractor or add site specific provisions in this paragraph.

Place an approved turbidity curtain as minimum containment barrier. The grout-containment barriers must be of a material and design such that they will restrict the escape of grout [into the body of water].[If used, forms must be of sufficient strength and design to contain the grout materials. Barriers may be constructed of wood, steel, impermeable geotextile, or other material accepted by the Contracting Officer, and may be single-use or reusable.] Barriers must be removed upon completion of the work, unless otherwise approved by the Contracting Officer. Do not perform grouting within 8 meters 25 feet of the leading edge of barriers.

]PART 3 EXECUTION

3.1 DRILLING EQUIPMENT

Supply equipment capable of advancing the grout pipe to the greatest specified depth, or as required to meet the project objectives. Equipment must be capable of drilling required hole depths at required diameters, inclinations, and tolerances required to install grout pipes at the locations and in the condition indicated. Any grout hole that is lost or damaged due to mechanical failure of drilling equipment or inadequacy of grout supply must be replaced by another hole, and drilled at no cost to the Government.

3.2 GROUTING EQUIPMENT

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NOTE: SECTION GROUTING EQUIPMENT, and associated subsections, will apply to cementitious or solution grouts as edited by the designer. Select cementitious or solution grouting brackets in the following subsections.

****

All grouting equipment used must be of a type, capacity, and mechanical condition suitable for performing the work as approved by the Contracting Officer. Provide all necessary equipment and materials, including but not limited to; electric generators, compressors, heaters, hoses, containers, valves, clamps, connections, and gauges to safely and efficiently conduct and control the work [and minimize the impact to the existing structure]. Equip each main pump with recording instruments and gauges to document continuous pressure, flow, and injection rate. Supply pressure gauges at the pump, and at the grout pipe head. Grout injection is not permitted without fully operational recording instrumentation and gauges in place.

The pumping unit must be equipped with piping and/or hoses of adequate capacity to carry the [cementitious grout] [solution grout and reactant solution components separately] from the point of mixing or batching to the point of placement. The pumping unit must be capable of varying the flowrate without changing the mixture proportions of the materials. Distribution of proportioned grout, under pressure, to the grouting locations must be monitored and controlled by separate, automatic recording, flow rate meters and gauges. Any grout hole that is lost or damaged due to mechanical failure of grouting equipment or inadequacy of grout supply must be replaced by another grout hole at no cost to the Government. Install all structural monitoring equipment required, including ground movement monitoring devices.

3.2.1 Solution Grouting Equipment

Advance solution grouting using MPSP or installed temporary casing. Inject solution grouts in accordance with paragraph GROUT PLACEMENT.

a. Provide solution grouting equipment having the capacity and mechanical capability to perform the specified work. Maintain equipment in operating condition at all times. Monitor and record constituent components and final mix volumes and pressures. Injection pumps must meet the grout manufacturer's recommendations per the selected grouting products.

b. Solution Grout Plant - The grout plant must be a continuous mixing type capable of proportioning and mixing to provide a continuous supply of pumped grout with a gel time established in paragraph SOLUTION GROUT MIX DESIGN. Batch-type systems are not permitted. Equip main pumps with positive displacement meters, capable of recording data, constructed of materials that are non-corrodible for the intended products, and that operate independently of the viscosity of the fluid. Provide a pumping unit with the capability to vary the rate of pumping while maintaining the component ratios constant.

c. Pumping Unit - Equip with piping and hoses of adequate capacity to carry the base grout and reactant solutions separately to the point of mixing. The hoses must contain check valves to prevent backflow. Place a water flushing connection or valve in the line to facilitate flushing the grout between grouting sessions. Distribute proportioned grout under pressure, to the grouting locations monitored by separate, automatic real-time display, flow rate indicators and gauges. Provide a sampling valve beyond the point of mixing and the baffling chamber, easily accessible for sampling mixed grout.

d. Provide, at the site, the required quality control testing apparatus including hydrometers, balance scales, graduates, viscometers, and other devices required to conduct acceptance tests, proportioning tests, and grout quality tests.

e. Provide redundant equipment to include, but not be limited to, hoses, headers, fittings, pumps, gauges, sensors, and instrumentation systems to ensure work can commence without interruption.

f. Grout delivery system must be via MPSP, through injection rams, lances, and probes, or open ended casing pipe.

3.2.2 Cement Grout Equipment

Select the appropriate storage vessels, proportioning equipment, hoses, measurement and control systems, mixing plant, transfer pumps, agitator, circulation systems, valves, injection pumps, and all other required equipment for grouting. The pumping unit must be capable of controlling the rate of flow of material as required to deliver the grout in a controlled manner. The unit must be equipped with a manufacturer's certified flow meter to measure the amount of grout injected at each location. All equipment must be maintained in a condition that allows safe operation and must be inspected before and after each shift. Any hoses, fittings, pipes, gauges or other equipment exhibiting significant wear or degradation must be promptly removed from service, tagged and replaced with safe and appropriate components. In addition, equipment must meet the following requirements:

a. Equipment for mixing and injecting cement grout - Designed for grouting service; maintained throughout duration of work to be capable of mixing, agitating, and forcing grout into grout holes, in a continuous flow, at required pressures in accordance with this specification.

b. Mixer Type: Must utilize a high speed colloidal mixer, sized to adequately supply a single grout pump at its full rated capacity.

c. Mixer Capacity: The mixer capacity must be as submitted and approved in the Drilling and Grouting Work Plan, but not be less than 400[750] Liters 100[200] gallons. The mixer must have an accurate water meter reading to within 0.5 percent, for measuring the amount of mixing water added to dry ingredients for the grout.

d. Provide grout pump capable of developing pressure in a continuous, uniform manner, without pulsation, at grout hole connections up to the maximum pressure required.

e. Hose for pressure grouting: Inside diameters must be sufficient for the expected flow rate identified in the Drilling and Grouting Work Plan with a rated burst pressure of at least 4 times the maximum working pressure.

f. Arrange grouting equipment to permit accurate pressure control at grout hole connection. Keep equipment and lines clean by circulation of grout and by periodic flushing with water.

g. Configure equipment so flushing can be accomplished with grout intake valves closed, with water supply valve open, and with grout pump running at full speed. Suitable check-valves must be placed in the grout lines at the proper locations to prevent backflow.

h. In addition to grout mixer, provide mechanical agitator tanks equipped with suitable screens.

i. Provide one pressure gauge on manifold hookup at collar of hole being grouted. Use pressure gauge, with range that includes maximum required injection pressure, and that can be read to an accuracy of at least 35 kPa 5 psi. Furnish accurately calibrated, high-precision gauge; use for weekly [daily] checks of accuracy of gauges used in grouting. Submit initial and periodic gauge calibration records in the Equipment Calibration and Certifications submittal.

j. Provide suitable stop valves at collar of hole for use in maintaining pressure, as required, until grout has set. When MPSPs are proposed by the Contractor, valves on the hole collar are not required.

k. Provide a totalizing type meter meeting the requirements of Paragraph INSTRUMENTATION to accurately determine amount of grout injected.

l. Equip pump with by-pass valve to prevent sudden excessive grout pressure from developing at the grout hole connection.

m. Sanded grout mixes can have sand added by batching and pumping grout to an intermediate mixing unit where the sand can be dosed and added to the mix outside of adding the material at the pump. Submit the method to be used in the Drilling and Grouting Work Plan.

3.2.3 Instrumentation

a. Install a flow measuring device with an accuracy of plus or minus 5 percent in the grout line to measure and record the cumulative grout volume pumped and flow rate.

b. Use a grout pressure sensor to measure, monitor, and record maximum and minimum grout pressure in the grout line on a time domain.

c. Monitor for ground heave or movement on a time domain.

3.3 GROUT HOLE DRILLING

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NOTE: Hole spacing will depend on grouting technique, grout materials, and the properties of the soils being grouted. In general, for permeation grouting, the primary hole spacing will vary from;
[2.5-3.5 meters] 7-10 feet for cobbles/boulders/armor stone;
[1.5-1.7] meters4.5-6 feet for sands and gravels;

[1.2-1.5] meters3.5-5 feet for medium sand;
[1-1.2] meters3-4 feet for fine sand;
[0.8-1] meters2-3 feet for silty sand;

****

Perform the general sequence of drilling as approved in the Drilling and Grouting Work Plan.

3.3.1 Drill Advancement

Advance grout holes at the diameter specified to support [installation of temporary casing][and]installation of MPSPs for each hole location, unless otherwise directed by the Contracting Officer. Be prepared to advance the grout holes spaced every [_____] metersfeet through[concrete][gravels][sands and gravels][sands][silts and sands][silts and clays][cobbles][boulders].

Drill grout holes at the locations and to the depths as shown on the drawings, or as directed by the Contracting Officer. The locations must be within 0.2 meter 0.5 foot (location of center of borehole) at the ground surface of the directed location. Drilling or grouting of holes that have been overdrilled will not be paid unless performed at the direction of the Contracting Officer.

3.4 INSTALLATION OF GROUT PIPES

****

NOTE: Casing is required when a hole is not stable or an area is not intended to be treated by the grouting operation. Sleeve-port pipes can be used for both permeation and void grouting. Oversized casing is typically not required for void/permeation grouting.

****

Maintain an open hole from time of drilling to grouting. Utilize temporary/permanent casing, MPSPs, or other methods to safely install grout as approved in the Drilling and Grouting Work Plan. All casing, if used, must be installed tight against the adjacent ground to prevent grout travel to the surface. Either of the following methods are permitted:

Advance temporary casing before installing the MPSP. Provide re-groutable MPSP with grout ports at maximum in 0.3 or 0.6 meters 1 or 2 foot increments on center along the pipe, and covered by expandable rubber sleeves. Thermoplastic sleeves are not permitted. Use a centralizer while installing the MPSP. If the MPSP cannot be placed to the full depth drilled, restore the open hole at no additional cost to the Government. Installation of MPSP within a borehole requires a weak grout to fill the annular space between the MPSP and the borehole wall in order to prevent unwanted grout communication within the annulus. This annulus grout material is integral to the installation of the MPSP and must be included in the agreed price for installation of grout pipes. This material will typically be an A-Mix Grout.

Steel pipes or lances that are vibrated or hammered into place are permissible to double as casing and the grout pipe, as long as the injection point is protected and can be opened and closed down hole to prevent clogging. The diameter of casing and grouting pipes may vary based on means and methods approved in the Drilling and Grouting Work Plan. The following requirements apply:

a. Provide the proper devices to horizontally and vertically align the drilling rigs and grout pipes as required to complete drilling and grouting. If adjustments in location are required to avoid obstructions or due to accessibility, contact the Contracting Officer for approval prior to drilling.

b. Place grout pipes in accordance with the approved work plan.

c. Grout pipes may be installed, inclined or vertically, to obtain the planned grout coverage between adjacent grout pipes. A continuous brittle sheath grout mix can be placed in the hole with the MPSP installed through the grout. Grouted MPSPs are not required if grouting is completed through open ended casing or with the use of a ram, lance, or probe.

d. Grout through the MPSP with an internal double packer to inject grout at each sleeve-port. Double packers are not required if grouting is completed through open ended casing or with the use of a ram, lance, or probe.

e. Fill and replace any grout holes that are lost or damaged due to mechanical failure of the equipment, inadequacy of grout supply, improper injection procedure, or inadequate coverage at no cost the Government.

f. Measure the cased depth with a weighted tape prior to grouting.

g. Adequately protect grout pipes from hazards.

h. Once the grout pipe is lowered to the full hole depth the grout pipe must not be withdrawn from the ground until grout injection for each stage is completed.

i. After completion of grouting in each area, fill all holes and leave the area clean of debris.

j. Provide grout pipe pulling jacks, or other mechanical withdrawal means, capable of safely withdrawing steel casing in specified increments during grouting.

3.5 GROUT PLACEMENT

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USACE Engineering Manual EM 1110-2-3506 GROUTING TECHNOLOGY recommends that grouting in soil not exceed an effective pressure of 1/2 psi per foot of depth. This requirement is conservative, and is based on experience grouting in embankment dams. Typically, allowable grouting pressures will exceed this value based on the scope and intent of the grouting. For any application where structural harm to a facility or loss of life may result, it is recommended to restrict grouting pressures to less than 90% of the theoretical effective hydrofacture pressure and to demonstrate methods in the field to establish safe grouting pressures to complete the work.

Do not use high pressures for grouting near dams. If grouting in or within 61 meters 200 feet of a dam, adherence to Engineering Regulation 1110-2-1807 is required. Increase the minimum offset as prudent to protect the structure.

Upstage grouting is typically (but not always) the preferred method. Downstaging is required if worried about isolation or confinement. A combination of methods may be necessary to meet the designers purpose. Complicated grout jobs and/or inexperienced designers should consult with industry or an A/E before methods are specified.

Inject grout on a continuous basis until grouting for any given stage is complete without damaging the structural integrity of existing or appurtenant structures. Conduct surface pressure test of each grout stage from the manifold to the injection point, or equivalent to the maximum hole depth, to ascertain system pressure differential. Use this measured pressure for estimating appropriate grouting pressures for production grouting.[Temporary high injection pressures are permitted to crack open sleeve-ports, but these pressures are not allowed for longer than [10][_____] seconds.] Stoppages in the grout injection must not be longer than the established working time for the last grout that has been injected. Perform all grouting operations in the presence of the Contracting Officer. Any deviations or changes must be approved by the Contracting Officer.

3.5.1 Permeation Grouting and Small Voids

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NOTE: Grouting increments must match sleeve port pipe openings. Note that items A-C must be specified for all jobs. Item D may be required for sensitive projects where the potential for overpumping grout may result in structural damage. The volume of voids in the soil stratum must be known, generally 0.2-0.4 for sands and gravels. This should be determined from soil gradations.

****

Perform permeation grouting using upstage grouting in [0.3][0.6] meters [1][2] foot increments. Limit grouting to the stage that is being treated. Complete holes according to the locations and sequences indicated on the plans. Inject grout until the specified volume or pressure thresholds are obtained, or a decision has been made to split space additional holes. Withdraw the grouting apparatus at suitable intervals to grout each grout stage. Sequence permeation grouting so that grouting does not take place within 1 meter 3 feet of recently grouted holes that have not reached the gel time for solution grout or the set time for cement grout. The termination header pressure may be adjusted in the field with approval of the Contracting Officer. Adjust injection procedures as required to prevent excessive surface or structure heave. The following criteria apply:

a. Pressure thresholds: Do not exceed 90 percent of the theoretical hydrofracture pressures based on the material type.[The effective grouting pressure for any stage cannot exceed [_____] kPa [_____] psi per meter foot as determined at the mid-point for the stage.]

b. Rate threshold. In any event, the rate of injection into any port must not exceed [4][8][_____] liters [1][2][_____] gallons per minute. Adjust injection procedures, (injection rate, mix design, and pressure), as required to prevent excessive heave.

c. Heave threshold: Stop grouting if 3 millimeters 1/8 inch of surface deflection is observed in any grout stage, or if grout is observed at the ground surface.

[d. The volume threshold for each stage is determined by the equation: Pi*(Hole spacing/2)^2*Stage Length*Volume Voids Percentage. The volume of voids percentage will vary from [0.2 to 0.4] based on [sands and gravels] in Stratum [_____]. [Grouting requires installation of grout plugs, as necessary to control grout loss.][Grouting requires a thick mix in the first grouting line to control grout loss.]]

[e. If a volume threshold is met, the Contracting Officer may require that the hole rest at least 12 hours for [gelling] [setting] before additional grouting is permitted in the remaining stages.]

f. Repeat grouting operations until termination criteria is reached for each successive stage.

g. Completely fill grout holes to the ground surface.

3.5.2 Ground Movement Monitoring Plan

****

NOTE: Utilities and allowable displacements must be determined as part of the design through coordination with local utility providers, owners, and regulatory agencies.

****

Monitor existing ground surface and structures within a radius of 8 meters 25 feet of each permeation grout column at all times during grout injection with laser levels, manometers, or other such equipment to immediately detect movement. Underground utilities that could be affected by grout intrusion and located within 15 meters 50 feet of the permeation grout holes must also be monitored at all times so that any intrusion of grout will be immediately detected. Provide a direct communication system linking the grout pump operator, the personnel at the grout pipe, and the personnel at the monitoring points/equipment. Damage to the existing underground utilities or surrounding buildings or other structures as a result of the failure to detect movements of the ground or intrusion of grout into the piping system must be repaired in kind at the Contractor's expense.[Maximum allowable displacement of underground utilities must not exceed a total of 6 millimeters 0.25 inches.] Perform manufacturers recommended calibration of any ground movement monitoring equipment and provide initial and periodic records in the Equipment Calibration and Certifications submittal.

[3.5.3 Automated Grouting Data Collection System (AGDCS)

****

NOTE: Automated grouting data collection systems are becoming more prevalent and may be options for

large jobs where a lot of data is generated in a short period of time.
****

Provide, set up, maintain, and operate the AGDCS. Utilize the system during all grouting operations. Include in the AGDCS all necessary equipment, materials, computer hardware, and software to direct grouting operations in accordance with these specifications and collect and display digital data in real-time. Ensure the system is capable of producing data in hard copy and digital formats. Perform manufacturer's recommended calibration of any AGDCS equipment utilized, and provide initial and periodic records in the Equipment Calibration and Certifications submittal.

3.5.3.1 AGDCS Equipment Capabilities

The AGDCS must have the following capabilities:

a. Monitor and record all grouting including but not limited to mix type, [line losses], target pressure, gauge pressure, total volume, flow rates and apparent Lugeon values at the midpoint of each stage.

b. Calculated maximum total pressures from the specified gravity pressure criteria

c. Measure effective pressure in the ground. Calculate effective grouting pressure based on 1) pressure readings in the grouting zone, minus 2) the pressure provided by the local water table.

d. The automated system must have the ability to continuously monitor the grouting operation without interference or interruption to the grout injection process while grouting a stage when a mix change is warranted.

e. List of cumulative drilling and grouting issues including but not limited to broken PVC, lost tooling , hole communications, rod drops, fluid loss etc.

f. Correct and reduce the collected data to account for correction factors and field parameters (pressure head losses, pressure measurements, actual depth of the stage being grouted, groundwater influence, mix batching/cycling).

g. Export raw data files into a non-proprietary file format and produce tabular digital records as specified in Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION, paragraph "DATA REQUIREMENTS".

h. Capable of producing graphs in Microsoft Excel format. Propose specific reporting graph design and the use of other file formats within this submittal.

i. Graphically display in real-time, record, and plot, the following at a minimum:

    (1) Total volume of grout placed in the stage;

    (2) Gauge pressure, [total pressure,] and [effective pressures,] [and measured effective pressure,] at active zone being grouted;

    (3) Start and stop times of grout injection;

(4) A continuous dotted line showing the target pressure;

(5) Rate of injection (volume per time);

(6) The time, type and volume of a particular grout mix for the full duration of the grouting;

(7) Plots for Time History of flow and pressure;

(8) The entire grouting record for the stage versus time[;][.]

[(9) A consistent time scale must be plotted on real-time plots.]

3.5.3.2 Automated Grouting Data Collection System (AGDCS) Submittal

Include the following information about the automated grouting data collection program in the submittal:

a. System name and manufacturer.

b. The calculations for producing effective pressure.

c. Describe the process for data input to the system.

d. Describe the process for data storage for all generated data, including but not limited to grouting, testing, or other required processes.

e. Describe the data visualization (e.g., GIS mapping, CAD profiles, and plots) methodology, including any data transformations.

f. Describe methodology used for export of data to[Excel Spreadsheets][Enterprise Database].

g. Data backup process used to ensure no data loss occurs.

h. Screenshots of raw data format and typical plots.

i. Example grout log showing change in mix type.

]3.6 FIELD QA/QC PROCEDURES

Perform all grouting operations under the supervision of the Contracting Officer. In addition, the Quality Control Manager must be present during grouting operations.

3.6.1 Drilling Logs

Keep records of all drilling operations and all quantities associated with the drilling activities. Submit complete, legible records of the locations, depths and designations of all grout holes drilled [as an attachment to submitted DAILY RECORDS][as directed by the Contracting Officer]. The drilling logs must utilize the [USACE Form 1836 and 1836 Continuation][_____] Form for drilling logging, including the date, hole ID, hole northing and easting, top elevation, and station, drill rig ID, driller ID, logger ID, start and stop times for drilling, and ground surface description. Describe any unusual drilling conditions encountered including but not limited to discontinuities, voids, soft zones, hole collapse, hole communication, water loss, or other conditions. Survey all

Primary and Verification holes.

3.6.2 Daily Records

Daily data and quality control records must be available to the Contracting Officer at all times. Submit field records upon completion of the hole. Submit digital records for each grout hole to the Contracting Officer within 7 days of grout injection.[Use an automated grouting data collection system to record grouting injection operations. Provide all raw data outputs from the AGDCS within [12][_____] hours of generation.] Maintain accurate daily records of all grout pipe installation, drilling logs, grouting quantities including stage data, volume, ground monitoring, pressure and depth for each grout pipe location in accordance with the following:

a. Draft and final drilling logs.

b. Hole ID,[hole series,] hole[station and offset][latitude and longitude].

c. [Hole][Casing and MPSP] top and bottom elevation, depth, and diameter of hole.

d. Hole inclination (vertical = 90 degrees).

e. Stage geologic formation.

f. Grout stage ID, date, injection depth and elevation, grout mix ID.

g. Stage target effective pressure and target gauge pressure.

h. Injection pressure, flow rate, and volume in liters gallons for each grout mix injected for each grout stage[and grout zone] summarized for each grout hole.[Include[w:c Ratio][Solution grout percentages][placed each hole.]]

i. Maximum pressure and flow rate reached in each zone.

j. Summary of grout mixes used for each grouting effort with itemized total quantities of grout materials placed vs quantity of grout wasted.

k. Location and number of grout holes completed.

l. Depth at which ground heave/displacement was detected.

m. Depth at which grout intrusion into an underground piping system or communication with another grout hole is detected.

n. Presence of any of the following:

    (1) Voids or changes in drill advancement rate in soil or other material with depths to the top and bottom of each void.

    (2) Groundwater depth.

    (3) Unusual or unexpected conditions including communication, bypass, etc.

Submit data electronically in a[.csv][.xls][, or other] ASCII-readable format. Submit clear, legible analog records in [PDF] format.

3.7 GROUT MONITORING

****

NOTE: Requirements for water quality monitoring are site specific and must be coordinated with local, state, and federal agencies based on the scope and sensitivity of the project. It is the responsibility of the Government to determine what these requirements are and include them in the Contract.

****

a. Closely monitor the rate of grout take during grout injection. Determine the cause of sudden drops in grout injection pressures following initial start-up pressure adjustments.

b. Cementitious Grout flow rate must be monitored by magnetic flow meter or coriolis mass flow meter during all grout injection. Gauges must be provided at the pump, and at the grout pipe head, to measure pressure. Type and location of gauges must be approved by the Contracting Officer in the Drilling and Grouting Work Plan. All pressure gauges must be certified for accuracy to within plus or minus 5 percent and submitted under the Equipment Calibration and Certifications submittal.

c. Periodically monitor paved areas and the ground surface adjacent to the grouting site for grout leakage. In the event that grout leaks are observed, temporarily terminate injection and plug leaks before resuming pumping.

d. If excessive grout take is experienced that is not attributable to leakage, change injection pressure, pumping rates, gel or setting times, or grout composition, subject to approval by the Contracting Officer, to reduce grout use to acceptable levels.

e. For storm drains located within the grout zone and in close proximity to the grout injection points, perform water quality monitoring continuously during grouting.

3.7.1 Grout Data Logger

Use a Grout Data Logger, at each individual grout header, capable of electronically storing and displaying the hole number, date and time of the start and stop of grout injection, continuous flow rates, injection pressures, and total grout placed for each grout hole. Perform manufacturer's recommended calibration of any equipment utilized, and provide initial and periodic records in the Equipment Calibration and Certifications submittal.

3.8 TESTING

The Contracting Officer reserves the right to require additional field testing if the grout appears to be out of specification tolerances.

[3.8.1 Solution Grouting

****

NOTE: Only select the second strength verification

paragraph if the verification program requires confirmation of the soil strength post grouting.
****

a. Production Strength Test: Prepare lab strength tests using the approved grout mix applied to three samples of [Ottawa sand] [material obtained on-site] for every 950 liters 2,500 gallons of grout injected in accordance with ASTM D4219. Verify strength requirements are met as approved in Paragraph "Solution Grout Mix Design".
[
Strength Verification Tests: During verification hole drilling, core a minimum of [three][_____] boreholes to obtain a total of [9][_____] recovered samples to verify the grouted zones have been thoroughly permeated and stabilized with grout. Perform compressive strength tests on the retrieved samples for each location per ASTM D4219. Verify the strength meets the requirements approved in Paragraph "Solution Grout Mix Design".]

b. Production Viscosity Test: Verify the viscosity of the grout mix 1 time per [shift] for each grout mix used in accordance with the manufacturer's recommendations. Ensure the viscosity meets the requirements approved in Paragraph "Solution Grout Mix Design".

c. Permeability Verification Test: Conduct falling head tests per the [Hvorslev Method,] [_____] in each open verification hole between two previously grouted holes. Conduct the test for a period of [4][8] [_____] hours to verify the design permeability of [_____] cm/s[_____] in/s was achieved. Pump the hole out upon completion, and grout the hole per the same methods as production holes. Verify of the grout hole refuses. Split spaced holes are required if the verification hole fails permeability and does not reach refusal.

[
d. Solution Grout Gel Times: Determine minimum and maximum gel times to ensure appropriate penetrations of grout into the grouted material. For gel time quality control, take at least one sample every [4] hours of pumping for each grout mix used. Verify gel time requirements are met as approved in paragraph SOLUTION GROUT MIX DESIGN. Properly label gel samples and store until completion of the work.]

][3.8.2 Cementitious Grouting

****
NOTE: Items A-F are specific to permeation and small void grouting. Item G applies to all.
****

a. Production Viscosity Test: Perform Marsh Funnel testing in accordance with ASTM D6910/D6910M 1 time per shift for each grout mix used. The Marsh time must meet the requirements approved in paragraph CEMENTITIOUS GROUT MIX DESIGN.[The Marsh time must be between [____] and [____] seconds for stratum [_____].]
[
Perform flow cone test, if used, in accordance with ASTM C939/C939M 1 time per [shift] for each grout mix used. The flow cone time must meet the requirements approved in paragraph CEMENTITIOUS GROUT MIX DESIGN.]

b. Production Strength Test: Perform [7] [28]-day unconfined compressive strength test per ASTM D4832/D4832M every 950 liters 2,500 gallons of grout batched to verify strength meets the requirements approved in paragraph CEMENTITIOUS GROUT MIX DESIGN.[Test each grout mix when used in production weekly].

c. Production Pressure Filtration Test: Conduct pressure filtration test in accordance with API RP 13B-1, low-pressure/low-temperature at least [1] time[s] per week for each grout mix used. Must meet requirements approved in paragraph CEMENTITIOUS GROUT MIX DESIGN.

d. Production Bleed Test: Conduct bleed tests in accordance with ASTM C940 at least [1] time[s] per week for each grout mix used. Must meet requirements approved in paragraph CEMENTITIOUS GROUT MIX DESIGN.

e. Cementitious Grout Set Time: Set Time is between 8-24 hours in accordance with ASTM C191, method 'A'. Test [1][_____] time per week.

f. Permeability Verification Test: Conduct falling head tests per the [Hvorslev Method,] [_____] in each open verification holes between two previously grouted holes. Conduct the test for a period of [4][8] [_____] hours to verify the design permeability of [_____] cm/s[_____] in/s was achieved. Pump the hole out upon completion, and grout the hole per the same methods as production holes. Verify of the grout hole refuses. Split spaced holes are required if the verification hole fails permeability and does not reach refusal.

g. Temperature must be between 50-90 degrees F tested 1 time per shift.

][3.9 DEMONSTRATION SECTION

****

NOTE: Tailor the section as needed based on the materials to be grouted.

****

After the Drilling and Grouting Work Plan is submitted, and at least [7][_____] days prior to initiating work, complete a demonstration section meeting the following requirements:

a. Verify the grout mixes are appropriate and effective for the subsurface material characteristics.

b. Demonstrate capabilities of proposed personnel, equipment, and materials.

c. Refine methodology and equipment; technical approach; and grout mix designs based on performance.

d. Demonstrate methods are effective at accomplishing the scope:

To verify permeability, advance [_____] verification borings to include falling head permeability tests per the requirements herein.
[
To verify strength and void filling, advance [_____] verification borings to obtain core for unconfined compressive strength testing per the requirements herein.]
[
To verify strength and void filling, conduct [Standard Penetration Testing (SPT)] [Cone Penetrometer Testing (CPT)] between two completed grout holes for the full depth of the hole.]

[
Excavate a test pit to expose a grouted hole for inspection.]

e. Demonstrate the compatibility of the proposed materials, including water source, equipment, and personnel to complete the work.

[f. Demonstrate protocols to protect the integrity of the structure against construction induced damage. Demonstrate emergency procedures if damage occurs.]

][3.10 GROUT CONTAINMENT

Contain grout by a combination of physical barriers suitable for the grouting program design. Place containment only in areas to be grouted within 24 hours of placement so as to limit the need to replace containment measures over time. Immediately stop grouting or adjust the grout mixes and pump rates if it is determined that the grout is too thin to be contained by the containment measures.

[As a minimum, place [[____] millimeters [____] inches diameter, [_____] millimeters [_____] inches thick stone protection,] to a depth of [_____] meters [_____] feet along the slope of the structure in the area to be grouted.][As a minimum, install a correspondingly sized approved turbidity silt fence on the interior side of the structure to at least the same depth.][Consult weather and water stage forecasts, and adjust placement of containment measures that might be damaged or rendered ineffective before grouting operations in those areas.]

]3.11 SITE RESTORATION

a. Remove grout pipes installed from surface. [Sleeve port pipes to be cut off flush with the ground surface].

b. Promptly clean up spilled materials and grout.

c. Restore street pavement and sidewalks in accordance with requirements of local jurisdiction.

d. Where grouting or grout operations are performed from the ground surface, restore grouting locations to their existing condition, including re-paving of the street right of way in areas where grout holes have been installed.

3.12 DATA MANAGEMENT

3.12.1 AS-BUILT DRAWINGS AND GROUTING PROFILES

Maintain progress drawings in the field and provide to the Government [weekly][monthly]. Include at least one updated plan view showing total grout volume for all grout holes. In profile, display stage pressure and volume for each grout hole. Use the progress drawings to develop the as-built drawings for submittal to the Government. Submit drawings of as-built grouting locations detailing grout volumes and pressures for each incremental grout injection upon completion of grouting activities[for each alignment].[Include separate profiles for drilling and grouting information.]

Produce drawings at scale of [1:250] or [1:150]. Provide separate sheets for 1) plan view, 2) [section] [profile] view(s) of drilling including lost tooling and interpretive geology, 3) [section] [profile] view(s) of grouting results. Submit records in [hard copy (2 copies),] [electronic format on CD or DVD,] in native file formats, and in .pdf, on the project SFTP site.[Drawing views of progress drawings that are unchanged from the previous week do not need to be submitted in hard copy, but the electronic copy must still be submitted.]

3.13 COMPLETION REPORT

Fourteen days prior to the Contract completion, prepare and submit a drilling and grouting final report that covers all the activities throughout construction. Submit[three][five] hard copies of the complete report, and a digital copy of the report. Include all forms, sketches, drawings, tables, graphs, and color photographs, or other supporting materials, as necessary to provide a full understanding of how the work was accomplished and any difficulties, problems, or unusual conditions which were encountered. The report must 'standalone' and not reference other material to the maximum extent possible, except for the As-Built drilling and grouting drawings.

Submit the final report no later than [30][60] days after grouting the final hole.[Submit an outline of the report for approval when 50 percent of the construction is completed.] The report must contain the following at a minimum:

a. The equipment used, final layout of the grout holes, grout takes by hole, problems encountered and solutions applied.

b. Drilling records including hole [easting and northing] [latitude longitude], elevation and depths, [hole azimuth and inclination,] vertical and horizontal datums used to survey the holes, and any applicable reference coordinate systems. Include the same data for all survey control points.

c. Include grout quantity pumped versus time for each completed stage in the project. Provide plots of grout injection (flow) and grout pressure versus time for each completed stage in the project. Include in a graphical presentation a depiction of pressure versus time where the maximum and minimum pressures can be directly compared.

d. A minimum of 15 annotated color photographs of each phase of construction and equipment.

e. A discussion of the grout mix(es) used and quality control procedures for maintaining the grout mix required properties during production. Include statistical analyses.

f. A descriptive list of any lost tooling, including type of tooling, length, depth, batter, and location (station and offset).

g. Discussion of any deviations from the Drilling and Grouting Work Plan submittal(s).

h. Instantaneous and Industrial Production rates for drilling and grouting. Compare production rates achieved with the production rates forecast in the baseline schedule.

i. Summary statistics of each test for each grout mix during the Contract. Include: Mean, Median, Mode, Standard Deviation, and

95-percent confidence limit.

j. For compressive strength data, include plots of the [7-day and] 28-day strength, for each mix, showing results versus time, with specifications limits clearly delineated on the plots.

3.14 COMMUNICATIONS

Install a communications system that links (at a minimum) the grout plants, grout injection stations, and all other operations on site as necessary.[Furnish two devices per shift to the Contracting Officer that communicate on the Contractor's frequency or line for monitoring and coordination of grouting operations. These will be returned by the Contracting Officer at the end of grouting operations, and it should be expected they will be subject to normal wear and tear.]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 33 30 (November 2024)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-31 33 30 (November 2024)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 31 33 30

LIMITED MOBILITY GROUTING IN SOIL
11/24

****
NOTE: This guide specification has been prepared as a construction guide specification to address limited mobility grouting (LMG) with cementitious grout. This specification includes requirements for drilling, grouting, furnishing, handling, transporting, storing, mixing and injecting the grouting materials; care and disposal of wastewater and waste grout; and clean-up of areas as necessary to complete the work.

This specification is appropriate for subsurface strength improvements and void filling. This specification is not appropriate for use to address seepage control issues--see specifications 31 33 20 Void and Permeation Grouting in Soil, 31 33 10 Foundation Grouting in Rock, and 31 73 19 Tunnel and Shaft Grouting for those grouting applications.

Do not use high pressures for grouting near dams. Methods for grouting in embankment dams or levees are not included in this specification. Grouting must not result in harm to the structure.

For USACE and Army: Soil grouting must never be used in any dam or levee embankment without approval from the appropriate Major Subordinate Command (MSC) Dam Safety Officer (DSO) and an approved Dam/Levee Safety Modification Study. If grouting in or within 61 meters 200 feet of a dam or levee embankment, or close enough for the proposed pressures to result in harm the foundation, adherence to Engineering Regulation 1110-2-1807 is required.

For Air Force and Navy: Soil grouting must never be used in any dam or levee embankment without approval of a qualified Subject Matter Expert (SME) and approval from the DSO.

This specification may be reworded for adaptation for various specialty forms of LMG to include compaction grouting, cap grouting, compensation grouting, etc. Edit this guide specification for project-specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information. Remove nonessential information whether or not brackets are present.

****

PART 1   GENERAL

****

NOTE: Caution must be exercised to not prohibit the use of a material or technique that may otherwise satisfy the scope. Proprietary products or manufacturers must not be specified within this specification without a Justification and Approval document from the Office of Counsel. Consideration must be given to conducting laboratory and field tests and evaluations of the system or systems being considered for a given application (including Standard Penetration Test (SPT) and Cone Penetratometer Test (CPT) data, soil gradation, unit weight, and shear strength tests).

If grouting is anticipated during extreme temperatures, alteration of certain field procedures may be necessary and must be included in the specifications. Generally, for cold weather cementitious grouting, the grout must be maintained at temperatures above 50 degrees F until injected, and storage of the grouting materials must be at temperatures above freezing. Insulation, heated enclosures, water heaters or other equipment or procedures may be required. Grouting in extremely hot weather may also require extra precautions.

Methods for listing subdivided items are described in Paragraph "Variations in Estimated Quantities-Subdivided Items" of Army Federal Acquisition Regulation Supplement (AFARS) 5152.211-9001. Subdivided items are recommended for all jobs unless there are extenuating circumstances for small jobs.

****

1.1   SYSTEM DESCRIPTION

****

NOTE: Provide a brief summary of the project scope and any prudent references applicable to the layout, depths, and orientation required for the grouting. Do not write the spec in such a manner that the entire program must be directed by the Government. Include relevant bracketed types of foundation features that may be encountered and specify where

they are found in the blank brackets. Include any special restrictions or coordination required.

****

The purpose of the work is to utilize limited mobility grouting (LMG) to [densify compressible soils] [fill voids in the subsurface soils][raise and level foundations (compensation grouting)]. Perform LMG according to the plans and as outlined in these specifications. Provide all labor, materials, tools, equipment, personnel, monitoring equipment, and quality control as necessary to accomplish the proposed work. Conditions encountered during the work may call for changes in the exact layout and number of grout holes as required herein.

1.2 PRICE AND PAYMENT

1.2.1 Mobilization and Demobilization

****

NOTE: The following unit prices can be adapted to the grouting techniques specified. If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) must be deleted from this section and the remaining appropriately edited subparagraphs below must be inserted into Section 01 20 00.

****

****

NOTE: This provision applies for inclusion in instances where grouting is the primary feature of work.

****

1.2.1.1 Payment

Payment is made for costs associated with assembling all plant and equipment at the site, preparatory activities prior to initiating the work, and for removal and clean-up of the site once the drilling and grouting program has been completed. Sixty (60) percent of the contract lump-sum price for mobilization and demobilization will be paid following on-site assembly of all equipment to working order, and the delivery of materials necessary to perform the required drilling and grouting operations to the site. The remaining forty (40) percent of the contract lump-sum mobilization and demobilization price will be paid when all equipment has been removed from the site and all site restoration requirements have been fulfilled.

1.2.1.2 Unit of Measure

Unit of measure: Job.

1.2.2 Casing Installation

****

NOTE: This specification anticipates holes will be upstage grouted and not downstage grouted. If holes must be downstage grouted, adjust measurement, payment, and procedures accordingly.

****

1.2.2.1 Payment

All incidental costs associated with the performance of work in this section are included in the contract price for this item. Payment will be made for costs associated with advancing[vertical][10][20][30][_____] degree boreholes with casing installation, as specified herein. The casing item includes but is not limited to: equipment set up on the proposed borehole location; [advancement][drilling] of the hole; installing permanent casing or installing and then removing temporary casing; care and disposal of drilling wastes; clean-up of the site; and furnishing all equipment, labor, material, and supplies necessary and incidental to the work, including all records. Grout will be paid for under the appropriate grouting pay item. The Government will make no additional separate payment for items included herein or by reference.

1.2.2.2 Measurement

Measurement for payment is by length of properly placed casing as measured from the ground surface to the bottom of the pipe. Any length of casing projecting above the ground surface is considered incidental to the work and will not be measured or given credit for payment. Grout pipe and casing can be the same material. Subdivide the total linear footage of properly installed casing into "initial quantity" and "over initial quantity".

1.2.2.3 Unit of Measure

Unit of measure: Linear meter foot.

1.2.3 Grout and Grout Placement

****

NOTE: If the designer requires a restrictive flow rate less than 1.5 cubic feet per minute then the specification writer should create a separate line item for paying grouting by time.

****

1.2.3.1 Payment

Payment will only be made for grout installed and accepted by the Government in accordance with the plans and specifications. All incidental costs associated with the performance of work for this section are included in the contract price. Incidental work includes, but is not limited to, the following: (1) costs for all equipment, labor, materials, and supplies necessary to complete the grouting including grout hole setups; (2) grout hole connections; and (3) furnishing, batching, handling, transporting, and grout placement at various grout mixes and materials specified [proposed] at the required stages, pressures, rates, and volumes. This also includes storage and transportation of grout materials and samples; Quality Control testing and records; and associated cleanup and disposal of excess grout. No payment is made for wasted grout from excessive batching, from improper batching, or by the Contractor for any reason, including failed quality control tests. No payment will be made for time lost due to fault or negligence of the Contractor or due to defective equipment furnished by the Contractor. The Government will make no additional separate payment for items included herein or by reference.

1.2.3.2 Measurement

Measure injection of grout for payment by the volume of LMG properly mixed and injected. The volume is measured for payment based on the volume of grout satisfactorily placed in grout holes. Subdivide grouting and grout placement into "initial quantity" and "over initial quantity".

1.2.3.3 Unit of Measure

Unit of measure: cubic meter (CM)cubic foot (cf).

[1.2.4 Grout Containment

****

NOTE: Consider this optional line item item if working below water or in an otherwise sensitive area where additional controls may need to be placed on grouting for environmental compliance. Delete this section if the Contract addresses these concerns through stormwater protection or other means as part of the general site work. This section must be tailored to the meet requirements of local, state, federal, and other jurisdictions, including downstream considerations, which may be impacted by the project.

****

1.2.4.1 Payment

All incidental costs associated with fugitive grout containment, including but not limited to containment barriers, the placement of cover materials, and general environmental compliance are included in the contract price for this item. Payment will be made for costs associated with furnishing all equipment, labor, and supplies necessary for this item.

****

NOTE: Containment barriers can consist of washed aggregate fill to be placed on the surface immediately prior to grouting to aid in the containment of grout exiting from breakwaters. Limit the placement area to areas being grouted within 24 hours to avoid wave wash erosion of the containment barrier prior to grouting.

Materials used for grout containment should be inert, biodegradable, or temporary in nature. These systems must be removed by the Contractor unless their continued presence is considered inconsequential and allowed to remain by the designer/local jurisdiction.

Where crushed stone, sand or similar materials are specifically called out, these materials may be paid for on a quantity basis - i.e. measured by either surface area covered or tons of aggregate or sand placed. This may be beneifical when quantities are uncertain due to variations in available materials.

****

1.2.4.2 Measurement

Measurement is based on successful installation of required systems and compliance to appropriate regulations and restrictions as required in the Contract.

1.2.4.3 Unit of Measure

Unit of measure:[Job][Each]

][1.2.5 Drilling and Grouting Closeout Records

****

NOTE: Include this subpart only if Specification 01 78 00 Closeout Submittals is not included as part of the project specification list. Consider adding this requirement if grouting is part of a larger project and closeout submittals for grouting are required before the official closeout for the project.

****

1.2.5.1 Payment

Payment is made for material and labor cost associated with completion of all closeout records under the section entitled DRILLING AND GROUTING CLOSEOUT RECORDS.

1.2.5.2 Measurement

Measurement will be made when closeout records have been submitted and given final approval by the Government.

1.2.5.3 Unit of Measure

Unit of Measure: Job

]1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 53-19	(2019) Compaction Grouting Consensus Guide

ASTM INTERNATIONAL (ASTM)

ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C403/C403M	(2023) Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C685/C685M	(2024) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1797	(2023) Standard Specification for Ground Calcium Carbonate and Aggregate Mineral Fillers for use in Hydraulic Cement Concrete
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4832/D4832M	(2023) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-1-1804	(2001) Engineering and Design -- Geotechnical Investigations
ER 1110-1-8100	(1997) Laboratory Investigations and Testing

1.4 DEFINITIONS

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NOTE: Definitions may be included by reference to engineering manuals if the exact definition in the reference is to be used in the Contract. If definitions are edited for the project, then they must be included in this section.

****

1.4.1 Automated Grouting Data Collection System (AGDCS)

A computerized system for receiving, translating, recording, storing, and displaying pressure grouting data. The system is capable of viewing results in real-time or at any time after the stage is tested or grouted. The system can also produce graphic and numerical outputs for grouting and water pressure test data in real-time with digital transmittable files, including but not limited to, PDF, MS Excel spreadsheets or workbooks, and raw data files such as delimited text, XML, and DIGGS XML grout data formats.

1.4.2 Blended Hydraulic Cement

Blended Hydraulic Cement is a combination of Portland Cement, and one or more pozzolans or limestone.

[1.4.3 Cap Grouting

Cap grouting is a process used to prevent further soil loss over sinkhole voids. It involves injecting a cement-based grout to create a protective cap above the bedrock, effectively sealing the sinkhole and stabilizing the surrounding soil. It is typically the lowest zone to be grouted generally occurring 0.6 Meters 2 feet above the top of bedrock or otherwise located at the bottom of the borehole.

]1.4.4 Cement Grout

****

NOTE: Verify the type of cement locally available and tailor the specification based on locally available materials.

****

A fluid cementitious material used to improve the strength and stability of soil and coarse-grained materials. Grout is composed of a cement (Portland Cement, micro fine Portland Cement, Blended Hydraulic Cement, or slag cement) and water, and may contain additives such as limestone, silica fume, fly ash, pozzolan, and/or admixtures as appropriate.

1.4.5 Closure

Closure is defined as the completion of all grouting within a section in a manner that refusal criteria are met and no additional split-spaced holes are required to achieve the objective of the grouting.

1.4.6 Communication

Communication is the passage of water, air, or grout from one hole to another or to any opening, observation point, or the ground surface during drilling and/or grouting.

1.4.7 Compaction Grouting

Compaction grouting is a ground improvement technique that improves ground strength and/or stiffness by slow and controlled injection of a low-mobility grout. Expansion of the grout mass displaces and compacts the soil. Provided that the injection process progresses in a controlled fashion, the grout material remains as a growing mass within the ground and does not permeate or fracture the soil. This behavior enables consistent densification around the expanding grout mass, resulting in stiff inclusions of grout surrounded by soil of increased density. This technique is typically applied to loose fills and loose native soils with sufficient drainage to prevent buildup of excess pore pressures.

1.4.8 Compensation Grouting

Compensation Grouting is the introduction of fluid or semi-fluid grout into the ground, increasing the local volume at the point of injection. This in turn causes movement by expansion of ground away from the area of injection, either compensating for movement in the opposite sense or causing movement to accumulate in the direction of expansion. Two processes have traditionally been used in conjunction with excavation for underground structures: soil fracture grouting and compaction grouting. For this specification, only the compaction grouting and LMG method is addressed.

1.4.9 Effective Pressure

The sum of all head losses and head gains in the injection system and the ground.

1.4.10 Exploratory Hole

Exploratory holes are drilled, grouted, and backfilled to investigate subsurface conditions.

1.4.11 Final Set

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NOTE: Use ASTM C807 to determine the time of setting for hydraulic cement mortar using the modified vicat needle test. Use ASTM C403 to determine the time of setting by measuring the penetration resistance on mortar sieved from the concrete mixture.

****

A degree of stiffening of a grout mixture indicating the time in hours and minutes required to stiffen sufficiently to resist the penetration of a weighted test needle ASTM C403/C403M. Also called 'Final Set Time' or 'Time of Final Set'.

1.4.12 Grout Take

The volume of grout placed. This can be for a specific grout stage, specific grout hole, a grout line, or treatment interval for the entire job.

1.4.13 Grout Verification Hole

A grout verification hole is drilled to verify the grouting results at the conclusion of grouting. All holes in a section must have reached refusal before a verification hole is initiated.

1.4.14 Hydrofracture / Hydrofracturing

The fracturing of an underground stratum by pumping water, drilling fluid, air, or grout under a pressure in excess of the tensile strength and minor principal stress, rupturing or heaving the soil fabric.

1.4.15 Karst Topography

A type of landscape, typically underlain by limestone, dolomite or gypsum, that has been eroded by dissolution, generally characterized by underground drainage, closed depressions, sinkholes, ridges, towers, fissures, or other characteristic landforms.

1.4.16 Limited Mobility Grouting (LMG)

Injection of a relatively stiff grout designed to displace the surrounding soils. The grout does not travel far from the point of injection and is intended to become immobile when injection pressure ceases, forming a compact mass or inclusion in the ground. The grout mass may improve the surrounding soil during pressure-displacement, although may also serve other functions such as settlement mitigation of overlying structures or grades, mitigation of soil loss to underlying sinkholes or solution features, compensation of settlement due to underground construction, or consolidation of open-graded rubble.

1.4.17 Primary Hole

The first series of holes to be drilled and grouted, usually at the maximum allowable spacing. Grouting of primary holes in one section or other defined work area, is completed prior to secondary holes being drilled. Primary holes can sometimes be the initial perimeter and grided rows of grout holes used for confinement to aid in the grouting.

1.4.18 Refusal

The point during grout injection where little or no grout is accepted into a particular stage per the refusal criteria

1.4.19 Refusal Criteria

When conditions are met to stop grouting within a stage, hole, or other established treatment zone that may include parameters such as pressure, flow, volume, grout communication, ground movement, or a prescribed combination of criteria.

1.4.20 Restoration

The correction by repair or replacement of any structure or area damaged, removed, or altered by construction activities under this section.

1.4.21 Secondary Hole

The second series of holes to be drilled and grouted, spaced midway between previously grouted primary holes. Secondary holes must be completed in a section or other defined work area prior to drilling tertiary holes.

1.4.22 Section

For linear or perimeter grouting, A section is a reach along the grout lines, not more than [_____] meters [_____] feet in length in which grouting operations are not to be permitted at the same time that drilling is in progress. For pattern grouting, a section is a subordinate component of the pattern grouting job, typically rectangular or square in shape.

1.4.23 Split Space Criteria

The split space criteria applies whenever a hole or stage does not meet refusal criteria.[The split space criteria may be applied for occurrence of hole communication, fugitive grout, hole collapse, equipment failure, premature termination, or any other interruption of grouting activities.] The split space criteria may vary depending on the stage, zone, series, or grout line under consideration.

1.4.24 Split Spacing

****

NOTE: See note under Succeeding Series

****

Split spacing is the procedure of locating an additional grout hole midway between two previously drilled and grouted holes that failed to reach refusal pressure limits or otherwise meet split space critieria. For this specification, split-spaced holes are unplanned succeeding series holes necessary to achieve desired engineering outcome(s), such as filling voids or stabilizing soils.

1.4.25 Stage

A stage is one complete operational cycle of pressure grouting, within a pre-defined depth of the grout hole.

1.4.26 Succeeding Series

****

NOTE: The designer must define the grouting sequence in terms of succeeding series (primary, secondary, or tertiary holes) or some other prescribed sequence. Some grouting plans may have a grid of primary holes on a spacing of 10-20 feet and will then evaluate grout takes, pressures, and flow

rates to determine where additional split spaced holes will be placed. In these instances, clarify that additional holes will be directed by the Government rather than based on pre-determined split space criteria. It is suggested that that the scope of the grouting campaign be bounded to prevent cost over runs due to unnecessary split spacing of grout holes.
****

Each of the succeeding series of holes must be located based on the split space criteria beyond the tertiary holes, or as assigned by the Government. Succeeding series holes are located as needed to achieve the desired engineering outcome, such as filling voids or stabilizing soils.

1.4.27 Tertiary Hole

The third series of holes to be drilled and grouted, spaced midway between previously grouted primary and secondary holes. Grouting must be complete in a section or other defined work area before any succeeding series of holes are drilled.

1.4.28 Upstage Grouting

Upstage grouting involves drilling a grout hole to its final depth and grouting successive stages from the bottom upward.

1.4.29 Void Grouting

Void grouting is a grouting technique to fill specific voids in the subsurface [or below a structure]. A casing pipe is advanced to the bottom of the void and the grout is injected at specified flow rates and depths to fill the void and not damage the structure. The process primarily fills voids for the purpose of increasing structural support.

1.4.30 Zone

A pre-determined vertical subdivision of the overall depth of grout treatment defined in the Contract. A single zone may make up the full depth of treatment, or the depth of treatment may be divided into several zones.

1.5 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

LMG Work Plan; G, [_____]

Grout Mix Design; G, [_____]

Field QC Procedures; G, [_____]

Ground Movement Monitoring Plan; G, [_____]

Laboratory Accreditation; G, [_____]

Qualifications; G, [_____]

SD-03 Product Data

Drilling/Casing Installation Equipment

Grouting Equipment; G, [_____]

Automated Grouting Data Collection System (AGDCS); G, [_____]

SD-06 Test Reports

Daily Records; G, [_____]

Drilling Logs; G, [_____]

Grouting Records; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings And Grouting Profiles; G, [_____]

LMG Grouting Final Report; G, [_____]

1.6 DELIVERY, STORAGE, AND HANDLING

****

NOTE: There are two methods of LMG grout production, from a commercial (supplier not non-subcontractor) ready-mix plant, or for a specialty plant onsite. Commercial plants utilzed for LMG will be a case by case basis and must be coordianted for each project. The sections below apply to a dedicated batch plant. If a commercial plant is utilized, coordinate those requirements and add them to the bracketted area below.

Grouting constituent components may pose health hazards. Verify grout products meet local, state, and federal laws and regulation and that appropriate health and safety precautions are considered during design and implemented during construction

****

A sufficient quantity of [cement][cementitious material] and fine aggregate is to be stored at or near the site of the work to ensure that grouting operations are not delayed by shortage of LMG grout components. Provide a storage capacity for each constituent component sufficient to supply at least [1 week's][1 month's] volume of grouting materials so as not to interrupt the work in the event of delivery delays.

Store material in accordance with the manufacturer's recommendation. Protect all materials from inclement weather, including rain, snow, and freezing conditions. The use of suitable enclosures to prevent the degradation of the various materials prior to use is required. The cement can be delivered to the jobsite in bags or by bulk delivery. Store delivered bulk cement in appropriate silos or other containers specially designed for cement storage. Cement storage facilities are subject to the Contracting Officer's approval. Otherwise, only use cement furnished in fabric or paper bags.[In the event the cement is found to contain deleterious lumps, as determined by the Contracting Officer, either screening through a standard 1.18 mm No. 16 mesh screen, or replacement is required. No payment will be made for such screening or replacement of material.] The use of bulk cement is permitted if methods of handling, transporting, and storage are approved by the Contracting Officer in writing.

[

Ready-mix batching plants are available at [_____]. Hours of operation are limited and must be coordianted direclty with the supplier. Any deviations proposed from the specification requirements for delivery, storage, and handling must be included in the LMG Work Plan for approval.]

1.7 PROJECT AND SITE CONDITIONS

The grouting program detailed in the plans and specifications is based on currently available information. Examine the site conditions and available surface and subsurface data, including the boring logs, foundation plans, utility plans, and site plans to successfully prepare a suitable work plan to complete the work. Review site conditions and the objectives for the proposed work and propose any necessary changes as part of the work plan.

Once the work plan is approved, field changes to grout mixes, injection pressures, injection rates, and the sequence in which the holes are drilled and grouted will require approval from the Contracting Officer.

The grout hole locations and depths are based on available geotechnical and structural exploration data. Conditions encountered during construction may require adjustments to the grouting program. As the work progresses, re-evaluate the precise limits of the area to be grouted and the exact location and required depth of the individual grout holes to confirm the objectives for the proposed work are met. The Contracting Officer may move locations of proposed grout holes, change the proposed depths to be grouted, add new holes, or eliminate some of the proposed holes shown on the plans.

****

NOTE: Select the following paragraph as required based on the status of previous or planned investigations. Choose the bracket as appropriate.

****

[Previous investigations and soils information obtained from the project are provided in the following document appended to the plans and specifications [_____].]

[Perform any necessary site investigations required in the plans and specifications in accordance with EM 1110-1-1804.]

1.7.1 Permits and Approvals

****

NOTE: Coordinate with property owners, utility providers, facilities, and other stakeholders as necessary to understand potential risks to personal property underground utilities and infrastructure from grouting operations. NPDES and Water Quality Permitting are the responsibility of the Contractor.

****

Obtain necessary permits and approvals based on application, site conditions, and project scope in a manner that is in compliance with all local, state, and federal laws and regulations.

The following permits are [obtained by the Contractor] [provided by the Government]: National Pollutant Discharge Elimination System (NPDES), [401 Water Quality], [_____].

1.7.2 Underground Utilities

Prior to the submission of the Drilling and Grouting Work Plan, verify the location, type, diameter, and depth of all underground utility lines in the work area. Mark utility information on the ground surface prior to the onset of drilling. Determine and comply with any additional underground utility location, marking and/or potholing requirements by local jurisdictional agencies. Notify the Contracting Officer of any conflicts between the underground utility lines and the approved LMG Work Plan.

1.8 QUALIFICATIONS

****

NOTE: The minimum acceptable level of experience is typically considered to be 5 years or 3 projects.

If grouting is scheduled for 2 shifts or allowed to run 2 shifts, there should be a requirement for one of these persons for each shift.

This guide spec has a PE/PG requirement, but experienced EITs and GITs may provide adequate oversight, with enough experience, on lower-risk jobs.

The qualifications for a grouting lead is a risk decision. For sensitive structures, more experience may be needed than on a simple job with no structure (yet) or a shallow structure. This requirement may be deleted for smaller grout jobs.

The 'Grouting Specialist' is sufficient on small jobs (1-2 drills), but on larger jobs, a 'grouting foreman' may be required.

****

Meet the following criteria.

a. The grouting program, including installation of grout pipes, must be performed by a specialty grouting contractor with at least [five years] [3 projects] of documented successful experience. Provide a project list that includedees a description of the project, relative size, and customer point of contact for the work.

b. Include resumes for the [Lead Grouting Professional Engineer/Professional Geologist,] Grouting Manager, Licensed Surveyor, and Grouting Foreman meeting the following requirements:

[(1) A Lead Grouting Professional Engineer/Geologist currently licensed in the State of [_____]. Required experience includes work on at least three projects where they successfully supervised similar grouting applications, and performed responsible supervision of ground treatment execution. The professional must have [3] years of experience over the past [10] years.[The Professional must have equivalent engineering and construction experience specific to drilling and grouting, including a minimum of 6 months of full-time field experience.] Provide complete documentation of applicable experience. This professional will be responsible for signing and stamping drawings, computations, and reports.

] (2) A Grouting Manager is full-time, on-site, and whose duties are limited to responsibility for LMG operations. Required experience includes at least [3] years of experience in the successful design and/or construction of LMG grouting technology similar to the requirements specified for this project, including a minimum of 6 months of full-time field experience. Provide complete documentation of applicable experience.

(3) A surveyor licensed in the state of [_____]. The surveyor must

establish temporary benchmarks, establish the ground monitoring system, provide input on the ground monitoring plan submittal, and check ground monitoring stations at least once a week, or when ground movement exceeds the limits established in the paragraph GROUND MOVEMENT MONITORING PLAN.[No prior experience with LMG is required.]

(4) A grouting foreman with at least [6][3] months of full-time, onsite experience with LMG grouting. When LMG grouting is in progress, the foreman is a full-time duty limited to grouting operations.[Provide documentation of applicable experience.]

1.9 LMG WORK PLAN

****

NOTE: Provide the subsurface information to the Contractor and allow flexibility for variations in the submitted work plan based on the Contractor's experience and site-specific conditions. Remain flexible during construction to balance contract administration with the need to adjust the grouting operations to effectively achieve the project goals.

****

At least [30][45][60] days prior to the commencement of drilling grout holes, submit the LMG Work Plan that includes but is not limited to details of the following:

a. Statement of proposed sequence of operations to include the type of LMG grout proposed, schematics of the site layout, hole sequence, hole naming convention in narrative form, and pertinent shop drawings. Detail step-by-step procedures for drilling methods, equipment, hole spacing, hole location, hole depth and grout injection operations. Include a synopsis for all proposed stage termination criteria.

   1. Include work schedules and production hours.

   2. Include theoretic quantities for a typical grout stage and a typical grout hole based on proposed pressure, flow, and volume criteria.

   3. Provide a general plan and description of proposed grout monitoring operations.

   4. Dimensionally reference grout hole locations to features on the Contract Drawings.

   5. Provide copies of proposed drilling and grouting record forms.

   6. Include work schedules and production hours.

b. A list, description, specifications, and technical data for all grouting equipment proposed for use, including but not limited to: mixers, grout pumps, delivery lines, gauges, instruments, and appurtenances. Include the make, model, year manufactured, and general condition of each item. If items are to be rented, submit written verification that the unit is available from the renter.

c. A list, description, specifications, and technical data for all drilling & casing equipment proposed for use, including the drilling mechanism (top-hammer, downhole-hammer, non-hammer rotary, sonic, etc.) and the type of drilling fluids proposed [including air]. If separate casing oscillators are proposed, include details. Include information on the type of casing proposed including inner or outer diameter, thickness, material composition, and the connection type between casing segments. Include the make, model, year manufactured, and general condition for drills, casing installers or removers, and casing. Note whether the Contractor has prior successful experience with this specific equipment or not.

d. Proposed methods to obtain and record grout monitoring data and copies of proposed monitoring data forms.[Details, technical specifications, and capabilities for the Automated Grouting Data Collection System (AGDCS).]

****

NOTE: AGDCS should only be required for large, complex jobs and may be deleted for low budget and smaller jobs.

****

e. A completed example for a daily report to be used for this LMG project.

f. A description of the casing and casing withdrawal system to be used, including a review of previous experience in the use of such casing in similar soils and to similar depths as the contemplated project.

g. Methods and equipment for calibrating the proportioning of the grout constituents, grout quantity pumped, and pumping rate.

h. Grout material sources, including grain-size distributions of the course & fine aggregate, Plasticity Index (PI) values [and hydrometer test results] of the fine aggregates to be used in the proposed mix design.

i. A description of all survey equipment and survey monitoring instruments to be used for the Ground Movement Monitoring Plan.

j. Names and qualification statements for all personnel who will be working on the drilling, grouting, and monitoring operations. Include all drillers, mixer and pump operators, grout header technicians, and monitoring personnel. List the previous LMG work experience (if any) of each employee. Meet the requirements for Paragraph QUALIFICATIONS for quality control personnel.

1.10 GROUND MOVEMENT MONITORING PLAN

****

NOTE: Utilities and allowable displacements must be determined as part of the design through coordination with local utility providers, owners, and regulatory agencies.

Change survey requirements based on the sensitivity of the job. In some cases detection of movement may

not be necessary, and in others it may be paramount. Requirements such as frequency and magnitude should be considered for addition here. Ensure the allowed equipment is capable of measuring the ground movement required by the specification.

This guide specification has limits of 1.6mm, 1/16 inch for vertical movement. Detecting the same horizontal limits are possible, but require a total station. Survey points can be used to detect horizontal movement more economically, and can be checked periodically as needed. The author must determine the resolution needed for the ground survey. Add these requirements if horizontal movement detection is necessary for your work.

****

Provide instrumentation to detect any movement of the ground surface in accordance with the project threshold and action limits. Provide monitoring devices capable of detecting movements of [1.6][_____] mm [1/16][_____] inch for any structure identified within [9 meters][30 feet].

The vertical instrumentation may include, but is not limited to, string lines, telltales, manometers, lasers, tiltmeters, and optical devices. Provide surveyor's instruments in such quantity as to allow evaluation of all structures' movements and ground heave. Provide backup surveyor instruments in such quantity as to allow evaluation of movement without needing to move the instruments during injection. Establish all structures' original positions before grout injection by placing suitable markings or targets thereon.

The licensed professional surveyor for the project must provide input and sign the Ground Movement Monitoring Plan. Assign experienced and fully qualified personnel to monitor the instrumentation to prevent any damage to the site or structures. Repair or replace any damage that occurs because of insufficient instrumentation or monitoring effort at no cost to the Government.

1.11 RESTRICTIONS

****

NOTE: List any restrictions to the working area, means and methods, or other site constraints. Delete any unneeded examples or brackets. Tailor to the project.

****

Notify the Contracting Officer each day prior to commencement of any grouting operations.[Perform all work in the presence of the Contracting Officer.][No LMG hole may be pressure grouted within [6 meters 20 feet] or 24 hours of another LMG hole being pressure grouted.][No grouting work may commence[between the following][dates,][times,][weather conditions] without written approval from the Contracting Officer.][Access the site from [street][access point][pier][dock][_____] as shown on the plans.][Special restrictions exist at the project which limit the use of [diesel equipment,] [gasoline equipment,] [electrical equipment] [_____].]

1.12 LABORATORY ACCREDITATION

Provide laboratories submitting testing results for this contract accredited by Engineering Regulation ER 1110-1-8100. Submit written proof of accreditation for each laboratory utilized. Submit accreditation renewal prior to the expiration if the accreditation expires during the contract period. Each laboratory will be submitted separately.

PART 2 PRODUCTS

2.1 GROUT MIX DESIGN

****

NOTE: Section GROUT MIX DESIGN applies to the general grouting submittal. Additional requirements that are part of this submittal are in brackets in the proceeding sections based on whether solution or cementitious grout is preferred.

There could be situations where the same supplies are used as a previous job, so that previous testing could be directly applied to the new job. The bracketed paragraph addresses this.

While this guide spec had a maximum slump of 50mm/2 inches, there may be special circumstances where higher slumps could be utilized. These include cap grouting and Karst grouting.

****

Submit mix design(s) for the project at least [30][60] days prior to the start of work. Detail the types of grout materials and source suppliers. Include mix proportions, and material test data[from previous projects] including compressive strength. Contracting Officer to approve the grout mixes prior to use. After initial approval, obtain the Contracting Officer's approval for any future changes recommended by the Contractor based on an evaluation of grout takes, site conditions, pumpability, or grout mix component availability.

[

When the Contractor is proposing the same mix design(s), using the same suppliers and gradations of coarse aggregate, fine aggregate, cement, and additives, as a job within the last 2 years, the Contractor may propose the same mix without re-testing that mix. Provide mix design testing mix QC test data collected from the prior job.]

a. Design a grout mixture consisting of cement, water, aggregate, and any necessary additive(s). Slump not to exceed [50] mm [2] inches when measured by the ASTM C143/C143M slump test cone. Either Portland Cement or Blended Hydraulic Cement is an acceptable source of cement.

****

NOTE: Typical LMG jobs may utilize a minimum of 10-percent cement. As little as 5-percent portland cement may work when sufficient silt aggregate is present in the mix and LMG strength is not a major concern.

****

b. Use a minimum of [10][5][_____]% cement by weight of the aggregate. Include the dry weight for each solid component and the weight of water used on a per cubic metercubic yard basis.

****
NOTE: The ASCE Consensus Guide to LMG states: "Grout strength is usually not a factor where compaction is the objective, although the grout usually provides some additional support because its strength is typically greater than that of the surrounding soil. Structural applications of this kind of grouting fall into the larger classification of limited-mobility displacement grouting, which is beyond the scope of this document. For compaction grouting the grout’s strength at the completion of injection need only match that of the improved soil. Strength beyond that of the surrounding soil is neglected in evaluating compaction grouting effectiveness." The ASCE Consensus guide also states; "A common requirement for compressive strength is 700 kN/m2 (100 lb/in.2)." Therefore, the LMG strength should be tied to the soil strength, unless higher strengths are desired. Tests. Strengths should generally not exceed 500 psi.
****

c. Provide a minimum grout unconfined compressive strength of [_____][700]kPa [_____][100] psi when tested in accordance with the requirements of ASTM D4832/D4832M.

d. Do not use additives such as concrete pumping aids, gums, gelling agents, organic matter, or similar materials. Bentonite may be used in specific circumstances, but only with prior approval from the Contracting Officer's.

2.1.1 Portland Cement

Meet the requirements of ASTM C150/C150M. Include the source(s) of cement, [3 months][6 months] of mill tests, and an ASTM C150/C150M compliance certificate in the Grout Mix Design Submittal. Provide monthly after approval.

2.1.2 Blended Hydraulic Cement

****
NOTE: Blended hydraulic cements are becoming more common, and in some areas, the only cement products that are available. The industry will continue to grow and develop new cement products to limit the carbon footprint by the industry. Alternate mix designs may be acceptable if field demonstrated to meet the intent of the design.
****

Conform to ASTM C595/C595M which recognizes four types of blended cements: Type IS (X), Type IP (X), Type IL (X), and Type IT. The "X" in the name refers to the percentage of secondary ingredient in the blend. Type IS (X) has slag as the secondary component, Type IP (X) has pozzolan, typically fly ash, as the secondary component. Type IL cement has limestone as the secondary component, and Type IT(PX)(PY) has two types of pozzolans. For example, Type IP (15) would contain 15-percent pozzolan. All four types of blended cements are permissible for use in grout.[Verify fresh and hardened grout properties through trial batching and field demonstrations.] Test blended cement with limestone to determine the chemical composition of the lime using ASTM C1797. Include the source(s) of cement, [3 months][6 months] of mill tests, and an ASTM C595/C595M compliance certificate in the Grout Mix Design submittal. Provide monthly after approval.

2.1.3 Mixing Water

Provide water free of excessive salts and other impurities that adversely affect the set or hydration of the cement in the grout mixture, as specified by ASTM C1602/C1602M.

2.1.4 Pozzolans

Transport, handle, and store all pozzolans so as to avoid damage, waste, or absorption of moisture.

a. Provide fly ash [or other raw or calcined natural pozzolans], if used, conforming to ASTM C618. Fly ash may be furnished in paper sacks or in bulk.

b. Provide ground-Granulated Blast Furnace Slag (GGBFS), if used, conforming to ASTM C989/C989M, [Grade 100][Grade 120].

c. Provide Silica Fume, if used, conforming to ASTM C1240. Pelletized silica fume is not permitted for use.

2.1.5 Admixtures

****

NOTE: For USACE projects the bracketed text in subpart b should be included.

Avoid specifying the use of air entrainment, except on rare occasions when grout may be exposed to severe freezing and thawing conditions.

Many admixtures and viscosity modifiers may be detrimental to LMG performance based on the application (compaction grouting). These products should generally not be used.

****

Ship, handle, and store materials to prevent deterioration, contamination, damage, or waste. Reject and replace any admixtures allowed to freeze without cost to the Government. Add admixtures to the grout immediately before or during mixing. Provide admixtures compatible with other components of the grout and that do not inhibit the grout's intended rheological properties, which are designed to limit the grout's mobility. Alternatives may be proposed as part of the work plan. Obtain approval from the Contracting Officer for any deviations from the work plan. No time extension will be given by the Government for review time required due to submitted alternative materials.

a. Provide Water Reducing Admixtures, if used, meeting the requirements of

ASTM C494/C494M, type A.

b. Provide Retarders, if used, meeting the requirements of ASTM C494/C494M, Type B.

2.1.6 Fine Aggregate

Provide grout aggregate consisting of naturally occurring, round-grained materials conforming to the grain-size distribution shown in the envelope in Figure A-1 of ASCE 53-19 from the Compaction Grouting Consensus Guide. Limit the inclusion of clay-size particles in the aggregate to 5% by mass (see Figure A-1 from the Compaction Grouting Consensus Guide). Ensure the portion of the aggregate passing a No. 40 sieve has a plasticity index (PI) of 15 or less when tested in accordance with ASTM D4318. Where gradations that meet Figure A-1 of ASCE 53-19 from the Compaction Grouting Consensus Guide are not available in a geographic area, the Contractor may propose by submittal an alternate fine aggregate gradation that will be subject to satisfactory performance. The gradation will be as close to Figure A-1 as economically possible with satisfactory performance in at least two Contractor-provided test LMG holes that are either cored or exposed by excavation.

[2.2 CONTAINMENT BARRIERS

****

NOTE: If containment barriers are required to prevent unwanted grout loss, either include this requirement in the Drilling and Grouting Work Plan to be submitted by the Contractor or add site specific provisions in this paragraph.

****

Provide grout-containment barriers of a material and design such that they will restrict the escape of grout[into the body of water].[Provide forms, if used, of sufficient strength and design to contain the grout materials. Barriers may be constructed of wood, steel, impermeable geotextile, or other material accepted by the Contracting Officer, and may be single-use or reusable.] Remove barriers upon completion of the work, unless otherwise approved by the Contracting Officer. Do not perform grouting within 8 meters 25 feet of the leading edge of barriers.

]PART 3 EXECUTION

3.1 DRILLING/CASING INSTALLATION EQUIPMENT

****

NOTE: Hole spacing will depend on grouting technique, grout materials, and the properties of the soils being grouted. In general primary hole spacing will vary from; 2.5-3.5 meters 7-10 feet.

Holes can be drilled with temporary casing or holes can be advanced with probes and lances that are vibrated or driven into the ground. Both methods result in a cased hole that is sufficient for grout injection.

****

The grout holes are produced either by drilling, driving a temporarily plugged casing, or by a probe/lance. Advance grouting lances and probes, both of which are considered casing, using driven/vibratory methods that allow for drilling and grouting to occur. The term drilling herein includes driving methods for casing placement. Provide a method capable of penetrating rocks and other obstructions. Regardless of the method used, provide casing in tight, intimate contact with the resulting hole’s surrounding soil so that it is held firmly in place and resists ejection from the grout pressure and/or leakage of grout around the perimeter.

Provide casing with a minimum of 45 mm 1 3/4 inch and a maximum of 150 mm 6 inch internal diameter that possess sufficient strength to withstand the drilling and driving, grout injection, and withdrawal forces required for the work. Provide casing with flush joints on both the interior and exterior surfaces that are threaded or welded. Install all casing as approved in the LMG Work Plan. Casing is considered temporary unless otherwise approved by the Contracting Officer in writing. Provide a casing withdrawal system capable of withdrawing the casing in the required stages under both normal and extraordinary conditions during grouting. Replace any hole lost because of the Contractor's inability to pull the casing with a new hole at the Contractor's expense. Report all lost drilling steel, drill rods, or casing to the Contracting Officer and document in the final reports and as-built drawings.

****

NOTE: Remnants of many drilling fluids, especially mud, can result in hydraulic fracturing of the soil and loss of control of the grout injection when pressurized by the grout. Compressed air has often caused fracturing and raised the ground surface for about a 3 m (10 ft) radius around the hole.

****

The Contracting Officer may require or prohibit injection of water into the drilled holes in addition to any remnant water from the drill circulation, depending on the exact soil conditions encountered. Accomplish circulation flush with [air] water or air-water foam.[The use of other drilling fluids is subject to the Contracting Officer's approval.] Capture and direct water or other circulation media to an approved disposal location. Ponding of uncontrolled drilling flush or wastewater in the work area is not permitted.[Use settling tanks or other devices to separate drill cuttings and other solids from the water.]

3.1.1 Hole Location and Alignment

Indicate hole locations, alignments, orientations, and tolerances in the LMG Work Plan. The exact location, depth, and spacing of the grout holes are subject to change, as directed by the Government during execution of the grouting program. Provide the proper devices to horizontally and vertically align the drilling rigs and injection pipes within the specified tolerances. Provide grout holes within [_____][2] degrees of vertical. Contact the Contracting Officer prior to drilling if adjustments in location are required to avoid utilities or due to accessibility.

3.2 GROUTING EQUIPMENT

Provide grouting equipment of a type, capacity, and mechanical condition suitable for performing the work, as determined by the Contracting

Officer. Provide equipment capable of advancing the grout pipe through overburden soils and other obstructions to the specified depth or as required to meet the project objectives.

3.2.1 Grout Plant

Provide a grout mixing system capable of precisely proportioning, mixing, and blending the mix constituents into a homogeneous grout of uniform consistency and in sufficient quantity, without interruption. Any grout hole that is lost or damaged due to mechanical failure of equipment or inadequacy of grout supply is required to be replaced by another hole drilled and grouted at the Contractor's expense. Provide equipment capable of allowing for changes to slump between batches and real-time changes to grout pressure during grouting, as needed in the field.

3.2.2 Grout Mixing

Mix grout in accordance with the approved LMG Work Plan and the approved mix design. Automatic volumetric proportioning and mixing systems that comply with the requirements of ASTM C685/C685M and/or ACI 304R are acceptable. Where used, calibrate automatic metering systems in the presence of the Contracting Officer before grout injection begins, and as directed. Provide properly calibrated volumetric containers and scales. Batch-type mixers may be used subject to provision of an accurate means of proportioning the individual grout constituents.[The use of ready mix grout is permitted.]

3.2.3 Grout Pump

Provide a positive displacement piston type grout pump with a stroke volume not to exceed 0.38 cubic meters 0.5 cy. Provide a grout pump capable of pumping low to zero slump grout at variable rates of 5 to 55 lit/min 0.2 to 2 cfm and at continuous pressures as high as 7,000 kPa 1,000 psi. Operate the pump in accordance with the specification and approved work plan. Provide a remote off-on control for the pump at the grout injection point.

Provide an accurate system to measure the quantity of grout pumped at any time interval. Perform a pump calibration in the presence of the Contracting Officer [daily][weekly] and when a new pump is brought to the site. Additionally, calibrate the grout volume-measuring system if short-stroking, if there is a change in the grout pumping rate, upon replacement of wear parts, or at any time by the direction of the Contracting Officer. Short stroking of the pump is not allowed, and any grout pumped during such malfunctions is at the Contractor's expense.

3.2.4 Grout Delivery Lines

Provide a grout delivery line consisting of high-pressure flexible hose or a combination of hose and rigid pipeline that is watertight under pressure and a maximum of 100 mm4 inches in diameter. Provide components of the delivery line, including coupling clamps, in good condition and capable of handling the pumping pressures to be used with a minimum safety factor of 2. Perform a pressure test of the delivery line to confirm its conformance herewith as required by the Contracting Officer. Secure connections with high pressure hoses with a safety lashing/whip.

3.2.5 Grout Gauges and Instruments

Install pressure gauges at the grout pump and at the grout header (top of the hole casing) to monitor the maximum pressure in the grout line. Provide gauges that are accurate and in good working order. Protect gauges from grout intrusion by suitable gauge protectors. Provide gauges with a minimum dial diameter of 75 mm 3 in, and a maximum pressure range be not greater than 150 percent of the anticipated maximum grout pressure. Provide [2][_____] spare pressure gauges at the jobsite. Replace any gauge of questionable accuracy promptly.[Install an appropriate flow measuring device in the grout line to measure grout volume pumped within accuracy of plus or minus 2 percent.]

3.3 GROUT PLACEMENT

****

NOTE: USACE Requirement: Do not use high pressures for grouting near dams. If grouting in or within 61 meters 200 feet of a dam, or close enough for the proposed pressures to result in harm to a dam, adherence to Engineering Regulation 1110-2-1807 is required. Increase the minimum offset as prudent to protect the structure.

Upstage grouting is typically (but not always) the preferred method. Downstaging is sometimes used to enhance confinement or to allow better control of uplift (such as in the case of compensation grouting)or to control fugitive grout. However, down-stage grout techniques are time-intensive and typically involve removal and re-installation of grout casing, often after previous stages have achieved initial set. A combination of methods may be necessary to meet the designer's purpose. Inexperienced designers should consult with industry experts or an experienced A/E before methods are specified to avoid recommending unnecessarily complicated procedures.

****

Confirm the actual depth of the open grout hole with a properly weighted measuring tape immediately before connection of the grout delivery line. Record the measured depth. Redrill the grout hole to the proper depth before grouting if the measured hole depth is not sufficient to allow grouting at the target depth. The Government may modify the sequence in which the holes are drilled and grouted. Inject holes located on or near a downslope of the treatment area, or near a retaining wall or structure foundation element, before holes that are farther from the outer edge of the treatment area. Provide access to the mixing, pumping, and injection locations to the Contractor Officer at all times. Inject holes in ascending stages, starting at the bottom and working upward. No stage can be injected until the immediate underlying stage has been completed. Provide individual stage lengths a minimum of 0.3 m 1 foot and a maximum of 0.6 m 2 feet. Stage lengths may be changed with prior approval from the Contracting Officer.

Backfill and replace at no cost to the Government any grout hole that:

1. Is lost or damaged;

2. Does not reach the design depth; or

3. Is not continuously grouted as a result of equipment deficiencies or mechanical failure; inadequate control of the grout pipe (including allowing the grout pipe to be expelled from the hole because of insufficient restraint); inadequacy of the grout mix; or improper drilling, mixing, or injection procedures.

The termination criteria is as identified in the following sections, or as directed by the Government. Injection rates are subject to change based on in-situ conditions.

3.3.1 LMG Termination Criteria In Cohesionless Soil

****

NOTE: Adjust the LMG termination criteria below to best suit the grouting application and project objectives. That is, adjust any or all numbers to best suit the engineering application this specification is trying to address. If there are concerns for hydrofracture, establish safe methods for drilling and grout placement, and calculate safe grouting pressures.

****

Discontinue grout injection into any stage of any grout hole if so directed by the Contracting Officer. Measure refusal pressures when injecting grout at the approved injection rates. General refusal criteria include any one of the following:

a. Pumping at a header pressure of [_____][1.0][1.8][3.5] MPa [_____][150][250][500] psi, except for the initial pressure that may be required to initiate grout flow when starting a new hole.

b. Sustained pumping at a header pressure of [_____][1.0][1.8][3.5] MPa [_____][150][250][500] psi or greater for a period of more than [30][60] seconds.

c. Maximum flow rate exceeding 0.0566 cubic meters per minute 2 cubic feet per minute (cfm). Consistent flow rate required through each hole.

d. A grout volume of [0.566][_____] cubic meters [20][_____] cubic feet has been injected in a stage.

e. Unwanted displacement of an adjacent structure of greater than 3 mm 1/8 in occurs.

f. Unwanted displacement of the ground surface of more than 1.6 mm 1/16 in occurs during a grout stage.

g. Grout communication to the ground surface.

All refusal criteria may be field adjusted with written approval by the Contracting Officer.

[3.3.2 LMG Termination Criteria in Clay Soils and Karst

****

NOTE: Cap grouting is a variation of compaction grouting where a special first stage, typically 2 feet thick, is placed above the top of rock. The interface is grouted at high pressures and with higher theoretical volumes and flow rates than typical LMG. This method is most prevalent for the treatment of karst. Delete the bracketed text for projects where cap grouting is not required. If there are concerns for hydrofracture, establish safe methods for drilling and grout placement, and calculate safe grouting pressures.

****

All refusal criteria may be field adjusted with written approval by the Contracting Officer. Upstage grout LMG grout holes. Do not inject a stage until the immediate underlying stage has been completed. Individual stage lengths will be a minimum of 30 cm 1 foot and maximum of 1.5 meters 5 feet. Discontinue grout injection into any stage of any grout hole if so directed by the Contracting Officer. Measure refusal pressures when injecting grout at the approved injection rates.

a. Refusal Pressure:

1. Deep Grouting: (10 meters 30 feet): Terminate when the sustained pumping pressure at the header reaches [_____][2.8] MPa [_____][400] psi.[Field adjust termination max pressure based on test holes.]

2. Shallow Grouting: (5-10 meters 15-30 feet): Terminate when the sustained pumping pressure at the header reaches [_____] [2.1] MPa [_____] [300] psi. [Field adjust refusal pressure based on test holes.]

3. Near Surface Grouting: (0-5 meters 0-15 feet): Terminate when the sustained pumping pressure at the header reaches [1.4 MPa][_____] [200][_____]psi.[Field adjust refusal pressure based on test holes.]

b. Flow Rate:

1. Deep Grouting: Limit maximum flow rate to [.05][.1][_____] cubic meter per minute [2][4][_____] cubic feet per minute (cfm). Provide consistent flow rate through each hole.

2. Shallow Grouting: Limit maximum flow rate to [.05][_____] cubic meter per minute [2][_____] cubic feet per minute (cfm). Provide consistent flow rate through each hole.

c. A grout volume of [0.566][_____] cubic meters [20][_____] cubic feet has been injected in a stage.

d. Unwanted displacement of an adjacent structure of greater than 3 mm 1/8 inch occurs.

e. Unwanted displacement of the ground surface of more than 1.6 mm 1/16 inch occurs during a grout stage.

f. Grout communication to the ground surface.

All refusal criteria may be field adjusted with written approval by the Contracting Officer.

][3.3.3 Cap Grouting

****

NOTE: Cap grouting is a variation of limited-mobility grouting in clay soils where a special first stage, typically 2 feet thick, is placed above the top of rock. The interface is grouted at high pressures and with higher theoretical volumes and flow rates than typical LMG. This method is most prevalent for the treatment of karst. In some instances, cap grouting holes may drill deeper below the soft interface zone to make sure they are penetrating boulder and weathered rock and may not be the lowest zone. Delete the bracketed text for projects where cap grouting is not required.

****

General refusal criteria is met when any one of the following occur:

a. Refusal Pressure:

[1. If bedrock is encountered at depths less than 4.5 meters 15 feet, terminate when the sustained pumping pressure at the header reaches [1][_____] MPa [150][_____] psi.]

2. If bedrock is encountered at depths greater than 4.5 meters 15 feet, terminate when the sustained pumping pressure at the header reaches [2.8][_____] MPa [400][_____] psi.[Field adjust refusal pressure based on test holes.]

b. Flow Rate: Limit maximum flow rate to [0.0566][0.1] cubic meters per minute [2][4] cubic feet per minute (cfm). Provide consistent flow rate through each hole.

c. A grout volume of [0.76][_____] cubic meters [27][_____] cubic feet has been injected in a stage.

d. A grout volume of [0.566][_____] cubic meters [20][_____] cubic feet has been injected in a stage.

e. Unwanted displacement of an adjacent structure of greater than 3 mm 1/8 in. occurs.

f. Unwanted displacement of the ground surface of more than1.6 mm 1/16 in occurs during a grout stage.

g. Grout communication to the ground surface.

All refusal criteria may be field adjusted with written approval by the Contracting Officer.

]3.3.4 Ground Movement Monitoring

Comply with paragraph GROUND MOVEMENT MONITORING PLAN, as approved. Assign experienced and fully qualified personnel to monitor the instrumentation to prevent any damage to the site or structures. Repair or replace at no cost to the Government any damage that occurs because of insufficient instrumentation or monitoring effort.

[3.4 DEMONSTRATION SECTION

****

NOTE: A demonstration section (test section) is not always required, but is usually recommended, except for the very smallest jobs. The designer needs to determine a nearby analog for the site that is suitable for demonstration. LMG columns can be: a) dug up, b) drilled through, or c) drilled nearby with a CPT rig, to determine grouting effectiveness.

****

After the LMG Work Plan is submitted, and at least [7][14][30] days prior to initiating work, complete a demonstration section meeting the following requirements:

a. Verify the subsurface material characteristics and determine the suitability of the proposed mix designs. Advance [Standard Penetration Testing (SPT)][Cone Penetrometer Testing (CPT)][geophysical testing] for the full depth of the hole.

b. Demonstrate capabilities of proposed personnel, equipment, and materials.

c. Refine methodology and equipment; technical approach; and grout mix designs based on performance.

d. Demonstrate methods are effective at accomplishing the scope to [fill voids][densify][strengthen][stabilize][_____] .

e. Demonstrate the compatibility of the proposed materials, including water source, equipment, and personnel to complete the work.

[

f. Demonstrate protocols to protect the integrity of the structure against construction induced damage. Demonstrate emergency procedures if damage occurs.]

]3.5 GROUT MONITORING

Obtain approval by the Contracting Officer for the type and location of gauges in the LMG Work Plan. Provide certified pressure gauges submitted under the Grouting Equipment submittal with accuracy to within plus or minus 5 percent. Where used, locate the primary pressure transducer at the grout header immediately above the top of the casing. Provide a communication system that allows immediate voice contact among the people at the grout hole, the pump operator, and monitoring personnel. Repair or replace at no cost to the Government any damage that occurs as a result of lack of immediate communication. Monitor the following items:

a. The rate of grout take during grout injection. Determine the cause of sudden drops in grout injection pressures following initial start-up pressure adjustments.

b. Grout flow rate during all grout injection. If using a flowmeter, use one compatible with the LMG rheology. Provide pressure gauges at the pump and at the grout pipe head to measure pressure.

[

c. Periodically monitor paved areas and the ground surface adjacent to the grouting site for grout leakage. In the event that grout leaks are observed, temporarily terminate injection, and plug leaks before resuming pumping.]

[

d. [_____]]

3.5.1 Grout Data Logger

At a minimum, record continual plots of pressure and injection rate in a time domain. Record data in a format compatible with contemporary spreadsheet software, such as Microsoft Excel. Supply data to the Contracting Officer in digital, and when requested, printed form.

[3.5.2 Automated Grouting Data Collection System (AGDCS)

****

NOTE: NOTE: Automated grouting data collection systems are becoming more prevalent and may be options for large jobs where a lot of data is generated in a short period of time. For small jobs or non-sensitive jobs, it may not represent a value-added. All provisions of this section apply to the submittal.

****

Provide, set up, maintain, and operate the AGDCS. Utilize the system during all grouting operations. Include in the AGDCS all necessary equipment, materials, computer hardware, and software to direct grouting operations in accordance with these specifications. Collect and display digital data [in real-time]. Ensure the system is capable of producing data in hard copy and digital formats. Perform manufacturer's recommended calibration of any AGDCS equipment utilized and provide initial and periodic records in the AGDCS submittal.

3.5.2.1 AGDCS Equipment Capabilities

Provide AGDCS capable of the following:

a. Monitoring and recording all grouting including but not limited to mix type, [line losses], pressure, volume, and flow rates.

b. Continuously monitoring the grouting operation without interference or interruption to the grout injection process while grouting a stage when a mix change is warranted.

c. Listing cumulative drilling and grouting issues including, but not limited, to lost tooling, hole communications, rod drops, etc.

d. Correcting and reducing the collected data to account for correction factors and field parameters (pressure head losses, pressure measurements, actual depth of the stage being grouted, etc.)

[

e. Exporting raw data files into a non-proprietary file format and producing tabular digital records as specified in Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION, paragraph DATA

REQUIREMENTS.]

f. Producing graphs in Microsoft Excel format. Propose specific reporting graph design and the use of other file formats within the AGDCS submittal.

g. Graphically displaying in real-time, recording, and plotting, the following at a minimum:

(1) Plots of flow versus time and maximum pressure versus time in any stage;

(2) Start and stop times of grout injection;

(3) The time, type, and volume of a particular grout mix for the full duration of the grouting;

(4) The entire grouting record for the stage versus time, organized and combined by grout hole[;][.]

[

(5) A consistent time scale plotted on real-time plots.]

3.5.2.2 Automated Grouting Data Collection System (AGDCS Submittal

Include the following information about the automated grouting data collection system in the submittal:

a. System name and manufacturer.

b. The calculations for determining stage pressure for conversion into both total and effective pressures. Obtain groundwater measurements from boreholes prior to grouting.

c. Describe the process for data input to the system.

d. Describe the process for data storage for all generated data, including but not limited to grouting, testing, or other required processes.

e. Describe the data visualization (e.g., GIS mapping, CAD profiles, and plots) methodology, including any data transformations.

f. Describe methodology used for export of data to [Excel Spreadsheets] [Enterprise Database].

g. Data backup process used to ensure no data loss occurs.

h. Screenshots of raw data format and typical plots.

i. Example grout log showing change in mix type.

]3.6 FIELD QC PROCEDURES

****

NOTE: This guide spec contains only three types of testing, slump testing, and compressive strength testing and grout quantity verification (including unit weight determination). More testing could be required, but these are the only types of testing

typically utilized in normal LMG jobs.

Often in soil improvement projects a pre and post CPT or SPT can be used to verify ground improvement. Consideration to whether this is necessary should be considered. If it is determined to be necessary, follow UFGS guide specification 02 32 13 Subsurface Drilling And Sampling.

In paragraph 1, select the most appropriate bracket for QA/QC required for your project.

****

Only conduct LMG operations in the presence of the Contractor's approved staff [and the Contracting Officer].[Notify the Contracting Officer prior to beginning LMG operations each work day.] Perform the following tests:

a. Modified Slump Testing: Perform slump testing in accordance with ASTM C143/C143M, except the Contractor is not required to rod the mix. Tapping the sides of the cylinder during filling instead of rodding is permitted. The slump test results must be within the requirements approved in Section "Grout Mix Design". Modified Slump tests are to be performed at least twice per dayshift, and at the request of the Contracting Officer. Additional slump tests are to be performed for any change in the mix design.

****

NOTE: Following the ASTM Method for slump testing utilizes rodding of the mix. This rodding will introduce air pockets into LMG mixes. This causes problems, as described at the beginning of the Chapter 3 of the ASCE Compaction Grouting Consensus Guide. Consideration should be given to directing that the slump testing should exclude the rodding during slump testing.

****

b. Strength Testing: Cast minimum size 7.5 cm by 15 cm 3 inch by 6 inch grout test cylinders or 15 cm by 30 cm 6 inch by 12 inch test cylinders for strength testing. One set of two cylinders or molds will be cast [during each slump test] [daily]. Both samples will be tested at [3][7] days in accordance with ASTM D4832/D4832M. Water can be added as long as the specified mix properties are met. If water is added to the mix after strength cylinders are cast, the Contractor will be required to cast 1 additional cylinder each time water is added to the mix.

c. Grout Set Time: Set Time is between 12-24 hours in accordance with ASTM C403/C403M, method 'A'. Test [1] time per week.

d. Fresh Grout Temperature: Must be between10-32 degrees C 50-90 degrees F tested 1 time per shift.

e. Grout Pump Volume Verification: Test the accuracy of the grout pump and measuring devices [Daily][Weekly] by filling a 208 Liters 55 gallon drum, or other object of known volume, to verify the accuracy of equipment.

[

f. The Contracting Officer reserves the right to require additional testing if determined necessary by the design engineer.]

3.7 GROUT VERIFICATION

3.7.1 Production Grouting Quantity Verification

Verify the reported grout volume by reconciling records of delivered grout constituents (cementitious material and fine aggregate) and water meter readings for water consumed in the grout batching process with its reported grout volume produced. Measure and record the grout unit weight at least [1][2] times every [shift][day][week]. Maintain daily records of all grout constituents delivered to the project including: certified weight tickets for grout fine aggregate; certified weight tickets or sack counts for all cementitious components; and water meter readings for all water used to batch the grout. Reported daily production grout volume must agree with records of grout constituents consumed during site batching (or with certified ready-mix delivery tickets) within a tolerance of 10 percent.

Collect samples for grout unit weight determination from the grout hose near the header connection (and not directly from the batch mixer or transit-mix truck prior to passing through the grout pump and primary delivery hoses). Collect grout into a container of known volume (typically 0.028 cubic meters 1 cubic foot) for unit weight testing and pump stroke count verification (or for comparison with flowmeter readings if so equipped). Following unit weight determination, the sampled material may also be used for slump determination and strength test samples

3.7.2 Post Grouting Verification

****

NOTE: Post grouting verification must always be paired with a pre-grouting baseline condition. Succeeding series holes should show a reduction in flow, volume, and an increase in pressure. If the pre-grouting average SPT blow count is 4, one level of success for the project would be to increase the average blow count to 8 or 12. The same requirement can be applied to cone penetrometers for changes in shear wave velocity, tip resistance, or other parameters.

****

Complete all testing before the grouting equipment is demobilized from the site. Verify the subsurface material characteristics for [strength][void filling][other]. Verify subsurface improvement by evaluation of pressure and grout volumes injected in the split spaced holes/verification holes. Provide borings made to depths similar to the depths treated for grouting.

[Additional verification and testing is required. Locations of testing must be agreed upon between the Contractor and the Contracting Officer. All testing must be overseen by the Contractor's QC staff and include one of the following methods:

a. Post grouting standard penetration test N-values achieve an average of [_____] blows per foot or greater within the soil improvement zone.

b. Post grouting CPT results indicate a minimum improvement of [_____] percent of the[pre-treatment cone tip resistance][pre-treatment shear wave velocity] within the target soil improvement zone.

c. Geophysical methods to include[ground penetrating radar][electrical resistively tomography][_____].]

3.8 DAILY RECORDS

Make daily data and quality control records available to the Contracting Officer at all times. Submit paper records included herein daily. Submit digital records for each grout hole to the Contracting Officer within [7][_____] days of grout injection.[Use an automated grouting data collection system to record grouting injection operations. Provide all raw data outputs from the AGDCS within [12][_____] hours of generation.] Monitoring and logging of data for LMG operations to be completed by the Grouting Contractor's Quality Control Manager or Project Superintendent. Maintain accurate daily records of all grout pipe installation, drilling logs, grouting quantities including stage data, volume, ground monitoring, pressure, and depth for each grout pipe location in accordance with the following:

a. Date and weather conditions.

b. Drilling and Grouting Hole ID,[hole series,] hole[station and offset][latitude and longitude] for any hole that is drilled or grouted.

c. Depth and diameter of each drilled hole, include depth to bedrock if applicable. Include hole inclination (vertical = 90 degrees).

d. Stage geologic formation.

e. Grout stage ID, date, injection depth and elevation, grout mix ID.

f. Field QC Procedures and testing performed, include test number and test ID.

g. For each grout hole, include a per stage summary to include the grout injected per stage, the maximum injection pressure, and maximum flow rate, per stage.

h. For each grout hole: Summarize the grout stage information to include the total volume of grout injected, the maximum/minimum pressure, maximum flowrate, depth at which ground heave was detected, depth at which grout intrusion into subsurface structures or communication with another grout hole was detected.

i. Summary of grout used for each grouting effort with itemized total quantities of grout injected vs quantity of grout wasted.

j. Materials received and time of delivery.

k. Copies of receipts or delivery tickets for all materials delivered to the jobsite and daily quantity reconciliation. Provide all receipts or delivery tickets to the Contracting Officer.

l. Names of Contractor's personnel on site. Include the names of any visitors and time at the jobsite.

m. Details of any accidents, injuries, or other unusual events, including time;

n. Presence of any of the following:

(1) Voids or changes in drill advancement rate in soil or other material with depths to the top and bottom of each void.

(2) Groundwater depth.

(3) Unusual or unexpected conditions including communication, bypass, etc.

Submit data electronically in a [.csv][.xls][, or other] ASCII-readable format. Submit clear, legible analog records in [PDF][_____] format. Make the Contractor's records available to the Contracting Officer at all times.

3.8.1 Drilling Logs

Prepare a log of each grout hole that delineates the nature of the geomaterial penetrated, including: the depths of hard or soft soil zones; any existing voids; reduction or loss of circulation flush; and any rocks, boulders, or other significant conditions encountered. Provide copies of the logs to the Contracting Officer on completion of drilling of each hole.

Maintain and provide the Contracting Officer a continuous log delineating the drilling and grout injection parameters for each hole. Provide the following minimum data on the log:

a. Date(s) and time the hole was drilled;

b. Any obstructions encountered or unusual events occurring during drilling;

c. Depth drilled or elevation of both the top and bottom of the hole;

d. Description of soil conditions encountered, including groundwater depths.

Provide the name of the person preparing the logs and the current date on all pages of the log and number the pages chronologically from the start of work. Note the time at each log entry. Submit typed copies of the logs for each LMG hole to the Contracting Officer within seven days of grout injection and include as part of the As-Built Drawings and the Final Report.

3.8.2 Grouting Records

Provide a daily report delineating grouting activities containing at a minimum the following:

a. Hole Id, location, elevation and depths - with datum.

b. For each grout stage, produce tabular data that summarizes the time, grout stage depth and depth interval, grout stage pressure, total stroke count for each grout stage (or flowmeter reading if so equipped), grout volume for each grout stage, and flowrate for each grout stage. At the completion of each hole, provide the total volume of grout injected. For the entire hole, provide the range of final grouting pressures obtained across all stages (absolute max/min). Include a comparison of theoretical vs actual grout takes. Note any grout communication to the ground surface and the approximate estimated quantity.

c. Provide plots of grout injection (flow) and grout pressure versus time for each completed stage in the project. Include in a graphical presentation a depiction of pressure versus time where the maximum and minimum pressures can be directly compared.

3.9 SITE CLEANING, MAINTENANCE, AND RESTORATION

Keep the site clean, organized, and safe at all times. Promptly clean up spilled materials and grout. Neatly store hoses, delivery lines, and other items that are not in immediate use where they will not impede the ongoing work. Upon completion of the work for each hole, remove grout pipes installed from surface. Promptly collect and dispose of water and waste grout. Do not allow water to pond in the work area. Collect trash and store in an approved manner until it is removed from the site. Remove all waste from the site. Restore the site to the original condition. Completely remove any remnants of drilling fluid or grout. Restore or replace any appurtenant structures damaged during production.

[3.10 DATA MANAGEMENT

Provide all generated data - no data source or format is subject to exemption. All data generated as part of this specification are subject to the requirements in Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION. This would include any GIS files, access files, and other programs/systems used to store raw and processed data. In case of a conflict in Contract language, whichever requirement is more detailed, rigorous, specific, precise, and complete as determined by the Contracting Officer will be used.

]3.11 AS-BUILT DRAWINGS AND GROUTING PROFILES

Submit progress drawings per the same format requirements for As-Built Drawings. Maintain progress drawings in the field and provide to the Government[weekly][monthly]. As-Built drawings are not limited to the sheets in the Contract drawings. Add as many sheets as necessary to show the work completed. Include two new views for the entire grouting work. The color and binning symbology for grout volume and drilling issues will be[provided by the Contracting Officer][chosen by the Contractor]. Make changes to symbology, binning, and color representations as directed by the Contracting Officer.

Produce drawings at scale of [1:250][1:150]. At minimum, include the following grouting drawings, along with raw data organized in tabular form:

a. Submit a plan view of the array of grouting holes to include hole-ID, station/offset, and hole coordinates.

b. Provide section and profile views of the drilling results, including interpretive geology. Include the grout holes on a series of lines, with the ground surface and top-of-rock noted for each hole. Display voids, an interpreted top-of-rock line, and interpreted connections between voids. Show any lost tooling at the presumed lost depth. Show all casing with top and bottom depth.

c. Provide section and profile views of the grouting results. Include the grout holes on a series of lines, with each grouting stage shown with a color-coded box indicating grout volume. Provide the maximum grout pressure and flow rate used for the corresponding stage for each box. For each grout hole on each line, include the absolute total volume for each grout hole with the max and min range of pressure and flowrate indicated below the total volume for the grout hole.

Submit records in [hard copy (2 copies),][electronic format on CD or DVD,] in native file formats, and in .pdf, on the project SFTP site.[Drawing views of progress drawings that are unchanged from the previous week do not need to be submitted in hard copy, but submit the electronic copy.]

3.12 LMG GROUTING FINAL REPORT

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NOTE: The Final Report should not be deleted. The final report provides critical information for permanent project record, some of which will be difficult for anyone but the contractor to know, including production rates. In addition, this information is critical for Government Cost Estimators for future jobs.

****

Prepare and submit a drilling and LMG grouting final report that covers all the activities throughout construction. Submit [three][five] hard copies of the complete report, and a digital copy of the report. Include all forms, sketches, drawings, tables, graphs, color photographs, and other supporting materials, as necessary to provide a full understanding of how the work was accomplished and any difficulties, problems, or unusual conditions which were encountered. The report must 'standalone' and not reference other material to the maximum extent possible, except for the As-Built drilling and grouting drawings.

Submit the final report no later than [30][60] days after grouting the final hole.[Submit an outline of the report for approval when 50 percent of the construction is completed.] The report must contain the following at a minimum:

a. The equipment used, final layout of the grout holes, grout takes by hole, problems encountered and solutions applied.

b. Drilling records including hole [easting and northing] [latitude longitude], elevation and depths, [hole azimuth and inclination,] vertical and horizontal datums used to survey the holes, and any applicable reference coordinate systems. Include the same data for all survey control points.

c. Include grout quantity pumped versus time for each completed stage in the project. Provide plots of grout injection (flow) and grout pressure versus time for each completed stage in the project. Include in a graphical presentation a depiction of pressure versus time where the maximum and minimum pressures can be directly compared.

d. A minimum of [25][____] annotated color photographs of each phase of construction and equipment.

e. A discussion of the grout mix(es) used and quality control procedures for maintaining the grout mix required properties during production.

f. A descriptive list of any lost tooling, including type of tooling, length, depth, batter, and location (station and offset plus longitude and latitude).

g. Discussion of any deviations from the Drilling and Grouting Work Plan submittal(s).

h. Instantaneous and Industrial Production rates for drilling and grouting. Compare production rates achieved with the production rates forecast in the baseline schedule; note any actual rate 25-percent different from that forecast in the baseline schedule, and an interpretation of why they were different.

i. Summary statistics of each test for each grout mix during the Contract. Include: Mean, Median, Mode, Standard Deviation, and 95-percent confidence limit.

j. For compressive strength data, include histogram of the [3][7]-day strength results. Additionally, include a time-series plot showing strength versus time, with specifications limits clearly delineated on the plot.

[3.13 LMG GROUTING RESULTS DATABASE

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NOTE: On very small jobs, it could make sense to utilize a spreadsheet instead of a database. If utilized, change the wording "[Enterprise][Microsoft Access] database" to "Microsoft Excel Spreadsheet".

****

Develop an [Enterprise][Microsoft Access] database in accordance with Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION that contains all data generated over the course of the project - including but not limited to drilling, grouting, water pressure testing, and verification drilling and testing. Provide a database that includes all of the information required in paragraph DAILY RECORDS.[A data dictionary detailing the specific data tables, fields, and relationships of the database required for use [is provided as an addendum to the Contract][will be provided by the Government upon issuance of the notice to proceed].] See Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION for additional database requirements.[Provide a database that complies with Section 01 78 00 CLOSEOUT SUBMITTALS, paragraph GEO-DATA-BASE FILES.]

]3.14 RADIO SYSTEM

At minimum, provide a radio system that allows immediate voice contact between personnel and inspectors at the grout injection location, grout pump operator, batching location, and all other operations on site.[Furnish two devices per shift to the Contracting Officer that communicate on the Contractor's frequency or line for monitoring and coordination of grouting operations. These will be returned by the Contracting Officer at the end of grouting operations. Normal wear and tear must be considered.]

Repair or replace any damage that occurs because of lack of immediate communication from a faulty or under-utilized radio system personnel at no cost to the Government.

[3.15 GROUT CONTAINMENT

Contain grout by a combination of physical barriers suitable for the grouting program design. Place containment only in areas to be grouted within 24 hours of placement so as to limit the need to replace containment measures over time. Immediately stop grouting or adjust the grout mixes and pump rates if it is determined that the grout is too thin to be contained by the containment measures.[As a minimum, place [____] millimeters [_____] inches diameter, [_____] millimeters [_____] inches thick stone protection, to a depth of [_____] meters [_____] feet along the slope of the structure in the area to be grouted.][As a minimum, install a correspondingly sized approved turbidity silt fence on the interior side of the structure to at least the same depth.][Consult weather and water stage forecasts and adjust placement of containment measures that might be damaged or rendered ineffective before grouting operations in those areas.]

]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 35 19.13 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 05 21 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-31 35 19.13 (February 2021)**

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SECTION 31 35 19.13

GEOGRID SLOPE PROTECTION
02/21

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NOTE: This guide specification covers the requirements for geogrid reinforcement to enhance the veneer soil stability for landfill liners and covers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: Geometric requirements such as slope length, and construction limits should be shown on the drawings.

****

1.1 MEASUREMENT AND PAYMENT

The unit of measurement for soil slope reinforcement will be square meters (SM) yards (SY). Overlaps for splices (if allowed) and for the Contractor's convenience will not be measured for payment. Payment will be made at the respective unit price listed on the bidding schedule. Payment will be full compensation for furnishing all material, labor, equipment, supplies and incidentals to complete the work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4595	(2017) Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D4873/D4873M	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D5262	(2007; R 2016) Standard Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics
ASTM D5321/D5321M	(2020) Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
ASTM D6637	(2011) Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
ASTM D6706	(2001; R 2013) Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GG4a	(2012) Determination of the Long-Term Design Strength of Stiff Geogrids
GSI GRI GG4b	(2012) Determination of the Long-Term Design Strength of Flexible Geogrids
GSI GRI GG6	(1996) Grip Types for Use in Wide Width Testing of Geotextiles and Geogrids

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, [_____]

SD-03 Product Data

Allowable Strength

Manufacturer

SD-04 Samples

Geogrid Reinforcement

SD-06 Test Reports

Geogrid Reinforcement

Coefficient of Interaction

Interface Friction Testing

Splices

Conformance Testing

SD-07 Certificates

Certificates of Compliance

1.4 QUALITY ASSURANCE

Submit a summary of the manufacturer's qualifications and [_____] copies of the manufacturer's quality control (QC) manual a minimum of 7 days prior to delivery of geogrid to the site. The reinforcement manufacturer must provide a qualified and experienced representative to be available on an as-needed basis during construction. Visit the site for consultation [at least once during construction] [as requested by the Contracting Officer].

1.5 DELIVERY, STORAGE, AND HANDLING

Check products upon delivery to ensure that the proper material has been received and is dry and undamaged. Protect the materials from damage and exposure following the guidelines presented in ASTM D4873/D4873M.

1.5.1 Labeling

Label each roll with the manufacturer's name, product identification, roll dimensions, lot number, and date manufactured.

1.5.2 Handling

Handle and unload geogrid rolls by hand, or with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Do not drag, lift by one end, lift by cables or chains, or drop geosynthetic rolls to the ground.

1.5.3 Storage

Protect geogrid from deleterious materials, chemicals, sparks and flames, temperatures in excess of 70 degrees C 160 degrees F, and any other environmental condition that may degrade the physical properties. If stored outdoors, elevate the rolls from the ground surface. Protect geogrids, except for extruded grids, with an opaque waterproof cover.

PART 2 PRODUCTS

2.1 GEOGRID REINFORCEMENT

****

NOTE: Polyester is susceptible to hydrolysis in alkaline conditions. A high molecular weight and low carboxyl end group number limit the hydrolysis. Normally, a mill certificate or certification of these properties is adequate. The molecular weight of polyester geosynthetics is determined from GSI GRI GG6, "Determination of the Number Average Molecular Weight of Polyethylene Terephthalate (PET) yarns Based on a Relative Viscosity Value", and ASTM D4603, "Determining Inherent Viscosity of Poly (Ethylene Terephthalate) (PET) by Glass Capillary Viscometer." The carboxyl end group number is determined from GSI GRI GG7, "Carboxyl End Group Content of Polyethylene Terephthalate (PET) Yarns."

The geogrid sample is intended to be for visual demonstration prior to product delivery. Conformance testing samples, if required, should be obtained from material actually delivered to the job. If testing is to be performed for pre qualification, the minimum sample size should be 1 meter (36 inches) in length and the full roll width. Although 1 square meter (yard) will provide enough material for testing, the full roll width should be sampled since it provides a better selection of specimen locations, it clearly shows the machine and cross directions, and the difference in waste and shipping costs is negligible.

****

Submit one properly identified 600 by 600 mm 24 by 24 inches minimum size geogrid sample with the fasteners proposed for use. Provide a geogrid that is a geosynthetic manufactured for reinforcement applications and a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil, aggregate, or other fill materials.

a. Submit manufacturer's certified raw and roll material test reports including ultimate strength performed in accordance with ASTM D6637 or ASTM D4595 (modified). Test results not meeting the requirements in Table 1 or in the approved Manufacturer's Quality Control Manual will result in rejection of applicable rolls. Provide certified test reports a minimum of 7 days prior to delivery of geogrid to the site.

b. Provide geogrid structure that is dimensionally stable and able to retain its geometry under manufacture, transport and installation. Manufacture geogrid with 100 percent virgin resin consisting of polyethylene, polypropylene, polyester, or other approved material and with a maximum of 5 percent in-plant regrind material. Provide polyester resin with a minimum molecular weight of 25,000 and a carboxyl end group number less than 30. Stabilize polyethylene and polypropylene with long term antioxidants.

c. Submit Certificates of Compliance for the materials provided and results of conformance testing. Submit an affidavit certifying raw and roll material test results submitted are accurate and that the reinforcement meets the requirements of the project specifications. The affidavit must be signed by an official authorized to certify on behalf of the manufacturer. [If the affidavit is dated after award of the contract and/or is not specific to the project, attach a statement certifying that the affidavit addressed to the wholesale company is representative of the material supplied.] Include a statement confirming that all purchased resin used to produce reinforcement is virgin resin. Provide affidavit a minimum of 7 days prior to delivery of geogrid to the site.

2.1.1 Geogrid Reinforcement Properties

The reinforcement shown on the contract drawings must meet the property requirements listed in Table 1. Reinforcement strength requirements represent minimum average roll values in the machine direction.

TABLE 1

PROPERTY	REQUIREMENT	TEST DESIGNATION
Allowable Strength (Ta) at [5] [10] percent strain	[_____] kN/m lb/inch	GSI GRI GG4a or GSI GRI GG4b
UV Resistance	70 percent after 500 hours	ASTM D4355/D4355M
Coefficient of Interaction* for Pullout	0.85	ASTM D6706
Interface Friction at [Peak] [Residual], Degrees	[_____]	ASTM D5321/D5321M

*Submit the coefficient of interaction for pull-out resistance of the proposed geogrid in a soil of similar gradation and texture to the material that will be used for fill in the reinforced zone. Establish the coefficient of interaction in accordance with ASTM D6706. Provide certified test results a minimum of 7 days prior to delivery of geogrid to

2.1.1.1 Allowable Strength

Submit Geogrid allowable strength calculated in accordance with GSI GRI GG4a or GSI GRI GG4b. Itemize each reduction factor. Account for splice efficiency in the calculations. Provide calculations a minimum of 7 days prior to delivery of geogrid to the site. Allowable strength is based on reduction factors for installation damage, durability, and creep that are applicable to site specific conditions. Determine reduction factors in accordance with the test procedures documented in GSI GRI GG4a or GSI GRI GG4b. The minimum reduction factor for durability is 1.1 for polyethylene and polypropylene geogrids and 1.15 for coated polyester geogrids. The minimum reduction factor for installation damage is 1.1 for all polymers. Base the reduction factor for creep on testing performed in accordance with ASTM D5262 at the strain specified in Table 1.

2.1.1.2 Interface Friction Testing

****

NOTE: If the geogrid will not be placed in an anchor trench, interface friction testing should be conducted to determine the runout length for the geogrid. All potential slip interfaces beneath the geogrid need to be tested in computing the required runout length. Normal stresses specified should be representative of anticipated field conditions. Selection of peak versus residual values should be based on anticipated interface displacements.

****

Submit certified laboratory interface friction test results including description of equipment and test method, a minimum of 7 days prior to delivery of geogrid to the site. Conduct laboratory interface friction tests on the following interfaces: [_____]. The frequency of testing for each interface must be at a rate of [1] [_____] per project. Conduct tests in accordance with ASTM D5321/D5321M. Use normal stresses of [_____], [_____], and [_____] kPa [_____], [_____], and [_____] psi along with a displacement rate of [5.0] [_____] mm [0.2] [_____] inches per minute. Orient geosynthetics such that the shear force is parallel to the down slope orientation of these components in the field.

2.2 SPLICES

Provide splices consisting of a standard method or device recommended by the manufacturer of the geogrid. Splices will not be allowed unless identified on the approved layout drawings. Splices must be at least 75 percent efficient. Demonstrate the splice efficiency through tests performed in accordance with GSI GRI GG4a or GSI GRI GG4b. Splicing may consist of overlaps, fusion wedge welding, sewing, or bodkin connections. Splicing methods that are dependent on installer experience and skill level, such as hot air and torch-applied open flame, are not acceptable. Construct overlap splices by placing a minimum of 50 mm 2 inches of soil between the layers of geogrid.

PART 3 EXECUTION

3.1 INSTALLATION

Submit Geogrid layout plan along with anchorage and joint details, sequencing and construction procedures, a minimum of 7 days prior to geogrid placement.

3.1.1 Subgrade Preparation

****

NOTE: For landfill slope reinforcement applications, geogrids are typically placed directly on the underlying geosynthetic surface.

****

Immediately prior to placement of the geogrid, place the geogrid on a surface that is free of rock and other material that could damage the geogrid or the underlying geosynthetics.

3.1.2 Anchor Trench

****

NOTE: Delete this paragraph if an anchor trench is not required. Anchor trench dimensions need to be determined on a site specific basis.

Anchor trench dimensions must be computed based on the pull-out resistance of the geogrid. However, pull-out resistance tests (ASTM D6706) are typically not performed due to the cost and complexity of this test procedure. Data bases of interaction coefficients for different geogrids, soils, and loading conditions are kept by geogrid manufacturers. Information from these data bases should be used to design the anchorage system.

****

Place the anchor trench a minimum of [610] [_____] mm [24] [_____] inches back from the edge of the slope to be covered. The anchor trench must be a minimum of [610] [_____] mm [24] [_____] inches deep and [610] [_____] mm [24] [_____] inches wide. Remove ponded water from the anchor trench while the trench is open. Round trench corners to avoid sharp bends in the geogrid. Remove loose soil, rocks larger than [51] [_____] mm [2] [_____] inches in diameter, and any other material which could reduce the effectiveness of the geogrid from the surfaces of the trench. Extend the geogrid down the front wall and across the bottom of the anchor trench. Perform backfilling and compaction of the anchor trench in accordance with Section 31 00 00 EARTHWORK.

3.1.3 Placement

Install the geogrid in accordance with the Manufacturer's recommendations. Unroll the geogrid in the direction of reinforcement. After a layer of geogrid has been placed, use suitable means, that do not damage the underlying geosynthetics, to hold the geogrid flat and in place until cover soil can be placed. Remove geogrid damaged during placement and covering and replace at no additional cost to the Government.

3.1.4 Overlaps and Fasteners

****

NOTE: Adjacent rolls of uniaxial geogrid should not be overlapped. The plastic-to-plastic contact has reduced frictional resistance.

****

Position adjacent rolls of geogrid edge-to-edge and loosely fasten to maintain alignment during fill placement. Do not overlap adjacent rolls. Use fastener type and spacing as recommended by the manufacturer and approved by the Contracting Officer. Metallic fasteners will not be allowed.

3.1.5 Splices

Submit test data showing splice efficiency. Provide certified test results a minimum of 7 days prior to delivery of geogrid to the site. Locate splices, if allowed, within the bottom one-third of the slope. Limit splicing to only one splice per reinforcing strip and do not include a splice for two consecutive reinforcing strips. Do not use individual reinforcing lengths less than 3 meters 10 feet. Pull and hold splices taut in geogrid reinforcement during cover soil placement.

3.1.6 Penetrations

For small penetrations through geogrids, cut only transverse members of the geogrid. The load-carrying longitudinal (machine direction) members must be spread around the penetration. For larger penetrations, place additional geogrid on each side of the penetration and spliced to the adjacent geogrid to compensate for any longitudinal tensile members that must be cut.

3.2 COVER SOIL PLACEMENT

****

NOTE: The maximum acceptable particle size of cover soil is a function of the minimum aperture size of the geogrid and the acceptable maximum particle size against the underlying geosynthetic layer. The book titled "Designing with Geosynthetics" by Dr. Robert Koerner provides guidance on computing the acceptable maximum particle size of cover soil material based on the apperature size of the geogrid.

****

Cover geogrid with soil within [5] [_____] calendar days of acceptance. Keep the geogrid smooth and taut during placement of cover materials. Do not drop cover soil onto the geogrid from a height greater than 1 m 3 feet. Push the soil out over the geogrid in an upward tumbling motion. Place soil from the bottom of the slope upward. The initial loose soil lift thickness must be [350] [_____] mm [12] [_____] inches. Use equipment with ground pressures less than 50 kPa 7 psi to place the first lift over the geogrid. Maintain a minimum of [460] [610] [915] [_____] mm [18] [24] [36] [_____] inches of soil between construction equipment with ground pressures greater than 50 kPa 7 psi and the geogrid. Do not use equipment placing cover soil that stops abruptly, makes sharp turns, spins their wheels, or travels at speeds exceeding [2.2] [_____] m/s [5] [_____] mph. Additional cover soil material and placement requirements are described in Section 31 00 00 EARTHWORK.

3.3 OVERSIGHT

Keep a QA Representative present at all times during geogrid installation.

3.4 CONFORMANCE TESTING

****

NOTE: Conformance testing is performed to verify quality control test results submitted by the manufacturer, to detect degradation during shipping and storage, and to verify the correct product is supplied. Verification of quality control by the manufacturer and detecting degradation during shipping and storage is not economically justified for small jobs. Unlike reinforcing steel for concrete, geosynthetics are difficult to identify in the field, and even experienced personnel can sometimes mistake the product identity of unlabeled

material. Testing after delivery to verify the correct product was supplied may be advisable for critical structures. The strength is usually the most critical property to verify.
****

Submit results of conformance testing. Conformance testing expenses are the responsibility of the Contractor. Perform testing using a commercial testing laboratory selected by the Contractor and approved by the Contracting Officer. The laboratory must be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the laboratory will be required to perform. The Contracting Officer reserves the right to direct the location and select the material for samples. Conformance test results must equal or exceed results reported on the Manufacturer's certified roll material test reports.

TABLE 5. CONFORMANCE TESTING

PROPERTY	TEST DESIGNATION	FREQUENCY
Wide Width Strip Tensile Strength	[ASTM D4595 (mod)][or][ASTM D6637]	[_____]

Modify ASTM D4595 for geogrids considering recommendations in GSI GRI GG6. Express the tensile strength on a unit length basis by substituting n*a for Ws, where:

Ws = specimen width, (mm inches)
n = number of ribs in the sample (must be a whole number)
a = nominal rib spacing for the product tested, (mm inches)

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 36 00 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 36 00 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 31 36 00

GABIONS

02/21

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NOTE: This guide specification covers the requirements for the procurement and installation of steel wire mesh gabion and mattress units used as a measure of protection against erosion forces of stream flow in water courses and slope instability. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 SUMMARY

The work under this specification includes furnishing, assembling, filling and tying open wire mesh rectangular compartmented gabions [and mattresses] placed on a prepared surface of [filter material] [geotextile], [geotextile and filter materials], as specified, and in accordance with the lines, grades, and dimensions shown or otherwise established in the field.

a. Gabions[and mattresses] are wire mesh containers of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stone at the project site to form flexible, permeable, monolithic structures. Manfacture gabions[and mattresses] with all components mechanically connected at the production facility with the exception of the mattress lid, which is produced separately from the base. The supply to the jobsite of unassembled individual wire mesh components (panels) forming gabions [and mattresses] will not be permitted.

b. Ensure definitions of terms specific to this specification and to all materials furnished on the jobsite, with the exception of the rock to fill the baskets and the filter material, refer to and are in compliance with ASTM A975 for double twisted wire mesh Gabions[and Revet mattresses], or with ASTM A974 for welded wire fabric Gabions[and Gabion Mattresses]. [For ease of reference, the term "mattress" will be used in this specification in place of Revet mattress and/or Gabion mattress, where the statement is of general nature and it is not specific to the double twisted or welded wire mesh products.]

1.2 UNIT PRICES

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NOTE: For small projects, the district may opt to use lump sum payment.

Double twisted wire mesh gabions manufactured in SI (metric) units are different in size from those manufactured in English (inch-pound) units.

Sizes for double twisted wire mesh gabions and mattresses in SI (metric) units must refer to Tables 3 and 5 on ASTM A975. Sizes for double twisted wire mesh gabions and mattresses in English (inch-pound) units must refer to Tables 4 and 6 on ASTM A975. Sizes for welded wire mesh gabions and mattresses both in SI (metric) and English (inch-pound) units must refer to Table 1 on ASTM A974.

This note also applies to the subparagraphs below titled Unit of Measure.

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1.2.1 Filter Material

1.2.1.1 Payment

Payment will be made for costs for filter material, including furnishing, hauling, placing, and maintenance of the filter layers until placement of the gabion [and mattress] cover is completed and accepted. No payment will be made for excess thickness of filter layers or for material required to replace material lost by rain wash, wind erosion, or otherwise, except for additional filter material ordered in writing.

1.2.1.2 Measurement

Filter material will be measured for payment based upon computations made from the theoretical filter thickness as specified or shown, and the areas acceptably placed where shown or staked in the field.

1.2.1.3 Unit of Measure

Unit of measure is cubic meter cubic yard.

1.2.2 Gabion [and Mattress] Protection

1.2.2.1 Payment

Payment will be made for costs associated with gabion [or mattress protection], including the costs of furnishing, assembling, and placing the wire baskets, the stone fill, and all other materials, labor, equipment, tools, supplies, and incidental costs in connection with completing this item of work.

1.2.2.2 Measurement

Gabions [or mattresses] meeting the requirements of these specifications and acceptably placed within the limits indicated on the drawings or otherwise established in the field, will be measured for payment by the cubic meter cubic yard of stone filled gabions [or mattresses] in place.

1.2.2.3 Unit of Measure

Unit of measure will be cubic meter cubic yard.

1.3 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A90/A90M	(2021) Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM A313/A313M	(2017) Standard Specification for

	Stainless Steel Spring Wire
ASTM A370	(2024) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A428/A428M	(2021) Standard Test Method for Weight (Mass) of Coating on Aluminum-Coated Iron or Steel Articles
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A764	(2007; R 2021) Standard Specification for Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs
ASTM A809	(2023) Standard Specification for Aluminum-Coated (Aluminized) Carbon Steel Wire
ASTM A853	(2019) Standard Specification for Steel Wire, Carbon, for General Use
ASTM A856/A856M	(2003; R 2020) Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Carbon Steel Wire
ASTM A974	(1997; R 2021) Standard Specification for Welded Wire Fabric Gabion and Gabion Mattresses (Metallic Coated or Polyvinyl Chloride (PVC) Coated)
ASTM A975	(2024) Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire With Poly(Vinyl Chloride) (PVC) Coating)
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1499	(2013) Filtered Open-Flame Carbon-Arc Type Exposures of Plastics
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D5312/D5312M	(2012; R 2013) Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 144	(1992) Standard Test Method for Resistance of Rock to Freezing and Thawing

1.4 DEFINITIONS

1.4.1 Rate of Aggressiveness

Make the determination of the rate of aggressiveness (non-aggressive, moderately, or highly aggressive) on a project-to-project basis, due to the many variables involved and the lack of criteria of general validity. It is normally recommended for the choice to be based on all the available data and on the experience of existing gabion structures in similar environments.

1.4.2 Double Twisted Wire Mesh Gabions[and Mattresses]

Classified according to the wire coating, which is applied prior to manufacturing the mesh. Coating styles are as follows:

1.4.2.1 Style 1

Wire mesh made from wire which is zinc coated before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are produced from zinc-coated wire. Style 1 for the wire coating is normally recommended for:

1.4.2.1.1 Permanent

Gabion[or mattress] structures, for works installed in non-aggressive or non-polluted environments, and this condition remains unaltered over time.

1.4.2.1.2 Temporary

Gabion[or mattress] structures, for works in moderately aggressive environments, depending on the minimum design life of the structure.

1.4.2.2 Style 2

Wire mesh made from wire which is coated with Zn-5Al-MM before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are also produced from Zn-5Al-MM coated wire. Style 2 for the wire coating is normally recommended for:

1.4.2.2.1 Permanent

Gabion[or mattress] structures, for works installed in moderately aggressive environments.

1.4.2.2.2 Temporary

Gabion[or mattress] structures, for works in aggressive environments, depending on the minimum design life of the structure.

1.4.2.3 Style 3

Wire mesh, lacing wire, and stiffeners as Style 1 and overcoated with PVC. Provide fasteners consisting of stainless steel wire. Style 3 for the wire coating is normally recommended for both permanent and temporary gabion structures, for works installed in aggressive or polluted environments, or when the aggressiveness of the site is moderately unpredictable or variable from low to high.

1.4.2.4 Style 4

Wire mesh made from wire which is aluminum-coated before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are also produced from aluminum-coated wire. Style 4 for the wire coating is very seldom used in the gabion industry. Adequately document its life expectancy to guarantee its consistency and reliability.

1.4.3 Welded Wire Fabric Gabions[and Mattresses]

Classified according to wire coating styles as follows:

1.4.3.1 Style 1

Welded wire fabric made from wire which is zinc coated before being welded into fabric. Spiral binders, lacing wire, and stiffeners are produced from zinc-coated wire. Style 1 for the wire coating is normally recommended for temporary gabion[or mattress] structures, for works in non-aggressive or non-polluted environments.

1.4.3.2 Style 2

Welded wire fabric which is made from uncoated wire and the fabric is subsequently zinc-coated after fabrication. Spiral binders, lacing wire, and stiffeners are produced from zinc-coated wire. Style 2 for the wire coating is normally recommended for permanent gabion[or mattress] structures, for works installed in non-aggressive or non-polluted environments, and this condition remains unchanged over time

1.4.3.3 Style 3

Welded wire fabric made from wire which is coated with zinc-5 percent aluminum-mischmetal alloy (Zn-5Al-MM) before being welded into fabric.

Spiral binders, lacing wire, and stiffeners are also produced from zinc-5 percent aluminum-mischmetal alloy (Zn-5Al-MM) coated wire. Style 3 for the wire coating is normally recommended for:

1.4.3.3.1 Permanent

Gabion[or mattress] structures, for works installed in moderately aggressive environments.

1.4.3.3.2 Temporary

Gabion[or mattress] structures, for works in aggressive environments, depending on the minimum design life of the structure.

1.4.3.4 Style 4

Welded wire fabric made from wire which is aluminum-coated before being welded into fabric. Spiral binders, lacing wire, and stiffeners are also produced from aluminum-coated (aluminized) wire. Style 4 for the wire coating is very seldom used in the gabion industry. Adequately document its life expectancy to guarantee its consistency and reliability.

1.4.3.5 Style 5

Welded wire fabric, spiral binders, lacing wire, and stiffeners as Styles 1, 2, 3, or 4, and overcoated with PVC. Style 5 for the wire coating is normally recommended for both permanent and temporary gabion structures, for works installed in aggressive or polluted environments, or when the aggressiveness of the site is moderately unpredictable or variable from low to high.

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Gabions or Mattresses

Alternative Wire Fasteners

SD-06 Test Reports

Gabions or Mattresses

Alternative Wire Fasteners; G, [_____]

SD-07 Certificates

Stone Fill

Filter Material

1.6 QUALITY ASSURANCE

1.6.1 Samples

Furnish samples of materials used to fabricate the gabions or mattresses to the Contracting Officer 60 days prior to start of installation. Samples will be tested in accordance with specification and either ASTM A974 or ASTM A975 depending on which system is being furnished by the Contractor. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

1.6.2 Test Report or Documents

Furnish copies of all test results to the Technical Representative of this specification, USACE District, Vicksburg, 4155 Clay St., Vicksburg, MS 39183-3435, Attn: Dale Goss (ED-GI).

1.7 DELIVERY, STORAGE, AND HANDLING

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NOTE: Delivery to the jobsite of unassembled units will not be permitted, due to the increased labor and onsite supervision time, and to the fact that

assembly is made on the jobsite and not in the quality-controlled manufacturer's facility.

Moreover, unassembled units delivered to the jobsite increase the likelihood to perform the construction by attaching units with a missing end panel rather than using entirely pre-assembled baskets. This will lower the structural integrity of the system, its strength at the connections and its overall resistance to the earth pressures.

It will be the responsibility of the manufacturer to guarantee that gabions are manufactured and delivered with all components mechanically attached, as required in ASTM A975 (Section 6.4) and ASTM A974 (Section 6.5).

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Deliver gabions[and mattresses] with all components mechanically connected at the production facility[with the exception of the mattress lid, which is produced separately from the base]. All gabions[and mattresses] are supplied in the collapsed form, either folded or bundled or rolled, for shipping. Bundles are banded together at the factory for ease of shipping and handling. [Mattress bases and lids may be packed in separate bundles].

a. Mattress lids may be supplied either as individual units (bundled) or in roll form. Ship lacing wire in coils with a diameter of the coil approximately 0.60 m 2 feet. Ship fasteners in boxes. Ship preformed stiffeners in bundles.

b. Deliver gabions[and mattresses] to the jobsite labeled in bundles. Labels show the dimensions of the gabions[or mattresses] included, the number of pieces and the color code.

PART 2 PRODUCTS

2.1 MATERIALS

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NOTE: The use of the most appropriate Style for the wire coating in double twisted and welded wire gabions [and mattresses] is determined by the minimum required design life of the structure in relationship with the aggressiveness of the surrounding environment (air and water quality).

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2.1.1 Double twisted wire mesh Gabions[and Mattresses]

Double twisted wire mesh gabions[and mattresses] must be [Style 1], [Style 2], [Style 3], [and] [Style 4] manufactured with a non-raveling mesh made by twisting continuous pairs of wires through three half turns (commonly called double twisted) to form a hexagonal-shaped opening. Ensure gabion [and mattress] sizes, wire diameters, mesh opening sizes, and tolerances comply with the requirements of ASTM A975 (Tables 1, 3, 4, 5, 6, and Sections 9). Provide gabions [and mattresses] that meet the following test requirements:

2.1.1.1 Metallic Coating

Ensure coating weights conform to the requirements of [ASTM A641/A641M, Class 3 (Style 1)], [ASTM A856/A856M (Style 2)], [ASTM A90/A90M] or [ASTM A428/A428M] as applicable, and [ASTM A809 (Style 4)].

2.1.1.2 PVC for Coating

Provide PVC coating which shows no cracks or breaks after the wires are twisted in the fabrication of the mesh. Ensure the initial properties of PVC coating material have a demonstrated ability to conform to the following requirements:

2.1.1.2.1 Specific Gravity

In the range from 1.30 to 1.35 dN/dm3, when tested in accordance with test method ASTM D792

2.1.1.2.2 Tensile Strength

Not less than 20.6 MPa 2985 psi when tested in accordance with test method ASTM D412

2.1.1.2.3 Modulus of Elasticity

Not less than 18.6 MPa 2700 psi when tested in accordance with test method ASTM D412

2.1.1.2.4 Hardness

Shore "D" between 50 and 60, when tested in accordance with test method ASTM D2240

2.1.1.2.5 Brittleness Temperature

Not higher than -9 degrees C 15 degrees F, or lower temperature when specified by the purchaser, when tested in accordance with test method ASTM D746.

2.1.1.2.6 Resistance to Abrasion

The percentage of the weight loss must be less than 12 percent

2.1.1.2.7 Salt Spray Exposure and Ultra Violet Light Exposure

The PVC must show no effect after 3,000 h of salt spray exposure in accordance with ASTM B117. The PVC must show no effect of exposure to ultra violet light with test exposure of 3,000 h, using apparatus Spectral Irradiance of Open Flame Carbon Arc with Daylight Filters and 63 degrees C 145 degrees F, when tested in accordance with practice ASTM D1499 and ASTM G152

2.1.1.2.8 Evaluation of Coating After Salt Spray and Ultraviolet Exposure Test

After the salt spray test and exposure to ultraviolet light, the PVC coating must not show cracks nor noticeable change of color, or blisters or splits. In addition, do not allow the specific gravity, tensile strength, hardness and resistance to abrasion to change more than 6 percent, 25 percent, and 10 percent respectively, from their initial values.

2.1.1.3 Wire Tensile Strength

The tensile strength of the wire used for the double twisted mesh, lacing wire, and stiffener, when tested in accordance with Test Methods and definitions ASTM A370, must be in accordance with the requirements of [ASTM A641/A641M (Style 1)], [ASTM A809 (Style 4)], and [ASTM A856/A856M (Style 2)], for soft temper wire.

2.1.1.4 Mesh Strength and Panel to Panel Joint Strength

Use the minimum strength requirements of the mesh, selvedge wire to mesh connection, panel to panel connection, and punch test, when tested in accordance with ASTM A975 Section 13.1, as shown in Table 1. The strength values reported in kN/m lb/ft are referred to the unitary width of the specimen. Perform the panel to panel test to demonstrate the ability of the fastening system to achieve the required strength, and indicate the number of wire revolutions for the lacing wire or the ring spacing for ring fasteners used. Use the same number of wire revolutions or ring spacing in the field installation. Pleating the based panel to obtain internal panels is prohibited.

TABLE 1
Minimum Strength Requirements of Mesh and Connections

Test Description	Gabions, metallic coated	Gabions, PVC coated	[Revet mattresses] (metallic and PVC
Tensile strength parallel to twist	51.1 kN/m3500 lb/ft	42.3 kN/m2900 lb/ft	33.6 kN/m2300 lb/ft
Tensile strength perpendicular to twist	26.3 kN/m1800 lb/ft	20.4 kN/m1400 lb/ft	13.1 kN/m900 lb/ft
Connection to selvedges	20.4 kN/m1400 lb/ft	17.5 kN/m1200 lb/ft	10.2 kN/m700 lb/ft
Panel to panel (using lacing wire or ring	20.4 kN/m1400 lb/ft	17.5 kN/m1200 lb/ft	10.2 kN/m700 lb/ft
Punch Test	26.7 kN6000 lb	23.6 kN5300 lb	17.8 kN4000 lb

2.1.2 Welded Wire Fabric Gabions[and Mattresses]

Provide welded wire fabric gabions[and mattresses] that are [Style 1], [Style 2], [Style 3], [Style 4], [and] [Style 5] manufactured with a welded wire mesh composed of a series of longitudinal and transverse steel wires arranged substantially at right angles to each other, and welded together at the points of intersection by electrical resistance welding to form fabricated sheets. Ensure gabion [and mattress] sizes, wire diameters, mesh opening sizes, physical properties of the PVC for coating, and tolerances comply with the requirements of ASTM A974 (Tables 1, 2, 3, and Sections 9). Provide gabions [and mattresses] that meet the following test requirements:

2.1.2.1 Metallic Coating

Ensure coating weights conform to the requirements of [ASTM A641/A641M, Class 3 (Style 1)], [ASTM A856/A856M (Style 2)], [ASTM A90/A90M] or [ASTM A428/A428M] as applicable, and [ASTM A809 (Style 4)].

2.1.2.2 PVC for Coating

PVC adhesion test must be PVC coating must show no cracks or breaks after the wires are twisted in the fabrication of the mesh. Ensure the initial properties of the PVC coating on the wire and welded wire fabric have a demonstrated ability to conform to the following requirements:

2.1.2.2.1 Adhesion

Ensure the PVC coating adheres to the wire such that the coating breaks rather than separates from the wire, in accordance with test method ASTM A974 Section 13.3;

2.1.2.2.2 Mandrel Bend

Provide PVC-coated wire that, when subjected to a single 360 bend at -18 degrees C 0 degrees F around a mandrel ten times the diameter of the wire, does not exhibit breaks or cracks in the PVC coating;

2.1.2.2.3 Specific Gravity

In the range from 1.20 to 1.40 dN/dm3, when tested in accordance with test method ASTM D792;

2.1.2.2.4 Tensile Strength

Not less than 15.7 MPa 2275 psi when tested in accordance with test method ASTM D638;

2.1.2.2.5 Modulus of Elasticity

Not less than 13.7 MPa 1980 psi at 100 percent strain, when tested in accordance with test method ASTM D638;

2.1.2.2.6 Hardness

Shore "A" not less than 75, when tested in accordance with test method ASTM D2240;

2.1.2.2.7 Brittleness Temperature

Not higher than -9 degrees C 15 degrees F, or lower temperature when specified by the purchaser, when tested in accordance with test method ASTM D746.

2.1.2.2.8 Resistance to Abrasion

The percentage of the weight loss must be less than 12 percent;

2.1.2.2.9 Salt Spray Exposure and Ultra Violet Light Exposure

The PVC must show no effect after 3,000 h of salt spray exposure in accordance with ASTM B117. The PVC must show no effect of exposure to ultra violet light with test exposure of 3,000 h, using apparatus Spectral Irradiance of Open Flame Carbon Arc with Daylight Filters and 63 degrees C 145 degrees F, when tested in accordance with practice ASTM D1499 and

ASTM G152;

2.1.2.2.10 Evaluation of Coating After Salt Spray and Ultraviolet Exposure Test

After the salt spray test and exposure to ultraviolet light, ensure the PVC coating does not show cracks nor noticeable change of color, or blisters or splits. In addition, do not allow the specific gravity, tensile strength, hardness and resistance to abrasion to change more than 6 percent, 25 percent, and 10 percent respectively, from their initial values.

2.1.2.3 Wire Tensile strength

The tensile strength of the wire used for the welded wire fabric, spiral binders, lacing wire and stiffeners must be soft medium in accordance with ASTM A641/A641M (Style 1), ASTM A856/A856M (Style 3), and ASTM A809 (Style 4) or hand drawn in accordance with ASTM A853 (Style 2). Base the cross-sectional area of the test specimen on the diameter of the metallic coated wire. All the wires used in the fabrication of gabions [and mattresses] must use the same temper wire in accordance with given order.

2.1.2.4 Weld Shear Strength

2.1.2.4.1 Minimum Average Shear Value

The minimum average shear value in Newtons pounds-force must be 70 percent of the breaking strength of the wire or as indicated in the table as follows, whichever is greater, when tested in accordance with ASTM A974 Section 13.4. Typical minimum average shear strengths as specified are as follows:

TABLE 2
Minimum average shear strength values for the welded mesh

Wire diameter mminch	Min. Av. Shear Strength Nlbs	Min. Shear Strength Nlbs
2.200.087	1300292	1000225
2.700.106	2100472	1600360
3.050.120	2600584	2000450

Deem the material to conform with the requirements for weld shear strength if the average of the test results of the first four specimens or if the average of the test results for all welds tested comply with TABLE 2.

2.1.2.4.2 Panel to Panel Joint Strength

Use the minimum strength of the joined panels, when tested as described in ASTM A974 Section 13.5, as follows:

TABLE 3 Panel to panel joint strength for welded gabions			
Test Description	Gabions, metallic coated (kN/mlb/ft)	Gabions, PVC coated (kN/mlb/ft)	[Revet mattresses] (metallic and PVC
Connection to selvedges	20.41400	17.51200	10.2700
Panel to panel (using lacing wire or ring	20.41400	17.51200	10.2700

The strength values reported in kN/m lb/ft are referred to the unitary width of the specimen. Perform the panel to panel test to demonstrate the ability of the fastening system to achieve the required strength, and indicate the number of wire revolutions for the lacing wire used. Use the same number of wire revolutions in the field installation.

2.1.3 Alternative Wire Fasteners for Gabions[and Mattresses]

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NOTE: The use of steel rings is normally accepted in ASTM A975, for woven wire gabions and mattresses. Stainless steel rings will be used on PVC coated gabions or mattresses which meet the requirements of ASTM A313/A313M. Accepted alternative wire fasteners for welded wire gabions and mattresses are spiral binders, according to ASTM A974. The inclusion of rings for welded gabions is allowed only if proper guarantees over the pull apart, connection strength and long term durability (salt spray) are provided.

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Subject to approval of the Contracting Officer, alternative fastening systems may be used in lieu of lacing wire. Alternative fasteners to lacing wire recommended for woven wire gabions and mattresses, according to ASTM A975, are steel ring fasteners for metallic coated gabions and mattresses, or stainless steel rings for PVC coated gabions and mattresses. For each shipment of wire gabions or mattresses delivered to the site, furnish the Contracting Officer, in duplicate, test reports or records that have been performed during the last year on all material contained within the shipment meets the composition, physical, and manufacturing requirements stated in this specification. Provide ring fasteners for woven wire gabions and mattresses in compliance with the minimum requirements indicated in paragraph Ring Fasteners below, and develop a minimum panel to panel joint strength as indicated in TABLE 1. Alternative fasteners to lacing wire for welded wire gabions and mattresses, according to ASTM A974, are spiral binders. Provide spiral binders for welded wire gabions and mattresses that comply with the minimum requirements indicated in paragraph Spiral Binders below. Ring fasteners may alternatively be used for welded wire gabions or mattresses, provided that they comply with the minimum specified requirements (salt spray and pull-apart resistance). Ensure panel to panel connections for welded gabions and mattresses with ring fasteners develop a minimum joint strength as indicated in TABLE 3. Provide a complete description of the fastener system and a description of a properly installed fastener, including drawings or photographs if necessary. Provide test results that demonstrate that the alternative-fastening system meets the requirements of the specifications, according to the following criteria:

a. That the proposed fastener system can consistently produce a panel to panel joint strength as indicated in the TABLE 1 for double twisted wire mesh gabions and TABLE 3 for welded wire mesh gabions;

b. That the proposed fastener system does not cause damage to the protective coating on the wire;

c. That the Contractor has the proper equipment and trained employees to correctly install the fasteners;

d. That proper installation can be readily verified by visual inspection.

Submit samples of wire fasteners with their certified test records at least 60 days in advance to the Contracting Officer for approval. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

2.1.3.1 Ring Fasteners

The tensile strength of the zinc-coated steel wire, zinc-5 percent aluminum coated mischmetal alloy-coated steel wire and aluminum-coated steel wire used for fasteners must be in accordance with the requirements of ASTM A764, Type A, B, or C, Table 2 or Table 3. Use stainless steel wire for fasteners with tensile strength in accordance with the requirements of ASTM A313/A313M, Type 302, Table 2. Any fastener system must give the number of fasteners required to comply with TABLE 1, in accordance with ASTM A975 (Section 13.1.2) for woven wire gabions and mattresses, and TABLE 3, in accordance with ASTM A974 (Section 7.3), for welded wire gabions and mattresses. Do not install ring fasteners more than 100 mm 4 inches apart. Close each fastener type and overlap the free ends of the fastener a minimum of 25 mm 1 inch. The manufacturer or supplier must state the number of fasteners required for all vertical and horizontal connections for single and multiple basket joining. Approved ring fasteners including fasteners made of stainless steel are subject to the salt spray test and pull-apart resistance test and provide documentation of actual testing of panel to panel connections within the last year by validated laboratories.

2.1.3.1.1 Salt Spray Test

Join a set of two identical rectangular gabion panels, each with a width about 10-1/2 mesh openings along a selvedge wire, by properly installed wire fasteners along the two selvedge wires so that each fastener confines two selvedge and two mesh wires. If the fasteners are also to be used to joint two individual empty gabion baskets, include two additional selvedge wires which are each mechanically wrapped with mesh wires so that each fastener confines four selvedge and four mesh wires. The set of the jointed panels are subject to salt spray test, ASTM B117, for a period of not less than 48 hours. At the end of the test, ensure the fasteners, the selvedge, or mesh wires confined by the fasteners show no rusty spots on any part of the surface excluding the cut ends. Properly install fastener meeting the following requirements:

a. Ensure each interlocking fastener is in a locked and closed position.

b. Close each ring fastener, and overlap the free ends of the fastener a minimum of 25 mm 1 inch.

2.1.3.1.2 Pull-Apart Resistance Test

Mount a new set of the jointed panels, which are prepared by the same method as specified in the salt spray test but without being subject to the 48-hour salt spray test, on a loading machine with grips or clamps such that the panels are uniformly secured along the full width. Design the grips or clamps to transmit only tension forces. The load will then be applied at a uniform rate of 220 N/s 50 lbs/sec until failure occurs. The failure is defined as when the maximum load is reached and a drop of strength is observed with subsequent loading or the opening between any two closest selvedge wires, applicable to a fastener confining either two or four selvedge wires, becomes greater than 50 mm 2 inches at any place along the panel width. The strength of the jointed panels at failure must have a minimum as indicated in TABLE 1 or TABLE 3.

2.1.3.2 Spiral Binders

Spiral binders are defined as a length of metallic coated steel wire or metallic coated steel wire with PVC coating preformed into a spiral, used to assemble and interconnect empty gabion and/or mattress units, and to close and secure stone-filled units. Fabricate spiral binders with the same wire and coating style as the wire mesh. Test requirements for spiral binders must refer to TABLE 3 regarding Metallic Coating, PVC for coating, Tensile Strength, and Panel to Panel Joint Strength.

.2.1.4 Testing

Test records made within one year by certified laboratories and Government agencies will be used to determine the acceptability of the fastening system. Submit samples of wire fasteners and samples of material for fabricating the gabions and mattresses with their certified test records at least 60 days in advance to the Contracting Officer for approval. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

2.1.5 Stone Fill

Submit a certificate or affidavit signed by a legally authorized official of the supplier of the stone fill and the supplier of the natural filter material (se next main paragraph below) that it meets the quality required and gradation limits specified.

2.1.5.1 General

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NOTE: Stones having a lower unit (not less than 2240 kg/m3 140 lb/ft3) may be approved by the Contracting Officer, provided that the design is performed on the selected unit weight and the stone has a performance record to prove its durability.

If stone sources are not listed in the bid documents, the District must ensure that these sources contain stone with required quality and

quantity. It is the Contractor's responsibility to determine that the selected source is capable of supplying the quantities and gradation needed and at the rate needed. Acceptance of a source of stone does not imply acceptance of all material from the source, when such materials are unsuitable as determined by the Contracting Officer.
****

For gabions[and mattresses], the ability to function properly depends upon their stability, which is partly depending upon the rocks filling them. Rock sizes should be chosen to prevent them from falling through the mesh of the gabions [or mattresses]. The rock has also to withstand natural weathering processes during the life of the project that would cause it to breakdown to sizes smaller than the wire mesh opening dimensions. Provide durable rock to fill gabions[and mattresses] and of suitable quality to ensure permanence in the structure and climate in which it is to be used.

2.1.5.1.1 Delivery

Deliver rock to the work site in a manner to minimize its reduction in sizes (breakdown) during the handling of the rock, and place and secure within the assembled and interconnected gabion[or mattress].

2.1.5.1.2 Sources

Select the sources from which the Contractor proposes to obtain the material well in advance of the time when the material will be required in the work. The inclusion of more than 5 percent by weight of dirt, sand, clay, and rock fines will not be permitted. Rock may be of a natural deposit of the required sizes, or may be crushed rock produced by any suitable method and by the use of any device that yields the required size limits chosen in TABLE 4.

2.1.5.1.3 Properties

Provide hard, angular to round, durable rocks and of such quality that they do not disintegrate on exposure to water or weathering during the life of the structure. [Selected stone from the required excavation may be used if satisfying all requirements as to quality and dimensions.] [Obtain all stone from one of the [sources listed below][sources listed at the end of this section]].

2.1.5.1.4 Non-Listed Source

As an option, propose to furnish stone from one non-listed source. The Government [will][may] make such investigations and tests as necessary to determine whether acceptable stone can be produced from the proposed source. Collect suitable samples of stone fill material in the presence of a Government representative and submit to the Contracting Officer for approval prior to delivery of any such material to the work site. Unless otherwise specified, obtain and deliver all test samples at the Contractor's expense to [_____] at least 60 days in advance of the time when placing of the stone-filled gabions [or mattresses] is expected to begin. Suitable tests and/or service records will be used to determine the acceptability of the stone. In the event suitable test reports and service records are not available, as in the case of newly operated sources, the material may be subjected to petrography analysis, specific gravity, absorption, wetting and drying, freezing and thawing, and such other tests as may be considered necessary to demonstrate to the satisfaction of the Contracting Officer that the materials are acceptable for use in the work. All tests will be made by or under the supervision of the Government and at its expense.

2.1.5.2 Stone Quality

Provide stone fill, crushed stone, meeting the quality requirements of ASTM C33/C33M, and freezing and thawing requirements of [ASTM D5312/D5312M][COE CRD-C 144] for the region of the United States in which the structure will be constructed.

2.1.5.3 Gradation

Perform gradation of stone for gabions every 1000 tons placed under this contract in accordance with ASTM C136/C136M. Sizes of rock to fill gabions and mattresses are chosen on the basis of the mesh sizes, the structure's thickness, and within the limits shown in TABLE 4. Within each range of sizes, provide rock large enough to prevent individual pieces from passing through the mesh openings. Each range of sizes may allow for a variation of 5 percent oversize rock by weight, or 5 percent undersize rock by weight, or both.

2.1.5.3.1 Oversize Rock

In all cases, ensure the sizes of any oversize rock allow for the placement of three or more layers of rock within each gabion compartment[and two or more layers of rock within each mattress compartment dependent upon the height of the mattress].

2.1.5.3.2 Undersize Rock

In all cases, place undersize rock within the interior of the gabion or mattress compartment and do not place on the exposed surface of the structure. There is a maximum limit of 5 percent undersize or 5 percent oversize rock, or both, within each gabion[or mattress] compartment. The required rock gradation is reported in Table 4.

TABLE 4
Required rock gradation for gabions [and mattresses]

Type of Structure	Thickness/Height (mm inch	Rock Sizes (mminch)
[Mattresses]	1706	75 - 1303 - 5
[Mattresses]	2309	75 - 1303 - 5
[Mattresses or] Gabions	30012	100 - 2004 - 8
Gabions	500 18 or higher	100 - 2004 - 8

2.1.6 Filter Material

****

NOTE: When a filter layer is required beneath the gabion or mattress foundation, care must be taken to ensure that the minimum thickness is achieved evenly across the surface to be protected. To assure

sufficient relative permeability and drainage, to prevent the migration of slope materials into the filter layer, and for the retention of filter materials by the overlying gabion units, the particle size distribution of the filter material should conform to "Filter Design," Appendix E of EM 1110-2-1913."

Stone-filled units have a potential for becoming impermeable. For extreme cases of long protected slope distances, or any application where large volumes of seepage or captured runoff is anticipated, design consideration should be given to the carrying capacity of the filter material and the need for providing pipe drains through the gabion units.

Although the provision of a pervious filter layer beneath gabion slope protection is preferred, particularly for slopes steeper than 1V on 2H, construction economy may be achieved in some cases through the use of geotextile. The specifications for the geotextile should be in accordance with the instructions contained in Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK.

****

Provide material meeting the quality requirements of ASTM C33/C33M for the region in which the structure is located. Perform the gradation test in accordance with ASTM C136/C136M. Provide filter material consisting of sand and gravel or crushed stone, well graded between the prescribed limits listed below.

[

Sieve Designations US Standard Square Mesh	Percent By Weight Passing
[_____]	[_____]

]

[Provide filter fabrics meeting the provisions of Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK].

PART 3 EXECUTION

3.1 FOUNDATION PREPARATION

Foundation preparation [may][must not] take place on frozen or snow-covered ground. After excavation or stripping, to the extent indicated on the drawings or as directed by the Contracting Officer, remove all remaining loose or otherwise unsuitable materials. Carefully backfill all depressions to grade. If pervious materials are encountered in the foundation depressions, backfill the areas with free-draining materials. Otherwise, backfill the depressions with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Also remove any debris that will impede the proper installation and final appearance of the gabion layer, and carefully backfill and compact the voids as specified above. Immediately prior to placing the material, the Contracting Officer will inspect the prepared foundation surface, and place no material thereon until that area has been approved.

3.2 FILTER PLACEMENT

Spread filter material uniformly on the prepared foundation surface in a manner satisfactory to the Contracting Officer, and to the slopes, lines, and grades as indicated on the drawings or as directed. Placing of filter material by methods, which will tend to segregate particle sizes, will not be permitted. Repair any damage to the foundation surface during the filter placement before proceeding with the work. Compaction of the filter materials will not be required, but it must be finished to present a reasonably even surface free from mounds or windrows.

3.3 ASSEMBLY

3.3.1 Double twisted wire mesh Gabions

Open the gabions and unfold one by one on a flat, hard surface. Gabion units over 1.82 m 6 foot in length usually have an extra shipping fold, which must be removed. Lift up the sides, ends and diaphragms into a vertical position to form an open box shape. Connect the back and the front panels of the gabion to the end panels and center diaphragms. The top corner of the end panels and center diaphragms have a selvedge wire extending approximately 100 mm 4 inches out from the corner edge. Raise the end panels and the diaphragms to a vertical position and wrap the selvedge wire around the edge wire of the top and back panels.

[3.3.2 Double Twisted Wire Mesh Revet Mattresses

****

NOTE: Remove this paragraph if not needed.

****

Lay the mattress on a flat, hard surface. When the units are unfolded for assembly, depending on their length, they will have one or two shipping folds, which must be removed. Fold in the double flap of the side panel and wire to the diaphragm. At the corners, fold the end flaps along the sides and lace up the joint. Assemble each Revet mattress individually, by erecting the sides, ends and diaphragms, ensuring that all creases are in the correct position and the tops of all sides are level.

]3.3.3 Welded Wire Fabric Gabions[and Gabion Mattresses]

Open the gabions[or gabion mattresses] and unfold on a flat, hard surface. Rotate the units into position and join the edges with fasteners for assembly. Where spiral fasteners are used, crimp the ends to secure them in place. Where lacing wire is used, wrap the wire with alternating double and single loops with spacings not to exceed 150 mm 6 inches. Secure ends with two complete revolutions and finish with a one-half hitch. Use the same fastening procedures to secure interior diaphragms and end panels. When two gabions are placed side by side, the two end panels may be connected along the vertical edges with a single spiral fastener.

3.4 LACING OPERATIONS

3.4.1 Double Twisted Wire Mesh Gabions[and Mattresses]

Either lacing wire or ring fasteners are permitted to lace double twisted wire mesh gabions[or revet mattresses].

3.4.1.1 Lacing Wire

When using lacing wire, cut off a piece of wire 1.2 to 1.5 times the length of the edge to be laced. If the edge of the basket is 0.91 m 3 foot long, no more than 1.2 to 1.5 m 4 to 5 feet of wire should be used at a time to lace. For vertical joints, starting at the bottom end of the panel, twist the lacing wire and wrap two times around the bottom selvedge and alternate double and single loops through at intervals no bigger than 100 to 150 mm 4 to 6 inches. Finish the operation by looping around the top selvedge wire. The use of pliers to assemble the units with lacing wire is normally recommended.

3.4.1.2 Steel Wire Ring Fasteners

When steel wire ring fasteners are used, install the rings at the top and bottom connections of the end and center diaphragms. Base the ring spacing on the minimum pull apart strength as specified in TABLE 1. In any case, do not exceed maximum ring spacing along the edges of 0.15 m 6 inches. The use of either a mechanical or a pneumatic fastening tool for steel wire ring fasteners is required. Provide galvanized, stainless steel or Zn-5 percent aluminum-mischmetal alloy coated ring fasteners.

3.4.2 Welded Wire Mesh Gabions[and Mattresses]

Either lacing wire or spiral binders are permitted to lace welded wire mesh gabions[or gabion mattresses]. Place the empty units on the foundation and interconnect with the adjacent unit along the top, bottom and vertical edges using spiral fasteners. Lacing wire may be used in lieu of spiral binders for the interconnection of gabions[or mattresses] as specified above. Base connection with lacing wire or spiral binders on the minimum panel to panel joint strength as specified in TABLE 3. Screw spiral binders along the connecting edges, and then crimp each end to secure the spiral in place. Interconnect each layer of gabions[or mattresses] to the underlying layer along the front, back and sides.

3.5 INSTALLATION AND FILLING

Assemble empty gabion[and mattress] units individually and place on the approved surface to the lines and grades as shown or as directed, with the sides, ends, and erect diaphragms in such a manner to ensure the correct position of all creases and that the tops of all sides are level. Properly stagger all gabion units [horizontally][and vertically] as shown in the construction drawings. Finished gabion[or mattress] structures must have no gaps along the perimeter of the contact surfaces between adjoining units. Connect all adjoining empty gabion units along the perimeter of their contact surfaces in order to obtain a monolithic structure. Securely fasten all lacing wire terminals. Make all joining through selvedge-to-selvedge or selvedge-to-edge wire connection; mesh-to-mesh or selvedge-to-mesh wire connection is prohibited except in the case where baskets are offset or stacked and selvedge-to-mesh or mesh-to-mesh wire connection would be necessary. As a minimum, install a fastener at each mesh opening at the location where mesh wire meets selvedge or edge wire.

a. Place the initial line of basket units on the prepared [filter layer surface][foundation] and adjoining empty baskets set to line and grade, and common sides with adjacent units thoroughly laced or fastened. Place them in a manner to remove any kinks from the mesh and to a uniform alignment. Then partially fill basket units to provide anchorage against deformation and displacement during the filling operation. Place stone in the units as specified in paragraph STONE FILL, subparagraph GRADATION.

b. Correct undue deformation and bulging of the mesh prior to further stone filling. Take care, when placing the stone by hand or machine, to assure that the PVC coating on gabions will not be damaged. Fill all visible faces with some hand placement to ensure a neat and compact appearance and that the void ratio is kept to a minimum.

c. Uniformly overfill gabions [and mattresses] by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements. Gabions [and mattresses] can be filled by any kind of earth-filling equipment, such as a backhoe, gradall, crane, etc. The maximum height from which the stones may be dropped into the baskets is 0.91 to 1.20 m 3 to 4 feet. If PVC coated materials are used, no work is allowed to take place unless the ambient temperature is above -7 degrees C 20 degrees F.

3.5.1 Double Twisted Wire Mesh Gabions

After the foundation has been prepared, place the pre-assembled gabions in their proper location to form the structure. Connect gabions together and align before filling the baskets with rock. Carry out all connections (panel-to-panel) and basket-to-basket as described in paragraph ASSEMBLY. Provide stone fill with a gradation of 0.10 to 0.20 m 4 to 8 inches, as described in paragraph Gradation, and place in 0.30 m 1 foot lifts. Fill cells to a depth not exceeding 0.30 m 1 foot at a time. The fill layer should never be more than 0.30 m 1 foot higher than any adjoining cell. Install stiffeners or internal cross ties in all front and side of the gabions at 1/3 and 2/3 of the height for 0.91 m 3 feet or higher gabions, as the cell is being filled. Install stiffeners in the center of the cells. In 0.46 m 1.5 foot high units, stiffeners or internal crossties are not required. Loop internal cross ties, or alternatively the preformed stiffeners, around three twisted wire mesh openings at each basket face and securely twist the wire terminals to prevent their loosening. Minimize the number of voids by using a well-graded stone in order to achieve a dense, compact stone fill. Connect all corners securely to the neighboring baskets of the same layer before filling the units. When more than one layer of gabions is required, in order for the individual units to become incorporated into one continuous structure, connect the next layer of gabions to the layer underneath after this layer has been securely closed. Overfill gabions uniformly by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements.

[3.5.2 Double Twisted Wire Mesh Revet Mattresses

****

NOTE: Remove this paragraph if not needed.

****

After being assembled, place the revet mattresses in their proper location and securely attach to the adjacent units. For structural integrity, connect all adjoining empty units by means of lacing wire or ring fasteners along the edges of their contact surfaces in order to form a monolithic structure. Place revet mattresses and securely connect while empty. Fill unit by unit; however, several units can be pre-assembled prior to filling the units. Fill revet mattress units with hard, durable, clean stone having a gradation as indicated in paragraph Gradation. Take care to ensure that diaphragm tops are accessible for wiring. On slopes, lay the revet mattress with the 1.83 m 6 foot dimension (width) longitudinally to the slope and progressing up the slope, except for small ditches or where otherwise specified in the project. When the installation is performed on a slope, start the filling of the baskets from the lower side of the bank. Where Revet mattresses are to be placed on steep slopes (3H to 2V), secure the units by hardwood pegs driven into the ground just below the upper end panel, at 1.83 m 6 foot centers, or as specified in the project. When the Revet mattress is to be placed over a geotextile, take care to ensure that any projecting ends of wire are bent upward to avoid puncturing or tearing the cloth. Connect lids securely to the ends of the mattress and to the top sides and diaphragms using alternate double and single loops, or steel wire ring fasteners, as indicated in paragraph FOUNDATION PREPARATION. In case that more adjacent bases are to be covered at one time, use mesh rolls in place of unit size lids. Overfill revet mattresses uniformly by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements.

]3.5.3 Welded Wire Fabric Gabions

After the foundation has been leveled, place the assembled gabions in their proper location to form the structure. Take care to ensure that the top of the diaphragms are aligned correctly. Connect the diaphragms securely by either spiral binders or lacing wire. Connect gabions together and align before filling them with 100 to 200 mm 4 to 8 inch diameter rocks. Provide rock filling material as specified in paragraph Gradation and place in 0.30 m 1 foot lifts. Hand-pack the fill layer carefully and brace to prevent bulging. Provide stiffeners every 0.30 m 12 inch levels for 0.91 m 3 foot or higher gabions. Form stiffeners from lacing wire and place across the corners at 0.30 m 12 inches from the corner, providing a diagonal bracing. Preformed hooked stiffeners can be utilized. Take care to ensure the number of voids is minimized by using a well-graded stone and avoiding large rocks in order to achieve a dense, compact compartment. After each 0.30 m 1 foot lift has been placed, level it for the next lift. Almost all gabion structures consist of more than one course of gabions; in order that the individual gabions may become incorporated into one continuous structure, wire them to neighboring gabions and the course below, before filling. Overfill gabions uniformly by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements.

[3.5.4 Welded Wire Fabric Gabion Mattresses

****
NOTE: Remove this paragraph if not needed.
****

After being assembled, place the gabion mattresses in their proper location and securely attach to the adjacent units. For structural integrity, connect all adjoining empty units by means of lacing wire or spiral binders along the edges of their contact surfaces in order to form a monolithic structure. Place gabion mattresses and securely connect while empty. Fill unit by unit; however, it is recommended that several units be pre-assembled prior to filling the units. Fill gabion mattress units with hard, durable, clean stone having a gradation as indicated in paragraph Gradation. Take care to ensure that diaphragm tops are accessible for wiring.

a. On slopes, lay the Gabion mattress with the 1.83 m 6 foot dimension (width) longitudinal to the bank, with the exception of small ditches or when otherwise specified in project. When the installation is performed on a slope, start the filling of the units from the lower side of the bank. Where Gabion mattresses are to be placed on steep slopes (3H to 2V), secure the units by galvanized pipes driven into the ground inside the upper end panel, at 1.83 m 6 foot centers, or as specified in the project.

b. When the gabion mattress is to be placed over a geotextile, take care to ensure that any projecting ends of wire are bent upward to avoid puncturing or tearing the cloth.

c. Connect lids securely to the ends of the mattress and to the sides and diaphragms using alternate double and single loops, or steel wire ring fasteners, as indicated in paragraph FOUNDATION PREPARATION. In case that more adjacent bases are to be covered at one time, mesh rolls can be used in place of unit size lids. Overfill gabion mattresses uniformly by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements.

]3.5.5 Non-Rectangular Shapes

Gabion[and mattress] units can conform to bends up to a radius of curvature of 18 to 21 m 60 to 70 feet without alterations. Securely connect units together first, and place to the required curvature, holding them in position by staking the units to the ground with hardwood pegs before filling. For other shapes, bevels and miters can be easily formed by cutting and folding the panels to the required angles.

3.6 CLOSING

Secure lids tightly along all edges, ends and diaphragms in the same manner as described for assembling. Adjacent lids may be securely attached simultaneously. Connect panel edges by pulling using the appropriate closing tools where necessary. Do not use single point leverage tools, such as crowbars, which may damage the wire mesh. Then turn in all end wires.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 41 16 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-31 41 16 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-31 41 16 (November 2020)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 31 41 16

METAL SHEET PILING
11/20

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NOTE: This guide specification covers the requirements for metal sheet piling. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Permanent earth retaining structures made with steel sheet piling such as caissons, quay walls, and retaining walls are covered by this section. Temporary structures such as shoring and sheeting are the responsibility of the Contractor and unless required by conditions of the project, are not to be covered by this section. The extent and location of the work to be accomplished should be indicated on the project drawings.

The following information must also be shown on the project drawings:

1. **Location of piles.**
2. **Soil data, where required.**
3. **Pile shape.**
4. **Pile size and weight.**
5. **Length or tip and cut-off elevations.**

****

1.1 DESCRIPTION

Design, furnish, install and test metal sheet piles at the locations indicated on the drawings and specified herein. [Assume test pile[s] will be directed to be placed in [a] location[s] that can be incorporated into the work.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.5M/D1.5	(2020; Errata 1 2022) Bridge Welding Code

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2024b) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A328/A328M	(2024) Standard Specification for Steel Sheet Piling
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium

	Structural Steel
ASTM A690/A690M	(2024) Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments
ASTM A857/A857M	(2007; R 2013) Standard Specification for Steel Sheet Piling, Cold-Formed, Light Gage
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B308/B308M	(2010; R 2020) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

1.3 BASIS OF BID

****

NOTE: Select one of the following options.

****

****

NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of piles must be determined as accurately as possible, prior to bidding, since the unit price per meter (foot) of the piles varies as the length increases or decreases. Refer to Standard Test Method for High-Strain Dynamic Testing of Deep Foundations (ASTM D4945).

Whenever sheet piling section properties greater

than required by design are acceptable, "(Min.)" should be indicated after the applicable value shown in this specification or on the drawings.
****

1.3.1 Contractor's Geotechnical Consultant

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and Pile Dynamic Analysis, to observe test pile installation and production pile installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and must have no employee of employer relationship which could constitute a conflict of interest.

[1.3.2 Lump Sum Payment

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.] [following Table I:

Table 1							
[Location]	Number	Section	[Section Modulus]*	[Moment of Inertia]*	Length (tip to cut-off)	[_____]	[_____]

[*] Section properties should be detailed per foot of wall, in^3 per ft.
[**] Section properties should be detailed per foot of wall, in^4 per ft.]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off, dispose of any cut-offs, pullout, and meet the applicable contract requirements. Include mobilization, pre-drilling, and redriving heaved piles. If, in redriving, it is found that any pile is not of sufficient length to provide the requirements specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be provided and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. If total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; backdriving; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys.]

]1.3.3 Unit Prices

****
NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the

remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
****

1.3.3.1 Steel Sheet Piling, Type [_____], Grade [_____]

1.3.3.1.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials, and work incident thereto.

1.3.3.1.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.3.3.1.3 Unit of Measure

Linear meter foot.

1.3.3.2 Steel Fabricated Sections, Type[s] [_____], Grade [_____]

1.3.3.2.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.3.3.2.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.3.3.2.3 Unit of Measure

Linear meter foot.

1.3.3.3 Steel Sheet Piling - Government Furnished

1.3.3.3.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.3.3.3.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.3.3.3.3 Unit of Measure

Linear meter foot.

1.3.3.4 Aluminum Sheet Piling, Type [_____]

1.3.3.4.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.3.3.4.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.3.3.4.3 Unit of Measure

Linear meter foot.

1.3.3.5 Aluminum Fabricated Sections, Type[s] [_____]

1.3.3.5.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.3.3.5.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.3.3.5.3 Unit of Measure

Linear meter foot.

1.3.3.6 Aluminum Sheet Piling - Government Furnished

1.3.3.6.1 Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear meter foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.3.3.6.2 Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear meter foot. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

1.3.3.6.3 Unit of Measure

Linear meter foot.

1.3.3.7 Cut-Offs

1.3.3.7.1 Payment

When pilings which have not been driven to penetration depths shown are directed to be cut off, except for cut-offs due to excessive battering, a lump sum payment will be made for cutting off each piling.

1.3.3.7.2 Measurement

An additional sum will be paid for each linear meter foot of the portion cut off and measured for payment. For installed pilings directed to be cut off before reaching the penetration depth shown, the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off at the rate of 50 percent of the applicable contract unit price.[No payment will be made for cut-off portions of Government furnished pilings.]

1.3.3.7.3 Unit of Measure

Each.

1.3.3.8 Splices

1.3.3.8.1 Payment

Payment will be made for each piling spliced at the direction of the Contracting Officer to drive the piling to a depth greater than shown and extend it up to the required top elevation. An additional sum will be paid for each linear meter foot of the piling extension at the applicable contract unit price.

1.3.3.8.2 Measurement

Splices will be measured for payment for each piling spliced.

1.3.3.8.3 Unit of Measure

Each.

1.3.3.9 Pulled Pilings

1.3.3.9.1 Payment

The Contractor furnished pilings which have been installed and are pulled at the direction of the Contracting Officer and found to be in good condition will be paid for at the applicable contract unit price for furnishing and installing the pilings in their initial position plus the applicable contract unit price for the cost of pulling.

1.3.3.9.2 Measurement

When such pulled pilings are redriven, an additional amount equal to 50 percent of the applicable contract unit price for furnishing and driving the pilings will be paid for redriving the pilings. This additional price constitutes payment for redriving only. The cost of furnishing, initial driving, and pulling the pilings is to be paid for as specified.

a. Government furnished pilings which are pulled at the direction of the Contracting Officer and found to be in good condition will be paid for at the applicable contract unit price for installing the pilings in their initial position plus an equal amount for the cost of pulling. Such piling when redriven will be paid for at the applicable contract unit cost for installing the pilings.

b. When pilings are pulled and found to be damaged no payment will be made for the initial furnishing and driving or for the pulling of such pilings. Pilings replacing damaged pilings will be paid for at the applicable contract unit prices.

1.3.3.9.3 Unit of Measure

Each.

1.3.3.10 Removal of Sheet Pilings

1.3.3.10.1 Payment

Payment will be made for costs associated with removal of sheet pilings. Payment will cover cost of pulling, cleaning the interlock, sorting, inventorying and storing.

1.3.3.10.2 Measurement

Removal of sheet piling will be made at the applicable contract price per linear meter foot for the removal of sheet pilings.

1.3.3.10.3 Unit of Measure

Linear meter foot.

1.4 NAVY PROJECT PRICE AND PAYMENT PROCEDURES

****

NOTE: Select the applicable paragraph(s) from the following.

****

1.4.1 Basis of Bids

****

NOTE: Use this option for fixed-price contracts.

****

Base bids on pile sections and lengths as indicated. Should the total number of piles or the number of each length vary from that specified as the basis for bidding, an adjustment in the contract price and time for completion will be made. No additional payment will be made for withdrawn, damaged, rejected, or misplaced piles; for any portion of a pile remaining above the cut-off elevation; for backdriving; for cutting off piles, or for any cut off length of piles.

1.4.2 Measurement and Payment

1.4.2.1 NAVFAC PAC Projects

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

1.4.2.2 NAVFAC LANT Projects

Payment will be at the contract unit price per length, multiplied by the total length of acceptable piles actually installed. Base bids on the number of piles with pile length from tip to cutoff, as indicated, and on the total length of piling from tip to cutoff as specified in the document titled "Instructions to Bidders." Include in bid a unit price per unit length piling based on the quantity stated in the document titled "Instructions to Bidders." If the Contracting Officer requires an increase or a decrease in length of piles furnished and installed, the contract price will be adjusted in accordance with the Contract Clauses of the contract. The unit price bid will be used for upward or downward adjustment of the quantity subject to provisions of FAR 52.211-18, Variation in Estimated Quantities.

1.5 ESTIMATED QUANTITIES

The estimated quantities of sheet piling listed in the unit price schedule of the contract, as to be furnished by the Contractor, are given for bidding purposes only. Sheet piling quantities for payment will consist of the linear meters feet of piling acceptably installed [and removed]. Installed quantities will consist of all piling including fabricated sections driven between the required top and bottom elevations of pilings plus any additions thereto resulting from changes in design or alignment as provided in paragraph DRIVING. [Removed quantities will consist of the lengths of piling pulled from below the ground level.]

1.6 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Interlock joint tension strength requirements should be deleted except for flat, or straight web, pilings used in radial or transverse tension applications.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G, [_____]

[Contractor's Geotechnical Consultant Documentation; G, [_____]

] Testing Agency Qualifications; G, [_____]

[Instrumentation and Monitoring Program Report; G, [_____]

] SD-02 Shop Drawings

Metal Sheet Piling; G, [_____]

Pile Splicing; G, [_____]

Pile Placement; G, [_____]

As-Driven Survey; G, [_____]

Pile Shoe; G, [_____]

SD-03 Product Data

Driving

Pile Driving Equipment; G, [_____]

Delivery, Storage, and Handling; G, [_____]

Pulling and Redriving; G, [_____]

[Interlocked Joint Strength in Tension Test Procedures; G, [_____]

] SD-05 Design Data

Procedure for Insufficient Pile Length; G, [_____]

SD-06 Test Reports

Materials Tests

[Interlocked Joint Strength in Tension Test

] SD-07 Certificates

Pile Shoe; G, [_____]

Welding Certifications; G, [_____]

Steel Plant Certificate; G, [_____]

SD-11 Closeout Submittals

Pile Driving Record; G, [_____]

1.7 DELIVERY, STORAGE, AND HANDLING

Conform all delivery, storage, and handling of materials to the requirements specified herein. Develop and submit plans for the delivery, storage, and handling of piles. Submit delivery, storage, and handling plans for piles at least 30 days prior to delivery of piles to the job site.

1.7.1 Delivery and Storage

Materials delivered to the site must be new and undamaged and must be accompanied by certified test reports. Provide the manufacturer's logo and mill identification mark on the sheet piling as required by the referenced specifications. Store and handle sheet piling in the manner recommended by the manufacturer to prevent permanent deflection, distortion or damage to the interlocks; as a minimum, support on level blocks or racks spaced not more than 3 m 10 feet apart and not more than 0.60 m 2 feet from the ends. Storage of sheet piling should also facilitate required inspection activities and prevent damage to coatings and corrosion protection prior to installation.

1.7.2 Handling

Lift piles to ensure that the maximum permissible curvature is not exceeded. Holes may be burned above the cutoff length for lifting piles into the leads. If there is evidence of pile damage during driving due to the holes, Contracting Officer may forbid the burning of holes. Do not damage piles when dragging piles across the ground or barge deck.

Inspect piles for excessive curvature and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Curvature in the pile must be measured with the pile laying on a flat surface and is the distance between the pile at the mid-length of the pile and the flat surface. Straightness of the sections of piles must conform to AWS D1.5M/D1.5, Section 3.5.1.1. Piles having excessive curvature will be rejected.

1.7.3 Damaged Piles

Inspect each pile for straightness and structural damage before transporting them to the project site and immediately prior to placement in the driving leads. Bring any damage to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

Any pile damaged by reason of internal defects or by improper driving must be corrected by one of the following methods approved by the Engineer for the pile in question:

a. The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile.

b. One or more replacement piles are driven adjacent to the defective pile.

c. A Pile Dynamic Analysis and/or low integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

A pile driven below the specified butt elevation must be corrected by one of the following methods approved by the Engineer:

a. The pile is spliced (if approved).

b. A sufficient portion of the footing is extended down to properly embed the pile.

A pile driven out of its proper location or out of plumb as approved by the Engineer, must be corrected by one of the following methods approved by the engineer:

a. One or more replacement piles are driven next to the pile in question.

b. As directed by the structural engineer.

1.8 MATERIAL CERTIFICATES

For each shipment, submit certificates identified with specific lots prior to installing piling. Include in the identification data piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.

[1.9 INTERLOCKED JOINT TENSION TEST

****

NOTE: Include this paragraph only when the design utilizes straight web metal sheet piles, such as a cellular cofferdam. This should not be included for Z-type sheet piles.

****

Submit, for approval, the procedure for testing the tension strength of piling interlocks prior to testing sheet piling.

]PART 2 PRODUCTS

2.1 METAL SHEET PILING

****

NOTE: ASTM A328/A328M covers one grade of steel sheet piling for general use. ASTM A572/A572M covers three grades (yield strengths of 290, 345, 414 MPa 42, 50, 55, 60 and 65 ksi) of steel available for high strength steel sheet piling, with ASTM A572/572M grade 345MPa 50ksi being the most common. ASTM A690/A690M covers one grade of steel available for high strength steel sheet piling for use where greater resistance to marine splash zone conditions is required. Availability of sheet piling sizes and grades should always be verified as part of the design. Each of the ASTM Specifications contains "Supplementary Requirements" for use when desired by the purchaser. Some of these are provided for and described in the individual ASTM specification; others are standardized, and are indicated only by number and title, with their description found in ASTM A6/A6M.

Hot-rolled straight web steel sheet piling sections are suitable for applications where interlocked joint strength in tension or section stability is a primary design requirement. Section stability (Biaxial Stress) is a consideration in highly stressed applications only. Cold-formed straight web steel sheet piles should not be used.

Hot-rolled z-type steel sheet pile sections have tighter interlocks and are suitable for applications where reduced permeability through the wall is a primary design requirement.

Cold-formed steel sheet pile sections are suitable for applications where the permeability through the

wall is not a primary design requirement. Cold-formed sheet piles typically have a hook and grip interlock which typically has the highest permeability rates. Cold formed sheet piling will not be used in I-walls that act as a flood barrier. This is due to the much greater permeability of the lapped connections between the sheets compared to the ball-and-socket interlock connections in hot rolled sheet piling.

Higher section modulus and stiffness (moment of inertia) of a z-type steel sheet pile improves integrity during driving and allows forces to be redistributed laterally along the wall at changes in wall alignment, in weak soil zones or when the I-wall undergoes wave loadings that vary along the length of the wall. The additional strength also provides some redundancy to sections that must bridge across localized weak zones in the foundation material.

For applications in salt or brackish water use the most economical of a ASTM A690/A690M steel sheet piling which offers greater corrosion resistance or a ASTM A328/A328M steel sheet piling with a protective coating in the splash zone. A protective coating should be applied to a ASTM A690/A690M sheet piling in the splash zone of waterway bulkheads located in salt or brackish water.

Corrosion protection should be provided where piling is exposed to an adverse environment. Choose system(s) based on economics and potential hazards due to sheet piling system failure; more than one system may be necessary depending on conditions above and below the splash zone. While ASTM A690/A690M is suggested for marine environments, its use alone without protective measures may not be effective enough.

Aluminum sheet piling sections are suitable for use in applications requiring moderate bending resistance and minimal design interlocked joint strength in tension. Non-draining, clay-muck soils and soils and water with a ph outside the range of 4.5 to 8.5 and containing chlorides, sulfates or heavy metals (copper, lead, tin, mercury and cobalt) are corrosive to aluminum and should be avoided. Protective coatings or cathodic protection can be used to provide longer service life to aluminum piling in corrosive environments.

****

Submit detail drawings for sheet piling, including fabricated sections, showing complete piling dimensions and details, driving sequence and location of installed piling.

a. Include in the drawings details of top protection, special reinforcing tips, tip protection, lagging, splices, fabricated additions to plain piles, cut-off method, corrosion protection, and dimensions of templates and other temporary guide structures for installing piling. Provide details of the method for handling piling to prevent permanent deflection, distortion or damage to piling interlocks.

b. Metal sheet piling must be [hot-rolled steel sections conforming to [ASTM A328/A328M] [ASTM A572/A572M, Grade [_____], [Type [_____]] [, interlocked joint strength in tension as shown]] [ASTM A690/A690M [, interlocked joint strength in tension as shown (for flat web sheet piles)]] [hot-rolled, light-duty steel sections conforming to ASTM A572/A572M, Grade [42,][55,][60,][or 65].]] [cold-formed steel sections formed from hot-rolled steel meeting the chemical and mechanical requirements of [ASTM A328/A328M] [ASTM A572/A572M, Grade [_____], Type [_____]] [ASTM A690/A690M]] [cold-formed steel sections conforming to ASTM A857/A857M, Grade [_____]] [extruded aluminum sections fabricated from aluminum conforming to [ASTM B221M ASTM B221,] [ASTM B308/B308M,] Alloy 6061, Temper T6.]

c. For protection of sheet piling, coat it in accordance with Section [09 97 02 PAINTING: HYDRAULIC STRUCTURES] [and] [provide cathodic protection in accordance with Section [26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM] [_____]].

2.1.1 Interlocks

The interlocks of sheet piling must be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed.

2.1.2 General Requirements

****

NOTE: Designers should contact suppliers to verify current availabilities and lead times. Based upon the design requirements for each piling section select the most suitable corresponding section from manufacturer's product specification tables or other commercial sources and place the pertinent section properties of this section on the drawings as minimum requirements.

Z-type sheet pile develop a maximum resistance to bending per unit weight and are particularly adapted to cantilever and anchored type retaining walls.

Straight-Web (S) sections have their interlocks designed for maximum flexibility and tensile strength and are particularly adapted to cellular retaining walls and cellular cofferdam construction.

Take consideration of which section properties are crucial to the design of the wall. Properties such as section modulus, moment of inertia, and minimum thickness can be listed.

Interlock types for z-type sheet piles, such as larssen or ball and socket, can also be specified if it is crucial to the performance of the design of

the wall. Cold formed sheet piles generally have the highest permeability rates with their hook and grip interlocks.

****

Provide sheet piles with minimum section modulus, moment of inertia, shape, and size as specified in the [drawings] [plans] [contract document][design]. Sheet piling [including special fabricated sections] must be [full-length] sections of the dimensions shown. [Provide fabricated sections conforming to the requirement and the piling manufacturer's recommendations for fabricated sections.] [Fabricated sections connecting cofferdam cells and adjacent arcs composed of pilings from different manufacturers must be Y-sections fabricated from the respective manufacturer's pilings.] [Fabricated tees, wyes and cross pieces must be fabricated of piling sections with a minimum web thickness of 13 mm 1/2 inch.] [Straight web sheet piling to be placed in a circular cell or a connecting arc must be of the same manufacture.] Provide sheet piling with standard lifting holes. Metalwork fabrication for sheet piling must be as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.2 APPURTENANT METAL MATERIALS

Provide metal plates, shapes, bolts, nuts, rivets and other appurtenant fabrication and installation materials conforming to manufacturer's standards and to the requirements specified in the respective sheet piling standards and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Requirements for material tests, workmanship and other measures for quality assurance must be as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide manufacturer's steel plant certificate for Government review and approval.

2.3.1 Materials Tests

Submit certified materials tests reports showing that sheet piling and appurtenant metal materials meet the specified requirements, for each shipment and identified with specific lots prior to installing materials. Material test reports must meet the requirements of ASTM A6/A6M. Perform materials tests conforming to the following requirements. Sheet piling and appurtenant materials must be tested and certified by the manufacturer to meet the specified chemical, mechanical and section property requirements prior to delivery to the site. Testing of sheet piling for mechanical properties must be performed after the completion of all rolling and forming operations. Testing of sheet piling must meet the requirements of ASTM A6/A6M.

2.3.2 Interlocked Joint Strength in Tension Test

****

NOTE: This is for straight web sheet pile only. This is not be included for z-type sheet pile.

****

Submit the procedure for testing sheet piling interlocked joint strength in tension, prior to testing piling. [The interlocked joint strength in tension test must conform to the piling manufacturer's standard test, include testing at least two 75 mm 3 inch long coupons taken randomly from different as-produced pilings of each heat and must be approved.] Submit a certified report showing results based on approved testing procedures.

2.4 PILE DRIVING EQUIPMENT

Submit complete descriptions of sheet piling driving equipment including hammers, [jetting equipment,] extractors, protection caps and other installation appurtenances, prior to commencement of work. Descriptive information includes manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, and templates. Provide pile driving equipment conforming to the following requirements. Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, hammer cushions, pile cushions, leads, extractors, jetting equipment, and preboring equipment at least 30 days prior to commencement of work.

2.4.1 Driving Hammers

****

NOTE: Insert desired energy ratings in this paragraph. Hammers with energy ratings between 11,860 and 21,700 J 8,750 and 16,000 foot pounds are recommended.

****

Hammers must be steam, air, or diesel drop, single-acting, double-acting, differential-acting[, or vibratory][or press-in] type. The driving energy of the hammers must be between [_____] and [_____] J foot-pounds as recommended by the manufacturer for the piling weights and subsurface materials to be encountered. Repair damage to piling caused by use of a pile hammer with excess delivered force or energy.

2.4.2 Jetting Equipment

Jetting [may be used at no additional cost to the Government] [will not be permitted]. [Jetting equipment must have not less than two removable or fixed jets of the water or combination air-water type. Water jets must be designed so that the discharge volume and pressure are sufficient to freely erode the material under and adjacent to the piling.]

PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Pile Length Markings

Mark each pile prior to driving with horizontal lines at 305 mm one foot intervals. Mark the interval number on pile every 1.52 m 5 feet from pile tip.

3.2 EARTHWORK

Perform in accordance with Section 31 00 00 EARTHWORK. Pre-excavation [will] [will not] [be permitted.] [permitted to a maximum depth [of [_____] meters feet below [_____]] [as indicated]]. Backfill as indicated.

3.3 INSTALLATION

3.3.1 Placing and Driving

3.3.1.1 Placing

****

NOTE: When long piles are being driven, templates are of value. Long piles are very flexible and damage easily. Use templates to keep piles vertical.

****

Submit a written description of the site specific pile installation procedures for Government review and approval. Pile placement installation drawings and details must also be provided.

Any excavation required within the area where sheet pilings are to be installed must be completed prior to placing sheet pilings. Pilings properly placed and driven must be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

[a. Pilings to be placed in cofferdam cells and connecting arcs must be picked up and completely threaded to demonstrate that they slide freely in interlock.]

b. [a.][b.] Pilings must be carefully located as [indicated] [or] [directed.] Pilings must be placed plumb with out-of-plumbness not exceeding [10] [22] mm per meter [1/8] [1/4] inch per foot of length and true to line. Place the pile so the face will not be more than 150 mm 6 inches from vertical alignment at any point. Top of pile at elevation of cut-off must be within 13 mm 1/2 inch horizontally and 50 mm 2 inches vertically of the location indicated. Manipulation of piles to force them into position will not be permitted. Check all piles for heave. Re-drive all heaved piles to the required tip elevation.

c. [b.][c.] Provide temporary wales, templates, [master pilings] [current deflectors] or guide structures to ensure that the pilings are placed and driven to the correct alignment. Use a system of structural framing sufficiently rigid to resist lateral and driving forces and to adequately support the sheet piling until design tip elevation is achieved. Use two templates, at least, when placing each piling [at third points] [not less than 6 m 20 feet apart]. Templates must not move when supporting sheet piling. Fit templates with wood blocking to bear against the web of each alternate sheet pile and hold the sheet pile at the design location alignment. Provide outer template straps or other restraints as necessary to prevent the sheets from warping or wandering from the alignment. Mark template for the location of the leading edge of each alternate sheet pile. If in view, also mark the second level to assure that the piles are vertical and in position. If two guide marks cannot be seen, other means must be used to keep the sheet pile vertical along its leading edge.

[d. [c.][d.] Master pilings must be used to maintain plumbness and proper configuration in placing cofferdam cells over 27 m 90 feet in height in water flowing at a velocity of more than 1.2 m/s 4 feet per second.]

3.3.1.2 Driving

****

NOTE: When hard driving or driving through rocky soil or debris is anticipated, require addition of tip protection to prevent damage to sheet piling.

Jetting should generally not be permitted for:

1. Piles dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Piles subject to uplift.

3. Piles adjacent to existing structures.

4. Piles in closely spaced clusters unless the load capacity is confirmed by tests and unless all jetting is done before final driving of any pile in the cluster.

Pre-augering or spudding should generally not be permitted for piles dependent on side friction in fine-grained, low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

The press-in pile driving method can be used for reduction of noise and/or vibration associated with sheet pile driving; however, site and soil conditions will need to be considered.

****

Submit records of the completed sheet piling driving operations, including a system of identification which shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations of installed piling. [The format for driving records must be as directed.] [Prior to driving pilings in water, paint a horizontal line on both sides of each piling at a fixed distance from the bottom so that it will be visible above the water line after installation. This line must indicate the profile of the bottom elevation of installed pilings and potential problem areas can be identified by abrupt changes in its elevation.] Drive pilings with the proper size hammer and by approved methods so as not to subject the pilings to damage and to ensure proper interlocking throughout their lengths.

a. Maintain driving hammers in proper alignment during driving operations by use of leads or guides attached to the hammer. [Caution must be taken in the sustained use of vibratory hammers when a hard driving condition is encountered to avoid interlock-melt or damages. Discontinue the use of vibratory hammers and impact hammers employed when the penetration rate due to vibratory loading is 300 mm one foot or less per minute.]

b. Employ a protecting cap in driving when using impact hammers to prevent damage to the tops of pilings. [Use cast steel shoe to prevent damage to the tip of the sheet piling. Submit pile shoe installation details and material data for Government review and approval prior to use in the field.] Remove and replace pilings damaged during driving or driven out of interlock at the Contractor's expense. [Store Government furnished pilings, damaged during driving, at the site as directed.]

c. Drive pilings without the aid of a water jet [unless otherwise authorized]. [Perform authorized jetting on both sides of the pilings simultaneously; discontinue it when the pile tip is approximately 1.5 m 5 feet above the ["calculated"] [indicated] pile tip elevation and make the final 1.5 m 5 feet of penetration by driving. Before commencing the driving of the final 1.5 m 5 feet, firmly seat the pile in place by the application of a number of reduced energy hammer blows.]

d. Take adequate precautions to ensure that pilings are driven plumb. Where possible, drive Z-pile with the ball end leading. If an open socket is leading, a bolt or similar object placed in the bottom of the interlock will minimize packing material into it and ease driving for the next sheet. If at any time the forward or leading edge of the piling wall is found to be out-of-plumb in the plane of the wall the piling being driven must be driven to the required depth and tapered pilings must be provided and driven to interlock with the out-of-plumb leading edge or other approved corrective measures must be taken to insure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling must be 10 mm per meter 1/8 inch per foot of length.

e. Pilings in each run or continuous length of piling wall must be driven alternately in increments of depth to the required depth or elevation. No piling will be driven to a lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. Incrementally sequence driving of individual piles such that the tip of any sheet pile must not be more than 1.2 m 4 feet below that of any adjacent sheet pile. When the penetration resistance exceeds five blows per 25 mm inch, the tip of any sheet pile must not be more than 0.6 m 2 feet below any adjacent sheet pile. [For cofferdam cells the driving increments must be such that no piling leads the adjacent piling by more than [_____] mm feet and the direction of advancing the driving hammer must be reversed after each pass around the cell.] If the piling next to the one being driven tends to follow below final elevation it may be pinned to the next adjacent piling.

f. If obstructions restrict driving a piling to the specified penetration, the obstructions must be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical, make changes in the design alignment of the piling structure as directed to ensure the adequacy and stability of the structure. Pilings must be driven to depths shown and must extend up to the elevation indicated for the top of pilings. [Piling driven to rock must be seated individually on the rock.] A tolerance of [_____] mm inches above the indicated top elevation will be permitted. [At least the first two sheets of the connecting arcs adjacent to the main cells must be driven in the cofferdam cells prior to filling the cells.] Pilings must not be driven within 30 m 100 feet of concrete less than 7 days old.

g. Pre-augering or spudding of piles [may be used at no additional cost to the Government] [will not be permitted]. [Discontinue pre-augering or spudding approximately [_____] meters feet above the [calculated] [indicated] pile tip elevation. Drive the pile the final [_____] meters feet of penetration].

3.3.2 Cutting-Off and Splicing

Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance must be cut off to the required elevation. Pilings driven below the required top elevation and pilings damaged by driving and cut off to permit further driving must be extended as required to reach the top elevation by splicing when directed at no additional cost to the Government. Submit procedure for insufficient pile length. Provide pile splicing information and details for Government review and approval prior to installation in the field. [If directed, pilings must be spliced as required to drive them to depths greater than shown and extend them up to the required top elevation.]

a. Pilings adjoining spliced pilings must be full length unless otherwise approved. [If splices are allowed in adjoining pilings, the splices must be spaced at least [_____] m feet apart in elevation.] Splicing of pilings must be as indicated. Ends of pilings to be spliced must be squared before splicing to eliminate dips or camber. Pilings must be spliced together with concentric alignment of the interlocks so that there are no discontinuities, dips or camber at the abutting interlocks. Spliced pilings must be free sliding and able to obtain the maximum swing with contiguous pilings. Welding of splices must conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop and field welding, qualification of welding procedures, welders, and welding operators must be in accordance with AWS D1.1/D1.1M. Submit welding certifications for all welders and welding operators for Government review and approval.

b. The tops of pilings excessively battered during driving must be trimmed when directed, at no cost to the Government. Piling cut-offs [except for Government furnished pilings] will become the property of the Contractor and must be removed from the site.

c. Cut holes in pilings for bolts, rods, drains or utilities in a neat and professional manner, as shown or as directed. Use a straight edge in cuts made by burning to avoid abrupt nicks. Bolt holes in steel piling must be drilled or may be burned and reamed by approved methods which will not damage the surrounding metal. [Bolt holes in aluminum pilings must be drilled.] Holes other than bolt holes must be reasonably smooth and the proper size for rods and other items to be inserted. [All holes in steel pilings on the wet side of cofferdams must be made watertight by welding steel plates over the holes after the piling installation is completed.] Do not use explosives for cutting.

3.3.3 Inspection of Driven Piling

Perform continuous inspection during pile driving. Inspect all piles for compliance with tolerance requirements. Bring any unusual problems which may occur to the attention of the Contracting Officer. Inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock must be removed and replaced at the Contractor's expense. [Use divers to inspect underwater interlocked joints of cofferdam sheet piling. Government divers may also inspect the interlocked joints. The inspection of cofferdams must be performed after driving is completed, prior to filling each cell and connecting arc, and within 48 hours after filling each cell and arc.]

3.3.4 Pulling and Redriving

Submit the proposed method of pulling sheet piling, prior to pulling any piling. Pull, as directed, selected pilings after driving to determine the condition of the underground portions of pilings. Any piling so pulled and found to be damaged, to the extent that its usefulness in the structure is impaired, must be removed and replaced at the Contractor's expense. Pilings pulled and found to be in satisfactory condition must be redriven when directed. [Government furnished pilings pulled and not redriven must be stored as directed.]

[3.3.5 Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM E329 for testing indicated, as documented according to ASTM D4945, and approved by the Contracting Officer.

]3.3.6 Survey Data

After the driving of each pile group is complete and before superimposed concrete is placed, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Submit an as-driven survey showing actual location and top elevation of each [production pile] [test pile] within [7][_____] calendar days of completing the pile installation. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a land surveyor licensed in [_____].

[3.4 DRAINAGE

****

NOTE: Include this paragraph in cases where sheet pile walls are not designed to retain saturated soils and drainage behind the sheet pile wall is required.

****

Backfill material behind the sheet piling must be free draining and in accordance with Section 31 00 00 EARTHWORK.[Install drainage system and weep holes as shown in the [contract documents] [plans].]

][3.5 ANCHORS

****

NOTE: Include this paragraph only when tiebacks (anchors) are required to support sheet pile wall.

****

Conform to Section 31 68 13 SOIL AND ROCK ANCHORS.

]3.6 REMOVAL

The removal of sheet pilings must consist of pulling, sorting, cleaning the interlocks, inventorying and storing previously installed sheet pilings as shown and directed.

3.6.1 Pulling

The method of pulling piling must be approved. Provide pulling holes in pilings, as required. Extractors must be of suitable type and size. Exercise care during pulling of pilings to avoid damaging piling interlocks and adjacent construction. If the Contracting Officer determines that adjacent permanent construction has been damaged during pulling, the Contractor will be required to repair this construction at no cost to the Government. Pull pilings one sheet at a time. Pilings fused together must be separated prior to pulling, unless the Contractor demonstrates, to the satisfaction of the Contracting Officer, that the pilings cannot be separated. The Contractor will not be paid for the removal of pilings damaged beyond structural use due to proper care not being exercised during pulling.

3.6.2 Sorting, Cleaning, Inventorying and Storing

Pulled pilings must be sorted, cleaned, inventoried and stored by type into groups as:

a. Piling usable without reconditioning.

b. Piling requiring reconditioning.

c. Piling damaged beyond structural use.

3.7 INSTALLATION RECORDS

Maintain a pile driving record for each sheet pile driven. Indicate on the installation record: installation dates and times, type and size of hammer, rate of operation, total driving time, dimensions of driving helmet and cap used, blows required per meter foot for each meter foot of penetration, final driving resistance in blows for final 150 mm 6 inches, pile locations, tip elevations, ground elevations, cut-off elevations, and any reheading or cutting of piles. Record any unusual pile driving problems during driving. Submit complete records to the Contracting Officer.

[3.8 VIBRATION CONTROL

****

NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project.

****

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs][and geophones] within a distance of 61 meters 200 feet from the pile driving activity. [Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [five] years of experience in vibration monitoring. A minimum of [28] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient vibrations. The vibration during the pile driving activities must be limited to [a peak particle velocity of not more than 5 cm 2 inches per second] [the limits mentioned in the [contract documents]]. [Determine appropriate vibration limits as per [US Bureau of Mines] [American Association of State Highway and Transportation Officials (AASHTO)] guidelines.]During pile driving activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity causing the vibration until [the Vibration consultant and the Contracting Officer] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.9 NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the pile driving operations. [Perform noise monitoring using [noise meters][, and][_____]]. [Engage the services of a qualified, independent noise consultant, accept able to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [five] years of experience in noise monitoring. A minimum of [28] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient noise levels. [The noise limits are mentioned in the [plan] [contract documents]]. [Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines]. During pile driving activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity and install noise mitigation measures.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.10 PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform preconstruction condition survey of [structures] [and utilities] [within 61 meters 200 feet of the pile driving activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

][3.11 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile driving activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements. Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement [and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile driving. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile driving when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile driving activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 41 16.16 (May 2023)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-31 41 16.16 (May 2023)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 31 41 16.16

SYNTHETIC SHEET PILING

05/23

****

NOTE: This guide specification covers the requirements for synthetic sheet piling. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Permanent earth retaining structures made with PVC or FRP sheet piling such as bulkheads, quay walls, flood walls, cutoff walls, and retaining walls are covered by this section. Temporary structures such as shoring and sheeting are the responsibility of the Contractor and unless required by conditions of the project, are not to be covered by this section. The extent and location of the work to be accomplished should be indicated on the project drawings.

The following information must also be shown on the project drawings:

1. Location of piles.
2. Soil data, where required.
3. Pile shape.
4. Allowable moment.
5. Length or tip and cut-off elevations.
6. Waler types, sizes, and locations, where required.
7. Tie-rod or soil anchor size, spacing and material, where required.
8. Anchorage type, size, and location, where required.

NOTE: This specification is intended for the use of NEW synthetic sheet piling. Synthetic structural design is often deflection-controlled instead of strength-controlled. Be sure to check or require deflection limits for serviceability. An example of a maximum deflection limit is less then 2 percent of the span; such as the distance from the lowest wale support to the ground line. Typically, it is more economical to design PVC sheet pile walls as an anchored wall system. For background information on synthetic piling and considerations, see: USACE EM 1110-2-2502, USACE ERDC/CRREL LR-03-19 A Study of the Long-term Applications of Vinyl Sheet Piles, USACE Interim Report - General Design Guide: PVC Sheet Pile, ASCE Pre-Standard for Load & Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D2343	(2017) Standard Test Method for Tensile Properties of Glass Fiber Strands, Yarns, and Rovings Used in Reinforced Plastics
ASTM D3917	(2015a) Standard Specification for Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Pultruded Shapes
ASTM D4216	(2017) Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) and Related PVC and Chlorinated Poly (Vinyl Chloride) (CPVC) Building Products Compounds
ASTM D4385	(2010) Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products
ASTM D5379/D5379M	(2019; E 2021) Standard Test Method for Shear Properties of Composite Materials by the V-Notched Beam Method
ASTM D6641/D6641M	(2016; E 2021) Standard Test Method for Compressive Properties of Polymer Matrix Composite Materials Using a Combined Loading Compression (CLC) Test Fixture
ASTM D7290	(2006; R 2022) Standard Practice for Evaluating Material Property Characteristic Values for Polymeric Composites for Civil Engineering Structural Applications
ASTM D8427	(2021) Standard Specification for Rigid Poly Vinyl Chloride (PVC) Exterior Profiles Used for Sheet Piling
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E548	(1994; E 1995) Standard Guide for General Criteria Used for Evaluating Laboratory Competence

1.2 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project

specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
****

1.2.1   [PVC Sheet Piling, Type [_____]][FRP Sheet Piling, Type [_____]]

1.2.1.1   Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing, and installing piling including placing, driving, cutting holes and other materials and work incident thereto.

1.2.1.2   Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear foot. For installed pilings directed to be cut off before reaching the penetration depth indicated, the portion cut off will be measured for payment as the difference between the total length of piling indicated for that location and the length of piling installed below the point of cut-off.

1.2.1.3   Unit of Measure

Unit of measure: linear meterfoot.

1.2.2   [PVC Sheet Piling - Government Furnished] [FRP Sheet Piling - Government Furnished]

1.2.2.1   Payment

Payment for sheet piling quantities will be made at the applicable contract price per linear foot for furnished and installed sheet piling. Payment will cover all cost of furnishing, handling, storing, and installing piling including placing, driving, cutting holes and other materials and work incident thereto [except the cost of furnishing piling will not be included in the contract price for Government furnished piling].

1.2.2.2   Measurement

The length of sheet piling installed [and removed] will be measured to the nearest tenth of a linear foot. For installed pilings directed to be cut off before reaching the penetration depth indicated, the portion cut off will be measured for payment as the difference between the total length of piling indicated for that location and the length of piling installed below the point of cut-off.

1.2.2.3   Unit of Measure

Unit of measure: linear meterfoot.

1.2.3   Cut-Offs

1.2.3.1   Payment

When pilings which have not been driven to penetration depths indicated are directed to be cut off, except for cut-offs due to excessive battering, a lump sum payment will be made for cutting off each piling.

1.2.3.2 Measurement

An additional sum will be paid for each linear meter foot of the portion cut off and measured for payment. For installed pilings directed to be cut off before reaching the penetration depth indicated, the portion cut off will be measured for payment as the difference between the total length of piling indicated for that location and the length of piling installed below the point of cut-off at the rate of 50 percent of the applicable contract unit price.[No payment will be made for cut-off portions of Government furnished pilings.]

1.2.3.3 Unit of Measure

Unit of measure: linear meterfoot.

1.2.4 Splices

Splicing of [PVC] [FRP] sheet piling is prohibited.

1.2.5 Pulled Pilings

1.2.5.1 Payment

The Contractor furnished pilings which have been installed and are pulled at the direction of the Contracting Officer and found to be in good condition will be paid for at the applicable contract unit price for furnishing and installing the pilings in their initial position plus an equal amount for the cost of pulling.

1.2.5.2 Measurement

When such pulled pilings are redriven, an additional amount equal to 50 percent of the applicable contract unit price for furnishing and driving the pilings will be paid for redriving the pilings. This additional price constitutes payment for redriving only. The cost of furnishing, initial driving, and pulling the pilings is to be paid for as specified.

a. Government furnished pilings which are pulled at the direction of the Contracting Officer and found to be in good condition will be paid for at the applicable contract unit price for installing the pilings in their initial position plus an equal amount for the cost of pulling. Such piling when redriven will be paid for at the applicable contract unit cost for installing the pilings.

b. When pilings are pulled and found to be damaged no payment will be made for the initial furnishing and driving or for the pulling of such pilings. Pilings replacing damaged pilings will be paid for at the applicable contract unit prices.

1.2.5.3 Unit of Measure

Unit of measure: each.

1.2.6 Removal of Sheet Pilings

1.2.6.1 Payment

Payment will be made for costs associated with removal of sheet pilings which have been installed and are removed at the direction of the Contracting Officer. Payment will cover the cost of pulling, cleaning the interlock, sorting, inventorying, and storing. No payment will be made if the pulled pilings are found to be defective or damaged due to Contractor negligence.

1.2.6.2 Measurement

Removal of sheet piling will be made at the applicable contract price per linear meter foot.

1.2.6.3 Unit of Measure

Unit of measure: linear meterfoot.

1.3 NAVY REQUIREMENTS

****

NOTE: Select the applicable paragraph(s) from the following.

****

1.3.1 Basis of Bids

****

NOTE: Use this option for fixed-price contracts.

****

Base bids on pile sections and lengths as indicated. Should the total number of piles or the number of each length vary from that specified as the basis for bidding, an adjustment in the contract price and time for completion will be made. No additional payment will be made for withdrawn, damaged, rejected, or misplaced piles; for any portion of a pile remaining above the cut-off elevation; for backdriving; for cutting off piles, or for any cut off length of piles.

1.3.2 Measurement and Payment

1.3.2.1 NAVFAC PAC Projects

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

1.3.2.2 NAVFAC LANT Projects

Payment will be at the contract unit price per length, multiplied by the total length of acceptable piles actually installed. Base bids on the number of piles with pile length from tip to cutoff, as indicated, and on the total length of piling from tip to cutoff as specified in the document titled "Instructions to Bidders." Include in bid a unit price per unit length piling based on the quantity stated in the document titled "Instructions to Bidders." If the Contracting Officer requires an increase or a decrease in length of piles furnished and installed, the contract price will be adjusted in accordance with the Contract Clauses of the

Contract. The unit price bid will be used for upward or downward adjustment of the quantity subject to provisions of FAR 52.211-18, VARIATION IN ESTIMATED QUANTITIES.

1.4 ESTIMATED QUANTITIES

The estimated quantities of sheet piling listed in the unit price schedule of the contract, as to be furnished by the Contractor, are given for bidding purposes only. Sheet piling quantities for payment will consist of the linear meters feet of piling acceptably installed [and removed]. Installed quantities will consist of all piling including fabricated sections driven between the required top and bottom elevations of pilings plus any additions thereto resulting from changes in design or alignment as provided in paragraph DRIVING. [Removed quantities will consist of the lengths of piling pulled from below the ground level.]

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G, [_____]

Pile Driving Equipment; G, [_____]

Pulling and Redriving Plan; G, [_____]

[Instrumentation and Monitoring Program Report; G, [_____]

] SD-02 Shop Drawings

Sheet Piling; G, [_____]

As-Driven Survey; G, [_____]

Pile Shoe; G, [_____]

SD-03 Product Data

Driving; G, [_____]

Pulling and Redriving; G, [_____]

Delivery, Storage, and Handling; G, [_____]

SD-06 Test Reports

Materials Tests

SD-07 Certificates

Pile Shoe; G, [_____]

SD-11 Closeout Submittals

Pile Driving Record; G, [_____]

1.6 DELIVERY, STORAGE, AND HANDLING

Materials delivered to the site must be new and undamaged and must be accompanied by certified test reports. Provide the manufacturer's name and mill identification mark on the sheet piling. Store and handle sheet piling in the manner recommended by the manufacturer to prevent permanent deflection, distortion, or damage to the interlocks; as a minimum, support on level blocks or racks spaced not more than 3 m 4 to 5 feet apart and not more than 0.60 m 2 feet from the ends. Storage of sheet piling should also facilitate required inspection activities and prevent damage to coatings and corrosion protection prior to installation. [Handle sheet piling over 80 feet long using a minimum of two pickup points.]

1.7 QUALITY ASSURANCE - MATERIAL CERTIFICATES

For each shipment, submit certificates provided by the sheet pile manufacturer prior to installing piling. Include in the identification data piling type, section depth, section width, sheet thickness, [cell classification of PVC virgin resin used in co-extrusion or mono-extrusion process], and section modulus. The allowable bending stress must not exceed [3,200 psi for the PVC sheet.] [10,000 psi for the FRP sheet.]

[a. The PVC sheet piling certifications must consist of the following:

(1) Certificate of analysis from an ISO certified compounder indicating that virgin material is of Class 1-4244-33 or superior

in accordance with ASTM D4216.

(2) Certificate showing compliance with the requirements of ASTM D8427.

(3) Material certification indicating that the material being received by the Contractor is in accordance with the geometric and material requirements outlined in the specifications.

(4) 50 year manufacturer's warranty. Reseller or outsourcer warranties are not sufficient.]

[b. The FRP sheet piling certifications must consist of the following:

(1) Certification that the material was produced in accordance with the manufacturer's Quality Control Plan in an ISO 9001 compliant manufacturing facility.

(2) Material certification indicating that all material properties have been characterized in accordance with ASTM D7290.

(3) Material certification indicating that the material being received by the Contractor is in accordance with the geometric and material requirements outlined in the Contract Documents.

(4) 20 year manufacturer's warranty.]

1.8 CONTRACTOR QUALIFICATIONS

The Contractor must have prior experience with driving [PVC] [FRP] sheeting and must provide a list or previous job(s) that demonstrate a satisfactory installation method. Coordinate with the sheet pile manufacturer and vibratory equipment supplier regarding their recommendations concerning the proper vibratory plates or hammer / equipment and tools.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit [to the Contracting Officer for approval] descriptions of pile driving equipment to be used in the work. Descriptive information includes manufacturer's name, model numbers, capacity, rated energy, hammer details, cushion material, helmet, templates, and jetting equipment.

2.2 [PVC] [FRP] SHEET PILING

****

NOTE: PVC/FRP sheeting is ideally suited for applications where corrosion is a design concern and when exposed wall heights are under 20-feet. PVC/FRP should also be considered in cutoff applications and lower height and risk floodwall applications in accordance with EM 1110-2-2502, "Floodwalls and Other Hydraulic Retaining Walls."

****

Submit detailed shop drawings for sheet piling showing complete piling dimensions and details, sheet pile section properties, pieces used to turn all required corners as indicated, driving sequence, and location of installed piling.

Include in the drawings details of top protection, special reinforcing tips, tip protection, and dimensions of templates and other temporary guide structures for installing piling. Provide details and description of the method for handling piling to prevent permanent deflection, distortion or damage to piling interlocks, plus the type of transportation vehicle for bringing piles to the point of installation.

2.2.1 Interlocks

The interlocks of sheet piling must be free-sliding when sheets are plumb/level.

2.2.2 General Requirements

****

NOTE: Designers should contact suppliers to verify current availabilities and lead times. Based upon the design requirements for each piling section select the most suitable corresponding section from the available suppliers. Designers should place the pertinent section properties of this section on the drawings as minimum requirements.

****

[PVC sheet piling must be manufactured entirely from a rigid, high impact, UV-inhibited, weatherable vinyl compound. Provide PVC sheet piling in accordance with ASTM D8427. All exposed surfaces of the sheet piling must be UV resistant and comprised of virgin material with a minimum ASTM D4216 Cell Classification of 1-42443-33 to ensure reliable performance and color consistency. If mono-extrusion technology is used, the entire sheet pile must be comprised of virgin material with a minimum ASTM D4216 Cell Classification of 1-42443-33.]

[FRP sheet piling must be [polyester][vinyl ester] resin thermoset pultruded shapes manufactured entirely from a rigid, high impact, UV-inhibited, weatherable fiberglass reinforced polymer. All exposed surfaces of the sheet piling must be UV resistant.]

a. Determine lengthwise and transverse tensile modulus and strength in accordance with ASTM D638.

b. Determine by testing the lengthwise and transverse compression modulus and strength in accordance with ASTM D6641/D6641M.

c. Determine by testing the in-plane shear strength and modulus in accordance with ASTM D5379/D5379M.

d. Fiber reinforcements must meet the minimum tensile strength of 290 ksi in accordance with ASTM D2343.

e. Calculate and submit the moment capacities in accordance with the ASCE Pre-Standard for Load and Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures including the local compression flange buckling limit state. If using Allowable Stress Design, use safety factors of 2.5 for flexural stresses and 3.0 for shear and connection stresses.

f. Meet the durability and environmental effects material requirements of the ASCE Pre-Standard for Load and Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures.

g. Visual requirements must be in accordance with ASTM D4385.

h. Sheet pile section must contain UV light absorbers and stabilizers. Include a minimum 3 mil polyester or nylon veil.

i. Dimensional requirements must be in accordance with ASTM D3917.

2.3 SHEET PROPERTIES

Sheet piling must be full-length sections of the dimensions indicated. Provide fabricated sections in accordance with the requirement and the piling manufacturer's recommendations for fabricated sections. Sheet piling must meet the following minimum properties:

Sheet Pile Location	Allowable Moment (ft-lbs./ft.)	Section Modulus (in^3/ft.)	Moment of Inertia (in^4/ft.)	Thickness (in.)	Depth (in.)	Coverage (in.)

[Color of the PVC sheet pile must be [_____].] [Color of the FRP sheet pile must be [_____].] Final color selection will be by the Engineer based on color samples submitted. Caps may be manufactured from [PVC] [FRP] [6063-T6 extruded aluminum] profiles suitable for covering the top surface of the sheet piles. Aluminum caps may be mill finish or anodized. Caps may also be reinforced concrete or wood. Wood caps must be coated with a UV resistant polymer. Sheet pile corners and caps may be PVC or 6061-T6 aluminum.

2.4 APPURTENANT METAL MATERIALS

Provide metal plates, shapes, bolts, nuts, rivets and other appurtenant fabrication and installation materials conforming to manufacturer's standards and to the requirements specified in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.5 PILE DRIVING EQUIPMENT

****

NOTE: Typical driving aids may include the use of a mandrel, an auger, or a pre-punch tool such as an I-beam or steel sheet pile.

****

Submit complete descriptions of sheet piling driving and installation equipment including hammers, [jetting equipment,] extractors, protection caps and other installation appurtenances including driving aids, prior to commencement of work. Provide pile driving equipment conforming to the following requirements.

2.5.1 Driving Hammers

Hammers must be single-acting, gravity drop, or vibratory type. The weight of the hammers must be determined jointly by the manufacturer and the Contractor for the piling products and subsurface materials to be encountered.

2.5.2 Jetting Equipment

Jetting [may be used at no additional cost to the Government] [is prohibited]. [Jetting equipment must have not less than two removable or fixed jets of the water or combination air-water type. Water jets must be designed so that the discharge volume and pressure are sufficient to freely erode the material under and adjacent to the piling.]

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

Requirements for material tests, workmanship, and other measures for quality assurance are as specified in this Section.

2.6.1 Materials Tests

Submit certifications from the suppliers of appurtenant metal materials showing that materials meet the specified requirements for each shipment. Certifications required for [PVC] [FRP] sheeting are referenced in paragraph QUALITY ASSURANCE - MATERIAL CERTIFICATES.

PART 3 EXECUTION

3.1 EARTHWORK

Perform in accordance with Section 31 00 00 EARTHWORK. Pre-excavation is [permitted] [prohibited] [permitted to a maximum depth [of [_____] meters feet below [_____]] [as indicated]]. Backfill as indicated.

3.2 INSTALLATION

3.2.1 Placing

****

NOTE: When long piles are being driven, templates are of value. Long piles are very flexible and damage easily. Use templates to keep piles vertical.

****

Submit a written description of the site specific pile installation procedures for Government review and approval.

Excavation that is required within the area where sheet pilings are to be installed must be completed prior to placing sheet pilings. Pilings properly placed and driven must be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

a. Pilings must be carefully located as [indicated] [or] [directed.] Pilings must be placed plumb with out-of-plumbness not exceeding [10] [22] mm per meter [1/8] [1/4] inch per foot of length and true to line. Place the pile so the face will not be more than 150 mm 6 inches from vertical alignment at any point. Top of pile at elevation of cut-off must be within 13 mm 1/2 inch horizontally and 50 mm 2 inches vertically of the location indicated. Manipulation of piles to force them into position is prohibited. Check all piles for heave. Re-drive all heaved piles to the required tip elevation.

b. Provide temporary wales, templates, [master pilings] [current deflectors] or guide structures to ensure that the pilings are placed and driven to the correct alignment. Use a system of structural framing sufficiently rigid to resist lateral and driving forces and to adequately support the sheet piling until design tip elevation is achieved. Use a minimum of two templates when placing each piling [at third points] [not less than 6 m 20 feet apart]. Templates must not move when supporting sheet piling. Fit templates with wood blocking to bear against the web of each alternate sheet pile and hold the sheet pile at the design location alignment. Provide outer template straps or other restraints as necessary to prevent the sheets from warping or wandering from the alignment. Mark the template for the location of the leading edge of each alternate sheet pile. If in view, also mark the second level to assure that the piles are vertical and in position. If two guide marks cannot be seen, other means must be used to keep the sheet pile vertical along its leading edge.

3.2.2 Driving

****

NOTE: When hard driving or driving through rocky soil or debris is anticipated, require addition of tip protection or a steel mandrel to prevent damage to sheet piling.

Jetting should generally not be permitted for:

1. Piles dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Piles subject to uplift.

3. Piles adjacent to existing structures.

4. Piles in closely spaced clusters unless the load capacity is confirmed by tests and unless all jetting is done before final driving of any pile in the cluster.

Pre-augering or spudding should generally not be permitted for piles dependent on side friction in fine-grained, low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

****

Submit records of the completed sheet piling driving operations, including a system of identification that shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations of installed piling. [The format for driving records is as directed.] [Prior to driving pilings in water, paint a horizontal line on both sides of each piling at a fixed distance from the bottom so that it will be visible above the water line after installation. This line must indicate the profile of the bottom elevation of installed pilings and potential problem areas can be identified by abrupt changes in its elevation.] Drive pilings with the proper sized hammer and by approved methods to prevent damage to the pilings and to ensure proper interlocking throughout their lengths.

a. Maintain driving hammers in proper alignment during driving operations by use of leads or guides attached to the hammer. [Caution must be taken in the sustained use of vibratory hammers when a hard driving condition is encountered to avoid interlock-melt or damage. Stop using vibratory hammers and impact hammers when the penetration rate due to vibratory loading is 300 mm less than one foot per minute.]

b. Use a protecting cap when using impact hammers to prevent damage to the tops of pilings. [Use cast steel shoe to prevent damage to the tip of the sheet piling. Submit pile shoe installation details and material data for Government review and approval prior to use in the field.] Remove and replace pilings damaged during driving or driven out of interlock at no additional cost to the Government. [Store Government furnished pilings, damaged during driving, as directed.]

c. Drive pilings without the aid of a water jet [unless otherwise authorized]. [Perform authorized jetting on both sides of the pilings simultaneously; discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the ["calculated"] [indicated] pile tip elevation and make the final 1.5 m 5 feet of penetration by driving. Before commencing the driving of the final 1.5 m 5 feet, firmly seat the pile in place with reduced energy hammer blows.]

d. Take adequate precautions to ensure that pilings are driven plumb. Where possible, drive Z-pile with the ball end leading. If an open socket is leading, a bolt or similar object placed in the bottom of the interlock will minimize packing material into it and ease driving for the next sheet. If the forward or leading edge of the piling wall is found to be out-of-plumb, in the plane of the wall, the piling being driven must be driven to the required depth and tapered pilings must be provided and driven to interlock with the out-of-plumb leading edge or other approved corrective measures taken to ensure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling is 10 mm per meter 1/8 inch per foot of length.

e. Pilings in each run or continuous length of piling wall must be driven alternately in increments of depth to the required depth or elevation. Do not drive piling to a lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. Incrementally sequence driving of individual piles so that the tip of any sheet pile is not more than 1.2 m 4 feet below that of any adjacent sheet pile. When the penetration resistance exceeds five blows per 25 mm inch, the tip of any sheet pile must not be more than 0.6 m 2 feet below any adjacent sheet pile.

f. If obstructions restrict driving a piling to the specified penetration, the obstructions must be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical, make changes in the design alignment of the piling structure as directed to ensure the adequacy and stability of the structure. Pilings must be driven to depths indicated and must extend up to the elevation indicated for the top of pilings. [Piling driven to rock must be seated individually on the rock.] A tolerance of [_____] mm inches above the indicated top elevation will be permitted.

g. Pre-augering or spudding of piles [may be used at no additional cost to the Government] [is prohibited]. [Discontinue pre-augering or spudding approximately [_____] meters feet above the [calculated] [indicated] pile tip elevation. Drive the pile the final [_____] meters feet of penetration].

h. If a void is left in stiff clay type soils, the void must be filled appropriately. The functional requirements of the wall and the soil conditions will determine if the backfill method will be bentonite slurry mix, sand, or earthen material to close the small void.

3.2.3 Cutting-Off

Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance must be cut off in a manner recommended by the manufacturer to the required elevation. Do not drive pilings below the required top elevation.

a. The tops of pilings excessively battered during driving must be trimmed when directed, at no additional cost to the Government. Piling cut-offs [except for Government furnished pilings] will become the property of the Contractor and must be removed from the site.

b. Cut holes in pilings for bolts, rods, drains or utilities neatly, as indicated or as directed. Bolt holes in piling must be drilled by approved methods which will not damage the pile. Holes other than bolt holes must be reasonably smooth and the proper size for rods and other items to be inserted.

3.2.4 Inspection of Driven Piling

Perform continuous inspection during pile driving. Inspect all piles for compliance with tolerance requirements. Bring unusual problems which may occur to the attention of the Contracting Officer. Inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock must be removed and replaced at no additional cost to the Government. [Use divers to inspect underwater interlocked joints of cofferdam sheet piling. Government divers may also inspect the interlocked joints. The inspection of cofferdams must be performed after driving is completed, prior to filling each cell and connecting arc, and within 48 hours after filling each cell and arc.]

3.2.5 Pulling and Redriving

****

NOTE: In general pulling of [PVC] [FRP] sheet piles is discouraged.

****

Submit a pulling and redriving plan, a proposed method of pulling sheet piling, prior to construction. Pull, as directed, selected pilings after driving to determine the condition of the underground portions of pilings.

Any piling so pulled and found to be damaged, to the extent that its usefulness in the structure is impaired, must be removed and replaced at no additional cost to the Government. Pilings pulled and found to be in satisfactory condition by the Contracting Officer must be redriven when directed. [Government furnished pilings pulled and not redriven must be stored as directed.]

When used for seepage cutoff, piles must maintain mechanical interlock throughout their alignment. When out-of-interlock piles cannot be pulled to reestablish interlocks, repair methods such as overlapping of piles and grout columns must be designed to provide an equivalent barrier. Remedial measures such as this must be designed by a Professional Engineer and submitted for approval.

[3.2.6 Testing Agency Qualifications

Engage an independent testing agency qualified in accordance with ASTM C1077 and ASTM E329 for the testing indicated, as documented according to ASTM E548, and approved by the Contracting Officer.

]3.2.7 Survey Data

After the driving of each pile group is complete and before superimposed concrete is placed, provide the Contracting Officer with an as-driven survey showing the actual location and top elevation of each pile. Submit an as-driven survey showing actual location and top elevation of each [production pile] [test pile] within [7][_____] calendar days of completing the pile installation. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to the nearest 13 mm half inch. The survey must be prepared and certified by a professional registered land surveyor licensed in the State of [_____].

3.3 DRAINAGE

****

NOTE: Include this paragraph in cases where sheet pile walls are not designed to retain saturated soils and drainage behind the sheet pile wall is required.

****

Backfill material behind the sheet piling must be free-draining and in accordance with Section 31 00 00 EARTHWORK.[Install drainage system and weep holes as indicated.]

3.4 REMOVAL

The removal of sheet pilings consists of pulling, sorting, cleaning the interlocks, inventorying, and storing previously installed sheet pilings as indicated and directed.

3.4.1 Pulling

****

NOTE: In general pulling of [PVC] [FRP] sheet piles

is discouraged as it is likely that the pile will break. Generally the best way to safely remove [PVC] [FRP] is to trench to the bottom and remove the sheet; however, consideration should be given to other proposed methods as well.

****

The method of pulling piling must be approved. Provide pulling holes in pilings, as required. Extractors must be of suitable type and size. Exercise care during pulling of pilings to avoid damaging piling interlocks and adjacent construction. If the Contracting Officer determines that adjacent permanent construction has been damaged during pulling, then repair the damaged construction at no additional cost to the Government. Pull pilings one sheet at a time. Pilings fused together must be separated prior to pulling, unless the Contractor demonstrates, to the satisfaction of the Contracting Officer, that the pilings cannot be separated. The Contractor will not be paid for the removal of pilings damaged beyond structural use due to proper care not being exercised during pulling.

3.4.2 Sorting, Cleaning, Inventorying, and Storing

Pulled pilings must be sorted, cleaned, inventoried, and stored by type into groups as:

a. Piling usable without reconditioning.

b. Piling requiring reconditioning.

c. Piling damaged beyond structural use.

3.5 INSTALLATION RECORDS

Maintain a pile driving record for each sheet pile driven. Indicate on the installation record: installation dates and times, type and size of hammer, rate of operation, total driving time, dimensions of driving helmet and cap used, blows required per meter foot for each meter foot of penetration, final driving resistance in blows for the final 150 mm 6 inches, pile locations, tip elevations, ground elevations, cut-off elevations, and reheading or cutting of piles. Record unusual pile driving problems during driving. Submit complete records to the Contracting Officer.

3.6 VIBRATION CONTROL

****

NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project.

****

Perform vibration monitoring at the locations [indicated] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs][and geophones] within a distance of 61 meters 200 feet from the pile driving activity. [Engage the services of a qualified, independent Vibration Consultant, acceptable to the Government, to conduct the vibration monitoring. The Vibration Consultant must have a minimum of [five] years of experience in vibration monitoring. A minimum of [28] days before the installation of vibration monitors, submit to the Government the name of the Vibration Consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

3.6.1 Monitoring

Prior to the pile driving activities, obtain baseline readings of ambient vibrations. The vibration during the pile driving activities must be limited to [a peak particle velocity of not more than 5 cm 2 inches per second] [the limits mentioned in the [Contract Documents]]. [Determine appropriate vibration limits in accordance with [U.S. Bureau of Mines] [American Association of State Highway and Transportation Officials (AASHTO)] guidelines.]During pile driving activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity causing the vibration until [the Vibration Consultant and the Contracting Officer] are on-site to observe the structures nearest to the vibration monitor that has exceeded the limits.

3.6.2 Damage Responsibility

The Contractor is responsible for damage resulting from the pile driving operations and must take the measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors from the site and from Government property and restore the monitoring locations back to their original condition.

3.7 NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform noise monitoring at the locations [indicated] [decided by the Contracting Officer] [at noise-sensitive public areas] during the pile driving operations. [Perform noise monitoring using [noise meters][, and][_____]]. [Engage the services of a qualified, independent Noise Consultant, acceptable to the Government, to conduct the noise monitoring. The Noise Consultant must have a minimum of [five] years of experience in noise monitoring. A minimum of [28] days before the installation of noise monitors, submit to the Government the name of the Noise Consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient noise levels. [The noise limits are mentioned in the [Contract Documents]]. [Determine appropriate noise limits in accordance with [local agency] [U.S. Occupation Safety and Health Administration] guidelines].

3.7.1 Monitoring

During pile driving activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity and install noise mitigation measures.

3.7.2 Damage Responsibility

The Contractor is responsible for damage resulting from the pile driving operations and must take the measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors from the site and from Government property, and restore the monitoring locations back to their original condition.

3.8 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM REPORT

****

NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile driving activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements. Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a Geotechnical Instrumentation Program to monitor settlement [and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile driving. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose, and application of each proposed type.[Perform noise and vibration monitoring in accordance with paragraphs NOISE CONTROL and VIBRATION CONTROL.]

Monitoring must extend before, during, and for a period after completion of construction activities related to pile driving when long-term performance issues are a concern. The Monitoring Plan must be designed to protect adjacent structures and utilities against damage due to pile driving activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

3.8.1 Reporting Requirements

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about the Instrumentation Consultant's experience, appropriate types, quantities, locations, and monitoring frequencies of the instruments.

Upon acceptance of the Instrumentation and Monitoring Program, provide, install, and monitor the instrumentation and interpret the data. Submit instrumentation data reports at least [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the Instrumentation and Monitoring Program.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 43 13.13 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 32 23 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 31 43 13.13

CONCRETE PRESSURE GROUTING

02/21

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USACE / NAVFAC / AFCEC **UFGS-31 43 13.13 (February 2021)**

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SECTION 31 43 13.13

CONCRETE PRESSURE GROUTING
02/21

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NOTE: This guide specification covers the requirements for drilling exploratory holes; drilling drain holes; drilling, washing and pressure testing grout holes; making grout connections; furnishing, handling, transporting, storing, mixing and injecting the grouting materials; patching the finished grout holes; care and disposal of drill cuttings, waste water and waste grout; clean-up grout galleries and shafts and areas upon completion of the work and all such other operations as are incidental to the drilling and the grouting. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: This guide specification has been prepared as a section in a general construction specification for concrete dams. By rewording as necessary, this specification may be adapted to other types of

foundation treatment, such as under power plants, locks, cutoff trenches, tunnels, and others.

Methods for listing subdivided items are described in Paragraph 52.2/9109(g) "Variations in Estimated Quantities - Subdivided Items" of Engineer Federal Acquisition Regulation Supplement (EFARS). However, effectiveness of the use of subdivided items in grouting has been questioned as being more hazardous than helpful and that FAR 52.211-16 Variation in Quantity should be used.

Provisions are made for the use of a sanded grout but should generally be limited to those formations where quantities in excess of one cubic foot of grout per linear foot of hole are anticipated. The information contained in EM 1110-2-3506, "Grouting Technology" and EM 1110-2-1302, "Cost Estimates - Government Estimate of Fair and Reasonable Cost to Contractor" should be used as a guide in estimating quantities.

Computer Application of Geotechnical Engineering (CAGE):

a. The CAGE Grouting Task Group has developed a microcomputer program for documentation of grouting operations and graphics for rapid display of data for better field control. Some of the highlights of the program include optional data entry by a laptop or hand held computer in the field, technical review and quality control, preparation of Contractors pay schedules, and preparation of foundation reports. The User's Guide "Microcomputer Grouting Data Package (Multiple Zone and Stage Version for PC and Hand Held Computer)" is available from the U.S. Army Engineer Waterways Experiment Station (USACE-WES-GL). Use of this CAGE package will not require contractual or technical additions to the contract specifications unless the computer equipment, other facilities, or personnel for data entry are to be Contractor supplied. In such case the proper provisions should be included. This program is also an attractive tool for use in grouting operations by Corps of Engineers personnel. Use of this program should be strongly considered for any grouting operation.

b. Computer-aided control and monitoring of the grout injection has recently been used by the U.S. Bureau of Reclamation (USBR) on several of their projects. Their system is appropriate for use on large grouting projects. Use of their system will necessitate certain contractual and technical additions to the specifications which are not included in this guide specification. If interested in this type system for a large grout program more information can be obtained by contacting the CAGE grout task group and the USBR.

Chemical or other specialty grouting applications have not been specifically addressed in this guide specification as most of the CE grouting in rock foundations for concrete structures, cutoff trenches, locks and powerhouses use cement grout. However, the specification may be used as a general outline for chemical or other specialty grouting applications by insertion of the proper equipment, materials, and procedures in the appropriate paragraphs and by modification and deletion of other paragraphs. Engineer Manuals 1110-2-3504, "Chemical Grouting", and 1110-2-3506, "Grouting Technology", should be used as guides when the use of chemical grouts and other specialty grouting applications are being considered. The manufacturer of those systems that meet the potential job requirements should be contacted for verification. Also, consideration should be given to conducting laboratory and field tests and evaluations of the system or systems being considered for a given applications. There may be occasions when the engagement of a consultant would be appropriate and advantageous to assist in the planning, selecting, and evaluating of a system under consideration. Engineer Manual 1110-2-2901, "Tunnels and Shafts in Rock", should be referred to when planning tunnel grouting and the guide specification for Tunnel and Shaft Grouting should be used in the preparation of project specifications.

If grouting is anticipated during extreme temperatures, alteration of certain field procedures may be necessary and should be included in the specifications. Generally, for cold weather grouting, the grout should be maintained at temperatures above 10 degrees C 50 degrees F until injected, and storage of the grouting materials should be at temperatures above freezing. Temperature controls for grouting surface rocks should be specified based on specific site conditions anticipated. Insulation, heated enclosures, water heaters or other equipment or procedures may be required. Grouting in extremely hot weather may also require extra precautions.
****

1.1 SUMMARY

****
NOTE: If no separate section on "CONCRETE" is used, the appropriate paragraphs applicable to sampling and testing in SECTION 03 70 00 MASS CONCRETE should be inserted in the following paragraphs in lieu of the section reference given below. If a "CONCRETE" section, other than SECTION 03 70 00 MASS CONCRETE is used, the Designer should ensure that the applicable sampling and testing is included in that section.
****

a. This section covers drilling exploratory holes; drilling drain holes; drilling, washing and pressure testing grout holes; making grout connections; furnishing, handling, transporting, storing, mixing and injecting the grouting materials; backfilling holes; patching the finished grout holes; care and disposal of drill cuttings, waste water and waste grout; clean up of [grout galleries and shafts][the areas] upon completion of the work and all other such operations as are incidental to the drilling and grouting. The work contemplated consists of [constructing a grout curtain and a drainage curtain][area grouting], the approximate locations, limits, and details which are indicated. Perform Government preconstruction sampling and testing as specified below:

b. Perform sampling and testing of sand, cementitious materials, and admixtures in accordance with Section [03 70 00 MASS CONCRETE][03 30 00 CAST-IN-PLACE CONCRETE].

c. Perform sampling and testing of grout materials in accordance with Section [03 70 00 MASS CONCRETE][03 30 00 CAST-IN-PLACE CONCRETE].

1.2 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

****

1.2.1 Mobilization and Demobilization

1.2.1.1 Payment

Payment will be made for costs for assembling all plant and equipment at the site, preparatory to initiating the work and for removing it therefrom when the drilling and grouting program has been completed. Sixty (60) percent of the contract lump sum price for mobilization and demobilization will be paid following completion of moving onto the site, including complete assembly, in working order, of all equipment necessary to perform the required drilling and grouting operations. The remaining forty (40) percent of the contract lump sum price will be paid when all equipment has been removed from the site.

1.2.1.2 Unit of Measure

Unit of measure: lump sum.

1.2.2 Drilling Grout Holes

****

NOTE: Delete the bracketed phrase if pay item "Pressure Washing and Pressure Testing" is retained as a pay item.

****

1.2.2.1 Payment

Payment will be made for costs associated with drilling and redrilling grout holes; [washing and pressure testing of grout holes;]care and disposal of waste water and waste grout; clean-up of the site; furnishing, handling, transporting and storing of grout materials; and for furnishing all labor and supplies incidental to the work. This price is subject to the cost limitation imposed by[Section 31 43 13.13 CONCRETE PRESSURE GROUTING,] paragraph PIPE FOR FOUNDATION GROUTING AND DRAINAGE, but only in those locations where pipe is specified. No payment will be made for grout, or the material constituents thereof, wasted due to improper anchorage of grout pipe or connections, or which is wasted due to negligence on the part of the Contractor, nor for grout which is rejected by the Contracting Officer because of improper mixing. Payment will be made at the applicable contract unit prices for materials contained in grout which are wasted, where the wasting is not due to negligence on the part of the Contractor.

1.2.2.2 Measurement

Drilling of grout holes will be measured for payment on the basis of the linear feet of holes actually drilled in concrete or rock, as shown or as directed, including all intermediate holes at locations where pipe was not installed.

1.2.2.3 Unit of Measure

Unit of measure: linear meter foot.

1.2.3 Drilling Drain Holes

1.2.3.1 Payment

Payment will be made for costs associated with drilling of drain holes actually drilled in concrete or rock, as shown or as directed. This price is subject to the cost limitation imposed by[Section 31 43 13.13 CONCRETE PRESSURE GROUTING,] paragraph PIPE FOR FOUNDATION GROUTING AND DRAINAGE.

1.2.3.2 Measurement

Drilling of drain holes will be measured for payment on the basis of the linear meter feet of holes actually drilled in concrete or rock, as shown or as directed.

1.2.3.3 Unit of Measure

Unit of measure: linear meter foot.

1.2.4 Drilling Exploratory Holes

****

NOTE: If a portion of exploratory drilling is to be done through overburden, a separate pay item should be included for this portion.

****

1.2.4.1 Payment

Payment will be made for costs associated with drilling of exploratory holes.

1.2.4.2 Measurement

Drilling of exploratory holes will be measured for payment on the basis of the linear meters feet of holes actually drilled in concrete or rock, as directed by the Contracting Officer.

1.2.4.3 Unit of Measure

Unit of measure: linear meter foot.

[1.2.5 Pressure Washing and Pressure Testing

[1.2.5.1 Payment

Payment will be made for pressure washing and pressure testing of grout holes, which includes the cost of making and breaking connections incidental to the work. Payment will be based upon the total amount of time required for pressure washing and pressure testing, determined by reducing the total number of minutes of operation to the nearest whole hour. No payment will be made for time lost due to fault or negligence of the Contractor, or due to defective equipment furnished by the Contractor. Time will be measured cumulatively to the next whole minute of operations.

][1.2.5.2 Measurement

Pressure washing and pressure testing will be measured for payment on the basis of the actual time water pumps are operating. Pressure washing and pressure testing will be measured from the time pumping is begun on a hole or section of a hole until the time pumping is completed on the hole or section of the hole as determined by the Contracting Officer. Operation time will be determined by rounding 30 or more minutes of operation up to the nearest whole hour, and rounding 29 or less minutes of operation down to the nearest whole hour. Fractional time will be measured cumulatively to the next whole minute of operation.

][1.2.5.3 Unit of Measure

Unit of measure: nearest whole hour.

]]1.2.6 Steel Pipe and Fittings

1.2.6.1 Payment

Payment will be made for costs associated with grout and drain hole pipe and fittings remaining in the permanent work.

1.2.6.2 Measurement

Pipe and fittings will be measured for payment on the basis of the actual weight of satisfactorily installed pipe and fittings left in place as shown. No additional allowance will be made because of differences in pipe size or length, or the number of pipes required.

1.2.6.3 Unit of Measure

Unit of measure: kilogram pound.

1.2.7   Portland Cement in Grout

1.2.7.1   Payment

Payment will be made for costs associated with Portland cement in grout.

1.2.7.2   Measurement

Portland cement in grout will be measured for payment on the basis of the number of cubic meters (42.6 kilograms) feet (94 pounds) of cement used in the grout satisfactorily placed in grout holes and in exploratory holes, or wasted when such wasting is not due to the Contractor's negligence.

1.2.7.3   Unit of Measure

Unit of measure: cubic meter (42.6 kilograms) foot (94 pounds).

1.2.8   Pozzolans (Fly Ash) in Grout

1.2.8.1   Payment

Payment will be made for costs associated with fly ash in grout.

1.2.8.2   Measurement

Fly ash in grout will be measured for payment on the basis of the number of cubic meters (33.6 kilograms) feet (74 pounds) of fly ash used in the grout satisfactorily placed in grout holes.

1.2.8.3   Unit of Measure

Unit of measure: cubic meter foot.

1.2.9   Sand in Grout

1.2.9.1   Payment

Payment will be made for costs associated with sand in grout.

1.2.9.2   Measurement

Sand in grout will be measured for payment on the basis of the number of cubic meters feet of sand[, dry rodded measurement,] used in the grout satisfactorily placed in grout holes or in exploratory holes.

1.2.9.3   Unit of Measure

Unit of measure: cubic meter foot.

1.2.10   Fluidifier in Grout

1.2.10.1   Payment

Payment will be made for costs associated with fluidifier in grout, including full allowance for the payment by the Contractor of all required royalties.

1.2.10.2 Measurement

Fluidifier in grout will be measured for payment on the basis of the number of kilograms pounds of fluidifier used in the grout satisfactorily placed in grout holes.

1.2.10.3 Unit of Measure

Unit of measure: kilogram pound.

1.2.11 Bentonite in Grout

1.2.11.1 Payment

Payment will be made for costs associated with bentonite in grout.

1.2.11.2 Measurement

Bentonite in grout will be measured for payment on the basis of the number of kilograms pounds of bentonite actually used in grout mixtures satisfactorily placed in grout holes.

1.2.11.3 Unit of Measure

Unit of measure: kilogram pound.

1.2.12 Placing Grout

****

NOTES: Select appropriate Alternative.

Under certain conditions it may be desirable to include a pay item for standby time for Government directed suspension of drilling or grouting operations.

****

1.2.12.1 Payment

Payment will be made for costs associated with satisfactorily placing grout in grout holes[, which includes full compensation for proportioning the mix as directed and mixing and injecting the grout as specified[in Section 31 43 13.13 CONCRETE PRESSURE GROUTING]. Separate payment will be made for all materials used in grout as provided in unit price pay item(s) "Portland Cement in Grout"[, "Pozzolans (Fly Ash) in Grout", "Sand in Grout", "Fluidifier in Grout", and "Bentonite in Grout"].][. No payment will be made for time lost due to fault or negligence of the Contractor or due to defective equipment furnished by the Contractor.]

1.2.12.2 Measurement

Placing grout will be measured for payment on the basis of [the number of cubic meters feet of materials, satisfactorily placed, exclusive of water [and fluidifier] and regardless of the proportions of the mixes, measured individually as specified in unit price pay items "Portland Cement in Grout", "Pozzolans (Fly Ash) in Grout", and "Sand in Grout".][the actual time grout pumps begin pumping on a hole or portion of hole and continuing until the time pumping is completed on that hole or portion of hole, as determined by the Contracting Officer. Time for satisfactory placement of grout will be determined by rounding 30 or more minutes of placement time up to nearest whole hour, and rounding 29 or less minutes of placement time down to the nearest whole hour. Fractional placement time will be measured cumulatively to the next whole minute of operation.]

1.2.12.3 Unit of Measure

Unit of measure: [cubic meter foot.] [nearest whole hour.]

[1.2.13 Connections to Grout Holes

****

NOTE: The price to be inserted in this paragraph should be determined on the basis of the estimated cost to the Contractor for the operation of moving the grout supply line onto the hole. This price should not include any allowance for pipe or other materials used in making the connections. This unit price pay item may be optional for grout payment on an hourly basis.

****

[1.2.13.1 Payment

[Payment will be made for costs associated with connections to grout holes at a rate of [_____] dollars per connection. Where stop grouting method is used [payment for at least one connection will be made for each packer setting in a hole].][Payment for only one connection will be made for each hole regardless of the number of settings.]

][1.2.13.2 Measurement

Connections to grout holes will be measured for payment per connection for each time the grout supply line is connected to a grout hole for the purpose of injecting grout regardless of the number of times connections are made per hole or the amount of grout actually injected.

][1.2.13.3 Unit of Measure

Unit of measure: each.

]]1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C70	(2020) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C91/C91M	(2018) Standard Specification for Masonry Cement
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C937	(2023) Grout Fluidifier for Preplaced-Aggregate Concrete

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing

1.4 DEFINITIONS

1.4.1 Zone

A zone is a predetermined partial depth of curtain. The first zone extends [_____] m feet downward from [the contact between the concrete and the rock] [the bottom of the cutoff trench] [overburden and the top of rock] overburden and elevation [_____]. The second zone extends [_____] m feet downward from the bottom of the first zone. The third zone extends [_____] m feet downward from the bottom of the second zone. [Define additional zones as needed]. Finish all grouting in a given zone and section before work is started in the next [higher] [lower] zone.

1.4.2 Section

A section is a reach along the grout curtain, not more than [_____] feet in length in which grouting operations will not be permitted at the same time that drilling is in progress. Insofar as practicable, the grout curtain will be subdivided into sections in a manner which will facilitate the Contractor's operations.

1.4.3 Stage

A stage is one complete operational cycle of drilling, cleaning, pressure washing, pressure testing, pressure grouting, and grout cleanout within a zone. The actual depth of a stage depends upon geologic conditions encountered in drilling. It may vary from a fraction to the full depth of the zone, and is marked by the loss or gain of drill water in appreciable amounts.

1.4.4 Stop

A stop is a predetermined depth at which the expanding plug or packer is positioned.

1.4.5 Split Spacing

Split spacing is the procedure of locating an additional grout hole midway between two previously drilled and grouted holes.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL

PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Drilling Equipment

Grouting Equipment

Grout Plant; G, [_____]

1.6 DELIVERY, STORAGE, AND HANDLING

****
NOTE: If no separate section on "CONCRETE" is used, the appropriate paragraphs applicable to material delivery, storage, and handling in SECTION 03 70 00 MASS CONCRETE should be inserted in this paragraph in lieu of the section reference given below. If a "CONCRETE" section, other than SECTION 03 70 00 is used, the Designer should ensure that the applicable material delivery, storage, and handling paragraphs are included in that section.
****

Furnish transportation and storage of materials in accordance with section [03 70 00 MASS CONCRETE][03 30 00 CAST-IN-PLACE CONCRETE]. Store a sufficient quantity of cement at or near the site of the work to insure that grouting operations will not be delayed by shortage of cement. In the event the cement is found to contain lumps or foreign matter of a nature and in amounts which, in the opinion of the Contracting Officer, may be deleterious to the grouting operations, screening through a standard 100 mesh screen may be required. No payment will be made for such screening.

1.7 PROJECT/SITE CONDITIONS

The program shown and described is based on currently available information. Conditions encountered during construction may require additions or deletions. Do not modify or curtail the grouting program as a construction expediency. It is a required part of design and is not secondary to any time or scheduling restrictions. Determine grouting mixes, pressures, injection rate and the sequence in which the holes are drilled and grouted in the field and as directed.

PART 2 PRODUCTS

2.1 GROUTING MATERIAL

Provide grout composed of water and cement, [pozzolans, admixtures, and fillers]. The grout mixes will be designed by the Contracting Officer and will be varied to meet the characteristics of each hole as determined by conditions encountered. Furnish various materials conforming to the specifications listed in paragraphs below.

2.1.1 Water

[Furnish the water used in the grout. Provide fresh, clean water that is free from injurious amounts of sewage, oil, acid, alkali, salts, or organic matter.][Water suitable for use in the work will be furnished by the Government. It is the responsibility of the Contractor to provide any necessary connections and extensions to the Government supply line shown.]

2.1.2 Cement

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NOTE: Avoid specifying the use of air entrained cement, except on rare occasions when grout may be exposed to severe freezing and thawing conditions.

****

Provide cement used in grout conforming to the requirements of ASTM C91/C91M and ASTM C150/C150M. The use of bulk cement will be permitted provided the Contractor employs methods of handling, transporting, and storage that are satisfactory to the Contracting Officer, otherwise only cement furnished in cloth or paper bags will be accepted to use in the work. Store cement in accordance with paragraph DELIVERY, STORAGE, AND HANDLING.

2.1.3 Pozzolans

Provide fly ash pozzolans [or other raw or calcined natural pozzolans] conforming to ASTM C618. Sampling will be done by an authorized representative of the Government. All tests will be made by and at the expense of the Government. Pozzolans may be furnished in paper sacks or in bulk. Transport, handle, and store it so as to avoid damage, waste, or absorption of moisture.

2.1.4 Admixtures

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NOTE: Refer to EM 1110-2-3506, "Grouting Technology", for discussions of properties, characteristics and limitations for principal admixture and filler materials. Only the more commonly used are included here.

****

Add admixtures to the grout immediately before or during its mixing that consist of [accelerators, retarders, water reducers, aluminum powder, and fluidifiers].

2.1.5 Fluidifier

Furnish fluidifier that is a compound possessing characteristics which will increase the flowability of the mixture, assist in dispersal of the cement grains, and neutralize the setting shrinkage of the grout. The quality of the material must meet the requirements specified in ASTM C937. Sample fluidifier by an authorized representative of the Contracting Officer. Trial mixtures should be tested prior to using the materials in field work. All tests will be made by and at the expense of the Government. Furnish fluidifier in moisture-resistant paper sacks shipped in sealed containers and handle and store so as to avoid absorption of moisture, damage or waste. Material which has become caked due to moisture absorption will be rejected.

2.1.6 Bentonite

Provide sodium (Na) cation, powdered montmorillonite bentonite. Add 2 percent to 5 percent by weight of cement to the cement grout. Adjust the percentage as directed by the Contracting Officer. A separate colloidal bentonite mixer is required to mix the bentonite and water to ensure fully dispensing and hydrating the bentonite before adding to the grout mixer. Handle and store the bentonite so as to avoid absorption of moisture, damage, or waste. Bentonite which has become caked due to moisture absorption will be rejected. Store a sufficient quantity of bentonite at or near the site of the work to insure that grouting operations will not be delayed by shortage of bentonite.

2.1.7 Sand

a. Provide clean sand for grout consisting of hard, tough, durable, uncoated particles with no more than [_____] percent passing the No. 200 sieve. Provide generally rounded or cubical shaped particles [containing no more than [_____] percent of flat or elongated pieces having a maximum dimension in excess of five times the minimum dimension]. Provide sand that is generally well graded from fine to coarse in accordance with ASTM C136/C136M with 100 percent passing the [No. 8][_____] sieve.

b. Subject the sand to such tests as are necessary to determine its acceptability. Perform sampling of sand in accordance with the applicable sampling provisions contained in COE CRD-C 100 or as directed. Unless otherwise directed, take all test samples under the supervision of the Contracting Officer and deliver to a designated point, at the expense of the Contractor, at least [_____] days in advance of the time when sand will be required at the site of work. All tests will be made by the Government at its expense. The tests to which the sand will be subjected will include specific gravity, absorption, soundness in magnesium sulfate, petrographic analyses, and any other tests that are necessary to demonstrate that grout of adequate durability can be produced.

c. The percentage of surface moisture in terms of the saturated surface-dried sand will be determined in accordance with ASTM C70, or other method giving comparable results.

d. Store sand in such a manner as to avoid the inclusion of any foreign materials in the grout. Maintain all sand in free draining storage for at least 72 hours prior to use.

2.2 METAL PIPE AND FITTINGS

Furnish, cut, thread, and fabricate pipe and fittings required for constructing grout, drainage and exploratory holes.

2.2.1 Pipe

Pipe will be black steel of the diameter and in the location indicated. Furnish pipe conforming to ASTM A53/A53M.

2.2.2 Fittings

Provide black, malleable iron fittings in accordance with ASME B16.3.

PART 3 EXECUTION

3.1 EQUIPMENT

****

NOTE: For jobs where the estimated quantity of solids is between zero and 30 cubic meters 1,000 cubic feet, a pumping capacity of 950 cm^3/s 15 gpm is recommended; from 30 to 1400 cubic meters 1,000 to 50,000 cubic feet, a 1900 cm^3/s 30 gpm pump; and for jobs greater than 1400 cubic meters 50,000 cubic feet, a 3800 cm^3/s 60 gpm pump. Also, for jobs where large grout quantities are anticipated it may be desirable to specify an automated batching plant with batch tickets for all items in the mix.

****

The use of internal combustion engines within dam galleries for operation of drilling and grouting equipment will not be permitted. Submit details and data on the drilling and grouting equipment.

3.1.1 General

Use drilling [including exploratory hole drilling] and grouting equipment of a type, capacity and mechanical condition suitable for performing the work, as determined by the Contracting Officer. Provide power and equipment and the layout thereof meeting all applicable requirements of local, State, and Federal regulations and codes, both safety and otherwise.

3.1.2 Drilling Equipment

Use standard drilling equipment of the rotary [or percussion] type to perform the drilling as specified in paragraphs GROUT HOLE DRILLING, DRAIN HOLE DRILLING, COMPLETION OF GROUTING AND DRAIN HOLE DRILLING, and EXPLORATORY HOLE DRILLING. Use [water] [air] for removing cuttings from the hole during drilling operations. Equip air driven drills used in galleries with suitable mufflers. Supplies include all bits, drill rods, tools, casing, piping, pumps, water, and power to accomplish the required drilling. All drilling rigs and pumps will be equipped with pressure gages.

3.1.3 Grouting Equipment

Furnish grout plant capable of supplying, mixing, stirring and pumping the grout and additives, to the satisfaction of the Contracting Officer. Submit a detailed plan showing equipment and grout plant layout proposed for mixing and placing grout. Furnish plant with a minimum capacity of [[_____] mL/s] [[_____] cm^3/s] [[_____] gpm] [[_____] cfm] of grout injected at a pressure not greater than [_____] kPa psi. Maintain it at all times and replace any grout hole that is lost or damaged due to mechanical failure of equipment or inadequacy of grout supply by another hole, drilled by the Contractor, at its expense. Provide the amount of grouting equipment as necessary to perform the work specified herein. Include the following:

a. A progressive cavity pump capable of passing particles up to a top size of [_____] mm inches, generating pressures up to [_____] kPa psi and pumping a maximum of [[_____] mL/s] [[_____] cm^3/s] [[_____] gpm] [[_____] cfm]. In no case will the pump be separated by more than [_____] meters feet of grout line from the header of a hole being grouted. Where grout lines are more than [_____] meters feet long, place an additional pump in the line within [_____] meters feet of the header.

b. A [colloidal] [paddle] type grout mixer having a minimum drum capacity of approximately [_____] cubic meters feet with a mix batch of [_____] cubic meters feet. Provide mixing time of approximately [_____] seconds per batch.

c. A separate colloidal mixer for mixing and hydrating bentonite.

d. A mechanically agitated sump having a minimum capacity of [_____] cubic meters feet.

e. A circulating grout header with control valves and a pressure gage with protector as shown on the plans. Connect control valves to the return line and header. Join the header directly to the riser pipe at the hole by means of a quick connector union.

f. A water storage tank or suitable source of clean auxiliary water for use in washing, pressure testing and flushing operations.

g. A water meter graduated in cubic meters feet and tenths having a direct reading totalizer and capable of conveniently being set back to zero.

h. Such valves, packers, pressure gages, pressure hose, supply lines, and small tools as may be necessary to provide a continuous supply of grout at accurately controlled pressures as specified. The inside diameter of the pressure hose and grout supply line less than [_____] mm inches is not permitted. Use an accurately calibrated, high precision pressure gage to check the accuracy of all gages used in the grouting. Chec gages at least every 24 hours, or more frequently if the Contracting Officer so determines. When defects are found, grouting operations will be stopped until calibration of gages has been obtained.

3.2 GROUT, DRAINAGE AND EXPLORATORY HOLES

Drill all holes for grouting, drainage or exploration at the locations, in the direction, angle, and to the depths indicated or as directed by the Contracting Officer.[Provide a maximum tolerance for deviation in angle and direction of [_____].] Drill and grout the first series of holes at [_____] meter foot intervals and hereinafter are referred to as primary holes. Determine the location of secondary and succeeding series (intermediate) holes by the split spacing method as defined in paragraph SPLIT SPACING. Increase the number of grout holes progressively by the split spacing method as defined in paragraph SPLIT SPACING. Increase the number of grout holes progressively by the split spacing method as deemed necessary by the Contracting Officer until the amount of grout used indicates that the foundation is tight. Protect each hole drilled from becoming clogged or obstructed by means of a cap or other suitable device on the collar and clean out any hole that becomes clogged or obstructed due to fault of the Contractor before completion of operations in a manner satisfactory to the Contracting Officer or provide another hole at the expense of the Contractor. That portion of holes which penetrates concrete of the dam must be [formed by embedding pipes in the concrete at the time of its placement] [drilled] as specified in paragraph PIPE FOR FOUNDATION GROUTING AND DRAINAGE. Payment will be made for such partial depth of holes at the unit contract price for [Item No. [_____] "Steel Pipe and Fittings"], [Item No. [_____] "Drilling Grout Holes"], [Item No. [_____] "Drilling Drain Holes"], [Item No. [_____] "Drilling Exploratory Holes"].

3.2.1 Pipe for Foundation Grouting and Drainage

Embed all metal pipe and fittings required for constructing grout, drainage and exploratory holes. Thoroughly clean pipe and fittings of all dirt, grease, oil, grout and mortar immediately before embedment. Make all joints snug and hold the assembly firmly in position and protect from damage or displacement while the concrete is being placed. Take all necessary precautions to prevent any pipe from becoming clogged or obstructed from any cause and clean out any pipe which becomes clogged in a manner satisfactory to the Contracting Officer at the Contractor's expense. Consider the presence of tramp metal such as nails, wire, bolts, nuts and other foreign material in the pipes through which diamond drilled holes are to be drilled as obstructions. As an option, substitute percussion or diamond drilled holes through the concrete in lieu of pipe, provided that the method proposed meets with the approval of the Contracting Officer and provided further that such substitution does not result in any increased cost to the Government.

3.2.2 Grout Hole Drilling

a. Drill grout holes with standard rotary [or percussion] drilling equipment. No core recovery will be required and the type bit used will be optional with the Contractor. [Provide hole of sufficient diameter to allow use of an expansion plug or packer with an effective inside diameter of not less than 13 mm 1/2 inch]. The minimum diameter of hole must be [35] [_____] mm [1 3/8] [_____] inches at the point of maximum penetration. No grout hole will be drilled at an angle greater than [_____] degrees measured from the vertical nor to a depth greater than [_____] meters feet measured from the collar of the hole. If, as the work progresses, it is determined that holes to depths greater than indicated are necessary, drilling to such greater depth will be ordered in writing, and the drilling to depths in excess of [_____] meters feet will be paid for at a negotiated unit price.

b. Perform drilling in accordance with the applicable grouting method hereinafter described. Whenever as much as [_____] percent of the drill water is lost or the cumulative total of successive water losses is estimated to amount to [_____] percent loss, or artesian flow is encountered, stop the drilling operations, wash the hole, pressure test and grout before drilling operations are resumed in such hole. Remove injected grout from a partially completed hole by washing or other methods before it has set sufficiently to require redrilling. Redrilling required because of the Contractor's failure to clean out a hole before the grout has set must be performed at the Contractor's expense except that where the grout has been allowed to set by direction of the Contracting Officer, the redrilling will be paid for at the contract price for drilling the grout hole. Upon completion of drilling of any hole and prior to pressure testing, remove all drill cuttings and slurry by applying water to the bottom of the hole [through open end rods] and returning the wash water through the hole to the surfaces until the return water is clear. No separate payment will be made for this washing.

3.2.3 Drain Hole Drilling

Drill drain holes with standard diamond drilling equipment, but no core recovery will be required and the Contractor may elect to use coring or noncoring bits. The minimum diameter of hole must be [72] [_____] mm [2 7/8] [_____] inches, measured at the point of maximum penetration. No drain hole will be drilled at an angle greater than [_____] degrees from the vertical nor to a depth greater than [_____] meters feet, measured from the collar of the hole. Do not drill drainage holes in any location until all adjacent grout holes within a minimum distance of 50 meters 150 feet have been drilled and grouted to full depth.

3.2.4 Completion of Grouting and Drain Hole Drilling

Complete all grouting operations and all drain hole drilling in proper working condition prior to the time of impounding water. At that time complete all work in the [grouting and drainage galleries] [tunnels], uncover and unobstruct all drain holes, and make [galleries and their gutters] [tunnels] free of all construction debris. Nipples for grout hole drilling will be removed from the [gallery] [cutoff trench] and disposed of and the finished grout holes will be patched.

3.2.5 Exploratory Hole Drilling

a. Perform such exploratory drilling as may be required to determine the condition of the rock prior to grouting or the effectiveness of the grouting operations during or after grouting. Perform all exploratory drilling with rotary drilling equipment using coring type bits. Since the maximum recovery of unpredictable soft or friable materials is of prime importance, make every effort to recover 100 percent of the core by use of the appropriate equipment and drilling procedures.

b. The holes may be required to be drilled to varying depths, with a maximum depth of [_____] meters feet. No exploratory hole will be drilled at an angle greater than [_____] degrees measured from the vertical.

c. Special care should be exercised to obtain cores in as good condition as possible. Keep, in a manner satisfactory to the Contracting Officer, an accurate Driller's Log of all exploratory holes drilled. Include a nontechnical description of all materials encountered in the drilling, their location in the holes and the location of special features such as seams, open cracks, soft or broken rock, points where abnormal loss or gain of drill water occurred, and any other items of interest in connection with the purpose for which the exploratory drilling is required.

d. Wooden or other approved core boxes will be furnished by [the Government] [the Contractor], and place the cores in the boxes in the correct sequence and separated accurately by wooden blocks, according to the measured distances in the hole. Do not contain cores from more than one hole. Fasten the covers securely to the core boxes and deliver in the vicinity of the work as directed.

e. Grout exploratory holes under pressure, if conditions so indicate, by [stop grouting] [grouting to full depth in one operation] and backfilled in accordance with paragraph BACKFILLING OF HOLES.

3.3 PROCEDURES FOR DRILLING AND GROUTING

3.3.1 General

Accomplish drilling and grouting in single or multiple lines as shown. Drill and grout by [zones, using the split spacing, stage grouting method] [split spacing, stop grouting method] as described herein.

3.3.2 Stage Grouting

Perform stage grouting of progressively deeper zones in stages with the placement of a grout curtain by drilling and grouting in successive operations in accordance with the following general procedure.

3.3.2.1 Primary Holes

Drill primary holes for foundation grouting to their first stage of depth within the first zone. The depths will be governed by the foundation conditions.

a. Wash and pressure test the holes thus drilled and then grout, except that when pressure testing indicates a relatively tight hole, the Contracting Officer may direct that the grouting of that hole be omitted for that stage and the hole be left open for drilling and grouting of the next stage.

b. After the grouting of any hole, [remove the grout within the hole by washing or by other methods before it has set sufficiently to require redrilling][allow the grout within the hole to set and subsequently redrillthe holes].

c. After the interval of time as specified in paragraph SECOND STAGE, drill the primary holes not already drilled to the limit of the first zone as directed to additional depths not exceeding the zone limit.

d. Wash the primary holes thus deepened again and pressure test and then grout at higher pressures as directed. Again, remove the grout within the hole as described above.

e. Repeat the process of successively drilling primary holes to additional depths and grouting at higher and higher pressures in stages, as directed, until all of the primary holes on the maximum spacing (see paragraph GROUT, DRAINAGE AND EXPLORATORY HOLES) have been completely drilled and grouted to the depth of the first zone in that section of the grout curtain.

3.3.2.2 Successive Holes

After the primary holes in the first zone have been completed in any section as specified above, drill and grout the second and succeeding series of holes, as determined by the "split spacing method," to the depth of the first zone in like manner until the first zone of that section is completely grouted as directed.

3.3.2.3 Completion of Section

Repeat the process of successively drilling to additional depths and grouting at higher and higher pressures in stages for the first series of holes and then for succeeding series of holes for the second and subsequent zones of that section. Grout other sections along the grout curtain in like manner until grouting of the foundation is completed to the satisfaction of the Contracting Officer. As the drilling and grouting work progresses, it may develop that conditions are such that all or parts of the foundation already grouted require additional grouting. In such event, return the equipment and drill and grout additional holes as directed.

3.3.3 Stop Grouting

Stop grouting is a method whereby each hole is drilled to a final depth and grouted by stops through an expansion plug or packer which is set at successively shallower depths. It involves the placement of a grout curtain by drilling and grouting in accordance with the following general procedure:

a. Drill hole to the full depth and wash as specified in paragraph GROUT HOLE DRILLING.

b. Pressure test holes thus drilled and washed, and pressure washd as specified in paragraph PRESSURE WASHING AND PRESSURE TESTING.

c. Place the expansion plug, or packer, in the hole at the top of the interval to be grouted blocking off the higher portion of the holes, and the interval is grouted. The lowest zone is grouted first. In no case will the Contractor be required to set the packer deeper than [_____] meters feet.

d. After placing the grout at the pressure and mix directed by the Contracting Officer, leave the expansion plug, or packer, in place until the grout pressure drops to that pressure required for the next higher stop or as directed by the Contracting Officer.

e. Move the expansion plug, or packer, to the next higher stop and place grout at the lower pressure as directed by the Contracting Officer.

f. Repeat the procedures described in subparagraphs "d" and "e" above until grouting of the hole is complete.

g. After the primary holes in the first zone have been completed in any section as specified above, grout the second and succeeding series of holes, as determined by the "split spacing method" in like manner until all zones of that section are completely grouted as directed.

h. Grout other sections along the grout curtain in like manner until grouting of the foundation is completed to the satisfaction of the Contracting Officer.

i. As the drilling and grouting work progresses, it may develop that conditions are such that all or parts of the foundation already grouted require additional grouting. In such event, return the equipment and drill and grout additional holes as directed and no allowance above contract unit prices will be made for drilling and grouting such holes or for the expense of any movement of equipment necessary to the performance of such work.

3.3.4 Pressure Washing and Pressure Testing

Immediately before the pressure grouting operation, thoroughly wash the hole under pressure and pressure test. Wash all intersected rock seams and crevices containing clay or other washable materials with water [and air] under pressure to remove as much of these materials as possible. If practicable, as determined by the Contracting Officer, eject such material from one or more holes by introducing water [and air] under pressure into an adjacent hole. Do not exceed the maximum grouting pressure as directed. Test all grout holes with clean water under continuous pressure up to the maximum grouting pressure as directed. Wash all holes sufficiently tight to build up the maximum required pressure and continue washing as long as there is any increase in the rate at which water is taken, such increase indicating the fractures are being opened by the washing operation. Wash open holes in which no pressure can be built up for a period of 5 minutes, with the pump operating at full capacity, or for such period of time as fracture-filling is being removed, as evidenced by the escape of muddy water through surface openings or other grout holes.

3.3.5 Stage Grouting Procedures

3.3.5.1 First Stage

Perform the first stage, or low-pressure, shallow-curtain grouting by washing and grouting holes at locations indicated or as directed, using the "split spacing" method described in paragraph SPLIT SPACING. Similar stages of drilling and grouting are repeated as necessary to reach the bottom of the first zone. Before grouting is begun in any hole of a given series in any section, completely drill at least the nearest two holes in advance of each such hole in that series for the same stage and completely wash the adjacent hole to facilitate washing and flushing out of any intervening clay-filled seams, fractures, or solution channels. Do not grout hole beneath any portion of the dam until all concrete within [35] [_____] meters [100] [_____] feet has been placed to [full height] [_____] unless otherwise directed.

3.3.5.2 Second Stage

After all first stage grouting in any section has been completed, as specified above, proceed, when so directed, with second stage drilling and grouting in accordance with the procedure outlined herein but in no case commence the deepening of any hole preparatory to grouting before the previously placed grout has set nor conduct second stage grouting within a distance of approximately 35 meters 100 feet of any hole in which a previous stage of grouting has been completed until the grout in such previous stage hole has [taken its set] [set for a period of 24-hours]. Perform grouting at subsequent stages conforming to the same requirements as to minimum time and distance. Upon completion of all holes to the bottom of the first zone, and after the waiting period the primary holes are drilled to the next stage in the second zone and grouted at higher pressures. The process of drilling, washing, pressure testing, pressure washing, and grouting at progressively higher pressures are continued until the ground is satisfactorily tight to the required depth.

3.3.6 Stop Grouting Procedures

3.3.6.1 Stop Grouting of Grout Holes

Perform the grouting by washing and grouting holes at locations indicated or as directed. Before grouting is begun in any hole of a given series in any section, completely drill at least the nearest two holes in the advance of each such hole in that series and completely wash the adjacent hole to facilitate washing and flushing out of any intervening clay-filled seams, fractures, or solution channels.

3.3.6.2 Grouting of Existing Exploratory Holes

Clean [pressure-test], and [pressure grout] [gravity grout] existing exploratory holes or portions of holes more than five feet deep after excavation as specified for grout holes. Backfill holes less than 1.5 meters five feet deep with grout mixed in proportions directed by the Contracting Officer. Gravity grout or backfill in accordance with paragraph BACKFILLING OF HOLES.

3.3.7 Grouting Pressures

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NOTE: Refer to EM 1110-2-3506, "Grouting Technology" for discussions of grouting pressures as an aid in selecting allowable pressures under different conditions.

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Grouting pressures to be used in the work will vary with conditions encountered in the respective holes and use pressures as directed. It is anticipated that pressures will range from [_____] kPa psi to [_____] kPa psi but in no event will pressures in excess of [_____] kPa psi be required or allowed.

3.3.8 Grouting

Perform all pressure grouting operations in the presence of the [Contracting Officer][Government Inspector], and in accordance with the following general procedures.

3.3.8.1 Grout Mixes

****

NOTE: Appropriate additives will be used for specific cases.

****

Provide mixese in the proportions directed by the Contracting Officer who will, from time to time, direct changes to suit the conditions found to exist in the particular grout hole. [The cement grout will include 2 percent to 5 percent (by weight of cement) of sodium bentonite]. The water/cement ratio by volume will be varied to meet the characteristics of each hole as revealed by the grouting operation and will range between [_____] and [_____]. Provide the types of grout as follows:

[a. Cement Grout consisting of cement, (bentonite) and water.]

[b. Mortar Grout consisting of cement, (bentonite), sand, and water.]

3.3.8.2 Grout Injection

a. In general, if pressure tests indicate a tight hole, start grouting with a thin mix. If an open hole condition exists, as determined by loss of drill water or inability to build up pressure during washing operations, then start grouting with a thicker mix and with a grout pump operating as nearly as practicable at constant speed at all times; decrease the ratio, if necessary, until the required pressure has been reached. [If this procedure does not produce the desired pressure, use mortar grout and vary the mix as necessary to produce the desired results.]

b. When the pressure tends to rise too high, increase the water/cement ratio [and/or change or discontinue the mix of mortar grout] as may be required to produce the desired results. If necessary to relieve premature stoppage, make periodic applications of water under pressure. Do not suddenly increase the pressure or rate of pumping as either may produce a water-hammer effect which may promote stoppage.

c. Do not consider the grouting of any hole complete until [that hole refuses to take any grout whatever at three-fourths of the maximum pressures required for that stage] [that hole takes grout at the rate of one cubic foot of grout or less in ten minutes measured over at least a five minute period at the pressure required for that portion of the hole being grouted.]

d. Should grout leaks develop, caulk such leaks when and as directed, the cost thereof being included in the contract price for unit price pay item "Placing Grout", in accordance with Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

e. If, due to size and continuity of fracture, it is found impossible to reach the required pressure after pumping a reasonable volume of grout at the minimum workable water/cement ratio [or mortar grout with the maximum volume of sand at the minimum water/cementing materials ratio] reduce the speed of the pumping or stop pumping temporarily and perform intermittent grouting, allowing sufficient time between grout injections for the grout to stiffen. Following such reduction in pumping speed, if the desired result is not obtained, discontinue grouting in the hole when directed. In such event, clean the hole, allow the grout to set, and perform additional drilling and grouting in this hole or in the adjacent areas as directed, until the desired resistance is built up.

f. After the grouting of any [stage] [stop] of a hole is finished, maintain the pressure by means of a stop-cock or other suitable device until the grout has set to the extent that it will be retained in the hole.

g. Grout that cannot be placed, for any reason, within two hours after mixing must be wasted. If such grout is mixed at the direction of the Contracting Officer or with his knowledge and consent, such wasted grout, except as specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES, must be paid for at the contract unit prices for the materials contained therein.

3.3.8.3 Backfilling of Holes

Backfill holes with grout proportioned as directed by the Contracting Officer and generally having a water/cement ratio less than 1.0. Accomplish backfilling by injection of grout through a tremie pipe or hose inserted to full depth of hole. When grout vents at the surface, gradually withdraw the tremie, maintaining grout in pipe or hose until completely removed. Do not backfill holes containing freshly injected grout until the injected grout has set. No separate payment will be made for backfilling holes; however, grout will be paid for at the contract unit price for the Portland cement therein.

3.3.8.4 Equipment Arrangement and Operation

Arrange the grouting equipment to provide a continuous circulation of grout throughout the system and to permit accurate pressure control by operation of a valve on the grout return line, regardless of how small the grout take may be. Prevent the equipment and lines from becoming fouled by the constant circulation of grout and by the periodic flushing out of the system with water. Flush with the grout intake valve closed, the water supply valve open, and the pump running at full speed.

3.3.8.5 Protection to Work and Cleanup

[Except as otherwise specified, no grouting will be permitted within [_____] meters feet of installed perforated pipe or gravel filters for foundation drains. Where permitted in such locations, maintain a flow of water through the drains likely to be affected, to serve as tell-tales. In case leakage of grout into drains does occur immediately stop the grouting operations and remove all grout from the drains affected by washing to the satisfaction of the Contracting Officer. Payment for washing will be in accordance with unit price pay item "Pressure Washing and Pressure Testing" in [this Section][Section 01 20 00 PRICE AND PAYMENT PROCEDURES]. Repeat such stopping of grouting operations and washing of drains as often as required to complete the curtain grouting.] During grouting operations take such precautions as may be necessary to prevent drill cuttings, equipment exhaust oil, wash water, and grout, from defacing or damaging the permanent structure. Daily maintenance may be required along grout lines, in order to offer better inspection of interconnected holes and breakouts. The Contractor will be required to furnish such pumps as may be necessary to care for waste water and grout from his operations. Upon completion of these operations, clean up all waste resulting from his operations that is unsightly or would interfere with the efficient operation of the project as anticipated by the original design.

3.3.9 Records

The Contracting Officer will keep records of all grouting operations, such as a log of the grout holes, results of washing and pressure testing operations, time of each change of grouting operation, pressure, rate of pumping, amount of cement for each change in water/cement ratio, and other data as deemed by him to be necessary. Furnish all necessary assistance and cooperation to this end.

3.3.10 Communications

When, for its own convenience, the Contractor has the individual elements of the plant so located that communication by normal voice between these elements is not satisfactory, the Contracting Officer may require him to install a satisfactory mechanical means of communications, such as a telephone or other suitable device.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 56 13.13 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-02 35 27 (May 2010)

GUIDE SPECIFICATION FOR CONSTRUCTION

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-31 56 13.13 (February 2021)**

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UFGS-02 35 27 (May 2010)

GUIDE SPECIFICATION FOR CONSTRUCTION

References are in agreement with UMRL dated January 2025

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SECTION 31 56 13.13

SOIL-BENTONITE SLURRY WALLS
02/21

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NOTE: This guide specification covers the requirements for constructing a soil-bentonite slurry trench at both conventional and hazardous waste projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: In using this guide specification, the designer should realize that the requirements for the bentonite, backfill, and construction procedure are highly dependent on the intended purpose of the slurry trench and the environment in which it is to be used.

The primary considerations for S-B slurry trenches are blowout requirements, permeability, strength, and compressibility.

The S-B backfill should be designed to prevent possible blowout or piping of the S-B backfill into

the surrounding foundation material due to the hydraulic gradient acting across the slurry trench. Design criteria are presented in Chapter 9, Corps of Engineers (COE) EM 1110-2-1901.

The permeability for S-B slurry trenches is usually in the order of 10-6 to 10-8 cm/sec. The actual permeability of the slurry trench is dependent on both the filter cake, which forms on the sides of the trench and the S-B backfill. The contributions of both are dependent on the relative permeability and thickness of the two materials. For design purposes, however, it is recommended that the permeability of the slurry trench be based only on the S-B backfill. For permanent or critical temporary projects, laboratory permeability tests should be utilized in establishing the mix design.

When design requirements dictate, both shear strength and compressibility of the S-B backfill should be analyzed by conducting laboratory testing.

Since chemical contaminants commonly associated with hazardous waste sites may increase the permeability of S-B backfill, a compatibility testing program must be undertaken prior to constructing a slurry trench. If the trench is to be excavated through contaminated material, consider performing compatibility testing using two potential backfill materials; soils to be excavated from the trench and an uncontaminated borrow source. It should be noted that compatibility testing can take from 2 to 6 months to complete. For this reason, it is generally recommended that compatibility testing be completed during the design phase of the project.

A recommended compatibility testing program consists of:

1. Free swell (ASTM D5890) and filter cake permeability tests of several bentonites using contaminated site ground water and site mixing water that will be used during construction to determine acceptable bentonites for use on the project.

2. Mix design optimization tests to determine the most economical mix of soils, dry bentonite, and bentonite slurry to produce the required permeability. This consists of short-duration (48-72 hours) permeability tests varying the amount of dry bentonite added (0, 2, and 4 percent) and if necessary the amount of additional fines added (0, 10, 20 percent) using site mixing water as the permeant.

3. Long-term flexible wall permeameter testing of at least 3 S-B backfill samples: the optimum mix design with site mixing water only as the permeant (control); the optimum mix design with contaminated

site ground water as the permeant (after 1 pore volume of site mixing water permeant to ensure a good test setup); and a bentonite content 2 percent greater than the optimum determined in step 2 with contaminated site ground water as the permeant (after 1 pore volume of site mixing water permeant). It is recommended that 3 pore volumes of ground water permeant pass through the S-B backfill samples. This typically takes at least 2 months.

To approximate field conditions in the lab, it is important to obtain contaminated ground water and mixing water from the site. The site mixing water used during compatibility testing must be the water used to make the bentonite slurry during construction.

For laboratory testing, consider requiring a permeability of one-half an order of magnitude less than the required field permeability (for example, 5x10-8 cm/sec in the lab for 1x10-7 cm/sec in the field).

****

1.1 MEASUREMENT AND PAYMENT

****

NOTE: Delete this paragraph when work is covered by lump sum contract price.

****

1.1.1 Measurement

Base measurement for S-B Slurry Trench on the area in square meters feet of completed slurry trench measured in a vertical plane through the centerline of the slurry trench, from the top of the working surface to the bottom of the excavated trench, and vertical lines at each corner of the full depth of the excavated trench. Base measurements on surveys and soundings taken at the site as directed and approved.

1.1.2 Payment

Payment for S-B Slurry Trench will be made at the contract unit price per square meter foot. Such price will include costs incurred for the construction and completion of the slurry trench. No separate payment will be made for material, equipment, handling and cleaning the slurry, quality control testing, record keeping, and site preparation including construction of the working surface.

1.2 DEFINITIONS

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NOTE: Remove items not required in the project.

****

The terms used in this Section are defined as follows:

1.2.1 Slurry Trench

The slurry trench is a [_____] [900] mm [3] feet minimum width trench excavated through the existing ground or prepared working surface using the slurry method of excavation and backfilled with S-B backfill material, to form a low permeability cutoff wall.

1.2.2 Slurry Method of Excavation

The slurry method of excavation consists of excavating a vertical walled trench and at the same time keeping the trench filled with a bentonite slurry mixture. The purpose of the slurry is to support the walls of the trench and prevent movement of ground water.

1.2.3 Bentonite

Bentonite is an ultrafine natural clay whose principal mineral constituent is sodium cation montmorillonite.

1.2.4 Slurry

Slurry is a colloidal mixture of bentonite and water.

1.2.5 Soil Bentonite (S-B) Backfill

S-B backfill is a homogeneous mixture of material produced by mixing soil with bentonite slurry [and additional dry bentonite], which is placed into the excavated trench to complete the soil-bentonite slurry trench.

1.2.6 Ground Water Level

The ground water level is the piezometric level of the ground water as determined from piezometers and wells.

1.2.7 Working Surface

The working surface is the top of the [stripped and/or prepared natural ground] [or] [the surface of previously compacted fill] from which the slurry trench is constructed.

1.2.8 Confining Stratum

The confining stratum is the soil stratum or rock unit to or into which the bottom of the slurry trench is excavated.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 13B-1	(2009; R 2016) Recommended Practice for Field Testing Water-Based Drilling Fluids
API Spec 13A	(2010; Errata 1 2014; Errata 2-3 2015) Specification for Drilling-Fluid Materials

ASTM INTERNATIONAL (ASTM)

ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D5084	(2016a) Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D7928	(2017) Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preconstruction Testing Plan; G, [_____]

Slurry Trench Implementation Plan; G, [_____]

Blasting Plan; G, [_____]

SD-02 Shop Drawings

As-Built Profile

SD-04 Samples

Bentonite; G, [_____]

Backfill Material; G, [_____]

SD-06 Test Reports

S-B Backfill Test Report

Quality Control Testing

Soundings

Water

Bentonite Slurry Mixes

Slurry Properties

SD-07 Certificates

Bentonite

1.5 OTHER SUBMITTAL REQUIREMENTS

Submit the following:

a. Plan describing the general work sequence and layout of operations. Include scale drawings, which depict slurry and S-B backfill preparation and storage areas. Describe Contractor qualifications, equipment, method of trench excavation, [blasting,] use or disposal of excavated material, bottom cleaning, slurry preparation and maintenance, S-B backfill preparation and placement, and site clean-up.

b. Plan describing quality control equipment and test procedures, sample test forms for reporting test results, and the offsite laboratory proposed for use.

c. Data on the equipment to be used in the construction of the slurry trench; equipment to be used to obtain [bedrock] [impervious stratum] samples; [equipment to be used to obtain record control samples of the completed slurry trench;] and equipment to be used in the Contractor's quality control testing.

d. A copy of the test results from the bentonite manufacturer for each lot shipped to the site and a certificate of compliance stating that the bentonite complies with applicable standards.

1.6 QUALITY ASSURANCE

The Government may perform quality assurance testing on representative samples obtained by the [Contractor] [Government] of the bentonite slurry and S-B backfill using the laboratory and equipment furnished by the Contractor. The Government testing will in no way relieve the Contractor of the responsibility of performing tests necessary to meet the Construction Quality Control (CQC) requirements. Provide the equipment and laboratory space to government personnel on demand and these services will be considered a subsidiary obligation of the soil bentonite slurry trench construction. Make all routine testing procedures available for inspection by the Contracting Officer at any time.

1.6.1 Qualifications

****

NOTE: Remove subparagraphs not required in the project.

****

1.6.1.1 Contractor

Successfully installed a minimum area of [_____] 100,000 square meters 1,000,000 square feet. Provide qualifications and experience of personnel who is responsible for conducting the operations including references (name and telephone number) of the owners of the Contractor's previous slurry trench construction projects.

1.6.1.2 Slurry Trench Specialist

An individual who has had experience with at least [_____] [5] projects in all aspects of slurry trench construction which includes, but is not limited to:

a. The use, testing, and control of bentonite slurries,

b. The mixing methods required to properly mix the slurry and backfill materials as required,

c. Trench excavation and backfilling procedures, and

d. A thorough knowledge of construction equipment and material testing required for slurry trench construction.

1.6.1.3 Slurry Trench Excavation Equipment Operator

The slurry trench excavation equipment operator must have experience using similar slurry trench excavation equipment to be used for this contract in a minimum of [_____] [2] projects of similar or greater magnitude (depth).

1.7 DELIVERY, STORAGE, AND HANDLING

Protect materials delivered and placed in storage from the weather, dirt, dust or other contaminants.

1.8 GEOTECHNICAL SITE CONDITIONS

1.8.1 Exploratory Borings

****

NOTE: In most cases, the exploratory borings along the alignment should be obtained during design. However, in some cases, it may be necessary to have the Contractor obtain exploratory borings to determine or verify the depth or characteristics of the key stratum. This should be performed well in advance of slurry trench installation to prevent delays. If additional drilling is required, it is recommended that a separate specification be prepared for that work.

****

Subsurface exploratory borings have been obtained by the Government to determine the character of materials to be excavated. Locations of the borings are shown on the drawings and the logs of those borings, which fall within the area of this contract, are included in [_____] for the convenience of the Contractor. The Government assumes no responsibility for interpretation or deductions made from the logs and borings. Local minor variations may exist in the subsurface materials between boring locations and, if encountered, will not be considered as being materially different within the purview of this contract [_____]. Soils classifications shown on the logs are the result of [field visual classifications] [laboratory classifications] in accordance with the Unified Soil Classifications System. [The results of all laboratory testing, including rock and soil, are available for review by the Contractor in the [_____].] [Attention is invited to FAR 52.236-4 Physical Data in the Special Contract [Clauses] [Requirements] for availability of core borings and soil samples for inspection.]

1.8.2 Subsurface Conditions

****

NOTE: A general description of the conditions to be encountered during the excavation should be provided. Also, provide a description of the stratum or formation into which the slurry trench will be keyed.

****

[_____].

1.8.3 Ground Water

****

NOTE: Provide a discussion of the ground water that could affect the slurry trench construction.

****

[_____].

1.8.4 [Embankment Conditions]

****

NOTE: When a slurry trench is installed through an existing embankment, a description of the embankment materials to be excavated should be provided.

****

[_____].

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Bentonite

****

NOTE: Bentonites for use may conform to either Section 4 or Section 5 of API Spec 13A, provided the desired permeability is obtained during pre-construction mix design and compatibility

testing. Bentonites, which conform to Section 4 of API Spec. 13A, have typically been treated with small amounts of polymers. Bentonites, which conform to Section 5 of API Spec 13A, have not been chemically treated. For this specification, the values shown in Table 1 for bentonite, reflect the requirements of API Spec 13A, Section 5. Values in Table 1 should be modified accordingly for Section 4 bentonites.

In the event no bentonites conforming to either Section 4 or 5 of API Spec 13A can produce the desired permeability due to contaminants in ground water, bentonites or other materials with substantial chemical alterations or additives may be used. Use of these materials will depend upon the successful completion of a compatibility testing program and the concurrence of all appropriate State and Federal regulatory agencies. These materials should be used with caution due to the general lack of long-term performance data. These materials may be proprietary products. Modify appropriate sections of this guide specification according to manufacturer's recommendations.

****

Provide bentonite consisting of sodium cation base montmorillonite powder that conforms to API Spec 13A, Section [4][5], and Table 1, located at the end of this section. [Chemically treated bentonite will not be allowed.] [Other chemically treated bentonites may be considered provided the required permeability values can not be obtained with bentonites conforming with Section 4 or Section 5 of API Spec 13A.] Do not use bentonite from the bentonite manufacturer prior to acceptance by the Contracting Officer. Remove bentonite not meeting specifications promptly from the site at the Contractor's expense. Protect bentonite from moisture during transit and storage. Submit a minimum of 4.5 kg 10 pounds of the proposed bentonite at least [1] [_____] month prior to use.

2.1.2 Water

The [Contractor must] [Government will] supply [and condition] water required for mixing with bentonite to produce slurry. Provide clean, fresh water in compliance with the standards specified in Table 1. Submit water quality test results for water used for mixing the bentonite slurry to assure conformance to these standards. Submit a record of the water source and associated chemical analysis.

2.1.3 Backfill Material

****

NOTE: For backfill materials with a low percentage of fines (less than 20 percent), it may be necessary to add supplemental fines from an additional borrow area to achieve the desired permeability.

If offsite borrow material is selected for use as the backfill material, it should be tested to ensure that it is uncontaminated. It may be possible to use material excavated from the trench as backfill

material, even if it is slightly contaminated. If contaminated material is being considered for use, it must be verified that the material can be safely handled in the field.

The gradation requirements below should be modified to fit the chosen backfill material. In general, no particles greater than 76 mm 3 inches should be in the mix, and a minimum fines content of 20 percent is always recommended.

****

Obtain backfill material from [material excavated from the slurry trench] [a Government furnished borrow area] [an offsite borrow area]. Thirty days prior to utilization of any off-site borrow, identify the site and submit a minimum of 22.5 kg 50 pounds of each type of proposed borrow soil, at least [1] [_____] month prior to use of each type of material, to the Contracting Officer for QA testing. Furnish backfill that is free of [contamination] [_____], roots, debris, brush, sod, organic or frozen material. [Material passing the 75 micrometer No. 200 sieve must have a liquid limit greater than [30] [_____] and a plasticity index greater than [10] [_____]]. Blend materials thoroughly prior to mixing with bentonite slurry and conform to the following gradation requirements:

Screen Size or Number (U.S. Standard)	Percent Passing by Dry Weight
[75 mm 3 inch][_____]	[100][_____]
[4.76 mm No. 4][_____]	[40-80][_____]
[0.42 mm No. 40][_____]	[25-60][_____]
[75 micrometer No. 200][_____]	[20-40][_____]

2.2 EQUIPMENT

Furnish all necessary plant and equipment for use on this project.

2.2.1 Trench Excavation Equipment

Provide equipment for excavating the slurry trench of any type or combination of excavating equipment capable of performing the work as specified and shown on the drawings. [Provide equipment capable of excavating the required minimum width of trench in a single pass of the excavating equipment.] The buckets utilized with such equipment may be perforated, tapered and equipped with bottom-side cutter teeth protruding no more than 150 mm 6 inches. Design the bucket to maintain the width of the trench and to minimize raveling of the trench sides during use. The equipment must be able to reach at least [_____] 1500 mm 5 feet deeper than the maximum depth shown on the drawings.

2.2.2 Slurry Mixing and Cleaning Equipment

Equip the slurry mixing plant with a high-speed/high-shear, colloidal mixer or a high-velocity/high pressure venturi jet mixer used in conjunction with a high-speed/high-shear centrifugal pump. Equip the plant with a mechanically or hydraulically agitated sump and include pumps, valves, hoses, supply lines, tools, and other equipment and materials required to prepare the slurry and deliver it in a continuous supply from the hydration pond [or tanks] to the slurry trench. Provide mixers capable of achieving complete dispersion of bentonite and additives, and capable of continually mixing the slurry to provide and maintain a uniform blended slurry. Provide sufficient ponds [or tanks] for storage of hydrated bentonite slurry. [Slurry cleaning equipment must be available to reduce sand, sediment, or other solids as necessary to maintain the sand content or density requirements of the slurry in the trench. Slurry cleaning equipment may include but not be limited to vibratory shaker screens, centrifugal sand separators, or stilling ponds.]

2.2.3 Field Laboratory Equipment

The field laboratory must contain as a minimum the following equipment:

1	Mold and rod for slump test
2	Marsh funnel sets
1	Standard filter press
2	Mud balances (direct reading of density)
1	Slurry sampler
2	0.075 mm Number 200 sieves
1	Set of standard sieves and sieve shaker
1	Oven for moisture content
1	Balance
1	pH [meter] [paper]
2	Sand content sets
1	101.6 mm 4 inch Cylindrical mold

2.3 BENTONITE SLURRY MIXES

2.3.1 Initial Bentonite Slurry Mixture

****

NOTE: For most bentonites, 4 to 6 percent by weight should produce a slurry that will meet all the specified requirements. Other mixtures may be determined to be acceptable during pre-construction tests. S-B backfill mix designs should be determined during pre-construction testing. Results from the tests should be used in Table 1.

****

Conform to the standards specified in Table 1.

2.3.2 Trench Bentonite Slurry Mixture

Conform to the standards specified in Table 1.

2.3.3 Additional Bentonite

If directed by the Contracting Officer, thicken the slurry to a more viscous condition than the limits specified above. Use additional bentonite, as directed.

2.3.4 Additives

Do not mix peptizing agents and bulking agents with the slurry. Approved thinners or dispersants and flocculants of the types used in the control of oil field drilling muds, may be used to control standard properties of the slurry such as apparent viscosity, pH and filtration characteristics.

2.3.5 S-B Backfill

Mix the S-B backfill, consisting of [backfill material and bentonite slurry] [backfill material, bentonite slurry, and a minimum of [2] [_____] percent dry bentonite] thoroughly and conform to the standards specified in Table 1 just prior to placement in the trench.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Construct the slurry trench to the elevations, lines, grades, and cross-sections shown and in accordance with these specifications, unless otherwise directed. The Government may modify the dimensions and quantities of the work as determined necessary. Submit a Slurry Trench Implementation Plan for approval, a minimum of [_____] weeks prior to the start of construction.

3.2 WORKING SURFACE

****

NOTE: The maximum slurry trench surface slope along the slurry trench alignment during construction should be 1 percent. For sites with grades greater than 1 percent, the working surface should be designed to achieve the 1 percent slope. If contaminated, it is common practice to remove the top 300 mm 12 inches of the working surface after completion of the slurry trench. Most excavation equipment requires 6 meters 20 feet of clearance to swing around; therefore, a minimum working surface width of 12 meters 40 feet is recommended. Some equipment may require wider work platforms in order to negotiate trench corners. At sites where S-B backfill will be mixed beside the trench, instead of at a central mixing area, a wider working surface may be required. The slurry trench alignment is not required to be in the centerline of the working surface.

****

Accomplish slurry trench construction from the working surface, as shown on the drawings. If the Contractor's operations require a wider working surface, sumit the reason for the change. If approved, a wider working surface may be constructed at no additional cost to the Government. Working surface material and compaction requirements are described in Section [_____]. In the event that the static ground water table is encountered at a depth of [_____] 1 m 3.0 foot or less below the designated working surface, at the direction of the Contracting Officer, raise the working surface to a height of [_____] [1] m [3] feet above the measured static ground water level with approved fill material. Utilize the constructed working surface as a basis for measurement for payment.

3.3 SLURRY TRENCH EXCAVATION

****

NOTE: For shallow (less than 15 m 50 feet) slurry walls, most excavation equipment can round trench corners with a 30 m 100 foot turning radius. For trenches deeper than 15 m 50 feet, consult with Contractors about the required turning radius.

****

Begin excavation from the working surface and provide a vertical (within 2 percent) continuous [_____] 900 mm 3 foot minimum width trench to the required depth along the centerline of the excavation. [Key the slurry trench [_____] 600 mm 2 feet into the [_____] stratum.] The Contracting Officer may direct the Contractor to modify the trench depth based on examination of bucket cuttings or drive samples. The toe of the slope of the trench excavation must not precede the toe of the S-B backfill slope by less than [_____] 9 meters 30 feet or more than [_____] 30 meters 100 feet. At the intersection of 2 straight line segments, extend the trench excavation a minimum of [_____] 1500 mm 5 feet beyond the outside of the intersection at all depths. If trench excavation overlaps into previously completed slurry trench, extend the excavation a minimum of [_____] 3 meters 10 feet into the previously placed S-B backfill at all depths. Refill any removed section of completed slurry trench with S-B backfill at no additional expense to the Government.

3.3.1 Confining Stratum Excavation

****

NOTE: If the confining stratum is a competent low permeability bedrock, a very small penetration into the bedrock may be satisfactory. High costs may result by requiring a 600 mm 2 foot key into competent bedrock. Remove this paragraph if not required in the project.

****

Excavate the confining stratum the full trench width to the depths shown [or to the depth of refusal] [or as otherwise directed]. [Remove any [sandstone] [_____] lenses encountered at the minimum excavation depth for the full width of the trench and into the underlying confining stratum.] Then sample the confining stratum in accordance with paragraph SAMPLES OF CONFINING STRATUM. Termination of excavation will be approved by the Contracting Officer.

3.3.2 Blasting Plan

****

NOTE: Blasting, if necessary, may cause unanticipated adverse effects in the subsurface. The designer should carefully evaluate the need for blasting to remove or loosen subsurface materials. Other methods such as chiseling or modfication of slurry trench alignment or depths should be considered prior to implementation of any blasting. Remove this paragraph if not required in the project.

****

Any blasting must be approved. Conduct blasting in accordance with an approved blasting plan. Include hole spacing and depths, loading, delay sequence, type of explosives, safety program, and any other pertinent information that will be necessary for the Contracting Officer's evaluation. [Store] [Do not store] explosive materials on the site. [Furnish on site storage at [_____].] [Submit a drawing showing the top and bottom elevations of the [sandstone] [_____] at each blasting drill hole.] Submit a blasting plan, as specified, for approval.

3.4 SLURRY PLACEMENT AND TESTING

****

NOTE: Sand content of the in-trench slurry is highly dependent upon the soils through which the trench is excavated. In many cases, typical values for sand content can be as high as 30 percent without impacting the quality of the installation. It should be noted that higher sand contents also lead to a higher density slurry. Adjustments should be made in Table 1 regarding slurry density and sand content limits according to site conditions. The main concern is to ensure that sand is not dropping out of the in trench slurry to the bottom of the trench in amounts so as to affect performance of the slurry trench.

****

3.4.1 Slurry Placement

Introduce slurry into the trench at the time excavation begins. Maintain the level of the slurry in open trenches a minimum of 900 mm 3 feet above ground water level and no more than 600 mm 2 feet below the top of the working surface until the placement of S-B backfill is complete. [If the density or sand content of the slurry in the trench does not conform to the standards specified in Table 1, remove the excess solids from the slurry using approved methods or replace the slurry with fresh slurry.] Do not dilute slurry by surface water. Conditioning of the slurry may require recirculation through a shaker screen or the addition of approved additives. Provide sufficient personnel, equipment, slurry storage areas, and prepared slurry materials ready to raise the slurry level at any time in the excavated trench, weekends and holidays included.

3.4.2 Slurry Testing

Sample the bentonite slurry in the trench a minimum of 2 times each [_____] [8] hour shift (near the beginning and end of each shift), at two depths; approximately 600 mm 2 feet below the slurry surface and approximately 600 mm 2 feet above the bottom of the trench. Take samples within 1500 mm 5 feet of the toe of the S-B backfill slope. Obtain additional samples at the request of the Contracting Officer.

3.5 EXCAVATED MATERIAL

[Use] [Do not use] materials excavated from the trench as backfill. [Stockpile material to be used as backfill for subsequent processing in approved areas.] [Place excavated trench material not used as backfill [in the waste disposal area] [as directed].]

3.6 STABILITY

****

NOTE: A stability analysis should be performed during design to determine required minimum slurry densities or levels, and to determine if any restrictions will be required regarding stockpile placement or other loading situations. Any site specific restrictions should be described below.

****

The Contractor is responsible for ensuring and maintaining the stability of the excavated trench at all times, for its full length and depth, and for maintaining slurry densities and levels within specified limits. Control surcharges from all excavation and backfilling equipment, waste, berm construction, backfill stockpiles, and any other loading situations that may affect trench stability. It is the Contractor's sole responsibility to ensure that the mixing of S-B backfill and any stockpiles do not affect the open trench stability. In the event of failure of the trench walls prior to completion of backfilling, re-excavate the trench, remove all material displaced into the trench, and take corrective action to prevent further deterioration, at the Contractor's expense.

3.7 TRENCH CLEANING

****

NOTE: The initial cleaning of the trench bottom can be accomplished with an excavator bucket. This method of trench cleaning will generally be sufficient for final cleaning of most projects. It is generally recommended to limit the distance between the excavated face and the toe of the S-B backfill, as required in Paragraph SLURRY TRENCH EXCAVATION, in order to assure trench stability. In some cases, the air-lift pump method may be the only way to clean certain reaches of the trench. However, the air-lift pump method can slow production, is somewhat difficult to manuver in the trench, and may not clean the trench bottom effectively in many cases.

Cleaning of the S-B backfill face can be difficult since the materials are very soft and may require the excavator to track over portions of the trench that are not yet backfilled. This procedure should only be specified when required to meet project needs.

****

At a minimum, unless otherwise approved, clean the trench bottom at the start of each [_____] [day]. [If S-B backfill placement operations have ceased for longer than [24] [_____] hours, clean the face of the S-B backfill slope prior to the placement of additional S-B backfill.] Probe the trench bottom for any deposits or sloughed materials prior to cleaning. Clean the trench bottom by using an [excavator bucket,] [air lift pump] or other approved equipment to ensure removal of sand, gravel, sediment, and other material left in the trench during excavation or which has settled out of the slurry. Do not remove material from the walls of the trench using cleaning equipment. The Contracting Officer may require more frequent cleaning. [After the trench bottom has been cleaned, sample the trench bottom with a [drive tube] [split tube] [_____] sampler approved by the Contracting Officer. Rock surfaces that cannot be penetrated by a [drive tube] [split spoon] sampler are not required to be sampled. After examining the samples, the Contracting Officer will either approve the excavation at the points checked or require additional cleaning. If additional cleaning is required, then furnish additional samples as specified above.]

3.8 S-B BACKFILL MIXING AND PLACEMENT

3.8.1 Mixing

****

NOTE: It may be preferable to mix the S-B backfill in a separate mixing area rather than along the side of the trench, particularly in contaminated areas, or where off-site borrow is used for backfill materials. Other mixing methods may include the utilization of a batch plant or pugmill operation to blend materials. Although more expensive, these procedures may minimize operations in a contaminated area.

****

Thoroughly mix S-B backfill via disking, harrowing, bulldozing, blading, or other approved methods into a homogeneous mass, free from large lumps or clods of soil or pockets of fines, sand, or gravel. Occasional lumps of up to [_____] [75] mm [3] inches in their largest dimension will be permitted. Coat all particles with slurry. The S-B backfill may be sluiced with slurry during the mixing operations. Sluicing with water is not permitted. Mix the S-B backfill [in a separate mixing location as shown on the drawings] [along the side of the trench]. [When mixing the S-B backfill along the side of the trench, do not operate heavy equipment such as bulldozers in a back and forth fashion, paralleling the open trench, closer than 5 meters 15 feet from the lip of the trench. Excess slurry may be allowed to flow back into the trench].

3.8.2 Placement

Place initial S-B backfill by one of the following methods: (1) Placement by lowering S-B slurry to the bottom of the trench with crane and clamshell bucket, or tremie methods until the surface of the S-B backfill rises above the surface of the slurry trench at the end of the trench; (2) Construct a lead-in trench [1H:1V] [_____] or flatter at a point outside of the limits of work to allow a S-B backfill face to form prior to reaching the full depth of the required slurry trench. No payments will be made for the portions of trenches which lie outside of the limits of work. Proceed with placement operations in such a manner that the slope of the initially placed S-B backfill is maintained. Free dropping of S-B backfill through the slurry is not permitted. Place the S-B backfill so that it will slide down the forward face of the S-B backfill slope. Place the S-B backfill in the excavated trench so that no pockets of slurry are trapped and that a constant slope is maintained. Make placement continuous from the beginning of the trench in the direction of the excavation to the end of the trench.

3.8.3 Mixing and Placing During Cold Weather

Do not mix or place the S-B backfill when the air temperature is below -7 degrees C 20 degrees F. Do not place frozen S-B backfill in the trench and do not use backfill material containing frozen lumps to mix S-B backfill.

3.8.4 Testing

When required, take additional samples for permeability testing at [_____] intervals for the [_____] [full depth] of the completed slurry trench using 75 mm 3 inch thin wall (Shelby) tubes. [If test results do not meet the requirements listed in Table 1, take corrective action as determined by the Contracting Officer.]

3.9 SOUNDINGS

Take excavation and S-B backfill soundings every [_____] 6 meters 20 feet along the trench centerline using a weighted tape, cable, or other approved device. Submit a record of soundings and measurements taken during construction of the slurry trench. Measure soundings to the nearest 30 mm 0.1 ft. Measure the following:

3.9.1 Elevation of Top of Confining Stratum

Determine the top of the confining stratum based on examination of samples taken as described under paragraph SAMPLES OF CONFINING STRATUM. This elevation is subject to approval.

3.9.2 Elevation of Trench Bottom Prior to Backfilling

Determine the elevation of the trench bottom after the trench has been cleaned and approved as described under paragraph Trench Cleaning. Do not precede the toe of the S-B backfill slope more than [_____] 15 meters 50 feet. This elevation is subject to approval by the Contracting Officer.

3.9.3 Profile of S-B Backfill Slope and Trench Bottom

Sound the S-B backfill slope and trench bottom at the beginning and end of each shift, and at additional times as directed, at intervals of [_____] meters feet.

3.10 AS-BUILT PROFILE

Continuously maintain an as-built profile of the trench bottom and S-B backfill slopes, including descriptions of materials encountered in the trench bottom. Indicate extent of excavation and the S-B backfill profile at the end of each work day [and after each S-B backfill batch is placed in the trench as determined from soundings]. [Indicate the S-B backfill batch numbers on the profile with the limits of each batch of material delineated as placed.] Submit a scale drawing providing a log of the subsurface materials excavated from the trench, and a profile of the completed slurry trench. [Delineate as placed the limits of each batch of S-B backfill.]

3.11 TREATMENT OF TOP OF SLURRY TRENCH

****

NOTE: For heavy equipment crossings, it is recommended the upper portion of the S-B backfill be excavated and a clay plug be placed under the compacted trench cover. Additional support may be necessary to support the anticipated loads.

****

Prior to placement of the compacted trench cover, place a temporary [non-compacted soil] [plastic sheeting] cover over the trench to prevent desiccation. Place the temporary cover material within [2] [_____] days after S-B backfill placement is completed over each 30 meter 100 foot reach. If any depression develops within the completed slurry trench area, repair it by placing and compacting additional trench cover soil. After a minimum [two] [_____] weeks, remove the temporary trench cover and replace by a final compacted trench cover. Place a final compacted trench cover [_____] mm feet wide and [_____] mm ft deep [as specified in Section [_____]] [to a dry density of [_____] [90] percent of maximum density at optimum moisture to plus 3 percent in accordance with ASTM D698]. Only drive heavy construction equipment and machinery over the slurry trench at approved heavy equipment crossing points.

3.12 QUALITY CONTROL TESTING

Provide Quality Control Inspectors as necessary for bentonite slurry preparation and maintenance, trench excavation, and S-B backfill preparation and placement. Submit all test results.

3.12.1 Bentonite Tests

Perform a minimum of 1 test for each specified requirement for each truck or rail car shipment delivered to the site.

3.12.2 Water Tests

****

NOTE: Acceptable slurries can generally be made from most water sources; however, any suspect water should be tested during pre-construction tests. Water with high hardness

****

Perform a minimum of [_____] [1] test[s] for each specified requirement for each water source used. Perform testing as specified in Table 1.

3.12.3 Backfill Material Tests

Perform one set of backfill material tests, as specified in Table 1, for every [_____] 500 cubic meters yards used.

3.12.4 Slurry Properties

****

NOTE: It is generally recommended that after high shear mixing, the slurry be allowed to hydrate for 8 hours before use in the trench. This process assures that the bentonite is fully hydrated and is

uniform throughout. Shorter hydration times may be allowed if it can be shown that the prepared slurry meets or exceeds project requirements.

****

[Allow slurry to hydrate a minimum of [8] [_____] hours prior to use.] Test the initial bentonite slurry prior to placing in the trench and a minimum of 2 times each [_____] [8] hour shift per mixing plant. Submit a record of bentonite slurry mix quantities, proportions of additives utilized, and adjustments for each batch.

3.12.5 S-B Backfill Tests

****

NOTE: The confining pressure used to perform permeability testing should be representative of site conditions. To simulate site conditions, the confining pressure specified should be representative of the upper quarter to one-half of the wall depth.

Shelby tube, split spoon, or other sampling devices may be pushed into the completed slurry trench to obtain samples for quality control testing; however, it can be difficult to obtain quality samples of many S-B backfills, especially if there are coarse materials in the S-B backfill. As a result, samples of S-B backfill obtained just prior to placement in the trench are used for QA/QC, and samples of the S-B backfill from the completed wall, if taken, may be used for QA or for information only. The designer should determine what samples are necessary to meet project requirements. It should be noted that permeablity tests may take several days before results are known.

****

Perform sampling and testing, in accordance with the approved Preconstruction Testing Plan, just prior to placing S-B backfill in the trench as shown in Table 1. [Calculate the density of the S-B backfill using a 101.6 mm 4 inch cylindrical mold as described in Paragraph 6 of ASTM D698. Place S-B backfill in the mold and rod 10 times. Then add additional S-B backfill to fill the mold. Use the weight and volume of the molded S-B backfill to determine the density.] [Determine the density of the S-B backfill using a mud balance.] Determine density at a rate of 1 test for every [_____] [1000] cubic meters yards. Take a sample of S-B backfill for permeability testing just prior to placement in the trench for every [1000] [_____] cubic meters yards. Submit a Plan providing a list of test equipment, procedures, and materials to be used to [verify] [develop] the mix design for the S-B backfill and an S-B Backfill Test Report containing the results of the tests performed, a report summarizing the procedures and results of the Pre-construction S-B backfill mix tests. Include a description of mix proportions, gradations, slumps, densities, permeabilities, and moisture contents of [_____] 3 samples of the final S-B backfill mix using the bentonite and backfill materials proposed for use.. Submit a minimum of 22.5 kg 50 pounds of each type of proposed borrow soil at least [1] [_____] month prior to use.

[3.12.6 Samples of Confining Stratum

****

NOTE: This paragraph is to be used if the slurry trench is to be keyed into a confining stratum. Samples of the confining stratum can be based on examination of samples taken from bucket cuttings or drive tube samplers. In many cases, examination of bucket cuttings alone will be sufficient to determine when the confining stratum has been reached. If required, samples can be obtained with drive tube samples. Drive tubes can be pushed with the excavator bucket or a drill rig. Remove this paragraph if not needed in the project.

****

Take samples of the confining stratum at [_____] meter foot horizontal intervals and at additional intervals or depths as directed. Obtain samples from [either] [excavator bucket cuttings] [drive tube samples]. [The sampler must be a [_____] mm inch I.D., or larger, [drive tube sampler] with a minimum length of [_____] m feet. Obtain samples by advancing the sampler a minimum of [_____] mm inches into the confining stratum. The samples must have a minimum length [recover] of [_____] mm inches.] After examining these samples, the Contracting Officer will either approve the termination of excavation at the sample points or require additional excavation. If additional excavation is required, then furnish additional samples as specified above. Properly identify and label all samples, place in sealed plastic containers and store in a location designated by the Contracting Officer.

]3.13 CLEAN-UP

Remove excavation spoil, unused S-B backfill, and excess slurry following completion of S-B backfill placement. Dispose of these materials [in the waste disposal area] [at the direction of the Contracting Officer] [_____].

BENTONITE SLURRY TRENCH QUALITY CONTROL TESTING

Property	Requirement	Test Method
Bentonite Powder		
YP/PV Ratio	[_____] [1.5] max.	API Spec 13A
Plastic Viscosity	> [_____] [10]	API Spec 13A
Filtrate Loss	< [_____] [12.5] cubic cm	API Spec 13A
Moisture Content	< [_____] [10] percent	ASTM D2216
Chemical Analysis of Water		
pH	6 to 8	API RP 13B-1
Hardness	< [_____] [50] [200] ppm	API RP 13B-1
Total Dissolved Solids	< [_____] [500] ppm	EPA 600/4-79/020 Method 160.1
VOCs	Maximum Contaminant Level (MCL)	SW-846 Method 5030B/8260B
SVOCs	MCL	SW-846 Method 3510C/8270C
TPH	MCL	SW-846 Modified 8015
Metals	MCL	SW-846 3005A/6010C
Pesticides	MCL	SW-846 3510C/8081A/8141A
Initial Bentonite Slurry		
Viscosity	> 40 sec	API RP 13B-1
Density	> 1025 kg/cubic m 64 pcf	API RP 13B-1
Filtrate Loss	< 20 cubic cm	API RP 13B-1
pH	6.5 to 10	API RP 13B-1
In-Trench Bentonite Slurry		
Density	[____]1025-1360 kg/cubic m and at least 240 kg/cubic m less than S-B backfill density [____]64-85 pcf and at least 15 pcf less than S-B backfill density	API RP 13B-1

BENTONITE SLURRY TRENCH QUALITY CONTROL TESTING		
Property	Requirement	Test Method
Viscosity	> 40 sec	API RP 13B-1
pH	6.5 to 10	API RP 13B-1
Sand Content	[____]10 percent max.	API RP 13B-1
Backfill Material		
Grain Size	Para. 2.1.3	ASTM D7928
Moisture content	For record	ASTM D2216
Fines Content	Para. 2.1.3	ASTM D1140
Atterberg limits	Para. 2.1.3	ASTM D4318
S-B Backfill		
Slump Cone	100-150 mm4-6 inches	ASTM C143/C143M
Density	For Record	ASTM D698 and Para. 2.4.5
Permeability	< [1 x 10-7] [_____] cm/sec	ASTM D5084
1) If more than one (1) batching plant is being used, these frequencies must apply to each batching plant separately.		
2) Permeability tests may be performed using an approved fixed wall permeameter except that for every 5 such tests, there must be 1 test using a flexible wall permeameter. Fixed wall test methods and procedures must be submitted and approved prior to use.		
3) Flexible wall permeability tests must be performed at a maximum effective confining pressure of [_____] kPa psi and a maximum hydraulic gradient of [30] [_____].		

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 62 13.13 (April 2006)**
Change 3 - 02/24

Preparing Activity: NAVFAC **Replacing without change**
UFGS-02459 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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****

USACE / NAVFAC / AFCEC **UFGS-31 62 13.13 (April 2006)**
Change 3 - 02/24

Preparing Activity: NAVFAC **Replacing without change**
UFGS-02459 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 31 62 13.13

CAST-IN-PLACE CONCRETE PILES

04/06, CHG 3: 02/24

****

NOTE: This guide specification covers the requirements for procurement, installation, and testing of cast-in-place concrete piles, steel casing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Requirements for materials and procedures for special or unusual design should be added as necessary to fit specific projects. It is expected that cast-in-place concrete will be used elsewhere on the project and therefore Section 03 30 00 CAST-IN-PLACE CONCRETE will be a part of the specification.

****

****

NOTE: Show the following information on the project drawings:

1. Locations, dimensions, shape, length, and design strength of piles.

2. Locations and lengths of test piles and load tests, if either is required.

3. Soil data, where required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A252	(2010) Standard Specification for Welded and Seamless Steel Pipe Piles
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load

1.2 REQUIREMENTS

****

NOTE: Select the applicable paragraph(s) from the following:

****

[1.2.1 Pile Lengths and Quantity

****

NOTE: Use this option for lump-sum contracts. This

method should be used in all but special cases. Fill in Table 1 as required selecting columns applicable to project. Generally, pile capacity, location, and tip elevation are shown on the plans.

****

Base bids upon the[number, size, capacity, and length of piles as indicated.][following Table 1:]

Table 1				
[Location]	Number	Size	[Capacity]	Length

When the total number of piles or the number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion will be made in accordance with Contract Clause, "changes." Adjustments in the contract will not be made for[pile splices;] cutting off piles; for a portion of a pile remaining above the cut-off elevation; or for broken, damaged, or rejected piles.

]1.2.2 Measurement and Payment

See SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****

NOTE: For NAVFAC LANT projects, use the following.

****

[Payment will be for the total length of completed and accepted piling, measuring from tip elevation to cutoff elevation. Payment will be by the contract unit price for furnishing labor, materials, tools, equipment, and incidentals, and for doing the work involved in furnishing and driving piling. Driving piling includes furnishing and driving piling including[test piles][jetting or drilling][pile splices][excavation and backfill around piling] pile cutoff, [redriving, and replacement of broken, or rejected piles].[Payment will be separate contract unit price for furnishing labor, materials, tools, equipment, and incidentals for doing the work involved in performing load tests on piles.]

]1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Piles and pile cap

Show placement of steel. Show casing details, closures, and splices.[Show placement of and calculations for reinforcement.]

SD-04 Samples

Test Piles

SD-06 Test Reports

Test Pile Data

[Load Tests
]

****

NOTE: Delete sentence in brackets when test piles are not driven.

****

For load tests, submit test data and results.[Submit test pile data from steel cased cast-in-place concrete test piles, from which the Government will determine and list the "calculated" tip elevations and the driving resistances for all piles. Use this list as the basis for ordering piles. Do not order piles until list is provided by the Government.]

SD-07 Certificates

****

NOTE: Mill certificates are generally required only when casings are used as structural members. Use bracketed sentence only when steel shell casing is used as a structural member.

****

Pipe Piles

Concrete Testing results

[Steel shell]Casings

Show name and location of steel mill and fabricating plant for pipe piles.

Data on Pile Driving Equipment

Include in data for driving equipment, make, model, and type of pile hammer; manufacturer's specification sheet on pile hammer; and detail drawings of driving helmets, hammer cushion or capblock with records of successful use.

SD-11 Closeout Submittals

Pile Driving Records

1.4 QUALITY ASSURANCE

1.4.1 Welding

Shop and field welding, qualification of welders, and inspection of welds must be in accordance with AWS D1.1/D1.1M.

1.5 EQUIPMENT

1.5.1 Pile Hammers

****

NOTE: Insert driving energy of hammer. Select hammer based on results of wave equation analysis such that hammer is compatible with pile type and capacity and hammer/cushion/pile system are capable of obtaining required capacity.

****

Furnish a hammer having a capacity at least equal to the hammer manufacturer's recommendation for the total weight of pile and character of subsurface material to be encountered. Obtain required driving energy of hammer, except for diesel hammers, by use of a heavy ram and a short stroke with low impact velocity.[For driving use the same type pile hammer, operated at same rate and in same manner, as that used for driving testing piles.]

1.5.2 Driving Helmets (Caps) and Cushion (Capblocks)

Use a hammer cushion or capblock between the helmet, driving cap or driving head and hammer ram. Driving cap and hammer cushion combination must be capable of protecting head of pile, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly to top of pile. When driving helmet or cap is used, it must fit loosely around top of pile so that the pile may rotate slightly without binding within helmet or cap.[During test pile period demonstrate to satisfaction of the Contracting Officer that equipment to be used on the project performs the above function.] Hammer cushion or capblock may be a solid hardwood block at least 150 mm 6 inches thick with grain parallel to pile axis and enclosed in a close-fitting steel housing or may consist of aluminum and micarta (or equal) discs stacked alternately in a steel housing. Use steel plates at the top and bottom of the capblock assembly. Under no circumstances will use of wood blocks, wood chips, rope or other material permitting excessive loss of hammer energy be permitted.

PART 2 PRODUCTS

2.1 PILING

2.1.1 Casings

****

NOTE: There are generally three types of casing or pipe used. Open-end and closed-end structural casings (usually steel pipe) and a closed-end non-structural casing (usually light gage shells). Non-structural casings must be driven with a mandrel. Specify the minimum thickness for any structural casing. Thickness of non-structural casings (light gage shells) is the responsibility of the Contractor as the shell is simply a form for the concrete. Ensure minimum nominal diameter at tip and two-third points above tip are indicated on drawings. In general, use closed-end casings except in the following conditions where open-end structural casings should be considered:

1. It is important to avoid soil displacement as in piles driven adjacent to existing structures.

2. Soil condition indicate a dense or clayey soil, or extremely coarse granular soil is present, such as gravel.

****

Provide a circular cross section throughout casing length whether or not modified by helical corrugations or flutings. Leave casing permanently in place. Provide casing with closed tips[, except for steel pipe casings conforming to ASTM A252 that may be open-end driven]. Provide watertight joint and tip connections.[Provide non-mandrel driven casings of steel with a wall thickness of [_____] mm inches.] Provide any one of the following types or combination of types of casings[, but provide only one type or combination of casing throughout the project].

2.1.1.1 Uniform Taper

Increase diameter from tip to cut-off at a uniform rate. Provide minimum nominal diameter at tip and two-third points above tip as indicated.

2.1.1.2 Step-Taper

Increase sectionincrements in diameter uniformly. Provide minimum nominal diameter at tip and two-third points above tip as indicated.

2.1.1.3 Constant Section

Provide constant diameter from tip to cut-off. Steel pipe piles, conforming to ASTM A252, Grade 2, may be used in lieu of casings of constant-diameter section. Provide minimum nominal diameter as indicated.

2.1.1.4 Combination Type

Combination type cast-in-place concrete piles, steel casing, may be any of the following combinations.

a. Steel pipe lower section with metal casing taper or constant-diameter upper section.

b. Constant-diameter or tapered lower section with tapered upper section.

c. Tapered lower section with constant-diameter upper section.

2.1.2 Piling

Provide steel cased cast-in-place concrete piles.

2.1.3 Reinforcement

****

NOTE: Ensure that reinforcing steel size is always indicated. Indicate length if less than full pile length.

****

Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.4 Concrete

****

NOTE: Normal usage would reference all concrete work to Section 03 30 00 CAST-IN-PLACE CONCRETE. If a mix design for this piling section is not or will not be specified in one of these sections, add the optional sentence to provide the required mix design. Insert the ultimate compressive strength required by the design. Fill in blank for slump if different values are required by mix design or pile diameter.

****

Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.[Provide concrete with a minimum compressive strength of [_____] MPa psi at 28 days, a slump of [from [100 to 150 mm] [4 to 6 inches] [_____], and a maximum aggregate size of 19 mm 3/4 inch].]

PART 3 EXECUTION

3.1 DRIVING

3.1.1 Driving Casing

****

NOTE: Delete items in brackets when test piles or

load tests are not used.

****

Drive casing to or below the["calculated"] tip elevation[to reach a driving resistance in accordance with the schedule which the Government will prepare from the test-pile driving data]. When a pile fails to reach the["calculated"] tip elevation,[or when a pile reaches the["calculated"] tip elevation without reaching the required driving resistance,] notify the Government and perform corrective measures as directed by the Contracting Officer.

3.1.2 Tolerance in Driving

****

NOTE: Pile butt tolerance may be increased if the design allows. Location within 100 mm 4 inches of indicated position is a strict tolerance.

****

Drive casing with a variation of not more than 21 mm per meter 0.25 inch per foot of pile length from the required axial alignment. Locate butts within [100] [_____] mm [4] [_____] inches of position indicated. Do not force casings into position. Check casings for heave after all piles are driven in a cluster within a 4.50 meters 15 foot radius. Redrive to required tip elevation or penetration resistance those casings found to have heaved. Maintain center of gravity of each group of footing piles with templates or other approved means. Where casings are damaged, mislocated, or driven out of alignment, replace or drive additional casing as directed.

3.1.3 Jetting or Predrilling of Casings

****

NOTE: Drilling may be used, providing the drill diameter is at least 50 mm 2 inches in diameter smaller than the pile, and the Contractor can demonstrate a procedure that will not detract from the carrying capacity of the pile. Jetting or predrilling should generally not be permitted in the following conditions:

1. For piles dependent on side friction in fine-grained, low-permeability soils (high clay or silt content) where considerable time is required for soil to reconsolidate around the piles;

2. For piles subject to uplift;

3. For piles adjacent to existing structures;

4. For piles in closely spaced clusters unless the load capacity is confirmed by test and unless all jetting is done before final driving of any pile in the cluster.

****

[Jetting or predrilling of pile casing[will be][is not] permitted.] Discontinue jetting or predrilling approximately 1.5 meters 5 feet above the[bearing stratum][calculated][pile tip elevation]. Drive casing[the final 1.5 meters 5 feet of penetration][to calculated pile tip elevation]. Before starting[final] driving, firmly seat casing in place by application of a number of reduced energy hammer blows.

3.2 SPLICING AND CUTTING

3.2.1 Splicing of Load Bearing Casings

****

NOTE: Restrict number of splices where design indicates splicing will cause structural weakness. In general uplift piles using a structural casing should have as few splices as possible.

****

Splices may be used when approved by the Contracting Officer.[Do not use more than two splices per full length of casing]. Splices must be able to transmit vertical and lateral forces, and in addition, develop 100 percent of the flexural capacity of the ordinary pile casing cross section. Make lateral joints with a full penetration groove weld in a butt joint in accordance with AWS D1.1/D1.1M or as approved by the Contracting Officer.

3.2.2 Cut-Off

Cut-off casings by oxyfuel cutting, sawing or other means approved by the Contracting Officer, to within 25 mm one inch of the designated cut-off elevation.

3.3 CONCRETING

Cast-in-place concrete is included in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3.1 Preparation

****

NOTE: Insert the radius distance 3 to 6 meters 10 to 20 feet. Where open end casings are required, do not place concrete until all soil, water, and foreign material is removed.

****

Do not place concrete in a pile casing until all other casings within a radius of [_____] meters feet or within heave range have been driven and inspected. Clean inside of casing by removing soil and other foreign material. Remove free water until the maximum depth of water in the casing is 100 mm 4 inches. Inspect each casing after installation and before placing[reinforcement and] concrete. Verify the integrity of the casing throughout its length. Verify the absence of distortion and that any reduction of area does not exceed 10 percent.

[3.3.2 Reinforcement

Reinforce unsupported sections of piles, uplift or tension piles[throughout their entire length][as indicated], piles exposed to high bending stresses not resisted by batter piles, and between top of pile and pile cap or slab. Assemble and place reinforcement in casing as a preassembled unit. Secure reinforcement prior to placement of concrete.

]3.3.3 Concrete

Deposit concrete in casing in a continuous operation by means of a funnel or hopper.

3.4 FIELD QUALITY CONTROL

3.4.1 Test Piles

****

NOTE: Indicate location of test piles on plans or insert the numbers of appropriate soil boring test holes.

****

****

NOTE: Drilling may be used, providing the drill diameter is at least 50 mm 2 inches in diameter smaller than the pile, and the Contractor can demonstrate a procedure that will not detract from the carrying capacity of the pile. Jetting or predrilling should generally not be permitted in the following conditions:

1. For piles dependent on side friction in fine-grained, low-permeability soils (high clay or silt content) where considerable time is required for soil to reconsolidate around the piles;

2. For piles subject to uplift;

3. For piles adjacent to existing structures;

4. For piles in closely spaced clusters unless the load capacity is confirmed by test and unless all jetting is done before final driving of any pile in the cluster.

****

Use test piles of the type, and drive in the manner specified for all piling elsewhere in this section. The Government will use test pile data to determine the "calculated" pile tip elevation and required driving resistance. Drive test piles[at the locations indicated][in the vicinity of soil boring test holes Nos. [_____], [_____], and [_____]]. Drive test piles to[indicated tip elevation][indicated bidding lengths]. Drive piles driven one day an additional 150 mm 6 inches using full rated driving energy hammer on the next work day, unless refusal is encountered. Record an increase or decrease in driving resistance. When there is a decrease in driving resistance, a load test, at the expense of the Government, may be required by the Contracting Officer. Use test piles, when located properly and offering adequate driving resistance in the finished work.[Jetting is permitted when test piles clearly establish the validity of its use, as directed by the Contracting Officer.]

[3.4.2 Load Tests

****

NOTE: If pile load tests are required, specify number of piles. Select method of load test. Permit

methods using anchor piles, see ASTM D1143, only if approved by EFD Code 411, Geotechnical Branch or in EFD's with no Code 411, EFD Code 402, Structural Branch or EFD Code 405, Civil Branch. Insert figures (tons) corresponding to 200 percent of the design load. Select the appropriate acceptance criterion. The first method (offset) is generally recommended for normal size piles. The second method (slope) and the third method (net-settlement) can be combined into one criterion.

****

Perform load tests on [_____] piles in accordance with ASTM D1143/D1143M as modified herein.[The use of anchor piles is not permitted.] Provide apparatus for applying the vertical loads as required by the method, either for load supported directly by the pile or load from weighted box or platform[or reaction frame attached to sufficient uplift piles to take safely the required load] applied to the pile by hydraulic jack. Increase the load in increments until rapid progressive settlement takes place or until a total load of [_____] metric tons tons has been applied. Consider the load test satisfactory when[after one hour at full test load the gross settlement of the pile butt is not greater than the gross elastic pile compression plus 4 mm 0.15 inches plus one percent of the pile tip diameter or width in millimeters inches.][the slope of the gross load-settlement curve under the full test load does not exceed 1.4 mm per metric ton 0.05 inches per ton.][the net settlement after removal of test loads does not exceed 19 mm 3/4 inches.] Make load tests at locations shown on driven test piles. Additional load tests, at the expense of the Government, may be required by the Contracting Officer.[Loading, testing, and recording and analysis of data must be under the direct supervision of a registered professional engineer provided and paid for by the Contractor.]

]3.4.3 Concrete Testing

****

NOTE: The following table is recommended for use in determining the number of test cylinders required in relation to the size of each lot of piles to be tested.

Pile Lot	**Number of Test Cylinders**
25	**2**
100	**48**
1,000	**20***
5,000	**50***
1,000	**100***
*** Samples taken from random batches of concrete.**	

****

Sample and test concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Take specimens for every [_____] piles with at least 4 specimens for any one day's operation. Take specimens from a batch chosen at random.

3.4.4 Pile Records

****

NOTE: Omit reference to load test when not required in project.

****

For each pile, keep a record of the number of blows required for each meter foot of penetration and number of blows for the last 150 mm 6 inches of penetration or fraction thereof for test piles, penetration in blows per meter foot for job piles [as required for the "calculated" driving resistance]. Include in record the beginning and ending times of each operation during driving of each pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammers, type of driving helmet, and type and dimensions of hammer cushion (capblock) and pile cushion used. Record retap data and any unusual occurrence during pile driving. Notify Contracting Officer 10 days prior to driving of[test] piles[and load test].

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 62 13.20 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-31 62 13.20 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 62 13.20

PRECAST/PRESTRESSED CONCRETE PILES

11/20, CHG 2: 02/24

PART 1 GENERAL

ATTACHMENTS:

Pile and Driving Equipment Data Form

pile driving log

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-31 62 13.20 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC | **Superseding**
UFGS-31 62 13.20 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 31 62 13.20

PRECAST/PRESTRESSED CONCRETE PILES

11/20, CHG 2: 02/24

****

NOTE: This guide specification covers the requirements for precast, prestressed piles.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

****

NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.

****

****

NOTE: Show the following information on the drawings:

1. Locations and design loads of piles. If both tension and compression piles are contained in

design, identify by type.

2. Size, shape, and length of piles.

3. Locations, sizes, and number of prestressing steel strands. Unit stresses for prestressing strands.

4. Details of reinforcement.

5. Details of splices, if required.

6. Locations of test piles, if required.

7. Soil data, where required.

8. Identify piles as vertical or battered.
****

PART 1 GENERAL

****
NOTE: Structural engineer must confirm the structural capacity of piles and provide specific bending moments, lateral loads and other design requirements for pile design.
****

1.1 DESCRIPTION

Design, furnish, install and test precast prestressed concrete piles at the locations indicated on the drawings and specified herein.[Assume test pile[s] will be directed to be placed in [a]location[s] that can be incorporated into the work.][Test piles that meet performance requirements can be incorporated into the permanent work.]

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI MNL-66	(2020) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for

	Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1202	(2022; E 2022) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures

ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D3689/D3689M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI BDM	(2011) Precast Prestressed Concrete Bridge Design Manual
PCI JR-382	(1993) PCI Journal: Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling
PCI MNL-116	(2021) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 5th Edition
PCI MNL-135	(2000) Tolerance Manual for Precast and Prestressed Concrete Construction

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-220-01	(2012; with Change 1, 2021) Geotechnical Engineering

[1.3 SUBSURFACE DATA

Subsurface soil data logs are [indicated][appended to the special contract requirements][provided on the project drawings].[The subsoil investigation report may be examined at [_____].]

]1.4 BASIS OF BID

****

NOTE: Select one of the following options:

****

****

NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of piles must be determined as accurately as possible, prior to bidding, since the unit price per meter foot of the piles varies as the length increases or decreases. Refer to Standard Test Method for High-Strain Dynamic Testing of Deep Foundations (ASTM D4945).

****

1.4.1 Production Pile Acceptance Criteria

Safe design capacity for piles is [_____] KN [_____] kips. Drive piles to [minimum tip elevation][a minimum depth of [_____] m [_____] feet below cut-off elevation], and to such additional depth as required to obtain a bearing capacity of not less than [_____] KN [_____] kips. The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at end of drive or restrike][static load tests][wave equation analysis].

The following formulas can be used in cases where allowable pile loads are less than 355 kN 80 kips (determined using a factor of safety of 3 for individual piles and 4 for pile groups) and are presented only as a guide to aid in establishing the controlling penetration per blow, which, together with the minimum depth of penetration will serve to determine the required minimum depth of penetration of each individual pile:

$$R = \frac{2E}{S \text{ plus } 0.1}$$ For double acting hammers

$$R = \frac{2WH}{S \text{ plus } 0.1}$$ For single acting hammers

Where R is the approximate allowable pile load in kips; E equals the energy in foot-kips per blow based on an acceptable certified statement from the manufacturer of the hammer; W equals the weight of the hammer or ram in kips; H equals the height of fall of the hammer of ram in feet; and S equals the average inches of penetration per blow for the last three blows. An allowance will be made for reduced penetration caused by shock absorption of the cushion or cap blocks.

[1.5 LUMP SUM PAYMENT

****

NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on

applicability of use prior to selection. This paragraph will be typically used when there are 1) relatively small quantity of piles, 2) allowable pile loading is less than 355 kN 80 kips, and 3) the subsurface conditions are well defined. Fill in Table I as required selecting columns applicable to project. Generally, pile capacity, location, and minimum tip elevation are shown on plans. Test piles and load tests are not incorporated on lump sum contracts. Delete this paragraph for unit-price contracts.

****

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.] [following Table I:

Table 1

[Location]	Number	Size	[Capacity]	Length (tip to cut-off)	[Maximum Bending Moment]	[Maximum Shear Force]

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off, dispose of any cut-offs, and meet the applicable contract requirements. Include mobilization, pre-drilling, and redriving heaved piles. If, in redriving, it is found that any pile is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be provided and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. If total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; backdriving; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys.]

][1.6 UNIT PRICE

****

NOTE: This paragraph is tailored for Navy.

Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items." Select first bracketed text.

For NAVFAC Southeast projects, where there is a need for unit pricing of piles, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items. Select first bracketed text.

****

[For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."
]

****

NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.

****

Requirements of FAR 52.211-18 Variation in Estimated Quantity do not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and driving the piles including mobilization and demobilization,[jetting][predrilling][probing], redriving uplifted piles, [an additional 1.5 m 5 feet in furnished length for any test pile not driven beyond estimated pile length,] and cutting off piles at the cut-off elevation.[Include the cost for additional length for the test piles in the total unit price cost for the job.] Payment will be made for production [and test piles] at the bid unit price for the length of pile, from tip to final cut-off, actually provided, excluding buildups and splices directed by the Contracting Officer to be made. If the actual cumulative pile length driven (tip to cut-off) vary more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of FAR 52.236-2 Differing Site Conditions.[Payments will be made per each at the respective bid unit price for pile cut-offs, pile build-ups, pile loads tests and pile splices.][Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys.]

][1.7 PAYMENT

****

NOTE: This paragraph is tailored for Army.

Delete this paragraph for lump-sum contracts.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (PAYMENT) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****

1.7.1 Furnishing and Delivering Prestressed Concrete Piles

1.7.1.1 Payment

Payment will be made for costs associated with furnishing and delivering the required lengths of permanent prestressed concrete piles,[including H-pile extensions,] which includes costs of furnishing and delivering piles to the work site. No payment will be made for the driving head or lengths of piles exceeding required lengths. No payment will be made for piles damaged during delivery, storage, or handling to the extent that they are rendered unsuitable for the work, in the opinion of the Contracting Officer.

1.7.1.2 Measurement

Furnishing and delivering permanent prestressed concrete piles will be measured for payment by the linear meter foot of piles required below the cut-off elevation as [determined by the Contracting Officer and furnished to the Contractor] [indicated].

1.7.1.3 Unit of Measure

Unit of measure: linear meter foot.

1.7.2 Driving Prestressed Concrete Piles

1.7.2.1 Payment

Payment will be made for costs associated with driving permanent prestressed concrete piles, which includes costs of handling, driving, [and splicing of piles,] [performing dynamic testing, interpreting data and submitting reports,] measuring heave, redriving heaved piles, removal of [build-ups] driving heads or cutting off piles at the cut-off elevation and removing from the work site, compiling and submitting pile driving records, backfilling voids around piles, and any other items incidental to driving piles to the required elevation.

1.7.2.2 Measurement

Permanent prestressed concrete piles will be measured for payment for driving on the basis of lengths, to the nearest hundredth tenth of a linear meter foot, along the axis of each pile acceptably in place below the cut-off elevation shown.

1.7.2.3 Unit of Measure

Unit of measure: linear meter foot.

1.7.3 Pulled Prestressed Concrete Piles

1.7.3.1 Payment

Payment will be made for costs associated with piles pulled at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing and delivering pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Furnishing and Delivering Prestressed Concrete Piles". The cost of driving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Prestressed Concrete Piles". The cost of pulling undamaged piles will be paid for at twice the applicable contract unit price for payment item "Driving Prestressed Concrete Piles", which includes backfilling any remaining void. The cost of redriving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Prestressed Concrete Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of piles, including pile driving points, pulled and found to be damaged and backfilling voids. New piles replacing damaged piles will be paid for at the applicable contract unit price for payment items "Furnishing and Delivering Prestressed Concrete Piles" and "Driving Prestressed Concrete Piles".

1.7.3.2 Measurement

Furnishing and delivering pulled and undamaged permanent prestressed concrete piles will be measured for payment as specified in paragraph PAYMENT, subparagraph FURNISH AND DELIVER PRESTRESSED CONCRETE PILES. Pulling undamaged prestressed concrete piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING PRESTRESSED CONCRETE PILES. Redriving pulled undamaged prestressed concrete piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING PRESTRESSED CONCRETE PILES. New piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraphs FURNISH AND DELIVER PRESTRESSED CONCRETE PILES and DRIVING PRESTRESSED CONCRETE PILES.

1.7.3.3 Unit of Measure

Unit of measure: linear meter foot.

[1.7.4 Prestressed Concrete Pile Driving Tests

1.7.4.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of driven test piles,[including [pile driving points] [and] [splices];] conducting pile driving tests; backfilling voids around piles; compiling pile driving test records[; performing dynamic testing; interpreting data; and submitting reports].

1.7.4.2 Measurement

Prestressed concrete pile driving tests will be measured for payment on the basis of the applicable contract unit price per pile driving test.

1.7.4.3 Unit of Measure

Unit of measure: each.

][1.7.5 Prestressed Concrete Piles for Load Tests

1.7.5.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of load test piles[including [pile driving points] [and] [splices];] backfilling voids around piles; compiling pile driving records[; furnishing, fabricating, and mounting of strain rods and protective assembly][; furnishing, fabricating, and mounting of inclinometer and inclinometer protective assembly][; performing dynamic testing; interpreting data; and submitting reports]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

1.7.5.2 Measurement

Prestressed concrete piles for load tests will be measured for payment on the basis of the applicable contract unit price per load test pile.

1.7.5.3 Unit of Measure

Unit of measure: each.

][1.7.6 Prestressed Concrete Pile Static Axial Compressive Load Tests

1.7.6.1 Payment

Payment will be made for costs associated with prestressed concrete pile static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile static axial load test reports. No payment will be made for rejected pile compressive load tests.

1.7.6.2 Measurement

Prestressed concrete pile static axial compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.7.6.3 Unit of Measure

Unit of measure: each.

][1.7.7 Prestressed Concrete Pile Static Tensile Load Tests

1.7.7.1 Payment

Payment will be made for costs associated with prestressed concrete pile static tensile load tests in accordance with ASTM D3689/D3689M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static tensile load tests.

1.7.7.2 Measurement

Prestressed concrete pile tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load test.

1.7.7.3 Unit of Measure

Unit of measure: each.

][1.7.8 Prestressed Concrete Pile Lateral Load Tests

1.7.8.1 Payment

Payment will be made for costs associated with prestressed concrete pile lateral load tests in accordance with ASTM D3966/D3966M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing inclinometers; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile lateral load tests.

1.7.8.2 Measurement

Prestressed concrete pile lateral load tests will be measured for payment on the basis of the applicable contract unit price per lateral load test.

1.7.8.3 Unit of Measure

Unit of measure: each.

][1.7.9 Pulled Load Test Prestressed Concrete Piles

1.7.9.1 Payment

Payment will be made for costs associated with load test prestressed concrete piles pulled prior to load testing at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing, delivering, driving, and pulling undamaged load test piles will be paid for at the applicable contract unit price for payment item "Prestressed Concrete Piles for Load Tests". The cost of pulling undamaged load test piles the second time after redriving and testing will be paid for at twice the applicable contract unit price for payment item "Driving Prestressed Concrete Piles". The cost of redriving pulled undamaged load test piles will be paid for at the applicable contract unit price for payment item "Driving Prestressed Concrete Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of load test piles pulled at the direction of the Contracting Officer and found to be damaged. New load test piles replacing damaged piles will be paid for at the applicable contract unit price for payment item "Prestressed Concrete Piles for Load Tests".

1.7.9.2 Measurement

Pulled undamaged load test prestressed concrete piles will be measured for payment as specified in paragraph PAYMENT, subparagraph PRESTRESSED CONCRETE PILES FOR LOAD TESTS. Pulling undamaged load test prestressed concrete piles the second time after redriving and testing will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING PRESTRESSED CONCRETE PILES. Redriving pulled undamaged prestressed concrete piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING PRESTRESSED CONCRETE PILES. New load test prestressed concrete piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraph PRESTRESSED CONCRETE PILES FOR LOAD TESTS.

1.7.9.3 Unit of Measure

Unit of measure: as specified in paragraph PAYMENT, subparagraphs DRIVING PRESTRESSED CONCRETE PILES and PRESTRESSED CONCRETE PILES FOR LOAD TESTS, respectfully.

][1.7.10 Pile Driving Shoes

1.7.10.1 Payment

Payment will be made for costs associated with pile driving shoes, including furnishing, delivering, and installing.

1.7.10.2 Measurement

Pile driving shoes will be measured for payment on the basis of the number of pile driving shoes required.

1.7.10.3 Unit of Measure

Unit of measure: each.

][1.7.11 Prestressed Concrete Pile Splices

1.7.11.1 Payment

Payment will be made for costs associated with prestressed concrete pile splices, including all plant, labor, and material required to make the splice.

1.7.11.2 Measurement

Prestressed concrete pile splices will be measured for payment on the basis of the applicable contract unit price per pile splice.

1.7.11.3 Unit of Measure

Unit of measure: each.

][1.7.12 Vibration Monitoring

1.7.12.1 Payment

Payment will be made for costs associated with vibration monitoring.

1.7.12.2 Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.7.12.3 Unit of Measure

Unit of measure: each.

][1.7.13 Sound Monitoring

1.7.13.1 Payment

Payment will be made for costs associated with sound monitoring.

1.7.13.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.7.13.3 Unit of Measure

Unit of measure: each.

][1.7.14 Preconstruction Condition Survey

1.7.14.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.7.14.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.7.14.3 Unit of Measure

Unit of measure: each.

][1.7.15 Construction Instrumentation and Monitoring

1.7.15.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.7.15.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.7.15.3 Unit of Measure

Unit of measure: one.

]]1.8 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G, [_____]

[Contractor's Geotechnical Consultant Documentation; G, [_____]

][Wave Equation Analysis; G, [_____]

] Precasting Manufacturer's Quality Control Procedures; G, [_____]

[Instrumentation and Monitoring Program Report; G, [_____]

] Testing Agency Qualifications; G, [_____]

SD-02 Shop Drawings

****

NOTE: When the size and complexity of project warrants certification by a registered engineer, insert requirements; otherwise delete.

****

Piles; G, [_____]

Pile Splices; G, [_____]

Pile Placement; G, [_____]

As-Driven Survey; G, [_____]

Load Tests; G, [_____]

Pile Shoe; G, [_____]

SD-03 Product Data

Pile Driving Equipment; G, [_____]

SD-05 Design Data

Concrete Mix Design; G, [_____]

SD-06 Test Reports

Aggregates; G, [_____]

[Silica Fume; G, [_____]

] Concrete Compressive Strength; G, [_____]

[Test Piles; G, [_____]

][Load Tests; G, [_____]

][Dynamic Pile Analysis; G, [_____]

] SD-07 Certificates

Aggregates; G, [_____]

Admixtures; G, [_____]

[Silica Fume Manufacturer's Representative; , [_____]

] Prestressing Steel; G, [_____]

Cement; G, [_____]

Fly Ash and Pozzolan; G, [_____]

Ground Slag; G, [_____]

[Epoxy Coating; G, [_____]

][Load Test Supporting Data; G, [_____]

] SD-11 Closeout Submittals

Pile Records; G, [_____]

1.9 DELIVERY, STORAGE, AND HANDLING

Store, handle, and transport piles in accordance with PCI MNL-116 except as follows. Use methods for handling and storage of piles such that the piles are not subjected to excessive bending stress, cracking, spalling, or other damage. Follow the lifting instructions of the precaster.

1.9.1 Damaged Piles

Inspect each pile for sweep and structural damage such as cracking and spalling before transporting them to the project site and immediately prior to placement in the driving leads. Bring any cracks (cracks other than crazing, surface drying, shrinkage cracks and end cracks) to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

Any pile damaged by reason of internal defects or by improper driving must be corrected by one of the following methods approved by the Engineer for the pile in question and the project Structural Engineer:

The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile.

One or more replacement piles are driven adjacent to the defective pile.

A Pile Dynamic Analysis and low integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

A pile driven below the specified butt elevation must be corrected by one of the following methods approved by the Engineer:

The pile is spliced (if approved).

A sufficient portion of the footing is extended down to properly embed the pile.

A pile driven out of its proper location or out of plumb as approved by the Engineer, must be corrected by one of the following methods approved by the engineer:

One or more replacement piles are driven next to the pile in question.

As directed by the structural engineer.

1.9.2 Repairable Cracks

Reject or repair piles with cracks equal to or greater than 0.15 mm 0.006 inches but less than 1.5 mm 0.06 inches. As an alternate to pile rejection, the Contractor may submit a proposal to repair deficient piles, which must be restored prior to driving to provide its required design capacity, perform its intended function in the structure, and take into consideration long term durability in corrosive environment.

1.9.3 Non-Repairable Cracks

Piles with cracks equal to or greater than 1.5 mm 0.06 inches will be rejected.

****

NOTE: Sweep and camber typically apply to steel piles. In special cases, this paragraph may apply to precast/pre-stressed concrete piles.

****

[1.9.4 Pile Sweep

Limit sweep to 3 mm per 3 M 1/8 inch per 10 feet over the length of the pile. Piles having excessive sweep will be rejected.

]1.10 QUALITY CONTROL

1.10.1 Piles

Prepare in accordance with ACI MNL-66. Indicate placement of reinforcement including tendons. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up. Provide certification of a Professional Engineer registered in any jurisdiction of the U.S. or its territories, that layout and details of reinforcement and tendons conform with that shown on the structural design drawings.

1.10.2 Quality Control Procedures

Submit the precasting manufacturer's quality control procedures and inspection records established in accordance with PCI MNL-116.

1.10.3 Installation Procedures

a. Submit information on the type of equipment proposed to be used, proposed methods of operation, pile driving plan including proposed sequence of driving, and details of all pile driving equipment and accessories.

[b. Provide details of pile driving equipment and a Wave Equation Analysis of pile drivability for selection of the hammer along with a statement of driving procedures. The Wave Equation Analysis is to be completed by the Contractor's Geotechnical Consultant for each test pile location where different subsurface conditions exist and is to include the following information pertaining to the proposed pile driving equipment:

    (1) Complete Pile and Driving Equipment Data Form, (which can be downloaded at: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables) for each proposed pile hammer and pile type combination.

    (2) Copies of computer input and output sheets and graphs showing soil resistance versus blow count as well as maximum tension and compression stresses versus blow count. Analysis must be run at the estimated tip elevation as well as other required elevations to define maximum stress levels in the pile during driving.

c. Provide detailed procedures for conducting the dynamic pile load test and equipment to be used for conducting the load test. The detailed description must explain how specific information of pile performance will be evaluated.

][1.10.4 Contractor's Geotechnical Consultant Documentation

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and Pile Dynamic Analysis, to observe test pile installation and production pile installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and must have no employee of employer relationship which could constitute a conflict of interest.

Provide instructions and procedures on how the Contractor will assist the

Government in the processes of[Dynamic Pile Testing,] Inspection and Monitoring of piles during installation and testing.

]1.10.5 Concrete Mix Design

Certify, using a Government-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI 211.1 or ACI 318M ACI 318 for specified strength and is based on aggregate data which has been determined by laboratory tests during last 12 months. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolan, ground slag, and admixtures; and applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submittal must clearly indicate where each mix design will be used when more than one mix design is submitted. Submit a concrete mix design before concrete is placed, for each type of concrete used for the piles. Submit concrete cylinder compressive strength test results.

[1.10.6 Load Test Supporting Data

Submit Jack calibration records, a testing arrangement description and diagram, and the proposed loading sequence.

]1.10.7 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

PART 2 PRODUCTS

2.1 PILE REQUIREMENTS

****

NOTE: Delete sentence in brackets when test piles are not required. Government requires the Contractor to employ a Geotechnical Consultant to determine the calculated tip elevation and provide oversight of piling installation and testing.

****

Provide precast prestressed concrete piles per PCI Journal Volume 38, Number 2 (PCI JR-382). Production of piles must be in accordance with PCI MNL-116.[Order test piles [3] [_____] meters [10] [_____] feet longer in length than production piles.[Drive the additional test pile length only when based upon the recommendation of the Contractor's Geotechnical Consultant and approved by the Contracting Officer.] The [Contractor's Geotechnical Consultant][Contracting Officer] will use test pile data to determine "calculated" pile tip elevation and necessary driving resistance. This information will be given to the Contractor no later than 7 days from receipt of complete test data. Use this list as the basis for ordering the piles. Do not order piles until list is provided by the [Contractor's Geotechnical Consultant][Contracting Officer].][Provide test piles [1.5] [_____] meter [5] [_____] feet longer than the bid length.]

2.2 MATERIALS

2.2.1 Cementitious Materials

Cementitious materials must be portland cement, [blended cement]or portland cement in combination with natural pozzolan or fly ash[or ground granulated blast furnace slag] and conforms to appropriate specifications listed below.

2.2.1.1 Cement

****

NOTE: Insert type of cement required. Generally, Types II, or I/II, is preferred. Type I, or Type III with 8 percent maximum C3A and "low alkali", may be used. Do not use Type III in conjunction with silica fume. In very special cases, Type V, "low alkali," which has limited availability, may be used.

****

****

NOTE: Cement type and quantity of cement required in mix design is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling:

(a) CHLORIDE PROTECTION:

Normal Use. In fresh water or air environment, specify Type I or Type II cement. Type III may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent and it is low alkali.

Marine Use. In soil or water environments, subject to chlorides above 1,000 ppm, within about 300 m 1000 feet of the ocean or tidal water, specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement, a minimum cementitious materials content of 335 kilograms per cubic meter 564 pounds per cubic yard and a maximum water to cementitious materials ratio of 0.40.

Seawater Exposure. In direct contact with ocean water, specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement, a minimum cementitious materials content of 390 kilograms per cubic meter 658 pounds per cubic yard and a maximum water to cementitious materials ratio of 0.40.

(b) SULFATE RESISTANCEA minimum cementitious materials content of 335 kilograms per cubic meter 564 pounds per cubic yardis recommended.

Normal Use. In soils with negligible amount of sulfate, specify Type I or Type II cement. Type III cement may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent and

it is low alkali.

Moderate Sulfate Exposure. In exposures with moderate sulfate content (between 0.10 and 0.20 percent in soil and less than 1500 ppm in water), specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement and a maximum water to cementitious materials ratio of 0.40. Do not use Class C fly ash, blast furnace slag, or silica fume for cement replacement.

Severe Sulfate Exposure. In exposures with high sulfate content (exceeds 0.20 percent in soil or 1500 ppm in water), specify Type V or Type II (with a maximum tricalcium aluminate content of 5 percent) cement, and a maximum water to cementitious materials ratio of 0.40. Do not use Class C fly ash, blast furnace slag, or silica fume for cement replacement.

Alkali-Silica Reactivity. When alkali-silica reactivity is a concern, it is recommended to limit the maximum alkali content of cement to 0.40 or 0.50, when it is locally available, otherwise use 0.60.

****

ASTM C150/C150M, [Type I, II, or III [_____] with a maximum alkali content of [0.40] [0.60] percent][; or] [ASTM C595/C595M, Type [IP(MS) or IS(MS)] [_____]] blended cement except as modified herein. The blended cement must consist of a mixture of ASTM C150/C150M cement (with alkali content not exceeding [0.40] [0.60] percent) and one of the following materials: ASTM C618 pozzolan or fly ash, or ASTM C989/C989M ground iron blast-furnace slag, or ASTM C1240 silica fume. Use cement with a maximum of 0.60 percent alkali if no satisfactory test results are available (made within the past 6 months) to prove that the cement alkali content is less than 0.40 percent. Cement certificates must include test results in accordance with ASTM C150/C150M, including equivalent alkalies indicated in the optional chemical requirements.[Use cement with a tricalcium aluminate (C3A) content of less than [8] [5] percent.] Do not use Type III cement in conjunction with silica fume.

****

NOTE: Fly ash, pozzolan, and ground iron blast-furnace slag increase durability. They may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Use Fly ash/pozzolan (loss on ignition not exceeding 3 percent) for frost areas to reduce carbon interference with air entraining admixture. Straight replacement with fly ash or natural pozzolan beyond 15 percent may decrease the concrete's strength gain rate. The following options can help mitigate this slower gain rate: (1) a lower water/cement ratio may be used, (2) partial cement replacement can be completed, e.g., one sack of cement can be replaced by 1.5 sacks of fly ash, as long as the final replacement ratio meets the

requirements, and (3) very fine fly ashes or pozzolans (e.g. with average particle sizes below 5 microns) can be used.

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2.2.1.2 Fly Ash and Pozzolan

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NOTE: Loss on ignition greater than 3 percent may result in significant variations in air content. The air entrainment admixture content may need to be varied often to maintain the same level of entrained air.

****

ASTM C618, Class N, or F except that the maximum total alkalies must be 3.0 percent, and the maximum allowable loss on ignition must be [3] [6] percent. If the aggregates are reactive, the maximum calcium oxide content must be 13.0 percent. Do not use Class C.

2.2.1.3 Ground Iron Blast-Furnace Slag

ASTM C989/C989M, Grade 120.

2.2.1.4 Silica Fume

****

NOTE: Use silica fume concrete for marine structures where low permeability and enhanced durability are necessary. The silica fume and HRWR additive should be from the same manufacturer. The Contractor and batch plant may need help from the manufacturer. Select weight percentage based on performance required. If used, a replacement of 7 percent is recommended.

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NOTE: Use for high durability and low permeability. The initial cost of the concrete will increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWR must be used with silica fume. The slump can be increased 50 to 125 mm 2 to 5 inches without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.

****

ASTM C1240, provide silica fume that is a by-product of silicon or ferrosilicon production. Provide percent by weight of the total cementitious materials as indicated in the table below.

2.2.1.5 Supplemental Cementitious Materials (SCM) Content

The concrete mix must contain one of the SCMs listed below, or a linear combination thereof.

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT		
SCM	Minimum Content	Maximum Content
Class N Pozzolan or Class F Fly Ash with SiO2 plus Al2O3 plus Fe2O3 greater than 70 percent	25 percent	35 percent
Class N Pozzolan or Class F Fly Ash with with SiO2 plus Al2O3 plus Fe2O3 greater than 80 percent	20 percent	35 percent
Class N Pozzolan or Class F Fly Ash with with SiO2 plus Al2O3 plus Fe2O3 greater than 90 percent	15 percent	35 percent
GGBF Slag	30 percent	50 percent
Silica Fume	5 percent	10 percent

2.2.2 Water

Water must be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete or steel.

2.2.3 Aggregates

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NOTE: For exposed piles in areas where reactive aggregates are likely to be supplied, provide for additional tests and certification to insure that reactive aggregates will not be used. While not wholly conclusive, petrographic examination (ASTM C295/C295M), chemical test (ASTM C289/C289M), and mortar bar method (ASTM C227) are valuable indicators.

While more reliable, the concrete prism test (ASTM C1293) takes 1 to 2 years to complete and is not practical. The accelerated mortar bar method (ASTM C1260) is similarly reliable and takes only 16 days to yield results. In areas where reactive aggregates can not be avoided, specify use of low alkali cement, and cements modified to mitigate alkali-silica reactivity. Service records of concrete made with these materials along with tests should be used in evaluating these materials.

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NOTE: Include modification to ASTM C33/C33M when reactive aggregates could be encountered. More modifications may be required. Additional tests and certifications may be required in the submittal paragraphs.

****

ASTM C33/C33M[, except as modified herein. Provide aggregate free from any substance which may be deleteriously reactive with alkalies in cement in an amount sufficient to cause excessive expansion of concrete]. Do not mix, store in same stockpile, or use fine aggregates from different sources of supply in same concrete mix or same structure without approval. The fineness modulus of fine aggregate must be not less than 2.40 or greater than 3.0. For piles that will be exposed to freezing and thawing, fine and coarse aggregate subjected to five cycles of the sodium sulfate soundness test must show a loss not greater than 10 percent. If the selected aggregates fail the soundness test, the Contractor may use the aggregate source, provided concrete specimens made with the aggregates to be used for the piles must have a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666/C666M. Prior to pile fabrication, submit certified test reports for the following tests specified in ASTM C33/C33M[, in addition, test the gradation of each size of aggregate in accordance with ASTM C136/C136M], [twice] [_____] during each shift when the concrete plant is operating:

a. Grading

b. Amount of material finer than 75 micrometers No. 200 sieve

c. Organic impurities

d. Soundness

e. Clay lumps and friable particles

f. Coal and lignite

g. Weight of slag

h. Abrasion of coarse aggregate

i. Fineness modulus

j. Reactive aggregates

k. Freezing and thawing

2.2.3.1 Alkali-Silica Reactivity (ASR)

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate activity.

Separately evaluate the fine and coarse aggregates using ASTM C1260. Test results of the individual aggregates must have a measured expansion equal to or less than 0.08 percent at 14 days after casting per ASTM C1260. If the test data indicates an expansion of greater than 0.08 percent, reject the aggregate(s) or perform additional testing, using ASTM C1567, as follows: utilize the Contractor's proposed low alkali portland cement [blended cement] and SCM in combination with the proposed aggregate for the test portioning. Determine the SCM quantity that will meet all the requirements of these specifications and that will lower the ASTM C1567 expansion to equal or less than 0.08 percent at 14 days after casting.

If the above option does not lower the expansion to less than 0.08 percent at 14 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.2.4 Admixtures

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NOTE: For guidance in use of either water-reducing admixtures, set retarding admixtures, or combination of admixtures, see ACI 543R-74, "Recommendations for Design, Manufacture, and Installation of Concrete Piles."

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Chemical admixtures must conform to ASTM C494/C494M, [Type A] [Type B].[Air-entraining admixture must conform to ASTM C260/C260M.] Do not use admixtures containing chlorides.

2.2.5 Prestressing Steel

Use seven-wire stress-relieved or low-relaxation strand conforming to ASTM A416/A416M, Grade 270. Use prestressing steel free of grease, oil, wax, paint, soil, dirt, and loose rust. Do not use prestressing strands or wire having kinks, bends, or other defects.

2.2.6 Reinforcing Steel

****

NOTE: Minimum cover for reinforcing steel in concrete structures is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling. For normal exposure minimum cover is 50 mm 2 inches. For piles exposed to marine conditions (chloride content above 1000 ppm) in or within about 300 m 1000 feet of the ocean or tidal water, use 75 mm 3 inches minimum cover, including the chamfered corners. For additional detailed guidance, see following publications: ACI 543R, "Recommendations for Design, Manufacture and Installation of Concrete Piles" (ACI Manual, Part 3); State of California, Department of Public Works, Design Specifications, Volume l, Bridge Planning and Design Manual, Chapter 6. Piles to be used in a marine environment may receive a protective coating, particularly if the piles are steam cured. The protective coating should be applied to that portion of pile which remains aboveground or water line. Show areas to be protected on drawings.

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NOTE: Insert grade of reinforcement. Specify ASTM A706/A706M reinforcing where welding or bending of reinforcement bars is important. In addition, ASTM A934/A934M may be specified where extra reinforcement protection is required.

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ASTM A615/A615M, Grade [300][420] [40][60]; [ASTM A706/A706M, Grade [420]

[60];] or ASTM A996/A996M, Grade [350][420] [50][60].[Weld reinforcing steel in accordance with AWS D1.4/D1.4M.]

2.2.7 Ties and Spirals

****

NOTE: If project has been designed for epoxy rebar, add ASTM A934/A934M, "Epoxy-Coated Prefabricated Steel Reinforcing Bars" in this paragraph and in the paragraph REFERENCES.

****

Steel, ASTM A1064/A1064M for spirals and ASTM A615/A615M [ASTM A706/A706M] for ties.

2.2.8 Anchorages and End Fittings

ACI 318M ACI 318.

2.2.9 Grout

Provide cement grout for prestressed piles using materials conforming to requirements stipulated herein for concrete mixes. Use admixtures, if required, known to have no injurious effects on steel or concrete. Do not use calcium chloride.

[2.2.10 Epoxy Coating

[EP-3][_____] conforming to Section [_____], "Epoxy-Resin Systems" of [_____]DOT RBS. Coat the top 7500 mm 25 feet of piles.

][2.2.11 H-Pile Extensions

Use H-pile extensions for composite prestressed concrete-steel piles of steel conforming to the requirements of [ASTM A36/A36M] [ASTM A572/A572M].

][2.2.12 Pile Driving Points

Use pile driving points of steel conforming to the requirements of ASTM A27/A27M or [ASTM A36/A36M] [ASTM A572/A572M], of the [type] [details] indicated.

]2.3 CONCRETE MIX DESIGN

****

NOTE: Insert the minimum 28 day compressive strength required by the design. A minimum of 35 MPa 5000 psi is generally required. Insert aggregate size, either 19 mm 3/4 inch or 25 mm one inch is generally maximum. For marine exposure, (or moderate and severe sulfate exposure) include last bracketed sentence, which limits the water-cement ratio to a maximum of 0.40.

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NOTE: Air-entrainment may be considered optional only in regions that do not experience freezing temperatures.

****

ACI 211.1 or ACI 318M ACI 318, Chapter 4. Concrete must have a minimum compressive strength of [35] [_____] MPa [5000] [_____] psi at 28 days and a maximum size aggregate of [_____] mm inches. Concrete must be air entrained with a minimum of 4.5 percent and a maximum of 7.5 percent. Mix must contain fly ash, ground iron blast furnace slag or silica fume to meet the requirements specified herein to mitigate Alkali-Silica Reactivity (ASR).[For marine exposure, ensure a dense concrete free of shrinkage cracks, with a minimum degree of permeability. The maximum water cement ratio must be 0.40.]

2.4 FABRICATION

2.4.1 Formwork

Formwork and dimensional tolerances must be in accordance with PCI MNL-116, PCI MNL-135, and as specified herein. Provide forms of metal, braced and stiffened against deformation, accurately constructed, watertight, and supported on unyielding casting beds. Forms must permit movement of pile without damage during release of prestressing force. Form precast dowel holes with galvanized flexible metal conduit.[Inside forms or void tubes not to be grouted may be treated cardboard, plywood, or other material.]

2.4.2 Pretensioning

Perform pretensioning in accordance with PCI MNL-116, and as specified herein. Use gage calibrated within last [6 months][_____] by a laboratory approved by Contracting Officer. Provide means for measuring elongation of steel to nearest 3 mm 1/8 inch. Give tensioning steel a uniform prestress prior to being brought to design prestress. Induce same initial prestress in each unit when several units of prestressing steel in a pile are stretched simultaneously.

2.4.3 Casting

2.4.3.1 Conveying

Convey concrete to formwork in accordance with PCI MNL-116, and as specified herein. Clean conveying equipment thoroughly before each run. During placing, make any free vertical drop of the concrete less than 0.91 m 3 feet. Remove concrete which has segregated in conveying or placing.

2.4.3.2 Placing and Casting

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NOTE: Select the size of chamfer required. Consult with local producers. Where project requires a large quantity of piling a specific value may be specified, otherwise, use a minimum or a range of values.

****

Perform concrete casting within 3 days after pretensioning steel; however, do not deposit concrete in forms until placement of reinforcement and anchorages has been inspected and approved by pile manufacturer's quality control representative. Produce each pile of dense concrete straight with smooth surfaces with reinforcement retained in its proper position during fabrication. Use vibrator with heads smaller than the minimum distance between steel for pretensioning. Make surface of pile ends perpendicular to axis of pile. Chamfer,[a minimum of 19 mm 3/4 inch,][[_____] mm [_____] inch,][between 19 mm and 31 mm 3/4 inch and 1 1/4 inch,] ends of piles and corners of square piles.

2.4.4 Curing of Piles

Cure piles using moist or accelerated curing in accordance with the PCI MNL-116 except as follows. [_____]

2.4.4.1 Moist Curing

Moist cure using moist burlap coverings, plastic sheeting, or membrane curing compound until minimum strength to detension is achieved.

2.4.4.2 Accelerated Curing

After placement of concrete, moist cure for a period of 4 hours. Follow by accelerated curing until concrete has reached specified release strength. Enclose casting bed for accelerated curing with a suitable enclosure. During application of steam or heat, increase the air temperature at a rate not to exceed 22 degrees C 40 degrees F per hour. Cure at a maximum temperature of 65 degrees C 150 degrees F until concrete has reached specified release strength. Reduce temperature at a rate not to exceed 11 degrees C 20 degrees F per hour until a temperature of 11 degrees C 20 degrees F above ambient air temperature is reached. After accelerated curing, moist cure using either water or membrane curing until a total accelerated and moist curing time of 72 hours is achieved.

2.4.5 Detensioning

****

NOTE: Specify "release strength." Release strength of 30 MPa 4000 psi (Design strength) of 35 MPa 5000 psi or 0.8 of the 28 day design strength is desirable; however, some regions use 0.7 of the design strength 25 MPa 3500 psi for design strength of 35 MPa 5000 psi. A minimum release strength of 0.6 of the design strength is required. Check with local pile manufacturers.

****

Perform detensioning in accordance with PCI MNL-116, and as specified herein. Gradually release tension in strands from anchorage. Detension after approval by pile manufacturer's quality control representative. Perform transfer of prestressing force when concrete has reached a minimum compressive strength of [_____] MPa psi.

2.5 PRODUCT QUALITY CONTROL

Where piling is manufactured in a plant with an established quality control program as attested to by a current certification in the PCI "Certification Program for Quality Control" perform product quality control in accordance with PCI MNL-116. Where piling is manufactured by specialists or in plants not currently enrolled in the PCI "Certification Program for Quality Control," set-up a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an independent commercial testing laboratory approved by the Contracting Officer in accordance with the following.

2.5.1 Piles

Prepare shop drawings in accordance with ACI MNL-66. Indicate placement of reinforcement including tendons. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up.[Provide certification of a Professional Engineer registered in any jurisdiction of the U.S. or its territories, that layout and details of reinforcement and tendons conform with that shown on the structural design drawings.]

[2.5.2 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

]2.5.3 Aggregate Tests

Take samples of fine and coarse aggregate at concrete batch plant and test. Perform mechanical analysis (one test for each aggregate size) in accordance with ASTM C136/C136M. Tabulate results of tests in accordance with ASTM C33/C33M.

2.5.4 Slump and Strength Tests

Sample concrete in accordance with ASTM C172/C172M at time concrete is deposited for each production line. Perform slump tests in accordance with ASTM C143/C143M. Mold cylinders in accordance with ASTM C31/C31M. Mold at least six cylinders per day or one for every [15] [45] cubic meter [20] [60] cubic yards of concrete placed, whichever is greater. Cure cylinders in same manner as piles and for accelerated curing, place at coolest point in casting bed. Perform strength tests in accordance with ASTM C39/C39M. Test two cylinders of each set at 7 days or 14 days, or at a time for establishing transfer of prestressing force (release strength) and removal of pile from forms. Test remaining cylinders of each set 28 days after molding.

2.5.5 Changes in Proportions

If, after evaluation of strength test results, compressive strength is less than specified compressive strength, make adjustments in proportions and water content and changes in temperature, moisture, and curing procedures as necessary to secure specified strength. Submit changes in mix design to Contracting Officer in writing.

2.5.6 Compressive Strength Test Results

Evaluate compressive strength test results at 28 days in accordance with ACI 214R using a coefficient of variation of 10 percent. Evaluate strength of concrete by averaging test results of each set of standard cylinders tested at 28 days. Not more than 10 percent of individual cylinders tested must have a compressive strength less than specified design strength.

[2.5.7 Chloride Ion Concentration

Sampling and determination of water soluble chloride ion content in accordance with ASTM C1218/C1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures must not exceed 0.06 percent by weight of cement.

][2.5.8 Chloride Ion Penetration

Proportion concrete to have the chloride ion penetration test in accordance with ASTM C1202 to ensure the durability of concrete in marine environment, and be below 3000 coulombs for concrete specimens tested at 56 days.

]2.5.9 Precasting Manufacturer's Quality Control Procedures

Submit the precasting manufacturer's quality control procedures and inspection records established in accordance with PCI MNL-116.

2.6 MATERIAL SUSTAINABILITY CRITERIA

For materials used, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan.

b. Recycled content for Ground Iron Blast-Furnace Slag.

c. Recycled content for Silica Fume.

d. Minimum [75 percent] [_____] recycled content for steel used for stressed tendon reinforcing.

2.7 PILE DRIVING EQUIPMENT

Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, hammer cushions, pile cushions, leads, extractors, jetting equipment, and preboring equipment at least 30 days prior to commencement of work.

Provide Pile Driving Equipment as mentioned in this section.

2.7.1 Pile Hammers

Provide a hammer capable of developing the indicated ultimate pile capacity at blow count less than 100 per 300 mm foot considering hammer impact velocity; ram weight; stiffness of hammer and pile cushions; cross section, length, and total weight of pile; and character of subsurface material to be encountered.[Use the same pile hammer, operating at the same rate and in the same manner, as that used for driving test piles.] Use wave equation analysis to verify that the hammer will develop stresses within acceptable limits in the piles. At final driving, operate pile hammer in accordance with manufacturer's recommendation. Provide the plant and equipment for air hammers that have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The hose connecting the compressor with the hammer must be at least the minimum size recommended by the Manufacturer. Evaluate hammer performance at the end of driving by measuring blows per minute and comparing with the manufacturer's recommendations. Measure impact velocity of open-end (single acting) diesel hammers at all times during pile driving operations with a device for this purpose. If such a device is not available, obtain the stroke by measuring the speed of operation either manually or with a device that makes the measurement automatically. Equip closed-end (double acting) diesel hammers with a bounce chamber pressure gauge in good working order, mounted near ground level so as to be easily read by the Contracting Officer. Provide a correlation chart of bounce chamber pressure and potential energy. Equip hydraulic hammers with a system for measurement of ram energy. The system must be in good working order and the results must be easily and immediately available to the Engineer.

2.7.2 Driving Helmets and Cushion Blocks

2.7.2.1 Driving Helmets or Caps and Pile Cushions

Use a steel driving helmet or cap including a pile cushion between top of pile and driving helmet or cap to prevent impact damage to pile. Use a driving helmet or cap and pile cushion combination capable of protecting pile head, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over top of pile. Provide driving helmet or cap that fits sufficiently loose around top of pile so that pile may be free to rotate without binding within driving helmet.[During test pile installation, demonstrate to satisfaction of Contracting Officer that equipment to be used on project performs specified function.] Use pile cushion of solid wood or of laminated construction using plywood, softwood or hardwood boards with grain parallel to end of pile. Select the pile cushion thickness placed on the pile head prior to driving by wave equation analysis so that the limiting driving stresses are not exceeded. Replace pile cushion at the start of driving of each pile and when it becomes highly compressed, charred or burned, or has become spongy or deteriorated in any manner. Show details of driving helmets, capblocks (hammer cushions), and pile cushions. Submit 2 weeks prior to [test] pile installation.

2.7.2.2 Hammer Cushion or Capblock

****

NOTE: Select either wood or aluminum/micarta capblock. Delete inappropriate sentences. An aluminum/micarta capblock is recommended because of its consistent elastic properties and long life. If final pile penetration resistance is based on a Wave Equation analysis, the type of capblock used should be the same as that used in the analysis.

****

Use a hammer cushion or capblock between driving helmet or cap and hammer ram consisting of[a solid hardwood block with grain parallel to the pile axis and enclosed in a close-fitting steel housing][aluminum and micarta (or equal) discs stacked alternately in a steel housing or a suitable polymer designed for this specific purpose as indicated by the hammer manufacturer]. Use steel plates at top and bottom of capblock (hammer cushion).[Replace wood capblock (hammer cushion) when it becomes highly compressed, charred or burned or becomes spongy or deteriorated in any manner.][Replace aluminum, micarta or polymer discs that have become damaged, split or deteriorated in any manner.][Do not replace wood capblock (hammer cushion) during final driving of any pile.] Do not use small wood blocks, wood chips, rope or other materials that permit excessive loss of hammer energy.

PART 3 EXECUTION

3.1 PRELIMINARY WORK

[3.1.1 Wave Equation Analysis of Pile Drivability

a. Prior to driving any pile, submit a pile Wave Equation Analysis, performed by Contractor's Geotechnical Consultant, for each size pile and distinct subsurface profile condition. These analyses must take into account the proposed hammer assembly, pile cap block and cushion characteristics, the pile properties and estimated lengths and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity.

b. Demonstrate using the Wave Equation Analysis that the piles will not be damaged during driving, must indicate that the driving stresses will be maintained within the limits below and indicate the blow count necessary to achieve the required ultimate static pile capacities.

Allowable Driving Stresses

Concrete

Compression - 0.85 f'c minus UPL
Tension - (3 times (the square root of f'c)) plus UPL

f'c is compressive strength of concrete
UPL = Unit Prestress after Losses
(Obtain values from pile manufacturer)

c. Perform a refined Wave Equation Analysis upon completion of the dynamic and static testing programs outlined in this specification section, taking into consideration the evaluated capacities, gain/loss factors and recommended production pile lengths.[Develop production pile driving criteria based on the results of the refined Wave Equation Evaluations.]

d. All pile driving equipment provided by the Contractor will be subject to the approval of the Contractor's Geotechnical Consultant. Complete the attached pile and driving equipment data form, including hammer information, in full as part of the submittal of the results of the Wave Equation Analyses.

e. Pay for the cost of performing the Wave Equation Analyses and include in the base bid.

]3.1.2 Pile Length Markings

Mark each pile prior to driving with horizontal lines at 305 mm one foot intervals. Mark the interval number on pile every 1.5 2m 5 feet from pile tip.

3.2 PILE DRIVING

3.2.1 Driving Piles

****

NOTE: Delete bracketed option for foundation excavation when not required. Delete items in brackets dealing with tip elevation and driving resistance when test piles or load tests are not used. Delete item in brackets regarding predrilling or jetting when procedure is not used. If needed, insert maximum hammer energy for no tip resistance. This can be determined by comparing tensile stresses in pile resulting from a Wave Equation Analysis with effective prestress in pile.

****

Notify Contracting Officer 10 days prior to driving of [test] piles[and load test].[Stop foundation excavation at 300 mm one foot above foundation grade before piles are driven. Do not drive piles within 30 meter 100 feet of concrete less than 7 days old. Complete excavation to lines and grades shown when pile driving is completed.] Piles may be driven when the specified 28-day concrete strength has been achieved but not less than 7 days after casting.[The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analysis].] Drive piles to [the terminal driving criteria][or below "calculated"] [indicated tip elevation] [to reach a driving resistance established by the [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analyses (WEAP)] in accordance with the schedule which the [Contractor's Geotechnical Consultant] [Contracting Officer] will prepare from the test-pile driving data]. During initial driving and until pile tip has penetrated beyond layers of very soft soil[or below bottom of predrilled or prejetted holes], use a reduced driving energy of the hammer as required to prevent pile damage. Refusal criteria will be established by the Contracting Officer. If a pile fails to reach ["calculated"] [indicated] tip elevation,[or if a pile reaches ["calculated"] tip elevation without reaching required driving resistance,] notify Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB. Do not handle or move piles or pile sections in any manner that would result in cracking or permanent damage to the concrete or to the grout surrounding the prestressing cables. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

3.2.2 Protection of Piles

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NOTE: Delete references to batter piles when not applicable to the project. Use more stringent criteria as necessary based on the application. Confirm with the structural engineer.

****

Take care to avoid damage to piles during handling, placing pile in leads, and during pile driving operations. Support piles laterally during driving, but allow rotation in leads.[Where pile or projecting reinforcement orientation is essential, take precautionary measures to maintain the orientation during driving.][Take special care in supporting battered piles to prevent excessive bending stresses in pile.] Square top of pile to longitudinal axis of pile. Maintain axial alignment of pile hammer with that of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through the reinforcement, by using a special driving head.

3.2.3 Pile Placement and Tolerances in Driving

****

NOTE: Omit references to batter piles when not applicable to the project. Select appropriate tolerances for type of pile.

****

Submit pile placement plans at least 30 days prior to delivery of piles to the job site.

Drive piles with a variation of not more than 2 percent from vertical for plumb piles or more than 4 percent from required angle for batter piles. Maintain and check axial alignment of pile and leads at all times. If subsurface conditions cause pile drifting beyond allowable axial alignment tolerance, notify Contracting Officer and perform corrective measures as directed. Place butts within 100 mm 4 inches of location indicated.[Manipulation of piles within specified tolerances[will not be permitted.][will be permitted, to a maximum of 1 1/2-percent of their exposed length above ground surface or mudline.]] In addition to specified tolerances, maintain a location to provide a clear distance of at least 125 mm 5 inches from butt to edge of pile cap. If clear distance can not be maintained, then notify Contracting Officer. Check each pile for heave. Redrive heaved piles to required point elevation.

3.2.4 Rejected Piles

Withdraw piles damaged or impaired for use during handling or driving, mislocated, or driven out of alignment beyond the maximum tolerance. Replace with new piles or cut-off and abandon damaged or impaired piles and drive new piles as directed. Remove excess cut-off from piles and unacceptable piles from the work site. Perform all work in connection with withdrawing and removing rejected piles from the site at no additional cost to the Government.

3.2.5 Jetting of Piles

****

NOTE: Jetting should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Adjacent to existing structures.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Water jets will[not] be permitted.[Use jetting to assist driving piles through strata that cannot be penetrated practicably by use of the hammer alone.[Restrict driving to a static weight while water is being injected to prevent inducing tensile stresses in the piles which damage the concrete.] Discontinue jetting and resume hammer driving after the penetration of the strata requiring jetting has been accomplished.][Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.][Take adequate measures for collecting and disposing of runoff water.][Jetting method and equipment must be approved by the Contracting Officer prior to commencing jetting operation.] Before starting final driving, firmly seat piles in place by application of a number of reduced energy hammer blows.[Employ measures, including use of a silt curtain, to contain turbid water created by jetting piles.]

3.2.6 Predrilling of Piles

****

NOTE: Predrilling should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Located in cohesionless soils.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven[will[not] be permitted][must be provided].[The diameter of the hole must not exceed two-thirds the width of the pile.][Predrill only to a depth of [_____] meters feet below cut-off elevation prior to setting piles.][Discontinue drilling when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.]

3.2.7 Pile Splices

****

NOTE: Splicing of piles normally should not be permitted except where extremely long or heavy piles are required. If splices are permitted, drawings should indicate splice details. (See PCI standard drawings for typical splice details).

****

[Splicing of piles is not permitted.] [Make splices as indicated. Splices must be capable of developing the full strength of the member in compression, tension, shear, and bending. Submit detail drawings of splices and design calculations demonstrating the strength of the splice for approval. Submit information for shop and field pile splices prior to fabrication.]

3.2.8 Build-Ups

****

NOTE: Insert compressive strength required by design, usually a minimum of 35 MPa 5,000 psi. Insert maximum percent of build-ups permitted for project. The percent will depend on criticality of pile failure at build-up; whether the top of the pile is designed as a moment connection; exposure of piles to external physical or corrosive damage. Normally, for piles supporting piers exposed to seawater, limit percentage of build-ups to 10 percent.

****

Where required, pile section may be extended to cut-off elevation by means of a cast-in-place reinforced concrete build-up. Make build-up in accordance with PCI BDM. Construct build-ups made after completion of driving in accordance with detail, "Build-Up Without Driving." Make build-ups to be driven in accordance with detail "Build-Up With Driving." Have details of means for protecting joints by a suitable mortar or epoxy approved by Contracting Officer. Where build-ups are exposed to water, protect cast-in-place section from water during curing period. Concrete in build-up must have a minimum compressive strength of [_____] MPa psi. Build-ups will not be permitted on more than [_____] percent of total number of piles. If this percent figure is exceeded, or if in the judgment of the Contracting Officer, the clustered location of build-ups is undesirable, withdraw piles of insufficient length and replace with longer piles. Payment for such withdrawal and replacement will be made as an adjustment to the contract price.

3.2.9 Pile Cut-Off

Cut-off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods approved by Contracting Officer. Use of explosives for cutting is not permitted. Remove cut-off sections of piles from the site and off government property upon completion of the work.

3.2.10 Patching

Provide a 25 mm one inch minimum conical depression around embedded lifting loops. Where indicated or directed, cut off lifting loops at bottom of depression and patch depression with epoxy mortar.

3.2.11 As-Driven Survey

After the driving of each pile group is complete and before concrete is placed, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a licensed land surveyor.

3.2.12 Protection of Existing Structures

****

NOTE: Include this paragraph only when protection

of existing structures from pile driving activities is required.

The designer must indicate on the drawings all structures and facilities for which protection is required. The designer must also provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.
****

Mitigate impact on existing facilities due to pile driving activities in accordance with the [project specific document] [_____].

3.2.13 Pile Shoe

Submit details about pile shoe used, if any. Where indicated or directed, securely attach pile shoes of an approved design to the piles in a manner described in the detail drawings.

3.3 FIELD QUALITY CONTROL

3.3.1 Test Piles

****
NOTE: Select the second bracketed option when soil conditions dictate the use of a test pile longer than production piles. The ordered pile length for test piles should be 1.5 m 5 feet longer than ordered length for production piles to allow additional penetration if driving conditions dictate. Indicate location and number (if required) of test piles on plans, or list appropriate soil boring test hole numbers.
****

[Use test piles of type, and drive as specified for piling elsewhere in this section.][Order test piles [_____] meters feet longer in length than production piles. Drive the additional test pile length only at the direction of the Contracting Officer.]The [Contractor's Geotechnical Consultant][Contracting Officer] will use test pile data to determine "calculated" pile tip elevation or necessary driving criteria. Drive test piles [at the locations indicated] [in vicinity of soil boring test holes Nos. [_____], [_____], and [_____]]. Drive test piles to [indicated tip elevation] [indicated bidding lengths] [required driving criteria]. Use test piles, if located properly and offering adequate driving resistance in finished work.[Pre-drilling or jetting is permitted only when test piles clearly establish validity of its use, or as directed by the Contracting Officer.][Provide and operate a pile driving analyzer as specified in paragraph DYNAMIC PILE ANALYSIS during the driving of each test pile. Modify driving as required based upon recommendation of [Contracting Officer] [Contractor's Geotechnical Consultant and approval of the Contracting Officer].]

[3.3.2 Dynamic Pile Analysis

Submit a performance report summarizing dynamic test results for test piles within [7][_____] calendar days of completing field work.[For production piles, submit a performance report within one day of testing. Submit a typed report summarizing the results of dynamic testing of production piles on a monthly basis.]

Dynamic testing provides supplemental information for evaluating pile integrity, hammer and drive system performance, assess pile installation driving stresses, and pile capacities. Perform dynamic testing on [_____] percent of the[test] piles during the full length of the pile driving and during restrike a minimum of [_____] days after initial driving. Dynamic pile testing must also be performed on [_____] production piles as chosen by the Contracting Officer. Use[test] piles of type as specified elsewhere in this section. Provide equipment to obtain dynamic measurements, record, reduce and display its data that meet the requirement of ASTM D4945. The equipment must have been calibrated within [6][_____] months prior to the start of the testing operations and thereafter throughout the contract duration. Drive[test] piles at the locations indicated or at the locations selected by the Contracting Officer. Employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile driving process[, monitoring of test pile installation,] and in the use of the Pile Driving Analyzer and its related equipment. Perform dynamic pile analysis as follows:

3.3.2.1 Pile Analysis

[_____] working days prior to driving the[test] piles, submit the pile and complete driving equipment data to the Contracting Officer. The Contractor's Geotechnical Consultant must use the submitted information to perform wave equation analyses and must prepare a summary report of the wave equation results. The wave equation analysis using GRLWEAP software by Pile Dynamics, Inc. or equivalent must be used to assess the ability of the proposed driving system to install the pile to the required capacity and desired penetration depth within the allowable driving stresses. Approval of the proposed driving system by the Contracting Officer must be based upon the wave equation analyses indicating that the proposed driving system can develop a pile capacity of [_____] kN kips at a driving resistance not greater than [_____] mm/blow blows per inch within allowable driving stress limits. The hammer must also be sized or adjustable such that the penetration per blow at the required ultimate capacity does not exceed 12 mm 0.5 inches.

3.3.2.2 Pile Drivability

Perform each dynamic pile analysis in two steps. The first step is to check the hammer, pile and soil performance, and to determine the suitability of the proposed hammer for the size, length and type of pile being installed for the soil types encountered as the piles are driven. This initial monitoring must determine whether pre-augering or jetting is appropriate, efficiency of the hammer relative to specified efficiency, effectiveness of cushion, level of compressive and tensile stress in pile and extent/location of any pile damage caused by the initial driving. With each blow of the pile, record the information listed below electronically and analyze the information using the Pile Driving Analyzer:

(1) Blow number

(2) Blow rate per minute and stroke.

(3) Input and reflected values of force and velocity.

(4) Value of upward and downward traveling force wave with time.

(5) Maximum and final transferred energy to pile, hammer system efficiency.

(6) Maximum compressive stress, velocity, acceleration and displacement.

(7) Maximum tensile stress in pile.

(8) Pile structural integrity, damage detection, extent and location.

(9) Bearing capacity of pile by Case method.

If the pile, hammer and soil performance evaluation recommends changes to the hammer stroke, pile cushioning, augering or any other aspect for the pile driving operation, incorporate these changes into production pile driving in an effort to control excessive stresses and pile damage. Replace test piles damaged or broken during installation incorporating driving modifications as determined by the Contractor's Geotechnical Consultant and reviewed and approved by the Contracting Officer. Repeat this procedure until allowable tensile and compressive stresses are achieved in the pile and/or pile damage is minimized. Subject selected initial driving records to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and estimation of anticipated gain/loss factors.

3.3.2.3 CAPWAP

Signal matching analysis by CAPWAP® software of the dynamic pile testing data must be performed on data obtained from the end of initial driving and the beginning of restrike of all control piles. CAPWAP analyses must be performed by an engineer who has achieved Advanced Level or better on the PDI / PDCA Dynamic Measurement and Analysis Proficiency Test for Providers of PDA Testing Services.

Upon completion of[test] pile driving, allow the piles to set-up for at least [72 hours][_____days]. After evaluation of pile, hammer and soil performance by the Contractor's Geotechnical Consultant, the second step of the dynamic pile analysis may proceed. This portion of the evaluation requires striking the set-up piles a minimum of 20-50 times, or as directed by the Contractor's Geotechnical Consultant using the same hammer which was used for the[test] pile driving and which will be used for production pile driving. "Warm up" the hammer and make it optimally ready prior to restriking, in order to avoid capacity losses during evaluation of restrike data. Apply maximum hammer energy during restrike in order to fully mobilize the soil resistance. However, exercise care so as to not overstress the pile. In addition to those items listed above, selected restrike driving records (as directed by the Contractor's Geotechnical Consultant are to be subjected to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and plot of applied load vs. average pile displacement based on the calculated soil properties.

3.3.2.4 Dynamic Load Test Reporting

Upon satisfactory completion of each dynamic load test, submit[a minimum of three copies of] a Pile Performance Report for the Contractor by the Contractor's Geotechnical Consultant. The submittal must be prepared and sealed by a Professional Engineer registered in [_____].

The report for the Dynamic Pile Analysis must contain the following information:

a. Capacity of pile from Case Pile Wave Analysis Program (CAPWAP). Information resulting from analysis of a selected restrike blow.

b. Maximum and final transferred energy, hammer system efficiency during pile installation.

c. Maximum compressive stress, velocity, acceleration and displacement.

d. Maximum tensile stress in pile.

e. Pile structural integrity, damage detection, extent and location.

f. Blows per minute and blow number.

g. Input and reflection values of force and velocity, upward and downward traveling force wave with time.

h. Pile skin friction and toe resistance distribution.

i. Maximum energy transferred to pile.

The maximum allowable pile design load must be proposed by the Contractor's Geotechnical Consultant based upon the results of a satisfactory pile load test conducted on a pile driven as specified herein and must include the effects of load transfer to the soil above the foundation stratum.

Use either a model 8G or PAX Pile Driving Analyzer as manufactured by Pile Dynamics, Inc., of Cleveland Ohio or approved equivalent, for dynamic testing of the pile hammer and for dynamic load testing of the test pile. All equipment necessary for the dynamic monitoring such as sensors, cables or wireless transmitters, etc., must be furnished by the Contractor's Geotechnical Consultant. The equipment must conform to the requirements of ASTM D4945.

Pay for all services of the Contractor's Geotechnical Consultant. The Contractor's Geotechnical Consultant must be available throughout the pile driving operation to consult with the Contracting Officer when required by the Contracting Officer. The cost of changes in the Contractor's procedure, as required by evaluation of the results of the Pile Driving Analysis, will be at the Contractor's expense.

]3.3.3 Static Load Tests

****

NOTE: If pile load tests are required and approved by the Contracting Officer, specify number and location of piles. Select method of load test. In ASTM D1143/D1143M, permit anchor piles only if

approved by the Contracting Officer's Technical Representative (Geotechnical Branch). Insert figure kN kips corresponding to 200 percent of the design load. Select appropriate acceptance criteria. The offset method (first option) is usually recommended.

****

Submit test set-up and procedures.

Perform compressive load tests on [_____] test piles in accordance with ASTM D1143/D1143M (standard loading procedure) as modified herein.[Allow a minimum of [72 hours][_____days] following final test pile driving for pile set-up prior to load testing.][Do not use anchor piles.] Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform [or reaction frame attached to sufficient uplift piles to safely take required load] applied to pile by hydraulic jack. Increase load in increments until rapid progressive settlement takes place or until application of total compressive load of [_____] kN kips for compressive load tests . Consider load test satisfactory when [after one hour at full test load gross settlement of pile butt is not greater than gross elastic pile compression plus 4 mm 0.15 inch plus one percent of pile tip diameter or width in [_____] mm inches,] [slope of gross load-settlement curve under full test load does not exceed 1.5 mm per metric ton 0.05 inches per ton,] [net settlement after removal of test load does not exceed 19 mm 3/4 inch]. Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.[Submit test pile records][and][load test data] within [7] [_____] calendar days of test completion.

[3.3.3.1 Safe Design Capacity

Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.

][3.3.4 Tensile Load Test

Perform tensile load tests on [_____] test piles in accordance with ASTM D3689/D3689M. Apply a tensile load of [_____] kN kips to each tensile load test pile. In performing the tension load test, apply the ultimate load equal to one and one-half times the safe tension capacity, and employ the Standard Loading Procedure.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

Perform dynamic measurements on [_____] piles designated as dynamic test piles in accordance with ASTM D4945 during driving. During easy driving, ensure that damaging tension stresses do not develop in the pile. Signal matching must be performed by the Contractor's Geotechnical Consultant on representative data collected at the end of the initial driving and at the beginning of all restrike events. Additional signal matching analysis must be performed as determined by the Engineer.

][3.3.5 Lateral Load Test

Perform lateral load tests on [_____] piles in accordance with ASTM D3966/D3966M. Lateral load tests must consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. Apply a lateral load of [_____] kN kips to each pair of lateral load test piles. Record required movement readings for each pile.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

]3.3.6 Pile Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not driven. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of driving, testing, recording and analysis of data for project may be useful.

****

****

NOTE: The Specifier must attach the specifications pile driving log graphic (for all pile driving projects) and the pile driving equipment data form (for projects using PDA) to the end of this specification section.

****

Submit pile [and test pile] records.[Submit load test data and results.]

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations, [batter alignment,] number of blows required for each 300 mm foot of penetration and number of blows for the last 150 mm 6 inches penetration or fraction thereof [as required] for the "calculated" [driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, splicing, obstructions, [jetting,] and any driving interruptions.[Install an energy monitor on the hammers and record readings every 250 mm of pile installation.] A preprinted pile driving log for recording pile driving data[and pile driving equipment data form], which can be downloaded at:

http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables.

[3.3.7 Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated. Submit testing agency qualifications to the Contracting Officer for approval.

][3.4 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-310-04, "Seismic Design for Buildings".

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

][3.5 VIBRATION CONTROL

****

NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project.

****

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs][and geophones] within a distance of [61] [_____] meters [200] [_____] feet from the pile driving activity.[Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [5] [_____] years of experience in vibration monitoring. A minimum of [28] [_____] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient vibrations. The vibration during the pile driving activities must be limited to [a peak particle velocity of not more than [5] [_____] cm [2.0] [_____] inches per second.] [the limits mentioned in the [contract documents][_____]].[Determine appropriate vibration limits as per [US Bureau of Mines] [American Association of State Highway and Transportation Officials (AASHTO)] guidelines.] During pile driving activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity causing the vibration until [the Vibration consultant and the Contracting Officer] [_____] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.6 NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the pile driving operations.[Perform noise monitoring using [noise meters][, and][_____].][Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [5] [_____] years of experience in noise monitoring. A minimum of [28] [_____] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient noise levels.[The noise limits are mentioned in the [plan] [contract documents].][Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines.] During pile driving activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity and install noise mitigation measures.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.7 PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform preconstruction condition survey of [structures][and utilities] [within [61] [_____] meters [200] [_____] feet of the pile driving activity][specified in the plans][decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] [_____] days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] [_____] days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

][3.8 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile driving activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement[and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile driving. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile driving when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile driving activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a Instrumentation and Monitoring Program Report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 62 13.24 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-31 62 13.24 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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CONCRETE CYLINDER PILES

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PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC UFGS-31 62 13.24 (November 2020)
Change 2 - 02/24

Preparing Activity: NAVFAC Superseding
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SECTION 31 62 13.24

CONCRETE CYLINDER PILES
11/20, CHG 2: 02/24

****

NOTE: This guide specification covers the requirements for post-tensioned, centrifugally cast cylinder piles and prestressed statically cast cylinder piles. Pile reinforcing specified in this guide specification is for steel, special reinforcement materials (i.e., composite, non-magnetic, etc.) should be added on a project by project basis.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

****

NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.

****

****

NOTE: Show the following information on the drawings:

1. Locations and design loads on piles. If both tension and compression piles are contained in design, identify by type.

2. Size, shape, and length of piles.

3. Locations, sizes, and number of longitudinal ducts for post tensioned steel. Location, sizes and number of prestressing strands. Unit stresses for post tensioned and prestressing strands or wire.

4. Details of reinforcement and tendons.

5. Details of splices, if required.

6. Locations of test piles, if required.

7. Soil data, where required.

****

PART 1 GENERAL

****

NOTE: Structural engineer must confirm the structural capacity of piles and provide specific bending moments, lateral loads and other design requirements for pile design.

****

1.1 DESCRIPTION

Design, furnish, install and test concrete cylinder piles at the locations indicated on the drawings and specified herein.[Assume test pile[s] will be directed to be placed in [a] location[s] that can be incorporated into the work.][Test piles which meet performance requirements may be incorporated into permanent work.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically

be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 259	(2002; R 2017) Standard Method of Test for Resistance of Concrete to Chloride Ion Penetration

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 212.3R	(2016) Chemical Admixtures for Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI MNL-66	(2020) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A615/A615M	(2024) Standard Specification for Deformed

	and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A886/A886M	(2024) Standard Specification for Steel Strand, Indented, Seven-Wire Stress-Relieved for Prestressed Concrete
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1202	(2022; E 2022) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

POST-TENSIONING INSTITUTE (PTI)

PTI M55.1	(2019; Errata 2020) Specification for Grouting of Post-Tensioned Structures

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI BDM	(2011) Precast Prestressed Concrete Bridge Design Manual
PCI JR-382	(1993) PCI Journal: Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling
PCI MNL-116	(2021) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 5th Edition
PCI MNL-135	(2000) Tolerance Manual for Precast and Prestressed Concrete Construction

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-220-01	(2012; with Change 1, 2021) Geotechnical Engineering

1.3   SUBSURFACE DATA

Subsurface soil data logs are[indicated][appended to the special contract requirements][provided on the project drawings].[The subsoil investigation report may be examined at [_____].]

1.4   BASIS OF BID

****

NOTE: Select one of the following options:

****

****

NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Determine lengths of piles as accurately as possible, prior to bidding, since the unit price per meter (foot) of the piles varies as the length increases or decreases. Refer to Standard Test Method for High-Strain Dynamic Testing of Deep Foundations (ASTM D4945).

****

1.4.1   Production Pile Acceptance Criteria

Safe design capacity for piles is [_____] KN [_____] kips. Drive piles to [minimum tip elevation] [a minimum depth of [_____] m [_____] feet below cut-off elevation], and to such additional depth as required to obtain a bearing capacity of not less than [_____] KN [_____] kips. The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of[dynamic pile driving tests at end of drive or restrike][static load tests][wave equation analysis].

The following formulas can be used in cases where allowable pile loads are less than 355 kN 80 kips (determined using a factor of safety of 3 for individual piles and 4 for pile groups) and are presented only as a guide to aid in establishing the controlling penetration per blow, which, together with the minimum depth of penetration will serve to determine the required minimum depth of penetration of each individual pile:

$$R = \frac{2E}{S \text{ plus } 0.1}$$ For double acting hammers

$$R = \frac{2WH}{S \text{ plus } 0.1}$$ For single acting hammers

Where R is the approximate allowable pile load in kips; E equals the energy in foot-kips per blow based on an acceptable certified statement from the manufacturer of the hammer; W equals the weight of the hammer or ram in kips; H equals the height of fall of the hammer of ram in feet; and S equals the average inches of penetration per blow for the last three blows. An allowance will be made for reduced penetration caused by shock absorption of the cushion or cap blocks.

[1.5 LUMP SUM PAYMENT

****

NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection. This paragraph will be typically used when there are 1) relatively small quantity of piles, 2) allowable pile loading is less than 40 tons, and 3) the subsurface conditions are well defined. Fill in Table I as required selecting columns applicable to project. Generally, pile capacity, location, and minimum tip elevation are shown on plans. Test piles and load tests are not incorporated on lump sum contracts. Delete this paragraph for unit-price contracts.

****

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.][following Table I:

Table I

[Location]	Number	Size	Capacity	Length (tip to cut-off)

]

Include in the contract price for piling the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off, dispose of any cut-offs, and meet the applicable contract requirements. The contract price also includes mobilization, pre-drilling, and redriving heaved piles. If, in redriving, it is found that any pile is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be furnished and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. Should total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; backdriving; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.

][1.6 UNIT PRICES

****

NOTE: Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

For NAVFAC Southeast projects, where there is a need for unit pricing of piles, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items.

****

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****

NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.

****

Requirements of FAR 52.211-18 Variation in Estimated Quantity do not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and driving the piles including mobilization and demobilization,[jetting][predrilling][probing], redriving uplifted piles, [an additional 1.5 m 5 feet in furnished length for any test pile not driven beyond estimated pile length,] and cutting off piles at the cut-off elevation.[Include the cost for additional length for the test piles in the total unit price cost for the job.] Payment will be made for production [and test piles]at the bid unit price for the length of pile, from tip to final cut-off, actually provided, excluding buildups and splices directed by the Contracting Officer to be made. If the actual cumulative pile length driven (tip to cut-off) vary more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of FAR 52.236-2 Differing Site Conditions.[Payments will be made per each at the respective bid unit price for pile cut-offs, pile build-ups, pile loads tests and pile splices.][Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys].

]1.7 PAYMENT

****

NOTE: This paragraph is tailored for Army. If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****

1.7.1 Furnishing and Delivering Concrete Cylinder Piles

1.7.1.1 Payment

Payment will be made for costs associated with furnishing and delivering the required lengths of permanent concrete cylinder piles, which includes costs of furnishing and delivering piles to the work site. No payment will be made for the driving head or lengths of piles exceeding required lengths. No payment will be made for piles damaged during delivery, storage, or handling to the extent that they are rendered unsuitable for the work, in the opinion of the Contracting Officer.

1.7.1.2 Measurement

Furnishing and delivering permanent concrete cylinder piles will be measured for payment by the linear meter foot of piles required below the cutoff elevation as [determined by the Contracting Officer and furnished to the Contractor] [indicated].

1.7.1.3 Unit of Measure

Linear meter foot.

1.7.2 Driving Concrete Cylinder Piles

1.7.2.1 Payment

Payment will be made for costs associated with driving permanent concrete cylinder piles, which includes costs of handling, driving, [and splicing of piles,][performing dynamic testing, interpreting data and submitting reports,]measuring heave, redriving heaved piles, removal of [build-ups]driving heads or cutting off piles at the cutoff elevation and removing from the work site, compiling and submitting pile driving records, backfilling voids around piles, and any other items incidental to driving piles to the required elevation.

1.7.2.2 Measurement

Permanent concrete cylinder piles will be measured for payment for driving on the basis of lengths, to the nearest hundredth of a linear meter tenth of a linear foot, along the axis of each pile acceptably in place below the cutoff elevation shown.

1.7.2.3 Unit of Measure

Linear meter foot.

1.7.3 Pulled Concrete Cylinder Piles

1.7.3.1 Payment

Payment will be made for costs associated with piles pulled at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing and delivering pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Furnishing and Delivering Concrete Cylinder Piles". The cost of driving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Concrete Cylinder Piles". The cost of pulling pulled and undamaged piles will be paid for at twice the applicable contract unit price for payment item "Driving Concrete Cylinder Piles", which includes backfilling any remaining void. The cost of redriving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Concrete Cylinder Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of piles pulled and found to be damaged and backfilling voids. New piles replacing damaged piles will be paid for at the applicable contract unit price for payment items "Furnishing and Delivering Concrete Cylinder Piles" and "Driving Concrete Cylinder Piles".

1.7.3.2 Measurement

Furnishing and delivering pulled and undamaged permanent concrete cylinder piles will be measured for payment as specified in paragraph PAYMENT, subparagraph FURNISHING AND DELIVERING CONCRETE CYLINDER PILES. Pulling undamaged concrete cylinder piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING CONCRETE CYLINDER PILES. Redriving pulled undamaged concrete cylinder piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING CONCRETE CYLINDER PILES. New piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraphs FURNISHING AND DELIVERING CONCRETE CYLINDER PILES and DRIVING CONCRETE CYLINDER PILES.

1.7.3.3 Unit of Measure

Linear meter foot.

[1.7.4 Concrete Pile Driving Tests

1.7.4.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of driven test piles, [including splices]; conducting pile driving tests; backfilling voids around piles; compiling pile driving test records[; performing dynamic testing; interpreting data; and submitting reports].

1.7.4.2 Measurement

Concrete pile driving tests will be measured for payment on the basis of the applicable contract unit price per pile driving test.

1.7.4.3 Unit of Measure

Each.

][1.7.5 Concrete Cylinder Piles for Load Tests

1.7.5.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of load test piles[including splices]; backfilling voids around piles; compiling pile driving records[; furnishing, fabricating, and mounting of strain rods and protective assembly][; furnishing, fabricating, and mounting of instrumentation and instrumentation protective assembly][; performing dynamic testing; interpreting data; and submitting reports]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

1.7.5.2 Measurement

Concrete cylinder piles for load tests will be measured for payment on the basis of the applicable contract unit price per load test pile.

1.7.5.3 Unit of Measure

Each.

][1.7.6 Concrete Pile Static Axial Compressive Load Tests

1.7.6.1 Payment

Payment will be made for costs associated with concrete pile static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static axial compressive load tests.

1.7.6.2 Measurement

Concrete pile compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.7.6.3 Unit of Measure

Each.

][1.7.7 Concrete Pile Static Tensile Load Tests

1.7.7.1 Payment

Payment will be made for costs associated with concrete pile static tensile load tests in accordance with ASTM D3689, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static tensile load tests.

1.7.7.2 Measurement

Concrete pile static tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load test.

1.7.7.3 Unit of Measure

Each.

][1.7.8 Concrete Pile Lateral Load Tests

1.7.8.1 Payment

Payment will be made for costs associated with concrete pile lateral load tests in accordance with ASTM D3966/D3966M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing inclinometers; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile lateral load tests.

1.7.8.2 Measurement

Concrete pile lateral load tests will be measured for payment on the basis of the applicable contract unit price per lateral load test.

1.7.8.3 Unit of Measure

Each.

][1.7.9 Pulled Load Test Concrete Cylinder Piles

1.7.9.1 Payment

Payment will be made for costs associated with load test concrete cylinder piles pulled prior to load testing at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing, delivering, driving, and pulling undamaged load test piles will be paid for at the applicable contract unit price for payment item "Concrete Cylinder Piles for Load Tests". The cost of pulling undamaged load test piles the second time after redriving and testing will be paid for at twice the applicable contract unit price for payment item "Driving Concrete Cylinder Piles". The cost of redriving pulled undamaged load test piles will be paid for at the applicable contract unit price for payment item "Driving Concrete Cylinder Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of load test piles pulled at the direction of the Contracting Officer and found to be damaged, unless the pile was damaged due to overdriving at the request of the Engineer. New load test piles replacing damaged piles will be paid for at the applicable contract unit price for payment item "Concrete Cylinder Piles for Load Tests".

1.7.9.2 Measurement

Pulled undamaged load test concrete cylinder piles will be measured for payment as specified in paragraph PAYMENT, subparagraph CONCRETE CYLINDER PILES FOR LOAD TESTS. Pulling undamaged load test concrete cylinder piles the second time after redriving and testing will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING CONCRETE CYLINDER PILES. Redriving pulled undamaged concrete cylinder piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING CONCRETE CYLINDER PILES. New load test concrete cylinder piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraph CONCRETE CYLINDER PILES FOR LOAD TESTS.

1.7.9.3 Unit of Measure

Unit of measure: as specified in paragraph PAYMENT, subparagraphs DRIVING CONCRETE CYLINDER PILES and CONCRETE CYLINDER PILES FOR LOAD TESTS, respectfully.

][1.7.10 Concrete Pile Splices

1.7.10.1 Payment

Payment will be made for costs associated with concrete pile splices, including all plant, labor, and material required to make the splice.

1.7.10.2 Measurement

Concrete pile splices will be measured for payment on the basis of the applicable contract unit price per pile splice.

1.7.10.3 Unit of Measure

Each.

][1.7.11 Pile Driving Shoes

1.7.11.1 Payment

Payment will be made for costs associated with pile driving shoes, including furnishing, delivering, and installing.

1.7.11.2 Measurement

Pile driving shoes will be measured for payment on the basis of the number of pile driving shoes required.

1.7.11.3 Unit of Measure

Unit of measure: each.

][1.7.12 Vibration Monitoring

1.7.12.1 Payment

Payment will be made for costs associated with vibration monitoring.

1.7.12.2 Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.7.12.3 Unit of Measure

Each.

][1.7.13 Sound Monitoring

1.7.13.1 Payment

Payment will be made for costs associated with sound monitoring.

1.7.13.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per sound monitoring point.

1.7.13.3 Unit of Measure

Each.

][1.7.14 Preconstruction Condition Survey

1.7.14.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.7.14.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.7.14.3 Unit of Measure

Each.

][1.7.15 Construction Instrumentation and Monitoring

1.7.15.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.7.15.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.7.15.3 Unit of Measure

One.

]1.8 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G, [_____]

[Contractor's Geotechnical Consultant Documentation; G, [_____]

][Wave Equation Analysis; G, [_____]

] Precast Manufacturer's Quality Control Procedures; G, [_____]

[Instrumentation and Monitoring Program Report; G, [_____]

] Testing Agency Qualifications; G, [_____]

SD-02 Shop Drawings

****

NOTE: When the size and complexity of project warrants certification by a registered engineer,

insert requirements; otherwise delete.
****

Piles; G, [_____]

Pile Splices; G, [_____]

Pile Placement; G, [_____]

As-Driven Survey; G, [_____]

Load Tests; G, [_____]

Pile Shoe; G, [_____]

SD-03 Product Data

Pile Driving Equipment; G, [_____]

SD-05 Design Data

Concrete Mix Design; G, [_____]

Grout; G, [_____]

Joint Sealing Material; G, [_____]

Prestressing Tendons; G, [_____]

SD-06 Test Reports

Aggregates; G, [_____]

[Silica Fume; G, [_____]

] Concrete Compressive Strength; G, [_____]

[Test Piles; G, [_____]

][Load Tests; G, [_____]

][Dynamic Pile Analysis; G, [_____]

][Destructive Pile Testing; G, [_____]

][Instrumentation and Monitoring Program Report; G, [_____]

] SD-07 Certificates

Aggregates; G, [_____]

Admixtures; G, [_____]

[Silica Fume Manufacturer's Representative; G, [_____]

] Prestressing Steel; G, [_____]

Cement; G, [_____]

Fly Ash and Pozzolan; G, [_____]

Ground Slag; G, [_____]

Epoxy Coating; G, [_____]

[Load Test Supporting Data; G, [_____]

] SD-11 Closeout Submittals

Pile Records; G, [_____]

1.9 DELIVERY, STORAGE, AND HANDLING

Store, handle, and transport piles in accordance with PCI MNL-116 except as follows. Use methods for handling and storage of piles such that the piles are not subjected to excessive bending stress, cracking, spalling, or other damage. Follow the lifting instructions of the precaster.

1.9.1 Damaged Piles

Inspect each pile for sweep and structural damage such as cracking and spalling before transporting them to the project site and immediately prior to placement in the driving leads. Bring any unusual cracks (cracks other than crazing, surface drying, shrinkage cracks and end cracks) to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

Correct any pile damaged by reason of internal defects or by improper driving by one of the following methods approved by the Engineer for the pile in question and the Structural Engineer of Record:

a. The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile.

b. One or more replacement piles are driven adjacent to the defective pile.

c. A Pile Dynamic Analysis and low integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

Correct piles driven below the specified butt elevation by one of the following methods approved by the Engineer:

a. The pile is spliced (if approved).

b. A sufficient portion of the footing is extended down to properly embed the pile.

Correct piles driven out of its proper location or out of plumb as approved by the Engineer, by one of the following methods approved by the engineer:

a. One or more replacement piles are driven next to the pile in question.

b. As directed by the structural engineer.

1.9.1.1 Repairable Cracks

Piles with cracks equal to or greater than 0.15 mm 0.006 inches but less than 1.5 mm 0.06 inches may be repaired or rejected at the discretion of the Contracting Officer. As an alternate to pile rejection, the Contractor may submit a proposal to repair deficient piles. Prior to driving, piles must be restored to their required design capacity so that they can perform their intended structural function and achieve long term durability in corrosive environment.

1.9.1.2 Non-Repairable Cracks

Piles with cracks equal to or greater than 1.5 mm 0.06 inches will be rejected.

1.9.2 Pile Sweep

****

NOTE: Sweep and camber typically apply to steel piles. In special cases, this paragraph may apply to precast concrete piles.

****

Limit sweep to the tolerances specified in PCI MNL-116 over the length of the pile. Piles having excessive sweep will be rejected. Piles that develop non repairable cracks due to handling and installation will be rejected.

1.10 QUALITY CONTROL

1.10.1 Piles

****

NOTE: When the size and complexity of project warrants certification by a registered engineer, insert requirements; otherwise delete.

****

Prepare in accordance with ACI MNL-66. Indicate placement of reinforcement including tendons. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up.[Provide certification by a professional engineer registered in any jurisdiction, that layout and details of reinforcement and tendons conform with that shown on the structural design drawings.]

1.10.2 Quality Control Procedures

Submit the precasting manufacturer's quality control procedures and inspection records established in accordance with PCI MNL-116.

1.10.3 Installation Procedures

a. Submit information on the type of equipment proposed to be used, proposed methods of operation, pile driving plan including proposed sequence of driving, and details of all pile driving equipment and accessories.

[b. Provide details of pile driving equipment and a Wave Equation Analysis of pile drivability for selection of the hammer along with a statement of driving procedures. The Wave Equation Analysis is to be completed by the Contractor's Geotechnical Consultant for each test pile location where different subsurface conditions exist and is to include the following information pertaining to the proposed pile driving equipment:

(1) Completed Pile and Driving Equipment Data Form (which can be downloaded at: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables), for each proposed pile hammer and pile type combination.

(2) Copies of computer input and output sheets and graphs showing soil resistance versus blow count as well as maximum tension and compression stresses versus blow count. Analysis must be run at the estimated tip elevation as well as other required elevations to define maximum stress levels in the pile during driving.

c. Provide detailed procedures for conducting the dynamic pile load test and equipment to be used for conducting the load test. The detailed description must explain how specific information of pile performance will be evaluated.

][1.10.4 Contractor's Geotechnical Consultant Documentation

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and Pile Dynamic Analysis, to observe test pile installation and production pile installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and have no employee of employer relationship which could constitute a conflict of interest.

Provide instructions and procedures on how the Contractor will assist the Government in the processes of Dynamic Pile Testing and Interior Inspection of Damaged Piles.

]1.10.5 Concrete Mix Design

Submit a concrete mix design before concrete is placed, for each type of concrete used for the piles. Certify, using a Government-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI 211.1 or ACI 318M ACI 318 for specified strength and is based on aggregate data which has been determined by laboratory tests during last 12 months. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolan, ground slag, and admixtures; and applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes. Clearly indicate in submittal where each mix design will be used when more than one mix design is submitted.

[1.10.6 Load Test Supporting Data

Submit Jack calibration records, a testing arrangement description and diagram, and the proposed loading sequence.

]1.10.7 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

PART 2 PRODUCTS

2.1 PILE MATERIALS

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NOTE: Delete sentence in brackets when test piles are not required. Government requires the Contractor to employ a Geotechnical Consultant to determine the calculated tip elevation and provide oversight of piling installation and testing.

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Provide precast concrete cylinder piles per PCI Journal Volume 38, Number 2 (PCI JR-382). Production of piles must be in accordance with PCI MNL-116.[Order test piles [3] [_____] meters [10] [_____] feet longer in length than production piles.][Drive the additional test pile length only when based upon the recommendation of the Contractor's Geotechnical Consultant and approved by the Contracting Officer.] The [Contractor's Geotechnical Consultant] [Contracting Officer] will use test pile data to determine "calculated" pile tip elevation and necessary driving resistance. This information will be given to the Contractor no later than 7 days from receipt of complete test data. Use this list as the basis for ordering the piles. Do not order piles until list is provided by the [Contractor's Geotechnical Consultant] [Contracting Officer].[Provide test piles [1.5] [_____] meters [5] [_____] feet longer than the bid length.]

2.2 MATERIALS

2.2.1 Cementitious Materials

Cementitious materials may be portland cement, [blended cement]or only portland cement in combination with natural pozzolan or fly ash [or ground granulated blast furnace slag]and conforming to appropriate specifications listed below.

2.2.1.1 Cement

****

NOTE: Insert type of cement required. Generally, Types II, or I/II, is preferred. Type I, or Type III with 8 percent maximum C3A and "low alkali" may be used. Do not use Type III in conjunction with silica fume. In very special cases, Type V, "low alkali," which has limited availability, may be used.

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NOTE: Cement type and quantity of cement required in mix design is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling:

(a) CHLORIDE PROTECTION:

Normal Use. In fresh water or air environment, specify Type I or Type II cement. Type III may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent and it is low alkali.

Marine Use. In soil or water environments, subject to chlorides above 1,000 ppm, within about 300 m 1000 feet of the ocean or tidal water, specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement, a minimum cementitious materials content of 335 kilograms per cubic meter 564 pounds per cubic yard and a maximum water to cementitious materials ratio of 0.40.

Seawater Exposure. In direct contact with ocean water, specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement, a minimum cementitious materials content of 390 kilograms per cubic meter 658 pounds per cubic yard and a maximum water to cementitious materials ratio of 0.40.

(b) SULFATE RESISTANCE:

A minimum cementitious materials content of 335 kilograms per cubic meter 564 pounds per cubic yard is recommended.

Normal Use. In soils with negligible amount of sulfate, specify Type I or Type II cement. Type III cement may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent and it is low alkali.

Moderate Sulfate Exposure. In exposures with moderate sulfate content (between 0.10 and 0.20 percent in soil and less than 1500 ppm in water), specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement and a maximum water to cementitious materials ratio of 0.40. Do not use Class C fly ash, blast furnace slag, or silica fume for cement replacement.

Severe Sulfate Exposure. In exposures with high sulfate content (exceeds 0.20 percent in soil or 1500 ppm in water), specify Type V or Type II (with a maximum tricalcium aluminate content of 5 percent) cement, and a maximum water to cementitious materials ratio of 0.40. Do not use Class C fly ash, blast furnace slag, or silica fume for cement replacement.

****

ASTM C150/C150M, [Type I, II, or III [_____] with a maximum alkali content of 0.60 percent[; or] [ASTM C595/C595M, Type [IP(MS) or IS(MS)] [_____]] blended cement except as modified herein.] The blended cement will consist of a mixture of ASTM C150/C150M cement (with alkali content not exceeding 0.60 percent) and one of the following materials: ASTM C618 pozzolan or fly ash, or ASTM C989/C989M ground iron blast-furnace slag, or ASTM C1240 silica fume. Include in cement certificates test results in accordance with ASTM C150/C150M, including equivalent alkalies indicated in the optional chemical requirements.[Use cement with a tricalcium aluminate (C3A) content of less than [8] [5] percent.] Do not use Type III cement in conjunction with silica fume.

****

NOTE: Fly ash, pozzolan, and ground iron blast-furnace slag increase durability. They may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Use Fly ash/pozzolan (loss on ignition not exceeding 3 percent) for frost areas to reduce carbon interference with air entraining admixture. Straight replacement with fly ash or natural pozzolan beyond 15 percent may decrease the concrete's strength gain rate. The following options can help mitigate this slower gain rate: (1) a lower water/cement ratio may be used, (2) partial cement replacement can be completed, e. g., one sack of cement can be replaced by 1.5 sacks of fly ash, as long as the final replacement ratio meets the requirements, and (3) very fine fly ashes or pozzolans (e. g. with average particle sizes below 5 microns) can be used.

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2.2.1.2 Fly Ash and Pozzolan

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NOTE: Loss on ignition greater than 3 percent may result in significant variations in air content. The air entrainment admixture content may need to be varied often to maintain the same level of entrained air.

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ASTM C618, Class N, or F except that the maximum total alkalies will be [3] [6] percent. If the aggregates are reactive the maximum calcium oxide content will be 13.0 percent. Do not use Class C.

2.2.1.3 Ground Iron Blast-Furnace Slag

ASTM C989/C989M, Grade 120.

[2.2.1.4 Silica Fume

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NOTE: Use silica fume concrete for marine structures where low permeability and enhanced durability are necessary. The silica fume and HRWR additive should be from the same manufacturer. The Contractor and batch plant may need help from the manufacturer. Select weight percentage based on performance required. If used, a replacement of 7 percent is recommended.

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NOTE: Use for high durability and low permeability. The initial cost of the concrete will

increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWR must be used with silica fume. The slump can be increased 50 to 125 mm 2 to 5 inches without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.

****

ASTM C1240, provide silica fume that is a by-product of silicon or ferrosilicon production. Provide percent by weight of the total cementitious materials as indicated in table below.

]2.2.1.5 Supplemental Cementitious Materials (SCM) Content

The concrete mix must contain one of the four SCMs listed below, or a linear combination thereof.

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT		
SCM	**Minimum Content**	**Maximum Content**
Class N Pozzolan or Class F Fly Ash with SiO2 plus Al2O3 plus Fe2O3 greater than 70 percent	25 percent	35 percent
Class N Pozzolan or Class F Fly Ash with SiO2 plus Al2O3 plus Fe2O3 greater than 80 percent	20 percent	35 percent
Class N Pozzolan or Class F Fly Ash with SiO2 plus Al2O3 plus Fe2O3 greater than 90 percent	15 percent	35 percent
GGBF Slag	30 percent	50 percent
Silica Fume	5 percent	10 percent

2.2.2 Water

Fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete or steel.

2.2.3 Aggregates

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NOTE: For piles in areas where reactive aggregates are likely to be supplied, provide for additional tests and certification to insure that reactive aggregates will not be used. While not wholly conclusive, petrographic examination (ASTM C295/C295M, chemical test (ASTM C289), and mortar

bar method (ASTM C227) are valuable indicators. While more reliable, the concrete prism test (ASTM C1293) takes 1 to 2 years to complete and is not practical. The accelerated mortar bar method (ASTM C1260) is similarly reliable and takes only 16 days to yield results. In areas where reactive aggregates can not be avoided, specify use of low alkali cement, and/or cements modified to mitigate alkali-silica reactivity. Service records of concrete made with these materials along with tests should be used in evaluating these materials.

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NOTE: Include modification to ASTM C33 when reactive aggregates could be encountered. More modifications may be required. Additional tests and certifications may be required in the submittal paragraphs.

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ASTM C33/C33M[, except as modified herein. Provide aggregate free from any substance which may be deleteriously reactive with alkalies in cement in an amount sufficient to cause excessive expansion of concrete].[Do not use dune sand as fine aggregate.] Do not mix, store in same stockpile, or use fine aggregates from different sources of supply in same concrete mix or same structure without approval. The fineness modulus of fine aggregate must be not less than 2.40 or greater than 3.0. For piles that will be exposed to freezing and thawing, fine and coarse aggregate subjected to five cycles of the sodium sulfate soundness test must show a loss not greater than 10 percent. If the selected aggregates fail the soundness test, the Contractor may use the aggregate source, provided concrete specimens made with the aggregates to be used for the piles have a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666/C666M. Prior to pile fabrication, submit certified test reports for the following tests specified in ASTM C33/C33M[, in addition, [twice] [_____] during each shift when the concrete plant is operating, test the gradation of each size of aggregate in accordance with ASTM C136/C136M]:

a. Grading

b. Amount of material finer than 75 micrometers No. 200 sieve

c. Organic impurities

d. Soundness

e. Clay lumps and friable particles

f. Coal and lignite

g. Weight of slag

h. Abrasion of coarse aggregate

i. Fineness modulus

j. Reactive aggregates

k. Freezing and thawing

2.2.3.1 Alkali-Silica Reactivity (ASR)

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate activity.

Evaluate the fine and coarse aggregates separately, using ASTM C1260. Test results of the individual aggregates must have a measured expansion equal to or less than 0.08 percent at 16 days after casting. Should the test data indicate an expansion of greater than 0.08 percent, the aggregates(s) will be rejected or additional testing, using ASTM C1567 performed as follows: utilize the Contractor's proposed low alkali portland cement[blended cement] and SCM in combination with the proposed aggregate for the test portioning. The SCM quantity must be determined that will meet all the requirements of these specifications and that will lower the ASTM C1567 expansion to equal or less than 0.08 percent at 16 days after casting.

If the above option does not lower the expansion to less than 0.08 percent at 16 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.2.4 Admixtures

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NOTE: For guidance in use of either water-reducing admixtures, set retarding admixtures, or combination of admixtures, see ACI 543R, "Recommendations for Design, Manufacture, and Installation of Concrete Piles.

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Chemical admixtures conforming to ASTM C494/C494M, [Type A] [Type B]. [Air-entraining admixture conforming to ASTM C260/C260M.]Do not use admixtures containing chlorides.

2.2.5 Prestressing Steel

Use seven-wire stress-relieved or low-relaxation strand conforming to ASTM A416/A416M, Grade 270. Use prestressing steel free of grease, oil, wax, paint, soil, dirt, and loose rust. Do not use prestressing strands or wire having kinks, bends, or other defects.

2.2.6 Reinforcing Steel

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NOTE: Minimum cover for reinforcing steel in concrete structures is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling. For normal exposure minimum cover is 50 mm 2 inches. For piles exposed to marine conditions (chloride content above 1000 ppm) in or within about 300 m 1000 feet of the ocean or tidal water, use 75 mm 3 inches minimum cover, including chamfered corners. For additional detailed guidance, see following publications: ACI 543R, "Recommendations for Design, Manufacture and

Installation of Concrete Piles" (ACI Manual, Part 3); State of California, Department of Public Works, Design Specifications, Volume l, Bridge Planning and Design Manual, Chapter 6. Piles to be used in a marine environment may receive a protective coating, particularly if the piles are steam cured. The protective coating should be applied to that portion of pile which remains aboveground or water line. Show areas to be protected on drawings.

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NOTE: Insert grade of reinforcement. Specify ASTM A706/A706M reinforcing where welding or bending of reinforcement bars is important. In addition, ASTM A934/A934M may be specified for epoxy coating of reinforcing where extra reinforcement protection is required.

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[ASTM A615/A615M, Grade [300 MPa] [420 MPa] [40 ksi] [60 ksi];] [ASTM A706/A706M, Grade [420 MPa] [[_____] MPa] [60 ksi] [[_____] ksi];] [ASTM A996/A996M, Grade [420 MPa] [[_____] MPa] [60 ksi] [[_____] ksi]]. Weld reinforcing steel in accordance with AWS D1.4/D1.4M.

2.2.6.1 Spirals and Ties

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NOTE: If project has been designed for epoxy rebar, add ASTM A934/A934M, "Epoxy-Coated Prefabricated Steel Reinforcing Bars" in this paragraph and in the paragraph REFERENCES.

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ASTM A1064/A1064M for steel spirals and ASTM A615/A615M [ASTM A706/A706M] for ties.

2.2.7 Grout

Provide cement grout for prestressed piles using materials conforming to requirements stipulated herein for concrete mixes or for post-tensioned piles, PTI M55.1. Use admixtures, if required, known to have no injurious effects on steel or concrete. Do not use admixtures containing calcium chloride. Grout must have a minimum compressive strength of 48 MPa 7,000 psi in 28 days, as determined by testing 50 mm by 50 mm by 50 mm 2 inch by 2 inch by 2 inch cubes.

2.2.8 Joint Sealing Material

Cover the abutting joint surfaces of precast segments by a sealing material of sufficient thickness to fill all voids between the end surface, except at the core holes for the stressing strands and telltales, when brought together under compression as specified. This sealing material must attain a minimum ultimate compressive strength of 48 MPa 7,000 psi in 28 days, and be as resistant to exposure and weathering as is the concrete.

2.2.9 Epoxy Coating

[EP-3] [_____] conforming to Section [_____], "Epoxy-Resin Systems" of

[_____] DOT RBS. Coat [_____]mm [_____] feet of piles outer surface.

2.2.10 Pressure Grouting Epoxy

2.2.10.1 Crack Sealer for Pressure Grouting

ASTM C881/C881M, Type IV, Grade 1, Class B or C without filler.

2.2.10.2 Crack Surface Sealer for Pressure Grouting

ASTM C881/C881M, Type IV, Grade 3, Class B or C with mineral filler.

[2.2.11 H-Pile Extensions

Use H-pile extensions for composite prestressed concrete-steel piles of steel conforming to the requirements of [ASTM A36/A36M] [ASTM A572/A572M].

][2.2.12 Pile Driving Points

Use pile driving points of steel conforming to the requirements of ASTM A27/A27M or [ASTM A36/A36M] [ASTM A572/A572M], of the [type] [details] indicated.

]2.2.13 Prestressing/Post Tensioning Tendons

ASTM A416/A416M, Grade [1720 MPa] [1860 MPa] [250 ksi] [270 ksi], uncoated, 7 wire, low-relaxation strand or ASTM A886/A886M, Grade [1860 MPa] [[_____] MPa] [270 ksi] [[_____] ksi], indented, 7 wire, low-relaxation strand (including supplement).

2.3 CONCRETE

2.3.1 Concrete Mix Design

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NOTE: Insert the specified compressive strength, f'c. A minimum of 48 MPa 7000 psi is normally specified. Consider reducing average overstrength factor to produce a more economical concrete mix design. ACI 318M ACI 318 may be modified for a specified compressive strength, f'c, over 35 MPa 5000 psi to permit a required average compressive strength, f'cr, of f'c plus 4.8 MPa 700 psi. Concrete may be proportioned in accordance with ACI 214R for the probability of one test in 10 falling below the specified compressive strength, f'c, if the mix design reflects actual concrete plant standard deviations and the resulting production concrete conforms to specified requirements. Do not use lightweight or fiber-reinforced concrete.

****

Provide concrete with a minimum specified compressive strength, f'c, of [_____] [7000] psi at 28 days. The minimum cementitious materials content will be 354 kg per cubic meter 600 pounds per cubic yard of concrete. Prepare the design in accordance with ACI 211.1 and ACI 318M ACI 318. Base the mix design on current materials previously evaluated by the concrete producer whose established methods of statistical quality control is in conformance with ACI 318M ACI 318. In the absence of such data, sample and test the aggregates for the design of concrete. Calcium Nitrite may be added to the mix at a rate of 10 liters per cubic meter 2.0 gallons per cubic yard.

2.3.2 Concrete Mix Design Proportioning

a. Water and cement ratio must be equal to or less than 0.40. If fly ash is used, calculate the water and cement ratio as the weight of water divided by the weight of cement plus 60 percent of the weight of fly ash. If silica fume is used, calculate the water and cement ratio as the weight of water divided by the weight of cement plus the weight of silica fume.

b. Maximum aggregate size must not exceed 19 mm 3/4 inch.

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NOTE: Air-entrainment may be considered optional only in regions that do not experience freezing temperatures.

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c. Air-entrainment will be 4.5 to 7.5 percent. Determine air void structure in accordance with ACI 212.3R. Spacing factor must be less than 2.5 mm 0.01 inch, the specific surface area greater than 0.39 square meter per 0.000016 cubic meter 600 square inches per cubic inch of air void volume, and the number of air voids per mm inch of traverse significantly greater than the numerical value of the percentage of air in the concrete.

2.3.3 Trial Mixtures

Make trial mixtures having proportions and consistencies of the proposed mix design to document ability to produce workable concrete which does not segregate or show excessive slump loss characteristics.

2.4 FABRICATION

Fabrication of the concrete cylinder piles, including storage and handling of materials, batching and mixing of concrete, stressing, sampling, testing and recording must follow the guidelines set forth in PCI MNL-116 "Manual for Quality Control for Plants and Production of Precast and Prestressed Products" or the QA/QC procedure established under the ISO 9002 certification program, unless otherwise noted in the specifications or approved by the Contracting Officer. Test piles must be identical to and manufactured by the same firm as the production piles.

2.4.1 Manufacturing of Piles and Pile Sections

The aggregates, cement and water must be proportioned batched by calibrated device and mixed thoroughly by suitable mixing plant to produce consistent and homogeneous concrete.

Full length, pretensioned concrete piles and post-tensioned pile sections can be manufactured by the centrifugal casting process. If this process is utilized, individual piles and pile sections must be formed and compacted by centrifugal force in a machine of suitable type so designed that the concrete molds may be revolved at speeds sufficient to ensure even distribution and dense packing of concrete without the creation of voids behind reinforcing steel.

Filling the mold and spinning should be continuous and take place before any of the concrete in the mold has taken an initial set. Drain or remove excess water forced to the center prior to curing. Cure the section in the mold until the concrete has attained the indicated strength to prevent deformation or damage during demolding.

Alternatively, concrete cylinder piles can be made by the static cast method. Extruded dry cast method is not allowed for static cast piles.

Manufacturing by the static cast method must utilize rigid steel forms and be vibrated as necessary to ensure that the concrete is consolidated and homogeneous for the entire pile length.

Filling the mold should be continuous and completed for each individual pile before any of the concrete in the mold has taken an initial set. Cure the pile in the mold until the concrete has attained the indicated strength to prevent deformation or damage during demolding. After initial set has occurred, the top form section may be removed to allow finishing of the pour stop along the exterior top face of the pile.

For both fabrication methods, the wall thickness of the pile sections must be as specified on the plans.

2.4.2 Spiral Reinforcing

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NOTE: Minimum cover for reinforcing steel in concrete structures is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling. For normal exposure minimum cover is 50 mm 2 inches. For piles exposed to marine conditions (chloride content above 1000 ppm), use 75 mm 3 inches minimum cover except at corners where 100 mm 4 inches of cover should be provided. In normal and marine conditions, 38 mm 1-1/2 inch cover may be used for post-tensioned, centrifugally cast piles using no-slump concrete, with minimum 9.15 sacks of cement per cubic meter 7 sacks cement per cubic yard. For additional detailed guidance, see following publications: ACI 543R, "Recommendations for Design, Manufacture and Installation of Concrete Piles" (ACI Manual, Part 3); State of California, Department of Public Works, Design Specifications, Volume l, Bridge Planning and Design Manual, Chapter 6. Piles to be used in a marine environment may receive a protective coating, particularly if the piles are steam cured. The protective coating should be applied to that portion of pile which remains aboveground or water line. Show areas to be protected on drawings. A marine environment is defined as in or within about 300 m 1000 feet of the ocean or tidal water.

****

Provide sections with a spiral reinforcement cage, arranged and dimensioned as shown on the contract drawings. This reinforcing cage must be securely held in position during the casting or spinning of the concrete.

Center to center spacing of spiral (defined as spiral pitch) must not exceed six times the spiral wire diameter in the portion of the pile extending from the soffit of the pile cap to a location equal to the point of fixity below mudline as shown on the contract drawings.

The spiral steel reinforcing must be outside the prestress bars and have a minimum concrete cover to the outside surface of the pile section as shown on the contract drawings.[The spiral steel reinforcing must be outside the tendon ducts and have a minimum concrete cover of 38 mm 1-1/2 inches to the outside surface of the pile section.]

2.4.3 Arrangement of Strands

The number, size, and arrangement of the prestressing strands in accordance with the details shown on the contract drawings.

2.4.4 Curing of Piles

Cure piles using moist or accelerated curing. Curing of piles in accordance with the PCI MNL-116 except as follows.

2.4.4.1 Moist Curing

Moist cure using moist burlap coverings, plastic sheeting, or membrane curing compound until minimum strength to detension is achieved.

2.4.4.2 Accelerated Curing

After placement of concrete, moist cure for a period of 4 hours. Accelerated cure until concrete has reached specified release strength. Enclose casting bed for accelerated curing with a suitable enclosure. During application of steam or heat, increase the air temperature at a rate not to exceed 22 C degrees 40 F degrees per hour. Cure at a maximum temperature of 65 degrees C 150 degrees F until concrete has reached specified release strength. Reduce temperature at a rate not to exceed 11 C degrees 20 F degrees per hour until a temperature of 11 C degrees 20 F degrees above ambient air temperature is reached. After accelerated curing, moist cure using either water or membrane curing until a total accelerated and moist curing time of 72 hours is achieved.

2.4.5 Handling

Piles may not be demolded or lifted off from casting beds unless the designed lifting strength or minimum works cube strength of 39.3 MPa 5,700 psi (whichever is greater) has been achieved. Lifting device or crane must be such that no shock or impact is imposed on piles.

Care should be taken at all stages or transporting, lifting and handling to ensure the piles are not damaged or cracked. Piles should be stored on firm stable ground not susceptible to settlement under the weight of piles. Place the piles on strong supports (hard wood) which are truly level and spaced so as to avoid undue bending stress in the piles. The supports should be vertically above one another.

No pile may be driven before the 28-day strength of concrete has been achieved.

2.5 CONCRETE CYLINDER PILE POST-TENSIONED CENTRIFUGALLY CAST (ALTERNATIVE I)

2.5.1 Anchorages and End Fittings

ACI 318MACI 318, for post-tensioned assemblies.

2.5.2 Forms

Provide forms of metal, braced and stiffened against deformation, accurately constructed, watertight, and supported on unyielding casting beds. Forms must permit movement of pile without damage during release of the prestressing force. Make piles to dimensional tolerances in accordance with PCI MNL-116 and as follows:

a. Location of Reinforcing Steel

    (1) Main Reinforcement: 3 to 6 mm 1/8 to 1/4 inch from position designated on drawings.

    (2) Spacing of Spiral: Plus or minus 13 mm 1/2 inch from position designated on drawings exclusive of concrete cover requirements.

b. Location of Pipe Sleeves from True Position: Plus or minus 10 mm 3/8 inch.

2.5.3 Longitudinal Reinforcement

The number, size, and arrangement of the longitudinal post tensioned tendons in accordance with the details shown on the contract drawings.

The main longitude reinforcement must be fitted symmetrically, equally and continuously spread over the whole length without joint or lap. The main longitudinal post tensioned tendons should be level at the top of the pile and should fit tightly into the pile shoe and end plate.

2.5.4 Spin Casting

The spinning of the whole assembly must follow proven spinning procedure that has been used by the manufacturer in the manufacturing of similar pile sections.

2.5.5 Longitudinal Ducts (holes) for Prestressing Tendons

Details and positioning of ducts (holes) in accordance with PCI MNL-116, and as specified herein. Form longitudinal ducts for the prestressing tendons in the walls of the pile sections during casting. The ducts will be 35 mm 1-3/8 inches (nominal diameter) and positioned so that there is a minimum cover of 38 mm 1-1/2 inches from the edge of the ducts to the outside surface of the pile section.

2.5.6 Concrete Strength

****

NOTE: Specify "assembly strength." Assembly strength of 30 MPa 4000 psi for (Design strength) of 50 MPa 7000 psi or 0.7 of the 28-day design strength is desirable; however, some regions use 0.8 of the design strength. Check with local pile manufacturers.

****

The pile sections may not be assembled together into a pile until the compressive strength of the concrete has reached 30 MPa 4,000 psi as determined by cylinders cured in the same manner as the sections.

2.5.7 Alignment of Sections

Position pile sections in accurate alignment so that the axis of the pile does not deviate from a straight line more than 3 mm per 3 m 1/8-inch per 10 feet of length. Position adjacent sections so that the maximum deviation of the outside surface of the joint does not exceed 6 mm 1/4-inch. Where membrane curing is used, remove curing compound from abutting end-surface of sections. Cover the abutting joining surfaces by a joint sealing material of sufficient thickness to fill voids between end surfaces, except at the core holes for the stressing. The pile section must be brought into contact and held together by a force equivalent to not less than 690 kPa 100 psi on the gross concrete area, until the sealing materials has set.

2.5.8 Post Tensioning

Tendons must be tensioned to an allowable unit stress as indicated on the plans. The specified tension will be measured by the gage pressure of the hydraulic stressing jack and verified by the elongation of the steel strand. Provide jack gage calibrated within past 6 months by a laboratory approved by the Contracting Officer. The variation in the actual elongation and the calculated elongation may not be greater than 5 percent. Maintain tension in the tendons by mechanical end-locks or anchors until final stress transfer. Aggregate prestress loss through transfer of stressing force from jack to temporary anchorage may not exceed an average of 10 percent in any one cable or an average of 5 percent for all cables in one pile.

2.5.9 Grouting

After tensioning all tendons, clean each tendon hole and completely fill with grout, including holes not used for tensioning. The pressure of the grout is to be slowly raised to a minimum of 690 kPa 100 psi but not over 1034 kPa 150 psi and held for at least one minute. While the grout is curing, the pile must not be moved or handled in any manner that could damage the pile.

2.5.10 Stress Transfer (Detensioning)

Transfer of the post tension force from temporary end locks to grouted tendons may not be done until the grout has reached a compressive strength of 30 MPa 4,000 psi. Prestressing tendons will be considered to be without slippage from the removal of the end locks when, upon cutting the wires between the end of the pile and the anchor with a burning torch, the wires do not part under stress with a "cup and cone" fracture, but are burned through with the torch. Piles that show evidence of prestressing cable slippage will be rejected.

2.6 CONCRETE CYLINDER PILE PRESTRESSED STATIC CAST (ALTERNATIVE II)

2.6.1 Forms

Use collapsible internal formwork to manufacture piles. Do not use a mandrel to manufacture piles. Provide forms of metal, braced and stiffened against deformation, accurately constructed, watertight, and supported on unyielding casting beds. Forms must permit movement of pile without damage during release of the prestressing force. Make piles to dimensional tolerances in accordance with PCI MNL-116, PCI MNL-135, and as follows:

a. Location of Reinforcing Steel

  (1) Main Reinforcement: 3 to 6 mm 1/8 to 1/4 inch from position designated on drawings.

  (2) Spacing of Spiral: Plus or minus 13 mm 1/2 inch from position designated on drawings exclusive of concrete cover requirements.

b. Location of Pipe Sleeves from True Position: Plus or minus 10 mm 3/8 inch.

2.6.2 Casting

2.6.2.1 Conveying

Convey concrete to formwork in accordance with PCI MNL-116, and as specified herein. Clean conveying equipment thoroughly before each run. During placing, make any free vertical drop of the concrete less than 0.91 m 3 feet. Remove concrete which has segregated in conveying or placing.

2.6.2.2 Placing and Casting

Perform concrete casting within 3 days after pretensioning steel; however, do not deposit concrete in forms until placement of reinforcement and anchorages has been inspected and approved by pile manufacturer's quality control representative. Produce each pile of dense concrete straight with smooth surfaces with reinforcement retained in its proper position during fabrication. Use vibrator with heads smaller than the minimum distance between steel for pretensioning. Make surface of pile ends perpendicular to axis of pile. Chamfer, a minimum of [19 mm] [3/4 inch] [ends of piles].

2.6.3 Pretensioning

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NOTE: Use minimum nominal level of prestress equal to 8.3 MPa 1200 psi in the gross pile section, resulting from the combined prestressing force in the strands after all losses.

****

Perform pretensioning in accordance with PCI MNL-116, and as specified herein. Measure tendon to which steel is to be pretensioned by jack pressure read on a calibrated gage and verify by elongation of steel. Use gage calibrated within last 6 months by a laboratory approved by Contracting Officer. Provide means for measuring elongation of steel to nearest 3 mm 1/8 inch. When difference between results of measurement and gage reading is more than 5 percent, determine cause of discrepancy and correct. Give tensioning steel a uniform prestress prior to being brought to design prestress. Induce same initial prestress in each unit when several units of prestressing steel in a pile are stretched simultaneously.

2.6.4 Stress Transfer (Detensioning)

****

NOTE: Specify "release strength." Release strength of 30 MPa 4000 psi for (Design strength) of 35 MPa 5000 psi or 0.7 of the 28-day design strength is desirable; however, some regions use 0.8 of the design strength. Check with local pile manufacturers.

****

Perform release of prestressed steel in pretensioned piles in such an order that eccentricity of prestress will be minimized. Gradually release tension in strands from anchorage. Detension after approval by pile manufacturer's quality control representative. Perform transfer of prestressing force when concrete has reached a minimum compressive strength of [_____] MPa [_____] psi.

2.7 FABRICATION TOLERANCES

a. Pile ends must be plane surfaces and perpendicular to the longitudinal axis of the pile with a maximum deviation of 6 mm 1/4-inch per 12 inches at the pile head. End surfaces must also be free of spalls. Any end surface which exhibits more than ten percent of the end surface area spalled to a depth of more than 3 mm 1/8 inch will be rejected.

b. Accumulated deviation from straightness measured along two perpendicular faces of the pile, while not subjected to bending (sweep), must not exceed 3 mm per 1 m 1/8-inch per 10 feet of length.

c. Overall lengths of individual piles must be within 0.3 percent of the overall length specified.

d. The outside diameter of piles is defined as the average of two measurements taken along the axes at right angles to each other on cross section. The wall thickness is defined as the average of four measurements taken along pile axes at right angles to each other in a cross section:

Cross Sectional Dimensions	Tolerances
nominal outside diameter	minus 3 mm to plus 6 mm minus 1/8-inch to plus 1/4-inch
wall thickness of hollow section	minus 3 mm to plus 10 mm minus 1/8-inch to plus 3/8-inch

[2.8 PROTECTION FROM FREEZING

For cylinder piles exposed to freezing, provide precast drain holes through pile wall at approximate ground water elevation and fill pile with free-draining material. For piles standing in open water, place a concrete plug from lowest freeze depth to a minimum of 300 mm one foot above maximum high-water level and provide precast drain holes through pile wall just above surface of concrete plug.

]2.9 PRODUCT QUALITY CONTROL

Where piling is manufactured in a plant with an established quality control program as attested to by a current certification in the PCI "Certification Program for Quality Control" or the QA/QC procedure established under the

ISO 9002 certification program, perform product quality control in accordance with PCI MNL-116 or ISO 9002, respectively. Where piling is manufactured by specialists or in plants not currently enrolled in the PCI "Certification Program for Quality Control," or the QA/QC procedure established under the ISO 9002 certification program, set-up a product quality control system in accordance with PCI MNL-116 or ISO 9002 and perform concrete and aggregate quality control testing using an independent commercial testing laboratory approved by the Contracting Officer in accordance with the following.

2.9.1 Aggregate Tests

Take samples of fine and coarse aggregate at concrete batch plant and test. Perform mechanical analysis (one test for each aggregate size) in accordance with ASTM C136/C136M. Tabulate results of tests in accordance with ASTM C33/C33M.

2.9.2 Slump and Strength Tests

Sample concrete in accordance with ASTM C172/C172M at time concrete is deposited for each production line. Perform slump tests in accordance with ASTM C143/C143M. Mold cylinders in accordance with ASTM C31/C31M. Mold at least six cylinders per day or one for every [15] [45] cubic meter [20] [60] cubic yards of concrete placed, whichever is greater. Cure cylinders in same manner as piles and for accelerated curing, place at coolest point in casting bed. Perform strength tests in accordance with ASTM C39/C39M. Test two cylinders of each set at 7 days or 14 days, or at a time for establishing transfer of prestressing force (release strength) and removal of pile from forms. Test remaining cylinders of each set 28 days after molding.

2.9.3 Compressive Strength Test Results

Evaluate compressive strength test results at 28 days in accordance with ACI 214R using a coefficient of variation of 10 percent. Evaluate strength of concrete by averaging test results of each set of standard cylinders tested at 28 days. Not more than 10 percent of individual cylinders tested may have a compressive strength less than specified design strength.

2.9.4 Changes in Proportions

If, after evaluation of strength test results, compressive strength is less than specified compressive strength, make adjustments in proportions and water content and changes in temperature, moisture, and curing procedures as necessary to secure specified strength. Submit changes in mix design to Contracting Officer in writing.

2.9.5 Chloride Ion Concentration

Sampling and determination of water-soluble chloride ion content in accordance with ASTM C1218/C1218M. Maximum water soluble-chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures must not exceed 0.06 percent by weight of cement.

2.9.6 Chloride Ion Penetration

To ensure the durability of concrete in marine environment, concrete must be proportioned to have the chloride ion penetration test in accordance with ASTM C1202, and be below 3,000 coulombs for concrete specimens tested at 60 days.[Alternatively, a ponding test in accordance with AASHTO T 259 may be performed to validate chloride ion penetration in accordance with ASTM C1202.]

[2.9.7 Destructive Pile Testing

At the beginning of production, produce three additional piles with the same length as production piles which will be randomly selected by the Contracting Officer for testing by taking core samples. Take three core samples each location at 2.4 m 8 feet from head and toe and at mid length of the pile or as directed by the Contracting Officer for a total of 9 core samples per pile. Visually inspect each sample for evidence of segregation and distribution of reinforcements. Test all core samples for compressive strength according to ASTM C42/C42M. The average compressive strength of any three consecutively tested samples must not be less than 85 percent of specified 28-day compressive strength of concrete. If any of the above requirements for segregation, distribution of reinforcement and strength are not met, all production piles produced until the date of testing will be subject to rejection.

In addition to the above, saw cut each pile into three equal length sections. Each section will be inspected for specified dimension, strand placement and clear cover tolerances.

]2.10 MATERIAL SUSTAINABILITY CRITERIA

For materials used, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan

b. Recycled content for Ground Iron Blast-Furnace Slag

c. Recycled content for Silica Fume

d. Minimum [75 percent] [_____] recycled content for steel used for stressed tendon reinforcing

2.11 PILE DRIVING EQUIPMENT

Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, hammer cushions, pile cushions, leads, extractors, jetting equipment, and preboring equipment at least 30 days prior to commencement of work. Provide Pile Driving Equipment as mentioned in this section.

2.11.1 Pile Hammers

Provide a hammer capable of developing the indicated ultimate pile capacity at blow count less than 100 per 300 mm foot considering hammer impact velocity; ram weight; stiffness of hammer and pile cushions; cross section, length, and total weight of pile; and character of subsurface material to be encountered.[Use the same pile hammer, operating at the same rate and in the same manner, as that used for driving test piles.] Use wave equation analysis to verify that the hammer will develop stresses within acceptable limits in the piles. At final driving, operate pile hammer in accordance with manufacturer's recommendation. Provide the plant and equipment for air hammers that have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The hose connecting the compressor with the hammer must be at least the minimum size recommended by the Manufacturer. Evaluate hammer performance at the end of driving by measuring blows per minute and comparing with the manufacturer's recommendations. Measure impact velocity of open-end (single acting) diesel hammers at all times during pile driving operations with a device for this purpose. If such a device is not available, obtain the stroke by measuring the speed of operation either manually or with a device that makes the measurement automatically. Equip closed-end (double acting) diesel hammers with a bounce chamber pressure gauge in good working order, mounted near ground level so as to be easily read by the Contracting Officer. Provide a correlation chart of bounce chamber pressure and potential energy. Equip hydraulic hammers with a system for measurement of ram energy. The system must be in good working order and the results easily and immediately available to the Engineer.

2.11.2 Driving Helmets and Cushion Blocks

2.11.2.1 Driving Helmets or Caps and Pile Cushions

Use a steel driving helmet or cap including a pile cushion between top of pile and driving helmet or cap to prevent impact damage to pile. Use a driving helmet or cap and pile cushion combination capable of protecting pile head, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over top of pile. Provide driving helmet or cap that fits sufficiently loose around top of pile so that pile may be free to rotate without binding within driving helmet.[During test pile installation, demonstrate to satisfaction of Contracting Officer that equipment to be used on project performs specified function.] Use pile cushion of solid wood or of laminated construction using plywood, softwood or hardwood boards with grain parallel to end of pile. Select the pile cushion thickness placed on the pile head prior to driving by wave equation analysis so that the limiting driving stresses are not exceeded. Replace pile cushion at the start of driving of each pile and when it becomes highly compressed, charred or burned, or has become spongy or deteriorated in any manner. Show details of driving helmets, capblocks (hammer cushions), and pile cushions. Submit 2 weeks prior to [test] pile installation.

2.11.2.2 Hammer Cushion or Capblock

****

NOTE: Select either wood or aluminum/micarta capblock. Delete inappropriate sentences. An aluminum/micarta capblock is recommended because of its consistent elastic properties and long life. If final pile penetration resistance is based on a Wave Equation analysis, the type of capblock used should be the same as that used in the analysis.

****

Use a hammer cushion or capblock between driving helmet or cap and hammer ram consisting of[a solid hardwood block with grain parallel to the pile axis and enclosed in a close-fitting steel housing][aluminum and micarta (or equal) discs stacked alternately in a steel housing or a suitable polymer designed for this specific purpose as indicated by the hammer manufacturer]. Use steel plates at top and bottom of capblock (hammer cushion).[Replace wood capblock (hammer cushion) when it becomes highly compressed, charred or burned or becomes spongy or deteriorated in any manner].[Replace aluminum, micarta or polymer discs that have become damaged, split or deteriorated in any manner.][Do not replace wood capblock (hammer cushion) during final driving of any pile.] Do not use small wood blocks, wood chips, rope or other materials that permit excessive loss of hammer energy.

PART 3 EXECUTION

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NOTE: In some cases, cylinder piles may be advanced using using a collapsible auger inside the pile and washing the pile section down. In other cases, large diameter piles have been assembled by stacking precast rings and post tensioning them together.

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3.1 PRELIMINARY WORK

3.1.1 Wave Equation Analysis of Pile Drivability

a. Prior to driving any pile, submit a pile Wave Equation Analysis, performed by Contractor's Geotechnical Consultant, for each size pile and distinct subsurface profile condition. These analyses must take into account the proposed hammer assembly, pile cap block and cushion characteristics, the pile properties and estimated lengths and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity.

b. Demonstrate using the Wave Equation Analysis that the piles will not be damaged during driving, indicate that the driving stresses will be maintained within the limits below and indicate the blow count necessary to achieve the required ultimate static pile capacities.

Allowable Driving Stresses	
Concrete	
Compression	0.85f'c minus UPL
Tension	(3 times (the square root of f'c)) plus UPL
f'c is compressive strength of concrete UPL = Unit Prestress after Losses (Obtain values from pile manufacturer)	

c. Perform a refined Wave Equation Analysis upon completion of the dynamic and static testing programs outlined in this specification section, taking into consideration the evaluated capacities, gain/loss factors and recommended production pile lengths.[Develop production pile driving criteria based on the results of the refined Wave Equation Evaluations.]

d. All pile driving equipment provided by the Contractor will be subject to the approval of the Contractor's Geotechnical Consultant. Complete the attached pile and driving equipment data form, including hammer information, in full as part of the submittal of the results of the

Wave Equation Analyses.

e. Pay for the cost of performing the Wave Equation Analyses and include in the base bid.

3.1.2 Pile Length Markings

Mark each pile prior to driving with horizontal lines at 305 mm one foot intervals. Mark the interval number on pile every 1.52 m 5 feet from pile tip.

3.2 PILE DRIVING

3.2.1 Driving Piles

****

NOTE: Delete bracketed option for foundation excavation when not required. Delete items in brackets dealing with tip elevation and driving resistance when test piles or load tests are not used. Delete item in brackets regarding predrilling or jetting when procedure is not used. If needed, insert maximum hammer energy for no tip resistance. This can be determined by comparing tensile stresses in pile resulting from a Wave Equation Analysis with effective prestress in pile.

****

Notify Contracting Officer 10 days prior to driving of [test]piles[and load test].[Stop foundation excavation at 300 mm one foot above foundation grade before piles are driven. Do not drive piles within 30 meter 100 feet of concrete less than 7 days old. Complete excavation to lines and grades shown when pile driving is completed.] Piles may be driven when the specified 28-day concrete strength has been achieved but not less than 7 days after casting.[The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analysis].] Drive piles to [the terminal driving criteria] [or below "calculated"] [indicated tip elevation] [to reach a driving resistance established by the [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analyses (WEAP)] in accordance with the schedule which the [Contractor's Geotechnical Consultant] [Contracting Officer] will prepare from the test-pile driving data]. During initial driving and until pile tip has penetrated beyond layers of very soft soil [or below bottom of predrilled or prejetted holes], use a reduced driving energy of the hammer as required to prevent pile damage. Refusal criteria will be established by the Contracting Officer. If a pile fails to reach ["calculated"] [indicated] tip elevation, [or if a pile reaches ["calculated"] tip elevation without reaching required driving resistance,] notify Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB. Do not handle or move piles or pile sections in any manner that would result in cracking or permanent damage to the concrete or to the grout surrounding the prestressing cables. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

3.2.2 Protection of Piles

****
NOTE: Delete references to batter piles when not applicable to the project.
****

Take care to avoid damage to piles during handling, placing pile in leads, and during pile driving operations. Support piles laterally during driving, but allow rotation in leads.[Where pile or projecting reinforcement orientation is essential, take precautionary measures to maintain the orientation during driving.][Take special care in supporting battered piles to prevent excessive bending stresses in pile.] Square top of pile to longitudinal axis of pile. Maintain axial alignment of pile hammer with that of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through the reinforcement, by using a special driving head.

3.2.3 Pile Placement and Tolerances in Driving

****
NOTE: Omit references to batter piles when not applicable to the project. Select appropriate tolerances for type of pile. Use more stringent criteria as necessary based on the application. Confirm with the structural engineer.
****

Submit pile placement plans at least 30 days prior to delivery of piles to the job site. Drive piles with a variation of not more than 2 percent from vertical for plumb piles or more than 4 percent from required angle for batter piles. Maintain and check axial alignment of pile and leads at all times. If subsurface conditions cause pile drifting beyond allowable axial alignment tolerance, notify Contracting Officer and perform corrective measures as directed. Place butts within 100 mm 4 inches of location indicated.[Manipulation of piles within specified tolerances[will not be permitted.][will be permitted, to a maximum of 1-1/2-percent of their exposed length above ground surface or mudline.]] In addition to specified tolerances, maintain a location to provide a clear distance of at least 125 mm 5 inches from butt to edge of pile cap. If clear distance can not be maintained, then notify Contracting Officer. Check each pile for heave. Redrive heaved piles to required point elevation.

3.2.4 Rejected Piles

Withdraw piles damaged or impaired for use during handling or driving, mislocated, or driven out of alignment beyond the maximum tolerance. Replace with new piles or cut-off and abandon damaged or impaired piles and drive new piles as directed. Remove excess cut-off from piles and unacceptable piles from the work site. Perform all work in connection with withdrawing and removing rejected piles from the site at no additional cost to the Government.

3.2.5 Jetting of Piles

****
NOTE: Jetting should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Adjacent to existing structures.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Water jets will[not] be permitted.[Use jetting to assist driving piles through strata that cannot be penetrated practicably by use of the hammer alone.[Restrict driving to a static weight while water is being injected to prevent inducing tensile stresses in the piles which damage the concrete.] Discontinue jetting and resume hammer driving after the penetration of the strata requiring jetting has been accomplished.][Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated][indicated]pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.][Take adequate measures for collecting and disposing of runoff water.][Jetting method and equipment will be approved by the Contracting Officer prior to commencing jetting operation.] Before starting final driving, firmly seat piles in place by application of a number of reduced energy hammer blows.[Employ measures, including use of a silt curtain, to contain turbid water created by jetting piles.]

3.2.6 Predrilling of Piles

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven[will [not] be permitted][will be provided].[The diameter of the hole must not exceed two-thirds the width of the pile.][Predrill only to a depth of [_____] meters feet below cut-off elevation prior to setting piles.][Discontinue drilling when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.]

3.2.7 Pile Splices

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NOTE: Splicing of piles normally should not be permitted except where extremely long or heavy piles are required. If splices are permitted, drawings should indicate splice details. (See PCI standard drawings for typical splice details).

****

[Splicing of piles is not permitted.] [Make splices as indicated. Splices must be capable of developing the full strength of the member in compression, tension, shear, and bending. Submit detail drawings of splices and design calculations demonstrating the strength of the splice for approval Submit information for shop and field pile splices prior to fabrication.]

3.2.8 Build-Ups

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NOTE: Insert compressive strength required by design, usually a minimum of 35 MPa 5,000 psi. Insert maximum percent of build-ups permitted for project. The percent will depend on criticality of pile failure at build-up; whether the top of the pile is designed as a moment connection; exposure of piles to external physical or corrosive damage. Normally, for piles supporting piers exposed to seawater, limit percentage of build-ups to 10 percent.

****

Where required, pile section may be extended to cut-off elevation by means of a cast-in-place reinforced concrete build-up. Make build-up in accordance with PCI BDM. Construct build-ups made after completion of driving in accordance with detail, "Build-Up Without Driving." Make build-ups to be driven in accordance with detail "Build-Up With Driving." Have details of means for protecting joints by a suitable mortar or epoxy approved by Contracting Officer. Where build-ups are exposed to water, protect cast-in-place section from water during curing period. Concrete in build-up must have a minimum compressive strength of [_____] MPa psi. Build-ups will not be permitted on more than [_____] percent of total number of piles. If this percent figure is exceeded, or if in the judgment of the Contracting Officer, the clustered location of build-ups is undesirable, withdraw piles of insufficient length and replace with longer piles. Payment for such withdrawal and replacement will be made as an adjustment to the contract price.

3.2.9 Pile Cut-Off

Cut-off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods approved by Contracting Officer. Use of explosives for cutting is not permitted. Remove cut-off sections of piles from the site and off government property upon completion of the work.

3.2.10 As-Driven Survey

After the driving of each pile group is complete and before concrete is placed, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a licensed land surveyor.

3.2.11 Protection of Existing Structures

****

NOTE: Include this paragraph only when protection of existing structures from pile driving activities is required.

Indicate on the drawings all structures and facilities for which protection is required. Also provide a project specific document that details

design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.

****

Mitigate impact on existing facilities due to pile driving activities in accordance with the [project specific document] [_____].

3.2.12 Pile Shoe

Submit details about pile shoe used,if any. Where indicated or directed, securely attach pile shoes of an approved design to the piles in a manner described in the detail drawings.

3.3 FIELD QUALITY CONTROL

3.3.1 Test Piles

****

NOTE: Select the second bracketed option when soil conditions dictate the use of a test pile longer than production piles. The ordered pile length for test piles should be 1.5 m 5 feet longer than ordered length for production piles to allow additional penetration if driving conditions dictate. Indicate location and number (if required) of test piles on plans, or list appropriate soil boring test hole numbers.

****

[Use test piles of type, and drive as specified for piling elsewhere in this section.][Order test piles [_____] meters feet longer in length than production piles. Drive the additional test pile length only at the direction of the Contracting Officer.] The [Contractor's Geotechnical Consultant] [Contracting Officer] will use test pile data to determine "calculated" pile tip elevation or necessary driving criteria. Drive test piles [at the locations indicated] [in vicinity of soil boring test holes Nos. [_____], [_____], and [_____]]. Drive test piles to [indicated tip elevation] [indicated bidding lengths] [required driving criteria]. Use test piles, if located properly and offering adequate driving resistance in finished work.[Pre-drilling or jetting is permitted only when test piles clearly establish validity of its use, or as directed by the Contracting Officer.][Provide and operate a pile driving analyzer as specified in paragraph DYNAMIC PILE ANALYSIS during the driving of each test pile. Modify driving as required based upon recommendation of [Contracting Officer] [Contractor's Geotechnical Consultant and approval of the Contracting Officer].]

3.3.1.1 Dynamic Pile Analysis

Submit a performance report summarizing dynamic test results for [test] piles within [7] [_____] calendar days of completing field work.[For production piles, submit a performance report within one day of testing. Submit a typed report summarizing the results of dynamic testing of production piles on a monthly basis.]

Dynamic testing provides supplemental information for evaluating pile integrity, hammer and drive system performance, assess pile installation driving stresses, and pile capacities. Perform dynamic testing on [_____] percent of the [test] piles during the full length of the pile driving and during restrike a minimum of [_____] days after initial driving. Dynamic pile testing may also be performed on [_____] production piles as chosen by the Contracting Officer. Use [test] piles of type as specified elsewhere in this section. Provide equipment to obtain dynamic measurements, record, reduce and display its data that meet the requirements of ASTM D4945. The equipment must have been calibrated within [6] [_____] months prior to the start of the testing operations and thereafter throughout the contract duration. Drive [test] piles at the locations indicated or at the locations selected by the Contracting Officer. Employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile driving process[, monitoring of test pile installation,] and in the use of the Pile Driving Analyzer and its related equipment. Perform dynamic pile analysis as follows:

3.3.1.2 Pile Analyzing

[_____] working days prior to driving the [test] piles, submit the pile and complete driving equipment data to the Contracting Officer. The Contractor's Geotechnical Consultant must use the submitted information to perform wave equation analyses and prepare a summary report of the wave equation results. The wave equation analysis using GRLWEAP software by Pile Dynamics, Inc. or equivalent must be used to assess the ability of the proposed driving system to install the pile to the required capacity and desired penetration depth within the allowable driving stresses. Approval of the proposed driving system by the Contracting Officer will be based upon the wave equation analyses indicating that the proposed driving system can develop a pile capacity of [_____] kN kips at a driving resistance not greater than [_____] blows per mm blows per inch within allowable driving stress limits. The hammer must also be sized or adjustable such that the penetration per blow at the required ultimate capacity does not exceed 12 mm 0.5 inches.

3.3.1.3 Pile Drivability

Perform each dynamic pile analysis in two steps. The first step is to check the hammer, pile and soil performance, and to determine the suitability of the proposed hammer for the size, length and type of pile being installed for the soil types encountered as the piles are driven. This initial monitoring will determine whether pre-augering or jetting is appropriate, efficiency of the hammer relative to specified efficiency, effectiveness of cushion, level of compressive and tensile stress in pile and extent/location of any pile damage caused by the initial driving. With each blow of the pile, record the information listed below electronically and analyze the information using the Pile Driving Analyzer:

a. Blow number

b. Blow rate per minute and stroke.

c. Input and reflected values of force and velocity.

d. Value of upward and downward traveling force wave with time.

e. Maximum and final transferred energy to pile, hammer system efficiency.

f. Maximum compressive stress, velocity, acceleration and displacement.

g. Maximum tensile stress in pile.

h. Pile structural integrity, damage detection, extent and location.

i. Bearing capacity of pile by Case method.

If the pile, hammer and soil performance evaluation recommends changes to the hammer stroke, pile cushioning, augering or any other aspect for the pile driving operation, incorporate these changes into production pile driving in an effort to control excessive stresses and pile damage. Replace test piles damaged or broken during installation, incorporating driving modifications as determined by the Contractor's Geotechnical Consultant and reviewed and approved by the Contracting Officer. Repeat this procedure until allowable tensile and compressive stresses are achieved in the pile and pile damage is minimized. Subject selected initial driving records to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and estimation of anticipated gain/loss factors.

3.3.1.4 CAPWAP

Signal matching analysis by CAPWAP software of the dynamic pile testing data will be performed on data obtained from the end of initial driving and the beginning of restrike of all control piles. CAPWAP analyses must be performed by an engineer who has achieved Advanced Level or better on the PDI / PDCA Dynamic Measurement and Analysis Proficiency Test for Providers of PDA Testing Services.

Upon completion of [test] pile driving, allow the piles to set-up for at least [72 hours] [_____ days]. After evaluation of pile, hammer and soil performance by the Contractor's Geotechnical Consultant, the second step of the dynamic pile analysis may proceed. This portion of the evaluation requires striking the set-up piles a minimum of 20-50 times, or as directed by the Contractor's Geotechnical Consultant using the same hammer which was used for the [test] pile driving and which will be used for production pile driving. "Warm up" the hammer and make it optimally ready prior to restriking, in order to avoid capacity losses during evaluation of restrike data. Apply maximum hammer energy during restrike in order to fully mobilize the soil resistance. However, exercise care so as to not overstress the pile. In addition to those items listed above, selected restrike driving records (as directed by the Contractor's Geotechnical Consultant) are to be subjected to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and plot of applied load vs. average pile displacement based on the calculated soil properties.

3.3.1.5 Dynamic Load Test Reporting

a. Upon satisfactory completion of each dynamic load test, submit[a minimum of three copies of] a Pile Performance Report for the Contractor by the Contractor's Geotechnical Consultant. The submittal must be prepared and sealed by a Professional Engineer registered in [_____].

b. The report for the Dynamic Pile Analysis must contain the following information:

(1) Capacity of pile from Case Pile Wave Analysis Program (CAPWAP). Information resulting from analysis of a selected restrike blow.

(2) Maximum and final transferred energy, hammer system efficiency during pile installation.

(3) Maximum compressive stress, velocity, acceleration and displacement.

(4) Maximum tensile stress in pile.

(5) Pile structural integrity, damage detection, extent and location.

(6) Blows per minute and blow number.

(7) Input and reflection values of force and velocity, upward and downward traveling force wave with time.

(8) Pile skin friction and toe resistance distribution.

(9) Maximum energy transferred to pile.

c. The maximum allowable pile design load must be proposed by the Contractor's Geotechnical Consultant based upon the results of a satisfactory pile load test conducted on a pile driven as specified herein and include the effects of load transfer to the soil above the foundation stratum.

Use either a model Model 8G or PAX Pile Driving Analyzer as manufactured by Pile Dynamics, Inc., of Cleveland Ohio or approved equivalent, for dynamic testing of the pile hammer and for dynamic load testing of the test pile. All equipment necessary for the dynamic monitoring such as sensors, cables or wireless transmitters, must be furnished by the Contractor's Geotechnical Consultant, and conforming to the requirements of ASTM D4945.

Pay for all services of the Contractor's Geotechnical Consultant. The Contractor's Geotechnical Consultant must be available throughout the pile driving operation to consult with the Contracting Officer when required by the Contracting Officer. The cost of changes in the Contractor's procedure, as required by evaluation of the results of the Pile Driving Analysis, will be at the Contractor's expense.

3.3.2 Load Tests

3.3.2.1 Static Load Tests

****

NOTE: If pile load tests are required and approved by the Contracting Officer, specify number and location of piles. Select method of load test. In ASTM D1143/D1143M, permit anchor piles only if approved by the Contracting Officer's Technical Representative (Geotechnical Branch). Insert figure kips kN corresponding to 200 percent of the design load. Select appropriate acceptance criteria. The offset method (first option) is usually recommended.

****

Submit test set-up and procedures. Perform compressive load tests on [_____] test piles in accordance with ASTM D1143/D1143M (standard loading procedure) as modified herein.[Allow a minimum of [72 hours] [_____ days] following final test pile driving for pile set-up prior to load testing.][Do not use anchor piles.] Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform[or reaction frame attached to sufficient uplift piles to safely take required load] applied to pile by hydraulic jack. Increase load in increments until rapid progressive settlement takes place or until application of total compressive load of [_____] KN kips for compressive load tests. Consider load test satisfactory when[after one hour at full test load gross settlement of pile butt is not greater than gross elastic pile compression plus 4 mm 0.15 inch plus one percent of pile tip diameter or width in [_____] mm inches,][slope of gross load-settlement curve under full test load does not exceed 1.5 mm per metric ton 0.05 inches per ton,][net settlement after removal of test load does not exceed 19 mm 3/4 inch.] Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.[Submit test pile records][and][load test data] within seven calendar days of conducting the test.

[3.3.2.1.1 Safe Design Capacity

Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.

]3.3.2.2 Tensile Load Tests

Perform tensile load tests on [_____] test piles in accordance with ASTM D3689, as modified[and]in paragraph LOAD TESTS. Apply a tensile load of [_____] kN kips to each tensile load test pile. In performing the tension load test, apply the ultimate load equal to one and one-half times the safe tension capacity, and employ the Standard Loading Procedure.

Perform dynamic measurements on [_____] piles designated as dynamic test piles in accordance with ASTM D4945 during driving. During easy driving, ensure that damaging tension stresses do not develop in the pile. Signal matching will be performed by the Contractor's Geotechnical Consultant on representative data collected at the end of the initial driving and at the beginning of all restrike events. Additional signal matching analysis will be performed as determined by the Engineer.

3.3.2.3 Lateral Load Tests

Perform lateral load tests on [_____] piles in accordance with ASTM D3966/D3966M, as modified[and]in paragraph LOAD TESTS. Lateral load tests will consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. Apply a lateral load of [_____] kN kips to each pair of lateral load test piles. Record required movement readings for each pile.

3.3.3 Pile Records

Submit pile[and test pile] records.[Submit load test data and results.]

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations, [batter alignment,]number of blows required for each 300 mm foot of penetration and number of blows for the last 150 mm 6 inches penetration or fraction thereof [as required]for the "calculated" [driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, splicing, obstructions, [jetting,]and any driving interruptions.[Install an energy monitor on the hammers and record readings every 300 mm 12 inches of pile installation.] A preprinted pile driving log for recording pile driving data[and pile driving equipment data form], which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

[3.3.4 Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated. Submit testing agency qualifications to the Contracting Officer for approval.

][3.4 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-310-04, "Seismic Design for Buildings".

Indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

][3.5 VIBRATION CONTROL

****

NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project.

****

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs][and geophones] within a distance of [61] [_____] meters [200] [_____] feet from the pile driving activity.[Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [5] [_____] years of experience in vibration monitoring. A minimum of [28] [_____] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient vibrations. The vibration during the pile driving activities must be limited to [a peak particle velocity of not more than [5] [_____] cm [2.0] [_____] inches per second] [the limits mentioned in the [contract documents]].[Determine appropriate vibration limits as per [US Bureau of Mines] [American Association of State Highway and Transportation Officials (AASHTO)] guidelines.] During pile driving activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity causing the vibration until [the Vibration consultant and the Contracting Officer] [_____] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor is responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.6 NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the pile driving operations.[Perform noise monitoring using [noise meters][, and] [_____]].[Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [5] [_____] years of experience in noise monitoring. A minimum of [28] [_____] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient noise levels.[The noise limits are mentioned in the [plan] [contract documents].][Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines.] During pile driving activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity and install noise mitigation measures.

The Contractor is responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.7 PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform preconstruction condition survey of [structures][and utilities] [within [61] [_____] meters [200] [_____] feet of the pile driving activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] [_____] days before performing the preconstruction condition survey. Obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey will include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] [_____] days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

][3.8 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile driving activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement[and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile driving. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile driving when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile driving activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare an Instrumentation and Monitoring Program Report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 62 13.26 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-31 62 13.26 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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PRESSURE-INJECTED FOOTINGS

11/20, CHG 2: 02/24

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-31 62 13.26 (November 2020)**

Change 2 - 02/24

Preparing Activity: NAVFAC **Superseding**

UFGS-31 62 13.26 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 31 62 13.26

PRESSURE-INJECTED FOOTINGS

11/20, CHG 2: 02/24

****

NOTE: This guide specification covers the requirements for the installation, testing, and forming of enlarged concrete footings and cylindrical shafts by ramming the concrete into place under a specific energy of impact.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Show the following information on the project drawings:

1. Plan of Pressure Injected Footings (PIF) (singles and clusters) and cluster configurations

2. Batter PIF angle

3. Design loads

4. Location of test PIF, unless option to allow direction by Contracting Officer is selected.

****

PART 1   GENERAL

1.1   DESCRIPTION

Design, furnish, install, and test pressure injected footings (PIF) at the locations indicated on the drawings and as specified herein. Assume test location[s] can be incorporated into the work.

1.2   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.3R	(2016) Guide for Selecting Proportions for No-Slump Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates

	for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

[1.3 SUBSURFACE DATA

Subsurface soil data logs are[indicated][appended to the special contract requirements][provided on the project drawings].[The subsoil investigation report may be examined at [_____].]

]1.4 BASIS OF BID

****

NOTE: Select one of the following options:

Use "Lump Sum" paragraph below for lump (principal) sum bidding of PIF. Use this in all projects except those where exact PIF lengths cannot be practically determined prior to the actual work. Clearly show number of PIF, PIF capacity, PIF locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of PIF. Specify unit price bid items for PIF only for projects where exact quantities cannot be practically determined prior to the actual work. Determine lengths of PIF as accurately as possible, prior to bidding, since the unit price per meter (foot) of the PIF varies as the length increases or decreases.

****

1.4.1 Production Acceptance Criteria

Safe design bearing capacity for PIF is [_____] KN [_____] kips. Install PIFs to[minimum tip elevation][a minimum depth of [_____] m [_____] feet below foundation level], and to such additional depth as required to obtain a bearing capacity of not less than [_____] KN [_____] kips. The Contractor's Geotechnical Consultant will determine the terminal driving criteria[based on results of static load tests].

****

NOTE: PIF bearing capacity must be computed per formula. In absence of a load test, use K-value from table below: (K-values and Bearing Capacity

Formula from "Dynamic Formula for PIF" by Reymond L. Norlund, Proceedings of the American Society of Civil Engineers, Vol. 108, March 1982.)

Recommended K-Values		
Recommended K with Compacted Soil Description	**Recommended K Concrete Shaft**	**With Cased Shafts**
Gravel	**9**	**12**
Medium to Coarse Sand	**11**	**14**
Fine to Medium Sand	**14**	**18**
Coarse Sand	**18**	**23**
Medium Sand	**22**	**28**
Fine Sand	**27**	**35**
Very Fine Sand	**32**	**40**
Silty Medium to Coarse Sand	**14**	**18**
Silty Fine to Medium Sand	**17**	**22**
Silty Fine Sand	**24**	**30**
Residual Soil Common to Southeast U.S.	**600 divided by N (but K less than 18)**	**1800 divided by N (but K less than 50)**
Fine Sand with "Limerock" Fragments and/or Shells	**18**	**25**
Glacial Till, Granular Matrix	**20**	**27**
Glacial Till, Clay Matrix	**30**	**40**
N = number of blows from Standard Penetration Test		

****

Determine safe bearing capacity by ramming zero-slump concrete, in batches of 0.14 cubic meter 5 cubic feet, into granular soil stratum by drop hammer in accordance with the following formula:

$$L = \frac{B \times W \times H \times V^{(2/3)}}{K}$$

where

L = Safe bearing capacity of PIF in metric tons (tons)

B = Average number of blows of hammer required to inject one cubic meter one cubic foot of concrete in expanded base, during injection of the last batch

W = Weight of drop hammer in metric tons tons

H = Height of fall of drop hammer in meters feet

V = Total volume of concrete in expanded base measured in cubic meters cubic feet, and

K = [Constant determined from the load test] [_____]

[1.4.2 Lump Sum Payment

****

NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection.

****

Base bids upon providing the number, size, capacity, and length of PIF as indicated on the [drawings.] [following Table I:

Table 1

[Location]	Number	Size	[Bearing Capacity]	Length	[Maximum Bending Moment]	[Maximum Shear Force]

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: install, test, and meet the applicable contract requirements. Include mobilization and pre-drilling. If it is found that any PIF is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of PIF to be provided and installed by changing the PIF locations or elevations, requiring the installation of additional PIF, or directing the omission of PIF from the requirements shown and specified. If total number of PIF or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for PIF will be based on successfully installing PIF to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: rejected PIF or other excesses beyond the assumed PIF length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys.]

]1.4.3 Unit Price

****

NOTE: Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for PIF, use this paragraph and edit applicable attachments in price schedule for

inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

For NAVFAC Southeast projects, where there is a need for unit pricing of PIF, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items.

****

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****

NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.

****

Requirements of FAR 52.211-18 Variation in Estimated Quantity do not apply to payment for PIF. Each PIF and test PIF acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and driving the PIF including mobilization and demobilization, and[jetting][predrilling]. Payment will be made for production[and test PIF] at the bid unit price for the length of PIF, from tip to final cut-off, actually provided, excluding buildups directed by the Contracting Officer to be made. If the actual cumulative PIF length driven (tip to cut-off) vary more than 25 percent from the total PIF length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of FAR 52.236-2 Differing Site Conditions.[Payments will be made per each at the respective bid unit price for PIF build-ups and loads tests.][Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys].

1.5 PAYMENT

****

NOTE: Delete this paragraph for lump-sum contracts.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****

1.5.1 Mobilization and Demobilization

1.5.1.1 Payment

Payment will be made for costs associated with mobilization and demobilization as a separate single lump sum item.

1.5.1.2 Measurement

Lump sum.

1.5.1.3 Unit of Measure

Lump sum.

1.5.2 Installing PIF

1.5.2.1 Payment

Payment will be made for costs associated with installing PIF, which includes costs of installing PIFs and removing excess waste from the work site, compiling and submitting PIF records, and any other items incidental to installing PIF to the required elevation.

1.5.2.2 Unit of Measure

Linear meter.Foot.

[1.5.3 PIF Static Axial Compressive Load Tests

1.5.3.1 Payment

Payment will be made for costs associated with PIF static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting load test reports. No payment will be made for rejected static axial compressive load tests.

1.5.3.2 Measurement

PIF static axial compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.5.3.3 Unit of Measure

Each.

][1.5.4 PIF Static Tensile Load Tests

1.5.4.1 Payment

Payment will be made for costs associated with PIF static tensile load tests in accordance with ASTM D3689, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting load test reports. No payment will be made for rejected static tensile load tests.

1.5.4.2 Measurement

PIF tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load test.

1.5.4.3   Unit of Measure

Each.

][1.5.5   PIF Lateral Load Tests

1.5.5.1   Payment

Payment will be made for costs associated with PIF lateral load tests in accordance with ASTM D3966/D3966M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing inclinometers; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting load test reports. No payment will be made for rejected lateral load tests.

1.5.5.2   Measurement

PIF lateral load tests will be measured for payment on the basis of the applicable contract unit price per lateral load test.

1.5.5.3   Unit of Measure

Each.

][1.5.6   Vibration Monitoring

1.5.6.1   Payment

Payment will be made for costs associated with vibration monitoring.

1.5.6.2   Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.6.3   Unit of Measure

Each.

][1.5.7   Sound Monitoring

1.5.7.1   Payment

Payment will be made for costs associated with sound monitoring.

1.5.7.2   Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.7.3   Unit of Measure

Each.

][1.5.8 Preconstruction Condition Survey

1.5.8.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.5.8.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.5.8.3 Unit of Measure

Each.

][1.5.9 Construction Instrumentation and Monitoring

1.5.9.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.5.9.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.5.9.3 Unit of Measure

One.

]1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Designer and Installer's Qualifications; G, [_____]

Testing Agency Qualifications; G, [_____]

Contractor's Geotechnical Consultant Documentation

SD-02 Shop Drawings

Steel-Shell Shaft Casings

Reinforcement

Dowels

Fabricated Additions and Modifications to Pressure-Injected Footings (PIF)

As-Driven Survey; G, [_____]

Load Tests; G, [_____]

SD-05 Design Data

****

NOTE: Calculations, mix designs, analyses or other data pertaining to a part of work.

****

Concrete Mix Design; G, [_____]

Design Calculations; G, [_____]

SD-06 Test Reports

Aggregates; G, [_____]

Concrete Compressive Strength; G, [_____]

Load Tests; G, [_____]

Fine Aggregate

SD-07 Certificates

PIF Installation Equipment

Load Test Apparatus

SD-11 Closeout Submittals

PIF Records

1.7 QUALITY CONTROL

1.7.1 PIF Records

Pressure-injected footings (PIF) consist of an expanded base of concrete, formed by ramming concrete into place, and a [cased][uncased][reinforced]concrete shaft to transmit the superstructure load to the expanded base.

1.7.2 PIF Installation Equipment

Submit descriptions of proposed PIF installation equipment before commencing work. Include details of the rig, hammer type, and available energy.

1.7.3 Load Test Apparatus

****

NOTE: Delete this paragraph if load testing is not required.

****

Submit equipment description lists or catalog cuts and a brief description of the load test procedure, including maximum load and modifications in accordance with the procedure required by ASTM D1143/D1143M before commencing tests.

[1.7.4 Contractor's Geotechnical Consultant Documentation

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics to observe test PIF installation and production PIF installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and have no employee or employer relationship which could constitute a conflict of interest.

]1.8 QUALIFICATIONS

Installation of PIF must be performed by a specialty Contractor experienced and competent in the installation of PIF as specified herein. Submit evidence that the contractor has had similar type projects. The projects must demonstrate proficiency of the designer as applicable to the intent of the project. The Designer must be a Professional Engineer registered in the state where the project is located.

Submit Designer and Installer's Qualifications at least 30 calendar days prior to installation.

[1.9 DESIGN CALCULATIONS

Submit two sets of detailed design calculations for approval at least 30 calendar days prior to the beginning of construction. Include a detailed explanation of the design parameters for the calculations . Additionally, submit the quality control test program confirming the design requirements. All calculations and drawings must be prepared and sealed by a Professional Engineer in the State in which the project is constructed.

]PART 2 PRODUCTS

2.1 CONCRETE

****

NOTE: Insert the correlated section number and title or include concrete specification in this section in the blank below in the correct format per UFC 1-300-02.

****

Provide as specified in [_____] except as specified otherwise herein, for minimum 28-day concrete compressive strength of [_____] MPa pounds per square inch, using 19 mm 3/4 inch maximum coarse aggregate. Concrete for base [and for uncased shaft]must have minimum 3-day compressive strength of [_____] MPa pounds per square inch.[Cased shaft must have minimum 3-day compressive strength of [_____] MPa pounds per square inch.] The expanded base must be made of zero-slump concrete. Use[zero-slump concrete for uncased shaft][75 mm 3 inch slump concrete for cased or uncased shaft][100 to 150 mm 4 to 6 inch slump concrete for cased shaft]. Develop zero-slump concrete by reducing water in regular-mix concrete in accordance with ACI 211.3R. Submit concrete mix design for approval at least 30 calendar days prior to installation.

2.1.1 Portland Cement

Conform to ASTM C150/C150M and Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.2 Water

Fresh, clean, and free from sewage, oil, acid, alkali, salts, or organic matter.

2.1.3 Fine Aggregate

Meet the requirements of ASTM C33/C33M. The sand must consist of hard, dense, durable, uncoated rock particles and be free from injurious amounts of silt, loam, lumps, soft or flaky particles, shale, alkali, organic matter, mica, and other deleterious substances. If washed, use a washing method that will not remove desirable fines, and the sand must subsequently be permitted to drain until the residual-free moisture is reasonably uniform and stable. The sand must be well-graded from fine to coarse, with fineness modulus between 1.30 and 3.40.

2.1.4 Aggregates

Meet the requirements of ASTM C33/C33M, for fine aggregate, except as to gradation. The sand must consist of hard, dense, durable, uncoated rock fragments and be free from injurious amounts of silt, lumps, loam, soft, or flaky particles, shale, alkali, organic matter, mica, and other deleterious substances. If washed, the method must not remove other desirable fines, and the sand permitted to drain until the residual free moisture is reasonably uniform and stable. Sand gradation must be reasonably consistent and conforming to the following requirements as delivered to the grout mixer:

Sieve Opening U.S. Standard Sieve Number	Cumulative Percent by Weight Passing	Cumulative Percent by Weight Retained
2.38 mm 8	100	0
1.19 mm 16	95-100	0-5
0.600 mm 30	55-80	20-45
0.300 mm 50	30-55	45-70
0.150 mm 100	10-30	70-90
0.075 mm 200	0-10	90-100

The sand must have a fineness modulus of not less than 1.30 nor more than 2.10. The sand gradation shown above may be modified with the approval of the Contracting Officer. Mortar test specimens made with the modified sand must exhibit compressive strength equal to or greater than that exhibited by similar specimens made with sand meeting grading and other requirements shown above.

2.1.5 Zero-Slump Concrete Sampling

Various testing agencies have developed special procedures to produce test specimens to mold zero-slump concrete test cylinders. These procedures should be used to mold zero-slump concrete cylinders. One such procedure that has been widely used is described below. Conform to appropriate sections of ASTM C143/C143M and ASTM C172/C172M.

Obtain approximately 0.08 cubic meter 3 cubic feet of concrete from the batch to be placed in the PIF. Obtain a fresh, moist sample of concrete for each cylinder. Record the mix temperature. Assemble the compaction steel mold 150 mm diameter by 300 mm high 6-inch diameter by 12 inch high and tighten all lugs. Using a US Standard 19 mm 3/4 inch sieve to screen the mix, place sufficient material in the mold to give a loose lift thickness of 50 mm 2 inches. Compact the lift using 20 blows of the Marshall hammer 4.53 Kg falling 457 mm 10-lb weight falling 18 inches, making sure that all blows are evenly spaced over the entire surface. Repeat the procedure for each lift until eight lifts are placed. The material should be passed through a 12.7 mm 1/2 inch sieve for the last two lifts in order to form a smooth top. The compacted specimen should remain in the reusable mold for 24 hours before removal for additional curing.

2.1.6 Compressive Strength Test Results

Evaluate compressive strength test results at 28 days in accordance with ACI 214R using a coefficient of variation of 10 percent. Evaluate strength of concrete by averaging test results of each set of standard cylinders tested at 28 days. Not more than 10 percent of individual cylinders tested may have a compressive strength less than specified design strength.

2.2 REINFORCEMENT

****

NOTE: Insert the correlated section number and title in paragraph REINFORCEMENT or include reinforcement specification in this section, in blank below in proper format per UFC 1-300-02. Shafts are reinforced only when the shaft is required to withstand tension, moment, or shear. Shaft reinforcement may also be required for compression or lateral loads for battered shafts.

****

Materials, assembly, and placement of reinforcement must conform to the requirements of Section [03 30 00 CAST-IN-PLACE CONCRETE] [_____].

2.3 CASINGS

****

NOTE: Delete paragraph UNCASED SHAFT if only cased shafts are used. Delete paragraphs CASINGS and CASED SHAFT if only uncased shafts are used. Do not use uncased shafts in soft clay or silt soils unless:

1. Adjacent PIF are installed in previously bored holes equal to the inside diameter of the driving tubes, or

2. PIF are located more than 2.7 m 9 feet apart.

****

Provide permanent steel casing of sufficient thickness, strength, and rigidity to prevent deformation, collapse, or distortion caused by driving adjacent PIF or by soil or hydrostatic pressure. Casings must be watertight.

2.4 MATERIAL SUSTAINABILITY CRITERIA

For materials used, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan

b. Recycled content for Ground Iron Blast-Furnace Slag

c. Recycled content for Silica Fume

d. Minimum [75 percent] [_____] recycled content for steel used for stressed tendon reinforcing

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General Requirements

Design of the PIF is based upon assumed subsurface elevations to which the PIF must penetrate at various locations and total energy required to drive them.[Based upon results of PIF test loadings, the Contracting Officer will specify the actual elevation to which PIF must penetrate and the total energy to be applied to drive the last 0.14 cubic meter 5 cubic feet of concrete into the base.]

3.1.2 Placement

Do not place PIF until earthwork has been graded to elevation indicated.[Do not place permanent PIF until load test[s] [have][has] been successfully completed.] Modifications to pressure-injected footings (PIF) must be approved by the Contracting Officer prior to placement.

3.1.3 Tolerance

A maximum 50 mm 2 inches from plan location for single PIF and 75 mm 3 inches from plan location for PIF in clusters. Except for batter installations, PIF may be a maximum of two percent out of plumb. Batter installations must be within five percent of the indicated required angle. The required angle may not exceed 0.44 rad 25 degrees from the vertical.

Monitor PIFs for heave immediately after installation and after adjacent PIFs are installed. If PIFs heave more than 13 mm 1/2 inch notify the Contracting Officer.

3.1.4 PIF Damaged, Mislocated, or Out of Alignment

****

NOTE: For PIF installed beyond tolerance, determine actual load to be supported. Reject PIF unless determination shows that overloading does not exceed 10 percent where no load test has been conducted, or 20 percent when load test has been conducted, providing that materials are not stressed beyond allowable limits.

****

Abandon PIF damaged, mislocated, or out of alignment beyond maximum tolerance and place additional PIF where directed without additional cost to the Owner.

3.1.5 As-Driven Survey

After the installation of each PIF group is complete, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each PIF. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the PIF group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each PIF to nearest 13 mm half inch. Survey must be prepared and certified by a licensed land surveyor.

3.1.6 Protection of Existing Structures

****

NOTE: Include this paragraph only when protection of existing structures from pile driving activities is required.

Indicate on the drawings all structures and

facilities for which protection is required. Also provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.

****

Mitigate impact on existing facilities due to PIF installation activities in accordance with the [project specific document] [_____].

3.2 BASE

****

NOTE: Use drive tubes from 508 to 610 mm 20 to 24 inches in diameter for loads 72.6 metric tons 80 tons and greater with energy of 189,840 J 140,000 foot-pounds or use drive tubes from 305 to 406 mm 12 to 16 inches in diameter for loads less than 72.6 metric tons 80 tons with energy of 67,800 to 135,600 J 50,000 to 100,000 foot-pounds.

****

Load steel drive tube of[[_____] mm [_____] inch][appropriate] diameter with a plug of 0.14 cubic meter 5 cubic feet of concrete or gravel and force into ground by drop hammer blows on plug at bottom inside of the steel tube. Pre-bore to assist driving if appropriate. Drive tube to predetermined depth of granular soil stratum suitable for forming expanded base. At this depth, expel plug while preventing further penetration of the tube, with sufficient seal maintained to prevent entry of water or soil. During injection of concrete, level of concrete in tube must be 150 mm 6 inches above bottom of tube.

3.3 SHAFTS

3.3.1 Uncased Shaft

****

NOTE: Delete paragraph UNCASED SHAFT if only cased shafts are used. Delete paragraphs CASINGS and CASED SHAFT if only uncased shafts are used. Do not use uncased shafts in soft clay or silt soils unless:

1. Adjacent PIF are installed in previously bored holes equal to the inside diameter of the driving tubes, or

2. PIF are located more than 2.7 m 9 feet apart.

****

Ensure continuous and complete contact between concrete shaft and surrounding soil. Form shaft by compacting charges of zero-slump concrete with hammer blows of 20,300 to 27,100 Joules 15,000 to 20,000 foot-pounds of energy and withdraw drive tube in not more than 600 mm 2 foot increments. Concrete level inside drive tube must be higher than bottom of tube at all times. Alternatively, when shaft is reinforced full length, fill drive-tube with 150 to 200 mm 6 to 8 inches of high-slump concrete and withdraw tube, recharging concrete as needed to ensure that final level is at or above cut-off elevation.

3.3.2 Cased Shaft

****

NOTE: Delete paragraph UNCASED SHAFT if only cased shafts are used. Delete paragraphs CASINGS and CASED SHAFT if only uncased shafts are used. Do not use uncased shafts in soft clay or silt soils unless:

1. Adjacent PIF are installed in previously bored holes equal to the inside diameter of the driving tubes, or

2. PIF are located more than 2.7 m 9 feet apart.

****

****

NOTE: Where soil conditions indicate that it may be impractical or difficult to fill the annular space between the shaft and the soil around a single casing, shaft must be supported laterally or PIF reinforced. Where a single PIF is used as a foundation and the shaft is cased, shaft must be supported at the top in at least two directions, perpendicular to each other. Where two PIF are used in a group and their shafts are cased, the groups must be supported laterally at the top in a direction perpendicular to a line drawn between centers of the footings. Insert minimum nominal diameter of casings.

****

A permanent steel casing formed by inserting a steel casing with a minimum diameter of [_____] mm inches into drive tube and embedding in expanded base as required to exclude water or other foreign material. Withdraw drive tube and fill steel casing with 75 mm 3 inch slump concrete to cut-off elevation but not until after all PIF within a 2.7 m 9 foot radius have been installed. Place concrete in continuous flow from bottom to top of shaft, and do not drop through water. Fill spaces between steel casing and surrounding soil with sand by a process of washing sand as the drive tube is withdrawn. Allow shaft to cure 24 hours minimum before constructing additional PIF within a 2.7 m 9 foot radius. Remove mud, water, and other foreign matter before filling casing with concrete. Extract and discard distorted, bent, or damaged casings and drive new casings.

3.4 REINFORCEMENT

****

NOTE: Insert the correlated section number and title in paragraph REINFORCEMENT or include reinforcement specification in this section. Shafts are reinforced only when the shaft is required to withstand tension, moment, or shear. Shaft reinforcement may also be required for compression or lateral loads for battered shafts.

****

Assemble, securely tie together, and place in shaft as a unit. Use spacers to center reinforcement in the shaft and maintain alignment.[Reinforce full length of battered shafts and uncased shafts to resist uplift force.] Connect shaft to superstructure with reinforcement as indicated. Provide necessary dowels. Submit drawings, details and schedules.

3.5 FIELD QUALITY CONTROL

****

NOTE: Delete these paragraphs if load testing is not required.

****

3.5.1 Load Tests

****

NOTE: This section is applicable to axial compression load tests. Revise accordingly for axial tension load tests (ASTM D3689) or lateral load tests (ASTM D3966/D3966M). The requirement of performing the load test under the direct supervision of a registered professional engineer may be waived at the discretion of the design agency.

****

ASTM D1143/D1143M[, measurement method as recommended by the Contractor]; provide [one] [_____] test PIF[s] conforming to requirements for permanent PIF at location[s] [indicated] [directed by the Contracting Officer]. Place test PIF in same manner specified for permanent PIF. Test PIF indicated or directed to be placed in permanent locations may be incorporated into the final work if load testing is satisfactory. Perform tests and recording of data under the direct supervision of a registered Professional Engineer provided by the [Government] [Contractor]. Load frames, jacks, pumps, and dial gauges are the responsibility of the Contractor.

3.5.2 Test Measurements

Maintain ultimate test load as per ASTM D1143/D1143M. Determine safe bearing capacity of test PIF from results of load test as approved by the Contracting Officer.[Safe bearing capacity is the lesser of two values computed as follows: (a) one-half the load at which the load vs. total settlement curve exhibits a slope of 1.3 mm per 907 kg 0.05 inches per ton of test load; or (b) one-half the load that causes net settlement after rebound of not more than 25.4 mm one inch.]

3.6 INSPECTION AND SAFETY

Engage an independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated. Submit testing agency qualifications to the Contracting Officer for approval at least 30 calendar days prior to installation.[Provide sufficient light and access for proper inspection of full length of casings.] Provide safety requirements and access equipment required for proper inspection.[Casing must be inspected and approved prior to installing shaft.]

3.6.1 Pressure Injected Footing Records

Maintain daily records and make available to the Contracting Officer at all times. Within 15 days after completion of PIF, furnish to the Contracting Officer a complete and accurate record of all PIF installed. Include, as a minimum, the following information for each PIF:

a. Reference or identification number

b. Shaft type and method of reinforcing used

c. Diameter, length, location, and elevation of finished concrete at top of shaft

d. Elevation of bottom of base

e. Type and volume of concrete in base

f. Number and magnitude of blows required to drive the last 0.14 cubic meter 5 cubic feet of base concrete

g. Unusual or unexpected conditions encountered during installation

h. Date of construction drilling, driving, concrete placing, high and low temperatures, and weather conditions for each PIF

i. For PIF closer than nine shaft diameters, elevations at adjacent PIF, recorded before and after driving

j. Sequence of placing PIF in groups.

3.7 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements", UFC 3-301-01 "Structural Engineering", and UFC 3-301-02 "Design of Risk Category V Structures, National Strategic Military Assets".

Indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

[3.8   VIBRATION CONTROL

****

NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project.

****

Perform vibration monitoring at the locations[shown in the plan][decided by the Contracting Officer] during the PIF installation operations. Perform vibration monitoring [using] [seismographs] [and geophones] within a distance of [61] [_____] meters [200] [_____] feet from the PIF installation activity.[Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [5] [_____] years of experience in vibration monitoring. A minimum of [28] [_____] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the PIF installation activities, obtain baseline readings of ambient vibrations. The vibration during the PIF installation activities must be limited to[a peak particle velocity of not more than [5] [_____] cm [2.0] [_____] inches per second][the limits mentioned in the [contract documents] [_____]].[Determine appropriate vibration limits as per [US Bureau of Mines][American Association of State Highway and Transportation Officials (AASHTO)]guidelines.] During PIF installation activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the PIF installation activity causing the vibration until [the Vibration consultant and the Contracting Officer] [_____] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor is responsible for all damages resulting from the PIF installation operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.9   NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the PIF installation operations.[Perform noise monitoring using [noise meters][, and] [_____].][Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [5] [_____] years of experience in noise monitoring. A minimum of [28] [_____] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the PIF installation activities, obtain baseline readings of ambient noise levels.[The noise limits are mentioned in the [plan] [contract documents].][Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines.] During PIF installation activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the PIF installation activity and install noise mitigation measures.

The Contractor is responsible for all damages resulting from the PIF installation and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.10 PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform preconstruction condition survey of [structures] [and utilities] [within [61] [_____] meters [200] [_____] feet of the PIF installation activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] [_____] days before performing the preconstruction condition survey. Obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] [_____] days before the commencement of PIF installation activity. Accept responsibility for damages to existing adjacent or adjoining structures created by PIF installation work, and repair any damages to these structures without cost to the Government.

][3.11 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: Include this section if instrumentation is to

be installed due to concerns about vibration, settlement, lateral movement, etc. during PIF installation activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement [and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during PIF installation. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Extend monitoring before, during and for a period after completion of construction activities related to PIF installation when long-term performance issues are a concern. Design the monitoring plan to protect adjacent structures and utilities against damage due to the PIF installation activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. Include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 62 16.13 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-31 62 16.13 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 31 62 16.13

STEEL PIPE PILES

11/20, CHG 2: 02/24

****

This guide specification covers the requirements for furnishing all equipment, labor, and materials (except materials specified to be furnished by the Government) and performing all operations in connection with the furnishing, installing and testing of steel pipe piles.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: The structural engineer confirms the structural capacity of the piles and provide specific requirements for bending moments, lateral loads etc. for the pile design.

****

1.1 DESCRIPTION

Design, furnish, install and test steel pipe piles at the locations indicated on the drawings and specified herein.[Assume test pile[s] will be directed to be placed in [a]location[s] that can be incorporated into the work.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.5M/D1.5	(2020; Errata 1 2022) Bridge Welding Code

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A109/A109M	(2024) Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A252	(2010) Standard Specification for Welded and Seamless Steel Pipe Piles
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A972/A972M	(2015) Standard Specification for Fusion Bonded Epoxy-Coated Pipe Piles
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations
ASTM E94/E94M	(2022) Standard Guide for Radiographic Examination Using Industrial Radiographic Film
ASTM E164	(2024) Standard Practice for Contact Ultrasonic Testing of Weldments
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-220-01	(2012; with Change 1, 2021) Geotechnical Engineering

1.3 SUBSURFACE DATA

****

NOTE: Section 00 31 32.13 Subsurface Drilling and Sampling Information is not a UFGS. CSI MasterFormat prescribes this section for inclusion of this data.

****

Subsurface soil data logs are [indicated] [appended to the special contract requirements] [provided on the project drawings].[The subsoil investigation report samples of material taken from subsurface investigations may be examined at [_____].]

1.4 BASIS OF BID

****

NOTE: Select one of the following options:

****

****

NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Determine lengths of piles as accurately as possible, prior to bidding, since the unit price per meter foot of the piles varies as the length increases or decreases. Refer to Standard Test Method for High-Strain Dynamic Testing of Deep Foundations (ASTM D4945)

****

1.4.1 Contractor's Geotechnical Consultant

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and Pile Dynamic Analysis, to observe test pile installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and have no employee of employer relationship, which could constitute a conflict of interest.

1.4.2 Production Pile Acceptance Criteria

Safe design capacity for piles is [_____] KN [_____] kips. Drive piles to [minimum tip elevation] [a minimum depth of [_____] m [_____] feet below cut-off elevation], and to such additional depth as required to obtain a bearing capacity of not less than [_____] KN [_____] kips. The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at end of drive or restrike] [static load tests] [wave equation analysis].

The following formulas can be used in cases where allowable pile loads are less than 355 kN 80 kips (determined using a factor of safety of 3 for individual piles and 4 for pile groups) and are presented only as a guide to aid in establishing the controlling penetration per blow, which, together with the minimum depth of penetration will serve to determine the required minimum depth of penetration of each individual pile:

$$R = \frac{2E}{S \text{ plus } 0.1}$$ For double acting hammers

$R = 2WH$ ___ For single acting hammers

S plus 0.1

Where R is the approximate allowable pile load in kips; E equals the energy in foot-kips per blow based on an acceptable certified statement from the manufacturer of the hammer; W equals the weight of the hammer or ram in kips; H equals the height of fall of the hammer of ram in feet; and S equals the average inches of penetration per blow for the last three blows. An allowance will be made for reduced penetration caused by shock absorption of the cushion or cap blocks.

[1.4.3 Lump Sum Payment

****

NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection. This paragraph will be typically used when there are 1) relatively small quantity of piles, 2) allowable pile loading is less than 355 kN 80 kips(, and 3) the subsurface conditions are well defined. Fill in Table I as required selecting columns applicable to project. Generally, pile capacity, location, and minimum tip elevation are shown on plans. Test piles and load tests are not incorporated on lump sum contracts. Delete this paragraph for unit-price contracts.

****

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.][following Table I:

Table 1

[Location]	Number	Size	[Capacity]	Length (Tip to Cut-Off)	[Maximum Bending Moment]	[Maximum Shear Force]

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off,[place concrete infill,] dispose of any cut-offs, and meet the applicable contract requirements. Include mobilization, pre-drilling, and redriving heaved piles to the required [depth of penetration] [tip elevation] [refusal blow count] as directed by the Contractor's Geotechnical Consultant. If, in redriving, it is found that any pile is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be provided and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. If total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; backdriving; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys.]

][1.4.4 Unit Price

****

NOTE: Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments from price schedule for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

For NAVFAC Southeast projects, where there is a need for unit pricing of piles, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items.

****

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****

NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.

****

Requirements of FAR 52.211-18 Variation in Estimated Quantity do not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and driving the piles including mobilization and demobilization, [concrete infill,][, jetting][, predrilling][, probing], redriving uplifted piles, [an additional 1.5 m 5 feet in furnished length for any test pile not driven beyond estimated pile length,] and cutting off piles at the cut-off elevation.[Include the cost for additional length for the test piles in the total unit price cost for the job.] Payment will be made for production[and test piles] at the bid unit price for the length of pile, from tip to final cut-off, actually provided, excluding buildups and splices directed by the Contracting Officer to be made. If the actual cumulative pile length driven (tip to cut-off) vary more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of FAR 52.236-2 Differing Site Conditions.[Payments will be made per each at the respective bid unit price for pile cut-offs, pile build-ups, pile loads tests and pile splices.]

][1.5 PAYMENT

****

NOTE: Delete this paragraph for lump-sum contracts.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this

paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****

1.5.1 Furnishing and Delivering Steel Pipe Piles

1.5.1.1 Payment

Payment will be made for costs associated with furnishing and delivering the required lengths of permanent steel pipe piles, which includes costs of furnishing and delivering piles to the work site. No payment will be made for the driving head or lengths of piles exceeding required lengths. No payment will be made for piles damaged during delivery, storage, or handling to the extent that they are rendered unsuitable for the work, in the opinion of the Contracting Officer.

1.5.1.2 Measurement

Furnishing and delivering permanent steel pipe piles will be measured for payment by the linear meter foot of piles required below the cut-off elevation as [determined by the Contracting Officer and furnished to the Contractor] [indicated].

1.5.1.3 Unit of Measure

Linear meter foot.

1.5.2 Driving Steel Pipe Piles

1.5.2.1 Payment

Payment will be made for costs associated with driving permanent steel pipe piles, which includes costs of handling, driving, [and splicing of piles,] [performing dynamic testing, interpreting data and submitting reports,] [placing concrete infill] measuring heave, redriving heaved piles, removal of [build-ups]driving heads or cutting off piles at the cut-off elevation and removing from the work site, compiling and submitting pile driving records, backfilling voids around piles, and any other items incidental to driving piles to the required elevation.

1.5.2.2 Measurement

Permanent steel pipe piles will be measured for payment for driving on the basis of lengths, to the nearest hundredth (tenth) of a linear meter foot, along the axis of each pile acceptably in place below the cut-off elevation shown.

1.5.2.3 Unit of Measure

Linear meter foot.

1.5.3 Pulled Steel Pipe Piles

1.5.3.1 Payment

Payment will be made for costs associated with piles pulled at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing and delivering pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Furnishing and Delivering Steel pipe Piles". The cost of driving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Steel pipe Piles". The cost of pulling undamaged piles will be paid for at twice the applicable contract unit price for payment item "Driving Steel pipe Piles", which includes backfilling any remaining void. The cost of redriving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Steel pipe Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of piles, including pile driving points, pulled and found to be damaged and backfilling voids. New piles replacing damaged piles will be paid for at the applicable contract unit price for payment items "Furnishing and Delivering Steel pipe Piles" and "Driving Steel pipe Piles".

1.5.3.2 Measurement

Furnishing and delivering pulled and undamaged permanent steel pipe piles will be measured for payment as specified in paragraph PAYMENT, subparagraph FURNISHING AND DELIVERING STEEL PIPE PILES. Pulling undamaged steel pipe piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL PIPE PILES. Redriving pulled undamaged steel pipe piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL PIPE PILES. New piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraphs FURNISHING AND DELIVERING STEEL PIPE PILES and DRIVING STEEL PIPE PILES.

1.5.3.3 Unit of Measure

Linear meter foot.

[1.5.4 Steel Pipe Pile Driving Tests

1.5.4.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of driven test piles, [including [pile driving points][and][splices]]; conducting pile driving tests; backfilling voids around piles; compiling pile driving test records[; performing dynamic testing; interpreting data; and submitting reports].

1.5.4.2 Measurement

Steel pipe pile driving tests will be measured for payment on the basis of the applicable contract unit price per pile driving test.

1.5.4.3 Unit of Measure

Each.

][1.5.5 Steel Pipe Piles for Load Tests

1.5.5.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of load test piles[including [pile driving points][and][splices]]; backfilling voids around piles; compiling pile driving records[; furnishing, fabricating, and mounting of strain rods and protective assembly][; furnishing, fabricating, and mounting of inclinometer and inclinometer protective assembly][; performing dynamic testing; interpreting data; and submitting reports]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

1.5.5.2 Measurement

Steel pipe piles for load tests will be measured for payment on the basis of the applicable contract unit price per load test pile.

1.5.5.3 Unit of Measure

Each.

][1.5.6 Steel Pipe Pile Static Axial Compressive Load Tests

1.5.6.1 Payment

Payment will be made for costs associated with steel pipe pile static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static axial compressive load tests.

1.5.6.2 Measurement

Steel pipe pile static axial compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.5.6.3 Unit of Measure

Each.

][1.5.7 Steel Pipe Pile Static Tensile Load Tests

1.5.7.1 Payment

Payment will be made for costs associated with steel pipe pile static tensile load tests in accordance with ASTM D3689, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static tensile load tests.

1.5.7.2 Measurement

Steel pipe pile tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load test.

1.5.7.3 Unit of Measure

Each.

][1.5.8 Steel Pipe Pile Lateral Load Tests

1.5.8.1 Payment

Payment will be made for costs associated with steel pipe pile lateral load tests in accordance with ASTM D3966/D3966M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing inclinometers; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile lateral load tests.

1.5.8.2 Measurement

Steel pipe pile lateral load tests will be measured for payment on the basis of the applicable contract unit price per lateral load test.

1.5.8.3 Unit of Measure

Each.

][1.5.9 Pulled Load Test Steel Pipe Piles

1.5.9.1 Payment

Payment will be made for costs associated with load test steel pipe piles pulled prior to load testing at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing, delivering, driving, and pulling undamaged load test piles will be paid for at the applicable contract unit price for payment item "Steel pipe Piles for Load Tests". The cost of pulling undamaged load test piles the second time after redriving and testing will be paid for at twice the applicable contract unit price for payment item "Driving Steel pipe Piles". The cost of redriving pulled undamaged load test piles will be paid for at the applicable contract unit price for payment item "Driving Steel pipe Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of load test piles pulled at the direction of the Contracting Officer and found to be damaged. New load test piles replacing damaged piles will be paid for at the applicable contract unit price for payment item "Steel pipe Piles for Load Tests".

1.5.9.2 Measurement

Pulled undamaged load test steel pipe piles will be measured for payment as specified in paragraph PAYMENT, subparagraph STEEL PIPE PILES FOR LOAD TESTS. Pulling undamaged load test steel pipe piles the second time after redriving and testing will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL PIPE PILES. Redriving pulled undamaged steel pipe piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL PIPE PILES. New load test steel pipe piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraph STEEL PIPE PILES FOR LOAD TESTS.

1.5.9.3 Unit of Measure

As specified in paragraph PAYMENT, subparagraphs DRIVING STEEL PIPE PILES and STEEL PIPE PILES FOR LOAD TESTS, respectfully.

][1.5.10 Pile Driving Shoes

1.5.10.1 Payment

Payment will be made for costs associated with pile driving shoes, including furnishing, delivering, and installing.

1.5.10.2 Measurement

Pile driving shoes will be measured for payment on the basis of the number of pile driving shoes required.

1.5.10.3 Unit of Measure

Each.

][1.5.11 Steel Pipe Pile Splices

1.5.11.1 Payment

Payment will be made for costs associated with steel pipe pile splices, including all plant, labor, and material required to make the splice.

1.5.11.2 Measurement

Steel pipe pile splices will be measured for payment on the basis of the applicable contract unit price per pile splice.

1.5.11.3 Unit of Measure

Each.

][1.5.12 Vibration Monitoring

1.5.12.1 Payment

Payment will be made for costs associated with vibration monitoring.

1.5.12.2 Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.12.3 Unit of Measure

Each.

][1.5.13 Sound Monitoring

1.5.13.1 Payment

Payment will be made for costs associated with sound monitoring.

1.5.13.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.13.3 Unit of Measure

Each.

][1.5.14 Preconstruction Condition Survey

1.5.14.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.5.14.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.5.14.3 Unit of Measure

Each.

][1.5.15 Construction Instrumentation and Monitoring

1.5.15.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.5.15.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.5.15.3 Unit of Measure

One.

]]1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G, [_____]

Contractor's Geotechnical Consultant Qualification; G, [_____]

Testing Agency Qualifications; G, [_____]

[Wave Equation Analysis; G, [_____]

][Instrumentation and Monitoring Program Reports; G, [_____]

] SD-02 Shop Drawings

Piles; G, [_____]

Pile Splices; G, [_____]

Pile Placement; G, [_____]

As-Driven Survey; G, [_____]

Pile Load Test; G, [_____]

Pile Shoes; G, [_____]

SD-03 Product Data

Pile Driving Equipment; G, [_____]

Delivery, Storage, and Handling; G, [_____]

Pile Test; G, [_____]

Fusion-Bonded Epoxy Coating; G, [_____]

SD-05 Design Data

Quantities List; G, [_____]

Procedure for Insufficient Pile Length; G, [_____]

[Concrete Mix Design; G, [_____]

] SD-06 Test Reports

[Test Piles; G, [_____]

][Load Tests; G, [_____]

][Dynamic Pile Analysis; G, [_____]

][Aggregates; G, [_____]

][Silica Fume; G, [_____]

][Concrete Compressive Strength; G, [_____]

] SD-07 Certificates

Fusion-Bonded Epoxy Coating; G, [_____]

Pile Shoes; G, [_____]

Pile Splices; G, [_____]

Welder Certification; G, [_____]

Steel Plant Certification; G, [_____]

[Aggregates; G, [_____]

][Admixtures; G, [_____]

][Cement; G, [_____]

][Fly Ash and Pozzolans; G, [_____]

] SD-11 Closeout Submittals

Pile Records; G, [_____]

1.7 DELIVERY, STORAGE, AND HANDLING

Conform all delivery, storage, and handling of materials to the requirements specified herein. Develop and submit plans for the delivery, storage, and handling of piles. Submit plans at least 30 calendar days prior to delivery of piles to the job site.

1.7.1 Delivery and Storage

Stack piles during delivery and storage so that each pile is maintained in a straight position and is supported every 3 meters 10 feet or less along its length (ends inclusive). Do not stack piles more than 1.5 meters 5 feet high.

1.7.2 Handling

Lift piles to ensure that the maximum permissible curvature is not exceeded. Holes may be burned above the cutoff length for lifting piles into the leads. If there is evidence of pile damage during driving due to the holes, Contracting Officer may forbid the burning of holes. Do not damage piles when dragging piles across the ground or barge deck.

Inspect piles for excessive curvature and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Measure curvature in the pile with the pile laying on a flat surface and is the distance between the pile at the mid-length of the pile and the flat surface. Straightness of the sections of steel pipe piles must conform to AWS D1.5M/D1.5, Section 3.5.1.1. Piles having excessive curvature will be rejected.

1.7.3 Damaged Piles

Inspect each pile for straightness and structural damage before transporting them to the project site and immediately prior to placement in the driving leads. Bring any damage to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

Any pile damaged by reason of internal defects or by improper driving may be corrected by one of the following methods approved by the Engineer for the pile in question:

a. The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile.

b. One or more replacement piles are driven adjacent to the defective pile.

c. A Pile Dynamic Analysis and low integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

A pile driven below the specified butt elevation may be corrected by one of the following methods approved by the Engineer:

a. The pile is spliced (if approved).

b. A sufficient portion of the footing is extended down to properly embed the pile.

A pile driven out of its proper location or out of plumb as approved by the Engineer, may be corrected by one of the following methods approved by the engineer:

a. One or more replacement piles are driven next to the pile in question.

b. As directed by the structural engineer.

1.8 QUALITY CONTROL

1.8.1 Piles

Prepare and submit shop drawings for piles. Indicate placement of piles. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up. Perform quality control testing of the concrete infill in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE and 31 62 13.13 CAST-IN-PLACE CONCRETE PILES.

1.8.2 Quality Control Procedures

Submit the pile manufacturer's quality control procedures.

1.8.3 Installation Procedures

a. Submit information on the type of equipment proposed to be used, proposed methods of operation, pile driving plan including proposed sequence of driving, and details of all pile driving equipment and accessories. Submit descriptions of pile driving equipment, including hammers, power packs, driving helmets, hammer cushions, pile cushions, leads, extractors, jetting equipment, and preboring equipment at least 30 days prior to commencement of work.

[b. Provide details of pile driving equipment and a Wave Equation Analysis of pile drivability for selection of the hammer along with a statement of driving procedures. Provide instructions and procedures on how the Contractor will perform[Dynamic Pile Testing], Inspection and Monitoring of piles during installation and testing The Wave Equation Analysis is to be completed by the Contractor's Geotechnical Consultant for each test pile location where different subsurface conditions exist and is to include the following information pertaining to the proposed pile driving equipment:

(1) Complete Pile and Driving Equipment Data Form, (which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables) for each proposed pile hammer and pile type combination.

(2) Copies of computer input and output sheets and graphs showing soil resistance versus blow count as well as maximum tension and compression stresses versus blow count. Analysis must be run at the estimated tip elevation as well as other required elevations to define maximum stress levels in the pile during driving.

c. Provide detailed procedures for conducting the dynamic pile load test and equipment to be used for conducting the load test. The detailed description must explain how specific information of pile performance will be evaluated.

][1.8.4 Pile Load Test Supporting Data

Submit test set-up and procedures. Submit Jack calibration records, a testing arrangement description and diagram, and the proposed loading sequence.

]PART 2   PRODUCTS

2.1   PILE REQUIREMENTS

****

NOTE: Delete sentence in brackets when test piles are not required. Government requires the Contractor to employ a Geotechnical Consultant to determine the calculated tip elevation and provide oversight of piling installation and testing.

****

[Order test piles [3] [_____] meters [10] [_____] feet longer in length than production piles.[Drive the additional test pile length only when based upon the recommendation of the Contractor's Geotechnical Consultant and approved by the Contracting Officer.] The [Contractor's Geotechnical Consultant][Contracting Officer]will use test pile data to determine "calculated" pile tip elevation and necessary driving resistance. This information will be given to the Contractor no later than 7 days from receipt of complete test data. Use this list as the basis for ordering the piles. Do not order piles until list is provided by the[Contractor's Geotechnical Consultant][Contracting Officer].][Provide test piles [1.5] [_____] meter [5] [_____] feet longer than the bid length.]

2.2   MATERIALS

2.2.1   Steel Pipe Piles

****

NOTE: Base selection of material on a comprehensive study of strength, cost, and corrosion resistance requirements.

ASTM A36/A36M and ASTM A572/A572M steels have the same corrosion resistance; ASTM A572/A572M can be obtained in yield strengths of 350 MPa through 448 MPa 42 ksi through 65 ksi; however, 350 MPa 50 ksi is the most available grade. ASTM A588/A588M has twice the atmospheric resistance of ASTM A36/A36M steel with 20 percent copper added.

1. Marine environment: Evaluate steel section piles exposed to seawater on the basis of application, location, degree of exposure, type of structure, and required service life. Where additional service life in the splash zone is required over that provided by conventional steel grades, ASTM A690/A690M or ASTM A588/A588M may be considered. ASTM A690/A690M steel 350 MPa 50 ksi (yield strength) has two to three times greater resistance to seawater splash zone corrosion than ordinary ASTM A36/A36M steel.

2. Seawater protection: To obtain reasonably long life for a structure immersed in seawater, provide steel piles with coatings, cathodic protection, or concrete encasement. Choice of protection is ultimately based on economics; usually, more than one type of protection will be used on a structure

for most economical, adequate protection. The following criteria applies:

a. The use of coating systems for protection, such as coal tar epoxy, is usually low in initial cost but may require relatively frequent maintenance; also, it is extremely difficult to renew in the tidal zone between mean tide and low tide.

b. Cathodic protection is low in initial cost and low in maintenance. It can be of value only where the piles are continually wet, as in the submerged zone.

c. Concrete encasement or metal jacketing is relatively expensive in initial cost but requires no maintenance if properly constructed. When concrete encasement is to be continuously submerged in water with low resistivity, it must (1) extend below the mudline, or (2) be coated to electrochemically insulate the concrete from the steel.

Use high-strength steel only when design analyses show that the use is the most economical solution or to increase the design life if approved by the Contractor's Geotechnical Consultant.

ASTM A27/A27M cast steel is used for some commercially available pile points.

****

ASTM A252, [Grade 3] [_____]. Provide test piles identical to those used elsewhere in the project. Provide steel pipe piles of the shape, size and sections shown in the drawings. Pipe piles may be either seamless pipe or full penetration welded with straight or spiral seams. Weld pipe in a manner that welding will not crack or fail when the pile is subjected to its intended use, including during installation. Test the weld seam of each length of pipe for acceptance by ultrasonic testing in accordance with the provisions for Nondestructive Electric Test of Weld Seam of ASTM A53/A53M.

2.2.2 Pile Splices

Submit detail drawings of shop and field pile splices prior to fabrication. Provide ASTM A148/A148M Grade 90-60 proprietary pile splicer sleeves or provide ASTM A109/A109M or ASTM A36/A36M backing rings to prevent weld blow out during weld process. Submit procedure for insufficient pile length.

2.2.3 Pile Shoes

****

NOTE: Outside flange open end cutting shoe may be allowed based on specific project needs such as drilling inside the pipe pile or rock socketing etc. Maximum friction may not be mobilized when using outside flange cutting shoe. Closed end cutting shoe may also be used based on project needs such as pipe pile closure, breaking through

difficult driving conditions, etc.
****

Submit details about pile shoes used, if any. ASTM A148/A148M Grade 90/60 for cast steel cutting shoe. Submit Certificates of compliance certifying that materials meet the requirements specified herein. Provide [inside flange open end] [_____] cutting shoe on all pipe piles. Perform all welding in accordance with the requirements for pile splices.

2.2.4 Pile Caps and Pile Inserts

Provide ASTM A572/A572M Grade 50 [_____] plates for pile caps and pile inserts. Pile caps must conform to details shown.

2.2.5 Fabrication

Conform to the requirements shown and as specified herein and in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS. Submit steel plant certification.

2.2.5.1 Pile Splices

****

NOTE: Splices are generally not permitted where required lengths are available in one piece or the pile is designed for a moment connection. Where splices are permitted, show details of the splice.
****

Perform all welding in accordance with the requirements for shield metal arc welding of AWS D1.1/D1.1M. Submit welding procedure for shop splices and verification of welder certification and qualifications. Make no more than [one] [_____] field splice per [_____] [25 m 80 feet] of pile, unless directed by the Contracting Officer. Show all shop splices on fabrication drawings.

Only use welders qualified by tests prescribed by AWS D1.1/D1.1M.

Splice sections of pipe with an approved full penetration butt or single bevel-groove weld. Both pipe ends must be square cut and seated to bear. Use an approved jig or alignment device during welding to maintain the required straightness of pipe. Minimize field splices or eliminate if possible.[No splices will be allowed in the top [7.6] [_____] meters [25] [_____] feet of pile to eliminate coating vulnerability.] For splices made during pile installation, rigid frame pile leads may be used as a jig in a manner approved by the Contracting Officer.

See paragraph FIELD QUALITY CONTROL for requirements.

2.2.5.2 Pile Caps

Ground the top of piles sufficiently smooth to provide a good welding surface for structural-shape pile caps.

[2.2.5.3 Fusion-Bonded Epoxy Coating

Pipe piles [_____] must have fusion-bonded epoxy coating applied from the cutoff elevation to [4 meters 14-feet below mean low water] [_____]. Coating of steel surfaces with an electrostatically applied fusion-bonded epoxy must be in accordance with ASTM A972/A972M. Submit supporting product data and details for fusion-bonded expoxy coating.

]2.2.6 Concrete Infill

Conform to the requirements as identified in the Sections 03 30 00 CAST-IN-PLACE CONCRETE and 31 62 13.13 CAST-IN-PLACE CONCRETE PILES. Submit a concrete mix design at least 30 calendar days before concrete is placed, for each type of concrete used for the piles. Provide material certifications and test data for aggregates, silica fume, admixtures, cement, fly ash and pozzolans. Submit concrete compressive strength test results.

2.3 PILE DRIVING EQUIPMENT

Select the proposed pile driving equipment, including hammers and other required items, and submit complete descriptions of the proposed equipment in accordance with paragraph SUBMITTALS. Final approval of the proposed equipment is subject to the satisfactory completion and approval of pile tests. Submit pile test plan at least 30 calendar days prior to installing any test piles. Approval of the plan will not relieve the Contractor of the responsibility for structural and operational adequacies of the testing system. Changes in the selected pile driving equipment will not be allowed after the equipment has been approved except as directed. No additional contract time will be allowed for Contractor proposed changes in the equipment.

2.3.1 Pile Driving Hammers

****

NOTE: When specifying the minimum driving energy, make an allowance for reduced penetration caused by shock absorption of pile helmets. Enter the appropriate minimum allowable driving energy for the project. Minimum allowable driving energy may be not less than the following:

Design Bearing Pile Capacity for Single Pile (Kilonewton) (Kips)	**Minimum Rated Hammer Driving Energy (Joules) (Foot-Pounds)**
Up to 534 120	**20,350 15,000**
Up to 534 120	**25,750 19,000**

The minimum and maximum hammer energies required may be determined from experience on other jobs or by a series of wave equation analyses.

****

Provide impact or vibratory type pile driving hammers.

2.3.1.1 Impact Hammers

Provide air, hydraulic or diesel-powered impact pile hammers of the single-acting, double-acting, or differential-acting type.[The size or capacity of hammers must be as recommended by the hammer manufacturer for the total pile mass weight and the character of the soil formation to be penetrated.][The rated driving energy of hammers is limited to a minimum of [20,350] [25,750] joules [15,000] [19,000] foot-pounds.][Hammers must be capable of[, and so demonstrated during the development of refusal criteria,] hard driving in excess of 20 blows per 25 mm one inch.] Provide boiler, compressor, or engine capacity sufficient to operate hammers continuously at the full rated speed. Provide hammers with a gage to monitor hammer bounce chamber pressure for diesel hammers or pressure at the hammer for air hammers. This gage must be operational during the driving of piles and be mounted in an accessible location for monitoring by the Contractor and the Contracting Officer.[Provide two spare operational bounce chamber read out units on site.][Provide bounce chamber pressure gage correction tables and charts for the type and length of hose to be used with the pressure gage to the Contracting Officer.][Equip hydraulic hammers with a system for measurement of ram energy. The system must be in good working order and the results easily and immediately available to the Engineer. Install an energy monitor on the hydraulic hammers and record readings every 250 mm 10 inches of pile installation.] Use wave equation analysis to verify that the hammer will develop stresses within acceptable limits in the piles. Position a pile cap or drive cap between the pile and hammer. Place hammer cushion or cap block between ram and the pile cap or drive cap. Hammer cushion or cap block must have consistent elastic properties, minimize energy absorption, and transmit hammer energy uniformly and consistently during the entire driving period.[Do not use a pile cushion block.] In accordance with paragraph SUBMITTALS, submit the following information for each impact hammer proposed:

a. Make and model.

b. Ram mass (kilograms) weight (pounds).

c. Anvil mass (kilograms) weight (pounds).

d. Rated stroke millimeters inches.

e. Rated energy range joules foot-pounds.

f. Rated speed (blows per minute).

g. Air pressure, hammer, and boiler [and] [or] compressor MPa psi.

[h. Rated bounce chamber pressure curves or charts, including pressure correction chart for type and length of hose used with pressure gage bar pounds per square inch.

] i. Pile driving cap, make, and mass (kilograms) weight (pounds).

j. Cushion block dimensions and material type.

k. Power pack description.

[2.3.1.2 Vibratory Hammers

[The use of vibratory hammers is dependent upon satisfactory driving and load testing of piles.][Final approval of the proposed hammer and other driving equipment is subject to the satisfactory completion and approval of the pile tests.][The size or capacity of hammers must be as recommended by the hammer manufacturer for the total pile mass weight and the character of the soil formation to be penetrated.] The hammer must provide for maintaining a rigid connection between the hammer and the pile. In accordance with paragraph SUBMITTALS, submit the following information for each vibratory hammer proposed:

a. Make and model.

b. Eccentric moment (newton-meters) (inch-pounds).

c. Dynamic force (kilonewtons) (tons).

d. Steady state frequency or frequency range (cycles per minute).

e. Vibrating mass (kilonewtons) weight (pounds).

f. Amplitude (millimeters) (inches).

g. Maximum pull capacity (metric tons) (tons).

h. Non-vibrating mass (kilonewtons) weight (pounds).

i. Power pack description.

]2.3.2 Pile Driving Leads

****

NOTE: Suspended leads should not be used on jobs where accurate pile placement and alignment are required.

Vibratory hammers are typically operated free hanging without leads unless accurate placement and alignment of the piles are required.

****

Support and guide hammers with fixed extended leads or fixed underhung leads.[For driving battered piles, support and guide impact hammers with three-axis, fixed-extended leads capable of 1 H and 2-1/2 V before and after batter and 1 H on 6 V side batter, with 30-degree rotation each side of an axis running along the center line of rotation of the crane through the center line of the leads.] Provide two intermediate supports for the pile in the leads to reduce the unbraced length of the pile during driving and pulling.

2.3.3 Pile Extractors

Pile extractors may be vibratory or impact pile driving hammers. Impact hammers are required for pulling piles not extractable with vibratory hammers.

[2.3.4 Jetting Equipment

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NOTE: Do not use jetting on piles carrying significant tension loads, lateral loads, or compression loads developed predominantly from skin friction.

****

Provide jetting equipment with not less than two removable or fixed jets of the water or combination air-water type. Design water jets so that the discharge volume and pressure are sufficient to freely erode the material immediately under and adjacent to piles without resulting in pile drift.

Submit jetting equipment including plant description, volume of water and pressure, and size and length of hoses and pipes in accordance with paragraph SUBMITTALS.

]PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Wave Equation Analysis of Pile Drivability

a. Prior to driving any pile, submit a pile Wave Equation Analysis, performed by Contractor's Geotechnical Consultant, for each size pile and distinct subsurface profile condition. These analyses must take into account the proposed hammer assembly, pile cap block and cushion characteristics, the pile properties and estimated lengths and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity.

b. Demonstrate using the Wave Equation Analysis that the piles will not be damaged during driving, indicate that the driving stresses will be maintained within the limits below and indicate the blow count necessary to achieve the required ultimate static pile capacities.

Allowable Driving Stresses

Steel Piles

Compression - 0.9 fy
Tension - 0.9 fy

Where fy is yield strength of steel

c. Perform a refined Wave Equation Analysis upon completion of the dynamic and static testing programs outlined in this specification section, taking into consideration the evaluated capacities, gain/loss factors and recommended production pile lengths.[Develop production pile driving criteria based on the results of the refined Wave Equation Evaluations.]

d. All pile driving equipment provided by the Contractor will be subject to the approval of the Contractor's Geotechnical Consultant. Complete the attached pile and driving equipment data form, including hammer information, in full as part of the submittal of the results of the Wave Equation Analyses.

e. Pay for the cost of performing the Wave Equation Analyses and include in the base bid.

3.1.2 Order List

Submit to the Contracting Officer for approval, an itemized quantities list for piles prior to placing the order with the supplier. Indicate the pile lengths required at each location as shown on the plans and the corresponding ordered length of each pile in the list.[Complete load testing and refined wave equation analysis and submit to Government for review and approval prior to submission of an order list.]

3.2 INSTALLATION

Inspect piles when delivered and when in the leads immediately before driving. Cut piles at cutoff grade by an approved method. Where cutoff is below existing ground or mudline elevation, complete excavation, sheeting, and dewatering before driving pile to driving criteria.

3.2.1 Lengths of Production Piles

The estimated quantities of piles are given for bidding purposes only. Drive piles to[or below "calculated"][indicated] tip elevation[to reach a driving resistance established by the wave equation analyses (WEAP) in accordance with the schedule which the Contractor's Geotechnical Consultant will prepare from the test-pile driving data].

3.2.2 Pile Driving Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not driven. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of driving, testing, recording and analysis of data for project may be useful.

Attach the specifications pile driving log graphic (for all pile driving projects) and the pile driving equipment data form (for projects using PDA) to the end of this specification section.

****

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations,[batter alignment,] number of blows required for each 300 mm foot of penetration and number of blows for the last 150 mm 6 inches penetration or fraction thereof [as required]for the "calculated"[driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, splicing, obstructions,[jetting,] and any driving interruptions.[Install an energy monitor on the hammers and record readings during pile installation.] A preprinted pile driving log for recording pile driving data [and pile driving equipment data form], which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables.

3.2.3 Pile Placement and Tolerances in Driving

Develop and submit a pile placement plan which shows the installation sequence and the methods proposed for controlling the location and alignment of piles. Submit pile placement plans at least 30 calendar days prior to delivery of piles to the job site. Complete all foundation preparation in the area prior to the placement of piles for driving.

Accurately place piles in the correct location and alignments, both laterally and longitudinally, and to the vertical or batter lines indicated. Establish a permanent base line to provide for inspection of pile placement by the Contracting Officer during pile driving operations prior to driving production piles and maintain during the installation of the production piles.

A final lateral deviation from the correct location at the cutoff elevation of not more than 76 mm 3 inches will be permitted for vertical and battered piles. Manipulation of piles will not be permitted. A variation of not more than 6 mm per 300 mm 0.25 inch per foot of pile length from the vertical for vertical piles nor more than 12 mm per 300 mm 0.50 inch per foot of pile length from the required angle for batter piles will be permitted. In addition to complying with the tolerances stated herein, the clear distance between the heads of piles and the edges of caps may be not less than 150 mm 6 inches. With prior approval of the Contracting Officer, the Contractor may provide additional concrete and reinforcement to maintain the required minimum clear distance. Redesign of pile caps or additional work required due to improper location of piles is the responsibility of the Contractor. A vertical deviation of not more than 25 mm one inch from the correct cutoff elevations shown is permitted. Inspect piles for heave. Redrive heaved piles to the required pile driving criteria. Maintain the correct relative position of all piles by the use of templates or by other approved means. Piles damaged or not located properly or exceeding the maximum limits for lateral and vertical deviation, or variation in alignment must be pulled and new piles redriven, or provide additional piles, at a location directed at no additional cost to the Government.

3.2.3.1 Survey Data

After the driving of each pile group is complete and before superimposed concrete is placed, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Submit the as-driven survey showing actual location and top elevation of each [production pile] [test pile] within [7] [_____] calendar days of completing the pile installation. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a land surveyor licensed in [_____].

3.2.4 Pile Penetration Criteria

The controlling driving resistance for production piles will be determined by the Contractor's Geotechnical Consultant. The required initial driving criteria and restrike will be established subsequent to the analysis of pile tests as specified in paragraph TEST PILES.

3.2.5 Pile Length Markings

Mark each pile prior to driving with horizontal lines at 305 mm one foot intervals. Mark the interval number on pile every 1.52 m 5 feet from pile tip.

3.2.6 Pile Driving

****

NOTE: Delete bracketed option for foundation excavation when not required. Delete items in brackets dealing with tip elevation and driving resistance when test piles or load tests are not used. Delete item in brackets regarding predrilling or jetting when procedure is not used. If needed, insert maximum hammer energy for no tip resistance. This can be determined by comparing tensile stresses in pile resulting from a Wave Equation Analysis with effective prestress in pile.
****

Notify Contracting Officer 10 days prior to driving of [test] piles [and load test].[Submit records for test piles][and][data for load tests].[The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analysis].][Stop foundation excavation at 300 mm one foot above foundation grade before piles are driven. Do not drive piles within 30 meter 100 feet of concrete less than 7 days old. Complete excavation to lines and grades shown when pile driving is completed.] Drive piles to [the terminal driving criteria] [or below "calculated"] [indicated tip elevation] [to reach a driving resistance established by the [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analyses (WEAP)] in accordance with the schedule which the [Contractor's Geotechnical Consultant] [Contracting Officer] will prepare from the test-pile driving data]. During initial driving and until pile tip has penetrated beyond layers of very soft soil [or below bottom of predrilled or prejetted holes], use a reduced driving energy of the hammer as required to prevent pile damage. Refusal criteria will be established by the Contracting Officer. If a pile fails to reach ["calculated"] [indicated] tip elevation, [or if a pile reaches ["calculated"] tip elevation without reaching required driving resistance,] notify Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB. Do not handle or move piles or pile sections in any manner that would result in cracking or permanent damage to the concrete or to the grout surrounding the prestressing cables. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

3.2.7 Protection of Piles

****
NOTE: Delete references to batter piles when not applicable to the project.
****

Take care to avoid damage to piles during handling, placing pile in leads, and during pile driving operations. Support piles laterally during driving, but allow rotation in leads.[Where pile or projecting reinforcement orientation is essential, take precautionary measures to maintain the orientation during driving.][Take special care in supporting battered piles to prevent excessive bending stresses in pile.] Maintain axial alignment of pile hammer with that of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through the reinforcement, by using a special driving head.

3.2.8 Rejected Piles

Withdraw piles damaged or impaired for use during handling or driving, mislocated, or driven out of alignment beyond the maximum tolerance. Replace with new piles or cut-off and abandon damaged or impaired piles and drive new piles as directed. Remove excess cut-off from piles and unacceptable piles from the work site. Perform all work in connection with withdrawing and removing rejected piles from the site at no additional cost to the Government.

3.2.8.1 Obstructions

If a pile encounters an underground obstruction within 5 feet of the ground surface of such size as to prevent driving the pile to the required driving criteria, the pile must be pulled or cut off at no cost to the Government. If such an obstruction is encountered more than 5 feet below the ground surface, the pile must be cut off and paid for as if a completed pile. In either event, a replacement pile must be installed at a location indicated by the Contracting Officer and paid for as a completed pile.

3.2.8.2 Splicing Piles

****

NOTE: Splicing of piles normally should not be permitted except where extremely long or heavy piles are required. If splices are permitted, drawings should indicate splice details. (See PCI standard drawings for typical splice details).

****

[Splicing of piles is not permitted.] [Make splices as indicated. Splices must be capable of developing the full strength of the member in compression, tension, shear, and bending. Submit detail drawings of splices and design calculations demonstrating the strength of the splice for approval.]

3.2.9 Jetting of Piles

****

NOTE: Jetting should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Adjacent to existing structures.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Water jets will [not] be permitted.[Use jetting to assist driving piles through strata that cannot be penetrated practicably by use of the hammer alone.[Restrict driving to a static weight while water is being injected to prevent inducing tensile stresses in the piles which damage the concrete.] Discontinue jetting and resume hammer driving after the penetration of the strata requiring jetting has been accomplished.][Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.][Take adequate measures for collecting and disposing of runoff water.][Jetting method and equipment will be approved by the Contracting Officer prior to commencing jetting operation.] Before starting final driving, firmly seat piles in place by application of a number of reduced energy hammer blows.[Employ measures, including use of a silt curtain, to contain turbid water created by jetting piles.]

3.2.10 Predrilling of Piles

****

NOTE: Predrilling should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Located in cohesionless soils.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven [will [not] be permitted] [will be provided].[The diameter of the hole may not exceed two-thirds the width of the pile.][Predrill only to a depth of [_____] meters feet below cut-off elevation prior to setting piles.][Discontinue drilling when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.]

3.2.10.1 Heaved Piles

When driving piles in clusters or under conditions of relatively close spacing, perform observations to detect heave of adjacent piles. Backdrive heaved piles to original to the required [depth of penetration] [tip elevation] [refusal blow count] as directed by the Contractor's Geotechnical Consultant, after reviewing the heave data, without additional cost to the Government.

3.2.10.2 Pulled Piles

Pull and replace piles damaged or impaired for use during driving with new piles, or cut off and abandon and drive new piles as directed without additional cost to the Government. The Contracting Officer may require that any pile be pulled for inspection. Redrive piles pulled as directed and found to be in suitable condition at another location as directed. Replace piles pulled as directed and found to be damaged with new piles at the Contractor's expense.

3.2.10.3 Long Piles

Provide pile driving rig with rigid supports so that leads remain accurately aligned. Where a high degree of accuracy is required, erect templates or guide frames at or close to the ground or water surface.

3.2.10.4 Welding

AWS D1.1/D1.1M. Welding of splices must conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop and field welding, qualification of welding procedures, welders, and welding operators must be in accordance with AWS D1.1/D1.1M.

[3.2.11 Protection of Existing Structures

****

NOTE: Include this paragraph only when protection of existing structures from pile driving activities is required.

Indicate on the drawings all structures and facilities for which protection is required. Provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.

****

Mitigate impact on existing facilities due to pile driving activities in accordance with the [project specific document] [_____].

][3.2.12 Concrete Infill

****

NOTE: Include this paragraph only when concrete infill is required.

Add any additional requirements as necessary.

****

Mix and place concrete infill in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 31 62 13.13 CAST-IN-PLACE CONCRETE PILES. Place concrete to the elevations as shown on the [contract documents] [Drawings] [plans].

]3.3 FIELD QUALITY CONTROL

3.3.1 Test Piles

****

NOTE: Select the second bracketed option when soil conditions dictate the use of a test pile longer than production piles. The ordered pile length for test piles should be 1.5 m 5 feet longer than ordered length for production piles to allow additional penetration if driving conditions

dictate. Indicate location and number (if required) of test piles on plans, or list appropriate soil boring test hole numbers.
****

[Use test piles of type, and drive as specified for piling elsewhere in this section.][Order test piles [_____] meters feet longer in length than production piles. Drive the additional test pile length only at the direction of the Contracting Officer.] The [Contractor's Geotechnical Consultant] [Contracting Officer] will use test pile data to determine "calculated" pile tip elevation or necessary driving criteria. Drive test piles [at the locations indicated] [in vicinity of soil boring test holes Nos. [_____,] [_____,] and [_____]]. Drive test piles to [indicated tip elevation] [indicated bidding lengths] [required driving criteria]. Use test piles, if located properly and offering adequate driving resistance in finished work.[Pre-drilling or jetting is permitted only when test piles clearly establish validity of its use, or as directed by the Contracting Officer.][Provide and operate a pile driving analyzer as specified in paragraph DYNAMIC PILE ANALYSIS during the driving of each test pile. Modify driving as required based upon recommendation of [Contracting Officer] [Contractor's Geotechnical Consultant and approval of the Contracting Officer].]

3.3.1.1   Dynamic Pile Analysis

Dynamic testing provides supplemental information for evaluating pile integrity, hammer and drive system performance, assess pile installation driving stresses, and pile capacities. Perform dynamic testing on [_____] percent of the [test] piles during the full length of the pile driving and during restrike a minimum of [_____] days after initial driving. Dynamic pile testing must also be performed on [_____] production piles as chosen by the Contracting Officer. Use [test] piles of type as specified elsewhere in this section. Provide equipment to obtain dynamic measurements, record, reduce and display its data that meet the requirements of ASTM D4945. The equipment must have been calibrated within [6] [_____] months prior to the start of the testing operations and thereafter throughout the contract duration. Drive [test] piles at the locations indicated or at the locations selected by the Contracting Officer. Employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile driving process[, monitoring of test pile installation,] and in the use of the Pile Driving Analyzer and its related equipment. Submit a performance report summarizing dynamic test results for [test] piles within [7] [_____] calendar days of completing field work.[For production piles, submit a performance report within one day of testing. Submit a typed report summarizing the results of dynamic testing of production piles on a monthly basis.] Perform dynamic pile analysis as follows:

3.3.1.2   Pile Analyzing

[_____] working days prior to driving the [test] piles, submit the pile and complete driving equipment data to the Contracting Officer. The Contractor's Geotechnical Consultant must use the submitted information to perform wave equation analyses and prepare a summary report of the wave equation results. The wave equation analysis using GRLWEAP software by Pile Dynamics, Inc. or equivalent is used to assess the ability of the proposed driving system to install the pile to the required capacity and desired penetration depth within the allowable driving stresses. Approval of the proposed driving system by the Contracting Officer will be based upon the wave equation analyses indicating that the proposed driving system can develop a pile capacity of [_____] kN kips at a driving resistance not greater than [_____] mm/blow blows per inch within allowable driving stress limits. The hammer must also be sized or adjustable such that the penetration per blow at the required ultimate capacity does not exceed 12 mm 0.5 inches.

3.3.1.3 Pile Drivability

Perform each dynamic pile analysis in two steps. The first step is to check the hammer, pile and soil performance, and to determine the suitability of the proposed hammer for the size, length and type of pile being installed for the soil types encountered as the piles are driven. This initial monitoring will determine whether pre-augering or jetting is appropriate, efficiency of the hammer relative to specified efficiency, effectiveness of cushion, level of compressive and tensile stress in pile and extent/location of any pile damage caused by the initial driving. With each blow of the pile, record the information listed below electronically and analyze the information using the Pile Driving Analyzer:

a. Blow number

b. Blow rate per minute and stroke.

c. Input and reflected values of force and velocity.

d. Value of upward and downward traveling force wave with time.

e. Maximum and final transferred energy to pile, hammer system efficiency.

f. Maximum compressive stress, velocity, acceleration and displacement.

g. Maximum tensile stress in pile.

h. Pile structural integrity, damage detection, extent and location.

i. Bearing capacity of pile by Case method.

If the pile, hammer and soil performance evaluation recommends changes to the hammer stroke, pile cushioning, augering or any other aspect for the pile driving operation, incorporate these changes into production pile driving in an effort to control excessive stresses and pile damage. Replace test piles damaged or broken during installation, incorporating driving modifications as determined by the Contractor's Geotechnical Consultant and reviewed and approved by the Contracting Officer. Repeat this procedure until allowable tensile and compressive stresses are achieved in the pile and pile damage is minimized. Subject selected initial driving records to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and estimation of anticipated gain/loss factors.

3.3.1.4 CAPWAP

Perform signal matching analysis by CAPWAP software of the dynamic pile testing data on data obtained from the end of initial driving and the beginning of restrike of all control piles. CAPWAP analyses must be performed by an engineer who has achieved Advanced Level or better on the PDI / PDCA Dynamic Measurement and Analysis Proficiency Test for Providers of PDA Testing Services.

Upon completion of [test] pile driving, allow the piles to set-up for at least [72 hours] [_____ days]. After evaluation of pile, hammer and soil performance by the Contractor's Geotechnical Consultant, the second step of the dynamic pile analysis may proceed. This portion of the evaluation requires striking the set-up piles a minimum of 20-50 times, or as directed by the Contractor's Geotechnical Consultant using the same hammer which was used for the [test] pile driving and which will be used for production pile driving. "Warm up" the hammer and make it optimally ready prior to restriking, in order to avoid capacity losses during evaluation of restrike data. Apply maximum hammer energy during restrike in order to fully mobilize the soil resistance. However, exercise care so as to not overstress the pile. In addition to those items listed above, selected restrike driving records (as directed by the Contractor's Geotechnical Consultant are to be subjected to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and plot of applied load vs. average pile displacement based on the calculated soil properties.

3.3.1.5 Dynamic Load Test Reporting

a. Upon satisfactory completion of each dynamic load test, submit [a minimum of three copies of] a Pile Performance Report for the Contractor by the Contractor's Geotechnical Consultant. The submittal must be prepared and sealed by a Professional Engineer registered in [_____].

b. Include in the report for the Dynamic Pile Analysis the following information:

   (1) Capacity of pile from Case Pile Wave Analysis Program (CAPWAP). Information resulting from analysis of a selected restrike blow.

   (2) Maximum and final transferred energy, hammer system efficiency during pile installation.

   (3) Maximum compressive stress, velocity, acceleration and displacement.

   (4) Maximum tensile stress in pile.

   (5) Pile structural integrity, damage detection, extent and location.

   (6) Blows per minute and blow number.

   (7) Input and reflection values of force and velocity, upward and downward traveling force wave with time.

   (8) Pile skin friction and toe resistance distribution.

   (9) Maximum energy transferred to pile.

c. The maximum allowable pile design load must be proposed by the Contractor's Geotechnical Consultant based upon the results of a satisfactory pile load test conducted on a pile driven as specified herein and include the effects of load transfer to the soil above the foundation stratum.

Use either a Model 8G or PAX Pile Driving Analyzer as manufactured by Pile Dynamics, Inc., of Cleveland Ohio or approved equivalent, for dynamic testing of the pile hammer and for dynamic load testing of the test pile. All equipment necessary for the dynamic monitoring such as sensors, cables or wireless transmitters, must be furnished by the Contractor's Geotechnical Consultant, and conform to the requirements of ASTM D4945.

Pay for all services of the Contractor's Geotechnical Consultant. The Contractor's Geotechnical Consultant must be available throughout the pile driving operation to consult with the Contracting Officer when required by the Contracting Officer. The cost of changes in the Contractor's procedure, as required by evaluation of the results of the Pile Driving Analysis, will be at the Contractor's expense.

3.3.2 Static Load Tests

****

NOTE: If pile load tests are required and approved by the Contracting Officer, specify number and location of piles. Select method of load test. In ASTM D1143/D1143M, permit anchor piles only if approved by the Contracting Officer's Technical Representative (Geotechnical Branch). Insert figure kNkips corresponding to 200 percent of the design load. Select appropriate acceptance criteria. The offset method (first option) is usually recommended.

****

Perform compressive load tests on [_____] test piles in accordance with ASTM D1143/D1143M (standard loading procedure) as modified herein.[Allow a minimum of [72 hours] [_____ days] following final test pile driving for pile set-up prior to load testing.][Do not use anchor piles.] Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform[or reaction frame attached to sufficient uplift piles to safely take required load] applied to pile by hydraulic jack. Increase load in increments until rapid progressive settlement takes place or until application of total compressive load of [_____] KN kips for compressive load tests. Consider load test satisfactory when [after one hour at full test load gross settlement of pile butt is not greater than gross elastic pile compression plus 4 mm 0.15 inch plus one percent of pile tip diameter or width in [_____] mm inches,] [slope of gross load-settlement curve under full test load does not exceed 1.5 mm per metric ton 0.05 inches per ton,] [net settlement after removal of test load does not exceed 19 mm 3/4 inch]. Perform load tests at locations [as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

[3.3.2.1 Safe Design Capacity

Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.

]3.3.3 Tensile Load Test

Perform tensile load tests on [_____] test piles in accordance with

ASTM D3689. Apply a tensile load of [_____] kN kips to each tensile load test pile. In performing the tension load test, apply the ultimate load equal to one and one-half times the safe tension capacity, and employ the Standard Loading Procedure.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

Perform dynamic measurements on [_____] piles designated as dynamic test piles in accordance with ASTM D4945 during driving. During easy driving, ensure that damaging tension stresses do not develop in the pile. Signal matching must be performed by the Contractor's Geotechnical Consultant on representative data collected at the end of the initial driving and at the beginning of all restrike events. Perform additional signal matching analysis as determined by the Engineer.

3.3.4 Lateral Load Test

Perform lateral load tests on [_____] piles in accordance with ASTM D3966/D3966M. Lateral load tests consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. Apply a lateral load of [_____] kN kips to each pair of lateral load test piles. Record required movement readings for each pile.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

3.3.5 Pile Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not driven. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of driving, testing, recording and analysis of data for project may be useful.

****

****

NOTE: Attach the specifications pile driving log graphic (for all pile driving projects) and the pile driving equipment data form (for projects using PDA) to the end of this specification section.

****

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations, [batter alignment,] number of blows required for each 300 mm foot of penetration and number of blows for the last 150 mm 6 inches penetration or fraction thereof [as required] for the "calculated" [driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, splicing, obstructions, [jetting,] and any driving interruptions.[Install an energy monitor on the hammers and record readings every 250 mm 10 inches of pile installation.] Submit to the Contracting Officer complete and accurate test and production pile driving records within 15 calendar days after completion of driving. Make pile driving records available to the Contracting Officer at the job site, within 24 hours after each day of pile driving. A preprinted pile driving log for recording pile driving data[and pile driving equipment data form], which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables.

3.3.6 Testing Agency Qualifications

Engage an independent testing agency to observe the production piles installation. The testing agency must be qualified according to ASTM E329 for testing indicated. Submit testing agency qualifications to the Contracting Officer for approval.

3.3.7 Welding Inspection

Employ a testing agency to perform the welding inspections as specified in the statement of special inspection.

3.3.8 Weld Testing

In addition to visual inspection, welds must be tested and inspected according to AWS D1.1/D1.1M and inspection procedures listed below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.[Test [10] [_____] percent of pile splices, the steel pile cap splice connections and the steel pile insert connection.]

a. Liquid Penetrant Inspection: ASTM E165/E165M.

b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

c. Radiographic Inspection: ASTM E94/E94M, minimum quality level "2-2T."

d. Ultrasonic Inspection: ASTM E164.

[3.3.9 Concrete Infill

Perform field quality control testing of the concrete infill in accordance with Sections 03 30 00 CAST-IN-PLACE CONCRETE and 31 62 13.13 CAST-IN-PLACE CONCRETE PILES.

]3.4 TOUCHUP PAINTING

Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC PA 1. Use same paint and apply same number of coats as specified. Apply touchup paint before driving piles to surfaces that are immersed or inaccessible after driving.

[3.5 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-301-01 "Structural Engineering" and UFC 3-301-02, "Design of Risk Category V Structures, National Strategic Military Assets".

Indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

][3.6 VIBRATION CONTROL

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs] [and geophones] within a distance of 61 meters 200 feet from the pile driving activity.[Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [5] [_____] years of experience in vibration monitoring. A minimum of [28] [_____] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient vibrations. The vibration during the pile driving activities must be limited to [a peak particle velocity of not more than 5 cm 2.0 inches per second] [the limits mentioned in the [contract documents]].[Determine appropriate vibration limits as per [US Bureau of Mines] [American Association of State Highway and Transportation Officials (AASHTO)] guidelines.] During pile driving activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity causing the vibration until [the Vibration consultant and the Contracting Officer] [_____] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor is responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.7   NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria or requirements as necessary for the particular project.

****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the pile driving operations.[Perform noise monitoring using [noise meters][, and] [_____]].[Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [5] [_____] years of experience in noise monitoring. A minimum of [28] [_____] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient noise levels.[The noise limits are mentioned in the [plan] [contract documents].][Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines.] During pile driving activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity and install noise mitigation measures.

The Contractor is responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.8   PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria or requirements as necessary for the particular project.

****

Perform preconstruction condition survey of [structures] [and utilities] [within 61 meters 200 feet of the pile driving activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] [_____] days before performing the preconstruction condition survey. Obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey will include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] [_____] days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

][3.9 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile driving activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement [and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile driving. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile driving when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile driving activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation and monitoring program reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 62 16.16 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-31 62 16.16 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-31 62 16.16 (November 2020)**

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References are in agreement with UMRL dated January 2025

****

SECTION 31 62 16.16

STEEL H-PILES

11/20, CHG 2: 02/24

****

NOTE: This guide specification covers the requirements for furnishing all equipment, labor, and materials (except materials specified to be furnished by the Government) and performing all operations in connection with the furnishing, installing and testing of steel H-piles in accordance with these specifications and applicable drawings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

****

NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.

****

****
NOTE: Show the following information on the project drawings:

1. Location, size, and cutoff elevation of project piles.

2. Location, size, cutoff elevation, and identification of test piles.

3. Subsurface soil data logs. Other subsurface data is design information and is not a part of the contract. Make data available for examination by the bidders at appropriate locations.

4. Staging area.
****

PART 1 GENERAL

****
NOTE: Structural engineer must confirm the structural capacity of piles and provide specific bending moments, lateral loads and other design requirements for pile design.
****

1.1 DESCRIPTION

Design, furnish, install and test piles at the locations indicated on the drawings and specified herein.[Assume test pile[s] will be directed to be placed in [a]location[s] that can be incorporated into the work.]

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588/A588M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A690/A690M	(2024) Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations
ASTM E94/E94M	(2022) Standard Guide for Radiographic Examination Using Industrial Radiographic Film
ASTM E164	(2024) Standard Practice for Contact Ultrasonic Testing of Weldments
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

ASTM E709	(2021) Standard Guide for Magnetic Particle Testing

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-220-01	(2012; with Change 1, 2021) Geotechnical Engineering

[1.3 SUBSURFACE DATA

****

NOTE: Section 00 31 32.13 Subsurface Drilling and Sampling Information is not a UFGS. CSI MasterFormat prescribes this section for inclusion of this data.

****

Subsurface soil data logs are[indicated][appended to the special contract requirements][provided on the project drawings].[The subsoil investigation report samples of material taken from subsurface investigations may be examined at [_____].]

]1.4 BASIS OF BID

****

NOTE: Select one of the following options:

****

****

NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of piles must be determined as accurately as possible, prior to bidding, since the unit price per meter foot of the piles varies as the length increases or decreases. Refer to Standard Test Method for High-Strain Dynamic Testing of Deep Foundations (ASTM D4945).

****

1.4.1 Production Pile Acceptance Criteria

Safe design capacity for piles is [_____] KN kips. Drive piles to[minimum tip elevation][a minimum depth of [_____] m feet below cut-off elevation], and to such additional depth as required to obtain a bearing capacity of not less than [_____] KN kips. The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at end of drive or restrike] [static load tests] [wave equation analysis].

The following formulas can be used in cases where allowable pile loads are less than 355 kN 80 kips (determined using a factor of safety of 3 for individual piles and 4 for pile groups) and are presented only as a guide to aid in establishing the controlling penetration per blow, which, together with the minimum depth of penetration will serve to determine the required minimum depth of penetration of each individual pile:

$$R = \frac{2E}{S \text{ plus } 0.1}$$ For double acting hammers

$$R = \frac{2WH}{S \text{ plus } 0.1}$$ For single acting hammers

Where R is the approximate allowable pile load in kips; E equals the energy in foot-kips per blow based on an acceptable certified statement from the manufacturer of the hammer; W equals the weight of the hammer or ram in kips; H equals the height of fall of the hammer of ram in feet; and S equals the average inches of penetration per blow for the last three blows. An allowance will be made for reduced penetration caused by shock absorption of the cushion or cap blocks.

[1.4.2 Lump Sum Payment

****

NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection. This paragraph will be typically used when there are 1) relatively small quantity of piles, 2) allowable pile loading is less than 355 kN 80 kips (, and 3) the subsurface conditions are well defined. Fill in Table I as required selecting columns applicable to project. Generally, pile capacity, location, and minimum tip elevation are shown on plans. Test piles and load tests are not incorporated on lump sum contracts. Delete this paragraph for unit-price contracts.

****

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.][following Table I:

Table 1

[Location]	Number	Size	[Capacity]	Length (Tip to Cut-Off)	[Maximum Bending Moment]	[Maximum Shear Force]

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off, dispose of any cut-offs, and meet the applicable contract requirements. Include mobilization, pre-drilling, and redriving heaved piles. If, in redriving, it is found that any pile is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be provided and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. If total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; backdriving; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys].

][1.4.3 Unit Price

****

NOTE: Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments in price schedule for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

For NAVFAC Southeast projects, where there is a need for unit pricing of piles, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items.

****

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****

NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.

****

Requirements of FAR 52.211-18 Variation in Estimated Quantity do not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and driving the piles including mobilization and demobilization,[jetting][predrilling][probing], redriving uplifted piles, [an additional 1.5 m 5 feet in furnished length for any test pile not driven beyond estimated pile length,]and cutting off piles at the cut-off elevation.[Include the cost for additional length for the test piles in the total unit price cost for the job.] Payment will be made for production [and test piles]at the bid unit price for the length of pile, from tip to final cut-off, actually provided, excluding buildups and splices directed by the Contracting Officer to be made. If the actual cumulative pile length driven (tip to cut-off) vary more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of FAR 52.236-2 Differing Site Conditions.[Payments will be made per each at the respective bid unit price for pile cut-offs, pile build-ups, pile loads tests and pile splices.][Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys].

][1.5 PAYMENT

****

NOTE: Delete this paragraph for lump-sum contracts.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (PAYMENT) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****

1.5.1 Furnishing and Delivering Piles

1.5.1.1 Payment

Payment will be made for costs associated with furnishing and delivering the required lengths of permanent steel H piles, which includes costs of furnishing and delivering piles to the work site. No payment will be made for the driving head or lengths of piles exceeding required lengths. No payment will be made for piles damaged during delivery, storage, or handling to the extent that they are rendered unsuitable for the work, in the opinion of the Contracting Officer.

1.5.1.2 Measurement

Furnishing and delivering steel H piles will be measured for payment by the linear meter foot of piles required below the cut-off elevation as [determined by the Contracting Officer and furnished to the Contractor] [indicated].

1.5.1.3 Unit of Measure

Linear meter foot.

1.5.2 Driving Steel H Piles

1.5.2.1 Payment

Payment will be made for costs associated with driving steel H piles, which includes costs of handling, driving,[and splicing of piles,][performing dynamic testing, interpreting data and submitting reports,] measuring heave, redriving heaved piles, removal of[build-ups] driving heads or cutting off piles at the cut-off elevation and removing from the work site, compiling and submitting pile driving records, backfilling voids around piles, and any other items incidental to driving piles to the required elevation.

1.5.2.2 Measurement

Steel H piles will be measured for payment for driving on the basis of lengths, to the nearest hundredth (tenth) of a linear meter foot, along the axis of each pile acceptably in place below the cut-off elevation shown.

1.5.2.3 Unit of Measure

Linear meter foot.

1.5.3 Pulled Steel H Piles

1.5.3.1 Payment

Payment will be made for costs associated with piles pulled at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing and delivering pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Furnishing and Delivering Piles". The cost of driving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Steel H Piles". The cost of pulling undamaged piles will be paid for at twice the applicable contract unit price for payment item "Driving Steel H Piles", which includes backfilling any remaining void. The cost of redriving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Steel H Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of piles, including pile driving points, pulled and found to be damaged and backfilling voids. New piles replacing damaged piles will be paid for at the applicable contract unit price for payment items "Furnishing and Delivering Steel H Piles" and "Driving Steel H Piles".

1.5.3.2 Measurement

Furnishing and delivering pulled and undamaged steel H piles will be measured for payment as specified in paragraph PAYMENT, subparagraph FURNISHING AND DELIVERING PILES. Pulling steel H piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL H PILES. Redriving pulled undamaged steel H piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL H PILES. New piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraphs FURNISHING AND DELIVERING PILES and DRIVING STEEL H PILES.

1.5.3.3 Unit of Measure

Linear meter foot.

[1.5.4 Pile Driving Tests

1.5.4.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of driven test piles, [including [pile driving points][and][splices];]conducting pile driving tests; backfilling voids around piles; compiling pile driving test records[; performing dynamic testing; interpreting data; and submitting reports].

1.5.4.2 Measurement

Pile driving tests will be measured for payment on the basis of the applicable contract unit price per pile driving test.

1.5.4.3 Unit of Measure

Each.

][1.5.5 Piles for Load Tests

1.5.5.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of load test piles, [including [pile driving points][and][splices];]backfilling voids around piles; compiling pile driving records[; furnishing, fabricating, and mounting of strain rods and protective assembly][; furnishing, fabricating, and mounting of inclinometer and inclinometer protective assembly][; performing dynamic testing; interpreting data; and submitting reports]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

1.5.5.2 Measurement

Piles piles for load tests will be measured for payment on the basis of the applicable contract unit price per load test pile.

1.5.5.3 Unit of Measure

Each.

][1.5.6 Pile Static Axial Compressive Load Tests

1.5.6.1 Payment

Payment will be made for costs associated with pile static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static axial compressive load tests.

1.5.6.2 Measurement

Pile static axial compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.5.6.3 Unit of Measure

Each.

][1.5.7 Pile Static Tensile Load Tests

1.5.7.1 Payment

Payment will be made for costs associated with pile static tensile load tests in accordance with ASTM D3689, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static tensile load tests.

1.5.7.2 Measurement

Pile tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load test.

1.5.7.3 Unit of Measure

Each.

][1.5.8 Pile Lateral Load Tests

1.5.8.1 Payment

Payment will be made for costs associated with pile lateral load tests in accordance with ASTM D3966/D3966M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing inclinometers; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile lateral load tests.

1.5.8.2 Measurement

Pile lateral load tests will be measured for payment on the basis of the applicable contract unit price per lateral load test.

1.5.8.3 Unit of Measure

Each.

][1.5.9 Pulled Load Test Piles

1.5.9.1 Payment

Payment will be made for costs associated with load test piles pulled prior to load testing at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing, delivering, driving, and pulling undamaged load test piles will be paid for at the applicable contract unit price for payment item "Piles for Load Tests". The cost of pulling undamaged load test piles the second time after redriving and testing will be paid for at twice the applicable contract unit price for payment item "Driving Steel H Piles". The cost of redriving pulled undamaged load test piles will be paid for at the applicable contract unit price for payment item "Driving Steel H Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of load test piles pulled at the direction of the Contracting Officer and found to be damaged. New load test piles replacing damaged piles will be paid for at the applicable contract unit price for payment item "Piles for Load Tests".

1.5.9.2 Measurement

Pulled undamaged load test piles will be measured for payment as specified in paragraph PAYMENT, subparagraph PILES FOR LOAD TESTS. Pulling undamaged load test piles the second time after redriving and testing will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL H PILES. Redriving pulled undamaged steel H piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING STEEL H PILES. New load test piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraph PILES FOR LOAD TESTS.

1.5.9.3 Unit of Measure

As specified in paragraph PAYMENT, subparagraphs DRIVING STEEL H PILES and PILES FOR LOAD TESTS, respectfully.

][1.5.10 Pile Driving Shoes and Points

1.5.10.1 Payment

Payment will be made for costs associated with pile driving shoes, pile driving points, including furnishing, delivering, and installing.

1.5.10.2 Measurement

Pile driving shoes will be measured for payment on the basis of the number of pile driving shoes required.

1.5.10.3 Unit of Measure

Each.

][1.5.11 Pile Splices

1.5.11.1 Payment

Payment will be made for costs associated with pile splices, including all plant, labor, and material required to make the splice.

1.5.11.2 Measurement

Pile splices will be measured for payment on the basis of the applicable contract unit price per pile splice.

1.5.11.3 Unit of Measure

Each.

][1.5.12 Vibration Monitoring

1.5.12.1 Payment

Payment will be made for costs associated with vibration monitoring.

1.5.12.2 Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.12.3 Unit of Measure

Each.

][1.5.13 Sound Monitoring

1.5.13.1 Payment

Payment will be made for costs associated with sound monitoring.

1.5.13.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.13.3 Unit of Measure

Each.

][1.5.14 Preconstruction Condition Survey

1.5.14.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.5.14.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.5.14.3 Unit of Measure

Each.

][1.5.15 Construction Instrumentation and Monitoring

1.5.15.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.5.15.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.5.15.3 Unit of Measure

One.

]]1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G, [_____]

Contractor's Geotechnical Consultant; G, [_____]

Testing Agency Qualification; G, [_____]

[Wave Equation Analysis; G, [_____]

][Instrumentation and Monitoring Program Report; G, [_____]

] SD-02 Shop Drawings

Pile splices; G, [_____]

Pile placement; G, [_____]

[Pile Reinforcing Tips or Steel Points

][Pile Encasements

][Pile Load Test Frame

] SD-03 Product Data

Pile Driving Equipment; G, [_____]

Pile Driving Records; G, [_____]

Delivery, Storage, and Handling; G, [_____]

SD-05 Design Data

[Wave Equation Analysis

] Quantities List; G, [_____]

Procedure for Insufficient Pile Length; G, [_____]

SD-06 Test Reports

[Test Pile; G, [_____]

][Load Test; G, [_____]

][Dynamic Pile Analysis; G, [_____]

] Pile Performance Report

SD-07 Certificates

Pile Material Certificates of Compliance; G, [_____]

Pile Splices; G, [_____]

Pile Shoes; G, [_____]

SD-11 Closeout Submittals

Pile Driving Records

1.7 DELIVERY, STORAGE, AND HANDLING

Conform all delivery, storage, and handling of materials to the requirements specified herein. Develop and submit plans for the delivery, storage, and handling of piles. Submit delivery, storage, and handling plans for piles at least 30 calendar days prior to delivery of piles to the job site.

1.7.1 Delivery and Storage

Stack piles during delivery and storage so that each pile is maintained in a straight position and is supported every 3 m 10 feet or less along its length (ends inclusive) to prevent exceeding the maximum camber or sweep. Do not stack piles more than 1.5 m 5 feet high.

1.7.2 Handling

Lift piles using a cradle or multiple points pick-up to ensure that the maximum permissible camber or sweep is not exceeded due to insufficient support for lifting piles that are not extremely long into the driving leads. One pick up point can be used for short piles. Point pick-up devices must be of the type that clamp to both pile flanges at each pick-up point. Holes may be burned in the flanges or webs of piles above the cutoff length for lifting piles into the leads. Do not damage piles when dragging piles across the ground.

1.7.3 Excessive Camber, Sweep, and Damage

Inspect piles for excessive camber and sweep and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Camber, curvature in the pile in the direction normal to the pile flanges, must be measured with the pile flange base laying on a flat surface and is the distance between the flange base at the mid-length of the pile and the flat surface. Sweep, curvature in the pile in the direction parallel to the pile flanges, must be measured with the pile flange tips laying on a flat surface and is the distance between the flange tips at the mid-length of the pile and the flat surface. The maximum permissible camber [and][or] sweep is 50 mm 2 inches over the length of the pile. Piles having excessive camber or sweep will be rejected.

1.7.4 Damaged Piles

Inspect each pile for straightness and structural damage before transporting them to the project site and immediately prior to placement in the driving leads. Bring any damage to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

Any pile damaged by reason of internal defects or by improper driving must be corrected by one of the following methods approved by the Engineer for the pile in question:

a. The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile.

b. One or more replacement piles are driven adjacent to the defective pile.

c. A Pile Dynamic Analysis and low integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

1.7.5 Pile Butt Location and Elevation

A pile driven below the specified butt elevation must be corrected by one of the following methods approved by the Engineer:

a. One or more replacement piles are driven next to the pile in question.

b. As directed by the structural engineer.

A pile driven out of its proper location or out of plumb as approved by the Engineer, must be corrected by one of the following methods approved by the engineer:

a. One or more replacement piles are driven next to the pile in question.

b. As directed by the structural engineer.

[1.7.6 Pile Sweep

Limit sweep to 3 mm per 3 M 1/8 inch per 10 feet over the length of the pile. Piles having excessive sweep will be rejected.

]1.8 QUALITY CONTROL

1.8.1 Piles

Prepare and submit shop drawings. Indicate placement of piles. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up.

1.8.2 Contractor's Geotechnical Consultant

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and Pile Dynamic Analysis, to observe test pile installation and production pile installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and must have no employee of employer relationship which could constitute a conflict of interest. Submit Contractor's geotechnical consultant qualifications at least 30 calendar days before pile installation.

Provide instructions and procedures on how the Contractor will assist the Government in the processes of[Dynamic Pile Testing,] Inspection and Monitoring of piles during installation and testing.

1.8.3 Pile Manufacturer's Quality Control Procedures

Submit the pile manufacturer's quality control procedures.

1.8.4 Installation Procedures

a. Submit information on the type of equipment proposed to be used, proposed methods of operation, pile driving plan including proposed sequence of driving, and details of all pile driving equipment and accessories. Submit pile driving equipment information at least 30 calendar days prior to commencement of work.

[b. Provide details of pile driving equipment and a Wave Equation Analysis of pile drivability for selection of the hammer along with a statement of driving procedures.[Submit wave equation analysis for each pile location.] The Wave Equation Analysis is to be completed by the Contractor's Geotechnical Consultant for each test pile location where different subsurface conditions exist and is to include the following information pertaining to the proposed pile driving equipment:

(1) Complete Pile and Driving Equipment Data Form, (which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables) for each proposed pile hammer and pile type combination.

(2) Copies of computer input and output sheets and graphs showing soil resistance versus blow count as well as maximum tension and compression stresses versus blow count. Analysis must be run at

the estimated tip elevation as well as other required elevations to define maximum stress levels in the pile during driving.

c. Provide detailed procedures for conducting the dynamic pile load test and equipment to be used for conducting the load test. The detailed description must explain how specific information of pile performance will be evaluated.

][1.8.5 Load Test Supporting Data

Submit Jack calibration records, a testing arrangement description and diagram, and the proposed loading sequence.

]PART 2 PRODUCTS

2.1 PILE REQUIREMENTS

****

NOTE: Delete sentence in brackets when test piles are not required. Government requires the Contractor to employ a Geotechnical Consultant to determine the calculated tip elevation and provide oversight of piling installation and testing.

****

[Order test piles [3] [_____] meters [10] [_____] feet longer in length than production piles.[Drive the additional test pile length only when based upon the recommendation of the Contractor's Geotechnical Consultant and approved by the Contracting Officer.] Submit test pile and load test reports. The[Contractor's Geotechnical Consultant][Contracting Officer] will use test pile data to determine "calculated" pile tip elevation and necessary driving resistance. This information will be given to the Contractor no later than 7 days from receipt of complete test data. Use this list as the basis for ordering the piles. Do not order piles until list is provided by the[Contractor's Geotechnical Consultant][Contracting Officer].][Provide test piles [1.5] [_____] meter [5] [_____] feet longer than the bid length.]

2.2 MATERIALS

****

NOTE: Base selection of material on a comprehensive study of strength, cost, and corrosion resistance requirements.

ASTM A36/A36M and ASTM A572/A572M steels have the same corrosion resistance; ASTM A572/A572M can be obtained in yield strengths of 350 MPa through 448 MPa 42 ksi through 65 ksi; however, 350 MPa 50 ksi is the most available grade. ASTM A588/A588M has twice the atmospheric resistance of ASTM A36/A36M steel with 20 percent copper added.

1. Marine environment: Evaluate steel section piles exposed to seawater on the basis of application, location, degree of exposure, type of structure, and required service life. Where additional service life in the splash zone is required over that provided by conventional steel

grades, ASTM A690/A690M or ASTM A588/A588M may be considered. ASTM A690/A690M steel 350 MPa 50 ksi (yield strength) has two to three times greater resistance to seawater splash zone corrosion than ordinary ASTM A36/A36M steel.

2. Seawater protection: To obtain reasonably long life for a structure immersed in seawater, provide steel piles with coatings, cathodic protection, or concrete encasement. Choice of protection is ultimately based on economics; usually, more than one type of protection will be used on a structure for most economical, adequate protection. The following criteria applies:

a. The use of coating systems for protection, such as coal tar epoxy, is usually low in initial cost but may require relatively frequent maintenance; also, it is extremely difficult to renew in the tidal zone between mean tide and low tide.

b. Cathodic protection is low in initial cost and low in maintenance. It can be of value only where the piles are continually wet, as in the submerged zone.

c. Concrete encasement or metal jacketing is relatively expensive in initial cost but requires no maintenance if properly constructed. When concrete encasement is to be continuously submerged in water with low resistivity, it must (1) extend below the mudline, or (2) be coated to electrochemically insulate the concrete from the steel.

Use high-strength steel only when design analyses show that the use is the most economical solution or to increase the design life if approved by the Contractor's Geotechnical Consultant.

ASTM A27/A27M cast steel is used for some commercially available pile points.

****

2.2.1 H-Piles

****

NOTE: Base selection of material on a comprehensive study of strength, cost, and corrosion resistance requirements.

ASTM A36/A36M and ASTM A572/A572M steels have the same corrosion resistance; ASTM A572/A572M can be obtained in yield strengths of 350 MPa through 448 MPa 42 ksi through 65 ksi; however, 350 MPa 50 ksi is the most available grade. ASTM A588/A588M has twice the atmospheric resistance of ASTM A36/A36M steel with 20 percent copper added.

1. Marine environment: Evaluate steel section piles exposed to seawater on the basis of application, location, degree of exposure, type of structure, and required service life. Where additional service life in the splash zone is required over that provided by conventional steel grades, ASTM A690/A690M or ASTM A588/A588M may be considered. ASTM A690/A690M steel 350 MPa 50 ksi (yield strength) has two to three times greater resistance to seawater splash zone corrosion than ordinary ASTM A36/A36M steel.

2. Seawater protection: To obtain reasonably long life for a structure immersed in seawater, provide steel piles with coatings, cathodic protection, or concrete encasement. Choice of protection is ultimately based on economics; usually, more than one type of protection will be used on a structure for most economical, adequate protection. The following criteria applies:

a. The use of coating systems for protection, such as coal tar epoxy, is usually low in initial cost but may require relatively frequent maintenance; also, it is extremely difficult to renew in the tidal zone between mean tide and low tide.

b. Cathodic protection is low in initial cost and low in maintenance. It can be of value only where the piles are continually wet, as in the submerged zone.

c. Concrete encasement or metal jacketing is relatively expensive in initial cost but requires no maintenance if properly constructed. When concrete encasement is to be continuously submerged in water with low resistivity, it must (1) extend below the mudline, or (2) be coated to electrochemically insulate the concrete from the steel.

Use high-strength steel only when design analyses show that the use is the most economical solution.

ASTM A27/A27M cast steel is used for some commercially available pile points.
****

[ASTM A36/A36M][ASTM A572/A572M, Grade [_____]][ASTM A588/A588M][ASTM A690/A690M].[Provide test piles identical to those used elsewhere in the project.][Provide square and blunt pile tips, as received from the mill.][Provide pile tip reinforcements or cast steel points.][Provide piles with concrete encasements in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.] Provide H-piles of the shape and sections shown. Submit pile material certificates of compliance certifying that materials meet the requirements specified herein. Determine lengths of piles as specified in paragraph INSTALLATION, subparagraph LENGTHS OF PRODUCTION PILES[and paragraph FIELD QUALITY CONTROL, subparagraph TEST PILES].[Submit pile load test plan at least 30 days prior to installing any test piles. Approval of the plan does not relieve the Contractor of the responsibility for structural and operational adequacies of the testing system.]

[2.2.2 Pile Splices

[[ASTM A36/A36M][ASTM A572/A572M, Grade [_____]][ASTM A588/A588M] for splice plates.][Materials for pile splices must be as specified.] Submit detail drawings of pile splices prior to fabrication. Submit Pile Splice Welder Qualifications.

][2.2.3 Pile Points

****

NOTE: Pile points may be required when driving piles in dense sand strata, gravel strata and cobble-boulder zones, and when driving piles to refusal on a hard layer or bedrock.

****

[ASTM A148/A148M for cast steel points.][[ASTM A36/A36M][ASTM A572/A572M, Grade [_____] for pile tip reinforcements.]] Pile points must[be the type][conform to details] shown[and be provided on all piles].

][2.2.4 Pile Caps

[ASTM A36/A36M.][ASTM A572/A572M, Grade [_____].][ASTM A588/A588M.] Pile caps must conform to details shown.

][2.2.5 Pile Tension Anchors

[ASTM A36/A36M.][ASTM A572/A572M, Grade [_____].][ASTM A588/A588M.] Pile tension anchors must conform to details shown.

][2.2.6 Fabrication

Fabrication must conform to the requirements shown and as specified herein and in[Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

[2.2.6.1 Pile Splices

****

NOTE: Splices are generally not permitted where required lengths are available in one piece or the pile is designed for a moment connection. Where splices are permitted, show details of the splice.

****

Fabricate pile splices as shown. Submit detail drawings of splices in accordance with paragraph SUBMITTALS. Perform all welding in accordance with the requirements for shield metal arc welding of AWS D1.1/D1.1M. Submit welding procedure for shop splices and verification of welder qualifications. Make no more than [one] [_____] field splice per [25] [_____] m [80] [_____] feet of pile, unless directed by the Contracting Officer. Fabrication drawings must show all shop splices.

][2.2.6.2 [Pile Caps,] [Pile Points,] [Pile Tension Anchors,] [Pile Shoes]

[Attach [pile caps,] [pile points,] [piles shoes,] [and] [pile tension anchors] as shown.][Ground the top of piles sufficiently smooth to provide a good welding surface for structural-shape pile caps.] Submit Certificates of compliance certifying that materials meet the requirements specified herein.

]]2.3 PILE DRIVING EQUIPMENT

Select the proposed pile driving equipment, including hammers and other required items, and submit complete descriptions of the proposed equipment in accordance with paragraph SUBMITTALS. Final approval of the proposed equipment is subject to the satisfactory completion and approval of pile tests. Changes in the selected pile driving equipment will not be allowed after the equipment has been approved except as directed. No additional contract time will be allowed for Contractor proposed changes in the equipment.

2.3.1 Pile Driving Hammers

****

NOTE: When specifying the minimum driving energy, make an allowance for reduced penetration caused by shock absorption of pile helmets. Enter the appropriate minimum allowable driving energy for the project. Minimum allowable driving energy must be not less than the following:

Design Bearing Pile Capacity for Single Pile (Kilonewton) (Kips)	**Minimum Rated Hammer Driving Energy (Joules) (Foot-Pounds)**
Up to 534 120	**20,350 15,000**
Over 534 120	**25,750 19,000**

The minimum and maximum hammer energies required may be determined from experience on other jobs or by a series of wave equation analyses.

****

Provide impact or vibratory type pile driving hammers.

2.3.1.1 Impact Hammers

Provide air, hydraulic or diesel-powered impact pile hammers of the single-acting, double-acting, or differential-acting type.[The size or capacity of hammers must be as recommended by the hammer manufacturer for the total pile mass (weight) and the character of the soil formation to be penetrated.][The rated driving energy of hammers is limited to a minimum of [20,350] [25,750] joules [15,000] [19,000] foot-pounds.][Hammers must be capable of[, and so demonstrated during the development of refusal criteria,] hard driving in excess of 20 blows per 25 mm inch.] Provide boiler, compressor, or engine capacity sufficient to operate hammers continuously at the full rated speed. Hammers must have a gage to monitor hammer bounce chamber pressure for diesel hammers or pressure at the hammer for air hammers. This gage must be operational during the driving of piles and be mounted in an accessible location for monitoring by the Contractor and the Contracting Officer.[Provide two spare operational bounce chamber read out units on site.][Provide bounce chamber pressure gage correction tables and charts for the type and length of hose to be used with the pressure gage to the Contracting Officer.][Hydraulic hammers must be equipped with a system for measurement of ram energy. The system must be in good working order and the results must be easily and immediately available to the Engineer. Install an energy monitor on the hydraulic hammers and record readings every 300 mm 12 inches of pile installation.] Use wave equation analysis to verify that the hammer will develop stresses within acceptable limits in the piles. Position a pile cap or drive cap between the pile and hammer. Place hammer cushion or cap block between ram and the pile cap or drive cap. Hammer cushion or cap block must have consistent elastic properties, minimize energy absorption, and transmit hammer energy uniformly and consistently during the entire driving period.[Do not use a pile cushion block.] In accordance with paragraph SUBMITTALS, submit the following information for each impact hammer proposed:

a. Make and model.

b. Ram mass (kilograms) weight (pounds).

c. Anvil mass (kilograms) weight (pounds).

d. Rated stroke (millimeters) (inches).

e. Rated energy range (joules) (foot-pounds).

f. Rated speed (blows per minute).

g. Air pressure, hammer, and boiler [and] [or] compressor (MPa)(psi).

[h. Rated bounce chamber pressure curves or charts, including pressure correction chart for type and length of hose used with pressure gage (bar) (pounds per square inch).

] i. Pile driving cap, make, and mass (kilograms) weight (pounds).

j. Cushion block dimensions and material type.

k. Power pack description.

[2.3.1.2 Vibratory Hammers

[The use of vibratory hammers is dependent upon satisfactory driving and load testing of piles.][Final approval of the proposed hammer and other driving equipment is subject to the satisfactory completion and approval of the pile tests.][The size or capacity of hammers must be as recommended by the hammer manufacturer for the total pile mass weight and the character of the soil formation to be penetrated.] The hammer must provide for maintaining a rigid connection between the hammer and the pile. In accordance with paragraph SUBMITTALS, submit the following information for each vibratory hammer proposed:

a. Make and model.

b. Eccentric moment (newton-meters) (inch-pounds).

c. Dynamic force (kilonewtons) (tons).

d. Steady state frequency or frequency range (cycles per minute).

e. Vibrating mass (kilonewtons) weight (pounds).

f. Amplitude (millimeters) (inches).

g. Maximum pull capacity (metric tons) (tons).

h. Non-vibrating mass (kilonewtons) weight (pounds).

i. Power pack description.

]2.3.2 Pile Driving Leads

****

NOTE: Suspended leads should not be used on jobs where accurate pile placement and alignment are required.

Vibratory hammers are typically operated free hanging without leads unless accurate placement and alignment of the piles are required.

****

Support and guide hammers with fixed extended leads or fixed underhung leads.[For driving battered piles, support and guide impact hammers with three-axis, fixed-extended leads capable of 1 H and 2-1/2 V before and after batter and 1 H on 6 V side batter, with 30 degree rotation each side of an axis running along the center line of rotation of the crane through the center line of the leads.] Provide two intermediate supports for the pile in the leads to reduce the unbraced length of the pile during driving and pulling.

2.3.3 Pile Extractors

Pile extractors may be vibratory or impact pile driving hammers. Impact hammers are required for pulling piles not extractable with vibratory hammers.

[2.3.4 Jetting Equipment

****

NOTE: Do not use jetting on piles carrying significant tension loads, lateral loads, or compression loads developed predominantly from skin friction.

****

Provide jetting equipment with not less than two removable or fixed jets of the water or combination air-water type. Water jets must be designed so that the discharge volume and pressure are sufficient to freely erode the material immediately under and adjacent to piles without resulting in pile drift. Submit jetting equipment including plant description, volume of water and pressure, and size and length of hoses and pipes in accordance with paragraph SUBMITTALS.

]PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Wave Equation Analysis of Pile Drivability

a. Prior to driving any pile, submit a pile Wave Equation Analysis, performed by Contractor's Geotechnical Consultant, for each size pile and distinct subsurface profile condition. These analyses must take into account the proposed hammer assembly, pile cap block and cushion characteristics, the pile properties and estimated lengths and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity. Provide instructions and procedures on how the Contractor will perform [Dynamic Pile Testing,] Inspection and Monitoring of piles during installation and testing

b. Demonstrate using the Wave Equation Analysis that the piles will not be damaged during driving, indicate that the driving stresses will be maintained within the limits below and indicate the blow count necessary to achieve the required ultimate static pile capacities.

Allowable Driving Stresses

Steel Piles

Compression - 0.9 fy
Tension - 0.9 fy

Where fy is yield strength of steel

c. Perform a refined Wave Equation Analysis upon completion of the dynamic and static testing programs outlined in this specification section, taking into consideration the evaluated capacities, gain/loss factors and recommended production pile lengths.[Develop production pile driving criteria based on the results of the refined Wave Equation Evaluations.]

d. All pile driving equipment provided by the Contractor will be subject to the approval of the Contractor's Geotechnical Consultant. Complete the attached pile and driving equipment data form, including hammer information, in full as part of the submittal of the results of the Wave Equation Analyses.

e. Pay for the cost of performing the Wave Equation Analyses and include in the base bid.

3.1.2 Order List

Submit to the Contracting Officer for approval, an itemized quantities list for piles prior to placing the order with the supplier. Indicate the pile lengths required at each location as shown on the plans and the corresponding ordered length of each pile in the list.[Complete load testing and refined wave equation analysis and submit to Government for review and approval prior to submission of an order list.]

3.2 INSTALLATION

Inspect piles when delivered and when in the leads immediately before driving. Cut piles at cutoff grade by an approved method. Where cutoff is below existing ground or mudline elevation, complete excavation, sheeting, and dewatering before driving pile to cutoff elevation.

3.2.1 Lengths of Production Piles

The estimated quantities of piles are given for bidding purposes only. Drive piles to [or below "calculated"] [indicated] tip elevation [to reach a driving resistance established by the wave equation analyses (WEAP) in accordance with the schedule which the Contractor's Geotechnical Consultant will prepare from the test-pile driving data].

3.2.2 Pile Driving Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not driven. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of driving, testing, recording and analysis of data for project may be useful.

NOTE: The Specifier must attach the specifications pile driving log graphic (for all pile driving projects) and the pile driving equipment data form (for projects using PDA) to the end of this specification section.

****

Submit the proposed form for compiling pile driving records 30 calendar days prior to commencement of work.

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations,[batter alignment,] number of blows required for each 300 mm foot of penetration and number of blows for the last 150 mm 6 inches penetration or fraction thereof [as required] for the "calculated" [driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, splicing, obstructions, [jetting,] and any driving interruptions.[Install an energy monitor on the hammers and record readings during pile installation.] A preprinted pile driving log for recording pile driving data[and pile driving equipment data form], which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Submit[to the Contracting Officer] complete and accurate[test and] job pile driving records as specified in paragraph PILE RECORDS of this section, within [15][_____] calendar days after completion of driving.

Make pile driving records available to the Contracting Officer at the job site, within 24 hours after each day of pile driving.

3.2.3 Pile Placement and Tolerances in Driving

Develop and submit a pile placement plan which shows the installation sequence and the methods proposed for controlling the location and alignment of piles. Submit pile placement plan at least 30 calendar days prior to delivery of piles to the job site. Complete all foundation preparation in the area prior to the placement of piles for driving. Accurately place piles in the correct location and alignments, both laterally and longitudinally, and to the vertical or batter lines indicated. Establish a permanent base line to provide for inspection of pile placement by the Contracting Officer during pile driving operations prior to driving production piles and maintain during the installation of the production piles.

A final lateral deviation from the correct location at the cutoff elevation of not more than 76 mm 3 inches will be permitted for vertical and battered piles. Manipulation of piles will not be permitted. A variation of not more than 6 mm per 300 mm 0.25 inch per foot of pile length from the vertical for vertical piles nor more than 12 mm per 300 mm 0.50 inch per foot of pile length from the required angle for batter piles will be permitted. In addition to complying with the tolerances stated herein, the clear distance between the heads of piles and the edges of caps must be not less than 150 mm 6 inches. Redesign of pile caps or additional work required due to improper location of piles is the responsibility of the Contractor. A vertical deviation of not more than 25 mm one inch from the correct cutoff elevations shown is permitted. Inspect piles for heave. Redrive heaved piles to the required pile driving criteria. Maintain the correct relative position of all piles by the use of templates or by other approved means. Piles damaged or not located properly or exceeding the maximum limits for lateral and vertical deviation, or variation in alignment must be pulled and new piles redriven, or provide additional piles, at a location directed at no additional cost to the Government.

3.2.3.1 Survey Data

After the driving of each pile group is complete, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Do not proceed until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a land surveyor licensed in [_____].

3.2.4 Pile Penetration Criteria

The controlling driving resistance for production piles will be determined by the Contractor's Geotechnical Consultant. The required initial driving criteria and restrike will be established subsequent to the analysis of pile tests as specified in paragraph TEST PILES.

3.2.5 Pile Length Markings

Mark each pile prior to driving with horizontal lines at 300 mm one foot intervals. Mark the interval number on pile every 1.5 m 5 feet from pile tip.

3.2.6 Pile Driving

****

NOTE: Delete bracketed option for foundation excavation when not required. Delete items in brackets dealing with tip elevation and driving resistance when test piles or load tests are not used. Delete item in brackets regarding predrilling or jetting when procedure is not used. If needed, insert maximum hammer energy for no tip resistance. This can be determined by comparing tensile stresses in pile resulting from a Wave Equation Analysis with effective prestress in pile.

****

Notify Contracting Officer 10 days prior to driving of[test] piles[and load test].[Stop foundation excavation at 300 mm one foot above foundation grade before piles are driven. Do not drive piles within 30 meter 100 feet of concrete less than 7 days old. Complete excavation to lines and grades shown when pile driving is completed.][The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analysis].] Drive piles to[the terminal driving criteria][or below "calculated"][indicated tip elevation][to reach a driving resistance established by the[dynamic pile driving tests at the end of drive or restrike][static load tests][wave equation analyses (WEAP)] in accordance with the schedule which the[Contractor's Geotechnical Consultant][Contracting Officer] will prepare from the test-pile driving data]. During initial driving and until pile tip has penetrated beyond layers of very soft soil[or below bottom of predrilled or prejetted holes], use a reduced driving energy of the hammer as required to prevent pile damage. Refusal criteria will be established by the Contracting Officer. If a pile fails to reach["calculated"][indicated] tip elevation,[or if a pile reaches["calculated"] tip elevation without reaching required driving resistance,] notify Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

3.2.7 Protection of Piles

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NOTE: Delete references to batter piles when not applicable to the project.

****

Take care to avoid damage to piles during handling, placing pile in leads, and during pile driving operations. Support piles laterally during driving, but allow rotation in leads.[Where pile or projecting reinforcement orientation is essential, take precautionary measures to maintain the orientation during driving.][Take special care in supporting battered piles to prevent excessive bending stresses in pile.] Maintain axial alignment of pile hammer with that of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through the reinforcement, by using a special driving head.

3.2.8 Rejected Piles

Withdraw piles damaged or impaired for use during handling or driving, mislocated, or driven out of alignment beyond the maximum tolerance. Replace with new piles or cut-off and abandon damaged or impaired piles and drive new piles as directed. Remove excess cut-off from piles and unacceptable piles from the work site. Perform all work in connection with withdrawing and removing rejected piles from the site at no additional cost to the Government.

3.2.8.1 Obstructions

If a pile encounters an underground obstruction within 1.5 meters 5 feet of the ground surface of such size as to prevent driving the pile to the required driving criteria, the pile must be pulled or cut off at no cost to the Government. If such an obstruction is encountered more than 5 feet below the ground surface, the pile must be cut off and paid for as if a completed pile. In either event, a replacement pile must be installed at a location indicated by the Contracting Officer and paid for as a completed pile.

3.2.8.2 Splicing Piles

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NOTE: Splicing of piles normally should not be permitted except where extremely long or heavy piles are required. If splices are permitted, drawings should indicate splice details. (See PCI standard drawings for typical splice details).

****

[Splicing of piles is not permitted.][Make splices as indicated. Splices must be capable of developing the full strength of the member in compression, tension, shear, and bending. Submit detail drawings of splices and design calculations demonstrating the strength of the splice for approval.][Provide a detailed procedure for insufficient pile length where recovering of pile length is required.]

3.2.9 Jetting of Piles

****

NOTE: Jetting should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Adjacent to existing structures.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Water jets will [not] be permitted.[Use jetting to assist driving piles through strata that cannot be penetrated practicably by use of the hammer alone.[Restrict driving to a static weight while water is being injected to prevent inducing tensile stresses in the piles.] Discontinue jetting and resume hammer driving after the penetration of the strata requiring jetting has been accomplished.][Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.][Take adequate measures for collecting and disposing of runoff water.][Jetting method and equipment must be approved by the Contracting Officer prior to commencing jetting operation.] Before starting final driving, firmly seat piles in place by application of a number of reduced energy hammer blows.[Employ measures, including use of a silt curtain, to contain turbid water created by jetting piles.]

3.2.10   Predrilling of Piles

****

NOTE: Predrilling should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Located in cohesionless soils.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven [will [not] be permitted] [will be provided].[The diameter of the hole must not exceed two-thirds the width of the pile.][Predrill only to a depth of [_____] meters feet below cut-off elevation prior to setting piles.][Discontinue drilling when the pile tip is approximately 1.5 m 5 feet above the[calculated][indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.]

3.2.10.1   Heaved Piles

When driving piles in clusters or under conditions of relatively close spacing, perform observations to detect heave of adjacent piles. Backdrive heaved piles to original to the required[depth of penetration][tip elevation][refusal blow count] as directed by the Contractor's Geotechnical Consultant, after reviewing the heave data, without additional cost to the Government.

3.2.10.2   Pulled Piles

Pull and replace piles damaged or impaired for use during driving with new piles, or cut off and abandon and drive new piles as directed without additional cost to the Government. The Contracting Officer may require that any pile be pulled for inspection. Redrive piles pulled as directed and found to be in suitable condition at another location as directed. Replace piles pulled as directed and found to be damaged with new piles at the Contractor's expense.

3.2.10.3 Long Piles

Provide pile driving rig with rigid supports so that leads remain accurately aligned. Where a high degree of accuracy is required, erect templates or guide frames at or close to the ground or water surface.

3.2.10.4 Welding

AWS D1.1/D1.1M. Welding of splices must conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop and field welding, qualification of welding procedures, welders, and welding operators must be in accordance with AWS D1.1/D1.1M.

[3.2.11 Protection of Existing Structures

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NOTE: Include this paragraph only when protection of existing structures from pile driving activities is required.

The designer must indicate on the drawings all structures and facilities for which protection is required. The designer must also provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.

****

Mitigate impact on existing facilities due to pile driving activities in accordance with the [project specific document][_____].

]3.3 FIELD QUALITY CONTROL

3.3.1 Test Piles

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NOTE: Select the second bracketed option when soil conditions dictate the use of a test pile longer than production piles. The ordered pile length for test piles should be 1.5 m 5 feet longer than ordered length for production piles to allow additional penetration if driving conditions dictate. Indicate location and number (if required) of test piles on plans, or list appropriate soil boring test hole numbers.

****

[Use test piles of type, and drive as specified for piling elsewhere in this section.][Order test piles [_____] meters [_____] feet longer in length than production piles. Drive the additional test pile length only at the direction of the Contracting Officer.] The [Contractor's Geotechnical Consultant] [Contracting Officer] will use test pile data to determine "calculated" pile tip elevation or necessary driving criteria.

Drive test piles [at the locations indicated] [in vicinity of soil boring test holes Nos. [_____,] [_____,] and [_____]]. Drive test piles to [indicated tip elevation] [indicated bidding lengths] [required driving criteria]. Use test piles, if located properly and offering adequate driving resistance in finished work.[Pre-drilling or jetting is permitted only when test piles clearly establish validity of its use, or as directed by the Contracting Officer.][Provide and operate a pile driving analyzer as specified in paragraph DYNAMIC PILE ANALYSIS during the driving of each test pile. Modify driving as required based upon recommendation of [Contracting Officer] [Contractor's Geotechnical Consultant and approval of the Contracting Officer].]

3.3.1.1 Dynamic Pile Analysis

Submit a performance report summarizing dynamic test results for [test] piles within [7] [_____] calendar days of completing field work.[For production piles, submit a performance report within one day of testing. Submit a typed report summarizing the results of dynamic testing of production piles on a monthly basis.]

Dynamic testing provides supplemental information for evaluating pile integrity, hammer and drive system performance, assess pile installation driving stresses, and pile capacities. Perform dynamic testing on [_____] percent of the[test] piles during the full length of the pile driving and during restrike a minimum of [_____] days after initial driving. Dynamic pile testing must also be performed on [_____] production piles as chosen by the Contracting Officer. Use[test] piles of type as specified elsewhere in this section. Provide equipment to obtain dynamic measurements, record, reduce and display its data that meet the requirements of ASTM D4945. The equipment must have been calibrated within [6] [_____] months prior to the start of the testing operations and thereafter throughout the contract duration. Drive[test] piles at the locations indicated or at the locations selected by the Contracting Officer. Employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile driving process[, monitoring of test pile installation,] and in the use of the Pile Driving Analyzer and its related equipment. Perform dynamic pile analysis as follows:

3.3.1.2 Pile Analyzing

[_____] working days prior to driving the [test] piles, submit the pile and complete driving equipment data to the Contracting Officer. The Contractor's Geotechnical Consultant must use the submitted information to perform wave equation analyses and must prepare a summary report of the wave equation results. The wave equation analysis using GRLWEAP software by Pile Dynamics, Inc. or equivalent must be used to assess the ability of the proposed driving system to install the pile to the required capacity and desired penetration depth within the allowable driving stresses. Approval of the proposed driving system by the Contracting Officer must be based upon the wave equation analyses indicating that the proposed driving system can develop a pile capacity of [_____] kN kips at a driving resistance not greater than [_____] blows per mm blows per inch within allowable driving stress limits. The hammer must also be sized or adjustable such that the penetration per blow at the required ultimate capacity does not exceed 12 mm 0.5 inches.

3.3.1.3 Pile Drivability

Perform each dynamic pile analysis in two steps. The first step is to check the hammer, pile and soil performance, and to determine the suitability of the proposed hammer for the size, length and type of pile being installed for the soil types encountered as the piles are driven. This initial monitoring must determine whether pre-augering or jetting is appropriate, efficiency of the hammer relative to specified efficiency, effectiveness of cushion, level of compressive and tensile stress in pile and extent/location of any pile damage caused by the initial driving. With each blow of the pile, record the information listed below electronically and analyze the information using the Pile Driving Analyzer:

a. Blow number.

b. Blow rate per minute and stroke.

c. Input and reflected values of force and velocity.

d. Value of upward and downward traveling force wave with time.

e. Maximum and final transferred energy to pile, hammer system efficiency.

f. Maximum compressive stress, velocity, acceleration and displacement.

g. Maximum tensile stress in pile.

h. Pile structural integrity, damage detection, extent and location.

i. Bearing capacity of pile by Case method.

If the pile, hammer and soil performance evaluation recommends changes to the hammer stroke, pile cushioning, augering or any other aspect for the pile driving operation, incorporate these changes into production pile driving in an effort to control excessive stresses and pile damage. Replace test piles damaged or broken during installation, incorporating driving modifications as determined by the Contractor's Geotechnical Consultant and reviewed and approved by the Contracting Officer. Repeat this procedure until allowable tensile and compressive stresses are achieved in the pile and pile damage is minimized. Subject selected initial driving records to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and estimation of anticipated gain/loss factors.

3.3.1.4 CAPWAP

Signal matching analysis by CAPWAP software of the dynamic pile testing data must be performed on data obtained from the end of initial driving and the beginning of restrike of all control piles. CAPWAP analyses must be performed by an engineer who has achieved Advanced Level or better on the PDI / PDCA Dynamic Measurement and Analysis Proficiency Test for Providers of PDA Testing Services.

Upon completion of[test] pile driving, allow the piles to set-up for at least [72 hours] [_____ days]. After evaluation of pile, hammer and soil performance by the Contractor's Geotechnical Consultant, the second step of the dynamic pile analysis may proceed. This portion of the evaluation requires striking the set-up piles a minimum of 20-50 times, or as directed by the Contractor's Geotechnical Consultant using the same hammer which was used for the[test] pile driving and which will be used for production pile driving. "Warm up" the hammer and make it optimally ready prior to restriking, in order to avoid capacity losses during evaluation of restrike data. Apply maximum hammer energy during restrike in order to fully mobilize the soil resistance. However, exercise care so as to not overstress the pile. In addition to those items listed above, selected restrike driving records (as directed by the Contractor's Geotechnical Consultant) are to be subjected to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and plot of applied load vs. average pile displacement based on the calculated soil properties.

3.3.1.5 Dynamic Load Test Reporting

a. Upon satisfactory completion of each dynamic load test, submit[a minimum of three copies of] a Pile Performance Report for the Contractor by the Contractor's Geotechnical Consultant. The submittal must be prepared and sealed by a Professional Engineer registered in [_____].

b. The report for the Dynamic Pile Analysis must contain the following information:

  (1) Capacity of pile from Case Pile Wave Analysis Program (CAPWAP). Information resulting from analysis of a selected restrike blow.

  (2) Maximum and final transferred energy, hammer system efficiency during pile installation.

  (3) Maximum compressive stress, velocity, acceleration and displacement.

  (4) Maximum tensile stress in pile.

  (5) Pile structural integrity, damage detection, extent and location.

  (6) Blows per minute and blow number.

  (7) Input and reflection values of force and velocity, upward and downward traveling force wave with time.

  (8) Pile skin friction and toe resistance distribution.

  (9) Maximum energy transferred to pile.

c. The maximum allowable pile design load must be proposed by the Contractor's Geotechnical Consultant based upon the results of a satisfactory pile load test conducted on a pile driven as specified herein and must include the effects of load transfer to the soil above the foundation stratum.

Use either a Model 8G or PAX Pile Driving Analyzer as manufactured by Pile Dynamics, Inc., of Cleveland Ohio or approved equivalent, for dynamic testing of the pile hammer and for dynamic load testing of the test pile. All equipment necessary for the dynamic monitoring such as sensors, cables or wireless transmitters, must be furnished by the Contractor's Geotechnical Consultant. The equipment must conform to the requirements of ASTM D4945.

Pay for all services of the Contractor's Geotechnical Consultant. The Contractor's Geotechnical Consultant must be available throughout the pile driving operation to consult with the Contracting Officer when required by the Contracting Officer. The cost of changes in the Contractor's procedure, as required by evaluation of the results of the Pile Driving Analysis, will be at the Contractor's expense.

3.3.2 Static Load Tests

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NOTE: If pile load tests are required and approved by the Contracting Officer, specify number and location of piles. Select method of load test. In ASTM D1143/D1143M, permit anchor piles only if approved by the Contracting Officer's Technical Representative (Geotechnical Branch). Insert figure kN kips corresponding to 200 percent of the design load. Select appropriate acceptance criteria. The offset method (first option) is usually recommended.

****

Submit details and procedures for Pile load test frame.

Perform compressive load tests on [_____] test piles in accordance with ASTM D1143/D1143M (standard loading procedure) as modified herein.[Allow a minimum of [72 hours] [_____ days] following final test pile driving for pile set-up prior to load testing.][Do not use anchor piles.] Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform [or reaction frame attached to sufficient uplift piles to safely take required load] applied to pile by hydraulic jack. Increase load in increments until rapid progressive settlement takes place or until application of total compressive load of [_____] KN kips for compressive load tests. Consider load test satisfactory when[after one hour at full test load gross settlement of pile butt is not greater than gross elastic pile compression plus 4 mm 0.15 inch plus one percent of pile tip diameter or width in [_____] mm inches,][slope of gross load-settlement curve under full test load does not exceed 1.5 mm per metric ton 0.05 inches per ton,][net settlement after removal of test load does not exceed 19 mm 3/4 inch]. Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

3.3.2.1 Safe Design Capacity

Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.

3.3.3 Tensile Load Test

Perform tensile load tests on [_____] test piles in accordance with ASTM D3689. Apply a tensile load of [_____] kN kips to each tensile load test pile. In performing the tension load test, apply the ultimate load equal to one and one-half times the safe tension capacity, and employ the Standard Loading Procedure.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer.

Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

Perform dynamic measurements on [_____] piles designated as dynamic test piles in accordance with ASTM D4945 during driving. During easy driving, ensure that damaging tension stresses do not develop in the pile. Signal matching must be performed by the Contractor's Geotechnical Consultant on representative data collected at the end of the initial driving and at the beginning of all restrike events. Additional signal matching analysis must be performed as determined by the Engineer.

3.3.4 Lateral Load Test

Perform lateral load tests on [_____] piles in accordance with ASTM D3966/D3966M. Lateral load tests must consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. Apply a lateral load of [_____] kN kips to each pair of lateral load test piles. Record required movement readings for each pile.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

3.3.5 Pile Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not driven. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of driving, testing, recording and analysis of data for project may be useful.

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NOTE: The Specifier must attach the specifications pile driving log graphic (for all pile driving projects) and the pile driving equipment data form (for projects using PDA) to the end of this specification section.

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Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations,[batter alignment,] number of blows required for each 300 mm foot of penetration and number of blows for the last 150 mm 6 inches penetration or fraction thereof[as required] for the "calculated"[driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion (capblock) and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, splicing, obstructions,[jetting,] and any driving interruptions.[Install an energy monitor on the hammers and record readings every 300 mm 12 inches of pile installation.] A preprinted pile driving log for recording pile driving data[and pile driving equipment data form], which can be downloaded at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

[3.3.6 Testing Agency Qualification

Engage an independent testing agency to observe the production piles installation. The testing agency must be qualified according to ASTM E329 for testing indicated. Submit testing agency qualifications to the Contracting Officer for approval.

]3.3.7 Welding Inspection

Employ a testing agency to perform the welding inspections as specified in the statement of special inspection.

3.3.8 Weld Testing

In addition to visual inspection, welds must be tested and inspected according to AWS D1.1/D1.1M and inspection procedures listed below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.[Test [10] [_____] percent of pile splices, the steel pile cap splice connections and the steel pile insert connection.]

a. Liquid Penetrant Inspection: ASTM E165/E165M.

b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

c. Radiographic Inspection: ASTM E94/E94M, minimum quality level "2-2T."

d. Ultrasonic Inspection: ASTM E164.

3.4 TOUCHUP PAINTING

Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC PA 1. Use same paint and apply same number of coats as specified. Apply touchup paint before driving piles to surfaces that are immersed or inaccessible after driving.

[3.5 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

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NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic

rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-310-04, "Seismic Design for Buildings".

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.
****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

][3.6 VIBRATION CONTROL

****
NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary for the particular project.
****

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs][and geophones] within a distance of [61] [_____] meters [200] [_____] feet from the pile driving activity.[Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [5] [_____] years of experience in vibration monitoring. A minimum of [28] [_____] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient vibrations. The vibration during the pile driving activities must be limited to[a peak particle velocity of not more than [5] [_____] cm [2.0] [_____] inches per second.][the limits mentioned in the [contract documents][_____].][Determine appropriate vibration limits as per[US Bureau of Mines][American Association of State Highway and Transportation Officials (AASHTO)] guidelines.] During pile driving activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity causing the vibration until[the Vibration consultant and the Contracting Officer] [_____] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.7 NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria or requirements as necessary for the particular project.

****

Perform noise monitoring at the locations[shown in the plan][decided by the Contracting Officer][at noise sensitive public areas] during the pile driving operations.[Perform noise monitoring using [noise meters][, and] [_____].][Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [5] [_____] years of experience in noise monitoring. A minimum of [28] [_____] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient noise levels.[The noise limits are mentioned in the[plan][contract documents].][Determine appropriate noise limits as per[local agency][Occupation Safety and Health Administration] guidelines.] During pile driving activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity and install noise mitigation measures.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.8 PRECONSTRUCTION CONDITION SURVEY

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NOTE: Add any additional criteria or requirements as necessary for the particular project.

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Perform preconstruction condition survey of[structures][and utilities] [within [61] [_____] meters [200] [_____] feet of the pile driving activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] [_____] days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction

Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] [_____] days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

][3.9 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

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NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile driving activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement [and lateral movement] of temporary and permanent structures, utilities,[embankments][and excavations] during pile driving. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile driving when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile driving activities. Establish limiting values of vertical[and horizontal] movement[and angular distortion][and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments. Submit interim and final instrumentation and monitoring program reports.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 62 19 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-31 62 19 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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TIMBER PILES

11/20, CHG 2: 02/24

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-31 62 19 (November 2020)**
Change 2 - 02/24

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****

SECTION 31 62 19

TIMBER PILES

11/20, CHG 2: 02/24

****

NOTE: This guide specification covers the requirements for procurement, installation, and testing of land and fresh water construction timber piles.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.

****

****

NOTE: Add requirements for materials and procedures for special or unusual design as necessary to fit specific projects. Specify marine piling for waterfront and other marine (salt water) type structures in another section of the project specification. Marine and Highway construction use of round piles requires the review of AWPA use categories 5A, 5B and 5C subject to geographical location.

****

****

NOTE: Show, as a minimum, the following information on the project drawings:

Subsurface data: Subsurface-soil-data logs.

The subsoil investigation report and samples of material taken from subsurface investigations may be examined in the office where bids are received, the office of the Resident Officer in Charge of Construction, and the Architect/Engineer's office.

Pile location plan with GPS coordinates.

Test Pile Locations

****

PART 1 GENERAL

****

NOTE: Structural engineer must confirm the structural capacity of piles and provide specific bending moments, lateral loads and other design requirements for pile design.

****

1.1 DESCRIPTION

Design, furnish, install and test timber piles at the locations indicated on the drawings and specified herein.[Assume test pile[s] will be directed to be placed in [a] location[s] that can be incorporated into the work.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

****

NOTE: The American Wood Protection Association (AWPA) has recently adopted many new Standards (2006 Book of Standards) as well as establishing the new USE CATEGORY SYSTEM: User Specification for Treated Wood. Specifiers are advised to familiarize themselves with the latest standards and their relationship to the specific project requirements and environmental considerations. Specifiers should refer to Section 3 of U1 and review the following use categories prior to editing this guideline specification:

"4C" for wood foundation piles used for building construction completely embedded in soil (ground contact).

"4C" for round piles used for highway construction (ground contact or fresh water.

"4B" for sawn piles supporting residential /business structures.

"4C" for sawn piles supporting residential/business structures, critical.

Specifier should also refer to Section 3 of AWPA U1.

The existence of the AWPA Standards for treated products does not imply that all other regulatory bodies recognize or permit the use of the particular combination of preservatives, processes, and wood species listed in the AWPA Standards.

****

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA A1	(2015) Standard Methods for Analysis of Creosote and Oil-Type Preservatives
AWPA A2	(2015) Standard Methods for Analysis of Waterborne Preservatives and Fire-Retardant Formulations
AWPA M1	(2021) Standard for the Purchase of Treated Wood Products
AWPA M2	(2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use
AWPA M3	(2016) Standard for the Quality Control of Preservative Treated Products for Industrial Use
AWPA M4	(2023) Standard for the Care of

	Preservative-Treated Wood Products
AWPA M6	(2024) Brands Used on Preservative Treated Materials
AWPA P1/P13	(2024) Standard for Creosote Preservative
AWPA P2	(2024) Standard for Creosote Solutions
AWPA P3	(2024) Standard for Creosote - Petroleum Oil Solution
AWPA P5	(2015) Standard for Waterborne Preservatives
AWPA T1	(2024) Use Category System: Processing and Treatment Standard
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D25	(2012; R 2017) Standard Specification for Round Timber Piles
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-220-01	(2012; with Change 1, 2021) Geotechnical Engineering

1.3 SUBSURFACE DATA

Subsurface soil data logs are [indicated] [appended to the special contract requirements] [provided on the project drawings].[The subsoil investigation report may be examined at [_____].]

1.4 BASIS OF BID

****
NOTE: Select one of the following options:
****

****
NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of piles must be determined as accurately as possible, prior to bidding, since the unit price per meter foot of the piles varies as the length increases or decreases. Refer to Standard Test Method for High-Strain Dynamic Testing of Deep Foundations (ASTM D4945).
****

1.4.1 Production Pile Acceptance Criteria

Base bids on the number, circumference of piles at the butt and tip, and length of piles from tip to cutoff as indicated. Safe design capacity for piles is [_____] KN kips. Drive piles to [minimum tip elevation] [a minimum depth of [_____] m feet below cut-off elevation], and to such additional depth as required to obtain a bearing capacity of not less than [_____] KN kips. The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at end of drive or restrike] [static load tests] [wave equation analysis].[Test piles that meet performance requirements may be included into the permanent work.]

The following formulas can be used in cases where allowable pile loads are less than 355 kN 80 kips (determined using a factor of safety of 3 for individual piles and 4 for pile groups) and are presented only as a guide to aid in establishing the controlling penetration per blow, which, together with the minimum depth of penetration will serve to determine the required minimum depth of penetration of each individual pile:

$$R = \frac{2E}{S \text{ plus } 0.1}$$ For double acting hammers

$$R = \frac{2WH}{S \text{ plus } 0.1}$$ For single acting hammers

Where R is the approximate allowable pile load in kips; E equals the energy in foot-kips per blow based on an acceptable certified statement from the manufacturer of the hammer; W equals the weight of the hammer or ram in kips; H equals the height of fall of the hammer of ram in feet; and S equals the average inches of penetration per blow for the last three blows. An allowance will be made for reduced penetration caused by shock absorption of the cushion or cap blocks.

[1.4.2 Lump Sum Payment

****

NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection. This paragraph will be typically used when there are 1) relatively small quantity of piles, 2) allowable pile loading is less than 355 kN 80 kips(, and 3) the subsurface conditions are well defined. Fill in Table I as required selecting columns applicable to project. Generally, pile capacity, location, and minimum tip elevation are shown on plans. Test piles and load tests are not incorporated on lump sum contracts. Delete this paragraph for unit-price contracts.

****

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.] [following Table I:

Table 1

[Location]	Number	Size	[Capacity]	Length (Tip to Cut-Off)	[Maximum Bending Moment]	[Maximum Shear Force]

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off, dispose of any cut-offs, and meet the applicable contract requirements. Include mobilization, pre-drilling, and redriving heaved piles. If, in redriving, it is found that any pile is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be provided and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. If total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; backdriving; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys].

][1.4.3 Unit Price

****

NOTE: Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments in price schedule for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

For NAVFAC Southeast projects, where there is a need for unit pricing of piles, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items.

****

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****

NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.

****

Requirements of FAR 52.211-18 Variation in Estimated Quantity do not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and driving the piles including mobilization and demobilization, [jetting] [predrilling] [probing], redriving uplifted piles, [an additional 1.5 m 5 feet in furnished length for any test pile not driven beyond estimated pile length,] and cutting off piles at the cut-off elevation.[Include the cost for additional length for the test piles in the total unit price cost for the job.] Payment will be made for production [and test piles] at the bid unit price for the length of pile, from tip to final cut-off, actually provided, excluding buildups and splices directed by the Contracting Officer to be made. If the actual cumulative pile length driven (tip to cut-off) vary more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of FAR 52.236-2 Differing Site Conditions.[Payments will be made per each at the respective bid unit price for pile cut-offs, pile build-ups, pile loads tests and pile splices.][Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys].

][1.5 PAYMENT

****

NOTE: Delete this paragraph for lump-sum contracts.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (PAYMENT) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****

1.5.1 Furnishing and Delivering Timber Piles

1.5.1.1 Payment

Payment will be made for costs associated with furnishing and delivering the required lengths of permanent timber piles, which includes costs of furnishing and delivering piles to the work site. No payment will be made for the driving head or lengths of piles exceeding required lengths. No payment will be made for piles damaged during delivery, storage, or handling to the extent that they are rendered unsuitable for the work, in the opinion of the Contracting Officer.

1.5.1.2 Measurement

Furnishing and delivering permanent timber piles will be measured for payment by the linear meter foot of piles required below the cut-off elevation as [determined by the Contracting Officer and furnished to the Contractor] [indicated].

1.5.1.3 Unit of Measure

Linear meter foot.

1.5.2 Driving Timber Piles

1.5.2.1 Payment

Payment will be made for costs associated with driving permanent timber piles, which includes costs of handling, driving, [and splicing of piles,] [performing dynamic testing, interpreting data and submitting reports,] measuring heave, redriving heaved piles, removal of [build-ups] driving heads or cutting off piles at the cut-off elevation and removing from the work site, compiling and submitting pile driving records, backfilling voids around piles, and any other items incidental to driving piles to the required elevation.

1.5.2.2 Measurement

Permanent timber piles will be measured for payment for driving on the basis of lengths, to the nearest hundredth (tenth) of a linear meter foot, along the axis of each pile acceptably in place below the cut-off elevation shown.

1.5.2.3 Unit of Measure

Linear meter foot.

1.5.3 Pulled Timber Piles

1.5.3.1 Payment

Payment will be made for costs associated with piles pulled at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing and delivering pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Furnishing and Delivering Timber Piles". The cost of driving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Timber Piles". The cost of pulling undamaged piles will be paid for at twice the applicable contract unit price for payment item "Driving

Timber Piles", which includes backfilling any remaining void. The cost of redriving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Timber Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of piles, including pile driving points, pulled and found to be damaged and backfilling voids. New piles replacing damaged piles will be paid for at the applicable contract unit price for payment items "Furnishing and Delivering Timber Piles" and "Driving Timber Piles".

1.5.3.2 Measurement

Furnishing and delivering pulled and undamaged permanent timber piles will be measured for payment as specified in paragraph PAYMENT, subparagraph FURNISHING AND DELIVERING TIMBER PILES. Pulling undamaged timber piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING TIMBER PILES. Redriving pulled undamaged timber piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING TIMBER PILES. New piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraphs FURNISHING AND DELIVERING TIMBER PILES and DRIVING TIMBER PILES.

1.5.3.3 Unit of Measure

Linear meter foot.

[1.5.4 Timber Pile Driving Tests

1.5.4.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of driven test piles[, including [pile driving points] [and] [splices]]; conducting pile driving tests; backfilling voids around piles; compiling pile driving test records[; performing dynamic testing; interpreting data; and submitting reports].

1.5.4.2 Measurement

Timber pile driving tests will be measured for payment on the basis of the applicable contract unit price per pile driving test.

1.5.4.3 Unit of Measure

Each.

][1.5.5 Timber Piles for Load Tests

1.5.5.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of load test piles[, including [pile driving points] [and] [splices]]; backfilling voids around piles; compiling pile driving records[; furnishing, fabricating, and mounting of strain rods and protective assembly][; furnishing, fabricating, and mounting of inclinometer and inclinometer protective assembly][; performing dynamic testing; interpreting data; and submitting reports]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

1.5.5.2 Measurement

Timber piles for load tests will be measured for payment on the basis of the applicable contract unit price per load test pile.

1.5.5.3 Unit of Measure

Each.

][1.5.6 Timber Pile Static Axial Compressive Load Tests

1.5.6.1 Payment

Payment will be made for costs associated with timber pile static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static axial compressive load tests.

1.5.6.2 Measurement

Timber pile static axial compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.5.6.3 Unit of Measure

Each.

][1.5.7 Timber Pile Static Tensile Load Tests

1.5.7.1 Payment

Payment will be made for costs associated with timber pile static tensile load tests in accordance with ASTM D3689, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static tensile load tests.

1.5.7.2 Measurement

Timber pile tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load test.

1.5.7.3 Unit of Measure

Each.

][1.5.8 Timber Pile Lateral Load Tests

1.5.8.1 Payment

Payment will be made for costs associated with timber pile lateral load tests in accordance with ASTM D3966/D3966M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing inclinometers; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile lateral load tests.

1.5.8.2   Measurement

Timber pile lateral load tests will be measured for payment on the basis of the applicable contract unit price per lateral load test.

1.5.8.3   Unit of Measure

Each.

][1.5.9   Pulled Load Test Timber Piles

1.5.9.1   Payment

Payment will be made for costs associated with load test timber piles pulled prior to load testing at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing, delivering, driving, and pulling undamaged load test piles will be paid for at the applicable contract unit price for payment item "Timber Piles for Load Tests". The cost of pulling undamaged load test piles the second time after redriving and testing will be paid for at twice the applicable contract unit price for payment item "Driving Timber Piles". The cost of redriving pulled undamaged load test piles will be paid for at the applicable contract unit price for payment item "Driving Timber Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of load test piles pulled at the direction of the Contracting Officer and found to be damaged. New load test piles replacing damaged piles will be paid for at the applicable contract unit price for payment item "Timber Piles for Load Tests".

1.5.9.2   Measurement

Pulled undamaged load test timber piles will be measured for payment as specified in paragraph PAYMENT, subparagraph TIMBER PILES FOR LOAD TESTS. Pulling undamaged load test timber piles the second time after redriving and testing will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING TIMBER PILES. Redriving pulled undamaged timber piles will be measured for payment as specified in paragraph PAYMENT, subparagraph DRIVING TIMBER PILES. New load test timber piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraph TIMBER PILES FOR LOAD TESTS.

1.5.9.3   Unit of Measure

As specified in paragraph PAYMENT, subparagraphs DRIVING TIMBER PILES and TIMBER PILES FOR LOAD TESTS, respectfully.

][1.5.10   Pile Driving Shoes

1.5.10.1   Payment

Payment will be made for costs associated with pile driving shoes, including furnishing, delivering, and installing.

1.5.10.2 Measurement

Pile driving shoes will be measured for payment on the basis of the number of pile driving shoes required.

1.5.10.3 Unit of Measure

Each.

][1.5.11 Timber Pile Splices

1.5.11.1 Payment

Payment will be made for costs associated with timber pile splices, including all plant, labor, and material required to make the splice.

1.5.11.2 Measurement

Timber pile splices will be measured for payment on the basis of the applicable contract unit price per pile splice.

1.5.11.3 Unit of Measure

Each.

][1.5.12 Vibration Monitoring

1.5.12.1 Payment

Payment will be made for costs associated with vibration monitoring.

1.5.12.2 Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.12.3 Unit of Measure

Each.

][1.5.13 Sound Monitoring

1.5.13.1 Payment

Payment will be made for costs associated with sound monitoring.

1.5.13.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.13.3 Unit of Measure

Each.

][1.5.14 Preconstruction Condition Survey

1.5.14.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.5.14.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.5.14.3 Unit of Measure

Each.

][1.5.15 Construction Instrumentation and Monitoring

1.5.15.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.5.15.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.5.15.3 Unit of Measure

One.

]]1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Testing Agency Qualifications; G, [_____]

SD-02 Shop Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

Driving Equipment; G, [_____]

Helmets and Cushion Blocks; G, [_____]

Pile Shoes; G, [_____]

SD-04 Samples

Test Piles; G, [_____]

SD-06 Test Reports

[Pile Driving Test Data; G, [_____]

][Pile Driving Analyzer; G, [_____]

][Dynamic Testing Of Piles

] Test Piles; G, [_____]

Load Tests; G, [_____]

SD-07 Certificates

Timber Piles; G, [_____]

SD-11 Closeout Submittals

Pile Driving Records; G, [_____]

1.7 DELIVERY, STORAGE, AND HANDLING

Stack piles during delivery and storage so that each pile is maintained in a straight position and is supported every 3 meters 10 feet or less along its length (ends inclusive). Do not stack piles more than 1.5 meters 5 feet high. Use methods for handling and storage of piles such that the piles are not subjected to excessive bending stress.

Load, unload or transfer treated wood products using procedures specified in AWPA M4. Use slings, padding, or any method to prevent or minimize damage to treated wood products. Treat any damage sustained during handling as specified above.

Untreated piles to be stored for an extended period of time must be inspected periodically, as well as shortly before driving, to detect damage due to fungus and insect attack. If treated piles are to be stored in a horizontal position for an extended period of time, they must be inspected periodically to ensure that the treatment does not seep to the lower half of the pile to the extent that the upper half does not contain a sufficient amount of treatment. Inspect piles for excessive curvature and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads. Curvature in the pile must be measured with the pile laying on a flat surface and is the distance between the pile at the mid-length of the pile and the flat surface. Maximum permissible curvature is 50 mm 2 inches over the length of the pile. Piles having excessive curvature will be rejected.

1.7.1 Damaged Piles

Inspect each pile for soundness, splits, knots and holes before transporting them to the project site and immediately prior to placement in the driving leads. Bring any unusual pile conditions to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

Any pile damaged by reason of internal defects or by improper driving must be corrected by one of the following methods approved by the Engineer for the pile in question:

a. The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile.

b. One or more replacement piles are driven adjacent to the defective pile.

c. A Pile Dynamic Analysis and integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the driven pile(s).

A pile driven below the specified butt elevation must be corrected by one of the following methods approved by the Engineer:

a. The pile is spliced (if approved).

b. A sufficient portion of the footing is extended down to properly embed the pile.

A pile driven out of its proper location or out of plumb as approved by the Engineer, must be corrected by one of the following methods approved by the engineer:

a. One or more replacement piles are driven next to the pile in question.

b. As directed by the structural engineer.

1.7.2 Pile Sweep

****
NOTE: Sweep and camber typically apply to steel piles. In special cases, this paragraph may apply to precast/pre-stressed concrete piles or timber piles.
****

Limit sweep to 3 mm per 3 M 1/8 inch per 10 feet over the length of the pile. Piles having excessive sweep will be rejected.

1.8 QUALITY ASSURANCE

The producer must brand each treated pile, in accordance with AWPA M1, AWPA M2, AWPA M6, AWPA T1 and AWPA U1. Submit the inspection report of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with applicable AWPA Standards, and that the plant conforms to AWPA M3.

1.9 PLANT INSPECTION

The Government, at its discretion, reserves the right to inspect the treating process. Notify the Contracting Officer at least 3 weeks prior to beginning the treatment, stating where preservative treatment will be done. Allow Government inspector access to all parts of the plant. Allow inspection of all facets of the treating process.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Piles

****
NOTE: Choose one of the following options.
****

****
NOTE: The option below covers piles pressure treated with a preservative for land or fresh water. Specify or indicate on the drawings the minimum butt or tip circumference of the pile. Use butt circumference for a friction pile and tip circumference for an end-bearing pile.
****

****
NOTE: For NAVFAC LANT projects only, the following minimum circumferences normally apply:

Capacity (metric tons)	**Minimum Butt Circumference for Friction Piles (Use Table 1. ASTM D25) (mm)**	**Minimum Tip Circumference for End-Bearing Piles (Use Table 2. ASTM D25) (mm)**
(18)	**(965 mm)**	**(483 mm)**
(23)	**(965 or 1041 mm)***	**(559 mm)**
(27)	**(1041 mm)**	**(635 mm)**
***Depends on specific soil conditions encountered at the site.**		

Capacity (tons)	**Minimum Butt Circumference for Friction Piles (Use Table 1. ASTM D25) (inches)**	**Minimum Tip Circumference for End-Bearing Piles (Use Table 2. ASTM D25) (inches)**
(200	**(38 inches)**	**(19 inches)**
(25)	**(38 or 41 inches)***	**(22 inches)**
(30)	**(41 inches)**	**(25 inches)**
***Depends on specific soil conditions encountered at the site.**		

****

[Provide pressure treated Douglas fir or southern pine clean-peeled piles conforming to ASTM D25. Minimum [butt circumference measured at 900 mm 3 feet from the butt] [tip circumference] must be [[_____] mm inches] [as indicated]. Piles must be in one piece. Splicing is [not] permitted.] Submit the inspection report of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with applicable AWPA Standards. Identify treatment on each piece by the quality mark of an agency accredited by the Board of Review of the America Lumber Standard Committee.

****

NOTE: The option below covers piles for use in construction where preservative treatment is not required. Specify or indicate on the drawings the minimum butt or tip circumference of the pile. Use butt circumference for friction piles and tip circumference for an end-bearing pile.

Numerous species of high density wood (Walaba, Purple Heart, etc.) are available for applications of untreated piles where environmental conditions prohibit the use of preservatives. Insert selected species in the blank provided below.

****

[Provide untreated [Douglas fir or southern pine] [_____] [clean-peeled] [rough-peeled] [unpeeled] piles conforming to ASTM D25, AWPA T1, and AWPA U1. Minimum [butt circumference measured at 900 mm 3 feet from the butt] [tip circumference] must be [[_____] mm inches] [as indicated]. Piles must be in one piece.[Splices are not permitted.][Splices are permitted.]] A straight line drawn from the center of the butt to the center of the tip must lie entirely within the body of the pile per ASTM D25.[Ensure a continuous taper from the point of butt measurement to the tip.]

2.1.2 Preservative Treatment

****

NOTE: This paragraph covers preservative and preservative treatment for land or fresh water piling. Compliance with treatment standards must be confirmed, by an inspection report from an approved independent inspection agency, on each pile. Select appropriate treatment for intended use. Do not use CCA, ACA, or ACZA treatment for round timber piles when significant bending or impact loads are expected.

****

Provide [round] piles[conforming to ASTM D25 and AWPA T1] treated with [creosote per AWPA A1, AWPA P1/P13, and AWPA P2], [or] [creosote-coal tar solution conforming to AWPA A1, AWPA P1/P13, and AWPA P3] [waterborne preservative either, Ammoniacal Copper Arsenate (ACA), Ammoniacal Copper Zinc Arsenate (ACZA), or Chromated Copper Arsenate (CCA) in accordance with AWPA A2 and AWPA P5] for Land and Fresh Water Piles, confirmed by the report of an approved independent inspection agency.

[Treat cut, bored, dappled, and damaged surfaces as specified in AWPA M4[project requirements].]

2.2 PILE DRIVING EQUIPMENT

Provide Pile Driving Equipment as mentioned in this section.

2.2.1 Pile Hammers

Provide a hammer capable of developing the indicated ultimate pile capacity at blow count less than 100 per 300 mm foot considering hammer impact velocity; ram weight; stiffness of hammer and pile cushions; cross section, length, and total weight of pile; and character of subsurface material to be encountered.[Use the same pile hammer, operating at the same rate and in the same manner, as that used for driving test piles.] Use wave equation analysis to verify that the hammer will develop stresses within acceptable limits in the piles. At final driving, operate pile hammer in accordance with manufacturer's recommendation. Provide the plant and equipment for air hammers that have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The hose connecting the compressor with the hammer must be at least the minimum size recommended by the Manufacturer. Evaluate hammer performance at the end of driving by measuring blows per minute and comparing with the manufacturer's recommendations. Measure impact velocity of open-end (single acting) diesel hammers at all times during pile driving operations with a device for this purpose. If such a device is not available, obtain the stroke by measuring the speed of operation either manually or with a device that makes the measurement automatically. Equip closed-end (double acting) diesel hammers with a bounce chamber pressure gauge in good working order, mounted near ground level so as to be easily read by the Contracting Officer. Provide a correlation chart of bounce chamber pressure and potential energy. Equip hydraulic hammers with a system for measurement of ram energy. The system must be in good working order and the results must be easily and immediately available to the

Engineer.

2.2.2 Driving Helmets and Cushion Blocks

2.2.2.1 Driving Helmets or Pile Cushions

Use a steel driving helmet or pile cushion between top of pile and driving helmet or cap to prevent impact damage to pile. Use a driving helmet or pile cushion combination capable of protecting pile head, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over top of pile. Provide driving helmet that fits sufficiently loose around top of pile so that pile may be free to rotate without binding within driving helmet.[During test pile installation, demonstrate to satisfaction of Contracting Officer that equipment to be used on project performs specified function.] Use pile cushion of solid wood or of laminated construction using plywood, softwood or hardwood boards with grain parallel to end of pile. Select the pile cushion thickness placed on the pile head prior to driving by wave equation analysis so that the limiting driving stresses are not exceeded. Replace pile cushion at the start of driving of each pile and when it becomes highly compressed, charred or burned, or has become spongy or deteriorated in any manner. Show details of driving helmets, and pile cushions. Submit 2 weeks prior to [test] pile installation.

2.2.2.2 Hammer Cushion

****

NOTE: Select either wood or aluminum/micarta cushion. Delete inappropriate sentences. An aluminum/micarta cushion is recommended because of its consistent elastic properties and long life. If final pile penetration resistance is based on a Wave Equation analysis, the type of cushion used should be the same as that used in the analysis.

****

Use a hammer cushion between driving helmet or cap and hammer ram consisting of [a solid hardwood block with grain parallel to the pile axis and enclosed in a close-fitting steel housing] [aluminum and micarta (or equal) discs stacked alternately in a steel housing or a suitable polymer designed for this specific purpose as indicated by the hammer manufacturer]. Use steel plates at top and bottom of hammer cushion.[Replace hammer cushion when it becomes highly compressed, charred or burned or becomes spongy or deteriorated in any manner].[Replace aluminum, micarta or polymer discs that have become damaged, split or deteriorated in any manner].[Do not replace hammer cushion during final driving of any pile.] Do not use small wood blocks, wood chips, rope or other materials that permit excessive loss of hammer energy.

If the cushion is other than that specified above, submit to the Contracting Officer at least 2 weeks prior to the commencement of test pile driving, detailed drawings and records of previous successful use. Generally, follow the pile hammer manufacturer's recommendations with respect to hammer cushions.

PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Installation Drawings

Submit pile installation drawings at least 28 calendar days prior to installation. Drawings must indicate individual pile numbers,sequencing, and any phasing or special installation considerations.

3.1.2 Wave Equation Analysis of Pile Drivability

a. Prior to driving any pile, submit a pile Wave Equation Analysis, performed by Contractor's Geotechnical Consultant, for each size pile and distinct subsurface profile condition. These analyses must take into account the proposed hammer assembly, pile capblock and cushion characteristics, the pile properties and estimated lengths and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity.

b. Demonstrate using the Wave Equation Analysis that the piles will not be damaged during driving, indicate that the driving stresses will be maintained within the limits below and indicate the blow count necessary to achieve the required ultimate static pile capacities.

Allowable Driving Stresses

Wood

Compression - 20.7 MPa 3 ksi
Tension - 20.7 MPa 3 ksi Qa Allowable static timber stress

c. Perform a refined Wave Equation Analysis upon completion of the dynamic and static testing programs outlined in this specification section, taking into consideration the evaluated capacities, gain/loss factors and recommended production pile lengths.[Develop production pile driving criteria based on the results of the refined Wave Equation Evaluations.]

d. All pile driving equipment provided by the Contractor will be subject to the approval of the Contractor's Geotechnical Consultant. Complete the attached pile and driving equipment data form, including hammer information, in full as part of the submittal of the results of the Wave Equation Analyses.

e. Pay for the cost of performing the Wave Equation Analyses and include in the base bid.

3.1.3 Pile Length Markings

Mark each pile prior to driving with horizontal lines at 305 mm one foot intervals. Mark the interval number on pile every 1.52 m 5 feet from pile tip.

3.2 PILE DRIVING

3.2.1 Driving Piles

****

NOTE: Delete bracketed option for foundation excavation when not required. Delete items in brackets dealing with tip elevation and driving resistance when test piles or load tests are not used. Delete item in brackets regarding predrilling or jetting when procedure is not used. If needed, insert maximum hammer energy for no tip resistance. This can be determined by comparing tensile stresses in pile resulting from a Wave Equation Analysis with effective prestress in pile.

****

Notify Contracting Officer 10 days prior to driving of [test] piles[and load test].[Submit pile driving test data and reports of the dynamic testing of piles within one [day] [week] after each test is completed.]

[Stop foundation excavation at 300 mm one foot above foundation grade before piles are driven. Do not drive piles within 30 meter 100 feet of concrete less than 7 days old. Complete excavation to lines and grades shown when pile driving is completed.] Piles may be driven when the specified 28-day concrete strength has been achieved but not less than 7 days after casting.[The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analysis].] Drive piles to [the terminal driving criteria] [or below "calculated"] [indicated tip elevation] [to reach a driving resistance established by the [dynamic pile driving tests at the end of drive or restrike] [static load tests] [wave equation analyses (WEAP)] in accordance with the schedule which the [Contractor's Geotechnical Consultant] [Contracting Officer] will prepare from the test-pile driving data]. During initial driving and until pile tip has penetrated beyond layers of very soft soil [or below bottom of predrilled or prejetted holes], use a reduced driving energy of the hammer as required to prevent pile damage. Refusal criteria will be established by the Contracting Officer. If a pile fails to reach ["calculated"] [indicated] tip elevation, [or if a pile reaches ["calculated"] tip elevation without reaching required driving resistance,] notify Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB. Do not handle or move piles or pile sections in any manner that would result in cracking or permanent damage to the concrete or to the grout surrounding the prestressing cables. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

3.2.2 Protection of Piles

****

NOTE: Delete references to batter piles when not applicable to the project.

****

Take care to avoid damage to piles during handling, placing pile in leads, and during pile driving operations. Support piles laterally during driving, but allow rotation in leads.[Where pile or projecting reinforcement orientation is essential, take precautionary measures to maintain the orientation during driving.][Take special care in supporting battered piles to prevent excessive bending stresses in pile.] Square top of pile to longitudinal axis of pile. Maintain axial alignment of pile hammer with that of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through the reinforcement, by using a special driving head.

3.2.3 Pile Placement and Tolerances in Driving

****

NOTE: Omit references to batter piles when not applicable to the project. Select appropriate tolerances for type of pile. Use more stringent criteria as necessary based on the application. Confirm with the structural engineer.

****

Drive piles with a variation of not more than 2 percent from vertical for plumb piles or more than 4 percent from required angle for batter piles. Maintain and check axial alignment of pile and leads at all times. If subsurface conditions cause pile drifting beyond allowable axial alignment tolerance, notify Contracting Officer and perform corrective measures as directed. Place butts within 100 mm 4 inches of location indicated.[Manipulation of piles within specified tolerances [will not be permitted.] [will be permitted, to a maximum of 1-1/2 percent of their exposed length above ground surface or mudline.]] In addition to specified tolerances, maintain a location to provide a clear distance of at least 125 mm 5 inches from butt to edge of pile cap. If clear distance can not be maintained, then notify Contracting Officer. Piles must be monitored for heave immediately after installation and after adjacent piles are installed. If piles heave more than 13 mm 1/2 inch notify the Contracting Officer Redrive heaved piles to required point elevation. Piles damaged or driven outside the above tolerances must be replaced, or additional piles driven at locations specified by the Contracting Officer at no expense to the Government.

3.2.4 Rejected Piles

Withdraw piles damaged or impaired for use during handling or driving, mislocated, or driven out of alignment beyond the maximum tolerance. Replace with new piles or cut-off and abandon damaged or impaired piles and drive new piles as directed. Remove excess cut-off from piles and unacceptable piles from the work site. Perform all work in connection with withdrawing and removing rejected piles from the site at no additional cost to the Government.

3.2.5 Jetting of Piles

****

NOTE: Jetting should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Adjacent to existing structures.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Water jets will [not] be permitted.[Use jetting to assist driving piles through strata that cannot be penetrated practicably by use of the hammer alone.[Restrict driving to a static weight while water is being injected to prevent inducing tensile stresses in the piles which damage the concrete.] Discontinue jetting and resume hammer driving after the penetration of the strata requiring jetting has been accomplished.][Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.][Take adequate measures for collecting and disposing of runoff water.][Jetting method and equipment must be approved by the Contracting Officer prior to commencing jetting operation.] Before starting final driving, firmly seat piles in place by application of a number of reduced energy hammer blows.[Employ measures, including use of a silt curtain, to contain turbid water created by jetting piles.]

3.2.6 Predrilling of Piles

****

NOTE: Predrilling should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Located in cohesionless soils.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven [will [not] be permitted] [will be provided].[The diameter of the hole must not exceed two-thirds the width of the pile.][Predrill only to a depth of [_____] meters feet below cut-off elevation prior to setting piles.][Discontinue drilling when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration or more to meet the required driving criteria.]

3.2.7 Pile Splices

****

NOTE: Timber pile splices are difficult and undesirable. AASHTO(2010) LRFD Bridge Construction Specifications state that timber piles should not be spliced unless specified in the contract documents

and approved by the engineer.
****

[Splicing of piles is not permitted.][Make splices as indicated in the contract drawings.][Splices must be capable of developing the full strength of the member in compression, tension, shear, and bending.][Submit detail drawings of splices and design calculations demonstrating the strength of the splice for approval.]

3.2.8 Pile Cut-Off

Cut-off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods approved by Contracting Officer. Use of explosives for cutting is not permitted. Remove cut-off sections of piles from the site and off government property upon completion of the work.

3.2.9 As-Driven Survey

After the driving of each pile group is complete and before concrete is placed, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a licensed land surveyor.

3.2.10 Protection of Existing Structures

****
NOTE: Include this paragraph only when protection of existing structures from pile driving activities is required.

The designer must indicate on the drawings all structures and facilities for which protection is required. The designer must also provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.
****

Mitigate impact on existing facilities due to pile driving activities in accordance with the [project specific document] [_____].

3.2.11 Pile Shoes

Where indicated or directed, securely attach pile shoes of an approved design to the piles in a manner described in the detail drawings.

3.3 FIELD QUALITY CONTROL

3.3.1 Test Piles

****

NOTE: Select the second bracketed option when soil conditions dictate the use of a test pile longer than production piles. The ordered pile length for test piles should be 1.5 m 5 feet longer than ordered length for production piles to allow additional penetration if driving conditions dictate. Indicate location and number (if required) of test piles on plans, or list appropriate soil boring test hole numbers.
****

[Use test piles of type, and drive as specified for piling elsewhere in this section.][Order test piles [_____] meters feet longer in length than production piles. Drive the additional test pile length only at the direction of the Contracting Officer.] The [Contractor's Geotechnical Consultant] [Contracting Officer] will use test pile data to determine "calculated" pile tip elevation or necessary driving criteria.[Submit pile driving analyzer data and resport within one [day] [week] after each test is completed.]

Drive test piles [at the locations indicated] [in vicinity of soil boring test holes Nos. [_____,] [_____,] and [_____]]. Drive test piles to [indicated tip elevation] [indicated bidding lengths] [required driving criteria]. Use test piles, if located properly and offering adequate driving resistance in finished work.[Pre-drilling or jetting is permitted only when test piles clearly establish validity of its use, or as directed by the Contracting Officer.][Provide and operate a pile driving analyzer as specified in paragraph DYNAMIC PILE ANALYSIS during the driving of each test pile. Modify driving as required based upon recommendation of [Contracting Officer] [Contractor's Geotechnical Consultant and approval of the Contracting Officer].]

3.3.1.1 Dynamic Pile Analysis

Dynamic testing provides supplemental information for evaluating pile integrity, hammer and drive system performance, assess pile installation driving stresses, and pile capacities. Perform dynamic testing on [_____] percent of the [test] piles during the full length of the pile driving and during restrike a minimum of [_____] days after initial driving. Dynamic pile testing must also be performed on [_____] production piles as chosen by the Contracting Officer. Use [test] piles of type as specified elsewhere in this section. Provide equipment to obtain dynamic measurements, record, reduce and display its data that meet the requirements of ASTM D4945. The equipment must have been calibrated within [6] [_____] months prior to the start of the testing operations and thereafter throughout the contract duration. Drive [test] piles at the locations indicated or at the locations selected by the Contracting Officer. Employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile driving process[, monitoring of test pile installation,] and in the use of the Pile Driving Analyzer and its related equipment. Perform dynamic pile analysis as follows:

3.3.1.2 Pile Analyzing

[_____] working days prior to driving the [test] piles, submit the pile and complete driving equipment data to the Contracting Officer. The Contractor's Geotechnical Consultant must use the submitted information to perform wave equation analyses and must prepare a summary report of the wave equation results. The wave equation analysis using GRLWEAP software by Pile Dynamics, Inc. or equivalent must be used to assess the ability of the proposed driving system to install the pile to the required capacity and desired penetration depth within the allowable driving stresses. Approval of the proposed driving system by the Contracting Officer must be based upon the wave equation analyses indicating that the proposed driving system can develop a pile capacity of [_____] kN kips at a driving resistance not greater than [_____] blows per mm blows per inch within allowable driving stress limits. The hammer must also be sized or adjustable such that the penetration per blow at the required ultimate capacity does not exceed 12 mm 0.5 inches.

3.3.1.3 Pile Drivability

Perform each dynamic pile analysis in two steps. The first step is to check the hammer, pile and soil performance, and to determine the suitability of the proposed hammer for the size, length and type of pile being installed for the soil types encountered as the piles are driven. This initial monitoring must determine whether pre-augering or jetting is appropriate, efficiency of the hammer relative to specified efficiency, effectiveness of cushion, level of compressive and tensile stress in pile and extent/location of any pile damage caused by the initial driving. With each blow of the pile, record the information listed below electronically and analyze the information using the Pile Driving Analyzer:

a. Blow number

b. Blow rate per minute and stroke.

c. Input and reflected values of force and velocity.

d. Value of upward and downward traveling force wave with time.

e. Maximum and final transferred energy to pile, hammer system efficiency.

f. Maximum compressive stress, velocity, acceleration and displacement.

g. Maximum tensile stress in pile.

h. Pile structural integrity, damage detection, extent and location.

i. Bearing capacity of pile by Case method.

If the pile, hammer and soil performance evaluation recommends changes to the hammer stroke, pile cushioning, augering or any other aspect for the pile driving operation, incorporate these changes into production pile driving in an effort to control excessive stresses and pile damage. Replace test piles damaged or broken during installation, incorporating driving modifications as determined by the Contractor's Geotechnical Consultant and reviewed and approved by the Contracting Officer. Repeat this procedure until allowable tensile and compressive stresses are achieved in the pile and pile damage is minimized. Subject selected initial driving records to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and estimation of anticipated gain/loss factors.

3.3.1.4 CAPWAP

Signal matching analysis by CAPWAP software of the dynamic pile testing data must be performed on data obtained from the end of initial driving and the beginning of restrike of all control piles. CAPWAP analyses must be performed by an engineer who has achieved Advanced Level or better on the PDI / PDCA Dynamic Measurement and Analysis Proficiency Test for Providers of PDA Testing Services.

Upon completion of [test] pile driving, allow the piles to set-up for at least [72 hours] [_____ days]. After evaluation of pile, hammer and soil performance by the Contractor's Geotechnical Consultant, the second step of the dynamic pile analysis may proceed. This portion of the evaluation requires striking the set-up piles a minimum of 20-50 times, or as directed by the Contractor's Geotechnical Consultant using the same hammer which was used for the [test] pile driving and which will be used for production pile driving. "Warm up" the hammer and make it optimally ready prior to restriking, in order to avoid capacity losses during evaluation of restrike data. Apply maximum hammer energy during restrike in order to fully mobilize the soil resistance. However, exercise care so as to not overstress the pile. In addition to those items listed above, selected restrike driving records (as directed by the Contractor's Geotechnical Consultant) are to be subjected to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and plot of applied load vs. average pile displacement based on the calculated soil properties.

3.3.1.5 Dynamic Load Test Reporting

a. Upon satisfactory completion of each dynamic load test, submit[a minimum of three copies of] a Pile Performance Report for the Contractor by the Contractor's Geotechnical Consultant. The submittal must be prepared and sealed by a Professional Engineer registered in [_____].

b. The report for the Dynamic Pile Analysis must contain the following information:

    (1) Capacity of pile from Case Pile Wave Analysis Program (CAPWAP). Information resulting from analysis of a selected restrike blow.

    (2) Maximum and final transferred energy, hammer system efficiency during pile installation.

    (3) Maximum compressive stress, velocity, acceleration and displacement.

    (4) Maximum tensile stress in pile.

    (5) Pile structural integrity, damage detection, extent and location.

    (6) Blows per minute and blow number.

    (7) Input and reflection values of force and velocity, upward and downward traveling force wave with time.

    (8) Pile skin friction and toe resistance distribution.

    (9) Maximum energy transferred to pile.

c. The maximum allowable pile design load must be proposed by the Contractor's Geotechnical Consultant based upon the results of a satisfactory pile load test conducted on a pile driven as specified herein and must include the effects of load transfer to the soil above the foundation stratum.

Use either a model Model 8G or PAX Pile Driving Analyzer as manufactured by Pile Dynamics, Inc., of Cleveland Ohio or approved equivalent, for dynamic testing of the pile hammer and for dynamic load testing of the test pile. All equipment necessary for the dynamic monitoring such as sensors, cables or wireless transmitters, must be furnished by the Contractor's Geotechnical Consultant. The equipment must conform to the requirements of ASTM D4945.

Pay for all services of the Contractor's Geotechnical Consultant. The Contractor's Geotechnical Consultant must be available throughout the pile driving operation to consult with the Contracting Officer when required by the Contracting Officer. The cost of changes in the Contractor's procedure, as required by evaluation of the results of the Pile Driving Analysis, will be at the Contractor's expense.

3.3.2 Static Load Tests

Perform compressive load tests on [_____] test piles in accordance with ASTM D1143/D1143M (standard loading procedure) as modified herein.[Allow a minimum of [72 hours] [_____ days] following final test pile driving for pile set-up prior to load testing.][Do not use anchor piles.] Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform [or reaction frame attached to sufficient uplift piles to safely take required load] applied to pile by hydraulic jack. Increase load in increments until rapid progressive settlement takes place or until application of total compressive load of [_____] KN kips for compressive load tests. Consider load test satisfactory when [after one hour at full test load gross settlement of pile butt is not greater than gross elastic pile compression plus 4 mm 0.15 inch plus one percent of pile tip diameter or width in [_____] mm inches,] [slope of gross load-settlement curve under full test load does not exceed 1.5 mm per metric ton 0.05 inches per ton,] [net settlement after removal of test load does not exceed 19 mm 3/4 inch]. Perform load tests at locations [as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

[3.3.2.1 Safe Design Capacity

Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.

][3.3.3 Tensile Load Test

Perform tensile load tests on [_____] test piles in accordance with ASTM D3689. Apply a tensile load of [_____] kN kips to each tensile load test pile. In performing the tension load test, apply the ultimate load equal to one and one-half times the safe tension capacity, and employ the Standard Loading Procedure.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

Perform dynamic measurements on [_____] piles designated as dynamic test piles in accordance with ASTM D4945 during driving. During easy driving, ensure that damaging tension stresses do not develop in the pile. Signal matching must be performed by the Contractor's Geotechnical Consultant on representative data collected at the end of the initial driving and at the beginning of all restrike events. Additional signal matching analysis must be performed as determined by the Engineer.

]3.3.4 Lateral Load Test

Perform lateral load tests on [_____] piles in accordance with ASTM D3966/D3966M. Lateral load tests must consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. Apply a lateral load of [_____] kN kips to each pair of lateral load test piles. Record required movement readings for each pile.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

3.3.5 Pile Driving Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not driven. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of driving, testing, recording and analysis of data for project may be useful.

****

****

NOTE: The Specifier must attach the specifications pile driving log graphic (for all pile driving projects) and the pile driving equipment data form (for projects using PDA) to the end of this specification section.

****

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations, [batter alignment,] number of blows required for each 300 mm foot of penetration and number of blows for the last 150 mm 6 inches penetration or fraction thereof [as required] for the "calculated" [driving resistance]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of hammer cushion and pile cushion used. Record retap data and unusual occurrences during pile driving such as redriving, heaving, weaving, splicing, obstructions, [jetting,] and any driving interruptions.[Install an energy monitor on the hammers and record readings every 300 mm 12 inches of pile installation.] A preprinted pile driving log for recording pile driving data[and pile driving equipment data form], which can be downloaded at: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

Submit complete and accurate pile driving records of installed piles to Contracting Officer within [15] [_____] calendar days after completion of pile driving. Make pile driving records available to the Contracting Officer at the job site, within 24 hours after each day of pile driving. Preparation of the record must be by, or under the direct supervision of a registered professional engineer.

3.3.6 Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated and approved by the Contracting Officer.

[3.4 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-301-01, "Structural Engineering".

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

][3.5 VIBRATION CONTROL

****

NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular

project.
****

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs][and geophones] within a distance of 61 meters 200 feet from the pile driving activity.[Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [5] [_____] years of experience in vibration monitoring. A minimum of [28] [_____] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient vibrations. The vibration during the pile driving activities must be limited to [a peak particle velocity of not more than 5 cm 2 inches per second] [the limits mentioned in the [contract documents]].[Determine appropriate vibration limits as per [US Bureau of Mines] [American Association of State Highway and Transportation Officials (AASHTO)] guidelines.] During pile driving activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity causing the vibration until [the Vibration consultant and the Contracting Officer] [_____] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.6 NOISE CONTROL

****
NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project.
****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the pile driving operations.[Perform noise monitoring using [noise meters][, and] [_____]].[Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [5] [_____] years of experience in noise monitoring. A minimum of [28] [_____] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient noise levels.[The noise limits are mentioned in the [plan] [contract documents].][Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines.] During pile driving activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity and install noise mitigation measures.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.7 PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform preconstruction condition survey of [structures] [and utilities] [within 61 meters 200 feet of the pile driving activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] [_____] days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] [_____] days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

][3.8 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile driving activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement[and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile driving. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile driving when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile driving activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 62 19.13 (November 2016)**

Change 2 - 05/22

Preparing Activity: NAVFAC **Superseding**

UFGS-31 62 19.13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

USACE / NAVFAC / AFCEC **UFGS-31 62 19.13 (November 2016)**

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****

SECTION 31 62 19.13

TIMBER MARINE PILES

11/16, CHG 2: 05/22

****

NOTE: This guide specification covers the requirements for furnishing all plant, labor, materials, and equipment, except material and equipment specified to be furnished by the Government, and for performing all operations in connection with the installation of round (treated) (untreated) (treated and untreated) timber piles and the testing of such piles for waterfront and other marine type structures as directed in accordance with this section of the specifications and the applicable drawings.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Requirements for materials and procedures for special or unusual design should be added as necessary.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA A3	(2015) Standard Method for Determining Penetration of Preservatives and Fire Retardants
AWPA M2	(2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use
AWPA M4	(2023) Standard for the Care of Preservative-Treated Wood Products
AWPA M6	(2024) Brands Used on Preservative Treated Materials
AWPA P1/P13	(2024) Standard for Creosote Preservative
AWPA P2	(2024) Standard for Creosote Solutions
AWPA P5	(2015) Standard for Waterborne Preservatives
AWPA P34	(2014) Standard for Copper Naphthenate, Waterbone (CuN-W)
AWPA T1	(2024) Use Category System: Processing and Treatment Standard
AWPA U1	(2024) Use Category System: User

	Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM D25	(2012; R 2017) Standard Specification for Round Timber Piles
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D5643/D5643M	(2012) Standard Specification for Coal Tar Roof Cement, Asbestos Free

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-W-410	(2022; Rev J) Wire Rope and Strand

WESTERN WOOD PRESERVERS INSTITUTE (WWPI)

WWPI Mgt Practices	(1996; R 2011) Best Management Practices for the Use of Treated Wood in Aquatic and Wetland Environments

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Piles; G, [_____]

Pile Driving Equipment; G, [_____]

Submit complete descriptions of pile driving equipment, including hammers, leads, driving helmets, cushion blocks, driving blocks, collars, extractors, and other appurtenances for approval prior to commencement of work.

[Pile Caps; G, [_____]

][Pile Shoes; G, [_____]

][Jetting Equipment and Method; G, [_____]

][Spudding Equipment; G, [_____]

][Predrilling Equipment; G, [_____]

The Contractor must provide the Contracting Officer's Representative (COR) with the predrilling method and size.

][SD-04 Samples

Test Piles; G, [_____]

If approved after test completion, include properly located test piles in finished work.

] SD-06 Test Reports

[Load Tests; G, [_____]

Test data and results as specified in paragraph LOAD TESTS.

] Preservative Treatment - Timber Marine Piles; G, [_____]

The Contractor must provide the Contracting Officer's Representative (COR) with the inspection report of an independent inspection agency, approved by the Contracting Officer, that offered products comply with applicable AWPA standards.

Delivery Inspection List; G, [_____]

SD-07 Certificates

SDS and CIS; G, [_____]

Pesticide Applicator Company Self-Certification; G, [_____]

Best Management Practices (BMPs); G, [_____]

SD-11 Closeout Submittals

Pile Driving Records; G, [_____]

Submit pile driving records within 15 calendar days after completion of driving.

As-Driven Pile Survey; G, [_____]

1.3 DELIVERY, STORAGE, AND HANDLING

Handle and store piles in accordance with AWPA M4. Follow precautions identified in SDS or CIS provided by the supplier of treated wood products. Special care must be taken in supporting piles to prevent the induction of excessive bending stresses in the piles. Piles must be carefully handled without dropping, breaking of outer fibers, and penetrating the surface with tools. Peaveys, cant hooks, pikes, and other pointed tools must not be used in handling treated piles.

1.4 QUALITY ASSURANCE

****

NOTE: Do not use untreated piling except for fender piles where an analysis of pile maintenance and replacement records clearly justifies its use or where plastic covered piling is specified. Special care in handling and frequent inspections of installed plastic-covered piles are required to ensure that no exposure of the untreated wood occurs.

****

****

NOTE: References listed in article REFERENCES, are intended for general references only. Consult with appropriate environmental office for possible local

regulations or policies that restrict either the use of treated wood in aquatic environments or the eventual disposal of treated piles. If applicable, the specifier should add those regulatory requirements.

****

1.4.1 Preservative Treatment - Timber Marine Piles

The Contractor must be responsible for the quality of treated wood products. The Contractor must provide the Contracting Officer's Representative (COR) with the inspection report of an independent inspection agency, approved by the Contracting Officer, certifying that the offered products comply with applicable AWPA standards. Identify treatment on each piece by the quality mark of an agency accredited by the Board of Review of the American Lumber Standard Committee. Inspect all preservative-treated wood visually to ensure there are no excessive residual materials or preservative deposits. Material must be clean and dry or it will be rejected because of environmental concerns.

1.4.2 SDS and CIS

Provide Safety Data Sheets (SDS) and Consumer Information Sheets (CIS) associated with timber pile preservative treatment. Contractor must comply with all safety precautions indicated on the SDS and CIS.

1.4.3 Delivery Inspection List

Field inspect and submit a verification list of each treated timber pile indicating the wording and lettering of the quality control markings, the species and the condition of the wood. Do not incorporate piles damaged in transport from plant to site. Inspect all preservative-treated piles, visually to ensure there are no excessive residual materials or preservative deposits. Material must be clean and dry or it will be rejected due to environmental concerns.

****

NOTE: Consult with appropriate environmental office for possible local regulations or policies that restrict pile installation or the use of preservative products at the project location.

****

[1.4.4 Regulatory Requirements

[_____].

]1.4.5 Pesticide Applicator Company Self-Certification

Provide the Contracting Officer, a statement signed by the responsible site supervisor or higher company representative, certifying that the contractor will comply with all pesticide label instructions. The certification should identify by name all individuals (applicators) who will be working with wood preserving pesticide products on site.

1.4.6 Best Management Practices (BMPs)

The producer of the treated wood products must provide certification that WWPI Mgt Practices for the use of Treated Wood in Aquatic and Wetland

Environments were utilized including a written description and appropriate documentation of the BMPs utilized.

[As part of the BMPs for CCA treated pier timberwork, certification must be provided that documents that the Chromotropic Acid Test (AWPA A3- Methods for Determination of the Presence of Hexavalent Chromium in Treated Wood) was performed on the timber and adequate fixation of the CCA treatment has been achieved prior to installation.

]

****

NOTE: For NAVFAC (Navy) projects, use and edit the appropriate following paragraph(s). Do not use for Army projects.

****

[1.5 BASIS OF BIDS

****

NOTE: Choose one of the two following Basis of Bids methods.

****

****

NOTE: For lump sum bidding of piles. This option should be used in all projects except those where exact quantities cannot be practically determined prior to the actual work. Numbers of piles, pile capacity, pile locations, and tip and cutoff elevations must be clearly shown on the drawings.

****

[Base bids on the number, circumference, and length of piles from tip to cutoff as indicated. [Test piles must be [1.5] [_____] meter [5] [_____] feet longer than bid length piles. [Base bids on the number of load tests indicated or specified.] From the data obtained as a result of driving the test piles [and load tests] specified herein, the Government will determine and list for the Contractor the calculated minimum pile tip elevations, the driving resistance for piles, or both. The information will be given to the Contractor no later than 10 days after receipt of complete test pile data. The list must be used as the basis for ordering piles. The Contractor must not order production piles prior to receipt of the above information from the Government.] Should the total number of piles or number of each length vary from that specified as the basis for bidding, the contract price will be adjusted in accordance with Contract Clause entitled "Changes." Adjustment in contract price will not be made for cutting off piles, for any portion of a pile remaining above the cutoff elevation, disposal of piles, or for broken, damaged, or rejected piles.
]

****

NOTE: For unit price bidding of piles or NAVFAC LANT projects. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of piles must be determined as accurately as possible prior to bidding, since the unit price per meter foot of the pile varies as the length increases or decreases.

****

****

NOTE: For NAVFAC PAC projects: Edit contract's price schedule for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****

[For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

] Payment will be at the contract unit price for furnishing labor, materials, tools, equipment, and incidentals required for furnishing and driving piles. Work includes furnishing and driving piles including [test piles] [load test] [jetting] [spudding] [predrilling], pile cutoff, redriving, and removal and replacement of damaged, misallocated, or otherwise rejected piles. Base bids on the number of piles with pile length from tip to cutoff, as indicated, and on total length of piling from tip to cutoff, including test piles. Include in bid a unit price per [load test[s] and] unit length of piling based on the quantity stated. From data obtained as a result of driving the test piles [and load tests] specified herein, the Government will determine and list for the Contractor the calculated minimum pile tip elevations, the driving resistance for piles, or both. The information will be given to the Contractor no later than 10 calendar days after receipt of complete test pile data. The list must be used as the basis for ordering piles. The Contractor must not order production piles prior to receipt of the above information from the Government. If the Contracting Officer requires an increase or a decrease in the unit length of piles furnished and installed, the contract price will be adjusted in accordance with FAR 52.211-18 Variation in Estimated Quantity.[Adjustment in contract price will also be made for each increase or decrease in number of pile load tests.]

****

NOTE: For USACE (Army) projects, use and edit the appropriate following paragraph(s). Do not use for Navy projects.

****

][1.6 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, the paragraph UNIT PRICES should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****

1.6.1 Round Timber Piles, [Vertical] [Batter]

1.6.1.1 Payment

Payment for each acceptably driven pile will be made at the applicable contract unit price for each pile as determined by the length and type of pile specified or directed to be driven; this price includes all items incidental to furnishing and driving the piles, redriving uplifted piles, any required notching, the cutting off of all piles at the cutoff elevation, disposal of cutoffs [and the preservative treatment of the tops of treated piles which are headed] but exclusive of any capping of heads.

1.6.1.2 Measurement

Acceptably driven piles will be measured for payment based upon each pile.

1.6.1.3 Unit of Measure

Unit of measure: each.

[1.6.2 Test Piles

1.6.2.1 Payment

Payment will be made for test piles, driven as directed and not incorporated in the permanent work. Payment will be made for test piles incorporated in the permanent work.

1.6.2.2 Measurement

Test piles, driven as directed and not incorporated in the permanent work, will be measured for payment at twice the applicable contract unit price for a permanent pile of the same type and length. Test piles, incorporated in the permanent work, will be measured for payment at the contract unit price for permanent piles.

1.6.2.3 Unit of Measure

Unit of measure: each.

][1.6.3 Pile Load Tests

****

NOTE: The designer will specify the number of pile loading tests to be performed and the loading data.

****

1.6.3.1 Payment

Payment for each complete test load of a single pile will be made at the contract unit price for each pile load test. When a group of piles is required to be test loaded, payment for the load test will be made at the contract unit price for "Pile Load Test" for the first loaded pile of the group, plus 50 percent of this amount for each additional loaded pile in the group.

1.6.3.2 Measurement

Pile load test will be measured for payment based upon furnishing, placing, and removing testing equipment and test loads.

1.6.3.3 Unit of Measure

Unit of measure: each.

][1.6.4 Pile Shoes

1.6.4.1 Payment

Payment will be made for furnishing all plant, labor, and materials for pile shoes and will be paid for at the contract unit price for each pile shoe.

1.6.4.2 Measurement

Pile shoes will be measured for payment based upon each pile shoe furnished.

1.6.4.3 Unit of Measure

Unit of measure: each.

][1.6.5 Pile Caps

1.6.5.1 Payment

Payment will be made for furnishing all plant, labor, and materials for pile caps and will be paid for at the contract unit price for each pile cap.

1.6.5.2 Measurement

Pile caps will be measured for payment based upon each pile cap furnished.

1.6.5.3 Unit of Measure

Unit of measure: each.

][1.6.6 Pulled Piles

1.6.6.1 Payment

Payment will be made for satisfactorily driven piles which are pulled at the direction of the Contracting Officer and found to be in good condition. Where piles are pulled at the direction of the Contracting Officer and found to be damaged, no payment will be made for originally furnishing and driving such piles nor for the operation of pulling, and damaged piles must be replaced by new piles for which payment will be made.

1.6.6.2 Measurement

Satisfactorily driven piles which are pulled at the direction of the Contracting Officer and found to be in good condition will be measured for payment at the applicable contract unit price for furnishing and driving the pile at its original position plus 50 percent of this amount to cover the cost of pulling. Pulled timber piles found to be sound and in a satisfactory condition by the Contracting Officer must be redriven and measured for payment at 50 percent of the applicable contract unit price for furnishing and driving the pile. Where piles are pulled at the direction of the Contracting Officer and found to be damaged, no measurement for payment will be made for originally furnishing and driving such piles nor for the operation of pulling, and the damaged piles must be replaced by new piles which will be measured for payment at the applicable contract unit price for furnishing and driving the pile.

1.6.6.3 Unit of Measure

Unit of measure: each.

]]PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Piles

****

NOTE: For Bearing Piles specify the minimum butt circumference for a friction pile or specify the minimum tip circumference for an end-bearing pile. Clean-peeled piles should be specified where preservative treatment is required.

****

Provide Douglas fir, Southern pine, or Red pine [clean-peeled] [rough-peeled], [treated] [and] [untreated] piles in accordance with AWPA U1 Commodity Specification G and conforming to ASTM D25 and other requirements as specified. Piles must be in one piece for the length[s] [shown] [as determined from pile load tests]. Splices will not be permitted. Each treated pile must be branded by the producer, in accordance with AWPA M6. Pile circumferences must be as follows:

a. Bearing Piles: Minimum [butt circumference measured at 0.91 m 3 feet from the butt end] [tip circumference] must be [[_____] mm inches] [as indicated].

b. [Fender] [,] [and] [Cluster] [,] [and] [Dolphin] [_____] Piles: Minimum butt circumference measured at 0.91 m 3 feet from the butt end must be [[_____] mm inches] [_____].

2.1.2 Preservative Treatment

****

NOTE: Select preservative treatment of marine piles as follows (consult the nearest organizational Applied Biologist for specific requirements for specific locations):

Based on AWPA's Use Criteria System (UCS) wood and wood products exposed to salt or brackish water in U.S. Coastal Waters must fall under one of three Use Categories for Marine Use.

UC5A MARINE USE Northern Waters
UC5B MARINE USE Central Waters
UC5C MARINE USE Southern Waters

Use Category requirements are based on the presence of specific marine organisms in the waters that require higher preservative loadings for control. Refer to AWPA's U1, Commodity Specification G to determine the approximate geographical location for each Use Category.

Recommended preservative treatment type (ACZA, CCA,

and Creosote), minimum preservative penetration, and retention requirements must be as specified by AWPA U1, Commodity Specification G based on wood species and Use Category.

NOTE: Consult with appropriate environmental office for possible local regulations or policies that restrict the use of creosote at the project location.
****

****
NOTE: In areas where limnoria, teredo or pholads are expected or known, pressure treated piles may be further protected by wrapping in plastic coatings. Load bearing piles not subject to excessive abrasion or severe impacts are particularly suited for this process.
****

****
NOTE: For fender piles, dolphin piles, and other piling requiring lateral load-carrying capacity, consideration should be given to increasing pile diameter because preservative pressure treatment tends to reduce lateral load-carrying capacity.
****

Treat piles based on Use Category and species in accordance with AWPA U1 and AWPA T1 to the retention and penetration for marine piling and produce in accordance with WWPI Mgt Practices. Piles preservative treatment must be [Creosote or creosote solution for marine piles in accordance with AWPA P1/P13 or AWPA P2, respectively] [Waterborne preservative for marine piles in accordance with AWPA P5 (ACZA - Ammoniacal Copper Zinc Arsenate, CCA - Chromated Copper Arsenate)] [Dual treatment of creosote or creosote solution plus waterborne preservative for marine piles in accordance with AWPA P1/P13 or AWPA P2, and AWPA P5].

2.1.3 Field Treatment

Piles must be field treated in accordance with AWPA M4. All cuts, holes and injuries such as holes from removal of spikes or nails which may penetrate the treated zone must be field treated with copper naphthenate conforming to AWPA P34 [and] [coal-tar roofing cement conforming to ASTM D5643/D5643M].

[2.1.4 Pile Shoes

****
NOTE: Pile shoes should be required only when extremely hard driving is required in upper strata for the penetration of such strata to reach the bearing stratum.
****

Pile Shoes must be a steel boot or welded-plate point shoe especially fabricated for pile driving and in accordance with ASTM A1011/A1011M. The product must be fabricated by a manufacturer regularly engaged in the manufacture of pile fittings. Welding procedures must be in accordance with a nationally recognized welding code. Provide size to fit pile tip.

Fabricate boot type of 5 mm 3/16 inch carbon steel fully welded, with at least three straps, each with three 5 mm 3/16 inch nail holes. Fabricate welded-plate point type of four 5 mm 3/16 inch or 6 mm 1/4 inch steel plates, fully welded and sized to adequately cover full pointed area of pile; provide each plate with one 5 mm 3/16 inch or one 6 mm 1/4 inch nail hole. The length of the joints formed by the intersection of the sides must not be less than one half of the height of the shoe. Shoes must be cleaned and painted with at least one coat of paint. The color and paint must be the manufacturer's standard. [Shoes may be furnished without painted finish.] Provide on the point of [each pile] [each bearing pile] [each fender, cluster, and dolphin pile] [_____].

][2.1.5 Pile Caps

Marine pile caps must consist of [a permanently fixed coating of epoxy] [fiberglass or polyethylene conical caps permanently attached to the pile] [_____].

][2.1.6 Hardware

****

NOTE: Give special attention to corrosion protection of hardware used with timber preserved with water-borne salts. Specify protection ranging from simple coatings to changing of the hardware metals dependent upon the required use and critical features of the hardware. Hot-dip galvanized hardware and fasteners will usually suffice in such cases.

****

Pile hardware must consisting of bolts with necessary nuts and washers, timber connectors, drift pins, dowels, nails, screws, spikes, and other fastenings. Provide bolts with washers under nut and head. Bolts and nuts must conform to ASTM A307. Provide cast-iron ogee, malleable iron washers, or plate or cut washers where indicated. Provide bolts with washers under nut and head. Provide timber connectors and other metal fastenings of type and size indicated. Hot-dip galvanize all hardware in accordance with ASTM A123/A123M or ASTM A153/A153M, as applicable.

][2.1.7 Wire Rope and Fitting

Wire ropes must be in accordance with FS RR-W-410 [Type III, Class 2][Type III, Class 3][Type I, Class 2]. All wire ropes must be zinc coated in accordance with ASTM A1023/A1023M.[Provide staples of 10 mm 0.375 inch diameter zinc-coated steel at least 125 mm 5 inches long.][Provide clips or clamps of zinc-coated steel.]

]2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Inspection of Piles

The Contractor must provide the necessary facilities for the proper inspection of each pile. Piles to be preservative treated will be inspected prior to treatment. Piles will be inspected at the shipping point or at the work site if so decided. Pile inspection at the shipping point will not be performed for less than 100 piles in one locality. Piles with specified variations in characteristics must be placed in separate lots for inspection. Piles must be so marked or segregated into marked lots that there will be no possibility of error in assignment after they have been inspected. Piles damaged after inspection may be subsequently rejected if damage is deemed sufficient for rejection. All rejected piles must be removed as directed.

2.2.2 Inspection of the Preservative Treatment Process

Inspection of the preservative treatment process will be in accordance with AWPA M2. The Contractor must notify the Contracting Officer where preservative treatment will be done not less than 15 days prior to the start of the treatment and must provide the necessary facilities for the proper inspection of the treatment process. Allow the Contracting Officer unlimited access to the plant and inspection privileges for each facet of the treating process.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Pile Driving Equipment

Pile driving equipment must meet the following requirements.

3.1.1.1 Pile Driving Hammers

****

NOTE: If vibratory hammers should not be used, the references to vibratory hammers should be deleted from the text.

****

Pile driving hammers must be steam, air or diesel, single-action, double-acting, differential-acting [, or] [vibratory] [_____] type. [The use of vibratory hammers is dependent upon satisfactory driving and load testing of piles.] The size or capacity of hammers must be as recommended by the manufacturer for the pile weights and solid formation to be penetrated. The pile hammer must be of sufficient weight and energy to install the specified pile without damage into the soils [as indicated] [expected to be encountered]. The maximum driving energy of hammers must be [16,270] [20,330] joules [12,000] [15,000] foot-pounds for piles for any length. Test piles must be driven with the same size and type hammer, operating with the same effective energy and efficiency as that to be used in driving job piles. Diesel powered hammers must be operated at the rate recommended by the manufacturer throughout the entire driving period. Sufficient pressure must be maintained at the hammer so that:

a. For double-acting hammers, the number of blows per minute during and at the completion of driving of a pile is equal approximately to that at which the hammer is rated;

b. For single-acting hammers, there is a full upward stroke of the ram; and,

c. For differential-type hammers, there is a slight rise of the hammer base during each upward stroke.

3.1.1.2 Leads

Leads are required and must be fixed at the top and adjustable at the bottom. Swinging leads [will] [will not] be permitted.

3.1.1.3 Driving Cap or Helmet and Cushion Block

Driving cap or helmet must be an approved design and must be capable of protecting pile heads, minimizing energy absorption, and transmitting hammer energy uniformly and consistently to piles. Place driving helmet or cap and cushion block combination between top of pile and the ram. Driving cap must fit snugly on the top of piles and must employ a cushion block to prevent impact damage to piles. The cushion block may be a solid or laminated softwood block with the grain parallel to the pile axis and enclosed in a close-fitting steel housing. The thickness of the block must be suitable for the length of pile to be driven and the character of subsurface material to be encountered. [Generally, thicker blocks are required for longer piles and softer subsurface material.] If block is damaged, split, highly compressed, charred or burned, or has become spongy or deteriorated, replace with new block. Under no circumstances will the use of small wood blocks, wood chips, rope, or other material permitting excessive loss of hammer energy be permitted.

3.1.1.4 Pile Collars

Collars or bands for protecting pile butts against splitting, brooming, and other damage while being driven must be of an approved design.

3.1.2 Pile Installation

Inspect piles when delivered and when in the leads immediately before driving. Cut piles at cutoff grade with pneumatic tools by sawing or other approved method. Where cutoff is below existing mudline elevation, complete excavation, sheeting and dewatering before pile is driven to cutoff elevation.

[3.1.2.1 Test Piles

****

NOTE: Insert the number of test piles required. Test pile locations should be shown on the drawings. The number of test piles is normally between 5 and 10 percent of the total number of piles required, dependent upon the magnitude of the project. Test piles are furnished longer than job piles to allow additional penetration if driving conditions dictate. Delete this paragraph if test piles are not required.

****

Provide [_____] test piles conforming to the same requirements as specified for job piles. Drive test piles in the same manner as specified for job piles. Furnish test piles([1.5] [_____] m[5] [_____] feet) longer than length specified for job piles and drive the additional depth, if directed. Drive test piles in locations indicated or as directed. Record driving data as specified in paragraph entitled "Records." Confirmation of the assumed allowable working loads of single piles must be made by static loading and measuring [each] [_____] test pile[s] in the manner described below. Test piles indicated or directed to be driven in permanent locations may be incorporated into the work if, after satisfactory completion of the load test, they are approved for inclusion in the work by the Contracting Officer. Every facility must be provided by the Contractor for the Contracting Officer to inspect and measure the deflection or settlement of the pile under test. Furnishing of measuring equipment and making measurements of deflection or settlement will be the responsibility of the [Contracting Officer] [Contractor] [_____].

][3.1.2.2 Load Tests

****

NOTE: Insert the number of test piles to be load tested. The safe design capacity of a test pile as determined from the results of load test must be the lesser of the two values computed according to the following:

1. One-half the test load which causes a settlement of 0.03 mm per kN 0.01 inch per ton of test load; and

2. One-half the test load that causes a gross settlement of 25 mm one inch provided the load-settlement curve shows no sign of failure.

****

ARMY NOTE: The designer will specify the method of load testing and the specific pile driving formulas used for design.

****

Perform load tests on [_____] test piles in accordance with ASTM D1143/D1143M loading procedures, as modified herein. Perform load tests at locations shown, or as directed. Provide testing and measuring equipment, perform loading, and provide observation facilities for a registered professional engineer employed by the Contractor to inspect and record settlement and deflection of piles under test loads. Do not mobilize load test equipment until directed. Loading frames and equipment must be ready to place in operation as soon as a test pile has been driven. The loading equipment must be of sufficient capacity to apply a maximum load of not less than [_____] kN [_____] tons. The ultimate test load must be maintained for not less than [24] [_____] hours and then unloaded in accordance with ASTM D1143/D1143M.

]3.1.2.3 Driving Piles

[Drive job piles with same hammer, cushion, or cap block, and using the same operating conditions as test piles.]Piles must not be driven within 30 meters 100 feet of concrete which is less than 7 days old unless otherwise authorized. A complete and accurate record of the driving of piles must be compiled by the Contractor for submission to the Contracting Officer. When driving long piles of high slenderness ratio, special precautions must be taken to ensure against overstressing and leading away from a plumb or true position. During driving, pile driving hammers must be operated at all times at the rate and conditions recommended by the hammer manufacturer. Each pile must be driven continuously and without interruption [to the [calculated] [indicated] tip elevation] [until the required depth of penetration and penetration rate per blow have been attained in accordance with the schedule that the Contracting Officer will prepare from the test pile driving [and test] data]. Deviation from this procedure will be permitted only in case the driving is stopped by causes which reasonably could not have been anticipated. The controlling penetration per blow will be determined by the Contracting Officer. Piles must be driven to the full penetration required where practicable to do so without damage to the piles. If found impracticable to drive any pile to the depth required, such pile must be cut off and abandoned or pulled as directed. Driven piles which have a penetration of less than [_____] meters [_____] feet [that specified for the following areas [_____]] and have not been driven to the established maximum penetration per blow are not satisfactory. Driving of piles beyond the point of refusal, as indicated by excessive bonding of the hammer or kicking of the pile, or a blow count of greater than twice the blow count required to produce the safe bearing capacity must not be attempted. Piles which have uplifted after driving must be redriven to grade after conclusion of driving in that general area. The maximum permissible penetration per blow for the last 20 blows will be established by the Contracting Officer. When the penetration per blow of any pile during the final blows exceeds that permitted or it is found that a pile is not of sufficient length to give the capacity specified, and the pile has been driven to its full depth, the Contractor must pull the pile, furnish, and drive a longer pile or take other corrective measures as directed by the Contracting Officer. The use of followers or splices must not be permitted. After driving is completed, all piles must be "headed" or cut off normal at the cutoff elevation. [Fender piles must have tops beveled outboard as indicated.] Pile heads at cutoff must be sound. Headed treated piles, including those to be capped with concrete, must be treated with copper naphthenate per AWPA M4. Piles driven in locations where they are constantly subject to water spray must be given this treatment immediately after they are cut off and before the cutoff surface has been wetted. Cutoffs must become the property of the Contractor and must be removed at his expense.

3.1.2.4 Tolerances in Driving Piles

Piles must be accurately placed in the correct location and alignments both laterally and longitudinally and to the vertical or batter lines as shown. At cutoff elevation, butts must be within([100] [_____] mm[4] [_____] inches) laterally of the location indicated. [Manipulation of piles is prohibited.] [Manipulation to move piles into position will be permitted only within the aforementioned tolerance to return the pile to the design location. [However, piles must not be manipulated more than 1.5 percent of the exposed length above the [ground] [mudline] surface.]] [[Fender] [,] [and] [Cluster] [,] [and] [Dolphin] [_____] Piles may be manipulated a maximum of 42 mm per m 0.50 inch per foot of pile length in a direction parallel to the pier face and 21 mm per m 0.25 inch per foot of pile length in a direction perpendicular to the pier face.] A variation of not more than 21 mm per m 0.25 inch per foot of pile length from the vertical for plumb piles or more than 42 mm per m 0.50 inch per foot of pile length from the required angle for batter piles will be permitted. The correct relative position of group piles must be maintained by the use of templates or by other approved means. [In addition to complying with the tolerances stated herein or otherwise specified, clear distance between heads of piles and edges of caps must be not less than 125 mm 5 inches. With prior approval of the Contracting Officer, the Contractor may provide additional concrete and reinforcement to maintain the required minimum clear distance. Redesign of pile caps or additional work required due to improper location of piles will be the responsibility of the Contractor.] Inspect piles for heave. Piles must be driven to the depths [shown] [as directed]. Redrive heaved piles to the required tip elevation. Remove and replace with new piles those damaged, misplaced, driven below the design cutoff, or driven out of alignment, or provide additional piles, driven as directed at no additional cost to the Government.

3.1.2.5 Pile Driving Records

Keep a complete and accurate driving record of each pile driven. Indicate pile location, deviations from design location, diameter, original length, mudline elevation, tip elevation, cutoff elevation, penetration in blows per meter foot for entire length of penetration for test piles, penetration in blows per meter foot for the last 3 m 10 feet for job piles, hammer data including rate of operation, make, and size, and unusual pile behavior or circumstances experienced during driving such as redriving, heaving, weaving, obstructions, [jetting,] [spudding,] [predrilling,] and unanticipated interruptions. Preprinted forms for recording pile driving data are attached at the end of this section. Make pile driving records available to the Contracting Officer at the job site, a minimum of 24 hours after each day of pile driving. Include in the construction records the wood species, preservative type, retention, and producer of installed treated timber.

3.1.2.6 Survey Data

After the driving of each pile group is complete and before superimposed concrete is placed, provide the Contracting Officer with an As-Driven Pile Survey showing actual location and top elevation of each pile. The Contractor must not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. A survey must be presented in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a [licensed land surveyor] [professional engineer].

[3.1.2.7 Lengths of Job Piles

****

NOTE: For USACE (Army) projects, use and edit the following paragraph. When the actual required lengths of piles can be determined without test driving and loading of piles (such as when piles are to be driven to bedrock), the actual required lengths must be indicated and listed in the unit price schedule.

****

[The estimated quantities of piles listed in the unit price schedule as to be furnished by the Contractor are given for bidding purposes only. The Contracting Officer will determine the actual lengths of piles required to be driven below cutoff elevation for the various locations in the work and will furnish the Contractor a quantities list which indicates lengths and locations of all piles to be placed. This determination will be made from the results of the test pile driving and test loading.][The lengths of piles must be as indicated.]The Contracting Officer will determine the number of overlength piles, if any, to be ordered to provide for variations in subsurface conditions. Where specified bearing capacities are attainable with piles of lesser length than those specified, shorter piles may be used subject to prior approval in writing. To provide for "heading" or cutting off normal after driving, piles must be furnished in lengths at least 300 mm one foot greater than the lengths specified to be below the cutoff elevations.

]3.1.3 Framing Treated Piles

Treated piles must not be cut to permit fitting of timbers. Piles of uniform size must be selected for each bent. If necessary, treated filler blocks must be used to fill out between piles and bracing. Holes for drift bolts in the tops of piles must be drilled to a depth of 75 mm 3 inches less than the penetration of drift bolts in the piles. Drill holes for drift bolts 3 mm 1/8 inch smaller than bolt diameter. Drill holes for through bolts 2 mm 1/16 inch larger than diameter of bolt shank. Drill holes for lag screws in two parts. Make lead hole for shank the same diameter as shank. Make lead hole for the threaded portion approximately two-thirds of the shank diameter. Counterbore holes for bolt heads and washers as indicated. Holes drilled into piles must be treated with copper naphthenate and sealed with coal-tar roofing cement in accordance with paragraph ON SITE APPLICATION OF WOOD PRESERVATIVES and when not used for bolts must be tightly closed by a treated plug. Holes must not be drilled or spikes must not be driven into piles to support scaffolding.

3.1.4 Fastening

Where bolts are used to fasten timber to timber, timber to concrete, or timber to steel, bolt members together when they are installed and retighten immediately prior to final acceptance of contract. Provide bolts having sufficient additional threading to provide at least 10 mm per m 3/8 inch per foot thickness of timber for future retightening. Provide timber connectors of types indicated. Install split-ring and shear-plate connectors in pre-cut grooves of the dimensions [shown] [as recommended by the manufacturer]. Force toothed-ring and spike-grid connectors and clamping plates into the contact surfaces of timbers joined by means of proper pressure tools; at joints, embed connectors of these types simultaneously and uniformly.

3.1.5 Wrapping Pile Clusters and Dolphins

Draw piles tightly together with wire rope. Fasten each turn of the wire rope with a staple to each pile with which it is in contact. Fasten ends of wire rope with two clips or clamps. Number of turns must be as indicated. Through bolts must be in place and drawn up before wrapping is finally secured.

[3.1.6 Jetting of Piles

****

NOTE: Jetting should not generally be permitted when:

1. Piles are dependent on side friction in fine-grained, low-permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles;

2. Piles are subject to significant uplift;

3. Piles are adjacent to existing structures; and

4. Piles are in closely spaced clusters, unless the load capacity is confirmed by test and unless jetting is completed before final driving of any pile in the cluster.

****

Water jets [will be permitted to assist in driving] [may be used in driving only when specifically authorized by the Contracting Officer] [may be used to assist driving of the pile through strata which cannot be penetrated practicably by use of the hammer alone.

Jetting equipment must have not less than two removable or fixed, water or combination air-water type jets. Equipment must be designed so that the discharge volume and pressure are sufficient to freely erode the material under and adjacent to the piles.

After the penetration of the strata requiring jetting has been accomplished, the use of the jet must be discontinued and direct hammer driving must be resumed] [must not be permitted to assist in driving]. [Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration [to the maximum penetration per blow established by the Contracting Officer]. Jetting equipment and method must be approved by the Contracting Officer prior to commencing jetting operations.]

][3.1.7 Spudding of Piles

****

NOTE: Spudding should not generally be permitted when:

1. Piles are dependent on side friction in fine-grained, low-permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles;

2. Piles are subject to significant uplift;

3. Piles are adjacent to existing structures; and

4. Piles are in closely spaced clusters, unless the load capacity is confirmed by test and unless spudding is completed before final driving of any pile in the cluster.

****

Spudding [will be permitted][must not be permitted]. [Discontinue driving and withdraw the spudding mandrel [approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation] [immediately after passing through the resistant substrate layer].] [Drive pile the final 1.5 m 5 feet of penetration [to the maximum penetration per blow established by the Contracting Officer]. Obtain Contracting Officer's approval of spudding equipment, prior to commencing spudding operations.]

][3.1.8 Predrilling of Piles

****

NOTE: Predrilling should not generally be permitted when:

1. Piles are dependent on side friction in fine-grained, low-permeability soils (high clay or silt content) where considerable time is required

for the soil to reconsolidate around the piles;

2. Piles are subject to significant uplift;

3. Piles are adjacent to existing structures; and

4. Piles are in closely spaced clusters, unless the load capacity is confirmed by test and unless predrilling is completed before final driving of any pile in the cluster.

****

Predrilling [will be permitted][must not be permitted][must be provided]. [Discontinue predrilling when pile tip is approximately 1.5 m 5 feet above the [calculated][indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration [to the maximum penetration per blow established by the Contracting Officer]]. [Obtain Contracting Officer's approval of predrilling equipment prior to commencing predrilling operations.]

]3.2 PROTECTION

3.2.1 Protection of Piles

Square the heads and tips of piles to the driving axis. Laterally support piles during driving, but do not unduly restrain piles from rotation in the leads. Where pile orientation is essential, take precautionary measures to maintain the orientation during driving. [Driven batter piles of sufficient unsupported lengths to cause a measurable deflection must have free ends secured until piles are fixed in the structure to prevent excessive bending stresses.] Handle, protect, and field treat piles in accordance with AWPA M4.

3.2.1.1 Damaged Piles

Driving of piles must not subject them to damage. Piles which are damaged, split, broomed, or broken by reason of internal defects or by improper driving below cutoff elevation so as to impair them for the purpose intended must be removed and replaced; a second pile may be driven adjacent thereto at the Contractor's expense. Minor damaged areas of treated piles must be field treated in accordance with AWPA M4. [The Contracting Officer may require the Contractor to pull certain selected piles after driving for test and inspection to determine the conditions of the piles. Any pile so pulled and found to be damaged to such extent as to impair its usefulness in the completed structure must be removed from the work and the Contractor must furnish and drive a new pile to replace the damaged pile. Piles pulled and found to be sound and in a satisfactory condition, by the Contracting Officer, must be redriven.]

3.2.1.2 On Site Application of Wood Preservatives

All on site application of wood preservatives must be performed by the person identified in accordance with paragraph PESTICIDE APPLICATOR COMPANY SELF-CERTIFICATION. Field application of wood preservatives must be made in accordance with the pesticide label. All cuts, holes and injuries such as holes from removal of spikes or nails which may penetrate the treated zone must be field treated in accordance with AWPA M4.

3.3 FIELD QUALITY CONTROL

3.3.1 Inspections

When Government inspections result in product rejection, the Contractor must promptly segregate and remove rejected material from the premises. The Government may also charge the Contractor an additional cost of inspection or test when prior rejection makes reinspection or retest necessary.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 62 23 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-31 62 21 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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PILING: COMPOSITE, WOOD AND CAST IN-PLACE CONCRETE

11/20

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-31 62 23 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-31 62 21 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 31 62 23

PILING: COMPOSITE, WOOD AND CAST IN-PLACE CONCRETE

11/20

****

NOTE: This guide specification covers the requirements for composite, wood and cast-in-place concrete piles.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 DESCRIPTION

Design, furnish, install and test composite wood and cast in-place concrete piles at the locations indicated on the drawings and specified herein.[Assume test pile[s] will be directed to be placed in [a] location[s] that can be incorporated into the work.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 133	(2012; R 2016) Standard Specification for Preservatives and Pressure Treatment Processes for Timber

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M1	(2021) Standard for the Purchase of Treated Wood Products
AWPA M2	(2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use

AWPA M3	(2016) Standard for the Quality Control of Preservative Treated Products for Industrial Use
AWPA M6	(2024) Brands Used on Preservative Treated Materials
AWPA T1	(2024) Use Category System: Processing and Treatment Standard
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C172	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C1202	(2022; E 2022) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM D25	(2012; R 2017) Standard Specification for Round Timber Piles
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-220-01	(2012; with Change 1, 2021) Geotechnical

Engineering

1.3 SUBSURFACE DATA

Subsurface soil data logs are [indicated] [appended to the special contract requirements] [provided on the project drawings]. [The subsoil investigation report may be examined at [_____].]

1.4 BASIS OF BID

****

NOTE: Select one of the following options:

****

****

NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of piles must be determined as accurately as possible, prior to bidding, since the unit price per meter (foot) of the piles varies as the length increases or decreases.

****

1.4.1 Contractor's Geotechnical Consultant

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and Pile Dynamic Analysis, to observe test pile installation and production pile installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and must have no employee of employer relationship which could constitute a conflict of interest.

1.4.2 Contractor Experience and Qualifications

The work must be performed by a Contractor with a minimum of 5 years of experience with the installation of the required foundation system in similar soil conditions of the project site. Submit past project lists indicating experience with such foundation systems.

1.4.3 Production Pile Acceptance Criteria

Safe design capacity for piles is [_____] KN kips. Drive piles to [minimum tip elevation] [a minimum depth of [____] m feet below cut-off elevation], and to such additional depth as required to obtain a bearing capacity of not less than [_____] KN kips. The Contractor's Geotechnical Consultant will determine the terminal driving criteria based on results of [static load test] [energy formulas.]

The following formulas can be used in cases where allowable pile loads are less than 355 kN 80 kips (determined using a factor of safety of 3 for individual piles and 4 for pile groups) and are presented only as a guide to aid in establishing the controlling penetration per blow, which, together with the minimum depth of penetration will serve to determine the required minimum depth of penetration of each individual pile:

For double acting hammers

$R = 166.7E/(S + 2.54\ P/W)$ ($R = 2E/(S + 0.1\ P/W)$)

For single acting hammers

$R = 166.7WH/(S + 2.54\ P/W)$ ($R = 2WH/(S + 0.1\ P/W)$)

Where:

R is the allowable static pile load in newtons pounds.
W is the weight of the striking part of the hammer in newtons pounds.
H is the effective height of fall in m feet.
E is the actual energy delivered by the hammer per blow in newton-meters foot-pounds.
S is the average net penetration in mm inches per blow for the last 5 blows after the pile has been driven to a depth where successive blows produce approximately equal net penetration (a minimum distance of 1 meter 3 feet for friction piles).
P is the weight of the pile in N (pounds). (If P is less than W, P/W must be taken as unity.)

An allowance must be made for reduced penetration caused by shock absorption of the cushion or cap blocks.

[1.4.4 Lump Sum Payment

****

NOTE: NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection. This paragraph will be typically used when there are 1) relatively small quantity of piles, 2) allowable pile loading is less than 355 kN 80 kips (, and 3) the subsurface conditions are well defined. Fill in Table I as required selecting columns applicable to project. Generally, pile capacity, location, and minimum tip elevation are shown on plans. Test piles and load tests are not incorporated on lump sum contracts. Delete this paragraph for unit-price contracts.

****

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.] [following Table I:

Table 1						
[Location]	Number	Size	[Capacity]	Length (Tip to Cut-Off)	[Maximum Bending Moment]	[Maximum Shear Force]

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, cut-off, dispose of any cut-offs, and meet the applicable contract requirements. Include mobilization, pre-drilling, and redriving heaved piles. If, in redriving, it is found that any pile is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be provided and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. If total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; backdriving; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys, construction instrumentation abd monitoring plan].

][1.4.5 Unit Price

****

NOTE: Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments in price schedule for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

For NAVFAC Southeast projects, where there is a need for unit pricing of piles, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items.

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For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

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NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.

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Requirements of "FAR 52.211-18, Variation in Estimated Quantity" do not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and driving the piles including mobilization and demobilization, [jetting] [predrilling] [probing], redriving uplifted piles, [an additional 1.5 m 5 feet in furnished length for any test pile not driven beyond estimated pile length,] and cutting off piles at the cut-off elevation. [Include the cost for additional length for the test piles in the total unit price cost for the job.] Payment will be made for production [and test piles] at the bid unit price for the length of pile, from tip to final cut-off, actually provided, excluding buildups and splices directed by the Contracting Officer to be made. If the actual cumulative pile length driven (tip to cut-off) vary more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of "FAR 52.236-2, Differing Site Conditions." [Payments will be made per each at the respective bid unit price for pile cut-offs, pile build-ups, pile loads tests and pile splices.]

][1.5 PAYMENT

****

NOTE: NOTE: Delete this paragraph for lump-sum contracts.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

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1.5.1 Furnishing and Delivering Piles

1.5.1.1 Payment

Payment will be made for costs associated with furnishing and delivering the required lengths of permanent piles, which includes costs of furnishing and delivering piles to the work site. No payment will be made for the driving head or lengths of piles exceeding required lengths. No payment will be made for piles damaged during delivery, storage, or handling to the extent that they are rendered unsuitable for the work, in the opinion of the Contracting Officer.

1.5.1.2 Measurement

Furnishing and delivering permanent piles will be measured for payment by the linear meter foot of piles required below the cut-off elevation as [determined by the Contracting Officer and furnished to the Contractor] [indicated].

1.5.1.3 Unit of Measure

Linear meter foot.

1.5.2 Driving Piles

1.5.2.1 Payment

Payment will be made for costs associated with driving permanent piles, which includes costs of handling, driving, concrete installation,[and splicing of piles,] measuring heave, redriving heaved piles, removal of [build-ups] driving heads or cutting off piles at the cut-off elevation and removing from the work site, compiling and submitting pile driving records, backfilling voids around piles, and any other items incidental to driving piles to the required elevation.

1.5.2.2 Measurement

Permanent piles will be measured for payment for driving on the basis of lengths including concrete section, to the nearest hundredth (tenth) of a linear meter foot, along the axis of each pile acceptably in place below the cut-off elevation shown.

1.5.2.3 Unit of Measure

Linear meter foot.

1.5.3 Pulled/Withdrawn Piles

1.5.3.1 Payment

Payment will be made for costs associated with piles pulled at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing and delivering pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Furnishing and Delivering Piles". The cost of driving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Piles". The cost of pulling undamaged piles will be paid for at twice the applicable contract unit price for payment item "Driving Piles", which includes backfilling any remaining void. The cost of redriving pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Driving Piles". No payment will be made for furnishing, delivering, driving, pulling, and disposing of piles, including pile driving points, pulled and found to be damaged and backfilling voids. New piles replacing damaged piles will be paid for at the applicable contract unit price for payment items "Furnishing and Delivering Piles" and "Driving Piles".

1.5.3.2 Measurement

Furnishing and delivering pulled and undamaged permanent piles will be measured for payment as specified in paragraph UNIT PRICES, subparagraph FURNISH AND DELIVER PILES. Pulling undamaged piles will be measured for payment as specified in paragraph UNIT PRICES, subparagraph DRIVING PILES. Redriving pulled undamaged piles will be measured for payment as specified in paragraph UNIT PRICES, subparagraph DRIVING PILES. New piles replacing damaged piles will be measured for payment as specified in paragraph UNIT PRICES, subparagraphs FURNISH AND DELIVER PILES and DRIVING PILES.

1.5.3.3 Unit of Measure

Linear meter foot.

[1.5.4 Pile Driving Tests

1.5.4.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of driven test piles, concrete pile section, [including [pile driving points] [and] [splices]]; conducting pile driving tests; backfilling voids around piles; compiling pile driving test records.

1.5.4.2 Measurement

Pile driving tests will be measured for payment on the basis of the applicable contract unit price per pile driving test.

1.5.4.3 Unit of Measure

Each.

][1.5.5 Piles for Load Tests

1.5.5.1 Payment

Payment will be made for costs associated with furnishing, delivering, driving, pulling, and disposing of load test piles [including [pile driving points] [and] [splices]]; backfilling voids around piles; compiling pile driving records [; furnishing, fabricating, and mounting of strain rods and protective assembly] [; furnishing, fabricating, and mounting of inclinometer and inclinometer protective assembly]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

1.5.5.2 Measurement

Piles for load tests will be measured for payment on the basis of the applicable contract unit price per load test pile.

1.5.5.3 Unit of Measure

Each.

][1.5.6 Pile Static Axial Compressive Load Tests

1.5.6.1 Payment

Payment will be made for costs associated with pile static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static axial compressive load tests.

1.5.6.2 Measurement

Pile static axial compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.5.6.3   Unit of Measure

Each.

][1.5.7   Pile Driving Shoes

1.5.7.1   Payment

Payment will be made for costs associated with pile driving shoes, including furnishing, delivering, and installing.

1.5.7.2   Measurement

Pile driving shoes will be measured for payment on the basis of the number of pile driving shoes required.

1.5.7.3   Unit of Measure

Each.

][1.5.8   Pile Splices

1.5.8.1   Payment

Payment will be made for costs associated with pile splices, including all plant, labor, and material required to make the splice.

1.5.8.2   Measurement

Pile splices will be measured for payment on the basis of the applicable contract unit price per pile splice.

1.5.8.3   Unit of Measure

Each.

][1.5.9   Vibration Monitoring

1.5.9.1   Payment

Payment will be made for costs associated with vibration monitoring.

1.5.9.2   Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.9.3   Unit of Measure

Each.

][1.5.10   Sound Monitoring

1.5.10.1   Payment

Payment will be made for costs associated with sound monitoring.

1.5.10.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per sound monitoring point.

1.5.10.3 Unit of Measure

Each.

][1.5.11 Preconstruction Condition Survey

1.5.11.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.5.11.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.5.11.3 Unit of Measure

Each.

]]1.6 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor Experience and Qualifications; G, [_____]

Contractor's Geotechnical Consultant; G, [_____]

SD-02 Shop Drawings

Installation Equipment and Testing Equipment; G, [_____]

SD-03 Product Data

Pile Driving Equipment; G, [_____]

Equipment Calibration Data; G, [_____]

Helmet and Cushion Block; G, [_____]

Pile Shoes; G, [_____]

Calibration Report

SD-06 Test Reports

Load Test Report

Field Test and Inspection Reports

SD-07 Certificates

Timber piles; G, [_____]

Aggregates; G, [_____]

Admixtures; G, [_____]

Cement; G, [_____]

Fly ash and pozzolan; G, [_____]

SD-11 Closeout Submittals

Pile records; G, [_____]

1.7 DELIVERY, STORAGE, AND HANDLING

Piles must be stored and handled avoiding overstress or any other condition that may cause damage to the piles. Untreated piles to be stored for an extended period of time must be inspected periodically, as well as shortly before driving, to detect damage due to fungus and insect attack. If treated piles are to be stored in a horizontal position for an extended period of time, they must be inspected periodically to ensure that the treatment does not seep to the lower half of the pile to the extent that the upper half does not contain a sufficient amount of treatment.

1.8 QUALITY CONTROL

1.8.1 Timber Piles

The producer must brand each treated pile, in accordance with AWPA M1, AWPA M2, AWPA M6, AWPA T1 and AWPA U1. Submit the inspection report of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with applicable AWPA Standards, and that the plant conforms to AWPA M3. Identify treatment on each piece by the quality mark of an agency accredited by the Board of Review of the America Lumber Standard Committee.

1.8.2 Quality Control Procedures

The Government, at its discretion, reserves the right to inspect the treating process. Notify the Contracting Officer at least 3 weeks prior to beginning the treatment, stating where preservative treatment will be done. Allow Government inspector access to all parts of the plant. Allow inspection of all facets of the treating process.

1.8.3 Installation Procedures

Submit information on the type of equipment proposed to be used, proposed methods of operation, pile driving plan including proposed sequence of driving, and details of all pile driving equipment and accessories.

1.8.4 Concrete Mix Design

Certify, using a Government-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI 211.1 or ACI 318M ACI 318 for specified strength and is based on aggregate data which has been determined by laboratory tests during last twelve months. Submit a complete list of materials including type; brand; source and amount of cement, fly ash and pozzolan, ground slag, and admixtures; and applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submittal must clearly indicate where each mix design will be used when more than one mix design is submitted.

[1.8.5 Load Test Supporting Data

Submit Jack calibration records, equipment calibration data, a testing arrangement description and diagram, and the proposed loading sequence Submit a calibration report (performed by an independent testing agency) for the drilling and load test equipment to be used. The report must include: the name, address, and phone number of testing agency; name of the project; name of the contractor; identification of the equipment; date of calibration; and calibration data. The equipment calibration must be performed within six months from the start of the testing operation..

]1.8.6 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

PART 2 PRODUCTS

2.1 PILES

2.1.1 Wood Sections

Pile diameters of the wooden piles must not be less than 300 mm 12 inches measured 900 mm 3 feet from the butt [note that piles 17 meters 55 feet and longer should be 330 mm at 900 mm 13 inches at 3 feet] (before forming of the tenon). Provide Douglas Fir or Southern Pine piles [clean peeled] [rough peeled] conforming to ASTM D25. Piles must [be pressure treated in accordance with AASHTO M 133, for Land and Fresh Water Piles by Pressure] [not be treated].

2.1.2 Metal Shells

Provide metal shells of steel of sufficient strength and rigidity to withstand all driving stresses, to prevent distortion caused by driving adjacent piles, to prevent collapse due to soil or hydrostatic pressure, and to maintain their shape, free from dents or deformation. Thickness of shells must be as indicated. Provide watertight shells to exclude groundwater during concrete placement. The actual or superficial perimeter of a cross section of the piles, at any point in their length, must be circular. Design the joint as specified herein, and in a manner to prevent the entrance of soil while driving, the leaking of concrete during placing, and the entrance of water at a rate that would not allow the shell to be properly dewatered before placement of concrete. The shells must be [step-tapered type with a minimum nominal diameter of [_____] mm inches at the joint between wood and shell and the diameter must increase from the joint to the cut-off elevation at a rate of not less than 10 mm per meter 1 inch per 8 feet of length] [or] [constant-section shells with a minimum nominal diameter of 300 mm12 inches].

2.1.3 Concrete

Provide materials, mixing, and placing of concrete in conformance with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide concrete with a minimum compressive strength of [_____] MPa psi at 28 days using [_____] -mm -inch maximum-size coarse aggregate. Slump must be [_____] to [_____] mm inches for manual compaction and [_____] to [_____] mm inches when concrete is mechanically vibrated.

2.1.4 Reinforcing Steel

Provide reinforcing steel of the dimensions and sizes indicated and complying with [ASTM A615/A615M, Grade [40] [60]] [ASTM A996/A996M, Grade [50] [60]].

2.2 EQUIPMENT

Submit detail drawings, to demonstrate compliance of driving equipment, including [metal shoes and] cap blocks, splicing of timber and concrete sections, and the forming, reinforcing and casting of piles. Installation equipment and testing equipment must include a list and description of equipment to be used, including manufacturer's catalog data and sufficient information to show compliance with the requirements specified.

2.2.1 Pile Hammer

Provide a hammer with a delivered energy suitable for the total weight of the pile, the character of subsurface material to be encountered, and the pile capacity to be developed without damage to the pile. The driving energy of the hammer must be not less than 20.3 kN-m 15,000 foot-pounds. Operate diesel-powered hammers at the rate recommended by the manufacturer throughout the entire driving period. Maintain sufficient pressure at the air hammer so that:

2.2.1.1 Double-Action Hammer

The number of blows per minute during and at the completion of driving of a pile is equal approximately to that at which the hammer is rated.

2.2.1.2 Single-Acting Hammer

There is full upward stroke of the ram.

2.2.1.3 Differential Type Hammer

There is a slight rise of the hammer base during each upward stroke.

2.2.2 Driving Helmets or Caps

Use a driving helmet or cap, including a pile cushion, between the top of the pile and the ram to prevent impact damage to the pile. The driving helmet, or cap and pile cushion combination, must completely cover the top surface of the pile and be capable of protecting the head of the pile, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over the top of the pile.Submit helmet and cushion block information.

a. The driving helmet or cap must fit loosely around the top of the pile so that the pile is not restrained by the driving cap, if the pile tends to rotate during driving. The pile cushion may be of solid wood, of laminated construction using plywood, softwood, or hardwood boards, or of other approved cushioning material.

b. The minimum thickness of the pile cushion must be 75 mm 3 inches and the thickness must be increased so as to be suitable for the size and length of pile, character of subsurface material encountered, hammer characteristics, and required driving resistance. Use a new pile cushion at the start of driving for each pile and the pile cushion must be replaced whenever it becomes highly compressed, charred, burned, or deteriorated in any manner during driving.

2.3 PRODUCT QUALITY CONTROL

2.3.1 Piles

The producer must brand each treated pile, in accordance with AWPA M1, AWPA M2, AWPA M6, AWPA T1 and AWPA U1. Indicate employment of pick-up points, support points other than pick-up points, and any other methods of pick-up.

[2.3.2 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

]2.3.3 Aggregate Tests

Take samples of fine and coarse aggregate at concrete batch plant and test. Perform mechanical analysis (one test for each aggregate size) in accordance with ASTM C136/C136M. Tabulate results of tests in accordance with ASTM C33/C33M.

2.3.4 Slump and Strength Tests

Sample concrete in accordance with ASTM C172 at time concrete is deposited for each production line. Perform slump tests in accordance with ASTM C143/C143M. Mold cylinders in accordance with ASTM C31/C31M. Mold at least six cylinders per day or one for every [15] [45] cubic meter [20] [60] cubic yards of concrete placed, whichever is greater. Cure cylinders in same manner as piles and for accelerated curing, place at coolest point in casting bed. Perform strength tests in accordance with ASTM C39/C39M. Test two cylinders of each set at 7 days [and 14 days]. Test remaining cylinders of each set 28 days after molding.

2.3.5 Changes in Proportions

If, after evaluation of strength test results, compressive strength is less than specified compressive strength, make adjustments in proportions and water content and changes in temperature, moisture, and curing procedures as necessary to secure specified strength. Submit changes in mix design to Contracting Officer in writing.

2.3.6 Compressive Strength Test Results

Evaluate compressive strength test results at 28 days in accordance with ACI 214R using a coefficient of variation of 10 percent. Evaluate strength of concrete by averaging test results of each set of standard cylinders tested at 28 days. Not more than 10 percent of individual cylinders tested must have a compressive strength less than specified design strength.

2.3.7 Chloride Ion Concentration

Sampling and determination of water soluble chloride ion content in accordance with ASTM C1218/C1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures must not exceed 0.06 percent by weight of cement.

2.3.8 Chloride Ion Penetration

Proportion concrete to have the chloride ion penetration test in accordance with ASTM C1202 to ensure the durability of concrete in marine environment, and be below 3000 coulombs for concrete specimens tested at 56 days.

2.4 MATERIAL SUSTAINABILITY CRITERIA

For materials used, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan

b. Recycled content for Ground Iron Blast-Furnace Slag

c. Recycled content for Silica Fume

PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Pile Length Markings

Mark each pile prior to driving with horizontal lines at 300 mm one foot intervals. Mark the interval number on pile every 1.5 m 5 feet from pile tip.

3.2 PILE DRIVING

****

NOTE: Past experience with similar structures is probably the best indicator of the need for protection. If protection is to be provided, this paragraph should be expanded to cover the type and extent of protection required. The following typical references offer detailed information on different types of pile protection:

a. Design and Construction of Ports and Marine Structures, by Alonzo DeF. Quinn, McGraw-Hill Book Company, New York, 1961.

b. Cathodic Protection, by L. M. Applegate, McGraw-Hill Book Company, New York, 1960.

c. Protection of Piling in Marine Environments, published by US Steel Corporation.

Additionally, the Construction Engineering Research Laboratory in Champaign, Illinois has done extensive research on pile protection, and may be contacted for information.

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Submit complete and accurate pile records of each driven pile indicating the pile location (as driven), size, length, final elevations of tip and top, elevation of top of wood section, pile weight, number of splices and locations, blows required for each m foot of penetration throughout the entire length of the pile and for the final 150 mm 6 inches of penetration, and the total driving time. The record should also include the type and size of the hammer used, the rate of operation, and the type and dimensions of the driving helmet and cushion block used. Record any unusual conditions encountered during pile installation and immediately report them to the Contracting Officer.Perform driving with fixed leads to hold the pile firmly in position, alignment, and in axial alignment with the hammer. Drive piles to or below the "calculated" tip elevation to reach a driving resistance in accordance with the schedule that the Contracting

Officer will prepare from the load test results.

a. The pile hammer used for driving must be the same type, operated at the same rate and in the same manner, as that used for driving the test piles. If a pile fails to reach the "calculated" tip elevation or if a pile reaches the "calculated" tip elevation without reaching the required driving resistance, notify the Contracting Officer and perform corrective measures as instructed.

b. No piles will be driven until the excavation or fill in the area that piles are to occupy has been completed. No piles will be driven within 30.5 m100 feet of concrete less than 7 days old, unless so directed. Carefully locate piles to the lines and spacing shown and drive them to either the plumb position or the batter indicated.

c. Limit dynamic driving stresses to the crushing strength of the timber. If the pile encounters a sudden high driving resistance, cease driving and immediately notify the Contracting Officer and proceed as directed. If during driving, the pile encounters a sudden decrease in penetration resistance, investigate the cause; unless a satisfactory reason is found and the pile is undamaged, reject the pile and replace it without additional cost to the Government.

d. Take care to operate the hammer at its short stroke when the tip of the pile encounters soft material of little resistance either at the start of the driving or in passing into poor subsoil. The hammer should continue at its short stroke until sufficient resistance is built up to prevent damage due to tensile wave stresses.

   When driving is interrupted before final penetration is reached, do not take the record of the penetration until after at least a 300 mm 12 inches penetration has been accomplished on the resumption of driving. Minimum penetration of the tops of wood piles being used in composite piles must be 600 mm 2 feet below the low water table.

e. The length of the metal shell may vary according to requirements for proper seating of the piles, elevations of groundwater, and the required pile cut-off. Where piles longer than the specified length measured from point to cut-off elevations are required to provide specific bearing capacities, provide the longer piles by furnishing longer wood sections as directed. As an option, provide longer piles by increasing the lengths of concrete sections, but only after approval. Upon approval, where the specified bearing capacities are obtained with piles of less than the specified lengths, shorter piles may be used, but the tops of wood sections must be driven at least 600 mm 2 feet below the water table.

3.2.1 Concrete Placement

Materials, mixing, and placing of concrete must conform with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE. Use an approved method for placing concrete in the shells. Place the concrete in a continuous flow from joint to top of piles. However, no concrete will be placed in any shell until all other piles within a radius of 6 m 20 feet [or heave range] have been driven. Shells must be free of deformations and water. Place concrete by tremie and not dropped through water.

3.2.2 Splices

Unless otherwise directed, construct field splices as indicated. Splices must maintain the true alignment and position of the pile sections and develop the full strength of the pile in both bearing and bending. Proprietary prefabricated splicer sleeves may be used upon approval.

3.2.3 Tolerances in Driving

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NOTE: Foundation piles should not be more than 75 to 150 mm 3 to 6 inches from their intended plan position.

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Top of any pile at elevation of cutoff must be within [_____] mm inches of the planar location indicated. Manipulation of piles to force them into position will not be permitted. Check piles for heave and re-drive those found to have heaved to the required tip elevation. Piles damaged or driven outside the above tolerances must be replaced, or additional piles driven at locations specified by the Contracting Officer at no expense to the Government.

3.2.4 Cutting of Piles

Cut off piles at the elevations indicated by an approved method; remove surplus material from the job site.

3.2.5 Rejected Piles

Withdraw piles damaged, mislocated, or driven out of alignment beyond the maximum tolerances and replace them with new piles; or cut off and abandon them. Additional piles must be driven as directed; excess cut off from piles and unacceptable piles must be removed from the site of work. Perform all work, in connection with withdrawing and removing from the site rejected piles; without additional cost to the Government.

Any pile damaged by reason of internal defects or by improper driving must be corrected by one of the following methods approved by the Contracting Officer for the pile in question:

a. The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile.

b. Fill the shell with concrete, abandon the pile and install one or more replacement pile(s) adjacent to the defective pile.

A pile terminated below the specified cut-off elevation must be corrected by one of the following methods approved by the Engineer:

a. The pile is spliced (if approved).

b. A sufficient portion of the footing is extended down to properly embed the pile.

A pile driven out of its proper location or out of plumb as approved by the Engineer, must be corrected by one of the following methods approved by the engineer:

a. The pile is withdrawn, if practicable, and replaced by a new pile.

b. One or more replacement piles are driven next to the pile in question.

c. Fill the shell with concrete, abandon the pile and install one or more replacement pile(s) adjacent to the pile in question.

d. As directed by the structural engineer.

3.2.6 Predrilling

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NOTE: Predrilling is normally terminated at a depth equal to two thirds of the total length of the pile embedment.

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Predrilling will be permitted only when approved. The hole must be [_____] mm inches less in diameter than the diagonal dimension of the pile. All predrilled piles must be seated by final driving to provide the required pile capacities.

3.2.7 Collars or Bands

Use collars or bands of an approved design where required for the protection of the top of piles against splitting, brooming, and other damage when the piles are being driven.

3.2.8 Metal Pile Shoes

Where indicated or directed, securely attach metal shoes of an approved design to the piles in a manner described in the detail drawings. Submit pile shoe material and installation details.

3.2.9 Joints

Joints between the wood and concrete sections must be as indicated in the detail drawings.

3.2.10 Welding

Conform all field welding, and preparation of materials for welding, to AWS D1.1/D1.1M or AWS D1.4/D1.4M, as appropriate, using proper materials and experienced personnel whose ability and qualifications to do acceptable work have been fully demonstrated.

3.2.11 Pile Heave

When large pile clusters or piles are driven with very close spacing, take periodic elevations on the tops of all piles to observe and determine pile heave. Such elevations must be taken on a telltale pipe 50 mm 2 inches in diameter placed inside the pile shell and bearing on the top of the wood section. When such checking indicates that pile heave has occurred, all heaved piles must be re-driven to either the original resistance or the elevation, or both, as directed. If pile heave occurs along the shell portion of the pile, resulting in separation of the joint, the Contractor may resort to predrilling to eliminate heave or may provide a joint of sufficient tension capacity, as authorized, without additional cost to the Government.

3.2.12 Curing

[Maintain concrete in a moist condition for not less than 7 days for normal portland cement and for not less than 3 days for high-early-strength cement. For each decrease of 2 degrees 5 degrees below 20 degrees C 70 degrees F in the average curing temperature, these curing periods must be increased by 4 days for units of normal portland cement and by 2 days for units of high-early-strength cement.] [Curing must be in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.]

3.2.13 Long Piles

Piles having a slenderness ratio greater than [22] [_____] must be handled and driven with special precautions to ensure against overstress or leading from a plumb or true position. The slenderness ratio must be the pile length divided by the least radius of gyration of the pile. When a high-resistance strata lying near the surface must be penetrated, spud piles may be used only when authorized by the Contracting Officer to minimize hard driving of long piles during the early stages of driving operations.

3.2.14 Jetting of Piles

****

NOTE: Jetting generally should not be permitted:

a. For piles dependent on side friction in fine-grained soils (high clay or silt content) with low-permeability where considerable time is required for the soil to reconsolidate around the piles.

b. For piles subject to uplift or lateral forces.

c. For piles adjacent to existing structures.

d. For piles in closely spaced clusters unless the load capacity is confirmed by test.

****

[Jetting of piles will not be permitted] [Jetting must be discontinued at a depth approximately 1.5 m 5 feet above the "calculated" tip elevation; the remaining penetration must be achieved by driving. Before the driving of the final 1.5 m 5 feet is started, the pile must be firmly seated in place by the application of a number of reduced-energy hammer blows].

3.2.15 Survey Data

****

NOTE: NOTE: Include this paragraph only when protection of existing structures from pile driving activities is required.

The designer must indicate on the drawings all structures and facilities for which protection is required. The designer must also provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical

instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.
****

After the driving of each pile group is complete and before concrete is placed, provide the Contracting Officer with an as-driven survey showing actual location and top elevation of each pile. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group driven. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a licensed land surveyor.

3.2.16 Protection of Existing Structures

Mitigate impact on existing facilities due to pile driving activities in accordance with the [project specific document].

3.3 FIELD TEST AND INSPECTION

Submit a complete report on the pile test, within [seven] [_____] days of completion of each pile test, including, but not limited to, a description of the pile driving equipment, driving records for both test piles and reaction piles, complete test data, analysis of test data, and recommended allowable design loads based on the pile test results. Provide final records of placement locations and depths of embedment of all piles. Prepare the report by or under the direct supervision of a registered professional engineer in the State of [_______________] and experienced in pile load testing and load test analysis.

3.3.1 Test Piles

Test piles must be of the type and must be driven in the manner specified. The Contractor's Geotechnical Engineer will use test pile and load test data to determine "calculated" pile tip elevations and the necessary driving resistance. Test piles that are located within the tolerances indicated and that provide a safe design capacity as determined by the results of a satisfactory load test may be used in the finished work. Drive test piles [at the locations indicated] [in the vicinity of the soil boring test holes No. [_____]]. [Jetting will be authorized only when pile testing clearly establishes the validity of its use.] Drive test piles to the tip elevation specified or indicated. Withdraw the specified number of test piles as indicated after reaching the "calculated" tip elevation for visual inspection of the pile.

3.3.2 Load Tests

Perform load tests in accordance with ASTM D1143/D1143M[, as modified], at locations shown or directed, on test piles placed to the tip elevation indicated except as otherwise directed. Loading, testing, and recording of data must be under the direct supervision of the Contractor's Geotechnical Consultant, as well as the analysis of the load test data. The installation of piles must not proceed in a new area with substantially different subsurface conditions until a satisfactory load test has been performed in that area and the results approved. Allow a minimum of [_____] days after submission of the test pile data for approval. Unless otherwise directed, piles must not be tested sooner than [____] days after driving unless sufficient time has elapsed to allow the cast-in-place section of the pile to obtain the minimum strength of [_____] MPa psi. Test loading must conform to ASTM D1143/D1143M, cyclic loading method. Apply the load to the pile [pile group] by [hydraulic jacks acting against an anchored reaction frame] [hydraulic jacks acting against a weighted platform or box] [direct loading of a weighted platform] using a spherical bearing to transmit the load to the pile. Maintain a data plot of load versus movement during the test procedures. Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.Submit load test report.

3.3.3 Safe Design Capacity

Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.

3.3.4 Inspection

The Contracting Officer may require that certain wood sections be withdrawn for test and inspection before the shell section is added to determine the condition of the wood sections. When so required, such wood sections must be redriven only when approved. Withdrawn piles not suitable for redriving must be treated as a rejected pile as specified in paragraph PILE DRIVING. Provide a suitable light for inspecting the interiors of pile shells.

3.3.5 Pile Capacity

The capacity, as driven, of single piles not in clusters in the structure must be not less than [_____] metric tons tons. Determine the capacity by the following formula, modified according to the data obtained by the load tests.

Single-Acting Hammers
R = 166.7WH/(S + 2.54 P/W) R = 2WH/(S + 0.1 P/W)

Double-Acting Hammers
R = 166.7E/(S + 2.54 P/W) R = 2E/(S + 0.1 P/W)

Where:

R is the allowable static pile load in newtons pounds.
W is the weight of the striking part of the hammer in newtons pounds.
H is the effective height of fall in m feet.
E is the actual energy delivered by the hammer per blow in newton-meters foot-pounds.
S is the average net penetration in mm inches per blow for the last 5 blows after the pile has been driven to a depth where successive blows produce approximately equal net penetration (a minimum distance of 1 meter 3 feet for friction piles).
P is the weight of the pile in N pounds. (If P is less than W, P/W must be taken as unity.)

[3.4 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-310-04, "Seismic Design for Buildings".

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.
****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

][3.5   VIBRATION CONTROL

****
NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project.
****

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile driving operations. Perform vibration monitoring [using] [seismographs] [and geophones] within a distance of 61 meters 200 feet from the pile driving activity. [Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [five] years of experience in vibration monitoring. A minimum of [28] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient vibrations. The vibration during the pile driving activities must be limited to [a peak particle velocity of not more than 5 cm 2 inches per second.] [the limits mentioned in the [contract documents].] [Determine appropriate vibration limits as per [US Bureau of Mines] [American Association of State Highway and Transportation Officials (AASHTO)] guidelines.]During pile driving activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity causing the vibration until [the Vibration consultant and the Contracting Officer] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.6 NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the pile driving operations. [Perform noise monitoring using [noise meters][, and] [_______]]. [Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [five] years of experience in noise monitoring. A minimum of [28] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

Prior to the pile driving activities, obtain baseline readings of ambient noise levels. [The noise limits are mentioned in the [plan] [contract documents]]. [Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines]. During pile driving activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile driving activity and install noise mitigation measures.

The Contractor must be responsible for all damages resulting from the pile driving operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.7 PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform preconstruction condition survey of [structures] [and utilities] [within 61 meters 200 feet of the pile driving activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] days before the commencement of pile driving activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile driving work, and repair any damages to these structures without cost to the Government.

][3.8 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile driving activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement [and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile driving. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type. [Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile driving when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile driving activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

]   -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 62 23.13 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 62 23.13 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 31 62 23.13

CONCRETE-FILLED STEEL PILES

02/21

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USACE / NAVFAC / AFCEC **UFGS-31 62 23.13 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 62 23.13 (November 2008)

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****

SECTION 31 62 23.13

CONCRETE-FILLED STEEL PILES
02/21

****
NOTE: This guide specification covers the requirements for procurement, installation, and testing of cast-in-place concrete piles utilizing steel casing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT PROCEDURES

Bids will be based on the number of piles as indicated, and on lengths from tip to cutoff as follows:

Number of piles	Length, meters feet
[_____]	[_____]

From the data obtained as a result of driving the test piles [and load tests] specified hereinafter, the Government will determine and will list the "calculated" pile tip elevations and the driving resistances for all piles. This list will be used as the basis for ordering piles. Payment will be on the basis of length of piling from cutoff elevation to final tip elevation, established by the requirements specified elsewhere in this section. Should the total number of piles or the number of each length vary from that specified as the basis for bidding, an adjustment on the contract price and the time for completion will be made. If excavation is made adjacent to piling and below the grade indicated and if piling is driven before backfilling of over-excavation, no payment will be made for the length of piling equal to the depth of the over-excavation. No additional payment will be made for cutting off piles, for any portion of a pile remaining above cutoff elevation, or for broken, damaged, or rejected piles.

1.1.1 Unit Price

The Contracting Officer reserves the right to increase or decrease the total length of piles to be furnished and installed, by changing the foundation pile locations or elevations, requiring the installation of additional piles, or requiring omission of piles from the requirements shown and specified. Whether or not such changes are made, payment will be made at the contract unit price per linear meter foot(including control test piles), multiplied by the total linear meters feet of acceptable piles actually installed.

1.1.2 Full Compensation

Payment in accordance with the above paragraph, "Unit Price," will constitute full compensation for furnishing, delivering, handling, and/or installing (as applicable) all material, labor and equipment necessary to meet contract requirements applicable to the foundation piles. No payment will be allowed for withdrawn, broken or rejected piles, nor (except for control test piles) for a portion of any pile remaining above the cut-off point.

1.1.3 Load Tests

The contract includes [_____] pile load tests. The Contracting Officer reserves the right to increase or decrease the number of pile tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Pile Load Test" or "Omitted Pile Load Test."

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project

specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A252	(2010) Standard Specification for Welded and Seamless Steel Pipe Piles
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(2015) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.3 SYSTEM DESCRIPTION

Perform the work through a general Contractor or a specialty subcontractor specialized in the specified foundation system and having experience installing the specified foundation system under similar subsurface conditions.

1.3.1 Subsurface Soil Data

****

NOTE: Section 00 31 32.13 Subsurface Drilling and Sampling Information is not a UFGS. CSI MasterFormat prescribes this section for inclusion of this data.

****

Subsurface soil data logs are [as indicated] [appended to the SPECIAL CONTRACT REQUIREMENTS] [found in Section 00 31 32.13 Subsurface Drilling and Sampling Information]. The subsurface investigation reports [and samples of materials as taken from subsurface investigations] are available for examination at [_____].

1.3.2 Equipment

Submit descriptions of all pile driving equipment to be employed in the work, prior to commencement of pile installations, including details of the pile hammer, power plant, leads, pile cushion, cap block, and helmet.

1.3.2.1 Pile Hammers

Provide a hammer having a delivered energy suitable for the total weight of the pile, the character of subsurface material to be encountered, and the pile capacity to be developed. Driving energy of the hammer less than [_____] newton-meters foot-pounds is not acceptable.

1.3.2.2 Driving Helmets and Pile Cushions

Use a driving helmet, cap block, and pile cushion between the top of the pile and the ram to prevent impact damage to the pile and capable of protecting the head of the pile, minimizing energy absorption and dissipation, and transmitting hammer energy uniformly over the top of the pile. The driving helmet must fit loosely around the top of the pile so that the pile is not restrained if the pile tends to rotate during driving. The pile cushion and cap block may be of solid wood or of laminated construction using plywood, softwood, or hardwood boards or other cushion material as approved by the Contracting Officer. Completely cover the top surface of the pile and retain by the driving helmet. The minimum thickness of the pile cushion and of the cap block must be 76 mm 3 inches each and increase the thickness to be suitable for the size and length of pile, character of subsurface material encountered, hammer characteristics, and required driving resistance.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

SD-03 Product Data

Driving Pile Casings

Equipment

SD-06 Test Reports

Test Piles.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Concrete

****

NOTE: Delete or modify second sentence when the job is small or the existence of certified plants is beyond acceptable distance of small jobs. Insert the ultimate compressive strength required by design.

****

Conform materials, mixing, and placing of concrete to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE. Ready-mix plant equipment and facilities must be certified in accordance with NRMCA QC 3. Provide minimum compressive strength at 28 days of[_____] MPa psi. Provide maximum coarse aggregate size of 19 mm 3/4 inch.

2.1.2 Reinforcement

****

NOTE: Reinforcement should be required for the unsupported sections of piles, for uplift or tension piles, for piles exposed to high bending stresses not resisted by batter piles, and for anchoring the top of the pile to the pile cap or slab. Reinforce tension or uplift piles throughout their entire length.

****

Conform materials, assembly, and placement of reinforcement to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE. Assemble and place reinforcement in the casing as a unit as detailed and scheduled.

2.1.3 Casings

****

NOTE: Closed-end steel pipes should generally be used. Open-end steel pipes should be considered where:

a. It is important to avoid soil displacement as in piles driven adjacent to existing structures.

b. Soil conditions indicate a dense or clayey soil, or extremely coarse granular soil is present, such as gravel.

Where open-end pipes are specified, concrete should not be placed until all soil, water and foreign material are removed from inside casing.

****

Provide casings of steel and sufficient strength to prevent harmful distortions during driving, after completion of driving, and during driving of adjacent casings. Casings driven without the use of an internal mandrel must have walls of a thickness sufficient to withstand the driving stresses. Close casings at the tip, except for steel pipe casings conforming to ASTM A252 that may be open-end driven. Make joints and tip connections watertight. Nominal circumference at any cross-section in length must be circular, whether or not modified by helical corrugations or flutings. Leave casings permanently in place; provide any one of the following types or combination of types; but use only one type or combination throughout.

2.1.3.1 Uniform Taper

Increase diameter from tip to cutoff at a uniform rate. Provide minimum nominal diameter at tip and two-third points above tip as indicated.

2.1.3.2 Step-Taper

Increase diameter of section increments uniformly. Provide minimum nominal diameter at tip and two-third points above tip as indicated.

2.1.3.3 Constant Section

Steel pipes, conforming to ASTM A252, Grade 2, may be used in lieu of casings of constant section. Indicate minimum nomin.

2.1.3.4 Combination Type

Combination type cast-in-place concrete piles, steel casing, may be any of the following or other types, depending upon design criteria. Specification requirements are in accordance with applicable paragraphs of this section.

a. Steel pipe lower section with metal casing taper or constant-diameter upper section.

b. Constant-diameter or tapered lower section with tapered upper section.

c. Tapered lower section with constant-diameter upper section.

PART 3 EXECUTION

3.1 INSTALLATION

Submit drawings demonstrating compliance of driving equipment and steel casing with contract documents. Include in the drawings shop and erection details, casing details, end closures, splices, driving helmets, and reinforcement.

3.1.1 Driving Pile Casings

Submit a complete and accurate record of each driven pile, within 3 days of completion of driving. Indicate in the record the pile location (as driven), driven length, embedded length, final elevations of tip and top, pile weight, butt and tip diameter, quantity and strength of concrete used in each pile, number of splices and locations, blows required for each meter foot of penetration throughout the entire length of the pile and for the final 150 mm 6 inches of penetration, and the total driving time. Also include in the record the type and size of the hammer used, the rate of operation, and the type and dimensions of driving helmet, pile cushion, and cap block used. Record any unusual conditions encountered during pile installation and immediately report to the Contracting Officer.

3.1.1.1 Driving Procedure

****

NOTE: The next-to-last sentence, concerning tip elevation and driving resistance, should be edited to conform to subsurface conditions and type of pile (friction or end bearing).

Insert the radius distance (3 to 6 meters10 to 20 feet) and the time (2 to 7 days). Do not place concrete in any pile until all other casings within a radius of 3 to 6 meters 10 to 20 feet have been driven and inspected.

****

Stop excavation at 300 mm (1 foot) above foundation grade before casings are driven. When pile driving is accomplished, complete excavation to lines and grades shown. Drive permanent pile casings, without interruption, to the "calculated" tip elevation to reach a driving resistance in accordance with the schedule which the Government will prepare from the test-pile driving data. Use the same type pile hammer for driving and operate at the same rate and in the same manner as that used for driving the test piles. Operate diesel powered hammers at the rate recommended by the manufacturer throughout the entire driving period. Maintain sufficient pressure at the steam hammer so that:

a. For a double-acting hammer, the number of blows per minute during and at the completion of driving of a pile is equal approximately to that at which the hammer is rated.

b. For a single-acting hammer, there is a full upward stroke of the ram.

c. For a differential-type hammer, there is a slight rise of the hammer base during each upward stroke.

Use a new pile cushion at the start of driving for each pile; replace the cushion whenever it has become highly compressed, charred, burned, or deteriorated in any manner during driving. Notify the Contracting Officer, to determine what procedure will be followed, if a pile reaches the "calculated" pile tip elevation without reaching the required driving resistance; or if the required driving resistance is reached before the "calculated" pile tip elevation. Casings will not be driven within a radius of [_____] mfeet of any other casing in which the concrete and reinforcement has been placed for less than [_____] days.

3.1.1.2 Tolerance in Driving

Drive casings with a variation of not more than 20 mm per m 0.25 inch per foot of pile length from the vertical. Furnish butts within 100 mm 4 inches of the location indicated. Manipulation of casings to force them into position will not be permitted. Check casings for heave, after all piles are driven in a cluster or under any conditions of relatively close spacing; redrive those found to have heaved to the required tip elevation. Maintain the center of gravity of each group of footing piles by templates or other approved means to conform to locations shown. Replace casings that are damaged, mislocated, or driven out of alignment or drive additional casings as directed.

3.1.1.3 Jetting of Pile Casings

****

NOTE: Jetting should generally not be permitted for piles:

a. Dependent on side friction in fine-grained, low-permeability soils (high clay or silt content) where considerable time is required for soil to reconsolidate around the piles.

b. Subject to uplift.

c. Adjacent to existing structures.

d. In closely spaced clusters unless the load capacity is confirmed by test and unless all jetting is done before final driving of any pile in the cluster.

****

Jetting of pile casings [may be used when permitted by the Contracting Officer] [will be permitted by the Contracting Officer as indicated] [will not be permitted]. [Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the "calculated" pile tip elevation; make the final 1.5 m 5 feet of penetration by driving. Before commencing with the driving of the final 1.5 meters 5 feet, firmly seat the pile casing in place by the application of a number of reduced energy hammer blows.]

3.1.2 Filling of Casings

Visually inspect each casing after its final installation and prior to depositing the concrete and placing the reinforcement. Notify the Contracting Officer prior to each such inspection to allow for quality assurance inspections of all casings. The inspection will verify the integrity of the casing throughout its length and the absence of distortion and reduction in area. Deposit concrete in the casing in a continuous operation by means of a funnel or hopper after all mud, water and other extraneous material has been removed from its interior.

3.1.3 Cutting of Casings

Cut casings with an acetylene torch or saw with prior approval by the Contracting Officer.

3.1.4 Welding

Perform shop and field welding, qualification of welders, and inspection of welds in accordance with AWS D1.1/D1.1M.

3.1.5 Splicing

Splices may be used after review by the Contracting Officer. No more than two splices per full length of casing will be permitted. They must be able to transmit any vertical and lateral forces adequately, and in addition, develop no less than 50 percent of the flexural capacity of the ordinary pile casing cross section. Make lateral joints with a continuous full penetration butt weld in accordance with AWS D1.1/D1.1M or as approved by the Contracting Officer.

3.2 FIELD TESTS AND INSPECTIONS

3.2.1 Test Piles

Submit a complete report on the load test, within [seven] [_____] days of completion of load test, including, but not limited to, a description of the pile driving equipment, driving records for both test piles and reaction piles, complete test data, analysis of test data, and recommended allowable design loads based on the load test results. Prepare report by or under the direct supervision of a registered professional engineer experienced in pile load testing and load test analysis.

3.2.1.1 Pile Driving

****

NOTE: Insert the number of test piles required. A minimum of three driving tests should be made; and possibly more, where subsurface conditions are questionable.

****

Drive test piles in the manner specified for all piling elsewhere in this section. Keep a record for each test pile of the number of blows required for each foot of penetration throughout the entire length of the pile, the penetration per blow at such intervals as directed, and the number of blows for the final 150 mm 6 inches of penetration. Include the type and size of the hammer used, the rate of operation, and the type and dimensions of casings. Record any unusual occurrence during driving of the pile casing and any increase and decrease of driving resistance and bring it to the attention of the Contracting Officer. The Government will use load test and test pile data to determine the "calculated" pile tip elevation and the necessary driving resistance. Drive [_____] test piles in the locations indicated, with surrounding earth at the elevations shown. Test piles properly driven and located and with adequate driving resistance may be used in the finished work. Jetting will be permitted by the Contracting

Officer only when test pile driving clearly establishes the validity of its use.

3.2.1.2 Load Tests

****

NOTE: Delete this paragraph for projects for which load testing is not specified. Insert the number of piles to be load tested. The provisions of ASTM D1143/D1143M, such as pile set-up time after driving, test load, method of applying load, loading and unloading procedures, instrumentation, etc., should be carefully examined and modified as necessary to fit the specific load test being conducted. When it is desirable to show analysis for determination of pile capacities from load tests and for relating load test capacities to job capacities, include the following:

a. Test Measurements: Maintain the ultimate test load for not less than 24 hours and then release it. The safe design capacity of a test pile as determined from the results of load tests will be the lesser of the two values computed according to the following:

(1) One-half the load that causes a net settlement after rebound of not more than 0.23 mm per metric ton 0.01-inch per ton of total test load.

(2) One-half the load that causes a gross settlement of not more than 25 mm 1 inch provided that the load settlement curve shows no sign of failure.

b. Pile Capacity: The capacity, as driven, of single piles not in clusters in the structure should be not less than [_____] metric ton tons. The capacity will be determined by the following formulas, modified according to the data obtained by the load tests:

For single-acting hammers: $R = 166.7WH/(s+2.54P/W)$ $(R = 2WH/(s+0.1P/W))$

For double-acting hammers: $R = 166.7E/(s=0.1P/W)$ $(R = 2E/(s=0.1P/W))$

Where: R is the allowable static pile load in newtons pounds.

W is the weight of the striking part of the hammer in newtons pounds.

H is the effective height of fall in meters feet.

E is the actual energy delivered by the hammer per blow in newton-meters foot-pounds.

S is the average net penetration in millimeters inches per blow for the last five blows after the pile has been driven to a depth where successive blows produce approximately equal net penetration a minimum distance of 1 m 3 feet for friction piles.

P is the weight of the pile in newtons (pounds). If P is less than W, P/W will be taken as unity.

Dynamic pile stresses should not exceed the crushing strength of piles.
****

Perform load tests in accordance with ASTM D1143/D1143M, [_____] loading method. Provide apparatus for applying the vertical loads given by the method, either for load supported directly by the pile, or load from weighted box or platform or reaction frame attached to sufficient uplift piles to take safely the required load applied to the pile by hydraulic jack. Perform the load tests; at locations shown or directed, on test piles driven to the tip elevation used for establishing lengths of piles for bidding, except as otherwise directed. Additional load test, at the expense of the Government, may be required. Leave pile in a place a minimum of 3 days before loading. Perform loading, testing, and recording of data under the direct supervision of a registered professional engineer. The analysis of the load test data must be done by the registered professional engineer. Provide and pay for the registered professional engineer.

3.2.2 Concrete Testing

****
NOTE: The following table is recommended for use in determining the number of test cylinders required in relation to the size of each lot of piles to be tested.

Pile Lot	**Number of Test Cylinders**
25	**2**
100	**4**
1000	**20**
5000	**50**
10,000	**100**

Samples taken from random batches of concrete.
****

During Concrete placement, strength tests will be made by a testing service provided and paid for by the Contractor in accordance with requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE. Take at least two specimens from each random batch and one test will be made for every [_____] piles with no less than two tests for any 1 day's operation.

3.3 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by Appendix 11A of ASCE 7-16.

This paragraph will be applicable to both new buildings designed according to UFC 3-301-01 SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs.

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with UFC 3-301-01 and Appendix 11A of ASCE 7-16. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with UFC 3-301-01 and Section 01 45 35 SPECIAL INSPECTIONS.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 62 50 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 31 - EARTHWORK

SECTION 31 62 50

DENSIFIED AGGREGATE PIERS

11/20, CHG 2: 02/24

PART 1 GENERAL

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-31 62 50 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 31 62 50

DENSIFIED AGGREGATE PIERS
11/20, CHG 2: 02/24

****
NOTE: This guide specification covers the requirements for the design and construction of densified aggregate piers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables
****

****
NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.
****

****
NOTE: Show the following information on the drawings:

1. Locations and design loads of aggregate piers.

2. Size, shape, and length of aggregate piers.

3. Locations of test piers, if required.

4. Soil data, where required.

****

****

NOTE: Edit this document for project specific ground improvement requirements such as reinforcement or densification. Add additional information and requirements or delete requirements not required. Care should be taken to coordinate an installation surface that will accommodate the top heavy equipment that is required for installation. Coordinate the use of working pads or special subgrade requirements with the appropriate paragraphs of Section 31 00 00 EARTHWORK.

****

****

NOTE: Provide the following information in the contract or supporting design documents as appropriate:

a. Soils data and a final Site Characterization and Geotechnical Engineering Report;

b. Dead and live loads for each footing location Bearing pressure diagrams for mat foundations, retaining wall footings, and shear wall footings, and actual load for supported slab locations. A loading diagram must be provided for any footings subject to a moment. Any net uplift loads must be highlighted so uplift anchors can be provided; and

c. Coordinated Civil Site design drawings that highlight all existing and future utilities and new fill that will be placed on site.

****

PART 1 GENERAL

1.1 DESCRIPTION

Work consists of designing, furnishing, installing, monitoring, and testing of the densified aggregate pier foundations to the lines and grades designated on the project foundation plan and as specified herein. Work will include all equipment, material, labor, and supervision to design and install aggregate pier elements, [load transfer platforms]and to perform soil and aggregate pier testing.

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 00 and Division 01 Specification Sections, apply to this Section.

The number of piers, diameters and depth of piers are to be determined by the aggregate pier designer. Design must rely on subsurface information presented in the project geotechnical report. The information on ground conditions must be assessed to determine its suitability for the specified ground improvement system. Prepare site [and predrill as necessary]for aggregate pier installation. The aggregate piers will be columns of compacted aggregate constructed in a columnar-type configuration to produce an intermediate foundation system for support of foundation loads to achieve the degree of improvement (allowable bearing capacity for maximum allowable settlements) as indicated in paragraph AGGREGATE PIER DESIGN ACCEPTANCE CRITERIA. The piers can be constructed with a down-hole vibratory probe, displacement mandrel system, or a down-hole tamper. It is the aggregate pier contractor's responsibility to determine and implement the systems and criteria to ensure that the specified performance is achieved.

The information on ground conditions must be assessed to determine its suitability for the specified ground improvement system. Prepare site [and predrill as necessary]for aggregate pier installation. For soils and groundwater conditions in which the predrilled hole remains open and stable, the aggregate can be placed by a loader into the open hole and compacted in lifts using a down-hole tamper. In unstable conditions, the hole stability must be maintained either with a down-hole vibratory probe, displacement mandrel system, or casing if the tamper method is used.

Removal of spoils from the site (which result from aggregate pier construction), removal of spoils off the working pad, footing excavation, and subgrade preparation following aggregate pier installation are not included. For removal of spoils from site due to aggregate pier installation, footing excavation and subgrade preparation, conform to Section 31 00 00 EARTHWORK, paragraph DISPOSITION OF SURPLUS MATERIAL.

1.1.1 Definitions

a. Aggregate piers are columns of compacted aggregate used to reinforce the ground to increase bearing capacity and reduce settlement of embankments or structures or to increase the density of soil. They can be constructed with a down-hole vibratory probe, a down-hole tamper, or a displacement mandrel system.

b. Designer is the firm employed by the Installer to design aggregate piers.

c. Installer: The firm that installs aggregate piers, who can be the general contractor or his subcontractor.

d. Load Transfer Platform: A structural layer used to transfer loads from the foundation or embankment to a group of aggregate piers.

e. Soil reinforcement refers to the aggregate piers being installed in the ground to increase the overall strength and stiffness of the soil mass, with little or no increase in the density of the soils in between the aggregate piers. A soil modulus test is typically performed to verify settlement and bearing capacity of the aggregate piers in both cohesive and cohesionless soils.

f. Soil densification refers to the aggregate piers being installed in the ground to increase the density of the soil in between the aggregate piers as well as the density of the overall soil matrix. This is only applicable to cohesionless soils and is typically verified by in situ testing of the soil between the aggregate piers, such as standard penetration, cone penetrometer, or flat dilatometer tests.

g. Down-Hole Vibrators: Down-Hole Vibrators are specially-designed, high-energy depth vibrators. The horizontal vibrations are created by a motor and eccentric weight located near the tip of the vibrator. Extension tubes are bolted to the vibrator to allow it to be lowered to the necessary treatment depth.

h. Displacement Mandrel System: Displacement mandrel systems are constructed by advancing a specially designed mandrel augmented by dynamic vertical ramming energy to the full design depth. The hollow-shaft mandrel, filled with aggregate, is incrementally raised, permitting the aggregate to be released into the shaft, and then lowered by vertically advancing and ramming to densify the aggregate and force it laterally into the adjacent soil. The cycle of raising and lowering the mandrel is repeated to the top of pier elevation. This equipment is most often used in soil conditions with high water tables or for soils where a pre-drilled hole will not remain open.

i. Down-Hole Tampers: Down-Hole Tampers are proprietary high-energy impact apparatus. The vertical tamping energy is provided by a hammer which is connected to a round, beveled tamper. The apparatus is lowered into a pre-drilled hole to the required treatment depth. Down hole tampers may also include minimum 4990 kg 11,000 pound circular steel tampers dropped from minimum heights of 7.6 m 25 feet to create high compactive energies.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D1196/D1196M	(2012; R 2016) Standard Test Method for Nonrepetitive Static Plate Load Tests of Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements
ASTM D1241	(2015) Materials for Soil-Aggregate Subbase, Base, and Surface Courses
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1586/D1586M	(2018) Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D6913/D6913M	(2017) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM STP 399	(1966) Vane Shear and Cone Penetration Resistance Testing of In-Situ Soils

1.3 SUBSURFACE DATA

Subsurface soil data such as[Standard Penetration Tests (SPT),][Flat Plate Dilatometer Tests (DMT),][Seismic Piezocone Penetration Tests (SCPTu),][Pressuremeter tests,] and [laboratory test data] are[indicated][appended to the special contract requirements][provided on the project drawings].[These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.]

1.4 BASIS OF BID

****
NOTE: Select one of the following options:
****

****
NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of aggregate piers. Use this in all projects except those where exact aggregate piers lengths cannot be practically determined prior to the actual work. Clearly show number of aggregate piers, capacity, locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of aggregate piers. Specify unit price bid items for aggregate piers only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of aggregate piers must be determined as accurately as possible, prior to bidding, since the unit price per meter foot of the aggregate piers varies as the length increases or decreases.
****

1.4.1 Aggregate Pier Design Acceptance Criteria

a. The ground improvement Installer is responsible for design of an Aggregate Pier ground improvement system that meets the global stability, allowable bearing capacity, densification, and settlement requirements stated on the contract plans. Industry recognized standards of design methods specific to the installer's equipment and construction methods must be used. The design must demonstrate by calculation that the spacing and layout fulfills the requirements.

b. The Aggregate Pier design stiffness modulus value must be verified by the results of the modulus test. The Contractor's Geotechnical Consultant must verify the modulus test based on the modulus test results.

c. Design Aggregate Piers in accordance with generally-accepted engineering practice and the methods described in Section 1 of these Specifications. The design must meet the following criteria.

    (1) Minimum Allowable Bearing Pressure for Aggregate Pier Reinforced Soils: [170] [_____] Kpa [3,570] [_____] psf.

(2) Estimated Total Long-Term Settlement for Footings: Less than or equal to [25] [_____] mm [1.0] [_____] inches.

(3) Estimated Long-Term Differential Settlement of Adjacent Footings: Less than or equal to [13] [_____] mm [0.5] [_____] inches.

(4) Estimated Liquefaction Settlement for Footings: Less than or equal to [38] [_____] mm [1.5] [_____] inch.

(5) The modulus of the aggregate material within the aggregate piers must have a minimum modulus of [27.7x106] [_____] N/m3 [100] [_____] pci.

(6) The minimum SPT blow count in the improved zone in between aggregate piers must be [15] [_____].

d. The design submitted by the Installer must consider the bearing capacity and settlement of all footings and other structures supported by aggregate piers, and must be in accordance with acceptable engineering practice and these specifications. Total and differential settlement must be considered. The design life of the structure must be [50] [_____] years.

[1.4.2 Lump Sum Payment

****

NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection. Fill in Table I as required selecting columns applicable to project. Generally, aggregate piers capacity, location, and minimum tip elevation are shown on plans. Test aggregate piers and load tests are not incorporated in lump sum contracts. Delete this paragraph for unit-price contracts.

****

Base bids upon providing the number, size, capacity, and length of aggregate piers as indicated on the [drawings.] [following Table I:

Table 1

[Location]	Number	Size	[Capacity]	Length (Tip to Cut-Off)

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to meet the applicable contract requirements. Include mobilization, pre-drilling, and installation. If total number of aggregate piers or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for aggregate piers will be based on successfully installing piers to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: rejected, or misplaced piers; withdrawn piers; any portion of a pier remaining above the planned top elevation; or other excesses beyond the assumed aggregate pier length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys].

][1.4.3   Unit Price

****
NOTE: Delete this paragraph for lump-sum contracts.
****

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****
NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.
****

Requirements of FAR 52.211-18 Variation in Estimated Quantity do not apply to payment for aggregate piers. Each aggregate pier and test aggregate pier acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to installing the piers including mobilization and demobilization,[jetting][predrilling][probing], and cutting off piers at the cut-off elevation. Payment will be made for production aggregate piers[and test aggregate piers] at the bid unit price for the length of piers, from tip to final cut-off, actually provided, excluding buildups directed by the Contracting Officer to be made. If the actual cumulative aggregate pier length installed (tip to cut-off) vary more than 25 percent from the total aggregate pier length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of FAR 52.236-2 Differing Site Conditions.[Payments will be made per each at the respective bid unit price for pier cut-offs, pier build-ups and pier loads tests.][Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys.]

][1.5   PAYMENT

1.5.1   Mobilization and Demobilization

1.5.1.1   Payment

Payment will be made for costs associated with mobilization and demobilization as a separate single lump sum item.

1.5.1.2   Measurement

Lump sum.

1.5.1.3   Unit of Measure

Lump sum.

1.5.2   Installing Aggregate Piers

1.5.2.1   Payment

Payment will be made for costs associated with installing aggregate piers, which includes costs of installing aggregate piers and removing excess waste from the work site, compiling and submitting aggregate pier records, and any other items incidental to installing aggregate piers to the required elevation.

1.5.2.2 Measurement

Aggregate piers will be measured for payment for installation on the basis of lengths, to the nearest hundredth of a linear meter tenth of a linear foot, along the axis of each pier acceptably in place below the cut-off elevation shown.

1.5.2.3 Unit of Measure

Linear meter foot.

[1.5.3 Aggregate Pier Modulus Compressive Load Tests

1.5.3.1 Payment

Payment will be made for costs associated with aggregate pier modulus compressive load tests in accordance with ASTM D1143/D1143M and ASTM D1196/D1196M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; load test plates; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting load test reports. No payment will be made for rejected modulus compressive load tests.

1.5.3.2 Measurement

Aggregate pier modulus compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.5.3.3 Unit of Measure

Each.

][1.5.4 Aggregate Pier Static Tensile Load Tests

1.5.4.1 Payment

Payment will be made for costs associated with aggregate pier static tensile load tests in accordance with ASTM D3689, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting load test reports. No payment will be made for rejected static tensile load tests.

1.5.4.2 Measurement

Aggregate pier tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load tests.

1.5.4.3 Unit of Measure

Each.

][1.5.5 Vibration Monitoring

1.5.5.1 Payment

Payment will be made for costs associated with vibration monitoring.

1.5.5.2 Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.5.3 Unit of Measure

Each.

][1.5.6 Sound Monitoring

1.5.6.1 Payment

Payment will be made for costs associated with sound monitoring.

1.5.6.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.6.3 Unit of Measure

Each.

][1.5.7 Preconstruction Condition Survey

1.5.7.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.5.7.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.5.7.3 Unit of Measure

Each.

][1.5.8 Construction Instrumentation and Monitoring

1.5.8.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.5.8.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.5.8.3 Unit of Measure

One.

]]1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Designer and Installer's Qualifications; G, [_____]

Contractor's Geotechnical Consultant Documentation; G, [_____]

Testing Agency Qualifications; G, [_____]

SD-02 Shop Drawings

****

NOTE: Drawings, diagrams and schedules specifically

prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

****

Uplift Anchor Hardware; G, [_____]

Aggregate Pier Installation Work Plans and Construction Drawings; G, [_____]

Load Test; G, [_____]

Aggregate Pier Progress and Final Reports; G, [_____]

Excavation Adjacent to Piers; G, [_____]

SD-03 Product Data

Uplift Anchor Hardware; G, [_____]

Load Tests; G, [_____]

Aggregate Material Data; G, [_____]

Aggregate Pier Installation Equipment; G, [_____]

SD-05 Design Data

****

NOTE: Calculations, mix designs, analyses or other data pertaining to a part of work.

****

Design Submittal; G, [_____]

Excavation to Adjacent Piers; G, [_____]

SD-06 Test Reports

****

NOTE: Test reports must include findings of tests on aggregate piers and made at the job site on portions of the work during or after installation.

Choose test methods suitable for specific project design purposes. Modulus tests on aggregate piers must be mainly for ground reinforcement applications. Standard penetration tests on soils in between aggregate piers must mainly be for soil densification applications.

****

Modulus Testing of Aggregate Piers and Test Aggregate Pier Records; G, [_____]

[Standard Penetration Testing (SPT) of Soils Between Aggregate Piers; G, [_____]

][Dynamic Cone Penetrometer Testing of Aggregate Piers; G, [_____]

] Aggregate Pier Progress and Final Reports;G, [_____]

Aggregate; G, [_____]

SD-07 Certificates

Aggregate; G, [_____]

[Cement; G, [_____]

] Load Test Supporting Data; G, [_____]

Warranty; G, [_____]

Daily Progress and Final Reports;G, [_____]

As-Driven Survey; G, [_____]

1.7 QUALITY CONTROL

1.7.1 Aggregate Pier Installation Equipment

Submit descriptions of proposed aggregate pier installation equipment before commencing work. Include details of the rig type and size, auger type, available torque and crowd. Include work procedures and control criteria. All proprietary tampers must be approved by the Contracting Officer prior to use.

[1.7.2 Modulus Load Test Apparatus

Submit equipment description lists or catalog cuts and a brief description of the modulus load test procedure, including maximum load and modifications in accordance with the procedure required by ASTM D1143/D1143M and ASTM D1196/D1196M before commencing tests.

][1.7.3 Contractor's Geotechnical Consultant Documentation

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics, to observe test pier installation and production pier installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and must have no employee of employer relationship which could constitute a conflict of interest. The consultant must demonstrate that they have been engaged in successful inspection of aggregate piers for at least 5 years and inspected similar projects in similar scope utilizing the methods being performed for the subject project.

]1.7.4 Design Submittal

The installer must submit three sets of detailed design calculations for aggregate piers [and load transfer platforms]for approval at least 4 weeks prior to the beginning of construction. A detailed explanation of the design parameters for settlement and bearing calculations must be included in the Design Submittal. Additionally, the quality control test program for aggregate piers, confirming the design requirements, must be submitted. All calculations and drawings must be prepared and sealed by a Professional Engineer in the State in which the project is constructed.

The design must consider the bearing capacity and settlement of all footings supported by aggregate piers, and be in accordance with acceptable engineering practice and these specifications. Total and differential settlement will be considered. The design life of the structure is [50] [_____] years. Detailed calculations, including anticipated loads, design assumptions and relevant subsurface information, must be provided. Drawings prepared for construction use and must include site plans showing Aggregate Pier locations and depths, and footing details showing Aggregate Pier layout beneath footings and uplift anchor connection details when applicable. Minimum Modulus at maximum design stress must be as specified in the final design documents provided by the Aggregate Pier Designer.

1.7.5 Aggregate Pier Installation Work Plans and Construction Drawings

The installer must submit three sets of construction drawings; installation work plan with aggregate pier installation details and testing details; and shop drawings with the location, spacing, numbering, diameter, and depth of the aggregate piers for approval at least 28 calendar days prior to the beginning of construction sealed by the Designer who must be a Professional Engineer in the State in which the project will be constructed.

[1.7.6 Concrete Mix Design

****

NOTE: Include this paragraph for cemented aggregate piers.

****

Certify, using a Government-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI 211.1 or ACI 318M ACI 318 for specified strength and is based on aggregate data which has been determined by laboratory tests during last 12 months. Submit a complete list of materials including type; brand; source and amount of cement, [fly ash, pozzolan, ground slag, and admixtures;]and applicable reference specifications. Submit additional data regarding concrete aggregate if the source of aggregate changes. Submittal must clearly indicate where each mix design will be used when more than one mix design is submitted.

]1.8 QUALIFICATIONS

Installation of aggregate piers must be performed by a specialty Contractor experienced and competent in the installation of aggregate piers as specified herein. Submit evidence that the contractor has worked on similar type of projects. The projects must demonstrate proficiency of the designer as applicable to the intent of the project. The Designer must be a Professional Engineer registered in the state where the project is located.

Designers and Installers of aggregate pier foundation systems must have a minimum of 5 years of experience with the design and installation of aggregate piers in similar soil conditions and must have completed at least

20 similar projects of comparable size and type in similar soil conditions. These projects must demonstrate proficiency of the designer and the installer with either reinforcement or densification applications as applicable to the intent of the project. A list of projects, including name and description of the project, relative size, and contact person with phone number must be provided.

PART 2 PRODUCTS

2.1 MATERIALS

a. Aggregate used by the aggregate pier Installer must be pre-approved by the Contracting Officer and must demonstrate suitable performance during modulus testing. Gradation curves and physical property tests results must be submitted 28 calendar days prior to scheduled start.

b. Aggregate stone consisting of[Type I Grade B in accordance with ASTM D1241,][ASTM C33/C33M No. 57 stone,][or other graded aggregate] approved by the Contracting Officer. For piers constructed below the water table, particles passing the No. 40 sieve must be eliminated. Where material is deemed appropriate for a dynamic penetration test (ASTM STP 399), aggregate must be compacted to a densification and strength, which provides resistance to the dynamic penetration test of a minimum average of 15 blows per 45 mm 2 inches vertical movement. Test aggregate gradation in accordance with ASTM D6913/D6913M.

c. The Installer must provide the soil laboratory test data on the proposed aggregate material including the source, type, and gradation of the aggregate to be used. Submit aggregate material data at least 30 calendar days before installation. Provide letters of certification and material delivery tickets from the aggregate supplier.

d. Materials selected must remain stable during construction and working life in the anticipated soil and ground water conditions.

e. Potable water or other suitable source supply must be used to increase aggregate moisture content where required. Access to water on site must be provided to the Installer by the General Contractor.

f. General Contractor to coordinate adequate and suitable marshalling areas on the project site for the storage of aggregate and equipment.

[g. Provide concrete as specified in [_____] except as specified otherwise herein, for minimum 28-day concrete compressive strength of [_____] MPa pounds per square inch, using 19 mm 3/4 inch maximum coarse aggregate. Concrete for base[and for uncased shaft] must have minimum 3-day compressive strength of [_____] MPa pounds per square inch.[Cased shaft must have minimum 3-day compressive strength of [_____] MPa pounds per square inch.]

][h. Provide uplift anchor hardware as specified in [the aggregate pier design][_____]. Provide drawings, diagrams, and schedules which detail hardware integration and installation. Letters of certification and material delivery tickets from the hardware suppliers must be submitted 28 calendar days prior to the scheduled start of the uplift test to verify that the materials are of the appropriate size, grade, and strength.

]PART 3 EXECUTION

3.1 CONSTRUCTION

3.1.1 Aggregate Pier Construction

Aggregate piers must be constructed in accordance with generally-accepted construction and engineering practices and the methods described in Section 1 of these Specifications. If pre-drill holes do not remain open before or during aggregate pier construction, bottom feed down-hole equipment must be used. Aggregate piers must be installed after fill is placed to raise grades if the aggregate piers are not designed to support new grading fill. The construction of the aggregate piers must not start until the project Geotechnical Engineer has determined that any ground settlement associated with placement of the new fill has ceased.

****

NOTE: Performance requirements may include criteria for structural, thermal, acoustical, or other properties. Tolerances should be stated here only as they apply to the performance of the complete system. Tolerances of fabrication and installation should be included in their respective paragraphs under Part 2.

****

a. Section 03 30 00 CAST-IN-PLACE CONCRETE.

b. Section 31 00 00 EARTHWORK.

c. Geotechnical Report and Recommendations.

3.1.2 Plan Location and Elevation of Aggregate Pier Elements

The location of each pier must be determined by the Designer to provide compliance with the design requirements of paragraph AGGREGATE PIER DESIGN ACCEPTANCE CRITERIA. The final measurement of the top of piers must be the lowest point on the aggregate in the last compacted lift. Piers not properly located and deemed not acceptable must be rebuilt at no additional expense to the Owner. The allowable construction tolerance must be within [152] [_____] mm [6] [_____] inches both for horizontal and vertical design locations.

3.1.3 Rejected Aggregate Pier Elements

Aggregate pier elements improperly located or installed beyond the allowable tolerance must be abandoned and replaced with new piers, unless the Designer approves other remedial measures. Aggregate must be replaced with fresh aggregate if cave-ins occur during aggregate placement where the volume of caved-in soil exceeds the volume of the aggregate being compacted by more than 10 percent. All material and labor required to replace rejected piers must be provided at no additional cost to the Owner, unless the cause of the rejection is due to an obstruction that is not pre-identified or mislocated by the Contracting Officer.[Obstructions include boulders, timbers, concrete, bricks, abandoned utilities.] Aggregate piers must be monitored for heave immediately after installation and after adjacent aggregate piers are installed. If piers heave more than 13 mm 1/2 inch notify the Contracting Officer.

3.1.4 As-Driven Survey

After the installation of each aggregate pier group is complete provide the Contracting Officer with an as-built survey showing actual location and top elevation of each aggregate pier.[Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pier group installed.] Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each aggregate pier to nearest 13 mm half inch. Survey must be prepared and certified by a licensed land surveyor.

3.1.5 Protection of Existing Structures

****

NOTE: Include this paragraph only when protection of existing structures from aggregate pier installation is required.

The designer must indicate on the drawings all structures and facilities for which protection is required. The designer must also provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.

****

Mitigate impact on existing facilities due to aggregate pier installation activities in accordance with the [project specific document] [_____].

3.1.6 Excavation Adjacent to Piers

Impacts to installed aggregate pier must be minimized. Submit a complete design and evaluation by the Aggregate Pier Designer in the event that utility excavations are required at horizontal distances of less than 5 [_____] feet from installed pier locations. Provide a drawing by the aggregate pier design which illustrates distances that must be maintained between aggregate piers and adjacent excavations.

3.2 FIELD QUALITY CONTROL

3.2.1 Quality Control Representative

The Contractor's Geotechnical Consultant must verify and report all aggregate pier installation procedures. Immediately report any unusual conditions encountered during installation to the Contracting Officer. The QC procedures must include the preparation of Aggregate Pier Progress Reports completed during each day of installation and containing the following minimum information:

a. Footing and Aggregate Pier location.

b. Aggregate Pier length and installed diameter.

c. Planned and actual Aggregate Pier elevations at the top and bottom of the element.

d. Average lift thickness for each Aggregate Pier.

e. Soil types encountered at the bottom of the Aggregate Pier and along the length of the element, if the holes were pre-drilled.

f. Depth to groundwater, if encountered.

g. Documentation of any unusual conditions encountered.

h. Type and size of densification equipment used.

i. Quality of aggregate in each individual pier

j. Any additional quality control testing performed, such as modulus tests, dynamic penetrometer tests, and standard penetration tests, as deemed appropriate by the Contracting Officer.

3.2.2 Quality Control Verification Program

****

NOTE: Edit this paragraph for project specific field verification testing and geotechnical instrumentation requirements. The minimum instrumentation requirements must be specified by the Owner and be provided in separate contract documents. The contractor should retain a testing agency (Contractor's Geotechnical Consultant) to perform quality control observations and testing. Typically a modulus test is specified if aggregate piers are installed for soil reinforcement (generally in cohesive soils), while in-situ testing such as Standard Penetration Testing is specified if aggregate piers are installed for soil densification (generally in cohesionless soils).

****

The Installer must be responsible for design of a verification program to assure the quality of the construction. The program must verify that the installed ground improvement system satisfies the performance requirements noted on the contract plans and the design requirements determined by the ground improvement system designer. The quality control program must include testing and observations by the Contractor's Geotechnical Consultant. As a minimum, the verification program must include the following:

a. Program to monitor performance of the ground improvement system during and after construction of the proposed structure. This program may include installation of settlement plates, monitoring points, inclinometers, piezometers, or other instrumentation.

b. Proposed means and methods for verification that the installed aggregate piers meet the strength and stiffness criteria required by the design. This may include, but must not be limited to modulus or load tests on individual elements and groups, soil borings, standard penetration testing (SPT), and other methods such as monitoring by instrumentation or settlement plates as approved by the Designer. Submit load test set-up and procedures utilized to confirm that the installation procedure develops the pier modulus utilized in design.

Submit load test supporting data.

c. Quality control program to verify that the ground improvement system is installed in accordance with the designer's specifications and the requirements in this specification. The quality control program must include testing and observations by Contractor's Geotechnical Consultant.

3.2.3 Bottom Stabilization Verification Test

After completion of the bottom pier bulb, or at any time during the process of construction of the pier, the energy source may be turned off, and bottom stabilization verification test may be performed. These tests must be performed when a new soil formation is encountered, or at the beginning of a project to provide quantitative information on pier stabilization. Acceptable performance is indicated if the vertical movement of the shaft is less than 150 percent of the vertical movement measured for the modulus test pier.

3.2.4 Modulus Testing of Aggregate Piers and Test Aggregate Pier Records

****

NOTE: A modulus compressive load test is appropriate if aggregate piers are installed for soil reinforcement (generally in cohesive soils).

****

A modulus test must be performed by the Installer to obtain the parameter values used in design. The number of tests and locations must be determined by the Contracting Officer. The Installer must provide and install all dial indicators and other measuring devices, conduct tests, and prepare the test reports. The tests must be performed generally in accordance with ASTM D1143/D1143M and ASTM D1196/D1196M. The aggregate piers must be tested to satisfy bearing capacity at 150 percent of the design stress and to satisfy the settlement criteria in paragraph AGGREGATE PIER DESIGN ACCEPTANCE CRITERIA at 100 percent of the design stress. The Installer must submit four copies of test reports for each test no later than 7 days after the test is completed. Report must include a description of the testing equipment, records, complete test data, analysis of the test data and recommended design parameter values based on the modulus test results. The report must be prepared under supervision of and sealed by a professional engineer registered in the state of project location.

[3.2.5 Standard Penetration Testing (SPT)

****

NOTE: Standard Penetration Testing on soils between aggregate pier locations is appropriate if aggregate piers are installed for densification of soils between piers.

****

a. The SPT must be performed by the Installer to verify if the ground modification criteria as measured by the SPT blow counts as specified in the Aggregate Pier Design Acceptance Criteria is met. The SPTs must be performed at midpoint locations between the aggregate piers.

b. The SPTs must be performed in accordance with ASTM D1586/D1586M.

c. The SPTs must be performed at 0.76 m 2.5 ft intervals through the entire depth of the improved soil zone.

d. Submit test results.

][3.2.6 Dynamic Cone Penetrometer Testing of Aggregate Piers

****

NOTE: Dynamic Cone Penetrometer Test must only be performed on dense graded aggregate material and not on ASTM C33 No. 57 open graded aggregate.

****

a. The Aggregate Pier element must be tested by the Dynamic Cone Penetrometer method (ASTM STP 399) at locations within the upper one third of the pier shaft length.

b. The minimum acceptable criteria as an indicator of acceptable densification must be at least 15 blows per 50 mm 2 inches penetration.

c. Perform dynamic Cone Penetrometer in each Aggregate Pier until such time as five consecutive tests indicate that the minimum criterion is met. Thereafter, such tests need not to be performed on every pier, provided that aggregate used in the element is representative of that previously tested. If average penetration resistances measured exceed 15 blows, and less than 10 percent of tests fall below 15 blows, the testing may be reduced to spot checks. A pattern of successful tests is sufficient to reduce testing to several tests per day.

d. Observation of questionable aggregate moisture content or questionable aggregate gradation appearance may determine the need for additional dynamic penetration testing to verify that the proper densification is being achieved.

e. Use of Dynamic Cone Penetrometer is not appropriate for use on open graded aggregate such as No. 57 stone.

]3.2.7 Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated. Submit testing agency qualifications to the Contracting Officer for approval.

3.2.8 Responsibilities of Contractor's Geotechnical Consultant

a. Review and verify that design meets the project requirements.

b. Report any discrepancies immediately.

c. Monitor the modulus compressive load tests when performed.

d. Monitor the installation of aggregate pier elements to verify that the production installation practices are similar to those used during the installation of the modulus compressive load test elements.

[e. Perform Dynamic Cone Penetrometer tests as described herein.

]3.2.9 Aggregate Pier Records

****

NOTE: Omit reference to load test when not required in project. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of installation, testing, recording and analysis of data for project may be useful.

****

Keep a complete and accurate record of each aggregate pier installed. Indicate the pier location, deviations from pier location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations, volume of aggregate used or number of lifts, densification forces during installation, and final elevations or depths of the base and top of piers. The records must also indicate the type and size of the installation equipment used, and the type of aggregate used and testing and material sampling that was performed. Provide a complete and accurate progress drawing of aggregate pier installation. Provide final drawing upon completion of installation activities.

Submit test aggregate pier records. [Submit load test data and results.]

The Installer must furnish a complete and accurate record of Aggregate Pier installation to the Government and the General Contractor. The record must indicate the pier location, length, average lift thickness and final elevations of the bases and tops of piers. The installation reports must also indicate the type and size of the densification equipment used. The installer must immediately report any unusual conditions encountered during installation to the General Contractor, to the Designer and to the Government. Submit Daily Progress and Final Reports Aggregate Pier Progress and Final Reports. Provide a Final Report documenting the results of all observations and tests conducted during the complete installation process. Report will certify that the bearing pressure has been achieved within settlement tolerances.

Provide warranty document good for [1][_____] year.

3.3 RESPONSIBILITIES OF GENERAL CONTRACTOR

3.3.1 Preparation

a. Locate the underground utilities. The Installer must protect underground and aboveground utilities and other structures from damage during installation of the Aggregate Pier elements.

b. Provide the site to the Installer after earthwork in the area has been completed, if applicable.

c. Site subgrade must be established by the General Contractor within 150 mm 6 inches of final design subgrade, as approved by the Contracting Officer.

d. Perform layout of the aggregate piers and provide a work platform if necessary.

3.3.2 Utility Excavations and Excavation to Adjacent Piers

The General Contractor must coordinate all excavations made subsequent to aggregate pier installations so that at least 1.5 m 5 feet of horizontal distance remains between the edge of any installed Aggregate Pier and the excavation[and that the piers are outside the zone of influence of the excavation]. In the event that utility excavations are required at horizontal distances of less than 1.5 m 5 feet from installed aggregate piers or the piers are within the zone of influence of the excavation, the General Contractor must notify the Aggregate Pier Designer to develop construction solutions to minimize impacts on the installed aggregate piers.

3.3.3 Footing Bottoms

a. Excavation and surface compaction of all footings is the responsibility of the General Contractor.

b. Foundation excavations to expose the tops of Aggregate Pier elements must be made in a workman like manner, and must be protected until concrete placement, with procedures and equipment best suited to (1) prevent softening of the matrix soil between and around the Aggregate Pier elements before pouring structural concrete, (2) achieve direct and firm contact between the dense, undisturbed Aggregate Pier elements and the concrete footing. Disturbed soil and aggregate must be recompacted per paragraph FOOTING BOTTOMS, list item c.(3) (below).

c. The following criteria must apply, and a written inspection report sealed by the Contractor's Geotechnical Consultant Agency must be furnished to the installer to confirm:

    (1) That water (which may soften the unconfined matrix soil between and around the Aggregate Pier elements, and may have detrimental effects on the supporting capability of the aggregate pier reinforced subgrade) has not been allowed to pond in the footing excavation at any time.

    (2) That all aggregate pier elements designed for each footing have been exposed in the footing excavation.

    (3) That immediately before footing construction, the tops of all aggregate pier elements exposed in each footing excavation have been inspected and recompacted as necessary with mechanical compaction equipment, and that the tops of any aggregate pier elements which may have been disturbed by footing excavation and related activity have been recompacted to a dry density equivalent to at least 95 percent of the maximum dry density obtainable by the [Standard][Modified] Proctor method [ASTM D698][ASTM D1557] unless approved otherwise by the Contracting Officer.

    (4) No excavations or drilled shafts must be made after installation of aggregate pier elements within a horizontal distance of 5 feet from the edge of any pier, without the written approval of the Contracting Officer.

[3.4 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems

is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-310-04, "Seismic Design for Buildings".

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.
****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

][3.5   VIBRATION CONTROL

****
NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project.
****

Perform vibration monitoring at the locations[shown in the plan][decided by the Contracting Officer] during the aggregate pier installation. Perform vibration monitoring[using][seismographs][and geophones] within a distance of 61 meters 200 feet from the aggregate pier installation.[Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [5] [_____] years of experience in vibration monitoring. A minimum of [28] [_____] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the aggregate pier installation, obtain baseline readings of ambient vibrations. The vibration during the aggregate pier installation must be limited to[a peak particle velocity of not more than 5 cm 2 inches per second.][the limits mentioned in the [contract documents] [_____].][Determine appropriate vibration limits as per[US Bureau of Mines][American Association of State Highway and Transportation Officials (AASHTO)] guidelines.] During aggregate pier installation, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the aggregate pier installation causing the vibration until[the Vibration consultant and the Contracting Officer] [_____] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor must be responsible for all damages resulting from the aggregate pier installation and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.6 NOISE CONTROL

****
NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project.
****

Perform noise monitoring at the locations[shown in the plan][decided by the Contracting Officer][at noise sensitive public areas] during the aggregate pier installation.[Perform noise monitoring using [noise meters][, and] [_____].][Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [5] [_____] years of experience in noise monitoring. A minimum of [28] [_____] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the aggregate pier installation, obtain baseline readings of ambient noise levels.[The noise limits are mentioned in the[plan][contract documents].][Determine appropriate noise limits as per[local agency][Occupation Safety and Health Administration] guidelines.] During aggregate pier installation, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the aggregate pier installation and install noise mitigation measures.

The Contractor must be responsible for all damages resulting from the aggregate pier installation and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.7 PRECONSTRUCTION CONDITION SURVEY

****
NOTE: Add any additional criteria, references or requirements as necessary to the particular project.
****

Perform preconstruction condition survey of[structures][and utilities][within 61 meters 200 feet of the aggregate pier installation][specified in the plans][decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] [_____] days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] [_____] days before the commencement of aggregate pier installation. Accept responsibility for damages to existing adjacent or adjoining structures created by aggregate pier installation, and repair any damages to these structures without cost to the Government.

][3.8 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during aggregate pier installation. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement[and lateral movement] of temporary and permanent structures, utilities,[embankments][and excavations] during aggregate pier installation. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with paragraphs NOISE CONTROL and VIBRATION CONTROL.]

Monitoring must extend before, during and for a period after completion of construction activities related to aggregate pier installation when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the aggregate pier installation. Establish limiting values of vertical[and horizontal] movement[and angular distortion][and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

]   -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 63 16 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-31 63 16 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-31 63 16 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-31 63 16 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 31 63 16

AUGERED CAST-IN-PLACE PILES

11/20

****

NOTE: This guide specification covers the requirements for augered cast-in-place grout piles.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification covers the requirements for augered cast in place piles.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be

submitted as a Criteria Change Request (CCR).
****

****
NOTE: TO DOWNLOAD UFGS GRAPHICS Go to http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf.
****

****
NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.
****

****
NOTE: Show the following information on the drawings:

1. Locations and design loads of piles. If both tension and compression piles are contained in design, identify by type.

2. Size, shape, and length of piles.

3. Details of reinforcement.

4. Locations of test piles, if required.

5. Soil data, where required.

6. Identify piles as vertical or battered
****

PART 1 GENERAL

****
NOTE: Special care should be taken when installing augered cast in-place piles in low strength soils such as peat where "necking" of piles can occur, or in soils containing layers or fields of boulders or cobbles, where there may be difficulties extending piles through the materials, or in methane gas producing soils, where gas bubbles and subsequently voids can develop in the piles.

On the drawings, show:

1. Subsurface-soil-data logs

2. Locations and size (diameter) of piles.

3. Design tip elevation for each pile indicated.

4. Reinforcing steel details.

5. Locations of test piles if required.

6. Locations of soil probes if required.
****

****

NOTE: Structural engineer must confirm the structural capacity of piles and provide specific bending moments, lateral loads and other design requirements for pile design.

****

1.1 DESCRIPTION

Design, furnish, install and test augered cast in place piles at the locations indicated on the drawings and specified herein. [Test piles that meet performance requirements can be incorporated into the permanent work.][Assume test pile[s] will be directed to be placed in [a] location[s] that can be incorporated into the work.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 315	(2018) Guide to Presenting Reinforcing Steel Design Details
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C937	(2023) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C939/C939M	(2022) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C942/C942M	(2021) Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1611/C1611M	(2021) Standard Test Method for Slump Flow

	of Self-Consolidating Concrete
ASTM D942	(2019) Standard Test Method for Oxidation Stability of Lubricating Greases by the Oxygen Pressure Vessel Method
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D5882	(2016) Standard Test Method for Low Strain Impact Integrity Testing of Deep Foundations
ASTM D6760	(2016) Standard Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Crosshole Testing
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E548	(1994; E 1995) Standard Guide for General Criteria Used for Evaluating Laboratory Competence

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[1.3 SUBSURFACE DATA

Subsurface soil data logs are [indicated] [appended to the special contract requirements] [provided on the project drawings]. [The subsoil investigation report may be examined at [_____].]

]1.4 SYSTEM DESCRIPTION

****

NOTE: Working load on the pile should be limited to limiting stress per IBC 2015 of 30 percent of the unconfined compressive strength of the grout, as measured by: ASTM C109. (2016). "Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)," ASTM International, West Conshohocken, PA.

****

Submit detail drawings to demonstrate compliance of augering, mixing, and pumping equipment, installation, and installed piles with contract documents. Include with the drawings erection details and reinforcement as specified. Augered cast-in-place piles are formed by the rotation of a continuous flight hollow-shaft auger into the ground to the tip elevation established by the requirements specified elsewhere in this section. Grout is then injected through the auger shaft as the auger is being withdrawn in such a way as to exert removing pressure on the withdrawing earth-filled auger as well as lateral pressure on the soil surrounding the grout-filled pile hole. Submit evidence to the Contracting Officer that the Contractor has been engaged in the successful installation of auger cast grout piles for at least 5 years.

1.4.1 Equipment

The minimum inside diameter of the hollow shaft of the augerflight must be 31.8 mm 1-1/4 inches. Provide grout injection equipment with a grout pressure gauge in clear view of the equipment operator. Rate of grout injection and rate of auger withdrawal from the soil must be so coordinated as to maintain at all times a positive pressure on this gauge which will, in turn, indicate the existence of a "removing pressure" on the bottom of the augerflight. Magnitude of this pressure and performance of other augering and grouting procedures, such as rate of augering, rate of grout injection, and control of grout return around the augerflight, are dependent on soil conditions and equipment capability and must be at the option of the Contractor, subject to review by the Contracting Officer. The auger hoisting equipment must be capable of withdrawing the auger smoothly and at a constant rate.

1.4.2 Grout Pump

Provide a positive displacement grout pump of an approved design capable of providing a positive displacement pressure not less than 2.4 MPa 350 psi. The pump discharge capacity must be calibrated at the beginning of the work to determine the volume of grout pumped per stroke in strokes per cubic meter foot or revolutions per cubic meter foot by a method approved by the Contracting Officer. The pump must be periodically recalibrated when deemed necessary by the Contracting Officer or the Contractor's Geotechnical Engineer during the project. Remove oil or other rust inhibitors from mixing drums and pressure grout pumps prior to mixing and pumping.

1.5 BASIS OF BID

****

NOTE: Select one of the following options:

****

****

NOTE: NOTE: Use paragraph LUMP SUM PAYMENT for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use paragraph UNIT PRICE for unit price bidding of piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of piles must be determined as accurately as

possible, prior to bidding, since the unit price per meter (foot) of the piles varies as the length increases or decreases. Refer to Standard Test Method for Low Strain Impact Integrity Testing of Deep Foundations (ASTM D5882)

****

1.5.1 Production Pile Acceptance Criteria

Safe design capacity for piles is [____] KN kips. Install piles to [minimum tip elevation] [a minimum depth of [____] m feet below cut-off elevation], and to such additional depth as required to obtain a bearing capacity of not less than [____] KN kips. The Contractor's Geotechnical Consultant will determine the terminal installation criteria based on results of the static load tests [non-destructive testing results].

[1.5.2 Lump Sum Payment

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.] [following Table I:

Table 1

[Location]	Number	Size	[Capacity]	[Length (Tip to Cut-Off)]	[Maximum Bending Moment]	[Maximum Shear Force]

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: install, cut-off, dispose of any spoils, and meet the applicable contract requirements. Include mobilization, and redrilling damaged and heaved piles. If, in redrilling, it is found that any pile is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. If total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; redrilled piles; any portion of a pile remaining above the cut-off elevation; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys].

][1.5.3 Unit Price

****

NOTE: Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments in price schedule for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

For NAVFAC Southeast projects, where there is a need for unit pricing of piles, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items.
****

For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****
NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.
****

Requirements of "FAR 52.211-18, Variation in Estimated Quantity" do not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and installing the piles including mobilization and demobilization, [jetting] [predrilling] [probing], redrilling uplifted piles, [and cutting off piles at the cut-off elevation]and reinforcing steel. [Include the cost for additional length for the test piles in the total unit price cost for the job.] Payment will be made for production [and test piles] at the bid unit price for the length of pile, from tip to final cut-off, actually provided, excluding buildups directed by the Contracting Officer to be made. If the actual cumulative pile length installed (tip to cut-off) varies more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of "FAR 52.236-2, Differing Site Conditions." [Payments will be made per each at the respective bid unit price for pile cut-offs, pile build-ups and pile loads tests.] [Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys].

][1.6 PAYMENT

****
NOTE: Delete this paragraph for lump-sum contracts.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.
****

1.6.1 Augered Cast in Place Piles Installation

1.6.1.1 Payment

Payment will be made for costs associated with installation of the required lengths of permanent augered cast in place piles, [including reinforcing steel,] [performing static load test, interpreting data and submitting reports,], compiling and submitting pile installation records, backfilling voids around piles, and any other items incidental to installing piles to the required elevation. No payment will be made for installing piles exceeding required lengths. No payment will be made for piles damaged during installation to the extent that they are rendered unsuitable for the work, in the opinion of the Contracting Officer.

1.6.1.2 Measurement

Permanent augered cast in place piles will be measured for payment for installation on the basis of lengths, to the nearest hundredth tenth of a linear meter foot, along the axis of each pile acceptably in place below the cut-off elevation shown as[determined by the Contracting Officer].

1.6.1.3 Unit of Measure

Linear meter foot.

[1.6.2 Augered Cast-in-Place Test Piles

1.6.2.1 Payment

Payment will be made for costs associated with installation of augered cast-in-place test piles, backfilling voids around piles; compiling pile installation test records[; performing dynamic testing; interpreting data; and submitting reports].

1.6.2.2 Measurement

Augered cast-in-place pile installation tests will be measured for payment on the basis of the applicable contract unit price per pile installation test.

1.6.2.3 Unit of Measure

Each.

][1.6.3 Augered Cast-in-Place Piles for Load Tests

1.6.3.1 Payment

Payment will be made for costs associated with installing, abandoning of load test piles [including structural steel]; backfilling voids around piles; compiling pile installation records[; furnishing, fabricating, and mounting of strain rods and protective assembly][; furnishing, fabricating, and mounting of inclinometer and inclinometer protective assembly][; performing non-destructive testing; interpreting data; and submitting reports]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

1.6.3.2 Measurement

Augered cast in place piles for load tests will be measured for payment on the basis of the applicable contract unit price per load test pile.

1.6.3.3 Unit of Measure

Each.

][1.6.4 Augered Cast-in-Place Pile Static Axial Compressive Load Tests

1.6.4.1 Payment

Payment will be made for costs associated with augered cast in place pile static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static axial compressive load tests.

1.6.4.2 Measurement

Augered cast in place pile static axial compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.6.4.3 Unit of Measure

Each.

][1.6.5 Augered Cast-in-Place Pile Static Tensile Load Tests

1.6.5.1 Payment

Payment will be made for costs associated with augered cast-in-place pile static tensile load tests in accordance with ASTM D3689, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static tensile load tests.

1.6.5.2 Measurement

Augered cast in place pile tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load test.

1.6.5.3 Unit of Measure

Each.

][1.6.6 Augered Cast-in-Place Pile Lateral Load Tests

1.6.6.1 Payment

Payment will be made for costs associated with augered cast-in-place pile lateral load tests in accordance with ASTM D3966/D3966M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing inclinometers; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile lateral load tests.

1.6.6.2 Measurement

Augered cast in place pile lateral load tests will be measured for payment on the basis of the applicable contract unit price per lateral load test.

1.6.6.3 Unit of Measure

Each.

][1.6.7 Low Integrity Impact Test

1.6.7.1 Payment

Payment will be made for costs associated with Low Integrity Impact Testing.

1.6.7.2 Measurement

Low Integrity Impact Test will be measured for payment on the basis of the applicable contract unit price per test cost.

1.6.7.3 Unit of Measure

Each.

][1.6.8 Sonic Logging

1.6.8.1 Payment

Payment will be made for costs associated with Sonic Logging Testing.

1.6.8.2 Measurement

Sonic Logging testing will be measured for payment on the basis of the applicable contract unit price per test cost.

1.6.8.3 Unit of Measure

Each.

][1.6.9 Vibration Monitoring

1.6.9.1 Payment

Payment will be made for costs associated with vibration monitoring.

1.6.9.2 Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.6.9.3 Unit of Measure

Each.

][1.6.10 Sound Monitoring

1.6.10.1 Payment

Payment will be made for costs associated with sound monitoring.

1.6.10.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per sound monitoring point.

1.6.10.3 Unit of Measure

Each.

][1.6.11 Preconstruction Condition Survey

1.6.11.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.6.11.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.6.11.3 Unit of Measure

Each.

][1.6.12 Construction Instrumentation and Monitoring

1.6.12.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.6.12.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.6.12.3 Unit of Measure

One.

]]1.7 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Under SD-07, from 3 to 5 years experience in installation of auger cast grout piles should be required.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G, [_____]

[Contractor's Geotechnical Consultant Documentation; G, [_____]

] Load Tests Procedures; G, [_____]

Grout Mix Design; G, [_____]

Field Quality Control Procedures; G, [_____]

SD-02 Shop Drawings

Augered Cast-in-Place Piles; G, [_____]

Load Tests; G

SD-03 Product Data

Test Piles; G, [_____]

Grout Pump

Materials

Grout Specimens for Laboratory Tests

Grout Specimens for Contractor Tests

Casings

SD-06 Test Reports

Test Piles

Load Tests

Flow Cone Test

SD-07 Certificates

Augered Cast-in-Place Piles

SD-11 Closeout Submittals

Pile Records

1.8 DAMAGED PILES

Piles which are damaged during installation to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected, or may be re-drilled, if approved, at no cost to the Government.

Any pile damaged by reason of improper installation must be corrected by one of the following methods approved by the Contracting Officer for the pile in question:

a. The pile is re-drilled and re-grouted, if practicable, and, if necessary, drilled deeper.

b. One or more replacement piles are installed adjacent to the defective pile.

c. Low strain integrity non-destructuve testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the pile(s)in question.

A pile installed below the specified butt elevation must be corrected by one of the following methods approved by the Engineer:

a. A sufficient portion of the footing is extended down to properly embed the pile.

b. Build up the pile butt by the use of casings.

A pile installed out of its proper location or out of plumb as approved by the Engineer, must be corrected by one of the following methods approved by the engineer:

a. One or more replacement piles are installed next to the pile in question.

b. As directed by the structural engineer.

1.9 QUALITY CONTROL

1.9.1 Field Quality Control Procedures

Submit the field quality control procedures. Provide instructions and procedures on how the Contractor will assist the Government in the processes of [Pile Load Testing,], Inspection and Monitoring of piles during installation and testing.

1.9.2 Installation Procedures

Submit information on the type of equipment proposed to be used, proposed methods of operation, pile installation plan including proposed sequence of installation, and details of all pile installation equipment and accessories.

[1.9.3 Contractor's Geotechnical Consultant Documentation

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in soil mechanics and augered cast in place pile installation, to observe test pile installation and production pile installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and must have no employee or employer relationship which could constitute a conflict of interest.

]1.9.4 Grout Mix Design

Certify, using a Government-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI 211.1 or ACI 318M ACI 318 for specified strength and is based on aggregate data which has been determined by laboratory tests during last twelve months. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolan, ground slag, and admixtures; and applicable reference specifications. Submit additional data regarding fine aggregates if the source of aggregate changes. Submittal must clearly indicate where each mix design will be used when more than one mix design is submitted.

[1.9.5 Load Test Supporting Data

Submit Jack calibration records, a testing arrangement description and diagram, and the proposed loading sequence.

]1.9.6 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Grout

****

NOTE: Insert the ultimate compressive strength required by the design (20.7 MPa 3,000 psi minimum).Select a minimum flow rate of 11 seconds

unless otherwise dictated by project specific requirements.
****

Provide grout consisting of a mixture of portland cement, a pozzolanic material when approved, fluidifier, sand, and water proportioned and mixed to produce a grout capable of being pumped with an ultimate compressive strength of [_____] MPa psi at 28 days. Consistency must not be less than [11] [_____] seconds when tested in accordance with paragraph FLOW CONE TEST. Other admixtures must not be used.

2.1.1.1 Portland Cement

Portland cement must conform to ASTM C150/C150M.

2.1.1.2 Pozzolan

Pozzolan must be a fly ash or other approved pozzolanic material conforming to ASTM C618, Class C or F.

2.1.1.3 Grout Fluidifier

Grout fluidifier must conform to ASTM C937, except that expansion must not exceed 4 percent. The fluidifier must be a compound possessing characteristics which will increase the flowability of the mixture, assist in the dispersal of cement grains, and neutralize the setting shrinkage of the high-strength cement mortar.

2.1.1.4 Chemical Admixtures

Chemical Admixtures must conform to ASTM C494/C494M and must consist of, but not be limited to, water reducers and/or set retarders.

2.1.1.5 Water

Water must be fresh, clean, and free from sewage, oil, acid, alkali, salts, organic matter, or other substances deleterious to grout or steel.

2.1.1.6 Fine Aggregate

****
NOTE: To be used as alternate requirement.
****

Fine aggregate must meet the requirements of ASTM C33/C33M. The sand must consist of hard, dense, durable, uncoated rock particles and be free from injurious amounts of silt, loam, lumps, soft or flaky particles, shale, alkali, organic matter, mica, and other deleterious substances. If washed, a washing method must be used that will not remove desirable fines, and the sand must subsequently be permitted to drain until the residual-free moisture is reasonably uniform and stable. The sand must be well-graded from fine to coarse, with fineness modulus between 1.30 and 3.40. The fineness modulus is defined as the total divided by 100 of the cumulative percentages retained on U.S. Standard Sieve 1.18, 0.600, 0.300 and 0.150 mm Numbers 16, 30, 50, and 100.

2.1.1.7 Aggregate

****

NOTE: For exposed piles in areas where reactive aggregates are likely to be supplied, provide for additional tests and certification to insure that reactive aggregates will not be used. While not wholly conclusive, petrographic examination (ASTM C295/C295M), chemical test (ASTM C289/C289M), and mortar bar method (ASTM C227) are valuable indicators.

While more reliable, the concrete prism test (ASTM C1293) takes 1 to 2 years to complete and is not practical. The accelerated mortar bar method (ASTM C1260) is similarly reliable and takes only 16 days to yield results. In areas where reactive aggregates can not be avoided, specify use of low alkali cement, and/or cements modified to mitigate alkali-silica reactivity. Service records of concrete made with these materials along with tests should be used in evaluating these materials.

****

****

NOTE: Include modification to ASTM C33/C33M when reactive aggregates could be encountered. More modifications may be required. Additional tests and certifications may be required in the submittal paragraphs.

****

Aggregate must meet the requirements of ASTM C33/C33M, for fine aggregate, except as to grading. The sand must consist of hard, dense, durable, uncoated rock fragments and must be free from injurious amounts of silt, lumps, loam, soft, or flaky particles, shale, alkali, organic matter, mica, and other deleterious substances. If washed, the method must not remove other desirable fines, and the sand must be permitted to drain until the residual free moisture is reasonably uniform and stable. Sand grading must be reasonably consistent and must conform to the following requirements as delivered to the grout mixer:

U.S. Standard Sieve Number	Cumulative Percent by Weight Passing	Cumulative Percent by Weight Retained
2.36 mm8	100	0
1.18 mm16	95-100	0-5
0.600 mm30	55-80	20-45
0.300 mm50	30-55	45-70
0.150 mm100	10-30	70-90
0.075 mm200	0-10	90-100

The sand must have a fineness modulus of not less than 1.30 nor more than 2.10. Sand grading shown above may be modified with the approval of the Contracting Officer. Mortar test specimens made with the modified sand must exhibit compressive strength equal to or greater than that exhibited by similar specimens made with sand meeting grading and other requirements shown above.

2.1.2 Reinforcement

Materials, assembly, and placement of reinforcement must conform to the requirements of Section [03 30 00 CAST-IN-PLACE CONCRETE] [_____].

2.1.3 Reinforcement

All Steel must conform to ASTM A1064/A1064M for spirals and ASTM A615/A615M [ASTM A706/A706M] for ties. Reinforcing bars must conform to the requirements of ASTM A615/A615M, Grade 60. Reinforcing steel assemblies must be detailed and fabricated in accordance with the latest manual of Standard Practice for Detailing Reinforced Concrete Structures ACI 315. Splicing details must be determined by the Designer and detailed on the plans. Single bars and cages should be equipped with a centralizer of acceptable size. More than one centering device must be used on long bars/cages. Centralizers must be spaced not greater than about 6 m 20 feet for vertical bars/cages, and about 3 m 10 feet for bars/cages installed in battered piles; actual spacing must be modified as necessary depending on the ground conditions or as directed by the Contracting Officer.

2.1.4 Casings

Submit a description of the materials to be used and the proposed methods of operations. Casings must be approved [steel] [_____] as soil warrants. Cylinder casings must be of sufficient strength and rigidity to withstand all installation stresses, to prevent distortion caused by placing adjacent piles, and to prevent collapse due to soil or hydrostatic pressure.

2.2 MATERIAL SUSTAINABILITY CRITERIA

For materials used, where applicable and to the extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan

b. Recycled content for Ground Iron Blast-Furnace Slag

c. Recycled content for Silica Fume

d. Minimum [75 percent] recycled content for steel used for stressed tendon reinforcing

PART 3 EXECUTION

3.1 GROUT VOLUME

The volume of grout per linear meter foot of pile must be not less than the theoretical volume of grout per meter foot of test piles. Volume of placed grout must at least [120] [____] percent of theoretical volume for every 1.5 m 5 foot interval. If less than required volume is placed for any given 1.5 m 5 foot interval, lower auger a minimum of 1.5 m 5 foot, or to bottom of pile if less than 1.5 m 5 foot. Monitor pumped grout volumes using stroke counter or other means of accurately measuring the quantity of the grout placed. All volume measurements must be made and recorded by the Contractor's Geotechnical representative.

3.2 INSTALLATION

Install piles after rough grading at pile locations have been completed. The ground surface at each pile location at the time of augering and grouting must be at least 300 mm 12 inches higher than the required pile cutoff elevation, unless a steel casing will be used, and the augered hole must be completely filled with grout.

The grout must consist of Portland cement, fine aggregate, and water, and may also contain a mineral admixture and approved fluidifier. All materials must be fed to the mixer accurately measured by weight, except water that may be measured by volume. The order of placing the materials must be in accordance with the ASTM standards. Mineral admixtures, if used, must be flyash or natural pozzolan and must conform to ASTM C618, Class C or Class F. Chemical Admixtures supplied by the ready-mix producer must conform to ASTM C494/C494M and might consist of, but not be limited to, water reducers and/or set retarders. Grout fluidifier, when utilized, must conform to ASTM C937.

Time of mixing must not be less than 1 minute. [Do not proceed with the installation of contract piles within any area of substantially different subsoil conditions until a satisfactory load test has been performed in that area.]

3.2.1 Casings Placement

Casings "can" must be approved by the Contracting Officer and must be left in place and filled with grout. The casings must be rotated by the auger drive unit or weighted or jetted to the required depth. Casings should be of proper diameter and at least 450 mm 18 inches in length to establish the pile cut-off level and to keep surface spoil from entering the grout column before it sets. After the casing is in place, the casing and hole must be cleared of water, sediment, and debris prior to pouring the grout. [When the cut-off level is above the drilling grade, extend the pile by using a sheet metal or fiber cylindrical "can" or sleeve placed part in and part out of the pile.]

3.2.2 Drilling Refusal

****

NOTE: Delete the sentence in brackets when test piles, load tests, and soil probes are not used.

****

Except where auger withdrawal is required or directed by the Contracting Officer, each pile hole must be drilled and filled with grout in an uninterrupted operation. Drill each pile hole to the required tip elevation [or until the specified refusal criteria is satisfied]. [Should the required tip elevation shown on the drawings differ from the calculated tip elevation, an adjustment in the contract requirements will be made.] Advance the auger at a continuous rate which prevents removal of excess soil. Stop rotation of auger after reaching the required pile tip elevation or refusal. Auger refusal is defined as a rate of auger penetration of less than 76 [___] mm per 5 [___] minute of drilling 3 [___] inches per 5 [___] minutes of drilling.

3.2.3 Grouting and Auger Removal

At the start of pumping grout, raise the auger from 152 to 300 mm 6 to 12 inches and after grout pressure builds up, indicating discharge of grout, redrill auger to the required tip elevation, and fill pile hole with grout without interruption. When the auger is withdrawn to check the soil profile, it must be reinserted in the pile hole to the required tip elevation and the pile hole then filled with grout without interruption. Coordinate rate of grout injection and rate of auger removal from the soil in such a manner as to maintain a positive pressure on the grout pressure gauge. The gauge indicates the existence of a removing pressure on the bottom of the auger flight. If the auger jumps upward during withdrawal, or if the grouting process is interrupted, or if there is decreased grouting pressure, reinsert it to the original tip elevation and decrease the rate of withdrawal to prevent further jumping. The auger may rotate very slowly during withdrawal. However, counterclockwise rotation is not permitted.

3.2.4 Pile Butts

Unless a permanent steel casing is provided as specified in paragraph CASINGS, place a steel sleeve at top of pile to form the pile butt. For pile cutoff above ground surface, the steel sleeve must extend from the pile cutoff elevation to a point not less than 300 mm one foot below the ground surface. For pile cutoff at or below ground surface, the steel sleeve must extend from the ground surface to a point not less than 300 mm one foot below the pile cutoff elevation. Pump excess grout to displace as much potential laitance as possible. Lower pile butt to required cutoff elevation or to sound grout, whichever is lower.

3.2.5 Placement Tolerances

****

NOTE: Refer to the DFI, Augered Cast in Place Manual for maximum permissible placement variation.

****

Locate piles where indicated. The maximum permissible variation of the center of each pile from the required location is [___] mm inches at the ground surface. No pile must be out of required axial alignment by more than 2 percent. Periodically check the required axial alignment of each pile during the drilling operation and after reaching required tip elevation with not less than 1.5 m 5 feet of the auger flight extending above ground surface. Abandon piles which are damaged, mislocated, or out of alignment beyond the maximum tolerance and provide additional piles where directed.

As-installed pile surveys must be performed after 35 percent, 65 percent, and 100 percent of the piles have been installed. The as-installed surveys must measure the actual location and top elevation of each acceptably installed pile. Measurements must be performed in such a manner as to provide the horizontal deviation from plan location in two perpendicular directions and the top of pile elevation to the nearest 13 mm 1/2 inch. Provide each interim as-installed survey to the Contracting Officer within 3 days following the surveying work for each increment. The as-installed surveys must be submitted and approved prior to performing any pile cut-off work or beginning any pile cap/grade beam installation work.

3.2.6 Cutoff

Removal of pile butts above the indicated cutoff elevation may be accomplished by dipping the grout from the pile, while grout is fluid, but not less than one hour after installation. At the option of the Contractor, and as approved prior to pile installation, grout may be allowed to harden at its initial top elevation and then carefully trimmed off to the indicated cutoff elevation with hand operated chipping guns.

3.2.7 Disposal of Excavated Material

Do not leave any piles partially completed overnight. Completely grout and protect piles at the termination of each day's operation. Dispose of excavated material, resulting from augering, [within the area indicated] [off Government property] [_____].

3.3 FLOW CONE TEST

The quantity of water used must produce a grout having a consistency of not less than 21 seconds when tested with a flow cone in accordance with ASTM C939/C939M. [For specified flow cone rates in the range of 10 to 25 seconds, the flow cone must be modified by removal of the 13 mm 1/2 inch orifice allowing grout to pass through the 19 mm 3/4 inch hole in bottom of cone.] Water retentive grouts that demonstrate cohesive or thixotropic properties may be more accurately tested for workability with a standard slump cone using Slump Flow (commonly referred to as a "spread" test) as described in ASTM C1611/C1611M. The Slump Flow or "Spread" test employs the use of the standard concrete slump cone.

Conduct tests at the beginning of grout injection and at subsequent intervals to ensure specification requirements are met.

3.4 GROUT SPECIMENS

Conduct grout tests in accordance with ASTM C31/C31M, ASTM C39/C39M and ASTM D942. Prepare test specimens of grout by pouring grout into 50 mm 2 inch cubes. Cure and test in accordance with ASTM C109/C109M. Cube specimens must be restrained from expansion as described in ASTM C942/C942M. Prepare test specimens of grout by pouring grout [150 mm by 305 mm 6 inch by 12 inch cylinders], [76 mm by 150 mm 3 inch by 6 inch], [50 mm by 100 mm 2 inch by 4 inch] cylinders. Provide molds with a top cover plate so designed as to restrain grout expansion and to permit escape of air and water.

Not less than one set of cylinders must be collected for each 38 m3 50 cy of grout placed, or at least one set for each day during which piles are placed. Test 2 [___] cubes at 7 [___] days, 2 [___] cubes tested at 28 [___] days, and 2 [___] cubes held in reserve. One set must consist of six [___] cubes [cylinders]. Any set of cubes [cylinders] of which one or more cylinders test at 10 percent or more below the required strength must be cause for rejection of the pile group.

3.5 DEPTH

****

NOTE: The requirement of this paragraph may be waived by those agencies that so desire. Insert the total number of pile holes requiring withdrawal of auger before inserting the mortar. Withdrawal and examination of the auger to verify soil profile should be required at all test pile locations and at 10 percent of the remaining pile locations to supplement the soil boring information.

****

For all test piles, the auger must be withdrawn after reaching the "calculated" tip elevation and before grout is pumped. The Contracting Officer will be present to check the soil conditions and will have the right to increase the test pile length if soil conditions warrant. In such cases, the Contracting Officer may require additional auger withdrawals after drilling to the lower tip elevation. Such additional auger withdrawals must be included in the total number of auger withdrawals made. The pile hole must not be filled with grout until the Contracting Officer has approved the final tip elevation.

3.5.1 Rejected Piles

Replace or redrill damaged piles during installation, piles with low grout volume, piles that heave or drop, mislocated, or installed out of alignment beyond the maximum tolerance. Replace rejected piles with new piles installed as directed. Perform all work in connection with rejected piles at no additional cost to the Government.

3.6 SOIL PROFILE

****

NOTE: The requirement of this paragraph may be waived by those agencies that wish to do so. Indicate on the drawings pile holes requiring soil probes. Soil probes should be required at all test pile locations, and at 10 percent of the remaining pile locations.

****

At [_____] pile holes, in addition to the test piles, the auger must be withdrawn from the ground before the grout is pumped to check the soil profiles. Drill soil probes within a radius of 6 m 20 feet of their associated test pile. The Contracting Officer will be present to verify the soil condition at the "calculated" pile tip elevation and has the right to increase the soil probe length or require additional soil probes, if soil conditions warrant. After soil conditions have been inspected and approved by the Contracting Officer, install test pile[s]. Soil probes that are located within the tolerances indicated for piles must be filled with grout and may be used in the finished work, if approved by the Contracting Officer and if satisfactorily load tested.

3.7 PROTECTION OF PILES

The sequence of pile installation must be such that adjacent piles show no evidence of disturbance. This evidence would actually appear as a drop in the grout surface. The load applied to the soil by the drilling equipment must be far enough away from the pile being drilled to avoid compressing or shearing of the soil which may in turn displace or squeeze-off the grout column. No piles must be placed within [1.5 m 5 feet][_]of adjacent piles until the grout in the piles has set for [24] [___] hours, unless otherwise directed by the Contracting Officer.

When large pile clusters or piles are installed with very close spacing, take periodic elevations on the tops of all piles to observe and determine pile heave or drop. Pile heave or drop must not exceed 13 mm 1/2 inch.

3.8 PILE RECORDS

Keep complete and accurate records of all augered cast in place piles. Indicate the pile location, diameter, length, elevation of tip and top of pile, quantity of grout material actually pumped in each pile hole, and the rated load capacity of the pile. Determine grout quantity by recording grout pump displacement [and by automated monitoring equipment equipped with a display and recording unit, depth sensor, magnetic flow meter, rotary head pressure sensor, rotation sensor and pressure sensor.] [The automated monitoring equipment must not replace recording of the grout pump displacement manually.] Record and report immediately any unusual conditions encountered during pile installation. Submit specified records upon completion of work.

3.8.1 Protection of Existing Structures

****

NOTE: Include this paragraph only when protection of existing structures from pile installationdriving activities is required.

The designer must indicate on the drawings all structures and facilities for which protection is required. The designer must also provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.

****

Mitigate impact on existing facilities due to pile installation activities in accordance with the [project specific document].

3.9 FIELD QUALITY CONTROL

3.9.1 Test Piles

Submit a complete and accurate record of all auger cast grout piles (both test piles and production piles), indicating the pile location, diameter, length, elevation of tip and top of pile, and the quantity and strength of grout material actually pumped in each pile hole.

3.9.2 Test Piles Placement

****

NOTE: Specify load tests when needed to confirm design capacities. The requirement for performing load tests would depend on the degree of variations in subsoil conditions. A minimum of one test pile should be load tested in each area of substantially different subsoil conditions. The requirement of performing the load tests under the direct supervision of a registered Professional Engineer may be waived at the discretion of the design agency.

Insert the grout strength required at the time the

test load is applied which could be the specified 28-day strength if Type III (high-early strength) cement is used or 75 percent of the specified 28-day strength if regular cement is used.

****

Provide test piles of the required type placed in the manner specified elsewhere in this section for all piling. Install test piles [at the locations indicated] [in vicinity of soil boring test holes Nos. [_____,] [_____,] and [_____]]. Install test piles to [indicated tip elevation] [indicated bidding lengths]. The Government will use test pile and load test data in addition to test reports on soil samples to determine "calculated" pile tip elevations. Piles immediately adjacent to the test pile must be placed after placing test pile and prior to load testing. Test piles that are located within the tolerances indicated for all piles and provide a safe design capacity as determined by the results of a satisfactory load test may be used in the finished work. Test loads must not be applied to the piles until the grout has obtained the design strength. Report immediately any unusual conditions encountered during pile installation to the Contracting Officer. Modify installation procedures as required based upon recommendation of [Contracting Officer] [Contractor's Geotechnical Consultant and approval of the Contracting Officer].

3.9.3 Static Load Tests

****

NOTE: NOTE: If pile load tests are required and approved by the Contracting Officer, specify number and location of piles. Select method of load test. In ASTM D1143/D1143M, permit anchor piles only if approved by the Contracting Officer's Technical Representative (Geotechnical Branch). Insert figure KN(kips) corresponding to 200 percent of the design load. Select appropriate acceptance criteria according to UFC 3-220-01.

****

Perform compressive load tests on [_____] test piles in accordance with ASTM D1143/D1143M (standard loading procedure) as modified herein. Allow a minimum of [7] [___] days following final test pile installation until the grout has obtained the maximum design strength to load testing. Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform [or reaction frame attached to sufficient uplift piles to safely take required load] applied to pile by hydraulic jack. Increase load in increments until rapid progressive settlement takes place or until application of total compressive load of [_____] KN kips [200 percent of the designed pile capacity] for compressive load tests. Consider load test satisfactory when [after one hour at full test load gross settlement of pile butt is not greater than gross elastic pile compression plus 4 mm 0.15 inch plus one percent of pile tip diameter or width in [_____] mm inches,] [slope of gross load-settlement curve under full test load does not exceed 1.5 mm per metric ton 0.05 inches per ton,] [net settlement after removal of test load does not exceed 19 mm 3/4 inch.] Perform load tests at locations [as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional

Engineer, registered in the state of project location, and provided and paid for by the Contractor. Submit test set-up.

3.9.3.1 Safe Design Capacity

Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.

3.9.4 Tensile Load Test

Perform tensile load tests on [_____] test piles in accordance with ASTM D3689, as modified [and] in paragraph LOAD TESTS. Apply a tensile load of [_____] kN kips to each tensile load test pile. In performing the tension load test, apply the ultimate load equal to one and one-half times the safe tension capacity, and employ the Standard Loading Procedure.

3.9.5 Lateral Load Test

Perform lateral load tests on [_____] piles in accordance with ASTM D3966/D3966M, as modified [and] in paragraph LOAD TESTS. Lateral load tests must consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. Apply a lateral load of [_____] kN kips to each pair of lateral load test piles. Record required movement readings for each pile.

3.9.6 Pile Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not installed. Where special or unusual soil conditions are expected, consultation with the Contracting Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of installing, testing, recording and analysis of data for project may be useful.

****

****

NOTE: NOTE: The Specifier must attach the specifications pile installation log graphic (for all pile installation projects) and the pile testing equipment data form to the end of this specification section.

****

Keep a complete and accurate record of each pile installed. Indicate the pile location, deviations from pile location, cross section shape and dimensions, length, ground elevation, tip elevation, cut-off elevations, [batter alignment,] theoretical and actual grout volume for every 1524 mm 5 feet interval, and reinforcement details. Include in the record the beginning and ending times of each operation during installation of pile, installation equipment, grout pump type, and pump calibration. Record unusual occurrences during pile installation such as heaving, obstructions, and any installation interruptions. A preprinted pile log for recording pile installation data[and pile installation equipment data form], which can be downloaded at: http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf.

[3.9.7 Low-Strain Integrity Testing

[Test [_____] piles for post-construction non-destructive low strain integrity testing to verify the pile integrity.] [Specific piles must be selected based on a review of the manual or automated monitoring equipment installation records for that pile.] Perform test(s) in accordance with ASTM D5882 standard. Low-Strain Integrity Testing should be limited to piles with length to diameter (L/D) ratios of approximately 30 or less. This test is typically limited to detecting defects/discontinuities that are equal to or greater than about 0.3 m 1 foot. The equipment must have been calibrated within [6] [____] months prior to the start of the testing operations and thereafter throughout the contract duration. Employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile Low-Strain Integrity Testing[, monitoring of test pile installation,].

][3.9.8 Sonic Logging

[Test [____] piles for post-construction non-destructive sonic logging testing to verify the pile integrity.] [Specific piles must be selected based on a review of the manual or automated monitoring equipment installation records for that pile.] Perform test(s) in accordance with ASTM D6760 standard. Perform sonic logging [3] [____] days after the pile has been installed to both allow for the grout to initially cure and to reduce the potential for de-bonding between access pipe and pile grout. The equipment must have been calibrated within [6] [____] months prior to the start of the testing operations and thereafter throughout the contract duration. Employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile Low-Strain Integrity Testing[, monitoring of test pile installation].

][3.9.9 Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E548, and approved by the Contracting Officer.

][3.10 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements", UFC 3-301-01, "Structural Engineering", and 3-301-02, "Design of Risk Category V Structures, National Strategic Military Assets".

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.
****

Perform special inspections and testing for seismic-resisting systems and components in accordance with and Section 01 45 35 SPECIAL INSPECTIONS.

][3.11 VIBRATION CONTROL

****
NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project. This section can normally be deleted for most augered cast in place pile projects.
****

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile installation operations. Perform vibration monitoring [using] [seismographs] [and geophones] within a distance of 61 meters 200 feet from the pile installation activity. [Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [five] years of experience in vibration monitoring. A minimum of [28] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

Prior to the pile installation activities, obtain baseline readings of ambient vibrations. The vibration during the pile installation activities must be limited to [a peak particle velocity of not more than 5 cm 2 inches per second.] [the limits mentioned in the [contract documents]]. [Determine appropriate vibration limits as per [US Bureau of Mines] [American Association of State Highway and Transportation Officials (AASHTO)] guidelines.]During pile installation activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile installation activity causing the vibration until [the Vibration consultant and the Contracting Officer] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor must be responsible for all damages resulting from the pile installation operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.12 NOISE CONTROL

****
NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project. This section can normally be deleted for most augered cast in place pile projects.
****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the pile installation operations. [Perform noise monitoring using [noise meters][, and] [_______]]. [Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [five] years of experience in noise monitoring. A minimum of [28] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] previously completed projects of similar scope and purpose.]

Prior to the pile installation activities, obtain baseline readings of ambient noise levels. [The noise limits are mentioned in the [plan] [contract documents]]. [Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines]. During pile installation activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile installation activity and install noise mitigation measures.

The Contractor must be responsible for all damages resulting from the pile installation operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.13 PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria, references or requirements as necessary to the particular project.

****

Perform preconstruction condition survey of [structures] [and utilities] [within 61 meters 200 feet of the pile installation activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] days before performing the preconstruction condition survey. The Contractor must obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation must be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] days before the commencement of pile installation activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile installation work, and repair any damages to these structures without cost to the Government.

][3.14 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****

NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile installation activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.

****

Prepare a geotechnical instrumentation program to monitor settlement [and lateral movement] of temporary and permanent structures, utilities, [embankments] [and excavations] during pile installation. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile installation when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile installation activities. Establish limiting values of vertical [and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 63 26 (August 2008)**

Preparing Activity: USACE **Superseding**
UFGS-31 63 26.00 10 (April 2006)
UFGS-31 63 26.16 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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08/08

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-31 63 26 (August 2008)**

Preparing Activity: USACE **Superseding**
UFGS-31 63 26.00 10 (April 2006)
UFGS-31 63 26.16 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 31 63 26

DRILLED CAISSONS

08/08

****

NOTE: This guide specification covers the requirements for the procurement, installation, and testing of drilled foundation caissons including reinforcing and cast-in-place concrete.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Use the following specifications in conjunction with this section:

SECTION 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS

On the drawings, show:

1. **Subsurface-soil-data logs.**

2. **Top and bottom elevation of each caisson.**

3. **Size (diameter in mm inches, bearing capacity,**

and total number of each size of caissons.

4. Dimensions of the bell, if required.

5. Dimensions of the casing.

6. Reinforcing steel details, if required.

7. Location of caissons to be penetration tested, if required.

8. Location of caisson to be proof tested, if required.

9. Locations, size, bell dimensions, and installation sequence of load testing caisson, if required.
****

[1.1 UNIT PRICES

a. Requirements for price breakdown of Drilled Caisson work are specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES. Requirements for construction scheduling related to Drilled Caisson work are specified in Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES.

****
NOTE: If requirements for price breakdown of drilled caissons work are specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES, use the following paragraph and delete subparts 1.1.1 through 1.1.4.
****

b. Requirements for price breakdown of Drilled Caisson work are specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****
NOTE: This paragraph anticipates bids on a lump sum price for an entire project including caisson work with directed changes being in accordance with the CONTRACT CLAUSES or in accordance with unit prices as defined in paragraph "Separate Unit Prices."

Delete "in accordance with the CONTRACT CLAUSES" or paragraphs "Tests" and "Separate Unit Prices" for lump sum projects.
****

[1.1.1 Basis of Bids

Base the bid on the number and total length of caissons, established by top and bottom elevations and diameters, as indicated and specified. Adjustment of the contract will be made [in accordance with the CONTRACT CLAUSES], should the total length of caissons installed and approved be greater or less than the total length shown. The Contractor will not receive payment for rejected caissons or for those not conforming to specifications.

][1.1.2 Tests

1.1.2.1 Load Test

The Contract includes [_____] load tests rated at [_____] metric ton ton per caisson. The Contracting Officer reserves the right to increase or decrease the number of load tests. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Caisson Load Test" or "Omitted Caisson Load Test".

1.1.2.2 Penetration Test

The Contract includes [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Penetration Test" or "Omitted Penetration Test".

1.1.2.3 Proof Test Hole

The Contract includes [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Proof Test Hole" or "Omitted Proof Test Hole".

][1.1.3 Separate Unit Prices

1.1.3.1 Additional Caisson Lengths

Additional caisson lengths will be paid for at the contract unit price for "Additional Caisson Length" for each diameter of caisson installed as approved.

1.1.3.2 Omitted Caisson Lengths

The contract price will be reduced by the amount bid for "Omitted Caisson Length" for each diameter of caisson omitted as directed.

1.1.3.3 Casings Permanently Left in Place

Steel casings permanently left in place due to contract conditions:

a. Total pounds of steel beyond casings indicated will be paid for at the contract unit price per pound for "Additional Steel Casing."

b. Omitted Casing Steel: The contract price will be reduced by the amount bid for "Omitted Casing Steel" omitted as directed.

1.1.3.4 Reinforcing Steel for Additional Caisson

Reinforcing steel for additional caisson lengths will be paid for at the contract unit price for "Additional Caisson Reinforcing Steel" installed as approved.

1.1.3.5 Reinforcing Steel for Caissons Omitted

The contract price will be reduced by the amount bid for "Omitted Caisson

Reinforcing Steel" omitted as directed.

1.1.3.6 Removal of Rock

Removal of rock within the limit of caissons will be paid for at the contract unit price for "Removal of Rock" per linear meter foot, for each diameter of caisson installed. Rock excavation is defined as any hard dense material that cannot be removed with caisson drilling equipment having the specified capacity and could only be removed by hand, air tools, blasting, or other specialized methods.

1.1.3.7 Removal of Obstructions Other Than Rock

Removal of obstructions other than rock within the limits of the caissons which cannot be removed using standard caisson drilling equipment with the specified capacity will be paid for at the contract unit price per linear meter foot for "Removal of Obstructions" for each diameter of caisson installed.

][1.1.4 Basis of Payment

****

NOTE: Where the basis for bidding is based entirely on unit price, subpart 1.1.1 through 1.1.3 should be deleted and the subparts 1.1.4.1 through 1.1.4.5 substituted.

****

1.1.4.1 Unit Price

The Contracting Officer has the right to increase or decrease the total length linear footage of drilled foundation caissons to be furnished and installed by changing the foundation caisson elevations, by requiring the installation of additional caissons, or omission of caissons from the requirements shown and specified. Whether or not such changes are made, the Contractor will be paid at the contract unit price per linear meter foot (including test caissons) multiplied by the total linear meters feet of acceptable caissons actually installed provided, however, that in the event the Contracting Officer requires an increase or decrease in the total length linear footage of caissons furnished and installed, the contract unit price will be adjusted in accordance with the CONTRACT CLAUSES.

1.1.4.2 Full Compensation

Payment in accordance with the above paragraph Unit Price constitutes full compensation for furnishing, delivering, handling, and/or installing (as applicable) all material, labor and equipment necessary to meet contract requirements applicable to the foundation caissons. The Contractor will not be allowed payment for rejected caissons.

1.1.4.3 Load Tests

The Contract includes [_____] [_____] -ton caisson load tests. The Contracting Officer reserves the right to increase or decrease the number of load tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Caisson Load Test" or "Omitted Caisson Load Test." Submit results of all tests performed.

1.1.4.4 Penetration Tests

The Contract includes [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Penetration Test" or "Omitted Penetration Test."

1.1.4.5 Proof Test Holes

The Contract includes [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Proof Test Hole" or "Omitted Proof Test Hole."

]]1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D1586/D1586M	(2018) Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Caissons; G, [_____]

Survey of Caisson Locations; G, [_____]

SD-04 Samples

Test Caissons; G, [_____]

SD-06 Test Reports

Load Tests; G, [_____]

Penetration Tests; G, [_____]

Proof Test Holes Report; G, [_____]

SD-07 Certificates

Caissons

Qualifications; G, [_____]

Records for Each Qualified Welding Operator; G, [_____]

SD-11 Closeout Submittals

Records

1.4 QUALITY ASSURANCE

1.4.1 Survey of Caisson Locations

Submit a certified survey meeting the requirements specified herein.

1.4.2 Specialty Subcontractor Qualifications

****

NOTE: Select applicable paragraph for agency requirements. 3 to 5 years should be required for qualifying experience.

****

Submit Contractor Qualifications for foundation systems, proving its engagement in the successful installation of similar drilled foundation caissons for at least [_____] years.

1.4.3 Welding

Perform all detail and field welding in accordance with AWS D1.1/D1.1M. Qualification of welding procedures, welders, and welding operators must be in accordance with AWS D1.1/D1.1M, Section 4. Keep and make available, for examination by the Contracting Officer, all records of test results of welding procedures not prequalified, copies of records for each qualified welding operator, and records on positions of welding and types of electrode qualifications. Submit records for each qualified welding operator.

[1.4.4 Pre-installation Conference

[Within [30][15] calendar days of notice to proceed][At the Pre-installation conference] provide, for approval, the following schedule of submittals: Preliminary detailed drawings in an approved form, for each caisson, showing shaft and bell diameters, depths of test holes, top and bottom elevations, bearing strata description, casing description, water conditions, concrete strength, concrete volume, rock elevations, dates of excavation and concrete placement, and other pertinent information.

]1.4.5 Contractor Supervision

Provide for the supervision of all phases of drilled pier construction. Supervision is the Contractor's responsibility as outlined in Quality Control provisions of the Specialty Subcontractor Requirements. Check each drilled pier excavation for its depth, water removal, cleanup, workmanship, and for all tolerance requirements before any concrete is placed.

1.4.6 Government Inspection

The Contracting Officer will inspect each drilled pier excavation. Do not place concrete until the excavation has been approved by the Contracting Officer. Furnish the Contracting Officer all necessary equipment required for proper inspection of drilled pier excavations.

1.4.7 Safety Precautions for Workmen and Inspectors

1.4.7.1 Life Line

Provide each person, entering a drilled pier excavation, with a life line suitable for instant rescue, securely fastened to a shoulder harness, separated from any line used to remove excavated materials, and rigged so that the person can be immediately hoisted out of the excavation in an emergency. Do not lower any person into a drilled pier excavation prior to casing the shaft through the overburden.

1.4.7.2 Ventilation

Provide each drilled pier excavation with a ventilating device of sufficient capacity to ensure a safe and healthy atmosphere before workmen and inspectors are permitted to enter the drilled pier excavation and during all work periods.

1.5 DELIVERY, STORAGE, and HANDLING

****

NOTE: Insert the appropriate Section number and title in the blank below using proper format per UFC 1-300-02.

****

Deliver casings and appurtenant equipment to the job site in an undamaged and ready to place condition. Deliver concrete in accordance with requirements of [_____].

1.6 PROJECT/SITE CONDITIONS

1.6.1 Subsurface Data

****

NOTE: Include location of available samples.

Section 00 31 32.13 Subsurface Drilling and Sampling Information is not a UFGS. CSI MasterFormat prescribes this section for inclusion of this data.

****

Subsurface soil data logs are [included in the drawings] [appended to the SPECIAL CONTRACT REQUIREMENTS] [found in Section 00 31 32.13 Subsurface Drilling and Sampling Information]. The subsurface investigation report and samples of materials, as taken from subsurface investigations, are available for examination at [_____].

1.6.2 Caisson Drilling Equipment

****

NOTE: Caisson drilling equipment criteria should be evaluated and specified for contract site conditions. Reference: Drilled Pier Foundations - Woodward, Gardner, Greer - McGraw-Hill Book Co. Requirements should be included for determination of minimum equipment standards.

****

Provide caisson drilling equipment having a minimum torque capacity and downward force capacity for the contract site conditions.

1.7 SEQUENCING

****

NOTE: Sequence of work criteria should be modified for agency requirements.

****

1.7.1 Caisson Excavation

Perform excavation of caissons or groups of caissons so that reinforcing steel and concrete placement is a continuous operation performed the same day that the excavation is completed. Do not leave excavations open overnight.

1.7.2 Acceptance

Place concrete within 3 hours after approval of the completed excavation.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Concrete Work

****

NOTE: Insert the correlated section number and

title or include concrete specification in this section, in the blank below using the proper format per UFC 1-300-02.

****

****

NOTE: Include information for concrete work. Correlate with Section 03 30 00 CAST-IN-PLACE CONCRETE for pertinent information or include concrete specifications in this section.

****

Perform all concrete work in accordance with requirements of Section [_____] 03 30 00 CAST-IN-PLACE CONCRETE, as modified herein:

2.1.1.1 Strength

****

NOTE: Compressive strength (28 day strength or f'c) of concrete should be 25 MPa 3000 psi or higher. When loads are high and drilling conditions difficult, it may be more economical to use 30 MPa 4000 psi or 35 MPa 5000 psi concrete and larger shafts rather than a smaller shaft with reinforcing or permanent casing. If there is a reinforcing cage, or if there is a large bell, the ability of the concrete to flow between reinforcing bars, or to completely fill the bell, is a matter of prime importance. For these piers, the concrete should have a slump of about 150 mm 6 inches. Slump may vary, depending on the mix, between 100 mm 4 inches and 150 mm 6 inches. A maximum size of 19 mm 3/4 inches appropriate under these circumstances.

****

Provide [_____] MPa [_____] psi strength concrete at 28 days, with slump from [_____] to [_____] mm [_____] to [_____] inches.

2.1.1.2 Coarse Aggregate

****

NOTE: Select 25 mm 1 inch maximum size coarse aggregate. Coarse aggregate may be smaller where reinforcement spacing is close or where dimension of caisson elements is dimensionally thin.

****

Provide [_____] mm [_____] inch maximum size coarse aggregate.

2.1.1.3 Reinforcing Steel

****

NOTE: Reinforcing steel grades should conform to one of the following:

ASTM A615/A615M for deformed billet - steel bars must be 400 or 500 MPa Grades 60 or 75

ASTM A966/A966M for rail-steel deformed bars must be

400 MPa Grade 60

ASTM A966/A966M for axle-steel deformed bars must be 400 MPa Grade 60

****

Provide reinforcing steel conforming to [ASTM A615/A615M] [ASTM A996/A996M] Grade [_____], welded into cages in accordance with AWS D1.4/D1.4M and inserted securely in the caissons, in position and alignment, as shown, prior to [concrete placement] [the concrete reaching an elevation of [_____] meters feet below the bottom elevation of the reinforcement].

2.1.2 Welding

Perform shop and field welding in accordance with AWS D1.1/D1.1M. Provide certification of qualification of welding procedures, welders, and welding operators in accordance with AWS D1.1/D1.1M. Keep records of test results of welding procedures not prequalified and copies of records for each qualified welding operator, containing records on positions of welding and types of electrode qualifications, and make available for examination by the Contracting Officer.

2.1.3 Casing Steel

****

NOTE: Determine minimum wall thickness based on the structural loading conditions.

****

ASTM A36/A36M. Provide zinc coating of casing steel conforming to ASTM A123/A123M. Provide casings with an outside diameters not less than indicated shaft sizes and a minimum of [6 mm] [1/4 inch] [_____] thick.

2.2 CAISSON DRILLING EQUIPMENT

****

NOTE: Caisson drilling equipment criteria should be evaluated and specified for contract site conditions. Reference: Drilled Pier Foundations - Woodward, Gardener, Greer - McGraw-Hill Book Co. Requirements should be included for determination of minimum equipment standards.

****

Provide caisson drilling equipment with minimum torque capacity and downward force capacity suitable for the site conditions.

PART 3 EXECUTION

3.1 PREPARATION

****

NOTE: Base selection of caissons for contract on analysis of subsurface investigation and design requirements. Provide complete installation information to the Contracting Officer.

Specify load tests when needed to confirm design capacities. At least one caisson location should be

load tested in each area of substantially different subsoil conditions. Indicate number, size, and location of test caisson and sequence.
****

Excavate caissons to established depths and dimensions shown; clean bottoms of caissons free of loose or soft material; level caissons; and dispose of excavated material in accordance with Section 31 00 00 EARTHWORK. Submit a certified copy of the survey. Establish lines, levels, and caisson centerline locations, staked and maintained by a registered surveyor or engineer.

a. When drilling caissons, protect the surrounding soil and the earth walls against cave-ins, displacement of the surrounding earth, and retention of ground water, by means of temporary steel casings. Provide casings with outside diameters not less than indicated shaft sizes, and a minimum of 6.4 mm 1/4 inch thick. Do not remove if the structural integrity of the caisson will be impaired, as determined by the Contracting Officer. Withdraw temporary steel casings as the concrete is being placed, maintaining sufficient head of concrete within the casing to prevent extraneous material from falling in from the sides and mixing with the concrete. Casings may be jerked upward a maximum of 100 mm 4 inches to break the bottom seal, but remove thereafter with a smooth, continuous motion.

b. Thoroughly clean and oil the inside of steel casings before reuse.

c. Leave the temporary casing in place from the caisson top to the ground surface until the concrete has set if the elevation of the top of the caisson is below the adjacent ground surface.

d. Provide permanent casing with outside diameter the same as the nominal shaft diameter. Provide a minimum wall thickness of permanent casings of [_____] mm inches.

e. Continuously remove all water that flows into the excavations and from the excavation bottom, to the extent possible, prior to concrete placement. The maximum permissible depth of water is 50 mm 2 inches. In the event of a severe water condition that makes it impossible or impractical to dewater the excavation, place concrete using an underwater tremie after water movement has stabilized.

f. Enlarge the bottoms of excavations indicated to be "belled" to diameters and shapes shown. Excavate or drill bells in a similar manner to that used for shafts.

g. Prepare the excavations for caissons indicated to be ["ribbed"] [_____] with the dimensions and shapes indicated.

h. Each caisson excavation will be inspected and approved by the Contracting Officer prior to placing concrete. Keep a record of all inspections, with related construction changes. Provide support personnel for inspection and testing procedures.

3.2 INSTALLATION

a. Continuously place concrete by methods that ensure against segregation and dislodging of excavation sidewalls, and completely fill the shaft. Place concrete by pumping or drop chutes in dry holes and by tremie or pumping in wet holes. Keep the discharge a minimum of 1 m 3 feet below the fresh concrete surface during placement. Drilling of caissons or driving of casings must not be within 6 m 20 feet of concrete placed within the last 3 days.

b. Bring concrete to a true level surface inside the shaft and a full width cross key formed, or dowels installed, if it becomes necessary to interrupt placing concrete in any caisson. Prior to placing additional concrete, clean surfaces of laitance and slush with one-to-one portland cement grout, having a water-cement ratio not exceeding that of the concrete.

c. Place concrete in dry batter caissons with a drop chute extending within 1 m 3 feet of the concrete surface in the excavation.

d. Vibrate concrete for [full height of caisson] [upper [_____] meters feet of caisson]. Vibrate belled caissons full height.

3.3 TOLERANCES

****

NOTE: Correlate tolerances with design criteria and types of caisson.

****

a. Correct any caisson out of center or plumb beyond the tolerance specified as necessary to comply with the tolerances. Any corrective cost is the responsibility of the Contractor.

b. Make cross sections of shafts and bells not less than design dimensions.

c. Install caissons with top location deviating a maximum of [75] [_____] mm [3] [_____] inches from centerline locations.

d. Install vertical caissons plumb within a maximum of 38 mm 1-1/2 inches for the first 3 m 10 feet and within 13 mm 1/2 inch for each 3 m 10 feet of additional depth.

e. Install batter caissons a maximum of [2] [_____] percent of length from specified inclination.

3.4 PENETRATION TESTS

****

NOTE: Include penetration tests when bearing investigations are determined to be a contract requirement.

****

Perform Penetration Tests conforming to the following:

a. After excavation, make penetration tests in the bottoms of the caissons, in [locations indicated] [[_____] caissons], to determine bearing conditions, in accordance with ASTM D1586/D1586M.

b. Make the tests after caisson bottoms have been cleaned out. Minimum blow count is [_____] per meter foot. [Take penetration tests to a depth of [_____] meters feet below the bearing elevation. Obtain and retain jar samples, as directed by the Contracting Officer.]

c. If the minimum blow count is not obtained, drill the shaft an additional [_____] meters feet and rerun the penetration test.

d. Submit reports to the Contracting Officer in accordance with ASTM D1586/D1586M.

The Contracting Officer will approve tests and authorize subsequent concrete placement or initiate redesign procedures.

3.5 PROOF TEST HOLE REQUIREMENTS

****

NOTE: Omit proof test holes if rock bearing is not anticipated or nature of rock and extent of principal testing makes further testing unnecessary.

****

Perform Rock Soundness test conforming to the following:

a. After excavation, proof test the rock below each caisson bearing level for soundness by percussion or rotary core drilling one hole in each caisson in locations indicated.

b. Make holes 50 mm 2 inch diameter and drilled with a uniform downward pressure to a depth below the bearing level equal to the design caisson shaft diameter but to a minimum of 1.2 m 4 feet.

c. Record penetration time for successive 150 mm 6 inch increments , noting conditions encountered.

Submit Proof Test Holes Report to the Contracting Officer. The Contracting Officer will approve test holes and authorize subsequent concrete placement or initiate redesign procedures.

3.6 LOAD TESTS

****

NOTE: Specify load tests to confirm caisson design. Indicate number, size, and location of test caissons and sequence.

****

3.6.1 General Requirements

a. Perform caisson load tests in locations indicated.

b. Perform tests under supervision of a registered engineer provided by the Contractor and in the presence of the Contracting Officer. Secure Contracting Officer approval of the test prior to commencement of work.

c. Apply load in concentric manner with magnitude of load accurately determined and controlled.

d. Laterally support the top of caisson during entire load test.

e. [Load caisson to [150] [200] percent of design load, but do not exceed ultimate concrete strength at time of loading. Apply the load in increments of [_____]. Maintain full test load for a period of [24]

[_____] hours and take settlement readings at not less than [1/2] [_____] -hour intervals.] [Perform load test in accordance with ASTM D1143/D1143M, except the maximum load must not exceed [_____] [200] percent of the design load.]

f. Submit [_____] copies of the test report directly to the Contracting Officer.

****

NOTE: Residual settlement is not to exceed 12 mm 1/2 inch for medium sized piers. Equally, the settlement caused by twice the design load is not to exceed 12 mm 1/2 inch.

****

g. Tested installations will be considered of adequate design and construction if:

(1) No apparent distress occurs in caisson construction.

(2) Residual settlement, after test load is removed, does not exceed [_____] mm inches.

(3) Twice the design load does not cause a gross settlement of more than [_____] mm inches.

3.6.2 Replacements

Replace and retest test caissons found inadequate because of improper instrumentation, testing, or construction procedures , at no additional cost to the Government.

3.7 PROTECTION

Provide protection around top of the excavation to prevent debris from being dislodged into the excavation and concrete.

3.8 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by Appendix 11A of ASCE 7-16.

This paragraph is applicable to both new buildings designed according to UFC 3-301-01 SEISMIC DESIGN FOR BUILDINGS, and to existing building seismic rehabilitation designs.

The designer must indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with UFC 3-301-01 and Appendix 11A of ASCE 7-16. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with UFC 3-301-01 and Section 01 45 35 SPECIAL INSPECTIONS.

3.9 RECORDS

Keep and submit complete, detailed and accurate records for each caisson installation. Include locations, shaft diameters, [bell dimensions,] top and bottom elevations, depths of test holes, casing dimensions, concrete strength, concrete volume, quantity of rock excavation, excavation condition, dates of excavation and concrete placement, bearing strata description, and subsurface water conditions. Base location on the survey of the registered surveys or engineer provided by the Contractor. Tabulate all records, including corrective measures. Upon completion of caisson work, provide a record of centerline locations based on the survey of the registered surveyor or engineer provided by the Contractor. In addition, also record corrective measures. Deliver a complete tabulation of all records pertaining to approved caissons to the Contracting Officer.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 63 26.60 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 31 - EARTHWORK

SECTION 31 63 26.60

[GROUTED] HELICAL PILES

11/20, CHG 2: 02/24

PART 1 GENERAL

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-31 63 26.60 (November 2020)**
Change 2 - 02/24

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 31 63 26.60

[GROUTED] HELICAL PILES

11/20, CHG 2: 02/24

****

NOTE: This guide specification covers the requirements for [grouted] helical piles.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

****

****

NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.

****

****

NOTE: Show the following information on the drawings:

1. Locations and design loads of piles. If both tension and compression piles are contained in

design, identify by type.

2. Size, shape, and length of piles.

3. Locations of test piles, if required.

4. Soil data, where required.

5. Identify piles as vertical or battered.

****

PART 1 GENERAL

****

NOTE: Structural engineer confirms the structural capacity of piles and provide specific bending moments, lateral loads and other design requirements for pile design.

****

1.1 DESCRIPTION

Design, furnish, install and test [grouted] helical piles at the locations indicated on the drawings and specified herein.[Test piles that meet performance requirements can be incorporated into the permanent work.]

1.1.1 Definitions

a. Helical Pile (helical pier or screw pile): Consists of 1) one or more helix plates attached to a central shaft and 2) load transfer device for attachment to a structure. May also include surface coating or other corrosion protection means.

b. Torque: The measure of the rotational force times the moment arm needed to overcome the shear strength of the soil N-m ft-lb. Torque is used in an empirical approach for predicting the ultimate capacity of a helical pile.

c. Minimum Installation Torque: Minimum torque necessary to attain the required pile capacity.

d. Maximum Torque Rating: Torque which if exceeded may cause damage to the pile or equipment.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	(2020) Specifications for Structural Concrete
ACI 301M	(2020) Metric Specifications for Structural Concrete

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C144	(2024) Standard Specification for Aggregate for Masonry Mortar
ASTM C939/C939M	(2022) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C942/C942M	(2021) Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates

	for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1611/C1611M	(2021) Standard Test Method for Slump Flow of Self-Consolidating Concrete
ASTM D942	(2019) Standard Test Method for Oxidation Stability of Lubricating Greases by the Oxygen Pressure Vessel Method
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-220-01	(2012; with Change 1, 2021) Geotechnical Engineering

[1.3 SUBSURFACE DATA

Subsurface soil data logs are[indicated][appended to the special contract requirements][provided on the project drawings].[The subsoil investigation report may be examined at [_____].]

]1.4 BASIS OF BID

****

NOTE: Select one of the following options:

****

****

NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of piles. Use this in all projects except those where exact pile lengths cannot be practically determined prior to the actual work. Clearly show number of piles, pile capacity, pile locations, and tip and cutoff elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of

piles. Specify unit price bid items for piles only for projects where exact quantities cannot be practically determined prior to the actual work. Determine lengths of piles as accurately as possible, prior to bidding, since the unit price per meter foot of the piles varies as the length increases or decreases. Refer to Standard Test Method for High-Strain Dynamic Testing of Deep Foundations (ASTM D4945).

****

1.4.1 Production Pile Acceptance Criteria

Safe design capacity for piles is [_____] KN kips. Install piles to [minimum tip elevation] [a minimum depth of [_____] m feet below cut-off elevation], and to such additional depth as required to obtain a bearing capacity of not less than [_____] KN kips. The Contractor's Geotechnical Consultant will determine the terminal installation criteria based on results of [dynamic pile installation tests] [static load tests].

[For cases where allowable pile loads are less than 355 kN 80 kips (determined using a factor of safety of 3 for individual piles and 4 for pile groups, the end bearing geotechnical capacity of [grouted] helical piers may be estimated during installation by monitoring and recording the final installation torque and[applying torque correlation factors provided by the designer][applying default torque correlation factors for the central steel shaft per well-document correlations].[Verify with the manufacturer that the correlation factors apply to their products.] The allowable end bearing capacity may be estimated as:

Qall = Kt X T

Where Qall is the approximate allowable end bearing pile load in Kn kips; T equals the final installation torque defined as the last torque reading taken during helical pile installation which must not exceed the maximum installation torque rating of the helical pile; and Kt is the torque correlation factor. Allowable skin friction resistance must be provided by the designer determined through a generally accepted method of analysis in accordance with UFC 3-220-01.

][1.4.2 Lump Sum Payment

****

NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection. This paragraph will be typically used when there are 1) relatively small quantity of piles, 2) allowable pile loading is less than 355 kN 80 kips (and 3) the subsurface conditions are well defined. Fill in Table I as required selecting columns applicable to project. Generally, pile capacity, location, and minimum tip elevation are shown on plans. Test piles and load tests are not incorporated on lump sum contracts. Delete this paragraph for unit-price contracts.

****

Base bids upon providing the number, size, capacity, and length of piles as indicated on the [drawings.] [following Table 1:

Table 1						
[Location]	Number	Size	[Capacity]	[Length (Tip to Cut-Off)]	[Maximum Bending Moment]	[Maximum Shear Force]

]

Include the cost of all necessary equipment, tools, material, labor, and supervision required to: [design,] deliver, handle, install, cut-off, dispose of any cut-offs, and meet the applicable contract requirements. Include mobilization, pre-drilling, and reinstallation of heaved piles. If, in reinstallation, it is found that any pile is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of piles to be provided and installed by changing the pile locations or elevations, requiring the installation of additional piles, or directing the omission of piles from the requirements shown and specified. If total number of piles or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for piles will be based on successfully installing piles to both the minimum tip elevation and satisfying the acceptance criteria identified herein. No additional payment will be made for: damaged, rejected, or misplaced piles; withdrawn piles; any portion of a pile remaining above the cut-off elevation; back installation; cutting off piles; splicing; build-ups; any cut-off length of piles; or other excesses beyond the assumed pile length indicated for which the Contractor is responsible.[Include payments for vibration monitoring, sound monitoring and precondition construction surveys].

][1.4.3 Unit Price

****

NOTE: Delete this paragraph for lump-sum contracts.

For NAVFAC PAC projects: Where there is unit pricing for piles, use this paragraph and edit applicable attachments in price schedule for inclusion in Standard Form 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

For NAVFAC Southeast projects, where there is a need for unit pricing of piles, include this paragraph. Refer to NAVFAC SE Instruction 00010, "Instructions for Preparing Basis of Bid Statement With Unit-Priced Items," for method of specifying unit price bid items.

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For unit price bid, see SF 1442, "Solicitation, Offer and Award" and "Schedule of Bid Items."

****

NOTE: For NAVFAC LANT projects, use the following paragraph for measurement and payment and subsequent sub-parts.

****

Requirements of FAR 52.211-18 Variation in Estimated Quantity do not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per unit length, which will include items incidental to furnishing and installation of the piles including mobilization and demobilization, [jetting] [predrilling] [probing], reinstallation of uplifted piles, [an additional 1.5 m 5 feet in furnished length for any test pile not installed beyond estimated pile length,] and cutting off piles at the cut-off elevation.[Include the cost for additional length for the test piles in the total unit price cost for the job.] Payment will be made for production [and test piles] at the bid unit price for the length of pile, from tip to final cut-off, actually provided, excluding buildups and splices directed by the Contracting Officer to be made. If the actual cumulative pile length installed (tip to cut-off) varies more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per unit length will be adjusted in accordance with provisions of FAR 52.236-2 Differing Site Conditions.[Payments will be made per each at the respective bid unit price for pile cut-offs, pile build-ups, pile load tests and pile splices.][Include payments for vibration monitoring, sound monitoring, construction instrumentation and monitoring, and precondition construction surveys].

][1.5 PAYMENT

****

NOTE: Delete this paragraph for lump-sum contracts.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (PAYMENT) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****

1.5.1 Furnishing and Delivering [Grouted] Helical Piles

1.5.1.1 Payment

Payment will be made for costs associated with furnishing and delivering the required lengths of permanent [grouted] helical piles, [including H-pile extensions,]which includes costs of furnishing and delivering piles to the work site. No payment will be made for the installation head or lengths of piles exceeding required lengths. No payment will be made for piles damaged during delivery, storage, or handling to the extent that they are rendered unsuitable for the work, in the opinion of the Contracting Officer.

1.5.1.2 Measurement

Furnishing and delivering permanent [grouted] helical piles will be measured for payment by the linear meter foot of piles required below the cut-off elevation as [determined by the Contracting Officer and furnished to the Contractor][indicated].

1.5.1.3 Unit of Measure

Linear meter foot.

1.5.2 Installation of [Grouted] Helical Piles

1.5.2.1 Payment

Payment will be made for costs associated with installation of permanent [grouted] helical piles, which includes costs of handling, installation, [and splicing of piles,] [performing dynamic testing, interpreting data and submitting reports,] measuring heave, reinstallation of heaved piles, removal of [build-ups] installation of heads or cutting off piles at the cut-off elevation and removing from the work site, compiling and submitting pile installation records, backfilling voids around piles, and any other items incidental to installation of piles to the required elevation.

1.5.2.2 Measurement

Permanent [grouted] helical piles will be measured for payment for installation on the basis of lengths, to the nearest hundredth tenth of a linear meter foot, along the axis of each pile acceptably in place below the cut-off elevation shown.

1.5.2.3 Unit of Measure

Linear meter foot.

1.5.3 Pulled [Grouted] Helical Piles

1.5.3.1 Payment

Payment will be made for costs associated with piles pulled at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing and delivering pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Furnishing and Delivering [Grouted] helical Piles". The cost of installation pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Installation of [Grouted] Helical Piles". The cost of pulling undamaged piles will be paid for at twice the applicable contract unit price for payment item "Installation of [Grouted] Helical Piles", which includes backfilling any remaining void. The cost of reinstallation of pulled and undamaged piles will be paid for at the applicable contract unit price for payment item "Installation of [Grouted] Helical Piles". No payment will be made for furnishing, delivering, installation, pulling, and disposing of piles, including piles pulled and found to be damaged and backfilling voids. New piles replacing damaged piles will be paid for at the applicable contract unit price for payment items "Furnishing and Delivering [Grouted] Helical Piles" and "Installation of [Grouted] Helical Piles".

1.5.3.2 Measurement

Furnishing and delivering pulled and undamaged permanent [grouted] helical piles will be measured for payment as specified in paragraph PAYMENT, subparagraph FURNISHING AND DELIVERING [GROUTED] HELICAL PILES. Pulling undamaged [grouted] helical piles will be measured for payment as specified in paragraph PAYMENT, subparagraph INSTALLATION OF [GROUTED] HELICAL PILES. Reinstallation pulled undamaged [grouted] helical piles will be measured for payment as specified in paragraph PAYMENT, subparagraph INSTALLATION OF [GROUTED] HELICAL PILES. New piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraphs FURNISHING AND DELIVERING [GROUTED] HELICAL PILES and INSTALLATION OF [GROUTED] HELICAL PILES.

1.5.3.3 Unit of Measure

Linear meter foot.

[1.5.4 [Grouted] Helical Pile Installation Tests

1.5.4.1 Payment

Payment will be made for costs associated with furnishing, delivering, installation, pulling, and disposing of installed test piles, [including [pile installation points][and][splices];] conducting pile installation tests; backfilling voids around piles; compiling pile installation test records[; performing dynamic testing; interpreting data; and submitting reports].

1.5.4.2 Measurement

[Grouted] helical pile installation tests will be measured for payment on the basis of the applicable contract unit price per pile installation test.

1.5.4.3 Unit of Measure

Each.

][1.5.5 [Grouted] Helical Piles for Load Tests

1.5.5.1 Payment

Payment will be made for costs associated with furnishing, delivering, installation, pulling, and disposing of load test piles [and] [splices]; backfilling voids around piles; compiling pile installation records[; furnishing, fabricating, and mounting of strain rods and protective assembly][; furnishing, fabricating, and mounting of inclinometer and inclinometer protective assembly][; performing dynamic testing; interpreting data; and submitting reports]. No additional payment will be made for load test piles incorporated in the permanent work other than as provided.

1.5.5.2 Measurement

[Grouted] helical piles for load tests will be measured for payment on the basis of the applicable contract unit price per load test pile.

1.5.5.3 Unit of Measure

Each.

][1.5.6 [Grouted] Helical Pile Static Axial Compressive Load Tests

1.5.6.1 Payment

Payment will be made for costs associated with [grouted] helical pile static axial compressive load tests in accordance with ASTM D1143/D1143M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static axial compressive load tests.

1.5.6.2 Measurement

[Grouted] helical pile static axial compressive load tests will be measured for payment on the basis of the applicable contract unit price per load test.

1.5.6.3 Unit of Measure

Each.

][1.5.7 [Grouted] Helical Pile Static Tensile Load Tests

1.5.7.1 Payment

Payment will be made for costs associated with [grouted] helical pile static tensile load tests in accordance with ASTM D3689, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing strain rods; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile static tensile load tests.

1.5.7.2 Measurement

[Grouted] helical pile tensile load tests will be measured for payment on the basis of the applicable contract unit price per number of tensile load test.

1.5.7.3 Unit of Measure

Each.

][1.5.8 [Grouted] Helical Pile Lateral Load Tests

1.5.8.1 Payment

Payment will be made for costs associated with [grouted] helical pile lateral load tests in accordance with ASTM D3966/D3966M, including material and labor for fabricating and furnishing load frames; calibrating load cells and hydraulic jacks; furnishing specified test equipment; installing inclinometers; placing and removing test loads and test equipment; recording, reducing, and submitting test data; and compiling and submitting pile load test reports. No payment will be made for rejected pile lateral load tests.

1.5.8.2 Measurement

[Grouted] helical pile lateral load tests will be measured for payment on the basis of the applicable contract unit price per lateral load test.

1.5.8.3 Unit of Measure

Each.

][1.5.9 Pulled Load Test [Grouted] Helical Piles

1.5.9.1 Payment

Payment will be made for costs associated with load test [grouted] helical piles pulled prior to load testing at the direction of the Contracting Officer and found to be undamaged. The cost of furnishing, delivering, installation, and pulling undamaged load test piles will be paid for at the applicable contract unit price for payment item "[Grouted] Helical Piles for Load Tests". The cost of pulling undamaged load test piles the second time after reinstallation and testing will be paid for at twice the applicable contract unit price for payment item "Installation of [Grouted] Helical Piles". The cost of reinstallation pulled undamaged load test piles will be paid for at the applicable contract unit price for payment item "Installation of [Grouted] Helical Piles". No payment will be made for furnishing, delivering, installation, pulling, and disposing of load test piles pulled at the direction of the Contracting Officer and found to be damaged. New load test piles replacing damaged piles will be paid for at the applicable contract unit price for payment item "[Grouted] Helical Piles for Load Tests".

1.5.9.2 Measurement

Pulled undamaged load test [grouted] helical piles will be measured for payment as specified in paragraph PAYMENT, subparagraph [GROUTED] HELICAL PILES FOR LOAD TESTS. Pulling undamaged load test [grouted] helical piles the second time after reinstallation and testing will be measured for payment as specified in paragraph PAYMENT, subparagraph INSTALLATION OF [GROUTED] HELICAL PILES. Reinstallation of pulled undamaged [grouted] helical piles will be measured for payment as specified in paragraph PAYMENT, subparagraph INSTALLATION OF [GROUTED] HELICAL PILES. New load test [grouted] helical piles replacing damaged piles will be measured for payment as specified in paragraph PAYMENT, subparagraph [GROUTED] HELICAL PILES FOR LOAD TESTS.

1.5.9.3 Unit of Measure

As specified in paragraph PAYMENT, subparagraphs INSTALLATION OF [GROUTED] HELICAL PILES and [GROUTED] HELICAL PILES FOR LOAD TESTS, respectfully.

][1.5.10 [Grouted] Helical Pile Splices

1.5.10.1 Payment

Payment will be made for costs associated with [grouted] helical pile splices, including all plant, labor, and material required to make the splice.

1.5.10.2 Measurement

[Grouted] helical pile splices will be measured for payment on the basis of the applicable contract unit price per pile splice.

1.5.10.3 Unit of Measure

Each.

][1.5.11 Vibration Monitoring

1.5.11.1 Payment

Payment will be made for costs associated with vibration monitoring.

1.5.11.2 Measurement

Vibration monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.11.3 Unit of Measure

Each.

][1.5.12 Sound Monitoring

1.5.12.1 Payment

Payment will be made for costs associated with sound monitoring.

1.5.12.2 Measurement

Sound monitoring will be measured for payment on the basis of the applicable contract unit price per vibration monitoring point.

1.5.12.3 Unit of Measure

Each.

][1.5.13 Preconstruction Condition Survey

1.5.13.1 Payment

Payment will be made for costs associated with preconstruction condition surveys.

1.5.13.2 Measurement

Preconstruction condition survey will be measured for payment on the basis of the applicable contract unit price per structure to be surveyed.

1.5.13.3 Unit of Measure

Each.

][1.5.14 Construction Instrumentation and Monitoring

1.5.14.1 Payment

Payment will be made for costs associated with construction instrumentation and monitoring.

1.5.14.2 Measurement

Construction instrumentation and monitoring will be measured as a single pay item.

1.5.14.3 Unit of Measure

One.

]]1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G, [_____]

[Contractor's Geotechnical Consultant; G, [_____]

][Wave Equation Analysis; G, [_____]

] Order List; G, [_____]

Manufacturer's Quality Control Procedures; G, [_____]

Contractor Certification For Helical Pile Installation; G, [_____]

Testing Agency Qualifications; G, [_____]

SD-02 Shop Drawings

Piles; G, [_____]

Pile Connections and Splices; G, [_____]

Pile Placement; G, [_____]

As-Installed Survey; G, [_____]

Pile Load Test; G, [_____]

SD-03 Product Data

Piles; G, [_____]

[Grouted] Helical Pile; G, [_____]

Installation Equipment and Testing Equipment; G, [_____]

Torque Monitoring Equipment; G, [_____]

SD-05 Design Data

Calibration Report; G, [_____]

[Pile Grout Mix Design; G, [_____]

] [Grouted] Helical Pile Design; G, [_____]

SD-06 Test Reports

Load Test Report; G, [_____]

[Grouted] Helical Pile Installation Records; G, [_____]

1.7 DELIVERY, STORAGE, AND HANDLING

Use methods for handling, transporting and storage of piles such that the piles are not subjected to excessive bending stress, cracking, spalling, or other damage. Follow the handling instructions of the manufacturer.

1.7.1 Damaged Piles

Inspect each pile for structural damage before transporting them to the project site and immediately prior to installation. Bring any damage to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

Correct any pile damaged by reason of internal defects or by improper installation by one of the following methods approved by the Structural Engineer of Record for the pile in question:

a. The pile is withdrawn, if practicable, and replaced by a new and, if necessary, longer pile.

b. One or more replacement piles are installed adjacent to the defective pile.

c. A Pile Dynamic Analysis and low integrity testing must be performed by the Contractor's Geotechnical Consultant to assess the structural integrity of the installed pile(s).

Correct piles installed below the specified butt elevation by one of the following methods approved by the Engineer:

a. The pile is spliced (if approved).

b. A sufficient portion of the footing is extended down to properly embed the pile.

Correct piles installed out of its proper location or out of plumb as approved by the Engineer, by one of the following methods approved by the engineer:

a. One or more replacement piles are installed next to the pile in question.

b. As directed by the structural engineer.

1.8 QUALITY CONTROL

1.8.1 Piles

Prepare and submit shop drawings. Indicate placement of piles. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up. Submit product designations for pile sections and connections.

1.8.2 [Grouted] Helical Pile Design

Submit data including: type material, and size of grout and helical system; maximum torque rating of system, calculations determining minimum installing torque, minimum and maximum pile depth requirements[, location and inclination tolerance requirements] and pile capacity. Design must be stamped by a Professional Engineer registered in the state of [_____] who is experienced with [grouted] helical pile foundations.

[1.8.3 Pile Grout Mix Design

Submit copies of laboratory test reports showing that the pile grout mix has been successfully tested to produce grout with the properties specified and that the mix is suitable for the job conditions. Include mill tests and all other tests for cement, aggregates, and admixtures in the laboratory test reports. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the grout mix design. Obtain approval before grout placement.

]1.8.4 Manufacturer's Quality Control Procedures

Submit the pile manufacturer's quality control procedures.

1.8.5 Installation Procedures

a. Submit information on the type of equipment proposed to be used, proposed methods of operation, pile installation plan including proposed sequence of installation, and details of all pile installation equipment and accessories. Submit pile placement plans at least 30 calendar days prior to delivery of piles to the job site.

[b. Provide detailed procedures for conducting the dynamic pile load test and equipment to be used for conducting the load test. The detailed description must explain how specific information of pile performance will be evaluated.

]1.8.6 Contractor Certification for Helical Pile Installation

[Grouted] helical piles must be installed by a contractor with a minimum of 5 years of experience with the installation of [grouted] helical pile foundations in similar soil conditions of the project site. Submit past project lists indicating their experience with such foundation systems. The Contractor must be trained and certified by a helical pile manufacturer in the proper methods of design and installation of [grouted] helical pile foundations. Submit a copy of their current certification for helical pile foundation Installation. Include a list and description of equipment to be used, including manufacturer's catalog data and sufficient information to show compliance with the requirements specified.

[1.8.7 Contractor's Geotechnical Consultant

Hire the services of an independent, Registered Professional Geotechnical Engineer, experienced in [grouted] helical pile foundation system, soil mechanics and Pile Dynamic Analysis, to observe test pile installation and production pile installation as specified herein. The Contractor's Geotechnical Consultant must be independent of the Contractor and must have no employee of employer relationship which could constitute a conflict of interest.Submit consultant qualifications and documentation at least 28 calendar days prior to pile installation.

][1.8.8 Load Test Supporting Data

Submit Jack calibration records, a testing arrangement description and diagram, and the proposed loading sequence.

][1.8.9 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

]PART 2 PRODUCTS

2.1 [GROUTED] HELICAL PILE SYSTEM

The shaft of the [grouted] helical pile system consists of a solid, steel square bar with one to four steel helical plates welded to the shaft, as required. The helical extension shafts, if required, consists of steel square bar shafts with one or two steel helical formed plates. Provide a coupling method for the helical extensions. Use the same square section bar material for helical pile extensions as for the lead extensions. Provide each extension with a means of coupling to a lead section or to another extension. Each coupling may be forged integral to the extension or a separate sleeve type. Supply each coupling with proper bolts(s) and nut(s) to develop the rated strength. Terminations consist of the bar material being cut off to the proper elevation and a steel termination plate field welded or bolted to the end of the bar material. Provide all steel components of the [grouted] helical pile system with an ASTM A153/A153M or ASTM A123/A123M hot dipped galvanizing. Fabricate displacement plates (lead or extension plates) from steel or other material that will not affect the structural integrity of the central steel shaft[or grout column]. Do not make displacement plates out of timber.[All grout components of [grouted] helical piles must have a 28 day compressive strength of 28,000 kPa 4,000 psi or greater. For purposes of bidding, pile capacity must be as indicated on the drawings.]

Submit details and material data for pile connections and splices.

[2.2 GROUT

2.2.1 Cement

ASTM C1157/C1157M, [Type G].

2.2.2 Water

Provide fresh, clean, potable water free from injurious amounts of sewage, oil, acid, alkali, salts, or organic matter.

2.2.3 Aggregates

Conform to ACI 301M ACI 301 and [ASTM C33/C33M for grout for backfilling holes] [or ASTM C144 for grout for pregrouting]. Aggregates must not contain substances which may be deleteriously reactive with alkalis in the cement.

[2.2.4 Admixtures

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NOTE: Accelerators are not permitted because of concern that they may cause corrosion of the steel. Only plasticizers or retarders should be permitted when necessary for hot conditions or long pumping distances.

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Admixtures which control bleed, improve flowability, reduce water content and retard set may be used in the grout subject to the approval of the Contracting Officer. Any admixtures used must be compatible with the prestressing steel and mixed in accordance with the manufacturer's recommendations.

]]2.3 EQUIPMENT

2.3.1 Installation Equipment

Capable of providing continuous measurement of applied torque throughout the installation process. Capable of applying sufficient down pressure to install the pile and with appropriate gauges to indicate the down pressure applied. Sufficient capacity to reverse rotation and uplift to withdraw pile. Percussion drilling equipment is not permitted. Install head must be capable of multiple positioning to accommodate adjustments in pile alignment.

2.3.2 Installation Tooling

Provide sufficient wrench extensions to advance the lead section a distance not less than 50 percent greater than the pile length indicated on the drawings. All installation tooling must be capable of transmitting the maximum torque of the installation machinery.

2.3.3 Torque Monitoring Equipment

Submit a calibration report (performed by an independent testing agency) for each torque indicator to be used. The report must include: the name, address, and phone number of testing agency; name of the project; name of the contractor; identification of torque indicator; date of calibration; and calibration data. The equipment calibration must be performed within 6 months from the start of the installation.

Provide device capable of providing continuous measurement of applied torque throughout the installation process in increments of 680 Newton meter 500 foot pounds or less. Calibrate torque indicators which are internal with respect to installation equipment on-site. Calibrate torque indicators which measure torque as a function of the hydraulic pressure of the installation equipment at normal operation temperatures. Protect devices from shock, impact, or other adversities that may affect their operation. A torque indicator must be recalibrated if, in the opinion of the Contracting Officer, it has been exposed to conditions which may adversely influence the accuracy of the torque measurements.

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NOTE: Suggestions for improvement of this specification are welcomed and should be submitted as a Criteria Change Request (CCR). To submit a Criteria Change Request, click on the CCR link next to the specific document located at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs

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PART 3 EXECUTION

3.1 PRELIMINARY WORK

3.1.1 Order List

Submit to the Contracting Officer for approval, an itemized list for piles prior to placing the order with the supplier. Indicate the pile lengths required at each location as shown on the plans and the corresponding ordered length of each pile in the list.[Complete load testing and refined wave equation analysis and submit to Government for review and approval prior to submission of an order list.]

3.2 INSTALLATION PROCEDURES

It is the responsibility of the Contractor to determine the location of any buried utilities before starting construction. If underground obstructions are encountered during installation, stop work immediately and contact the Contracting Officer who will decide whether the obstruction is to be removed or the [grouted] helical pile relocated. Resume work only upon receipt of the Contracting Officer's decision.

3.2.1 Pre-Drilling

Pre-drilled starter holes will be required for penetrating through hard natural strata or fills. Omitting drilling or augering will be permitted only with the approval of the Contracting Officer. The hole may be no greater than two-thirds of the average helices diameter. The drilling or augering must not be deeper than required to bypass the obstructing layer. Drilling deeper than 3 meters 10 feet above the estimated pile tip elevation is not permitted. Field modification of pre-drilling operations will be permitted based on the recommendations of the Owner's Geotechnical Consultant and with the approval of the Contracting Officer.

3.2.2 Positioning, Alignment, and Advancing the Helical Lead Section

Position the pile at the location indicated. Advance the helical lead section in a smooth and continuous manner. Avoid abrupt starts after interruptions. Apply sufficient down pressure to advance the lead section approximately 75 mm 3 inches per revolution. Maintain the penetration rate by adjusting the rate of rotation and magnitude of down pressure for different soil condition and depths.

Position a lead displacement plate of appropriate diameter on the central steel shaft at the location necessary to install the grout column as shown on the drawings. Do not locate the lead displacement plate closer than 300 mm 12 inches above the top helical plate. Position extension displacement plates on the central steel shaft at a minimum of every coupling joint. Do not space displacement plates more than 2 meters 7 feet apart. Displacement plates must permit the free flow of grout without misalignment of the central steel shaft.

[Mix grout with equipment capable of providing a steady supply at the required level of production. Place grout via a gravity fed reservoir located at the surface. The reservoir consists of a temporary casing or form, which is capable of containing liquid grout and appropriately sized (diameter and length) to accommodate the soil conditions and grout column diameter. Place grout in the reservoir immediately prior to the advancement of the first lead displacement plate into the soil. Maintain the volume of grout contained in the reservoir at a level sufficient to maintain positive hydrostatic pressure on the grout column.

Grout placement must continue until the minimum grout column length has been achieved as shown on the working drawings. Take volume measurements throughout the installation in order to determine the actual grout column diameter. Grout must be allowed to attain the minimum design strength prior to being loaded.

]3.2.3 Rejected Piles

Withdraw piles damaged or impaired for use during handling or installation, mislocated, or installed out of alignment beyond the maximum tolerance. Replace with new piles or cut-off and abandon damaged or impaired piles and install new piles as directed. Remove excess cut-off from piles and unacceptable piles from the work site. Perform all work in connection with withdrawing and removing rejected piles from the site at no additional cost to the Government.

3.2.4 As-Installed Survey

After the installation of each pile group is complete and before concrete is placed, provide the Contracting Officer with an as-installed survey showing actual location and top elevation of each pile. Submit survey within [7] [_____] calendar days of completing the test and production pile installation. Do not proceed with placing concrete until the Contracting Officer has reviewed the survey and verified the safe load for the pile group installed. Present a survey in such form that it gives deviation from plan location in two perpendicular directions and elevations of each pile to nearest 13 mm half inch. Survey must be prepared and certified by a licensed land surveyor.

3.2.5 Termination Criteria

If the required minimum installation torque is reached before the minimum length is achieved, the installation must continue until the minimum length is attained. However, the installation torque must not exceed the maximum torque rating (refer paragraph DEFINITIONS in PART 1) of the pile or equipment. If the maximum torque rating is reached before the minimum length is achieved, stop torquing operations and contact the Contracting Officer. Use the average torque for the last meter 3 feet of penetration as a basis of comparison with the minimum installation torque.

3.2.6 [Grouted] Helical Pile Installation Records

For each pile installed, provide a formal record including the following:

a. Name of project, contractor and contractors superintendent.

b. Date and time of installation.

c. Name and model of installation equipment and operator name.

d. Type of torque indicator.

e. Location of pile.

f. Time and duration of pile installation.

g. Elevation of lead pile.

h. Total length of installed pile.

i. Identification of lead section (manufacturer's description and catalog number).

j. Identification of extensions (manufacturer, diameter, minimum ultimate strength).

k. Number of displacement plates/centralizers and their location.

l. Down pressure applied.

m. Installation torque [and grout flow] at one-foot intervals.

n. Effective torsional resistance and calculated geotechnical capacity based on the effective torsional resistance and as derived from the pre-production test program.

o. Comments pertaining to interruptions, obstructions or other pertinent information.

3.2.7 Protection of Existing Structures

****

NOTE: Include this paragraph only when protection of existing structures from pile installation activities is required.

Indicate on the drawings all structures and facilities for which protection is required. Provide a project specific document that details design criteria, requirements for preconstruction condition surveys, post construction condition surveys, geotechnical instrumentation to measure ground movements and any other requirements.

Add any additional requirements as necessary.

****

Mitigate impact on existing facilities due to pile installation activities in accordance with the [project specific document] [_____].

3.2.8 Disposal of Excavated Material

Do not leave any piles partially completed overnight. Completely[grout and] protect piles at the termination of each day's operation. Dispose of excavated material, resulting from augering, [within the area indicated] [off Government property] [_____].

3.3 FIELD TESTS

3.3.1 Test Piles

****

NOTE: Select the second bracketed option when soil conditions dictate the use of a test pile longer than production piles. The ordered pile length for test piles should be 1.5 m 5 feet longer than ordered length for production piles to allow additional penetration if installation conditions dictate. Indicate location and number (if required) of test piles on plans, or list appropriate soil boring test hole numbers.

****

[Use test piles of specified type, and install as specified for piling elsewhere in this section.][Order test piles [_____] meters feet longer in length than production piles. Install the additional test pile length only at the direction of the Contracting Officer.] The [Contractor's Geotechnical Consultant] [Contracting Officer] will use test pile data to determine "calculated" pile tip elevation or necessary installation criteria. Install test piles [at the locations indicated] [in vicinity of soil boring test holes Nos. [_____], [_____], and [_____]]. Install test piles to [indicated tip elevation] [indicated bidding lengths] [required installation criteria]. Use test piles, if located properly and offering adequate installation resistance in finished work.[Pre-drilling or jetting is permitted only when test piles clearly establish validity of its use, or as directed by the Contracting Officer.] Provide and operate a pile driving analyzer as specified in paragraph DYNAMIC PILE ANALYSIS during the installation of each test pile. Modify installation as required based upon recommendation of [Contracting Officer] [Contractor's Geotechnical Consultant and approval of the Contracting Officer]. Submit test set-up and procedures.

[3.3.1.1 Dynamic Pile Analysis

Dynamic testing provides supplemental information for evaluating pile integrity, hammer and install system performance, assess pile installation stresses, and pile capacities. Perform dynamic testing on [_____] percent of the [test] piles during the full length of the pile installation and during restrike a minimum of [_____] days after initial installation. Dynamic pile testing may also be performed on [_____] production piles as chosen by the Contracting Officer. Use [test] piles of type as specified elsewhere in this section. Provide equipment to obtain dynamic measurements, record, reduce and display its data that meet the requirements of ASTM D4945. The equipment must have been calibrated within [6] [_____] months prior to the start of the testing operations and thereafter throughout the contract duration. Install [test] piles at the locations indicated or at the locations selected by the Contracting Officer. Employ an independent inspection firm, hereinafter referred to as the "Contractor's Geotechnical Consultant", experienced in the pile installation process[, monitoring of test pile installation,] and in the use of the Pile Driving Analyzer and its related equipment. Perform dynamic pile analysis as follows:

][3.3.1.2 Pile Analyzing

[_____] working days prior to installation the [test] piles, submit the pile and complete installation equipment data to the Contracting Officer. The Contractor's Geotechnical Consultant must use the submitted information to perform wave equation analyses and prepare a summary report of the wave equation results. The wave equation analysis using GRLWEAP software by Pile Dynamics, Inc. or equivalent must be used to assess the ability of the proposed installation system to install the pile to the required capacity and desired penetration depth within the allowable installation stresses. Approval of the proposed installation system by the Contracting Officer will be based upon the wave equation analyses indicating that the proposed installation system can develop a pile capacity of [_____] kN kips.

][3.3.1.3 CAPWAP

Perform signal matching analysis by CAPWAP software of the dynamic pile testing data on data obtained from the end of initial installation and the beginning of restrike of all control piles. CAPWAP analyses must be performed by an engineer who has achieved Advanced Level or better on the PDI / PDCA Dynamic Measurement and Analysis Proficiency Test for Providers of PDA Testing Services.

Upon completion of [test] pile installation, allow the piles to set-up for at least [72 hours] [_____ days]. After evaluation of pile, hammer and soil performance by the Contractor's Geotechnical Consultant, the second step of the dynamic pile analysis may proceed. This portion of the evaluation requires striking the set-up piles a minimum of 20-50 times, or as directed by the Contractor's Geotechnical Consultant "Warm up" the hammer and make it optimally ready prior to restriking, in order to avoid capacity losses during evaluation of restrike data. Apply maximum hammer energy during restrike in order to fully mobilize the soil resistance. However, exercise care so as to not overstress the pile. In addition to those items listed above, selected restrike installation records (as directed by the Contractor's Geotechnical Consultant are to be subjected to rigorous computer analysis by the Case Pile Wave Analysis Program (CAPWAP) for determination of resistance distribution, soil resistance and properties, and plot of applied load vs. average pile displacement based on the calculated soil properties.

][3.3.1.4 Dynamic Load Test Reporting

a. Upon satisfactory completion of each dynamic load test, submit[a minimum of three copies of] a Pile Performance Report for the Contractor by the Contractor's Geotechnical Consultant. The submittal must be prepared and sealed by a Professional Engineer registered in [_____].

b. Include in the report for the Dynamic Pile Analysis the following information:

   (1) Capacity of pile from Case Pile Wave Analysis Program (CAPWAP). Information resulting from analysis of a selected restrike blow.

   (2) Maximum and final transferred energy, hammer system efficiency during pile installation.

   (3) Maximum compressive stress, velocity, acceleration and displacement.

   (4) Maximum tensile stress in pile.

   (5) Pile structural integrity, damage detection, extent and location.

   (6) Blows per minute and blow number.

   (7) Input and reflection values of force and velocity, upward and downward traveling force wave with time.

   (8) Pile skin friction and toe resistance distribution.

   (9) Maximum energy transferred to pile.

c. The maximum allowable pile design load must be proposed by the Contractor's Geotechnical Consultant based upon the results of a satisfactory pile load test conducted on a pile installed as specified herein and include the effects of load transfer to the soil above the foundation stratum.

Use either a model Model 8G as manufactured by Pile Dynamics, Inc., of Cleveland Ohio or approved equivalent, for dynamic load testing of the test pile. All equipment necessary for the dynamic monitoring such as sensors, cables or wireless transmitters, etc., must be furnished by the Contractor's Geotechnical Consultant and conform to the requirements of ASTM D4945.

Pay for all services of the Contractor's Geotechnical Consultant. The Contractor's Geotechnical Consultant must be available throughout the pile installation operation to consult with the Contracting Officer when required by the Contracting Officer. The cost of changes in the Contractor's procedure, as required by evaluation of the results of the Pile Installation Analysis, will be at the Contractor's expense.

]3.3.2 Compression Tests

Perform load tests at the test pile locations indicated on the drawings. Perform "quick test" in accordance with ASTM D1143/D1143M. Provide apparatus for applying vertical loads as required by method, using load from weighted box or platform or reaction frame attached to sufficient uplift piles to safely take the required load applied to pile hydraulic jack. Increase load in increments until rapid progressive settlement takes place or until application of total load equals 200 percent of the design load, whichever occurs first. Equipment utilized to measure pile movements must be as outlined in ASTM D1143/D1143M Section 7. Maintain a data plot of load versus movement during the test procedures.[Determine the safe design capacity of a test pile as determined from the results of load tests according to UFC 3-220-01.][Safe design capacity will be based on the maximum axial deflection of [25 mm one inch] [5 percent of helix diameter] [the deflection criteria as stated on the plans or drawings].]

[3.3.3 Tensile Load Test

Perform tensile load tests on [_____] test piles in accordance with ASTM D3689. Apply a tensile load of [_____] kN kips to each tensile load test pile. In performing the tension load test, apply the ultimate load equal to one and one-half times the safe tension capacity, and employ the Standard Loading Procedure.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

Perform dynamic measurements on [_____] piles designated as dynamic test piles in accordance with ASTM D4945 during installation. During easy installation, ensure that damaging tension stresses do not develop in the pile. Signal matching must be performed by the Contractor's Geotechnical Consultant on representative data collected at the end of the initial installation and at the beginning of all restrike events. Additional signal matching analysis must be performed as determined by the Engineer.

][3.3.4 Lateral Load Test

Perform lateral load tests on [_____] piles in accordance with

ASTM D3966/D3966M. Lateral load tests consist of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. Apply a lateral load of [_____] kN kips to each pair of lateral load test piles. Record required movement readings for each pile.

Perform load tests at locations[as proposed by the Contractor's Geotechnical Consultant and] as directed by the Contracting Officer. Additional load tests, at Government expense, may be required by the Contracting Officer. Perform the loading, testing, and recording and analysis under the direct supervision of a Registered Professional Engineer, registered in the state of project location, and provided and paid for by the Contractor.

]3.3.5 Field Test Report

A Load Test Report must be submitted by the Contractor's Geotechnical Consultant upon satisfactory completion of each load test. The submittal must be prepared and stamped by a Professional Engineer registered in the State of [_____] and made within three working days of the completion of the load test. The Load Test Report contains the following information at a minimum:

a. Name or project, contractor and contractor's superintendent.

b. Name of the third party testing agency.

c. Date, time, and duration of test.

d. Type of test.

e. Name of test equipment and description of test set-up.

f. Equipment calibration data.

g. Location of pile and identification number.

h. Pile installation record, reaction piles and test pile.

i. Load increments and duration of each increment.

j. Time and amount of each interval reading.

k. Cumulative pile movement after each increment.

l. Maximum applied load.

m. Data plot of load versus movement.

n. Comments pertaining to interruptions, equipment adjustments or other pertinent information.

3.3.6 Pile Records

****

NOTE: Omit reference to load test when not required in project. Omit reference to test piles and "calculated tip elevation" when test piles are not installed. Where special or unusual soil conditions are expected, consultation with the Contracting

Officer's Technical Representative (Geotechnical Branch) regarding special engineering supervision of installation, testing, recording and analysis of data for project may be useful.
****

****
NOTE: Attach the specifications pile installation log graphic (for all pile installation projects) and the pile installation equipment data form (for projects using PDA) to the end of this specification section.
****

Keep a complete and accurate record of each pile installed. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations[, batter alignment]. Include in the record the beginning and ending times of each operation during installation of pile. Record retap data and unusual occurrences during pile installation such as reinstallation, heaving, weaving, splicing, obstructions, [jetting,] and any installation interruptions.[Install an energy monitor on the hammers and record readings every 300 mm 12 inches of pile installation.] A preprinted pile installation log for recording pile installation data[and pile installation equipment data form], which can be downloaded at: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables.

3.3.7 Testing Agency Qualifications

Engage an independent testing agency qualified according to ASTM C1077 and ASTM E329 for testing indicated. Submit testing agency qualifications to the Contracting Officer for approval.

3.3.8 Flow Cone Test

The quantity of water used must produce a grout having a consistency of not less than 21 seconds when tested with a flow cone in accordance with ASTM C939/C939M.[For specified flow cone rates in the range of 10 to 25 seconds, modify the flow cone by removal of the 13 mm 1/2 inch orifice allowing grout to pass through the 19 mm 3/4 inch hole in bottom of cone.][Water retentive grouts that demonstrate cohesive or thixotropic properties may be more accurately tested for workability with a standard slump cone using Slump Flow (commonly referred to as a "spread" test) as described in ASTM C1611/C1611M. The Slump Flow or "Spread" test employs the use of the standard concrete slump cone.]

Conduct tests at the beginning of grout injection and at subsequent intervals to ensure specification requirements are met.

3.3.9 Grout Specimens

Conduct grout tests in accordance with ASTM C31/C31M, ASTM C39/C39M and ASTM D942. Prepare test specimens of grout by pouring grout into 50 mm 2 inch cubes. Cure and test in accordance with ASTM C109/C109M. Restrain cube specimens from expansion as described in ASTM C942/C942M.[Prepare test specimens of grout by pouring grout [150 mm by 300 mm 6 inch by 12 inch cylinders], [76 mm x 150 mm 3 inch by 6 inch], [50 mm by 100 mm 2 inch by 4 inch] cylinders. Provide molds with a top cover plate so designed as to restrain grout expansion and to permit escape of air and water.]

Collect not less than one set of cylinders for each 38 m^3 50 cy of grout placed, or at least one set for each day during which piles are placed. Test 2 [_____] cubes at 7 [_____] days, 2 [_____] cubes tested at 28 [_____] days, and 2 [_____] cubes held in reserve. One set will consist of six [_____] cubes [cylinders]. Any set of cubes [cylinders] of which one or more cylinders test at 10 percent or more below the required strength will be cause for rejection of the pile group.

[3.4 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

****

NOTE: Include this paragraph only when special inspection and testing for seismic-resisting systems is required by the International Building Code (IBC).

This paragraph will be applicable to both new buildings designed and to existing building seismic rehabilitation designs done according to UFC 1-200-01, "General Building Requirements" and UFC 3-301-01 "Structural Engineering" and UFC 3-301-02, "Design of Risk Category V Structures, National Strategic Military Assets".

Indicate on the drawings all locations and all features for which special inspection and testing is required in accordance with Chapter 17 of the IBC. This includes indicating the locations of all structural components and connections requiring inspection.

Add any additional requirements as necessary.

****

Perform special inspections and testing for seismic-resisting systems and components in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

][3.5 VIBRATION CONTROL

****

NOTE: Include this paragraph when vibration monitoring is required. Add any additional criteria or requirements as necessary to the particular project. This section can normally be deleted for most [grouted] helical pile projects.

****

Perform vibration monitoring at the locations [shown in the plan] [decided by the Contracting Officer] during the pile installation operations. Perform vibration monitoring [using] [seismographs] [and geophones] within a distance of 61 meters 200 feet from the pile installation activity.[Engage the services of a qualified, independent vibration consultant, acceptable to the Government, to conduct the vibration monitoring. The vibration consultant must have minimum of [5] [_____] years of experience in vibration monitoring. A minimum of [28] [_____] days before the installation of vibration monitors, submit to the Government the name of the vibration consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile installation activities, obtain baseline readings of ambient vibrations. The vibration during the pile installation activities must be limited to[a peak particle velocity of not more than 5 cm 2 inches per second][the limits mentioned in the[contract documents]].[Determine appropriate vibration limits as per[US Bureau of Mines][American Association of State Highway and Transportation Officials (AASHTO)] guidelines.] During pile installation activities, monitor the vibrations to ensure the limits are not exceeded. If the limits are exceeded, cease the pile installation activity causing the vibration until[the Vibration consultant and the Contracting Officer] [_____] are on site to observe the structures nearest to the vibration monitor which has exceeded the limits.

The Contractor is responsible for all damages resulting from the pile installation operations and must take whatever measures necessary to maintain peak particle velocity within the specified limit. After completion of the project, remove the vibration monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.6 NOISE CONTROL

****

NOTE: Include this paragraph when noise monitoring is required. Add any additional criteria, references or requirements as necessary to the particular project. This section can normally be deleted for most [grouted] helical pile projects.

****

Perform noise monitoring at the locations [shown in the plan] [decided by the Contracting Officer] [at noise sensitive public areas] during the pile installation operations.[Perform noise monitoring using [noise meters][, and] [_____].][Engage the services of a qualified, independent noise consultant, acceptable to the Government, to conduct the noise monitoring. The noise consultant must have minimum of [5] [_____] years of experience in noise monitoring. A minimum of [28] [_____] days before the installation of noise monitors, submit to the Government the name of the noise consultant and a list of at least [three] [_____] previously completed projects of similar scope and purpose.]

Prior to the pile installation activities, obtain baseline readings of ambient noise levels.[The noise limits are mentioned in the [plan] [contract documents].][Determine appropriate noise limits as per [local agency] [Occupation Safety and Health Administration] guidelines.] During pile installation activities, monitor the noise to ensure the limits are not exceeded. If the limits are exceeded, cease the pile installation activity and install noise mitigation measures.

The Contractor is responsible for all damages resulting from the pile installation operations and must take whatever measures necessary to maintain noise within the specified limit. After completion of the project, remove the noise monitors off the site and off Government property and restore the monitoring locations back to their original condition.

][3.7 PRECONSTRUCTION CONDITION SURVEY

****

NOTE: Add any additional criteria, references or

requirements as necessary to the particular project.
****

Perform preconstruction condition survey of structures[and utilities] [within 61 meters 200 feet of the pile installation activity] [specified in the plans] [decided by the Contracting Officer]. Perform outreach to the owner of the structures [28] [_____] days before performing the preconstruction condition survey. Obtain written permission from the owner of the structure prior to accessing the structure. The preconstruction condition survey must include video and photographic documentation of the exterior and interior of above ground structures and of the interior of underground structures. Video documentation will be in high definition, and show existing conditions and highlight, where possible, existing cracks, deteriorated concrete, exposed and corroded reinforcement, cracked or broken brick or mortar, and other signs of distress. For utilities, perform the survey when the greatest extent of the interior is exposed. Provide supplementary artificial lighting as needed. The video must include annotation with location and structure nomenclature which describes any areas of distress over the video and time code superimposed on the video. Photographs must be accompanied by sketches or descriptions that indicate the location and direction of each photograph. For each structure surveyed, provide a Pre-Construction Condition Survey Report following completion of the survey. The report must contain all documentation associated with the survey including DVD copies. In the report, include notes, sketches, photographs, and videos. Provide general information, such as location details and structure type, as well as particular information on materials, condition, existing damage, aperture and persistence of cracks, and disrepair observed during visual survey. Provide a graphical depiction of locations of damage or other features of concern. Submit the Preconstruction Condition Survey Reports no later than [28] [_____] days before the commencement of pile installation activity. Accept responsibility for damages to existing adjacent or adjoining structures created by pile installation work, and repair any damages to these structures without cost to the Government.

][3.8 CONSTRUCTION INSTRUMENTATION AND MONITORING PROGRAM

****
NOTE: Include this section if instrumentation is to be installed due to concerns about vibration, settlement, lateral movement, etc. during pile installation activities. Instrumentation should be specified and included in the specification. This section can be deleted if there are no instrumentation requirements.

Add any additional criteria or requirements as necessary for the particular project.
****

Prepare a geotechnical instrumentation program to monitor settlement[and lateral movement] of temporary and permanent structures, utilities, [embankments][and excavations] during pile installation. The design and distribution of instrumentation must demonstrate an understanding of the need, purpose and application of each proposed type.[Perform noise and vibration monitoring in accordance with NOISE CONTROL and VIBRATION CONTROL sections.]

Monitoring must extend before, during and for a period after completion of construction activities related to pile installation when long-term performance issues are a concern. The monitoring plan must be designed to protect adjacent structures and utilities against damage due to the pile installation activities. Establish limiting values of vertical[and horizontal] movement [and angular distortion] [and vibration] for each structure and utility within the zone of influence, subject to review by the Government.

Prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. The report must include details about instrumentation consultant's experience, appropriate types, quantities, locations and monitoring frequencies of the instruments.

Upon acceptance of the instrumentation and monitoring program, provide, install and monitor the instrumentation and interpret the data. Submit instrumentation data reports not less than every [_____] days after the monitoring program has begun. Take corrective actions, as necessary, based on the field instrumentation data and as defined in the instrumentation and monitoring program.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 63 29 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-31 63 29 (November 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-31 63 29 (November 2019)**

Preparing Activity: USACE **Superseding**

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SECTION 31 63 29

DRILLED CONCRETE PIERS AND SHAFTS

11/19

****

NOTE: This guide specification covers the requirements for the procurement, installation, and testing of drilled concrete piers and shafts.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Use the following specifications in conjunction with this section:

Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS

On the drawings, show:

1. Subsurface-soil-data logs.

2. Top and bottom elevation of each drilled pier and/or shaft.

3. Size (diameter in mm inches), bearing capacity, and total number of each size of drilled pier and/or

shaft.

4. Dimensions of the bell, if required.

5. Dimensions of the casing.

6. Reinforcing steel details, if required.

7. Location of drilled piers and/or shafts to be penetration tested, if required.

8. Location of drilled piers and/or shafts to be proof tested, if required.

9. Locations, size, and installation sequence of load testing drilled pier and/or shaft, if required.
****

[1.1 UNIT PRICES

a. Requirements for price breakdown of drilled concrete piers or shafts are specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES. Requirements for construction scheduling related to drilled concrete piers or shaft work are specified in Section 01 32 17.00 20 NETWORK ANALYSIS SCHEDULES (NAS).

b. Requirements for price breakdown of drilled concrete piers or shaft work are specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES.
****

NOTE: This paragraph anticipates bids on a lump sum price for an entire project including drilled concrete piers or shaft work with directed changes being in accordance with the CONTRACT CLAUSES or in accordance with unit prices as defined in paragraph SEPARATE UNIT PRICES.

Delete "in accordance with the CONTRACT CLAUSES" or paragraphs "TESTS" and "SEPARATE UNIT PRICES" for lump sum projects.
****

[1.1.1 Basis of Bids

Base the bid on the number and total length of drilled concrete [piers] [and] [shafts], established by top and bottom elevations and diameters, as indicated and specified. Adjustment of the contract will be made [in accordance with the CONTRACT CLAUSES], if the total length of drilled concrete [piers] [or] [shafts] installed and approved is greater or less than the total length shown. The Contractor will not receive payment for rejected concrete [piers] [or] [shafts] or for those not conforming to specifications.

][1.1.2 Tests

1.1.2.1 Load Test

The Contract includes [_____] load tests rated at [_____] metric tons kips per drilled concrete [pier] [or] [shaft]. The Contracting Officer reserves the right to increase or decrease the number of load tests. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Drilled Concrete [Pier] [or] [Shaft] Test" or "Omitted Drilled Concrete [Pier] [or] [Shaft] Load Test".

1.1.2.2 Penetration Test

The Contract includes [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Penetration Test" or "Omitted Penetration Test".

1.1.2.3 Proof Test Hole

The Contract includes [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for each such increase or decrease by the amount bid for "Additional Proof Test Hole" or "Omitted Proof Test Hole".

][1.1.3 Separate Unit Prices

1.1.3.1 Additional Concrete [Pier][or][Shaft] Lengths

Additional [pier] [shaft] lengths will be paid for at the contract unit price for "Additional [Pier] [Shaft] Length" for each diameter of [pier] [shaft] installed as approved.

1.1.3.2 Omitted [Pier] [and] [Shaft] Lengths

The contract price will be reduced by the amount bid for "Omitted [Pier] [Shaft] Length" for each diameter of [pier] [shaft] omitted as directed.

1.1.3.3 Casings Permanently Left in Place

Steel casings permanently left in place due to contract conditions:

a. Total pounds of steel beyond casings indicated will be paid for at the contract unit price per pound for "Additional Steel Casing."

b. Omitted Casing Steel: The contract price will be reduced by the amount bid for "Omitted Casing Steel" omitted as directed.

1.1.3.4 Reinforcing Steel for Additional [Piers] [Shafts]

Reinforcing steel for additional [pier] [shaft] lengths will be paid for at the contract unit price for "Additional [Pier] [Shaft] Reinforcing Steel" installed as approved.

1.1.3.5 Reinforcing Steel for [Piers] [Shafts] Omitted

The contract price will be reduced by the amount bid for "Omitted [Pier] [Shaft] Reinforcing Steel" omitted as directed.

1.1.3.6 Removal of Rock

Removal of rock within the limit of [piers] [shafts] will be paid for at the contract unit price for "Removal of Rock" per linear meter foot, for each diameter of [pier] [shaft] installed. Rock excavation is defined as any hard dense material that cannot be removed with [pier] [shaft] drilling equipment having the specified capacity and could only be removed by hand, air tools, blasting, or other specialized methods.

1.1.3.7   Removal of Obstructions Other Than Rock

Removal of obstructions other than rock within the limits of the [piers] [shafts] which cannot be removed using standard drilling equipment with the specified capacity will be paid for at the contract unit price per linear meter foot for "Removal of Obstructions" for each diameter of [pier] [shaft] installed.

][1.1.4   Basis of Payment

1.1.4.1   Unit Price

The Contracting Officer has the right to increase or decrease the total length linear footage of drilled [piers] [shafts] to be furnished and installed by changing the [pier] [shaft] elevations, by requiring the installation of additional [piers] [shafts], or omission of [piers] [shafts] from the requirements shown and specified. Whether or not such changes are made, the Contractor will be paid at the contract unit price per linear meter foot (including drilled pier and/or shaft) multiplied by the total linear meters feet of acceptable [piers] [shafts] actually installed provided, however, that in the event the Contracting Officer requires an increase or decrease in the total lengthlinear footage of [piers] [shafts] furnished and installed, the contract unit price will be adjusted in accordance with the CONTRACT CLAUSES.

1.1.4.2   Full Compensation

Payment in accordance with the above paragraph Unit Price constitutes full compensation for furnishing, delivering, handling, and/or installing (as applicable) all material, labor and equipment necessary to meet contract requirements applicable to the [piers] [shafts]. The Contractor will not be allowed payment for rejected [piers] [shafts].

1.1.4.3   Load Tests

The Contract includes [_____] [_____] -metric tonskips [pier] [shaft] load tests. The Contracting Officer reserves the right to increase or decrease the number of load tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional [Pier] [Shaft] Load Test" or "Omitted [Pier] [Shaft] Load Test."

1.1.4.4   Penetration Tests

The Contract includes [_____] penetration tests. The Contracting Officer reserves the right to increase or decrease the number of penetration tests. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Penetration Test" or "Omitted Penetration Test."

1.1.4.5   Proof Test Holes

The Contract includes [_____] proof test holes. The Contracting Officer reserves the right to increase or decrease the number of proof test holes. Adjustments in the contract price will be made for such increases or decreases by the amounts bid for "Additional Proof Test Hole" or "Omitted

Proof Test Hole."

]]1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2020) Specifications for Structural Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 336.1	(2001) Specification for the Construction of Drilled Piers
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for

Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172	(2010) Standard Practice for Sampling Freshly Mixed Concrete

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2018; Errata 2019) Manual of Standard Practice

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA NHI-18-024	(2018) Drilled Shafts: Construction Procedures and LRFD Design Methods

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.651	Specific Excavation Requirements

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Plan

SD-02 Shop Drawings

Drilled Shaft Diameters[; G, [_____]]

Depth of Test Holes[; G, [_____]]

Top and Bottom of Shaft Elevations[; G, [_____]]

Steel Reinforcement[; G, [_____]]

Anchor Bolt Locations[; G, [_____]]

Accessories[; G, [_____]]

SD-05 Design Data

Drilled Shaft Foundation Design Analysis[; G, [_____]]

Mix Design Data[; G, [_____]]

SD-06 Test Reports

Soils Report[; G, [_____]]

Ground Water Conditions

Load Test[; G, [_____]]

Penetration Test[; G, [_____]]

Slump

Concrete[; G, [_____]]

Compressive Strength[; G, [_____]]

SD-07 Certificates

****

NOTE: Specify load tests when needed to confirm design capacities. At least one pier or shaft location should be load tested in each area of substantially different subsoil conditions. Indicate number, size, and location of test pier or shaft and sequence.

****

Bill of Lading for Ready-Mix Concrete Deliveries

Steel Reinforcement[; G, [_____]]

Welding Certificates[; G, [_____]]

Excavation and Drilling Equipment

Qualifications of Excavator[; G, [_____]]

Qualifications of Engineer[; G, [_____]]

1.4 QUALITY CONTROL

1.4.1 General

Install drilled shaft foundations in accordance with applicable requirements as described by ACI 336.1, and FHWA NHI-18-024.

1.4.2 Sequencing and Scheduling

Submit a detailed installation plan describing the schedule for drilling and/or excavation, installation of steel reinforcement and concrete placement with anticipated site conditions so that each excavated shaft is poured the same day that the drilling is performed.

1.4.3 Inspection Criteria

Design inspection activities to minimize delays while insuring the intent of the Industry Standard Specifications.

1.4.4 Qualification of Excavation Contractor

An experienced excavator with five (5) years experience and licensed in the State of [_____], specialized in excavating and installing work similar in material, design, and extent to that indicated for this Project. Submit certificates substantiating the Qualifications of Excavator.

1.4.5 Qualification of Professional Engineer

Provide engineering services by an authorized engineer currently licensed in the State of [_____]; having a minimum of four (4) years experience as an engineer knowledgeable in drilled shaft foundation design analysis, protocols and procedures for the ACI 336.1, FHWA NHI-18-024, ASCE 7-16, and the [_____] Building Code. Submit certificates substantiating the Qualifications of Engineer.

1.4.6 Welding Qualifications

Provide and maintain qualified procedures and personnel according to AWS D1.1/D1.1M, AWS D1.4/D1.4M, and AWS A5.1/A5.1M. Submit Welding Certificates to the Contracting Officer.

1.4.7 Pre-Construction Conference

After submittals are received and approved but before drilled shaft excavation and foundation work, including associated work, is performed, the Contracting Officer will hold a pre-construction conference to review the following:

a. The drawings, specifications and the geotechnical report.

b. Finalize construction schedule and verify availability of materials, Excavator's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to drilled shaft foundation installation, including engineer's written instructions.

d. Support conditions for compliance with requirements, including alignment between foundation system and erection of structural members.

e. Governing regulations and requirements for, certificates, insurance, tests and inspections if applicable.

f. Temporary protection requirements for foundation assembly during and after installation.

1.5 PROJECT CONDITIONS

****

NOTE: Require proof testing if the soundness of rock below the pier or shaft bearing level is

unknown. Indicate location of each pier or shaft to be proof tested.
****

1.5.1 Existing Conditions

Locate existing underground utilities before excavating drilled shaft foundations. If existing utilities are to remain in place, provide protection during drilled shaft operations.

1.5.2 Interruption of Existing Utilities

Do not interrupt any utility to occupied facilities unless directed in writing by the Contracting Officer.

1.5.3 Weather Limitations

Proceed with installation preparation only when existing and forecasted weather conditions permit work to proceed without water entering into the area of excavation.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

Submit design data for the following:

a. Drilled shaft foundation design analysis to include, but not limited to the following:

   (1) Applicable Building code criteria for the excavation's geographic area

   (2) Dead and Live Loads

   (3) Compressive and Lateral Loads

   (4) Collateral Loads

   (5) Foundation Loads

   (6) Bearing strata

   (7) Casing description

b. Mix design data in accordance with paragraph READY-MIX CONCRETE accompanied by the Bill of Lading for Ready Mix Concrete deliveries.

2.1.1 Assembly

Installation drawings are to include, but not limited to, the following items indicating a completely dimensioned layout and location of drilled shafts and concrete placement for foundation system. Submit detailed shop drawings for the following:

a. Drilled shaft diameters

b. Depth of test holes

c. Top and bottom of shaft elevations

d. Steel reinforcement

e. Anchor bolt locations

f. Accessories

2.2 EQUIPMENT

2.2.1 Drilling and Excavation Equipment

Provide drilling and excavation equipment having adequate capacity, including but not limited to, power, torque and down thrust to excavate a hole of diameter and depth indicated. Also provide excavation and over-reaming tools of adequate design, size and strength to perform the work indicated.

Provide special drilling equipment including, but not limited to, rock core barrels, rock tools, air tools and other equipment as necessary to construct the shaft excavation to the size and depth indicated when materials encountered can not be drilled using earth augers and/or over-reaming tools.

Submit certificates substantiating appropriate selection of excavation and drilling equipment.

2.3 MATERIALS

2.3.1 Steel Reinforcement

2.3.1.1 Deformed Steel Bars

Steel bars conforming to ASTM A615/A615M, Grade 60 ksi and ACI 318.

2.3.1.2 Plain Steel Wire

Steel wire conforming to ASTM A1064/A1064M.

2.3.2 Ready-Mix Concrete

Ready-Mix concrete and mix design conforming to ACI 117, ACI 301, and ACI 304R, minimum compressive strength 5,500 psi at 28 days. Slump results between 5 to 6 inches, according to ASTM C143/C143M.

Portland cements conforming to ASTM C150/C150M, Type II. Provide one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

Potable water conforming to ASTM C94/C94M.

Measure, batch, mix and deliver concrete according to ASTM C94/C94M and furnish batch ticket information.

PART 3 EXECUTION

3.1 PREPARATION

Protect existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled shaft foundation operations.

Provide Fall Protection as required by Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and 29 CFR 1926.651.

3.2 INSTALLATION

3.2.1 Construction Criteria

Provide equipment for checking the dimensions and alignment of each shaft excavation. Determine dimensions and alignment jointly with the contractor and engineer. Measure final shaft depths with appropriate weighted tape measure or other approved method after cleaning.

Provide and install monolithically cast-in-place concrete drilled shaft foundation to the sizes indicated.

Provide and install straight cylindrical shaft foundation of the type indicated.

Tolerances:

a. Maximum variation of the center of any shaft foundation from the required location: 7.62 cm 3 inches, measured at the ground surface.

b. Bottom Diameter: Minus zero, plus 15.24 cm 6 inches, measured in any direction.

c. Maximum variation from plumb: 1:40.

d. Maximum bottom level: Plus or minus 5.08 cm 2 inches.

3.2.2 Excavation

Accomplish excavation of shaft foundations by standard excavation methods including, but not limited to, conventional augers fitted with soil and/or rock teeth, or under-reaming tools attached to drilling equipment of adequate size, power, torque and down thrust necessary for the work.

Perform excavation through whatever materials that are encountered to the dimensions, depths and applicable ACI 336.1 tolerances.

Protect excavated walls with temporary watertight steel casings of sufficient length to prevent water intrusion, cave-ins, displacement of surrounding earth, and injury to personnel and damage to construction operations.

Excavate shafts for drilled foundations to indicated elevations. Remove loose debris, materials and/or muck to make bottom surfaces level within ACI 336.1 tolerances.

Remove water from excavated shaft prior to concrete placement.

3.2.3 Steel Reinforcement

Comply with recommendations in the CRSI "Manual of Standard Practice" CRSI 10MSP for fabricating, placing and supporting reinforcement. Shop fabricate steel reinforcement in accordance with ACI SP-66.

When practicable, deliver the reinforcement cage assembly to the jobsite as a complete unit ready for installation. Should it be necessary to make any additional connections and/or splices, provide as indicated on the approved shop drawings, at-grade level prior to lowering the complete assembly into the hole.

Clean reinforcement of loose rust, mill scale, earth and other foreign materials. Do not tack weld crossing reinforcing bars. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

Lower reinforcement steel into the hole in such a manner as to prevent damage to the walls of the excavation. Place, tie and/or clip cage symmetrically about the axis of the shaft. Use centering devices securely attached to the cage to clear the shaft walls and maintain the cage in place throughout the concrete placement operations.

Cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between reinforcing and embedded items, notify the Contracting Officer in order to reconcile conflicts before concrete placement. Position and support anchors and embedded items with appropriate accessories.

Use templates to set anchor bolts, leveling plates and other accessories required for structure erection. Provide blocking and/or holding devices to maintain required anchoring positions during final concrete placement.

3.2.4 Concrete Placement

Keep all equipment, including but not limited to, mixers, pumps, hoses, tools and screeds clean and free of set concrete throughout the placement operation.

Convey concrete from the mixer to place of deposit by best industry methods that prevents segregation and loss of material. Size and design the equipment for conveying concrete to ensure uniform, continuous placement of concrete.

Place concrete in accordance with ACI 318.

Place concrete in a continuous operation and without segregation into dry excavations whenever possible after inspection and written approval by the Contracting Officer. Use all practicable means to obtain a dry excavation before and during concrete placement.

Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. When hot weather conditions exist that would impair quality and strength of placed concrete, comply with ACI 305R. Comply with ACI 306.1 for cold-weather protection.

A minimum of 50 percent of the base for each shaft is to be less than 1.27 cm 1/2 inch of sediment at the time of concrete placement. Maximum depth of sediment or debris at any place on the base of the shaft is not to exceed 3.81 cm 1-1/2 inches. Shaft cleanliness is to be determined by the engineer by visual inspection.

3.3 FIELD QUALITY CONTROL

3.3.1 Test Reports

As a minimum, submit the following test reports and data.

a. Soils Report

b. Ground Water conditions

c. Load Test

d. Penetration Test

e. Slump

f. Concrete

g. Compressive Strength

Sample and test concrete for quality control during placement.[Quality control testing is provided by the contract.]

Sample freshly placed concrete for testing in accordance with ASTM C172.

Make concrete test specimens for compressive strength at 7 and 28 days for each design mix conforming to ASTM C31/C31M. Compression test concrete in accordance with ASTM C39/C39M.

Test Slump at plant for each design mix in accordance with ASTM C143/C143M.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 66 10 (February 2021)**

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Preparing Activity: USACE **Superseding without Revision**
UFGS-31 60 00 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 31 - EARTHWORK

SECTION 31 66 10

ROCK FOUNDATION PREPARATION

02/21

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-31 66 10 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 60 00 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 31 66 10

ROCK FOUNDATION PREPARATION

02/21

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NOTE: This guide specification covers the requirements for embankments and concrete structures placed on rock foundations, including all operations on the rock surface to make that surface acceptable for the placement of embankment or concrete. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: This section is not complete, but should normally be incorporated into the sections dealing with 31 00 00 EARTHWORK, and/or CONCRETE, or a separate section on FOUNDATION PREPARATION may be included in the project specifications.

****

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

****

1.1.1 Preliminary Cleanup

1.1.1.1 Payment

Payment will be made for costs for each preliminary cleanup satisfactorily performed at the direction of the Contracting Officer. Payment will be made for each cleanup of the same area if more than one cleanup has been directed and satisfactorily performed.

1.1.1.2 Measurement

Preliminary cleanup will be measured for payment by determining the area cleaned to the nearest square meter yard.

1.1.1.3 Unit of Measure

Unit of measure: square meter yard.

1.1.2 Final Cleanup

1.1.2.1 Payment

Payment will be made for costs associated with final cleanup of the area [for each type of foundation preparation] that has been satisfactorily prepared. Where preliminary cleanup has been directed and performed and the Contractor subsequently performs final cleanup, payment will be made for preliminary cleanup. Payment will not be made for any cleanup subsequent to final cleanup.

1.1.2.2 Measurement

Final cleanup will be measured for payment by determining the area cleaned to the nearest square meter yard.

1.1.2.3 Unit of measure

Square meter yard.

1.1.3 Foundation Preparation

1.1.3.1 Payment

Payment will be made for costs associated with foundation preparation of the area [for each type of foundation preparation] that has been satisfactorily prepared. Where preliminary cleanup has been directed and performed and the Contractor subsequently performs foundation preparation, payment will be made for foundation preparation. Payment will not be made for more than one foundation preparation of the same area.

1.1.3.2 Measurement

Foundation preparation will be measured for payment by determining the area prepared to the nearest square meter yard.

1.1.3.3 Unit of measure

Square meter yard.

1.1.4 Dental Concrete

1.1.4.1 Payment

Payment will be made for costs associated with dental concrete placed.

1.1.4.2 Measurement

Dental concrete will be measured for payment by determining the volume to the nearest one-tenth cubic meter yard.

1.1.4.3 Unit of measure

Cubic meter yard.

1.1.5 Dental Mortar

1.1.5.1 Payment

Payment will be made for costs associated with dental mortar placed.

1.1.5.2 Measurement

Dental mortar will be measured for payment by determining the volume to the nearest one-tenth cubic meter yard.

1.1.5.3 Unit of measure

Cubic meter yard.

[1.1.6 Shotcrete

1.1.6.1 Payment

Payment will be made for costs associated with shotcrete satisfactorily placed.

1.1.6.2 Measurement

Shotcrete will be measured for payment by determining the area satisfactorily covered to the nearest square meter yard.

1.1.6.3 Unit of measure

Square meter yard.

][1.1.7 Protective Coating

1.1.7.1 Payment

Payment will be made for costs associated with protective coating satisfactorily applied. Separate payment will not be made for reapplication necessary due to damage by construction activities, fault or negligence of the Contractor, or failure of the Contractor to prosecute the work in a timely manner. Otherwise, make separate payment for each reapplication directed and satisfactorily performed.

1.1.7.2 Measurement

Protective coating will be measured for payment by determining the area satisfactorily covered to the nearest square meter yard.

1.1.7.3 Unit of measure

Square meter yard.

]1.2 REFERENCES

****

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AMERICAN CONCRETE INSTITUTE (ACI)

ACI 506.2	(2013; R 2018) Specification for Materials, Proportioning, and Application of Shotcrete

ASTM INTERNATIONAL (ASTM)

ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C387/C387M	(2023) Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar

1.3 DEFINITIONS

1.3.1 Foundations

The rock foundation is comprised of the rock surfaces upon which [embankment] [and] [concrete] structures are placed. Vertical surfaces, where permitted or required by these specifications, are included.

1.3.2 Rock Joints

Rock joints are all planar and/or curvilinear fractures, including cracks, crevices, and seams which separate a rock mass into individual rock blocks of various sizes. They may be open or closed and may be filled with material other than rock material.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Tools; G, [_____]

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Dental Concrete

Provide dental concrete conforming to the requirements of ASTM C387/C387M, normal weight and strength.

2.1.2 Dental Mortar

Provide dental mortar conforming with ASTM C270 or ASTM C387/C387M, Type N.

2.1.3 Shotcrete

****

NOTE: Select appropriate alternative.

****

Furnish shotcrete conforming to the requirements of [Section 03 37 13 SHOTCRETE] [ACI 506.2. The compressive strength of the concrete must be 27.6 MPa 4000 psi].

2.1.4 Welded Wire Fabric

Use welded wire fabric 150 by 150 mm 6 by 6 inches - W3 x W3, conforming to ASTM A1064/A1064M.

2.1.5 Filter Material

****

NOTES: Information on the design of filter materials can be found in the Engineering Manual (ER) 1110-2-1901, "Seepage Analysis and Control for Dam," ER 1110-2-2300, "Earth and Rock Fill Dams General Design and Construction Considerations.

The Specifier should use the first paragraph if there is a concrete section, an embankment for earth dams, or a stone protection section in the specifications and if the gradation therein is satisfactory for filter materials. If there is no concrete section, or if the gradation therein is unsatisfactory for filter materials, the Specifier should use the second paragraph.

****

[Provide filter material consisting of [sand and gravel] [and crushed stone]. Provide [sand and gravel] [and crushed stone] for filter materials meeting the applicable requirements of [Section 03 70 00 MASS CONCRETE, paragraph MATERIALS] [Section 35 31 19.40 STONE REVETMENTS, paragraph MATERIALS,] [Section 35 73 13 EMBANKMENT FOR EARTH DAMS, paragraph MATERIALS.]] [Provide filter material consisting of [sand,] [gravel,] [crushed stone]. Provide [filter material] composed of tough, durable particles, reasonably free from thin, flat and elongated pieces, and containing no organic matter nor soft, friable particles in quantities considered objectionable by the Contracting Officer. Furnish grading conforming to the following requirements:

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
SAND	
[_______]	[_______]
[_______]	[_______]
[_______]	[_______]
GRAVEL "D"	
[_______]	[_______]
[_______]	[_______]
[_______]	[_______]
CRUSHED STONE	
[_______]	[_______]
[_______]	[_______]
[_______]	[_______]

Well-grade the [filter materials] between the limits shown. [Do not use crushed stone for gravel.] Perform at least one test on each 1000 tons (metric) 2,000,000 lb to be delivered to the project site for each gradation band. Obtain points on individual grading curves from representative samples of [filter material] that lie between the boundary limits as defined by smooth curves drawn through the tabulated grading limits plotted on a mechanical analysis diagram. Do not exhibit abrupt changes in slope denoting either skip grading or scalping of certain sizes or other irregularities which would be detrimental to the proper functioning of the filter.]

PART 3 EXECUTION

3.1 EXAMINATION

The limits of the proposed foundations for the various parts of the work are approximately as indicated. The Contracting Officer reserves the right to change the depth to, or the width of, the foundations if, conditions exposed in the foundation excavations, or as determined by exploratory drilling, warrant such modifications.

3.2 PREPARATION

3.2.1 Equipment

3.2.1.1 Tools

Submit for approval tabular list of light power tools, to be used in lieu of hand tools, prior to their use on the job site. Hand tools, where required or permitted by these specifications include, but are not limited to [shovels,] [bars,] [picks,] [wedges,] [and] [brooms]. Light power tools may be used in lieu of hand tools only when such use is approved.

3.2.1.2 Air Jet

Furnish an air jet consisting of a [40] [_____] mm [1-1/2] [_____] inch nozzle with a supply hose connected to a suitable source of compressed air. Provide compressed air with a pressure between [620] [_____] and [760] [_____] kPa [90][_____] and [110] [_____] psi. Control compressed air at the nozzle.

3.2.1.3 Air/Water Jet

Furnish an air/water jet consisting of a [40] [_____] mm [1-1/2][_____] inch nozzle with associated controls and supply hoses connected to suitable sources of compressed air and water. Provide compressed air with a pressure between [620] [_____] and [760] [_____] kPa [90] [_____] and [110] [_____] psi. Introduce water into the airstream at the nozzle when needed, at a rate of up to [2] [_____] L/s [30] [_____] gpm. Control air and water separately at the nozzle.

3.2.1.4 Water Jet

Furnish a water jet consisting of a [25] [_____] mm [1] [_____] inch nozzle with a supply hose connected to a suitable source of water. Provide system capable of delivering up to [13] [_____] L/s [200] [_____] gpm. Control the flow rate at the nozzle.

3.3 PRELIMINARY CLEANUP

When the excavation has reached the approximate limits shown or when the Contracting Officer determines that a satisfactory foundation may have been reached, the Contracting Officer may direct that a preliminary cleanup be performed on all or any part of the rock foundation surface. Remove all debris, loose rock, sand, silt, and other objectionable material by hand tools followed by [air] [water] [air/water] jets or any combination of additional methods approved or directed. The Contracting Officer may require that the excavation be continued and the preliminary cleanup procedure repeated until a satisfactory foundation surface is reached.

3.4 FINAL CLEANUP AND FOUNDATION PREPARATION

****

NOTE: Insert a description of the areas to receive (this type) foundation preparation.

Where more than one type of final cleanup and foundation preparation is needed, this paragraph may

be repeated with appropriate variations. See EM 1110-2-2300 for guidance on where foundation preparation should be required under embankment dams. Compacted filter material should be used under overhangs only when granular fill is being placed against the foundation.

****

Unless otherwise directed, perform final cleanup and foundation preparation [, structural] [, embankment] [, type [_____]] [_____]. This work consists of removing loose and/or weather rock and pockets of fines, sand, rock rubble or gravel and other objectionable material from the in place rock surface including areas of depression, large crevices, and open rock joints. [The loose material need not be removed where the width of the opening is less than [_____] mm inches.] [Mechanical equipment may be used but such equipment will be rubber tired only.] Picking, barring, and hand excavation may be necessary to obtain a foundation surface free from loose, drummy, or shattered materials. [Trim irregularitites in the rock surfaces to form a reasonable uniform slope on the abutments.] [Slopes steeper than [_____] vertical on [_____] horizontal are not permitted.] [Overhangs are not be permitted at any location.] [Excavate and backfill overhangs with compacted [filter] [granular] materials. Place filter materials in accordance with the provisions contained in Section [35 73 13 EMBANKMENT FOR EARTH DAMS] [_____].] [Vertical surfaces are not be [permitted.] [higher than [_____] m feet] and benches between vertical surfaces must be of such width so as to provide a stepped slope comparable to the adjacent uniform slope.] Thoroughly clean the final rock surface using [air jets] [water jets] [air/water jets] or other approved method and maintain in a clean condition until the placement of [embankment] [or] [concrete] thereon.

3.5 DENTAL TREATMENT

****

NOTE: If a schedule is not provided, a description of the areas to receive dental treatment, and the minimum width joint to be treated should be included. For embankment dams, the minimum width joint to be treated depends on the gradation of the embankment material that will be placed against the joint (see EM 1110-2-2300).

****

Provide dental treatment consisting of excavation, if necessary, of the material in joints, cavities, depressions, and overhangs and the placement of [concrete] [or] [mortar] such that the final surface is satisfactory for the subsequent placement of [embankment] [or] [concrete]. [Unless otherwise directed, perform dental treatment in accordance with the following schedule:

Foundation Area	Minimum Width Joint to be Treated
[______]	[______]
[______]	[______]

]

Excavate joints and cavities to a depth [3] [_____] times the width (measured at the base of the excavation) of the joint or cavity.

3.5.1 Dental Concrete

****

NOTE: Normally the concrete specification will be included in Division 03, Concrete. When Division 03 would not otherwise be included, and only small quantities will be needed, the ASTM alternate may be used. The maximum aggregate size in dental concrete should not be more than one third the minimum widths of joints in which it is to be used.

****

Use concrete to fill joints, cavities, depressions, and overhangs except where the use of mortar is required or permitted. Prior to placement, the surfaces of the joint, cavity, depression, or overhang will be thoroughly cleaned using [air] [or] [air/water] [or] [water] jets. Provide maximum aggregate size of [[_____] mm inch] [as directed]. Furnish concrete conforming with paragraph MATERIALS.

3.5.2 Dental Mortar

Use mortar to fill joints, cavities, depressions, and overhangs when the width of the opening is less than [_____] mm inches and at other areas as directed or approved. Placement of the sand-cement mortar will be accomplished by [troweling] [brooming] the mortar [with stiff bristled brooms] into the cleaned joints, cracks, and crevices so as to provide a thorough seal. Minimize the absorption of water from the mortar mix in the surface moisture of the rock. However, no standing water will be allowed. Remove all mortar which cannot be worked into the joints from the rock surface. [Moist cure the mortar for a period of at least [_____].] Provide mortar conforming with paragraph MATERIALS.

3.6 PROTECTIVE TREATMENT

****

NOTE: Insert here a description of the areas to be protected, and the type(s) of protection to be used. If more than one type of protection is specified, it should be clear which method(s) is (are) required for each area. If the choice of methods is optional with the Contractor that should be stated. Care should be used when selecting protective measures. Not all methods are suitable in all situations or with all types of rock. Of the following paragraphs, only those methods specified should be included.

****

Provide [_____] protective treatment.

3.6.1 Wetting

Keep the area wet by [continuous spraying] [flooding] or by other approved method. [Provide positive measures to control the runoff.]

3.6.2 Shotcrete

****

NOTE: See ACI 506.2 for additional options that may

be specified and for guidance on their use. The first alternate should be used if shotcrete is being used for other purposes on the job, or if a different shotcrete specification is appropriate.
****

Alternate 1: [Furnish shotcrete conforming to the requirements of paragraph MATERIALS.]

Alternate 2: [Cover the area to be protected by welded wire fabric in accordance with paragraph MATERIALS.] Anchor the fabric securely in place as shown on the contract drawings. Furnish shotcrete conforming to paragraph MATERIALS. The Contractor is responsible for construction and preconstruction testing. [Gradation [_____] will be used.] [Gradations [_____] or [_____] will be used.] Provide minimum cover [over reinforcement,] of [_____] mm inches.

3.6.3 Protective Coating

****
NOTE: Celtite 42-51 HI-SEAL, (42-52C (Clear)), and (45-51W (White)) epoxy resin and emulsion, manufactured by Celtite, Inc., telephone 1-800-626-2948 and Aero-Spray, manufactured by American Cyanamid/CYTEC, telephone 1-800-835-9844, (Mining Products Division) have been successfully used and were available at time of publication. However, the availability of these and similar products should be investigated before their use is specified. Asphaltic emulsions have been used, with limited success, in some applications.
****

Apply an approved protective coating within [_____] hours of exposure of the rock surface in accordance with the manufacturer's recommendations or as otherwise approved. Reapply the coating as necessary to repair damage caused by construction activities or when needed to provide adequate protection. [Provide [_____] protective coating, or equal.]

3.6.4 Protective Backfill

Accomplish the final [600] [_____] mm [2] [_____] feet of excavation, final cleanup and foundation preparation, inspection, [dental treatment,] and placement of the first [300] [_____] mm [12] [_____] inches of backfill within a period of [16] [_____] hours. Within [48] [_____] hours after the start of the final excavation, provide backfill with a minimum thickness of [1000] [_____] mm [3] [_____] feet. Place thebackfill in accordance with the requirements of Section [31 00 00 EARTHWORK] [_____].

3.6.5 Protective Concrete

Accomplish the final [600] [_____] mm [2] [_____] feet of excavation, [cleanup,] inspection, preparation, [dental treatment,] and placement of at least [_____] mm inches of protective concrete within a period of [_____] hours. Provide concrete conforming to the requirements of Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [_____].

3.6.6 Temporary Earth Cover

****

NOTE: Insert the requirements of the material to be used.

****

[Within [_____] hours of excavation,] [Before freezing weather is expected,] [Before other construction activities are permitted,] the area will be protected by a temporary earth cover [_____] mm feet thick. The material must [_____]. Remove the material and [clean,] [inspect,] [and prepare] the area prior to placement of [embankment] [or] [concrete] thereon.

3.7 TESTS

3.7.1 General

Establish and maintain quality control for foundation preparation operations to assure compliance with contract specifications and maintain records of the quality control for all operations including but not limited to the following:

3.7.1.1 Equipment

Quantity and type.

3.7.1.2 Foundation Excavation

Strict adherence to foundation excavation limits and depths.

3.7.1.3 Inspection, Mapping, and Cleanup

Orderly prosecution of inspections, mapping, and cleanup of foundation excavation areas.

3.7.1.4 Specialized operations

Protective treatment [and Dental treatment].

3.7.2 Reports

Submit three copies of these records of inspection as well as corrective action taken daily.

3.8 FOUNDATION INSPECTION AND GEOLOGIC MAPPING

Inspections to determine adequacy of the foundations will be performed by the Contracting Officer in all foundation areas between completion of excavation and placement of [embankment,] [or] [concrete,] [or protective treatment]. The Contractor will cooperate to the extent necessary to assist in inspection and mapping activities which may require additional survey control points and access. Coordinate the schedule for foundation excavation and preliminary cleanup with the Contracting Officer to ensure that the cleanup, inspection, and mapping proceed in an orderly manner.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-31 68 13 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-31 68 13 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-31 68 13 (November 2020)**

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****

SECTION 31 68 13

SOIL AND ROCK ANCHORS

11/20

****

NOTE: This guide specification covers the requirements for soil and rock anchors. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This specification is based on, and references, the POST-TENSION INSTITUTE (PTI) recommendations for prestressed rock and soil anchors. The PTI manual is available from:

POST-TENSIONING INSTITUTE.
1717 W. NORTHERN AVE., SUITE 114
PHOENIX, AZ 85021 U.S.A
PHONE: (602) 870-7540 FAX: (602) 870-7541

The designer should carefully investigate the PTI document to ensure that the design conforms to PTI requirements and that conflicts do not occur between the referenced document and this specification. In

the event deviations from the PTI recommendations are necessary, the specification must be edited to clearly identify such deviations. For unusual conditions, the designer should also consult specialty contractors during the design process.

Rock and soil anchors may be used for temporary support or for permanent support. This specification must be carefully edited to reflect the design parameters applicable for the intended durability.

For projects requiring specialized methods or experience, particularly those which are primarily for installation of soil or rock anchors, consideration should be given to using a REQUEST FOR PROPOSAL (RFP) Method of procurement instead of an INVITATION FOR BIDS (IFB) Method. Use of RFP permits evaluation of offers on technical criteria in addition to price.

This guide specification is written for new construction where the anchor is installed after the structure is completed or for installing anchors in existing structures. Where the anchors must be installed and/or stressed prior to completion of the structure additional requirements will be necessary. Where pre-installation is required, means must be taken to protect the anchor components during the subsequent construction of the structure. If the anchors are to be stressed prior to completion of the structure, it may be necessary to stress the anchors against casings or other structures and transfer the load to the structure upon completion of construction.

Where the design of the structure to be anchored requires that the anchors be installed and stressed prior to construction of the new structure (i.e. where a new anchored wall is to be constructed to protect or support an existing wall which is not capable of resisting stressing loads), the anchors may be stressed against casings or a waler or thrust blocks may be used to distribute the load. In this case, the casing and rock socket must be designed to prevent deflection or excessive pulling of the casing into the rock during stressing. The design of the casing and rock socket must be included in the design computations. The casing must be seated into the rock socket and remain in place after grouting of the anchors.

Monitoring of stressing should include monitoring of movement of the casing.

Where anchors must be installed prior to construction of the new structure, the Contractor must adequately protect the anchor components during subsequent construction.

The following sentence should be included in paragraph FIELD QUALITY CONTROL, subparagraph GENERAL when the conditions apply or when stressing and testing the anchor is expected to cause significant movement of the structure such as:

a. Highly loaded anchors within the top 1.5 m 5 feet of the structure

b. High test loads on passive anchors

c. Anchors designed to support future loads which are much higher than current loads

"Stressing for [performance] [and] proof [and extended creep] tests must be by a method which does not induce excessive movement or damage on the existing structure"

****

1.1 SYSTEM DESCRIPTION

****

NOTE: This guide specification may be used as a performance specification or a prescriptive specification by use of tailoring options. For the performance specification tailoring option, the Government provides the design loads, locations, minimum unbonded length, minimum bond lengths, soil- or rock-grout bond strength, corrosion protection requirements, and limitations on anchor inclination. The Contractor is then responsible for selecting the type of anchor and designing the anchor system to conform with the prescribed design criteria. In order to use the performance specification, sufficient foundation information must be given to permit the Contractor to accurately estimate the design and installation costs.For the prescriptive specification tailoring option, the design of the anchors must be completely shown on the drawings and must include location, design load, unbonded and bonded length, drilling and grouting method, drill hole size, corrosion protection, and anchor inclination.

****

Prior to commencing any work on the anchors, the Contractor, including all field personnel to be involved in drilling and installation of the anchors, must meet with the Contracting Officer to review the drawings and specifications, work plans, and submittals. Drilling may commence upon approval of the anchor installation plan and procedures described in paragraph SUBMITTALS and after the conduct of the Preparatory Meeting.

1.1.1 General Requirements

Submit drawings and detailed installation procedures and sequences showing complete details of the installation procedure and equipment; anchor fabrication; grouting methods; grout mix designs; anchor [and casing] placement and installation; corrosion protection for bond length, stressing length and anchorage; anchorage and trumpet; stressing and testing procedures with lengths, forces, deformations, and elongations for the approval by the Contracting Officer. Shop drawings for anchors must include locations and details of the spacers, centralizers, and banding. If different types of anchors are to be installed, each anchor type must be readily identifiable. Once reviewed by the Contracting Officer, no changes or deviation from shop drawings will be permitted without further review by the Contracting Officer. The work includes design, fabrication and installation of the [soil] [rock] anchor system. Install and fabricate the anchors as shown on the drawings. Prepare fabrication and installation drawings and an installation plan for approval. [Soil] [Rock] anchors must be [threaded bar] [or] [strand] type.

1.1.2 Scope of Work

Provide the design of the [soil] [rock] anchor system that will be completely the Contractor's responsibility. General design criteria are [shown on the drawings] [given in paragraph Design Requirements]. The materials, design, stressing, load testing, and acceptance must be in accordance with PTI DC35.1 and these specifications.

a. [Soil] [Rock] anchors may be threaded bar or strand type. The Contractor is responsible for the design of the anchor and bearing plate, [determining top of rock], determining drilling methods, and determining hole diameter and bond length. Submit design computations and data for the [soil] [rock] anchors, bearing plates, and bond zones.

b. Include computations with drawings, design assumptions, calculations, and other information in sufficient detail to verify the design proposed. The design must be certified by a registered Professional Engineer with proven experience in design of [soil] [rock] anchor components as stated in paragraph Qualifications. Include calculations for the stressing frames.

c. The Contracting Officer will approve the design calculations. Approval of the design calculations will not relieve the Contractor of responsibility for unsatisfactory performance of the installed [soil] [rock] anchors. Furnish all design computations at least [30] [_____] calendar days prior to the proposed commencement of drilling. The complete design, including design computations, fabrication and installation drawings and installation plan, must be certified by a registered Professional Engineer and must be submitted for approval.

d. Submit a plan for installing the [soil] [rock] anchors for review and comment. The proposal must describe the sequence for installation and other restrictions as outlined on the drawings or specified. Determine the anchor [and casing] installation procedures as part of the anchor design. Include the installation plan with descriptions of methods and equipment to be used for alignment checking of anchor holes [and casings]. [Payment for [soil and] rock anchors, as specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES, must include all costs in connection with designing, fabricating, and installing the anchors.]

1.1.3 Anchor Design

****

NOTE: The following information must be provided to the Contractor to facilitate the design of the

anchor system. The anchor location, Design Load (capacity) and angle of inclination will be determined by the design of the structure being anchored. If the design load cannot be determined by the Designer, this determination may be assigned to the Contractor, in which case, the specification must be appropriately modified. The Contractor will also be required to redesign the anchored structure to the extent required to accommodate the anchor design loads. Assumed soil or rock to grout bond strength will be determined from testing of the soil or rock in which the anchors are to be installed. Minimum required bond length will be determined in accordance with PTI DC35.1, Section 6.7. Type of grouting material will be determined by site conditions and the structure being anchored. Type of corrosion protection required will be determined in accordance with PTI DC35.1, Section 5.4

****

Design the individual [soil] [rock] anchors to meet the following criteria:

Anchor Location	As indicated
Horizontal [and] [Vertical] Spacing	[_____] m feet minimum, [_____] m feet maximum
Hole Diameter	[_____] mm inches minimum, [_____] mm inches maximum
Design Load	[_____] N kips
Assumed [Soil-][Rock-]Grout Bond Strength	[_____] MPa psi
Minimum Unbonded Length	[4.6] [_____] m [15] [_____] feet
Minimum Required Bond Length	[4.6] [_____] m [15] [_____] feet
Maximum Bond Length	[[Rock:] [10.7] [_____] m [35] [_____] feet] [Soil Type 1:] [10.7] [_____] m [35] [_____] feet [[Soil Type 2:] [10.7] [_____] m [35] [_____] feet [Soil Type 3:] [10.7] [_____] m [35] [_____] feet]
Corrosion Protection	Class [I, Encapsulated Tendon] [II, Grout Protected Tendons]
Angle of Anchor Inclination	[_____] rad degrees from vertical [with a tolerance of ± [0.05] [_____] rad [3] [_____] degrees]

1.1.3.1 Design Load

The Design Load must not exceed 60 percent of the ultimate strength of the prestressing steel. The Lock-off Load must not exceed 70 percent of the ultimate strength of the prestressing steel. The maximum Test Load must not exceed 80 percent of the ultimate strength of the prestressing steel. The designer should include consideration of group effect of closely spaced anchors when determining design load and minimum spacing. Design the bearing plates so that the bending stresses in the plate do not exceed the yield strength of the steel when a load equal to 95 percent of the minimum specified ultimate tensile strength of the prestressing steel is applied and so that the average bearing stress on the structure does not exceed [24.1] [_____] MPa [3500] [_____] psi. Design the anchorage assembly connection to the structure in accordance with [AISC 325] [ACI 318M ACI 318].

1.1.3.2 Design Schedule

Submit a design schedule for the anchors which includes the following:

a. Anchor number.

b. Anchor design load.

c. Type and size of tendon.

d. Minimum total anchor length.

e. Minimum bond length.

f. Minimum tendon bond length.

g. Minimum unbonded length.

h. Details of corrosion protection, including details of anchorage and installation.

i. Submit the design schedule at least 30 days prior to commencement of work on the anchors covered by the schedule.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	(2020) Specifications for Structural Concrete
ACI 301M	(2020) Metric Specifications for Structural Concrete
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5CT	(2018) Casing and Tubing

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588/A588M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion

	Resistance
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A779/A779M	(2016) Standard Specification for Steel Strand, Seven-Wire, Uncoated, Compacted, Stress-Relieved for Prestressed Concrete
ASTM A882/A882M	(2020) Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Steel Strand
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C144	(2024) Standard Specification for Aggregate for Masonry Mortar
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials

POST-TENSIONING INSTITUTE (PTI)

PTI DC35.1	(2014) Recommendations for Prestressed Rock and Soil Anchors
PTI TAB.1	(2006) Post-Tensioning Manual

1.3 SITE CONDITIONS

****

NOTE: Where unique site conditions are anticipated, as evidenced by drilling performance such as loss of drill water, the information should be clearly presented on the drilling logs or otherwise made known to the Contractor. Generally, the plans and specifications should provide sufficient information to clearly identify anticipated foundation conditions. If, based on available information and site conditions, it is anticipated that additional foundation exploration will be required by the Contractor, this work should be added to the specifications.

****

A foundation investigation has been conducted at the site by the government and data is presented on the foundation exploration drawings. [Logs of core borings] [subsurface soil data logs] are shown on the drawings. While the foundation information is representative of subsurface conditions at the respective locations, local variations in the characteristics of the subsurface materials may be anticipated. Local variations which may be encountered include, but are not limited to, classification and thickness of rock strata, fractures, and other discontinuities in the rock structure, and variation in the soil classifications. Such variations will not be considered as differing materially within the purview of the contract clauses, paragraph differing site conditions. [Core from the borings indicated] [additional foundation data] are available for inspection as specified in the special contract requirements, paragraph physical data. The contractor is responsible for verifying the location of all utilities that may be affected by construction or the installation of the anchors.

1.4 BASIS OF BID

****

NOTE: Select one of the following options:

****

****

NOTE: Use "Lump Sum" paragraph below for lump (principal) sum bidding of anchors. Clearly show number of anchors, anchor capacity, anchor locations, and elevations on the drawings.

Use "Unit Price" paragraph for unit price bidding of anchors. Specify unit price bid items for anchors only for projects where exact quantities cannot be practically determined prior to the actual work. Lengths of anchors must be determined as accurately as possible, prior to bidding, since the unit price per meter foot of the anchors varies as the length

increases or decreases.
****

[1.4.1 Lump Sum Payment

****
NOTE: Use this paragraph for lump-sum contracts, consult with Contracting Officer's Technical Representative (Geotechnical Branch) on applicability of use prior to selection. This paragraph will be typically used when there are relatively small quantity of anchors. Delete this paragraph for unit-price contracts.
****

Base bids upon providing the number, size, capacity, and length of anchors as indicated on the [drawings]. Include the cost of all necessary equipment, tools, material, labor, and supervision required to: deliver, handle, install, grout, test, cut-off, dispose of any cut-offs, and meet the applicable contract requirements. Include mobilization, pre-drilling, and redrilling anchors. If it is found that any anchor is not of sufficient length to provide the capacity specified, notify the Contracting Officer, who reserves the right to increase or decrease the total length of anchors to be provided and installed by changing the anchor locations, requiring the installation of additional anchors, or directing the omission of anchors from the requirements shown and specified. If total number of anchors or number of each length vary from that specified as the basis for bidding, an adjustment in the contract price or time for completion, or both, will be made in accordance with the contract documents. Payment for anchors will be based on successfully installing anchors to satisfy the acceptance criteria. No additional payment will be made for: damaged, rejected, or misplaced anchors; withdrawn anchors; or other excesses beyond the assumed anchor length indicated for which the Contractor is responsible. [Include payments for vibration monitoring, sound monitoring and precondition construction surveys].

]1.5 UNIT PRICES

****
NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
****

1.5.1 Drilling Holes in Soil

****
NOTE: This payment item will be used only when a prescriptive specification is desired. It will be deleted when a performance specification is desired.
****

1.5.1.1 Payment

Payment will be made for costs associated with Drilling Holes in Soil.

1.5.1.2 Measurement

Drilling Holes in soil will be measured for payment to the nearest 300 mm foot, based upon the meters linear feet of hole actually drilled in soil in accordance with the specifications.

1.5.1.3 Unit of Measure

Meter Linear foot.

1.5.2 Drilling Holes in Rock

****

NOTE: This payment item will be used only when a prescriptive specification is desired. It will be deleted when a performance specification is desired.

****

1.5.2.1 Payment

Payment will be made for costs associated with Drilling Holes in Rock.

1.5.2.2 Measurement

Drilling Holes in Rock will be measured for payment to the nearest 300 mm foot, based upon the meters linear feet of hole actually drilled in rock in accordance with the specifications.

1.5.2.3 Unit of Measure

Meter Linear foot.

1.5.3 [Soil] [Rock] Anchors

****

NOTE: This payment item will be used only when a prescriptive specification is desired. It will be deleted when a performance specification is desired.

****

1.5.3.1 Payment

Payment will be made for costs associated with furnishing and installing [Soil] [Rock] Anchors. No payment will be made for anchors which do not meet the acceptance criteria.

1.5.3.2 Measurement

[Soil] [Rock] Anchors will be measured for payment to the nearest 300 mm foot, based upon the meters linear feet of anchor actually installed below the bearing plate in accordance with the specifications.

1.5.3.3 Unit of Measure

Meter Linear foot.

1.5.4 Performance Tests

1.5.4.1 Payment

Payment will be made for costs associated with performing Performance Tests on anchors which are accepted.

1.5.4.2 Measurement

Performance Tests will be measured based upon the number of tests performed.

1.5.4.3 Unit of Measure

Each.

1.5.5 Proof Tests

1.5.5.1 Payment

Payment will be made for costs associated with performing Proof Tests on anchors which are accepted.

1.5.5.2 Measurement

Proof Tests will be measured based upon the number of tests performed on anchors which are accepted in accordance with the specifications.

1.5.5.3 Unit of Measure

Each.

1.5.6 Creep Tests

1.5.6.1 Payment

Payment will be made for costs associated with performing Creep Tests on anchors which are accepted. No payment will be made for creep tests on anchors which do not meet the acceptance criteria.

1.5.6.2 Measurement

Performance Tests will be measured based upon the number of tests performed on anchors which are accepted in accordance with the specifications.

1.5.6.3 Unit of Measure

Each.

1.5.7 [Soil] [Rock] Anchors, Complete

****

NOTE: This payment item will be used only when a performance specification is desired. It will be deleted when a prescriptive specification is desired.

If significant variation in length and/or type of anchors is anticipated, separate payment items should be considered for different ranges in anchor length.

****

1.5.7.1 Payment

Payment will be made for costs associated with furnishing and installing [Soil] [Rock] Anchors, Complete which are accepted. The price must include installation of anchors and proof testing as specified. No payment will be made for anchors which do not meet the acceptance criteria, except when failure is due to lower than assumed [soil-][rock-]grout bond strength or other information furnished by the Government.

1.5.7.2 Measurement

[Soil] [Rock] Anchors, Complete will be measured based upon the number of anchors installed and accepted in accordance with the specifications.

1.5.7.3 Unit of Measure

Each.

1.5.8 Watertightness Testing

****

NOTE: This payment item will be deleted when watertightness testing is not required.

****

1.5.8.1 Payment

Payment will be made for costs associated with Watertightness Testing.

1.5.8.2 Measurement

Watertightness Testing will be measured for payment based upon the number of watertightness tests actually performed at the direction of the Contracting Officer and in accordance with the specifications or as otherwise required.

1.5.8.3 Unit of Measure

Each.

1.5.9 Pregrouting Holes

****

NOTE: This payment item will be deleted when hole pregrouting is not required.

****

1.5.9.1 Payment

Payment will be made for costs associated with Pregrouting Holes [which fail] [prior to] watertightness testing.

1.5.9.2 Measurement

Pregrouting Holes will be measured for payment based upon the number of 94-pound bags of cement grout or neat cement grout that were actually injected into the anchor hole as specified.

1.5.9.3 Unit of Measure

Bags of cement (42 kg 94 lbs).

1.5.10 Redrilling Grouted Holes

****

NOTE: This payment item will be deleted when grouted hole redrilling is not required.

****

1.5.10.1 Payment

Payment will be made for costs associated with Redrilling Grouted Holes.

1.5.10.2 Measurement

Redrilling Grouted Holes will be measured for payment to the nearest 300 mm foot, based upon the meters linear feet of hole actually drilled in grout in accordance with the specifications.

1.5.10.3 Unit of Measure

Meter Linear foot.

1.6 DEFINITIONS

The following definitions are in addition to those given in PTI DC35.1, Section 2.0:

1.6.1 Anchored Structure

The wall, foundation or other structure to which the anchor is to transfer force.

1.6.2 Demonstration Test Anchor

An anchor which is performance tested to verify design assumptions and installation practices.

1.7 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Fabricator Qualifications; G, [_____]

Installer Qualifications; G, [_____]

SD-02 Shop Drawings

Fabrication and Installation Drawings; G, [_____]

SD-03 Product Data

Equipment

Designer Qualifications; G, [_____]

Core Logging and Soil Sampling; G, [_____]

Installation Plan; G, [_____]

SD-05 Design Data

Design Computations; G, [_____]

Anchor Design; G, [_____]

Design Schedule

SD-06 Test Reports

Prestressing Steel

Cement Grout Mixture Proportions

SD-07 Certificates

Prestressing Steel

Epoxy-Coated Steel Bars

Cement

Bearing Plate

Epoxy Coating

Corrosion Inhibiting Compound

SD-08 Manufacturer's Instructions

Polyester Resin Grout

Resin Grouted Anchors

SD-11 Closeout Submittals

Driller Logs

Anchor Records

1.8 QUALITY ASSURANCE

Submit anchor designer, fabricator and installer qualifications for approval in accordance with paragraph SUBMITTALS. The submittals must, where applicable, identify individuals who will be working on this contract and their relevant experience. No changes must be made in approved personnel without prior approval of the Contracting Officer.

1.8.1 Designer Qualifications

The anchors must be designed by Professional Engineers who have designed a minimum [three] [_____] [soil] [rock] anchors projects similar in size and scope to this project within the past ten years. The drawings and calculations must be signed by the Professional Engineer.

1.8.2 Fabricator Qualifications

The anchors must be fabricated by a manufacturer that has been in the practice of designing and fabricating [soil] [rock] anchors similar in size and scope to this project for at least [ten] [_____] years.

1.8.3 Installer Qualifications

Submit the qualifications and experience records for approval. In the experience record, identify all the individuals responsible for the anchors and must include a listing of projects of similar scope performed within the specified period along with points of contact. Qualifications prior to the installation of any anchors specified in this section. The anchors must be installed by a firm which is regularly engaged in the installation of [soil] [rock] anchors and has at least [ten] [_____] years experience in the installation of similar anchors. The superintendent must have installed anchors on at least [five projects of similar scope and size] [___ years of experience installing ground anchors].

[1.8.4 Core Logging and Soil Sampling

****
NOTE: Core logging and soil sampling should only be required when necessary to verify design assumptions or to provide additional foundation information.
****

Logging of core and preparation of drilling logs and records must be performed by a [Registered] Geologist or Geotechnical Engineer who has at least [five] [_____] years experience in identifying and logging rock core and soil samples.

]1.9 DELIVERY, STORAGE, AND HANDLING

Materials must be suitably wrapped, packaged or covered at the factory or shop to prevent being affected by dirt, water, oil, grease, and rust. Protect materials against abrasion or damage during shipment and handling. Place materials stored at the site above ground on a well-supported platform and covered with plastic or other approved material. protect materials from adjacent construction operations. Grounding of welding leads to prestressing steel will not be permitted. Reject and remove from the site prestressing steel which is damaged by abrasion, cuts, nicks, heavy corrosions, pitting, excessive heat, welds or weld spatter. Inspect tendons prior to insertion into anchor holes for damage to corrosion protection. Repair any such damage in a manner recommended by the tendon manufacturer and approved by the Contracting Officer. Lifting of pre-grouted tendons must be to manufacturers' recommendations and not cause excessive bending, which can debond the prestressing steel from the surrounding grout.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Prestressing Steel

Submit certified test reports for each heat or lot of prestressing steel with materials delivered to the site. [Strands must conform to PTI DC35.1 -14 Section 4.2.1.] Submit [5] [_____] copies of mill reports and [5] [_____] copies of a certificate from the manufacturer stating chemical properties, ultimate strengths, yield strengths, modulus of elasticity, and any other physical properties needed for the required computations, for the type of steel furnished.

2.1.1.1 High-Strength Steel Bars

ASTM A722/A722M, Type [I] [or] [II], meeting all supplementary requirements.

2.1.1.2 Epoxy-Coated Steel Bars

Submit written certification for coating material and coated bars with the delivery of the bars. Epoxy coated steel bars must conform to PTI DC35.1 -14 Section 4.2.4. Coating at the anchorage end may be omitted over the length provided for threading the nut against the bearing plate.

2.1.1.3 Steel Bar

[ASTM A615/A615M] [ASTM A108, Grade [___]].

2.1.1.4 Strand

ASTM A416/A416M, Grade [1725] [1860] [250] [270], low relaxation strand. Do not weld strand.

2.1.1.5 Compact Strand

ASTM A779/A779M, Type [1790] [1860] [260] [270], low relaxation strand. Strand must not be welded.

2.1.1.6 Epoxy Coated Strand

ASTM A882/A882M, Grade [1725] [1860] [250] [270], including Supplementary Requirements S1.

2.1.2 Structural Steel

ASTM A36/A36M [ASTM A572/A572M, Grade 345 50] [ASTM A588/A588M] [ASTM A709/A709M Grade [248] [345] [36] [50]].

2.1.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Steel Tube

[ASTM A500/A500M] or [API Spec 5CT, Grade N-80, Oil Field Seconds / Mill Secondary Tubing].

2.1.5 Ductile Iron Castings

ASTM A536.

2.1.6 Polyethylene Tubing

2.1.6.1 Smooth Polyethylene Tubing

[ASTM D3350] [ASTM D1248, Type III].

2.1.6.2 Corrugated Polyethylene Tubing

PTI DC35.1-14 Section 4.7, with average minimum wall thickness of 1.5 mm 0.06 inch.

2.1.7 Smooth Polypropylene Tubing

ASTM D4101, designation PP 210 B5542-11.

2.1.8 Polyvinyl Chloride (PVC) Pipe

ASTM D1785[, Schedule 40].

2.1.9 Polyvinyl Chloride (PVC) Tubing

2.1.9.1 Smooth Polyvinyl Chloride (PVC) Tubing

ASTM D1784. [Class 12454 or 13464.]

2.1.9.2 Corrugated Polyvinyl Chloride (PVC) Tubing

Manufactured from rigid PVC compounds conforming to ASTM D1784, Class 13464-8 with average minimum wall thickness of 1.0 mm 0.04 inch.

2.1.10 Heat Shrinkable Sleeve

Radiation crosslinked polyolefin tube internally coated with an adhesive sealant and conforming to PTI DC35.1-14 Section 4.8.1.

2.1.11 Corrosion Inhibiting Compound

The corrosion inhibiting compound must conform to the requirements of Section 4.6 of PTI DC35.1-14.

2.2 MANUFACTURED UNITS

2.2.1 Anchor Head

Anchor head must consist of [steel bearing plate with wedge plate and wedges for strand anchors] [or] [steel bearing plate with nut for bar anchors], trumpet and corrosion protection. Submit bearing plate material and details.

Anchorage devices must be capable of developing 95 percent of the guaranteed ultimate strength of prestressing steel. The anchorage devices must conform to the static strength requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and (2) of PTI TAB.1. [Wedges must be designed to not cause premature failure of the prestressing steel due to notching or pinching. Provide special wedges as required for epoxy coated strand. Removal of epoxy coating to permit use of standard wedges will not be permitted.] [Design threaded anchorage items for epoxy coated bars to fit over the epoxy coating and maintain the capacity of the prestressing steel.] Fabricate the trumpet used to provide a transition from the anchorage to the unbonded length corrosion protection from steel pipe or steel tube. The minimum wall thickness must be 3.0 mm for diameters up to 100 mm and 5.0 mm for larger diameters 0.125 inch for diameters up to 4 inches and 0.20 inch for larger diameters. Weld the trumpet to the bearing plate.

2.2.2 Prestressing Steel Couplers

[Prestressing steel couplers for bars must be capable of developing 100 percent of the minimum specified ultimate tensile strength of the prestressing steel.] [Splicing of strand will not be permitted.]

2.2.3 Centralizers and Spacers

Fabricate centralizers [and spacers] from plastic, steel or other approved material which is nondetrimental to the prestressing steel. Do not use wood. The centralizer must be able to support the tendon in the drill hole and position the tendon so a minimum of 13 mm 0.5 inch of grout cover is provided. Centralizers and spacers must permit grout to freely flow up the drill hole.

2.2.4 Casing

Casing must be [steel pipe] [or] [steel tube] [selected and sized by the Contractor where required. Casing must be the necessary type and size to permit proper drilling of anchor holes and placing of anchors as specified herein and shown on the drawings. Straightening of casings and machining of joints may be necessary in order to meet specified alignment tolerances.]

2.2.5 Anchorage Covers

****

NOTE: When the anchorage recess is to remain open, delete the last sentence. If anchor head has 75 mm 3 inches or more of concrete or non-shrink grout cover, the anchorage cover may be eliminated and the anchorage coated to prevent corrosion.

****

Fabricate anchorage covers from steel or plastic. The material used must not be subject to attack by cement, corrosion-inhibiting greases or the environment. If plastic is used, it must not be susceptible to ultraviolet light degradation. Securely attach the cover to the bearing plate. If the cover is to be grease filled, the cover must form a permanent watertight enclosure for the anchorage device.

2.3 EQUIPMENT

The Contractor's Quality Control manager must verify that the equipment used on site is the same as the equipment submitted for approval. Submit catalog cuts, brochures, or other descriptive literature describing the equipment to be used for drilling, grouting, handling, and installing the [soil] [rock] anchors. Submit sketches, drawings or details showing the access and temporary supports where required for the drilling equipment and stressing frames. Provide descriptions of stressing jacks, gages, dynamometers, load cells, or other devices for measuring stressing load, certified calibration records for each set of jacking equipment, and current testing curves for stress measurement gages which show that gages have been calibrated for the jacks for which they are used [30] [_____] days prior to the start of the testing operations.

2.3.1 Drilling Equipment

Provide drilling equipment suitable for advancing the drill tools to the depths and at the alignment [specified][required].

2.3.2 Grouting Equipment

2.3.2.1 Grout Mixer

Grout mixer must conform to PTI DC35.1-14 Section 7.8.1.

2.3.2.2 Grout Pump

The grout pump must be of the positive displacement type, and must be capable of pumping at all flow rates below [75] [_____] L/minute [20] [_____] gpm, must be capable of pumping at the pressure of at least 345 [_____] kPa [50] [_____] psi at zero flow rate. For neat cement grout, the pump must have a screen with [3] [_____] mm [0.125] [_____] inch maximum clearance to sieve the grout before being introduced into the pump. Screens are not required for shear type mixers. Make available a pump which is capable of pumping both neat cement grout mixes and sanded grout mixes. The pumping equipment must have a pressure gage capable of measuring pressures of at least 1.0 MPa 150 psi or twice the required grout pressure, whichever is greater.

2.3.3 Stressing Equipment

Stressing equipment must be hydraulically operated and must have a capacity sufficient to stress the anchors to the [specified][required] Test Loads within the rated capacity in one stroke. Pumps must be capable of applying each load increment in less than 60 seconds and must be capable of maintaining the hydraulic pressure within 345 kPa 50 psi. The equipment must permit stressing of the tendon in increments and raising or lowering the load in the tendon. [Stressing equipment for strands must be capable of stressing all elements equally and simultaneously.] Calibrate the equipment with an accuracy of ±2 percent and ensure that the calibration certificate and graphs must be available at the site. The production gage must have graduations of 500 kPa 100 psi or less. Maintain a second certified gage for periodic verification of the production gage. Provide a dial gage or approved device to measure total tendon elongation at each load increment to the nearest 0.03 mm 0.001 inch. The dial gage must be capable of measuring the entire anchor movement without being reset. Verify the calibration of gages no more than 30 calendar days prior to commencing work under this contract and at six-month intervals throughout the period of use.

2.3.4 Testing Equipment

Provide testing equipment consisting of a hydraulic jack with calibrated pressure gage for applying the load and a dial gage or vernier scale to measure anchor movement. The ram travel of the stressing equipment must be not less than the theoretical elastic elongation of the total anchor length at the maximum Test Load. Graduate the pressure gage in [500] [_____] kPa [100] [_____] psi increments. Calibrate the stressing equipment and pressure gage as a unit no more than 30 calendar days prior to commencing work under this contract and at six-month intervals throughout the period of use. The movement measuring device must have a minimum travel equal to the theoretical elastic elongation of the total anchor length at the maximum Test Load without resetting the device.[Provide an approved dial gage or vernier scale and stand to measure movement of the [wall] [structure].]

2.4 GROUT

2.4.1 Cement

****

NOTE: When the ambient rock temperature is below 10 degrees C 50 degrees F, Type III cement may be necessary.

****

ASTM C150/C150M, Type I, II, III or V.

2.4.2 Water

Provide fresh, clean, potable water free from injurious amounts of sewage, oil, acid, alkali, salts, or organic matter.

2.4.3 Aggregates

Fine aggregate for sand-cement grout must conform to ACI 301MACI 301 and [ASTM C33/C33M for grout for backfilling holes] [or ASTM C144 for grout for pregrouting]. Aggregates must not contain substances which may be deleteriously reactive with alkalis in the cement.

2.4.4 Admixtures.

****

NOTE: Accelerators are not permitted because of concern that they may cause corrosion of the prestressing steel. Only plasticizers or retarders should be permitted when necessary for hot conditions or long pumping distances.

****

Admixtures which control bleed, improve flowability, reduce water content and retard set may be used in the grout subject to the approval of the Contracting Officer. Any admixtures used must be compatible with the prestressing steel and must be mixed in accordance with the manufacturer's recommendations.

2.4.5 Grout for Anchors

****

NOTE: Ground and rock ambient temperatures may only have an effect on the grout when they are below 10 degrees C 50 degrees F or when polyester resin grout is used. If unusual ground or rock temperatures are known to exist, this information should be provided to the Contractor

****

2.4.5.1 Cement Grout

Cement grout must conform to PTI DC35.1-14 Section 6.11 and Section 7.8.2.3. Submit cement grout mixture proportions.

2.4.5.2 Polyester Resin Grout

****

NOTE: Polyester resin grout should not be used for anchors installed in wet holes. Single stage grouting can be accomplished with polyester resin grout by using fast setting resin grout in the bond zone and slower setting resin grout in the free stressing zone. The cure times of the resin grout will be affected by ground or rock ambient temperatures.

****

Polyester resin grout must consist of high strength, unsaturated polyester resin filled with nonreactive, inorganic aggregate and a separated catalyst contained in a tube of polyester film or glass. Gel time and cure time must be appropriate for the installation procedures. The polyester resin grout must have the following minimum properties:

Compressive Strength	83 MPa 12000 psi
Tensile Strength	27.6 MPa 4000 psi
Shear Strength	20.7 MPa 3000 psi

Resin cartridges with expired shelf life are not allowed.

2.4.6 Sand-Cement Grout

****

NOTE: Where an excessive volume of neat cement grout is required for pregrouting holes or grouting holes which fail watertightness tests, sand-cement grout may be used. The section below provides two options for sand-cement grout mix. The first option for grout mix is suitable for normal applications. When a specific strength grout is required, the second option should be used.

****

Grout for waterproofing holes, grouting holes which fail the watertightness test, and for backfilling holes which are abandoned must consist of a mixture of portland cement, [fine aggregate] [masonry sand] and water. [The grout must consist of one-part portland cement and two parts fine aggregate by volume, mixed with sufficient water to provide a uniform consistency.] [The grout mix proportions are the responsibility of the Contractor. Submit the proposed mix design to the Contracting Officer for approval. The water content must be the minimum necessary for proper placement. Base the final proportions of materials on results of tests made on sample mixtures of grout. The minimum compressive strength of two-inch cubes, molded, cured, and tested in accordance with ASTM C109/C109M, must be [27.6] [_____] MPa [4,000] [_____] psi.] The Contractor is responsible for taking, curing, and breaking of grout test cubes for determining mix design, and all testing must be done by an independent laboratory approved by the Contracting Officer. [Replicate [soil] [rock] conditions and temperatures in the curing process.]

2.4.7 Grout for Anchor Pads

Use nonshrink grout conforming to ASTM C1107/C1107M for leveling bearing plates.

2.5 TENDON FABRICATION

****

NOTE: The tendon consists of the prestressing steel, anchorage, corrosion protection, centralizers and spacers, and sheathing where required. For fully bonded anchors, the free stressing length is grouted after stressing. For unbonded anchors, the free stressing length is provided with bond breaker to prevent bonding with the grout or two-stage grouting is performed.

****

2.5.1 General

Fabrication of the anchors must be as recommended by the suppliers. Completely assemble anchors with all [centralizers], [spacers], grout and vent tubes and corrosion protection prior to insertion into the hole. Protect, transport and store fabricated anchors in a manner to prevent contamination or damage to any components.

2.5.2 Tendon

Locate all spacers for multiple element tendons as indicated on the approved shop drawings. Furnish strands full length with no splicing or coupling permitted. Tendon material must be unblemished and free of pitting, nicks, grease, or injurious defects. When required to maintain the tendon location within the hole, provide centralizers at a maximum of [3] [_____] meter [10] [_____] foot intervals center-to-center throughout the bond length. [Provide spacers at a maximum [3] [_____] meter [10] [_____] foot intervals center-to-center throughout the bond length.] The entire bond length of the tendon must be free of dirt, lubricants, loose rust, corrosion-inhibiting coatings or other contaminants.

2.5.3 Bond Breaker

Bond breaker for free stressing length of unbonded anchors must consist of smooth polyethylene tubing, minimum wall thickness 1 mm 0.04 inch, or smooth PVC tubing, minimum wall thickness 1.0 mm 0.04 inch.

2.5.4 Vent Tubes

Vent tubes used during grouting operations, if necessary, must be any appropriate type for the job, as recommended by the supplier of the anchors.

2.5.5 Grout Tubes

Grout tubes must be polyethylene tubing or as recommended by the anchor manufacturer and approved by the Contracting Officer. Inside diameter of grout tubes must be adequate to fully grout the entire hole.

2.5.6 Corrosion Protection

****

NOTE: Type of corrosion protection required will be determined in accordance with PTI DC35.1, Paragraph 5.3. Fusion bonded epoxy coatings may contain holidays and may be damaged during fabrication and installation, therefore epoxy coating should not be relied on to provide adequate corrosion protection. The grout or encapsulation must be included in the corrosion protection design. The paragraphs on encapsulation will be included for Class I (Encapsulated Tendon) corrosion protection. Additional corrosion protection may not be required for temporary anchors.

****

Corrosion protection must be as indicated. Provide corrosion protection for the entire anchor and include anchorages covers and trumpets filled with corrosion inhibiting compound or grout and encapsulation of the free stressing length and bond length.

2.5.6.1 Anchorage Protection

****

NOTE: Compound filled trumpets should only be used for restressable anchors or anchors with permanent load cells.

****

The trumpet must be sealed to the bearing plate and must overlap the free stressing length encapsulation by at least 100 mm 4 inches. The trumpet and anchorage cover must be completely filled with corrosion inhibiting compound or grout. Compound filled trumpets must have a permanent seal between the trumpet and the free length corrosion protection.

2.5.6.2 Free Stressing Length Encapsulation

****

NOTE: Encapsulation of the free stressing length is intended to provide corrosion protection in the free stressing length. If corrugated tubing or heat shrinkable sleeve is used for encapsulation for unbonded anchors, a separate bond breaker must be used.

****

Encapsulation for free stressing length must consist of a sheath of smooth polyethylene tubing, minimum wall thickness 1.5 mm 0.06 inch; smooth polypropylene tubing, minimum wall thickness 1.5 mm 0.06 inch; smooth PVC tubing, minimum wall thickness 1.0 mm 0.04 inch; steel pipe or tube with minimum wall thickness 5.0 mm 0.20 inch or corrugated tubing conforming to paragraph Bond Length Encapsulation. Sheath for bars and strands may be heat shrinkable sleeve with a minimum thickness of 0.6 mm 0.024 inch. Free stressing length encapsulation must extend at least 100 mm 4 inches into the trumpet, but must not contact the bearing plate during testing and stressing of the tendon. [Where corrugated tubing is used for sheath for unbonded anchors, a separate bond breaker must be provided.]

2.5.6.3 Bond Length Encapsulation

****

NOTE: Encapsulation of the bond length for Class I (Encapsulated Tendon) corrosion protection is intended to provide corrosion protection in the bond zone and transfer stresses from the prestressing steel through the grout. For Class II (Grout Protected Tendons) corrosion protection, the grout provides the only corrosion protection in the bond zone, and separate encapsulation will not be specified.

****

Bond length encapsulation must consist of corrugated polyethylene tubing, minimum wall thickness 1.5 mm 0.060 inch or corrugated PVC tubing, minimum wall thickness 1.0 mm 0.040 inch.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

Perform required material tests, on prestressing steel and accessories, by an approved laboratory to demonstrate that the materials are in conformance with the specifications. Test grout in accordance with ASTM C109/C109M. These tests will be at the Contractor's expense. Furnish to the Contracting Officer prestressing steel test results prior to beginning fabrication of any anchors and within 24 hours of testing.

PART 3 EXECUTION

3.1 DRILLING HOLES

3.1.1 General

****

NOTE: If redesign of anchored structures due to relocation of anchors is to be performed by the Contractor, the appropriate design criteria must be furnished by the Government.

Limitations on distance between grout holes and holes being drilled is based on prevention of washout of fresh grout by drill water. The actual distance, if required, should be determined on the basis of integrity of the rock and whether or not the hole was pregrouted.

When environmental considerations require containment and disposal of waste water, the last two sentences should be included and the work should be coordinated with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

****

The [top of bond zone elevations] [and other] physical conditions indicated on the drawings are the result of [soil sampling] [and] [core borings]. (See also paragraph "PROJECT SITE CONDITIONS"). Drill holes at the locations and inclinations shown and to the depths and diameters determined by the Contractor to provide the design bond length and capacity indicated on the drawings. The locations of the holes may be changed only as approved by the Contracting Officer. Any redesign of the [anchored structure] [_____] due to relocation of anchor holes [must be performed by the Government] [must be performed by the Contractor]. Unless otherwise specified, theThe Contractor must determine the drilling method to be used. Do not drill holes within [[15] [_____] meters [50] [_____] feet of] a grouted hole until the grout has set at least 24 hours. [Do not preform pressure grouting and drilling simultaneously within a distance of [15] [_____] meters [50] [_____] feet.] Take care while drilling to avoid damage of any kind to the existing structures. Damages of any nature will be evaluated by the Contracting Officer and repairs or replacements must be made as required. Drill holes a maximum of [1] [_____] meter [3] [_____] feet beyond the required anchor bond length. Provide a temporary plug for all holes drilled more than 10 days prior to installation of the anchor. [Collect, recycle, or treat waste water from drilling operations; do not discharged directly into the [river] [water] or on the ground. See also Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS].

3.1.2   Drilling Through Existing Structures

****

NOTE: Core drilling through existing structures should only be required where close tolerances are required or where vibrations from other drilling methods might be objectionable.

****

Drill holes through existing structure by [core drilling equipment to prevent] [any method which does not cause] damage to the surrounding structure. The Contractor is advised that foreign material, including metals and other materials remaining from original construction of the existing structure, may be encountered during drilling through existing structures.

3.1.3   Drilling in Soil

****

NOTE: Where loss of surrounding material could endanger nearby structures, the casing should be advanced by methods which preclude removal of material surrounding the casing, such as use of duplex method with annular flow of drill water or fluid between the inner drill string and the casing.

****

Holes in soil may be drilled by rotary drilling, rotary percussive, or vibratory driven casing. Holes in soil must be provided with steel casing where required for support of the surrounding material. [Remove casing [prior to] [during] anchor grouting.] [Remove hollow-stem augers which are used for installation of the tendon during anchor grouting.] Where soil is susceptible to caving, holes through soil must be drilled by the duplex method using an inner and outer casing with return water flow between the casings.

3.1.4   Casing

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NOTE: Casing may also be required to span voids when drilling through existing structures.

****

Utilize casing for drilling through unstable soil formations [and] [_____]. Advance the casing by [rotary drilling] [or] [driving].

[3.1.5   Drilling in Rock

****

NOTE: Core drilling is more expensive and slower than other drilling methods and should be specified only where excessive vibration could endanger existing structures or would otherwise be objectionable, where it is expected that embedded items will be encountered in an existing structure, or as otherwise determined by the designer to be necessary. Anchor holes which are core drilled may require overdrilling with a roller bit or other approved means to roughen the circumference of the

hole to promote bond with the grout. Where existing foundation information is not complete, e.g. when anchoring existing structures, it may be advisable to require core drilling for initial (demonstration test) anchor holes in each area to determine the nature of the rock material and permit determination of actual hole depths. If sufficient foundation information cannot be provided to permit the Contractor to estimate design and installation of the anchors prior to bidding, the prescriptive tailoring option should be used.

****

Unless otherwise specified, holesHoles in rock may be drilled by core drilling, rotary drilling, percussion drilling or down-the-hole hammer using equipment suitable for the intended purpose. [The drilling method must not cause structural damage to existing structures. Modify drilling method if damage is observed.] [Perform core drilling with rotary drilling equipment using diamond-matrix coring bits.] [Core from holes must be furnished to the Contracting Officer in core boxes at the site for information. Additional drilling may be required based on the quality of the rock encountered. Rock core from demonstration test anchor holes only must be retained by the Contractor for the duration of the contract as specified in paragraph "Retention of Core". Retention of core from other holes, after evaluation and release by the Contracting Officer, is not required.] Overdrilling of holes by a maximum of one meter three feet beyond the required elevation will be permitted if complete removal of cuttings and other material cannot be accomplished. If the hole is overdrilled, the tendon must be supported so that the free length corrosion protection extends the required length into the trumpet and so that the anchor can be stressed.

]3.1.6 Records

****

NOTE: If core recovery and logging is required to verify design assumptions or to provide additional foundation information, Section 02 32 13 SUBSURFACE DRILLING AND SAMPLING should be included in the project, or applicable portions should be inserted into this specification.

****

Submit driller logs and records as specified in paragraph Driller Logs. The presence of a Government inspector or the keeping of separate drilling records by the Contracting Officer must not relieve the Contractor of the responsibility for the work specified in this paragraph. Payment will not be made for any work for which the required records have not been furnished by the Contractor.

3.1.7 Alignment

****

NOTE: The specifier should consult PTI DC35.1, paragraph 7.3.5. Tolerances are governed by project-specific requirements. The practical lower bound is 0.01 rad 0.5 degree.

****

3.1.7.1 Tolerances

The anchor hole must be located within [300] [_____] mm [12] [_____] inches of the plan location. The entry angle must be within [0.05] [_____] rad [3] [_____] degrees of the specified inclination. The alignment of the drilled hole must be within [0.05] [_____] rad [3] [_____] degrees of the theoretical alignment. Check tolerance for each anchor hole. If the hole alignment is not within these tolerances, [the hole must be backfilled with cement or sand-cement grout and a new hole drilled adjacent to the rejected hole] [notify Contracting Officer and perform corrective measures as directd]. If tolerances cannot be maintained, then notify Contracting Officer.

3.1.7.2 Alignment Check

****

NOTE: Alignment checks are rarely performed for soil anchors. Alignment check should only be required when the actual alignment of the anchor is critical to the design of the structure. Situations where alignment is critical include: anchors through structures with voids or embedded items, where there is a possibility that anchors could intersect each other, and where the purpose of the anchors is overturning resistance.

****

Check each drilled hole for alignment as specified herein upon completion of drilling and before commencement of any other work. Check direction and inclination of all anchor holes for each [3-meter 10-foot] [_____] intervals throughout the hole. Checking the alignment of each anchor hole must be done by measuring the inclination of the actual drilled anchor hole center line in place with respect to the specified anchor center line. The specified anchor center line must consist of a single, straight, continuous line extending from the top of the hole to the required bottom elevation of the hole. Specified anchor centerlines must slope at the inclinations shown on the drawings. The Contracting Officer must have access to holes for alignment surveys that may include, but not be limited to, slope indicators or other down-the-hole equipment. Drill rods may be required to be removed from the hole or left in place as directed by the Contracting Officer. Holes, or portions of holes, which are out of alignment must be corrected or filled with cement grout having a water-cement ratio of 0.40 or sand-cement grout, and a new hole drilled as directed by the Contracting Officer. Slight adjustments to inclinations indicated on the drawings may be required, as directed by the Contracting Officer. The Contractor is responsible for all drilled holes until accepted by the Contracting Officer. Holes to replace incorrectly drilled holes must be drilled at no additional cost to the Government. All equipment for checking alignment of anchor holes must be operated by personnel experienced in the operation of such equipment.

3.1.7.3 Alignment Checking Equipment

****

NOTE: Because of the expense involved, the down-hole gyrocompass should only be used when there is a reasonable anticipation that embedded metal will be encountered within the structure in sufficient mass to affect the magnetic compass. In

such case, an appropriate payment item for a cost per day should be included.
****

Check alignment of holes by means of a magnetic single shot survey instrument, or equal equipment, and selected based on the maximum expected range of angle deviation to be measured. [If embedded metal within the structure is reasonably believed to have affected the standard magnetic compass, then a down-hole gyrocompass may be required. Payment for use of the gyrocompass will be made at the contract unit price per day.]

3.1.8 Watertightness Testing

****
NOTE: Anchor holes should be watertight to prevent loss of grout from the rock zone, prevent dilution of grout prior to setting, and prevent corrosion of the tendon. Watertightness testing should be performed where any of the following conditions are known to occur or where sufficient data is not available to adequately determine the integrity of the rock:

a. the rock formation has open fractures which would permit loss of grout from around the prestressing steel after initial placement.
b. artesian water flow or seepage exists in the strata where the rock anchor is located.
c. interconnection exists between drilled holes.

Watertightness testing may be performed after drilling the hole or after pregrouting the hole. Where the rock is known to be highly fractured, pregrouting and redrilling should be considered prior to watertightness testing.
****

The rock portion of all drilled holes must be watertightness tested in accordance with the procedures of PTI DC35.1, Section 7.5. A packer must be used where necessary to facilitate pressure testing of the bond zone. Holes which have a water loss in excess of [9.5] [_____] liters [2.5] [_____] gallons in ten minutes must be grouted as specified in paragraph Waterproofing Anchor Holes, and redrilled.

3.1.9 Waterproofing Anchor Holes

****
NOTE: Where the rock is known to be fractured or have interconnections, pregrouting of the hole prior to watertightness testing may be required. Where the rock in the free stressing zone is fractured and where the anchor is installed through unconsolidated material, a packer will be required to properly grout the rock. Waterproof grouting of anchor holes should only be done with a Government representative present to avoid overruns in the amount of grout used. When cement grout take is excessive, a sand-cement grout should be used.
****

The rock portion of anchor holes which fail the watertightness test must be [tremie] [pressure] grouted with cement grout as specified in paragraph Grout for Waterproofing or Backfilling Holes. [A packer must be installed at the top of rock.] Grouted holes must be redrilled while the grout strength is considerably less than that of the surrounding rock, but not less than [24] [_____] hours after grouting. [If the grout take for the hole exceeds [_____] bags of cement, grouting with cement will be stopped and the hole will be grouted with a sand-cement grout.]

3.2 INSTALLATION OF ANCHORS

3.2.1 General

****

NOTE: Demonstration test anchors should be designated to verify the Contractor's installation methods and design assumptions. Demonstration test anchors should be installed and approved prior to drilling for other anchors represented by the anchor to facilitate changes which may be required in anchor depth or drilling techniques. Demonstration test anchors must be performance tested to verify capacity. The last sentence should only be included when verification of anchor bond length is needed prior to installation of production anchors.

****

The Contractor is responsible for each drilled hole until the anchor has been installed, grouted, stressed and accepted. Holes in rock and casings must be cleaned by pressurized air and/or water to remove drill cuttings and mud. [The anchors designated as demonstration test anchors must be installed and tested prior to drilling the bond zone for other anchors within the area represented by the demonstration test anchor.]

3.2.2 Placing

All the equipment used in handling and placing the anchors must be such that it does not damage or deteriorate the prestressing steel, corrosion protection, or the anchorages. Each anchor must be inspected prior to insertion into the hole. Any damage to corrosion protection must be repaired prior to insertion or, if determined by the Contracting Officer to be not repairable, the anchor must be replaced. Insertion of anchors must be in accordance with PTI DC35.1.

3.2.3 Resin Grouted Anchors

Insertion of resin-grouted anchors must be in accordance with the resin manufacturer's written recommendations and recommendations for hole diameter, cartridge selection, and tendon installation and rotation prior to installing the anchors. Tendons must be inserted until contact is made with the first cartridge. The tendon must then be rotated and advanced at the rate recommended by the resin grout manufacturer. After reaching its final position, the tendon must be rotated as recommended by the resin grout manufacturer to ensure complete mixing of the resin.

3.2.4 Cement Grouted Rock Anchors

****

NOTE: Single stage grouting requires the use of a bond breaker on the tendon in the free stressing zone to prevent bonding of the grout to prestressing steel in the stressing zone. When two-stage grouting is required, the specification must be modified to reflect the additional grouting step. [Second stage grouting must be performed after the anchor is stressed, tested, and locked off.]

Rock anchors are normally gravity grouted, however, in weak or weathered rock pressure grouting may be used to increase rock-grout bond, to consolidate the foundation or to provide a grout curtain to restrict flow of water through the rock. When pressure grouting is required, the specification must include the required grouting pressure. This grouting would normally take place during the waterproofing of the holes.

When the ambient rock temperature is known to be below 10 degrees C 50 degrees F, the provisions of ACI 306R should be added.

****

Grouting equipment must be of type and capacity required for successful installation of the rock anchors. All anchors must use single stage grouting to encase the anchor. Grouting must be performed by a method in accordance with PTI DC35.1, paragraph 7.6. Grouting must commence at the bottom of the grout zone and proceed to the top of the zone. Grouting must be gravity flow. [The casing must be withdrawn as the grouting proceeds.]

3.2.5 Grouting of Soil Anchors

****

NOTE: Soil anchors in cohesive soils will have somewhat higher bond strengths when pressure grouted. Soil anchors in cohesionless soils may have significantly higher bond strengths depending on the type of soil. Since the installation and grouting procedures for soil anchors are highly dependent on the specific soil conditions, the procedure should be left to the discretion of the Contractor to meet the performance criteria. When a specific grouting procedure is required to develop the design capacity, the procedure should be included in this paragraph.

****

Within the bond length, grout placement must proceed such that the hole is filled in a manner to prevent air voids. The soil anchor hole must be progressively filled with grout and maintained completely full from bottom to top of the zone until the grout has set. Grouting of a soil anchor hole must be performed within 48 hours of the time the hole is drilled. Grouting may be accomplished through the casing pipe, grout tubes, hollow-stem augers or hollow drill rods. The grouting procedure used must provide soil anchors which meet the specified design capacity. Post-grouting will normally result in higher bond values.

3.2.5.1 Gravity Grouting

Gravity grouting must proceed from the bottom of the hole to the top of the [bond zone] [hole].

3.2.5.2 Pressure Grouting

The method of pressure grouting must be determined by the Contractor and proven in the demonstration anchor. Production anchors must be grouted using the methods and target pressures that were used on the acceptable demonstration anchor. Grouting pressures and pumping rates must be controlled to prevent ground surface heave or fracturing. Grouting pressures must be incrementally increased until a refusal is reached or an acceptable amount of grout is pumped.

3.2.5.3 Post-Grouting

****

NOTE: Post-grouting is performed using grout tubes with special check valves in the grouting zone which are installed with the tendon. Post-grouting may be utilized as additional pressure grouting after initial grout has set to increase the bond values for anchors. It may also be used, when post-grouting tubes have been installed, for increasing the bond values of anchors which fail load tests. The maximum grouting pressure is determined by the pressure-volume characteristics of the soil. Three phases of post-grouting is considered to be the practical limit.

****

The number of phases of post-grouting must be determined by the Contractor and proven in the demonstration anchor. Production anchors must be grouted using the methods and target pressures that were used on the acceptable demonstration anchor. Grouting pressures and pumping rates must be controlled to prevent ground surface heave or fracturing. Grouting pressures must be incrementally increased until a refusal is reached or an acceptable amount of grout is pumped.

3.2.6 Anchorage Installation

The bearing plate and [anchor head] [nut] must be installed perpendicular to the tendon, within [0.05] [_____] rad [3] [_____] degrees, and centered on the tendon without bending of the stressing steel. [Wedges, wedge holes and tendons must be free of dirt, grout or other contaminants.] [Corrosion protection must be maintained intact at the anchorage and any damage must be repaired prior to stressing.]

3.3 STRESSING

****

NOTE: The lock-off loads should be a function of the structure being anchored and tolerable or anticipated movements for loading changes on the structure that will cause load changes on the anchor. Typically, lock-off loads are equal to or slightly higher than design loads. The last sentence should only be included when verification

of anchor length is needed prior to installation of production anchors.
****

3.3.1 General Requirements

After the anchor grout [in the bond zone] has reached sufficient strength in accordance with the Contractor's designthe specified strength, as verified by grout cube break, the anchors must be stressed. Prior to stressing, surfaces upon which the stressing equipment is resting must be clean and the stressing equipment must be aligned as nearly with the center of the hole as possible. An Alignment Load of [10] [_____] percent of the Design Load must be applied to the anchor prior to setting dial gauges. Stress the anchor in accordance with the anchor manufacturer's recommendation, subject to the approval of the Contracting Officer. Design and Lock-off loads are given on the drawings. Determine the lock-off procedure so that the lift-off results meet the acceptance criteria specified in paragraph Acceptance. The maximum stress must never exceed 80 percent of the guaranteed ultimate strength of anchor steel. The process of stressing the anchors must be so conducted that accurate elongation of the anchor steel can at all times be recorded and compared with the computations submitted to, and accepted by the Contracting Officer. [Stressing elements of strand anchors must be stressed simultaneously.] Safety precautions must be taken to prevent workers from being [behind] [or in front of] the stressing equipment during stressing. Stressing of the anchors must be performed in a sequence submitted by the Contractor for review by the Contracting Officer. All stressing must be done in the presence of a representative of the Contracting Officer. At no time during the stressing and testing of an anchor will the stressing equipment be disconnected from the temporary stressing head or anchor. [Each anchor to be performance tested must be declared acceptable before proceeding with drilling for other anchors within the section [type] represented by that anchor.]

3.3.2 Lock-off

After completion of the all required tests, the load must be returned to the Alignment Load and the specified Lock-off Load must be applied to the anchor. A lift-off test must be made to verify the load in the anchor tendon before the tendon is locked-off and the stressing equipment is removed. The lift-off reading must be within five percent of the specified lock-off load. If the lift-off reading is not within five percent of the specified lock-off load, the anchorage will be reset and another lift-off reading must be made. This procedure must be repeated until a satisfactory lift-off reading is obtained. After lock-off, the trumpet must be filled with [grout] [corrosion inhibiting compound] and [the anchor head protective cap must be installed] [the anchorage recess must be fully grouted flush with the adjacent surfaces].

3.4 FIELD QUALITY CONTROL

The first three anchors and a minimum of 2 percent of the remaining anchors must be designated as demonstration test anchors. designated demonstration test anchors must be used to verify [top of rock elevation,] [rock] [soil] quality and the adequacy of the Contractor's anchor design and installation procedures. Demonstration test anchors must pass the performance test prior to placing other anchors within the section represented by the respective demonstration test anchor. All other anchors must be proof tested. During the stressing of each anchor, a record must be kept of gage pressure and of anchor elongation at each stage of stressing to the specified test or Lock-off Load, as applicable. The Test Load must not be exceeded. Provide a qualified engineer to evaluate the anchor test results and determine the acceptability of the anchors in accordance with the criteria indicated hereunder. Final acceptance of each anchor will be made by the Contracting Officer. All tests must be run in the presence of the Contracting Officer or his representative.

3.4.1 Performance Test

****

NOTE: Performance tests cannot be performed on fully-grouted resin-grouted anchors. The slow setting resin cartridges cannot be installed for resin-grouted anchors which are to be performance tested and provision must be made for grouting the free stressing length if the anchors are to be used as production anchors.

****

Performance test must consist of cyclically and incrementally loading and unloading the anchor, and must be conducted in accordance with PTI DC35.1, Paragraph 8.3.2. During the testing of each anchor, a record must be kept of gage pressure and of anchor elongation at each stage of stressing to each Test Load required by PTI DC35.1. Measurements of the elongation of prestressing steel must be made in accordance with PTI DC35.1. If the total movement at the end of 10 minutes at the Test Load exceeds 1 mm 0.040 inch, the Test Load will be held an additional 50 minutes and the movement readings will be taken at the interval specified in PTI DC35.1, Paragraph 8.3.2. Test records, including plots and graphical analysis of test data, must be furnished upon acceptance of each performance tested anchor in accordance with paragraph SUBMITTALS.

3.4.2 Proof Test

Proof test must consist of incrementally loading the anchor and will be conducted in accordance with PTI DC35.1, Paragraph 8.3.3. During the testing of each anchor, a record must be kept of gage pressure and of anchor elongation at each stage of stressing to the Test Load required by PTI DC35.1. Measurements of the elongation of prestressing steel must be made in accordance with PTI DC35.1. If the total movement at the end of 10 minutes at the Test Load exceeds 1 mm 0.040 inch, the Test Load must be held an additional 50 minutes and the movement readings will be taken at the interval specified in PTI DC35.1, Paragraph 8.3.3. Test records, including plots and graphical analysis of test data, must be furnished upon acceptance of each proof tested anchor in accordance with paragraph SUBMITTALS. The proof test results will be compared with similar anchors in which performance tests have been performed. If any significant variation from the proof tests occurs, the Contracting Officer may require additional performance tests.

3.4.3 Supplementary Extended Creep Test

****

NOTE: Rock anchors installed in competent rock normally do not exhibit time-dependent movement and do not require extended creep test. However, decomposed or weak argillaceous rock may exhibit creep, and extended creep test should be

considered. At least 2 extended creep tests should be performed on permanent anchors in soils with a Plasticity Index greater than 20.

****

Where specified, anchors must have an extended creep test performed. Creep test must consist of cyclically and incrementally loading and unloading the anchor, and will be conducted in accordance with PTI DC35.1, Paragraph 8.3.4. Each maximum load must be held in accordance with PTI TAB.1, Table 8.3.4. A plot of each family of creep curves must be submitted along with the recorded readings taken at time of the test.

3.4.4 Driller Logs

****

NOTE: This paragraph should be used when a record of the drilling is desired for verification of design assumptions or to document the actual conditions encountered. The list of information must be edited to reflect the work involved (rock or soil anchor, core drilling, drilling methods, etc.

This paragraph includes a reference to DRILLING LOG, ENG FORM 1836 and 1836A. The forms, or appropriate local equivalent, must be added by the specifier.

****

Submit the original handwritten log and three (3) copies in typed format within two days of the completion of each hole. Keep accurate driller logs and records of all work accomplished under this contract and deliver complete, legible copies of these logs and records to the Contracting Officer upon completion of the work or at such other time or times as he may be directed. All such records must be preserved in good condition and order by the Contractor until they are delivered and accepted, and the Contracting Officer will have the right to examine such records at any time prior to their delivery. Separate logs must be made for each hole. Use DRILLING LOG, ENG FORM 1836 and 1836A [or other approved form which provides the required information] for his logs. The following information must be included on the logs or in the records for each hole:

a. Hole number or designation and elevation of top of hole.

b. Inclination of the hole.

c. Make and manufacturer's model designation of drilling equipment.

d. Dates and time when drilling operations were performed.

e. Time required for drilling each run.

f. Elevation of top of rock.

g. Steel casing seat elevation.

h. Depths and elevations at which core was recovered or attempts made to core including top and bottom depth of each run.

i. Geologic classification or description by depths of each stratigraphic unit cored. This classification or description must be made immediately following the taking of the core.

j. Percentage of core recovered and rock quality designation per run.

k. Depth and elevation of rod drops and other unusual occurrences.

l. Depth and elevation at which groundwater is encountered.

m. Depths and elevations at which drill water is lost and regained and amounts.

n. Depth and elevation of bottom of hole, determined by measuring the drill steel length.

3.4.5 Anchor Records

Upon completion of installation of each anchor, the anchor records must be furnished to the Contracting Officer with [watertightness test results and report of remedial action taken,] [top of bond zone elevation,] bond length, free stressing length of anchor, grout mix, grouting pressure, [bags of cement injected] [grout volume], [and] a report of performance test or proof test [and extended creep test] results, [and hole alignment surveys]. The performance test, proof test [and extended creep test] results must include measured lengths of drill holes and anchors, the loads and elongations recorded during testing, monitoring and stressing of the anchors, and graphs of test results.as specified in paragraph SUBMITTALS. In addition as-built drawings showing the completed installation of the anchors must be furnished upon completion of installation of all anchors.

3.5 ACCEPTANCE

3.5.1 General

Acceptance of anchors must be determined by the Contracting Officer. The following criteria will be used in determination of the acceptability of each anchor:

3.5.1.1 Creep

Creep movement must not exceed 1 mm 0.040 inch at maximum Test Load during the first 10 minutes of the performance or proof test. If the creep movement exceeds this limit, it must not exceed 2 mm 0.080 inch at the maximum Test Load at the end of 60 minutes. If the creep movement exceeds 2 mm 0.080 inch at the maximum Test Load at the end of 60 minutes, the anchor will be rejected.

3.5.1.2 Movement

Apparent free length must be calculated from the observed elastic movement in accordance with PTI DC35.1, Section 8.6.2.

3.5.1.2.1 Minimum Apparent Free Length

****

NOTE: If the anchor is not returned to the Alignment Load after testing, only total movement data will be available. In this case, only the minimum apparent free length criteria will apply.

****

The calculated free length must be not less than [80] [_____] percent of the designed free tendon length plus the jack length. If the anchor does not meet this criteria, the anchor must be restressed from the Alignment Load to the Test Load and the apparent free length must be recalculated. If the anchor does not meet this criteria after 3 attempts (original plus 2 restresses), the anchor will be rejected.

3.5.1.2.2 Maximum Apparent Free Length

The calculated free length must be not more than 100 percent of the designed free tendon length plus 50 percent of the bond length plus the jack length. If the anchor does not meet this criteria, and the cause of the behavior is not investigated and explained to the satisfaction of the Contracting Officer, the anchor will be rejected.

3.5.1.3 Initial Lift-Off Reading

The initial lift-off reading must be within 5 percent of the specified Lock-off Load. If the anchor does not meet this criteria, the anchor must be adjusted as necessary and the lift-off reading must be repeated.

3.5.2 Replacement of Rejected Anchors

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NOTE: For redesign of anchored structure due to relocation of anchor, see note at paragraph DRILLING HOLES, General.

****

Any anchor that fails the performance or proof test or is rejected by the Contracting Officer must be replaced. A replacement anchor, including a new anchor hole, must be provided by the Contractor at no expense to the Government. The location of the replacement anchor will be as [directed by the Contracting Officer] [determined by the Contractor in accordance with the redesign of the anchored structure]. Provide all materials, supplies, equipment, and labor necessary to provide a new anchor assembly to the satisfaction of the Contracting Officer. No drilling will be performed for a replacement anchor until the grouting of all rock anchors within [15] [_____] meters [50] [_____] feet of the replacement anchor location has been allowed to set for at least 24 hours. Payment will not be made for rejected or failed anchors. Either remove failed anchors and thoroughly ream and clear the anchor hole or remove the load and cut the anchor and casing flush.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-31 71 19 (November 2022)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 31 71 19

TUNNEL AND SHAFT EXCAVATION IN ROCK - MECHANICAL

11/22

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NOTE: This guide specification covers the requirements for tunnel excavation for underground construction by mechanical excavation using Tunnel Boring Machine (TBM), roadheader, or hydraulic rock breaker. This specification is currently for use in tunnel excavation in bedrock conditions. For mixed-face or soft ground tunneling conditions (i.e., soil-like conditions), revise specification to account for anticipated ground conditions for appropriate equipment selection and methods of ground support and groundwater control. The term "mining" is often used synonymously with "excavation" for underground construction applications. Where the construction of an underground cavity is the primary purpose, the term "excavation" is more appropriate, and is used herein.

For localized ground conditions including fault zones or other specialized ground conditions, revise specification to account for rock characterization conditions identified in the Geotechnical Baseline Report or other geotechnical design documents where the rock mass is characterized. This specification can be modified for micro-tunneling applications; however, exercise care for Execution requirements. This section was originally developed for USACE Civil Works projects.

For underground construction and tunnel excavation requiring drill and blasting methods, include guide specification 31 23 00.00 TUNNEL EXCAVATION - BLASTING.

For projects on a naval facility, consult with local NAVFAC office, and NAVSEA on requirements.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing

this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: For USACE: Consult with Subject Matter Experts (SME) from the Geotechnical Engineering, Structural Engineering, Engineering Geology, and Materials Community of Practice or District Office that have completed a similar type of underground construction project, while editing this section, to be appraised of recent, specific requirements, guidance, excavation methods, lessons learned, or understandings for the subject project.

Consult with or have Specification reviewed by Subject Matter Experts in Underground Construction for projects involving Tunnel Excavation as a primary component of a project, or where Underground Construction issues are particularly challenging. For a Tunnel Excavation project in the vicinity of a dam or levee, Subject Matter Experts in Dam and Levee Safety must review the Specification.

There are likely decisions and/or requirements of other agencies, the Safety Manual, and/or internal offices/divisions/ branches, which could have an influence upon a project's underground construction specifications. Some of these issues may be: concerns from federal, state, and local jurisdictions and agencies; public use of federal, state and/or local properties near or adjacent to the project; evaluations of acceptable construction vibrations, noise and/or pressures affecting individuals or reaching nearby structures; natural resource impact reviews, negotiations and/or requirements; constraints on the excavation means and methods; pre-construction inspections; special studies to facilitate lower cost of the bids or to encourage more bid submissions; the acquisition strategy for the payment for the project; and, other concerns specific to the project. Depending on the acquisition strategy, a Design Bid Build or Design Build will require adequate up-front planning and tailoring of specifications depending on strategy

This Tunnel Excavation guide specification covers the construction of underground facilities by means of mechanical excavation by Tunnel Boring Machine (TBM), or other mechanical excavation such as roadheader or hydraulic breaker, and includes mucking. The details on excavation are typically covered by a separate Rock Excavation specification depending on the contract mechanism used. Tailor this specification for your specific project needs

The following minimum requirements for project information will be indicated on the project drawings:

1. Surface elevations, existing and proposed, with reference datums provided for vertical and horizontal coordinates.

2. All utilities, whether trenched, buried, at the surface or overhead to distances well beyond the project's boundary limits;

3. Spatial location and record of all soil and rock borings and test pits, instrumentation, geologic mapping, and geophysical surveys including soil and rock classifications and the pertinent engineering properties. For example, this data may include, but is not limited to, weathered rock, material strength, bit drops, circulation loss, voids, ground water observations, SPT, Recovery, RQD, RMR and Q System rock mass classification systems, lab testing results, permeability, stratigraphy, geologic features and structure, faults and other significant discontinuities, and topsoil thickness encountered in borings and mapped surface exposures. (NOTE: This is a list of examples of data pertinent to the tunnel design that may be provided in the project drawings or GBR/GDR but does not include all possible engineering properties or conditions of soil and rock that characterize a specific site.);

4. Hazardous gases, such as methane are a concern. As well as coal seams, coal lenses, abandoned gas/oil wells, or gas lines shown on the appropriate drawings.

5. Reference to project Geotechnical Data Report (GDR), Geotechnical Interpretation Report (GIR) and/or Geotechnical Baseline Report (GBR) for additional site characterization information not contained on the project drawings.

6. Location and limits of hard material, whether rock or concrete, or other building materials;

7. Excavation or demolition limits, and clearing, stripping and grubbing limits, and tolerances of excavation;

8. Location of borrow and disposal area, if located on Government property; or on site (as some sites may or may not remain government property, and disposal sites may be under control of project partners);

9. Hydrological, hydraulic and impoundment data, where applicable;

10. Details of all rights-of-way within the project boundaries; and

11. History of relevant construction, earthwork, and any environmental conditions of potential concern at the site.

****

****

NOTE: Typical Measurement and Payment language is to be inserted into the Measurement and Payment specification section. This is typical language used that will need to be tailored for the project needs.

****

1.1 METHOD OF MEASUREMENT

Tunnel support for the various support categories must be measured and paid by the individual components comprising each support category (e.g., Rock Bolts, Dowels, High-Capacity Anchors, Steel Arch Ribs, Welded Wire Fabric, Shotcrete, Reinforced Concrete), under their respective specification or special provision section.

Tunnel Excavation must be measured by the[meter][cubic meter][linear foot][cubic yard] excavated in accordance with the 'B' line payment limit shown on the Drawings. Tunnel drainage must be measured and paid under Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

1.2 BASIS OF PAYMENT

The accepted quantities measured as specified above must be paid for at the contract unit price for the pay items listed below.

Pay Item	Pay Unit
Tunnel Excavation	[Meter][Cubic Meter][Linear Foot][Cubic Yard]

Payment for Tunnel Excavation must constitute full compensation for all excavation, scaling, scaling reports, rock support, removal, hauling and disposal of excavated materials, air monitoring and ventilation and illumination, instrumentation and stability monitoring, survey control, control of water and groundwater inflow including groundwater testing, supply of potable water, safety, supervision and management coordination, control and oversight of said work, and all other work necessary for completion of the tunnel in accordance with the Contract Documents.

****

NOTE: The coordination with other federal, state,

and local jurisdictions and agencies, the public, and private entities must be completely resolved before finalizing the specifications. A project's excavation and/or foundation requirements, for which, dense materials are being removed, may require navigation, highway, structural and/or other regulations and codes to be followed. Depending upon the proximity of public-use areas, private residences or businesses, and the project's location within a county or township, various accommodations will need to be required for the protection of the public, and the safety of private entities regarding local laws, regulations, and ordinances. Avoiding natural resource impacts may overlay other measures and require seasonal or daily time limitations; special observers for some or all the underground construction work; special studies or monitoring; and other potential considerations.

Agency coordination will vary by project. Be certain that all government stakeholders have been involved with planning of the project and approved of all requirements for the specifications. List those important navigation or safety stakeholders.

It is essential that the agency/service person, using these Guide Specifications to prepare Plans and Specifications, coordinate with the planners and environmental compliance specialists within their agency/Service to ensure that all appropriate restrictions and mitigation measures for hazards associated with tunnel excavation and underground construction are incorporated into the Plans and Specifications. Failure to comply with the requirements of applicable Federal or state laws and regulations could result in project delays or stoppages, as well as the potential for increased project costs.

****

1.3 SCOPE

This work consists of excavation and disposal of all material within the rock tunnel limits indicated on the plans, in accordance with these specifications and in conformity to the lines, grades, stations and tolerances shown on the plans or as established in the field by the Contracting Officer. Also included is the initial design support and tunnel reinforcement requirements for the rock tunnel to maintain the inherent strength and control deformations of the ground surrounding the tunnel opening. In addition, the work also includes geotechnical instrumentation for monitoring rock displacement and water management in the tunnel, including but not limited to: furnishing, installing, and monitoring of instrumentation and optical survey targets in the tunnel, collection and interpretation of data and furnishing all other necessary material, equipment and labor incidental to such work, [furnishing of optical survey targets][furnishing of weirs and flumes to measure ground water inflow and outflow], including installation and monitoring of instruments in accordance with the specifications. The Contractor's qualified staff must monitor all geotechnical instrumentation and interpret the data obtained from them, performed in a timely manner to ensure that potential safety issues are identified and effectively mitigated. The data must be made available to the Contracting Officer upon request or otherwise required per specification.

1.4 RELATED WORK SPECIFIED ELSEWHERE

****

NOTE: These specifications for related work specified elsewhere are not all inclusive. Add and remove specifications as needed for the project.

List any specifications that are related, such as Earthwork, Excavation, Soil and Rock Anchors, Temporary Environmental Controls, Shotcrete, Natural Resources, are typical specs related depending on the project.

The specifications without numbers listed below presently do not have a corresponding UFGS Guide Specification. The designer will need to write a project-specific specification to address those features of work, if needed.

****

Section 01 20 00 PRICE AND PAYMENT PROCEDURES
Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS
Section 01 33 00 SUBMITTAL PROCEDURES
Section 02 32 13 SUBSURFACE DRILLING AND SAMPLING
Section 03 30 00 CAST-IN-PLACE CONCRETE
Section 03 37 13 SHOTCRETE
Section 31 00 00 EARTHWORK
Section 31 23 06.00 BLASTING - SURFACE
Section 31 68 13 SOIL AND ROCK ANCHORS
Section 31 73 19 TUNNEL AND SHAFT GROUTING
[Section XX XX XX GEOTECHNICAL AND STRUCTURAL INSTRUMENTATION]
[Section XX XX XX GEOTECHNICAL DATA]
[Section XX XX XX GROUNDWATER TREATMENT SYSTEM]
[Section XX XX XX REINFORCING STEEL]
[Section XX XX XX SURVEYING AND LAYOUT]
[Section XX XX XX TEMPORARY ELECTRICAL SYSTEMS]
[Section XX XX XX TEMPORARY LIGHT AND POWER]
[Section XX XX XX TUNNEL AND SHAFT DEWATERING]
[Section XX XX XX TUNNEL EXCAVATION SUPPORT]

1.5 REFERENCES

****

NOTE: Add and remove references as needed for the project. Reference the appropriate state and local laws, regulations and ordinances concerning blasting where the project is to occur.

This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D5434	(2012) Field Logging of Subsurface Explorations of Soil and Rock
ASTM D6032/D6032M	(2017) Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISEE PSBS	(2017) ISEE Performance Specification for Blasting Seismographs

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements
EM 1110-1-1804	(2001) Engineering and Design -- Geotechnical Investigations
EM 1110-2-1009	(2018) Engineering and Design -- Structural Deformation Surveying
EM 1110-2-2901	(1997) Engineering and Design -- Tunnels and Shafts in Rock

1.6 RELATED ATTACHMENTS AND SPECIFICATIONS

****

NOTE: Geotechnical Data Report (GDR) and Geotechnical Baseline Report (GBR) Importance. Project-specific site data should be presented in Geotechnical Data Report (GDR); design interpretations of the expected subsurface conditions and expected behavior should be presented

in the Geotechnical Baseline Report (GBR). GDR/GBR data must be consistent with information presented in the project specifications and drawings without conflict. Agencies may require different types of documents; there may be a Geotechnical Interpretive Report (GIR).
****

"Geotechnical Data Report" (GDR) dated [_____], prepared by [_____].

"Geotechnical Baseline Report" (GBR) dated [_____], prepared by [_____].

"Geotechnical Interpretive Report" (GIR) dated [_____], prepared by [_____].

1.7 DEFINITIONS

****
NOTE: Delete definitions that will not be used in the specification text for a specific project. A complete list of frequently used tunneling terms can be found in Appendix B of the EM 1110-2-2901 and other references. Recommend only including definitions not already referenced in the EM and definitions to further define the work on the specific project in the specification. It may be necessary to add definitions depending on what the Earthwork and/or Excavation specifications for the project have terms for Rock, Weathered Rock, Sound Rock, Voids, or Sediment. The same rock classification terms and definitions used in design should be carried through construction to avoid ambiguities and conflict.
****

[1.7.1 Green Concrete

****
NOTE: If no concrete placement is expected on the project, then delete this definition. There needs to be limits on vibrations when there is green concrete because of the strength loss due to vibrations while curing. Involve the Structural Engineer project development team members in these determinations.
****

Concrete that has undergone initial setting but has not hardened to design strength. Green concrete also includes the materials of shotcrete or cementitious grouts. Note the paragraph Green Concrete.

]1.7.2 Vibrations

****
NOTE: Velocity units are expressed in centimeters per second (cps) or inches per second (ips). Tailor this for project purposes. Frequency of vibration is also a factor of potential concern to be measured with PPV.
****

Vibrations are the result of various wave forms emanating from the source. Peak particle velocity (PPV) and associated frequencies are defined as the maximum absolute value of the three ground vibration velocities measured in the three mutually perpendicular directions along the vertical, longitudinal, and transverse plane over the period of a record by a seismograph, capable of producing a permanent record and capable of internal dynamic calibration. Peak, total vector-sum particle velocity is the peak value over the full-time history of each time-unit's value of the square-root sum of the squared, component velocities.

1.7.3 Initial Support

****

NOTE: In addition, the initial support systems indicated on the drawings for additional openings in the tunnel, must form part of the Permanent Support.

****

The support system installed after an excavation advance within the tunnel forward area to minimize ground deformation and loosening and to maintain stability and safety of the opening. Provide initial support to minimize ground movement and loosening and to maintain stability of the opening prior to construction of the permanent rock reinforcement/support and tunnel lining. Initial support generally refers to all elements of rock support required to provide a safe, stable rock excavation at all times during construction. Initial support measures include but may not be limited to [_____],[rock bolts and dowels for rock reinforcement], [shotcrete lining], [steel ribs], [timber blocking], (cribbing), (lagging), (chemical grout), [spiling or forepoling], [steel straps], [lattice girders], [welded wire fabric], [shotcrete], and [pre-reinforcement].

1.7.4 Additional Support

May include rock bolts and dowels, crib and lagging, steel straps, spot-holds, steel sets, steel liner plates, chemical grout, shotcrete and pre-reinforcement spiling in addition to the initial support types and quantities for the support categories as shown on the Contract Drawings to stabilize rock and provide water control. Install additional ground support measures as conditions warrant for local stabilization and safety during tunneling operations.

1.7.5 Final Lining

****

NOTE: Tailor this paragraph to the type of final lining for the project, this may be a cast-in-place or precast reinforced concrete liner, steel liner that is backfilled with contact grout, or left unlined, maybe with shotcrete or reinforced (steel fiber) shotcrete or other.

****

[Cast-in-place reinforced concrete, steel] lining that is placed after the tunnel has been excavated and supported with initial support. Backfill concrete and contact grout are also included in the final lining.

1.7.6 Design (Excavation) Line

****

NOTE: This nomenclature should be defined during the development of the plans and specifications as it will be specific for each project.

****

A line defined as that completed excavation surface/line within which no unexcavated material must remain. Only shotcrete, structural steel rib supports with limited blocking, rock bolts or dowels, including bearing plates and metal hardware, and tie rods may extend beyond the design line as shown on the Drawings. The minimum concrete cover over these elements is shown on the Drawings. Embedments shown on the Drawings within the design line must be placed as shown. The Contractor may select the size of the excavated opening provided that finished minimum excavation tolerances are maintained and the design line requirements and diameter constraints given in this section are satisfied.

1.7.7 A-line (Theoretical Excavation Line)

The A-line, shown in the contract drawings, is the line within which unexcavated material must not be permitted to remain.

1.7.8 B-line (Pay Line)

The B-line shown in the contract drawings is the outside limit to which measurement for payment for excavation must be made. Excavation beyond the B-line must be avoided and will be at the Contractor's expense unless approved by the Contracting Officer.

1.7.9 Heading

A wall of unexcavated rock at the advance end of a tunnel (synonymous with the term "Face"). Also use to designate either a small tunnel or a small tunnel driven as part of a larger tunnel.

1.7.10 Face

The position of the underground works that has been advanced the furthest for the respective section of the overall construction sequence adopted for the tunnel, adit or shaft. Also referred to as "Working Face" or "Heading."

1.7.11 Fissure Grouting

Is the drilling and grouting of holes, including in advance of the face being excavated, in order to seal off water passages or solidify discontinuities or other areas of jointed or fractured ground intercepting the underground works, which if left untreated could lead to instability of the tunnel excavation. Also referred to as "Pre-Grouting."

1.7.12 Forward Area

Is that area within which the initial ground support is to be installed behind the heading in the vicinity of the face, also referred to as spilling or forepoling (depends on rock mass conditions, stand up time, and heading advance rate).

1.7.13 Intermediate Jacking Station

A fabricated steel cylinder fitted with hydraulic jacks that is incorporated into a pipeline between two pipe segments. Its function is to distribute the jacking load over the pipe string on long drives.

1.7.14 Length of Advance Interval

Length of the unsupported span of exposed ground opened up during one excavation increment (depends on rock mass conditions, stand up time, and heading advance rate).

1.7.15 Overbreak

The amount of ground unintentionally removed beyond the pay line, or B-Line. Minimize overbreak, reduce excessive rock removal or over-excavation.

1.7.16 Micro-Tunneling

Trenchless construction of small diameter tunnel used to construct utility tunnels from approximately 0.5 to 4m 1ft 8in to 13ft 1in in diameter and remotely operated.

1.7.17 Over-Excavation

Excavation of ground beyond the theoretical excavation line, or A-Line.

1.7.18 Pipe Jacking

A one-pass tunneling method by which a pipe string with the leading edge directly behind the TBM is pushed forward as the tunnel advances and will serve as the tunnel support and carrier pipe.

1.7.19 Probe Hole

An exploratory hole drilled in advance of an excavation to explore ground conditions or water infiltration conditions. Supplemental probe holes are those installed in addition to the probe holes shown on the Drawings or required herein and at the direction or approval of the Contracting Officer.

1.7.20 Scaling

Consists of barring, wedging, and picking to remove loose, shattered, or unstable pieces of rock around the heading advance. Individual pieces not in accordance with the specified tolerance must also be removed during scaling. Scaling may be performed manually or with mechanical equipment depending on tunnel configuration and safety considerations.

1.7.21 Shotcrete

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NOTE: EM 1110-1-2907 Rock Reinforcement, Chapter 6 Surface Treatment provides guidance on shotcrete (wet and dry mix) applications.

****

Mortar or concrete conveyed through a hose and pneumatically projected at high velocity onto a surface.

1.7.22 Staged Excavation

****

NOTE: Advancing multiple headings is often performed in poor ground or for larger final tunnel dimensions, where a top (left and/or right) heading is advanced, supported, then the other heading or bench removed, potentially also removing the center support system separating the headings.

****

Sequence of excavation by which the final excavation is divided into a group of smaller drifts, also referred to as slashes and cuts, or top heading and bench.

1.7.23 Support Type

Method of excavation and initial ground support defined in the Drawings for use at a particular location.

1.7.24 Tights or Underbreak

Projections of rock in a tunnel inside the minimum excavation profile (A-line) that need to be removed prior to placement of lining.

1.7.25 Tunnel Boring Machine (TBM)

A mechanized, shielded machine that is steerable, guided, and articulated. The TBM may be operated and steered either from within the machine or remotely.

1.7.26 Backfill Tunnel Grouting

Filling the annular space between the pipe string and the excavated ground.

1.7.27 Water Sheet and Drain Hose

Sheeting and drain hose used to collect and pan off ground water from areas at either the excavated surface behind the shotcrete lining or to collect and drain seepage through the shotcrete lining.

****

NOTE: The following restrictions apply to tunnel excavation methods using Tunnel Boring Machine (TBM) only. Tunnels may be excavated and supported using a continuous or incremental excavation-observation-support approach to provide the necessary and justifiable levels of ground control and permanent stabilization.

****

1.7.28 Adit

A horizontal passage for the purpose of access or drainage. Supplemental to the main tunnel heading and typically shorter in length.

1.7.29 Roadheader

A mechanical excavator consisting of a rotating cutterhead mounted on a boom; boom may be mounted on wheels or tracks or in a tunnel boring machine.

1.7.30 Hydraulic Breaker

Hydraulic operated rock breaker, also known as a percussion hammer or hydraulic impact breaker, mounted on heavy duty excavator or backhoe with point tools selected for impact rock breakage in tunnel or rock slope excavation.

1.7.31 Reverse Circulation Drill

Method of drilling using combined rotary drill and pneumatic reciprocating piston (hammer) action, with dual wall drill rods consisting of an outer drill rod with an inner tube. Hollow inner tubes allow drill cuttings to be transported back to the surface. Can be used for shaft excavation in rock within certain limits of maximum shaft diameter.

1.7.32 Stand-Up-Time

The amount of time the tunnel will support itself without any added support structures. The time that elapses between the exposure of rock or soil in a tunnel excavation and the beginning of noticeable movements of the ground.

1.8 RESTRICTIONS

****

NOTE: Revise these requirements to accommodate project-specific constraints based upon variables such as ground conditions, locations of adjacent structures, construction vibration criteria, ordnances, or other requirements.

****

The use of a staged excavation approach with integral, concurrent initial support and permanent stabilization of the tunnel periphery is fundamental to the successful execution of the project and recognizes that tunnel spans of different dimensions must be developed in variable and fractured rock mass conditions.

Do not begin tunnel excavation until the following conditions have been met:

1. Required submittals as listed in Paragraph SUBMITTALS have been made and the Contracting Officer has reviewed and approved the submittals.

2. Pre-construction inspections near the tunnel excavation have been completed by the Contractor and pre-construction documents have been provided to Contractoring Officer.

3. Installation of geotechnical and structural instrumentation for surface structures and ground near the tunnel excavation alignment have been completed and initialized by others.

4. All issues related to health and safety have been met and all submittals have been made in accordance with OSHA requirements, EM 385-1-1, and other applicable codes and regulations of Federal, State, and local agencies having jurisdiction.

5. Required personnel with qualifications specified in paragraph TUNNELING PERSONNEL are available on site to perform work.

6. Temporary construction power substation has been installed and tested in accordance with the Division 16 specifications.

7. Installation of all vibration monitoring and air quality equipment with required background monitoring completed.

1.9 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

****

NOTE: The following Submittal requirements are for tunnel excavation using any excavation methods and should be included in all project specifications.

Several other considerations include Tunnel and Confined space rescue team training and setting up an independent emergency communication lines within the tunnel. The requirements for safety will need to comply with EM 385-1-1 and additional requirements included in safety section. If the local fire department is not trained in confined space tunnel or mine rescue, they may have to be trained in confined space tunnel/mine rescue procedures prior to excavation of tunnel or a private specialty company can be hired for rescue services as required by local, state, and federal work ordinances.

Haul routes for muck disposal can also be an issue in densely populated areas. Haul routes may need to be coordinated with local and state officials as required by local ordinances.

****

Power Supply Requirements and Anticipated Power Source(S); G, [_____]

Dust Suppression System; G, [_____]

Muck Removal System; G, [_____]

Method and System For Maintaining Line And Grade; G, [_____]

Pre-Construction Surveys; G, [_____]

****

NOTE: The section below should be used when excavating near vibration sensitive equipment.

****

SD-03 Product Data

Manufacturer's Specifications; G, [_____]

Seismographs; G, [_____]

Roadheader; G, [_____]

SD-05 Design Data

Tunnel Excavation Plan; G, [_____]

Ventilation Plan; G, [_____]

SD-06 Test Reports

Daily Records

Drilling Logs

Post-Construction Surveys; G, [_____]

Individual Vibration Monitoring Report; G, [_____]

SD-07 Certificates

Certification from the Roadheader Manufacturer; G, [_____]

Tunneling Superintendent and Supervisors; G, [_____]

Professional Engineer or Professional Geologist; G, [_____]

TBM Operators and Mechanics; G, [_____]

Vibration Monitoring Specialty Firm; G, [_____]

Structural Condition Assessment Inspection/Evaluation Technician; G, [_____]

Roadheader; G, [_____]

SD-10 Operation and Maintenance Data

Manuals for Operation and Maintenance; G, [_____]

1.10 COORDINATION

****

NOTE: The following paragraph can be used if working with multiple stakeholders/owners.

****

Underground construction methods will be in the vicinity of the [existing lock, railroad, and highway, and river barge, train, hospital highway traffic, utilities and businesses] and their operation will not be impeded or delayed beyond that which has been coordinated with TVA, U.S. Coast Guard, U.S. Army Corps of Engineers - [_____] District, [_____] environmental or natural resources offices, [_____] Department of Transportation, local government entities, [[_____] Railroad, regional or local utilities, and/private businesses]. Include a coordination and traffic control with the appropriate authorities that mitigates navigation and traffic delays.

Coordinate, through the Contracting Officer, with other Contractors working onsite to minimize work stoppages during tunnel excavation.

1.11 LIABILITY

Compliance with provisions in the contract will not relieve the Contractor of their responsibility for damages or injuries caused by, related to, or arising out of tunneling or associated activities. The Contractor assumes all liability and hold and save the Government, its agents, officers, and employees harmless for all claims for personal injuries, property damage, or other claims arising out of or in connection with, under this contract.

PART 2 PRODUCTS

2.1 SAFETY EQUIPMENT

****

NOTE: This section requires tailoring for the specific project design, geology, and site

conditions.
****

a. Provide safety equipment and monitoring instruments according to requirements of Safety and Health Plan in accordance with Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS, to be included in the Materials Handling Plan as required in Section 01 33 00 SUBMITTAL PROCEDURES.

b. Provide personal protective equipment for protection against respirable dust, and all other protective measures that may be deemed necessary for dust control as per Federal Requirements. Submit the details of the Dust Suppression System.

c. All rock reinforcement, including spiling and other ground support in accordance with the requirements set forth in Section 31 68 13 SOIL AND ROCK ANCHORS and 03 37 13 SHOTCRETE.

d. Lattice girders and shotcrete lining must be in accordance with the requirements of [Section XX XX XX TUNNEL EXCAVATION SUPPORT], and Section 03 37 13 SHOTCRETE.

e. Steel sets must be in accordance with the requirements of [Section XX XX XX TUNNEL EXCAVATION SUPPORT], and [Section XX XX XX REINFORCING STEEL].

f. Shotcrete materials must be in accordance with the requirements of Section 03 37 13 SHOTCRETE.

g. Water sheet and drain hoses as part of temporary construction measures to drain off local water inflows:

    (1) . PVC sheet, or approved equal by the Contracting Officer, for application at exposed ground surface or shotcrete surface.

    (2) . Flexible PVC hose with end couplings as required

2.2 PROBEHOLE DRILLING EQUIPMENT

A continuous probe must be maintained at [_____] meters [_____] feet, or least [_____] tunnel diameters ahead of the tunnel face. If the probing results indicate the presence of poor ground requiring the installation of pre-reinforcement, the Contractor must adjust as necessary to achieve the required excavation profile prior to excavating through the anticipated poor ground. During the probing operation the Contractor must monitor and measure the amount of in-flowing water.

Probe hole drilling equipment must be capable of drilling a minimum [_____]-inch diameter holes through sound and decomposed rock [and concrete]. Provide all necessary probe hole drilling personnel, equipment, and accessories.

****
NOTE: Designer of record to provide input on the flow pressures for packer tests. Consideration must be taken by reviewing other available data such as piezometers, pressure cells, rock mass features.
****

The drill must be suitable for drilling in wet ground conditions, highly sheared or fractured zones, and through fault gouge. The drilling equipment must be capable offsetting packers in the hole against a pressure of [_____] kg/cm^2 [_____] psi.

2.3 ROADHEADER

****

NOTE: The following Submittal requirements for Roadheader should only be included if this method of mechanical excavation will be employed on the project.

****

Conform to Section 01 33 00 SUBMITTAL PROCEDURES. Submit for review at least sixty (60) days before the start of excavation with the roadheader(s) the following:

a. Make and model number, manufacturer's specifications, and manuals for operation and maintenance.

b. Certification from the roadheader manufacturer that the proposed machine(s) can excavate the anticipated rock conditions as described in the Contract Documents at a rate sufficient to meet the project schedule.

c. Power supply requirements and anticipated power source(s).

d. Details of dust suppression system.

e. Details of muck removal system.

f. Details of method and system for maintaining line and grade.

g. For refurbished (used) machines, in addition to the information required herein, submit the following additional information: maintenance record(s) and description of last three (3) projects, including rock types excavated, advance rates, total operated hours, and rebuild records of major components.

2.4 TUNNEL BORING MACHINE (TBM)

****

NOTE: Accurate TBM performance estimation is critical for construction schedule and cost development for any mechanical tunneling. The selection of an appropriate TBM for excavation conditions at a site depends on rock properties, rock mass characterization and machine specifications anticipated along the tunnel alignment. TBM parameters including thrust and power, as well as cutter disk spacing and layout together with the anticipated rock material properties and rock mass characteristics are main parameters used for TBM performance estimation. Therefore, these key parameters should be quantified carefully along any tunnel alignment for any type of hard rock TBM projects. These conditions should be

defined in the project GDR/GBR and/or GIR. The impact of these factors on TBM performance cannot be understated. Significant detail should be given to joint and fracture systems within the rock mass. The fracture systems should be classified and quantified by using fracture class designation system. Orientation of discontinuities via alpha angle and distance between the planes of weakness should be quantified and used to make correlation between the geology present along the alignment and the rate of penetration for the selected TBM. These results can be modeled in several different tunnel penetration prediction models. Rock fracture index (RFI) should be introduced and used as an adjustment factor for fractured rock mass conditions. Typical Rock Mass Classifications systems used include RMR, Q, and GSI.

Specific technical considerations for the use of TBMs include geological parameters (rock type, rock alteration, rock strength, rock abrasivity, durability, groundwater inflows), discontinuities in the rock mass (joints, fractures, bedding, shears, faults), depth of cover and the potential for overstressing/rock bursts, site access and terrain, portal locations, TBM constraints, minimum tunnel size, tunnel support requirements, contractor and labor experience, and project schedule demands. A thorough evaluation of the anticipated ground conditions should be performed as part of the investigation and the design decision to utilize TBM excavation techniques. Minimum specifications for TBMs are necessary in order to prevent the incorrect type of TBM from being used. Appropriate geotechnical investigations are essential in order to provide critical information on the anticipated subsurface conditions for careful planning and design of the proposed tunnel alignment.

TBMs offer high rates of tunnel excavation progress that can be run around the clock, which is a unique economic advantage recognized for tunneling projects where timing is a critical component of the project. TBMs are most appropriately applied in homogeneous rock conditions that are conducive for excavation, including very strong rock varying from 150 MPa to 250 MPa (21,755 to 35,300 psi).

One of the key considerations for the use of TBMs is the depth of rock cover along the tunnel alignment and the potential for overstressing. Overstressing will occur under the following conditions:
1) High rock cover.
2) Low/moderate rock strength.
3) High in situ stresses.

Evaluation of the uniaxial compressive strength and in situ stresses should be included in the tunnel investigation program. Estimates of rock strength can be made by field observations at bedrock

outcrops, and rock alteration and joint spacing can be measured in the field. Drilling programs can collect in-situ samples for laboratory testing of rock block or core samples.

The vertical alignment for TBMs is typically kept below a maximum grade of 3 percent; otherwise, special braking systems must be incorporated in the TBM design. Horizontal alignments also have similar limitations, with typical minimum radii of curvature of about 250-300 meters 820-954 feet.

Project schedule and procurement are probably the two biggest issues regarding TBM selection. Early or on-time completion is critical for major tunneling projects due to the large amount of infrastructure and manpower associated with their construction. Some projects may mandate the use of TBMs in order to provide an overall shorter construction schedule. Typical procurement and building time for new TBMs is typically over a calendar year.

The minimum requirements for the application of TBMs on any given tunnel project should be based on the following:
1) Distribution of main rock types, strength, quality, and durability.
2) Quantification of number and extent of major fault and shear zones.
3) Presence of weak rock units and potential for overstressing and squeezing conditions.
4) Installation requirements for initial tunnel support.
5) Final support and lining requirements.

The main disadvantages for the use of TBMs for tunneling projects are as follows:
1) Limited to use for relatively straight tunnels where radius of curvature may be restricted
2) TBMs are typically not considered to be appropriate for long, deep tunnels, where extensive lengths may be subject to overstressing due to low rock strengths and/or high in situ stresses.

Geological mapping and evaluation should be considered the first step in tunnel planning and design. This work can comprise a desk review of existing literature and historical reports and investigations. The key requirement is the identification of rock mass characteristics and engineering properties critical to tunnel design. Consideration should be given to structural discontinuities such as faults along the tunnel alignment and then, field proofing/mapping of suspected features. The key lessons learned from past tunneling projects where TBM were utilized are that every tunnel project and site location is unique in terms of geology, access, terrain/cover, experience of candidate contractors and project

completion demands. TBMs offer key project schedule benefits regarding production which is a unique economic advantage recognized and utilized when selecting TBM excavation methods.

****

The TBM will be a fully shielded machine built or rebuilt by an established TBM manufacturer with at least 10 years' experience manufacturing or rebuilding TBMs.

The TBM must have the following specific characteristics, capabilities, and equipment:

a. Configured to excavate to the dimensions indicated on the Contractor's shop drawings and designed to advance through all anticipated ground conditions as detailed in the GBR.

b. Full-circle shield, for the entire length of the TBM and tail that will continuously and fully support the ground as the TBM advances.

c. Ability to steer TBM and trailing equipment to maintain line and grade within the specified tolerances.

d. Full-face cutterhead. Select cutter types, changeability, and configuration as required to excavate through the anticipated ground conditions.

e. TBM performance specifications, including cutterhead rotation horsepower, must be specified based upon anticipated ground conditions (e.g., lithology and in-situ rock stress conditions) along the proposed tunnel alignment.

f. The tail of the shield must have a sealing system that prevents soil from flowing into the shield and tunnel through the joint between the tail of the shield and the first jacked pipe if required by anticipated ground conditions.

g. When starting and stopping TBM, provide equipment and implement procedures to avoid high voltage fluctuations on the power distribution system.

h. TBM must be equipped with suitable safety systems in accordance with applicable OSHA requirements.

i. Equip TBM with laser target system to permit accurate monitoring of line and grade.

j. Maintain an inventory of spare parts and wear items recommended by the TBM and trailing systems manufacturers to ensure continued functioning of TBM and all essential systems.

2.5 PIPE JACKING SYSTEM

****

NOTE: Depending on the project design, include language for the pipe jacking system, as needed. Delete if pipe jacking for tunnel liner installation is not required.

****

Provide a pipe jacking system with the following features:

a. Has the main jacks mounted in a jacking frame located at the jacking portal.

b. Has a jacking frame which successively pushes a string of connected pipes following the TBM towards the receiving portal.

c. Has sufficient capacity to push the TBM and pipe string through the ground. Incorporate intermediate jacking stations, if necessary.

d. Develops a uniform distribution of jacking forces on the end of the pipe by use of spreader rings and packing, measured by operating gauges.

e. Provides and maintains a lubrication system at all times to lower the friction developed on the surface of the pipe during jacking.

f. Use thrust reactions for pipe jacking that are adequate to support the jacking pressure developed by the main jacking system. Special care must be taken when setting the pipe guide rails at the jacking pit to ensure correctness of the alignment, grade, and stability.

****

NOTE: Expansive grouts were introduced as an alternative rock breakage method but were not used extensively in mining due to low productivity rate and cost per excavation volume ratios. Expansive grouts can be used to induce fractures in saturated conditions. Effectiveness is generally determined by water content, ambient temperature, and borehole diameter. Expansive grouts can have low efficiencies and take a long time to set and expand to induce rock breakage. Depending on access line drilling can be performed with an air track or hydraulic hammer drilling set ups. Localized small breaks can be done with a rotary hammer drilled line patterns.

Expansive grout is utilized to eliminate fly-rock, noise, blast or mechanical excavation vibration, and structural damage related to air blast overpressure or mechanical excavation. It does not require special permits, or special blasting certifications. Expansive grouts are typically used in specialized ground condition conditions that necessitate its use (examples: rock excavation adjacent to embankment structures or grout curtains, or in close urban environments where blasting techniques would exceed local variances on peek particle velocities and/or vibration and dust.

To best utilize this technique bedrock information should be collected regarding rock type, grain size, planes of weakness, foliation, strength, cementation, fracture spacing, rock mass characterization and engineering parameters. Test panels to specifically develop expansive grout

excavation techniques could be utilized and finalized prior to critical excavation in environmentally sensitive near critical structures at the site.

A hydraulic splitting machine is another mechanical means of excavation that utilizes predrilled patterns in the rock. It is comprised of two parts: a splitter and a power station. The splitter consists of a power cylinder with multiple pistons or wedges (based on a machine model) that apply pressure into a bore hole wall, pushing the rock toward a free face. The power station consists of a hydraulic pump, hydraulic pipe, and control panel. These can be utilized locally in critically sensitive areas in place of expansive grout techniques.

****

PART 3 EXECUTION

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NOTE: This specification is for use for tunnel excavation. For mixed face tunneling conditions, revise specification to account for anticipated ground conditions. This specification requires a Geotechnical Baseline Report (GBR) that defines the ground properties, conditions, and behavior related to tunnel excavation, support, and constructability along the tunnel alignment, portals, or along separate tunnel segments that is expected. The Geotechnical Data Report (GDR) contains all the testing and rock mass characterization data used to characterize the conditions and behavior of the ground along the tunnel alignment to establish the base line conditions for the project. The GBR defines what constitutes a differing site conditions for claim resolution per the frameworks of the contract.

****

3.1 GENERAL

****

NOTE: This paragraph should agree with the designations under paragraph SUBMITTALS.

****

a. Care must be exercised to minimize overbreak, to prevent immediate or subsequent rock falls from within the tunnel or from portal areas and other rock slopes outside the tunnel, and to preserve the integrity of the rock outside the limits of tunnel excavation.

b. Clean working conditions must be always maintained inside the tunnel. All muck, slush grout, grout spills, and any other material not required for tunneling must be removed from the tunnel in a timely manner.

c. Detailed construction sequencing must be the responsibility of

Contractor, consistent with the requirements of these Specifications, and those shown on the Contract Drawing and in agreement with the approved submittals.

d. Perform work in a manner that minimizes safety hazards and exposure of personnel and equipment to hazardous and potentially hazardous conditions in accordance with specified safety requirements and Contractor's Safety and Health Plan.

e. Minimize ground movement at the tunnel face and in the surrounding excavation, and prevent ground loss, subsidence, and movement in surface features, overlying structures, and utilities above and around the vicinity of the tunnel excavation.

f. Provide additional face and excavation stabilization by means of discretionary ground support wherever ground conditions dictate.

g. In case of stoppages for any reason, maintain qualified personnel on-duty to monitor conditions that may threaten stability of the heading.

h. If monitoring of ground vibrations indicate that vibration levels are exceeding response levels as defined under paragraph titled Ground Vibration and Deformation Effects Monitoring, and [Section XX XX XX GEOTECHNICAL AND STRUCTURAL INSTRUMENTATION] then adjust procedures for excavation and initial support installation in accordance with the accepted Contingency Plan to reduce the levels to within acceptable limits.

****

NOTE: The need to maintain enough tunnel support materials/equipment will vary per project. Define this quantity during design phase and incorporate in GBR. The following paragraph should be tailored for the specific project requirements.

****

i. Maintain enough shotcrete materials at the tunnel face, ready for immediate application, during the entire excavation period. Excavation will not be permitted without this requirement being met or as approved by the Contracting Officer.

j. As the excavation progresses, the Contracting Officer will perform inspection, [photogrammetry,LiDAR scanning] and geologic mapping or other documentation of the exposed tunnel sections. This mapping will be accomplished after excavation and either before or in conjunction with support installation. The Contractor must provide cleaning of the heading and completed crown and sidewalls and a safe means of access to these areas to allow this mapping. Mapping of the crown and sidewalls will be conducted for documentation of the actual geologic conditions encountered and assessment of rock mass characteristics of the heading. The Contractor must assume that this inspection and mapping will be performed once each shift for a period of minimum [20] minutes in each heading. Lighting, ventilation, and access will be provided for close inspection of the face. Where necessary the excavated surfaces may need to be cleaned by air or water jets to provide surfaces suitable for mapping, as directed by the Contracting Officer; provided, however, such cleaning will be minimal in areas where softer materials can be gouged out to depths greater than three inches. The

Contractor must cease operations to the extent necessary to permit such mapping as directed by the Contracting Officer. Such work will be coordinated by the Contracting Officer in a manner to avoid undue disruption to Contractor's operations.

k. Establish and maintain surveyed tunnel station markers throughout both lined and unlined excavated tunnel. Placed station markers indicating the tunnel stationing at 15.24 meters50 feet intervals by spray painting the rock or shotcrete surface in a color to contrast with background. Intermediate station markers will be made at 3.05 meters 10-foot intervals with visible paint marks located at or near tunnel spring-line.

l. Sequence and direction of tunneling to be as shown on the Drawings and as reviewed by the Contracting Officer.

m. Temporary niches or adits, temporary or future pump sump pits and other temporary openings:

(1) . Excavate these temporary openings conforming to excavation and support criteria of this Specification and as reviewed by the Contracting Officer.

(2) . Seal all temporary openings with [27.58 MPa][4,000-psi] 28-day strength concrete in accordance with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE when no longer needed, before Contract completion and as reviewed by the Contracting Officer.

n. Survey:

(1) . Contractor is responsible for the development and implementation of a surveying program capable of satisfying all survey and accuracy requirements. This program is subject to the review of the Contracting Officer prior to the commencement of the work. The review does not release the Contractor of liabilities associated with or dependent on this part of the work.

(2) . Design and implement a functional underground network and determine all required measurements and the required accuracy of each measurement including horizontal angles, zenith angles, azimuth angles, distances, and height differences. Include analysis of required redundancy and measure of internal reliability associated with each planned observation.

(3) . Design and implement a functional surface control network, stations, positions, measurements, and accuracies. Measurements may include Global Positioning System (GPS) vectors, horizontal angles, zenith angles, azimuth angles, distances, and height differences. Include analysis of required redundancy and measure of internal reliability associated with each planned observation.

(4) . Obtain survey information prior to completing the last [_____] meters [_____] feet of the tunnel excavation. Adjustments to line and grade to the tunnel over the last 30.48 meters100 feet may be necessary to meet project requirements. The purpose of conducting the survey is to obtain the true centerline alignment in 3-dimensions to locate the connections as shown on the drawings. Vertical and horizontal alignment must be taken along both invert/sidewall construction joints. The center point on the

invert is assumed as the dividing line between both invert/sidewall joints.

(5) . Obtain start point alignment for the survey from the surface at [_____] data for alignment consisting of at least 2 benchmarks with known elevation and geographic coordinates enabling tie-in to [NAVD88] elevation and the [_____] State Plane Coordinate System, respectively.

(6) . Perform in-tunnel survey to an accuracy of one-half-inch in the horizontal and vertical dimensions. Record sufficient survey points to enable the complete horizontal and vertical profile of tunnel alignment to be detailed. Some tunnel alignment curves may not necessarily be circular arcs; they may be based on complex parabola or other geometric shape forms.

(7) . Assume that station of benchmarks or survey monuments are as indicated in historical documents. All new survey stationing must reference these stations.

(8) . A survey was completed on [_____]. This information is available and must be reviewed by the Contractor, prior to conducting the tunnel survey.

(9) . Shaft centerline is the basis of all tunnel stationing up and down station of the shaft centerline.

(10) . Calibration and data processing:

a. Calibrate all survey instrumentation as required and as recommended by instrument manufacturer. Submit all calibration records to the Contracting Officer.

b. Data reduction must incorporate calibrations and meteorological correction, and reduction of measurements to the ellipsoid and thence to the [_____] State Plane Coordinate System. Correct distance measurements by electro-optical distance measurement instrument (EODMI) for scale, cyclic error, zero error, and meteorological effects. Correct azimuth angles using the Laplace correction and include the deflection of the vertical components on angles and azimuth measurements.

c. Data regression processing must include least squares adjustments, as required. Employ data outlier detection. Determine horizontal and vertical confidence intervals.

3.2 TEMPORARY SYSTEMS

****

NOTE: Review applicable consideration in EM 385-1-1 and/or consult with a safety professional with tunneling background. Ensure groundwater conditions and overall regime through rock mass is well understood by tunnel reach and rock type. The safety requirements for the contract should be specified in Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. This specification section below can be tailored to remove some items if they will be included in Section 01 35 26.

****

1. Provide, operate, and maintain a complete backup generator systems for all tunnel ventilation, lighting and dewatering systems.

2. Provide, operate, and maintain a complete groundwater control/ treatment system to collect water from within the tunnel and shaft and suitably treats it before discharge in accordance with the requirements of [Section XX XX XX TUNNEL AND SHAFT DEWATERING].

3. Water entering the tunnel from all sources must be controlled, managed, and disposed of in a manner to prevent damage to the tunnel and surrounding property and in accordance with all Federal, State, and local regulations.

4. Design, furnish, install, operate, and maintain a temporary lighting system in all underground and other working areas in strict compliance with all applicable Federal, State, and local regulations and industry standards.

5. The system must provide a minimum light level in accordance with OSHA requirements and EM 385-1-1. In case of failure of the lighting system, provide an emergency lighting system in all work areas in strict compliance with all applicable Federal, State, and local regulations, and industry standards.

6. Design, furnish, install, operate, and maintain temporary ventilation during all phases of construction complying with all applicable Federal, State, local regulations, and industry standards. Operate and maintain the entire temporary ventilation system. Details of the Contractor's ventilation system must be presented to the Contracting Officer for his agreement at least 60 days prior to its installation.

7. Two battery-operated handlamps of 20-Watts minimum power must be provided and maintained at each working face and portal for emergencies and inspection of the work.

8. Electric heaters or radiators having exposed coils or elements must not be allowed in the tunnels.

9. All main electrical cables installed within the tunnels must comply with all applicable Federal, Municipal, and Local Requirements.

****

NOTE: Designer will need to ensure safety requirements in specification at a minimum follow OSHA/EM 385-1-1/MSHA.

****

10. Provide additional floodlighting and ventilation locally as required at active ground support installation, shotcrete, and other locations, and provide portable floodlighting and ventilation equipment, as needed, for localized construction operations. Equipment for short-term use may be battery-operated.

11. For Contract requirements regarding temporary construction power, refer to [Section XX XX XX TEMPORARY LIGHT AND POWER] [and] [Section XX XX XX TEMPORARY ELECTRICAL SYSTEMS].

12. In all parts of the Underground Works, the atmosphere inhaled by those present must contain not less than 19.5% nor greater than 23.5% of oxygen and must not contain a concentration of contaminates such as gases, vapors, and dusts greater than is safe for the health of the construction personnel, considering the effects of exposure time, temperature, humidity, and the combined effects of several contaminants. The concentration of inflammable contaminants must not exceed 10 percent of the lower explosive limit (minimum explosive concentration).

13. Use of wet drilling methods. Carry out drilling using hollow bits with continuous water feed to reduce dust. Always wear suitable protective equipment.

14. The Contractor must be responsible for obtaining all information necessary to determine what concentrations of contaminants are harmless, without prejudice to the adoption of such lower figures as may be stated by competent authorities or directed by the Contracting Officer. The atmosphere inhaled by the workmen and other authorized persons in all parts of the tunnel must not contain more than 5 ppm of nitrous fumes (measured as NO2) for longer than 10 minutes after each blast, 30 ppm of nitrous fumes as an absolute maximum, 50 ppm of carbon monoxide as an absolute maximum, 5,000 ppm of carbon dioxide as an absolute maximum, or for other contaminants. The Safety Professional must field calibrate air quality monitoring instrumentation in accordance with manufacturer's recommendations.

15. In all parts of the Underground Works, throughout the period in which materials producing contaminants are used, and at such time as may be necessary to maintain the standard of purity of air required in this subsection, clean fresh air must be supplied by forced ventilation, using an exhaust system at the face or other method as agreed by the Contracting Officer, at a rate not less than the greater of the following:

****

NOTE: OSHA 29 CFR 1926.800(k)(2) requires each employee working underground have at least 200 cu ft (5.7 m3) of fresh air per minute. OSHA 29 CFR 1926.800(k)(3) addresses minimum velocity of air.

****

a. [_____] cubic meters[_____] cubic feet per hour per person present in a tunnel;

b. [_____] meters[_____] feet per hour per kilowatt of combustion-engine generated power operating simultaneously in the heading.

16. The Contractor must take special measures to minimize the effect of fumes. These measures must include the use of efficient and properly maintained exhaust smoke washers (scrubbers) for all internal combustion engines in the tunnel. Gasoline engines must not be permitted in the tunnel.

17. Notwithstanding any requirements of this subsection the method of ventilation and treatment of fumes or airborne particulate matter, must be submitted to the Contracting Officer. The Contractor must provide, maintain, and use as directed by the Contracting Officer, an instrument approved by the Contracting Officer to measure the velocity of air, and

an approved gas detector. Maintenance of the gas detectors must include the supply of all detector tubes.

3.3 PUBLIC MEETINGS

****

NOTE: Communicate with the project manager and stakeholders about whether specific requirements for a meeting or multiple meetings are needed. It may be necessary to advertise the meeting in a local newspaper and specify the meeting room capacity. Several planning meetings with stakeholders will need to take place during design and the need and content of the public meetings determined and this specification tailored appropriately.

****

Fifteen calendar days prior to commencing tunneling operations, provide the approved Project Manager, Tunneling Superintendent and Vibration Specialist, to attend a public meeting to be conducted on an evening to be determined by the Contracting Officer. This meeting will inform the public about the anticipated tunneling and underground construction operations. The Project Manager and Tunneling Superintendent must make a short presentation on tunneling and underground construction. [The Vibration Specialist must make a presentation explaining the potential impacts tunneling activities may have on nearby structures.] Answer any questions pertaining to public concerns that may impact the public.

3.4 TUNNELING PERSONNEL

3.4.1 Tunneling Superintendent and Supervisors

****

NOTE: The nomenclature of tunneling "supervisors" could vary based on geographic location. Foreman, Shifters or Walking-Boss are common terms for supervisor.

****

Submit for approval the qualifications. Perform the work under the direct supervision of an experienced tunneling superintendent and tunneling supervisors with experience requirements in accordance with Section [_____], or as directed by the Contracting Officer. In addition, the Tunneling Superintendents' experience must include at least one project of a comparable size to this Project within the previous ten years (or as approved by the Contracting Officer). Duties of the tunneling superintendent and tunneling supervisors will include the requirements set forth in Section [____]. Substitutions for the tunnel superintendent during the Contract period will not be made without prior written acceptance by the Contracting Officer. Substitute personnel must have the same qualifications specified herein for the position to be held.

Tunneling superintendents and supervisors must have a minimum of 15 years of comparable experience in supervising the excavation and support of tunnels in similar ground using the similar construction methods and must have all necessary licenses and permits required by local agencies or others having jurisdiction. Supervisors and superintendents must have experience on at least two projects with full face hard [roadheader, TBM] excavation. Tunneling must not be performed unless the tunneling superintendent, supervisors, drillers, and miners meeting the above experience requirements are on site and in actual supervision of this portion of the work.

The following duties are also part of the responsibilities of tunneling supervisors and superintendents:

a. Supervising excavation to ensure safety and quality of construction.

b. Meeting daily [at the start of each shift] with the Contracting Officer or the Contracting Officer's designated representative at the tunnel face to discuss ground conditions encountered and corresponding excavation and support requirements including additional initial support and keeping records thereof.

c. Devising and implementing additional initial support measures as required by ground conditions or as directed by the Contracting Officer, coordinating remedial measures when ground loss at mined tunnel heading or instability of mined tunnel occurs, or appears likely to occur.

****

NOTE: Nomenclature of these positions may vary depending on geographic area. The level of experience of the TBM Operator (and Mechanics) should be a function of the size and complexity of the project. Ten years should be a minimum for most small projects.

****

3.4.2 TBM Operators and Mechanics

TBM operators and TBM mechanics must have at least [ten] years (or as approved by the Contracting Officer) of demonstrated experience in operating bedrock TBM(s).

3.4.3 Professional Engineer or Professional Geologist

****

NOTE: A licensed professional must be used, that may vary on the state, since some do not license Engineering Geologists or Geotechnical Engineers. Tailor this section appropriately for your project needs. There could be different functions for the different positions, with the geologist expert in defining the rock conditions and understanding the design requirements, while providing input in design of tunnel and underground support. Expertise in both design and construction aspects of the work is needed - how that's accessed might be different whether Design Build or Design Bid Build.

****

Contractor's Professional Engineer or Professional Geologist must be a licensed Civil Engineer, Geotechnical Engineer, Geologist, or Engineering Geologist in the State of [_____] with a minimum of 10 years' experience designing underground excavations and constructing such excavations, installing slope stabilization support, designing tunnel and underground support, evaluating rock mass properties, and groundwater conditions for large underground excavations. The Civil Engineer, Geotechnical Engineer, Geologist, or Engineering Geologist must have worked on a minimum of two projects with full face hard rock tunnel excavation. Tunneling must not be performed unless the Civil Engineer, Geotechnical Engineer, Geologist, or Engineering Geologist meeting the above experience requirements is on site and in actual supervision of this portion of the work. Submit for approval the qualifications.

The Contractor's Professional Engineer or Professional Geologist as defined above will:

****

NOTE: Depending upon the nature of the Contract, the Contractor's Professional Engineer or Professional Geologist may provide geologic mapping or other services previously specified as responsibilities falling under the Contracting Officer. The designer should determine which party will be responsible for providing these services.

****

a. Provide inspection of excavations and evaluate rock and groundwater conditions during construction.

b. Perform pre-construction and periodic site visits throughout construction to assess site conditions.

c. Update the excavation, dewatering plans, rock support, and rock mass characterization as construction progresses to reflect changing conditions and changes in contract rock support based on in-situ conditions observed.

d. Submit a written Monthly Excavation Status Report that informs the Contractor and Contracting Officer of the status of the excavation and provide an accounting of the Contractor's adherence to the plans and address present or potential problems or issues with ongoing construction.

e. Be available to meet with the Contracting Officer and Government representatives throughout the Contract duration.

3.4.4 Vibration Monitoring Specialty Firm

****

NOTE: This requirement is a new format from previous specifications. The firm is submitted for approval, having the appropriate experience and the firm must have on staff the Vibration specialists and Seismograph Technicians, typically a firm is subcontracted by the Contractor and having multiple experienced people approved allows them to have flexibility on supporting the site work. The people coming to the project or responding to the work must be within the group approved but does not need to be a single person anymore.

****

Retain the services of a vibration monitoring specialty firm that specializes in the prediction, monitoring, and control of ground vibrations. The firm must have experience conducting installation of seismographs for vibration monitoring and communicating vibration results. The firm must have on staff at least [_____] Vibration Specialists that specialize in vibration monitoring and analysis. The firm must have on staff at least [_____] Seismograph Technicians that have five years or more experience with seismograph installation and vibration monitoring. Submit resumes for all personnel and for the firm for approval citing, in additional to other pertinent data, experience, training, and education, at least 60 days prior to the commencement of work. The Seismograph Technicians must be persons capable of setting up the seismographs at designated locations, effectively recording the work, and appropriately interpreting results. The Vibration Specialists must interpret the seismograph records to ensure that the seismic data must be effectively utilized in the control of operations with respect to the existing structures. The Seismograph Technicians must supervise the placement, operation, and maintenance of the seismographs. The Contracting Officer may require the Vibration Specialists and Seismograph Technicians to be present during the production tunneling work.

3.4.5 Structural Condition Assessment Inspection/Evaluation Technician

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NOTE: This may be required for shaft/portal construction. Depending on proximity of the tunnel it may be needed to document condition of structures and ground in proximity to the work. Designers will need to determine if this is necessary.

****

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NOTE: Five years is the minimum experience requirement, depending on the project it might be necessary to increase the minimum if there is a special concern or sensitive structures, consult with USACE SME to help determine.

****

Pre and Post Construction structural inspections must be performed by technicians with at least [five] years' experience in pre-construction and post construction surveys in the State of [_____]. [The inspections must be done under the supervision of a professional engineer and be stamped by the engineer]. Submit a copy of the qualifications and certificates to the Contracting Officer.

****

NOTE: The paragraph below should be used when Tunnel Boring Machine (TBM) excavation techniques are required.

****

3.5 PRE-CONSTRUCTION DOCUMENTS

****

NOTE: The following submittal requirements are for tunnel excavation using Tunnel Boring Machine (TBM) and should only be included if this method of excavation will be employed on the project.

****

Training certifications and/or resumes of TBM operators and mechanics, experienced in operating and maintaining TBMs suitable for the Project conditions, at least 60 days before TBM assembly or excavation commences.

Sequence and methods for mobilizing each TBM to Assembly Chamber, launching TBMs in Starter Tunnels, partial or complete disassembly, backing up and re-assembling TBMs and re- launching in Starter Tunnels for subsequent tunnel drives, as applicable.

Contingency plan for providing additional initial support of tunnel sidewalls and advancing TBM if rock mass has insufficient bearing capacity to support required gripper pressure.

3.5.1 Tunnel Excavation Plan

3.5.1.1 General

The following documents must be submitted to the Contracting Officer at least 60 days prior to commencing excavation:

1. A scale drawing of proposed tunneling operations. The drawing must include detailed working drawings of mobilization, proposed methods, and sequence of excavating and disposing of materials for each portion of the work, ventilation, illumination, identification of known shears/faults/weak rock, survey control, type and location of vibration and stability-related instrumentation, installation of ground support including placing of shotcrete, steel sets and rock reinforcement, dimensions for excavation and types of equipment to be used.

2. Drawings and details of the initial support of all excavations.

3. Procedures for the control and disposal of groundwater and water supplied for use during tunneling.

4. Methods and equipment for measuring and recording groundwater inflow. Methods, equipment, guidelines, and criteria for the use of fissure grouting must be proposed by the Contractor in his method statement as required in Section 31 73 19 TUNNEL AND SHAFT GROUTING.

5. Instruments for monitoring air quality.

6. The following records of work accomplished must be submitted to the Contracting Officer within one day of the installation of any geotechnical instrumentation measuring tunnel convergence:

a. A list of instruments installed, including instrument identification numbers, calibration, elevation, orientation, stationing, offset, and initial coordinates as applicable to each instrument or installation.

b. Drawings showing details of installed instruments. All dimensions and materials used must be fully identified.

c. A statement describing the procedure used for the installation of each instrument.

7. A method statement of the proposed tunneling operations. This method statement must include details of the Contractors proposed tunnel-logging system such as the NGI "Q" system or Rock Mass Rating

(RMR) system for determining ground support, as defined in the GBR, in concert with guidelines provided in Chapter 7 Design of Initial Support, EM 1110-2-2901. The report must present details of proposed methods and sequences of excavating and disposing of materials for each portion of the work, probing ahead of the tunnel face, pre-grouting, ventilation, illumination, placing shotcrete, steel sets and rock reinforcement, surveying, monitoring, and construction equipment to be used.

8. Catalog cuts of excavation, drilling, mucking and transportation equipment to be used.

9. Contingency Plan for the excavation and support of the tunnels in the event that monitoring of excavation operations in accordance with Section [_____] and monitoring of ground deformations in accordance with [Section XX XX XX TUNNEL INSTRUMENTATION] indicate vibrations or movements exceeding threshold values defined in the drawings. Refer to EM 1110-2-1009 for further guidance on instrumentation.

10. The following Survey Details must be submitted to the Contracting Officer for approval:

d. Manufacturer's address, phone number and name of the contact person.

e. List and description of special modifications if there are changes.

f. Description of instrument's operational principle.

g. Plans or diagrams of instrument.

h. Maintenance requirements.

i. Reading procedures, including sample data, and data processing calculations.

j. Complete data on all tests done to calibrate instruments or verify accuracy.

11. Working Drawings - The following must be submitted in accordance with the specifications:

k. Drawings and details of the initial and permanent reinforcement and/or support of all excavations.

l. Procedures for the control [, treatment]and disposal of groundwater and water supplied for use during tunneling.

m. Methods and equipment for measuring and recording groundwater inflow. Methods, equipment, guidelines, and criteria for the use of fissure grouting must be proposed by the Contractor in a method statement as required in Section 31 73 19 TUNNEL AND SHAFT GROUTING.

12. Instruments for monitoring air quality and ventilation.

13. The following records of work accomplished must be submitted to the Contracting Officer within 24-hours of the installation of geotechnical instrumentation measuring tunnel convergence and any other devices to monitor tunnel stability:

n. A list of instruments installed, including instrument identification numbers, calibration, elevation, orientation, stationing, offset, and initial coordinates as applicable to each instrument or installation.

o. Drawings showing details of installed instruments. All surveyed locations, dimensions and materials used must be fully identified.

p. A statement describing purpose and the procedure used for the installation of each instrument.

14. Complete working drawings and system description of proposed equipment, materials, and method for handling water within the tunnel, measurement of pumped water, and disposal methods.

3.5.1.2 Roadheader

Submit for review at least sixty (60) days before the start of excavation with the roadheader(s)the following:

1. Make and model number, year manufactured, manufacturer's specifications, and manuals for operation and maintenance.

2. Certification from the roadheader manufacturer that the proposed machine(s)can excavate the anticipated rock conditions as described in the Contract Documents at a rate sufficient to meet the project schedule.

3. Power supply requirements and anticipated power source(s).

4. For refurbished (used) machines, in addition to the information required herein, submit the following additional information: maintenance record(s) and description of last three (3) projects, including rock types excavated, advance rates, total operated hours, and rebuild records of major components.

5. Roadheader Shift Report: Prepare a roadheader shift report for each shift in which the roadheader(s) was operating and submit to the Contracting Officer for review by noon the following day in a form and format acceptable to the Contracting Officer. The following minimum information should be included with these reports:

a. Time and position of cutter/pick changes.

b. Identification of all roadheader downtime, including classification and duration. Categories of downtime identified should include roadheader repair, cutter/pick changes, installation of initial support, groundwater inflow, gas inflow, power outages and electrical repair, muck disposal delays, mechanical repairs, alignment survey, grouting, routine maintenance, or other category as described by the Contractor.

6. Contingency Plan for additional initial support of pillars with signs of instability or if excessive ground deformations are detected. Contingency Plan must include a backup roadheader. Contingency Plan for the excavation and support of the tunnels if monitoring of excavation operations and monitoring of ground deformations in accordance with [Section XX XX XX GEOTECHNICAL AND STRUCTURAL INSTRUMENTATION] indicate vibrations or movements exceeding threshold values defined in the drawings.

****

NOTE: If the XX XX XX TUNNEL EXCAVATION SUPPORT Specification will be used, the proceeding section can be deleted.

****

****

NOTE: The following Submittal requirements for Roadheader should only be included if this method of mechanical excavation will be employed on the project.

Prediction of roadheader performance plays a significant role in the plan of tunnel and underground construction in regard to cost, schedule, and excavation assessment. The roadheaders advancement rates underground are influenced by rock strength, abrasivity, rock mass discontinuities, rock type, brittleness, machine specifications (rotary rotation speeds and teeth or pick metal type, and weight and power of roadheader machine) combined with the time to install rock support and muck out. Roadheader performance results illustrate that rock mass properties have a considerable impact on the applicability and rate of the roadheader advancement. Several models demonstrate and accurately predict the roadheader performance as a function of rock mass properties. The very low vibration emissions and precise profile of a roadheader excavation may facilitate excavation near embankment infrastructures or vibration sensitive infrastructure. Dust, and associated mitigative measures should be considered carefully as well. The higher susceptibility of this excavation method in regard to the rock and rock mass characteristics does imply a significant risk potential to the application of this method in regard to the variability of the excavated rock mass. For these reasons a comprehensive site GBR should be performed during the site characterization process outlined in USACE 1110-1-1804 and utilized with this specification.

****

3.5.2 Ventilation Plan

Provide, operate, document, and maintain for the duration of tunnel construction operations a temporary ventilation system and air quality monitoring system which conforms to the requirements of all federal, state, and local regulations in accordance with EM 385-1-1. Remove system(s) from the site when work is completed.

3.5.3 Pre-Construction Surveys

****

NOTE: During design consult with the adjacent businesses/stakeholders/jurisdictions to determine what Pre-Construction Survey needs to be conducted and whether access is allowed, or special

considerations are needed. This needs to be outlined in the specifications for a proper bid to be made for the scope. It is important to include the entire Project Development Team in design to ensure all project features of importance are documented before tunnel construction.

Special attention should be given to clear identification of Real Estate property and boundary information in support of design and construction.

****

Prior to the commencement of construction, conduct a Pre-Construction Survey of any nearby buildings, structures, and utilities within [_____] meters [_____] feet from the construction area, or otherwise delineated by plan drawing, that may potentially be at risk of vibration damage to document pre-existing conditions. The survey extent and method used must be acceptable to both the Contractor's insurance company and the Contracting Officer. The Contractor is responsible for any damages or injuries resulting from construction. Submit all Pre-Construction Surveys 60 calendar days before the start of work. There will be no construction allowed until the Pre- Construction Survey is submitted and approved by the Contracting Officer. Provide owners of surveyed features a copy of their feature's Pre-Construction Survey results before or with the notice of work commencement. Notify owners and occupants of local buildings prior to the commencement of work. Perform the following when conducting Pre-Construction Surveys:

a. Each [Civil Works] structure must be documented (including high resolution photography and/or videotaping) as to its construction, foundation type, condition, and closest distance to excavation. The general condition and all observable defects of each structure must be documented. This includes measurements of the defects.

b. The facilities that may be impacted by construction must be addressed by the Contractor for safety and continued operation during the tunnel program.

c. Freestanding structures (such as retaining walls) must be inspected on the exterior and on the interior if connected to a structure. All concrete walks, driveways, or adjacent structures must be inspected for cracks, level condition, holes, and defects.

d. Industrial structures, silo/elevators and special facilities, and office space must be described relative to their present condition and tolerance to vibration. Besides the inspection of walls, columns and stairwells, the Contractor must survey the work areas and structures for distress.

e. Survey the current condition of above and underground utilities to include water, power, gas, sewer, and communication lines, and any associated above-ground connections to said underground utilities such as fuel tanks and hard connections to structures.

f. An inspection of accessible structures must be made and a list of all structures, which could not be surveyed or refused to allow survey, must be completed. The dates of possible subsequent surveys and physical constraints prohibiting the survey must be documented. The requirement to perform Pre-Construction Surveys is not an indication of

Right-of-Entry by the Contractor. Any Right-of-Entry associated with Pre-Construction Surveys, monitoring during construction and Post-Construction surveys are the responsibility of the Contractor. In the event a property or properties identified as significant or intended to be included in the Surveys and monitoring are not included because access was denied, indicate this occurrence including the points of contact, dates contacted, and any reasons provided for denial of access (if given.)

g. Certify that the survey was prepared prior to the start of any construction under this Contract. Submit a copy of the Pre-Construction survey in conjunction with the Tunnel Excavation Plan.

3.6 RECORD KEEPING

****

NOTE: The paragraph below applies to all excavation techniques.

****

3.6.1 Daily Records

Maintain daily records as excavation progresses and one copy of such records must be submitted to the Contracting Officer before 12:00 PM of the following workday. Keep such other records as deemed necessary. The following data must be included in the daily record for each tunnel heading:

1. Station of tunnel heading faces at start and end of each work shift.

2. Type, quantity, and location of initial support and additional initial support installed. Draft Geologic mapping and excavation records that comply with EM 1110-1-1804 Appendix B and C.

3. Evaluation of in-tunnel monitoring results.

4. Probe hole records in accordance with Drilling Logs paragraph of this Section.

5. Number of workers employed per shift for each workday categorized by union trade, idle equipment, active equipment, and site visitors.

6. Water inflow measurements.

7. Air quality Measurements.

8. Vibration Monitoring Measurements.

9. Tunnel Deformation Monitoring Measurements.

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NOTE: The section below should be used when Tunnel Boring Machine (TBM) excavation techniques are required.

****

10. Daily shift reports on TBM operation and performance data must be prepared commencing on the first day of TBM assembly and cover a continuous period until the TBM(s) are removed from the tunnel. One copy of the shift reports, signed by Contractor's representative, must

be provided to the Contracting Officer before 12:00 PM the following workday. Use manual and automatic recording data collection systems in accordance with [Section XX XX XX GEOTECHNICAL AND STRUCTURAL INSTRUMENTATION]. Include the following information, as a minimum, in the shift reports for each tunnel heading excavated by TBM:

a. TBM performance information, including stations of each advance of the TBM, the TBM clock time at the start and end of each shift.

b. For each shove or stroke of the TBM, the date, time, and tunnel station at start of shove, the duration and length of shove.

c. TBM and excavation system downtime, including classification, details, and duration. Iinclude the impact on excavation progress. Categories of downtime may include, but not be limited to, TBM repair, cutter head changes, installation of initial support, groundwater inflow, gas inflow, power outages and electrical repair, downtime of backup equipment, muck disposal system delays, hydraulics repair, gripper problems, alignment survey, probe hole drilling, waiting time due to lack of grout, and routine maintenance.

d. Cutter head changes, including time, date, and reason for replacement, cutter position, or number.

e. TBM clock record of utilization and penetration rates.

f. Air quality and gas monitoring data. Line and grade survey reports.

g. Water inflows, if any, with locations and estimates of rates.

h. Overbreak

i. Any other geological and/or unusual features such as faults, shears, crushed or soft zones, and raveling areas.

3.6.2 Drilling Logs

The drillers are required to keep precise drilling logs on each probe hole to show the depth and position of the geological features. At minimum, each drilling log must include:

a. Borehole designation and location station number;

b. Borehole depth, groundwater depth, inclination, azimuth, and diameter;

c. Elevation of top of borehole;

d. Depth(s) of geologic structural features, e.g., voids, gouge or mud seams, soft weathered or altered zones, Ocher iron-stained intervals, changes in rock chip color, and other features encountered in the probe hole;

e. Relative penetration rates;

f. Start and end times of drilling;

g. List hole misalignment;

h. Soft seams within the rock and sudden feed pressure changes on the drill;

i. Seepage and groundwater flow from the borehole; and

j. Drill make, model, and serial number.

k. If qualitative descriptors are used (e.g., soft, moderately hard, hard, very hard, decomposed, highly weathered, moderately weathered, slightly weathered, unweathered), ensure consistency between drill operators in logging using these terms. [Log soil and rock in accordance with ASTM D2487, ASTM D5434, ASTM D6032/D6032M.] Submit an example of the Drilling Logs with the Tunnel Excavation Plan. Copies, both hard and electronic PDFs, of these drilling logs must be provided within 24 hours to Contracting Officer.

3.6.3 Post-Construction Surveys

****

NOTE: Pre- and Post-Construction Inspections and the Structural Inspection/Evaluation Specialist would only be required if there are structures or facilities requiring such inspections. Eliminate the paragraphs referencing Pre- and Post-Construction Inspections and the Structural Inspection/Evaluation Specialist if the project does not have a requirement for these inspections.

****

Post-Construction Survey must be conducted at any structure previously surveyed during pre-construction and locations where a reasonable notice of damage from construction has been provided. Post-Construction surveys will be conducted by, or under the supervision of, the Structural Inspection/ Evaluation Specialist, who will also sign and date each survey. The survey extent and method used must be acceptable to both the Contractor's insurance company and the Contracting Officer. The post-construction surveys must be conducted within a week of the notice of damage. The Contractor is responsible for any damages or injuries resulting from construction. Submit a copy of all post-construction surveys within two business days of the on-premises surveys to both the structure's owner and the Contracting Officer.

3.6.4 Probe Hole Drilling

****

NOTE: The design team must evaluate expected ground conditions including but not limited to: zones of intensely jointed rock mass due to faults, shears, or other structural dislocations, rock types, weathering profiles, groundwater regime, other pertinent geological information available from the site investigations to determine the adequate length of probing ahead of tunnel. This information must be included in the Geotechnical Baseline Report as a recommendation.

Insert gallons per minute (gpm) based upon results of any packer tests performed, or other estimates of water inflow. In lieu of available project data assume nominal amount of water on the order of 15-20

gpm. The inflow information must be included in the GBR and/or GDR.

The number of supplemental probe holes expected for the project must be determined during design phase and clearly listed as a recommendation in the GBR.

****

a. The Contracting Officer must be informed 24 hours prior to any probing activities in the tunnel so that a government representative be present during the probing. The results of probing ahead, along with any proposed amendments to excavation profile, sequence or support must be submitted to the Contracting Officer immediately upon completion of the probing.

b. Probe holes must be drilled to provide advance warning of any abnormal inflow of water or degradation in rock quality, which might occur. Probe hole locations and extent of hole drilling is shown on the Drawings and will be modified as needed in the field as approved by the Contracting Officer. The Contracting Officer may direct supplemental probe holes to be drilled based on ground conditions. Exploratory probe holes may also be required to explore the nature of subsurface formations or following grout operations to investigate the effectiveness of the grouting program.

c. If the inflow of water from the probe hole exceeds [_____] gpm, supplemental probe holes will be required, at the direction of the Contracting Officer, to probe the extent and character of the ground, and/or to drain the water, and/or for use as grout holes. If directed by the Contracting Officer, grout the face of the tunnel heading in accordance with 31 73 19 TUNNEL AND SHAFT GROUTING.

d. Probe holes must be drilled to a minimum of [_____] meters [_____] feet measured along the drilled hole and will overlap to maintain at least one hole a minimum of [_____] meters [_____] feet ahead of the plane of the tunnel face at all times. The Contracting Officer may reduce the drilling length based on ground conditions.

e. During probe hole drilling, the Contractor will stop at a minimum of each 3.05 meters10 feet of hole advance to measure water flow and water pressure. The Contracting Officer may waive this requirement on a hole-by-hole basis if little or no water is encountered.

f. Probe hole must be terminated [_____] meters [_____] feet beyond the first groutable feature, as determined by the Contracting Officer.

g. Probe holes must be sealed by grouting through a packer close to the first water producing feature to prevent water flows into the tunnel while the tunnel face is advanced.

****

NOTE: Depending on the project the probe holes may be incidental to the work and no additional time or payment will be required as in this paragraph. If the Contracting Officer directs the Contractor to do probe hole drilling outside of the contracting payment procedures, then it would be compensated. Tailor this paragraph for your project requirements.

****

h. If, in any section of the tunnel excavation, drilling is directed by the Contracting Officer for supplemental probe holes, other operations will be suspended or modified as may be necessary to permit such drilling; and the Contractor will not be entitled to any compensation for delay nor will the Contractor be entitled to any extension of time, such stopping of work being deemed an ordinary delay to be expected during construction operations.

i. Follow format requirement in the paragraph DRILLING LOGS.

3.7 GROUND VIBRATION AND DEFORMATION EFFECTS MONITORING

****

NOTE: Incorporate requirements for a data acquisition system and real time monitoring in certain sensitive areas on project-specific basis as needed.

****

3.7.1 General Tolerance

The instruments must be installed as close as practicable to the locations [shown on the Drawings] [or as established in the field by the Contracting Officer]. The Contractor must submit to the Contracting Officer for consent, all final instrument locations prior to their installation. Where instruments are shown on the contract drawings to be installed in clusters, the Contractor must install all instruments shown within a [_____] mm [_____] in. radius

3.7.1.1 Availability of Data

The Contractor must monitor all instruments and provide data obtained to the Contracting Officer within a maximum of [24 hours] after taking the readings unless otherwise directed by the Contracting Officer.

Instrument monitoring data must not be disclosed to third parties and must not be published without the prior written approval of the Contracting Officer.

3.7.1.2 Instrument Installation Sequence

Optical survey targets must be installed following scaling and within [_____] meters [_____] feet of the advancing tunnel face.

3.7.1.3 Installation Requirements

The Contractor must assign an instrument identification number to each instrument. Each instrument identification number must be permanently affixed to a suitable material, such as the stamping of a brass tag. The tag must be attached to the instrument or must be secured at the instrument location.

Optical survey targets must be installed as shown on the drawings.

3.7.1.4 Protection of Instruments

Full responsibility must be borne by the Contractor for protecting the instruments from damage caused by construction operations. Damaged instruments must be promptly replaced or repaired, as directed by the Contracting Officer, at the expense of the Contractor.

The instruments must be clearly marked and protected to avoid being covered by shotcrete. Access must be maintained to permit reading of instruments. Shotcrete applied around instruments must be removed immediately.

****

NOTE: Depending on the project, this section will vary and need to be tailored for the monitoring locations and thresholds specifically. The designer should engage necessary subject matter experts for various disciplines - Structural for concrete and Mechanical/Electrical for related equipment (powerhouses or locks).

****

3.7.2 Vibration Control Monitoring

****

NOTE: Vibration monitoring may be required for underground construction using mechanical excavation means. Consult with the Structural, Mechanical, and Electrical Engineers as appropriate on the project in developing the vibration thresholds. The paragraph's narrative is a generic description for most projects, where the nearest structure/facility is: Standard Construction Timber Frame, Brick, and Concrete Buildings; Lock Monoliths; Powerhouse Switchyard; Highway and Railroad Bridges; Buried Utilities; and Wells and Aquifers. Some projects may require assessment by a trained experienced vibration specialist or structural engineer of lower allowable vibration criteria at critical or historic or special structures or facilities or structures with continuous occupants. Ground vibrations can cause the occupants of structures to become physically uncomfortable at levels well below the allowable vibration levels to avoid damage to the structure itself. Projects a with a Powerhouse and Electrical Power Relay Equipment or Pipelines, besides those with continuous occupants, should be evaluated for lower allowable vibration criteria. Some projects could utilize the assessment by a trained experienced vibration specialist or structural engineer to include higher allowable vibration criteria for those projects where typical structures/facilities are more than twice the distance of the closest approach from construction to: Steel and Reinforced-Concrete Structures; Mass Concrete Monoliths; and Cured Shotcrete. The specification writer must include a limitation of the allowable vibration.

****

Vibration monitoring must conform to current industry standards and use equipment developed for that purpose. Peak particle velocity must be used as the unit of measure. Begin seismic vibration monitoring at least four weeks prior to the commencement of any mechanical excavation anticipated to induce excessive ground vibrations to determine background levels on adjacent roads, and the [_____]. Permanently mount the seismograph to record seismic events for a 24-hour period daily. Submit the background vibration monitoring reports and the baseline vibrations levels determined from the data for approval at least two weeks prior to the commencement of mechanical excavation anticipated to induce excessive ground vibrations. The peak particle velocity of each component must not be allowed to exceed current local, State and Federal vibration limits, whichever is more stringent, and never exceed the safe limits of the nearest structure subject to vibration damage.

3.7.3 Measuring and Recording Instruments

Submit seismographs for approval. Provide up to [_____] seismographs capable of sampling rates of 15,000 samples per second or higher that meets ISEE PSBS. The 15,000 samples per second accuracy is required to acquire reproducible vibration readings. The units must be self-contained except for external geophones and microphones. The seismograph must be capable of providing a printout or downloading the data to a portable device for off-site printing. The units must be programmed with specific data for each site of seismograph placement, which includes seismograph location, geophone burial or mounting method, calibration signal, date, time, and closest distance to the excavation. The seismographs and geophones must be placed on and secured to sound bedrock, buried in virgin soil, or affixed to mass concrete foundations or to other structures where vibration data is needed. Include the raw data values from the seismograph of vibration.

3.7.4 Seismograph Locations

****

NOTE: This paragraph will vary depending on the project, the designer should determine what structures need to be monitored. It may be necessary to require one or two extra seismographs that are placed at the Contracting Officer's direction.

****

Install seismographs at locations approved by the Contracting Officer. These locations are subject to change as the project progresses.

3.7.5 Individual Vibration Monitoring Report

Provide the original digital results of vibration monitoring in the form of peak readings and frequencies for each monitoring period, provide the Contracting Officer with access to the online data available immediately after data is collected. Submit the vibration monitoring reports. Data recorded for each monitoring period must include the following:

a. Identification of instrument used and location.

b. Name of qualified observer and interpreter.

c. Distance and direction of recording station from excavation area.

d. Type of ground at recording station and material on which the instrument is sitting.

e. How the geophone is anchored, if peak acceleration is greater than 0.2 g to prevent decoupling of the sensor.

f. Maximum particle velocity in each component direction.

g. A dated and signed copy of seismic records with their supporting information.

3.7.6 Convergence Monitoring Construction Requirements

3.7.6.1 General Tolerance

The instruments must be installed as close as practicable to the locations shown on the Drawings or as established in the field as approved by the Contracting Officer. The Contractor must submit to the Contracting Officer for consent, all final instrument locations prior to their installation. Where instruments are shown on the contract drawings to be installed in clusters, the Contractor must install all instruments shown within a [_____] mm [_____] in. radius.

3.7.6.2 Availability of Data

The Contractor must monitor all instruments and provide data obtained to the Contracting Officer within a maximum of 24 hours after taking the readings unless otherwise directed by the Contracting Officer.

Instrument monitoring data must not be disclosed to third parties and must not be published without the prior written approval of the Contracting Officer.

3.7.6.3 Protection of Instruments

Full responsibility must be borne by the Contractor for protecting the instruments from damage caused by construction operations. Damaged instruments must be promptly replaced or repaired, as directed by the Contracting Officer, at the expense of the Contractor.

The instruments must be clearly marked and protected to avoid being covered by shotcrete. Access must be maintained to permit reading of instruments. Shotcrete applied around any instrument must be removed immediately.

3.7.7 Rock Damage Control

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NOTE: Tailor this paragraph to the specific site conditions that may affect underground construction.

****

The rock formations are known to contain geological features including variable weathering, alteration, fracturing and shearing, voids, weathered joints, and gouge seams. Rock cores recovered during site exploration drilling investigations disclose the site's geological conditions and are available for review by the Contractor. The Contractor is encouraged to review the [Geotechnical Data Report, Geotechnical Baseline Report, other reports provided with bid documents or made accessible], the drill core, drill core photographs, cut slopes or outcrops, and all geotechnical and structural information available before planning and conducting tunnel excavation operations.

****

NOTE: The section below should be used when Roadheader mechanical excavation techniques are required on the project.

A Roadheader is more economical for shorter tunnels rather than using/mobilizing a TBM and where Drill and Blast excavation is not allowed.

A Roadheader is a hybrid mechanical excavator and consists of a boom-mounted rotating cutting head with a conveyor for broken rocks, crawler tracks move the entire machine forward into the rock face. High mobility, advance rates, reliability, low rock disturbance, safety, and small labor force for deployment, staging area footprint, are some of the advantages of Roadheader.

The power density ratio provided by the small diameter cutting drum gives the Roadheader an edge over other mechanical excavation techniques. Recent advances have made Roadheaders more efficient in hard rock tunneling. Increases in machine weight, size, automation, and remote control, cutterhead and boom positioning, advances in hydraulic and electrical systems, muck pick and loading systems, and cutter head design are the biggest developments in Roadheader which make them economical choices in some underground excavation scenarios.

Boom-type Roadheaders are small size (up to 30 tons), mid-size (between 30 and 70 tons) and large size (between 70 and 120 tons). Several rock properties affect the cutting force of a Roadheader. Uniaxial Compressive Strength (UCS), Brazilian Tensile Strength (BTS), quartz content, Ratio of UCS to BTS, and Cone indenter hardness, tangent Young's modulus, density, porosity, static elasticity modulus, shore scleroscope hardness, specific energy, rock quality designation, Rock mass cuttability index, Cercher abrasivity index, Schmidt Hammer rebound hardness, and point load strength, are some of the parameters of rock that are found to influence Roadheader performance.

Cutting performance is a term used to illustrate the influence of cutting rate and cutter wear in different geological conditions. The prediction of cutting performance for any type of excavating conditions, or rock formation in which the machine is deployed, is one of the main factors determining the economics of a mechanized excavation operation. The instantaneous cutting rate or ICR has widely been applied and modified for specific rock types. Progress over a construction shift or on hourly basis is also taken as a performance metric tracked on the job. Machine selection is performed on the basis of tunnel dimensions and ground conditions which in turn, determine production rate and bit

consumption. Deployment of the Roadheader is mainly dependent on how effectively the performance rating is geologically investigated. Accordingly, if not selected as per geological conditions anticipated the consequences can be economically costly leading to claims and scheduling implications.

Despite the advantages, the Roadheader has some disadvantages such as high pick consumption rate in very abrasive rocks, making excavation uneconomical due to frequent bit changes with increased machine vibrations and maintenance costs. Exposure to silica or rock dust continues to be a major risk to the health of workers. Dust particles such as coal dust, silica dust and other finely powdered materials, can damage lungs and airways.

****

3.8 ROADHEADER EXCAVATION

The roadheader(s) must excavate the tunnel(s) to the minimum excavation size as shown on the Drawings or as approved by the Contracting Officer, to provide the required lining thickness indicated on the Drawings within the size, alignment and grade tolerances specified. The roadheader(s) must be maintained and utilized to handle the various ground conditions as described in the GBR and sustain advance rates that will permit completion of the work within the allowable schedule. Minimize the loss of ground ahead of and around the roadheader and always provide support of the excavation. Use a dust control system.

Install the rock support and initial support system as close behind the excavation operation as possible. The face must not extend more than [_____] meters [_____] feet in front of the nearest installed support.

The tunnel must be excavated by a mobile fully articulated boom excavating machine, commonly known as a "road header". The excavating machine must meet the following requirements:

1. Must be a [25] ton or heavier machine with a minimum horsepower of [150] HP to the cutter head.

2. Be equipped to excavate to the "A" or over excavation lines shown on the above drawings with capability to quickly adjust excavation size to meet varied support requirements.

3. Be equipped with a gas-detection devices and warning system.

4. Be of such a configuration that structural-steel adit supports or rock reinforcement may be installed at or near the heading ahead of the main body of the machine where required.

5. Be designed so that the entire machine and its trailing equipment may be backed out through the structural-steel supported reaches of the adit or any other restricted reaches so designed to provide free access for passage of men, equipment, and materials to the face to perform ground support or excavation tasks. To assist in backing excavating equipment out of the adit, partial disassembly of the machine is acceptable. However, the capabilities of backing the equipment out of the adit and providing free access to the adit heading must be provided

in a manner that maintains the integrity of the machine and trailing equipment during removal from the adit and reinstallation in the adit.

6. Be equipped to remove muck with high water content from adit invert in areas of high water inflow and in standing water.

7. Be equipped so that adit drainage inflow of water in the vicinity of the machine, as deep as 0.61 meters2 feet, will not stop the operation of the tunneling machine.

8. Be designed to provide for adequate ventilation for all workmen in vicinity of the machine and its trailing equipment.

9. Be capable of maintaining its correct alignment and grade at all times.

10. Be capable of wetting the face of the excavation and cutter head for effective dust control.

11. Excavation of quartzo-feldspathic bedrock lithologies are expected to result in higher than normal wear on the cutter and fracturing of carbide cutter tips.

****

NOTE: While it has been demonstrated that roadheaders have been used in conglomerates, sandstones, granite, quartzite and diabase, these formations are particularly hard for roadheader tunnel excavation. Roadheader is most efficient in low to medium hardness rock. Use in hard rock and highly abrasive rock should be expected to result in low-production excavation rates. Equipment is limited by a shorter life of tools and increased cutting tool cost.

****

3.9 REQUIRED MUCKING

Required mucking operations must adhere to the detailed plan for muck handling.

****

NOTE: The section below should be used when Tunnel Boring Machine (TBM) excavation techniques are required.

****

Provide a mucking system for handling and transporting the excavated rock from the tunnel face, through the TBM backup system, the tunnel and shaft, and on the surface, to the muck stockpiling area, with the capacity to sustain peak hourly penetration, peak shift, and peak daily advance rates. Ensure the mucking system does not restrict any of the other operations including handling and erecting of initial support system materials.

For rail mucking systems, a track with ties and ballast or direct fixation system will be maintained for safe operation of trains. Do not allow the head of the rails to be submerged in water or covered with tunnel muck or other debris. Upon completion of excavation of the tunnel, remove all such trackwork prior to placement of final lining.

For conveyor mucking systems, the tunnel must be immediately cleared of all spillage and other debris to maintain a safe and clear personnel egress and evacuation route throughout the tunnel. Do not store tunnel muck on the mucking conveyor when not in use. In the event the conveyor mucking system is repaired, all replaced parts and components must be removed from the tunnel to minimize safety hazards.

3.10 SCALING

****

NOTE: Typically, a level of scaling is required for each project to remove loose, unstable rock prior to mucking operations or prior to required bolting application, shotcrete, or other methods of stabilization before carrying out additional excavation operations.

****

A program of frequent inspection and scaling must be maintained in all portions of the tunnel. Immediately after excavation advancement, the roof and walls of rock excavations must be inspected by experienced and suitably equipped scalers who must dislodge and scale down all loose and unstable rock. Scale any loose and unstable or unsafe appearing material remaining on the tunnel periphery at the portal areas as the excavation proceeds. No separate payment will be made for scaling.

****

NOTE: The section below on grouting should be used when Tunnel Boring Machine (TBM) excavation techniques are required, and high groundwater conditions are anticipated or unstable geologic materials (such as fault zones, karst, or other unstable geologic conditions) and grouting is used to control water inflow to the tunnel heading or stabilize ground conditions. The anticipated volume of water as indicated in the Geotechnical Baseline Report should be specified in the section below.

****

3.11 GROUTING

Conduct pre-excavation and post-construction grouting in accordance with Section 31 73 19 TUNNEL AND SHAFT GROUTING and as shown on the Contract Drawings.

If groundwater exceeds [_____] liters per minute (lpm) gallons per minute (gpm) during probe hole advancement during tunnel construction the Contractor's Engineering Geologist or Geotechnical Engineer will submit a grouting and excavation plan or establish protocols for excavation if certain inflows exceed threshold lpm gpm values prior to tunnel excavation. The Contracting Officer must be informed of the implementation of the grouting plan if groundwater inflows exceed excavation plan established inflow thresholds.

****

NOTE: The section below should be used when Roadheader excavation techniques are required.

****

3.12 MAINTAINING PILLAR STABILITY

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NOTE: The use of rock pillars as an excavation support means in tunneling is expected to have limited application. Historically, pillars have been used in mining applications. Delete this section if rock pillars are not anticipated on the project.

In addition to pillar stabilization using rock dowels, a narrow pillar may be designed to be stabilized/widened by a heavily reinforced concrete section. Modify as applicable to project conditions.

****

Install additional rock dowels in pillars where the pillar width measured at springline is less than or equal to [_____] meters [_____] feet. Install dowels as shown on the Contract Drawings.

****

NOTE: The section below should be used when Tunnel Boring Machine (TBM) excavation techniques are required.

****

3.13 INITIAL SUPPORT

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NOTE: A UFGS for TUNNEL EXAVATION SUPPORT is being developed. The designer will need to include Initial Support as listed here and Permanent support. Often the contractor will be responsible for designing their own initial ground support types and may not be defined in the GBR or specs. Alternatively, the GBR may give conceptual initial support types (spacing, type, lengths) to bid on but give multiple support Types that may be applied along different alignment stationing depending on the geologic conditions. Tailor this section as appropriate

****

3.13.1 Support Classes and Support Class Ranges

All stations indicating limits of typical support classes referenced herein or as shown on the Contract Drawings are only approximate and may vary due to the geological and hydrological conditions encountered in the field. Tunnel excavation support classes, as shown on the Contract Drawings, are the minimum to be installed and adjusted above and beyond the said minimum based on the actual ground conditions encountered and be determined in the field in consultation between Contractor and the Contracting Officer. Each support class defines installation of a specific initial support system. The support elements are as specified in [Section XX XX XX TUNNEL EXCAVATION SUPPORT] and as shown on the Contract Drawings.

3.13.2 Initial Support Measures

Initial support measures have been derived based on anticipated ground conditions and the need to provide stabilization of the tunnel openings under this Contract. Excavation and support measures delineated hereafter are typical and will be supplemented by additional initial support measures as required by ground conditions encountered or as directed by the Contracting Officer. Expect to install additional ground support across weak or open geological features to minimize ground deformation. Damage is defined as the loosening of rock behind final lines and grades, opening of joints in the excavation or rock block displacement. If any damage occurs to the final excavation that requires remediation, it must be the responsibility of the Contractor to provide a timely, recommended corrective action to the Contracting Officer and demonstrate that the methods employed did not cause the damage.

To minimize ground movement; the initial support must be installed following each heading and as close to the working face as practical in accordance with [Section XX XX XX TUNNEL EXCAVATION SUPPORT].

****

NOTE: Verify that a Geotechnical Baseline Report has been prepared for the project and has been referenced in Section Related Attachments and Specifications.

****

a. Ground support guidelines for the tunnel excavation are shown on the Drawings and provided in the GBR. In addition to the ground support shown on the contract plans, the Contractor must install such ground support as necessary to always ensure the stability of the excavation and the safety of the construction personnel. Ground support installed by the Contractor without agreement or instruction from the Contracting Officer must be for the Contractors convenience and at the Contractor's expense.

b. The ground support must be installed as soon as practicable after tunnel excavation to minimize loosening or movement of the surrounding ground. The Contractor must be responsible for providing confirmation that the ground support system has produced a stable excavation. The support layouts shown on the contract drawings are a guide only and must be modified as required in the field based on geologic conditions exposed during tunnel excavation.

c. The approval of the proposed excavation and support sequence by the Contracting Officer or failure to call attention upon improper or inadequate application of the related excavation sequence or tunnel support, pre-support, or face support or to require respective change must not relieve the Contractor of responsibility for the integrity of the tunnel support or the proper execution of the work.

d. Lengths of excavation rounds shown on the contract drawings are maximum values and may have to be reduced due to the ground conditions encountered.

e. Pneumatically projected concrete, either fiber reinforced Shotcrete or plain Shotcrete must comply with provisions set forth in Section 03 37 13 SHOTCRETE.

f. Rock reinforcement for tunnel excavation must comply with 31 68 13 SOIL AND ROCK ANCHORS.

g. Steel arch ribs, liner plates and additional ground support elements must comply with [Section XX XX XX TUNNEL EXCAVATION SUPPORT].

3.14 EXCAVATION SEQUENCE FOR TUNNELS

****

NOTE: This is a placeholder for an excavation sequence. Depending on the project design and site conditions each project will require a specific excavation sequence. Example language: "Tunnel excavation must be accomplished in either a full face or top heading and bench format as indicated on the contract drawings. All initial support must be applied or installed prior to tunnel heading advance."

****

3.15 GROUND SUPPORT SYSTEM TYPES

****

NOTE: Ground support systems are often referred to as "categories" of ground support types. These categories are applied throughout a tunnel alignment in various zones as defined by the geologic conditions encountered as part of the pre-design investigations. See the Geotechnical Baseline Report for anticipated ground conditions.

****

[_____] ground support categories have been developed for the stabilization of the main tunnels as defined in [Section XX XX XX TUNNEL EXCAVATION SUPPORT].

An estimate has been made as to the lengths of each of the ground support categories required to stabilize the tunnel. The estimated lengths are shown on the contract drawings and presented in the Geotechnical Baseline Report (GBR). Actual stabilization requirements may vary from those estimated based on the geologic conditions encountered. In accordance with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS, the Contractor must be responsible for the safety of the work and for accomplishing the initial and permanent stabilization of the tunnel opening.

3.16 EXCAVATION FOR TRENCHES AND SUMPS

Excavation for trenches and sumps must conform with 31 00 00 EARTHWORK and as shown on the contract drawings.

****

NOTE: Excess Excavation section is applicable to mechanical excavation using roadheader. It should not be expected that the excess excavation section will be applicable to TBM excavation methods.

****

3.17 EXCESS EXCAVATION

****

NOTE: The type/class of shotcrete used to fill overbreak areas in the tunnel should be defined by the designer in early stages of the development of the bid documents. Similarly, the type of material used to fill overbreak in tunnel invert must also be defined during early stages of the project design.

****

Excavation outside of the B-Line shown on the drawings must be filled with Class I,II, III Shotcrete in accordance with Section 03 37 13 SHOTCRETE, or as directed by the Contracting Officer, at the expense of the Contractor. Overbreak excavation in the tunnel invert must be filled with [compacted crushed rock, lean concrete], or as directed by the Contractor Officer, at the expense of the Contractor.

3.18 TOLERANCES

The tunnels must be excavated in accordance with the A-line dimensions shown on the Drawings. No unexcavated rock or other material must protrude within the A-line.

3.19 CONTROL OF WATER

****

NOTE: This section will likely be incorporated into a future UFGS for Tunnel Dewatering. This section will need to be heavily tailored for your project needs. Adhere to the current version of the ETL 1110-2-586 DEWATERING: Methods, Installation, and Performance Monitoring. The project may develop a Diversion and Care of Water specification that is included in the front-end specifications and this language may be included there.

Beyond safety considerations of ice accumulation around portals and shafts, ice formation can create havoc with tunnel drainage and related rock subdrain systems in unheated area subjected to freezing conditions (e.g. near portals). This has been a critical issue for prior USACE underground facilities during construction.

****

The Contractor is responsible for control of water in the tunnel during construction and must take all means necessary for such control. Control of water must include but not be limited to, furnishing, installing, operating, and maintaining pumps and other equipment including temporary measuring devices must as per (b) below, constructing temporary ditches and drains and keeping ditches and drains free to carry all water to sumps or other disposal areas; and disposal of all water, tested as required, draining, or pumped from the tunnel. Disposal of water must conform to all applicable Federal, State, and local laws. [Treatment of groundwater is required if determined to be contaminated.]

3.19.1 Automatic Measuring Devices

Automatic measuring devices must be furnished by the Contractor and must be employed to measure the flow rate of water coming out of the tunnel portals. Water piped in for construction operations and water exiting at the portals must be separately measured. The difference between the total flow rate out of and the total flow rate into the tunnel must be considered the rate of groundwater inflow to the tunnel. This rate of flow must be measured and recorded on a [daily basis, [_____] hour basis] for information only.

3.19.2 Fissure Grouting

Fissure grouting must mean grouting carried out in the rock mass surrounding the Underground Works to stem water flows emanating from fissures in the rock where if left un-stemmed the inflows could initiate instability. Pressure grouting must be carried out when instructed by the Contracting Officer and, where necessary the Contractor must carry out lugeon permeability tests to establish the extent of the fissure to delineate zones that will take grout. Further requirements are detailed in Section 31 73 19 TUNNEL AND SHAFT GROUTING.

3.20 PERMANENT TUNNEL DRAINAGE

A drainage geotextile must be installed on the walls and crown of the excavation behind the shotcreted surface at locations where actual flows of water are encountered and at other locations as shown on the Drawings or as may be required to the satisfaction of the Contracting Officer. The drainage geotextile may be accompanied by drill holes installed into the rock face at discrete locations to capture concentrated seepage flow. The installation must comprise full coverage for ground support in accordance with [Section XX XX XX TUNNEL EXCAVATION SUPPORT].

The drainage membrane must be fixed and sealed to the approval of the Contracting Officer so that the placing of shotcrete does not block or obstruct the drainage geotextile. Geotextile must be installed in accordance with Section [_____] and Waterproof Membrane must be installed in accordance with Section [_____].

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-31 73 19 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 73 00 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 73 19

TUNNEL AND SHAFT GROUTING

02/21

PART 1 GENERAL

ATTACHMENTS:

[, ___ Form ___, dated ______]

ENG FORM 1836

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-31 73 19 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-31 73 00 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 31 73 19

TUNNEL AND SHAFT GROUTING
02/21

****

NOTE: This guide specification covers the requirements for tunnel and shaft grouting applicable to constructing new and repairing existing underground structures. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 SUMMARY

****

NOTE: The work will be under the direction of the Contracting Officer or his authorized representative, i.e., Government Representative who will be an engineering geologist or geotechnical engineer experienced in the design and grouting of tunnels and shafts.

****

This section describes the equipment, materials, and procedures to perform drilling and grouting work. It covers the equipment and materials to use;

drilling grout, drain and exploratory holes; installing grouting pipe and fittings; connections to grout holes; furnishing, handling, transporting, storing, mixing, and injecting grout; handling, controlling, and disposing of drill cuttings, waste water, and waste grout; patching finished grout and exploratory holes; final cleanup upon completion of work and all other operations incidental to drilling and grouting. The work consists of drilling exploratory and drain holes as directed or shown and performing [contact][and][tunnel and shaft][and][steel liner][and][ring curtain] grouting as shown. Exploratory drilling may be required to define problem areas or verify results ahead of the working face or through the lining during construction. The total amount of drilling and grouting required is not known and will be determined by conditions encountered as the work progresses. Grouting mixes, pressures, pumping rates, and the sequence in which holes are drilled and/or grouted will be determined in the field and as directed. Perform work under this section in accordance with EM 1110-1-3500, EM 1110-2-2901, and EM 1110-2-3506

1.2 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

****

1.2.1 Mobilization and Demobilization

1.2.1.1 Payment

Payment will be made for costs of assembling all plant and equipment at the site preparatory to initiating the work and for removing it when the drilling and grouting has been completed. Sixty (60) percent of the contract lump sum price for mobilization and demobilization will be paid following completion of moving onto the site, including complete assembly, in working order, of all equipment necessary to perform the required drilling and grouting operations. The remaining forty (40) percent of the contract lump sum price will be paid when all equipment has been removed from the site.

1.2.1.2 Unit of Measure

Unit of measure: lump sum.

1.2.2 Drilling Grout Holes

1.2.2.1 Payment

Payment will be made for costs associated with drilling and redrilling grout holes; washing and pressure testing of grout holes; containing and disposing of waste water and waste grout; clean-up of the site; furnishing, handling, transporting and storing of grout materials; and for furnishing all labor and supplies incidental to the work. [Unless otherwise specified, no][No] separate payment will be made for any material constituent of the grout, including cement and/or chemical grout materials placed in the performance of contract grouting. No payment will be made for grout, or the material constituents thereof, wasted due to improper anchorage of grout pipe or connections, or which is wasted due to negligence on the part of the Contractor, nor for grout which is rejected by the Contracting Officer because of improper mixing. Payment will be made at the applicable contract unit prices for materials contained in grout which are wasted, where the wasting is not due to negligence on the part of the Contractor.

1.2.2.2 Measurement

Drilling of grout holes will be measured for payment on the basis of the linear meters feet of holes actually drilled in concrete, rock or soil, as shown or as directed, including all intermediate holes at locations where pipe was not installed.

1.2.2.3 Unit of Measure

Unit of measure: linear meter foot.

1.2.3 Drilling Drain Holes

1.2.3.1 Payment

Payment will be made for costs associated with drilling of drain holes actually drilled in concrete, rock, or soil, as shown or as directed.

1.2.3.2 Measurement

Drilling of drain holes will be measured for payment on the basis of the linear meters feet of holes actually drilled in concrete, rock, or soil, as shown or as directed.

1.2.3.3 Unit of Measure

Unit of measure: linear meter foot.

1.2.4 Drilling Exploratory Holes

1.2.4.1 Payment

Payment will be made for costs associated with drilling of exploratory holes.[Provide core boxes at no additional cost to the Government.]

1.2.4.2 Measurement

Drilling of exploratory holes will be measured for payment on the basis of the linear meters feet of holes actually drilled in concrete, rock, or soil, as directed by the Contracting Officer.

1.2.4.3 Unit of Measure

Unit of measure: linear meter foot.

1.2.5 Placing Grout

****

NOTE: Select appropriate alternatives.

Under certain conditions it may be desirable to include a pay item for standby time for Government

directed suspension of drilling or grouting operations.
****

1.2.5.1 Payment

[Payment will be made for costs associated with satisfactorily placing grout in contact grout holes[and behind steel liner], which includes full compensation for[furnishing all materials,] proportioning the mix as directed,[drilling grout holes if necessary,] and mixing and injecting the grout as specified or as directed.][Payment will be made for costs associated with satisfactorily placing grout in grout holes, which includes full compensation for proportioning the mix, mixing, and injecting the grout as specified or as directed. Separate payment will be made for all materials used in [contact]grout as provided in unit price pay item(s) "Portland Cement in Grout" "Mineral Filler in Grout", "Sand in Grout", "Fluidifier in Grout", and "Chemicals in Chemical Grout".]

1.2.5.2 Measurement

The operation of placing grout will be measured for payment on the basis of the number of[cubic meters cubic feet of the component materials (bulk materials), satisfactorily placed, exclusive of water [and fluidifier] and regardless of the proportions of the mixes, measured individually as specified in unit price pay items "Portland Cement in Grout", "Mineral Filler in Grout", and "Sand in Grout".][hours of satisfactory placing regardless of the proportions of the mixes. Measurement will begin with the initiation of grout injection at the proper elevation or stage and continue until grout injection ceases, for a given hole, exclusive downtime. Downtime is defined as any failure to inject grout continuously, except for intermittent grouting as directed by the Contacting Officer. Time will be measured cumulatively to the next whole hour of operation. Payment for placing grout in holes will be based on the total amount of time required for satisfactorily placing grout, determined by reducing the total number of minutes of operation to the nearest whole hour.]

1.2.5.3 Unit of Measure

Unit of measure: [cubic meter foot][nearest whole hour].

1.2.6 Connections to Grout Holes

1.2.6.1 Payment

****
NOTE: The price to be inserted in this paragraph should be determined on the basis of the estimated cost to the Contractor for the operation of moving the grout supply line onto the hole. This price should not include any allowance for pipe or other materials used in making the connections. This unit price pay item may be optional for grout payment on an hourly basis.
****

[Payment will be made for costs associated with connections to grout holes at a rate of [_____] dollars per connection.] [Payment for only one connection will be made for each hole regardless of the number of settings.]

1.2.6.2 Measurement

Connections to grout holes will be measured for payment per connection for each time the grout supply line is connected to the ring grout hole or an exploratory hole for the purpose of injecting grout, regardless of the number of times such connections are made per hole or the amount of grout actually injected.

1.2.6.3 Unit of Measure

Unit of measure: each.

1.2.7 Portland Cement in Grout

1.2.7.1 Payment

Payment will be made for costs associated with Portland cement in grout.

1.2.7.2 Measurement

Portland cement in grout will be measured for payment on the basis of the number of cubic meters (42.6 kg) cubic feet (94 pounds) of cement used in the grout satisfactorily placed in ring grout holes and in filling exploratory holes, or wasted when such wasting is not due to the Contractor's negligence.

1.2.7.3 Unit of Measure

Unit of measure: meter (42.6 kg) cubic foot (94 pounds).

1.2.8 Mineral Filler in Grout

1.2.8.1 Payment

Payment will be made for costs associated with mineral filler in grout.

1.2.8.2 Measurement

Mineral filler in grout will be measured for payment on the basis of the number of cubic meters (36.3 kg) cubic feet (80 pounds) of filler used in the grout and satisfactorily placed in grout holes.

1.2.8.3 Unit of Measure

Unit of measure: cubic meter (36.3 kg) cubic foot (80 pounds).

1.2.9 Sand in Grout

1.2.9.1 Payment

Payment will be made for costs associated with sand in grout.

1.2.9.2 Measurement

Sand in grout will be measured for payment on the basis of the number of cubic meters cubic feet of sand [, dry rodded measurement,] used in the grout satisfactorily placed in ring grout holes or in filling exploratory holes.

1.2.9.3 Unit of Measure

Unit of measure: cubic foot.

1.2.10 Fluidifier in Grout

1.2.10.1 Payment

Payment will be made for costs associated with fluidifier in grout [, including full allowance for the payment by the Contractor of all required royalties].

1.2.10.2 Measurement

Fluidifier in grout will be measured for payment on the basis of the number of pounds of fluidifier used in the grout satisfactorily placed in ring grout holes.

1.2.10.3 Unit of Measure

Unit of measure: kilogram pound.

1.2.11 Chemicals in Chemical Grout

1.2.11.1 Payment

Payment will be made for costs associated with chemicals in chemical grout.

1.2.11.2 Measurement

Chemicals in chemical grout will be measured for payment on the basis of the number of gallons of chemicals actually used in grout mixtures satisfactorily placed in ring grout holes.

1.2.11.3 Unit of Measure

Unit of measure: kilogram pound.

1.2.12 Steel Pipe and Fittings

1.2.12.1 Payment

Payment will be made for costs associated with embedded grout and drain hole pipe and fittings remaining in the permanent work, which includes costs for removal of pipe and fittings, and patching and cleanup pursuant to Section 31 73 19 TUNNEL AND SHAFT GROUTING, paragraph PATCHING AND CLEANUP. All pipe and fittings removed is the property of the Contractor.

1.2.12.2 Measurement

Embedded pipe and fittings through which holes will be drilled and grouted, as shown and as directed or approved, will be measured for payment on the basis of the actual [kilograms][linear meters] [pounds][linear feet][, as differentiated by pipe size and schedule number,] of satisfactorily installed pipe and fittings left in place. No additional allowance will be made for [overweight][differences] caused by installation of oversized pipe (diameter or length) and pipes that are not specified or approved. Upon completion of the grouting, no additional allowance will be made for costs of cutting off and removing from the project site all grout pipe connections protruding from the inside face of the concrete liner.

1.2.12.3 Unit of Measure

Unit of measure: kilogram pound.

1.2.13 Pressure Washing and Pressure Testing

1.2.13.1 Payment

Payment will be made for pressure washing, and pressure testing of grout holes and pressure testing of exploratory holes, which includes the cost of preliminary washing, materials for washing and testing, and making and breaking connections incidental to the work. Payment will be based upon the total amount of time required for pressure washing and pressure testing, determined by reducing the total number of minutes of operation to the nearest whole hour. No payment will be made for time lost due to fault or negligence of the Contractor, or due to defective equipment furnished by the Contractor.

1.2.13.2 Measurement

Pressure washing and pressure testing will be measured for payment on the basis of the actual time water pumps are operating. Pressure washing and pressure testing will be measured from the time pumping is begun on a hole or section of a hole until the time pumping is completed on the hole or section of the hole as determined by the Contracting Officer. Time will be measured cumulatively to the next whole minute of operations.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C937	(2023) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C939/C939M	(2022) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C940	(2022) Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C942/C942M	(2021) Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

EM 1110-1-3500	(1995) Engineering and Design -- Chemical Grouting
EM 1110-2-2901	(1997) Engineering and Design -- Tunnels and Shafts in Rock
EM 1110-2-3506	(2017) Engineering and Design -- Grouting Technology

1.4 SEQUENCING

Perform grouting in the work sequence as shown and as specified. [Perform [contact grouting][and/or][grouting behind steel liner] at a reasonable time following installation of the permanent liner and prior to any application of internal or external water pressure, air shock, or vibration.][Perform tunnel and shaft grouting or ring grouting at the appropriate time during the excavation/muck/support mining cycle to achieve the desired water flow reduction or stabilization prior to the passage of any water within the tunnel or shaft.] Once grouting is started, normally proceed to completion without significant interruption.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drilling Operations

Pressure Washing and Pressure Testing Operations

Cement and Chemical Grouting Operations

SD-03 Product Data

Qualifications

Grouting Equipment; G, [_____]

Grout Application; G, [_____]

SD-04 Samples

Grouting Material Samples; G, [_____]

1.6 QUALIFICATIONS

Perform grouting by a specialty Contractor or subcontractor experienced and competent in [cement grouting] [chemical grouting] [both cement and chemical grouting]. Submit evidence that the grouting specialist or grouting foreman has had at least 3 years experience within the past 5 years on similar grouting type projects.

Perform all grouting work under the direct field supervision of a qualified grouting specialist or grouting foreman whose qualifications have been provided to the Contracting Officer. Supervise the performance of the work in compliance with these specifications.

PART 2 PRODUCTS

2.1 GROUTING MATERIALS

Provide grout of a nonshrink type and normally composed of water, cement, and fluidifier with shrinkage compensators (expanding agents). Use sand, admixtures to vary grout properties, and mineral fillers as specified or approved. The grout mixes will be designed or approved by the Contracting Officer and will be varied to meet the characteristics of each hole or situation as determined by the conditions encountered. Furnish the various materials conforming to the following paragraphs.

2.1.1 Water

[Furnish the water used in the grout. It must be fresh, clean, and free of sewage, oil, or organic matter and injurious amounts of acid, alkali, and salts or other damaging substances as determined by COE CRD-C 400.][Water suitable for use in the work will be furnished by the Government. Provide any necessary connections and extensions to the Government supply line.]

2.1.2 Cement

****

NOTE: Designer should insert the Section number and title that specifies the storage requirements for cement.

****

Provide cement used in grout conforming to the requirements of ASTM C150/C150M, portland cement Type [_____]. Store cement in accordance with Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [_____]. Employ methods of handling, transporting, and storage that are satisfactory to the Contracting Officer. Only cement furnished in cloth or paper bags will be accepted for use in the work unless bulk cement is approved. Store a sufficient quantity of cement at or near the site of the work to ensure that grouting operations will not be delayed due to shortage of cement. Take care in storage and handling to protect the cement from contamination and moisture. In the event the cement contains lumps or foreign matter that will not pass through a standard #100 mesh screen, remove the cement from the work site and replace it at no cost to the Government.

2.1.3 Sand

Provide sand for grout consisting of hard, tough, durable, uncoated particles. It may be composed of [natural sand][manufactured sand][a combination of natural and manufactured sand]. Provide generally rounded or cubical shaped particles containing no more than 5 percent of flat or elongated pieces having a maximum dimension in excess of five times the minimum dimension. If the sand is a combination of separately processed sizes, classification, or a combination of natural and manufactured sands, batch the different components separately, or, subject to written approval, blend prior to delivery to the mixing plant. Provide sand that is well-graded from fine to coarse, of the gradation, as determined in accordance with ASTM C136/C136M and ASTM C117, conforming to the following requirements:

SIEVE DESIGNATION (U.S. STANDARD SQUARE MESH)	CUMULATIVE PERCENTAGE BY WEIGHT	
	PASSING	RETAINED
8	100	0
16	95-100	0-5
30	60-85	15-40
50	20-50	50-80
100	10-30	70-90
200	0-5	95-100

In addition to the grading limits shown, use sand that has a fineness modulus within the range of 1.50 to 2.00. Control the grading of the sand as delivered to the mixes, during any 24-hour period of operation, so that the fineness moduli of samples taken will not vary more than 0.10 from the average fineness modulus. The results of previous tests and the service record may be used to determine the acceptability of the sand. Store sand in a manner to facilitate drainage and avoid the inclusion of any foreign materials in the grout. Construct storage piles to prevent segregation and contamination.

2.1.4 Admixtures

An admixture is any material other than water, sand, and cement added to the grout immediately before or during its mixing to alter its chemical or physical properties to a desired characteristic during its fluid or plastic state. Provide admixtures conforming to ASTM C494/C494M at the time of acceptance testing sample submittal; furnish certification from the manufacturer that the material meets all the requirements of these specifications. Package all admixtures to be used in each batch of grout separately and weigh prior to use. Provide grout fluidifier and expanding agents conforming to the requirements of ASTM C937. Provide accelerator additive that is calcium chloride ($CaCl_2$) in amounts up to 2 percent of the cement by weight or an approved product manufactured for the specific purpose of accelerating grout set-up time. Provide granular or flaked calcium chloride and add to the grout by dissolving it in a portion of the mix water.

2.1.5 Mineral Filler

Use fly ash fillers in grout as replacement for a portion of the cement composed of finely divided siliceous residue and in accordance with ASTM C618, Class F. The maximum amount of fly ash should not exceed 30 percent of the cement by weight.

2.1.6 Chemical Grouting Materials

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NOTE: Designers should seek information from chemical grout suppliers and manufacturers and other reference material on the subject about which type(s) of chemical grout is best suited for their particular application and job.

****

Furnish nonflammable grouting materials and use either water-based (gel forming) or water-reactive (foam forming) in grouts. Use only the following water-based chemical types; silicates, acrylates, polyacrylamides, acrylamides (only certain products), modified tannin, and epoxy resins. Use only the following water-reactive chemical types; polyurethanes and elastomers. Provide EPA approved chemical compounds. Store a sufficient quantity of chemical grouting materials at or near the work site to ensure that grouting operations will not be delayed due to storage of these materials. Storage requirements, mixing, and handling of all component materials as well as the grout mixture itself must be in accordance with the manufacturer's or supplier's recommendations.

2.2 EQUIPMENT

Provide drilling and grouting equipment of a type, capacity, and mechanical condition suitable for the work, as approved by the Contracting Officer. Power, compressed air, all other equipment, and the layout thereof must meet the requirements of local, State, and Federal regulations and codes, both with respect to safety and otherwise. The use of gasoline internal combustion engines for operation of drilling and grouting equipment underground is not permitted. Internal combustion engines must be diesel powered fitted with suitable and efficient scrubbers and in compliance with EM 385-1-1.

2.2.1 Drilling Equipment

Use standard drilling equipment of the rotary, percussion, or rotary-percussion type to perform grout hole, drain hole, and exploratory hole drilling. The use of hand-held equipment, such as jackhammer or jackleg percussion-type drills for drilling holes above the horizontal, is not permitted. Furnish equipment of a type and condition that will allow a drilling rate which will not delay the work and will be adequate to maintain an alignment within a tolerance of 4 percent or less of the depth. Properly maintain all drilling equipment and keep a sufficient supply of bits, tools, and spare parts at the job site to avoid delays. In the case of equipment breakdown, make repairs promptly. Accomplish exploratory drilling using rotary core drilling rigs and equipment. Use a standard ball bearing, swivel type, triple-tube, or double-tube core barrel at all times when drilling exploratory holes. The core barrel must be of a length, generally 1.5 or 3 meters 5 or 10 feet, appropriate for the working space and the type of material being drilled. Appropriate coring bits for exploratory holes and drain holes must be NW size except wire line bits must be NQ in size or as directed. Grout hole sizes must be EW. Use a wire line system on downward inclined holes that are [15][_____] meters [50][_____] feet or greater in depth.

2.2.2 Grouting Equipment

2.2.2.1 Cement Grouting Equipment

Submit a plan of the proposed grouting equipment types and layout for approval. An example of a typical grouting equipment layout is included at the end of this section. Furnish grout plant capable of supplying, mixing, stirring, and pumping the grout as specified. Provide plant with a minimum capacity of [0.11][_____] cubic meters per minute [4][_____] cubic feet per minute (cfm) of grout injected at a pressure not greater than [690][_____] kPa [100][_____] pounds per square inch (psi). Maintain it in first-class operating condition at all times, and replace any grout hole lost or damaged due to mechanical failure of equipment or inadequacy of grout supply at no expense to the Government. Furnish the following grouting equipment:

2.2.2.1.1 Grout Pump

Air or electrically powered grout pump(s) of the progressive cavity (helical screw) type that is free of surging are capable of pumping a great range of grout consistencies, provide close control of pumping pressures and variable rates of injection, and can be easily and quickly serviced during grouting operations. Keep a minimum of one spare grout pump and spare pump parts available on site during all grouting operations.

2.2.2.1.2 Grout Mixer

Grout mixers either mechanically driven, high-speed, shear-type tub mixers with either vertical or horizontal drum, or high-speed colloidal mixers. Provide mixers that are capable of effectively mixing and stirring a capacity of at least 0.11 cubic meters 4 cubic feet of grout with water to cement ratios from 0.6:1 to 6.0:1 and achieve mixing by constant rapid circulation of grout. Equip the mixer with a suitable volume-measuring water metering device for batching water for the grout mix. Calibrate the water meter to read in cubic meters and thousandths cubic feet and tenths and design in a manner that after each delivery the hands can be conveniently set back to zero. The water meter must have a certificate of calibration from an independent laboratory. Prior to each use, check the water meter for accuracy and, if necessary, recalibrate.

2.2.2.1.3 Holding Tank or Sump

Holding tank(s) or sump(s) of the mechanically agitated type to provide a high volume and continuous injection of grout. The sump must be capable of holding the solids of the mix in suspension and have a capacity of at least 0.34 cubic meters 12 cubic feet of grout or three times the capacity of the mixing system. Measure the volume of grout used from the agitator holding tank(s) or sump(s) by a vertical graduated stick or marks at different levels in the tank(s)/sump(s).

2.2.2.1.4 Supply and Pressure Control

Valves, pressure gauges, grout lines, header arrangements, and accessories as necessary to provide a continuous supply of grout and accurate pressure control. Convey grout between the pump and the hole using a [single-line system consisting of a pipe or hose or combination of both extending from the pump discharge to the header at the hole collar with grout injection rate controlled by the pump speed][or][circulating double-line system composed of a supply line to the header at the hole collar and a return line from the header to the grout pump, sump, or holding tank]. Grout lines must consist of either black steel pipe or reinforced rubber or plastic hose or a combination of both. The maximum inside diameter of all grout lines must be 25 millimeters 1 inch. Control the grout injection rate for the single-line system by the pump speed so that settlement of solids within the lines will not occur when pumping at or above the minimum discharge capacity of the pump. Control the pressure in the double-line system by one or more valves on the control line. Make the distance between the hole and the pump or holding tanks as short as possible to minimize the accumulation of solids and possible clogging. Pressure gauges must be high precision, graduated with divisions not greater than 10 kPa 2 psi on the dial face, calibrated and certified correct prior to use. Test gauges for accuracy[daily] during the work by cross comparison with a standard set of oil-filled gauges. Protect the moving parts of all gauges from dust, grit, and direct contact with grout.

2.2.2.1.5 Flow Cone

Flow cone(s) to ascertain the fluidity of grout mixtures. The flow cone and method of test must be in accordance with ASTM C939/C939M.

2.2.2.1.6 Communications

Telephone or radio communications between the grout plant and the hole being grouted when the site conditions such as distance, noise level, or visual obstructions negatively impact on the proper control of grouting operations.

2.2.2.2 Chemical Grouting Equipment

The chemical grout plant must be of the continuous mixing and pumping type. Provide all chemical grouting equipment in strict compliance with the grout manufacturer or supplier recommendations for the specific grout and The method to be used in grout application approved by the Contracting Officer. Provide all equipment of a type, capacity, and mechanical condition suitable for doing the work, compatible with the chemical to be handled, and maintain in first-class operating conditions throughout the job.

2.3 GROUT

2.3.1 Cement Grout

Design the grout mixture to expand [3 to 5 percent][2 to 4 percent] when tested in accordance with ASTM C940. Grout flow time-of-efflux, when tested in accordance with ASTM C939/C939M must be [between 10 and 30 seconds]. The unconfined compressive strength of the solidified grout must range between [3.5 and 13.8][13.8 and 20] MPa [500 and 2,000][2,000 and 3,000] psi when tested in accordance with ASTM C942/C942M.

2.3.2 Chemical Grout

Provide chemical grout composed of commercially available materials consisting of base material, reactant, water, and accelerator if required. Set times for chemical grout must be controllable from 1 to 30 minutes following injection. Provide components that are compatible with each other and with the rock or soil and groundwater. Certify that the proposed grout is chemically stable and will not render surrounding groundwater unpotable.[The grout mix must be such that when injected in medium dense Ottawa 20-30 sand and tested by an approved method, the unconfined compressive strength of the grouted sand must average at least 690 kPa 100 psi.]

2.3.3 Grouting Material Samples

****

NOTE: The Designer should insert the name and address of the Division Laboratory where material samples are to shipped and tested.

****

Ship grouting material samples for acceptance laboratory testing to:

[_____] Division Laboratory
[_____]
[_____]

The samples must include:

Cement	5 sacks (or 213 kg 470 pounds)
Additive(s)	2.25 kg 5 pounds of each
Sand	0.75 cubic meter 1 cubic yard

Mineral Filler	68 kg 150 pounds
Chemical Grout (to include reactant and catalyst)	4 L 1 gallon

Provide sample from the manufacturer or supplier and representative of the materials to be used in the work or from the shipment received at the work site. Make shipment to permit arrival at the lab 28 calendar days before the earliest start of grouting. Any substitution of materials after mix design is approved will require a new mix design and an additional 28 days. State the intended grout pumping temperature range. Grout mixes will be designed and approved only for the stated temperature range.

2.4 PIPE AND FITTINGS

Furnish all pipe conforming to ASTM A53/A53M standard weight. Provide fittings that are malleable iron Type I in accordance with ASME B16.3, ASME B16.5, and ASME B16.9, Class 150. Furnish black steel pipe of the diameter shown or as directed.

PART 3 EXECUTION

3.1 GROUT, DRAINAGE, AND EXPLORATORY HOLES

Locate holes through shotcrete or concrete or into the surrounding rock, for the purpose of injecting grout or air release and providing drainage, in the direction and to the depths shown or as directed or approved. Form holes by embedding pipe in the concrete or shotcrete at the time of placing or made by drilling through the concrete, shotcrete, or rock as indicated below for the various kinds of holes. Drill all grout, drainage, and exploratory holes using only water or compressed air.

3.1.1 Embedded Pipe

Provide all metal pipe and fittings required for constructing grout holes, grout hole connections, and air vents. Thoroughly clean al pipe and fittings embedded in concrete of dirt, grease, grout, and mortar immediately before embedding and firmly hold in position and protect from damage or displacement while the concrete is being placed. Take great care to avoid premature clogging of pipes and claen out any pipe that becomes clogged or obstructed before completion of operations in a satisfactory manner or replace at the expense of the Contractor. Cut, thread, fabricate, and install all piping required for the work as required.

3.1.2 Grout and Vent Hole Drilling

Locate grout and vent holes as shown and as directed. Drill grout holes through shotcrete or concrete of sufficient size to permit the caulking or grouting of short lengths of 40 mm 1-1/2 inch diameter pipe into the hole for attachment of the grout supply line. Grout hole diameters in rock must be as shown within a tolerance of 6 mm 0.25 inch and not less than 35 mm 1-3/8 inch at the point of deepest penetration. Check the size of completed grout holes frequently during the work to assure proper hole diameters are achieved. It is anticipated that the required depth of [ring][tunnel and shaft] grout holes will not exceed [15][_____] m [50][_____] feet. Protect each hole drilled from becoming clogged or obstructed by means of a cap or other suitable device on the collar. The use of greases, "rod dope," or other lubricants on the drill rods or in grout holes will not be permitted. No core recovery will be required, and the drilling fluid must be water or compressed air. During the drilling of grout holes, take all precautionary measures to control dust, fumes, and noise in conformity with [other sections of these specifications and] the applicable local, State, and Federal laws, codes, and regulations. Do not accomplish drilling of tunnel and shaft or ring grout holes until all contact grouting within [60][_____] m [200][_____] feet has been completed.

3.1.3 Drain Hole Drilling

Locate drainage holes as shown and as directed, and drill through the permanent liner after all grouting from holes within [60][_____] m [200][_____] feet has been completed. Drain hole diameters must be as shown but not less than [50][_____] mm [2][_____] inches with a tolerance of 6 mm 0.25 inch for their full lengths.

3.1.4 Exploratory Hole Drilling

Perform exploratory drilling as directed when required to determine the condition of the rock prior to grouting or the effectiveness of the grouting operations. Such drilling may be required at any inclination and in advance of the excavation face or from the perimeter of the tunnel or shaft. Exploratory drill hole depths may vary but will not exceed a maximum of [15][_____] m [50][_____] feet. Core drill the entire length of each exploratory hole using water or compressed air. Core size must be[either] NW (54 mm 2-1/8 inch diameter)[or HQ (54 mm 2-1/2 inch diameter)]. Perform core drilling by competent and experienced drillers and take special care to obtain cores in as good condition as possible. Core logging [will][must] be performed by [the Government Representative][a qualified geologist experienced in core logging]. Suitable wooden core boxes [will be furnished by the Government][as shown in Section [02 32 13 SUBSURFACE DRILLING AND SAMPLING] [03 37 29 CONCRETE FOR CONCRETE CUTOFF WALLS]] [must be furnished by the Contractor] for core storage in a suitable area on site. Protect core boxes from the weather prior to being delivered to the storage area upon completion of each exploratory drill hole. Place the core in the boxes in the correct sequence with each run marked by accurately labeled wooden blocks according to the measured distances in the holes. No box is permitted to contain cores from more than one hole.

3.1.5 Disposal of Drill Cuttings

Remove drill cuttings and water produced during the drilling process from the tunnel or shaft area on a routine basis to avoid buildup that may impede the function of temporary or permanent drainage system components such as slotted pipe, sumps, and pumps. Dispose of drill cuttings at an approved location outside the tunnel or shaft.

3.2 GROUTING PROCEDURES

Perform grouting in the presence and under the direction of the Contracting Officer. Remove cement grout, which is not injected into the hole within 1 hour after mixing (30 minutes if the mix contains fluidifier with expanding agent), from the mixer, sump, and supply line and waste it.

3.2.1 Washing and Pressure Testing Holes

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NOTE: Develop the appropriate form to record test results and attach it to the end of this section.

****

Immediately before the injection of grout into any hole drilled for the purpose of tunnel and shaft grouting or exploratory drilling, wash the hole thoroughly under pressure and then pressure test to provide an indication of potential grout take.

a. Wash all intersected rock seams and crevices containing clay or other washable materials with water and air under pressure to remove as much of these materials as practicable (normally this means until the return wash water runs clean). The maximum pressure at which air and water are introduced for any separate washing operation must be as directed.

b. Wash all holes sufficiently tight to build up the maximum required pressure at such pressure, and continue washing as long as there is any increase in the rate at which water is taken. Wash holes in which the required pressure cannot be reached or maintained as long as there is any increase in the rate of flow or drop in pressure when the pump is delivering a capacity flow. Wash open holes in which no pressure can be built up for a period of 5 minutes or for such a period of time as fracture-filling is being removed, as determined by the venting of muddy water through surface openings or other grout holes. Water pressure testing is also required in grout holes and exploration holes for the purpose of either assessing the grout take potential or the imperviousness of a grouted area.

c. Provide the necessary fittings, a gauge for measuring hydraulic water pressure up to [690][_____] kPa [100][_____] psi and a meter large enough to measure 0.14 cubic meter per minute to the nearest 0.001 cubic meter 5 cfm to the nearest 0.1 cubic foot. The volume of water available at the drill hole must be a minimum of [0.11][_____] cubic meters per minute [4][_____] cfm. Test drill holes as directed with clean water under a continuous pressure as determined in the field. After the waterline or header has been secured to the collar of the hole, pump water into the system until approximately [100][_____] kPa [15][_____] psi pressure is obtained. Maintain the pressure by control of a bypass valve and continue the flow test for 5 minutes. If no flow occurs, shut in the pressure and hold for 5 minutes and recordany pressure drop. Both the hold test and the flow test may be repeated in the same interval if necessary to confirm indications of grout take or tightness of an already grouted area. During each test, record the data on the Government supplied form [, ___ Form ___, dated ______]. Do not drill, wash, and water pressure test in previously grouted areas before 24 hours following the completion of all the planned grouting in that particular area.

3.2.2 Contact Grouting

Contact grouting is defined as the injection of grout behind cast-in-place concrete lining (shaft and/or tunnel), or grouting behind the initial support system, to achieve continuous contact between the lining and the surrounding rock or soil. Tunnel plug contact grouting is also included in this definition. Perform contact grouting in such a manner as to ensure that all voids between the concrete or initial support members and the rock or soil face will be filled with grout. No pressure washing or testing is required prior to injecting grout. Leave cast-in-place concrete final lining in place at least [7][_____] days before grouting commences. Grout must be a [neat][sanded][[cement][chemical] grout] mixture. Do not terminate grouting of any hole until all voids have been filled to the maximum extent practicable and the Government Representative directs the Contractor to stop grouting. Provide vent pipes, for the release of air and water during grouting of crown overbreak cavities[which may not be filled with concrete], as shown and in such locations as directed or approved. The installation requirements of paragraph EMBEDDED PIPE applies to vent pipes. Perform contact grouting at the highest safe pressure as directed but initially not exceeding [69][_____] kPa [10][_____] psi. Initiate grouting from the lower end and at the invert of a tunnel and the grout behind the liner displaced upward. Grouting in the tunnel crown area may require secondary grouting to completely fill all the void space due to overbreak. Perform secondary grouting with expansive grout mixtures after the initial contact grout has been injected and set up. For shaft linings, radially locate grout holes or nipples and grout from inside the shaft. Split spaced grout injection holes or nipples may be necessary in shaft liner grouting.

[3.2.3 Grouting Behind a Steel Liner

This type of grouting, often called "skin" grouting, consists of placing neat cement grout in the annular space surrounding a steel liner or "can" to fill the void between the steel liner and the cast-in-place concrete final lining. Grouting procedures are the same as those described in paragraph CONTACT GROUTING with the following exceptions:

a. Provide grout holes and sealing plugs in the steel liner plates during fabrication. Provide pattern as shown.

b. Furnish grouting equipment such that sudden surges in pressure at refusal do not occur.

c. Grind grout hole plugs flush with the steel liner and finish smooth.

d. After grouting is completed, the Government Representative will sound the liner with hammer blows to determine if all voids are filled. If directed, drill and tap additional grout holes to receive a nipple. The use of a cutting torch to cut-in and weld-on a nipple is prohibited.

]3.2.4 Tunnel, shaft, and Ring Curtain Grouting

****

NOTE: Tunnel, shaft, and ring curtain grouting are defined as the grouting in areas of the work including, but not limited to, ahead of the tunnel or shaft face or along any reach of tunnel or shaft to control water flows or aid in stabilizing and filling voids in the formation.

****

Accomplish tunnel, shaft, and ring curtain grouting at the locations shown and/or as directed. Replace any grout hole that is lost or damaged due to mechanical failure of equipment, inadequacy of grout supply, or Contractor error by another hole or holes at the Contractor's expense.

3.2.4.1 Grout Injection (Cement Grout)

a. If the water pressure testing indicates a relatively tight hole, start grouting with a thin grout mixture. For an open hole condition, reduce the water-cement ratio accordingly and, with the grout pump operating as nearly as practicable at constant speed at all times, reduce the ratio further, if necessary, until the required pressure has been reached. If the pressure tends to rise too high, as determined by the Government Representative, change the water-cement ratio as directed. Provide grout mixes in the proportions directed by the Government Representative who will direct changes to suit the conditions existing in the particular grout hole. The water-cement ratio by volume will be varied to meet the characteristics of each hole as revealed by the pressure washing and testing operations and will normally range between [3.0:1.0 and 0.6:1.0][[_____] and [_____]].

b. Vary grouting pressures as directed with conditions encountered in the respective holes. If it is found impossible to reach the required pressure after pumping a reasonable volume of grout at the minimum workable water-cement ratio, use a sanded grout mix, reduce the pumping speed, or stop pumping temporarily and perform intermittent grouting, allowing sufficient time between grout injections for the grout to stiffen. If necessary to relieve premature stoppage, make periodic applications of water under pressure at the direction of the Government Representative. If the desired results are not obtained with this mix, discontinue grouting in the hole if so directed.

c. In such event, clean the hole, allow the grout to set, and perform additional drilling and grouting in this hole or in the adjacent area, as directed, until the desired resistance is built up. Do not increase the pressure or rate of pumping suddenly, because either may produce a water-hammer effect which may promote stoppage. After the grouting of any hole is completed, maintain the pressure by means of a stopcock or other suitable device until the grout has set to the extent that it will be retained in the hole.

3.2.4.2 Refusal

Do not consider the grouting of any hole complete until that hole refuses to take grout at a rate of less than [0.015 cubic meter 0.5 cubic foot of solids (cement) per 1/2 hour][0.03 cubic meter 1.0 cubic foot of solids (cement) per 10 minutes] at whatever grout mixture and pressure is being used.

3.2.4.3 Grout in Drains

If leakage of grout into drains occurs, immediately stop the grouting operations and remove all grout from the drains by washing, to the satisfaction of the Contracting Officer. No separate payment will be made for such work. Such stopping of grouting operations and washing of drains must be repeated as often as required to complete the grouting.

3.2.4.4 Stage Grouting

Stage grouting is the procedure by which a grout hole or a ring curtain hole is drilled, pressure tested, and grouted in successive stages within progressively deeper zones from the top of the grout hole, either from the ground surface or from the tunnel or shaft wall, to the depth shown or as directed, prepared for grouting, and then grouted. After the grout has achieved an initial set, wash, clean and deepen the hole and then grout to the bottom of the next stage. If the Contractor allows the grout to harden within the grout hole, no payment will be made for redrilling the grout hole. A minimum period of [24][_____] hours must elapse between the completion of grouting in one stage and the start of drilling for the next stage. Repeat this procedure for the full depth of the grout application.

Increase grouting pressures [as directed][as shown] as successive stages deepen the grout holes. Normally the grout holes are split spaced by locating secondary holes midway between two previously drilled and grouted primary holes, and the stage grouting process is repeated until the desired results are attained for the full depth of the grout application. Also drill and grout tertiary and succeeding series of split spaced holes in stages if directed by the Government Representative.

3.2.4.5 Grout Injection (Chemical Grout)

In the zones to be chemically grouted, perform chemical grouting in such a way as to produce a continuous cylinder or mass of chemically grouted ground outside the excavation perimeter of the tunnel or shaft in either soils or finely fissured rock strata, increasing the strength and reducing the permeability of the material. Grout in place must be chemically stable and nontoxic for the environment in which it is placed. Do not commence excavation through grouted areas until the grouting work has been completed and approved by the Government Representative. Perform regrouting if the required degree of waterproofing and/or stabilization is not achieved by the first application. The method of injection must be the continuous mixing method, with the proper amounts of grout base material, water, reactant, and accelerator automatically proportioned and continuously supplied at proper flow rates and pressures. The batch system of mixing grout is not permitted unless high volumes of chemical grout with shortened gel times are necessary in flowing water conditions. The base material and the water-accelerator-catalyst solution must pass through parallel separate hoses to a suitable baffling chamber near the top of the hole. Place a sampling cock to allow frequent gel time checks after the baffling chamber. Place suitable check valves in the grout lines at the proper locations to prevent backflow and unintentional gelations. Perform all mixing, handling, pumping, and injection operations in accordance with the manufacturer's recommendations. A technical representative of the manufacturer or supplier must be present at the work site during the initial grouting operations.

[3.2.4.6 Grout Injection Pipes

****

NOTE: The following paragraph may be specified for grouting when it is desirable to exercise maximum control over the grout injection process, i.e., to grout or regrout at any specific depth.

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Grout pipes are commercially available or field fabricated as illustrated by the attached sketch. Perform installation with care to assure the sealing grout encapsulates the entire pipe and completely fills the annulus. Use grout to fill the annulus consisting of portland cement, bentonite and fly ash, be thick enough to prevent infiltration into the soil or rock, and be of low strength and brittle.

]3.2.5 Waste Water and Grout

Waste grout that cannot be placed or injected prior to initial set or maximum specified time limit. If such grout is mixed at the direction or approval of the Government Representative, it will be paid for at the applicable contract unit prices for the material constituents of the wasted grout. During the progress of the work, provide for adequate disposal of all wash and waste water and remove all waste grout, on a daily basis if necessary, to maintain a safe and effective grouting operation.

3.3 PATCHING AND CLEANUP

Upon completion of the grouting operations, remove all grout supply connections from embedded pipe to a minimum depth of 25 mm 1-inch, measured from the face of the concrete [shotcrete]. Patch holes or depressions thus formed with a damp-pack mortar composed of water, one part portland cement to two parts sand. One teaspoonful of aluminum powder will be added to each sack of cement used in the mortar mix to compensate for shrinkage. An unpolished, nonleafing powder of high purity and low grease will be used. Use damp-pack mortar just moist enough to form a ball in the hands. Thoroughly tamp into the hole using hard wooden tools. Patch in a neat and professional manner to provide a surface smoothness at least equal to undisturbed areas of the final lining. Pack exploratory holes which have not been grouted to the full depth of the final lining with tightly rammed dry mortar and then patch as described above. Prior to final acceptance of the work, clean the interior surface of the final lining of excess cement or chemical grout, mortar, oil, and grease to the greatest extent practicable, as determined by the Government Representative.

3.4 RECORDS

****

NOTE: Attach ENG FORM 1836 to the end of this section.

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Prepare, on a daily basis, records of all grout hole and drain hole drilling operations, all pressure washing and pressure testing operations and all cement and chemical grouting operations. Include: driller's logs of all grout holes, drain holes, and exploratory holes; pressure washing information and pressure testing results[on Government provided form]; grouting data including time of each change of operation, rate of pumping, grouting pressures, changes in water-cement ratio, changes in proportions of additives such as fluidifier, accelerator, or sand, and amounts of various materials injected[on Government provided form]; [core logging data on Government provided ENG FORM 1836 at a vertical scale of 1 inch equals 1 foot]; and other data considered necessary as determined by the Government Representative. Blank report forms of the type to be used are attached at the end of this specification.

Duplicate records of all grout hole and drain hole drilling operations, all pressure washing and pressure testing operations, and all cement and chemical grouting operations. The Government must receive the originals of all such records before final payment will be processed.

3.5 CONTRACTOR QUALITY CONTROL

In accordance with Section 01 45 00 QUALITY CONTROL, establish and maintain quality control that specifically includes, but is not limited to, inspections to assure that:

a. The specified qualification requirements are met.

b. Drilling and grouting equipment is provided as specified and maintained in satisfactory condition.

c. The required amount of [cement is][chemical grout materials are] kept on hand during grouting operations.

d. Grouting is performed in the presence of a Government Representative.

e. Required records are kept and submitted as specified.

f. Accurate [cement][chemical] grout mixture proportions are maintained [as directed][as recommended by the manufacturer or supplier].

g. Materials are properly protected from moisture and contamination after delivery and transportation to the site.

h. Only approved materials are used.

i. The quantity of bulk materials used equals the computed amount.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 01 11.51 (November 2023)**

Preparing Activity: USACE **Superseding**

UFGS 32 01 11.51 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 01 11.51

[RUBBER] [AND] [PAINT] REMOVAL FROM AIRFIELD PAVEMENTS

11/23

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NOTE: This guide specification covers the requirements for removal of rubber deposits and paint from asphalt concrete or portland cement concrete airfield pavements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information. This section contains a Tailoring Option for rubber or paint removal. Make this selection before editing the section.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Do not specify rubber removal without a friction test evaluation of the existing pavement condition, unless the need for rubber removal is prompted by other factors which limit the functionality of the airfield. Such factors may include airfield markings being obscured by excess rubber buildup, or a clean surface being required prior to new markings. Per the requirements of TSPWG 3-270-01.04-10, "Determining the Need for Runway Rubber Removal," when the average Mu value on the wet runway pavement surface in a rubber deposit area at both 65 and 95 km/h 40 and 60 mph is less

than the planning level in Table 2-2 for a distance of 305 meters 1000 feet or more, initiate a project to have rubber removed from the affected areas of the runway before the next friction test is scheduled. Contact the AFCEC, the Navy EFDs, or the USACE TSMCX for guidance.

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****

Shotblasting is prohibited from use on airfield pavements. Sandblasting is prohibited from use on Navy airfield pavements.

NOTE: On the project drawings, show:

1. Locations and dimensions of areas applicable to removal work.

2. Type and general condition of pavement and any joints or markings for each removal area. Identify the thickness of the existing markings to be removed. Use ASTM D1005 to determine the dry film thickness of the painted markings.

3. Indication of whether rubber, paint, or both are to be removed in each work area.

4. Locations of Government hydrants to be provided for Contractor use.

****

PART 1 GENERAL

1.1 UNIT PRICES

1.1.1 Measurement

Removal of rubber [and] paint is measured by the number of square meters feet of rubber [and] paint to be removed, based on type and percentage of removal.

1.1.2 Payment

****

NOTE: Delete unit price sentence when the work is covered by a lump sum contract price.

****

Removal of rubber [and] paint is paid for at the contract unit price per square meter feet of rubber [and] paint to be removed, based on the type and percentage of removal.[Removal of rubber [and] paint is paid for as a lump sum based on the areas shown on the drawings.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1005	(1995; R 2020) Standard Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.3 DEFINITIONS

1.3.1 Pavement Damage

Scarring is defined as the erosion of the pavement fine aggregate and binder that leaves some of the aggregate exposed. Pavement damage occurs when more than 25 percent of the depth (vertical dimension) of the nominal-sized aggregate diameter is uniformly exposed and aggregate could loosen.

1.3.2 Rubber Buildup

Deposits of rubber buildup are defined as any surface deposit that can be removed by scratching the deposit with a flat sharp object (such as a pocket knife) without damaging the pavement surface. Stains are defined as materials in the pavement surface microtexture resulting from rinse water residue. Staining resulting from rinse water residue that is not immediately removed is not acceptable and requires additional removal action.

1.3.3 Paint Buildup

****

NOTE: There is no ASTM standard method for determining the in-place dry film thickness (DFT) of marking paint on pavement. If the DFT is desired, include the bracketed sentence to test a chip removed from the pavement marking.

****

When paint thickness builds up over 40 mils (approximately five coats of paint), remove the coating thickness in accordance with paragraph TOLERANCES, ensuring the remaining material is well bonded and not subject to delamination when new coatings are applied. [Determine the paint dry film thickness (DFT) using ASTM D1005, Procedure C or D.]

1.3.4 Paint Removal

If markings are obsolete or non-compliant, irrespective of thickness of existing coatings, remove the paint in accordance with paragraph TOLERANCES so that any residual marking will not result in confusion.

1.3.5 Ghosting of Paint Markings

****
NOTE: See FAA AC 150-5340-1M, Standards for Airport Markings, Figures 1-1 through 1-4 for examples.
****

Ghosting is the continued visual appearance of removed markings. Do not paint over old markings to be removed. Remove a predetermined larger size and shape of area that encompasses the old marking(s) and group adjacent markings together into a larger rectangular removal area.

1.4 ADMINISTRATIVE REQUIREMENTS

Submit a schedule of work to the Contracting Officer. Describe the work to be accomplished; noting the location of work, distances from the ends of runways, touchdown areas, taxiways, buildings, and other structures; and indicating dates and hours during which the work is to be accomplished. Schedule the work to conform to aircraft operating schedules. The Government will try to schedule aircraft operations so as to permit the maximum amount of time for the Contractor's work. However, in the event of any emergency, intense operational demands, adverse wind conditions, and other unforseen difficulties, discontinue all work at locations in the aircraft operational area. Keep the approved schedule of work current and notify the Contracting Officer of any changes prior to beginning each day's work.

1.5 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Schedule of work; G, [_____]

Waste Collection, Identification and Disposal Plan; G, [_____]

Pre-Existing Conditions Inspection Report; G, [_____]

SD-03 Product Data

Waterblasting Removal Equipment; G, [_____]

Sandblasting Equipment; G, [_____]

[Rubber] [and] [Paint] Removal Detergents or Chemicals ; G, [_____]

Detergent And Chemical Removal Equipment; G, [_____]

Mechanical Removal Equipment; G, [_____]

SD-06 Test Reports

Test Section Results; G, [_____]

SD-09 Manufacturer's Field Reports

Damage Repair Plan

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver detergents and chemicals required for rubber [and] paint removal in original manufacturer's containers labeled with appropriate EPA, OSHA, or other agency warnings, if applicable, and Safety Data Sheets. Protect materials from degrading until their use is required during execution of the work.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Environmental Requirements

****

NOTE: For Navy, delete sandblasting. The use of sandblasting is prohibited for use on Navy airfield pavements.

****

Ensure pavement surface is free of snow, ice or slush. Ensure surface temperature is at least 5 degrees C 40 degrees F and rising at the beginning of operations[except those involving sandblasting for which a lower surface temperature may be approved]. Do not permit chemical rubber removal operations to begin if rain is predicted within 24 hours. Cease operation during thunder and lightning storms. Cease operation during rainfall except for waterblasting and removal of previously applied chemicals. Cease waterblasting where surface water accumulation alters the effectiveness of material removal.

1.7.2 Airfield Traffic Control

Coordinate performance of all work in the controlled zones of the airfield with the Contracting Officer and with the [Flight Operations Officer or Airfield Manager] [control tower]. Neither equipment nor personnel can use any portion of the airfield without permission of these officers unless the runway is closed. Runways will be closed during the following times:

Day or Date	Runway Closing Time	Runway Opening Time	Important Notes
[_____]	[_____]	[_____]	[_____]

1.7.3 Radio Communication

Do not allow personnel or equipment to enter the controlled zones of the airfield until radio contact has been made with the control tower and permission is granted by the control tower. A radio for this purpose [will be provided by the Government. The Contractor is responsible for the radio and must reinburse the Government for repair or replacement of the radio if it is lost, damaged, or destroyed] [is to be provided by the Contractor and approved by the Government]. Always maintain contact with the control tower at all times during work in vicinity of the airfield. Notify the control tower when work is completed and all personnel, equipment and materials have been removed from all aircraft operating surfaces.

1.7.4 Emergency Landing and Takeoff

Emergencies take precedence over all operations. Upon notification from the Control Tower of an emergency landing or imminent takeoff, stop all operations immediately and evacuate all personnel and equipment to an area not utilized for aircraft traffic which is at least 76 m 250 feet measured perpendicular to and away from the near edge of the runway unless otherwise authorized by the Contracting Officer or the Contracting Officer's Representative. Clear the work area of equipment, chemicals or detergents, and excess water within 15 minutes.

1.7.5 Airfield Lighting

When night operations are necessary, provide all necessary lighting and equipment. Direct or shield lighting to prevent interference with aircraft, the air traffic control tower, and other base operations. Provide lighting and related equipment capable of being removed from the runway within 15 minutes of notification of an emergency. Night work must be coordinated with the Flight Operations Officer or Airfield Manager and approved in advance by the Contracting Officer or authorized representative.

1.7.6 Water

Water to be used for high-pressure water equipment will be made available from Government hydrant[s] [as shown on the drawings,] [within [_____] m feet of all points of the work area,] [at no cost] [at the prevailing rates]. Furnish equipment and labor for delivery of water from the hydrant to the job site. Notify the Government on location of fire hydrant[s] to be used and the respective times of use. Connections to a fire hydrant are subject to inspection and approval. Provide and use a backflow prevention device for filling water tanks. Test, treat, and filter the water to verify it will not interfere with the rubber removal or damage or clog the rubber removal equipment.

1.8 SAFETY

Comply with OSHA 29 CFR 1910.

1.9 ACCEPTANCE

1.9.1 Tolerances

****

NOTE: The following provides recommended rubber and paint removal percentages based on visual estimation of pavement area required to be exposed by the removal process. The degree of removal possible without damaging the pavement surface depends on pavement condition. Portland cement concrete pavements can withstand more water pressure impact than asphaltic concrete pavements before aggregates are exposed. Do not specify 100 percent removal, as this can result in excessive exposure of pavement aggregates.

****

Acceptance of the removal of rubber [and] paint is based on compliance with the tolerances presented in the following Table. Reclean any area representing a failing test.

RUBBER REMOVAL	
Pavement Surface	Tolerance
Portland Cement Concrete Pavement	Minimum 90 percent
Asphalt Pavement	Minimum 85 percent

PAINT REMOVAL	
Pavement Surface	Tolerance
Paint Removal to Reduce Paint Build Up	
Portland Cement Concrete Pavement	Minimum 85 percent of build up
Asphalt Pavement	Minimum 85 percent of build up
Paint Removal For Obsolete or Non-Compliant Markings	
Portland Cement Concrete Pavement	Minimum 95 percent
Asphalt Pavement	Minimum 90 percent

1.9.2 Test Section

Prior to the start of work, remove not less than 15 m 50 feet in length of rubber [and] paint on designated runways and touchdown areas. Use procedures, equipment, and movement rate to achieve the required degree of removal in accordance with the Table above. Use methods in paragraph COMPLIANCE TESTING to determine if the rubber [and] paint was successfully removed from the test section. Submit the test section results for approval before conducting any further removal work. Provide photos of the seven random locations within the test area taken before and after the removal.[Provide photos of four random locations at joint seals within the test area taken before and after removal.] The Government will compare the surface texture of the cleaned demonstration area to that of the non-trafficked areas to determine satisfactory completion of the removal operation. After approval of the operations, the cleaned sample area will become the standard for rubber [and] paint removal and final surface texture for the remainder of work.

PART 2 PRODUCTS

2.1 [RUBBER] [AND] [PAINT] REMOVAL DETERGENTS OR CHEMICALS

The use of environmentally acceptable detergents or chemical agents must be considered on a case-by-case basis. Submit the Safety Data Sheet (SDS) for detergents or chemicals in the [rubber] [and] [paint] removal process. Use of any detergents or chemicals in the [rubber] [and] [paint] removal process must be approved in advance by the Contracting Officer. The Government specifically reserves the right to reject the use of any process which the Contracting Officer determines may pose unnecessary risks to human health, the environment, the pavement, aircraft or NAVAIDS due to corrosion or foreign object damage (FOD) potential as a result of its use, storage, or disposal.

2.2 EQUIPMENT, TOOLS, AND MACHINES

****

NOTE: Shotblasting is prohibited from use on all airfield pavements. Sandblasting is prohibited from use on Navy airfield pavements.

Coal tar concrete or surface sealers have been used as a jet fuel resistant surface course in older

pavements. Coal tar has been determined to be a hazardous material and removal requires extensive protection to workers and the environment. Do not specify removal of coal tar without the express consent of the AFCEC, the Navy EFDs, or the USACE TSMCX Subject Matter Experts.

****

Control the equipment used on asphalt [or tar concrete]and portland cement concrete pavements to remove rubber [and] paint accumulations while minimizing disturbances to asphalt [or tar]mixtures and preventing removal of hardened paste from the concrete.

2.2.1 Waterblasting Equipment

Submit product data for waterblasting removal equipment including area of coverage per pass, range of water pressures, and water tank capacity. Provide mobile waterblasting equipment capable of producing a pressurized stream of water that effectively removes rubber [and] paint from the pavement surface in accordance with paragraph TOLERANCES without significantly damaging the pavement. Provide equipment, tools, and machinery which are safe and in good working order. Provide equipment interlocks to prohibit high pressure water discharge when the vehicle or cleaning head is stationary (not moving forward or side to side).

2.2.2 Detergent and Chemical Removal Equipment

Submit product data for detergent and chemical removal equipment. Use equipment capable of applying and removing detergents and chemicals from the pavement surface. Provide sandbags or barriers to prevent detergents, chemicals or flush water from running over other markings or onto shoulders.

2.2.3 Mechanical Removal Equipment

Submit product data for mechanical removal equipment including area of coverage per pass.

2.2.3.1 Sandblasting Equipment

Provide mobile sandblasting equipment capable of producing a pressurized stream of sand and air that effectively removes rubber [and] paint from the pavement surface without filling voids with debris in asphalt or tar pavements or removing joint sealants in portland cement concrete pavements. Include with the equipment an air compressor, hoses, and nozzles of adequate size and capacity for removing rubber [and] paint. Equip the compressor with traps and coalescing filters that maintain the compressed air free of oil and water.

2.2.3.2 Grinding or Scarifying Equipment

Provide equipment capable of removing surface contaminants, paint build-up, or extraneous markings from the pavement surface. Identify the width of cut and type of scarifier proposed for use. After removal operations, clean the surface with pressurized water to remove residual debris or contaminants.

PART 3 EXECUTION

****

NOTE: The Contracting Officer's Representative, the airfield manager and the pavements engineer will jointly develop guidelines and requirements for rubber and paint removal operations; and will jointly evaluate the feasibility of the Contractor's methods and project compliance with applicable regulations.

****

3.1 REMOVAL OF RUBBER [AND] PAINT

****

NOTE: The following provides recommended rubber and paint removal percentages based on visual estimation of pavement area required to be exposed by the removal process. The degree of removal possible without damaging the pavement surface will depend on pavement condition. Portland cement concrete pavements can withstand more water pressure impact than asphaltic concrete pavements before aggregates are exposed. Do not specify 100 percent removal, as this will result in excessive exposure of pavement aggregates.

1. Rubber removal from Portland cement concrete pavements: 90 percent.

2. Rubber removal from asphaltic concrete pavements: 85 percent.

3. Paint removal from Portland cement concrete pavements and asphaltic concrete pavements: 85 percent.

NOTE: The drawings should indicate areas surfaced with a porous friction course.

****

Prior to any work being completed, submit a [Rubber] [and] [Paint] Removal Process Plan for approval by the Contracting Officer.

a. Prior to commencing any work, inspect the pavement where rubber [and] paint removal will be conducted. Inspect pavements, joints, lights, etc. to identify any pre-existing conditions. Mark areas and take pictures where joint seal, crack seal, and pavements are already compromised. Submit a Pre-Existing Conditions Inspection Report for approval.

b. The pavement surface type is [portland cement concrete] [and] [asphalt mixture] [as indicated].

c. Remove rubber on portland cement concrete pavements and asphaltic concrete pavements to within the tolerances of paragraph ACCEPTANCE. Remove paint on portland cement and asphaltic concrete pavement to within the tolerances of paragraph ACCEPTANCE. Remove all paint that is loose, flaking, chalky, or not to be re-marked or does not comply with size or pattern standards.

d. Chemical methods used must be compatible with pavement materials, the environment and working personnel.

e. Exercise close control of water pressure and blasting time/duration to prevent damage to joint sealants, existing markings that are not intended for removal, or the wearing surface. [Neither hydroblasting or abrasive blasting may be used for rubber removal on porous friction courses.]

f. Demonstrate the ability to remove rubber at a touchdown area of the runway selected by the Contracting Officer; at least one site per runway will be chosen. Rubber removal must not damage the pavement surface. The surface texture of the cleaned demonstration area will be compared to that of non-rubber traffic areas to determine satisfactory completion of the removal operation.

g. Protect light fixtures and runway surface sensors from damage throughout the removal operations.

h. Compliance testing for the amount of rubber and paint to be removed must conform to the requirements in paragraph COMPLIANCE TESTING.

****

NOTE: For contracts including rubber removal, include UFGS 32 17 23.16, ROAD AND PARKING LOT PAVEMENT MARKINGS, to refresh the markings.

****

i. Refresh paint markings in accordance with Section 32 17 23.16 ROAD AND PARKING LOT PAVEMENT MARKINGS.

3.2 RATE OF REMOVAL

Remove rubber at an expected rate of 929 square meter 10,000 square feet per hour. Remove paint at an expected rate of 93 square meter 1,000 square feet per hour. Do not permit high-pressure water application to remove the existing pavement surface, joint seals or crack seals.

3.3 WATER PRESSURE

****

NOTE: The optimum water pressure to be used for rubber and paint removal will be determined by the test specified in paragraph entitled "Rubber and Paint Removal."

****

Provide water pressure impact upon the indicated pavement areas sufficient to remove the designated rubber [and] paint to the required degree of removal without damaging the existing pavement, joint sealant, or other airfield appurtenances. Determine the optimum water pressure for removal from the test section. The Contractor is responsible for repairing any damage caused by the removal work.

3.4 CLEANUP AND WASTE DISPOSAL

****

NOTE: The Contractor is normally responsible for total contract performance. However, at

geographically isolated airfields, it may be necessary to furnish Government equipment and personnel for cleanup operations.

****

Keep the worksite clean of by-products, debris and waste from [rubber] [and] [paint] removal operations. Perform cleanup operations continuously. [Residue will be removed from the pavement by Government-furnished sweepers and personnel. Notify the Government for coordination.] [Remove all residue from the pavement. Obtain the approval of residue removal and disposal method from the Contracting Officer prior to beginning work.] Prior to the start of work, submit a Waste Collection, Identification and Disposal Plan for approval,describing proposed actions regarding waste collection, control, identification, and disposal. . Address disposal methods and requirements for hazardous and non-hazardous wastes.

3.5 COMPLIANCE TESTING

a. Compliance with the [rubber] [and] [paint] removal requirements must be determined by direct testing within the designated work area.

b. Divide each work area designated for rubber removal into at least four equal zones for the purpose of compliance testing, as approved. Evaluate a minimum of seven random locations within each of the four equal zones. Divide each painted line, numeral or chevron into 30 m 100 ft. lengths. Randomly select a test location within the sample length and determine the percentage of paint removal.

c. Use a 0.1 square meter one square foot section of transparent material inscribed with a grid of 100 equal squares as a tool for quantitative measurement of the percent removal. Place the grid pattern on the pavement surface and count the squares which contain rubber [and] paint deposits. Compare the percentage of rubber [and] paint removed at each of the test locations to the tolerances described in paragraph ACCEPTANCE. Do not permit the number of squares containing rubber [and] paint deposits in each of the randomly selected locations to exceed the allowed percentage in paragraph ACCEPTANCE. Reclean zones not meeting the required percentage.

3.6 DAMAGE REPAIR

****

NOTE: Include bracketed paragraph for runways or touchdown areas with grooved pavements.

****

Repair any damage to the pavement surface, joint, joint and crack seals, or other Government property caused during the performance of the work at the Contractor's expense. Submit a damage repair plan to include methods and material to the Contracting Officer's Representative for approval prior to performance of the repairs. Complete the repairs within the performance period of the Contract.

[Repair damage to runway or touchdown area grooves exceeding that identified in the Pre-Existing Conditions Inspection Report using an approved grooving machine of standard manufacture. Provide grooves that are 6 mm 1/4 inch deep by 6 mm 1/4 inch wide on 37 mm 1-1/2 inch centers and carried into, and tapered to zero depth within the non-corrected surface, or match any existing grooves in the adjacent pavement.]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 01 13.62 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 13.62 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-32 01 13.62 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 13.62 (May 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 01 13.62

BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL]

11/23

****

NOTE: This guide specification covers the requirements for single and double bituminous surface treatment of pavements for airfields, roads, streets, parking areas, and other general applications.

Bituminous Surface and Sand Seal- A layer of spray-on bituminous material covered by aggregate used on existing unpaved or paved surfaces. The bituminous material can be hot liquid asphalt cement (Penetration graded, Asphalt Cement viscosity graded, Aged Residue graded, and Performance Graded), cutback asphalt, or asphalt emulsion with or without polymer modification. The most common are asphalt emulsions or cutback asphalts, with cutback use restricted to regions allowing environmental volatile release to the atmosphere.

The bituminous material is covered, normally within 1 minute, with a layer of approximately uniform size aggregate of about a 12.5 mm 1/2 inch nominal maximum size. BSTs can be applied in single, double, and triple applications, with a maximum thickness of about 19.5 mm 3/4 inch. DoD policy is to use single and double BSTs; the Designer needs to consider asphalt overlays if more than a double BST is needed. BSTs are low-cost maintenance methods, that produce all-weather surfaces, renew weathered pavement, improve skid resistance, improve lane demarcation, and seal pavement surfaces including small cracks.

This specification also addresses sand seals which are spray-applied liquid asphalt covered with sand, used to restore uniform cover, restore weathered pavement, and reduce raveling. The treated surface is rolled with a pneumatic roller. Delete sand seal aggregate and other paragraphs if not using sand seal. Do not apply over DoD airfield pavements

without approval of the Pavements Discipline Working Group or their designated representative. The Federal Aviation Administration has a similar product known as Seal Coat.

UFC 3-270-01 states not to use BSTs on airfield pavements except for overruns and not within 60.96 meters 200 feet of the threshold, but BSTs can be used on light-traffic roads, and parking lots. BSTs have been used as a dust palliative on unpaved airfield shoulders, and for unpaved airfield shoulder surface runoff erosion protection in arid regions where vegetation doesn’t establish.

BSTs have fair performance to fill ruts up to 12.5 mm 1/2 inch depth. If the existing road is bleeding or flushing (appearance of liquid asphalt covering the existing pavement as if spilled on surface), do not use BST; sand seal or asphalt resurfacing is preferred. BSTs are also known as Chip Seals.

Alternative treatments to paved or unpaved surfaces are:

Section 32 12 36.13 BITUMINOUS FOG SEAL (ASPHALTIC SEAL AND FOG COATS) – A light spray application of asphalt emulsion to the surface of a chip seal, an open-graded mix, or a weathered asphalt surface. It is classified as a Preventive Maintenance process when nonstructural cracking or raveling first begins. Fog seals of asphalt emulsion slow the oxidation process of asphalt pavements but skid resistance is lowered.

Slurry Seal - A mixture of crushed, well-graded aggregate (e.g., fine sand, mineral filler) and asphalt emulsion that is spread over the entire pavement surface with either a squeegee or spreader box attached to the back of a truck. There is no UFGS for slurry seal. Application is restricted to parking lots, storage yards, container handling facilities, and other similar low-speed pavements due to loss of skid resistance. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative

Micro-Surfacing - Applied in a process similar to slurry seals, micro-surfacing consists of a mixture of cationic quick set emulsified asphalt, mineral aggregate, mineral filler, water, and additives. Micro-surfacing provides friction and rapid roadway surface correction. With a special mix design, it can fill ruts up to 19.5 mm 1.5 inches deep. Material is mixed in specialized, compartmentalized, self-powered trucks, and placed on the pavement using a screed box with auger. There is no UFGS for Micro-Surfacing. Application is restricted to parking lots, storage yards, container handling

facilities, and other similar low-speed pavements due to loss of skid resistance. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative

Cape Seal – An application of micro-surfacing a few days after construction of a BST; used to cover the aggregates and improve aggregate bonding. There is no UFGS for Cape Seal. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative

Sandwich Seal – Process is to spread large aggregate, spray-apply emulsion, then cover with smaller aggregate to lock in larger aggregate. Requires the use of very clean aggregate. Used to improve skid resistance and seal pavements. There is no UFGS for Sandwich Seal. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative

Rejuvenator, Spray-On – Rejuvenators are commercially available products (proprietary) designed to restore original properties to aged (oxidized) asphalt binders by restoring the original ratio of asphaltenes to maltenes. A rejuvenator will retard the loss of surface fines and reduce the formation of additional cracks. Rejuvenators will not fill or remove existing cracks unless cracking is very minor hairline cracking. Bituminous-based spray-on surface rejuvenators are covered in Section 32 01 13.64 REJUVENATION OF ASPHALT PAVEMENT SURFACES. There is no UFGS for bio-based rejuvenators.

Rejuvenator, Mix-in-Place – Designed to be used with advanced cold or hot in-place recycling of existing aged asphalt pavements which exhibit relatively high stiffness due to the aged binder. Proprietary chemical rejuvenators reduce the brittleness, but also affect the fatigue and thermal cracking properties of the recycled pavement. DoD provides a mix-in-place rejuvenator procedure in TM 5-822-10/AFM 88-6 Chapter 6. Section 32 01 16.70 COLD-MIX REUSED ASPHALT PAVING uses emulsion recycling agents and Section 32 01 16.74 IN PLACE HOT REUSED ASPHALT PAVING uses ASTM D4552 recycling agents. Substantial testing and engineering is required to specify the correct rejuvenator or emulsion and resultant mixture properties. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Cold or Hot In-Place Recycling - Detailed discussions are provided in TM 5-822-10/AFM 88-6

Chapter 6. Recent literature further refines cold in-place recycling (CIR) involves the recycling of the asphalt portion of flexible or composite pavements. This includes recycling of both hot-mix asphalt (HMA) layers and surface treatments, including chip, slurry, and cap seals of flexible pavements, mixed with asphalt emulsion or foamed asphalt. Full-depth reclamation (FDR) includes the recycling of the entire depth of the flexible pavement and, in some cases, a portion of the subgrade with asphalt, cement, or lime products. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative. Section 32 01 16.70 COLD-MIX REUSED ASPHALT PAVING uses emulsion recycling agents and Section 32 01 16.74 IN PLACE HOT REUSED ASPHALT PAVING used ASTM D4552 recycling agents.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 UNIT PRICES

****
NOTE: Delete unit price paragraphs when lump sum bidding is used. Edit submittal requirements accordingly for waybills and quantities. Keep paragraph Waybills and Delivery Tickets for lump sum projects, they are for Government use to validate payment. For determining quantities for Government estimates, refer to application rates in UFC 3-270-01, Chapters 6 and 7.
****

1.1.1 Measurement

1.1.1.1 Bituminous Material

The bituminous material paid for will be the measured quantities of residual bituminous material used in the accepted work as approved by the Contracting Officer, provided that the measured quantities are not 10 percent over the specified quantities. Any amount of bituminous material more than 10 percent over the approved application rate will be deducted from the measured quantities. Express measured quantities in[metric tons 2000 pound tons.][the number of liters gallons of material used in the accepted work, corrected to liters at 15.6 degrees C gallons at 60 degrees F in accordance with ASTM D1250, using a coefficient of expansion of 0.00045 per degree C 0.00025 per degree F for asphalt emulsion.] Dilution water added to emulsified asphalt will not be measured for payment.

1.1.1.2 Aggregate

The amount of aggregate paid for will be the number of [metric 2000 pounds tons] [cubic meters yards] of aggregate placed and accepted in the completed work or placed in authorized stockpiles.

1.1.1.3 Quantity Limits

****

NOTE: Only the appropriate application rates consistent with the gradations of Table III will be retained.

****

Spread the bituminous material and aggregate within the quantity limits shown in PART 2; base the bids on the mean of the values in the tables for bituminous material and aggregate application rates. Vary the individual quantities of bituminous material and aggregate to meet specific field conditions at all times during progress of the work, as approved by the Contracting Officer, without adjustments to Contract unit prices.

1.1.1.4 Waybills and Delivery Tickets

Submit waybills and delivery tickets during progress of the work. Before the final statement is allowed, file with the Contracting Officer certified waybills and certified delivery tickets for all bituminous and aggregate materials used in the construction of the pavement covered by the Contract. Do not remove bituminous material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

1.1.2 Payment

****

NOTE: Delete this paragraph when lump sum bidding is used.

****

Accepted measured quantities of bituminous material and aggregate will be paid for at respective unit prices. Payment will constitute full compensation for providing all materials, equipment, plant, test section, testing, and tools, and for all labor and other incidentals necessary to complete work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO R 102	(2022) Standard Practice for Emulsified Asphalt Chip Seal Design

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D946/D946M	(2020) Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction

ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D1139/D1139M	(2015) Aggregate for Single or Multiple Bituminous Surface Treatments
ASTM D1250	(2019; E 2020) Standard Guide for Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1
ASTM D2027/D2027M	(2019) Cutback Asphalt (Medium-Curing Type)
ASTM D2028/D2028M	(2015; R 2021) Cutback Asphalt (Rapid-Curing Type)
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt
ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction
ASTM D3625/D3625M	(2012) Standard Practice for Effect of Water on Bituminous-Coated Aggregate Using Boiling Water
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills and Delivery Tickets; G, [_____]

Bituminous Distributors; G, [_____]

Mechanical Spreader; G, [_____]

Mineral Aggregate; G, [_____]

Coarse Aggregate; G, [_____]

Fine Aggregate; G, [_____]

Cutback Asphalt; G, [_____]

Emulsified Asphalt; G, [_____]

Asphalt Cement; G, [_____]

Power Rollers; G, [_____]

Power Brooms and Power Blowers; G, [_____]

Scales; G, [_____]

Sand Seal Aggregate; G, [_____]

SD-04 Samples

Coarse Aggregate; G, [_____]

Bituminous Materials; G, [_____]

Fine Aggregate; G, [_____]

SD-06 Test Reports

Bituminous Materials; G, [_____]

Aggregate Testing; G, [_____]

Test Section; G, [_____]

Inspection Reports; G, [_____]

1.4 QUALITY CONTROL

****

NOTE: For projects where surface treatment is the primary definable feature of work, the testing laboratory can be the Contractor's laboratory, the emulsion manufacturer's laboratory, or an independent commercial laboratory. Frequently, the emulsion manufacturer is the most knowledgeable of emulsion/aggregate interactions in the local area. What is important is the laboratory is accredited as referenced. Select the appropriate quality control section for the project and include with the Contract. If surface treatment is a minor part of a project, and an independent commercial laboratory is already part of the Contract, may select that option for continuity, provided accredited in the appropriate tests.

****

Sampling and testing is the responsibility of the Contractor. Perform sampling and testing using [a] [an independent commercial] testing laboratory accredited in the required tests in accordance with Section 01 45 00 QUALITY CONTROL approved by the Contracting Officer. Sampling must be in accordance with ASTM D75/D75M for aggregates and ASTM D140/D140M for bituminous material. Contracting Officer may inspect testing facilities. Perform tests in the numbers, and at the location and times indicated, to ensure that the materials meet specified requirements. Submit copies of the test results within 24 hours after completion of each test.

1.4.1 Preconstruction Sampling and Testing

Conduct preconstruction sampling and testing of aggregates and bituminous materials in Part 2 PRODUCTS. Repeat testing when there is a change in source, size, or material type. Submit copies of test results within 24 hours after completion of each test.

1.4.2 Equipment Calibration

Furnish all equipment, materials, and labor necessary to calibrate equipment in accordance with paragraph EQUIPMENT, TOOLS, AND MACHINES. Perform all calibrations with the approved job materials and prior to applying the specified coatings to the prepared surface. Inspect all equipment prior to start of work and at regular intervals as needed during work.

1.4.3 Construction Quality Control Testing

Sample and conduct aggregate gradation tests one working day prior for each material used, and repeat each day of application. Conduct aggregate testing (wear, soundness, deleterious material and stripping) for each 18,000 metric tons 20,000 tons of aggregate used in the project, or fraction thereof. Submit copies of test results, within 24 hours after completion of each test. Repeat testing when there is a change in source, size, or material type. Conduct measurement and testing each application day to ensure bituminous and aggregate application rates are satisfactory in accordance with paragraph FIELD QUALITY CONTROL.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver bituminous materials to the site in a homogenous and undamaged condition. Inspect the materials for contamination and damage. Unload and store the materials with minimal handling. Bituminous materials, if stored on project site, must be stored in a manner recommended by the bituminous supplier and not exceed storage life or temperatures ranges.[Do not allow asphalt emulsions to freeze or boil.] Replace defective or damaged materials.

1.5.1 Bituminous Delivery Tickets

For every distributor load of bituminous material brought to site, provide the following: manufacturer, manufacture date, lot number, storage tank number, total volume of bituminous material on truck, weight of bituminous material, and weight of dilution water added for emulsions. Include data for the type of bituminous material used: percent oil distillate by volume of emulsion (prior to field dilution), cutback residue from distillation to 360 C 680 F, penetration of penetration grade at 25 C 77 F.

1.5.2 Aggregate Delivery Tickets

For every load of aggregate brought to site provide the aggregate source, supplier's aggregate size designation, size designation in accordance with this Section (Gradation 1, 2, 3, or 4), and the weight of aggregate on the truck.

1.5.3 Safety Precautions

Smoking or open flames will not be permitted within 8 meters 25 feet of heating, distributing, or transferring operations of bituminous materials that are flammable.

1.6 PROJECT SITE CONDITIONS

1.6.1 Environmental Requirements

Apply the bituminous surface treatment [and]sand seal when the existing surface is dry, and when the weather is not foggy, rainy, or when the wind velocity will prevent the uniform application. Apply bituminous surface treatment only when the existing surface or base course is dry or contains moisture not in excess of the amount that will permit uniform distribution of the asphalt material and provide the desired adhesion between the asphalt material and the materials underneath and above. Do not apply bituminous surface treatment when either the atmospheric temperature, in the shade, is below 10 degrees C 50 degrees F or the pavement surface to be treated is below 20 degrees C 70 degrees F unless otherwise directed. Do not apply if wind disperses bituminous material application. Delay application if rain appears imminent within 8 hours following time of application.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Edit the following paragraph for the work included in the project.

****

Provide bituminous surface treatment [and]sand seal on existing prepared pavement surface.

2.2 EQUIPMENT, TOOLS, AND MACHINES

Provide equipment for the purpose intended and properly maintained in satisfactory and safe operating condition at all times. Discontinue the use of equipment which fails to safely produce satisfactory work and replace with satisfactory equipment.

2.2.1 Scales

****

NOTE: For CONUS, select NIST 44 Class III L. For OCONUS, select the local governing authority, note the tolerances are the same as NIST 44 Class III L. For the scale divisions, 9 kg 20 lb is common for manufacturers; e.g. 20 X 2000=40,000 lb capacity for the lowest capacity Class III L scale.

****

Use standard truck scales of the beam type equipped with a weight-recording device. Use scales with sufficient size and capacity to accommodate the trucks used in hauling aggregates. Keep the necessary number of standard weights on hand, at all times, for testing the scales. Permanent or portable scales used for payment and application rates must be calibrated by a certified calibration agency before commencing work, following the method and calibration frequency [in accordance with NIST HB 44 Class III L.][recognized by governing local authority in which the project is located with the scale division 2 kg 5 lb or greater and a minimum of 2000 divisions and a maximum of 10,000 divisions. Scale acceptance tolerance is 2 kg 5 lb for 2000 scale divisions, and increases 1 kg 2.5 lb for each 500 increase of scale divisions. Example: for 5000 scale divisions, tolerance is 2 kg 5 lb + (6 x 1kg 2.5 lb) = 8 kg 15 lb.] Conduct calibrations in presence of the Contracting Officer. Provide certified calibration documentation. Recalibrate at 6 months from date of last approved calibration for permanent scales, and weekly for portable scales, for the duration of the Contract. Recalibrate scales if previous recognized calibration is outdated. Recalibrate scales or equipment if directed by the Contracting Officer. Provide adequate protection for the indicating and recording devices of the scales.

2.2.2 Bituminous Distributors

Provide self-propelled distributors with pneumatic tires of such size and number to prevent rutting, shoving, or otherwise damaging the surface being sprayed. Clean distributor trucks and lines of all materials before loading for project; open inspection hatches if requested by the Contracting Officer. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Provide a distributor that is approved by the Contracting Officer and:

a. Is capable of circulating and agitating the bituminous material during the heating process.

b. Is capable of spraying in a triple overlap. Equip the spray bar with the appropriate nozzle sizes to achieve a uniform bituminous application across the pavement at the specified rate and acceptable distributor speed. Adjust all nozzles to 30 degrees from the spray bar long axis, or to the same angle between 15 and 30 degrees only as recommended by the manufacturer and Contractor will demonstrate that the specified application rate is achieved. Only use the calibrated wrench provided by manufacturer to adjust nozzle angle.

c. Is designed and equipped to spray the bituminous material at variable widths at the specified temperature, at readily determined and controlled total liquid rates from 0.14 to 4.5 liters per square meter 0.03 to 1.0 gallons per square yard. Operate the distributor within a pressure range of 172.4 to 517.1 kPa 25 to 75 psi and with an allowable variation from the specified rate of not more than plus or minus 5 percent.

d. Each nozzle to be within 10 percent of the average flow rate for all the nozzles. Repair/replace out of tolerance nozzles.

e. Provide certification of distributor radar calibration for equipment with mounted radar which monitors travel speed and distance, used for the project. The date of calibration is to be no more than 6 months prior to project application

2.2.2.1 Distributor Calibration

Verify the distributors application rate no more than 96 hours prior to the start of bituminous application following ASTM D2995. Use ASTM D2995 Method A for cutbacks and asphalt cements, use ASTM D2995 Method B for emulsified asphalts. For each day of application, validate using the dipstick method of volume applied divided by the applied area. Repeat ASTM D2995 calibration after 7 calendar days after start of project application. May use Berber carpet for ASTM D2995 Method A. Submit bituminous material application rate and the residual asphalt application rate (for emulsified asphalts and cutbacks) results to Government. Provide the following information for ASTM D2995 Method A:

a. Project name, Contract number,and testing date.

b. Emulsified, cutback, or asphalt cement material.

c. Distributor make, model and serial number.

d. Distributor setup at the time of calibration including target application rate (shot rate as shown on the computer control system), spray bar height, and distributor truck speed.

e. Dry weight of each pad prior to application.

f. Wet weight of each pad immediately after application.

g. For emulsions, oven dry weight of each pad in 15 minute increments until constant weight (all water has evaporated).

2.2.3 Mechanical Spreader

****

NOTE: If a mechanical spreader of the type described is not available, contact the Pavements Discipline Working Group for direction.

****

Provide a self-propelled aggregate spreader that is capable of uniformly distributing aggregate at the specified rates. Equip the spreader with a hopper at the rear that accepts bulk aggregate from a dump truck, a delivery or belt system internal to the machine that carries the aggregate to the front of the machine, and a series of gates on the front hopper that applies a uniform layer of aggregate across the width of the roadway. Use a front hopper at least 3.6 meters 12 feet wide and adjustable so the width of the laydown can be adjusted by turning gates on or off. Connect the spreader to the dump truck and pull it along the roadway, preventing excessive spillage between the two. Apply a uniform, single, even layer of aggregate across the full width of the binder at the specific rate with the spreader. Truck-attached spreader boxes [are not allowed.] [are only to be used in areas not subject to aircraft or vehicle traffic and as shown on plans.] Calibrate aggregate spreaders no more than 96 hours prior to the first day of each aggregate layer spreading. Calibrate the aggregate spreader by dividing the dry weight of aggregate, contained on a series of pads laid across the pavement for the full width of the spreader, by the area of the pads. Recalibrate spreader after 7 calendar days after start of project application. Submit calibration measurements, aggregate spread rates, and spreader speed to the Contracting Officer.

2.2.4 Bituminous Storage Tank

Provide bituminous storage tanks capable of heating the bituminous material under effective and positive control at all times to the required temperature. Accomplish heating by steam coils, hot oil, or electricity. Provide steam heaters consisting of steam coils and equipment for producing steam, so designed that the steam cannot come in contact with the bituminous material. Affix an armored thermometer to the tank with a range from 4.4 to 204.4 degrees C 40 to 400 degrees F so that the temperature of the bituminous material may be determined at all times. Clean tanks and pipelines of all materials before loading for project; open inspection hatches if requested by the Contracting Officer.

2.2.5 Power Rollers

Use only rollers conforming to the following requirements:

a. Use self-propelled pneumatic-tired rollers having wheels mounted on two axles in such manner that the rear tires will not follow in the tracks of the forward group. Provide rollers with four or more tires on the front axle and five or more tires on the rear axle. Maintain uniform tire inflation to not less than 414 kPa 60 psi nor more than 552 kPa 80 psi pressure. Equip pneumatic-tired rollers with boxes or platforms for ballast loading. Load rollers so that the tire print width of each wheel is not less than the clear distance between tire prints. All rollers used on sand seals are to follow this requirement.

b. Use steel-wheeled rollers having at least one steel drum and weigh a minimum of 4.5 metric tons 5 tons. Equip steel-wheeled rollers with adjustable scrapers.

c. Use combination rollers meeting the requirements of a pneumatic-tired roller in the front and a steel-wheeled roller in the rear, with a gross weight of 4.5 metric tons 5 tons or more.

2.2.6 Power Brooms and Power Blowers

Provide power brooms and power blowers capable of cleaning surfaces to be treated.

2.3 MATERIALS

2.3.1 Bituminous Materials

****

NOTE: In some states and localities, the use of cutback asphalt is prohibited or curtailed by local air pollution regulations. In areas where cutback asphalt is restricted by air pollution regulations, asphalt cement or emulsified asphalt should be used. RC-800 is most commonly recommended for surface treatments. Where cooler temperatures are anticipated, use of RC-250 may be desirable. The type of cutback or emulsion to be used will depend on local conditions and temperature; and these factors must be carefully considered in making the selection for surface treatments.

Penetration Graded, Viscosity Graded and Performance Graded asphalt cements can also be used. A majority of surface treatments utilize asphalt emulsion. Sand seals often use the same bituminous materials as BSTs. Some agencies have substantial experience with BSTs and sand seals and have advanced bituminous materials well-matched to regional

aggregates, climates, and application rates; it is acceptable for the Designer to research and edit the specification to the local practices, with prior approval of Pavements Discipline Working Group or its representative and documented in the design analysis.

Include bracketed sentence if a sample is desired. For enduring facilities or applications with activity projected for 5 or more years, recommend always requesting sample.

****

For each bituminous material used, provide manufacturer, manufacture date, lot number, and storage tank number. Include data for the type of bituminous material used: percent oil distillate by volume of emulsion, cutback residue from distillation to 360 C 680 F, penetration of penetration grade at 25 C 77 F.[From each source of supply, submit a 4.0 liter 1.0 gallon sample of bituminous material sampled at the project site for the Government to store for one year in case of latent issues.]

[2.3.1.1 Cutback Asphalt

****

NOTE: Some regions and designers may have experience or local practice to use medium cure cutbacks on BSTs. If this is not the case with known and documented local practice, delete the following bracketed sentence.

****

Use rapid-curing cutback asphalt conforming to ASTM D2028/D2028M, Designation [RC-250] [RC-800] [RC-3000] [_____]. Submit temperature-viscosity relationship of cutback asphalt.[Use medium-curing cutback asphalt conforming to ASTM D2027/D2027M, Designation [MC-3000] [_____].]

]2.3.1.2 Emulsified Asphalt

****

NOTE: ASTM D977 RS-1, RS-2, HFRS-2, and ASTM D2397 CRS-1 and CRS-2 are very commonly used with BSTs. However, the Designer should allow the use of the local agency emulsions meeting either of the ASTMs, as some emulsions adhere better to the local aggregate than others, local knowledge and testing is required for such determination.

Rapid setting asphalt emulsions should be selected where the BST will be exposed to traffic immediately after construction. By breaking or setting quickly, the asphalt cement in the asphalt emulsion is able to develop a strong bond with the cover aggregate, providing the BST with more resistance to the disintegrating forces of traffic. Fast traffic should never be allowed on newly constructed BSTs.

Rapid-setting asphalt emulsions may be modified with a polymer additive. ASTM does not have published

specifications for polymer modified asphalt emulsions, and most specifying agencies have developed their own specifications for them. AASHTO M316 does address cationic polymer modified asphalts typically used for BSTs. Polymer-modified asphalt emulsions are generally used for BST of pavements that are subject to higher traffic volumes. The polymer modified asphalt emulsions offer a more resilient surface course and tend to reduce chip or aggregate loss due to traffic and environmental conditions. Adjustments may also be made to the asphalt used in the emulsion based on climatic conditions. Edit the bracketed sentence for polymer modified emulsified asphalts, insert the local agency criteria that is to be used.

Even though rapid setting asphalt emulsions are most commonly used for BST, there may be certain applications where medium setting asphalt emulsions provide better performance. Graded aggregate BSTs (not used in this specification) most often use medium-setting high float (HFMS-1 or HFMS-2) asphalt emulsion. Medium setting asphalt emulsions may also work better with cover aggregate that is “dirty” or contains larger amounts of fine particles than desirable.

****

Use [rapid-setting][_____] emulsified asphalt conforming to ASTM D977, [Grade RS-1, or RS-2, HFRS-2] [_____] or ASTM D2397/D2397M, [Grade CRS-1 or CRS-2] [_____][or polymer modified emulsified asphalt conforming to [_____]]. Do not dilute emulsified asphalt.

[2.3.1.3 Asphalt Cement

Use asphalt cement conforming to ASTM D946/D946M, Penetration Grade [120-150] [200-300] or ASTM D6373, Performance Graded Asphalt Binder [PG 64-22] [PG 58-28] [PG 52-34] [_____], ASTM D3381/D3381M Viscosity-Graded Asphalt Binder [AC-2.5] [AC-5] [AC-10] [AC-20] [AC-30] [AC-40]. Submit temperature-viscosity relationship of asphalt cement.

]2.3.2 Application Rate for Bituminous Surface Treatment

****

NOTE: Designer is to evaluate the pavement and determine the traffic correction factor and pavement correction factor following procedures in AASHTO R 102. Some agencies may have a more refined version of AASHTO R 102; Designer can review and use if alternative method is at least as adequate as AASHTO R 102 and document in design analysis. Select bracketed application rates for emulsion and cutbacks as appropriate for project.

****

Contractor to determine the bituminous material application rate and aggregate spread rate following AASHTO R 102 as approved by the Contracting Officer. The Traffic Correction Factor is [_____]. The pavement correction factor is [_____]. AASHTO R 102 provides the residual asphalt cement application rate; calculate and submit the bituminous material application rate of [emulsified asphalt][and][cutback asphalt] for the bituminous distributor.

2.3.2.1 Application Rate Adjustments

Vary the individual quantities of bituminous material and aggregate to meet specific field conditions during progress of the work, as approved by the Contracting Officer[, without adjustments to Contract unit prices]. Aggregate weights shown are for aggregates having a specific gravity of 2.65. Adjust the number of kilograms pounds required if the specific gravity of the aggregate used is other than 2.65 in order to ensure a constant volume of aggregate per square meter yard of treatment.

2.3.3 Mineral Aggregate

Provide aggregate consisting of crushed stone,[crushed slag,] or crushed gravel. The portion of material retained on the 4.75mm No. 4 sieve is coarse aggregate. The portion of material passing the 4.75 mm No. 4 sieve is fine aggregate.

2.3.3.1 Coarse Aggregate

Provide coarse aggregate of such nature that thorough coating of bituminous material, used in the work, will not strip off upon contact with water when tested using ASTM D3625/D3625M.

2.3.3.1.1 Moisture

Maintain aggregate moisture content so that the aggregate will be readily coated with the bituminous material.

2.3.3.1.2 Gradation

Use aggregate conforming to the gradation shown below. Determine gradation of the aggregates by ASTM C136/C136M.

2.3.3.1.3 Particle Shapes

Use aggregate that has no more than 20 percent by weight of flat and elongated particles on any sieve when determined in accordance with ASTM D4791 Method A and include all of the reportable items for Method A. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3.

2.3.3.1.4 Abrasion Resistance

Use aggregate with a percent weight loss not exceeding 40 after 500 revolutions, as determined in accordance with ASTM C131/C131M.

2.3.3.1.5 Soundness Test

****

NOTE: The magnesium-sulfate soundness test is to be used in excluding aggregates known to be unsatisfactory or for evaluating aggregates from new sources. The maximum allowable percentage of loss will be inserted in the blank and normally should be

within the range of 10 to 20 percent. The values used will be based on knowledge of aggregated in the area that have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years and will assure that aggregates from new sources will be equal to or better than these aggregates. Default value should be 18 for magnesium sulfate and 12 for sodium sulfate.

****

Perform the soundness test as specified by ASTM C88 to ensure that aggregates have a weight loss not greater than [18] [_____] percent when subjected to five cycles of the magnesium sulfate test or [12] [_____] percent when subjected to five cycles of the sodium sulfate test.

2.3.3.1.6 Friable Particles

Use aggregate with no more than 0.1 percent of the total weight of aggregate sample consisting of friable particles when tested in accordance with ASTM C142/C142M.

2.3.3.1.7 Stripping Test

Deleterious substances must not exceed the requirements of ASTM D1139/D1139M.

[2.3.3.1.8 Crushed Slag

****

NOTE: Delete crushed slag if it is not common in the locality.

****

Use crushed slag aggregate with a dry weight not less than 1200 kg/cubic meter 75 pcf, as determined in accordance with ASTM C29/C29M.

]2.3.3.1.9 Fractured Faces

Coarse aggregate must contain at least 75 percent by weight of crushed pieces having one or more fractured faces with the area of each face equal to at least 75 percent of the smaller midsectional area of the aggregate particle. When two fractures are contiguous, the angle between the planes of fractures must be at least 30 degrees to count as two fractured faces.

2.3.3.2 Fine Aggregate

Use fine aggregate consisting of clean, sound, durable particles of crushed stone,[crushed slag,] or crushed gravel.[Use aggregate that meets the requirements for stripping, abrasion resistance and percent friable particles as specified for coarse aggregate.]

2.3.3.3 Bituminous Surface Treatment Gradations

****

NOTE: Delete the sentence and table below that does not apply. If project has both single and double bituminous surface treatments, keep both.

****

[Select gradations for Single Bituminous Surface Treatment from Table I.]
[Select gradations for Double Bituminous Surface Treatment from Table II.]

****

NOTE: Designer to select the aggregate size from Table I and II. Note that for single BST, Gradation 1 can only be used with approval with the Pavements Discipline Working Group or its representative. For estimating quantities for unit pricing, Designer may use local experience or from Table III. Generally, the coarser or more uniformly graded aggregate will be the heavier application rate. For an initial application on unpaved surfaces (e.g. aggregate or granular base, sand, lime or cement stabilized layer, or similar), use a prime coat and the double BST.

For single BST do not use Gradation 1 unless the Designer has direct knowledge that this is an established local practice and there is an established engineering reason for doing so. Edit tables as appropriate for application; delete if not using Bituminous Surface Treatments (BST).

For double surface treatment, select the required gradations (either No.1 and No. 2 or No. 3 and No. 4) from Table II.

Delete Table I if not using single BST; delete Table II if not using double BST.

****

[

TABLE I. AGGREGATE GRADATION SINGLE BITUMINOUS SURFACE TREATMENT (PERCENT BY WEIGHT PASSING)

Sieve Designation (mm)	No. 1	No. 2	No. 3
25.0 1 inch	100	--	--
19.0 3/4 inch	90-100	100	--
12.5 1/2 inch	20-55	90-100	100
9.5 3/8 inch	0-15	40-70	85-100
4.75 No. 4	0-5	0-15	10-30
2.36 No. 8	--	0-5	0-10
1.18 No. 16	--	--	0-5
0.075 No. 200	0-1	0-1	0-1

]
[

TABLE II. AGGREGATE GRADATION DOUBLE BITUMINOUS SURFACE TREATMENT (PERCENT BY WEIGHT PASSING)1				
Sieve Designation (mm)	No. 1	No. 2	No. 3	No. 4
25.0 1 inch	100	--	--	--
19.0 3/4 inch	90-100	--	100	--
12.5 1/2 inch	20-55	100	90-100	--
9.5 3/8 inch	0-15	85-100	40-70	100
4.75 No. 4	0-5	10-30	0-15	85-100
2.36 No. 8	--	0-10	0-5	10-40
1.18 No. 16	--	0-5	--	0-10
0.30 No. 50	--	--	--	0-5
0.075 No. 200	0-1	0-1	0-1	0-1
1 Select Gradation 1 and 2, or Gradation 3 and 4. Gradations 1 or 3 must be the first aggregate application for double bituminous surface treatments.				

]

2.3.3.4 Aggregate Application Rates – Bituminous Surface Treatments

****

NOTE: If only single or double bituminous surface treatment is being used, delete the bracketed sentence as appropriate. If the project requires both, keep both sentences.

****

[For single Bituminous Surface Treatment use Gradation [1] [,or] [2] [or,] [3] of Table III.] [For Double Bituminous Surface Treatment, use [Gradation 1 for the first application and Gradation 2 for the second application] [,or] [Gradation 3 for the first application and Gradation 4 for the second application] of Table III.]

TABLE III. Bituminous Surface Treatment Aggregate Application Rates, pounds/cubic yard				
Aggregate Gradation	Gradation 1	Gradation 2	Gradation 3	Gradation 4
Single	35-50	20-35	15-25	---
Double	28-45	20-30	20-35	10-15

2.3.4 Sand Seal Aggregate

****

NOTE: The bituminous quantities may have to be increased when the pavement has rough surface texture and may have to be decreased when the pavement surface is very tight. Adjust the moisture content based upon local knowledge, otherwise,

select the bracket to readily bond.

****

Use mineral aggregate consisting of crushed stone, crushed gravel,[crushed slag,] sand and screenings. Use aggregate with a moisture content [of not greater than [1] [3] percent] [such that the aggregate will readily bond with the bituminous material]. Drying may be required, as directed by the Contracting Officer, to improve bonding. Use aggregate conforming to gradation shown in TABLE IV.

TABLE IV. SAND SEAL AGGREGATE GRADATIONS (Percent by Weight Passing Square-Mesh Sieves)	
Sieve Designation (mm)	Percent Passing
12.5 1/2 inch	---
9.5 3/8 inch	---
4.75 No. 4	100
2.36 No. 8	10-40
1.18 No. 16	0-10
0.3 No. 50	0-5
Aggregate passing the 4.75 No. 4 and smaller sieves	Tolerance of plus or minus 3 percent

2.3.4.1 Sand Seal Application Rates

Spread the bituminous material at the rate of 0.45-0.60 liters per square meter 0.10-0.15 gallons per square yard. Spread the aggregate at a rate of 5-8 kg per square meter 10-15 pounds per square yard. The aggregate weights identified are those of aggregate having a specific gravity of 2.65. If the specific gravity of the aggregate to be used is less than 2.55 or greater than 2.75, make adjustments in the number of kilograms pounds of aggregate required per square meter yard to ensure a constant volume of aggregate per square meter yard of treatment. The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contractor and approved by the Contracting Officer prior to use. Apply additional sand as blotter if bituminous material bleeds through to the surface.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Site Protection

****

NOTE: Modify the bracketed sentence as appropriate for the project location. Public notices and signage 3 days prior is reasonable, unless local ordinance requires otherwise. Designer is to identify temporary parking for homes or business access that is interrupted by the work and curing. Delete paragraph if not needed.
****

[Provide public notices and post signage at least [3] [_____] days in advance of starting work. Plan detours as provided in the Contract prior to performing work at site.]During work, protect adjacent buildings, structures, vehicles, manhole covers, inlet grates, and trees to prevent splattering or marring. Protect manhole covers, inlet grates, electrical boxes, utility boxes, and other similar pavement penetrations with building paper cut to size to protect the entire casting size and opening. If the building paper becomes dislodged, replace with plywood, or other continuous board medium, cut to fit and of a thickness sufficient to remain in place during bituminous and aggregate application. Open and remove debris from all covers, grates, and boxes after bituminous and aggregate application.

3.1.2 Traffic Control

Provide warning signs and barricades for proper traffic control, in accordance with [MUTCD] [local governing traffic control authority].

3.1.3 Surface Preparation

****
NOTE: If the surface to be treated requires repairs, the method of repairs and extent of work involved should be shown or described.
****

[Complete repairs to existing pavement as specified in the Contract documents [and] [or] [as shown on plans].]Immediately before applying the first course of bituminous material, clean the surface of loose material with power brooms or power blowers. Take care to remove all dirt, clay, and other loose or foreign matter. Flush the surface with water when necessary to remove dirt or debris not removed by sweeping or brooming; allow the surface to dry after flushing.

3.2 STOCKPILING ON SITE

Use the following aggregate stockpiling techniques for stockpiles at the project site:

a. Build the stockpile on a platform acceptable to the Contracting Officer [by either a][600 mm 24 inch sacrificial layer beneath the entire area of the piles and where the loader will operate] [300 mm 12 inch thick layer of the project aggregate stabilized with Portland cement or asphalt] [300 mm 12 inch thick lime stabilized subgrade in accordance with Section 32 11 13.13 LIME TREATED SUBGRADE] [on existing pavement as shown on plans] [on existing pavement selected by the Contractor and as approved by the Contracting Officer]. All platforms except existing pavement must be removed at end of project.

b. Use a computer-automated radial telescoping stacker that makes small windrow piles no more than 1.8 meters 6 feet high and then automatically adjusts position and height to make larger windrow piles.

c. Build piles with end loaders to a maximum height from ground level of the bucket hinge point.

3.3 PRIME COAT

****

NOTE: For unpaved surfaces such as aggregate base course or unpaved shoulders, where there is no previous hard pavement, apply a prime coat and then a double BST. If using an emulsion prime, ensure schedule allows for full penetration and curing before double BST is applied. Penetrating Emulsified Prime (PEP) may provide better penetration and curing, but not less than 4 hours; edit prime coat specification accordingly.

****

Apply bituminous prime coat following Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.4 TEST SECTION

****

NOTE: Adjust test section length for the project conditions. Typical BST test sections are 60 to 150 meters 200 to 500 feet in length. For sand seals, 30 meters 100 feet is common. Select brackets for BST and/or Sand Seal as appropriate for project.

****

Determine the required application rates from test sections on the pavement to be treated.

3.4.1 Bituminous Distributor Temperature

Ensure bituminous material is at the recommended application temperature and has been thoroughly cycled through the distributor bar. Test the bituminous distributor under pressure by means of a test shot area (outside the project limits) to ensure there are no leaks or dripping from nozzles after shut-off.

3.4.2 Test Section Construction

Construct three test sections in the presence of the Contracting Officer at least [60 to 150 meters 200 to 500 feet] [_____] long for bituminous surface treatments. Construct each test section at the start of the project in a location agreed upon with the Contracting Officer for each layer of Bituminous Surface Treatment. For each test section, vary the bituminous application rate or aggregate spread rate. [For Double Bituminous Surface Treatments, the test sections must be at the start of each layer.]Construct three test sections in the presence of the Contracting Officer at least [30 meters 100 feet] [_____] long for sand seals. Construct each test section at the start of the project in a location agreed upon with the Contracting Officer.

3.4.3 Test Section Evaluation

Evaluate each test section for acceptable application of bituminous material, aggregate spread rate, rolling pattern, time to complete rolling, proper aggregate embedment after rolling, and brooming operations. Contractor must adjust application rates, equipment, and operations as necessary to demonstrate compliance with specification, and as approved by the Contracting Officer. Application rates are as approved by the Contracting Officer to bind the aggregate without bleeding, flushing, or streaking. Continue constructing test sections until an acceptable test section is achieved. Summarize the results, including the recommended application rates, and submit to the Contracting Officer within 24 hours of test section completion. Bituminous surface treatment [and]Sand seal construction may begin as soon as acceptable test section is demonstrated. Sweep, remove, or recoat unacceptable test sections as approved by the Contracting Officer with adjusted application rates to avoid unbound aggregate on the surface, bleeding, or flushing of the bituminous material, at no additional cost to Government.

3.5 BITUMINOUS APPLICATION TEMPERATURE

****

NOTE: Emulsified asphalt temperatures obtained from Asphalt Emulsion Manufacturers Association & Asphalt Institute 2008; A Basic Asphalt Emulsion Manual Series No. 19 (MS-19), Fourth Edition. Lexington, KY: The Asphalt Institute. Polymer modified asphalt emulsions and polymer modified asphalt cements may require different application temperatures unique to the producer. Designer may adjust temperature to local materials or allow producer to submit recommended application temperatures.

****

3.5.1 Cutback Asphalt

Apply cutback asphalt in the range of[38 to 93 degrees C 100 to 200 degrees F] [_____] [or as recommended by cutback asphalt producer].

3.5.2 Emulsified Asphalt

Apply asphalt emulsions in the range of[20 to 71 degrees C 70 to 160 degrees F] [_____] for all grades [except for RS-2, HFRS-2, CRS-1, and CRS-2 the range is[50 to 85 degrees C 125 to 185 degrees F] [_____]] [and for RS-1 the range is[20 to 60 degrees C 70 to 140 degrees F] [_____]] [or as recommended by emulsified asphalt producer].

3.5.3 Asphalt Cement

Apply asphalt cement in the range of[163 to 191 degrees C 325 to 375 degrees F] [_____] [or as recommended by asphalt cement producer].

3.6 APPLICATION OF FIRST COURSE

3.6.1 Bituminous Material

****

NOTE: Application temperatures will vary with the grade of asphalt used. Recommended materials and

application temperatures may be found in paragraph Bituminous Application Temperature, below and in Asphalt Institute Publications: Asphalt Surface Treatments - Specifications (publication No. ES-11) and Asphalt Surface Treatments - Construction Techniques (publication No. ES-12).
****

Apply bituminous material by means of a bituminous distributor at the temperature specified in paragraph Bituminous Application Temperature below or as directed, and within the limits specified in paragraph Quantity Limits in PART 1. Apply bituminous material using triple overlap in such a manner that uniform distribution is obtained over all surfaces treated. Reduce spray bar height to double overlap if wind disperses triple overlap and only if double overlap applies the specified coverage, otherwise discontinue work until acceptable coverage is obtainable. For double overlap, adjust distributor operation and settings to achieve target application rate. Unless the distributor is equipped to obtain a satisfactory result at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application so that flow through the sprays may be started and stopped on the paper in order that all sprays will operate at full force on the surface treated. Remove the building paper immediately after application. Properly treat areas missed by the distributor with the hand spray. Protect adjacent buildings, structures, and trees to prevent spattering or marring.

3.6.2 Spreading of Aggregate

Immediately following application of bituminous material, spread aggregate uniformly over the surface within the limits of the quantities specified in paragraph Quantity Limits in PART 1 using mechanical spreaders. Increase or decrease aggregate spread rate up to 10 percent to avoid aggregate pick up on rollers. Spread aggregate evenly by hand on all areas missed by the mechanical spreader. Operate equipment spreading aggregate so that the bituminous material will be covered ahead of the truck wheels. When hand-spreading is employed on inaccessible areas, spread aggregate directly from trucks. Spread additional aggregate by hand over areas having insufficient cover.

3.6.3 Application of Sand Seal Aggregate

****
NOTE: Designer to edit the paragraph for only the appropriate time frames for the bituminous material selected. When using cutback asphalt, the asphalt cools to the temperature of the surface to which it is applied in approximately 1 1/2 minutes. In the case of emulsified asphalt, breaking of the emulsion occurs in 3 to 4 minutes. No bituminous material should be down more than the following number of minutes before it is covered with aggregate.

Cutback Asphalt	**1 to 1 1/2 minutes**
Emulsified Asphalt	**3 to 4 minutes**

Asphalt Cement	**1 minute**

****

Spread the specified quantity of cover aggregate uniformly over the bituminous material. Provide sufficient aggregate on trucks at the work site to cover the planned application of bituminous material before the bituminous material is applied. No bituminous material may be down more than [_____] minutes before it is covered with aggregate. Uniformly spread aggregate with aggregate-spreading equipment. Re-cover areas having insufficient cover with additional aggregate by hand during the operations whenever necessary.

3.6.4 Rolling and Brooming Single Bituminous Surface Treatment

Roll the surface with at least three passes of a pneumatic-tired roller after sufficient aggregate is spread. Continue rolling until no more aggregate can be worked into the treated surface. If the aggregate is not distributed properly, broom the surface 24 hours after rolling but not until the surface has set sufficiently to prevent excessive marking. In places not accessible to rollers, compact the aggregate with pneumatic tampers. Remove aggregate that has become contaminated with foreign matter and replace with clean aggregate and reroll as directed. Maintain and protect the treated areas by use of barricades until properly cured.

3.7 APPLICATION OF SECOND COURSE

****

NOTE: If not being used in double BST, delete the following paragraphs.

****

3.7.1 Bituminous Treatment

Apply the bituminous material for the second course within 48 hours after construction of the first course, weather permitting. Remove excess aggregate by sweeping prior to the second application of bituminous material. If the treated surface is excessively moistened by rain, allow the surface to dry for such time as deemed necessary. Perform the second application of bituminous material in the manner specified in article APPLICATION OF FIRST COURSE, including temperature and Quantity Limits.

3.7.2 Aggregate

Immediately following the second application of bitumen, spread aggregate conforming to the gradation and limits specified in paragraph Quantity Limits uniformly over the bituminous material and process in the manner specified for the first course.

3.7.3 Rolling and Brooming Second Course Bituminous Surface Treatment

Roll and broom the surface in the manner specified for the first course until a thoroughly bonded, smooth, even-textured surface is produced. For double bituminous surface treatments, after first application of aggregate is completed and accepted, use a steel-wheeled or combination roller after at least three coverages of pneumatic-tired rollers. Sweep off the surface surplus aggregate and remove it prior to final acceptance.

3.8 SAND SEAL ROLLING AND BROOMING

Begin rolling operations immediately following the application of cover aggregate. Perform rolling using pneumatic-tired rollers. Operate the rollers at a speed that will not displace the aggregate. Continue rolling until the aggregate is uniformly seated into the bituminous material. Sweep off the surface and remove all surplus aggregate not less than 24 hours nor more than 4 days after rolling is completed. Immediately prior to opening to traffic, roll the entire treated area with a self-propelled pneumatic-tired roller.

3.9 FIELD QUALITY CONTROL

Inspect application uniformity and determine application rates of bituminous material and aggregate each day of application.

3.9.1 Inspection Reports

****

NOTE: Edit the following paragraph for the products used in the work.

****

Furnish a written report each day of application citing climatic temperature during application of bituminous surface treatment [and]sand seal, bituminous temperature during application, rate of bituminous material application, residual bituminous material rate, truck speed in meters per minute feet per minute, RPM of truck, digital wet (shot) rate, spray bar height, pump setting, aggregate application rates, and aggregate spreader speed. Include any observations.

3.10 SURFACE PROTECTION

****

NOTE: Delete bracketed sentence if pavement markings are not in Contract.

****

Keep all traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces. Protect the treated areas from traffic for at least 24 hours after final application of bituminous material and aggregate, or for such time as necessary to prevent tracking. Immediately prior to opening to traffic, roll the entire treated area with a self-propelled pneumatic-tired roller.[Apply pavement markings as required in Contract after final brooming.] After opening, post speed to maximum 32 kilometers per hour 20 miles per hours for 3 days.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 01 13.63 (February 2016)**
Change 1 - 08/16

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-32 01 13.63 (February 2016)**
Change 1 - 08/16

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 32 01 13.63

GILSONITE MODIFIED ASPHALT EMULSION SEAL COATS

02/16, CHG 1: 08/16

****

NOTE: This guide specification covers the requirements for gilsonite modified asphalt surface coatings (not coal tars products, only Gilsonite modified asphalt emulsion sea coats with a bituminous base residue containing no less than 20 percent Uintaite or Gilsonite, here after referred to as Gilsonite modified asphalt emulsion.) for low volume roads, parking areas, airfield secondary and tertiary pavements (low-speed taxiways, shoulders, overruns), and other general applications with or without aggregate applied on the applied coating. An asphalt seal coat without aggregate, more commonly called a 'fog seal", can be considered for use on pavements with low to moderate weathered surfaces (as defined by ASTM D5340). The use of Gilsonite modified asphalt emulsion should be used whenever possible. The use of this product on a runway must be approved by cognizant NAVFAC (Echelon III), AFCEC, MAJCOM or TSMCX Pavement Engineer).

This specification can be used for high volume or high speed roads, taxiways and runways only with the incorporation of a suitable aggregate in order to maintain adequate surface friction and only with the written approval of the cognizant NAVFAC (Echelon III), AFCEC, MAJCOM or TSMCX Pavement Engineer. At present, only the Gilsonite modified asphalt emulsion, seal coat product with aggregate should be considered for use on airfield runway pavements.

If used on Design/Build projects involving high volume or high speed roads or any airfield pavement, this section must be prepared by the Government RFP preparer and must not be further edited by the Contractor's Designer of Record.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project**

specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

UFC 3-250-03, "Standard Practice Manual for Flexible Pavements" should be used for guidance in preparing these specifications.

****

1.1 MEASUREMENT AND PAYMENT PROCEDURES

****

NOTE: Payment and Measurement must be made on a unit price bases with the test section determined application rate for emulsion and aggregate. Therefore, this requires that the contract documents reflect unit pricing for the asphalt emulsion and aggregate, if used.

****

Measure the quantities of gilsonite modified asphalt emulsion and aggregate used in the accepted work and to be paid for, provided that the measured quantities are not more than 10 percent over the test section determined application rate. Any amount of gilsonite modified asphalt emulsion and aggregate more than 10 percent over the test section determined application rate for each application will be deducted from the measured quantities except for irregular areas where hand spraying of the bituminous material and hand spreading of the aggregate is necessary.

1.1.1 Gilsonite Seal Coat Measurement Methods

The area of applied emulsion and aggregate to be paid for will be measured in square meters square yards.

1.1.2 Payment

The approximate amounts of materials per square meter square yard for gilsonite modified asphalt emulsion and aggregate used in production must be as provided in Table 6 for the treatment area[s] at the specified dilution rate[s] as noted. The actual application rates will vary within the range specified to suit field conditions and will be recommended by the manufacturer's representative and approved by the Contracting Officer from test areas and sections evaluated.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D5/D5M	(2020) Standard Test Method for Penetration of Bituminous Materials
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D244	(2009; R 2017) Standard Test Methods and Practices for Emulsified Asphalts
ASTM D1474/D1474M	(2013) Standard Test Method for Indentation Hardness of Organic Coatings
ASTM D2007	(2011) Standard Test Method for Characteristic Groups in Rubber Extender and Processing Oils and Other Petroleum-Derived Oils by the Clay-Gel Absorption Chromatographic Method
ASTM D2042	(2015) Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene

ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors
ASTM D4402/D4402M	(2015) Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 150/5320-12	(1997, Rev C; Change 1-3, 5 and 6) Measurement, Construction and Maintenance of Skid-Resistant Airport Pavement Surfaces

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices

1.3 SYSTEM DESCRIPTION

****

NOTE: Retain equipment units required for the project and delete all others.

****

1.3.1 Equipment, Plant and Tools

Equipment, plant and tools used in the work are subject to Government approval and must be maintained in a satisfactory working condition at all times. Provide equipment which is adequate and has the capability of producing the results specified. Provide calibrated equipment, such as asphalt distributors, spreaders and similar equipment, that has been recalibrated by an approved calibration laboratory within 12 months prior to commencing work and every 6 months thereafter, by such laboratory from the date of recalibration, during the term of the contract. Submit an equipment list with calibration reports.

1.3.2 Asphalt Distributors

The emulsion must be applied with an equipment manufacturer-approved computer rate-controlled bituminous distributor. The equipment must be in good working order and contain no contaminants or diluents in the tank when product to be applied is added to the tank. Spreader bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under 13 kilometers per hour eight miles per hour or 213 meters per minute 700 feet per minute. Test the equipment under pressure for leaks and to ensure it is in good working order before use.

The distributor truck must be equipped with a 3.66 meter 12 foot, minimum, spreader bar with individual nozzle control. The distributor truck must be capable of specific application rates in the range of 0.15 to 0.80 liters per square meter 0.05 to 0.25 gallons per square yard. These rates must be computer-controlled rather than mechanical. The distributor truck must have an easily accessible thermometer that constantly monitors the temperature of the emulsion.

In the event of a temperature problem with the material, a distributor truck will be provided that is equipped to effectively heat and mix the material to the required temperature prior to application. Heating and mixing will be done in accordance with the manufacturer's recommendations. Care must be taken not to overheat or over mix the material.

The distributor must be equipped to hand spray the emulsion in areas identified either on the plans or by the Contracting Officer.

1.3.3 Aggregate Spreader

The asphalt distributor truck will be equipped with an aggregate spreader that can apply sand to the emulsion in a single pass operation without driving through wet emulsion. The aggregate spreader must be equipped with a variable control system capable of uniformly distributing the sand at the specified rate at varying application widths and speeds. Spinner type equipment will be acceptable. The sander must have a minimum hopper capacity of at least 1,360 kilograms 3,000 pounds of sand. Push-type hand sanders will be allowed for use around lights, signs and other obstructions.

1.3.4 Power Brooms and Power Blowers

A power broom or blower must be provided for removing loose material from the surface to be treated.

1.3.5 Vacuum Sweepers

Provide self-propelled, vacuum pickup sweepers capable of removing loose sand, water, and debris from pavement surface.

1.3.6 Equipment Calibration

For the calibration of the aggregate spreader, only option b. is permitted unless aggregate spreader has been calibrated with the same aggregate within the last six months. Equipment calibration for emulsion may be achieved by either one of the two following procedures:

a. First Procedure: Contractor to furnish a State Calibration Certification for the asphalt emulsion distributor, from any state providing that service, or other acceptable agency certification at the approval of the Contracting Officer, and the calibration date must have been within 6 months of the contract award, or up to 12 months if supporting documents substantiate continuous work using the same distributor.

b. Second Procedure: Furnish all equipment, materials and labor necessary to calibrate the asphalt emulsion distributor and the aggregate spreader. Perform all calibrations with the approved job materials and prior to applying the specified coatings to the prepared surface. Perform calibration of the asphalt emulsion distributor in accordance with ASTM D2995. Perform work to calibrate the tank and measuring devices of the distributor. Perform inspection and calibration at the beginning of the work and at least once a day during construction.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Contractor Qualifications; G, [_____]

Provide copies of Qualifications.

Manufacturer Representative’s Experience

Material Performance

Equipment List; G, [_____]

List of equipment used in the project along with calibration reports.

Friction Test that includes date, time, weather, speed, wet or dry and operator name for each run of each test; G, [_____]

Inspection Reports; G, [_____]

Provide reports and all Quality Assurance records daily when application is made.

SD-04 Samples

Gilsonite Modified Asphalt Emulsion

Aggregates

Provide in accordance with Field Quality Control.

SD-06 Test Reports

Manufacturer's Certificate of Compliance for Bituminous Material,

Manufacturer's Certificate of Compliance for Aggregates

Recommendation by contractor/manufacturer from results of test section application.

Any additional testing as requested by Contracting Officer

Bituminous Materials; G, [_____]

1.5 QUALITY ASSURANCE

Provide copies of Contractor Qualifications for applicators, personnel and equipment, Certified by Manufacturer to apply product and to have made three (3) applications similar to this project in past two (2) years. Include details of previous work, schedule adherence, quality of workmanship, materials and name and work phone of contracting officer's points of contact.

Obtain Manufacturer's Certificate of Compliance for emulsion and aggregates. Obtain samples at time of delivery to the field as necessary to satisfy the requirements herein.

****

NOTE: The requirement for the Contractor to require a manufacturer's authorized representative on the job site at the beginning of the work is recommended for all DoD projects.

****

1.5.1 Manufacturer's Representation

The manufacturer’s representative must have knowledge of the material, procedures, and equipment described in the specification and must be responsible for determining the application rates and must oversee the preparation and application of the seal coat product. Documentation of the manufacturer representative’s experience and knowledge for applying the seal coat product must be furnished to the Contracting Officer a minimum of 10 work days prior to placement of the test sections. The cost of the manufacturer’s representative must be included in the bid price.

1.5.2 Samples

Take aggregate samples for laboratory tests in accordance with ASTM D75/D75M. Take samples of gilsonite modified asphalt emulsion in accordance with ASTM D140/D140M.

1.5.3 Aggregates Source

Select sources from which aggregates are to be obtained and notify the Contracting Officer within [15] days after the award of the Contract. Perform tests for the evaluation of aggregates by using an approved commercial laboratory at no expense to the Government. Tests for determining the suitability of aggregate must include: gradation in accordance with ASTM C136/C136M, and ASTM C117 and must be within the last six months. Independent laboratory testing is required for all new aggregate sources.

1.5.4 Gilsonite Modified Asphalt Emulsion Source

The Contractor must furnish the vendor’s certified test reports for bituminous materials, in its concentrated form, to the Contracting Officer, showing that the material meets the properties of Table 1. Bituminous materials must meet the properties of Table 2 and Table 3.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver gilsonite modified asphalt emulsion to the site in a homogenous and undamaged condition. Inspect the materials for contamination and damage. Unload and store the materials with a minimum of handling. Protect stored aggregate from contamination and segregation. Replace defective or damaged materials.

1.7 ENVIRONMENTAL REQUIREMENTS

Apply the coating when the existing surface is dry, and when the weather is not foggy, rainy, or when the wind velocity will prevent the uniform application of the material. Apply gilsonite modified asphalt emulsion seal coat only when both the atmospheric temperature and the pavement surface temperature are above 15.5 degrees C 60 degrees F, unless otherwise directed.

PART 2 PRODUCTS

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NOTE: The quantities of material shown in the table above cover an average range of conditions. The quantity of sand, the dilution rate of the emulsified asphalt and its rate of spread should take into consideration local conditions and experience. The Designer of Record should select the dilution rate(s) reflecting the local condition of the pavement such as surface texture, porosity, and age of the asphalt pavement to be sealed.

A dilution rate of one (1) part emulsified asphalt to one (1) part water is recommended for most applications. A dilution rate of two (2) parts emulsified asphalt to one (1) part water is recommended for grooved, rough or course surfaces, or where the pavement is highly oxidized or badly cracked.

Application rates can vary from 0.36 to 0.68 l per m2 0.08 to 0.15 gallons per square yard. For a 1:1

dilution, 0.45 to 0.68 k per m2 0.10 to 0.15 gallons per square yard is recommended. For a 2:1 dilution, 0.36 to 0.68 l per m2 0.08 to 0.15 gallons per square yard is recommended. Exceeding recommended application rates is not advisable without consulting a responsible manufacturer's representative.

If the manufacturer's representative cannot consult on the appropriate dilution and rate to apply it is recommended that the manufacturer's representative is contacted during the design phase to discuss the appropriate dilution and rate to select.

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2.1 GILSONITE MODIFIED ASPHALT EMULSION

The bituminous material must be a gilsonite modified asphalt emulsion. The material must meet the following requirements of the applicable portions of Table 1, 2, and 3.:

Table 1: Concentrated Bituminous Material Properties

Properties	Specification	Limits
Saybolt Furol Viscosity at 77 deg F25 deg C	ASTM D244	20-100 seconds
Residue by Distillation or Evaporation	ASTM D244	57 percent minimum
Sieve Test	ASTM D244	0.1 percent maximum
24-hour Stability	ASTM D244	1 percent maximum
5-day Settlement Test	ASTM D244	5.0 pecent maximum
Particle Charge pH, cationic (see Note 1)	ASTM D244	Positive 6.5 percent maximum pH

Note 1: pH may be used in lieu of the particle charge test which is sometimes inconclusive in slow setting, bituminous emulsions.

The bituminous material concentrate must be diluted with heated water prior to application. The bituminous material, when diluted in the volumetric proportion of [one part hot water to one part concentrate] [one part hot water to two parts concentrate] must meet the requirements shown in Table 2.:

[

Table 2: 1 Part Bitumen : 1 Part Water Dilution Emulstion Properties (see Note 2)

Properties	Specification	Limits
Saybolt Furol Viscosity at 77 deg F25 deg C	ASTM D244	10-50 seconds
Residue by Distillation or Evaporation	ASTM D244	28.5 percent minimum
Pumping Stability (see Note 3)		Pass

][

Table 2: 2 Part Bitumen : 1 Part Water Dilution Emulsion Properties (see Note 2)

Properties	Specification	Limits
Saybolt Furol Viscosity at 77 deg F25 deg C	ASTM D244	10-50 seconds
Residue by Distillation or Evaporation	ASTM D244	38 percent minimum
Pumping Stability (see Note 3)		Pass

]

Note 2: In ready-to-apply form by volume.

Note 3: Pumping stability is tested by pumping 475 ml 1 pint of diluted material at 25 deg C 77 deg F,through a 6 mm 1/4 inch gear pump operation 1,750 rpm for 10 minutes with no significant separation or coagulation.

The bituminous base residue must contain not less than 20 percent uintaite or gilsonite, and must not contain any tall oil pitch or coal tar material. This must be stated in the Manufacturer's Certificate of Compliance for bituminous material. The material must be compatible with asphaltic concrete, and have a 5-year minimum proven performance record at airports with similar climatic conditions. Curing time, under recommended application conditions, must not exceed eight hours.

Table 3: Emulsion Residue by Distillation or Evaporation Tests

Properties	Specification	Limits
Viscosity at 135 deg C 275 deg F	ASTM D4402/D44	1,750 cts maximum
Solubility in 1, 1, 1 trichloroethylene	ASTM D2042	97.5 minimum

Table 3: Emulsion Residue by Distillation or Evaporation Tests

Properties	Specification	Limits
Penetration	ASTM D5/D5M	50 dmm maximum
Asphaltenes	ASTM D2007	15 percent minimum
Saturates	ASTM D2007	15 percent maximum
Polar Compounds	ASTM D2007	25 percent minimum
Aromatics	ASTM D2007	15 percent minimum

The Contractor must furnish vendor's certified test reports showing that the material is the type, grade and quality specified for each load of bituminous material delivered to the project. The certification must also show the shipment number, refinery, consignee, destination, contract number and date of shipment. The test reports and certification must be delivered to the Contracting Officer before permission is granted to use the material. The furnishing of the vendor's certified test report for the bituminous material must not be interpreted as a basis for final acceptance. The manufacturer's material test report certification may be subject to verification by testing the material delivered for use on the project.

The bituminous material storage and handling temperature must be between 10 deg C - 71 deg C 50 deg F - 160 deg F and the material must be protected from freezing, or whenever outside temperature drops below 5 deg C 40 deg F for prolonged time periods.

2.2 AGGREGATE

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NOTE:
Aggregate should be used on runways and where friction may also be an issue. Where friction is not an issue the sand requirement can be removed.

The gradations in the table represent the limits in determining aggregate suitability for use in the emulsified asphalt surface treatment. The sand gradation used, within the limits designated in the table, must provide sufficient friction levels to meet or exceed the Maintenance Planning Friction Level in Table 3-2, “Friction Level Classification for Runway Pavement Surfaces” of AC 150/5320-12, Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces.

Locally available sand or abrasive material may be available that is slightly outside of the gradation requirements listed below. These may be submitted for review and approval by the Contracting Officer. It is recommended to obtain concurrence for use by the seal coat manufacturer; and the Designer of

Record and manufacturer’s field representative should verify acceptance during application of test sections
****

The aggregate material must be a dry, clean, dust and dirt free, sound, durable, angular shaped manufactured specialty sand, such as that used as an abrasive, with a Mohs hardness of 6 to 8. The Contractor must submit manufacturer’s technical data and a manufacturer’s certification indicating that the specialty sand meets the requirements of the specification to the Contracting Officer prior to start of construction. The sand must be approved for use by the Contracting Officer and must meet the following gradation limits when tested in accordance with ASTM C136/C136M and ASTM C117:

Table 4: Aggregate Material Gradation Requirements

Sieve Size	By Weight Min/Max
No. 8	0
No. 16	0-8
No. 30	20-78
No. 50	10-85
No. 100	0-7
No. 200	0-2

The Contractor must submit gradation and manufacturer's specification for review at or prior to the pre bid for approval. The gradations in the chart represent the limits in determining aggregate source suitability for use in the bituminous surface treatment. The final gradations approved, within the limits designated in Table 4, must provide sufficient friction levels to meet the Minimum Friction Level in Table 3-2, "Friction Level Classification for Runway Pavement Surfaces" of FAA AC 150/5320-12.

2.2.1 Material Performance

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NOTE: The following Material Performance submittal must be required for airfield runways and taxiways.
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Friction tests previously performed in accordance with FAA Advisory Circular, FAA AC 150/5320-12, at 40 and 60 mph-wet, must be submitted showing, as a minimum; friction value of pavement surface prior to sealant application; two values, test between 24 and 96 hours after application, with a minimum of 24 hours between tests; and one value test at no less than 90 days or greater than 360 days after the application. The results of the two tests between 24 and 96 hours must indicate friction is increasing at a rate to obtain similar friction value on the 90th day as the orginal friction value, and the long term test must indicate no apparent adverse effect with time relative to friction values and existing pavement surface.

The contractor must submit a list of airports which meet the above requirements, as well as technical details on application rates, aggregate rates, and point of contact at these airports to confirm use and success of sealer with aggregate. Friction tests must be submitted from no less than one of the airports on the list and each set of tests described above, must be from one project.

Seal coat material submittal without required friction performance will not be approved. Friction tests performed on this project, if any, cannot be used as a substitute of this requirement.

2.2.2 MOHS Hardness

MOHS hardness must be within 6-8 in accordance with ASTM D1474/D1474M.

2.3 POLYMER

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NOTE: If the Designer of Record determines that polymer is required, the Designer of Record must verify that the vinyl acrylic polymer is approved for use by the asphalt material manufacturer. Polymer will generally increase cost, but it also increases durability. A lifecycle cost analysis may justify its use.

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Vinyl acrylic polymer must be approved for use by the manufacturer of the bituminous material for compatibility and must meet the requirements provided in Table 5:

Table 5: Polymer Properties

Properties	Limits
Solids Content	52-57 percent by weight
Weight	1,066-1,174 grams per liter8.4-9.4 pounds per gallon
pH	4.0 to 6.0
Particle Charge	Nonionic/Anionic
Mechanical Stability	Excellent
Film Forming Temperature	5 deg C41 deg F, minimum

Table 5: Polymer Properties

Properties	Limits
Tg	22 deg C71.6 deg F, maximum

The Contractor must submit manufacturer's specifications for the vinyl acrylic polymer with the bituminous materials submittal for review and approval.

2.4 WATER

Water used in diluting the emulsion must be potable, free from harmful soluble salts and chemicals, and at least 38 deg C 100 deg F.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

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NOTE: If the surface to be treated requires repairs, the method of repairs and extent of work involved should be shown or described. For substantial amounts of repair work use applicable UFGS sections.

Removal of paint and rubber deposits are generally accomplished by high pressure water blasting. Few approved chemicals are effective and sandblasting is not permitted by air pollution regulations at some locations. Mechanical abrasion generally causes damage to the pavement.

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Provide Inspection Reports of; air and surface temperature during application of seal coat, emulsion temperature and rate of application, dilution rate used, adequacy of surface cleaning and preparation, aggregate rate of application, and protection of site facilities as applicable, each day of application.

Repair and patch all major pavement defects in accordance with [Section 32 01 17.61 SEALING CRACKS IN ASPHALT PAVING][the following subparagraphs]. All cracks sealed with a joint sealant compatible with the emulsion prior to application of the emulsion.

[3.1.1 Hairline Cracks

Cracks that are less than 6 mm 1/4 inch wide do not need to be sealed.

3.1.2 Small Cracks

Cracks that are 6 to 20 mm 1/4 to 3/4 inch wide must be routed to a nominal width 3 mm 1/8 inch greater than the existing nominal width and to a depth not less than 20 mm 3/4 inch, waterblasted and cleaned using compressed air.

3.1.3 Medium Cracks

Cracks that are 20 to 50 mm 3/4 to 2 inches wide must be waterblasted and cleaned using compressed air.

3.1.4 Large Cracks

Cracks that are greater than 50 mm 2 inches wide must be repaired using pothole repair techniques instead of sealing.

]3.1.5 Cleaning Operations

Provide a clean surface for the seal coat. If considered necessary by the manufacturer's representative and is approved by the Contracting Officer, flushing with water will be permitted. Water will be made available for the contractor's use from a hydrant location within [_____] km(s) mile(s) of the project site [at prevailing Government rates]. The contractor must provide tools, hoses and hauling equipment for providing and dispensing of the water.

Immediately before applying the sealcoat, the asphalt surface to be treated must be free of all dirt, sand, vegetation, loose paint, excessive oil or grease, rubber deposits or other objectionable material. The surface must be cleaned with a power broom or power blower supplemented by hand sweeping or any other means required to remove deleterious matter to the satisfaction of the Contracting Officer.

3.1.6 Weather Limitations

The asphalt emulsion shall be applied only when the existing pavement surface is dry and when the weather is not foggy, rainy, or when the wind velocity will prevent the uniform application of the material. No material shall be applied when dust or sand is blowing or when rain is anticipated within eight hours of application completion. The atmospheric temperature and the pavement surface temperature shall both be above 16 deg C 60 deg F. During application, account for wind drift.

3.1.7 Protection of Site Facilities

Cover existing buildings, structures, runway edge lights, taxiway edge lights, informational signs, retro-reflective marking and in-pavement duct markers as necessary before applying the emulsion. Should emulsion get on any light or marker, clean property promptly. If cleaning is not satisfactory to the Contracting Officer, the Contractor must replace any light, sign or marker with equivalent equipment at no cost to the Government.

3.2 GILSONITE EMULSION MIXING

The application emulsion must be obtained by blending bituminous material concentrate, polymer and water. Always add heated water to the bituminous material concentrate; never add bituminous material concentrate to heated water. Add one percent polymer, by volume, to the emulsion mix. If the polymer is added to the emulsion mix at the plant, submit weigh scale tickets to the Contracting Officer. As an option, the polymer may be added to the emulsion mix at the job site provided the polymer is added while the circulating pump is running. The mix must be agitated for a minimum of 15 minutes or until the polymer is mixed to the satisfaction of the Contracting Officer.

3.3 QUANTITIES OF MATERIAL PER SQUARE METER YARD

The approximate amounts of materials per square meter yard for the bituminous surface treatment must be as provided in Table 6 for the treatment area(s) at the specified dilution rate(s) as noted on the plans. The exact amounts to be used must be determined by the results of the test section program as directed by the Contracting Officer. Pavements with more progressive deterioration issues may require heavier than normal application rates for emulsion and aggregate. In such cases a manufacturer's representative should be consulted as directed by the Contracting Officer.

Table 6: Application Rate

Dilution Rate	Gilsonite Modified Asphalt Emulsion l/m2 gal/yd2	Quantity of Aggregate kg/m2 lbs/yd2
[1:1 Gilsonite Modified Asphalt Emulsion]	[0.45-0.680.10-0.15]	[0.11-0.270.20-0.50]
[2:1 Gilsonite Modified Asphalt Emulsion]	[0.36-0.540.08-0.12]	[0.11-0.270.20-0.50]

3.3.1 Applicatoin of Gilsonite Modified Asphalt Emulsion

The emulsion must be applied upon the properly prepared, clean and dry surface at the application rate approved by the Contracting Officer for each designated treatment area. The emulsion temperature must be at a temperature at or above 54 deg C 130 deg F, but not exceeding 71 deg C 160 deg F or in accordance with the manufacturer's recommendation using a pressure distributor to obtain uniform distribution at all points.

During all applications, the surfaces of adjacent structures must be protected in such manner as to prevent their being spattered or marred. Bituminous materials must not be discharged into borrow pits or gutters or upon the airport area.

3.3.2 Application of Aggregate

The emulsion, along with sand at the rate specified for each designated application area must be spread uniformly over the emulsion in a single pass from a sanding attachment to the asphalt distributor. The aggregate must be spread in the same width of application as the bituminous material and must not be applied in such thickness as to cause overspreading.

Sprinkling of additional aggregate material, and spraying additional bituminous material over areas that show up having insufficient cover or bitumen, must be done by hand whenever necessary. In areas where hand work is necessitated, the sand must be applied before the sealant begins to break.

Sanding must be performed in a manner so as to prevent appreciable amounts of sand from going onto any pavement prior to the emulsion being applied. The Contractor must clean up areas with excess or loose sand and dispose of off airport property.

3.4 TEST SECTIONS AND AREAS

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NOTE: Note to designer: There may be more than one test section needed. Specify the number based upon the pavement surface conditions, slope, and texture.

For projects calling for application of the asphalt surface treatment on runway and high speed exit taxiway, the Designer of Record must document skid resistance in accordance with AC 150/5320-12, Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces, prior to full application.

The test areas/sections afford the Contractor and the Designer of Record an opportunity to determine the quality of the mixture in place as well as the performance of the equipment.

If operational conditions preclude placement of a test section on the pavement to be seal coated, it may be applied on a pavement with similar surface texture.

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Prior to production seal coating applying the seal coat, place up to 3[_____] test sections at a location determined by the Contracting Officer approximately 15 meters 50 feet long by a minimum of 2.5 meters 8 feet wide in a single pass of equipment using the approved job materials in accordance with the specification requirements, unless noted otherwise. Perform tests to determine the application rates of the asphalt emulsion and aggregate. Test sections must be performed on pavement areas that are not considered critical to operations. Vary the application rates along the longitudinally along the test section in order to effectively evaluate the pavement absorption rates. If the tests indicate that the seal coat test section does not conform to the specification requirements, make necessary adjustments to the application equipment and to the spreading procedures, and construct additional test sections for conformance to the specifications. Where test sections do not conform to specification requirements, repair or remove seal coat at no expense to the Government; no separate payment will be made for seal coat materials and labor, either in placement or removal of any test section. Removal of seal coat must be performed only if 500 feet of length or greater on a runway surface do not meet the friction requirements of FAA AC 150/5320-12. Perform quality control sampling and testing during construction as specified in paragraph FIELD QUALITY CONTROL. Test sections must be performed in the presence of the Contracting Officer and the Seal Coat Manufacturer's Representative (SCMR). Notify the Contracting Officer 7[_____] days prior to the planned test section date. The SCMR must recommend to the Contracting Officer application rates of materials used in production seal coating. The Contracting Officer must approve the application rates prior to production seal coating.

A qualified manufacturer's representative must be present in the field to assist the Contractor in applying test areas or test sections to determine the optimum rate of application of both sealant and sand.

A test area or section must be applied for each differing HMA pavement surface identified in the project. The test area or sections must be used to determine the material application rate(s) of both sealant and sand prior to full production. The same equipment and method of operations must be utilized on the test section(s) as will be utilized on the remainder of the work.

a. For Taxiway, Taxilane and Apron Surfaces - Prior to full application, the Contractor must place test areas at application rate(s) stipulated by the Contracting Officer or judged necessary by the manufacturer's representative to determine proper application rate. The area to be tested will be designated by the Contracting Officer and will be located on a representative section of the pavement to receive the bituminous surface coat.

b. If the test area should prove to be unsatisfactory, necessary adjustments to the application rate, placement operations, and equipment must be made. Additional test areas must be placed and evaluated, if required. Full production must not begin without the Contracting Officer's approval.

c. For Runway and High Speed Taxiway Exit Surfaces - If friction testing is required by the contract, the Contractor will test according to FAA AC 150/5320-12. The contractor must place a series of friction test sections a minimum of 90 meters long by 2.5 meters wide300 feet long by 8 feet wide at application rate(s) determined by application test sections and areas. The area to be tested will be located on a representative section of the pavement to receive the bituminous surface coat.

d. The Contractor must perform tests for skid resistance of the test sections after a time frame determined by the contractor, manufacturers representative (if present), and the Contracting Officer. Full application can proceed when the results of the friction evaluation are equal to or greater than the Maintenance Minimum levels provided in Table 3-2, "Friction Level Classification for Runway Pavement Surfaces," in FAA AC 150/5320-12. Documentation will be provided by the manufacture that demonstrates a history of rapid increase of pavement friction to above Maintenance Planning levels provided in Table 3-2 and returning to pre-application numbers shortly thereafter.

e. If the test section should prove to be unsatisfactory, necessary adjustments to the application rate, placement operations, and equipment must be made. Additional test sections must be placed and evaluated, if required. Full production must not begin without the Contracting Officer's approval.

3.5 FIELD QUALITY CONTROL - SEAL COAT

3.5.1 Aggregate Gradation

Perform gradation tests in accordance with ASTM C136/C136M when directed by the Contracting Officer. When the source of materials is changed or deficiencies are found, the gradation must be repeated and the material already placed must be retested to determine the extent of the unacceptable material where friction issues exist. Replace all in-place unacceptable material or re-apply seal coat material conforming to the specification as directed by Contracting Officer at no additional expense to the Government.

3.5.2 Gilsonite Modified Asphalt Emulsion Sample

Obtain a sample of the asphalt emulsion used under the supervision of the Contracting Officer. The sample will be retained by the contractor until the completion of the project and must be turned over to the government upon request of the Contracting Officer.

3.5.3 Water Compatibility Test

In some localities an incompatibility may exist between the asphalt emulsion and the water to be used for dilution due to their characteristics. Clear, potable water should be used. No less than thirty days prior to commencing work, 0.24 liter one half pint of the proposed asphalt emulsion and 0.24 liter one half pint of the proposed water must be combined, agitated, and allowed to sit for a period of 24 hours to test their compatibility. If they prove to be incompatible, indicated by separation of the emulsion, clotting, particles settling or other adverse properties from mixing with water, an approved chemical treatment must be provided for all water used for dilution or a different and compatible source of water must be selected. Report results to the Contracting Officer.

3.5.4 Application Inspection

Inspect application of seal coat for uniformity. Furnish a written report within 24 hours of testing citing air and surface temperature during application, emulsion temperature during application, dilution rate, and rate of emulsion application determined from testing compared to the approved production rates.

3.6 TRAFFIC CONTROL

Protect freshly placed coatings from damage by traffic. Provide sufficient warning signs and barricades to prevent traffic over freshly treated surfaces. Protect treated areas from traffic for at least [2][_____] hours after final application of seal coat material, or for such time as necessary to prevent picking up. Immediately prior to opening for subsequent construction operations (markings) or traffic, broom and vacuum to remove loose material only after material has completely cured. Provide warning signs and barricades for proper traffic control in accordance with MUTCD.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 01 13.64 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 13.64 (February 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-32 01 13.64 (November 2023)**

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SECTION 32 01 13.64

REJUVENATION OF ASPHALT PAVEMENT SURFACES

11/23

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NOTE: This guide specification covers the requirements for applying a bituminous-based rejuvenator containing maltenes to the surface of asphalt pavements. Application is restricted to parking lots, storage yards, container handling facilities, and other similar low-speed pavements due to loss of skid resistance. Bituminous-based rejuvenators are applied with conventional liquid asphalt distributor trucks. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Rejuvenators are applied to asphalt pavement surfaces that do not have structural defects or environmental block cracking. Surface rejuvenators penetrate up to about 9.5 millimeter 3/8 inch into the pavement. Rejuvenators restore asphalt pavement binder flexible properties at the molecular level and can delay the occurrence of load-induced structural distress.

Research suggests the best asphalt pavement longevity is accomplished with an initial treatment two to four years after paving to restore asphalt binder flexibility lost during hot plant production, and then a recurring treatment about every five years thereafter. However, that research was conducted prior to development of Superpave PG binders, therefore, the performance protocol timeframes may not be as stringent.

Surface rejuvenators can cause dangerous loss of friction for up to a year, therefore project selection and application rates require careful investigation. Research has shown that pavements with substantial oil or fuel spillage may negatively impact surface rejuvenation effectiveness.

Due to the many proprietary commercial products, this Section is written for pavement binder properties after application; do not modify to use a specified application rate.

Industry has developed bio-based rejuvenators that can improve a hot mix asphalt binder but in a chemically different process than the bituminous-based rejuvenators. This Section uses DoD researched and approved bituminous-based rejuvenators. Bio-based rejuvenators are applied with agricultural sprayers. Bio-based rejuvenators are not incorporated into this Section.

Alternative treatments to paved or unpaved surfaces are:

Section 32 12 36.13 BITUMINOUS FOG SEAL – A light spray application of asphalt emulsion to the surface of a chip seal, an open-graded mix, or a weathered asphalt surface. It is classified as a Preventive Maintenance process when nonstructural cracking or raveling first begins. Fog seals of asphalt emulsion slow the oxidation process of asphalt pavements but skid resistance is lowered.

Section 32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL] (BST) – used on existing unpaved or paved surface. BSTs are low-cost maintenance methods that produce all-weather surfaces, renew weathered pavement, improve skid resistance, improve lane demarcation, and seal pavement surfaces including small cracks. BSTs are also known as Chip Seals.

Sand Seals are addressed in Section 32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL] and are spray-applied liquid asphalt covered with sand, used to restore uniform cover, restore weathered pavement, and reduce raveling. The treated surface is rolled with a pneumatic roller. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative. The Federal Aviation Administration has a similar product known as Seal Coat.

Slurry Seal - A mixture of crushed, well-graded aggregate (e.g., fine sand, mineral filler) and asphalt emulsion that is spread over the entire pavement surface with either a squeegee or spreader box attached to the back of a truck. There is no UFGS for slurry seal. Application is restricted to parking lots, storage yards, container handling facilities, and other similar low-speed pavements due to loss of skid resistance. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Micro-Surfacing - Applied in a process similar to slurry seals, micro-surfacing consists of a mixture of cationic quick set emulsified asphalt, mineral aggregate, mineral filler, water, and additives. Micro-surfacing provides a friction and rapid roadway surface correction. With a special mix design, it can fill ruts up to 19.5 mm 1.5 inches deep. Material is mixed in specialized, compartmentalized, self-powered trucks, and placed on the pavement using a screed box with auger. There is no UFGS for Micro-Surfacing. Application is restricted to parking lots, storage yards, container handling facilities, and other similar low-speed pavements due to loss of skid resistance. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Cape Seal – An application of micro-surfacing a few days after construction of a BST; used to cover the aggregates and improve aggregate bonding. There is no UFGS for Cape Seal. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Sandwich Seal – Process is to spread large aggregate, spray-apply emulsion, then cover with smaller aggregate to lock in larger aggregate. Requires the use of very clean aggregate. Used to improve skid resistance and seal pavements. There is no UFGS for Sandwich Seal. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Rejuvenator, Spray-on - Rejuvenators are commercially available products (proprietary) designed to restore original properties to aged (oxidized) asphalt binders by restoring the original ratio of asphaltenes to maltenes. A rejuvenator will retard the loss of surface fines and reduce the formation of additional cracks. Rejuvenators will not fill or remove existing cracks unless cracking is very minor hairline cracking. There is no UFGS for bio-based rejuvenators.

Rejuvenator, Mix-in-Place – Designed to be used with advanced cold or hot in-place recycling of existing aged asphalt pavements which exhibit relatively high stiffness due to the aged binder. Proprietary chemical rejuvenators reduce the brittleness, but also affect the fatigue and thermal cracking properties of the recycled pavement. DoD provides a mix-in-place rejuvenator procedure in TM 5-822-10/AFM 88-6 Chapter 6. Section 32 01 16.70 COLD-MIX REUSED ASPHALT PAVING uses emulsion recycling agents and Section 32 01 16.74 IN PLACE

HOT REUSED ASPHALT PAVING uses ASTM D4552 recycling agents. Substantial testing and engineering is required to specify the correct rejuvenator or emulsion and resultant mixture properties. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 UNIT PRICES

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NOTE: Delete these paragraphs when lump sum bidding is used.

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1.1.1 Measurement

1.1.1.1 Quantity of Rejuvenator

The quantity of rejuvenator to be paid for will be the measured quantities of liters gallons used in the accepted work as approved by the Contracting Officer, corrected to liters at 15 degrees C gallons at 60 degrees F in accordance with ASTM D1250, and provided that the measured quantities are not 20 percent over the approved application rate. Any amount of rejuvenator exceeding the approved application rate by more than 20 percent will be deducted from the measured quantities except for irregular areas where hand spraying of the rejuvenator is necessary. The actual application rate will be determined by the Contracting Officer by dividing the number of liters gallons of rejuvenator actually applied by the number of square meters square yards of pavement treated.

1.1.1.2 Treated Pavement

The quantity of pavement treated with rejuvenator to be paid for will be the number of square meters square yards completed and accepted as determined by the Contracting Officer. The number of square meters square yards of treated pavement will be determined by measuring the length and width of the specified work area. Measurements to determine the number of square meters square yards will be along the pavement surface.

1.1.1.3 Waybills and Delivery Tickets

Submit waybills and delivery tickets during progress of the work. Before the final statement is allowed, file with the Contracting Officer certified waybills and certified delivery tickets for all bituminous materials used in the construction of the pavement covered by the Contract. Do not remove bituminous material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

1.1.2 Payment

Accepted measured quantities of rejuvenator and treated pavement will be paid for at respective unit prices. Payment will constitute full compensation for providing all materials, equipment, plant, test section, testing, and tools, and for all labor and other incidentals necessary to complete work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials

ASTM D244	(2009; R 2017) Standard Test Methods and Practices for Emulsified Asphalts
ASTM D1250	(2019; E 2020) Standard Guide for Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1
ASTM D1856	(2009; R 2015) Recovery of Asphalt from Solution by Abson Method
ASTM D2170/D2170M	(2018) Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)
ASTM D2171/D2171M	(2018) Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills And Delivery Tickets; G, [_____]

Distributor; G, [_____]

Scales; G, [_____]

Rejuvenator; G, [_____]

Recommended Temperature; G, [_____]

Mineral Aggregate; G, [_____]

SD-04 Samples

Bituminous-based Chemical Rejuvenator; G, [_____]

SD-06 Test Reports

Quality Control; G, [_____]

Surface Preparation; G, [_____]

Test Section; G, [_____]

Inspection Reports; G, [_____]

1.4 QUALITY CONTROL

****

NOTE: For projects where rejuvenator is the primary definable feature of work, the testing laboratory can be the Contractor's laboratory, the rejuvenator manufacturer's laboratory, or an independent

commercial laboratory. Frequently, the rejuvenator manufacturer is the most knowledgeable. What is important is the laboratory is accredited as referenced. Select the appropriate quality control section for the project and include with Contract. If rejuvenator is a minor part of a project, and an independent commercial laboratory is already part of the Contract, may select that option for continuity, provided accredited in the appropriate tests.

****

Sampling and testing is the responsibility of the Contractor. Perform sampling and testing using [a] [an independent commercial] testing laboratory accredited in the required tests in accordance with Section 01 45 00 QUALITY CONTROL approved by the Contracting Officer. Sampling must be in accordance with ASTM D75/D75M for aggregates and ASTM D140/D140M for bituminous material. Contracting Officer may inspect testing facilities. Perform tests in the numbers, and at the location and times indicated, to ensure that the materials meet specified requirements. Submit copies of test results within 24 hours after completion of each test.

1.4.1 Preconstruction Sampling and Testing

Conduct preconstruction sampling and testing of rejuvenator in PART 2 PRODUCTS. Submit initial test results of rejuvenator at least 30 days prior to starting work. Repeat sampling and testing when there is a change in source or material.

1.4.2 Equipment Calibration

Furnish all equipment, materials, and labor necessary to calibrate equipment in accordance with paragraph EQUIPMENT, TOOLS, AND MACHINES. Perform all calibrations with the approved job materials and prior to applying the specified coatings to the prepared surface. Inspect all equipment prior to start of work and at regular intervals as needed during work.

1.4.3 Construction Quality Control Testing

Conduct sampling and testing in accordance with paragraph FIELD QUALITY CONTROL. Conduct measurement and testing each application day to ensure rejuvenator application rates are satisfactory. Submit copies of test results within 24 hours after completion of each test.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver rejuvenator to the site in a homogenous and undamaged condition. Inspect the materials for contamination and damage. Unload and store the materials with minimal handling. If rejuvenator is stored on project site, it must be stored in a manner recommended by the supplier and not exceed storage life or temperature ranges. Do not allow rejuvenator material to freeze or boil. Replace defective or damaged materials.

1.5.1 Bituminous Delivery Tickets

For every distributor load of rejuvenator material brought to site, provide the following: manufacturer, manufacture date, lot number, storage tank number, and total volume of rejuvenator material on truck.

1.5.2 Aggregate Delivery Tickets

For every load of mineral aggregate brought to site provide the aggregate source, supplier's aggregate size designation, and the weight of aggregate on the truck.

1.5.3 Safety Precautions

Smoking, or open flames (other than heaters that are part of the equipment) are not permitted within 8 meters 25 feet of heating, distributing, or transferring operations for rejuvenators that are flammable.

1.6 Environmental Requirements

Apply the rejuvenator when the existing surface is dry, and when the weather is not foggy, rainy, or when the wind velocity will prevent the uniform application. Apply the rejuvenator when the atmospheric temperature in the shade is 10 degrees C 50 degrees F and rising or when pavement temperature is above 15.5 degrees C 60 degrees F and rising, and the temperature has not been below 2 degrees C 35 degrees F for the 12 hours prior to application unless otherwise directed. Do not apply if wind disperses rejuvenator application. Delay application if rain appears imminent within 8 hours following time of application.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide bituminous-based rejuvenator on existing prepared asphalt pavement surface.

2.2 EQUIPMENT, TOOLS, AND MACHINES

Provide equipment for the purpose intended and properly maintained in satisfactory and safe operating condition at all times. Discontinue the use of equipment which fails to safely produce satisfactory work and replace with satisfactory equipment.

2.2.1 Scales

****

NOTE: For CONUS, select NIST 44 Class III L. For OCONUS, select the local governing authority, note the tolerances are the same as the NIST 44 Class III L. For the scale divisions, 9 kg 20 lb is common for manufacturers; e.g. 20 X 2000=40,000 lb capacity for the lowest capacity Class III L scale.

****

Use standard truck scales of the beam type equipped with a weight-recording device. Use scales with sufficient size and capacity to accommodate the trucks used in hauling aggregates. Keep the necessary number of standard weights on hand, at all times, for testing the scales. Permanent or portable scales used for payment and application rates must be calibrated by a certified calibration agency before commencing work, following the method and calibration frequency [in accordance with NIST HB 44 Class III L][recognized by governing local in which the project is located with the scale division 2 kg 5 lb for 2000 scale divisions and a maximum of 10,000 divisions. Scale acceptance tolerance is 2 kg 5 lb for 2000 scale divisions, and increases 1 kg 2.5 lb for each 500 increase in scale divisions. Example: for 5000 scale divisions, tolerance is 2 kg 5 lb + (6 x 1 kg 2.5 lb) = 8 kg 15 lb.] Conduct calibrations in presence of Contracting Officer. Provide certified calibration documentation. Recalibrate at 6 months from date of last approved calibration for permanent scales, and weekly for portable scales, for the duration of the Contract. Recalibrate scales if previous recognized calibration is outdated. Recalibrate scales or equipment if directed by the Contracting Officer. Provide adequate protection for the indicating and recording devices of the scales.

2.2.2 Distributor

Provide self-propelled distributors with pneumatic tires of such size and number to prevent rutting, shoving, or otherwise damaging the surface being sprayed. Clean distributor trucks and lines of all materials before loading for project; open inspection hatches when requested by the Contracting Officer. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Provide a distributor that is approved by the Contracting Officer and:

a. Is capable of circulating and agitating the bituminous material during the heating process.

b. Is capable of spraying in a triple overlap. Equip the spray bar with the appropriate nozzle sizes to achieve a uniform bituminous application across the pavement at the specified rate and acceptable distributor speed. Adjust all nozzles to 30 degrees from the spray bar long axis, or to the same angle between 15 and 30 degrees only as recommended by the manufacturer and Contractor will demonstrate that the specified application rate is achieved. Only use the calibrated wrench provided by manufacturer to adjust nozzle angle.

c. Is designed and equipped to spray the bituminous material at variable widths at the specified temperature, at readily determined and controlled total liquid rates, from 0.14 to 4.5 liters per square meter 0.03 to 1.0 gallons per square yard. Operate the distributor within a pressure range of 172.4 to 517.1 kPa 25 to 75 psi and with an allowable variation from the specified rate of not more than plus or minus 5 percent.

d. Each nozzle to be within 10 percent of the average flow rate for all the nozzles. Repair/replace out of tolerance nozzles.

e. Provide certification of distributor radar calibration for equipment with mounted radar which monitors travel speed and distance, used for the project. The date of calibration is to be no more than 6 months prior to project application

2.2.2.1 Distributor Calibration

Verify the distributors application rate no more than 96 hours prior to the start of bituminous application following ASTM D2995 Method B. For each day of application, validate using the dipstick method of volume applied divided by the applied area. Repeat ASTM D2995 calibration after 7 calendar days after start of project application. Submit bituminous material application rate and the residual asphalt application rate (for emulsified asphalts and cutbacks) results to Government. Provide the ASTM D2995 Method B calculations for transverse and longitudinal application rates.

2.2.3 Bituminous Storage Tank

Provide bituminous storage tanks capable of heating the bituminous material under effective and positive control at all times to the required temperature. Accomplish heating by steam coils, hot oil, or electricity. Provide steam heaters consisting of steam coils and equipment for producing steam, so designed that the steam cannot come in contact with the bituminous material. Affix an armored thermometer to the tank with a range appropriate for manufacturer recommended storage temperatures so that the temperature of the bituminous material may be determined at all times. Clean tanks and pipelines of all materials before loading for project; open inspection hatches if requested by the Contracting Officer.

2.2.4 Power Brooms and Power Blowers

Provide power brooms and power blowers capable of cleaning surfaces to be treated.

2.2.5 Broom Drag

Provide broom drag or hand broom for removing rejuvenator that ponds, pools, or is in excess.

2.2.6 Vacuum Sweepers

Provide self-propelled, vacuum pickup sweeper capable of removing loose sand, water, and debris from pavement surface.

2.3 MATERIALS

****

NOTE: Recommend re-striping pavements treated with rejuvenator.

****

2.3.1 Rejuvenator

Provide bituminous-based chemical rejuvenator having a demonstrated record of performance based on the ability of the material to decrease the viscosity of the binder material, through molecular modification of the asphaltenes and maltenes, to reduce the rate of loss of fines, and to retard crack propagation. Select a material that neither permanently damages nor obscures pavement markings. Provide specific application specifications, rates, temperatures, and weather conditions recommended by the manufacturer to the Contracting Officer for review and approval. Sample the rejuvenating material according to ASTM D140/D140M. Provide rejuvenator conforming to the following test requirements in Table I:

TABLE I: Rejuvenator Properties		
Property	Requirement	Test Method
Residue, percent	55 minimum	ASTM D244 (1)
Viscosity at 60 degrees C, sq mm/sec 140 degrees F, centistokes (2)	80-500	ASTM D2170/D2170M
Flash Point (3) Cleveland Open Cup (COC), degrees C degrees F	177 350 minimum	ASTM D92
(1) Modify ASTM D244 evaporation test for percent residue by heating 50 gram samples to 150 degrees C 300 degrees F until foaming ceases, cooling immediately, and calculating the results.		
(2) Viscosity on the residue obtained from evaporation test.		
(3) Flash point on residue from evaporation test.		

2.3.2 Rejuvenator Application Rate

****

NOTE: Designer to determine if the pavement surface grades, transverse or longitudinal, are too steep for the rejuvenator to adhere in a single application. Typically, bituminous tack coat emulsion application rates of 0.45 liters per square meter 0.10 gallon per square yard do not have application issues with grade. If there is not a grade-related application issue, then delete the bracketed paragraph.

****

Determine the application rate from analysis of the applications in paragraph TEST SECTION. The application rate is that which reduces binder viscosities extracted from samples of the upper 9 mm 3/8 inch of the treated surfaces by at least 40 percent. Compute the percent decrease in viscosity as follows:

100 ((Viscosity of untreated sample) - (Viscosity of treated sample)) / (Viscosity of untreated sample)

[2.3.2.1 Multiple Rejuvenator Applications

Treat pavement surfaces in two or more applications. Perform each additional application after the prior application of material has penetrated into the pavement.

]2.3.3 Mineral Aggregate

Sample mineral aggregate sand for blotting in accordance with ASTM D75/D75M. Provide gradation of mineral aggregate sand in accordance with ASTM C136/C136M and meet the following gradation requirements in Table II:

TABLE II: Mineral Aggregate Gradation

Sieve Designation (mm)	Percent by Weight Passing
1.18 No. 16	100
0.60 No. 30	40-75
0.30 No. 50	4-12
0.15 No. 100	0-5

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Site Protection

****

NOTE: Modify the bracketed sentence as appropriate for the project location. Public notices and signage 3 days prior is reasonable, unless local ordinance requires otherwise. Designer is to identify temporary parking for homes or business access that is interrupted by the work and curing. Delete paragraph if not needed.

****

[Provide public notices and post signage at least [3] [_____] days in advance of starting work. Plan detours as provided in the Contract prior to performing work at site.]During work, protect adjacent buildings, structures, vehicles, manhole covers, inlet grates, and trees to prevent splattering and marring. Protect manhole covers, inlet grates, electrical boxes, utility boxes, and other similar pavement penetrations with building paper cut to size to protect the entire casting size and opening. If the building paper becomes dislodged, replace with plywood, or other continuous board medium, cut to fit and of a thickness sufficient to remain in place during rejuvenator application. Open and remove debris from all covers, grates, and boxes after rejuvenator application.

3.1.2 Traffic Control

Provide warning signs and barricades for proper traffic control, in accordance with [MUTCD] [local governing traffic control authority].

3.1.3 Surface Preparation

****

NOTE: Rejuvenators are applied to pavements that exhibit no or very minor distresses. If a major distress is present, consider if the pavement is an appropriate candidate for a rejuvenator. Designer must first design appropriate repairs to existing pavements prior to rejuvenator application. If the pavement contains substantial areas of oil or fuel spill penetration, Designer must core and investigate the areas and determine depth of penetration to determine if there is an appropriate

repair prior to rejuvenator application. Otherwise, conventional mill and resurface, bituminous surface treatment, or similar operation may be appropriate.

Some rejuvenators do not require paint removal before application. For those that do, removal of paint and rubber deposits are generally accomplished by high pressure water blasting but care must be used to ensure that the water pressure does not significantly damage the asphalt pavement surface. Designer to consider use of Section 32 01 11.51 RUBBER AND PAINT REMOVAL FROM AIRFIELD PAVEMENTS for thermoplastic markings. Few approved chemicals are effective and sandblasting is not permitted by air pollution regulations at some locations. Mechanical abrasion generally causes damage to the pavement.

****

[[Complete repairs to existing pavement as specified in the Contract documents] [and] [remove existing oil and fuel penetration as specified in Contract documents].]Immediately before applying the rejuvenator, remove loose material, dirt, clay, or other objectionable material from the surface to be treated. Flush the surface with water when necessary to remove dirt or debris not removed by sweeping or brooming; allow the surface to dry after flushing. Paint bonded to the surface may remain. After the cleaning operation and prior to application of the rejuvenator, the Contracting Officer is to inspect the area to be treated to determine suitability of the area to receive the rejuvenator.

3.2 TEST SECTION

Determine the required application rates from test sections on the pavement to be treated.

3.2.1 Bituminous Distributor Temperature

Ensure bituminous material is at the recommended application temperature and has been thoroughly cycled through the distributor bar. Test the bituminous distributor under pressure by means of a test shot area (outside the project limits) to ensure there are no leaks or dripping from nozzles after shut-off.

3.2.2 Test Section Construction

Construct each test section 30 meters 100 feet in length. Treat each test section with a different application rate of rejuvenator, and conduct tests on samples obtained from the top 9 mm 3/8 inch of each of these treated areas to measure viscosity and thus determine desired application rate. Obtain the samples of treated material no sooner than 24 hours after application of rejuvenator. Select an application rate to obtain the specified reduction in asphalt viscosity and to ensure that all rejuvenator material penetrates into the pavement surface within 24 hours. Do not apply rejuvenator at a rate what exceeds that which the pavement can absorb within 24 hours after application. Do not begin application of the rejuvenator until the test section report has been evaluated and the required application rate has been approved by the Contracting Officer. Trial application rates may be modified as approved by the Contracting Officer.

3.2.3 Test Section Viscosity Testing

Conduct tests to extract the bituminous rejuvenator according to ASTM D2172/D2172M and recover according to ASTM D1856. Submit samples of sufficient size to provide enough bituminous binder for determination of viscosity. Measure viscosity of the bituminous material in accordance with ASTM D2170/D2170M or ASTM D2171/D2171M, as applicable, and conducted at 60 degrees C 140 degrees F unless otherwise specified. Determine the change in viscosity for each application rate of rejuvenator in the test section from tests conducted on samples taken before and samples taken after the pavement surface has been rejuvenated. Submit for approval a test report indicating each change in viscosity for each application rate in the test section. Summarize the report with the recommended application rate. Rejuvenating production work may proceed after the Contracting Officer approves the application rate.

3.3 REJUVENATOR MATERIAL APPLICATION

Apply rejuvenator material at the approved rate and at manufacturer's recommended temperature using triple overlap in such a manner that uniform distribution is obtained over all surfaces treated. Reduce spray to double overlap if wind disperses triple overlap and only if double overlap applies the specified coverage, otherwise discontinue work until acceptable coverage is obtainable. For double overlap, adjust distributor operation and settings to achieve target application rate. To obtain uniform application of the rejuvenator on the surface treated at the junction of previous and subsequent applications, spread building paper on the surface at a sufficient distance from each end of each application so that application of the rejuvenator may be started and stopped on the paper. Remove the building paper immediately after application. Properly treat areas missed by the distributor with the hand spray. Protect the surface for a period of at least 24 hours following application of the rejuvenator.

3.4 FIELD QUALITY CONTROL

Inspect application uniformity and determine application rates of rejuvenator each day of application.

3.4.1 Ponding and Pooling of Rejuvenator Material

If low spots and depressions in the pavement surface cause ponding or pooling of the rejuvenating agent, drag the pavement surface with a broom. Continue broom dragging until the pavement surface is free of any pools of excess material.

3.4.2 Blotting Excess Rejuvenator Material

Apply mineral aggregate sand for blotting, in sufficient quantity, to effectively blot up any excess rejuvenator material remaining on the treated pavement surface after 24 hours. Apply blotter sand by hand or mechanical spreader. After rejuvenator is absorbed by blotter sand, sweep, remove, and dispose of blotter sand.

3.4.3 Insufficient Rejuvenator Material

When the actual application rate of the rejuvenator is more than 20 percent below the approved application rate, make subsequent applications of rejuvenator to bring the sum of the applied application rates up to but not exceeding the approved rate with penetration into the pavement surface occurring within 24 hours after application.

3.4.4 Inspection Reports

Furnish a written report each day of application citing air temperature and humidity during application of rejuvenator, rejuvenator temperature during application, rate of rejuvenator application, truck speed in meters per minute feet per minute, RPM of truck, digital wet (shot) rate, spray bar height, and pump setting. Include any observations.

3.5 SURFACE PROTECTION

****

NOTE: Delete bracketed sentence if pavement markings are not in Contract.

****

Protect freshly placed coatings from damage by traffic. Provide sufficient warning signs and barricades to prevent traffic over freshly treated surfaces. Protect treated areas from traffic for at least 24 hours after final application of coatings, or for such time as necessary to prevent tracking.[Apply pavement markings as required in Contract after final brooming.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 01 16.70 (May 2018)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 17 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 16.70

COLD-MIX REUSED ASPHALT PAVING

05/18

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PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 01 16.70 (May 2018)**

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****

SECTION 32 01 16.70

COLD-MIX REUSED ASPHALT PAVING
05/18

****

NOTE: This guide specification covers the requirements for recycled cold-mix asphalt mixture.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: This paragraph will be deleted if the work is included in one lump sum contract price for the entire work covered by the invitation for bids. This paragraph may be revised to combine the payment for cold-mix recycled mixture, rejuvenator (if needed), and emulsified asphalt cement, when separate payment for emulsified asphalt cement material is not considered warranted based on local experience and job conditions. Lump sum contracts can be used when the total job does not exceed 17,000 square meters 20,000 square yards or 1000 metric tons tons.

****

1.1.1 Measurement

****
NOTE: Where in place mixing is used, measurement will be in square meters yards of accepted work.
****

Cold-mix recycling paid for will be the number of [metric tons tons] [square meters yards] used in the accepted work. Aggregates will be paid for by the number of [metric tons tons] [square meters yards] used in the accepted work. The recycling agent will be paid for by the number of [liters gallons] [metric 2000-pound tons] of material used in accepted work. The emulsified asphalt cement will be paid for by the number of [liters gallons] [metric 2000-pound tons] of material used in accepted work. Determine the number of liters gallons of emulsified asphalt cement used either by measuring the material at a temperature of 15.6 degrees C 60 degrees F or by correcting the amount measured at another temperature to liters gallons at 15.6 degrees C 60 degrees F, using a coefficient of expansion of 0.00045 per degree C 0.00025 per degree F for the emulsified asphalt.

1.1.2 Payment

The quantities of recycled paving mixture, aggregates, recycling agent, and emulsified asphalt cement, determined as provided above, will be paid for at respective contract unit prices per [metric ton ton] [square meter yard] for paving mixture and aggregates and per [liter gallon] [metric ton ton] for recycling agent and emulsified asphalt cement. If deficiencies in the finished product exceed specified tolerances, no payment will be made for such areas of pavement until the defective areas are corrected and accepted by the Contracting Officer.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 88	(2013) Standard Method of Test for Particle Size Analysis of Soils

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt

ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4944	(2018) Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method
ASTM D4959	(2016) Determination of Water (Moisture) Content of Soil by Direct Heating
ASTM D5505	(2014) Classifying Emulsified Recycling Agents
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy

and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Aggregates

Asphalt Emulsion

Recycling Agent

Job-Mix Formula (JMF); G, [_____]

SD-04 Samples

Samples

Cold Recycled Mixtures

SD-06 Test Reports

Testing

1.4 QUALITY CONTROL

1.4.1 Sampling and Testing

Perform sampling and testing by using a commercial testing laboratory or Contractor facilities, upon approval by the Contracting Officer. No work requiring testing will be permitted until the testing facilities have been inspected and approved. The first inspection will be at the expense of the Government. Cost incurred by the Government for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor.

1.4.2 Samples

Submit samples from the existing pavement obtained from at least two locations to provide representative samples of the pavement. Take recyclable asphalt pavement and aggregate samples for laboratory tests in accordance with ASTM D75/D75M. Take samples of the emulsified asphalt cement (bituminous material) [and recycling agent] in accordance with ASTM D140/D140M.

1.4.3 Sampling and Testing During Construction

Perform quality control sampling and testing as required in paragraph ACCEPTABILITY OF WORK.

1.5 EQUIPMENT, TOOLS AND MACHINES

Allow the Contracting Officer access, at any time, to all equipment used to produce the cold-recycled mixture; this can involve checking the adequacy of the equipment used, inspecting the operation of the equipment, and verifying weights, mixture proportions, and the character and physical properties of the materials used for construction. Plant, machines, tools, and miscellaneous equipment to be used on the production and placement of the cold recycled mixture must be approved by the Contracting Officer. Tentative approval of specific items will be made only after adequacy of the plant, machines, tools, and miscellaneous equipment has been demonstrated in full-scale production.

1.5.1 Central Plant Mixing

****

NOTE: This paragraph and paragraph In-Place Mixing should be left in only when it is desired to give the Contractor a choice between central plant mix and in-place methods.

****

Provide a mixing plant designed, coordinated, operated to produce mixture within the JMF, and capable of producing recycled mixture at a minimum rate of [136] [_____] Mg [150] [_____] tons per hour. Equip the plant with a positive means to control the amount of asphalt, water, [recycling agent,] and time of mixing.

1.5.2 In-Place Mixing

Use equipment for in-place mixing construction that will produce mixture within the JMF. Use mixing equipment that is equipped with positive means to control the amount of asphalt[, recycling agent,] and water added and is capable of producing a homogeneous mixture.

1.5.3 Straightedge

Furnish and maintain at the site, in good condition, one 3.66 meter 12 foot straightedge for each mechanical spreader. Make straightedge available for Government use. Use straightedges constructed of aluminum or other lightweight metal with blades of box or box-girder cross section and with flat bottom reinforced to insure rigidity and accuracy. Use straightedge with handles to facilitate movement on pavement.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not construct recycled cold-mix course in rain or on a layer which contains free water either within the layer or on its surface. Construct recycled cold-mix courses only when the atmospheric temperature is 10 degrees C 50 degrees F or above.

PART 2 PRODUCTS

2.1 RECLAIMED ASPHALT PAVEMENT (RAP)

****

NOTE: Cold-mix recycling could include the use of existing RAP material stockpiles. If this condition exists, the desired material properties must be included below. The gradation of the existing stockpile will need to be determined.

****

Provide RAP consisting of material obtained from cold milling or from removal and crushing of the existing asphalt pavement. The maximum particle size of the RAP material must never exceed half the thickness of the compacted cold mix layer. When lifts of 75 mm 3 inches or more are used, the maximum particle size of the RAP material must not exceed a maximum of 38 mm 1-1/2 inch and a minimum of 90 percent of the RAP must pass a 25 mm 1 inch sieve.

2.2 AGGREGATES

****

NOTE: Delete this paragraph when new or additional aggregates are not required as part of the recycling project. When required, new aggregates may be added to produce an aggregate gradation that meets the desired end product. Gradations for base course, stabilized base course or intermediate asphalt mixture course should be specified in Table I below. For airfields, cold recycled mixture will only be used for base course material or lower levels in the pavement structure. The choice of which gradation to specify should be based on the type, quality, and uniformity of the RAP material available for use. The gradation of the recycled mixture must be determined on the aggregate recovered from an extraction or ignition test.

The gradation may require only that a maximum aggregate particle size not be exceeded or it may be more detailed, requiring further processing or adjustment with new aggregates to meet the desired gradation. The tolerances applied to this gradation should follow standard tolerances given for aggregates or asphalt aggregate mixtures when used in similar situations. When the recycled mixture is intended to be used as an intermediate or binder course (for non airfield areas), the gradation tolerances should follow those given in UFC 3-250-03, Table "Aggregate Gradations for Bituminous Concrete Pavements," for low-pressure tires. When the recycled mixture is to be used as a base course, an exact JMF aggregate gradation is not normally given and therefore tolerances are not required. The only requirement is that the gradation must stay within the gradation range specified.

****

Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screening, natural sand, and mineral filler, as required. The portion of materials retained on the 4.75 mm No. 4 sieve will be known as coarse aggregate, the portion passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve will be known as fine aggregate, and the portion passing the 0.075 mm No. 200 sieve will be known as mineral filler. The combined recycled aggregate gradation must conform to the gradation specified in TABLE I. TABLE I is based on aggregates of uniform specific gravity; the percentage passing various sieves may be changed by the Contracting Officer when aggregates of varying specific gravities are used. Adjustments of percentage passing various sieves may be changed by the Contracting Officer when the specific gravity of the aggregates varies by more than 0.2.

TABLE I. COMBINED RECYCLED AGGREGATE GRADATION

Sieve Size	Percent Passing
[_____]	[_____]

2.2.1 Coarse Aggregate

****

NOTE: The values of percentage of loss will be based on knowledge of aggregates in the area which have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years. Typically, RAP will come from existing pavement being repaved and aggregate from RAP will not be tested except for gradation. New aggregates will meet required properties described in this section. Cold mix layers will always be overlaid with hot mix layers or bituminous surface treatment.

****

New coarse aggregate will consist of clean, sound, durable particles meeting the following requirements.

a. Percentage of loss not exceeding 40 after 500 revolutions, as determined in accordance with ASTM C131/C131M.

b. Percentage of loss not exceeding [_____] after five cycles performed in accordance with ASTM C88, using magnesium sulfate.

c. Dry weight of crushed slag not less than 1200 kg/cubic m 75 pcf, as determined in accordance with ASTM C29/C29M.

d. Crushed gravel retained on the 4.75 mm No. 4 sieve and each coarser sieve containing at least 75 percent by weight of crushed pieces having one or more fractured faces with the area of each face equal to at least 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of fractures must be at least 30 degrees to count as two fractured faces.

e. Essentially cubical particle shape of crushed aggregates. Provide aggregate that contains no more than 20 percent by weight of flat and elongated particles in any sieve size when determined in accordance with ASTM D4791.

2.2.2 Fine Aggregate

Provide new fine aggregate consisting of clean, sound, durable particles including natural sand or crushed stone, slag, or gravel that meets requirements for wear and soundness specified for coarse aggregate. Fine aggregate produced by crushing gravel must have at least 90 percent by weight of crushed particles having two or more fractured faces in the portion larger than the 0.600 mm No. 30 sieve. This requirement applies to the material before blending with natural sand, when blending is necessary. Quantity of new natural sand to be added to the intermediate course mixtures must not exceed 25 percent by weight of new coarse and new fine aggregate and material passing the 0.075 mm No. 200 sieve. Provide natural sand that is clean and free from clay and organic matter. The percentage of loss must not exceed [_____] after five cycles of the soundness test performed in accordance with ASTM C88, using magnesium sulfate.

2.2.3 Mineral Filler

Use mineral filler conforming to ASTM D242/D242M. Determine grain size in accordance with AASHTO T 88.

2.3 ASPHALT EMULSION

****

NOTE: The material being recycled may contain sufficient asphalt binder to meet the specification requirements. In this case, only water will be added as a lubricant to improve compaction. When additional asphalt binder is needed grade SS-1 or CSS-1 should be specified in moderate or cold climates. Grade SS-1h or CSS-1h should be specified in hotter climates such as the southern or southwestern areas of the United States. Medium set, high float, or other types of emulsions may be used with open graded mixtures or in instances where previous experience with these types of emulsions has provided good results.

****

Asphalt, if required, must be an emulsified asphalt, Grade [_____] conforming to [ASTM D977] [ASTM D2397/D2397M].

2.4 WATER

Generally, any potable water will be acceptable for diluting the asphalt emulsion. Prior to construction, mix a sample of the water intended for use on the job with a sample of the emulsion at the ratio to be used in the project. If any adverse effect is observed on the emulsion, use a new source of water.

2.5 RECYCLING AGENT

****

NOTE: Depending on the material properties of the

existing asphalt cement binder and the type and method of recycling used, an appropriate type of recycling agent (rejuvenator) will be selected. An emulsified recyling agent should be selected according to ASTM D5505. The type of rejuvenator specified must match the recycling process used. The recycling agent selected should be capable of decreasing the viscosity of the reclaimed asphalt cement to levels that approach the viscosity values of asphalt cement in new asphalt concrete pavements for that area or region. Delete this paragraph if a recycling agent is not required.
****

Use [_____] recycling agent selected in accordance with ASTM D5505. Submit notification on sources from which aggregates, emulsified asphalt cement and recycling agent are to be obtained within 15 days after contract award.

2.6 JOB-MIX FORMULA (JMF)

****
NOTE: The mix design primarily establishes the amount of asphalt binder and recycling agent (if used) to be added to the mixture, and then establishes the amount of water to insure optimum compaction conditions. The optimum asphalt content (this includes the recycling agent, if used) is determined based on hot compacted samples because this produces the density that will ultimately be obtained in the field. Ideally, the water content should be selected to provide maximum density based on samples compacted at the mixture temperature (ambient air temperature) which will be encountered during construction.

Prior to bidding the contract, the designer may want to sample and obtain the material properties of the asphalt and aggregates in the existing pavement. This information is required to allow the development of a JMF and to allow for estimates of emulsified asphalt cement and/or recycling agent type and quantities required. The need for new aggregates to meet JMF requirements may also be determined. For lump sum bidding, a reasonable estimate of required quantities of materials will be needed.
****

Submit the JMF for the recycled mixture to the Contracting Officer for acceptance after the award of the contract and at least [30] [_____] days prior to placement of recycled mixture. Samples will be compacted using 50 blows with Marshall equipment or 50 gyrations with the Superpave gyratory compactor. Prior to compaction mixes will be heated to temperatures equivalent to hot mix asphalt and the mix will be designed to provide 3-4 percent air voids in the compacted mixture. Mixes will be compacted at expected construction temperature to determine optimum moisture content. No payment will be made for cold recycled mixtures produced prior to the completion and acceptance of the JMF. The formula will indicate the gradation of the aggregate and a definite percentage of water [,recycling agent] and asphalt emulsion to be added to the mixture.

2.6.1 Gradation Tolerances

****

NOTE: Eliminate the corresponding material size and tolerance values to agree with sieve sizes specified in Table 1. Eliminate these completely if no new aggregate is added and no specific JMF gradation is developed.

****

The tolerances allowed on the gradation are as follows:

Material	Tolerance, Plus or Minus
Aggregate passing the 4.75 mm No. 4 or larger sieve	4 percent
Aggregate passing the 2.36, 1.18, 0.6, and 0.3 mm Nos. 8, 16, 30, and 50 sieves	3 percent
Aggregate passing the 0.15 and 0.074 mm Nos. 100 and 200 sieves	1 percent

2.6.2 Asphalt Content

The JMF will be allowed an asphalt content tolerance of 0.3 percent. The asphalt content may be adjusted by the Contractor to improve paving mixture, without adjustment in contract unit price when approved by the Contracting Officer. Select the optimum asphalt content to provide the tabulated properties when samples are compacted at 120 degrees C 250 degrees F using 50 blows of the Marshall hammer or 50 gyrations with the Superpave gyratory compactor.

Property		Requirement (50 blows)
Voids in total mix, percent		3-5
Voids filled with bitumen, percent		75-85

2.6.3 Water Content

Select the water content to provide maximum dry density when samples are prepared at the optimum asphalt content and compacted with 50 blows/gyrations at ambient temperature. When no asphalt binder is added to the mixture, select the water content to provide maximum dry density. Prepare samples with water contents, in 0.5 percent intervals, from 0 to 2.5 percent (water content may be increased to achieve maximum density). After compaction, place the samples in an oven at 60 degrees C 140 degrees F for 96 hours. After cooling to ambient temperature, determine the dry density according to ASTM D2726/D2726M. Select the optimum moisture content as the moisture content that provides maximum density.

PART 3 EXECUTION

3.1 CONDITION OF EXISTING SURFACE

Correct areas in the existing pavement that provide indications of underlying structural deficiencies (alligator cracking or depressions) prior to the completion of the recycling process.

3.2 CONSTRUCTION METHODS

****

NOTE: Depending on the type of recycling desired the following paragraphs should be edited to remove the undesired method. The following can remain in its entirety when the type of construction used is to be a Contractor's option.

****

Use only RAP materialthat meets the requirements given in paragraph RECLAIMED ASPHALT PAVEMENT prior to mixing.

3.2.1 Central Plant Mixing

Introduce the required amount of bituminous material for each batch, or calibrated amount of continuous mixing, into the mixer to meet the requirements of the JMF. Mix the material in a manner that provides a uniform dispersion of the emulsified asphalt, recycling agent if used, and water and achieves a thorough coating (visually) of all aggregate particles. If this process requires excessive mixing, resulting in premature breaking of the emulsified asphalt, shorten the mixing times as approved by the Contracting Officer. Use a mixing process that thoroughly coats all particles.

3.2.2 Test Section

****

NOTE: Use of a test section is recommended for all recycled mixtures, especially for central-plant mix recycling. The following paragraph is written for placing central-plant mix with a paver and must be edited when another type of recycling is used.

****

Prior to the start of the recycling project, prepare a sufficient quantity of mixture to construct a test section at least 15 meters 50 feet long, two spreader widths wide and of thickness to be used in the project. Place, spread, and roll the mixture with the equipment to be used in the project and in accordance with requirements specified above. This test section will be tested and evaluated as a lot conforming to all specification requirements. If approved by the Contracting Officer, the test section may be located in one of the less critical areas of the project. Otherwise, it will be located outside the project area. If tests results are satisfactory, the test section will remain in place as part of the completed pavement if constructed in the project pavement area. If tests indicate that the pavement does not conform to specification requirements, remove the test section and dispose of the material offsite. Make necessary adjustments to the plant and placing operations and rolling procedures immediately, and construct another test section, all at no additional cost to the Government. Construct additional test sections, as necessary and as directed. Sample and test additional test sections for conformance with specification requirements. In no case will full production of the recycled mixture begin without approval of the Contracting Officer.

3.2.3 In-Place-Mixing

****

NOTE: In-place recycling can be divided into either partial- or full-depth recycling. Partial-depth recycling involves only a portion of the asphalt bound layers and normally involves recycling to a depth of 50 to 100 mm 2 to 4 inches. Full-depth recycling involves all asphalt bound layers and often portions of the underlying base course layer.

****

Produce a uniform blend of the RAP, new aggregate (when required), asphalt emulsion, recycling agent, water, and a mixture containing the required amounts of emulsified asphalt and water as given in the JMF when using the in-place recycling process.

3.3 PLACEMENT

3.3.1 Spreaders

Provide spreading equipment capable of spreading material uniformly; and resulting in a surface that meets the grade and smoothness requirements when compacted. Unless otherwise directed, begin spreading along the centerline of areas paved on a crowned section, or on the high side of areas with a one-way slope, in the direction of major traffic flow. Spray contact surfaces of previously constructed pavement, curbs, manholes, and other structures with a thin coat of bituminous material conforming to Section 32 12 13 BITUMINOUS TACK AND PRIME COATS. Place the recycled mixture without segregation.When segregation occurs during placement, suspend the spreading operation until the cause is determined and corrected. When placing by hand, dump and distribute the mixture into place and spread with lutes in a uniformly loose layer of such thickness to conform to the required grade and thickness when compacted. During hand spreading, carefully place each shovelful of mixture by dropping the material in place by turning the shovel over in a manner to prevent segregation. Do not place the mixture by throwing or broadcasting.

3.3.2 Placement with a Paver

Place the recycled asphalt mixture with a self-propelled asphalt paver or similar equipment containing a vibrating or tamping screed. Operate the paver so that the course being laid will be smooth and continuous without pulling or tearing.

3.3.3 Layer Thickness and Curing

****

NOTE: The minimum layer thickness allowed should be at least twice the size of the maximum aggregate particle of the RAP or aggregate. The maximum layer thickness may vary from 100 to 150 mm 4 to 6 inches. However, it is typically recommended to not exceed

100 mm 4 inch layer unless there is a good reason to use a thicker layer. Constructing layers thicker than 100 mm 4 inches makes it more difficult to compact, more difficult to control smoothness, and more time to cure. The curing period should range from 7 to 14 days, depending on climatic conditions. The hotter and drier the weather, the shorter the curing period. Generally, the cure period should be about 2 days for each 25 mm 1 inch of lift thickness. The water content of the recycled mixture should be below 1.5 percent prior to placing additional layers or a wearing surface.
****

Construct each layer of compacted mixture at least [_____] mm inches but no more than [_____] mm inches in thickness. Allow each layer of recycled mixture to cure for [_____] days before placing a succeeding layer, unless a shorter curing period is approved in writing by the Contracting Officer.

3.3.4 Windrows

When windrows are used, construct them of such size and shape to allow adequate mixing of materials without segregation, ensuring that the required thickness of pavement can be constructed.

3.4 COMPACTION OF MIXTURE

Conduct compaction of the mixture to satisfy density, grade, and smoothness requirements. Roll bituminous mixtures until all roller marks are eliminated, and a field density of at least 88 percent of the theoretical maximum density has been obtained when tested in accordance with ASTM D2041/D2041M.

3.4.1 Operation of Rollers and Tampers

Provide the sufficient number, weight, and type of rollers to obtain the required density. Begin initial rolling of the recycled mixture as the emulsion is starting to break. Vibratory rolling will be allowed to achieve required density. Use finish rolling with a steel-wheel roller to remove any existing roller marks.

3.4.2 Correcting Deficient Areas

Remove mixture that becomes contaminated with foreign material, or is defective in any way, to the full thickness of the course. Cut the hole with sides vertical and perpendicular to each other, with one side parallel to the direction of traffic. Do not skin patch rolled areas to correct low areas and do not be mill rolled areas to correct high areas. Place fresh paving mixture in holes in sufficient quantity to produce a finished surface conforming to grade and smoothness requirements. Aerate paving mixture, if necessary, and compact to the density specified herein. Provide competent workmen capable of performing all work incidental to the correction of deficiencies and defects.

3.5 JOINTS

Provide joints of the same texture, density, and smoothness as other sections of the course. Carefully make joints between old and new pavements or between successive days' work to ensure continuous bond between old and new sections of the course.

3.5.1 Transverse Joints

Pass the roller over the unprotected end of freshly laid mixture only when laying of the course has been discontinued. Cut back the edge of the previously laid course to expose even, vertical surface for the full thickness of the course. Rake the fresh mixture against the joints, thoroughly tamp, and then roll.

3.5.2 Longitudinal Joints

Construct longitudinal joints which are uniform, and without mixture segregation. When directed by the Contracting Officer, cut back the longitudinal joint to expose an even, vertical surface for the full thickness of the course.

3.6 EDGES OF PAVEMENT

Make edges of pavement straight and true to required lines. After final rolling, cut off and square excess material and dispose of as directed.

3.7 TRAFFICKING

Trafficking on newly placed cold recycled mixtures will not be allowed prior to completion of compaction and the curing period.

3.8 ACCEPTABILITY OF WORK

3.8.1 Testing

Perform field tests in sufficient numbers to ensure that the specifications are being met. Submit copies of test results within 24 hours of completion of tests. Submit copies of test reports for aggregate source, not less than [30] [_____] days before the material is required in the work. Certified copies of the emulsified asphalt cement and/or recycling agent manufacturer's test reports indicating compliance with applicable specified requirements, will be placed not less than [30] [_____] days before material is required in the work. Testing is the Contractor's responsibility and performed by an approved commercial laboratory. Perform the following tests at the appropriate time, as the minimum acceptable for each type of operation.

3.8.1.1 Mixture Properties

****

NOTE: The mixture should normally be sampled and tested twice a day or for every 4 hours of production or placement.

****

Obtain a sample of the recycled mixture for every [_____] hours of placement of the mix. Determine the asphalt content of the mix according to ASTM D2172/D2172M or ASTM D6307. Provide asphalt content of the recycled material within the tolerance given in paragraph JOB-MIX FORMULA. Determine the gradation of the extracted aggregate in accordance with ASTM C117 and ASTM C136/C136M. Provide extracted gradation meeting the JMF and the corresponding tolerances.

3.8.1.2 Density Testing

****

NOTE: The frequency of testing for the maximum theoretical density (ASTM D2041/D2041M) should be tied to the frequency of the field nuclear test readings. Depending on the anticipated construction methods used, a nuclear density test should be performed about every 500 square meters yards of recycled mixture placed. Generally, one ASTM D2041/D2041M test should be conducted for every 4 nuclear tests and four ASTM D2041/D2041M tests should be performed for each full day of production.

****

Conduct field density tests in accordance with ASTM D6938 or ASTM D1556/D1556M. When ASTM D6938 is used, perform testing by the direct transmission method. Accomplish the calibration of the nuclear test device by testing in accordance with ASTM D1556/D1556M as described in paragraph "Calibration" of ASTM D6938. Tests performed in accordance with ASTM D6938 result in a wet unit weight of material. Determine the moisture content of the recycled mixture by ASTM D2216, ASTM D4643, ASTM D4944, or ASTM D4959. Perform calibration testing in an area representative of the entire project in regards to materials and compactive effort. Perform a minimum of three of these tests and take at least three nuclear readings near each of these areas. Calibrate each nuclear device accordingly. Each day recalibrate the used nuclear devices in the manner stated above or the selected area preserved and the devices calibrated in the same approximate locations each day. Express the field density as a percentage of the maximum theoretical density in accordance with ASTM D2041/D2041M. Furnish all tools, labor, and materials for obtaining samples and refilling sample locations. Perform a minimum of one nuclear field density test for every [_____] [metric tons tons] [square meters yards] of mixture placed.

3.8.1.3 Grade Conformance

****

NOTE: For cold-recycled mixtures used only as a base course in aircraft traffic areas, such as airfield runways and taxiways, intervals between grade-conformance tests should not exceed 8 m 25 feet. This should be the procedure for wide non airfield pavement such as parking lots. For roads, the intervals between grade-conformance tests should not exceed 8 m 25 feet longitudinally and should be at transverse intervals as appropriate.

****

Take measurements for deviation from grade by running lines of levels at intervals of [_____] meters feet longitudinally and [_____] meters feet transversely to determine the elevation of the completed pavement. Provide finished and completed surface conforming within 15 mm 0.05 foot to lines, grades, cross section, and dimensions shown on the drawings.

3.8.1.4 Surface Smoothness

Take measurements for deviation from surface smoothness with a 3.66 meter 12 foot straightedge. Do not deviate more than 10 mm 3/8 inch from the testing edge of the straightedge in the transverse or longitudinal direction. Place the straightedge parallel to the centerline of each lane paved at intervals of [_____] meters feet and perpendicular to the centerline at intervals of [_____] meters feet. Record the locations and deviations from the straightedge of all measurements. Remove defective areas and replace them with fresh paving mixture at no additional cost to the Government.

3.8.2 Material Samples

Obtain a sample of all materials used in the recycled mixture under the supervision of the Contracting Officer. The sample will be retained by the Government.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 01 16.71 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 16.17 (February 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 16.71

COLD MILLING ASPHALT PAVING

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USACE / NAVFAC / AFCEC **UFGS-32 01 16.71 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 16.17 (February 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 32 01 16.71

COLD MILLING ASPHALT PAVING
11/22

****
NOTE: This guide specification covers the requirements for cold milling of bituminous pavement for airfields, roads, streets, parking areas, and other general applications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This guide specification can be used to specify cold milling alone on structurally sound pavements for surface texturing to increase skid resistance of a worn pavement, or for pavement removal to restore roadway and airfield geometry. Cold milling can also be used in conjunction with mill and overlay operations.

Consider the overall weight of the milling equipment to ensure there is not damage to the existing pavements and pavement remaining after milling.

Consider limits of milling to ensure sufficient material is left to minimize the potential for delamination or the entire layer may require removal. In certain cases, full depth reclamation may be more valuable than cold milling.

Evaluate the existing pavement section by taking pavement cores to determine appropriate milling depth. Delamination potential exists anytime cold milling depth is approximately equal to the layer placed. If base course is not to be disturbed, leave a layer of bituminous pavement, 25 mm 1-inch thick, over the undisturbed base course.

On the project drawings, show:

1. Location and extent of milling operation.

2. Required elevation of finish surface of new pavement. Provide spot elevations on a maximum 7.5 meter 25 foot by 7.5 meter 25 foot grid.

3. Section indicating in mm inches the depth that existing pavement has to be removed.

4. Location, size and elevation of existing manholes, valve boxes, utility lines or other structures penetrating the pavement..

****

1.1 Payment

****

NOTE: For unit-price Contracts, include first bracketed statements and delete the second set. For lump sum Contracts, delete the first bracketed statements and include the second set. Additional CLIN is required on the bid schedule if unit price is utilized.

It is recommended on lump sum Contracts to include additional unit price CLINs to address scabbing/delamination of asphalt pavements. In this scenario, use an appropriate quantity for the size of the project, additional depth of milling (minimum of 25.4 mm 1 inch), and and square meter yard as the unit.

****

1.1.1 Measurement

[The quantity of milled pavement measured will be paid for at the contract unit price when completed and accepted by the Contracting Officer. Payment will be made at the contract unit price for the nearest square meter yard for the scheduled item at the proposed depth displayed in the Contract. Measure the width of the area to the closest mm inch and measure the length of the area to the closest meter foot. Payment will constitute full compensation for providing all equipment, labor, tools, and other incidentals necessary to complete the milling operation. Unless otherwise stated, unit price will also include cost for clean-up and disposal operations as per paragraph REMOVAL OF MILLED MATERIAL. No payment will be made for milling outside the specified area of work.][The measured quantity of asphalt milling, including cost for clean-up and disposal, will be paid for and included in the lump sum Contract price.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 247	(2013) Standard Specification for Glass Beads Used in Pavement Markings

ASTM INTERNATIONAL (ASTM)

ASTM E965	(2015; R 2019) Standard Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique

1.3 DEFINITIONS

1.3.1 Scabbing/Delamination

Scabbing or delamination is defined as the debonding or raveling of material which may be caused by either the condition of the existing underlying layers of asphalt mixture or the milling operation.

1.3.2 Milling Machine

Milling machines may also be known as pavement cold planers. Throughout this specification, any references to milling machines will also apply to pavement cold planers.

1.3.3 Milling Drum

Milling drums are upward-rotating drums or rotors which are outfitted with toolholders and teeth (picks). Milling drums perform different tasks dependent on the structure and design. The main tasks are cutting particles from the composite pavement, conveying removed material to the ejector, and ejecting removed material. Any reference to milling drum also applies to milling rotors.

1.4 TRAFFIC CONTROL

Provide all necessary traffic control during milling operations.

1.5 SCHEDULING

After completion of the preconstruction submittals, provide notice to the Contracting Officer a minimum of seven days prior to starting milling operations.

1.6 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Equipment; G, [_____]

Proposed Techniques; G, [_____]

Quality Control Plan; G, [_____]

Qualifications; G, [_____]

SD-06 Test Reports

QC Monitoring

Grade-Conformance Tests; G, [_____]

Test Section Results; G, [_____]

Macrosurface Texture Acceptance; G, [_____]

1.7 QUALITY CONTROL

1.7.1 Qualifications

****

NOTE: Use below paragraph when profile milling (e.g. milling to specified plan grade) or performance milling (e.g. using fine or mirco-milling drum) is being specified. Otherwise, delete this paragraph.

****

Provide documentation of at least five successful projects utilzing [profile] [and] [performance] milling. Documentation will include project references, equipment used (including scanning/sensing equipment), and company personnel associated with the project. Project documentation will also include if any equipment was owned or rented in the execution of the project.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

Do not perform milling when there is accumulation of snow or ice on the pavement surface.

PART 2 PRODUCTS

2.1 EQUIPMENT

Maintain in a satisfactory working condition equipment, tools, and machines used in the performance of this work.

2.1.1 Cold Milling Machine

****
NOTE: Analyze the project layout and constraints. Specify the appropriate cutting width for the project.

Milling machines range from cutting widths less than 61 cm 2 feet up-to 4.4 meters 14.5 feet. Typical milling machines have cutting widths around 2 meters 6.5 feet. When specifying milling machine cutting widths, ensure milling drums are manufactured in the specified width for the intended purpose.
****

Use a self-propelled unit capable of removing the existing asphalt pavement to the depths and widths shown in the Contract. Milling machines will have a minimum cutting width of [2 meters][6.5 feet]. Use milling machines designed and built exclusively for pavement milling operations and with sufficient power, traction and stability to accurately maintain depth of cut and slope. The equipment will be capable of operating the machine speed independently from the cutting equipment speed. Use milling machines capable of being equipped with dual longitudinal controls (operated from both sides of the machine). Use electronic control systems that will automatically control the longitudinal profile and cross slope of the milled surface. Accomplish this through the use of a mobile grade reference, an erected string line, joint matching shoe, slope control systems, or a combination of approved methods. When using a mobile grade reference, use systems capable of averaging the existing grade or pavement profile over at least 9 meters 30 foot. Use a machine capable of leaving a uniform surface suitable for handling traffic without damage to the underlying pavement structure. Provide additional equipment necessary to satisfactorily remove the pavement in the area of manholes, water valves, curb, gutter and other obstructions. Provide milling machines with a means of effectively limiting the amount of dust escaping from the removal operations. If milling operations result in excessive fugitive dust, a silica dust suppressant is required at no additional cost to the Government. Milling equipment is not allowed to damage any part of the pavement structure that is not to be removed. Equip the milling machine with a lighting system for night work as required by the Contract. Smaller width milling machines may be necessary for use around structures or other penetrations. Produce the same surface texture with small milling machines as with the large milling machines.

2.1.2 Milling Drums

****
NOTE: Select the appropriate milling drum for the intended use. Delete the others.

The texture of the milled surface is impacted by the bit spacing, which is the distance between one cutting bit to the next. If unsure, select the standard milling drum.

For rigid pavement milling, complete removal of flexible pavement, or removing surface and binder courses, select the "Rough/Coarse" or "Standard" milling drum.

Where correction of an existing surface is required, or when milling for replacement with a thin lift (e.g. bonded wearing course), a fine or micro milling drum offers a smoother milled surface by reducing the line spacing and making it easier to produce shallower peak-to-valley depths. Fine or micro-milling is sometimes required by surface treatment manufacturers. Typically fine and micro milling drums are utilized only for partial or full wearing/surface courses of asphalt. Fine and micro-milling drums are limited in milling depth and should be only selected when appropriate. Select the fine or micro-milling tailoring option as appropriate and edit the desired drum based upon the tool spacing.

****

[2.1.2.1 Rough/Coarse Milling Drum

Provide a Rough/Coarse milling drum having a tool spacing between 18 mm - 25 mm 11/16 inch - 1 inch.]

[2.1.2.2 Standard Milling Drum

Provide a standard milling drum having a tool spacing between 12 - 18 mm 1/2 - 3/4 inch.]

[2.1.2.3 Fine Milling Drum

Provide a fine milling drum having a tool spacing between 8 - 10 mm 5/16 - 3/8 inch.]

[2.1.2.4 Micro Milling Drum

Provide a micro milling drum having a tool spacing between 3 - 6 mm 1/8 - 1/4 inch.]

2.1.3 Sensors and Scanning Components

****

NOTE: Available sensors and scanning components consist of sonic, laser and 3-D systems.

It is recommended for projects with asphalt pavement grade or smoothness requirements to utilize a laser or 3-D sensor. When new surface grades or contours are required, laser or 3-D sensors will most likely be used. It is recommended that a 3-D model be available to supply to the Contractor to adjust and input into the milling machine interface. Additional text may be added for when 3-D or laser sensors are required. Excercise caution on the verbiage added as intent is to keep specification performance driven.

****

Provide sensors and scanners as necessary to produce the grade and smoothness as specified. Submit all sensors and scanning components for Government approval. [_____]

2.1.4 Cleaning Equipment

Provide cleaning equipment suitable for removing and cleaning loose material from the pavement surface. If using street sweeper type equipment, equip the street sweeper with a water tank, dust control spray assembly, both a pick-up and gutter broom, and a debris hopper.

2.1.5 Straightedge

Furnish and maintain at the site, in good condition, at least one 4 meter 12 foot straightedge for each milling machine, for testing the finished surface. Make the straightedge available for Government use. Use straightedges constructed of aluminum or other lightweight metal, with blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Use straightedges with handles to facilitate movement on the milled surface.

PART 3 EXECUTION

3.1 CONTRACTOR QUALITY CONTROL

3.1.1 General Quality Control Requirements

****

NOTE: Based upon anticipated project duration, edit the text within brackets with an appropriate timeline for adequate review prior to milling operations.

****

Submit the Quality Control Plan a minimum of [30] days in advance of starting milling operations. The Quality Control Plan is specific to this specification and supplements the overall Quality Control Plan required by the project. Do not start milling operations until the Quality Control Plan has been approved. In the Quality Control Plan, address all elements which affect the quality of the milling operation including, but not limited to:

a. Type of cutting teeth and schedule for replacement.

b. The daily preventative maintenance schedule and checklist.

c. The proposed use of grade and slope controls (longitudinal and transverse).

d. The frequency of smoothness testing.

e. The process for milling distressed areas (scabbing/delamination).

f. Corrective procedures if the milling operation does not meet the specified texture or grade requirements.

g. Corrective procedures if the milled surface does not meet the specified minimum transverse or longitudinal smoothness when measured with a 4 meter 12 foot straightedge.

h. The frequency of macrotexture testing.

3.2 PROPOSED TECHNIQUES

Submit the proposed techniques a minimum of [30] days in advance of starting milling operations. The proposed techniques will be project specific and address the following items:

a. The number, type(s) and size(s) of milling machines to be used.

b. The width and location of each cutting pass.

c. The number and types of brooms to be used with their location with respect to milling machines.

d. The proposed method for milling around existing structures such as manholes, valve boxes, and inlets.

e. The longitudinal and transverse typical sections for tie-ins at the end of the work day.

3.3 MILLING OPERATION

****

When the milled material (millings) is to be cold recycled, the maximum size of the millings should be equal to or less than one-half of the recycled pavement thickness. Generally, the maximum size for a single 100 mm 4 inch lift of pavement will be 50 mm 2 inches or less. For central-plant hot recycling the recommended maximum size of the milled material is 50 mm 2 inches.

****

Make sufficient passes so that the designated area is milled to the profile, cross-slope, grade and elevations as indicated. Mill the pavement in depth increments that will not damage the pavement below the designated finished grade. If scabbing or delamination occurs, the milled surface is unlikely to meet smoothness requirements. Notify the Contracting Officer for further direction when delamination or scabbing occurs. Repair or replace items damaged during milling operations such as manholes, valve boxes, utility lines, pavement that is torn, cracked, gouged, broken, or undercut, at no additional cost to the Government. [Windrow the milled material.] Remove the milled material from the pavement and load into trucks.

3.3.1 Milling Machine and Drum Speed

Operate the milling machine and drum speed at appropriate speeds required to produce a uniform and acceptable surface texture per paragraph ACCEPTABLE SURFACE TEXTURE.

3.4 TEST SECTION

****

NOTE: For length of test section, analyze project limits and make adjustments as necessary in the empty bracketed text. Otherwise use default length. When milling on active roadways, select one milling lane wide. When the entire roadway is closed or on

airfields, select two milling lanes wide.

Only include item d. when plan grade spot elevations are provided in design.

Ensure list of alpha-characters are in sequencial order after editing bracketed text.

****

The test section will be considered the first half-day of milling production. The test section will be a minimum of [300] meters [1,000] feet [_____] long and [one][two] milling lanes wide. Evaluate the milled surface texture[, grade,] and smoothness as part of the test section. Make any changes necessary, including the speed of the milling machine, to produce the desired milled surface texture and smoothness. Any adjustments in grade should be approved by the Contracting Officer. Perform macrosurface texture acceptance testing at two random locations no closer than 150 m 500 feet. At a minimum, provide the following in the Test Section Results:

a. Overall visual appearance of the milled surface texture noting any scabbing or delamination concerns. Provide five or more photos of the cleaned surface texture with a scale showing the line spacing.

b. Speed of milling machine and drum (rpm).

c. Approximate station and offset of straightedge testing and measurements.

[d. Interpolated grade of milled surface reported as a comparison from the spot elevations provided in the Contract.]

e. Macrosurface mean texture depth results.

[3.5 MILLING TO PLAN GRADE

****

NOTE: Delete paragraphs relating to Grade when Contractor is not required to mill to grade. Select 15 m 50 feet for roadway and 7.5 m 25 feet for airfields.

****

3.5.1 Grade Reference

If string-line is utilized as a grade reference, place grade reference points at maximum intervals of [7.5] m [25] feet. Use reliable control points to set the grade reference. Support the grade reference so the maximum deflection does not exceed 1.5 mm 1/16 inch between supports. If utilzing a surface model, ensure the model is reviewed and accepted by the Government prior to execution of the work.

3.5.2 Grade

Mill pavement such that the finished milled surface conforms to the lines, grades, and cross sections indicated in the contract. The maximum allowable deviation of the finished milled pavement surfaces from the established plan grade line and elevation is plus 0 mm inch minus 6 mm 1/4 inch.

3.5.3 Grade-Conformance Tests

****

NOTE: For airfield pavements, lines of levels are required to determine elevation of the milled pavement. Lines of levels will be run longitudinally and transversely at intervals not exceeding 7.5 meters 25 feet.

For all other pavements, select appropriate interval for grade conformance verification.

****

After clean-up, test the finished milled surface of the pavement for conformance with the plan-grade requirements and for acceptance by the Contracting Officer by running lines of levels at maximum intervals of [7.5] m [25] feet longitudinally and [7.5] m [25] feet transversely to determine the elevation of the completed milled surface. Correct variations from the designated grade line and elevation in excess of the plan-grade requirements as directed. Skin patching for correcting low areas will not be permitted. If it is determined that Contractor operations resulted in deficient low areas, remove and replace area with a minimum 25 mm 1 inch of asphalt leveling course as approved by the Government.]

3.6 SURFACE SMOOTHNESS

3.6.1 Straightedge Testing

After completion of the final milling and clean-up, test the finished milled surface with the straightedge. Correct surface irregularities that depart from the testing edge by more than 6 mm 1/4 inch. Straightedge testing will be performed continuously throughout production as a Quality Control check for the milled surface on a frequency longitudinally and transversely as approved in the Quality Control Plan. Skin patching for correcting low areas will not be permitted. If it is determined that Contractor operations resulted in deficient low areas, remove and replace area with a minimum 25 mm 1 inch of asphalt leveling course as approved by the Government. Report approximate station and individual measurements taken and submit QC Monitoring to the Contracting Officer on a daily basis.

3.7 ACCEPTABLE SURFACE TEXTURE

Produce a milled surface texture with continuous, longitudinal milling striations with no gaps in the longitudinal striations. Gaps in the milling striations and cases where gaps create a diagonal pattern or chevron appearance are required to be milled again such that continuous, longitudinal striations are achieved.

3.7.1 Macrosurface Texture Acceptance

****

NOTE: Edit the bracketed text that corresponds with the milling surface intended. The below acceptance test will determine the macrotexture of the pavement surface prior to an overlay or surface treatment.

Use below information to fill in bracketed text or research any state DOT standard for acceptable alternatives.

Fine Milling: 228 mm 9 inch
Micro Milling: 300 mm 12 inch
****

Conduct macrosurface texture acceptance testing in accordance with ASTM E965 to determine the average macrotexture circular diameter for the day's production. Provide four randomly selected locations from each day's production which are randomly selected using ASTM D3995. Change location of test area by moving upstation 3 m 10 feet if any test area has unique, localized features such as cracks or joints. Provide a minimum circle diameter of [_____] when tested in accordance with ASTM E965 with the following revisions:

a. Use 200 ml12 $inch^3$ of material (glass spheres) meeting AASHTO M 247.

b. Use a flat, stiff hard disk made from methyl methacrylate (plexiglass) with a thickness of 12 mm plus or minus 2.5 mm 0.5 inch plus or minus 0.1 inch, diameter of 203 mm plus or minus 50 mm 8 inches plus or mins 2 inches.

c. Measure and record the diameter of the circular area four times, at intervals of 45 degrees and to the nearest 5 mm 0.25 inch. Measure the diameter of the circular area from the extent of the glass beads on one side, through the center, and to the extent of the glass beads on the other side of the circular area. Report the average diameter of the circle for acceptance using the following equation:

$$D_a = (D_1 + D_2 + D_3 + D_4)/4$$

If surface texture does not meet the minimum circle diameter specified, evaluate the cause and provide adjustment procedures detailing methods to the Government to meet specified macrosurface texture.

3.8 TRAFFIC ON MILLED SURFACE

****
NOTE: Delete this paragraph and subparagraph when traffic is not expected to be allowed on the milled surface. If milled surface is anticipated to be exposed to traffic, review the state DOT or agency requirements for longitudinal and transverse joints. At a minimum analyze project geometrics and speed limit and fill in bracketed text for taper distance. If unknown, use 5 m 15 feet.
****

Mill the entire pavement width to a flush surface at the end of each work day when the pavement is open to traffic. If uncompleted operations result in a vertical or near vertical longitudinal face, re-slope the longitudinal face to provide a taper, construct a temporary bituminous taper or provide protective measures, as approved by the Contracting Officer. Taper transverse cutting faces at the end of each work day where pavement is open to traffic. Taper transverse edges to a minimum 10:1 taper. Provide taper over a distance of [_____]metersfeet. Construct temporary bituminous tapers (paper joint) at intersecting streets, around utility appurtenances, and drainage structures during the milling operation. Maintain adequate drainage on the milled surface.

3.8.1 Taper Material

Use the same quality of asphalt mixture used elsewhere on the project or as detailed in the Contract.

3.9 CLEAN-UP OPERATIONS

After milling to the depth shown in the Contract, sweep or vacuum clean the milled area with the approved equipment.

3.10 REMOVAL OF MILLED MATERIAL

****

NOTE: Select the appropriate bracketed text below and delete others. If using Cold In-Place Recycling (CIR) techniques coordinate this section with Section 32 01 16.70 Cold-Mix Reused Asphalt Paving.

****

[Place material that is removed [in the disposal area as specified] [into traveling mixing plant for cold-mix recycling].] [Transport material that is removed to central plant for hot-mix or cold-mix recycling.] [Stockpile material that is removed as specified and in such a manner to prevent segregation or contamination. Dress the reclaimed asphalt area to drain rainwater from the material.] [Material that is removed will become the property of the Contractor and removed from the site.]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 01 16.74 (May 2018)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 24 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 16.74

IN PLACE HOT REUSED ASPHALT PAVING

05/18

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-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-32 01 16.74 (May 2018)**

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References are in agreement with UMRL dated January 2025
****

SECTION 32 01 16.74

IN PLACE HOT REUSED ASPHALT PAVING
05/18

****
NOTE: This guide specification covers the requirements for the hot in-place recycling of existing bituminous pavement using either single- or multiple-pass methods.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: Experience and data indicate that scarifying is feasible only on existing asphalt pavements that are structurally sound but in need of surface leveling or exhibit superficial distresses. In the single-pass method, new asphalt mixture is placed over the recycled asphalt at the time of construction. When using a multiple-pass in-place recycling process, apply an asphalt overlay or surface treatment to the recycled pavement after construction of the in-place recycled mixture. Hot in-place recycling is a good method for roads in poor surface condition, but approval of the responsible government agency's member on the

Pavements Discipline Working Group is required for use on airfields.

****

1.1 UNIT PRICES

****

NOTE: When other methods of measurement are desired or are necessary, this paragraph will be modified accordingly. Delete paragraph NEW ASPHALT MIXTURE when new asphalt is not added to the mixture. The term "recycling agent" is used in this section to mean any product used to decrease the viscosity of old asphalt binders as specified in ASTM D4552.

****

1.1.1 Measurement

1.1.1.1 In-Place Recycled Mixture

The quantity of hot in-place recycled mixture paid for will be the number of square meters yards completed and accepted as determined by the Contracting Officer. The number of square meters yards of planed pavement will be determined by measuring the length and width of the specified work area. Recycling agent will be paid for by the number of liters gallons of material used in the accepted work.

1.1.1.2 New Asphalt Mixture

New asphalt mixture will be paid for by the number of metric tons short tons of material used in accepted work.

1.1.2 Payment

The quantities of recycled asphalt mixture, new asphalt mixture, and recycling agent as determined in paragraph IN-PLACE RECYCLED MIXTURE and paragraph NEW ASPHALT MIXTURE, will be paid for at contract unit prices per square meter yard for recycled mixture [and per metric ton short ton for new asphalt mixture] and per liter gallon for recycling agent. If deficiencies in the finished product exceed specified tolerances, no payment will be made for such areas of pavement until the defective areas are corrected and accepted by the Contracting Officer.

1.2 REFERENCES

****

NOTE: Paragraph REFERENCES is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in paragraph REFERENCES by organization, designation, date, and title.

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2170/D2170M	(2018) Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)
ASTM D2171/D2171M	(2018) Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D4552/D4552M	(2010; R 2016; E 2016) Standard Practice for Classifying Hot-Mix Recycling Agents
ASTM D5404/D5404M	(2012; R 2017) Standard Practice for Recovery of Asphalt from Solution Using the Rotary Evaporator
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder

ASTM D6925	(2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
ASTM D6926	(2020) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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****

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SD-03 Product Data

Job-Mix Formula; G, [_____]

SD-04 Samples

Samples

SD-06 Test Reports

Field Testing and Sampling

1.4 EQUIPMENT, TOOLS, AND MACHINES

Maintain equipment, tools, and machines used in the performance of the work in a satisfactory working condition at all times, and in conformance with applicable governing regulations for local air pollution controls. Provide equipment capable of performing recycling operations at a minimum rate of 600 square meters 720 square yards per hour to the depth required.

1.4.1 Heating Units

Provide heating units that use radiant heat with no flame directly on the pavement. Provide combustion chamber(s) that is(are) insulated and totally enclosed. Shield the heating units with an enclosed hood to hold in the heat and to protect workers and surrounding areas.

1.4.2 Scarifying/Milling Equipment

****

NOTE: The depth of scarification is approximately 25 mm 1 inch unless otherwise stated for a specific project. Never scarify deeper than 50 mm 2 inches. Do no scarify to a depth within 25 mm 1 inch of the underlying base course.

****

Provide scarifying or hot milling equipment that is able to penetrate the pavement surface and cut to the depth as shown on the plans, without fracturing the aggregate in the pavement. When used for this purpose, the scarifiers or hot milling heads have to be able to mix the recycled mixture with any material that is added as part of the recycling process. Provide equipment with height adjustments to clear obstacles in the pavement.

1.4.3 Distribution and Mixing Equipment

Provide at least one unit of the recycling equipment capable of uniformly distributing and thoroughly mixing the recycling agent [and new asphalt mixture] with the recycled material. The distribution system(s) of the added material is(are) required to have a positive feed and shut-off linked to the movement of the unit.

1.4.4 Vibratory Screed

****

NOTE: Cross slope and grade can be adjusted when additional asphalt materials are added to the mixture. When only the recycling agent is added to the mixture, there is little opportunity to adjust the existing slope and grade.

****

Provide a unit with a vibratory screed capable of spreading, leveling, and finishing the recycled mixture uniformly across the processed width.

1.4.5 Straightedge

Provide and maintain at the site, in good condition, one 3.66 meter 12 foot straightedge for each finishing unit (paver) for testing the finished surface. Make straightedges available for Government use. Straightedges have to be constructed of aluminum or other lightweight metal, with blades of box or box-girder cross section with flat bottom, reinforced to insure rigidity and accuracy, and with handles to facilitate movement on the pavement.

1.5 QUALITY CONTROL

****

NOTE: The amount of sampling and testing required depends upon the type of hot in-place recycling performed. Processes that do not add additional asphalt mixture only require testing for the amount of recycling agent added to the mixture. Processes that add additional asphalt material require gradation, asphalt content, and mixture volumetric testing.

****

1.5.1 Initial Sampling and Testing

Perform sampling and testing using a commercial testing laboratory or Contractor's facilities, upon approval by the Contracting Officer. Do not perform any work that requires testing until the testing facilities have been inspected and approved. The first inspection of the testing facilities will be at the expense of the Government. Cost incurred by the Government, for any subsequent inspection required because of failure of the facilities to pass the first inspection, will be charged to the Contractor.

1.5.2 Samples

Take samples of existing asphalt pavement from at least two locations to the expected depth of milling for laboratory tests in accordance with ASTM D979/D979M. Take samples of existing aggregate stockpiles in accordance with ASTM D75/D75M. Take samples of asphalt cement in accordance with ASTM D140/D140M and take samples of recycling agent in accordance with ASTM D140/D140M. Use the samples of asphalt pavement to determine the job-mix formula (JMF).

1.6 ENVIRONMENTAL REQUIREMENTS

Perform hot in-place recycling procedures only when the existing pavement is dry and the pavement surface temperature is above 15 degrees C 60 degrees F.

PART 2 PRODUCTS

****

NOTE: Delete the inapplicable paragraphs. Develop a mix design or JMF containing the type and amount of new aggregates and asphalt cement for processes requiring additional new asphalt mixture. The material requirements for the new aggregates and

asphalt cement used to produce the new asphalt mixture have to be listed below. The requirements listed are as given in Section 32 12 15.13 HOT-MIX ASPHALT AIRFIELD PAVING or Section 32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL].
****

2.1 RECYCLING AGENTS

****
NOTE: Select the appropriate grade of recycling agent based upon the ability of the recycling agent to provide the desired asphalt binder properties in the designed mixture.
****

Provide and use a hot-mix recycling agent of the appropriate grade conforming to ASTM D4552/D4552M.

2.2 JOB-MIX FORMULA

****
NOTE: When additional asphalt mixture is added to the mixture, the Government will have to sample and provide information concerning the material properties (asphalt content and gradation) of the existing pavement to the bidding parties. Add an edited version of either Section 32 12 16.16 ROAD-MIX ASPHALT PAVING or Section 32 12 15.13 HOT-MIX ASPHALT AIRFIELD PAVING to the project specifications in order to provide the material and mixture properties required in the JMF. The grade of asphalt specified ought to be that which is specified by the State DOT for that location.
****

Furnish the JMF to the Contracting Officer for review at least 14 days prior to the start of recycling operations. Do not begin demolition or recycling operations until the mix design has been approved by the Contracting Officer.

a. No payment will be made for hot in-place recycled mixtures produced prior to the completion and acceptance of the JMF. Provide [the gradation of the aggregate] [and] [the percentage of [asphalt and] recycling agent to be added to the mixture] in the JMF submitted for approval. Also provide, with the JMF, the amount of [asphalt and] recycling agent given per square meter yard of recycled material.

****
NOTE: Specify 50 gyrations for pavements designed for low tire pressures (less than or equal to 690 kPa 100 psi). Specify 75 gyrations for pavements designed for high tire pressures (greater than 690 kPa 100 psi).
****

b. Develop the JMF by combining various percentages of the selected recycling agent with the existing pavement material. Increase the amount of recycling agent in the recycled mixture until the void content of specimens made according to ASTM D6925 or ASTM D6926 using [50] [75] gyrations/blows reaches 3.5 percent. This reveals the maximum amount of recycling agent that can be added to the mixture. If the voids in the mixture are at 3.5 percent or lower with no recycling agent added, then no recycling agent will be used unless new asphalt mixture is added. At the selected amount of recycling agent and new asphalt mixture, if used, extract the asphalt cement from the samples made and recovered according to ASTM D2172/D2172M and ASTM D5404/D5404M, respectively.

c. Obtain the viscosity of the recovered asphalt cements in accordance with either ASTM D2170/D2170M or ASTM D2171/D2171M. The grade of recycling agent used in the recycled mixture has to be one that results in a dynamic shear rheometer measurement approaching the value indicated by ASTM D6373 for the high temperature PG grade requirements in the project location.

d. List the asphalt content tolerance as plus or minus 0.5% of the developed asphalt content target value in the JMF. [The in-place hot reused asphalt paving will be covered with hot mix asphalt meeting the requirements given in Section [32 12 16.16 ROAD-MIX ASPHALT PAVING] [32 12 15.13 HOT-MIX ASPHALT AIRFIELD PAVING]] [The in-place hot reused asphalt paving will be covered with surface treatment meeting the requirements given in Section 32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL]].

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Prior to recycling, clean the pavement surface of all loose and foreign or objectionable material with brooms or other suitable methods. Localized patching, structural corrections, and adjustments to existing structures (i.e., manhole covers) have to be completed prior to the recycling process.

3.2 HEATING

****

NOTE: Control the amount of heat applied to the pavement sufficiently to avoid damaging the heated pavement. Excess heat burns and therefore damages the asphalt binder. Experience has shown that a dense graded asphalt mix that is relatively lean in asphalt cement content is easiest to heat.

****

Provide heating units of sufficient number and size to heat the pavement surface as required for successful scarifying or hot milling to the required depth. Do not allow these units to overheat the existing pavement. Generate sufficient heat to result in a minimum recycled mixture temperature of 115 degrees C 240 degrees F as the mixture is being placed. Do not allow the maximum temperature of the recycled mixture to exceed 143 degrees C 300 degrees F at any time during the recycling process. Dispose of any recycled mixture that exceeds 143 degrees C 300 degrees F in accordance with approved waste disposal procedures and locations/facilities and replace the recycled mixture at no cost to the Government.

3.3 RECYCLING PROCEDURE

****

NOTE: Based on the requirements of the project, select either a single- or multiple-pass method of recycling. The single-pass method is further broken down into remix and repave procedures. The multiple-pass method requires a wearing surface that can be applied at any time from immediately prior to compaction of the recycled mixture to several weeks later.

Edit the following paragraphs according to the type of recycling to be accomplished.

****

3.3.1 Single-Pass Method

Perform the single-pass method using self-contained, self-propelled, automated units capable of heating, scarifying or hot rotary mixing, and redistributing the recycled mixture. The mixture consists of the existing pavement, recycling agent, [and new asphalt mixture] to the specified depth and design. Automatically feed the reclaimed material into a mixing unit. Add a recycling agent [and new asphalt mixture] to the reclaimed material in the mixer. Apply the recycling agent within the range required for the project and control the application within plus or minus 0.023 L/square meter 0.05 gallons/square yard. Heat the recycling agent, at the time of application, to within plus or minus 14 degrees C 25 degrees F of the temperature of the recycled mixture. Specify the [type and quantity of the new asphalt mixture as well as the proportion of new material and] reclaimed material in the JMF. Thoroughly mix all materials while maintaining the minimum temperature of 115 degrees C 240 degrees F. After [mixing, the combined bituminous material] [the addition of the recycling agent], gather the reclaimed material using a leveling device equipped with augers for mixing and placing to a uniform depth over the width being processed (Repaving). Place a layer of new hot mix asphalt conforming to the JMF over the recycled mix while it still has a residual minimum temperature of 107 degrees C 225 degrees F. Automatically feed the layer of new hot mix asphalt (meeting the requirements of Section 32 12 16.16 or Section 32 12 15.13) into a finishing unit (paver) that has automatic screed control for longitudinal leveling of the homogeneous recycled mixture to the required thickness in conformance with the specified cross-section.

3.3.2 Multiple-Pass Method

Perform the multiple-pass method consisting of self-contained, self-propelled or towed, automated units capable of heating, scarifying or hot rotary mixing, redistributing, and screeding. The equipment used in the method has to also provide for controlled leveling at the crown and across the screed to insure a cross-section that conforms to the pavement profile specified. Control the heating to provide a minimum recycled mixture temperature of 115 degrees C 240 degrees F behind the screed. The unit must be able to uniformly distribute the specified amount of recycling agent throughout the recycled mixture. Apply the recycling agent within the range required for the project and control the application within plus or minus 0.023 L/square meter 0.05 gallons/square yard. Heat the recycling agent, at the time of application, to within plus or minus 14 degrees C 25 degrees F of the temperature of the recycled mixture. Apply a wearing course meeting the requirements of Section [32 12 16.16 ROAD-MIX ASPHALT PAVING] [32 12 15.13 HOT-MIX ASPHALT AIRFIELD PAVING] [32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL]] following completion of the recycling process.

3.4 JOINTS

Heat the existing pavement a minimum of 100 mm 4 inches beyond the width of the recycling. When recycling adjacent to an existing hot-mix recycled pavement mat, the heating has to extend 150 mm 6 inches into the existing mat and at least 100 mm 4 inches of the mat has to be recycled with the new mat.

3.5 COMPACTION

****

NOTE: The amount of compaction required for the in-place recycled asphalt mixture depends on the pavement application. Pavements subjected to high tire pressure (over 690 kPa 100 psi) vehicles, heavy loads, or numerous application of loads require a minimum density or degree of compaction of 93 percent of the theoretical maximum specific gravity of the recycled mixture. Pavements subjected to low tire pressure (equal to or less than 690 kPa 100 psi) vehicles, lighter loads, or fewer applications of loads will require a minimum density or degree of compaction of 92 percent of the theoretical maximum specific gravity of the recycled mixture.

****

Uniformly compact the in-place recycled asphalt mixture to a density of greater than or equal to [93] [92] percent of the theoretical maximum specific gravity but less than or equal to 96 percent of the theoretical maximum specific gravity as determined according to ASTM D2041/D2041M. Provide and utilize the type, size and number of rollers using the rolling pattern that produced the approved test section in production paving. Use a pneumatic-tire roller to seal the surface. Use additional rollers as required to remove any roller marks. Use only water or an approved release agent on rollers, tamps, and other compaction equipment. Operate rollers in vibratory mode only when doing so does not damage the pavement. Establish a new rolling pattern when changes occur in the recycled mix or placement conditions. Adjust or cease compaction when cracking or displacement occurs. Repair cracked pavement before sealing, overlaying or applying surface treatments. Ensure that pavement is fully compacted before allowing rollers to park on the pavement. Suspend operations when the density is found to be outside the specified range. Provide a written corrective action plan to the Contracting Officer that will ensure future operations will result in pavement densities within the specified range. Do no restart recycling operations until operations have been adjusted so that density requirements are met. Correct pavement with density lower than the minimum specified by either removing and replacing or reheating with an infrared heater with no open flame and recompacting at no additional cost to the Government. Pavement can only be reheated and recompacted once. If its density remains below the minimum specified, remove and replace the pavement mixture having inadequate density at no additional cost to the government.

3.6 TEST SECTION

****
NOTE: Use of a test section is recommended for all hot in-place recycling projects, especially for single-pass methods of construction. Placement of test sections in two adjacent paving lanes is required for recycling of pavement areas where extensive longitudinal construction joints are required, i.e. parking lots.
****

Prior to the start of the recycling, recycle a length of pavement at least 30 meters 100 feet long to the depth required in the project. If possible, at the direction of the Contracting Officer, place this test section in two adjacent paving lanes to demonstrate joint construction. In accordance with requirements specified in paragraph PREPARATION OF SURFACE, paragraph HEATING, paragraph RECYCLING PROCEDURE and paragraph COMPACTION, place or spread the recycled mixture and then roll the recycled mixture with the equipment to be used in the project. Test and evaluate this test section as a full day's production. The test section may be located in one of the less critical areas of the project pavement construction, as directed by the Contracting Officer. Begin full production if test results are satisfactory, and as approved by the Contracting Officer. If the test section was constructed within the project boundaries and demonstrates satisfactory test results, keep it in place as part of the completed pavement. If tests indicate that the pavement does not conform to specification requirements, make necessary adjustments to operations and procedures immediately and construct another test section, all at no additional cost to the Government. Construct additional test sections, as necessary and as directed by the Contracting Officer, to be sampled and tested for conformance with specification requirements. Do not start full production without test section approval by the Contracting Officer.

3.7 ACCEPTABILITY OF WORK

3.7.1 Field Testing and Sampling

Perform the tests described in paragraph MIXTURE PROPERTIES and paragraph DENSITY TESTING on one set of samples taken at the rates and times specified in these sub paragraphs. Submit copies of all test results within 24 hours of material sampling. Submit copies of test reports on material properties of existing asphalt pavement [and new asphalt mixture], not less than [30] [_____] days before the material is required in the work. Include with the test reports all of the information establishing compliance with the requirements detailed in this section and in referenced publications. Certified copies of the recycling agent manufacturer's test reports indicating compliance with applicable specified requirements, have to be received no less than [30] [_____] days before the material is required for the project. Perform sampling and testing using a commercial testing laboratory or Contractor's facilities, upon approval by the Contracting Officer.

3.7.1.1 Mixture Properties

****
NOTE: Select the information in the first set of brackets when the single-pass remix process is used and select the information in the second set of

brackets when the multiple-pass process is used. Sample and test the mixture twice a day, or once for every 4 hours, of production or placement.

****

[Obtain a sample of the recycled mixture for every [_____] hours of mix production. Extract the asphalt cement from the mix according to ASTM D2172/D2172M. The asphalt content of the recycled material has to be within the tolerance given in paragraph JOB-MIX FORMULA. Determine the gradation of the extracted aggregate according to ASTM C117 and ASTM C136/C136M. The extracted gradation has to meet the JMF and the corresponding tolerances.] [Record and report to the Contracting Officer the amount of recycling agent used per day along with the square meter yard area recycled. Use these values to verify that the correct amount of recycling agent is being added to the recycled mixture.]

3.7.1.2 Density Testing

****

NOTE: A 100 mm 4 inch core or 150 mm 6 inch core sample is required for each 1,700 to 5,000 square meters 2,000 to 6,000 square yards of hot in-place recycled mixture. Default area of sampling is 1,700 square meters 2,000 square yards.

****

Obtain one 100 or 150 mm 4 or 6-inch diameter core sample for each [_____] square meters yards of hot in-place recycled mixture. Determine the location of the core samples according to ASTM D3665. Determine the density of the cores in accordance with ASTM D2726/D2726M. Report the density as a percent of the theoretical maximum specific gravity, as determined by ASTM D2041/D2041M, of the cores. Correct pavement with density lower than the minimum specified by either removing and replacing or reheating with an infrared heater with no open flame and recompacting at no additional cost to the Government.

3.7.2 Grade Conformance

****

NOTE: Run lines of levels to determine elevation of the planed pavement longitudinally and transversely at intervals not exceeding 7.6 meters 25 feet for pavements subject to aircraft traffic, such as airfield runways and taxiways. Grade measurements for roads will be 7.6 m 25 feet longitudinally along centerline and as appropriate transversely.

****

Test the finished surface of the recycled pavement, for conformance with the plan-grade requirements and acceptance in the presence of the Contracting Officer, by running lines of levels at intervals of [_____] meters feet longitudinally and [_____] meters feet transversely to determine the elevation of the completed pavement. Correct the finished surface where it varies more than 15 mm 0.6 inch from the established plan-grade line and elevation. Correct the finished surfaces at junctures with other pavements where the surface does not coincide with the finished surfaces of abutting pavements.

3.7.3 Surface-Smoothness

During construction of the recycled pavement, the finished surface will be tested by the Contractor using a straightedge. The measurements of any deviations from the straightedge and the locations of those deviations will be recorded. Other approved devices may be used provided that, when satisfactorily and properly operated, such devices reveal all surface irregularities exceeding the tolerances specified. Correct surface irregularities that depart from the testing edge by more than 6 mm 1/4 inch as directed.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 01 16.75 (February 2017)**

Preparing Activity: USACE

Superseding
UFGS-32 01 25 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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HEATER SCARIFYING OF ASPHALT PAVING

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USACE / NAVFAC / AFCEC **UFGS-32 01 16.75 (February 2017)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 25 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 01 16.75

HEATER SCARIFYING OF ASPHALT PAVING
02/17

****

NOTE: This guide specification covers the requirements for heater scarifier procedures for bituminous pavements in connection with surface treatments or asphalt overlays.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Experience and data indicate that scarifying is feasible only on existing asphalt concrete pavements which are structurally sound but in need of surface leveling or sealing, for example, pavements disturbed for utility trenches or other openings or where patches have settled and surface deterioration exists. This specification covers the use of heater scarifiers for the maintenance of bituminous pavements. Heater scarification should not be used on airfields but is useful for relatively low volume roads when applying surface treatments or thin overlays. Heater scarifying is to be used in conjunction with surface treatments

and asphalt overlays; therefore, a surface treatment or asphalt overlay section should be included in the project specifications.
****

1.1 UNIT PRICES

****
NOTE: When other methods of measurement are desired or are necessary, this paragraph will be modified accordingly.
****

1.1.1 Measurement

Determine quantities of [bituminous material] [recycling agent] applied and area of pavement treated in the accepted work by the following methods.

1.1.1.1 Bituminous Material and Recycling Agent

The quantity of [bituminous material] [recycling agent] to be paid for will be the number of liters gallons used in the accepted work as determined by the Contracting Officer, corrected to liters at 15.6 degrees C gallons at 60 degrees F in accordance with ASTM D1250 and using a coefficient of expansion of 0.00045 per degree C 0.00025 per degree F for asphalt emulsion.

1.1.1.2 Treated Pavement

The quantity of pavement treated with [bituminous material] [recycling agent] is the number of square meters yards completed and accepted as determined by the Contracting Officer. Determine the number of square meters yards of treated pavement by measuring the length and width of the specified work area. Take measurements to determine the number of square meters yards along the surface of the pavement and to the closest mm inch for width and the closest meter foot for length.

1.1.1.3 Heater Scarifying

The quantity of heater scarifying of bituminous concrete surfaces is the number of square meters yards completed and accepted, as determined by the Contracting Officer. Determine the number of square meters yards of scarified pavement by measuring the length and width of the specified work area. Take measurements along the surface of the pavement.

1.1.2 Payment

Quantities of heater scarifying, treated pavement and [bituminous material] [recycling agent] will be paid for at respective contract unit prices.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 102	(2009; R 2013) Standard Method of Test for Spot Test of Asphaltic Materials

ASTM INTERNATIONAL (ASTM)

ASTM D92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D244	(2009; R 2017) Standard Test Methods and Practices for Emulsified Asphalts
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D1250	(2019; E 2020) Standard Guide for Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1
ASTM D2170/D2170M	(2018) Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Materials; G, [_____]

SD-06 Test Reports

Testing

1.4 EQUIPMENT, TOOLS, AND MACHINES

Maintain equipment, tools, and machines used in the performance of the work in a satisfactory working condition at all times and conforming to applicable governing regulations for local air pollution controls.

1.4.1 Heater Scarifier

Provide a heater scarifier that is: 1) a self-propelled machine having, in combination, the means of heating and scarifying the existing asphalt concrete surface and spreading the scarified material in a uniform layer. 2) capable of producing a minimum thickness of 19 mm 3/4 inch of uncompacted reclaimed mix without damaging the asphalt binder or violating pollution standards of the area. 3) capable of working at a rate of speed that allows heating and scarifying the pavement to meet the specified requirements. Provide a machine that heats, scarifys, and spreads material in equal widths.

1.4.2 Bituminous Distributor

Provide a bituminous distributor mounted on pneumatic tires of such size and number to prevent rutting, shoving, or other damage to the base, surface, or other layers in the pavement structure. Design and equip the bituminous distributor to spray the bituminous material in a uniform double or triple lap at the temperature recommended by the manufacturer, at variable widths up to at least 3.7 meter 12 feet, and at readily determined and controlled rates from 0.09 to 2.3 L/square meter 0.02 to 0.5 gallon/square yard with an allowable variation from the specified rate of not more than plus or minus 5 percent. Include with the distributor equipment a separate power unit for the bitumen pump, full circulation spray bars, tachometer, pressure gauges, volume measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the bituminous material during the heating process.

1.4.3 Cleaning Equipment

Use power brooms, power blowers, and power vacuuming equipment suitable for cleaning the surface and cracks in the existing pavement prior to treatment.

1.5 ENVIRONMENTAL REQUIREMENTS

Perform heater scarifying procedures only when the existing pavement is dry and the pavement surface temperature is above 15 degrees C 60 degrees F.

PART 2 PRODUCTS

****

NOTE: Designer will specify either bituminous asphalt emulsion or recycling agent to be used for treating the scarified surface, and will delete the inapplicable paragraph and renumber all subsequent paragraphs accordingly. When bituminous asphalt emulsion is to be used, grade SS-1 or CSS-1 asphalt emulsion should be specified in moderate or cold climates and grade SS-1h or CSS-1h should be specified in hotter climates such as the southern or southwestern areas of the United States.

****

2.1 BITUMINOUS MATERIAL

Provide an emulsified asphalt, Grade [_____], conforming to [ASTM D977] [ASTM D2397/D2397M]. The asphalt from which emulsion is required to have a negative spot when tested in accordance with AASHTO T 102.

2.2 RECYCLING AGENTS

Provide recycling agents composed of a petroleum base oil uniformly emulsified with water, conforming to the requirements of the table below, and having a proven record of satisfactory service for at least two years prior to use in this contract.

RECYCLING AGENT		
Property	Requirement	Test Method
Residue, percent	55 minimum	ASTM D244 (1)
Viscosity at 60 degrees C, sq mm/sec 140 degrees F, 80-500 centistokes (2)	80-500	ASTM D2170/D2170M
Flash Point (3) Cleveland Open Cup (COC), degrees C F	350 minimum	ASTM D92
(1) Modify ASTM D244 evaporation test for percent residue by heating 50-gram samples to 148 degrees C 300 degrees F until foaming ceases; then cool immediately and calculate results.		
(2) Viscosity on the residue obtained from evaporation test.		
(3) Flash point on residue from evaporation test.		

2.3 SAMPLING AND TESTING

2.3.1 Sampling

Take all samples of [bituminous material] [recycling agent] in accordance with the requirements of ASTM D140/D140M, unless otherwise specified. All materials will be subject to approval before use. Submit samples of proper size for approval, not less than [_____] days before commencing the work. Furnish additional samples of materials as required during construction.

2.3.2 Testing

Testing [will be the Government's responsibility] [is the responsibility of the Contractor. Perform testing using an approved commercial testing laboratory or by the Contractor's testing laboratory, subject to the approval of the Contracting Officer]. Test the materials to establish compliance with the specified requirements. Before delivery of materials, submit certified copies of the test reports establishing compliance with specifications detailed herein and in referenced publications. Submit test results on materials prior to and during construction.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

****

NOTE: If the surface to be treated contains utility accesses, drainage systems, etc., which require repairs, the method of repairs and extent of work involved should be shown on plans and described in a separate section of the specifications.

****

Repair all potholes, defective base areas, utility cuts, and large cracks.

Adjust manhole covers, valve boxes, and like structures to the desired grade prior to pavement surface repair operations.

3.2 SCARIFYING OPERATION

****

NOTE: Control the amount of heat applied to the pavement so that the heated pavement is not checked, charred, or otherwise damaged. The scarified pavement will not be heated while in a loosened, scarified condition. Experience has indicated that loose material on the surface tends to insulate the pavement, and thus less heat is absorbed by the pavement. Excess heat will burn the asphalt binder; however, sufficient heat should be applied to hold the temperature of the scarified material to a minimum of 90 degrees C 200 degrees F prior to the application of an overlay.

****

Use a heater scarifier to scarify the existing bituminous surface as shown. The temperature at which the work is performed, the nature and condition of the equipment, and the manner of performing the work should be such that no pavement damage occurs during the heating and scarifying operation. Accomplish heating with a unit or units that uniformly heat the pavement to the depth to be scarified. Uniformly spread the scarified material with the scarifier unit. Scarify the surface to a depth of at least 19 mm 3/4 inch. Do not heat the pavement while in a loosened, scarified condition.

3.3 APPLICATION OF BITUMINOUS EMULSION AND RECYCLING AGENTS

Uniformly apply the [bituminous emulsion] [recycling agent] with a bituminous distributor or other approved equipment at a temperature between 23 and 54 degrees C75 and 130 degrees F in quantities of not less than 0.20, nor more than 1.40 L/square meter 0.05, nor more than 0.30 gallon/square yard. The exact quantities, which may be varied to suit field conditions, will be determined by the Contracting Officer. Apply the [emulsion] [recycling material] while the scarified material is hot. The bituminous material or recycling agent should be added after the heating process and before the scarification process.

3.4 COMPACTION

When a surface treatment is to be added, compact the scarified surface to provide a density that results in less than 8% air voids. When a thin asphalt overlay is to be applied the overlay asphalt material will be added on top of the scarified surface behind the scarifier. This can be placed prior to compaction of the scarified material and all material compacted together or it can be added after the scarified material has been compacted. Compact the entire area including the overlay and scarified material to a density that provides less than 7% air voids.

3.5 COMPLETION OF PAVEMENT

After application of [bituminous emulsion] [recycling agents] complete pavement construction.

-- End of Section --

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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05/22, CHG 1: 11/23

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References are in agreement with UMRL dated January 2025

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SECTION 32 01 17.61

SEALING CRACKS IN ASPHALT PAVING

05/22, CHG 1: 11/23

****

NOTE: This guide specification covers the requirements for sealing cracks in bituminous pavements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Treatment of cracks in asphalt pavements can consist of sealing or filling the crack. There are differences in both materials and methods for crack sealing or crack filling. Crack sealing uses specialized sealants to seal working cracks and prevent moisture infiltration into the pavement substructure. Crack filling uses ordinary materials (asphalt cement and emulsions) to fill non-working cracks and reduce moisture infiltration into the pavement substructure. Working cracks are typically transverse or reflective cracks that move more than 3 mm 1/8 inch due to seasonal temperature variations. Non-working cracks are typically longitudinal cracks and block cracks. This

specification covers crack sealing using routed and cleaned cracks sealed with joint sealant.

For additional information concerning crack sealing and filling of bituminous pavements see UFC 3-270-01, "O&M Manual: Asphalt and Concrete Pavement Maintenance and Repair"

****

1.1 UNIT PRICES

****

NOTE: Delete paragraphs Measurement and Payment for lump sum bidding. If cracks of different widths are measured and paid separately, revise the following paragraphs to properly describe each crack condition found within the repair area.

****

1.1.1 Measurement

Determine the quantity of each sealing item to be paid for by actual measurement of the number of linear meters feet of approved in-place material.

1.1.2 Payment

Payment will be made at the contract unit bid prices per linear meter foot for the sealing items scheduled. Include in the unit bid prices the cost of all labor, materials, and the use of all equipment and tools required to complete the work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D5249	(2010; R 2016) Standard Specification for Backer Material for Use with Cold-and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
ASTM D6690	(2021) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Equipment, Tools, And Machines; G, [_____]

SD-03 Product Data

Manufacturer's Instructions; G, [_____]

Crack Sealant; G, [_____]

Backer Rod; G, [_____]

SD-06 Test Reports

Laboratory Tests; G, [_____]

1.4 QUALITY ASSURANCE

Test the crack sealant and backup materials for conformance with the referenced applicable material specification. Perform testing of the materials in an approved, independent laboratory; submit certified copies of the test reports for approval [_____] days prior to the use of the materials at the job site. Submit reports of all tests. Samples will be retained by the Government for possible future testing, if the materials appear defective during or after application. Furnish samples of materials, in sufficient quantity to be tested by the Government upon request. Conformance with the test requirements of the laboratory tests specified will not constitute final acceptance of the materials. Final acceptance will be based on the performance of materials that have been satisfactorily installed.

1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the job site for defects; unload, and store them with a minimum of handling to avoid damage. Provide storage facilities at the job site to protect materials from weather and maintain them at the temperatures recommended by the manufacturer.

1.6 ENVIRONMENTAL REQUIREMENTS

Apply the materials only when the ambient air temperature and the pavement temperature within the joint wall are at least 4 degrees C 40 degrees F and rising. Do not apply sealant if moisture is observed in the crack.

1.7 ACCEPTANCE

1.7.1 Crack Sealant

Inspect the crack sealant for proper cure and rate of set, tack free surface, bonding to the bituminous pavement, cohesive separation within the sealant, reversion to liquid, and entrapped air and voids. Remove sealants exhibiting any of these deficiencies, at any time prior to the final acceptance of the project, and replace as specified herein.

1.7.2 Test Section

Prior to the cleaning and sealing of the cracks for the entire project, construct a test section at least 60 m 200 feet long using the specified materials and approved equipment to demonstrate the proposed preparation and sealing of all cracks of the project. Following the completion of the test section and before any other crack is sealed, inspect the test section to determine that the materials and installation meet the requirements specified. If materials or installation do not meet requirements, remove the materials and reclean and reseal the cracks. [When the test section meets the requirements, it can be incorporated into the permanent work and accepted for payment. Seal all other cracks in the manner approved and successfully completed for sealing the test section.]

PART 2 PRODUCTS

2.1 SEALANTS

****

NOTE: Use the state DOT guidance to specify the Performance Grade (PG) asphalt binder for roads and streets in the project vicinity. The sealant manufacturer will use this PG value to determine the ASTM D 6690 Type (I through IV) suitable for the project. Type III sealant is equivalent to the cancelled Federal Spec SS-S-1401C grade requirement, which includes evaluation of immersed bond at -29 degrees C -20 degrees F.

Additional guidance on selecting the asphalt binder PG grade includes the following: Asphalt Institute MS-26, The Asphalt Binder Handbook; the Asphalt Institute's State Binder Specification Database, or the FHWA LTPPBind software.

If the bituminous pavement is covered by a fuel-resistant pavement sealer, seal the cracks using the above mentioned sealants and then cover with a fuel-resistant pavement sealer. Do not use fuel-resistant crack sealants in asphalt pavements for compatibility reasons.

****

Provide crack sealant conforming to ASTM D6690, Type as suitable over the Performance Grade [_____] temperature range for sealing cracks.

2.2 BACKER ROD MATERIALS

****

NOTE: The use of backer rod materials in bituminous pavements is to control the routed crack width to depth (W/D) ratio and minimize waste of sealant material. Backer rod material is not required in cracks with a sealant reservoir depth of less than 20 mm 3/4 inch.

****

Provide backer rod material compliant with ASTM D5249 Type 1 which is compressible, nonshrinking, nonstaining, nonabsorptive material and nonreactive with the crack sealant. Use backer rod with a melting point temperature of at least 2 degrees C 5 degrees F greater than the maximum pouring temperature of the sealant being used. Use backer rod material that is 25 percent (plus or minus 5 percent) larger in diameter than the nominal width of the crack.

2.3 EQUIPMENT, TOOLS, AND MACHINES

Equipment, tools, and machines used in performance of the work are subject to approval by the Government. Maintain in a satisfactory working condition at all times.

2.3.1 Routing Equipment

****

NOTE: Rotary impact routers that are equipped with vertical sided, carbide tipped bits have been used successfully to rout cracks in bituminous pavements. Impact routers that are not equipped with carbide tipped bits normally chip and damage the surrounding pavement and are not be permitted.

****

Provide routing equipment which is a self-powered machine operating a power driven tool or bit specifically designed for routing bituminous pavements. Use a bit rotating about a vertical axis at sufficient speed to cut a smooth vertical-walled reservoir in the pavement surface and maintain accurate cutting without damaging the sides or top edges of the reservoir. Provide a router capable of following the trace of the crack without deviation. The use of rotary impact routing devices [will not be permitted for cleaning cracks.][can be permitted if vertical-sided carbide tipped bits are used.]

2.3.2 Air Compressor

Provide air compressor capable of furnishing not less than 0.071 cubic meters per second 150 cubic feet per minute and maintaining a line pressure of not less than 621 kPa 90 psi at the nozzle. Equip the compressor with filters that maintain the compressed air free of oil and water.

2.3.3 Heat Lance

****

NOTE: Specify a heat lance if temperatures less than 4 degrees C 40 degrees F or moisture in the cracks are anticipated.

****

Provide a heat lance operating with propane and compressed air in combination to provide flame-free high temperature hot air up to 1650 degrees C 3000 degrees F with exit velocities of 915 meters per second 3000 feet per second.

2.3.4 Hand Tools

Hand tools can be used, when approved, for removing defective sealant from cracks and repairing or cleaning the crack faces.

2.3.5 Crack Sealing Equipment

Provide unit applicators, used for heating and installing the hot-poured crack sealant materials, that are mobile and equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the prepared crack to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. Allow the sealant to circulate through the delivery hose and return to the inner kettle when not in use.

PART 3 EXECUTION

3.1 PREPARATION OF CRACKS

****

NOTE: In bituminous pavements that have large quantities of hairline cracks or cracks less than 6 mm 1/4 inch, use a bituminous fog coat or a bituminous seal coat to prevent water intrusion into the base material. See UFC 3-270-01, "O&M Manual: Asphalt and Concrete Pavement Maintenance and Repair", UFGS 32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL] and UFGS 32 12 36.13 BITUMINOUS FOG SEAL. Fog coats, seal coats and other asphalt surface treatments are suitable for airfield pavement shoulders. UFC 3-270-01 requires approval by the Pavements DWG for the use of surface treatments on runways or taxiways.

If the pavement being sealed is to receive a hot asphalt concrete overlay, do not seal small cracks. Medium and large cracks can be sealed but maintain the top of the sealant 6 mm 1/4 inch below the pavement surface to prevent "bleeding" of the material through the overlay. If the cracks are overfilled, the sealant material will be tracked onto the pavement.

****

Immediately before the installation of the crack sealant, thoroughly dry and clean the cracks to remove oxidized pavement, loose aggregate and foreign debris. Prepare cracks as follows:

3.1.1 Cracks

3.1.1.1 Hairline Cracks

[Cracks that are less than 6 mm 1/4 inch wide do not need to be sealed.] [Seal cracks that are less than 6 mm 1/4 inch wide in accordance with Section [_____].]

3.1.1.2 Small and Medium Cracks

Rout cracks that are 6 to 37 mm 1/4 to 1-1/2 inches wide to a nominal width 3 mm 1/8 inch greater than the existing nominal width and to a depth not greater than 20 mm 3/4 inch. Clean and dry using compressed air or a heat lance.

****

NOTE: Repairs of large cracks greater than 37 mm 1-1/2 inches wide are not covered by this specification. Consult UFC 3-270-01, "O&M Manual: Asphalt and Concrete Pavement Maintenance and Repair," Chapters 3 and 4 and Standard Drawing 2-34b for construction details and incorporate as appropriate.

****

3.1.1.3 Large Cracks

Do not seal cracks that are greater than 37 mm 1-1/2 inches wide. [Refer to the drawings for repair methods for large cracks].

3.1.2 Existing Sealant Removal

****

NOTE: Delete this paragraph if the cracks have never been sealed in the past.

****

Cut loose the in-place sealant from both crack faces and to a depth shown on the drawings. Remove sealant to a depth sufficient to accommodate any backer rod material that is required to maintain the depth of new sealant to be installed. Prior to further cleaning operations, remove all old loose sealant remaining in the crack opening by blowing with compressed air.

3.1.3 Routing

Perform routing of the cracks using a rotary router with a bit that is at least 3 mm 1/8 inch wider than the nominal width of the crack to remove all residual old sealant (resealing), oxidized pavement and any loose aggregate in the crack wall.

3.1.4 Cleaning

Use compressed air or a heat lance to clean the crack faces and the pavement surfaces extending a minimum of 13 mm 1/2 inch from the crack edges. Use a multiple-pass technique until the surfaces are free of dust, dirt, old sealant residue, moisture, or foreign debris that might prevent the sealant material from bonding to the asphalt pavement. Use a heat lance when pavement temperature is less than 4 degrees C 40 degrees F. Do not burn the pavement, a slight darkening is acceptable. Immediately follow the heat lance with the sealing operation.

3.1.5 Backer Rod Material

When required, use backer rod material in all cracks that otherwise would require excessive sealant or exceed the sealant reservoir depth. Insert the backer rod material into the lower portion of the crack as shown on the drawings. Place the backer rod so that the top of the backer rod is a maximum of 19 mm 3/4 inch and a minimum width to depth ratio of 1 below the top of the pavement. Ensure that the backer rod material is placed evenly at the specified depth and is not stretched or twisted during installation.

3.1.6 Rate of Progress of Crack Preparation

Limit the stages of crack preparation, which include routing, air pressure or heat lance cleaning and placing of the backer rod material, to only that linear footage that can be sealed during the same day.

3.2 PREPARATION OF SEALANT

Do not heat hot-poured sealants in excess of the safe heating temperature recommended by the manufacturer, as shown on the sealant containers. Withdraw and waste sealant that has been overheated or subjected to application temperatures for over 4 hours or that has remained in the applicator at the end of the day's operation.

3.3 INSTALLATION OF SEALANT

Submit manufacturer's instructions [_____] days prior to the use of the material on the project. Installation of the material will not be allowed until the instructions are received.

3.3.1 Time of Application

Seal cracks immediately following final cleaning and drying of the crack walls and following the placement of the backer rod material (when required). Place sealant only when cracks are dry. Reclean cracks that cannot be sealed under the conditions specified, or when rain interrupts sealing operations, and allow to dry or dry by mechanical means prior to installing the sealant.

3.3.2 Sealing the Crack

****

NOTE: Slightly underfill cracks to preclude tracking the material onto the pavement surface. For airfield pavements, recess the sealant 3 mm 1/8 inch below the pavement surface; for roads, streets and parking lots, recess the sealant 6 mm 1/4 inch. For pavements that are to receive an overlay, recess the sealant a minimum of 6 mm 1/4 inch and a maximum of 13 mm 1/2 inch below the pavement surface.

****

Immediately preceding, but not more than 15 m 50 feet ahead of the crack sealing operations, perform a final cleaning and drying with compressed air or heat lance. This distance can be increased if demonstrated and approved during the test section. Fill the cracks from the bottom of reservoir formed by the routing or the top of the backer rod up to [3] [6] mm [1/8] [1/4] inch below the pavement surface. Remove excess or spilled sealant from the pavement by approved methods and discard it. Install the sealant in a manner which prevents the formation of voids and entrapped air. Make multiple passes with the applicator wand as necessary to obtain the specified sealant depth from the pavement surface. Do not use gravity methods or pouring pots to install the sealant material. Do not permit traffic over newly sealed pavement until authorized. Check sealed cracks frequently to ensure that the newly installed sealant is cured to a tack-free condition within 3 hours.

3.4 CLEANUP

Upon completion of the project, remove unused materials from the site and leave the pavement in a clean condition.

3.5 QUALITY CONTROL PROVISIONS

3.5.1 Crack Cleaning

Provide quality control provisions during the crack cleaning process to correct improper equipment and cleaning techniques that damage the bituminous pavement in any manner.

3.5.2 Crack Seal Application Equipment

Inspect the application equipment to ensure conformance to temperature requirements and proper installation. If evidence of bubbling, improper installation, and failing to cure or set are identified, suspend operations until causes of the deficiencies are determined and corrected.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 01 17.62 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-32 01 17.62 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 17.62

PAVING FABRIC INTERLAYER

05/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 01 17.62 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-32 01 17.62 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 32 01 17.62

PAVING FABRIC INTERLAYER
05/20

****
NOTE: This guide specification covers the requirements for geosynthetic paving fabric interlayer for asphaltic overlays and surface treatments for roads, streets, and airfield pavements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: To achieve maximum performance with the use of paving fabrics in asphalt pavement, do not overextend their range of application. Consult UFC 3-250-01, Chapter 15-8, for additional guidance on geosynthetic paving fabrics. The paving fabric not only retards or reduces low-severity reflection cracking but prevents surface infiltration of water. Paving fabrics have performed well when used on pavements with oxidation cracking, on longitudinal construction joint cracks in asphalt pavement, and on the longitudinal joint between portland cement concrete pavement widened with flexible pavement. Cracks that are greater than 6 mm 1/4 inch wide should be filled with a suitable crack filler prior to installing the paving fabric.

Cover the paving fabric with a hot-mix asphalt overlay or an asphalt surface treatment.
****

PART 1 GENERAL

1.1 UNIT PRICES

****
NOTE: Delete paragraphs MEASUREMENT and PAYMENT when lump sum bidding is used.
****

1.1.1 Measurement

Measure the as-built surface area, covered by geosynthetic paving fabrics, in square meters square yards. No allowance will be made for waste, overlaps, damaged materials, repairs, or materials used for the convenience of the Contractor.

1.1.2 Payment

Geosynthetic paving fabric installed and accepted will be paid for at the respective contract unit price in the bidding schedule. This unit price will include the cost of geosynthetic paving fabric, asphalt binder, equipment, installation, testing, and other costs associated with placement of the geosynthetic paving fabric.

1.2 REFERENCES

****
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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications

ASTM INTERNATIONAL (ASTM)

ASTM D4873/D4873M	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder

1.3 STATE STANDARD SPECIFICATIONS

****

NOTE: Where SSS-[_____] is found in the text, insert the appropriate State Standard Specification.

Do not specify state standards for airfield paving projects.

****

Provide materials and workmanship specified herein with the reference State Standard specifications (SSS) in accordance with the referenced articles, sections and paragraphs of the standard except that contractual and payment provisions do not apply. Where the term "Engineer" is used, it means the Contracting Officer. Where the term "state" is used, it means "Federal Government."

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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and Air Force projects.

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SD-03 Product Data

Plant, Equipment, Machines, And Tools

SD-06 Test Reports

Asphalt Distributor Calibration Documentation

SD-07 Certificates

Asphalt Cement; G, [_____]

Geosynthetic Paving Fabric; G, [_____]

1.5 QUALITY CONTROL

1.5.1 Design Conformance

****

NOTE: Cover the paving fabric with a hot-mix asphalt overlay or an asphalt surface treatment. Select the choice in brackets and delete the other.

Check with agency Subject Matter Expert before specifying an asphalt surface treatment for airfield paving projects.

****

[Provide an asphalt concrete conforming to the requirements of Section 32 12 16.16 ROAD-MIX ASPHALT PAVING.][Provide an asphalt surface treatment conforming to the requirements of Section 32 01 13.62 ASPHALT SURFACE TREATMENT.] [Provide an asphalt concrete conforming to the requirements of Section 32 12 15.13 ASPHALT PAVING FOR AIRFIELDS.]

1.6 DELIVERY AND STORAGE

Deliver materials to job site in original unopened rolls, packages, cartons, bundles, or containers. Handle and store geosynthetic paving fabric in accordance with ASTM D4873/D4873M. Prevent damage to materials during loading, transporting, and unloading. Inspect materials for contamination. Protect geosynthetic materials against sunlight, UV radiation, moisture, rain, dust, or rodents. Replace defective or damaged materials. Remove rejected materials from Government property.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Placement Conditions

Place geosynthetic paving fabric under the following conditions:

a. Ambient air temperature for asphalt cements above 10 degrees C 50 degrees F and rising.

b. Dry pavement surface temperature above 4.5 degrees C 40 degrees F and rising.

1.8 ACCEPTANCE

1.8.1 Tolerances

Acceptance of the paving fabric interlayer is based on compliance with the tolerances presented in Table 1. Remove and replace paving fabric interlayer represented by the failing tests or submit repair plan for approval.

TABLE 1

Attribute	Tolerance
Asphalt Binder Application Rate	Within specified range
Asphalt Binder Application Temperature	Within specified range
Paving Fabric Overlap	Maximum 150 mm 6 inches
Paving Fabric Wrinkles	Maximum 25 mm 1 inch

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Asphalt Cement

****
NOTE: Specify Performance Grade (PG) asphalt wherever available. When selecting PG asphalt cements, the asphalt cement grade should be the same as specified for the hot mix asphalt overlay or surface treatment.
****

****
NOTE: Add appropriate State Standard specification (SSS) in the blanks below.
****

Asphalt cement binder conforming to [ASTM D6373] [Section [_____] of SSS-[_____]], Performance Grade (PG) [_____].

2.1.2 Geosynthetic Paving Fabric

****

NOTE: Paving fabrics are fabrics designed with higher ultimate elongation and are manufactured with synthetic polymers. All paving fabrics available that meet these specifications are nonwoven. Check properties against any other manufacturers' literature or information or data that may be more current.

****

Geosynthetic paving fabric conforming to AASHTO M 288, Type II. The numeric values in AASHTO M 288 are Minimum Average Roll Values (MARV) in the weaker principal direction.

2.2 EQUIPMENT

Submit list of proposed equipment to be used in performance of construction work, including descriptive data. Plant, equipment, machines, and tools used in the work are subject to approval. Maintain in a satisfactory working condition at all times.

2.2.1 Asphalt Distributor

Provide a distributor capable of spraying asphalt binder at the prescribed temperature and application rate without streaking, skipping, or dripping. Equip distributor with hand spray having single nozzle and positive shut-off valve. Check and clean the filters at the start of each day during the installation. Provide calibrated instruments to determine temperature of asphaltic binder in both the distributor and its application site as well as instrumentation for securing uniformity at the junction of the two loads. Submit current asphalt distributor calibration documentation for all calibrated equipment, certified by an approved calibration laboratory within [12] [_____] months prior to commencing work[and every [_____] month, thereafter during the term of the contract].

2.2.2 Geosynthetic Paving Fabric Handling Equipment

Provide mechanical or manual laydown equipment capable of laying fabric smoothly with minimum wrinkles or folds.

2.2.3 Vacuum Sweeper

Provide a Self-propelled, vacuum pickup capable of completely removing loose material and debris from pavement surface.

2.2.4 Miscellaneous Equipment

Additional equipment includes, but not limited to, stiff bristle brooms; squeegees to spread asphalt binder; rollers to smooth paving fabric; scissors or blades to cut paving fabric; and brushes for applying binder at paving fabric overlaps.

2.2.5 Condition of Equipment

Keep storage tanks, piping, retorts, booster tanks, and distributors used in storing and handling asphalt material clean and in good operating condition throughout the duration of the work. Do not allow contamination of asphaltic material with foreign material in equipment during operation. Provide and maintain a recording thermometer in good working order in storage heating unit. Submit calibration documentation as required in paragraph: Asphalt Distributor.

PART 3 EXECUTION

3.1 PREPARATION

****

NOTE: Consult UFC 3-270-01 for methods and materials used to repair underlying asphalt concrete pavement. Do not seal cracks under 6 mm 1/4 inch wide.

****

3.1.1 Cracks

Seal all cracks wider than 6 mm 1/4 inch in accordance with 32 01 17.61 SEALING CRACKS IN ASPHALT PAVING

3.1.2 Potholes

Remove surface pavement and base course as indicated. Make saw cuts to provide a square or rectangular shape with vertical straight faces around the pothole. Make one pair of faces at right angles to traffic flow. Spray vertical surfaces with emulsified asphalt. Fill with asphalt concrete, and compact patch level with existing pavement using a vibratory plate compactor for small patches or a roller for large patches.

3.1.3 Surface Preparation

[Cold-mill existing pavement in accordance with Section 32 01 16.71 COLD MILLING ASPHALT PAVING. Use micro-milling equipment if required by the geosynthetic manufacturer.]Clean pavement surfaces immediately prior to application of asphalt binder by using a power broom followed by a power blower using compressed air.

3.2 PAVING FABRIC INSTALLATION

3.2.1 Asphalt Binder

****

NOTE: The amount of asphalt cement required depends on the condition and texture of the asphaltic surface on which the paving fabric is to be placed and on the type of paving fabric. Most common paving fabrics require about 0.9 - 1.58 L/sq.m 0.20 - 0.35 gal/sq.yd. of residual asphalt to achieve installation. Use 1.13 - 1.36 L/sq.m 0.25 - 0.30 gal/sq.yd. for cracked and weathered surface of existing asphalt pavement. Use 1.36 - 1.58 L/sq.m 0.30 - 0.35 gal/sq.yd. for heavily distressed, oxidized, or milled surfaces.

****

Spray area to receive paving fabric with asphalt binder at a rate of residual asphalt content of [1.0 - 1.31] [_____] L per square meter [0.22-0.29] [_____] gallon per square yard. Maintain the application temperature within the range of 135 to 175 degrees C 275 to 350 degrees F for asphalt cement. Where the paving fabric will be joined with another layer of paving fabric, apply asphalt binder to cover a minimum width of the paving fabric plus 150 mm 6 inches. Minimize time interval between placing asphalt binder and placing paving fabric so that temperature loss of asphalt binder due to dust, wind, or cooler temperatures does not cause loss of adhesion. Keep newly placed paving fabric free of traffic and debris until asphalt overlay or surface treatment is complete.

3.2.2 Paving Fabric Placement

Place paving fabric with minimal wrinkles and folds. In cold and windy conditions, shorten the incremental length of paving fabric that is placed to accommodate the rapid cooling of the applied asphalt cement. Place paving fabric manually on areas where it cannot be mechanically installed. In the event of improper alignment during placement which causes the paving fabric to wrinkle or fold in excess of the tolerances provided in Table 1, slit the paving fabric and realign by overlapping the previous material and proceed as before. Overlap the paving fabric not to exceed the tolerances shown in Table 1 at all joints[, except as otherwise shown]. Do not lap joints with more than two paving fabric layers. Construct transverse joints by shingling in the direction of placement to prevent paving fabric disturbance by paver. Use a pneumatic tire roller to roll the paving fabric to remove air bubbles that form under the paving fabric. In case binder bleeds through paving fabric, blot binder with sand before overlay is placed. Remove excess sand before placing overlay. Neatly cut and contour paving fabric at joints. Remove and replace damaged paving fabric before resurfacing.

3.2.2.1 Traffic Control

Prohibit vehicles, except handling equipment, from traveling on paving fabric. Limit equipment speed to 8 kph 5 miles per hour. During construction and at intersections and corners, turn equipment gradually to avoid damaging paving fabric.

3.2.2.2 Additional Asphalt Binder

If the paving fabric does not stay bonded with the underlying surface, apply additional binder at a residual asphalt content of at least 0.09 L per square meter 0.02 gallon per square yard to paving fabric surface.

3.2.3 [Asphalt Concrete Overlay][Asphalt Surface Treatment]

****

NOTE: Cover the paving fabric with a hot-mix asphalt overlay or an asphalt surface treatment. Select the choice in brackets and delete the other.

****

[Place overlay in accordance with [Section 32 12 16.16 ROAD-MIX ASPHALT PAVING] [Section 32 12 15.13 ASPHALT PAVING FOR AIRFIELDS].][Construct asphalt surface treatment in accordance with Section 32 01 13.62 ASPHALT SURFACE TREATMENT.]Do not place paving fabric that cannot be covered with overlay the same day. If rain is imminent, and the paving fabric cannot be covered in time, use a pneumatic tire roller on top of the installed paving fabric. After the rainfall stops, if water is displaced while walking on the paving fabric, do not proceed with paving. If the paving fabric is still wet, but no free water is visible underfoot, paving can proceed.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 01 18.71 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 18.71 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 18.71

GROOVING OF AIRFIELD PAVING

11/23

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 01 18.71 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 18.71 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 32 01 18.71

GROOVING OF AIRFIELD PAVING
11/23

****
NOTE: This guide specification covers the requirements for providing grooves in airfield pavements to reduce the potential for hydroplaning of aircraft by providing a skid-resistance surface..

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 FULL PAYMENTe

[1.1.1 Method of Measurement

****
NOTE: For unit price bidding, ensure appropriate CLIN is included in bid schedule for grooving per square metersquare yard. Keep paragraph METHOD OF MEASUREMENT.

For lump sum bidding, delete paragraph METHOD OF MEASUREMENT but keep paragraph paragraph BASIS OF PAYMENT.
****

The quantity of grooving to be paid for will be the number of square meters square yards of grooving performed in accordance with the contract documents and accepted by the Government in accordance with paragraph ACCEPTANCE.

]1.1.2 Basis of Payment

****

NOTE: For unit price bidding, select first bracketed text. For lump sum bidding, select second bracketed text.

****

[Payment for grooving will be made at the Contract unit price per square meter square yard. Unit price will include full compensation for furnishing all materials, preparation, delivering, and application of those materials, and for all labor, equipment, tools, and incidentals necessary to complete the work.][The measured quantity of grooves will be paid for and included in the lump sum Contract price. Lump sum value will include furnishing all materials, preparation, delivering and application of those materials, and for all labor, equipment, tools, and incidentals necessary to complete the work.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Environmental Requirements; G, [_____]

SD-03 Product Data

Equipment; G, [_____]

Procedures; G, [_____]

SD-06 Test Reports

Test Section; G, [_____]

Inspection Test Reports; G, [_____]

1.4 ENVIRONMENTAL REQUIREMENTS

****

NOTE: Consult with airfield manager and installation engineer on method of waste disposal. While on-site disposal methods are favorable regarding cost/productivity, local/state environmental requirements may not permit such.

Retain the first bracketed item if the Contractor will be required to dispose of the waste material off base. Retain second bracketed item for unique requirements given by the airfield/installation. Retain third bracketed item if on-site dewatering locations are accessible to the Contractor during construction.

****

Grooving operations are not permitted when expected freezing conditions prevent the immediate removal of debris and/or drainage of water from the grooved area. Remove and dispose of hardened waste slurry[off base][in accordance with the base waste disposal requirements] after it has been dewatered.[On-site dewatering locations are to be provided by the Government.] No less than 30 days before the start of grooving, submit information and details on the following, and ensure all items are in accordance with base environmental regulations:

a. Plan to flush debris off pavement (if permitted).

b. Plan to discharge and dispose of waste slurry.

c. Plan to maintain temporary storm drainage, pollution control and erosion control.

d. Plan describing how disposal pit areas will be regraded and restored to original conditions.

[1.5 ANTICIPATED DELAYS DUE TO MISSION REQUIREMENTS

****

NOTE: If grooving on an active runway, include paragraph ANTICIPATED ADVERSE DELAYS DUE TO MISSION REQUIREMENTS; otherwise, do not include.

Coordinate with the local base, airfield manager, or other user representatives to configure an appropriate amount of days to be allotted to the Contractor for interruptions during grooving. Fill bracketed options below. Ensure to make user aware that Notices to Air Missions (NOTAMs) may be required to safely coordinate grooving in an active area, as well as to coordinate concurrent and/or subsequent activities with pilot landing/trafficking in the grooving area.

Ensure project restrictions are captured on the contract drawings, for example, need for removal of grooving equipment during non-shift hours, or

communication required with air traffic control.
****

Grooving operations are to expect [_____] interruptions per day, with each interruption not anticipated to exceed [_____] hours. Grooving equipment is not permitted to be in any possible active aircraft operations areas during non-shift hours. Adhere to the [base][airfield] safety requirements when performing work in any possible active aircraft operations areas.

]PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Grooving Machine

Provide a grooving machine that is self-propelled, specifically designed and manufactured for pavement grooving, and has a self contained and integrated continuous slurry vacuum system as the primary method for removing waste slurry. Equip the grooving machine with diamond-saw cutting blades capable of making one pass of grooving with a minimum width of 914 mm 36 inches. Use cutting blades capable of making the required width and depth of grooves in one pass of the machine. A mixture of new and worn blades or blades of unequal wear or diameter are not permitted in the cutting head. Match the blade type and configuration with the hardness of the existing airfield pavement. Provide wheels on the grooving machine which do not scar or spall the pavement. Provide the machine with devices to control alignment within the specified tolerances. Provide depth-control wheels or outriggers to control depth of grooves.

2.1.2 Auxiliary Grooving Machine

In areas inaccessible to the equipment specified in paragraph GROOVING MACHINE, a smaller grooving machine is permitted. All requirements specified in paragraph GROOVING still apply to any grooving performed by auxiliary equipment.

2.2 MEASUREMENT TOOLS

Utilize a measuring tool capable of measuring length in increments of 2.0 mm 1/16 inch, except for all depth measurements, where a tire tread depth gauge graduated in 1 mm 1/32 inch is required. Utilize tools or molds to accurately measure the top and bottom width of trapezoidal grooves to the nearest 2.0 mm 1/16 inch.

PART 3 EXECUTION

3.1 PREPARATION

****
NOTE: Limits of the grooved area are described in UFC 3-260-02. Grooves will be perpendicular to the runway centerline. Do not groove the following areas: overruns, UAS only runways, rotary-wing runways (i.e. heliport runways), the first and last 3m 10 feet of the runway, and 6m 20 feet either side of an arresting barrier cable that requires hook engagement for operation. Existing aircraft-arresting systems (AAS) which have only 6 m 10 feet free of grooves on each side do not require

pavement repair solely to comply with the requirements within this designer note. For full-strength overruns, consult with the airfield manager or installation engineer if grooving is desired. Figures 2-10 and 2-11 of FAA Advisory Circular 150/5320-12. Show examples of saw-cut step patterns at the intersection of secondary runways and exit taxiways to primary runways, respectively.

****

3.1.1 Existing Pavements

****

NOTE: If grooving is to be done adjacent to existing pavement, include the bracketed text. When tying into existing pavements, larger variations in groove depth can be expected, and alignment should be established by method of survey markings.

****

Do not groove bumps, depressed areas, bad or faulted joints, and badly cracked and/or spalled areas in the pavement until such areas are adequately repaired or replaced.[The depth tolerances specified in Table 1 do not apply for the first 9 meters 30 feet from existing (not in contract) pavements. Do not perform the test section within 9 meters 30 feet of existing (not in contract) pavement. Utilize survey marks to establish proper alignment when grooving adjacent to existing pavements.]

3.1.2 New Pavements

Allow new asphalt concrete pavements to cure for a minimum of 30 days before grooving. Allow new portland cement concrete pavements to cure for a minimum of 28 days before grooving. As a construction expedient, grooving of new portland cement concrete pavements is permitted before 28 days if all of the following conditions are met:

a. Pavement has been cured for a minimum of 14 days.

b. All joints have been sealed or otherwise protected.

c. Concrete has attained a minimum field cured flexural strength of 4.5 MPa 650 psi in accordance ASTM C31/C31M and evaluated in accordance with ASTM C78/C78M.

d. Grooves are stable with no spalling, tearing or raveling of the grooved edges.

3.2 WATER SUPPLY

****

NOTE: If transportation of the water by surface laid pipe is permitted, show the routing of the pipe. Identify the available source location on the drawings. Coordinate with airfield manager or installation engineer to confirm if water will be supplied by the Government, or if water for grooving operations will need to be supplied by the Contractor. Note on the drawings the location of

where the water is to be supplied from.
****

[Provide water for the grooving operation][The Government will provide water for the grooving operation as shown in the drawings].

3.3 GROOVING

****
NOTE: Selection of standard grooves or trapezoidal-shaped grooves should mirror existing conditions, or for full replacements, consult with the airfield manager and installation engineer on preference between groove style.

Benefits to trapezoidal-shaped grooves include added resistance to rubber contamination, improved performance with regards to heavy aircraft tire loading, water dispersion, and resistance to chipping and closing. Due to expected increased blade wear, the option of trapezoidal-shaped grooves is most likely more expensive than standard grooves.
****

3.3.1 Grooving Dimensions

Cut grooves that meet the dimensions and tolerances specified in Table 1.

Table 1

Standard Grooving Dimensions and Tolerances

Component	Required dimension	Tolerance above required dimension	Tolerance below required dimension
Width	6 mm1/4 inch	2 mm1/16 inch	0 mm0 inch
Depth	6 mm1/4 inch	2 mm1/16 inch	2 mm1/16 inch
Center-to-center spacing	38 mm1-1/2 inch	0 mm0 inch	3 mm1/8 inch

Table 1

Trapezoidal Grooving Dimensions and Tolerances

Component	Required dimension	Tolerance above required dimension	Tolerance below required dimension
Width at top of groove	12 mm1/2 inch	2 mm1/16 inch	0 mm0 inch
Width at bottom of groove	6 mm1/4 inch	2 mm1/16 inch	0 mm0 inch
Depth	6 mm1/4 inch	2 mm1/16 inch	2 mm1/16 inch

Table 1			
Trapezoidal Grooving Dimensions and Tolerances			
Component	Required dimension	Tolerance above required dimension	Tolerance below required dimension
Center-to-center spacing	57 mm2-1/4 inch	0 mm0 inch	3 mm1/8 inch

3.3.2 Procedures

****

NOTE: Include applicable Sections regarding field molded sealants, preformed compression seals where prompted below. If both field molded sealants and preformed compression seals are used, utilize bracketed text accommodating both specification sections to be referenced.

If the designer chooses to not groove through PCC longitudinal joints, include the last bracketed statement. The choice to skip every PCC longitudinal joint may result in lower production rates and increased pricing. Skipping every PCC longitudinal joint may not fully disperse water off of runways at these areas, which may be hazardous in freezing climates. Reflect the prescriptions below in the contract drawings.

Coordinate depth of grooves and joint material with Section 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT and Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT. Depth tolerances associated with the grooves are 1/4-inch plus or minus 1/16-inch. For airfields, depth tolerances associated with compression joint sealants are 3/16-inch plus or minus 1/8-inch from the pavement surface or from the bottom of the joint bevel, if a bevel is present. Depth tolerances for field molded sealants are 1/8-inch plus or minus 1/16-inch from the pavement surface or from the bottom of the joint bevel, if a bevel is present. Ensure drawing details reflect the recess of joint material such that the maximum depth of grooving is taken into account.

****

No less than 30 days before the start of grooving, submit a procedures plan to indicate grooving sequence, methods to inspect equipment wear, and methods to control grooving operations in order to meet the requirements of this section. Indicate areas which may be inaccessible to the equipment specified paragaph GROOVING MACHINE above, how these areas will be grooved, and how slurry will be captured. Damage or roughening of the pavement between grooves is prohibited. Spalling along or tearing or raveling of the groove edges is not allowed. Cut grooves that are normal to the longitudinal axis of the centerline of the [runway][taxiway]. Do not vary the transverse alignment of the grooves more than plus or minus 38 mm 1-1/2 inches per 20 m 65 feet of groove length. Do not groove within 150 mm plus or minus 75 mm 6 inches plus or minus 3 inches of the runway centerline, the edge of portland cement concrete transverse joints, or the center of asphalt transverse joints. If damage to longitudinal joint material is caused by grooving, repair damaged joint material as specified in Section [_____][and [_____]].[Do not groove within 150 mm plus or minus 75 mm 6 inches plus or minus 3 inches of each longitudinal PCC joint.] Provide grooves that are no closer than 150 mm 6 inches and no further than 457 mm 18 inches from all working cracks and in-pavement lighting fixtures, including block-outs for lighting structures. Provide grooves that are at least 3 meters 10 feet away, not to exceed 4.5 meters 15 feet away, from the beginning and end of the runway. Provide grooves that are at least 6 meters 20 feet away, not to exceed 7.5 meters 25 feet, from either side of the arresting barrier cable. Terminate grooves 3 meters10 feet from the pavement edge, such that grooving equipment is allowed to operate. Lowering of the cutting head over existing grooving to match new grooves (overlapping) is not permitted.

3.4 TEST SECTION

****

NOTE: Edit for runway or taxiway as required by the project. It is recommended to begin grooving at runway ends.

****

Groove a test section which consists of two adjacent passes, and spans the required grooving width of the [runway][and][taxiway]. Conduct the test section in the presence of the Government[at the beginning or end of the runway][in an area approved by the Government]. Conduct a test section for each piece of grooving equipment. Demonstrate the setup and alignment process, the grooving operation, and the waste slurry disposal.

3.4.1 Test Section Requirements

During the test section, for each pass, record six random groove measurements for depth of each cutting head, per zone. Each zone is identified in Table 2. Record two measurements each for center-to-center spacing (one measurement between grooves within the same cutting head, and one measurement between two separate passes), width, and alignment per cutting head, per pass. Conduct a visual inspection for correct groove shape, stable grooves and damaged joint material, providing two photographs per measurement with scale in photo. Include all measurements in the test section report, and take the average of all depth measurements across all zones, per cutting head. A successful test section consists of an average depth measurement that meets the tolerances of Table 1, as well as meeting all other tolerances and clearances of Table 1 and paragraph PROCEDURES above, per cutting head. Consult with the grooving operator about all measurables. After any failing test sections, make revisions to grooving operations and control processes, and perform another test section to demonstrate compliance. See Grooving Test Section/Inspection Diagram for an illustration of zone testing for the test section. Utilize the Grooving Depth Measurement Spreadsheet, or other means of recording depth measurements, to determine an average of groove depth measurements.

Table 2	
Zone Identification	
Zone 1	Centerline to 1.5 meters 5 feet left and right of centerline.
Zone 2	1.5 meters5 feet to 7.5 meters25 feet left of centerline.
Zone 3	1.5 meters5 feet to 7.5 meters25 feet right of centerline.
Zone 4	7.5 meters25 feet to edge of grooving, left of centerline.
Zone 5	7.5 meters25 feet to edge of grooving, right of centerline.

3.5 ACCEPTANCE

At the beginning of each work shift, furnish a full complement of grooving blades with each saw that are capable of cutting grooves of the specified width, depth, and spacing. If during the work, a single grooving blade on a machine becomes incapable of cutting a groove, work may be continued for the remainder of the work shift. It is not required to cut the groove omitted because of the failed blade. Should two or more grooving blades on a machine become incapable of cutting grooves, cease operating the machine until it is repaired. If during work, a single grooving blade on a machine becomes incapable of cutting a groove to the required dimensions of Table 1, cease operating the machine until it is repaired.

3.5.1 Inspection Test Reports

****

NOTE: Include testing frequency within brackets which corresponds to the magnitude of grooving for the project. For large-scale grooving operations, a recommended number of daily inspections is three per day. Consider project magnitude, grooving limits, and schedule when recommending a testing interval.

****

A test is defined as the set of measurements for depth, width, for center-to-center spacing, alignment, and a visual assessment of grooves specified herein. For each day's production, record [3] separate tests, each one consisting of six random groove measurements for depth for each cutting head, per zone. Each zone is identified in Table 2. For each separate test, record two measurements each for center-to-center spacing (one measurement between grooves within the same cutting head, and one measurement between two separate passes), width, and alignment per cutting head, per pass. Conduct a visual inspection for groove shape, stable grooves and damaged joint material. Submit inspection test reports for each day of production, to include at a minimum: beginning and ending limits of day's grooving shift(s), measurements made with their approximate stationing identified, two photos per measurement with scale in picture, and corrective actions for damaged pavement, lighting fixtures or joints. Indicate any items which are damaged or out of compliance on inspection test reports. For each separate test, if the average of all depth measurements across all zones, per cutting head, is outside of the tolerances of Table 1, or if any other tolerances of Table 1 or clearances of paragraph PROCEDURES above are not being met, consult with the grooving operator prior to any additional grooving. Revise grooving procedures and test the latest pass of grooving. Acceptance of airfield grooving is not complete until all inspection test reports are approved. See attachments Grooving Test Section/Inspection Diagram for an illustration of zone testing for daily tests. Utilize the Grooving Depth Measurement Spreadsheet attachment, or other means of recording depth measurements, to determine an average of groove depth measurements.

3.6 Clean-Up

****

NOTE: Provide additional guidance in open bracketed text if base environmental requirements do not permit flushing of dust, debris, or slurry. Include first bracketed text if base environmental requirements permit flushing of debris, dust and slurry.

****

Continuously clean-up debris from the grooving operation.[Flush debris produced by the equipment to the edge of the grooved area or pick it up before it dries and hardens. Flush the remaining dust coating to the edge of the area if the resultant accumulation is not detrimental to the vegetation or storm drainage system. Accomplish all flushing operations in a manner to prevent erosion on the shoulders, damage to vegetation, or clogging of storm drainage.][_____]

3.7 Repair of Damaged Pavement

****

NOTE: Include references to applicable Sections as necessary in bracketed statement below. If both asphalt and portland cement concrete pavements are used, include last bracketed item which permits two specification sections.

****

Repair any pavement damaged as a result of grooving operations in accordance with Section [_____][and [_____]], at no additional cost to the Government.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 01 19.61 (November 2019)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Superseding**
UFGS-32 01 19.61 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 32 01 19.61

SEALING OF JOINTS IN RIGID PAVEMENT

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USACE / NAVFAC / AFCEC **UFGS-32 01 19.61 (November 2019)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Superseding**
UFGS-32 01 19.61 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 32 01 19.61

SEALING OF JOINTS IN RIGID PAVEMENT
11/19CHG 1: 11/24

****
NOTE: This guide specification covers the requirements for field molded sealants in sealing or resealing joints in rigid pavements on airfields, roads, streets, and other areas.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****
NOTE: When crack repair is involved, edit accordingly, including the section title. This specification should not be used for liquid oxygen compatible joint seals.
****

****
NOTE: The following information shall be shown on the project drawings:

1. Spacing, width, and type of joints in concrete pavements to be sealed.

2. Typical details of existing joints.

3. Depth of existing sealant to be removed for each type of joint, if not specified.

4. Detail of type of joint to be refaced or widened with a concrete saw. Show extent of new width and depth of sawing to provide the proper shape factor of the void space in the joint. For materials, other than silicone, the ratio of the depth to width (d/w) of the sealant reservoir should generally be not less than 1 nor greater than 1.5. For silicone sealant a depth to width ratio of approximately 0.5 is preferred. Depending upon the width of the refaced joint, the thickness of the sealant bead should be between 6 and 13 mm 1/4 and 1/2 in. Following are the recommended details for silicone sealants:

Refaced Joint Width	10 mm	13 mm	19 mm	25 mm
Recess Below Surface	6 mm	6 mm	6 mm	13 mm
Thickness of Sealant	6 mm	6 mm	10 mm	13 mm
Backer Rod Diameter	13 mm	16 mm	22 mm	31 mm
Total Depth of Joint	25 mm	28 mm	38 mm	56 mm

Refaced Joint Width	3/8"	1/2"	3/4"	1"
Recess Below Surface	1/4"	1/4"	1/4"	1/2"
Thickness of Sealant	1/4"	1/4"	3/8"	1/2"
Backer Rod Diameter	1/2"	5/8"	7/8"	1 1/4"
Total Depth of Joint	1"	1 1/8"	1 1/2"	2 1/4"

5. Location and type of bond breaker or back-up.

6. Identify type of sealant based on proposed use of pavements. (See note in paragraph entitled "Joint Sealant.")

7. For joint details see UFC 3-260-02, "Pavement Design for Airfields".

****

PART 1 GENERAL

****

NOTE: In preparing Contract specifications for concrete pavements, use UFC 3-250-04 Standard Practice for Concrete Pavements.

****

1.1 UNIT PRICES

****

NOTE: Delete this paragraph when lump sum bidding is used.

****

1.1.1 Measurement

Determine the quantity of each sealing item to be paid for by actual measurement of the number of linear m ft of in-place material that has been approved.

1.1.2 Payment

Make payment at the Contract unit bid prices per linear meter foot for the sealing items scheduled. Include the cost of labor, materials, and the use of equipment and tools required to complete the work in the unit bid price.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C603	(2014; R 2019) Standard Test Method for Extrusion Rate and Application Life of Elastomeric Sealants
ASTM C639	(2015; R 2020)Standard Test Method for Rheological (Flow) Properties of Elastomeric Sealants
ASTM C661	(2015; R 2022) Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer

ASTM C679	(2015; R 2022) Standard Test Method for Tack-Free Time of Elastomeric Sealants
ASTM C719	(2014; R 2019) Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
ASTM C792	(2023) Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants
ASTM C793	(2023) Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1016	(2014; R 2022) Standard Test Method for Determination of Water Absorption of Sealant Backing (Joint Filler) Material
ASTM C1193	(2016) Standard Guide for Use of Joint Sealants
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D789	(2015) Determination of Relative Viscosity and Moisture Content of Polyamide (PA)
ASTM D903	(1998; R 2017) Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
ASTM D5249	(2010; R 2016) Standard Specification for Backer Material for Use with Cold-and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
ASTM D5893/D5893M	(2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
ASTM D6690	(2021) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants

Submit catalog cuts, specifications, Safety Data Sheets and other information documenting conformance to Contract requirements.

Manufacturer's Recommendations

SD-04 Samples

****
NOTE: Liquid joint sealer proposed for use in airfield pavements should be tested by the U.S. Army Corps of Engineer, Waterways Experiment Station, P. O. Box 631, Vicksburg, MS 39180, Attn: Larry Lynch, telephone: (601) 634-4274, before acceptance. Project Managers should assure that sufficient funds (approximately $1500) are available and that the 45 day testing time requirement has been taken into account when establishing contract completion time. For small projects involving approximately less than 3,000 m 10,000 linear ft of joint sealing, the

requirement for testing may be waived provided that a Factory Test Report is submitted. In no case should materials not meeting the applicable specification be accepted.

****

Sealants

Provide for testing a 19-L 5-gal sample of each sealant with associated primer to the Contracting Officer a minimum of 60 days prior to its use on the job. Provide factory-sealed containers with a factory applied label showing the following information:

Name of sealant

Identification of component, or primer

Specification number and type

Manufacturer's name

Manufacturer's lot and batch number

Date of Manufacture (month and year)

Shelf life retest date (month and year)

List of hazardous components

Quantity of material in container (volume)

Storage instructions

Instructions for use

Blocking Media/Backup Materials

Backer Rod

Bond Breaking Tapes

SD-06 Test Reports

****

NOTE: Liquid joint sealer proposed for use in airfield pavements should be tested by the U.S. Army Corps of Engineer, Waterways Experiment Station, P. O. Box 631, Vicksburg, MS 39180, Attn: Larry Lynch, telephone: (601) 634-4274, before acceptance. Project Managers should assure that sufficient funds (approximately $1500) are available and that the 45 day testing time requirement has been taken into account when establishing contract completion time. For small projects involving approximately less than 3,000 m 10,000 linear ft of joint sealing, the requirement for testing may be waived provided that a Factory Test Report is submitted. In no case should materials not meeting the applicable specification be accepted.

****

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NOTE: Factory test report should be required for joint seals on projects when the Government testing is waived.

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[Sealants

] SD-07 Certificates

Equipment List

SD-08 Manufacturer's Instructions

Sealants

Provide instructions that include, but not limited to: storage requirements, ambient temperature and humidity ranges, and moisture condition of joints for successful installation; requirements for preparation of joints; safe heating temperature; mixing instructions; installation equipment and procedures; application and disposal requirements; compatibility of sealant with filler material; curing requirements; and restrictions to be adhered to in order to reduce hazards to personnel or to the environment. Submit instructions at least 30 days prior to use.

1.4 QUALITY ASSURANCE

1.4.1 Test Requirements

****

NOTE: Select the applicable statement for testing and determining specification compliance and delete the inapplicable statement. Select the first statement for projects except where the project is less than 200 L 50 gal or 200 kg 440 lbs of material. When the project requires less than 200 L 50 gal or 200 kg 440 lbs of sealant, the first statement can be deleted and the sealant and back-up material may be accepted on certified certificate that contains the test data showing compliance with the laboratory test requirements. The cost of testing can be obtained from U.S. Army Corps of Engineer Division Laboratories or Waterways Experiment Station.

****

Test the sealant and backup or separating material for conformance with the referenced material specification.[The materials will be tested by the Government. Do not use material at the project prior to receipt of written notice that the materials meet the laboratory requirements. The cost of the first test of samples will be borne by the Government. If the samples fail to meet specification requirements, replace the materials represented by the sample and test the new materials at the Contractor's expense.][Perform testing of the materials in an approved independent laboratory and submit certified copies of the test reports for approval [_____] days prior to the use of the materials at the job site. Submit samples to be retained by the Government for possible future testing if the materials appear defective during or after application.] Conformance with the requirements of the laboratory tests specified does not constitute final acceptance of the materials. Base final acceptance on the performance of the in-place materials. Submit samples of the materials (sealant, primer if required, and backup material), in sufficient quantity for testing and approval [_____] days prior to the beginning of work. Do not use material until it has been approved.

1.4.2 Trial Joint Sealant Installation

Prior to cleaning and sealing the joints for the entire project, prepare a test section at least 60 m 200 ft long using the specified materials and approved equipment, so as to demonstrate the proposed joint preparation and sealing of the types of joints in the project. Following the completion of the test section and before any other joint is sealed, inspect the test section to determine that the materials and installation meet the requirements specified. Inspect joint seal test section.[Provide written notice of deficiencies and required corrections or adjustments in the joint seal installation procedures.] Correct deficiencies and obtain approval of test section prior to installing joint seals. If it is determined that the materials or installation do not meet the requirements, remove the materials, and reclean and reseal the joints at no cost to the Government. Permit the test section meeting the requirements to be incorporated into the permanent work and paid for at the Contract unit price per linear foot for sealing items scheduled. Prepare and seal other joints in the manner approved for sealing the test section. Notify the Contracting Officer upon completion of the test section.

1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for visible damage, and unload and store with a minimum of handling. Deliver joint materials in original sealed containers and protect from freezing or overheating. Provide jobsite storage facilities capable of maintaining temperature ranges within manufacturers recommendations.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not proceed with work when weather conditions detrimentally affect the quality of cleaning joints or applying sealants. Proceed with joint preparation and sealing only when weather conditions are in accordance with manufacturer's instructions. Install joint sealant to dry surfaces and protect sealant and bond breakers from moisture.

1.7 TRAFFIC CONTROL

Do not permit vehicular or heavy equipment traffic on the pavement in the area of the joints being sealed during the protection and curing period of the sealant. Permit traffic on the pavement at the end of the curing period.

PART 2 PRODUCTS

2.1 SEALANTS

****

NOTE: Select joint sealants based on the proposed use and local experience. Specify ASTM D6690, Type

III sealants in lieu of ASTM D6690, Type II when possible.

Permit ASTM D5893/D5893M sealants to be specified in place of ASTM D6690 sealants. ASTM D5893/D5893M covers silicone sealants that provide improved life-cycle cost benefits. Permit silicone sealant to be used for general purpose sealing and re-sealing of joints in concrete pavements not subject to severe jet fuel or lubricant spillage. Silicone swells up under fuel spills. This may result in an unsatisfactory seal in aircraft or vehicle servicing areas where spillage is frequent.

****

Use materials for sealing[cracks][and][joints] in accordance with[ASTM D6690][and][ASTM D5893/D5893M] based on the type of area as follows:

Area	Sealing Material
[_____]	[ASTM D6690, [Type III]]
[_____]	[ASTM D5893/D5893M]

Use self leveling, non-acid curing silicone sealant meeting the following requirements in accordance with ASTM C920 or ASTM C1193:

TEST	TEST METHOD	REQUIREMENTS
Weight Loss	ASTM C792 Modified (see Note 1 below)	10 percent max.
Flow	ASTM C639 (Type I)	Smooth and level
Extrusion Rate	ASTM C603	30 sec. max.
Tack Free Time	ASTM C679	5 hours max.
Hardness (Shore 00) (see Note 2 below)	ASTM C661	30 - 80
Tensile Stress at 150 Percent Elongation (see Note 2 below)	ASTM D412 (Die C)	200 kPa 30 psi max.
Percent Elongation (see Note 2 below)	ASTM D412 (Die C)	700 min.
Accelerated Weathering	ASTM C793	Pass 5000 hours
Bond and Movement Capability	ASTM C719	Pass 10 cycles at plus 50 percent movement (no adhesion or cohesion failure)
Peel	ASTM D903	Minimum 140 kPa 20 psi of width with at least 75 percent cohesive failure

TEST	TEST METHOD	REQUIREMENTS
NOTES: 1. Percent weight loss of wet (uncured) sample after placing in forced-draft oven maintained at 70 degrees plus 2 degrees C 158 degrees plus 1 degree F for two hours. 2. Specimen cured 21 days at 23 degrees C plus 2 degrees C 73 degrees plus 1 degree F and 50 percent plus 5 percent humidity.		

ACCELERATED WEATHERING FACTORY TEST REPORT. For the Accelerated Weathering test, in lieu of testing of actual sealant to be used on the project, it is permitted to submit a report of a factory test, performed within two years of Contract award.

2.2 PRIMERS

Use primers in accordance with the recommendation of the manufacturer.

2.3 BOND BREAKERS

2.3.1 Blocking Media/Backup Materials

****

NOTE: The use of a bond breaking separation tape or backup material in the joint may prevent an adverse reaction between incompatible materials, maintain the desired configuration (shape factor of the material), and act as a bond breaker to prevent excessive stresses from being placed on the sealant during pavement movement. Therefore, the separating or backup material should be carefully selected and installed to form an effective and durable support for the sealant. Separating or blocking media should be placed to a depth below the pavement approximately equal to the width of the joint. This is to achieve a shape factor (ratio of the depth of the sealant to the width of the joint) of 1. ASTM D5893/D5893M sealants sometimes require a shape factor of 0.5 instead of 1. This is equivalent to a width-to-depth ratio of 2:1 and requires the standard joint detail to be modified. If an ASTM D5893/D5893M sealant is to be used the placement depth of the bond breaking separating tape or backup material should be adjusted accordingly. Drawings should be included in the Contract drawings to indicate application details.

****

Provide backup (joint filler) material that is a compressible, nonshrinking, nonstaining, nonabsorbing, nonreactive material with the sealant. Use backup material compliant with ASTM D5249. Use material with a melting point at least 3 degrees C 5 degrees F greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. Use material with a water absorption of not more than 5 percent of the sample weight when tested in accordance with ASTM C1016. Use backup (joint filler) material that is 25 plus or minus 5 percent larger in diameter than the nominal width of the crack. Use blocking media consistent with the sealant manufacturer's installation instructions.

2.3.2 Bond Breaking Tapes

Provide a bond breaking tape or separating material that is a flexible, nonshrinkable, nonabsorbing, nonstaining, and nonreacting adhesive-backed tape. Use material with a melting point at least 3 degrees C 5 degrees F greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. Use bond breaker tape approximately 3 mm 1/8 in wider than the nominal width of the joint and that does not bond to the sealant. Use bond breaking tape consistent with the sealant manufacturer's installation instructions.

PART 3 EXECUTION

3.1 EXECUTING EQUIPMENT

Submit equipment list and description of the equipment to be used and a statement from the supplier of the sealant that the proposed equipment is acceptable for installing the specified sealant. Use equipment for heating, mixing, and installing seals in accordance with the instructions provided by the sealant manufacturer. Provide equipment, tools, and accessories necessary to clean existing joints and install liquid joint sealants. Maintain machines, tools, and other equipment in proper working condition. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, [_____] days prior to use on the project.

3.1.1 Joint Cleaning Equipment

3.1.1.1 Tractor-Mounted Routing and Plowing Tool

Use routing tools for removing old sealant from the joints, of such shape and dimensions and so mounted on the tractor that do not damage the sides of the joints. Use tools designed to be adjusted to remove the old material to varying depths and widths as required. Use equipment capable of maintaining accurate cutting depth and width control. Use a joint plow equipped with a spring or hydraulic mechanism to release pressure on the tool prior to spalling the concrete. Do not permit the use of V-shaped tools or rotary impact routing devices. Permit the use of hand-operated spindle routing devices to clean and enlarge random cracks.

3.1.1.2 Concrete Saw

Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified, for refacing joints, cleaning sawed joints where sandblasting does not provide a clean joint, widening, or deepening existing joints as specified without damaging the sides, bottom, or top edge of joints. Permit single or gang type blades with one or more blades mounted in tandem for fast cutting. Select saw adequately powered and sized to cut specified opening with not more than two passes of the saw through the joint.

3.1.1.3 Sandblasting Equipment

****

NOTE: Sandblasting equipment with a 6 mm 1/4 in nozzle requires at least 65 L per second 137 cubic

ft per minute of air to function efficiently.
****

Include with the sandblasting equipment an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. Do not permit the maximum nozzle opening to exceed 6 mm 1/4 in. Use a portable air compressor capable of providing not less than 71 L/s 150 cfm and maintaining a line pressure of not less than 620 kPa 90 psi at the nozzle while in use. Demonstrate compressor capability, under job conditions, before approval. Use a compressor equipped with traps that maintain the compressed air free of oil and water. Use a nozzle with an adjustable guide that holds the nozzle aligned with the joint approximately 25 mm 1 in above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle to secure satisfactory results.

3.1.1.4 Waterblasting Equipment

****
NOTE: Waterblasting equipment varies considerably with respect to design of wand, nozzle, water pressure, and water volume, depending upon the manufacturer. Consequently, the effectiveness of a particular set of equipment cannot be predicted. Delete this paragraph if waterblasting is not used.
****

Include with the waterblasting equipment a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment. Provide water tank and auxiliary resupply equipment of sufficient capacity to permit continuous operations. Use a nozzle with an adjustable guide that holds the nozzle aligned with the joint approximately 25 mm 1 in above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle to obtain satisfactory results. Use a pressure gauge mounted at the pump that shows the pressure in kPa psi at which the equipment is operating.

3.1.1.5 Air Compressor

Use a portable air compressor capable of operating the sandblasting equipment and capable of blowing out sand, water, dust adhering to sidewalls of concrete, and other objectionable materials from the joints. Use a compressor that provides air at a pressure not less than 620 kPa 90 psi and a minimum rate of 0.07 cubic m of air per second 150 cubic ft of air per minute at the nozzles and free of oil.

3.1.1.6 Vacuum Sweeper

Use a self-propelled, vacuum pickup sweeper capable of completely removing loose sand, water, joint material, and debris from pavement surface.

3.1.1.7 Hand Tools

****
NOTE: Where spalled joint edges have not been repaired prior to any previous sealing, it may be necessary for the Contractor to employ other types of small tools for the repair work. Such tools should be carefully evaluated for potential spalling effects prior to approval for use. For repairing

concrete pavements adjacent to joints, the designer is referred to Section 32 01 29.61 PARTIAL DEPTH PATCHING OF RIGID PAVING, and to Technical Manual 5-822-9.
****

Permit the use of hand tools, such as brooms and chisels, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces.

3.1.2 Sealing Equipment

****
NOTE: Delete the inappropriate paragraphs.
****

Use joint sealing equipment of a type required by the sealant manufacturer's installation instructions. Use equipment capable of installing sealant to the depths, widths and tolerances indicated. Do not proceed with joint sealing when malfunctions are noted until the malfunctions are corrected.

3.1.2.1 Hot-Poured Sealing Equipment

Use mobile unit applicators equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer for heating and installing ASTM D6690 joint sealant materials; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording thermometer for indicating the temperature of the sealant. Use an applicator unit designed so that the sealant circulates through the delivery hose and returns to the inner kettle when not in use.

3.1.2.2 Cold-Applied, Single-Component Sealing Equipment

****
NOTE: Some ASTM D5893/D5893M sealants cure when exposed to moisture. When the sealant is moisture sensitive it is necessary to use Teflon-lined hoses to prevent the sealant from curing in the hoses.
****

Use equipment for installing ASTM D5893/D5893M single component joint sealants that consists of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. Use a nozzle with dimensions that allows the tip of the nozzle to extend into the joint to allow sealing from the bottom of the joint to the top. Maintain the initially approved equipment in good working condition, serviced in accordance with the supplier's instructions, and unaltered in any way without obtaining prior approval. Use lined hoses and seals to prevent moisture penetration and withstand pumping pressures. Use equipment free of contamination from previously used or other type sealant. Permit use of small hand-held air-powered equipment (i.e., caulking guns) for small applications.

3.2 SAFETY

****

NOTE: Delete this paragraph if liquid oxygen (LOX) equipment, storage, or piping is not within the project area. Joint sealant should not be used within 8 m 25 ft of any LOX equipment or storage.

If LOX equipment, storage, or piping is within the project area, use continuously reinforced concrete slabs in the 8 m 25 ft clear area of LOX to reduce the number of joints. If joints cannot be eliminated within the 8 m 25 ft clear area, clean the joints in the area and leave unsealed. DO NOT PERMIT LOX TO MIX WITH ANY ORGANIC MATERIAL.

Specify sandblasting of joint walls as a light cleaning method following sawing of joints. Sandblasting sometimes causes minor deterioration around the joint area. Secure station permission before sandblasting. If necessary, insert a cross-reference to Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

****

Do not place sealant within 8 m 25 ft of LOX equipment, LOX storage, or LOX piping. Clean joints in this area and leave them unsealed.

In accordance with the provisions of the Contract respecting "Accident Prevention," take appropriate measures to control worker exposure to toxic substances during the work. Provide personnel protective equipment as required. Make Material Safety Data Sheets (Department of Labor Form OSHA-20 or comparable form) available on the site.

[Perform sandblasting operations in accordance to paragraph entitled "Abrasive Blasting" of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

]3.3 PREPARATION OF JOINTS

****

NOTE: The proper preparation of joints with respect to size of joint opening, required cleanliness of concrete surfaces to be bonded, and proper separation of noncompatible materials from the joint sealant cannot be overemphasized. The same applies to storage, preparation, proportioning, mixing and placement of sealants. The neglect of any facet of these operations can result, and has resulted, in poor performance of the joint sealant.

Provide details of the existing joints and the required depth of removal of old sealant on the drawings.

****

Unless otherwise indicated, remove existing material, saw, clean and reseal joints. Do not proceed with final cleaning operations by more than one working day in advance of sealant. Clean joints by removing existing joint sealing compound, bond-breakers, dirt, laitance, curing compound, filler, and protrusions of hardened concrete from the sides and upper edges of the joint space to be sealed and other foreign material with the equipment. Do not permit cleaning procedures that damage joints or previously repaired patches by chipping or spalling. Remove existing sealant to the required depth. Precise shape and size of existing joints vary, and conditions of joint walls and edges vary and include but are not limited to rounding, square edges, sloping, chips, voids, depressions, and projections.

3.3.1 Existing Sealant Removal

****

NOTE: Delete this paragraph if the joints have never been sealed and renumber the subsequent paragraphs. Specify and show on the plans the depth to remove the old sealant from the joints. Show typical existing joint dimensions. Waterblasters have been used successfully to remove sealants that still have some resilience. A nozzle that puts out a thin stream of water is required to cut the sealant loose from the joint walls. Do not use the concrete saw if it widens the joint to a width greater than 25 mm 1 in.

****

Cut loose the in-place sealant from both joint faces and to the required depth, using the[tractor-mounted routing equipment][concrete saw][waterblaster] as specified in paragraph EQUIPMENT. Provide a depth sufficient to accommodate blocking media and bond breakers that are required to maintain the depth of new sealant to be installed. For expansion joints, remove existing sealant to a depth of not less than[the indicated depth.][25 mm 1 in.] When existing preformed expansion-joint material is more than 25 mm 1 in below the surface of the pavement, remove existing sealant to the top of the preformed joint filler. Prior to further cleaning operations, remove loose old sealant remaining in the joint opening by blowing with compressed air. Permit use of hand tools to remove sealant from random cracks. Do not permit chipping, spalling, or other damage to the concrete. Clean pavement surface with vacuum sweeper. Protect previously cleaned joints from being contaminated by subsequent cleaning operations.

3.3.2 Sawing

****

NOTE: Joints often need to be refaced or widened to provide vertical faces and remove damaged concrete. Care should be used when refacing or widening joints so that the joint's width does not exceed 25 mm 1 in. If the joint width exceeds 25 mm 1 in, rebuilding of the joint should be considered. Joint walls should be vertical. The edges should not be rounded or beveled unless required by design.

****

3.3.2.1 Refacing of Joints

****

NOTE: Specify refacing of joints by sawing for the following reasons:

1. To widen the joint space or change the shape factor.

2. To straighten the vertical walls inside the joints and remove old sealant.

If the joints have never been sealed, change the title of this paragraph to Facing of Joints and the appropriate words and sentences used. If "dry" sawing is used to face or reface the joints, remove the debris using compressed air.
****

Accomplish[refacing][facing] of joints using a concrete saw as specified in paragraph EQUIPMENT[to remove residual old sealant and a minimum of concrete from the joint face to provide exposure of newly cleaned concrete, and, if required, to enlarge the joint opening to the width and depth shown on the drawings.][to saw through sawed and filler-type joints to loosen and remove material until the joint is clean and open to the full specified width and depth.] Provide exposure of newly clean concrete through removal. Remove burrs and irregularities from sides of joint faces. Stiffen the blade with a sufficient number of dummy (used) blades or washers. Clean, immediately following the sawing operation, the joint opening using a water jet to remove saw cuttings and debris and adjacent concrete surface. Protect adjacent previously cleaned joint spaces from receiving water and debris during the cleaning operation.

a. Joint Widening (Except Expansion Joints): Saw joints having grooves less than 10 mm 3/8 in wide and less than 25 mm 1 in deep to a minimum width of [10] [13] [_____] mm [3/8] [1/2] [_____] in and to the minimum depth, [of] [25 mm] [38 mm] [1 in] [1-1/2 in] [as indicated].

3.3.2.2 Refacing of Random Cracks

****
NOTE: Use a vertical spindle routing device to clean random cracks. Sandblast clean random cracks that are approximately 25 mm 1 in wide to prevent additional widening of the crack instead of sawing or routing.
****

Accomplish sawing of the cracks using a power-driven concrete saw as specified in paragraph EQUIPMENT. Use a saw blade 150 mm 6 in or less in diameter to enable the saw to follow the trace of the crack. Stiffen the blade with dummy (or used) blades or washers. Immediately following the sawing operation, clean the crack opening using a water jet to remove saw cuttings and debris.

3.3.3 Final Cleaning of Joints

3.3.3.1 Sandblasting

****
NOTE: Specify sandblasting of joint walls following sawing of joints. Sandblasting may cause some minor deterioration around the joint area. Secure station permission before sandblasting. If necessary, insert a cross-reference to Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

Do not permit sandblasting of joints under certain conditions. Blowing sand and dust may either violate atmospheric pollution statutes or may drift into areas where it is objectionable. When sandblasting is prohibited, substitute cleaning the joints with a waterblaster or wire brushes. Wire brushes do not clean as well as the sandblaster or waterblaster; use only for small areas. When wire brushes are used, provide attention to ensure worn brushes are not used and that the joints are being adequately cleaned. When waterblasting is required instead of sandblasting, replace the word sandblasting with waterblasting.

****

Following removal of existing sealant, and sawing, and immediately before resealing, clean newly exposed concrete joint faces and pavement surface extending to a mimimum of 13 mm 1/2 in up to 50 mm 2 in from each joint edge by sandblasting until concrete surfaces in the joint space are free of sealants, dust, dirt, water and other foreign materials that prevent bonding of new sealants to the concrete. Use sand particles of the proper size and quality for the work. Perform sandblasting with specified nozzles, air compressor, and other appurtenant equipment. Position nozzles to clean the joint faces. Make at least two passes; one for each joint face. Make as many passes as required for proper cleaning. Immediately prior to sealing the joint, blow out the joint spaces with compressed air until completely free of sand, water, and dust. Install joint sealants to dry joints. Replace expansion joint filler material damaged in performing the work with new materials of the same type and dimensions as the existing material, or with appropriate blocking media.

3.3.4 Bond Breaker

At the time the joints receive the final cleaning and are dry, install bond breaker material as indicated with a steel wheel or other approved device.

3.3.4.1 Blocking Media (Backer Rod) (Except for Expansion Joints)

When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a blocking media/back-up material to prevent the entrance of the sealant below the specified depth. Take care to ensure that the blocking media/backup material is placed at the specified depth and is not stretched or twisted during installation.

3.3.4.2 Bond Breaking Tape

Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond breaker separating tape to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Bond the tape to the bottom of the joint opening to prevent it from floating up into the new sealant.

3.3.5 Rate of Progress of Joint Preparation

Limit the stages of joint preparation, including sandblasting, air pressure cleaning and placing of the back-up material to only that lineal footage that can be sealed during the same day.

3.3.6 Disposal of Debris

****

NOTE: Specify location of disposal of debris.

****

Sweep pavement surface to remove excess joint material, dirt, water, sand, and other debris by vacuum sweepers or hand brooms. Remove the debris immediately[to a point off station.][to a designated area.][in accordance with Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION].]

3.4 PREPARATION OF SEALANT

****

NOTE: Delete the inappropriate paragraphs.

****

3.4.1 Hot-Poured Sealants

Heat hot-poured sealing materials in accordance with ASTM D6690 and with safe heating temperature ranges recommended by the manufacturer. Withdraw and waste sealant that has been overheated or subjected to heating for over 3 hours or that remain in the applicator at the end of the day's operation. Heat sealant in specified equipment.

3.4.2 Single-Component, Cold-Applied Sealants

Inspect the ASTM D5893/D5893M sealant and containers prior to use. Reject materials that contain water, hard caking of any separated constituents, nonreversible jell, or materials that are otherwise unsatisfactory. Do not reject sealants that exhibit settlement of constituents in a soft mass that can be readily and uniformly remixed in the field with simple tools.

3.5 INSTALLATION OF SEALANT

3.5.1 Time of Application

After approval of the test section, seal joints immediately following final cleaning and placing of bond breakers. Commence sealing joints when walls are dust free and dry, and when weather conditions meet sealant manufacturer's instructions. If the above conditions cannot be met, or when rain interrupts sealing operations, reclean and permit the joints to dry prior to installing the sealant.

3.5.2 Sealing Joints

****

NOTE: Joints should be slightly underfilled to preclude extrusion of the material above the surface of the pavement at summertime temperatures. For airfield pavements, the sealant should be recessed 3 mm 1/8 in below the pavement surface; for roads, streets and parking lots, the sealant should be recessed 6 mm 1/4 in. For pavements that receive tracked vehicle traffic, the sealant should be recessed a minimum of 6 mm 1/4 in below the pavement surface after it has cured or cooled to ambient temperature.

****

Do not install joint sealant until joints to be sealed have been inspected and approved. Install bond breaker just prior to pouring sealant. Fill the joints with sealant from bottom up until joints are uniformly filled solid from bottom to top using the specified equipment for the type of sealant required. Fill joints to [3][6] mm [1/8][1/4] in plus or minus 1.5 mm 1/16 in below top of pavement, and without formation of voids or entrapped air. Do not permit gravity methods or pouring pots to be used to install the sealant material. Except as otherwise permitted, tool the sealant immediately after application to provide firm contact with the joint walls and to form the indicated sealant profile below the pavement surface. Remove excess sealant that has been inadvertently spilled on the pavement surface. Do not permit traffic over newly sealed pavement until authorized. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's recommendations. Check sealed joints frequently to ensure that newly installed sealant is cured to a tack-free condition within the specified time. Protect new sealant from rain during curing period.

3.6 INSPECTION/FIELD QUALITY CONTROL

3.6.1 Joint Cleaning

Inspect joints during the cleaning process to correct improper equipment and cleaning techniques that damage the concrete pavement in any manner. Approve cleaned joints prior to installation of the separating or back-up material and joint sealant.

3.6.2 Sampling Sealant

Obtain a 4-L one gal sample of each type of sealant on the project from material used for each 3000 m 10,000 linear ft or less of joints sealed. Store samples according to sealant manufacturer's instructions. Retain samples until final acceptance of the work.

3.6.3 Sealant Application Equipment

Inspect the application equipment to ensure conformance to temperature requirements, proper proportioning and mixing (if two-component sealant) and proper installation. Suspend operations if there is evidences of bubbling, improper installation, or failure to cure or set until causes of the deficiencies are determined and corrected.

3.6.4 Joint Sealant

Inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Remove sealants exhibiting these deficiencies prior to the final acceptance of the project from the joint, wasted, and replace at no additional cost to the Government. Obtain approval for each joint seal installation.

3.7 ACCEPTANCE

Reject sealer that fails to cure properly, or fails to bond to joint walls, or reverts to the uncured state, or fails in cohesion, or shows excessive air voids, blisters, surface defects, swelling, or other deficiencies, or is not properly recessed within indicated tolerances. Remove rejected sealer and reclean and reseal joints. Perform removal and reseal work promptly by and at the expense of the Contractor.

3.8 CLEAN-UP

Upon completion of the project, remove unused materials from the site and leave the pavement in a clean condition.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 01 29.61 (May 2017)**
Change 1 - 08/17

Preparing Activity: USACE **Superseding**
UFGS-32 01 28 (April 2008)
UFGS-32 01 29.61 November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 29.61

PARTIAL DEPTH PATCHING OF RIGID PAVING

05/17, CHG 1: 08/17

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 01 29.61 (May 2017)**
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SECTION 32 01 29.61

PARTIAL DEPTH PATCHING OF RIGID PAVING

05/17, CHG 1: 08/17

****

NOTE: This guide specification covers the requirements for partial depth patching of spalled concrete and popout areas of rigid paving. The work involves removal of spalled concrete, preparing the area to be repaired, and placing, finishing, and curing (as needed) the repair material. It is emphasized that this specification is for rehabilitation applications only and is not to be used with new construction.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This specification is not intended for repair of heat resistant concrete pavements. See second note in paragraph entitled "Cement."

For details, drawings and illustrations related to partial depth patching, refer to UFC 3-270-03, "Concrete Crack and Partial-Depth Spall Repair" for

drawings, details and illustrations, at http://www.wbdg.org/ccb/DOD/UFC/ufc_3_270_3.pdf and UFC 3-270-01, "Asphalt and Concrete Pavement Maintenance and Repair". To download UFGS graphics related to this section, go to
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms
****

****
NOTE: For full-depth repairs of PCC pavements for roads and streets only, use Section 32 13 13.06 PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES. For full-depth patches or slab removal and replacement of airfield pavements, use Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS.

****

****
NOTE: As a minimum, show the following information on the drawings:

1. Plans showing layout and identification of each affected joint and joint type. Include identification of joints with dowels and with tie-bars. Identify pavements or slabs that are reinforced and the reinforcement. Include location of each random crack where spall repairs are needed.

Spalling along a longitudinal joint in older concrete pavements may be a result of a broken keyway. Details for repairing broken keyways should be included in the project plans. Repair of broken keyways using the full-depth repair technique should be considered.

2. Show approximate location, length and width of each spall and location and size (usually average diameter) of popouts to be repaired. Dimensions of spalls and popouts need not be to scale. Identify by legend and symbol whether spall repair needed is approximately rectangular or circular or pentagonal (triangular spall). Specifically detail any special or unusual shapes or partial depth repairs.

3. If required spall repairs are extensive, provide a schedule showing scope of work and quantities for bid purposes in addition to the location plans. Identify feature areas where spalls or groups of spalls are located, area of spall repairs in square meter square feet, location and number or area of popouts, and other PCC pavement repairs which may be a part of the contract.

4. Provide details of spall and popout repairs. Refer to UFC 3-270-01 and UFC 3-270-03 for suggested details to be included on project drawings. Ensure

that these drawings include the required 50 mm 2 inch minimum horizontal beyond the unsound spalled areas in the length and width dimensions shown for each spall repair area.

5. In conducting field surveys to locate and size spalls needing repair, each suspect area must be sounded to determine extent of damage. Sounding may be done with a steel hammer, steel rod, or other suitable means for locating unsound areas that exhibit hollow sound, and indicator of potentially delaminated concrete that may develop into a spall. It is not unusual for delamination in a spall area to extend well beyond that visually obvious. Each existing partial depth patch should also be sounded to determine the performance of the patch. If soundings indicated that existing patches may be unsound, these patches should be included in the new patching program.

6. Indicate the maximum allowable time to return the repair area to aircraft/vehicle traffic. The pavement repair material that is required for the repairs may be dictated by the maximum allowable time to return the repair area to aircraft/vehicle traffic. Mixes based on the use of a standard Type I, II or V cement can be used when the time required to return the area to traffic is in excess of 3 days. Mixes based on the use of standard Type III cement can be used when the time required to return the area to traffic is in excess of 24 hours. Mixes which utilize blends of admixture in conjunction with standard cement types to further accelerate strength gains can be used when the time required to return the area to traffic is in excess of 4 hours; however, these blends are very sensitive to the mixing proportions and deviation as small as 5 percent can lead to a 6 to 8 hour increase in the cure times. When the time required to return the area to traffic is less than 4 hours use of proprietary or magnesium phosphate repair materials is required. In general, repairs using material designed for traffic after short curing periods have shorter life spans.

****

1.1 UNIT PRICES

****

NOTE: When lump sum payment is used, delete this paragraph . If patching is a separate pay item, revise the paragraph accordingly.

****

1.1.1 Measurement

The quantity of concrete and proprietary repair products to be paid for is the number of [cubic meters feet][kgs lbs] placed in the completed and accepted patched areas.

1.1.2 Payment

The quantity of concrete and proprietary repair products, measured as specified, is paid for at the contract unit price. The unit price includes full compensation for furnishing labor; materials; and for performing work involved in patching the pavements as specified.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO SDDP-1-OL	(2003) Shop Detail Drawing Presentation Guidelines

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the

	Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C267	(2020) Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C469/C469M	(2022) Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C531	(2018; R 2023) Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings, and Polymer Concretes
ASTM C579	(2023) Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C580	(2018; R 2023) Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C617/C617M	(2015) Standard Practice for Capping Cylindrical Concrete Specimens
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing

ASTM C685/C685M	(2024) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C882/C882M	(2024) Standard Test Method for Bond Strength of Bonding Systems Used With Concrete by Slant Shear
ASTM C884/C884M	(2023) Standard Test Method for Thermal Compatibility between Concrete and Epoxy-Resin Overlay
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1581/C1581M	(2024) Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D5023	(2015) Standard Test Method for Plastics: Dynamic Mechanical Properties: In Flexure (Three-Point Bending)

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Shop Drawings; G, [_____]]

SD-03 Product Data

Concrete Mix Design; G, [_____]

Rigid Proprietary Repair Products; G, [_____]

Polymeric Proprietary Repair Products; G, [_____]

Pigmented Liquid Membrane-Forming Compound; G, [_____]

Aggregate Service Record

SD-04 Samples

Absorbent Curing Material; G, [_____]

Joint Filler; G, [_____]

Joint Sealant; G, [_____]

SD-05 Design Data

Concrete Mix Design; G, [_____]

SD-06 Test Reports

Laboratory Test Results

Aggregate Gradation

Cement

Concrete Slump

Concrete Air Content

Concrete Compressive Strength (cylinder)

Mixer Calibration and Efficiency

Concrete Uniformity

Bond Strength

Polymeric Proprietary Repair Products; G, [_____]

SD-07 Certificates

Cement

Aggregate

Admixtures

Absorbent curing material

Pigmented Liquid Membrane-Forming Compound

Joint Filler

Joint Sealant

1.4 QUALITY ASSURANCE

****

NOTE: Guidance for preparation of criteria to be used in inspection of laboratory facilities is contained in ASTM E329.

****

1.4.1 Preconstruction Testing Of Materials

Submit proposed concrete mix design at least [30] [_____] days prior to placement. Provide mix design evaluation and certification by a Government approved engineering testing laboratory, and indicate the weight of each ingredient of the mixture, aggregate gradation, slump, air content, water-cement ratio, time of trafficking and 3-day and 28-day compressive strength test results. Include a complete list of materials including admixtures and applicable reference specifications. Place no concrete prior to Government approval of the proposed mix design. No deviation from the approved mix design is permitted without prior Contracting Officer approval.

Within 24 hours of physical completion of laboratory testing, submit copies of laboratory test results for Contracting Officer approval.

1.4.1.1 Cement

Test cement as prescribed in the referenced specification under which it is furnished. Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specification.

1.4.1.2 Aggregate

Take aggregate gradation samples for laboratory testing in conformance with ASTM D75/D75M.

1.4.1.3 Proprietary Repair Products

At least 30 days before the repair material is used, submit certified copies of test results for the specific lots or batches to be used on the project, not more than 6 months old prior to use in the work.

Manufacturer's certifications may be submitted rather than laboratory test results for proprietary repair products. Include in the submittals details for substrate preparation, mixing, placing, finishing, curing and testing of the material, as applicable. Include a minimum of three case histories documenting the use of the product in a similar freeze-thaw environment and pavement condition. Certify compliance with the appropriate specification referenced herein. Place no materials without prior approval from the Contracting Officer.

1.4.2 Equipment; Approval, Maintenance, and Safety

Provide and use only dependable and well maintained equipment that is appropriate to accomplish the work specified. Allow sufficient time for assembly of equipment requiring such at the work site to permit thorough inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required prior to the start of work.

a. Submit volumetric mixer calibration and efficiency test results in accordance with the requirements of ASTM C685/C685M within 6 months of concrete placement. If applicable, submit concrete uniformity test data for the first load of the ready-mixed concrete to be used as the repair material.

b. Provide Safety Data Sheets (SDS) and Personal Protection Equipment (PPE) per 29 CFR 1910.

1.4.3 Shop Detail Drawings

****

NOTE: Delete this paragraph if the project scope does not require detailed shop drawings and staging plans from the Contractor.

****

Submit detailed Shop Drawings conforming to AASHTO SDDP-1-OL.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Cement

Deliver cement in bulk or in suitable bags used for packaging cements and store in a manner to prevent absorption of moisture.

1.5.2 Aggregate

Deliver, handle, and store aggregates in a manner to avoid breakage, segregation, inter-mingling or contamination by foreign materials.

1.5.3 Other Materials

Deliver epoxy-resin, chemical admixtures and proprietary repair products to the site in such manner as to avoid damage or loss. Provide storage areas in a windowless and weatherproof, but ventilated, insulated noncombustible building, with provision nearby for conditioning the material to 20 to 30 degrees C 70 to 85 degrees F for a period of 48 hours prior to use. Keep the ambient temperature in the storage area no higher than 40 degrees C 100 degrees F.

1.6 Project/Site Conditions

Do not place concrete or other repair products when weather conditions detrimentally affect the quality of the finished product. Do not place concrete when the air temperature is below 5 degrees C 40 degrees F in the shade. When air temperature is likely to exceed 35 degrees C 90 degrees F, provide concrete having a temperature not exceeding 35 degrees C 90 degrees F when deposited. Keep the surface of placed concrete damp with a water fog until the approved curing medium is applied. Take similar precautions for placing other repair products, as directed by the product vendor's instructions. Do not place concrete or other repair products if the weather forecast indicates that the air temperature is expected to drop below 5 degrees C 40 degrees F over the next 7 days.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Coarse Aggregate

2.1.1.1 Composition

Provide coarse aggregate consisting of gravel, crushed gravel, crushed stone, or a combination thereof.

2.1.1.2 Quality

****
NOTE: Do not allow types of aggregate at locations where they have an unsatisfactory performance record. Specify aggregate to be washed in areas where deleterious substances are present and unsatisfactory performance has been observed.

If concrete is used for the repair, the concrete aggregates should be similar to aggregates in existing concrete pavement to ensure that there is thermal compatibility between the aggregate in the existing concrete pavement and the aggregate in the repair concrete.
****

Provide aggregate , as delivered to the mixers, consisting of clean, hard, unweathered, and uncoated particles. Remove dust and other coatings from the coarse aggregate by adequate washing. Meet the requirements of ASTM C33/C33M, Class 5S. Provide aggregates with an abrasion loss, when tested in accordance with ASTM C131/C131M, not exceeding 40 percent; the maximum allowable percentage for clay lumps and friable particles is [1.5] [_____] percent. Provide documentation of aggregate conforming to ASTM C136/C136M.

2.1.1.3 Particle Shape

Provide spherical or cubical shaped coarse aggregate particles. Remove all course aggregates with the largest dimension that is equal to or larger than three times the smallest dimension.

2.1.1.4 Gradation

****
NOTE: The spall repair depth should be a minimum of 50 mm 2 inches. The 13 mm 1/2 inch maximum nominal size for coarse aggregate specified below is suitable for 50 mm 2 inches deep spall repair areas.
****

The maximum nominal size of the coarse aggregate is 13 mm 1/2 inch. Provide well graded coarse aggregate conforming to gradation size 7 in Table 3 of ASTM C33/C33M when tested in accordance with ASTM C136/C136M as delivered to the batching hoppers.

2.1.1.5 Alkali Silica Reactivity

****
NOTE: For small quantity patching projects, include the first paragraph and require the use of non-reactive aggregate.

For large quantity patching projects, include reference to Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS MORE THAN 10,000 CUBIC YARDSand include the second paragraph cross-referencing ASR evaluation and mitigation

testing.
****

[Evaluate and test coarse aggregate, to be used in all concrete, for alkali-silica reactivity in accordance with ASTM C1260. Provide aggregate with a measured expansion not exceeding 0.08 percent at 28 days when tested. Aggregates with test data indicating an expansion greater than 0.08 percent will be rejected.]

[Evaluate coarse aggregate in accordance with Section 32 13 14.13, paragraph: Alkali-Silica Reactivity, with mitigation of reactive aggregate in accordance with the referenced paragraph.]

For proprietary repair products, provide documentation from the supplier that the repair product combination with the aggregates selected will not exhibit alkali-silica reactivity.

2.1.2 Fine Aggregate

2.1.2.1 Composition

Provide fine aggregate consisting of either natural sand, manufactured sand, or a combination of natural and manufactured sand, and composed of clean, hard, durable particles; conforming to Table 2 of ASTM C33/C33M.

2.1.2.2 Particle Shape

Ensure particles of the fine aggregate are generally spherical or cubical in shape.

2.1.2.3 Grading

Provide fine aggregate as delivered to the mixer conforming to the gradation in Table 1 of ASTM C33/C33M when tested in accordance with ASTM C136/C136M.

In addition, provide fine aggregate, as delivered to the mixer, with a fineness modulus of not less than 2.40 nor more than 2.90, when calculated in accordance with ASTM C136/C136M.

2.1.2.4 Alkali Silica Reactivity

Evaluate and test fine aggregate to be used in all concrete for alkali-silica reactivity in accordance with Paragraph ALKALI SILICA REACTIVITY.

2.1.3 Admixtures

2.1.3.1 Air-Entraining Admixtures

Provide air-entraining admixtures conforming to ASTM C260/C260M.

2.1.3.2 Chemical Admixtures

ASTM C494/C494M. Where not shown or specified, the use of admixtures is subject to written approval of the Contracting Officer.

2.1.4 Cement

****

NOTE: Specify type of portland cement to suit project requirement and location. Specify Type III cement only when pavements are expected to be returned to active service in excess of 24 hours and less than 3 calendar days. Specify type of cement, including low-alkali, to suit local aggregate conditions. Types of cements other than those bracketed may be specified provided the designer knows that they have a satisfactory service record in partial depth repairs.

****

****

NOTE: In addition to portland cement, there are many types of cements, polymers, blends and modifications thereto, and other cementitious materials available for patching PCC. Some have performed very well in some cases but failed in others. Many are unusually sensitive to moisture, temperature conditions, mixing criteria, curing techniques, quality of workmanship, or other critical processes. Some are suitable for use during cold weather. Many will develop a level of strength in excess of that needed for patching PCC pavements. Many are not as durable as PCC. Some have been introduced fairly recently and do not have a long term performance record. For patching PCC, most are less compatible, and more expensive than portland cement. Use of any of these materials will depend on the knowledge of the design engineer as well as project requirements and may necessitate significant modifications to this guide specification and attached details.

****

Provide portland cement conforming to ASTM C150/C150M, Type [_____]. Provide low alkali cement if the proposed fine or coarse aggregate are found to have greater than 0.08 percent expansion when tested in accordance with ASTM C1260, as per paragraph: Alkali Silica Reactivity.

2.1.4.1 Portland Cement ConcreteMix Design

****

NOTE: The required time for strength gain and compressive tests needs to be adjusted based on the maximum time available to return traffic to the repaired pavement. Pavement materials must reach the minimum required strength requirements within the time available to return traffic to the repaired pavement. Retain the bracketed time of testing, based on the length of time from finishing the placement, not to the initial set of the concrete, that best represents the time available before returning the area to traffic. The maximum interval for required compressive strength and testing is 3 days.

The minimum allowable compressive strength at the time of trafficking is 17.5 MPa 2,500 psi for roads, streets and parking areas and 20.7 MPa 3,000 psi for airfield pavements.

A list of materials that can meet the 2 hour cure time to return to traffic can be found on the approved material list on the Pavement Repair Material Certification Program web page at Blockedhttps://transportation.erdc.dren.mil/cacsites/TriService/pavement_repai

Delete the bracketed portion of the second paragraph for patching airfield pavements.

****

Design the concrete mixture to produce a minimum compressive strength of [17.5] [20.7] [____] MPa [2,500] [3,000] [____] psi at [2] [4] [24] [72] [___] hrs from the time the material is screeded and finished in the repair area and a minimum compressive strength of [31] [35] MPa [4,500] [5,000] psi at 28 days of age, determined in conformance with ASTM C39/C39M and ASTM C192/C192M, using standard 150 by 300 mm 6 by 12 inch cylinder specimens; and providing an air content by volume of [5] [6] [_____] percent, plus or minus 1.5 percent, based on measurements made on concrete immediately after discharge from the mixer in conformance with ASTM C231/C231M.

The allowable range of slump is 13 to 50 mm 1/2 to 2 inches when tested in accordance with ASTM C143/C143M [except that maximum slump may be increased to 100 mm 4 inches when the Contractor has included an approved water-reducing, mid range, admixture conforming to ASTM C494/C494M in the mix design]. To minimize drying shrinkage, the maximum water-cement ratio by weight is limited to 0.45.

2.1.5 Curing Materials

****

NOTE: Use of curing material and curing type is dependent on the specific repair product used. Concrete and cementitious repair products must be cured using pigmented liquid membrane curing compound typically used for curing conventionally placed concrete pavement.

Polymer (epoxy) repair products will need to be cured as per the product vendor's instructions.

When time is critical and the curing time for concrete or cementitious repair material is not acceptable, specify use of rapid setting proprietary repair materials.

****

2.1.5.1 Pigmented Liquid Membrane-Forming Compound

****

NOTE: Delete reference to ASTM C309 when repairing airfield pavements. ASTM C309 may only be specified for repair of roads, streets, and parking areas only.

****

Provide pigmented liquid membrane-forming compound conforming to COE CRD-C 300 [or ASTM C309].

2.1.6 Bonding-Agents

****

NOTE: Bonding agents should be used only for proprietary repair materials that require their use. Use only bonding agents recommended by the manufacturer of the repair material. For concrete and cementitious repair materials, a saturated surface dry or damp contact area is sufficient and easier to manage under a range of ambient conditions. A grout scrub may be used on projects with slow setting materials placed in repair areas with irregular surfaces.

****

2.1.6.1 Epoxy-Resin

Provide two component epoxy-resin material formulated to meet the requirements of ASTM C881/C881M, Type III, grade and class as approved, for use in bond coat applications and as a component of epoxy-resin concrete or mortar.

Mix epoxy-resin grout components in the proportions recommended by the manufacturer. Condition the components to 20 to 30 degrees C 70 to 85 degrees F for 48 hours prior to mixing. Mix the two epoxy components with a power-driven, explosion-proof stirring device in a metal or polyethylene container having a hemispherical bottom. Add the curing-agent component gradually to the epoxy-resin component with constant stirring until a uniform mixture is obtained. Stir such that the amount of entrained air is a minimum.

2.1.7 Joint Sealant

Provide joint sealant as [indicated on the drawings.] [as specified in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVING.]

2.1.8 Joint Filler

Provide joint filler material conforming to ASTM D1751 or ASTM D1752, Type II[or 100 percent recycled material meeting ASTM D1752, subparagraphs 5.1 to 5.4].

2.1.9 Water

Test water that is not approved by Public Health authorities for domestic consumption in accordance with ASTM C1602/C1602M and only use water that meets the acceptance criteria of Table 1 or 2 of ASTM C1602/C1602M or provide documentation that the water does meet the acceptance criteria of Table 2 of ASTM C1602/C1602M.

2.1.10 RigidProprietary Repair Products

****

NOTE: The required time for strength gain and

compressive tests needs to be adjusted based on the maximum time available to return traffic to the repaired pavement. Pavement materials must reach the minimum required strength requirements within the time available to return traffic to the repaired pavement. Retain the bracketed time of testing, based on the length of time from finishing, not the initial set of the concrete, that best represents the time available before returning the area to traffic. The maximum interval for required compressive and bond strength and testing is 3 days.

****

A rigid proprietary repair product is defined as a rigid material in its hardened state with an elastic modulus greater than 6,900 MPa 1,000,000 psi. For partial depth repairs do not extend the product with aggregates that are or can be retained on a 19 mm 3/4 inch sieve. Test the product in accordance with the following test series. Replicate each test on three specimens. Report all three results for each test and use the average value for comparison with the specification requirements. Report the curing conditions for each test type.

2.1.10.1 Compressive Strength

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NOTE: The minimum allowable compressive strength at the time of trafficking is 17.5 MPa 2,500 psi for roads, streets and parking areas and 20.7 MPa 3,000 psi for airfield pavements.

****

Cast 75 by 150 mm 3 by 6 inch cylinder specimens in accordance with ASTM C192/C192M and test in accordance with ASTM C39/C39M, using bonded or unbonded caps, after [2] [4] [24] [72] [___] hours and 3 day curing period. Use only materials with a minimum compressive strength of [17.5] [20.7] MPa [2,500] [3,000] psi at the time traffic is returned to the repair.

2.1.10.2 Bond Strength

Cast 75 by 150 mm 3 by 6 inch cylinder specimens and test in accordance with ASTM C882/C882M. Cast the candidate material against a 30-degree wedge specimen consisting of the candidate material itself or an ordinary portland cement mixture. Test specimens, using bonded caps, after 1 day curing period. For a bond consisting of the candidate material bonded to OPC mortar, a minimum bond strength of 5,800 kPa 850 psi is required at 1 day of age. For a bond consisting of the candidate material bonded to itself, a minimum bond strength of 6,900 kPa 1,000 psi is required at 1 day of age.

2.1.10.3 Modulus of Elasticity

Cast 150 by 300 mm 6 by 12 inch cylinder specimens in accordance with ASTM C192/C192M and test in accordance with ASTM C469/C469M, using bonded caps, after 3 day curing period. A maximum chord modulus of elasticity of 27,600 MPa 4,000,000 psi is required at 3 days of age.

2.1.10.4 Coefficient of Thermal Expansion

Cast 25 by 25 by 250 mm 1 by 1 by 10-inches prismatic bar specimens and test in accordance with ASTM C531, after 3 days curing period. Use repair product with a coefficient not exceeding 11.6 by 10^{-6} mm per mm per degree C 7 by 10^{-6} inch per inch per degree F at 3 days of age. Also, determine the coefficient of thermal expansion of the existing pavement concrete by testing a core or by estimating based on material composition. Use a repair product with a coefficient of expansion within 20 percent of the coefficient of the existing pavement concrete.

2.1.10.5 Shrinkage Potential

Cast 330 mm I.D. by 406 mm O.D. by 150 mm 13 inch I.D. by 16 inch O.D. by 6 inch tall restrained toroidal specimens and test in accordance with ASTM C1581/C1581M. Start measuring strain after completion of casting. Use repair products with shrinkage not exceeding 40 microstrain is required at 14 days of age. No cracking is permitted at 28 days of age.

2.1.10.6 Freeze-Thaw Resistance

Use aggregate with a satisfactory service record in freezing and thawing environments of at least 5 years of sucessful service in three concrete paving projects. Provide aggregate service record certified by an independent third party professional engineer, petrographer, or concrete materials engineer along with their resume. Otherwise, cast prismatic specimens in accordance with ASTM C192/C192M and test in accordance with ASTM C666/C666M, Procedure A. Begin freeze-thaw testing after specimens have been immersed in saturated lime-water for 3 days. Report the Durability Factor (DF) and the number of cycles to failure.

2.1.11 Polymeric Proprietary Repair Products

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NOTE: This specification does not address materials that require heating or melting for application. Polymeric materials may be selected for spall repair when rapid curing is necessary. Manufacturer-recommended cure times range from ten minutes to eight hours for most polymeric repair materials. Cure times are most often a function of environmental conditions, especially temperature, so cure times may vary from the laboratory to the field. Many materials require the application of a primer to the concrete surface before applying the repair material. Some repairs are designed to immediately follow the priming step, while some require that the primer coat be allowed to fully cure before repairing. Some polymeric repair materials comprise manufacturer supplied aggregates or fillers with the resin, others are designed to use local aggregates which must be acquired independently by the Contractor. Follow manufacturers' recommendations regarding aggregate selection and preparation.

****

Polymeric repair materials include epoxies, methacrylates, and urethanes with or without aggregate. Use only materials that have not reached the manufacturer's published shelf life for the material lot. Ship and store materials in areas with temperature, humidity, solar exposure and packaging integrity in accordance with manufacturer's recommendations. Use and apply primers, bond agents or bond adhesives, in accordance with manufacturer's recommendations. Procure, prepare and use aggregates and fillers in accordance with manufacturer's recommendations.

2.1.11.1 Chemical Reistance

Prepare two sets of three 51 mm 2-inch cubes cured at 23 Degrees C 73 Degrees F for seven days. Measure and weigh the specimens before submerging the test solvent, JP8 fuel at 66 Degrees C 150 Degrees F for 24 hours in accordance with ASTM C267 one set of three specimen. Test compressive strength of the other three specimens for comparison. Measure, test, record and report the weight change and loss of compressive strength. Use only materials that have less than or equal to a 20 percent reduction in the average compressive strength of the three immersed sample compared to the average compressive strength of the non-immersed samples. Use only materials that have a change in weight of 10 percent or less.

2.1.11.2 Compressive Strength

Determine, record and report the compressive strength of the material using procedures contained in ASTM C579. Prepare three sets of three samples, one set per curing interval. Prepare the sample so that no sample dimension is less 51 mm 2 in or 5 times the maximum aggregate size. The maximum aggregate size is the smallest standard sieve size through which 100 percent or the aggregate will pass. Cure the samples at 23 Degrees C 73 Degrees F. Test the first set of specimens after a curing period of one hour and a second set after a curing period of four hours. Test the third set of samples at the manufacturer’s published cure or trafficability time for the product at 23 Degrees C 73 Degrees F. Use only those materials which exceed 3,450 kPa 500 psi at the time of trafficking of the repair.

2.1.11.3 Flexural Strength and Modulus of Elasticity

Determine, record and report the Flexural strength and tangent modulus of elasticity of the material using procedures contained in ASTM C580 using three-point bending. Prepare three sets of three beam samples, one set per curing interval. Prepare the sample so that no sample dimension is less 51 mm 2 in or 5 times the maximum aggregate size. The maximum aggregate size is the smallest standard sieve size through which 100 percent of the aggregate will pass. Cure the samples at 23 Degrees C 73 Degrees F. Test the first set of specimens after a curing period of one hour and a second set after a curing period of four hours. Test the third set of samples at the manufacturer’s published cure or trafficability time for the product at 23 Degrees C 73 Degrees F. Use only those materials with a flexural strength which exceeds 2,410 kPa 350 psi and a tangent modulus greater than 34.5 MPa 5,000 psi at the time of trafficking of the repair.

2.1.11.4 Bond Strength by Slant Shear

Test, determine, record and report the material bond strength using ASTM C882/C882M, with the following modification. In lieu of the specified testing using a layer of material sandwiched between two PCC dummies, prepare samples which contain one PCC dummy that represents half of the specimen with repair material use to produce the other half of the sample. Cast 75 by 150 mm 3 by 6 inch cylinder specimens by casting the polymeric repair material against a 30-degree wedge specimen consisting of an ordinary portland cement mixture. Prepare three sets of three cylinder samples, one set per curing interval. Cure the samples at 23 Degrees C 73 Degrees F. After curing, cap the cylinders according to ASTM C617/C617M.

Test the composite cylinder in compression causing a shear failure at the bond line. Test one set of specimens after a curing period of four hours. Test another set after a curing period of 24 hours. Test the other set of samples at the manufacturer’s published cure or trafficability time for the product at 23 Degrees C 73 Degrees F. Use only those materials with a calculated bond strength in excess of 3,450 kPa 500 psi at the time of traffic.

2.1.11.5 Thermal Compatibility

In accordance with ASTM C884/C884M, prepare two samples by first casting and curing for 28 days two PCC blocks, each measuring 305 mm x 305 mm x 76 mm 12 in x 12 in x 3 in. After 28 days of curing, apply an overlay of the repair material on each of these two PCC blocks measuring 13 mm 0.5 in thick. Cure each block for seven days at 23 Degrees C 73 Degrees F. Expose the composite specimens to five freeze–thaw cycles, each cycle consisting of exposure to -21 Degrees C -6 Degrees F for 24 hours then 23 Degrees C 73 Degrees F for 24 hours. Use only those materials that do not have any signs of delamination in either specimen.

2.1.11.6 Dynamic Mechanical Analysis (DMA)

Prepare three sample in accordance with ASTM D5023 using the largest samples that will fit in the test apparatus. Prepare the sample without aggregates if possible. Test, determine, record and report the change in Modulus of Elasticity as a function of temperature at intervals of 5 Degrees C 10 Degrees F . Report any melting of the repair material over the selected temperature range. Test the pavement repair material from -51 Degrees C to 204 Degrees C -60 Degrees F to 400 Degrees F. Use a sinusoidal three-point bending load on the specimen at a frequency of 0.1 second with a maximum strain of 0.01 percent. Increase the temperature linearly at a rate of 3 Degrees C per minute. Record the storage modulus (modulus of elasticity), loss modulus, and tangent delta as a function of temperature. Test the specimens after curing the specimens for seven days at 23 Degrees C 73 Degrees F. Report the temperature at which the storage modulus value decreases to 50 percent of the modulus value at 23 Degrees C 73 Degrees F. Report if the sample melts or combusts at temperatures less than or equal to 204 Degrees C 400 Degrees F. Use only materials which have 50 percent reduction in modulus at temperatures in excess of 66 Degrees C 150 Degrees F. Use only materials which do not melt or combust at temperatures less than or equal to 204 Degrees C 400 Degrees F.

2.1.12 Sand-Cement Mortar for Filling Small Popouts

Sand-cement mortars are not permitted for spall repair. For small popouts, an approved epoxy may the used as the repair material.

2.1.13 Reinforcement

Provide reinforcement as [indicated on the drawings][specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE].

PART 3 EXECUTION

3.1 PATCH MATERIAL SELECTION

Use Portland cement concrete (PCC) or approved proprietary product for repair areas more than 9,400 cubic centimeters 600 cubic inches in volume after unsound concrete is removed. Use Portland cement mortar for cavities between 850 and 9,400 cubic centimeters 50 and 600 cubic inches in size after unsound concrete is removed.

3.2 BATCHING, MIXING AND PROPORTIONING OF CONCRETE REPAIR MATERIAL

Provide facilities and equipment for the accurate measurement and control of each of the materials entering the concrete, mortar, and grout. Provide free access for the Contracting Officer to the batching and mixing plant at all times. Provide mixing equipment capable of combining the aggregate, cement, admixture, and water into a uniform mixture and discharging this mixture without segregation. The concrete mixing equipment is to meet the applicable requirements of ASTM C94/C94M.

The use of volumetric batching and continous mixing is acceptable, provided all operations are in accordance with ASTM C685/C685M.

3.2.1 Equipment

Assemble dependable and operable equipment, allowing time for thorough inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required prior to final approval and the commencement of work. Maintain the equipment in good working condition. Use only equipment that can ensure the water to cement ratio is within 2 percent of required.

3.2.2 Conveying

Convey concrete from mixer to repair area as rapidly as practible by methods which prevent segregation or loss of ingredients.

3.2.3 Facilities for Sampling

Provide facilities for readily obtaining representative samples of aggregate and concrete for test purposes. Furnish necessary platforms, tools, and equipment for obtaining samples.

3.2.4 Concrete Mix Proportions

Use proportions of concrete materials entering into the concrete mixture in accordance with the approved mix design. Revise the mix design whenever necessary to maintain the workability, strength, and standard of quality required, and to meet the varying conditions encountered during the construction; however, make no changes without prior approval. The water to cement ratio cannot exceed 0.45 at any time.

3.2.5 Measurement

Provide equipment necessary to measure and control the amount of each material in each batch of concrete. Weigh bulk cement. Cement in unopened bags as packed by the manufacturer may be used without weighing. One bag of portland cement is considered as weighing 42.64 kg 94 pounds.

Measure mixing water and air-entraining admixtures by volume or by weight. Consider one liter gallon of water as weighing 1 kg 8.33 pounds.

Use only equipment, sensors and measurement controls that ensure the water to cement ratio is accurately controlled within 2 percent of required.

3.2.6 Workability

Maintain the slump of the concrete at the lowest practicable value, not exceeding the value specified in Paragraph PORTLAND CEMENT CONCRETE MIX DESIGN or the manufacturer's recommendation when proprietary repair materials are used.

3.3 PREPARATION OF EXISTING PAVEMENT

****

NOTE: Airfield projects require full depth repairs in accordance with Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS. For projects other than airfields, full depth repairs should be requied as specified in Section 32 13 13.06 PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES.

****

****

NOTE: Specify minimum depth of removal of existing PCC. A 50 mm 2 inch minimum depth is usually satisfactory and should be specified, except where local conditions indicate 50 mm 2 inch thick shallow patches have an unsatisfactory service record. When required depth of repair is known or reasonably expected to exceed one-half the pavement thickness, full depth repairs should be required.

****

3.3.1 Preparation of Existing Surfaces

In the area to be patched, [except popouts,] remove existing concrete to a minimum depth of [50] [_____] mm [2] [_____] inches below the pavement surface adjacent to spalls and to such additional depth where necessary to expose a surface of sound, unweathered, and non-delaminated concrete that is not contaminated by sealants, oils, greases, or deicing salts or solutions. Make a vertical perimeter saw cut at least 50 mm 2 inches deep and at least 50 mm 2 inches outside of the area needing repair. Accomplish concrete removal in spalled areas with light, hand-held, high-frequency chipping hammers weighing not more than 14 kg 30 pounds or other approved hand tools. Do not use jack hammers weighing more than 14 kg 30 pounds and do not use pavement breaker devices mounted on or pulled by mobile equipment. Use of milling devices such as a cold planer are allowed but require augmentation with concrete saws and jack hammers to generate the required vertical surfaces on edges of the repair which are milled at the curvature of the drum.

Clean the repair area surface by [sandblasting] [waterblasting], blowing with compressed air, sweeping, and vacuums. Use [sandblasting] [waterblasting] to remove all traces of sealer, oils, grease, rust, and other contaminants.

3.3.2 Reinforcement

****

NOTE: Dowel bars and tie bars are typically located at mid-depth of the slab. If unsound concrete extends to the depth of the dowel bars or tie bars,

perform full-depth repairs at these locations.
****

Clean to bare metal by sandblasting any existing reinforcement exposed in the repair area. Remove any reinforcement that cannot be properly re-embedded in the new repair concrete. Cut and remove at the joint not less than 50 mm 2 inches of existing exposed reinforcement that is continuous through the repair area and is embedded in the adjacent slab.

3.3.3 Preparation of Joints Adjacent to Spalls

Remove existing joint sealing and joint filler materials. Saw as indicated and install insert board, cut to appropriate dimensions, to prevent contact between new patch material and existing concrete at the adjacent joint face. Use insert board with a thickness equal to or slightly larger than the joint width (groove) adjacent to the repair material, as indicated on the drawings. Install a bead of approved caulking material to preclude new patching material from getting around insert and into the joint from the sides and bottom of the insert. Clean up any caulking material accidentally deposited on the prepared spall surface. Repair any sawcut overcuts with an approved epoxy repair material.

3.3.4 Disposal of Debris

****
NOTE: Specify location of disposal of debris.
****

Sweep pavement surface to remove excess joint material, dirt, water, sand, and other debris using vacuum sweepers or hand brooms. Remove the debris immediately [to a point off station.] [to an area designated by the Contracting Officer.] [in accordance with Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION].]

3.3.5 Bonding Agent, Adhesive or Coat

****
NOTE: Epoxy-resin bond coats should be limited to patches less than 600 mm 2 feet square. For proprietary patching products, prepare the substrate in accordance with the manufacturer's recommendations.
****

Prior to placing concrete, wash the previously prepared surfaces with a high pressure water jet followed by an air jet to remove free water on the repair surface.

3.3.5.1 Epoxy-Resin

Limit epoxy-resin bonding coat to use on patches with a surface area of less than 600 mm 2 feet square. Coat the clean and dry surface, including sawed faces, with a 0.02 to 0.04 mm 20 to 40 mil thick film of the epoxy-resin bonding coat Place the epoxy-resin bonding coat in one application, just prior to concrete placement, with the use of mechanical combination, mixing and spraying equipment, or two coat application with stiff brushes. Scrub the first brush coat into the concrete surface, followed by an additional brush coat to obtain the required thickness. Apply the final coat just prior to placement of the concrete.

3.3.5.2 Proprietary Repair Products

Apply in accordance with the manufacturer's written instructions.

3.3.6 Popout Repair

****

NOTE: Delete this paragraph if no popout repairs are included in the project. Note the first sentence for definition of popouts.

Delete the bracketed statements containing "sand-cement " and "chipping" for airfield projects, and specify overcoring surface defects in concrete. Overcoring refers to coring a hole around the popout that is at least 50 mm 2 inches in diameter wider than the popout, centered on the popout and that is at least 25 mm 1 inch deeper than the popout or 50 mm 2 inches deep, whichever is deeper.

When the time to return to traffic is less than 12 hours normal concrete mixes will not likely meet mission requirements and the use of approved proprietary repair materials, including epoxy materials, should be considered. When repairs must be made in temperatures below 45 degrees F and above 90 degrees F the use of approved proprietary repair materials, including epoxy materials designed for use in the prevailing weather conditions at placement, should be considered. Epoxy materials should not be considered for repairs in excess of 4 square feet.

****

Popouts, as used herein, are pavement surface defects caused by deterioration of unsatisfactory coarse aggregate, decaying of organic material such as wood or roots, mechanical accidents, or other reasons. Most popouts are indicated on the drawings by average diameter but the actual surface configuration will vary from circular to polygonal. Repair popouts as indicated using [epoxy mortar] [approved proprietary repair material]. Clean popout cavities of all dirt and contaminants prior to filling. As indicated on drawings, prepare popout areas by [chipping] [overcoring surface defects in] the concrete to eliminate feather edging of the mortar or concrete repair material. Core out the distressed areas at least 50 mm 2 inches deep or 25 mm 1 inch below the depth of the popout.

3.4 PLACING

3.4.1 Portland Cement Concrete

****

NOTE: Specify placing time to suit concrete materials and environmental conditions. For most projects, 90 minutes from the time of initial mixing is adequate. However, during hot weather when daytime temperatures exceed 85 degrees F, specifiy

45 minutes.
****

Place concrete within [45] [90] minutes after the introduction of the mixing water to the cement and aggregate or the introduction of the cement to the aggregate and before the concrete has obtained its initial set. The temperature of the concrete, as deposited in the repair area, can not be not less than 10 degrees C 50 degrees F nor more than 32 degrees C 90 degrees F. Deposit concrete as to require a minimum of re-handling and in such a manner so as to least disturb the sand-cement grout. Place concrete as indicated to maintain existing joints [and working cracks]. Use an insert or other bond-breaking medium where the spalled area abuts a joint to prevent bond at the joint face and to allow movement of the slabs and to prevent stress concentrations. Do not allow new repair material to infiltrate or span existing joints [and cracks] indicated to remain. Place concrete continuously in each spall area. Do not allow workmen to walk on the damp repair surface or in the concrete during placing and finishing operations.

Consolidate the concrete by small spud vibrators not greater than 25 mm one inch in diameter, except that repair areas less than 100 mm 4 inches deep or 0.093 square meter one square foot in area may be consolidated by hand tamping or other approved means. To avoid pulling material away from patch edge and to maximize bond strength, work the finishing screed from the center of the patch out to the patch boundary. Fill all saw kerfs extending beyond the repair area with grout. Start finishing operations immediately after placement of the concrete. Match finished surface grade of patched areas to the existing surface grade of the adjacent undisturbed pavement. Keep screeding, floating, or troweling of patch material onto adjacent pavements to a minimum and remove loose or poorly bonded patch material from adjacent surfaces. Before the concrete becomes non-plastic, finish the surface with a [broom] [burlap drag] [_____] to approximately match the surface finish of existing adjacent concrete pavement. Remove repair materials for surfaces adjacent to but outside the repair surface.

[Popouts and spalls, both with a maximum dimension less than 150 mm 6 inches, and not within 100 mm 4 inches of a joint or working crack, may be prepared by drilling a core 50 mm 2 inches in diameter greater than the size of the defect, centered over the defect, and 50 mm 2 inches deep or 13 mm 1/2 inch into sound concrete, whichever is greater. Repair the core hole as specified above for other spalls.]

3.4.2 Epoxy-Resin Concrete and Mortar

Limit epoxy-resin bonding coat to use on patches with a surface area of less than 600 mm 2 feet square. Place the epoxy resin materials in layers not over 50 mm 2 inches thick. Make the time interval between placement of additional layers such that the temperature of the epoxy resin material does not exceed 60 degrees C 140 degrees F at any time during hardening. Use mechanical vibrators and hand tampers to consolidate the concrete or mortar. Remove any repair material on the surrounding surfaces of the existing concrete before it hardens.

Place the repair material as indicated to maintain existing joints [and working cracks]. Use an insert or other bond-breaking medium where the spalled area abuts a joint to prevent bond at the joint face. Do not allow new repair material to infiltrate or span existing joints [and cracks] indicated to remain. Place the repair material continously in each spall area. Finish the repair material to match the grade of the adjacent concrete surface.

Spalls not adjacent to joints and popouts, both less than 150 mm 6 inches in maximum dimension, may be prepared by drilling a core 50 mm 2 inches in diameter greater than the size of the defect, centered over the defect, and 50 mm 2 inches deep or 13 mm 1/2 inch into sound concrete, whichever is greater. Repair the core hole as specified above for other spalls.

3.4.3 Proprietary Repair Products

Perform placing, consolidating, finishing, and curing operations in accordance with the manufacturer's written instructions.

Place the repair material as indicated to maintain existing joints [and working cracks]. Use an insert or other bond-breaking medium where the spalled area abuts a joint to prevent bond at the joint face. Do not allow new repair material to infiltrate or span existing joints [and cracks]. Place the repair material continuously in each spall area. Finish the repair material to match the grade of the adjacent concrete surface.

3.5 CURING

****

NOTE: A minimum curing time of 3 days is required when Type I or Type II cements are used.

****

Cure the repair concrete by protection against loss of moisture and rapid temperature changes for a period of not less than [3] [_____] days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. Provide all equipment needed for adequate curing and protection of the concrete on hand and ready to install before actual concrete placement begins. Cure proprietary repair products in accordance with manufacturer's recommendations. Failure to comply with curing requirements will be cause for immediate suspension of concreting operations.

3.5.1 Membrane-Forming Curing Compound

Apply membrane -forming curing compound immediately to exposed concrete surfaces. Apply the curing compound with an overlapping coverage that will give a two-coat application at a coverage of not more than 20 square m/L 200 square feet per gallon for both coats. When application is made by hand-operated sprayers, apply the second coat in a direction approximately at right angles to the first coat.

Cure concrete properly at joints, but do not allow absorbent curing compound to enter joints that are to be sealed with a joint-sealing compounds. Provide a uniform, continuous, cohesive compound film that will not check, crack, or peel, and that will be free from pinholes and other imperfections. Respray concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied at the coverage specified above and at no additional cost to the Government. Respray areas covered with absorbent curing material that are damaged by pedestrian and vehicular traffic or by subsequent construction operations within the specified curing period at no additional cost to the Government.

3.6 JOINT RE-ESTABLISHMENT

For joint spall repairs, after the repair material has cured, saw a reservoir for the joint sealant to the dimensions required for other joints. Thoroughly clean and seal the reservoir with the sealer and backer rod specified for the joints. Construct new joints as detailed on the drawings and align with existing joints.

3.7 FINISH TOLERANCE

Provide finished surfaces of patched areas meeting the grade of the adjoining pavements without deviations more than 3 mm 1/8 inch from a true plan surface within the patched area or at the interface with the adjoining pavement.

3.8 REPAIR AREA PROTECTION

Protect the patched areas against damage prior to final acceptance of the work by the Government. Exclude traffic from the patched areas by erecting and maintaining barricades and signs until the completion of the curing period of the concrete or the curing period of proprietary repair products as per the manufacturer's instructions.

3.9 FIELD QUALITY CONTROL

3.9.1 General Requirements

Test proprietary products in accordance with the manufacturer's written instructions.

3.9.2 Testing for Strength, Slump, and Air Content

Sample concrete in the field and test to determine the slump, air content, and strength of the concrete.

Make cylinders for each shift of placed concrete. Mold each group of test cylinders from the same batch of concrete, consisting of a sufficient number of specimens to provide two compressive-strength tests at each test age. Make one group of specimens during the first half of the shift, and the other during the last portion of the shift. However, at the start of paving operations and each time the aggregate source, aggregate characteristic, or mix design is changed, make one additional set of test cylinders. Mold and cure test cylinders at the site for the first 24 hours or until the testing is required if less than 24 hours of curing is required and later in the laboratory in conformance with ASTM C31/C31M. Test cylinders in accordance with ASTM C39/C39M.

Determine the air content and slump in accordance with ASTM C231/C231M and ASTM C143/C143M, respectively.

3.9.2.1 Test Results

Remove concrete not meeting strength, consistency, and air content requirements and provide concrete that meets the requirements of this specification. The removal and replacement method or methods are subject to approval of the Contracting Officer.

3.9.2.2 Acceptance

Within 30 days of spall repair or prior to final acceptance, any spall repair material that cracks, or delaminates, or loses bond partly or completely as indicated by soundings, or causes spalling of adjacent portland cement concrete, or is not separated properly from adjacent slabs at joints, or fails to cure uniformly and completely, or is otherwise defective will be rejected by the Government.

Remove all unacceptable repairs, including new damaged areas adjacent to new spall patches, and provide new repairs meeting the specifications.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 01 29.62 (November 2018)**

Preparing Activity: USACE **Superseding**
UFGS-32 01 29.62 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 01 29.62

CONCRETE PAVEMENT RAISING

11/18

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NOTE: This guide specification covers the requirements for slabjacking of rigid pavements for roads, streets, parking areas, airfield and other general applications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: Delete paragraphs MEASUREMENT and PAYMENT when lump sum bidding is used.

****

1.1.1 Measurement

Accurately measure the dry materials by weight or volume if delivered in bulk or packaged in uniform volume sacks. Batch the water through a meter or scale with a totalizer for the day's consumption. Make these measurements in the presence of the Contracting Officer. Submit weigh bills for cement and sand after slabjacking operations are completed to validate mix proportions used.

1.1.1.1 Quantity of Portland Cement Grout

The quantity of portland cement grout to be paid for will be that actually used in the accepted work.

1.1.1.2 Quantity of Portland Cement

The quantity of portland cement to be paid for will be accurately measured by weight.

1.1.1.3 Number of Holes

The quantity of holes to be paid for will be the number of holes actually drilled to accomplish the work specified and as shown on the drawings.

1.1.1.4 Broken Slabs

Repair or replacement of concrete slabs broken due to jacking will not be measured for payment. Furnish all labor, equipment, tools, and materials necessary to repair or replace broken concrete pavement at no cost to the Government.

1.1.2 Payment

1.1.2.1 Portland Cement Unit Price

The quantity of portland cement, measured as specified, will be paid for at the contract unit price for portland cement. The unit price for portland cement will include full compensation for furnishing labor, grout materials, and tools and equipment; for furnishing, loading and unloading, storing, hauling and handling grout ingredients; for mixing and pumping grout; and for furnishing of manufacturer's test report for each lot of cement. All of the above will be considered in the unit price per kg hundred weight of portland cement.

1.1.2.2 Drilled Holes

The quantity of holes determined as specified, will be paid for at the contract unit price for Drilled Holes, which will include full compensation for furnishing all labor, equipment, tools, materials, and for filling of holes.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C266	(2020) Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C937	(2023) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C939/C939M	(2022) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C940	(2022) Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C953	(2024) Standard Test Method for Time of

	Setting of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Weigh Bills; G, [_____]

Equipment; G, [_____]

SD-05 Design Data

Grout Mixture; G, [_____]

SD-06 Test Reports

Production Sampling and Testing

Tests, Inspections, and Verifications

SD-07 Certificates

Cement

Grout Mixture

1.4 QUALITY CONTROL

1.4.1 Bench Marks

Determine, establish, and maintain elevations of bench marks for grade control.

1.4.2 Testing Facilities

Perform sampling and testing using a commerical testing laboratory approved in accordance with Section 01 45 00 QUALITY CONTROL. Work requiring testing will not be permitted until the facilities have been inspected and approved. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. The laboratory is to maintain this certification for the duration of the project. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the tests.

1.4.3 Cement

Do not use cement until its test report is approved by the Contracting Officer. Sample cement at the mill or shipping point and at the work site. If tests prove that a cement that has been delivered is unsatisfactory, promptly remove it from the work site. Retest cement that has not been used within 6 months after testing when directed by the Contracting Officer. Cement will be rejected if test results are not satisfactory.

1.4.4 Aggregate

Sample aggregates in the presence of the Contracting Officer. Obtain samples in accordance with ASTM D75/D75M that are representative of the materials to be used for the project. Perform all aggregate tests no earlier than [30] [_____] days prior to starting grouting operations. Conduct aggregate testing in a laboratory approved by the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Provisions for Cement

Deliver and store all cementitious materials at a temperature not exceeding

65 degrees C 150 degrees F. Furnish cement in bulk or in suitable bags used for packaging cement. Plainly mark the bags with the manufacturer's name, brand, and lot number. Furnish cement that is dry and free from lumps and caking when delivered. Check shipments of bagged cement for weight when delivered. Provide accurate scales and labor for checking the weight of bagged cement. Approximately 1 percent of each shipment will be selected at random and checked for weight except that additional weight checks will be made to determine compliance with the cement specification when deficiencies in weight are found. Deliver bulk cement, if used, in weathertight carriers and unload it into the storage facilities by means of weathertight conveyors or other suitable means that will completely protect the cement from moisture. Storage facilities are subject to approval. Provide storage facilities that permit easy access for inspection and identification. Store and use different brands of cement separately so that a complete record will be available of the grade of cement used in all batches of grout mixes.

1.5.2 Provisions for Aggregates

Handle and store aggregates at the site so that segregation, intermixing between stockpiles, or contamination by foreign materials does not occur. Prepare and maintain sites for stockpiles to prevent the inclusion of foreign materials with the aggregate. Segregated aggregate is not permitted. Discard aggregate when segregation is apparent at no cost to the Government.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not perform pavement slabjacking when the ambient temperature at the bottom of the pavement slab is less than 5 degrees C 40 degrees F or when the subgrade or aggregate base is frozen.

PART 2 PRODUCTS

2.1 EQUIPMENT

Furnish all equipment, tools, and other apparatus necessary for the proper construction and acceptable completion of the work specified under this contract. The equipment must be approved by the Contracting Officer prior to starting the work. Maintain equipment in good working condition during the progress of the work. Submit list of proposed equipment to be used in performance of construction work including descriptive data.

2.1.1 Grout Plant

****

NOTE: When the use of limestone dust grouts is approved, a paddle type mixer may be substituted for the high speed colloidal mixer.

****

Provide a grout plant consisting of a positive displacement grout injection pump capable of applying up to 1.72 MPa 250 psi pressure, a high speed colloidal mixing machine, and a grout return system. Produce the colloidal grout by mixing in a colloidal mill connected to the cone-shaped bottom of a cylindrical drum. Operate the colloidal mill between 800 and 2,000 RPM, creating a high shearing action and subsequent pressure release to make a homogeneous mixture. Provide an injection system capable of continuously pumping grout at rates as low as 5.68 liters 1-1/2 gallons per minute and equipped with pressure monitoring devices and a quick action valving system that can be closed instantly and provide for the grout to be recirculated through the system.

2.1.2 Water Tanker

If water tanks and metered pumps are not an integral part of the plant, provide a water truck equipped with a metered pump for delivery to the grout plant.

2.1.3 Drilling

Provide an air compressor and rock drill or other device capable of drilling the grout injection holes through the pavement and base material. Keep the equipment in good condition. Provide injection holes that are vertical and round. Do not exceed a down-feed pressure of 1.38 MPa 200 psi whether by hand or mechanical means.

2.1.4 Flow Cone

Provide a flow cone with necessary components in accordance with ASTM C939/C939M so that the consistency of the mixture can be determined.

2.1.5 Miscellaneous

Provide all necessary hoses; valving, valve manifolds, and positive cut-off and bypass provisions to control pressure and volume; pressure gauges with gauge protectors; expanding packers for positive seal grout injection; wood plugs; hole washing tools; and drill steel and bits.

2.2 MATERIALS

2.2.1 Portland Cement

Provide portland cement Type [_____] meeting the requirements of ASTM C150/C150M. Do not use cement salvaged by cleaning bags mechanically or otherwise, or from discarded bags of cement. Use cement that has been stored at the site for 60 days or more before using cement of lesser age.

2.2.2 Pozzolans and Fly Ash

Provide pozzolans and fly ash meeting the requirements of ASTM C618.

2.2.3 Mineral Aggregate

Provide aggregate to be used for slabjacking consisting of natural sand, manufactured sand, or a combination of natural and manufactured sand and limestone dust. If the aggregate is a combination of separately processed sizes from the same or different sources, or a blend of different materials, batch the different components separately or blend under approved conditions prior to delivery to the batching plant.

2.2.3.1 Particle Shape

Provide particles of the aggregate that are generally spherical or cubical in shape. Aggregates containing flat platelet grains or rhombohedral grains will not be approved.

2.2.3.2 Grading

Provide aggregate conforming to the following gradation when tested in accordance with ASTM C136/C136M and ASTM C117.

Sieve designation U.S. Standard square mesh	Percentage by weight passing
2.36 mmNo. 8	100
1.18 mmNo. 16	80-95
0.30 mmNo. 50	50-70
0.075 mmNo. 200	25-45

2.2.3.3 Deleterious Materials

Do not exceed the following limits for deleterious materials in the aggregate when tested in accordance with ASTM C142/C142M.

Material	Percentage by Weight
Clay lumps	2.0
Coal and lignite	1.0

2.2.4 Chemical Admixtures

Provide chemical admixtures that are proposed to be used to assist in pumping grouts or to compensate for climatic conditions conforming to ASTM C494/C494M and ASTM C937.

2.2.5 Water

Provide water for mixing and curing that is fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water, or water from concrete production operations may be used if it meets the requirements of ASTM C1602/C1602M.

2.3 MIXES

2.3.1 Proportioning of Materials

Proportion the grout mixture to be used for slabjacking as follows:

a. One part (by volume) portland cement.

b. Three parts (by volume) aggregates or a mixture of aggregates and pozzolans or fly ash.

c. Water to achieve fluidity.

d. Additives (when approved), high range water reducers, water reducers, fluidifiers.

2.3.2 Grout Mixture

Submit certified mix designs by an approved commerical laboratory for each type of concrete, grout, or blended material including a complete list of ingredients, admixtures, and set time. Include certificates for cement, cementitious materials, and admixtures. Proportion and test a mix design to meet the specification requirements. Provide portland cement grout mixture used for slabjacking consisting of portland cement, pozzolan or fly ash, limestone dust, sand, and water. The use of accelerators, high range water reducers and fluidifiers are subject to the approval of the Contracting Officer. Do not produce grout until the mix design has been approved.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit certified copies of test reports for aggregates, cement, and fly ash not less than [30] [_____] days before the material is required in the work and daily during construction. Provide certified reports of inspections and laboratory tests including analysis and interpretation of test results. Properly identify each report by contract number, location, quantity of material placed, and timed events of milestones. Describe test methods used and compliance with specified standards.

2.4.1 Daily Report

Provide daily mixture test results of the materials and additives used in the mixture including aggregate gradation, flow cone times, shrinkage and expansion observed, time of initial set, and 1-day, 3-day, and 7-day strengths of previous day's placements.

2.4.2 Compressive Strength

Provide a minimum 7-day strength not less than 4 MPa 600 psi as determined by tests made in accordance with ASTM C39/C39M. Fabricate test specimens from the materials being used on the project including water and admixtures. Make, cure, and test specimens as described in paragraph FIELD TEST SPECIMENS in PART 3.

2.4.3 Expansion

Determine the expansion in accordance with ASTM C940 at the beginning of the job and whenever the mix proportions are changed.

2.4.4 Set Time

Determine the time of initial set in accordance with ASTM C266 or ASTM C953 at the beginning of the job and when a different lot of cement is used.

2.4.5 Fluidity

Test the fluidity of each batch of grout slurry in accordance with ASTM C939/C939M. Provide time of efflux (fluidity) for pozzolanic grouts that range from 16 to 26 seconds. Provide time of efflux for limestone dust grouts that range from 22 to 32 seconds. A flow cone time of efflux of 9 to 15 seconds can be used during the initial injection at each hole.

PART 3 EXECUTION

3.1 PAVEMENT INSPECTION

Closely examine the slabs for any existing cracks prior to jacking any pavements. Perform this investigation with the Contracting Officer. Both parties must agree regarding the existing condition of the pavement with existing cracks noted and marked.

3.2 DRILLING HOLES FOR GROUT INJECTION

Drill grout injection holes in a pattern as shown on the drawings. Drill grout injection holesto a maximum diameter of 50 mm 2 inches. Drill holes vertically to a depth sufficient to penetrate through any chemically stabilized base, but not more than 75 mm 3 inches into the subgrade. Drill holes so that breakout does not occur at the bottom of the slab.

3.3 WASH HOLES

Subject to the Contracting Officer's approval, holes may be washed or air blown to create a small cavity to allow the initial spread of grout.

3.4 JACKING

Erect string lines that will be blocked up from the pavement high points to monitor movement prior to jacking operations. Lower into the holes an expanding rubber packer or other approved device providing a positive seal and connected to the discharge hose on the grout plant. Do not extend the discharge end of the packer or hose below the lower surface of the concrete pavement. Pump in a pattern and in the amount required to raise the pavement to string line grade. Continuous pressures up to 1.38 MPa 200 psi are permitted. Pressures within the range of 1.38 MPa 200 psi to 2.07 MPa 300 psi are allowed only for short periods. In the event the pavement is bonded to the aggregate base, brief pressure rises (10 seconds or less) up to 4.14 MPa 600 psi are allowed. Loss of grout through cracks, joints, other injection holes, or from back pressure in the hose or in the shoulder area is not permitted. Do not use grout for jacking that is held for more than 1 hour in the mixer or in the injection pump or hose.

3.5 RAISING OF SLABS

Do not raise the slabs more than 5 mm 1/4 inch when pumping in any one hole at any time. Do not raise any part of a slab so that it leads any other part of the slab or any adjacent slab more than 5 mm 1/4 inch at any time. Keep the entire slab and all adjacent slabs on the same plane at all times within the 5 mm 1/4 inch tolerance. Make observations to ensure that when pumping from one hole, the grout flows to adjacent holes filling all voids. Slabs can be cut to prevent breakage when it is bound against an adjoining slab. If the temperature is 27 degrees C 80 degrees F or higher during the jacking operation, moisten the slabs sufficiently to prevent expansion of the slabs.

3.6 SEALING OF INJECTION HOLES

Immediately remove the packer and plug the hole temporarily with a tapered wooden plug after jacking has been completed at any one hole. Do not remove the temporary wooden plugs until the grout has set sufficiently so that back pressure will not force it through the hole. Permanently seal each hole flush with the pavement surface with a fast setting sand/cement or other patch material approved by the Contracting Officer. Provide patch material having a minimum thickness of 75 mm 3 inches.

3.7 PLAN GRADE REQUIREMENTS

****

NOTE: The designer will evaluate which procedure, i.e., grinding or raising the adjacent pavement, should be used to correct for overjacking. If the slabjacking is to be accomplished adjacent to a fixed structure it will be necessary to grind or remove the overjacked pavement. The 3 mm 1/8 inch tolerance is appropriate for airfield and high-speed roadway pavements. For low-speed roadways and parking areas a tolerance of 6 mm 1/4 inch should be specified.

****

Provide qualified personnel and equipment for determining the proper elevations required to conform to the plan elevations. Perform jacking operations so that all slabs within the work area present an even grade at each joint and that do not vary from the plan grade elevations by more than [3] [6] mm [1/8] [1/4] inch. If slabs are found that are lower than the specified tolerance from the plan grade, continue jacking these slabs until the tolerance is met. [If slabs are found that are higher than the specified tolerance, raise the grade of the surrounding pavement to a newly established grade as determined by the Contracting Officer.] [Grind individual sections of pavement that are raised above the specified tolerances.] Should the overjacking be greater than 5 mm 1/4 inch the Contracting Officer has the option to require removal and replacement of the pavement. Perform repairs to jacked slabs at no additional cost to the Government.

3.8 REPLACING AND REPAIR OF DAMAGED PAVEMENT

Replace or repair any slabs broken due to jacking as determined by the Contracting Officer. Cracks emanating radially from the grout injection holes will be presumed to be caused by improper injection techniques. For each 1.5 m 5 feet of such crack measured, the pay quantity will be reduced by 0.03 cubic meters 1 cubic foot of grout. In the event that transverse cracks develop between adjacent grout injection holes, repair these cracks by an epoxy injection method to the satisfaction of the Contracting Officer. The Contracting Officer may require the removal and replacement of the entire slab or a portion of the slab damaged by radial or transverse cracks at no cost to the Government. Replace the pavement in accordance with Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS.

3.9 PRODUCTION SAMPLING AND TESTING

3.9.1 Aggregates

Sample aggregates delivered to the mixer during slabjacking operations to determine compliance with specifications. Test aggregate gradation daily.

3.9.2 Field Test Specimens

Take samples of grout in the field from mixtures used for jacking to determine the adequacy of control of materials and the proportioning, consistency, and mixing of the grout. Take three sets of three cylinders from each day's operation or when the mixture proportions are changed. Make and cure the test cylinders in accordance with ASTM C31/C31M and test them in accordance with ASTM C39/C39M for strength. Additional sets of test cylinders will be required at the start of jacking operations and when the aggregate source, aggregate characteristics, or mix design is changed until the Contracting Officer is satisfied that the grout mixture being used complies with the strength requirements specified. Use an approved commerical laboratory to cure and test specimens for compressive strength. The test result will be the average of the strength of the 3 cylinders. If the average strength of cylinders falls below the specified strength, the Contracting Officer may require changes in the mix proportions.

3.10 PROTECTION OF PAVEMENT

Do not permit traffic on the pavement slab until the grout has obtained a minimum set. Include the minimum set time in the grout mixture submittal. Adjust the minimum set time daily to account for variations in temperature.

3.11 ACCEPTANCE OF WORK

Prior to acceptance, remove loose concrete, joint filler, or grout spilled on the surface or shoulder. Remove waste construction material and leave the surrounding areas in a neat and orderly condition prior to opening to traffic or final acceptance.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 05 33 (August 2017)**

Preparing Activity: NAVFAC **Superseding**
UFGS-32 05 33 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 32 05 33

LANDSCAPE ESTABLISHMENT
08/17

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NOTE: This guide specification covers the requirements for plant material and irrigation during the establishment period.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2103	(2015) Standard Specification for Polyethylene Film and Sheeting
ASTM D5851	(1995; R 2015) Planning and Implementing a Water Monitoring Program
ASTM D6155	(2019) Nontraditional Coarse Aggregate for Bituminous Paving Mixtures

TREE CARE INDUSTRY ASSOCIATION (TCIA)

TCIA Z133	(2017) American National Standard for Arboricultural Operations - Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush - Safety Requirements

1.2 DEFINITIONS

1.2.1 Pesticide

Any substance or mixture of substances, including biological control agents, that may prevent, destroy, repel, or mitigate pests and are specifically labeled for use by the U.S. Environmental Protection Agency (EPA). Also, any substance used as a plant regulator, defoliant, disinfectant, or biocide. Examples of pesticides include fumigants, herbicides, insecticides, fungicides, nematicides, molluscicides and rodenticides.

1.2.2 Stand of Turf

[100][95] percent ground cover of the established species.

1.2.3 Planter Beds

A planter bed is defined as an area containing one or a combination of the following plant types: shrubs, vines, wildflowers, annuals, perennials, ground cover, [and a mulch topdressing] excluding turf. Trees may also be found in planter beds.

1.3 RELATED REQUIREMENTS

[Section 32 84 24 IRRIGATION SPRINKLER SYSTEM applies to this section for installation of irrigation equipment requirements, with additions and modifications herein.

] [Section 32 92 19 SEEDING][Section 32 92 23 SODDING][Section 32 92 26 SPRIGGING] applies to this section for installation of [seed][sod][sprigging] requirements, with additions and modifications herein.

[Section 32 93 00 EXTERIOR PLANTS applies to this section for installation of [trees,] [shrubs,] [ground cover,] [vines,] and [wildflower,] with additions and modifications herein.

][Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS applies to this section for transplanting of [trees,] [shrubs,] [ground cover,] [vines,] and [wildflower,] with additions and modifications herein.

]1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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SD-01 Preconstruction Submittals

Integrated Pest Management Plan; G, [_____]

SD-03 Product Data

Fertilizer; G, [_____]

Mulches Topdressing

Organic Mulch Materials

SD-07 Certificates

Maintenance Inspection Report

[Plant Quantities; G, [_____]

] SD-10 Operation and Maintenance Data

Maintenance

SD-11 Closeout Submittals

Tree Staking and Guying Removal

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Delivery

Deliver fertilizer, [gypsum,] [iron] to the site in original containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer, [gypsum] may be furnished in bulk with a certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Fertilizer, [Lime], [Iron,] [Mulch] Storage

Store material in designated areas. Store [lime and] fertilizer in cool, dry locations away from contaminants.

1.5.2.2 Antidesiccant's Storage

Do not store with fertilizers or other landscape maintenance materials.

1.5.3 Handling

Do not drop or dump materials from vehicles.

1.6 MAINTENANCE

Submit Operation and Maintenance (O&M) Manuals for planting materials. Include instructions indicating procedures during one typical year including variations of maintenance for climatic conditions throughout the year. Provide instructions and procedures for watering; promotion of growth, including fertilizing, pruning, and mowing; and integrated pest management. O&M Manuals must include pictures of planting materials cross referenced to botanical and common names, with a description of the normal appearance in each season.

Develop a water monitoring program for surface and ground water on the project site in accordance with ASTM D5851 and consistent with the water management program utilized during construction operations.

PART 2 PRODUCTS

2.1 POST-PLANT FERTILIZER

****

NOTE: Check with the local Agriculture County Extension Service Office for recommended fertilizer mixture for local conditions.

****

Fertilizer for groundcover, wildflowers, and grasses is not permitted. Provide fertilizer for trees, plants, and shrubs as recommended by plant supplier, except synthetic chemical fertilizers are not permitted. Fertilizers containing petrochemical additives or that have been treated with pesticides or herbicides are not permitted.

2.1.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

[_____] percent available nitrogen
[_____] percent available phosphorus
[_____] percent available potassium
[_____] percent sulfur
[[_____] percent iron

]2.2 WATER

****

NOTE: When water is Government furnished, locate the source. Recycled or reclaimed irrigation water may be available through a tertiary treatment plant on or off site. It is preferred that this type of water be used for irrigation whenever possible. Check project specific conditions.

Unless otherwise directed, water is the responsibility of the Contractor. Water source must be potable or non-potable. Non-potable is preferred. If non-potable edit specification accordingly. Source of water must be approved by the Contracting Officer and must be of suitable quality for irrigation, containing no elements toxic to plant life.

Coordinate information presented here with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS

****

Source of water must be approved by the Contracting Officer, and be of suitable quality for irrigation. Use collected storm water or graywater when available.

2.3 MULCHES TOPDRESSING

****

NOTE: Check with the local Agriculture County Extension Service Office for recommended and locally available mulch material. Specify only one type of mulch for the project.

****

Free from noxious weeds, mold, pesticides, or other deleterious materials.

****

NOTE: Use inert mulch materials only when organic mulch is not available, or when site is located in a dry climate.

****

2.3.1 Inert Mulch Materials

****

NOTE: Select desired mulch materials. Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying products with recycled content.

****

Provide [recycled] [stone,] [riverbank stone,] [crushed pit-run rock,] [granite chips,] [_____,] [or other recycled material] complying with ASTM D6155, ranging in size from [_____] to [_____] mm inches.[Provide materials from site and construction waste to the greatest extent possible.]

2.3.2 Organic Mulch Materials

****

NOTE: For projects at Camp Lejeune and New River, use pine straw mulch only. Delete all other options.

****

****

NOTE: Hydraulic mulch is an EPA designated product for recycled content. Recycled content percentages listed are recommended by EPA; additional information can be found on the EPA's "Comprehensive Procurement Guidelines (CPG)" page within EPA's website at http://www.epa.gov.

****

Provide [wood cellulose fiber,] [wood chips,] [shredded hardwood,] [shredded redwood bark,] [pine straw mulch,] [pine needles,] or [recycled] [_____] from site when available. Wood cellulose fiber must be processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to an appropriate color to facilitate visual metering of materials application. Paper-based hydraulic mulch must contain a minimum of 100 percent post-consumer recycled content. Wood-based hydraulic mulch must contain a minimum of 100 percent total recovered materials content.

2.3.3 Recycled Organic Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 65 by 65 mm 2-1/2 by 2-1/2 inch screen. Clean recycled mulch of all sticks a minimum 25 mm one inch in diameter and plastic materials a minimum 75 mm 3 inch length. The material must be treated to retard the growth of mold and fungi.

2.4 PESTICIDES

****

NOTE: Integrated pest management, according to the U.S. Department of Agriculture - Agricultural Research Service, is the judicious use and integration of various pest control tactics of the associated environment of the pest in ways that complement and facilitate the biological and other natural controls of pests to meet economic, public health, and environmental goals. The national goal of implementing integrated pest management methods on 75 percent of the nation's cropland was jointly announced by USDA, the U.S. EPA, and the FDA in September 1993. This goal represents a commitment by the federal government to work with its state and private sector partners to develop and implement ecologically-based pest management approaches that rely less on synthetic chemical pest controls and are more sustainable. Specify use of native beneficial insects and appropriate companion plants, such as those with natural pyrethrums.

****

Pesticides and herbicides are not permitted. [Use black sheet polyethylene conforming to ASTM D2103, minimum thickness 4 mm 5/32 inch.]Submit an Integrated Pest Management Plan, including [weed and pest management strategies] [proposed alternatives to herbicides and pesticides]. Use biological pest controls as approved in the Plan.

PART 3 EXECUTION

3.1 EXTENT OF WORK

****

NOTE: Typically native plants will require less maintenance than non-native plants and turf. Verify maintenance requirements appropriate to the species and climate.

****

Provide landscape construction maintenance to include [irrigation equipment cleaning and adjustments,] [mowing,] [edging,] [overseeding,] [aeration,] [fertilizing,] [watering,] [weeding,] [pruning,] [stake and guy adjusting,] [and] [_____] for all [newly installed] [renovated] landscape areas [and existing plant material], unless indicated otherwise, and at all areas inside or outside the limits of the construction that are disturbed by the Contractor's operations.

[3.1.1 Policing

Police all landscaped areas. Policing includes removal of leaves, branches and limbs regardless of length or diameter, dead vegetation, paper, trash, cigarette butts, garbage, rocks or other debris. [Policing must extend to both sides of fencing or walls.] Collected debris must be promptly removed and disposed of at an approved disposal site.

][3.1.2 Drainage System Maintenance

Remove all obstructions from surface and subsurface drain lines to allow water to flow unrestricted in [swales,] [gutters,] [catch basins,] [storm drain curb inlets,] [and] [yard drains]. Remove grates and clear debris in catch basins. Open drainage channels are to be maintained free of all debris and vegetation at all times. Edges of these channels must be clear of any encroachment by vegetation.

][3.2 IRRIGATION ESTABLISHMENT PERIOD

The irrigation establishment period will commence on the date that inspection by the Contracting Officer shows that the [new] [repaired] irrigation equipment furnished under this contract have been satisfactorily installed and is functional and must continue for a period of [365] [_____] days.

3.2.1 Maintenance During the Irrigation Establishment Period

Begin maintenance immediately after irrigation equipment has been installed and is functional. Inspect irrigation equipment at least [once a week][_____] during the installation and establishment period and perform needed maintenance promptly. Automatic controllers not equipped with rain shut-off sensors must be turned off during periods of rain that exceed twelve hours of continuous rainfall in one day or during rain storms of one day or more. Once the rain has subsided timers must be reactivated. Irrigation controllers must be inspected and reprogrammed after power outages. Contractor must be responsible for winterization and startup. Sprinkler heads must direct water away from buildings and hard surfaced areas.

3.2.2 Water Restrictions

Abide by state, local or other water conservation regulations in force during the establishment period. Automatic controller must be adjusted to comply with the water conservation regulations schedule.

3.2.3 Fire Hydrants

****

NOTE: Coordinate information presented here with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS

****

To use a fire hydrant for irrigation, obtain prior clearance from the Contracting Officer and provide the tools and connections approved for use on fire hydrants. If a fire hydrant is used, Provide a reduced pressure backflow preventer for each connection between hose and fire hydrant. Backflow preventer used must be tested once per month by a certified backflow preventer tester.

3.2.4 Final Acceptance

[Upon completion of the irrigation establishment period and final acceptance of groundcover and exterior plants, irrigation equipment must be removed.][Operation and coverage test is acceptable if system operates through at least one complete cycle for areas to be irrigated and all leaks or repairs have been completed.]

3.2.5 Controller Charts

Provide one chart for each controller supplied. Indicate in chart area controlled by the automatic controller. The chart is a reduction of the actual plan[s] that will fit the maximum dimensions inside the controller housing. Use a black line print for the chart and a different pastel or transparent color to indicate each station zone of coverage. After chart is completed and approved for final acceptance, seal chart between two 0.5 mm 20 mil pieces of clear plastic.

]3.3 GROUNDCOVER ESTABLISHMENT PERIOD

Groundcover establishment period will commence on the date that inspection by the Contracting Officer shows that the [new] [renovated] turf furnished under this contract has been satisfactorily installed to a [_____][95 percent][100 percent] stand of coverage. The establishment period must continue for a period of [365] [_____] days.

3.3.1 Frequency of Maintenance

Begin maintenance immediately after turf has been [installed] [fully renovated]. Inspect area[s] [once a week][_____] during the installation and establishment period and perform needed maintenance promptly.

3.3.2 Promotion of Growth

Maintain groundcover in a manner that promotes proper health, growth, natural color. Turf must have a neat uniform manicured appearance, free of bare areas, ruts, holes, weeds, pests, dead vegetation, debris, and unwanted vegetation that present an unsightly appearance. Mow, remove excess clippings, eradicate weeds, water, fertilize, [overseed,] [aerate,] [topdress] and perform other operations necessary to promote growth, as approved by Contracting Officer and consistent with approved Integrated Pest Management Plan. Remove noxious weeds common to the area from planting areas by mechanical means.

3.3.3 Mowing

****

NOTE: Check with the local Agriculture County Extension Service for turf mowing heights as this requirement may vary due to local conditions and species specified.

****

3.3.3.1 Turf

Mow turf at a uniform finished height. Mow turfed area[s] to a minimum average height of [76][102][_____] mm [3][4][_____] inches when average height of grass becomes [_____] mm inches for spring/summer maintenance and to a minimum average height of [76][102][_____] mm [3][4][_____] inches when the average height of grass reaches [_____] mm inches for fall [winter] maintenance. The height of turf is measured from the soil. Perform mowing of turf in a manner that prevents scalping, rutting, bruising, uneven and rough cutting. Prior to mowing, all rubbish, debris, trash, leaves, rocks, paper, and limbs or branches on a turf area must be picked up and disposed. Adjacent paved areas must be swept/vacuumed clean.

3.3.3.2 Native Grasses

[Mow above height of native grass seedlings (approximately 89 to 102 mm 3.5 to 4 inches). Mow during spring or early summer. Do not mow after early summer during the second growing season.

]3.3.3.3 Wildflowers

[Mow three times per season above height of the wildflowers (approximately 305 to 381 mm 12 to 15 inches).

]3.3.4 Turf Edging and Trimming

Perimeter of planter bed edges, sidewalks, driveways, curbs, and other paved surfaces must be edged. Uniformly edge these areas to prevent encroachment of vegetation onto paved surfaces and to provide a clear cut division line between planter beds, turf, and ground cover. Edging is to be accomplished in a manner that prevents scalping, rutting, bruising, uneven and rough cutting. Perform edging on the same day that turf is mowed. Use of string line trimmers is permitted in "soft" areas such as an edge between turfgrass and a planter bed. Exercise care to avoid damage to any plant materials, structures, and other landscape features.

Trimming around [trees,] [fences,] [poles,] [walls,] [irrigation valve boxes] and other similar objects is to be accomplished to match the height and appearance of surrounding mowed turf growth. Trimming must be performed on the same day the turf's mowed. Care must be exercised to avoid "Girdling" trees located in turf areas. The use of protective tree collars on trees in turf areas may be utilized as a temporary means to avoid injury to tree trunks. At the end of the plant establishment period Contractor will be responsible for removing all protective tree collars.

3.3.5 Post-Fertilizer Application

****

NOTE: Check with the local Agriculture County Extension Service for type of fertilizer, time intervals, and application rate as these requirements may vary due to local conditions and specie specified.

****

Do not fertilize wildflowers, groundcover, and grasses. Apply turf fertilizer in a manner that promotes health, growth, vigor, color and appearance of cultivated turf areas. The method of application, fertilizer type and frequencies must be determined by the laboratory soil analysis results the requirements of the particular turf species.[Organic fertilizer must be used. In the event that organic fertilizer is not producing the desired effect, the Contractor must contract the Contracting Officer for approval prior to the use of a synthetic type of fertilizer.] Apply fertilizer by approved methods in accordance with the manufacturer's recommendations.

3.3.6 Turf Watering

Perform irrigation in a manner that promotes the health, growth, color and appearance of cultivated vegetation and that complies with all Federal, State, and local water agencies and authorities directives. The Contractor must be responsible to prevent over watering, water run-off, erosion, and ponding due to excessive quantities or rate of application. Abide by state, local or other water conservation regulations or restrictions in force during the establishment period.[Adjust irrigation controllers to comply with the water conservation regulations schedule].

[3.3.7 Turf Aeration

Upon completion of weed eradication operations and Contracting Officer's approval to proceed, aerate turf areas by approved device. Core, by pulling soil plugs, to a minimum depth of [_____] mm inches. Leave all soil plugs that are produced in the turf area.[After aeration operations are complete, topdress entire area [6.35] [12.70] mm [1/4] [1/2] inch depth with the following mixture:

[[_____] percent sand
][[_____] percent humus
][[_____] percent gypsum
][[_____] percent lime

] Blend all parts of topdressing mixture to a uniform consistency throughout.] Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean all soil plugs off of other paving when work is complete. This work must commence [_____] days prior final acceptance of the maintenance establishment period.

][3.3.8 Turf Clearance Area

Trees located in turf areas must be maintained with a growth free clearance of [450 mm18 inches][_____] from the tree trunk base. The use of mechanical weed whips to accomplish the turf growth free bed area is prohibited.

]3.3.9 Replanting

Replant in accordance with [Section 32 92 19 SEEDING][Section 32 92 23 SODDING][Section 32 92 26 SPRIGGING] and within specified planting dates areas which do not have a satisfactory stand of turf. Replant areas which do not have a satisfactory stand of other groundcover and grasses.

3.3.10 Final Inspection and Acceptance

Final inspection will be make upon written request from the Contractor at least 10 days prior to the last day of the turf establishment period. Final turf acceptance will be based upon a satisfactory stand of turf. Final acceptance of wildflower and grass areas will be based upon a stand of 95 percent groundcover of established species.

3.3.11 Unsatisfactory Work

When work is found to not meet design intent and specifications, maintenance period will be extended at no additional cost to the Government until work has been completed, inspected and accepted by Contracting Officer.

3.4 EXTERIOR PLANT ESTABLISHMENT PERIOD

****
NOTE: It is advisable to coordinate the Planter Bed Establishment Period Time Frame with the Guarantee Period.
****

The exterior plant establishment period will commence on the date that inspection by the Contracting Officer shows that the [new plants][transplanted plants] furnished under this contract [has][have] been satisfactorily installed and must continue for a period of [365] [_____] days.

3.4.1 Frequency of Maintenance

Begin maintenance immediately after plants have been installed. Inspect exterior plants at least [once a week][_____] during the installation and establishment period and perform needed maintenance promptly.

3.4.2 Promotion of Plant Growth and Vigor

Water, prune, fertilize, mulch, adjust stakes, guys and turnbuckles, eradicate weeds and perform other operations necessary to promote plant growth, and vigor.

3.4.3 Planter Bed Maintenance

Planter beds must be weeded, fertilized, irrigated, kept pest free, turf free, pruned, and mulch levels maintained. Planter beds will not be allowed to encroach into turf areas. A definite break must be maintained between turf areas and planter beds. Fertilize exterior planting materials to promote healthy plant growth without encouraging excessive top foliar growth. Remove noxious weeds common to the area from planting areas by mechanical means.

3.4.3.1 Shrub Selective Maintenance

In addition to the above requirements, shrubs must be selectively pruned, and shaped for health and safety when the following conditions exist: Remove growth in front of windows, over entrance ways or walks, and any growth which will obstruct vision at street intersections or of security personnel; Remove dead, damaged or diseased branches or limbs; where shrub growth obstructs pedestrian walkways; where shrub growth is found growing against or over structures; where shrub growth permits concealment of unauthorized persons. Dispose of all pruning debris in a proper manner.

3.4.3.2 Tree Maintenance

Tree maintenance must include adjustment of stakes, ties, guy supports [and turnbuckles], watering, fertilizing, pest control, mulching, pruning for health and safety [and fall leaf cleanup]. Fertilize exterior trees to promote healthy plant growth without encouraging excessive top foliar growth. Inspect and adjust stakes, ties, guy supports [and turnbuckles] to avoid girdling and promote natural development. All trees within the project boundaries, regardless of caliper, must be selectively pruned for safety and health reasons. These include but are not limited to removal of dead and broken branches and correction of structural defects. Prune trees according to their natural growth characteristics leaving trees well shaped and balanced. Pruning of all trees including palm trees must be accomplished by or in the presence of a certified member of the International Society of Arboriculture and in accordance with TCIA Z133. All pruning debris generated must be disposed of in a proper manner.

[3.4.4 Slope Erosion Control Maintenance

Provide slope erosion control maintenance to prevent undermining of all slopes in [newly landscaped] [and] [natural growth areas]. Maintenance tasks include immediate repairs to weak spots in sloped areas, [and] [maintaining clean, clear [culverts,] and graded [berms,] [and] [terraces] to intercept and direct water flow to prevent development of large gullies and slope erosion] [and] [during periods of extended rainfall, irrigation systems must be secured.] Eroded areas must be filled with amended topsoil and replanted with the same plant species. [Erosion control [netting] [blankets] damaged due to slope erosion must be reinstalled.]

]3.4.5 Removal of Dying or Dead Plants

Remove dead and dying plants and provide new plants immediately upon commencement of the specified planting season, and replace [stakes,] [guys,] mulch and eroded earth mound water basins. Provide an additional 90 day establishment period for replacement plants beyond the original warranty period. A tree must be considered dying or dead when the main leader has died back, or a minimum of 20 percent of the crown has died. A shrub or ground cover must be considered dying or dead when a minimum of 20 percent of the plant has died. This condition must be determined by scraping on a branch an area 2 mm 1/16 inch square, maximum, to determine the cause for dying plant material and must provide recommendations for replacement. The Contractor must determine the cause for dying plant material and provide recommendations for replacement.

3.4.6 Tracking of Unhealthy Plants

Note plants not in healthy growing condition, as determined by the Contracting Officer, and as soon as seasonal conditions permit, remove and replace with plants of the same species and sizes as originally specified. Install replacement plantings in accordance with Section 32 93 00 EXTERIOR PLANTS.

3.4.7 Final Inspection

Final inspection will be made upon written request from the Contractor at least 10 days prior to the last day of the establishment period. Final inspection will be based upon satisfactory health and growth of plants and on the following:

3.4.7.1 Total Plants on Site

Plants have been accepted and required number of replacements have been installed.

3.4.7.2 Mulching and Weeding

Planter beds and earth mound water basins are properly mulched and free of weeds.

[3.4.7.3 Tree Supports

[Stakes] [guys] guys and turnbuckles are in good condition.

]3.4.7.4 Remedial Work

Remedial measures directed by the Contracting Officer to ensure plant material survival and promote healthy growth have been completed.

3.4.8 Unsatisfactory Work

When work is found to not meet design intent and specifications, maintenance period will be extended at no additional cost to the Government until work has been completed, inspected and accepted by Contracting Officer.

3.5 FIELD QUALITY CONTROL

3.5.1 Maintenance Inspection Report

Provide maintenance inspection report to assure that landscape maintenance is being performed in accordance with the specifications and in the best interest of plant growth and survivability. Site observations must be documented at the start of the establishment period, then quarterly following the start, and at the end of establishment period. Submit results of site observation visits to the Contracting Officer within 7 calendar days of each site observation visit.

[3.5.2 Plant Quantities

Provide Contracting Officer with the number of plant quantities. In addition, provide total exterior area of hardscape and landscaping such as turf and total number of shrubs.

]3.5.3 Tree Staking and Guying Removal

Provide a certified letter that all stakes and guys are removed from all project trees at the end of the establishment period.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 11 13.13 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 29 (November 2009)
UFGS-32 11 30 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 11 13.13

LIME TREATED SUBGRADE

11/19

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 11 13.13 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 29 (November 2009)
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 32 11 13.13

LIME TREATED SUBGRADE
11/19

****

NOTE: This guide specification covers the requirements for lime stabilization or modification of subgrades airfield pavements and for roads, streets, and parking areas.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The Designer should refer to UFC 3-250-11 or TM 5-822-14 for guidance on modification or stabilization of materials with lime.

Sulfate reaction with either the soil to be stabilized or mixing water used in the stabilization process may be detrimental to the finished product due to the expansive nature of the sulfate reaction. Soluble sulfate contents as low as 0.5 percent have resulted in excessive expansion of the soil due to the formation of ettringite and thaumasite. During the design phase soils and water

anticipated to be included in the stabilized material should be tested for potential to cause an adverse expansion reaction. The contractor should be required to test any off site borrow sources for sulfates.

If Lime stabilization or modification is considered where sulfates are present, the USACE Transportation Systems Center (CENWO-ED-TX), appropriate Air Force MAJCOM pavements engineer, or NAVFAC Engineering and Expeditionary Warfare Center (EXWC) should be consulted for up-to-date guidance.

****

1.1 SUMMARY

The work specified consists of the construction of a lime-[stabilized][modified] subgrade course. Perform the work conforming to the lines, grades, notes, and typical sections shown in the drawings. Select sources of materials well in advance of the time when materials are required in the work.

1.2 UNIT PRICES

****

NOTE: Delete this paragraph when lump sum payment is desired.

****

1.2.1 Measurement for Payment

****

NOTE: Delete method of measurement not applicable to the job conditions. If it is desirable for material to be paid for separately, select the desired method of measurement.

****

1.2.1.1 Lime [Stabilization] [Modification]

Perform measurement by the square m yd of work completed and accepted.

1.2.1.2 Lime

Perform measurement by the number of metric 2000 lb tons of lime used in the completed and accepted work. Do not permit measurement for wasted lime or lime used in work determined defective.

1.2.1.3 Bituminous Material

Measure bituminous material in terms of the number of [L gal of the material used in the completed and accepted work, corrected to L at 16 degrees C gal at 60 degrees F in accordance with [ASTM D633] [ASTM D1250]. Use a coefficient of 0.000139 per degree C 0.00025 per degree F for asphalt emulsion.] [metric 2000 lb tons of the material used in the completed accepted work.]

1.2.2 Basis for Payment

Pay for the lime [stabilization] [modification], constructed and accepted, including lime, [bituminous material] and other materials, labor and equipment required to provide a product meeting the requirements at the respective Contract unit prices in the bidding schedule. Do not permit payment for material wasted, used for the convenience of the Contractor, unused or rejected, or for water used. Do not permit separate payment for sanding or dusting the bituminous prime-coated surfaces, as the costs for sanding or dusting are included in the Contract unit price for bituminous material.

1.2.3 Waybills and Delivery Tickets

Submit certified waybills and delivery tickets for materials used. Submit copies of waybills or delivery tickets during the progress of the work. Before the final payment is allowed, provide waybills and certified delivery tickets for lime [and bituminous materials] used in the construction.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when user adds a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also, use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when the user chooses to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 81	(1992; R 2017) Standard Specification for Cutback Asphalt (Rapid-Curing Type)
AASHTO M 82	(2017) Standard Specification for Cutback Asphalt (Medium-Curing Type)
AASHTO T 102	(2009; R 2013) Standard Method of Test for Spot Test of Asphaltic Materials
AASHTO T 135	(2013; R 2017) Standard Method of Test for

	Wetting-and-Drying Test of Compacted Soil-Cement Mixtures
AASHTO T 136	(2013; R 2017) Standard Method of Test for Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures

ASTM INTERNATIONAL (ASTM)

ASTM C25	(2024) Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
ASTM C50/C50M	(2013) Sampling, Sample Preparation, Packaging, and Marking of Lime and Limestone Products
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C977	(2018; R 2024) Quicklime and Hydrated Lime for Soil Stabilization
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D633	(2011; R 2016) Standard Volume Correction Table for Road Tar
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D1250	(2019; E 2020) Standard Guide for Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1632	(2007) Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D2027/D2027M	(2019) Cutback Asphalt (Medium-Curing Type)
ASTM D2028/D2028M	(2015; R 2021) Cutback Asphalt

	(Rapid-Curing Type)
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt
ASTM D3551	(2008) Laboratory Preparation of Soil-Lime Mixtures Using a Mechanical Mixer
ASTM D3740	(2019) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D5102	(2009) Standard Test Method for Unconfined Compressive Strength of Compacted Soil-Lime Mixtures
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

NATIONAL LIME ASSOCIATION (NLA)

NLA BUL 326	(2004) Lime-Treated Soil Construction Manual: Lime Stabilization and Lime Modification

1.4 DEFINITIONS

1.4.1 Lime-[Stabilized][Modified] Course

Lime-[stabilized][modified] course is a mixture of lime and in-place or borrow material uniformly blended, wetted, and compacted to produce a pavement layer course that meets the criteria set forth in the plans.

1.4.2 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D1557, abbreviated as percent laboratory maximum density.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the list provided, and corresponding submittal items in the text, to reflect only the submittals required

for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, Machines, and Tools; G, [_____]

Submit a list of construction equipment 7 days prior to bringing equipment on the job.

Mix Design; G, [_____]

Waybills and Delivery Tickets

Contractor's Plans; G, [_____]

SD-04 Samples

Lime

Submit a typical cured sample of on-site material with the required percent of lime content. Refer to ASTM C50/C50M for sample size requirements.

SD-05 Design Data

Job-Mix Formula; G, [_____]

SD-06 Test Reports

****

NOTE: Allow nuclear testing methods for site preparation testing or final in place testing on larger projects of over 3300 per square m 4000 square yd.

****

Sampling and Testing

Field Density

SD-07 Certificates

Bituminous Material

Lime

Laboratory

1.6 WEATHER LIMITATIONS

Do not construct subgrade when weather conditions detrimentally affect the quality of the materials. Do not apply lime unless the air temperature is at least 2 degrees C 35 degrees F in the shade and rising. Protect the completed [stabilized] [modified] materials against freezing by a sufficient covering of straw, or by other approved methods, until the course has dried out. Bring areas of completed [stabilized] [modified] materials that are damaged by freezing, rainfall, or other weather conditions to a satisfactory condition without additional cost to the Government.

1.6.1 Freeze Protection Method(s)

Submit Contractor's plans for freeze protection for approval.

1.7 DELIVERY AND STORAGE

Deliver lime, [bituminous materials] in containers showing or including designated trade name, product identification, specification number, manufacturer's name, and source. Store in a manner that prevents moisture damage, overexposure, and contamination.

1.8 QUALITY ASSURANCE

1.8.1 Required Data

[Ten][_____] days prior to the commencement of the work, submit a job-mix formula (JMF) showing the amount of lime and water required per cubic m cubic yd, and procedures for blending the lime/subgrade mixture for each type of existing soil or for blended soil, as applicable. Include process type and number of: lime applications, stages of mixing, slurry injection depths, mixing depths and depths of compaction lifts. Also, include a list of equipment to be used and their relation to method of mixing proportioning, spreading, pulverizing and compacting subgrade, slurry injection, jet slurry mixing and other related work. The formula contains the amount of lime, either in sacks or kg per cubic me lbs per cubic yd and the amount of water to be used, if slurry method is used. Use ASTM D3551 laboratory test method.

PART 2 PRODUCTS

2.1 PLANT, EQUIPMENT, MACHINES, AND TOOLS

****

NOTE: Delete types of equipment specified but not required for the work and add other items of equipment not listed as appropriate.

****

Submit list of proposed equipment to be used in performance of construction work including descriptive data for Government approval.

2.1.1 General Requisites

Plant, equipment, machines, and tools used in the work are subject to approval and maintained in satisfactory working condition. Allow use of other compacting equipment in lieu of that specified, where it can be demonstrated that the results are equivalent. Provide protective equipment, apparel, and barriers to protect the eyes, respiratory system, and the skin of workers exposed to contact with lime dust or slurry.

2.1.2 Steel-Wheeled Rollers

Use self-propelled steel wheeled rollers . Use tandem or 3-wheel self-propelled non-vibratory steel-wheel rollers or steel-wheel trailer not weighing less than 4.5 metric tons 5 tons. When drive rolls or trailer rolls produce a compressive force of not less than 3.6 kg/mm 200 lbs per linear in of contact area, allow a roller weighing less than 4.5 metric tons 5 tons to be used. Equip wheels of the rollers with adjustable scrapers. The use of vibratory rollers is optional.

2.1.3 Pneumatic-Tired Rollers

Use pneumatic-tired rollers having 4 or more tires, inflated to a minimum pressure of 0.6 MPa 90 psi. Equally distribute the loading to the wheels, and uniformly inflate the tires. Also provide pneumatic-tired towing equipment.

2.1.4 Tamping-Type Roller

Use a tamping type roller, under working conditions, having a minimum weight of 1.6 kg/mm 90 lbs per linear in of length of drum and a minimum load on each sheeps-foot of 0.07 kg per square mm 100 psi of cross sectional area of the sheeps-foot in contact with the ground. Do not allow the maximum area of the face of each sheeps-foot to be more than 7740 square mm 12 square in. Do not allow the feet on the sheeps-foot roller to project less than 180 mm 7 in from the face of the drum, and equip the roller with teeth-cleaning devices. Space the feet in adjacent rows so that the distance from center to center of adjacent parallel rows is not less than 150 mm 6 in nor more than 280 mm 11 in. Do not allow individual drums of the roller to exceed 1.5 m 5 ft in width. Use drums that oscillate independently. Operate the and tractor for pulling at a speed of approximately 5 to 10 km/h 3 to 6 mph.

2.1.5 Mechanical Spreader

Use a self-propelled mechanical spreader or attached to a propelling unit capable of moving the spreader and material truck. Use a steerable device having variable forward and reverse speeds. Carry the spreader and propelling unit on tracks, rubber tires, or drum-type steel rollers that do not disturb the underlying material. Provide a spreader that conforms to the following:

a. Containing a hopper, an adjustable screed, and outboard bumper rolls;

b. Designed to have a uniform, steady flow of material from the hopper; and

c. Capable of laying material without segregation, across the full width of the lane, to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers conform to thickness and grade requirements indicated.

[Provide a demonstration of the spreader prior to use in performance of the work.

]2.1.6 Pulvimixer

Use self-propelled, four-wheel drive pulverizing and mixing equipment capable of pulverizing the soil in a single pass for the full depth to be stabilized. Use mixing action capable of uniformly blending and mixing the required lime content with the subgrade soil. Use a rotor capable of up or down cutting.

2.1.7 Slurry Mixer/Distributor

Mix the lime with water in trucks with approved distributors and applied as a thin water suspension or slurry. Apply commercial lime slurry with a lime percentage not less than that applicable for the grade used. Attain the distribution of lime by successive passes over a measured section of subgrade until the proper amount of lime has been spread. Use the amount of lime spread required for mixing to the specified depth that results in the percentage determined in the JMF. Use a distributor truck that continually agitates the slurry to keep the mixture uniform.

2.1.8 Central Mixing Plant

Use a lime-slurry central mixing plant consisting of a lime storage silo, water supply tank, lime and water metering devices, and a lime-water mixer. Provide storage tanks for lime-water slurry with mechanical agitation to maintain the lime-water slurry in suspension.

2.1.9 Sprinkling Equipment

Provide sprinkling equipment consisting of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

2.1.10 Tampers

Provide tampers of an approved mechanical type, having sufficient weight and striking power to produce the compaction required.

2.1.11 Straightedge

Provide and maintain at the site one 3. meter 12 ft straightedge for use in the testing of the finished surface. Make available a straightedge for Government use. Use straightedges constructed of aluminum or other lightweight metal with blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Use straightedges with handles to facilitate movement on pavement.

2.2 MATERIALS

2.2.1 Lime

Submit copies of certified test data. Use a standard brand of [quicklime][hydrated lime] conforming to ASTM C977 and the following physical and chemical requirements. Sample lime in accordance with ASTM C50/C50M.

a. Gradation that 97 percent passes a 0.60 mm No. 30 sieve and a minimum of 75 percent passes a 0.075 mm No. 200 sieve.

b. Combined calcium oxide and magnesium oxide not less than 90 percent.

c. [Quicklime] [Hydrated Lime] does not exceed 5 percent Carbon Dioxide or 2 percent free moisture (taken at the point of manufacture).

The percent of[hydrated lime][quicklime] by weight of dry soil material is: [_____] percent.

2.2.2 Bituminous Material

****

NOTE: Specify asphalt of one grade or type.

****

Submit copies of certified test data. Material conforming to one of the following:

2.2.2.1 Cutback Asphalt

[AASHTO M 82] [ASTM D2027/D2027M], Grade [MC-30] [MC-70] [MC-250] [MC-800]; [AASHTO M 81] [ASTM D2028/D2028M], Grade [RC-70] [RC-250] [RC-800] [_____].

2.2.2.2 Emulsified Asphalt

ASTM D977, Type [RS-1] [RS-2] [SS-1] [CSS-1] [_____].

Conform to ASTM D977,[Type RS-1][Type RS-2][Type SS-1][or][Type SS-1h]; ASTM D2397/D2397M,[Type CSS-1][or][Type CSS-1h][_____]. Use a base asphalt to manufacture the emulsion that shows a negative spot when tested in accordance with AASHTO T 102 using standard naphtha.

2.2.2.3 Material to be [Stabilized] [Modified]

****

NOTE: Soils classified as CH, CL, MH, SC, and GC have potential for lime stabilization; however, it is not recommended to use lime alone for the stabilization of sandy soils. Check the soluble

sulfate content of the materials to be stabilized and tested during design to determine if stabilization with lime can react and induce heave. Refer to UFC 3-250-11 and UFC 3-260-02 for further guidance.

****

Use material to be [stabilized] [modified] consisting of in situ, borrow, or compacted fill material [if preliminary earthwork is required: See Section 31 00 00 EARTHWORK]. Provide material free of deleterious substances such as sticks, debris, organic matter, and stones greater than 75 mm 3 in in any dimension. Confirm at least 10 percent of the material passes the 0.425 mm No. 40 sieve. [Confirm the plasticity index is greater than 18].

2.2.2.4 Water

Use water clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the lime or soil-lime mixture and subject to approval. Test water for conformance to the requirements of ASTM C1602/C1602M including the optional requirements of Table 2. Allow potable water sources to be used without testing.

2.2.3 Stockpiling Materials

Stockpile borrow material, including approved material available from excavation and grading, in the manner and at the locations designated. Before stockpiling material, clear storage sites and slope to drain. Separately stockpile materials obtained from different sources.

2.2.4 Mix Design

****

NOTE: Determine the compressive strength requirement based on the use of the final pavement. The required compressive strength varies with the pavement type and stabilization or modification product. Refer to Table 2-2 of UFC-3-250-11 for the appropriate values. Refer to UFC 3-250-11 for the appropriate valuesfurther guidance, including applicability of stabilization or modification with lime.

Lime modification to provide an improved working platform, reduce shrink-swell potential, or provide a more uniform work surface can often be specified as a given percentage range based on local experience, or it can be estimated by the designer using the pH test per ASTM D6276.

****

[Submit certification of testing laboratory compliance. Develop and submit for approval a proposed mix design for each material type to be [stabilized] [modified] at least [14] [_____] days before it is to be used. Obtain approval of the proposed mix designs from the Government prior to starting the work. Develop mix designs by an approved commercial laboratory which meets the requirements of ASTM D3740 [and which has been approved by the Corps of Engineers Materials Testing Center]. Develop the mix design using representative samples of each soil to be [stabilized] [modified] and using the proposed project lime. Conduct three trials for each mix design tested. Prepare samples in accordance with ASTM D3551. Allow the prepared samples to mellow for [24 hours for modified materials] [48 hours for stabilized materials] before testing is performed.[For soil stabilization, vary the lime content to produce a maximum plasticity index of 10 when tested in accordance with ASTM D4318. Provide the results in a graph of plasticity index versus lime content. Determine the maximum dry density and optimum moisture content for the proposed lime-soil mixture in accordance with ASTM D1557. Cure samples at a constant moisture content and temperature for [7] [28] [___] days.][Provide a soil stabilization mix design capable of producing an unconfined compressive strength of [_____] [1] MPa [_____] [150] psi at 28-days [___] age (average of three specimens) when compacted to the design percent of laboratory maximum density and tested in accordance with ASTM D5102, Method A. Prepare three specimens per test evaluation for durability testing for each mix design tested. Do not allow samples to exceed loss indicated in Table 2 after 12 cycles of the wet-dry test in accordance with AASHTO T 135.][Conduct freeze thaw tests in accordance with AASHTO T 136 (but omitting wire brushing) for projects susceptible to freeze/thaw conditions.] Provide the mix design submittal information including the following:

a. Material type
b. Material classification including plasticity test data
c. Laboratory maximum density
d. Percent of lime and rate of application
e. Optimum water content during mixing, curing, and compaction
f. Gradation of material before and after treatment
g. Compressive strength
h. Durability Wet-Dry [and Freeze/Thaw]test data
i. Mixing or equipment requirements
j. Mellowing time requirements
k. Water quality test data, if non-potable source used

Table 2

Type of Soil Stabilized	Maximum Allowable Weight Loss After 12 Wet-Dry or Freeze-Thaw Cycles, as a Percent of Initial Specimen Weight
Silt	8
Clays	6

]
[Modify the in situ soil or compacted fill with lime at a rate of [_____] percent to [_____] percent per dry unit weight of soil.]

PART 3 EXECUTION

****

NOTE: Consider in which application methods there are potential health and safety issues associated with lime dust. Breathing the dust may cause respiratory issues, safety issues related to visibility both on and off the site, and complaints from off site due to dust settlement at nearby

facilities. Use of quicklime can increase health risks, but can be of use for drying existing materials if the site is too wet. If a significant amount is lost it can affect the total amount applied and result in inadequate materials to achieve the design intent. Dry application may also lead to greater variability in the rate of application. Application as a slurry may reduce the number of construction steps required and give a more uniform application. Consider use of a pulvimixer to incorporate either a dry material or slurry where available.

****

3.1 LIME [STABILIZATION] [MODIFICATION] MIXTURE

Pulverize the subgrade material to be [stabilized] [modified] and, [when lime is applied in the dry state,] blend the mix at a moisture content below optimum. Confirm the proportions of the mixture are in accordance with the approved mix design after blending is completed. After blending, add water into the dry mix in amounts to bring the moisture content to a minimum of [5][_____] percent above optimum. After mixing, control field moisture content within plus [2][_____] or minus [1][_____] percent of optimum. When the [stabilized] [modified] course is constructed in more than one layer, clean the previously constructed layer of loose and foreign matter by sweeping with power sweepers or power brooms. Allow hand brooms to be used in areas where power cleaning is not practicable. Provide adequate drainage during the entire construction period to prevent water from collecting or standing on the area to be [stabilized] [modified] or on pulverized, mixed, or partially mixed material. Provide line and grade stakes for control. Place grade stakes in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF BORROW PITS

****

NOTE: Determine if onsite borrow sources for materials are available and if sufficient quantities required are available from designated borrow sources.

****

[Clear, strip and excavate borrow pits in a manner that exposes vertical faces of the deposit for suitable working depths. Waste strata of unsuitable materials overlying or occurring in the deposit. Allow methods of operating pits and the processing and blending of materials to be changed or modified to obtain material conforming to the specified requirements. Upon completion of the work, condition pits to drain readily and be left in a satisfactory condition as determined by the Government.] [Obtain borrow material from offsite sources.]

3.3 PREPARATION OF AREA TO BE [STABILIZED] [MODIFIED]

Clean the area of debris, roots, thrash, organic and other deleterious materials. Perform clearing and grubbing [to a depth of [_____] mm in] [as specified in Section[31 11 00 CLEARING AND GRUBBING][31 00 00 EARTHWORK]] [as required]. Remove rocks larger than 75 mm 3 in. Inspect original ground for adequacy for the forthcoming compactive effort of lime treatment work. Inspect the area for adequate compaction and that it is capable of withstanding, without displacement, the compaction specified for the soil-lime mixture. Dispose of debris and removed unsatisfactory in-place material as specified. [Rough grade and shape the area to be stabilized to conform to the lines, grades, and cross-sections indicated.] [Comply with subgrade requirements of Section 31 00 00 EARTHWORK].

3.3.1 In-Place Material to be [Stabilized] [Modified]

Grade the entire area to conform to the lines, grades, and cross sections shown in the drawings prior to being processed. Make soft or yielding subgrade areas stable before construction is begun. Remove and replace unsatisfactory material as directed by the Government.

3.3.2 In-Place Material to Receive [Stabilized] [Modified] Course

[Correct soft, yielding areas and ruts or other irregularities in the surface. Loosen the material in the affected areas and remove unsatisfactory material. Add approved material where directed. Shape the area to line, grade, and cross section, and compact to the specified density.] [Use subgrade conforming to Section 31 00 00 EARTHWORK.]

3.3.3 Grade Control

Excavate underlying material to sufficient depth for the required [stabilized][modified]-course thickness so that the finished [stabilized] [modified] course with the subsequent surface course meets the fixed grade. When stabilized course is to be constructed to meet a fixed grade, provide adequate line and grade stakes for control. Locate grade stakes in lanes parallel to center line of areas under construction, and suitably placed for string lining. Maintain line and grade. Confirm finished and completed stabilized area conform to the lines, grades, cross section, and dimensions indicated.

3.3.4 Soil Testing

****

NOTE: Perform site preparation tests dependent upon the criteria required, the condition of the existing site and the purpose of the stabilization.

****

Test original ground prior to scarification in accordance with ASTM D1557.

3.4 INSTALLATION

3.4.1 Mixed In-Place Method

3.4.1.1 Application Requirements

****

NOTE: Specify double application of lime or two stage pulverization and mixing when the site contains extremely plastic or heavy clays.

****

Comply with NLA BUL 326 and sequence of construction operations, unless specified otherwise.

After site preparation, scarify subgrade and spread lime. Blend lime into subgrade to required depth as indicated. Apply lime and water only to those areas where mixing operations can be completed during the same working day. Accomplish application and mixing of lime by either the dry placing method or the slurry method. Use same method during a single day's operation. [Double application of lime is required; use between 2 and 3 percent of lime for the initial application. Apply curing seal as specified and allow 6 to 7 days curing.]

3.4.1.2 Scarifying and Pulverizing of Soil

Prior to application of lime, scarify and pulverize the soil [to the depth shown in the drawings][to a depth of [_____] mm in]. Control scarification so that the layer beneath the layer to be treated is not disturbed. Do not exceed the depth of scarification with pulverizing. Remove organic materials such as stumps and roots. Remove rocks larger than 75 mm 3 in.

3.4.1.3 Application of Lime

Shape pulverized material to approximately the cross section indicated. Apply lime so that when uniformly mixed with the soil, the specified lime content is obtained, and a sufficient quantity of lime-treated soil is produced to construct a compacted lime-treated course conforming to the lines, grades, and cross section indicated. Spread lime only on areas where the mixing operations can be completed during the same work shift or day.[Use mechanical spreaders in applying bulk lime.] [Apply lime as a slurry, and use distributors in applying slurry.] If lime is spread by hand, spot the bags accurately on the area being stabilized so that when the bags are opened the lime is dumped and spread uniformly on the area being processed. Limit hand spreading to areas inaccessible to mechanical spreaders. Do not permit equipment, except that used in spreading and mixing, to pass over the freshly applied lime.

a. Dry Placing: Spread and distribute lime at a uniform rate with protection from wind as an important distribution and timing criteria. Prevent dry lime from blowing by adding water to lime or by other suitable means. Do not apply lime when wind conditions are objectionable.

b. Slurry Method: Apply or inject mixture of lime and water into the existing soil. Maintain the water content at 5 percent above optimum during application to lime/soil mixture. Prepare hydrate slurry either in a central mixing tank or tank trucks, with agitation provided for mixing or using a jet slurry maker. Prepare quicklime slurry using a portable batch slaking unit. Accurately weigh or meter lime and water. Use standard water or asphalt trucks, properly cleaned, with or without pressure distributors, to apply lime treatment. Spread or inject lime slurry evenly to yield uniform distribution of lime throughout soil. Distribute lime in successive passes over subgrade materials until proper amount of lime has been spread or injected to proper depth. Continually agitate slurry to keep mixture uniform. Keep pumps, distribution spray bars, slurry injection equipment and other equipment clean of excessive lime slurry. Verify the specified amount and rate of application of lime for the various materials encountered.

3.4.1.4 Initial Mixing

Distribute lime uniformly by mixing and pulverizing subgrade. Mix the lime and soil immediately after the lime has been distributed. Use sufficient initial mixing to alleviate dusting or wetting of the lime that might occur in the event of wind or rainstorms. During mixing, add water to subgrade to provide a moisture content of material and to insure chemical action of lime and subgrade materials. Make passes with the mixer until it has produced a homogenous, uniform mixture of lime, soil, and water. After initial mixing, control field moisture content within plus [2][_____] or minus [1][_____] percent of optimum. Continue mixing or remixing operations, until material is free of streaks or pockets of lime and mixture is uniform as indicated by testing. After initial mixing, shape and roll subgrade lightly to seal surface in order to reduce evaporation of moisture and lime carbonation. Allow this to be accomplished several days in advance of the final application and mixing.

3.4.1.5 Water Application and Moist Mixing

Determine moisture content of the mixture in preparation for final mixing. Do not allow moisture in the mixture following final mixing to be less than the water content determined to be optimum based on dry weight of soil and or to exceed the optimum water content by more than [2] [_____] percentage points. Add water in increments as large as the equipment permits; however, partially incorporate such increments of water in the mix to avoid concentration of water near the surface. After the last increment of water has been added, continue mixing until the water is uniformly distributed throughout the full depth of the mixture, including satisfactory moisture distribution along the edges of the section. Mix soil in two stages, allowing for an intervening 24 to 48 hour mellowing period. Allow the [stabilized] [modified] mixture to mellow to allow the chemical reaction to alter (break down) the material. Identify the duration of this mellowing period in the mix design and base on soil type. After mellowing, remix the soil before compaction.

[3.4.1.6 Two-Stage Pulverization and Mixing

****

NOTE: Specify double application of lime or two stage pulverization and mixing when the site contains extremely plastic or heavy clays.

****

After curing, pulverize lime treated material until soil particles pass a 25 mm 1 in sieve and 60 percent pass the 4.75 mm No. 4 sieve. If resultant mixture contains clods, reduce their size by scarifying, remixing, or pulverization to meet specified gradation. Compact lime-treated material immediately after final mixing and testing. Aerate or sprinkle to provide moisture content within plus [2][_____] or minus [1][_____] percent of optimum moisture content during compaction.

]3.4.1.7 Preliminary Curing

Moisture cure lime-soil mixture up to 48 hours until adhesive quality of clay is reduced to almost normal soil consistency. Allow 7 days or more for curing heavy clays.

3.4.1.8 Confined Areas

In areas inaccessible to machinery, excavate soils to be [stabilized] [modified] and move to an area to perform machine mixing, process, and place back in the original location. Place material in its final location within 24 hours of initial mixing, and prior to final mixing and compaction.

3.4.2 Edges of [Stabilized] [Modified] Course

Place approved material along the edges of the [stabilized] [modified] course in a quantity to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 300 mm 1 ft width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the [stabilized] [modified] course.

3.4.3 Central-Plant Method

Provide a plant capable of producing a uniform lime-treated mixture at the specified lime and moisture contents. Haul the mixture to the job in trucks equipped with protective covers. Moisten underlying course, and place the mixture on the prepared area in a uniform layer with mechanical spreaders. Confirm the layer is uniform in thickness and surface contour; and confirm the completed layer, after compaction, conforms to the required grade and cross section.

3.4.4 Traveling-Plant Method

Move the traveling plant at a uniform rate of speed and accomplish mixing of the materials in one pass. Deliver water and lime from supply trucks or bins at a predetermined rate. Use windrows of prepared soil-lime mixture covering a predetermined width to the indicated compacted thickness.

3.4.5 Layer Thickness

Confirm the compacted thickness of the [stabilized] [modified] course is [as indicated] [[_____] mm in]. Do not allow layers more than 200 mm 8 in or less than 75 mm 3 in in compacted thickness.

3.4.6 Compaction

Before compaction operations are started and as a continuation of the mixing operation, loosen and pulverize the mixture to the full depth. Start compaction immediately after final mixing is completed. During final compaction moisten the surface and shape it to the required lines, grades, and cross section. Confirm the density of compacted mixture is at least [95] [_____] percent of laboratory maximum density. Base density value on a representative soil sample obtained from site and treated with required proportion of lime. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Make alternate trips of the roller slightly different lengths. Do not permit the speed of the roller to cause displacement of the mixture to occur. Compact areas inaccessible to the rollers with mechanical tampers; shape and finish the areas by hand methods. As compaction progresses, maintain the shape of the lifts by blading. Check that the surface upon completion is smooth and conforms to indicated section and established lines and grades. Perform initial compaction with sheeps-foot roller or other suitable roller. Perform final rolling by means of sheeps-foot, steel-tired, or pneumatic rollers.

3.4.7 Finishing

Finish the surface of the top layer to the grade and cross section shown in the drawings. Confirm the surface is of uniform texture. Allow light blading during rolling for the finished surface to conform to the lines, grades, and cross sections. Do not permit the surface to vary more than 15 mm 0.6 in[_____] above or below established grade. Finish completed section by rolling with a pneumatic or suitable roller sufficiently light to prevent hairline cracking. If the surface becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, scarify, rework, relay, or replace the unsatisfactory portions. If the course, when laid, becomes watersoaked, remove that portion immediately, and the mix placed in a windrow and aerated until a moisture content within the limits specified is obtained; and then spread, shaped, and rolled. Keep surface of each compacted layer or lime-treated material moist until covered by a subsequent layer of lime-treated material or curing seal.

3.4.8 Construction Joints

At the end of each working day, prepare a temporary joint in fully compacted material normal to paved surface centerline. Form a straight transverse construction joint by cutting back into the completed work to form a true vertical face free of loose or shattered material. Construct a longitudinal temporary joint for partial width sections against which future material is to be placed. Remove temporary joints during next work period by trimming 75 mm 3 in into treated material for continuity. Allow trimmed material to be incorporated in subsequent work. Do not allow temporary joints to coincide with longitudinal or transverse temporary joint location of previous or subsequent construction. Allow remixing 100 mm 4 in into the previous day's work to be substituted for joints providing the method and equipment is acceptable. Remove and replace material along construction joints not properly compacted with soil-lime mixture that is mixed, moistened, and compacted as specified.

3.4.9 Final Curing

Immediately after the soil-lime area has been finished as specified above, protect the surface against rapid drying for 7 days by the application of a bituminous material.

****

NOTE: Select the application temperatures from the following table and insert in the blanks:

Asphalt Types	**Degrees C Degrees F**
Cutback Asphalt	
MC-30	**29-87 85-190**
MC-70	**50-107 120-225**
RC-250, MC-250	**65-105 150-220**
RC-800, MC-800	**80-125 175-255**
Emulsified Asphalt:	

Asphalt Types	**Degrees C Degrees F**
RS-1	**25-55 75-130**
RS-2	**45-70 115-160**
SS-1	**20-70 70-160**

****

Uniformly apply bituminous material by means of a bituminous distributor within a temperature range of [_____] to [_____] degrees C [_____] to [_____] degrees F. Apply bituminous material in quantities of not less than 0.45 L/square m 0.1 gal/square yd nor more than 1.13 L/square m 0.25 gal/square yd. Properly treat areas inaccessible to or missed by the distributor using the manually operated hose attachmentt. Apply bituminous material only to the top layer. At the time the bituminous material is applied, check that the surface of the area is free of loose or foreign matter and contains sufficient moisture to prevent excessive penetration of the bituminous material. Sprinkle the area immediately before the bituminous material is applied. [Sand][Dust][_____] the treated surface to prevent the bituminous material from being picked up by traffic.

[3.5 SAMPLING AND TESTING

Submit calibration curves and related test results prior to using the device or equipment being calibrated. Provide copies of field test results within [24] [_____] hours after the tests are performed. Submit certified copies of test results of materials and sources not less than [30] [_____] days before material is required for the work.

3.5.1 General Requirements

Perform sampling and testing using an approved commercial testing laboratory or facilities which have been inspected by the Cement and Concrete Reference Laboratory (of ASTM/CCRL) within the past 3 years or by a Government approved independent commercial testing laboratory provided by the Contractor. The first inspection and subsequent inspections required because of failure of the facilities to pass the first inspection is at the expense of the Contractor. Perform sampling and testing using a laboratory frequency of sampling and testing of materials for conformance and quality control as specified and to be performed at such other times to document contract compliance. Provide certified copies of the test results within 24 hours of completion.

3.5.2 Results

Verify that results comply with the material specification. When [the source of materials is changed] [deficiencies are found], repeat the initial analysis including mix design studies if the material source is changed, and retest the material already placed to determine the extent of unacceptable material. Replace unacceptable in-place material.

3.5.3 Sampling

Take aggregate samples for laboratory testing in accordance with

ASTM D75/D75M. Take samples of lime in accordance with ASTM C50/C50M. Prepare specimens for the unconfined compression tests in accordance with ASTM D1632.

3.5.4 Sieve Analysis

Before starting work, test one sample of material to be [stabilized] [modified] in accordance with ASTM C136/C136M on sieves conforming to ASTM E11. After the initial test, perform a minimum of one analysis for each [910] [_____] metric tons [1000] [_____] tons of material placed, with a minimum of three analyses for each day's run until the course is completed.

3.5.5 Liquid Limit and Plasticity Index

Perform one liquid limit and plasticity index for each sieve analysis. Confirm the liquid limit and plasticity index are in accordance with ASTM D4318.

3.5.6 Chemical Analysis

Test lime for the specified chemical requirements in accordance with ASTM C25.

3.5.7 Optimum Moisture, Maximum Density

Perform optimum moisture, maximum density test on lime-treated material sampled after final mixing and prior to final compaction. Laboratory compact soil mixture within 3 hours of sampling and then moist-cure for 24 hours prior to optimum moisture-maximum density determination. Perform testing in accordance with ASTM D1557, Method D and the JMF.

3.5.8 Uniformity Tests

After placement and mixing of each lift perform a series of uniformity tests. Excavate a hole 250 mm 10 in in diameter through full depth of lift and impregnate sides of hole with a standard phenolphthalein alcohol indicator. Non-conformity of color reaction, when material is treated as above, is considered evidence of inadequate mixing.

3.5.9 Compaction

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NOTE: Allow nuclear testing methods for site preparation testing or final in-place testing on larger projects of over 3300 square m 4000 square yd. The required frequency of ASTM D1556/D1556M check testing varies according to the critical nature and purpose of the project.

****

Perform in-place density test to determine degree of compaction between 24 and 72 hours after final compaction and 24 hour moist cure period. Test in accordance with ASTM D1556/D1556M. Allow use of ASTM D6938 and compatible meter methods providing one ASTM D1556/D1556M check test is made after every [four] [_____] nuclear tests.

3.5.10 Thickness and Smoothness

Do not allow the thickness of the final lime treated subgrade to be less than thickness shown. Do not allow the final grade smoothness to deviate by more than 10 mm 3/8 in, when tested with a 3 m 10 ft straightedge.

[3.5.11 Field Application Rate Test

Test for initial lime spreading rate.

]3.5.12 Frequency of Tests

Use the minimum number and type of quality control tests as follows:

a. Optimum moisture, maximum density. [Two] [_____] of each type or change of material with in-place density requirements.

b. Thickness, smoothness and uniformity. [Two] [_____] tests each day for every 840 square m 1000 square yd [_____] or less mixed and placed.

c. Field density. One set of [3] [_____] tests for each lift for every 1670 square m 2000 square yd [_____] or less.

[d. Field application rate test. One test for each lime spreading vehicle to be used on site.]

]3.6 FIELD QUALITY CONTROL

Provide a moisture-density relationship for the lime-soil mixture from the tests. Verify that the material complies based on results of field quality control testing. When a material source is changed, [test the new material for compliance] [_____]. Repeat the initial analysis when deficiencies are found. Retest material already placed to determine the extent of unacceptable material. Replace and repair unacceptable in-place material at no additional cost to the Government.

3.6.1 Treatment Depth Checks

Measure the depth of stabilization at an interval for each of [250][_____] square m [300][_____] square yd of [stabilized] [modified] course. Make measurements in test holes in soil by spraying with a pH indicator such as phenolphthalein. Phenolphthalein changes from clear to red between pH 8.3 and 10. The color change indicates the location of the bottom of the mixing zone. Other pH indicators can measure higher pH levels if there is reason to suspect that inadequate lime has been mixed into the soil.

3.6.2 Thickness Control

****

NOTE: When subgrade courses are constructed less than 150 mm 6 in in total thickness, a deficiency of 13 mm 1/2 in in thickness is considered excessive. Applicable to job conditions, modify thickness tolerance provisions as required, restricting deficiencies to not over 6 mm 1/4 in.

****

Complete thicknesses of the [stabilized] [modified] course within [13] [6] mm [1/2] [1/4] in of the thickness indicated. Where the measured thickness of the [stabilized] [modified] course is more than [13] [6] mm [1/2] [1/4] in deficient, correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the [stabilized] [modified] course is more than [13] [6] mm [1/2] [1/4] in thicker than indicated, it consider it as conforming to the specified thickness requirement. Average the thickness measuremets taken for the job to be the job thickness within 6 mm 1/4 in of the thickness indicated. Measure the thickness of the [stabilized] [modified] course at intervals which ensure one measurement for each [210] [_____] square m [250] [_____] square yd of [stabilized] [modified] course. Make measurements in 75 mm 3 in diameter test holes penetrating the [stabilized] [modified] course.

3.6.3 Field Density

Determine field in-place density in accordance with [ASTM D1556/D1556M] [ASTM D2167] [ASTM D6938]. [When ASTM D6938 is used, check the calibration curves, and adjust, using the sand cone method as described in paragraph Calibration of the ASTM publication.] Allow ASTM D6938 to be used to determine both the wet unit weight and the moisture content of the soil. Check calibration curves provided with the moisture gauges along with density calibration checks as described in ASTM D6938. If ASTM D6938 is used, check in-place densities by ASTM D1556/D1556M at least once per lift and at a frequency not to exceed one test under ASTM D1556/D1556M per [8] [_____] tests performed under ASTM D6938. Provide calibration curves and calibration tests results within 24 hours of conclusion of the tests. Perform at least one field density test for each [210][_____] square m [250][_____] square yd of each layer of [stabilized] [modified] material.

3.6.4 Smoothness Test

Do not permit the surface of a [stabilized] [modified] layer to show deviations in excess of 13 mm 1/2 in when tested with the [3] [3.7] m [10-] [12-] ft straightedge. Correct deviations exceeding this amount by removing material and replacing with new material, or by reworking existing material and compacting, as directed. Take measurements for deviation from grade and cross section shown in successive positions parallel to the pavement centerline with a [3] [3.7] m [10-] [12-] ft straightedge. Take measurements perpendicular to the pavement centerline at [15] [_____] m [50-] [_____] ft intervals.

3.7 TRAFFIC CONTROL, CURING MAINTENANCE, AND DRAINAGE PROTECTION

Allow completed portions of the lime-treated soil area to be opened to light traffic after a period of 3 days if cured with a bituminous material provided the curing is not damaged. Provide warning signs and barricades so that traffic does not travel over freshly treated surfaces. After the curing period has elapsed, open completed areas to traffic, provided the [stabilized][modified] course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Do not permit heavy equipment on the area during the curing period. [Allow lime and water to be hauled over the completed area with pneumatic-tired equipment if approved.] Protect finished portions of lime-[stabilized][modified] soil, that are traveled on by equipment used in constructing an adjoining section, in a manner to prevent equipment from marring or damaging completed work. Provide drainage during entire period of construction to prevent water from collecting or standing on area to be stabilized.

3.8 EQUIPMENT LIMITATIONS

3.8.1 General

Use the type of equipment for each category of work conforming to the NLA BUL 326 unless specified otherwise. Maintain equipment in satisfactory and safe operating condition.

3.8.2 Spreading Equipment

At windy locations, use an approved screw type spreader box, mixer, or other semi-enclosed equipment which offers protection from wind. Spreading hydrated lime by aggregate spreaders, dump trucks or agricultural spreaders is not allowed. Spreading by end-dumping or tailgate control methods are not allowed. Change or alter equipment to be used in the event of non-uniform spreading of lime.

3.8.3 Additional Mixing Equipment Limitations

a. Do not allow motor graders to mix lime with clays.

b. Allow use of deep-lift rotary mixers to facilitate changes in specified depths of operation, providing equipment and method of operation sustains uniform distribution of lime with required compacted density throughout the deeper layer, with approval of Contracting Officer.

3.8.4 Additional Compaction Equipment Limitations

Do not allow unauthorized equipment, hauling or transportation vehicles for compaction purposes.

3.9 SAFETY REQUIREMENTS

In addition to the Contract Clause entitled "Accident Prevention," prevent employee eye or skin contact with quicklime during transport or application. Provide and require employees use the following:

a. Protective clothing, high top boots, gauntlet-type gloves and protective headwear.

b. Splash-proof safety goggles and face shields.

c. Protective cream.

3.10 MAINTENANCE

Maintain [stabilized] [modified] area in a satisfactory condition until the completed work is accepted. Include immediate repairs of defects in maintenance and repeat to keep the area intact. Correct defects as specified.

3.11 DISPOSAL OF UNSATISFACTORY MATERIALS

Dispose of removed in-place materials that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris [as directed] [in waste disposal areas indicated].

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 11 13.16 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 27 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-32 11 13.16 (May 2020)**

Preparing Activity: USACE **Superseding**
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SECTION 32 11 13.16

BITUMINOUS-STABILIZED SUBGRADE
05/20

****

NOTE: This guide specification covers the requirements for bituminous stabilization of subgrades for airfield pavements, roads, streets, and parking areas.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

The purposes of bituminous stabilization are to waterproof and improve the cohesive strength of non-cohesive granular soils and aggregates. This specification is limited to soils and aggregates with less than 30 percent passing the No. 200 sieve and a Plasticity Index equal to or less than 10. For bituminous base course or subbase stabilization, use UFGS 32 11 26.19.

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: Delete these paragraphs when lump sum payment is desired.

****

1.1.1 Measurement for Payment

1.1.1.1 Bituminous Stabilization

Measurement will be by the square meter yard of work completed and accepted.

1.1.1.2 Bituminous Material

Submit quantity of residual bituminous material used in the job. Bituminous material to be paid for will be measured in the number of [liters gallons of the material used in the accepted work, corrected to liters at 15 degrees C gallons at 60 degrees F in accordance with ASTM D1250. Use a coefficient of 0.00025 per degree C F for asphalt emulsion.] [metric 2000 pound tons of the material used in the accepted work.]

1.1.2 Basis for Payment

Bituminous-stabilized mixture, constructed and accepted, [and the quantities of bituminous material] will be paid for at the respective contract unit prices. Payment will not be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used.

1.1.3 Waybills and Delivery Tickets

Submit copies of waybills and delivery tickets during the progress of the work. Before the final payment is allowed, furnish waybills and certified delivery tickets for all bituminous materials actually used in the construction.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASPHALT RECYCLING AND RECLAIMING ASSOCIATION (ARRA)

ARRA FDR201A	(2018) Recommended Mix Design Guidelines for Full Depth Reclamation (FDR) Using Emulsified Asphalt Stabilizing Agent

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D1250	(2019; E 2020) Standard Guide for Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1883	(2016) Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt
ASTM D2419	(2014) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	(2017; E 2018) Standard Practice for

	Description and Identification of Soils (Visual-Manual Procedure)
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 DEFINITION

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure in accordance with ASTM D1557, abbreviated in this specification as percent laboratory maximum density.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Mix Design; G, [_____]

Notification of the Selected Source

Waybills and Delivery Tickets

Plant, Equipment, Machines And Tools
SD-06 Test Reports

Sampling and Testing

SD-07 Certificates

Bituminous Material

1.5 QUALITY CONTROL

1.5.1 Qualifications

****
NOTE: Include bracketed sentence for Corps-managed projects.
****

Perform sampling and testing using an approved commercial testing laboratory or on-site facilities. Submit accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM D3666, including all applicable test procedures. Do not start work requiring testing until the facilities have been inspected and approved. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. Maintain this certification for the duration of the project. [In addition, all contractor quality control testing laboratories performing acceptance testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at
http://www.erdc.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/9254/Article/
for costs and scheduling.]

1.5.2 Test Results

Verify that materials comply with the specification. When an in-place material source materially changes, re-test the material for compliance with specification requirements. When deficiencies are found, repeat the initial analysis and retest the material already placed to determine the extent of unacceptable material.

1.5.3 Bituminous Material

Submit notification of the selected source of bituminous material within 15 days after the award of contract. Submit certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements, not less than [30] [_____] days before the material is required in the work.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Environmental Requirements

Do not apply bituminous material when the atmospheric temperature is less than 10 degrees C 50 degrees F or to soils that are frozen or contain frost. If the temperature falls below 2 degrees C 35 degrees F, protect completed bitumen-treated areas against any detrimental effects of freezing.

1.7 ACCEPTANCE

1.7.1 Tolerances

Acceptance of bituminous stabilized subgrade is based on compliance with the tolerances presented in Table 1. Remove and replace bituminous stabilized mixture represented by the failing tests or submit repair plan for approval.

TABLE 1

Attribute	Tolerance
Field Density	minimum of 95 percent
Asphalt Content	plus/minus 0.5 percent of mix design
Grade	plus/minus 15 mm 0.05 foot
Smoothness	maximum of 13 mm 1/2 inch
Thickness (individual measurement)	maximum of 13 mm 1/2 inch
Thickness (average of all measurements)	minimum of 6 mm 1/4 inch

1.7.2 Test Section

[Place a test section of at least 2.5 by 30 m 8 by 100 feet, utilizing the equipment and procedures proposed for use, to demonstrate that bituminous stabilized mixture conforming to this specification can be produced. Acceptance of the test section is based on compliance with the tolerances listed in Table 1.] [A test section is not required.]

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Bituminous Material

****

NOTE: Select asphalt emulsion type for the bituminous-stablized subgrade based on the soil classification of the subgrade soils evaluated during the site geotechnical investigation.

Subgrade Classification	**Emulsion Type**
GP	**MS-1, HFMS-1, MS-2h, HFMS-2h, CMS-2, CMS-2h**
GW	**MS-2h, HFMS-2h, HFMS-2s, SS-1, SS-1h, CSS-1, CSS-1h**
SW, SP	**MS-2h, HFMS-2h, HFMS-2s, SS-1, SS-1h, CSS-1, CSS-1h**
GM, SM	**MS-2h, HFMS-2h, HFMS-2s, SS-1, SS-1h, CSS-1, CSS-1h**
Combinations of above	**MS-2h, HFMS-2h, HFMS-2s, SS-1, SS-1h, CSS-1, CSS-1h**

****

2.1.1.1 Emulsified Asphalt

Provide bituminous material conforming to [ASTM D977 Type [MS-1] [MS-2h] [HFMS-1] [HFMS-2h] [HFMS-2s] [SS-1] [SS-1h]] [ASTM D2397/D2397M Type [CMS-2][CMS-2h][CSS-1][CSS-1h]].

2.1.2 Material to be Stabilized

****

NOTE: This specification is limited to in-place low-plasticity soils with less than 30 percent passing the 0.075 mm No. 200 sieve. If the in-place soils do not meet the listed requirements, do not use this section. Consider lime or cement stabilization in accordance with UFC 3-250-11 and UFC 3-270-01.

****

In-place soil or aggregate conforming to soil classifications GW, GP, GM, SW, SP, SM, or combinations thereof. Soil classification in accordance with ASTM D2487 and ASTM D2488. Verify Plasticity Index equal to or less than 10 in accordance with ASTM D4318; sand equivalent percentage greater than 35 percent in accordance with ASTM D2419; and percent passing the No. 200 sieve less than 30 percent. Perform sieve analysis in accordance with ASTM C117 and ASTM C136/C136M.

2.1.3 Water

Furnish clean, fresh, and potable water.

2.2 MIX DESIGN

****

NOTE: Specify design subgrade CBR value to be verified during the mix design. Specify soaked condition and surcharge load. Default values are 24-hour soaked and 4.5 kg 10 lb surcharge load.
****

Develop and submit for approval a proposed mix design prior to stabilization work. Develop mix using samples of the material to be stabilized. Conduct mix design in accordance with ARRA FDR201A. Verify CBR bearing value of [_____] or greater in accordance with ASTM D1883 when tested in a [24-hour soaked] [unsoaked] condition under a surcharge load of 4.5 [_____] kg 10 [_____] lb.

2.2.1 Mix Design Report

Perform trial design batches, mixture proportioning studies, testing, and submit test results demonstrating that the proposed mixture proportions produce a bituminous-stabilized mixture of the qualities indicated. Submit test results in a mix design report to include:

a. Gradation, sand equivalent, and Plasticity Index of soil or aggregate.
b. Maximum dry density and optimum moisture content.
c. Density, maximum specific gravity, air void content, dry and moisture conditioned indirect tensile strength and level of saturation at each emulsified asphalt stabilizing agent content.
d. Optimum emulsified asphalt stabilizing agent content as a percentage of dry materials.
e. Density, air void content, dry and moisture conditioned indirect tensile strength and CBR value at recommended moisture and emulsified asphalt stabilizing content.
f. Emulsified asphalt stabilizing agent designation, supplier name and location.
g. Emulsified asphalt residue content and certificates of compliance.

2.3 PLANT, EQUIPMENT, MACHINES, AND TOOLS

Submit list of proposed plant, equipment, machines and tools to be used in performance of construction work, including descriptive data. Plant, equipment, machines, and tools used in the work are subject to approval. Maintain in a satisfactory working condition at all times. Provide equipment with the capability of producing the required compaction, meeting grade controls, thickness control and smoothness requirements indicated.

2.3.1 Mixer/Reclaimer

Provide a self-propelled, four-wheel drive rotary mixer/reclaimer, capable of pulverizing the soil in a single pass for the full depth to be stabilized and providing a mixing action capable of uniformly blending and mixing the required bituminous material content with the aggregate. Equip with a rotor capable of up or down cutting. Equip the mixer/reclaimer with an integrated additive injection system capable of introducing bituminous emulsion into the cutting drum during the mixing process. Provide a metering device capable of automatically adjusting the flow of the bituminous emulsion to compensate for any variation in the amount of reclaimed material introduced into the mixing chamber.

2.3.2 Traveling Plant

Provide a traveling plant capable of moving at a uniform rate of speed and accomplishing thorough mixing of the materials in one pass. Deliver water and bituminous material from supply trucks or bins at a predetermined rate. Construct windrows of prepared bituminous stablized mixture to cover a predetermined width to the indicated compacted thickness.

2.3.3 Bituminous Distributor

Provide a distributor with pneumatic tires that prevent rutting, shoving, or otherwise damaging other layers in the pavement structure. Design and equip the distributor to spray bituminous material in a uniform double or triple lap at the specified temperature, at variable widths, and at readily determined and controlled rates from 0.15 to 6.5 L/square meter 0.05 to 2.0 gallons/square yard with an allowable variation from the specified rate of plus or minus 5 percent and with a pressure range of 175 to 515 kPa 25 to 75 psi. Provide capability to circulate and agitate the bituminous material during the heating process. The bituminous distributor is permitted only for applying tack, prime, and seal coats and not for applying bitumen to be mixed into the stabilized mixture.

2.3.4 Rollers

Compact the bituminous stabilized mixture using one or a combination of the following pieces of equipment: tamping or grid roller; steel-wheeled roller; vibratory roller; pneumatic-tire roller, and/or vibrating plate compactor (for areas inaccessible to rollers). Compact the bituminous stabilized mixture using the number, type, and weight of rollers and/or compactors sufficient to compact the mixture to the required density.

2.3.5 Straightedge

Furnish and maintain at the site, in good condition, one [3.05] [3.66] meter [10] [12] foot straightedge for use in the testing of the finished surface. Make straightedge available for government use. Construct straightedges of aluminum or other lightweight metal having blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Provide handles to facilitate straightedge movement on the bituminous stabilized surface.

PART 3 EXECUTION

3.1 PREPARATION OF AREAS TO BE STABILIZED

Clean area of debris. Inspect area for adequate compaction and capability of withstanding, without displacement, compaction specified for the bituminous-stabilized mixture. Dispose of debris and removed unsatisfactory in-place material [as directed] [in waste disposal areas indicated]. Provide adequate drainage to prevent water from collecting or standing on the area during the duration of the bituminous-stabilization construction.

3.1.1 In-Place Material to be Stabilized

Grade and shape the entire area to conform to the lines, grades, and cross sections shown prior to being processed. Make soft or yielding areas stable before construction is begun.

3.2 GRADE CONTROL

Excavate underlying material to sufficient depth for the required stabilized-course thickness so that the finish stabilized course and the subsequent surface course will meet the fixed grade. Provide line and grade stakes as necessary for control. Place grade stakes in lines parallel to the centerline of the area under construction and suitably spaced for string lining. Conform finished and completed stabilized area to the lines, grades, cross section, and dimensions indicated.

3.3 MIXING OF MATERIALS

****

NOTE: Both mix-in-place and traveling plant mixing methods are presented. Select one method or permit both as a contractor option.

****

3.3.1 Mixed-in-Place Method

3.3.1.1 Scarifying and Pulverizing of Soil

Prior to the application of bituminous materials, scarify and pulverize the soil [to the depth shown] [to a depth of [_____] mm inches]. Control scarification so that the layer beneath the layer to be stabilized is not disturbed. Do not permit the depth of pulverizing to exceed the depth of scarification. Unless otherwise permitted, limit the area scarified and pulverized not exceeding the area that can be completed in 2 working days.

3.3.1.2 Application of Water

Shape pulverized material to the cross section and grade indicated. Determine the moisture content. Add water in increments and partially incorporate each increment of water in the mix to avoid concentration of water near the surface. After the last increment of water has been added, continue mixing until the water is uniformly distributed throughout the mixture, including satisfactory moisture distribution along the edges of the section.

3.3.1.3 Application of Bituminous Material

Uniformly apply bituminous material, of the amount required for each application, by a spraybar integrated into the cutting drum of the mixer/reclaimer within a temperature range of 25 to 55 degrees C 75 to 130 degrees F. Uniformly mix bituminous material with the soil. If the bituminous material is applied in more than one increment, partially mix each application into the material. After the required amount of bituminous material has been added to the loose material, thoroughly mix the bituminous material and soil. After mixing is completed, verify the bituminous-stabilized mixture conforms to the mix design proportions and the moisture content is within 1 percent of the mix design. Include the water used to dilute the asphalt emulsion in the moisture content calculation. Do not permit equipment, except that used for spreading and mixing operations, to pass over the freshly spread bituminous material.

3.3.2 Traveling-Plant Method

Place the pulverized material in windrows of sufficient size to cover a predetermined width to the indicated compacted thickness. Advance the traveling plant at a uniform rate of speed and provide thorough mixing of the materials. Deliver water and bituminous material separately or together at a predetermined rate.

3.4 PLACEMENT AND COMPACTION

****

NOTE: Density will be based on the material being stabilized.

****

For mixed-in-place material, allow the bituminous-stabilized mixture an adequate amount of time to cure. After curing, shape the mixture approximately to the specified lines and grades and thoroughly loosened to its full depth and width. Begin compaction at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate the length of trips of the roller. Do not permit displacement of materials to occur. Compact mixture to a density at least [95] [_____] percent of laboratory maximum density. Compact areas inaccessible to rollers to the required density with mechanical tampers.

3.5 JOINTS

3.5.1 Longitudinal Joints

For the shoulders of the stabilized areas, place approved material along the edges of the stabilized course to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course. Simultaneously compact a minimum 300 mm 1 foot width of the shoulder or previously placed strip with the compacting of each layer of the stabilized course.

3.5.2 Transverse Joints

At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to obtain a true vertical face free of loose or shattered material. Remove material along construction joints not properly compacted and replace with bituminous-stabilized mixture that is mixed, moistened, and compacted in accordance with this specification.

3.6 FINISHING

Finish the surface of the top layer to grade and cross section shown with a uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. If the surface becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, scarify, rework, relay, or replace as directed. If any portion of the course, when laid, becomes saturated for any reason, immediately remove that portion, place in a windrow and aerate until a moisture content within the limits specified is obtained; and then spread, shape, and compact as specified.

3.6.1 Thickness Control

****

NOTE: Applicable to job conditions, the thickness tolerance provisions may be modified as required, restricting all deficiencies to not over 6 mm 1/4 inch.

****

Build the compacted thickness of the stabilized course within 13 mm 1/2 inch of the thickness indicated. Where measured thickness of the stabilized course is more than 13 mm 1/2 inch deficient, correct such areas by removing and replacing the bituminous-stabilized mixture and recompacting as directed. Where the measured thickness of the stabilized course is more than 13 mm 1/2 inch thicker than indicated, consider the course as conforming to the specified thickness requirements. Average job thickness is the average of all thickness measurements taken for the job, but within 6 mm 1/4 inch of the thickness indicated.

3.7 FIELD QUALITY CONTROL

3.7.1 Sampling and Testing

Perform sampling and testing in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified tolerances in Table 1. Furnish certified copies of test results within 24 hours of completion of tests. Test for properties not listed in Table 1 are for Contractor Quality Control only.

3.7.2 Field Density

Express the compaction as a percentage of the laboratory maximum density. Prepare laboratory samples from an uncompacted mixture taken from the bituminous-stabilized material immediately prior to field compaction and compact the samples in accordance with ASTM D1557. Perform a minimum of one laboratory compaction test for each 4 hours of mixture placed. Determine field in-place density in accordance with [ASTM D1556/D1556M] [ASTM D6938. When ASTM D6938 is used, check the calibration curves and adjust if necessary, using the sand cone method as described in paragraph Calibration of the ASTM publication. ASTM D6938 results in a wet unit weight of soil and is used to determine the moisture content of the soil]. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. If ASTM D6938 is used, check the in-place densities by ASTM D1556/D1556M at least once per lift for each day's production of stabilized material. Furnish calibration curves and calibration test results within 24 hours of conclusion of the tests. Perform at least one field density test for each [200] [_____] square meters [250] [_____] square yards of each layer of stabilized material.

3.7.3 Sieve Analysis

Perform a minimum of 1 analysis for each [1000] [_____] metric tons tons of material to be stabilized, with a minimum of 3 analyses for each day's production until the course is completed. If the gradation varies by more than 10 percent on the No. 200 sieve from the mix design value, stop production and re-evaluate the mix design.

3.7.4 Liquid Limit and Plasticity Index

Perform one liquid limit and plasticity index for each sieve analysis in accordance with ASTM D4318.

3.7.5 Extraction Test

Conduct asphalt content tests in accordance with ASTM D2172/D2172M or ASTM D6307, to confirm the amount of bitumen and moisture in the mixture.

Adjust operations as required to maintain the asphalt content within the tolerance of Table 1. Conduct one test [for every 4 hours of placement] [for every 275 metric tons 300 tons of mixture placed]. Take samples in accordance with ASTM D979/D979M.

3.7.6 Grade Test

Determine the grade by running lines of levels at intervals of 7.6 m 25 feet, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface.

3.7.7 Smoothness Test

Take measurements for deviation from grade and cross section shown in successive positions parallel to the bituminous-stabilized lane, with a straightedge. Take measurements perpendicular to the bituminous-stabilized lane at [15] [_____] meter [50] [_____] foot intervals.

3.7.8 Thickness

Measure thickness of the stabilized course at intervals of 1 measurement for each [400] [_____] square meters [500] [_____] square yards of stabilized course. Take measurements in 75 mm 3 inch diameter test holes penetrating the stabilized course.

3.7.9 Bituminous Material

Sample the bituminous material used in accordance with ASTM D140/D140M.

3.8 MAINTENANCE

Maintain stabilized area in a satisfactory condition until accepted. Maintenance includes immediate repairs to any defects, repeated as often as necessary to keep the area intact. Correct defects as specified.

3.9 TRAFFIC

Completed portions of the bituminous-stabilized area may be opened to controlled traffic within 4 hours of completion of the course, if approved.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 11 20 (May 2022)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 20 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 11 20

[BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING]

05/22

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC UFGS-32 11 20 (May 2022)

Preparing Activity: USACE Superseding
UFGS-32 11 20 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 32 11 20

[BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING]

05/22

****

NOTE: This guide specification covers the requirements for base course for rigid pavements and subbase or select-material for flexible airfield pavements, roads and streets.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification is applicable to subbase courses for airfield pavements, roads and streets including select-material courses in the lower levels of the pavement structure. Use this specification for any subbase course that has a design California bearing ratio (CBR) between 20 and 50 or any select-material with design CBR less than 20. Select-material does not require processing or blending.

This specification can also be used for:

a. The base course directly beneath the bituminous surface of a pavement design for roads and streets where the required CBR value of the material is 50 or less and the material conforms to Gradation No. 1.

b. The base course beneath rigid pavements.

c. Select-Materials are typically locally available coarse grained soils with a maximum CBR of 20 when used in a flexible pavement section.

When this guide specification is used for aggregate base course under rigid pavement, edit section title of the project specification to: BASE COURSE FOR RIGID PAVING and select the words "rigid pavement base course" throughout.

When this guide specification is used in combination for a subbase course under flexible pavements and a base course under rigid pavements, edit the section title to: BASE COURSE FOR RIGID AND SUBBASES FOR FLEXIBLE PAVING and include the words "or rigid pavement base course" after "subbase" throughout.

If Select-Materials are specified in this section, revise the title to include the words "SELECT-MATERIAL" and edit the appropriate paragraphs throughout the section

****

1.1 UNIT PRICES

****

NOTE: Delete unit price paragraphs when the work is covered by a lump-sum contract price.

****

1.1.1 Measurement

****

NOTE: Delete the method of measurement paragraph not applicable to job conditions. Specify measurement by Area for courses with constant thickness.

****

1.1.1.1 Area

Measure the quantity of [_____] mm inch thick [subbase] [and] [select-material] [or] [rigid pavement base] course completed and accepted in square meters yards.

1.1.1.2 Volume

Measure the quantity of [subbase] [and] [select-material] [or] [rigid pavement base] course completed and accepted in cubic meters yards. Determine the volume of material in-place and accepted by the average job thickness obtained in accordance with paragraph LAYER THICKNESS and the dimensions shown on the drawings.

1.1.2 Payment

1.1.2.1 Course Material

Quantities of [subbase] [and] [select-material] [or] [rigid pavement base] course, determined as specified above, will be paid for at the respective contract unit prices, which will constitute full compensation for the construction and completion of the [subbase] [and] [select-material] [or] [rigid pavement base] course.

1.1.2.2 Stabilization

Cohesionless subgrade or underlying courses to be stabilized, as specified in paragraph PREPARATION OF UNDERLYING COURSE OR SUBGRADE, will be paid for as a special item on a tonnage basis including extra manipulation as required.

1.1.3 Waybills and Delivery Tickets

Submit copies of waybills and delivery tickets during progress of the work. Before the final payment is allowed, file certified waybills and certified delivery tickets for all aggregates actually used.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C117	(2023) Standard Test Method for Materials

	Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4718/D4718M	(2015) Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D7928	(2017) Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 DEGREE OF COMPACTION

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557.. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 9.0 mm 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 9.0 mm 3/4 inch sieve as a percentage of the laboratory maximum dry density in accordance with ASTM D1557 Method C and corrected with ASTM D4718/D4718M.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Tailoring options are available for "ADDITIONAL DATA COLLECTION PLAN SUBMITTALS", "DATA VISUALIZATION SPECIALIST", "WEB-BASED GIS INTERFACE", "DESKTOP GIS FILES", "CAD 3D MODEL", "CAD QUALIFICATIONS AND ROLES", and "OPENGROUND".

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools; G[, [_____]]

Waybills and Delivery Tickets

SD-06 Test Reports

Initial Tests; G[, [_____]]

In-Place Tests; G[, [_____]]

Test Section Report; G[, [_____]]

1.5 QUALITY ASSURANCE

****

NOTE: Select UFGS Section 01 45 00 for Army, Air Force, and Navy projects.

For Navy projects, delete the bracketed sentence requiring MTC validation.

****

Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00 QUALITY CONTROL. Do not start work requiring testing until the testing laboratory has been inspected and approved. [All contractor quality control testing laboratories performing acceptance testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at https://mtc.erdc.dren.mil/requestvalidation.aspx# for costs and scheduling.] Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. Furnish copies of test results within 24 hours of completion of the tests.

1.5.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M.

1.5.2 Tests

1.5.2.1 Gradation

****

NOTE: Require testing in accordance with ASTM D7928when the materials need to be tested for the 0.02 mm particle size.

****

Perform gradation in conformance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11. [Perform particle-size analysis of the soils in conformance with ASTM D7928.]

1.5.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

1.5.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture in accordance with paragraph DEGREE OF COMPACTION.

1.5.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556/D1556M, or ASTM D6938. For the method presented in ASTM D1556/D1556M, use the base plate, as shown in the drawing. For the method presented in ASTM D6938, check the calibration curves and adjust them, if necessary, using only the sand cone method as described in Annex A2, of the ASTM publication. Use ASTM D6938 to determine the moisture content of the soil. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. Make the calibration checks of both the density and moisture gauges using the prepared containers of material method, as described in Annex A2, in ASTM D6938, on each different type of material to be tested at the beginning of a job and at intervals as directed. Submit calibration curves and related test results prior to using the device or equipment being calibrated.

1.5.2.5 Wear Test

****

NOTE: Wear tests are not required for select-material course materials.

****

Perform wear tests on [subbase course] [and] [or] [rigid pavement base course] material in conformance with ASTM C131/C131M.

1.5.2.6 Weight of Slag

****

NOTE: Omit this paragraph when it is unlikely that slag will be supplied.

****

Determine weight per cubic meter foot of slag in accordance with ASTM C29/C29M.

1.6 ENVIRONMENTAL REQUIREMENTS

****

NOTE: Delete this paragraph in localities where freezing temperatures do not occur, and elsewhere when it is definitely known that the work will not be carried on during periods when such temperatures are to be expected. Otherwise, retain this requirement, but modify the protective measures specified to suit local conditions and individual project requirements.

****

Perform construction when the atmospheric temperature is above 2 degrees C 35 degrees F. When the temperature falls below 2 degrees C 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

1.7 ACCEPTANCE

1.7.1 Tolerances

****

NOTE: Determine compaction requirements for select-material from UFC 3-260-02, paragraph 7-3 and insert values in Table 1. Delete select-material row from the table if not used.

Specify 100 percent compaction For Navy airfield rigid pavement base courses.

****

Acceptance of [rigid pavement base course] [subbase course] [select-material] is based on compliance with the tolerances presented in Table 1. Remove and replace any course identified by the failing tests.

TABLE 1

Measurement	Tolerance
Grade	Plus 0, Minus 13 mm 1/2 inch
Smoothness	Plus/Minus 12 mm 1/2 inch
Total Thickness	Plus/Minus 13 mm 1/2 inch
Average Job Thickness	Plus/Minus 6 mm 1/4 inch
Compaction	
[Subbase]	Mimimum 100 percent
[Rigid Pavement Base Course]	Mimimum [95] [100] percent
[Select-Material]	[_____]

1.7.2 Test Section

****

NOTE: A test section is required for subbases and rigid pavement base courses under airfield pavement.

****

[Construct a test section consisting of 1000 square meters square yards of [rigid pavement base course] [subbase] [select-material] to demonstrate the materials, equipment, and construction processes meet the requirements of this specification. Acceptance of the test section is based on compliance with the tolerances listed in Table 1. Rework, re-compact, or remove and replace test sections that do not meet specification requirements. Do not commence full operations until the test section report has been approved. Use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments are approved in advance.] [A test section is not required.]

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Subbase Course

****

NOTE: As written, this paragraph applies to general conditions. Other materials such as disintegrated granite, volcanic ash or cinders, limerock, caliche, or asphalt millings can be specified when supported by adequate performance data. If recycled concrete aggregate (RCA) is proposed, evaluate the source using the protocol of Section 32 11 23 [AGGREGATE BASE COURSE] [AND/OR][GRADED CRUSHED AGGREGATE BASE COURSE] FOR FLEXIBLE PAVINGbefore specifying use of the material.

Delete the requirement for percentage of wear when local experience indicates the material is satisfactory.

As an option for specifying subbase course for roads, streets, or similar-use pavements, incorporate the material requirements from State or other local highway agency specifications if conditions a, b, c, and d below are met:

a. The percentage of material by weight passing the 0.075 mm (No. 200) sieve not to exceed 8.

b. When local conditions dictate a nonfrost-susceptible material, limit particles having a diameter of less than 0.02 mm to a maximum of 3 percent.

c. Limit the portion of the material passing the 0.425 mm (No. 40) sieve to a liquid limit not greater than 25 and a plasticity index not greater than 5.

d. The project requires less than 600 cubic meters (750 cubic yards) of material and it is not an airfield pavement. (See item e below if project does not meet this requirement).

e. Approval from AFCEC, the Navy EFDs, or USACE TSMCX is required before state or other local highway specifications can be used for airfield projects of any size. Project specific information will be submitted to AFCEC, the Navy EFDs, or USACE TSMCX with the request for approval.

Insert the desired maximum top size in the blank. The necessity for meeting grades dictates that maximum top size does not exceed 75 mm (3 inches). When this specification is to be used as base course for roads, streets, and parking areas, limit the top size to a maximum of 50 mm (2 inches) for a layer

thickness of less than 150 mm (6 inches). Delete the inapplicable gradation.

Gradation No.	**Design CBR**
1	**50 Max**
2	**40 Max**
3	**30 Max**
Select Material	**20 Max**

Use gradation band No. 1 or 2 for lower design CBR values than specified above where no increase in price results. Exceptions to the gradation requirements will be permitted when supported by adequate in-place CBR data.

Both a graded aggregate and a geotextile can act as a separation later beneath the drainage layer. Graded aggregates are typically selected since a geotextile is not a structural component of the pavement system and does not provide extra stability for compaction of the drainage layer. Consult UFC 3-230-06, Subsurface Drainage, for guidance on selecting and specifying a geotextile.

Use gradation No. 1 when a drainage layer will be placed above the subbase and the subbase is designed as a separation layer. Limit the maximum size to 1/4 of the separation layer thickness and include the bracketed sentence for separation layer piping criteria.

Where local conditions dictate a nonfrost-susceptible material, retain the sentence in brackets requiring particles having a diameter of less than 0.02 mm not to exceed 3 percent by weight of the total aggregate, as determined in accordance with ASTM D 7926.

****

Provide aggregates consisting of crushed stone or [slag,] gravel, shell, sand, [on-site recycled concrete aggregate (RCA),] or other sound, durable, approved materials processed and blended or naturally combined. Provide aggregates which are free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. Limit the percentage of loss to a maximum of 50 percent after 500 revolutions when tested in accordance with ASTM C131/C131M. Provide aggregate that is reasonably uniform in density and quality. [Provide slag that is an air-cooled, blast-furnace product having a dry weight of not less than 1120 kg/cubic meter 70 pcf.] Provide aggregates with a maximum size of [_____] mm inch, a minimum of 70 percent passing the 37.5 mm 3/4 inch sieve, and within the limits specified as follows:

Table 2

Maximum Allowable Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	No. 1	No. 2	No. 3
2 mm No. 10	50	80	100

0.075 mm No. 200	8	8	8

[Provide a gradation for the separation layer meeting the gradation requirements of Table 2 Gradation No. 1 and the additional requirement that the 15 percent particle size (D15) of the separation layer is less than or equal to 5 times the 85 percent particle size (D85) of the underlying layer.]

[Limit particles having diameters less than 0.02 mm to a maximum of 3 percent by weight of the total sample tested as determined in accordance with ASTM D7928.] Limit the portion of any blended component and of the completed course passing the 0.425 mm No. 40 sieve to be either nonplastic or have a Liquid Limit not greater than 25 and a Plasticity Index not greater than 5.

2.1.2 Select-Material Course

****

NOTE: When used as material for embankment, use the applicable specification to determine the maximum size of particles. The requirement on the amount passing the 0.075 mm (No. 200) sieve can be increased for locally available materials but will not be relaxed to the point where materials with insufficient CBR under ASTM D4429 will pass.

Where local conditions dictate a nonfrost-susceptible material, retain the sentence in brackets requiring particles having a diameter of less than 0.02 mm not to exceed 3 percent by weight of the total aggregate, as determined in accordance with ASTM D7928.

****

Provide materials consisting of selected soil or other materials from field excavation, stockpiles, or other sources and free from lumps and balls of clay and from organic and other objectionable matter. Provide materials with not more than 25 percent by weight passing the 0.075 mm No. 200 sieve. Limit the portion of material passing the 0.425 mm No. 40 sieve to a Liquid Limit less than 35 and a Plasticity Index less than 12. Provide materials having a maximum particle size not exceeding 75 mm 3 inches. [Limit particles having diameters less than 0.02 mm to a maximum of 3 percent by weight of the total sample tested as determined in accordance with ASTM D7928.]

2.1.3 Rigid Pavement Base Course

****

NOTE: For airfields, reduce the maximum allowable percentage passing the No. 200 sieve to 8 and increase the maximum plasticity index to 8.

Do not adjust the percentage passing the No. 10 sieve, this protects against pumping of fines through the concrete pavement joints.

****

Provide aggregates consisting of crushed stone or [slag,] gravel, shell, sand, or other sound, durable, approved materials processed and blended or naturally combined. Provide aggregates which are durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. Limit the percentage of loss to a maximum of 50 percent after 500 revolutions when tested in accordance with ASTM C131/C131M. Provide aggregates with at least 75 percent by weight retained on each sieve having one freshly fractured face with the area at least equal to 75 percent of the smallest midsectional area of the piece. Provide aggregate that is reasonably uniform in density and quality. [Provide slag that is an air-cooled, blast-furnace product having a dry weight of not less than 1120 kg/cubic meter 70 pcf.] Provide aggregates having a maximum size of 50 mm 2 inches, a minimum of 70 percent passing the 37.5 mm 3/4 inch sieve, and within the limits specified as follows:

TABLE 3

Maximum Allowable Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	Rigid Pavement Base Course
2 mm No. 10	85
0.075 mm No. 200	15

[Limit particles having diameters less than 0.02 mm to a maximum of 3 percent by weight of the total sample tested as determined in accordance with ASTM D7928.] Limit the portion of any blended component and of the completed course passing the 0.425 mm No. 40 sieve to be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 6. Provide any additional stability required to maintain a working platform for construction equipment. If a test section can demonstrate that a material has adequate stability to support construction equipment, the fractured face requirement can be deleted, subject to approval by the Government.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Initial Tests

****

NOTE: Include the 0.02 mm sieve analysis requirements when frost susceptibility concerns exist.

****

Perform one of each of the following Initial Tests on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation. Complete this testing for each source if materials from more than one source are proposed.

a. Gradation [including 0.02 mm size material].

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. [Wear.]

e. [Weight per cubic meter foot of Slag.]

f. [_____].

Submit certified copies of test results for approval not less than [30] [_____] days before material is required for the work.

2.2.2 Approval of Material

Tentative approval of material will be based on initial test results.

2.3 EQUIPMENT, TOOLS, AND MACHINES

****

NOTE: If desirable or based on local conditions, include requirements for types of equipment applicable to methods of construction.

****

All plant, equipment, and tools used in the performance of the work are subject to approval by the Government before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Use equipment capable of minimizing segregation, producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Provide adequate drainage during the entire period of construction to prevent water from collecting or standing on the working area.

3.2 OPERATION OF AGGREGATE SOURCES

****

NOTE: Retain the first sentence in brackets for aggregate sources on private lands. Retain the second sentences in brackets for aggregate sources on Government-owned land.

****

[Condition aggregate sources on private lands in accordance with local laws and authorities.] [Clear, strip and excavate as required. Condition aggregate sources on Government property to readily drain and leave in a satisfactory condition upon completion of the work.]

3.3 STOCKPILING MATERIAL

Clear and level storage sites prior to stockpiling of material. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Stockpile aggregates on the cleared and leveled areas designated to prevent segregation. Stockpile materials obtained from different sources separately.

3.4 PREPARATION OF UNDERLYING COURSE OR SUBGRADE

****
NOTE: For cohesionless underlying courses and subgrades, as defined in 31 00 00, include bracketed text for stabilization and coordinate with paragraph PAYMENT.
****

Clean the underlying course or subgrade of all foreign substances prior to constructing the [subbase] [or] [select-material] [or] [rigid pavement base] course. Do not construct [subbase] [or] [select-material] [or] [rigid pavement base] course on underlying course or subgrade that is frozen. Construct the surface of the underlying course or subgrade to meet specified compaction and surface tolerances. Correct ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the specified requirements set forth herein by loosening and removing soft or unsatisfactory material and adding approved material, reshaping to line and grade, and recompacting to specified density requirements. [For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, stabilize the surface prior to placement of the overlying course. Stabilize by mixing the overlying course material into the underlying course and compacting by approved methods. Consider the stabilized material as part of the underlying course and meet all requirements of the underlying course. Do not allow traffic or other operations to disturb the finished underlying course and maintain in a satisfactory condition until the overlying course is placed.]

3.5 GRADE CONTROL

Provide a finished and completed [subbase] [select-material] [and] [or] [rigid pavement base] course[s] conforming to the lines, grades, and cross sections shown. Place line and grade stakes as necessary for control.

3.6 MIXING AND PLACING MATERIALS

****
NOTE: Include more details on applicable methods of placing, mixing, and spreading when appropriate.
****

Mix and place the materials to obtain uniformity of the material at the water content specified. Make such adjustments in mixing or placing procedures or in equipment as directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to provide a satisfactory course.

3.7 LAYER THICKNESS

****
NOTE: When subbase or rigid pavement base courses are constructed less than 150 mm (6 inches) in total thickness, limit all deficiencies to not more than 6 mm (1/4 inch). Revise Table 1 to match.
****

Compact the completed course to the thickness indicated. Limit individual compacted lifts to a maximum thickness of 150 mm 6 inches and a minimum thickness of 75 mm 3 inches. Compact the course(s) to a total thickness that is within the tolerances of paragraph ACCEPTANCE. Where the measured thickness is more than 13 mm 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 13 mm 1/2 inch thicker than indicated, the course will be considered as conforming to the specified thickness requirements. However, the requirements for the overlying course thickness and plan grade are still applicable. The average job thickness will be the average of all thickness measurements taken for the job and within the tolerances of paragraph ACCEPTANCE.

3.8 COMPACTION

****

NOTE: Insert appropriate percentage in the first bracketed blank. Cohesionless materials are often free-draining; as such, the optimum water content is normally limited to the maximum water content the material will retain. .

****

Compact each lift of the material, as specified, with approved compaction equipment. For cohesive soils, maintain water content during the compaction procedure to within plus or minus [2] [_____] percent of optimum water content determined from laboratory tests as specified in this Section and for cohesionless soils, maintain a water content to facilitate compaction without bulking. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Slightly vary the length of alternate trips of the roller. Adjust speed of the roller as needed so that displacement of the aggregate does not occur. Compact mixture with hand-operated power tampers in all places not accessible to the rollers. [Continue compaction of the [subbase] [rigid pavement base] [or select-material] until each lift is compacted through the full depth to meet the compaction requirements of Table 1.] Make such adjustments in compacting or finishing procedures to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a compliant [subbase] [and] [select-material] [rigid pavement base] course. Remove any materials that are found to be non-compliant and replace with compliant material or rework, as directed, to meet the requirements of this specification.

3.9 PROOF ROLLING

****

NOTE: Check drawings to verify that any supplementary information required by this paragraph has been shown and that there is no conflict between the drawings and the specifications.

Proof rolling is only required when a subbase course is used under a flexible airfield pavement with the following conditions:

Air Force Bases. Proof roll top of subbase of Type A traffic areas and the center 23 meters (75 feet) of heavy, modified heavy, and medium load runways with 30 coverages.

Navy and Marine Corps Airfields. Proof roll top of subbase on center 12 meters (40 feet) of taxiways and on center 30.5 meters (100 feet) of runways with eight coverages. To all other paved areas exclusive of runway overrun and blast protection areas, apply four coverages.

Army Airfields. On Class IV airfields with runways greater than 1,525 meters (5,000 feet), proof roll top of subbase in Type A traffic areas and center 23 meters (75 feet) of runways with 30 coverages.

Proof rolling the separation layer (subbase course gradation 1) under a drainage layer is recommended, but not required. If used, specify six passes.

The specified roller might not be available in all areas. UFC 3-250-01, "Pavement Design for Roads and Parking Areas," recommends a smaller roller with the following properties: a rubber-tired roller loaded to provide a minimum tire force of 90 kN 20,000 lb. and inflated to at least 620 kPa 90 psi.

Apply a minimum of six coverages, where a coverage is the application of one tire print over each point in the surface of the designated area. During proof rolling, monitor the action of the separation layer for any sign of excessive movement or pumping that would indicate soft spots in the separation layer or the subgrade. Remove, replace and retest all weak spots.

****

In addition to the compaction specified, proof roll subbase course in areas designated on the drawings by application of [_____] coverages of a heavy pneumatic-tired roller having four or more tires abreast, each tire loaded to a minimum of 13,600 kg 30,000 pounds and inflated to a minimum of 862 kPa 125 psi. A coverage is defined as the application of one tire print over the designated area. In the areas designated, apply proof rolling to the top lift of the completed subbase course. Maintain water content of the top lift of the subbase course as specified in paragraph COMPACTION from start of compaction to completion of proof rolling. Remove any subbase course materials that produce permanent deformation exceeding 13 mm 1/2 inch and replace with satisfactory materials. Then recompact and proof roll to meet specifications.

3.10 EDGES OF [SUBBASE] [AND] [SELECT-MATERIAL] [RIGID PAVEMENT BASE COURSE]

Place approved material along the outer edges of the [subbase] [and] [select-material] [rigid pavement base] course in sufficient quantity to compact to the thickness of the course being constructed. When the course is being constructed in two or more lifts, simultaneously roll and compact at least a 600 mm 2 foot width of this shoulder material with the rolling and compacting of each lift of the [subbase] [and] [select-material] [rigid pavement base] course, as directed.

3.11 FINISHING

****

NOTE: Delete paragraph if rigid pavement base course is not included in the project.

****

Finish the surface of the top lift of rigid pavement base course after final compaction [and] [proof rolling] by cutting any overbuild to grade and rolling with a steel-wheeled roller. Do not add thin lifts of material to the top lift of rigid pavement base course to meet grade. If the elevation of the top lift of rigid pavement base course exceeds the tolerances of paragraph ACCEPTANCE, scarify the top lift to a depth of at least 75 mm 3 inches and blend new material in and compact to bring to grade. Make adjustments to rolling and finishing procedures to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable rigid pavement base course. If the surface becomes rough, corrugated, uneven in texture, or traffic marked prior to completion, scarify the non-compliant portion and rework and recompact it or replace as directed.

3.12 SMOOTHNESS TEST

Construct the top lift so that the surface shows no deviations exceeding the tolerances of paragraph ACCEPTANCE when tested with a 3.66 m 12 foot straightedge. Test the entire area in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines 4.5 m 15 feet or less apart, as directed. Perform the longitudinal lines at the centerline of each placement lane and at the 1/8th point in from each side of the lane. Hold the straightedge in contact with the surface and move ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the surface and measuring the maximum gap between the straightedge and the surface. Determine measurements along the entire length of the straight edge. Correct deviations exceeding the tolerances of Table 1 by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.13 FIELD QUALITY CONTROL

****

NOTE: Adjust frequency of testing as required to produce a minimum of one test for each half-day's production. For example, the frequency of one test of a 125 mm 6-inch lift per 500 square meter square yards corresponds to approximately 63 cubic meters 83 cubic yards or 117 tonnes 129 tons of in-place material. This frequency can be too high for a large project.

****

3.13.1 In-Place Tests

Perform one of each of the following In-Place Tests on samples taken from the placed and compacted [subbase] [and] [select-material] [rigid pavement base] course. Determine sample locations using random sampling in accordance with ASTM D3665. Take samples and test at the rates indicated.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 500 [_____] square meters yards, or portion thereof, of completed area.

b. Perform gradation [including 0.02 mm size material] on every lift of material placed and at a frequency of one gradation for every 1,000 [_____] square meters yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the gradation.

d. Measure the thickness of each course at intervals providing at least one measurement for each 500 [_____] square meters yards or part thereof. Measure the thickness using test holes, at least 75 mm 3 inches in diameter through the course.

3.13.2 Approval of Material

Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and fully compacted course(s).

3.14 TRAFFIC

Completed portions of the rigid pavement base course can be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Do not allow heavy equipment on the completed rigid pavement base course except when necessary for construction. When it is necessary for heavy equipment to travel on the completed rigid pavement base course, protect the area against marring or damage to the completed work. Repair damage to meet these specifications.

3.15 MAINTENANCE

Maintain the completed course in a satisfactory condition until the full pavement section is completed and accepted. Immediately repair any defects and repeat repairs as often as necessary to keep the area intact. Retest any course that was not paved over prior to the onset of winter to verify that it still complies with the requirements of this specification. Rework or replace any area that is damaged as necessary to comply with this specification.

3.16 DISPOSAL OF UNSATISFACTORY MATERIALS

Dispose of any unsuitable materials that have been removed [outside the limits of Government-controlled land] [as directed] [in waste disposal areas indicated]. No additional payments will be made for materials that have to be replaced.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 11 23 (May 2022)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 23 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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[AGGREGATE BASE COURSE] [AND/OR][GRADED CRUSHED AGGREGATE BASE COURSE] FOR FLEXIBLE PAVING

05/22

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 11 23 (May 2022)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 23 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 32 11 23

[AGGREGATE BASE COURSE] [AND/OR][GRADED CRUSHED AGGREGATE BASE COURSE] FOR FLEXIBLE PAVING

05/22

****

NOTE: This guide specification covers the requirements for base course to be used directly under bituminous pavement courses for airfields, roads, and streets.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification is applicable to base courses placed directly beneath bituminous surface courses.

a. Refer to the material in this specification and on the drawings as "aggregate base course (ABC)" whenever a base course material with a California Bearing Ratio (CBR) of 80 is required. Retain "Aggregate Base Course" in the title and edit the rest of the specification accordingly to retain the information necessary for this material.

b. Refer to the material in this specification and on the drawings as "graded-crushed aggregate base course (GCA)" wherever a base material with a CBR of 100 is required. Retain "Graded-Crushed Aggregate Base Course" in the title and edit the rest of the specification accordingly to retain the information necessary for this material.

c. When this specification is to be used in projects that require both types of materials, change the title of this specification to "Aggregate and/or Graded-Crushed Aggregate Base Course". Verify the drawings clearly call out which material is being used in any particular place and that this specification is edited to retain the information for both types of materials. If only a small amount of one of these types of materials is needed for the project, determine if only one of these materials can be specified and the design adjusted.

****

1.1 UNIT PRICES

****

NOTE: Delete unit price paragraphs when the work is covered by a lump-sum contract price.

****

1.1.1 Measurement

****

NOTE: Delete the method of measurement paragraph not applicable to job conditions. Specify measurement by area for courses with constant thickness.

****

1.1.1.1 Area

Measure the quantity of [___] mm inch thick [ABC] [and] [GCA] completed and accepted, in square meters yards.

1.1.1.2 Volume

Measure the quantity of [ABC] [and] [GCA] completed and accepted, in cubic meters yards. Determine the volume of material in-place and accepted by the average job thickness obtained in accordance with paragraph LAYER THICKNESS and the dimensions shown on the drawings.

1.1.2 Payment

1.1.2.1 Base Course Material

Quantities of [ABC] [and] [GCA], determined as specified above, will be paid for at the respective contract unit prices, which will constitute full compensation for the construction and completion of the [ABC] [and] [GCA].

1.1.2.2 Stabilization

Cohesionless subgrade or subbase courses to be stabilized, as specified in paragraph PREPARATION OF UNDERLYING COURSE OR SUBGRADE, will be paid for as a special item on a tonnage basis including extra manipulation as required.

1.1.3 Waybills and Delivery Tickets

Submit copies of waybills and delivery tickets during progress of the work. Before the final payment is allowed, file certified waybills and certified delivery tickets for all aggregates actually used.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and

	Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C1252	(2017) Standard Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4718/D4718M	(2015) Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D7928	(2017) Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation

	(Hydrometer) Analysis
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.3.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.3.2 Graded-Crushed Aggregate Base Course

Graded-crushed aggregate (GCA) base course is well graded, crushed, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.3.3 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 19.0 mm 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 19.0 mm 3/4 inch sieve as a percentage of the laboratory maximum dry density in accordance with ASTM D1557 Method C and corrected with ASTM D4718/D4718M.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Tailoring options are available for "ADDITIONAL DATA COLLECTION PLAN SUBMITTALS", "DATA VISUALIZATION SPECIALIST", "WEB-BASED GIS INTERFACE", "DESKTOP GIS FILES", "CAD 3D MODEL", "CAD QUALIFICATIONS AND ROLES", and "OPENGROUND".

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools; G, [_____]

Waybills and Delivery Tickets

SD-06 Test Reports

Initial Tests; G, [_____]

In-Place Tests; G, [_____]

Test Section Report; G, [_____]

1.5 QUALITY ASSURANCE

****

NOTE: Select UFGS Section 01 45 00 for Army, Air Force, and Navy projects. For Navy projects, delete the bracketed sentence requiring MTC validation

****

Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00 QUALITY CONTROL. Do not start work requiring testing until the testing laboratory has been inspected and approved. [All contractor quality control testing laboratories performing acceptance testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at https://mtc.erdc.dren.mil/requestvalidation.aspx# for costs and scheduling.] Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. Furnish copies of test results within 24 hours of completion of the tests.

1.5.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M.

1.5.2 Tests

1.5.2.1 Gradation Analysis

****

NOTE: Where frost susceptibility concerns exist, require testing in accordance with ASTM D7928 for the percentage passing the 0.02 mm particle size.

****

Perform gradation analysis in conformance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11.[Perform particle-size analysis of the soils in conformance with ASTM D7928].

1.5.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

1.5.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with paragraph DEGREE OF COMPACTION.

1.5.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556/D1556M, or ASTM D6938. For the method presented in ASTM D1556/D1556M use the base plate as shown in the drawing. For the method presented in ASTM D6938 check the calibration curves and adjust them, if necessary, using only the sand cone method as described in Annex A2 of ASTM D6938. Use ASTM D6938 to determine the moisture content of the soil. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. Make the calibration checks of both the density and moisture gauges using the prepared containers of material method, as described in Annex A2 of ASTM D6938, on each different type of material being tested at the beginning of a job and at intervals as directed. Submit calibration curves and related test results prior to using the device or equipment being calibrated.

1.5.2.5 Wear Test

Perform wear tests on [ABC] [and] [GCA] course material in conformance with ASTM C131/C131M.

1.5.2.6 Flat and Elongated Pieces

Determine flat and elongated pieces on [ABC] [and] [GCA] course material in conformance with ASTM D4791, Method A.

1.5.2.7 Soundness

****

NOTE: Retain this paragraph only for graded-crushed aggregate base course.

****

Perform soundness tests on GCA in accordance with ASTM C88.

1.5.2.8 Fractured Faces

****

NOTE: Retain bracketed sentence only for GCA

****

Perform fractured faces test on [ABC] [GCA] coarse aggregate in comformance with ASTM D5821. [Determine uncompacted void content of the GCA fine aggregate in accordance with ASTM C1252, Method A.]

1.5.2.9 Weight of Slag

****

NOTE: Omit this paragraph when slag is unlikely to be supplied as base course material.

****

Determine weight per cubic meter foot of slag in accordance with ASTM C29/C29M on the [ABC] [and] [GCA] course material.

1.6 ENVIRONMENTAL REQUIREMENTS

****

NOTE: Delete this paragraph in localities where freezing temperatures do not occur, and elsewhere when it is definitely known that the work will not be carried on during periods when such temperatures are to be expected. Modify the protective measures specified to suit local conditions and individual project requirements.

****

Perform construction when the atmospheric temperature is above 2 degrees C 35 degrees F. When the temperature falls below 2 degrees C 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

1.7 ACCEPTANCE

1.7.1 Tolerances

Acceptance of [ABC] [GCA] is based on compliance with the tolerances presented in Table 1. Remove any materials found to be non-compliant and replace with compliant material or rework, as directed, to meet the requirements of this specification

TABLE 1

Measurement	Tolerance
Grade	Plus 6 mm 1/4 inch, Minus 13 mm 1/2 inch
Smoothness	Plus/Minus 10 mm 3/8 inch

TABLE 1	
Individual Test Total Thickness	Plus/Minus 13 mm 1/2 inch
Average Job Thickness	Plus/Minus 6 mm 1/4 inch
Compaction	Minimum 100 percent

1.7.2 Test Section

****

NOTE: A test section is required for base courses under airfield flexible pavements.

****

[Construct a test section consisting of 1000 square meters square yards to demonstrate the materials, equipment, and construction processes meet the requirements of this specification. Acceptance of the test section is based on compliance with the tolerances listed in Table 1. Rework, re-compact, or remove and replace test sections that do not meet specification requirements. Do not commence full operations until a test section report has been approved. Use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments are approved in advance.] [A test section is not required.]

PART 2 PRODUCTS

2.1 AGGREGATES

****

NOTE: Approval from AFCEC, the Navy EFDs, or USACE TSMCX is required before state or other local highway specifications can be used for airfield projects.

As an option for specifying ABC or GCA for roads, streets, or similar use pavements, incorporate material requirements from State or other local highway agency specifications if the following conditions are met:

a. Limit the percentage of material by weight passing the 0.075 mm (No. 200) sieve to a maximum of 8.

b. Where local conditions dictate a non-frost-susceptible material, limit particles passing the 0.02 mm particle size to a maximum of 3 percent.

c. Limit the portion of the material passing the 0.425 mm (No. 40) to a maximum liquid limit of 25 and a maximum plasticity index of 5.

d. Materials to be used for GCA are required to meet the specified L.A. Abrasion and Sulfate Soundness requirements.

****

Provide [ABC] [and] [GCA] consisting of clean, sound, durable particles of crushed stone, [crushed slag,] crushed gravel, [crushed recycled concrete,] angular sand, or other approved material. [Provide ABC that is free of lumps of clay, organic matter, and other objectionable materials or coatings.] [Provide GCA that is free of silt and clay as defined by ASTM D2487, organic matter, and other objectionable materials or coatings.] The portion retained on the 4.75 mm No. 4 sieve is known as coarse aggregate; that portion passing the 4.75 mm No. 4 sieve is known as fine aggregate. When the coarse and fine aggregate is supplied from more than one source, provide aggregate from each source that meets the specified requirements.

2.1.1 Coarse Aggregate

Provide coarse aggregates with angular particles of uniform density. Separately stockpile coarse aggregate supplied from more than one source.

a. Crushed Gravel: Provide crushed gravel that has been manufactured by crushing gravels and that meets all the requirements specified below.

b. Crushed Stone: Provide crushed stone consisting of freshly mined quarry rock, meeting all the requirements specified below.

****

NOTE: Only recycled concrete aggregates (RCA) from on-base stockpiles or concrete pavement demolished under this contract are permitted, subject to an evaluation of suitability.

Verify the subgrade soil contains less than 0.3 percent of sulfates, to prevent expansive reaction with the recycled concrete. See UFC 3-250-11, "Soil Stabilization for Pavements" Appendix C for testing procedure. Otherwise, delete recycled concrete option.

Do not permit recycled concrete aggregate (RCA) to be used without evaluating for Alkali-Silica Reactivity (ASR). Evaluate the impact of potential Alkali-Silica Reaction (ASR) as follows;

a. For Roads and Streets: Use Figure 5.1 of IPRF-01-G-002-03-5, "Evaluation, Design and Construction Techniques for Airfield Concrete Pavement Used as Recycled Material for Base," to rate the ASR severity of the proposed source of RCA as either MILD or AGGRESSIVE. Evaluate the ratings as follows:
Ignore Table 5.1 for roads and streets.

If the rating is AGGRESSIVE, do not use the proposed RCA as a base course.

If the rating is MILD, the proposed RCA can be used as a base course. Limit thickness to a maximum of 150 mm 6 inches to minimize potential swelling.

b. For DoD Airfields: Prepare a risk assessment as

outlined in TSPWG 3-250-07.07-6, "Risk Assessment Procedure for Recycling Portland Cement Concrete (PCC) Suffering from Alkali-Silica Reaction (ASR) in Airfield Pavement Structures," and submit to the Base for approval.

If RCA is suitable for use, limit LA Abrasion loss to 45 percent and delete requirements for sulfate soundness testing. The sulfates in the testing solution can react with the cement, causing spurious results.

****

c. Crushed Recycled Concrete: Provide crushed recycled concrete (RCA) consisting of previously hardened portland cement concrete or other concrete containing pozzolanic binder material. Provide RCA of a consistent gradation and properties obtained from on-base stockpiles or concrete pavement demolished under this contract. Provide recycled concrete that is free of all reinforcing steel, bituminous concrete surfacing, and any other foreign material and that has been crushed and processed to meet the required gradations for coarse aggregate. Reject recycled concrete aggregate exceeding this value. Provide crushed recycled concrete that meets all other applicable requirements specified below.

d. [d. Crushed Slag: Provide crushed slag that is an air-cooled blast-furnace product having a minimum air dry unit weight of 1120 kg/cubic meter 70 pcf as determined by ASTM C29/C29M, and meets all the requirements specified below.]

2.1.1.1   Aggregate Base Course

Limit the percentage of loss of ABC coarse aggregate to a maximum of 50 percent when tested in accordance with ASTM C131/C131M. Provide aggregate that contains a maximum of 30 percent flat and elongated particles when tested in accordance with ASTM D4791, Method A. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, provide crushed aggregates containing a minimum of 50 percent by weight of crushed pieces having two or more freshly fractured faces determined in accordance with ASTM D5821. When two fractures are contiguous, the angle between planes of the fractures is required to be a minimum of 30 degrees in order to count as two fractured faces. Manufacture crushed gravel from gravel particles 50 percent of which, by weight, are retained on the maximum size sieve listed in TABLE 2.

2.1.1.2   Graded-Crushed Aggregate Base Course

Limit the percentage of loss of GCA coarse aggregate to a maximum of 40 percent when tested in accordance with ASTM C131/C131M. Provide GCA coarse aggregate that does not exhibit a loss greater than 18 percent weighted average, at five cycles, when tested for soundness in magnesium sulfate, or 12 percent weighted average, at five cycles, when tested in sodium sulfate in accordance with ASTM C88. [Soundness tests are not required for RCA sources]. Provide aggregate that contains a maximum of 20 percent flat and elongated particles for the fraction retained on the 12.5 mm 1/2 inch sieve nor 20 percent for the fraction passing the 12.5 mm 1/2 inch sieve when tested in accordance with ASTM D4791, Method A. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, provide crushed aggregate containing a minimum of 90 percent by weight of crushed pieces having two or more freshly fractured faces determined in accordance with ASTM D5821. When two fractures are contiguous, the angle between planes of the fractures is required to be a minimum of 30 degrees in order to count as two fractured faces. Manufacture crushed gravel from gravel particles 90 percent of which by weight are retained on the maximum size sieve listed in TABLE 2.

2.1.2 Fine Aggregate

Provide fine aggregates consisting of angular particles of uniform density.

2.1.2.1 Aggregate Base Course

Provide ABC fine aggregate that consists of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

2.1.2.2 Graded-Crushed Aggregate Base Course

****

NOTE: The GCA fine aggregate will be entirely the product of crushing, but need not be of the same material crushed for the coarse aggregate. Retain only the statement describing the method of crushing desired.

****

Provide GCA fine aggregate consisting of angular particles produced by crushing stone, slag, [recycled concrete,] or gravel that meets the requirements for wear and soundness specified for GCA coarse aggregate. Provide fine aggregate that contains a minimum of 45 percent by weight of uncompacted voids when tested in accordance with ASTM C1252, Method A.

2.1.3 Gradation Requirements

****

NOTE: Specify the gradation or gradations applicable to the specific job. Delete the frost susceptibility requirement in areas where the material is not subject to frost action. On the basis of local conditions, the percentage passing the 0.075 mm (No. 200) sieve can be further restricted to help control the amount of particles passing the 0.02 mm particle size. However, the cleaner gradations can have reduced stability. If more than one gradation is maintained, edit this specification and/or the project drawings to make sure it is evident where these different gradations are to be used.

****

Apply the specified gradation requirements to the completed base course. Provide aggregates that are continuously well graded within the limits specified in TABLE 2. Use sieves that conform to ASTM E11.

TABLE 2. GRADATION OF AGGREGATES

Percentage By Weight Passsing Square-Mesh Sieve

Sieve Designation	No. 1	No. 2	No.3
50 mm 2 inch	100	---	---
37.5 mm 1-1/2 inch	70-100	100	---
25.0 mm 1 inch	45-80	60-100	100
12.5 mm 1/2 inch	30-60	30-65	40-70
4.75 mm No. 4	20-50	20-50	20-50
2.0 mm No. 10	15-40	15-40	15-40
0.425 mm No. 40	5-25	5-25	5-25
0.075 mm No. 200	0-8	0-8	0-8

NOTE 1: Limit particles having diameters less than 0.02 mm to a maximum of 3 percent by weight of the total sample tested as determined in accordance with ASTM D7928.

NOTE 2: The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, test the materials in accordance with ASTM C127 and ASTM C128 to determine their specific gravities. Correct the percentages passing the various sieves as directed if the specific gravities vary by more than 10 percent.

NOTE 3: Gradations containing more than 30 percent retained on the 37.5 mm ¾ inch sieve can produce inconsistent compacted density values when tested in accordance with paragraph DEGREE OF COMPACTION.

2.2 LIQUID LIMIT AND PLASTICITY INDEX

****

NOTE: Values shown are the maximum allowable values for liquid limit and plasticity index.

****

Apply liquid limit and plasticity index requirements to the completed course and to any component that is blended to meet the required gradation. Limit the portion of any component or of the completed course passing the 0.425 mm No. 40 sieve to be either nonplastic or have a maximum liquid limit of 25 and a maximum plasticity index of 5.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

2.3.1 Initial Tests

****

NOTE: Include the 0.02 mm sieve analysis requirements when frost susceptibility concerns exist.

****

Perform one of each of the following initial tests on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. Complete this testing for each source if materials from more than one source are proposed. Submit certified copies of test results for approval a mimimum of [30] [_____] days before material is required for the work.

a. Gradation Analysis [including 0.02 mm material].

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

e. Flat and Elongated Pieces.

f. [Soundness].

g. Fractured Faces [and Uncompacted Voids].

h. [Weight per cubic meter foot of Slag].

i. [_____].

2.3.2 Approval of Material

Tentative approval of material will be based on initial test results.

2.4 EQUIPMENT, TOOLS, AND MACHINES

All plant, equipment, and tools used in the performance of the work are subject to approval by the Government before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Use equipment capable of minimizing segregation, producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the [ABC] [or] [GCA] is constructed in more than one lift, clean the previously constructed lift of loose and foreign matter by sweeping with power sweepers or power brooms. Use hand brooms in areas where power cleaning is not practicable. Provide adequate drainage during the entire period of construction to prevent water from collecting or standing on the working area.

3.2 OPERATION OF AGGREGATE SOURCES

****

NOTE: Retain the first sentence in brackets for aggregate sources on private lands. Retain the second sentences in brackets for aggregate sources on Government-owned land.

****

[Condition aggregate sources on private lands in accordance with local laws or authorities.] [Clear, strip, and excavate as required. Condition aggregate sources on Government property to readily drain and leave in a satisfactory condition upon completion of the work.]

3.3 STOCKPILING MATERIAL

Clear and level storage sites prior to stockpiling of material. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Stockpile aggregates on the cleared and leveled areas designated to prevent segregation. Stockpile materials obtained from different sources separately.

3.4 PREPARATION OF UNDERLYING COURSE OR SUBGRADE

****

NOTE: For cohesionless underlying courses and subgrades, as defined in 31 00 00, include bracketed text for stabilization and coordinate with paragraph PAYMENT.

****

Clean the underlying course or subgrade of all foreign substances prior to constructing the base course(s). Do not construct base course(s) on underlying course or subgrade that is frozen. Construct the surface of the underlying course or subgrade to meet specified compaction and surface tolerances. Correct ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the specified requirements set forth herein by loosening and removing soft or unsatisfactory material and adding approved material, reshaping to line and grade, and recompacting to specified density requirements. [For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, stabilize the surface prior to placement of the base course(s). Stabilize by mixing [ABC] [or] [GCA] into the underlying course and compacting by approved methods. Proof roll in accordance with paragraph PROOF ROLLING. Consider the stabilized material as part of the underlying course and meet all requirements of the underlying course. Do not allow traffic or other operations to disturb the finished underlying course and maintain in a compliant condition until the base course is placed.]

3.5 GRADE CONTROL

Provide a finished and completed base course conforming to the lines, grades, and cross sections shown. Place line and grade stakes as necessary for control.

3.6 MIXING AND PLACING MATERIALS

****

NOTE: The most uniform mixture of coarse and fine aggregates is produced by using a stationary plant.

****

3.6.1 Mixing

Mix the coarse and fine aggregates in a stationary plant[, or in a traveling plant]. Make adjustments in mixing procedures or in equipment to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to produce a satisfactory base course meeting all requirements of this specification.

3.6.2 Placing

Place the mixed material on the prepared subgrade or subbase in lifts of uniform thickness with an approved spreader. Place the lifts so that when compacted they are true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than one lift, clean the previously constructed lift of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to produce an acceptable base course.

3.7 LAYER THICKNESS

****

NOTE: When base courses are constructed less than 150 mm (6 inches) in total thickness, limit all deficiencies to a maximum of 6 mm (1/4 inch). Revise Table 1 to match.

****

Compact the completed base course to the thickness indicated. Limit individual compacted lifts to a maximum thickness of 150 mm 6 inches and a minimum thickness of 75 mm 3 inches. Compact the base course(s) to a total thickness that is within the tolerances of paragraph ACCEPTANCE of the thickness indicated. Where the measured thickness is more than 13 mm 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 13 mm 1/2 inch thicker than indicated, the course will be considered as conforming to the specified thickness requirements. However, the requirements for wearing course thickness and plan grade are still applicable. The average job thickness will be the average of all thickness measurements taken for the job and within the tolerances of paragraph ACCEPTANCE of the thickness indicated.

3.8 COMPACTION

****

NOTE: Cohesionless materials are often free-draining; as such, the optimum water content is normally limited to the maximum water content the material will retain.

****

Compact each lift of the base course, as specified, with approved compaction equipment. For cohesive soils, maintain water content during the compaction procedure to within plus or minus [2] [_____] percent of the optimum water content determined from laboratory tests as specified and for cohesionless soils, maintain the water content to facilitate compaction without bulking. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Slightly vary the length of alternate trips of the roller. Adjust speed of the roller as needed so that displacement of the aggregate does not occur. Compact mixture with hand-operated power tampers in all places not accessible to the rollers. Continue compaction until each lift is compacted through the full depth to meet the compaction requirements of Table 1. Make such adjustments in compacting or finishing procedures to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to produce a compliant base course. Remove any materials found to be non-compliant and replace with compliant material or rework, as directed, to meet the requirements of this specification.

3.9 PROOF ROLLING

****

NOTE: Check the drawings to verify any supplementary information required by this paragraph has been shown and that there is no conflict between the drawings and the specifications.

Proof rolling is only required when a base course is used under a flexible airfield pavement with the following conditions:

Air Force Bases. Proof roll each layer of base course of Type A traffic areas and the center 23 meters (75 feet) of heavy, modified heavy, and medium load runways with 30 coverages.

Navy and Marine Corps Airfields. Proof roll top of completed aggregate base course on center 12 meters (40 feet) of taxiways and on center 30.5 meters (100 feet) of runways with eight coverages. To all other paved areas exclusive of runway overrun and blast protection areas, apply four coverages.

Army Airfields. On Class IV airfields with runways greater than 1,525 meters (5,000 feet), proof roll each layer of aggregate base course in Type A traffic areas and center 23 meters (75 feet) of runways with 30 coverages

The specified roller might not be available in all areas. UFC 3-250-01, "Pavement Design for Roads and Parking Areas," recommends a smaller roller with the following properties: a rubber-tired roller loaded to provide a minimum tire force of 20,000 lb (90 kN) and inflated to at least 90 psi (620 kPa).

****

In addition to the compaction specified, proof roll areas designated on the drawings by application of [_____] coverages of a heavy pneumatic-tired roller having four or more tires abreast, each tire loaded to a minimum of 13,600 kg 30,000 pounds and inflated to a minimum of 862 kPa 125 psi. A coverage is defined as the application of one tire print over the designated area. In the areas designated, apply proof rolling to the top of the underlying material on which the base course is laid and to the top of [each lift of] [the completed] base course. Maintain water content of the underlying material and each lift of the base course as specified in Paragraph COMPACTION from start of compaction to completion of proof rolling of that lift. Remove any base course materials or any underlying materials that produce permanent deformation exceeding 10 mm 3/8 inch by proof rolling and replace with satisfactory materials. Then recompact and proof roll to meet these specifications.

3.10 EDGES OF BASE COURSE

****

NOTE: Coordinate the first sentence with the typical pavement sections shown on the drawings. The extra width of material is a working platform during construction to provide the paving equipment a solid surface to track.

****

[Place the base course(s) so that the completed section is a minimum of [600] [_____] mm [2] [_____] feet wider, on all sides, than the next lift that will be placed above it.] Place approved material along the outer edges of the base course in sufficient quantity to compact to the thickness of the course being constructed. When the course is being constructed in two or more lifts, simultaneously roll and compact at least a 600 mm 2 foot width of this shoulder material with the rolling and compacting of each lift of the base course.

3.11 FINISHING

Finish the surface of the top lift of base course after [final compaction] [and] [proof rolling] by cutting any overbuild to grade and rolling with a steel-wheeled roller. Do not add thin lifts of material to the top lift of base course to meet grade. If the elevation of the top lift of base course exceeds the tolerances of paragraph ACCEPTANCE, scarify the top lift to a depth of at least 75 mm 3 inches and blend new material in and compact [and proof roll] to bring to grade. Make adjustments to rolling and finishing procedures to minimize segregation and degradation, obtain grades, maintain moisture content, and produce an acceptable base course. If the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, scarify the non-compliant portion and rework and recompact it or replace as directed.

3.12 SMOOTHNESS TEST

Construct the top lift so that the surface shows no deviations exceeding the tolerances of paragraph ACCEPTANCE when tested with a 3.66 meter 12 foot straightedge. Test the entire area in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines at a maximum spacing of 4.5 m 15 feet or less apart, as directed. Perform the longitudinal lines at the centerline of each placement lane, regardless of whether multiple lanes are allowed to be paved at the same time, and at the 1/8th point in from each side of the lane. Hold the straightedge in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and measuring the maximum gap between the straightedge and the pavement surface. Determine measurements along the entire length of the straight edge. Correct deviations exceeding this amount by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.13 FIELD QUALITY CONTROL

3.13.1 In-Place Tests

****

NOTE: Include the last bracketed sentence if recycled concrete aggregate (RCA) is proposed as an aggregate source.

Adjust frequency of testing as required to produce a minimum of one test for each half-day's production. For example, the frequency of one test of a 125 mm 6-inch lift per 500 square meter yards corresponds to approximately 63 cubic meters 83 cubic yards or 117 tonnes 129 tons of in-place material. This frequency can be too high for a large project.

****

Perform each of the following in-place tests on samples taken from the placed and compacted [ABC] [and] [GCA]. Determine sample locations using random sampling in accordance with ASTM D3665. Take samples and test at the rates indicated. [Perform sampling and testing of recycled concrete aggregate at twice the specified frequency until the material uniformity is established.]

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 250 [_____] square meters square yards, or portion thereof, of completed area. Gradations containing more than 30 percent retained on the 37.5 mm ¾ inch sieve can produce inconsistent compacted density values when tested in accordance with paragraph DEGREE OF COMPACTION.

b. Perform gradation analysis [including 0.02 mm size material] on every lift of material placed and at a frequency of one sieve analysis for every 500 [_____] square meters square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the thickness of the base course at intervals providing at least one measurement for each 500 [_____] square meters yards of base course or part thereof. Measure the thickness using test holes, at least 75 mm 3 inch in diameter through the base course.

3.13.2 Approval of Material

Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and fully compacted course(s).

3.14 TRAFFIC

Completed portions of the base course can be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Do not allow heavy equipment on the completed base course except when necessary for construction. When it is necessary for heavy equipment to travel on the completed base course, protect the area against marring or damage to the completed work. Repair damage to meet these specifications.

3.15 MAINTENANCE

Maintain the base course in a satisfactory condition until the full pavement section is completed and accepted. Immediately repair any defects and repeat repairs as often as necessary to keep the area intact. Retest any base course that was not paved over prior to the onset of winter to verify that it still complies with the requirements of this specification. Rework or replace any area of base course that is damaged as necessary to comply with this specification.

3.16 DISPOSAL OF UNSATISFACTORY MATERIALS

Dispose of any unsuitable materials that have been removed [outside the limits of Government-controlled land] [as directed] [in waste disposal areas indicated]. No additional payments will be made for materials that have to be replaced.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 11 23.23 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 23.23 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

USACE / NAVFAC / AFCEC **UFGS-32 11 23.23 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 23.23 (August 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 32 11 23.23

BASE COURSE DRAINAGE LAYERS

08/22

****

NOTE: This guide specification covers the requirements for a drainage layer under roads, streets and airfield pavements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: Delete this paragraph when the work is covered by a lump-sum contract price.

****

1.1.1 Measurement

Deductions will be made for any material wasted, unused, rejected, or used for convenience.

1.1.1.1 Aggregate Drainage Layer Material

Measure the quantity of aggregate drainage layer material, completed and accepted, in [square][cubic] meters yards. [Determine the volume of aggregate drainage layer material, in place and accepted, by the average job thickness obtained in accordance with paragraph THICKNESS CONTROL and the dimensions indicated.]

1.1.1.2 Bituminous or Cement Stabilized Drainage Layer

Measure the quantity of bituminous or cement stabilized drainage layer material, completed and accepted, in [square][cubic] meters yards.

1.1.2 Payment

The quantities of drainage layer aggregates bituminous or cementitious stabilized drainage layer, as specified above, will be paid for at the contract unit prices, which will constitute full compensation for the construction and completion of the drainage layer, including the test section, and the furnishing of all other necessary labor and incidentals.

1.1.3 Waybills and Delivery Tickets

Submit copies of waybills and delivery tickets during the progress of the work. Before the final payment is allowed, file certified waybills and certified delivery tickets for all aggregates, bituminous, and cementitious materials actually used.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications
AASHTO T 102	(2009; R 2013) Standard Method of Test for Spot Test of Asphaltic Materials

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D946/D946M	(2020) Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction

ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plants, Equipment, and Tools; G, [_____]

Waybills and Delivery Tickets

Releasing Agent

SD-06 Test Reports

Initial Tests; G, [_____]

Test Section Construction Report; G, [_____]

Job-Mix Formula; G, [_____]

SD-07 Certificates

Geotextile

1.4 QUALITY ASSURANCE

****

NOTE: Select UFGS Section 01 45 00 for Army, Air Force, and Navy projects.

For Navy projects, deleted the bracketed sentence requiring MTC validation.

****

Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00 QUALITY CONTROL. Do not start work requiring testing until the testing laboratory has been inspected and approved.[All contractor quality control testing laboratories performing acceptance testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at https://mtc.erdc.dren.mil/requestvalidation.aspx# for costs and scheduling.] Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. Furnish copies of test results within 24 hours of completion of the tests.

1.4.1 Sampling

Take aggregate samples in accordance with ASTM D75/D75M. Take bituminous samples in accordance with ASTM D140/D140M. Take bituminous or cement stabilized mixture samples using approved methods.

1.4.2 Tests

1.4.2.1 Gradation Analyses

Perform gradation analyses in accordance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11.

1.4.2.2 Compaction Tests

Perform field compaction tests in accordance with ASTM D6938 by Backscatter Method (Procedure B). Use ASTM D6938 to determine the moisture content of the aggregate drainage layer material. Check the calibration curves furnished with the moisture gauges along with compaction calibration checks as described in ASTM D6938. Make the calibration checks of both the compaction and moisture gauges using the prepared containers of material method, as described in Annex A2 of ASTM D6938, on each different type of material being tested at the beginning of a job and at intervals as directed. Submit copies of field test results within [24] [____] hours after the tests are performed.

1.4.2.3 Soundness Test

Perform soundness tests in accordance with ASTM C88.

1.4.2.4 Wear Test

Perform wear tests in conformance with ASTM C131/C131M.

1.4.2.5 Flat or Elongated Particles Tests

Perform flat and/or elongated particles tests in accordance with ASTM D4791 Method A.

1.4.2.6 Fractured Faces Tests

When aggregates are supplied from crushed gravel, test in accordance with ASTM D5821 to verify the aggregate meets the requirements for fractured faces in paragraph AGGREGATES.

1.4.2.7 Bitumen Content

Perform bitumen extraction tests in accordance with ASTM D2172/D2172M or ignition tests in accordance with ASTM D6307.

1.4.3 Testing Frequency

1.4.3.1 Initial Tests

Perform one of each of the following tests on the proposed material, prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, complete the following tests for each source.

a. Gradation Analysis.

b. Flat and/or elongated particles.

c. Fractured Faces.

d. Wear.

e. Soundness.

1.4.4 Approval of Materials

Submit material sources and material test results prior to field use.

1.4.4.1 Aggregate

Select the aggregate source at least [60] [_____] days prior to field use in the test section. Tentative approval of the source will be based on certified test results to verify that materials proposed for use meet the contract requirements. Final approval of both the source and the material will be based on test section performance and tests for gradation, soundness, wear, flat and/or elongated particles tests and fractured faces tests. For aggregate drainage layer materials, perform these tests on samples taken from the completed and compacted drainage layer course within the test section. For bituminous or cement stabilized drainage layer material, perform these tests on aggregate samples taken prior to addition of bituminous or cementitious material and subsequent placement in the test section.

1.4.4.2 Bituminous or Cementitious Materials

Submit bituminous or cementitious sources and certified material test results for approval not less than [60] [_____] days prior to field use in the test section.

1.5 ENVIRONMENTAL REQUIREMENTS

Place drainage layer material when the atmospheric temperature is above 2 degrees C 35 degrees F. Correct areas of completed drainage layer or underlying courses that are damaged by freezing, rainfall, or other weather conditions or by contamination from sediments, dust, dirt, or foreign material to meet specified requirements. If the temperature falls below 2 degree C 35 degrees F, protect completed cement-stabilized mixture against detrimental effects of freezing. Bring any areas of completed cement-stabilized mixture that are damaged by freezing, rainfall, or other weather conditions to a compliant condition in conformance with this specification. Do not apply bituminous material when the atmospheric temperature is less than 10 degrees C 50 degrees F or to soils that are frozen or contain frost. If the temperature falls below 2 degrees C 35 degrees F, protect completed bitumen-stabilized areas against any detrimental effects of freezing.

1.6 ACCEPTANCE

1.6.1 Tolerances

Acceptance of the drainage layer is based on compliance with the tolerances presented in Table 1. Remove and replace any course represented by the failing tests or submit plan for approval.

TABLE 1

Measurement	Tolerance

TABLE 1	
Grade	Plus/Minus 13 mm 1/2 inch
Smoothness	Plus/Minus 10 mm 3/8 inch
Layer Thickness	Plus/Minus 13 mm 1/2 inch
Average Job Thickness	Plus/Minus 6 mm 1/4 inch
Compaction	Based on Test Section Evaluation

1.6.2 Test Section

1.6.2.1 Data

Construct a test section to evaluate the constructability of the drainage layer including required mixing, placement, and compaction procedures as well as the ability to carry traffic. Test section data will be used to validate the required number of compaction passes given in paragraph Compaction Requirements and the field compaction requirements for full scale production.

1.6.2.2 Schedule/Evaluation

Construct the test section a minimum of [30] [_____] days prior to the start of full scale production to provide sufficient time for an evaluation of the proposed materials, equipment and testing.

1.6.2.3 Location and Size

Construct a test section [near the job site, but not as part of the production pavement area.][as part of the production paving area at an outer edge as indicated on the drawings.] Provide an underlying grade or pavement structure upon which the test section is to be constructed the same as the remainder of the course. Do not construct the drainage layer in the test section until the underlying courses and subgrade preparation, required for the pavement section, have been completed, inspected and approved. Place the test section a minimum of [30] [_____] m [100] [_____] feet long and two full paving lanes wide side by side, with a longitudinal cold joint between the lanes.

1.6.2.4 Initial Testing

Provide approved certified test results prior to the start of the test section to verify that the materials proposed for use in the test section meet the contract requirements.

1.6.2.5 Mixing, Placement, and Compaction

Accomplish mixing, placement, and compaction using equipment meeting the requirements of paragraph EQUIPMENT. Operate compaction equipment at speeds no greater than 2.4 km/hour 1.5 mph.

1.6.2.6 Procedure

1.6.2.6.1 General

Use the same equipment, materials, and construction techniques on the test section as proposed for use in all subsequent work. Compact the [RDM] [stabilized material] with the number of passes specified below. A pass is defined as the movement of a roller over the drainage layer area for one direction only. Divide the test section into three equal areas for the required compaction and gradation sampling. Conduct compaction tests in each area of the test section in accordance with ASTM D6938, Procedure B (Backscatter Method) until the maximum variation in compaction is less than 32 kg per cubic meter 2 pounds per cubic foot. Once a rolling pattern has been determined based on the variation in compaction, take a minimum of two gradations in each area of the test section. Evaluate the gradation results in accordance with paragraph: Evaluation. In addition, perform a minimum of two nuclear tests per area and determine the average of the six tests for establishing the compaction range for production. If compaction is not within the required maximum variation in compaction limits after the specified number of passes, perform additional passes and gradation testing, as directed

1.6.2.6.2 RDM Aggregate Drainage Layer Tests

Construct the test section with aggregate in a wet state so as to establish a correlation between number of roller passes and compaction achievable during field production. Compact the RDM using a minimum of 4 passes in the vibrating mode and one final pass in the static mode.

1.6.2.6.3 Bituminous/Cement Stabilized Drainage Layer

Use placement procedures and equipment as described herein. Compact the stabilized material for a minimum of 3 passes in the vibratory mode and one final pass in the static mode. Take one sample before compaction and after each subsequent compaction pass in each of the three areas of the test section as directed. Perform visual examination of each sample to determine if and when crushing of aggregate occurs. Demonstrate removal procedure and equipment for approval.

1.6.2.7 Evaluation

Within 10 days of completion of the test section, submit a Test Section Construction Report complete with all required test data and correlations. Evaluate the data as follows:

a. Plot the compaction and percent passing the 4.75 mm No. 4 and 1.18 mm No.16 sieve sizes against cumulative passes. If the percent passing the given sieve sizes is increasing, the aggregate is being broken down by the compaction effort. Maximize compaction while minimizing aggregate degradation. Establish the required compaction at plus or minus 64 kg per cubic meter 4 pounds per cubic foot from the average compaction value determined during the test section.

b. Base the required number of passes on test section observations of degradation in lieu of sieve analyses. Establish the required compaction at plus or minus 64 kg per cubic meter 4 pounds per cubic foot from the average compaction value determined during the test section.

c. Evaluate the ability to carry construction traffic for the proposed paving width using the fleet of vehicles proposed for use on the work by applying 10 passes of the highest ground pressure vehicle in the construction traffic mix. If rutting or displacement of the drainage layer occurs, adjust the equipment for drainage layer construction.

PART 2 PRODUCTS

2.1 AGGREGATES

Provide aggregates consisting of clean, sound, hard, durable, angular particles of crushed stone, crushed slag, or crushed gravel which meet the specification requirements. Slag must be an air-cooled, blast-furnace product having a dry weight of not less than 1040 kg per cubic meter 65 pcf determined by ASTM C29/C29M. Provide aggregates free of silt and clay as defined by ASTM D2487, vegetable matter, and other objectionable materials or coatings.

2.1.1 Aggregate Quality

Provide aggregate with a maximum soundness loss of 18 percent weighted averaged at 5 cycles when tested in magnesium sulfate or 12 percent weighted average at five cycles when tested in sodium sulfate in accordance with ASTM C88 and a maximum percentage of loss on abrasion of 40 after 500 revolutions as determined by ASTM C131/C131M. Determine the percentage of flat and/or elongated particles by ASTM D4791 Method A with the following modifications: 1) Separate the aggregates into two size fractions, particles greater than 12.5 mm 1/2 inch sieve and particles passing the 12.5 mm 1/2 inch sieve and retained on the 4.75 mm No. 4 sieve. 2) Limit thepercentage of flat and/or elongated particles in either fraction to a maximum of 20. 3) A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. 4) When the aggregate is supplied from more than one source, aggregate from each source is required to meet the specified requirements. Manufacture crushed gravel from gravel particles 90 percent of which by weight are retained on the maximum-size sieve listed in TABLE 2. In the portion retained on each sieve specified, provide crushed gravel containing at least [90] [75] percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the face. When two fractures are contiguous, the angle between planes of the fractures is required to be at least 30 degrees in order to count as two fractured faces. Test for fractured faces in accordance with ASTM D5821.

2.1.2 Gradation Requirements

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NOTE: Specify the gradation or gradations applicable to the specific job. Select rapid draining material (RDM) and/or open graded material (OGM) depending on the required permeability and material availability. The permeability range of RDM is 300 to 1500 meters (1000 to 5000 feet) per day. OGM provides a permeability greater than 1500 meters (5000 feet) per day.

RDM is typically well graded enough to be stable to work on, but could require stabilization if lane width construction is not used. OGM requires

asphalt cement or portland cement for stability.

For roads, where the drainage path is short and a permeability of 300 meters (1000 feet) per day is adequate, the following Optional Table 2 can be specified. Retain Note 4 below if Optional Table 2 is included.

OPTIONAL TABLE 2	
GRADATION OF DRAINAGE LAYER MATERIAL	
Percentage By Weight Passing Square-Mesh Sieve	
Sieve Designation	**Rapid Draining Material (RDM)**
50 mm 2 inch	**100**
37.50 mm 1-1/2 inch	**95-100**
25.00 mm 1 inch	**70-100**
19.00 mm 3/4 inch	**60-100**
12.50 mm 1/2 inch	**50-76**
9.50 mm 3/8 inch	**40-65**
4.75 No. 4	**20-45**
2.36 mm No. 8	**17-30**
1.18 mm No. 16	**5-16**
0.30 mm No. 50	**0-5**
0.15 mm No. 100	**0-2.5**

****

Provide drainage layer aggregates that are well graded within the limits specified in TABLE 2.

TABLE 2		
GRADATION OF DRAINAGE LAYER MATERIAL		
Percentage by Weight Passing Square-mesh Sieve		
Sieve Designation	Rapid Draining Material (RDM)	Stabilized OGM
37.50 mm 1-1/2 inch	100	100
25.00 mm 1 inch	70-100	95-100
19.00 mm 3/4 inch	55-100	---
12.50 mm 1/2 inch	40-80	25-80

TABLE 2		
9.50 mm 3/8 inch	30-65	---
4.75 mm No. 4	23-50	0-10
2.36 mm No. 8	0-25	0-5
1.18 mm No. 16	0-5	---

NOTE 1: The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves require appropriate correction when aggregates of varying specific gravities are used.

****

NOTE: Depending on the tailoring options retained, renumber the following notes.

****

NOTE 2: For RDM, maintain the coefficient of uniformity (CU) greater than 3.5 (CU = D60/D10). Adjust the RDM gradation within the ranges listed in Table 2 to provide a stable construction surface for the proposed equipment and method of transporting materials. Stabilize the RDM drainage layer with Portland cement or asphalt at no additional cost, if approved during the test section.

NOTE 3: Stabilize the OGM with asphalt cement or portland cement.

****

NOTE: Retain Note 4 if Optional Table 2 is included.

****

[NOTE 4: The Optional Table 2 gradation can be met in some areas with 77% #57 stone and 23% concrete sand blend.]

2.1.3 Bond Breaker

****

NOTE: At the Contractor's discretion but at no additional cost to the Government, an aggregate or geotextile bond breaker can be considered if a cement-stabilized drainage layer is to be overlaid with Portland cement concrete.

****

For cement-stabilized drainage layers an aggregate bond breaker or a nonwoven geotextile bond breaker can be used at no cost to the Government. Use of membrane forming curing compounds as a bond breaker is not allowed.

2.1.3.1 Aggregate Bond Breaker

Provide an aggregate bond breaker meeting the aggregate quality requirements of paragraph AGGREGATE QUALITY and the gradation of TABLE 3.

TABLE 3
GRADATION OF AGGREGATE BOND BREAKER

TABLE 3	
Percentage By Weight Passing Square-Mesh Sieve	
Sieve Designation	Aggregate
12.5 mm 1/2 inch	100
9.5 mm 3/8 inch	80-100
4.75 mm No. 4	23-100
2.4 mm No. 8	5-40
1.2 mm No. 16	0-10

2.1.3.2 Geotextile Bond Breaker

Provide a nonwoven geotextile certified by the manufacturer as meeting AASHTO M 288, Class 1 with a mass per unit area of 500 grams per square meter 15 ounces per square yard. A minimum of [7] [_____] days prior to scheduled use, submit manufacturer's certificate of compliance attested to by a person having legal authority to bind the geotextile manufacturer stating that the geotextile meets the requirements of this section.

2.2 BITUMINOUS MATERIALS

****

NOTE: Specify Performance Grade (PG) asphalt wherever available. Consider local experience of State Department of Transportation and availability of desired asphalt grade. Use the same grade PG binder used by the state highway department for roads and streets. For airfield projects, only specify the state PG grade. No other state DOT provisions are applicable.

****

Provide asphalt cement conforming to [ASTM D6373 Performance Grade PG [____]][ASTM D946/D946M Penetration Grade [____]] [ASTM D3381/D3381M Viscosity Grade [_____]] and showing a negative spot when subjected to the spot test in accordance with AASHTO T 102, using the standard naphtha specified.

2.3 CEMENTITIOUS MATERIALS

Provide Portland cement conforming to [ASTM C150/C150M, Type I or II] [ASTM C595/C595M, Type IP, IS or IL].

2.4 BITUMINOUS OR CEMENT STABILIZED JOB-MIX FORMULA

Provide bituminous stabilized mix consisting of a mixture of OGM and a minimum of 2 percent asphalt cement by weight. Maintain tolerances for bituminous stabilized material for field production at plus or minus 0.25 percent for asphalt cement and plus or minus 14 degrees C 25 degrees F for mixing temperatures. Provide cement stabilized mix consisting of OGM and a minimum of 90 kg 200 pounds of portland cement per cubic meter yard with a water/cement ratio of 0.37. Based on the test section performance, adjust the asphalt cement or portland cement quantities, temperatures, equipment, and procedures to produce an acceptable stabilized drainage layer. Submit a job-mix formula (JMF) for approval prior to construction of the test section and include:

a. Aggregate gradations and plots.

b. Aggregate quality test results.

c. Mill certificates for cementious materials.

d. Refinery certificates for bituminous materials.

e. Recommended proportions for proposed mixture.

f. Narrative discussing methodology on how the mix design was developed.

2.5 EQUIPMENT, TOOLS, AND MACHINES

2.5.1 Equipment

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NOTE: If desirable, include requirements for specific types of equipment applicable to methods of construction based on local conditions.

****

All plants, equipment, and tools used in the performance of the work are subject to approval before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times.

2.5.2 Placement Equipment

Use an asphalt paving machine to place drainage layer material. Alternate methods can be used if it can be demonstrated in the test section that these methods obtain the specified results.

2.5.3 Compaction Equipment

Use a dual smooth 10 metric tonne short ton (min.) vibratory drum roller, which provides a maximum compactive effort without crushing the drainage layer aggregate, to compact drainage layer material.

2.5.4 Bituminous Mixing Plant

Provide mixing plants in accordance with AASHTO M 156 which are automatic or semiautomatic controlled, commercially manufactured units designed, coordinated, and operated to consistently produce a mixture within the job-mix formula (JMF). Prequalify drum or batch mixers at the production rate to be used during actual mix production.

2.5.5 Cementitious Mixing Plant

Provide a cementitious mixing plant that is an automatic or semiautomatic controlled, commercially manufactured unit capable of producing a cement stabilized aggregate mixture consistent with the job mix formula. Dry mix aggregate and cement sufficiently to prevent cement balls from forming when water is added.

2.5.6 Material Transfer Vehicle

For cement stabilized material placed with other than an asphalt paver, provide a Material Transfer Vehicle (MTV) to transfer the stabilized material from the hauling equipment to the paver. Provide a MTV capable of moving between the hauling equipment and the paver and equipped with a swing conveyor that delivers material to the paver from outside the paving lane and without making contact with the paver while allowing the paver to operate at a constant speed.

PART 3 EXECUTION

3.1 STOCKPILING MATERIAL

Clear and level storage sites prior to stockpiling of material. Stockpile all materials in the manner and at the locations designated. Stockpile aggregates on the cleared and leveled areas to prevent segregation. Stockpile materials obtained from different sources separately.

3.2 PREPARATION OF UNDERLYING COURSE

Clean the underlying course of all foreign materials prior to constructing the drainage layer. Do not construct the drainage layer on underlying course that is frozen. Construct the underlying course in accordance with Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING]. Correct ruts or soft yielding spots in the underlying courses having inadequate compaction and deviations of the surface from the requirements set forth herein by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line, and grade, and recompacting to specified density. Do not allow traffic or other operations to disturb the finished underlying course and maintain in a satisfactory condition until the drainage layer is placed.

3.3 TRANSPORTING MATERIAL

3.3.1 Aggregate Drainage Layer Material

Transport aggregate drainage layer material to the site in a manner which prevents segregation and contamination of materials.

3.3.2 Bituminous Stabilized Material

Transport bituminous stabilized material from the mixing plant to the site in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of the stabilized material to the truck beds. Drain excessive releasing agent prior to loading. Cover each load with canvas or other approved material of ample size to protect the stabilized material from the weather and to prevent loss of heat. Rejct loads that have crusts of cold, unworkable material or have become wet. Do not permit hauling over freshly placed material.

3.3.3 Cement Stabilized Material

Transport cement stabilized material from the mixing plant to the site in trucks equipped with protective covers. Reject loads that have crusts of unworkable material or have become excessively wet. Do not permit hauling over freshly placed material.

3.4 PLACING

3.4.1 General

Place drainage layer material on the underlying course in lifts of uniform thickness using equipment meeting the requirements of paragraph EQUIPMENT. When a compacted layer 150 mm 6 inches or less in thickness is required, place the material in a single lift. When a compacted layer in excess of 150 mm 6 inches is required, place the material in lifts of equal thickness. Limit compacted lift thickness to a maximum of 150 mm 6 inches and a minimum of 75 mm 3 inches in compacted thickness. Place and compact lifts true to the grades or levels required with the least possible surface disturbance. Where the drainage layer is placed in more than one lift, clean the previously constructed lift of loose and foreign material. Make adjustments in placing procedures or equipment as needed to obtain true grades and minimize segregation and degradation of the drainage layer material.

3.4.2 Placement of Stabilized Material

Reject bituminous stabilized material having temperatures less than 80 degrees C 175 degrees F when dumped into the asphalt paving machine. Adjust the paving machine so that the surface of the lift being laid is smooth and continuous without tears and pulls. Correct irregularities in alignment of the lift left by the paving machine by trimming directly behind the machine. Immediately after trimming, thoroughly compact the edges of the lift by an approved method. Do not permit distortion of the lift during tamping. If more than one lift is required, offset the longitudinal joint in one lift over that in the lift immediately below by at least 300 mm 1 foot; however, construct the joint in the top layer at the centerline of the pavement. Offset transverse joints in one layer by at least 600 mm 2 feet from transverse joints in the previous layer. Offset transverse joints in adjacent strips by a minimum of 3 meters 10 feet. At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to form a true vertical face free of loose or shattered material. Use cutting and removal equipment and procedures approved during the test section. Remove material along construction joints not properly compacted.

3.4.3 Placing Adjacent Stabilized Strips

Place the stabilized material in consecutive adjacent strips having a minimum width of 3 meters 10 feet, except where edge lanes require strips less than 3 meters 10 feet to complete the area. When placing adjacent strips, operate the paving machine so that the screed overlaps the previously placed strip 75 to 100 mm 3 to 4 inches and is sufficiently high so that compaction produces a smooth, dense joint. Push back the stabilized material placed on the edge of the previously placed strip by the paver to the edge of the strip being placed. Remove and waste excess stabilized material.

3.4.4 Hand Spreading

Hand spread drainage layer material in areas where machine spreading is impractical. Spread the material uniformly in a loose layer to prevent segregation. Construct the layer so that the compacted material conforms to the required grade and thickness after compaction.

3.5 COMPACTION REQUIREMENTS

3.5.1 General

Base field compaction requirements on the results of the test section, using the materials, methods, and equipment demonstrated in the test section

3.5.2 Number of Passes

Accomplish compaction using rollers meeting the requirements of paragraph EQUIPMENT and operating at a rolling speed of no greater than 2.4 km 1.5 miles per hour. Follow the rolling pattern established during the test section. Compact each lift of drainage material with the number of passes determined from successful completion of the test section in accordance with paragraph ACCEPTANCE.

3.5.3 Compaction

In addition, maintain a minimum field dry density as specified by the Contracting Officer. If the required field dry density is not obtained, adjust the number of roller passes in accordance with paragraph DEFICIENCIES. Compact aggregate in a moisture state as determined in the test section. Avoid crushing of aggregate particles by excessive rolling. Begin compaction of bituminous stabilized material immediately when the material has cooled to 77 degrees C 170 degrees F. Not more than 30 minutes may elapse between the start of moist mixing of cement stabilized material and the start of field compaction. Complete field compaction within 60 minutes. In all places not accessible to the rollers, compact the drainage layer material with mechanical hand operated tampers.

3.6 FINISHING

Finish the top surface of the drainage layer after final compaction, as determined from the test section. Make adjustments in rolling and finishing procedures to obtain grades and minimize segregation and degradation of the drainage layer material.

3.7 CURING OF CEMENT STABILIZED MATERIAL

Cure the completed cement stabilized drainage layer with water for a period of 12 hours following completion of compaction. Commence curing operations within 3 hours after compaction. Curing consists of one of the following: 1) Sprinkling the surface of the drainage layer with a fine spray of water every 2 hours for the required 12 hour period, 2) by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap, 3) Impervious sheet curing. Apply curing water so that the cement paste on the surface of the mixture will not be eroded. Water trucks will not be permitted on the completed cement stabilized drainage layer. Impervious sheeting curing consists of all surfaces being thoroughly wetted and then completely covered with the sheeting. Place sheeting at least 450 mm 18 inches wider than the stabilized drainage layer surface to be covered. Lay covering with light-colored side up. Lap covering not less than 300 mm 12 inches; securely weight covering to prevent displacement so that it remains in contact with the surface during the specified length of curing. Fold down coverings over exposed edges of slabs and secure by approved means. Immediately repair or replace sheets if tears or holes appear during the curing period

3.8 EDGES OF DRAINAGE LAYER

Place shoulder material along the edges of the drainage layer course in a quantity that will compact to the thickness of the layer being constructed. Roll and compact at least a 1 m 3 feet width of the shoulder simultaneously with the rolling and compacting of each lift of the drainage layer.

3.9 SMOOTHNESS TEST

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NOTE: A 3.66 m (12 foot) straightedge with the deviations unchanged may be specified instead of a 3.05 m (10 foot) straightedge, especially if the paving specifications call for a 3.66 m (12 foot) straight edge.

****

Construct the top lift so that the surface show no deviations in excess of 10 mm 3/8 inch when tested with either a 3.05 or 3.66 m 10 or 12 foot straightedge applied parallel with and at right angles to the centerline of the area to be paved. Correct deviations exceeding 10 mm 3/8 inch in accordance with paragraph DEFICIENCIES.

3.10 THICKNESS CONTROL

Compact the drainage layer to a thickness that is within 13 mm 1/2 inch of the thickness indicated. Measure thickness at intervals providing at least one measurement for each 500 square meters yards of drainage layer. Make measurements in test holes at least 75 mm 3 inches in diameter unless the Contractor can demonstrate, for COR approval, that a steel rod pushed through the drainage layer clearly stops at the material interface. Where the measured thickness is more than 13 mm 1/2 inch deficient, correct such areas in accordance with paragraph DEFICIENCIES. Where the measured thickness is 13 mm 1/2 inch more than indicated, it will be considered as conforming to the requirements plus 13 mm 1/2 inch, provided the surface of the drainage layer is within 13 mm 1/2 inch of established grade. The average job thickness will be the average of all job measurements as specified above but within 8 mm 1/4 inch of the thickness shown on the drawings.

3.11 DEFICIENCIES

3.11.1 Grade and Thickness

Correct deficiencies in grade and thickness so that both grade and thickness tolerances are met. Do not add thin layers of material to the top surface of the drainage layer to meet grade or increase thickness. Trim the top of the drainage layer to grade and finish in accordance with paragraph FINISHING if the surface elevation is more than 13 mm 1/2 inch above the plan grade. If the elevation of the top surface of the drainage layer is 13 mm 1/2 inch or more below the required grade, scarify the surface of the drainage layer to a depth of at least 75 mm 3 inches, add new material , and blend and recompact the layer to bring it to grade. Where the measured thickness of the drainage layer is more than 13 mm 1/2 inch deficient, correct such areas by excavating to the required depth and replace with new material to obtain a compacted lift thickness of at least 75 mm 3 inches. Control the depth of required excavation to keep the final surface elevation within grade requirements and to preserve layer thicknesses of materials below the drainage layer.

3.11.2 Density

Density will be considered deficient if the field dry density test results are below the dry density specified by the Contracting Officer. Roll the layer with 2 additional passes of the specified roller if the densities are deficient. If the dry density is still deficient, work will be stopped until the cause of the low dry densities can be determined and reported to the Contracting Officer.

3.11.3 Smoothness

Correct deficiencies in smoothness as if they are deficiencies in grade or thickness. Maintain all tolerances for grade and thickness while correcting smoothness deficiencies.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 11 26 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 26 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 11 26

HOT-MIX BITUMINOUS BASE COURSE FOR ROADS AND STREETS

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USACE / NAVFAC / AFCEC **UFGS-32 11 26 (May 2020)**

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SECTION 32 11 26

HOT-MIX BITUMINOUS BASE COURSE FOR ROADS AND STREETS

05/20

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NOTE: This guide specification covers the requirements for hot-mix bituminous base course for road and street pavements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

Use Section 32 12 16.16 ROAD-MIX ASPHALT PAVING to specify wearing or surface courses for roads and streets.

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PART 1 GENERAL

1.1 UNIT PRICES

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NOTE: These paragraphs will be deleted when lump sum payment is desired.

****

1.1.1 Measurement

The amount paid for will be the number of metric 2000-pound tons of bituminous mixture used in the accepted work. Weigh bituminous mixture after mixing. No payment will be made for defective areas until corrected.

1.1.2 Basis for Payment

The quantities of bituminous base course will be paid for at the respective contract unit prices in the bid schedule. Payment will constitute full compensation for preparing and reconditioning the underlying layer; for furnishing all material, equipment, plant, and tools; and for all labor and other incidentals necessary to complete the work required by this section.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

ASPHALT INSTITUTE (AI)

AI MS-2	(2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C183/C183M	(2022) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D946/D946M	(2020) Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D1856	(2009; R 2015) Recovery of Asphalt from Solution by Abson Method
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials

ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder
ASTM D6925	(2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification

and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sources of Aggregates

Job Mix Formula; G, [_____]

SD-06 Test Reports

Sources of Aggregates

Bituminous Materials

Test Section; G, [_____]

Service Record; G, [_____]

SD-09 Manufacturer's Field Reports

Batch Tickets

1.4 QUALITY CONTROL

1.4.1 Qualifications

****

NOTE: Include bracketed sentence for Corps-managed projects.

****

Perform sampling and testing using an approved commercial testing laboratory or on-site facilities. Submit accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM D3666, including all applicable test procedures. Do not start work requiring testing until the facilities have been inspected and approved. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. Maintain this certification for the duration of the project. [In addition, all contractor quality control testing laboratories performing acceptance testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at http://www.erdc.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/9254/Article/ for costs and scheduling.]

1.4.2 Test Results

Verify that materials comply with the specification. When a material source is changed, test the new material for compliance. When deficiencies are found, repeat the initial analysis and retest the material already placed to determine the extent of unacceptable material. Replace or repair all in-place unacceptable material to conform to the contract requirements. Submit copies of field tests results within [24] [_____] hours after the tests are performed and certified copies of tests results for approval not less than [30] [_____] days before material is required for the work.

1.4.3 Batch Tickets

Provide batch tickets in accordance with AASHTO M 156.

1.4.4 Aggregates

****

NOTE: Satisfactory service record for an aggregate will be determined based on the aggregate's ability to resist polishing, raveling, stripping, and degradation under traffic and climate conditions similar to that expected during its use. If performance data indicate that an aggregate is susceptible to one or more of the above-mentioned problems, mitigate the problem or reject that source of aggregate.

****

Select sources of aggregates and submit a plan for operation of a new source of aggregates at least 45 [_____] days in advance of starting production. If a previously developed source is selected, submit test results with evidence that central plant hot-mix bituminous pavements constructed with the aggregates have had a satisfactory service record of at least 5 years under similar climatic conditions. Include in the service record a tabulation of aggregate gradation and quality test results, typical hot-mix asphalt mix design using the aggregate, and a list of representative paving projects using the aggregate. Make such tests and other investigations as necessary to determine whether or not aggregates meeting the requirements specified can be produced from the proposed sources. Sample aggregates in accordance with ASTM D75/D75M and test them at the start of production.

1.4.5 Mineral Filler

Sample mineral filler in accordance with ASTM C183/C183M.

1.4.6 Bituminous Materials

Select sources where bituminous materials are obtained in advance of time when materials will be required in the work. Sample bituminous materials in accordance with ASTM D140/D140M. Submit test results not less than 30 [_____] days before such material is required for use in the work.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not construct bituminous courses when the underlying course contains free surface water, or when temperature of the surface of the underlying course is below 5 degrees C 40 degrees F, unless otherwise directed.

1.6 ACCEPTANCE

1.6.1 Tolerances

Acceptance of bituminous base course is based on compliance with the tolerances presented in Table 1. Remove and replace bituminous base course represented by the failing tests or submit repair plan for approval.

TABLE 1

Attribute	Measurement
Plant Mixture	
Delivery to Laydown Machine	Minimum 121 deg C 250 deg F
Laboratory Air Voids	3 to 5 percent
Finished Mat	
Mat Density (avg of 4 cores/lot)	Minimum 92 percent of TMD
Joint Density (avg of 4 cores/lot)	Minimum 90.5 percent of TMD
Grade	plus/minus 15 mm 0.05 foot
Smoothness	plus/minus 10 mm 3/8 inch
Longitudinal Joint Offset	Minimum 300 mm 1 foot
Transverse Joint Offset	Minimum 600 mm 2 feet

1.6.2 Test Section

At the start of plant operation, prepare a quantity of the mixture sufficient to construct a test section at least 30 meters 100 feet long and two spreader widths wide. Place, spread, and compact the mixture with equipment to be used in the project and in accordance with requirements specified herein. Construct a cold joint between spreader widths. Test and evaluate the test section and conform to all specified requirements. If tests indicate that the pavement does not conform to the tolerances of Table 1, remove and construct additional test sections and sample for conformance to specification requirements. Do not start production of the bituminous base course mixture without approval.

PART 2 PRODUCTS

2.1 AGGREGATES

Provide aggregates consisting of crushed stone, crushed slag, crushed gravel screenings, sand, and mineral filler, as required. The portion of these materials retained on the 4.75 mm No. 4 sieve is classified as coarse aggregate; the portion passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve, as fine aggregate; and the portion passing the

0.075 mm No. 200 sieve, as mineral filler.

2.1.1 Coarse Aggregates

Provide coarse aggregates consisting of clean, sound, durable fragments of crushed stone, crushed slag, or crushed gravel meeting the following requirements:

2.1.1.1 Aggregate Wear

Percentage of wear not exceeding 40 after 500 revolutions, as determined in accordance with ASTM C131/C131M.

2.1.1.2 Aggregate Loss

****

NOTE: Use the magnesium-sulfate soundness test to exclude aggregates known to be unsatisfactory or for evaluating aggregates from new sources. Insert the percentage of loss will in the blanks based on knowledge of aggregates in the area that have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years and will assure that aggregates from new sources will be equal to or better than these aggregates.

****

Percentage of loss not exceeding 18 [_____] after five cycles performed in accordance with ASTM C88, using magnesium sulfate.

2.1.1.3 Fractured Faces

At least 75 percent by weight of coarse aggregate containing two or more fractured faces produced by crushing when tested in accordance with ASTM D5821.

2.1.1.4 Flat and Elongated Pieces

Particle shape essentially cubical and containing not more than 20 percent, by weight, of flat particles and elongated particles (3:1 ratio of maximum to minimum) when tested in accordance with ASTM D4791.

2.1.1.5 Dry Weight of Crushed Slag

Dry weight of crushed slag not less than 1200 kg/cubic meters 75 pcf as determined in accordance with ASTM C29/C29M.

2.1.2 Fine Aggregates

Provide fine aggregates consisting of clean, durable natural sands; manufactured sands prepared by crushing stone, slag, or gravel, or any combination of natural and manufactured sands. Natural sands consist of grains of clean, hard, durable rock. Limit the quantity of uncrushed material to a maximum of 25 percent by weight of total aggregate.

2.1.3 Mineral Filler

Mineral filler conforming to ASTM D242/D242M.

2.1.4 Liquid Limit and Plasticity Index

Measure liquid limit and plasticity index on the portion of the aggregate passing the 0.425 mm No. 40 sieve in accordance with ASTM D4318. Requirements apply to the individual aggregate fractions and the combined blend in the completed base course. Provide aggregates classified as either nonplastic or having a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.2 BITUMINOUS MATERIALS

2.2.1 Asphalt Cement

****

NOTE: Specify Performance Grade (PG) asphalt wherever available. When selecting PG asphalt cements, it is recommended that 98 percent reliability be used. For low volume roads, use a 50 percent reliability. Also, consider local experience of State Department of Transportation and availability of desired asphalt grade.

****

Provide asphalt cement binder conforming to ASTM D6373 Performance Grade (PG) [_____].[As an alternate, provide ASTM D3381/D3381M Viscosity Grade [_____] or ASTM D946/D946M penetration grade [_____] asphalt cement.]

2.3 AGGREGATE GRADATION

****

NOTE: Delete from Table 1 the gradations that will not be used as a part of this project. Use of gradation 3 is limited to shoulders and leveling courses. Use Section 32 12 16.16 ROAD-MIX ASPHALT PAVING to specify wearing or surface courses for roads and streets.

Generally, the minimum compacted layer thickness for gradation No. 1 would be at least 57 mm 2.25 inches, the minimum compacted layer thickness for gradation No. 2 would be at least 37.5 mm 1.5 inches, and the minimum compacted layer thickness for gradation No. 3 would be at least 25 mm 1.0 inch.

****

Provide mineral aggregate of such size that percentage composition by weight, as determined by ASTM C136/C136M, conforms to the gradation specified in TABLE 2, and does not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

TABLE 2. AGGREGATE GRADATION			
Percent Passing			
Sieve Size (mm)	Gradation 1	Gradation 2	Gradation 3
25 1 inch	100	---	---
19 3/4 inch	90-100	100	---
12.5 1/2 inch	68-88	90-100	100
9.5 3/8 inch	60-82	72-88	90-100
4.75 No. 4	45-67	53-73	58-78
2.36 No. 8	32-54	38-60	40-60
1.18 No. 16	22-44	26-48	28-48
0.60 No. 30	15-35	18-38	18-38
0.30 No. 50	9-25	11-27	11-27
0.15 No. 100	6-18	6-18	6-18
0.075 No. 200	3-6	3-6	3-6

2.4 COMPOSITION OF MIXTURE

****

NOTE: For state DOT Superpave mixes, specify the design ESALs from site-specific traffic studies or the following:

Design ESALs (millions)	**Typical Roadway Application**
< 0.3	**Very light traffic; no trucks (local/county roads, city streets)**
0.3 to < 3	**Medium traffic (collector roads, most county roads)**
3 to 30	**High traffic (most of interstate system, climbing lanes, truck weigh stations)**

Specify the nominal maximum aggregate size (NMAS) in accordance with state DOT guidance.

****

2.4.1 Job-Mix Formula (JMF)

2.4.1.1 Develop the JMF

Provide an asphalt mix composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt binder. Size the aggregate fractions, handle in separate size groups, and combine in such proportions that the resulting mixture meets the grading requirements of Table 2. Submit proposed JMF; do not produce hot-mix asphalt for payment until a JMF has been approved. Design the hot-mix asphalt in accordance with Marshall or Superpave procedures and the criteria shown in Table 3. Use the hand-held hammer to compact the specimens for Marshall mix design. Design Superpave mixes with the number of gyrations specified in Table 3, unless the DOT option is chosen. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M, is less than 75, reject the aggregates or treat the asphalt mixture with an approved anti-stripping agent. Add the amount of anti-stripping agent sufficient to produce a TSR of not less than 75. Provide an antistrip agent, if required, at no additional cost. Provide sufficient materials to produce 90 kg 200 pound of blended mixture for verification of mix design at least 14 days prior to construction of test section.

2.4.1.2 Option

A currently used DOT Superpave hot mix may be used in lieu of developing a Marshall hot mix design as described herein. Design the Superpave volumetric mix in accordance with AI MS-2 and ASTM D6925. Provide a nominal maximum aggregate size (NMAS) of [37.5] [25.0] [19.0] [12.5] [9.5] mm [1-1/2] [1] [3/4] [1/2] [3/8] inch. Other DOT hot mix design methods may be suitable, as approved. Select the number of compaction gyrations, Ndes, based on a design traffic of [_____] equivalent single axle loads (ESALs).

2.4.2 JMF Requirements

****

NOTE: In Table 3, use a 75 Blow or 75 gyration compactive effort for all asphalt mixtures designed for tire pressures of 690 kPa 100 psi or higher. For mixtures designed for tire pressures less than 690 kPa 100 psi, use a 50 Blow or 50 gyration compactive effort. Also, use a 50 Blow or 50 gyration compactive effort for shoulder pavement mixtures.

In Table 3, delete the column which does not apply, unless the project includes both 75 Blow or 75 gyration and 50 Blow or 50 gyration mixes. If both mixes are used on a project, identify which mix is applicable to which location.

Select the appropriate gradation and VMA requirements in Table 3 to be consistent with the gradation chosen in Table 2 and delete the other two lines.

Remove item u., below if RAP is not used in the job.

****

Submit in writing the job mix formula for approval at least 30 [_____] days prior to the start of the test section including as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt binder.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt performance grade [viscosity grade] [penetration grade].

e. Number of blows of hand-held hammer per side of molded specimen. (NA for Superpave)

f. Number of gyrations of Superpave gyratory compactor, (NA for Marshall mix design)

g. Laboratory mixing temperature.

h. Lab compaction temperature.

i. Temperature-viscosity relationship of the asphalt cement.

j. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

k. Graphical plots of stability (NA for Superpave), flow (NA for Superpave), air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2.

l. Specific gravity and absorption of each aggregate.

m. Percent natural sand.

n. Percent particles with 2 or more fractured faces (in coarse aggregate).

o. Fine aggregate angularity.

p. Percent flat or elongated particles (in coarse aggregate).

q. Tensile Strength Ratio(TSR).

r. Antistrip agent (if required) and amount.

s. List of all modifiers and amount.

t. Correlation of hand-held hammer with mechanical hammer (NA for Superpave).

u. Percentage and properties (asphalt content, binder properties, and aggregate properties) of reclaimed asphalt pavement (RAP) in accordance with paragraph RECYCLED HOT-MIX ASPHALT, if RAP is used.

Table 3. Mix Design Criteria

Test Property	50 Blows or Mix Gyrations	75 Blows or Mix Gyrations
Stability, N pounds, minimum (NA for Superpave)	*60001350	*80001800
Flow,0.25 mm 0.01 inch, (NA for Superpave)	8-18	8-16
Air voids, percent	3-5	3-5
Percent Voids in mineral aggregate (VMA),(minimum)		
Gradation 1	14.0	14.0
Gradation 2	15.0	15.0
Gradation 3	16.0	16.0
TSR, minimum percent	75	75
* This is a minimum requirement.		
** Calculate VMA in accordance with AI MS-2, based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate.		

2.4.2.1 Adjustment to JMF

The JMF for each mixture is in effect until a new formula is approved in writing. Should a change in sources of any materials be made, perform a new mix design and obtain approval before the new material is used. Make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF are limited to plus or minus 4 percent on the 4.75 mm No. 4 and coarser sieves; plus or minus 3 percent on the 2.36 mm No. 8 to 0.30 mm No. 50 sieves; and plus or minus 1 percent on the 0.15 mm No. 100 sieve. Adjustments to the JMF are limited to plus or minus 1.0 percent on the 0.075 mm No. 200 sieve. Asphalt content adjustments are limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, develop a new mix design.

2.5 RECYCLED ASPHALT PAVEMENT

****

NOTE: If RAP is not permitted, include the first sentence in brackets and delete the following sets of brackets and text. Limit the amount of RAP so the asphalt binder from the RAP does not exceed 30 percent of the total asphalt content.

****

[RAP is not permitted.] [Provide recycled asphalt consisting of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. Recycled Asphalt Shingles (RAS) are not permitted. Provide RAP of a consistent gradation, asphalt content, and properties obtained from on-base stockpiles or asphalt pavement milled under this contract. Maintain RAP stockpiles free from contamination, including coal-tar sealers. When RAP is fed into the plant, limit the maximum RAP chunk size to 50 mm 2 inches. The individual aggregates in a RAP chunk are not to exceed the maximum size aggregate of the gradation specified in Table 1. Design the recycled asphalt mixture using procedures contained in AI MS-2. Provide RAP job mix that meets the requirements of paragraph COMPOSITION OF MIXTURE. Limit the amount of RAP so the asphalt binder from the RAP does not exceed 30 percent of the total asphalt content.]

2.5.1 RAP Aggregates and Asphalt Cement

[Provide a blend of aggregates used in the recycled mix that meet the requirements of paragraph AGGREGATES. Establish the percentage of asphalt in the RAP for the mixture design according to ASTM D2172/D2172M using the appropriate dust correction procedure.]

2.5.2 RAP Mix

[Select the virgin asphalt binder as described below:

a. For 0-20 percent recycled binder content - no change in virgin binder selection.

b. For 20+ to 30 percent recycled binder content - select virgin binder one grade softer than normal for both the high and low temperature limits, i.e., PG 64-22 would soften to PG 58-28.]

2.6 EQUIPMENT, TOOLS, AND MACHINES

2.6.1 Bituminous Plant

Provide a bituminous plant of such capacity to produce the quantities of bituminous mixtures required for the project within the completion time of the contract. Provide hauling equipment, paving machines, rollers, miscellaneous equipment, and tools in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output. Provide a sufficient number of adequately trained personnel during paving operations to produce a pavement meeting the requirements in this specification.

2.6.2 Mixing Plants

Provide mixing plants in accordance with AASHTO M 156 which are automatic or semiautomatic controlled, commercially manufactured units designed, coordinated, and operated to consistently produce a mixture within the job-mix formula (JMF). Prequalify drum or batch mixers at the production rate to be used during actual mix production. The prequalification tests include extraction in accordance with ASTM D2172/D2172M and recovery of the asphalt binder in accordance with ASTM D1856.

2.6.3 Asphalt Paver

Provide asphalt pavers which are self-propelled, with an activated screed, heated as necessary, and capable of spreading and finishing courses of hot-mix asphalt which will meet the specified thickness, smoothness, and grade, with sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. Provide a receiving hopper of sufficient capacity to permit a uniform spreading operation and equipped with a distribution system to place the mixture uniformly in front of the screed without segregation and produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. If screed extensions are used to increase the paving width, provide auger extensions to distribute the hot mix along the additional screed length. Equip the paver with a control system capable of automatically maintaining the specified screed elevation. Automatically actuate the control system from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.

2.6.4 Hauling Equipment

Provide trucks for hauling hot-mix asphalt having tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, lightly coat the truck beds with a release agent specifically designed for use with hot mix asphalt. Provide each truck with a suitable cover to protect the mixture from adverse weather. When necessary to maintain the mixture at the specified temperature, insulate or heat truck beds and securely fasten covers (tarps).

2.6.5 Rollers

Provide the number, type, and weight of rollers sufficient to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate or displacement of the asphalt mixture.

2.6.6 Straightedge

Furnish and maintain at the site, in good condition, one 3.7 meter 12 foot straightedge for each bituminous paver for use in testing the finished surface. Construct straightedges of aluminum with blades of box or box-girder cross section and a flat bottom reinforced to insure rigidity and accuracy. Provide handles to facilitate movement on pavement.

PART 3 EXECUTION

3.1 CONDITIONING OF UNDERLYING COURSE

****

NOTE: If the underlying surface to be paved is an unbound granular layer, apply a prime coat, especially if this layer will be exposed to weather for an extended period of time prior to covering with an asphalt mixture.

If the underlying surface to be paved is an existing asphalt or concrete layer, apply a tack coat to ensure an adequate bond between layers.

****

Prior to placing the bituminous base course, clean the underlying surface of foreign or objectionable matter. Apply a [prime coat] [tack coat] in accordance with 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.2 MIXING

3.2.1 Preparation of Mineral Aggregates

Place and maintain each aggregate stockpile in such a manner to prevent segregation. Regulate rates of feed of aggregates so that the moisture content and temperature of aggregates will be within tolerances specified herein. Provide dry storage for mineral filler.

3.2.2 Preparation of Bituminous Mixtures

****

NOTE: For Performance Graded (PG) asphalt cements, insert the plant temperature range from the Table below into the last sentence of the following paragraph.

Performance Graded Asphalt Plant Mixing Temperatures	
Binder Grade	**Mixing Temp Range (Deg C) (Deg F)**
PG 46-28	**115 - 146240 - 295**
PG 46-34	**115 - 146240 - 295**
PG 46-40	**115 - 146240 - 295**
PG 52-28	**115 - 149240 - 300**
PG 52-34	**115 - 149240 - 300**
PG 52-40	**115 - 149240 - 300**
PG 52-46	**115 - 149240 - 300**
PG 58-22	**127 - 154260 - 310**
PG 58-28	**127 - 154260 - 310**
PG 58-34	**127 - 154260 - 310**
PG 64-22	**129 - 160265 - 320**
PG 64-28	**129 - 160265 - 320**
PG 64-34	**129 - 160265 - 320**
PG 67-22	**135 - 163275 - 325**
PG 70-22	**138 - 166280 - 330**
PG 70-28	**135 - 163275 - 325**

Performance Graded Asphalt Plant Mixing Temperatures	
Binder Grade	**Mixing Temp Range (Deg C) (Deg F)**
PG 76-22	**141 - 168285 - 335**
PG 76-28	**138 - 166280 - 330**
PG 82-22	**143 - 171290 - 340**

****

Convey aggregates, mineral filler, and bitumen into the mixer in proportionate quantities required to meet the JMF. Set the mixing time as required to obtain a uniform coating of the aggregate with the bituminous material. Limit the temperature of bitumen at time of mixing not to exceed 150 degree C 300 degrees F. Maintain the temperature of aggregate and mineral filler in the mixer within the range of [_____] to [_____] degree C [_____] to [_____] degrees F when bitumen is added. Overheated and carbonized mixtures or mixtures that foam will be rejected.

3.2.3 Water Content of Aggregates

Perform drying operations to reduce the water content of mixture to less than 0.75 percent. Conduct the water content test in accordance with ASTM D2216. If the water content is determined on individual hot bin samples, calculate the water content as a weighted average based on composition of blend.

3.2.4 Storage of Bituminous Paving Mixture

Store the mixture according to the requirements of AASHTO M 156. Empty uninsulated surge bins at the end of each working day. If excessive heat loss, segregation,or oxidation of the stored asphalt mixture is observed, discontinue the use of the surge bin.

3.3 TRANSPORTATION OF BITUMINOUS MIXTURE

Transport the bituminous mixture from the paving plant to the site in trucks having tight, clean, smooth beds lightly coated with an approved release agent to prevent adhesion of mixture to truck bodies. Drain excessive release agent prior to loading. Cover each load with canvas or other approved material of ample size to protect mixture from weather and prevent loss of heat. Reject loads that have crusts of cold, unworkable material or have become wet by rain. Do not haul over freshly placed material.

3.4 PLACING

Do not place bituminous mixtures without ample time to complete placement and compaction during daylight hours, unless artificial lighting is provided.

3.4.1 Tack Coat

Spray contact surfaces of previously constructed pavement, curbs, manholes, and similar structures with a tack coat conforming to the requirements of

Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.4.2 Offsetting Joints in Bituminous Base Course

Place the bituminous base course so that longitudinal joints are offset from joints in the underlying course by at least 300 mm 1 foot. Offset transverse joints by at least 600 mm 2 feet from transverse joints in the underlying course.

3.4.3 Use of Laydown Machine

Reject mixtures having temperatures less than 121 degrees C 250 degrees F when delivered to the laydown machine. Adjust the laydown machine and regulate the speed so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface conforms to the cross section, grade, and contour indicated. Begin placement of the mixture along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture as nearly continuous as possible, and adjust the speed of placing to permit proper compaction. When segregation occurs in the mixture during placing, suspend the laydown operation until the cause is determined and corrected. Correct irregularities in alignment of the course left by the laydown machine by trimming directly behind machine. Immediately after trimming, thoroughly compact the edges of the course by tamping laterally with a lute. Do not permit distortion of the course during tamping.

3.4.4 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after the initial strip has been spread and compacted as specified below, overlap the screed of the laydown machine 12 to 25 mm 1/2 to 1 inch over the previously placed strip and sufficiently high so that compaction will produce a smooth, dense joint. Use a lute to push back the mixture placed on the edge of the previously placed strip to the edge of the strip being placed. Do not broadcast material onto the mat. Remove and waste excess mixture.

3.4.5 Hand Spreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, spread the mixture by hand. Prevent segregation during spreading. Do not broadcast material onto the mat. Remove and waste excess mixture. Maintain grade and smoothness tolerances presented in Table 1.

3.5 COMPACTION OF MIXTURE

Begin compaction as soon after placing as the mixture will bear roller without undue displacement. Do not permit delays in compacting the freshly placed mixture. After the initial rolling, perform preliminary tests of the crown, grade, and smoothness. Correct deficiencies so that the finished course will conform to requirements for the grade and smoothness specified in subpart: ACCEPTANCE. After meeting crown, grade, and smoothness requirements, continue rolling until a mat density of at least 92 percent of the theoretical maximum density (TMD) determined in accordance with ASTM D2041/D2041M is obtained. Roll the joints until until a joint density of at least 90.5 percent of the theoretical maximum density (TMD) determined in accordance with ASTM D2041/D2041M is obtained. Thoroughly compact areas inaccessible to rollers with hot hand tampers.

3.5.1 Correcting Deficient Areas

Remove mixtures that become contaminated or are defective. Do not permit skin patching of an area that has been rolled. Cut holes the full thickness of the base course so that the sides are perpendicular and parallel to the direction of traffic and the edges are vertical. Spray sides with tack coat conforming to requirements of Section 32 12 13 BITUMINOUS TACK AND PRIME COATS. Place hot mix asphalt in the holes in sufficient quantity so that the finished surface will conform to grade, smoothness, and density requirements.

3.6 JOINTS

3.6.1 General

Carefully construct joints between old and new pavements or between successive day's work or joints that have become cold to establish a continuous bond between old and new sections of the course. Construct joints having the same texture, density, and smoothness as other sections of the course. Clean contact surfaces of previously constructed pavements that have become coated with dust, sand, or other objectionable material by brushing or cut back with approved power saw, as approved. Spray the surface against which new material is placed with a thin, uniform coat of tack coat conforming to requirements of Section 32 12 13 BITUMINOUS TACK AND PRIME COATS. Apply the material far enough in advance of placement of the fresh mixture to insure adequate curing. Take care to prevent damage or contamination of sprayed surface.

3.6.2 Transverse Joints

Pass the roller over the unprotected end of freshly placed mixture only when placing of the course is discontinued or when delivery of the mixture is interrupted to the extent that the unrolled material may become cold. In all cases, cut back the edge of the previously placed course a mimimum of 50 mm 2 inches to expose an even, straight, vertical surface for the full thickness of the course. In continuing placement of the strip, position the mechanical spreader on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

3.6.3 Longitudinal Joints

Cut back edges of a previously placed strip that have cooled or are irregular, honeycombed, poorly compacted, damaged, or otherwise defective. In all cases, cut back the edge of the previously placed course a mimimum of 50 mm 2 inches to expose an even, straight, vertical surface for the full thickness of the course.

3.7 EDGES OF PAVEMENT

Neatly trim outside edges adjacent to shoulders.

3.8 QUALITY CONTROL

Perform tests in sufficient numbers and at the locations and times directed to ensure that materials, mixtures and compaction meet specified requirements. Obtain samples of finished pavement, including samples that span the longitudinal joint. Sample bituminous materials during construction when shipments of bituminous materials are received or when necessary to assure that some condition of handling or storage has not been detrimental to the bituminous material.

3.8.1 Sampling

Obtain plant mix and in-place samples on a lot and sublot basis. Each full day's production or a maximum of 900 metric tonnes 1000 tons is considered a lot. Divide the lot into four (4) equal sublots and obtain random samples in accordance with ASTM D3665 within each sublot. Obtain plant mix samples from the haul truck or from behind the paver. Test for grade and smoothness on a total lot basis.

3.8.2 In-Place Density

Take one random core (100 mm 4 inches or larger in diameter) from the mat (interior of the lane) of each sublot, and one random core from the joint (immediately over joint) of each sublot, with each random core the full thickness of the layer being placed. When the random core is less than 25 mm 1 inch thick, do not include in the analysis. In this case, take another random core. After air drying to a constant weight, determine the density of each core in accordance with ASTM D2726/D2726M. Determine percent compaction using the TMD. Evaluate for acceptance in accordance with subpart: ACCEPTANCE. Remove and replace unacceptable lots.

3.8.3 Laboratory Air Voids and Theoretical Maximum Density

Calculate laboratory air voids by determining the bulk density of each lab compacted specimen using the laboratory-prepared, thoroughly dry method of ASTM D2726/D2726M and determining the theoretical maximum density of each sublot sample using ASTM D2041/D2041M. Use the latest theoretical maximum density value to calculate the laboratory air voids for each sublot. Evaluate for acceptance in accordance with subpart: ACCEPTANCE. Complete and report all laboratory air void tests within 24 hours after completion of construction of each lot.

3.8.4 Plan Grade

Provide finished surfaces conforming, within tolerances specified, to the lines, grades, and cross sections indicated. Do not permit finished surfaces to vary more than the tolerances provided in subpart: ACCEPTANCE from the plan gradeline and elevation established and approved at the site. Maintain finished surfaces flush with finished surfaces of abutting pavements. Do not permit deviations from the plan gradeline and elevation in areas of pavements where closer conformance with plan grade and elevation is required for the proper functioning of drainage and other appurtenant structures involved.

3.8.5 Surface Smoothness

Provide finished surfaces not deviating from the testing edge of a straightedge more than the tolerances of subpart: ACCEPTANCE in any direction.

3.8.6 Temperatures

Check temperatures at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.9 PROTECTION OF PAVEMENT

After final rolling of the pavement, do not permit vehicular traffic of any kind until the pavement has cooled to ambient temperature.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 11 26.19 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 27 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-32 11 26.19 (May 2020)**

Preparing Activity: USACE **Superseding**
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SECTION 32 11 26.19

BITUMINOUS-STABILIZED BASE AND SUBBASE COURSES

05/20

****

NOTE: This guide specification covers the requirements for bituminous stabilization of base and subbase courses for airfield pavements, roads, streets, and parking areas.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

The purposes of bituminous stabilization are to waterproof and improve the cohesive strength of non-cohesive granular soils and aggregates. This specification is limited to soils and aggregates with less than 30 percent passing the No. 200 sieve and a Plasticity Index less than 10. For bituminous subgrade stabilization, use UFGS 32 11 13.16.

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: Delete these paragraphs when lump sum payment is desired.

****

1.1.1 Measurement for Payment

1.1.1.1 Bituminous Stabilization

Measurement will be by the square meter yard of work completed and accepted.

1.1.1.2 Bituminous Material

Submit quantity of residual bituminous material used in the job. Bituminous material to be paid for will be measured in the number of [liters gallons of the material used in the accepted work, corrected to liters at 15 degrees C gallons at 60 degrees F in accordance with ASTM D1250. Use a coefficient of 0.00025 per degree C F for asphalt emulsion.] [metric 2000 pound tons of the material used in the accepted work.]

1.1.1.3 Select Material

****

NOTE: Delete the reference to select material when select material is not required.

****

Select material will be measured by the [cubic meter yard] [metric 2000 pound ton] of material placed and used in the completed and accepted stabilization. Measurement will not be made for select material that is wasted or used in work determined to be defective.

1.1.2 Basis for Payment

****

NOTE: Delete reference to select material when select material is not required.

Delete the last sentence in brackets if sanding or dusting of the bituminous-primed surfaces is not required or if bituminous-primed surfaces are to receive bituminous surfacing under the contract.

****

Bituminous-stabilized mixture, constructed and accepted, [and the quantities of bituminous material] [and select material] will be paid for at the respective contract unit prices. Payment will not be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used. [Select material obtained from grading and excavation operations at the project site will not be paid for under this section but will be included for payment under other sections specifying grading and excavating.] [Separate payment will not be made for sanding or dusting the bituminous prime-coated surfaces. Costs for sanding or dusting will be included in the contract unit price for bituminous material.]

1.1.3 Waybills and Delivery Tickets

Submit copies of waybills and delivery tickets during the progress of the work. Before the final payment is allowed, furnish waybills and certified delivery tickets for all bituminous materials [and select materials] actually used in the construction.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASPHALT RECYCLING AND RECLAIMING ASSOCIATION (ARRA)

ARRA FDR201A	(2018) Recommended Mix Design Guidelines for Full Depth Reclamation (FDR) Using Emulsified Asphalt Stabilizing Agent

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D1250	(2019; E 2020) Standard Guide for Use of

	the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1883	(2016) Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt
ASTM D2419	(2014) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D2940/D2940M	(2020) Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 DEFINITION

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure in accordance with ASTM D1557, abbreviated in this specification as percent laboratory maximum density.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, Machines, and Tools

Mix Design; G, [_____]

Waybills and Delivery Tickets

Notification Of Selected Source

SD-06 Test Reports

Sampling and Testing

1.5 QUALITY CONTROL

1.5.1 Qualifications

****

NOTE: Include bracketed sentence for Corps-managed projects.

****

Perform sampling and testing using an approved commercial testing laboratory or on-site facilities. Submit accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM D3666, including all applicable test procedures. Do not start work requiring testing until the facilities have been inspected and approved. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. Maintain this certification for the duration of the project. [In addition, all contractor quality control testing laboratories performing acceptance testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at http://www.erdc.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/9254/Article/ for costs and scheduling.]

1.5.2 Test Results

Verify that materials comply with the specification. When a material source is changed, test the new material for compliance. When deficiencies are found, repeat the initial analysis and retest the material already placed to determine the extent of unacceptable material.

1.5.3 Aggregate

Submit notification of selected source from which aggregates are to be obtained, within 15 days after the award of contract. Perform tests for determining the suitability of aggregate including, but not limited to: sieve analysis in accordance with ASTM C136/C136M using sieves conforming to ASTM E11, liquid limits and plasticity index in accordance with ASTM D4318, and sand equivalent test in accordance with ASTM D2419. Do not submit aggregate test data older than 6 months since the testing was performed. Take aggregate samples for laboratory tests in accordance with ASTM D75/D75M. Submit certified copies of aggregate test results, not less than [30] [_____] days before the material is required in the work.

1.5.4 Bituminous Material

Submit notification of selected source of bituminous material within 15 days after the award of contract. Submit certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements, not less than [30] [_____] days before the material is required in the work.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Environmental Requirements

Do not apply bituminous material when the atmospheric temperature is less than 10 degrees C 50 degrees F or to soils that are frozen or contain frost. If the temperature falls below 2 degrees C 35 degrees F, protect completed bitumen-treated areas against any detrimental effects of freezing.

1.7 ACCEPTANCE

1.7.1 Tolerances

Acceptance of bituminous stabilized [base course] [subbase] is based on compliance with the tolerances presented in Table 1. Remove and replace bituminous stabilized mixture represented by the failing tests or submit repair plan for approval.

TABLE 1

Attribute	Tolerance
Field Density	minimum of 95 percent
Asphalt Content	plus/minus 0.5 percent of mix design
Smoothness	maximum of 10 mm 3/8 inch
Thickness (individual measurement)	maximum of 13 mm 1/2 inch
Thickness (average of all measurements)	minimum of 6 mm 1/4 inch

1.7.2 Test Section

[Place a test section of at least 2.5 by 30 m 8 by 100 feet, utilizing the equipment and procedures proposed for use, to demonstrate that bituminous stabilized mixture conforming to this specification can be produced. Acceptance of the test section is based on compliance with the tolerances listed in Table 1.] [A test section is not required.]

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Bituminous Material

****

NOTE: Select asphalt emulsion type for the bituminous-stabilized mixture based on the classification of the soils evaluated during the site geotechnical investigation.

Course	**Emulsion Type**
Base Course	**MS-2h, HFMS-2h, HFMS-2s, SS-1, SS-1h, CSS-1, CSS-1h**

Course	**Emulsion Type**
Subbase Course	
GP	**MS-1, HFMS-1, MS-2h, HFMS-2h, CMS-2, CMS-2h**
GW	**MS-2h, HFMS-2h, HFMS-2s, SS-1, SS-1h, CSS-1, CSS-1h**
SW, SP	**MS-2h, HFMS-2h, HFMS-2s, SS-1, SS-1h, CSS-1, CSS-1h**
GM, SM	**MS-2h, HFMS-2h, HFMS-2s, SS-1, SS-1h, CSS-1, CSS-1h**
Combinations of above	**MS-2h, HFMS-2h, HFMS-2s, SS-1, SS-1h, CSS-1, CSS-1h**

****

2.1.1.1 Bituminous-Stabilized Mixture

Provide emulsified asphalt conforming to [ASTM D977 Type [MS-1] [MS-2h] [HFMS-1] [HFMS-2h] [HFMS-2s] [SS-1] [SS-1h]] [ASTM D2397/D2397M Type [CMS-2][CMS-2h][CSS-1][CSS-1h]].

2.1.1.2 Prime Coat

Provide emulsified asphalt conforming to [ASTM D977, Type [SS-1] [SS1h]] [ASTM D2397/D2397M, Type [CSS-1] [CSS-1h]]. Asphalt emulsion can be diluted up to 1 part water to 1 part emulsion for prime coat use.

2.1.2 Material to be Stabilized

****

NOTE: Specify imported select material for 80 CBR bituminous base course.

Specify in-place or imported materials for subbase. The CBR depends on aggregate gradation as follows. Delete inapplicable materials.

Gradation No.	**Design CBR**
1	**50 Max**
2	**40 Max**
3	**30 Max**

Refer to UFC 3-250-11 and UFC 3-270-01 for further information, including applicability of bituminous stabilization.

****

2.1.2.1 Select Material for Bituminous Stabilized Base Course

[Select material conforming to ASTM D2940/D2940M, base course gradation Table 1. Verify select material has a liquid limit less than 25 [_____] and a Plasticity Index less than 4 [_____] when tested in accordance with ASTM D4318; the percentage of wear less than 40 [_____] percent in accordance with ASTM C131/C131M; and a sand equivalent percentage greater than 35 percent in accordance with ASTM D2419. Perform sieve analysis in accordance with ASTM C117 and ASTM C136/C136M.]

2.1.2.2 Aggregate for Bituminous-Stabilized Subbase Course

[In-place or imported soil or aggregate conforming to soil classifications GW, GP, GM, SW, SP, SM, or combinations thereof. Soil classification in accordance with ASTM D2487 and ASTM D2488. Verify material has a plasticity index equal to or less than 10 in accordance with ASTM D4318 and a sand equivalent percentage greater than 35 percent in accordance with ASTM D2419. Perform sieve analysis in accordance with ASTM C117 and ASTM C136/C136M. Provide aggregates within the limits specified as follows:

TABLE 2

Maximum Allowable Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	No. 1	No. 2	No. 3
50 mm2 inch	100	100	100
2 mmNo. 10	50	80	100
0.075 mmNo. 200	30	30	30

]

2.1.3 Stockpiling Materials

****

NOTE: Delete this paragraph when select material is not required or when small quantities do not justify the inclusion of select materials.

****

Stockpile select material, including approved material available from excavation and grading in the manner and at the locations designated. Clear, drain, and level storage sites before stockpiling material. Separately stockpile materials obtained from different sources. Maintain a separation distance or barrier between stockpiles to prevent cross-contamination.

2.1.4 Water

Furnish clean, fresh, and potable water.

2.2 MIX DESIGN

****

NOTE: For base courses, specify a CBR of 80. For subbase courses, specify CBR value on the basis of the gradation chosen.

Specify soaked condition and surcharge load. Default values are 24-hour soaked and 4.5 kg 10 lb surcharge load.

****

Develop and submit for approval a proposed mix design prior to stabilization work. Develop mix using samples of the material to be stabilized. Conduct mix design in accordance with ARRA FDR201A. Verify CBR bearing value of [80][50][40][30] or greater in accordance with ASTM D1883 when tested in a [24-hour soaked] [unsoaked] condition under a surcharge load of 4.5 [_____] kg 10 [_____] lb.

2.2.1 Mix Design Report

Perform trial design batches, mixture proportioning studies, testing, and submit results demonstrating that the proposed mixture proportions produce a bituminous-stabilized mixture of the qualities indicated. Submit test results in a mix design report to include:

a. Gradation, sand equivalent, and Plasticity Index of soil or aggregate.
b. Maximum dry density and optimum moisture content.
c. Density, maximum specific gravity, air void content, dry and moisture conditioned indirect tensile strength and level of saturation at each emulsified asphalt stabilizing agent content.
d. Optimum emulsified asphalt stabilizing agent content as a percentage of dry materials.
e. Density, air void content, dry and moisture conditioned indirect tensile strength and CBR value at recommended moisture and emulsified asphalt stabilizing content.
f. Emulsified asphalt stabilizing agent designation, supplier name and location.
g. Emulsified asphalt residue content and certificates of compliance.

2.3 PLANT, EQUIPMENT, MACHINES, AND TOOLS

****

NOTE: NOTE: Specify a central plant and mechanical spreader for mixing and placing bituminous stabilized base course and delete the mixer/reclaimer and traveling plant provisions. For bituminous stabilized subbase, include central plant, mixer/reclaimer, and traveling plant provisions.

****

Submit list of proposed equipment to be used in performance of construction work, including descriptive data. Plant, equipment, machines, and tools used in the work are subject to approval. Maintain in a satisfactory working condition at all times. Provide equipment with the capability of producing the required compaction, meeting grade controls, thickness control and smoothness requirements indicated.

2.3.1 Central Plant

Provide a batch or continuous flow type central plant capable of producing a uniform bituminous stabilized mixture at the required asphalt emulsion and moisture contents. Equip the mixer with calibrated metering and feeding devices that introduce the aggregate, bituminous material, water, and additives (if used) into the mixer in the specified quantities. If necessary, use a screening device to remove oversized material greater than 2 inches (50 mm) from the raw aggregate feed.

2.3.2 Mechanical Spreader

Provide a steerable, self propelled, mechanical spreader having variable speeds forward and reverse. Mount the spreader on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material.

Provide a spreader containing a hopper, an adjustable screed, and outboard bumper rolls; designed to have a uniform, steady flow of material from the hopper; and capable of laying material without segregation, across the full width of the lane, to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers conform to thickness and grade requirements indicated.

2.3.3 Mixer/Reclaimer

Provide a self-propelled, four-wheel drive rotary mixer/reclaimer, capable of pulverizing the soil in a single pass for the full depth to be stabilized and providing a mixing action capable of uniformly blending and mixing the required bituminous material content with the aggregate. Equip with a rotor capable of up or down cutting. Equip the mixer/reclaimer with an integrated additive injection system capable of introducing bituminous emulsion into the cutting drum during the mixing process. Provide a metering device capable of automatically adjusting the flow of the bituminous emulsion to compensate for any variation in the amount of reclaimed material introduced into the mixing chamber.

2.3.4 Traveling Plant

Provide a traveling plant capable of moving at a uniform rate of speed and accomplishing thorough mixing of the materials in one pass. Deliver water and bituminous material from supply trucks or bins at a predetermined rate. Construct windrows of prepared bituminous stabilized mixture to cover a predetermined width to the indicated compacted thickness.

2.3.5 Bituminous Distributor

Provide a distributor with pneumatic tires that prevent rutting, shoving, or otherwise damaging other layers in the pavement structure. Provide capability to spray bituminous material in a uniform double or triple lap at the specified temperature, at variable widths, and at readily determined and controlled rates from 0.15 to 6.5 L/square meter 0.05 to 2.0 gallons/square yard. Equip distributor to circulate and agitate the bituminous material during the heating process. The bituminous distributor is permitted only for applying tack, prime, and seal coats and not for applying bitumen to be mixed into the stabilized mixture.

2.3.6 Rollers

Compact the bituminous stabilized mixture using one or a combination of the following pieces of equipment: tamping or grid roller; steel-wheeled roller; vibratory roller; pneumatic-tire roller, and/or vibrating plate compactor (for areas inaccessible to rollers). Compact the bituminous stabilized mixture using the number, type, and weight of rollers and/or compactors sufficient to compact the mixture to the required density.

2.3.7 Straightedge

Furnish and maintain at the site, in good condition, one [3.05] [3.66] meter [10] [12] foot straightedge for each bituminous paver, for use in the testing of the finished surface. Make straightedge available for government use. Construct straightedges of aluminum or other lightweight metal having blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Equip straightedge with handles to facilitate straightedge movement on the bituminous stabilized surface.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

****

NOTE: Delete this paragraph when select material is not required or when small quantities do not justify the inclusion of select materials. Delete sentence in the first set of brackets when onsite material is not available.

****

Select aggregate sources than can produce the quality and quantity of base course materials meeting these specification requirements in the specified time limits. [Upon completion of the work, condition aggregate sources on Government property to drain readily and leave in a satisfactory condition.] [Obtain aggregate material from offsite sources. Condition aggregate sources on private lands in agreement with local laws or authorities.]

3.2 PREPARATION OF AREAS TO BE STABILIZED

****

NOTE: Delete inapplicable subparagraph.

Remove brackets and retain second sentence for imported base course material. Remove brackets and retain third sentence for in-place subbase material.

****

Clean area and dispose of debris and unsatisfactory in-place material [as directed] [in waste disposal areas indicated]. [Visually inspect area for adequate compaction and capability of withstanding, without displacement, compaction specified for the bituminous-stabilized base course mixture.] [Visually inspect the exposed material to be stabilized prior to mixing.] When the stabilized course is constructed in more than one layer, clean the previously constructed layer of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Provide adequate drainage during the entire construction period to prevent water from collecting or standing on the area to be stabilized or on pulverized, mixed, or partially mixed material.

3.2.1 In-Place Material to be Stabilized

Grade and shape the entire area to conform to the lines, grades, and cross sections shown prior to being processed. Make soft or yielding areas stable before construction is begun.

3.2.2 In-Place Materials to Receive Stabilized Course

[Remove and replace or rework soft or yielding areas on the surface prior to placing bituminous-stabilized mixture. Aerate material in the affected area and remove all unsatisfactory materials. Add material as directed. Shape to line, grade, and cross section and compact the new work to the specified density.] [Conform subgrade to Section 31 00 00 EARTHWORK.] [Conform subbase course to Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING].]

3.2.3 Select Material

****

NOTE: Delete paragraph if select material is not required.

****

Utilize sufficient select material to provide the required thickness of the bituminous-stabilized layer after compaction; process it to meet the requirements specified, before bituminous stabilization is undertaken.

3.3 GRADE CONTROL

Excavate underlying material to sufficient depth for the required bituminous-stabilized course thickness so that the finish stabilized course and the subsequent surface course will meet the fixed grade. Provide line and grade stakes as necessary for control. Place grade stakes in lines parallel to the centerline of the area under construction and suitably spaced for string lining. Verify the finished and completed stabilized area conforms to the lines, grades, cross section, and dimensions indicated.

3.4 MIXING OF MATERIALS

****

NOTE: For base courses, specify central plant mixing method and delete requirements for traveling plant and mix-in-place mix methods.

For subbase courses, select mixing method based on material source (imported or in-place).

****

3.4.1 Mixed-in-Place Method

****

NOTE: Mixing the materials by the mixed-in-place method should be considered for those jobs where the thickness of the stabilized layer is 150 mm 6 inches or less. Because the maximum layer thickness is 150 mm 6 inches, constructing a thicker layer by this method would require removal of the top portion of material. The lower portion would then be mixed and compacted, and the top portion mixed, replaced and compacted.

****

3.4.1.1 Scarifying and Pulverizing of Soil

Prior to the application of bituminous materials, scarify and pulverize the soil [to the depth shown on the drawings] [to a depth of [_____] mm inches]. Control scarification so that the layer beneath the layer to be stabilized is not disturbed. Do not exceed the depths indicated. Unless otherwise noted, do not scarify or pulverize any area larger than can be completed in 2 working days.

3.4.1.2 Application of Water

Once soils have been scarified and pulverized, shape to cross sections and grades indicated and determine moisture content of the soils. Add water in increments and partially incorporate each increment of water in the mix to avoid concentration of water near the surface. After the last increment of water has been added, continue mixing until the water is uniformly distributed throughout the mixture, including satisfactory moisture distribution along the edges of the section.

3.4.1.3 Application of Bituminous Material

Distribute the bituminous material at the specified rate of residual asphalt by a spray bar integrated into the mixer/reclaimer cutting drum within a temperature range of 25 to 55 degrees C 75 to 130 degrees F. Uniformly mix bituminous material with the soil. If the bituminous material is applied in more than one increment, partially mix each application into the material as directed. After the required amount of bituminous material has been added to the loose material, thoroughly mix the bituminous material and soil. After mixing is completed, verify the bituminous-stabilized mixture conforms to the mix design proportions and the moisture content is within 1 percent of the mix design. Include the water used to dilute the asphalt emulsion in the moisture content calculation. Do not permit heavy equipment, except the soil mixer, to pass over the freshly spread bituminous material.

3.4.2 Traveling Plant Method

Place the pulverized material in windrows of sufficient size to cover a predetermined width to the indicated compacted thickness. Operate the traveling plant at a constant speed and sufficiently slowly so that the soils and bitumen are thoroughly mixed. Deliver water and bituminous material separately or together at a predetermined rate.

3.4.3 Central Plant Method

3.4.3.1 Mixing

Load and haul select material from pits or stockpiles so that a uniform grade of each material is delivered to the central-mixing plant. Feed properly batched or proportioned aggregate and soil binder materials into the mixing unit together with the bituminous material and the quantity of water needed to obtain the required optimum moisture content. Continue mixing until a homogeneous mixture is obtained. Haul mixture to the job in trucks equipped with protective covers. Place mixture with mechanical spreaders.

3.4.3.2 Placing

Place the mixed material on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. When a compacted layer 150 mm 6 inches or less in thickness is required, place the material in a single layer. When a compacted layer in excess of 150 mm 6 inches is required, place the material in layers of equal thickness. Do not place layers more than 150 mm 6 inches or less than 80 mm 3 inches when compacted. When compacted, provide layers true to the grades or levels required with the least possible surface disturbance. Make such adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to ensure an acceptable base course.

3.5 PLACEMENT AND COMPACTION

****

NOTE: If central plant is not specified, delete the first sentence. Density will be based on the material being stabilized.

****

[For plant-mixed, machine laid materials, begin compaction immediately following placement.] [For mixed-in-place material, allow the bituminous-stabilized mixture an adequate amount of time to cure. After curing, shape the bituminous-stabilized mixture approximately to the specified lines and grades and thoroughly loosen to its full depth and width.] Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive passes at least one-half the width of the roller. Make adjacent passes of the roller at slightly different lengths. Do not permit bituminous-stabilized materials to displace, pump, or shove. Continue compaction efforts until the compacted mixture is at least [95] [_____] percent of laboratory maximum density. Compact areas inaccessible to rollers using mechanical tamping equipment.

3.6 JOINTS

3.6.1 Longitudinal Joints

For areas where plant-mixed bituminous-stabilized material is placed in successive strips, remove 300 mm 1 foot of the edge of the material prior to placing the adjacent strip. For the shoulders of the bituminous-stabilized areas, place approved material along the edges of the bituminous-stabilized course to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course. Compact at least 300 mm 1 foot width of the shoulder or previously placed strip at the same time as compacting each layer of the bituminous-stabilized course.

3.6.2 Transverse Joints

At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to obtain a true vertical face free of loose or shattered material. Remove material along construction joints not properly compacted and replace with bituminous-stabilized mixture that is mixed, moistened, and compacted in accordance with this specification.

3.7 FINISHING

Finish the surface of the top layer to grade and cross section as shown on the drawings and to a uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. If the surface becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, rework or replace the unsatisfactory area, as directed. If any areas become saturated by water, immediately remove that portion, place in a windrow and aerate until a moisture content within the limits specified is obtained. Verify the moisture content is within the specified limits, replace the bituminous-stabilized mixture in layers, and compact to the specified density.

3.7.1 Smoothness

****
NOTE: For subbase stabilization, delete this paragraph.
****

Evaluate the finished surface with a straightedge. Limit deviations in the surface of each layer to the tolerances shown in Table 1. Correct deviations exceeding this tolerance by removing and replacing with new bituminous-stabilized mixture, or by reworking existing material and compacting, as directed.

3.7.2 Thickness Control

****
NOTE: When subbase or base courses are constructed less than 150 mm 6 inches in total thickness, a deficiency of 13 mm 1/2 inch in thickness is considered excessive. Applicable to job conditions, the thickness tolerance provisions may be modified as required, restricting all deficiencies to not over 6 mm 1/4 inch. Coordinate changes with Table 1.
****

Build the compacted thickness of the stabilized course within 13 mm 1/2 inch of the thickness indicated. Where measured thickness of the stabilized course is more than 13 mm 1/2 inch deficient, correct such areas by removing the full depth of the layer, replacing with new material of proper gradation, and recompacting as directed. Where the measured thickness of the stabilized course is more than 13 mm 1/2 inch thicker than indicated, consider the course as conforming to the specified thickness requirements. Average job thickness is the average of all thickness measurements taken for the job, but within the tolerances of Table 1.

3.8 PRIME COAT

****
NOTE: A bituminous stabilized course should be waterproof without an additional prime coat. Retain prime coat provisions if sanding or dusting of the bituminous-primed surfaces is required or if it will be at least 7 days before an asphalt mixture is constructed on the stabilized course.
****

Before dust settles on the area, apply a prime coat of bituminous material to the finished surface. Uniformly apply bituminous material at the rate of 0.22 to 0.91 L/square meter 0.05 to 0.20 gallons/square yard. [Protect bituminous material by sanding or dusting the treated surface. Uniformly apply sand at the rate of 3.5 to 4.5 kg/square meter 6 to 8 pounds/square yard].

3.9 FIELD QUALITY CONTROL

3.9.1 Sampling and Testing

Perform sampling and testing in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified requirements. Furnish certified copies of test results within 24 hours of completion of tests. Replace or repair all in-place unacceptable material.

3.9.2 Field Density

Express compaction as a percentage of the laboratory maximum density. Prepare laboratory samples from an uncompacted mixture obtained immediately prior to field compaction and compact the samples in accordance with ASTM D1557. Perform a minimum of one laboratory compaction test for each 4 hours of mixture placed. Determine as-built density of the bituminous-stabilized and compacted course in accordance with [ASTM D1556/D1556M][ASTM D6938. When a nuclear gauge is used, check the calibration curves and adjust if necessary, using the sand cone method as described in paragraph Calibration of ASTM D6938. ASTM D6938 results in a wet unit weight of soil and is used to determine the moisture content of the soil. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. If ASTM D6938 is used, check the in-place densities by ASTM D1556/D1556M at least once per lift for each day's production of stabilized material. Furnish calibration curves and calibration test results within 24 hours of conclusion of the tests.] Perform at least one field density test for each [200] [_____] square meters [250] [_____] square yards of each layer of stabilized material.

3.9.3 Sieve Analysis

****

NOTE: Delete the bracketed reference to source of materials when select material is not required.

****

Perform a minimum of 1 analysis for each [1000] [_____] metric tons tons of material to be stabilized until the course is completed. When [the source of materials is changed or] deficiencies are found, repeat the analysis and retest the material already placed to determine the extent of unacceptable material. Replace all in-place unacceptable material at no additional cost to the Government.

3.9.4 Liquid Limit and Plasticity Index

Perform one liquid limit and plasticity index for each sieve analysis in accordance with ASTM D4318.

3.9.5 Extraction Test

Conduct asphalt content tests in accordance with ASTM D2172/D2172M or ASTM D6307, to confirm the amount of bitumen and moisture in the mixture. Adjust operation as required to maintain the asphalt content within the tolerances of Table 1. Conduct one test [for every 4 hours of placement] [for every 275 metric tons 300 tons of mixture placed]. Take samples in accordance with ASTM D979/D979M.

3.9.6 Smoothness Test

****

NOTE: For subbase stabilization, delete this paragraph.

****

Test the entire area of the bituminous-stabilized course in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines 4.5 m 15 feet or less apart, as directed. Locate the longitudinal lines at the centerline of each bituminous-stabilized pass and at the 1/8th point in from each side of the pass.

3.9.7 Thickness

Measure thickness of the stabilized course at intervals of 1 measurement for each [400] [_____] square meters [500] [_____] square yards of stabilized course. Take measurements in 75 mm 3 inch diameter test holes penetrating the stabilized course.

3.9.8 Bituminous Material

Sample the bituminous material used in accordance with ASTM D140/D140M.

3.10 MAINTENANCE

Maintain stabilized area in a satisfactory condition until accepted. Maintenance includes immediate repairs to any defects, repeated as often as necessary to keep the area intact. Correct defects as specified.

3.11 TRAFFIC

Completed portions of the bituminous-stabilized area may be opened to controlled traffic within 4 hours of completion of the course, if approved.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 11 33.13 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS-32 11 33 (August 2008)
UFGS-32 11 34 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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****

USACE / NAVFAC / AFCEC **UFGS-32 11 33.13 (May 2020)**

Preparing Activity: USACE
Superseding
UFGS-32 11 33 (August 2008)
UFGS-32 11 34 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 32 11 33.13

PORTLAND CEMENT-STABILIZED BASE COURSES

05/20

****

NOTE: This guide specification covers the requirements for portland cement-stabilized base or subbase for airfields, roads, and streets.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: In general, this specification is written for portland cement-stabilized base or subbase courses. Use UFGS 32 11 36.13, LEAN CONCRETE BASE COURSE, for Lean Concrete Base (LCB) or Econocrete applications.

****

1.1 UNIT PRICES

1.1.1 Measurement

****

NOTE: Delete this paragraph when lump sum payment is desired.

****

Measure by the square m yard of work completed and accepted.

1.1.2 Payment

****

Delete the last sentence in brackets if sanding and dusting of the bituminous-cured surfaces is not required or if bituminous-cured surfaces are to receive bituminous surfacing under the contract.

****

Cement stabilization, constructed and accepted, will be paid for at the respective contract unit prices in the bidding schedule. No payment will be made for any material wasted, used for convenience, unused or rejected, or for water used. [No separate payment will be made for sanding or dusting the bituminous prime-coated surfaces, and all costs for sanding or dusting will be included in the contract unit price for bituminous material.]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D558/D558M	(2019) Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures
ASTM D559	(2003) Wetting and Drying Compacted Soil-Cement Mixtures

ASTM D560	(2003) Freezing and Thawing Compacted Soil-Cement Mixtures
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1632	(2007) Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D1633	(2000; R 2007) Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 DEFINITION

Cement-stabilized mixture, as used herein, is a mixture of Portland cement and in-place or select borrow material uniformly blended and compacted as specified to produce a pavement base course or subbase which meets the criteria set forth in the drawings and specifications. The cement-stabilized mixture placed directly under the bituminous surface course or under the concrete pavement is a base course. The cement-stabilized mixture placed under a base course is a subbase course.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Mix Design; G, [_____]

Aggregate
Asphalt Emulsion

SD-06 Test Reports

Aggregate

Compressive Strength

1.5 QUALITY CONTROL

1.5.1 Qualifications

Perform sampling and testing using an approved commercial testing laboratory or on-site facilities that is accredited in accordance with ASTM C1077. Do not start work requiring testing until the facilities have been inspected and approved. The Government will inspect all laboratories requiring validation for equipment and test procedures prior to the start of any stabilization operations for conformance to ASTM C1077. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. Maintain this certification for the duration of the project.

1.5.2 Test Results

Verify that materials comply with the specification. When a material source is changed, [test the new material for compliance] [_____]. When deficiencies are found, repeat the initial analysis and retest the material already placed to determine the extent of unacceptable material. Replace or repair all in-place unacceptable material to conform to the contract requirements. Perform tests in sufficient numbers, and as specified, to ensure that materials and compaction meet specified requirements. Furnish copies of the test results within 24 hours of completion of tests.

1.5.3 Aggregate

Submit notification of sources from which aggregates are to be obtained, within 15 days after the award of contract. Perform tests for determining the suitability of aggregate including, but not limited to: sieve analysis in accordance with ASTM C136/C136M using sieves conforming to ASTM E11 and liquid limits and plasticity index in accordance with ASTM D4318. Take aggregate samples for laboratory tests in accordance with ASTM D75/D75M. Submit certified copies of aggregate test results, not less than [30] [_____] days before the material is required in the work.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not apply cement when the atmospheric temperature is less than 5 degree C 40 degrees F or to soils that are frozen or contain frost, or when the underlying material is frozen. If the temperature falls below 2 degree C 35 degrees F, protect completed cement-stabilized mixture against detrimental effects of freezing. Bring any areas of completed cement-stabilized mixture that are damaged by freezing, rainfall, or other weather conditions to a satisfactory condition in conformance with this specification.

1.7 ACCEPTANCE

1.7.1 Tolerances

Acceptance of cement-stabilized mixture is based on compliance with the tolerances presented in Table 1. Remove and replace cement-stabilized mixture represented by the failing tests or submit plan for approval.

TABLE 1	
Measurement	Tolerance
Grade	plus/minus 15 mm 0.05 foot
Smoothness	plus/minus 10 mm 3/8 inch
Thickness (individual	plus/minus 13 mm 1/2 inch
Thickness (average)	plus/minus 6 mm 1/4 inch
Field Density	98 percent minimum
Compressive Strength	minus 350 kPa 50 psi below specified strength

1.7.2 Test Section

[Place a test section of at least 2.5 by 30 m 8 by 100 feet, utilizing the equipment and procedures proposed for use, to demonstrate that cement stabilized mixture conforming to this specification can be produced. Acceptance of the test section is based on compliance with the tolerances listed in Table 1.] [A test section is not required].

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

2.1.1.1 Portland Cement

Provide cement conforming to ASTM C150/C150M, Type I, IA, II, or IIA low alkali or ASTM C595/C595M, Type IS or IS(A).

2.1.1.2 Slag Cement

Provide slag cement (ground-granulated blast-furnace slag) conforming to ASTM C989/C989M, [Grade 100 or]Grade 120.

2.1.1.3 Fly Ash

Provide fly ash conforming to ASTM C618, Class F, including the optional requirements for uniformity and a loss on ignition not exceeding 6 percent.

2.1.2 Material to be Stabilized

****

NOTE: For base courses, delete requirements for in-place materials. For cement-treated base to be overlaid with Portland cement concrete pavement, limit maximum aggregate size to 25 mm 1 inch.

****

2.1.2.1 Aggregate for Cement Treated Base

Provide aggregate consisting of crushed or uncrushed gravel and/or stone, free of roots, sod, and weeds, meeting the requirements below:

a. Plasticity index of less than 6 and liquid limit less than 25 in accordance with ASTM D4318.
b. Percentage of wear less than 40 percent in accordance with ASTM C131/C131M.
c. Soundness loss after 5 cycles of 10 percent maximum using Sodium Sulfate or 15 percent maximum using Magnesium Sulfate in accordance with ASTM C88.
d. Flat, elongated or flat and elongated particles 10 percent maximum, by weight, for fraction retained on the 12.5 mm 1/2 inch sieve and 20 percent maximum, by weight, for the fraction passing the 12.5 mm 1/2 inch sieve in accordance with ASTM D4791.
e. Clay lumps and friable particles less than or equal to 3 percent in accordance with ASTM C142/C142M
f. Test virgin crushed stone or gravel sources for alkali-aggregate reactivity in accordance with ASTM C1260, and reject materials having a measured expansion greater than 0.10 percent in 16 days.
g. Gradation meeting the limits of Table 2, in accordance with ASTM C117 and ASTM C136/C136M.

TABLE 2

Sieve Designation	Percent Passing By Weight
50 mm2 inch	100
25 mm1 inch	90-100
4.75 mmNo.4	45-95
2.00 mmNo. 10	37-80
425 micrometersNo. 40	15-50
75 micrometersNo. 200	0-15
Note: For Cement Treated Base under concrete surfacing, limit the 25 mm 1 inch size to 100 percent passing.	

2.1.2.2 Aggregate for Cement-Treated Subbase

****

NOTE: Evaluate native subgrade for potential sulfate reaction. If the soil has a water-soluble sulfate content greater than 0.10 percent, by weight, do not use cement stabilization for subbase materials. Consult UFC 3-260-02, Chapter 9, for additional guidance for airfield projects.

****

[Aggregate materials conforming to ASTM D2487, classified as GW, GP, GM, SW, SM, SP or combination(s) thereof. Sample materials in accordance with ASTM D75/D75M. Plasticity index of less than 12 [_____] and liquid limit less than 25 [_____] in accordance with ASTM D4318. Perform sieve analysis in accordance with ASTM C117 and ASTM C136/C136M. Provide aggregates with a maximum size of 50 mm 2 inches and within the limits specified as follows:

TABLE 3	
Sieve Designation	Percent by Weight Passing
4.75 mm No. 4	55 - 100
2.00 mm No. 10	36 - 60
150 micrometers No. 100	3 - 20

]

2.1.3 Water

Provide water which is clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the hardening of the cement-stabilized mixture, and subject to approval. Test non-potable water sources for conformance with ASTM C1602/C1602M.

2.1.4 Curing Materials

****

NOTE: It may be advantageous to specify only bituminous curing for stabilized base courses which are to receive bituminous surfacing or to specify membrane forming curing compound for stabilized base courses which are to receive Portland cement concrete surfacing, in which case, other curing materials and methods will be deleted.

****

2.1.4.1 Burlap

Conforming to AASHTO M 182.

2.1.4.2 Impervious Sheeting

White waterproof paper, white opaque polyethylene film or white burlap-polyethylene sheets conforming to ASTM C171.

2.1.4.3 Bituminous Material

Asphalt emulsion conforming to ASTM D977, Type [RS-1] [SS-1] or ASTM D2397/D2397M Type [CRS-1].

2.1.4.4 Curing Compound

White-pigmented, liquid membrane-forming compound conforming to ASTM C309, Type 2, Class A or Class B (wax-based) for curing cement-stabilized mixture placed as a base course under Portland cement concrete pavement.

2.2 MIX DESIGN

****

NOTE: Designer should refer to UFC 3-250-11 for general guidance and UFC 3-260-02 for airfield pavement projects for further guidance on restrictions to be placed or requirements added to

the mix design paragraph, and information on applicability of stabilization with portland cement.

Remove bracket from selected choice and delete the others.

****

Submit proposed mix design, prior to start of stabilization work. Develop the mix using the aggregate or soil-aggregate material to be stabilized. Design mix for a minimum 7-day compressive strength of [[1.75 MPa 250 psi for subbase,][5 MPa 750 psi for base] under flexible pavement,][[1.37 MPa 200 psi for subbase][3.44 MPa 500 psi for base] under Portland cement concrete pavement. Avoid higher strength due to potential to cause shrinkage and reflective cracks.] Limit weight loss to 14 percent or less after 12 cycles of the durability test.

2.2.1 Laboratory Density

Conduct moisture-density tests in accordance with the procedure contained in ASTM D558/D558M. Use the apparatus and procedures outlined in ASTM D1557 to compact the cement-stabilized mixture.

2.2.2 Unconfined Compression

Conduct three unconfined compression tests, in accordance with ASTM D1633, for each mix design tested. Prepare specimens to be used for unconfined compression tests in accordance with ASTM D1632. Use a 100 mm 4 inch diameter by 200 mm 8 inch high mold to prepare specimens when more than 35 percent of the material is retained on the 4.75 mm No. 4 sieve. Cure samples at a constant moisture content and temperature for 7 days.

2.2.3 Durability

****

NOTE: Where the aggregate is an approved select material, the use of the test procedures conforming to ASTM D 559 and ASTM D 560 may be waived. For other soil-aggregates, consult ASTM C 33, Figure 1 for weathering region of project site. Conduct wet-dry and freeze-thaw durability tests for sites located in the severe weathering region.

****

[Conduct wet-dry tests in accordance with ASTM D559.] [Conduct freeze-thaw tests in accordance with ASTM D560.] Test three specimens for each mix design.

2.2.4 Mix Design Report

Perform trial design batches, mixture proportioning studies, testing, and include results demonstrating that the proposed mixture proportions produce cement-stabilized mixture of the qualities indicated. Submit test results in a mix design report to include:

a. Coarse and fine aggregate gradations and plots.
b. Coarse aggregate quality test results, include deleterious materials.
c. Fine aggregate quality test results.
d. Durability test results.
e. Mill certificates for cement and supplemental cementitious materials.

f. Recommended proportions and volumes for proposed mixture.
g. Moisture-density curve for selected cement content.
h. Individual compressive strength test results.
i. Narrative discussing methodology on how the mix design was developed.

2.3 EQUIPMENT

****

NOTE: Specify a Central Plant for mixing cement-treated base and delete the pulvimixer and traveling plant provisions. For cement-treated subbase, retain central plant, pulvimixer, and traveling plant provisions.

****

Plant, equipment, machines, and tools used in the work are subject to approval. Maintain in a satisfactory working condition at all times. Provide equipment with the capability of producing the required compaction, meeting grade controls, thickness control and smoothness requirements specified.

2.3.1 Central Plant

Provide a batch or continuous flow type central plant capable of producing a uniform cement stabilized mixture at the required cement and moisture contents. Equip the mixer with calibrated metering and feeding devices that introduce the aggregate, cement, water, and cementitious additives (if used) into the mixer in the specified quantities. If necessary, use a screening device to remove oversized material from the raw aggregate feed prior to mixing.

2.3.2 Mechanical Spreader

Provide a steerable, self propelled, mechanical spreader having variable speeds forward and reverse. Mount the spreader on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. Provide a spreader containing a hopper, an adjustable screed, and outboard bumper rolls; designed to have a uniform, steady flow of material from the hopper; and capable of laying material without segregation, across the full width of the lane, to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers conform to thickness and grade requirements indicated.

2.3.3 Pulvimixer

Provide self-propelled, four-wheel drive pulverizing and mixing equipment, capable of pulverizing the soil in a single pass for the full depth to be stabilized and providing a mixing action capable of uniformly blending and mixing the required cement content with the aggregate. Equip with a rotor capable of up or down cutting.

2.3.4 Traveling Plant

Provide a traveling plant capable of moving at a uniform rate of speed and accomplishing thorough mixing of the materials in one pass. Deliver water and cement from supply trucks or bins at a predetermined rate. Construct windrows of prepared cement stabilized mixture to cover a predetermined width to the indicated compacted thickness.

2.3.5 Rollers

Compact the cement stabilized mixture using one or a combination of the following pieces of equipment: tamping or grid roller; steel-wheeled roller; vibratory roller; pneumatic-tire roller, and/or vibrating plate compactor (for areas inaccessible to rollers). Compact the cement stabilized mixture to the required density using the number, type, and weight of rollers and/or compactors sufficient to compact the mixture to the required density.

2.3.6 Straightedge

Furnish and maintain at the site, in good condition, one [3.0] [3.7] meter [10] [12] foot straightedge for use in the testing of the finished surface. Make straightedges available for Government use. Construct straightedges of aluminum or other lightweight metal with blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Provide handles on straightedges to facilitate movement on pavement.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Do not apply cement if the soil moisture content exceeds optimum moisture content specified for the cement-stabilized mixture. When the stabilized course is constructed in more than 1 layer, clean the previously constructed layer of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Provide adequate drainage during the entire construction period to prevent water from collecting or standing on the areas to be stabilized or on pulverized, mixed, or partially mixed material. Provide line and grade stakes as necessary for control. Place grade stakes in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF BORROW PITS

****

NOTE: Paragraph will be deleted when select material is not required or when small quantities do not justify the inclusion of select material.

****

[Clear, strip, and excavate borrow pit working depth in a manner that produces excavation faces that are as nearly vertical as practicable for the materials being excavated. Waste strata of unsuitable materials overlying or occurring in the deposit. Upon completion of the work, condition pit to drain readily, and leave in a satisfactory condition.] [Obtain borrow material from approved offsite sources.]

3.3 STOCKPILING MATERIALS

****

NOTE: Delete this paragraph when select material is not required or when small quantities do not justify the inclusion of select material.

****

Stockpile select material, including approved material available from excavation and grading, in the manner and at the locations designated. Before stockpiling of material, clear, drain and level the storage sites. Separately stockpile materials obtained from different sources.

3.4 PREPARATION OF AREA TO BE STABILIZED

****

NOTE: Delete inapplicable paragraph.

****

Clean debris from area to be stabilized; inspect for adequate compaction; and ability to withstand, without displacement, the compaction specified for the cement stabilized mixture. Dispose of debris and removed unsatisfactory in-place material as specified.

3.4.1 In-Place Material to be Stabilized

Grade the entire area to be stabilized and shape to conform to the lines, grades, and cross sections shown in the plans, prior to being processed. Stabilize soft or yielding areas before construction is begun.

3.4.2 In-Place Materials to Receive Stabilized Course

****

NOTE: If this paragraph is retained, delete inapplicable portions.

****

[Correct soft, yielding areas and ruts or other irregularities in the surface. Loosen material in the affected areas and remove unsatisfactory material. Add approved select material where directed. Shape the area to line, grade, and cross section, and compact to the specified density.] [Conform Subgrade to Section 31 00 00 EARTHWORK.] [Conform Subbase course to Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING].]

3.4.3 Select Material

****

NOTE: Delete if select material is not required.

****

Utilize sufficient select material to provide the required thickness of the cement stabilized mixture layer after compaction and process to meet the requirements specified before cement stabilization is undertaken.

3.5 INSTALLATION

****

NOTE: For base courses using imported select material, specify central plant mixing and delete requirements for in-place materials, traveling plant, and in-place mix method. For native soil subbase courses, retain all methods as a contractor option.

****

3.5.1   Edges of Stabilized Course

Placed approved material along the edges of the cement-stabilized mixture in such quantity as will compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 300 mm 1 foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the cement-stabilized mixture.

3.5.2   Mixed-in-Place Method

3.5.2.1   Scarifying and Pulverizing of Soil

Prior to the application of cement, scarify and pulverize the soil [to the depth shown] [to a depth of [_____] mm inches]. Carefully control scarification so that the layer beneath the layer to be stabilized is not disturbed. Do not pulverize to a depth exceeding the depth of scarification. Unless otherwise permitted, do not scarify and pulverize an area greater than can be completed in 2 working days.

3.5.2.2   Application of Cement

Approximately shape pulverized material to the cross section indicated. Apply cement so that when uniformly mixed with the soil, the specified cement content is obtained, and a sufficient quantity of cement-treated soil is produced to construct a compacted cement-stabilized mixture conforming to the lines, grades, and cross section indicated. Do not pass over the freshly spread cement-stabilized mixture, except for equipment used in spreading and mixing operations.

3.5.2.3   Dry Mixing

Immediately after the cement has been distributed, mix with the soil. Do not mix below the required depth. Continue mixing until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied.

3.5.2.4   Water Application and Moist Mixing

Determine moisture content of the cement stabilized mixture immediately after completion of mixing of the soil and cement. Provide water-supply and pressure distributing equipment that will permit the continuous application within 3 hours of all water required on the section being processed. Incorporate water in the mix so that concentration of water near the surface does not occur. After all the mixing water has been added, continue mixing until the water is uniformly distributed throughout the full depth of the mixture, with no portion of the mixture remaining undisturbed during mixing for more than 30 minutes. Dispose of any portion of the cement stabilized mixture remaining undisturbed more than 30 minutes during mixing.

3.5.3   Central-Plant Method

Haul the cement stabilized mixture to the job in trucks equipped with protective covers. Thoroughly moisten the underlying course and deposit the material on the prepared area in a quantity that will produce a compacted base of uniform density to the required grade and cross section. Operate spreading or spreading-trimming equipment to produce a layer of material which is uniform in thickness and surface contour and free from irregularities in density. Use spreading or spreading-trimming equipment in sufficient numbers and in staggered formation to obtain full-width spreading in one construction operation. Start the compaction of the treated layer within 60 minutes after the start of the moist mixing. Place cement stabilized mixture in adjacent lanes within 30 minutes.

3.5.4 Traveling-Plant Method

Move traveling plant at a uniform rate of speed to accomplish thorough mixing of the materials. Deliver water and cement from supply trucks or bins at a predetermined rate. Construct windrows of prepared cement stabilized mixture of sufficient size to cover a predetermined width to the indicated compacted thickness.

3.5.5 Layer Thickness

Compact thickness of the cement-stabilized mixture [as indicated] [to [_____] mm inches]. Do not compact layers in excess of 200 mm 8 inches nor less than 100 mm 4 inches in compacted thickness.

3.5.6 Compaction

****

NOTE: Density will be based on the material being stabilized.

****

As a continuation of the mixing operation, thoroughly loosen the mixture to the full depth before compaction operations are started. At the beginning of compaction, process the mixture to provide a uniform blend with 100 percent passing the specified maximum aggregate size. Start compaction immediately after mixing is completed. Compact the cement stabilized mixture to at least 98 [_____] percent of the maximum density obtained from the laboratory samples prepared and tested in accordance with paragraph: LABORATORY DENSITY. Uniformly and continuously compact the loose mixture until the entire depth and width of the area are compacted to the density specified. Maintain the moisture content at the surface near optimum at all times through the rolling, but less than that quantity which will cause the cement stabilized mixture to become unstable during compaction. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Use slightly different lengths on alternate trips of the roller. Do not permit displacement of the cement stabilized mixture due to the speed of the roller. Compact areas inaccessible to rollers with mechanical tampers.

3.6 FINISHING

Moisten the surface, if necessary, and shape to the required lines, grades, and cross section. Lightly scarify the surface, if necessary, to eliminate any imprints made by the compacting or shaping equipment. Thoroughly compact the surface to the specified density with rubber-tired rollers and smooth-wheel tandem rollers to the extent necessary to provide a smooth, dense, uniform surface that is free of surface checking, ridges, or loose material, and that conforms to the crown, grade, and line indicated. Complete these finishing operations within 2 hours after completion of mixing operations. In places not accessible to finishing and shaping equipment, compact the cement-stabilized mixture with mechanical tampers to the density specified and shape and finish by hand methods. Correct, as specified below, any portion of the compacted mix that has density less than that specified, that has not properly hardened, or that is improperly finished.

3.7 CONSTRUCTION JOINTS

At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to form a true vertical face free of loose or shattered material. Remove material along construction joints not properly compacted and replace with cement stabilized mixture mixed, moistened, and compacted as specified.

3.8 CURING AND PROTECTION

****

NOTE: Coordinate curing requirements with materials selection in Part 2. Delete Bond Breaker if the stabilized base will not be overlaid with Portland cement concrete.

****

Protect the finished surface against rapid drying for 7 days by one of the methods specified.

3.8.1 Burlap

Provide burlap consisting of 2 or more layers of burlap having a combined weight of 400 grams 14 ounces or more per square meter square yard in a dry condition. Provide burlap that is either new or used only for curing concrete. Provide burlap strips with a length, after shrinkage, of at least 300 mm 1 foot greater than necessary to cover the entire width and edges of the finished stabilized area. Overlap mats at least 150 mm 6 inches. Thoroughly wet mats before placing and keep continuously wet and in contact with the surface and edges of the finished stabilized area for the entire curing period.

3.8.2 Impervious Sheeting

Moisten the surface of the finished stabilized area with a fine spray of water and then cover with impervious sheeting. Thoroughly saturate the burlap of the polyethylene-coated burlap with water before placing. Place sheeting with the light-colored side up. Extend sheets over the edges of the stabilized area and hold securely in place throughout the curing period. Overlap edges of sheets each other at least 300 mm 12 inches and securely glue or tape to form continuous closed joints. Repair tears and holes in sheets immediately.

3.8.3 Bituminous Material

****

NOTE: The last sentence will be deleted if sanding and dusting of the bituminous-cured surfaces is not required or if bituminous-cured surfaces are to receive bituminous surfacing under the contract.

****

Apply bituminous material uniformly by means of a bituminous distributor within a temperature range of 25 to 55 degrees C 75 to 130 degrees F, as directed. Uniformly apply bituminous material at the residual asphalt content rate of 0.7 to 1.4 L/square meter 0.15 to 0.30 gallon/square yard. Treat areas inaccessible to or missed by the distributor using the manually operated hose attachment. Apply bituminous material only to the top layer. At the time the bituminous material is applied, provide a surface free of loose or foreign matter and containing sufficient moisture to prevent excessive penetration of the bituminous material. When necessary, apply water in sufficient quantity to fill the surface voids immediately before the bituminous material is applied. [Sand or dust treated surface to prevent the bituminous material from being picked up by traffic.]

3.8.4 Liquid Membrane Forming Curing Compound

Uniformly spray the surface of the cement treated base course with the curing compound at the rate of 3.8 L/9.3 square meter one gallon/100 square feet to obtain a uniform cover over the surface. Provide spraying equipment of the fully atomizing type equipped with a tank agitator. Thoroughly and uniformly mix the curing compound with the pigment in the storage tank. During application, stir the compound continuously by mechanical means. Hand spray odd widths or shapes and surfaces.

3.8.5 [Bond Breaker]

[Within 8 to 24 hours before concrete pavement placement, coat the surface of the cement treated base course with an additional application of wax-based liquid membrane forming curing compound applied in a quality sufficient to prevent bonding of the concrete pavement to the base course.]

3.9 FIELD QUALITY CONTROL

3.9.1 Grade Control

Excavate underlying material to sufficient depth for the required stabilized-course thickness. Provide a finished stabilized course with the subsequent surface course meeting the fixed grade. Conform finished and completed stabilized area to the lines, grades, cross section, and dimensions indicated and the tolerances of Table 1. Correct deviations exceeding the tolerances by removing and replacing the cement-stabilized mixture. Do not permit skin patching of deficient areas.

3.9.2 Smoothness Test

****

NOTE: For subbase stabilization, paragraph should be deleted.

****

Take measurements for deviation from grade and cross section in successive positions parallel to the road centerline with a straightedge. Also take measurements perpendicular to the road centerline at [15] [_____] meter [50] [_____] foot intervals. Correct deviations exceeding the tolerances of Table 1 by removing and replacing the cement-stabilized mixture. Do not permit skin patching of deficient areas.

3.9.3 Thickness Control

****

NOTE: Thickness allowance may be modified to 6 mm 1/4 inch when the course thickness is 150 mm 6 inches or less. The designer may describe the sampling, testing, and approval considered necessary for a particular project.

****

Measure the thickness of the cement stabilized mixture at intervals which ensure one measurement for each [400] [_____] square meters [500] [_____] square yards of cement stabilized mixture. Make measurements in 75 mm 3 inch diameter test holes penetrating the cement stabilized mixture. Where the measured thickness exceeds the tolerances of Table 1, correct such areasby removing and replacing the cement-stabilized material. Where the measured thickness is more than 13 mm 1/2 inch thicker than indicated, the course will be considered as conforming with the specified thickness requirements. Calculate the average job thickness as the average of all thickness measurements taken for the job, but within the tolerances of Table 1.

3.9.4 Field Density

Perform field density tests in accordance with ASTM D1556/D1556M or ASTM D6938. Use ASTM D6938 to determine the moisture content of the soil. ASTM D6938 results in a wet unit weight of soil. Check calibration curves furnished along with the density gauge described in ASTM D6938. Make calibration checks of the density gauge at the beginning of a job on each type of material encountered. If ASTM D6938 is used, check in-place densities by ASTM D1556/D1556M at least once per lift for each 850 [_____] square meters 1000 [_____] square yards of stabilized material. Perform at least 1 field density test for each [200] [_____] square meters [250] [_____] square yards of each layer of cement-stabilized mixture.

3.9.5 Compressive Strength

Test composite sample of cement stabilized mixture for compressive strength. Fabricate three test cylinders for each set of tests in accordance with ASTM D558/D558M, Method A or B (as appropriate), cure and test according to ASTM D1632 and ASTM D1633. Test specimens for compressive strength at 7 days, and submit results. If the average of the three compressive strengths is less than 350 kPa 50 psi below the required strength, stop operations and adjust the mix design. If the average of the three compressive strengths is more than 350 kPa 50 psi below the required strength, remove and replace the area represented by the failing tests, as directed. Take samples not less than once a day, nor less than once for each [380] [_____] cubic meters [500] [_____] cubic yards of cement stabilized mixture.

3.9.6 Sieve Analysis

****

NOTE: Delete reference to source of material when select material is not required and edit submittal requirements accordingly.

****

Perform a minimum of one analysis for each [1000] [_____] metric tons tons of material to be stabilized, with a minimum of 3 analyses for each day's run until the course is completed. When the source of materials is changed or deficiencies are found, repeat the analysis and retest the material already placed to determine the extent of unacceptable cement-stabilized mixture. Replace all in-place unacceptable cement-stabilized mixture.

3.9.7 Liquid Limit and Plasticity Index

Perform one liquid limit and plasticity index for each sieve analysis. Test for liquid limit and plasticity index in accordance with ASTM D4318.

3.9.8 Maintenance

Maintain the cement-stabilized mixture in a satisfactory condition until the completed work is accepted. Perform immediate repairs to any defects and repeat as often as necessary to keep the area intact. Repair defects as specified.

3.9.9 Traffic

Completed portions of the cement stabilized mixture may be opened immediately to light traffic provided the curing is not impaired. After the curing period has elapsed, completed areas may be opened to all traffic provided that the cement-stabilized mixture has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment will not be permitted on the area during the curing period. Cement and water may be hauled over the area with pneumatic-tired equipment as approved. Protect finished portions of cement-stabilized mixture that are traveled on by equipment used in constructing an adjoining section in a manner that prevents equipment from marring or damaging the completed work.

3.10 DISPOSAL OF UNSATISFACTORY MATERIALS

Dispose of removed in-place materials that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris [as directed] [in disposal area indicated].

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 11 36.13 (November 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-32 11 36.13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-32 11 36.13 (November 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-32 11 36.13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 11 36.13

LEAN CONCRETE BASE COURSE
11/19

****

NOTE: This guide specification covers the requirements for lean concrete base course for portland cement concrete pavement.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Lean concrete is composed of a lean concrete mix and is not recommended for use in flexible pavement structures. Some paragraphs may need to be supplemented or modified to meet the project requirements. The extent of the work to be accomplished should be indicated on the project drawings or included in the project specifications.

****

****

NOTE: On the drawings, show:

1. Paving Plan, showing horizontal dimensions; locations with respect to existing structures; and new and existing ground contours.

2. Sections of pavement structures showing thicknesses and details.

3. Location and character of all joints.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams

	of Concrete
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174/C174M	(2017) Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars

ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 81-123	(1981) Occupational Health Guideline for Chemical Hazards, (Vols. I, II, and III)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.1153	Respirable Crystalline Silica

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-05 Design Data

Mix Design

At least 30 days prior to mixing and placing lean concrete, submit the design mix for approval. Provide a complete list of materials including type, brand, source and amount of cement, pozzolan, ground granulated blast-furnace slag, admixtures, reference specifications, and results of 28-day compressive strength test of the lean concrete. Prepare compressive strength test specimens in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M.

SD-06 Test Reports

Mix Design Review

Aggregate Testing

Slump

Air Content

Concrete Temperature

Yield

Surface

Base Course Thickness

Compressive Strength

Submit testing results as required in paragraph entitled "Field Quality Control."

SD-07 Certificates

Ready-mix Concrete Plant Identification

Batch Ticket Information

Cement

Aggregates

Admixtures

Curing Materials

1.3 DELIVERY

Do not deliver lean concrete until ready for placement.

1.4 STORAGE

1.4.1 Cement, Aggregate, and Admixture Materials

Store in accordance with recommendations of ACI 304R.

1.4.2 Curing Compounds and Bond Breaker

Inspect materials for contamination and damage. Unload and store with a minimum of handling.

1.5 QUALITY ASSURANCE

1.5.1 Required Information

Submit name and location of the ready-mix concrete plant. Submit batch ticket information as specified in ASTM C94/C94M.

1.5.2 Required Review

Before lean concrete is placed at the job site, submit a mix design review accomplished by a Government-approved independent commercial engineering testing laboratory. Include cement factor, standard deviation of compressive strength used in the design of the mix, water-cement ratio (by weight), percentage of fine aggregate to total aggregate by weight, weight in kg lbs of saturated surface-dry aggregates (fine and coarse) per sack of cement, volume of admixtures and yield for 1 cubic m 1 cubic yd of concrete.

1.6 SAFETY

In addition to Safety Requirements contained in the Contract Clauses; prevent employee respiratory, eye or skin contact with Portland cement and silica dust in accordance with 29 CFR 1926.1153 during wet or dry mixing. Provide and require employees to use and dispose or clean the following in accordance with the pertinent provisions of NIOSH 81-123:

a. Impervious clothing, boots and gloves.

b. Splash-proof safety googles and face shields.

c. Respiratory protection equipment.

PART 2 PRODUCTS

2.1 MIX DESIGN

Specify the mix design under paragraph SUBMITTALS and conform to the following specifications.

****

NOTE: Specify an upper limit on compressive strength when reflective cracking is a concern.

****

a. 28-day compressive strength MPa psi: 8 1200 minimum.

b. Cement factor kg per cubic m lbs. per cubic yd: 120 200 minimum.

The minimum cement factor indicated is for concrete durability only; increase to meet minimum compressive strength requirements.

****

NOTE: Specify 7 percent minimum air content when lean concrete is exposed to freeze-thaw cycle.

****

c. Air content (percent by volume): [4] [7] minimum.

d. Water-cement ratio: [0.6] [_____] maximum.

e. Slump: 25 mm 1 in minimum to 75 mm 3 in maximum for fixed form; 38 mm 1-1/2 in maximum for slip-forming.

****

NOTE: In locations subject to freeze-thaw cycles, insert the following, "Do not allow the freeze-thaw weight loss to exceed 14 percent when testing in accordance with AASHTO T 136."

****

2.2 MATERIALS

2.2.1 Cement

****

NOTE: Allowable types of cement are:

ASTM C150/C150M Portland	**ASTM C595/C595M Blended**	**Use**
Type I	**Type IP or IS**	**For general use in construction.**
Type II	**Type IP (MS) or Type IS (MS)**	**For general use in construction where concrete is exposed to moderate sulfate action or where moderate heat of hydration is required. ASTM C595/C595M (blended hydraulic cements): add the suffix MS or MH where either moderate sulfate resistance moderate heat of hydration, respectively, is required.**
Type III		**For use when high early strength is required.**
Type IV		**For use when low heat of hydration is required.**

ASTM C150/C150M Portland	**ASTM C595/C595M Blended**	**Use**
Type V		**For use when high sulfate resistances is required.**
Require cement to meet low alkali requirements of ASTM C150/C150M, Table 1A, when using potential alkali-reactive aggregates.		

NOTE: Do not use ASTM C595/C595M blended hydraulic cements on WESTNAVFACENGCOM airfield pavement projects without consulting WESTNAVFACENGCOM Code 411.

****

ASTM C150/C150M, Type(s) [I] [II] [I or II] [Type III, for high early strength concrete] [_____]. [ASTM C595/C595M, Type IS or IP.]

2.2.2 Water

Use water in accordance with ASTM C1602/C1602M. Do not use hot water.

2.2.3 Aggregates

Use stone or gravel, crushed or uncrushed[, or crushed Portland cement concrete pavement]. Use fine aggregate that is naturally contained in the aggregate material or sand. Use aggregates consisting of hard, durable particles, free from objectionable matter.

2.2.3.1 Gradation

Use aggregate in compliance with one of the gradations shown in Table 1 when tested in accordance with ASTM C136/C136M. Allow the gradation to be modified to suit [locally available aggregate] [recycled Portland cement concrete pavement], provided the strength requirements are met.

TABLE 1 - AGGREGATE GRADATION - LEAN CONCRETE BASE COURSE

	Percentage by Weight Passing Sieves		
Sieve Sizes	A	B	C
50 mm 2 in.	100	---	---
37.5 mm 1 1/2 in.	---	100	---
25.0 mm 1 in.	55-85	70-95	100
19.0 mm 3/4 in.	50-80	55-85	70-100
4.75 mm No. 4	30-60	30-60	35-65
425 micrometers No. 40	10-30	10-30	15-30

TABLE 1 - AGGREGATE GRADATION - LEAN CONCRETE BASE COURSE			
	Percentage by Weight Passing Sieves		
Sieve Sizes	A	B	C
75 micrometers No. 200	0-15	0-15	0-15

2.2.3.2 Deleterious Substances

Do not permit aggregates to contain substances which are deleteriously reactive with the alkalies in the cement, except as permitted in ASTM C33/C33M using the test methods in ASTM C1260.

2.2.4 Admixtures

****

NOTE: Admixtures are used in concrete to improve the concrete or to provide sound concrete under conditions where it would be burdensome to do so without use of an admixture.

1. Air entraining agents. Specify air entrainment for all concrete, particularly that exposed to freezing and thawing and sulfates and for seawater exposed concrete. Air entrainment improves the workability of plastic concrete.

2. Retarders. Retarding admixtures act to slow the hardening of concrete in hot weather. Permit use of approved retarders.

3. Water reducers. Water reducing admixtures are used to improve the quality of concrete, obtain specified strength at lower water-cement ratios or to increase the slump of a given mixture without increase in water content. Permit use of approved water reducing admixtures.

4. Accelerators. Calcium chloride and non-calcium chloride types are available. When added to the concrete acts to accelerate the hardening of concrete in cold weather. Do not permit calcium chloride accelerators for seawater exposed concrete, reinforced concrete and in concrete in contact with aluminum or other non-ferrous materials.

5. Pozzolans. Due to EPA guidelines, allow the use of fly ash, either in blended cements or as an admixture, as an optional material unless it can be shown that use of fly ash is technically inappropriate. Pozzolans are used to replace or augment cement in concrete mixes. In general, it allows less cement to be used to achieve the required strength although the time required to reach the required strength may be longer than for a totally Portland cement concrete mix. Use Class F for sulfate resistant concrete. Do not use fly ash

as a substitute for Portland cement on WESTNAVFACENGCOM airfield pavement projects without consulting WESTNAVFACENGCOM Code 411.

****

Where not shown or specified, allow admixtures to be used subject to written approval.

2.2.4.1 Air-Entraining Admixtures

ASTM C260/C260M.

2.2.4.2 Retarding Admixtures

ASTM C494/C494M, Type B or D.

2.2.4.3 Water-Reducing Admixtures

ASTM C494/C494M, Type A, D, E, F, or G.

2.2.4.4 Accelerating Admixtures

ASTM C494/C494M, Type C.

2.2.4.5 Pozzolans

Class N, F, or C ASTM C618, except that the maximum allowable loss on ignition is 6 percent for Classes N and F.

2.2.4.6 Ground Granulated Blast-Furnace Slag

ASTM C989/C989M, Grade 120.

2.2.5 Curing Materials

2.2.5.1 Waterproof Paper

ASTM C171, white color.

2.2.5.2 Polyethylene Sheeting

ASTM C171, white color.

2.2.5.3 Polyethylene-Coated Burlap

ASTM C171.

2.2.5.4 Liquid Membrane-Forming Compound

ASTM C309, white-pigmented Type 2, Class B, or clear or translucent Type 1-D, Class B with white fugitive dye.

2.2.6 Bond Breaker

Liquid membrane-forming curing compound as specified.

PART 3 EXECUTION

3.1 PREPARATION

Before placing lean concrete, compact underlying surface to within 13 mm 1/2in of finish grade and elevations shown in drawings. Wet underlying material in advance of placing lean concrete to ensure a firm, moist condition at time lean concrete is placed. Do not permit equipment, other than lean concrete delivery or paving equipment on prepared underlying material. In cold weather, protect underlying material from frost. Do not use chemicals to eliminate frost.

3.2 FIXED FORMS

Set forms for full bearing on foundation for entire length and width and in alignment with edge of base course. Support forms during entire operation of placing, consolidation, and finishing. Do not allow the maximum vertical and horizontal deviation of forms, including joints, to exceed 6 mm 1/4 in from a 3.7 m 12 ft straightedge. Provide stake sockets and interlocking devices to prevent movement of the forms.

3.3 JOINTS

Locate joints as required to provide a minimum of 150 mm 6 in from joints in overlying surface course.

3.4 MEASURING, MIXING, AND TRANSPORTING LEAN CONCRETE

****

NOTE: Include bracketed sentence except for projects at MCB Camp Pendleton.

****

Use ASTM C94/C94M, except as modified. Provide batch ticket information for each load of lean concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place lean concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 29.5 degrees C 85 degrees F.[Reduce placement time to 60 minutes if the air temperature is greater than 29.5 degrees C 85 degrees F.] Permit additional water to be added, provided that both the specified maximum slump and water-cement ratio are not exceeded.

3.5 PLACING LEAN CONCRETE

3.5.1 General

Do not permit lean concrete placement when weather conditions prevent proper placement and consolidation. Maintain drainage ditches, gutters and side drains to drain the subgrade during the construction of the base. Place lean concrete in one continuous operation for the full width and depth of the section between transverse joints with slip or fixed form equipment.

3.5.2 Lean Concrete Placement

Deposit lean concrete in its final location within the time limits specified and before initial set. Deposit the lean concrete in a manner that requires a minimum of re-handling. Complete work incidental to handling and placing of lean concrete in a manner that does not damage the underlying surface. Place lean concrete continuously at a uniform rate without unscheduled stops except for equipment failure or other emergencies. Avoid contamination of lean concrete with foreign material on construction equipment or workman's footwear. Use shovels to spread lean concrete by hand not with rakes.

3.5.3 Consolidation

Consolidate immediately after spreading with internal vibrating equipment. Limit duration of vibration to produce consolidation of concrete. Do not permit excessive vibration.

3.5.4 Cold Weather

Do not permit lean concrete temperature to fall below 10 degrees C 50 degrees F. Do not place lean concrete when the ambient temperature is below 4.5 degrees C 40 degrees F. Cover lean concrete and provide with a source of heat sufficient to maintain 10 degrees C 50 degrees F minimum while curing. Adhere to practices recommended in ACI 306R.

3.5.5 Hot Weather

Do not permit lean concrete temperature to exceed 32 degrees C 90 degrees F starting at time of batching and extending for a period of seven days. Cool ingredients before mixing, or substitute chip ice for part of required mixing water or use other suitable means to control lean concrete temperature to prevent rapid drying of newly placed lean concrete. Shade the fresh lean concrete and start curing as soon as the surface is sufficiently hard to permit curing without damage. Adhere to practices recommended in ACI 305R.

3.5.6 Protection Against Rain

Halt mixing and batching operations and cover unhardened lean concrete surface when rain is falling in the locale where the lean concrete is being placed. Extend the length of base to be protected back to a point where rain is not indenting base surface.[When slipform construction is used, install side forms in areas of base where edge cannot otherwise be protected to prevent edge erosion.] After rain ceases, install side forms as required to prevent excessive edge slump, and remove protective covering without delay. Remove remaining water without using cement. Refinish or replace areas damaged by rain at no additional cost to the Government.

3.6 FINISHING

Start lean concrete finishing operations immediately after consolidation. Use finishing machine. Permit hand finishing to be used in emergencies and for lean concrete in inaccessible locations or of such shapes that machine finishing is impracticable. Finish base surface on both sides of a joint to the same grade. Make as many finish trips over each area of base and at such intervals as necessary to retain coarse aggregate near finished surface, and produce a smooth surface true to grade and crown. Do not permit excessive operation over an area, which results in an excess of mortar and water being brought to the surface.

3.6.1 Surface Correction and Testing

After finishing is completed but while lean concrete is still plastic, use straightedges to eliminate minor irregularities and score marks. Use straightedges 3 m 10 ft in length and operated from sides of base and from bridges. Check surface for trueness with straightedge held in successive positions parallel and at right angles to centerline of pavement. Advance straightedge along pavement in successive stages of not more than one-half the length of the straightedge. Immediately fill depressions with freshly mixed lean concrete, strike off, consolidate, and refinish. Strike off and refinish projections above required elevation. Continue straightedge testing and finishing until entire surface of lean concrete is free of defects and meets specified requirements.

3.6.2 Surface Finish

Apply a uniform, smooth surface finish to lean concrete base. Do not allow textured surface.

3.7 CURING AND PROTECTION

Protect lean concrete from injurious action by sun, rain, flowing water, frost, or mechanical injury. At completion of finishing and at the time lean concrete surface has hardened enough to prevent the surface being marred by the curing material, cure by one or more of the following methods. Use fresh water for curing. Keep base moist and at a temperature above 0 degree C 32 degrees F, for a full curing period of 7 days. Protect lean concrete base from damage during removal of form work and from injury resulting from storage or transportation of materials and equipment during construction. Protect exposed vertical faces of lean concrete with curing compound or by other suitable means.

3.7.1 Moist Curing

Wet lean concrete surface with a fine spray of water and cover with waterproof paper, polyethylene-coated burlap, or polyethylene sheeting. Saturate polyethylene-coated burlap with water before placing. Select size of sheets that are at least 300 mm 1 ft longer than necessary to cover the entire width and edges of base. Place sheets with light-colored side up. Overlap adjacent sheets not less than 300 mm 1 ft with the lapped edges securely weighted down or the sheets lapped 150 mm 6 in and cemented or tapered to form a continuous cover and a closed joint. Weight cover down to prevent displacement or billowing from winds. Fold coverings down over the exposed edges and secure with a continuous bank of earth or other approved means. Use covers in good condition when placed and immediately repair tears and holes that occur during the 7-day curing period.

3.7.2 Liquid Membrane-Forming Compound Curing

Apply compound immediately after surface loses its water sheen and has a dull appearance. Mechanically agitate curing compound during use. Apply at a maximum rate of 5.0 square m/L 200 square ft/gal of compound. If compound lacks a uniform continuous, coherent films, or exhibits checks, cracks, peels, or pinholes, apply an additional coat of compound to areas where film is defective. Have readily available impervious sheet curing for use to protect freshly placed lean concrete in the event conditions occur to prevent correct application of compound at the proper time. Re-spray surfaces with curing compound after rainfall. Apply at same rate required above.

3.7.3 Protection of Treated Surfaces

Protect lean concrete surfaces from foot and vehicular traffic and other sources of abrasion for a minimum of 72 hours. Maintain continuity of applied curing method for the entire curing period.

3.8 BOND BREAKER

Prior to placement of overlying Portland cement concrete layer, coat the surface of the lean concrete base with a bond breaker to prevent bonding between the two layers. Use a bond breaker consisting of a double application of liquid membrane-forming curing compound. Use the rates specified for curing for each application . Allow the first application to be the lean concrete curing application. Place the second application no more than 24 hours prior to placement of the overlying surface course.

3.9 FIELD QUALITY CONTROL

3.9.1 Sampling

3.9.1.1 Aggregates

Sample aggregates prior to delivery to the batch plant. During lean concrete placement sample aggregates for each [500] [_____] metric tons [500] [_____] tons. Use sampling methods in accordance with ASTM D75/D75M. Identify each sample for conformance tests. When test results indicate that the aggregates consistently meet the specified gradation requirements, allow the rate of sampling to be reduced if approved.

3.9.1.2 Lean Concrete

Obtain random samples of plastic lean concrete in accordance with ASTM C172/C172M. Permit quality control samples to be taken at the lean concrete batch plant; however, obtain samples for verification of lean concrete slump and air content for submittal to the Government at the point of discharge. From each sample obtained, mold one set of compressive strength test specimens for laboratory testing in accordance with ASTM C39/C39M. Supplier may obtain samples of the lean concrete for quality control purposes; however, obtain random samples of the lean concrete at the point of discharge for field testing and report results to the Government in writing. Cast one set of concrete compressive strength test specimens for each random sample obtained. Determine sampling location (or timing) in accordance with ASTM D3665.

3.9.2 Testing

3.9.2.1 Aggregate Testing

Perform aggregate gradation testing on random samples obtained during the batching process. Perform additional aggregate and cement sampling and testing whenever there is a change of source or material deficiency.

3.9.2.2 Lean Concrete Testing

Perform laboratory testing on aggregates and cement samples from the materials to be used in the project prior to the start of construction. During construction perform additional laboratory testing at no cost to the Government if concrete strength deficiency or other material defect is reported. Adjust the concrete mix as necessary to obtain specified concrete compressive strength.

a. Slump: Measure the cement water ratio of lean concrete in accordance with ASTM C143/C143M. Determine slump of lean concrete at the start of each day's placement, on each random sample obtained, and for each set of concrete compressive strength test specimens cast.

b. Air content: Determine air content in accordance with ASTM C173/C173M or ASTM C231/C231M. Determine air content at the start of each day's lean concrete placement, on each random sample obtained, and for each set of concrete compressive strength test specimens. Report results in writing to the Government.

c. Concrete Temperature: Determine temperature of plastic lean concrete hourly at the point of discharge. During hot and cold weather periods, increase frequency of measurement as necessary to ensure concrete is placed within temperature specifications in ACI 305R.

d. Yield: Measure the yield in accordance with ASTM C138/C138M, twice for each day's production of lean concrete, and whenever materials or mix proportions are changed.

e. Surface: After curing, test the surface of the pavement with a straightedge or device to identify irregularities, if any. For a portion of the pavement containing irregularities greater than 0.6 mm in 3 m 1/4 in in 10 ft in a longitudinal or transverse direction, remove and replace the lean concrete, mechanically grind the lean concrete surface, or correct the surface using an approved method.

f. Base course thickness: Obtain 100 mm 4 in diameter core samples to determine the in place thickness of the lean concrete base course. Obtain cores in accordance with ASTM C42/C42M. Repair the core holes with non-shrink grout. The tolerance for any one core in a test section is 13 mm 1/2 in. The average of all core lengths within a test section must be the specified base material thickness indicated on the approved project drawings. When determining the average, assign cores with a length of more than 13 mm 1/2 in greater than the specified base thickness a length of the specified thickness plus 13 mm 1/2 in. If the measured base course thickness is less than that shown on the drawings by more than 13 mm 1/2 in, remove the deficient areas and replace with lean concrete of the specified strength, quality and thickness at no additional cost to the Government. When a core indicates unsatisfactory thickness, determine the limits of the base course to be removed and replaced as follows: Take one core 4.5 m 15 ft of the deficient location in both directions from the unsatisfactory core until satisfactory thickness is indicated; remove and replace base course for the full width of the lane where a core indicated unsatisfactory thickness. Determine length of cores in accordance with ASTM C174/C174M. Submit copies of each of the coring reports , in triplicate, and include the following information:

(1) Date lean concrete represented by core was placed.

(2) Date core was taken.

(3) Location of core - lane number, station number.

(4) Length of core.

(5) Condition of core - appearance, concrete texture, honeycombed.

(6) Disposition of core - In Contracting Officer or Contractor possession.

g. Compressive strength: ASTM C39/C39M. Fabricate four compressive strength test specimens per set in accordance with ASTM C31/C31M. Test one specimen at 7 days and three at 28 days. If the testing agency elects to cast 150 mm x 300 mm 6 in x 12 in test specimens only two specimens are required to be tested at 28 days; therefore, the set size may be reduced to three specimens. Sample lean concrete delivered to the jobsite, perform the prescribed field tests, and fabricate one set of compressive strength test specimens for every [380] cubic yds [500] cubic yds of lean concrete placed but not less than once for each day's placement. For evaluation purposes, use the average of all 28-day compressive strength test results for each set of specimens. If the average of the 28-day compressive strength test results for a set, or multiple sets, of specimens is below the specified minimum compressive strength by more than 690 kPa 100 psi, take a minimum of three ASTM C42/C42M core samples from the in-place work represented by the low test results and perform compressive strength tests. Consider the lean concrete test section represented by the core samples as acceptable if the average of the compressive strengths is at least the minimum specified compressive strength on the contract documents and that no core is more than 690 kPa 100 psi below the specified minimum compressive strength Retest locations represented by irregular core tests. Removed and replace at no cost to the Government the lean concrete sections failing to meet the specified minimum compressive strength after additional testing. Use additional coring and compressive strength testing as necessary at no additional cost to the Government to delineate areas requiring removal and replacement or remove the entire portion represented by the deficient set of specimens of subsequent test cores. Repair core holes with non shrink grout.

3.9.3 Acceptance

Base acceptance of lean concrete on compressive strength, thickness, grade and surface tolerance, as described in the previous section.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 12 13 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-32 12 13 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 12 13 (May 2024)**

Preparing Activity: USACE **Superseding**
UFGS-32 12 13 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 32 12 13

BITUMINOUS TACK[AND][PRIME] COATS
05/24

****
NOTE: This guide specification covers the requirements for bituminous tack and prime coats for airfield pavements, roads, parking areas and general paving needs.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Prime coats are a tailoring option and should be selected when required. Prime coats are required for Navy projects. If the designer for Army or Air Force projects chooses not to specify a prime coat at the time of design, remove the tailoring option for prime coat within this section. Generally a prime coat should be used but may be deleted in certain situations. For example, the prime coat may be deleted when it is necessary to reduce construction time or when a drainage layer is used underneath the hot mix asphalt. The primary purpose of prime coat is to protect the underlying layers from wet or inclement weather by providing a temporary waterproofing layer. Additional benefits from prime coat are stabilizing or binding the surface fines together and promoting bond to the asphalt pavement layers above, as well as acting as a dust palliative. It is recommended to specify asphalt prime coats when using thinner lifts (less than 4 inches) or when the construction sequence is such that the compacted base course will carry light

traffic. Moreover, conditions where a prime coat may be beneficial include: preventing lateral movement of the unbound base during pavement construction, reducing lateral movement of the asphalt mixture during compaction over the unbound material, waterproofing during pavement construction, and forming a tight base to which the asphalt pavement will adhere. Indicate prime coat on Drawings (typically on the pavement cross-sections) as well as specifying them herein.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

[1.1 UNIT PRICES

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NOTE: Delete unit price paragraphs when lump sum bidding is used. Edit submittal requirements accordingly.

****

1.1.1 Measurement

****

NOTE: The quantity of material will be the quantity of residual asphalt.

****

Payment for the bituminous material is to be paid from measured quantities of residual bituminous material used in the accepted work, provided that the measured quantities are not 10 percent over the specified quantities. Accepted work and measured quantities will be determined by the Government. Deductions from the measured quantities are applicable for any amount of bituminous material more than 10 percent over the specified quantity. For bituminous materials, express measured quantities in metric tons 2000 pound tons liters at 15.6 degrees C gallons at 60 degrees F. Correct volumes measured at temperatures other than 15.6 degrees C 60 degrees F in accordance with ASTM D1250 using a coefficient of expansion of 0.00045 per degree C 0.00025 per degree F for asphalt emulsion. Dilution water added to emulsified asphalt will not be measured for payment.

1.1.2 Payment

The quantities of bituminous material, determined as specified above, will be paid for at the respective contract unit prices. Payment will constitute full compensation for all operations necessary to complete the work as specified herein.

1.1.3 Waybills and Delivery Tickets

Submit waybills and delivery tickets, during progress of the work. Before the final payment is allowed, file with the Contracting Officer certified waybills and certified delivery tickets for all bituminous materials used in the construction of the pavement covered by the Contract.

]1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D8	(2022a) Standard Terminology Relatimg to Materials for Roads and Pavements
ASTM D88/D88M	(2007; R 2009; E 2019) Standard Test Method for Saybolt Viscosity
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D946/D946M	(2020) Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D1250	(2019; E 2020) Standard Guide for Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1
ASTM D2027/D2027M	(2019) Cutback Asphalt (Medium-Curing Type)
ASTM D2028/D2028M	(2015; R 2021) Cutback Asphalt (Rapid-Curing Type)
ASTM D2170/D2170M	(2018) Standard Test Method for Kinematic

	Viscosity of Asphalts (Bitumens)
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt
ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder

1.3 DEFINITIONS

See ASTM D8 for more definitions relating to this specification.

1.3.1 Prime Coat

Application of a low-viscosity asphalt material to an absorptive surface, such as an unbound granular layer, designed to penetrate, bond, temporarily weatherproof, and stabilize this existing surface and to promote adhesion between it and construction course that follows.

1.3.2 Tack Coat

Tack Coat is also referred to as bond coat. Tack coat is an application of bituminous material to an existing relatively nonabsorptive surface, such as existing densely graded asphalt mixture (milled or new), to provide a thorough bond between old and new surfacing.

1.3.3 Emulsion

Emulsion is also known as emulsified asphalt or asphalt emulsion. Mostly made of paving grade asphalt binder and water containing a small amount of emulsifying agent. Emulsifying agent may also be referred to as a surfactant. The purpose of the surfactant is to prevent the coalescence of the asphalt droplets and to keep them suspended independently in the water. Surfactants used in the emulsions can be produced with positive or negative charges resulting in anionic or cationic emulsions.

1.3.4 Diluted Emulsion

An emulsion that has been diluted by adding an additional amount of water equal to or less than the total volume of emulsion.

1.3.5 Residual Asphalt

The amount of asphalt binder remaining after all water has evaporated from an asphalt emulsion.

1.3.6 Shot Rate

Shot rate, also referred to as bar rate, is the application rate set by the computerized control system in the bituminous distributor for the cutback asphalt, asphalt binder, or the asphalt emulsion. This value is typically represented by units of l/m^2 g/yd^2.

1.3.7 Emulsion Break

Emulsion break, also referred to as break or breaking, is the initiation of asphalt binder droplets coalescing and water separating within the emulsion, at which point color begins to change from brown to black.

1.3.8 Emulsion Set

Emulsion set, also referred to as cure or curing, is the completion of emulsion breaking when water has evaporated, leaving behind a thin film of asphalt binder residue.

1.3.9 Certificate of Analysis (COA)

The COA is the manufacturer’s Certificate of Compliance (COC) including all applicable test results required by the specifications.

1.3.10 Certificate of Compliance (COC)

The manufacturer’s certification stating that materials or assemblies furnished fully comply with the requirements of the contract. Provide signed COC by the manufacturer’s authorized representative. The COC may also be referred to as the Bill of Lading.

1.3.11 Screenings

Screenings are a uniformly sized, fine, sandy material with some silt particles. The term screening is used to designate the finer fraction of crushed stone that accumulates after primary and secondary crushing and separation on a 4.75mm No. 4 sieve. Screenings commonly range in particle size from 3.2 mm 1/8 in down to finer than 0.075 mm No. 200 sieve. The size distribution, particle shape, and other physical properties can be somewhat different from one quarry location to another, depending on the geological source of the rock quarried, the crushing equipment used, and the method used for coarse aggregate separation. Screenings generally contain freshly fractured faces, have a fairly uniform gradation, and do not usually contain large quantities of plastic fines.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Equipment; G, [_____]

Distributor Radar or Distance Measurement Instrument (DMI) Calibration; G, [_____]

SD-03 Product Data

Waybills and Delivery Tickets

Prime Coat Certificate Of Analysis (COA); G, [_____]

Tack Coat Certificate Of Analysis (COA); G, [_____]

SD-06 Test Reports

Sampling and Testing

Application Rate Calibration; G, [_____]

Daily Application Rate Verification

SD-07 Certificates

Certificates Of Compliance (COC)

1.5 DELIVERY, STORAGE, AND HANDLING

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NOTE: If specifying asphalt emulsions, keep bracketed text. Cutback asphalt and asphalt binder can be reheated to the appropriate application temperature with minimal impact to the material.
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Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with minimal handling.[Do not allow asphalt emulsions to freeze or boil during transport or storage. Asphalt emulsions, if allowed to freeze or boil, may cause the asphalt emulsion to break. Remove this material from site if allowed to freeze or boil.]

1.6 ENVIRONMENTAL REQUIREMENTS

Apply bituminous coat only when the surface to receive the bituminous coat is dry. A limited amount of moisture (approximately 0.14 liter/square meter 0.03 gallon/square yard) can be sprayed on the surface of unbound material when prime coat is used to improve coverage and penetration of asphalt material. Apply bituminous coat only when the atmospheric temperature in the shade is 4 degrees C 40 degrees F or above and when the temperature has not been below 2 degrees C 35 degrees F for the 12 hours prior to application, unless otherwise directed.

PART 2 PRODUCTS

2.1 EQUIPMENT

Submit equipment, tools and machines used in the work. Maintain the equipment in satisfactory working condition at all times.

2.1.1 Bituminous Distributor

Provide a self propelled pressure distributor with pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the surface being sprayed. Provide a bituminous distributor capable of circulating and agitating the bituminous material during the heating process. The distributor truck is required to have a ground speed control device (radar or contact-wheel: DMI) interconnected with the asphalt pump such that the desired application rate will be supplied at any speed. Include with the distributor equipment a tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose or wand attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. A uniform double or triple overlap is required to be produced by the equipped spray bar. Equip the distributor and spray bar with an instantaneous shutoff. No dripping of material from the spray bar is allowed after shutoff.

Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled total liquid rates from 0.14 to 4.5 L/square meter 0.03 to 1.0 gallon per square yard, with a pressure range of 172.4 to 517.1 kPa 25 to 75 psi and with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths.

2.1.1.1 Distributor Radar or Distance Measurement Instrument (DMI) Calibration

The radar or DMI mounted on the distributor truck, which monitors the travel speed and distance traveled, will be calibrated within 6-months of performing the. Provide certification of radar or DMI calibration with date of calibration by an officer of the company that operates the distributor truck stating the radar or DMI has been calibrated per the distributor manufacture's instructions.

2.1.1.2 Sampling Device

Equip the bituminous distributor and transport tanks with a spigot-type sampling device.

2.1.1.3 Temperature Sensing Device

Equip the bituminous distributor and transport tanks with a minimum of 50 mm 2-inch dial type thermometer with a temperature range of 10 degrees C to 260 degrees C50 degrees F to 500 degrees F, with increments having resolution of 5 degrees C 25 degree F or finer. Locate the thermometer near the midpoint of the tank's length and within the middle third of the tank's height, or as specified by the manufacturer. Enclose the thermometer in a well with a protective window or by other means as necessary to keep the instrument clean and in the proper working condition.

2.1.2 Spray Bar Nozzles

On the spray bar, each nozzle is required to be a fan nozzle and be at the same spray angle as all other nozzles except for the outermost left and outermost right nozzle which will be a end nozzle (half-fan) such that the spray stays to the inside of the spray bar, unless otherwise approved by the Government. Orient the nozzles of the spray bar approximately 30-degrees from the axis of the spray bar, unless otherwise directed by the the equipment manufacturer. Provide nozzles on the spray bar that produce the same flow rate, at the same distance above the pavement. Change the nozzles on the spray bar, as appropriate, for the material being applied and when substantial adjustments are required to the application rate.

2.1.3 Heating Equipment for Storage Tanks

Use steam, electric, or hot oil heaters for heating the bituminous material. Fix an armored thermometer to the tank with a temperature range from 10 degrees C to 260 degrees C50 degrees F to 500 degrees F, with increments having resolution of 5 degrees C 25 degree F or finer so that the temperature of the bituminous material may be determined at all times.

2.1.4 Cleaning Equipment

Provide cleaning equipment suitable for removing and cleaning loose material from the pavement surface. If using street sweeper type equipment, equip the street sweeper with a water tank, dust control spray assembly, both a pick-up and gutter broom, and a debris hopper.

2.2 PRIME COAT MATERIAL

****

NOTE: Remove brackets from around the material to be allowed in the contract specifications and delete the other materials and references.

Cutback asphalts are a source of volatile organic compounds (VOC). These VOC result in some jurisdictions prohibiting the use of cutback asphalt. VOC emissions from cutback asphalt result from the evaporation of the petroleum distillate used to liquefy the asphalt binder. For prime coat, cutback asphalt penetrates the unbound material better than emulsion and hence is often preferred, if available. If specifying cutback asphalt, ensure no violation of local environmental policy occurs. If cutback asphalts are used, one of the following

types and grades is recommended (medium-curing type cutback asphalts are the most common type of cutbacks used as prime coat):

Cutback Asphalts Types and Standards for Prime Coat(1)		
Type	Standard Specification	Designation
Medium-Curing	ASTM D2027/D2027M	MC-70, MC-250
Rapid-Curing	ASTM D2028/D2028M	RC-70, RC-250
(1) Recommendations per ASTM D2399 (2021).		

Selection of a particular type and grade should consider the nature of the surface to be treated. An open base course material will be penetrated readily, and all of the above types and grades can be considered except for the low viscosity MC-30. A tight surface will not be penetrated as readily; therefore, the less viscous materials are recommended such as RC-70, MC-30, MC-70 and SC-70. Some caution might be urged in using RC-70 or RC-250 because the solvent may separate or be absorbed by the base course fines and leave the asphalt deposited on the surface.

The following types of emulsions can be used for prime coats. If using an asphalt emulsion, it is recommended that prime coats be limited to slow-setting emulsified asphalt as these will allow the greatest opportunity for penetration into the underlying course.

Slow-Setting emulsions are indicated with SS.

Emulsified Asphalt Types and Standards for Prime Coat(2),(3)		
Emulsified Asphalt Charge	Standard Specification	Designation
Anionic	ASTM D977	SS-1, SS-1h(1)
Cationic	ASTM D2397/D2397M	CSS-1, CSS-1h(1)
(1) Emulsions with the designation including "h" in the name indicates a hard asphalt binder, or more specifically, an asphalt binder with lower penetration. Harder binders are known to resist pick up from traffic better than softer (higher penetration) asphalt binders.		
(2) Other products in the market (e.g. solvent free prime coats) can be considered, if approved on the state agency's qualified/approved product list.		
(3) Recommendations per ASTM D3628 (2015; R2021).		

Some state DOT's use an asphalt emulsion that is designed for prime coat. It is normally referred to as EA-P (emulsified asphalt-prime)or AEP (Asphalt Emulsion Priming). Emulsions generally do not penetrate very much into the underlying layer (unbound base course) and these specially designed emulsions provide better penetration. This type of emulsion is preferred for prime coat if available. Check the approved product list (if available) on the State Agency/DOT website for EA-P prime coats before specifying.

Penetration and coating of prime coat material will be most efficient at approximately optimum moisture content. Water dilution of the emulsion is also sometimes required for prime coat to improve penetration but dilution of tack coat materials should not be allowed.

****

Provide the prime coat Certificate of Analysis (COA), including specific gravity, for the product specified below. COA's should be provided at preconstruction, prior to Application Rate Calibration, and any other COA's during production:

[2.2.1 Cutback Asphalt

Provide cutback asphalt conforming to[ASTM D2027/D2027M, Grade [MC-30] [MC-70] [MC-250]][ASTM D2028/D2028M, Grade [RC-70] [RC-250]].

][2.2.2 Emulsified Asphalt

Provide emulsified asphalt conforming to [ASTM D977, Type [SS-1] [SS-1h]] [ASTM D2397/D2397M, Type [CSS-1] [CSS-1h]][EA-P]. Asphalt emulsion can be diluted up to 1 part water to 1 part emulsion for prime coat use. Where prime coats are to be diluted, certify the dilution was done in accordance with the specific dilution requirements for each product and for each load of material used.

][2.3 TACK COAT MATERIAL

****

NOTE: Consider local practice as well as availability and cost of various grades within the area when evaluating alternate grades to be specified for the project.

Cutback asphalt has been used previously for tack coat applications. This specification has been edited to remove cutback asphalt for tack coats although it is still recommended in ASTM D2399. If required to use cutback asphalt for prime coat, RC-70 is recommended in the current edition of ASTM D2399. Emulsions and asphalt binders are preferred over cutback asphalts for use as tack coat.

Table EMULSIFIED ASPHALT TYPES AND STANDARDS FOR TACK COAT identify many different emulsion variants. The Designer will need to investigate the

needs of the project and determine what type of emulsified tack coat is appropriate for the project. The table below identifies examples of asphalt emulsions that are used for tack coats as recommended by ASTM D3628. In the market, there exist too many designations to list in this section. The following are only examples.

<table>
<tr><th colspan="4">Emulsified Asphalt Types and Standards for Tack Coat(4)</th></tr>
<tr><th>Type</th><th>Standard Specification(3)</th><th>Designation</th><th>Emulsified Asphalt Charge</th></tr>
<tr><td rowspan="2">Slow-Setting</td><td>ASTM D977</td><td>SS-1, SS-1h(1)</td><td>Anionic</td></tr>
<tr><td>ASTM D2397/D2397M</td><td>CSS-1, CSS-1h(1)</td><td>Cationic</td></tr>
<tr><td>Medium-Setting</td><td>ASTM D977</td><td>MS-1, HFMS-1</td><td>Anionic</td></tr>
<tr><td rowspan="3">Reduced-Tracking (2)</td><td rowspan="3">See Note 3.</td><td>NTSS-1HM,
BC-1HT, CNTT-1hs</td><td>Anionic</td></tr>
<tr><td>CBC-1HT</td><td>Cationic</td></tr>
<tr><td>NTQS-1HL</td><td>Non-ionic</td></tr>
<tr><td colspan="4">(1) Emulsions with the designation including "h" indicates an asphalt binder with lower penetration or higher high-end of Performance Grade binder. Harder binders are known to resist pick up from traffic better than softer (higher penetration or lower high-end temperature) asphalt</td></tr>
<tr><td colspan="4">(2) In the market, there exists too many designations to list in this section. Providing as example only. Specify reduced-tracking (non-tracking) tack coats only if approved by the state DOT or agency and represented on their Approved Product List or Qualified Product</td></tr>
<tr><td colspan="4">(3) Some products used may not have a governing ASTM standard specification. If there is an equivalent AASHTO standard used by the state agency, modify the referenced standard appropriately.</td></tr>
<tr><td colspan="4">(4) Asphalt emulsions specified by ASTM D977 or ASTM D2397 in this table are recommended for tack coat applications by ASTM D3628 (2015; R2021). Other tack coat products (e.g. RS-1, CRS-1, CQS-1h, etc.) can be used if shown that a successful history for use by the state agency or DOT and is listed on the associated Approved Product List or Qualified Product List for tack coat applications.</td></tr>
</table>

For most applications, cationic and anionic emulsions will perform equally well. Anionic emulsions, such as SS-1, may provide better adhesion to calcareous aggregates with pH less than 7, such as limestone. Cationic emulsions such as CSS-1 may provide better adhesion to siliceous aggregates with pH greater than 7, such as granite.

Reduced-tracking tack coats are recommended for stressed airfield pavements and high volume roads due to significantly greater bond strengths. Grades SS-1h, CSS-1h may also be considered for these applications if there is a history of adequate performance. Other grades can be considered for

general use (e.g. tack coats for low volume roads, parking lots, and other similar features). Grades SS-1, and SS-1h or their cationic equivalents, are the most widely used tack coat materials.

In warmer climates, or when material pick-up is of concern, reduced-tracking tack coats should be considered. Oftentimes, "h" grade emulsions, such as SS-1h or CSS-1h, do not provide a hard enough base asphalt to prevent cohesive failure that may be present with high temperatures or short set times prior to commencing with paving. Several State, Federal, and Military agencies have begun to use tack coats with reduced-tracking properties to minimize spreading the tack coat along the haul route. Moreover, some State agencies have mandated reduced-tracking tack coats on all state projects, therefore resulting in significantly reduced or eliminated local availability for alternate tack coat products. In most cases, if a State agency has moved to reduced-tracking tack coats, it is not practical to specify alternate products that would require the supplier to devote an emulsion tank to local non-standard products. Before specifying, check with local DOT or state agency to determine their experience with reduced-tracking materials. Reduced tracking tack coats may require specialized application equipment. If necessary, modify the equipment section and materials section per manufacturer's guidance if reduced-tracking tack coats are specified.

Emulsions may not be desirable when night operations, short set times, or high-humidity environmental conditions are expected. In these scenarios, it is common to select quick setting emulsions, rapid setting emulsions, or hot-applied asphalt binders. High heat is required to achieve spraying consistency for asphalt binders. When asphalt binder is used, the tack coat grade should be the same grade as that for the asphalt mixture or the normal unmodified asphalt grade used for the local area by the DOT.

****

Provide the tack coat Certificate of Analysis (COA), including specific gravity, for the product specified below. No dilution is allowed for tack coat applications.

[2.3.1 Asphalt Binder

****

NOTE: See Note above for guidance on selected grade of asphalt binder for use.

****

Provide asphalt binder conforming to [ASTM D946/D946M Penetration Grade [_____], Table 2][ASTM D6373 PG [_____], Table 1].

][2.3.2 Emulsified Asphalt

****

NOTE: Other emulsified asphalt products can be specified besides those listed below if the product is approved by the state agency or DOT and is listed on the associated Approved Product List or Qualified Product List for tack coat applications.

****

Provide emulsified asphalt conforming to [ASTM D977, Type [MS-1] [HFMS-1] [SS-1] [SS1h]] [ASTM D2397/D2397M, Type [CRS-1] [CSS-1] [CSS-1h]].

][2.3.3 Reduced-Tracking Tack Coat

Provide emulsified asphalt conforming to [_____].

]][2.4 Blotter Aggregate

****

NOTE: Blotter aggregate such as a clean, dry sand, screenings, or other cover material may need to be specified when traffic is allowed on a primed surface or when friction is needed on a tacked surface. Blotter aggregates are also used to remove excess tack or prime coat material.

****

Provide an aggregate gradation that conforms to gradations specified in Table 1. Obtain material used as blotter aggregate from an approved state agency or Department of Transportation (DOT) source.

Table 1

Blotter Aggregate Gradation

	Sand(1)	Screenings
Sieve Size, mm inch	Percent Passing by Mass	Percent Passing by Mass
9.53/8	100	100
4.75No. 4	95 - 100	75 - 100
2.36No. 8	85 - 100	---
1.18No. 16	65 - 97	---
0.60No. 30	25 - 70	---
0.30No. 50	5 - 35	---
0.15No. 100	0 - 7	---
0.075No. 200	0.0 - 4.0	0.0 - 15.0

]PART 3 EXECUTION

3.1 PREPARATION OF ASPHALT STORAGE AND BITUMINOUS DISTRIBUTOR

****

NOTE: Keep bracketed text if emulsified asphalt is specified.

****

[Most anionic and cationic emulsions are not compatible. Thoroughly clean the asphalt emulsion storage and bituminous distributor if previous asphalt emulsion used is non-compatible with the specified emulsion. As an example, if CSS-1h (cationic) was utilized in the distributor previously, and the specified emulsion is a SS-1h (anionic), this would require the storage to be thoroughly cleaned prior to receiving the material and the bituminous distributor storage tanker to be thoroughly cleaned prior to depositing into the bituminous distributor storage tanker.]

Ensure bituminous material is at the recommended application temperature and it has been thoroughly cycled through the distributor bar. Test the bituminous distributor under pressure by means of a test shot area (outside the project limits) to ensure there are no leaks or dripping for the nozzles after shut-off.

3.2 PREPARATION OF SURFACE

****

NOTE: If the surface to be treated requires repair, the method of repair and extent of work involved should be shown or described.

****

Immediately before applying the bituminous coat, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated by means of a power broom or blower supplemented with hand brooms. Apply treatment only when the surface is dry and clean.

3.3 TRIAL APPLICATIONS AND CALIBRATIONS

****

NOTE: Most modern distributors are typically equipped with computerized methods to manage and control application rate of the bituminous material. Calibrations for these computerized control systems are needed to confirm the residual asphalt rate is being obtained. Do not remove the distributor truck calibrations. Edit only what is in bracketed text for emulsified asphalts. Residual asphalt rate is the basis of this specification.

****

3.3.1 Trial Applications

Trial applications below are for the initial settings of the bituminous distributor computer controlled application rate settings prior to performing the APPLICATION RATE CALIBRATION.

3.3.2 Prime Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous materials in the amount of 0.66 L/square meter 0.15 gallon per square yard (shot rate). For emulsions, make other trial applications using various amounts of material or adjusting other setting as may be deemed necessary to meet the residual application rate and uniform coverage.

3.3.3 Tack Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous tack coat materials in the amount of 0.27 L/square meter 0.06 gallons per square yard. Make other trial applications using various amounts of material or adjusting other setting as may be deemed necessary to meet the residual application rate and uniform coverage.

3.3.4 Application Rate Calibration

****

NOTE: Modern distributors are typically equipped with computerized methods to manage application rate. Calibration of the radar or DMI that utilize inputs based upon forward rate of speed and total distance traveled is required. Even with computerized rate control, based upon radar or DMI, calibration of the distributor is still needed to verify residual application rates. Application Rate Calibration and the Daily Application Rate Verification apply to both prime coat and tack coats.

****

Provide all equipment, materials, and labor necessary to calibrate the application rate produced from the bituminous distributor per the following guidance. Each distributor truck proposed for use on the project will have the application rate calibrated for each material type proposed for use. Perform the application rate calibration after the distributor arrives on the project, after the test shot, and at least 24 hours prior to use for application of prime coat and tack coat. Calibrate the application rate in accordance with ASTM D2995. If utilizing a cutback or asphalt binder, utilize ASTM D2995 Option A. If utilizing an emulsified asphalt, utilize ASTM D2995 Option B. Provide pads made from berber carpet (or other approved durable absorbent pad) with rubber or waterproof backing measuring 305 mm 12 inches by 305 mm 12 inches. For transverse testing, stack pads end-to-end that spans the maximum width of the spray bar. For longitudinal testing, stack three sets of six pads end-to-end longitudinally with 30 meter 100 foot separation between sets.

Measure the transverse and longitudinal application rates with all nozzles inserted in the distributor bar. Submit the results for the application rate calibration in the longitudinal direction and the transverse direction to the Government identifying, at a minimum, the following items:

a. Project name, Contract number, testing date.

b. Emulsified, cutback, or asphalt binder material.

c. Distributor make, model and serial number.

d. Distributor setup at time of calibration including target application rate (shot rate as shown on the computer control system), spray bar height, and distributor truck speed or motor RPM.

e. Dry weight of each pad prior to application.

f. Wet weight of each pad immediately after application.

g. For emulsions, oven dry each pad until constant mass. Record oven dry mass of each pad in 20 minute increments. Mass at the end of a 60 minute oven dry period is considered constant mass.

h. For emulsions, residual asphalt rate for each pad and average residual asphalt rate. For cutbacks, shot rate for each pad and average shot rate.

For the Application Rate Calibration to be acceptable, provide the average residual asphalt rate for emulsions or the average shot rate for cutbacks and asphalt binder in compliance with Table 3a or Table 3b and no individual pad rate is to vary more than 20 percent from the average. Perform the Estimating Application Rate of Bituminous Distributors in the presence of the project QC staff and the Government. Reference ATTACHMENT 1. If the application rate calibration fails to meet the requirements of this section, make adjustments to the distributor setup, shot rate or other settings as appropriate, and re-perform the application rate calibration until the results are within an acceptable range. Do not modify the distributor setup, or shot rate after application rate calibration is accepted without approval by the Government. Use ASTM D2995 to determine the estimation of application rate of bituminous distributors every 14 days of production, or as determined necessary by the Government.

3.3.5 Daily Application Rate Verification

Following acceptable results as outlined in paragraph APPLICATION RATE CALIBRATION, perform daily application rate verification each day when the distributor is in use and provide results daily during execution. The production application rates will utilize the volume method of determination as follows:

a. Determine the total distance to be sprayed.

b. Calculate the area sprayed.

c. Calculate the liters gallons of material applied by subtracting the beginning volume by the ending volume. Utilizing the dipstick which has been provided with the distributor truck or the onboard meter.

d. Correct for temperature back to 15.6 degrees C 60 degrees F by applying correction factor as provided in ASTM D1250.

e. Calculate and report the temperature corrected shot rate by dividing the corrected liters gallons per item d. by the total area sprayed.

3.4 APPLICATION RATE CORRECTION

If the daily application rate verification varies by more than 0.07 liters per square meter 0.015 gallon per square yard from the shot rate established during application rate calibration that met the rates in Table 3a or Table 3b, immediately re-perform the application rate calibration in accordance with paragraph APPLICATION RATE CALIBRATION and ensure results are in compliance with the rates specified in Table 3a or Table 3b prior to applying additional prime coat or tack coat.

3.5 APPLICATION TEMPERATURE

3.5.1 Viscosity Relationship

Apply bituminous material at a temperature that will provide a viscosity between 10.0 and 60.0 seconds, Saybolt Furol in accordance with ASTM D88/D88M or between 20 and 120 square mm/sec 20 and 120 centistokes in accordance with ASTM D2170/D2170M. Furnish the temperature viscosity relation to the Contracting Officer.

3.5.2 Temperature Ranges

****

NOTE: Typical spray application temperatures are provided. Edit and coordinate materials with Part 2 PRODUCTS. Retain material to be allowed in the specification and delete the other materials.

****

The viscosity requirements determine the application temperature to be used. Table 2 presents a normal range of application temperatures. If Table 2 is different than the manufacturer's recommendation, use the manufacturer's recommendation.

Table 2	
Tack Coat or Prime Coat Application Temperatures	
Cutback Asphalt	
MC-70, RC-70(1)	50-107 degrees C120-225 degrees F
MC-250, RC-250(1)	75-132 degrees C165-270 degrees F
Asphalt Emulsion	
Cationic Emulsified Asphalt	54-77 degrees C130-170 degrees F
Anionic Emulsified Asphalt	65-82 degrees C150-180 degrees F
Non-Ionic Emulsified Asphalt	65-82 degrees C150-180 degrees F
Asphalt Binder	
All Grades	135-175 degrees C275-350 degrees F(2)
(1) Some temperatures within these ranges provided may exceed the flash point for certain rapid cure cutbacks. Care should be taken in their heating.	
(2) Max temperature may be increased to 190 degrees C 375 degrees F if recommended by the manufacturer to facilitate uniform application free of equipment clogging issues when hard base asphalt is used.	

3.6 APPLICATION

3.6.1 General

Following preparation and subsequent inspection of the surface, apply the prime coat or tack coat with the distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots, not capable of being sprayed with the distributor, with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment are permitted within 8 meters 25 feet of heating, distributing, and transferring operations of cutback materials. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed.

3.6.2 Prime Coat

Apply the prime coat at locations shown on the Drawings only when the underlying material meets the specified material density requirements, and the moisture content is within 2 percent of optimum moisture. Application should be achieved within the limits of the temperature described in paragraph ENVIRONMENTAL REQUIREMENTS and quantities to achieve the rate of residual asphalt shown in Table 3a. At the time of priming, ensure that the base is firm, unyielding and in such condition that no undue distortion will occur. Ensure the prime coat adheres to the underlying material. Apply the prime coat material using a bituminous distributor. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper and to ensure that all sprayers will operate at full force on the surface to be treated. Immediately after application, remove and discard the building paper. If blotter aggregate is used, lightly sweep the area with a power broom, or other approved means, to remove any excess blotter aggregate.

Table 3a

Prime Coat Application Rates

Surface Type	Product Type	Rate (L/m^2)(gal/yd^2)
Unbound Layers	Emulsion(1)	0.23 - 0.540.05 - 0.12 (residual rate)
	Cutback Asphalt	0.36 - 0.81 0.08 - 0.18 (shot rate)

(1) Emulsion prime coats may be diluted up-to a 1 to 1 dilution rate.

3.6.3 Tack Coat

Immediately following the preparation of the surface for treatment, apply the tack coat by means of the distributor, within the limits of the temperature described in paragraph ENVIRONMENTAL REQUIREMENTS and in quantities to achieve the rate of residual application rates shown in Table 3b. Ensure the surface is clean and dry. Apply tack coat at the locations shown on the Drawings sufficiently in advance of placing the asphalt mixture to permit breaking and initial stages of curing. Do not apply tack coat so far in advance that it might lose its adhesiveness as a result of being covered with dust or other foreign material. When using a spray paver with appropriate tack coat products, tack coat breaking requirements do not apply. Dilution of tack coat is prohibited. A tack coat should be applied to every bound surface (asphalt or concrete pavement) that is being overlaid with asphalt mixture and at transverse and longitudinal joints. Apply the bituminous material so that uniform distribution is obtained over the entire surface to be treated. Treat lightly coated areas and spots missed by the distributor by spraying with a hand wand or using other approved method. To obtain uniform application of the tack coat, at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application to start and stop the tack coat on the paper and to ensure that all sprayers will operate at full force on the surface to be treated. Immediately after application, remove and discard the building paper. If blotter aggregate is used, lightly sweep with a power broom, or other approved means, to remove any excess blotter aggregate. Maintain and protect the treated surface from damage until the succeeding course of pavement is placed.

Table 3b

Tack Coat Application Rates(1,3,4)

Surface Type	Residual Rate (L/m^2)(gal/yd^2)	Approximate Bar Rate Undiluted(2) (L/m^2)(gal/yd^2)
New Asphalt (between layers)	0.09 - 0.230.02 - 0.05	0.14 - 0.320.03 - 0.07
Existing Asphalt	0.18 - 0.320.04 - 0.07	0.27 - 0.500.06 - 0.11
Milled Surface	0.18 - 0.360.04 - 0.08	0.27 - 0.540.06 - 0.12
Portland Cement Concrete	0.14 - 0.230.03 - 0.05	0.23 - 0.360.05 - 0.08

(1) Dilution of tack coat is not allowed

(2) Assumes emulsion is 33 percent water and 67 percent asphalt

(3) Emulsified asphalt is prohibited to be applied at application rates over 0.54 L/m^2 0.12 gal/yd^2

(4) Residual rate is the same as bar rate when using hot-applied asphalt binders. Use residual rate tolerances as shown above for target when using hot-applied asphalt binders.

3.7 FIELD QUALITY CONTROL

****

NOTE: Retain bracketed text for unit price bids only. For lump sum Contracts, remove bracketed text.

****

Certificates of compliance (COC) for asphalt materials delivered will be obtained and checked to ensure that specification requirements are met. Quantities of applied material will be determined.[Payment will be for amount of residual asphalt applied.] Prime coat materials when emulsions are used can be diluted on site with potable water up to 1 part water to 1 part emulsion, as long as the residual rate is still being met. Do not dilute tack coat materials. If requested by the Government, obtain samples of the bituminous material under the supervision of the Government per paragraph SAMPLING and send for analysis.

3.7.1 Sampling and Testing

Furnish certified copies of the manufacturer's test reports indicating temperature-viscosity relationship for asphalt materials and compliance with applicable specified requirements, not less than 5 days before the material is required in the work.

3.7.2 Sampling

Unless otherwise specified, sample bituminous material in accordance with ASTM D140/D140M.

3.8 PRIME COAT SET PERIOD

****

NOTE: It is recommended for prime coats to set for a minimum of 48 hours. This set time allows the prime coat to penetrate into the base course and also minimize pick-up during paving operations. Some solvent-free prime coats may not require the full 48 hour set time. If solvent-free prime coats are specified, obtain direction from the manufacturer on how to edit the set time.

****

Allow the prime coat to set without being disturbed for a period of at least [48 hours][_____] or longer, as may be necessary to attain penetration into the treated course. Furnish and spread enough blotter aggregate to effectively blot up excess bituminous material.

3.9 TACK COAT BREAKING PERIOD

Following application of an emulsified asphalt tack coat and prior to application of the succeeding layer of asphalt mixture, allow emulsified asphalt tack coats to break. No break period is required for cutback or hot-applied asphalt binder tack coat products.

3.10 TRAFFIC CONTROLS

Maintain the primed surface and tacked surface in good condition until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

3.11 ATTACHMENT

ATTACHMENT 1: Estimating Application Rate of Bituminous Distributors

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 12 15.13 (November 2020)**
Change 1 - 05/22

Preparing Activity: USACE **Superseding**
32 12 15.13 (November 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 32 12 15.13

ASPHALT PAVING FOR AIRFIELDS

11/20, CHG 1: 05/22

****

NOTE: This guide specification covers the requirements for bituminous intermediate and wearing courses (central-plant hot-mix and warm-mix) for airfields using Marshall or Gyratory compaction method.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Do not edit or rewrite the unbracketed text without the express consent of the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement subject matter expert (SME), or the Naval Facilities Engineering Systems Command (NAVFAC). Edit bracketed items by choosing applicable item(s) or inserting appropriate text.**

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Make modifications within bracketed items to this guide specification during conversion to a project specification in accordance with the NOTES which are located throughout the document. These NOTES are instructions to the designer, and will not appear in the project specification.

Edit specifications developed for Corps of Engineers managed projects in accordance with ER 1110-34-1 Engineering and Design Transportation Systems Mandatory Center of Expertise (Section 11, 12, App A, B, C).

This guide specification only pertains to the hot-mix and warm-mix asphalt pavement aspects of the project and not to any surface preparation requirements dealing with aggregate base courses, milling, or tack and prime coats. Cover surface preparation requirements by adding pertinent sections to the project documents.

This specification utilizes a Quality Assurance and Quality Control (QA/QC) construction management philosophy. Quality Assurance refers to the actions performed by the Government or designated representative to assure the final product meets the job requirements. This specification has been developed for QC testing to be used as a basis of pay. It is recommended that the Government's QA testing include a minimum of 5 percent of the QC tests performed by the Contractor. Results of QC testing are the basis for pay unless there are discrepancies between QC and QA testing. Quality Control also refers to the actions of the Contractor to monitor the construction and production processes and to correct these processes when out of control. Results of QC testing are reported daily on the process control charts maintained by the Contractor. Quality Control is covered in paragraph CONTRACTOR QUALITY CONTROL STAFF and paragraph CONTRACTOR QUALITY CONTROL.

****

1.1 FULL PAYMENT

1.1.1 Method of Measurement

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NOTE: For unit-price contracts, include first bracketed statements and delete the second set. For lump sum contracts, delete the first bracketed statements and include the second set.

Do not delete PART 1 for lump sum Contracts.

****

[The amount paid for will be the number of metric tons tons of hot-mix warm-mix asphalt pavement mixture used in the accepted work. Weigh the hot-mixwarm-mix asphalt pavement mixture after mixing. No separate payment will be made for weight of asphalt binder material incorporated herein.] [Utilize the quantity of hot-mixwarm-mix asphalt pavement, per metric ton ton placed and accepted, for the purposes of assessing the pay factors stipulated below.]

1.1.2 Basis of Payment

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NOTE: For unit-price contracts, include first bracketed statements and delete the second set. For lump sum contracts, delete the first bracketed statements and include the second set. Include prescriptive unit price based on the Government

estimate for payment adjustment. Lump sum contracts should not be used when the job exceeds 1000 metric tons tons.
****

[Quantities of hot-mixwarm-mix asphalt pavement, determined as specified above, will be paid for at respective contract unit prices or at reduced prices adjusted in accordance with paragraphs PERCENT PAYMENT and ACCEPTANCE. Payment will constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification.] [The measured quantity of hot-mixwarm-mix asphalt pavement will be paid for and included in the lump sum contract price. If less than 100 percent payment is due based on the pay factors stipulated in paragraph PERCENT PAYMENT and ACCEPTANCE, a unit price of [_____] per metric ton ton will be used for purposes of calculating the payment reduction.]

1.2 PERCENT PAYMENT

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NOTE: The basis of percent payment includes material tests to determine laboratory air voids, in-place density, smoothness and plan grade which are needed to determine percent payment.
****

When a pavement lot of material fails to meet the specification requirements for 100 percent pay as outlined in the following paragraphs, remove and replace the lot, or accept at a reduced price which will be computed by multiplying the unit price per ton by the lot's pay factor. The lot pay factor is determined by taking the lowest computed pay factor based on either laboratory air voids, in-place density, grade or smoothness (each discussed below). At the end of the project, an average of all lot pay factors will be calculated. If this average lot pay factor exceeds 95.0 percent and no individual lot has a pay factor less than 75.0 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot's pay factor. For any lots which are less than 2000 metric tons tons, a weighted lot pay factor will be used to calculate the average lot pay factor. When work on a lot is required to be terminated before all sublots are completed, the results from the completed sublots will be analyzed to determine the percent payment for the lot following the same procedures and requirements for full lots but with fewer test results.

1.2.1 Mat and Joint Densities

The average in-place mat and joint densities are expressed as a percentage of the average theoretical maximum density (TMD) for the lot. The average TMD for each lot will be determined as the average TMD of the four random samples per lot. The average in-place mat density and joint density for a lot are determined and compared with Table 1 to calculate a single pay factor per lot based on in-place density, as described below. All density results for a lot will be completed and reported within 24 hours after the construction of that lot. Use the following process to determine the single pay factor for in-place density:

a. Step 1: Determine the pay factors for mat density and joint density using Table 1.

b. Step 2: Determine ratio of joint area to mat area. The area associated with the joint is considered to be 3 m 10 feet wide times the length of completed longitudinal construction joint in the lot. This joint area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of asphalt pavement, either any cold joint against another lot or any other existing asphalt paved previously. The area associated with the joint is expressed as a percentage of the total lot.

c. Step 3: Compute the weighted pay factor for the joint using the formula in the example shown in paragraph PAY FACTOR BASED ON IN-PLACE DENSITY.

d. Step 4: Where freshly placed asphalt pavement abuts old (not in contract) asphalt pavement, determine density at the tie-in longitudinal joint by taking one core per sublot at a random location for each lot of material placed adjacent to the joint. If Step 4 is not applicable, move to Step 5. The size of joint area is 3 m 10 feet wide by the length of the joint being paved. Locate the center of each of the four cores 150 mm 6 inches from the edge of the existing pavement. Take each core at a random location along the length of the joint. The requirements for joint density for this lot, adjacent to the existing asphalt joint, are the same as that for the mat density specified in Table 1. For the interface of new asphalt pavement abutting existing asphalt (not in contract) joints at taxiways abutting runways, aprons, or other taxiways, take two additional randomly located cores along each taxiway intersection.

e. Step 5: Compare weighted pay factor for joint density to pay factor for mat density and select the lowest. This selected pay factor is the pay factor based on density for the lot. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD values will be used as the TMD needed to calculate the percent joint density.

When 0 percent payment is determined for mat density, remove and replace the rejected lot at least 100 mm 4 inches into the cold lane adjacent to the longitudinal joint. Evaluate this as a new lot per paragraph MAT AND JOINT DENSITIES.

When 0 percent payment is determined for joint density, remove and replace the rejected longitudinal joint with a 3 m 10 feet wide paving lane that is centered over the joint. This 3 m 10 feet wide placement will be evaluated as a new lot. When removing and replacing a joint that fails to meet the project requirements, the result will be two additional longitudinal joints. Determine a pay factor for these longitudinal joints by randomly selecting two cores per lot centered on the joint each side of the lot. This will result in four total cores for joint density evaluation. Take the average of the joint density of the four cores to develop a pay factor for joint density determination. Average the new lot TMD values with the adjacent lot TMD values to determine a final average for joint density evaluation. In this case do not use a weighted pay factor. Evaluate the mat density for this lot per paragraph MAT AND JOINT DENSITIES.

Table 1

Pay Factor Based on In-place Density

Average Mat Density (4 cores) (Percent of TMD)	Pay Factor, percent	Average Joint Density (4 cores)(Percent of TMD)
94.0 - 96.0	100.0	Above 92.5
93.9	100.0	92.4
93.8 or 96.1	99.9	92.3
93.7	99.8	92.2
93.6 or 96.2	99.6	92.1
93.5	99.4	92.0
93.4 or 96.3	99.1	91.9
93.3	98.7	91.8
93.2 or 96.4	98.3	91.7
93.1	97.8	91.6
93.0 or 96.5	97.3	91.5
92.9	96.3	91.4
92.8 or 96.6	94.1	91.3
92.7	92.2	91.2
92.6 or 96.7	90.3	91.1
92.5	87.9	91.0
92.4 or 96.8	85.7	90.9
92.3	83.3	90.8
92.2 or 96.9	80.6	90.7
92.1	78.0	90.6
92.0 or 97.0	75.0	90.5
below 92.0, above 97.0	0.0 (reject)	below 90.5

1.2.2 Pay Factor Based on In-place Density

An example of the computation of a pay factor (in I-P units only) based on in-place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 93.2 percent (of lab TMD). (2) Average joint density = 91.5 percent (of lab TMD). (3) Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2,000 feet.

a. Step 1: Determine pay factor based on mat density and on joint density, using Table 1:

    (1) Mat density of 93.2 percent = 98.3 pay factor.

    (2) Joint density of 91.5 percent = 97.3 pay factor.

b. Step 2: Determine ratio of joint area (length of longitudinal joint x 10 feet) to mat area (total paved area in the lot): Multiply the length of completed longitudinal construction joint by the specified 10 feet width and divide by the mat area (total paved area in the lot).

    (1) ,000 feet x 10 feet)/30000 square feet = 0.6667 ratio of joint area to mat area (ratio).

c. Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:

(1) wpf = joint pay factor + (100 - joint pay factor) (1 - ratio) wpf = 97.3 + (100-97.3) (1-0.6667) = 98.2 percent

d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:

(1) Pay factor for mat density: 98.3 percent. Weighted pay factor for joint density: 98.2 percent

(2) Select the smaller of the two values as pay factor based on density: 98.2 percent

1.2.3 Payment Adjustment for Smoothness (Final Wearing Surface Only)

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NOTE: When Profilograph testing is not required, delete the following paragraph for pay adjustment for smoothness. This paragraph may be deleted for projects where a profilograph cannot record 161 meters 0.10 of a mile in length. Profilograph testing is required for runways, taxiways and landing zone pavements.

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1.2.3.1 Longitudinal Smoothness

Evaluate smoothness per paragraph PROFILOGRAPH TESTING. Determine the pay factor for longitudinal smoothness by entering Table 2.

Table 2

Pay Factor for Smoothness

Profile Index of a 0.1 km 0.1 mile segment of a lot exceeds the tolerance specified in paragraph SURFACE SMOOTHNESS by:	Pay Factor, Percent
0.0 mm per km0.0 inch per mile	100.0
greater than 0.0 mm per km0.0 inch per mile but less than 16.0 mm per km 1.0 inches per mile	95.0
16.0 mm per km1.0 inches per mile but less than 32.0 mm per km 2.0 inches per mile	90.0
32.0 mm per km 2.0 inches per mile but less than 47.0mm per km 3.0 inches per mile	75.0

Table 2	
Pay Factor for Smoothness	
Profile Index of a 0.1 km 0.1 mile segment of a lot exceeds the tolerance specified in paragraph SURFACE SMOOTHNESS by:	Pay Factor, Percent
47.0 mm per km3.0 inches per mile or greater	Remove and Replace

1.2.4 Laboratory Air Voids and Theoretical Maximum Density

Laboratory air voids will be calculated in accordance with ASTM D3203/D3203M by determining the density of each lab compacted specimen using the laboratory-prepared, thoroughly dry method in ASTM D2726/D2726M and determining the theoretical maximum density (TMD) of four of the sublots using ASTM D2041/D2041M. Laboratory air void calculations for each lot will use the average TMD values obtained for the lot. The mean absolute deviation of the four laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated and a pay factor determined from Table 3. All laboratory air void tests will be completed and reported within 24 hours after completion of construction of each lot. The TMD is also used for computation of in-place density, as required in paragraph MAT AND JOINT DENSITIES above.

1.2.4.1 Mean Absolute Deviation

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 random samples of a lot (where 3 specimens were compacted from each sample). The average laboratory air voids for each sublot sample are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

$$\text{Mean Absolute Deviation} = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|)/4$$

$$= (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45$$

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 3 that the lot's pay factor based on laboratory air voids, is 100 percent.

Table 3	
Pay Factor Based on Laboratory Air Voids	
Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, Percent
0.60 or less	100
0.61 - 0.80	98
0.81 - 1.00	95

Table 3	
Pay Factor Based on Laboratory Air Voids	
Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, Percent
1.01 - 1.20	90
Above 1.20	reject (0)

1.2.5 Pay Factor Based on Plan Grade

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NOTE: The plan grade requirements specified below are for the final wearing surface only. If there is a requirement to test and control the grade and smoothness for the intermediate courses, for example, when the intermediate courses will be exposed to traffic, slight modifications to this specification will be required. Designer is responsible for providing spot elevations at 15 m 50 feet or less and cross section in a frequency that is satisfactory for the project. Spot elevations should be provided on a grid or mesh pattern. These spot elevations will be utilized to ensure the construction adheres to the design and to determine percent payment during production.

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Evaluate plan grade per paragraph PLAN GRADE. Use Table 4 for determining Pay Factor for Plan Grade. Evaluate plan grade on a lot basis.

Table 4	
Pay Factor for Plan Grade	
Percent of All Measurements Outside Tolerance	Pay Factor, percent
Less than 5	100
Greater than or equal to 5 but less than 10	90
Greater than or equal to 10 but less than 15	75
Greater than or equal to 15	Remove and replace the surface lift

1.3 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
AASHTO T 329	(2015) Standard Test Method for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method

ASPHALT INSTITUTE (AI)

AI MS-2	(2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C1252	(2017) Standard Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D946/D946M	(2020) Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2419	(2014) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489/D2489M	(2016) Standard Test Method for Estimating Degree of Particle Coating of Asphalt Mixtures
ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3203/D3203M	(2017) Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction

ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4125/D4125M	(2010) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5361/D5361M	(2016) Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
ASTM D5444	(2015) Mechanical Size Analysis of Extracted Aggregate
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6084/D6084M	(2018) Standard Test Method for Elastic Recovery of Asphalt Materials by Ductilometer
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder
ASTM D6925	(2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
ASTM D6926	(2020) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus
ASTM D6927	(2015) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM E1274	(2018); R 2024 Standard Test Method for Measuring Pavement Roughness Using a Profilograph

[1.4 AIRFIELD ASPHALT PAVING WORKSHOP

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NOTE: TSMCX provides airfield asphalt paving workshops regardless of project management organization - USACE, AFCEC or NAVFAC.

For USACE managed projects, review ER 1110-34-1 TRANSPORTATION SYSTEMS MANDATORY CENTER OF EXPERTISE and retain the following paragarph if deemed a Mandatory Service or if the project development team requests it as an Elective Service.

For AFCEC and NAVFAC managed projects, the below airfield asphalt paving workshop is optional. Appropriate coordination with TSMCX, AFCEC, or NAVFAC is recommended prior to specifying the airfield asphalt paving workshop.

Select MTV Operator if required by paragraph MATERIAL TRANSFER VEHICLE.

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Attend a one day paving workshop held in advance of asphalt paving. Acquire a facility for the workshop in the vicinity of the installation, or other appropriate location, as approved by the Government. Provide a facility that includes at a minimum, parking and seating for forty attendees, audio/visual with standard connections, including TV, projector, screen and any other items as required for display of digital presentations, and access to Wi-Fi. Coordinate schedule with the Government. Attendance requirements apply to each paving crew anticipated to be on the project. At a minimum, the following attendees are required.

a. Project Superintendent

b. Paving Superintendent or Foreman(s)

c. Paving Machine Operator(s)

d. Asphalt Plant Operator(s)

e. Airfield Asphalt Pavement Quality Control Manager

f. Airfield Asphalt Pavement Inspector

g. Airfield Asphalt Pavement Laboratory Technicians

h. Roller Operators

i. Aggregate Supplier(s)

[j. MTV Operator(s)]

]1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Equipment; G, [_____]

SD-02 Shop Drawings

Placement Plan; G, [_____]

SD-03 Product Data

Diamond Grinding Plan; G, [_____]

Mix Design; G, [_____]

Contractor Quality Control; G, [_____]

SD-04 Samples

Aggregates

Asphalt Binder

Warm-mix Additive

SD-06 Test Reports

Aggregates; G, [_____]

QC Monitoring

Pavement Lots; G, [_____]

SD-07 Certificates

Asphalt Binder; G, [_____]

Testing Laboratory

Warm-mix Additive

Airfield Asphalt Pavement QC Manager

Airfield Asphalt Pavement Inspector

Airfield Asphalt Pavement Laboratory Technician

1.6 CONTRACTOR QUALITY CONTROL STAFF

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NOTE: Select UFGS 01 45 00 for Army, Air Force , and Navy projects. Select appropriate second set of bracketed text if asphalt pavement is associated with other more predominant features of work (e.g. hangar projects, concrete runways with asphalt shoulders, etc.).

The airfield asphalt certification program is intended to increase quality of construction for work performed under this specification. The certification program will provide knowledge to the project team members as it relates to airfield asphalt. Intended audience is the Contractor and Government personnel. The below paragraph should be modified or the general provisions of the contract should be modified to require Title II inspectors or third party laboratory firms attend the certification program.

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Reference Section 01 45 00QUALITY CONTROL for Contractor personnel qualification requirements along with the information included below. [The Airfield Asphalt Pavement QC Manager is a separate person and is in addition to the CQC System Manager identified in Section 01 45 00 QUALITY CONTROL. The Airfield Asphalt Pavement QC Manager will report to and assist the project CQC System Manager.] Submit certifications for Contractor Quality Control Staff in the following areas:

a. Airfield Asphalt Pavement QC Manager(1): The QC manager will oversee all QC testing and inspection, review asphalt pavement transmittals prior to submission to the Government, be responsible for making mix design adjustments, and in charge of all other activities related to performance. The QC manager will also ensure that daily reports and necessary transmittals arrive for Government review as specified.

b. Airfield Asphalt Pavement Inspector(1): The Inspector will be available on the project during all paving operations. The Inspector is responsible for identifying observed paving issues and ensuring these issues are addressed by the Contractor Quality Control staff.

c. Airfield Asphalt Pavement Laboratory Technician(1): The Technician will be responsible for conducting laboratory tests. The Airfield Asphalt Pavement Technician will be present in the laboratory anytime laboratory testing is underway.

(1): Registration for the Airfield Asphalt Pavement Certification Program can be found at www.airfieldasphaltcert.com.

1.7 ACCEPTANCE

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NOTE: It is recommended that an independent material testing firm be hired by the Contractor to provide the acceptance testing for the project. It is also recommended to keep the Government QA testing separate and distinct from the Contractor's QC testing for all airfield projects.

The acceptance testing program includes material tests to determine laboratory air voids and in-place density, which are needed to determine percent payment. The Contractors acceptance testing laboratory will also conduct tests to monitor aggregate gradation, asphalt content, and volumetric properties.

For projects with less than 2000 total metric tons tons, the entire project can be considered as a single lot. In this case, sublot sampling could occur over several days' production, which could lead to higher sublot variability.

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1.7.1 Acceptability of Work

Acquire the services of an independent commercial laboratory to perform acceptance testing. Acceptance of the plant produced mix and in-place requirements will be on a lot to lot basis. The materials and the pavement itself will be accepted on the basis of production testing. The Government may make check tests from split samples to validate the results of the production testing. Testing performed by the Government does not reduce the required testing of the independent commercial laboratory. Split samples will be taken for Government testing to reduce the variability between the independent commercial laboratory and the Government's test results. When the difference between the independent commercial laboratory and the Government's test results for split samples exceed the acceptable range of two results for multi-laboratory precision for the appropriate test method (i.e. ASTM) then at least one of the laboratories is determined to be in error. An evaluation of procedures and equipment in both laboratories will be made to determine the cause(s) for the differences. Develop steps to correct procedures and equipment to bring multi-laboratory precision to within acceptable limits.

1.7.2 Acceptance Requirements

Provide all sampling and testing required for acceptance and payment adjustment. Where appropriate, adjustments in payment for individual lots of asphalt pavement will be made based on laboratory air voids, in-place density, smoothness, and grade in accordance with the following paragraphs. Surface smoothness and grade determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus smoothness and grade measurements for the entire lot cannot be made.

1.7.3 Pavement Lots

A standard lot for all requirements is equal to one day's production or 2,000 metric tons tons, whichever is smaller. Divide each lot into four equal sublots in order to evaluate laboratory air voids and in-place density. When operational conditions cause a lot to be terminated before the specified four sublots have been completed, use the following procedure to adjust the lot size and number of tests for the lot. Where three sublots have been completed, they constitute a lot. Where one or two sublots have been completed, incorporate them into the next lot and the total number of sublots (i.e. 5 or 6 sublots) is used for acceptance criteria. Maintain 4 sublots when possible. Include partial lots at the end of asphalt production into the previous lot. When more than one plant is simultaneously producing asphalt for the project, apply the lot size separately for each plant. Complete and report all asphalt testing including but not limited to aggregate gradation, asphalt content, theoretical maximum density, laboratory air voids, and in-place density testing within 24 hours, unless otherwise stated, after construction of each lot.

1.7.4 Sublot Sampling

Obtain one random mixture sample from each sublot in accordance with ASTM D979/D979M from a loaded truck or another approved location for determining laboratory air voids, theoretical maximum density, Contractor Quality Control, and for any additional testing as directed the Government. Representative samples will be selected from random trucks, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs. Laboratory air voids will be determined from three laboratory compacted specimens of each sublot sample in accordance with ASTM D3203/D3203M. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

1.7.5 Additional Sampling and Testing

The Government reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Contractor. Testing in these areas will be treated as a separate lot. Payment will be made for the quantity of asphalt pavement represented by these tests in accordance with the provisions of this section.

1.7.6 Theoretical Maximum Density (TMD)

Measure theoretical maximum density one time for each sublot in accordance with ASTM D2041/D2041M for purposes of calculating laboratory air voids and determining in-place density. The average TMD for each lot will be determined as the average TMD of the random sublot samples. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD values will be used as the TMD needed to calculate the percent joint density.

1.7.7 Laboratory Air Voids

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NOTE: Select the appropriate tailoring option for the Marshall or Superpave Methods.

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Prepare one set of laboratory compacted specimens for each sublot in accordance with ASTM D6926 using the hand-held hammer for the Marshall Method.Prepare one set of laboratory compacted specimens for each sublot in accordance with ASTM D6925 using the Superpave gyratory compactor. Provide three test specimens prepared from the same sample for each set of laboratory compacted specimens. Compact the specimens within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Do not reheat samples prior to compaction. Provide insulated containers as necessary to maintain the sample temperature. Measure the bulk density of laboratory compacted specimens in accordance with ASTM D2726/D2726M. Determine laboratory air voids from one set (three laboratory compacted specimens) for each sublot sample in accordance with ASTM D3203/D3203M.

1.7.8 In-place Density

Obtain one random 150 mm 6 inch diameter core from the mat and joint of each sublot in accordance with ASTM D5361/D5361M for determining in-place density. Where different job mix formulas are required as part of the same project, and are adjacent to one another, follow the same joint density sampling and joint density testing instructions of this specification. Cut samples neatly with a diamond core drill bit. Obtain random cores that are the full thickness of the layer being placed. Select core locations randomly using the procedures contained in ASTM D3665. Locate cores for mat density no closer than 300 mm 12 inches from a transverse or longitudinal joint. Center all cores for joint density on the joint. Discard samples that are clearly defective as a result of sampling and take an additional random core. When the random core is less than 25 mm 1 inch thick, it will not be included in the analysis. In this case, obtain another random core sample. Clean and tack coat dry core holes before filling with asphalt mixture. Fill all core holes with asphalt mixture and compact using a manual (hand-held) Marshall hammer to the density specified. Provide all tools, labor, and materials for cutting samples, cleaning, and filling the cored pavement. Measure in-place density in accordance with ASTM D2726/D2726M using each core obtained from the mat and joint.

1.7.9 Surface Smoothness

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in each entire lot by use of a straightedge and/or profilograph to reveal surface irregularities exceeding the tolerances specified. Straightedge is used for all lifts. Use the profilograph method for testing longitudinal smoothness on surface lifts only, except for paving lanes less than 161 m 0.10 miles, and at the ends of the paving limits for the project. Use straightedge method for all other measurements. If any pavement areas are diamond ground, retest these areas immediately after diamond grinding and submit results to the Government for evaluation. At a minimum, provide enough information to determine exact location of grinding (station and offset from centerline), smoothness results, and the associated lot(s) pay factor for smoothness. Follow requirements of paragraph DIAMOND GRINDING if diamond grinding is required to correct smoothness. Where drawings show required deviations from a plane surface (for instance crowns, drainage inlets), finish the surface to meet the approval of the Government.

1.7.9.1 Straightedge Testing

****

NOTE: Select bracketed text when paving lots are anticipated to be less than 1/10 mile longitudinally.

****

Provide finished surfaces of the pavements within the tolerances specified in Table 5 when checked with an approved 4 m 12 foot straightedge. Start longitudinal and transverse straightedge testing with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurements. Perform continuous tests across all joints. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Use the straightedge to also measure abrupt changes in surface smoothness. Abrupt changes in the surface can be visually observed where the surface exhibits irregularities or discontinuities. Surface areas with obvious smoothness defects will be tested with the straightedge to determine the limits of the surface not meeting the tolerance requirements in Table 5. Do not perform straightedge measurements across grade changes or cross slope transitions.

Perform transverse measurements perpendicular to centerline every 15 m 50 feet or more often as determined by the Government. [For longitudinal measurements, test parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 6 m 20 feet; and at the third points of paving lanes when widths of paving lanes are 6 m 20 feet or greater.] After two full lots have been placed with an average of less than five percent of measurements out, a request can be made to reduce the testing frequency at a rate approved by the Government. Report all individual straightedge measurements coinciding with project stationing in each paving lot report.

Table 5

Straightedge Surface Smoothness

Pavement Category	Direction of Testing	Tolerance, mm inch
Runways, taxiways, and landing zones	Longitudinal	31/8
	Transverse	61/4
Shoulders (outside edge stripe)	Longitudinal	61/4
	Transverse	61/4

Table 5

Straightedge Surface Smoothness

Pavement Category	Direction of Testing	Tolerance, mm inch
Calibration hardstands and compass swinging bases	Longitudinal	31/8
	Transverse	31/8
All other airfield pavements (including overruns) and helicopter paved areas	Longitudinal	61/4
	Transverse	61/4

1.7.9.2 Profilograph Testing

Test the entire lot in the longitudinal direction with an approved California-type profilograph per ASTM E1274. Provide equipment that utilizes electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. Use a "blanking band" that is 5 mm 0.2 inch wide and the "bump template" spanning 25 mm 1 inch with an offset of 10 mm 0.4 inch. Perform the longitudinal testing at the centerline of each paving lot. If paving widths are greater than 5 m 16 feet test at the centerline and at 1/8th points from each side of the lot. Record the location and data from all profilograph measurements. Compute the profile index for each pass of the profilograph in each 0.1 km 0.1 mile segment. Provide a profile index not greater than 110 mm per km 7 inches per mile per segment for runways, taxiways and landing zones. Provide a profile index not greater than 140 mm per km 9 inches per mile per segment for all other pavements. Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm 0.4 inch in height by diamond grinding until they do not exceed 7.5 mm 0.3 inch when retested. Taper diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding. Skin patching for correcting low areas and planing or milling for correcting high areas are not permitted. When the profile index of a lot exceeds the tolerance specified, determine pay factor using Table 2. Diamond grinding is allowed to reduce the scallop height of pavement to decrease the lot profile index as long as minimum lift thickness per Contract is met and the diamond grinding limit per paragraph SURFACE SMOOTHNESS is not exceeded. Perform additional profilograph testing in all areas corrected by diamond grinding. Provide profilograph operated by an approved, factory-trained operator. Provide a digital copy of all test results to the Government in each paving lot report.

[1.7.9.3 Final Profilograph Testing

****

NOTE: Select this paragraph if project includes long linear pavements such as a runway or taxiway where evaluation of between lot transitions are desired. Appropriate projects would include new construction, complete mill/overlay or reconstruction of a runway/taxiway or other similar airfield feature. Edit bracketed text for the

airfield feature(s) to be evaluated.
****

After all paving on the [runway][taxiway] is complete, perform final profilograph testing in the longitudinal direction per paragraph PROFILOGRAPH TESTING with the following changes. Operate the profilograph the full length of the asphalt pavement on the [runway][taxiway] to facilitate testing of the smoothness between lots and to evaluate the transition of any transverse joints. Provide pavements having an average total profile index less than 158 mm per km 10 inches per mile. Operate the profilograph 0.3 m 1 foot left and right of centerline and 4.5 m 15 feet right and left of project centerline (four total traces). Correct any "must grind" areas by diamond grinding or by removing and replacing full depth of the surface course. Reevaluate the pavement with a second profilograph run after corrections to ensure an average profile index of 158 mm per km10 inches per mile or less is achieved. Final profilograph testing is to be done in addition to the profilograph traces being performed on a lot basis. Provide a digital copy of the test results to the Government prior to full acceptance of the pavement.]

1.7.10 Plan Grade

Within 5 working days after completion of a particular lot incorporating the final wearing course, test the lot for conformance with specified plan grade requirements. Provide a final wearing surface of pavement conforming to the elevations and cross sections and not vary more than 9 mm 0.03 foot for runways and landing zones or 15 mm 0.05 foot for taxiways, aprons and shoulders. Deviation from the plan elevations will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. The grade will be determined by running lines of levels at intervals of 15 m 50 feet, or less, longitudinally that coincides with the project spot elevations and lateral spacing to match the paving lane width (after cut back). In areas where the grade exceeds the tolerance by more than 50 percent, remove the surface lift full depth and replace the lift with asphalt pavement to meet specification requirements, at no additional cost to the Government. Match finished surfaces at juncture with other pavements with finished surfaces of abutting pavements except for where paragraph ASPHALT PAVEMENT-PORTLAND CEMENT CONCRETE JOINTS apply. Diamond grinding can be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas is not permitted. Provide finished surface grades in record drawing format showing design and constructed elevations which are stamped and signed by a licensed surveyor. Provide a comparison of the as-built grades to the design grades and determine a percentage of individual measurements exceeding the tolerances specified and determine pay factor per paragraph PAY FACTOR BASED ON PLAN GRADE. Submit the survey CAD files to the Government for record purposes. Submit all files including the calculation for percent measurements in each paving lot report.

1.8 Laboratory Accreditation and Validation

****
NOTE: For Army managed projects, keep the bracketed text. For Air Force, and Navy, managed projects, utilization of the USACE Materials Testing Center (MTC) Validated Laboratory is optional.
****

Provide laboratories used to develop the Job Mix Formula (JMF), perform acceptance testing, and Contractor Quality Control testing that meet the requirements of ASTM D3666. Perform all required test methods by an accredited [and validated] laboratory including field standards. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory accreditation is not allowed. The Government will inspect the laboratory equipment and test procedures prior to the start of asphalt pavement operations for conformance with ASTM D3666. [In addition, all testing laboratories performing JMF, acceptance testing and Contractor Quality Control requires USACE validation by the Material Testing Center (MTC) for both parent laboratory and plant testing laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at https://mtc.erdc.dren.mil/ for costs and scheduling.] Submit a certificate of compliance signed by the manager of the laboratory stating that it meets these requirements to the Government prior to the start of construction. At a minimum, include the following certifications:

a. Qualification(s) and certification(s) of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment, with calibration dates, to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

1.9 ENVIRONMENTAL REQUIREMENTS

****

NOTE: The temperature requirements in Table 6 are included to avoid problems with the Contractor achieving density because the mix cools too fast. Waivers to these requirements, for isolated incidences during production, are applicable if the density requirements are still met.

****

Do not place asphalt pavement upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 6. The temperature requirements may be waived by the Government, if requested; provided all other requirements, including in-place density, are met.

Table 6	
Surface Temperature Limitations of Underlying Course	
Mat Thickness, mm inches	Degrees C F
75 3 or greater	440
Less than 75 3	745

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

This section is intended to stand alone for construction of asphalt pavement. However, where the construction covered herein interfaces with other sections, construct each interface to conform to the requirements of both this section and the other section, including tolerance for both.

Perform the work consisting of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. Provide hot-mix asphalt (HMA)warm-mix asphalt (WMA) pavement designed and constructed in accordance with this section conforming to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Construct each course to the depth, section, or elevation required by the drawings and rolled, finished, and approved before the placement of the next course (adjacent to or above). Submit proposed Placement Plan, indicating lane widths, longitudinal joints, and transverse joints for each course or lift.

2.2 Equipment

Provide product data for all components below.

2.2.1 Asphalt Mixing Plant

Provide plants used for the preparation of asphalt mixture conforming to the requirements of AASHTO M 156, including calibration data.

2.2.1.1 Truck Scales

Weigh the asphalt mixture on approved scales, or on certified public scales at no additional expense to the Government. Inspect and seal scales at least annually by an approved calibration laboratory.

2.2.1.2 Inspection of Plant

Provide access to the Government at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance as requested, for the Government to procure any desired samples.

2.2.1.3 Storage Silos

The asphalt mixture may be stored in non-insulated storage silos for a period of time not exceeding 3 hours. The asphalt mixture may be stored in insulated storage silos for a period of time not exceeding 8 hours. No differences in the mix removed from silos and the mix loaded into trucks are allowed.

2.2.2 Hauling Equipment

Provide trucks used for hauling asphalt mixture that have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, lightly coat the truck beds with a minimum amount of paraffin oil, lime solution, or other approved material. Do not use petroleum based products as a release agent. Cover the bed of each truck with a tarp or other suitable cover at all times during transport. When necessary to ensure that the mixture is delivered to the site at the specified temperature, provide insulated or heated truck beds with covers (tarps) that are securely fastened.

2.2.3 Material Transfer Vehicle (MTV)

****

NOTE: A Material Transfer Vehicle (MTV) is required for runway, taxiway, landing zone, overruns and apron construction. The use of an MTV is optional for shoulder construction. MTV is recommended for all pavements where the weight of the MTV will not damage the pavement structure.

****

Provide a self-propelled MTV with a swing conveyor that delivers material to the paver from outside the paving lane and without making contact with the paver. Provide MTV capable to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. Provide Material Transfer Vehicle with remixing and a minimum onboard storage capability of 13 metric tons tons.

2.2.4 Asphalt Pavers

Provide mechanical spreading and finishing equipment consisting of a self-powered paver, capable of spreading and finishing the mixture to the specified line, grade, and cross section. Provide paver with a vibrating screed capable of placing a uniform mixture to meet the specified thickness, smoothness, and grade without physical or temperature segregation, the full width of the material being placed. Provide a screed that effectively produces a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. Provide information on the tractor(s) and screed(s) proposed for use.

2.2.4.1 Receiving Hopper

Provide paver with a receiving hopper of sufficient capacity to permit a uniform spreading operation and a distribution system to place the mixture uniformly in front of the screed without segregation.

2.2.4.2 Automatic Grade Controls

****

NOTE: Delete information on automatic grade control if not needed. Automatic grade control is needed when the design requires elevations for the asphalt pavement surface. Many maintenance and rehabilitation projects require an overlay thickness and do not specify actual grades.

****

If an automatic grade control device is used, provide a paver equipped with a control system capable of automatically maintaining the specified screed elevation that is automatically actuated from either a reference line or through a system of mechanical sensors or sensor-directed mechanisms or devices which maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. Provide transverse slope controller capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. Do not use the transverse slope controller to control grade. Provide controls capable of working in conjunction with any of the following attachments:

a. Ski-type device of not less than 9.14 m 30 feet in length.

b. Taut stringline set to grade.

c. Short ski or shoe for joint matching.

d. Laser control.

e. GPS control.

2.2.5 Rollers

Provide rollers in good condition and operated at slow speeds to avoid displacement of the asphalt mixture. Provide sufficient number, type, and weight of rollers to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate.

2.2.6 Diamond Grinding

Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth is limited below. Reduce high areas by diamond grinding the asphalt pavement with approved equipment after the asphalt pavement is at a minimum age of 14 days. Perform diamond grinding by sawing with saw blades impregnated with an industrial diamond abrasive. Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the asphalt pavement. Provide diamond grinding equipment with saw blades that are 3 mm 1/8-inch wide, a minimum of 60 blades per 300 mm 12 inches of cutting head width, and capable of cutting a path a minimum of 0.9 m 3 feet wide. Diamond grinding equipment that causes raveling, fracturing of aggregate , or disturbance to the underlying material will not be allowed. The maximum area corrected by diamond grinding the surface of the asphalt pavement is 10 percent of the total area of any sublot. The maximum depth of diamond grinding is 12 mm 1/2 inch. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government property. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified.

Prior to production diamond grinding operations, perform a test section at the approved location, consisting of a minimum of two adjacent passes with a minimum length of 12 m 40 feet to allow evaluation of the finish and transition between adjacent passes. Production diamond grinding operations cannot be performed prior to approval.

2.3 AGGREGATES

****

For Design-Bid-Build projects, select the first bracketed text. For Design-Build projects, select the second bracketed text..

****

Sample aggregates in the presence of a Government Representative. Obtain samples in accordance with ASTM D75/D75M and be representative of the materials to be used for the project. Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. The portion of material retained on the 4.75 mm No. 4 sieve is coarse aggregate. The portion of material passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve is fine aggregate. The portion passing the 0.075 mm No. 200 sieve is defined as mineral filler. Submit sufficient materials to produce 90 kg 200 pounds 181 kg 400 pounds of blended mixture for mix design verification. Submit all aggregate test results and samples to the Government at least 14 days prior to start of construction. Aggregate tests can be no older than [6 months prior to contract award][6 months prior to test section].

2.3.1 Coarse Aggregate

****

NOTE: The requirement for sulfate soundness (requirement b., below) may be deleted in climates where freeze-thaw does not occur. However, in those areas where freeze-thaw does not occur, keep requirement b. if experience has shown that this test separates good performing aggregates from bad performing aggregates. Retain this requirement for all Navy projects.

It is recommended that percentage of Wear (ASTM C131/C131M) not exceed 40. Aggregates with a higher percentage of wear may be specified, provided a satisfactory record under similar conditions of service and exposure has been demonstrated.

****

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Provide coarse aggregate particles meeting the following requirements:

a. The percentage of loss not greater than 40 [_____] percent after 500 revolutions when tested in accordance with ASTM C131/C131M.

b. The sodium sulfate soundness loss not exceeding 12 percent, or the magnesium sulfate soundness loss not exceeding 18 percent after five cycles when tested in accordance with ASTM C88.

c. At least 75 percent by weight of coarse aggregate contain at least two or more fractured faces when tested in accordance with ASTM D5821 with fractured faces produced by crushing.

d. The particle shape essentially cubical and the aggregate containing not more than 5 percent, by weight, of flat particles, elongated particles, or flat and elongated particles (5:1 ratio of maximum to minimum) when tested in accordance with ASTM D4791 Method A.

e. Slag consisting of air-cooled, blast furnace slag, with a compacted weight of not less than 1200 kg per cubic meter 75 pounds per cubic foot when tested in accordance with ASTM C29/C29M.

f. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.3.2 Fine Aggregate

****

NOTE: Set the lower limit for uncompacted void content (requirement c., below) at 45 for fine aggregate angularity unless local experiences indicate that a lower value can be used. There are some aggregates which have a good performance record and have an uncompacted void content less than 45. In no case set the limit at less than 43.

****

Provide fine aggregate consisting of clean, sound, tough, durable particles. Provide aggregate particles that are free from coatings of clay, silt, or any objectionable material, contain no clay balls, and meet the following requirements:

a. Quantity of natural sand (noncrushed material) added to the aggregate blend not exceeding 15 percent by weight of total aggregate.

b. Individual fine aggregate sources with a sand equivalent value greater than 45 when tested in accordance with ASTM D2419.

c. Fine aggregate portion of the blended aggregate with an uncompacted void content greater than 45.0 percent when tested in accordance with ASTM C1252 Method A.

d. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.3.3 Mineral Filler

Provide mineral filler consisting of a nonplastic material meeting the requirements of ASTM D242/D242M.

2.3.4 Aggregate Gradation

****

NOTE: Delete from Table 7, the gradations that will not be used as a part of this project.

Limit use of gradation 1 to intermediate courses. Gradation 2 is suitable for intermediate and surface courses. Limit gradation 3 to shoulders and leveling courses. Do not use gradation 1 for surface courses.

Generally, the layer thickness for gradation No. 1 would be at least 57 mm 2.25 inches, the thickness for gradation No. 2 would be at least 37.5 mm 1.5 inches, and thickness for gradation No. 3 would be at least 25 mm 1.0 inch. The preferred thickness of the surface layer is 50 mm 2 inches. The surface layer should not be less than 37 mm 1.5 inches. The thickness of the underlying layers can be up to 75 mm

3 inches depending on the total designed thickness of the asphalt mixture.

****

Provide a combined aggregate gradation that conforms to gradations specified in Table 7, when tested in accordance with ASTM C136/C136M and ASTM C117, and does not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grades uniformly from coarse to fine. Provide a JMF within the specification limits; however, the gradation can exceed the limits when the allowable deviation from the JMF shown in Tables 10 and 11 are applied.

Table 7

Aggregate Gradations

	Gradation 1	Gradation 2	Gradation 3
Sieve Size, mm inch	Percent Passing by Mass	Percent Passing by Mass	Percent Passing by Mass
25.01	100	---	---
19.03/4	90-100	100	---
12.51/2	68-88	90-100	100
9.53/8	60-82	69-89	90-100
4.75No. 4	45-67	53-73	58-78
2.36No. 8	32-54	38-60	40-60
1.18No. 16	22-44	26-48	28-48
0.60No. 30	15-35	18-38	18-38
0.30No. 50	9-25	11-27	11-27
0.15No. 100	6-18	6-18	6-18
0.075No. 200	3-6	3-6	3-6

2.4 ASPHALT BINDER

****

NOTE: Specify Performance Graded (PG) asphalt binders wherever available. Consider using the same grade PG binder used by the state highway department in the area as the base grade for the project (for example, the grade typically specified in that specific location for dense graded mixes on highways with design ESALS less than 10 million). Do not use grades with a low temperature higher than PG XX-22 (i.e. PG XX-16, PG XX-10).

Typically, rutting is not a problem on airport pavements. However, at airports with a history of

stacking on end of runways and taxiway areas, rutting has accrued due to the slow speed of loading on the pavement. If there has been rutting on the project or it is anticipated that stacking may accrue during the design life of the project, then apply the following grade "bumping" for the top 125 mm 5 inches of paving in the end of runway and taxiway areas: for aircraft tire pressure between 0.7 and 1.4 MPa 100 and 200 psi, increase the high temperature one grade; for aircraft tire pressure greater than 1.4 MPa 200 psi, increase the high temperature two grades.

For Navy projects, a high temperature increase of two grades is required. Each grade adjustment is 6 degrees C. Polymer Modified Asphalt, PMA, has shown to perform very well in these areas.

The low temperature grade should remain the same. The Engineer may lower the low temperature grade to comply with the recommendations of the FHWA's software program "LTPPBind", if it is believed to be appropriate.

Retain bracketed verification testing text for runway, taxiway, and apron projects.

For asphalt binders that are anticipated to be polymer modified, select the bracketed text requiring PG Plus testing. If designers are unaware of acceptable elastic recovery, use a minimum percentage of 75.

****

Provide asphalt binder that conforms to ASTM D6373 for Performance Grade (PG) [_____][Provide asphalt binder that conforms to ASTM D946/D946M Penetration Grade [_____]][Provide asphalt binder that conforms to ASTM D3381/D3381M Viscosity Grade [_____]]. Provide test data indicating grade certification by the supplier at the time of delivery of each load to the mix plant. [For modified binders, perform PG Plus test requirements in ASTM D6084/D6084M Procedure B on RTFO aged binder, with a minimum elastic recovery of [_____] percent.] When warm-mix asphalt technology involves additives, grade the the asphalt binder with the additive included. Submit copies of these certifications to the Government. The supplier is defined as the last source of any modification to the binder. The Government may sample and test the binder at the mix plant at any time before or during mix production. [Obtain samples for this verification testing in accordance with ASTM D140/D140M and in the presence of the Government. Provide these samples to the Government for the verification testing, which will be performed at the Governments expense. Submit 20 L 5 gallon sample of the asphalt binder specified for mix design verification and approval not less than 14 days before start of the test section.]

2.5 WARM-MIX ASPHALT TECHNOLOGIES/PRODUCTS

Provide warm-mix asphalt technologies/products that have a record of good performance and are included on the local state DOT's qualified products list, if the DOT maintains a qualified products list. Also, include the warm-mix asphalt technologies/products in at least two out of the following three states DOT's qualified products lists: Florida, Texas, and Virginia. These qualified products lists can be found at each state DOT's website.

2.6 MIX DESIGN

****

NOTE: Use 75 blow Marshall hand-held hammer compaction or 75 gyration Superpave gyratory compaction for all pavements designed for tire pressures of 690 kPa 100 psi or higher.

Use 50 Blow Marshall hand-held hammer compaction or 50 gyration Superpave gyratory compaction for all shoulder pavements and pavements designed for tire pressures less than 690 kPa 100 psi.

For Marshall mixes, delete the column in Table 8 which does not apply, unless the project includes both 75 Blow and 50 Blow mixes.

Select the appropriate gradation and VMA requirements in Table 9 to be consistent with the gradation chosen in Table 7. Delete the other two rows in Table 9 unless using multiple gradations.

In areas exposed to frequent freeze/thaw, require freeze/thaw conditioning.

****

Develop the mix design and provide results of the Job Mix formula (JMF) and aggregates testing performed no earlier than 6 months prior to contract award. Provide asphalt mixture composed of well-graded aggregate, mineral filler if required, and asphalt material. Provide aggregate fractions sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of Table 7. Do not produce asphalt pavement for payment until a JMF has been approved. Design the asphalt mixture using hand-held (manual) Marshall hammer procedures contained in AI MS-2 and the criteria shown in Table 8. Mechanical hammers are not permitted during JMF development. Design the asphalt mixture using the Superpave gyratory compactor set at [50] [75] gyrations using the procedures contained in AI MS-2 and the criteria shown in Table 8. Prepare samples at various asphalt contents and compacted in accordance with ASTM D6925ASTM D6926. Use laboratory compaction temperatures for Polymer Modified Asphalts as recommended by the asphalt binder supplier. For tensile strength ratio (TSR) testing, adjust the compactive effort, as required, to provide specimens with an air void content of 7 plus or minus 1 percent. [Use freeze/thaw conditioning in lieu of moisture conditioning per Note 6 of ASTM D4867/D4867M. If freeze/thaw conditioning is used, include that fact on the report.] If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M is less than 75, reject the aggregates or treat the asphalt mixture with an anti-stripping agent. Add a sufficient amount of anti-stripping agent to produce a TSR of not less than 75. If an antistrip agent is required, provide it at no additional cost to the Government. Provide sufficient materials to produce 90 kg 200 pounds 181 kg 400 pounds of blended mixture to the Government for verification of mix design at least 14 days prior to construction of test section.

2.6.1 JMF Requirements

Submit the proposed JMF in writing, for approval, at least 14 days prior to the start of the test section, including as a minimum:

a. Percent passing each sieve size.

b. Optimum asphalt content.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt viscosity grade, penetration grade, or performance grade and additional test requirements as specified in paragraph ASPHALT BINDER.

e. Number of blows of hammer per side of molded specimen.Number of Superpave gyratory compactor gyrations.

f. Laboratory mixing and compaction temperatures.

g. Supplier-recommended field mixing and compaction temperatures.

h. Percentage and properties (asphalt content aggregate gradation, and aggregate properties) of RAP in accordance with paragraph RECYCLED ASPHALT PAVEMENT, if RAP is used.

i. Temperature-viscosity relationship of the asphalt binder.

j. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

k. Graphical plots and summary tabulation of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2. Include summary tabulation that includes individual specimen data for each specimen tested.

l. Specific gravity and absorption of each aggregate.

m. Percent natural sand.

n. Percent particles with two or more fractured faces (in coarse aggregate).

o. Fine aggregate angularity.

p. Percent flat or elongated particles (in coarse aggregate).

q. Tensile Strength Ratio and wet/dry specimen test results.

r. Type and amount of antistrip agent (if required).

s. List of all modifiers.

t. Percentage and properties (asphalt content aggregate gradation, and aggregate properties) of RAP in accordance with paragraph RECLAIMED ASPHALT PAVEMENT, if RAP is used.

u. Date the JMF was developed. Mix designs that are not dated or which are from a prior construction season may not be accepted.

v. Warm-mix additive.

Table 8

Marshall Design Criteria

Test Property	75 Blow Mix	50 Blow Mix
Stability, N pounds minimum	95602150(1)	60001350(1)
Flow, 0.25 mm 0.01 inch	8-16(2)	8-18(2)
Air voids, percent	4(4)	4(4)
Percent Voids in mineral aggregate (minimum)	See Table 9	See Table 9
Dust Proportion(3)	0.8-1.2	0.8-1.2
TSR, minimum percent	75	75
TSR Conditioned Strength (minimum kPa psi)	41560	41560

(1) This is a minimum requirement. Provide significantly higher average during construction to ensure compliance with the specifications.

(2) The flow requirement is not applicable for Polymer Modified Asphalts

(3) Dust Proportion is calculated as the aggregate content, expressed as a percent of mass, passing the 0.075 mm No. 200 sieve, divided by the effective asphalt content, in percent of total mass of the mixture.

(4) Select the JMF asphalt content corresponding to an air void content of 4 percent. Verify the other properties of Table 8 meet the specification requirements at this asphalt content.

Table 8

Superpave Gyratory Compaction Criteria

Test Property	Value
Air voids, percent	4(1)
Percent Voids in mineral aggregate (minimum)	See Table 9
Dust Proportion(2)	0.8-1.2
TSR, minimum percent	75

Table 8	
Superpave Gyratory Compaction Criteria	
Test Property	Value
TSR Conditioned Strength (minimum kPa psi)	41560
(1) Select the JMF asphalt content corresponding to an air void content of 4 percent. Verify the other properties of Table 8 meet the specification requirements at this asphalt content.	
(2) Dust Proportion is calculated as the aggregate content, expressed as a percent of mass, passing the 0.075 mm No. 200 sieve, divided by the effective asphalt content, in percent of total mass of the mixture.	

Table 9	
Minimum Percent Voids in Mineral Aggregate (VMA)(1)	
Aggregate (See Table 7)	Minimum VMA, percent
Gradation 1	13.0
Gradation 2	14.0
Gradation 3	15.0
(1) Calculate VMA in accordance with AI MS-2, based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate.	

2.6.2 Adjustments to JMF

The JMF for each mixture is in effect until a new formula is approved in writing by the Government. Should a change in sources of any materials be made, perform a new mix design and a new JMF approved before the new material is used. Make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF are limited to plus or minus 4 percent on the 4.75 mm No. 4 and coarser sieves; plus or minus 3 percent on the 2.36 mm No. 8 to 0.30 mm No. 50 sieves; and plus or minus 1 percent on the 0.15 mm No. 100 sieve. Adjustments to the JMF are limited to plus or minus 1.0 percent on the 0.075 mm No. 200 sieve. Asphalt content adjustments are limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, develop a new mix design.

2.7 RECLAIMED ASPHALT PAVEMENT

****

NOTE: Do not use Reclaimed Asphalt Pavement (RAP) for surface mixes, except on shoulders. It can be used very effectively in lower layers, or for shoulders. Limit the amount of RAP so the asphalt binder from the RAP does not exceed 20 percent of the total asphalt content.

Select first bracketed text when RAP is not used and delete the following two paragraphs. Select second bracketed text when RAP will be used for shoulders or lower layers (non-surface) and keep the following two paragraphs.

****

[Reclaimed asphalt is not allowed for the project.][Provide reclaimed asphalt consisting of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt binder. Provide RAP of a consistent gradation, asphalt content, and properties. Do not use RAP containing Coal Tar. When RAP is fed into the plant, the maximum RAP chunk size is 50 mm 2 inches. The individual aggregates in a RAP chunk are not to exceed the maximum size aggregate of the gradation specified in Table 7. Design the reclaimed asphalt mixture using procedures contained in AI MS-2. Provide RAP job mix that meets the requirements of paragraph MIX DESIGN. RAP is only allowed to be used for shoulder surface course mixes and for any intermediate courses. Limit the amount of RAP so the asphalt binder from the RAP does not exceed 20 percent of the total asphalt content. If RAP is anticipated to include natural sand, reduce the proportions of virgin natural sand appropriately to account for natural sand contained in the RAP.]

2.7.1 RAP Aggregates and Asphalt Binder

Provide a blend of aggregates used in the reclaimed mix that meet the requirements of paragraph AGGREGATES. Establish the percentage of asphalt in the RAP for the mixture design according to ASTM D2172/D2172M using the appropriate dust correction procedure.

2.7.2 RAP Mix

Do not make adjustments to the virgin binder selection for 0-20 percent recycled binder content.

2.8 RECYCLED ASPHALT SHINGLES

****

NOTE: Recycled asphalt shingles (RAS) usually is available as pre-consumer (manufacturer waste) or post consumer (tear-off) products. Due to the extreme stiffness of the binder in these products, do not allow on airfield pavements. Contact the cognizant representatives of the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement subject matter expert (SME), or the Naval Facilities Engineering Systems Command (NAVFAC) engineer for further guidance if RAS is being further considered.

****

Recycled asphalt shingles (RAS) is not allowed for the project.

PART 3 EXECUTION

3.1 CONTRACTOR QUALITY CONTROL

****

NOTE: The Contractor may be able to meet the

specified quality control requirements with in-house capability or may have to use the independent commercial laboratory to provide the required quality control testing.

****

3.1.1 General Quality Control Requirements

Submit the Pavement Quality Control Plan. The Quality Control Plan is specific to this specification and supplements the overall Quality Control Plan required by Section 01 45 00. Do not produce hot-mixwarm-mix asphalt pavement for payment until the quality control plan has been approved. In the quality control plan, address all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design and unique JMF identification code

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management and procedures to prevent contamination

e. Proportioning including percent of warm-mix additive

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction, including Asphalt Pavement-Portland Cement Concrete joints

l. Surface Smoothness

m. Truck bed release agent

n. Correlation of mechanical hammer to hand-held (manual) hammer. Determine the number of blows of the mechanical hammer required to provide the same density of the JMF as provided by the hand-held (manual) hammer. Use the average of three specimens per trial blow application.

3.1.2 Testing Laboratory

Provide a fully equipped asphalt laboratory located at the plant or job site that is equipped with heating and air conditioning units to maintain a temperature of 24 plus or minus 2.3 degrees C 75 plus or minus 5 degrees F. Provide laboratory facilities that are kept clean and all equipment maintained in proper working condition. Provide the Government with unrestricted access to inspect the laboratory facility, to witness quality control activities, and to perform any check testing desired. The Government will advise in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, immediately suspend the incorporation of the materials into the work. Incorporation of the materials into the work will not be permitted to resume until the deficiencies are corrected.

3.1.3 Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The quality control (QC) testing is separate and distinct from the acceptance testing in paragraph ACCEPTANCE. Use in-house capabilities or the independent commercial laboratory for quality control testing. Required elements of the testing program include, but are not limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, stability, flow, in-place density, grade and smoothness. Develop a Quality Control Testing Plan as part of the Quality Control Program.

3.1.3.1 Asphalt Content

Determine asphalt content a minimum of twice per lot (a lot is defined in paragraph PAVEMENT LOTS) by one of the following methods: extraction method in accordance with ASTM D2172/D2172M, Method A or B, the ignition method in accordance with ASTM D6307, or the nuclear method in accordance with ASTM D4125/D4125M, provided each method is calibrated for the specific mix being used. For the extraction method, determine the weight of ash, as described in ASTM D2172/D2172M, as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. Use the last weight of ash value in the calculation of the asphalt content for the mixture. The asphalt content for the lot will be determined by averaging the test results.

3.1.3.2 Aggregate Properties

Determine aggregate gradations a minimum of twice per lot (a lot is defined in paragraph PAVEMENT LOTS) from mechanical analysis of recovered aggregate in accordance with ASTM D5444, ASTM C136/C136M, and ASTM C117. Determine the specific gravity of each aggregate size grouping for each 18,000 metric tons 20,000 tons in accordance with ASTM C127 or ASTM C128. Determine fractured faces for gravel sources for each 18,000 metric tons 20,000 tons in accordance with ASTM D5821. Determine the uncompacted void content of fine aggregate (including manufactured sand and blending aggregate) for each 18,000 metric tons 20,000 tons in accordance with ASTM C1252 Method A.

3.1.3.3 Temperatures

Check temperatures at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt binder in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.1.3.4 Moisture Content of Aggregate

Determine the moisture content of aggregate used for production a minimum of once per lot in accordance with ASTM C566.

3.1.3.5 Moisture Content of Mixture

Determine the moisture content of the mixture at least once per lot in accordance with AASHTO T 329.

3.1.3.6   Laboratory Air Voids, TMD, and VMA VMA, Marshall Stability and Flow

Obtain mixture samples at least four times per lot and compacted into specimens, using [50] [75] blows per side with the Marshall hand-held (manual) hammer as described in ASTM D6926. The mechanical Marshall hammer can be used only after JMF development and after correlation from hand-held (manual) Marshall hammer to mechanical Marshall hammer per guidance in AI MS-2.using [50] [75] gyrations of the Superpave gyratory compactor as described in ASTM D6925. After compaction, measure the bulk density of laboratory compacted specimens in accordance with ASTM D2726/D2726M. Determine the laboratory air voids from the set (three laboratory compacted specimens) for each sample in accordance with ASTM D3203/D3203M. Also calculate the VMA of each specimen in accordance with AI MS-2 based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate, as well as the Marshall stability and flow, as described in ASTM D6927. Provide VMA within the limits of Table 9.

3.1.3.7   In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge or other non-destructive testing device may be used to monitor pavement density for Contractor Quality Control purposes only.

3.1.3.8   Grade and Smoothness

Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph ACCEPTANCE.

3.1.3.9   Additional Testing

Perform any additional testing, deemed necessary to control the process.

3.1.3.10   QC Monitoring

Submit all QC test results to the Government on a daily basis as the tests are performed. The Government reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.1.4   Sampling

When directed by the Government, sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected. Perform all sampling in accordance with standard procedures specified.

3.1.5   Control Charts

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 10, as a minimum. Post the control charts as directed by the Government and maintain current at all times. Identify the following on the control charts, the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 10 applicable to the test parameter being plotted, and the test results. Also show target values (JMF) on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. When the Suspension Limit is exceeded for individual values or running average values, the Government has the option to require removal and replacement of the material represented by the samples or to leave in place and base acceptance on mixture volumetric properties and in place density. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make decisions concerning mix modifications based on analysis of the results provided in the control charts. In the Quality Control Plan, indicate the appropriate action to be taken to bring the process into control when certain parameters exceed their Action Limits.

Table 10

Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of Last Four Samples	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
4.75 mm No. 4 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values	6	8	4	5
0.6 mm No. 30 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus	4	6	3	4
0.075 mm No. 200 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus	1.4	2.0	1.1	1.5
Asphalt content, percent deviation from JMF target; plus or minus value	0.4	0.5	0.2	0.3
Laboratory Air Voids, percent deviation from JMF target value	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Mat Density, percent of TMD	No specific action and suspension limits set since this parameter is used to determine			
In-place Joint Density, percent of TMD	No specific action and suspension limits set since this parameter is used to determine			
VMA, percent deviation from JMF target				
Gradation 1, 2 & 3	-0.5	-1.0	-0.25	-0.5
$P_{0.075}/P_{be}$ Ratio, deviation from 1.0; plus or minus values	0.7	0.8	0.3	0.4

Table 10 cont'd				
Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts - Marshall Compaction				
Stability, N pounds (minimum)				
75 blow JMF	78301760	72901640	95602150	90302030
50 blow JMF	4230950	3690830	60001350	54701230
Flow, 0.25 mm 0.01 inch				
75 blow JMF	8 min.	7 min.	9 min.	8 min.
	16 max.	17 max.	15 max.	16 max.
50 blow JMF	8 min.	7 min.	9 min.	8 min.
	18 max.	19 max.	17 max.	18 max.

3.2 PREPARATION OF ASPHALT BINDER MATERIAL

Heat the asphalt binder material while avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. Maintain the temperature of unmodified asphalts to no more than 160 degrees C 325 degrees F when added to the aggregates. The temperature of modified asphalts is not to exceed 175 degrees C 350 degrees F.

3.3 PREPARATION OF MINERAL AGGREGATE

Heat and dry the aggregate for the mixture prior to mixing. No damage to the aggregates due to the maximum temperature and rate of heating used is allowed. Maintain the temperature no lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.4 PREPARATION OF ASPHALT MIXTURE

Weigh or meter the aggregates and the asphalt binder and introduce into the mixer in the amount specified by the JMF. Limit the temperature of the asphalt mixture to 175 degrees C 350 degrees F 132 degrees C 270 degrees F when the asphalt binder is added. Mix the combined materials until the aggregate obtains a thorough and uniform coating of asphalt binder (testing in accordance with ASTM D2489/D2489M may be required by the Contracting Officer) and is thoroughly distributed throughout the mixture. The moisture content of all asphalt mixture upon discharge from the plant is not to exceed 0.5 percent by total weight of mixture as measured by AASHTO T 329.

3.5 PREPARATION OF THE UNDERLYING SURFACE

****

NOTE: If the underlying surface to be paved is an unbound granular layer, apply a prime coat, especially if this layer will be exposed to weather

for an extended period of time prior to covering with an asphalt mixture. Benefits derived from a prime coat include an additional weatherproofing of the base, improving the bond between the base and asphalt layer, and preventing the base from shifting under construction equipment. If the prime coat requirement is not a separate pay item and is waived from this contract, make an adjustment to the contract price. Environmental laws in certain states may not allow prime coats to be applied.

If the underlying surface to be paved is an existing asphalt or concrete layer, use a tack coat to ensure an adequate bond between layers.

Tack and prime coat requirements will need to be covered in the contract documents.

****

Immediately before placing asphalt pavement, clean the underlying course of dust and debris. Apply a [prime coat][or][tack coat] in accordance with Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.6 TEST SECTION

Prior to full production, place a test section for each JMF used. Construct a test section 150 m 500 feet long and two paver passes wide with a longitudinal cold joint. Do not place the second lane of test section until the temperature of pavement edge is less than 80 degrees C 175 degrees F. Construct the test section with the same depth as the course which it represents. Ensure the underlying grade or pavement structure upon which the test section is to be constructed is the same or very similar to the underlying layer for the project. Use the same equipment in construction of the test section as on the remainder of the course represented by the test section. Construct the test section as part of the project pavement as approved by the Government.

3.6.1 Sampling and Testing for Test Section

****

NOTE: Table 11 applies only to the test section. The limits in Tables 1, 3, and 10, apply to a number of tests run from a lot. This is why the limits listed in Table 11 are different from those listed in Tables 1, 3 and 10.

Select the appropriate stability and flow value to match the laboratory compactive effort (50 or 75 blows).

****

Obtain one representative sample from random trucks at the plant, compact triplicate specimens, and test for stability, flow, and laboratory air voids. Test a portion of the same sample for theoretical maximum density (TMD), aggregate gradation and asphalt content. Test an additional portion of the sample to determine the TSR. Adjust the compactive effort as required to provide TSR specimens with an air void content of 7 plus or minus 1 percent. Obtain four randomly selected cores from the finished pavement mat, and four from the longitudinal joint, and test for density.

Perform random sampling in accordance with procedures contained in ASTM D3665. Construction may continue provided the test results are within the tolerances or exceed the minimum values shown in Table 11. If all test results meet the specified requirements, the test section may remain as part of the project pavement. If test results exceed the tolerances shown, remove and replace the test section and construct another test section at no additional cost to the Government.

Table 11

Test Section Requirements for Material and Mixture Properties

Property	Specification Limit
Aggregate Gradation-Percent Passing (Individual Test Result)	
4.75 mm No. 4 and larger	JMF plus or minus 8
2.36, 1.18, 0.60, and 0.30 mmNo. 8, No. 16, No. 30, and No. 50	JMF plus or minus 6
0.15 and 0.075 mmNo. 100 and No. 200	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	See Table 9
Tensile Strength Ratio (TSR) (At 7 percent plus/minus 1 percent air void content)	75 percent minimum
Conditioned Strength	415 kPa 60 psi minimum
Mat Density, Percent of TMD (Average of 4 Random Cores)	92.0 - 96.0
Joint Density, Percent of TMD (Average of 4 Random Cores)	90.5 minimum

Table 11 cont'd

Test Section Requirements for Material and Mixture Properties
Marshall Compaction

Stability, (Average of 3 specimens)	[9560 N 2150 pounds minimum for 75-blow][6000 N 1350 pounds minimum for 50-blow]
Flow, 0.25 mm 0.01 inch (Average of 3 specimens)	[8 - 16 for 75-blow] [8 - 18 for 50-blow]

3.6.2 Additional Test Sections

If the initial test section proves to be unacceptable, make the necessary adjustments to the JMF, plant operation, placing procedures, and rolling procedures before beginning construction of a second test section. Construct and evaluate additional test sections, as required, for conformance to the specifications. Full production paving is not allowed to begin until an acceptable test section has been constructed and accepted.

3.7 TRANSPORTING AND PLACING

3.7.1 Transporting

Transport asphalt mixture from the mixing plant to the site in clean, tight vehicles. Schedule deliveries so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Provide adequate artificial lighting for night placements. Hauling over freshly placed material is not permitted until the material has been compacted as specified, and allowed to cool to 60 degrees C 140 degrees F.

3.7.2 Placing

Place the mix in lifts of adequate thickness and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Place the mixture to the full width by an asphalt paver; strike off in a uniform layer of such depth that, when the work is complete, the required thickness conforms to the grade and contour indicated. Do not broadcast waste mixture onto the mat or recycle it into the paver hopper. Collect waste mixture and dispose off site. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat. Begin placement of the mixture along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture in consecutive adjacent strips having a minimum width of 3 m 10 feet. Offset the longitudinal joint in one course from the longitudinal joint in the course immediately below by at least 300 mm 1 foot; however, locate the joint in the surface course at the centerline of the pavement. Offset transverse joints in one course by at least 3 m 10 feet from transverse joints in the previous course. Offset transverse joints in adjacent lanes a minimum of 3 m 10 feet. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools. Construct the free edge of shoulder pavements following a guide (e.g. plumb-bob, stringline, etc.) to prevent various widths of the asphalt shoulder. Contractor may elect to cut-back the asphalt edge to maintain consistent shoulder dimensions shown on the plans.

3.8 COMPACTION OF MIXTURE

3.8.1 General

a. After placing, thoroughly and uniformly compact the mixture by rolling. Compact the surface as soon as possible without causing displacement, cracking or shoving. Determine the sequence of rolling operations and the type of rollers used, except as specified in paragraph ASPHALT PAVEMENT-PORTLAND CEMENT CONCRETE JOINTS. Maintain the speed of the roller, at all times, sufficiently slow to avoid displacement of the asphalt mixture and be effective in compaction. Correct at once any displacement occurring as a result of reversing the direction of the roller, or from any other cause.

b. Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, keep the drums properly moistened, but excessive water is not permitted. In areas not accessible to the roller, thoroughly compact the mixture with hand tampers. Remove the full depth of any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective, replace with fresh asphalt mixture and immediately compact to conform to the surrounding area. Perform this work at no expense to the Government. Skin patching is not allowed.

3.8.2 Segregation

The Government can sample and test any material that looks deficient. When the in-place material appears to be segregated, the Government has the option to sample the material and have it tested and compared to the aggregate gradation, asphalt content, and in-place density requirements in Table 11. If the material fails to meet these specification requirements, remove and replace the extent of the segregated material the full depth of the layer of asphalt mixture at no additional cost to the Government. When segregation occurs in the mat, take appropriate action to correct the process so that additional segregation does not occur.

3.9 JOINTS

Construct joints to ensure a continuous bond between the courses and to obtain the required density. Provide all joints with the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.9.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, construct by means of placing a bulkhead or by tapering the course. Utilize a dry saw cut on the transverse joint full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. Neither cutting equipment that uses water as a cooling or cutting agent nor milling equipment is permitted. Remove the cutback material and cutting debris from the project. Provide a tack coat in accordance with Section 32 12 13 BITUMINOUS TACK AND PRIME COATS to all contact surfaces before placing any fresh mixture against the joint.

3.9.2 Longitudinal Joints

Cut back longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80 degrees C 175 degrees F at the time of placing the adjacent lane), or otherwise defective, a minimum of 75 mm 3 inches and a maximum of 150 mm 6 inches from the top edge of the lift with a cutting wheel to expose a clean, sound, near vertical surface for the full depth of the course. Remove all cutback material from the project. Neither cutting equipment that uses water as a cooling or cutting agent nor milling equipment is permitted. Remove the cutback material and cutting debris from the project. Provide tack coat in accordance with Section 32 12 13 BITUMINOUS TACK AND PRIME COATS to all contact surfaces prior to placing any fresh mixture against the joint.

3.9.3   Echelon Paving

If echelon paving is accomplished to minimize longitudinal cold joints, visually inspect the interface between the two paving lanes to ensure that the interface is not segregated or appears to be visually different from other sections of the course. If visual inspection identifies quality concerns, extract 1 randomly selected cores per sublot centered over the interface between the two paving lanes being placed. The requirements for density at the interface between the two echelon paved lanes are the same as that for the joint density specified in paragraph MAT AND JOINT DENSITIES.

3.9.4   Asphalt Pavement-Portland Cement Concrete Joints

Joints between asphalt pavement and Portland Cement Concrete (PCC) require specific construction procedures for the asphalt pavement. The following criteria are applicable to the first 3 m 10 feet or paver width of asphalt pavement adjacent to the PCC.

a. For all lifts, place the asphalt pavement side of the joint in a direction parallel to the joint.

b. For non-surface lifts (e.g. base or intermediate lifts), compact the mixture per paragraph MAT AND JOINT DENSITIES.

c. For the surface lift place the asphalt pavement side sufficiently high so that when fully compacted the asphalt pavement is greater than 3 mm 1/8 inch but less than 6 mm 1/4 inch higher than the PCC side of the joint.

d. For the surface lift, compact with steel wheel rollers and at least one rubber tire roller. Compact with a rubber tire roller that weights at least 18 metric tons 20 tons with tires inflated to at least 620 kPa 90 psi. Avoid spalling the PCC during placement and compaction of the asphalt pavement. Operate steel wheel rollers in a way that prevents spalling the PCC. Repair any damage to PCC edges or joints as directed by the Government. If damage to the PCC joint or panel edge exceeds a total of 1 m 3 feet, remove and replace the PCC panel at no additional expense to the Government.

e. For the surface lift, after compaction is finished, diamond grind a minimum width of 1 m 3 feet of the asphalt pavement so that the asphalt pavement side is less than 3 mm 1/8 inch higher than the PCC side. Perform diamond grinding in accordance with subparagraph DIAMOND GRINDING above. The asphalt pavement immediately adjacent to the joint is not allowed to be lower than the PCC after the grinding operation. Transition the grinding into the asphalt pavement in a way that ensures good smoothness and provides drainage of water. The joint and adjacent materials when completed is required to meet all of the requirements for grade and smoothness. Measure smoothness across the asphalt pavement-PCC joint using a 4 m 12 feet straightedge. The acceptable tolerance is 3 mm 1/8 inch.

f. For all lifts, consider the asphalt pavement next to the PCC as a separate weighted pay factor associated with the lot being placed for evaluation. Lots are based on individual lifts. Do not commingle cores from different lifts for density evaluation purposes. Take four cores for each lot of material placed adjacent to the asphalt pavement-PCC joint. The size of lot is 3 m 10 feet wide by the length of the joint being paved. Perform the same computation as displayed in paragraph PAY FACTOR BASED ON IN-PLACE DENSITY above to determine the weighted pay factor. Select the lowest computed pay factor for the lot. Locate the center of each of the four cores 150 mm 6 inches from the edge of the concrete. Take each core at a random location along the length of the joint. The requirements for joint density, adjacent to the PCC joint, are the same as that for the mat density specified in Table 1. For asphalt pavement-PCC joints at taxiways abutting runways, aprons, or other taxiways, take two additional randomly located cores along each taxiway intersection.

g. All procedures, including repair of damaged PCC, are required to be in accordance with the approved Quality Control Plan.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 12 15.16 (February 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 13 17 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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STONE MATRIX ASPHALT (SMA) FOR AIRFIELD PAVING

02/19

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USACE / NAVFAC / AFCEC **UFGS-32 12 15.16 (February 2019)**

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SECTION 32 12 15.16

STONE MATRIX ASPHALT (SMA) FOR AIRFIELD PAVING
02/19

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NOTE: This guide specification covers the requirements for stone matrix asphalt (SMA) for airfield pavements.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present. Do not edit or rewrite the unbracketed text without the express consent of the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement subject matter expert (SME), or the Naval Facilities Engineering Systems Command (NAVFAC).

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

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NOTE: Modifications must be made to this guide specification during conversion to a project specification in accordance with the NOTES which are located throughout the document. These NOTES are instructions to the designer, and will not appear in the project specification.

Specifications developed for Corps of Engineers

managed projects must be edited in accordance with ER 1110-34-1 Engineering and Design Transportation Systems Mandatory Center of Expertise (Section 11, 12, App A, B, C).

This guide specification only pertains to the stone matrix asphalt aspects of the project and not to any surface preparation requirements dealing with aggregate base courses, milling, or tack or prime coats. Cover surface preparation requirements by either including them in this guide specification or by adding pertinent sections to the project documents.

SMA can be used as a surface course for any airfield pavement. SMA provides increased durability, resistance to rutting, resistance to reflective cracking compared to HMA. Local state highway experiences with SMA should be considered when developing the job specification.

This specification utilizes a Quality Assurance and Quality Control (QA/QC) construction management philosophy. Quality Assurance refers to the actions performed by the Government or designated representative Engineer to assure the final product meets the job requirements. Results of QA testing are the basis for pay. Quality Control refers to the actions of the Contractor to monitor the construction and production processes and to correct these processes when out of control. Results of QC testing are reported daily on the process control charts maintained by the Contractor. Quality Control is covered in paragraph CONTRACTOR QUALITY CONTROL.

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1.1 FULL PAYMENT

1.1.1 Method of Measurement

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NOTE: For unit-price Contracts, include first bracketed statements and delete the second set. For lump sum Contracts, delete the first bracketed statements and include the second set. Lump sum Contracts should not be used when the job exceeds 1000 metric tons tons.

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[The amount paid for will be the number of metric tons tons of SMA used in the accepted work. Weigh the SMA after mixing, and no adjustment will be made for weight of asphalt cement material incorporated herein.] [Measurement of the quantity of SMA, per metric ton ton placed and accepted, will be made for the purposes of assessing the pay factors stipulated below.]

1.1.2 Basis of Payment

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NOTE: For unit-price contracts, include first bracketed statements and delete the second set. For lump sum contracts, delete the first bracketed statements and include the second set. Include prescriptive unit price based on the Government/Engineer estimate for payment adjustment. Lump sum contracts should not be used when the job exceeds 1000 metric tons tons.

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[Quantities of SMA mixture, determined as specified above, will be paid for at respective contract unit prices or at reduced prices adjusted in accordance with paragraphs PERCENT PAYMENT and QUALITY ASSURANCE. Payment will constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification.][The measured quantity of SMA mixture will be paid for and included in the lump sum Contract price. If less than 100 percent payment is due based on the pay factors stipulated in paragraph QUALITY ASSURANCE, a unit price of [_____] per ton will be used for purposes of calculating the payment reduction.]

1.2 PERCENT PAYMENT

When a lot of material fails to meet the specification requirements for 75 percent pay as outlined in the following paragraphs, remove and replace that lot. The lot pay factor is determined by taking the lowest computed pay factor based on either laboratory air voids, in place density, grade or smoothness (each discussed below). Pay factors based on different criteria (i.e., laboratory air voids and in place density) of the same lot will not be multiplied together to get a lower lot pay factor. At the end of the project, an average of all lot pay factors will be calculated. If this average lot pay factor exceeds 95.0 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by that lot's pay factor. When work on a lot is required to be terminated before all sublots are completed, the results from the completed sublots will be analyzed to determine the percent payment for the lot following the same procedures and requirements for full lots but with fewer test results.

1.2.1 Mat and Joint Densities

The average in place mat and joint densities are expressed as a percentage of the average theoretical maximum density (TMD) for the lot. The average TMD for each lot will be determined as the average TMD of the four random samples per lot. The average in place mat density and joint density for a lot are determined and compared with Table 1 to calculate a single pay factor per lot based on in place density, as described below. First, a pay factor for both mat density and joint density are determined from Table 1. The area associated with the joint is then determined and will be considered to be 3 meters 10 feet wide times the length of completed longitudinal construction joint in the lot. This area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of SMA mixture, either an adjacent freshly paved lane or one paved at any time previously. The area associated with the joint is expressed as a percentage of the total lot area. A weighted pay factor for the joint is determined based on this percentage (see example below). The pay factor for mat density and the weighted pay factor for joint density is compared and the lowest selected. This selected pay factor is the pay factor based on density for the lot. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD values will be used as the TMD needed to calculate the percent joint density. Remove and replace rejected lots. Remove 100 mm 4 inches into the cold (existing) lane for rejected areas adjacent to longitudinal joints. Complete and report all density results for a lot within 24 hours after the construction of that lot.

Table 1. Pay Factor Based on In-Place Density

Average Mat Density (4 Cores)	Pay Factor, Percent	Average Joint Density (4 Cores)
94.0 or 96.0	100	above 92.5
93.9	100	92.4
93.8 or 96.1	99.9	92.3
93.7	99.8	92.2
93.6 or 96.2	99.6	92.1
93.5	99.4	92.0
93.4 or 96.3	99.1	91.9
93.3	98.7	91.8
93.2 or 96.4	98.3	91.7
93.1	97.8	91.6
93.0 or 96.5	97.3	91.5
92.9	96.3	91.4
92.8 or 96.6	94.1	91.3
92.7	92.2	91.2
92.6 or 96.7	90.3	91.1
92.5	87.9	91.0
92.4 or 96.8	85.7	90.9
92.3	83.3	90.8
92.2 or 96.9	80.6	90.7
92.1	78.0	90.6
92.0 or 97.0	75.0	90.5
below 92.0, above 101.0	0.0 reject	below 90.5

1.2.2 Pay Factor Based on In-Place Density

An example of the computation of a pay factor (in inch-pound units only) based on in place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 93.2 percent (of TMD). (2) Average joint density = 91.5 percent (of TMD). (3) Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2000 feet.

a. Step 1: Determine pay factor based on mat density and on joint density, using Table 1:

Mat density of 93.2 percent = 98.3 pay factor
Joint density of 91.5 percent = 97.3 pay factor

b. Step 2: Determine ratio of joint area (length of longitudinal joint x 10 ft) to mat area (total paved area in the lot): Multiply the length of completed longitudinal construction joint by the specified 10 feet width and divide by the mat area (total paved area in the lot).

(a) 2000 ft. x 10 ft)/30000 sq ft = 0.6667 ratio of joint area to mat area (ratio).

c. Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:

wpf = joint pay factor + (100 - joint pay factor) (1 - ratio) wpf = 97.3 + (100-97.3) (1-0.6667) = 98.2 percent

d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:

Pay factor for mat density: 98.3 percent. Weighted pay factor for joint density: 98.2 percent.
Select the smaller of the two values as pay factor based on density: 98.2 percent.

1.2.3 Payment Adjustment for Smoothness (Final Wearing Surface Only)

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NOTE: When Profilograph testing is not required, delete the following paragraph for pay adjustment for smoothness. Profilograph testing is required for runway pavements.

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Profilograph Testing. Record the location and data from all profilograph measurements When the Profile Index of a lot exceeds the tolerance specified in paragraph SMOOTHNESS REQUIREMENTS above by 16 mm per km 1.0 inch per mile, but less than 32 mm per km 2.0 inches per mile, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 32 mm per km 2.0 inches per mile, but less than 47 mm per km 3.0 inches per mile, the computed pay factor will be 90 percent. When the Profile Index exceeds the tolerance by 47 mm per km 3.0 inches per mile, but less than 63 mm per km 4.0 inches per mile, the computed pay factor will be 75 percent. Remove and replace the lot when the Profile Index exceeds the tolerance by 63 mm per km 4.0 inches per mile or more at no additional cost to the Government. Regardless of the above, correct any small individual area with surface deviation which exceeds the tolerance given above by more than 79 mm per km 5.0 inches per mile or more, by grinding to meet the specification requirements above or remove and replace at no additional cost to the Government.

1.2.4 Laboratory Air Voids and Theoretical Maximum Density

Calculate laboratory air voids in accordance with ASTM D3203/D3203M by determining the density of each lab compacted specimen using the laboratory prepared, thoroughly dry method in ASTM D2726/D2726M and determining the theoretical maximum density (TMD) of four of the sublots using ASTM D2041/D2041M. Laboratory air void calculations for each lot use the average TMD values obtained, for the lot. The mean absolute deviation of the four laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated and a pay factor determined from Table 2. All laboratory air void tests will be completed and reported within 24 hours after completion of construction of each lot. The TMD is also used for computation of compaction, as required in paragraph: MAT AND JOINT DENSITIES above.

1.2.5 Mean Absolute Deviation

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 random samples of a lot (where 3 specimens were compacted from each sample). The average laboratory air voids for each sublot sample are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

Mean Absolute Deviation = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7- 4.0|)/4

= (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 2 below that the lot's pay factor based on laboratory air voids is 100 percent.

Table 2. Pay Factor Based on Laboratory Air Voids

Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, percent
0.60 or less	100
0.61 - 0.80	98
0.81 - 1.00	95
1.01 - 1.20	90
Above 1.20	0 (reject)

1.2.6 Pay Adjustment Based on Grade

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NOTE: The grade and surface smoothness requirements specified below are for the final wearing surface only. If there is a requirement to test and control the grade and smoothness for the intermediate courses, for example, when the intermediate courses will be exposed to traffic, slight modifications to this specification will be required.

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Within 5 working days after completion of a particular lot incorporating the final wearing course, test the final wearing surface of the pavement for conformance with specified plan grade requirements. Construct a final wearing surface of pavement conforming to the elevations and cross sections shown and varying not more than 9 mm 0.03 foot for runways or 15 mm 0.05 foot for taxiways and aprons from the plan grade established and approved at site of work. Match finished surfaces at juncture with other pavements with finished surfaces of abutting pavements. Deviation from the plan elevation is not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. Determine the grade of the completed pavement surface by running lines of levels at intervals of 7.6 m 25 feet, or less, longitudinally and transversely. Maintain detailed notes of the results of the testing and provide a copy to the Government Engineer immediately after each day's testing. When more than 5 percent of all measurements made within a lot are outside the 9 or 15 mm 0.03 or 0.05 foot tolerance, the pay factor based on grade for that lot will be 95 percent. In areas where the grade exceeds the tolerance by more than 50 percent, remove the surface lift full depth; then replace the lift with SMA mixture to meet specification requirements, at no additional cost to the Government Owner. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas is not permitted.

1.3 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving

	Mixtures
AASHTO M 320	(2017) Standard Specification for Performance-Graded Asphalt Binder
AASHTO M 325	(2008) Standard Specification for Stone Matrix Asphalt (SMA)
AASHTO R 46	(2008; R 2017) Standard Practice for Designing Stone Matrix Asphalt (SMA)
AASHTO T 304	(2011; R 2015) Standard Method of Test for Uncompacted Void Content of Fine Aggregate
AASHTO T 329	(2015) Standard Test Method for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method

ASPHALT INSTITUTE (AI)

AI MS-2	(2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation

ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D946/D946M	(2020) Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D1461	(2017) Standard Test Method for Moisture or Volatile Distillates in Asphalt Mixtures
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2419	(2014) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489/D2489M	(2016) Standard Test Method for Estimating Degree of Particle Coating of Asphalt Mixtures
ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3203/D3203M	(2017) Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4125/D4125M	(2010) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures

ASTM D5444	(2015) Mechanical Size Analysis of Extracted Aggregate
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder
ASTM D6390	(2011; R 2017) Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
ASTM D6925	(2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
ASTM D6926	(2020) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus
ASTM D6927	(2015) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM E1274	(2018); R 2024 Standard Test Method for Measuring Pavement Roughness Using a Profilograph

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G, [_____]

SD-02 Shop Drawings

Placement Plan; G, [_____]

SD-03 Product Data

Diamond Grinding Plan; G, [_____]

Mix Design; G, [_____]

Contractor Quality Control; G, [_____]

SD-04 Samples

Asphalt Cement Binder

Aggregates

SD-06 Test Reports

Aggregates

QC Monitoring

SD-07 Certificates

Asphalt Cement Binder

Fiber Stabilizer

Testing Laboratory

1.5 QUALITY ASSURANCE[AND QUALITY CONTROL]

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NOTE: It is highly recommended to keep the

Government Engineer's QA testing separate and distinct from the Contractor's QC testing for all runway, taxiway, and apron projects. However, it is recognized that in house testing capability to provide the QA testing required by this section will not always be available; in this case, it is recommended that an independent material testing company be hired to provide the QA testing for the project. The cost of this testing to assure good long-term performance is very small relative to the overall cost of the construction, and especially compared to the cost of a pavement failure.

QA acceptance testing for projects consisting only of shoulder or overrun areas can be performed by either the Government or Contractor. Although not recommended, this guide specification may be modified to require the Contractor to hire an independent material-testing laboratory to perform the QA testing listed in this section. The results would need to be forwarded daily to the Contracting Officer as the basis for acceptance and pay.

Based on the above, delete the appropriate bracketed statement below.

The QA acceptance testing program includes material tests to determine laboratory air voids and in place density, which are needed to determine percent payment. The project engineer may choose to have additional tests conducted by the QA acceptance test agency to monitor aggregate gradation, asphalt content and volumetric properties. These tests would serve as a check to the Contractor's QC testing.

For projects with less than 2000 total metric tons tons, the entire project can be considered as a single lot. In this case, sublot sampling could occur over several days' production, which could lead to a high sublot variability.
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[The Government Engineer's quality assurance (QA) program for this project is separate and distinct from the Contractor's quality control (QC) program specified in PART 3. Testing for acceptability of work will be performed by the Government Engineer or by an independent laboratory hired by the Contracting Officer Engineer, except for smoothness and grade testing which is performed by the Contractor.][Acquire the services of an independent commercial laboratory to perform acceptance testing.] Acceptance of the plant produced mix and in place requirements will be on a lot to lot basis. A standard lot for all requirements will be equal to 2000 metric tons tons. Where appropriate, adjustment in payment for individual lots of SMA mixture will be made based on in place density, laboratory air voids, grade and smoothness in accordance with the following paragraphs. Grade and surface smoothness determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus grade and smoothness measurements for the entire lot cannot be made. In order to evaluate laboratory air voids and in place (field) density, each lot will be divided into four equal sublots.

1.5.1 Sublot Sampling

One random mixture sample for determining laboratory air voids, theoretical maximum density, and for any additional testing the Government Engineer desires, will be taken from a loaded truck delivering mixture to each sublot, or other appropriate location for each sublot. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs. Determine laboratory air voids from three laboratory compacted specimens of each sublot sample in accordance with ASTM D3203/D3203M. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

1.5.2 Additional Sampling and Testing

The Government Engineer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government Owner. Testing in these areas will be treated as a separate lot. Payment will be made for the quantity of SMA mixture represented by these tests in accordance with the provisions of this specification.

1.5.3 In-Place Density

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NOTE: Retain the bracketed text when editing for Government Engineer's QA acceptance testing separate and distinct from the Contractor's QA testing as described in the above Designer Note (all runway, taxiway, and apron projects). Delete the bracketed text when specification is edited for Contractor QA testing.

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For determining in place density, one random core (100 mm or 150 mm in diameter) (4 inches or 6 inches in diameter) at locations [identified by the Government Engineer][identified by random sampling procedures] from the mat (interior of the lane and at least 300 mm 12 inches from longitudinal joint of pavement edge)of each sublot in accordance with ASTM D979/D979M. Each random core will be full thickness of the layer being placed. When the random core is less than 25 mm 1 inch thick, it will not be included in the analysis. In this case, another random core will be taken. After air-drying to meet the requirements for laboratory prepared, thoroughly dry specimens, cores obtained from the mat and from the joints will be used for in place density determination in accordance with ASTM D2726/D2726M.

1.5.4 Surface Smoothness

Use a straightedge and profilograph for measuring smoothness of runway pavements. Use a straightedge for measuring smoothness of all other pavement surfaces. Perform all testing in the presence of the Government Engineer. Maintain detailed notes of the testing results and provide a copy to the Government Engineer immediately after each day's testing. Where drawings show required deviations from a plane surface (for instance crowns, drainage inlets), finish the surface to meet the approval of the Government Engineer.

1.5.4.1 Smoothness Requirements

1.5.4.1.1 Straightedge Testing

Provide finished surfaces of the pavements with no abrupt change of 3 mm 1/8 inch or more, and all pavements within the tolerances specified in Table 3 when checked with an approved 4 m 12-foot straightedge.

Table 3. Straightedge Surface Smoothness-Pavements

Pavement Category	Direction of Testing	Tolerance, mm inch
Runways and taxiways	Longitudinal	31/8
	Transverse	61/4
Shoulders (outside edge stripe)	Longitudinal	61/4
	Transverse	61/4
Calibration hardstands and compass swinging bases	Longitudinal	31/8
	Transverse	31/8
All other airfield and helicopter paved areas	Longitudinal	61/4
	Transverse	61/4

1.5.4.1.2 Profilograph Testing

Provide finished surfaces of runway with a Profile Index not greater than 100 mm per km 7 inches per mile when tested with an approved California-type profilograph.

1.5.4.2 Testing Method

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in each entire lot in a manner to reveal surface irregularities exceeding the tolerances specified above. If any pavement areas are diamond ground, retest these areas immediately after diamond grinding. The maximum area allowed to be corrected by diamond grinding is 10 percent of the total area of the lot. Test the entire area of the pavement with a profilograph. Check a number of random locations along with any observed suspicious locations primarily at transverse and longitudinal joints with the straightedge.

1.5.4.2.1 Straightedge Testing

Hold the straightedge in contact with the pavement surface and measure the maximum distance between the straightedge and the pavement surface. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between these two high points. Use the straightedge to measure abrupt changes in surface grade.

1.5.4.2.2 Profilograph Testing

Perform profilograph testing using an approved California profilograph and procedures described in ASTM E1274. Provide equipment that utilizes electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. Use a "blanking band" that is 5 mm 0.2 inches wide and the "bump template" spanning 25 mm 1 inch with an offset of 10 mm 0.4 inch. Provide profilograph operated by an approved, factory-trained operator on the alignments specified above. Provide a copy of the reduced tapes to the GovernmentEngineer at the end of each day's testing.

1.5.4.2.3 Bumps ("Must Grind" Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm 0.4 inch in height by diamond grinding until they do not exceed 7.5 mm 0.3 inch when retested. Taper diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding. The following will not be permitted: (1) skin patching for correcting low areas, (2) planing or milling for correcting high areas. [At the Contractor's option, pavement areas, including diamond ground areas, may be rechecked with the profilograph in order to record a lower Profile Index.] [Perform additional profilograph testing in all areas corrected by diamond grinding.]

1.6 ENVIRONMENTAL REQUIREMENTS

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NOTE: The temperature requirements are included to avoid problems with the Contractor achieving density because the mix cools too fast. Waivers to these requirements, for isolated incidences during production, are applicable if the density requirements are still met. SMA mixtures are typically placed to provide a compacted thickness of 2 inches.

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Do not place the SMA upon a wet surface or when the surface temperature of the underlying course is less than 7 degrees C 45 degrees F. The temperature requirements may be waived by the Contracting Officer, if requested; however, all other requirements, including compaction, must be met.

PART 2 PRODUCTS

2.1 SYSTEM EQUIPMENT

Perform the work consisting of pavement courses composed of mineral aggregate, polymer-modified asphalt binder, and a stabilizer, heated and mixed in a central mixing plant and placed on a prepared course. Provide SMA mixture designed and constructed in accordance with this specification conforming to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Construct each course to the depth, section, or elevation required by the drawings and rolled, finished, and approved before the placement of the next course. Submit proposed Placement Plan, indicating lane widths, longitudinal joints, and transverse joints for each course or lift.

2.1.1 Asphalt Mixing Plant

Provide plants used for the preparation of SMA mixture conforming to the requirements of AASHTO M 156 with the following changes:

2.1.1.1 Truck Scales

Weigh the SMA mixture on approved scales, or on certified public scales at no additional expense to the Government. Inspect and seal scales at least annually by an approved calibration laboratory.

2.1.1.2 Inspection of Plant

Provide access to the Government Engineer at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance, as requested, for the Government Engineer to procure any desired samples.

2.1.1.3 Storage Silos

The SMA mixture may be stored in non-insulated storage silos for a period of time not to exceed 2 hours. The SMA mixture may be stored in insulated storage silos for a period of time not exceeding 4 hours. Ensure that draindown of the asphalt binder in the SMA mixture is not a problem when stored in the storage silo and when hauling to the job site. Provide draindown less than 0.3 percent when measured in accordance with ASTM D6390. Provide the mix drawn from silos that meet the same requirements as mix loaded directly into trucks.

2.1.2 Hauling Equipment

Provide trucks used for hauling SMA mixture that have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, lightly coat the truck beds with a minimum amount of paraffin oil, lime solution, or other approved material. Do not use petroleum based products as a release agent. Provide each truck with a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture is delivered to the site at the specified temperature, provide insulated or heated truck beds with covers (tarps) that are securely fastened.

2.1.3 Material Transfer Vehicle (MTV)

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NOTE: A Material Transfer Vehicle is required for runway, taxiway, and apron construction. The use of an MTV is optional for shoulder construction.

****

Provide Material Transfer Vehicles for placement of the SMA mixture. To transfer the material from the hauling equipment to the paver, use a self-propelled, material transfer vehicle with a swing conveyor that is capable of delivering material to the paver from outside the paving lane and without making contact with the paver. Provide MTV capable to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. Provide MTV with remixing and storage capability to prevent physical and thermal segregation.

2.1.4 Asphalt Pavers

Provide mechanical spreading and finishing equipment consisting of a self-powered paver, capable of spreading and finishing the SMA mixture to the specified line, grade, and cross section. Provide paver having screed capable of laying a uniform mixture to meet the specified thickness, smoothness, and grade without physical or temperature segregation, the full width of the material being placed. Provide paver with vibrating screed equipped with a compaction device to be used during all placement.

2.1.4.1 Receiving Hopper

Provide paver with a receiving hopper of sufficient capacity to permit a uniform spreading operation and a distribution system to place the mixture uniformly in front of the screed without segregation. Provide paver with vibrating screed that effectively produces a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

2.1.4.2 Automatic Grade Controls

****

NOTE: Delete information on automatic grade control if not needed. Automatic grade control is needed when the design requires elevations for the SMA pavement surface. Many maintenance and rehabilitation projects require an overlay thickness and do not specify actual grades.

****

If an automatic grade control device is used provide a paver equipped with a control system capable of automatically maintaining the specified screed elevation that is automatically actuated from either a reference line or through a system of mechanical sensors or sensor-directed mechanisms or devices which maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. Provide transverse slope controller capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. Do not use the transverse slope controller to control grade. Provide controls capable of working in conjunction with any of the following attachments:

a. Ski-type device of not less than 9.14 meters 30 feet in length.

b. Taut stringline set to grade.

c. Short ski or shoe for joint matching.

d. Laser control.

2.1.5 Rollers

Provide rollers in good condition and operated at slow speeds to avoid displacement of the SMA mixture. Provide sufficient number, type, and weight of rollers to compact the mixture to the required density while it is still in a workable condition. Do not use equipment that causes excessive crushing of the aggregate.

2.1.6 Diamond Grinding

Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade. Reduce high areas by diamond grinding the SMA pavement with approved equipment after the SMA pavement is at a minimum age of 14 days. Perform diamond grinding by sawing with saw blades impregnated with an industrial diamond abrasive. Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the SMA mixture or joint faces. Provide diamond grinding equipment with saw blades that are 3 mm 1/8-inch wide, a minimum of 60 blades per 300 mm 12 inches of cutting head width, and capable of cutting a path a minimum of 0.9 m 3 feet wide. Diamond grinding equipment that causes raveling, fracturing or aggregate, or disturbance to the underlying material is not allowed. The maximum area corrected by diamond grinding the surface of the SMA mixture is 10 percent of the total area of any sublot. The maximum depth of diamond grinding is 12 mm 1/2 inch. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government Owners property. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified.

Prior to production diamond grinding operations, perform a test section at the approved location, consisting of a minimum of two adjacent passes with a minimum length of 12 m 40 feet to allow evaluation of the finish and transition between adjacent passes. Production diamond grinding operations cannot be performed prior to approval.

2.2 AGGREGATES

Sample aggregates in the presence of a Government Owner Representative. Obtain samples in accordance with ASTM D75/D75M and be representative of the materials to be used for the project. Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screenings, and mineral filler, as required. The portion of material retained on the 4.75 mm No. 4 sieve is coarse aggregate. The portion of material passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve is fine aggregate. The portion passing the 0.075 mm No. 200 sieve is defined as mineral filler. Submit sufficient materials to produce 90 kg 200pounds of blended mixture for mix design verification. Submit all aggregates test results and samples to the Government Engineer at least 14 days prior to start of construction. Perform job aggregate testing no earlier than 6 months before Contract award.

2.2.1 Coarse Aggregate

****

NOTE: The requirement for sulfate soundness (requirement b., below) may be deleted in climates where freeze-thaw does not occur. However, in these areas where freeze-thaw does not occur, requirement b., should remain if experience has shown that this

test separates good performing aggregates from bad performing aggregates. Retain this requirement for all Navy projects.

Percentage of Wear (ASTM C131/C131M) must generally not exceed 30. Aggregates with a higher percentage of wear may be specified, provided a satisfactory record under similar conditions of service and exposure has been demonstrated.

****

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt binder and free from organic matter and other deleterious substances. Provide coarse aggregate particles meeting the following requirements:

a. Loss no greater than 30 percent after 500 revolutions when tested in accordance with ASTM C131/C131M.

b. Sodium sulfate soundness loss not exceeding 12 percent, or the magnesium sulfate soundness loss not exceeding 18 percent after five cycles when tested in accordance with ASTM C88.

c. At least 95 percent by weight of coarse aggregate contain at least two or more fractured faces when tested in accordance with ASTM D5821 with fractured faces produced by crushing.

d. Provide aggregate with essentially cubical particles and containing no more than 20 percent, by weight, of flat and elongated particles (3:1 ratio of maximum to minimum) when tested in accordance with ASTM D4791.

e. Provide aggregates with absorption not greater than 2 percent when tested in accordance with ASTM C127.

f. Provide aggregate with clay lumps and friable particles not exceeding 0.3 percent, by weight, when testing in accordance with ASTM C142/C142M.

2.2.2 Fine Aggregate

****

NOTE: Set the lower limit for uncompacted void content (requirement c., below) at 45 for fine aggregate angularity unless local experiences indicates that a lower value can be used. There are some aggregates which have a good performance record and have an uncompacted void content less than 45. In no case should the limit be set less than 43.

****

Provide fine aggregate consisting of clean, sound, tough, durable particles. Provide aggregate particles free from coatings of clay, silt, or any objectionable material, containing no clay balls and meet the following requirements:

a. Fine aggregate portion of the blended aggregate consisting of 100 percent crushed manufactured fines. No natural sand is allowed.

b. Individual fine aggregate sources with a sand equivalent value greater than 45 when tested in accordance with ASTM D2419.

c. Fine aggregate portion of the blended aggregate with an uncompacted void content greater than 45.0 percent when tested in accordance with AASHTO T 304 Method A.

d. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.2.3 Mineral Filler

Provide mineral filler consisting of a non-plastic material meeting the requirements of ASTM D242/D242M.

2.2.4 Aggregate Gradation

Provide a combined aggregate gradation that conforms to gradations specified in Table 4, when tested in accordance with ASTM C136/C136M and ASTM C117, and does not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grades uniformly from coarse to fine. Individual aggregate test tolerances can be found in Table 8; however, the JMF must be in compliance with the specification range.

Table 4. Aggregate Gradations

Sieve Size, mm inches	Percent Passing by Mass
25.0 1 inch	---
19.0 3/4 inch	100
12.5 1/2 inch	90-100
9.5 3/8 inch	50-85
4.75 No. 4	20-40
2.36 No. 8	16-28
1.18 No. 16	---
0.60 No. 30	---
0.30 No. 50	---
0.15 No. 100	---
0.075 No. 200	8-11

2.2.5 Fiber Stabilizer

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NOTE: Fibers, either cellulose or mineral, must be used in the SMA mixture.

****

Provide a fiber stabilizer to be used in all SMA mixtures. Provide a stabilizer consisting of cellulose or mineral fibers and in amounts sufficient to prevent draindown exceeding 0.3 percent when tested in accordance with ASTM D6390. Submit copies of certified test data. Requirements and test procedures are outlined in Tables 5 and 6.

Table 5. Cellulose Fibers Quality Requirements

Properties	Requirement
Sieve Analysis Method A - Alpine Sieve (1) Analysis	
Fiber length	6 mm 0.25 inch (max)
Passing 0.15 mm No. 100 sieve	70 percent (± 10%)
Sieve Analysis Method B - Mesh Screen (2) Analysis	
Fiber length	6 mm 0.25 inch (max)
Passing 0.850 mm No. 20 sieve	85 percent (± 10%)
Passing 0.425 mm No. 40 sieve	65 percent (± 10%)
Passing 0.106 mm No. 140 sieve	30 percent (± 10%)
Ash Content (3)	18 percent (± 5%) non-volatiles
pH (4)	7.5 (± 1.0)
Oil Absorption (5)	5.0 (± 1.0)(times fiber weight)
Moisture Content (6)	<5 percent (by weight)
(1) This test is performed using an Alpine Air Jet Sieve (Type 200 LS). A representative 5-gram sample of fiber is sieved for 14 minutes at a controlled vacuum of 75 kPa 11 psi. The portion remaining on the screen is weighed.	
(2) This test is performed using standard 850, 425, 250, 180, 150, 106 micron No. 20, 40, 60, 80, 100, 140 sieves, nylon brushes, and a shaker. A representative 10-gram sample of fiber is sieved using a shaker and two nylon brushes on each screen. The amount retained on each sieve is weighed and the percentage passing calculated. The repeatability of this method is suspect and needs to be verified.	
(3) A representative 2-3 gram sample of fiber is placed in a tared crucible and heated between 595 and 650 degrees C 1100 and 1200 degrees F for not less than 2 hours. The crucible and ash are cooled in a desiccator and reweighed.	
(4) Five grams of fiber is added to 100 mL of distilled water, stirred, and let sit for 30 minutes. The pH is determined with a probe calibrated with pH 7.0 buffer.	
(5) Five grams of fiber is accurately weighed and suspended in an excess of mineral spirits for not less than 5 minutes to ensure total saturation. It is then placed in a screen mesh strainer (approximately 0.5 square millimeter hole size) and shaken on a wrist-action shaker for 10 minutes (approximately 31.75 mm 1.25 inch motion at 240 shakes/minute). The shaken mass is then transferred without touching, to a tared container and weighed. Results are reported as the amount (number of times its own weight) the fibers are able to absorb.	

Table 5. Cellulose Fibers Quality Requirements	
Properties	Requirement
(6) Ten grams of fiber is weighed and placed in a 121 degree C 250 degrees F forced-air oven for 2 hours. The sample is then reweighed immediately upon removal from the oven.	

Table 6. Mineral Fibers Quality Requirements	
Properties	Requirement
Sieve Analysis	
Fiber length(1)	6 mm 0.25 inch max mean test value
Thickness(2)	0.005 mm 0.0002 inch max mean test value
Shot content(3)	
0.250 mm No. 60 sieve	95 percent passing (min)
0.063 mm No. 230 sieve	65 percent passing (min
(1) The fiber length is determined according to the Baur McNett fractionation.	
(2) The fiber diameter is determined by measuring at least 200 fibers in a phase contrast microscope.	
(3) Shot content is a measure of non-fibrous material. The shot content is determined on vibrating sieves. Two sieves, 0.25 mm No. 60 and 0.063 mm No. 230, are typically utilized; for additional information see ASTM C612.	

2.3 ASPHALT CEMENT BINDER

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NOTE: Specify Performance Graded (PG) asphalt binders wherever available. Use a bumped grade of asphalt binder. In most areas of the US this would be a 76-22 but will vary in colder climates to match the lower PG requirements used by the local DOT.

Retain bracketed verification testing text for runway, taxiway, and apron projects.

****

[Provide asphalt binder that conforms to ASTM D6373 or AASHTO M 320, Performance Grade (PG) [_____]].[Provide asphalt binder that conforms to

ASTM D946/D946M Penetration Grade [______]]. Provide test data indicating grade certification by the supplier at the time of delivery of each load to the mix plant. Submit copies of these certifications to the Government Engineer. The supplier is defined as the last source of any modification to the binder. The Government Engineer may sample and test the binder at the mix plant at any time before or during mix production. [Obtain samples for this verification testing in accordance with ASTM D140/D140M and in the presence of the Government Engineer. Provide these samples to the Government Engineer for the verification testing, which will be performed at the Governments Engineers expense. Submit 20 L 5 gallon sample of the asphalt binder specified for mix design verification and approval not less than 14 days before start of the test section.]

2.4 MIX DESIGN

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NOTE: Use 50 blow Marshall hand-held hammer compaction or 50 gyration Superpave gyratory compaction for all SMA mixtures.

****

Develop the mix design. Perform Job Mix Formula (JMF) and aggregates testing no earlier than 6 months before Contract award. Provide SMA mixture composed of crushed aggregate, mineral filler if required, a fiber stabilizer, and asphalt binder. Provide aggregate fractions sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the Table 4. Do not produce SMA mixture for payment until a JMF has been approved. Design the SMA mixture using 50 blows with hand-held hammer procedures contained in AI MS-2 and the criteria shown in Table 7A. Design the SMA mixture using the Superpave gyratory compactor set at 50 gyrations and the criteria shown in Table 7B. Prepare samples at various asphalt contents and compacted in accordance with ASTM D6925, AASHTO M 325 and AASHTO R 46. Use laboratory compaction temperatures for Polymer Modified Asphalts as recommended by the asphalt binder manufacturer. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M, is less than 75 percent, reject the aggregates or treat the SMA mixture with an anti-stripping agent. Add a sufficient amount of anti-stripping agent to produce a TSR of not less than 75 percent. If an anti-strip agent is required, provide it at no additional cost to the Government. Provide sufficient materials to produce 90 kg 200 pounds of blended mixture to the Government Engineer for verification of mix design at least 14 days prior to construction of test section.

2.4.1 JMF Requirements

Submit the job mix formula in writing, for approval, at least 14 days prior to the start of the test section including as a minimum:

a. Percent passing each sieve size

b. Percent of asphalt binder

c. Percent of each aggregate and mineral filler to be used

d. Asphalt penetration grade or Performance Grade (PG)

e. Type and amount of stabilizer

f. Number of blows of hammer per side of molded specimen. Number of Superpave gyratory compactor gyrations

g. Lab mixing temperature

h. Lab compaction temperature

i. Temperature-viscosity relationship of the asphalt binder

j. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size

k. Graphical plots and summary tabulation of air voids, voids in mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2. Include summary tabulation that includes individual specimen data for each specimen tested

l. Specific gravity and absorption of each aggregate

m. Percent particles with two or more fractured faces (in coarse aggregate)

n. Fine aggregate angularity

o. Percent flat or elongated particles (in coarse aggregate)

p. Tensile Strength Ratio and wet/dry specimen test results

q. Antistrip agent (if required)

r. List of all modifiers

s. Percent draindown

Table 7A. Marshall Mix Design Criteria

Test Property	50 Blow Mix
Air voids, percent	3.5 (1)
Percent Voids in mineral aggregate (minimum)	17.0
TSR, minimum percent	75
Draindown, percent (maximum)	0.3

(1) Select the JMF asphalt content corresponding to an air void content of 3.5 percent. Verify the other properties of Table 7A meet the specification requirements at the asphalt content.

Table 7B Superpave Gyratory Mix Design Criteria

Test Property	50 Gyration mix
Air voids, percent (1)	3.5 (1)

Table 7B Superpave Gyratory Mix Design Criteria	
Test Property	50 Gyration mix
Percent Voids in mineral aggregate (minimum)	17.0
TSR, minimum percent	75
Draindown, percent (maximum)	0.3
(1) Select the JMF asphalt content corresponding to an air void content of 3.5 percent. Verify the other properties of Table 7B meet the specification requirements at the asphalt content.	

2.4.2 Adjustments to JMF

The JMF for each mixture must be in effect until a new formula is approved in writing by the Government Engineer. Should a change in sources of any materials be made, submit for approval by the Government Engineer, a new mix design and a new JMF before the new material is used. Make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF are limited to plus or minus 4 percent on the 4.75 mm No.4 and coarser sieves; plus or minus 3 percent on the 2.36 mm No. 8 to 0.30 mm No. 50sieve; and plus or minus 1 percent on the 0.15 mm No. 100 sieve. Adjustments to the JMF are limited to plus or minus 1.0 percent on the 0.075 mm No. 200sieve. Asphalt content adjustments are limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, develop a new mix design.

PART 3 EXECUTION

3.1 CONTRACTOR QUALITY CONTROL

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NOTE: The Contractor may be able to meet the specified quality control requirements with in-house capability or may have to hire a material testing firm to provide the required quality control testing.

****

3.1.1 General Requirements

Submit the Quality Control Plan. Do not produce SMA mixture for payment until the quality control plan has been approved. In the quality control plan address all elements which affect the quality of the SMA mixture including, but not limited to:

a. Mix Design and unique JMF identification code

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management and procedures to prevent contamination

e. Mixture proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction, including SMA-Portland Cement Concrete joints

l. Surface Smoothness

m. Truck bed release agent

3.1.2 Testing Laboratory

Provide a fully equipped asphalt laboratory, located at the plant or job site that is equipped with heating and air conditioning units to maintain a temperature of 24 plus or minus 2.3 degrees C 75 plus or minus 5 degrees F. Provide laboratory facilities that are kept clean and all equipment maintained in proper working condition. Provide the Government Engineer unrestricted access to inspect the laboratory facility, to witness quality control activities, and to perform any check testing desired. The Government Engineer will advise in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, immediately suspend the incorporation of the materials into the work. Incorporation of the materials into the work will not be permitted to resume until the deficiencies are corrected.

3.1.3 Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. Required elements of the testing program include, but are not limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the SMA mixture, laboratory air voids, in-place density, grade and smoothness. Develop a Quality Control Testing Plan as part of the Quality Control Program.

3.1.3.1 Asphalt Content

A minimum of two tests to determine asphalt content will be performed per lot (a lot is defined in paragraph QUALITY ASSURANCE) by one of the following methods: extraction method in accordance with ASTM D2172/D2172M, Method A or B, the ignition method in accordance with the ASTM D6307, or the nuclear method in accordance with ASTM D4125/D4125M, provided each method is calibrated for the specific mix being used. For the extraction method, determine the weight of ash, as described in ASTM D2172/D2172M, as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. Use the last weight of ash value in the calculation of the asphalt content for the mixture.

3.1.3.2 Aggregate Properties

Determine aggregate gradations a minimum of twice per lot from mechanical analysis of recovered aggregate in accordance with ASTM D5444 or ASTM D6307. For batch plants, test aggregates in accordance with ASTM C136/C136M using actual batch weights to determine the combined aggregate gradation of the mixture. Determine the specific gravity of each aggregate size grouping for each 18,000 metric tons 20,000 tons in accordance with ASTM C127 or ASTM C128. Determine fractured faces for gravel sources for each 18,000 metric tons 20,000 tons in accordance with ASTM D5821. Determine the uncompacted void content of manufactured sand for each 18,000 metric tons 20,000 tons in accordance with AASHTO T 304 Method A.

3.1.3.3 Temperatures

Check temperatures at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt binder in the storage tank, the SMA mixture at the plant, and the SMA mixture at the job site.

3.1.3.4 Aggregate Moisture

Determine the moisture content of aggregate used for production a minimum of once per lot in accordance with ASTM C566.

3.1.3.5 Moisture Content of Mixture

Determine the moisture content of the mixture at least once per lot in accordance with AASHTO T 329.

3.1.3.6 Laboratory Air Voids and VMA

Obtain mixture samples at least four times per lot and compacted into specimens, using 50 blows per side with the Marshall hand-held hammer as described in ASTM D6926 50 gyrations of the Superpave gyratory compactor as described in ASTM D6925. After compaction, determine the laboratory air voids of each specimen and VMA of each specimen as described in ASTM D6927. Provide mixture with VMA equal to or greater than 17.

3.1.3.7 In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge or other non-destructive testing device may be used to monitor pavement density but only extracted cores are allowed for acceptance.

3.1.3.8 Grade and Smoothness

Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph QUALITY ASSURANCE.

3.1.3.9 Additional Testing

Perform any additional testing, deemed necessary to control the process.

3.1.3.10 QC Monitoring

Submit all QC test results to the Government Engineer on a daily basis as the tests are performed. The Government Engineer reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.1.4 Sampling

When directed by the Government Engineer, sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected. Perform all sampling in accordance with standard procedures specified.

3.1.5 Control Charts

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 8, as a minimum. Provide electronic copies or post the control charts as directed by the Government Engineer and maintain current at all times. Identify the following on the control charts, the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 8 applicable to the test parameter being plotted, and the test results. Also show target values (JMF) on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. When the Suspension Limit is exceeded for individual values or running average, the Government Engineer has the option to require removal and replacement of the material represented by the samples or to leave in place and base acceptance on mixture volumetric properties and in place density. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make decisions concerning mix modifications based on analysis of the results provided in the control charts. In the Quality Control Plan, indicate the appropriate action to be taken to bring the process into control when certain parameters exceed their Action Limits.

Table 8. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of Last Four Samples	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
4.75 mm No. 4 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values	6	8	4	5
0.60 mm No. 30 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values	4	6	3	4
0.075 mm No. 200 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values	1.4	2.0	1.1	1.5

Table 8. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of Last Four Samples	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
Asphalt content, percent deviation from JMF target; plus or minus values	0.4	0.5	0.2	0.3
Laboratory Air Voids, percent deviation from JMF target value	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Mat Density, percent of TMD	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Joint Density, percent of TMD	No specific action and suspension limits set since this is used to determine percent payment parameter			

3.2 PREPARATION OF ASPHALT BINDER MATERIAL

Heat the asphalt binder material while avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. Maintain the temperature of unmodified asphalts to no more than 160 degrees C 325 degrees F when added to the aggregates. The temperature of modified asphalts is not to exceed 175 degrees C 350 degrees F.

3.3 PREPARATION OF MINERAL AGGREGATE

Heat and dry the aggregates for the mixture prior to mixing. No damage to the aggregates due to the maximum temperature and rate of heating used is allowed. Do not exceed a temperature of 175 degrees C 350 degrees F for the aggregates and mineral filler when the asphalt cement is added. Maintain the temperature no lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.4 PREPARATION OF STONE MATRIX ASPHALT MIXTURE

Weigh or meter the aggregates, stabilizer, and the asphalt binder and introduce into the mixer in the amount specified by the JMF. Limit the temperature of the SMA mixture to 175 degrees C 350 degrees F when the asphalt binder is added. Mix the combined materials until the aggregate and stabilizer obtain a thorough and uniform coating of asphalt binder (testing in accordance with ASTM D2489/D2489M may be required by the Government Engineer) and is thoroughly distributed throughout the mixture. The moisture content of all SMA mixture upon discharge from the plant is not to exceed 0.5 percent by total weight of mixture as measured by ASTM D1461 or AASHTO T 329.

3.5 PREPARATION OF THE UNDERLYING SURFACE

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NOTE: A SMA is used as a wearing or surface course overlying a conventional hot-mixed asphalt (HMA). The existing HMA should be cleaned and tack-coated before placing the SMA. Tack coat materials and procedures will need to be addressed in the Contract documents. See Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

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Clean the underlying course of dust and debris immediately before placing the SMA. Apply a tack coat in accordance with the Contract specifications.

3.6 TEST SECTION

Prior to full production, place a test section for each JMF used. Construct a test section of250 tons and two paver passes wide, placed in two lanes, with a longitudinal cold joint. Do not place the second lane of the test section until the temperature of pavement edge is less that 80 degrees C 175 degrees F. Construct the test section of the same depth as the course which it represents. Ensure the underlying grade or pavement structure upon which the test section is to be constructed is the same or very similar to the underlying layer for the project. Use the same equipment in construction of the test section as on the remainder of the course represented by the test section. Construct the test section as part of the project pavement if approved by the Government Engineer.

3.6.1 Sampling and Testing for Test Section

****

NOTE: Table 9 applies only to the test section. The limits in Tables 7A, 7B, and 8, apply to a number of tests run from a lot. This is why the limits listed in Table 9 are different from those listed in Tables 7A, 7B, and 8.

****

Take one random sample at the plant, triplicate specimens compacted, and tested for density and laboratory air voids. Test a portion of the sample size for TMD, aggregate gradation and asphalt content. Test an additional portion of the sample to determine TSR. Adjust the compacted effort as required to provide TSR specimens with an air void content of 7 plus or minus 1 percent. Obtain four randomly selected cores from the finished pavement mat, and four from the longitudinal joint, and tested for density. Perform random sampling in accordance with procedures contained in ASTM D3665. Construction may continue provided the test results are within the tolerances or exceed the minimum values shown in Table 9. If all test results meet the specified requirements, the test section may remain as part of the project pavement. If test results exceed the tolerances shown, remove and replace the test section and construct another test section at no cost to the Government Owner.

Table 9. Test Section Requirements for Material and Mixture Properties

Property	Specification Limit
Aggregate Gradation-Percent Passing (Individual Test Result)	
4.75 mm No. 4 and larger	JMF plus or minus 8.0
2.36, 1.18, 0.60, and 0.30 mm No. 8, No. 16, No. 30, and No. 50	JMF plus or minus 6.0
0.15 and 0.075 mm No. 100 and No. 200	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	17.0 minimum
Tensile Strength Ratio (TSR) (At 7 percent plus or minus 1 percent air void content	75 percent minimum
Mat Density, Percent of Maximum Theoretical Density (Average of 4 Random Cores)	92.0 - 96.0
Joint Density, Percent of TMD (Average of 4 Random Cores)	90.5 minimum

3.6.2 Additional Test Sections

If the initial test section proves to be unacceptable, make the necessary adjustments to the JMF, plant operation, placing procedures, and rolling procedures before beginning construction of a second test section. Construct and evaluate additional test sections, as required, for conformance to the specifications. Full production paving is not allowed until an acceptable section has been constructed and accepted.

3.7 TESTING LABORATORY

****

NOTE: Include bracketed sentence for Corps-managed projects.

****

Laboratories used to develop the JMF, perform Contractor Quality Control testing, and Government Engineer quality assurance and acceptance testing are required to meet the requirements of ASTM D3666. Perform all required test methods by an accredited laboratory. [The Government will inspect the laboratory equipment and test procedures prior to the start of SMA mixture operations for conformance with ASTM D3666. Maintain the validation for the duration of the project.] Submit a certification of compliance signed by the manager of the laboratory stating that it meets these requirements to the Government Engineer prior to the start of construction. At a minimum, include the following certifications:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

3.8 TRANSPORTING AND PLACING

3.8.1 Transporting

Transport SMA mixture from the mixing plant to the site in clean, tight vehicles. Schedule deliveries so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Provide adequate artificial lighting for night placements. Do not haul over freshly placed material until the material has been compacted as specified, and allowed to cool to 60 degrees C 140 degrees F.

3.8.2 Placing

Place the SMA mixture in lifts of adequate thickness and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, place the mixture to the full width by an asphalt paver; strike off to provide a uniform layer of such depth that, when the work is completed, the required thickness is obtained and the surface conforms to the grade and contour indicated. Do not broadcast waste mixture onto the mat or recycle into the paver hopper. Collect waste mixture and dispose of off site. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat. Begin placement of the mixture along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture in consecutive adjacent strips having a minimum width of 3 m 10 feet. Offset the longitudinal joint of one course from the longitudinal joint in the course immediately below by at least 300 mm 1 foot; however, locate the joint in the surface course at the centerline of the pavement. Offset transverse joints in one course by at least 3 m 10 feet from transverse joints in the previous course. Offset transverse joints in adjacent lanes a minimum of 3 m 10 feet. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, spreading and luting with hand tools is permitted.

3.9 COMPACTION OF MIXTURE

3.9.1 General

a. After placing, thoroughly and uniformly compact the SMA mixture by rolling. Compact the surface as soon as possible without causing displacement, cracking or shoving. Determine the sequence of rolling operations and the type of rollers used, except as specified in paragraph SMA-PORTLAND CEMENT CONCRETE JOINTS and with the exception that application of more than three passes with a vibratory roller in the vibrating mode is prohibited. Maintain the speed of the roller, at all times, sufficiently slow to avoid displacement of the SMA mixture and be effective in compaction. Correct at once any displacement occurring as a result of reversing the direction of the roller, or from any other cause.

b. Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened, but excessive water is not permitted. In areas not accessible to the roller, thoroughly compact the mixture with hand tampers. Remove the full depth of any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective. Replace with fresh SMA mixture and immediately compact to conform to the surrounding area. Perform this work at no expense to the Government. Skin patching is not allowed.

3.9.2 Segregation

The Government Engineer can sample and test any material that looks deficient. When the in-place material appears to be segregated, the Government Engineer has the option to sample the material and have it tested and compared to the aggregate gradation, asphalt content, and in-place density requirements in Table 9. If the material fails to meet these specification requirements, remove and replace the extent of the segregated material the full depth of the layer of asphalt mixture at no additional cost to the Government Engineer. When segregation occurs in the mat, take appropriate action to correct the process so that additional segregation does not occur.

3.10 JOINTS

Construct joints to ensure a continuous bond between the courses and to obtain the required density. Provide all joints with the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.10.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, place a bulkhead or taper the course. Utilize a cutting wheel on the transverse joint full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. Cutting equipment that uses water as a cooling or cutting agent nor milling equipment is permitted. In both methods, provide a light tack coat of asphalt material before placing any fresh mixture against the joint.

3.10.2 Longitudinal Joints

Cut back longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80 degrees C 175 degrees F at the time of placing the adjacent lane), or otherwise defective, a maximum of 75 mm 3 inches from the edge with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. Remove cutback material from the project. Cutting equipment that uses water as a cooling or cutting agent nor milling equipment is permitted. Provide a light tack coat of asphalt material to all contact surfaces prior to placing any fresh mixture against the joint.

3.10.2.1 SMA-Portland Cement Concrete Joints

Joints between SMA and Portland Cement Concrete (PCC) require specific construction procedures for the SMA mixture. The following criteria are applicable to the first 3 m 10 feet or paver width of SMA mixture adjacent to the PCC.

a. Place the SMA mixture side of the joint in a direction parallel to the joint.

b. Place the SMA mixture side sufficiently high so that when fully compacted the SMA mixture is greater than 3 mm 1/8 inch but less than 6 mm 1/4 inch higher than the PCC side of the joint.

c. Compact with steel wheel rollers and at least one rubber tire roller. Compact with a rubber tire roller that weights at least 18 metric tons 20 tons with tires inflated to at least 620 kPa 90 psi. Avoid spalling the PCC during placement and compaction of the SMA mixture. Operate steel wheel rollers in a way that prevents spalling the PCC. Repair any damage to PCC edges or joints as directed by the Government Engineer. If damage to the PCC joint or panel edge exceeds a total of 1 m 3 feet, remove and replace the PCC panel at no additional expense to the Government.

d. After compaction is finished, diamond grind a minimum width of 1 m 3 feet of the SMA mixture so that the SMA mixture side is less than 3 mm 1/8 inch higher than the PCC side. Perform diamond grinding in accordance with subparagraph DIAMOND GRINDING above. The SMA mixture immediately adjacent to the joint is not allowed to be lower than the PCC after the grinding operation. Transition the grinding into the SMA mixture in a way that ensures good smoothness and provides drainage of water. The joint and adjacent materials when completed is required to meet all of the requirements for grade and smoothness. Measure smoothness across the SMA-PCC joint using a 4 m 12 feet straightedge. The acceptable tolerance is 3 mm 1/8 inch.

e. Consider the SMA mixture next to the PCC as a separate lot for evaluation. Lots are based on individual lifts. Do not comingle cores from different lifts for density evaluation purposes. Take four cores for each lot of material placed adjacent to the joint. The size of lot is 3 m 10 feet wide by the length of the joint being paved. Locate the center of each of the four cores 150 mm 6 inches from the edge of the concrete. Take each core at a random location along the length of the joint. The requirements for joint density for this lot, adjacent to the PCC joint, are the same as that for the mat density specified in Table 1. For SMA-PCC joints at taxiways abutting runways, aprons, or other taxiways, take two additional randomly located cores along each taxiway intersection.

f. All procedures, including repair of damaged PCC, are required to be in accordance with the approved Quality Control Plan.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 12 16.16 (November 2020)**

Preparing Activity: USACE **Superseding**

UFGS-32 12 16 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-32 12 16.16 (November 2020)**

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SECTION 32 12 16.16

ROAD-MIX ASPHALT PAVING

11/20

****

NOTE: This guide specification covers the requirements for intermediate and wearing courses (central-plant hot-mix and warm-mix) for roads using Marshall or Gyratory compaction methods.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present. Do not lessen the quality of the work.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: Modifications must be made to this guide specification during conversion to a project specification in accordance with the NOTES which are located throughout the document. These NOTES are instructions to the designer, and will not appear in the project specification.

This guide specification only pertains to the hot-mix and warm-mix asphalt aspects of the project and not to any surface preparation requirements dealing with aggregate base courses, milling, or tack and prime coats. Cover surface preparation requirements adding pertinent sections to the

project documents.

This specification utilizes a Quality Assurance and Quality Control (QA/QC) construction management philosophy. Quality Assurance refers to the actions performed by the Government or designated representative to assure the final product meets the job requirements. This specification has been developed for QC testing to be used as a basis for acceptance and percent payment. The Government's QA testing should include as a minimum 10 percent of the QC tests.

For projects less than 1,000 tonnes tons, State DOT material's requirements may be specified. Only material requirements may be substituted as an option. The designer should select which DOT mix design is appropriate for the project. Construction procedures and acceptability of work requirements must stay the same. Designer has the option to eliminate submittal requirement for material samples for this size project.

For projects over 1,000 tonnes tons use this guide as is. Lot size should be specified appropriately.

Do not delete PART 1. Select the tailoring option for PERCENT PAYMENT when pay reduction factors are desired. Select the tailoring option for ACCEPT-REJECT when pass/fail criteria is desired. PERCENT PAYMENT is recommended for most projects and is the standard of practice used by most State DOTs. Adequate justification must be provided by the DOR when selecting the ACCEPT-REJECT tailoring option.

****

1.1 PERCENT PAYMENT

****

NOTE: The basis of pay testing program includes material tests to determine laboratory air voids and in-place density, which are needed to determine percent payment.

****

1.1.1 Method of Measurement

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NOTE: For unit-price contracts, include first bracketed statements and delete the second set.

For lump sum contracts, delete the first bracketed statements and include the second set.

Do not use lump sum contracts when the job exceeds 1,000 tonnes tons.

****

[The amount paid for will be the number of tonnes tons of hot-mix warm-mix asphalt pavement mixture used in the accepted work. Weigh the hot-mix warm-mix asphalt pavement mixture after mixing. No separate payment will be made for weight of asphalt cement material incorporated herein.] [Measurement of the quantity of hot-mix warm-mix asphalt pavement, per tonne ton placed and accepted, will be made for the purposes of assessing the pay factors stipulated below.]

1.1.2 Basis of Payment

****

NOTE: For unit-price contracts, include first bracketed statements and delete the second set.

For lump sum contracts, delete the first bracketed statements and include the second set. Include prescriptive unit price based on the Government/Engineer estimate for payment adjustment.

****

[Quantities of hot-mix warm-mix asphalt pavement, determined as specified above, will be paid for at respective contract unit prices or at reduced prices adjusted in accordance with paragraphs PERCENT PAYMENT and ACCEPTANCE. Payment will constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification.] [The measured quantity of hot-mixed warm-mixed asphalt pavement will be paid for and included in the lump sum contract price. If less than 100 percent payment is due based on the pay factors stipulated in paragraph PERCENT PAYMENT, a unit price of [_____] per tonne ton will be used for purposes of calculating the payment reduction.]

1.1.3 Lot Pay Factor

The lot pay factor is determined by taking the lowest computed pay factor based on either laboratory air voids, in-place density, smoothness, or grade (each discussed below). Remove and replace lots when the lowest computed pay factor requires rejection. At the end of the project calculate the average pay factor for all lots. If this average lot pay factor exceeds 95.0 percent and no individual lot has a pay factor less than 75.0 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot's pay factor. For any lots which are less than 2,000 tonnes tons, a weighted lot pay factor will be used to calculate the average lot pay factor. When work on a lot is required to be terminated before all four sublots are completed, the results from the completed sublots will be analyzed to determine the percent payment for the lot following the same procedures and requirements for full lots but with fewer or more test results as determined in paragraph PAVEMENT LOTS.

1.1.4 Payment Adjustment for Laboratory Air Voids

Laboratory air void calculations for each lot will use the average theoretical maximum density values obtained for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). The mean absolute deviation of the laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated as shown in the example below and a pay factor will be determined from Table

1. When 0 percent payment is determined, remove and replace the rejected lot at least 100 mm 4 inches into the cold (existing) lane adjacent to the longitudinal joint.

Table 1. Pay Factor Based on Laboratory Air Voids	
Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, percent
0.60 or less	100
0.61 - 0.80	98
0.81 - 1.00	95
1.01 - 1.20	90
Above 1.20	reject (0)

1.1.4.1 Pay Factor Example for Laboratory Air Voids

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 sublots where one set of laboratory compacted specimens is from a single sublot. The laboratory air voids for the 4 sublots are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

$$\text{Mean Absolute Deviation} = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|)/4$$

$$\text{Mean Absolute Deviation} = (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45$$

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 1 that the lot's pay factor based on laboratory air voids is 100 percent.

1.1.5 Payment Adjustment for In-place Densities

The average in-place mat and joint densities are expressed as a percentage of the average theoretical maximum density (TMD) for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). The average in-place mat density and joint density for a lot are determined and compared with Table 2 to calculate a single pay factor per lot. Use the following process to determine the single pay factor for in-place density:

a. Step 1: Determine the pay factors for mat density and joint density using Table 2.

b. Step 2: Determine ratio of joint area to mat area. The area associated with the joint is considered to be 3 m 10 feet wide times the length of completed longitudinal construction joint in the lot. This joint area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of asphalt pavement, either an adjacent freshly paved lane or one paved at any time previously.

c. Step 3: Compute the weighted pay factor for the joint using the formula in the example below.

d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller. This selected pay factor is the pay factor based on density for the lot.

When 0 percent payment is determined for mat density, remove and replace the rejected lot at least 100 mm 4 inches into the cold (existing) lane adjacent to the longitudinal joint. When 0 percent payment is determined for joint density, remove and replace the rejected longitudinal joint with a 3 m 10 feet wide paving lane that is centered over the joint.

Table 2. Pay Factor Based on In-place Density

Average Mat Density (4 Cores) (Percent of TMD)	Pay Factor, Percent	Average Joint Density (4 Cores) (Percent of TMD)
93.0 - 96.0	100.0	91.5 or above
92.9	100.0	91.4
92.8 or 96.1	99.9	91.3
92.7	99.8	91.2
92.6 or 96.2	99.6	91.1
92.5	99.4	91.0
92.4 or 96.3	99.1	90.9
92.3	98.7	90.8
92.2 or 96.4	98.3	90.7
92.1	97.8	90.6
92.0 or 96.5	97.3	90.5
91.9	96.3	90.4
91.8 or 96.6	94.1	90.3
91.7	92.2	90.2
91.6 or 96.7	90.3	90.1
91.5	87.9	90.0
91.4 or 96.8	85.7	89.9
91.3	83.3	89.8
91.2 or 96.9	80.6	89.7
91.1	78.0	89.6
91.0 or 97.0	75.0	89.5
below 91.0, above 97.0	0.0 (reject)	below 89.5

1.1.5.1 Pay Factor Example for In-place Density

An example of the computation of a pay factor (in I-P units only) based on in-place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 92.2 percent (of lab TMD). (2) Average joint density = 90.5 percent (of lab TMD). (3)

Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2,000 feet.

a. Step 1: Determine pay factor based on mat density and on joint density, using Table 2:

(1) Mat density of 92.2 percent = 98.3 pay factor.

(2) Joint density of 90.5 percent = 97.3 pay factor.

b. Step 2: Determine ratio of joint area to mat area. Multiply the length of completed longitudinal construction joint by the specified 10 foot width and divide by the mat area (total paved area in the lot).

(1) Ratio = Ratio of joint area to mat area

(2) Ratio = (2,000 feet x 10 feet)/30,000 square feet

(3) Ratio = 0.6667

c. Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:

(1) wpf = joint pay factor + (100 - joint pay factor) x (1 - ratio)

(2) wpf = 97.3 + (100-97.3) x (1-0.6667) = 98.2 percent

d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:

(1) Pay factor for mat density: 98.3 percent.

(2) Weighted pay factor for joint density: 98.2 percent

(3) Selected pay factor: 98.2 percent

1.1.6 Payment Adjustment for Smoothness (Final Wearing Surface Only)

****

NOTE: This paragraph may be deleted for projects where a profilograph cannot record 400 meters 0.25 miles in length.

****

Profilograph Testing. Record the location and data from all profilograph measurements. When the Profile Index of a lot exceeds the tolerance specified in paragraph SMOOTHNESS REQUIREMENTS by 16 mm per km 1.0 inch per mile, but less than 32 mm per km 2.0 inches per mile, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 32 mm per km 2.0 inches per mile, but less than 47 mm per km 3.0 inches per mile, the computed pay factor will be 90 percent. When the Profile Index exceeds the tolerance by 47 mm per km 3.0 inches per mile, but less than 63 mm per km 4.0 inches per mile, the computed pay factor will be 75 percent. Remove and replace the lot when the Profile Index exceeds the tolerance by 63 mm per km 4.0 inches per mile or more, at no additional cost to the Government. Regardless of the above, correct any small individual area with surface deviation which exceeds the tolerance given above by more than 79 mm per km 5.0 inches per mile or more, by grinding to meet the specification requirements above or remove and replace at no additional cost to the Government.

1.1.7 Payment Adjustment for Plan Grade

****

NOTE: The grade and surface smoothness requirements specified below are for the final wearing surface only. If there is a requirement to test and control the grade and smoothness for the intermediate courses, for example, when the intermediate courses will be exposed to traffic, slight modifications to this specification are required.

****

When more than 5 percent of all measurements made within a lot are outside the 15 mm 0.05 foot tolerance, the pay factor based on grade for that lot will be 95 percent. For individual locations where the grade exceeds 22.5 mm 0.075 foot tolerance, remove the surface lift full depth and replace the lift with asphalt pavement to meet specification requirements at no additional cost to the Government. High spots can be diamond ground as an alternative to remove and replace in order to meet grade requirements for the lot and at individual locations.

1.2 PAYMENT

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NOTE: The basis of acceptance includes material tests to determine laboratory air voids and in-place density.

****

1.2.1 Method of Measurement

****

NOTE: For unit-price contracts, include first bracketed statements and delete the second set.

For lump sum contracts, delete the first bracketed statements and include the second set.

Do not use lump sum contracts when the job exceeds 1,000 tonnes tons.

****

[The amount paid for will be the number of tonnes tons of hot-mix warm-mix asphalt pavement mixture used in the accepted work. Weigh the hot-mix warm-mix asphalt pavement mixture after mixing. No separate payment will be made for weight of asphalt cement material incorporated herein.] [Measurement of the quantity of hot-mix warm-mix asphalt pavement per lot will be made for the purposes of assessing acceptance stipulated in paragraph ACCEPTANCE.]

1.2.2 Basis of Payment

****

NOTE: For unit-price contracts, include first bracketed statements and delete the second set.

For lump sum contracts, delete the first bracketed statements and include the second set.
****

[Quantities of hot-mix warm-mix asphalt pavement, determined as specified above, will be paid for at respective contract unit prices. Payment will constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification.][The measured quantity of hot-mixed warm-mixed asphalt pavement will be paid for and included in the lump sum contract price.]

1.3 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
AASHTO T 304	(2011; R 2015) Standard Method of Test for Uncompacted Void Content of Fine Aggregate
AASHTO T 329	(2015) Standard Test Method for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method

ASPHALT INSTITUTE (AI)

AI MS-2	(2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D946/D946M	(2020) Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder

	from Asphalt Mixtures
ASTM D2419	(2014) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D2872	(2019) Standard Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)
ASTM D3203/D3203M	(2017) Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5361/D5361M	(2016) Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
ASTM D5444	(2015) Mechanical Size Analysis of Extracted Aggregate
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6084/D6084M	(2018) Standard Test Method for Elastic Recovery of Asphalt Materials by Ductilometer
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder
ASTM D6925	(2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

ASTM D6926	(2020) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus
ASTM D6927	(2015) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM D7405	(2020) Standard Test Method for Multiple Stress Creep and Recovery (MSCR) of Asphalt Binder Using a Dynamic Shear Rheometer
ASTM D8239	(2018) Standard Specification for Performance-Graded Asphalt Binder Using the Multiple Stress Creep and Recovery (MSCR) Test
ASTM E1274	(2018); R 2024 Standard Test Method for Measuring Pavement Roughness Using a Profilograph

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Placement Plan; G, [_____]

SD-03 Product Data

Diamond Grinding Plan; G, [_____]

Mix Design; G, [_____]

Contractor Quality Control; G, [_____]

SD-04 Samples

Aggregates

Asphalt Cement Binder

Warm-mix Additive

SD-06 Test Reports

Aggregates; G, [_____]

QC Monitoring

SD-07 Certificates

Asphalt Cement Binder; G, [_____]

Laboratory Accreditation and Validation

Warm-mix Additive

1.5 ACCEPTANCE

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NOTE: It is recommended that an independent material testing company be hired by the Contractor to provide the acceptance testing for the project.

Typically acceptance testing will be performed by the Contractor's independent laboratory with oversight from the Government. The results from laboratory testing need to be forwarded daily to the Government as the basis for acceptance and percent payment.

The acceptance testing program includes material tests to determine laboratory air voids and in-place density, which are needed to determine percent payment. The acceptance testing laboratory will also conduct tests to monitor aggregate gradation, asphalt content, and voids in mineral aggregate

(VMA). These tests would serve as a check to the Contractor's QC testing.

For projects with less than 2,000 tonnes tons, the entire project can be considered as a single lot. In this case, sublot sampling could occur over several days production, which could lead to higher sublot variability.

Select the tailoring option for PERCENT PAYMENT when pay reduction factors are desired. Select the tailoring option for ACCEPT-REJECT when pass/fail criteria is desired.

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1.5.1 Acceptability of Work

Acquire the services of an independent commercial laboratory to perform acceptance testing. Acceptance of the plant produced mix and in-place requirements will be on a lot to lot basis. The materials and the pavement itself will be accepted on the basis of production testing. The Government may make check tests from split samples to validate the results of the production testing. Testing performed by the Government does not reduce the required testing of the independent commercial laboratory. Split samples will be taken for Government testing to reduce the variability between the independent commercial laboratory and the Government's test results. When the difference between the independent commercial laboratory and the Government's test results for split samples exceed the acceptable range of two results for multilaboratory precision for the appropriate test method (i.e. ASTM) then at least one of the laboratories is determined to be in error. An evaluation of procedures and equipment in both laboratories will be made to determine the cause(s) for the differences. Develop steps to correct procedures and equipment to bring multilaboratory precision to within acceptable limits.

1.5.2 Acceptance Requirements

Provide all sampling and testing required for acceptance and payment adjustment. Where appropriate, adjustments in percent payment acceptance for individual lots of asphalt pavement will be made based on laboratory air voids, in-place density, smoothness, and grade in accordance with the following paragraphs. Surface smoothness and grade determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus smoothness and grade measurements for the entire lot cannot be made.

1.5.3 Pavement Lots

A standard lot for all requirements is equal to one day's production or 2,000 tonnes tons, whichever is smaller. Divide each lot into four equal sublots in order to evaluate laboratory air voids and in-place density. When operational conditions cause a lot to be terminated before the specified four sublots have been completed, use the following procedure to adjust the lot size and number of tests for the lot. Where three sublots have been completed, they constitute a lot. Where one or two sublots have been completed, incorporate them into the next lot and the total number of sublots (i.e. 5 or 6 sublots) is used for acceptance criteria. Include partial lots at the end of asphalt production into the previous lot.

Complete and report all theoretical maximum density, laboratory air voids, and in-place density testing within 24 hours after construction of each lot.

1.5.4 Sublot Sampling

Take one mixture sample for each sublot in accordance with ASTM D979/D979M from a random truck or another location for determining theoretical maximum density, laboratory air voids, any additional testing the Government desires, and Contractor Quality Control. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs.

1.5.5 Additional Sampling and Testing

The Government reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government. Testing in these areas will be treated as a separate lot. Payment Acceptance will be made for the quantity of asphalt pavement represented by these tests in accordance with the provisions of this section.

1.5.6 Theoretical Maximum Density (TMD)

Measure theoretical maximum density one time for each sublot in accordance with ASTM D2041/D2041M for purposes of calculating laboratory air voids and determining in-place density. The average TMD for each lot will be determined as the average TMD of the random sublot samples. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD values will be used as the TMD needed to calculate the percent joint density.

1.5.7 Laboratory Air Voids

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NOTE: Select the appropriate tailoring option for the Marshall or Superpave Methods.

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[Prepare one set of laboratory compacted specimens for each sublot in accordance with ASTM D6926 using the hand-held hammer for the Marshall Method.][Prepare one set of laboratory compacted specimens for each sublot in accordance with ASTM D6925 using the Superpave gyratory compactor.] Provide three test specimens prepared from the same sample for each set of laboratory compacted specimens. Compact the specimens within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Do not reheat samples prior to compaction. Provide insulated containers as necessary to maintain the sample temperature. Measure the bulk density of laboratory compacted specimens in accordance with ASTM D2726/D2726M. Determine laboratory air voids from one set (three laboratory compacted specimens) for each sublot sample in accordance with ASTM D3203/D3203M.

1.5.7.1 Tolerance

Provide laboratory air voids with a mean absolute deviation of 1.00 percent or less from the JMF for each lot. Remove and replace lots that do not meet the laboratory air voids requirement at least 100 mm 4 inches into the cold (existing) lane adjacent to the longitudinal joint, at no additional cost to the Government. The mean absolute deviation of the laboratory air void contents from the JMF air void content will be evaluated as shown in the example below.

1.5.7.2 Calculating Laboratory Air Voids

Laboratory air void calculations for each lot will use the average theoretical maximum density values obtained for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). The mean absolute deviation of the laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated as in the following example:

Assume that the laboratory air voids are determined from 4 sublots where one set of laboratory compacted specimens is from a single sublot. The laboratory air voids for the 4 sublots are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

$$\text{Mean Absolute Deviation} = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|)/4$$

$$\text{Mean Absolute Deviation} = (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45$$

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen that 0.45 is less than 1.00 percent. The lot is acceptable for laboratory air voids.

1.5.8 In-place Density

Obtain one random 100 mm 4 inch or 150 mm 6 inch diameter core from the mat and joint of each sublot in accordance with ASTM D5361/D5361M for determining in-place density. Cut samples neatly with a diamond core drill bit. Obtain random cores that are the full thickness of the layer being placed. Select core locations randomly using the procedures contained in ASTM D3665. Locate cores for mat density no closer than 300 mm 12 inches from a transverse or longitudinal joint including the pavement edge. Center all cores for joint density on the joint. Discard samples that are clearly defective as a result of sampling and take an additional random core. When the random core is less than 25 mm 1 inch thick, it will not be included in the analysis. In this case, obtain another random core sample. Clean and tack coat dry core holes before filling with asphalt mixture. Fill all core holes with asphalt mixture and compact using a standard Marshall hammer to the density specified. Provide all tools, labor, and materials for cutting samples, cleaning, and filling the cored pavement. Measure in-place density in accordance with ASTM D2726/D2726M using each core obtained from the mat and joint.

1.5.8.1 Tolerance

Provide a minimum in-place mat density of 93.0 percent and a minimum in-place joint density of 90.0 percent for each lot. The average in-place mat and joint densities are expressed as a percentage of the average theoretical maximum density (TMD) for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). Remove and replace lots that do not meet the in-place mat density requirement at least 100 mm 4 inches into the cold (existing) lane adjacent to the longitudinal joint, at no additional cost to the Government. Remove and replace the longitudinal joint when the lot does not meet the in-place joint density, at no additional cost to the Government. Use a 3 m 10 feet wide paving lane that is centered over the joint.

1.5.9 Surface Smoothness

Use a straightedge and profilograph for measuring surface smoothness. Use the profilograph method for all longitudinal testing, except for paving lanes less than 400 meters 0.25 miles in length. Use the straightedge method for transverse testing, for longitudinal testing where the length of each pavement lane is less than 400 meters 0.25 miles, and at the ends of the paving limits for the project. Smoothness requirements do not apply over crowns or grade breaks. Maintain detailed notes of the testing results and provide a copy to the Government immediately after each day's testing.

1.5.9.1 Smoothness Requirements

1.5.9.1.1 Straightedge Testing

Provide finished surfaces of the pavements with no abrupt change of 6 mm 1/4 inch or more when checked with an approved 4 m 12 foot straightedge. Remove and replace surface lift lots when the surface smoothness exceeds 9 mm 3/8 inch, at no additional cost to the Government. High spots can be diamond ground as an alternative to remove and replace in order to meet surface smoothness requirements at individual locations.

1.5.9.1.2 Profilograph Testing

Provide finished surfaces with a Profile Index not greater than 140 mm per km 9 inches per mile when tested with an approved California-type profilograph. Remove and replace the lot when the Profile Index exceeds the tolerance by 63 mm per km 4.0 inches per mile or more, at no additional cost to the Government. Correct any small individual area with surface deviation which exceeds the tolerance given above by more than 79 mm per km 5.0 inches per mile or more by diamond grinding to meet the specification requirements above or remove and replace at no additional cost to the Government.

1.5.9.2 Testing Method

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in each entire lot in a manner to reveal surface irregularities exceeding the tolerances specified above. If any pavement areas are diamond ground, retest these areas immediately after diamond grinding. The maximum area allowed to be corrected by diamond grinding is 10 percent of the total area of the lot. Test the entire area of the pavement with a profilograph. Check a number of random locations along with any observed suspicious locations primarily at transverse and longitudinal joints with the straightedge.

1.5.9.2.1 Straightedge Testing

Use the straightedge to measure abrupt changes in surface smoothness. Hold the straightedge in contact with the pavement surface and measure the maximum distance between the straightedge and the pavement surface. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

1.5.9.2.2 Profilograph Testing

Perform profilograph testing using an approved California profilograph and procedures described in ASTM E1274. Provide equipment that utilizes electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. Use a "blanking band" that is 5 mm 0.2 inch wide and the "bump template" spanning 25 mm 1 inch with an offset of 10 mm 0.4 inch. Provide profilograph operated by an approved, factory-trained operator on the alignments specified above. Provide a copy of the reduced tapes to the Government at the end of each day's testing.

1.5.9.2.3 Bumps ("Must Grind" Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm 0.4 inch in height by diamond grinding until they do not exceed 7.5 mm 0.3 inch when retested. Taper diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding. The following will not be permitted: (1) skin patching for correcting low areas, (2) planing or milling for correcting high areas.[At the Contractor's option, pavement areas including diamond ground areas can be rechecked with the profilograph in order to record a lower Profile Index.][Perform additional profilograph testing in all areas corrected by diamond grinding.]

1.5.10 Plan Grade

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NOTE: For roadway projects, select the first bracketed option.

For parking lots, select the second bracketed option.

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Provide a final wearing surface of pavement conforming to the elevations and cross sections shown and not vary more than 15 mm 0.05 foot from the plan grade established and approved at site of work. Within 5 working days after completion of a particular lot incorporating the final wearing course, test the final wearing surface of the pavement for conformance with specified plan grade requirements. Match finished surfaces at juncture with other pavements with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved.[For roads, the grade will be determined by running lines of levels along the centerline at intervals of 7.6 m 25 feet or less longitudinally to determine the elevation of the completed pavement surface. Measure transverse grades at appropriate intervals.][For parking lots, the grade will be determined by running lines of levels at intervals of 7.6 m 25 feet or less longitudinally and transversely to determine the elevation of the completed pavement surface.] Diamond grinding can be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted. Maintain detailed notes of the results of the testing and provide a copy to the Government immediately after each day's testing. Remove and replace surface lift lots when individual locations exceed the 15 mm 0.05 foot tolerance, at no additional cost to the Government. High spots can be diamond ground as an alternative to remove and replace in order to meet plan grade requirements at individual locations.

1.5.11 Laboratory Accreditation and Validation

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NOTE: Include bracketed sentence for Corps-managed projects. Utilization of the USACE Materials Testing Center (MTC) is optional for Air Force and Navy managed projects.

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Provide laboratories used to develop the Job Mix Formula (JMF), perform acceptance testing, and Contractor Quality Control testing that meet the requirements of ASTM D3666. Provide laboratories with a masonry saw having a diamond blade for trimming pavement cores and samples. Perform all required test methods by an accredited laboratory. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory accreditation is not allowed.[The Government will inspect the laboratory equipment and test procedures prior to the start of hot-mix warm-mix operations for conformance with ASTM D3666. In addition, all testing laboratories performing acceptance testing require USACE validation by the Material Testing Center (MTC)[for both parent laboratory and plant testing laboratory]. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at https://mtc.erdc.dren.mil for costs and scheduling.] Submit a certificate of compliance signed by the manager of the laboratory stating that it meets these requirements to the Government prior to the start of construction. At a minimum, include the following certifications:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

1.6 ENVIRONMENTAL REQUIREMENTS

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NOTE: The temperature requirements in Table 3 Table 1 are included to avoid problems with the Contractor achieving density because the mix cools too fast. Waivers to these requirements for isolated incidences during production are applicable if the density requirements are still met.

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Do not place the asphalt mixture upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 3 Table 1. The temperature requirements may be waived by the Government, if requested; however, meet all other requirements including compaction.

Table 3. Table 1. Surface Temperature Limitations of Underlying Course	
Mat Thickness, mm inches	Degrees C F
75 3 or greater	4 40
Less than 75 3	7 45

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Perform the work consisting of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. Provide asphalt pavement designed and constructed in accordance with this section conforming to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Construct each course to the depth, section, or elevation required by the drawings and rolled, finished, and approved before the placement of the next course. Submit proposed Placement Plan indicating lane widths and longitudinal joints for each course or lift.

2.1.1 Asphalt Mixing Plant

Provide plants used for the preparation of asphalt mixture conforming to the requirements of AASHTO M 156 with the following changes:

2.1.1.1 Truck Scales

Weigh the asphalt mixture on approved scales, or on certified public scales at no additional expense to the Government. Inspect and seal scales at least annually by an approved calibration laboratory.

2.1.1.2 Inspection of Plant

Provide access to the Government at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance as requested, for the Government to procure any desired samples.

2.1.1.3 Storage bins

The asphalt mixture can be stored in non-insulated storage bins for a period of time not exceeding 3 hours. The asphalt mixture can be stored in insulated storage bins for a period of time not exceeding 8 hours. Provide the mix drawn from bins that meets the same requirements as mix loaded directly into trucks.

2.1.2 Hauling Equipment

Provide trucks used for hauling asphalt mixture that have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, lightly coat the truck beds with a minimum amount of paraffin oil, lime solution, or other approved material. Do not use petroleum based products as a release agent. Provide each truck with a suitable cover to protect the mixture from adverse weather, contamination, and loss of material during hauling. When necessary due to long haul distance and cold weather, provide insulated truck beds with covers (tarps) that are securely fastened.

[2.1.3 Material Transfer Vehicle (MTV)

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NOTE: A Material Transfer Vehicle (MTV) should be considered for use on high volume roads such as base entrance roads and roads that will be subjected to significant truck traffic or other heavy vehicles. This paragraph should be deleted if a MTV will not be required.

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Provide Material Transfer Vehicle for placement of the asphalt mixture. Transfer the material from the hauling equipment to the paver using a self-propelled, material transfer vehicle with a swing conveyor that is capable of delivering material to the paver without making contact with the paver. Provide MTV capable to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. Provide Material Transfer Vehicle with remixing and storage capability to prevent physical and thermal segregation.

]2.1.4 Asphalt Pavers

Provide mechanical spreading and finishing equipment consisting of a self-powered paver, capable of spreading and finishing the mixture to the specified line, grade, and cross section. Provide paver screed capable of laying a uniform mixture to meet the specified thickness, smoothness, and grade without physical or temperature segregation, the full width of the material being placed. Provide a paver with a vibrating screed to be used during all placement.

2.1.4.1 Receiving Hopper

Provide paver with a receiving hopper of sufficient capacity to permit a uniform spreading operation and a distribution system to place the mixture uniformly in front of the screed without segregation. Provide a screed that effectively produces a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

[2.1.4.2 Automatic Grade Controls

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NOTE: Automatic grade control is needed when the design requires elevations for the asphalt pavement surface. Many maintenance and rehabilitation projects require an overlay thickness and do not specify actual grades. Delete information on automatic grade control if not needed.

****

Provide a paver equipped with a control system capable of maintaining the specified screed elevation. One of three methods can be used to control grade: stringline, laser, or computerized elevations along with GPS. For multiple layers it is acceptable to control the grade in the underlying layer and control the grade of the surface layer by applying a constant thickness over the underlying layer which has been placed to the desired grade. Slope control can also be used to control the grade of the surface for roads, but is not acceptable for wide pavements such as parking lots. Provide transverse slope controller capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. A ski-type device of not less than 9.14 m 30 ft can be used to provide improved smoothness. Use a shoe on one side of the paver to match an existing paved surface to provide a smooth joint.

]2.1.5 Rollers

Provide rollers in good condition and operate at slow speeds to avoid displacement of the asphalt mixture. Provide sufficient number, type, and weight of rollers to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate.

2.1.6 Diamond Grinding

Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth is limited below. Reduce high areas by diamond grinding the asphalt pavement with approved equipment. Perform diamond grinding by sawing with saw blades impregnated with an industrial diamond abrasive. Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the asphalt pavement or joint faces. Provide diamond grinding equipment with saw blades that are 3 mm 1/8-inch wide, a minimum of 60 blades per 300 mm 12 inches of cutting head width, and capable of cutting a path a minimum of 0.9 m 3 feet wide. Diamond grinding equipment that causes raveling, fracturing of aggregate, or disturbance to the underlying material will not be allowed. The maximum area corrected by diamond grinding the surface of the asphalt pavement is 10 percent of the total area of any lot. The maximum depth of diamond grinding is 12 mm 1/2 inch. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government property. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified.

Prior to production diamond grinding operations, perform a test section at the approved location, consisting of a minimum of two adjacent passes with a minimum length of 12 m 40 feet to allow evaluation of the finish and transition between adjacent passes. Production diamond grinding operations cannot be performed prior to approval.

2.2 AGGREGATES

Notify the Government at least 7 days before sampling aggregates. Obtain samples in accordance with ASTM D75/D75M that are representative of the materials to be used for the project. Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screenings, natural sand, and mineral filler as required. The portion of material retained on the 4.75 mm No. 4 sieve is coarse aggregate. The portion of material passing the 4.75

mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve is fine aggregate. The portion passing the 0.075 mm No. 200 sieve is defined as mineral filler. Submit sufficient materials to produce 90 kg 200 pounds of blended mixture for mix design verification. Submit all aggregate test results and samples to the Government at least 14 days prior to start of construction. Perform job aggregate testing no earlier than 6 months before contract award.

2.2.1 Coarse Aggregate

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NOTE: Retain the sulfate soundness (requirement b., below) in areas where freeze-thaw occurs. The requirement for sulfate soundness may be deleted in climates where freeze-thaw does not occur. However, in those areas where freeze-thaw does not occur, requirement b. must remain if experience has shown that this test separates good performing aggregates from bad performing aggregates. Retain this requirement for all Navy projects.

Percentage of Wear (ASTM C131/C131M) must not exceed 40. Aggregates with a higher percentage of wear may be specified, provided a satisfactory record under similar conditions of service and exposure has been demonstrated.

****

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Provide coarse aggregate particles meeting the following requirements:

a. The percentage of loss not greater than [40] [_____] percent after 500 revolutions when tested in accordance with ASTM C131/C131M.

[b. The sodium sulfate soundness loss not exceeding 12 percent, or the magnesium sulfate soundness loss not exceeding 18 percent after five cycles when tested in accordance with ASTM C88.]

c. At least 75 percent by weight of coarse aggregate containing two or more fractured faces when tested in accordance with ASTM D5821 with fractured faces produced by crushing.

d. The particle shape essentially cubical and the aggregate containing not more than 10 percent, by weight, of flat and elongated particles (5:1 ratio of length to thickness) when tested in accordance with ASTM D4791, Method B.

e. Slag consisting of air-cooled, blast furnace slag with a compacted weight of not less than 1200 kg/cubic meter 75 lb/cu ft when tested in accordance with ASTM C29/C29M.

f. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.2.2 Fine Aggregate

****

NOTE: Set the lower limit for uncompacted void content (requirement c., below) at 45 for fine aggregate angularity unless local experience indicates that a lower value can be used. There are some aggregates which have a good performance record and have an uncompacted void content less than 45. In no case set the limit at less than 43.

****

Provide fine aggregate consisting of clean, sound, tough, durable particles. Provide aggregate particles that are free from coatings of clay, silt, or any objectionable material, contain no clay balls, and meet the following requirements:

a. Quantity of natural sand (noncrushed material) added to the aggregate blend not exceeding 15 percent by weight of total aggregate.

b. Individual fine aggregate sources with a sand equivalent value greater than [45] [_____] when tested in accordance with ASTM D2419.

c. Fine aggregate portion of the blended aggregate with an uncompacted void content greater than 45.0 percent when tested in accordance with AASHTO T 304 Method A.

d. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.2.3 Mineral Filler

Provide mineral filler consisting of a nonplastic material meeting the requirements of ASTM D242/D242M.

2.2.4 Aggregate Gradation

****

NOTE: Delete from Table 4 Table 2 the gradations that will not be used as a part of this project.

Gradation 1 is limited to intermediate courses. Do not use gradation 1 for surface courses.

Gradation 2 is suitable for intermediate and surface courses. Typically gradation 2 is used on most projects except where leveling courses are needed.

Gradation 3 is limited to leveling courses and shoulders.

Generally, the layer thickness for gradation No. 1 is at least 57 mm 2.25 inches, the thickness for gradation No. 2 is at least 37.5 mm 1.5 inches, and thickness for gradation No. 3 is at least 25 mm 1.0 inch. The preferred thickness of the surface layer is 50 mm 2 inches. The surface layer should not be less than 37 mm 1.5 inches. The thickness of the underlying layers can be up to 75 mm 3 inches

depending on the total designed thickness of the asphalt pavement.

****

Provide a combined aggregate gradation that conforms to gradations specified in Table 4 Table 2, when tested in accordance with ASTM C136/C136M and ASTM C117, and does not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grades uniformly from coarse to fine. Provide a JMF within the specification limits; however, the gradation can exceed the limits when the allowable deviation from the JMF shown in Tables 6 and 7 Tables 4 and 5 are applied.

Table 4. Table 2. Aggregate Gradations

Sieve Size, mm inch	Gradation 1 Percent Passing by Mass	Gradation 2 Percent Passing by Mass	Gradation 3 Percent Passing by Mass
25.0 1	100	---	---
19.0 3/4	90-100	100	---
12.5 1/2	68-88	90-100	100
9.5 3/8	60-82	69-89	90-100
4.75 No. 4	45-67	53-73	58-78
2.36 No. 8	32-54	38-60	40-60
1.18 No. 16	22-44	26-48	28-48
0.60 No. 30	15-35	18-38	18-38
0.30 No. 50	9-25	11-27	11-27
0.15 No. 100	6-18	6-18	6-18
0.075 No. 200	3-6	3-6	3-6

2.3 ASPHALT CEMENT BINDER

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NOTE: For CONUS locations specify Performance Graded (PG) asphalt binders. Consider using the same grade PG binder used by the State DOT near the project location. For example the PG grade typically specified in that region of the state for dense graded mixes on highways with design ESALs less than 10 million. The exception to that would be grades with a low temperature higher than PG XX-22 must not be used such as PG XX-16 or PG XX-10 unless the Engineer has had successful experience with them.

For OCONUS locations penetration graded asphalt binders may be used.

If rutting is a typical problem in the area or if high traffic volume is expected then consider "bumping" the high temperature grade for the top 100

mm 4 inches of pavement. The low temperature grade should remain the same. For most roads rutting is not a concern.

For State DOTs that use performance graded asphalt binder, select ASTM D6373. For State DOTs that use performance graded asphalt binder using the Multiple Stress Creep Recovery test, select ASTM D8239.

When the PG spread between the high and low temperature is less than 90, delete the three bracketed options for elastic recovery and MSCR recovery.

When the PG spread between the high and low temperature is greater than 90, a PG Plus Test will be required to determine if the asphalt cement has been polymer modified. Use the PG Plus Test found in the State DOT specifications for the project location. When the State DOT does not specify a PG Plus Test, use ASTM D6084/D6084M with a minimum elastic recovery of 75 percent.

Select one of the three bracketed option below for PG plus testing. Use the first option for State DOTs with elastic recovery, ASTM D6084/D6084M. Use the second option for State DOTs that have Multiple Stress Creep Recovery testing, ASTM D7405. Use the third option for State DOTs that have no PG plus testing, ASTM D6084/D6084M.

Consider contacting a materials engineer or the State DOT when editing this criteria.

****

Provide asphalt cement binder that conforms to [ASTM D6373] [ASTM D8239] Performance Grade (PG) [_____].[As an alternate, provide ASTM D946/D946M Penetration Grade [_____]]. [Provide an asphalt binder with a minimum elastic recovery of [_____] percent when tested at 25 degrees C plus or minus 0.5 degrees C 77 degrees F plus or minus 0.9 degrees F in accordance with ASTM D6084/D6084M. Condition the specimen for elastic recovery in accordance with ASTM D2872.][Provide an asphalt binder with an average recovery of [_____] percent at [_____] kPa psi when tested in accordance with ASTM D7405. Condition the specimen for elastic recovery in accordance with ASTM D2872.][Provide an asphalt binder with a minimum elastic recovery of 75 percent in accordance with ASTM D6084/D6084M.] Provide test data indicating grade certification by the supplier at the time of delivery of each load to the mix plant. When warm-mix asphalt technology involves additives, grade the asphalt binder with the asphalt binder additive included. Submit copies of these certifications to the Government. The supplier is defined as the last source of any modification to the binder. The Government may sample and test the binder at the mix plant at any time before or during mix production. [Submit 20 L 5 gallon sample of the asphalt cement or asphalt binder not less than 14 days before start of the test section for mix design verification and approval. Obtain samples for this verification testing in accordance with ASTM D140/D140M and in the presence of the Government. Provide these samples to the Government for the verification testing, which will be performed at the Government's expense.]

2.4 WARM-MIX ASPHALT TECHNOLOGIES/PRODUCTS

****

NOTE: Warm-mix asphalt (WMA) can be used in lieu of hot mix asphalt (HMA). The WMA is primarily used to reduce emissions during production and placement of HMA. Research has shown that WMA mixes provide similar performance to HMA mixture. It is recommended only HMA should be specified unless there is a good reason to use WMA.

Delete if WMA is not allowed.

****

Provide warm-mix asphalt technologies/products that have a record of good performance and are included on the local state DOT's qualified products list, if the DOT maintains a qualified products list. These qualified products lists can be found at each state DOT's website.

2.5 MIX DESIGN

****

NOTE: Select the appropriate gradation and VMA requirements in Table 5 Table 3 to be consistent with the gradation chosen in Table 4 Table 2. Delete from Table 5 Table 3 the gradations that will not be used as a part of this project.

Use 75 blows with the Marshall hand-held hammer for high traffic areas or all pavements designed for tire pressures of 690 kPa 100 psi or higher.

Use 50 blows with the Marshall hand-held hammer for all shoulder pavements and pavements designed for tire pressures less than 690 kPa 100 psi.

For Marshall mixes, select the appropriate Marshall column in Table 5 Table 3 and delete the column that will not be used as a part of this project.

Use 75 gyrations with the Superpave gyratory compactor for high traffic areas or all pavements designed for tire pressures of 690 kPa 100 psi or higher.

Use 50 gyrations with the Superpave gyratory compactor for all shoulder pavements and pavements designed for tire pressures less than 690 kPa 100 psi.

For Superpave mixtures delete the columns in Table 5 Table 3 that refer to Marshall.

****

Develop the mix design. Perform Job Mix formula (JMF) and aggregates testing no earlier than 6 months before contract award. Provide asphalt mixture composed of well-graded aggregate, mineral filler if required, and asphalt material. Provide aggregate fractions sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of Table 4 Table 2. Do not produce asphalt pavement for payment acceptance until a JMF has been approved.[Design the asphalt mixture using [50] [75] blows with the Marshall hand-held hammer procedures contained in AI MS-2 and the criteria shown in Table 5 Table 3.] [Design the asphalt mixture using the Superpave gyratory compactor set at [50] [75] gyrations. Prepare samples at various asphalt contents and compacted in accordance with ASTM D6925.] Use laboratory compaction temperatures for Polymer Modified Asphalts as recommended by the asphalt binder manufacturer. Determine the Tensile Strength Ratio (TSR) of the composite mixture in accordance with ASTM D4867/D4867M. Compact the TSR specimens to an air void content of 7 percent plus or minus 1 percent. If the Tensile Strength Ratio (TSR) of the composite mixture is less than 75, reject the aggregates or treat the asphalt mixture with an anti-stripping agent. Add a sufficient amount of anti-stripping agent to produce a TSR of not less than 75. If an antistrip agent is required, provide it at no additional cost to the Government. Provide sufficient materials to produce 90 kg 200 pound of blended mixture to the Government for verification of mix design at least 14 days prior to construction of test section.

2.5.1 JMF Requirements

Submit the proposed JMF in writing, for approval, at least 14 days prior to the start of the test section including, as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt cement.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt performance grade or penetration grade.

e. [Number of blows of hammer per side of molded specimen.][Number of Superpave gyratory compactor gyrations.]

f. Laboratory mixing temperature.

g. Laboratory compaction temperature.

h. Temperature-viscosity relationship of the asphalt cement

i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

j. Graphical plots and summary tabulation of[Marshall stability, flow,] air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2. Include summary tabulation that includes individual specimen data for each specimen tested.

k. Specific gravity and absorption of each aggregate.

l. Percent natural sand.

m. Percent particles with two or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

o. Percent flat or elongated particles in coarse aggregate.

p. Tensile Strength Ratio and wet/dry specimen test results.

q. Antistrip agent (if required).

r. List of all modifiers.

s. Percentage and properties (asphalt content, aggregate gradation, and aggregate properties) of RAP in accordance with paragraph RECYCLED ASPHALT PAVEMENT, if RAP is used.

t. Warm-mix additive or process.

Table 5. Table 3. Mix Design Criteria

Test Property	Marshall (50 Blows)	Marshall (75 Blows)	Superpave ([50][75] gyrations)
Stability, N pounds, minimum (NA for Superpave)	44501000(1)	80001800(1)	NA
Flow, 0.25 mm 0.01 inch, (NA for Superpave)	8-18	8-16	NA
Air voids, percent	3-5	3-5	3-5
Minimum Percent Voids in Mineral Aggregate (VMA)(2)			
Gradation 1	13.0	13.0	13.0
Gradation 2	14.0	14.0	14.0
Gradation 3	15.0	15.0	15.0
TSR, minimum percent	75	75	75
(1) This is a minimum requirement. Provide significantly higher average during construction to ensure compliance with the specifications.			
(2) Calculate VMA in accordance with AI MS-2, based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate.			

2.5.2 Adjustments to JMF

The JMF for each mixture is in effect until a new formula is approved in writing by the Government. Should a change in sources of any materials be made, perform a new mix design and a new JMF approved before the new material is used. Make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF are limited to plus or minus 4 percent on the 4.75 mm No. 4 and coarser sieves; plus or minus 3 percent on the 2.36 mm No. 8 to 0.30 mm No. 50 sieves; and plus or minus 1 percent on the 0.15 mm No. 100 sieve and 0.075 mm No. 200 sieve. Asphalt content adjustments are limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, develop a new mix design.

2.6 RECYCLED HOT MIX ASPHALT

****

NOTE: Reclaimed Asphalt Pavement (RAP) can be used but the amount of asphalt binder from RAP cannot exceed 30 percent of the total asphalt content in the recycled asphalt mixture. The resulting recycled mix must meet all requirements that are specified for virgin mixtures.

The 30 percent is an upper limit. If the existing asphalt pavement is relatively old, the amount of RAP used should not approach this limit. If the recycling involves relatively new RAP materials, the percentage of RAP specified below can reach 30 percent binder as long as the recycled mixture meets the specification requirements.

Select the first option if RAP is not used.

In addition to MS-02, refer to UFC 3-250-03, "Standard Practice Manual for Flexible Pavements" for further design guidance.

****

[Recycled asphalt mixture is not allowed for the project.] [Provide recycled asphalt mixture consisting of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. Provide RAP of a consistent gradation, asphalt content, and properties. Maintain RAP stockpiles free from contamination including coal-tar sealers. Limit the maximum RAP chunk size to 50 mm 2 inches when feeding RAP into the plant. The individual aggregates in a RAP chunk are not to exceed the maximum size aggregate of the gradation specified in Table 4 Table 2. Design the recycled asphalt mixture using procedures contained in AI MS-2. Provide RAP job mix that meets the requirements of paragraph MIX DESIGN. Limit the amount of RAP so the asphalt binder from the RAP does not exceed 30 percent of the total asphalt content.]

[2.6.1 RAP Aggregates and Asphalt Cement

Provide a blend of aggregates used in the recycled mix that meet the requirements of paragraph AGGREGATES. Establish the percentage of asphalt binder in the RAP for the mixture design according to ASTM D2172/D2172M or ASTM D6307 using the appropriate dust correction procedure.

2.6.2 RAP Mix

Select the virgin asphalt binder as described below:

a. For 0 to 20 percent recycled binder content - no change in virgin binder selection.

b. For 20+ percent to 30 percent recycled binder content - select virgin binder one grade softer than normal.

]PART 3 EXECUTION

3.1 CONTRACTOR QUALITY CONTROL

****

NOTE: The Contractor may be able to meet the specified quality control requirements with in-house capability or may have to use the independent commercial laboratory to provide the required quality control testing.

Select the bracketed option for Marshall mixes.

****

3.1.1 General Quality Control Requirements

Submit the Quality Control Plan. Do not produce hot-mix warm-mix asphalt for payment acceptance until the quality control plan has been approved. In the quality control plan, address all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design and unique JMF identification code

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management and procedures to prevent contamination

e. Proportioning including percent of warm-mix additive

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Compaction

j. Joints

k. Surface Smoothness

l. Truck bed release agent

[m. Correlation of mechanical hammer to hand hammer. Determine the number of blows of the mechanical hammer required to provide the same density of the JMF as provided by the hand hammer. Use the average of three specimens per trial blow application.]

3.1.2 Testing Laboratory

Provide a fully equipped asphalt laboratory located at the plant or job site that is equipped with heating and air conditioning units to maintain a temperature of 24 plus or minus 2.3 degrees C 75 plus or minus 5 degrees F. Provide laboratory facilities that are kept clean and all equipment maintained in proper working condition. Provide the Government with unrestricted access to inspect the laboratory facility, to witness quality control activities, and to perform any check testing desired. The

Government will advise in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, immediately suspend the incorporation of the materials into the work. Incorporation of the materials into the work will not be permitted to resume until the deficiencies are corrected.

3.1.3 Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. Use the independent commercial laboratory for acceptance testing in paragraph ACCEPTANCE. Use in-house capabilities or the independent commercial laboratory for quality control testing. Required elements of the testing program include, but are not limited to tests for the control of asphalt content, aggregate gradation, aggregate moisture, moisture in the asphalt mixture, temperatures, VMA, [Marshall stability, flow,]and in-place density. Develop a Quality Control Testing Plan as part of the Quality Control Program.

3.1.3.1 Asphalt Content

Determine asphalt content a minimum of twice per lot (a lot is defined in paragraph PAVEMENT LOTS) using the ignition method in accordance with ASTM D6307. Use the extraction method in accordance with ASTM D2172/D2172M if the correction factor for the ignition method in ASTM D6307 is greater than 1.0. The asphalt content for the lot will be determined by averaging the test results.

3.1.3.2 Aggregate Properties

Determine aggregate gradations a minimum of twice per lot from mechanical analysis of extracted aggregate in accordance with ASTM D5444, ASTM C136/C136M, and ASTM C117. Determine the specific gravity of each aggregate size grouping for each 18,000 tonnes 20,000 tons in accordance with ASTM C127 or ASTM C128. Determine fractured faces for gravel sources for each 18,000 tonnes 20,000 tons in accordance with ASTM D5821. Determine the uncompacted void content of natural sand, manufactured sand, and blended aggregate for each 18,000 tonnes 20,000 tons in accordance with AASHTO T 304 Method A.

3.1.3.3 Moisture Content of Aggregate

Determine the moisture content of aggregate used for production a minimum of once per lot in accordance with ASTM C566.

3.1.3.4 Moisture Content of Asphalt Mixture

Determine the moisture content of the asphalt mixture at least once per lot in accordance with AASHTO T 329.

3.1.3.5 Temperatures

Check temperatures at least four times per lot, at necessary locations to determine the temperature at the dryer, the asphalt cement binder in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.1.3.6 VMA[, Marshall Stability, and Flow]

Obtain mixture samples at least four times per lot. Calculate the VMA of each specimen in accordance with AI MS-2 based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate[, as well as the Marshall stability and flow, as described in ASTM D6927]. Provide VMA within the limits of Table 5 Table 3.

3.1.3.7 In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge or other non-destructive testing device can be used to monitor pavement density.

3.1.3.8 Additional Testing

Perform any additional testing deemed necessary to control the process.

3.1.3.9 QC Monitoring

Submit all QC test results to the Government on a daily basis as the tests are performed. The Government reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.1.4 Sampling

When directed by the Government, sample and test any material which appears to not meet specification requirements unless such material is voluntarily removed and replaced or deficiencies corrected. Perform all sampling in accordance with standard procedures specified.

3.1.5 Control Charts

****

NOTE: For Marshall mixes, select the appropriate Marshall row in Table 6 Table 4 and delete the row that will not be used as a part of this project.

For Superpave mixes, delete the rows in Table 6 Table 4 that refer to Marshall.

Select the appropriate gradation and VMA requirements in Table 6 Table 4 to be consistent with the gradation chosen in Table 4 Table 2.

For projects less than 2,000 tonnes tons, the control chart requirements may be deleted.

****

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 6 Table 4, as a minimum. Post the control charts as directed by the Government and maintain current at all times. Identify the following on the control charts: the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 6 Table 4 applicable to the test parameter being plotted, and the test results. Also show target values (JMF) on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. When the Suspension Limit is exceeded for individual values or running average values, the Government has the option to require removal and replacement of the material represented by the samples or to leave in place and base acceptance on mixture volumetric properties and in place density. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make decisions concerning mix modifications based on analysis of the results provided in the control charts. In the Quality Control Plan, indicate the appropriate action to be taken to bring the process into control when certain parameters exceed their Action Limits.

Table 6. Table 4. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
4.75 mm No. 4 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values	6	8	4	5
0.6 mm No. 30 sieve, Cumulative percent passing, deviation for JMF target; plus or minus values	4	6	3	4
0.075 mm No. 200 sieve, Cumulative percent passing, deviation for JMF target; plus	1.4	2.0	1.1	1.5
Asphalt content, percent deviation from JMF target; plus or minus value	0.4	0.5	0.2	0.3
Stability, Newtons pounds (minimum) (NA for Superpave)				
75 Blow JMF	80001800	75601700	84401900	80001800
50 Blow JMF	44501000	4000900	49001100	44501000
Flow, 0.25 mm 0.01 inch (NA for Superpave)				
75 Blow JMF	8 min.	7 min.	9 min.	8 min.
	16 max.	17 max.	15 max.	16 max.
50 Blow JMF	8 min.	7 min.	9 min.	8 min.
	18 max.	19 max.	17 max.	18 max.
Laboratory Air Voids, percent deviation from JMF target value	No specific action and suspension limits set since this parameter is used for acceptance			
In-place Mat Density, percent of TMD	No specific action and suspension limits set since this parameter is used for acceptance			
In-place Joint Density, percent of TMD	No specific action and suspension limits set since this parameter is used for acceptance			
VMA				
Gradation 1	13.5	13.0	13.3	13.0
Gradation 2	14.5	14.0	14.3	14.0

Table 6. Table 4. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts				
	Individual Samples		Running Average of	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
Gradation 3	15.5	15.0	15.3	15.0

3.2 PREPARATION OF ASPHALT BINDER MATERIAL

Heat the asphalt cement material while avoiding local overheating. Provide a continuous supply of the asphalt material to the mixer at a uniform temperature. Maintain the temperature of the asphalt delivered to the mixer to provide a suitable viscosity for adequate coating of the aggregate particles. For hot-mix, do not heat unmodified asphalt to a temperature exceeding 160 degrees C 325 degrees F when added to the aggregate. Do not heat modified asphalt to a temperature exceeding 175 degrees C 350 degrees F when added to the aggregate. For warm-mix, do not heat asphalt binder to a temperature exceeding 132 degrees C 270 degrees F when added to the aggregate.

3.3 PREPARATION OF MINERAL AGGREGATE

Heat and dry the aggregate prior to mixing. Provide a rate of heating and a maximum temperature that does not damage the aggregates. Do not heat the aggregate to a temperature exceeding 175 degrees C 350 degrees F when the asphalt binder is added. Maintain the temperature no lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.4 PREPARATION OF ASPHALT MIXTURE

Weigh or meter the aggregates and the asphalt cement and introduce into the mixer the amount specified by the JMF. Mix the combined materials until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. The moisture content of all asphalt mixture upon discharge from the plant is not to exceed 0.5 percent by total weight of mixture as measured by AASHTO T 329.

3.5 PREPARATION OF THE UNDERLYING SURFACE

****

NOTE: If the underlying surface to be paved is an unbound granular layer, apply a prime coat, especially if this layer will be exposed to weather for an extended period of time prior to covering with an asphalt mixture. Benefits derived from a prime coat include an additional weatherproofing of the base, improving the bond between the base and asphalt layer, and preventing the base from shifting under construction equipment.

If the underlying surface to be paved is an existing asphalt or concrete layer, use a tack coat to ensure an adequate bond between layers.

Tack and prime coat requirements will need to be covered in the contract documents.

****

Immediately before placing the asphalt mixture, clean the underlying course of dust and debris. Apply a [prime coat] [or] [tack coat] in accordance with Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.6 TEST SECTION

****

NOTE: Delete requirement for a test section if the project requires less than 2,000 tonnes tons.

****

Prior to full production, place a test section for each JMF used. Construct a test section 75 to 150 m 250 to 500 feet long and two paver passes wide with a longitudinal cold joint. Do not place the second lane of test section until the temperature of pavement edge is less than 80 degrees C 175 degrees F. Construct the test section with the same depth as the course which it represents. Ensure the underlying grade or pavement structure upon which the test section is to be constructed is the same or very similar to underlying layer for the project. Use the same equipment and procedures in construction of the test section as on the remainder of the course represented by the test section. Construct the test section as part of the project pavement, as approved by the Government.

3.6.1 Sampling and Testing for Test Section

****

NOTE: Table 7 Table 5 applies only to the test section and localized areas appearing to deviate from the specification. The limits in Tables 1, 2, and 6 Table 4 apply to the results of 4 full scale production tests run for each lot. This is why the limits listed in Table 7 Table 5 are different from those listed in Tables 1, 2, and 6 Table 4.

Select the appropriate VMA requirement to match the selected gradation.

For Marshall mixes, select the appropriate stability and flow value to match the laboratory compactive effort (50 or 75 blows).

For Superpave mixes, delete the rows in Table 7 Table 5 that refer to Marshall.

****

Obtain one sample at the plant from a random truck. Compact three specimens and test for laboratory air voids[as well as the Marshall stability and flow]. Test a portion of the same sample for theoretical maximum density (TMD), aggregate gradation, asphalt content, and TSR. Adjust the compactive effort as required to provide TSR specimens with an air void content of 7 plus or minus 1 percent. Obtain four randomly selected cores from each finished pavement mat (eight total), four from the longitudinal joint, and test for density. Perform random sampling in accordance with procedures contained in ASTM D3665. Construction may continue provided the test results are within the tolerances or exceed the minimum values shown in Table 7 Table 5. If all test results meet the specified requirements, the test section may remain as part of the project pavement. If test results exceed the tolerances shown, remove and replace the test section and construct another test section at no additional cost to the Government.

Table 7. Table 5. Test Section Requirements for Material and Mixture Properties	
Property	Specification Limit
Aggregate Gradation-Percent Passing (Individual Test Result)	
4.75 mm No. 4 and larger	JMF plus or minus 8
2.36, 1.18, 0.60, and 0.30 mmNo. 8, No. 16, No. 30, and No. 50	JMF plus or minus 6
0.15 and 0.075 mmNo. 100 and No. 200	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	See Table 5 Table 3
Tensile Strength Ratio (TSR) (At 7 percent plus/minus 1 percent air void content)	75 percent minimum
Conditioned Strength	415 kPa 60 psi minimum
Mat Density, Percent of TMD (Average of 4 Random Cores)	92.0 - 96.0 93.0 minimum
Joint Density, Percent of TMD (Average of 4 Random Cores)	89.5 minimum 90.0 minimum
Stability, newtons pounds (Average of 3 specimens) (for Marshall only)	[4450 1000 minimum for 50 blows][8000 1800 minimum for 75 blows]
Flow, 0.25 mm 0.01 inch (Average of 3 specimens) (for Marshall only with non-modified asphalt)	[8 - 18 for 50 blows][8 - 16 for 75 blows]

3.6.2 Additional Test Sections

If the initial test section should prove to be unacceptable, make the necessary adjustments to the JMF, plant operation, placing procedures, and rolling procedures before beginning construction of a second test section. Construct and evaluate additional test sections, as required, for conformance to the specifications. Full production paving is not allowed until an acceptable section has been constructed and accepted.

3.7 TRANSPORTING AND PLACING

3.7.1 Transporting

Transport asphalt mixture from the mixing plant to the site in clean, tight vehicles. Schedule deliveries so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Provide adequate artificial lighting for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 60 degrees C 140 degrees F.

3.7.2 Placing

Place the mix in lifts of adequate thickness and compact at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, place the mixture to the full width by an asphalt paver; strike off in a uniform layer of such depth that, when the work is completed, the required thickness is obtained and the surface conforms to the grade and contour indicated. Do not broadcast waste mixture onto the mat or recycle into the paver hopper. Collect waste mixture and dispose off site. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat. Begin placement of the mixture along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture in consecutive adjacent strips having a minimum width of 3 m 10 feet. Offset the longitudinal joint in one course from the longitudinal joint in the course immediately below by at least 300 mm 1 foot; however, locate the joint in the surface course at the centerline of the pavement. Offset transverse joints in one course by at least 3 m 10 feet from transverse joints in the previous course. Offset transverse joints in adjacent lanes a minimum of 3 m 10 feet. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture can be spread and luted by hand tools.

3.8 COMPACTION OF MIXTURE

3.8.1 General

a. After placing, thoroughly and uniformly compact the mixture by rolling. Compact the surface as soon as possible without causing displacement, cracking, or shoving. Determine the sequence of rolling operations and the type of rollers used with the exception that application of more than three passes with a vibratory roller in the vibrating mode is prohibited. Maintain the speed of the roller, at all times, sufficiently slow to avoid displacement of the asphalt mixture and to be effective in compaction. Correct at once any displacement occurring as a result of reversing the direction of the roller, or from any other cause.

b. Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened, but excessive water is not permitted. In areas not accessible to the roller, thoroughly compact the mixture with hand tampers or small compactors. Remove the full depth of any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective. Replace with fresh asphalt mixture and immediately compact to conform to the surrounding area. Perform this work at no expense to the Government. Skin patching is not allowed.

3.8.2 Segregation

****
NOTE: Select the first bracketed option when a test section is required.

Select the second bracketed option for projects less than 2,000 tonnes tons.
****

The Government can sample and test any material that looks deficient. When the in-place material appears to be segregated, the Government has the option to sample the material and have it tested and compared to the [aggregate gradation, asphalt content, and in-place density requirements in Table 7 Table 5][in-place density requirements in Table 2 paragraph ACCEPTANCE]. If the material fails to meet these specification requirements, remove and replace the extent of the segregated material the full depth of the layer of asphalt mixture at no additional cost to the Government. When segregation occurs in the mat, take appropriate action to correct the process so that additional segregation does not occur.

3.9 JOINTS

Construct joints to ensure a continuous bond between the courses and to obtain the required density. Provide all joints with the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.9.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, construct by means of placing a bulkhead or by tapering the course. Utilize a dry saw cut on the transverse joint full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. Remove the cutback material from the project. In both methods, provide a light tack coat of asphalt material to all contact surfaces before placing any fresh mixture against the joint.

3.9.2 Longitudinal Joints

Provide a joint that meets density and smoothness requirements for joints and has uniform texture. Cut back longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80 degrees C 175 degrees F at the time of placing adjacent lanes), or otherwise defective, a maximum of 75 mm 3 inches from the top of the course with a cutting wheel to expose a clean, sound, near vertical surface for the full depth of the course. Remove all cutback material from the project. Provide a light tack coat of asphalt material to all contact surfaces prior to placing any fresh mixture against the joint.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 12 16.19 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 12 19 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-32 12 16.19 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 12 19 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 12 16.19

COLD-MIX ASPHALT PAVING
11/19

****

NOTE: This guide specification covers the requirements for cold-mix asphalt paving.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: Delete this paragraph if the work covered by this section is included in one lump sum Contract price for the entire work covered by the invitation for bids. Revise this paragraph to combine the payment for cold-mix recycled mixture, rejuvenator (if needed), and emulsified asphalt cement, when separate payment for emulsified asphalt cement material is not considered warranted based on local experience and job conditions. Lump sum Contracts can be used when the total job does not exceed 17000 square m 20,000 square yd or 1000 metric tons 2000-lb tons.

****

1.1.1 Measurement

Pay for cold-mix recycling by the number of[metric tons 2000-lb tons][square m square yds] used in the accepted work. Pay for aggregates by the number of[metric tons 2000-lb tons][square m square yds] used in the accepted work. Pay for the recycling agent by the number of[L gal][metric tons 2000-lb tons] of material used in accepted work. Pay for the emulsified asphalt cement by the number of[L gal][metric tons 2000-lb tons] of material used in accepted work. Determine the number of liters gallons of emulsified asphalt cement used either by measuring the material at a temperature of 15 degrees C 60 degrees F or by correcting the amount measured at another temperature to L gal at 15 degrees C 60 degrees F, using a coefficient of expansion of 0.00045 per degree C 0.00025 per degree F for the emulsified asphalt.

1.1.2 Payment

****

NOTE: Deletet this paragraph if the work covered by this section is included in one job (lump sum) Contract price for the entire work covered by the invitation for bids.

****

Pay for the quantities of recycled paving mixture, aggregates, recycling agent, and emulsified asphalt cement, determined as provided above, at respective Contract unit prices per[metric ton 2000-lb ton] [square m square yd] for paving mixture and aggregates and per[L gal][metric ton 2000-lb ton] for recycling agent and emulsified asphalt cement. If deficiencies in the finished product exceed specified tolerances, no payment will be made for such areas of pavement until the defective areas are corrected and accepted by the Contracting Officer.

1.1.3 Waybills and Delivery Tickets

Submit copies of waybills or delivery tickets during the progress of the work. Before the final payment is allowed, provide waybills or certified delivery tickets for bituminous materials and paving mixtures used in the construction. Do not remove bituminous material from the tank car or storage tank until the initial outage has been taken; nor release the car or tank until final outage has been taken.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 81	(1992; R 2017) Standard Specification for Cutback Asphalt (Rapid-Curing Type)
AASHTO M 226	(1980; R 2017) Standard Specification for Viscosity-Graded Asphalt Cement
AASHTO R 66	(2016) Standard Practice for Sampling Asphalt Materials
AASHTO T 326	(2005; R 2013) Standard Method of Test for Uncompacted Void Content of Coarse Aggregate (As Influenced by Particle Shape, Surface Texture, and Grading)

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C183/C183M	(2022) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling

	Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D692/D692M	(2020) Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures
ASTM D946/D946M	(2020) Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D1073	(2016) Fine Aggregate for Bituminous Paving Mixtures
ASTM D1461	(2017) Standard Test Method for Moisture or Volatile Distillates in Asphalt Mixtures
ASTM D2027/D2027M	(2019) Cutback Asphalt (Medium-Curing Type)
ASTM D2028/D2028M	(2015; R 2021) Cutback Asphalt (Rapid-Curing Type)
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt
ASTM D2489/D2489M	(2016) Standard Test Method for Estimating Degree of Particle Coating of Asphalt Mixtures
ASTM D2950/D2950M	(2014) Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction
ASTM D3625/D3625M	(2012) Standard Practice for Effect of Water on Bituminous-Coated Aggregate Using Boiling Water
ASTM D3628	(2015; R 2021) Standard Practice for Selection and Use of Emulsified Asphalts

ASTM D4215	(2007; R 2013) Standard Specification for Cold-Mixed, Cold-Laid Bituminous Paving Mixtures
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5404/D5404M	(2012; R 2017) Standard Practice for Recovery of Asphalt from Solution Using the Rotary Evaporator
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6925	(2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
ASTM D6926	(2020) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus
ASTM D7175	(2015) Standard Test Method for Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills and Delivery Tickets

Bituminous Materials

Aggregates

Job Mix Formula (JMF); G, [_____]

Control Strip; G, [_____]

SD-06 Test Reports

Tests; G, [_____]

SD-07 Certificates

Bituminous Material

1.4 SAFETY

[Do not permit smoking or open flames within 8 m 25 ft of heating, distributing or transferring operations of bituminous materials other than bituminous emulsions.]

1.5 QUALITY ASSURANCE

Submit certified copies of test results, not less than [30][_____] days before the material is required in the work.

1.5.1 Sampling and Testing

Engage a commercial testing laboratory to perform sampling and testing or use Contractor facilities approved by the Contracting Officer. Do not permit work requiring testing until the testing facilities have been inspected and approved. The first inspection of the testing facilities will be at the expense of the Government. Cost incurred by the Government for subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Perform tests in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified requirements. Provide copies of the test results to the Contracting Officer within 24 hours of the completion of the tests.

1.5.2 Samples

Submit samples from the existing pavement obtained from at least two locations to provide representative samples of the pavement. Perform sampling in accordance with ASTM D75/D75M for aggregates, ASTM C183/C183M for mineral filler, AASHTO R 66 or ASTM D140/D140M for bituminous material, and ASTM D979/D979M for bituminous paving mixtures.

1.5.3 Sampling and Testing during Construction

Perform quality control sampling and testing as required in paragraph FIELD QUALITY CONTROL AND TESTING.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Mineral Aggregates

Deliver mineral aggregates to the site and stockpile them in such a manner to preclude fracturing of aggregate particles, segregation, contamination or intermingling of different materials in the stockpiles or cold feed hoppers. Before stockpiling material, clear, drain, level, and dry the storage areas if needed. Deliver and store mineral filler in a manner to preclude exposure to moisture or other detrimental conditions.

1.6.2 Bituminous Materials

Submit certified copies of the bituminous material manufacturer's test reports indicating compliance with specified requirements, not less than [30] [_____] days before the material is required in the work. Maintain bituminous material at appropriate temperature during storage but do not heat it by application of direct flame to walls of storage tanks or transfer lines. Clean storage tanks, transfer lines, and weigh bucket before a different type or grade of bitumen is introduced into the system. Heat the bituminous material to allow satisfactory pumping of the material; however, maintain the storage temperature below 150 degrees C 300 degrees F.

1.7 ENVIRONMENTAL REQUIREMENTS

Construct bituminous courses only when the base course or existing pavement is dry and when the weather is not foggy or rainy. Unless otherwise directed, do not construct such courses when the atmospheric temperature is below 15 degrees C 60 degrees F.

PART 2 PRODUCTS

2.1 PLANT, EQUIPMENT, MACHINES, AND TOOLS

2.1.1 General Requirements

****

NOTE: Determine the type and capacity of the plant, the number and size of trucks, paving machines, and

other equipment from the metric tons 2000-lb tons of paving mixtures required, haul distances, number of working days permitted by the Contract, and other pertinent factors.
****

Maintain plant, equipment, machines, and tools used in the work in a satisfactory condition and are subject to approval. Provide equipment that is adequate for placing the bituminous mixtures at a rate equal to the plant output and that is capable of producing the required compaction, meeting grade controls, thickness control and smoothness requirements.

2.1.2 Mixing Plant

Use an automatic or semi-automatic controlled mixing plant, commercially manufactured unit designed and operated to consistently produce a mixture within the JMF. Use a plant with a minimum capacity of [_____] metric tons 2000-lb tons per hour.

2.1.3 Rollers

Provide rollers that are self-propelled, weigh not less than 9 metric tons 10 2000-lb tons and have a maximum contact pressure of 620 kPa 90 psi. Equip wheels on the roller with adjustable scrapers and water sprinkling apparatus to keep the wheels and prevent the adherence of bituminous material. Use a sufficient number of rollers on the work so that one roller is in continuous operation for 1 hour on each 100 square m square yd of completed pavement, operating at a speed of not more than 5 kph 3 mph.

2.1.4 Power Brooms and Power Blowers

Provide brooms and blowers for cleaning surfaces of the bases and the bituminous course.

2.1.5 Straightedge

Provide and maintain at the site, in good condition, one[3][3.7] m[10][12] ft straightedge for each bituminous paver for use in testing the finished surface. Construct the straightedges of aluminum or other approved lightweight metal with blades of box girder cross section and with flat bottom, reinforced to insure rigidity and accuracy. Equip straightedges with handles for operation on pavement.

2.2 MATERIALS

2.2.1 Bituminous Material

****
NOTE: Only retain the desired type and grade of bituminous material and the appropriate ASTM specification. Select the grade of bituminous material based on the information contained in UFC 3-250-10FA.

In the case where the material being recycled contains sufficient asphalt binder to meet the specification requirements, only add water as a lubricant to improve compaction. Specify Grade SS-1

or CSS-1 in moderate or cold climates. Specify Grade SS-1h or CSS-1h in hotter climates such as the southern or southwestern areas of the United States. Allow use of medium set, high float, or other emulsions with open graded mixtures or in instances where previous experience with these emulsions has provided good results.
****

Provide bituminous material conforming to [AASHTO M 81] [AASHTO M 226] [ASTM D946/D946M] [ASTM D977] [ASTM D2397/D2397M] [ASTM D2027/D2027M] [ASTM D2028/D2028M] [ASTM D3381/D3381M][, Grade [_____]].

2.2.1.1 Emulsified Asphalt

Provide emulsified asphalt conforming to [ASTM D977] [ASTM D2397/D2397M]. Select the type of emulsified asphalt according to ASTM D3628.

2.2.1.2 Cutback Asphalt

Provide cutback asphalt conforming to [ASTM D2027/D2027M] or [ASTM D2028/D2028M].

2.2.2 Aggregates

****
NOTE: Delete this paragraph when new or additional aggregates are not required as part of the recycling project. When required, allow new aggregates to be added to produce an aggregate gradation that meets the desired end product. Gradations for base course, stabilized base course or asphalt concrete intermediate course materials are specified in Table I below. Specify the gradation based on the type, quality, and uniformity of the RAP material available for use.

Retain the desired gradation to be used for the project in the project specifications; omit the other gradation. Use a gradation in the JMF meeting the requirements of the specifications.

Allow the gradation to only require a maximum aggregate particle size not be exceeded, or to require further processing or adjustment with new aggregates to meet the desired gradation. Follow the tolerances given for aggregates or asphalt aggregate mixtures when used in similar situations. When the recycled mixture is intended to be used as an intermediate or binder course, follow the gradation tolerances in UFC 3-250-03, Table "Aggregate Gradations for Bituminous Concrete Pavements," for low-pressure tires. When the recycled mixture is to be used as a base course, an exact JMF aggregate gradation is not normally given and therefore tolerances are not required. Use a gradation that meets the gradation range specified.
****

Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screening, sand, and mineral filler, as required. Coarse aggregate is the portion of materials retained on the 4.75 mm No. 4 sieve. Fine aggregate is the portion passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve. Mineral filler is the portion passing the 0.075 mm No. 200 sieve. Use a combined recycled aggregate gradation conforming to the gradation specified in TABLE I when tested in accordance with ASTM C117 and ASTM C136/C136M. TABLE I is based on aggregates of uniform specific gravity; allow the percentage passing various sieves to be changed by the Contracting Officer when aggregates of varying specific gravities are used. Adjustments of percentage passing various sieves to be changed by the Contracting Officer when the specific gravity of the aggregates varies by more than 0.2.

TABLE I. COMBINED RECYCLED AGGREGATE GRADATION

Sieve Size	Percent Passing
[_____]	[_____]

2.2.2.1 Coarse Aggregates

Provide coarse aggregates consisting of clean, sound, durable particles conforming to ASTM D692/D692M and meeting the following requirements:

a. Do not allow the percentage of loss to exceed 40 after 500 revolutions as determined in accordance with ASTM C131/C131M.

****

NOTE: Use the magnesium-sulfate soundness test to exclude aggregates known to be unsatisfactory or to evaluate aggregates from new sources. Insert the maximum allowable percentage of loss, usually in the range of 10 to 15 percent, in the blanks. Base the values inserted on knowledge of aggregates in the area that have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years. Assure that aggregates from new sources are of equal or better than these aggregates.

****

b. Do not allow percentage of loss to exceed [_____] after five cycles performed in accordance with ASTM C88 using magnesium sulfate.

c. Do not allow the dry weight of crushed slag to be less than 1200 kg per cubic m 75 lbs per cubic ft, as determined in accordance with ASTM C29/C29M.

d. Determine the percentage of coarse aggregate that consists of fractured particles in accordance with [ASTM D5821][AASHTO T 326] and be not less than [____], by mass, of the aggregate particles retained on the 4.75 mm No. 4 sieve.

e. Particle shape of crushed aggregates are to be cubical. Do not allow the quantity of flat and elongated particles in any sieve size to exceed 20 percent by weight when determined in accordance with

ASTM D4791.

2.2.2.2 Fine Aggregate

Provide fine aggregate consisting of clean, sound, durable particles of natural sand, crushed stone, slag or gravel conforming to ASTM D1073 and that meets the requirements for abrasion resistance and soundness specified for coarse aggregate. Do not allow the quantity of natural sand to be added to the wearing and intermediate course mixtures to exceed 25 percent by weight of coarse and fine aggregate and mineral filler. Provide natural sand that is clean and free from clay and organic matter. Do not allow the percentage of loss to exceed [_____] after five cycles of the soundness test performed in accordance with ASTM C88, using magnesium sulfate.

2.2.2.3 Mineral Filler

Use mineral filler in accordance with ASTM D242/D242M. Determine grain size in accordance with ASTM D422. Use the tabulated gradation requirements in Table II in areas where dune sand or one-size material is allowed as mineral filler, unless otherwise directed.

TABLE II. MINERAL FILLER GRADATION REQUIREMENTS

Particle Size mm inch	Percent Finer
0.05 [_____]	70-100
0.02 [_____]	35-65
0.005 [_____]	10-22

2.2.3 Recycling Agents

****

NOTE: Depending on the material properties of the existing asphalt cement binder and the type and method of recycling used, select an appropriate type of recycling agent (rejuvenator). Specify non-emulsified recycling agents according to ASTM D4552/D4552M. Specify a rejuvenator matching the recycling process used. Select the recycling agent capable of decreasing the viscosity of the recycled asphalt cement to levels that approach the viscosity values of asphalt cement in new asphalt concrete pavements for that area or region. Delete this paragraph if a recycling agent is not required.

****

Use bituminous recycling agent consisting of either foamed asphalt or emulsified asphalt. Use [_____] for the recycling agent or an approved equal. Submit notification on sources from which recycling agent are to be obtained within 15 days after Contract award.

Allow cement, lime slurry and corrective aggregates to be used as recycling additives to improve CCPR mix properties.

2.2.4 Liquifiers

The use of liquefiers as anti-stripping agent is subject to prior approval by the Contracting Officer.

2.2.5 Water

Use water in accordance with ASTM C1602/C1602M. Do not use hot water unless approved by a Contracting Officer. Prior to construction, mix a sample of the water intended for use on the job with a sample of the emulsion at the ratio to be used in the project. If adverse effect is observed on the emulsion, use a new source of water

2.3 JOB MIX FORMULA (JMF)

****

NOTE: Use the procedure for the design mixture given in UFC 3-250-03 to determine the JMF.

****

Do not produce bituminous mixtures until a JMF has been determined and approved by the Contracting Officer. Submit the JMF, at least [_____] days before it is used, notification on the selection of aggregate source, and notification on the selection of bituminous materials source. The Contracting Officer will verify this JMF through samples of materials submitted. No payment will be made for cold recycled mixtures produced prior to the completion and acceptance of the JMF. Submit a 45 kg 100 lb sample of each aggregate, a 90 kg 200 lb representative sample of the recyclable asphalt pavement, a 20 L 5 gal sample of recycling agent, and a 20 L 5 gal sample of emulsified asphalt cement for mix design, not less than [30] [_____] days before material is required in the work. Indicate the gradation of the aggregate and a definite percentage of water [,recycling agent] and asphalt to be added to the mixture.

The JMF is allowed the tolerances given in TABLE III. Allow the aggregate gradation and bitumen content to be adjusted, as directed, within the limits specified to improve paving mixtures. Determine the proportions established in the JMF using ASTM D4215.

TABLE III. JOB-MIX TOLERANCES

Material	Tolerance, Plus or Minus
[Liquefier]	[0.20 percent]
Temperatures	-4 degrees C 25 degrees F

2.3.1 Gradation Tolerances

****

NOTE: Eliminate the corresponding material size and tolerance values to agree with sieve sizes specified in Table 1. Eliminate these completly if no new aggregate is added and no specific JMF gradation is developed.

****

The tolerances allowed on the aggregate gradation - coarse aggregate, fine aggregate and mineral filler combined are presented in Table IV.

TABLE IV. GRADATION TOLERANCES	
Material	Tolerance, Plus or Minus
Aggregate passing 4.75 mm No. 4 sieve	4 percent
Aggregate passing 2.36, 1.18, 0.6 and 0.3 mm Nos. 8, 16, 30, and 50 sieves	3 percent
Affregate passing 0.15 and 0.075 mm Nos. 100 and 200 sieves	1 percent

2.3.2 Asphalt Content

The JMF is allowed an asphalt content tolerance of plus or minus 0.3 percent. Allow the asphalt content to be adjusted by the Contracting Officer to improve paving mixture, without adjustment in Contract unit price. Select the optimum asphalt content to provide the tabulated properties when samples are compacted [at 120 degrees C 250 degrees F with [50] [75] blows of standard Marshall hammer on each side of the specimen, according to the test procedure in [ASTM D6926][prepared in accordance with ASTM D6925].]

2.3.3 Water Content

Select the water content to provide maximum dry density when samples are prepared at the optimum asphalt content and [compacted with [50] [75] blows of standard Marshall hammer on each side of the specimen, according to the test procedure in ASTM D6926][prepared in accordance with ASTM D6925]. When no asphalt binder is added to the mixture, select the water content to provide maximum dry density. Prepare samples with water contents, in 0.5 percent intervals, from 0 to 2.5 percent (increase water content to achieve maximum density). After compaction, place the samples in an oven at 60 degrees C 140 degrees F for 96 hours. After cooling to ambient temperature, determine the dry density according to ASTM D6925.

2.4 INITIAL SAMPLING AND TESTING

2.4.1 Source of Aggregates

Select sources from which aggregates are to be obtained and provide notification of the selection to the Contracting Officer within [15][_____] days of the award of the Contract. Make tests for the evaluation of aggregates by an approved commercial laboratory at no expense to the Government. Include tests for determining the suitability of aggregate, but not limited to: gradation in accordance with ASTM C136/C136M, abrasion resistance in accordance with ASTM C131/C131M, and soundness in accordance with ASTM C88.

2.4.2 Source of Bituminous Materials

Select sources from which bituminous materials are to be obtained and provide notification of the selection to the Contracting Officer within [15][_____] days after the award of the Contract.

2.4.3 Reclaimed Asphalt Pavement (RAP)

****

NOTE: Cold-mix recycling could include the use of existing RAP material stockpiles. If this condition exists, include the desired material properties below. Determine the gradation of the existing stockpile.

****

Evaluate the properties of the RAP, extracted aggregate, and recovered bituminous material. Determine the moisture content in accordance with ASTM D1461.

a. RAP Binder: Recover the aged asphalt binder from the RAP according to ASTM D5404/D5404M. Test the recovered asphalt binder to determine the effects of aging on the stiffness and consistency in accordance with ASTM D7175. Determine the asphalt content in accordance with [ASTM D2172/D2172M][ASTM D4215][ASTM D6307].

b. RAP Aggregate: Determine the gradation of the RAP in accordance with ASTM C136/C136M. Do not permit the maximum particle size of the RAP material to exceed half the thickness of the compacted recycled pavement. When lifts of 75 mm 3 in or more are used, do not permit the maximum particle size of the RAP material to exceed a maximum of 38 mm 1-1/2 in and having a minimum of 90 percent of the RAP passing the 25 mm 1 in sieve.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

3.1.1 Base Course

Clean the surface of the base course of loose and foreign material. Correct ruts or soft yielding spots, areas having inadequate compaction, and deviations of surface from requirements specified for the base course by loosening affected areas, removing unsatisfactory material, adding approved material where required, reshaping, and recompacting to line and grade to specified density requirements. Spray the surface with bituminous material conforming to Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.1.2 Existing Pavement

Clean the existing pavement of loose and foreign matter. Clean cracks 5 mm 1/4 in in width and larger and fill with crack filler material. Repair deteriorated areas of the pavement as directed. Spray the surface with a thin coat of bituminous material conforming to Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.2 GRADE CONTROL

Confirm the finished and completed surface course (whether a base course or existing pavement) conform to the lines, grades, cross sections, and dimensions as indicated in the drawings. Place line and grade stakes at the site of the work, in accordance with the SPECIAL CONTRACT REQUIREMENTS, to maintain indicated lines and grades.

3.3 MIXING

3.3.1 Preparation of Mineral Aggregates

Place each component of various sizes of aggregates blended in preparing bituminous mixtures in separate stockpiles in such manner that separate sizes are not intermixed. Feed aggregate into the cold elevator by means of separate mechanical feeders to produce a total aggregate graded within requirements specified.

3.3.2 Preparation of Bituminous Mixtures

****

NOTE: If asphalt emulsion is specified, delete the statement in brackets pertaining to moisture content.

****

Measure aggregates and convey into the mixer in proportionate quantities of each aggregate size required to meet the JMF. [Do not allow the moisture content of the finished mixture to exceed 2 percent by weight.] Introduce materials into the mixer in the following order: aggregate, [lime,] [flux oil,] [liquefier,] and bituminous material, unless otherwise directed. Check that the temperature of the bituminous material is [_____] at the time of mixing. Do not allow the temperature of the aggregate and mineral filler in the mixer to exceed [_____] when the bituminous material is added. If slag aggregate is used, spray the liquefier over slag after coating with bituminous material. [Use the percentage of hydrated lime in the mix ranging from 0.5 to 1.5 percent by weight, as directed.] Mix aggregates and other ingredients for 35 seconds or longer to coat particles with bituminous material. Do not permit the finished mixture to vary from the approved JMF without prior approval of the Contracting Officer.

3.3.3 Construction Methods

****

NOTE: Depending on the type of recycling desired, edit the following paragraphs to remove the undesired method.

****

3.3.3.1 Central Plant Mixing

Introduce the required amount of bituminous material for each batch, or calibrated amount of continuous mixing, into the mixer to meet the requirements of the JMF. Provide a uniform dispersion of the emulsified asphalt and water to achieve a coating (visually) of aggregate particles. If this process requires excessive mixing, resulting in premature breaking of the emulsified asphalt, shorten the mixing times as directed by the Contracting Officer. As a minimum, when the recycled mixture contains fine particles passing the 4.75 mm No. 4 sieve, provide a coating of these particles.

3.3.3.2 In-Place-Mixing

****

NOTE: In-place recycling can be divided into either partial- or full-depth recycling. Partial-depth recycling involves only a portion of the asphalt

bound layers and normally involves recycling to a depth of 50 to 100 mm 2 to 4 in. Full-depth recycling involves asphalt bound layers and often portions of the underlying base course layer.
****

Produce a uniform blend of the RAP, aggregate (when required), asphalt emulsion, water, and a mixture containing the required amounts of emulsified asphalt and water as given in the JMF when using the in-place recycling process.

3.4 TRANSPORTATION OF BITUMINOUS MIXTURES

Transport mixtures to the site in trucks having tight, clean, smooth bodies. Schedule deliveries so that the spreading and rolling of mixtures delivered to the site are completed during daylight unless approved artificial light is provided.

3.5 CONTROL STRIP

****
NOTE: Use of a test section is recommended for recycled mixtures, especially for central-plant mix recycling. The following paragraph is written for placing central-plant mix with a paver; edit when another type of recycling is used.
****

Prior to the start of the recycling project, prepare a sufficient quantity of mixture to construct a control strip at least 15 m 50 ft long, two spreader widths wide and of thickness to be used in the project. Place, spread, and roll the mixture with the equipment to be used in the project and in accordance with requirements specified above. Test and evaluate the control strip as a lot conforming to specification requirements. If approved by the Contracting Officer, allow the control strip to be located in one of the less critical areas of the project pavement construction. Otherwise, allow it to be located outside the project paving. If tests results are satisfactory, allow the control strip to remain in place as part of the completed pavement if constructed in the project pavement area. If tests indicate that the pavement does not conform to specification requirements, remove the control strip and the material disposed of offsite. Make necessary adjustments to the plant operations and rolling procedures immediately, and construct another control strip, all at no additional cost to the Government. Construct and sample other additional control strips and test for conformance with specification requirements. Do not start full production with the recycled mixture without approval of the Contracting Officer.

3.6 PLACEMENT

3.6.1 Thickness of Layer

Spread the mixture in a layer not greater than 50 mm 2 in in thickness. Allow each layer to cure at least 12 hours or longer, if required to achieve proper curing before placing a succeeding layer.

3.6.2 General Requirements for Use of Motor Grader

When approved motor graders are used for spreading the mixture, place the material on the roadbed in a windrow so that the proper amount of material is available to cover a predetermined width to the indicated compacted thickness. Allow use of the motor grader to aerate the mixture by working it back and forth across the roadbed in order to get the mixture to the proper condition for compaction.

3.6.3 General Requirements for Use of Mechanical Spreader

When mechanical spreaders are used, dump the bituminous mixture into an approved mechanical spreader and placed as nearly continuous as possible. Adjust the speed of placing to permit proper rolling.

3.6.4 Offsetting Joints Between Succeeding Courses

Place a succeeding course in such a manner that the longitudinal joints of the succeeding course do not coincide with joints of the previous course and are offset from joints in the previous course by at least 300 mm 1 ft. Offset transverse joints in the succeeding course by at least 600 mm 2 ft from transverse joints in the previous course.

3.6.5 Special Requirements for Laying Strips Succeeding Initial Strip

In laying each succeeding strip after the initial strip has been spread and compacted as specified, overlap the blade of the motor grader or the screed of the mechanical spreader of the previously placed strip 75 to 100 mm 3 to 4 in at a height required for compaction to produce a smooth, dense joint.

3.6.6 Shoveling, Raking, and Tamping After Machine Spreading

Follow the spreading machine with shovelers and rakers, raking, removing, and adding mixture as required to obtain a course that, when completed, conforms to specified requirements. Do not permit excessive handwork and broadcasting or fanning of mixture.

3.6.7 Hand Spreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, spread the mixture by hand. Spreadin a manner to prevent segregation. Spread mixture uniformly in a loose layer of thickness that, when rolled, is in accordance with the required thickness.

3.7 COMPACTION

[Begin compaction immediately after placement.][Allow the mixture an adequate amount of time for aeration and curing. After curing, shape the mixture approximately to the specified lines and grades and loosened to its full depth and width. Begin rolling as soon after placing as the mixture bears the roller without undue displacement.] Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Use alternate trips of the roller that are slightly different lengths. Operate the the roller at a speed that displacement of the material does not occur. [Check that the density of the compacted mixture is at least 96 percent of that of laboratory specimens of the same mixture [subjected to 50 blows of the standard Marshall hammer according to the test procedure in ASTM D6926][prepared in accordance with ASTM D6925].] [Roll bituminous mixtures until roller marks are eliminated, and a field density of at least 86 percent of the theoretical maximum density is obtained when tested in accordance with ASTM D2041/D2041M.]

3.7.1 Operation of Rollers and Tampers

Provide the sufficient number, weight, and type of rollers to obtain the required density. Begin initial rolling of the recycled mixture as the emulsion is starting to break. Where lift thicknesses exceed 75 mm 3 in, accomplish breakdown rolling with a large 23 to 27 Mg 25 to 30-lb tons pneumatic roller. Use either a pneumatic or a steel-wheel roller to breakdown roll thinner lifts. Equip rollers with watering devices to prevent material adhesion; however, do not permit excess water. Allow vibratory rolling to achieve required density. Use finish rolling with a steel-wheel roller to remove existing roller marks.

3.7.2 Correcting Deficient Areas

Remove mixture that becomes contaminated with foreign material or is defective, to the full thickness of the course. Cut the hole with sides vertical and perpendicular to each other, with one pair parallel to the direction of traffic. Do not permit rolled areas to be skin patched to correct low areas and to be planed to correct high areas. Place fresh paving mixture in holes in sufficient quantity to produce a finished surface conforming to grade and smoothness requirements. Aerate paving mixture and compact to the density specified. Provide workmen capable of performing work incidental to the correction of deficiencies and defects.

3.8 EDGES OF PAVEMENT

Compact the edges of the pavement to the required density and straight and true to required lines. Place approved material along the edges of the pavement in such quantity to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple-layer course, allowing at least a 300 mm 1 ft width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the pavement as directed.

3.9 FINISHING

Finish the surface of the top layer to grade and cross section shown in the drawings. Provide a finished surface with a uniform texture. Allow light blading during rolling for the finished surface to conform to the lines, grades, and cross sections in the drawings. If the surface becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, scarify, rework, relay or replace such unsatisfactory portion as directed. If the course, when laid, becomes water-soaked, remove that portion immediately, and placethe mix in a windrow, aerated, and then spread, shaped, and rolled as specified. If required, this will be at no additional expense to the Government.

3.10 CURING

After compaction has been achieved and prior to opening the pavement layer to traffic, apply a fog seal, if required, to the pavement surface. Use a fog seal composed of [ASTM D2397/D2397M CSS-1H][ASTM D977 SS-1h] emulsified asphalt diluted up to 50 percent by volume with water or an engineered emulsion diluted up to 60 percent by volume with water. Apply the fog seal at a rate of 0.2 to 0.7 L per square m 0.05 to 0.15 gal/square yd. When sand blotter is required, apply it to the surface at approximately 1 to 5 kg per square m 2 to 3 lbs per square yd. Use sand free from clay or organic material. Determine the application rates of the fog seal and sand blotter and be such that a stable and safe roadway surface can be maintained until the surface course is placed.

3.11 THICKNESS REQUIREMENTS

Confirm the compacted thickness of the pavement is within 13 mm 1/2 in of the thickness indicated in the drawings. Where measured thickness of the pavement is more than 13 mm 1/2 in deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed at no additional expense to the Government. Where the measured thickness of the pavement is more than 13 mm 1/2 in thicker than indicated, consider the pavement as conforming to the specified thickness requirements.

3.12 SURFACE-SMOOTHNESS REQUIREMENTS

3.12.1 Intermediate Courses

Check the surface of each intermediate course longitudinally with a [3] [3.7] m [10] [12] ft straightedge and checked transversely with a template conforming to the specified cross section. Do not allow the surface of the layer, after rolling to deviate more than 6 mm 1/4 in from the [3] [3.7] m [10] [12] ft straightedge nor 6 mm 1/4 in from the template. Correct irregularities by loosening and reshaping the aggregate, removing or adding aggregate as required, and rerolling such areas.

3.12.2 Finished Surfaces

3.12.2.1 Roads and Streets

Check the surface of the finished pavement longitudinally with a [3] [3.7] m [10] [12] ft straightedge and transversely with a template cut to the specified cross section. Do not allow the finished surface of the surface course to deviate more than 3 mm 1/8 in from the [3] [3.7] m [10] [12] ft straightedge or from the template. Correct surface irregularities exceeding those specified as [_____] [directed].

3.12.2.2 Other Than Roads and Streets

Check the surface of the finished pavement longitudinally and transversely with a [3] [3.7] m [10] [12] ft straightedge. Do not allow the finished surface of the finished pavement to deviate more than 6 mm 1/4 in from the [3] [3.7] m [10] [12] ft straightedge. Correct surface irregularities exceeding tolerances specified as [_____] [directed].

3.13 JOINTS

Make joints having the same texture, density, and smoothness as other sections of the course. Make joints between old and new pavements or between successive days' work carefully to insure continuous bond between old and new sections of the course. Apply a thin, uniform coat of bituminous material, conforming to Section 32 12 13 BITUMINOUS TACK AND PRIME COATS, just before the fresh mixture is placed to contact surfaces of previously constructed pavements.

3.13.1 Transverse Joints

Pass the roller over the unprotected end of the freshly laid mixture only when the laying of the course is discontinued. Cut back the edge of the previously laid course to expose an even, vertical surface for the full thickness of the course. Rake the fresh mixture against the joints, tamp and then roll.

3.13.2 Longitudinal Joints

When the edges of the longitudinal joints are irregular, honeycombed, or poorly compacted, cut back unsatisfactory sections of the joint to expose an even, vertical surface for the full thickness of the course. Where required, rake fresh mixture against the joint, tamp, and then roll.

3.14 FIELD QUALITY CONTROL AND TESTING

****

NOTE: Insert the appropriate frequency interval of testing in the blanks.

****

3.14.1 Testing

Perform field tests in sufficient numbers to assure that the specifications are being met. Perform testing by an approved commercial laboratory. The following number of tests, if performed at the appropriate time, are the minimum acceptable for each type of operation.

3.14.1.1 Field Density

Express the field density as a percentage of the laboratory density. Prepare laboratory samples from an uncompacted mixture taken from the pavement immediately prior to field compaction and compact the samples in accordance with [_____]. Do not reheat the asphalt mixture in the laboratory. Perform a minimum of one field density test for every [_____] metric tons 2000-lb tons of mixture placed. Determine field density according to ASTM D2950/D2950M, or other Owner Agency approved method.

3.14.1.2 Gradation

Perform a minimum of one gradation test for every [_____] metric ton 2000-lb ton of aggregate used in the mixture, with a minimum of three gradations for each day's run. When the source of materials is changed, or deficiencies are found, replace the gradation and retest the material already placed to determine the extent of the unacceptable material. Replace in-place unacceptable material at no additional expense to the Government.

3.14.1.3 Abrasion Resistance

Perform abrasion resistance tests in accordance with ASTM C131/C131M to ensure that the aggregates have a percentage of wear not exceeding 40 percent after 500 revolutions. Perform one test for every [_____] metric ton 2000-lb ton of aggregate placed.

3.14.1.4 Soundness Test

****

NOTE: The magnesium-sulfate soundness test is to be used in excluding aggregates known to be unsatisfactory or for evaluating aggregates from new sources. Insert the maximum allowable percentage of loss, usually in the range of 10 to 15 percent, in the blanks. Base the values inserted on knowledge of aggregates in the area that have been previously approved or that have a satisfactory service record in bituminous pavement construction for at least 5 years and assure that aggregates from new sources are of equal to or better than these aggregates.

****

Perform soundness tests as specified by ASTM C88 to ensure that the aggregates have a weight loss not greater than [_____] percent when subjected to five cycles of the magnesium sulfate test. Perform one test for every [_____] metric tons 2000-lb tons of aggregate placed.

3.14.1.5 Smoothness

Take measurements, for deviation from grade and cross section shown in the drawings, in successive positions parallel to the road centerline, with a [3] [3.7] m [10] [12] ft straightedge. Check the surface of each course transversely with [a template cut to the specified cross section] [a [3] [3.7] m [10] [12] ft straightedge] placed perpendicular to the road centerline at [_____] m ft intervals.

3.14.1.6 Thickness

Determine the thickness of the pavement every [_____] m ft along the finished surface. Make measurements in 75 mm 3 in diameter test holes penetrating the pavement. Refill the holes to conform to these specifications.

3.14.1.7 Asphalt Paving Mixtures

Obtain samples in accordance with ASTM D979/D979M. Take stockpile samples at least 100 mm 4 in below surface excluding the slight outer crust that has formed.

a. Coating: Determine adequate coating of the aggregate by the asphalt emulsion in accordance with ASTM D2489/D2489M.

b. Bitumen Content: Take samples of finished plant mixture and test for each [_____] metric tons 2000-lb tons or fraction thereof, to determine if bitumen content is in accordance with ASTM D2172/D2172M and conforms to the specified requirements.

c. Stripping: Determine stripping of residual asphalt from aggregate in accordance with ASTM D3625/D3625M.

3.14.2 Bituminous Material Sample

Obtain a sample of the bituminous material used under the supervision of the Contracting Officer. The sample will be retained by the Government.

3.15 PROTECTION OF PAVEMENT

Maintain the pavement in a satisfactory condition until accepted by the

Contracting Officer.

3.16 TRAFFICKING

Do not allow trafficking on newly placed recycled mixtures prior to completion of compaction and the curing period.

3.17 MAINTENANCE

After opening to traffic and prior to placing the surface course, maintain the surface of the recycled pavement in a condition suitable for the safe movement of traffic. Protect and maintain the recycled surface from nuisance water, other deleterious substances, and/or other damage. Repair damage to the completed recycled material prior to placement of the surface course.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 12 17.19 (November 2020)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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****

SECTION 32 12 17.19

FUEL RESISTANT ASPHALT PAVING FOR AIRFIELDS - SURFACE COURSE

11/20

****

NOTE: This guide specification covers the requirements for fuel resistant asphalt pavement - surface course (central-plant) for airfields using Marshall or Gyratory compaction method.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Do not edit or rewrite the unbracketed text without the express consent of the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement subject matter expert (SME), or the Naval Facilities Engineering Systems Command (NAVFAC). Edit bracketed items by choose applicable items(s) or inserting appropriate text.**

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: Modifications must be made to this guide specification during conversion to a project specification in accordance with the NOTES which are located throughout the document. These NOTES are instructions to the designer, and will not appear in the project specification.

Specifications developed for Corps of Engineers managed projects must be edited in accordance with ER 1110-34-1 Engineering and Design Transportation Systems Mandatory Center of Expertise (Section 11, 12, App A, B, C).

This guide specification only pertains to the fuel

resistant asphalt pavement for airfields - surface course aspects of the project and not to any surface preparation requirements dealing with aggregate base courses, milling, or tack and prime coats. Cover surface preparation requirements by either including them in this guide specification or by adding pertinent sections to the project documents.

This specification utilizes a Quality Assurance and Quality Control (QA/QC) construction management philosophy. Quality Assurance refers to the actions performed by the Government or designated representative to assure the final product meets the job requirements. This specification has been developed for QC testing to be used as a basis of pay. It is recommended that the Government's QA testing should include a minimum of 5 percent of the Contractor's QC tests. Results of QC testing are the basis for pay unless there are discrepancies between QC and QA testing. Quality Control also refers to the actions of the Contractor to monitor the construction and production processes and to correct these processes when out of control. Results of QC testing are reported daily on the process control charts maintained by the Contractor. Quality Control is covered in paragraph CONTRACTOR QUALITY CONTROL STAFF and paragraph CONTRACTOR QUALITY CONTROL.

****

1.1 FULL PAYMENT

1.1.1 Method of Measurement

****

NOTE: For unit-price contracts, include first bracketed statements and delete the second set. For lump sum contracts, delete the first bracketed statements and include the second set.

Do not delete PART 1 for lump sum Contracts.

****

[The amount paid for will be the number of metric tons tons of fuel resistant asphalt pavement used in the accepted work. Weigh the fuel resistant asphalt pavement after mixing. No separate payment will be made for weight of asphalt binder material incorporated herein.] [Utilize the quantity of fuel resistant asphalt pavement, per ton placed and accepted, for the purposes of assessing the pay factors stipulated below.]

1.1.2 Basis of Payment

****

NOTE: For unit-price contracts, include first bracketed statements and delete the second set. For lump sum contracts, delete the first bracketed statements and include the second set. Include prescriptive unit price based on the Government estimate for payment adjustment. Use unit prices

when the job exceeds 1,000 metric tons tons.
****

[Quantities of fuel resistant asphalt pavement, determined as specified above, will be paid for at respective Contract unit prices or at reduced prices adjusted in accordance with paragraphs PERCENT PAYMENT and ACCEPTANCE. Payment will constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification.] [The measured quantity of fuel resistant asphalt pavement will be paid for and included in the lump sum Contract price. If less than 100 percent payment is due based on the pay factors stipulated in paragraph PERCENT PAYMENT, a unit price of [_____] per metric tonton will be used for purposes of calculating the payment reduction.]

1.2 PERCENT PAYMENT

****
NOTE: The basis of pay testing includes material tests to determine laboratory air voids, in-place density, smoothness and plan grade which are needed to determine percent payment.
****

The lot pay factor is determined by taking the lowest computed pay factor based on either laboratory air voids, in-place density, smoothness, or grade (each discussed below). Remove and replace lots when the lowest computed pay factor requires rejection. At the end of the project calculate the average pay factor for all lots. If this average lot pay factor exceeds 95.0 percent and no individual lot has a pay factor less than 75.0 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot pay factor. For any lots which are less than 2,000 metric tonstons, a weighted lot pay factor will be used to calculate the average lot pay factor. When work on a lot is required to be terminated before all four sublots are completed, the results from the completed sublots will be analyzed to determine the percent payment for the lot following the same procedures and requirements for full lots but with fewer or more test results as determined in paragraph PAVEMENT LOTS.

1.2.1 Payment Adjustment for Laboratory Air Voids

Laboratory air void calculations for each lot will use the average theoretical maximum density values obtained for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). The mean absolute deviation of the laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated as shown in the example below and a pay factor will be determined from Table 1. When 0 percent payment is determined, remove and replace the rejected lot at least 100 mm 4 inches into the cold (existing) lane adjacent to the longitudinal joint.

Table 1 Pay Factor Based on Laboratory Air Voids	
Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, percent
0.60 or less	100
0.61 - 0.80	98
0.81 - 1.00	95
1.01 - 1.20	90
Above 1.20	reject (0)

1.2.1.1 Pay Factor Example for Laboratory Air Voids

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 sublots where one set of laboratory compacted specimens is from a single sublot. The laboratory air voids for the 4 sublots are determined to be 2.0, 1.5, 2.5, and 2.2. Assume that the target air voids from the JMF is 2.5. The mean absolute deviation is then:

$$\text{Mean Absolute Deviation} = (|2.0 - 2.5| + |1.5 - 2.5| + |2.5 - 2.5| + |2.2 - 2.5|)/4$$

$$\text{Mean Absolute Deviation} = (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45$$

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 1 that the lot pay factor based on laboratory air voids is 100 percent.

1.2.2 Payment Adjustment for In-place Densities

The average in-place mat and joint densities are expressed as a percentage of the average TMD for the lot. Determine the average TMD in accordance with paragraph THEORETICAL MAXIMUM DENSITY (TMD). The average in-place mat density and joint density for a lot are determined and compared with Table 2 to calculate a single pay factor per lot. Use the following process to determine the single pay factor for in-place density:

a. Step 1: Determine the pay factors for mat density and joint density using Table 2.

b. Step 2: Determine ratio of joint area to mat area. The area associated with the joint is considered to be 3 m 10 feet wide times the length of completed longitudinal construction joint in the lot. This joint area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of asphalt pavement, either any cold joint against another lot or any other existing asphalt paved previously. The area associated with the joint is expressed as a percentage of the total lot.

c. Step 3: Compute the weighted pay factor for the joint using the formula in the example shown in paragraph PAY FACTOR BASED ON IN-PLACE DENSITY.

d. Step 4: Where freshly placed fuel resistant asphalt pavement abuts old (not in contract) asphalt pavement, determine density at the tie-in longitudinal joint by taking one core per sublot at a random location for each lot of material placed adjacent to the joint. If Step 4 is not applicable, move to Step 5. The size of joint area is 3 m 10 feet wide by the length of the joint being paved. Locate the center of each of the four cores 150 mm 6 inches from the edge of the existing pavement. Take each core at a random location along the length of the joint. The requirements for joint density for this lot, adjacent to the existing asphalt joint, are the same as that for the mat density specified in Table 2. For freshly placed fuel resistant asphalt pavement-old asphalt (not in contract) joints at taxiways abutting runways, aprons, or other taxiways, take two additional randomly located cores along each taxiway intersection.

e. Step 5: Compare weighted pay factor for joint density to pay factor for mat density and select the lowest. This selected pay factor is the pay factor based on density for the lot. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD will be used as the TMD needed to calculate the percent joint density.

When 0 percent payment is determined for mat density, remove and replace the rejected lot at least 100 mm 4 inches into the cold (existing) lane adjacent to the longitudinal joint. When 0 percent payment is determined for joint density, remove and replace the rejected longitudinal joint with a 3 m 10 feet wide paving lane that is centered over the joint.

Table 2
Pay Factor Based on In-place Density

Average Mat Density (4 cores) (Percent of TMD)	Pay Factor, percent	Average Joint Density (4 cores) (Percent of TMD)
95.0 - 98.0	100.0	Above 93.5
94.9	100.0	93.4
94.8 or 98.1	99.9	93.3
94.7	99.8	93.2
94.6 or 98.2	99.6	93.1
94.5	99.4	93.0
94.4 or 98.3	99.1	92.9
94.3	98.7	92.8
94.2 or 98.4	98.3	92.7
94.1	97.8	92.6
94.0 or 98.5	97.3	92.5
93.9	96.3	92.4
93.8 or 98.6	94.1	92.3
93.7	92.2	92.2
93.6 or 98.7	90.3	92.1
93.5	87.9	92.0
93.4 or 98.8	85.7	91.9
93.3	83.3	91.8
93.2 or 98.9	80.6	91.7
93.1	78.0	91.6
93.0 or 99.0	75.0	91.5

Table 2
Pay Factor Based on In-place Density

Average Mat Density (4 cores) (Percent of TMD)	Pay Factor, percent	Average Joint Density (4 cores) (Percent of TMD)
below 93.0, above 99.0	0.0 (reject)	below 91.5

1.2.2.1 Pay Factor Based on In-place Density

An example of the computation of a pay factor (in I-P units only) based on in-place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 94.2 percent (of lab TMD). (2) Average joint density = 92.5 percent (of lab TMD). (3) Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2,000 feet.

a. Step 1: Determine pay factor based on mat density and on joint density, using Table 2:

    (1) Mat density of 94.2 percent = 98.3 pay factor.

    (2) Joint density of 92.5 percent = 97.3 pay factor.

b. Step 2: Determine ratio of joint area to mat area. Multiply the length of completed longitudinal construction joint by the specified 10 foot width and divide by the mat area (total paved area in the lot).

    (1) Ratio = Ratio of joint area to mat area

    (2) Ratio = (2,000 feet x 10 feet)/30,000 square feet

    (3) Ratio = 0.6667

c. Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:

    (1) wpf = joint pay factor + (100 - joint pay factor) x (1 - ratio)

    (2) wpf = 97.3 + (100-97.3) x (1-0.6667) = 98.2 percent

d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:

    (1) Pay factor for mat density: 98.3 percent.

    (2) Weighted pay factor for joint density: 98.2 percent

    (3) Selected pay factor: 98.2 percent

1.2.3 Payment Adjustment for Smoothness (Final Wearing Surface Only)

****

NOTE: When Profilograph testing is not required, delete the following paragraph for pay adjustment for smoothness. This paragraph may be deleted for projects where a profilograph cannot record 400 meters 0.10 of a mile in length. Profilograph testing is required for runway and applicable taxiway pavements.
****

1.2.3.1 Profilograph Testing

Test the entire lot in the longitudinal direction per ASTM E1274. Perform the longitudinal testing at the centerline of each paving lot and 1/8th point from each side of the lot. Record the location and data from all profilograph measurements. Compute the profile index for each pass of the profilograph (3 per lot) in each 0.1 km0.1 mile segment. The profile index for each segment is the average of the profile indices for each pass in each segment. When the average Profile Indices of a lot exceeds the tolerance specified in paragraph SMOOTHNESS REQUIREMENTS determine pay factor using Table 3. Correct any small individual area with surface deviation which exceeds the tolerance specified in paragraph SMOOTHNESS REQUIREMENTS by more than 79 mm per km 5.0 inches per mile or more, by grinding to meet the specification requirements in Table 3 or remove and replace at no additional cost to the Government.

Table 3
Pay Factor for Smoothness

Average of Profile Indices Exceeding Tolerance (per lot)	Pay Factor, Percent
less than or equal to 16 mm km1.0 inch per mile	100.0
greater than 16 mm per km1.0 inch per mile but less than or equal to 32 mm per km2.0 inches per mile	95.0
greater than 32 mm per km2.0 inch per mile but less than 47 mm per km3.0 inches per mile	90.0
greater than 47 mm per km3.0 inch per mile but less than 63 mm per km4.0 inches per mile	75.0
greater than 63 mm per km4.0 inches per mile	Remove and Replace at no cost to the Government

1.2.4 Pay Factor Based on Plan Grade

Within 5 working days after completion of a particular lot incorporating the final wearing course, test the final wearing surface of the pavement for conformance with specified plan grade requirements. Provide a final wearing surface of pavement conforming to the elevations and cross sections shown and not vary more than 9 mm 0.03 foot for runways and landing zones or 15 mm 0.05 foot for taxiways, aprons, and shoulders from the plan grade established and approved at site of work. Match finished surfaces at juncture with other pavements with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. The grade will be determined by running lines of levels at intervals of 7.6 m 25 feet, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Maintain detailed notes of the results of the testing and provide a copy to the Government immediately after each day's testing. In areas where the grade exceeds the tolerance by more than 50 percent, remove the surface lift full depth; and replace the lift with fuel resistant asphalt pavement to meet specification requirements, at no additional cost to the Government. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

Table 4
Pay Factor for Plan Grade

Percent of All Measurements Outside Tolerance	Pay Factor, percent
Greater than or equal to 5 but less than 10	90
Greater than or equal to 10 but less than 15	75
Greater than 15	Remove and replace the surface lift at no cost to the Government

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

AASHTO R 30	(2002; R 2019) Standard Practice for Mixture Conditioning of Hot Mix Asphalt (HMA)

ASPHALT INSTITUTE (AI)

AI MS-2	(2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C1252	(2017) Standard Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)
ASTM D36/D36M	(2014; R 2020) Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling

	Asphalt Materials
ASTM D242/D242M	(2009; R 2014) Mineral Filler for Bituminous Paving Mixtures
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D1461	(2017) Standard Test Method for Moisture or Volatile Distillates in Asphalt Mixtures
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2419	(2014) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489/D2489M	(2016) Standard Test Method for Estimating Degree of Particle Coating of Asphalt Mixtures
ASTM D2726/D2726M	(2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D3203/D3203M	(2017) Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D3699	(2019) Standard Specification for Kerosene
ASTM D4125/D4125M	(2010) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5361/D5361M	(2016) Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
ASTM D5444	(2015) Mechanical Size Analysis of Extracted Aggregate

ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6084/D6084M	(2018) Standard Test Method for Elastic Recovery of Asphalt Materials by Ductilometer
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
ASTM D6373	(2023) Standard Specification for Performance Graded Asphalt Binder
ASTM D6925	(2014) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
ASTM D6926	(2020) Standard Practice for Preparation of Asphalt Mixture Specimens Using Marshall Apparatus
ASTM D6927	(2015) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM D7173	(2020) Standard Practice for Determining the Separation Tendency of Polymer from Polymer Modified Asphalt
ASTM E1274	(2018); R 2024 Standard Test Method for Measuring Pavement Roughness Using a Profilograph

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Placement Plan; G, [_____]

SD-03 Product Data

Diamond Grinding Plan; G, [_____]

Mix Design; G, [_____]

Contractor Quality Control; G, [_____]

SD-04 Samples

Aggregates

Asphalt Binder

SD-06 Test Reports

Aggregates; G, [_____]

QC Monitoring

Resistance to Fuel; G, [_____]

SD-07 Certificates

Asphalt Binder; G, [_____]

Testing Laboratory

Airfield Asphalt Pavement QC Manager

Airfield Asphalt Pavement Inspector

Airfield Asphalt Pavement Technician

1.5 CONTRACTOR QUALITY CONTROL STAFF

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NOTE: The airfield asphalt certification program is intended to increase quality of construction for work performed under this specification. The certification program will provide knowledge to the project team members as it relates to airfield asphalt. Intended audience is the Contractor and Government personnel. The below paragraph should be modified or the general provisions of the contract should be modified to require Title II inspectors or third party laboratory firms attend the certification program.

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Reference Section 01 45 00 QUALITY CONTROL for Contractor personnel qualification requirements along with the information included below. Submit certifications for Contractor Quality Control Staff in the following areas:

a. Airfield Asphalt Pavement QC Manager(1): The QC manager will oversee all QC testing and inspection, review asphalt pavement transmittals prior to submission to the Government, be responsible for making mix design adjustments, and in charge of all other activities related to performance. The QC manager will also ensure that daily reports and necessary transmittals arrive for Government review as specified.

b. Airfield Asphalt Pavement Inspector(1): The Inspector will be available on the project during all paving operations. The Inspector is responsible for identifying observed paving issues and ensuring these issues are addressed by the Contractor Quality Control staff.

c. Airfield Asphalt Pavement Technician(1): The Technician will be responsible for conducting laboratory tests. The Airfield Asphalt Pavement Technician will be present in the laboratory anytime laboratory testing is underway.

(1): Registration for the Airfield Asphalt Pavement Certification Program can be found at www.airfieldasphaltcert.com.

1.6 ACCEPTANCE

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NOTE: It is recommended that an independent material testing company be hired by the Contractor to provide the acceptance testing for the project. It is also recommended to keep the Government QA testing separate and distinct from the Contractor's QC testing for all airfield projects. (Generally, fuel resistant asphalt pavement will be used for aprons or other areas where fuel spillage is expected.)

The acceptance testing program includes material tests to determine laboratory air voids and in-place density, which are needed to determine percent payment. The Contractors acceptance testing

laboratory will also conduct tests to monitor aggregate gradation, asphalt content, and volumetric properties. These tests serve as a check to the Contractor's QC testing.

For projects with less than 2,000 total metric tons tons, the entire project can be considered as a single lot. In this case, sublot sampling could occur over several days' production, which could lead to higher sublot variability.

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1.6.1 Acceptability of Work

Acquire the services of an independent commercial laboratory to perform acceptance testing. Acceptance of the plant produced mix and in-place requirements will be on a lot to lot basis. The materials and the pavement itself will be accepted on the basis of production testing. The Government may make check tests from split samples to validate the results of the production testing. Testing performed by the Government does not reduce the required testing of the independent commercial laboratory. Split samples will be taken for Government testing to reduce the variability between the independent commercial laboratory and the Government's test results. When the difference between the independent commercial laboratory and the Government's test results for split samples exceed the acceptable range of two results for multi-laboratory precision for the appropriate test method (i.e. ASTM) then at least one of the laboratories is determined to be in error. An evaluation of procedures and equipment in both laboratories will be made to determine the cause(s) for the differences. Develop steps to correct procedures and equipment to bring multi-laboratory precision to within acceptable limits.

1.6.2 Acceptance Requirements

Provide all sampling and testing required for acceptance and payment adjustment. Where appropriate, adjustments in payment for individual lots of asphalt pavement will be made based on laboratory air voids, in-place density, smoothness, and grade in accordance with the following paragraphs. Surface smoothness and grade determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus smoothness and grade measurements for the entire lot cannot be made.

1.6.3 Pavement Lots

A standard lot for all requirements is equal to one day's production or 2,000 metric tons short tons, whichever is smaller. Divide each lot into four equal sublots in order to evaluate laboratory air voids and in-place density. When operational conditions cause a lot to be terminated before the specified four sublots have been completed, use the following procedure to adjust the lot size and number of tests for the lot. Where three sublots have been completed, they constitute a lot. Where one or two sublots have been completed, incorporate them into the next lot and the total number of sublots (i.e. 5 or 6 sublots) is used for acceptance criteria. Include partial lots at the end of asphalt production into the previous lot. Complete and report all asphalt testing including but not limited to aggregate gradation, asphalt content, theoretical maximum density, laboratory air voids, and in-place density testing within 24 hours after construction of each lot.

1.6.4 Sublot Sampling

Obtain one random mixture sample from each sublot in accordance with ASTM D979/D979M from a loaded truck or another location for determining laboratory air voids, theoretical maximum density, Contractor Quality Control any additional testing as directed by the Government. Representative samples will be selected from random trucks using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs. Laboratory air voids will be determined from three laboratory compacted specimens of each sublot sample in accordance with ASTM D3203/D3203M. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

1.6.4.1 Additional Sampling and Testing

The Government reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Contractor. Testing in these areas will be treated as a separate lot. Payment will be made for the quantity of fuel resistant asphalt pavement represented by these tests in accordance with the provisions of this section.

1.6.4.2 Theoretical Maximum Density (TMD)

Measure theoretical maximum density one time for each sublot in accordance with ASTM D2041/D2041M for purposes of calculating laboratory air voids and determining in-place density. The average TMD for each lot will be determined as the average TMD of the random sublot samples. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD values will be used as the TMD needed to calculate the percent joint density.

1.6.4.3 Laboratory Air Voids

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NOTE: Select the appropriate tailoring option for the Marshall or Superpave Methods.

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[Prepare one set of laboratory compacted specimens for each sublot in accordance with ASTM D6926 using the hand-held hammer for the Marshall Method.][Prepare one set of laboratory compacted specimens for each sublot in accordance with ASTM D6925 using the Superpave gyratory compactor.] Provide three test specimens prepared from the same sample for each set of laboratory compacted specimens. Compact the specimens within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Do not reheat samples prior to compaction. Provide insulated containers as necessary to maintain the sample temperature. Measure the bulk density of laboratory compacted specimens in accordance with ASTM D2726/D2726M. Determine laboratory air voids from one set (three laboratory compacted specimens) for each sublot sample in accordance with ASTM D3203/D3203M.

1.6.5 In-place Density

Obtain one random 100 mm 4 inch or 150 mm 6 inch diameter core from the mat and joint of each sublot in accordance with ASTM D5361/D5361M for determining in-place density. Where different job mix formulas are required as part of the same project, and are adjacent to one another, follow the same joint density sampling and joint density testing instructions of this specification. Cut samples neatly with a diamond core drill bit. Obtain random cores that are the full thickness of the layer being placed. Select core locations randomly using the procedures contained in ASTM D3665. Locate cores for mat density no closer than 300 mm 12 inches from a transverse or longitudinal joint including the pavement edge. Center all cores for joint density on the joint. Discard samples that are clearly defective as a result of sampling and take an additional random core. When the random core is less than 25 mm 1 inch thick, it will not be included in the analysis. In this case, obtain another random core sample. Clean and tack coat dry core holes before filling with asphalt mixture. Fill all core holes with asphalt mixture and compact using a manual (hand-held) Marshall hammer to the density specified. Provide all tools, labor, and materials for cutting samples, cleaning, and filling the cored pavement. Measure in-place density in accordance with ASTM D2726/D2726M using each core obtained from the mat and joint.

1.6.6 Surface Smoothness

Use a straightedge and profilograph for measuring surface smoothness ofpavements. Use the profilograph method for all longitudinal testing, except for paving lanes less than 400 meters 0.10 miles in length. Use the straightedge method for transverse testing, for longitudinal testing where the length of each pavement lane is less than 400 meters 0.10 miles, and at the ends of the paving limits for the project. Use the straightedge to also perform smoothness checks for any localized areas that look suspicious, including localized areas that were already tested with the profilograph. Perform all testing in the presence of the Government. Maintain detailed notes of the testing results and provide a copy to the Government immediately after each day's testing. Where drawings show required deviations from a plane surface (for instance crowns, drainage inlets), finish the surface to meet the approval of the Government.

1.6.6.1 Smoothness Requirements

1.6.6.1.1 Straightedge Testing

Provide finished surfaces of the pavements with no abrupt change of 3 mm 1/8 inch or more, and all pavements within the tolerances specified in Table 5 when checked with an approved 4 m 12 foot straightedge.

Table 5
Straightedge Surface Smoothness

Pavement Category	Direction of Testing	Tolerance, mm inch
Runways, taxiways, and landing zones	Longitudinal	31/8
	Transverse	61/4
Shoulders (outside edge stripe)	Longitudinal	61/4
	Transverse	61/4

Table 5
Straightedge Surface Smoothness

Pavement Category	Direction of Testing	Tolerance, mm inch
Calibration hardstands and compass swinging bases	Longitudinal	31/8
	Transverse	31/8
All other airfield pavements (including overruns) and helicopter paved areas	Longitudinal	61/4
	Transverse	61/4

1.6.6.1.2 Profilograph Testing

Provide finished surfaces of runways, taxiways and landing zones with a Profile Index not greater than 110 mm per km 7 inches per mile when tested with an approved California-type profilograph per ASTM E1274. For pavements other than runways, provide finished surfaces with a Profile Index not greater than 140 mm per km 9 inches per mile when tested with an approved California-type profilograph per ASTM E1274.

1.6.6.2 Testing Method

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in each entire lot in a manner to reveal surface irregularities exceeding the tolerances specified above. If any pavement areas are diamond ground, retest these areas immediately after diamond grinding and submit results to the Government for evaluation. The maximum area allowed to be corrected by diamond grinding is 10 percent of the total area of the lot. Test the entire area of the pavement with a profilograph. Check a number of random locations along with any observed suspicious locations primarily at transverse and longitudinal joints with the straightedge.

1.6.6.2.1 Straightedge Testing

Hold the straightedge in contact with the pavement surface and measure the maximum distance between the straightedge and the pavement surface. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Use the straightedge to measure abrupt changes in surface grade.

1.6.6.2.2 Profilograph Testing

Perform profilograph testing using an approved California profilograph and procedures described in ASTM E1274. Provide equipment that utilizes electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. Use a "blanking band" that is 5 mm 0.2 inch wide and the "bump template" spanning 25 mm 1 inch with an offset of 10 mm 0.4 inch. Provide profilograph operated by an approved, factory-trained operator on the alignments specified above. Provide a copy of the reduced tapes to the Government at the end of each day's testing.

1.6.6.2.3 Bumps ("Must Grind" Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm 0.4 inch in height by diamond grinding until they do not exceed 7.5 mm 0.3 inch when retested. Taper diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding. The following will not be permitted: (1) skin patching for correcting low areas, (2) planing or milling for correcting high areas. [At the Contractor's option, pavement areas, including diamond ground areas, can be rechecked with the profilograph in order to record a lower Profile Index.][Perform additional profilograph testing in all areas corrected by diamond grinding.]

1.6.7 Plan Grade

Within 5 working days after completion of a particular lot incorporating the final wearing course, test the final wearing surface of the pavement for conformance with specified plan grade requirements. Provide a final wearing surface of pavement conforming to the elevations and cross sections shown and not vary more than 15 mm 0.05 foot from the plan grade established and approved at site of work. Match finished surfaces at juncture with other pavements with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. The grade will be determined by running lines of levels along the centerline at intervals of 7.6 m 25 feet or less longitudinally to determine the elevation of the completed pavement surface. Measure transverse grades at appropriate intervals. Diamond grinding can be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted. Maintain detailed notes of the results of the testing and provide a copy to the Government immediately after each day's testing.

1.6.8 Laboratory Accreditation and Validation

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NOTE: For Army managed projects, keep the bracketed text. For Air Force, and Navy, managed projects, utilization of the USACE Materials Testing Center (MTC) is optional.

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Provide laboratories used to develop the Job Mix Formula (JMF), perform acceptance testing, and Contractor Quality Control testing that meet the requirements of ASTM D3666. Provide laboratories with a masonry saw having a diamond blade for trimming pavement cores and samples. Perform all required test methods by an accredited laboratory. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory accreditation is not allowed. The Government will inspect the laboratory equipment and test procedures prior to the start of fuel resistant asphalt pavement operations for conformance with ASTM D3666. [In addition, all testing laboratories performing JMF, acceptance testing and Contractor Quality Control requires USACE validation by the Material Testing Center (MTC) for both parent laboratory and plant testing laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at https://mtc.erdc.dren.mil/ for costs and scheduling.] Submit a certificate of compliance signed by the manager of the laboratory stating that it meets these requirements to the Government prior to the start of construction. At a minimum, include the following certifications:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment, with calibration dates, to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

1.7 ENVIRONMENTAL REQUIREMENTS

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NOTE: The temperature requirements below are included to avoid problems with the Contractor achieving density because the mix cools too fast. Waivers to these requirements, for isolated incidences during production, are applicable if the density requirements are still met.

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Do not place the fuel resistant asphalt pavement upon a wet surface or when the surface temperature of the underlying course is less than specified. The temperature requirements may be waived by the Government, if requested; provided all other requirements, including compaction, are met. The surface temperature limitations of the underlying base course is 7 degrees C45 degrees F for a mat thickness of 50 mm 2 inches.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

This section is intended to stand alone for construction of asphalt pavement. However, where the construction covered herein interfaces with other sections, construct each interface to conform to the requirements of both this section and the other section, including tolerance for both.

Perform the work consisting of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. Provide fuel resistant asphalt pavement designed and constructed in accordance with this section conforming to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Construct each course to the depth, section, or elevation required by the drawings and rolled, finished, and approved before the placement of the next course. Submit proposed Placement Plan, indicating lane widths, longitudinal joints, and transverse joints for each course or lift.

2.1.1 Asphalt Mixing Plant

Provide plants used for the preparation of asphalt mixture conforming to the requirements of AASHTO M 156 with the following changes:

2.1.1.1 Truck Scales

Weigh the fuel resistant asphalt mixture on approved scales, or on certified public scales at no additional expense to the Government. Inspect and seal scales at least annually by an approved calibration laboratory.

2.1.1.2 Inspection of Plant

Provide access to the Contracting Officer at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance as requested, for the Government to procure any desired samples.

2.1.1.3 Storage Silos

The fuel resistant asphalt mixture may be stored in non-insulated storage silos for a period of time not exceeding 3 hours. The fuel resistant asphalt pavement may be stored in insulated storage silos for a period of time not exceeding 8 hours. No differences in the mix removed from silos and the mix loaded into trucks are allowed.

2.1.2 Hauling Equipment

Provide trucks used for hauling fuel resistant asphalt pavement that have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, lightly coat the truck beds with a minimum amount of paraffin oil, lime solution, or other approved material. Do not use petroleum based products as a release agent. Provide each truck with a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture is delivered to the site at the specified temperature, provide insulated or heated truck beds with covers (tarps) that are securely fastened.

2.1.3 Material Transfer Vehicle (MTV)

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NOTE: A Material Transfer Vehicle (MTV) is required for runway, taxiway, landing zone and apron construction.

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Provide Material Transfer Vehicles (MTV) for placement of the fuel resistantasphalt pavement. To transfer the material from the hauling equipment to the paver, use a self-propelled, material transfer vehicle with a swing conveyor that delivers material to the paver from outside the paving lane and without making contact with the paver. Provide MTV capable to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. Provide MTV with remixing and storage capability to prevent physical and thermal segregation.

2.1.4 Asphalt Pavers

Provide mechanical spreading and finishing equipment consisting of a self-powered paver, capable of spreading and finishing the mixture to the specified line, grade, and cross section. Provide paver with vibrating screed capable of placing a uniform mixture to meet the specified thickness, smoothness, and grade without physical or temperature segregation, the full width of the material being placed.

2.1.4.1 Receiving Hopper

Provide paver with a receiving hopper of sufficient capacity to permit a uniform spreading operation and a distribution system to place the mixture uniformly in front of the screed without segregation. Provide a screed that effectively produces a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

[2.1.4.2 Automatic Grade Controls

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NOTE: Delete information on automatic grade control if not needed. Automatic grade control is needed when the design requires elevations for the fuel resistant asphalt pavement surface. Many maintenance and rehabilitation projects require an overlay thickness and do not specify actual grades.

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If grade control is required, provide a paver equipped with a control system capable of maintaining the specified screed elevation. One of three methods can be used to control grade: stringline, laser, or computerized elevations along with GPS. For multiple layers it is acceptable to control grade in the underlying layer and control the grade of the surface layer by applying a constant thickness over the underlying layer which has been placed to the desired grade. Provide transverse slope controller capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. Do not use the transverse slope controller to control grade. A ski-type device of not less than 9.14 m 30 ft can be used to provide improved smoothness. Use a shoe on one side of the paver to match an existing paved surface to provide a smooth joint.

]2.1.5 Rollers

Provide rollers in good condition and operated at slow speeds to avoid displacement of the fuel resistant asphalt pavement. Provide sufficient number, type, and weight of rollers to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate.

2.1.6 Diamond Grinding

Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth is limited below. Reduce high areas by diamond grinding the fuel resistant asphalt pavement with approved equipment after the fuel resistant asphalt pavement is at a minimum age of 14 days. Perform diamond grinding by sawing with saw blades impregnated with an industrial diamond abrasive.

Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the asphalt pavement. Provide diamond grinding equipment with saw blades that are 3 mm 1/8-inch wide, a minimum of 60 blades per 300 mm 12 inches of cutting head width, and capable of cutting a path a minimum of 0.9 m 3 feet wide. Diamond grinding equipment that causes raveling, fracturing of aggregate, or disturbance to the underlying material will not be allowed. The maximum depth of diamond grinding is 6 mm 1/4 inch. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government property. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified.

Prior to production diamond grinding operations, perform a test section at the approved location, consisting of a minimum of two adjacent passes with a minimum length of 12 m 40 feet to allow evaluation of the finish and transition between adjacent passes. Production diamond grinding operations cannot be performed prior to approval.

2.2 AGGREGATES

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For Design-Bid-Build projects, select the first bracketed text. For Design-Build projects, select the second bracketed text..

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Sample aggregates in the presence of a Government Representative. Obtain samples in accordance with ASTM D75/D75M and be representative of the materials to be used for the project. Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screenings, and mineral filler, as required. Natural sand is not allowed in the fuel resistant asphalt pavement. The portion of material retained on the 4.75 mm No. 4 sieve is coarse aggregate. The portion of material passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve is fine aggregate. The portion passing the 0.075 mm No. 200 sieve is defined as mineral filler. Submit sufficient materials to produce 90 kg 200 pounds 181 kg 400 pounds of blended mixture for mix design verification. Submit all aggregate test results and samples to the Government at least 14 days prior to start of construction. Aggregate tests can be no older than [6 months prior to contract award][6 months prior to test section].

2.2.1 Coarse Aggregate

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NOTE: The requirement for sulfate soundness (requirement b., below) may be deleted in climates where freeze-thaw does not occur. However, in those areas where freeze-thaw does not occur, requirement b. must remain if experience has shown that this test separates good performing aggregates from bad performing aggregates. Retain this requirement for all Navy projects.

Percentage of Wear (ASTM C131/C131M) must not exceed

40. Aggregates with a higher percentage of wear may be specified, provided a satisfactory record under similar conditions of service and exposure has been demonstrated.

****

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Provide coarse aggregate particles meeting the following requirements:

a. The percentage of loss not be greater than 40 percent after 500 revolutions when tested in accordance with ASTM C131/C131M.

b. The sodium sulfate soundness loss not exceeding 12 percent, or the magnesium sulfate soundness loss not exceeding 18 percent after five cycles when tested in accordance with ASTM C88.

c. At least 75 percent by weight of coarse aggregate contain at least two or more fractured faces when tested in accordance with ASTM D5821 with fractured faces produced by crushing.

d. The particle shape essentially cubical and the aggregate containing not more than 5 percent, by weight, of flat particles, elongated particles, or flat and elongated particles (5:1 ratio of maximum to minimum) when tested in accordance with ASTM D4791 Method A.

e. Slag consisting of air-cooled, blast furnace slag, with a compacted weight of not less than 1200 kg per cubic meter 75 pounds per cubic foot when tested in accordance with ASTM C29/C29M.

f. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.2.2 Fine Aggregate

****

NOTE: Set the lower limit for uncompacted void content (requirement c., below) at 45 for fine aggregate angularity unless local experiences indicate that a lower value can be used. There are some aggregates which have a good performance record and have an uncompacted void content less than 45. In no case set the limit at less than 43.

****

Provide fine aggregate consisting of clean, sound, tough, durable particles. Natural Sand is not allowed. Provide aggregate particles that are free from coatings of clay, silt, or any objectionable material, contain no clay balls, and meet the following requirements:

a. Individual fine aggregate sources with a sand equivalent value greater than 45 when tested in accordance with ASTM D2419.

b. Fine aggregate portion of the blended aggregate with an uncompacted void content greater than [45.0] percent when tested in accordance with ASTM C1252 Method A.

c. Clay lumps and friable particles not exceeding 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.2.3 Mineral Filler

Provide mineral filler consisting of a nonplastic material meeting the requirements of ASTM D242/D242M.

2.2.4 Aggregate Gradation

Provide a combined aggregate gradation that conforms to gradations specified in Table 6, when tested in accordance with ASTM C136/C136M and ASTM C117, and does not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grades uniformly from coarse to fine. Provide a JMF within the specification limits; however, the gradation can exceed the limits when the allowable deviation from the JMF shown in Tables 8 and 9 are applied.

Table 6
Aggregate Gradations

Sieve Size, mm inch	12.51/2 mix(1) Percent Passing by Mass
12.51/2	100
9.53/8	90-100
4.75No. 4	58-78
2.36No. 8	40-60
1.18No. 16	28-48
0.60No. 30	18-38
0.30No. 50	11-27
0.15No. 100	6-18
0.075No. 200	3- 6
(1) This mix is to be used only as a surface course. The allowable lift thickness is 50 mm2 inches.	

2.3 ASPHALT BINDER

****

NOTE: Select binder grade based upon the PG lower temperature as dictated by the project environment.

****

Provide asphalt binder that conforms to ASTM D6373 for Performance Grade (PG) [82-28][88-22] and meeting the requirements annotated below.

a. Test the original binder according to ASTM D6084/D6084M Procedure A – Elastic Recovery at 25 degrees C 77 degrees F with a minimum of 85 percent.

b. Test the original binder according to ASTM D7173 and meeting the maximum temperature difference of 4.0 degrees C7.2 degrees F when using the ASTM D36/D36M Ring-and-Ball apparatus.

c. Prepare the fuel resistant asphalt pavement specimens with the asphalt binder meeting the above requirements and the fuel resistance requirements when tested in accordance with paragraph TESTING REQUIREMENT FOR ASPHALT MIXTURE RESISTANCE TO FUEL. After passing the above requirements and those listed in Table 7, grade the asphalt binder as [PG 82-28FR][88-22FR].

Provide test data indicating grade certification by the supplier at the time of delivery of each load to the mix plant. Submit copies of these certifications to the Government. The supplier is defined as the last source of any modification to the binder. The Government may sample and test the binder at the mix plant at any time before or during mix production. [Obtain samples for verification testing in accordance with ASTM D140/D140M and in the presence of the Government. Provide these samples to the Government for verification testing, which will be performed at the Governments expense. Submit 20 L 5 gallon sample of the asphalt binder specified for mix design verification and approval not less than 14 days before start of the test section.]

2.4 MIX DESIGN

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NOTE: In areas subject to freeze/thaw, retain bracketed text.

****

Develop the mix design. Provide results of the Job Mix Formula (JMF) and aggregate testing performed no earlier than 6 months prior to Contract award. Provide fuel resistant asphalt mixture composed of well-graded aggregate, mineral filler if required, and asphalt material. Provide aggregate fractions sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of Table 6. Do not produce fuel resistant asphalt pavement for payment until a JMF has been approved. Design the fuel resistant asphalt pavement using hand-held (manual) Marshall Hammer procedures contained in AI MS-2 and the criteria shown in Table 7. Design the fuel resistant asphalt mixture using the Superpave gyratory compactor using the procedures contained in AI MS-2 and the criteria shown in Table 7. Prepare samples at various asphalt contents and compacted in accordance with ASTM D6925 or ASTM D6926 as required by the Government. Use laboratory compaction temperatures for Polymer Modified Asphalts as recommended by the asphalt binder manufacturer. Adjust the compactive effort of the specimens, as required, to provide a Tensile Strength Ratio (TSR) with an air void content of 7 plus or minus 1 percent. [Use freeze/thaw conditioning in lieu of moisture conditioning per ASTM D4867/D4867M]. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M is less than 80, reject the aggregates or the asphalt mixture treated with an anti-stripping agent. Add a sufficient amount of anti-stripping agent to produce a TSR of not less than 80. If an antistrip agent is required, provide it at no additional cost to the Government. Provide sufficient materials to produce 90 kg 200 pound of blended mixture to the Government for verification of mix design at least 14 days prior to construction of test section.

2.4.1 JMF Requirements

Submit the proposed JMF in writing, for approval, at least 14 days prior to the start of the test section, including as a minimum:

a. Percent passing each sieve size.

b. Optimum asphalt binder.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt performance grade and additional test requirements as specified in paragraph ASPHALT BINDER.

e. Number of blows of hammer per side of molded specimen.Number of Superpave gyratory compactor gyrations.

f. Laboratory mixing and compaction temperature.

g. Supplier-recommended field mixing and compaction temperatures.

h. Temperature of mix when discharged from mixer.

i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

j. Graphical plots and summary tabulation of stability, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2. Include summary tabulation that includes individual specimen data for each specimen tested.

k. Specific gravity and absorption of each aggregate.

l. Percent manufactured sand.

m. Percent particles with two or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

o. Percent flat or elongated particles (in coarse aggregate).

p. Tensile Strength Ratio and wet/dry specimen test results.

q. Type and amount of antistrip agent (if required).

r. Date the JMF was developed. Mix designs that are not dated or which are from a prior construction seasons may not be accepted.

s. Test results for asphalt resistance to fuel in accordance with paragraph TESTING REQUIREMENTS FOR ASPHALT MIXTURE RESISTANCE TO FUEL.

t. List of all modifiers.

u.

Table 7 Marshall Design Criteria	
Test Property	50 Blow Mix
Stability, N pounds minimum	95602150(1)
Flow, 0.25 mm 0.01 inch	Waived(2)
Air voids, percent	2.5(4)
Percent Voids in mineral aggregate (minimum)	14
Dust Proportion(3)	0.8-1.2
TSR, minimum percent	80
TSR Conditioned Strength (minimum kPa psi)	41560
Weight loss by fuel Immersion, maximum percent	1.5(5)
(1) This is a minimum requirement. Provide significantly higher average during construction to ensure compliance with the specifications	
(2) The flow requirement is not applicable for Polymer Modified Asphalts	
(3) Dust Proportion is calculated as the aggregate content, expressed as a percent of mass, passing the 0.075 mm No. 200 sieve, divided by the effective asphalt content, in percent of total mass of the mixture	
(4) Select the JMF asphalt content corresponding to an air void content of 2.5 percent. Verify the other properties of Table 7 meet the specification requirements at this asphalt content.	
(5) Tested in accordance with paragraph TESTING REQUIREMENT FOR ASPHALT MIXTURE RESISTANCE TO FUEL	

v.

Table 7 Superpave Gyratory Compaction Criteria	
Test Property	50 Gyration Mix
Air voids, percent	2.5(1)
Percent Voids in mineral aggregate (minimum)	14
Dust Proportion(2)	0.8-1.2
TSR, minimum percent	80
TSR Conditioned Strength (minimum kPa psi)	41560
Weight loss by fuel Immersion, maximum percent	1.5(3)

Table 7
Superpave Gyratory Compaction Criteria

Test Property	50 Gyration Mix
(1) Select the JMF asphalt content corresponding to an air void content of 2.5 percent. Verify the other properties of Table 7 meet the specification requirements at this asphalt content.	
(2) Dust Proportion is calculated as the aggregate content, expressed as a percent of mass, passing the 0.075 mm No. 200 sieve, divided by the effective asphalt content, in percent of total mass	
(3) Tested in accordance with paragraph TESTING REQUIREMENT FOR ASPHALT MIXTURE RESISTANCE TO FUEL	

2.4.2 Testing Requirement for Asphalt Mixture Resistance to Fuel

Determine asphalt pavement resistance to fuel by the following procedures:

a. Prepare three test specimens in accordance with the Mix Design requirements at optimum asphalt binder content and 2.5 plus or minus 0.7 percent air voids. Short term age the mix prior to compaction in accordance to AASHTO R 30.

b. Determine the percent air voids in each specimen, if any do not meet the requirements above discard and replace them. Dry the specimens under a fan at room temperature (20C to 27C) (68F to 80F) for a minimum of 24 hours.

c. Totally immerse the sample in kerosene(1) at room temperature (20C to 27C) (68F to 80F).

d. After submersing for 2.0 minutes plus or minus 30 seconds, remove the sample and immediately surface dry with a clean paper towel. Then immediately determine the weight in air to the nearest 0.1 grams. Report this as weight ‘A’ (weight before).

e. Resubmerse the sample in kerosene for 24 hours.

f. After 24 hours plus or minus 10 minutes, carefully remove the sample from the kerosene and suspension container and place it on an absorptive cloth or paper towel. Dry the specimen under a fan at room temperature (20C to 27C) (68F to 80F) for 24 hours.

g. After drying for 24 hours plus or minus 10 minutes weigh the sample in air to the nearest 0.1 grams. Report this as weight ‘B’ (weight after immersion).

h. Calculations:

Percent of weight loss by fuel immersion = $[(A - B) / A] \times 100$

Where: A = Weight before
B = Weight after

(1) Kerosene must meet the requirements of ASTM D3699.

2.4.3 Adjustments to JMF

The JMF for each mixture is in effect until a new formula is approved in writing by the Government. Should a change in sources of any material be made, perform a new mix design and a new JMF approved before the new material is used. Make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF are limited to plus or minus 4 percent on the 4.75 mm No. 4 and coarser sieves; plus or minus 3 percent on the 2.36 mm No. 8 to 0.30 mm No. 50 sieves; and plus or minus 1 percent on the 0.15 mm No. 100 sieve. Adjustments to the JMF are limited to plus or minus 1.0 percent on the 0.075 mm No. 200 sieve. Asphalt content adjustments are limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, develop a new mix design.

2.5 RECLAIMED ASPHALT PAVEMENT

Reclaimed asphalt pavement (RAP) or recycled asphalt shingles (RAS) is not allowed.

PART 3 EXECUTION

3.1 CONTRACTOR QUALITY CONTROL

****

NOTE: The Contractor may be able to meet the specified quality control requirements with in-house capability or may have to use the independent commercial laboratory to provide the required quality control testing.

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3.1.1 General Quality Control Requirements

Submit the Quality Control Plan. The Quality Control Plan is specific to this specification section and supplements the overall Quality Control Plan required by the project. Do not produce asphalt pavement for payment until the quality control plan has been approved. In the quality control plan, address all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design and unique JMF identification code

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management and procedures to prevent contamination

e. Proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction, including Fuel Resistant Asphalt Pavement-Portland Cement Concrete joints

l. Surface Smoothness

m. Truck bed release agent

n. Correlation of mechanical hammer to hand hammer. Determine the number of blows of the mechanical hammer required to provide the same density of the JMF as provided by the hand hammer. Use the average of three specimens per trial blow application.

3.1.2 Testing Laboratory

Provide a fully equipped asphalt laboratory located at the plant or job site that is equipped with heating and air conditioning units to maintain a temperature of 24 plus or minus 2.3 degrees C 75 plus or minus 5 degrees F. Provide laboratory facilities that are kept clean and all equipment maintained in proper working condition. Provide the Government with unrestricted access to inspect the laboratory facility, to witness quality control activities, and to perform any check testing desired. The Government will advise in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, immediately suspend the incorporation of the materials into the work. Incorporation of the materials into the work will not be permitted to resume until the deficiencies are corrected.

3.1.3 Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The quality control (QC) testing is separate and distinct from the acceptance testing in paragraph ACCEPTANCE. Use in-house capabilities or the independent commercial laboratory for quality control testing. Required elements of the testing program include, but are not limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, stability, in-place density, grade and smoothness. Develop a Quality Control Testing Plan as part of the Quality Control Program.

3.1.3.1 Asphalt Content

Determine asphalt content a minimum of twice per lot (a lot is defined in paragraph PAVEMENT LOTS) by one of the following methods: extraction method in accordance with ASTM D2172/D2172M, Method A or B, the ignition method in accordance with the ASTM D6307, or the nuclear method in accordance with ASTM D4125/D4125M, provided each method is calibrated for the specific mix being used. For the extraction method, determine the weight of ash, as described in ASTM D2172/D2172M, as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. Use the last weight of ash value in the calculation of the asphalt content for the mixture. The asphalt content for the lot will be determined by averaging the test results.

3.1.3.2 Aggregate Properties

Determine aggregate gradations a minimum of twice per lot from mechanical analysis of recovered aggregate in accordance with ASTM D5444 or ASTM D6307. For batch plants, test aggregates in accordance with ASTM C136/C136M using actual batch weights to determine the combined aggregate gradation of the mixture. Determine the specific gravity of each aggregate size grouping for each 18,000 metric tons 20,000 tons in accordance with ASTM C127 or ASTM C128. Determine fractured faces for gravel sources for each 18,000 metric tons 20,000 tons in accordance with ASTM D5821. Determine the uncompacted void content of manufactured sand, and blended aggregate for each 18,000 metric tons 20,000 tons in accordance with ASTM C1252 Method A.

3.1.3.3 Temperatures

Check temperatures at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt binder in the storage tank, the fuel resistant asphalt mixture at the plant, and the fuel resistant asphalt mixture at the job site.

3.1.3.4 Moisture Content of Aggregate

Determine the moisture content of aggregate used for production a minimum of once per lot in accordance with ASTM C566.

3.1.3.5 Moisture Content of Mixture

Determine the moisture content of the mixture at least once per lot in accordance with ASTM D1461.

3.1.3.6 Laboratory Air Voids, TMD, and VMAVMA and Marshall Stability

Obtain mixture samples at least four times per lot. Measure theoretical maximum density in accordance with ASTM D2041/D2041M. Compact the remaining portion of the sample into specimens, using 50 blows per side with the Marshall hand-held hammer as described in ASTM D6926. using 50 gyrations of the Superpave gyratory compactor as described in ASTM D6925. After compaction, measure the bulk density of laboratory compacted specimens in accordance with ASTM D2726/D2726M. Determine laboratory air voids from one set (three laboratory compacted specimens) for each sample in accordance with ASTM D3203/D3203M. Also calculate the VMA of each specimen in accordance with AI MS-2 based on ASTM C127 and ASTM C128 bulk specific gravity for the aggregate, as well as the Marshall stability, as described in ASTM D6927. Provide VMA within the limits of Table 7.

3.1.3.7 In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge or other non-destructive testing device may be used to monitor pavement density.

3.1.3.8 Grade and Smoothness

Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph ACCEPTANCE.

3.1.3.9 Additional Testing

Perform any additional testing, deemed necessary to control the process.

3.1.3.10 QC Monitoring

Submit all QC test results to the Government on a daily basis as the tests are performed. The Government reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.1.4 Control Charts

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 8, as a minimum. Post the control charts as directed by the Government and maintain current at all times. Identify the following on the control charts, the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 8 applicable to the test parameter being plotted, and the test results. Also show target values (JMF) on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. When the Suspension Limit is exceeded for individual values or running average values, the Government Engineer has the option to require removal and replacement of the material represented by the samples or to leave in place and base acceptance on mixture volumetric properties and in place density. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make decisions concerning mix modifications based on analysis of the results provided in the control charts. In the Quality Control Plan, indicate the appropriate action to be taken to bring the process into control when certain parameters exceed their Action Limits.

Table 8
Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of Last Four Samples	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
4.75 mm No. 4 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus	6	8	4	5
0.6 mm No. 30 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values	4	6	3	4
0.075 mm No. 200 sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus	1.4	2.0	1.1	1.5
Asphalt content, percent deviation from JMF target; plus or minus value	0.4	0.5	0.2	0.3

Table 8
Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

	Individual Samples		Running Average of Last Four Samples	
Parameter to be Plotted	Action Limit	Suspension Limit	Action Limit	Suspension Limit
Laboratory Air Voids, percent deviation from JMF target value	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Mat Density, percent of TMD	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Joint Density, percent of TMD	No specific action and suspension limits set since this parameter is used to determine percent payment			
$P_{0.075}/P_{be}$ Ratio, deviation from 1.0; plus or minus values	0.7	0.8	0.3	0.4
VMA of Fuel Resistant Asphalt Pavement, percent deviation from JMF target	-0.5	-1.0	-0.25	-0.5

Table 8 cont'd. Marshall Compaction

Stability, N pounds (minimum)				
50 blow JMF	78301760	72901640	95602150	90302030

3.2 PREPARATION OF ASPHALT BINDER MATERIAL

Heat the asphalt binder material while avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. Maintain the temperature of unmodified asphalts to no more than 160 degrees C 325 degrees F when added to the aggregates. The temperature of modified asphalts is not to exceed 175 degrees C 350 degrees

F. Performance Graded (PG) asphalts must be within the temperature range of 145 degrees C to 170 degrees C 290 degrees F to 340 degrees F when added to the aggregates and in accordance with the supplier's recommendations.

3.3 PREPARATION OF MINERAL AGGREGATE

Heat and dry the aggregate for the mixture prior to mixing. No damage to the aggregates due to the maximum temperature and rate of heating used is allowed. Maintain the temperature no lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.4 PREPARATION OF ASPHALT MIXTURE

Weigh or meter the aggregates and the asphalt binder and introduce into the mixer in the amount specified by the JMF. Limit the temperature of the asphalt mixture to 175 degrees C 350 degrees F when the asphalt binder is added. Mix the combined materials until the aggregate obtains a thorough and uniform coating of asphalt binder (testing in accordance with ASTM D2489/D2489M may be required by the Contracting Officer) and is thoroughly distributed throughout the mixture. The moisture content of all asphalt mixture upon discharge from the plant is not to exceed 0.5 percent by total weight of mixture as measured by ASTM D1461.

3.5 PREPARATION OF THE UNDERLYING SURFACE

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NOTE: If the underlying surface to be paved is an existing asphalt or concrete layer, use a tack coat to ensure an adequate bond between layers.

Tack and prime coat requirements will need to be covered in the Contract documents.

****

Immediately before placing the fuel resistant asphalt pavement, clean the underlying course of dust and debris. Apply a tack coat in accordance with Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.6 TEST SECTION

Prior to full production, place a test section for each JMF used. Construct a test section 75 to 150 m 250 to 500 feet long and two paver passes wide with a longitudinal cold joint. Do not place the second lane of test section until the temperature of pavement edge is less than 80 degrees C 175 degrees F. Construct the test section with the same depth as the course which it represents. Ensure the underlying grade or pavement structure upon which the test section is to be constructed is the same or very similar to underlying layer for the project. Use the same equipment and procedures in construction of the test section as on the remainder of the course represented by the test section. Construct the test section as part of the project pavement as approved by the Government.

3.6.1 Sampling and Testing for Test Section

****

NOTE: Table 9 applies only to the test section and localized areas appearing to deviate from the specification. The limits in Tables 1, 2, and 6,

apply to the results of 4 full scale production testsrun from each lot. This is the reason the limits listed in Table 9 are different from those listed in Tables 1, 2, and 6.
****

Obtain one random sample at the plant, triplicate specimens compacted, and tested for stability, and laboratory air voids. Test a portion of the same sample for TMD, aggregate gradation and asphalt content. Test an additional portion of the sample to determine the TSR. Adjust the compactive effort as required to provide TSR specimens with an air void content of 7 plus or minus 1 percent. Obtain four randomly selected cores from the finished pavement mat, and four from the longitudinal joint, and tested for density. Perform random sampling in accordance with procedures contained in ASTM D3665. Construction may continue provided the test results are within the tolerances or exceed the minimum values shown in Table 7. If all test results meet the specified requirements, the test section may remain as part of the project pavement. If test results exceed the tolerances shown, remove and replace the test section and construct another test section at no additional cost to the Government.

Table 9
Test Section Requirements for Material and Mixture Properties

Property	Specification Limit
Aggregate Gradation-Percent Passing (Individual Test Result)	
4.75 mm No. 4 and larger	JMF plus or minus 8
2.36, 1.18, 0.60, and 0.30 mmNo. 8, No. 16, No. 30, and No. 50	JMF plus or minus 6
0.15 and 0.075 mmNo. 100 and No. 200	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	14 minimum
Tensile Strength Ratio (TSR) (At 7 percent plus or minus 1 percent air void content)	80 percent minimum
TSR Conditioned Strength	415 kPa 60 psi minimum
Mat Density, Percent of TMD (Average of 4 Random Cores)	See Table 2
Joint Density, Percent of TMD (Average of 4 Random Cores)	See Table 2

Table 9 cont - Marshall Compaction Requirements

Property	Specification Limit
Stability, (Average of 3 specimens)	9560 N 2150 pounds minimum

3.6.2 Additional Test Sections

If the initial test section proves to be unacceptable, make the necessary adjustments to the JMF, plant operation, placing procedures, and rolling procedures before beginning construction of a second test section. Construct and evaluate additional test sections, as required, for conformance to the specifications. Full production paving is not allowed until an acceptable test section has been constructed and accepted.

3.7 TRANSPORTING AND PLACING

3.7.1 Transporting

Transport the fuel resistant asphalt mixture from the mixing plant to the site in clean, tight vehicles. Schedule deliveries so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Provide adequate artificial lighting for night placements. Hauling over freshly placed material is not permitted until the material has been compacted as specified, and allowed to cool to 60 degrees C 140 degrees F.

3.7.2 Placing

Place the mix in lifts of adequate thickness and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. At daily paving start-up, load the first truck and stage it near the paving operation. Process the second and third truck through the MTV and into the paver. After the third truck has processed through the MTV and paver, the first truck can be deposited into the MTV and paver. If internal temperature of the first truck drops below compaction temperatures, the asphalt mixture will be rejected. The method presented in the previous sentences also applies to when a stoppage or delay exceeds one hour. Upon arrival, place the mixture to the full width by an asphalt paver; strike off in a uniform layer of such depth that, when the work is completed, the required thickness and conform to the grade and contour indicated. Do not broadcast waste mixture onto the mat or recycle it into the paver hopper. Collect waste mixture and dispose off site. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat. Begin placement of the mixture along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture in consecutive adjacent strips having a minimum width of 3 m 10 feet. Offset the longitudinal joint in one course from the longitudinal joint in the course immediately below by at least 300 mm 1 foot; however, locate the joint in the surface course at the centerline of the pavement. Offset transverse joints in one course by at least 3 m 10 feet from transverse joints in the previous course. Offset transverse joints in adjacent lanes a minimum of 3 m 10 feet. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools. Construct the free edge of shoulder pavements following a guide (e.g. plumb-bob, stringline, etc.) to prevent various widths of the asphalt shoulder. Contractor may elect to cut-back the asphalt edge to maintain consistent shoulder dimensions shown on the plans.

3.8 COMPACTION OF MIXTURE

3.8.1 General

After placing, thoroughly and uniformly compact the mixture by rolling. Compact the surface as soon as possible without causing displacement, cracking or shoving. Determine the sequence of rolling operations and the type of rollers used, except as specified in paragraph FUEL RESISTANT ASPHALT PAVEMENT-PORTLAND CEMENT CONCRETE JOINTS and with the exception that application of more than three passes with a vibratory roller in the vibrating mode is prohibited. Maintain the speed of the roller, at all times, sufficiently slow to avoid displacement of the asphalt mixture and be effective in compaction. Correct at once any displacement occurring as a result of reversing the direction of the roller, or from any other cause.

Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened, but excessive water is not permitted. In areas not accessible to the roller, thoroughly compact the mixture with hand tampers. Remove the full depth of any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective, replace with fresh fuel resistant asphalt mixture and immediately compact to conform to the surrounding area. Perform this work at no expense to the Government. Skin patching is not allowed.

3.8.2 Segregation

Sample and test any material that looks deficient. When the in-place material appears to be segregated, the Government has the option to sample the material and have it tested and compared to the aggregate gradation, asphalt content, and in-place density requirements in Table 7. If the material fails to meet these specification requirements, remove and replace the extent of the segregated material the full depth of the layer of asphalt mixture at no additional cost to the Government. When segregation occurs in the mat, take appropriate action to correct the process so that additional segregation does not occur.

3.9 JOINTS

Construct joints to ensure a continuous bond between the courses and to obtain the required density. Provide all joints with the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.9.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, construct by means of placing a bulkhead or by tapering the course. Utilize a dry saw cut on the transverse joint full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. Cutting equipment that uses water as a cooling or cutting agent nor milling equipment is permitted. Remove the cutback material from the project. In both methods, provide a light tack coat of asphalt material to all contact surfaces before placing any fresh mixture against the joint.

3.9.2 Longitudinal Joints

Cut back longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80 degrees C 175 degrees F at the time of placing the adjacent lane), or otherwise defective, a maximum of 75 mm 3 inches from the top edge of the lift with a cutting wheel to expose a clean, sound, near vertical surface for the full depth of the course. Remove all cutback material from the project. Attach the cutting wheel to a roller to perform the longitudinal joint cut back. Provide a light tack coat of asphalt material to all contact surfaces prior to placing any fresh mixture against the joint.

3.9.3 Fuel Resistant Asphalt Pavement-Portland Cement Concrete Joints

Joints between fuel resistant asphalt pavement and Portland Cement Concrete (PCC) require specific construction procedures for the fuel resistant asphalt pavement. The following criteria are applicable to the first 3 m 10 feet or paver width of fuel resistant asphalt pavement adjacent to the PCC.

a. Place the fuel resistant asphalt pavement side of the joint in a direction parallel to the joint.

b. Place the fuel resistant asphalt pavement side sufficiently high so that when fully compacted the fuel resistant asphalt pavement is greater than 3 mm 1/8 inch but less than 6 mm 1/4 inch higher than the PCC side of the joint.

c. Compact with steel wheel rollers and at least one rubber tire roller. Compact with a rubber tire roller that weights at least 18 metric tons 20 tons with tires inflated to at least 620 kPa 90 psi. Avoid spalling the PCC during placement and compaction of the fuel resistant asphalt pavement. Operate steel wheel rollers in a way that prevents spalling the PCC. Repair any damage to PCC edges or joints as directed by the Government. If damage to the PCC joint or panel edge exceeds a total of 1 m 3 feet, remove and replace the PCC panel at no additional expense to the Government.

d. After compaction is finished, diamond grind a minimum width of 1 m 3 feet of the fuel resistant asphalt pavement so that the fuel resistant asphalt pavement side is less than 3 mm 1/8 inch higher than the PCC side. Perform diamond grinding in accordance with subparagraph DIAMOND GRINDING above. The fuel resistant asphalt pavement immediately adjacent to the joint is not allowed to be lower than the PCC after the grinding operation. Transition the grinding into the fuel resistant asphalt pavement in a way that ensures good smoothness and provides drainage of water. The joint and adjacent materials when completed is required to meet all of the requirements for grade and smoothness. Measure smoothness across the fuel resistant asphalt pavement-PCC joint using a 4 m 12 feet straightedge. The acceptable tolerance is 3 mm 1/8 inch.

e. Consider the fuel resistant asphalt pavement next to the PCC as a separate pay factor associated with the lot being placed for evaluation. Lots are based on individual lifts. Do not comingle cores from different lifts for density evaluation purposes. Take four cores for each lot of material placed adjacent to the joint. The size of lot is 3 m 10 feet wide by the length of the joint being paved. Perform the same computation as displayed in paragraph PAY FACTOR BASED ON IN-PLACE DENSITY above to determine the weighted pay factor. Select the lowest computed pay factor for the lot. Locate the center of each of the four cores 150 mm 6 inches from the edge of the concrete. Take each core at a random location along the length of the joint. The requirements for joint density for this lot, adjacent to the PCC joint, are the same as that for the mat density specified in Table 2. For fuel resistant asphalt pavement-PCC joints at taxiways abutting runways, aprons, or other taxiways, take two additional randomly located cores along each taxiway intersection.

f. All procedures, including repair of damaged PCC, are required to be in accordance with the approved Quality Control Plan.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 12 19.16 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 12 18 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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****

SECTION 32 12 19.16

RESIN-MODIFIED ASPHALT PAVING WEARING COURSES
11/19

****
NOTE: This guide specification covers the requirements for resin-modified asphalt paving wearing courses.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: Consult a representative of the Airfield and Pavements Branch, Geotechnical and Structures Laboratory, U.S. Army Engineer Research and Development Center (CERDC) in the planning and designing of a Resin Modified Pavement (RMP).
****

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in

this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when user adds a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also, use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when user chooses to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156	(2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
AASHTO M 320	(2017) Standard Specification for Performance-Graded Asphalt Binder

ASTM INTERNATIONAL (ASTM)

ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM D70	(2018a) Standard Test Method for Density of Semi-Solid Bituminous Materials (Pycnometer Method)
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D1461	(2017) Standard Test Method for Moisture or Volatile Distillates in Asphalt Mixtures
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction
ASTM D4125/D4125M	(2010) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5444	(2015) Mechanical Size Analysis of Extracted Aggregate
ASTM D6307	(2019) Standard Test Method for Asphalt Content of Asphalt Mixture by Ignition Method

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control (QC) System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Open Graded Bituminous Job Mix Formula

Job Mix Formula for Slurry Grout

SD-06 Test Reports

Coarse and Fine Aggregates; G, [_____]

Coarse Aggregate; G, [_____]

Open-Graded Mix Aggregate; G, [_____]

Slurry Grout Sand; G, [_____]

Filler (Fly Ash); G, [_____]

Bituminous Material; G, [_____]

Job Mix Formula for Slurry Grout; G, [_____]

Contractor Quality Control; G, [_____]

SD-07 Certificates

Cement; G, [_____]

Cross Polymer Resin; G, [_____]

Curing Compound; G, [_____]

1.3 QUALITY ASSURANCE

Provide the Contracting Officer access to the bituminous plant, for checking adequacy of equipment in use; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking temperatures maintained in preparation of the mixtures.

1.3.1 Aggregates

1.3.1.1 Sampling and Testing

Use ASTM D75/D75M in sampling coarse and fine aggregates. Points of sampling will be designated by the Contracting Officer. Conduct tests to determine compliance with the specified requirements, using a Corps of Engineers certified commercial laboratory.

1.3.1.2 Sources

Select sources of aggregates well in advance of the time when the materials are required in the work. Submit samples 30 days before starting production. If a sample of material fails to meet the specified requirements, replace the material represented by the sample, and the cost of testing the replaced sample will be at the Contractor's expense. Approval of the source of the aggregate does not relieve the Contractor of the responsibility to deliver aggregates that meet the specified requirements.

1.3.2 Bituminous Materials

Obtain samples of bituminous materials in accordance with ASTM D140/D140M. Select sources well in advance of the time materials are required for the work. Coordinate with the DWG, client, and testing laboratory to ensure that the required qualification testing can be completed and reported to the client and the information can be reviewed and approved prior to the beginning of construction. In addition to the initial qualification, obtain samples and test before and during construction when shipments of bituminous materials are received, to assure that some condition of handling or storage has not been detrimental to the bituminous material.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Mineral Aggregates

Deliver mineral aggregates to the site of the bituminous mixing plant and stockpile them in such a manner as to preclude segregation or contamination with objectionable material.

1.4.2 Bituminous Materials

Maintain bituminous materials below a temperature of 150 degrees C 300 degrees F during storage. Clean storage tanks, transfer lines and weigh buckets before a different type or grade of bitumen is introduced into the system.

1.4.3 Slurry Grout Sand

Store slurry grout sand at the grout production site to prevent contamination with foreign materials and saturation with rain water. Submit aggregate and QC test results. Conduct slurry grout viscosity tests immediately prior to application on the pavement surface and 30 minutes thereafter. Determine moisture content of this sand just prior to grout production so that corrections to the job mix formula (JMF) water content can be made to compensate for moisture in the sand.

1.4.4 Cementitious Materials

Do not allow the temperature of the cementitious materials, as delivered for storage at the site, to exceed 65 degrees C 150 degrees F.

1.4.5 Open Graded Bituminous Mixture

Do not store the open graded bituminous mixture for longer than one hour prior to hauling to the job site.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not place the bituminous mixture upon a wet surface, unprotected in the rain, or when the surface temperature of the underlying course is less than 10 degrees C 50 degrees F. Once the bituminous mixture has been placed, and if rain is imminent, place protective materials consisting of rolled polyethylene sheeting at least 0.1 mm 4 mils thick, of sufficient length and width to cover the mixture. If the open graded bituminous mixture becomes saturated, allow the pavement voids to dry out prior to applying the slurry grout.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Asphalt Mixing Plant

Provide a bituminous asphalt plant with enough capacity to produce the quantities of bituminous mixtures required for the project and conforming to the requirements of AASHTO M 156, with the following changes:

2.1.1.1 Testing Facilities

Provide laboratory facilities at the plant for the use of the Government's acceptance testing and the Contractor's QC testing.

2.1.1.2 Storage Bins

Permit use of insulated storage bins for temporary storage of hot-mix asphalt for a period of time not exceeding 1 hour.

Provide hauling equipment, paving machines, rollers, miscellaneous equipment, and tools in sufficient numbers, capacity and in proper working condition to place the asphalt paving mixtures at a rate equal to the plant output.

2.1.2 Asphalt Paver

Provide asphalt paver that is self-propelled, with a vibrating screed, heated, and capable of spreading and finishing courses of hot-mix asphalt meeting the specified thickness, smoothness, and grade. Use a paver with sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

2.1.3 Receiving hopper

Use a paver with a receiving hopper of sufficient capacity to permit a uniform spreading operation. Equip the hopper with a distribution system to place the mixture uniformly in front of the screed without segregation. Check that the screed produces a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

2.1.4 Automatic Grade Control

If an automatic grade control device is used, equip the paver with a control system capable of automatically maintaining the specified screed elevation. Use a control system that is automatically actuated from either a reference line and/or through a system of mechanical sensors, or sensor-directed mechanisms or devices that maintains the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. Use a transverse slope controller capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. Do not use the transverse slope controller to control grade. Use controls capable of working in conjunction with the following attachments:

a. Ski-type device of not less than 9 m 30 ft in length.

b. Taut stringline set to grade.

c. Short ski or shoe for joint matching.

d. Laser control.

2.1.5 Slurry Grout

Provide a concrete batch plant, a ready-mix truck, or portable mixer for grout mixing, and small 1.8 metric ton 2 ton (maximum) tandem steel wheeled vibratory roller for compaction of Resin Modified Pavement (RMP) for production of slurry grout for the RMP.

2.2 AGGREGATE

Provide aggregate consisting of crushed stone, or crushed gravel without sand or other inert finely divided mineral aggregate. Coarse aggregate is the portion of materials retained on the 4.75 mm No. 4 sieve. Fine aggregate is the portion of material passing the 4.75 mm No. 4 sieve and retained on the 0.075 mm No. 200 sieve. Conduct sieve analysis of coarse and fine aggregates in accordance with ASTM C136/C136M.

2.2.1 Coarse Aggregate

Provide coarse aggregate consisting of sound, tough, durable particles, free from adherent films of matter that would prevent coating with the bituminous material. Do not allow the percentage of wear to be greater than 40 percent when tested in accordance with ASTM C131/C131M. Do not allow the magnesium sulfate soundness loss to exceed 18 percent, after five cycles, when tested in accordance with ASTM C88. Provide aggregate containing at least 75 percent by weight of crushed pieces having two or more fractured faces. Check that the area of each fractured face is equal to at least 75 percent of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, check that the angle between the planes of fractures is at least 30 degrees to count as two fractured faces. Obtain fractured faces by artificial crushing.

2.2.1.1 Crushed Aggregates

Particle shape of crushed aggregates are to be cubical. Do not allow the quantity of flat (width to thickness ratio greater than 3) and elongated particles (width to length ratio greater than 3) in any sieve size to exceed 8 percent by weight, when determined in accordance with ASTM D4791.

2.2.2 Open-Graded Mix Aggregate

The gradations in Table I represent the limits that determine the suitability of open-graded mix aggregate for use from the sources of supply. Use aggregate having a gradation within the limits designated in Table I and that does not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but is uniformly graded from coarse to fine.

TABLE I
OPEN-GRADED MIX AGGREGATE

Sieve Size	Percent by Weight Passing
19 mm 3/4 in	100
12.5 mm 1/2 in	54-76
9.5 mm 3/8 in	38-60
4.75 mm No. 4	10-20
2.36 mm No. 8	8-16
0.60 mm No. 30	4-10
0.075 mm No. 200	1-3

Table I is based on aggregates of uniform specific gravity; the percent passing various sieves may be changed by the Contracting Officer when aggregates of varying specific gravities are used. Adjustments of percentages passing various sieves may be directed by the Contracting Officer when aggregates vary more than 0.2 in specific gravity.

2.2.3 Slurry Grout Sand

Provide slurry grout sand consisting of clean, sound, durable, particles of processed silica sand that meet the requirements for wear and soundness specified for coarse aggregate. Use sand containing no clay, silt, or other objectionable matter. The gradations in Table II represent the limits which determine the suitability of silica sand for use from the sources of supply.

TABLE II FINE SAND FOR SLURRY GROUT	
Sieve Size	Percent by Weight Passing
1.18 mm No. 16	100
0.60 mm No. 30	95-100
0.075 mm No. 200	0-2

The sand gradations shown are based on sand of uniform specific gravity, and the percentages passing the various sieves are subject to appropriate correction by the Contracting Officer when aggregates of varying specific gravities are used.

2.2.4 Filler (Fly Ash)

Provide fly ash having at least 95 percent by weight of material passing the 0.075 mm No. 200 sieve and conforming to ASTM C618 Class F requirements.

2.3 BITUMINOUS MATERIAL

Provide bituminous material conforming to the requirements of [ASTM D3381/D3381M with a viscosity grade [AC-10] [AC-20] [AC-30] [AR-4000] [AR-8000] and an original penetration of 40 to 100.][AASHTO M 320 Performance Grade (PG) [_____]].

2.4 CEMENT

Use Portland cement in the slurry grout in accordance with ASTM C150/C150M, Type [I] [II] [III] [V]. Submit copies of conformance certificates for cement, cross polymer resin and curing compound.

2.5 CROSS POLYMER RESIN

****

NOTE: The cross polymer resin to be used in the slurry grout, Prosalvia-7, is a proprietary product which has been waived for use throughout the Corps of Engineers and is available from the Alyan Corporation, P.O. Box 788, Vienna, VA 22183, (703) 573-8134.

A complete description of the Marsh flow cone and the grout viscosity test method is found in ETL 1110-1-177 "Use of Resin Modified Pavement (RMP)".

****

Utilize a cross polymer resin of styrene and butadiene, Prosalvia L7, as a plasticizing and strength producing agent. After mixing the resin into the slurry grout, check that the mixture has a viscosity that would allow it to flow from a Marsh Cone in accordance with Table III. A Marsh cone has dimensions of 155 mm 6-1/8 in base inside diameter, tapering 315 mm 12-3/8 in to a tip inside diameter of 10 mm 3/8 in. The 10 mm 3/8 in diameter neck has a length of 60 mm 2-3/8 in.

TABLE III SLURRY GROUT VISCOSITY	
Time Elapsed After Addition of PL7	Marsh Flow Cone Viscosity
0 to 30 minutes	8 to 10 seconds
After 30 minutes	9 to 11 seconds

2.6 CURING COMPOUND

Use membrane-forming curing compound with white pigmented compounds conforming to ASTM C309.

2.7 JMF FOR OPEN-GRADED ASPHALT AND SLURRY GROUT

****

NOTE: It is recommended that the JMF for the open graded bituminous mixture and the mixture proportions for the slurry grout be approved by the appropriate ERDC representative. On a case by case basis, this approval may result from a simple review of the Contractor's mix design test reports, or it may require verification of the mix design by repeating some or all of the required mix design tests. This recommendation is to ensure that proper laboratory procedures are used to determine mix designs for this paving process.

A complete description of the proper methods used to produce JMFs for the open graded bituminous mixture and slurry grout is found in ETL 1110-1-177 "Use of Resin Modified Pavement (RMP)."

****

2.7.1 Open Graded Bituminous Job Mix Formula

Provide the JMF for the open graded bituminous mixture for approval by the Government. No payment will be made for mixtures produced prior to the approval of the JMF by the Contracting Officer.

a. Quantities of the materials required to produce the open graded bituminous mixture and slurry grout JMFs are indicated below. Use aggregate stockpiles in the production of the open-graded bituminous mixture having the quantities below.

(1)

Aggregate	45 kg 100 lbs ea
Bituminous Material	19 liters 5 gal
Slurry Grout Sand	23 kg 50 lbs
Fly Ash	23 kg 50 lbs
Cement	23 kg 50 lbs

Cross Polymer Resin	4 liters l gallon

b. Along with the Contractor's preliminary JMFs, deliver material samples, 30 days before starting production, to U.S. Army Engineer Waterways Experiment Station Research and Development Center, 3909 Halls Ferry Road, Vicksburg, Mississippi, 39180-6199, ATTN: CEWESERD-GP-Q.

2.7.1.1 Initial Laboratory Procedure

a. Sample aggregates according to ASTM D75/D75M and asphalt cement according to ASTM D140/D140M. An open-graded asphalt concrete mix design requires a minimum of 45 kg 100 lbs of each aggregate stockpile and 15 L 4 gal of asphalt cement.

b. Oven dry aggregate stockpile samples and conduct a sieve analysis (ASTM C136/C136M) on each sample. Determine the combination of aggregate stockpiles that results in a gradation closest to the center of the limiting gradation band in Table I. Use this stockpile combination as the blending formula for the open-graded asphalt concrete.

c. Measure apparent specific gravity of aggregates (ASTM C127 and ASTM C128) from each stockpile used in the final gradation. Calculate apparent specific gravity of combined aggregates using the blending formula percentages. Measure specific gravity of asphalt cement (ASTM D70).

d. Estimate the optimum asphalt content using the following equation:

$$\text{Optimum asphalt content} = (8.61*(0.21G + 5.4S + 7.2s + 135f)^{0.2})/SG$$

where

SG = apparent specific gravity of the combined aggregates
G = percentage of material retained on the 4.75 mm No. 4 sieve
S = percentage of material passing the 4.75 mm No. 4 and retained on the 0.6 mm No. 30 sieve
s = percentage of material passing the 0.6 mm No. 30 sieve and retained on the 0.075 mm No. 200 sieve
f = percentage of material passing 0.075 mm No. 200 sieve

e. Round the calculated optimum asphalt content value to the nearest tenth of a percent. Use this asphalt content value along with two asphalt contents above this amount and two asphalt contents below this amount in the production of mix design samples. Use 0.5 percent above and below the optimum and 1.0 percent above and below the optimum as the four additional asphalt contents. Calculate maximum theoretical specific gravities for each of these five asphalt cement contents using ASTM D2041/D2041M.

2.7.1.2 Specimen Production

Using the five mix design asphalt contents, produce three 100 mm 4 in diameter Marshall specimens at each asphalt content. Use approximately 800 g 1.8 lbs of combined aggregates following the previously determined aggregate blending formula for each specimen. Before mixing, check that the temperature of the aggregates is 145 ± 5 degrees C 290 ± 9 degrees F and the asphalt cement is 135 ± 5 degrees C 275 ± 9 degrees F. With normal mixing procedures, the temperature of the asphalt mixture during compaction is 120 ± 5 degrees C 250 ± 9 degrees F. Compact the open-graded asphalt concrete specimens with 25 blows from a 4.5 kg 10 lbs Marshall hand hammer on one side of each specimen. Allow the specimens to air cool for a minimum of 4 hours before carefully removing from molds.

2.7.1.3 Measuring voids total mix (VTM)

a. Measure the VTM of each open-graded specimen using the following formula:

VTM = (1 - WTAIR /Volume * 1/SGT) * 100 VTM = [1 - WTAIR /Volume * 1/(SGT * 62.4lbs/CF)] * 100

where

WTAIR = dry weight of specimen in g lbs
Volume =0.785$(D)^2(H)$ cubic cm cubic ft
D = diameter in cm ft
H = height in cm ft
SGT = maximum theoretical specific gravity

b. Calculate the average VTM for each of the five asphalt cement contents. Select the optimum asphalt content as that which resulted in a VTM value closest to 30.0 percent. If no VTM averages are in the 30.0 percent range, then make adjustments to the aggregate gradation to achieve the proper void content. Optimum asphalt contents resulting in average VTM values in the 25 to 35 percent range are acceptable, but due to normal production and construction variations, base the JMF on a mix design that provides a 28 to 32 percent VTM value is required. Typical optimum asphalt contents are between 3.5 and 4.5 percent.

2.7.1.4 Job-Mix Formula Submittal

Check that the open-graded asphalt concrete JMF consists of the following information:

(1) Percentage of each aggregate stockpile.
(2) Percentage passing each sieve size for the blended aggregate.
(3) Percentage of bitumen.
(4) Temperature of discharged asphalt mixture.
(5) Voids total mix percentage.

The target temperature of the asphalt mixture when it is discharged from the mixing plant is 125 ± 5 degrees C 257 ± 9 degrees F. Adjust the temperature depending on the ambient temperatures and the haul distance from the asphalt plant to the job site to meet the lay-down temperature.

2.7.2 Job Mix Formula for Slurry Grout

Provide the JMF for the slurry grout for approval by the Government. Develop the slurry grout JMF using the proportions given in Table IV.

TABLE IV
RESIN MODIFIED CEMENT SLURRY GROUT MIXTURE PROPORTIONS

Material	Percent by Weight
Silica Sand	16-20
Fly Ash	16-20
Water	22-26
Portland Cement	34-40
Cross Polymer Resin	2.5-3.5

Use approximately 12 to 15 kg 22 to 28 lbs of mixed slurry grout to fill in one square m square yd (25 mml inch thickness) of open graded bituminous mixture with 25 to 35 percent voids total mix.

2.7.2.1 Initial Laboratory Procedure

a. Minimum sample size is 23 kg 51 lbs for cement, sand, and fly ash; and it is 4 L 1 gal for resin additive.

b. Using the grout material proportions specified in Table V, develop a matrix of initial JMFs for laboratory viscosity testing. The goal of the grout mix design is to produce a material formulation, which results in a field Marsh Flow Cone viscosity of 8.0 to 10.0 seconds. Use the initial formulations so that a grout formulation can be produced with a Marsh viscosity no greater than the 10.0 seconds maximum. This is accomplished by testing grout formulations with relatively high water/cement (w/c) ratios and the maximum allowable amount of resin additive.

c. Use a w/c ratio between 0.65 to 0.75 for the grout, unless approved by the Contracting Officer. Higher w/c ratios are sometimes necessary to produce grout with Marsh Flow viscosity less than the 10.0-second maximum value. Therefore, the focus of the initial grout viscosity tests is to determine the minimum w/c ratio that produces a grout viscosity less than or equal to 10.0 seconds. The resin additive serves as a plasticizer which reduces grout viscosity while reducing the amount of water required.

d. The standard laboratory grout batch size is 4 to 5 kg 9 to 11 lbs. Calculate the material batch weights based on the desired proportions. Multiple grout viscosity tests are facilitated by first blending the dry ingredients (cement, sand, fly ash) for each test sample and then adding the appropriate amount of water and resin additive during the mixing process. Keep dry ingredient batches in air-tight containers to prevent loss of material or contamination before mixing. Replicate two samples per blend for grout viscosity testing.

2.7.2.2 Mixing

The equipment needed to effectively mix the resin grout includes a laboratory mixer equipped with a wire whip mixing attachment and approximately 10 L 2.5 gal capacity mixing bowl, a calibrated set of weight scales, and various small containers to weigh and transfer mix water and resin additive.

Place dry ingredients into mixing bowl and adjust the bowl height so that the wire whip is just off of or touching the bottom and the sides of the bowl. Begin mixing the dry ingredients at a slow speed and immediately add the appropriate amount of water. Once the water is added, speed up the mixer to a point where the grout is being thrown onto the sides of the mixing bowl. Mix the grout at this high speed for 5 minutes, then add the appropriate amount of resin additive. Mix the grout again at a high mixing speed for an additional 3 minutes before testing for Marsh Flow viscosity.

2.7.2.3 Viscosity Testing

a. The equipment needed to measure grout viscosity includes a Marsh Flow Cone, a 1 L 0.25 gal glass or clear plastic graduated cylinder beaker, a 1.5 L 0.38 gal (approximately) empty beaker or bucket, and a stopwatch.

b. Immediately after mixing the grout, transfer the grout from the mixing bowl to the empty beaker or bucket. Take note of lumps of material or excess sand in the bottom of the mixing bowl. Excess lumps indicate inadequate mixing and render the grout useless for viscosity testing. Immediately fill the Marsh Flow Cone with about 1.1 L 0.28 gal of grout. A consistent head of grout in the flow cone is achieved for viscosity tests by marking an 1.1 L 0.28 gal fill line inside the flow cone. Plug the flow cone outlet by simply placing one's finger over the outlet opening. Immediately after the flow cone is filled to the 1.1 L 0.28 gal fill line, position the cone over the 1 L 0.25 gal graduated beaker. Release the grout opening and start the stopwatch timer simultaneously. Measure the time of flow for 1 L 0.25 gal of grout from the flow cone to the nearest tenth of a second.

c. Record each test sample's viscosity, averaging the two replicates for each blend. Adjust the grout mix proportions as needed with the following considerations:

    (1) Grout viscosity between 8.0 and 10.0 seconds is acceptable. When field construction temperatures are expected to be high (greater than 32 degrees C 90 degrees F) or the open-graded asphalt concrete voids are expected to be low (less than 30 percent), lower viscosity grouts help to ensure grout application and full grout penetration. In most cases, these variables are unknown; therefore, it is prudent to select the grout formulation which has the lowest viscosity.

    (2) Select a grout JMF with water and resin additive contents below the maximum allowable limits to allow the Contracting Officer Representative to approve small additions of these ingredients in the field to meet viscosity requirements.

    (3) Select low w/c ratios, within the viscosity criteria, to produce grout with higher strengths; reduce the chances for drying shrinkage cracking; and produce grout that is more consistent and better able to keep the sand in suspension during mixing and placement.

    (4) When the sand is noted to settle out of solution during or immediately after mixing, adjust the JMF reducing the amount of sand and increasing the amount of fly ash (both within the specified tolerances).

(5) If the viscosity requirements cannot be met, change the source of materials. Typical problems to investigate include the following: grout sand that is too coarse, Portland cement that is highly reactive during the early stages of the hydration process, and fly ash with excess cementitious nature.

2.7.2.4 Job-Mix Formula Submittal

Provide the grout JMF consisting of the following information:

a. Percentage (by weight) of each mixture ingredient rounded to the nearest tenth of a percent.

b. Type and source of Portland cement.

c. Source of fly ash, silica sand, and resin additive.

d. Marsh Flow Cone viscosity of JMF grout.

PART 3 EXECUTION

3.1 PREPARATION OF OPEN GRADED MIXTURES

Regulate rates of feed of aggregates so that moisture content and temperature of aggregates are within tolerances specified. Convey aggregates and bitumen into the mixer in proportionate quantities required to meet the JMF. Require mixing time to obtain a uniform coating of the aggregate with the bituminous material. Do not allow the temperature of bitumen at time of mixing to exceed 135 degrees C 275 degrees F. Do not allow the temperature of aggregate in the mixer to exceed 150 degrees C 300 degrees F when bitumen is added. Reject overheated and carbonized mixtures or mixtures that foam.

3.2 WATER CONTENT OF AGGREGATES

Reduce the water content of mixture to less than 0.75 percent by drying operations. Determine water content in accordance with ASTM D2216; use weight of sample at least 500 g 17.6 oz. Report the water content as a percentage of the total mixture.

3.3 TRANSPORTATION OF MIXTURE

Accomplish transportation from the mixing plant to the job site by trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of mixture to truck bodies. Do not use diesel fuel as a releasing agent. Drain excessive release agent prior to loading. Cover each load with canvas or other approved material of ample size to protect mixture from the weather and to prevent loss of heat. Reject loads that have crusts of cold, unworkable material or have become wet. Do not permit hauling over freshly placed material.

3.4 TEST SECTION

Prior to full production, and in the presence of the Contracting Officer, prepare and place a quantity of open graded bituminous mixture and slurry grout according to the JMFs. Place the test section a minimum of 30 m 100 ft long and 6 m 20 ft wide placed in one section and of the same depth specified for the construction of the course that it represents. Use the same equipment in construction of the test section to be used on the remainder of the course represented by the test section. Check that the test section meets the requirements specified in paragraph ACCEPTABILITY OF WORK. If the test section fails to meet these requirements, make adjustments to the mix design, plant operation, and/or construction procedures. Construct additional test sections, as required, and evaluate them for conformance to the specifications at the Contractor's expense. Require a representative for the resin manufacturer to be on site during the test section construction and during the initial placement.

3.5 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to placing of open graded bituminous mixture, clean the underlying course of foreign or objectionable matter with power brooms and hand brooms.

3.6 TACK COATING

Immediately before placing open-graded asphalt mix, spray contact surfaces of previously constructed pavement with a coat of bituminous material as specified in Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

3.7 PLACING OPEN GRADED BITUMINOUS MIXTURE

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NOTE: The amount of rolling required to achieve the required voids total mix criteria is usually 1 to 3 passes of the 1.8 metric ton 2-ton tandem steel wheel roller in the static mode. The appropriate temperature of the freshly placed bituminous mixture required to prevent undue shoving and cutting from the roller is usually in the 50 to 70 degrees C 120 to 160 degrees F range. Determine the actual number of required passes and temperature range for rolling during construction and subsequent evaluation of the test section.

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Place the mix at a temperature of not less than 80 degrees C 175 degrees F. Upon arrival, spread the mixture to the full width (minimum 3 m 10 ft) by a bituminous paver. Strike off the mix in a uniform layer to a depth that, when the work is completed, produces the required thickness indicated. Regulate the speed of the paver to eliminate pulling and tearing of the bituminous mat. Unless otherwise directed, begin placement of the mixture along the center line of a crowned pavement or along the highest side of a sloped cross-section. Place the mixture in consecutive adjacent strips. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, allow the mixture to be spread, raked, and luted by hand tools. Offset the longitudinal joint in the RMP from the longitudinal joint in the underlying asphalt pavement by at least 300 mm 1 ft.

3.7.1 Rollers

Use small (1.8 metric ton 2-ton maximum) tandem steel wheel vibratory rollers to smooth over the surface of freshly placed open graded bituminous mixture. Turn off the vibratory unit during smoothing of the bituminous mixture. Keep rollers in good condition, capable of operating at slow speeds to avoid displacement of the bituminous mixture. Use the number, type, and weight of rollers sufficient to roll the mixture to the voids total mix requirement of 25 to 35 percent while it is still in a workable condition. Do not permit the use of equipment which causes excessive crushing of the aggregate.

3.7.2 Smoothing of Open Graded Bituminous Mixture

Smooth the open graded bituminous mixture with one to three passes of the prescribed roller without vibration. Check that the temperature of the freshly placed open graded bituminous mixture is low enough to prevent excessive shoving or cutting of the mat under the roller.

3.7.3 Protection of Ungrouted Pavement

Protect the ungrouted pavement and its appurtenances from traffic and against contamination from mud, dirt, wind blown debris, waterborne material, or other contamination which could enter the void spaces of the open graded bituminous mixture before grout application. Accomplish protection against contamination by keeping the construction site clean and free of such contaminants and by covering the ungrouted pavement with protective materials when directed by the Contracting Officer. Use protective materials consisting of rolled polyethylene sheeting as described in paragraph WEATHER LIMITATIONS. Allow the sheeting to be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the pavement surface.

3.8 PREPARATION OF SLURRY GROUT

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NOTE: Generally, add the cross polymer resin to the grout mixture at the batch plant if the haul distance is less than 20 minutes. If the haul distance is greater than 20 minutes, add the cross polymer resin to the grout mixture at the job site.

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Mix the slurry grout using a batch plant, portable mixer and/or ready-mix truck according to mix proportions stated in the approved JMF. Add the cross-polymer resin to the mixture after other ingredients have been mixed. When using ready-mix trucks for transporting slurry grout, mix the grout mixture at the job site immediately before application for a minimum of 10 minutes. Accomplish mixing by rotating the mixing drum at the maximum allowable revolutions per minute.

3.9 PLACING SLURRY GROUT

Check that the temperature of the bituminous mixture is less than 38 degrees C 100 degrees F before applying grout. Test each batch of slurry grout at the job site immediately before placement and used in the finished product only if it meets the requirements specified in paragraph ACCEPTABILITY OF WORK. Spread the slurry grout over the bituminous mixture using a spreader or squeegees. Apply the slurry grout to fill the internal voids of the open graded bituminous mixture. Begin the grouting operation at the lowest side of the sloped cross-section and proceed from the low side to the high side. The practical limit for the surface slope of an RMP section is 2 percent. Pavement slopes up to 5 percent can be constructed, but excess hand work and grout overruns are to be expected at slopes greater than 2 percent. Place the slurry grout in successive paving lanes with a maximum width of 6 m 20 ft. The use of strips of wood lumber or foamed rubber to separate each of the grouting lanes and the RMP from adjacent pavements is optional. Perform the grouting operation in the same direction as used to pave the open graded bituminous mixture. Use the small (1.8 metric ton 2 ton maximum) tandem steel wheel roller (vibratory mode) passing over the grout covered bituminous mixture to promote full penetration of the slurry grout into the void spaces.

3.10 JOINTS

3.10.1 Joints Between Successive Lanes of RMP

Make joints between successive lanes of RMP ensuring a continuous bond between the paving lanes. Ensure RMP joints have the same texture, density, and smoothness as other sections of the course.

3.10.2 Joints Between RMP and Adjacent Pavements

Saw cut the joints between the RMP and surrounding pavement surfaced with Portland cement concrete to the full thickness of the RMP layer and fill them with a joint sealant material approved by the Contracting Officer.

3.11 CURING

Apply the curing compound to the finished pavement surface, by means of a pressurized spraying machine, within 2 hours of the completed slurry grout application. Apply the curing compound uniformly in one or two coats with a total application rate of not more than 10 square m/L 400 square ft/gal.

3.12 PROTECTION OF GROUTED PAVEMENT

Protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents for a period of 21 days. Repair damage to the pavement occurring prior to final acceptance or replace the pavement at the Contractor's expense. In order to properly protect the pavement against the effects of rain before the pavement is sufficiently hardened have available materials for the protection of the edges and surfaces of the unhardened RMP. Use the protective materials and method of application as described in paragraph WEATHER LIMITATIONS. When rain appears imminent, stop paving operations, and cover the surface of the hardened RMP with protective covering.

3.13 CONTRACTOR QUALITY CONTROL

3.13.1 General Quality Control Requirements

Develop a QC Plan for approval. Do not produce hot-mix asphalt for payment until the QC Plan has been approved. Develop the plan addressing elements that affect the quality of the pavement including, but not limited to:

a. Mix Design

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management

e. Proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction

l. Surface Smoothness

3.13.2 Quality Control Testing

Perform QC tests, applicable to these specifications, as set forth in the QC Program. Include tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, slurry grout viscosity, grade and smoothness in the testing program. Develop a QC Testing Plan as part of the QC Program.

3.13.3 Asphalt Content

Perform a minimum of two tests to determine asphalt content per days production of open-graded asphalt mix, by one of the following methods: the extraction method in accordance with ASTM D2172/D2172M, Method A or B, the ignition method in accordance with the ASTM D6307, or the nuclear method in accordance with ASTM D4125/D4125M, provided the nuclear gauge is calibrated for the specific mix being used. For the extraction method, determine the weight of ash, as described in ASTM D2172/D2172M, as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. Use the last weight of ash value obtained in the calculation of the asphalt content for the mixture.

3.13.4 Gradation

Determine aggregate gradations a minimum of twice per day from mechanical analysis of recovered aggregate in accordance with ASTM D5444. When asphalt content is determined by the nuclear method, determine aggregate gradation from hot bin samples on batch plants, or from the cold feed on drum mix plants. For batch plants, test aggregates in accordance with ASTM C136/C136M using actual batch weights to determine the combined aggregate gradation of the mixture.

3.13.5 Temperatures

Check temperatures at least four times per day to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.13.6 Aggregate Moisture

Determine the moisture content of aggregate used for production a minimum of once per day in accordance with ASTM C566.

3.13.7 Moisture Content of Mixture

Determine the moisture content of the mixture at least once per lot in accordance with ASTM D1461 or an approved alternate procedure.

3.13.8 Air Voids

Determine voids total mix from random core samples taken from in-place open-graded asphalt mixture. Calculate sample voids as outlined in the JMF criteria. Check that voids are between 25 and 35 percent. Remove and replace material not meeting the void criteria at no additional cost to the Government.

3.13.9 Grade and Smoothness

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NOTE: Retain requirements for grade for projects having large paved areas where standing water or ponding of water may occur and projects with plan and profile details. Evaluate projects for the possibility of standing water before removing the grade requirements.

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Conduct the checks to ensure the grade and smoothness requirements are met in accordance with paragraph ACCEPTABILITY OF WORK.

3.13.9.1 Grade

Test the final wearing surface of the pavement for conformance with specified plan grade requirements, before grout is applied. Determine the grade by running lines of levels at intervals of 7 m 25 ft, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Within 5 working days, after the completion of a particular area, the Contracting Officer will inform the Contractor in writing, of the results of the grade-conformance tests.

3.13.9.2 Smoothness

Perform testing in the presence of the Contracting Officer. Notify the Contracting Officer [_____] days prior to testing to schedule testing availability. Keep detailed notes of the results of the testing and provide a copy to the Government immediately after each day's testing. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), finish the surface to meet the approval of the Contracting Officer. After the slurry grout has sufficiently cured, but not later than 48 hours after placement, test the surface of the pavement in such a manner as to reveal surface irregularities exceeding the 6 mm 1/4 in tolerances. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. Test transverse lines 8 m 25 ft or less apart. Test longitudinal lines at the centerline of each paving lane for lines less than 6 m 20 ft and at the third points for lanes 6 m 20 ft or greater. Also test other areas having obvious deviations. Test longitudinal lines continuously across joints. Hold the straightedge in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

3.13.10 Job-Mix-Formula

Perform routine testing for acceptability of work by a Corps of Engineers certified commercial laboratory and approved by the Contracting Officer. Perform additional tests required to determine acceptability of non-conforming material at the Contractor's expense. Use a Marsh Flow Cone for testing the viscosity of grout.

3.14 ACCEPTABILITY OF WORK

3.14.1 General

When a section of pavement fails to meet the specification requirements, remove and replace the section at the Contractor's expense. The Contracting Officer reserves the right to sample and test any area which appears to deviate from the specification requirements.

3.14.2 Field Sampling of RMP Materials

3.14.2.1 Open Graded Bituminous Mixture

Take samples of open graded bituminous mixture from loaded trucks for every 1000 square m square yds of pavement, but not less than two samples for each day of paving for determining asphalt content, aggregate gradation, and laboratory compacted voids total mix. Compact laboratory specimens of open graded bituminous material in 102 mm 4 in diameter molds to a 51 mm 2 in thickness using 25 blows on one side from a Marshall hand hammer. Compare test results from the sampled open graded bituminous mixture to the approved JMF for acceptance by the Contracting Officer. Apply the tolerances given in Table V for sieve analysis, bitumen content, and temperature to QC test results on the open graded bituminous mixture as discharged from the mixing plant.

TABLE V
JMF TOLERANCES

Material	Tolerance, Plus or Minus
Aggregate passing 4.75 mm No.4 or larger sieves	4 percent
Aggregate passing 2.36 and 0.60 mm Nos. 8 and 30 sieves	3 percent
Aggregate passing 0.075 mm No. 200 sieve	1 percent
Bitumen	0.20 percent
Temperature of discharge mix	10 degrees C 50 degrees F
Voids Total Mix	2 percent

3.14.2.2 Slurry Grout

Test each batch of slurry grout for viscosity at the jobsite after mixing and before application. Reject the batch of slurry grout failing to meet the specified viscosity and remove it from the jobsite. Reject slurry grout with visible amounts of sand settling out of suspension during application and remove from the jobsite.

3.14.2.3 Core Samples

Take random core samples from the in-place open graded bituminous mixture before and after application of the slurry grout. Take at least two field core samples before grout application and two after grout application for every 1000 square m square yds of finished RMP. Take half of the core samples taken after grout application from joints between successive grouting lanes. Extract field core samples 102 or 152 mm 4 or 6 in diameter and extend the full depth of the RMP surface layer. Test the ungrouted core samples for thickness. Visually inspect the grouted core samples for acceptable grout penetration. Check for acceptable grout penetration as through the full thickness of the RMP layer with a minimum of 90 percent of the visible void spaces filled with slurry grout. After testing, turn over cores to the Contracting Officer. Fill core holes in ungrouted RMP with hot open graded bituminous material and leveled to match the surrounding pavement surface. Fill core holes in grouted RMP within 24 hours from the time of coring with RMP material, low-shrinkage Portland cement concrete material, or other approved patching material.

3.14.3 Thickness, Grade and Surface-Smoothness Requirements

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NOTE: Increase the surface smoothness requirements specified below to 9 to 12 mm 3/8 to 1/2 in for tank trails and non-critical pavements.

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Check that the finished surface of RMP, when tested as specified below, conforms to the thickness and grade specified and to surface smoothness requirements of 6 mm 1/4 in in the longitudinal and transverse direction of testing. In areas where the thickness, grade or smoothness exceeds the tolerance, remove the surface lift to full depth; replace the lift with open graded bituminous mixture to meet specification requirements, at no additional cost to the Government. Allow use of diamond grinding, after grout has cured, to remove high spots to meet grade or smoothness requirements. Do not permit skin patching for correcting low areas or planing or milling for correcting high areas.

3.14.3.1 Thickness

Check that the thickness of the RMP meets the requirements shown on the contract drawings. Do not allow the measured thickness of the RMP to exceed the design thickness by more than 13 mm 1/2 in, or be deficient in thickness by more than 6 mm 1/4 in.

3.14.3.2 Surface Smoothness

Do not allow finished surfaces to deviate from testing edge of a 3.7 m 12 ft straightedge more than 6 mm 1/4 in in the longitudinal or transverse direction of testing.

3.14.3.3 Surface Texture

Check that the surface texture is uniform and free of excess cement grout.

Remove grout below the top of the open-graded asphalt concrete.

3.14.3.4 Grade

Check that the finished surface of pavement conform to the elevations and the cross sections shown on the plan and do not vary by more than 15 mm 0.6 in from the plan grade established and approved at site of work. Check that finished surfaces at juncture with other pavements coincide with finished surfaces of abutting pavements.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 12 36.13 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-32 12 36.13 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-32 12 36.13 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-32 12 36.13 (May 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 12 36.13

BITUMINOUS FOG SEAL

11/23

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NOTE: This guide specification covers the requirements for fog seals which are a light spray application of asphalt emulsion to the surface of a chip seal, an open-graded mix, or a weathered asphalt surface. Fog seals are applied to a freshly placed bituminous surface treatment in accordance with Section 32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL] (BST) after 1 to 6 days to improve aggregate retention.

Fog seals are classified as a Preventative Maintenance process when nonstructural cracking or raveling first begins. Fog seals of asphalt emulsion slow the oxidation process of asphalt pavements but skid resistance is lowered.

Fog seal application is restricted to parking lots, storage yards, and container handling facilities and other similar low-speed pavements due to loss of skid resistance. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative, and then only to paved shoulders and overruns.

Fog seals are not used to correct pavement grades, correct structural deficiencies, fill potholes, or fill ruts. Designer must first design appropriate repairs to existing pavements prior to application of fog seal. If existing pavement friction is low that fog seal will further reduce friction, Designer must conduct the grease smear test following Federal Aviation Administration AC 150/5320-12C 1997 "Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces", U.S. Department of Transportation. Fog seals must not be applied if surface friction is less than 0.8 millimeter 0.03 inch or if it is likely the fog seal application will lower friction below that value.

The Federal Aviation Administration has similar variants with or without coal tar emulsions and modifiers.

Alternative treatments to paved or unpaved surfaces are:

Section 32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL] (BST) - used on existing unpaved or paved surface. BSTs are low-cost maintenance methods that produce all-weather surfaces, renew weathered pavement, improve skid resistance, improve lane demarcation, and seal pavement surfaces including small cracks. BSTs are also known as Chip Seals.

Sand Seals are addressed in Section 32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL] and are spray-applied liquid asphalt covered with sand, used to restore uniform cover, restore weathered pavement, and reduce raveling. The treated surface is rolled with a pneumatic roller. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative. The Federal Aviation Administration has a similar product known as Seal Coat.

Slurry Seal - A mixture of crushed, well-graded aggregate (e.g., fine sand, mineral filler) and asphalt emulsion that is spread over the entire pavement surface with either a squeegee or spreader box attached to the back of a truck. There is no UFGS for slurry seal. Application is restricted to parking lots, storage yards, container handling facilities, and other similar low-speed pavements due to loss of skid resistance. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Micro-Surfacing - Applied in a process similar to slurry seals, micro-surfacing consists of a mixture of cationic quick set emulsified asphalt, mineral aggregate, mineral filler, water, and additives. Micro-surfacing provides a friction and rapid roadway surface correction. With a special mix design, it can fill ruts up to 19.5 mm 1.5 inches deep. Material is mixed in specialized, compartmentalized, self-powered trucks, and placed on the pavement using a screed box with auger. There is no UFGS for Micro-Surfacing. Application is restricted to parking lots, storage yards, container handling facilities, and other similar low-speed pavements due to loss of skid resistance. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Cape Seal - An application of micro-surfacing a few days after construction of a BST; used to cover the aggregates and improve aggregate bonding. There is no UFGS for Cape Seal. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Sandwich Seal - Process is to spread large aggregate, spray apply emulsion, then cover with smaller aggregate to lock in larger aggregate. Requires the use of very clean aggregate. Used to improve skid resistance and seal pavements. There is no UFGS for Sandwich Seal. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Rejuvenator, Spray-on - Rejuvenators are commercially available products (proprietary) designed to restore original properties to aged (oxidized) asphalt binders by restoring the original ratio of asphaltenes to maltenes. A rejuvenator will retard the loss of surface fines and reduce the formation of additional cracks. Rejuvenators will not fill or remove existing cracks unless cracking is very minor hairline cracking. Bituminous-based spray-on surface rejuvenators are covered in Section 32 01 13.64 REJUVENATION OF ASPHALT PAVEMENT SURFACES. There is no UFGS for bio-based rejuvenators.

Rejuvenator, Mix-in-Place - Designed to be used with advanced cold or hot in-place recycling of existing aged asphalt pavements which exhibit relatively high stiffness due to the aged binder. Proprietary chemical rejuvenators reduce the brittleness, but also affect the fatigue and thermal cracking properties of the recycled pavement. DoD provides a mix-in-place rejuvenator procedure in TM 5-822-10/AFM 88-6 Chapter 6. Section 32 01 16.70 COLD-MIX REUSED ASPHALT PAVING uses emulsion recycling agents and Section 32 01 16.74 IN PLACE HOT REUSED ASPHALT PAVING uses ASTM D4552 recycling agents. Substantial testing and engineering is required to specify the correct rejuvenator or emulsion resultant mixture properties. Do not apply over DoD airfield pavements without approval of the Pavements Discipline Working Group or their designated representative.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert**

appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 UNIT PRICES

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NOTE: Delete unit price paragraphs when lump sum bidding is used. Edit submittal requirements accordingly for waybills and quantities. Keep paragraph WAYBILLS AND DELIVERY TICKETS for lump sum projects, they are for Government use to validate payment.
****

1.1.1 Measurement

[1.1.1.1 Bituminous Material

The bituminous material paid for will be the measured quantities of bituminous material used in the accepted work as approved by the Contracting Officer, provided that the measured quantities are not 10 percent over the specified quantities. Any amount of bituminous material more than 10 percent over the specified quantity will be deducted from the measured quantities. Base bids on application of diluted emulsion at 0.63 liters per square meter 0.14 gallons per square yard. If the actual amount required is more or less than 0.63 liters per square meter 0.14 gallons per square yard, an adjustment in the Contract price will be made as provided by the Contract. Express measured quantities in[metric 2000 pound tons.][the number of liters gallons of material used in the accepted work, corrected to liters at 15.6 degrees C gallons at 60 degrees F in accordance with ASTM D1250, using a coefficient of expansion of 0.00045 per degree C 0.00025 per degree F for asphalt emulsion.] Dilution water added to emulsified asphalt will not be measured for payment.

]1.1.1.2 Treated Pavement

The quantity of pavement treated with fog seal to be paid for will be the number of square meters square yards completed and accepted as determined by the Contracting Officer. The number of square meters square yards of treated pavement will be determined by measuring the length and width of the specified work area. Measurements to determine the number of square meters square yards will be along the pavement surface.

1.1.1.3 Waybills and Delivery Tickets

Submit waybills and delivery tickets during progress of the work. Before the final statement is allowed, file with the Contracting Officer certified waybills and certified delivery tickets for all bituminous materials used in the construction of the pavement covered by the Contract. Do not remove bituminous material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

1.1.2 Payment

Accepted measured quantities of bituminous material and treated pavement will be paid for at respective unit prices. Payment will constitute full compensation for providing all materials, equipment, plant, test section, testing, and tools, and for all labor and other incidentals necessary to complete work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

When fog seal is being specified delete reference for aggregates.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D1250	(2019; E 2020) Standard Guide for Use of the Joint API and ASTM Adjunct for Temperature and Pressure Volume Correction

	Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils: API MPMS Chapter 11.1
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt
ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills and Delivery Tickets; G, [_____]

Residual Bituminous Material; G, [_____]

Residual Bituminous Material After Dilution; G, [_____]

Distributor; G, [_____]

Scales; G, [_____]

Mineral Aggregate; G, [_____]

Emulsified Asphalt for Fog Seal; G, [_____]

SD-04 Samples

Emulsified Asphalt Sample; G, [_____]

SD-06 Test Reports

Quality Control; G, [_____]

Surface Preparation; G, [_____]

Test Sections; G, [_____]

Inspection Reports; G, [_____]

1.4 QUALITY CONTROL

****

NOTE: For projects where fog seal is the primary definable feature of work, the testing laboratory can be the Contractor's laboratory, the emulsion manufacturer's laboratory, or an independent commercial laboratory. Frequently, the emulsion manufacturer is the most knowledgeable of emulsion/aggregate interactions in the local area. What is important is the laboratory is accredited as referenced. Select the appropriate quality control section for the project and include with Contract. If fog seal is a minor part of a project, and an independent commercial laboratory is already part of the Contract, may select that option for continuity, provided accredited in the appropriate tests.

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Sampling and testing is the responsibility of the Contractor. Perform sampling and testing using [a][an independent commercial] testing laboratory accredited in the required tests in accordance with Section

01 45 00 QUALITY CONTROL approved by the Contracting Officer. Sampling must be in accordance with ASTM D75/D75M for aggregates and ASTM D140/D140M for bituminous material. Contracting Officer may inspect testing facilities. Perform tests in the numbers, and at the location and times indicated, to ensure that the materials meet specified requirements. Submit copies of test results within 24 hours after completion of each test.

1.4.1 Preconstruction Sampling and Testing

Conduct preconstruction sampling and testing of bituminous material in accordance with ASTM D140/D140M. Repeat sampling and testing when there is a change in source or material. Submit copies of test results, within 24 hours after completion of each test.

1.4.2 Equipment Calibration

Furnish all equipment, materials, and labor necessary to calibrate equipment in accordance with paragraph EQUIPMENT, TOOLS, AND MACHINES. Perform all calibrations with the approved job materials and prior to applying the specified coatings to the prepared surface. Inspect all equipment prior to start of work and at regular intervals as needed during work.

1.4.3 Construction Quality Control Testing

Conduct sampling and testing in accordance with paragraph FIELD QUALITY CONTROL. Conduct measurement and testing each application day to ensure bituminous material application rates are satisfactory. Submit copies of test results within 24 hours after completion of each test.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver asphalt materials to the site in a homogenous and undamaged condition. Inspect the materials for contamination and damage. Bituminous materials, if stored on project site, must be stored in a manner recommended by the bituminous supplier and not exceed storage life or temperature ranges. Do not allow asphalt emulsions to freeze or boil. Replace defective or damaged materials.

1.5.1 Bituminous Delivery Tickets

For every distributor load of emulsified asphalt material brought to site, provide the following: manufacture date, lot number, storage tank number, total volume of diluted emulsified material on truck, weight of undiluted emulsified material, weight of dilution water added for emulsions. Include data for the type of material used: percent oil distillate by volume of emulsion (prior to dilution).

1.5.2 Aggregate Delivery Tickets

For every load of mineral aggregate brought to site provide the aggregate source, supplier's aggregate size designation, and the weight of aggregate on the truck.

1.5.3 Safety Precautions

Smoking or open flames (other than the heaters that are part of the equipment) are not permitted within 8 meters 25 feet of heating, distributing, or transferring operations of bituminous materials that are flammable.

1.6 PROJECT/SITE CONDITIONS

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NOTE: Retain correct temperatures depending on the type of coating used for the project.

****

1.6.1 Environmental Requirements

Apply the fog seal when the existing surface is dry, and when the weather is not foggy, rainy, or when the wind velocity will prevent the uniform application. Apply fog seal when [atmospheric temperature is above 10 degrees C 50 degrees F and rising] [or] [when pavement temperature is above 15.5 degrees C 60 degrees F and rising] [and] the temperature has not been below 2 degrees C 35 degrees F for the 12 hours prior to application unless otherwise directed. Do not apply if wind disperses fog seal application. Delay application if rain appears imminent within 8 hours following time of application.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide Fog Seal on existing prepared surface.

2.2 EQUIPMENT, TOOLS AND MACHINES

Provide equipment for the purpose intended and properly maintained in satisfactory and safe operating condition at all times. Discontinue the use of equipment which fails to safely produce satisfactory work and replace with satisfactory equipment.

2.2.1 Scales

****

NOTE: For CONUS, select NIST 44 CLASS III L. For OCONUS, select the local governing authority, note the tolerances are the same as the NIST 44 CLASS III L. For the scale divisions, 9 kg 20 lb is common for manufacturers; e.g. 20 X 2000=40,000 lb capacity for the lowest capacity Class III L scale.

****

Use standard truck scales of the beam type equipped with a weight-recording device. Use scales with sufficient size and capacity to accommodate the trucks used in hauling aggregates. Keep the necessary number of standard weights on hand, at all times, for testing the scales. Permanent or portable scales used for payment and application rates must be calibrated by a certified calibration agency before commencing work, following the method and calibration frequency [in accordance with NIST HB 44 Class III L][recognized by governing local authority in which the project is located with the scale division 2 kg 5 lb or greater and a minimum of 2000 divisions and a maximum of 10,000 divisions. Scale acceptance tolerance is 2 kg 5 lb for 2000 scale divisions, and increases 1 kg 2.5 lb for each 500 increase of scale divisions. Example: for 5000 scale divisions, tolerance is 2kg 5 lb + (6 x 1 kg 2.5 lb)= 8 kg 15 lb.] Conduct calibrations in presence of the Contracting Officer. Provide certified calibration documentation. Recalibrate at 6 months from date of last approved calibration for permanent scales, and weekly for portable scales, for the duration of the Contract. Recalibrate scales if previous recognized calibration is outdated. Recalibrate scales or equipment if directed by the Contracting Officer. Provide adequate protection for the indicating and recording devices of the scales.

2.2.2 Distributor

Provide self-propelled distributors with pneumatic tires of such size and number to prevent rutting, shoving, or otherwise damaging the surface being sprayed. Clean distributor trucks and lines of all materials before loading for project; open inspection hatches if requested by the Contracting Officer. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Provide a distributor that is approved by the Contracting Officer and:

a. Is capable of circulating and agitating the bituminous material during the heating process.

b. Is capable of spraying in a triple overlap. Equip the spray bar with the appropriate nozzle sizes to achieve a uniform bituminous application across the pavement at the specified rate and acceptable distributor speed. Adjust all nozzles to 30 degrees from the spray bar long axis, or to the same angle between 15 and 30 degrees only as recommended by the manufacturer and Contractor will demonstrate that the specified application rate is achieved. Only use the calibrated wrench provided by manufacturer to adjust nozzle angle.

c. Is designed and equipped to spray the bituminous material at variable widths at the specified temperature, at readily determined and controlled total liquid rates from 0.14 to 4.5 liters per square meter 0.03 to 1.0 gallons per square yard. Operate the distributor within a pressure range of 172.4 to 517.1 kPa 25 to 75 psi and with an allowable variation from the specified rate of not more than plus or minus 5 percent.

d. Each nozzle to be within 10 percent of the average flow rate for all the nozzles. Repair/replace out of tolerance nozzles.

e. Provide certification of distributor radar calibration for equipment with mounted radar which monitors travel speed and distance, used for the project. The date of calibration is to be no more than 6 months prior to project application.

2.2.2.1 Distributor Calibration

Verify the distributors application rate no more than 96 hours prior to the start of bituminous application following ASTM D2995calibration after 7 calendar days after start of project application. Submit bituminous material application rate and the residual asphalt application rate (for emulsified asphalts and cutbacks) results to Government. Provide the ASTM D2995 Method B calculations for transverse and longitudinal application rates.

2.2.3 Bituminous Storage Tanks

Provide bituminous storage tanks capable of heating the bituminous material under effective and positive control at all times to the required temperature. Accomplish heating by steam coils, hot oil, or electricity. Provide steam heaters consisting of steam coils and equipment for producing steam, so designed that the steam cannot come in contact with the bituminous material. Affix an armored thermometer to the tank with a range of 4.4 to 204.4 degrees C 40 to 400 degrees F so that the temperature of the bituminous material may be determined at all times. Clean tanks and pipelines of all materials before loading for project; open inspection hatches if requested by the Contracting Officer.

2.2.4 Power Brooms and Power Blowers

Provide power brooms and power blowers capable of cleaning surfaces to which the fog seal is to be applied.

2.2.5 Vacuum Sweepers

Provide self-propelled, vacuum pickup sweeper capable of removing loose sand, water, and debris from pavement surface.

2.3 MATERIALS

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NOTE: Designer is to research local practice and edit bracketed items appropriately.

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2.3.1 Emulsified Asphalt for Fog Seal

Use emulsified asphalt for Fog Seal conforming to ASTM D977, [SS-1] [SS-1h] [_____] for anionic and ASTM D2397/D2397M, [CSS-1] [CSS-1h] [_____] for cationic materials. For application, approved emulsified asphalt may be diluted at the emulsion plant at a maximum rate of 1 part approved emulsified asphalt to 1 part water. Provide residual bituminous material content of emulsion before dilution and residual bituminous material after dilution. Provide dilution rate and weight of dilution water for each distributor truck load on delivery ticket. Field dilution is not allowed.

2.3.1.1 Emulsified Asphalt Sample

****

NOTE: Include bracketed sentence if a sample is desired. For enduring facilities or applications with activity projected for 5 or more years, recommend always requesting sample.

****

For each undiluted emulsified asphalt used, provide manufacturer, manufacture date, lot number, and storage tank number. Include data for the type of bituminous material used: percent oil distillate by volume of emulsion.[From each source of supply, submit a 4.0 liter 1.0 gallon sample of bituminous material sampled at the project site for the Government to store for one year in case of latent issues.]

2.3.2 Mineral Aggregate

Sample mineral aggregate sand for blotting in accordance with ASTM D75/D75M. Provide gradation of mineral aggregate sand in accordance with ASTM C136/C136M and meet the following gradation requirements in Table I:

TABLE I: Mineral Aggregate Gradation

Sieve Designation (mm)	Percent by Weight Passing
1.18 No. 16	100
0.60 No. 30	40-75
0.30 No. 50	4-12
0.15 No. 100	0-5

2.3.3 Water

Provide fresh, clean, and potable water.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Site Protection

****

NOTE: Modify the bracketed sentence as appropriate for the project location. Public notices and signage 3 days prior is reasonable, unless local ordinance requires otherwise. Designer is to identify temporary parking for homes or business access that is interrupted by the work and curing. Delete paragraph if not needed.

****

[Provide public notices and post signage at least [3] [_____] days in advance of starting work. Plan detours as provided in the Contract prior to performing work at site.]During work, protect adjacent buildings, structures, vehicles, manhole covers, inlet grates, and trees to prevent splattering or marring. Protect manhole covers, inlet grates, electrical boxes, utility boxes, and other similar pavement penetrations with building paper cut to size to protect the entire casting size and opening. If the building paper becomes dislodged, replace with plywood, or other continuous board medium, cut to fit and of a thickness sufficient to remain in place during fog seal application. Open and remove debris from all covers, grates, and boxes after fog seal application.

3.1.2 Traffic Control

Provide warning signs and barricades for proper traffic control, in accordance with [MUTCD][local governing traffic control authority].

3.1.3 Surface Preparation

****

NOTE: If the surface to be treated requires repairs, the method of repairs and extent of work involved should be shown or described.

Fog Seals are not used to correct pavement grades, correct structural deficiencies, fill potholes, or fill ruts. Designer must first design appropriate repairs to existing pavements prior to application of fog seal. If existing pavement condition is marginal that fog seal application could lower friction, Designer must conduct the grease smear test following Federal Aviation Administration AC 150/5320-12C 1997 "Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces", U.S. Department of Transportation. Do not apply fog seals if the existing surface friction is less than 0.8 millimeter 0.03 inch or if it is likely the fog seal application will lower friction below that value. If no repairs are needed prior to applying fog seal, delete bracketed sentence addressing repairs.

Removal of paint and rubber deposits are generally accomplished by high pressure water blasting but care must be used to ensure that the water pressure does not significantly damage the asphalt pavement surface. Designer to consider use of Section 32 01 11.51 RUBBER AND PAINT REMOVAL FROM AIRFIELD PAVEMENTS for thermoplastic markings. Few approved chemicals are effective and sandblasting is not permitted by air pollution regulations at some locations. Mechanical abrasion generally causes damage to the pavement.

****

[[Complete repairs to existing pavement as specified in the Contract documents] [and] [or] [as shown on plans].][Thermoplastic pavement markings are to be removed prior to fog seal application following Section 32 01 11.51 RUBBER AND PAINT REMOVAL FROM AIRFIELD PAVEMENTS.]Immediately before applying the fog seal, remove loose material, dirt, clay, or other objectionable material from the surface to be treated. Flush the surface with water when necessary to remove dirt or debris not removed by sweeping or brooming; allow the surface to dry after flushing. Paint bonded to the surface may remain. After the cleaning operation and prior to application of the fog seal, the Contracting Officer is to inspect the area to be treated to determine suitability of the area to receive the fog seal.

3.2 TEST SECTIONS

****

NOTE: In some localities, an incompatibility may exist between the asphaltic emulsion and the water to be used for dilution due to their characteristics. Clear, potable water should be used, and if there is any doubt with the compatibility of the water and the asphalt emulsion, add the following to this paragraph: Prior to commencing work, combine 0.24 liter one half pint of

the proposed asphalt emulsion and 0.24 liter one half pint of the proposed water, agitate, and allow to sit for a period of 24 hours to test their compatibility. If they prove to be incompatible, provide an approved chemical treatment for all water used for dilution or a different and compatible source of water.

****

Determine the required application rates from test sections on the pavement to be treated.

3.2.1 Bituminous Distributor Temperature

Ensure bituminous material is at the recommended application temperature and has been thoroughly cycled through the distributor bar. Test the bituminous distributor under pressure by means of a test shot area (outside the project limits) to ensure there are no leaks or dripping from nozzles after shut-off.

3.2.2 Test Section Construction

Select an area of the prepared pavement that is to receive fog seal at least 90 m 300 feet long and as wide as the distributor spray bar. Dilute emulsified asphalt with an equal part of water or as agreed to by the Contracting Officer. Apply the water diluted asphalt emulsion in at least three test sections; each a minimum of 30 m 100 feet long. Make trial applications at residual rates ranging from 0.15 to 0.5 liters per square meter 0.03 to 0.11 gallons per square yard for tight surface (low absorbance) pavements. Make trial applications at residual rates ranging from 0.4 to 1.0 liters per square meter 0.09 to 0.22 gallons per square yard for loose surface (high absorbance) pavements. Always start at the lowest application rate and adjust upwards. Trial application rates may be modified as approved by the Contracting Officer. Additional trial applications may be required by the Contracting Officer to obtain desired coverage in paragraph Application Rate.

3.2.3 Application Rate

Use the minimum application rate from the test section, which has been satisfactorily applied without leaving an excess of asphalt residue on the surface. Submit for approval a report indicating approximate percent of coverage to target a minimum of 90 percent uniform coverage but less than 100 percent uniform coverage, for each application rate in the test section. A coverage of 100 percent or is an excess of asphalt residue, and may reduce friction. Summarize the report with the recommended application rate. Fog sealing production work may proceed after the Contracting Officer approves the application rate.

3.3 FOG SEAL APPLICATION

Apply the water-diluted emulsified asphalt at the rate to achieve the approved residual application rate from paragraph Application Rate. Maintain application temperature of emulsified asphalt between[24 and 71 degrees C 75 and 160 degrees F] [_____]. Apply emulsified asphalt using triple overlap in such a manner that uniform distribution is obtained over all surfaces treated. Reduce spray to double overlap if wind disperses triple overlap and only if double overlap applies the specified coverage, otherwise discontinue work until acceptable coverage is obtainable. For double overlap, adjust distributor operation and settings to achieve target application rate. To obtain uniform application of the fog seal on the surface treated at the junction of previous and subsequent applications, spread building paper on the surface at a sufficient distance from each end of each application so that application of the rejuvenator may be started and stopped on the paper. Remove the paper immediately after application. Properly treat areas missed by the distributor with the hand spray. For longitudinal joints, do not spray adjacent lane until the previous lane emulsion breaks and is tack free. Provide uniform application to the spray joint and minimize overlapping onto previously treated surfaces.

3.4 FIELD QUALITY CONTROL

Inspect application of fog seal for uniformity each day of application. During application, take one sample at the start and for each 400 square meters 500 square yards, or portion thereof of surface area to receive emulsified asphalt.

3.4.1 Blotting Excess Fog Seal

Apply mineral aggregate sand for blotting, in sufficient quantity, to treated areas where fog seal pools in low areas or from excess application rates before emulsion breaks. Apply blotter sand by hand or mechanical spreader. After asphalt emulsion is absorbed by blotter sand, sweep, remove, and dispose of blotter sand.

3.4.2 Insufficient Fog Seal Application

When the actual application rate of the residual bituminous material is more than 20 percent below the approved application rate, make subsequent applications of fog seal to bring the sum of the applied residual bituminous material application rate up to but not exceeding the approved rate within 24 hours after application. If the residual bituminous rate is exceeded, apply mineral aggregate blotter sand and roll with pneumatic tire roller before the fog seal application breaks. After asphalt emulsion is absorbed by blotter sand, sweep, remove, and dispose of blotter sand.

3.4.3 Inspection Reports

Furnish a written report each day of application citing temperature and humidity during application of fog seal, emulsion temperature during application, rate of emulsion application, dilution rate, residual bituminous material rate, truck speed in meters per minute feet per minute, RPM of truck, digital wet (shot) rate, spray bar height, and pump setting. Include any observations.

3.5 SURFACE PROTECTION

****

NOTE: Delete bracketed sentence if pavement markings are not in Contract.

****

Protect freshly placed coatings from damage by traffic. Provide sufficient warning signs and barricades to prevent traffic over freshly treated surfaces. Protect treated areas from traffic for at least 24 hours after final application of coatings, or for such time as necessary to prevent tracking.[Apply pavement markings as required in Contract after final brooming.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 12 36.26 (November 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-32 12 36.26 10 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 12 36.26

POLYMER CONCRETE MICRO-OVERLAY (PCMO) FOR FUEL AND ABRASION RESISTANT WEARING SURFACES

11/20

PART 3   EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 12 36.26 (November 2020)**

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****

SECTION 32 12 36.26

POLYMER CONCRETE MICRO-OVERLAY (PCMO) FOR FUEL AND ABRASION RESISTANT WEARING SURFACES

11/20

****
NOTE: This guide specification covers the requirements for Polymer Concrete Micro-Overlay (PCMO) for fuel and abrasion resistant wearing surfaces.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: PCMO can be used as an alternative to coal-tar seal coats placed over asphalt surfaces to provide fuel resistance. PCMO also has application as a seal coat over asphalt surfaces not requiring fuel resistance. PCMO can be applied to concrete surfaces to bridge cracks, repair spalled areas and provide increased friction characteristics while improving aesthetics. For airfields, PCMO may be used on taxiways and parking aprons, it is not recommended for runway use. If PCMO is applied to grooved surfaces, take care to restore the friction characteristics of the surface by patterning the

PCMO. Colored PCMO may be used for taxiway markings, stop bars and/or directional designations on both asphalt or concrete. PCMO may also be used on roads and parking lots for friction enhancement or for delineation of crosswalks, bus areas or pedestrian areas as well as a fuel and abrasion resistant wearing surface.

This guide specification only pertains to the polymer concrete micro-overlay aspects of the project and not to any surface preparation requirements. Surface preparation requirements should be covered by either including them in this guide specification or by adding pertinent sections to the project documents.

This specification utilizes a Quality Assurance and Quality Control (QA/QC) construction management philosophy. Quality Assurance refers to the actions performed by the Government to assure the final product meets the job requirements. Results of QA testing are the basis for pay. Quality Control refers to the actions of the Contractor to monitor the construction and production processes and to correct these processes when out of control. Results of QC testing are reported daily on the process control charts maintained by the Contractor. Quality Control is covered in paragraph CONTRACTOR QUALITY CONTROL.

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1.1 UNIT PRICES

****

NOTE: Delete this paragraph when lump sum payment is desired.

****

1.1.1 Measurement

Measure the quantity of PCMO, per square meter square yard placed and accepted, for the purposes of assessing payment.

1.1.2 Payment

****

NOTE: Delete this paragraph when lump sum payment is desired.

****

Quantities of PCMO mixture, determined as specified above will be paid for at respective contract unit prices. Payment will constitute full compensation for furnishing all materials, equipment, plant, surface preparation, and tools; and for all labor and other incidentals necessary to complete the required work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 201.1R	(2008) Guide for Conducting a Visual Inspection of Concrete in Service

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C67/C67M	(2024) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1583/C1583M	(2013) Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
ASTM D242/D242M	(2009; R 2014) Mineral Filler for

	Bituminous Paving Mixtures
ASTM D3699	(2019) Standard Specification for Kerosene
ASTM E274/E274M	(2015) Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire

1.3 SUBMITTALS

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SD-03 Product Data

    Safety Data Sheets (SDS)

    COA/QCC Documentation

SD-05 Design Data

Mix Design; G, [_____]

Service Record; G, [_____]

Quality Control Plan; G, [_____]

SD-06 Test Reports

Aggregate Test Results

SD-07 Certificates

Portland Cement

Testing Laboratory

SD-08 Manufacturer's Instructions

Manufacturer Representative Resume

SD-09 Manufacturer's Field Reports

QC Test Results

1.4 QUALITY CONTROL

1.4.1 Qualifications

Perform sampling and testing using an approved commercial testing laboratory or on-site facility that is accredited in accordance with ASTM C1077. Do not start work requiring testing until the facilities have been inspected and approved. The Government will inspect all laboratories requiring validation for equipment and test procedures prior to the start of any concreting operations for conformance to ASTM C1077. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. Maintain this certification for the duration of the project.

1.4.2 Quality Control Plan

Develop and submit a Quality Control Plan. Do not produce PCMO for payment until the quality control plan has been approved. Address all elements that affect the quality of the PCMO including, but not limited to:

a. Mix Design.
b. Aggregate Grading.
c. Quality of Materials.
d. Fuel Resistance Testing.
e. Preparation of Existing Pavement Surface

1.4.3 Manufacturer Representative

At the beginning of job site operations, provide an independent technical consultant with a minimum of 3 years experience in the use of PCMO and knowledge of the materials, procedures, and equipment described in this specification. The consultant will assist in the proper mixing of the component materials and application of the PCMO. Submit manufacturer representative resume documenting this experience prior to the start of operations.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

Do not apply PCMO when the surface is wet unless permitted by the manufacturer or when the humidity or impending weather conditions will not allow proper curing. Apply PCMO only when the atmospheric or pavement temperature is 7.5 degrees C 45 degrees F and rising and is expected to remain above 7.5 degrees C 45 degrees F for 24 hours, unless otherwise directed. Pavement temperatures exceeding 50 degrees C 130 degrees F are not recommended for PCMO application. Ideal conditions for placement are air temperatures between 15 and 32 degrees C 60 and 90 degrees F and humidity levels between 50 and 60 percent.

1.6 ACCEPTANCE

1.6.1 Tolerances

Acceptance of PCMO mixture is based on compliance with the tolerances presented in Table 1. Remove and replace PCMO represented by the failing tests or submit repair plan for approval.

TABLE 1

Attribute	Tolerance
Color	Uniform throughout
Appearance	Free of excessive pinholes, air bubbles, lumps, or other visible
Thickness	No lumps or thin spots
Fuel Resistance	Passes
Skid Resistance	SN(65)RSN40R greater than 35
Bond to Substrate	Failure in substrate

1.6.2 Test Section

****

NOTE: The test section is used to determine the exact application rate, quality of the mixture in place, and the performance of the equipment.

The application rate depends on the pavement surface texture, desired PCMO thickness, PCMO aggregate size, and equipment used during PCMO placement. If operational conditions preclude placement of a test section on the pavement to be seal coated, apply on a pavement with similar surface texture.

****

Prior to full production, prepare a quantity of mixture in the proportions shown in the approved mix design and in sufficient amount to place a test section a minimum of 37 square m 400 square feet at the rate specified in the job mix formula. Locate the proposed test section on a representative section of the pavement. The test application rate depends on the condition of the pavement surface. Use the test section to verify the adequacy of the mix design and to determine the actual application rate for the project. Use the same equipment and method of operations on the test section as will be used on the remainder of the work. Acceptance of the test section is based on compliance with the Tolerances listed in Table 1. If the test section should prove to be unsatisfactory, make the necessary adjustments to the mix composition, application rate, placement operations, and equipment. Place additional test sections and evaluate. Do not begin full production without approval. Schedule a minimum of 1 day following the placement of the test section prior to job mix approval to allow for proper curing, and an overall assessment of the PCMO test section.

1.6.2.1 Fuel Resistance

****

NOTE: Select first bracketed option for laboratory fuel resistance testing (Appendix A) and coordinate with paragraph: MIX DESIGN. Select second bracketed option for test section fuel resistance testing (Appendix B).

****

[Submit test results, performed in accordance with the test method given in Appendix A, showing that the PCMO mixture meets the tolerances of Table 1.] [Conduct fuel resistance testing on the test section in accordance with Appendix B. If the fuel resistance test results meet the tolerances of Table 1, the test section may remain as part of the project pavement. If the test section fails the tolerances, remove the test section, construct another test section, and retest.]

1.6.2.2 Skid Resistance

Evaluate the skid resistance of the test section using a ribbed tire (R), traveling at 65 kilometers per hour 40 miles per hour over a wetted PCMO in accordance with ASTM E274/E274M. Report the result as SN(65)R SN40R and meet the tolerances of Table 1.

1.6.2.3 Bond To Substrate

Evaluate the bond strength of the PCMO to the prepared pavement substrate in accordance with ASTM C1583/C1583M. Report the failure mode and meet the tolerances of Table 1.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The work consists of placing one or more applications of a polymer concrete micro overlay, with mineral or synthetic aggregate, applied on an existing, previously prepared bituminous or concrete surface. Requirements for the mixing and placement equipment are specific to the manufacturer's product and are not specified herein.

2.2 CEMENT

Provide cement for PCMO conforming to ASTM C150/C150M for Type I, II, I/II or III Portland Cement. Submit copies of certified test data.

2.3 WATER

Provide potable water free from harmful soluble salts. Control the temperature of the water added during mixing to a minimum of 10 degrees C 50 degrees F and not above 32 degrees C 90 degrees F. Control the pH of the water added during mixing to the requirements of the manufacturer.

2.4 AGGREGATES

Provide aggregate which is either a natural or manufactured aggregate composed of clean, hard, durable, uncoated particles, free from lumps of clay and all organic matter, meeting the quality requirements of ASTM C33/C33M or ASTM D242/D242M. Submit all aggregate test results and samples at least 14 days prior to start of construction.

2.5 MIX DESIGN

****

NOTE: For laboratory fuel resistance testing, include the bracketed item specifying Appendix A.

****

Submit proposed JMF [including fuel resistance test results in accordance with Appendix A]. Develop the mix design and submit the recommended formulation of water, polymer, and cement/aggregate blend and estimated application rate proposed for use at least 14 days prior to the start of operations. Submit a service record of five years successful performance for a similar JMF on comparable substrate equal to or exceeding the proposed exposure and traffic conditions for the related use. Include photographs and written report addressing pinholes, air bubbles, lumps or other visible defects in accordance with ACI 201.1R. Submit service record performed by a third party engineer, petrographer, or concrete materials engineer. Exact application rates cannot be determined until the test section is placed due to the variability in surface textures of asphalt pavement. The specific JMF selected will be submitted in writing and approved prior to the start of the project.

2.5.1 Composition

Provide PCMO consisting of a polymer, water, cement, additives, and aggregate [and/or fibers] in the specified proportions and according to the specific manufacturer's requirements. Develop a job mix formula (JMF) suitable to the range of different PCMO products available, the local climatic zone, local temperature during application, and pavement surface conditions.

2.5.2 Mix Design Report

Perform trial design batches, mixture proportioning studies, testing, and submit test results demonstrating that the proposed mixture proportions produce PCMO of the qualities indicated. Submit test results in a mix design report to include:

a. Coarse and fine aggregate gradations and plots.

b. Coarse aggregate quality test results, include deleterious materials.
c. Fine aggregate quality test results.
d. Mill certificates for cement.
e. Recommended proportions and volumes for proposed mixture.
f. Narrative discussing methodology on how the mix design was developed.

2.5.3 Adjustments to JMF

Maintain the JMF in effect until a new formula is approved in writing. Should a change in sources of any materials be made, do not use new material until a new mix design has been performed and approved.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

2.6.1 Certifications

Submit Safety Data Sheets (SDS) and certificate of analyses (COA) or quality control certificates (QCC) verifying the composition of each separate material employed in the PCMO without revealing proprietary information. Submit COA/QCC documentation traceable to the batch/lot of materials received from the supplier of each proposed component of the PCMO. Clearly mark batch/lot identification on all packaging to be traceable to a specific COA/QCC for that particular batch.

PART 3 EXECUTION

3.1 PREPARATION OF THE UNDERLYING SURFACE

****

NOTE: In order to ensure adequate adhesion and minimize cracking and curling, allow the pavement surface to cure prior to application of the seal coat. Experience has shown that a minimum of 30 days and an average of approximately 90 days of hot weather (daytime temperatures of 21 degrees C 70 degrees F) are needed for adequate curing of a HMA surface prior to application of a PCMO.

This guide specification only pertains to the polymer concrete micro-overlay aspects of the project and not to any surface preparation requirements. Address surface preparation requirements by either including them in this guide specification or by adding pertinent sections to the project documents..

****

Prior to placing PCMO, clean the surface of the pavement to remove dust, dirt, other loose foreign matter, grease, oil, any type of objectionable surface film, or thermoplastic or painted pavement markings, using a vacuum sweeper or a combination of wire brushes and a power blower. Where vegetation exists in cracks, remove the vegetation and clean the cracks to a depth of 50 mm 2 inches where practical. Treat those cracks with a concentrated solution of an approved herbicide. [Clean, rout, and repair cracks in accordance with Section 32 01 17.61 SEALING OF CRACKS IN ASPHALT PAVING.] Remove bituminous pavement surfaces softened by petroleum derivatives, or that have failed due to any other cause, to the full depth of the damage and replace with new bituminous concrete similar to that of the existing pavement. Maintain areas of the pavement surface to be sealed with PCMO in a firm consolidated condition, and sufficiently cured so that there is no concentration of oils on the surface. Allow a period of a minimum of 30 days to elapse between the placement of a bituminous surface course and the application of the seal coat unless detergent washing is chosen as an alternative to the time requirement. After the 30 day curing period or detergent washing, verify the surface is suitable by pouring a cup of water on the pavement surface (on a warm day) and observing if any oils appear in the standing water. If oils appear, the surface is not sufficiently cured to accept a seal coat.

3.2 APPLICATION

Continuously agitate the mixture from the initial mixing until its application on the pavement surface. Maintain the distributor or applicator, pumps, and all tools in a satisfactory working condition. Apply a primer prior to placement of PCMO, if recommended by the manufacturer. Apply the PCMO seal coat at the application rate determined from the test section. When an area will be subjected to significant fuel spillage, place a double coat of PCMO in the appropriate area at an approved application rate. The application rate for the second coat of PCMO can vary significantly from the underlying PCMO coat due to changes in the surface texture of the surface after PCMO application.

3.2.1 Calibration

Furnish all equipment, materials, and labor necessary to calibrate the equipment so that it will produce and apply a mix that conforms to the job mix design. Make all calibrations with the approved job materials prior to applying the PCMO to the pavement as part of the test section. Submit a copy of the calibration test results.

3.2.2 Curing

Permit the mixture to cure for a minimum of 24 hours, after the final application, before opening to traffic. Repair any damage to the uncured mixture due to early traffic.

3.3 JOINTS

Overlap all joints with the adjacent PCMO section and maintain a similar texture as other sections of the PCMO.

3.4 FIELD QUALITY CONTROL

3.4.1 QC Monitoring

Document each batch of material prepared for placement, and keep written records of the weights of cement, aggregate, polymer emulsion, and water used for each batch. In addition, keep records of air temperature, pavement temperature), wind velocity (speed and direction), and humidity. Submit all QC test results on a daily basis, as the tests are performed.

3.4.2 Sampling

Perform sieve analyses on aggregates a minimum of once for each half-days's production. Conduct tests in accordance with ASTM C117 and ASTM C136/C136M.

3.5 APPENDICES

APPENDIX A

LABORATORY FUEL RESISTANCE TEST

1. Scope. This method determines the resistance of the PCMO to kerosene.

2. Apparatus.

a. Two 150 X 150 mm 6 X 6 inch square 16 gauge sheet metal masks with a 100 by 100 mm 4 by 4 inch square center removed.

b. One 150 X 150 mm 6 X 6 inch unglazed white ceramic tile with an absorption rate of 10-18 percent (according to ASTM C67/C67M).

c. Brass ring, 50 mm 2 inch diameter and 50 mm 2 inch high.

d. Kerosene meeting requirements of ASTM D3699.

e. Silicone rubber sealant or fast-setting epoxy.

3. Procedure

a. Immerse the ceramic tile in distilled water for a minimum of ten minutes.

b. Remove excess water from the tile to produce a damp surface before applying the seal coat.

c. Using the mask described in 2.a apply one layer of the PCMO blend (mixed as specified). Spread even with the top of the mask using a spatula or other straight edge.

d. Allow the sample to cure for 24 hours at 24 degrees C + 1 77 + 2 degrees and 50 + 10 percent relative humidity.

e. If a two-layer application is specified, position a second mask on top of the first mask. Apply a second coat of PCMO emulsion mixture. Spread even with the top of the second mask.

f. Cure as in step 3.d.

g. After curing, affix the brass ring to the seal coat on the tile with silicone rubber or epoxy. Epoxy often adheres better to the PCMO than silicone.

h. Fill the brass ring with kerosene. Add a small amount of coloring to the kerosene, asphalt works well for this. The coloring may be necessary to determine if the kerosene breached the PCMO surface.

i. After 24 hours, remove the kerosene from the brass ring, blot dry and immediately examine the film for softness and loss of adhesion. Immediately after the film is examined, break the tile in half, exposing that part of the tile whose film was subjected to the kerosene.

j. Evaluate for penetration of kerosene through the sealer and loss of adhesion.

4. Report. Report the results as pass or fail. Visible evidence of leakage through or discoloration in the tile constitutes failure of the test.

APPENDIX A

LABORATORY FUEL RESISTANCE TEST

5. Criterion. A "pass" rating in the fuel resistance test is required.

APPENDIX B

FIELD FUEL RESISTANCE TEST

1. Scope. This field method is recommended to verify the resistance of the PCMO to aviation fuel. This procedure is adapted from a field test proposed for use with coal-tar materials. Some slight modifications to the method have been made to accommodate PCMO. This test is best conducted in conditions of little wind and moderate temperatures (around 21-24 degrees C 70-75 degrees F).

2. Apparatus

a. A 150 mm 6-inch diameter metal, glass, or PVC pipe at least 76 mm 3 inches long.

b. A lid for the pipe.

c. RTV silicone rubber sealant or fast-setting epoxy for affixing the pipe to the pavement surface.

e. A ruler.

3. Procedure

a. Locate a clean, flat surface on the pavement to be tested.

b. Place the pipe on the pavement surface and seal the edge with silicone or epoxy. Firmly mold the adhesive between the pipe and the surface of the pavement to prevent leakage.

c. Allow the sealant/adhesive to cure for 24 hours.

d. Pour approximately one inch of aviation fuel or kerosene inside the pipe. Determine baseline of fluid by placing the ruler inside the pipe and measuring the distance from the surface of the fluid to the top of the pipe. Record this distance. Place the lid on the top of the pipe.

e. After 30 minutes remove the lid and measure the distance from the top of the fluid to the top of the pipe. Record this distance. Any discoloration of the fuel or softening of the PCMO surface should be recorded.

f. If seepage occurs between the bottom of the pipe and the pavement surface through the adhesive, the test is invalid. Retest in a different location.

4. Report. Report the distance from the surface of the fluid to the top of the pipe immediately after placing the fluid and after 30 minutes. Determine the difference between the two readings. If less than 5 mm 0.2 inches of fluid has penetrated the surface, a 'Pass' rating is given. If more than 5 mm 0.2 inches of fluid penetrates the surface, the pavement surface is deemed 'Failed' and may be unacceptable for fuel resistance. If any discoloration of the fuel or softening of the PCMO surface is evident, the PCMO surface is deemed 'Failed' and may be unacceptable for fuel resistance.

5. Criterion: A "pass" rating in the fuel resistance test.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 13 13.06 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-32 13 13.06 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES

05/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 13 13.06 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
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References are in agreement with UMRL dated January 2025

****

SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES
05/20

****

NOTE: This guide specification covers the requirements for Portland cement concrete paving jobs such as roads, streets, sidewalks, and parking lots.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings, or included in the project specifications.

Portland cement pavements for airfields and special military vehicles, identified in UFC 3-201-01 (2018), paragraph 4-1, Surface and Unsurfaced Road And Site Pavement, are not included in this specification. Specify airfield and special military vehicle Portland cement concrete paving using Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS. Consult agency Subject Matter Expert (SME) for appropriate use of this guide specification.

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: If lump sum payment is used, delete the following paragraphs on Measurement and Payment.

****

1.1.1 Measurement

The quantity of concrete to be paid for will be the volume of concrete in cubic meters yards including monolithic curb, where required, placed in the completed and accepted pavement. Concrete will be measured in place in the completed and accepted pavement only within the neat line dimensions shown in the plan and cross section. No deductions will be made for rounded edges or the space occupied by embedded items or voids.

1.1.2 Payment

Payment will be made at the contract price per cubic meter yard for the scheduled item. Payment will constitute full compensation for furnishing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete

ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2024) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A966/A966M	(2024) Standard Practice for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for

	Air-Entraining Admixtures for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1542/C1542M	(2019) Standard Test Method for Measuring Length of Concrete Cores
ASTM C1549	(2016; R 2022) Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural

	Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors
ASTM D6155	(2019) Nontraditional Coarse Aggregate for Bituminous Paving Mixtures
ASTM E1274	(2018); R 2024 Standard Test Method for Measuring Pavement Roughness Using a Profilograph

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(2015) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing Materials

Reinforcement

Epoxy Resin

Cementitious Materials; G, [_____]

[Albedo

] Dowel Bars

Expansion Joint Filler

SD-04 Samples

Test Section; G, [_____]

SD-05 Design Data

Mix Design Report; G, [_____]

SD-06 Test Reports

Concrete Slump Tests

Concrete Uniformity

Flexural Strength

Air Content

SD-07 Certificates

Batch Tickets

NRMCA Certificate Of Conformance

SD-08 Manufacturer's Instructions

Diamond Grinding Plan

1.4 QUALITY CONTROL

1.4.1 NRMCA Certificate of Conformance

Provide a batching and mixing plant consisting of a stationary-type central mix plant, including permanent installations and portable or relocatable plants installed on stable foundations. Provide a plant designed and operated to produce concrete within the specified tolerances, with a minimum capacity of 200 cubic meters 250 cubic yards [_____] per hour. Submit NRMCA Certificate of Conformance that conforms to the requirements of NRMCA QC 3 including provisions addressing:

1. Material Storage and Handling

2. Batching Equipment

3. Central Mixer

4. Ticketing System

5. Delivery System

1.4.2 Qualifications

1.4.2.1 Laboratory Accreditation

Perform sampling and testing using an approved commercial testing laboratory or on-site facilities that are accredited in accordance with ASTM C1077. Do not start work requiring testing until the facilities have been inspected and approved. The Government will inspect all laboratories requiring validation for equipment and test procedures prior to the start of any concreting operations for conformance to ASTM C1077. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. Maintain this certification for the duration of the project.

1.4.2.2 Field Technicians

Provide field technicians meeting one of the following criteria:

a. Have at least one National Ready Mixed Concrete Association (NRMCA) certified concrete craftsman and at least one American Concrete Institute (ACI) Flatwork Finisher Certified craftsman on site, overseeing each placement crew during all concrete placement.

b. Have no less than three NRMCA certified concrete installers and at least two American Concrete Institute (ACI) Flatwork Finisher Certified installers on site working as members of each placement crew during all concrete placement.

1.4.3 Batch Tickets

Submit batch tickets for each load of ready-mixed concrete in accordance with ASTM C94/C94M.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver concrete paving in accordance with ASTM C94/C94M.

1.6 ACCEPTANCE

1.6.1 Tolerances

Acceptance of Portland cement concrete pavement is based on compliance with the tolerances presented in Table 1. Remove and replace concrete pavement represented by the failing tests or submit repair plan for approval.

Table 1	
Measurement	Tolerance
PLASTIC CONCRETE	
Slump	plus 0, minus 37.5 mm 1.5 inches
Air Content	plus/minus 1.5 percent
Flexural Strength	No individual specimen less than 0.69 MPa 100 psi below specified strength.
HARDENED CONCRETE	
Grade	plus/minus 15 mm 0.05 feet from plan
Smoothness	No abrupt change exceeding 3 mm 1/8 inch
Straightedge	Not more than 3 mm 1/8 in for roads. Not more than 6 mm 1/4 in for open storage areas.
Profilograph	Not more than 140 mm/km 9 inches/mile
Thickness	[minus 19 mm 3/4 inch for pavement equal to/greater than 200 mm 8 inches thick] [minus 12.5 mm 1/2 inch for
Edge Slump	85 percent less than 6 mm 1/4 inch and 100 percent less than 9 mm 3/8 inch.

1.6.2 Test Section

Construct a minimum [_____] 37 square meters 400 square feet test section to demonstrate typical joints, surface finish, texture, color, thickness, and standard of workmanship using the mixture proportions, materials, and equipment as proposed for the project. Test in accordance with requirements in FIELD QUALITY CONTROL.

When a test section does not meet one or more of the tolerances in Table 1, remove and reconstruct the test section. If the test section is acceptable, it may be incorporated into the project.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

****

NOTE: Coal fly ash, slag, and silica fumes are EPA designated recovered products to be ingredients in concrete and cement. Use materials with recycled content where appropriate for use. The following section allows a percentage range of supplementary cementitious materials(SCM). Consult agency SME for

guidance on choice.

Select sentence in brackets to specify SCM content.
****

[Provide cementitious materials in concrete mix with 20 to 50 percent non-portland cement pozzolanic materials [or slag]by weight.

]2.1.1.1 Portland Cement

Conforming to ASTM C150/C150M, Type I or II [III, for high early concrete] [or V] [low alkali].

2.1.1.2 Blended Cement

Provide blended cement conforming to ASTM C595/C595M, Type IP or IS, including the optional requirement for mortar expansion [and sulfate soundness]. Provide pozzolan added to the Type IP blend consisting of ASTM C618 Class F or Class N and that is interground with the cement clinker. Include in written statement from the manufacturer that the amount of pozzolan in the finished cement does not vary more than plus or minus 5 mass percent of the finished cement from lot to lot or within a lot. The percentage and type of mineral admixture used in the blend are not allowed to change from that submitted for the aggregate evaluation and mixture proportioning. The requirements of paragraph Supplementary Cementitious Materials (SCM) Content do not apply to the SCM content of blended cement.

2.1.1.3 Fly Ash and Pozzolan

****
NOTE: Use loss on ignition not exceeding 3 percent for frost areas to reduce carbon interference with air entraining admixture.
****

Conforming to ASTM C618, Type F, or N, with a loss on ignition not exceeding [3] [6] percent. Include test results in accordance with ASTM C618.

2.1.1.4 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) conforming to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age at least 95 percent of the control specimens.

b. The average particle size not exceeding 6 microns.

c. Loss on ignition not exceeding [3] [6] percent.

2.1.1.5 Silica Fume

****
NOTE: Silica Fume is only used for OCONUS projects where Class F fly ash and slag cement are not available, and when approved by the TSMCX, AFCEC pavement SME, or NAVFAC. Delete this paragraph here

and where encountered throughout the remainder of this section.

****

Provide silica fume that conforms to ASTM C1240, including the optional limits on reactivity with cement alkalis. Provide silica fume as a dry, densified material or as a slurry. Provide the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume, at no expense to the Government. This representative is required to be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume.

2.1.1.6 Slag

Conforming to ASTM C989/C989M, Slag Cement (formerly Ground Granulated Blast Furnace Slag) Grade 100 or 120. Include test results in accordance with ASTM C989/C989M.

2.1.1.7 Supplementary Cementitious Materials (SCM) Content

****

NOTE: Select first sentence in brackets for mandatory use of SCMs. Select second sentence in brackets for optional use of SCMs. Consult agency SME for guidance on choice.

****

[Include one of the SCMs listed in Table 2 within the range specified therein, whether or not the aggregates are found to be reactive in accordance with the paragraph Alkali Reactivity Test.] [Use of one of the SCMs listed below is optional, unless the SCM is required to mitigate ASR. The use of SCMs is encouraged in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.]

TABLE 2
SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum Content (percent)	Maximum Content (percent)
Class N Pozzolan and Class F Fly Ash		
SiO2 + Al2O3 + Fe2O3 greater than 70 percent	25	35
SiO2 + A12O3 + Fe2O3 greater than 80 percent	20	35
SiO2 + A12O3 + Fe2O3 greater than 90 percent	15	35
UFFA and UFP	7	16
GGBF Slag	40	50
[Silica Fume]	[7]	[10]

2.1.2 Water

Water conforming to ASTM C1602/C1602M.

2.1.3 Aggregate

2.1.3.1 Durability

Evaluate and test all fine and coarse aggregates to be used in all concrete for durability in accordance with ASTM C88. Provide fine and coarse aggregates with a maximum of 18 percent loss when subjected to 5 cycles using Magnesium Sulfate or a maximum of 12 percent loss when subjected to 5 cycles of Sodium Sulfate.

2.1.3.2 Alkali Reactivity Test

****

NOTE: Documentation of alkali reactivity testing is required for all aggregate sources.

****

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate reactivity. Test all size groups and sources proposed for use.

a. Evaluate the fine and coarse aggregates separately, using ASTM C1260. Reject individual aggregates with test results that indicate an expansion of greater than 0.08 percent after 28 days of immersion in 1N NaOH solution, or perform additional testing as follows: utilize the proposed low alkali portland cement, blended cement, or SCM in combination with each individual aggregate. Test in accordance with ASTM C1567. Determine the quantity that meets all the requirements of these specifications and that lowers the expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Base the mixture proportioning on the highest percentage of SCM required to mitigate ASR-reactivity.

b. If any of the above options does not lower the expansion to less than 0.08 percent after 28 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing for evaluation and acceptance.

2.1.3.3 Fine Aggregates

Conforming to the quality and gradation of ASTM C33/C33M.

2.1.3.4 Coarse Aggregates

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Select sentence in brackets for mandatory use of recycled materials. Consult agency SME for guidance.

****

Coarse aggregate consisting of crushed or uncrushed gravel, crushed stone, or a combination thereof.[Provide coarse aggregate with a minimum of [25][_____] percent recycled porcelain, concrete, stone, or other recycled material complying with ASTM D6155.] Provide aggregates, as delivered to the mixers, consisting of clean, hard, uncoated particles. Wash coarse aggregate sufficient to remove dust and other coatings. Provide fine aggregate consisting of natural sand, manufactured sand, or a combination of the two, and composed of clean, hard, durable particles. Provide both coarse and fine aggregates meeting the requirements of ASTM C33/C33M.

****

NOTE: Fill in the blank according to the size aggregate available in the project area, and the type of paving. Use nominal maximum aggregate size of 37.5 mm 1-1/2 inch. Subject to approval of the agency pavement SME, a 25 mm 1-inch nominal maximum aggregate size may be used to avoid durability problems associated with some larger size aggregate.

Select class 4M for exterior concrete exposed to frequent wetting in moderate weathering regions. Select class 4S for exterior concrete exposed to frequent wetting in severe weathering regions.

****

a. Gradation: Provide coarse aggregate with a nominal maximum size of [37.5] [_____] mm [1.5] [_____] inches. Grade and provide the individual aggregates in two or more size groups meeting the individual grading requirements of ASTM C33/C33M, Size No. 4 (37 mm to 19 mm1.5 to 0.75 inch) and Size No. 67 (19 mm to No. 40.75 inch to No. 4).

b. Quality: Conforming to ASTM C33/C33M, Class [4M] [4S].

2.1.4 Chemical Admixtures

2.1.4.1 Water Reducing Admixtures

Provide admixture conforming to ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures. ASTM C494/C494M Type S specific performance admixtures and ASTM C1017/C1017M flowable admixtures are not allowed.

2.1.4.2 Air Entraining Admixture

Conforming to ASTM C260/C260M: Air-entraining.

2.1.4.3 High Range Water Reducing Admixture

****

NOTE: High Range Water Reducing Admixtures are permitted only for OCONUS projects when using Silica Fume. Retain first bracketed sentence for CONUS projects. Retain the second paragraph for OCONUS projects.

****

[ASTM C494/C494M Type F and G high range water reducing admixtures are not allowed.] [Provide a high-range water-reducing admixture that meets the requirements of ASTM C494/C494M, Type F or G, that is free from chlorides, alkalis, and is of the synthesized, sulfonated complex polymer type. Add the HRWRA to the concrete as a single component at the batch plant. Add the admixture to the concrete mixture only when its use is approved or directed, and only when it has been used in mixture proportioning studies to arrive at approved mixture proportions. Submit certified copies of the independent laboratory test results required for compliance with ASTM C494/C494M.]

2.1.5 Reinforcement

2.1.5.1 Dowel Bars

Dowel bars conforming to ASTM A615/A615M, [Grade 300] [Grade 420] [Grade 40] [Grade 60] for plain billet-steel bars of the size and length indicated. Remove all burrs and projections from the bars.[Epoxy coat in accordance with ASTM A775/A775M.]

2.1.5.2 Tie Bars

Billet or axle steel deformed bars conforming to ASTM A615/A615M or ASTM A966/A966M [Grade 300] [Grade 420] [Grade 40] [Grade 60].[Epoxy coat in accordance with ASTM A775/A775M.]

[2.1.5.3 Reinforcement

Deformed steel bar mats conforming to ASTM A184/A184M. Bar reinforcement conforming to [ASTM A615/A615M] [ASTM A966/A966M], [Grade 300] [Grade 420] [Grade 40] [Grade 60].[Epoxy coat in accordance with ASTM A775/A775M.]

]2.1.6 Curing Materials

Provide curing materials consisting of:

2.1.6.1 White-Burlap-Polyethylene Sheet

Conforming to ASTM C171, 0.10 mm 0.004 inch thick white opaque polyethylene bonded to 0.31 kg per meter 10 oz/linear yard (1.0 meter) (40 inch) wide burlap.

2.1.6.2 Liquid Membrane-Forming Compound

Conforming to ASTM C309, white pigmented, Type 2, Class B, free of paraffin or petroleum.

2.1.6.3 Liquid Chemical Sealer-Hardener Compound

Compound consisting of magnesium fluosilicate which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions.

2.1.7 Joint Fillers and Sealants

Provide as specified in Section [32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT][32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT].[Match new joints with existing alignment.]

2.1.8 Biodegradable Form Release Agent

****

NOTE: Concrete release fluids are recognized as a biobased material. Use materials with biobased content where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying product biobased content requirements. A resource that can be used to identify products with bio-based content is the "Catalog" tab within the USDA's "Biopreferred" website at https://www.biopreferred.gov/BioPreferred/. **Other products with biobased content are also acceptable when meeting all requirements of this specification.**

****

Provide form release agent that is colorless and biodegradable. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent with a minimum of 87 percent biobased material and does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

2.1.9 Epoxy Resin

Provide epoxy-resin materials that consist of two-component materials conforming to the requirements of ASTM C881/C881M, Class as appropriate for each application temperature to be encountered, except that in addition, the materials meet the following requirements:

a. Type IV, Grade 3, for use for embedding dowels and anchor bolts.

b. Type III, Grade as approved, for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar.

c. Type IV, Grade 1, for use for injecting cracks.

d. Type V, Grade as approved, for bonding freshly mixed portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete.

2.1.10 Joint Materials

****

NOTE: Edit as appropriate for project requirements. Coordinate with Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT for Army projects and Section 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT for all other projects.

****

2.1.10.1 Expansion Joint Materials

Provide preformed expansion joint filler material conforming to [ASTM D1751][or][ASTM D1752 Type [II] [III]]. Provide expansion joint filler that is

19 mm 3/4 inch thick, unless otherwise indicated, and provided in a single full depth piece.

2.1.10.2 Slip Joint Material

Provide slip joint material that is 6 mm 1/4 inch thick expansion joint filler, unless otherwise indicated, conforming to paragraph EXPANSION JOINT MATERIAL.

2.2 MIX DESIGN

Proportion concrete mix in accordance with ACI 211.1 except as modified herein.

2.2.1 Specified Concrete Properties

****

NOTE: This specification is based on a flexural strength basis. Specify the design strength based on local or state DOT experience in the area. For small jobs 75 cubic meters or less 100 cubic yards or less, compressive strength may be used. In that case modify these paragraphs to reflect a compressive strength basis.

NOTE: Allowable Air Content: Select 5.5 percent air content for maximum aggregate size of 37.5 mm 1 1/2 inches, and 6 percent air content for maximum aggregate size of 25 mm one inch. Maximum water-cementitious material ratio should be 0.45 for exposure to moisture and freeze-thaw cycling or 0.40 for reinforcement corrosion protection and exposure to deicing salts.

****

2.2.1.1 Flexural Strength

Provide concrete with a minimum flexural strength of [4.48][_____]MPa [650][_____] psi at 28 days of age.

2.2.1.2 Air Entrainment

Provide an entrained air content of [5.5] [6.0] percent.

2.2.1.3 Slump

[For fixed form and hand placement, provide a maximum slump of 75 mm 3 inches.] [For slipformed pavement, at the start of the project, select a maximum allowable slump which will produce in-place pavement meeting the specified tolerances for control of edge slump. The selected slump is applicable to both pilot and fill-in lanes.]

2.2.1.4 Water/Cementitious Materials Ratio

Maximum allowable water-cementitious material ratio is [0.40] [0.45]. The water-cementitious material ratio is based on absolute volume equivalency, where the ratio is determined using the weight of cement for a cement only mix, or using the total volume of cement plus pozzolan converted to an equivalent weight of cement by the absolute volume equivalency method described in ACI 211.1.

2.2.1.5 Albedo

****

NOTE: The urban heat island effect forms as vegetation is replaced by low reflectivity materials such as dark colored paving. These surfaces absorb, rather than reflect, the sun's heat, causing surface temperatures and urban ambient temperatures to be 1 to 6 degrees C 2 to 10 degrees F hotter than surrounding rural areas.

Mitigation of heat island effect is not required by UFC 1-200-02 but may be desired for sustainability reasons. The albedo requirements below for roads and parking lot paving are most beneficial in ASHRAE climate zones 1 through 5. Retain the following section when needed to meet project requirements.

****

[Provide an Albedo with a minimum initial Solar Reflectance of at least 0.33 as tested in accordance with ASTM C1549.

]

2.2.2 Mix Design Report

Perform trial design batches, mixture proportioning studies, testing, and include test results demonstrating that the proposed mixture proportions produce concrete of the qualities indicated. An existing mix design may be submitted if developed within the previous 12 months. Submit test results in a mix design report to include:

a. Coarse and fine aggregate gradations and plots.

b. Coarse and fine aggregate quality test results, include deleterious materials and ASR testing.

c. Mill certificates for cement and supplemental cementitious materials.

d. Certified test results for all proposed admixtures.

e. Specified flexural strength, slump, and air content.

f. Recommended proportions and volumes for proposed mixture and each of three trial water-cementitious materials ratios.

g. Individual beam breaks.

h. Flexural strength summaries and plots.

i. Historical record of test results, documenting production standard deviation (if available).

j. Narrative discussing methodology on how the mix design was developed.

2.2.3 Mix Verification

Mix verification tests may be performed by the Government. Provide quantities of cementitious materials, aggregates and admixtures as requested.

2.3 EQUIPMENT

2.3.1 Batching and Mixing

****

NOTE: Edit bracketed items according to whether use of truck mixers is to be permitted. Truck mixers should not be permitted for mixing concrete if slipform paving is permitted for pavement thicker than 200 mm 8 inches.

****

Provide [stationary mixers] [truck mixers]. Provide a batch plant conforming to ASTM C94/C94M and as specified. Do not weigh water or measure cumulatively with another ingredient. Batch all concrete materials in accordance with ASTM C94/C94M requirements. Verify batching, mixers, mixing time, permitted reduction of mixing time, and concrete uniformity in accordance with the requirements of ASTM C94/C94M, and document in the initial weekly QC Report.[Do not use truck mixers for mixing slipformed concrete. Provide only truck mixers designed for mixing or transporting paving concrete with extra large blading and rear opening specifically for low-slump paving concrete and conforming to the requirements of ASTM C94/C94M.]

2.3.2 Transporting Equipment

Provide transporting equipment in conformance with ASTM C94/C94M and as specified herein. Transport concrete to the paving site in rear-dump trucks, in truck mixers designed with extra large blading and rear opening specifically for low slump concrete, or in agitators. Do not permit bottom-dump trucks for delivery of concrete.

2.3.3 Delivery Equipment

When concrete transport equipment cannot operate on the paving lane, provide side-delivery transport equipment consisting of self-propelled moving conveyors to deliver concrete from the transport equipment and discharge it in front of the paver. Do not permit front-end loaders, dozers, or similar equipment to distribute the concrete.

2.3.4 Paver-Finisher

Provide a heavy-duty, self-propelled paver-finisher machine designed specifically for paving and finishing high quality pavement and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass.[Provide a paver-finisher weighing at least 3280 kg/m 2200 lb/foot of lane width, and powered by an engine having at least 15000 W/meter 6.0 horsepower/foot of lane width.] Equip the paver-finisher with a full width "knock-down" auger, capable of operating in both directions, which will evenly spread the fresh concrete in front of the screed or extrusion plate. Gang-mount immersion vibrators at the front of the paver on a frame equipped with suitable controls so that all vibrators can be operated at any desired depth within the slab or completely withdrawn from the concrete. Automatically control the vibrators so they will be immediately stopped as forward motion of the paver ceases. Space the immersion vibrators across the paving lane as necessary to properly consolidate the concrete, but limit the clear distance between vibrators not to exceed 750 mm 30 inches, and the outside vibrators not to exceed 300 mm 12 inches from the edge of the lane. Vibrators may be pneumatic, gas driven, or electric, and operated at frequencies within the concrete between 6,000 and 7,000 vibrations per minute, with an amplitude of vibration such that noticeable vibrations occur at 450 mm 1.5 foot radius when the vibrator is inserted in the concrete to the depth specified. Equip the paver-finisher with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface.

2.3.4.1 Paver-Finisher with Fixed Forms

Equip the paver-finisher with wheels designed to ride the forms, keep it aligned with the forms, and to prevent deformation of the forms.

2.3.4.2 Slipform Paver-Finisher

Provide a track-mounted slipform paver-finisher with automatic controls and padded tracks. Electronically reference horizontal alignment to a taut wire guideline. Electronically reference vertical alignment on both sides of the paver to a taut wire guideline, to an approved laser control system, or to a ski operating on a completed lane. Do not control from a slope-adjustment control or from the underlying material.

2.3.4.3 Other Types of Finishing Equipment

****

NOTE: Edit bracketed item according to whether use of bridge deck finishers is desired, and based on thickness of pavement and surface smoothness tolerances required.

****

[Bridge deck finishers are permitted for pavements 250 mm 10 inches or less in thickness.]Heavy duty vibratory truss screeds may be approved for use if successfully demonstrated on the test section to consolidate the slab full depth and without segregation. Clary screeds, rotating tube floats, or laser screeds will not be allowed on the project. Provide hand floats that are not less than 3.65 m 12 feet long and 150 mm 6 inches wide and stiffened to prevent flexing and warping.

2.3.4.4 Work Bridge

Provide a self-propelled work bridge capable of spanning the paving lane and supporting the workmen without excessive deflection.

2.3.5 Texturing Equipment

****

NOTE: Edit the following paragraphs and delete non-applicable texturing methods to correlate with the drawings and with paragraph TEXTURING in PART 3. Do not specify artificial turf drag for Air Force projects.

****

Provide texturing equipment as specified below.

2.3.5.1 Fabric Drag

[Clean, reasonably new burlap][Artificial turf fabricated of a plastic material]measuring from 0.91 to 3 m 3 to 10 feet long, 600 mm 2 feet wider than the width of the pavement, and securely attached to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. Select dimension of burlap drag so that at least 0.91 m 3 feet of the material is in contact with the pavement.

2.3.5.2 Deep Texturing Equipment

Provide texturing equipment consisting of [a stiff bristled broom] [a comb with spring wire tines] [spring strips] which will produce true, even grooves. Mount this drag in a wheeled frame spanning the paving lane and constructed to mechanically pull the drag in a straight line across the paving lane perpendicular to the centerline.

2.3.6 Curing Equipment

Provide equipment for applying membrane-forming curing compound mounted on a self-propelled frame that spans the paving lane. Constantly agitate the curing compound reservoir mechanically (not air) during operation and provide a means for completely draining the reservoir. Provide a spraying system that consists of a mechanically powered pump which maintains constant pressure during operation, an operable pressure gauge, and either a series of spray nozzles evenly spaced across the lane to provide uniformly overlapping coverage or a single spray nozzle which is mounted on a carriage which automatically traverses the lane width at a speed correlated with the forward movement of the overall frame. Protect all spray nozzles with wind screens. Calibrate the spraying system in accordance with ASTM D2995, Method A, for the rate of application required in subpart CURING AND PROTECTION. Provide hand-operated sprayers powered by compressed air supplied by a mechanical air compressor. Immediately replace curing equipment if it fails to apply an even coating of compound at the specified rate.

2.3.7 Sawing Equipment

Provide equipment for sawing joints and for other similar sawing of concrete consisting of standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment. Provide diamond tipped blades. If demonstrated to operate properly, abrasive blades may be used. Provide spares as required to maintain the required sawing rate. Early-entry saws may be used, subject to demonstration and approval. No change to the initial sawcut depth is permitted.

2.3.8 Straightedge

Furnish one 4 m 12 foot straightedge constructed of aluminum or magnesium alloy, having blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Provide handles for operation on the pavement.

PART 3 EXECUTION

3.1 PREPARATION FOR PAVING

3.1.1 Weather Limitations

When windy conditions during paving appear probable, have equipment and material at the paving site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.1.1.1 Inclement Weather

Do not commence placing operations when heavy rain or other damaging weather conditions appear imminent. At all times when placing concrete, maintain on-site sufficient waterproof cover and means to rapidly place it over all unhardened concrete or concrete that might be damaged by rain. Suspend placement of concrete whenever rain, high winds, or other damaging weather commences to damage the surface or texture of the placed unhardened concrete, washes cement out of the concrete, or changes the water content of the surface concrete. Immediately cover and protect all unhardened concrete from the rain or other damaging weather. Completely remove and replace any slab damaged by rain or other weather full depth, by full slab width, to the nearest original joint.

3.1.1.2 Hot Weather

Maintain required concrete temperature in accordance with ACI 305R to prevent evaporation rate from exceeding 0.98 kg of water per square meter 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing, place concrete during cooler night time hours, or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Water is not allowed to be added after the initial introduction of mixing water except, when on arrival at the job site, the slump is less than specified and the water-cement ratio is less than that given as a maximum in the approved mixture. Additional water may be added to bring the slump within the specified range provided the approved water-cement ratio is not exceeded. Inject water into the head of the mixer (end opposite the discharge opening) drum under pressure, and turn the drum or blades a minimum of 30 additional revolutions at mixing speed. The addition of water to the batch at any later time is not allowed. After placement, use fog spray, apply monomolecular film, or use other suitable means to reduce the evaporation rate. Start curing when surface of fresh concrete is sufficiently hard to permit curing without damage. Cool underlying material by sprinkling lightly with water before placing concrete. Follow practices found in ACI 305R.

3.1.1.3 Prevention of Plastic Shrinkage Cracking

During weather with low humidity, and particularly with high temperature and appreciable wind, develop and institute measures to prevent plastic shrinkage cracks from developing. If plastic shrinkage cracking occurs, halt further placement of concrete until protective measures are in place to prevent further cracking. Periods of high potential for plastic shrinkage cracking can be anticipated by use of ACI 305R. In addition to the protective measures specified in the previous paragraph, the concrete placement may be further protected by erecting shades and windbreaks and by applying fog sprays of water, the addition of monomolecular films, or wet covering. Apply monomolecular films after finishing is complete, do not use in the finishing process. Immediately commence curing procedures when such water treatment is stopped.

3.1.1.4 Cold Weather

Do not place concrete when ambient temperature is below 5 degrees C 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. When authorized, when concrete is likely to be subjected to freezing within 24 hours after placing, heat concrete materials so that temperature of concrete when deposited is between 18 and 27 degrees C 65 and 80 degrees F. Methods of heating materials are subject to approval. Do not heat mixing water above 74 degrees C 165 degrees F. Remove lumps of frozen material and ice from aggregates before placing aggregates in mixer. Follow practices found in ACI 306R.

3.1.2 Conditioning of Underlying Material

Verify the underlying material, upon which concrete is to be placed is clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. Prior to setting forms or placement of concrete, verify the underlying material is well drained and has been satisfactorily graded by string-line controlled, automated, trimming machine and uniformly compacted in accordance with the applicable Section of these specifications. Test the surface of the underlying material to crown, elevation, and density in advance of setting forms or of concrete placement using slip-form techniques. Trim high areas to proper elevation. Fill and compact low areas to a condition similar to that of surrounding grade, or fill with concrete monolithically with the pavement. Low areas filled with concrete are not to be cored for thickness to avoid biasing the average thickness used for evaluation and payment adjustment. Rework and compact any underlying material disturbed by construction operations to specified density immediately in front of the paver. If a slipform paver is used, continue the same underlying material under the paving lane beyond the edge of the lane a sufficient distance that is thoroughly compacted and true to grade to provide a suitable trackline for the slipform paver and firm support for the edge of the paving lane.

3.1.3 Forms

****

NOTE: Delete bracketed sentences on overlay pavements if not applicable.

****

Use steel forms, except that wood forms may be used for curves having a radius of 45 m 150 feet or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. Provide forms with the base width not less than eight-tenths of the vertical height of the form, except that for forms 200 mm 8 inches or less in vertical height, provide forms with a base width not less than the vertical height of the form. Provide wood forms adequate in strength and rigidly braced for curves and fillets. Set forms on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Do not set forms on blocks or on built-up spots of underlying material.[Set and secure forms in place with stakes or by other approved methods for overlay pavements and for other locations where forms are set on existing pavements. Carefully drill holes in existing pavements for form stakes without cracking or spalling the existing pavement. Prior to setting forms for paving operations, demonstrate the proposed form setting procedures at an approved location and do not proceed further until the proposed method is approved.] Before placing the concrete, coat the contact surfaces of forms[except existing pavement sections where bonding is required,] with a non-staining mineral oil, non-staining form coating compound, biodegradable form release agent, or two coats of nitro-cellulose lacquer.[When using existing pavement as a form, clean existing concrete and then coat with asphalt emulsion bondbreaker before concrete is placed.] Check and correct grade elevations and alignment of the forms immediately before placing concrete.

3.1.4 Reinforcement

3.1.4.1 Dowel Bars

****

NOTE: For projects which require dowel bars or coated dowel bars, show location, size, and tolerances on the drawings. Include sentence in brackets for coated dowel bars. Delete references to slipform paving installation of dowels and tie bars if slipform paving is not allowed. Delete references to installation in contraction joints if not required. Delete bracketed references to tie bars, if tie bars are not used.

****

Install dowels with horizontal and vertical alignment plus or minus 25 mm 1 inch. Except as otherwise specified, maintain location of dowels within a skew alignment of 6 mm over 300 mm length 1/4 inch over 1 foot length. [Reject coatings which are perforated, cracked or otherwise damaged. While handling avoid scuffing or gouging of the coatings.] Omit [Dowels] [and tie bars] when the center of the [dowel] [tie bar] is located within a horizontal distance from an intersecting joint equal to or less than one-fourth of the slab thickness. Maintain dowels in position during concrete placement and curing. Before concrete placement, thoroughly grease the entire length of each dowel secured in a dowel basket or fixed form.

3.1.4.2 Tie Bars

****

NOTE: When tie bars are required in the contract, indicate location on drawings. Show bar size, spacing, and placement tolerances required and method of support.

****

Install bars, accurately aligned horizontally and vertically, and to the tolerances shown on the drawings, at indicated locations.[For slipform construction, insert bent tie bars by hand or other approved means.]

3.1.4.3 Setting Slab Reinforcement

****

NOTE: For contracts which require reinforcing steel, specify the type, size and material of reinforcement. Delete bracketed item if CRCP is not being constructed.

****

Position reinforcement on suitable chairs prior to concrete placement. At expansion, contraction and construction joints, place the reinforcement as indicated. Clean reinforcement free of mud, oil, scale or other foreign materials. Place reinforcement accurately and wire securely. Lap splices 300 mm 12 inches minimum. Maintain the bar spacing from ends and sides of slabs and joints as indicated.[If reinforcing for Continuously Reinforced Concrete Pavement (CRCP) is required, submit the entire operating procedure and proposed equipment for approval.]

3.2 MEASURING, MIXING, CONVEYING, AND PLACING CONCRETE

3.2.1 Measuring

Conform to ASTM C94/C94M.

3.2.2 Mixing

Conform to ASTM C94/C94M, except as modified herein. Begin mixing within 30 minutes after cement has been added to aggregates. When the air temperature is greater than 29.4 degrees C 85 degrees F, place concrete within 60 minutes. With approval, a hydration stabilizer admixture meeting the requirements of ASTM C494/C494M Type D, may be used to extend the placement time to 90 minutes. Additional water may be added to bring slump within required limits as specified in ASTM C94/C94M, provided that the specified water-cement ratio is not exceeded.

3.2.3 Conveying

Conform to ASTM C94/C94M.

3.2.4 Placing

Do not exceed a free vertical drop of 1.5 m 5 feet from the point of discharge. Deposit concrete either directly from the transporting equipment or by conveyor on to the pre-wetted subgrade or subbase, unless otherwise specified. Deposit the concrete between the forms to an approximately uniform height. Place concrete continuously at a uniform rate, without damage to the grade and without unscheduled stops except for equipment failure or other emergencies. If an unscheduled stop occurs within 3 m 10 feet of a previously placed expansion joint, remove concrete back to joint, repair any damage to grade, install a construction joint and continue placing concrete only after cause of the stop has been corrected.

3.3 PAVING

Construct pavement with paving and finishing equipment utilizing [fixed forms] [slipforms].

3.3.1 Paving Plan

Submit for approval a paving plan identifying the following items:

a. A description of the placing and protection methods proposed when concrete is to be placed in or exposed to hot, cold, or rainy weather conditions.

b. A detailed paving sequence plan and proposed paving pattern showing all planned construction joints.

c. Plan and equipment proposed to control alignment of formed or sawn joints within the specified tolerances.

3.3.2 Required Results

Operate the paver-finisher to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. Adjust the paver-finishing operation to produce a surface finish free of irregularities, tears, voids of any kind, and other discontinuities, with only a minimum of paste at the surface. Do not permit multiple passes of the paver-finisher. Produce a finished surface requiring no hand finishing, other than the use of cutting straightedges, except in very infrequent instances. Do not apply water, other than true fog sprays (mist), to the concrete surface during paving and finishing.

3.3.3 Operation

When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), make provisions to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of debris, and placing rubber mats beneath the paver tracks. Operate transversely oscillating screeds and extrusion plates to overlap the existing pavement the minimum possible, but in no case more than 200 mm 8 inches.

3.3.4 Consolidation

Immediately after spreading concrete, consolidate full depth with internal type vibrating equipment along the boundaries of all slabs regardless of slab thickness, and interior of all concrete slabs. For pavements less than 250 mm 10 inches thick, operate vibrators at mid-depth parallel with or at a slight angle to the base course. For thicker pavements, angle vibrators toward the vertical, with vibrator tip preferably about 50 mm 2 inches above the base course, and top of vibrator a few mm inches below pavement surface. Automatically control the vibrators or tamping units in front of the paver so that they stop immediately as forward motion ceases. Limit duration of vibration to that necessary to produce consolidation of concrete. Do not permit excessive vibration. Vibrate concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment with a hand-operated immersion vibrator operated from a bridge spanning the area. Do not operate vibrators at one location for more than 15 seconds. Do not use vibrators to transport or spread the concrete.

3.3.5 Fixed Form Paving

Spread and strike off concrete with with the paver. Shape the concrete to the specified and indicated cross section in one pass, and finish the surface and edges so that only a very minimum amount of hand finishing is required. Use single spud hand vibrators to consolidate the concrete adjacent to fixed forms as required to achieve a void-free formed edge. Do not allow vibrators to contact reinforcement, forms, or the grade during vibration.

3.3.6 Slipform Paving

****

NOTE: Retain slipform paving as an option unless the designer has specific, valid reasons for deleting it. Be sure all other paragraphs correlate with choice made here.
****

Shape the concrete to the specified and indicated cross section in one pass, and finish the surface and edges so that only a very minimum amount of hand finishing is required. Do not install dowels by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete.[If a keyway is required, install a 0.45 to 0.55 mm 26 gauge thick metal keyway liner as the keyway is extruded.[Protect the keyway liner to remain in place and become part of the joint.]]

3.4 JOINTS

****
NOTE: Delete references to slipform paving installation of dowels and tie bars if slipform paving is not allowed. Delete references to installation in contraction joints if not required. Delete bracketed references to tie bars, if tie bars are not used.
****

3.4.1 Contraction Joints

Hold [dowels][and][tie bars] in longitudinal and transverse contraction joints within the paving lane securely in place by means of rigid metal basket assemblies. Weld the [dowels] [and tie bars] to the assembly or hold firmly by mechanical locking arrangements that will prevent them from becoming distorted during paving operations. Anchor the basket assemblies securely in the proper location.

3.4.2 Construction Joints - Fixed Form Paving

Install [dowels] [and tie bars] by the bonded-in-place method, supported by means of devices fastened to the forms. Do not permit installation by removing and replacing in preformed holes.

3.4.3 Dowels Installed In Hardened Concrete

Install by bonding the dowels into holes drilled into the hardened concrete. Drill holes into the hardened concrete approximately 3 mm 1/8 inch greater in diameter than the dowels. Bond the dowels in the drilled holes using epoxy resin injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel is not permitted. Hold the dowels in alignment at the collar of the hole, after insertion and before the epoxy resin hardens, by means of a suitable metal or plastic collar fitted around the dowel. Check the vertical alignment of the dowels by placing the straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel.[Where tie bars are required in longitudinal construction joints of slipform pavement, install bent tie bars at the paver, in front of the transverse screed or extrusion plate. If tie bars are required, construct a standard keyway and install the bent tie bars into the plastic concrete through a 0.45 to 0.55 mm 26 gauge thick metal keyway liner. Do not install tie bars in preformed holes. Protect the keyway liner and maintain in place and become part of the joint. Before placement of the adjoining paving lane, straighten the tie bars, without spalling the concrete around the bar.]

3.5 FINISHING CONCRETE

Start finishing operations immediately after placement of concrete. Use finishing machine, except hand finishing may be used in emergencies and for concrete slabs in inaccessible locations or of such shapes or sizes that machine finishing is impracticable. Immediately halt any operations which produce more than 3 mm 1/8 inch of mortar-rich surface (defined as deficient in plus 4.75 mm U.S. No. 4 sieve size aggregate) and modify the equipment, mixture, or procedures. Finish pavement surface on both sides of a joint to the same grade. Finish formed joints from a securely supported transverse bridge. Provide hand finishing equipment for use at all times.

3.5.1 Machine Finishing

Strike off and screed concrete to the required [crown] [slope] and cross-section by a power-driven transverse finishing machine. A transverse rotating tube or pipe is not permitted. Maintain elevation of concrete such that, when consolidated and finished, pavement surface will be adequately consolidated and at the required grade. Equip finishing machine with a screed which is readily and accurately adjustable for changes in pavement [crown] [slope] and compensation for wear and other causes. Do not permit excessive operation over an area, which will result in an excess of mortar and water being brought to the surface.

3.5.1.1 Equipment Operation

Maintain the travel of machine on the forms without lifting, wobbling, or other variation of the machine which tend to affect the precision of concrete finish. Keep the tops of the forms clean by a device attached to the machine. Maintain a uniform ridge of concrete ahead of the front screed for its entire length.

3.5.1.2 Joint Finish

Before concrete is hardened, correct edge slump of pavement, exclusive of edge rounding, in excess of 6 mm 0.25 inches. Finish concrete surface on each side of construction joints to the same plane, and correct deviations before newly placed concrete has hardened.

3.5.1.3 Hand Finishing

Strike-off and screed surface of concrete to elevations slightly above finish grade so that when concrete is consolidated and finished, the pavement surface is at the indicated elevation. Vibrate entire surface until required compaction and reduction of surface voids is secured with a strike-off template. After initial finishing, further smooth and consolidate concrete by means of hand-operated longitudinal floats.

3.5.2 Texturing

****

NOTE: Select type of texturing required by the using service, retain that subparagraph, and delete

the others. If no guidance is given, the usual default method should be burlap drag. Edit bracketed sentence as appropriate.

Select the type of texturing for roads. Consider climatic conditions for exposed concrete. When required, specify surfaces to receive brooming.

1. Specify wire brooming for non-skid concrete surface textures. Permit steel or new fiber brooms.

2. Specify broomed finish, if required in lieu of burlap drag finish. Broomed finish may cause excessive tire wear and is not recommended, except for special conditions in which light mechanical brooming may be desirable.

3. Additional information is published by American Concrete Paving Association (ACPA) in Technical Bulletins No. 6 (1969) and No. 19 (1975), Interim Recommendations for the Construction of Skid-Resistant Concrete Pavement and Guideline for Texturing of Portland Cement Concrete Highway Pavements, respectively.

****

Before the surface sheen has disappeared and before the concrete hardens, provide a texture to the surface of the pavement as described herein. After curing is complete, thoroughly broom all textured surfaces to remove all debris. Finish the concrete in areas of recesses for tie-down anchors, lighting fixtures, and other outlets in the pavement to provide a surface of the same texture as the surrounding area.

3.5.2.1 Burlap Drag Finish

[Before concrete becomes non-plastic, finish the surface of the slab by dragging a strip of clean, wet burlap on the surface. Drag the surface so as to produce a finished surface with a fine granular or sandy texture without leaving disfiguring marks. Keep the burlap clean and saturated during use.

]3.5.2.2 Brooming

[Finish the surface of the slab by brooming the surface with a new wire broom at least 450 mm 18 inches wide. Gently pull the broom over the surface of the pavement from edge to edge just before the concrete becomes non-plastic. Slightly overlap adjacent strokes of the broom. Broom perpendicular to centerline of pavement so that corrugations produced will be uniform in character and width, and not more than 2 mm 1/16 inch in depth. Maintain broomed surface free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface.

]3.5.2.3 Wire-Comb Texturing

[Apply surface texture transverse to the pavement center line using a mechanical wire comb drag capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure.

Overlap successive passes of the comb the minimum necessary to obtain a continuous and uniformly textured surface, with scores 2 to 5 mm 1/16 to 3/16 inch deep, 1.5 to 3 mm 1/16 to 1/8 inch wide, and spaced 10 mm 3/8 inch apart.

]3.5.2.4 Surface Grooving

[Groove the areas indicated on the drawings with a spring tine drag producing individual grooves 6 mm 1/4 inch deep and 6 mm 1/4 inch wide at a spacing between groove centerlines of 50 mm 2 inches. Cut these grooves perpendicular to the centerline. Before grooving begins, allow the concrete to stiffen sufficiently to prevent dislodging of aggregate. Do not cut grooves within 150 mm 6 inches of a transverse joint or crack.

]3.5.3 Edging

At the time the concrete has attained a degree of hardness suitable for edging, carefully finish slab edges, including edges at formed joints, with an edge having a maximum radius of 3 mm 1/8 inch.[When brooming is specified for the final surface finish, edge transverse joints before starting brooming, then operate broom to obliterate as much as possible the mark left by the edging tool without disturbing the rounded corner left by the edger.] Clean by removing loose fragments and soupy mortar from corners or edges of slabs which have crumbled and areas which lack sufficient mortar for proper finishing. Refill voids solidly with a mixture of suitable proportions and consistency and refinish. Remove unnecessary tool marks and edges. Smooth remaining edges true to line.

3.6 CURING AND PROTECTION

Protect concrete adequately from injurious action by sun, rain, flowing water, [frost,] mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Do not use membrane-forming compound on surfaces where its appearance would be objectionable, on surfaces to be painted, where coverings are to be bonded to concrete, or on concrete to which other concrete is to be bonded.

3.6.1 Moist Curing

****

NOTE: For OCONUS projects using Silica Fume, specify a minimum 24-hour moist cure before applying membrane curing compound.

****

Maintain concrete to be moist-cured continuously wet for the entire curing period, or until curing compound is applied, commencing immediately after finishing. If forms are removed before the end of the curing period, provide curing on unformed surfaces, using suitable materials. Cure surfaces by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Provide burlap and mats that are clean and free from any contamination and completely saturated before being placed on the concrete. Lap sheets to provide full coverage. Provide an approved work system to ensure that moist curing is continuous 24 hours per day and that the entire surface is wet.

3.6.2 White-Burlap-Polyethylene Sheet

Wet entire exposed surface thoroughly with a fine spray of water, saturate burlap but do not have excessive water dripping off the burlap and then cover concrete with White-Burlap-Polyethylene Sheet, burlap side down. Lay sheets directly on concrete surface and overlap 300 mm 12 inches. Make sheeting not less than 450 mm 18 inches wider than concrete surface to be cured, and weight down on the edges and over the transverse laps to form closed joints. Repair or replace sheets when damaged during curing. Check daily to assure burlap has not lost all moisture. If moisture evaporates, resaturate burlap and re-place on pavement (limit re-saturation and re-placing to less than 10 minutes per sheet). Leave sheeting on concrete surface to be cured for at least 7 days.

3.6.3 Liquid Membrane-Forming Compound Curing

Apply compound immediately after surface loses its water sheen and has a dull appearance and before joints are sawed. Agitate curing compound thoroughly by mechanical means during use and apply uniformly in a two-coat continuous operation by suitable power-spraying equipment. Apply a total coverage for the two coats at least 4 liters one gallon of undiluted compound per 20 square meters 200 square feet to produce a uniform, continuous, coherent film that will not check, crack, or peel and free from pinholes or other imperfections. The application of curing compound by hand-operated, mechanical powered pressure sprayers is permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms. When the application is made by hand-operated sprayers, apply a second coat in a direction approximately at right angles to the direction of the first coat. Apply an additional coat of compound immediately to areas where film is defective. Respray concrete surfaces that are subject to heavy rainfall within 3 hours after curing compound has been applied in the same manner.

3.6.4 Protection of Treated Surfaces

After the initial saw cut is complete and the slurry has been removed, respray the area with curing compound or restore the white burlap polyethylene sheet to maintain a continuous curing environment in the area of the sawn joints. Keep concrete surfaces to which liquid membrane-forming compounds have been applied free from vehicular traffic and other sources of abrasion for not less than 72 hours. Foot traffic is allowed after 24 hours for inspection purposes. Maintain continuity of coating for entire curing period and repair damage to coating immediately.

3.7 FIELD QUALITY CONTROL

3.7.1 Sampling

Collect samples of fresh concrete in accordance with ASTM C172/C172M during each working day as required to perform tests specified herein. Make test specimens in accordance with ASTM C31/C31M.

3.7.2 Consistency Tests

Perform concrete slump tests in accordance with ASTM C143/C143M. Take samples for slump determination from concrete during placement. Perform tests at the beginning of a concrete placement operation and for each batch (minimum) or every 16 cubic meters 20 cubic yards (maximum) of concrete to ensure that specification requirements are met. In addition, perform tests each time test beams are made.

3.7.3 Flexural Strength Tests

Test for flexural strength in accordance with ASTM C78/C78M. Fabricate and cure four test specimens in accordance with ASTM C31/C31M for each set of tests. Test two specimens at 7 days, and the other two at 28 days. Concrete strength will be considered satisfactory when the minimum of the 28-day test results equals or exceeds the specified 28-day flexural strength, and no individual strength test is less than the tolerance indicated on Table 1. If the ratio of the 7-day strength test to the specified 28-day strength is less than 65 percent, make necessary adjustments for conformance. Fabricate, cure and test a minimum of one set of four beams for each shift of concrete placement. Remove concrete which is determined to be defective, based on the strength acceptance criteria therein, and replace with acceptable concrete.

3.7.4 Air Content Tests

Test air-entrained concrete for air content at the same frequency as specified for slump tests. Determine percentage of air in accordance with ASTM C231/C231M on samples taken during placement of concrete in forms.

3.7.5 Surface Testing

****

NOTE: Edit these paragraphs as appropriate to the project. If it is desired to restrict surface smoothness testing and evaluation to either straightedge method or profilograph method, retain the one and delete the other; otherwise, retain both as an option. When the profilograph method is allowed, and there are areas with dimensions less than 60 m 200 feet in any direction, retain the straightedge method for these short runs. Typically, a profilograph is used to measure longitudinal smoothness and a straightedge is used for transverse smoothness.

****

Use the profilograph method for all longitudinal testing, except for paving lanes less than 60 m 200 feet in length. Use the straightedge method for transverse testing, for longitudinal testing where the length of each pavement lane is less than 60 m 200 feet, and at the ends of the paving limits for the project. Smoothness requirements do not apply over crowns, drainage structures, or similar penetrations. Maintain detailed notes of the testing results and submit a copy to the Government after each day's testing.

3.7.5.1 Straightedge Testing Method

Test the surface of the pavement with the straightedge to identify all surface irregularities exceeding the tolerances specified in Table 1. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines approximately 4.5 m 15 feet apart. Hold the straightedge in contact with the surface and move ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface, in the area between these two high points.

3.7.5.2 Profilograph Testing Method

Perform profilograph testing using approved California profilograph and procedures described in ASTM E1274. Utilize electronic recording and automatic computerized reduction of data equipment to indicate "must-grind" bumps and the Profile Index for each 0.1 km 0.1 mile segment of the day's paving. Accommodate grade breaks on parking lots by breaking the profile segment into short sections and repositioning the blanking band on each section. Provide the "blanking band" of 5 mm 0.2 inch wide and the "bump template" span 25 mm 1 inch with an offset of 10 mm 0.4 inch. Count the profilograph testing of the last 9.1 m 30 feet of a paving lane in the longitudinal direction from each day's paving operation on the following day's continuation lane. Compute the profile index for each pass of the profilograph (3 per lane) in each 0.1 km 0.1 mile segment. The profile index for each segment is the average of the profile indices for each pass in each segment. Scale and proportion profilographs of unequal lengths to an equivalent 0.1 km 0.1 mile as outlined in the ASTM E1274. Submit a copy of the reduced tapes to the Government at the end of each day's testing.

3.7.5.3 "Bumps" (Must Grind Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm 0.4 inch in height by diamond grinding in accordance with subparagraph Diamond Grinding until they do not exceed 7.5 mm 0.3 inch when retested. Taper such diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding.

3.7.5.4 Diamond Grinding

Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of rigid concrete pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth is limited below. Reduce high areas by diamond grinding the hardened concrete with an approved equipment after the concrete is at a minimum age of 14 days. Perform diamond grinding by sawing with an industrial diamond abrasive which is impregnated in the saw blades. Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the concrete pavement or joint faces. Provide diamond grinding equipment with saw blades that are 3 mm 1/8-inch wide, a minimum of 60 blades per 300 mm 12 inches of cutting head width, and capable of cutting a path a minimum of 0.9 m 3 ft wide. Diamond grinding equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints is not permitted. The maximum area corrected by diamond grinding the surface of the hardened concrete is 10 percent of the total area of a day's production. The maximum depth of diamond grinding is 6 mm 1/4 inch. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government property. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified in Table 1.[Retexture pavement areas given a wire comb or tined texture, areas exceeding 2 square meters 25 square feet that have been corrected by diamond grinding by transverse grooving using an approved grooving machine of standard manufacture. Provide grooves that are 6 mm 1/4 inch deep by 6 mm 1/4 inch wide on 37 mm 1-1/2 inch centers and carried into, and tapered to zero depth within the non-corrected surface, or match any existing grooves in the adjacent pavement.] All areas in which diamond grinding has been performed are subject to the thickness tolerances specified in Table 1.

3.7.6 Plan Grade Testing and Conformance

Within 5 days after each day's paving, test the finished surface of the pavement area by running lines of levels at intervals corresponding with every longitudinal and transverse joint to determine the elevation at each joint intersection. Record the results of this survey and submit a copy to the Government at the completion of the survey.

3.7.7 Edge Slump

Test the pavement surface to determine edge slump immediately after the concrete has hardened sufficiently to permit walking thereon. Perform testing with a minimum 4 m 12 foot straightedge to reveal irregularities exceeding the edge slump tolerance specified in Table 1. Determine the vertical edge slump at each free edge of each slipformed paving lane constructed. Place the straightedge transverse to the direction of paving and the end of the straightedge located at the edge of the paving lane. Record measurements at 1.5 to 3.0 m 5 to 10 foot spacings, as directed, commencing at the header where paving was started. Initially record measurements at 1.5 m 5 foot intervals in each lane. When no deficiencies are present after 5 measurements, the interval may be increased. The maximum interval is 3.0 m 10 feet. When any deficiencies exist, return the interval to 1.5 m 5 feet. In addition to the transverse edge slump determination above, at the same time, record the longitudinal surface smoothness of the joint on a continuous line 25 mm 1 inch back from the joint line using the minimum 4 m 12 foot straightedge advanced one-half its length for each reading. Perform other tests of the exposed joint face to ensure that a uniform, true vertical joint face is attained. Properly reference all recorded measurements in accordance with paving lane identification and stationing, and submit a report within 24 hours after measurement is made. Identify areas requiring replacement within the report.

3.7.8 Test for Pavement Thickness

Take full depth cores of 102 millimeter 4 inch diameter of concrete pavement every [_____] square meters square feet in accordance with ASTM C42/C42M. Measure thickness in accordance with ASTM C1542/C1542M. Record and submit testing, inspection, and evaluation of each core for surface paste, uniformity of aggregate distribution, segregation, voids, cracks, and depth of reinforcement or dowel (if present). Moisten the core with water to visibly expose the aggregate and take a minimum of three photographs of the sides of the core, rotating the core approximately 120 degrees between photographs. Include a ruler for scale in the photographs. Submit plan view of location for each core.

3.7.9 Reinforcement

Inspect reinforcement prior to installation to verify it is free of loose flaky rust, loose scale, oil, mud, or other objectionable material.

3.7.10 Dowels

Inspect dowel placement prior to placing concrete to verify that dowels are of the size indicated, and are spaced, aligned and painted and oiled as specified. Do not permit dowels to exceed the tolerances shown in paragraph: DOWEL BARS.

****

NOTE: Suggestions for improvement of this specification will be welcomed using the Navy "Change Request Forms" subdirectory located in SPECSINTACT in Jobs or Masters under "Forms/Documents" directory or DD Form 1426. Suggestions should be forwarded to:

Commander
Naval Facilities Engineering Systems Command
Engineering Criteria Office, Code CI1
6506 Hampton Blvd.
Norfolk, VA 23508-1278

****

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 13 13.17 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-32 13 16.16 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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ATTACHMENTS:

-- End of Section Table of Contents --

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SECTION 32 13 13.17

ROLLER COMPACTED CONCRETE PAVING
11/20

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NOTE: This guide specification covers the requirements for roller compacted concrete (RCC) pavements for roads, streets, parking areas, repair yards, open-storage areas, and other utility grade pavements. For DOD projects, RCC cannot be used for airfield pavement unless approved by the USACE Transportation Systems Center or the appropriate DOD service.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: Use guidance found in Appendix D of UFC 3-250-04FA when preparing contract specifications for RCC pavement construction.

Insert name and location of project. Tailor specifications for the specific site conditions, available materials, design requirements and construction practices.

Attachment:
Appendix A - Example of Computations
Appendix B - Procedures For Molding RCC Test Specimens For Flexural Strength Testing Using a Vibrating Hammer
Appendix C - RCC Pavement Mixture Proportioning Method

****

1.1 UNIT PRICES

1.1.1 Measurement Procedures

****

NOTE: It is necessary for the Designer to carefully correlate and edit the bid items, measurement and payment paragraphs, and all the technical paragraphs so use of Portland cement, pozzolan, Portland-pozzolan cement, and ground granulated blast furnace slag will be well coordinated. Do not permit use of ground slag with pozzolan or Portland-pozzolan cement. Either use no separate pozzolan or use only a reduced amount if Portland-pozzolan cement is used.

Unit price bid items are recommended when the quantity of RCC and or the quantity of cementitious materials is not known or likely to be variable. If the quantity could range beyond 15 percent of the bid item, split bid items should be used. If quantities are known at the time of bidding, lump sum bid items are recommended.

****

1.1.1.1 Concrete Quantity

1.1.1.1.1 Measurement of Concrete Quantity

The quantity of concrete to be paid for will be the number of cubic meters yards, rounded to the nearest tenth of a cubic meter yard, placed in the completed and accepted pavements, including the accepted test section. Payment will not be made for wasted concrete, for concrete used for the convenience of the Contractor, or for concrete outside the neat lines shown on the drawing. Concrete will be measured in the completed and accepted pavements in accordance with the dimensions shown in the plan and cross section. No deductions will be made for rounded or beveled edges or the space occupied by pavement reinforcement, dowel bars, tie bars, or electrical conduits, nor for any void, drainage, or other structure extending into or through the pavement slab measuring one cubic meter 3 cubic feet or less in volume. No other allowance for concrete will be made unless placed in specified locations in accordance with written instructions previously issued by the Contracting Officer.

1.1.1.1.2 Payment for Concrete Quantity

The quantity of concrete measured as specified above, will be paid for at the contract unit price when placed in completed and accepted pavements or, where appropriate, at reduced prices adjusted in accordance with paragraph PAYMENT ADJUSTMENT. The unit price will include the cost of labor and materials and the use of equipment and tools required to complete the work, except the cement, pozzolan, or ground granulated blast furnace slag that is specified for separate payment.

1.1.1.2 Cement Quantity

1.1.1.2.1 Measurement of Cement Quantity

The quantity of cement to be paid for will be the number of metric tons of cement used in the completed and accepted pavements. Payment will not be made for wasted cement or for cement used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kg pounds of cement required by the mixture proportions per cubic m yard by the number of cubic m yards of the various mixtures placed and measured for payment, then dividing by 1000 2000 and rounding off to the nearest tenth of a metric ton ton.

1.1.1.2.2 Payment for Cement Quantity

The quantity of cement, determined as specified above, will be paid for at the contract unit price, which includes all costs of handling, hauling, and storage at the site.

1.1.1.3 Pozzolan Quantity

1.1.1.3.1 Measurement of Pozzolan Quantity

The quantity of pozzolan paid for will be the number of metric tons tons used as a cementitious material in the completed and accepted pavements. Payment will not be made for wasted pozzolan or for pozzolan used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kilogram per cubic meter pounds/cubic yard of pozzolan used as a cementitious material, and required by the mixture proportions by the number of cubic m yards of the various mixtures placed and measured for payment, then dividing by 1000 2000 and rounding off to the nearest tenth of a metric ton ton. Payment will not be made for pozzolan used strictly as a Contractor's option to compensate for lack of fines in the aggregate.

1.1.1.3.2 Payment for Pozzolan Quantity

The quantity of pozzolan, determined as specified above, will be paid for at the contract unit price, which includes costs of delivery, handling, and storage at the site.

1.1.1.4 Ground Granulated Blast Furnace Slag (GGBFS)

****

NOTE: If ground granulated blast furnace slag is not locally and readily available, remove this paragraph and all further reference to the material.

****

1.1.1.4.1 Measurement of GGBFS Quantity

The quantity of GGBFS to be paid for will be the number of metric tons tons of GGBFS used in the completed and accepted pavements. Payment will not be made for wasted ground iron blast furnace slag or for GGBFS used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kg pounds of GGBFS required by the mixture proportions per cubic meter yard by the number of cubic meters yards of the various mixtures placed and measured for payment and then dividing by 1,000 2,000 and rounding off to the nearest tenth of a metric ton ton.

1.1.1.4.2 Payment for GGBFS Quantity

The quantity of GGBFS, determined as specified above, will be paid for at the contract unit price, which includes costs of handling, hauling, and storage at the site.

1.1.1.5 Portland-Pozzolan Cement

****

NOTE: If Portland-Pozzolan cement is not locally and readily available, remove this paragraph and all further references to the material.

****

1.1.1.5.1 Measurement of Portland-Pozzolan Cement Quantity

The quantity of Portland-pozzolan cement to be paid for will be the number of metric tons tons of Portland-pozzolan cement used in the completed and accepted pavements. Payment will not be made for wasted Portland-pozzolan cement or for Portland-pozzolan cement used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kg pounds of Portland-pozzolan cement required by the mixture proportions per cubic meter yard by the number of cubic meters yards of the various RCC mixtures placed and measured for payment, then dividing by 1,000 2,000 and rounding off to the nearest tenth of a metric ton ton.

1.1.1.5.2 Payment for Portland-Pozzolan Cement

The quantity of Portland-pozzolan cement, determined as specified above, will be paid for at the contract unit price, which includes costs of handling, hauling, and storage at the site.

1.1.1.6 RCC Lump Sum Contract

****

NOTE: For fixed-price contracts, inapplicable portions of the unit price paragraphs above should be deleted. It may be necessary to add features of the RCC pavement included in the lump sum bid item.

****

The quantity of RCC will be paid for and included in the lump-sum contract price. The lump sum payment will be for the completed RCC pavement in place at the location(s) as shown on the drawings and includes all incidental work and materials necessary for the completed pavement. If less than 100 percent payment is due based on the pay factors stipulated in paragraph: PAYMENT ADJUSTMENTS, use a unit price of $200.00 per cubic meter yard for purposes of calculating the payment reduction.

1.1.2 Payment Adjustments

****

NOTE: If payment adjustment are not used, the specification will have to be edited to delete

references to payment adjustments. In addition to other items, there will have to be inserted, at some appropriate location, the acceptance criteria to be used for surface smoothness and thickness, which are presently covered only in this paragraph.

Do not, under any conditions, reduce the requirements for density, surface smoothness, surface texture, or thickness or the testing required for those items. Do not, under any conditions, reduce the requirements for daily calibration of the nuclear density meter

****

1.1.2.1 General Considerations

Adjustment in payment for individual lots of RCC pavement will be made in accordance with the following paragraphs for all RCC pavement. The parameters to be measured are aggregate gradation, pavement thickness, density, surface smoothness, and surface texture. No adjustment in payment will be made for cementitious materials. Unless otherwise specified, comply with testing specified in paragraph: Contractor Quality Control. Complete and report all tests within 24 hours after completion of construction of each lot.

1.1.2.2 Percent Payment/Acceptance of Lots

a. When a lot of material fails to meet the specification requirements for 100 percent payment as outlined in the following paragraphs, remove and replace that lot, or accept at a reduced price, as specified herein. The lowest computed payment factor for any pavement characteristic (i.e., gradation, density, surface smoothness, thickness, and surface texture) discussed below will be the actual percent payment for that lot. Payment factors based on different criteria of the same lot will not be multiplied together to get a lower payment factor. The actual percent payment is applied to the bid price and to the quantity of RCC pavement placed in the lot to determine actual payment.

b. At the end of the project, an average of all lot pay factors will be calculated. If this average lot pay factor exceeds 95.0 percent and no individual lot has a pay factor less than 75.1 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot's pay factor.

1.1.2.3 Density

1.1.2.3.1 Field Density

a. To evaluate field density for acceptance, 4 nuclear density gauge tests to determine wet density will be performed at random locations on the interior of the paving lane immediately behind final rolling operations, and 4 similar tests will be performed at random locations on fresh joints and 4 at random locations on cold joints, if such exist, for each sublot, and each set will be averaged for the sublot. Field density for each sublot will be compared with the target density for that lot. The locations of the tests on fresh joints will be alternated from side to side of the joint and will be between 75 and

130 mm 3 and 5 inches from the joint.

b. For cold joints, it is expected that the primary (originally placed) lane will be placed with one sublot and the secondary lane with another sublot. The cold joint evaluation for each of these sublots will be based on 4 density tests made for each sublot being evaluated on that sublot's side of the cold joint. These tests will be between 75 and 130 mm 3 and 5 inches from the proposed (sawed) joint line on the originally placed side of the cold joint and between 75 and 130 mm 3 and 5 inches from the actual joint on the secondary placement side.

1.1.2.3.2 Target Density

Determine, for each lot, the laboratory maximum wet density of an RCC sample tested in accordance with ASTM D1557 based on a one-point wet density test and as described for moisture-density testing in paragraph CONTRACTOR QUALITY CONTROL. This procedure for determining the target density will be repeated for each lot and as necessary whenever the mixture proportions or materials change. Since the "target density" for a lot will not be known until after the beginning of construction of the lot, use the "target density" of the previous lot for quality control until the new "target density" is obtained.

1.1.2.3.3 Computed Percent Payment for Density

a. The average field densities for the sublots for lane interior and for each type of joint will in turn be averaged to determine the lot density for the lane interior, for fresh joints, and, if such exist, for cold joints. These lot average field densities will be compared with Table 1 and used to calculate the computed percent payment based on field density as described below.

b. First, the percent payment deduction for lane interior density, for fresh joint density, and for cold joint density will each be computed by subtracting the percent payment values found in Table 1 from 100.

c. Second, the weighted percent payment deduction for fresh joint density will be computed by multiplying the percent payment deduction for fresh joint density, as computed above, by the ratio of the total amount of RCC pavement in the fresh joint strip to the total amount of RCC pavement in the entire area of the lot. The area of fresh joint strip will be considered to be 3 m 10 feet wide times the length of completed fresh longitudinal construction joint in the lot, but not to exceed the total lot size.

d. Third, the weighted percent payment deduction for cold joint density will be computed by multiplying the percent payment deduction for cold joint density, as computed above, by the ratio of the total amount of RCC pavement in the cold joint strip to the total amount of RCC pavement in the entire area of the lot. The area of cold joint strip will be considered to be 1.5 m 5 feet wide times the length of each half of the cold joint (each side of the joint) completed with the lot being evaluated, but not to exceed the lot size. (Although not probable, it could be possible that, for a full lot, both sides of a cold joint can be constructed in the same lot).

e. Finally, the percent payment deduction for the lane interior, the weighted percent payment deduction for fresh joint density, and the weighted percent payment deduction for cold joint density will be compared and the greatest value selected. This selected percent payment deduction will be subtracted from 100 to obtain the computed percent payment based on field density.

Table 1
Percent Payment for Density

Average Lane Interior and Fresh Joint Density (16 Nuclear Density Gauge Readings Each)	Percent Payment	Average Cold Joint Density (16 Nuclear Density Readings)
98.0 and above	100.0	96.0 and above
97.9	99.5	95.9
97.8	99.0	95.8
97.7	98.2	95.7
97.6	97.0	95.6
97.5	95.0	95.5
97.4	86.5	95.4
97.3	81.0	95.3
97.2	72.0	95.2
97.1	65.0	95.1
97.0	58.0	95.0
96.9	52.0	94.9
96.8	47.0	94.8
below 96.8	reject	below 94.8

1.1.2.4 Surface Smoothness

Use the straightedge method for longitudinal and transverse testing. Where drawings show required deviations from a plane surface (for example crowns, drainage inlets), finish the surface to meet the approval of the Contracting Officer. Record detailed notes of the results of the testing and furnish a copy to the Contracting Officer after each day's testing.

1.1.2.4.1 Smoothness Requirements

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NOTE: Smoothness requirements can be relaxed for RCC applications on roads design for tanks.

****

Straightedge Testing: Provide a finished surface of the pavement that has no abrupt change of 9.5 mm 3/8 inch or more, and a pavement that is within the limits specified hereinafter when checked with an approved 4 m 12 foot straightedge. Provide a pavement surface with variation from the specified straight edge not greater than 9.5 mm 3/8 inch in either the longitudinal or transverse direction.

1.1.2.4.2 Testing Method

After completion of the final rolling of a lot, test the entire surface of the pavement in each lot in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. If any pavement areas are ground, retest these areas immediately after diamond grinding. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. Test the transverse lines 25 feet or less apart, as directed. Test the longitudinal lines at the centerline of each paving lane shown on the drawings, regardless of whether the contractor is allowed to pave two lanes at a time, and test at the 1/8th point in from each side of the lane. Test all other areas having obvious deviations. Test continuously across all joints in the longitudinal direction. For pilot lanes, carry testing in the transverse direction to the construction joint lines and for adjacent lanes carry the straightedge 610 mm24 inches across construction joints, and apply the readings in this area to the adjacent lane. Record the location and deviation from straightedge for all measurements.

1.1.2.4.3 Payment Adjustment for Smoothness

When between 5.0 and 10.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph "Smoothness Requirements" above, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When more than 10.0 percent and less than 15.0 percent of all measurements exceed the tolerance, the computed percent payment will be 90 percent. When between 15.0 and 20.0 percent of all measurements exceed the tolerance, the computed percent payment will be 75 percent. Remove and replace all pavement within the lot, at no additional cost to the Government, when 20.0 percent or more of the measurements exceed the tolerance.

1.1.2.5 Thickness

a. The computed percent payment for thickness for the lot will be 100 percent if no core taken for that lot is deficient in thickness by 6 mm 1/4 inch or more. Acquire all cores in accordance with ASTM C42/C42M and test in accordance with ASTM C174/C174M.

   (1) When the measurement of any core indicates that the pavement is deficient in thickness by 6 mm 1/4 inch or more, drill and test additional cores parallel to the center line of the lane at 8 m 25 foot intervals on each side of the deficient core until the cores indicate that the deficiency in thickness is less than 6 mm 1/4 inch.

   (2) When the deficiencies in thickness for a series of cores are between 6 and 13 mm 1/4 and 1/2 inch, the average thickness will be established from an average of all core thicknesses, considering any core less than 6 mm 1/4 inch deficient as being full depth.

   (3) Remove and replace any areas 13 mm 1/2 inch or more deficient in thickness, re-core and include in the measurements before the final calculation of computed percent payment for the lot is made.

b. The computed percent payment for thickness for the lot will then be determined as follows: the proportional part of the total lot area (expressed in percent) for Categories I and II in Table 2 will be multiplied by their respective percent payment from the table and the 2 products then added to obtain the computed percent payment for the lot.

c. Use the full paving lane width and midway between cores having thicknesses, representing different categories, for calculating area of pavement and the percent payment calculations. Remove and replace any pavement area represented by cores with a deficiency in thickness of 13 mm 1/2 inch or more before any payment calculations are made. The area represented by the core is to be bound by the full paving lane width and a transverse line midway between the cores adjacent to the core in question, or the regularly scheduled transverse joint should such a joint fall between the cores.

d. If the Contractor believes that the cores and measurement taken are not sufficient to indicate fairly the actual thickness of the pavement, additional cores can be taken and measured provided the Contractor will bear the extra cost of drilling the cores. When surface grinding is required that results in thickness deficiencies, the final surface will be considered in evaluation for thickness.

Table 2
Percent Payment for Thickness

Percent Payment Category	Deficiency in Thickness Determined by Cores	Percent Payment or Action Required
I	0.0 - 6.30.00 to 0.24	100
II	6.4 - 12.00.25 to 0.49	65
III	12.7 or greater0.50 or greater	Remove and Replace

1.1.2.6 Surface Texture

a. The surface texture of each lot will be visually examined by a representative of the Contractor's Quality Control immediately after construction to determine compliance with the surface texture requirements in paragraph RCC PAVEMENT PERFORMANCE REQUIREMENTS. The classification of the surface texture of any area of the pavement as acceptable or deficient will be made on the basis of comparison with a selected portion of the test section which has been chosen and marked as having an acceptable surface texture as determined by the Contracting Officer. The computed percent payment for surface texture requirements for the lot will be determined as shown in Table 3.

b. Regardless of payment, removed and replaced full depth with suitable pavement at no cost to the Government any area of any size of extremely poor surface texture as determined by the Contracting Officer. No payment calculations will be made until all such defective material is removed and replaced.

Table 3
Percent Payment for Surface Texture

Percent of Lot Area with Deficient Surface Texture	Percent Payment or Action Required
0.0 to 5.0	100
5.1 to 10.0	90
10.1 to 20.0	75

Table 3 Percent Payment for Surface Texture	
Percent of Lot Area with Deficient Surface Texture	Percent Payment or Action Required
20.1 and above	Remove and Replace

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.3R	(2016) Guide for Selecting Proportions for No-Slump Concrete
ACI 327R	(2014) Guide to Roller-Compacted Concrete Pavements

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C174/C174M	(2017) Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C294	(2024) Standard Descriptive Nomenclature for Constituents of Concrete Aggregates
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1040/C1040M	(2024) Standard Test Methods for In-Place Density of Unhardened and Hardened

	Concrete, Including Roller Compacted Concrete, by Nuclear Methods
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1170/C1170M	(2020) Standard Test Method for Determining Consistency and Density of Roller-Compacted Concrete Using a Vibrating Table
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1435/C1435M	(2020) Standard Practice for Molding Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Hammer
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000; R 2006) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 400	(1963) Requirements for Water for Use in

Mixing or Curing Concrete

1.3 EQUIPMENT, TOOLS, AND MACHINES

1.3.1 General Requirements

****

NOTE: Fill in the bracket with the name and location of the project.

****

a. The work covered by this section consists of furnishing all plant, material, and equipment, and performing all labor for the manufacturing, transporting, placing, compacting, finishing, joint sawing, sealing, and curing of roller-compacted concrete (RCC) pavement.

b. Provide access to the Contracting Officer at all times to all parts of the mixing and paving plant, placement site, and materials sources for inspection, sampling, and testing to assure compliance with the specifications.

1.4 QUALITY CONTROL

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NOTE: Where they are available, specify only ACI certified personnel. Check the American Concrete Institute (ACI) website for local availability (www.concrete.org/Certification).

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1.4.1 Contractor Quality Control Staff

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NOTE: This submittal requires verification that the laboratory has passed COE laboratory validation. USACE validation does not apply to navy projects. Such validation does not preclude specific facility and staff qualifications specified.

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A detailed plan of the proposed facility, equipment, procedures and qualifications at least 14 days prior to placement of the test section. Include:

a. Qualifications of Contractor CQC Staff

b. USACE Laboratory accreditation documents and staff certifications

c. Equipment list and calibration certificates

d. Nuclear gage license and calibration curves

Provide Contractor Quality Control personnel, that are assigned to concrete construction, American Concrete Institute (ACI) certified in the following grade (or have written evidence acceptable to the Contracting Officer of having completed similar qualification programs):

a. CQC personnel responsible for inspection of concrete paving operations: ACI Concrete Transportation Inspector.

b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews: ACI Concrete Flatwork Technician/Finisher.

c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

d. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and Laboratory Testing Technician, Grade I or II.

1.4.2 Other Staff

Submit for approval, the qualifications and resumes for the following staff:

a. Petrographer: Bachelor of Science degree in geology or petrography, trained in petrographic examination of concrete aggregate according to ASTM C294 and ASTM C295/C295M and trained in identification of the specific deleterious materials and tests identified in this specification. Resume with detail of education, training and experience related to the project-specific test methods and deleterious materials. Submit resumes at least 20 days before petrographic and deleterious materials examination is to commence.

b. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager certification at the Plant Manager level.

1.4.3 Laboratory Accreditation

Provide laboratory and testing facilities to support quality control which is accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260 and includes onsite temperature-controlled concrete curing facilities. Submit for approval a current accreditation which includes the required and optional test methods, as specified throughout this Section.

a. Provide aggregate testing and mixture proportioning studies performed by a commercial laboratory. Accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM C1077, including all applicable test procedures.

b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Utilize steel molds for molding the beam specimens. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M. Provide flexural loading equipment in accordance with ASTM C78/C78M.

c. Contractor Quality Control: Utilize only an approved, independent, commercial laboratory for sampling and testing, except for testing cementitious materials and admixtures, the manufacturer's laboratory can be use.

d. Laboratory Inspection: The Contracting Officer or his/her representative will inspect the laboratory equipment and test procedures prior to the start of concreting operations for conformance to ASTM C1077. The laboratory certification is required for the duration of the project.

1.4.4 Allowable Tolerances

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NOTE: Table 5 is a comprehensive listing of geometric and testing limits and corresponding allowable variations. Edit those values as appropriate for the project. Edit line items as appropriate. Where payment adjustment is not to be done, edit the exceedance action column to remove pay adjustment and add requirement.

****

Comply with the limits for parameters shown in Table 5. The table identifies specified limits and allowable tolerances from these limits.

Table 5
Limits and Allowable Variations

Parameter	Specified Limit	Allowable Variation	Exceeding Action
Grade	as shown on contract drawings	as shown on contract drawings	remove and replace
Alignment	as shown on contract drawings	Up to 13 mm1/2 inch variation	remove and replace (construction and transverse joints only)
Thickness	as shown on contract drawings	Plus or Minus 6 mm 1/4 inch	pay adjustment up to 13 mm1/2 inch otherwise remove and replace
Density	Per ASTM D1557	98.0 percent interior 96.0 percent at joints	remove and replace
Smoothness	checked with 4 m 12 ft straightedge	Up to 10 percent of all measurements within specified limit	pay adjustment or remove and replace
Hardstands, parking areas, open store areas	Longitudinal and Transverse	9.5 mm3/8 inch	
Roads and Streets	Longitudinal Transverse	5 mm3/16 inch 6 mm1/4 inch	
Abrupt Offsets	Any Direction	3 mm1/8 inch	grind specified tolerance or remove and
Surface Texture	Conforming to designated test patch on test section	Up to 5 percent of area less than test patch surface textures	Pay adjustment or remove and replace

Table 5 Limits and Allowable Variations			
Parameter	Specified Limit	Allowable Variation	Exceeding Action
Strength	Specified Strength	Not more than 10 percent of strength results can be less than f'c	Remove and replace if more than 10 percent of test results is less than specified f'c

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Batching and Mixing Plant

Transporting and Placing Methods

Test Section

Placement Schedule

Contractor Quality Control

SD-03 Product Data

Placing and Spreading; G, PO

Joints; G, AO

SD-05 Design Data

Mixture Proportioning Studies; G, DO

SD-06 Test Reports

Sampling and Testing; G, DO

SD-07 Certificates

Contractor Quality Control Staff; G, AO

Laboratory Accreditation; G, AO

Commercial Laboratory; G, DO

1.6 QUALITY ASSURANCE

1.6.1 Sampling and Testing

The Government may sample and test aggregates and concrete during construction and inspect production and placement facilities and equipment to determine compliance with the specifications as specified herein and as otherwise considered appropriate. Provide facilities and labor as may be necessary for procurement of representative test samples. Testing performed by the Government will not relieve the Contractor from the quality control testing requirements specified.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Bulk Cementitious Materials

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NOTE: Cement storage consists of dedicated plant silos for each cementitious material. In addition, higher capacity storage tankers (aka guppies, pigs) are often stored on site. Cementitious materials are usually truck hauled from the closest terminal or rail cars can be used as a temporary terminal. Provide Dual silos containing a clear air space between silo sidewalls to prevent cross contamination.

****

Furnish cementitious material in bulk. Provide all cementitious materials in bulk at a temperature, as delivered for storage at the site, not exceeding 65 degrees C 150 degrees F. Provide separate facilities for unloading, transporting, storing, and handling of each type of cementitious material.

1.7.1.1 Transporting Cementitious Materials

When bulk cementitious material is not unloaded from primary carriers directly into weather-tight hoppers at the batching plant, transportation from the railhead, mill, or intermediate storage to the batching plant in adequately designed weather-tight trucks, conveyors, or other means that will completely protect the cementitious material from exposure to moisture.

1.7.1.2 Storage of Cementitious Materials

Immediately upon receipt at the site of the work, store cementitious materials in a dry and properly ventilated structure. Provide storage facilities to permit easy access for inspection and identification. To prevent cement from becoming unduly aged after delivery, use any cement that has been stored at the site for 60 days or more before using cement of lesser age.

1.7.2 Aggregate Materials

1.7.2.1 Storage

Store aggregate at the site of the mixing plant, avoiding breakage, segregation, or contamination by foreign materials. Store each size of aggregate from each source separately in free-draining stockpiles. Provide free-draining storage for aggregate at least 24 hours immediately prior to use.

1.7.2.2 Handling

Handle aggregate preventing segregation or degradation. Keep vehicles used for stockpiling or moving aggregate clean of foreign materials.

PART 2 PRODUCTS

2.1 BATCHING AND MIXING PLANT

2.1.1 Location of Plant

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NOTE: The mixing plant should be on the construction site or as close as possible, but should be no further than 15 minutes haul time from the placing site. This is especially true if the project is on a military facility. The security delays at entrances are prohibitive.

Time for this Submittal is intended to provide advance information to the field staff so that timely plant inspection can be done.

****

Submit details and data on the RCC Batching and Mixing Plant a minimum of 30 days in advance of RCC test section construction and prior to plant assembly. Locate the mixing plant onsite as indicated on the drawings. Include as a minimum the following:

a. Detailed layout of aggregate stockpiles and RCC batching equipment.

b. Equipment manufacturer's literature on the Batching and Mixing Plant prior to plan assembly including manufacturer's literature showing that the equipment meets all requirements specified herein and to include but not limited to:

   (1) Cementitious material storage, handling, and controls

   (2) Aggregate handling controls

   (3) Water system controls

   (4) Mixers and controls

   (5) Re-screening systems

   (6) Cooling systems

   (7) Plant conveyors, bins, and feeders

   (8) If truck mixers are used, a certified copy of the NRMCA QC Manual Section 3 Concrete Plant Certification Checklist and Calibration documentation on all measuring and weighing devices, submitted prior to uniformity testing.

2.1.2 Type of Plant

****

NOTE: Plant capacity should be governed by the laydown pattern or the size of the job to help eliminate or minimize cold joints.

****

Design and operate the mixing plant to produce an RCC mixture within the specified tolerances. Use a stationary-type plant having a twin-shift pug mill mixer and either weigh-batch type or continuous type with a minimum rated capacity of [230][_____] metric tons 250 tons per hour. Use a plant equipped with positive means for controlling and adjusting the mixing time (amount of mixing), maintaining the time of mixing constant, and maintaining the speed of rotation of the pug mill shafts constant.

2.1.3 Cementitious Material Feed Unit

Use suitable equipment, incorporating either weighing or volumetric measurements, to separately batch or feed the required percentage of each cementitious material in the mixture within tolerances specified. Use silos and feeders equipped and operated so that no caking of material or variation in feed will occur, including use of any necessary air pressure or vacuum vents on the silos. Provide provisions for readily sampling each cementitious material.

2.1.4 Aggregate Bins

Provide aggregate bins for aggregate storage, one for each size group with each bin having sufficient capacity to supply the mixer continuously operating at full capacity. Arrange the bins to ensure separate storage of appropriate fractions of aggregate, and each compartment provided with some means of preventing spilling of material into other bins. Unless the aggregate in the bin is readily visible to operating personnel, equip each aggregate bin with mechanical or electrical telltales to indicate when the aggregate in the bin is below level to permit accurate proportioning to mixing unit. Construct each bin so that a representative sample may be readily and safely obtained from each bin discharge during plant operations. Provide appropriate means for separately storing, metering, and feeding into the mixer when the use of blended material is necessary.

2.1.5 Water Control Units

Provide satisfactory means, incorporating either weighing, metering, or volumetric measurements, to batch or feed the required quantity of water in the mixture within tolerances specified. Provide adjusting controls that are convenient to and capable of easy and accurate operation by the mixer operator. When metering controls the quantity of water, provide capability for a fixed quantity of water delivered through the meter to be readily checked by weight or volume. A water storage tank is required to prevent surge drawdown effect.

2.1.6 Batching or Feeding Tolerances

Provide batching or feeding to conform to the mixture proportions directed within the tolerances in Table 4. For batch-type plants, the variation is in percent by weight from batch weight of each material based on the mixture proportions directed. For continuous feeding and mixing plants, the variation is in percent by weight from the mixture proportions of each material designed to be in a total timed sample obtained from a designated location in the plant.

Table 4
Batching or Feeding Tolerances

Material	Tolerance, percent
Each Cementitious Material	plus or minus 2.0
Water	plus or minus 3.0
Admixtures	zero to plus 4.0
Each Individual Aggregate Size Group	plus or minus 3.0
Total Aggregate	plus or minus 4.0

2.1.7 Additional Requirements for Batch-Type Mixing Plants

a. Plant Scales: Utilize plant scales conforming to requirements of NRMCA CPMB 100, with modifications as follows: Use plant scales for any weigh box or hopper that are of either beam or springless-dial type and sensitive to 0.5 percent of maximum load required. Beam-type scales having a separate beam for each size aggregate, with a single pointer actuated for each beam and a tare beam for balancing hopper.

b. Weigh Box or Hopper for Aggregates: Provide weigh box or hopper for aggregates that conform to requirements of NRMCA CPMB 100, with modifications as follows: Means for weighing each bin size of aggregate in a weigh box or hopper suspended on scales, ample in size to hold a full batch without running over. The gate design on both the bins and the hoppers are required to prevent leakage of aggregate when closed. On manually or semi-automatically operated plants, provide an interlocking device to prevent opening more than one gate at a time. The interlocking device is not required on automatic plants designed for simultaneous weighing of all sizes of aggregate while the plant is operating under automatic control.

****
NOTE: Modify or delete GGBFS (bracketed) sentence.
****

c. Weigh Hoppers for Cementitious Materials: Weigh hoppers for cementitious materials are to conform to requirements of NRMCA CPMB 100, with modifications as follows: Provide weigh hoppers with sufficient capacity to hold not less than 10 percent in excess of the weight of the cementitious material required for one batch. Portland cement and pozzolan may both be weighed cumulatively in the same hopper on the same scale, provided the Portland cement is weighed first, or the Portland cement and pozzolan may be weighed in separate hoppers on separate scales. Suspend the hopper on dial or beam scales equipped with a pointer so the tare weight of the hopper is shown for each weighing; net weight of cementitious material is to be measured within 1 percent of the weight required.

d. Mixer Unit: Utilize a stationary mixer of the twin pug mill-type capable of producing a uniform mixture within tolerances specified for batch method mixer. Use a mixer with the following properties:

    (1) A time lock, accurate within 5 seconds, to control operation of the complete mixing cycle by locking the weigh hopper gate after mixer is charged until closing of mixer gate throughout dry- and wet-mixing periods. The dry-mixing period is defined as the interval of time between the opening of the weigh hopper and the application of water. The wet-mixing period is the interval between application of water and the opening of the mixer gate.

    (2) Control of mixing time capable of being set at intervals of not more than 5 seconds throughout cycles up to 3 minutes.

    (3) A mechanical batch counter installed as part of the timing device and be designed to preclude register of dry batches or of any material run through during operation of pulling bins.

2.1.8 Additional Requirements for Continuous-Mixing Plants

****
NOTE: Delete the bracketed statement except for small or low-production jobs.
****

a. Provide aggregate feed with the following properties for each bin:

    (1) Feed rate controlled by a variable speed belt, gate remotely operated from the central control panel, calibrated to accurately deliver any specified quantity of material within the required tolerance.

    (2) Feed rate readily adjustable from the control panel to change

aggregate proportions or to compensate for changes in moisture content.

(3) Feed rate controls automatically maintain the established proportions of aggregate when the combined aggregate delivery is increased or decreased.

(4) Combined aggregate belt feeding equipped with an approved belt scale that operate automatic controls, either electronic or mechanical, which will maintain the established proportion of each cementitious material and water as ratios of the total aggregate, with provisions for readily changing the proportions at the control panel.

(5) Capability for storing, metering, and feeding blend material as a separate material when use of blending material is necessary.

b. Provide cementitious material control with the following properties:

(1) Approved system to separately meter the required amount of each cementitious material in the mix within the tolerance specified.

(2) Metering by readily adjustable vane feeders or other approved positive metering devices.

(3) Metering and feed designed and controlled so that the cementitious material is uniformly fed into the mixer or into the stream of aggregate on the feeder belt, all with necessary controls to prevent loss of cementitious material as dust or in any other form.

(4) Control of the quantity of each cementitious material automatically linked to the aggregate belt scales.

(5) A provision so the amount of each cementitious material delivered can be readily sampled and checked by weight.

c. Provide a mixer unit with the following properties:

(1) Blades adjustable for angular position on shafts and reversible to retard flow of the mixture.

(2) A manufacturer's plate indicating net volumetric contents of mixer at several heights permanently inscribed on the wall and the rate of feed of aggregate per minute at plant-operating speed.

d. Provide a discharge hopper having a capacity of at least one metric ton ton equipped with dump gates to assure rapid and complete discharge without segregation.

2.2 MATERIAL SOURCES

Certified copies of laboratory test reports and sources for cement, supplementary cementitious materials (SCM), aggregates, admixtures, curing compound, epoxy, and proprietary patching materials proposed for use on this project. Perform all aggregate tests no earlier than 9 months prior to contract award.

2.2.1 Aggregate Sources

****

NOTE: The specification provides in Table 6, a complete list of material properties that the aggregate must have to be used on the project. It is the Contractor's responsibility to find sources that meet those requirements prior to the start of work and throughout the work.

Where complete testing has been done to determine acceptable sources, it may be expedient to list the sources that have been tested and are acceptable.

Where it is intended that a specific source or sources be used exclusively, they should be listed and so stated.

Performance testing of aggregate will require at least 90 days to perform the required freezing and thawing tests. Requirements for Contractor testing or design phase government testing of aggregate quality should be evaluated based on project schedule requirements.

Where service records are acceptable in lieu of performance testing, satisfactory service record for an aggregate will be determined based on the aggregate's ability to resist degradation under traffic and/or climatic conditions similar to that expected during its use. If performance data indicate that an aggregate is susceptible to one or more of the above mentioned problems, that source of aggregate will be rejected.

****

Locate and test the sources from which the aggregates are to be obtained. Provide all aggregate for each nominal size group of aggregates from a single aggregate source and that meet specified quality requirements. Complete aggregate quality testing prior to performing mixture proportion studies.

2.2.2 Portland Cement Source

****

NOTE: Confirm that required portland cement is available in the required quantity from a single source.

****

Provide portland cement from sources actively producing portland cement that have a documented record of consistent physical and chemical properties meeting the specified provisions of ASTM C150/C150M. Provide all portland cement for the project from a single source. A second source of portland cement may be used if documentation is provided that the primary source cannot provide for the entire project needs. Test additional trial mixtures to confirm mixture performance.

2.2.3 Aggregate Samples

Provide facilities for obtaining representative test samples for Government testing. Obtain samples of aggregates during paving at the point of batching. Additional tests and analyses of aggregates at various stages in the processing and handling operations may be made by the Government at the discretion of the Contracting Officer.

2.2.4 Pozzolan Source

****

Note: Confirm that required pozzolan is available in the required quantity from a single source.

****

Provide pozzolan from sources actively producing pozzolan that have a documented record of consistent physical and chemical properties meeting the specified provisions of ASTM C618. Submit production tests for the past 2 years to verify acceptable performance. Provide all pozzolan for the project from a single source.

2.2.5 Ground Granulated Blast Furnace Slag Source

****

NOTE: Confirm that required GGBFS is available in the required quantity from a single source.

****

Provide GGBFS from sources actively producing GGBFS that have a documented record of consistent physical and chemical properties meeting the specified provisions of ASTM C989/C989M. Submit production tests for the past 2 years to verify acceptable performance. Provide all GGBFS for the project from a single source.

2.3 CEMENTITIOUS MATERIALS

2.3.1 Portland Cement

****

NOTE: The option of Type I or Type II portland cement should normally be specified, but only type II portland cement should be required when moderate resistance to sulfate attack is needed. Low alkali cements should be required when alkali reactive aggregates are used in the concrete. The false set requirement should be added if a history of false set exists for the area. Portland cement may also be specified using performance specification ASTM C1157.

****

Provide portland cement conforming to ASTM C150/C150M, Type I or II. Use low alkali cement if the proposed aggregates are found to have greater than 0.04 percent expansion when tested in accordance with paragraph: Alkali-Silica Reactivity.

2.3.2 Pozzolan

****

NOTE: The supplemental requirements for limit on alkalies and limit on reactivity in brackets should be specified any time low alkali cement is specified or if class C pozzolan is permitted. Class C pozzolan should not be used if there is potential for sulfate attack. The supplemental requirements a-c should be used if there is potential for sulfate attack.
****

Utilize fly ash conforming to the requirements of ASTM C618, Class F with a loss on ignition not exceeding 4 percent, including the optional requirements for drying shrinkage, uniformity, and effectiveness in controlling Alkali-Silica reaction. Use class F fly ash for use in mitigating Alkali-Silica Reactivity with a Calcium Oxide (CaO) content of less than 8 percent.

2.3.3 Portland-Pozzolan Cement

****
NOTE: The optional requirement for mortar expansion should be specified when the Portland-pozzolan cement will be used with alkali-reactive aggregate.

If portland-pozzolan cement is not locally and readily available, remove this paragraph and all other references to the material in this specification.
****

Utilize portland-pozzolan cement conforming to the requirements of ASTM C595/C595M, Type IP.

2.3.4 Ground Granulated Blast Furnace Slag

****
NOTE: If ground granulated blast furnace slag is not locally and readily available, remove this paragraph and all other references to the material in this specification. Select the appropriate grade of GGBFS.
****

Utilize ground granulated blast furnace slag conforming to the requirements of ASTM C989/C989M, grade 100 or 120.

2.4 WATER

Provide water conforming to the requirements of COE CRD-C 400 that is clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the hardening of concrete, subject to approval. Water that meets local drinking water standards and has no pronounced taste or odor may be used without testing.

2.5 CURING MATERIALS

a. Utilize impervious-Sheet materials conforming to ASTM C171. The type is optional.

b. Utilize membrane-forming curing compound conforming to ASTM C309, Type 2.

2.6 AGGREGATES

****

NOTE: Modify the 90 percent limits if local information indicates that available aggregates cannot comply with this requirement and it is in the government's best interest to allow such a variation.

If the desire is to use State approved aggregates sources, revise the table values to match the state requirements and add supplemental line items as necessary.

****

Furnish, separately, both fine and coarse aggregates that meet requirements of these specifications. The coarse aggregate may consist of one or more nominal size groups each consisting of at least 90 percent by weight of aggregate retained on the 4.75 mm No. 4 sieve, and if used, provide fine aggregate and blending material having at least 90 percent by weight of aggregate passing the 4.75 mm No. 4 sieve.

2.6.1 Coarse Aggregate

****

NOTE: Crushing the gravel tends to improve quality and bond characteristics and generally results in higher flexural strength of concrete and a more stable mixture under compaction. When mixture proportioning studies or local experience indicates that low flexural strength will be attained by using an uncrushed gravel, the possibility of attaining higher strength by crushing the gravel should be investigated. When desirable to require all the coarse aggregate to be crushed, modify the paragraph by deleting uncrushed gravel and adding the sentence in brackets.

If history of aggregate sources in the project area indicates lower concrete strengths are caused if dust and other coatings are not washed from the aggregate, then the option in brackets for washing aggregate should be considered if economically justified.

****

Provide crushed or uncrushed gravel, crushed stone, or a combination thereoffor coarse aggregate. Provide crushed gravel which contain not less than 60 percent by weight of crushed particles size having at least one freshly fractured face, in each sieve. Provide coarse aggregates that consist of clean, hard, uncoated particles meeting the specified requirements of ASTM C33/C33M and deleterious substances for Class 5S. Provide aggregate particles generally spherical or cubical in shape.

2.6.2 Fine Aggregate

2.6.2.1 General Requirements

Provide natural sand, manufactured sand, or a combination of the two meeting the requirements of TABLE 6 - QUALITY LIMITS FOR AGGREGATE for the fine aggregate. Where necessary to meet grading requirements, a fine blending material may be used. Provide aggregate particles generally spherical or cubical in shape and composed of clean, hard, durable particles meeting the requirements of ASTM C33/C33M.

2.6.2.2 Blending Material

To meet the specified gradation, additional fines (minus 0.150 and 0.075 mm No. 100 and No. 200sieve size material), if necessary, can be provided at the Contractor's expense by adding to the aggregates a fine blending sand or pozzolan (fly ash). If pozzolan is used, provide the same material as furnished for cementitious material in accordance with paragraph CEMENTITIOUS MATERIALS. If pozzolan is used for blending additional fines,batch or feed the material together with pozzolan used as cementitious material. . If used, provide clean, hard, siliceous material for blending sand meeting all quality requirements specified herein for fine aggregate. Furnish the blending sand as a separate material to the mixer.

****

NOTE: Edit Deleterious Table according to use of RCC pavement. Use ASTM C33/C33M limits for roads, streets, and open storage areas. Include test within brackets for airfield paving.

****

2.6.3 Alkali-Silica Reactivity

****

NOTE: Use these paragraphs for regions where aggregates have a history of high alkali-silica reactivity. This requirement is more restrictive than the procedure required in Table 3.

****

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate reactivity in accordance with ASTM C1260. Test both coarse aggregate size groups if from different sources. Evaluate the fine and coarse aggregates separately and in combination matching the proposed mix design proportioning. Provide test results of each individual group and combination having a measured expansion less than 0.08 percent at 28 days after casting. Should the test data indicate an expansion equal to or greater than 0.08 percent, reject the aggregate(s) or perform additional testing in accordance with ASTM C1567 using one of the following options listed below. If any of the above options does not lower the expansion to less than 0.08 percent at 28 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance. Any changes in aggregate sources or mix proportioning will require retesting of the aggregate(s)as stated above.

2.6.3.1 Class F Fly Ash Option

Utilize the Contractor's proposed low alkali portland cement and Class F fly ash pozzolan in combination with the proposed aggregate percentage for the test proportioning. Use Class F fly ash pozzolan in the range of 20 percent to 40 percent of the total cementitious material by mass. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion to less than 0.08 percent at 28 days after casting.

2.6.3.2 GGBF Option

Utilize the Contractor's proposed low alkali portland cement and ground granulated blast furnace (GGBF) slag in combination with the proposed aggregate percentage for the test proportioning. Use GGBF slag in the range of 40 percent to 50 percent of the total cementitious material by mass. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion to less than 0.08 percent at 28 days.

2.6.4 Aggregate Gradation

****

NOTE: The combined aggregate grading is the property that must be evaluated and controlled. However, aggregates are stockpiled and handled in size groups that are typically fine aggregate 5 to 0 mmNo. 4 to 0, 19 to 5 mm3/4-inch to No. 4, and 38 to 19 mm1.5 to 3/4 inch. This section requires that the Contractor designate the size groups, the gradings of each size group, and the proportion of each size group such that the combined grading is met. Typically the grading of each size group is monitored and controlled with little regard for the combined grading. This specification requires that the combined grading also be monitored and controlled.

****

Provide a combined aggregate consisting of a minimum of at least two nominal size groups of coarse and fine aggregate with blending material, if necessary, as previously described. Provide each nominal aggregate size group with a gradation such that the two or more materials can be combined in proportions that will produce a combined gradation within the specified limits. Batch separately each size group of aggregate and blending material and feed separately to the mixer. The specified grading limits are determined in a 2 part process:

a. Determining the initial combined aggregate grading

b. Determining the base grading limit

2.6.4.1 Initial Combined Aggregate Grading Limits

Combine nominal aggregate size groups to produce a uniform distribution of aggregate particles forming a smooth, well-graded curve. Provide a selected aggregate blend that falls within the limits specified in the Table 7 - Initial Combined Aggregate Grading Limits. Utilize sSieve analysis of fine and coarse aggregates in accordance with (ASTM C136/C136M, ASTM C117) to develop the Contractor's selected aggregate blend and initial grading.

Table 7 Initial Combined Aggregate Grading Limits	
Sieve Size	Cumulative Percent Passing (by weight)
25 mm1 inch	100
19 mm3/4 inch	85-100
12.5 mm1/2 inch	70-95
9.5 mm3/8 inch	55-85
4.75 mmNo. 4	40-65
2.36 mmNo. 8	30-55
1.18 mmNo. 16	20-45
0.600 mmNo. 30	15-35
0.300 mmNo. 50	10-25
0.150 mmNo. 100	5-15
0.075 mmNo. 200	2-10

2.6.4.2 Base Aggregate Grading Limits

After testing is completed and the aggregate blend meeting the initial combined aggregate grading shown in Table 7 is selected, and after mix proportions and properties are determined using the selected blend, the base grading limits of each nominal size group of aggregate to be used during production is established. Utilize the base grading limit for each nominal aggregate size group, including any necessary blending material, in the mix proportioning study with tolerances shown in Table 8 applied to each individual sieve size. The base grading limit for each aggregate size group is used for acceptance of aggregates entering the mixer.

Table 8 Grading Limits for Each Aggregate Sieve Size	
Sieves	Tolerance, plus or minus Percentage Points
12.5 mm, 9.5 mm1/2 inch, 3/8 inch	5
2.36 mm, 1.18 mm, 0.600 mmNo. 8, No. 16, No. 30	4
25 mm, 19 mm, 4.75 mm, 0.300 mm1 inch, 3/4 inch, No. 50, No. 4	3
0.150 mm, 0.075 mmNo. 100, No. 200	2

2.7 ADMIXTURES

If used, provide water-reducing and retarding admixtures in accordance with ASTM C494/C494M, Type B or D.

2.8 EQUIPMENT

2.8.1 Paver Requirements

****

NOTE: This specification prohibits the use of traditional asphalt concrete pavers. Those are pavers that consolidate the material using a vibrating screed plate. The specified paver, also used for asphalt concrete, utilizes one or more tamping bars that compacts the material before exiting the machine. Much higher degree of compaction is attained by this type of machine.

****

Provide heavy-duty, track-equipped paver machines of the self-propelled type, similar to laydown machines (pavers) used for asphalt concrete or soil-cement construction. Provide pavers that are:

a. Equipped with hoppers, distributing screws, vibrating screed and have 2 tamping bars, adjustable screeds capable of being operated both manually and automatically, and equalizing devices.

b. Equipped with dual tamping bars and high density vibrating screeds capable of placing the RCC mix to at least 90 percent of the required density and of suitable weight and stability to spread and finish the concrete to the indicated thickness, smoothness, and surface texture requirements.

c. Confine edges of lanes to true lines without use of stationary side forms and place the concrete to the required thickness, free from segregation.

d. Equipped with interchangeable side forms (shoes) which form the edge of the pavement lane from vertically to 15 degrees from vertical.

e. Designed to operate forward at variable speeds and in reverse.

2.8.2 Paver Control

Provide a paver with automatic control of both line and grade by means of electronic controls operating from stationary stringlines on both sides of the paver. However, as appropriate, a short ski riding on an adjacent paved lane may be used in lieu of one of the stringlines. Laser control devices may be used in lieu of a stringline provided the entire process is approved by Contracting Officer. Electronic radar sensing devices may be used as screed control provided the base layer immediately below the RCC layer has been mechanically trimmed using stringlines or laser control devices. Upon final compaction and approval of the base layer, no vehicles or construction equipment are to be placed upon the area to receive RCC.

2.8.3 Compaction Equipment

2.8.3.1 Vibratory Rollers

Provide vibratory rollers that are self-propelled, double-drum, steel-wheeled. Light, walk behind, plate type or similar sized vibratory rollers will be allowed to compact the RCC. Within the range of the operational capability of the equipment, the Contracting Officer may direct or allow variations within the specified range to the frequency, amplitude, and speed of operation which result in the required density and satisfactory surface texture at the fastest production rate. Use at least one self-propelled vibratory roller, in good operating condition and meeting these requirements, full time for each paver used full time. Adjust, modify, or replace any rollers that pick up material from the surface of the pavement. Provide vibratory roller having the following features:

a. An average operating weight per drum of at least 2.7 kg/mm 150 pounds/lineal inch of drum.

b. A dynamic impact to the surface through the drums by means of revolving weights, eccentric shafts, or other equivalent methods.

c. A vibrating frequency of at least 1,500 cycles per minute.

d. An amplitude between 0.38 and 1.02 mm 0.015 and 0.040 inch at the operating frequency used.

e. Controls that permit ready variation of the amplitude at a minimum of two settings over at least 50 percent of the above range.

f. Drum diameter between 1219 and 1676 mm 48 and 66 inches and between 1676 to 2438 mm 66 to 96 inches in width.

g. Each drum equipped with an operating scraper and pad.

h. Equipped with a means of keeping the drums damp during operation.

2.8.3.2 Rubber-Tired Roller

Provide rubber-tired roller having the following features:

a. Smooth tires, nonoscillating wheels and a tire pressure adjustable between a minimum of 345 and a maximum of 620 kPa 50 and a maximum of 90 psi and with a total load between 1400 and 2000 kg 3,000 and 4,500 pounds per wheel.

b. 2 axles with at least 3 wheels per axle, offset so the front and back tires do not track in the same path.

2.8.3.3 Finish Roller

Utilize a smooth-wheeled tandem roller with a weight of 5 to 9 metric tons tons. The vibratory roller may be used without vibration as a finish roller to remove surface blemishes. Utilize a finish roller with the steel wheel coated with neoprene rubber.

2.8.4 Straightedge

Provide one 3.6 meter 12 foot straightedge for each paving spreader for testing the finished surface. Make straightedges available for Government use upon request. Utilize straightedges constructed of aluminum or other lightweight metal and having blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy; and handles to facilitate movement on the pavement.

2.8.5 Nuclear Density Gauge

Furnish one operable and properly calibrated nuclear density gauge for each paver conforming to ASTM C1040/C1040M, Method A, and be of a single-probe type. Make the nuclear density gauge available for Government use upon request.

2.8.6 Curing Equipment

Provide equipment for applying membrane-forming curing compound with the following features and configuration:

a. Be mobile, self-propelled, and pneumatically wheeled.

b. The curing compound reservoir equipped with constantly mechanically (not air) agitation during operation and a means for completely draining the reservoir.

c. A spraying system consisting of a mechanically powered pump which will maintain constant pressure during operation and an operable pressure gauge.

d. Either a series of spray nozzles evenly spaced to give uniformly overlapping coverage or a single spray nozzle which is mounted on a carriage which automatically traverses the lane width at a speed correlated with the forward movement of the overall frame

e. All spray nozzles protected with wind screens.

2.9 SAWING EQUIPMENT

****

NOTE: Retain bracketed sentence as necessary to correlate with paragraph Removal of Existing Pavement Slab. Otherwise delete. Also delete wheel saw option on Navy projects.

****

Provide equipment for sawing joints and for other similar sawing with the following features and configuration:

a. Standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment.

b. Diamond tipped blades. If demonstrated to operate properly, abrasive blades may be used.

c. Provide spares as required to maintain the required sawing rate.

d. Wheel saws with large diameter tungsten carbide tipped blades mounted on a heavy-duty chassis which produce a saw kerf at least 38 mm 1-1/2 inch wide to be used in the removal of concrete.

e. Saws capable of sawing to the full depth required.

f. Early-entry saws may be used, subject to demonstration and approval of the Contracting Officer. The initial sawcut depth can not be changed.

2.10 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

****

NOTE: Designer to fill in blanks as appropriate. Specified strength is based on flexural strength used in the structural design of the pavement or a correlation of cylinders to beams should be used. The flexural strength range for RCC is typically in the range of 450 psi to 600 psi2.7 to 4.2 MPa at 90 days of age. Designer to ensure that this strength is attainable with the available aggregates. Specify strength at 90 days. Alternate strength ages may be modified to 28 or 56 days. Consult the Transportation Systems Center for more guidance. Edit this and succeeding paragraphs to ensure the strength age is the same.

****

2.10.1 Specified Flexural Strength

****

NOTE: Use the Tailoring Option "Beams", or "Cylinders/Beams", to specify flexural strength for concrete. Use "Splitting Tensile" if specifying strength by cylinders only. Pavement design is mostly based on the flexural strength of the mixture. Field control of mixtures is most easily done by evaluating compressive strength. One purpose of the mix design program is to correlate flexural strength and compressive strength of the mixture. It is important to not overspecify strength because that will result in mixtures that generate higher heat and may result in more cracking than would otherwise occur. Consequently overdesign strength values should be added to the extent required but not be excessive. It should be added to the specified strength and no separate provision made for computing overdesign strength. Suggest that 10 percent should be added to design compressive and flexural strengths.

****

Specified flexural strength, R, for RCC is 3.8 MPa 550 psi at 28 days as determined by equivalent flexural strength, as specified in paragraph: Mixture Proportioning for Flexural Strength. Maximum allowable water-binder(cementitious material) ratio is 0.45. The water-binder (cementitious material) ratio will be the equivalent water-cement ratio as determined by conversion from the volume ratio of water to cement plus SCM by the absolute volume equivalency method described in ACI 211.1. ACI 211.1 can be supplemented with ACI 211.3R or ACI 327R.

2.10.2 Concrete Strength for Final Acceptance

****

NOTE: Use the Tailoring Option "Beams", or "Cylinders/Beams", to specify flexural strength for concrete. Use "Splitting Tensile" if specifying strength by cylinders only.

****

The strength of the concrete will be considered acceptable when the equivalent 28 day flexural strengths for each lot are above the 'Specified Flexural Strength' as determined by correlation with 14-day flexural strength tests specified in paragraph: Mixture Proportioning for Flexural Strength, The strength of the concrete will be considered acceptable when the average equivalent 28-day flexural strengths for each lot are above the 'Specified Flexural Strength' as determined by correlation with 14-day compressive strength tests specified in paragraph: Mixture Proportioning for Flexural Strength and no individual set (2 specimens per sublot) in the lot are 170 kPa 25 psi or more below the equivalent 'Specified Flexural Strength'. Remove and replace any lot or sublot, respectively, that fails to meet the above criteria at no additional cost to the Government.

2.11 MIXTURE PROPORTIONING

****

NOTE: Mixture proportioning studies include aggregate quality testing which may take considerable time. The mixture trial phase and follow up testing will require several months. Consider these time limits in selection when the submittal is required. Generally, mixture proportioning studies through 28-day test results require at least 60 days to perform. If later age strength results are necessary, more time is necessary.

****

At least 45 days in advance of RCC test section construction and prior to plant assembly. Include:

a. Laboratory report on mixture design studies following proportioning method as outlined in Appendix C.

b. Source information on all proposed RCC mix materials.

c. Laboratory report of coarse and fine aggregate quality tests including individual and combined gradations and ASR testing.

d. Certified test results for chemical admixtures.

e. Mill certificates for portland cement and supplemental cementitious materials.

f. Individual beam and cylinder strength data results.

g. Compressive strength summaries and plots

h. Correlation ratios for acceptance testing and CQC testing,28 day strength test results.

The Contractor is responsible for all activities leading to development of the RCC pavement mix design. The work includes sampling aggregates, collecting materials, and laboratory testing and evaluations. The Contractor will be responsible for initial mixture proportions by the laboratory mixture proportioning trials. With approval of the Contracting Officer, the Contractor may make minor adjustments to the mixture proportions during construction as necessary to achieve the desired properties.

2.12 Composition

****

NOTE: A typical range for most applications is 250 (min) to 350 (max) kg/cubic meter (400 (min) to 600 (max) lbs/cubic yard) of cementitious material and 15 to 25 percent pozzolan by absolute volume replacement of cementitious material. Add sentence in last set of brackets on ground slag only if it will be used. Actual proportions will be determined by the testing laboratory.

****

Provide RCC composed of portland cement, water, and fine and coarse aggregates, including any necessary fine blending material. Pozzolans may be used in the RCC composition. The cementitious materials used may be portland cement in combination with a pozzolan or, at the Contractor's option, cementitious material may be portland-pozzolan cement or portland cement in combination with ground granulated blast furnace slag. A retarding admixture may be used, if ambient temperatures above [27][_____]degrees C 80 degrees F are anticipated during placement. Government approval in writing is required to use any othere admixtures demonstrated to be beneficialand used in the mixture proportioning studies. All materials used in the mixture proportioning studies are to be representative of those proposed for use on the project.

2.13 Criteria for Mixture Proportions

Proportion the RCC mixture based on the following criteria:

a. Provide a RCC mixture with workability appropriate for the paving machine to achieve the required density, thickness, smoothness, grade, and finish texture.

b. The strength of the concrete will be considered acceptable when the equivalent 28 day flexural strengths for each lot are above the 'Specified Flexural Strength' as determined by correlation with 14-day flexural strength tests specified in paragraph: Mixture Proportioning for Flexural Strength,

c. Minimize the volume of Portland cement.

d. The mixture may contain pozzolan at a minimum replacement of 20 percentof the volume of cementitious materials.

e. The mixture may contain granulated ground blast furnace slag.

2.14 Mixture Proportioning for Flexural Strength

****

NOTE: The first Tailoring Option, "Beams", includes items a through j; the second option "Cylinders/Beams" includes the second listing of items 1 through 10.

****

Select the total mixture proportions using the procedure detailed in Appendix C at the end of this Section. Determine Compressive and flexural strength performance for each trial mixture by testing 3 nominal 150 by 300 mm 6 by 12-inch cylinders and 3 nominal 150 by 500 mm 6 by 6 by 20-inch beams each at 7, 14, 28, days.

a. Strength: Proportion a minimum of three trial mixes at approximately 2 percent above and below the cementitious material content initially selected to meet the target project design flexural strength.

b. Workability: Adjust the paste volume for each of the trial mixes to produce workability approximately 10 seconds higher and 10 seconds lower than the target workability level. Base the subsequent moisture variations on observed performance during compaction of specimens.

c. Pozzolan: If pozzolan is used, proportion two additional 2 trial mixes during the trial mix design study to establish the effects of the pozzolan addition. Using the cementitious material content selected to meet the target project flexural design, proportion two additional mixes varying the percentage of pozzolan by plus 5 percent and minus 5 percent from the selected proportioning. Replacement is calculated by volume of cementitious material. If ground granulated blast furnace slag is used the proportions will vary between 25 and 50 percent by absolute volume of the cementitious material, depending on the temperature during placing. No pozzolan or portland-pozzolan cement will be used if ground granulated blast furnace slag is used.

d. Aggregate Fines: Using the cementitious material content selected to meet the target project design, proportion two additional mixes with fines content (materials passing 0.075 mm No. 200 sieve) at 2 percent above and below the target blend.

e. Select the final mixture proportions from the performance data of the trial mixtures that best meets the mix performance criteria. The Contracting Officer may direct further adjustments to the mix proportions before and during placement.

2.14.1 Concrete Strength

a. Fabricate all beams and cylinders for each mixture from the same batch or blend of batches. Fabricate beams in accordance to Appendix B and cure all beams and cylinders in accordance with ASTM C192/C192M, using 152 x 152 mm 6 x 6 inch steel beam forms and 152 x 305 mm 6 x 12 inch single-use cylinder forms.

b. Cure test beams from each mixture for 7, 14, and 28 day flexural tests; 3 beams to be tested per age.

c. Cure test cylinders from each mixture for 7, 14, and 28 day compressive strength tests; 3 cylinders to be tested per age.

d. Test beams in accordance with ASTM C78/C78M, cylinders in accordance with ASTM C39/C39M.

e. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:

(1) 7-day flexural strength
(2) 14-day flexural strength
(3) 28-day flexural strength

(4) 7-day compressive strength
(5) 14-day compressive strength
(6) 28-day compressive strength

f. From these graphs select a w/c that will produce a mixture giving a 28 day flexural strength equal to the required strength determined in accordance with paragraph "Average CQC Flexural Strength Required for Mixtures".

g. Using the above selected w/c, select from the graphs the expected 7, 14, and 28 day flexural strengths and the expected 7, 14, and 28 day compressive strengths for the mixture.

h. From the above expected strengths for the selected mixture determine the following Correlation Ratios:

(1) Ratio of the 14-day compressive strength of the selected mixture to the 28 day flexural strength of the mixture (for acceptance).

(2) Ratio of the 7-day compressive strength of the selected mixture to the 28 day flexural strength of the mixture (for CQC control).

i. If there is a change in materials, make additional mixture design studies using the new materials and determine a new correlation ratios.

j. Obtain Contracting Officer approval of the mixture proportions prior to placement of any concrete pavement. Provide a water-binder (cementitious materials) ratio for approval that does not exceed the maximum value specified in paragraph: "Specified Flexural Strength" and do not increase ratio without the Contracting Officer's written approval.

a. Fabricate all beams for each mixture from the same batch or blend of batches. Fabricate and cure all beams in accordance with ASTM C192/C192M, using 152 x 152 mm 6 x 6 inch steel beam forms.

b. Cure test beams from each mixture for 7, 14, and 28 day flexural tests; 4 beams to be tested per age.

c. Test beams in accordance with ASTM C78/C78M.

d. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:

(1) 7-day flexural strength
(2) 14-day flexural strength
(3) 28-day flexural strength

e. From these graphs select a w/c that will produce a mixture giving a 28 day flexural strength equal to the required strength determined in accordance with paragraph "Average CQC Flexural Strength Required for Mixtures".

f. Using the above selected w/c, select from the graphs the expected 7, 14, and 28 day flexural strengths.

g. From the above expected strengths for the selected mixture, determine the Ratio of the 7-day flexural strength of the selected mixture to the 28 day flexural strength of the mixture (for CQC control).

h. From the above expected strengths for the selected mixture, determine the Ratio of the 14-day flexural strength of the selected mixture to the 28 day flexural strength of the mixture (for acceptance).

i. If there is a change in materials, provide additional mixture design studies made using the new materials and determine a new Correlation Ratios.

j. Obtain Contracting Officer approval of the Contractor's mixture proportions prior to placement of any concrete pavement. Provide an approved water-cementitious materials ratio that does not exceed the maximum value specified in paragraph: "Specified Flexural Strength" and do not increase ratio without the Contracting Officer's written approval.

PART 3 EXECUTION

3.1 PRE-PLACEMENT ACTIONS

Complete the following activities prior to the commencement of pavement placement.

3.1.1 Test Strips

Place as many test strips as necessary to adjust contractor's RCC mixture to allow evaluation of the placing characteristics and texture of the mixture and to make necessary adjustments prior to placing the test section. The test strips may be in the vicinity of the onsite plant or off site. The Contracting Officer or his Representative is to be notified 7 days in advance of the start of the test strip placement and is required be present to observe equipment and the placement process. Construct the strips one paver width wide and 9-12 m a minimum of 60 feet in length. Perform Removal of the onsite strips in coordination with the Contracting Officer or his representative at no additional cost to the Government.

3.1.2 Test Section

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NOTE: For non-critical pavement areas, the test section may be included into the actual pavement area. For critical areas, the test section should be constructed in a separate area near the jobsite, with similar conditions and pavement section to the actual construction site.

The test section should demonstrate ALL the required elements specified and should be done after

calibration of the mixing plant.

The requirement of building the test section 10 days before the main construction begins may be lengthened or shortened in the project specifications, depending on the confidence of the designer in the ability to obtain the design flexural strength in the test section.

If the test section will be included into the actual pavement area, this paragraph should be modified to state that the test section will be removed if it is unacceptable.

****

A detailed plan of the proposed test section layout, location and placement sequence at least 14 days prior to placement of the test section. At a minimum include:

a. Cold and hot weather protection methods

b. Paving sequence

c. Joint pattern

d. Curing equipment

e. Smoothness testing methods

f. Density measurement equipment and procedures

g. Diamond grinding equipment and procedures

At least 10 days but not more than 30 days prior to construction of the pavement, construct a test section near the job site at the location designated on the contract plans. Notify the Contracting Officer at least 5 days in advance of the date of test section construction. Place the test section in portions as directed by the Government. Remove all test sections unacceptable to the Contracting Officer at the Contractor's expense.

a. Timing: Two separate days are to be used for construction of the test section. The test section will provide the Contractor the opportunity to develop and demonstrate that the proposed techniques of mixing, hauling, placing, compacting, finishing and curing, and the preparation of the construction joints meet the contract requirements. Prior to placing the test section, complete the uniformity testing and calibrate the mixing plant.

b. Features: Use the same equipment, materials, and construction techniques on the test section as will be used in all subsequent work. Provide base course preparation, concrete production, placing, compacting, curing, construction of joints, and all testing in accordance with applicable provisions of this specification. Construct the test section to:

(1) Be no less than two adjacent paving lanes each 30 m 100 feet long

(2) Be the designated thickness and number of lifts

    (3) Use the same lane width proposed for use in the project

    (4) Include at least one cold transverse joint.

    (5) Include one longitudinal cold construction joint that is at least 12 hours old before placing the adjacent lane.

c. Operational Demonstration: Demonstrate the ability to meet the specified requirements for:

    (1) Plant operations and paving start-up procedures

    (2) The RCC laydown method and production rate

    (3) The rolling pattern and method for the mat, and fresh and cold construction joints

    (4) Cold joint preparation

    (5) Saw-cutting

    (6) Initial saw cutting and saw cutting for joint reservoir widening and joint sealant installation

    (7) RCC testing and evaluation methods.

d. Adjustments During Test Placement: Be prepared to make adjustments to various aspects of the test section placement as directed by the Contracting Officer. Adjustments include:

    (1) Varying the amplitude and frequency of the roller to identify the optimums

    (2) Varying the rolling pattern of the all rollers to determine the best pattern

    (3) Varying the mixture proportions other than water

    (4) Varying the water content, as necessary, to arrive at the appropriate content

e. Testing: Remove six 150 mm6-inch diameter coresfull depth, from points selected in the test section by the Contracting Officer 5 days after completion of the test section. Obtain cores in accordance with ASTM C42/C42M. Perform a visual examination of the cores for consolidation. Use the RCC cores to define the effected pavement limits for cores showing signs of large air voids other then normal entrapped air voids, a layer of paste greater then 6 mm1/4 inch at the top of the core, rock pockets or aggregate segregation. Remove and replace pavements within these defined limits as stated above at no additional cost to the Government. Test compressive strength of the cores in accordance to ASTM C39/C39M at 7, 14, and 28 days of age.

f. Acceptance: The acceptability of the test section is determined by all specified performance factors, density, thickness, strength, surface smoothness, and surface texture. Failure to construct an acceptable test section will necessitate construction of additional test sections at no additional cost to the Government. Remove test sections if outside the paving limits after completion of the test section evaluations and with the approval of the Contracting Officer. Submit all test results in report form and obtain the Contracting Officer approval, prior to starting full production.

3.1.3 Subgrade Preparation

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NOTE: Designer will include the title of the applicable specification section used for base course or subgrade, and delete inappropriate sections.

****

Condition all previously constructed material underlying the RCC pavement as specified in Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING]. Correct all deficiencies in the underlying material prior to placing RCC concrete on a cleaned and moistened surface, as directed. The Contracting Officer will inspect and approve the surface of the underlying material prior to placing RCC pavement.

3.1.4 Grade Control

Establish and maintain lines and grades shown on contract drawings for each pavement category of the contract by means of line and grade stakes. Establish and control the finished pavement gradelines and elevations shown at the site of work in accordance with bench mark elevations shown on the contract drawings. Finish the surface of the underlying material to the necessary grade such that when the required thickness of RCC is placed, the pavement surface will meet the indicated grade. Construct the finished and completed RCC pavement to the lines, grades, cross section, and dimensions indicated.

3.2 TRANSPORTING AND PLACING METHODS

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NOTE: The Submittal is to be reviewed in advance of the test section construction. The test section is where the Contractor demonstrates the proposed processes. The processes may change as a result of the test section and the resubmittal documents that change.

****

Provide initial submittal 30 days in advance of the test section construction. A resubmittal is to be done after completion of a successful test section at least 10 days in advance to the RCC Pavement full production placement.

a. Provide narrative, equipment, crew list, and manufacturer's literature for the following operations for normal and adverse weather conditions:

    (1) Transporting RCC from plant to placement area

    (2) RCC feeders to the laydown equipment

    (3) Laydown equipment

(4) Grade and alignment control

(5) Compaction

(6) Curing

b. Instructions on adjustment and operating procedures including corrective action(s) necessary to assure a tight, smooth surface on the RCC pavement, free of tears and other surface imperfections, including surface pitting.

Haul concrete from the mixer to the placing site in dump trucks. Dump the trucks directly into the hopper of the paver or into an approved secondary material distribution system which deposits material into the paver hopper. Do not dump RCC directly onto the prepared subgrade or adjacent areas. Schedule deliveries so that concrete will be spread and rolled within the time limit specified in paragraph COMPACTION and spreading and rolling of all mixture prepared for 1 day's run can be completed during daylight unless artificial lighting is provided. Loads that have become visibly contaminated or have become wet by rain will be rejected. Hauling over freshly placed concrete will not be permitted. Remove RCC not meeting these specifications from the placement area and disposed of at a location designated by the Contracting Officer.

3.3 BATCHING AND MIXING

Operate the plant to produce a uniform and homogeneous mixture with the proportions developed during the mixture proportioning process and otherwise approved. Batch or feed all materials separately used in the mixture, except that fly ash used as aggregate fines that are to batched or fed with fly ash used as cementitious material.

3.3.1 Mixing

Convey the aggregates, cementitious materials, water, and admixtures to the mixer in proportions, as required. In batch mixing,dry-mixed at least 15 seconds the aggregates and cementitious materials charged into the mixer. Add water and continue mixing as required to obtain a homogeneous mixture. Adjust the paddles of the pug mill, as necessary, to provide the required mixing time and to provide a thorough mixing. Maintain the shaft speed of the pug mill at the speed recommended by the manufacturer. Maintain the RCC mixture below the tips of the paddles of the pug mill mixer when paddles are in vertical position. Maintain the mixer and mixer paddle surfaces free of hardened concrete and other contamination. Replace mixer paddles when the dimensions are worn down more than 10 percent from new paddles of the same type and manufacture. Keep new paddles onsite for comparison.

3.3.2 Water Content

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NOTE: Mixture workability is a major factor in achieving the required density and the most desirable surface texture. Periodic water content adjustments are necessary to compensate for stockpile moisture variations or variable aggregate properties. Typically these adjustments are minor and it is normal that the Contractor have the latitude to make the adjustments as required.

Otherwise a timely response to an observed condition cannot be made.
****

The initial or start-up water content will be approved by the Contracting Officer based on results of the mixture proportioning trials. After startup, control the total water content of the mix as necessary to meet all requirements stated herein. Vary the water content at frequent intervals, as necessary and as considered appropriate, because of placing and compacting operations. In general, base water content on:

a. The action of the vibratory roller on the freshly placed concrete

b. The field density test results attained in the pavement

c. The texture of the RCC surface being produced

3.3.3 Mixture Uniformity Testing

Perform mixture uniformity testing, prior to the production and placement of any RCC, to evaluate the batching and mixing process. Use the same RCC mix proportions, materials,and mixing equipment for testing as proposed for use on the project. Perform all mixture uniformity testing in accordance with COE CRD-C 55 as modified herein and paragraph CONTRACTOR QUALITY CONTROL.

3.3.3.1 Mixer Regular Uniformity Testing

a. Perform regular uniformity testing on three separate samples or batches representing full-production batch of concrete. For continuous mix plants, take samples during full plant production at 1 minute intervals.

b. Before uniformity data are available, use at least 75 seconds for the mixing time for each batch after all solid materials are in the mixer, and provided that all of the mixing water is introduced before one-fourth of the mixing time has elapsed.

c. Batch RCC that meets the limits of the five uniformity requirements listed in Table 9 below. For regular testing, perform all five tests on each of three batches of concrete. The range for determining acceptability is the range of test results for each of the three samples representing the single batch. The range for regular testing is the average of the ranges of the three batches. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, the results of tests on one of the mixers may apply to the others, subject to the approval of the Contracting Officer.

3.3.3.2 Abbreviated Uniformity Testing

When abbreviated testing is performed, batch the concrete to meet only those requirements in Table 9 listed for abbreviated testing. Use the same concrete proportions for uniformity tests that are to be used on the project. Perform five required tests on a single batch of concrete for abbreviated testing. The range for abbreviated testing is equal to the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, the results of tests on one of the mixers can apply to the others, subject to the approval of the Contracting Officer. Perform all mixer performance (uniformity) testing in accordance with COE CRD-C 55 and with paragraph titled TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL.

Table 9
Uniformity Requirements - Stationary Mixers

Parameter	Regular Test - Allowable Maximum Range for Average of 3 Batches	Abbreviated Test - Allowable Maximum Range for 1 Batch
Coarse Aggregate	6.0 percent	6.0 percent
Compressive Strength at 7 days	10.0 percent	10.0 percent
Water Content	1.5 percent	1.0 percent
Unit Weight of Concrete (full mix including air)	24 kg/cubic m1.5 lbs/ft	16 kg/cubic m1.0 lbs/ft
Consistency (Test - ASTM C1170/C1170M	3.0 sec	3.0 sec

3.4 PLACING AND SPREADING

3.4.1 Placing

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NOTE: Placement Schedule may be deleted if it is duplicated in the overall project schedule.

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a. Placement Schedule: Schedule of paving operations, at least 15 days prior to start of paving unless otherwise specified.

b. Timing: Place mixture as nearly continuous as possible, with an absolute minimum of stops and starts; control speed of placing to permit proper rolling. Control the timing of placement so that all RCC mixture isplaced and rolled within the time limit specified in paragraph COMPACTION. Except as specified below, for certain extremely small odd-shaped isolated areas, place and spread all concrete with the paver.

c. Charging: Do not allow the level of concrete in the paver hopper to approach empty between loads. Maintain concrete mix above the auger shaft during paving.

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NOTE: If the total pavement thickness is greater than 250 mm10 inches, use the first statement in brackets regarding lift thickness; otherwise, the second statement should be used.

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d. Setup: Adjust the paver and the speed to prevent segregation, to meet the surface requirements, and to produce a depth that, when compacted, the surface will conform to cross section, grade, and contour indicated. Do not place a layer of RCC in excess of 250 mm 10 inches or less than 100 mm 4 inches in compacted thickness.

e. Edges: Construct each edge of each lane with a sloped face of 15 degrees from vertical configuration, as directed. Utilize an edge shoe constructed so that it is within 19 mm 3/4 inch of the compacted base surface.

f. Lanes: Place mixture in consecutive adjacent lanes having a minimum width of 3 m 10 feet and a maximum width of6 m 20 feet. A wider lane may be approved by COR to prevent edge lanes less than 3 m 10 feet in width. If more than 60 minutes should elapse between placements in adjacent lanes, the construction joint is considered a "cold joint" and treatment as specified herein for cold joints isto be provided. Limit the time elapse between placement of lifts to 60 minutes on multi-lift construction. During extremely hot weather, both of these limits will be decreased by the Contracting Officer as specified in paragraph: Placing During Hot Weather or as otherwise considered appropriate. Where practical, place each lane of such length that the succeeding lane can be placed without the use of a cold joint.

g. Joints: Utilize pavers in sufficient numbers and operated in staggered formation to assist in achieving the above requirement and to produce multilane construction in one construction operation to minimize cold construction joints. Otherwise, the joint is to be constructed as a cold joint. Utilize a separate paver for placement of each lift of pavement in multi-lift construction. Obtain COR approval for the length of a lane that is to be followed by another lane.Decrease or increase this length of lane as required by air temperatures, wind, and other climatic conditions existing at the time of placement. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of an area to be paved.

h. Control of Water: Discontinue placing concreteduring rain except for light mists that do not cause intermixing of cement and water slurry on the surface.Place concrete in a pattern so that curing water from previous placements will not pose a runoff problem on the fresh surface or base course.

3.4.2 Placing Adjacent Lanes

Complete fresh longitudinal construction joints between separate lanes of concrete pavement within the time limitations in the paragraph PLACING AND SPREADING. Treat other longitudinal joints as "cold joints." Construct joints to assure continuous bond between old and new sections of pavement. Utilize extra passes of the vibratory roller and other compaction and hand finishing as necessary to assure specified full depth compaction and surface finish.

3.4.3 Special Requirements for Placing Lanes Succeeding Initial Lanes

For longitudinal construction joints, locate the screed of the paver to overlap the previously placed lane 25 to 50 mm 1 to 2 inches and tobe sufficiently high so that compaction will produce a smooth, dense joint, without offset. Remove any excess concrete, placed on the edge of the previously placed lane by the paver, by carefully using a lute by hand to push back concrete to the edge of the lane being placed, so none will remain on the surface of the previously placed lane. If necessary, when the quantity of concrete on the edge of the previously placed lane plus uncompacted material in the lane being placed exceeds that required to produce a smooth, dense joint, remove and waste the excess concrete by approved methods.

3.4.4 Handwork

Correct any paving operations that require significant handwork, other than as specified above, before restarting. Broadcasting or fanning of concrete mixture over areas being compacted will not be permitted. Suspend spreading operation, when segregation occurs in the concrete during placement, until the cause is determined and corrected. Remove segregated coarse aggregate from the surface prior to compaction. Correct irregularities in alignment of the pavement left by the mechanical spreader by hand trimming directly behind the spreader before rolling. Distortion of pavement during edge trimming arenot permitted.

3.4.5 Placing Odd-Shaped Areas

In isolated instances involving very small, odd-shaped areas where use of machine spreading is impractical, spread concrete by hand. Spread concrete in a manner to prevent segregation. Spread mixture uniformly with shovels in a loose layer of thickness that, when compacted, will conform to density, grade, thickness, and surface texture requirements.

3.4.6 Placing During Cold Weather

Discontinue placement when the air temperature reaches 5 degrees C 40 degrees F and is falling and do not resume until the air temperature reaches 2 degrees C 35 degrees F and is rising. Do not place RCC on any surface containing frost or frozen material. Make provisions to protect the concrete from freezing during the specified curing period. Heat mixing water and/or aggregates , as necessary, to produce concrete having a temperature between 10 and 30 degrees C 50 and 85 degrees F as placed. Methods and equipment for heating are to be as approved by COR. Utilize aggregates free of ice, snow, and frozen lumps before entering the mixer. Provide coverings and other means for maintaining the RCC at a temperature of at least 10 degrees C 50 degrees F for not less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. Remove and replace concrete damaged by freezing as directed.

3.4.7 Placing During Hot Weather

Take the following precautions, during periods of hot weather when the maximum daily air temperature is likely to exceed 30 degrees C 85 degrees F:

a. Utilize a 45 minute maximum period between placing succeeding lifts or lanes.

b. Sprinkle the underlying material with water immediately before placing the concrete.

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NOTE: The maximum placing temperature at which concrete should be placed is dependent on the minimum temperatures that can occur in the region. For simplicity 3 regions have been established based on average ambient air temperatures (AAAT). When air temperatures during RCC placement in these regions exceeds 30 degrees C (85 degrees F), one of the following maximum concrete temperatures should be required:

AAAT.<40 degrees, concrete temperat. <70 degrees F
AAAT <50 degrees, concrete temperat. <80 degrees F
AAAT <60 degrees, concrete temperat. <90 degrees F
****

c. Place the concrete at the coolest temperature practicable, to ensure the concrete when placed is less than degrees 32C 90 F.

d. Apply a waterfog or mist, not streams of water to the finished surfaces of the newly laid pavement to keep damp, with approved spraying equipment until the pavement is covered by the curing medium.

When the Contracting Officer determines heat or wind to be excessive, immediately take additional measures, as necessary, to protect the concrete surface. Construct wind screens, more effective fog sprays, and similar measures commencing immediately behind the paver. If these measures are not effective, immediately stop paving operations until satisfactory placement conditions exist.

3.5 COMPACTION

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NOTE: Do not, under any conditions, reduce the requirements for use of vibratory rollers operating in the vibratory mode or for use of electronic controls and stringlines or lasers.
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Accomplish compaction by self-propelled, vibratory, steel-wheeled rollers and rubber-tired rollers. Do not operate rollers in the vibratory mode when not moving. Vary the frequency and amplitude of vibration, as needed or directed, within the range specified. Keep the surfaces of roller drums and wheels clean at all times.

3.5.1 Timing

Begin rolling within 10 minutes of spreading and, except for fresh joints, complete rolling within 45 minutes of start of mixing, except during hot or dry weather conditions. In hot or dry weather, begin rolling within 5 minutes of spreading and, except for joints, complete rolling within 30 minutes of start of mixing. Delays in rolling freshly laid mixture will not be permitted.

3.5.2 Initial Rolling

Initial rolling consist of vibratory passes of the vibratory roller. This requirement for vibratory rolling is not to be relaxed. Initial static passes may be necessary before the vibratory rolling to "set" the pavement surface before vibratory compaction is started. Count a round trip over the same material as 2 complete passes (i.e., from point A to point B and return to point A by the same route are 2 complete passes).

3.5.3 Deficiency Evaluation

After initial vibratory rolling, conduct preliminary tests and examination of density, crown, grade, smoothness, and surface texture under the supervision of the Contracting Officer. Correct deficiencies before rolling is continued, so that the finished surface will conform to requirements for grade, surface texture, and smoothness specified herein.

Make further smoothness checks as directed by the Contracting Officer.

3.5.4 Vibratory Rolling and Testing

Continue rolling with the vibratory roller in vibratory mode, if necessary, until the specified wet field density as a percentage of the "Target Density," maximum wet density is attained in the lane interior, at fresh joints, and at cold joint. Perform nuclear density testing in accordance with paragraph CONTRACTOR QUALITY CONTROL.

3.5.5 Final Rolling

Stop rolling with a steel wheeled vibratory roller whenthe specified density is attained . All additional rolling beyond the vibratory passes required to produce the specified field density are at the Contractor's expense. As soon as rolling with the vibratory roller is complete, provide at least two additional passes of a rubber-tired roller with tire pressure and loading per wheel at the midpoint of the range previously specified, unless otherwise directed. Follow these passes by 2 complete passes of the finish roller with a neoprene coated steel wheel.

3.5.6 Operation of Rollers and Tampers

Adjust the speed of rollers to be slow enough to avoid displacement of the concrete but not more than 2.5 km/hr 1.5 mph. Immediately correct any displacement of concrete resulting from reversing direction of roller or from any other cause. Vary slightly in length alternate passes of roller and overlap sufficiently to provide full coverage over the surface. Utilize additional rollers if pavement density specified is not attained and/or if paving operations are getting ahead of rolling. Do not alter paving operations to accommodate a lack of rollers. Thoroughly compacted places inaccessible to large vibratory rollers with walk-behind rollers and hand-tampers to the required density, using multiple thin lifts, as necessary. Take additional field density tests for hand-tampered areas to check for required density.

3.5.7 Rolling Pattern

a. Commence rolling at the outer edge of the lane, followed by the other edge, and then the center. On subsequent adjacent lanes, begin rolling at the outer edge. Extend rolling of the first pass along each edge to within approximately 450 mm 18 inches of the edge except as otherwise approved or directed.

b. If there will be a subsequent lane placed along an edge and the joint will be constructed as a "fresh" joint, the roller is to go no closer than the 450 mm 18 inches to the outer edge until the subsequent lane is placed.

c. If there will be a subsequent lane and the joint will be treated as a "cold" construction joint, or if the edge will be the final edge of the pavement, roll the outer 450 mm 18 inches after rolling of the center of the lane.

d. If the edge abuts a previously placed strip, either as a "fresh" joint or as a "cold" joint, roll the uncompacted joint area after the center of the lane. Provide additional passes of the vibratory roller and rubber-tired roller to this joint area, as necessary, to produce the specified compaction in the joint area.

e. Utilize approved hand-finishing operations, as necessary to produce a tight surface at the joint, meeting the specified surface tolerances in Table 3. Utilize a consistent rolling pattern throughout production.

3.6 JOINTS

Provide a detailed plan of the proposed paving pattern showing all planned construction, contraction and expansion joints. Place all longitudinal and transverse construction joints on a 30 foot grid that are perpendicular to the finished layout of the pavement. The joint area is considered the RCC material within 305 mm12 inches of the joint. Construct joints to:

a. Be straight and continuous from edge to edge of the pavement.

b. Be made to ensure continuity in smoothness and grade between old and new sections of pavement, as specified hereinafter.

c. Have the same texture, full-depth density, and smoothness as specified for other sections of pavement or as specified for joints.

d. Be cleaned by brushing or cut back with approved power saw, as directed, regardless of age, contact surfaces of previously constructed strips that have become coated with dust, sand, or other objectionable material.

3.6.1 Longitudinal Construction Joints

Any construction joints in which the density fails to meet the specified limits is to be trimmed by sawing the edge of the hardened concrete with a power concrete saw, not earlier than 24 hours age.

a. Make the sawcut at least 150 mm 6 inches from the original edge, and more if necessary to produce an acceptable joint.

b. Make the sawcut the full depth of the pavement to produce a face within 15 degrees of vertical, free of all loose or uncompacted material.

c. Carefully remove the outer portion to prevent any damage to the sawed face. Resaw edge if damage occurs.

d. If necessary, utilize additional rolling to assure that full depth density and surface texture is attained.

3.6.2 Transverse Construction Joints

a. When a transverse construction joint is required, operate the roller to pass over the end of the freshly placed concrete.

b. Cut the tapered end of the strip, with a power concrete saw to full depth of the lift and the excess material removed.

c. In continuing placement of the strip, position the paver on the transverse joint so that sufficient fresh concrete will be spread to obtain a joint which will conform to required full-depth density and smoothness specified, after rolling. When necessary, hand finish the fresh mixture at the joints and provide additional rolling to assure that specified full-depth density and surface finish is attained.

3.6.3 Joints in Multi-lift Construction

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NOTE: Delete this paragraph if only one course construction is to be used in the project. Delete bracketed statement if all lift joints are to receive bedding mortar.

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a. Place the top layer so that longitudinal joints in that layer will coincide with joints in the lower layers of the pavement.

b. Place the transverse joints in the top layer to coincide with transverse joints in the lower layers of the pavement.

3.6.4 Slip Joints

Construct slip joints between roller-compacted and conventional concrete where no expansion joint is required and as shown on the contract drawings. For either RCC or PCC, coat the edge of the initial placement with a bituminous product, a minimum of 3 mm 1/8 inch thick, prior to placing the next material. If RCC is placed prior to conventional concrete, sawcut the RCC full depth at the joint line and remove excess RCC material. Prepare the joint for sealing as described below. Provide a full depth expansion joint, in lieu of a slip joint, for any mismatched joints or three sided joint. Utilize a thickened edge type joint for the pcc side.

3.6.5 Sawing of Contraction Joints

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NOTE: Sawing of transverse contraction joints is recommended because of appearance and ease of sealing. However, in the past much RCC pavement has been allowed to crack naturally without benefit of sawing. These natural cracks normally occur at 12 to 20 m (30 to 70 ft) spacing. Saw joints for hardstands, streets, and roads. Sawing of transverse joints on tank trails may be deleted. Delete this paragraph if all sawed joints are not being used and modify paragraph Sealing Joints and Cracks accordingly. The bracketed statement should be included if longitudinal construction joints are to be sawed and sealed.

****

a. Saw transverse contraction joints at 12 m 30 foot spacing or as otherwise indicated. Saw longitudinal construction joints between lanes to form a reservoir for joint sealant in the same manner as specified below.

****

NOTE: Very early age sawing is commonly done for conventional concrete pavements. It is also appropriate for RCC pavements where sawn joints is desired. Specialized equipment is necessary for sawcutting to be done at very early ages so that damage to the joint and pavement is prevented.

****

b. Timing for Sawing. Accomplish initial joint sawing where indicated by using a 3 mm 1/8 inch blade to the depth indicated. Vary the time of sawing depending on existing and anticipated weather conditions and to prevent uncontrolled cracking of the pavement. Commence sawing of the joints as soon as the concrete has hardened sufficiently to permit sawing the concrete without chipping, spalling, or tearing. Conduct sawing operations as requiredduring both day and night regardless of weather conditions. If water-curing is required, discontinue only in small areas to facilitate sawing.

c. Cracking. Before sawing a joint, examine the concrete closely for cracks, and the joint is not to be sawed if a crack has occurred within 3 m 10 feet from the planned joint location. Discontinue sawing when a crack develops ahead of the saw cut.

d. Spacing and Alignment. Saw all joints at the required spacing consecutively in the sequence of the concrete placement. Use a chalk-line or other suitable guide to mark the alignment of the joint. Do not vary the saw cut more than 13 mm 1 inch from the true joint alignment from edge to edge of the pavement area, and do not have abrupt offsets.

e. Undercutting. Inspect the sawed faces of joints for undercutting or washing of the concrete due to the early sawing, and delay sawing if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint.

****

NOTE: Installation of the final joint seal or sealant, if required, should be done after completion of the curing period. To minimize costs, it is always preferable that the sealing subcontractor be able to install all the seals or sealant at one time rather than to mobilize several times. Sealing as soon as practical is desirable so that continued construction operations don't damage or contaminate joints.

****

f. Joint Widening. After expiration of the curing period and no later than 21 days, widen the joint by sawing the upper portion of the groove to the width and depth indicated to form a reservoir for the joint sealer.

g. Cleaning Joint. Immediately after initial and final sawing of the joint, thoroughly flushed the saw cut and adjacent concrete surface with water until all waste from sawing is removed from the joint. Upon sawing the initial sawcut, install a temporary seal in the joint until the end of the curing period.

h. Equipment. Provide sawing equipment that is adequate in the number of units and the power to complete the sawing at the required rate. Provide, at the job site, an ample supply of saw blades before concrete placement is started, and at least one standby sawing unit in good working order during the sawing operation.

3.6.6 Routing Cracks

Thirty to 45 days after placement of concrete, route all random cracks which have been opened to 3 mm 1/8 inch or more and seal as specified in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT. Immediately after routing, clean and seal all random cracks. Accomplish routing with a vertical spindle type rotary router mounted on a rigid chassis so that the spindle will caster to minimizing spalling.

3.6.7 Sealing Joints

Seal construction and contraction joints as specified in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT.

3.7 CURING AND PROTECTION

****

NOTE: It is not practical to moist cure surfaces where water runoff may effect adjacent construction operations. In most cases it is preferable that RCC surfaces be cured by a membrane curing compound.

****

3.7.1 General

a. Continuously protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. Have all equipment needed for adequate curing and protection of the concrete on hand and ready for use before actual concrete placement begins. If any selected method of curing does not afford the proper curing and protection against concrete cracking, remove and replace the damaged pavement , and implement another method of curing as directed.

b. Calibrate the spraying system in accordance with ASTM D2995, Method A, for the rate of application required in paragraph: Membrane Curing. If required, utilize hand-operated sprayers operated by compressed air supplied by a mechanical air compressor which are allowed by paragraph: Membrane Curing. If the curing equipment fails to apply an even coating of compound at the specified rate, replace equipment immediately.

3.7.2 Membrane Curing

a. Timing. Apply a uniform coating of white-pigmented, membrane-forming, curing compound to the entire exposed surface of the concrete and the edge surfaces as soon as the free water has disappeared from the surface. Do not allow the concrete to dry before the application of the membrane. If any drying has occurred, moisten the surface of the concrete with a fine spray of water, and apply the curing compound as soon as the free water disappears.

b. Coverage. Apply the curing compound to the finished surfaces by means of an approved automatic self-propelled spraying machine. Apply the curing compound with an overlapping coverage that will give two-coat application coverage of 93 square m/L 400 square feet/gallon per coat, plus or minus 5.0 percent for each coat. A one-coat application may be applied provided a uniform overlapping application and coverage of 47 squarem/L 200 square feet/gallon, plus or minus 5.0 percent is obtained.

c. Manual Application. The application of curing compound by hand-operated, mechanical powered pressure sprayers will be permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms. When the application is made by hand-operated sprayers, apply a second coat in a direction approximately at right angles to the direction of the first coat. If pinholes, abrasions, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes.

d. Protection. Adequately protect concrete surfaces to which membrane-curing compounds have been applied from pedestrian and vehicular traffic and from any other possible damage to the continuity of the membrane during the entire curing period, except as required for joint-sawing operations and surface tests.

e. Membrane Damage. Resprayed by the method and at the coverage specified above, any concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied or any areas where the curing compound is damaged by subsequent construction operations within the curing period.

3.7.3 Burlap

Utilize burlap covers of 2 or more layers of burlap having a combined weight of 4746 gm or more/sq m 14 ounces or more/square yard in a dry condition. Utilize burlapthat is either new or used exclusively for curing concrete. Apply burlap strips having a length after shrinkage of at least 305 mm 1 foot greater than necessary to cover the entire width and edges of the pavement. Overlay mats at least 150 mm 6 inches. Before placing mats thoroughly wet and keep mats continuously wet and in intimate contact with the surface and edges of the pavement area for the entire curing period.

3.7.4 Protection of Pavement

After final rolling of the pavement, no vehicular traffic or equipment is permitted until the end of the curing period, except for approved curing equipment having wheel loads not exceeding 2000 kg 4,500 pounds Maintain a supply of plastic sheeting meeting the requirements of ASTM C171 and keep readily available to cover pavement less than 12 hours old if rainfall occurs.

3.8 TREATMENT OF DEFECTIVE PAVEMENT

Remove and replace defective pavements unless the deficiency is subject to payment adjustments. RCC mixtures that are improperly proportioned or become contaminated are considered defective pavements. Skin patching of an area that has been rolled are not permitted. No additional payment will be made for the repair or removal and replacement of defective pavement. Except as noted below, the following defects will require complete removal and replacement or pay adjustment. Remove and replace any defects greater than allowed for pay adjustment.

a. Reduced thickness of pavement.
b. Surface texture.
c. Smoothness.
d. Density.
e. Horizontal Alignment.

3.8.1 Pavement Removal and Replacement

Delineated defective areas to be replaced by sawing full depth of the pavement around the perimeter of the defective area. Remove the delineated area to the full pavement depth of the course without damaging the adjacent pavement. Delineated areas are to have a length or width no less than 3 m 10 feet.Adjacent slabs or portion of a slab that remains in the pavement abutting the replacement area are to have a length or width no less than 2.5 m 8 feet when measured from a joint or edge. Create a clean vertical face of the existing concrete to pave against. Conventional concrete or RCC may be used at the Contractor's option to fill the void. Construct new slabs that conform to all requirements of smoothness, surface texture, density, thickness, and concrete quality, as stated herein. Construct and seal longitudinal and transverse joints in the new slab in accordance with the original plans, if required for the adjacent slab.

3.8.2 Mix Proportion Variations

Variation in aggregate grading of of mix proportioning are subject to pay adjustment. Remove and replace pavement sections where grading variations are greater than allowed for pay adjustment orvariations in other mixture constituents beyond the specified tolerances.

3.8.3 Grade Variations

Mark and remove high spots indicated by the testing straight edge in excess of applicable tolerance or reduced by rubbing with a carborundum brick and water. Discontinue rubbing as soon as contact with the coarse aggregate is made. If high spots cannot be removed in the above manner because of disturbing the coarse aggregate, corrected by an approved surface-grinding machine after the RCC is 14 days old or remove and replace the defective pavement. When grinding of 13 mm 1/2 inch or more would be required, remove and replace the pavement.

3.9 CONTRACTOR QUALITY CONTROL

The Contractor is responsible for sampling and testing aggregates, cementitious materials, and RCC to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Furnish sampling platforms and belt templates to obtain representative samples of aggregates from charging belts at the concrete plant. Obtain samples of RCC at the point of delivery to the paver. Perform the inspection and tests described below, and based upon the results of these inspections and tests, take the action required and submit reports as required. Perform this testing regardless of any other testing performed by the Government, either for pay adjustment purposes or for any other reason.

3.9.1 Laboratory Accreditation

Provide laboratory and testing facilities at the expense of the Contractor. Utilize laboratories that are accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation are to be current and include the required and optional test methods, as specified throughout this Section.

a. Aggregate Testing and Mix Proportioning: Utilize a commercial laboratory for aggregate testing and mixture proportioning studies

b. Contractor Quality Control: Utilize an approved, onsite, independent, commercial laboratory for all sampling and testing be performed or the manufacturer's laboratory for cementitious materials and admixtures.

c. Laboratory Inspection: The Government will inspect the laboratory equipment and test procedures prior to the start of concreting operations for conformance to ASTM C1077. Maintain any certifications at the laboratory for the duration of the project.

3.9.2 Reports

Report all results of tests conducted at the project site on the same day tested and deliver to the Contracting Officer. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Confirmed in writing in the routine reports, such reports of failure and the action taken. The Contracting Officer has the right to examine all Contractor quality control records at any time.

3.9.3 Lots and Sublots

****

NOTE: The lot size can be specified on the basis of time (i.e., 4 hours, 1 shift, etc.) or amount of production (i.e, 500 cu m (665 cu yd), 1000 cu m (1333 cu yd), etc.). If the lot size is based on the amount of production, it normally should be selected to be approximately equal to the amount of RCC expected to be produced in 1 shift of operation. The lot size should not exceed 1500 cu m (2000 cu yd) of RCC. When a lump sum contract is used, the lot size becomes the total job; thus, the percent payment is applied to the contract price. The following paragraphs will be edited accordingly.

Delete this paragraph if the project is small or control based on lots is not appropriate. Revise QC table where lots and sublots are identified.

****

Areas to be tested and quantities for which payment is to be adjusted will be based on pavement areas subdivided into lots and lots subdivided into sublots. A lot will be that quantity of construction that will be evaluated for compliance with specification requirements. A lot will be equal to [375][_____] cu m10hours production. Sublots are designated and defined for the specific parameter to be tested. Thickness, surface smoothness, and surface texture determinations will be made on the lot as a whole. In order to evaluate field density, each lot will be divided into 4 equal sublots. All samples and test locations will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs.

3.9.4 Additional Sampling and Testing

****

NOTE: Add bid items for requirements that may need additional testing.

****

The Contracting Officer will request additional samples and tests for any area that appears to deviate from the specification requirements. The Contractor will pay for the cost of any additional testing if tests verify deficient material. If tests verify that materials conform to the specifications, payment will be made under the appropriate bid item. Testing in these areas will be in addition to the lot testing, and the requirements for these areas will be the same as those for a lot.

3.9.5 Testing and Evaluation

****

NOTE: In Table 10 modify testing items and frequency of testing to fit project specific conditions.

****

Based upon the results of these tests, take the action and submit reports as required in Table 10, and any additional tests to ensure that the requirements of these specifications are met.

TABLE 10
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Cementitious Materials Sampling			
1 Sample per 500 metric tonstons	None	none	2.2 kg5 lbs samples to be collected labeled, stored and delivered to the Contracting Officer after completion of the project
Fine Aggregate Gradation and Fineness Modulus			
1 sample every 500 metric tonstons of aggregate during production	ASTM C136/C136M sample stockpile	Outside limits on any sieve	Retest
		2nd failure	report to COR, stop, repair, retest
1 per sublot during RCC placement	ASTM C136/C136M sample discharge belt from plant	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, stop, repair, retest
Coarse Aggregate Gradation			
1 sample every 500 metric tonstons of aggregate during production	ASTM C136/C136M sample stockpile	Outside limits on any sieve	Retest
		2nd failure	report to COR, stop, repair, retest

TABLE 10
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
1 per sublot during RCC	ASTM C136/C136M sample discharge belt from plant	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, stop, repair, retest
Aggregate Deleterious and Quality			
First test no later than time of uniformity testing and then every [30][60] days of RCC	see paragraph AGGREGATES		Stop production, retest, replace aggregate. Increase testing interval to 90 days if previous 2 tests pass
Aggregate Moisture			
Daily	ASTM C566		Stop, adjust plant settings accordingly
Plant - Scales, Weighing Accuracy			
Monthly	NRMCA CPMB 100		Stop plant ops, repair, recalibrate standard test weights accurate to plus or minus 0.1 percent and provide for checking
Plant - Calibration of Batching and Recording Equipment			
Weekly	Record/Report	Record required/recorded/actu batch mass	Stop plant ops, repair, recalibrate. See paragraph 3.11.1
Plant - Record of Batch Plant Controls			
Every lot	Record/Report		Record type and amount of each material per lot
Plant - Mixer Uniformity - Stationary Mixers			
Every 4 months during paving	COE CRD-C 55	After initial approval, use abbreviated method	Increase mixing time, change batching sequence, reduce batch size to bring into compliance.
RCC Moisture Density Relationship			
Start of each lot	ASTM D1557	Sample taken at plant discharge	See paragraph 3.9.8
Nuclear Density Gage RCC Calibration			

TABLE 10
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Daily	Test Block	Calculate calibration factor for placing period	Report change of more than 4 percent of previous value to Contracting Officer and initiate gage
Field Density and Field Moisture			
Per 100ft of paving lane and 100ft of Joint	ASTM C1040/C1040M Method A, and ASTM D6938 at the placement within 30 minutes of mixing RCC		See paragraph 3.9.8
Concrete Mixture - Temperature			
When test specimens prepared	ASTM C1064/C1064M sample at point of discharge within the paving lane	See paragraph WEATHER LIMITATIONS	
Concrete Mixture - Strength			
8 per lot	ASTM C39/C39M sample at point of discharge within the paving lane	See paragraph CONCRETE STRENGTH TESTING for CQC Perform fabrication of strength specimens and initial cure outside the paving lane and within 300 m 1,000 feet of the sampling point.	
Surface Smoothness			
Continuous and within 1 hour of		Exceed tolerances	Notify Contracting Officer and modify operation. See paragraph 3.10.4
Pavement Texture			
Each lot			See paragraph 3.10.6
Pavement Thickness			
1 core per sublot	ASTM C174/C174M		See paragraph 3.10.5
Paving - Inspection Before Paving			

TABLE 10
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Prior to each paving operation	Report	Inspect underlying materials, construction joint faces, forms, reinforcing, dowels, and embedded items	
Paving - Inspection During Paving			
During paving operation	Report	Monitor and control paving operation, including placement, consolidation, finishing, texturing, curing, and joint sawing. See paragraph 3.9.13	
Paving - Roller Vibration			
Weekly, during paving	Vibration Meter	Test frequency and amplitude of each roller.	Repair or replace defective rollers.
Membrane Compound Curing			
Daily	Visual	Calculate coverage based on quantity/area	Respray areas where coverage defective. Recalibrate equipment
Inspection of Hot Weather Measures			
Once per day	Visual		Repair defects, report conditions to Contracting Officer
Inspection of Cold Weather Protection			
Once per day	Visual		Repair defects, report conditions to Contracting Officer

3.9.6 Calibration of Mixing Plant

Check the accuracy of proportioning for continuous plants by simultaneously securing timed samples of the cementitious materials and the combined aggregate as they are fed to the mixer and weighing each as appropriate.

3.9.7 Field Density Testing

****

NOTE: For record, nuclear density gauge readings of moisture content and density should be taken at 50 mm 2 inchintervals to the thickness of the pavement minus 50 mm2 inches, although the deepest reading only will be the basis for acceptance. The deepest readings of the nuclear density gauges of the Contractor and Government should be checked for agreement. The deepest reading should be approximately 50 mm2 inches less than the depth of the pavement slab.

****

a. Furnish one operable and properly calibrated single probe nuclear density gauge meeting the requirements of ASTM C1040/C1040M for each paver. Submit a copy of the State license authorizing the use of a nuclear gage, and manufacturer certification that operators have completed an approved safety and gage operation training session. For each gage to be used on site, provide the date of calibration, the calibrating organization, list of calibration standards, and the calibration curve. Include a description of the nuclear density gauge apparatus proposed for use, the manufacturer's literature and the latest manufacturer's calibration results of the nuclear density gauge in the submittal.

b. Determined the maximum wet density or "target density" by ASTM D1557 using a 150 mm 6-inch mold.

c. Perform the density test using a single probe nuclear density gauge operating in the direct transmission mode so density of the full depth of the pavement can be measured. Include test readings at a depth of 2" above the bottom of the lift being placed mm Report both wet and dry densities, and all individual readings. Determined moisture content at the same depths. Report wet field density as a percentage of the "Target Density" maximum laboratory wet density as determined for that lot. Fill all holes left in the concrete as a result of nuclear density testing with a commercially available pre-packaged nonshrink grout that meets the requirements of ASTM C1107/C1107M.

d. Take additional tests as directed, particularly during start-up and when problems with attaining required density occur. Upon request, provide a nuclear density gauge for Government use.

e. See Appendix A, at the end of this Section for sample density computations. If any nuclear density gauge reading is below 97.8 percent for interior or fresh joint or below 95.8 percent for a cold joint, perform another test within a 1.5 to 2.4 m 5 to 8 foot radius of the previous testing location. If this adjacent reading is also below the density requirements, immediately notified the Contracting Officer, and apply additional vibratory roller passes across the full lane width between the last testing location that produced an acceptable reading and the paver. If additional vibratory roller passes cause the density to decrease or cause the surface texture and appearance to deteriorate in the opinion of the Contracting Officer, discontinue the paving operation until appropriate adjustments are made to the moisture content of the mixture, to the operation of the paver, to rolling procedures, or other operations to assure that the specified density and surface requirements can be achieved.

3.9.8 Concrete Strength

Contractor Quality Control is responsible for the following steps for concrete strength determination:

a. Correlation of Beams and Cylinders in Laboratory, Cylinders in Field

(1) Take samples for strength tests at the paving site. Fabricate test cylinders in accordance to ASTM C1435/C1435M and cure test cylinders in accordance with ASTM C31/C31M; test them in accordance with ASTM C39/C39M.

(2) Fabricate and cure 2 test cylinders per sublot from the same batch or truckload and at the same time acceptance cylinders are fabricated and test them for compressive strength at 7-day age.

(3) Average all 8 compressive tests per lot. Convert this average 7-day compressive strength per lot to equivalent 28 day flexural strength using the Correlation Ratio determined during mixture proportioning studies. See Appendix B at the end of this Section.

****

NOTE: Adjust ages to match design requirement.

****

(4) Compare the equivalent 28 day flexural strength from the conversion to the Average Flexural Strength Required for Mixtures from paragraph of same title.

****

NOTE: Adjust ages to match design requirement.

****

(5) If the equivalent average 28 day strength for the lot is below the Average Flexural Strength Required for Mixtures by 138 Pa 20 psi flexural strength or more, at any time, adjust the mixture to increase the strength, as approved.

****

NOTE: Adjust ages to match design requirement.

****

(6) The Contractor's CQC testing agency is responsible for maintaining up-to-date control charts for strength, showing the 7-day CQC compressive strength, the 14-day compressive strength (from acceptance tests) and the 28 day equivalent flexural strength of each of these for each lot.

3.9.9 Surface-Smoothness Determination (Straightedge Testing)

a. Furnish one 3.7 m 12 ft straightedge for each paving spreader for testing the finished surface. Provide straightedges for Government's representative use upon request. Provide straightedges constructed of aluminum or other lightweight metal and blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Provide straightedges with handles to facilitate movement on the pavement.

b. Test the surface of the pavement with an approved straightedge immediately after rolling is complete in each area, but not later than 1 hour after the concrete has been placed or test with other approved device that will reveal all surface irregularities varying from the testing edge exceeding tolerances specified in Table 5-LIMITS AND ALLOWABLE VARIATIONS. Test the entire area of the pavement involved in both a longitudinal and a transverse direction on parallel lines 3 m 10 feet or less apart. Hold the straightedge in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Carry straightedge testing continuously across joints. Perform the testing in the presence of the Contracting Officer.

3.9.10 Surface Texture

After all rolling and curing is complete, provide a smooth and uniform final surface texture over the whole area of the pavement. Provide a final surface that is totally free of any surface pitting, voids or indentations, pockmarks, surface tears, check cracking, segregation or rock pockets, pumped areas, aggregate drag marks, areas loosened by construction operations, and areas where fines have been washed away during the curing process.

3.9.11 Determine Pavement Thickness

Drill 150 mm 6 inch diameter cores from points in the pavement within 7 days after placement of the pavement. A minimum of one core per sublot will be taken from locations selected in a random fashion by the Contracting Officer. After the first 2 lots and the thickness of all cores meet the required specified thickness and examination of the cores show good consolidation with appropriate orientation of aggregates and there are no excessive voids 102 mm4 inch diameter cores may be used. Refill core holes with a commercially available pre-packaged nonshrink grout meeting the requirements of ASTM C1107/C1107M. Cores will become the property of the Government and may be tested for strength determination or other properties as considered appropriate.

3.9.12 Inspection During Placing

The placing foremen is responsible for supervising all placing operations and for measuring and recording concrete temperatures, ambient temperature, weather conditions, time of placement, yardage placed, and method and location of placement.

a. Cold-Weather Placing. At least once during each shift, inspect all areas subject to cold-weather protection. Record all deficiencies. During removal of protection, measure the concrete and ambient temperatures at least hourly.

b. Hot-Weather Placing and Initial Curing at All Times. When the maximum daily air is likely to exceed 30 degrees C 85 degrees F, take and record the temperature of the concrete mixture at 30-minute intervals during hot-weather placement. Inspect the surface of the base course to ensure that it is sprinkled with water immediately before the concrete is placed and any deficiencies noted. Regardless of ambient temperature, inspect the finished concrete to ensure that it is kept damp until the curing medium is applied and any deficiencies noted and immediately brought to the attention of the Contracting Officer. Correct any deficiencies immediately.

c. Temperature Protection. Notify the Contracting Officer whenever the concrete temperature is not within specifications limits during the period of protection or protection removal fails to comply with the specifications requirements, and take immediate steps to correct the situation. Regardless of the ambient temperature, stop mixing and placing operations, and notify the Contracting Officer when the temperature of the concrete mixture exceeds 32 degrees C 90 degrees F.

d. Curing Operation. Inspect the curing operation to assure that the surface of the pavement is kept very moist (or wet) continuously until the end of the curing period. Notify the Contracting Officer when any pavement surface is allowed to dry before the end of the curing period, and take immediate steps to correct the situation.

APPENDIX A
Example of Computations

1.0 Field Density.
The calculation of computed percent payment based on field density is illustrated below for a typical set of field tests on the lane interior and on the fresh and cold joints in a typical lot. Assume the following test results for field density made on the lot:

a. Average lane interior density: 98.0 percent (of target density)

b. Average fresh joint density: 97.7 percent (of target density)

c. Average cold joint density: 95.4 percent (of target density)

d. Total area of lot: 2,790 sq m 30,000 sq ft (3,333 sq yd)

e. Length of completed fresh longitudinal construction joint: 610 m (2000 ft) (Paving lane on each side of joint complete)

f. Length of cold longitudinal construction joint: 228 m (750 ft) (Paving lane on one side of joint constructed with this lot)

Step 1: Determine percent payment based on lane interior density and on fresh joint and on cold joint density, using Table 1.

a. Lane interior density of 98.0 percent: 100.0 percent payment

b. Fresh joint density of 97.7 percent: 98.2 percent payment

c. Cold joint density of 95.4 percent: 86.5 percent payment

Step 2: Determine percent payment deduction based on lane interior density and on both fresh and cold joint density by subtracting each percent payment from 100.

a. Lane interior: 100 percent - 100.0 percent = 0.0 percent deduction

b. Fresh joint: 100 percent - 98.2 percent = 1.8 percent deduction

c. Cold joint: 100 percent - 86.5 percent = 13.5 percent deduction

Step 3: Determine ratio of fresh joint strip area to lane interior area (total paved area in the lot).

Multiply the length of completed fresh longitudinal construction joint by the specified 3 m 10 ft width and divide by the lane interior area (total paved area in the lot):

610 m x 3m /2790 sq m 2000 ft. x 10 ft./30000 sq ft = 0.6667 ratio of fresh joint strip area to lane interior area

Step 4: Determine the weighted percent payment deduction for fresh joint density:

Multiply percent payment deduction for fresh joint density by ratio of fresh joint strip area to lane interior area:

1.8 percent x 0.6667 = 1.2 percent weighted percent payment deduction for fresh joint density

Step 5: Determine ratio of cold joint strip area to lane interior area (total paved area in the lot):

Multiply the length of completed cold longitudinal construction joint (one side) by the specified 1.5 m 5 ft width and divide by the lane interior area (total paved area in the lot):

228 m x 1.5 m/2790 sq ft 750 ft x 5 ft/30000 sq ft = 0.125 ratio of cold joint strip area to lane interior area

Step 6: Determine the weighted percent deduction for cold joint density:

Multiply percent payment deduction for cold joint density by ratio of cold joint strip area to lane interior area:

13.5 percent x 0.125 = 1.7 percent payment deduction for cold joint density

Step 7: Compare weighted percent payment deduction for fresh joint area, for cold joint area, and for lane interior density, and select the larger:

a. Percent payment deduction for lane interior density: 0.0 percent

b. Weighted percent payment deduction for fresh joint density: 1.2 percent

c. Weighted percent payment deduction for cold joint density: 1.7 percent

d. Select the larger = 1.7 percent

Step 8: Determine computed percent payment based on field density by subtracting the larger value from Step 7 from 100:

100 - 1.7 percent = 98.3 percent computed percent payment based on field density.

2.0 Thickness

A lot in which 18 percent of the area is deficient in thickness by an average of 10 mm 3/8 inch (Category II) will have a computed percent payment for thickness of:

Category	Proportion of Total Lot Area		Percent Payment From Table 2	Weighted Percent Payment
I	(1.0-0.18) = 0.82	x	100	82.0
II	0.18	x	65	11.7
			Computed Percent Payment for Total Lot =	93.7

APPENDIX B

Procedure for Molding RCC Test Specimen for Flexural Strength Testing Using a Vibrating Hammer:

A-1 Field of Application

The procedure is for molding RCC test specimens using a vibrating hammer for third-point flexural-strength testing. Utilize a maximum aggregate size of not to exceed 25 mm 1 inch.

A-2 Equipment

1. Rectangular steel molds with inside measurements of 100 x 100 x 400 mm 6-inch x 6-inch x 16-inch.

2. Utilize a vibrating hammer, conforming to ASTM C1435/C1435M, having a 10 ± 2 kg weight, having a minimum power input of 900W and being capable of providing 2000 impacts/minute.

3. Removable steel collar to contain the last layer of RCC.
4. Steel compaction plate with a minimum thickness of 15 mm 0.6-inch that can fit into the rectangular mold.
5. Steel finishing plate with a minimum thickness of 15 mm 0.6-inch that can fit into the rectangular mold.

A-3 Molding Specimens for Flexural-Strength Testing

1. Produce specimens within 20 min of collecting the sample.
2. Using the wet density of the RCC, weigh a quantity of fresh concrete corresponding to the volume of the test specimen to be produced.
3. Use a flat shovel to fill the mold to the halfway point, moving the shovel along the rim of the mold to distribute the concrete evenly and keeping segregation to a minimum. A tamping rod can be used to spread the concrete evenly within the mold prior to consolidation.
4. Compact the concrete until the mold is half full. Install the collar. Put in the remaining concrete and compact it.
5. Remove the collar, place the steel plate on top of the mold, and complete consolidation by applying the compactor to the steel plate.
6. Spray all concrete surfaces with an evaporation retarder. Immediately cover the specimens with a nonabsorbent, nonreactive plate to retard evaporation.
7. Store the specimens on a rigid, level surface protected from sunlight, vibration, and other disturbances in an environment maintained at a temperature of 15 to 25°C 60 to 77°F. The specimens should be removed from the molds 24 ± 4 h after fabrication and moist-cured at a temperature of 21 to 25°C 70 to 77°F so that they are constantly covered with a thin coating of moisture until time of testing. Do not expose specimens to running water.

A-4 Flexural-Strength Testing

Perform flexural testing in accordance with ASTM C78/C78M.

APPENDIX C
RCC Pavement Mixture Proportioning Method

****
NOTE: TO DOWNLOAD UFGS GRAPHICS OF APPENDIX C

Go to http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf**.**

Appendix C exists as a PDF file to be inserted here after the project specification has been printed to pdf.
****

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 13 13.43 (February 2018)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-32 13 13.43 (February 2018)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 32 13 13.43

HIGH TEMPERATURE CONCRETE PAVING FOR AIRFIELDS USING LIGHTWEIGHT AND TRAPROCK AGGREGATES

02/18

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NOTE: This specification is for concrete pavements exposed to temperatures of 482 degrees C 900 degrees F or higher, referred to herein as High Temperature Concrete. Heat Resistant recommendations exist for concrete exposed to moderate temperatures of 149 to 482 degrees C 300 to 900 degrees F per ETL 14-2 but are also applicable to the specification. Those responsible for design and construction of High Temperature Concrete pavement should familiarize themselves with the most current criteria pertaining to High Temperature Concrete. The most current criteria may be obtained from the cognizant Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC, Echelon III) Pavement Engineer.

This specification is based on ETL 14-4, Vertical Landing Zone (VLZ) and Other Airfield Pavement Design and Construction Using High Temperature Concrete and NAVFAC EXWC Technical Report - traprock Aggregate Characterization for High Temperature Concrete.

Tailoring options are for both traprock and lightweight aggregates (TRAPROCK AND LIGHTWEIGHT), traprock aggregate only (TRAPROCK), lightweight aggregate only (LIGHTWEIGHT), US customary and metric units. To properly tailor this specification, choose one of the three tailoring options and hide the other two. For instance, if you chose TRAPROCK AND LIGHTWEIGHT to show both, you would hide the individual tailoring options for TRAPROCK and LIGHTWEIGHT. When tailoring for traprock or lightweight, check for bracketed items to edit. Use the TRAPROCK tailoring option whenever possible. Traprock aggregates require deleterious

materials and Alkali-Silica Reaction testing similar to normal airfield concrete; lightweight aggregates are a manufactured product to ASTM C330/C330M standards and do not require deleterious or Alkali-Silica Reaction testing.

This specification includes the ability to place the thigh temperature concrete via hand placement with a vibrating truss screed, or a fixed or slipform paver. Continuously reinforced concrete placements must always be performed with a vibrating truss screed. It is encouraged to avoid using a slipform paver, however there are some plain jointed applications where this method of placement would be advantageous.

This specification is to be used only with the written approval of the cognizant Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC, Echelon III) Pavement Engineer.

If used on Design/Build projects, this section must be prepared by the Government RFP preparer. Edit this guide specification for project specific requirements by deleting non applicable paragraphs only. For bracketed items, choose applicable items(s) or insert appropriate information. No further edited by the contractor's designer of record, unless specifically stated otherwise in the contract documents is authorized.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: In preparing contract specifications for concrete pavement, the designer will use UFC 3-250-04 STANDARD PRACTICE FOR CONCRETE PAVEMENTS

for guidance. State highway specifications may not be used.

Specifications developed for Corps of Engineers managed projects must be edited in accordance with ER 1110-34-1 Engineering and Design Transportation Systems Mandatory Center of Expertise (Section 11, 12, App A, B, C).

Contact the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC) for guidance on interpreting and editing this specification section.

This specification section is structured for Contractor sampling and testing of materials and mixture proportioning. If Government sampling, testing and mixture proportioning is required, contact the TSMCX, AFCEC pavement SME, or NAVFAC for specification language.

****

1.1 UNIT PRICES

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NOTE: For Lump Sum payment, include concrete unit price from Government estimate in paragraph PAYMENTS to provide cost basis for calculating payment reduction.

****

1.1.1 Measurements

The quantity of concrete to be paid for will be the volume of concrete in cubic meters yards including thickened edges [monolithic curb], where required, placed in the completed and accepted pavement. Concrete will be measured in place in the completed and accepted pavement only within the neat line dimensions shown in the plan and cross section. No deductions will be made for rounded or beveled edges or the space occupied by pavement reinforcement, dowel bars, or electrical conduits, nor for any void, or other structure extending into or through the pavement slab, measuring 0.1 cubic meter 3 cubic feet or less in volume. No other allowance for concrete will be made unless placed in specified locations in accordance with the approved contract modification. The quantity of other materials specified herein, and used in the construction of the work covered by this section, will not be measured for payment, but will be considered a subsidiary obligation, covered under the price per cubic meter yard for concrete. Joint sealing materials are covered in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT or Section 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT.

1.1.2 Payments

****

NOTE: Use the applicable paragraph from the two choices below and delete the other.

If this specification is used for the to construct a certified F-35B landing or hover point, typical of Vertical Landing Pads and LHA Simulators, use Lump Sum.

This specification is not intended to be used as the primary pavement of Runways and Taxiways unless there is a specific operational need to do so. The use of Unit Price should be limited to large areas such as Aprons in support of MV-22 operations.

****

1.1.2.1 Unit Price

The quantity of concrete measured as specified above will be paid for at the contract unit price when placed in completed and accepted pavements. Payment will be made at the contract price for cubic meter yard for the scheduled item, with necessary adjustments as specified below. Payment will constitute full compensation for providing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement, except for other items specified herein for separate payment.

1.1.2.2 Lump Sum

The quantity of concrete will be paid for and included in the lump-sum contract price. If less than 100 percent payment is due based on the pay factors stipulated below, a unit price of [_____] per cubic meter yard will be used for purposes of calculating the payment reduction.

1.1.3 Payment of Lots

When a lot of material fails to meet the specification requirements, that lot will be accepted at a reduced price or be removed and replaced. The lowest computed percent payment determined for any pavement characteristic discussed below (for example, thickness, grade, and surface smoothness) becomes the actual percent payment for that lot. The actual percent payment will be applied to the unit price and the measured quantity of concrete in the lot to determine actual payment. Use results of strength tests to control concreting operations. Strength will be evaluated, but will not be considered for payment adjustment. Remove and replace any pavement not meeting the required 'Concrete Strength for Final Acceptance' at no additional cost to the Government.

1.1.4 Payment Adjustment for Smoothness

1.1.4.1 Straightedge Testing

Record location and deviation from straightedge for all measurements. When more than 5.0 and less than or equal to 10.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph SURFACE SMOOTHNESS, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When more than 10.0 percent and less than or equal to 15.0 percent of all measurements exceed the tolerance, the computed percent payment will be 90 percent. When more than 15.0 and less than or equal to 20.0 percent of all measurements exceed the tolerance, the computed percent payment will be 75 percent. Remove and replace the lot when more than 20.0 percent of the measurements exceed the tolerance, at no additional cost to the Government.

1.1.4.2 Profilograph Testing

Record location and data from all profilograph measurements. When the Profile Index of a 0.1 km 0.1 mile segment of a lot exceeds the tolerance specified in paragraph SURFACE SMOOTHNESS by 16 mm per km 1.0 inch per mile but less than 32 mm per km 2.0 inches per mile, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 32 mm per km 2.0 inches per mile but less than 47 mm per km 3.0 inches per mile, the computed percent payment will be 90 percent. When the Profile Index exceeds the tolerance by 47 mm per km 3.0 inches per mile but less than 63 mm per km 4.0 inches per mile, the computed percent payment will be 75 percent. Remove and replace the lot when the Profile Index exceeds the tolerance by 63 mm per km 4.0 inches per mile or more, at no additional cost to the Government.

1.1.5 Payment Adjustment for Plan Grade

When more than 5.0 and less than or equal to 10.0 percent of all measurements made within a lot are outside the specified tolerance, the computed percent payment for that lot will be 95 percent. When more than 10.0 percent but less than 50 percent are outside the specified tolerances, the computed percent payment for the lot will be 75 percent. Remove and replace the deficient area where the deviation from grade exceeds the specified tolerances by 50 percent or more, at no additional cost to the Government.

1.1.6 Payment Adjustment for Thickness

Using the Average Thickness of the lot, determine the computed percent payment for thickness by entering the following table:

Computed Percent Payment for Thickness		
Deficiency in Thickness Determined by cores millimeters inches	Pavements Equal To or Greater Than 200 mm 8 inches Thick	Pavements Less Than 200 mm 8 inches Thick
0.00 to 6.2 0.00 to 0.24	100	100
6.3 to 12.5 0.25 to 0.49	75	65
12.6 to 18.9 0.50 to 0.74	50	0
19.0 0.75 or greater	0	0

Where 0 percent payment is indicated, remove the entire lot and replace at no additional cost to the Government. Where either of the two cores from a sublot show a thickness deficiency of 19 mm 0.75 inch or greater, [13 mm 0.50 inch for pavements 200 mm 8 inches or less in thickness] drill two more cores in the sublot and compute the average thickness of the four cores. If this average shows a thickness deficiency of 19 mm 0.75 inch or more [13 mm0.50 inch for pavements 200 mm 8 inches or less in thickness] remove the entire sublot.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 201.1R	(2008) Guide for Conducting a Visual Inspection of Concrete in Service
ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 213R	(2014; E2017) Guide for Structural Lightweight-Aggregate Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 325.14R	(2017) Guide for Design and Proportioning of Concrete Mixtures for Pavements

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2024) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123	(2014) Standard Test Method for Lightweight Particles in Aggregate

ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C294	(2024) Standard Descriptive Nomenclature for Constituents of Concrete Aggregates
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing

ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1116/C1116M	(2023) Standard Specification for Fiber-Reinforced Concrete
ASTM C1231/C1231M	(2023) Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1646/C1646M	(2016) Making and Curing Test Specimens for Evaluating Frost Resistance of Coarse Aggregate in Air-Entrained Concrete by Rapid Freezing and Thawing
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2628	(1991; R 2016) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D4791	(2019) Flat Particles, Elongated

	Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5893/D5893M	(2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
ASTM E1274	(2018); R 2024 Standard Test Method for Measuring Pavement Roughness Using a Profilograph

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(2015) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

NEW YORK STATE DEPARTMENT OF TRANSPORTATION MATERIALS BUREAU (NYSDOT)

NY 703-19 E	(2008) Moisture Content of Lightweight Fine Aggregate

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Diamond Grinding Plan; G, [_____]

Dowels; G, [_____]

Dowel Bar Assemblies; G, [_____]

Equipment; G, [_____]

Proposed Techniques; G, [_____]

Forms; G, [_____]

Reinforcement; G, [_____]

Supports; G, [_____]

Curing Materials; G, [_____]

Surface Sealer Solution; G, [_____]

SD-05 Design Data

Preliminary Proposed Proportioning; G, [_____]

Proportioning Studies; G, [_____]

SD-06 Test Reports

Batch Plant Manufacturer's Inspection Report; G, [_____]

Slipform Paver Manufacturer's Inspection Report; G, [_____]

Sampling and Testing; G, [_____]

Diamond Grinding of PCC Surfaces; G, [_____]

Mixer Performance (Uniformity) Testing; G, [_____]

Repair Recommendations Plan; G, [_____]

SD-07 Certificates

Contractor Quality Control Staff; G, [_____]

Laboratory Accreditation and Validation; G, [_____]

Commercial Laboratory; G, [_____]

NRMCA Certificate of Conformance;

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NOTE: A USACE validation letter is also required for Navy projects in regions where an accredited laboratory is not available.

****

Commercial Laboratory; G, [_____]

NRMCA Certificate of Conformance; G, [_____]

1.4 QUALITY CONTROL

1.4.1 Contractor Quality Control Staff

Reference Section 01 45 00 QUALITY CONTROL for Contractor personnel qualification requirements. Submit American Concrete Institute certification for Contractor Quality Control Staff. Qualifications and resumes for petrographer, surveyor, concrete batch plant operator, and profilograph operator. All Contractor Quality Control personnel assigned to concrete construction are required to be American Concrete Institute (ACI) certified in the following grade:

a. The minimum requirements for the CQC System Manager consist of being a graduate engineer or a graduate of construction management, with a minimum of 5 years airfield construction experience and a minimum of 1 year experience as a CQC System Manager on an airfield construction project.

b. CQC personnel responsible for inspection of concrete paving operations: ACI Concrete Transportation Inspector. The ACI Concrete Transportation Inspector is required to be present at the paving site during all paving operations, with the exception of the initial saw cutting operation. The QC manager is required to be present during initial saw cutting operations.

c. CQC staff is required to oversee all aspects of sawing operations (sawing, flushing, vacuuming, checking for random cracking, lighting).

d. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews: ACI Concrete Flatwork Technician/Finisher.

e. Batch Plant Manufacturer's Representative: A representative from the batch plant manufacturer is required to be on-site to inspect and make necessary adjustments to all components of the batch plant including but not limited to aggregate bin weighing operations, water metering, cement and fly ash weighing devices. All necessary inspections and adjustments by the manufacturer representative is required to be performed prior to uniformity testing. Submit a written Batch Plant Manufacturer's Inspection Report signed by the representative noting all inspection items and corrections and stating the batch plant is capable of producing the volume of concrete as required herein.

f. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

g. Slipform Paving Equipment Manufacturer's Representative: A representative of the slipform paving equipment manufacturer is required to be on-site to inspect and make corrections to the paving equipment to ensure proper operations. Perform a complete and full hydraulic flow test of the vibrator system prior to the test section being placed. Submit a written Slipform Paver Manufacturer's Inspection Report signed by the manufacturer's representative noting all inspections, corrections, and flow tests have been performed and the paver is in a condition to perform the required work.

h. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and Laboratory Testing Technician, Grade I or II.

1.4.2 Other Staff

Submit for approval, the qualifications and resumes for the following staff:

a. Petrographer: Bachelor of Science degree in geology or petrography, trained in petrographic examination of concrete aggregate according to ASTM C294 and ASTM C295/C295M and trained in identification of the specific deleterious materials and tests identified in this specification. Detail the education, training and experience related to the project-specific test methods and deleterious materials in the Resume and submit at least 20 days before petrographic and deleterious materials examination is to commence.

b. Licensed Surveyor: Perform all survey work under the supervision of a Licensed Surveyor.

c. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager certification.

d. Profilograph Operator: Certification by equipment manufacturer or a state Department of Transportation.

1.4.3 Laboratory Accreditation and Validation

****

NOTE: The USACE validation letter requirement does not apply to the Navy.

****

Provide laboratory and testing facilities. Submit accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM C1077, including all applicable test procedures. The laboratories performing the tests are required to be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. Provide current accreditation and include the required and optional test methods, as specified. In addition, all contractor quality control testing laboratories performing acceptance testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Contact the MTC manager listed at http://www.erdc.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/9254/Article/ for costs and scheduling. Provide on-site temperature-controlled concrete curing facilities.

1.4.3.1 Aggregate Testing and Mix Proportioning

Aggregate testing and mixture proportioning studies are required to be performed by a commercial laboratory.

1.4.3.2 Acceptance Testing

Provide all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the paving site and in the laboratory. Provide steel molds for molding the beam specimens. Provide and maintain boxes or other facilities suitable for storing and curing the specimens at the paving site while in the mold within the temperature range stipulated by ASTM C31/C31M. Provide flexural loading equipment in accordance with ASTM C78/C78M.

1.4.3.3 Contractor Quality Control

All sampling and testing is required to be performed by an approved, on-site, independent, commercial laboratory, or for cementitious materials and admixtures, the manufacturer's laboratory.

1.4.3.4 Laboratory Inspection

The Government will inspect all laboratories requiring validation for equipment and test procedures prior to the start of any concreting operations for conformance to ASTM C1077. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. The laboratory is to maintain this certification for the duration of the project.

1.4.4 Preconstruction Testing of Materials

****

NOTE: Designer must edit this paragraph and following subparagraphs as appropriate. For Design Build Contracts the testing must be performed by the Contractor utilizing an approved petrographer and commercial testing laboratory. Delete any subparagraphs which are not applicable. Fill in blanks as appropriate.

****

All sampling and testing is required to be performed. Use an approved commercial laboratory or, for cementitious materials and chemical admixtures, a laboratory maintained by the manufacturer of the material. Materials are not allowed to be used until notice of acceptance has been given. Additional payment or extension of time due to failure of any material to meet project requirements, or for any additional sampling or testing required is not allowed. Additional tests may be performed by the Government; such Government testing does not relieve any required testing responsibilities.

1.4.4.1 Aggregates

****

NOTE: Delete 'test section' for Design-Bid-Build projects. Delete 'contract award' for Design-Bid projects.

****

Sample aggregates in the presence of a Government Representative. Obtain samples in accordance with ASTM D75/D75M and be representative of the materials to be used for the project. Perform all aggregate tests no earlier than 120 days prior to [contract award][test section]. Submit test results a minimum of 7 days before commencing mixture proportioning studies.

1.4.4.2 Chemical Admixtures, Curing Compounds and Epoxies

At least 30 days before the material is used, submit certified copies of test results for the specific lots or batches to be used on the project. Provide test results less than 6 months old prior to use in the work. Retest chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing, and rejected if test results do not meet manufacturer requirements.

1.4.4.3 Cementitious Materials

Cement, slag cement, [and pozzolan]will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports showing that the material in each shipment meets the requirements of the specification under which it is provided. Provide mill test reports no more than 1 month old, prior to use in the work. Do not use cementitious materials until notice of acceptance has been given. Cementitious materials may be subjected to testing by the Government from samples obtained at the mill, at transfer points, or at the project site. If tests prove that a cementitious material that has been delivered is unsatisfactory, promptly remove it from the project site. Retest cementitious material that has not been used within 6 months after testing, and reject if test results do not meet manufacturer requirements.

[1.4.4.4 Multifilament Polypropylene Fibers

****

NOTE: Retain this paragraph for High Temperature Concrete supporting F-35B operations. Delete this paragraph if High Temperature Concrete is only intended to be used by V-22 aircraft.

Deletion of this paragraph will preclude any F-35B vertical landing operations on this High Temperature Concrete.

****

Multifilament polypropylene fibers will be accepted on the basis of the manufacturer's certification of compliance, accompanied by test reports showing that the material in each shipment meets the requirements of the specification under which it is furnished. Test reports must be no older than 6 months, prior to use in the work. Fibers may be subjected to check testing by the Government from samples obtained at the manufacturer site, at transfer points, or at the project site. Promptly remove all unsatisfactory fiber material that has been delivered to the site. Retest fibers that have not been used within 6 months after initial testing at the Contractor's expense. The Government can reject fiber material if results are not satisfactory.

]1.4.5 Testing During Construction

During construction, the Contractor is responsible for sampling and testing aggregates, cementitious materials, and concrete as specified herein. The Government will sample and test concrete and ingredient materials as considered appropriate. Provide facilities and labor as may be necessary for procurement of representative test samples. Testing by the Government will in no way relieve the Contractor of the specified testing requirements.

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NOTE: Purpose of test batches and test sections is for Contractor to optimize mixture to placement conditions. Traprock usually will only require a few of the 10 test patches. Test batches are required, as it is important that the mix have sufficient paste to close concrete surface. Traprock mixtures are very similar to normal weight airfield concrete, with the exception of fibers influencing the finishing of the surface. Finishing concrete with lightweight aggregates requires additional mixture optimization efforts to meet requirements and will likely use all 10 batches. Test batches are not required to be cured. Test sections are vital for High Temperature Concrete as sequencing of forming, steel placement, use of telebelt and developing surface finishing techniques are critical prior to actual placement.

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1.4.6 Test Batches and Sections

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NOTE: Use Test Sections for Continuously Reinforced Concrete paragraph in areas where CRC is required, such as for F-35B Vertical Landing Pad Landing Zones or other areas that may experience high jet blast pressures. Seek Echelon III guidance where other areas may be applicable.

For continuously reinforced concrete used for isolated areas that necessitate an absence of joints, such as vertical landing pads, use the first bracketed paragraph.

For plain jointed concrete used for large areas,

such as aprons, use the second bracketed paragraph.

Coordinate with the End User regarding the location of the test batches and test sections. The intent for test batches and test sections is to simulate production paving, thus delivery distance, smoothness of the roads, access through ECP’s, etc. may not be fully understood if the Test Batches and Test Sections are selected at a locations which do not represent what will be experienced during production paving.

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a. At least 10 days but not more than 90 days prior to construction of the concrete pavement, conduct trial batches and build two test sections as described herein. Provide a dedicated concrete batch plant for the Test Batch, Test Section and Production Paving production while batching is being conducted for that day. To avoid cross contamination, it is not permissible to produce other loads of other concrete between loads of High Temperature Concrete.

b. Prepare up to five, 3.8 cubic meter 5 cubic yard traprock batches 10, 3.8 cubic meter 5 cubic yard light weight batches five, 3.8 cubic meter 5 cubic yard traprock batches or 10, 3.8 cubic meter 5 cubic yard light weight batches of High Temperature Concrete to optimize mix proportions to field conditions. Start test Batches no sooner than 60 days and completed no later than 30 days prior to production paving. Prepare batches in the presence and to the satisfaction of the Government. Batches may be placed at or near batch plant to improve coordination of mix proportion adjustment. Conduct test batches at or near the batch plant to simulate travel time to site. Place batches in forms, nominally 3 m x 3 m 10 feet by 10 feet and 300 mm 12 inches thick. Provide hand-held vibrators, strike-off and hand floats similar to what will be used for production and paving. It is not required to cure test batch pads; this enables observation of time to any potential cracking.

c. Fabricate and cure six beams and six cylinders per test batch in accordance with ASTM C1231/C1231M, using 150 mm x 150 mm 6 x 6 inch steel forms and 150 mm x 300 mm 6 x 12 inch single-use or steel cylinder forms. Cure and test 2 beams and 2 cylinders at 3, 7 and 28 days. Test beams in accordance with ASTM C78/C78M, cylinders in accordance with ASTM C39/C39M. Extract two 150 mm 6 inch diameter cores from selected pads. Contracting Officer may reduce the amount of testing.

d. Concrete loads that are rejected due to noncompliance of this specification, including temperature, slump and water/cement ratio, do not count as part of the ten test batches.

[1.4.6.1 Test Sections - Continuously Reinforced Concrete

Construct two test sections near the job site at a location agreed upon with Contracting Officer, but not as part of the production pavement area. Commence test section paving after Government and Contractor have agreed upon target proportions from Test Batches. Use the test sections to develop and demonstrate to the satisfaction of the Contracting Officer the proposed techniques of SSD stockpile moisture content determination during production paving, mixing, hauling, placing, consolidating, finishing, brooming, curing, initial saw cutting, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. Include use of proposed conveyor at maximum extension necessary for production paving. Variations in mixture proportions can only be made in the presence of the Contracting Officer. Calibrate and operate the mixing plant prior to start of placing the test section. Use the same equipment, materials, and construction techniques on the test section as will be used in all subsequent work, including reinforcing steel. Provide base course preparation of six inch thick layer of the same granular base, concrete production, placing, consolidating, curing, construction of joints, and all testing in accordance with applicable provisions of this specification. Within three days after completion of each test section, provide up to six cores 150 mm 6 inch diameter by full depth cut from points selected in the test section by the Government. The cores will be evaluated by the Government. Construct the test section meeting all specification requirements and being acceptable to the Contracting Officer in all aspects, including surface texture. Failure to follow specification requirements will necessitate construction of additional test sections at no additional cost to the Government. Do not commence production paving until the results on aggregates and concrete, concrete has reached the specified 28 day strength, and evaluation of the cores, and all pavement measurements for actual plan grade, surface smoothness and thickness have been submitted and approved by the Contracting Officer.

a. First Test Section

b. Construct the first test section to consist of one paving lane at least 30 m 100 feet long and constructed 300 mm 12 inches thick on a 150 mm 6 inch thick layer of the same granular base prepared and compacted as required for the production paving. Provide a lane width of 20 feet. Wet cure pilot lane for 14 days.

c. Second Test Section

d. Construct a second test section lane adjacent to the first lane with the same dimensions as the first test lane after the minimum wet cure time of first lane per paragraph WET CURING. Purpose is to further evaluate joint construction methods, differential shrinkage and Contractor's work sequencing. Provide a header at the end of the lane. To demonstrate an unplanned transverse construction joint, provide a split header with reinforcement protruding. All requirements for the test section are applicable, as appropriate. Wet cure fill-in lane.

e. Cracks in Test Sections

f. Cracks are expected to, but do not always, develop in test sections. If cracks do occur in test section lanes, inform Contracting Officer to notify cognizant Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC, Echelon III) Pavement Engineer.

][1.4.6.2 Test Section - Plain Jointed Concrete

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NOTE: Use Test Sections for Non-Continuously Reinforced Concrete paragraph for areas that only necessitate jointed heat resistant concrete. This

may be applicable for F-35B Vertical Landing Pad Safety Zones, parking, warmup, and holding areas. Test section areas may be reduced to half a lot where areas are small like the F-35B Vertical Landing Zones.

If test section is not to be part of the production pavement area, delete the two bracketed sentences referring to test sections constructed as part of production pavement and production lot payment.
****

Up to 10 days, but not more than 60 days, prior to construction of the concrete pavement, construct a test section [near the job site, but not as part of the production pavement area.][as part of the production paving area at an outer edge as indicated on the drawings .]Construct test section of the same depth as the course which it represents. The underlying grade or pavement structure upon which the test section is to be constructed is required to be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section is required to be the same equipment to be used on the remainder of the course represented by the test section. Use the test section to develop and demonstrate the proposed techniques of mixing, hauling, placing, consolidating, finishing, curing, initial saw cutting, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. Perform variations in mixture proportions, other than water, if directed. Operate and calibrate the mixing plant prior to start of placing the test section. Use the same equipment, materials, and construction techniques on the test section proposed for use in all subsequent work. Perform base course preparation, concrete production, placing, consolidating, curing, construction of joints, and all testing in accordance with applicable provisions of this specification. Three days after completion of the test section, provide eight cores at least 150 mm 6 inches in diameter by full depth cut from points selected in the test section by the Government. Construct the test section meeting all specification requirements and being acceptable in all aspects, including surface texture, thickness, grade, and longitudinal and transverse joint alignment. Failure to construct an acceptable test section necessitates construction of additional test sections at no additional cost to the Government. [Remove test sections allowed to be constructed as part of the production pavement which do not meet specification requirements at no expense to the Government.] If slipform paving is performed and is unable to construct an acceptable test section, repair or replace the slipform paving equipment, or paving completed using fixed-forms and equipment compatible with them and allowed by the specification. Do not commence production paving until the results on aggregates and concrete, including evaluation of cores, and all pavement measurements for edge slump, joint face deformation, actual plan grade, surface smoothness and thickness have been submitted and approved.[Pavement accepted as a production lot will be evaluated and paid as specified in PART 1 GENERAL.]

1.4.6.2.1 Pilot Lane

Construct the test section consisting of one paving lane at least 130 m 400 feet long and to the same thickness as the thickest portion of pavement shown on the Drawings. Construct at the same lane width as that required for use in the project. Provide at least one transverse construction joint in the test section. If [keyed or]doweled longitudinal construction joints are required in any of the production pavements, install them full length along one side of the test lane throughout the test section. [If both keys and dowels are required, install each in half of the test section.]Construct the test section on two separate days.

1.4.6.2.2 Fill-In Lane

Consider the first 130 m 400 feet of the initial production fill-in lane as a fill-in lane test section for purposes of testing and evaluation. All requirements for the test section are applicable. Obtain cores from the fill-in lane side of the longitudinal construction joint with the pilot lane.

]1.4.7 Acceptability of Work

The materials and the pavement itself will be accepted on the basis of production testing. The Government may make check tests to validate the results of the production testing. If the results of the production testing vary by less than 2.0 percent of the Government's test results, the results of the production testing will be used. If the results of the Government and production tests vary by 2.0 percent, but less than 4.0 percent, the average of the two will be considered the value to be used. If these vary by 4.0 percent or more, carefully evaluate each sampling and testing procedure and obtain another series of Government and production tests on duplicate samples of material. If these vary by 4.0 percent or more, use the results of the tests made by the Government and the Government will continue check testing of this item on a continuous basis until the two sets of tests agree within less than 4.0 percent on a regular basis. Testing performed by the Government does not relieve the specified testing requirements.

1.4.8 Acceptance Requirements

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NOTE: The lot size can be specified on the basis of time or volume of production. Normally, it is most practical for construction oversight if a lot is made equal to one shift, but not over 10 hours. If the lot size is based on the amount of production, it is to be selected to be approximately equal to the amount of concrete pavement produced in one shift (one day) of operation. The lot size must never exceed 750 cubic meters 1000 cubic yards. of concrete pavement. When the total job does not exceed 750 cubic meters 1000 cubic yards, the lot size becomes the total job. Edit the following paragraphs accordingly. Do not change terminology (for instance computed percent payment, actual percent payment).

For continuously reinforced concrete used for isolated areas that necessitate an absence of joints, such as vertical landing pads, use the first bracketed paragraph.

For plain jointed concrete used for large areas, such as aprons, use the second bracketed paragraph.

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[1.4.8.1 Pavement Lots - Continually Reinforced Concrete

A lot will be that quantity of construction that will be evaluated for acceptance with specification requirements. A lot will be equal to one shift of production, not to exceed 76 cubic meters 100 cubic yards for continuously reinforced areas. For non-continuously reinforced areas, a lot is equal to one shift of production, not to exceed 230 cubic meters 300 cubic yards. Each lot will be divided into two equal sublots. Grade and surface smoothness determinations will be made on the lot as a whole. All samples locations are to be selected on a random basis in accordance with ASTM D3665.

][1.4.8.2 Pavement Lots - Plain Jointed Concrete

A lot is that quantity of construction to be evaluated for acceptance with specification requirements. A lot is equal to one shift of production not to exceed 750 cubic meters 1000 cubic yards. In order to evaluate thickness, divide each lot into four equal sublots. A sublot is equal to one shift of production not to exceed 190 cubic meters 250 cubic yards. Grade determinations will be made on the lot as a whole. Surface smoothness determinations will be made on every 0.1 km 0.1 mile segment in each lot. Select sample locations on a random basis in accordance with ASTM D3665. When operational conditions cause a lot to be terminated before the specified four sublots have been completed, use the following procedure to adjust the lot size and number of tests for the lot. Where three sublots have been completed, they constitute a lot. Where one or two sublots have been completed, incorporate them into the next lot (except for the last lot), and the total number of sublots used and acceptance criteria adjusted accordingly.

]1.4.8.3 Evaluation

Provide all sampling and testing required for acceptance and payment adjustment, including batch tickets with all required acceptance testing. Individuals performing sampling, testing and inspection duties are required to meet the Qualifications. The Government reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. Testing in these areas are in addition to the sublot or lot testing, and the requirements for these areas are the same as those for a sublot or lot. Provide facilities for and, where directed, personnel to assist in obtaining samples for any Government testing.

1.4.8.4 Additional Sampling and Testing

The Contracting Officer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. Testing in these areas will be in addition to the sublot or lot testing, and the requirements for these areas will be the same as those for a sublot or lot. Provide facilities for and, where directed, personnel to assist in obtaining samples for any Government testing.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Bulk Cementitious Materials

Provide all cementitious materials in bulk at a temperature, as delivered to storage at the site, not exceeding 65 degrees C 150 degrees F. Provide sufficient cementitious materials in storage to sustain continuous operation of the concrete mixing plant while the pavement is being placed.

Provide separate facilities to prevent any intermixing during unloading, transporting, storing, and handling of each type of cementitious material.

1.5.2 Aggregate Materials

Store aggregate at the site of the batching and mixing plant avoiding breakage, segregation, intermixing or contamination by foreign materials. Store each size of aggregate from each source separately in free-draining stockpiles. Provide a minimum 0.6 m 24 inch thick sacrificial layer left undisturbed for each aggregate stored on ground. Provide free-draining storage for fine aggregate and the smallest size coarse aggregate for at least 24 hours immediately prior to use. Maintain sufficient aggregate at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time concrete pavement is being placed. Do not allow tracked equipment on coarse aggregate stockpiles.

Any aggregate, coarse or fine, that is not approved for High Temperature Concrete, that is observed or detected in a stockpile must constitute rejection of the complete stockpile. Any debris, mud, dirt, organic matter, trash, garbage or any other material that Contracting Officer deems detrimental to the High Temperature Concrete, regardless of the quantity, must constitute rejection of the stockpile. Ensure that batch plant loaders, hoppers, conveyors, weigh hoppers, drums, mixers, conveyors, haul truck beds, delivery truck beds, rail cars, delivery containers, and other equipment are cleaned, washed and be free of any non-High Temperature Concrete aggregate. Any unapproved material in the High Temperature Concrete is considered noncompliant and rejection, removal and replacement of the entire affected lot is required at Contractor's expense. Instruct loader operators not to disturb the bottom 300 mm 12 inch layer of aggregate. Post a sign at the working face of each stockpile. If all the aggregate for the project will not be stockpiled at one time then access from all sides of the stockpile for charging the batch plant is required. Stockpile and continuously water all lightweight aggregates for a planned day's placement by sprinklers for 7 days prior to paving. Stockpile and continuously water manufactured traprock sands for a planned day's placement by sprinklers for 7 days prior to paving. Stockpile and continuously water all lightweight aggregates and manufactured traprock sands for a planned day's placement by sprinklers for 7 days prior to paving. Spraying by water trucks or hand-held hoses is supplemental but does not replace continuous sprinkler operation. Maintain sufficient watered aggregate at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time concrete pavement is being placed. Tracked equipment is not permitted on aggregate stockpiles. Protect all aggregate from contamination of other stockpiles, materials or deleterious material considered objectionable to Government. Reject all unsatisfactory stockpiles.

[1.5.3 Multifilament Polypropylene Fibers

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NOTE: Retain this paragraph for High Temperature Concrete supporting F-35B operations. Delete this paragraph if High Temperature Concrete is only intended to be used by V-22 aircraft.

Deletion of this paragraph will preclude any F-35B vertical landing operations on this High Temperature Concrete.

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Furnish all fibers in bulk or water soluble bags added at the plant. Store fibers in a dry and protected location and protected from damage.

]1.5.4 Other Materials

Store reinforcing bars and accessories above the ground on supports. Store all materials to avoiding contamination and deterioration.

PART 2 PRODUCTS

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NOTE: Delete any reference to any products which are not to be used on the project. Coordinate all product requirements with the appropriate agency's Pavements or Materials Engineer.

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2.1 SYSTEM DESCRIPTION

This section is intended to stand alone for construction of High Temperature Concrete airfield pavement for applied pavement temperatures of 482 degrees Celsius 900 degrees Fahrenheit or above. However, where the construction covered herein interfaces with other sections, construct each interface to conform to the requirements of both this section and the other section, including tolerances for both. Aggregates for High Temperature Concrete are defined as either lightweight (produced from expanded slate or shale) or traprock. This specification is for light weight aggregate only. This specification is for traprock aggregate only. This specification is for lightweight and traprock aggregates. Aggregates for High Temperature Concrete require additional modified testing and time for materials testing compared to normal weight concrete. High temperature concrete aggregates are very specific. Contractor to enact additional precautions to avoid cross-contamination with other materials during transportation (rail cars, trucks, containers clean of other materials), during stockpiling, and not laying tools directly on ground during placing and finishing. Contractor must note there are substantial scheduling requirements for test lanes, placing sequence, wet curing, joint sealing, sodium silicate application, and pavement markings. It requires approximately 100 days for materials sampling through test section paving and another 100 days for placement through sodium silicate application. Where the construction covered herein interfaces with other sections, the construction at each interface must conform to the requirements of either this section or the other section, whichever has the more stringent tolerances.

2.1.1 Surface Smoothness

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NOTE: Edit these paragraphs as appropriate to the project. If it is desired to restrict surface smoothness testing and evaluation to either straightedge method or profilograph method, retain the one and delete the other; otherwise, retain both as a Contractor's option. Require use of the profilograph method for airfield taxiways and runways. When the profilograph method is allowed, and there are areas with dimensions less than 60 m (200 feet) in any direction, retain the straightedge method for these short runs. Profilograph is

typically used to measure longitudinal smoothness and straightedge for transverse smoothness. Aircraft arresting systems require straightedge for longitudinal and transverse smoothness.
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Use the profilograph method for all longitudinal testing, except for paving lanes less than 60 m 200 feet in length. Use the straightedge method for transverse testing, for longitudinal testing where the length of each pavement lane is less than 60 m 200 feet,[within 60 m 200 feet on both the approach and departure sides of an aircraft arresting gear,] and at the ends of the paving limits for the project. Smoothness requirements do not apply over crowns, drainage structures, or similar penetration. Maintain detailed notes of the testing results and provide a copy to the Government after each day's testing.

2.1.1.1 Straightedge Testing

2.1.1.1.1 For Certified Vertical Landing Spots

Provide the finished surfaces of the pavements with no abrupt change of 3 mm 1/8 inch or more, and all pavements within the limits specified when checked with an approved 4 m 12 foot straightedge. Provide vertical landing spots with a variation from the specified straight edge not greater than 3 mm 1/8 inch in the longitudinal direction and not greater than 3 mm 1/8 inch in the transverse direction.

2.1.1.1.2 For All Other Areas

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NOTE: Retain first and third bracketed statements for airfield projects. Retain second bracketed statement for projects with an aircraft arresting systems.
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Provide the finished surfaces of the pavements with no abrupt change of 6 mm 1/4 inch or more, and all pavements within the limits specified when checked with an approved 4 m 12 foot straightedge.[Provide runways and taxiways with a variation from the specified straight edge not greater than 3 mm 1/8 inch in the longitudinal direction and not greater than 6 mm 1/4 inch in the transverse direction.][Provide runway pavement within 60 m 200 feet on both the approach and departure sides of an aircraft arresting gear with a variation in the longitudinal direction from the specified straightedge not more than plus or minus 3 mm 1/8 inch.][Provide all other airfield areas with a variation from a straight edge not greater than 6 mm 1/4 inch in either the longitudinal or transverse direction.]

2.1.1.2 Profilograph Testing

Provide the finished surfaces of the pavements with no abrupt change of 6 mm 1/4 inch or more, and each 0.1 km 0.1 mile segment of each pavement lot with a Profile Index not greater than specified when tested with an approved California-type profilograph.[Provide runways and taxiways with a Profile index not greater than 110 mm per km 7 inches per mile in the longitudinal direction. Provide runway and taxiway transverse smoothness measured with the straightedge method and the straightedge requirements apply. Provide all other airfield areas with a Profile Index not greater than 140 mm per km 9 inches per mile in the longitudinal direction.][

Provide roads, streets, tank hardstands, vehicular parking areas and open storage areas with a Profile index not greater than 140 mm per km 9 inches per mile in the longitudinal direction.]

2.1.1.3 Bumps ("Must Grind" Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm 0.4 inch in height by diamond grinding in accordance with subparagraph DIAMOND GRINDING OF PCC SURFACES below until they do not exceed 7.5 mm 0.3 inch when retested. Taper such diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding.

2.1.1.4 Testing Method

After the concrete has hardened sufficiently to permit walking thereon, but not later than 48 hours after placement, test the entire surface of the pavement in each lot in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. If any pavement areas are diamond ground, retest these areas immediately after diamond grinding. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines 4.5 m 15 feet or less apart, as directed. Perform the longitudinal lines at the centerline of each paving lane shown on the drawings, regardless of whether multiple lanes are allowed to be paved at the same time, and at the 1/8th point in from each side of the lane. Also test other areas having obvious deviations. Perform longitudinal testing lines continuous across all joints. Perform transverse testing lines for pilot lanes carried to construction joint lines and for fill-in lanes carried 600 mm 24 inches across construction joints, and the readings in this area applied to the fill-in lane. Perform straightedge testing of the longitudinal edges of slipformed pilot lanes before paving fill-in lanes as specified below.

2.1.1.4.1 Straightedge Testing

Hold the straightedge in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and measuring the maximum gap between the straightedge and the pavement surface. Determine measurements along the entire length of the straight edge.

2.1.1.4.2 Profilograph Testing

Perform profilograph testing using approved California profilograph and procedures described in ASTM E1274. Utilize electronic recording and automatic computerized reduction of data equipment to indicate "must-grind" bumps and the Profile Index for each 0.1 km 0.1 mile segment of the pavement lot. Accommodate grade breaks on aprons [parking lots]by breaking the profile segment into short sections and repositioning the blanking band on each section. Provide the "blanking band" of 5 mm 0.2 inch wide and the "bump template" span 25 mm 1 inch with an offset of 10 mm 0.4 inch. Count the profilograph testing of the last 9.1 m 30 feet of a paving lane in the longitudinal direction from each day's paving operation on the following day's continuation lane. Compute the profile index for each pass of the profilograph (3 per lane) in each 0.1 km 0.1 mile segment. The profile index for each segment is the average of the profile indices for each pass in each segment. Scale and proportion profilograph's of unequal lengths to an equivalent 0.1 km 0.1 mile as outlined in the ASTM E1274.

Provide a copy of the reduced tapes to the Government at the end of each day's testing.

2.1.2 Edge Slump and Joint Face Deformation

2.1.2.1 Edge Slump

When slip-form paving is used, provide a maximum of 15.0 percent of the total free edge of each pavement panel with a maximum edge slump of 6 mm 1/4 inch and none of the free edge of the pavement lot with an edge slump exceeding 9 mm 3/8 inch. (A pavement panel is defined as a lane width by the length between two adjacent transverse contraction joints. The total free edge of the pavement is the cumulative total linear measurement of pavement panel edge originally constructed as non-adjacent to any existing pavement; for example, 30 m 100 feet of pilot lane originally constructed as a separate lane, would have 60 m 200 feet of free edge; 30 m 100 feet of fill-in lane would have no free edge). The area affected by the downward movement of the concrete along the pavement edge is a maximum of 450 mm 18 inches back from the edge.

2.1.2.2 Joint Face Deformation

In addition to the edge slump limits specified above, provide a vertical joint face with a surface within the maximum limits shown below:

Offset from Straightedge Applied Longitudinally to Pavement Surface (a)	Offset from Straightedge Applied Longitudinally to Vertical Face (b)	Offset from Straightedge Applied Top to Bottom Against the Joint Face (c)	Abrupt Offset in Any Direction (d)	Offset of Joint Face from True Vertical (e)
Airfield Pavement				
3 mm 1/8 inch	6 mm 1/4 inch	9 mm 3/8 inch	3 mm 1/8 inch	8 mm per 100 mm 1 inch per 12 inches
All Other Pavement				
6 mm 1/4 inch	All other items same as airfield pavement			
(a) Measurement is taken by placing the straightedge longitudinally on the pavement surface 25 mm 1 inch from the free edge.				
(b) Measurement is taken by applying the straightedge longitudinally along the vertical joint face.				
(c) Measurement places a 9.5 mm 3/8 inch spacer attached to a straightedge and spaced approximately equal to the thickness of the concrete being measured. The offset from straightedge with spacers is measured by placing the spacers against the top and bottom of the vertical concrete face.				
(d) An abrupt offset in the joint face occurring along a short distance. Check for abrupt offsets at any location that an abrupt offset appears to be a possible issue.				

Offset from Straightedge Applied Longitudinally to Pavement Surface (a)	Offset from Straightedge Applied Longitudinally to Vertical Face (b)	Offset from Straightedge Applied Top to Bottom Against the Joint Face (c)	Abrupt Offset in Any Direction (d)	Offset of Joint Face from True Vertical (e)
(e) Measurement of the offset from the joint face to a level in the true vertical position against the joint face.				

2.1.2.3 Slump Determination

Test the pavement surface to determine edge slump immediately after the concrete has hardened sufficiently to permit walking thereon. Perform testing with a minimum 4 m 12 foot straightedge to reveal irregularities exceeding the edge slump tolerance specified above. Determine the vertical edge slump at each free edge of each slipformed paving lane constructed. Place the straightedge transverse to the direction of paving and the end of the straightedge located at the edge of the paving lane. Record measurements at 1.5 to 3.0 m 5 to 10 foot a spacing, as directed, commencing at the header where paving was started. Initially record measurements at 1.5 m 5 foot intervals in each lane. When no deficiencies are present after 5 measurements, the interval may be increased. The maximum interval is 3.0 m 10 feet. When any deficiencies exist, return the interval to 1.5 m 5 feet. In addition to the transverse edge slump determination above, at the same time, record the longitudinal surface smoothness of the joint on a continuous line 25 mm 1 inch back from the joint line using the minimum 4 m 12 foot straightedge advanced one-half its length for each reading. Perform other tests of the exposed joint face to ensure that a uniform, true vertical joint face is attained. Properly reference all recorded measurements in accordance with paving lane identification and stationing, and a report submitted within 24 hours after measurement is made. Identify areas requiring replacement within the report.

2.1.2.4 Excessive Edge Slump

When edge slump exceeding the limits specified above is encountered on either side of the paving lane, record additional straightedge measurements to define the linear limits of the excessive slump. Remove and replace concrete slabs having excessive edge slump or joint deformation to the next transverse joint in conformance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. Discontinue use of slip-form paving equipment and procedures that fail to consistently provide edges within the specified tolerances on edge slump and joint face deformation construct by means of standard paving procedures using fixed forms.

2.1.3 Plan Grade

Within 5 days after paving of each lot, test the finished surface of the pavement area by running lines of levels at intervals corresponding with every longitudinal and transverse joint to determine the elevation at each joint intersection. Record the results of this survey and provide a copy to the Government at the completion of the survey of each lot.[Provide finished surfaces of all airfield pavements that vary less than 13 mm 1/2 inch above or below the plan grade line or elevation indicated.][Provide surfaces of [_____] that vary less than 19 mm 3/4 inch.] The above deviations from the approved grade line and elevation are not permitted in areas where closer conformance with the planned grade and elevation is required for the proper functioning of appurtenant structures. Provide finished surfaces of new abutting pavements that coincide at their juncture. Provide horizontal control of the finished surfaces of all airfield pavements that vary not more than 13 mm 1/2 inch from the plan alignment indicated.

2.1.4 Flexural Strength

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NOTE: Normally, concrete for airfield pavement is to be proportioned and accepted on the basis of 90-day flexural strength. If it is desired to use 28-day strength for design of airfield pavement, approval must be obtained through the TSMCX, AFCEC pavement SME, or NAVFAC.

The designer may choose the first tailoring option CYLINDERS/BEAM or the second tiloring option BEAMS for strength testing.

****

Submit certified copies of laboratory test reports and sources for cement, supplementary cementitious materials (SCM), aggregates, admixtures, curing compound, epoxy, and proprietary patching materials proposed for use on this project. Each lot of pavement will be evaluated for acceptance in accordance with the following procedures.

2.1.4.1 Sampling and Testing

For acceptance, obtain one composite sample of concrete from each sublot in accordance with ASTM C172/C172M from one batch or truckload.[Fabricate and cure test cylinders 152 x 305 mm 6 x 12 inches in accordance with ASTM C31/C31M, and tested in accordance with ASTM C39/C39M. Test two test cylinders per sublot (8 per lot) at 14 days.][Fabricate and cure test beams 152 x 152 mm 6 x 6 inches in accordance with ASTM C31/C31M; and tested in accordance with ASTM C78/C78M.]

2.1.4.2 Computations

Average the eight 14-day strength tests for the lot. Use the average strength in accordance with paragraph CONCRETE STRENGTH FOR FINAL ACCEPTANCE.

2.1.5 Thickness

Each lot of pavement will be evaluated for acceptance and payment adjustment in accordance with the following procedure:

a. Contractor must maintain positive control of grades, and Contractor must also use surveyed elevations at the top of concrete and the top of the layer directly beneath the concrete elevation. Measure elevations on a grid measuring a maximum of 6 m by 6 m 20 feet by 20 feet. Contracting Officer may require additional surveyed elevations.

b. Prior to placing concrete, stringline across forms and measure proposed thickness of concrete. Correct any deficiencies prior to placement. Stringline measurements must be on a maximum 6 m 20 foot spacing with at least 4 measurements between forms at each stringline position.

c. Do not extract cores from High Temperature Concrete production paving lanes unless explicitly directed in writing from Contracting Officer.

2.1.6 Evaluation of Cores

Record and submit testing, inspection, and evaluation of each core for surface paste, uniformity of aggregate distribution, segregation, voids, cracks, and depth of reinforcement or dowel (if present). Moisten the core with water to visibly expose the aggregate and take a minimum of three photographs of the sides of the core, rotating the core approximately 120 degrees between photographs. Include a ruler for scale in the photographs. Provide plan view of location for each core.

2.1.7 Diamond Grinding of PCC Surfaces

Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth is limited below. Reduce high areas by diamond grinding the hardened concrete with an approved equipment after the concrete is at a minimum age of 14 days. Perform diamond grinding by sawing with an industrial diamond abrasive which is impregnated in the saw blades. Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the concrete pavement or joint faces. Provide diamond grinding equipment with saw blades that are 3 mm 1/8-inch wide, a minimum of 60 blades per 300 mm 12 inches of cutting head width, and capable of cutting a path a minimum of 0.9 m 3 ft wide. Diamond grinding equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints is not permitted. The maximum area corrected by diamond grinding the surface of the hardened concrete is 10 percent of the total area of any sublot. The maximum depth of diamond grinding is 6 mm 1/4 inch. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government property. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above in conformance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. All areas in which diamond grinding has been performed are subject to the thickness tolerances specified in paragraph THICKNESS, above.

Prior to production diamond grinding operations, perform a test section at the approved location. Perform a test section that consists of a minimum of two adjacent passes with a minimum length of 12 m 40 feet to allow evaluation of the finish, transition between adjacent passes, and the results of crossing a transverse joint. Production diamond grinding operations are not to be performed prior to approval.

2.2 CEMENTITIOUS MATERIALS

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NOTE: Edit these paragraphs as appropriate for the particular project. Guidance for use of

cementitious materials should be sought from the Pavement Materials engineer or from the TSMCX, Air Force MAJCOM paving engineers, or NAVFAC, especially for areas subject to alkali-aggregate reactivity, or sulfate attack.

When sulfate bearing soil or water is encountered, specify Type II cement for moderate sulfate concentration and consider requiring use of fly ash for partial replacement. Do not specify Type I or III cement. See UFC 3-250-04FA for guidance. Specify limit on false set if it is a problem in the area.

****

Provide cementitious materials of portland cement in combination with supplementary cementitious materials (SCM), and must conform to appropriate specifications listed below. New submittals are required when the cementitious materials sources or types change.

2.2.1 Portland Cement

Portland cement must conform to ASTM C150/C150M, Type I or II, low alkali including false set requirements.

2.2.2 Pozzolan

2.2.2.1 Fly Ash

****

NOTE: Class C fly ash is not permitted for paving concrete.

Use loss on ignition not exceeding 3 percent for frost areas to reduce carbon interference with air entraining admixture.

****

Provide fly ash that conforms to ASTM C618, Class F, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction with a loss on ignition not exceeding [3][6] percent. Provide Class F fly ash for use in mitigating Alkali-Silica Reactivity with a total equivalent alkali content less than 3 percent.

2.2.3 Supplemental Cementitious Materials (SCM) Content

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NOTE: Use first tailoring option for Navy projects. Use second tailoring option for Army/Air Force projects.

****

[Provide a concrete mix that contain one of the SCMs listed in Table 2 within the range specified therein, whether or not the aggregates are found to be reactive in accordance with paragraph ALKALI SILICA REACTIVITY.][Use of one of the SCMs listed below is optional, unless the SCM is required to mitigate ASR. The use of SCMs is encouraged in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.]

TABLE 2
SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum Content	Maximum Content
Class F Fly Ash		
SiO2 + Al2O3 + Fe2O3 > 70 percent	25 percent	35 percent
Si02 + A1203 + Fe203 > 80 percent	20 percent	35 percent
Si02 + A1203 + Fe203 > 90 percent	15 percent	35 percent

2.3 AGGREGATES

****

NOTE: Provide aggregates meeting the requirements of this specification. If aggregate sources in the project area do not meet the requirements of this specification, provide aggregates from sources outside the project area that do meet the requirements of this specification.

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2.3.1 Aggregate Sources

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NOTE: Note that the workability box for lightweight aggregate is larger than for traprock and normal weight concrete. This is because more workability is necessary to close lightweight aggregate concrete mixture pavement surface.

****

Conduct aggregate sampling for testing no more than 120 days prior to test batching unless otherwise stated.

2.3.1.1 Combined Aggregate Gradation

In addition to the grading requirements specified for coarse aggregate and for fine aggregate, the combined aggregate grading must meet the following requirements for Workability and Coarseness factors, Percent Retained Chart, and 0.45 Power Curve. Coarse, intermediate and fine aggregate gradations are commonly required. Deliver coarse and fine aggregate as individual materials to batch plant.

a. The materials selected and the proportions used must be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in 3 3 3 and 4 below, the point thus determined must fall within the parallelogram described therein.

  (1) Determine the Coarseness Factor (CF) from the following equation: CF = (cumulative percent retained on the 9.5 mm sieve)(100)/(cumulative percent retained on the 2.36 mm sieve)CF = (cumulative percent retained on the 3/8 in. sieve)(100)/(cumulative percent retained on the No. 8 sieve)

  (2) The Workability Factor WF is defined as the percent passing the 2.36 mm No. 8 sieve based on the combined gradation. Adjust the WF upwards only, by 2.5 percentage points for each 42 kg 94 pounds of cementitious material per cubic meter yard greater than 335 kg

per cubic meter 564 pounds per cubic yard.

(3) For light weight aggregate only, a diagram must be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram must be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-43), (CF-45, WF-32.5), and (CF-45, WF-47.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected must be changed as necessary.)

(4) For traprock aggregate only, a diagram must be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram must be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected must be changed as necessary.)

(5) For light weight aggregate only, a diagram must be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram must be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-43), (CF-45, WF-32.5), and (CF-45, WF-47.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected must be changed as necessary.)

(6) For traprock aggregate only, a diagram must be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram must be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected must be changed as necessary.)

b. Percent Retained Chart. Design the percent retained chart to meet the following criteria:

(1) The highest peak (the maximum percent retained) must be on the 9.5 mm 3/8 inch sieve or larger. The proportions must also have at least 60 percent of the total aggregate mass be retained on the 4.75 mm No. 4 sieve.

(2) There can only be at least 4 points difference between the two highest peaks.

(3) There can be no more than one low point between any two peaks. If there are two low points, the mixture is gap graded; if there are

three or more low points, the mixture is severely gap graded and will not function as an airfield concrete mixture.

c. 0.45 Power Curve. The 0.45 power curve upper limit is defined as a line from the origin (0,0) to 100 percent at the 19 mm 3/4 inch sieve. The 0.45 power curve lower limit is defined as a line starting at 21 percent at the 1.18 mm No. 16 sieve to 100 percent at the 37.5 mm 1.5 inch sieve. The combined gradation must plot within the upper and lower limits of the 0.45 Power Curve.

d. Some aggregate combinations may not be able to achieve all criteria. In this case, if the Workability and Coarseness factors plot correctly, the 0.45 Power Curve criteria is achieved, Criteria b.1 and b.2 of the Percent Retained Chart are achieved, and the mixture is demonstrated it can be placed, consolidated and finished to meet specification requirements, then the third Percent Retained Chart criteria, b.3, can be relaxed from specification requirements provided there are no more than two low points between any two peaks.

e. Combined gradation of all the aggregates, coarse and fine, must have no more than 10 percent passing the 0.150 mm No. 100 sieve.

2.3.1.2 Alkali-Silica Reactivity for Traprock

Evaluate and test fine and coarse traprock aggregates to be used in all concrete for alkali-aggregate reactivity. Test all coarse aggregate size groups.

a. Separately evaluate the fine and coarse aggregates using ASTM C1260. Test results of the individual aggregates must have a measured expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Should the test data indicate an expansion of greater than 0.08 percent, reject the aggregate(s) or additional testing must be performed as follows: utilize the Contractor's proposed low alkali portland cement, blended cement, and/or SCM in combination with each individual aggregate. If only SCMs are being evaluated, the testing accordance with ASTM C1567. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Base mixture proportioning on the highest percentage of SCM required to mitigate ASR-reactivity.

b. If any of the above options does not lower the expansion to less than 0.08 percent after 28 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.3.1.3 Durability Testing for Traprock

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NOTE: Use first tailoring option for Army and Air Force; second option is for Navy projects only.

****

[Provide aggregate with a satisfactory service record in freezing and thawing of at least 5 years successful service in three concrete paving projects. Include a condition survey of the existing concrete and a review of the concrete-making materials, including coarse aggregates, cement, and mineral admixtures in the service record. Consider the previous aggregate source and test results, cement mill certificate data, mineral admixture chemical and physical composition, and the mix design (cement factor and water-cementitious material ratio) in the review. Provide service record performed by an independent third party professional engineer, petrographer, or concrete materials engineer along with their resume. Include photographs and a written report addressing D-cracks and popouts in accordance with ACI 201.1R in the service record. Provide coarse aggregate with a durability factor of 80 or more when subjected to freezing and thawing of specimens prepared in accordance with ASTM C1646/C1646M and tested in accordance with ASTM C666/C666M, Procedure A, when a coarse aggregate size group or source proposed for use does not have a satisfactory demonstrable service record. Test all coarse aggregate size groups and sources proposed for use individually.][Evaluate and test all fine and coarse aggregates to be used in all concrete for durability in accordance with ASTM C88. Provide fine and coarse aggregates with a maximum of 18 percent loss when subjected to 5 cycles using Magnesium Sulfate or a maximum of 12 percent loss when subjected to 5 cycles if Sodium Sulfate is used.]

2.3.1.4 Alkali-Silica Reactivity for Traprock

Evaluate and test fine and coarse traprock aggregates to be used in all concrete for alkali-aggregate reactivity. Test both coarse aggregate size groups.

a. Separately evaluate the fine and coarse aggregates using ASTM C1260. Test results of the individual aggregates must have a measured expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Should the test data indicate an expansion of greater than 0.08 percent, reject the aggregate(s) or additional testing must be performed as follows: utilize the Contractor's proposed low alkali portland cement, blended cement, and/or SCM in combination with each individual aggregate. If only SCMs are being evaluated, the test in accordance with ASTM C1567. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Base mixture proportioning on the highest percentage of SCM required to mitigate ASR-reactivity.

b. If any of the above options does not lower the expansion to less than 0.08 percent after 28 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.3.1.5 Durability Testing for Traprock

****

NOTE: Use first tailoring option for Army and Air Force; second option is for Navy projects only.

****

[Provide aggregate with a satisfactory service record in freezing and thawing of at least 5 years successful service in three concrete paving projects. Include a condition survey of the existing concrete and a review of the concrete-making materials, including coarse aggregates, cement, and mineral admixtures in the service record. Consider the previous aggregate source and test results, cement mill certificate data, mineral admixture chemical and physical composition, and the mix design (cement factor and water-cementitious material ratio) in the review. Provide service record performed by an independent third party professional engineer, petrographer, or concrete materials engineer along with their resume. Include photographs and a written report addressing D-cracks and popouts in accordance with ACI 201.1R in the service record. Provide coarse aggregate with a durability factor of 80 or more when subjected to freezing and thawing of specimens prepared in accordance with ASTM C1646/C1646M and tested in accordance with ASTM C666/C666M, Procedure A, when a coarse aggregate size group or source proposed for use does not have a satisfactory demonstrable service record. Test all coarse aggregate size groups and sources proposed for use individually.][Evaluate and test all fine and coarse aggregates to be used in all concrete for durability in accordance with ASTM C88. Provide fine and coarse aggregates with a maximum of 18 percent loss when subjected to 5 cycles using Magnesium Sulfate or a maximum of 12 percent loss when subjected to 5 cycles if Sodium Sulfate is used.]

2.3.2 Coarse Aggregate

Aggregates, as delivered to the mixers, must consist of clean, uncoated particles. Contractor is required to conduct all testing identified in this specification.

2.3.2.1 Material Composition

Coarse aggregate used for High Temperature Concrete must consist of lightweight aggregate. Lightweight aggregate is defined as expanded slate or expanded shale meeting the requirements at the manufacturing facility of ASTM C330/C330M and is produced in a rotary kiln operated at 1,149 degrees C 2,100 degrees F or more. Conduct ASTM C330/C330M tests within 30 days prior to delivery to batch plant, except for freeze/thaw testing which must have been completed within 12 months prior to delivery. Freeze-thaw specimens can be coated on all sides using the same sodium silicate solution that will be used in on the pavement. Coarse aggregate must not show more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M. The sodium sulfate soundness loss must not exceed 12 percent, or the magnesium sulfate soundness loss must not exceed 18 percent after five cycles when tested in accordance with ASTM C88.
Coarse aggregate used for High Temperature Concrete consist of a fine-grained aggregate composed of unweathered diabase or basalt as classified per ASTM C294 and meeting the requirements of ASTM C33/C33M except as specified herein. Identify and confirm coarse aggregate material meets the material specifications via ASTM C295/C295M and be coarse aggregate must not show more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M. The sodium sulfate soundness loss must not exceed 12 percent, or the magnesium sulfate soundness loss must not exceed 18 percent after five cycles when tested in accordance with ASTM C88.
Coarse aggregate used for High Temperature Concrete must have Coarse aggregate showing no more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M, sodium sulfate soundness loss must not exceed 12 percent, or the magnesium sulfate soundness loss must not exceed 18 percent after five cycles when tested in accordance with ASTM C88 and must consist of one of the following materials:

a. Coarse aggregate used for High Temperature Concrete must consist of lightweight aggregate. Lightweight aggregate is defined as expanded slate or expanded shale meeting the requirements at the manufacturing facility of ASTM C330/C330M and is produced in a rotary kiln operated at 1,149 degrees C 2,100 degrees F or more. Conduct ASTM C330/C330M tests within 30 days prior to delivery to batch plant, except for freeze/thaw testing which must have been completed within 12 months prior to delivery. Freeze-thaw specimens can be coated on all sides using the same sodium silicate solution that will be used in on the pavement.

b. Coarse aggregate used for High Temperature Concrete must consist of a fine-grained trap rock aggregate composed of unweathered diabase or basalt as classified per ASTM C294 and meeting the requirements of ASTM C33/C33M except as specified herein. Coarse aggregate material must be identified and confirmed that it meets the material specifications via ASTM C295/C295M.

2.3.2.2 Particle Shape Characteristics

Provide particles of the coarse aggregate that are generally spherical or cubical in shape. The quantity of flat particles and elongated particles in any size group coarser than the 9.5 mm 3/8 inch sieve are not allowed to exceed 20 percent by weight as determined by the Flat Particle Test and the Elongated Particle Test of ASTM D4791. A flat particle is defined as one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3.

2.3.2.3 Size and Grading

****

NOTE: Designer must research lightweight aggregate manufacturers and specify the largest nominal aggregate size available. Normally in CONUS, expanded slate is currently only available in eastern US with a 19 mm 3/4 inch nominal maximum size. Expanded shales are commonly available elsewhere CONUS with a 12.5 mm 1/2 inch nominal maximum size. All sizes are based on the nominal maximum size and all aggregates must meet the individual grading requirements of ASTM C33/C33M and ASTM C330/C330M. OCONUS sources need to be researched. Industry website is http://www.escsi.org.

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For traprock aggregate, the Contractor must select either a 19 mm 3/4 inch or 25 mm 1 inch nominal maximum size aggregate. Grade and provide the individual aggregates in two size groups meeting the individual grading requirements of ASTM C33/C33M. For lightweight aggregate the nominal maximum size is [19 mm3/4 inch][12.5 mm1/2 inch]. Grade and provide the individual aggregates in two size groups meeting the individual grading requirements of ASTM C330/C330M. For traprock aggregate, the Contractor must select either a 19 mm 3/4 inch or 25 mm 1 inch nominal maximum size aggregate. Grade and provide the individual aggregates in two size groups meeting the individual grading requirements of ASTM C33/C33M. For lightweight aggregate, the nominal maximum size is [19 mm3/4 inch][12.5 mm 1/2 inch]. Grade and provide the individual aggregates in two size groups meeting the individual grading requirements of ASTM C330/C330M. Nominal maximum size is defined as the largest standard sieve size with 3 to 10 percent retained by weight. The individual aggregates are required to be graded and furnished in size groups to meet the coarseness and workability factor criteria for the Contractor-proposed combined gradation.

2.3.2.4 Deleterious Materials - Traprock

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NOTE: In Table 5 select columns showing appropriate percentage by weight in accordance with the following. Delete the inapplicable column in the table and the heading of the column used.

Weather Severity	**Air Freezing Index Coldest Year in 30 (a)**	**Average Precipitation for any Single Month During the Freezing Period**
Moderate	**500 or less**	**Any Amount**
Moderate (b)	**501 or more**	**Less than 25 mm 1 inch**
Severe	**501 or more**	**25 mm 1 inch or more**
(a) Calculated as described in UFC 3-130-01. See ASTM C33/C33M for simplified map of CONUS weather severity.		
(b) In poorly drained areas, the weather must be considered severe even though the other criteria indicate a rating of moderate.		
(c) For Navy projects, select "Severe Weather" column of Table 5. Delete "Moderate Weather" and associated limits.		

****

Do not exceed the amount of deleterious material in each size group of coarse aggregate shown in Table 3 below, determined in accordance with the test methods shown.

TABLE 3
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE
FOR AIRFIELD PAVEMENTS
Percentage by Mass

Materials $^{(h)}$	Severe Weather	Moderate Weather
Clay lumps and friable particles (ASTM C142/C142M)	0.2	0.2
Shale (a) (ASTM C295/C295M)	0.1	0.2

TABLE 3
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE FOR AIRFIELD PAVEMENTS
Percentage by Mass

Materials (h)	Severe Weather	Moderate Weather
Material finer than 0.075 mm No. 200 sieve (b) (ASTM C117)	0.5	0.5
Lightweight particles (c) (ASTM C123)	0.2	0.2
Clay ironstone (d) (ASTM C295/C295M)	0.1	0.5
Chert and cherty stone (less than 2.40 Mg/cubic meter 2.40 Sp. Gr. density SSD) (e) (ASTM C123 and ASTM C295/C295M)	0.1	0.5
Claystone, mudstone, and siltstone (f) (ASTM C295/C295M)	0.1	0.1
Shaly and argillaceous limestone (g) (ASTM C295/C295M)	0.2	0.2
Other soft particles (COE CRD-C 130)	1.0	1.0
Total of all deleterious substances exclusive of material finer than 0.075 mm No. 200 sieve	1.0	2.0

a. Shale is defined as a fine-grained, thinly laminated or fissile sedimentary rock. It is commonly composed of clay or silt or both. It has been indurated by compaction or by cementation, but not so much as to have become slate.

b. Limit for material finer than 0.075 mm No. 200 sieve is allowed to be increased to 1.5 percent for crushed aggregates if the fine material consists of crusher dust that is essentially free from clay or shale. Use XRD or other appropriate techniques as determined by petrographer to quantify amount and justify increase.

c. The separation medium must have a density of 2.0 Mg/cubic meter Sp. Gr. of 2.0.

d. Clay ironstone is defined as an impure variety of iron carbonate, iron oxide, hydrous iron oxide, or combinations thereof, commonly mixed with clay, silt, or sand. It commonly occurs as dull, earthy particles, homogeneous concretionary masses, or hard-shell particles with soft interiors. Other names commonly used for clay ironstone are "chocolate bars" and limonite concretions.

e. Chert is defined as a rock composed of quartz, chalcedony or opal, or any mixture of these forms of silica. It is variable in color. The texture is so fine that the individual mineral grains are too small to be distinguished by the unaided eye. Its hardness is such that it scratches glass but is not scratched by a knife blade. It may contain impurities such as clay, carbonates, iron oxides, and other minerals. Cherty stone is defined as any type of rock (generally limestone) that contains chert as lenses and nodules, or irregular masses partially or completely replacing the original stone.

f. Claystone, mudstone, or siltstone, is defined as a massive fine-grained sedimentary rock that consists predominantly of indurated clay or silt without laminations or fissility. It may be indurated either by compaction or by cementation.

g. Shaly limestone is defined as limestone in which shale occurs as one or more thin beds or laminae. These laminae may be regular or very irregular and may be spaced from a few inches down to minute fractions of an inch. Argillaceous limestone is defined as a limestone in which clay minerals occur disseminated in the stone in the amount of 10 to 50 percent by weight of the rock; when these make up from 50 to 90 percent, the rock is known as calcareous (or dolomitic) shale (or claystone, mudstone, or siltstone).

h. Perform testing in accordance with the referenced test methods, except that the minimum sample size is specified below.

2.3.2.5 Testing Sequence/Deleterious Materials - Traprock Only

No extension of time or additional payment due to any delays caused by the testing, evaluation, or personnel requirements is allowed. The minimum test sample size of the coarse aggregate is 90 kg 200 pounds for the 19 mm 3/4 inch and larger maximum size and 12 kg 25 pounds for the 4.75 to 19 mm No. 4 to 3/4 inch coarse aggregate. Provide facilities for the ready procurement of representative test samples. The testing procedure on each sample of coarse aggregate for compliance with limits on deleterious materials is as follows:

Step 1: Wash each full sample of coarse aggregate for material finer than the 0.075 mm No. 200 sieve. Discard material finer than the 0.075 mm No. 200 sieve.

Step 2: Test remaining full sample for clay lumps and friable particles and remove.

Step 3. Test remaining full sample for chert and cherty stone with SSD density of less than 2.40 specific gravity. Remove lightweight chert and cherty stone. Retain other materials less than 2.40 specific gravity for Step 4.

Step 4: Test the materials less than 2.40 specific gravity from Step 3 for lightweight particles (Sp. GR. 2.0) and remove. Restore other materials less than 2.40 specific gravity to the sample.

Step 5: Test remaining sample for clay-ironstone, shale, claystone, mudstone, siltstone, shaly and argillaceous limestone, and remove.

Step 6: Test a minimum of one-fifth of remaining full sample for other soft particles.

2.3.2.6 Deleterious Materials - Traprock

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NOTE: In Table 5 select columns showing appropriate percentage by weight in accordance with the following. Delete the inapplicable column in the table and the heading of the column used.

Weather Severity	**Air Freezing Index Coldest Year in 30 (a)**	**Average Precipitation for any Single Month During the Freezing Period**
Moderate	**500 or less**	**Any Amount**
Moderate (b)	**501 or more**	**Less than 25 mm 1 inch**
Severe	**501 or more**	**25 mm 1 inch or more**
(a) Calculated as described in UFC 3-130-01. See ASTM C33/C33M for simplified map of CONUS weather severity.		
(b) In poorly drained areas, the weather must be considered severe even though the other criteria indicate a rating of moderate.		
(c) For Navy projects, select "Severe Weather" column of Table 5. Delete "Moderate Weather" and associated limits.		

****

Do not exceed the amount of deleterious material in each size group of coarse aggregate shown in Table 3 below, determined in accordance with the test methods shown.

TABLE 3
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE
FOR AIRFIELD PAVEMENTS
Percentage by Mass

Materials (h)	Severe Weather	Moderate Weather
Clay lumps and friable particles (ASTM C142/C142M)	0.2	0.2
Shale (a) (ASTM C295/C295M)	0.1	0.2
Material finer than 0.075 mmNo. 200 sieve (b) (ASTM C117)	0.5	0.5

TABLE 3
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE
FOR AIRFIELD PAVEMENTS
Percentage by Mass

Materials (h)	Severe Weather	Moderate Weather
Lightweight particles (c) (ASTM C123)	0.2	0.2
Clay ironstone (d) (ASTM C295/C295M)	0.1	0.5
Chert and cherty stone (less than 2.40 Mg/cubic meter2.40 Sp. Gr. density SSD) (e) (ASTM C123 and ASTM C295/C295M)	0.1	0.5
Claystone, mudstone, and siltstone (f) (ASTM C295/C295M)	0.1	0.1
Shaly and argillaceous limestone (g) (ASTM C295/C295M)	0.2	0.2
Other soft particles (COE CRD-C 130)	1.0	1.0
Total of all deleterious substances exclusive of material finer than 0.075 mm No. 200 sieve	1.0	2.0

a. Shale is defined as a fine-grained, thinly laminated or fissile sedimentary rock. It is commonly composed of clay or silt or both. It has been indurated by compaction or by cementation, but not so much as to have become slate.

b. Limit for material finer than 0.075 mm No. 200 sieve is allowed to be increased to 1.5 percent for crushed aggregates if the fine material consists of crusher dust that is essentially free from clay or shale. Use XRD or other appropriate techniques as determined by petrographer to quantify amount and justify increase.

c. The separation medium must have a density of 2.0 Mg/cubic meter Sp. Gr. of 2.0.

d. Clay ironstone is defined as an impure variety of iron carbonate, iron oxide, hydrous iron oxide, or combinations thereof, commonly mixed with clay, silt, or sand. It commonly occurs as dull, earthy particles, homogeneous concretionary masses, or hard-shell particles with soft interiors. Other names commonly used for clay ironstone are "chocolate bars" and limonite concretions.

e. Chert is defined as a rock composed of quartz, chalcedony or opal, or any mixture of these forms of silica. It is variable in color. The texture is so fine that the individual mineral grains are too small to be distinguished by the unaided eye. Its hardness is such that it scratches glass but is not scratched by a knife blade. It may contain impurities such as clay, carbonates, iron oxides, and other minerals. Cherty stone is defined as any type of rock (generally limestone) that contains chert as lenses and nodules, or irregular masses partially or completely replacing the original stone.

f. Claystone, mudstone, or siltstone, is defined as a massive fine-grained sedimentary rock that consists predominantly of indurated clay or silt without laminations or fissility. It may be indurated either by compaction or by cementation.

g. Shaly limestone is defined as limestone in which shale occurs as one or more thin beds or laminae. These laminae may be regular or very irregular and may be spaced from a few inches down to minute fractions of an inch. Argillaceous limestone is defined as a limestone in which clay minerals occur disseminated in the stone in the amount of 10 to 50 percent by weight of the rock; when these make up from 50 to 90 percent, the rock is known as calcareous (or dolomitic) shale (or claystone, mudstone, or siltstone).

h. Perform testing in accordance with the referenced test methods, except that the minimum sample size is specified below.

2.3.2.7 Testing Sequence/Deleterious Materials - Traprock Only

No extension of time or additional payment due to any delays caused by the testing, evaluation, or personnel requirements is allowed. The minimum test sample size of the coarse aggregate is 90 kg 200 pounds for the 19 mm 3/4 inch and larger maximum size and 12 kg 25 pounds for the 4.75 to 19 mm No. 4 to 3/4 inch coarse aggregate. Provide facilities for the ready procurement of representative test samples. The testing procedure on each sample of coarse aggregate for compliance with limits on deleterious materials is as follows:

Step 1: Wash each full sample of coarse aggregate for material finer than the 0.075 mm No. 200 sieve. Discard material finer than the 0.075 mm No. 200 sieve.

Step 2: Test remaining full sample for clay lumps and friable particles and remove.

Step 3. Test remaining full sample for chert and cherty stone with SSD density of less than 2.40 specific gravity. Remove lightweight chert and cherty stone. Retain other materials less than 2.40 specific gravity for Step 4.

Step 4: Test the materials less than 2.40 specific gravity from Step 3 for lightweight particles (Sp. GR. 2.0) and remove. Restore other materials less than 2.40 specific gravity to the sample.

Step 5: Test remaining sample for clay-ironstone, shale, claystone, mudstone, siltstone, shaly and argillaceous limestone, and remove.

Step 6: Test a minimum of one-fifth of remaining full sample for other soft particles.

2.3.3 Fine Aggregate

2.3.3.1 Composition

****

NOTE: For TRAPROCK and TRAPROCK AND LIGHTWEIGHT tailoring options; use the bracketed sentence for High Temperature Concrete supporting F-35B aircraft.

The use of natural sands will preclude any future utilization of the High Temperature Concrete for F-35B vertical landing operations. Delete bracket reference to the use of natural sand if intended use of pavement is for F-35B Aircraft.

****

Lightweight fine aggregate must consist of the same high temperature material as the coarse aggregates, and composed of clean, hard, durable particles meeting the requirements at the manufacturing facility of ASTM C330/C330M for expanded slate or expanded shale. Conduct ASTM C330/C330M tests within 30 days prior to delivery to batch plant, except for freeze/thaw testing which must have been completed within 12 months prior to delivery. Each type of fine aggregate is required to be stockpiled and batched separately. Produce fine aggregate in a rotary kiln operated at 1,149 degrees C 2,100 degrees F. Particles of the fine aggregate are required to be generally spherical or cubical in shape. [Traprock fine aggregate must meet requirements of paragraph DELETERIOUS MATERIALS FOR TRAPROCK FINE AGGREGATE to include the parent material consisting of a fine-grained trap rock aggregate composed of unweathered diabase or basalt as classified per ASTM C294][Provide fine aggregate consisting of manufactured sand[, natural sand, or a combination of the two,] and composed of clean, hard, durable particles meeting the requirements of ASTM C33/C33M]. Stockpile and batch each type of fine aggregate separately. Provide fine aggregate with particles that are generally spherical or cubical in shape.Lightweight fine aggregate must consist of the same high temperature material as the coarse aggregates, and composed of clean, hard, durable particles meeting the requirements at the manufacturing facility of ASTM C330/C330M for expanded slate or expanded shale. Conduct ASTM C330/C330M tests within 30 days prior to delivery to batch plant, except for freeze/thaw testing which must have been completed within 12 months prior to delivery. Each type of fine aggregate is required to be stockpiled and batched separately. Produce fine aggregate in a rotary kiln operated at 1,149 degrees C 2,100 degrees F. Particles of the fine aggregate are required to be generally spherical or cubical in shape.

[Traprock fine aggregate must meet requirements of paragraph DELETERIOUS MATERIALS FOR TRAPROCK FINE AGGREGATE to include the parent material consisting of a fine-grained trap rock aggregate composed of unweathered diabase or basalt as classified per ASTM C294][Provide fine aggregate consisting of manufactured sand[, natural sand, or a combination of the two,] and composed of clean, hard, durable particles meeting the requirements of ASTM C33/C33M]. Stockpile and batch each type of fine aggregate separately. Provide fine aggregate with particles that are generally spherical or cubical in shape.

2.3.3.2 Grading

Grading of the fine aggregate, as delivered to the mixer, must conform to the requirements of ASTM C33/C33M for traprock and ASTM C330/C330M for lightweight aggregate ASTM C33/C33M for traprock ASTM C330/C330M for lightweight aggregate. Select a gradation not to exceed the combined gradation limits for the amount passing the 0.150 mm No. 100 sieve.

2.3.3.3 Deleterious Materials for Traprock Fine Aggregate

The amount of deleterious material in the fine aggregate must not exceed the following limits by mass:

Material	Percentage by Mass
Clay lumps and friable particles ASTM C142/C142M	1.0
Material finer than 0.075 mm ASTM C117	3.0
Material finer than No. 200 sieve ASTM C117	3.0
Lightweight particles ASTM C123 using a medium with a density of 2.0 Mg/cubic meter Sp. Gr. of 2.0	0.5
Total of all above	3.0

2.3.3.4 Deleterious Materials[for Traprock] Fine Aggregate

The amount of deleterious material in the fine aggregate must not exceed the following limits by mass:

Material	Percentage by Mass
Clay lumps and friable particles ASTM C142/C142M	1.0
Material finer than 0.075 mm ASTM C117	3.0
Material finer than No. 200 sieve ASTM C117	3.0
Lightweight particles ASTM C123 using a medium with a density of 2.0 Mg/cubic meter Sp. Gr. of 2.0	0.5
Total of all above	3.0

2.4 CHEMICAL ADMIXTURES

2.4.1 General Requirements

Chemical admixtures may only be used when the specific admixture type and manufacturer is the same material used in the mixture proportioning studies. Provide air-entraining admixture conforming to ASTM C260/C260M. An accelerating admixture conforming to ASTM C494/C494M, Type C, may be used only when specified in paragraph MIXTURE PROPORTIONS below provided it is not used to reduce the amount of cementitious material. Calcium chloride and admixtures containing calcium chloride are not allowed. Provide retarding or water-reducing admixture that meet the requirements of ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived. ASTM C494/C494M, Type F and G high range water reducing admixtures and Type S specific performance admixtures are not allowed. ASTM C1017/C1017M flowable admixtures are not allowed.

[2.5 MULTIFILAMENT POLYPROPYLENE FIBERS

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NOTE: Retain this paragraph for High Temperature Concrete supporting F-35B operations. Delete this

paragraph if High Temperature Concrete is only intended to be used by V-22 aircraft.

Deletion of this paragraph will preclude any F-35B vertical landing operations on this High Temperature Concrete.

****

Multifilament polypropylene fibers must have a length between 9.5 and 19 mm 0.375 and 0.75 inches and either a maximum diameter of 0.4 mm 0.0157 inches or maximum average 10 denier weight. The concrete mix must contain 1.78 kg per cubic meter 3 lb per cubic yard to prevent spalling. Add the fibers to the concrete mixture at the batch plant. Fibers must be multifilament polypropylene meeting ASTM C1116/C1116M, Standard Specification for Fiber-Reinforced Concrete. Submit certified copies of the laboratory test results showing length, and diameter or denier.

]2.6 CURING MATERIALS

2.6.1 Impervious Sheet

Impervious sheet materials must conform to ASTM C171.

2.6.2 Burlap and Cotton Mat

Burlap and cotton mat used for curing must conform to AASHTO M 182.

2.6.3 Membrane Forming Curing Compound

Membrane forming curing compound is prohibited from use where ever sodium silicate surface sealer is to be applied. Therefore membrane forming curing compound is limited only to vertical faces of pilot lane paving. Provide membrane forming curing compound that conforms to COE CRD-C 300 and is white pigmented.

2.7 WATER

Water for mixing and curing is required to be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water, or water from concrete production operations, may be used if it meets the requirements of ASTM C1602/C1602M.

2.8 REINFORCING

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NOTE: Edit these paragraphs to conform to project requirements. Delete those not needed. Add epoxy-coated bars (ASTM A775/A775M) or low-alloy bars (ASTM A 706/A 706M) when required by design.

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All reinforcement is required to be free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete. Removal of thin powdery rust and tight rust is not required. However, reinforcing steel which is rusted to the extent that it does not conform to the required dimensions or mechanical properties must not be used.

[2.8.1 Reinforcing Bars for Continuously Reinforced Concrete

a. Reinforcing bars must conform to ASTM A722/A722M Type 2, 25 mm 1 inch nominal diameter threaded bars with a minimum yield strength of 827 MPa 120,000 psi (Dywidag, Williams and Skylinesteel are possible sources, Grade 150) and conform to requirements shown on plans.

b. Reinforcement support is required to be continuous mesh supports or numerous chairs, and is required to be steel and support to height as shown on plans. Any sag or displacement of steel reinforcement during concrete placement is cause for rejection of paving lane with removal and replacement at Contractor's expense.

][2.8.2 Reinforcing Bars and Bar Mats for Non-Continuously Reinforced Concrete

Provide reinforcing bars conforming to [ASTM A615/A615M, billet-steel] [ASTM A996/A996M, rail and axle steel], Grade 60 [_____]. Provide bar mats conforming to ASTM A184/A184M. The bar members may be billet rail or axle steel.

][2.8.3 Welded Wire Reinforcement for Non-Continuously Reinforced Concrete

Provide welded wire reinforcement that is deformed or smooth, conforming to ASTM A1064/A1064M or ASTM A185/A185M, and is provided in flat sheets.

]2.9 JOINT MATERIALS

****

NOTE: Studies have shown that various joint sealant techniques perform better with varying degrees of temperature and pressure exposure. In Vertical Landing Pad Safety Zones self-leveling silicone sealant meeting ASTM D5893/D5893M perform better whereas elastomeric joint sealant ignites under the extreme heat. However, elastomeric joint sealant meeting ASTM D2628/D2628M tends to perform better than self-leveling silicone sealant when exposed to temperatures less than 500 degrees Fahrenheit.

Use first bracket for self-leveling silicone sealant meeting ASTM D5893/D5893M for the vicinity to extreme temperature exposure like the Vertical Landing Pad Safety Zone.

Use second bracket for elastomeric joint sealant meeting ASTM D2628/D2628M temperature exposure less than 500 degrees Fahrenheit like parking aprons, warm up areas, etc.

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[Joint filler and sealant materials is required as shown on plans and Specification 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT. Use only self-leveling silicone sealant meeting ASTM D5893/D5893M. Submit proposed methods and/or sacrificial materials for forming joint seal reservoir above expansion board.][Joint filler and sealant materials is required as shown on plans and Specification 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT. Use only elastomeric joint sealant meeting ASTM D2628.]

2.9.1 Dowels

Provide dowels in single piece bars fabricated or cut to length at the shop or mill before delivery to the site. Dowels are to be free of loose, flaky rust and loose scale and be clean and straight. Dowels may be sheared to length provided that the deformation from true shape caused by shearing does not exceed 1 mm 0.04 inch on the diameter of the dowel and does not extend more than 1 mm 0.04 inch from the end of the dowel. Dowels are required to be plain (non-deformed) steel bars conforming to ASTM A615/A615M, Grade 40 or 60; ASTM A996/A996M, Grade 50 or 60. Dowel bars are required to be epoxy coated in conformance with ASTM A775/A775M, to include the ends. Provide grout retention rings that are fully circular metal or plastic devices capable of supporting the dowel until the epoxy hardens. Dowel sleeves or inserts are not permitted.

2.9.2 Dowel Bar Assemblies

Provide dowel bar assemblies that consist of a framework of metal bars or wires arranged to provide rigid support for the dowels throughout the paving operation, with a minimum of four continuous bars or wires extending along the joint line. Provide dowels that are welded to the assembly or held firmly by mechanical locking arrangements that prevent them from rising, sliding out, or becoming distorted during paving operations.

2.9.3 Expansion Joint Materials

Expansion joint filler is required to be a preformed material conforming to ASTM D1752 Type II or Type III. Expansion joint filler is required to be 19 mm 3/4 inch thick, unless otherwise indicated. Expansion joint filler is required to be furnished in a single full depth piece.

2.10 EPOXY RESIN

Provide epoxy-resin materials that consist of two-component materials conforming to the requirements of ASTM C881/C881M, Class as appropriate for each application temperature to be encountered, except that in addition, the materials meet the following requirements:

a. Material for use for embedding dowels and anchor bolts be Type IV, Grade 3.

b. Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar be Type III, Grade as approved.

c. Material for use for injecting cracks be Type IV, Grade 1.

d. Material for bonding freshly mixed portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete be Type V, Grade as approved.

2.11 EQUIPMENT

All plant, equipment, tools, and machines used in the work are required to be maintained in satisfactory working conditions at all times. Submit the following:

a. Details and data on the batching and mixing plant prior to plant assembly including manufacturer's literature showing that the equipment meets all requirements specified herein.

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NOTE:For OCONUS projects, contact NRMCA (http://www.nrmca.org) concerning approved engineers available in the geographic area.

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b. Obtain National Ready Mixed Concrete Association (NRMCA) certification of the concrete plant, at no expense to the Government. Provide inspection report of the concrete plant by an engineer approved by the NRMCA. A list of NRMCA approved engineers is available on the NRMCA website at http://www.nrmca.org. Submit a copy of the NRMCA QC Manual Section 3 Concrete Plant Certification Checklist, NRMCA Certificate of Conformance, and Calibration documentation on all measuring and weighing devices prior to uniformity testing.

c. A description of the equipment proposed for transporting concrete mixture from the central mixing plant to the paving equipment.

d. A description of the equipment proposed for the machine and hand placing, consolidating and curing of the concrete mixture. Manufacturer's literature on the paver and finisher, together with the manufacturer's written instructions on adjustments and operating procedures necessary to assure a tight, smooth surface on the concrete pavement. The literature is required to show that the equipment meets all details of these specifications.[Include detailed information on automatic laser controlled systems if proposed for use.]

2.11.1 Batching and Mixing Plant

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NOTE: The batching and mixing plant must be on the construction site or as close as possible, but must be no farther than 15 minutes haul time from the placing site during all periods of the work day. Verify the availability of water and electrical power for sites on Government land. On Navy projects, specify an off-site batch plant. Edit bracketed items as appropriate.

Plant capacity must be governed by the laydown pattern or the size of the job to prevent delay of paving operations.

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2.11.1.1 Location

Locate the batching and mixing plant [on project site as indicated on the drawings][off Government premises no more than 15 minutes haul time from the placing site].[Water and electrical power [are][are not] available on the project site.] Provide operable telephonic or radio communication between the plant and the placing site at all times concreting is taking place.

2.11.1.2 Type and Capacity

Provide a batching and mixing plant consisting of a stationary-type central mix plant, including permanent installations and portable or relocatable plants installed on stable foundations. Provide a plant designed and operated to produce concrete within the specified tolerances, with a minimum capacity of 200 cubic meters 250 cubic yards [_____] per hour, that conforms to the requirements of NRMCA QC 3 including provisions addressing:

1. Material Storage and Handling
2. Batching Equipment
3. Central Mixer
4. Ticketing System
5. Delivery System

2.11.1.3 Tolerances

Materials	Percentage of Required Mass
Cementitious Materials	plus or minus 1
Aggregate	plus or minus 2
Water	plus or minus 1
Admixture	plus or minus 3

For volumetric batching equipment for water and admixtures, the above numeric tolerances apply to the required volume of material being batched. Dilute concentrated admixtures uniformly, if necessary, to provide sufficient volume per batch to ensure that the batchers consistently operate within the above tolerance.

2.11.1.4 Moisture Control

Provide a plant capable of ready adjustment to compensate for the varying moisture contents of the aggregates and to change the quantities of the materials being batched.[Provide an electric moisture meter complying with the provisions of COE CRD-C 143 for measuring of moisture in the fine aggregate. Provide a sensing element arranged so that measurement is made near the batcher charging gate of the fine aggregate bin or in the fine aggregate batcher.]

2.11.2 Concrete Mixers

Stationary or truck mixers or approved horizontal shaft concrete mixers are permitted. Pugmills are not allowed. Mixers are required to be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers are not be charged in excess of the capacity recommended by the manufacturer. Operate the drum or or mixing blade speed designated by the manufacturer. Maintain the mixers in satisfactory operation condition. Keep mixer drums free of hardened concrete. Replace mixer blades or paddles when worn down more than 10 percent of their depth when compared with the manufacturer's dimension for new blades or paddles.

2.11.2.1 Stationary

Stationary mixers are required to be drum mixers. Mixers with a device to lock the discharge mechanism until the prescribed mixing time has elapsed in required.

2.11.2.2 Mixing Time and Uniformity for Stationary Mixers

For stationary mixers, the mixing time for each batch after all solid materials are in the mixer[, including fibers,] is determined in accordance with CRD-C-55 for stationary mixers and ASTM C 94 for truck mixers. For all mixtures, the minimum mixing time is 65 seconds; extend as necessary to achieve uniformity[, and dispersal of multifilament polypropylene fiber]. Immediately prior to any change in mixing time a mixer performance tests at the new mixing times is required. If using traprock, conduct the Regular Test sequence with approved mix; if using lightweight aggregate, conduct the Regular Test sequence on normal weight concrete (or provide results from normal weight concrete on this project if using the same approved batch plant). For initial determination of the mixing time conduct the Regular Test sequence first. When regular testing is performed, the concrete must meet the limits of any five of the six uniformity requirements listed in Table 1 below. Before batching of High Temperature Concrete per paragraph TEST BATCHES uniformity testing for normal weight concrete is required to conducted, submitted and approved.

2.11.2.3 Abbreviated Test

Conduct the Abbreviated Test sequence for production concrete verification at the frequency specified in Table 6. When abbreviated testing is performed, the concrete is required to meet only those requirements listed for abbreviated testing. Use the projects approved mix design proportions for uniformity testing. For regular testing perform all six tests on three batches of concrete. The range for regular testing is the average of the ranges of the three batches. Abbreviated testing consists of performing the three required tests on a single batch of concrete. The range for abbreviated testing is the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, the results of tests on one of the mixers apply to the others, subject to the approval. Perform all mixer performance (uniformity) testing in accordance with COE CRD-C 55 and with paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL in PART 3.

TABLE 1
UNIFORMITY REQUIREMENTS--STATIONARY MIXERS
NORMAL WEIGHT CONCRETE

Parameter	Regular Tests Allowable Maximum Range for Average of 3 Batches	Abbreviated Tests Allowable Maximum Range for 1 Batch
Unit weight of air-free mortar	32 kg/cubic m	32 kg/cubic m
Unit weight of air-free mortar	2.0 lbs/cubic ft	2.0 lbs/cubic ft
Air content	1.0 percent	--
Slump	25 mm	25 mm
Slump	1.0 inch	1.0 inch
Coarse aggregate	6.0 percent	6.0 percent
Compressive strength at 7 days,	10.0 percent	10.0 percent
Water content	1.5 percent	

2.11.2.4 Truck

Truck mixers are not allowed for mixing or transporting slipformed paving concrete. Provide only truck mixers designed for mixing or transporting paving concrete with extra large blading and rear opening specifically for low-slump paving concrete. Provide truck mixers, the mixing of concrete therein, and concrete uniformity and testing thereof that conform to the requirements of ASTM C94/C94M. Determine the number of revolutions between 70 to 100 for truck-mixed concrete and the number of revolutions for shrink-mixed concrete by uniformity tests as specified in ASTM C94/C94M and in requirements for mixer performance stated in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL in PART 3. If requirements for the uniformity of concrete are not met with 100 revolutions of mixing after all ingredients including water are in the truck mixer drum, discontinue use of the mixer until the condition is corrected. Water is not allowed to be added after the initial introduction of mixing water except, when on arrival at the job site, the slump is less than specified and the water-cement ratio is less than that given as a maximum in the approved mixture. Additional water may be added to bring the slump within the specified range provided the approved water-cement ratio is not exceeded. Inject water into the head of the mixer (end opposite the discharge opening) drum under pressure, and turn the drum or blades a minimum of 30 additional revolutions at mixing speed. The addition of water to the batch at any later time is not allowed.[Perform mixer performance (uniformity) tests for truck mixers in accordance with ASTM C94/C94M.]

2.11.3 Transporting Equipment

Transport slipform concrete to the paving site in non-agitating equipment conforming to ASTM C94/C94M or in approved agitators. Transport fixed form concrete in approved truck mixers designed with extra large blading and rear opening specifically for low slump concrete. Provide transporting equipment designed and operated to deliver and discharge the required concrete mixture completely without segregation.

2.11.4 Transfer and Spreading Equipment

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NOTE: A transfer spreader is required for all paving projects.

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A telescoping conveyor for conveying concrete (transfer spreader belt placers not allowed)is required equipment for transferring concrete from the transporting equipment to the paving lane in front of the vibrating truss. The telescoping conveyor will accept the concrete outside the paving lane and will transfer and deposit it evenly across the paving lane in front of the vibrating truss to a depth which permits the vibrating truss to operate efficiently. High Temperature Concrete may also be discharged directly from ready mix trucks provided the concrete is deposited in its final location within 1 m 3.28 feet radially from the end of the chute. Direct discharge from mixer trucks with specified low slump requires coordination of formwork and placement phasing. Do not allow haul trucks or equipment onto High Temperature Concrete unless joints have temporary backer rod inserted, surface is clean from any debris, concrete has reached 28 day strength, and protective matting is placed between truck wheels and concrete surface (curing materials are insufficient protective matting).

2.11.5 Vibrating Truss - For Continuously Reinforced Concrete

a. General: It is required that the vibrating truss screed has a triangular cross-section using a rotating eccentric weight type vibrator. Use three, 37.5 mm 1.5 inch diameter or larger spud vibrators, with a fourth vibrator at the site on standby to achieved or supplement consolidation of High Temperature Concrete. Ensure a vibrator is inserted between every grid of reinforcement and where workers have stepped in fresh concrete. Roller screeds or other types of paving and finishing equipment are not permitted.

2.11.6 Paver-Finisher - For Non-Continuously Reinforced Concrete

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NOTE: The following subparagraphs apply to both fixed-form and slip-form paver-finishers. FIXED FORMS is applicable to fixed-form paver-finishers and SLIPFORM is applicable to slip-form paver-finishers.

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Provide paver-finisher consisting of a heavy-duty, self-propelled machine designed specifically for paving and finishing high quality pavement, with a minimum weight of 3280 kg per m 2200 pounds per foot of lane width, and powered by an engine having a minimum 15,000 W per m 6.0 horsepower per foot of lane width. The paver-finisher is required to spread, consolidate, and shape the plastic concrete to the desired cross section in one pass. The mechanisms for forming the pavement are required to be easily adjustable in width and thickness and for required crown. In addition to other spreaders required by paragraph above, the paver-finisher equipped with a full width knock-down auger or paddle mechanism, capable of operating in both directions, which evenly spreads the fresh concrete in front of the screed or extrusion plate.

2.11.6.1 Vibrators

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NOTE: Retain bracketed electronic vibrator monitoring equipment statement for airfield paving.

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Provide gang mounted immersion vibrators at the front of the paver on a frame equipped with suitable controls so that all vibrators can be operated at any desired depth within the slab or completely withdrawn from the concrete, as required. Provide vibrators that are automatically controlled to immediately stop as forward motion of the paver ceases. [Equipped the paver-finisher with an electronic vibrator monitoring device displaying the operating frequency of each individual internal vibrator with a readout display visible to the paver operator that operates continuously while paving, and displays all vibrator frequencies with manual or automatic sequencing among all individual vibrators. Discontinue paving if the vibrator monitoring system fails to operate properly during the paving operation.] Provide the spacing of the immersion vibrators across the paving lane as necessary to properly consolidate the concrete, with a maximum clear distance between vibrators of 750 mm 30 inches and outside vibrators a maximum of 300 mm 12 inches from the lane edge. Operate spud vibrators at a minimum frequency of 135 Hz 8000 impulses per minute and a minimum amplitude of 0.75 mm 0.03 inch, as determined by COE CRD-C 521.

2.11.6.2 Screed or Extrusion Plate

Equipped the paver-finisher with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface and finish the surface that no significant amount of hand finishing, except use of cutting straightedges, is required. Provide a screed or extrusion plate constructed to adjust for crown in the pavement. Provide adjustment for variation in lane width or thickness and to prevent more than 200 mm 8 inches of the screed or extrusion plate extending over previously placed concrete on either end when paving fill-in lanes. Repair or replace machines that cause displacement of properly installed forms or cause ruts or indentations in the prepared underlying materials and machines that cause frequent delays due to mechanical failures as directed.

2.11.6.3 Longitudinal Mechanical Float

A longitudinal mechanical float may be used. If used, provide a float that is specially designed and manufactured to smooth and finish the pavement surface without working excess paste to the surface that is rigidly attached to the rear of the paver-finisher or to a separate self-propelled frame spanning the paving lane. Provide float plate at least 1.5 m 5 feet long by 200 mm 8 inches wide and automatically be oscillated in the longitudinal direction while slowly moving from edge to edge of the paving lane, with the float plate in contact with the surface at all times.

2.11.6.4 Other Types of Finishing Equipment

Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to approval. Provide bridge deck finishers with a minimum operating weight of 3400 kg 7500 pounds that have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Only use vibrating screeds or pans for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

2.11.6.5 Fixed Forms

Provide paver-finisher equipped with wheels designed to ride the forms, keep it aligned with the forms, and spread the load so as to prevent deformation of the forms. Provide paver-finishers traveling on guide rails located outside the paving lane that are equipped with wheels when traveling on new or existing concrete to remain. Alternatively, a modified slipform paver that straddles the forms may be used. Provide a modified slipform paver which has the side conforming plates removed or rendered ineffective and travels over or along pre-placed fixed forms.

2.11.6.6 Slipform

The slipform paver-finisher is required to be automatically controlled and crawler mounted with padded tracks so as to be completely stable under all operating conditions and provide a finish to the surface and edges so that no edge slump beyond allowable tolerance occurs. Provide suitable moving side forms that are adjustable and produce smooth, even edges, perpendicular to the top surface and meeting specification requirements for alignment and freedom from edge slump.

2.11.7 Texturing Equipment

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NOTE: Designer must select type of texturing desired, retain that subparagraph, and delete the others. A genuine effort must be made to determine the type of texturing, if any, desired by the using service. If no guidance is given, the usual default method must be burlap drag. If other than a burlap drag textured finish is required, edit the appropriate paragraph(s) as shown below.

For Air Force airfield paving projects, do not specify artificial turf, wire comb, or surface grooving textures. For Navy airfield paving projects, do not specify wire comb or surface grooving textures. Use Section 32 01 18.71 GROOVING OF AIRFIELD PAVING, to specify saw-cut grooves.

Spring tine grooving is limited to use on roads and streets only.

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Provide texturing equipment as specified below. Before use, demonstrate the texturing equipment on a test section, and modify the equipment as necessary to produce the texture directed.

[2.11.7.1 Burlap Drag

Securely attach a burlap drag to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. Provide length of the material between 600 to 900 mm 24 to 36 inches dragging flat on the pavement surface. Provide burlap drag with a width at least equal to the width of the slab. Provide clean, reasonably new burlap material, completely saturated with water before attachment to the frame, always re-saturate before start of use, and kept clean and saturated during use. Provide burlap conforming to AASHTO M 182, Class 3 or 4.

][2.11.7.2 Broom

Apply surface texture using an approved mechanical stiff bristle broom drag of a type that provides a uniformly scored surface transverse to the pavement center line. Provide broom capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure that results in scores uniform in appearance and approximately 1.5 mm 1/16 inch in depth but not more than 3 mm 1/8 inch in depth.

][2.11.7.3 Artificial Turf

Provide full-width artificial turf drag with the leading transverse edge securely fastened to a lightweight pole on a traveling bridge. Provide a minimum of 600 mm 2 feet of the artificial turf in contact with the concrete surface during texturing operations that results in corrugations uniform in appearance and approximately 2 mm 1/16 inch in depth. A variety of different types of artificial turf are available and approval of any one type will be done only after it has been demonstrated to provide a satisfactory texture. One type that has provided satisfactory texture consists of 7,200 approximately 0.85-inch-long polyethylene turf blades per square foot.

][2.11.8 Sawing Equipment

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NOTE: Retain bracketed sentence as necessary to correlate with paragraph REMOVAL OF EXISTING PAVEMENT SLAB in PART 3. Otherwise delete. Also delete wheel saw option on Navy projects.

****

Provide equipment for sawing joints and for other similar sawing of concrete consisting of standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment. Provide diamond tipped blades. If demonstrated to operate properly, abrasive blades may be used. Provide spares as required to maintain the required sawing rate. [Provide wheel saws used in the removal of concrete with large diameter tungsten carbide tipped blades mounted on a heavy-duty chassis which produce a saw kerf at least 40 mm 1-1/2 inches wide.]Provide saws capable of sawing to the full depth required. Early-entry saws may be used, subject to demonstration and approval. No change to the initial sawcut depth is permitted.

]2.11.9 Straightedge

Provide and maintain at the job site, in good condition, a minimum 4 m 12 foot straightedge for each paving train for testing the hardened portland cement concrete surfaces. Provide straightedges constructed of aluminum or magnesium alloy and blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Provide straightedges with handles for operation on the pavement.

2.11.10 Work Bridge

Provide a self-propelled working bridge capable of spanning the required paving lane width where workmen can efficiently and adequately reach the pavement surface.

2.12 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

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NOTE: Specified concrete strength of 550 psi is readily attainable with lightweight aggregates at 28 days. Do not specify higher strength as that may not be achieved in 28 days. Although traprock mixtures are similar to normal weight concrete with higher strengths of 650 psi common, do not specify higher strength.

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2.12.1 Specified Flexural Strength - For Lightweight Aggregate

Specified flexural strength, R, for High Temperature Concrete is 3.8 MPa 550 psi at 28 days. Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus SCM by the mass equivalency method described in ACI 211.2, ACI 213R and ACI 325.14R for expanded slate or expanded shale. The concrete must have air-entrained with a total air content of 6 percent plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C173/C173M. The required slump of the concrete at the point of placement is 50 to 100 mm 2 to 4 inches.

2.12.2 Specified Flexural Strength - For Traprock Aggregate

Specified flexural strength, R, for High Temperature Concrete is 4.5 MPa 650 psi at 28 days. Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus SCM by the mass equivalency method described in ACI 211.1 and ACI 325.14R. The concrete must have air-entrained with a total air content of 6 percent plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C173/C173M. The required slump of the concrete at the point of placement is 50 to 100 mm 2 to 4 inches,

2.12.3 Specified Flexural Strength - For Lightweight Aggregate

Specified flexural strength, R, for High Temperature Concrete is 3.8 MPa 550 psi at 28 days. Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus SCM by the mass equivalency method described in ACI 211.2, ACI 213R and ACI 325.14R for expanded slate or expanded shale. The concrete must have air-entrained with a total air content of 6 percent plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C173/C173M. The required slump of the concrete at the point of placement is 50 to 100 mm 2 to 4 inches.

2.12.4 Specified Flexural Strength - For Traprock Aggregate

Specified flexural strength, R, for High Temperature Concrete is 4.5 MPa 650 psi at 28 days. Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus SCM by the mass equivalency method described in ACI 211.1 and ACI 325.14R. The concrete must have air-entrained with a total air content of 6 percent plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C173/C173M. The required slump of the concrete at the point of placement is 50 to 100 mm 2 to 4 inches.

2.12.5 Water-Cementitious Materials Ratio

Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio is the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus SCM by the mass equivalency method described in ACI 211.1.

2.12.6 Air Content

Provide concrete that is air-entrained with a total air content of [4.0] [6.0] [6.5] plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C231/C231M.

2.12.7 Slump

The maximum allowable slump of the concrete at the point of placement is 50 mm 2 inches for pavement constructed with fixed forms. For slipformed pavement, at the start of the project, select a slump which produces in-place pavement meeting the specified tolerances for control of edge slump. The selected slump is applicable to both pilot and fill-in lanes.

2.12.8 Concrete Temperature

The temperature of the concrete as delivered is required to conform to the requirements of paragraphs PAVING IN HOT WEATHER and PAVING IN COLD WEATHER, in PART 3. Determine the temperature of concrete in accordance with ASTM C1064/C1064M.

2.12.9 Concrete Strength for Final Acceptance

The strength of the concrete will be considered acceptable when the average 28-day flexural strengths for each lot is above the 'Specified Flexural Strength', and no individual beam in the lot is 170 kPa 25 psi or more below the equivalent 'Specified Flexural Strength'. Removed and replaced at no additional cost to the Government any lot or sublot, respectively, that fails to meet the above criteria.

2.13 MIXTURE PROPORTIONS

2.13.1 Composition

Allowable constituents of concrete are cementitious material, water, fine and coarse aggregates, [fibrillated polypropylene fibers,]and admixtures. Supplementary Cementitious Materials (SCM) choice and usage must conform with paragraph SUPPLEMENTAL CEMENTITIOUS MATERIALS (SCM) CONTENT. The total cementitious material content is required to be at least 310 kg per cubic meter 517 pounds per cubic yard for traprock and 447 kg per cubic meter 752 pounds per cubic yard for lightweight aggregate 310 kg per cubic meter 517 pounds per cubic yard for traprock 447 kg per cubic meter 752 pounds per cubic yard for lightweight aggregate. Admixtures consist of air entraining admixture and may also include, as approved, accelerator, retarder, and water-reducing admixture.

2.13.2 Proportioning Studies

Trial design batches, mixture proportioning studies, and testing requirements are the responsibility of the Contractor. Submit for approval the Preliminary Proposed Proportioning to include items a., b., and i. below a minimum of 7 days prior to beginning the mixture proportioning study. Trial mixtures having proportions, slumps, and air content suitable for the work based on methodology described in ACI 211.2, ACI 213R and ACI 325.14R for expanded slate or expanded shale, modified as necessary by manufacturer's recommendations to accommodate flexural strength and workability.Trial mixtures having proportions, slumps, and air content suitable for the work based on methodology described in ACI 211.2, ACI 213R and ACI 325.14R for expanded slate or expanded shale, or ACI 211.1 and ACI 325.14R for trap rock, modified as necessary by manufacturer's recommendations to accommodate flexural strength and workability.Trial mixtures having proportions, slumps, and air content suitable for the work based on methodology described in ACI 211.1 and ACI 325.14R for trap rock, modified as necessary by manufacturer's recommendations to accommodate flexural strength and workability.

2.13.2.1 Determination of Moisture Properties Coarse and Fine Lightweight Aggregates and Fine Traprock Aggregate

Use the following procedures to determine the moisture properties of lightweight aggregate, coarse and fine, and manufactures traprock fines:

Saturated Surface Dry (SSD) Specific Gravity:

a. Obtain sample and oven dry (not microwave) at 110 degrees C 230 degrees F until constant weight, which may take several days.

b. Submerge sample in water container for 7 days

c. Determine soaked sample Bulk Specific Gravity

d. Towel dry, no water sheen, determine SSD Specific Gravity

Free Water on Aggregates (NY 703-19 E):

Conduct the following procedures a minimum of three times for the project: prior to developing the laboratory mixtures, when build stockpiles, and when replenish stockpiles.

a. Obtain minimum of two stockpile samples after continuous watering has ensured aggregates have reached 100 percent absorption.

b. Determine moisture content of one sample by drying to constant weight.

c. Determine moisture content of second sample after first towel drying to surface dry condition.

d. Difference of two moisture contents is free water on aggregates.

e. General targets for production are 1-3 percent free moisture on coarse aggregate and 6-10 percent free moisture on fine aggregate.

Prior to conducting any High Temperature Concrete batching, determine the stockpile free moisture content prior to first batch of day and at frequency indicated in paragraph TESTING AND INSPECTION REQUIREMENTS.

2.13.2.2 Water-Cementitious Materials Ratio

Perform at least three different water-cementitious materials ratios, which produce a range of strength encompassing that required on the project. The maximum allowable water-cementitious material ratio required in paragraph SPECIFIED FLEXURAL STRENGTH, above is the equivalent water-cementitious materials ratio. The maximum water-cementitious materials ratio of the approved mix design becomes the maximum water-cementitious materials ratio for the project, and in no case exceeds 0.45.

2.13.2.3 Trial Mixture Studies

Perform separate sets of trial mixture studies made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either are to be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerating or retarding admixture may be used without separate trial mixture study. Perform separate trial mixture studies for each placing method (slip form, fixed form, or hand placement) proposed.

Report the temperature of concrete in each trial batch. Design each mixture to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding. Proportion laboratory trial mixtures for maximum permitted slump and air content.

2.13.3 Example High Temperature Concrete Mix Designs

The Contractor is responsible to develop the High Temperature Concrete mixture proportions for the project. The Contractor must select the aggregates for use, develop and adapt the mixture based upon mixing and paving methods, site temperature and humidity for time of placement. Government personnel resources are available at no charge to Contractor for consultation after contract award, and will be present during test batches, test sections and production paving. The following mix design was used with 100 percent expanded slate lightweight aggregates at Eglin AFB in December 2010. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

2.13.3.1 Example Traprock Aggregate Mix Design

The following mix design was used for laboratory studies by NAVFAC EXWC. It uses the Carolina Sunrock aggregates. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

TABLE 4

Material	Quantity per Cubic Yard
Type I/II Portland Cement	307 kg 517 pounds
Class F Fly Ash	77 kg 129 pounds
Water	148 kg 250 pounds
Course Aggregate (25 mm to 4.75 mm 1 to No. 4)	905 kg 1525 pounds
Medium Course Aggregate (9.5 mm to 4.75 mm 3/8 to No. 4)	317 kg 534 pounds
Fine Aggregate (minus 4.75 mm No. 4)	739 kg 1245 pounds
Air admix	0.18 kg 4.72 fl. ounces
Super plasticizer	0.77 kg 20.68 fl. ounces
Fibers	1.8 kg 3 pounds

2.13.3.2 Example Lightweight Aggregate Mix Design

The following mix design in Table 5 was used with 100 percent expanded slate lightweight aggregates at Eglin AFB in December 2010. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

TABLE 5
High Temperature Mix Design using Expanded Slate at Eglin AFB

Material	Quantity per Cubic Meter (Cubic Yard)
Type I/II Portland Cement	334 kg 564 pounds
Class F Fly Ash	112 kg 188 pounds
Water	174 kg 294 pounds
19 mm3/4 inch Lightweight Aggregate	459 kg 773 pounds
9.5 mm3/8 inch Lightweight Aggregate	188 kg 317 pounds
Fine Lightweight Aggregate	388 kg 654 pounds
Darex AEA	0.15 kg 4.14 fl. ounces
WRDA 64	1.67 kg 45.12 fl. ounces
Fibers	1.8 kg 3 pounds

Mixture Results

W/C Ratio	0.39
WF	41
CF	61

2.13.3.3 Example Traprock Aggregate Mix Design

The following mix design was used for laboratory studies by NAVFAC EXWC. It uses the Carolina Sunrock aggregates. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

TABLE 4

Material	Quantity per Cubic Yard
Type I/II Portland Cement	307 kg 517 pounds
Class F Fly Ash	77 kg 129 pounds
Water	148 kg 250 pounds

Material	Quantity per Cubic Yard
Type I/II Portland Cement	307 kg 517 pounds
Course Aggregate (25 mm to 4.75 mm 1 to No. 4)	905 kg 1525 pounds
Medium Course Aggregate (9.5 mm to 4.75 mm 3/8 to No. 4)	317 kg 534 pounds
Fine Aggregate (minus 4.75 mm No. 4)	739 kg 1245 pounds
Air admix	0.18 kg 4.72 fl. ounces
Super plasticizer	0.77 kg 20.68 fl. ounces
Fibers	1.8 kg 3 pounds

2.13.3.4 Example Lightweight Aggregate Mix Design

The following mix design in Table 3 was used with 100 percent expanded slate lightweight aggregates at Eglin AFB in December 2010. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

TABLE 3
High Temperature Mix Design using Expanded Slate at Eglin AFB

Material	Quantity per Cubic Meter (Cubic Yard)
Type I/II Portland Cement	334 kg 564 pounds
Class F Fly Ash	112 kg 188 pounds
Water	174 kg 294 pounds
19 mm3/4 inch Lightweight Aggregate	459 kg 773 pounds
9.5 mm3/8 inch Lightweight Aggregate	188 kg 317 pounds
Fine Lightweight Aggregate	388 kg 654 pounds
Darex AEA	0.15 kg 4.14 fl. ounces
WRDA 64	1.67 kg 45.12 fl. ounces
Fibers	1.8 kg 3 pounds

Mixture Results

W/C Ratio	0.39
WF	41
CF	61

[2.14 SURFACE CLEANING SOLUTIONS

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NOTE: In order to prepare the surface of existing concrete or new concrete which has POL spillage, POL stains must be removed to ensure penetration of surface sealer solution. This paragraph is optional for new construction and may be deleted.

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To remove existing POL stains from the concrete surface prior to surface sealer solution application, use one of the following:

a. A mixture of dishwashing (Dawn or Simple Green) detergent and hot water

b. Trisodium phosphate (TSP)

c. Sodium hydroxide if TSP is not available or permitted

d. Sodium carbonate (washing soda)

e. Phosphoric acid cleaner

f. Bio-remediation via Eximo (CAF Environmental Solutions) or G Force (Winsol Laboratories)

]2.15 SURFACE SEALER SOLUTION

Surface sealer is required to be a colorless, water-based solution containing at least 9 percent sodium silicate at time of application.

PART 3 EXECUTION

3.1 PREPARATION FOR PAVING

Before commencing paving, perform the following. If used, place cleaned, coated, and adequately supported forms. Have any reinforcing steel needed at the paving site; all transporting and transfer equipment ready for use, clean, and free of hardened concrete and foreign material; equipment for spreading, consolidating, screeding, finishing, and texturing concrete at the paving site, clean and in proper working order; and all equipment and material for curing and for protecting concrete from weather or mechanical damage at the paving site, in proper working condition, and in sufficient amount for the entire placement.

3.1.1 Weather Prevention

When windy conditions during paving appear probable, have equipment and material at the paving site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.1.2 Proposed Techniques

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NOTE: Include joint layout and typical detail of joint/reinforcing/dowel bar size and spacing in drawings and coordinate with paragraph PLACING REINFORCING STEEL. Insert office title for approval of joint plan changes.

Delete requirement for profilograph if not required.

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Submit for approval the following items:

a. A description of the placing and protection methods proposed when concrete is to be placed in or exposed to hot, cold, or rainy weather conditions.

b. A detailed paving sequence plan and proposed paving pattern showing all planned construction joints; transverse and longitudinal reinforcing bar size and spacing; and identifying pilot lanes and hand placement areas. Place the five continuously reinforced High Temperature Concrete lanes in a minimum of three pours and in the following sequence: place the center lane first; then the two adjacent lanes, then the two outside lanes. This paving sequence allows installation of threaded reinforcing steel and couplers. Without written approval of the Contracting Officer, no deviation from the jointing pattern shown on the drawings are allowed.

c. Plan and equipment proposed to control alignment of sawn joints within the specified tolerances.

d. Data on the curing equipment, media and methods to be used.

e. Pavement demolition work plan, presenting the proposed methods and equipment to remove existing pavement and protect pavement to remain in place.

[f. Data on profilograph and methods to measure pavement smoothness.

]3.2 CONDITIONING OF UNDERLYING MATERIAL

3.2.1 General Procedures

Verify the underlying material, upon which concrete is to be placed is clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. Prior to setting forms or placement of concrete, verify the underlying material is well drained and have been satisfactorily graded by string-line controlled, automated, trimming machine and uniformly compacted in accordance with the applicable Section of these specifications. Test the surface of the underlying material to crown, elevation, and density in advance of setting forms or of concrete placement using slip-form techniques. Trim high areas to proper elevation. Fill and compact low areas to a condition similar to that of surrounding grade, or filled with concrete monolithically with the pavement. Low areas filled with concrete are not to be cored for thickness to avoid biasing the average thickness used for evaluation and payment adjustment. Rework and compact any underlying material disturbed by construction operations to specified density immediately in front of the paver. If a slipform paver is used, continue the same underlying material under the paving lane beyond the edge of the lane a sufficient distance that is thoroughly compacted and true to grade to provide a suitable trackline for the slipform paver and firm support for the edge of the paving lane.

3.2.2 Traffic on Underlying Material

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NOTE: Transporting equipment must not be allowed to operate on the prepared underlying material for airfield paving. Operating hauling equipment in the paving lane will cause the paver to stop frequently, producing a discontinuity in the pavement surface. Edit bracketed items as appropriate and coordinate with Part 2, subparagraph TRANSFER AND SPREADING EQUIPMENT.

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After the underlying material has been prepared for concrete placement, equipment is not permitted thereon with exception of the paver. Subject to specific approval, crossing of the prepared underlying material at specified intervals for construction purposes may be permitted, provided rutting or indentations do not occur. Rework and repair the surface before concrete is placed.[Transporting equipment is not to be allowed to operate on the prepared and compacted underlying material in front of the paver-finisher.][Equipment may be allowed to operate on the underlying material only if approved and only if no damage is done to the underlying material and its degree of compaction. Correct any disturbance to the underlying material that occurs, as approved, before the paver-finisher or the deposited concrete reaches the location of the disturbance and replace the equipment or change procedures to prevent any future damage.]

3.3 WEATHER LIMITATIONS

3.3.1 Placement and Protection During Inclement Weather

Do not commence placing operations when heavy rain or other damaging weather conditions appear imminent. At all times when placing concrete, maintain on-site sufficient waterproof cover and means to rapidly place it over all unhardened concrete or concrete that might be damaged by rain. Suspend placement of concrete whenever rain, high winds, or other damaging weather commences to damage the surface or texture of the placed unhardened concrete, washes cement out of the concrete, or changes the water content of the surface concrete. Immediately cover and protect all unhardened concrete from the rain or other damaging weather. Completely remove any slab damaged by rain or other weather full depth, by full slab width, to the nearest original joint, and replaced as specified in paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS below, at no expense to the Government.

3.3.2 Paving in Hot Weather

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NOTE: Additional information concerning hot weather concreting may be obtained from ACI 305R. Do not delete this paragraph or the next paragraphs dealing with weather.

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When the ambient temperature during paving is expected to exceed 32 degrees C 90 degrees F, properly place and finish the concrete in accordance with procedures previously submitted, approved, and as specified herein. Provide concrete that does not exceed the temperature shown in the table below when measured in accordance with ASTM C1064/C1064M at the time of delivery. Cooling of the mixing water or aggregates or placing in the cooler part of the day may be required to obtain an adequate placing temperature. Cool steel forms and reinforcing as needed to maintain steel temperatures below 49 degrees C 120 degrees F. Cool or protect transporting and placing equipment if necessary to maintain proper concrete placing temperature. Keep the finished surfaces of the newly laid pavement damp by applying a fog spray (mist) with approved spraying equipment until the pavement is covered by the curing medium.

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature in Degrees C F
Greater than 60	33 90
40-60	30 85
Less than 40	27 80

3.3.3 Prevention of Plastic Shrinkage Cracking

During weather with low humidity, and particularly with high temperature and appreciable wind, develop and institute measures to prevent plastic shrinkage cracks from developing. If plastic shrinkage cracking occurs, halt further placement of concrete until protective measures are in place to prevent further cracking. Periods of high potential for plastic shrinkage cracking can be anticipated by use of ACI 305R. In addition to the protective measures specified in the previous paragraph, the concrete placement may be further protected by erecting shades and windbreaks and by applying fog sprays of water, the addition of mono-molecular films, or wet covering. Apply mono-molecular films after finishing is complete, do not use in the finishing process. Immediately commence curing procedures when such water treatment is stopped. Repair plastic shrinkage cracks in accordance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. Never trowel over or fill plastic shrinkage cracks with slurry.

3.3.4 Paving in Cold Weather

Cold weather paving is required to conform to ACI 306R. Use special protection measures, as specified herein, if freezing temperatures are anticipated or occur before the expiration of the specified curing period. Do not begin placement of concrete unless the ambient temperature is at least 2 degrees C 35 degrees F and rising. Thereafter, halt placement of concrete whenever the ambient temperature drops below 5 degrees C 40 degrees F. When the ambient temperature is less than 10 degrees C 50 degrees F, the temperature of the concrete when placed is required to be not less than 10 degrees C 50 degrees F nor more than 25 degrees C 75 degrees F. Provide heating of the mixing water or aggregates as required to regulate the concrete placing temperature. Materials entering the mixer are required to be free from ice, snow, or frozen lumps. Do not incorporate salt, chemicals or other materials in the concrete to prevent freezing. [If allowed under paragraph MIXTURE PROPORTIONS in PART 2, an accelerating admixture may be used when the ambient temperature is below 10 degrees C 50 degrees F.] Provide covering and other means for maintaining the concrete at a temperature of at least 10 degrees C 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period. Remove pavement slabs, full depth by full width, damaged by freezing or falling below freezing temperature to the nearest planned joint, and replace as specified in paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS, at no expense to the Government.

3.4 CONCRETE PRODUCTION

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NOTE: Designer must correlate these paragraphs with paragraph EQUIPMENT. Delete item in brackets if truck mixers are not permitted.

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Provide batching, mixing, and transporting equipment with a capacity sufficient to maintain a continuous, uniform forward movement of the paver of not less than 0.8 m 2.5 feet per minute. Deposit concrete transported in non-agitating equipment in front of the paver within 45 minutes from the time cement has been charged into the mixing drum, except that if the ambient temperature is above 32 degrees C 90 degrees F, the time is reduced to 30 minutes. Deposit concrete transported in truck mixers in front of the paver within 90 minutes from the time cement has been charged into the mixer drum of the plant or truck mixer. If the ambient temperature is above 32 degrees C 90 degrees F, the time is reduced to 60 minutes. Accompany every load of concrete delivered to the paving site with a batch ticket from the operator of the batching plant. Provide batch ticket information required by ASTM C94/C94M on approved forms. In addition provide design quantities in mass or volume for all materials, batching tolerances of all materials, and design and actual water cementitious materials ratio on each batch delivered, [the water meter and revolution meter reading on truck mixers]and the time of day. Provide batch tickets for each truck delivered as part of the lot acceptance package to the placing foreman to maintain on file and deliver them to the Government weekly.

3.4.1 Batching and Mixing Concrete

Maintain scale pivots and bearings clean and free of rust. Remove any equipment which fails to perform as specified immediately from use until properly repaired and adjusted, or replaced.

3.4.2 Transporting and Transfer - Spreading Operations

Operate non-agitating equipment only on smooth roads and for haul time less than 15 minutes. Deposit concrete as close as possible to its final position in the paving lane. Operate all equipment to discharge and transfer concrete without segregation. Dumping of concrete in discrete piles is not permitted. No transfer or spreading operation which requires the use of front-end loaders, dozers, or similar equipment to distribute the concrete are permitted.

3.5 PAVING - FOR CONTINUOUSLY REINFORCED CONCRETE

3.5.1 General Requirements - for Continuously Reinforced Concrete

Construct pavement with paving and finishing equipment utilizing rigid fixed forms. Utilize paving and finishing equipment and procedures capable of constructing paving lanes of the required width. Control and coordinate paving equipment and its operation with all other operations, such that the vibrating truss has a continuous forward movement, at a reasonably uniform speed, from beginning to end of each paving lane, except for inadvertent equipment breakdown. Failure to achieve this must require the Contractor to halt operations, regroup, and modify operations to achieve this requirement. Workmen with foreign material on their footwear or construction equipment that might deposit foreign material are not permitted to walk or operate in the plastic concrete. Provide clean matting to lay tools not in use and workers to stand to prevent contamination of the High Temperature Concrete.

3.5.2 Consolidation - for Continuously Reinforced Concrete

Consolidate concrete with three hand-held spud vibrators across the paving lane. Insert the vibrators into the concrete to a depth that will provide the best full-depth consolidation. Insert a vibrator into every reinforcement grid and in worker's footsteps. Vibrators may be used and operated from a bridge spanning the area. Vibrators are not to be used to transport or spread the concrete. Hand-operated vibrators are not to be operated in the concrete at one location for more than 20 seconds. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) must require the immediate stopping of the paving operation and approved adjustment of the equipment or procedures.

3.5.3 Operation - for Continuously Reinforced Concrete

When the vibrating truss approaches a header at the end of a paving lane, maintain a sufficient amount of concrete ahead of the vibrating truss to provide a roll of concrete which will spill over the header. Ensure the required amount of extra concrete sufficient to prevent any slurry that is formed and carried along ahead of the vibrating truss from being deposited adjacent to the header is present. Provide additional consolidation adjacent to the headers by hand-held vibrators. When the vibrating truss is operated between or adjacent to previously constructed pavement (fill-in lanes), make provisions to prevent damage to the previously constructed pavement. At all times, keep the overlapping area of existing pavement surface completely free of any loose or bonded foreign material as the vibrating truss operates across it.

3.5.4 Required Results - for Continuously Reinforced Concrete

Adjust, operate, and coordinate the vibrating truss, and its hand placed equipment together with its operating procedures with the concrete mixture being used to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The vibrating truss operation must produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. The vibrating truss must make only one pass across the pavement; multiple passes will not be permitted. The equipment and its operation must produce a finished surface as specified and requiring no excessive hand finishing other than the use of cutting straightedges. If any equipment or operation fails to produce the above results, stop the paving, replace or properly adjust the equipment.

Appropriately modify the operation or mixture proportions in order to produce the required results before recommencing paving. Apply no water, other than approved fog sprays, to the concrete or the concrete surface during paving and finishing.

3.5.5 Forms for Fixed-Form Paving - for Continuously Reinforced Concrete

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NOTE: Fixed-form paving is mandatory for high temperature concrete with fibers and continuous reinforcement.

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a. Furnish straight forms made of steel in sections not less than 3 m 10 feet in length. Use flexible or curved forms of proper radius for curves of 31 m 100-foot radius or less. Make wood forms for curves and fillets of well-seasoned, surfaced plank or plywood, straight, and free from warp or bend. Furnish wood forms adequate in strength and rigidly braced. Forms must have a depth equal to the pavement thickness at the edge. Where the project requires several different slab thicknesses, forms may be built up by bolting or welding a tubular metal section or by bolting wood planks to the bottom of the form to completely cover the underside of the base of the form and provide an increase in depth of not more than 25 percent. The base width of the one-piece or built-up form cannot be less than eight-tenths of the vertical height of the form, except than forms 200 mm 8 inches or less in vertical height must have a base width not less than the vertical height of the form. Maximum vertical deviation of top of any side form, including joints, must not vary from a true plane more than 3 mm 1/8 inch in 3 m 12 feet, and the upstanding leg must not vary more than 6 mm 1/4 inch.

b. Tightly lock form sections. Restrict form sections from play or movement in any direction. Provide forms with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment.

c. Set forms for full bearing on foundation for entire length and width and in alignment with edge of finished pavement. Support forms during entire operation of placing, compaction, and finishing so that forms will not deviate vertically more than 3 mm 0.01 foot from required grade and elevations indicated. Check conformity to the alignment and grade elevations shown on the drawings. Immediately make necessary corrections prior to placing the concrete. Clean and oil the forms each time before concrete is placed. Do not place concrete until setting of forms has been checked and approved by the CQC team.

3.5.5.1 Form Removal - for Continuously Reinforced Concrete

Remove forms for preparation to place adjacent lanes at a time in accordance with paragraph WET CURING, but no sooner than 24 hours after the end of the placement. Cover in burlap and polyethylene and keep wet concrete edges exposed after form removal until the adjacent concrete is placed or the 14 day wet curing period is achieved, as appropriate for the edge location. When conditions are such that the early strength gain of the concrete is delayed, leave the forms in place for a longer time, as directed. Remove forms by procedures that do not injure the concrete. Do not use bars or heavy metal tools directly against the concrete in removing the forms. Promptly repair any concrete found to be defective after form removal using procedures specified hereinafter or as directed.

3.5.6 Placing Reinforcing Steel - for Continuously Reinforced Concrete

Use the type and amount of steel reinforcement shown on the drawings.

3.5.6.1 Reinforcement Support - for Continuously Reinforced Concrete

Position the reinforcement on approved continuous mesh support devices or numerous chairs securely fastened to the subgrade prior to concrete placement. Support and anchor reinforcement to maintain proper position in final concrete pavement on a maximum 1.2 m by 1.2 m 4 foot by 4 foot grid, including at edges if steel does not penetrate forms. Vibrate concrete after the steel has been placed. Regardless of placement procedure, use reinforcing steel free from coatings which could impair bond between the steel and concrete, and laps in the reinforcement must be as indicated. Regardless of the equipment or procedures used for installing reinforcement, ensure that the entire depth of concrete is adequately consolidated.

3.6 PAVING - FOR NON-CONTINUOUSLY REINFORCED CONCRETE

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NOTE: Designer must correlate these paragraphs with paragraph EQUIPMENT.

****

3.6.1 General Requirements - for Non-Continuously Reinforced Concrete

Construct pavement with paving and finishing equipment utilizing rigid fixed forms or by use of slipform paving equipment. Provide paving and finishing equipment and procedures capable of constructing paving lanes of the required width at a rate of at least 0.8 m 2.5 feet of paving lane per minute on a routine basis. Control paving equipment and its operation, and coordinated with all other operations, such that the paver-finisher has a continuous forward movement at a reasonably uniform speed from beginning to end of each paving lane, except for inadvertent equipment breakdown. Backing the paver and refinishing a lane is not permitted. Remove and replace concrete refinished in this manner. Failure to achieve a continuous forward motion requires halting operations, regrouping, and modifying operations to achieve this requirement. Personnel are not permitted to walk or operate in the plastic concrete at any time. Where an open-graded granular base is required under the concrete, select paving equipment and procedures which operate properly on the base course without causing displacement or other damage.

3.6.2 Consolidation - for Non-Continuously Reinforced Concrete

Consolidate concrete with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. Insert vibrators into the concrete to a depth that provides the best full-depth consolidation but not closer to the underlying material than 50 mm 2 inches. Excessive vibration is not permitted. Discontinue paving operations if vibrators cause visible tracking in the paving lane, until equipment and operations have been modified to prevent it. Vibrate concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment with an approved hand-operated immersion vibrator operated from a bridge spanning the area. Do not use vibrators to transport or spread the concrete. Do not operate hand-operated vibrators in the concrete at one location for more than 20 seconds. Insert hand-operated vibrators between 150 to 400 mm 6 to 15 inches on centers. For each paving train, provide at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) requires the immediate stopping of the paving operation and approved adjustment of the equipment or procedures.

3.6.3 Operation - for Non-Continuously Reinforced Concrete

When the paver approaches a header at the end of a paving lane, maintain a sufficient amount of concrete ahead of the paver to provide a roll of concrete which spills over the header. Provide a sufficient amount of extra concrete to prevent any slurry that is formed and carried along ahead of the paver from being deposited adjacent to the header. Maintain the spud vibrators in front of the paver at the desired depth as close to the header as possible before they are lifted. Provide additional consolidation adjacent to the headers by hand-manipulated vibrators. When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provide provisions to prevent damage to the previously constructed pavement. Electronically control screeds or extrusion plates from the previously placed pavement so as to prevent them from applying pressure to the existing pavement and to prevent abrasion of the pavement surface. Maintain the overlapping area of existing pavement surface completely free of any loose or bonded foreign material as the paver-finisher operates across it. When the paver travels on existing pavement, maintain approved provisions to prevent damage to the existing pavement. Pavers using transversely oscillating screeds are not allowed to form fill-in lanes that have widths less than a full width for which the paver was designed or adjusted.

3.6.4 Required Results - for Non-Continuously Reinforced Concrete

Adjust and operate the paver-finisher, its gang-mounted vibrators and operating procedures coordinated with the concrete mixture being used, to produce a thoroughly consolidated slab throughout that is true to line and grade within specified tolerances. Provide a paver-finishing operation that produces a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities in a single pass across the pavement; multiple passes are not permitted. Provide equipment and its operation that produce a finished surface requiring no hand finishing other than the use of cutting straightedges, except in very infrequent instances. Stop paving if any equipment or operation fails to produce the above results. Prior to recommencing paving, properly adjust or replace the equipment, modify the operation, or modify the mixture proportions, in order to produce the required results. No water, other than fog sprays (mist) as specified in paragraph PREVENTION OF PLASTIC SHRINKAGE CRACKING above, is allowed to be applied to the concrete or the concrete surface during paving and finishing.

3.6.5 Fixed Form Paving - for Non-Continuously Reinforced Concrete

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NOTE: Fixed-form paving should always be included as an option or mandatory item as appropriate. Edit bracketed items in subparagraph a. Keys are only permitted for roads and streets with a thickness of

230 mm 9 inches or greater. Do not permit keys for airfield pavements.
****

Provide paving equipment for fixed-form paving and the operation that conforms to the requirements of paragraph EQUIPMENT, and all requirements specified herein.

3.6.5.1 Forms for Fixed-Form Paving - for Non-Continuously Reinforced Concrete

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NOTE: Delete subparagraph e. when overlay pavements are not required.
****

a. Provide straight forms made of steel and in sections not less than 3 m 10 feet in length that are clean and free of rust or other contaminants. Seal any holes or perforations in forms prior to paving unless otherwise permitted. Maintain forms in place and passable by all equipment necessary to complete the entire paving operation without need to remove horizontal form supports. Provide flexible or curved forms of proper radius for curves of 31 m 100-foot radius or less. Provide wood forms for curves and fillets made of well-seasoned, surfaced plank or plywood, straight, and free from warp or bend that have adequate strength and are rigidly braced. Provide forms with a depth equal to the pavement thickness at the edge. Where the project requires several different slab thicknesses, forms may be built up by bolting or welding a tubular metal section or by bolting wood planks to the bottom of the form to completely cover the underside of the base of the form and provide an increase in depth of not more than 25 percent. Provide forms with the base width of the one-piece or built-up form not less than eight-tenths of the vertical height of the form, except provide forms 200 mm 8 inches or less in vertical height with a base width not less than the vertical height of the form. Provide forms with maximum vertical deviation of top of any side form, including joints, not varying from a true plane more than 3 mm 1/8 inch in 3 m 10 feet, and the upstanding leg not varying more than 6 mm 1/4 inch.[Where keyway forms are required, rigidly attach the keyway form to the main form so no displacement can take place. Tack-weld metal keyway forms to steel forms. Align keyway forms so that there is no variation over 6 mm 1/4 inch either vertically or horizontally, when tested with a 4 m 12 foot template after forms are set, including tests across form joints.]

b. Provide form sections that are tightly locked and free from play or movement in any direction. Provide forms with adequate devices for secure settings so that when in place they withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment.

c. Set forms for full bearing on foundation for entire length and width and in alignment with edge of finished pavement. Support forms during entire operation of placing, compaction, and finishing so that forms do not deviate vertically more than 3 mm 0.01 foot from required grade and elevations indicated. Check conformity to the alignment and grade elevations shown on the drawings and make necessary corrections immediately prior to placing the concrete. Clean and oil the forms each time before concrete is placed. Concrete placement is not allowed until setting of forms has been checked and approved by the CQC team.

d. Do not anchor guide rails for fixed form pavers into new concrete or existing concrete to remain.

[e. Securely hold forms for overlay pavements and for other locations where forms set on existing pavements in place with stakes or by other approved methods. Carefully drill holes in existing pavements for form stakes by methods which do not crack or spall the existing pavement. After use, fill the holes flush with the surrounding surface using approved material, prior to overlying materials being placed. Immediately discontinue any method which does not hold the form securely or which damages the existing pavement. Prior to setting forms for paving operations, demonstrate the proposed form setting procedures at an approved location without proceeding further until the proposed method is approved.

]3.6.5.2 Form Removal - for Non-Continuously Reinforced Concrete

Keep forms in place at least 12 hours after the concrete has been placed. When conditions are such that the early strength gain of the concrete is delayed, leave the forms in place for a longer time, as directed. Remove forms by procedures that do not damage the concrete. Do not use bars or heavy metal tools directly against the concrete in removing the forms. Promptly repair any concrete found to be defective after form removal, using procedures specified or as directed.

3.6.6 Slipform Paving - for Non-Continuously Reinforced Concrete

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NOTE: Retain slipform paving as an option unless there are specific, valid reasons for deleting it. Be sure all other paragraphs correlate with choice made here.

****

3.6.6.1 General - for Non-Continuously Reinforced Concrete

Provide paving equipment for slipform paving and the operation thereof that conforms to the requirement of paragraph EQUIPMENT, and all requirements specified herein. Provide a slipform paver capable of shaping the concrete to the specified and indicated cross section, meeting all tolerances, with a surface finish and edges that require only a very minimum isolated amount of hand finishing, in one pass. If the paving operation does not meet the above requirements and the specified tolerances, immediately stop the operation, and regroup and replace or modify any equipment as necessary, modify paving procedures or modify the concrete mix, in order to resolve the problem. Provide a slipform paver that is automatically electronically controlled from a taut wire guideline for horizontal alignment and on both sides from a taut wire guideline for vertical alignment, except that electronic control from a ski operating on a previously constructed adjoining lane is required where applicable for either or both sides. Automatic, electronic controls are required for vertical alignment on both sides of the lane. Control from a slope-adjustment control or control operating from the underlying material is not allowed. Properly adjust side forms on slipform pavers so that the finished edge of the paving lane meets all specified tolerances. Install dowels in longitudinal construction joints as specified below. The installation of these dowels by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete is not permitted.[If a keyway is required, install a 0.45 to 0.55 mm 26 gauge thick metal keyway liner as the keyway is extruded. Provide keyway forms that do not vary more than plus or minus 3 mm 1/8 inch from the dimensions indicated and do not deviate more than plus or minus 6 mm 1/4 inch from the mid-depth of the pavement. An abrupt offset either horizontally or vertically in the completed keyway is not allowed. Maintain the keyway liner to remain in place and become part of the joint.]

3.6.6.2 Guideline for Slipform Paving - for Non-Continuously Reinforced Concrete

Accurately and securely install guidelines well in advance of concrete placement. Provide supports at necessary intervals to eliminate all sag in the guideline when properly tightened. Provide guideline consisting of high strength wire set with sufficient tension to remove all sag between supports. Provide supports that are securely staked to the underlying material or other provisions made to ensure that the supports are not displaced when the guideline is tightened or when the guideline or supports are accidentally touched by workmen or equipment during construction. Provide appliances for attaching the guideline to the supports that are capable of easy adjustment in both the horizontal and vertical directions. When it is necessary to leave gaps in the guideline to permit equipment to use or cross underlying material, provide provisions for quickly and accurately replacing the guideline without any delay to the forward progress of the paver. Provide supports on either side of the gap that are secured in such a manner as to avoid disturbing the remainder of the guideline when the portion across the gap is positioned and tightened. Check the guideline across the gap and adjacent to the gap for a distance of 60 m 200 feet for horizontal and vertical alignment after the guideline across the gap is tightened. Provide vertical and horizontal positioning of the guideline such that the finished pavement conforms to the alignment and grade elevations shown on the drawings within the specified tolerances for grade and smoothness. The specified tolerances are intended to cover only the normal deviations in the finished pavement that may occur under good supervision and do not apply to setting of the guideline. Set the guideline true to line and grade.

3.6.6.3 Stringless Technology - for Non-Continuously Reinforced Concrete

If the use of any type of stringless technology is proposed, submit a detailed description of the system and perform a trial field demonstration at least one week prior to start of paving. Approval of the control system will be based on the results of the demonstration and on continuing satisfactory operation during paving.

3.6.7 Placing Reinforcing Steel - for Non-Continuously Reinforced Concrete

Provide the type and amount of steel reinforcement indicated.

3.6.7.1 Pavement Thickness Greater Than 300 mm 12 inches - for Non-Continuously Reinforced Concrete

For pavement thickness of 300 mm 12 inches or more, install the reinforcement steel by the strike-off method wherein a layer of concrete is deposited on the underlying material, consolidated, and struck to the indicated elevation of the steel reinforcement. Place the reinforcement upon the pre-struck surface, followed by placement of the remaining concrete and finishing in the required manner. When placement of the second lift causes the steel to be displaced horizontally from its original position, provide provisions for increasing the thickness of the first lift and depressing the reinforcement into the unhardened concrete to the required elevation. Limit the increase in thickness only as necessary to permit correct horizontal alignment to be maintained. Remove and replace any portions of the bottom layer of concrete that have been placed more than 30 minutes without being covered with the top layer with newly mixed concrete without additional cost to the Government.

3.6.7.2 Pavement Thickness Less Than 300 mm 12 Inches - for Non-Continuously Reinforced Concrete

****

NOTE: Delete bracketed item if CRCP is not being constructed.

****

For pavements less than 300 mm 12 inches thick, position the reinforcement on suitable chairs or continuous mesh support devices securely fastened to the subgrade prior to concrete placement. Consolidate concrete after the steel has been placed. Regardless of placement procedure, provide reinforcing steel free from coatings which could impair bond between the steel and concrete, with reinforcement laps as indicated. Regardless of the equipment or procedures used for installing reinforcement, ensure that the entire depth of concrete is adequately consolidated.[If reinforcing for Continuously Reinforced Concrete Pavement (CRCP) is required, submit the entire operating procedure and equipment proposed for approval at least 30 days prior to proposed start of paving.]

3.6.8 Placing Dowels - for Non-Continuously Reinforced Concrete

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NOTE: Delete references to slipform paving installation of dowels if slipform paving is not allowed. Delete references to installation in contraction joints if not required.

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Ensure the method used to install and hold dowels in position result in dowel alignment within the maximum allowed horizontal and vertical tolerance of 3 mm per 300 mm 1/8 inch per foot after the pavement has been completed. Except as otherwise specified below, maintain the horizontal spacing of dowels within a tolerance of plus or minus 15 mm 5/8 inch. Locate the dowel vertically on the face of the slab within a tolerance of plus or minus 13 mm 1/2 inch. Measure the vertical alignment of the dowels parallel to the designated top surface of the pavement, except for those across the crown or other grade change joints. Measure dowels across crowns and other joints at grade changes to a level surface. Check horizontal alignment perpendicular to the joint edge with a framing square. Do not place longitudinal dowels closer than 0.6 times the dowel bar length to the planned joint line. If the last regularly spaced longitudinal dowel is closer than that dimension, move it away from the joint to a location 0.6 times the dowel bar length, but not closer than 150 mm 6 inches to its nearest neighbor. Resolve dowel interference at a transverse joint-longitudinal joint intersection by deleting the closest transverse dowel. Do not position the end of a transverse dowel closer than 300 mm 12 inches from the end of the nearest longitudinal dowel. Install dowels as specified in the following subparagraphs.

3.6.8.1 Contraction Joints - for Non-Continuously Reinforced Concrete

Securely hold dowels in longitudinal and transverse contraction joints within the paving lane in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. Securely hold the basket assemblies in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires.

3.6.8.2 Construction Joints-Fixed Form Paving - for Non-Continuously Reinforced Concrete

Install dowels by the bonded-in-place method or the drill-and-dowel method. Installation by removing and replacing in preformed holes is not permitted. Prepare and place dowels across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. Provide the spacing of dowels in construction joints as indicated, except that, where the planned spacing cannot be maintained because of form length or interference with form braces, provide closer spacing with additional dowels.

3.6.8.3 Dowels Installed in Hardened Concrete - for Non-Continuously Reinforced Concrete

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NOTE: The first tailoring option is for CYLINDERS/BEAMS and the second option is for BEAMS.

****

Install dowels in hardened concrete by bonding the dowels into holes drilled into the hardened concrete. Before drilling commences, cure the concrete for 7 days or until it has reached a minimum [compressive strength of 17 MPa 2500 psi][flexural strength of 3.1 MPa 450 psi]. Drill holes 3 mm 1/8 inch greater in diameter than the dowels into the hardened concrete using rotary-core drills. Rotary-percussion drills are permitted, provided that excessive spalling does not occur to the concrete joint face. Excessive spalling is defined as spalling deeper than 6 mm 1/4 inch from the joint face or 12 mm 1/2 inch radially from the outside of the drilled hole. Continuing damage requires modification of the equipment and operation. Drill depth of dowel hole within a tolerance of plus or minus 13 mm 1/2 inch of the dimension shown on the drawings. Upon completion of the drilling operation, blow out the dowel hole with oil-free, compressed air. Bond dowels in the drilled holes using epoxy resin. Inject epoxy resin at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel is not permitted. Hold the dowels in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic grout retention ring fitted around the dowel. Provide dowels required between new and existing concrete in holes drilled in the existing concrete, all as specified above.

3.6.8.4 Lubricating Dowel Bars - for Non-Continuously Reinforced Concrete

Wipe the portion of each dowel intended to move within the concrete clean and coat with a thin, even film of lubricating oil or light grease before the concrete is placed.

3.7 FINISHING

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NOTE: Edit bracketed items as appropriate. Retain slipform paving subparagraph except when it is prohibited elsewhere. Delete Other Types of Finishing Equipment here and in PART 2, if not wanted. Hand finishing is to be allowed only for isolated, small, odd-shaped slabs or places inaccessible to the paver.
****

Provide finishing operations as a continuing part of placing operations starting immediately behind the strike-off of the paver. Provide initial finishing by the transverse screed or extrusion plate. Provide the sequence of operations consisting of transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Provide finishing by the machine method. Provide a work bridge as necessary for consolidation and hand finishing operations. Use the hand method only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Keep supplemental hand finishing for machine finished pavement to an absolute minimum. Immediately stop any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing. Prior to recommencing machine finishing, properly adjust or replace the equipment. Immediately halt any operations which produce more than 3 mm 1/8 inch of mortar-rich surface (defined as deficient in plus 4.75 mm U.S. No. 4 sieve size aggregate) and the equipment, mixture, or procedures modified as necessary. Compensate for surging behind the screeds or extrusion plate and settlement during hardening and take care to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) is at the required line and grade. Maintain finishing equipment and tools clean and in an approved condition. Water is not allowed to be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

3.7.1 Machine Finishing With Fixed Forms

Replace machines that cause displacement of the forms. Only one pass of the finishing machine is allowed over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, immediately stop the operation and the equipment, mixture, and procedures adjusted as necessary.

3.7.2 Machine Finishing with Slipform Pavers

Operate the slipform paver so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Immediately modify or replace any equipment or procedure that fails to meet these specified requirements as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float is allowed. If there is concrete slurry or fluid paste on the surface that runs over the edge of the pavement, immediately stop the paving operation and the equipment, mixture, or operation modified to prevent formation of such slurry. Immediately remove any slurry which does run down the vertical edges by hand, using stiff brushes or scrapers.

Slurry, concrete or concrete mortar is not allowed to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

3.7.3 Surface Correction and Testing

After all other finishing is completed but while the concrete is still plastic, eliminate minor irregularities and score marks in the pavement surface by means of cutting straightedges. Provide cutting straightedges with a minimum length of 4 m 12 feet that are operated from the sides of the pavement or from bridges. Provide cutting straightedges operated from the side of the pavement equipped with a handle 1 m 3 feet longer than one-half the width of the pavement. Test the surface for trueness with a straightedge held in successive positions parallel and at right angles to the center line of the pavement, and the whole area covered as necessary to detect variations. Advance the straightedge along the pavement in successive stages of not more than one-half the length of the straightedge. Immediately fill depressions with freshly mixed concrete, strike off, consolidate with an internal vibrator, and refinish. Strike off projections above the required elevation and refinish. Continue the straightedge testing and finishing until the entire surface of the concrete is free from observable departure from the straightedge and conforms to the surface requirements specified in paragraph SURFACE SMOOTHNESS. This straight edging is not allowed to be used as a replacement for the straightedge testing of paragraph SURFACE SMOOTHNESS. Use long-handled, flat bull floats very sparingly and only as necessary to correct minor, scattered surface defects. If frequent use of bull floats is necessary, stop the paving operation and the equipment, mixture or procedures adjusted to eliminate the surface defects. Keep finishing with hand floats and trowels to the absolute minimum necessary. Take extreme care to prevent over finishing joints and edges. Produce the surface finish of the pavement essentially by the finishing machine and not by subsequent hand finishing operations. All hand finishing operations are subject to approval.

3.7.4 Hand Finishing

Use hand finishing operations only as specified below. Provide a work bridge to be used as necessary for consolidation and placement operations to avoid standing in concrete.

3.7.4.1 Equipment and Template

In addition to approved mechanical internal vibrators for consolidating the concrete, provide a strike-off and tamping template and a longitudinal float for hand finishing. Provide a template at least 300 mm 1 foot longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, that is constructed of metal or other suitable material shod with metal. Provide a longitudinal float at least 3 m 10 feet long, of approved design, is rigid and substantially braced, and maintain a plane surface on the bottom. Grate tampers (jitterbugs) are not allowed.

3.7.4.2 Finishing and Floating

As soon as placed and vibrated, strike off the concrete and screeded to the crown and cross section and to such elevation above grade that when consolidated and finished, the surface of the pavement is at the required elevation. In addition to previously specified complete coverage with handheld immersion vibrators, tamp the entire surface with the strike-off and tamping template, and the tamping operation continued until the required compaction and reduction of internal and surface voids are accomplished. Immediately following the final tamping of the surface, float the pavement longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, place additional concrete, consolidated and screeded, and the float operated until a satisfactory surface has been produced. Do not advance the floating operation more than half the length of the float and then continued over the new and previously floated surfaces.

3.7.5 Texturing

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NOTE: Designer must select type of texturing desired, retain that subparagraph, and delete the others. A genuine effort must be made to determine the type of texturing, if any, desired by the using service. If no guidance is given, the usual default method must be burlap drag. If other than a burlap drag textured finish is required, edit the appropriate paragraph(s) as shown below.

For Air Force airfield paving projects, do not specify artificial turf, wire comb, or surface grooving textures. For Navy airfield paving projects, do not specify wire comb or surface grooving textures. Use Section 32 01 18.71 GROOVING OF AIRFIELD PAVING to specify saw-cut grooves.

Spring tine grooving is limited to use on roads and streets only.

****

Before the surface sheen has disappeared and before the concrete hardens or curing compound is applied, texture the surface of the pavement as described herein. After curing is complete, thoroughly power broom all textured surfaces to remove all debris.

[3.7.5.1 Burlap Drag Surface

Apply surface texture by dragging the surface of the pavement, in the direction of the concrete placement, with an approved burlap drag. Operate the drag with the fabric moist, and the fabric maintained clean or changed as required to keep clean. Perform the dragging so as to produce a uniform finished surface having a fine sandy texture without disfiguring marks.

][3.7.5.2 Broom Texturing

Complete brooming before the concrete has hardened to the point where the surface is unduly torn or roughened, but after hardening has progressed enough so that the mortar does not flow and reduce the sharpness of the scores. Overlap successive passes of the broom the minimum necessary to obtain a uniformly textured surface. Wash brooms thoroughly at frequent intervals during use. Remove worn or damaged brooms from the job site. Hand brooming is permitted only on isolated odd shaped slabs or slabs where hand finishing is permitted. For hand brooming, provide brooms with handles longer than half the width of slab to be finished. Transversely draw the hand brooms across the surface from the center line to each edge with slight overlapping strokes.

][3.7.5.3 Artificial Turf Drag Surface

Apply artificial turf texture by dragging the surface of the pavement in the direction of concrete placement with an approved full-width drag made with artificial turf.

]3.7.6 Edging

Before texturing has been completed, carefully finish the edge of the slabs along the forms, along the edges of slipformed lanes, and at the joints with an edging tool to form a smooth rounded surface of 3 mm 1/8 inch radius. Eliminate tool marks, and provide edges that are smooth and true to line. Water is not allowed to be added to the surface during edging. Take extreme care to prevent overworking the concrete.

3.7.7 Outlets in Pavement

Construct recesses for the tie-down anchors, lighting fixtures, and other outlets in the pavement to conform to the details and dimensions shown. Carefully finish the concrete in these areas to provide a surface of the same texture as the surrounding area that is within the requirements for plan grade and surface smoothness.

3.8 CURING

3.8.1 Protection of Concrete

Continuously protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. Have all equipment needed for adequate curing and protection of the concrete on hand and ready for use before actual concrete placement begins. If any selected method of curing does not afford the proper curing and protection against concrete cracking, remove or replace the damaged pavement, and provide another method of curing as directed.

3.8.2 Wet Curing

Wet-cure concrete and continuously maintain wet for the entire curing period, commencing immediately after finishing. If forms are removed before the end of the curing period, carry out curing as on unformed surfaces, using suitable materials. Apply burlap to concrete surface and cover with polyethylene; lap sheets to ensure full coverage. When forms are removed, cover pavement sides with burlap and polyethylene and keep wet. Anchor burlap and polyethylene to prevent blowing or dislodging by wind or jet blast. Provide an approved work system to ensure that concrete surface is continuously wet 24 hours per day. Wet cure for 14 days. Adjacent lanes of High Temperature Concrete may be placed after 72 hours of wet curing and minimizing the disturbance of the burlap and polyethylene. Curing may be interrupted for no more than 12 hours (includes time for preparation, paving and initial hardening before wet curing). Reinstate wet curing until 14 days of wet curing are completed (add time for lack of curing while paving adjacent lanes).

3.9 JOINTS FOR NON-CONTINUOUSLY REINFORCED CONCRETE

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NOTE: Edit bracketed items in following

subparagraphs to conform to design requirements. Even if not required, dowels must be permitted for construction joints. Remove joint types not required in the project.

****

3.9.1 General Requirements for Joints

Construct joints that conform to the locations and details indicated and are perpendicular to the finished grade of the pavement. Provide joints that are straight and continuous from edge to edge or end to end of the pavement with no abrupt offset and no gradual deviation greater than 13 mm 1/2 inch. Where any joint fails to meet these tolerances, remove and replace the slabs adjacent to the joint at no additional cost to the Government. Change from the jointing pattern shown on the drawings is not allowed without written approval. Seal joints immediately following curing of the concrete or as soon thereafter as weather conditions permit as specified in Section [32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT][32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT].

3.9.2 Longitudinal Construction Joints

Install dowels in the longitudinal construction joints, or thicken the edges as indicated. Install dowels as specified above.[If any length of completed keyway of 1.5 m 5 feet or more fails to meet the previously specified tolerances, install dowels in that part of the joint by drilling holes in the hardened concrete and grouting the dowels in place with epoxy resin.] After the end of the curing period, saw longitudinal construction joints to provide a groove at the top for sealant conforming to the details and dimensions indicated.

3.9.3 Transverse Construction Joints

Install transverse construction joints at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for 30 minutes or longer. Install the transverse construction joint at a planned transverse joint. Provide transverse construction joints by utilizing headers or by paving through the joint, then full-depth saw cutting the excess concrete. Construct pavement with the paver as close to the header as possible, with the paver run out completely past the header. Provide transverse construction joints at a planned transverse joint constructed as shown or, if not shown otherwise, dowelled in accordance with paragraph DOWELS INSTALLED IN HARDENED CONCRETE, or paragraph FIXED FORM PAVING above.

3.9.4 Expansion Joints

Provide expansion joints where indicated, and about any structures and features that project through or into the pavement, using joint filler of the type, thickness, and width indicated, and installed to form a complete, uniform separation between the structure and the pavement or between two pavements. Attach the filler to the original concrete placement with adhesive and mechanical fasteners and extend the full slab depth. After placement and curing of the adjacent slab, sawcut the sealant reservoir depth from the filler. Tightly fit adjacent sections of filler together, with the filler extending across the full width of the paving lane or other complete distance in order to prevent entrance of concrete into the expansion space. Finish edges of the concrete at the joint face with an edger with a radius of 3 mm 1/8 inch.

3.9.5 Slip Joints

Install slip joints where indicated using the specified materials. Attach preformed joint filler material to the face of the original concrete placement with adhesive and mechanical fasteners. Construct a 19 mm 3/4 inch deep reservoir for joint sealant at the top of the joint. Finish edges of the joint face with an edger with a radius of 3 mm 1/8 inch.

3.9.6 Contraction Joints

Construct transverse and longitudinal contraction joints by sawing an initial groove in the concrete with a 3 mm 1/8 inch blade to the indicated depth. During sawing of joints, and again 24 hours later, the CQC team is required to inspect all exposed lane edges for development of cracks below the saw cut, and immediately report results. If there are more than six consecutive uncracked joints after 48 hours, saw succeeding joints 25 percent deeper than originally indicated at no additional cost to the Government. The time of initial sawing varies depending on existing and anticipated weather conditions and be such as to prevent uncontrolled cracking of the pavement. Commence sawing of the joints as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. The sawed faces of joints will be inspected for undercutting or washing of the concrete due to the early sawing, and sawing delayed if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint. Continue the sawing operation as required during both day and night regardless of weather conditions. Saw the joints at the required spacing consecutively in the sequence of the concrete placement. Provide adequate lighting for night work. Illumination using vehicle headlights is not permitted. Provide a chalk line or other suitable guide to mark the alignment of the joint. Before sawing a joint, examine the concrete closely for cracks, and do not saw the joint if a crack has occurred near the planned joint location. Discontinue sawing when a crack develops ahead of the saw cut. Immediately after the joint is sawed, thoroughly flush the saw cut and adjacent concrete surface with water and vacuumed until all waste from sawing is removed from the joint and adjacent concrete surface. Respray the surface with curing compound as soon as free water disappears. Take necessary precautions to insure that the concrete is properly protected from damage and cured at sawed joints. Tightly seal the top of the joint opening and the joint groove at exposed edges with cord backer rod before the concrete in the region of the joint is resprayed with curing compound, and be maintained until removed immediately before sawing the joint sealant reservoir. Seal the exposed saw cuts on the faces of pilot lanes with bituminous mastic or masking tape. After expiration of the curing period, widen the upper portion of the groove by sawing with ganged diamond saw blades to the width and depth indicated for the joint sealer. Center the reservoir over the initial sawcut.

3.9.7 Thickened Edge Joints

Construct thickened edge joints as indicated on the drawings. Grade the underlying material in the transition area as shown and meet the requirements for smoothness and compaction specified for all other areas of the underlying material.

[3.10 SURFACE PREPARATION FOR SEALING

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NOTE: In order to prepare the surface of existing concrete or new concrete which has POL spillage, POL stains must be removed to ensure penetration of surface sealer solution. This paragraph is optional for new construction and may be deleted.

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Utilize one of the following agents and methodologies for removing POL stains prior to sodium silicate sealing:

a. Dishwashing detergent and hot water: Apply to stained concrete and scrub to develop a thick lather. Let set for five minutes then rinse with warm/hot water. Use of steam to pre-treat the area and rinse may aid removal.

b. Trisodium phosphate (TSP): Note that some states have banned this product because phosphate can cause problems with nearby waterways. DO NOT MIX TSP WITH ANY ACID! A violent reaction can occur and release noxious gas. You can use both products but they must be used separately, with a thorough rinsing with water between applications.

c. Application method 1: Mix one measure of TSP with six measures of water. Apply over the stain with a paintbrush and allow it to dry completely before scraping off the dried paste. Rinse the concrete surface and scrub with a stiff brush and clean water.

d. Application method 2: Dissolve 1 pound, 6 ounces of TSP in a gallon of water. Add enough finely ground calcium carbonate (also called whiting or agricultural lime) to make a thick paste. (Agricultural lime is available at garden supply stores.) Spread the paste over the stain and allow it to dry for a day, if possible. Brush off the dry paste with a stiff brush and scrub the concrete with water. The paste has a high pH so personal protective equipment (PPE) must be used and the paste should be kept away from aircraft. If it is windy, protect the treated area until the area is cleaned and rinsed to keep the caustic material from blowing around the apron.

e. Sodium hydroxide: Make a solution of 5 percent sodium hydroxide (caustic soda: NaOH). Apply it over the stain with a paintbrush and allow it to dry for at least 24 hours. Rinse and scrub with clean water then repeat as required. This has a high pH so PPE must be used and the solution should be kept away from aircraft. If it is windy, protect the treated area until the area is cleaned and rinsed to keep the caustic material from blowing around the apron.

f. Sodium carbonate: Apply as directed. Rinse well with water. This is an organic salt. If it is windy, protect the treated area until the area is cleaned and rinsed to keep the salt from blowing around the apron.

g. Phosphoric acid cleaner: Apply as directed. Rinse well with water and sodium carbonate (washing soda or soda ash) to neutralize the pH then rinse with clear water. This product will etch the concrete so do not leave it on too long and ensure the area is rinsed well to ensure no acid is left on the concrete.

h. Bio-remediation: Apply as directed.

]3.11 SODIUM SILICATE SEALING

Seal the High Temperature Concrete surfaces with a sodium silicate solution, after paint marking application, using the following procedures:

a. After last continuously reinforced High Temperature Concrete pour is 90 days of age, and non-continuously reinforced High Temperature Concrete is 70 days of age (if used), dry broom and air blow concrete surfaces and apply sodium silicate sealant. Concrete surface must be dry for 24 hours prior to applying sealer. Air temperature must be 5 degrees C 40 degrees F or more and relative humidity must be 80 percent or less, both during application and the 48 hours after application.

b. Apply three coats of sodium silicate solution, using low pressure airless spraying equipment that ensures uniform application. Start applying the solution at the highest point in the pavement and continue downgrade. Each coat must cover not more than 5 square meters per liter 200 square feet per gallon. Excessive application is to be avoided to prevent efflorescence. Allow sodium silicate to penetrate for 2 hours then wash off any visible excess (ponded) solution. Allow the area to dry for 24 hours between each coat.

c. After allowing the last coat to dry for 24 hours, evaluate the surface for any excess silica or dusting. Wash off any excess silica or dusting as needed. Protect application from any pedestrian or vehicular traffic until the last coat has dried.

3.11.1 Pavement Marking Installation

Apply pavement markings and glass beads before sodium silicate application. Apply sodium silicate over markings and glass beads.

3.12 REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED CONCRETE FOR CONTINUOUSLY REINFORCED CONCRETE

3.12.1 High Temperature Concrete

Remove and replace new High Temperature Concrete determined to not meet acceptance requirements using materials, methods and equipment, and to the limits as directed by Contracting Officer at no additional cost to Government. Removal of partial slabs, or partial lanes of continuously reinforced lanes, is not permitted; remove and replace the entire continuously reinforced lane.

3.12.1.1 Removal and Replacement Of Continuously Reinforced High Temperature Concrete

Removal of partial slabs, or partial lanes of continuously reinforced lanes, is not permitted; remove and replace the entire continuously reinforced lane. Removal of a lane of continuously reinforced High Temperature Concrete pavement requires saw cutting the concrete full depth on all sides 380 mm 15 inches inside from each edge of the lane to be removed using a diamond saw. Remove the concrete within this initial sawcut . Remove the remaining 380 mm 15 inch concrete buffer only with hand held 14 kg 30 pound or less pneumatic hammers to remove the concrete above and below the remaining continuous reinforcement. Remove any loose longitudinal rebar exposed. Regrade and recompact surface of base course. Use manufacturer approved mechanical connector clamp, weld or use threaded connector to attach new transverse reinforcement to existing; lap splicing is not adequate. Replace continuous reinforcement in both directions per plans. Replace concrete following this specification. Submit complete removal and repair plan to Contracting Officer for review prior to work.

3.12.2 Removal and Replacement of Plane Jointed Concrete Pavement

Where it is necessary to remove concrete pavement, remove in accordance with paragraph EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR. Remove and replace full depth, by full width of the lane, and the limit of removal must be normal to the paving lane and extend to each original joint. Remove and replace any damaged reinforcing bars. Place concrete as specified for original construction. Prior to placement of new concrete, recompact and shape the underlying material as specified in the appropriate section of these specifications, and clean the surfaces of all four joint faces of all loose material and contaminants. Prepare the resulting joints around the new slab as specified for original construction.

3.13 REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS FOR NON-CONTINUOUSLY REINFORCED CONCRETE

3.13.1 General Criteria

Repair or remove and replace new pavement slabs as specified at no cost to the Government. Removal of partial slabs is not permitted. Prior to any repairs, submit a Repair Recommendations Plan detailing areas exceeding the specified limits as well as repair recommendations required to bring these areas within specified tolerances.

3.13.2 Slabs with Cracks

No cores can be taken within continuously reinforced concrete. Before repairing cracks that have developed within continuously reinforced concrete consultation with [Corps of Engineers Transportation Systems Center (TSMCX)][Air Force Civil Engineer Center (AFCEC)][Naval Facilities Engineering Systems Command (NAVFAC, Echelon III)] pavement Subject Matter Expert (SME).

The Government may require cores to be taken over cracks to determine depth of cracking. Such cores are to be drilled with a minimum diameter of 150 mm 6 inches, and be backfilled with an approved non-shrink concrete. Perform drilling of cores and filling of holes at no expense to the Government. Clean cracks that do not exceed 50 mm 2 inches in depth; then pressure injected full depth with epoxy resin, Type IV, Grade 1. Remove and replace slabs containing cracks deeper than 50 mm 2 inches.

3.13.3 Removal and Replacement of Full Slabs

Remove and replace slabs containing more than 15.0 percent of any longitudinal or transverse joint edge spalled. Where it is necessary to remove full slabs, remove in accordance with paragraph REMOVAL OF EXISTING PAVEMENT SLAB below. Remove and replace full depth, by full width of the slab, and the limit of removal normal to the paving lane and extend to each original joint. Compact and shape the underlying material as specified in the appropriate section of these specifications, and clean the surfaces of all four joint faces of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Install dowels of the size and spacing as specified for other joints in similar pavement by epoxy grouting them into holes drilled into the existing concrete using procedures as specified in paragraph PLACING

DOWELS, above. Provide dowels for all four edges of the new slab. Cut off original damaged dowels flush with the joint face. Lightly oil or grease protruding portions of new dowels. Place concrete as specified for original construction. Take care to prevent any curing compound from contacting dowels. Prepare and seal the resulting joints around the new slab as specified for original construction.

3.13.4 Repairing Spalls Along Joints

Conventional spall repairs are prohibited of all Vertical Landing Zones, Short Take-Off Lanes, and associated safety zones, blast zones, and rotation areas. In these areas, only full depth repairs are acceptable. In areas which have continuously reinforced steel, repair must not damage reinforcing steel in any way.

Repair spalls along joints to be sealed to a depth to restore the full joint-face support prior to placing adjacent pavement. Where directed, repair spalls along joints of new slabs, along edges of adjacent existing concrete, and along parallel cracks by first making a vertical saw cut at least 75 mm 3 inches outside the spalled area and to a depth of at least 50 mm 2 inches. Provide saw cuts consisting of straight lines forming rectangular areas without sawing beyond the intersecting saw cut. Chip out the concrete between the saw cut and the joint, or crack, to remove all unsound concrete and into at least 13 mm 1/2 inch of visually sound concrete. Thoroughly clean the cavity thus formed with high pressure water jets supplemented with oil-free compressed air to remove all loose material. Immediately before filling the cavity, apply a prime coat to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. Apply the prime coat in a thin coating and scrubbed into the surface with a stiff-bristle brush. Provide prime coat for portland cement repairs consisting of a neat cement grout and for epoxy resin repairs consisting of epoxy resin, Type III, Grade 1. Fill the prepared cavity with material identified in the following table based on the cavity volume.

Spall Repairs

Volume of Prepared Cavity After Removal Operations	Material
less than 0.00085 cubic meter 0.03 cubic foot	epoxy resin mortar or epoxy resin or latex modified mortar
0.00085 cubic meter 0.03 cubic foot and 0.009 cubic meter 1/3 cubic foot	Portland cement mortar
more than 0.009 cubic meter 1/3 cubic foot	Portland cement concrete or latex modified mortar

Provide portland cement concretes and mortars that consist of very low slump mixtures, 13 mm 1/2 inch slump or less, proportioned, mixed, placed, consolidated by tamping, and cured, all as directed. Provide epoxy resin mortars made with Type III, Grade 1, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved. Proprietary patching materials may be used, subject to Government approval. Place the epoxy resin materials in the cavity in layers with a maximum thickness of 50 mm 2 inches. Provide adequate time between placement of additional layers such that the temperature of the epoxy resin material does not exceed 60 degrees C 140 degrees F at any time during hardening. Provide mechanical vibrators and hand tampers to consolidate the concrete or mortar. Remove any repair material on the surrounding surfaces of the existing concrete before it hardens. Where the spalled area abuts a joint, provide an insert or other bond-breaking medium to prevent bond at the joint face. Saw a reservoir for the joint sealant to the dimensions required for other joints. Thoroughly clean the reservoir and then sealed with the sealer specified for the joints.[In lieu of sawing, spalls not adjacent to joints and popouts, both less than 150 mm 6 inches in maximum dimension, may be prepared by drilling a core 50 mm 2 inches in diameter greater than the size of the defect, centered over the defect, and 50 mm 2 inches deep or 13 mm 1/2 inch into sound concrete, whichever is greater. Repair the core hole as specified above for other spalls.]

3.13.5 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Diamond grind slabs containing weak surfaces less than 6 mm 1/4 inch thick to remove the weak surface. Diamond grind in accordance with paragraph DIAMOND GRINDING OF PCC SURFACES. All diamond ground areas are required to meet the thickness, smoothness and grade criteria specified in PART 1 GENERAL. Remove and replace slabs containing weak surfaces greater than 6 mm 1/4 inch thick.

3.13.6 Repair of Pilot Lane Vertical Faces

Repair excessive edge slump and joint face deformation in accordance with paragraph EDGE SLUMP AND JOINT FACE DEFORMATION in PART 1. Repair inadequate consolidation (honeycombing or air voids) by saw cutting the face full depth along the entire lane length with a diamond blade. Obtain cores, as directed, to determine the depth of removal.

3.14 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

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NOTE: It is imperative that sufficient exploration be made (not just reference to as-built drawings) for the designer to know exactly what the in-place existing pavement thickness and load-transfer are at the jointing area--dowels, keys, tie bars, etc--and its condition. Normally, the joint between the new pavement and existing pavement should be made at an existing joint in the old pavement. Coordinate with Section 02 41 00 [DEMOLITION][AND][DECONSTRUCTION].

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Remove existing concrete pavement at locations indicated on the drawings. Prior to commencing pavement removal operations, inventory the pavement distresses (cracks, spalls, and corner breaks) along the pavement edge to remain. After pavement removal, survey the remaining edge again to quantify any damage caused by removal operations. Perform both surveys in the presence of the Government. Perform repairs as indicated and as specified herein. Carefully control all operations to prevent damage to the concrete pavement and to the underlying material to remain in place. Perform all saw cuts perpendicular to the slab surface, forming rectangular areas. Perform all existing concrete pavement repairs prior to paving adjacent lanes.

3.14.1 Removal of Existing Pavement Slab

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NOTE: The saw cut at a distance from the joint should be sawed with a wheel saw which produces a 38 mm 1-1/2 inches or wider kerf and better prevents stress from propagating across the saw cut. Specify wheel saw for Army and Air Force projects. Specify diamond saw for Navy projects.

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When existing concrete pavement is to be removed and adjacent concrete is to be left in place, perform the first full depth saw cut on the joint between the removal area and adjoining pavement to stay in place with a standard diamond-type concrete saw. Next, perform a full depth saw cut parallel to the joint that is at least 600 mm 24 inches from the joint and at least 150 mm 6 inches from the end of any dowels with a [wheel saw] [diamond saw] as specified in paragraph SAWING EQUIPMENT. Remove all pavement beyond this last saw cut in accordance with the approved demolition work plan. Remove all pavement between this last saw cut and the joint line by carefully pulling pieces and blocks away from the joint face with suitable equipment and then picking them up for removal. In lieu of this method, this strip of concrete may be carefully broken up and removed using hand-held jackhammers, 14 kg 30 lb or less, or other approved light-duty equipment which does not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place. In lieu of the above specified removal method, the slab may be sawcut full depth to divide it into several pieces and each piece lifted out and removed. Use suitable equipment to provide a truly vertical lift, and safe lifting devices used for attachment to the slab.

3.14.2 Edge Repair

Protect the edge of existing concrete pavement against which new pavement abuts from damage at all times. Remove and replace slabs which are damaged during construction as directed at no cost to the Government. Repair of previously existing damage areas is considered a subsidiary part of concrete pavement construction. Saw off all exposed keys and keyways full depth.

3.14.2.1 Spall Repair

Conventional spall repairs are prohibited of all Vertical Landing Zones, Short Take-Off Lanes, and associated safety zones, blast zones, and rotation areas. In these areas, only full depth repairs are acceptable. In areas which have continuously reinforced steel, repair must not damage reinforcing steel in any way.

Not more than 15.0 percent of each slab's edge is allowed to be spalled. Provide a full depth saw cut on the exposed face to remove the spalled face of damaged slabs with spalls exceeding this quantity, regardless of spall size. Provide repair materials and procedures as previously specified in paragraph REPAIRING SPALLS ALONG JOINTS.

3.14.2.2 Underbreak and Underlying Material

Repair all underbreak by removal and replacement of the damaged slabs in accordance with paragraph REMOVAL AND REPLACEMENT OF FULL SLABS above. Protect the underlying material adjacent to the edge of and under the existing pavement which is to remain in place from damage or disturbance during removal operations and until placement of new concrete, and be shaped as shown on the drawings or as directed. Maintain sufficient underlying material in place outside the joint line to completely prevent disturbance of material under the pavement which is to remain in place. Remove and replace any slab with underlying material that is disturbed or loses its compaction.

3.15 PAVEMENT PROTECTION

Protect the pavement against all damage prior to final acceptance of the work by the Government. Placement of aggregates, rubble, or other similar construction materials on airfield pavements is not allowed. Exclude traffic from the new pavement by erecting and maintaining barricades and signs until the concrete is at least 14 days old, or for a longer period if so directed. As a construction expedient in paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment is permitted on the new pavement after the pavement has been cured for 7 days and the joints have been sealed or otherwise protected, the concrete has attained a minimum field cured flexural strength of 3.8 MPa 550 psi and approved means are provided to prevent damage to the slab edge. Continuously maintain all new and existing pavement carrying construction traffic or equipment completely clean, and spillage of concrete or other materials cleaned up immediately upon occurrence. Take special care in areas where traffic uses or crosses active airfield pavement. Power broom other existing pavements at least daily when traffic operates. For fill-in lanes, provide equipment that does not damage or spall the edges or joints of the previously constructed pavement.

3.16 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

3.16.1 Testing and Inspection by Contractor

During construction, perform sampling and testing of aggregates, cementitious materials (cement, slag cement, and pozzolan), and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Furnish sampling platforms and belt templates to obtain representative samples of aggregates from charging belts at the concrete plant. Obtain samples of concrete at the point of delivery to the paver. Testing by the Government in no way relieves the specified testing requirements. Perform the inspection and tests described below, and based upon the results of these inspections and tests, take the action required and submit reports as required. Perform this testing regardless of any other testing performed by the Government, either for pay adjustment purposes or for any other reason.

3.16.2 Testing and Inspection Requirements

Perform CQC sampling, testing, inspection and reporting in accordance with the following Table.

TABLE 6 5 4
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

TABLE 6
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Fine Aggregate Gradation and Fineness Modulus			

TABLE 6
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
2 per lot	ASTM C136/C136M sample at belt	9 of 10 tests must vary less than 0.15 from average	Retest, resolve, retest
		Outside limits on any sieve	Retest
		2nd gradation failure	Stop, resolve, retest
1 per 10 gradations	ASTM C117	Outside limits on any sieve	Retest
		2nd gradation failure	Stop, repair, retest
Coarse Aggregate Gradation (each aggregate size)			
2 per lot	ASTM C136/C136M sample at belt	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, correct
		2 consecutive averages of 5 tests outside limits	report to COR, stop ops, repair, retest
1 per 10 gradations	ASTM C117	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, correct
		2 consecutive averages of 5 tests outside limits	report to COR, stop ops, repair, verify all operations
Workability Factor and Coarseness Factor Computation			
Same as C.A. and F.A.	see paragraph AGGREGATES	Use individual C.A. and F.A. gradations. Combine using batch ticket percentages. Tolerances: plus or minus 3 points on WF; plus or minus 5 points on CF from approved adjusted mix design values; only the portion of the tolerance box within the parallelogram is available for use	Check batching tolerances, re-calibrate scales
		2 consecutive averages of 5 tests outside limits	Stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Aggregate Deleterious, Quality, and ASR Tests			

TABLE 6
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
First test no later than time of uniformity testing and then every [30][60] days of concrete	see paragraph AGGREGATES		Stop production, retest, replace aggregate. Increase testing interval to 90 days if previous 2 tests pass
Plant - Scales, Weighing Accuracy			
Monthly	NRMCA QC 3		Stop plant ops, repair, re-calibrate
Plant - Batching and Recording Accuracy			
Weekly	Record/Report	Record required/recorded/actu batch mass	Stop plant ops, repair, re-calibrate
Plant - Batch Plant Control			
Every lot	Record/Report		Record type and amount of each material per
Plant - Mixer Uniformity - Stationary Mixers			
Every 4 months during paving	COE CRD-C 55	After initial approval, use abbreviated method	Increase mixing time, change batching sequence, reduce batch size to bring into compliance. Retest
Plant - Mixer Uniformity - Truck Mixers			
Every 4 months during paving	ASTM C94/C94M	Random selection of truck.	Increase mixing time, change batching sequence, reduce batch size to bring into compliance. Retest
Concrete Mixture - Air Content			
When test specimens prepared plus 2 random	ASTM C231/C231M sample at point of discharge within the paving lane	Individual test control chart: Warning plus or minus	Adjust AEA, retest
		Individual test control chart: Action plus or minus 1.5	Halt operations, repair, retest
		Range between 2 consecutive tests: Warning plus 2.0	Re-calibrate AEA dispenser
		Range between 2 consecutive tests: Action plus 3.0	Halt operations, repair, retest
Concrete Mixture - Unit Weight and Yield			

TABLE 6
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Same as Air Content	ASTM C138/C138M sample at point of discharge within the paving lane	Individual test basis: Warning Yield minus 0 or plus 1	Check batching tolerances
		Individual test basis: Action Yield minus 0 or plus 5 percent	Halt operations
Concrete Mixture - Slump			
When test specimens prepared plus 4 random	ASTM C143/C143M sample at point of discharge within the paving lane	Individual test control chart: Upper Warning minus 13 mm 1/2 inch below max	Adjust batch masses within max W/C ratio
		Individual test control chart: Upper Action at maximum allowable slump	Stop operations, adjust, retest
		Range between each consecutive test: 38 mm 1-1/2 inches	Stop operations, repair, retest
Concrete Mixture - Temperature			
When test specimens prepared	ASTM C1064/C1064 sample at point of discharge within the paving lane	See paragraph WEATHER LIMITATIONS	
Concrete Mixture - Strength			
8 per lot	ASTM C31/C31M sample at point of discharge within the paving lane	See paragraph CONCRETE STRENGTH TESTING for CQC Perform fabrication of strength specimens and initial cure outside the paving lane and within 300 m 1,000 feet of the sampling point.	
Paving - Inspection Before Paving			
Prior to each paving operation	Report	Inspect underlying materials, construction joint faces, forms, reinforcing, dowels, and embedded items	
Paving - Inspection During Paving			
During paving operation		Monitor and control paving operation, including placement, consolidation, finishing, texturing, curing, and joint sawing.	
Paving - Vibrators			

TABLE 6 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
Weekly during paving	COE CRD-C 521	Test frequency (in concrete), and amplitude (in air), average measurement at tip and head.	Repair or replace defective vibrators.
Moist Curing			
2 per lot, min 4 per day	Visual		Repair defects, extend curing by 1 day
Membrane Compound Curing			
Daily	Visual	Calculate coverage based on quantity/area	Respray areas where coverage defective. Re-calibrate equipment
Cold Weather Protection			
Once per day	Visual		Repair defects, report conditions to COR

3.16.3 Concrete Strength Testing for CQC

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NOTE: If paragraph FLEXURAL STRENGTH AND THICKNESS is based on 28-day flexural strength for acceptance, modify this subparagraph to match it. The first tailoring option CYLINDERS/BEAMS includes items a through g; the second tailoring option BEAMS includes listing a through f.

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Perform Contractor Quality Control operations for concrete strength consisting of the following steps:

[a. Take samples for strength tests at the paving site. Fabricate and cure test cylinders in accordance with ASTM C31/C31M; test them in accordance with ASTM C39/C39M.

b. Fabricate and cure two test cylinders per sublot from the same batch or truckload and at the same time acceptance cylinders are fabricated and test them for compressive strength at 7-day age.

c. Average all eight compressive tests per lot. Convert this average 7-day compressive strength per lot to equivalent [28] [90]-day flexural strength using the Correlation Ratio determined during mixture proportioning studies.

d. Compare the equivalent [28] [90]-day flexural strength from the conversion to the Average Flexural Strength Required for Mixtures from paragraph of same title.

e. If the equivalent average [28][90]-day strength for the lot is below the Average Flexural Strength Required for Mixtures by 138 kPa 20 psi flexural strength or more, at any time, adjust the mixture to increase the strength, as approved.

f. Fabricate and cure two beams for every 1500 cubic meters 2000 cubic yards of concrete placed. Fabricate and cure in accordance with ASTM C31/C31M; test at 14-days of age in accordance with ASTM C78/C78M. Use the flexural strength results to verify the cylinder-beam acceptance correlation ratio.

g. Maintain up-to-date control charts for strength, showing the 7-day CQC compressive strength, the 14-day compressive strength (from acceptance tests) and the [28] [90]-day equivalent flexural strength of each of these for each lot.

][a. Take samples for strength tests at the paving site. Fabricate and cure test beams in accordance with ASTM C31/C31M; test them in accordance with ASTM C78/C78M.

b. Fabricate and cure two test beams per sublot from the same batch or truckload and at the same time acceptance beams are fabricated and test them for flexural strength at 7-day age.

c. Average all eight flexural tests per lot. Convert this average 7-day flexural strength per lot to equivalent [28] [90]-day flexural strength using the Correlation Ratio determined during mixture proportioning studies.

d. Compare the equivalent [28] [90]-day flexural strength from the conversion to the Average Flexural Strength Required for Mixtures from paragraph of same title.

e. If the equivalent average [28] [90]-day strength for the lot is below the Average Flexural Strength Required for Mixtures by 490 kPa 69 psi flexural strength or more, at any time, adjust the mixture to increase the strength, as approved.

f. Maintain up-to-date control charts for strength, showing the 7-day CQC flexural strength and the [28] [90]-day flexural strength (from acceptance tests) of each of these for each lot.

]3.16.4 Reports

Report all results of tests or inspections conducted informally as they are completed and in writing daily. Prepare a weekly report for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, make daily reports of pertinent temperatures. These requirements do not relieve the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Government has the right to examine all Contractor quality control records.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 13 14.13 (November 2022)**
Change 1 - 05/24

Preparing Activity: USACE **UFGS-32 13 14.13 (August 2019)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-32 13 14.13 (November 2022)**
Change 1 - 05/24

Preparing Activity: USACE **UFGS-32 13 14.13 (August 2019)**

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****

SECTION 32 13 14.13

CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS

11/22, CHG 1: 05/24

****

NOTE: This guide specification covers the requirements for construction of concrete pavement for Army, Navy and Air Force airfields and heavy-duty roads, parking areas, hardstands, and vehicular pavement.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. For bracketed items, choose applicable item(s) or insert appropriate information.**

Comments, suggestions and recommended changes for this guide specification are welcome and must be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: In preparing contract specifications for concrete pavement, use UFC 3-250-04 STANDARD PRACTICE FOR CONCRETE PAVEMENTS for guidance. Use UFGS 32 13 13.06, "Portland Cement Concrete Pavement for Roads and Site Facilities," or State highway specifications only for non organizational parking, roads, streets, and driveways where the equivalent passes of an 18-kip ESAL are less than 5.7 million. Use UFGS 32 13 14.13 for all organizational vehicle parking, special military vehicles, and airfield concrete pavements. Special military vehicles identified in UFC 3-201-1 include, but are not limited to: cranes, aircraft tow tractors, forklifts, container handling vehicles, tracked vehicles, heavy military cargo trucks (greater than 10,000 pounds (4535 kg) (e.g., Heavy Expanded Mobility Tactical Truck (HEMTT), Heavy Equipment Transport Systems (HETS), Palletized Load Systems

(i.e. M1074, M1075), Mine Resistant Ambush Protected (MRAP), and Stryker vehicles.

Edit specifications developed for Corps of Engineers managed projects in accordance with ER 1110-34-1 Engineering and Design Transportation Systems Mandatory Center of Expertise (Section 11, 12, App A, B, C).

Contact the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC) for guidance on interpreting and editing this specification section.

This specification section is structured for Contractor sampling and testing of materials and mixture proportioning. If Government sampling, testing and mixture proportioning are required, contact the TSMCX, AFCEC pavement SME, or NAVFAC for specification language.

****

1.1 UNIT PRICES

1.1.1 Measurements

The quantity of concrete to be paid for will be the volume of concrete in cubic meters yards including thickened edges [monolithic curb], where required, placed in the completed and accepted pavement. Concrete will be measured in place in the completed and accepted pavement only within the neat line dimensions shown in the plan and cross section. No deductions will be made for rounded or beveled edges or the space occupied by pavement reinforcement, dowel bars, [tie bars,]or electrical conduits, nor for any void, or other structure extending into or through the pavement slab, measuring 0.1 cubic meter 3 cubic feet or less in volume. No other allowance for concrete will be made unless placed in specified locations in accordance with the approved contract modification. The quantity of other materials specified herein, and used in the construction of the work covered by this section, will not be measured for payment, but will be considered a subsidiary obligation, covered under the price per cubic meter yard for concrete. Joint sealing materials are covered in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT or 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT.

1.1.2 Payments

****

NOTE: Use the applicable paragraph from the two choices below and delete the other. For Lump Sum payment, include concrete unit price from Government estimate in paragraph LUMP SUM to provide cost basis for calculating payment reduction.

Always retain one payment method.

****

1.1.2.1 Unit Price

The quantity of concrete measured as specified above will be paid for at the contract unit price when placed in completed and accepted pavements. Payment will be made at the contract price for cubic meter yard for the scheduled item, with necessary adjustments as specified below. Payment will constitute full compensation for providing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement, except for other items specified herein for separate payment.

1.1.2.2 Lump Sum

The quantity of concrete will be paid for and included in the lump-sum contract price. If less than 100 percent payment is due based on the pay factors stipulated below, a unit price of [_____] per cubic meter yard will be used for purposes of calculating the payment reduction. Payment will constitute full compensation for all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement, except for other items specified herein for separate payment.

1.1.3 Payment of Lots

When a lot of material fails to meet the specification requirements, that lot will be accepted at a reduced price or be removed and replaced. The lowest computed percent payment determined for any pavement characteristic discussed below (for example, thickness, grade, and surface smoothness) becomes the actual percent payment for that lot. The actual percent payment will be applied to the unit price and the measured quantity of concrete in the lot to determine actual payment. Use results of strength tests to control concreting operations. Strength will be evaluated, but will not be considered for payment adjustment. Remove and replace any sublot not meeting the required 'Concrete Strength for Final Acceptance' at no additional cost to the Government.

1.1.4 Payment Adjustment for Smoothness

1.1.4.1 Straightedge Testing

Record location and deviation from straightedge for all measurements. Determine the computed percent payment for straightedge testing by entering Table 1.

TABLE 1

PAYMENT ADJUSTMENT FOR SMOOTHNESS USING STRAIGHTEDGE

Deviation from straightedge for all measurements made within a lot exceed the tolerance specified in paragraph SURFACE SMOOTHNESS by:	Computed Percent Payment
Less than or equal to 5.0 percent	100
More than 5.0 percent but Less than or equal to 10.0 percent, after any reduction of high spots or removal and replacement	95

TABLE 1	
PAYMENT ADJUSTMENT FOR SMOOTHNESS USING STRAIGHTEDGE	
Deviation from straightedge for all measurements made within a lot exceed the tolerance specified in paragraph SURFACE SMOOTHNESS by:	Computed Percent Payment
More than 10.0 percent but Less than or equal to 15.0 percent	90
More than 15.0 percent but Less than or equal to 20.0 percent	75
More than 20.0 percent	Remove and Replace

1.1.4.2 Profilograph Testing

Record location and data from all profilograph measurements. Determine the computed percent payment for profilograph smoothness by entering Table 2.

TABLE 2	
PAYMENT ADJUSTMENT FOR SMOOTHNESS USING PROFILOGRAPH	
Profile Index of a 0.1 km 0.1 mile segment of a lot exceeds the tolerance specified in paragraph SURFACE SMOOTHNESS by:	Computed Percent Payment
Less than 16 mm per km 1.0 inch per mile	100
16 mm per km 1.0 inch per mile but Less than 32 mm per km 2.0 inches per mile, after any reduction of high spots or removal and replacement	95
32 mm per km 2.0 inches per mile but Less than 47 mm per km 3.0 inches per mile	90
47 mm per km 3.0 inches per mile but Less than 63 mm per km 4.0 inches per mile	75
63 mm per km 4.0 inches per mile or more	Remove and Replace

1.1.4.3 Aircraft Arresting Systems

****

NOTE: Delete this paragraph, AIRCRAFT ARRESTING SYSTEMS, if not present or impacted by paving operations.

****

The 60 m 200 feet of airfield pavement on both the approach and departure sides of the arresting system pendant is a critical area. Consider this area as a separate lot for payment adjustment for smoothness. Protruding objects and undulating surfaces are detrimental to successful tailhook engagements and are not allowable. No exceedance of the tolerances specified in paragraph STRAIGHTEDGE TESTING is acceptable. Remove and replace pavements exceeding the tolerances.

1.1.5 Payment Adjustment for Plan Grade

Determine the computed percent payment for plan grade by entering TABLE 3.

TABLE 3

PAYMENT ADJUSTMENT FOR PLAN GRADE

Percent of all measurements made within a lot that are within the payment adjustment limits specified in paragraph Plan Grade	Computed Percent Payment
Less than or equal to 5.0	100
More than 5.0 but Less than or equal to 10.0	95
More than 10.0 but Less than 20	90
More than 20.0 but Less than 50	75
50 or more	Remove and Replace

As an example, if 100 measurements are required for the specified lot, and 9 of the required measurements are within the Payment Adjustment limits identified in paragraph Plan Grade, 9 percent would be used to determine the computed percent payment of 95 percent.

1.1.6 Payment Adjustment for Thickness

Using the Average Thickness of the lot, determine the computed percent payment for thickness by entering Table 4.

TABLE 4

PAYMENT ADJUSTMENT FOR THICKNESS

Deficiency in Thickness Determined by cores millimetersinches	Computed Percent Payment	
	Pavements Equal To or Greater Than 200 mm 8 inches Thick	Pavements Less Than 200 mm 8 inches Thick
0.00 to 6.2 0.00 to 0.24	100	100
6.3 to 12.5 0.25 to 0.49	75	65
12.6 to 18.9 0.50 to 0.74	50	Remove and Replace
19.0 0.75 or greater	Remove and Replace	Remove and Replace

Where either of the two cores from a sublot show a thickness deficiency of 19 mm 0.75 inch or greater, [13 mm 0.50 inch for pavements 200 mm 8 inches or less in thickness] drill two more cores in the sublot and compute the average thickness of the four cores. If this average shows a thickness deficiency of 19 mm 0.75 inch or more [13 mm 0.50 inch for pavements 200 mm 8 inches or less in thickness] remove the entire sublot.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for

	Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 201.1R	(2008) Guide for Conducting a Visual Inspection of Concrete in Service
ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 325.14R	(2017) Guide for Design and Proportioning of Concrete Mixtures for Pavements

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2024) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1078/A1078M	(2019) Standard Specification for Epoxy-Coated Steel Dowels in Concrete Pavement
ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C114	(2024) Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2023) Standard Test Method for Lightweight Particles in Aggregate
ASTM C125	(2024) Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C174/C174M	(2017) Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the

	Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C294	(2024) Standard Descriptive Nomenclature for Constituents of Concrete Aggregates
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1646/C1646M	(2016) Making and Curing Test Specimens for Evaluating Frost Resistance of Coarse Aggregate in Air-Entrained Concrete by Rapid Freezing and Thawing
ASTM C1895	(2020) Standard Test Method for Determination of Mohs Scratch Hardness
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2196	(2010) Standard Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer
ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E1274	(2018); R 2024 Standard Test Method for Measuring Pavement Roughness Using a Profilograph

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(2015) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 130	(2001) Standard Recommended Practice for

	Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 662	(2009) Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

U.S. DEPARTMENT OF DEFENSE (DOD)

TSPWG M 3-250-04.97-05	(2019) Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Forceprojects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Proposed Techniques; G, [_____]

Preliminary Proposed Proportioning; G, DO

Pavement Quality Control Plan; G, [_____]

Stringless Technology; G, [_____]

SD-03 Product Data

Diamond Grinding Plan; G, [_____]

Dowels; G, [_____]

Dowel Bar Assemblies; G, [_____]

Equipment; G, [_____]

Concrete Patching Mixture; G, [_____]

SD-05 Design Data

Proportioning Studies; G, DO

SD-06 Test Reports

Batch Plant Manufacturer's Inspection Report; G, [_____]

Slipform Paver Manufacturer's Inspection Report; G, [_____]

Sampling and Testing; G, [_____]

Diamond Grinding of PCC Surfaces; G, [_____]

Mixer Performance (Uniformity) Testing; G, [_____]

Repair Recommendations Plan; G, [_____]

Paving Lot Report; G, [_____]

Test Section Paving Lot Report; G, [_____]

Test Section Lot Report; G, [_____]

SD-07 Certificates

Contractor Quality Control (CQC) Staff; G, [_____]

Laboratory Accreditation and Validation; G, [_____]

Commercial Laboratory; G, [_____]

NRMCA Certificate of Conformance

Petrographer Resume; G, [_____]

Licensed Surveyor; G, [_____]

Concrete Batch Plant Operator; G, [_____]

Profilograph Operator; G, [_____]

1.4 QUALITY CONTROL

****

NOTE:For Air Force and Army airfield paving projects, retain the first bracketed statement, delete the second bracketed statement, and coordinate Concrete Paving CQC Manager requirements with the Quality Control Manager paragraph of the Quality Control specification (01 45 00).

For Other Heavy Duty (non-airfield) paving projects, retain the second bracketed statement, delete the first bracketed statement, and ensure consistency with the Quality Control specification.

****

1.4.1 Contractor Quality Control (CQC) Staff

Reference Section 01 45 00 QUALITY CONTROL for general CQC personnel qualification requirements. In addition, submit specific CQC personnel qualification requirements listed below. Submit qualifications and resumes for the Concrete Paving CQC Manager and petrographer. Submit certification for all CQC personnel assigned to concrete construction for their respective position:

a. Identify an individual within the onsite work organization as the Concrete Paving CQC Manager, who is responsible for overall management of concrete paving CQC and has the authority to act in all concrete paving CQC matters including authority to stop concrete paving work which is out of compliance.

[The minimum requirements for the Concrete Paving CQC Manager consist of 8 years airfield concrete paving experience similar to work required under this contract with a minimum of 3 years in a concrete paving CQC role. The Concrete Paving CQC Manager is a separate person, and is in addition to the Quality Control Manager identified in Section 01 45 00 QUALITY CONTROL.]

[The minimum requirements for the Concrete Paving CQC Manager consist of 5 years concrete paving experience similar to work required under this contract with a minimum of 2 years in a concrete paving CQC role. The Concrete Paving CQC Manager can also serve as the Quality Control Manager provided they meet the requirements of Section 01 45 00 QUALITY CONTROL and the Concrete Paving CQC Manager experience requirements above.]

b. CQC personnel responsible for inspection of concrete paving operations: ACI Concrete Transportation Construction Inspector. The ACI Concrete Transportation Construction Inspector is required to be present at the paving site during all paving operations, with the exception of the initial saw cutting operation. The QC manager is required to be present during initial saw cutting operations.

c. CQC staff is required to oversee all aspects of sawing operations (sawing, flushing, vacuuming, checking for random cracking, lighting).

d. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews: ACI Advanced Concrete Flatwork Finisher.

e. Batch Plant Manufacturer's Inspection Report : A technical representative from the batch plant manufacturer is required to be on-site to inspect and make necessary adjustments prior to uniformity testing and after major component repairs or replacements. The inspection and necessary adjustments of all batch plant components include but are not limited to aggregate bin weighing operations, water metering, cement and fly ash weighing devices. All necessary inspections and adjustments by the manufacturer technical representative are required to be performed prior to uniformity testing. Submit a written Batch Plant Manufacturer's Inspection Report signed by the technical representative noting all inspection items and corrections and stating the batch plant is capable of producing the volume of concrete as required herein.

f. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

g. Slipform Paving Equipment Manufacturer's Representative: A technical representative of the slipform paving equipment manufacturer is required to be on-site during the test section construction to inspect and make corrections to the paving equipment to provide proper operations. Perform a complete and full hydraulic flow test of the vibrator system prior to the test section being placed. Submit a written Slipform Paver Manufacturer's Inspection Report signed by the manufacturer's technical representative noting all inspections, corrections, and flow tests have been performed and the paver is in a condition to perform the required work.

h. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and ACI Concrete Laboratory Testing Technician, Level 1 or 2.

1.4.2 Other Staff

****

NOTE: For Licensed Surveyor, select the first bracketed text for CONUS projects and the second set of bracketed text for OCONUS project.

****

Submit for approval the qualifications and resumes for the following staff:

a. Petrographer: Bachelor of Science degree in geology or petrography, trained in petrographic examination of concrete aggregate according to ASTM C294 and ASTM C295/C295M and trained in identification of the specific deleterious materials and tests identified in this specification. Detail the education, training and experience related to the project-specific test methods and deleterious materials in the Petrographer Resume and submit at least 20 days before petrographic and deleterious materials examination is to commence.

b. Licensed Surveyor: Perform all survey work under the supervision of a professional land surveyor licensed in the [state][region] the work is being performed.

c. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager certification.

d. Profilograph Operator: Certification by equipment manufacturer or a state Department of Transportation.

1.4.3 Laboratory Accreditation and Validation

****

NOTE: At the discretion of the Navy project engineer, the requirements for the USACE MTC validation of construction testing laboratories may be deleted. Validation of the project laboratories will provide an additional level of quality control for the project, and is strongly recommended by NAVFAC and USACE based on past experience.

For all Air Force and Army projects, retain the bracketed statement requiring USACE MTC validation of laboratories.

****

Provide laboratory and testing facilities. Submit accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM C1077, including all applicable test procedures identified in this specification. If multiple laboratories are proposed, identify which tests will be conducted by each. Submit accreditation documentation a minimum of 30 days before any specified testing is performed. The laboratories performing the tests are required to be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. Provide current accreditation and include the required and optional test methods, as specified. [In addition, all laboratories performing testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Request MTC laboratory validation at https://mtc.erdc.dren.mil/requestvalidation.aspx for costs and scheduling. Contact the MTC Director at https//mtc.erdc.dren.mil/contact2.aspx with questions or additional information.]

1.4.3.1 Aggregate Testing and Mix Proportioning

Aggregate testing and mixture proportioning studies are required to be performed by a commercial laboratory.

1.4.3.2 Acceptance Testing

****

NOTE: While ASTM C31 and ASTM C192 allow use of

other materials for beam molds, steel molds are required for flexural beam specimens (ASTM C78).
****

Provide all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the paving site and in the laboratory. Provide steel molds for molding the beam specimens. Provide on-site temperature-controlled concrete curing facilities. Provide and maintain boxes or other facilities suitable for storing and curing the specimens at the paving site while in the mold within the temperature range stipulated by ASTM C31/C31M. [Provide flexural loading equipment in accordance with ASTM C78/C78M] [Provide compressive loading equipment in accordance with ASTM C39/C39M.]

1.4.3.3 Pavement Quality Control Plan

Submit the Pavement Quality Control Plan. The Pavement Quality Control Plan is specific to this specification and supplements the overall Quality Control Plan required by Section 01 45 00 QUALITY CONTROL. Do not produce portland cement concrete pavement for payment until the Pavement Quality Control Plan has been approved. In the Pavement Quality Control Plan, address all elements which affect the quality of the pavement including, but not limited to:

a. Condition of underlying course
b. Condition of adjacent pavement and dowels
c. Stockpile management and aggregate grading
d. Mix proportions and batching operations
e. Transportation
f. Placing and consolidation
g. Placing dowels [and tie bars]
h. Finishing and texturing
i. Curing
j. Sawcutting Joints
k. CQC Testing and Inspection
l. Inclement / Hot / Cold Weather Plans

1.4.3.4 Laboratory Inspection

The Government will inspect all laboratories requiring validation for equipment and test procedures prior to the start of any concreting operations for conformance to ASTM C1077. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. The laboratory is to maintain this certification for the duration of the project.

1.4.4 Preconstruction Testing of Materials

All sampling and testing is required to be performed using an approved commercial laboratory or, for cementitious materials and chemical admixtures, a laboratory maintained by the manufacturer of the material. Materials are not allowed to be used until notice of acceptance has been given. Additional payment or extension of time due to failure of any material to meet project requirements, or for any additional sampling or testing required is not allowed. Additional tests may be performed by the Government; such Government testing does not relieve any required testing responsibilities.

1.4.4.1 Aggregates

Sample aggregates in the presence of a Government Representative. Obtain samples representative of the materials to be used for the project in accordance with ASTM D75/D75M. Perform all aggregate tests no earlier than 6 months prior to test section construction.

1.4.4.2 Chemical Admixtures, Curing Compounds and Epoxies

At least 30 days before the material is used, submit certified copies of test results for the specific lots or batches to be used on the project. Provide test results less than 5 years old prior to use in the work. Retest chemical admixtures that have been in storage for longer than 6 months or that have been subjected to temperatures outside of manufacturer requirements. Reject if test results do not meet the Level 2 proof of compliance requirements of ASTM C494/C494M.

1.4.4.3 Testing of Cementitious Materials

All materials referenced under paragraph CEMENTITIOUS MATERIALS will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports showing that the material in each shipment meets the requirements of the specification under which it is provided. Provide mill test reports no more than 1 month old, prior to use in the work. Do not use cementitious materials until notice of acceptance has been given. Cementitious materials may be subjected to testing by the Government from samples obtained at the mill, at transfer points, or at the project site. If tests prove that a cementitious material that has been delivered is unsatisfactory, promptly remove it from the project site. Retest cementitious material that has not been used within 6 months after testing, and reject if test results do not meet manufacturer requirements.

1.4.5 Testing During Construction

During construction, sample and test aggregates, cementitious materials, and concrete as specified herein. The Government will sample and test concrete and ingredient materials as considered appropriate. Provide facilities and labor necessary for procurement of representative test samples. Testing by the Government does not relieve the specified testing requirements.

1.4.6 Test Section

****

NOTE: If test section is not to be part of the production pavement area, delete the bracketed sentence referring to test sections constructed as part of production pavement and production lot payment.

****

1.4.6.1 General

a. Schedule the test section after all required submittals and uniformity testing has been reviewed and approved. Perform a preparatory meeting before commencing the test section.

b. Construct a separate test section for each placement method (slipform, fixed form, and hand placement) proposed for use. Construct a separate test section for each paver and each batch plant proposed for use.

c. Up to 15 days, but not more than 60 days, prior to construction of the concrete pavement, construct a test section [near the job site, but not as part of the production pavement area.][as part of the production paving area at an outer edge as indicated on the drawings.] Construct the pilot lane and fill-in lane test sections on separate days using the approved mixture proportions. Aggregate proportioning changes may be required due to specification requirements not being met.

d. Construct the test section matching the thickest pavement section and underlying structure required in the work. Use the same equipment, materials, and construction techniques on the test sections as proposed for use in all subsequent work. The underlying layers must be reviewed and approved by the Government prior to paving of the test section.

e. Perform underlying layer preparation, concrete production, placing, consolidating, texturing, curing, construction of joints, and all testing in accordance with applicable provisions of this specification.

f. Use the test sections to develop and demonstrate the proposed techniques of mixing, hauling, placing, consolidating, finishing, texturing, curing, initial saw cutting, start-up procedures, sampling, testing methods, plant operations, and the preparation of the joints for production paving. Report per requirements of paragraph Reports as the Test Section Paving Lot Report.

1.4.6.2 Pilot Lane

Construct the test section consisting of one continuous paving lane at least 130 m 400 feet long and to the same thickness as the thickest portion of pavement shown on the Drawings. The test section may not exceed 180 m 600 feet; all pavement placed for the test section before or after 130 m 400 feet of continuously acceptable placement must be removed. Construct at the same lane width as that required for use in the project. If [keyed or] doweled longitudinal construction joints are required in any of the production pavements, install them full length along one side of the test lane throughout the test section. [If both keys and dowels are required, install each in half of the test section.]

1.4.6.3 Fill-In Lane

A fill-in lane is defined as full width concrete placement using two adjacent lanes as forms. Consider the first 130 m 400 feet of the initial production fill-in lane as a test section for purposes of testing and evaluation. All requirements for the test section are applicable. Obtain cores from the fill-in lane side of the longitudinal construction joint with the pilot lane. No measurements will be required for longitudinal vertical faces that are against existing or recently placed panels. Straightedge measurements are required across the joint per paragraph Testing Method.

1.4.6.3.1 Alternative Placement Method

If proposed techniques includes alternative placement method resulting in lanes with one free edge and one edge placed against existing or new pavement the first placement will be considered the fill-in lane for test section evaluation purposes. The fill-in lane test section requirements in paragraph Fill-In Lane will apply to the first lane that is not a pilot lane. Test the free edge for all measurements required for a pilot lane and the enclosed edge with all measurements for a fill-in lane.

1.4.6.4 Testing and Inspection

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NOTE: Subparagraph b. Air content loss through the paver is For Information Only, but required information to be submitted within the Test Section Lot Report.

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a. Provide aggregate, fresh concrete, and hardened concrete sampling and testing in accordance with paragraph Testing and Inspection by Contractor and Table 17. Provide inspection of the hardened concrete for surface smoothness, plan grade, edge slump and joint face deformation in accordance with the specifications. Provide a test section report in accordance with paragraph Reports.

b. Provide sampling and testing to determine the loss of air content through the paving equipment. Samples are to be obtained before and after the paving equipment along the vibrator path and in-between the vibrators. Obtain one sample of the fresh concrete before the paving equipment has passed with material in the sublot. Once the paver has passed, obtain two samples of the in-place, plastic concrete to the full depth of the placement avoiding the underlying layer. Provide stationing references for all samples. Report this data in the Test Section Lot Report. This testing is in addition to required testing in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL DURING CONSTRUCTION and only required during the Test Section(s). Adjustments to air contents to meet the specified air content in paragraph Air Content are only to be made based on measured air contents before the paver has passed. Immediately fill voids resulting from sample collection with freshly mixed concrete, strike off, consolidate with an internal vibrator, and refinish.

c. No more than three working days after completion of the test sections, procure, evaluate and measure eight cores with a minimum diameter of 150 mm 6 inches by full depth cut from points selected in the test sections by the Government on a basis of two cores per sublot. Evaluate cores in accordance with paragraph EVALUATION OF CORES. Measure cores in accordance with paragraph THICKNESS.

1.4.6.5 Acceptance of Test Section

a. Construct the test sections meeting the specification requirements including plastic and hardened concrete properties, surface texture, thickness, plan grade, smoothness, joint face deformation, edge slump, and plan joint alignment.

b. Do not commence production paving until the results on aggregates and concrete, including evaluation of cores, and all pavement measurements for edge slump, joint face deformation, actual plan grade, surface smoothness, and thickness have been submitted and approved, and the payment calculation has been submitted for information only. Remove test sections which do not meet specification requirements and conduct additional test sections, as required. If an acceptable test section is unable to be constructed by slipform paving, repair or replace the slipform paving equipment, or complete the paving using fixed-forms and equipment as required by the specification. [Pavement accepted as a production lot will be evaluated and paid as specified in PART 1 GENERAL.]

1.4.7 Acceptability of Work

The materials and the pavement itself will be accepted on the basis of production testing. The Government may make check tests to validate the results of the production testing. If the results of the production testing vary by less than 2.0 percent of the Government's test results, the results of the production testing will be used. If the results of the Government and production tests vary by 2.0 percent, but less than 4.0 percent, the average of the two will be considered the value to be used. If these vary by 4.0 percent or more, carefully evaluate each sampling and testing procedure and obtain another series of Government and production tests on duplicate samples of material. If these vary by 4.0 percent or more, use the results of the tests made by the Government and the Government will continue check testing of this item on a continuous basis until the two sets of tests agree within less than 4.0 percent on a regular basis. Testing performed by the Government does not relieve the specified testing requirements.

1.4.8 Acceptance Requirements

1.4.8.1 Pavement Lots

****

NOTE: Specify the lot size on the basis of volume of production. Select the lot size not to exceed 750 cubic meters 1000 cubic yards of concrete pavement. When the total job does not exceed 750 cubic meters 1000 cubic yards, the lot size becomes the total job. Edit the following paragraphs accordingly. Do not change terminology (for instance computed percent payment, actual percent payment).

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A lot is that quantity of construction to be evaluated for acceptance with specification requirements. A lot is equal to production paving not to exceed [750] [ ] cubic meters [1000] [ ] cubic yards. In order to evaluate thickness, divide each lot into sublots not to exceed 190 cubic meters 250 cubic yards. Perform grade determinations on the lot as a whole. Perform surface smoothness determinations on every 0.1 km 0.1 mile segment in each lot. Select sample locations on a random basis in accordance with ASTM D3665. [Areas of pavement placed with hand methods are considered a separate lot for evaluation.]When operational conditions cause a lot to be terminated before the specified four sublots have been completed, use the following procedure to adjust the lot size and number of tests for the lot. Where three sublots have been completed, they constitute a lot. Where one or two sublots have been completed, incorporate them into the next lot (except for the last lot), and the total number of sublots used and acceptance criteria adjusted accordingly.

1.4.8.2 Evaluation

Provide all sampling and testing required for acceptance and payment adjustment, including batch tickets with all required acceptance testing. Individuals performing sampling, testing and inspection duties are required to meet the requirements of paragraph: Contractor Quality Control Staff.

The Government reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. Testing in these areas are in addition to the sublot or lot testing, and the requirements for these areas are the same as those for a sublot or lot. Provide facilities, and where directed personnel, to assist in obtaining samples for any Government testing.

1.5 AIRFIELD PCC PAVING WORKSHOP

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NOTE: TSMCX provides airfield PCC paving workshops regardless of project management organization - USACE, AFCEC or NAVFAC.

For USACE managed projects, review ER 1110-34-1 TRANSPORTATION SYSTEMS MANDATORY CENTER OF EXPERTISE and retain the following paragraph if deemed a Mandatory Service or if the project development team requests it as an Elective Service.
For AFCEC and NAVFAC managed projects, the below airfield asphalt paving workshop is optional.

Appropriate coordination with TSMCX, AFCEC, or NAVFAC is recommended prior to specifying the airfield PCC paving workshop.

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USACE Transportation Systems Center will conduct a mandatory two day pavement workshop in advance of the concrete paving for the Contractor and his representatives for the minimum amount of time listed below. Additionally, personnel may attend any non-mandatory sessions on a space-available basis. Contractor is to acquire a facility for the workshop in the vicinity of the installation, or other appropriate location, as approved by the Government. Provide a facility that includes at a minimum, parking and seating for forty attendees, audio/visual with standard connections, including TV, projector, screen and any other items as required for display of digital presentations, and access to Wi-Fi. Coordinate schedule with the Government. Attendance requirements apply to each paving crew anticipated to be on the project. At a minimum, the following attendees are required.

a. Project Engineer/Pavement Engineer: 2 days
b. Project Superintendent: 2 days
c. Paving Superintendent or Foreman(s): 2 days
d. ACI Transportation Inspector: 2 days
e. Quality Control Manager & Alternate(s): 2 days
f. Quality Control Testing Lab Technicians: 2 days
g. Paving Machine Operator(s):2 days
h. Batch Plant Manager(s): 1 day
i. Sawing/Sealing/Contractor(s): 1 day.
j. PCC Aggregate Supplier: 1/2 day.
k. MTV Operator(s): 2 days

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Bulk Cementitious Materials

Provide all cementitious materials in bulk at a temperature, as delivered to storage at the site, not exceeding 65 degrees C 150 degrees F. Provide sufficient cementitious materials in storage to sustain continuous operation of the concrete mixing plant while the pavement is being placed. Provide separate facilities to prevent any intermixing during unloading, transporting, storing, and handling of each type of cementitious material.

1.6.2 Aggregate Materials

Store aggregate at the site of the batching and mixing plant avoiding breakage, segregation, intermixing or contamination by foreign materials. Store each size of aggregate from each source separately and allow the fine aggregate and the smallest size coarse aggregate to drain. Provide a minimum 0.6 m 24 inch thick sacrificial layer left undisturbed for each aggregate stored on ground or provide a paved or chemically stabilized surface course beneath the stockpiles. Maintain sufficient aggregate at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time concrete pavement is being placed. Do not allow tracked equipment on coarse aggregate stockpiles.

1.6.3 Other Materials

Store reinforcing bars and accessories above the ground on supports. Store all materials properly to avoid contamination and deterioration.

PART 2 PRODUCTS

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NOTE: Coordinate all product requirements with the appropriate agency's Pavements or Materials Engineer.

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2.1 SYSTEM DESCRIPTION

This section is intended to stand alone for construction of concrete pavement. However, where the construction covered herein interfaces with other sections, construct each interface to conform to the requirements of both this section and the other section, including tolerances for both.

2.1.1 Surface Smoothness

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NOTE: Edit these paragraphs as appropriate to the project. If it is desired to restrict surface smoothness testing and evaluation to either straightedge method or profilograph method, retain the one and delete the other; otherwise, retain both as an option. Require use of the profilograph method for airfield taxiways and runways. When the profilograph method is allowed, and there are areas with dimensions less than 60 m (200 feet) in any direction, retain the straightedge method for these short runs. Profilograph is typically used to measure longitudinal smoothness and straightedge for transverse smoothness. Aircraft arresting systems require straightedge for longitudinal and transverse smoothness.

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Use the profilograph method for all longitudinal testing, except for paving lanes less than 60 m 200 feet in length. Use the straightedge method for transverse testing, for longitudinal testing where the length of each pavement lane is less than 60 m 200 feet,[within 60 m 200 feet on both the approach and departure sides of an aircraft arresting gear,] and at the ends of the paving limits for the project. Smoothness requirements do not apply over crowns, drainage structures, or similar penetrations. Maintain detailed notes of the testing results and provide a copy to the Government after each day's testing.

2.1.1.1 Straightedge Testing

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NOTE: Retain first and third bracketed statements for airfield projects and delete the fourth bracketed statement. Retain second bracketed statement for projects with an aircraft arresting systems. Retain fourth bracketed statement for roads and streets projects and delete first and third bracketed statements.

****

Provide the finished surfaces of the pavements with no sudden change in elevation or abrupt change of 6 mm 1/4 inch or more from the as-built finished surface or face, and all pavements within the limits specified when checked with an approved 4 m 12 foot straightedge. Report measurements to the nearest 2 mm 1/16 inch. [Provide runways and taxiways with a variation from the specified straight edge not greater than 3 mm 1/8 inch in the longitudinal direction and not greater than 6 mm 1/4 inch in the transverse direction.][Provide runway pavement within 60 m 200 feet on both the approach and departure sides of an aircraft arresting gear with a variation in the longitudinal direction from the specified straightedge not more than plus or minus 3 mm 1/8 inch.][Provide all other airfield areas with a variation from a straight edge not greater than 6 mm 1/4 inch in either the longitudinal or transverse direction.] [Provide roads, streets, tank hardstands, vehicular parking areas, and open storage areas with a variation from the specified straight edge not greater than 6 mm 1/4 inch in either the longitudinal or transverse direction.]

2.1.1.2 Profilograph Testing

Provide the finished surfaces of the pavements with no sudden change in elevation or abrupt change of 6 mm 1/4 inch or more from the as-built finished surface, and each 0.1 km 0.1 mile segment of each pavement lot with a Profile Index not greater than specified when tested with an approved California-type profilograph. [Provide runways and taxiways with a Profile index not greater than 110 mm per km 7 inches per mile in the longitudinal direction. Provide runway and taxiway transverse smoothness measured with the straightedge method and the straightedge requirements in accordance with paragraph Straightedge Testing. Provide all other airfield areas with a Profile Index not greater than 140 mm per km 9 inches per mile in the longitudinal direction.] [Provide roads, streets, tank hardstands, vehicular parking areas and open storage areas with a Profile index not greater than 140 mm per km 9 inches per mile in the longitudinal direction.]

2.1.1.3 Bumps ("Must Grind" Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace or by straightedge measurements which exceed 10 mm 0.4 inch in height by diamond grinding in accordance with paragraph DIAMOND GRINDING OF PCC SURFACES below until they do not exceed 7.5 mm 0.3 inch when retested. Taper such diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding.

2.1.1.4 Testing Method

After the concrete has hardened sufficiently to permit walking thereon, but not later than 48 hours after placement, test the entire surface of the pavement in each lot in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. If any pavement areas are diamond ground, retest these areas immediately after diamond grinding. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines 4.5 m 15 feet or less apart, as directed. Perform the longitudinal lines at the 1/8th point in from each side of the lane and at the centerline of each paving lane shown on the drawings, regardless of whether multiple lanes are allowed to be paved at the same time. Also test other areas having obvious deviations. Perform longitudinal testing lines continuous across all joints. Perform transverse testing lines for pilot lanes carried to construction joint lines and for fill-in lanes carried 600 mm 24 inches across construction joints, and the readings in this area applied to the fill-in lane. Perform straightedge testing of the longitudinal edges of slipformed pilot lanes before paving fill-in lanes as specified below.

2.1.1.4.1 Straightedge Testing

Hold the straightedge in contact with the surface and move ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and measuring the maximum gap between the straightedge and the pavement surface. Determine measurements along the entire length of the straight edge.

2.1.1.4.2 Profilograph Testing

Perform profilograph testing using approved California profilograph and procedures described in ASTM E1274. Utilize electronic recording and automatic computerized reduction of data equipment to indicate "must-grind" bumps and the Profile Index for each 0.1 km 0.1 mile segment of the pavement lot. Accommodate grade breaks on aprons [parking lots] by breaking the profile segment into short sections and repositioning the blanking band on each section. Provide the "blanking band" of 5 mm 0.2 inch wide and the "bump template" span 25 mm 1 inch with an offset of 10 mm 0.4 inch. Count the profilograph testing of the last 9.1 m 30 feet of a paving lane in the longitudinal direction from each day's paving operation on the following day's continuation lane. Compute the profile index for each pass of the profilograph (3 per lane) in each 0.1 km 0.1 mile segment. The profile index for each segment is the average of the profile indices for each pass in each segment. Scale and proportion profilographs of unequal lengths to an equivalent 0.1 km 0.1 mile as outlined in the ASTM E1274. Provide a copy of the reduced tapes or digital record to the Government at the end of each day's testing.

2.1.2 Edge Slump and Joint Face Deformation

2.1.2.1 Edge Slump

Provide a maximum of 15.0 percent of each free edge of each pavement panel with a maximum edge slump of 6 mm 1/4 inch and none of the free edge of the pavement lot with an edge slump exceeding 9 mm 3/8 inch. (A pavement panel is defined as a lane width by the length between two adjacent transverse contraction joints. The free edge of the pavement is the linear measurement of pavement panel edge originally constructed as non-adjacent to any existing pavement; for example, 30 m 100 feet of pilot lane originally constructed as a separate lane, would have 30 m 100 feet of free edge on each side; 30 m 100 feet of fill-in lane would have no free edge.) The area affected by the downward movement of the concrete along the pavement edge is a maximum of 450 mm 18 inches back from the edge.

2.1.2.2 Joint Face Deformation

Provide a vertical joint face with a surface within the maximum limits shown in Table 5. Provide the offset measurements from all five Joint Face Deformation Limits from Table 5 at the specified testing frequency. Properly reference all recorded measurements in accordance with paving lane identification and stationing, and submit a report within 10 days after measurement is made. Identify areas requiring replacement within the report.

TABLE 5

JOINT FACE DEFORMATION LIMITS

Offset from Straightedge Applied Longitudinall to Pavement Surface (a)	Offset from Straightedge Applied Longitudinall to Vertical Face (b)	Offset from Straightedge Applied Top to Bottom Against the Joint Face (c)	Abrupt Offset in Any Direction (d)	Offset of Joint Face from True Vertical (e)
Airfield Pavement				
3 mm 1/8 inch	6 mm 1/4 inch	9.5 mm 3/8 inch	6 mm 1/4 inch	8 mm per 100 mm 1 inch per 12 inches
All Other Pavement				
6 mm 1/4 inch	All other items same as airfield pavement			
(a) Measurement is taken by placing the straightedge longitudinally on the pavement surface 25 mm 1 inch from the free edge. Record the longitudinal joint face deformation of the joint on a continuous line 25 mm 1 inch back from the joint line using the minimum 4 m 12 foot straightedge advanced one-half its length for each reading.				
(b) Measurement is taken by applying the straightedge longitudinally along the center of the vertical joint face. Record the longitudinal joint face deformation using the minimum 4 m 12 foot straightedge advanced one-half its length for each reading.				
(c) Measurement places a 9.5 mm 3/8 inch spacer attached to a straightedge and spaced approximately equal to the thickness of the concrete being measured. The offset from straightedge with spacers is measured by placing the spacers against the top and bottom of the vertical concrete face. Record measurements at 1.5 m 5 foot spacings.				

TABLE 5

JOINT FACE DEFORMATION LIMITS

Offset from Straightedge Applied Longitudinall to Pavement Surface (a)	Offset from Straightedge Applied Longitudinall to Vertical Face (b)	Offset from Straightedge Applied Top to Bottom Against the Joint Face (c)	Abrupt Offset in Any Direction (d)	Offset of Joint Face from True Vertical (e)
(d) Check for abrupt offsets at any location that an abrupt change in the joint face plane appears to be present through use of a 4 meter 12 foot straightedge.				
(e) Measurement of the offset from the joint face to a level in the true vertical position against the joint face. Record measurements at 1.5 m 5 foot spacings.				

2.1.2.3 Edge Slump Determination

Test the pavement surface to determine edge slump immediately after the concrete has hardened sufficiently to permit walking thereon. Perform testing with a minimum 4 m 12 foot straightedge to reveal irregularities exceeding the edge slump tolerance specified above. Determine the vertical edge slump at each free edge of each slipformed paving lane constructed. Place the straightedge transverse to the direction of paving and the end of the straightedge located at the edge of the paving lane. Record measurements at 1.5 to 3.0 m 5 to 10 foot spacings, as directed, commencing at the header where paving was started. Initially record measurements at 1.5 m 5 foot intervals in each lane. When no deficiencies are present after 5 measurements, the interval may be increased. The maximum interval is 3.0 m 10 feet. When any deficiencies exist, return the interval to 1.5 m 5 feet. Perform other tests of the exposed joint face to produce a uniform, true vertical joint face. Properly reference all recorded measurements in accordance with paving lane identification and stationing, and submit a report within 10 days after measurement is made. Identify areas requiring replacement within the report.

2.1.2.4 Excessive Edge Slump or Joint Face Deformation

When edge slump or joint face deformation exceeding the limits specified above is encountered on either side of the paving lane, record additional straightedge measurements to define the linear limits of the excessive slump or joint face deformation. Remove and replace concrete slabs having excessive edge slump or joint deformation to the next transverse joint in conformance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. Discontinue use of slip-form paving equipment and procedures that fail to consistently provide edges within the specified tolerances on edge slump and joint face deformation and construct by means of standard paving procedures using fixed forms.

2.1.3 Plan Grade

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NOTE: Remove Heavy-duty Pavement other than Airfields if no heavy-duty pavements are included in the scope.

****

Within 5 working days after completion of a particular lot, survey the surface of the pavement area for conformance with specified plan grade requirements. The grade will be determined by running lines of levels at intervals corresponding to every longitudinal and transverse joint to determine the elevation at each joint intersection. Resurvey any areas corrected after initial survey.

TABLE 6

Plan Grade Tolerances

Airfield Pavements	**Finished Surface Measurements at Joint Intersections** (after allowable corrections)	
	0-13mm 0-0.04 foot from designed Plan Grade	Acceptable, no Payment Adjustment considered on grade measurements at these Joint Intersections
	13.1-19.5mm 0.041-0.06 foot from designed Plan Grade	Calculate Plan Grade Pay Adjustment Factor per paragraph PAYMENT ADJUSTMENT FOR PLAN GRADE
	Greater than 19.5 mm0.06 foot from designed Plan Grade	Remove and Replace affected Panel(s)
Heavy-Duty Pavements other than Airfield Pavements	0-19 mm 0-0.06 foot from designed Plan Grade	Acceptable, no Payment Adjustment considered on grade measurements at these Joint Intersections
	19.1-28.5 mm 0.041 foot-0.09 foot from designed Plan Grade	Calculate Plan Grade Pay Adjustment Factor per paragraph PAYMENT ADJUSTMENT FOR PLAN GRADE
	Greater than 28.5 mm0.09 foot from designed Plan Grade	Remove and Replace affected Panel(s)

The above deviations from the approved grade line and elevation are not permitted in areas where closer conformance with the planned grade and elevation is required for the proper functioning of appurtenant structures. Provide finished surfaces of new abutting pavements that coincide at their juncture. Corrections within the tolerances of paragraph

REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS are allowed to improve the payment adjustment or to improve an unacceptable surface to allow for a payment adjustment. Provide horizontal control of the finished surfaces of all airfield pavements that vary not more than 13 mm 1/2 inch from the plan joint alignment indicated.

2.1.3.1 Joint Alignment

Provide survey points for the joint intersections. Provide horizontal control of the finished surfaces of all airfield pavements.

TABLE 7		
Joint Alignment Tolerances		
All Airfield Pavements	**Horizontal Measurements of Joint Intersections (both transverse and longitudinal joints)**	
	0-13mm 0-1/2 inch from designed Jointing Plan	Acceptable
	Greater than 13 mm 1/2 inch from the designed Jointing Plan	Remove and Replace affected Panel(s)

2.1.4 Flexural Strength

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NOTE: Normally, concrete for airfield pavement is proportioned and accepted on the basis of 90-day flexural strength. If it is desired to use 28-day strength for design of airfield pavement, obtain written approval from the TSMCX, AFCEC pavement SME, or NAVFAC. Make the same changes if this is concrete for road pavement proportioned for 28-day strength (no approval needed).

Use "Beams" Tailoring Option for projects with less than 2,300 cubic meters 3,000 cubic yards of airfield paving. For airfield or heavy duty roads/streets paving projects with more than 2,300 cubic meters 3,000 cubic yards, choose the first Option "Cylinders/Beam" or the second Option "Beams" for strength testing.

****

Each lot of pavement will be evaluated for acceptance for flexural strength in accordance with paragraph Sampling and Testing and paragraph Computations.

2.1.4.1 Sampling and Testing

For acceptance, obtain one composite sample of concrete from each sublot in accordance with ASTM C172/C172M from one batch or truckload.Fabricate and cure test cylinders 152 x 305 mm 6 x 12 inches in accordance with

ASTM C31/C31M, and test at 14 days in accordance with ASTM C39/C39M. Test two test cylinders per sublot (8 per lot).Fabricate and cure test beams 152 x 152 mm 6 x 6 inches in accordance with ASTM C31/C31M; and test at 14 days in accordance with ASTM C78/C78M. Test two beams per sublot (8 per lot).

2.1.4.2 Computations

Average the eight 14-day strength tests for the lot. Use the average strength in accordance with paragraph Concrete Strength For Final Acceptance.

2.1.5 Thickness

Each lot of pavement will be evaluated for acceptance and payment adjustment in accordance with the following procedure. Drill two cores, between 100 and 150 mm 4 and 6 inches in diameter, from the pavement, per sublot (8 per lot). Drill the cores within 3 days after lot placement, fill the core holes with an approved concrete patching mixture, and respray the cored areas with curing compound. Prevent the core hole from drying or damage until backfilled. Complete backfillng of core hole during the subsequent production placement or within 5 calendar days, whichever occurs first. Record eight measurements of thickness around the circumference of each core and one in the center, in accordance with ASTM C174/C174M. Provide the results with the thickness measurement data. Average the pavement thickness from the 8 cores for the lot and evaluate as described in paragraph Payment Adjustment For Thickness above.

2.1.6 Evaluation of Cores

Record and submit testing, inspection, and evaluation of each core for mortar-rich surface, uniformity of aggregate distribution, segregation, voids, cracks, and depth of reinforcement or dowels (if present). Moisten the core with water to visibly expose the aggregate and take a minimum of three photographs of the sides of the core's entire length, rotating the core approximately 120 degrees between photographs. Provide photographs with the clarity and quality to identify the defects identified above. Each core is to be identified on the top with the core number referenced to paving lot plan view. Photograph the core against a contrasting background, in profile, and with an extended tape measure parallel and to the right of the core with incremental measurements clearly visible. Provide plan view of location for each core. Store the cores and make available to the Government when requested, until otherwise directed.

2.1.7 Diamond Grinding of PCC Surfaces

Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth and surface area is limited below. Reduce high areas by diamond grinding the hardened concrete with approved equipment after the concrete is at a minimum age of 14 days. Provide diamond grinding equipment capable of cutting a path a minimum of 0.9 m 3 feet wide. Equip the cutting head with saw blades that are 3 mm 1/8-inch wide with sufficient number of blades to create grooves between 2 mm and 3.5 mm 0.090-inches and 0.130-inches wide and peaks and ridges approximately 1 mm 1/32-inch higher than the bottom of the grinding cut. Diamond grinding equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints is not permitted. The maximum area corrected by diamond grinding the surface of the hardened concrete is 10 percent of the total area of any sublot. The maximum depth of diamond grinding is 6 mm 1/4 inch. Provide diamond grinding equipment capable of flushing and vacuuming the pavement surface. Dispose of all debris from diamond grinding operations off Government property, leaving the surface of the pavement in a clean condition. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above in conformance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. Repair aggregate popouts using the core and patch method of paragraph REPAIRING SPALLS ALONG JOINTS. [Retexture pavement areas given a wire comb, tined texture, or areas exceeding 2 square meters 25 square feet that have been corrected by diamond grinding transverse grooves using an approved grooving machine of standard manufacture. Provide grooves that are 6 mm 1/4 inch deep by 6 mm 1/4 inch wide on 37 mm 1-1/2 inch centers and carried into, and tapered to zero depth within the non-corrected surface, or match any existing grooves in the adjacent pavement.]All areas in which diamond grinding has been performed are subject to the thickness tolerances specified in paragraph Thickness, above.

Prior to production diamond grinding operations, perform a test section at the approved location. Perform a test section that consists of a minimum of two adjacent passes with a minimum length of 12 m 40 feet to allow evaluation of the finish, transition between adjacent passes, and the results of crossing a transverse joint. Production diamond grinding operations are not to be performed prior to approval.

2.2 CEMENTITIOUS MATERIALS

****

NOTE: Edit these paragraphs as appropriate for the particular project. Obtain guidance for use of cementitious materials from the Pavement Materials engineer or from the TSMCX, AFCEC pavement SME, or NAVFAC, especially for areas subject to alkali-aggregate reactivity, or sulfate attack.

When sulfate bearing soil or water is encountered, specify Type II cement for moderate sulfate concentration and Type V cement for high concentration and consider requiring use of fly ash or slag cement for partial replacement. Do not specify Type I or III cement. See UFC 3-250-04 for guidance. Specify limit on early stiffening (a.k.a.false set) if it is a problem in the area.

Do not specify Type III cement unless accelerated paving is involved and then only after laboratory mixture proportioning studies and tests during the design stage of the project.

****

Provide cementitious materials consisting of portland cement, [blended cement] or portland cement in combination with supplementary cementitious materials (SCM), that conform to appropriate specifications listed below. New submittals are required when the cementitious materials sources or types change.

2.2.1 Portland Cement

****

NOTE: ASTM C 150 has deleted the option to specify low alkali cement. To mitigate ASR, current practice (ASTM C 1778) is to limit the total alkalis in the concrete mixture as addressed in paragraph Mixture Proportions Composition.

****

Provide portland cement conforming to ASTM C150/C150M, Type [I] [II] [V], [including the Optional Physical Requirements for early stiffening]. [Provide Type III cement only in the following locations [_____].]

2.2.2 Blended Cements

****

NOTE: Portland cement blended with limestone up to 15 percent by mass of the blended cement is acceptable.

When sulfate bearing soil or water is encountered: specify ASTM C150 Type II cement and ASTM C595 Type IX (MS) blended cement for moderate sulfate concentration; specify ASTM C150 Type V and ASTM C595 Type IX (HS) for high concentration and consider requiring use of fly ash or slag cement for partial replacement.

****

Provide blended cement conforming to ASTM C595/C595M, Type IP, IS, or IL [with [(MS)] [(HS)] designation]. Provide pozzolan added to the Type IP blend consisting of ASTM C618 Class F or Class N and that is interground with the cement clinker. Include a written statement from the manufacturer that the amount of pozzolan in the finished cement does not vary more than plus or minus 5 mass percent of the finished cement from lot to lot or within a lot. Provide limestone added to the Type IL blend that is interground with the cement clinker. Include a written statement from the manufacturer that the amount of limestone in the finished cement does not vary more than plus or minus 2.5 mass percent of the finished cement from lot to lot or within a lot. Limit the percent of slag, pozzolan, or limestone to a maximum of IS(50), IP(35) or IL(15). The percentage and type of mineral admixture used in the blend is not allowed to change from that submitted for the aggregate evaluation and mixture proportioning.

2.2.3 Pozzolan

2.2.3.1 Fly Ash

****

NOTE: Class C fly ash is not permitted for paving concrete.

Use loss on ignition not exceeding 3 percent for frost areas to reduce carbon interference with air entraining admixture.

****

Provide fly ash that conforms to ASTM C618, Class F, including the optional requirement for uniformity with a loss on ignition not exceeding [3] [6] percent. Provide Class F fly ash for use in mitigating Alkali-Silica Reactivity with a total equivalent alkali content less than 4 percent.

2.2.3.2 Raw or Calcined Natural Pozzolan

Provide natural pozzolan that is raw or calcined and conforms to ASTM C618, Class N, including the optional requirement for uniformity with a loss on ignition not exceeding [3] [6] percent. Provide Class N pozzolan for use in mitigating Alkali-Silica Reactivity with a total equivalent alkali content less than 4 percent.

2.2.3.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Provide Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) that conforms to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age of at least 95 percent of the control specimens.

b. The average particle size is a maximum of 6 microns.

2.2.3.4 Silica Fume

****

NOTE: Use Silica Fume only for OCONUS projects where Class F fly ash and slag cement are not available, and with written approval from the TSMCX, AFCEC pavement SME, or NAVFAC. If not applicable, delete this paragraph here and where encountered throughout the remainder of this section.

****

[Provide silica fume that conforms to ASTM C1240, including the optional limits on reactivity with cement alkalis. Provide silica fume as a dry, densified material or as a slurry. Provide the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume, at no expense to the Government. This representative is required to be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume.]

2.2.4 Slag Cement

Provide slag cement (ground-granulated blast-furnace slag) that conforms to ASTM C989/C989M, Grade 100 or Grade 120.

2.2.5 Supplementary Cementitious Materials (SCM) Content

****

NOTE: Use first bracketed sentence for Navy projects. Use second bracketed sentence for Army/Air Force projects.

****

[Provide a concrete mix that contain one of the SCMs listed in Table 6 within the range specified therein, whether or not the aggregates are found to be reactive in accordance with paragraph ALKALI SILICA REACTIVITY.][Use of one of the SCMs listed below is optional, unless the SCM is required to mitigate ASR. The use of SCMs is encouraged in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.]

TABLE 8

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum Content (percent)	Maximum Content (percent)
Class N Pozzolan and Class F Fly Ash		
SiO2 + Al2O3 + Fe2O3 > 70 percent	25	35
SiO2 + A12O3 + Fe2O3 > 80 percent	20	35
SiO2 + A12O3 + Fe2O3 > 90 percent	15	35
UFFA and UFP	7	16
Slag Cement	40	50
[Silica Fume]	[7]	[10]

2.3 AGGREGATES

****

NOTE: During the design stage, research the availability of aggregate sources capable of conforming with the project specifications.

****

Provide aggregates meeting the requirements of this specification. If aggregate sources in the project area do not meet the requirements of this specification, provide aggregates from sources outside the project area.

2.3.1 Aggregate Sources

2.3.1.1 Durability of Coarse Aggregate

****

NOTE: Use first bracketed paragraph for Army and Air Force; use the second bracketed paragraph for Navy projects.

Subject to written approval by the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC), the second paragraph can be specified for projects in negligible weathering areas, as defined by ASTM C 33, Figure 1.

****

[Provide aggregate with a satisfactory service record in freezing and thawing of at least 5 years successful service in three concrete paving projects. Include a condition survey of the existing concrete and a review of the concrete-making materials, including coarse aggregates, cement, and mineral admixtures in the service record. Consider the previous aggregate source and test results, cement mill certificate data, mineral admixture chemical and physical composition, and the mix design (cement factor and water-cementitious material ratio) in the review. Provide service record performed by an independent third party professional engineer, petrographer, or concrete materials engineer along with their resume. Include photographs and a written report addressing D-cracks and popouts in accordance with ACI 201.1R in the service record. Provide coarse aggregate with a durability factor of 80 or more when subjected to freezing and thawing of specimens prepared in accordance with ASTM C1646/C1646M and tested in accordance with ASTM C666/C666M, Procedure A, when a coarse aggregate size group or source proposed for use does not have a satisfactory demonstrable service record. Test all coarse aggregate size groups and sources proposed for use individually.] [Evaluate and test all fine and coarse aggregates to be used in all concrete for durability in accordance with ASTM C88. Provide fine and coarse aggregates with a maximum of 18 percent loss when subjected to 5 cycles using Magnesium Sulfate or a maximum of 12 percent loss when subjected to 5 cycles if Sodium Sulfate is used.]

2.3.1.2 Alkali-Silica Reactivity

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate reactivity. Test all size groups and sources proposed for use individually.

a. Evaluate the aggregate size groups and sources separately using ASTM C1260. Reject individual aggregates with test results that indicate an expansion of greater than 0.08 percent after 28 days of immersion in 1N NaOH solution, or perform additional testing as follows: utilize the proposed portland cement, blended cement, and SCM, or Lithium Nitrate in combination with each individual aggregate. If only SCMs are being evaluated, test in accordance with ASTM C1567. If Lithium Nitrate is being evaluated, with or without SCMs, test in accordance with COE CRD-C 662. Determine the quantity that meets all the requirements of these specifications and that lowers the expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Base the mixture proportioning on the highest percentage of SCM required to mitigate ASR-reactivity.

b. If any of the above options does not lower the expansion to less than 0.08 percent after 28 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing for evaluation and acceptance.

2.3.1.3 Combined Aggregate Gradation

In addition to the grading requirements specified for coarse aggregate and for fine aggregate, provide the combined aggregate grading meeting the following requirements:

a. Provide materials selected and the proportions used such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in d. below, the point and its associated production tolerance thus determined falls within the parallelogram described therein. Refer to TSPWG M 3-250-04.97-05 for combined aggregate plot locations for the intended placement technique(s).

b. Determine the Coarseness Factor (CF) from the following equation:

$$CF = \frac{\text{(cumulative percent retained on the 9.5 mm sieve)(100)}}{\text{(cumulative percent retained on the 2.36 mm sieve)}}$$

$$CF = \frac{\text{(cumulative percent retained on the 3/8 inch sieve)(100)}}{\text{(cumulative percent retained on the No. 8 sieve)}}$$

c. The Workability Factor (WF) is defined as the percent passing the 2.36 mm No. 8 sieve based on the combined aggregate gradation. Adjust the WF, prorated upwards only, by 2.5 percentage points for each 56 kg per cubic meter 94 pounds per cubic yard of cementitious material greater than 335 kg per cubic meter 564 pounds per cubic yard.

d. Plot a diagram using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram, plot a parallelogram with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, revise the grading of each size of aggregate used and the proportions selected as necessary.

e. Plot the associated production tolerance limits, identified in Table 17, around the CF and adjusted WF point.

2.3.2 Coarse Aggregate

2.3.2.1 Coarse Aggregate Composition

****

NOTE: Crushing gravel tends to improve quality and bond characteristics and generally results in higher flexural strength of concrete. When desirable to limit coarse aggregate to crushed materials, modify this paragraph appropriately.

For Vertical Landing Pads, V-22 parking positions and other areas subject to very high temperatures and jet blast, use UFGS 32 13 13.43 HIGH TEMPERATURE CONCRETE PAVING FOR AIRFIELDS USING LIGHTWEIGHT AND TRAPROCK AGGREGATES

Do not, under any conditions, permit use of steel furnace slag for any aggregate. (It is markedly different from iron blast furnace slag.)

In power check pads, the high temperatures from jet blast can cause distress in aggregates in the concrete. Include bracketed item if power check pads are to be constructed. If no service record is available, make a lab study of available aggregates. Only basalt is permitted on Navy projects.

Give special attention to aggregates proposed for compass calibration pads. Do not use aggregates with magnetic properties, such as, but not limited to, magnetite in granites, high-iron minerals in traprock, pyrite in limestone, and free iron or iron

oxide in slag. When the paving of compass calibration pads is required, add the bracketed item concerning compass pads as additional requirements for coarse and fine aggregates.

Retain the bracketed requirement for washing coarse aggregate if aggregates in the area require it. Add the requirement to use a log washer or other specific equipment if experience in the area shows the need. Delete if not needed. It is permissible to list certain aggregate sources that do not require washing, if that is appropriate. Make this decision during preparation of specifications; do not make the Resident Engineer decide after award if aggregates need to be washed.

****

Provide coarse aggregate consisting of crushed or uncrushed gravel, crushed stone, [crushed adequately seasoned air-cooled iron blast-furnace slag; steel furnace slag is not permitted,] or a combination thereof. [Provide aggregate used for paving compass calibration hardstands free of materials having undesirable magnetic properties, including magnetite in granite, high-iron minerals in traprock, and pyrite in limestone.][Provide coarse aggregate for paving power check pads consisting of limestone, dolomite, basalt or other approved low-silica content aggregate which do not cause thermal distress from jet blast.] Provide aggregates, as delivered to the mixers, consisting of clean, hard, uncoated particles meeting the requirements of ASTM C33/C33M except as specified herein. [Provide coarse aggregate that has been washed sufficient to remove dust and other coatings.] [Provide coarse aggregate that has been cleaned by processing with an approved log washer.] [Provide iron blast-furnace slag conforming to the grading to be used in the concrete with a compact density of not less than 1125 kg per cubic meter 70 lb per cubic foot determined in accordance with ASTM C29/C29M]. Provide coarse aggregate with no more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M. Provide coarse aggregates with a maximum sodium sulfate soundness loss of 12 percent, or with a magnesium sulfate soundness loss of 18 percent after five cycles when tested in accordance with ASTM C88.

2.3.2.2 Particle Shape Characteristics

Provide particles of the coarse aggregate that are generally spherical or cubical in shape. The quantity of flat particles and elongated particles in any size group coarser than the 9.5 mm 3/8 inch sieve are not allowed to exceed 20 percent by weight as determined by the Flat Particle Test and the Elongated Particle Test of ASTM D4791, Method A. A flat particle is defined as one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3.

2.3.2.3 Size and Grading

****

NOTE: Aggregate quality requirements are not allowed to be reduced or eliminated for airfield projects. Use nominal maximum size of 37.5 mm 1-1/2 inch (ASTM C33 size number 4) for airfield pavements. Subject to written approval of the TSMCX, AFCEC pavement SME, or NAVFAC, a 25 mm 1-inch

nominal maximum size may be used to avoid durability problems associated with some larger size aggregate. For thin bonded overlays, limit the nominal maximum size to less than one-third of the uniform overlay thickness (not including leveling portion). For projects with less than 7,650 cubic meters 10,000 cubic yards of airfield pavement, delete the second bracketed statement. For projects with 7,650 cubic meters 10,000 cubic yards or more of airfield pavement, delete the first bracketed statement.

****

Provide coarse aggregate with a nominal maximum size (as defined in ASTM C125) of [37.5] [_____] mm [1.5] [_____] inches with a minimum of 10 percent retained on the [25] mm [1.0] inch sieve of the proposed combined aggregate gradation that meets the criteria of paragraph COMBINED AGGREGATE GRADATION. [Grade and provide the coarse aggregates in a minimum of two size groups meeting the individual grading requirements of ASTM C33/C33M, Size No. 4 (37 mm to 19 mm 1.5 inches to 0.75 inch) and Size No. 67 (19 mm to No. 4 0.75 inch to No. 4). A third coarse aggregate size group may be required to meet the criteria of paragraph Combined Aggregate Gradation.] [Grade and provide the coarse aggregates in a minimum of three size groups. The ASTM C33/C33M, Size Number 4 coarse aggregate (37.5 mm to 19.0 mm1.5 inches to 0.75 inch) meets the 37.5 mm 1.5 inches requirement. The ASTM C33/C33M, Size Number 67 (19.0 mm to 4.75 mm0.75 inch to No. 4) is a common medium coarse aggregate.]

Mix designs that include a minimum of three coarse aggregate size groups can use grading limits not defined by ASTM C33/C33M provided all other requirements are met. Provide upper and lower grading limits of historic gradations and for all proposed coarse aggregates not defined by ASTM C33/C33M but intended for use in the mix design.

2.3.2.4 Deleterious Materials - Airfield Pavements

****

NOTE: Include these deleterious material requirements for airfield paving projects only, otherwise, delete. In Table 7A select columns showing appropriate percentage by weight in accordance with the following. Delete the inapplicable column in the table and the heading of the column used.

Weather Severity	**Air Freezing Index Coldest Year in 30 (a)**	**Average Precipitation for any Single Month During the Freezing Period**
Moderate	**500 or less**	**Any Amount**
Moderate (b)	**501 or more**	**Less than 25 mm 1 inch**
Severe	**501 or more**	**25 mm 1 inch or more**

Weather Severity	**Air Freezing Index Coldest Year in 30 (a)**	**Average Precipitation for any Single Month During the Freezing Period**
(a) Calculated as described in UFC 3-130-01. See ASTM C33/C33M for simplified map of CONUS weather severity.		
(b) In poorly drained areas, the weather must be considered severe even though the other criteria indicate a rating of moderate.		
(c) For Navy projects, select "Severe Weather" column of Table 5. Delete "Moderate Weather" and associated limits.		

****

The amount of deleterious material in each individual size group and source of coarse aggregate is not allowed to exceed the limits shown in Table 7A below, determined in accordance with the test methods shown.

TABLE 9A		
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE FOR AIRFIELD		
Percentage by Mass		
Materials (h)	Severe Weather	Moderate Weather
Clay lumps and friable particles (ASTM C142/C142M)	0.2	0.2
Shale (a) (ASTM C295/C295M)	0.1	0.2
Material finer than 0.075 mm No. 200 sieve (b) (ASTM C117)	0.5	0.5
Lightweight particles (c) (ASTM C123/C123M)	0.2	0.2
Clay ironstone (d) (ASTM C295/C295M)	0.1	0.5
Chert, cherty stone, and other aggregates (less than 2.40 Sp. Gr.) (e) (ASTM C123/C123M and ASTM C295/C295M)	0.1	0.5
Claystone, mudstone, and siltstone (f) (ASTM C295/C295M)	0.1	0.1
Shaly and argillaceous limestone (g) (ASTM C295/C295M)	0.2	0.2
Other soft particles (COE CRD-C 130)	1.0	1.0
Total of all deleterious substances exclusive of material finer than 0.075 mm No. 200 sieve	1.0	2.0

TABLE 9A

LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE FOR AIRFIELD

Percentage by Mass

Materials (h)	Severe Weather	Moderate Weather
(a) Shale is defined as a fine-grained, thinly laminated or fissile sedimentary rock. It is commonly composed of clay or silt or both. It has been indurated by compaction or by cementation, but not so much as to have become slate.		
(b) Limit for material finer than 0.075 mm No. 200 sieve is allowed to be increased to 1.5 percent for crushed aggregates if the fine material consists of crusher dust that is essentially free from clay or shale. Use XRD or other appropriate techniques as determined by petrographer to quantify amount and justify increase.		
(c) Test with a separation medium with a density of Sp. Gr. of 2.0. This limit does not apply to coarse aggregate manufactured from blast-furnace slag unless contamination is evident.		
(d) Clay ironstone is defined as an impure variety of iron carbonate, iron oxide, hydrous iron oxide, or combinations thereof, commonly mixed with clay, silt, or sand. It commonly occurs as dull, earthy particles, homogeneous concretionary masses, or hard-shell particles with soft interiors. Other names commonly used for clay ironstone are "chocolate bars" and limonite concretions.		
(e) Chert is defined as a rock composed of quartz, chalcedony or opal, or any mixture of these forms of silica. It is variable in color. The texture is so fine that the individual mineral grains are too small to be distinguished by the unaided eye. Its hardness is such that it scratches glass but is not scratched by a knife blade. It may contain impurities such as clay, carbonates, iron oxides, and other minerals. Cherty stone is defined as any type of rock (generally limestone) that contains chert as lenses and nodules, or irregular masses partially or completely replacing the original stone. Other aggregates consist of obsidian, ash tuff, and palygorskite.		
(f) Claystone, mudstone, or siltstone, is defined as a massive fine-grained sedimentary rock that consists predominantly of indurated clay or silt without laminations or fissility. It may be indurated either by compaction or by cementation.		
(g) Shaly limestone is defined as limestone in which shale occurs as one or more thin beds or laminae. These laminae may be regular or very irregular and may be spaced from a few inches down to minute fractions of an inch. Argillaceous limestone is defined as a limestone in which clay minerals occur disseminated in the stone in the amount of 10 to 50 percent by weight of the rock; when these make up from 50 to 90 percent, the rock is known as calcareous (or dolomitic) shale (or claystone, mudstone, or siltstone).		

TABLE 9A

LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE FOR AIRFIELD

Percentage by Mass

Materials (h)	Severe Weather	Moderate Weather

(h) Perform testing in accordance with the referenced test methods, except use the minimum sample size specified below.

2.3.2.5 Testing Sequence for Deleterious Materials in Coarse Aggregate - Airfields Only

No extension of time or additional payment due to any delays caused by the testing, evaluation, or personnel requirements is allowed. The minimum test sample size of the coarse aggregate is 90 kg 200 pounds for the 19 mm 3/4 inch and larger maximum size and 12 kg 25 pounds for the 4.75 to 19 mm No. 4 to 3/4 inch coarse aggregate. Provide facilities for the ready procurement of representative test samples. The testing procedure on each sample of coarse aggregate for compliance with limits on deleterious materials is as follows:

Step 1: Wash each full sample of coarse aggregate for material finer than the 0.075 mm No. 200 sieve. Discard material finer than the 0.075 mm No. 200 sieve.

Step 2: Test remaining full sample for clay lumps and friable particles and remove.

Step 3. Test remaining full sample for chert and cherty stone with SSD density of less than 2.40 specific gravity. Remove lightweight chert and cherty stone. Retain other materials less than 2.40 specific gravity for Step 4.

Step 4: Test the materials less than 2.40 specific gravity from Step 3 for lightweight particles (Sp. GR. 2.0) and remove. Restore other materials less than 2.40 specific gravity to the sample.

Step 5: Test remaining sample for clay-ironstone, shale, claystone, mudstone, siltstone, shaly and argillaceous limestone, and remove.

Step 6: Test a minimum of one-fifth of remaining full sample for other soft particles.

2.3.2.6 Deleterious Material - Heavy Duty Pavements

****

NOTE: Use this paragraph only for heavy-duty pavements, roads, streets, and parking lots for vehicular and tracked traffic identified in the PART 1 GENERAL Note. Otherwise, delete.

****

[The amount of deleterious material in each size group of coarse aggregate is not to exceed the limits in Table 7B when tested as indicated.

TABLE 9B	
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE FOR HEAVY DUTY PAVEMENTS	
Percentage by Mass	
Clay lumps and friable particles (ASTM C142/C142M)	2.0
Material finer than 0.075 mm No. 200 sieve (ASTM C117)	1.0
Lightweight particles (ASTM C123/C123M)	1.0
Other soft particles (COE CRD-C 130)	2.0
Total of all deleterious substances, exclusive of material finer than 0.075 mm No. 200 sieve	5.0

The limit for material finer than the 0.075 mm No. 200 sieve is allowed to be increased to 1.5 percent for crushed aggregates consisting of crusher dust that is essentially free from clay or shale. Use a separation medium for lightweight particles with a density of 2.0 specific gravity. This limit does not apply to coarse aggregate manufactured from blast-furnace slag unless contamination is evident.]

2.3.3 Fine Aggregate

2.3.3.1 Fine Aggregate Composition

Provide fine aggregate consisting of natural sand, manufactured sand, or a combination of the two, each composed of clean, hard, durable particles meeting the requirements of ASTM C33/C33M. [Provide aggregate used for paving compass calibration hardstands free of materials having undesirable magnetic properties, including magnetite in granite, high-iron minerals in traprock, and pyrite in limestone.]Stockpile and batch each type of fine aggregate separately. Provide fine aggregate with particles that are generally spherical or cubical in shape. For fine aggregate provided as a combination of sources, test each source individually.

2.3.3.2 Grading

Provide fine aggregate, as delivered to the mixer, with a grading that conforms to the requirements of ASTM C33/C33M and having a fineness modulus of not less than 2.50 nor more than 3.40. For fine aggregate supplied as a combination of sources, determine the fineness modulus on a composite sample.

2.3.3.3 Deleterious Material

****

NOTE: Retain sample size for airfield pavements.

****

[The minimum test sample size for fine aggregate proposed for use in airfield paving is 5 kg 10 pounds.] The amount of deleterious material in the fine aggregate is not to exceed the limits listed in Table 8 when performed on the full sample:

TABLE 9	
LIMITS OF DELETERIOUS MATERIALS IN FINE AGGREGATE	
Material	Percentage by Mass
Clay lumps and friable particles ASTM C142/C142M	1.0
Material finer than 0.075 mm No. 200 sieve ASTM C117	3.0
Lightweight particles ASTM C123/C123M using a medium with a density of Sp. Gr. of 2.0	0.5
Total of all above	3.0

2.3.3.4 Testing Sequence for Deleterious Materials in Fine Aggregate - Airfields Only

The testing procedure on each sample of fine aggregate for compliance with limits on deleterious materials is as follows:

Step 1: Wash each full sample of fine aggregate for material finer than the 0.075 mm No. 200 sieve. Discard material finer than the 0.075 mm No. 200 sieve.

Step 2: Test remaining full sample for clay lumps and friable particles and remove.

Step 3. Test remaining full sample for lightweight particles (Sp. GR. 2.0).

2.4 CHEMICAL ADMIXTURES

2.4.1 General Requirements

Only use chemical admixtures when the specific admixture type and manufacturer is the same material used in the mixture proportioning studies. Provide all chemical admixtures from the same manufacturer. Provide air-entraining admixture conforming to ASTM C260/C260M. Use an accelerating admixture conforming to ASTM C494/C494M, Type C or Type E, when specified in paragraph MIXTURE PROPORTIONS below provided it is not used to reduce the amount of cementitious material. Calcium chloride and admixtures containing calcium chloride are not allowed. Provide retarding or water-reducing admixture that meet the requirements of ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived. ASTM C494/C494M, Type F and G high range water reducing admixtures and Type S specific performance admixtures are not allowed. ASTM C1017/C1017M flowable admixtures are not allowed.

2.4.2 Lithium Nitrate

****

NOTE: Evaluate cost effectiveness and availability of a Lithium Nitrate admixture before specifying.

****

Provide lithium admixture consisting of a nominal 30 percent aqueous solution of Lithium Nitrate, with a density of 1.2 kg per L 10 pounds per gallon, with the approximate chemical form as shown below:

TABLE 10	
LITHIUM NITRATE COMPOSITION	
Constituent	Limit (Percent by Mass)
$LiNo_3$ (Lithium Nitrate)	30 plus or minus 0.5
SO_4^{-2} (Sulfate Ion)	0.1 (max)
Cl^- (Chloride Ion)	0.2 (max)
Na^+ (Sodium Ion)	0.1 (max)
K^+ (Potassium Ion)	0.1 (max)

Provide the services of a manufacturer's technical representative experienced in dispensing, mixing, proportioning, placement procedures and curing of concrete containing lithium nitrate, at no expense to the Government. This representative is required to be present on the project prior to and during at least the first two days of placement using lithium nitrate.

2.4.3 High Range Water Reducing Admixture (HRWRA)

****

NOTE: High Range Water Reducing Admixtures are permitted only when using Silica Fume. Delete for all other projects

****

[Provide a high-range water-reducing admixture that meets the requirements of ASTM C494/C494M, Type F or G, that is free from chlorides, alkalis, and is of the synthesized, sulfonated complex polymer type. Add the HRWRA to the concrete as a single component at the batch plant. Add the admixture to the concrete mixture only when its use is approved or directed, and only when it has been used in mixture proportioning studies to arrive at approved mixture proportions. Submit certified copies of the independent laboratory test results required for compliance with ASTM C494/C494M.]

2.5 MEMBRANE FORMING CURING COMPOUND

****

NOTE: Use CRD-C 300 for airfield pavement projects. ASTM C309 may be used for roads and streets.

****

Provide membrane forming curing compound that [conforms to COE CRD-C 300 and is white pigmented.] [conforms to ASTM C309, white-pigmented Type 2, Class B.]

2.6 WATER

Provide water for mixing and curing that is fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water, or water from concrete production operations, can be used if it meets the requirements of ASTM C1602/C1602M.

2.7 JOINT MATERIALS

****

NOTE: Edit as appropriate for project requirements.

****

2.7.1 Expansion Joint Material

Provide preformed expansion joint filler material conforming to [ASTM D1751] [or] [ASTM D1752 Type [II] [III].] Provide expansion joint filler that is 19 mm 3/4 inch thick, unless otherwise indicated, and provided in a single full depth piece.

2.7.2 Slip Joint Material

Provide slip joint material that is 6 mm 1/4 inch thick expansion joint filler, unless otherwise indicated, conforming to paragraph EXPANSION JOINT MATERIAL.

2.8 REINFORCING

****

NOTE: Edit these paragraphs to conform to project requirements. Delete those not needed. Add epoxy-coated bars (ASTM A775/A775M) or low-alloy bars (ASTM A706/A706M) when required by design.

****

Provide reinforcement that is free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete. Removal of thin powdery rust and tight rust is not required. However, reinforcing steel which is rusted to the extent that it does not conform to the required dimensions or mechanical properties is not allowed to be used.

2.8.1 Reinforcing Bars and Bar Mats

Provide reinforcing bars conforming to [ASTM A615/A615M, billet-steel] [ASTM A996/A996M, rail and axle steel], Grade 60 [_____]. Provide bar mats conforming to ASTM A184/A184M. The bar members may be billet rail or axle steel.

2.8.2 Welded Wire Reinforcement

Provide welded wire reinforcement that is deformed or smooth, conforming to ASTM A1064/A1064M, and provided in flat sheets.

2.9 DOWELS[AND TIE BARS]

****

NOTE: Retain paragraph on dowels. Even if not

required, allow dowels as an option. Edit tie bars as required by design.
****

2.9.1 Dowels

Provide dowels in single piece bars fabricated or cut to length at the shop or mill before delivery to the site. Dowels are to be free of loose, flaky rust and loose scale and be clean and straight. Dowels may be sheared to length provided that the deformation from true shape caused by shearing does not exceed 1 mm 0.04 inch on the diameter of the dowel and does not extend more than 1 mm 0.04 inch from the end of the dowel. Dowels are required to be smooth steel bars conforming to ASTM A615/A615M, Grade 40 or 60; ASTM A996/A996M, Grade 50 or 60. Epoxy coat dowels in conformance with Type 1 coating requirements of ASTM A1078/A1078M, to include the ends. Provide grout retention rings that are fully circular metal or plastic devices capable of supporting the dowel until the epoxy hardens. Dowel sleeves or inserts are not permitted.

2.9.2 Dowel Bar Assemblies

Provide dowel bar assemblies that consist of a framework of metal bars or wires arranged to provide rigid support for the dowels throughout the paving operation, with a minimum of four continuous bars or wires extending along the joint line. Provide dowels that are welded to the assembly or held firmly by mechanical locking arrangements that prevent them from rising, sliding out, or becoming distorted during paving operations.

2.9.3 Tie Bars

Provide tie bars that are deformed steel bars conforming to ASTM A615/A615M, or ASTM A996/A996M, Grade 60 [_____], and of the sizes and dimensions indicated.

2.10 EPOXY RESIN

Provide epoxy-resin materials that consist of two-component materials conforming to the requirements of ASTM C881/C881M, Class as appropriate for each application temperature to be encountered, except that in addition, the materials meet the following requirements:

a. Type IV, Grade 3 for use for embedding dowels and anchor bolts.

b. Type III, Grade as required for use as patching materials for complete filling of spalls, saw-cut runouts, and other voids and for use in preparing epoxy resin mortar.

c. Type IV, Grade 1 for use for injecting cracks.

d. Type V, Grade as required for bonding freshly mixed portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete.

2.11 EQUIPMENT

Maintain all plant, equipment, tools, and machines used in the work in satisfactory working conditions at all times. Submit the following:

a. Details and data on the batching and mixing plant prior to plant assembly including manufacturer's literature showing that the equipment meets all requirements specified herein.

****

NOTE: For OCONUS projects, contact NRMCA (http://www.nrmca.org) concerning approved engineers available in the geographic area.

****

b. Obtain National Ready Mixed Concrete Association (NRMCA) certification of the concrete plant, at no expense to the Government. Provide inspection report of the concrete plant by an engineer approved by the NRMCA. The NRMCA certified engineer cannot be employed by the primary contractor or a subcontractor. A list of NRMCA approved engineers is available on the NRMCA website at http://www.nrmca.org. Submit a copy of the NRMCA QC Manual Section 3 Concrete Plant Certification Checklist, NRMCA Certificate of Conformance, and Calibration documentation on all measuring and weighing devices prior to uniformity testing.

c. A description of the equipment proposed for transporting concrete mixture from the central mixing plant to the paving equipment.

d. A description of the equipment proposed for the machine and hand placing, consolidating and curing of the concrete mixture. Manufacturer's literature on the paver and finisher, together with the manufacturer's written instructions on adjustments and operating procedures necessary to assure a tight, smooth surface on the concrete pavement. The literature is required to show that the equipment meets all details of these specifications. [Include detailed information on automatic laser controlled systems if proposed for use.]

2.11.1 Batching and Mixing Plant

****

NOTE: Locate the batching and mixing plant on the construction site or as close as possible, but no farther than 30 minutes haul time from the placing site during all periods of the work day. Verify the availability of water and electrical power for sites on Government land. On Navy projects, specify an off-site batch plant. Edit bracketed items as appropriate.

Plant capacity is governed by the laydown pattern or the size of the job to prevent delay of paving operations.

****

2.11.1.1 Location

Locate the batching and mixing plant [on project site as indicated on the drawings][off Government premises no more than a 15 minute haul time from the placing site. At no time is the haul time and gate security check time to exceed30 minutes from the offloading of the concrete mixture into the truck to the placing site]. [Water and electrical power [are] [are not] available on the project site.] Provide operable telephonic or radio communication between the plant and the placing site at all times concreting is taking place.

2.11.1.2 Type and Capacity

Provide a batching and mixing plant consisting of a stationary-type central mix plant, including permanent installations and portable or relocatable plants installed on stable foundations. Provide a plant designed and operated to produce concrete within the specified tolerances, with a minimum capacity of 200 cubic meters 250 cubic yards [_____] per hour, that conforms to the requirements of NRMCA QC 3 including provisions addressing:

1. Material Storage and Handling
2. Batching Equipment
3. Central Mixer
4. Ticketing System
5. Delivery System

2.11.1.3 Tolerances

TABLE 11

BATCH PLANT MIXING TOLERANCES

Materials	Percentage of Required Mass
Cementitious Materials	plus or minus 1
Aggregate	plus or minus 2
Water	plus or minus 1
Admixture	plus or minus 3

For volumetric batching equipment for water and admixtures, the above numeric tolerances apply to the required volume of material being batched. Dilute concentrated admixtures uniformly, if necessary, to provide sufficient volume per batch so that the batchers operate consistently within the above tolerance.

2.11.1.4 Moisture Control

Provide a plant capable of ready adjustment to compensate for the varying moisture contents of the aggregates and to change the quantities of the materials being batched. Provide an electric moisture meter complying with the provisions of COE CRD-C 143 for measuring of moisture in the fine aggregate. Provide a sensing element arranged so that measurement is made near the batcher charging gate of the fine aggregate bin or in the fine aggregate batcher.

2.11.2 Concrete Mixers

Use the project's approved mixture proportions for uniformity testing. Provide stationary or truck mixers that are capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. Do not charge the mixers in excess of the capacity recommended by the manufacturer. Operate the mixers at the drum or mixing blade speed designated by the manufacturer. Maintain the mixers in satisfactory operating condition, with the mixer drums kept free of hardened concrete. Replace mixer blades or paddles when worn down more than 10 percent of their depth when compared with the manufacturer's dimension for new blades or paddles.

2.11.2.1 Stationary Mixers

Stationary mixers are required to be drum or pan mixers. Provide mixers with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. Perform mixer performance (uniformity) testing in accordance with COE CRD-C 55 and with paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL DURING CONSTRUCTION in PART 3.

2.11.2.1.1 Mixing Time and Uniformity for Stationary Mixers

For stationary mixers, before uniformity data are available, the minimum mixing time for each batch after all solid materials are in the mixer, provided that all of the mixing water is introduced before one-fourth of the mixing time has elapsed, is 1 minute for mixers having a capacity of 0.75 cubic meter 1 cubic yard. For mixers of greater capacity, increase this minimum time by 20 seconds for each additional cubic meter 1.33 cubic yard or fraction thereof. Provide uniformity test results meeting the properties required by this specification in addition to meeting the requirements of Table 11. After results of uniformity tests are available, the mixing time may be reduced to the minimum time required to meet uniformity requirements; but if uniformity requirements are not being met, increase the mixing time as directed. Perform mixer uniformity tests at new mixing times immediately after any change in mixing time or volume. Any changes to the mix constituents or sequence of charging the mixer after a batch requires an additional three consecutive passing batches. For regular testing perform all six tests on three consecutive batches of concrete. The range for regular testing is the average of the ranges of the three consecutive batches. Conduct the Regular Test sequence for initial determination of the mixing time or as directed. When regular testing is performed, the concrete is required to meet the limits of any five of the six uniformity requirements listed in Table 11 below.

2.11.2.1.2 Abbreviated Uniformity Test

Conduct the Abbreviated Test sequence for production concrete verification at the frequency specified in Table 17. Provide uniformity test results meeting the fresh and hardened concrete properties required by this specification in addition to meeting the requirements of Table 11. When abbreviated testing is performed, the concrete is required to meet only those requirements listed for abbreviated testing. Abbreviated testing is performed on a single batch of concrete. The range for abbreviated testing is the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, the results of tests on one of the mixers apply to the others, subject to Government approval.

TABLE 12

UNIFORMITY REQUIREMENTS--STATIONARY MIXERS

Parameter	Regular Tests Allowable Maximum Range for 3 Consecutive Batches	Abbreviated Tests Allowable Maximum Range for 1 Batch
Unit weight of air-free mortar	32 kg per cubic m 2.0 pounds per cubic foot	32 kg per cubic m 2.0 pounds per cubic foot
Air content	1.0 percent	Not Applicable

TABLE 12

UNIFORMITY REQUIREMENTS--STATIONARY MIXERS

Parameter	Regular Tests Allowable Maximum Range for 3 Consecutive Batches	Abbreviated Tests Allowable Maximum Range for 1 Batch
Slump	25 mm 1.0 inch	25 mm 1.0 inch
Coarse aggregate	6.0 percent	6.0 percent
Compressive strength at	10.0 percent	10.0 percent
Water content	1.5 percent	Not Applicable

2.11.2.2 Truck Mixers

Truck mixers are not allowed for mixing or transporting slipformed paving concrete. Provide only truck mixers designed for mixing or transporting paving concrete with extra large blading and rear opening specifically for low-slump paving concrete. Provide truck mixers, the mixing of concrete therein, and concrete uniformity and testing thereof that conform to the requirements of ASTM C94/C94M. Any changes to the mix constituents or sequence of charging the truck mixer requires an additional three consecutive passing batches. Determine the number of revolutions between 70 to 100 for truck-mixed concrete and the number of revolutions for shrink-mixed concrete by uniformity tests as specified in ASTM C94/C94M and in requirements for mixer performance stated in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL DURING CONSTRUCTION in PART 3. If requirements for the uniformity of concrete are not met with 100 revolutions of mixing after all ingredients including water are in the truck mixer drum, discontinue use of the mixer until the condition is corrected. Water is not allowed to be added after the initial introduction of mixing water except, when on arrival at the job site, the slump is less than specified and the water-cement ratio is less than that given as a maximum in the approved mixture. Additional water may be added to bring the slump within the specified range provided the approved water-cement ratio is not exceeded. Inject water into the head of the mixer (end opposite the discharge opening) drum under pressure, and turn the drum or blades a minimum of 30 additional revolutions at mixing speed. The addition of water to the batch at any later time is not allowed.

2.11.3 Transporting Equipment

Provide non-agitating equipment conforming to ASTM C94/C94M or approved open top agitators for slipformed paving concrete transportation. Provide non-agitating equipment or approved truck mixers conforming to ASTM C94/C94M for fixed form and hand placement paving concrete transportation. Truck mixers are not allowed for mixing or transporting slipformed paving concrete. All truck mixers are to bedesigned with extra large blading and rear opening specifically for low slump concrete. Provide transporting equipment designed and operated to deliver and discharge the required concrete mixture completely without segregation.

2.11.4 Transfer and Spreading Equipment

****

NOTE: A transfer spreader is required for all Army and Air Force airfield paving projects. This

paragraph is required for Navy projects if the design incorporates a drainage layer. Coordinate with Part 3 requirements in sub-paragraph TRAFFIC ON UNDERLYING MATERIAL.
****

Provide a Material Transfer Vehicle (MTV) capable of moving between the hauling equipment and the paver and equipped with a swing conveyor that delivers material to the paver from outside the paving lane without making contact with the paver while allowing the paver to operate at a constant speed.

2.11.5 Paver-Finisher

****
NOTE: The following subparagraphs apply to both fixed-form and slip-form paver-finishers. FIXED FORMS is applicable to fixed-form paver-finishers and SLIPFORM is applicable to slip-form paver-finishers.
****

Provide paver-finisher consisting of a heavy-duty, self-propelled machine designed specifically for paving and finishing high quality pavement, with a minimum weight of 3280 kg per m 2200 pounds per foot of lane width, and powered by an engine having a minimum 15,000 W per m 6.0 horsepower per foot of lane width. The paver-finisher is required to spread, consolidate, and shape the plastic concrete to the desired cross section in one pass. The mechanisms for forming the pavement are required to be easily adjustable in width and thickness. In addition to other spreaders required by paragraph above, equip the paver-finisher with a full width knock-down auger or plow mechanism, capable of operating in both directions, which evenly spreads the fresh concrete in front of the screed or extrusion plate.

2.11.5.1 Vibrators

****
NOTE: Retain bracketed electronic vibrator monitoring equipment statement for airfield paving.
****

Provide gang mounted immersion vibrators at the front of the paver on a frame equipped with suitable controls so that all vibrators can be operated at any desired depth within the slab or completely withdrawn from the concrete, as required. Provide vibrators that are automatically controlled to immediately stop as forward motion of the paver ceases. [Equip the paver-finisher with an electronic vibrator monitoring device displaying the operating frequency of each individual internal vibrator with a readout display visible to the paver operator that operates continuously while paving, and displays all vibrator frequencies with manual or automatic sequencing among all individual vibrators. Discontinue paving if the vibrator monitoring system fails to operate properly during the paving operation.] Provide the spacing of the immersion vibrators across the paving lane as necessary to properly consolidate the concrete, with a maximum clear distance between vibrators of 750 mm 30 inches and outside vibrators a maximum of 300 mm 12 inches from the lane edge. Determine vibrator frequency and amplitude per COE CRD-C 521.

2.11.5.2 Screed or Extrusion Plate

Equip the paver-finisher with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface and finish the surface that no significant amount of hand finishing, except use of cutting straightedges, is required. Provide adjustment for variation in lane width or thickness and to prevent more than 200 mm 8 inches of the screed or extrusion plate extending over previously placed concrete on either side when paving fill-in lanes. Repair or replace machines that cause displacement of properly installed forms or cause ruts or indentations in the prepared underlying materials and machines that cause frequent delays due to mechanical failures.

2.11.5.3 Longitudinal Mechanical Float

A longitudinal mechanical float may be used. If used, provide a float that is specially designed and manufactured to smooth and finish the pavement surface without working excess paste to the surface and is rigidly attached to the rear of the paver-finisher or to a separate self-propelled frame spanning the paving lane. Provide float plate at least 1.5 m 5 feet long by 200 mm 8 inches wide that automatically oscillates in the longitudinal direction while slowly moving from edge to edge of the paving lane, with the float plate in contact with the surface at all times.

2.11.5.4 Other Types of Finishing Equipment

Clary screeds (triple drum roller screeds), other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to approval. Only use vibrating screeds or pans for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

2.11.5.5 Fixed Forms

Provide paver-finisher equipped with wheels designed to ride the forms, keep it aligned with the forms, and spread the load so as to prevent deformation of the forms. When traveling on new or existing concrete to remain, provide paver-finishers traveling on guide rails located outside of the paving lane that are equipped with wheels that will not cause damage or spalling to concrete joint edges to remain. Alternatively, a modified slipform paver that straddles the forms may be used. Provide a modified slipform paver which has the side conforming plates removed or rendered ineffective and travels over or along pre-placed fixed forms.

2.11.5.6 Slipform

Provide an automatically controlled slipform paver-finisher that is crawler mounted with padded tracks so as to be completely stable under all operating conditions and provide a finish to the surface and edges so that no edge slump beyond allowable tolerance occurs. Provide suitable moving side forms that are adjustable and produce smooth, even edges, perpendicular to the top surface and meeting specification requirements for alignment, edge slump, and joint face deformation.

2.11.6 Curing Equipment

Provide equipment for applying membrane-forming curing compound mounted on a self-propelled frame that spans the paving lane. Constantly agitate the curing compound reservoir mechanically (not air) during operation and provide a means for completely draining the reservoir. Provide a spraying system that consists of a mechanically powered pump which maintains constant pressure during operation, an operable pressure gauge, and either a series of spray nozzles evenly spaced across the lane to provide uniformly overlapping coverage or a single spray nozzle which is mounted on a carriage which automatically traverses the lane width at a speed correlated with the forward movement of the overall frame. Protect all spray nozzles with wind screens. Calibrate the spraying system in accordance with ASTM D2995, Method A, for the rate of application required in paragraph MEMBRANE CURING. Provide hand-operated sprayers allowed by that paragraph with compressed air supplied by a mechanical air compressor. Immediately replace curing equipment if it fails to apply an even coating of compound at the specified rate.

2.11.7 Texturing Equipment

****

NOTE: Select type of texturing desired, retain that subparagraph, and delete the others. Determine the type of texturing desired by the using service. If no guidance is given, the usual default method is a burlap drag. If other than a burlap drag textured finish is required, edit the appropriate paragraph(s) as shown below.

For Air Force airfield paving projects, do not specify artificial turf, wire comb, or deep textures. For Navy airfield paving projects, do not specify wire comb or deep textures. Use Section 32 01 18.71 GROOVING OF AIRFIELD PAVING to specify saw-cut grooves.

Spring tine grooving is limited to use on roads and streets only.

****

Provide texturing equipment as specified below. Before use, demonstrate the texturing equipment on the test section, and modify the equipment as necessary to produce the texture directed.

2.11.7.1 Burlap Drag

Securely attach a burlap drag to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. Provide length of the material between 600 to 900 mm 24 to 36 inches dragging flat on the pavement surface and with a width at least equal to the width of the slab. Provide clean, reasonably new burlap material, completely saturated with water before attachment to the frame, moistened before start of use, and kept clean and maintained moist during use. Provide burlap conforming to AASHTO M 182, Class 3 or 4. Burlap drag is not to include any impervious layers, such as a polyethylene layer.

2.11.7.2 Broom

Apply surface texture using an approved mechanical stiff bristle broom drag of a type that provides a uniformly scored surface transverse to the pavement center line. Provide broom capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure that results in scores uniform in appearance and approximately 1.5 mm 1/16 inch in depth but not more than 3 mm 1/8 inch in depth.

2.11.7.3 Artificial Turf

[Provide full-width artificial turf drag with the leading transverse edge securely fastened to a lightweight pole on a traveling bridge. Provide a minimum of 600 mm 2 feet of the artificial turf in contact with the concrete surface during texturing operations that results in corrugations uniform in appearance and approximately 2 mm 1/16 inch in depth. A variety of different types of artificial turf are available and approval of any one type will be done only after it has been demonstrated to provide a satisfactory texture. One type that has provided satisfactory texture consists of 7,200 approximately 0.85-inch-long polyethylene turf blades per square foot.]

2.11.7.4 Deep Texturing Equipment

[Provide texturing equipment that consists of [a stiff bristled broom] [a comb with spring wire tines] [spring strips which produce true, even grooves] forming a drag at least 1.2 m 4 feet long. Mount this drag in a wheeled frame spanning the paving lane and so constructed that the drag is mechanically pulled in a straight line across the paving lane perpendicular to the centerline.]

2.11.8 Sawing Equipment

****

NOTE: Retain bracketed sentence as necessary to correlate with paragraph REMOVAL OF EXISTING PAVEMENT SLAB in PART 3. Otherwise delete. Also delete wheel saw option on Navy projects.

****

Provide equipment for sawing joints and for other similar sawing of concrete consisting of standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment. Provide diamond tipped blades. If demonstrated to operate properly, abrasive blades may be used. Provide spares as required to maintain the required sawing rate. [Provide wheel saws used in the removal of concrete with large diameter tungsten carbide tipped blades mounted on a heavy-duty chassis which produce a saw kerf at least 40 mm 1-1/2 inches wide.]Provide saws capable of sawing to the full depth required. Early-entry saws may be used, subject to demonstration and approval. No change to the initial sawcut depth is permitted.

2.11.9 Straightedge

Provide and maintain at the job site, in good condition, a minimum 4 m 12 foot straightedge for each paving train for testing the hardened portland cement concrete surfaces. Provide straightedges constructed of aluminum or magnesium alloy and blades of box or box-girder cross section with flat bottom, adequately reinforced to maintain rigidity and accuracy. Provide straightedges with handles for operation on the pavement.

2.11.10 Work Bridge

Provide a self-propelled work bridge capable of spanning the required paving lane width where workmen can efficiently and adequately reach the pavement surface.

2.11.11 Hand Finishing Tools

Provide hand finishing equipment in accordance with the provisions of this specification. Use the hand method only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Keep supplemental hand finishing for machine finished pavement to an absolute minimum. Do not seal the paving surface with steel trowels.

2.12 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

****

NOTE: Fill in blanks as appropriate. Specify the flexural strength used in the structural design of the pavement a maximum of 650 psi 4.5 MPa at 90 days of age. However, modify to 28-days if 28-day strength is approved in writing by TSMCX, AFCEC pavement SME, or NAVFAC as stated in paragraph FLEXURAL STRENGTH. Be sure this and succeeding paragraphs remain consistent.

For the standard coarse aggregate with the nominal maximum size of 37 mm 1.5 inches, the total air content must be specified as 6.0 percent where freezing and thawing is a concern. For a coarse aggregate with the nominal maximum size of 25 mm 1.0 inch, the total air content must be specified as 6.5 percent where freezing and thawing is a concern. Specify 4.0 percent where freezing and thawing is not a concern.

****

2.12.1 Specified Flexural Strength

****

NOTE: Use the Tailoring Option "Beams" or "Cylinders/Beams" to specify flexural strength for concrete.

****

Specified flexural strength, R, for concrete is [_____] MPa psi at [28] [90] days, as determined by tests made in accordance with ASTM C78/C78M of beams fabricated and cured in accordance with ASTM C192/C192Mequivalent flexural strength, as specified in paragraph Mixture Proportioning For Flexural Strength below.

2.12.2 Allowable Water-Cementitious Materials Ratio

The allowable water-cementitious material ratio is 0.38 to 0.45. The water-cementitious material ratio is the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus SCM by the mass equivalency method described in ACI 211.1.

2.12.3 Air Content

Provide concrete that is air-entrained with a total air content of [4.0] [6.0] [6.5] plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C231/C231M.

2.12.4 Slump

The maximum allowable slump of the concrete at the point of placement is listed in Table 12.

TABLE 13

MAXIMUM ALLOWABLE SLUMP

Placement Method	Maximum Slump
Slipform	As required to meet edge slump and joint face deformation limits
Fixed Form	50 mm2 inches
Hand Placement utilizing Other Types of Finishing Equipment	75 mm3 inches

The selected slump is applicable to both pilot and fill-in lanes. Perform separate trial mixture studies for each placement method, as specified in paragraph Trial Mixture Studies.

2.12.5 Concrete Temperature

The temperature of the concrete as delivered is required to conform to the requirements of paragraphs Paving In Hot Weather and Paving In Cold Weather. Determine the temperature of concrete in accordance with ASTM C1064/C1064M.

2.12.6 Concrete Strength for Final Acceptance

****

NOTE: Use the Tailoring Option to specify concrete strength by using "Cylinders/Beams" or "Beams".

****

[The strength of the concrete will be considered acceptable when the average equivalent [90-day] [28-day] flexural strengths for each lot are above the 'Specified Flexural Strength' as determined by correlation with 14-day compressive strength tests specified in paragraph Mixture Proportioning For Flexural Strength below,][The strength of the concrete will be considered acceptable when the equivalent [90-day] [28-day] flexural strengths for each lot are above the 'Specified Flexural Strength' as determined by correlation with 14-day flexural strength tests specified in paragraph Mixture Proportioning For Flexural Strength below,] and no individual set (2 specimens per sublot) in the lot are 170 kPa 25 psi or more below the equivalent 'Specified Flexural Strength'. If any lot or sublot, respectively, fails to meet the above criteria, remove and replace the lot or sublot at no additional cost to the Government. This is in addition to and does not replace the average strength required for day-to-day CQC operations as specified in paragraph Average Cqc Flexural Strength Required For Mixtures, below.

2.13 MIXTURE PROPORTIONS

****

NOTE: Edit bracketed items as appropriate. Normally, permit accelerating admixtures only with fast-track paving. If approval has been obtained and airfield pavement has been designed and specified for 28-day flexural strength in paragraph SPECIFIED FLEXURAL STRENGTH, modify the following subparagraphs accordingly. Do the same if this is road pavement designed for 28-day strength. Use the higher bracketed total cementitious content if a supplementary cementitious material is used.

Include bracketed sentences on limiting alkali loading for airfield pavement projects.

****

2.13.1 Mixture Proportions Composition

Provide concrete composed of cementitious material, water, fine and coarse aggregates, and admixtures. Include supplementary Cementitious Materials (SCM) choice and usage in accordance with paragraph Supplementary Cementitious Materials (SCM) Content. Provide a minimum total cementitious materials content of [280 kg per cubic meter 470 pounds per cubic yard] [310 kg per cubic meter 517 pounds per cubic yard]. [Limit the total alkali loading contributed by the portland cement or the portland cement portion of a blended cement to a maximum of 1.8 kg per cubic meter 3.0 lb per cubic yard. Calculate the alkali loading as the product of the portland cement content of the concrete multiplied by the alkali content of the portland cement or the portland cement portion of the blended cement, divided by 100. Determine the alkali content in accordance with ASTM C114.]Acceptable admixtures consist of air entraining admixture and may also include, as approved, [water-reducing admixture,][retarding admixture,][accelerating admixture,][water-reducing and retarding admixtures,][water reducing and accelerating admixtures].

2.13.2 Proportioning Studies

Perform trial design batches, mixture proportioning studies, and testing, at no expense to the Government. Submit for approval the Preliminary Proposed Proportioning to include items a., b., and i. below a minimum of 21 days prior to beginning a mixture proportioning study. Submit the results of the mixture proportioning studies signed and stamped by the registered professional engineer having technical responsibility for the mix design study, and submitted at least 30 days prior to commencing concrete placing operations. Include a statement summarizing the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic meter yard basis. Base aggregate quantities on the mass in a saturated surface dry condition. Provide test results demonstrating that the proposed mixture proportions produce concrete of the qualities indicated. Base methodology for trial mixtures having proportions, slumps, and air content suitable for the work as described in ACI 211.1, modified as necessary to accommodate flexural strength. ACI 211.1 can be supplemented with ACI 325.14R. Submit test results including:

a. Individual coarse and fine aggregate gradations and plots that meet ASTM C33. Include historic gradation averages and standard deviations on individual sieves for each aggregate size group produced within the past 12 months. Historical gradation averages are not to be utilized for the Proportioning Studies.

b. Combined aggregate gradation and coarseness vs. workability plots.
c. Coarse aggregate quality test results. Report the Aggregate Correction Factor (ACF).
d. Fine aggregate quality test results.
e. Mill certificates for cement and supplementary cementitious materials.
f. Certified test results for air entraining, water reducing, retarding, non-chloride accelerating[, and Lithium Nitrate] admixtures.
g. Specified flexural strength, slump, and air content.
h. Documentation of required average CQC flexural strength, Ra.
i. Recommended proportions and volumes for each proposed mixture for each proposed placement method (slipform, fixed form, and hand placement) if different. Include three trial water-cementitious materials ratios for each proposed placement method (slipform, fixed form, and hand placement).
j. Individual beam [and cylinder]breaks.
k. Flexural [and compressive]strength summaries and plots.
l. Correlation ratios for acceptance testing and CQC testing.
m. Historical record of ACI 214R strength test results, documenting production standard deviation (if available).
n. Narrative discussing methodology on how the mix design was developed in accordance with ACI 211.1 and ACI 325.14R.
o. Alternative aggregate blending to be used during the test section if necessary to meet the required surface and consolidation requirements.

2.13.2.1 Water-Cementitious Materials Ratio

Perform at least three different water-cementitious materials ratios, within the limits specified in paragraph Allowable Water-Cementitious Materials Ratio, which produce a range of strength encompassing that required on the project. The minimum and maximum water-cementitious materials ratios of the approved mix design become the minimnum and maximum water-cementitious materials ratio for the project during production.

2.13.2.2 Trial Mixture Studies

Perform separate sets of trial mixture studies made for each combination of cementitious materials and each combination of admixtures proposed for use. No combinations are to be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerating or retarding admixture can be used without separate trial mixture study. Perform separate trial mixture studies for each placing method (slip form, fixed form, or hand placement) proposed. Report the temperature of concrete in each trial batch. Design each mixture to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding. Proportion laboratory trial mixtures for maximum slump and air content, as permitted by the placement method being utilized.

2.13.2.3 Mixture Proportioning for Flexural Strength

****

NOTE: The first Tailoring Option, "Beams", includes items a through j; the second option "Cylinders/Beams" includes the second listing of items a through j.

****

Follow the step by step procedure below:

a. Fabricate all beams for each mixture from the same batch or blend of batches. Fabricate and cure all beams in accordance with ASTM C192/C192M, using 152 x 152 mm 6 x 6 inches steel beam molds.

b. Cure test beams from each mixture for 3, 7, 14, and [and 28] [56 and 90]-day flexural tests; 6 beams to be tested per age.

c. Test beams in accordance with ASTM C78/C78M.

d. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:
    3-day flexural strength
    7-day flexural strength
    14-day flexural strength
    [28-day flexural strength]
    [56 and 90-day flexural strength]

e. From these graphs select a w/c that produces a mixture giving a [28] [56] [90]-day flexural strength equal to the required strength determined in accordance with paragraph Average CQC Flexural Strength Required for Mixtures.

f. Using the above selected w/c, select from the graphs the expected 3, 7 and 14-day flexural strengths.

g. From the above expected strengths for the selected mixture, determine the Ratio of the 7-day flexural strength of the selected mixture to the [28] [56] [90]-day flexural strength of the mixture (for CQC control).

h. From the above expected strengths for the selected mixture, determine the Ratio of the 14-day flexural strength of the selected mixture to the [28] [90]-day flexural strength of the mixture (for acceptance).

i. If there is a change in materials, perform additional mixture design studies using the new materials and determine new Correlation Ratios.

j. No concrete pavement placement is allowed until the mixture proportions are approved. The approved water-cementitious materials ratio is restricted to the minimum and maximum values specified in paragraph Water-Cementitious Materials Ratio and is not to be increased without written approval.

a. Fabricate all beams and cylinders for each mixture from the same batch or blend of batches. Fabricate and cure all beams and cylinders in accordance with ASTM C192/C192M, using 152 x 152 mm 6 x 6 inches steel beam molds and 152 x 305 mm 6 x 12 inches single-use cylinder molds.

b. Cure test beams from each mixture for 3, 7, 14, [and 28] [56 and 90]-day flexural tests; 6 beams to be tested per age.

c. Cure test cylinders from each mixture for 3, 7, 14, [and 28] [56 and 90]-day compressive strength tests; 6 cylinders to be tested per age.

d. Test beams in accordance with ASTM C78/C78M, cylinders in accordance with ASTM C39/C39M.

e. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:
    3-day flexural strength

7-day flexural strength
14-day flexural strength
[28-day flexural strength]
[56 and 90-day flexural strength]

3-day compressive strength
7-day compressive strength
14-day compressive strength
[28-day compressive strength]
[56 and 90-day compressive strength]

f. From these graphs select a w/c that produces a mixture giving a [28] [56] [90]-day flexural strength equal to the required strength determined in accordance with paragraph Average CQC Flexural Strength Required for Mixtures.

g. Using the above selected w/c, select from the graphs the expected 3, 7, 14, [28] [56] [90]-day flexural strengths and the expected 3, 7, 14, [28] [56] [90]-day compressive strengths for the mixture.

h. From the above expected strengths for the selected mixture determine the following Correlation Ratios:

    (1) Ratio of the 14-day compressive strength of the selected mixture to the [28][90]-day flexural strength of the mixture (for acceptance).

    (2) Ratio of the 7-day compressive strength of the selected mixture to the [28][90]-day flexural strength of the mixture (for CQC control).

i. If there is a change in materials, perform additional mixture design studies using the new materials and new Correlation Ratios determined.

j. No concrete pavement placement is allowed until the mixture proportions are approved. The approved water-cementitious materials ratio is restricted to the minimum and maximum values specified in paragraph Water-Cementitious Materials Ratio and is not to be increased without written approval.

2.13.3 Average CQC Flexural Strength Required for Mixtures

a. In order to meet the strength requirements specified in paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES during production, the mixture proportions selected during mixture proportioning studies and used during construction require an average CQC flexural strength, Ra, exceeding the specified flexural strength, R, by the amount indicated below.

b. The required average CQC flexural strength, Ra, is used only for proportioning studies and CQC operations as specified in paragraph Concrete Strength Testing for CQC.

c. Acceptance of production flexural strength results is based on the specified flexural strength R specified in paragraph: Specified Flexural Strength.

2.13.3.1 From Previous Test Records

Where a concrete production facility has previous test records current to within 18 months, establish a standard deviation in accordance with the applicable provisions of ACI 214R. Include test records from which a standard deviation is calculated that represent materials, quality control procedures, and conditions similar to those expected, that represent concrete produced to meet a specified flexural strength or strengths within 1 MPa 150 psi of the [28] [90]-day flexural strength specified for the proposed work, and that consist of at least 30 consecutive tests. Perform verification testing to document the current strength. A strength test is the average of the strengths of two specimens made from the same sample of concrete and tested at [28] [90] days. Required average CQC flexural strength, Ra, used as the basis for selection of concrete proportions is the value from the equation that follows, using the standard deviation as determined above:

$$Ra = R + 1.34S$$

Where: S = standard deviation
R = specified flexural strength
Ra = required average CQC flexural strength

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, establish a standard deviation as the product of the calculated standard deviation and a modification factor from Table 13:

TABLE 14	
MODIFICATION FACTOR FOR STANDARD DEVIATION	
NUMBER OF TESTS	MODIFICATION FACTOR
20	1.08
25	1.03
30 or more	1.00

2.13.3.2 Without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, determine the required average CQC flexural strength, Ra, by adding 15 percent to the specified flexural strength, R.

PART 3 EXECUTION

3.1 PREPARATION FOR PAVING

Before commencing paving, perform the following actions to prepare for paving operations. If used, place cleaned, coated, and adequately supported forms. Have any reinforcing steel needed at the paving site; all transporting and transfer equipment ready for use, clean, and free of hardened concrete and foreign material; equipment for spreading, consolidating, screeding, finishing, and texturing concrete at the paving site, clean and in proper working order; and all equipment and material for curing and for protecting concrete from weather or mechanical damage at the paving site, in proper working condition, and in sufficient amount for the entire placement.

3.1.1 Weather Precaution

When windy conditions during paving appear probable, have equipment and material at the paving site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete. During these conditions, record and report the evaporation rate hourly.

3.1.2 Proposed Techniques

****

NOTE: Include joint layout and typical detail of joint/dowel bar spacing in drawings and coordinate with paragraph PLACING DOWELS AND TIE BARS. Insert office title for approval of joint plan changes.

****

Submit placing and protection methods; paving sequence; jointing pattern; data on curing equipment and profilographs; repair in accordance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS, demolition of existing pavements, as specified; pavement diamond grinding equipment and procedures. Submit for approval the following items:

a. Pavement demolition work plan, presenting the proposed methods and equipment to remove existing pavement and protect pavement to remain in place.

b. A description of the placing and protection methods proposed when concrete is to be placed in or exposed to hot, cold, or inclement weather conditions

c. A detailed paving sequence plan and proposed paving pattern showing all planned construction joints; transverse and longitudinal dowel bar spacing; and identifying pilot lanes, fill-in lanes, and hand placement areas. Include stationing for reference to all sampling and testing performed. Deviations from the jointing pattern shown on the drawings are not allowed without written approval of the [design engineer] [_____].

d. Plan and equipment proposed to control alignment of sawn joints within the specified tolerances.

e. Data on the curing equipment, media and methods to be used.

f. Data on profilograph and methods to measure pavement smoothness.

g. A description of the equipment and methods to be used for grinding and repairs.

3.2 CONDITIONING OF UNDERLYING MATERIAL

3.2.1 General Procedures

Confirm the underlying material upon which concrete is to be placed is clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. Prior to setting forms or placement of concrete, confirm the underlying material is well drained and has been satisfactorily graded and uniformly compacted in accordance with the applicable contract documents. Test the surface of the underlying material to crown, elevation, and density in advance of setting forms or of concrete placement using slip-form techniques. Trim high areas to proper elevation. Fill and compact low areas to a condition similar to that of surrounding grade, or fill with concrete monolithically with the pavement. Low areas filled with concrete are not to be cored for thickness to avoid biasing the average thickness used for evaluation and payment adjustment. Rework and compact any underlying material disturbed by construction operations to specified density immediately in front of the paver. If a slipform paver is used, continue the same underlying material beyond the edge of the lane a sufficient distance to provide a suitable trackline for the slipform paver and firm support for the edge of the paving lane.

3.2.2 Traffic on Underlying Material

****

NOTE: Do not allow transporting equipment to operate on the prepared underlying material for airfield paving. Operating hauling equipment in the paving lane can cause the paver to stop frequently, producing a discontinuity in the pavement surface. Edit bracketed items as appropriate and coordinate with paragraph TRANSFER AND SPREADING EQUIPMENT. The second bracketed item is only intended for use on roads and other areas where site limitations require consideration of this approach.

****

After the underlying material has been prepared for concrete placement, equipment is not permitted thereon with exception of the paver. Subject to specific approval, crossing of the prepared underlying material at specified intervals for construction purposes may be permitted, provided rutting or indentations do not occur. Rework and repair the surface before concrete is placed. [Transporting equipment is not to be allowed to operate on the prepared and compacted underlying material in front of the paver-finisher.] [Equipment may be allowed to operate on the underlying material only if approved and only if no damage is done to the underlying material and its degree of compaction. Correct any disturbance to the underlying material that occurs, as approved, before the paver-finisher or the deposited concrete reaches the location of the disturbance and replace the equipment or change procedures to prevent any future damage.]

3.3 WEATHER LIMITATIONS

3.3.1 Placement and Protection During Inclement Weather

Do not commence placing operations when heavy rain or other damaging weather conditions appear imminent. At all times when placing concrete, maintain on-site sufficient waterproof cover and means to rapidly place it over all unhardened concrete or concrete that might be damaged by rain. Immediately cover and protect all unhardened concrete from rain or other damaging weather. Suspend placement of concrete whenever rain, high winds, or other weather commences to damage the surface or texture of the placed unhardened concrete, washes cement out of the concrete, or changes the water content of the surface concrete.

Remove and replace any slab damaged by rain or other weather, as defined in paragraph Weak Surfaces, full depth, by full slab width, to the nearest original joint as specified in paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS, at no expense to the Government.

3.3.2 Paving in Hot Weather

****

NOTE: See ACI 305R for additional information concerning hot weather concreting. Do not delete this paragraph or the next paragraphs dealing with weather.

****

Prepare for hot weather paving in accordance with ACI 305R. When the ambient temperature during paving is expected to exceed 32 degrees C 90 degrees F, properly place and finish the concrete in accordance with procedures previously submitted, approved, and as specified herein. Provide concrete that does not exceed the temperature shown in Table 14 below when measured in accordance with ASTM C1064/C1064M at the time of delivery. Cool the mixing water or aggregates or place in the cooler part of the day to obtain an adequate placing temperature. Cool steel forms and reinforcing as needed to maintain steel temperatures below 49 degrees C 120 degrees F. Cool or protect transporting and placing equipment if necessary to maintain proper concrete placing temperature. Keep the finished surfaces of the newly laid pavement damp by applying a fog spray (mist) with approved spraying equipment until the pavement is covered by the curing medium.

TABLE 15

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature in Degrees C F
Greater than 60	3290
55-60	2985
Less than 55	2475

3.3.3 Prevention of Plastic Shrinkage Cracking

During weather with low humidity, and particularly with high temperature and appreciable wind, develop and institute measures to prevent plastic shrinkage cracks from developing. If plastic shrinkage cracking occurs, halt further placement of concrete until protective measures are in place to prevent further cracking. Periods of high potential for plastic shrinkage cracking can be anticipated by use of ACI 305R. In addition to the protective measures specified in the previous paragraph, further protect the concrete placement by erecting shades and windbreaks and by applying fog sprays of water, the addition of monomolecular films, or wet covering. If monomolecular films are used, apply only after finishing is complete, do not use in the finishing process, and follow manufacturer recommendations. Immediately commence curing procedures when such water treatment is stopped. Repair plastic shrinkage cracks in accordance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS.

Never trowel over or fill plastic shrinkage cracks with slurry.

3.3.4 Paving in Cold Weather

Cold weather paving is required to conform to ACI 306R. Use special protection measures, as specified herein, if freezing temperatures are anticipated or occur before the expiration of the specified curing period. Do not begin placement of concrete unless the ambient temperature is at least 2 degrees C 35 degrees F and rising. Thereafter, halt placement of concrete whenever the ambient temperature drops below 5 degrees C 40 degrees F. When the ambient temperature is less than 10 degrees C 50 degrees F, the temperature of the concrete when placed is required to be not less than 10 degrees C 50 degrees F nor more than 25 degrees C 75 degrees F. Provide heating of the mixing water or aggregates as required to regulate the plastic concrete temperature. Provide materials entering the mixer that are free from ice, snow, or frozen lumps. Do not incorporate salt, chemicals or other materials in the concrete to prevent freezing. [If allowed under paragraph MIXTURE PROPORTIONS in PART 2, use an accelerating admixture when the ambient temperature is below 10 degrees C 50 degrees F.] Provide covering and other means for maintaining the concrete at a temperature of at least 10 degrees C 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period as defined in paragraph Protection of Concrete. Remove pavement slabs, full depth by full width, damaged by freezing or falling below freezing temperature to the nearest planned joint, and replace as specified in paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS, at no expense to the Government.

3.4 CONCRETE PRODUCTION

****

NOTE: Coordinate these paragraphs with paragraph EQUIPMENT. Delete item in brackets if truck mixers are not permitted.

****

Maintain a continuous, uniform forward movement of the paver of not less than 0.8 m 2.5 feet per minute. Provide batching, mixing, and transporting equipment with a capacity sufficient to meet this production rate. Deposit concrete transported in non-agitating equipment in front of the paver within 45 minutes from the time cement has been charged into the mixing drum, except that if the ambient temperature is above 32 degrees C 90 degrees F, the time is reduced to 30 minutes. Deposit concrete transported in truck mixers in front of the paver within 90 minutes from the time cement has been charged into the mixer drum of the plant or truck mixer. Truck mixers are not allowed for mixing or transporting slipformed paving concrete. If the ambient temperature is above 32 degrees C 90 degrees F, the time is reduced to 60 minutes. Accompany every load of concrete delivered to the paving site with a batch ticket from the operator of the batching plant. Provide batch ticket information required by ASTM C94/C94M on approved forms. In addition provide design quantities in mass or volume for all materials, batching tolerances of all materials, mixture batching time, and design and actual water cementitious materials ratio on each batch delivered, [the water meter and revolution meter reading on truck mixers]and the time of day on all batch tickets. Provide batch tickets for each truck delivered as part of the lot acceptance package to the placing foreman to maintain on file and deliver them to the Government weekly.

3.4.1 Batching and Mixing Concrete

Remove any equipment which fails to perform as specified immediately from use until properly repaired and adjusted or replaced.

3.4.2 Transporting and Transfer - Spreading Operations

Operate non-agitating equipment only on smooth roads and for haul time less than 30 minutes. Deposit concrete as close as possible to its final position in the paving lane[using a transfer-spreader]. Operate all equipment to discharge and transfer concrete without segregation. Dumping of concrete in discrete piles is not permitted. No transfer or spreading operation which requires the use of front-end loaders, dozers, or similar equipment to distribute the concrete is permitted. No equipment is permitted to operate on the grade in front of the paver.

3.5 PAVING

****

NOTE: Coordinate these paragraphs with paragraph EQUIPMENT.

****

3.5.1 General Requirements

Construct pavement with paving and finishing equipment utilizing rigid fixed forms or by use of slipform paving equipment. Provide paving and finishing equipment and procedures resulting in paving lanes of the required width at a rate of at least 0.8 m 2.5 feet of paving lane per minute on a routine basis. Control paving equipment and its operation, and coordinate with all other operations, such that the paver-finisher has a continuous forward movement at a reasonably uniform speed from beginning to end of each paving lane, except for inadvertent equipment breakdown. Backing the paver and refinishing a lane is not permitted. Remove and replace concrete refinished in this manner. Failure to achieve a continuous forward motion requires halting operations, and modifying procedures, equipment, or mix proportions to achieve this requirement. Personnel are not permitted to walk or operate in the plastic concrete at any time. Select paving equipment and procedures which operate properly on the underlying material without causing displacement or other damage.

3.5.2 Consolidation

Consolidate concrete with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. Insert vibrators into the concrete to a depth that provides the best full-depth consolidation but not closer to the underlying material than 50 mm 2 inches. Excessive vibration is not permitted. If vibrators cause visible tracking in the paving lane, discontinue paving operations until equipment and operations have been modified to prevent it. Consolidate concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment with an approved hand-operated immersion vibrator operated from a bridge spanning the area. Do not use vibrators to transport or spread the concrete. Do not operate hand-operated vibrators in the concrete at one location for more than 20 seconds. Insert hand-operated vibrators between 150 to 400 mm 6 to 15 inches on centers. For each paving train, provide at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) requires the immediate stopping of the paving operation and approved adjustment of the equipment or procedures.

3.5.3 Operation

When the paver approaches a header at the end of a paving lane, maintain a sufficient amount of concrete ahead of the paver to provide a roll of concrete which spills over the header. Provide a sufficient amount of extra concrete to prevent any grout that is formed and carried along ahead of the paver from being deposited adjacent to the header. Maintain the spud vibrators in front of the paver at the desired depth as close to the header as possible before they are lifted. Provide additional consolidation adjacent to the headers by hand-manipulated vibrators. When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provide provisions to prevent damage to the adjacent pavement. Electronically control screeds or extrusion plates so as to prevent them from applying pressure to the existing pavement and to prevent abrasion of the pavement surface. Maintain the overlapping area of existing pavement surface completely free of any loose or bonded foreign material as the paver-finisher operates across it. Pavers using transversely oscillating screeds are not allowed to form fill-in lanes that have widths less than a full width for which the paver was designed or adjusted.

3.5.4 Required Results

Adjust and coordinate the paver-finisher, its gang-mounted vibrators, and operating procedures with the concrete mixture being used, to produce a thoroughly consolidated slab throughout that is true to line and grade within specified tolerances. Provide a paver-finishing operation that produces a surface finish with a minimum, isolated amount of irregularities, tears, voids of any kind, and any other discontinuities in a single pass across the pavement; multiple passes are not permitted. Provide equipment and its operation that produce a finished surface requiring no hand finishing other than the use of cutting straightedges, except in very infrequent instances. Stop paving if any equipment or operation fails to produce the above results. Prior to recommencing paving, properly adjust or replace the equipment, modify the operation, or modify the mixture proportions, in order to produce the required results. No water, other than fog sprays (mist) as specified in paragraph Prevention Of Plastic Shrinkage Cracking above, is allowed to be applied to the concrete or the concrete surface during paving and finishing.

3.5.5 Fixed Form Paving

****

NOTE: Include fixed-form paving as an option or mandatory item as appropriate. Edit bracketed items in subparagraph a. Keys are only permitted for roads and streets with a thickness of 230 mm 9 inches or greater. Do not permit keys for airfield pavements.

****

Provide paving equipment for fixed-form paving and operation that conforms to the requirements of paragraph EQUIPMENT, and all requirements specified herein.

3.5.5.1 Forms for Fixed-Form Paving

****

NOTE: Delete subparagraph e. when overlay pavements are not required.

****

a. Provide straight forms made of steel and in sections not less than 3 m 10 feet in length that are clean and free of rust or other contaminants. Seal any holes or perforations in forms prior to paving unless otherwise permitted. Maintain forms in place and passable by all equipment necessary to complete the entire paving operation without need to remove horizontal form supports. Provide flexible or curved forms of proper radius for curves of 31 m 100-foot radius or less. Provide wood forms for curves and fillets made of well-seasoned, surfaced plank or plywood, straight, and free from warp or bend that have adequate strength and are rigidly braced. Provide forms with a depth equal to the pavement thickness at the edge. Where the project requires several different slab thicknesses, build up forms by bolting or welding a tubular metal section or by bolting wood planks to the bottom of the form to completely cover the underside of the base of the form and provide an increase in depth of not more than 25 percent. Provide forms with the base width of the one-piece or built-up form not less than eight-tenths of the vertical height of the form, except provide forms 200 mm 8 inches or less in vertical height with a base width not less than the vertical height of the form. Provide forms with maximum vertical deviation of top of any side form, including joints, not varying from a true plane more than 3 mm 1/8 inch in 3 m 10 feet, and the upstanding leg not varying more than 6 mm 1/4 inch. [Where keyway forms are required, rigidly attach the keyway form to the main form so no displacement can take place. Tack-weld metal keyway forms to steel forms. Align keyway forms so that there is no variation over 6 mm 1/4 inch either vertically or horizontally, when tested with a 4 m 12 foot template after forms are set, including tests across form joints.]

b. Provide form sections that are tightly locked and free from play or movement in any direction. Provide forms with adequate devices for secure settings so that when in place they withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment.

c. Set forms for full bearing on foundation for entire length and width and in alignment with edge of finished pavement. Support forms during entire operation of placing, consolidation, and finishing so that forms do not deviate vertically more than 3 mm 0.01 foot from required grade and elevations indicated. Check conformity to the alignment and grade elevations shown on the drawings and make necessary corrections immediately prior to placing the concrete. Clean and oil the forms each time before concrete is placed. Concrete placement is not allowed until setting of forms has been checked and approved by the CQC team.

d. Do not anchor guide rails for fixed form pavers into new concrete or existing concrete to remain.

[e. Use stakes or other approved methods to securely hold forms for overlay pavements and for other locations where forms are set on existing pavements. Carefully drill holes in existing pavements for form stakes by methods which do not crack or spall the existing pavement. After use, fill the holes flush with the surrounding surface using approved material, prior to overlying materials being placed. Immediately discontinue any method which does not hold the form securely or which damages the existing pavement. Prior to setting forms for paving operations, demonstrate the proposed form setting procedures at an approved location without proceeding further until the proposed method is approved.]

3.5.5.2 Form Removal

Keep forms in place at least 12 hours after the concrete has been placed. When conditions are such that the early strength gain of the concrete is delayed, leave the forms in place for a longer time. Remove forms by procedures that do not damage the concrete. Do not use bars or heavy metal tools directly against the concrete in removing the forms. Promptly repair any concrete found to be defective after form removal, using procedures specified or as directed.

3.5.6 Slipform Paving

****

NOTE: Retain slipform paving as an option unless there are specific, valid reasons for deleting it. Be sure all other paragraphs correspond with choice made here.

****

3.5.6.1 General

Provide paving equipment for slipform paving and the operation thereof that conforms to the requirement of paragraph EQUIPMENT, and all requirements specified herein. Provide a slipform paver capable of shaping the concrete in one pass to the specified and indicated cross section, meeting all tolerances, with a surface finish and edges that require only a very minimum isolated amount of hand finishing. If the paving operation does not meet the above requirements and the specified tolerances, immediately stop the operation and modify any equipment, paving procedures, or the concrete mix in order to resolve the problem. Provide a slipform paver that is automatically electronically controlled from a taut guideline for horizontal alignment and on both sides from a taut guideline for vertical alignment, except that electronic control from a ski operating on a previously constructed adjoining lane is required where applicable for either or both sides. Automatic, electronic controls are required for vertical alignment on both sides of the lane. Control from a slope-adjustment control or control operating from the underlying material is not allowed. Properly adjust side forms on slipform pavers so that the finished edge of the paving lane meets all specified tolerances. Install dowels in longitudinal construction joints as specified below. The installation of these dowels by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete is not permitted. [If a keyway is required, install a 0.45 to 0.55 mm 26 gauge thick metal keyway liner as the keyway is extruded. Provide keyway forms that do not vary more than plus or minus 3 mm 1/8 inch from the dimensions indicated and do not deviate more than plus or minus 6 mm 1/4 inch from the mid-depth of the pavement. An abrupt offset either horizontally or vertically in the completed keyway is not allowed. Maintain the keyway liner to remain in place and become part of the joint.]

3.5.6.2 Guideline for Slipform Paving

Accurately and securely install guidelines well in advance of concrete placement. Provide supports at necessary intervals to eliminate all sag in the guideline when properly tightened. Provide guideline consisting of high strength material designed for use as a paving guideline with sufficient tension to remove all sag between supports. Provide supports that are securely staked to the underlying material or make other provisions to keep the supports from displacing when the guideline is tightened or when the guideline or supports are accidentally touched by workmen or equipment during construction. Provide appliances for attaching the guideline to the supports that are capable of easy adjustment in both the horizontal and vertical directions. When it is necessary to leave gaps in the guideline to permit equipment to use or cross underlying material, provide provisions for quickly and accurately replacing the guideline without any delay to the forward progress of the paver. Provide supports on either side of the gap that are secured in such a manner as to avoid disturbing the remainder of the guideline when the portion across the gap is positioned and tightened. Check the guideline across the gap and adjacent to the gap for a distance of 60 m 200 feet for horizontal and vertical alignment after the guideline across the gap is tightened. Provide vertical and horizontal positioning of the guideline such that the finished pavement conforms to the alignment and grade elevations shown on the drawings within the specified tolerances for grade and smoothness. The specified tolerances are intended to cover only the normal deviations in the finished pavement that occur under good supervision and do not apply to setting of the guideline. Set the guideline true to line and grade.

3.5.6.3 Stringless Technology

If the use of any type of stringless technology is proposed, submit a detailed description of the system and perform a trial field demonstration at least one week prior to start of paving. Approval of the control system will be based on the results of the demonstration and on continuing satisfactory operation during paving.

3.5.7 Placing Reinforcing Steel

****

NOTE: Delete bracketed item if CRCP is not being constructed.

****

Provide the type and amount of steel reinforcement indicated. Regardless of placement procedure, provide reinforcing steel free from coatings which could impair bond between the steel and concrete, with reinforcement laps as indicated. Regardless of the equipment or procedures used for installing reinforcement, adequately consolidate the entire depth of concrete. Install steel reinforcement at the required elevation within a tolerance of plus of minus 13 mm1/2 inch. [If reinforcing for Continuously Reinforced Concrete Pavement (CRCP) is required, submit the entire operating procedure and equipment proposed for approval at least 30 days prior to proposed start of paving.]

3.5.7.1 Pavement Thickness Greater Than 300 mm 12 inches

For pavement thickness of 300 mm 12 inches or more, place an initial lift of concrete on the underlying material to the required elevation of the steel reinforcement, consolidate the initial lift of concrete, place the steel reinforcement upon the surface of the initial lift, place a second lift of concrete to final grade, consolidate, and finish in the required manner. When placement of the second lift causes the steel reinforcement to be displaced horizontally from its original position, provide provisions for increasing the thickness of the initial lift and depressing the steel reinforcement into the unhardened concrete to the required elevation. Limit the increase in thickness only as necessary to permit correct horizontal alignment to be maintained. Remove and replace any portions of the initial lift of concrete that have been placed more than 30 minutes without being covered with the second lift with newly mixed concrete without additional cost to the Government.

3.5.7.2 Pavement Thickness Less Than 300 mm 12 Inches

For pavements less than 300 mm 12 inches thick, position the reinforcement on suitable chairs or continuous mesh support devices securely fastened to the subgrade prior to concrete placement. Consolidate concrete after the steel has been placed.

3.5.8 Placing Dowels[and Tie Bars]

****

NOTE: Delete references to installation in contraction joints if not required. Tie bars are not permitted in airfield pavements. Use tie bars only for roads and streets projects.

****

Provide a method to install and hold dowels in position that meets the tolerances for location, alignment, and spacing of Table 15. Do not place longitudinal dowels [and tie bars]closer than 0.6 times the dowel bar [tie bar]length to the planned joint line. If the last regularly spaced longitudinal dowel [tie bar]is closer than that dimension, move it away from the joint to a location 0.6 times the dowel bar [tie bar]length, but not closer than 150 mm 6 inches to its nearest neighbor. Resolve dowel [tie bar] interference at a transverse joint-longitudinal joint intersection by deleting the closest transverse dowel [tie bar]. Do not position the end of a transverse dowel closer than 300 mm 12 inches from the end of the nearest longitudinal dowel. Install dowels as specified in the following subparagraphs.

TABLE 16

DOWEL ALIGNMENT TOLERANCES

Dowel Measurement	Tolerance
Horizontal alignment (a)	Maximum of 3 mm per 300 mm 1/8 inch per foot after the pavement has been completed
Vertical alignment (b)	Maximum of 3 mm per 300 mm 1/8 inch per foot after the pavement has been completed
Horizontal spacing	plus or minus 15 mm 5/8 inch, except as otherwise specified above

TABLE 16	
DOWEL ALIGNMENT TOLERANCES	
Dowel Measurement	Tolerance
Vertical location on the face of the slab	plus or minus 13 mm 1/2 inch
(a) Check horizontal alignment perpendicular to the joint edge with a framing square.	
(b) Measure the vertical alignment of the dowels parallel to the designated top surface of the pavement, except for those across the crown or other grade change joints. Measure dowels across crowns and other joints at grade changes to a level surface.	

3.5.8.1 Contraction Joints

Securely hold dowels [and tie bars]in longitudinal and transverse contraction joints within the paving lane in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. Securely hold the basket assemblies in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires.

3.5.8.2 Construction Joints-Fixed Form Paving

Install dowels [and tie bars]by the bonded-in-place method or the drill-and-dowel method. Installation by removing and replacing in preformed holes is not permitted. Prepare and place dowels [and tie bars] across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. Provide the spacing of dowels [and tie bars] in construction joints as indicated, except that, where the planned spacing cannot be maintained because of form length or interference with form braces, provide closer spacing with additional dowels [or tie bars].

3.5.8.3 Dowels Installed in Hardened Concrete

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NOTE: The first Tailoring Option is for "Cylinders/Beams" and the second option is for "Beams".

****

Install dowels in hardened concrete by bonding the dowels into holes drilled into the hardened concrete. Before drilling commences, cure the concrete for 7 days or until it has reached a minimum field cured compressive strength of 17 MPa 2500 psi flexural strength of 3.1 MPa 450 psi. Drill holes 3 mm 1/8 inch greater in diameter than the dowels into the hardened concrete using rotary-core drills. Rotary-percussion drills are permitted, provided that excessive spalling does not occur at the concrete joint face. Excessive spalling is defined as spalling deeper than 6 mm 1/4 inch from the joint face or 12 mm 1/2 inch radially from the outside of the drilled hole. Continuing damage requires modification of the equipment and operation. Drill depth of dowel hole within a tolerance of plus or minus

13 mm 1/2 inch of the half length of the embedded dowel. Upon completion of the drilling operation, blow out the dowel hole with oil-free, compressed air. Bond dowels in the drilled holes using epoxy resin. Inject epoxy resin at the back of the hole before installing the dowel and extrude to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel is not permitted. Hold the dowels in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic grout retention ring fitted around the dowel. Provide dowels required between new and existing concrete in holes drilled in the existing concrete, all as specified above. Where tie bars are required in longitudinal construction joints of slipform pavement, install bent tie bars at the paver, in front of the transverse screed or extrusion plate. Do not install tie bars in preformed holes. Construct a standard keyway, with the bent tie bars inserted into the plastic concrete through a 0.45 to 0.55 mm 26 gauge thick metal keyway liner. Protect and maintain the keyway liner to remain in place and become part of the joint. When bending tie bars, provide the radius of bend not greater than the minimum recommended for the particular grade of steel in the appropriate material standard. Before placement of the adjoining paving lane, straighten the tie bars using procedures which do not spall the concrete around the bar.

3.5.8.4 Lubricating Dowel Bars

Wipe clean the portion of each dowel intended to move within the concrete and coat with a thin, even film of lubricating oil or light grease before the concrete is placed. Form oil is not acceptable.

3.6 FINISHING

****

NOTE: Edit bracketed items as appropriate. Retain slipform paving subparagraph except when it is prohibited elsewhere. Delete Other Types of Finishing Equipment here and in PART 2, if not wanted. Hand finishing is allowed only for isolated, small, odd-shaped slabs or places inaccessible to the paver.

****

Provide finishing operations as a continuing part of placing operations starting immediately behind the paver. Provide finishing by the machine method. Hand finishing requirements are specifed in paragraph HAND FINISHING. Provide the sequence of operations consisting of transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Provide a work bridge as necessary for consolidation and hand finishing operations. Use the hand method only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Keep supplemental hand finishing for machine finished pavement to an absolute minimum. Immediately stop any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing. Prior to recommencing machine finishing, properly adjust or replace the equipment. Immediately halt any operations which produce more than 3 mm 1/8 inch of mortar-rich surface (defined in paragraph Weak Surfaces) and modify the equipment, mixture, or procedures as necessary. Compensate for surging behind the screeds or extrusion plate and settlement during hardening and adjust the paving and finishing machines so that the finished surface of the concrete (not just the cutting edges of the screeds) is at the required line and grade. Maintain finishing equipment and tools clean and in an approved condition. Water is not allowed to be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

3.6.1 Machine Finishing With Fixed Forms

Replace machines that cause displacement of the forms. Only one pass of the fixed form finishing machine is allowed over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, immediately stop the operation and adjust the equipment, mixture, and procedures as necessary.

3.6.2 Machine Finishing with Slipform Pavers

Operate the slipform paver so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Immediately modify or replace any equipment or procedure that fails to meet these specified requirements as necessary. A non-rotating pipe float can be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float is allowed. If there is concrete slurry or fluid paste on the surface that runs over the edge of the pavement, immediately stop the paving operation and modify the equipment, mixture, or operation to prevent formation of such slurry. Immediately remove any slurry which runs down the vertical edges by hand, using stiff brushes or scrapers. Slurry, concrete or concrete mortar is not allowed to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

3.6.3 Surface Correction and Testing

After all other finishing is completed but while the concrete is still plastic, eliminate minor irregularities and score marks in the pavement surface by means of cutting straightedges. Provide cutting straightedges with a minimum length of 4 m 12 feet that are operated from the sides of the pavement or from bridges. Provide cutting straightedges operated from the side of the pavement equipped with a handle 1 m 3 feet longer than one-half the width of the pavement. Test the surface for trueness with a straightedge held in successive positions parallel and at right angles to the center line of the pavement, and cover the whole area to detect variations. Advance the straightedge along the pavement in successive stages of not more than one-half the length of the straightedge. Immediately fill depressions with freshly mixed concrete, strike off, consolidate with an internal vibrator, and refinish. Strike off projections above the required elevation and refinish. Continue the straightedge testing and finishing until the entire surface of the concrete is free from observable departure from the straightedge and conforms to the surface requirements specified in paragraph SURFACE SMOOTHNESS. This straightedging is not allowed to be used as a replacement for the straightedge testing of paragraph SURFACE SMOOTHNESS. Use long-handled, flat bull floats very sparingly and only as necessary to correct minor, scattered surface defects. If frequent use of bull floats is necessary, stop the paving operation and adjust the equipment, mixture or procedures to eliminate the surface defects. Keep finishing with hand floats and trowels to the absolute minimum necessary. Take extreme care to prevent overfinishing joints and edges. Produce the surface finish of the pavement essentially by the finishing machine and not by subsequent hand finishing operations. All hand finishing operations are subject to approval.

3.6.4 Hand Finishing

Use hand finishing operations only as specified below. Provide a work bridge to be used as necessary for consolidation and placement operations to avoid standing in concrete.

3.6.4.1 Equipment and Template

In addition to approved mechanical internal vibrators for consolidating the concrete, provide a strike-off and tamping template and a longitudinal float for hand finishing. Provide a template at least 300 mm 1 foot longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, that is constructed of metal or other suitable material shod with metal. Provide a longitudinal float at least 3 m 10 feet long, of approved design, that is rigid and substantially braced to maintain a plane surface on the bottom. Grate tampers (jitterbugs) are not allowed.

3.6.4.2 Finishing and Floating

As soon as the plastic concrete is placed and consolidated, strike off the concrete and screed to the cross section and to such elevation above grade that when consolidated and finished, the surface of the pavement is at the required elevation. Immediately following the final tamping of the surface, float the pavement longitudinally from bridges resting on the side forms and spanning but not touching the concrete. Do not advance the floating operation more than half the length of the float and continue over the new and previously floated surfaces.

3.6.5 Texturing

****

NOTE: Select type of texturing desired, retain that subparagraph, and delete the others. Determine the type of texturing, if any, desired by the using service. If no guidance is given, the usual default method is a burlap drag.

For Army airfield paving projects, specify a burlap drag texture.

For Air Force airfield paving projects, do not specify artificial turf, wire comb, or surface grooving textures.

For Navy airfield paving projects, do not specify wire comb or surface grooving textures.

Use Section 32 01 18.71 GROOVING OF AIRFIELD PAVING to specify saw-cut grooves.

Spring tine grooving is limited to use on roads and streets only.

****

Before the surface sheen has disappeared and before the concrete hardens or curing compound is applied, texture the surface of the pavement as described herein. After the curing period is complete, thoroughly power broom all textured surfaces to remove all debris.

3.6.5.1 Burlap Drag Surface

Apply surface texture by dragging the surface of the pavement, in the direction of the concrete placement, with an approved burlap drag. Operate the drag with the fabric moist, and maintain the fabric clean. Change as required to keep clean. Perform the dragging so as to produce a uniform finished surface having a fine sandy texture without disfiguring marks.

3.6.5.2 Broom Texturing

Complete brooming before the concrete has hardened to the point where the surface is unduly torn or roughened, but after hardening has progressed enough so that the mortar does not flow and reduce the sharpness of the scores. Overlap successive passes of the broom the minimum necessary to obtain a uniformly textured surface. Wash brooms thoroughly at frequent intervals during use. Remove worn or damaged brooms from the job site. Hand brooming is permitted only on isolated odd shaped slabs or slabs where hand finishing is permitted. For hand brooming, provide brooms with handles longer than half the width of slab to be finished. Transversely draw the hand brooms across the surface from the center line to each edge with slight overlapping strokes.

3.6.5.3 Artificial Turf Drag Surface

[Apply artificial turf texture by dragging the surface of the pavement in the direction of concrete placement with an approved, full-width, artificial turf drag.]

3.6.5.4 Wire-Comb Texturing

[Apply surface texture using an approved mechanical wire comb drag operated to comb the surface transverse to the pavement centerline. Provide a comb capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Overlap successive passes of the comb the minimum necessary to obtain a continuous and uniformly textured surface. Complete texturing before the concrete has hardened to the point where the surface and edges are unduly torn, but after hardening has progressed to the point where the serrations do not close up. Provide serrations 2 to 5 mm 1/16 to 3/16 inch deep, 1.5 to 3 mm 1/16 to 1/8 inch wide, and spaced 9.5 mm 3/8 inch apart. Produce transverse texturing grooves in straight lines across each lane within a tolerance of plus or minus 13 mm 1/2 inch of a true line.]

3.6.5.5 Surface Grooving

[Groove the areas indicated on the drawings as required in 32 01 18.71 GROOVING OF AIRFIELD PAVEMENTS.][Groove the areas indicated on the drawings with a spring tine drag producing individual grooves 6 mm 1/4 inch deep and 6 mm 1/4 inch wide at a spacing between groove centerlines of 37 mm 1-1/2 inches. Cut grooves perpendicular to the centerline. Before grooving begins, allow the concrete to attain sufficient strength to prevent aggregate spalling. Do not cut grooves within 150 mm 6 inches of a runway centerline, transverse joint, or crack; or through neoprene compression seals. Produce transverse texturing grooves in straight lines across each lane within a tolerance of plus or minus 13 mm 1/2 inch of a true line.]

3.6.6 Edging

Before texturing has been completed, carefully finish the edge of the slabs along the forms, along the edges of slipformed lanes, and at the joints with an edging tool to form a smooth rounded surface of 3 mm 1/8 inch radius. Eliminate tool marks, and provide edges that are smooth and true to line. Water is not allowed to be added to the surface during edging. Take extreme care to prevent overworking the concrete.

3.6.7 Pavement Penetrations

Construct recesses for the tie-down anchors, lighting fixtures, and other outlets in the pavement to conform to the details and dimensions shown. Carefully finish the concrete in these areas to provide a surface of the same texture as the surrounding area that is within the requirements for plan grade and surface smoothness.

3.7 CURING

****

NOTE: Retain bracketed item at end of first paragraph mandating 24 hour moist cure only where locally required and only where approved in writing by the using service. Include membrane curing as a choice of curing methods.

****

3.7.1 Protection of Concrete

Continuously protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. Have all equipment needed for adequate curing and protection of the concrete on hand and ready for use before actual concrete placement begins. If any selected method of curing does not afford the proper curing and protection against concrete cracking, remove or replace the damaged pavement, and provide another method of curing as directed. Accomplish curing by one of the following methods [except use only moist curing for the first 24 hours].

3.7.2 Membrane Curing

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NOTE: Retain the first set of bracketed sentences for Army and Air Force jobs; retain the the second set of bracketed sentences for Navy projects only.

****

Apply a uniform coating of white-pigmented, membrane-forming, curing compound to the entire exposed surface of the concrete as soon as the free water has disappeared from the surface after [finishing] [moist curing ceases]. Apply immediately along the formed edge faces after the forms are removed. Do not allow the concrete to dry before the application of the membrane. If any drying has occurred, moisten the surface of the concrete with a fine spray of water, and apply the curing compound as soon as the free water disappears. Apply the curing compound to the finished surfaces by means of an approved automatic spraying machine. [Apply the curing compound with an overlapping coverage that provides a two-coat application at a coverage of 10 square meters per L 400 square feet per gallon, plus or minus 5.0 percent for each coat. A one-coat application is allowed provided it is applied in a uniform application and coverage of 5 square meters per L 200 square feet per gallon, plus or minus 5.0 percent is obtained.][Apply the curing compound with a single overlapping application that provides a uniform coverage of 3.7 square meters per L 150 square feet per gallon.] The application of curing compound by hand-operated, mechanical powered pressure sprayers is permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms. When the application is made by hand-operated sprayers, apply a second coat in a direction approximately at right angles to the direction of the first coat. If pinholes, abrasions, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes. Respray curing compound to concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied. Within the curing period, immediately respray areas where the curing compound is damaged by subsequent construction operations. During the entire curing period, adequately protect membrane-cured concrete surfaces from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.3 Moist Curing

****

NOTE: For OCONUS projects using Silica Fume, specify a minimum 24-hour moist cure before applying membrane curing compound.

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Maintain concrete to be moist-cured continuously wet for the entire curing period, or until curing compound is applied, commencing immediately after finishing. If forms are removed before the end of the curing period, provide curing on unformed surfaces, using suitable materials. Cure surfaces by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Provide burlap and mats that are clean and free from any contamination and completely saturated before being placed on the concrete. Lap sheets to provide full coverage. Provide an approved system to provide continuous moist curing 24 hours per day and such that the entire surface is wet.

3.8 JOINTS

****

NOTE: Edit bracketed items in following subparagraphs to conform to design requirements. Retain dowels for construction joints.

For roads and streets, analyze the effect of tie bars on the pavement action and potential cracking before requiring or permitting their use. Remove joint types not required in the project.

****

3.8.1 General Requirements for Joints

Construct joints that conform to the locations and details indicated and are perpendicular to the finished grade of the pavement. Provide joints that are straight and continuous from edge to edge or end to end of the pavement with no abrupt offset and no gradual deviation greater than 13 mm

1/2 inch. Where any joint fails to meet these tolerances, remove and replace the slabs adjacent to the joint at no additional cost to the Government. Changes from the jointing pattern shown on the drawings are not allowed without written approval. Seal joints immediately following curing of the concrete or as soon thereafter as weather conditions permit as specified in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT or 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT.

3.8.2 Longitudinal Construction Joints

Install dowels [or keys] [or tie bars] in the longitudinal construction joints, or thicken the edges as indicated. Install [dowels] [tie bars] as specified above. [If any length of completed keyway of 1.5 m 5 feet or more fails to meet the previously specified tolerances, install dowels in that part of the joint by drilling holes in the hardened concrete and grouting the dowels in place with epoxy resin.] After the end of the curing period, saw longitudinal construction joints to provide a reservoir at the top for sealant conforming to the details and dimensions indicated.

3.8.3 Transverse Construction Joints

Install transverse construction joints at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for 30 minutes or longer. Provide transverse construction joints by utilizing headers or by paving through the joint, then full-depth sawcutting the excess concrete. Construct pavement with the paver as close to the header as possible, with the paver run out completely past the header. Provide transverse construction joints at a planned transverse joint constructed as shown or, if not shown otherwise, dowelled in accordance with paragraph DOWELS INSTALLED IN HARDENED CONCRETE, or paragraph FIXED FORM PAVING above.

3.8.4 Expansion Joints

Provide expansion joints where indicated, and about any structures and features that project through or into the pavement, using joint filler of the type, thickness, and width indicated, and installed to form a complete, uniform separation between the structure and the pavement or between two pavements. Attach the filler to the original concrete placement with adhesive and mechanical fasteners and extending to the full slab depth. Tightly fit adjacent sections of filler together, with the filler extending across the full width of the paving lane or other complete distance in order to prevent entrance of concrete into the expansion space. Finish edges of the concrete at the joint face with an edger with a radius of 3 mm 1/8 inch. After placement and curing of the adjacent slab, sawcut the sealant reservoir depth from the filler.

3.8.5 Slip Joints

Install slip joints where indicated using the specified materials. Attach preformed joint filler material to the face of the original concrete placement with adhesive and mechanical fasteners. Sawcut a 19 mm 3/4 inch deep reservoir for joint sealant at the top of the joint. Finish edges of the joint face with an edger with a radius of 3 mm 1/8 inch.

3.8.6 Contraction Joints

Construct transverse and longitudinal contraction joints by an initial sawcut in the concrete with a 3 mm 1/8 inch blade to the indicated depth.

During sawing of joints, and again 24 hours later, inspect all exposed lane edges for development of cracks below the saw cut, and immediately report results. If there are more than six consecutive uncracked joints after 48 hours, saw succeeding joints 25 percent deeper than originally indicated at no additional cost to the Government. Vary the time of initial sawing depending on existing and anticipated weather conditions to prevent uncontrolled cracking of the pavement. Commence sawing of the joints as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. Inspect the sawed faces of joints for undercutting or washing of the concrete due to the early sawing, and delay sawing if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint. Continue the sawing operation as required during both day and night regardless of weather conditions. Saw the joints in the sequence of the concrete placement. Provide adequate lighting for night work. Illumination using vehicle headlights is not permitted. Provide a chalk line or other suitable guide to mark the alignment of the joint. Before sawing a joint, examine the concrete closely for cracks, and do not saw the joint if a crack has occurred near the planned joint location. Discontinue sawing if a crack develops ahead of the saw cut. Immediately after the joint is sawed, thoroughly flush the saw cut and adjacent concrete surface with water and vacuum until all waste from sawing is removed from the joint and adjacent concrete surface. Properly protect the concrete from damage and cure at sawed joints. Tightly seal the top of the joint opening and the joint groove at exposed edges with cord backer rod before the concrete in the region of the joint is resprayed with curing compound, and maintain until removed immediately before sawing the joint sealant reservoir. Respray the surface with curing compound as soon as free water disappears. Seal the exposed saw cuts on the vertical faces of pilot lanes with bituminous mastic or masking tape. After expiration of the curing period, widen the upper portion of the groove by sawing with ganged diamond saw blades to the width and depth indicated for the joint sealer. Center the reservoir over the initial sawcut.

3.8.7 Thickened Edge Joints

Construct thickened edge joints as indicated on the drawings. Grade the underlying material in the transition area as shown and meet the requirements for smoothness and compaction specified for all other areas of the underlying material.

3.9 REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS

3.9.1 General Criteria

Repair or remove and replace new pavement slabs as specified at no cost to the Government. Removal of partial slabs is not permitted. Prior to any repairs, submit a Repair Recommendations Plan detailing areas exceeding the specified limits as well as repair recommendations required to bring these areas within specified tolerances.

3.9.2 Repair of Free Edge Lane Vertical Faces

Repair excessive edge slump and joint face deformation while concrete is in a plastic state by approved methods using forms in accordance with paragraph Forms for Fixed-Form Paving.

3.9.3 Slabs with Cracks

The Government may require cores to be taken over cracks to determine depth of cracking. Drill cores with a minimum diameter of 150 mm 6 inches, and backfill with an approved concrete mixture. Perform drilling of cores and filling of holes at no expense to the Government. Clean cracks that do not exceed 50 mm 2 inches in depth; then pressure inject full depth with epoxy resin, Type IV, Grade 1. In lieu of injectable epoxy the following may be used:

a. For cracks of a width less than or equal to 0.4mm0.015 inch: A High Molecular Weight Methyl Methacrylate (HMWMMA) with a neat monomer viscosity of less than or equal to 50 centipoise and greater than 5 centipoise as measured using ASTM D2196. If measuring the viscosity of a catalyzed or polymerization initiated HMWMMA the viscosity as measured using ASTM D2196 must be less than or equal to 60 centipoise and greater than 5 centipoise.

b. For crack widths greater than 0.4mm0.015 inch: A HMWMMA with a neat monomer viscosity of less than 300 centipoise as measured using ASTM D2196. The cured surface of the MMA must be flush with the surface of the surrounding PCC Plus or minus 1.5mm1/16 inch.

c. Do not apply HMWMMA to surfaces larger than 25 square feet 2.3 square meter prior to 70 days of curing of the PCC. Perform a test section with the HMWMMA product manufacturer's representative present before production application in the presence of the government.

Remove and replace slabs containing cracks deeper than 50 mm 2 inches.

3.9.4 Removal and Replacement of Full Slabs

Remove new or existing slabs damaged during construction that contain more than 15.0 percent of each longitudinal or transverse joint edge spalled. Where it is necessary to remove full slabs, remove in accordance with paragraph Removal Of Existing Pavement Slab below. Remove and replace full depth, by full width of the slab, and extend to each original joint. Compact and shape the underlying material as specified in the appropriate section of these specifications, clean the surfaces of all four joint faces of all loose material and contaminants, and coat with a double application of membrane forming curing compound as a bond breaker and to protect concrete that has not been cured for at least 7 days. Install dowels of the size and spacing as specified for other joints in similar pavement by epoxy grouting them into holes drilled into the existing concrete using procedures as specified in paragraph PLACING DOWELS[AND TIE BARS], above. Provide dowels for all four edges of the new slab. Cut off original damaged dowels[or tie bars] flush with the joint face. Lightly oil or grease protruding portions of new dowels. Place concrete as specified for original construction. Take care to prevent any curing compound from contacting dowels[or tie bars]. Prepare and seal the resulting joints around the new slab as specified for original construction.

3.9.5 Repairing Spalls Along Joints

Repair spalls along joints to be sealed to a depth to restore the full joint-face support prior to placing adjacent pavement. Where directed, repair spalls along joints of new slabs, along edges of adjacent existing concrete, and along parallel cracks by first making a vertical saw cut at least 75 mm 3 inches outside the spalled area and to a depth of at least 50 mm 2 inches. Provide saw cuts consisting of straight lines forming rectangular areas without sawing beyond the intersecting saw cut. Chip out the concrete between the saw cut and the joint, or crack, to remove all unsound concrete and into at least 13 mm 1/2 inch of visually sound concrete. Thoroughly clean the cavity thus formed with high pressure water jets supplemented with oil-free compressed air to remove all loose material. Immediately before filling the cavity, apply a prime coat to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. Apply the prime coat in a thin coating and scrub into the surface with a stiff-bristle brush. Provide prime coat for portland cement repairs consisting of a neat cement grout and for epoxy resin repairs consisting of epoxy resin, Type III, Grade 1. Fill the prepared cavity with material identified in Table 16 based on the cavity volume.

TABLE 17

SPALL REPAIRS

Volume of Prepared Cavity After Removal Operations	Material
less than 0.00085 cubic meter 0.03 cubic foot	epoxy resin mortar or epoxy resin or latex modified mortar
0.00085 cubic meter 0.03 cubic foot and 0.009 cubic meter 1/3 cubic foot	portland cement mortar
more than 0.009 cubic meter 1/3 cubic foot	portland cement concrete or latex modified mortar

Provide portland cement concretes and mortars that consist of very low slump mixtures, 13 mm 1/2 inch slump or less, proportioned, mixed, placed, consolidated by tamping, and cured, all as directed. Provide epoxy resin mortars made with Type III, Grade 1, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved. Proprietary patching materials may be used, subject to Government approval. Place the epoxy resin materials in the cavity in layers with a maximum thickness of 50 mm 2 inches. Provide adequate time between placement of additional layers such that the temperature of the epoxy resin material does not exceed 60 degrees C 140 degrees F at any time during hardening. Provide mechanical vibrators and hand tampers to consolidate the concrete or mortar. Remove any repair material on the surrounding surfaces of the existing concrete before it hardens. Where the spalled area abuts a joint, provide an insert or other bond-breaking medium to prevent bond at the joint face. For existing joints, seal the bottom contraction crack with backer rod to prevent instrusion of primer or mortar. Saw a reservoir for the joint sealant to the dimensions required for other joints. Thoroughly clean the reservoir and then seal with the sealer specified for the joints. In lieu of sawing, spalls and popouts, less than 150 mm 6 inches in maximum dimension and not adjacent to a joint, may be prepared by drilling a core 50 mm 2 inches in diameter greater than the size of the defect, centered over the defect, and 50 mm 2 inches deep or 13 mm 1/2 inch into sound concrete, whichever is greater. Repair the core hole as specified above for other spalls.

3.9.6 Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Rain damaged pavement is pavement with coarse aggregate exposed at the surface. Cores evaluated by a qualified petrographer to contain carbonation to a depth greater than 3 mm 1/8 inch or Mohs hardness of less than 2, when tested in accordance with ASTM C1895, are also considered rain damaged. A mortar-rich surface is defined as pavement deficient in plus 4.75 mm U.S. No. 4 sieve size aggregate. Diamond grind slabs containing weak surfaces less than 6 mm 1/4 inch thick to remove the weak surface. Diamond grind in accordance with paragraph Diamond Grinding Of PCC Surfaces. All diamond ground areas are required to meet the thickness, smoothness and plan grade criteria specified in PART 1 GENERAL. Remove and replace slabs containing weak surfaces greater than 6 mm 1/4 inch thick.

3.9.7 Repair of Pilot Lane Vertical Faces

Repair excessive edge slump and joint face deformation while concrete is in a plastic state by approved methods.

3.10 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

****

NOTE: Make sufficient exploration (not just reference to as-built drawings) to know exactly what the in-place existing pavement thickness and load-transfer are at the jointing area--such as dowels, keys, tie bars--and its condition. Normally, the joint between the new pavement and existing pavement is made at an existing joint in the old pavement. Coordinate with Section 02 41 00 DEMOLITION.

****

Demolition of existing operational pavement is not allowed prior to approval of the Proportioning Studies. Remove existing concrete pavement at locations indicated on the drawings. Prior to commencing pavement removal operations, inventory the pavement distresses (cracks, spalls, and corner breaks) along the pavement edge to remain. After pavement removal, survey the remaining edge again to quantify any damage caused by removal operations. Perform both surveys in the presence of the Government. Perform repairs as indicated and as specified herein. Carefully control all operations to prevent damage to the concrete pavement and to the underlying material to remain in place. Perform all saw cuts perpendicular to the slab surface, forming rectangular areas. Perform all existing concrete pavement repairs prior to paving adjacent lanes.

3.10.1 Removal of Existing Pavement Slab

****

NOTE: Make the second saw cut at a distance from the joint with a wheel saw which produces a 38 mm 1-1/2 inches or wider kerf and better prevents stress from propagating across the saw cut. Specify wheel saw for Army and Air Force projects. Specify diamond saw for Navy projects.

****

When existing concrete pavement is to be removed and adjacent concrete is to be left in place, perform the first full depth saw cut on the joint between the removal area and adjoining pavement to stay in place with a standard diamond-type concrete saw. Next, perform a full depth saw cut parallel to the joint that is at least 600 mm 24 inches from the joint and at least 150 mm 6 inches from the end of any dowels with a [wheel saw] [diamond saw] as specified in paragraph SAWING EQUIPMENT. Remove all pavement beyond this last saw cut in accordance with the approved demolition work plan. Remove all pavement between this last saw cut and the joint line by carefully pulling pieces and blocks away from the joint face with suitable equipment and then picking them up for removal. In lieu of this method, this strip of concrete may be carefully broken up and removed using hand-held jackhammers, 14 kg 30 lb or less, or other approved light-duty equipment which does not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place. In lieu of the above specified removal method, the slab may be sawcut full depth to divide it into several pieces and each piece lifted out and removed. Use suitable equipment to provide a truly vertical lift, and safe lifting devices used for attachment to the slab.

3.10.2 Edge Repair

Protect the edge of existing concrete pavement against which new pavement abuts from damage at all times. Remove and replace slabs which are damaged during construction as directed at no cost to the Government. Repair of previously existing damaged areas is considered a subsidiary part of concrete pavement construction. Saw off all exposed keys and keyways full depth.

3.10.2.1 Spall Repair

Repair spalls caused by construction activities if less than 15.0 percent of any slab's edge. Provide repair materials and procedures as previously specified in paragraph, Repairing Spalls Along Joints. Remove and replace full slabs if spalls exceed 15.0 percent of any slab's edge as specified in paragraph, Removal and Replacement of Full Slabs.

3.10.2.2 Underbreak and Underlying Material

Repair all underbreak by removal and replacement of the damaged slabs in accordance with paragraph REMOVAL AND REPLACEMENT OF FULL SLABS above. Protect the underlying material adjacent to the edge of and under the existing pavement which is to remain from damage or disturbance during removal operations and until placement of new concrete, and shape as directed. Maintain sufficient underlying material in place outside the joint line to completely prevent disturbance of material under the pavement which is to remain in place. Remove and replace any slab with underlying material that is disturbed or loses its compaction.

3.11 PAVEMENT PROTECTION

Exclude traffic from the new pavement by erecting and maintaining barricades and signs until the concrete is at least 14 days old, or for a longer period if so directed. As a construction expedient in paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment is permitted on the new pavement after the pavement has been cured for 7 days, the joints have been sealed or otherwise protected, the concrete has attained a minimum field cured flexural beam strength of 3.8 MPa 550 psi and approved means are provided to prevent damage to the slab edge. Fabricate and field cure specimens in accordance with ASTM C31/C31M. Continuously maintain all new and existing pavement carrying construction traffic or equipment completely clean, and clean up spillage of concrete or other materials immediately upon occurrence. Take special care in areas where traffic uses or crosses active airfield pavement. Power broom other existing pavements at least daily when traffic operates. For fill-in lanes, provide equipment that does not damage or spall the edges or joints of the previously constructed pavement. Protect the pavement against all damage prior to final acceptance of the work by the Government. Placement of aggregates, rubble, or other similar construction materials on airfield pavements is not allowed.

3.12 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL DURING CONSTRUCTION

3.12.1 Testing and Inspection by Contractor

During construction, perform sampling and testing of aggregates, cementitious materials (cement, slag cement, and pozzolan), and concrete to determine compliance with the specifications. Provide facilities and labor for procurement of representative test samples. Furnish sampling platforms and belt templates to obtain representative samples of aggregates from charging belts at the concrete plant. Obtain samples of concrete at the point of delivery to the paver. Testing by the Government in no way relieves the specified testing requirements. Perform the inspection and tests described below, and based upon the results of these inspections and tests, take the action required and submit reports as required. Perform this testing regardless of any other testing performed by the Government, either for pay adjustment purposes or for any other reason. Include stationing for all sampling and testing.

3.12.2 Testing and Inspection Requirements

Perform CQC sampling, testing, inspection and reporting in accordance with the following Table. Retest aggregate sources and stockpiles in accordance with Table 17 if not used within the previous 3 months.

TABLE 18
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Fine Aggregate Gradation and Fineness Modulus			
2 per lot	ASTM C136/C136M sample at belt	9 of 10 tests vary less than 0.15 from average	Retest, resolve, retest
		Outside limits on any sieve	Retest
		2nd gradation failure	Stop, resolve, retest
1 per 10 gradations	ASTM C117	Outside limits on any sieve	Retest
		2nd gradation failure	Stop, repair, retest
Coarse Aggregate Gradation (each aggregate size)			
2 per lot	ASTM C136/C136M sample at belt	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, correct
		2 consecutive averages of 5 tests outside limits	report to COR, stop ops, repair, retest

TABLE 18
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
1 per 10 gradations	ASTM C117	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, correct
		2 consecutive averages of 5 tests outside limits	report to COR, stop ops, repair, reverify all operations
Workability Factor and Coarseness Factor Computation			
Same as C.A. and F.A.	see paragraph AGGREGATES	Use individual C.A. and F.A. gradations. Combine using batch ticket percentages (average of aggregate percentages from 3 before and 3 after sampling). Tolerances: plus or minus 3 points on WF; plus or minus 5 points on CF from approved adjusted mix design values; only the portion of the tolerance box within the parallelogram is	Check batching tolerances, recalibrate scales
		2 consecutive averages of 5 tests outside limits	Stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Aggregate Deleterious, Quality, and ASR Tests			
Every 30 days of concrete production	see paragraph AGGREGATES		Stop production, retest, replace aggregate. Increase testing interval to 90 days if previous 2 tests pass
Plant - Scales, Weighing Accuracy			
Monthly	NRMCA QC 3		Stop plant ops, repair, recalibrate
Plant - Batching and Recording Accuracy			
Weekly	Record/Report	Record required/recorded/actu batch mass	Stop plant ops, repair, recalibrate

TABLE 18

TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Plant - Batch Plant Control			
Every lot	Record/Report		Record type and amount of each material per
Plant - Mixer Uniformity - Stationary Mixers			
Before test section and Every 4 months during paving or Every 6 months when not generating production paving	COE CRD-C 55	After initial approval, use abbreviated method	Increase mixing time, change batching sequence, reduce batch size to bring into compliance. Retest
Plant - Mixer Uniformity - Truck Mixers			
Every 4 months during paving	ASTM C94/C94M	Random selection of truck.	Increase mixing time, change batching sequence, reduce batch size to bring into
Concrete Mixture - Air Content			
When test specimens prepared plus 2 random per lot	ASTM C231/C231M sample at point of discharge within the paving lane	Individual test control chart: Warning plus or minus	Adjust AEA, retest
		Individual test control chart: Action plus or minus 1.5	Halt operations, repair, retest
		Range between 2 consecutive tests: Warning plus 2.0	Recalibrate AEA dispenser
		Range between 2 consecutive tests:	Halt operations, repair, retest
Concrete Mixture - Unit Weight and Yield			
Same as Air Content	ASTM C138/C138M sample at point of discharge within the	Individual test basis: Warning Yield	Check batching tolerances
		Individual test basis: Action Yield minus 0 or plus 5	Halt operations
Concrete Mixture - Slump			

TABLE 18
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
When test specimens prepared plus 4 random per lot	ASTM C143/C143M sample at point of discharge within the paving lane	Individual test control chart: Upper Warning slipform minus 13 mm 1/2 inch below max fixed form 37 mm 1.5 inches hand placement 64 mm 2.5 inches	Adjust batch masses within max W/C ratio
		Individual test control chart: Upper Action at maximum allowable slump	Stop operations, adjust, retest
		Range between each consecutive test: 38 mm 1-1/2 inches	Stop operations, repair, retest
Concrete Mixture - Temperature			
When test specimens prepared	ASTM C1064/C1064 sample at point of discharge within the	See paragraph WEATHER LIMITATIONS	
Concrete Mixture - Strength			
8 per lot	ASTM C31/C31M sample at point of discharge within the	See paragraph CONCRETE STRENGTH TESTING for CQC Perform fabrication of strength specimens and initial cure outside the paving lane and	
Paving - Inspection Before Paving			
Prior to each paving operation	Report	Inspect underlying materials, construction joint faces, forms, reinforcing, dowels, and embedded items	
Paving - Inspection During Paving			
During paving operation		Monitor and control paving operation, including placement, consolidation, finishing, texturing, curing, and joint	
Paving - Vibrators			
Weekly during paving	COE CRD-C 521	Test frequency (in concrete), and amplitude (in air), average measurement at tip and head	Repair or replace defective vibrators.
Moist Curing			
2 per lot, min	Visual		Repair defects, extend curing by 1 day

TABLE 18
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Membrane Compound Curing			
Daily	Visual	Calculate coverage based on quantity/area	Respray areas where coverage defective. Recalibrate equipment
Cold Weather Protection			
Once per day	Visual		Repair defects, report conditions to COR

3.12.3 Control Charts

Maintain linear control charts for fine and coarse aggregate gradation, combined gradation coarseness factor/workability factor, slump, air content, unit weight, yeld, and 7 and 14 day flexural strengths.

Post the control charts as directed and maintain current at all times. Identify the following on the control charts: the project number, the test parameter being plotted, the individual sample numbers, the Warning and Action Limits listed in Table 17 applicable to the test parameter being plotted, and the test results. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make decisions concerning mix modifications based on analysis of the results provided in the control charts.

3.12.4 Concrete Strength Testing for CQC

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NOTE: If paragraph FLEXURAL STRENGTH AND THICKNESS is based on 28-day flexural strength for acceptance, modify this subparagraph to match it. The first option "Cylinders/Beams" includes items a through g; the second option "Beams" includes listing a through f.

****

Perform Contractor Quality Control operations for concrete strength consisting of the following steps:

[a. Take samples for strength tests at the paving site. Fabricate and cure test cylinders in accordance with ASTM C31/C31M; test them in accordance with ASTM C39/C39M.

b. Fabricate and cure 2 test cylinders per sublot from the same batch or truckload and at the same time acceptance cylinders are fabricated and test them for compressive strength at 7-day age.

c. Average all 8 compressive tests per lot. Convert this average 7-day compressive strength per lot to equivalent [28] [90]-day flexural strength using the Correlation Ratio determined during mixture proportioning studies.

d. Compare the equivalent [28] [90]-day flexural strength from the conversion to the required average CQC flexural strength, Ra.

e. If the equivalent average [28][90]-day strength for the lot is below the required average CQC flexural strength, Ra, by 138 kPa 20 psi flexural strength or more, at any time, adjust the mixture to increase the strength, as approved.

f. Fabricate and cure two beams for every 1500 cubic meters 2000 cubic yards of concrete placed. Fabricate and cure in accordance with ASTM C31/C31M; test at 14-days of age in accordance with ASTM C78/C78M. Use the flexural strength results to verify the cylinder-beam acceptance correlation ratio.

g. Maintain up-to-date control charts for strength, showing the 7-day CQC compressive strength, the 14-day compressive strength (from acceptance tests) and the [28] [90]-day equivalent flexural strength of each of these for each lot.]

[a. Take samples for strength tests at the paving site. Fabricate and cure test beams in accordance with ASTM C31/C31M; test them in accordance with ASTM C78/C78M.

b. Fabricate and cure 2 test beams per sublot from the same batch or truckload and at the same time acceptance beams are fabricated and test them for flexural strength at 7-day age.

c. Average all 8 flexural tests per lot. Convert this average 7-day flexural strength per lot to equivalent [28] [90]-day flexural strength using the Correlation Ratio determined during mixture proportioning studies.

d. Compare the equivalent [28] [90]-day flexural strength from the conversion to the required average CQC flexural strength, Ra.

e. If the equivalent average [28] [90]-day strength for the lot is below the required average CQC flexural strength, Ra, by 490 kPa 69 psi flexural strength or more, at any time, adjust the mixture to increase the strength, as approved.

f. Maintain up-to-date control charts for strength, showing the 7-day CQC flexural strength, the Ratio of the 14-day flexural strength to the [28] [90]-day flexural strength (from acceptance tests), and the [28] [90]-day flexural strength (from acceptance tests) of each of these for each lot.]

3.12.5 Reports

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NOTE: The first bracket is default. Before selecting the second bracket, obtain approval from the TSMCX, AFCEC pavement SME, or NAVFAC. The second bracket is only to be utilized when reviewed and approved by the agency's SME.

****

Report all results of tests or inspections conducted as they are completed and in writing daily. Post updated control charts and identify accepted paving lots on the detailed paving sequence paving plan covering the entire period from the start of paving through the current week. These requirements do not relieve the obligation to report failures immediately as required in preceding paragraphs and Section 01 45 00 QUALITY CONTROL. Confirm reports of failures and the corrective action taken in writing in the daily Quality Control reports and within each respective Paving Lot Report. Compile, reduce, analyze and compute pay adjustment factors for all associated test data collected on each paving lot.

Submit complete and comprehensive Paving Lot Reports for the test section and production paving within [16][_____]days after the completion of the placement.[Do not place an adjacent or contiguous lane/lot prior to providing required pavement data identified in items a.-y. conforming to the acceptance criteria. Payment will not be made until all required data identified in items a.-y. has been submitted and reviewed by the government.][Adjacent or contiguous lane/lot can be placed after government receipt of preliminary pavement data to include items k.-q.,r.-u.,w., and y. Payment will not be made until all required lot data identified in items a.-y. has been submitted and reviewed by the government.] Organize each Paving Lot Report by the following specific items. The list below is not all inclusive. Add tests and inspections as appropriate for each specific paving lot constructed.

Table Summary of payment adjustment factors and pass/fail factors Detailed Placement Plan, labeling lots/sublots with stationing. Identify core locations, and testing locations.

Provide narrative addressing the following at a minimum:

a. Protective Measures: Rain, Cold, Hot and/or windy on-site conditions including evaporation rates, high/low ambient temperature. Post-Production protection and traffic control.
b. Success, failures, and issues encountered during all operations associated with the placement to include, but not limited to, batching, transporting, paving, texturing and curing.Include any process control changes that were necessary to meet specified tolerances.
c. Stockpile Management before and during placement.
d. Initial saw cutting operation to include start and finish times (early entry or wet diamond, flushing and vacuuming, backer rod installation and reapplication of curing compound).
e. Finishing operations (cutting straight-edge, automatic longitudinal float, edging tool, minimal hand work and excess paste).
f. Texturing operations to include start and finish times.
g. Curing operations to include start and finish times.
h. Environmental conditions of initial cure facility to include location and temperatures.
i. Planned correction(s) or correction(s) completed
j. Dowel installation

Provide required inspection documentation for the following at a minimum:
k. Batch Plant, Equipment, and Curing Equipment Verification
l. Dowel Baskets, forms, reinforcing, embeds and block-outs
m. Summary of recent underlying material test results showing compliance. Include information such as submittal numbers or date of daily report(s) where the detailed testing data is located.

Quality Control Testing
n. PCC Plastic Mixture Properties (temperature, air content, slump, unit weight)
o. Aggregate gradation test results and CF-WF plot
p. Control Charts
q. Joint Crack Tracking and Record

Acceptance Testing (before and after corrections)
r. Surface Smoothness test results (straightedge and profilograph) in both longitudinal and transverse directions.
s. Edge Slump test results(identify excessive, lost and rebuilt edge(s)).
t. Joint Face Deformation test results.
u. Plan Grade: table providing x, y, and elevation values versus design values signed by licensed surveyor.
v. Strength: beam/cylinder strength results (with updated correlation ratios and control chart).
w. Cores: Locations/Stationing of cores shown on Placement Plan, thickness measurements, photos and evaluation of cores.
x. Dowel holes, and dowel alignment
y. Legible copies of batch tickets. Tickets should include all required data, time received, and time discharge completed.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 13 14.14 (August 2023)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC   **UFGS-32 13 14.14 (August 2023)**

Preparing Activity: USACE   **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 13 14.14

CONCRETE PAVING FOR SMALL AIRFIELD PROJECTS

08/23

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NOTE: This guide specification covers the requirements for construction of exterior concrete pavement for airfield projects with less than 750 cubic meters 1,000 cubic yards. Do not divide projects into small construction phases so this spec can be used. This specification is not permitted for high risk areas such as aircraft arresting systems, compass calibration pads, and fixed-wing short takeoff and vertical landing (STOVL) facilities.

For all situations where this specification will be used consult with the using agency's subject matter experts regarding its applicability. Contact the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC) for approval.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and must be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: In preparing contract specifications for concrete pavement, the designer will use UFC 3-250-04 STANDARD PRACTICE FOR CONCRETE PAVEMENTS for guidance. State highway specifications are not permitted. All airfield concrete pavements will use the UFGS without exception.

Specifications developed for Corps of Engineers managed projects must be edited in accordance with ER 1110-34-1 Engineering and Design Transportation Systems Mandatory Center of Expertise (Section 11, 12, App A, B, C).

Contact the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC) for guidance on interpreting and editing this specification section.

This specification section is structured for Contractor sampling and testing of materials and mixture proportioning. If Government sampling, testing and mixture proportioning is required, contact the TSMCX, AFCEC pavement SME, or NAVFAC for specification language.

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[1.1 UNIT PRICES

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NOTE: Delete unit price paragraphs when the work is covered by a lump-sum contract price.

****

1.1.1 Measurements

The quantity of concrete to be paid for will be the volume of concrete in cubic meters yards including thickened edges [monolithic curb], where required, placed in the completed and accepted pavement. Concrete will be measured in place in the completed and accepted pavement only within the neat line dimensions shown in the plan and cross section. No deductions will be made for rounded or beveled edges or the space occupied by pavement reinforcement, dowel bars, or electrical conduits, nor for any void, or other structure extending into or through the pavement slab, measuring 0.1 cubic meter 3 cubic feet or less in volume. No other allowance for concrete will be made unless placed in specified locations in accordance with the approved contract modification. The quantity of other materials specified herein, and used in the construction of the work covered by this section, will not be measured for payment, but will be considered a subsidiary obligation, covered under the price per cubic meter yard for concrete. Joint sealing materials are covered in [Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT] [Section 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT].

1.1.2 Payments

1.1.2.1 Unit Price

The quantity of concrete measured as specified above will be paid for at the contract unit price when placed in completed and accepted pavements. Payment will be made at the contract price for cubic meter yard for the scheduled item, with necessary adjustments as specified below. Payment will constitute full compensation for providing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement, except for other items specified herein for separate payment.

]1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 201.1R	(2008) Guide for Conducting a Visual Inspection of Concrete in Service
ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete

ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 309R	(2005) Guide for Consolidation of Concrete
ACI 325.14R	(2017) Guide for Design and Proportioning of Concrete Mixtures for Pavements

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2024) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1078/A1078M	(2019) Standard Specification for Epoxy-Coated Steel Dowels in Concrete Pavement
ASTM C29/C29M	(2023) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94/C94M	(2024c) Standard Specification for

	Ready-Mixed Concrete
ASTM C114	(2024) Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2023) Standard Test Method for Lightweight Particles in Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C174/C174M	(2017) Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C294	(2024) Standard Descriptive Nomenclature for Constituents of Concrete Aggregates
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical

	Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685/C685M	(2024) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1646/C1646M	(2016) Making and Curing Test Specimens for Evaluating Frost Resistance of Coarse Aggregate in Air-Entrained Concrete by Rapid Freezing and Thawing
ASTM C1895	(2020) Standard Test Method for Determination of Mohs Scratch Hardness

ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(2015) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

U.S. DEPARTMENT OF DEFENSE (DOD)

TSPWG M 3-250-04.97-05	(2019) Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item,

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Proposed Techniques; G, [_____]

SD-03 Product Data

Diamond Grinding Plan; G, [_____]

Dowels; G, [_____]

Dowel Bar Assemblies; G, [_____]

Equipment

SD-05 Design Data

Preliminary Proposed Proportioning; G, DOProportioning Studies; G, DO

SD-06 Test Reports

Mixer Performance (Uniformity) Testing; G, [_____]

Batch Tickets

Contractor Quality Control Reports

Sampling and Testing; G[, [_____]]

Diamond Grinding of PCC Surfaces; G[, [_____]]

Repair Recommendations Plan; G, [_____]

SD-07 Certificates

Contractor Quality Control Staff; G, [_____]

Laboratory Accreditation[and Validation]

NRMCA Certificate of Conformance

Petrographer Resume; G, [_____]

Licensed Surveyor

Concrete Batch Plant Operator

1.4 QUALITY CONTROL

1.4.1 Contractor Quality Control (CQC) Staff

Reference Section 01 45 00 QUALITY CONTROL for general CQC personnel qualification requirements. Submit the Contractor Quality Control Staff for approval. Provide American Concrete Institute certificates of CQC staff in addition to the qualifications and resumes of the petrographer, surveyor, concrete batch plant operator, and CQC System Manager. All Contractor Quality Control personnel assigned to concrete construction are required to be American Concrete Institute (ACI) certified in the following grade:

a. Identify an individual within the onsite work organization as the Concrete Paving CQC Manager, who is responsible for overall management of concrete paving CQC and has the authority to act in all concrete paving CQC matters including authority to stop concrete paving work which is out of compliance.

   The minimum requirements for the Concrete Paving CQC Manager consist of 8 years airfield concrete paving experience similar to work required under this contract with a minimum of 3 years in a concrete paving CQC role. The Concrete Paving CQC Manager is a separate person, and is in addition to the CQC System Manager identified in Section 01 45 00 QUALITY CONTROL.

b. CQC staff is required to oversee all aspects of sawing operations (sawing, flushing, vacuuming, checking for random cracking, lighting).

c. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews: ACI Advanced Concrete Flatwork Finisher.

d. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

e. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and ACI Concrete Laboratory Testing Technician, Level 1 or 2.

1.4.2 Other Staff

Submit for approval, the qualifications and resumes for the following staff:

a. Petrographer: Bachelor of Science degree in geology or petrography, trained in petrographic examination of concrete aggregate according to ASTM C294 and ASTM C295/C295M and trained in identification of the specific deleterious materials and tests identified in this specification. Detail the education, training and experience related to the project-specific test methods and deleterious materials in the Petrographer Resume and submit at least 20 days before petrographic and deleterious materials examination is to commence.

b. Licensed Surveyor: Perform all survey work under the supervision of a Licensed Surveyor.

c. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager certification.

1.4.3 Preconstruction Testing of Materials

All sampling and testing is required to be performed by an approved commercial laboratory. For cementitious materials and chemical admixtures use a laboratory maintained by the manufacturer of the material. Materials are not allowed to be used until notice of acceptance has been given. Additional payment or extension of time is not allowed due to failure of any material to meet project requirements.

1.4.3.1 Aggregates

Sample aggregates in the presence of a Government Representative. Obtain samples in accordance with ASTM D75/D75M that are representative of the materials to be used for the project. Perform all aggregate tests no earlier than one year prior to initial submission of the proportioning studies submittal.

1.4.3.2 Chemical Admixtures, Curing Compounds, and Epoxies

Submit certified copies of test results of admixtures, curing compounds, and epoxies that are going to be used on the project at least 30 days before the material is used. Provide test results less than 5 years old prior to use in the work. Reject if the test results do not meet the Level 2 proof of compliance requirements of ASTM C494/C494M.

1.4.3.3 Cementitious Materials

Cement, slag cement, and pozzolan will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports showing that the material in each shipment meets the requirements of the referenced test standard under which it is provided. Provide mill test reports no more than 6 months old prior to use in the work. Do not use cementitious materials until notice of acceptance has been given. Cementitious materials may be subjected to testing by the Government from samples obtained at the mill, at transfer points, or at the project site. If tests prove that a cementitious material that has been delivered is unsatisfactory, promptly remove it from the project site.

1.4.4 Acceptability of Work

The materials and the pavement itself will be accepted on the basis of production testing. The Government may make check tests to validate the results of the production testing. If the results of the production testing vary by less than 2.0 percent of the Government's test results, the results of the production testing will be used. If the results of the Government and production tests vary by 2.0 percent, but less than 4.0 percent, the average of the two will be considered the value to be used. If these vary by 4.0 percent or more, carefully evaluate each sampling and testing procedure and obtain another series of Government and production tests on duplicate samples of material. If these vary by 4.0 percent or more, use the results of the tests made by the Government and the Government will continue check testing of this item on a continuous basis until the two sets of tests agree within less than 4.0 percent on a regular basis. Testing performed by the Government does not relieve the specified testing requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Bulk Cementitious Materials

Provide all cementitious materials in bulk at a temperature, as delivered to storage at the site, not exceeding 65 degrees C 150 degrees F. Provide sufficient cementitious materials in storage to sustain continuous operation of the concrete mixing plant while the pavement is being placed. Provide separate facilities to prevent any intermixing during unloading, transporting, storing, and handling of each type of cementitious material.

1.5.2 Aggregate Materials

Store aggregate at the site of the batching and mixing plant avoiding breakage, segregation, intermixing or contamination by foreign materials. Store each size of aggregate from each source separately and allow the fine aggregate and the smallest size coarse aggregate to drain. Provide a minimum 0.6 m 24 inch thick sacrificial layer left undisturbed for each aggregate stored on ground or provide a hard surface course beneath the stockpiles. Maintain sufficient aggregate at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time concrete pavement is being placed. Do not allow tracked equipment on coarse aggregate stockpiles.

1.5.3 Other Materials

Store reinforcing bars and accessories above the ground on supports. Store all materials to avoid contamination and deterioration.

1.6 ACCEPTANCE

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NOTE: Provide accredited and validated laboratories on USACE managed projects. Utilization of the USACE Materials Testing Center (MTC) for laboratory validation is optional for Air Force and Navy managed projects.

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1.6.1 Acceptance Requirements

Provide all sampling and testing required for acceptance including batch tickets. Select sample locations on a random basis in accordance with ASTM D3665. Individuals performing sampling, testing and inspection duties are required to meet the qualifications of the accredited [and validated

]laboratory. The Government reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. Testing in these areas are additional and must meet the same requirements as random tests. Provide facilities and personnel where directed to assist in obtaining samples for any Government testing. Acceptance of work is based on compliance with the pavement characteristics discussed below.

1.6.2 Concrete Strength

Acceptance test results are the average strengths of two specimens tested at 28 days. The strength of the concrete is considered satisfactory so long as every average of three consecutive acceptance test results equal or exceeds the specified compressive strength (f'c) and no individual test result falls below f'c by more than 3.4 MPa 500 psi. Remove and replace the deficient area where any portion of the work fails to meet the acceptance criteria for concrete strength, at no additional cost to the Government.

1.6.3 Thickness

Provide the pavement design thickness required. Measure pavement thickness in accordance with ASTM C174/C174M using cores taken from the completed pavement section. Record and report all pavement thicknesses. If any thicknesses deviate from the design thickness by more than the values listed in Table 1 Maximum Job Thickness Deviations, remove and replace full panels as necessary to bring the pavement within tolerance.

Table 1
Maximum Job Thickness Deviations

Job Design Thickness	Individual Thickness Deficiency Greater than or Equal to	Average Job Thickness Deficiency Greater than or Equal to
Greater than or equal to 200 mm 8 inches	19 mm 0.75 inch	13 mm 0.50 inch
Less than 200 mm 8 inches	13 mm 0.50 inch	6 mm 0.25 inch

1.6.4 Surface Smoothness

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NOTE: Retain first bracketed item if any runway or taxiway pavement is included in the design. Retain second bracketed item for all designs including any other airfield pavement.

****

[Provide runways and taxiways with a variation from the specified straight edge not greater than 3 mm 1/8 inch in the longitudinal direction and not greater than 6 mm 1/4 inch in the transverse direction.][Provide all other airfield areas with a variation from a straight edge not greater than 6 mm 1/4 inch in either the longitudinal or transverse direction.] Perform all smoothness testing on each design lane and report all measurements to the nearest 2 mm1/16 in. Perform the testing at 5 foot intervals.

Smoothness requirements do not apply over crowns, drainage structures, or similar penetrations. Where more than 20.0 percent of the measurements exceed the tolerance, remove and replace full panels at no additional cost to the Government to bring the full design lane within tolerance.

1.6.5 Grade

Provide finished surfaces of all airfield pavements that vary less than 13 mm 1/2 inch above or below the plan grade line or elevation indicated. The above deviations from the approved grade line and elevation are not permitted in areas where closer conformance with the planned grade and elevation is required for the proper functioning of appurtenance structures. Provide finished surfaces of new abutting pavements that coincide at their juncture. Provide horizontal control of the finished surfaces of all airfield pavements that vary not more than 13 mm 1/2 inch from the design joint alignment indicated. Remove and replace full panels where the deviation from grade exceeds the specified tolerances by 50 percent or more, at no additional cost to the Government.

1.6.6 Diamond Grinding

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NOTE: For some projects the designer may need to consider reducing the amount of diamond grinding below a maximum of 20 percent.

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The maximum depth of diamond grinding is 6 mm 1/4 inch. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the maximum diamond grinding depth permitted, at no additional cost to the Government. The maximum area corrected by diamond grinding the surface of the hardened concrete is [20][_____] percent of the total area of the project.

Submit a Diamond Grinding Plan for review and approval prior to diamond grinding. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth and area are limited above. Reduce high areas by diamond grinding the hardened concrete with an approved equipment after the concrete is at a minimum age of 14 days. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above in conformance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. All areas in which diamond grinding has been performed are subject to the thickness tolerances specified in paragraph THICKNESS, above.

Prior to production diamond grinding operations, perform a test section at the approved location. Perform a test section that consists of a minimum of two adjacent passes with a minimum length of 12 m 40 feet to allow evaluation of the finish, transition between adjacent passes, and the results of crossing a transverse joint. Production diamond grinding operations are not to be performed prior to approval.

1.6.6.1 Bumps

Reduce any bumps by diamond grinding areas exceeding the tolerances shown by the smoothness measurements. Continue diamond grinding until the tolerances for surface smoothness are met. Taper such diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding. Perform additional smoothness measurements in all areas corrected by diamond grinding and report results to the nearest 2 mm1/16 in.

1.6.7 Deficient Areas

The size of a deficient area is measured as one or more failing tests or measurements that are in between two passing tests. Deficient areas may be reduced in size by performing additional tests or measurements to show areas that meet the requirements for acceptance.

1.6.8 Laboratory Accreditation[and Validation]

****

NOTE: At the discretion of the Air Force or Navy project engineer, the requirements for the USACE MTC validation of construction testing laboratories may be deleted. Validation of the project laboratories will provide an additional level of quality control for the project, and is strongly recommended by NAVFAC and USACE based on past experience.
For all Air Force and Army projects, retain the bracketed statement requiring USACE MTC validation of laboratories.

For all Army managed projects, retain the bracketed statement requiring USACE MTC validation of laboratories.

****

Provide laboratory and testing facilities. Submit accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM C1077, including all applicable test procedures identified in this specification. If multiple laboratories are proposed, identify which tests will be conducted by each. Submit accreditation documentation a minimum of 30 days before any specified testing is performed. The laboratories performing the tests are required to be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. Provide current accreditation and include the required and optional test methods, as specified.[In addition, all contractor quality control testing laboratories performing testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Request MTC laboratory validation at https://mtc.erdc.dren.mil/requestvalidation.aspx for costs and scheduling. Contact the MTC Director at https//mtc.erdc.dren.mil/contact2.aspx with questions or additional information.]

PART 2 PRODUCTS

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NOTE: Coordinate all product requirements with the

appropriate agency's Pavements or Materials Engineer.
****

2.1 SYSTEM DESCRIPTION

This section is intended to stand alone for construction of concrete airfield pavement. However, where the construction covered herein interfaces with other sections, construct each interface to conform to the requirements of both this section and the other section including tolerances for both.

2.2 CEMENTITIOUS MATERIALS

****

NOTE: Edit these paragraphs as appropriate for the particular project. Obtain guidance for use of cementitious materials from the Pavement Materials engineer or from the TSMCX, AFCEC pavement SME, or NAVFAC, especially for areas subject to alkali-aggregate reactivity, or sulfate attack.

When sulfate bearing soil or water is encountered, specify Type II cement for moderate sulfate concentration and Type V cement for high concentration and consider requiring use of fly ash or slag cement for partial replacement. Do not specify Type I or III cement. See UFC 3-250-04 for guidance.

Do not specify Type III cement unless accelerated paving is involved and then only after laboratory mixture proportioning studies and tests during the design stage of the project.
****

Provide cementitious materials consisting of blended cement or portland cement in combination with supplementary cementitious materials (SCM), that conform to appropriate specifications listed below. New submittals are required when the cementitious materials sources or types change.

2.2.1 Portland Cement

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NOTE: ASTM C 150 has deleted the option to specify low alkali cement. To mitigate ASR, current practice (ASTM C 1778) is to limit the total alkalis in the concrete mixture as addressed in paragraph Composition.
****

Provide portland cement conforming to ASTM C150/C150M, Type [I] [II] [V], [including the Optional Physical Requirements for early stiffening]. [Provide Type III cement only in the following locations [_____].]

2.2.2 Blended Cements

****

NOTE: Portland cement blended with limestone up to 15 percent by mass of the blended cement is acceptable.

****

Provide blended cement conforming to ASTM C595/C595M, Type IP, IS, or IL[including the optional requirement for sulfate resistance]. Provide pozzolan added to the Type IP blend consisting of ASTM C618 Class F or Class N and that is interground with the cement clinker. Include a written statement from the manufacturer that the amount of pozzolan in the finished cement does not vary more than plus or minus 5 mass percent of the finished cement from lot to lot or within a lot. Provide limestone added to the Type IL blend that is interground with the cement clinker. Include a written statement from the manufacturer that the amount of limestone in the finished cement does not vary more than plus or minus 2.5 mass percent of the finished cement from lot to lot or within a lot. Limit the percent of slag, pozzolan, or limestone to a maximum of IS(50), IP(35) or IL(15). The percentage and type of mineral admixture used in the blend is not allowed to change from that submitted for the aggregate evaluation and mixture proportioning.

2.2.3 Pozzolan

2.2.3.1 Fly Ash

****

NOTE: Class C fly ash is not permitted for paving concrete.

Use loss on ignition not exceeding 3 percent for frost areas to reduce carbon interference with air entraining admixture.

****

Provide fly ash conforming to ASTM C618, Class F including the optional requirement for uniformity and a loss on ignition not exceeding [3] [6] percent. Provide Class F fly ash for use in mitigating Alkali-Silica Reactivity with a total equivalent alkali content less than 4 percent.

2.2.3.2 Raw or Calcined Natural Pozzolan

Provide natural pozzolan that is raw or calcined and conforms to ASTM C618, Class N, including the optional requirements for uniformity and a loss on ignition not exceeding [3] [6] percent. Provide Class N pozzolan for use in mitigating Alkali-Silica Reactivity with a total equivalent alkali content less than 4 percent.

2.2.3.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Provide Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) conforming to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age of at least 95 percent of the control specimens.

b. The average particle size is a maximum of 6 microns.

[2.2.3.4 Silica Fume

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NOTE: Use Silica Fume only for OCONUS projects

where Class F fly ash and slag cement are not available, and with written approval from the TSMCX, AFCEC pavement SME, or NAVFAC. If not applicable, delete this paragraph here and throughout all other locations in this specification..

****

Provide silica fume conforming to ASTM C1240 including the optional limits on reactivity with cement alkalis. Provide silica fume as a dry, densified material or as a slurry. Provide the services of a manufacturer's technical representative that is experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume at no expense to the Government. This representative is required to be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume.

]2.2.4 Slag Cement

Provide slag cement (ground-granulated blast-furnace slag) that conforms to ASTM C989/C989M, Grade 100 or Grade 120.

2.2.5 Supplementary Cementitious Materials (SCM) Content

Provide a concrete mix that contains one of the SCMs in Table 2 within the ranges specified therein.

TABLE 2

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum Content (percent)	Maximum Content (percent)
Class F Fly Ash and Class N Pozzolan	25	35
Slag Cement	40	50
[Silica Fume]	[7]	[7]

2.3 AGGREGATES

****

NOTE: During the design stage, the designer must research the availability of local aggregate materials near the project area to determine if they conform with this specification. If local materials do not meet the requirements of this specification material needs to be imported that meets the specification. Aggregate quality requirements are not allowed to be reduced or eliminated for airfield projects.

****

2.3.1 Aggregate Sources

2.3.1.1 Durability of Coarse Aggregate

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NOTE: Subject to written approval by the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC), the third paragraph can be specified for projects in negligible weathering areas, as defined by ASTM C 33, Figure 1.

****

Provide durable aggregate that meets one of the following requirements:

a. Provide aggregate with a satisfactory service record in freezing and thawing of at least 5 years successful service in three concrete paving projects. Include a condition survey of the existing concrete and a review of the concrete-making materials, including coarse aggregates, cement, and mineral admixtures in the service record. Consider the previous aggregate source and test results, cement mill certificate data, mineral admixture chemical and physical composition, and the mix design (cement factor and water-cementitious material ratio) in the review. Provide service record performed by an independent third party professional engineer, petrographer, or concrete materials engineer along with their resume. Include photographs and a written report addressing D-cracks and popouts in accordance with ACI 201.1R in the service record.

b. Provide coarse aggregate with a durability factor of 80 or more when subjected to freezing and thawing of specimens prepared in accordance with ASTM C1646/C1646M and tested in accordance with ASTM C666/C666M, Procedure A. Test all coarse aggregate size groups and sources proposed for use individually. Historical data, within 2 years of proportioning studies submission, that is representative of material on the project may be provided.

[c. Provide coarse aggregate with a maximum sodium sulfate soundness loss of 12 percent, or with a magnesium sulfate soundness loss of 18 percent after five cycles when tested in accordance with ASTM C88.]

2.3.1.2 Alkali-Silica Reactivity

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate reactivity. Test all aggregate fractions, size groups, and sources proposed for use individually.

a. Evaluate the fine and coarse aggregates separately using ASTM C1260. If the expansion is less than 0.30 percent after 14 days of immersion in a 1N NaOH solution, provide a SCM within the limits of Table 2.

b. If any individual aggregate has an expansion greater than 0.30 percent after 14 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. As an alternative provide low alkali portland cement or blended cement and SCM within the limits of Table 2 that has a measured expansion less than 0.08 percent after 28 days of immersion in 1N NaOH solution in accordance with ASTM C1567.

2.3.1.3 Combined Aggregate Gradation

In addition to the grading requirements specified for coarse aggregate and for fine aggregate, provide the combined aggregate grading meeting the following requirements:

a. Provide materials selected and the proportions used such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in d. below, the point and its associated production tolerance thus determined falls within the parallelogram described therein. Refer to TSPWG M 3-250-04.97-05 for combined aggregate plot area recommendations for the intended placement technique(s).

b. Determine the Coarseness Factor (CF) from the following equation:

$$CF = \frac{(\text{cumulative percent retained on the 9.5 mm sieve})(100)}{(\text{cumulative percent retained on the 2.36 mm sieve})} \quad CF = \frac{(\text{cumulative percent retained on the 3/8 inch sieve})(100)}{(\text{cumulative percent retained on the No. 8 sieve})}$$

c. The Workability Factor (WF) is defined as the percent passing the 2.36 mm No. 8 sieve based on the combined aggregate gradation. Adjust the WF, prorated upwards only, by 2.5 percentage points for each 56 kg per cubic meter 94 pounds per cubic yard of cementitious material greater than 335 kg per cubic meter 564 pounds per cubic yard.

d. Plot a diagram using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram, plot a parallelogram with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, revise the grading of each size of aggregate used and the proportions selected as necessary.

e. Plot the associated production tolerance limits, identified in Table 8, around the CF and adjusted WF point.

2.3.2 Coarse Aggregate

2.3.2.1 Material Composition

****

NOTE: Modify this paragraph appropriately when it is desirable to limit coarse aggregate to crushed materials. Crushing gravel tends to improve quality, bond characteristics, and generally results in higher compressive strength. Investigate using crushed gravel when mixture proportioning studies or local experience indicates that low compressive strength concrete will be produced with an uncrushed gravel.

Do not under any conditions permit use of steel furnace slag for any aggregate. It is markedly different from iron blast furnace slag.

In power check pads, the high temperatures from jet blast can cause distress in aggregates in the concrete. Include bracketed item if power check pads are to be constructed. A lab study of available aggregates must be made if no service record is available. Only basalt is permitted on Navy projects.

Retain the bracketed requirement for washing coarse aggregate if aggregates in the area require it to meet the limits of Table 3. Add the requirement to use a log washer or other specific equipment if experience in the area shows the need. Delete if not needed. It is permissible to list certain aggregate sources that do not require washing if that is appropriate. Make this decision during preparation of specifications; do not make the Resident Engineer decide after award if aggregates need to be washed.

****

Provide coarse aggregate consisting of crushed or uncrushed gravel, crushed stone, [crushed adequately seasoned air-cooled iron blast-furnace slag; steel furnace slag is not permitted], or a combination thereof. [Provide coarse aggregate for paving power check pads consisting of limestone, dolomite, basalt or other approved low-silica content aggregate which do not cause thermal distress from jet blast.] Provide aggregates, as delivered to the mixers, consisting of clean, hard, uncoated particles meeting the requirements of ASTM C33/C33M except as specified herein. [Provide coarse aggregate that has been washed sufficient to remove dust and other coatings.] [Provide coarse aggregate that has been cleaned by processing with an approved log washer.] [Provide iron blast-furnace slag conforming to the grading to be used in the concrete with a compact density of not less than 1125 kg per cubic meter 70 lb per cubic foot determined in accordance with ASTM C29/C29M]. Provide coarse aggregate with no more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M. Provide coarse aggregates with a maximum sodium sulfate soundness loss of 12 percent, or with a magnesium sulfate soundness loss of 18 percent after five cycles when tested in accordance with ASTM C88.

2.3.2.2 Particle Shape Characteristics

Provide particles of the coarse aggregate that are generally spherical or cubical in shape. The quantity of flat particles and elongated particles in any size group coarser than the 9.5 mm 3/8 inch sieve are not allowed to exceed 20 percent by weight as determined by the Flat Particle Test and the Elongated Particle Test of ASTM D4791. A flat particle is defined as one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3.

2.3.2.3 Size and Grading

****

NOTE: Use nominal maximum aggregate size of 37.5 mm 1-1/2 inch for airfield pavements. Subject to approval of the TSMCX, AFCEC pavement SME, or NAVFAC, a 25 mm 1-inch nominal maximum aggregate

size may be used with two size groups. If utilizing a nominal maximum aggregate size of 37.5 mm 1-1/2 inch retain the third bracketed item. If approval has been given to use 25 mm 1-inch nominal maximum aggregate size, retain the fourth bracketed item. Utilizing a 25 mm 1-inch nominal maximum aggregate size requires the use of dowels in all joints.

****

Provide coarse aggregate with a nominal maximum size of [37.5 mm 1.5 inches with a minimum of 10 percent retained on the 25 mm 1.0 inch][25 mm 1.0 inches with a minimum of 5 percent retained on the 19 mm 0.75 inch] sieve of the proposed combined aggregate gradation that meets the criteria of paragraph COMBINED AGGREGATE GRADATION.[Grade and provide the coarse aggregates in a minimum of two size groups meeting the individual grading requirements of ASTM C33/C33M, [Size No. 4 (37.5 mm to 19 mm 1.5 ins. to 0.75 in.) and Size No. 67 (19 mm to 4.75 mm 0.75 in. to No. 4)][Size No. 57 (25 mm to 4.75 mm 1.0 ins. to No. 4) and Size No. 8 (9.5 mm to 2.36 mm 3/8 in. to No. 8)]. A third coarse aggregate size group may be required to meet the criteria of paragraph COMBINED AGGREGATE GRADATION.] Mix designs that include a minimum of three coarse aggregate size groups can use grading limits not defined by ASTM C33/C33M provided all other requirements are met. Provide upper and lower grading limits of historic gradations for all proposed coarse aggregates not defined by ASTM C33/C33M.

2.3.2.4 Deleterious Materials - Airfield Pavements

****

NOTE: Select the first bracketed option for chert in areas subjected to severe freezing and thawing. Select the second bracketed option for chert in areas subjected to negligible to moderate freezing and thawing. The first bracketed option may also be selected in negligible and moderate weather areas where airfield pavements have had historical problems with popouts. It is very rare for sedimentary deposits to meet deleterious limits that are less than 1 percent. Selecting the first tailoring option may require using non-sedimentary aggregates. Verify the availability and location of non-sedimentary aggregates for the project.

Weather Severity	**Air Freezing Index Coldest Year in 30 (a)**	**Average Precipitation for any Single Month During the Freezing Period**
Moderate	**500 or less**	**Any Amount**
Moderate (b)	**501 or more**	**Less than 25 mm 1 inch**
Severe	**501 or more**	**25 mm 1 inch or more**
(a) Calculated as described in UFC 3-130-01. See ASTM C33/C33M for simplified map of CONUS weather severity.		

Weather Severity	**Air Freezing Index Coldest Year in 30 (a)**	**Average Precipitation for any Single Month During the Freezing Period**
(b) In poorly drained areas, the weather must be considered severe even though the other criteria indicate a rating of moderate.		

****

The amount of deleterious material in each size group of coarse aggregate is not allowed to exceed the limits shown in Table 3 below, determined in accordance with the test methods shown.

TABLE 3	
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE FOR AIRFIELD	
Materials (d)	Percentage by Mass
Clay lumps and friable particles (ASTM C142/C142M)	1.0
Material finer than 0.075 mm No. 200 sieve (a) (ASTM C117)	1.0
Lightweight particles (b) (ASTM C123/C123M)	0.5
Chert, cherty stone, and other aggregates (less than 2.40 Sp. Gr.) (c) (ASTM C123/C123M and ASTM C295/C295M)	[0.1][1.0]
(a) Limit for material finer than 0.075 mm No. 200 sieve is allowed to be increased to 1.5 percent for crushed aggregates if the fine material consists of crusher dust that is essentially free from clay or shale. Use X-Ray Diffraction or other appropriate techniques as determined by petrographer to quantify amount and justify increase.	
(b) Test with a separation medium with a density of Sp. Gr. of 2.0. This limit does not apply to coarse aggregate manufactured from blast-furnace slag unless contamination is evident.	

TABLE 3	
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE FOR AIRFIELD	
Materials (d)	Percentage by Mass
(c) Chert is defined as a rock composed of quartz, chalcedony or opal, or any mixture of these forms of silica. It is variable in color. The texture is so fine that the individual mineral grains are too small to be distinguished by the unaided eye. Its hardness is such that it scratches glass but is not scratched by a knife blade. It may contain impurities such as clay, carbonates, iron oxides, and other minerals. Cherty stone is defined as any type of rock (generally limestone) that contains chert as lenses and nodules, or irregular masses partially or completely replacing the original stone. Other aggregates consist of obsidian, ash tuff, and palygorskite.	
(d) Perform testing in accordance with the referenced test methods, except use the minimum sample size specified below.	

2.3.2.5 Testing for Deleterious Materials in Coarse Aggregate

No extension of time or additional payment due to any delays caused by the testing, evaluation, or personnel requirements is allowed. The minimum test sample size of the coarse aggregate is 15 kg 33 pounds for the 19 mm 3/4 inch and larger maximum size and 8.5 kg 19 pounds for the 4.75 to 19 mm No. 4 to 3/4 inch coarse aggregate. Provide facilities for the ready procurement of representative test samples.

2.3.3 Fine Aggregate

2.3.3.1 Composition

Provide fine aggregate consisting of natural sand, manufactured sand, or a combination of the two, each composed of clean, hard, durable particles meeting the requirements of ASTM C33/C33M. Stockpile and batch each type of fine aggregate separately. Provide fine aggregate with particles that are generally spherical or cubical in shape. For fine aggregate provided as a combination of sources, test each source individually.

2.3.3.2 Grading

Provide fine aggregate, as delivered to the mixer, with a grading that conforms to the requirements of ASTM C33/C33M and having a fineness modulus of not less than 2.50 nor more than 3.40. For fine aggregate supplied as a combination of sources, determine the fineness modulus on a composite sample.

2.3.3.3 Deleterious Material

The minimum test sample size for fine aggregate proposed for use in airfield paving is 5 kg 10 pounds. The amount of deleterious material in the fine aggregate is not to exceed the limits listed in table 4 when performed on the full sample:

TABLE 4	
LIMITS OF DELETERIOUS MATERIALS IN FINE AGGREGATE	
Material	Percentage by Mass
Clay lumps and friable particles ASTM C142/C142M	1.0
Material finer than 0.075 mm No. 200 sieve ASTM C117	3.0
Lightweight particles ASTM C123/C123M using a medium with a density of Sp. Gr. of 2.0	0.5
Total of all above	3.0

2.4 CHEMICAL ADMIXTURES

2.4.1 General Requirements

Only use chemical admixtures when the specific admixture type and manufacturer is the same material used in the mixture proportioning studies. Provide air-entraining admixture conforming to ASTM C260/C260M. Use an accelerating admixture conforming to ASTM C494/C494M, Type C or Type E, when specified in paragraph MIXTURE PROPORTIONS below provided it is not used to reduce the amount of cementitious material. Calcium chloride and admixtures containing calcium chloride are not allowed. Provide retarding or water-reducing admixture that meet the requirements of ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived. Type S specific performance admixtures are not allowed. ASTM C1017/C1017M flowable admixtures are not allowed.

2.4.2 High Range Water Reducing Admixture (HRWRA)

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NOTE: Select the first bracketed option for projects not using Silica Fume. Select the second bracketed option for OCONUS projects that require the use of Silica Fume.

****

[ASTM C494/C494M, Type F and G high range water reducing admixtures are not allowed.][Provide a high-range water-reducing admixture that meets the requirements of ASTM C494/C494M, Type F or G, that is free from chlorides, alkalis, and is of the synthesized, sulfonated complex polymer type. Add the HRWRA to the concrete as a single component at the batch plant. Add the admixture to the concrete mixture only when its use is approved or directed, and only when it has been used in mixture proportioning studies to arrive at approved mixture proportions. Submit certified copies of the independent laboratory test results required for compliance with ASTM C494/C494M.]

2.5 MEMBRANE FORMING CURING COMPOUND

Provide membrane forming curing compound that conforms to COE CRD-C 300 and is white pigmented.

2.6 WATER

Provide water for mixing and curing that is fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water, or water from concrete production operations, can be used if it meets the requirements of ASTM C1602/C1602M.

2.7 JOINT MATERIALS

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NOTE: Coordinate with Section 32 01 19.61 for Army projects and 32 13 73.19 for all other projects.

****

2.7.1 Expansion Joint Material

Provide preformed expansion joint filler material conforming to ASTM D1751 or ASTM D1752 Type II or III. Provide expansion joint filler that is 19 mm 3/4 inch thick, unless otherwise indicated, and provided in a single full depth piece.

2.7.2 Slip Joint Material

Provide slip joint material that is 6 mm 1/4 inch thick expansion joint filler, unless otherwise indicated, conforming to paragraph EXPANSION JOINT MATERIAL.

2.8 REINFORCING

****

NOTE: Edit these paragraphs to conform to project requirements. Delete those not needed. Add epoxy-coated bars (ASTM A775/A775M) or low-alloy bars (ASTM A706/A706M) when required by design. Low-alloy steel bars are intended for welding.

****

Provide reinforcement that is free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete. Removal of thin powdery rust and tight rust is not required. However, reinforcing steel which is rusted to the extent that it does not conform to the required dimensions or mechanical properties is not allowed to be used.

2.8.1 Reinforcing Bars and Bar Mats

Provide deformed reinforcing bars conforming to ASTM A615/A615M, Grade 420 Grade 60 or ASTM A996/A996M, Grade 420 Grade 60. Provide bar mats conforming to ASTM A184/A184M.

2.8.2 Welded Wire Reinforcement

Provide welded wire reinforcement that is deformed or smooth, conforming to ASTM A1064/A1064M or ASTM A185/A185M, and provided in flat sheets.

2.9 DOWELS

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NOTE: Retain paragraph on dowels. Even if not required, allow dowels as an option. .

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2.9.1 Dowels

Provide dowels in single piece bars fabricated or cut to length at the shop or mill before delivery to the site. Dowels are to be free of loose, flaky rust and loose scale and be clean and straight. Dowels may be sheared to length provided that the deformation from true shape caused by shearing does not exceed 1 mm 0.04 inch on the diameter of the dowel and does not extend more than 1 mm 0.04 inch from the end of the dowel. Dowels are required to be smooth steel bars conforming to ASTM A615/A615M, Grade 280 or 420 Grade 40 or 60; ASTM A996/A996M, Grade 350 or 420 Grade 50 or 60. Epoxy coat dowels in conformance with Type 1 coating requirements of ASTM A1078/A1078M, to include the ends. Provide grout retention rings that are fully circular metal or plastic devices capable of supporting the dowel until the epoxy hardens. Dowel sleeves or inserts are not permitted.

2.9.2 Dowel Bar Assemblies

Provide dowel bar assemblies that consist of a framework of metal bars or wires arranged to provide rigid support for the dowels throughout the paving operation, with a minimum of four continuous bars or wires extending along the joint line. Provide dowels that are welded to the assembly or held firmly by mechanical locking arrangements that prevent them from rising, sliding out, or becoming distorted during paving operations.

2.10 EPOXY RESIN

Provide epoxy-resin materials that consist of two-component materials conforming to the requirements of ASTM C881/C881M, Class as appropriate for each application temperature to be encountered, except that in addition, the materials meet the following requirements:

a. Type IV, Grade 3 for use for embedding dowels and anchor bolts.

b. Type III, Grade as required for use as patching materials for complete filling of spalls, saw-cut runouts, and other voids and for use in preparing epoxy resin mortar.

c. Type IV, Grade 1 for use for injecting cracks.

d. Type V, Grade as required for bonding freshly mixed portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete.

2.11 EQUIPMENT

Maintain all plant, equipment, tools, and machines used in the work in satisfactory working conditions at all times. Submit the following:

a. Details and data on the batching and mixing plant prior to plant assembly including manufacturer's literature showing that the equipment meets all requirements specified herein.

****

NOTE:For OCONUS projects, contact NRMCA (http://www.nrmca.org) concerning approved engineers available in the geographic area.

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b. Obtain National Ready Mixed Concrete Association (NRMCA) certification of the concrete plant, at no expense to the Government. Provide inspection report of the concrete plant by an engineer approved by the NRMCA. A list of NRMCA approved engineers is available on the NRMCA website at http://www.nrmca.org. Submit a copy of the NRMCA QC Manual Section 3 Concrete Plant Certification Checklist, NRMCA Certificate of Conformance, and Calibration documentation on all measuring and weighing devices prior to uniformity testing.

c. A description of the equipment proposed for transporting concrete mixture from the central mixing plant to the paving equipment.

d. A description of the equipment proposed for the machine and hand placing, consolidating and curing of the concrete mixture. Manufacturer's literature on the paver and finisher, together with the manufacturer's written instructions on adjustments and operating procedures necessary to assure a tight, smooth surface on the concrete pavement. The literature is required to show that the equipment meets all details of these specifications.

2.11.1 Batching and Mixing Plant

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NOTE: The batching and mixing plant must be no further than 45 minutes haul time from the placing site during all periods of the work day.

****

2.11.1.1 Location

Utilize a batching and mixing plant off Government premises no more than 45 minutes haul and gate security check time from the placing site. Provide communications between the plant and the active work site at all times during concrete placement.

2.11.1.2 Type and Capacity

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NOTE: Adjust the production rate using the typical paving lane width, thickness, and anticipated placement rate for the project.

The paving sequence plan and proposed paving pattern and size of the job dictate the necessary plant capacity requirements to avoid any delay in paving operations.

****

Provide a batching and mixing plant consisting of a stationary-type central mix plant, including permanent installations and portable plants installed on stable foundations. Provide a plant designed and operated to produce concrete within the specified tolerances, with a minimum capacity of [75][_____] cubic meters [100][_____] cubic yards per hour, that conforms to the requirements of NRMCA QC 3 including provisions addressing:

1. Material Storage and Handling
2. Batching Equipment
3. Central Mixer
4. Ticketing System
5. Delivery System

2.11.1.3 Ready-Mixed Concrete

Provide ready-mixed concrete in accordance with ASTM C94/C94M.

2.11.1.4 Concrete Made by Volumetric Batching and Continuous Mixing

Provide concrete made by volumetric batching and continuous mixing in accordance with ASTM C685/C685M.

2.11.1.5 Concrete Uniformity Requirements

Provide concrete meeting the uniformity requirements of ASTM C94/C94M. Perform uniformity testing no earlier than 6 months before placement using the approved mixture proportions for the project. Submit mixer performance (uniformity) testing showing concrete is within the limits of ASTM C94/C94M.

2.11.2 Truck

Truck mixers are not allowed for mixing or transporting slipformed paving concrete. Provide only truck mixers designed for mixing or transporting paving concrete with extra large blading and rear opening specifically for low-slump paving concrete. Provide truck mixers, the mixing of concrete therein, and concrete uniformity and testing thereof that conform to the requirements of ASTM C94/C94M. Determine the number of revolutions between 70 to 100 for truck-mixed concrete and the number of revolutions for shrink-mixed concrete by uniformity tests as specified in ASTM C94/C94M and in requirements for mixer performance stated in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL DURING CONSTRUCTION in PART 3. If requirements for the uniformity of concrete are not met with 100 revolutions of mixing after all ingredients including water are in the truck mixer drum, discontinue use of the mixer until the condition is corrected. Water is not allowed to be added after the initial introduction of mixing water except, when on arrival at the job site, the slump is less than specified and the water-cement ratio is less than that given as a maximum in the approved mixture. Additional water may be added to bring the slump within the specified range provided the approved water-cement ratio is not exceeded. Inject water into the head of the mixer (end opposite the discharge opening) drum under pressure, and turn the drum or blades a minimum of 30 additional revolutions at mixing speed. The addition of water to the batch at any later time is not allowed.[Perform mixer performance (uniformity) tests for truck mixers in accordance with ASTM C94/C94M.]

2.11.3 Transporting Equipment

Deliver concrete to the paving site in accordance with ASTM C94/C94M. Do not use non-agitating equipment unless total haul time is less than 15 minutes.Provide transporting equipment designed and operated to deliver and discharge the required concrete mixture completely without segregation.

[2.11.4 Transfer and Spreading Equipment

****

NOTE: Delete this requirement when transporting equipment will be trafficking on existing airfield pavement placed prior to the start of work for the current project. Select a transfer spreader when transporting equipment will be trafficking on either

subgrade, base course, or drainage layers. When either conveyance system below is appropriate select both options to allow the contractor the option for either (i.e. an MTV or a placer-spreader).
****

[Provide a Material Transfer Vehicle (MTV) capable of moving between the hauling equipment and the paver and equipped with a swing conveyor that delivers material to the paver from outside the paving lane without making contact with the paver while allowing the paver to operate at a constant speed.] [Alternatively,] [Provide placer-spreader equipment for transferring concrete from the transporting equipment to the paving lane in front of the paver that is specially manufactured, self-propelled transfer equipment which accepts the concrete outside the paving lane, transfers, and spreads it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.]

]2.11.5 Paver-Finisher

2.11.5.1 General

Use a heavy duty vibratory truss screed or triple roller tube paver for concrete placement.

2.11.5.2 Heavy Duty Vibratory Truss Screed

Provide a heavy duty vibratory truss screed designed specifically for paving and finishing low slump concrete with an engine having a minimum of 6.7 kW 9 horsepower. The truss screed is required to be easily adjustable and capable of spanning the lane being paved with a minimum weight of 27 kg per m 18 pounds per foot of lane width. Operate the screed to shape, compact, and smooth the surface and finish the surface so that no significant amount of hand finishing except use of cutting straightedges is required. Provide adjustment for variation in lane width or thickness and to prevent more than 200 mm 8 inches of the screed extending over previously placed or existing concrete.

2.11.5.3 Triple Roller Tube Paver

Provide a triple roller tube paver with an engine having a minimum of 55.2 kW 74 horsepower. The paver is required to be easily adjustable and capable of spanning the lane being paved with a minimum weight of 720 kg per m 480 pounds per foot of lane width. Operate the paver to shape, compact, and smooth the surface and finish the surface so that no significant amount of hand finishing except use of cutting straightedges is required.

2.11.5.4 Vibrators

Provide full-depth consolidation using immersion vibrators from a work bridge. Provide vibrators that can be operated at any desired depth within the slab and can be completely withdrawn from the concrete as required. Equip vibrators with controls to immediately stop vibration as forward motion of the work ceases. Space immersion vibrators across the paving lane as necessary to properly consolidate the concrete with a maximum clear distance between vibrators of 750 mm 30 inches. Place outside vibrators within 300 mm 12 inches from the lane edge. Measure the vibrator frequency and amplitude in accordance with COE CRD-C 521.

2.11.5.5 Other Types of Finishing Equipment

Grate tampers (jitterbugs), laser screeds, single or double rotating tube floats, or bridge deck finishers are not allowed.

2.11.6 Curing Equipment

Provide equipment for applying membrane-forming curing compound mounted on a self-propelled frame that spans the paving lane. Constantly agitate the curing compound reservoir mechanically (not air) during operation and provide a means for completely draining the reservoir. Provide a spraying system that consists of a mechanically powered pump which maintains constant pressure during operation, an operable pressure gauge, and either a series of spray nozzles evenly spaced across the lane to provide uniformly overlapping coverage or a single spray nozzle which is mounted on a carriage which automatically traverses the lane width at a speed correlated with the forward movement of the overall frame. Protect all spray nozzles with wind screens. Calibrate the spraying system in accordance with ASTM D2995, Method A, for the rate of application required in paragraph MEMBRANE CURING. Provide hand-operated sprayers allowed by that paragraph with compressed air supplied by a mechanical air compressor. Immediately replace curing equipment if it fails to apply an even coating of compound at the specified rate.

2.11.7 Texturing Equipment

Provide texturing equipment as specified below. Before use, demonstrate the texturing equipment on a test section, and modify the equipment as necessary to produce the texture directed.

2.11.7.1 Burlap Drag

Securely attach a burlap drag to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. Provide length of the material between 600 to 900 mm 24 to 36 inches dragging flat on the pavement surface. Provide burlap drag with a width at least equal to the width of the slab. Provide clean, reasonably new burlap material, completely moistened before start of use, and keep clean and maintained moist during use. Provide burlap conforming to AASHTO M 182, Class 3 or 4.

2.11.7.2 Broom

Apply surface texture using an approved stiff bristle broom drag of a type that provides a uniformly scored surface transverse to the pavement center line. Provide broom with handles longer than the width of slab to be finished capable of traversing the full width of the pavement at a uniform speed and with a uniform pressure that results in scores uniform in appearance and approximately 2 mm 1/16 inch in depth but not more than 3 mm 1/8 inch in depth.

2.11.8 Sawing Equipment

Provide saws capable of sawing to the full depth required.

2.11.8.1 Diamond Saw

Provide equipment for sawing joints and for other similar sawing of concrete consisting of standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment. Provide diamond tipped blades. Provide spares as required to maintain the required sawing rate. Early-entry saws may be used subject to demonstration and approval. No change to the initial sawcut depth is permitted.

2.11.8.2 Wheel Saw

Provide wheel saws used in the removal of concrete with large diameter tungsten carbide tipped blades mounted on a heavy-duty chassis which produce a saw kerf at least 40 mm 1-1/2 inches wide.

2.11.9 Straightedge

Provide and maintain at the job site, in good condition, a minimum 4 m 12 foot straightedge for each paving train for testing the hardened portland cement concrete surfaces. Provide straightedges constructed of aluminum or magnesium alloy and blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Provide straightedges with handles for operation on the pavement.

2.11.10 Work Bridge

Provide a self-propelled working bridge capable of spanning the required paving lane width where workmen can efficiently and adequately reach the pavement surface.

2.11.11 Diamond Grinding of PCC Surfaces

Perform diamond grinding by sawing with an industrial diamond abrasive which is impregnated in the saw blades. Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the concrete pavement or joint faces. Provide diamond grinding equipment with saw blades that are 3 mm 1/8-inch wide, a minimum of 55 to 60 blades per 300 mm 12 inches of cutting head width, and capable of cutting a path a minimum of 0.9 m 3 ft wide. Diamond grinding equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints is not permitted. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government property.

2.12 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

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NOTE: Concrete for airfield pavement is typically proportioned and accepted on the basis of 90-day flexural strength. However, use 28-day compressive strength for small projects. Specified compressive strength must be equivalent to the flexural strength used in the design of the pavement. Do not specify a compressive strength that exceeds an equivalent flexural strength of 4.5 MPa 650 psi at 28 days of age. Designer must also ensure that the specified strength is attainable with the available aggregates.

****

2.12.1 Specified Compressive Strength

Specified compressive strength, f'c, for concrete is 35 MPa 5,000 psi at 28 days of age as determined by test specimens fabricated in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M.

2.12.2 Water-Cementitious Materials Ratio

The allowable water-cementitious material ratio is 0.38 0.45. The water-cementitious material ratio is the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus SCM by the mass equivalency method described in ACI 211.1.

2.12.3 Air Content

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NOTE: For the standard coarse aggregate with the nominal maximum size of 37 mm 1.5 inches, the total air content must be specified as 6.0 percent where freezing and thawing is a concern. For a coarse aggregate with the nominal maximum size of 25 mm 1.0 inch, the total air content must be specified as 6.5 percent where freezing and thawing is a concern. Specify 4.0 percent where freezing and thawing is not a concern.

****

Provide concrete that is air-entrained with a total air content of [4.0] [6.0] [6.5] plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C231/C231M.

2.12.4 Slump

The maximum allowable slump of the concrete at the point of placement is 75 mm 3 inches for pavement constructed with fixed forms.

2.12.5 Concrete Temperature

The temperature of the concrete as delivered is required to conform to the requirements of paragraphs PAVING IN HOT WEATHER and PAVING IN COLD WEATHER, in PART 3. Determine the temperature of concrete in accordance with ASTM C1064/C1064M.

2.13 MIXTURE PROPORTIONS

2.13.1 Composition

Provide concrete composed of cementitious material, water, fine and coarse aggregates, and admixtures. Include supplementary Cementitious Materials (SCM) choice and usage in accordance with paragraph SUPPLEMENTARY CEMENTITIOUS MATERIALS (SCM) CONTENT. Provide a minimum total cementitious materials content of 310 kg per cubic meter 517 pounds per cubic yard. Limit the total alkali loading contributed by the portland cement or the portland cement portion of a blended cement to a maximum of 1.8 kg per cubic meter 3.0 lb per cubic yard. Calculate the alkali loading as the product of the portland cement content of the concrete multiplied by the alkali content of the portland cement or the portland cement portion of the blended cement, divided by 100. Determine the alkali content in accordance with ASTM C114.

2.13.2 Proportioning Studies

Perform trial design batches, mixture proportioning studies, and testing, at no expense to the Government. Submit for approval the Preliminary Proposed Proportioning to include items a., b., and i. below a minimum of 7 days prior to beginning the mixture proportioning study. Submit the results of the mixture proportioning studies signed and stamped by the registered professional engineer having technical responsibility for the mix design study, and submitted at least 30 days prior to commencing concrete placing operations. Include a statement summarizing the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic meter yard basis. Base aggregate quantities on the mass in a saturated surface dry condition. Provide test results demonstrating that the proposed mixture proportions produce concrete of the qualities indicated. Base methodology for trial mixtures having proportions, slumps, and air content suitable for the work as described in ACI 211.1 and ACI 325.14R. Submit test results including:

a. Coarse and fine aggregate gradations and plots. Include historic gradation averages and standard deviations on individual sieves for each aggregate size group if available.
b. Combined aggregate gradation and coarseness vs. workability plots.
c. Coarse aggregate quality test results including deleterious materials.
d. Fine aggregate quality test results including deleterious materials.
e. Mill certificates for cement and supplementary cementitious materials.
f. Certified test results for air entraining, water-reducing, retarding, and non-chloride accelerating admixtures.
g. Specified compressive strength, slump, and air content.
h. Documentation of required average compressive strength, f'cr.
i. Recommended proportions and volumes for proposed mixture and each of three trial water-cementitious materials ratios.
j. Individual cylinder breaks.
k. Compressive strength summaries and plots.
l. Historical record of ACI 214R strength test results, documenting production standard deviation (if available).
m. Narrative discussing methodology on how the mix design was developed in accordance with ACI 211.1 and ACI 325.14R.
n. Alternative aggregate blending to be used during the test section if necessary to meet the required surface and consolidation requirements.

2.13.2.1 Water-Cementitious Materials Ratio

Perform at least three different water-cementitious materials ratios, which produce a range of strength encompassing that required on the project. The maximum water-cementitious materials ratio of the approved mix design becomes the maximum water-cementitious materials ratio for the project, and in no case exceeds 0.45.

2.13.2.2 Trial Mixture Studies

Perform separate sets of trial mixture studies made for each combination of cementitious materials and each combination of admixtures proposed for use. No combinations are to be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerating or retarding admixture can be used without separate trial mixture study. Perform separate trial mixture studies for each placing method (fixed form or hand placement) proposed. Report the temperature of concrete in each trial batch. Design each mixture to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding. Proportion laboratory trial mixtures for maximum permitted slump and air content.

2.13.2.3 Mixture Proportioning for Compressive Strength

Follow the step by step procedure below:

a. Fabricate all cylinders for each mixture from the same batch or blend of batches. Fabricate and cure all cylinders in accordance with ASTM C192/C192M, using 152 x 305 mm 6 x 12 inches single-use cylinder forms.

b. Cure test cylinders from each mixture for 3, 7, and 28-day compressive strength tests; 3 cylinders to be tested per age.

c. Test cylinders in accordance with ASTM C39/C39M.

d. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:
    3-day compressive strength
    7-day compressive strength
    28-day compressive strength

e. From these graphs select a w/c that produces a mixture giving a 28-day compressive strength equal to the required average compressive strength (f'cr) determined in accordance with the next paragraph.

f. If there is a change in materials, perform additional mixture design studies using the new materials.

g. No concrete pavement placement is allowed until the mixture proportions are approved. The approved water-cementitious materials ratio is restricted to the maximum w/c ratio and is not be increased without written approval.

h. If previous trial mixture studies have been completed and approved using the same materials within one year only one w/c ratio is required for verification purposes. Select a w/c ratio within the range of the previous trial mixture studies.

2.13.3 Required Average Compressive Strength

Establish mixture proportions during trial mixture studies that produce a required average compressive strength (f'cr) exceeding the specified compressive strength (f'c) by the amount indicated below.

2.13.3.1 From Previous Test Records

Where a concrete production facility has previous test records current to within 24 months, establish a standard deviation in accordance with the applicable provisions of ACI 214R. Test records used to calculate the standard deviation are to be representative of materials, quality control procedures, and expected conditions. Test records are to be within 7 MPa 1000 psi of the strength specified for the proposed work and consist of at least 30 consecutive tests. A strength test is the average of the strengths of two specimens made from the same sample of concrete and tested at 28-days. Use the equations below to compute the required average compressive strength (f'cr):

f'cr,1 = f'c + 1.34KS

f'cr,2 = f'c + 2.33KS - 3.5 MPa f'cr,2 = f'c + 2.33KS - 500 psi

f'cr,final = larger of f'cr,1 and f'cr,2

Where:
f'c = specified compressive strength
K = Modification factor
S = Standard Deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, establish a standard deviation as the product of the calculated standard deviation and a modification factor from Table 5

TABLE 5

MODIFICATION FACTOR FOR STANDARD DEVIATION

NUMBER OF TESTS	MODIFICATION FACTOR (K)
20	1.08
25	1.03
30 or more	1.00

2.13.3.2 Without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, determine the required average compressive strength (f'cr) by the following equation:

f'cr = f'c + 8.3 MPa f'cr = f'c + 1,200 psi

PART 3 EXECUTION

3.1 PREPARATION FOR PAVING

Perform the following actions to prepare for paving operations:

a. Concrete plant has been inspected and approved. Mixer uniformity testing for optimum mixing time has been determined.

b. All equipment in the paving train is in operational condition, ready for use, clean, and free of hardened concrete and foreign material.

c. An acceptable length of grade for concrete paving is available. All base materials are verified to conform to project plans and specification requirements.

d. Test reports for all materials in the concrete mixture are on file at the job site and at the plant site.

e. Backup testing equipment and a test equipment backup plan is available.

f. All necessary concrete placement tools such as hand tools, straight edges, hand floats, edgers, and hand vibrators are available.

g. The needed number of haul trucks are available.

h. Vibrators have been checked for frequency and amplitude. Vibrator spacing has been checked and conforms to the vibrator manufacturer recommendations.

i. Measures have been developed and taken to mitigate extreme weather conditions during paving.

j. Weather forecast for each day of paving is available and checked daily.

k. Fixed-forms and reinforcing steel is placed, clean, and adequately supported.

3.1.1 Weather Precaution

When windy conditions during paving appear probable, have equipment and material at the paving site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete. During these conditions, monitor and report the evaporation rate hourly.

3.1.2 Proposed Techniques

****

NOTE: Include joint layout and typical detail of joint/dowel bar spacing in drawings and coordinate with paragraph PLACING DOWELS. Insert office title for approval of joint plan changes.

****

Submit placing and protection methods; paving sequence; jointing pattern; data on curing equipment; demolition of existing pavements; pavement diamond grinding equipment and procedures. Submit for approval the following items:

a. A description of the placing and protection methods proposed when concrete is to be placed in or exposed to hot, cold, or rainy weather conditions.

b. A detailed paving sequence plan and proposed paving pattern showing all planned construction joints; transverse and longitudinal dowel bar spacing; and identifying paving lanes and hand placement areas. Deviations from the jointing pattern shown on the drawings are not allowed without written approval of the [design engineer] [_____].

c. Plan and equipment proposed to control alignment of sawn joints within the specified tolerances.

d. Data on the curing equipment, media and methods to be used.

e. Method used to measure pavement smoothness.

f. Pavement demolition work plan, presenting the proposed methods and equipment to remove existing pavement and protect pavement to remain in place.

g. Submit a Diamond Grinding Plan for review and approval prior to diamond grinding. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth is limited below. Reduce high areas by diamond grinding the hardened concrete with an approved equipment after the concrete is at a minimum age of 14 days.

3.2 CONDITIONING OF UNDERLYING MATERIAL

3.2.1 General Procedures

Confirm the underlying material upon which concrete is to be placed is clean, damp, and free of debris, waste concrete, waste cement, frost, ice, standing water, and running water. Confirm the underlying material is well drained and has been satisfactorily graded and uniformly compacted in accordance with [Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASES FOR FLEXIBLE] PAVING] [Section 32 11 23.23 BASE COURSE DRAINAGE LAYERS] prior to setting forms or placement of concrete. Rework and compact any underlying material disturbed by construction operations to specified density immediately in front of the paver.

3.2.2 Traffic on Underlying Material

****

NOTE: Do not allow transporting equipment to operate on the prepared underlying material in front of the paver. Operating hauling equipment in the paving lane will cause the paver to stop frequently producing a discontinuity in the pavement surface. Coordinate with Part 2, subparagraph TRANSFER AND SPREADING EQUIPMENT.

****

Transporting equipment is not to be allowed to operate on the prepared and compacted underlying material in front of the paver-finisher. Subject to specific approval, crossing of the prepared underlying material at specified intervals for construction purposes may be permitted, provided rutting or indentations do not occur. Rework and repair the surface before concrete is placed.

3.3 WEATHER LIMITATIONS

3.3.1 Placement and Protection During Inclement Weather

Do not commence placing operations when heavy rain or other damaging weather conditions appear imminent. At all times when placing concrete, maintain on-site sufficient waterproof cover and means to rapidly place it over all unhardened concrete or concrete that might be damaged by rain.

Immediately cover and protect all unhardened concrete from rain or other damaging weather. Suspend placement of concrete whenever rain, high winds, or other weather commences to damage the surface or texture of the placed unhardened concrete, washes cement out of the concrete, or changes the water content of the surface concrete.

Remove and replace any slab damaged by rain or other weather full depth by full slab width to the nearest original joint as specified in paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS, at no expense to the Government.

3.3.2 Paving in Hot Weather

****

NOTE: See ACI 305R for additional information concerning hot weather concreting. Do not delete this paragraph or the next paragraphs addressing weather.

****

Prepare for hot weather paving in accordance with ACI 305R. When the ambient temperature during paving is expected to exceed 32 degrees C 90 degrees F, properly place and finish the concrete in accordance with procedures previously submitted, approved, and as specified herein. Provide concrete that does not exceed 35 deg C95 deg F when measured in accordance with ASTM C1064/C1064M at the time of delivery. Cool the mixing water or aggregates or place in the cooler part of the day to obtain an adequate placing temperature. Cool steel forms and reinforcing as needed to maintain steel temperatures below 49 degrees C 120 degrees F. Cool or protect transporting and placing equipment if necessary to maintain proper concrete placing temperature. Keep the finished surfaces of the newly laid pavement damp by applying a fog spray (mist) with approved spraying equipment until the pavement is covered by the curing medium.

3.3.3 Prevention of Plastic Shrinkage Cracking

Develop and institute measures to prevent plastic shrinkage cracks during weather with low humidity, high temperature, or appreciable winds. Halt further placement of concrete if plastic shrinkage cracking occurs until protective measures are in place to prevent further cracking. Periods of high potential for plastic shrinkage cracking can be anticipated by use of ACI 305R. In addition to the protective measures specified in the previous paragraph, further protect the concrete placement by erecting shades and windbreaks and by applying fog sprays of water, the addition of monomolecular films, or wet covering. Apply monomolecular films after finishing is complete. Do not use monomolecular films in the finishing process. Immediately commence curing procedures when such water treatment is stopped. Repair plastic shrinkage cracks in accordance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. Never trowel over or fill plastic shrinkage cracks with slurry.

3.3.4 Paving in Cold Weather

Cold weather paving is required to conform to ACI 306R. During periods of cold-weather protection make daily reports of pertinent temperatures. Use special protection measures, as specified herein, if freezing temperatures are anticipated or occur before the expiration of the specified curing period. Do not begin placement of concrete unless the ambient temperature is at least 2 degrees C 35 degrees F and rising. Thereafter, halt placement of concrete whenever the ambient temperature drops below 5 degrees C 40 degrees F. When the ambient temperature is less than 10 degrees C 50 degrees F, the temperature of the concrete when placed is required to be not less than 10 degrees C 50 degrees F nor more than 25 degrees C 75 degrees F. Provide heating of the mixing water or aggregates as required to regulate the concrete placing temperature. Provide materials entering the mixer that are free from ice, snow, or frozen lumps. Do not incorporate salt, chemicals, or other materials in the concrete to prevent freezing.[If allowed under paragraph MIXTURE PROPORTIONS in PART 2, use an accelerating admixture when the ambient temperature is below 10 degrees C 50 degrees F.] Provide covering and other means for maintaining the concrete at a temperature of at least 10 degrees C 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period. Remove pavement slabs, full depth by full width, damaged by freezing or falling below freezing temperature to the nearest planned joint, and replace as specified in paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS, at no expense to the Government.

3.4 CONCRETE PRODUCTION

Provide batching, mixing, and transporting equipment with a capacity sufficient to maintain a continuous, uniform forward movement of the paving operation. Deposit concrete transported in truck mixers in front of the paver within 90 minutes from the time cement has been charged into the mixer drum of the plant or truck mixer. If the ambient temperature is above 32 degrees C 90 degrees F, the time is reduced to 60 minutes. Accompany every load of concrete delivered to the paving site with a batch ticket from the operator of the batching plant. Provide batch ticket information required by ASTM C94/C94M on approved forms. In addition provide design quantities in mass or volume for all materials, batching tolerances of all materials, and design and actual water cementitious materials ratio on each batch delivered, the water meter and revolution meter reading on truck mixers and the time of day. Provide batch tickets for each truck delivered to the placing foreman to maintain on file. Submit batch tickets to the Government weekly.

3.4.1 Batching and Mixing Concrete

Maintain scale pivots and bearings clean and free of rust. Remove any equipment which fails to perform as specified immediately from use until properly repaired and adjusted, or replaced.

3.4.2 Transporting and Transfer - Spreading Operations

Deposit concrete as close as possible to its final position in the paving lane. Operate all equipment to discharge and transfer concrete without segregation. Dumping of concrete in discrete piles is not permitted. Operate non-agitating equipment only on smooth roads and for haul time less than 15 minutes. No transfer or spreading operation which requires the use of front-end loaders, dozers, or similar equipment to distribute the concrete is permitted. Do not exceed a free vertical drop of 1 m 3 feet at any point in concrete conveyance. No equipment is permitted to operate on the grade in front of the paver.

3.5 PAVING

****

NOTE: Correlate these paragraphs with paragraph

EQUIPMENT.
****

3.5.1 General Requirements

Construct pavement with paving and finishing equipment utilizing rigid fixed forms. Control paving equipment and its operation with all other operations such that the paver-finisher has a continuous forward movement at a reasonably uniform speed from beginning to end of each paving lane. Failure to achieve a continuous forward motion requires halting operations, regrouping, and modifying procedures, equipment, or mix proportions to achieve this requirement. Personnel are not permitted to walk or operate in the plastic concrete at any time. Select paving equipment and procedures which can properly operate on open-graded drainage layers without causing displacement or other damage.

3.5.2 Consolidation

Consolidate the concrete full-depth by use of immersion vibrators operated from a work bridge spanning the lane of placement. Do not use vibrators to transport or spread the concrete. Insert vibrators into the concrete to a depth that provides the best full-depth consolidation but not closer to the underlying material than 50 mm 2 inches. Insert hand-operated vibrators between 150 to 400 mm 6 to 15 inches on centers. Do not use hand-operated vibrators in the concrete in one location for more than 20 seconds. If vibrators cause visible tracking in the paving lane, or there are any other indications of inadequate consolidation (honeycomb along the edges, large air pockets or other voids, or any other evidence), discontinue paving operations until equipment and procedures have been modified to prevent it. Excessive vibration is not permitted. See ACI 309R for additional guidance on internal consolidation. Provide at least one additional vibrator spud or sufficient parts for rapid replacement and repair of vibrators at the paving site at all times.

3.5.3 Operation

3.5.3.1 Headers

Maintain a sufficient amount of concrete ahead of the paver to provide a roll of concrete which spills over the header. Provide a sufficient amount of extra concrete to prevent any slurry that is formed and carried along ahead of the paver from being deposited adjacent to the header. Maintain the spud vibrators in front of the paver-finisher operation at the desired depth as close to the header as possible before they are lifted. Provide additional consolidation adjacent to the headers by hand-manipulated vibrators.

3.5.3.2 Fill-In Lanes

Provide provisions to prevent damage to the previously constructed or existing pavement when placing fill-in lanes. Control heavy duty vibratory truss screeds and triple roller tubes from applying excess pressure to the existing pavement and to prevent abrasion of the pavement surface. Maintain the overlapping area of existing pavement surface completely free of any loose or bonded foreign material as the paver-finisher operates across it.

3.5.4 Required Results

Adjust and operate the paver-finisher to produce a well consolidated slab throughout that is true to line and grade within specified tolerances. Provide a paver-finishing operation that produces a surface finish with a minimum, isolated amount of irregularities, tears, voids of any kind, and any other discontinuitiesacross the pavement. Provide equipment and paving operations that produce a finished surface requiring only the use of cutting straightedges. Keep hand finishing behind the paving equipment to a minimum.

3.5.5 Fixed Form Paving

Provide paving equipment for fixed-form paving and the operation that conforms to the requirements of paragraph EQUIPMENT, and all requirements specified herein.

3.5.5.1 Forms for Fixed-Form Paving

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NOTE: Delete subparagraph e. when overlay pavements are not required.

****

a. Provide straight forms made of steel and in sections not less than 3 m 10 feet in length that are clean and free of rust or other contaminants. Seal any holes or perforations in forms prior to paving unless otherwise permitted. Maintain forms in place and passable by all equipment necessary to complete the entire paving operation without need to remove horizontal form supports. Provide flexible or curved forms of proper radius for curves of 31 m 100-foot radius or less. Provide wood forms for curves and fillets made of well-seasoned, surfaced plank or plywood, straight, and free from warp or bend that have adequate strength and are rigidly braced. Provide forms with a depth equal to the pavement thickness at the edge. Where the project requires several different slab thicknesses, forms may be built up to provide an increase in depth of not more than 25 percent by bolting or welding a tubular metal section or by bolting wood planks to the bottom of the form to completely cover the underside of the base of the form. Provide forms with the base width of the one-piece or built-up form not less than eight-tenths of the vertical height of the form, except provide forms 200 mm 8 inches or less in vertical height with a base width not less than the vertical height of the form. Provide forms with maximum vertical deviation of top of any side form, including joints, not varying from a true plane more than 3 mm 1/8 inch in 3 m 10 feet, and the upstanding leg not varying more than 6 mm 1/4 inch.

b. Provide form sections that are tightly locked and free from play or movement in any direction. Provide forms with adequate devices for secure settings so that when in place they withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment.

c. Set forms for full bearing on foundation for entire length and width and in alignment with edge of finished pavement. Support forms during entire operation of placing, compaction, and finishing so that forms do not deviate vertically more than 3 mm 0.01 foot from required grade and elevations indicated. Check conformity to the alignment and grade elevations shown on the drawings and make necessary corrections immediately prior to placing the concrete. Clean and oil the forms each time before concrete is placed. Concrete placement is not allowed until setting of forms has been checked and approved by the CQC team.

d. Do not anchor guide rails for fixed form pavers into new concrete or existing concrete to remain.

[e. Use stakes or other approved methods to securely hold forms for overlay pavements and for other locations where forms are set on existing pavements. Carefully drill holes in existing pavements for form stakes by methods which do not crack or spall the existing pavement. After use, fill the holes flush with the surrounding surface using approved material, prior to overlying materials being placed. Immediately discontinue any method which does not hold the form securely or which damages the existing pavement. Prior to setting forms for paving operations, demonstrate the proposed form setting procedures at an approved location without proceeding further until the proposed method is approved.]

3.5.5.2 Form Removal

Keep forms in place at least 12 hours after the concrete has been placed. When conditions are such that the early strength gain of the concrete is delayed, leave the forms in place for a longer time. Remove forms by procedures that do not damage the concrete. Do not use bars or heavy metal tools directly against the concrete in removing the forms. Promptly repair any concrete found to be defective after form removal, using procedures specified or as directed.

3.5.6 Placing Reinforcing Steel

****

NOTE: Delete bracketed item if CRCP is not being constructed.

****

Provide the type and amount of steel reinforcement indicated. Regardless of placement procedure, provide reinforcing steel free from coatings which could impair bond between the steel and concrete, with reinforcement laps as indicated. Regardless of the equipment or procedures used for installing reinforcement, adequately consolidate the entire depth of concrete.[If reinforcing for Continuously Reinforced Concrete Pavement (CRCP) is required, submit the entire operating procedure and equipment proposed for approval at least 30 days prior to proposed start of paving.]

3.5.6.1 Pavement Thickness Greater Than 300 mm 12 inches

For pavement thickness of 300 mm 12 inches or more, place an initial lift of concrete on the underlying material to the required elevation of the steel reinforcement, consolidate the initial lift of concrete, place the steel reinforcement upon the surface of the initial lift, place a second lift of concrete to final grade, consolidate, and finish in the required manner. When placement of the second lift causes the steel reinforcement to be displaced horizontally from its original position, provide provisions for increasing the thickness of the initial lift and depressing the steel reinforcement into the unhardened concrete to the required elevation. Limit the increase in thickness only as necessary to permit correct horizontal alignment to be maintained. Remove and replace any portions of the initial lift of concrete that have been placed more than 30 minutes without being covered with the second lift with newly mixed concrete without additional cost to the Government.

3.5.6.2 Pavement Thickness Less Than 300 mm 12 Inches

For pavements less than 300 mm 12 inches thick, position the reinforcement on suitable chairs or continuous mesh support devices securely fastened to the subgrade prior to concrete placement. Consolidate concrete after the steel has been placed.

3.5.7 Placing Dowels

Provide a method to install and hold dowels in position that meets the tolerances for location, alignment, and spacing of Table 6 after the pavement has been completed. Do not place longitudinal dowels closer than 0.6 times the dowel bar length to the planned joint line. If the last regularly spaced longitudinal dowel is closer than that dimension, move it away from the joint to a location 0.6 times the dowel bar length, but not closer than 150 mm 6 inches to its nearest neighbor. Resolve dowel interference at a transverse joint-longitudinal joint intersection by removing the closest transverse dowel. Do not position the end of a transverse dowel closer than 300 mm 12 inches from the end of the nearest longitudinal dowel. Install dowels as specified in the following subparagraphs.

TABLE 6

DOWEL ALIGNMENT TOLERANCES

Dowel Measurement	Tolerance
Horizontal alignment (a)	Maximum of 3 mm per 300 mm 1/8 inch per foot after the pavement has been completed
Vertical alignment (b)	Maximum of 3 mm per 300 mm 1/8 inch per foot after the pavement has been completed
Horizontal spacing	plus or minus 15 mm 5/8 inch, except as otherwise specified above
Vertical location on the face of the slab	plus or minus 13 mm 1/2 inch
(a) Check horizontal alignment perpendicular to the joint edge with a framing square.	
(b) Measure the vertical alignment of the dowels parallel to the designated top surface of the pavement, except for those across the crown or other grade change joints. Measure dowels across crowns and other joints at grade changes to a level surface.	

[3.5.7.1 Contraction Joints

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NOTE: Delete references to installation of dowels in contraction joints if not required.

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Securely hold dowels in longitudinal and transverse contraction joints within the paving lane in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. Securely hold the basket assemblies in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires.

]3.5.7.2 Construction Joints-Fixed Form Paving

Install dowels by the bonded-in-place method or the drill-and-dowel method. Installation by removing and replacing in preformed holes is not permitted. Prepare and place dowels across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. Provide the spacing of dowels in construction joints as indicated, except that, where the planned spacing cannot be maintained because of form length or interference with form braces, provide closer spacing with additional dowels.

3.5.7.3 Dowels Installed in Hardened Concrete

Install dowels in hardened concrete by bonding the dowels into holes drilled into the hardened concrete. Before drilling commences, cure the concrete for 7 days or until it has reached a minimum field cured compressive strength of 17 MPa 2500 psi. Drill holes 3 mm 1/8 inch greater in diameter than the dowels into the hardened concrete using rotary-core drills. Rotary-percussion drills are permitted provided that excessive spalling does not occurat the concrete joint face. Excessive spalling is defined as spalling deeper than 6 mm 1/4 inch from the joint face or 12 mm 1/2 inch radially from the outside of the drilled hole. Modify the equipment and operation if excess spalling occurs. Drill depth of dowel hole within a tolerance of plus or minus 13 mm 1/2 inch of the half length of the embedded dowel. Blow out the dowel hole with oil-free, compressed air upon completion of the drilling operation. Bond dowels in the drilled holes using epoxy resin. Inject epoxy resin at the back of the hole before installing the dowel and extrude to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel is not permitted. Hold the dowels in alignment at the collar of the hole after insertion and before the grout hardens by means of a suitable metal or plastic grout retention ring fitted around the dowel. Provide dowels required between new and existing concrete in holes drilled in the existing concrete, all as specified above.

3.5.7.4 Lubricating Dowel Bars

Immediately prior to placement, wipe clean the portion of each dowel intended to move within the concrete and coat with a thin, even film of lubricating oil or light grease. Form oil is not acceptable for dowel lubrication. Do not place caps on the dowel ends.

3.6 FINISHING

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NOTE: Hand finishing is to be allowed only for isolated, small, odd-shaped slabs or places inaccessible to the paver.

****

Provide finishing operations as a continuing part of placing operations starting immediately behind the strike-off of the paver. Provide finishing by the vibratory truss screed or triple roller tube paver. Provide the sequence of operations consisting of transverse finishing, cutting straightedge finishing, edging of joints, and texturing . Provide a work bridge for consolidation and hand finishing operations. Use hand finishing only in isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Keep supplemental hand finishing for machine finished pavement to an absolute minimum. Immediately stop any machine finishing operation which requires appreciable hand finishing other than a moderate amount of straightedge finishing. Make proper adjustments or replace the equipment before recommencing paving. Immediately halt any operations which produce more than 3 mm 1/8 inch of mortar-rich surface (defined as deficient in plus 4.75 mm U.S. No. 4 sieve size aggregate) and modify the equipment, mixture, or procedures as necessary before recommencing paving. Compensate for surging behind the screeds and settlement during hardening and adjust the paving and finishing machines so that the finished surface of the concrete (not just the cutting edges of the screeds) is at the required line and grade. Maintain finishing equipment and tools in a clean and an approved working condition. Water is not allowed to be added to the surface of slabs using finishing equipment, tools, or any other method except fog (mist) sprays may be applied to slab surfaces to prevent plastic shrinkage cracking.

3.6.1 Machine Finishing With Fixed Forms

Provide a machine that is designed to ride the forms and can be operated to screed and consolidate the concrete. Replace paving equipment that causes displacement of the forms. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in minimal passes, immediately stop the operation and adjust the equipment, mixture, and procedures as necessary before recommencing paving.

3.6.2 Surface Correction and Testing

Evaluate the surface for trueness with a 4 m 12 feet straightedge after all other finishing is completed but while the concrete is still plastic. Equip the straightedge with a handle 1 m 3 feet longer than the width of the placement and operate the straightedge from the sides of the pavement or from bridges. Evaluate the surface trueness with a straightedge held in successive positions parallel and at right angles to the center line of the pavement to detect variations. Advance the straightedge along the pavement in successive stages of one-half the length of the straightedge. Eliminate minor irregularities and score marks in the pavement surface by means of cutting straightedges. Immediately fill depressions with freshly mixed concrete then strike off, consolidate with an internal vibrator, and refinish. Strike off projections above the required elevation and refinish. Continue the straightedge testing and finishing until the entire surface of the concrete is free from observable departure from the straightedge and conforms to the surface requirements specified in paragraph SURFACE SMOOTHNESS. This straightedging is not allowed to be used as a replacement for the straightedge testing of hardened concrete for acceptance. Use long-handled flat bull floats very sparingly and only as necessary to correct minor, scattered surface defects. Stop the paving operation if frequent use of bull floats is necessary. Adjust the equipment, mixture, or procedures to eliminate surface defects and frequent use of bull floats before recommencing paving. Keep finishing with hand floats and trowels to the absolute minimum necessary. Take extreme care to prevent over finishing joints and edges. Produce the surface finish of the pavement essentially by the finishing machine and not by subsequent hand finishing operations. All hand finishing operations are subject to approval.

3.6.3 Hand Finishing

Use hand finishing operations only as specified below. Provide a work bridge for full-depth consolidation operations. Walking or operating in plastic concrete is not allowed.

3.6.3.1 Finishing and Floating

Strike off and screed the concrete to the required cross section and elevation immediately after placement and full-depth consolidation. Do not overlap the floating operation more than half the length of the float between new and previously floated surfaces. If necessary, place additional concrete then consolidate, screed, and float until the specified surface, cross section, and elevation has been produced.

3.6.4 Texturing

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NOTE:Use Section 32 01 18.71 GROOVING OF AIRFIELD PAVING to specify saw-cut grooves. Delete pararaph Surface Grooving if grooving is not used.

For Navy airfield paving projects, do not specify surface grooving textures.

****

Texture the surface of the pavement as described herein when the concrete is still plastic, before the surface sheen has disappeared, and before the curing compound is applied. Apply the texture in a single continuous drag. Multiple passes are not allowed. The corrugations produced by the drag need to be uniform in appearance and approximately 1 mm 1/16 inch in depth. Thoroughly power broom all textured surfaces to remove all debris after curing is complete.

3.6.4.1 Burlap Drag Surface

Apply surface texture by dragging the surface of the pavement with an approved burlap drag in the direction of the concrete placement. Operate the drag with the fabric moist, and maintain the fabric in a clean condition. Perform the dragging so as to produce a uniform finished surface having a fine sandy texture without disfiguring marks.

3.6.4.2 Broom Texturing for Hand Finishing

Hand brooming is permitted only where hand finishing is allowed. Complete brooming before the concrete has hardened to the point where the surface is unduly torn or roughened, but after hardening has progressed enough so that the mortar does not flow and reduce the sharpness of the scores. Overlap successive passes of the broom the minimum necessary to obtain a uniformly textured surface. Wash brooms thoroughly at frequent intervals during use. Remove worn or damaged brooms from the job site. Transversely draw the hand brooms across the surface from the center line to each edge with slight overlapping strokes.

[3.6.4.3 Surface Grooving

Groove the areas indicated on the drawings as required in Section 32 01 18.71 GROOVING FOR AIRFIELD PAVEMENTS.

]3.6.5 Edging

Before texturing has been completed, carefully finish the edge of the slabs along the forms and at the joints with an edging tool to form a smooth rounded surface of 3 mm 1/8 inch radius. Eliminate tool marks and provide edges that are smooth and true to line. Water is not allowed to be added to the surface during edging. Take extreme care to prevent overworking the concrete.

3.6.6 Pavement Penetrations

Construct recesses for the tie-down anchors, lighting fixtures, and other outlets in the pavement to conform to the details and dimensions shown. Carefully finish the concrete in these areas to provide a surface of the same texture as the surrounding area that is within the requirements for plan grade and surface smoothness.

3.7 CURING

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NOTE: Membrane curing should be the first choice for curing methods. For most projects delete the first bracketed item. Retain the first bracketed item requiring moist curing for OCONUS projects using Silica Fume.

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3.7.1 Protection of Concrete

Continuously protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations as required below. Have all equipment needed for adequate curing and protection of the concrete on hand and ready for use before actual concrete placement begins. If any selected method of curing does not afford the proper curing and protection against concrete cracking, remove or replace the damaged pavement, and provide another method of curing as directed. [Accomplish curing by application of moist curing for the first 72 hours, followed by curing operations as required below for the remainder of the curing period].

3.7.2 Membrane Curing

Apply a uniform coating of white-pigmented, membrane-forming, curing compound to the entire exposed surface of the concrete as soon as the free water has disappeared from the surface after [finishing] [moist curing ceases]. Apply immediately along the formed edge faces after the forms are removed. Do not allow the concrete to dry before the application of the membrane. Moisten the surface of the concrete with a fine spray of water if any drying has occurred and apply the curing compound as soon as the free water disappears. Apply the curing compound to the finished surfaces by means of an approved automatic spraying machine. Apply the curing compound with an overlapping coverage that provides a two-coat application at a coverage of 10 square meters per L 400 square feet per gallon, plus or minus 5.0 percent for each coat. A one-coat application is allowed provided it is applied in a uniform application and coverage of 5 square meters per L 200 square feet per gallon, plus or minus 5.0 percent is obtained. The application of curing compound by hand-operated, mechanical powered pressure sprayers is permitted but application rate must meet the above requirements. When the application is made by hand-operated sprayers, apply a second coat in a direction approximately at right angles to the direction of the first coat. If pinholes, abrasions, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes. Respray curing compound to concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified above. Respray curing compound to areas where the curing compound is damaged by subsequent construction operations within the curing period immediately. Adequately protect concrete surfaces to which membrane-curing compounds have been applied during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

[3.7.3 Moist Curing

Maintain concrete to be moist-cured continuously wet for the entire curing period, or until curing compound is applied, commencing immediately after finishing. If forms are removed before the end of the curing period, provide curing on unformed surfaces, using suitable materials. Cure surfaces by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Provide burlap and mats that are clean and free from any contamination and completely saturated before being placed on the concrete. Lap sheets to provide full coverage. Provide an approved system to provide continuous moist curing 24 hours per day and such that the entire surface is wet.

]3.8 JOINTS

3.8.1 General Requirements for Joints

Construct joints that conform to the locations and details indicated and are perpendicular to the finished grade of the pavement. Provide joints that are straight and continuous from edge to edge or end to end of the pavement with no abrupt offset and no gradual deviation greater than 13 mm 1/2 inch. Where any joint fails to meet these tolerances, remove and replace the slabs adjacent to the joint at no additional cost to the Government. Change from the jointing pattern shown on the drawings is not allowed without written approval. Seal joints immediately following curing of the concrete or as soon thereafter as weather conditions permit as specified in Section [32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT][or][32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT].

3.8.2 Longitudinal Construction Joints

Install dowels in the longitudinal construction joints or thickened edges as indicated.

3.8.3 Transverse Construction Joints

Install transverse construction joints at the end of each day's placing operations at a planned transverse joint. Match transverse joint locations with adjacent lanes where indicated. If concrete placement is interrupted for 30 minutes or longer, stop work and remove concrete to the nearest completed joint to form a construction joint. Provide transverse construction joints by utilizing headers or by paving through the joint then full-depth sawcutting the excess concrete. Construct pavement with the paver as close to the header as possible with the paver run out completely past the header.

3.8.4 Expansion Joints

Provide expansion joints where indicated and at all intersections of airfield pavement with structures and features that project through or into the pavement. Use joint filler of the type, thickness, and width indicated, and install to form a complete, uniform separation between the structure and the pavement or between two pavements. Attach the filler to the original concrete placement with adhesive and mechanical fasteners extending to the full slab depth. Sawcut the sealant reservoir depth from the filler after placement and curing of the adjacent slab. Tightly fit adjacent sections of filler together, with the filler extending across the full width of the paving lane or other complete distance in order to prevent entrance of concrete into the expansion space. Finish edges of the concrete at the joint face with an edger with a radius of 3 mm 1/8 inch.

[3.8.5 Slip Joints

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NOTE: Slip joints should only be designed if conventional expansion joints or thickened edge joints are not expected to work well. Delete slip joints if not used on project.

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Install slip joints where indicated using the specified materials. Attach preformed joint filler material to the face of the original concrete placement with adhesive and mechanical fasteners. Sawcut a 19 mm 3/4 inch deep reservoir for joint sealant at the top of the joint. Finish edges of the joint face with an edger with a radius of 3 mm 1/8 inch.

]3.8.6 Contraction Joints

Construct transverse and longitudinal contraction joints by an initial sawcut in the concrete with a 3 mm 1/8 inch blade to the indicated depth. The CQC team is required to inspect and immediately report results of all exposed lane edges for development of cracks below the saw cut during sawing of joints and again 24 hours later. If there are more than six consecutive uncracked joints after 48 hours, saw succeeding joints 25 percent deeper than originally indicated at no additional cost to the Government. Vary the time of initial sawing depending on existing and anticipated weather conditions to prevent uncontrolled cracking of the pavement. Commence sawing of the joints as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. Inspect the sawed faces of joints for undercutting or washing of the concrete due to the early sawing. Delay sawing if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint. Continue the sawing operation as required during both day and night regardless of weather conditions. Saw the joints in the sequence of the concrete placement. Provide adequate lighting for night work. Illumination using vehicle headlights is not permitted. Provide a chalk line or other suitable guide to mark the alignment of the joint. Examine the concrete closely for cracks before sawing a joint and do not saw the joint if a crack has occurred near the planned joint location. Discontinue sawing if a crack develops ahead of the saw cut. Immediately after the joint is sawed thoroughly flush the saw cut and adjacent concrete surface with water and vacuum until all waste from sawing is removed from the joint and adjacent concrete surface. Properly protect the concrete from damage and cure at sawed joints. Tightly seal the top of the joint opening and the joint groove at exposed edges with cord backer rod before the concrete in the region of the joint is resprayed with curing compound. Maintain the backer rod until removal is required immediately before sawing the joint sealant reservoir. Respray the surface with curing compound as soon as residual water disappears. Seal the exposed saw cuts on the vertical faces of pilot lanes with bituminous mastic or masking tape. After expiration of the curing period, widen the upper portion of the groove by sawing with ganged diamond saw blades to the width and depth indicated for the joint sealer. Center the reservoir over the initial sawcut.

3.8.7 Thickened Edge Joints

Construct thickened edge joints as indicated on the drawings. Grade the underlying material in the transition area as shown and meet the requirements for smoothness and compaction specified for all other areas of the underlying material.

3.9 REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS

3.9.1 General Criteria

Repair or provide complete removal and replacement of new pavement slabs as specified at no cost to the Government. Removal of partial slabs is not permitted. Prior to any repairs, submit a Repair Recommendations Plan detailing areas exceeding the specified limits as well as repair recommendations required to bring these areas within specified tolerances.

3.9.2 Slabs with Cracks

The Government may require cores to be taken over cracks to determine depth of cracking. Drill cores with a minimum diameter of 150 mm 6 inches and backfill with an approved concrete mixture. Perform drilling of cores and filling of holes at no expense to the Government. Clean cracks that do not exceed 50 mm 2 inches in depth; then pressure inject full depth with epoxy resin, Type IV, Grade 1. Remove and replace slabs containing cracks deeper than 50 mm 2 inches.

3.9.3 Removal and Replacement of Full Slabs

Remove new or existing slabs damaged during construction that contain more than 15.0 percent of any longitudinal or transverse joint edge spalled. Remove full slabs in accordance with paragraph REMOVAL OF EXISTING PAVEMENT SLAB below. Remove and replace full depth by full width of the slab. Limit the removal of slabs to the paving lane and nearest joints. Compact and shape the underlying material as specified in the appropriate section of these specifications. Cut off original damaged dowels flush with the joint face. Clean the existing concrete surfaces of all loose material and contaminants, then coat with a double application of membrane forming curing compound as a bond breaker. Install dowels of the size and spacing as specified for other joints in similar pavement by epoxy grouting them into holes drilled into the existing concrete using procedures as specified in paragraph PLACING DOWELS, above. Provide dowels for all edges of the new slab. Lightly oil or grease protruding portions of new dowels in accordance with pargraph LUBRICATING DOWEL BARS. Place concrete as specified for original construction. Take care to prevent any curing compound from contacting dowels. Prepare and seal the resulting joints around the new slab as specified for original construction.

3.9.4 Repairing Spalls Along Joints

Repair spalls along joints to a depth to restore the full joint-face support prior to placing adjacent pavement. Where directed, repair spalls along joints of new slabs, along edges of adjacent existing concrete, and along parallel cracks by first making a vertical saw cut at least 75 mm 3 inches outside the spalled area and to a depth of at least 50 mm 2 inches. Provide saw cuts consisting of straight lines forming rectangular areas without sawing beyond the intersecting saw cut. Chip out the concrete between the saw cut and the joint, or crack, to remove all unsound concrete and into at least 13 mm 1/2 inch of visually sound concrete. Thoroughly clean the cavity thus formed with high pressure water jets supplemented with oil-free compressed air to remove all loose material. Immediately before filling the cavity, apply a prime coat to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. Apply the prime coat in a thin coating and scrub into the surface with a stiff-bristle brush. Provide prime coat for portland cement repairs consisting of a neat cement grout and for epoxy resin repairs consisting of epoxy resin, Type III, Grade 1. Fill the prepared cavity with material identified in Table 7 based on the cavity volume.

TABLE 7

Spall Repairs

Volume of Prepared Cavity After Removal Operations	Material
less than 0.00085 cubic meter 0.03 cubic foot	epoxy resin mortar or epoxy resin or latex modified mortar
0.00085 cubic meter 0.03 cubic foot and 0.009 cubic meter 1/3 cubic foot	Portland cement mortar
more than 0.009 cubic meter 1/3 cubic foot	Portland cement concrete or latex modified mortar

Provide portland cement concretes and mortars that consist of very low slump mixtures, 13 mm 1/2 inch slump or less, proportioned, mixed, placed, consolidated by tamping, and cured, all as directed. Provide epoxy resin mortars made with Type III, Grade 1, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved. Proprietary patching materials may be used, subject to Government approval. Place the epoxy resin materials in the cavity in layers with a maximum thickness of 50 mm 2 inches. Provide adequate time between placement of additional layers such that the temperature of the epoxy resin material does not exceed 60 degrees C 140 degrees F at any time during hardening. Provide mechanical vibrators and hand tampers to consolidate the concrete or mortar. Remove any repair material on the surrounding surfaces of the existing concrete before it hardens. Where the spalled area abuts a joint, provide an insert or other bond-breaking medium to prevent bond at the joint face. For existing joints, seal the bottom contraction crack with backer rod to prevent instrusion of primer or mortar. Saw a reservoir for the joint sealant to the dimensions required for other joints. Thoroughly clean the reservoir and then provide the sealer specified for the joints. In lieu of sawing, spalls and popouts not adjacent to joints, both less than 150 mm 6 inches in maximum dimension, may be prepared by drilling a core 50 mm 2 inches in diameter greater than the size of the defect, centered over the defect, and 50 mm 2 inches deep or 13 mm 1/2 inch into sound concrete, whichever is greater. Repair the core hole as specified above for other spalls.

3.9.5 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed aggregates, voids, or deleterious materials. Cores evaluated by a qualified petrographer to contain carbonation to a depth greater than 3 mm 1/8 inch or Mohs hardness of less than 2, when tested in accordance with ASTM C1895, are also considered rain damaged. Diamond grind slabs containing weak surfaces less than 6 mm 1/4 inch thick to remove the weak surface. Diamond grind in accordance with paragraph DIAMOND GRINDING OF PCC SURFACES. All diamond ground areas are required to meet the thickness, smoothness, and grade criteria specified in paragraph ACCEPTANCE. Remove and replace slabs containing weak surfaces greater than 6 mm 1/4 inch thick.

3.10 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

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NOTE: It is imperative that sufficient exploration be made (not just reference to as-built drawings) for the designer to know exactly what the in-place existing pavement thickness and load-transfer are at the jointing area--such as dowels, keys, tie bars--and its condition. Normally, the joint between the new pavement and existing pavement is made at an existing joint in the old pavement. Coordinate with Section 02 41 00 DEMOLITION.

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Demolition of existing operational pavement is not allowed prior to approval of the Proportioning Studies. Remove existing concrete pavement at locations indicated on the drawings. Inventory the pavement distresses (cracks, spalls, and corner breaks) along the pavement edge to remain prior to commencing pavement removal operations. Survey the remaining edge again after pavement removal to quantify any damage caused by removal operations. Perform both surveys in the presence of the Government. Perform repairs as indicated and as specified herein. Carefully control all operations to prevent damage to the concrete pavement and to the underlying material to remain in place. Perform all saw cuts perpendicular to the slab surface forming rectangular areas. Perform all existing concrete pavement repairs prior to paving adjacent lanes.

3.10.1 Removal of Existing Pavement Slab

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NOTE: Use a wheel saw to produce a saw kerf at least 40 mm 1-1/2 inches wide to prevent stress from propagating across the saw cut into existing pavement to be left in place.

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Use one of the following methods when existing concrete pavement is to be removed and adjacent concrete is to be left in place:

Method 1

a. Perform the first full depth saw cut on the joint between the removal area and adjoining pavement to stay in place with a standard diamond-type concrete saw.

b. Next, perform a full depth saw cut parallel to the joint that is at least 600 mm 24 inches from the joint and at least 150 mm 6 inches from the end of any dowels with a wheel saw as specified in paragraph SAWING EQUIPMENT.

c. Remove all pavement beyond this last saw cut in accordance with the approved demolition work plan.

d. Remove all pavement between this last saw cut and the joint line by carefully pulling pieces and blocks away from the joint face with suitable equipment and then picking them up for removal. As an alternative, this strip of concrete may be carefully broken up and removed using hand-held jackhammers, 14 kg 30 lb or less, or other approved light-duty equipment which does not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place.

Method 2

e. Sawcut the slab full depth to divide it into several pieces and lift each piece out. Use suitable equipment to provide a truly vertical lift with safe lifting devices used for attachment to the slab.

3.10.2 Edge Repair

Protect the edge of existing concrete pavement against which new pavement abuts from damage at all times. Remove and replace slabs which are damaged during construction as directed at no cost to the Government. Repair of previously existing damaged areas is considered a subsidiary part of concrete pavement construction. Saw off all exposed keys and keyways full depth.

3.10.2.1 Spall Repair

Repair spalls caused by construction activities for slabs that have less than 15.0 percent spalling along any edge. Provide repair materials and procedures as previously specified in paragraph REPAIRING SPALLS ALONG JOINTS. Remove and replace full slabs containing more than 15.0 percent spalling along any edge in accordance with paragraph REMOVAL AND REPLACEMENT OF FULL SLABS.

3.10.2.2 Underbreak and Underlying Material

Repair all underbreak by removal and replacement of the damaged slabs in accordance with paragraph REMOVAL AND REPLACEMENT OF FULL SLABS above. Protect the underlying material adjacent to the edge of and under the existing pavement to remain from damage or disturbance during removal operations and until placement of new concrete. Replace the concrete panels with the dimensions shown on the drawings or as directed. Maintain sufficient underlying material in place outside the joint line to completely prevent disturbance of material under the pavement which is to remain in place. Remove and replace any slab with underlying material that is disturbed or loses its compaction.

3.11 PAVEMENT PROTECTION

3.11.1 Existing Pavement Protection

Protect existing pavement from all damage. Placement of aggregates, rubble, or other similar construction materials is not allowed on existing pavement. Take special care in areas where traffic uses or crosses active airfield pavement. Power broom existing pavements at least daily when traffic operates. Immediately clean up spillage of concrete or other materials upon occurrence. Provide equipment that does not damage or spall existing concrete when trafficking and provide means to protect joints and edges as necessary to prevent damage

3.11.2 New Pavement Protection

Protect new pavement against all damage prior to final acceptance of the work by the Government. Placement of aggregates, rubble, or other similar construction materials on airfield pavements is not allowed. Exclude traffic from the new pavement by erecting and maintaining barricades and signs until the concrete is at least 14 days old or for a longer period if so directed. Operation of the hauling and paving equipment is permitted on the new pavement as a construction expedient after the pavement has been cured for 7 days, the joints have been sealed or otherwise protected, the concrete has attained a minimum field cured compressive strength of 24.1 MPa 3,500 psi, and approved means are provided to prevent damage to the slab edges. Fabricate and field cure specimens in accordance with ASTM C31/C31M. Continuously maintain and completely clean all new pavement carrying construction traffic or equipment. Immediately clean up spillage of concrete or other materials upon occurrence. For fill-in lanes, provide equipment that does not damage or spall the edges or joints of the previously constructed pavement.

3.12 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL DURING CONSTRUCTION

3.12.1 Testing and Inspection by Contractor

Perform sampling and testing of aggregates, cementitious materials (cement, slag cement, and pozzolan), and concrete during construction to determine compliance with the specifications. Select sample locations on a random basis in accordance with ASTM D3665. Provide facilities and labor as may be necessary for procurement of representative test samples. Furnish sampling platforms and belt templates to obtain representative samples of aggregates from charging belts at the concrete plant. Obtain samples of concrete at the point of delivery to the paver. Testing by the Government in no way relieves the specified testing requirements. Perform the inspection and tests described below, and based upon the results of these inspections and tests, take the action required and submit reports as required. Perform this testing regardless of any other testing performed by the Government.

3.12.2 Sampling and Testing Concrete

Obtain one random composite sample of concrete in accordance with ASTM C172/C172M from one batch or truckload at the frequency shown in Table

7. Fabricate and cure six test cylinders 152 x 305 mm 6 x 12 inches in accordance with ASTM C31/C31M and test them in accordance with ASTM C39/C39M. Test two test cylinders at 7 days, two cylinders at 28 days, and hold two cylinders in reserve for each collected sample.

3.12.3 Thickness and Consolidation Testing

Drill two random cores between 100 and 150 mm 4 and 6 inches in diameter from the pavement at the frequency shown in Table 7. Drill the cores within 3 days after placement. Fill each core hole with an approved concrete mixture and respray cored areas with curing compound. Record eight measurements of thickness around the circumference of each core and one in the center in accordance with ASTM C174/C174M. Record and submit testing, inspection, and evaluation of each core for mortar-rich surface, uniformity of aggregate distribution, segregation, voids, cracks, and depth of reinforcement or dowel (if present). Moisten the core with water to visibly expose the aggregate and take a minimum of three photographs of the sides showing the core's entire length, rotating the core approximately 120 degrees between photographs. Include a ruler for scale in the photographs that does not obscure the core. Provide plan view of location for each core.

3.12.4 Surface Smoothness Testing

Test the entire surface of the pavement in such a manner as to reveal all surface irregularities exceeding the tolerances specified in paragraph ACCEPTANCE. Begin smoothness testing after the concrete has hardened sufficiently to permit walking thereon, but not later than 48 hours after placement. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines 1.5 m 5 feet or less apart, as directed. Perform the longitudinal lines at the centerline of each paving lane shown on the drawings, regardless of whether multiple lanes are allowed to be paved at the same time and at the 1/8th point in from each side of the lane. Also perform testing lines across all joints and at other areas having obvious deviations. Retest areas if they are diamond ground. Maintain detailed notes of the testing results and provide a copy to the Government after each day's testing.

3.12.4.1 Straightedge Testing

Use the straightedge method for transverse testing, longitudinal testing, joints, and at the ends of the paving limits for the project. Hold the straightedge in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and measuring the maximum gap between the straightedge and the pavement surface. Determine measurements along the entire length of the straight edge and submit all test results to the government prior to placement of adjacent concrete.

3.12.5 Plan Grade Testing

Within 5 days after paving, test the finished surface of the pavement area to reveal all elevations exceeding the tolerances specified in paragraph ACCEPTANCE. Run lines of levels at intervals corresponding with every longitudinal and transverse joint to determine the elevation at each joint intersection. Record the results of this survey and provide a copy to the Government at the completion of the survey prior to placement of adjacent concrete.

3.12.6 Cementitious Materials Testing

Retest cementitious material that has not been used within 6 months after testing and reject if test results do not meet manufacturer requirements.

3.12.7 Chemical Admixture Testing

Retest chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing and reject if test results do not meet manufacturer requirements.

3.12.8 Testing and Inspection Requirements

Perform CQC sampling, testing, inspection and reporting in accordance with Table 8.

TABLE 8
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Fine Aggregate Gradation and Fineness Modulus			
Once per day	ASTM C136/C136M and ASTM C117 sample at belt	Outside limits on any sieve	Retest
		2nd gradation failure	Stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Coarse Aggregate Gradation (each aggregate size)			
Once per day	ASTM C136/C136M and ASTM C117 sample at belt	Outside limits on any sieve	Retest
		2nd gradation failure	Stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Workability Factor and Coarseness Factor Computation			

TABLE 8
TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Same as C.A. and F.A.	see paragraph AGGREGATES	Use individual C.A. and F.A. gradations. Combine using batch ticket percentages (average of aggregate percentages from 3 before and 3 after sampling). Tolerances: plus or minus 3 points on WF; plus or minus 5 points on CF from approved adjusted mix design values; only the portion of the tolerance box within the parallelogram is available for use	Check batching tolerances, recalibrate scales
		Test result outside limits	Stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
<u>Concrete Mixture - Slump</u>			
40 cubic meters50 cubic yards and when test specimens prepared	ASTM C143/C143M sample at point of discharge within the paving lane	At maximum allowable slump	Retest
		2nd slump failure	Reject concrete, stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
<u>Concrete Mixture - Air Content</u>			
Same as slump	ASTM C231/C231M sample at point of discharge within the paving lane	Plus or minus 1.5 percent	Retest
		2nd air content failure	Reject concrete, stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving

TABLE 8 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
Concrete Mixture - Temperature			
Same as slump	ASTM C1064/C1064 sample at point of discharge within the paving lane	See paragraph WEATHER LIMITATIONS	
Concrete Mixture - Strength			
120 cubic meters150 cubic yards, minimum one test per day	ASTM C31/C31M sample at point of discharge within the paving lane	See paragraph ACCEPTANCE Perform fabrication of strength specimens and initial cure outside the paving lane and within 300 m 1,000 feet of the sampling point.	
Concrete Mixture - Unit Weight and Yield			
Same as concrete strength	ASTM C138/C138M sample at point of discharge within the paving lane	0 or plus 5 percent	Retest
		2nd unit weight and yield failure	Reject concrete, stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Concrete Thickness			
Same as concrete strength	ASTM C174/C174M	See paragraph ACCEPTANCE	

3.12.9 Contractor Quality Control Reports

Report informally and in writing daily the results of all tests and inspections conducted. Submit Contractor Quality Control reports on a daily basis using a format that is clear and allows for ready determination of compliance with specification. Use testing and inspections for early identification and correction of issues to production. These requirements do not relieve the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Government has the right to examine all Contractor quality control records.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 13 15.20 (November 2022)**

Preparing Activity: USACE **UFGS-32 13 15.20 (November 2010)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 32 13 15.20

CONCRETE PAVEMENT FOR FUEL STORAGE CONTAINMENT DIKES

11/22

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NOTE: This guide specification covers the requirements for concrete containment dikes and basins See DEPARTMENT OF DEFENSE (DOD) definitive design "AW 78-24-27 Aboveground Vertical Steel Fuel Tanks with Fixed Roofs" for standard details and design guidance when using this specification for a fuel storage tank containment system. A fuel impermeable containment system is required for fuel storage tank containment areas per UFC 3-460-01. This dike and basin concrete provides cover and protection for a geomembrane liner covered by Section 33 56 19 FUEL IMPERMEABLE LINER SYSTEM. The dike and basin concrete in of itself is not a substitute for a geomembrane liner and is never to be considered an impermeable containment system on its own accord..

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates

ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1116/C1116M	(2023) Standard Specification for Fiber-Reinforced Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Aggregate Sources

SD-06 Test Reports

Independent Laboratory Test Results

Placing, Spreading And Vibrating; G, [_____].

SD-07 Certificates

Concrete Sampling and Testing; G, [_____].

Certified Test Results

1.3 CONCRETE SAMPLING AND TESTING

1.3.1 General

Provide certification of sampling and testing of all concrete and concrete materials, including design of concrete mixes, conforming to the requirements specified in ASTM C94/C94M Option A and submit to the Contracting Officer for approval. During actual concrete operations, no substitutions are allowed in the materials or proportions that were used in the mix design without additional testing unless specifically approved or directed by the Contracting Officer. In lieu of performing new concrete mix design studies, a concrete mix design from a current project at the military base may be used provided the required concrete strength is obtained and the materials proposed for use in this project are identical to those used in the concrete mix design. Perform quality control sampling and testing in accordance with Section 01 45 00 QUALITY CONTROL and as specified herein. The Government may perform verification tests as considered necessary.

1.3.2 Certification for Additional Pavement Materials

Prior to the use of materials not listed in ASTM C94/C94M, but listed in this section, submit Certified Test Results for each lot as directed by the Contracting Officer.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

2.1.1 General Requirements

Provide concrete and the equipment, workmanship, materials and quality control conforming to the applicable requirements of ASTM C94/C94M, except as otherwise specified herein. Use concrete composed of cement, supplementary cementitious materials (SCM), fine aggregate, coarse aggregate, water, and an air entraining mixture. State final mix proportions by weight and batch; cementitious materials by weight. Do not exceed a water-cementitious materials ratio (WCR) of 0.45. Maintain the air content of the concrete by volume at 6.0 percent plus or minus 1.0 percent. Do not exceed a concrete slump of 75 mm 3 inches for fixed form paving. Do not increase the slump of transit-mixed concrete because of the inadequacy of mixing, discharge, or placing equipment.

2.1.2 Strength Requirements

Provide concrete with the following average compressive strength:
Containment Dikes and Basin 30 MPa 4000 psi at 28 days

2.2 MATERIALS

2.2.1 Aggregate

2.2.1.1 Gradation

Provide coarse and fine aggregate conforming to ASTM C33/C33M with a maximum nominal size of 25 mm 1 inch.

2.2.1.2 Quality

Provide coarse and fine aggregate conforming to ASTM C33/C33M, Class 4.

2.2.1.3 Alkali-Silica Reactivity (ASR)

a. Evaluate and test fine and coarse aggregates to be used for alkali-aggregate reactivity. Evaluate fine and coarse aggregates separately, using ASTM C1260. Test results of the individual aggregates must show a measured expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Should the test data indicate an expansion of greater than 0.08 percent, reject the aggregate(s) or perform additional testing as follows: utilize the Contractor's proposed low alkali portland cement, blended cement, and/or SCM in combination with each individual aggregate and test in accordance with ASTM C1567. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Base the mixture proportioning on the highest percentage of SCM required to mitigate ASR.

b. If any of the above options does not lower the expansion to less than 0.08 percent after 28 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.2.2 Admixtures

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NOTE: High Range Water Reducing Admixtures are permitted only when using Silica Fume in OCONUS projects. Delete for all other projects

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a. Provide air-entraining admixture conforming to ASTM C260/C260M.

b. Use accelerating admixture conforming to ASTM C494/C494M, Type C, only when cold weather protection is required and only when approved in writing. Do not use admixtures containing the chlorine ion.

c. Provide water-reducing or retarding admixtures conforming to ASTM C494/C494M, Type A, B, or D.

d. When using Silica Fume, provide a high-range water-reducing admixture (HRWRA) meeting the requirements of ASTM C494/C494M, Type F or G. Provide the HRWRA that is a synthesized, sulfonated complex polymer type and free from chlorides and alkalies. Add the HRWRA to the concrete as a single component at the batch plant. Add the admixture to the concrete mixture only when its use is approved or directed, and only when it has been used in mixture proportioning studies to arrive at approved mixture proportions. Submit certified copies of the independent laboratory test results required for compliance with ASTM C494/C494M.

2.2.3 Cementitious Materials

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NOTE: Edit these paragraphs as appropriate for the particular project. Since the containment dike

concrete is underlain by an impervious geomembrane, adverse reactions between the cement and subgrade soils are not anticipated. Only Type I or II cements are required.

****

Provide cementitious materials of portland cement, blended cement, or only portland cement in combination with supplementary cementitious materials (SCM), and conforming to appropriate specifications listed below. New submittals are required when the cementitious materials sources or types change.

2.2.3.1 Portland Cement

Provide portland cement conforming to ASTM C150/C150M, Type I or II, low alkali [including false set requirements]. Low alkali cement is required if the proposed aggregates are found to have greater than 0.04 percent expansion when tested in accordance with paragraph: Alkali-Silica Reactivity above.

2.2.3.2 Blended Cement

Provide blended cement conforming to ASTM C595/C595M, Type IP or IS, including the optional requirement for mortar expansion [and sulfate soundness]. Provide statement in writing from the manufacturer that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot to lot or within a lot. No change is allowed in the percentage and type of mineral admixture used in the blend from that submitted for the aggregate evaluation and mixture proportioning.

2.2.4 Supplementary Cementitious Materials (SCM)

2.2.4.1 Fly Ash

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NOTE: Use loss on ignition not exceeding 3 percent for frost areas to reduce carbon interference with air entraining admixture.

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Provide fly ash conforming to ASTM C618, Class F, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and not have a loss on ignition exceeding [3] [6] percent. For use in mitigating Alkali-Silica Reactivity, provide a Calcium Oxide (CaO) content of less than 13 percent and a total equivalent alkali content less than 3 percent.

2.2.4.2 Raw or Calcined Natural Pozzolan

Provide raw or calcined natural pozzolan conforming to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and not have a loss on ignition exceeding [3] [6] percent. Provide a Calcium Oxide (CaO) content of less than 13 percent and a total equivalent alkali content less than 3 percent for use in mitigating Alkali-Silica reactivity.

2.2.4.3 Ground Granulated Blast Furnace Slag (GGBFS)

Provide Ground Granulated Blast-Furnace Slag conforming to ASTM C989/C989M, Grade 100 or Grade 120.

2.2.4.4 Silica Fume

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NOTE: Use Silica Fume only for OCONUS projects where Class F fly ash and GGBF slag are not available. Delete this paragraph here and where encountered throughout the remainder of this section.

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Provide silica fume conforming to ASTM C1240, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as a slurry. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume.

2.2.4.5 Supplementary Cementitious Materials (SCM) Content

The Contractor may elect to use one of the SCMs listed below, unless the SCM is required to mitigate ASR. The use of SCMs is encouraged in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

TABLE 2 SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum, percent	Maximum Content, percent
Class N Pozzolan and Class F Fly Ash		
$SiO_2 + Al_2O_3 + Fe_2O_3 > 70$ percent	25	35
$SiO_2 + Al_2O_3 + Fe_2O_3 > 80$ percent	20	35
$SiO_2 + Al_2O_3 + Fe_2O_3 > 90$ percent	15	35
GGBFS	40	50
Silica Fume	7	10

2.2.5 Reinforcement Steel and Dowels

Provide reinforcement bars conforming to ASTM A615/A615M Grade 40 or 60. Provide welded steel wire fabric conforming to ASTM A1064/A1064M. Provide dowels that are plain (non-deformed) steel bars conforming to ASTM A615/A615M, Grade 40 or 60; ASTM A996/A996M, Grade 50 or 60. Provide epoxy coated dowel bars in conformance with ASTM A775/A775M. Use grout retention rings of fully circular metal or plastic devices capable of supporting the dowel until the epoxy hardens. Dowel sleeves or inserts are not permitted.

2.2.6 CURING MATERIALS

Only approved white pigmented membrane-forming curing compound materials conforming to the requirements specified in ASTM C309, Type 2, Class A or B may be used.

2.2.7 Joint Filler

For expansion joints use a preformed joint filler material conforming to ASTM D1751 or ASTM D1752.

2.2.8 SYNTHETIC FIBER REINFORCEMENT

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NOTE: Synthetic fibers may only be used in addition to conventional steel reinforcment to mitigate plastic shrinkage cracking. Do not use synthetic fibers as a replacement for reinforcing steel or mesh.

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ASTM C1116/C1116M. Use 100 percent virgin nylon or polypropylene fibers, 23 micron diameter, 19 mm 3/4 inch length with a minimum tensile strength of 482 MPa 70 ksi. Add fibers to the concrete mix at the batch plant at the rate of 0.89 kg/cubic meter 1.5 lbs/cubic yard.

PART 3 EXECUTION

3.1 GRADE CONTROL

Using bench-mark elevations furnished by the Contracting Officer, establish and maintain the lines and grades shown for the pavement by means of line and grade stakes placed at the jobsite. Construct pavements to the thicknesses and elevations indicated.

3.2 SUBGRADE, FORMS AND STRINGLINE

3.2.1 Underlying Material

3.2.1.1 General

Test the surface of the subgrade as to elevation and density in advance of setting forms. Keep the prepared surface free of foreign matter, waste concrete and/or cement, and debris at all times and thoroughly wet down sufficiently in advance to insure a firm, moist condition when the concrete is placed. In cold weather, prepare and protect the underlying material so that it will be entirely free from frost when the concrete is placed. The use of chemicals to eliminate frost in the underlying material will not be permitted.

3.2.1.2 Liner System

Where an impermeable liner system is placed directly under the concrete, take precautions to protect the underlying liner system from damage. See Section 33 56 19 FUEL IMPERMEABLE LINER SYSTEM for additional requirements.

3.2.2 Forms for Fixed-Form Paving

Use either steel or wood forms and forms subject to approval. Provide one-piece forms that are equal in depth to the edge thickness of the slab as shown on the drawings. Under no conditions are forms other than the depth of the pavement to be used and adjusted by filling or excavating under the forms to an elevation other than the bottom of the pavement slab. Do not vary the top surface of a form by more than 3 mm 1/8 inch in 3 m 10 feet from a true line and the face by more than 6 mm 1/4 inch in 3 m 10 feet from a true plane.

3.2.2.1 Steel Forms

Furnish steel forms in sections not less than 3 m 10 feet in length, except that on curves the sections are required to be flexible or curved to the proper radius. Provide each form section with form braces, pin sockets, and rigid joint locking devices.

3.2.2.2 Wood Forms

Furnish wood forms made of not less than 50 mm 2 inches nominal thickness, well-seasoned, surfaced plank or plywood, straight, and free from warp or bend. Use wood forms that have the strength and rigidity to resist the impact and vibrations of concrete placing, spreading and finishing without springing, weaving or settling.

3.2.2.3 Form Setting

Set the forms on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire length and base width. Setting forms on blocks or on built-up spots of subgrade and then attempting to fill and compact under forms after they are in place will not be permitted under any condition. Lock the form sections tightly together. When tested by a 3 m 10-foot straightedge, provide the top of the form conforming to the requirements specified for the finished surface of the concrete, and do not vary the longitudinal axis of the upstanding leg by more than 6 mm 1/4 inch from the straightedge. Clean and oil the forms each time before concrete is placed. Do not place concrete until setting of forms has been approved. Do not drive form stakes in areas underlain by a geomemebrane. Anchoring of the forms in these areas is required to be approved by the Contracting Officer prior to installation.

3.3 PLACING, SPREADING AND VIBRATING

Submit a document detailing proposed concrete placement procedures. At a minimum, address form setting, protection of geomembrane, conveyance/pumping, construction joints, expansion joints, placement of reinforcement, curing and joint sealing procedures.

3.3.1 General

Place concrete between stationary forms. Deposit concrete between the forms within 90 minutes from the time all ingredients are charged into the mixing drum. Deposit concrete as close as possible to its final position in the pavement cross section. Place concrete at a continuous and uniform rate. Spread and vibrate concrete immediately after placement.

3.3.2 Paver Fixed-Form Method

Use a paver that is self-propelled and capable of spreading, consolidating and shaping the plastic concrete. Hand spreading will be permitted only when approved for odd widths or shapes of slabs. Equip pavers with a full-width mechanical spreader at the front which is capable of ready adjustment to provide a uniform cross section of concrete in front of the screed as necessary for proper operation. Use an auger, paddle or other approved type spreader. Hand spreading, where permitted, is to be done with shovels; rakes are not to be used. Where the concrete is delivered to the form in truck mixers, suitable chutes may be used, provided windrows cover essentially the entire area with-in the form. In no case is dumping of concrete in piles permitted.

3.3.3 Vibration

Consolidate concrete by properly designed vibrating screeds, internal vibrators, or other approved techniques immediately after spreading. Cease forward motion of the paver as soon as a vibrator becomes inoperable. Maintain additional vibrators at the site at all times.

3.3.3.1 Slabs 200 mm 8 Inches Thick

Consolidate concrete, greater than 200 mm 8 inches in thickness, with mechanical vibrating equipment immediately after spreading. Provide internal type mechanical vibrating equipment and the number of units and adequate power of each unit to properly consolidate all of the concrete. Automatically control the vibrators and/or tamping elements so that they will be stopped as forward motion ceases. Do not exceed vibrator unit spacing of 750 mm 30 inches, and provide a space from the outside unit and the edge of the slab of approximately 300 mm 1 foot. Insert vibrators into the concrete to a depth that will provide the best consolidation, but not closer to the underlying material than 50 mm 2 inches. Change the depth and angle of vibrators whenever directed by the Contracting Officer.

3.3.3.2 Slabs Less Than 200 mm 8 Inches Thick

Consolidate concrete 200 mm 8 inches or less in thickness with properly designed and operating vibratory screeds immediately after spreading.

3.3.3.3 Hand Placement

Vibrate concrete in odd shaped slabs, or lanes 15 m 50 feet or less in length or in locations inaccessible to the above vibrating equipment with a hand-manipulated vibrator operated from a bridge spanning the concrete placement. Do not have workmen walk in the fresh concrete. Do not use vibrators to transport or spread the concrete in the forms. Do not operate vibrators in the concrete at one location for more than 20 seconds.

3.3.4 Placing Reinforcing Steel

Position reinforcement steel on suitable chairs prior to concrete placement or it may be installed by the strike-off method wherein the concrete is deposited on the underlying material, consolidated and struck to the indicated elevation of the steel reinforcement. When using the strike-off method, lay the reinforcement upon the prestruck surface, and place and finish the remaining concrete in the required manner. Remove and replace any portions of the bottom layer of concrete, that was placed more than 30 minutes without being covered with the top layer, with newly mixed concrete at no additional cost to the Government. Regardless of placement procedure, keep the reinforcing steel free from coatings which could impair bond between the steel and concrete and provide laps in the reinforcement as indicated.

3.3.5 Placing During Cold Weather

Place concrete in cold weather in accordance with ACI 306R. Do not place concrete on base course or subgrade containing frost or frozen material. Include provision to protect the concrete from freezing during the specified curing period. Remove and replace concrete damaged by freezing at no cost to the Government.

3.3.6 Placing During Warm Weather

Place concrete during warm weather in accordance with ACI 305R. During warm weather, produce concrete at the lowest temperature practicable under the existing conditions. Cool the mixing water and/or aggregates, if necessary, to maintain a satisfactory placing temperature. Place concrete continuously and rapidly at a rate of not less than 30 m 100 feet of paving lane per hour. Keep the finished surfaces of newly placed pavement damp by applying a waterfog or mist with approved spraying equipment until the pavement is covered by the curing medium.

3.4 FINISHING

Start finishing operations immediately after placing, spreading and vibrating of the concrete. Finish by the machine method except that, as specifically approved, the hand method may be used for lanes 15 m 50 feet or less in length, minor amounts of narrow slabs, irregular slab widths or shapes and separate, isolated slabs during removal and replacement type repair operations. Maintain finishing equipment and tools clean and in an approved condition.

3.4.1 Machine Finishing - Fixed Forms

3.4.1.1 Equipment

Conform to applicable requirements specified in subparagraph: PAVER FIXED-FORM METHOD of paragraph: PLACING, SPREADING AND VIBRATING above. Check screed and float adjustments of these machines at the start of each day's paving operations and more often as required. When finishing machines ride the edge of a previously constructed slab, include provision to protect the surface of these slabs.

3.4.1.2 Transverse Finishing

As soon as placed, accurately strike off and screed the concrete to the crown and cross section shown and to such elevation that when consolidated and finished, the surface of the pavement will be free from porous places and will be at the required grade. Excessive manipulation that brings to the surface an excess of mortar and water will not be permitted. Keep the top of the form or pavement edge upon which the finishing machine travels clean.

3.4.1.3 Mechanical Floating

Operate the mechanical float to smooth and finish the pavement to grade and maintain surface contact at all times. Do not use rotating pipe or tube floats or finishers, such as: Clary screeds, rotating "bridge deck finishers" and similar equipment.

3.4.1.4 Other Types of Finishing Equipment

Except for rotating pipe or tube floats or finishers, concrete finishing equipment of types other than specified above may be used on a trial basis, when specifically approved. Replace equipment that fails to produce finished concrete of the required quality with the approved equipment before specified herein.

3.4.2 HAND FINISHING

3.4.2.1 Finishing and Floating

As soon as placed and vibrated, strike off and screed the concrete to the crown and cross section and to such elevation above grade that, when consolidated and finished, the surface of the pavement will be at the required elevation. Tamp the entire surface. Continue the tamping operation until the required compaction and reduction of internal and surface voids are accomplished. Immediately following the final tamping of the surface, float the pavement longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, place and screed additional concrete, and the float operated until a satisfactory surface has been produced. Advance the floating operation to not more than half the length of the float, and the floating continued over the new and previously floated surfaces.

3.4.3 Surface Correction and Testing

After all other finishing is completed but while the concrete is still plastic, eliminate minor irregularities and score marks in the pavement surface by means of straight-edges. Use straightedges 3 m 10 feet in length rigidly constructed to prevent deflection in any direction during use, and operate from the sides of the pavement and from bridges. After straight-edge finishing appears complete, test the entire surface for trueness with a 3 m 10 foot straightedge held in successive positions parallel and at right angles to the centerline of the pavement, and the whole area covered as necessary to detect variations. Advance the straightedge along the pavement in successive stages of not more than one-half the length of the straightedge. Continue the straightedge testing and finishing until the entire surface of the concrete is free from observable departure from the straightedge and conforms to the surface requirements specified under subparagraph: SURFACE TESTS AND CORRECTIONS below.

3.4.4 Texturing

Before the surface sheen has disappeared and before the concrete becomes nonplastic, give the surface of the pavement a stiff broom finish.

3.4.5 Edging

After texturing has been completed, the edge of slabs along the forms, and at the joints, where indicated or directed, carefully finish with an edging tool to form a smooth rounded surface of the required radius. Eliminate tool marks, and the provide edges that are smooth and true to line.

3.5 FORM REMOVAL

Keep forms in place at least 12 hours after the concrete has been placed or for a longer period, if directed by the Contracting Officer. Remove forms without injuring the concrete. Repair any concrete found defective after form removal promptly, using approved procedures.

3.6 CURING

3.6.1 General

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days commencing immediately after finishing is complete. Protect unhardened concrete from rain and flowing water. Keep all equipment needed for adequate curing and protection of the concrete on hand and ready to use before actual concrete placement begins. If the curing materials and procedures used do not provide proper curing and protection against concrete cracking caused by temperature changes during the curing period, remove and replace the damaged pavement and employ another method of curing as directed.

3.6.2 Membrane Curing

Apply a uniform coating of white pigmented membrane curing compound to the entire exposed surface of the concrete as soon after finishing as free water has disappeared from the finished surface. Coat formed surfaces immediately after the forms are removed and in no case longer than 1 hour after removal of forms. Do not allow the concrete to dry before the application of the membrane. Apply the curing compound to the finished surfaces by means of an approved automatic spraying machine as soon as the free water has disappeared. Thoroughly and continuously agitate the curing compound in the drum used for the spraying operation mechanically throughout the full depth of the drum during the application. Air agitation may be used only to supplement mechanical agitation. Apply the curing compound with an overlapping coverage that will give a two-coat application at a coverage of not more than 10 square meters/Liter 400 square feet/gallon for each coat. The application of curing compound by hand-operated pressure sprayers will be permitted only on odd widths or shapes of slabs where specifically approved, and on concrete surfaces exposed by the removal of forms. When application is made by hand-operated sprayers, apply the second coat in a direction approximately at right angles to the direction of the first coat. Respray curing compound that has pinholes, abrasions, or other discontinuities, that was subjected to heavy rainfall within 3 hours of application, or was damaged by subsequent construction operations by the method and at the coverage specified above. Take necessary precautions to insure that the concrete is properly cured at sawed joints, but that no curing compound enters the joints. Tightly seal the top of the joint opening and the joint groove at exposed edges by approved procedures using a temporary sealer or filler before the concrete in the region of the joint is resprayed with curing compound. Use the method for sealing the joint groove that prevents loss of moisture from the joint during the entire specified curing period. Provide approved standby facilities for curing concrete pavement at an accessible location at the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane curing compound at the proper time. Protect concrete surfaces to which membrane curing compounds have been applied adequately during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7 GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS AND TESTS

3.7.1 General

Provide pavements that are smooth and true to grade and cross section. When tested with a 3 m 10 foot straightedge on lines 1.5 m 5 feet apart parallel with and at right angles to the centerline of the pavement, do not vary the surface no more than 6 mm 1/4 inch from the testing edge of the straightedge.

3.7.2 Surface Tests And Corrections

Not later than 24 hours after concrete has been placed, test the surface of the pavement in the presence of the Contracting Officer using an approved straightedge or other approved device that will reveal all surface irregularities varying from the testing edge exceeding tolerances specified above for concrete pavements. Plainly mark high spots indicated by the testing edge in excess of applicable tolerances. Reduce high areas by approved methods or remove and replace the pavement at no cost to the Government.

3.8 TOLERANCES IN PAVEMENT THICKNESS

Provide pavements of the thicknesses indicated on the plans. Treat deficiencies in the thickness as described below.

3.8.1 Thickness Determination

Determine the anticipated thickness of the concrete prior to placement by passing a template through the formed section. When measurements indicate that the completed concrete section is deficient in thickness by more than 6 mm 1/4 inch, the deficient section will be removed, between regularly scheduled joints, and replaced at no cost to the Government.

3.9 FIELD TEST SPECIMENS

3.9.1 General

Except as modified hereinafter, perform tests to determine the slump, air content, and strength of the concrete in accordance with the requirements of ASTM C94/C94M. Complete tests for slump and air content each time cylinders are fabricated and at such other times as directed by the Contracting Officer.

3.9.2 Specimens for Strength Tests

Take compressive test cylinders not less than once a day nor less than once for each 190 cubic meters 250 cubic yards of concrete or fraction thereof. Take the samples of strength tests in accordance with ASTM C172/C172M. Mold and cure cylinders for acceptance tests in accordance with ASTM C31/C31M. Test cylinders in accordance with ASTM C39/C39M by an approved testing laboratory at no cost to the Government. Mold sufficient cylinders each time to provide two compressive-strength tests at each test age. Test ages are 7, 14, and 28 days.

3.10 JOINTS

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NOTE: A joint layout plan should be provided with a

maximum just spacing of 3 m 10 feet. Panels should be as closed to square as possible.
****

3.10.1 General

Provide joints conforming to the details indicated and that are perpendicular to the finished grade of the pavement. Provide transverse expansion and contraction joints that are straight and continuous from edge to edge of the pavement.

3.10.2 Construction Joints

Install transverse construction joints at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for 30 minutes or longer. Install transverse construction joints in the location of a planned joint.

3.10.3 Expansion Joints

Form expansion joints by means of a preformed filler material.

3.10.4 Contraction Joints

Provide transverse and longitudinal contraction joints of the weakened-plane, and constructed as indicated hereinafter in subparagraph: SAWED JOINTS. Construct longitudinal contraction joints by sawing a groove in the hardened concrete with a power-driven saw in conformance with subparagraph: SAWED JOINTS below, unless otherwise approved.

3.10.4.1 Sawed Joints

Construct sawed joints by sawing a groove in the concrete with a 3 mm 1/8 inch blade to full depth as indicated, without chipping, spalling, or tearing the concrete adjacent to the joint. After expiration of the curing period, widen the upper portion of the groove by sawing to the width and depth indicated. Vary the time of sawing depending on existing and anticipated weather conditions, and such as to prevent uncontrolled cracking of the pavement. Saw the joints at the required spacing consecutively in the sequence of the concrete placement. Do not vary the saw cut by more than 13 mm 1/2 inch from the true joint alignment. Do not saw joints if a crack has occurred near the joint location and discontinue sawing when a crack develops ahead of the saw cut. Immediately after joint is sawed, thoroughly flush the saw cut and adjacent concrete surface with water until all waste from sawing is removed from the joint. Seal the top of the joint opening immediately as specified in subparagraph: MEMBRANE CURING. Provide an ample supply of saw blades and at least one standby sawing unit in good working order at the jobsite at all times during concrete paving operations.

3.10.4.2 Sealing Joints

****
NOTE: In Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT, ASTM D5893/D5893M (Silicone) should be specified for all dikes and basins. Surfaces sloping 6h:1v or greater should be type NS (non-sag).
****

Seal joints immediately following curing of the concrete, or as soon as weather conditions permit, as directed. Accomplish sawing of the reservoir or space for seals, immediately before sealing of the joints. Perform sawing by a multi-blade concrete saw. Perform sawing to the width specified and to the depth indicated in one pass. Readily adjust the cutting unit for width by the addition and removal of spacers or by other suitable means. Equip the machine with a mechanical guide which will keep the cutting unit aligned so as to cut equal widths from each side of the joint groove.

a. Sealing Dike Berms: Seal the joints in the concrete dike berms with a non-sag type fuel resistant sealant as specified in SECTION 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT.

b. Sealing Dike Basins: Seal joints in the concrete surface within the diked areas with fuel resistant sealant as specified in SECTION 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT.

3.11 PAVEMENT PROTECTION

Protect the pavement against all damage, prior to final acceptance of the work by the Government. No vehicular traffic will be allowed on the 100 mm 4 inch concrete pavement at any time.

3.12 REPAIR OF DAMAGED SLABS

Repair new pavement slabs that are broken, have spalled edges, or contain cracks as specified hereinafter at no cost to the Government.

3.12.1 Cracked Slabs

Rout and seal cracks in reinforced slabs in accordance with Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT. Do not epoxy inject these cracks.

3.12.2 Spalled Slabs

Where directed, repair spalls along joints of new slabs, along edges of adjacent existing concrete, and along parallel cracks by first making a vertical saw cut at least 25 mm 1 inch outside the spalled area and to a depth of at least 50 mm 2 inches. Provide straight line saw cuts forming rectangular areas. Chip out the concrete between the saw cut and the joint, or crack, to remove all unsound concrete and into at least 13 mm 1/2 inch of visually sound concrete. For patching materials and construction requirements, see Section 32 01 29.61 PARTIAL DEPTH PATCHING OF RIGID PAVING.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 13 43 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-32 13 43 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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****

SECTION 32 13 43

PERVIOUS CONCRETE PAVING
05/20

****
NOTE: This guide specification covers the requirements for Pervious Portland cement concrete paving such as roads, streets, sidewalks, and parking lots.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Pervious concrete is a near-zero-slump, open-graded material consisting of portland cement, coarse aggregate, little or no fine aggregate, admixtures, and water. The combination of these ingredients produces a hardened material with connected pores that allow water to pass through easily. Pervious concrete is recognized as a sustainable building material, as it reduces storm water runoff, improves storm water quality, may recharge groundwater supplies, and can reduce the impact of the urban heat island (albedo) effect.

NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings, or included in the project

specifications. Pervious portland cement pavements for airfields are not included in this specification.

Pervious concrete paving may be used on site pavements, provided there is documented evidence of successful past performance for similar applications. Parking lots are generally good pervious pavement applications. Typical thicknesses range from 150 to 250 mm 6 to 10 inches.

Permeable pavements may not be used in areas where there is potential to contaminate existing soils, such as fuel areas, industrial storage, marina, vehicle maintenance or service areas. Do not install pervious pavement systems in areas subject to high wheel loads (such as aircraft, ground support equipment, forklifts, and heavy truck traffic) or the special military vehicles listed in UFC 3-201-01, paragraph 4-1.

Consult industry practice for cold regions, arid regions, and regions with high wind erosion. Pervious concrete in freezing areas should be designed with adequate base thickness to ensure that water does not remain in the pavement layer during freezing conditions.

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: Delete this paragraph when the work is covered by a lump-sum contract price.

****

1.1.1 Measurement

Measure the quantity of pervious concrete paving, completed and accepted,in [square][cubic] meters [square][cubic] yards.[Determine the volume of pervious concrete paving, in place and accepted, by the average job thickness obtained in accordance with paragraph FIELD QUALITY CONTROL and the dimensions indicated.]

1.1.2 Payment

The quantity of completed and accepted pervious concrete paving will be paid for at the contract unit price, which will constitute full compensation for the construction and completion of the pervious concrete paving, including the test section, and the furnishing of all other necessary labor and incidentals.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 305.1	(2014) Specification for Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 522.1	(2013) Specification For Pervious Concrete Pavement

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete

ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1542/C1542M	(2019) Standard Test Method for Measuring Length of Concrete Cores
ASTM C1549	(2016; R 2022) Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1688/C1688M	(2014a) Standard Test Method For Density And Void Content Of Freshly Mixed Pervious Concrete
ASTM C1701/C1701M	(2017a) Standard Test Method for Infiltration Rate of In Place Pervious Concrete
ASTM C1754/C1754M	(2012) Standard Test Method for Density and Void Content of Hardened Pervious Concrete
ASTM D6155	(2019) Nontraditional Coarse Aggregate for Bituminous Paving Mixtures

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(2015) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing Materials

SD-04 Samples

Test Section

SD-05 Design Data

Mix Design Report; G, [_____]

SD-06 Test Reports

Concrete Density Tests

Field Infiltration Tests

Surface Smoothness

Core Thickness

Plan Grade

SD-07 Certificates

NRMCA Certificate Of Conformance

1.4 QUALITY CONTROL

1.4.1 NRMCA Certificate of Conformance

Provide a batching and mixing plant consisting of a stationary-type central mix plant, including permanent installations and portable or relocatable plants installed on stable foundations. Provide a plant designed and operated to produce concrete within the specified tolerances, with a minimum capacity of 200 cubic meters 250 cubic yards [_____] per hour. Submit NRMCA Certificate of Conformance that conforms to the requirements of NRMCA QC 3 including provisions addressing:

1. Material Storage and Handling
2. Batching Equipment
3. Central Mixer
4. Ticketing System
5. Delivery System

1.4.2 Qualifications

1.4.2.1 Laboratory Accreditation

Perform sampling and testing using an approved commercial testing laboratory or on-site facility that is accredited in accordance with ASTM C1077. Maintain this certification for the duration of the project.

1.4.2.2 Field Technicians

Provide field technicians meeting one of the following criteria:

a. Provide at least one National Ready Mixed Concrete Association (NRMCA) certified pervious concrete craftsman on site, overseeing each placement crew during all concrete placement.

b. Provide no less than three NRMCA certified pervious concrete installers on site working as members of each placement crew during all concrete placement.

1.5 DELIVERY AND STORAGE

In accordance with ACI 522.1

1.6 ACCEPTANCE

1.6.1 Tolerances

Acceptance of pervious concrete paving is based on compliance with the tolerances presented in Table 1. Remove and replace pervious concrete paving represented by the failing tests or submit repair plan for approval.

TABLE 1

Attribute	Tolerance
TEST SECTION	
Fresh Density	plus/minus 80 kg/cm 5 lb/cf of approved mix design
Core Length (avg 3)	plus 37.5 mm 1.5 inches
Core Length (ind)	minus 19 mm 3/4 inch
FRESH CONCRETE	
Fresh Density	plus/minus 80 kg/cm 5 lb/cf of approved mix design
FINISHED PAVEMENT	
Core Length (avg 3)	plus 37.5 mm 1.5 inches
Core Length (ind)	minus 19 mm 3/4 inch
Hardened Density	plus/minus 5 percent of test section value
Grade	plus/minus 15 mm 0.05 foot from plan
Grade at	plus 3 to 6 mm 1/8 to 1/4 inch above plan
Smoothness	6 mm1/4 inch longitudinal and transverse
Surface Finish	Free of irregularities, tears, and discontinuities

1.6.2 Test Section

Construct a minimum 37 square meters 400 square feet test section to demonstrate typical joints, surface finish, texture, color, infiltration rate, thickness, density, and standard of workmanship. Place test section using the mixture proportions, materials, and equipment as proposed for the project. Test in accordance with requirements in subpart FIELD QUALITY CONTROL.

When a test section does not meet one or more of the tolerances in Table 1, remove and replace the test section. If the test section is acceptable, it may be incorporated into the project.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

****

NOTE: Coal fly ash and slag are EPA designated recovered products to be ingredients in concrete and cement. Use materials with recycled content where appropriate for use. The following section allows a percentage range of supplementary cementitious materials (SCM). Consult agency Subject Matter Expert (SME) for guidance on choice.

Select first sentence in brackets to require the use of SCMs. Select the second option in brackets to permit the use of SCMs.

****

[Provide cementitious materials in concrete mix with 20 to 50 percent non-portland cement pozzolanic materials by weight.] [Provide cementitious materials consisting of portland cement, [blended cement] or only portland cement in combination with supplementary cementitious materials (SCM), that conform to appropriate specifications listed below. New submittals are required when the cementitious materials sources or types change.]

2.1.1.1 Portland Cement

ASTM C150/C150M, Type I or II [or V] [low alkali].

2.1.1.2 Blended Cement

Provide blended cement conforming to ASTM C595/C595M, Type IP or IS, including the optional requirement for mortar expansion [and sulfate soundness]. Provide pozzolan added to the Type IP blend consisting of ASTM C618 Class F or Class N and that is interground with the cement clinker. Include in written statement from the manufacturer that the amount of pozzolan in the finished cement does not vary more than plus or minus 5 percent by mass of the finished cement from lot to lot or within a lot. Do not permit the percentage and type of mineral admixture used in the blend to change from that submitted for the aggregate evaluation and mixture proportioning. The requirements of paragraph SUPPLEMENTARY CEMENTITIOUS MATERIALS (SCM) CONTENT do not apply to the SCM content of blended cement.

2.1.1.3 Fly Ash and Pozzolan

****

NOTE: Class C fly ash is not permitted for paving concrete. Use loss on ignition not exceeding 3 percent for frost areas to reduce carbon interference with air entraining admixture.

****

ASTM C618, Type F or N, including the optional requirement for uniformity, with a loss on ignition not exceeding [3] [6] percent. Provide Class F fly ash for use in mitigating Alkali-Silica Reactivity with a total equivalent alkali content less than 3 percent.

2.1.1.4 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Provide Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) that conforms to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age of at least 95 percent of the control specimens.

b. The average particle size not exceeding 6 microns.

2.1.1.5 Slag

ASTM C989/C989M, Slag Cement (formerly Ground Granulated Blast Furnace

Slag) Grade 100 or 120.

2.1.1.6 Supplementary Cementitious Material (SCM) Content

****

NOTE: Select first sentence in brackets for mandatory use of SCMs. Select second sentence in brackets of optional use of SCMs. Consult agency SME for guidance on choice.

****

[Provide a concrete mix that contains one of the SCMs listed in Table 2 within the range specified therein, whether or not the aggregates are found to be reactive in accordance with paragraph ALKALI REACTIVITY TEST.] [Use of one of the SCMs listed below is optional, unless the SCM is required to mitigate ASR.]

TABLE 2
SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum Content (percent)	Maximum Content (percent)
Class N Pozzolan and Class F Fly Ash		
SiO2 + Al2O3 + Fe2O3 greater than 70 percent	25	35
SiO2 + A12O3 + Fe2O3 greater than 80 percent	20	35
SiO2 + A12O3 + Fe2O3 greater than 90 percent	15	35
UFFA and UFP	7	16
Slag Cement	40	50

2.1.2 Water

Water conforming to ASTM C1602/C1602M.

2.1.3 Aggregates

2.1.3.1 Durability

Evaluate and test all aggregates to be used in all concrete for durability in accordance with ASTM C88. Provide fine and coarse aggregates with a maximum of 18 percent loss when subjected to 5 cycles using Magnesium Sulfate or a maximum of 12 percent loss when subjected to 5 cycles using Sodium Sulfate.

2.1.3.2 Alkali Reactivity Test

****

NOTE: Documentation of alkali reactivity testing is required for all aggregate sources.

****

Evaluate the fine and coarse aggregates separately, using ASTM C1260. Reject individual aggregates with test results that indicate an expansion of greater than 0.10 percent at 16 days after casting, or perform additional testing as follows: utilize the proposed low alkali portland cement, blended cement, and SCM in combination with each individual aggregate in accordance with ASTM C1567. Determine the quantity that meets all the requirements of these specifications and that lowers the expansion equal to or less than 0.10 percent at 16 days after casting. Base the mixture proportioning on the highest percentage of SCM required to mitigate ASR-reactivity. If any of the above options does not lower the expansion to less than 0.10 percent at 16 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing for evaluation and acceptance.

2.1.3.3 Fine Aggregates

Provide fine aggregate conforming to the quality and grading requirements of ASTM C33/C33M.

2.1.3.4 Coarse Aggregates

****

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Select sentence in brackets for mandatory use of recycled materials. Consult agency SME for guidance.

****

Provide coarse aggregate consisting of crushed or uncrushed gravel, crushed stone, or a combination thereof meeting the requirements of ASTM C33/C33M [.][and containing a minimum of [25][_____] percent recycled porcelain, concrete, stone, or other recycled material complying with ASTM D6155.] Deliver aggregates to the mixers consisting of clean, hard, uncoated particles. Wash aggregate sufficient to remove dust and other coatings.

****

NOTE: For pervious concrete, use No.67 (19 mm to 4.75 mm) (3/4 inch to No.4), No. 7 (12.5 mm to 4.75 mm) (1/2 inch to No. 4), No.8 (9.5 mm to 1.2 mm) (3/8 inch to No.16) or No.89 (9.5 mm to 0.30 mm) (3/8 inch to No. 50) to provide 15 percent to 20 percent optimum void factor in hardened concrete.

Gradations No. 8 and No. 89 are commonly used for parking lot and pedestrian walkway applications. The larger aggregate (No. 67) provides a more pervious pavement structure, but with a rougher surface finish and is less suited for pedestrian areas. Gradation No 67 is recommended for vehicle pavements.

****

a. Gradation: ASTM C33/C33M,#67 [#7] [#8] [#89].

****

NOTE: Select class 4M for exterior concrete exposed to frequent wetting in moderate weathering regions. Select class 4S for exterior concrete exposed to frequent wetting in severe weathering regions.

****

b. Quality: ASTM C33/C33M, Class [4M] [4S].

2.1.4 Chemical Admixtures

2.1.4.1 Water Reducing and Retarding Admixtures

ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water reducing and accelerating. Acceptance is based on 28 day physical properties. Do not use calcium chloride admixtures.

2.1.4.2 Air Entraining Admixture

Air entraining admixture conforming to ASTM C260/C260M.

2.1.4.3 Hydration Retarding Admixture

Hydration retarding admixture conforming to ASTM C494/C494M, Type B, retarding, or Type D, water-reducing and retarding.

2.1.5 Curing Materials

2.1.5.1 Polyethylene Sheet

Provide curing materials conforming to ASTM C171, 0.15 mm 0.006 inch clear or white opaque polyethylene cut to a minimum of 600 mm 24 inches wider than full placement width, for curing of pervious concrete.

2.1.6 Edge Restraints

Provide edge restraints consisting of concrete curb sections [_____].

2.1.7 Riser Strips

Provide wood strips of thickness to accommodate the initial strike off and consolidation of the pervious concrete.

2.2 MIX DESIGN

****

NOTE: Pervious concrete is air-entrained per manufacturer's recommendations for freeze thaw durability. However, due to the open void structure of the material, air content cannot be measured by standard ASTM test procedures.

The urban heat island effect forms as vegetation is replaced by low reflectivity materials such as dark colored paving. These surfaces absorb, rather than reflect, the sun's heat, causing surface

temperatures and urban ambient temperatures to be one to 6 degrees C 2 to 10 degrees F hotter than surrounding rural areas.

Mitigation of heat island effect is not required by UFC 1-200-02 but may be desired for sustainability reasons. The albedo requirements below for roads and parking lot paving are most beneficial in ASHRAE climate zones 1 through 5. Retain the bracketed sentence when needed to include solar reflectance criteria.

****

Design pervious concrete mix in accordance with ACI 522.1 to meet the following criteria: the water/cementitious materials ratio within the range of 0.26-0.40 and the air voids of freshly mixed pervious concrete within the range of 18 to 22 percent, as measured in accordance with ASTM C1688/C1688M. Provide air entrainment in freeze-thaw environments.[Provide system with a minimum initial Solar Reflectance of at least 0.33 as tested in accordance with ASTM C1549.]

2.2.1 Mix Design Report

Perform trial design batches, mixture proportioning studies, testing, and include test results demonstrating that the proposed mixture proportions produce pervious concrete of the qualities indicated. Submit test results in a mix design report to include:

a. Aggregate gradations and plots.

b. Aggregate quality test results, including deleterious materials and ASR tests.

c. Mill certificates for cement and supplemental cementitious materials.

d. Certified test results for all admixtures.

e. Recommended proportions and volumes for proposed mixture.

f. Water/cementitious materials ratio and air voids.

g. Narrative discussing methodology on how the mix design was developed.

2.2.2 Mix Verification

Mix verification tests may be performed by the Government. Provide quantities of cementitious materials, aggregates and admixtures as requested. Verification tests may be conducted on the proposed mix design proportions to confirm the fresh concrete air voids content. An existing mix design may be submitted if developed within the previous 12 months.

2.3 EQUIPMENT

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times.

2.3.1 Compaction Equipment

2.3.1.1 Pipe Roller

A steel pipe roller or a motorized or hydraulically actuated rotating tube screed spanning the width of the section placed.

2.3.1.2 Plate Compactor

Compact small areas using a standard soil plate compactor that has a base area of at least 0.2 square meters two square feet and exerts a minimum of 69 kPa 10 psi vertical pressure on the pavement surface (through a temporary cover of 19 mm 3/8 inch thick plywood).

2.3.2 Vibratory Screed

Truss mounted vibratory screed, adjustable in length to span the paving lane. Provide capability to adjust the vibration along the screed length and compact the full depth of the pervious concrete thickness.

2.3.3 Jointing Tool

Provide a jointing tool consisting of a "pizza cutter roller" to which a beveled fin with a minimum depth of 1/4 the thickness of the slab has been welded around the circumference of a steel roller.

2.3.4 Concrete Saw

Provide equipment for sawing joints and for other sawing of concrete consisting of standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment. Provide diamond tipped blades. Provide spares as required to maintain the required sawing rate.

2.3.5 Straightedge

Furnish one 4 m 12 foot straightedge constructed of aluminum or magnesium alloy, having blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Provide handles for operation on the pavement.

PART 3 EXECUTION

3.1 PREPARATION FOR PERVIOUS PAVING

Verify the underlying material, upon which pervious concrete is to be placed is clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. Correct soft, yielding areas and ruts or other irregularities in the surface. Loosen material in the affected areas and remove unsatisfactory material. Add approved select material where directed. Shape the area to line, grade, and cross section, and compact to the specified density.[Conform Subgrade to Section 31 00 00 EARTHWORK.][Conform Base course to Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING].] Rework and compact any underlying material disturbed by construction operations to specified density immediately in front of the pervious concrete placement.

3.2 WEATHER LIMITATIONS

3.2.1 Inclement Weather

Do not commence placing operations when heavy rain or other damaging weather conditions appear imminent. At all times when placing pervious concrete, maintain on-site sufficient waterproof cover and means to rapidly place it over all unhardened concrete or concrete that might be damaged by rain. Suspend placement of concrete whenever rain, high winds, or other damaging weather commences to damage the surface or texture of the placed unhardened concrete, washes cement out of the concrete, or changes the water content of the surface concrete. Immediately cover and protect all unhardened concrete from the rain or other damaging weather. Completely remove and replace any area damaged by rain or other weather full depth.

3.2.2 Cold Weather

Do not place concrete when ambient temperature is below 5 degrees C 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours without approval. If approval is granted, heat concrete materials so that the temperature of the concrete at placement is between 18 and 29 degrees C 65 and 80 degrees F. Methods of heating materials are subject to approval. Do not use heated mixing water. Follow practices found in ACI 306.1.

3.2.3 Hot Weather

Maintain required concrete temperature in accordance with ACI 305.1 to prevent evaporation rate from exceeding 0.98 kg of water per square meter 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. After placement, use fog spray or other suitable means to reduce the evaporation rate. Start curing within 20 minutes of concrete discharge. Cool underlying material by sprinkling lightly with water before placing concrete.

3.3 CONCRETE PRODUCTION

Batch, mix, and deliver pervious concrete in accordance with ACI 522.1.

3.4 PAVING

3.4.1 Paving Plan

Submit for approval a paving plan identifying the following items:

a. A description of the placing and protection methods proposed when concrete is to be placed in or exposed to hot, cold, or rainy weather conditions.

b. A detailed paving sequence plan and proposed paving pattern showing all planned construction joints.

c. Plan and equipment proposed to control alignment of formed or sawn joints within the specified tolerances.

3.4.2 Placing

Comply with guidelines set in ACI 522.1 for placement of pervious concrete, except as modified herein. Do not exceed a free vertical drop of 1.5 m 5 feet. Deposit concrete either directly from the transporting equipment or by conveyor onto the pre-wetted subgrade or subbase, unless otherwise specified. Do not place concrete on frozen subgrade or subbase. Deposit the concrete between the forms to an approximately uniform height. Do not allow foot traffic on the fresh concrete. Place concrete continuously at a uniform rate, without damage to the grade and without unscheduled stops except for equipment failure or other emergencies. If this occurs within 3 m 10 feet of a previously placed expansion joint, remove concrete back to joint, repair any damage to grade, install a construction joint and continue placing concrete only after cause of the stop has been corrected. Spread the concrete using a come-along, square ended shovel, or rake. Strike off the concrete between forms using a vibrating screed. Other strike off devices may be submitted for Government approval. Remove riser strips immediately after strike off operations are complete.

3.4.3 Fixed Form Paving

Use steel forms, except that wood forms may be used for curves having a radius of 45 m 150 feet or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. Provide forms with the base width of the form not less than eight-tenths of the vertical height of the form, except that for forms 200 mm 8 inches or less in vertical height, provide forms with a base width not less than the vertical height of the form. Provide wood forms for curves and fillets that are adequate in strength and rigidly braced. Provide forms and anchors suitable to resist lateral pressures from compaction. Set forms on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Do not set forms on blocks or on built-up spots of underlying material.[Prior to setting forms for paving operations, demonstrate the proposed form setting procedures at an approved location and do not proceed further until the proposed method is approved.] Maintain forms in place at least 12 hours after the concrete has been placed. Remove forms without damaging the concrete.

3.4.4 Operation

When paving between or adjacent to previously constructed pavement, make provisions to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of any debris.

3.4.5 Compaction

Automatically control surface vibration so that it stops immediately as forward motion ceases. Do not permit excessive vibration. Tamp concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment. Do not use vibrators to transport or spread the concrete. After initial compaction, further smooth and compact concrete by means of hand-operated longitudinal rollers. Use rollers that are not less than 1.82 m 6 feet long and 200 mm 8 inches in diameter and stiffened to prevent flexing and warping. Operate the paving equipment to produce a thoroughly compacted concrete layer throughout, requiring no hand finishing, other than the use of jointing tools, except in very infrequent instances.

3.5 FINISHING CONCRETE

Start finishing operations immediately after placement of concrete. Use finishing machine, except hand finishing may be used in emergencies and for concrete slabs in inaccessible locations or of such shapes or sizes that machine finishing is impracticable. Finish pavement surface on both sides of a joint to the same grade. Provide hand finishing equipment for use at all times.

3.5.1 Fixed Form Finishing

Strike off and screed concrete to the required [crown] [slope] and cross-section. When using a static roller for consolidation, stiffen the roller to prevent flexing and warping. Do not permit excessive operation over an area, which will result in an excess of mortar and water being brought to the surface.

3.5.1.1 Joint Finish

Before concrete is hardened, correct edge slump of pavement, exclusive of edge rounding, in excess of 6 mm 0.25 in. Finish concrete surface on each side of construction joints to the same plane, and correct deviations before newly placed concrete has hardened.

3.5.2 Edging

Immediately after consolidation and jointing, carefully finish slab edges, including edges at formed joints, with an edge having a radius of not less than 6 mm 0.25 inch. Clean by removing loose fragments and soupy mortar from corners or edges of slabs which have crumbled.[Install edge restraints of pervious systems per the drawings and manufacturer's recommendations.]

3.5.3 Jointing

Construct joints at the locations, depths, and width dimensions indicated on the project drawings or the approved shop drawings. Saw cut or use the jointing tool to form contraction joints in fresh concrete immediately after the concrete has been compacted to the specified depth and width. Extend expansion joints through the full depth of the pavement. Cut expansion material flush to grade after concrete has fully hardened and provide joint filler material as indicated or as approved on the shop drawings.

3.6 CURING

Cure pervious concrete for a minimum of 7 days. Protect concrete adequately from injurious action by sun, rain, flowing water, [frost,] mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Maintain temperature of air next to concrete above 5 degrees C 40 degrees F for the full curing periods.

3.6.1 White-Polyethylene Sheet

Begin curing within 20 minutes of concrete discharge unless longer working time is approved. Lay sheets directly on concrete surface and overlap 300 mm 12 inches. Make sheeting not less than 600 mm 24 inches wider than concrete surface to be cured, and weight down on the edges, without using soil or debris, and over the transverse laps to form closed joints. Repair or replace sheets when damaged during curing. Check daily to assure sheets are soundly in place. If moisture evaporates, re-saturate concrete and replace polyethylene on pavement (limit re-saturation and re-placing no longer than 10 minutes per sheet).

3.7 FIELD QUALITY CONTROL

3.7.1 Sampling

Collect samples of fresh concrete in accordance with ASTM C172/C172M during each working day as required to perform tests specified herein.

3.7.2 Consistency Tests

Conduct concrete density tests on the fresh concrete in accordance with ASTM C1688/C1688M. Take samples for density determination from concrete during placement. Perform tests at the beginning of a concrete placement operation and for each batch (minimum) or every 40 cubic meters 50 cubic yards (maximum) of concrete to ensure that specification requirements are met.

3.7.3 Sample Cores

After a minimum of seven days following each placement, take three cores at random locations. Core hardened concrete panels in accordance with ASTM C42/C42M. Test thickness and density of the cores in accordance with ASTM C1542/C1542M and ASTM C1754/C1754M Drying Method B, respectively. Compute the tolerance for core thickness and density reported as the average of three cores of each test panel. Fill core holes with regular concrete or pre-mixed grout.

3.7.4 Field Infiltration Tests

After the curing period is complete, determine the infiltration rate of the pervious concrete in accordance with ASTM C1701/C1701M. Locate field infiltration tests at three random locations for each 930 square meters 10000 square feet of pervious concrete surface area. Determine the location of each test using GPS or other methods suitable to repeat testing during the life of the pavement. Submit the test results For Information Only.

3.7.5 Surface Testing

****

NOTE: Drawings should clearly show all pavement joint intersection elevations, and specific required deviations from a plane surface for such special features as crowns, drainage inlets, etc.

****

Perform surface testing for surface smoothness and plan grade as indicated below. Reference the measurements in accordance with paving lane identification and stationing, and submit a report within 24 hours after measurement is made. Upon conclusion of surface testing, submit a final report of surface testing, signed by a Registered Engineer, containing all surface measurements and a description of all actions taken to correct deficiencies. Mechanically sweep pavement before testing hardened concrete for compliance tolerances.

3.7.5.1 Surface Smoothness Requirements

Provide the finished surfaces of the pavements with no abrupt change of 3 mm 1/8 inch or more, and within the tolerances specified in Table 1 when checked with a 4 meter 12 foot straightedge.

3.7.5.2 Surface Smoothness Testing Method

Test the surface of the pavement with the straightedge to identify all surface irregularities exceeding the tolerances specified above. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines approximately 4.5 m 15 feet apart. Hold the straightedge in contact with the surface and move ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Make the measurement of the gap with a steel spacer bar of rectangular section the same thickness as the allowable gap, and width of four times the nominal maximum aggregate size.

3.7.6 Plan Grade Testing and Conformance

Check each pavement category for conformance with plan grade requirements by running lines of levels to determine the elevation at locations on the pavement surface 4.5 meters 15 feet on center.

3.8 Pavement Protection

Protect the pavement against all damage prior to final acceptance of the work. Do not stockpile aggregates, landscaping materials, or other construction materials on pervious concrete pavements. Keep all new and existing pervious pavement carrying construction traffic or equipment completely clean, and clean up spillage of concrete or other materials immediately upon occurrence. Remove dust, leaves and debris with a leaf blower or dry vacuum.

3.9 Open To Traffic

Do not open the pavement to vehicular traffic until the concrete has cured at least 7 uninterrupted days during which the ambient temperature has exceeded 13 deg C 55 deg F or until the pavement is accepted.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 13 73.19 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 13 73 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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COMPRESSION CONCRETE PAVING JOINT SEALANT

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USACE / NAVFAC / AFCEC **UFGS-32 13 73.19 (November 2019)**

Preparing Activity: USACE **Superseding**
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SECTION 32 13 73.19

COMPRESSION CONCRETE PAVING JOINT SEALANT
11/19

****

NOTE: This guide specification covers the requirements for polychloroprene compression seals used for sealing joints of rigid pavements for airfields, roads, streets, hardstands, and other areas.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: For U.S. Air Force pavements, specify the uncompressed width of the seals to be used, and the width of the saw cut reservoir including tolerances. The minimum sawed joint seal reservoir width is 13 mm 1/2 in. The specified uncompressed seal width is twice the specified nominal saw cut reservoir width, i.e., for a 13 mm 1/2 in wide joint seal reservoir saw cut, specify a 25 mm 1 in uncompressed width joint seal.

Consider total joint opening and movement when specifying the size of the joint and seal. Consider

factors affecting the proper sizing of the joint seal to assure the seal remains within the allowable compression range and that the working range of the proposed seal is greater than the total movement of the joints. Follow the computational procedures in UFC 3-250-08FA Chapter 7, Appendix C. Factors to be considered are saw cut reservoir width including tolerances, maximum pavement thermal expansion and contraction, pavement shrinkage during curing and pavement temperature limitations during joint seal reservoir sawing.

Show on the drawings or specify in this section the compression joint seal size, general shape and dimensional tolerances, especially uncompressed seal width. Manufacturer's literature is helpful in determining the seal size with the anticipated joint movement.

****

1.1 UNIT PRICES

****

NOTE: Delete paragraphs MEASUREMENT and PAYMENT for lump sum bidding.

****

1.1.1 Measurement

Determine the quantity of each sealing item to be paid by measuring the length of in-place material that has been approved.

1.1.2 Payment

Make Payment at the Contract unit bid prices per unit length for the sealing items scheduled, including approved trail joint installation. Include in the unit bid prices the cost of labor, materials, the use of equipment, and tools required to complete the work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile

references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D2628	(1991; R 2016) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D2835	(1989; R 2017) Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 548	(1988) Standard Specification for Jet-Fuel and Heat-Resistant Preformed Polychloroprene Elastomeric Joint Seals for Rigid Pavements

1.3 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification

and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment

Manufacturer's Instructions

SD-04, Samples

Compression Seals; G, [_____]

SD-06 Test Reports

Test Requirements; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Trial Joint Seal and Lubricant/Adhesive Installation

Prior to the cleaning and sealing of the joints for the entire project, prepare a test section at least 61 m 200 ft long at a designated location in the project pavement, using the specified materials and the approved equipment to demonstrate the proposed joint preparation and sealing of the joints in the project. Following the completion of the trial length and before another joint is sealed, the Government will inspect the trial joints to determine that the materials and installation meet the requirements specified. If materials or installation do not meet requirements, remove the materials, and reclean and reseal the joints at no cost to the Government. Do not seal other joints until the test installation has been approved. If the trial section is approved, permit the section to be incorporated into the permanent work. Seal other joints in the manner approved for sealing the trial joint.

1.5 SAFETY

****
NOTE: Delete this paragraph if liquid oxygen (LOX) equipment, storage, or piping is not within the project area and renumber subsequent paragraphs. If LOX equipment, storage, or piping is within the project area, use continuously reinforced concrete slabs within the 7.5 m 25 ft clear area of LOX to reduce the number of joints. If joints cannot be eliminated within the clear area, then clean the joints in the area and seal with a LOX compatible sealant that has been approved by Headquarters, U.S. Army Corps of Engineers (CEMP-ET) or the appropriate

Air Force Major Command. The Major Command or CEMP-ET will be contacted to obtain a list of approved materials.

A MIXTURE OF LOX AND ORGANIC MATERIAL IS EXTREMELY FLAMMABLE, AND MAY SELF-IGNITE OR EXPLODE.

****

Do not place compression joint seals within 7.5 m 25 ft of liquid oxygen (LOX) equipment, LOX storage, or LOX piping.

1.6 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the jobsite for defects. Unload and store materials with a minimum of handling to avoid damage. Provide storage facilities that protect materials from weather and maintain materials within temperatures recommended by the manufacturer.

1.7 ENVIRONMENTAL REQUIREMENTS

Install materials only when the ambient temperature and the pavement temperature within the joint wall is at least 2 degrees C 35 degrees F and rising. Do not permit sealant installation if moisture or foreign material is observed in the joint.

PART 2 PRODUCTS

2.1 SYSTEM EQUIPMENT

Provide machines, tools, and equipment, for use in the performance of the work required by this section, approved before the work is started, and maintained in satisfactory condition. Submit list of proposed machines, tools, and equipment to be used in the performance of joint sealing, including descriptive data, [_____] days prior to use on the project.

2.1.1 Joint Cleaning Equipment

2.1.1.1 Concrete Saw

Provide a self-propelled power saw with water-cooled diamond saw blades for cutting joints to the depths and widths specified and for removing filler, existing old joint seal, or other material embedded in the joints or adhered to the joint faces.

2.1.1.2 Sandblasting Equipment

****

NOTE: Sandblasting equipment with a 6 mm 1/4 in nozzle requires at least 3880 L 137 cubic ft per minute of air to function efficiently. A larger nozzle would not serve a useful purpose in cleaning a joint.

****

Include with the sandblasting equipment an air compressor, hose, and a long-wearing venturi-type nozzle of proper size, shape, and opening. Do not permit the maximum nozzle opening to exceed 6 mm 1/4 in. Provide a portable air compressor capable of providing not less than 4200 L 150 cubic ft per minute and maintaining a line pressure of not less than 620 kPa 90 psi at the nozzle while in use. Use a compressor equipped with traps that maintains the compressed air free of oil and water. Use a nozzle with an adjustable guide that holds the nozzle aligned with the joint approximately 25 mm 1 in above the pavement surface and directs the blast to clean the joint walls. Adjust the height, angle of inclination, and the size of the nozzle to ensure satisfactory results.

2.1.1.3 Waterblasting Equipment

Include with the waterblasting equipment a trailer-mounted water tank, pumps, high-pressure hose, a wand with safety release cutoff controls, nozzle, and auxiliary water resupply equipment. Use a water tank and auxiliary water resupply equipment of sufficient capacity to permit continuous operations. Use pumps, hoses, wand, and nozzle of sufficient capacity to permit the cleaning of both walls of the joint and the pavement surface for a width of at least 13 mm 1/2 in on either side of the joint. Use a pressure gauge mounted at the pump that shows the pressure in kPa psi at which the equipment is operating.

2.1.2 Sealing Equipment

****

NOTE: Do not permit single-axle seal application equipment; this tool tends to cause excessive stretching and may cut or distort the seal. The following subparagraph may be added only for road, parking lot, and street pavements less than 1800 square m 2,000 square yds, and for airfield and tracked pavements less than 450 square m 500 square yds in area:

"Use a hand operated joint seal application equipment that is a two-axle, four-wheel machine that includes means for compressing and inserting the compression seal into the joint and a reel capable of holding one full spool of compression seal. Provide auxiliary equipment to coat both sides of the joint or the seal with lubricant/adhesive just prior to the installation of the compression seal."

****

Install the compression seal by placing the compression seal to the prescribed depths and within the specified tolerances without cutting, nicking, twisting, or otherwise damaging the seal. Use equipment capable of placing the seal with not more than two percent longitudinal stretch or compression of the seal during installation. Use a machine that is an automatic self-propelled joint seal application equipment and engine powered. Use a machine that includes a reservoir for the lubricant/adhesive, a device for conveying the lubricant/adhesive in the proper quantities to the sides of the compression seal or the sidewalls of the joints, a reel capable of holding one full spool of compression seal, and a power-driven apparatus for feeding the joint seal through a compression device and inserting the seal into the joint. Include a guide with the equipment to maintain the proper course along the joint being sealed. Operate the machine by an experienced operator.

2.1.3 Test Requirements

Submit certified copies of test results, [_____] days prior to use of material on the project. Sample, identify and test each lot of compression joint seal and lubricant/adhesive for conformance with the material specification.

a. A lot of compression seal consists of 1 day's production or 6,000 m 20,000 linear ft for each cross section, whichever is less. A lot of lubricant/adhesive consists of 1 day's production. [Submit samples of the compression joint seal and lubricant/adhesive material to be tested by the Government. Do not permit use of material at the project prior to receipt of written notice that the materials meet the laboratory requirements.

b. The cost of testing the samples from each original lot supplied will be borne by the Government. If the samples fail to meet specification requirements, replace the materials represented by the sample and the new materials tested. Charge a cost of [_____] for Government testing of each lot of replacement material to the Contractor] [Testing of the compression joint seal and lubricant/adhesive material is the responsibility of the Contractor. Perform testing in an approved, independent laboratory, and submit certified copies of the test reports for approval [_____] days prior to the use of the materials at the jobsite.

c. Submit samples of each lot of material to be retained by the Government for possible future testing if the materials appear defective during or after application]. Provide additional samples of materials, in sufficient quantity to be tested, upon request. Base final acceptance on conformance to the specified test requirements and the performance of the in-place materials with respect to slipping down the joint or material coming out of the joint..

2.2 COMPRESSION SEALS

****

NOTE: The first statement will be selected for projects except where the project is less than 1200 m 4000 linear ft of compression joint seal material. When the project requires less than this amount of seal material, the first statement can be deleted and the second statement used. The cost of testing can be obtained from U.S. Army Engineer Waterways Experiment Station.

Allow the Contractor the option of the actual width of the joint seal. However, for guidance on unusual circumstances, or for resealing joints in existing pavement that have to be sawed out to an extra width, see UFC 3-250-08FA Chapter 7, "Standard Practice for Sealing Joints and Cracks in Rigid and Flexible Pavements."

****

Regardless of testing responsibility, submit 2.7 m 9 ft long samples of the materials, [60] [_____] days prior to use on the project. Provide printed directions from the manufacturer on recommended installation criteria with the samples plus the manufacturer's certification that the selected seal is recommended for the installation on this project. Use compression joint seal materials that are vulcanized elastomeric compound using polychloroprene as the only base polymer. Use material and manufactured seal in accordance with [ASTM D2628] [ASTM D2628 and COE CRD-C 548 where jet fuel and/or heat blast resistance is required] as tested by ASTM D412. Use a labryinth seal for the joint seal. The uncompressed depth of the face of the compression seal (that is to be bonded to the joint wall) is greater than the uncompressed width of the seal, except that for seals 25 mm 1 in or greater in width, the depth need be only 25 mm 1 in or greater. The actual width of the uncompressed seal for construction and contraction joints is [21 or 25] [_____] mm [0.75 or 1] [_____] in and for expansion joints is [32][_____] mm 1.25 [_____] in. The tolerance on the seal is plus 3 mm or minus 1.5 mm plus 1/8 in or minus 1/16 in.

2.3 LUBRICANT/ADHESIVE

Use a lubricant/adhesive for the compression elastomeric joint seal that is a one-component compound conforming to ASTM D2835.

PART 3 EXECUTION

****

NOTE: Joint openings of uniform cross section are essential to satisfactory installation of the compression joint seal. Saw openings to provide smooth vertical faces of consistent width, within specified tolerances. Nonuniformity in width or roughness causes variations in resistance of the joint seal to insertion and results in irregular depth of insertion, stretching, and a tendency of the joint seal to twist so that the top of the seal is not at the surface.

The proper preparation of joints with respect to the size of joint opening, required cleanliness of vertical and parallel joint faces, and uniform contact between the seal and the joint face can not be overemphasized. The neglect of these operations can result and has resulted in poor performance of joint seals. For the repair of concrete pavements adjacent to the joints, refer to UFC 3-270-01, and Section 32 01 29.61 PARTIAL DEPTH PATCHING OF RIGID PAVING.

****

3.1 PREPARATION OF JOINTS

Immediately before installation of the compression joint seal, clean the joints to remove laitance, filler, existing sealer, foreign material and protrusions of hardened concrete from the sides and upper edges of the joint space to be sealed. Clean by sandblasting or waterblasting and extend along pavement surfaces at least 13 mm 1/2 in on either side of the joint. After final cleaning and immediately prior to sealing, blow out the joints with compressed air and leave free of debris and water. Demonstrate that the selected cleaning operation meets the cleanliness requirements resulting in joint sidewalls that are clean and dry and exhibit newly exposed concrete. Correct irregularities in the joint face which would prevent uniform contact between the joint seal and the joint face prior to the installation of the joint seal.

3.1.1 Sawing

****

NOTE: Requirements are based on giving the Contractor the option of using either nominal 21 mm 13/16 in or 25 mm 1 in wide compression seal. Select the required values from columns (3) and (4) of the following tables, based on the geographical area and the nominal sealant width to be used for this project.

The first table is metricated, followed by a similar tabulation in I-P units.

Area	(1) Expected Pavement Temperature Range in Service, Degrees C	(2) Nominal Uncompressed Sealant Width, mm	(3) Nominal Saw Cut, mm	(4) Allowable Pavement Temperature Range for Sawing, Degrees C
Southwest Desert Area	-12 to +71	20.6	12.7	+10 to +45
		25.4	14.3	+13 to +82
Southern U.S.	-18 to +57	20.6	12.7	-1 to +44
		25.4	14.3	-1 to +77
Other Contiguous U.S.	-35 to +57	20.6	12.7	-4 to +27
		25.4	14.3	-4 to +60
Alaska and Similar Areas	-57 to +44	20.6	11.1	+10 to +42
		25.4	12.7	+16 to +71
* Note in the project specifications to not install this seal in a saw cut less than 11 mm nor in an area if sawing at temperatures less than 10 degrees C.				

Area	(1) Expected Pavement Temperature Range in Service, Degrees F	(2) Nominal Uncompressed Sealant Width, in	(3) Nominal Saw Cut, in	(4) Allowable Pavement Temperature Range for Sawing, Degrees F
Southwest Desert Area	+10 to +160	13/16	8/16	+50 to +115
		1	9/16	+55 to +180

Area	(1) Expected Pavement Temperature Range in Service, Degrees F	(2) Nominal Uncompressed Sealant Width, in	(3) Nominal Saw Cut, in	(4) Allowable Pavement Temperature Range for Sawing, Degrees F
Southern U.S.	0 TO +135	13/16	8/16	+30 to +110
		1	9/16	+30 to +170
Other Contiguous U.S.	-30 to +135	13/16	8/16	+25 to +80
		1	9/16	+25 to +140
Alaska and Similar Areas	-70 to +110	13/16*	7/16	+50* to +105
		1	8/16	+60 to +160
* Note in the project specifications to not install this seal in a saw cut less than 71/6 IN nor in an area if sawing at temperatures less than 50 degrees F.				

The above tables are based on the following:

a. Tolerance from nominal specified width of uncompressed seal plus 3 mm 1/8 in and minus 1.5 mm 1/16 in.

b. Tolerance from nominal saw cut width plus or minus 1.5 mm 1/16 in.

c. Compress the compression seal at least 20 percent of its uncompressed width.

d. Do not permit compression seal to be compressed more than 60 percent of its uncompressed width (narrowest opening in hot weather is at least 40 percent of uncompressed seal width).

For unusual conditions and for resealing joints in existing pavements where the prepared joint is extra wide, compute values to insert in the blanks using the procedures given in UFC 3-250-08FA, Chapter 7, and the parameters given above. (Before the compression seal is used for resealing joints in existing pavements, it is common practice to resaw the joints, which provides a wider cavity. Hold the width of sawing to the same tolerance as specified for new pavements).
****

Clean and open joints to the specified width and depth by sawing. Immediately following the sawing operation, clean the joint faces and opening using a water jet to remove saw cuttings or debris remaining on the faces or in the joint opening. Install compression seal within 3 calendar days of the time the joint cavity is sawed. Provide a depth of the joint cavity in accordance with manufacturer's instructions. Where installation procedures are required in accordance with the manufacturer's recommendations, submit printed copies of manufacturers' instructions, [_____] days prior to use on the project. Center the saw cut for the joint seal cavity over the joint line. Provide the nominal width of the sawed joint seal cavity as follows:

a. If a nominal 20 mm 13/16 in wide compression seal is provided, the nominal width of the saw cut is [_____] mm in when the pavement temperature at the time of sawing is between [_____] and [_____] degrees C F. If the pavement temperature at the time of sawing is above this range, decrease the nominal width of the saw cut 1.5 mm 1/16 in. If the pavement temperature at the time of sawing is below this range, increase the nominal width of the saw cut 1.5 mm 1/16 in.

b. If a nominal 25 mm 1 in wide compression seal is provided, the nominal width of the saw cut is [_____] mm ins when the pavement temperature at the time of sawing is between [_____] and [_____] degrees C F. If the pavement temperature at the time of sawing is above this range, decrease the nominal width of the saw cut 1.5 mm 1/16 in. If the pavement temperature at the time of sawing is below this range, increase the nominal width of the saw cut 1.5 mm 1/16 in.

c. Measure the pavement temperature in the presence of the Contracting Officer. Make measurement each day before commencing sawing and when the temperature appears to be varying from the allowable sawing range.

Use a tolerance of plus or minus 1.5 mm 1/16 in for the actual width.

3.1.2 Sandblast Cleaning

****

NOTE: Delete this paragraph and paragraph entitled "SANDBLASTING EQUIPMENT" when sandblasting is prohibited.

****

Use a multiple pass sandblasting technique until the joint surfaces are free of dust, dirt, curing compound, or residue that might prevent ready insertion or uniform contact of the seal and bonding of the lubricant/adhesive to the concrete.

3.1.3 Waterblast Cleaning

****

NOTE: Waterblasting equipment varies considerably with respect to design of wand, nozzle, water pressure, and water volume depending upon the manufacturer. Consequently, the effectiveness of a particular set of equipment cannot be predicted. The joints may be waterblasted the previous day and cleaned with compressed air immediately prior to sealing. Inspect the joints to insure no foreign debris remains in the joint before sealing.

****

Use a multiple pass waterblast technique until the surfaces are free of dust, dirt, curing compound, or residue that might prevent ready insertion or uniform contact of the seal and bonding of the lubricant/adhesive to the concrete. After final cleaning and immediately prior to sealing, blow out the joints with compressed air and leave completely free of debris and water.

3.1.4 Rate of Progress

Limit sandblasting or waterblasting of joint faces to the length of joint that can be sealed during the same workday.

3.2 INSTALLATION OF THE COMPRESSION SEAL

****

NOTE: Temperatures of the pavement and the atmosphere are not as critical for the installation of compression joint seals as they are for poured sealants. Therefore, lower temperatures are acceptable, and under some conditions sealing can proceed satisfactorily at temperatures lower than 2 degrees C 35 degrees F. However, joints should be dry to obtain maximum cementing of the lubricant/adhesive to the concrete and contact manufacturers for special instructions under cold conditions.

Include the bracketed text in this paragraph on projects that the Contractor may not be familiar with this practice, predominantly OCONUS projects.

****

[Confirm a representative of the joint seal manufacturer is present at the trial joint installation to correct installation issues prior to full installation.
]

3.2.1 Time of Installation

Seal joints immediately within 3 calendar days of sawing the joint seal cavity and following concrete cure and the final cleaning of the joint walls. Provide open joints, ready for sealing that cannot be sealed under the specified conditions, with an approved temporary seal to prevent infiltration of foreign material. When rain interrupts the sealing operations, wash, clean with air pressure, and allow joints to dry prior to installing the lubricant/adhesive and compression seal.

3.2.2 Sequence of Installation

Seal longitudinal joints first, followed by transverse joints. Install seals in longitudinal joints so that transverse joint seals are intact from edge to edge of the pavement. Make intersections monolithic by use of joint seal adhesive and care in fitting the intersection parts together. Do not permit extender pieces of seal at intersections. Remove and replace seals falling short at the intersection with new seals at no additional cost to the Government. Require a poured sealant at the intersection where seals are required to change direction by more than 20 degrees. Provide poured sealant in accordance with compression seal manufacturer's instructions.

3.3 SEALING OF JOINTS

****

NOTE: Do not permit stretching of the compression joint seal beyond the specified maximum, as breaks in the seal could occur later.

It is also possible that if the maximum is exceeded, when the longitudinal joints are cut to install the transverse joints that the joint seal material returns to its natural length leaving openings in the final product. Conversely, placing the seal so that the compression seal is compressed longitudinally is also undesirable, as this practice tends to cause unsightly undulations and may exceed depth of installation tolerances.

Use the minimum depth of the seal 6 mm 1/4 in below the surface of the pavement to prevent treads of tracked vehicles from damaging the compression seal if tracked vehicles are to use the pavement. Revise depth of installation to read "10 mm, plus or minus 3 mm" "3/8 in, plus or minus 1/8 in." On airfield pavements a shallower depth of installation may be desired by the using agency, to reduce the accumulation of dust and debris on top of the compression seal, which could be ingested by aircraft engines. In such cases, revise the depth of installation to read "5 mm, plus or minus 3 mm" "3/16 in, plus or minus 1/8 in", if requested in writing by the using service major command. It is also recommended when the compression seal in the longitudinal intersections are being cut that a knife blade be used to reduce the possibility of damage to the compression seal on either side of the intersection.

****

Cover the sides of the joint seal or the sides of the joint with a coating of lubricant/adhesive and the seal installed as specified. Coat butt joints and seal intersections with liberal applications of lubricant/adhesive. Immediately removed lubricat/adhesive spilled on the pavement to prevent setting on the pavement.

Provide the in-place joint seal will be in an upright position and free from twisting, distortion, and cuts. Adjustments will be made to the installation equipment and procedure, if the stretch exceeds 1 percent. Remove and replace seals exceeding 2 percent stretch. Place the joint seal at a uniform depth within the tolerances specified. Remove and replace in-place joint seals which fail to meet the specified requirements with new joint seal at no cost to the Government.

Place the compression joint seal to a depth of 6 mm 1/4 in, plus or minus 3 mm 1/8 in, below the pavement surface except when the joint is beveled or has a radius at the surface, or unless otherwise directed. For beveled joints or joints with a radius at the surface, install the compression joint seal at a depth of 3 mm 1/8 in, plus or minus 3 mm 1/8 in, below the bottom of the edge of the bevel or radius. Do not permit the seal to project above the surface of the pavement or above the edge of the bevel or radius.

Install the seal in the longest practicable lengths in longitudinal joints and cut at the joint intersections to provide continuous installation of the seal in the transverse joints. Permit the lubricant/adhesive in the longitudinal joints to set for 1 hour prior to cutting at the joint intersections to reduce the possibility of shrinkage. For transverse joints, the minimum length of the compression joint seal is the pavement width from edge to edge.

3.4 CLEAN-UP

Upon completion of the project, remove unused materials from the site, remove lubricant/adhesive on the pavement surface, and leave the pavement in clean condition.

3.5 QUALITY CONTROL PROVISIONS

3.5.1 Application Equipment

Inspect the application equipment to assure uniform application of lubricant/adhesive to the sides of the compression joint seal or the walls of the joint. If equipment causes cutting, twisting, nicking, excessive stretching or compressing of the seal, or improper application of the lubricant/adhesive, suspend the operation until causes of the deficiencies are determined and corrected.

3.5.2 Procedures

3.5.2.1 Quality Control Inspection

Provide quality control provisions during the joint cleaning process to prevent or correct improper equipment and cleaning techniques that damage the concrete. Cleaned joints will be approved by the Government prior to installation of the lubricant/adhesive and compression joint seal.

3.5.2.2 Conformance to Stretching and Compression Limitations

Determine conformance to stretching and compression limitations. Mark the top surface of the compression seal at 300 mm 1 ft intervals in a manner clear and durable to enable length determinations of the seal. After installation, measure the distance between the marks on the seal. If the stretching or compression exceeds 2 percent, remove the seal and replace it with new joint at no additional cost to the Government. Remove the seal up to the last correct measurement. Inspect the seal a minimum of once per [30] [120] m [100] [400] ft of seal for compliance to the shrinkage or compression requirements. Make measurements at the same interval to determine conformance with depth and width of installation requirements. Remove and replace compression seal that is not in conformance with specification requirements with new joint seal at no additional cost to the Government.

3.5.2.3 Pavement Temperature

Determine the pavement temperature by placing a thermometer in the initial saw cut for the joint and record the reading. Pemrit the thermometer to remain in the joint for an adequate time to provide a stable control reading.

3.5.3 Acceptance

Inspect the joint sealing system (compression seal and lubricant/adhesive) for proper rate of cure and bonding to the concrete, cuts, twists, nicks and other deficiencies. Remove, waste and replace seals exhibiting defects prior to final acceptance of the project from the joint.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 14 13.13 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 16 15 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-32 14 13.13 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-32 16 15 (April 2008)

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****

SECTION 32 14 13.13

INTERLOCKING PRECAST CONCRETE UNIT PAVING

11/19

****

NOTE: This guide specification covers the requirements for constructing a concrete block pavement.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 PAYMENT PROCEDURES

****

NOTE: Delete this paragraph in fixed price Contracts.

****

1.1.1 Pavements

Pay per square m square ft of satisfactorily installed unit pavement surface including the units, cut units, bedding sand, and jointing sand.

1.1.2 Edge Restraint

Pay per lineal m ft of satisfactorily installed edge restraint.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	(2020) Specifications for Structural Concrete
ACI 301M	(2020) Metric Specifications for Structural Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C140/C140M	(2024) Standard Test Methods for Sampling and Testing Concrete Masonry Units and

	Related Units
ASTM C144	(2024) Standard Specification for Aggregate for Masonry Mortar
ASTM C535	(2016; R 2024) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C936/C936M	(2024) Standard Specification for Solid Concrete Interlocking Paving Units
ASTM C979/C979M	(2024) Standard Specification for Pigments for Integrally Colored Concrete
ASTM C1645/C1645M	(2022a; E 2024) Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D7428	(2015) Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion inthe Micro-Deval Apparatus
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the list provided, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Field-Constructed Mock-Up; G, [_____]

Concrete Paving Unit; G, [_____]

SD-06 Test Reports

Tests, Inspections and Verifications

SD-07 Certificates

Paving Unit Installer Field Supervisor; G, [_____]

Provide a copy of an ICPI Concrete Paver Installer School Certification, including a record of completion from a PICP or Permeable Interlocking Concrete Pavement Installer Technician Course.

1.4 DELIVERY, STORAGE AND HANDLING

Deliver materials in manufacturer's original, unopened, undamaged container packaging with identification tags intact on each paver bundle. Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving. Deliver concrete pavers to the site in steel banded, plastic banded, or plastic wrapped bundles capable of transfer by forklift or clamp lift. Unload pavers at job site in such a manner that no damage occurs to the product or to existing construction.

Stockpile jointing, bedding, base and subbase aggregates such that they do not segregate within each pile. Keep piles (1) free from standing water, (2) free of organic material, sediment, or debris, and (3) ready for placement. Store aggregates on paved surfaces. Do not store aggregates on exposed soil or grassed areas unless first covered with geotextile to keep the aggregates clean.

1.5 QUALITY ASSURANCE

1.5.1 Concrete Paver Installer Certification

A paving unit installer field supervisor with a certificate of completion from the Interlocking Concrete Pavement Institute (ICPI) Concrete Paver Installer School Certification is required.

1.5.2 Pre-Construction Meeting

Prior to starting work, hold a pre-construction meeting with the project engineer or other Government representative responsible for the project. Determine the following:

a. Delivery and storage locations for aggregates and concrete paving unit bundles;

b. Anticipated start date;

c. Starting point(s) and direction(s) of paving;

d. Methods for checking slopes and surface tolerances for smoothness and elevations;

e. Estimated daily production for installation of aggregates, edge restraints and paving units; and

f. Recording and reporting actual daily paving production, including identifying the site location and recording the number of bundles installed each day.

For machine assisted installation of paving units, review:

a. Concrete unit manufacturer's written method that explains processes for controlling paver dimensional tolerances, and

b. Diagram(s) of the concrete paver laying pattern and how the paver layers or clusters join together to provide a continuous pattern across the pavement surface.

1.5.3 Weather Requirements

Do not install paver units during rain or snow events or when jointing sand, bedding sand, base or subbase aggregates are frozen. Do not place base or subbase aggregates on frozen soil subgrades.

****
NOTE: Mechanized installations may require a larger field-constructed mock-up area.
****

1.5.4 Field-Constructed Mock-Up

Install paver units on a minimum 3 x 3 m 10 x 10 ft area to determine surcharge of the bedding layer, joint sizes, and lines, laying pattern, color and texture of the job. Use this area as the standard by which the work is judged. Subject to acceptance by Contracting Officer or project engineer, allow the mock-up to be retained as part of finished work. If mock-up is not retained, remove mock-up from the installation boundary and properly dispose of material.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Bedding and Jointing Sand

Use two separate sand gradations for the bedding layer and for the paver unit joints.

Prepare bedding sand and gradation in accordance with:

a. ASTM C33/C33M with a maximum amount passing the 0.075 mm No. 200 sieve of 1 percent.

b. A maximum loss of 8 percent in accordance with ASTM D7428 and a maximum loss of 7 percent in accordance with ASTM C88.

c. A minimum of 60 percent combined sub-angular and sub-rounded particle shapes in accordance with ASTM D2488

Prepare jointing sand gradtion in accordance with:

a. ASTM C144 with a maximum of 100 percent passing the 1.18 mm No. 16 sieve and no more than 5 percent passing the 0.075 mm No. 200 sieve.

Prepare bedding and jointing sand in accordance with:

a. Material consisting of crushed sand, natural sand, or a combination of crushed and natural sand.

b. A minimum L.A. Abrasion of 40 percent when tested in accordance with ASTM C131/C131M and ASTM C535.

c. A minimum of 90 percent fractured faces in accordance with ASTM D5821.

d. Nonplastic when tested in accordance with ASTM D4318 and free of lumps, clay, vegetation, soft particles, sulphates, and other contaminants.

e. The following gradations, determined in accordance with ASTM C136/C136M and ASTM C117, using ASTM E11 sieve.

Sieve, mm (ASTM E11)	Percent Passing	
	Bedding Sand	Jointing Sand
9.5 3/8 in	100	-
4.75 No. 4	95-100	100
2.36 No. 8	80-100	95-100

Sieve, mm (ASTM E11)	Percent Passing	
	Bedding Sand	Jointing Sand
1.18 No. 16	50-85	70-100
0.600 No. 30	25-60	40-75
0.300 No. 50	5-30	10-35
0.150 No. 100	0-10	2-15
0.075 No. 200	0-1	0-5

2.1.2 Concrete Paving Unit

****

NOTE: Allow color of unit to be specified. Check local availability of specific colors before specifying. Do not permit organic pigments to be used since they are unstable in the alkaline concrete environment and subject to weathering.

****

Submit a sample of five paving units prior to the start of the work. Also, a representative sample of not less than 15 units as directed by the Contracting Officer, from each lot of 20,000 concrete paving units or fraction thereof. Use concrete paving units that are in accordance with ASTM C936/C936M and [_____] thick, [_____] in color, and [_____] in shape. Use units with a pigmentation in accordance with ASTM C979/C979M.

2.1.3 Edge Restraints

2.1.3.1 Precast Concrete

****

NOTE: Minimum compressive strength of precast concrete at 28 days is 21 MPa 3,000 psi unless analysis requires some other value. Entrained air content of the fresh concrete is 6 percent plus or minus 1.5 percent in areas where freezing and thawing coverage is a design consideration. Delete this paragraph when this option is not retained.

****

Use the edge restraints made of precast Portland cement concrete elements with the dimensions shown on the plans. Use precast concrete having a compressive strength of not less than [_____] at 28 days and an entrained air content of not less than [_____].

2.1.3.2 Cast-in-Place Concrete

****

NOTE: Minimum compressive strength of cast-in-place concrete at 28 days is 21 MPa 3,000 psi unless analysis requires some other value. Entrained air content of the fresh concrete is 6 percent plus or

minus 1.5 percent in areas where freezing and thawing coverage is a design consideration. Delete this paragraph when this option is not retained.

****

Place edge restraints using Portland cement concrete with the dimensions shown in the plans. Use concrete in conformance with the requirements of ACI 301MACI 301, except that it has a compressive strength of not less than [_____] at 28 days and an entrained air content of not less than [_____].

2.2 TESTS, INSPECTIONS AND VERIFICATIONS

Submit a written report within seven (7) calendar days after completion of the work, covering the following testing which is required for each lot.

2.2.1 Paving Unit

****

NOTE: Require sampling of paving units prior to the start of the work for the purposes of verifying the color and shape of the units only when these considerations are critical to the project aesthetics. For jobs of less than 1000 square m 10,000 square ft or for pavements not to be exposed to vehicular traffic, allow a manufacturer's certificate which certifies that the paving units meet the requirements of ASTM C936/C936M to be accepted in lieu of sampling and testing the units of each lot.

****

Conduct the tests prescribed by ASTM C936/C936M and the following tests on the remaining units of each sample from each lot.

2.2.1.1 Freezing and Thawing

****

NOTE: Allow the freezing and thawing test to be waived for climates not subject to freezing and thawing. For jobs of less than 1000 square m 10,000 square ft, allow a manufacturer's certificate which certifies that the paving units meet the requirements of this paragraph to be accepted in lieu of sampling and testing the units of each lot.

****

Determine the resistance to freezing and thawing in accordance with ASTM C1645/C1645M and check that the results meet the freeze-thaw requirements stated in ASTM C936/C936M.

2.2.1.2 Dimensional Tolerance

Sample and measure three paving units from each lot in accordance with ASTM C140/C140M. Do not permit the length and width of each unit in the sample to vary from other units in this or other lot samples by more than 1.6 mm 1/16 in. Do not permit the thickness of the unit in the sample to vary by more than 3.2 mm 1/8 in from the specified unit thickness.

2.2.1.3 Compressive Strength

Test three paving units in accordance with ASTM C140/C140M. Do not permit the average minimum compressive strength to be less than 55 MPa 8,000 psi with no individual unit less than 50 MPa 7,200 psi.

2.2.1.4 Retest

Notify the Contracting Officer if units fail to meet the specified requirements. In case the shipment fails the specified requirements, take another sample and new specimens selected from the retained lot for retesting, as directed by the Contracting Officer. Concrete paving unit retests are to be performed at the expense of the Contractor. In case the second set of specimens fails to meet the test requirements, reject the entire lot..

2.2.2 Bedding and Jointing Sand

Obtain representative samples of bedding and jointing sand in accordance with ASTM D75/D75M from each 75 cubic m 100 cubic yds of sand to be used in the project. If the sand fails to meet the gradation requirements take another sample and retest it at no cost to the Government. If this retest fails or if no second test is taken, reject the sand and remove from the job site.

PART 3 EXECUTION

****

NOTE: Use a base course for the block pavement that is a dense graded or bound material to avoid loss of the sands from the bedding layer. Properly grade and level the base course. A smoothness of no more than 10 mm 3/8 in deviation from a 3 m 10 ft straight edge is needed. Check the project specification for the pavement base course to ensure these requirements are met.

****

3.1 PREPARATION

3.1.1 Edge Restraint Location

Install the edge restraint as shown in the drawings prior to placement of the units.

3.1.2 Bedding Sand Layer

Spread the bedding sand evenly over the area to be paved and screed to an uncompacted average thickness of 25 mm 1 in with a tolerance for grade and surface smoothness of plus or minus 6 mm 1/4 in. Do not use this bedding sand to fill low areas that exceed the specified tolerance for the base. Lease the sand uncompacted and do not disturb by pedestrian or vehicle construction traffic.

3.2 UNIT PLACEMENT

****

NOTE: Place paving unit subject to vehicular traffic in herringbone pattern, and this pattern can

be specified here.

****

Place the paving units by hand or machine in the indicated pattern. Start the placement of paving units from a corner or straight edge and proceed forward over the undisturbed sand bedding layer. Do not permit the joints, excluding chamfer between paving units, to be less than 2 mm 1/16 in or more than 5 mm 3/16 in in width. After seating, check that the unit surface is flush or up to 6 mm 1/4 in above the edge restraint.

3.2.1 Unfilled Gaps

Fill gaps between paving units and the edge restraint, drainage structure, or other member that cannot be filled with a whole unit with a paving unit cut to fit the gap, except do not allow slivers and the minimum size of cut unit is be [_____]. Use a hydraulic splitter, a masonry saw, or other device that accurately leaves a clean, vertical face without spalling for cutting. Do not accept a remaining gap between the unit and adjoining edge restraint, drainage structures, or other member that is greater than 6 mm 1/4 in. Cut or rearrangeadjacent units to prevent this.

3.2.2 Seating Units

Seat the units in the bedding sand by compacting them with a minimum of three passes of a vibratory plate compactor, sized as follows: [_____].

3.2.3 Jointing Sand

Sweep the jointing sand into joints and vibrate with a vibratory plate or vibratory roller compactor. Continue this process until sweeping and vibrating have filled joints with sand and further vibration cannot force additional sand into the joints. Sweep the coarser sand particles that did not enter the joints and remain on the surface and excess sand on the surface off the pavement.

3.2.4 Timing of Operations

Seating of units and placement of jointing sand can be done concurrently with unit placement. However, do not allow seating of units and placement of jointing sand within 1.5 m 5 ft of an unfinished edge of the pavement that is not supported by the edge restraint.

3.2.5 Final Rolling

****

NOTE: This paragraph can be deleted for light load pavements such as driveways or pedestrian walkways.

****

Roll the final finished paving unit surface with four passes of a vibratory or pneumatic roller with a static weight of not less than 4.5 metric tons 10,000 lbs.

3.2.6 Construction Traffic

Do not allow construction traffic on the paving unit surface until the jointing sand has been placed and vibrated into the joints and debris and excess sand have been swept off.

3.3 SMOOTHNESS AND GRADE TOLERANCES

3.3.1 Smoothness

Do not allow a portion of the finished pavement surface to deviate by more than 10 mm 3/8 in from a 3 m 10 ft long metal straightedge placed on the pavement surface.

3.3.2 Unit Height

Check that the finished unit surface is either flush or up to 6 mm 1/4 in higher than edge restraints or drainage structures.

3.3.3 Grade

Check that the finished pavement is within 12 mm 1/2 in of the planned grade shown on the plans.

3.3.4 Remedial Action

Remove paver units and sand in those area not meeting the smoothness, unit height, or grade tolerance , adjust aggregate base grade, and relay the units and sand.

3.4 CLEANUP

Sweep the entire pavement surface and remove excess sand, units and debris from the project area.

3.5 MAINTENANCE

****

NOTE: Include this paragraph only if the project has aesthetic considerations where future maintenance has to exactly match the color of the block.

****

At the completion of work provide [_____] paving units matching those used in the project. Deliver these paving units stacked on pallets to a Base location provided by the Project Engineer.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 15 00 (May 2017)**

Preparing Activity: USACE **Superseding**
UFGS-32 15 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 15 00

AGGREGATE SURFACING

05/17

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 15 00 (May 2017)**

Preparing Activity: USACE **Superseding**
UFGS-32 15 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 32 15 00

AGGREGATE SURFACING
05/17

****
NOTE: This guide specification covers the requirements for aggregate surfacing for roads, parking areas and Army airfields.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 UNIT PRICES

****
NOTE: Delete this paragraph for lump sum construction projects.
****

1.1.1 Measurement

Measure the quantity of aggregate surface course completed and accepted, as determined by the Contracting Officer, in [square] [cubic] meters yards. The [volume] [area] of aggregate surface course in-place and accepted will be determined by the [average job thickness obtained in accordance with paragraph LAYER THICKNESS and the] dimensions shown on the drawings.

1.1.2 Payment

Quantities of aggregate surface course, determined as specified above, will be paid for at the respective contract unit prices, which will constitute full compensation for the construction and completion of the aggregate surface course.

1.1.3 Waybills and Delivery Tickets

Submit copies of waybills and delivery tickets during progress of the work. Before the final payment is allowed, file certified waybills and certified delivery tickets for all aggregates actually used.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
AASHTO T 224	(2010) Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance

	to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 DEGREE OF COMPACTION

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 9.0 mm 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 9.0 mm 3/4 inch sieve will be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

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SD-03 Product Data

Plant, Equipment, and Tools; G[, [_____]]

Waybills And Delivery Tickets

SD-06 Test Reports

Initial Tests; G[, [_____]]

In-Place Tests; G[, [_____]]

1.5 EQUIPMENT, TOOLS, AND MACHINES

****

NOTE: If desirable, requirements for types of equipment applicable to methods of construction based on local conditions will be included.

****

All plant, equipment, and tools used in the performance of the work will be subject to approval by the Contracting Officer before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Provide adequate equipment having the capability of minimizing segregation, producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.6 QUALITY ASSURANCE

Sampling and testing are the responsibility of the Contractor. Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00 QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. The Contracting Officer may specify the time and location of the tests. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the tests.

1.6.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.6.2 Testing

1.6.2.1 Sieve Analysis

Perform sieve analysis in conformance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11.

1.6.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

1.6.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with paragraph DEGREE OF COMPACTION.

1.6.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556/D1556M, ASTM D2167 or ASTM D6938. For the method presented in ASTM D1556/D1556M use the base plate as shown in the drawing. For the method presented in ASTM D6938 check the calibration curves and adjust them, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D6938 result in a wet unit weight of soil and ASTM D6938 will be used to determine the moisture content of the soil. Also check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. Make the calibration checks of both the density and moisture gauges using the prepared containers of material method, as described in paragraph Calibration of ASTM D6938, on each different type of material being tested at the beginning of a job and at intervals as directed. Submit calibration curves and related test results prior to using the device or equipment being calibrated.

1.6.2.5 Wear Test

Perform wear tests on aggregate surface course material in conformance with ASTM C131/C131M.

1.7 ENVIRONMENTAL REQUIREMENTS

****

NOTE: This paragraph may be deleted in localities

where freezing temperatures do not occur, and elsewhere when it is definitely known that the work will not be carried on during periods when such temperatures are to be expected. Otherwise, this requirement will be retained, but the protective measures specified may be modified to suit local conditions and individual project requirements.

****

Perform construction when the atmospheric temperature is above 2 degrees C 35 degrees F. It is the responsibility of the Contractor to protect, by approved method or methods, all areas of surfacing that have not been accepted by the Contracting Officer. Bring surfaces damaged by freeze, rainfall, or other weather conditions to a satisfactory condition.

PART 2 PRODUCTS

2.1 AGGREGATES

****

NOTE: As written, this paragraph applies to general conditions. Other materials such as disintegrated granite, volcanic ash or cinders, limerock, and caliche will be specified when supported by adequate performance data. The requirement for soundness and percentage of wear will be deleted when local experience indicates the material is satisfactory.

The gradation or gradations applicable to the specific job will be specified. The gradations shown are recommended, but others may be used where they have been used successfully. The liquid limit and plasticity index specified are normally used, but may be changed as required. Gradations No. 3 and No. 4 may be susceptible to frost damage.

When an aggregate surfacing is used in construction of Army Class IV airfields, paragraph PROOF ROLLING will be retained, and the extent of proof rolling will be precisely shown on the drawings. When using the specifications for an aggregate surface course subjected to highway vehicular traffic such as roads, streets, and parking areas or for Army Class I, II, and III airfields, references to proof rolling will be deleted in paragraph AGGREGATES, and paragraph PROOF ROLLING will be deleted.

****

Provide aggregates consisting of clean, sound, durable particles of natural gravel, crushed gravel, crushed stone, sand, slag, soil, or other approved materials processed and blended or naturally combined. Provide aggregates free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign materials. The Contractor is responsible for obtaining materials that meet the specification and can be used to meet the grade and smoothness requirements specified herein after all compaction and proof rolling operations have been completed.

2.1.1 Coarse Aggregates

****

NOTE: A percentage of wear other than 50 may be specified where experience indicates that the material is satisfactory.

****

The material retained on the 5 mm No. 4 sieve is known as coarse aggregate. Use only coarse aggregates that are reasonably uniform in density and quality. Use only coarse aggregate having a percentage of wear not exceeding 50 percent after 500 revolutions as determined by ASTM C131/C131M. The amount of flat and/or elongated particles must not exceed 20 percent. A flat particle is one having a ratio of width to thickness greater than three; an elongated particle is one having a ratio of length to width greater than three. When the coarse aggregate is supplied from more than one source, aggregate from each source must meet the requirements set forth herein.

2.1.2 Fine Aggregates

The material passing the 5 mm No. 4 sieve is known as fine aggregate. Fine aggregate consists of screenings, sand, soil, or other finely divided mineral matter that is processed or naturally combined with the coarse aggregate.

2.1.3 Gradation Requirements

Gradation requirements specified in TABLE I apply to the completed aggregate surface. It is the responsibility of the Contractor to obtain materials that will meet the gradation requirements after mixing, placing, compacting, and other operations. TABLE I shows permissible gradings for granular material used in aggregate surface roads and airfields. Use sieves conforming to ASTM E11.

TABLE I. GRADATION FOR AGGREGATE SURFACE COURSES
Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation (mm)	No. 1	No. 2	No. 3	No. 4
25 1 inch	100	100	100	100
9.5 3/8 inch	50-85	60-100	--	--
4.7 No. 4	35-65	50-85	55-100	70-100
2.00 No. 10	25-50	40-70	40-100	55-100
0.425 No. 40	15-30	24-45	20-50	30-70
0.075 No. 200	8-15	8-15	8-15	8-15

2.2 LIQUID LIMIT AND PLASTICITY INDEX

The portion of the completed aggregate surface course passing the 0.425 mm No. 40 sieve must have a maximum liquid limit of 35 and a plasticity index of 4 to 9.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

2.3.1 Initial Tests

Perform one of each of the following tests, on the proposed material prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. Complete this testing for each source if materials from more than one source are proposed.

a. Sieve Analysis.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

Submit certified copies of test results for approval not less than [30] [_____] days before material is required for the work.

2.3.2 Approval of Material

Tentative approval of material will be based on initial test results.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

[Perform clearing, stripping, and excavating. Operate the aggregate sources to produce the quantity and quality of materials meeting these specification requirements in the specified time limit. Upon completion of the work, leave aggregate sources on Government property in a satisfactory condition so that they readily drain.] [Finalize aggregate sources on private lands in agreement with local laws or authorities.]

3.2 STOCKPILING MATERIAL

****

NOTE: In cases where material previously stockpiled under a separate contract is utilized in the construction of the aggregate surface course, this requirement will be included in the SPECIAL CONTRACT REQUIREMENTS of the specifications, and this paragraph will be modified as required.

****

Prior to stockpiling the material, clear and level the storage sites. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Stockpile aggregates in such a manner that will prevent segregation. Stockpile aggregates and binders obtained from different sources separately.

3.3 PREPARATION OF UNDERLYING [COURSE] [SUBGRADE]

****

NOTE: The reference to the specification section that covers the preparation of the subgrade surface

for the particular project will be included in this paragraph.

****

Clean the [underlying course] [subgrade] and shoulders of all foreign substances. Do not construct the surface course on [underlying course] [subgrade] that is frozen material. Correct ruts or soft yielding spots in the [underlying course] [subgrade], areas having inadequate compaction and deviations of the surface from the requirements set forth herein by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade and recompacting to density requirements specified in [Section 31 00 00 EARTHWORK] [Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING]]. Do not allow traffic or other operations to disturb the completed [underlying course] [subgrade] and maintain in a satisfactory condition until the surface course is placed.

3.4 GRADE CONTROL

During construction, maintain the lines and grades including crown and cross slope indicated for the aggregate surface course by means of line and grade stakes placed by the Contractor in accordance with the SPECIAL CONTRACT REQUIREMENTS.

3.5 MIXING AND PLACING MATERIALS

****

NOTE: More details of applicable methods of placing, mixing, and spreading will be included when appropriate.

****

Mix and place the materials to obtain uniformity of the material and a uniform optimum water content for compaction. Make adjustments in mixing, placing procedures, or in equipment to obtain the true grades, to minimize segregation and degradation, to obtain the desired water content, and to ensure a satisfactory surface course.

3.6 LAYER THICKNESS

****

NOTE: When gravel surfaces are constructed less than 150 mm (6 inches) in total thickness, a deficiency of 13 mm (1/2 inch) in the thickness of any area of such paving is considered excessive. Applicable to job conditions, the thickness tolerance provisions may be modified as required, restricting all deficiencies to not more than 6 mm (1/4 inch).

****

Place the aggregate material on the [underlying course] [subgrade] in layers of uniform thickness. Compact the completed aggregate surface course to the thickness indicated. No individual layer may be thicker than 150 mm 6 inches nor be thinner than 75 mm 3 inches in compacted thickness. Compact the aggregate surface course to a total thickness that is within 13 mm 1/2 inch of the thickness indicated. Where the measured thickness is more than 13 mm 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 13 mm 1/2 inch thicker than indicated, the course will be considered as conforming to the specified thickness requirements. The average job thickness will be the average of all thickness measurements taken for the job and must be within 6 mm 1/4 inch of the thickness indicated. Measure the total thickness of the aggregate surface course at intervals of one measurement for each [500] [_____] square meters yards of surface course. Measure total thickness using 75 mm 3 inch diameter test holes penetrating the aggregate surface course.

3.7 COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D1557 abbreviated herein as percent laboratory maximum density. Compact each layer of the aggregate surface course with approved compaction equipment, as required in the following paragraphs. Maintain the water content during the compaction procedure at optimum or at the percentage specified by the Contracting Officer. Compact the mixture with mechanical tampers in locations not accessible to rollers. Continue compaction until each layer through the full depth is compacted to at least 100 percent of laboratory maximum density. Remove any materials that are found to be unsatisfactory and replace them with satisfactory material or rework them to produce a satisfactory material.

3.8 PROOF ROLLING

****

NOTE: When an aggregate surfacing is used in construction of Army Class IV airfields, this paragraph will be retained, and the extent of proof rolling will be shown on the drawings. When using the specifications for an aggregate surface course subjected to highway vehicular traffic such as roads, streets, and parking areas or for Army Class I, II, and III airfields, references to proof rolling will be deleted in paragraph AGGREGATES, and this paragraph will be deleted.

****

In addition to the compaction specified above, proof roll the designated areas by application of 30 coverages of a heavy rubber-tired roller having four tires abreast with each tire loaded to 13,600 kg 30,000 pounds and tires inflated to 1000 kPa150 psi. In the areas designated, proof roll the top lift of layer on which surface course is laid and to each layer of the surface course. Maintain the water content of the lift of the layer on which the surface course is placed and each layer of the aggregate surface course at optimum or at the percentage directed from the start of compaction to the completion of a proof rolling. Remove and replace materials in the aggregate surface course or underlying materials indicated to be unacceptable by the proof rolling with acceptable materials as directed.

3.9 EDGES OF AGGREGATE SURFACE COURSE

Place approved material along the edges of the aggregate surface course in such quantity as to compact to the thickness of the course being constructed. Simultaneously roll and compact at least 300 mm 1 foot of shoulder width with the rolling and compacting of each layer of the surface course when the course is being constructed in two or more layers.

3.10 SMOOTHNESS TEST

Construct each layer so that the surface shows no deviations in excess of 10 mm 3/8 inch when tested with a 3 m 10 foot straightedge applied both parallel with and at right angles to the centerline of the area to be paved. Correct deviations exceeding this amount by removing material, replacing with new material, or reworking existing material and compacting, as directed.

3.11 FIELD QUALITY CONTROL

3.11.1 In-Place Tests

Perform each of the following tests on samples taken from the placed and compacted aggregate surface course. Take samples and test at the rates indicated.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 250 [_____] square meters square yards, or portion thereof, of completed area.

b. Perform sieve analysis on every lift of material placed and at a frequency of one sieve analysis for every 500 [_____] square meters square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the thickness of the aggregate surface course at intervals providing at least one measurement for each 500 [_____] square meters yards of base course or part thereof. Measure the thickness using test holes, at least 75 mm 3 inch in diameter through the aggregate surface course.

3.11.2 Approval of Material

Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and full coompacted aggregate surface course.

3.12 MAINTENANCE

Maintain the aggregate surface course in a condition that will meet all specification requirements until accepted.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 16 19 (May 2018)**

Preparing Activity: USACE **Superseding**
UFGS-32 16 13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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CONCRETE CURBS, GUTTERS AND SIDEWALKS

05/18

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USACE / NAVFAC / AFCEC **UFGS-32 16 19 (May 2018)**

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****

SECTION 32 16 19

CONCRETE CURBS, GUTTERS AND SIDEWALKS
05/18

****

NOTE: This guide specification covers the requirements for concrete sidewalks and curbs and gutters.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This specification may be adjusted to cover separate curbs and gutters or combination curbs and gutters. This guide specification will not be used for integral or monolithic curbs of concrete pavement or for curbs and gutters for bridges.

****

1.1 UNIT PRICES

****

NOTE: Delete unit price paragraphs when the work is covered by a lump-sum contract price.

****

1.1.1 Measurement

1.1.1.1 Sidewalks

The quantities of sidewalks to be paid for will be the number of square meters yards of each depth of sidewalk constructed as indicated.

1.1.1.2 Curbs and Gutters

The quantities of curbs and gutters to be paid for will be the number of linear meters feet of each cross section constructed as indicated, measured along the face of the curb at the gutter line.

1.1.2 Payment

1.1.2.1 Sidewalks

Payment of the quantities of sidewalks measured as specified will be at the Contract unit price per square meter yard of the thickness specified.

1.1.2.2 Curbs and Gutters

Payment of the quantities of curbs and gutters measured as specified will be at the Contract unit price per linear meter foot of each cross section.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D5893/D5893M	(2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2017) Standard And Commentary Accessible and Usable Buildings and Facilities

1.3 SUBMITTALS

****

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****

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SD-03 Product Data

Concrete

[Biodegradable Form Release Agent]

SD-06 Test Reports

Field Quality Control

1.4 EQUIPMENT, TOOLS, AND MACHINES

1.4.1 General Requirements

Plant, equipment, machines, and tools used in the work will be subject to approval and must be maintained in a satisfactory working condition at all times. Use equipment capable of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Discontinue using equipment that produces unsatisfactory results. Allow the Contracting Officer access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.4.2 Slip Form Equipment

Slip form paver or curb forming machines, will be approved based on trial use on the job and must be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass.

1.5 ENVIRONMENTAL REQUIREMENTS

1.5.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 5 degrees C 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 2 degrees C 35 degrees F and is rising, or is already above 5 degrees C 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 2 degrees C 35 degrees F, placement and protection must be approved in writing. Approval will be contingent upon full conformance with the following provisions. Prepare and protect the underlying material so that it is entirely free of frost when the concrete is deposited. Heat [mixing water and aggregates] [mixing water] [aggregates] as necessary to result in the temperature of the in-place concrete being between 10 and 30 degrees C 50 and 85 degrees F. Methods and equipment for heating must be approved. Use only aggregates that are free of ice, snow, and frozen lumps before entering the mixer. Provide covering or other means as needed to maintain the concrete at a temperature of at least 10 degrees C 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.5.2 Placing During Warm Weather

The temperature of the concrete as placed must not exceed 30 degrees C 85 degrees F except where an approved retarder is used. Cool the mixing water and aggregates as necessary to maintain a satisfactory placing temperature. The placing temperature must not exceed 35 degrees C 95 degrees F at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Provide concrete conforming to the applicable requirements of [Section 03 30 00 CAST-IN-PLACE CONCRETE] [ASTM C94/C94M] except as otherwise specified. Concrete must have a minimum compressive strength of 24 MPa 3500 psi at 28 days. Size of aggregate must not exceed 37.5 mm 1-1/2 inches. Submit copies of certified delivery tickets for all concrete used in the construction.

2.1.1 Air Content

****

NOTE: The air content specified is for concrete that will be subjected to freezing weather and the possible action of deicing chemicals. In climates where freezing is not a factor but where air entrainment is used in local commercial practice to improve the workability and placeability of concrete, concrete having air content percent of 4.5 plus or minus 1.5 percent may be specified as Contractor's option to non air-entrained concrete.

****

Use concrete mixtures that have an air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

Use concrete with a slump of 75 mm 3 inches plus or minus 25 mm 1 inch for hand placed concrete or 25 mm 1 inch plus or minus 10 mm 1/2 inch for slipformed concrete as determined in accordance with ASTM C143/C143M.

2.1.3 Reinforcement Steel

****

NOTE: Reinforcement steel normally will not be required for curb and gutter construction. Where conditions exist that make it advantageous to use reinforcement steel, include the reinforcing steel details in the drawings, and include the following paragraphs in the Contract specification.

****

Use reinforcement bars conforming to ASTM A615/A615M. Use wire mesh reinforcement conforming to ASTM A1064/A1064M.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Use impervious sheet materials conforming to ASTM C171, type optional, except that polyethylene film, if used, must be white opaque.

2.2.2 Burlap

Use burlap conforming to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

Use white pigmented membrane-forming curing compound conforming to ASTM C309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Use concrete protection materials consisting of a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Use hard-pressed fiberboard contraction joint filler for curb and gutter.

2.4.2 Expansion Joint Filler, Premolded

****

NOTE: Either type of joint sealer may be specified if determined necessary by the Contracting Officer and the inapplicable publication removed. Joint sealing material may be omitted where sealing of expansion joints is not deemed essential or advisable.

****

Onless otherwise indicated, use 13 mm 1/2 inch thick premolded expansion joint filler conforming to ASTM D1751 or ASTM D1752.

2.5 JOINT SEALANTS

Use cold-applied joint sealant conforming to ASTM C920 or ASTM D5893/D5893M.

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Use wood or steel forms that are straight and of sufficient strength to resist springing during depositing and consolidating concrete.

2.6.1 Wood Forms

Use forms that are surfaced plank, 50 mm 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Use forms with a nominal length of 3 m 10 feet. Radius bends may be formed with 19 mm 3/4 inch boards, laminated to the required thickness.

2.6.2 Steel Forms

Use channel-formed sections with a flat top surface and welded braces at each end and at not less than two intermediate points. Use forms with interlocking and self-aligning ends. Provide flexible forms for radius forming, corner forms, form spreaders, and fillers as needed. Use forms with a nominal length of 3 m 10 feet and that have a minimum of 3 welded stake pockets per form. Use stake pins consisting of solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.3 Sidewalk Forms

Use sidewalk forms that are of a height equal to the full depth of the finished sidewalk.

2.6.4 Curb and Gutter Forms

Use curb and gutter outside forms that have a height equal to the full depth of the curb or gutter. Use rigid forms for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 3 m 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 38 mm 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

[2.6.5 Biodegradable Form Release Agent

****

NOTE: Concrete release fluids are recognized as a biobased material. Use materials with biobased content where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying product biobased content requirements. A resource that can be used to identify products with bio-based content is the "Catalog" tab within the USDA's "Biopreferred" website at https://www.biopreferred.gov/BioPreferred/. Other products with biobased content are also acceptable when meeting all requirements of this specification.

****

Use form release agent that is colorless and biodegradableand that is composed of at least 87 percent biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

]2.7 Detectable Warning System

Detectable Warning Systems shown on the Contract plans are to meet requirements of ICC A117.1 - Section 705.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

****

NOTE: On most projects, major grading operations involving excavation and construction of embankments will be performed and paid for under other sections of the specifications and, therefore, are not included in this guide specification. Where such work, including the construction of any required subbase, must be done under this section, paragraphs FORM SETTING, SIDEWALK CONCRETE PLACEMENT AND FINISHING, and CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING will be revised to cover necessary additional requirements. The subgrade will be

indicated as extending at least 600 mm 2 feet in width back of curb, gutter, entrance, and combination curb and gutters.

****

Construct subgrade to the specified grade and cross section prior to concrete placement.

3.1.1 Sidewalk Subgrade

Place and compact the subgrade in accordance with [Section 31 00 00 EARTHWORK] [Section [_____]]. Test the subgrade for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

Place and compact the subgrade in accordance with [Section 31 00 00 EARTHWORK] [Section 32 11 23 [AGGREGATE BASE COURSE] [AND/OR][GRADED CRUSHED AGGREGATE BASE COURSE] FOR FLEXIBLE PAVING] [Section [_____]]. Test the subgrade for grade and cross section by means of a template extending the full width of the curb and gutter. Use subgrade materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

Maintain subgrade in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade must be in a moist condition when concrete is placed. Prepare and protect subgrade so that it is free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 1.2 m 4 feet. Use additional stakes and braces at corners, deep sections, and radius bends, as required. Use clamps, spreaders, and braces where required to ensure rigidity in the forms. Remove forms in a manner that will not injure the concrete. Do not use bars or heavy tools against the concrete when removing the forms. Promptly and satisfactorily repair concrete found to be defective after form removal. Clean forms and coat with form oil or biodegradable form release agent each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 3 mm 1/8 inch in any 3 m 10 foot long section. After forms are set, grade and alignment must be checked with a 3 m 10 foot straightedge. Sidewalks must have a transverse slope [as indicated] [of 20 mm per meter 1/4 inch per foot] [Unless otherwise indicated, construct sidewalks that are located adjacent to curbs with the low side adjacent to the curb.] Do not remove side forms less than 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

Remove forms used along the front of the curb not less than 2 hours nor more than 6 hours after the concrete has been placed. Do not remove forms used along the back of curb until the face and top of the curb have been finished, as specified for concrete finishing. Do not remove gutter forms while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks must be of the thickness indicated. Use a strike-off guided by side forms after concrete has been placed in the forms to bring the surface to proper section to be compacted. Consolidate concrete by tamping and spading or with an approved vibrator. Finish the surface to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. Produce a scored surface by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

Finish all slab edges, including those at formed joints, with an edger having a radius of 3 mm 1/8 inch. Edge transverse joints before brooming. Eliminate the flat surface left by the surface face of the edger with brooming. Clean and solidly fill corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing with a properly proportioned mortar mixture and then finish.

3.3.4 Surface and Thickness Tolerances

Finished surfaces must not vary more than 8 mm 5/16 inch from the testing edge of a 3 m 10-foot straightedge. Permissible deficiency in section thickness will be up to 6 mm 1/4 inch.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Place concrete to the required section in a single lift. Consolidate concrete using approved mechanical vibrators. Curve shaped gutters must be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Float and finish exposed surfaces with a smooth wood float until true to grade and section and uniform in texture. Brush floated surfaces with a fine-hair brush using longitudinal strokes. Round the edges of the gutter and top of the curb with an edging tool to a radius of 13 mm 1/2 inch. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the front curb surface, while still wet, in the same manner as the gutter and curb top. Finish the top surface of gutter [and entrance] to grade with a wood float.

3.4.4 Joint Finishing

Finish curb edges at formed joints as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces must not vary more than 6 mm 1/4 inch from the testing edge of a 3 m 10-foot straightedge. Permissible deficiency in section thickness will be up to 6 mm 1/4 inch.

3.5 SIDEWALK JOINTS

Construct sidewalk joints to divide the surface into rectangular areas. Space transverse contraction joints at a distance equal to the sidewalk width or 1.5 m 5 feet on centers, whichever is less, and continuous across the slab. Construct longitudinal contraction joints along the centerline of all sidewalks 3 m 10 feet or more in width. Construct transverse expansion joints at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, install transverse expansion joints as indicated. Form expansion joints around structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.5.1 Sidewalk Contraction Joints

Form contraction joints in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness. Unless otherwise approved or indicated, either use a jointer to cut the groove or saw a groove in the hardened concrete with a power-driven saw. Construct sawed joints by sawing a groove in the concrete with a 3 mm 1/8 inch blade. Provide an ample supply of saw blades on the jobsite before concrete placement is started. Provide at least one standby sawing unit in good working order at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Form expansion joints using 13 mm 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or building paper. Hold joint filler in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, round joint edges using an edging tool having a radius of 3 mm 1/8 inch. Remove any concrete over the joint filler. At the end of the curing period, clean the top of expansion joints and fill with cold-applied joint sealant. Use joint sealant that is gray or stone in color. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Apply joint sealing material only when the concrete at the joint is surface dry and atmospheric and concrete temperatures are above 10 degrees C 50 degrees F. Immediately remove any excess material on exposed surfaces of the concrete and clean the concrete surfaces.

3.5.3 Reinforcement Steel Placement

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NOTE: Reinforcement steel normally will not be required for curb and gutter construction. Where conditions exist that make it advantageous to use reinforcement steel, the reinforcing steel details will be indicated, and the following paragraphs will be included in the Contract specification.

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Accurately and securely fasten reinforcement steel in place with suitable supports and ties before the concrete is placed.

3.6 CURB AND GUTTER JOINTS

Construct curb and gutter joints at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Construct contraction joints directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 1.5 m 5 feet nor greater than 4.5 m 15 feet in length.

a. Construct contraction joints (except for slip forming) by means of 3 mm 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Remove separators as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

b. When slip forming is used, cut the contraction joints in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. Cut the contraction joint to a depth of at least one-fourth of the gutter/curb depth using a 3 mm 1/8 inch saw blade.

3.6.2 Expansion Joints

Form expansion joints by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Construct expansion joints in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement using the same type and thickness of joints as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, provide expansion joints at least 13 mm 1/2 inch in width at intervals not less than 10 meters 30 feet nor greater than 36 meters 120 feet. Seal expansion joints immediately following curing of the concrete or as soon thereafter as weather conditions permit. Seal expansion joints and the top 25 mm 1 inch depth of curb and gutter contraction-joints with joint sealant. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Concrete at the joint must be surface dry and atmospheric and concrete temperatures must be above 10 degrees C 50 degrees F at the time of application of joint sealing material. Immediately remove excess material on exposed surfaces of the concrete and clean concrete surfaces.

3.7 CURING AND PROTECTION

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NOTE: Only the methods of curing appropriate to local weather conditions and construction practices will be retained, but Contractor's option of at least two curing methods will be retained to promote competition in bidding.

****

3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete must be on hand and ready for use before actual concrete placement begins. Protect concrete as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

Cover the entire exposed surface with two or more layers of burlap. Overlap mats at least 150 mm 6 inches. Thoroughly wet the mat with water prior to placing on concrete surface and keep the mat continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

Wet the entire exposed surface with a fine spray of water and then cover with impervious sheeting material. Lay sheets directly on the concrete surface with the light-colored side up and overlapped 300 mm 12 inches when a continuous sheet is not used. Use sheeting that is not less than 450 mm 18-inches wider than the concrete surface to be cured. Secure sheeting using heavy wood planks or a bank of moist earth placed along edges and laps in the sheets. Satisfactorily repair or replace sheets that are torn or otherwise damaged during curing. Sheeting must remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

Apply a uniform coating of white-pigmented membrane-curing compound to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Coat formed surfaces immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Do not allow concrete surface to dry before application of the membrane. If drying has occurred, moisten the surface of the concrete with a fine spray of water and apply the curing compound as soon as the free water disappears. Apply curing compound in two coats by hand-operated pressure sprayers at a coverage of approximately 5 square meters/L 200 square feet/gallon for the total of both coats. Apply the second coat in a direction approximately at right angles to the direction of application of the first coat. The compound must form a uniform, continuous, coherent film that will not check, crack, or peel and must be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes. Respray concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified above. Respray areas where the curing compound is damaged by subsequent construction operations within the curing period. Take precautions necessary to ensure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. Tightly seal the top of the joint opening and the joint groove at exposed edges before the concrete in the region of the joint is resprayed with curing compound. Use a method used for sealing the joint groove that prevents loss of moisture from the joint during the entire specified curing period. Provide approved standby facilities for curing concrete pavement at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Adequately protect concrete surfaces to which membrane-curing compounds have been applied during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, remove debris and backfill, grade, and compact the area adjoining the concrete to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Protect completed concrete from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Remove and reconstruct concrete that is damaged for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Dispose of removed material as directed.

3.7.4 Protective Coating

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NOTE: Concrete may require protection against the action of urea, sodium chloride, and calcium chloride used for de-icing purposes. Protection against these chemicals is not required for concrete of the specified air content that will be in place for a cumulative time of 6 weeks at a continuous minimum temperature of 5 degrees C 40 degrees F, excluding the curing time. Concrete which is to receive protective coating should be moist cured to eliminate the need for removing a curing membrane prior to application of the protective coating. ACI Committee Report 515 provides a detailed discussion of protective coating for concrete. The following paragraphs will be inserted if protective coating is required.

****

Apply a protective coating of linseed oil mixture to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Moist cure concrete to receive a protective coating.

3.7.4.1 Application

Complete curing and backfilling operation prior to applying two coats of protective coating. Concrete must be surface dry and clean before each application. Spray apply at a rate of not more than 11 square meters/L 50 square yards/gallon for first application and not more than 15.5 square meters/L 70 square yards/gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture must be in accordance with the manufacturer's instructions. Protect coated surfaces from vehicular and pedestrian traffic until dry.

3.7.4.2 Precautions

Do not heat protective coating by direct application of flame or electrical heaters and protect the coating from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Do not apply material at ambient or material temperatures lower than 10 degrees C 50 degrees F.

3.8 FIELD QUALITY CONTROL

Submit copies of all test reports within 24 hours of completion of the test.

3.8.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and additional tests to ensure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

Take concrete samples in accordance with ASTM C172/C172M not less than once a day nor less than once for every 190 cubic meters 250 cubic yards of concrete placed. Mold cylinders in accordance with ASTM C31/C31M for strength testing by an approved laboratory. Each strength test result must be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 4 MPa 500 psi.

3.8.2.2 Air Content

Determine air content in accordance with ASTM C173/C173M or ASTM C231/C231M. Use ASTM C231/C231M with concretes and mortars made with relatively dense natural aggregates. Make two tests for air content on randomly selected batches of each class of concrete placed during each shift. Make additional tests when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. Notify the placing foreman if results are out of tolerance. The placing foreman must take appropriate action to have the air content corrected at the plant.

Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Perform two slump tests on randomly selected batches of each class of concrete for every 190 cubic meters 250 cubic yards, or fraction thereof, of concrete placed during each shift. Perform additional tests when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

Determine the anticipated thickness of the concrete prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, construct the subgrade true to grade prior to concrete placement. The thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

Provide finished surfaces for each category of the completed work that are uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 6 mm 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, reduce high areas either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete must not exceed 5 percent of the area of any integral slab, and the depth of grinding must not exceed 6 mm 1/4 inch. Remove and replace pavement areas requiring grade or surface smoothness corrections in excess of the limits specified.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Contracting Officer and deficiencies in appearance will be identified. Remove and replace areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work.

3.10 DETECTABLE WARNING SYSTEM

Install Detectable Warning Systems required by Contract plans in accordance with ICC A117.1, Section 705, and by manufacturers' installation instructions.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 17 23.16 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-32 17 23 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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ROAD AND PARKING LOT PAVEMENT MARKINGS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 17 23.16 (November 2024)**

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SECTION 32 17 23.16

ROAD AND PARKING LOT PAVEMENT MARKINGS

11/24

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NOTE: This guide specification covers pavement marking requirements for roads and parking lots by means of paint and raised pavement markers. This guide specification also covers removal of existing pavement markings on roads and parking lots. If curbs, obstructions, and other appurtenant structures are included in the work area, the same requirements apply, but hand application with spray guns and manual bead dispensers may be required.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project-specific requirements by adding, deleting, or revising text. Choose applicable item(s) or insert appropriate information for bracketed items.**

Reference UFC 3-260-04**, Airfield and Heliport Marking before editing this specification. Review Chapter 3, Chapter 4, and Appendix B for specific information about paint types, reflective glass beads, and wet film thickness.**

Remove information and requirements not required for the project, whether or not brackets are present.

This guide specification includes tailoring options for AIR FORCE, ARMY, and NAVY. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Be specific in identifying existing materials to be removed or prepared for marking on the Contract drawings. On the Contract drawings, show location, width, paint type, color,and raised pavement markers to be used. Indicate whether pavement marking is reflective or non-reflective.

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NOTE: For Air Force applications, coordinate deviations from this guide specification with the Air Force Installation & Mission Support Center.

****

PART 1 GENERAL

1.1 UNIT PRICES

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NOTE: Delete this paragraph when pavement marking is included in a lump sum project. Edit the following paragraph when raised pavement markers or paint removal are not included in the scope of work.

****

1.1.1 Measurement

1.1.1.1 Surface Preparation

The unit of measurement for surface preparation (cleaning [and paint removal]) is the number of square meters feet of pavement surface prepared for marking and accepted by the Contracting Officer.

1.1.1.2 Pavement Striping and Markings

The unit of measurement for pavement markings is the number of square meters feet of reflective and/or non-reflective striping or markings actually completed and accepted by the Contracting Officer.

[1.1.1.3 Raised Pavement Markers

The unit of measurement for raised pavement markers is the number actually placed as specified and approved by the Contracting Officer.

]1.1.2 Payment

The quantities of surface preparation, [marking removal] pavement striping or markings, [and] [raised pavement markers,] as specified in paragraph Measurement, will be paid for at the contract unit price. The payment constitutes full compensation for furnishing all labor, materials, tools, equipment, appliances, and doing all work involved in preparing and marking the pavements as shown on the drawings. Remove and replace any striping or markings which required reflective media, but are placed without it, do not meet the stated minimum retro-reflective requirements, or with other defects, at no cost to the Government. Remove and replace striping or markings which do not conform to the required physical characteristics, alignment, or location required at no cost to the Government.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 247	(2013) Standard Specification for Glass Beads Used in Pavement Markings
AASHTO M 249	(2012; R2016) Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form)

ASTM INTERNATIONAL (ASTM)

ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D476	(2015) Dry Pigmentary Titanium Dioxide Pigments
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D711	(2010; R 2015) No-Pick-Up Time of Traffic Paint
ASTM D823	(2018) Standard Practices for Producing Films of Uniform Thickness of Paint, Coatings, and Related Products on Test Panels
ASTM D968	(2022) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling

	Abrasive
ASTM D1652	(2011; E 2012) Standard Test Method for Epoxy Content of Epoxy Resins
ASTM D2074	(2007; R2013) Standard Test Methods for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2621	(1987; R 2016) Standard Test Method for Infrared Identification of Vehicle Solids from Solvent-Reducible Paints
ASTM D2697	(2003; R 2014) Volume Nonvolatile Matter in Clear or Pigmented Coatings
ASTM D3335	(1985a; R 2020) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D3718	(1985a; R 2015) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D3924	(2016) Standard Specification for Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials
ASTM D3960	(2005; R 2013) Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4280	(2012) Extended Life Type, Nonplowable, Raised, Retroreflective Pavement Markers
ASTM D4383	(2012) Standard Specification for Plowable, Raised Retroreflective Pavement Markers
ASTM D4414	(1995; R 2020) Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4505	(2012; R 2017) Standard Specification for Preformed Retroflective Pavement Marking Tape for Extended Service Life
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E1710	(2011) Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed

	Geometry Using a Portable Retroreflectometer
ASTM E2302	(2003; R 2016) Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer
ASTM G154	(2023) Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials

MASTER PAINTERS INSTITUTE (MPI)

MPI 97	(2012) Traffic Marking Paint, Latex

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-B-1325	(Rev D; Notice 1; Notice 2 2017) Beads (Glass Spheres) Retro-Reflective (Metric)
FS TT-P-1952	(2015; Rev F; Notice 1) Paint, Traffic and Airfield Markings, Waterborne

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1200	Hazard Communication
40 CFR 60	Standards of Performance for New Stationary Sources

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G, [_____]

Qualifications; G, [_____]

Safety Data Sheets For Each Paint Type; G, [_____]

Safety Data Sheets For Chemicals Used In Surface Preparation; G, [_____]

Data Sheets For Paint Removal Equipment; G, [_____]

Surface Preparation Equipment List; G, [_____]

Marking Applications Equipment List; G, [_____]

Detour Plans; G, [_____]

SD-03 Product Data

Manufacturer Data Sheets for all Marking Materials; G[, [_____]]

Manufacturer Data Sheets for all Reflective Media; G, [_____]

SD-04 Samples

Samples of Marking Materials; G, [_____]

Samples of each Reflective Media; G, [_____]

SD-06 Test Reports

Marking Application Wet Film Thickness Test; G, [_____]

Reflective Media Reflectivity Test; G, [_____]

SD-07 Certificates

Manufacturer Certificate of Compliance for Marking Materials; G, [_____]

Manufacturer Certificate of Compliance for Reflective Materials; G, [_____]

Manufacturer Certificate of Conformance for Volatile Organic Compliance; G[, [_____]]

SD-08 Manufacturer's Instructions

Marking Materials Storage and Application; G, [_____]

Reflective Media Storage and Application; G, [_____]

Chemicals Used in Surface Preparation; G, [_____]

1.4 QUALITY CONTROL

1.4.1 Quality Control Plan

Within [10][_____] calendar days of project award, submit a quality control plan. The plan must state the means, methods, equipment, and materials to be employed for the performance of the surface preparation, existing markings removal, application of reflective and non-reflective marking, and marking layout. At a minimum, provide descriptive criteria for each of the following activities for review and approval by the Contracting Officer:

a. Describe the means and methods used to layout marking geometry and the location of marking elements.

b. Describe the protocol for determination of the operating pressure and speed of the equipment for surface preparation.

c. Describe the protocol for surface preparation when not using water.

d. Describe the protocol for existing markings removal.

e. Define the protocol for the performance of test stripes for each line width, color, and paint type.

f. Provide equipment details to include speed, pressures and application rate for the minimum wet film thickness and the application rate of reflective media to provide the specified glass bead anchoring and reflectivity.

g. Provide and discuss safety directives for maintaining traffic on roads and parking lots.

h. Define communications procedures when operating on roads and parking lots.

1.4.2 Qualifications

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NOTE: The brackets in the paragraph below require the designer to select the years of experience required for those people operating equipment. The years of experience selected is based upon the level of difficulty expected in performing the work.

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Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of applicable chemicals. The documentation should include experience on five projects of similar size and scope with references for all personnel.

1.4.3 Qualifications For Roads and Parking Marking Personnel

Submit documentation of qualifications in resume format a minimum of [14] [_____] days before pavement marking work is to be performed showing personnel who will be performing the work have experience working on airfields, operating mobile self-powered marking, cleaning, and paint removal equipment and performing these tasks. Include with their resume a list of references complete with points of contact and telephone numbers. Provide certification for pavement marking machine operator and Foreman demonstrating experience successfully completing a minimum of two airfield pavement marking projects of similar size and scope. Provide documentation demonstrating personnel have a minimum of [two] [three] [four] years of experience operating similar equipment and performing the same or similar work in similar environments, similar in size and scope of the planned project. The Contracting Officer reserves the right to require additional proof of competency or to reject proposed personnel.

1.5 DELIVERY, STORAGE, AND HANDLING

[Provide a conditioned storage and staging area located off the installation][A conditioned storage and staging area on the installation will be provided] for all materials intended to be used on the project. Ensure all materials delivered to the storage location are in the original container and clearly marked with the product name, compliance information, batch number, color, manufactured date, instructions for storage, instructions for application, and the name of the manufacturer. All materials are to be stored in conformance with the manufacturer instructions. Provide manufacturer instructions for; marking materials storage and application, reflective media storage and application, and the chemicals used in surface preparation.

1.6 PROJECT/SITE SPECIAL CONDITIONS

1.6.1 Environmental Requirements

Pavement surface must be free of snow, ice, or slush; with a surface temperature of at least 4 degrees C 40 degrees F and rising at the beginning of operations, except those involving shot blasting or grinding. Cease operation during thunderstorms, or during rainfall, except for water blasting and removal of previously applied chemicals. Cease water blasting where surface water accumulation alters the effectiveness of material removal.

1.6.1.1 Weather Limitations for Marking Application

Apply pavement markings to clean, dry surfaces and only when the ambient temperature is at least 3 degrees C 5 degrees F above the dew point and the pavement surface temperatures are within the limits recommended by the manufacturer of the material being used unless otherwise noted. Allow the pavement surface to dry after the water has been used for surface preparation or after a precipitation event. Do not perform marking applications when the wind carries overspray onto locations adjacent to the marking. Provide wind screens to shroud application equipment.

1.6.1.2 Testing Dry Surfaces

Do not commence marking until the pavement surface is dry. Use the plastic wrap method as described in paragraph PRE-APPLICATION TESTING to test the pavement surface for moisture. Do not proceed with marking until the Contracting Officer has observed the moisture test and has accepted the area prepared for marking.

1.6.1.3 Volatile Organic Compounds Compliance

Submit a manufacturer certificate stating that the proposed pavement marking paint meets the Volatile Organic Compound (VOC) regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Submit manufacturer certificate of conformance for volatile organic compliance.

1.6.2 Traffic Control for Roads and Parking Lots

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NOTE: Guidance for traffic control procedures can be obtained from the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways.

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Place approved signs conforming to MUTCD near the beginning of the worksite and well ahead of the worksite to alert approaching traffic from both directions. Place markers along newly painted lines to control traffic and prevent damage to newly painted surfaces [or displacement of raised pavement markers]. Mark painting equipment with warning signs that can be read from a distance of 30 meters 100 feet, indicating slow-moving painting equipment in operation. Provide all lighting and equipment necessary to light the work area during night operations effectively.

When traffic is rerouted or controlled to accomplish the work, provide necessary warning signs, flag persons, and related equipment for the safe passage of vehicles. Submit detour plans to the Contracting Officer for approval before doing the work.

1.7 APPLICATION EQUIPMENT CALIBRATION

Before performing any marking application, calibrate the paint and glass bead application equipment at the necessary speed to execute the application. Calibration and application will be performed using paint that is not diluted or thinned. Paint will be used as formulated by the manufacturer. Calibrate paint and bead guns for each line width and color intended to be applied. Use metal coupons placed in the path of the equipment to capture a test line without glass beads. Use a wet film gauge in accordance with ASTM D4414, to determine if the wet film thickness is the same at each edge and at the center of the marking. Adjust each paint gun to provide a line of uniform thickness.

Collect a sample of glass beads directly from the glass bead dispenser along a measured distance. Weigh the glass beads captured and determine the coverage by dividing the weight by the area of the line placed during the calibration. Adjust the glass bead dispenser to provide an application rate necessary to meet or exceed the reflectivity specified. After determining the application rate, apply a reflective marking using the wet film thickness to be used for the color and marking element. Using a magnifying glass, examine the distribution and embedment of the glass beads. Beads are to be distributed uniformly for the width of the marking. Adjust the wet film thickness if the beads are submerged or predominantly on the surface of the marking.

PART 2 PRODUCTS

2.1 EQUIPMENT

Submit a surface preparation equipment list by serial number, type, model, and manufacturer. Include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Mobile equipment must allow for removal of markings without damaging the pavement surface or joint sealant. Maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition.

2.1.1 Surface Preparation and Paint Removal for Roads and Parking Lots

Submit data sheets for paint removal equipment intended for use in preparation of the pavement surface for marking. In the submittal, include descriptive information on the means for adjusting coverage per each pass, water pressure adjustment range, and tank and flow capacities. The equipment must have a range of adjustments that will provide a clean surface free of dirt, dust, oil, grease, algae, mildew, mold, and loose paint.[When preparing new portland cement concrete for marking, provide equipment capable of removing curing compounds without damage to the concrete surface and joint seal materials.] Submit safety data sheets for chemicals used in surface preparation. Chemicals must be bio-degradable.

2.1.1.1 Water Blasting Equipment

Use mobile water blasting equipment capable of producing a pressurized stream of water that effectively removes paint from the pavement surface without significantly damaging the pavement. Provide equipment, tools, and machinery which are safe and in good working order.

2.1.1.2 Shot Blasting Equipment

Use mobile self-propelled shot blasting equipment capable of producing an adjustable depth of paint removal and propelling abrasive particles at high velocities on the paint for effective removal. Ensure each unit is self-cleaning and self-contained. Use equipment able to confine the abrasive, any dust that is produced, and removed paint and is capable of recycling the abrasive for reuse.

2.1.1.3 Grinding or Scarifying Equipment

Use equipment capable of removing surface contaminates, paint build-up, or extraneous markings from the pavement surface without leaving any residue. Clean the surface by a hydro blast to remove surface contaminants, and ash after a weed torch is used to remove paint.

2.1.1.4 Chemical Removal Equipment

Use chemical equipment capable of applying and removing chemicals and paint from the pavement surface, leaving only non-toxic biodegradable residue without scarring or other damage to the pavement or joints and joint seals.

2.1.2 Markings Application Equipment

Submit a marking applications equipment list of equipment appropriate for the material(s) to be used. Include the manufacturer's descriptive data and certification for the planned use that indicates the area of coverage per pass, pressure adjustment range, tank and flow capacities, and all safety precautions required for operating and maintaining the equipment. Provide and maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition, or remove equipment that is not providing satisfactory performance from the work site. Provide mobile and maneuverable application equipment to the extent that straight lines can be followed and normal curves can be made in a true arc.

2.1.2.1 Airless or Atomizing Equipment

Provide mobile airless or pneumatic air-atomized application equipment that is maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. Mount equipment on trucks, skids or tractors. Use equipment suitable for application of the marking material specified. Airless systems are used to apply waterborne and epoxy coatings. Pneumatic systems are used only to apply waterborne and solvent based coatings.

Provide equipment capable of applying a marking from 100mm to 300mm 4 inches to 12 inches wide in a single pass and also capable of applying two single solid or intermittent lines using a minimum of two colors. Provide equipment with tanks or reservoirs equipped with mechanical agitators, pressure regulators, and gages in full view of the equipment operator. Use paint strainers suitable to screen paint flowing in all supply lines.

2.1.2.2 Hand-Operated Machines

Provide a hand-operated push-type applicator machine commonly used for the application of water-based paint or two-component, chemically curing paint, thermoplastic, or preformed tape to pavement surfaces for small marking projects, such as legends and cross-walks, parking lots, or surface painted signs. Provide an applicator machine with the necessary tanks and spraying nozzles capable of applying paint uniformly at specified wet film thickness. Provide spray guns for hand application of paint in areas where push-type machines cannot be used.

2.1.2.3 Reflective Media Dispenser

Mount glass bead dispensers that are automatically triggered when paint guns are activated. The dispensers may be pressurized or gravity-drop systems. Pressurized systems require moisture control.

2.1.3 Reflective Thermoplastic Striping Material (Hot Applied) Application Equipment

Apply thermoplastic material with equipment capable of providing continuous uniformity for the dimensional and reflectivity requirements of the marking.

2.1.3.1 Application Equipment

a. Provide application equipment capable of continuous mixing and agitation of the material, with conveying parts that prevent accumulation and clogging between the main material reservoir and the extrusion shoe or spray gun. Ensure all parts of the equipment which come into contact with the material are easily accessible and exposed for cleaning and maintenance. All mixing and conveying parts including the extrusion shoes and spray guns are to maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. Provide application equipment constructed to ensure continuous uniformity in the stripe dimensions. Provide an applicator with a means for cleanly cutting off stripe ends squarely and providing a method of applying skip lines. Provide equipment capable of applying varying widths of traffic markings.

c. Provide mobile application equipment allowing straight lines to be followed and normal curves to be made in a true arc. Provide equipment for the placement of thermoplastic pavement markings of two general types: mobile applicator and hand-operated applicator.

d. Equip the applicator with a pressurized or drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled flow rates. The bead dispenser must operate automatically to begin flow before the flow of the binder to assure that the strip is fully reflectorized.

2.1.3.2 Mobile Application Equipment

Provide a truck-mounted, self-contained pavement marking machine capable of hot applying thermoplastic by either the extrusion or spray method.

a. Equip the mobile unit with a melting kettle that holds a minimum of 2.7 metric tons 6000 pounds of molten thermoplastic material, capable of heating the thermoplastic composition to temperatures as recommended by the manufacturer. Use a thermostatically controlled heat transfer liquid. Heating the composition by direct flame is not allowed. Oil and material temperature gauges must be visible at both ends of the kettle.

b. Equip mobile units for application of extruded markings with a minimum of two extrusion shoes; located one on each side of the truck, capable of marking simultaneous edge line and centerline stripes, each being a closed, oil-jacketed unit.

c. Equip the mobile unit with an electronic programmable line pattern control system capable of applying skip or solid lines in any sequence, through any and all extrusion shoes, or spray guns, and in programmable cycle lengths. In addition, equip the mobile unit with an automatic counting mechanism capable of recording the number of lineal meters feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

2.1.3.3 Hand-Operated Machines

Provide portable hand-operated equipment, specifically designed for placing special markings such as crosswalks, stop bars, legends, arrows, and short lengths of the lane, edge, and centerlines; and apply thermoplastic pavement markings by the extrusion method. Equip the hand-operated applicator with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories.

2.1.3.4 Reflective Media Dispenser

Attach the dispenser for applying the reflective media to the thermoplastic dispenser that is designed to operate automatically and simultaneously with the applicator through the same control mechanism. Provide a bead applicator capable of adjustment and designed to provide a uniform flow of reflective media over the full length and width of the marking.

2.1.4 Preformed Retroreflective Pavement Marking Tape Application Equipment

Provide mechanical application equipment specifically designed for the placement of preformed marking tape. The equipment is specifically designed to apply pressure-sensitive pavement marking tape of varying widths. Equip the applicator with rollers, or other suitable compaction devices to provide initial adhesion of the material with the pavement surface. Use additional tools and devices for properly seating the applied material, as the manufacturer recommends.

2.2 ROAD AND PARKING LOT MATERIALS

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NOTE: For Navy projects, refer to the MPI Manual for recommendations on uses and application rates of paints and select paint systems for the project in accordance with the MPI Architectural Painting Decision Tree available on the Whole Building Design Guide. The MPI Decision Tree identifies paint systems for each interior and exterior coated surface in "Normal" or "Aggressive environmental conditions. It lists the applicable paint systems in descending order of performance. The paint system at the top of each substrate list indicates the highest-performing acceptable coating system.

NOTE: The designer is responsible for preparing drawings identifying where each type, color, and reflective or non-reflective marking is located. The designer is responsible for providing a Table or notes that identifies the paint type, color, and bead type for each marking type. For non-reflective markings, mark the bead type as “NA” or not applicable.

Waterborne paint is usually the material of choice for use on roads and parking lots. Highly durable materials such as methacrylate, epoxy, and thermoplastic hot applied stripping materials are used on high-volume traffic surfaces such as

interstate or primary highways. Durable materials are very difficult to remove, and in northern tiers, snowplows shear off glass beads resulting in a loss of reflectivity. Durable materials have a higher unit cost.

For NAVFAC LANT projects only: When using pavement marking materials (epoxy, thermoplastic, and preformed tape) that perform better than the paint desired for new pavement in Virginia and North Carolina, contact NAVFAC LANT for a sample section.

High Build Acrylic Coating (HBAC) performs similarly to epoxy, thermoplastic compounds, and preformed tape when applied to pavements with high daily vehicular traffic.

Polyurea and urethane are durable marking products that may be used on Roads and Parking Lots only. For designs specifying the use of polyurea or urethane, the respective specifications relating to equipment and materials recognized by local or state agencies in which the project is located must be incorporated herein, and paragraphs appropriately re-numbered.

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Submit safety data sheets for each paint type[and preformed tape] as well as manufacturer data sheets for all marking materials; include with the submittal a manufacturer certificate of compliance for marking materials and a manufacturer certificate of compliance for reflective materials.

2.2.1 Marking Colors

Provide markings for pavements that conform to SAE AMS-STD-595A color numbers as listed in Table I.

Table I - SAE AMS-STD-595A Color Numbers

Paint Color	SAE AMS-STD-595A Color Number
White	37925
Yellow	33538
Black	37038
Green	34108
Red	33411

2.2.2 Waterborne Paint

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NOTE: Waterborne paint is typically used on roads and parking lots. Waterborne paints have been known to provide service lives of up to 2 years on low-volume roads, and on higher-volume roads the

service life may be reduced to 6 to 12 months. Waterborne paint can be used to restripe over existing waterborne, methacrylate, epoxy paints, thermoplastic stripping material, and high-build acrylic coating.

Specify FS TT-P-1952 for Air Force and Army projects.

Specify MPI 97 for Navy projects. A list of approved products conforming to MPI 97 is on the Master Painters Institute website.

FS TT-P-1952 covers three types of low VOC, ready-mixed, one-component, and 100 percent acrylic waterborne airfield and traffic marking paints.

Type I - For normal weather conditions and not for use at the wet film thickness required for Type IV beads.

Type II - For use under adverse conditions (faster drying for wet film thickness required for Type IV beads.

Type III - For use under normal weather conditions where higher durability and greater adhesion to glass beads is desired. Type III is recommended for use on asphalt pavement because of its higher elasticity which impedes cracking of asphalt at the paint interface.

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Use FS TT-P-1952, Type [I or II] [III] paint.Use MPI 97 paint.

[2.2.3 Reflective Thermoplastic Striping Material (Hot Applied)

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NOTE: Thermoplastic striping materials are durable markings used for high-traffic pavements. Caution should be exercised when using thermoplastic stripping material because of a reduction of surface friction, the difficulty of removal, damage from snow removal equipment causing low reflectivity and foreign object debris (FOD), and de-bonding from the pavement surface. Thermoplastic striping materials have intermixed beads and a top dressing of beads applied during placement.

Thermoplastic markings cannot be placed over markings made from materials other than thermoplastic.

Thermoplastic Striping Material is recommended for use on asphalt pavements. The application temperature is about 204.4 degrees C 400 degrees F. Liquid asphalt materials burn at temperatures over 176.7 degrees C 350 degrees F. The bonding between paint and asphalt occurs when the asphalt is liquefied and not when the asphalt is burned.

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2.2.3.1 Composition

Thermoplastic materials must conform to AASHTO M 249. Formulate the binder component as an alkyd resin.

2.2.3.2 Primer

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NOTE: A primer is not required for thermoplastic striping material placed on new asphalt pavement. Specify a primer when thermoplastic is applied to existing asphalt pavements or concrete pavements. Primers are used to reduce the risk of thermoplastic striping material de-bonding from the pavement.

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2.2.3.2.1 Existing Asphalt Primer

Provide thermosetting adhesive primer with a solids content of pigment-reinforced synthetic rubber and synthetic plastic resin dissolved or dispersed in a volatile organic solvent for asphaltic concrete pavements. The solids content must not be less than 10 percent by weight at 21 degrees C 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.13 mm 0.005 inch, plus or minus 0.03 mm 0.001 inch, must dry to a tack-free condition in less than 5 minutes.

2.2.3.2.2 Portland Cement Concrete Primer

Provide an epoxy resin primer for portland cement concrete pavements of the type recommended by the manufacturer of the thermoplastic composition.

][2.2.4 Methacrylate Paint

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NOTE: Methacrylate paint may be used to mark roads and parking lots where cold weather may not allow the use of waterborne paint. Methacrylate paint cannot be placed over markings made from materials other than methacrylate.

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Paint must be a two-component, minimum 99 percent solids type system conforming to the following:

2.2.4.1 Pigments

Titanium dioxide, ASTM D476, Type II must be 10 percent minimum by weight for white paint. Titanium dioxide, ASTM D476, Type II must be one percent minimum for yellow and other colors. Methacrylate resin must be 18 percent minimum for all colors.

2.2.4.2 Prohibited Materials

Provide the manufacturer certification that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents nor any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits specified in relevant federal regulations.

2.2.4.3 Daylight Directional Reflectance

The daylight directional reflectance must not be less than 80 percent for white paint and 55 percent for yellow paint (relative to magnesium) when tested in conformance with ASTM E2302.

2.2.4.4 Volatile Organic Compounds

Determine the volatile organic compounds in conformance with 40 CFR 60 Appendix A, Method 24.

2.2.4.5 Dry Opacity

When tested at a wet film thickness of 0.38mm 0.015 inches, the minimum opacity for white and colors must be 0.92 when measured in accordance with ASTM E2302.

2.2.4.6 Hardness

Hardness must be at least 80 when tested in accordance with ASTM D2240.

2.2.4.7 Abrasion Resistance

Subject the panels prepared to the abrasion test in accordance with ASTM D968, Method A, except that the inside diameter of the metal guide tube must be from 8.97 to 19.05 mm 0.747 to 0.750 inch. Five liters 17.5 lbs (7.94 kg) of unused sand must be used for each test panel. Run the test on two test panels. Both baked and weathered paint films require not less than 150 liters 525 lbs (239 kg) of sand to remove the paint films.

][2.2.5 Epoxy Paint

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NOTE: Epoxy pavement markings are a durable, two-component system with exceptional durability on asphalt and concrete surfaces alike. On low to medium volume highways, epoxies have been known to provide service lives in excess of four years. Epoxies often take much longer to dry than other materials. Epoxies also cannot be placed over markings made from other materials. Epoxy can be applied over existing epoxy markings once. After a second application, the old material must be removed.

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2.2.5.1 Formulation

Epoxy paint must be a two-component, minimum 99 percent solids, material formulated to provide a simple mixing ratio of Component A and Component B as recommended by the manufacturer. Provide the manufacturer certification that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, nor any carcinogen, as defined in 29 CFR 1910.1200, in amounts exceeding permissible limits specified in federal regulations.

2.2.5.2 Composition (Component A)

The titanium dioxide percent by weight, determined by ASTM D476, of white and yellow paints must be 18 percent minimum and 14 to 17 percent minimum, respectively. The percent by weight of the epoxy resin must be 75 to 79 percent. Tint as required to match Federal Standard No. 595 color number.

2.2.5.3 Epoxide Value

When tested in accordance with ASTM D1652, the epoxide value for white and yellow (Component A) must be within plus or minus 50 of the manufacturer’s target value.

2.2.5.4 Total Amine Value

When tested in accordance with ASTM D2074, the curing agent (Component B) must be within plus or minus 50 of the manufacturer’s target value.

2.2.5.5 Toxicity

Upon heating to application temperature, the material cannot produce toxic or injurious fumes to persons or property.

2.2.5.6 Daylight Directional

The daylight directional reflectance of the white paint must not be less than 75 percent relative to magnesium oxide when tested to conform to ASTM E1710.

The daylight directional reflectance of the yellow paint must not be less than 55 percent relative to magnesium oxide when tested to conform to ASTM E1710.

2.2.5.7 Hardness

Hardness must be at least 80 when tested in accordance with ASTM D2240.

2.2.5.8 Abrasion Resistance

Subject the panels prepared to the abrasion test in accordance with ASTM D968, Method A, except that the inside diameter of the metal guide tube must be from 18.97 to 19.05 mm 0.747 to 0.750 inch. Five liters 17.5 lbs (7.94 kg) of unused sand must be used for each test panel. Run the test on two test panels. Both baked and weathered paint films must require not less than 150 liters 525 lbs (239 kg) of sand to remove the paint films.

][2.2.6 High Build Acrylic Coating (HBAC)

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NOTE: High Build Acrylic Coating (HBAC): When applied to pavements with high daily vehicular traffic counts, HBAC performs similar to epoxy and thermoplastic striping materials.

HBAC is suitable for reflective and non-reflective use and is applied at approximately twice the thickness of conventional marking paints. The paint produces upraised markings and is appropriate for use in marking crosswalks, stop legends, railroad crossings, lettering, centerlines, skip lines, and edge lines. HBAC at a thickness beyond conventional marking paints is not intended for use on pavements with snowplow use. However, application at standard

thickness, per MPI, is acceptable on surfaces employing snowplows.

Consider either HBAC or thermoplastic stripingmaterials to reduce maintenance costs in desert areas, where painted markings are susceptible to a "sandblasting" effect during high winds.

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Formulate High Build Acrylic Coating (HBAC) to meet the requirements of Table II.

TABLE II - REQUIREMENTS FOR HIGH BUILD ACRYLIC COATINGS (HBAC)

TEST	MINIMUM REQUIREMENT (AND MAXIMUM WHERE INDICATED)
Resin System (ASTM D2621)	Waterborne 100 percent Acrylic
Percent Volume Solids (ASTM D2697)	58 percent
Volatile Organic Compound, max. (ASTM D3960)	150 g/l 1.25 lbs/gal
White (SAE AMS-STD-595A)	37925
Yellow (SAE AMS-STD-595A)	33538
Shore D Hardness (ASTM D2240)	45
1/8 inch Mandrel Bend at 5 mils Dry Film Thickness (DFT, one-week cure (ASTM D522/D522M, Method B)	No visual defects at bend (Conditions at ASTM D3924)
Adhesion to Concrete and Asphaltic Pavements (ASTM D4541)	0.97 MPa 140 psi or 100 percent cohesive failure in pavement
Accelerated Weathering, Yellow, 2500 Hours UV Exposure (ASTM G154: see note 1)	Max. color loss to 33655 (SAE AMS-STD-595A)
Water Absorption at 168 Hours Immersion Tap Water (ASTM D471)	9.0 percent max. weight increase (conditions at ASTM D3924)
Application at 1650 microns 65 mils Wet,One Coat, One-week Cure, (see note 2)	No visual cracking or curling (conditions at ASTM D3924)

TABLE II - REQUIREMENTS FOR HIGH BUILD ACRYLIC COATINGS (HBAC)

TEST	MINIMUM REQUIREMENT (AND MAXIMUM WHERE INDICATED)
No Pick-Up at 630 microns 25 mils (ASTM D711)	Wet 10 minutes max.
Lead (ASTM D3335)	0.06 percent max.
Cadmium (ASTM D3335)	0.06 percent max.
Chromium (ASTM D3718)	0.00 percent

Notes:

(1) Properly mix and apply yellow paint at 250 microns plus or minus 50 microns 10 mils plus or minus 2 mils DFT over a suitably sized, clean aluminum substrate (ASTM D823), and cure for a minimum of 48 hours: prepare four individual yellow samples. Expose three samples to continuous Ultraviolet (UV) light for 2500 hours, without cycles condensation, in accordance to ASTM G154: use UVA-340 lamps in the testing apparatus. Following exposure, compare the three exposed samples to the "one" non-exposed sample using SAE AMS-STD-595A colors 33538 and 33655 as visual references: evaluate exposed samples for degree of visual color loss. Yellow paint is rated as passing if each exposed sample appears equivalent to the non-exposed sample, and in addition, displays color loss no greater than SAE AMS-STD-595A color 33655.

(2) Using double-stick, foam mounting tape (or equal) with a nominal thickness of 1625 microns 65 mils, apply a rectangular mold with inner dimensions of 7.6 cm by 25.5 cm 3 in by 10 in to a clean aluminum sample approximately sized at 15 cm by 30 cm by 0.30 cm 6 in by 12 in by 1/8 in. Do not remove the tape's plastic backing. Mix and apply excess paint into mold. Remove excess paint, by squeegee or other appropriate draw down technique, to a uniform thickness equal to the tape's height. Perform paint application and draw down within a period of no more than 60 seconds. Approximately one to two minutes following the draw down, remove tape from sample and allow coating to cure for a minimum period of one week ASTM D3924. Using a micrometer or other appropriate device, measure cured coating thickness (less sample thickness) to confirm resulting coating application was at or above 950 microns 38 mils DFT. Inspect coating for visual signs of cracking and curling. Following a one week cure, the coating is rated as passing if applied greater than 950 microns 38 mils DFT and visually free of both cracking and curling.

][2.2.7 Preformed Reflective Pavement Marking Tape

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NOTE: Preformed Retroreflective Pavement Marking Tape is normally used for temporary markings when

not subject to turning vehicle movements or abrasion. Preformed Marking Tape is usually considered a temporary marking. The expected service life is usually less than a few months. Preformed tape cannot be placed over markings made from other materials nor applied over existing preformed tape markings. All existing markings must be removed when using preformed tape.

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Provide adherent reflectorized strip preformed tape in accordance with ASTM D4505 Retroreflectivity Level II, Class 1, 2 or 3, Skid Resistance Level B.

][2.2.8 Raised Pavement Markers

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NOTE: Line marker segments having a 1 to 3 ratio of stripe to gap are standard. Line segments of 3 m 10 feet with gaps of 9 m 30 feet are recommended. When raised pavement markers are used in lieu of striping, make the line marker segments a 3 to 5 ratio of stripe to gap with line segments of 5 m 15 feet with gaps of 8 m 25 feet recommended.

Nonplowable, raised retroreflective pavement markers are specified in ASTM D4280. Plowable, raised retroreflective pavement markers are specified in ASTM D4383.

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Use either metallic or nonmetallic markers of the button or prismatic reflector type. Provide permanent color markers as specified for pavement marking, which retain the color and brightness under the action of traffic. Provide button markers with a diameter of not less than 100 mm 4 inches, spaced not more than 12 m 40 feet apart on solid longitudinal lines. Make broken centerline marker spacing in segments [of [_____]] [indicated] with gaps [of [_____]] [indicated] between segments. Provide button markers with rounded surfaces presenting a smooth contour to traffic and not projecting more than 19 mm 3/4 inch above level of pavement. Provide [nonplowable] [plowable] pavement markers and adhesive epoxy conforming to [ASTM D4280][ASTM D4383].

]2.2.9 Reflective Media for Roads and Parking Lots

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The designer should read paragraph 3.1.2., UFC 3-260-04, Airfield and Heliport Marking, Appendix B, before selecting a reflective bead type and gradation.

For Air Force and Army projects, reflective media for roads and parking lots will conform to FS TT B-1325 Type 1 Gradation A.

Reflective Media for Navy projects will conform to AASHTO M 247, Type I.

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NOTE: When selecting retro-reflective media using FS TT-B-1325, refer to the following for the intended uses.

Type I, Coarse (Gradation A), low index recycled glass beads for drop-on applications are intended for marking highways. Type I beads have a low Index of Reflectivity (IOR of 1.5) because the beads return light in a diffused pattern. Type I waterborne marking paint is typically used with Type I beads.

Type III beads are not used on Roads and Parking Lots.

Type IV, Gradation B, large diameter, low index recycled glass beads for drop-on applications intended for highways. The wet film thickness must be increased compared to using Type I beads to provide proper anchoring (between 20 to 22 mils). Type IV beads are used with HBAC, Thermoplastic and Epoxy because of the wet film thickness associated with those materials.

Type I glass beads can be used with Type I, II, or III paint when using waterborne paint. Type IV glass beads can only be used with Type III paint.

****

Provide FS TT-B-1325 [Type I, Gradation A][and][Type III][and][Type IV, Gradation B] glass beads.Provide AASHTO M 247 reflective media. Paint and glass bead types used with markings are designated on the drawings.

Provide glass beads with those coatings to promote adhesion, limit flotation, and absorb moisture to preclude bundling and dual coatings for waterborne materials. Submit manufacturer data sheets for all reflective media used.

PART 3 EXECUTION

3.1 TEST SECTIONS

Before the performance of any marking application, demonstrate to the Government, using the equipment, materials, and personnel identified in the approved quality control plan, that the requirements for acceptance of the final product(s) are attainable. The minimum length of the test section is 15 meters 50 feet of marking for each line width, color, and wet film thickness. Perform demonstrations in a location designated by the Contracting Officer within the project scope of work. Do not perform the test section(s) until the Contracting Officer is present to observe the test. Table III identifies minimum and maximum wet film thickness based on glass bead type. Each test section's result is the standard of performance for the color, width, wet film thickness, and glass bead application rate for each marking element. Submit the color, line width, wet film thickness, and measured reflectivity.

3.1.1 Surface Preparation and Paint Removal Test Section

****

NOTE: Delete brackets if project does not include removal of existing markings.

****

[Perform a demonstration removal of pavement markings in an area designated by the Contracting Officer.] Prepare an area large enough to determine [cleanliness][, adhesion of remaining markings][, and cleaning rate][and removal rate]. Use the means, methods, and equipment identified in the approved quality control plan. Adjust the means, methods, equipment, or equipment settings until the prepared surface is free of dirt, debris, oils and greases, algae, mold, mildew, and loose or flaking paint without damage to the pavement. Remove any equipment that fails to provide an acceptable product during the demonstration and provide new equipment that will produce an acceptable product.[Approved demonstration area establishes the standard for the work.]

3.1.2 Wet Film Thickness Test Section

****

NOTE: The purpose of providing glass beads embedded in a paint marking is to provide easy sight acquisition for vehicle drivers at night under diffused light. Embedment is critical. If beads are submerged light will not be returned. If there is not enough paint to anchor beads then beads become fugitive materials. Determining proper embedment is critical to the performance and durability of the reflective marking.

Proper embedment is determined by providing a paint mil thickness that allows for the largest diameter bead in the distribution to be embedded to one-half of the bead diameter. The smaller beads will “float” and the wicking of the paint will coat the beads to a range of 50 to 60 percent of the diameter. The minimum wet film thickness threshold in Table III result in glass bead embedment at approximately 50 percent of the glass bead diameter for the specified bead type. Confirm the reflectivity of the marking using a retro-reflectometer at night under diffuse lighting using ASTM E1710 protocol. If the reflectivity exceeds the minimum at three locations from different directions then the embedment is correct.

****

Adjust the marking application rate for equipment speed, operating pressure, and line width, to provide a minimum wet film thickness, full coverage, and reflective media anchoring. Minimum and maximum wet film thickness is identified in Table III. Measure the wet film thickness using a wet film gauge at three points along the test section. Wet film thickness is determined using ASTM D4414 as the performance standard. When the average of the three readings is less than the minimum specified in Table III, repeat the test section. Submit the results of the marking application wet film thickness test to the Contracting Officer

3.1.3 Reflective Value Test Section

Measure the reflectivity at three points, along the length of the marking placed for wet film thickness. After the application is cured, measure the retro-reflective value using a Retro-Reflectometer with a direct readout in millicandelas per square meter per lux (mcd/m2/lx) using ASTM E1710. Take three readings on each test section. When the average of the three readings is less than the minimum specified in Table V repeat the test section. Document the application rate of the reflective media required to meet the specified minimum reflectivity. Submit the results of the reflective media reflectivity test to the Contracting Officer before proceeding with work on the project.

3.2 SURFACE PREPARATION

Clean surfaces before the application of marking materials. Remove all dust, dirt, scaling or loose paint, algae, oils, and grease and mineral deposits such as iron stains by use of water blasting or chemical removal. Follow the cleaning with sweeping, blowing or using water rinse. Do not begin painting in any location prepared for marking until surfaces are dry and clean.

Scrub areas with oil or grease present with applications of trisodium phosphate solution or other approved detergent or degreaser. Rinse thoroughly after each application to prevent staining of the new marking. After cleaning oil-soaked areas, seal with shellac or primer as the manufacturer recommends to prevent bleeding through the new paint.

3.3 PRE-APPLICATION TESTING

Test the pavement surface for moisture before beginning pavement marking after each period of rainfall, fog, high humidity, or cleaning or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the Contracting Officer has approved the pavement condition.

Employ the plastic wrap method, described as follows, to test the pavement for moisture:

a. Cover the pavement with a 300 mm by 300 mm 12 inch by 12 inch section of clear plastic wrap and seal the edges with tape.

b. After 15 minutes, examine the plastic wrap for any visible moisture accumulation. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap.

c. Re-test surfaces when work has been stopped due to a precipitation event.

3.4 MARKINGS APPLICATION

3.4.1 Marking Materials for Roads and Parking Lots Pavement

3.4.1.1 Waterborne Paint

****

NOTE: Most waterborne paints can be applied at temperatures down to 10 degrees C 50 degrees F. Waterborne paints formulated to be applied at

temperatures down to approximately 2 degrees C 35 degrees F are available.

The actual application rate for paint will vary because of the texture, age, and condition of the material being marked. The application rate is determined as a result of the TEST SECTIONS (Wet Film Thickness). The application rate is required to provide a wet film thickness approximately equal to provide a 50 percent embedment of the glass bead diameter being used. Edit Table III to delete content of those cells with paint wet film thickness or bead application rates not applicable to the scope of work.

Type I glass beads can be used with Type I, Type II, or Type III waterborne paint; Type IV glass beads can only be used with Type III waterborne paint. The expected wet film thickness when using Type I glass beads is 14 to 16 mils. When using Type IV gradation B glass beads, the wet film thickness must be increased to the range of 25 to 30 mils because of the larger bead diameter. Type IV beads do not increase the reflectivity because they are low index beads. Type IV beads are only used where Type III paint is used to provide thicker paint.

Application rates for glass beads will vary.

Specify FS TT-P-1952 waterborne paint and FS TT-B-1325 reflective media for Air Force and Army projects.

Specify MPI 97 waterborne paint and AASHTO M 247 reflective media for Navy projects.

Edit the following paragraphs by deleting those that do not apply.

****

The dilution or thinning of paint prior to application is not allowed.

[
Provide FS TT-P-1952waterborne paint and FS TT-B-1325 glass beads. Apply [reflective][and][non-reflective] markings in accordance with Table III. Use the paint type[and bead type] as shown on the drawings.]

[
Provide MPI 97 paint and apply AASHTO M 247 glass beads. Apply [reflective][and][non-reflective] markings in accordance with Table III. Use the paint type[and bead type] as shown on the drawings.]

The paint wet film thickness and glass bead application rate is provided in Table III. Perform the marking and bead application test section beginning at the minimum value and adjust the application rate up or down until the requirements of WET FILM THICKNESS TEST SECTION and REFLECTIVE TEST SECTION are satisfied. The values of wet film thickness and bead application rate established by the test section will be the standard of performance for the respective marking type and color.

Table III. Paint Wet Film Thickness and Bead Application Rate

Paint Type	Non-Reflectorized Marking Wet Film Thickness (mil)	Reflectorized Marking			
		Wet Film Thickness (mil) based on Glass Bead Type		Minimum Bead Application Rate	
		Type I Gradation A	Type IV Gradation B	Type I Gradation A	Type IV Gradation B
Type I	14-16	14-16	--	0.8 kg/L 7 lb/gal	--
Type II	14-16	14-16	--	0.8 kg/L 7 lb/gal	--
Type III	16-20	--	25-30	--	1 kg/L 8 lb/gal

[3.4.1.2 Methacrylate Paint

****

NOTE: Methacrylate paint is used for roads and parking lots and is suitable for use on portland cement concrete, asphalt and brick traffic surfaces. Methacrylate may be applied at temperatures down to -1 degrees C 30 degrees F.

Reference UFC 3-260-04, Appendix B, Best Practices Handbook, prior to selecting bead and paint types.

For Air Force and Army Projects, use either FS TT B 1325 Type I (Gradation 1) for Roadway traffic markings. Use Type IV (Gradation B) for cross walks or markings that require high durability because of traffic abrasion.

For Navy projects use the AASHTO M247 equivalent for glass beads.

The wet film thickness for paint and the application rate for glass beads will be variable because of pavement conditions and ambient temperature at the marking time. The wet film thickness for methacrylate paint and application rate for glass beads must be determined by test section. The minimum wet film thickness is that required to provide embedment of the glass beads at approximately 50 percent of the glass bead diameter.

****

Apply methacrylate paints at a minimum wet film thickness recommended by the manufacturer, provided it is the wet film thickness required to embed glass beads at approximately 50 percent of the bead diameter. Apply [FS TT-B-1325 [Type I (Gradation A)] [Type IV (Gradation B)]] [AASHTO M 247] glass beads at an application rate that provides the minimum reflectivity in accordance with paragraph TEST SECTION.

Apply methacrylate paint only on surfaces prepared for marking application and free of moisture, dirt, debris, oils and greases, algae, mold, or mildew. Apply methacrylate paint only to dry pavement surfaces. Do not apply methacrylate paint when ambient temperature conditions are outside of the ranges recommended by the manufacturer.]

[3.4.1.3 Reflective Thermoplastic Striping Material (Solid Form)-AASHTO M 249

Place thermoplastic pavement markings upon the dry pavement. The pavement temperature must be at a minimum of 4 degrees C 40 degrees F and rising at the time of application. Apply all centerline, edge, and other longitudinal type markings with a mobile applicator. Place all special markings, stop bars, legends, and similar patterns with a hand-operated applicator.

3.4.1.3.1 Primer

****

NOTE: A primer is not required for thermoplastic striping material placed on new asphalt pavement. Specify a primer when thermoplastic is applied to existing asphalt pavements or concrete pavements. Primers are used to reduce the risk of thermoplastic striping material de-bonding form the pavement.

Use the first and second paragraphs for Air Force, Navy, and Army projects, and delete the third paragraph.

****

[After surface preparation has been completed, prime the asphalt or concrete pavement surface with spray equipment.][Allow primer materials to achieve a tack-free condition.][Allow the asphalt primer to dry to a tack-free condition.][Allow the portland cement concrete primer to dry in accordance with the thermoplastic manufacturer recommendations.][An infrared heating device may be used on the concrete primer.][Apply asphalt primer to all asphalt pavements at a wet film thickness of 0.13 mm 5 mils, plus or minus 0.03 mm 1 mil 6.5 to 9.82 square meters per liter 265 to 400 square feet per gallon.][Apply portland cement concrete primer to all concrete pavements at a wet film thickness of between 1.0 to 1.3 mm 40 to 50 mils 7.85 to 9.82 square meters per liter 320 to 400 square feet per gallon.]

[

After the primer has achieved a tack-free condition, apply the thermoplastic at temperatures no lower than 191 degrees C 375 degrees F nor higher than 218 degrees C 425 degrees F at the point of deposition. Apply all extruded thermoplastic markings at the specified width and a thickness of not less than 3 mm 0.125 inches nor more than 5 mm 0.190 inches. Apply all sprayed thermoplastic markings at the specified width and thickness designated in the contract plans. If the plans do not specify a thickness, apply centerline markings at a wet film thickness of 2.3 mm 0.090 inches, plus or minus 0.13 mm 0.005 inches, and edgeline markings at a wet film thickness of 1.5 mm 0.060 inches, plus or minus 0.13 mm 0.005 inches.]

[

Extrude or spray thermoplastic reflectorized pavement marking compound in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking must be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.]

3.4.1.3.2 Reflective Media

****

NOTE: For Air Force and Army designs use the first paragraph below and delete the second paragraph. For Navy designs delete the first paragraph below and use the second paragraph.

****

[
Immediately after installation of the thermoplastic material, mechanically apply drop-on reflective glass spheres conforming to FS TT-B-1325 Type I (Gradation A) at the rate of 0.24 kg per square meter one pound per 20 square feet such that the spheres are held by and embedded in the surface of the molten material. Accomplish drop-on application of the glass spheres to ensure uniform distribution.]
[
Immediately after installation of the thermoplastic material, mechanically apply drop-on reflective glass spheres conforming to AASHTO M 247 at the rate of 0.24 kg per square meter one pound per 20 square feet such that the spheres are adhered and embedded in the surface of the molten material. Accomplish drop-on application of the glass spheres to ensure uniform distribution.]

][3.4.1.4 Epoxy Paint

****

NOTE: Epoxy pavement markings are a durable, two-component system with exceptional durability on asphalt and concrete surfaces. Epoxies have been known to provide service lives over four years on low to medium-volume highways, and epoxies often take much longer to dry than other materials. Epoxies cannot be placed over markings made from other materials. Epoxy can be applied over existing epoxy markings once, and after a second application, the old material must be removed.

Reference UFC 3-260-04, Appendix B, Best Practices Handbook, prior to selecting bead and paint types.

For Air Force and Army Projects, use either FS TT B 1325 Type I (Gradation 1) for Roadway traffic markings. Use Type IV (Gradation B) for crosswalks or markings that require high durability because of traffic abrasion.

For Navy projects use the AASHTO M247 equivalent for glass beads.

The wet film thickness for paint and the application rate for glass beads will be variable because of pavement conditions and ambient temperature at the

marking time. The wet film thickness for methacrylate paint and application rate for glass beads must be determined by test section. The minimum wet film thickness is that required to provide embedment of the glass beads at approximately 50 to 60 percent of the glass bead diameter.

****

Apply [FS TT-B-1325 [Type I (Gradation A)]] [Type IV (Gradation B)] [AASHTO M 247] glass beads that provides the minimum or exceeds the reflectivity in accordance with paragraph TEST SECTION. Apply epoxy paint only on surfaces prepared for marking application and free of moisture, dirt, debris, oils and greases, algae, mold, or mildew. Apply epoxy paint only to dry pavement surfaces. Do not apply epoxy paint when ambient temperature conditions are outside of the ranges recommended by the manufacturer. Epoxies cannot be placed over markings made from other materials. Epoxy can be applied over existing epoxy markings once, and after a second application, the old material must be removed.

][3.4.1.5 High Build Acrylic Coating (HBAC)

****

NOTE: FS TT-B-1325 Type IV beads or the equivalent AASHTO M 247 must be used with HBAC paint due to the increased wet film thickness. The expected wet film thickness required for using Type IV glass beads is 20 to 22 mils.

****

Apply [FS TT-B 1325 Type IV] [AASHTO M 247] glass beads at a wet film thickness that provides the retro-reflectivity in accordance with paragraph TEST SECTION. Apply HBAC paint only on surfaces prepared for marking application and free dirt, debris, oils and greases, algae, mold, or mildew. Apply HBAC paint only to dry pavement surfaces. Do not apply HBAC paint when ambient temperature conditions are outside of the ranges recommended by the manufacturer.

][3.4.1.6 Preformed Reflective Pavement Marking Tape

The pavement surface and ambient air temperature must be at a minimum of 15 degrees C 60 degrees F and rising. Place the preformed tape markings according to the written instructions provided by the manufacturer.]

3.4.1.7 Raised Pavement Markers

Align prefabricated markers carefully at the spacing indicated on the drawings and permanently fix them by using epoxy adhesives. Clean all areas where markers are to be set by water blasting. Markers are not to be set until the pavement surface is dry and contaminant-free.

[3.4.1.8 Polyurea or Urethane

****

NOTE: For designs specifying the use of polyurea or urethane marking products, the respective specifications relating to applications recognized

by the local or state agencies in which the project is located must be incorporated herein.
****

[_____]

]3.5 FIELD QUALITY CONTROL AND ACCEPTANCE

3.5.1 Material Inspection

The Contractor is responsible for examining all materials accepted for delivery for compliance with the certificate of compliance.

3.5.2 Sampling and Testing

****
NOTE: It is recommended that samples of all marking materials be collected directly from the application equipment before or during the calibration of the equipment. Taking samples directly from the application equipment will avoid the possibility that marking materials have been thinned or altered from the time of manufacture until the time of application.

Certifications issued by the manufacturer can be used to determine if the marking materials meet the specified criteria. And samples of the materials can be collected and stored in the environment recommended by the manufacturer. Samples can be tested if there are problems with the markings before the end of the warranty period.
****

As soon as the marking materials are available for sampling, obtain materials by random selection directly from equipment already calibrated. Four liters Four quarts of paint are to be collected; two liters two quarts for the Contractor and two liters two quarts for the Government. Samples of marking materials and samples of each reflective media are to be collected by the Contractor in the presence of the Contracting Officer. Identify samples by project name and number, manufacture date, batch number, and the square yards of markings represented by the sample.

The Government will retain samples for the warranty period under storage conditions recommended by the manufacturer. If there is an issue with a material defect during the period of the warranty the Contractor will incur the cost for an accredited independent laboratory to test the material(s) for conformance with the certifications and the contract specifications. The Government reserves the right to test the samples for verification of materials.

3.5.3 Dimensional Tolerance

The Contractor applies layout markings. All layout markings are placed before the marking material application. The edges of a line must not vary from a straight line drawn between the beginning and end of the line more than 12 mm 1/2-inch to 45 m 50 feet. Marking dimensions and spacing must be within the tolerances provided in Table IV.

TABLE IV - Dimensional Tolerance for Marking Elements	
Dimension and Spacing	Tolerance
300 mm 12 inch or less	12 mm +/- 1/2 inch
Greater than 910 mm to 1.85 m 36 inch to 6 feet	25 mm +/- 1 inch
Greater than 1.85 m to 18.3 m 6 feet to 60 feet	50 mm +/- 2 inch
Greater than 18.3 m 60 feet	76 mm +/- 3 inch

3.5.4 Coating and Reflective Media Application Reporting

3.5.4.1 Reporting Wet Film Thickness and Reflectivity

Submit documentation on the wet film thickness and reflectivity for each marking element. Provide a reading at the rate of one reading per 300 linear meters 1000 linear feet of line marking. A reading is the average of 10 measurements at random locations within the marking element area. Submit the results of the marking application wet film thickness test and Reflective Media Reflectivity Test to the Contracting Officer before proceeding with work on the project.

3.5.4.2 Wet Film Thickness

Conduct a marking application wet film thickness test. Provide a wet film thickness gauge to measure the wet film thickness using ASTM D4414 at the edge(s) and one interior location of the marking. When more than 3 in 10 consecutive measurements of wet film thickness are outside of the tolerances in Table III, remove and replace areas not meeting the wet film thickness requirement.

3.5.4.3 Reflectivity

Provide documentation that records the readings for white, yellow and red reflective markings. Conduct a Reflective Media Reflectivity Test. Measure the reflectivity using a Retro-Reflectometer using ASTM E1710. The minimum reading for white, yellow, and red markings is provided in Table V in millicandelas per square meter per lux (mcd/m2/lx) at the time of marking. When more than 3 in 10 consecutive measurements of reflectivity are outside of the minimum in Table V, remove and replace the areas not meeting the minimum reflectivity requirements.

TABLE VI - Minimum Reflectivity (millicandelas per square meter per lux)		
Bead Type	Minimum Reflectivity at Time of Marking	
Type I	White - 300	Yellow - 175
Type IV	White - 300	Yellow - 200

[Preformed Tape pavement markings will yield a minimum of 225 mcd/m2/lux on white markings at installation and a minimum of 100 mcd/m2/lux on yellow markings at installation.]

3.6 CLEANUP AND WASTE DISPOSAL

The worksite and the material staging area must be free of debris, dirt, and items that will blow away during periods of elevated wind speeds. Dispose of all materials at a site approved by the Contracting Officer. Dispose of waste from cleaning the marking equipment at a facility that is permitted to accept the material.

3.6.1 Cleanup Requirements

Provide a vacuum sweeper after each work area when markings are cured. Vacuum sweep the entire pavement surface to provide a clean pavement without fugitive glass beads and debris.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 17 23.19 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-32 17 23 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-32 17 23.19 (November 2024)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 32 17 23.19

AIRFIELD PAVEMENT MARKINGS
11/24

****
NOTE: This guide specification covers pavement marking requirements for airfields, heliports,and hangar floors by means of paint with spray guns and glass bead dispensers. This guide specification includes only those requirements for surface preparation. Where the removal of rubber build up and existing pavement markings is specified, use Section 32 01 11.51 RUBBER AND PAINT REMOVAL FROM AIRFIELD PAVEMENTS.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project-specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

This guide specification includes tailoring options for AIR FORCE, NAVY, and ARMY. Selection or deselection of a tailoring option will include or exclude that option in the section. Editing the resulting section to fit the project is still required.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Be specific in the identification of existing

materials to be removed or prepared for marking on the Contract drawings. On the Contract drawings, show location, width, paint type, and paint color to be used for new markings. Indicate whether new markings are to be reflective or non-reflective.

****

****

NOTE: For Air Force applications, coordinate deviations from this guide specification with the Air Force Installation & Mission Support Center.

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: Delete this paragraph when pavement marking is included in a lump sum project. Edit items in brackets to provide the type of pavement to be prepared and type of marking to be placed.

****

1.1.1 Measurement

1.1.1.1 Surface Preparation

The unit of measurement for surface preparation is the number of square meters feet for [new][existing][and existing] surface preparation completed and accepted by the Contracting Officer.

1.1.1.2 Pavement Markings

****

NOTE: Delete subparagraph c when the project does not include temporary pavement markings. Temporary pavement markings are used where construction or repair of pavements requires aircraft operations coincident with the work effort.

****

a. Reflective Pavement Markings
The unit of measurement for reflective pavement markings is the number of square meters feet completed at the application rate that provides the specified wet film thickness for markings and application rates of reflective media accepted by the Contracting Officer.

b. Non-reflective Pavement Markings
The unit of measurement for non-reflective pavement markings is the number of square meters feet completed at the same wet film thickness as that used for reflective markings accepted by the Contracting Officer.

[

c. Temporary Pavement Markings
The unit of measurement for temporary pavement markings is the number of square meters feet completed at the application rate that provides the specified wet film thickness for markings accepted by the Contracting Officer.]

1.1.2 Payment

The quantity of surface preparation, applied reflective and non-reflective markings[,][and][temporary markings] will be paid for at the measured quantity Contract unit prices. Payment constitutes full compensation for furnishing all labor, materials, tools, and equipment for preparing and marking pavements shown on the Contract drawings and as specified. Remove and replace any markings, specified to have reflective media, but are placed without it, do not meet the standard minimum retro-reflective requirements, or with other defects, at no cost to the Government. Remove and replace markings not conforming to the required physical characteristics, alignment, or location required at no cost to the Government.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 247	(2013) Standard Specification for Glass Beads Used in Pavement Markings

ASTM INTERNATIONAL (ASTM)

ASTM D4414	(1995; R 2020) Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4505	(2012; R 2017) Standard Specification for Preformed Retroflective Pavement Marking Tape for Extended Service Life
ASTM E1710	(2011) Standard Test Method for Measurement of Retroreflective Pavement

	Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer

MASTER PAINTERS INSTITUTE (MPI)

MPI 97	(2012) Traffic Marking Paint, Latex

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-B-1325	(Rev D; Notice 1; Notice 2 2017) Beads (Glass Spheres) Retro-Reflective (Metric)
FS TT-P-1952	(2015; Rev F; Notice 1) Paint, Traffic and Airfield Markings, Waterborne

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G, [_____]

Qualifications; G, [_____]

Safety Data Sheets For Each Paint Type; G, [_____]

Safety Data Sheets For Chemicals Used In Surface Preparation; G, [_____]

Data Sheets For Surface Preparation Equipment; G, [_____]

Marking Applications Equipment List; G, [_____]

SD-03 Product Data

Manufacturer Data Sheets for all Marking Materials; G, [_____]

Manufacturer Data Sheets for all Reflective Materials; G, [_____]

SD-04 Samples

Samples Of Marking Materials; G, [_____]

Samples Of Each Reflective Media; G, [_____]

SD-06 Test Reports

Marking Application Wet Film Thickness; G, [_____]

Reflective Media Reflectivity Test; G, [_____]

SD-07 Certificates

Manufacturer Certificate of Compliance for Marking Materials; G, [_____]

Manufacturer Certificate of Compliance for Reflective Materials; G, [_____]

Manufacturer Certificate Of Conformance For Volatile Organic Compliance; G, [_____]

SD-08 Manufacturer's Instructions

Marking Materials Storage and Application; G, [_____]

Reflective Media Storage and Application; G, [_____]

Chemicals Used in Surface Preparation; G, [_____]

1.4 QUALITY CONTROL

1.4.1 Quality Control Plan

Within [10][_____] calendar days of project award, submit a quality control plan. The plan must state the means, methods, equipment and materials to be employed for performance of the marking layout, surface preparation, and application of reflective and non-reflective markings. At a minimum, provide descriptive criteria for each of the following activities for review and approval by the Contracting Officer:

a. Describe the means and methods used to layout marking geometry and the location of marking elements.

b. Describe the protocol for determination of the operating pressure and speed of the equipment for surface preparation.

c. Describe the protocol for surface preparation when not using water.

d. Define the protocol for the performance of test sections for each line width, color, and paint type.

e. Provide equipment details to include speed, pressures and application rate for the minimum wet film thickness and the application rate of reflective media to provide the specified glass bead anchoring and reflectivity. The information will be presented in a table format for each type of marking, width and color.

f. Provide and discuss safety directives for vehicle operations on the airfield.

g. Define communications procedures when operating on the airfield.

1.4.2 Personnel Qualifications for Airfield Pavement Marking

Submit documentation, within [10][_____] calendar days of project award, that describes the training and experience of each person performing work on the project.

1.4.2.1 Qualifications of Airfield Marking Personnel

****

NOTE: The brackets in the paragraph below requires the designer to select the years of experience required for those people operating equipment. The years of experience selected should be based upon the level of difficulty expected in performing the work.

****

Submit documentation of qualifications for personnel performing work on the airfield and operating mobile self-powered or drawn marking equipment, hand-operated equipment, hand application equipment and surface preparation equipment. The minimum experience is operating similar equipment in a similar environment, size and scope of work as the project. [Two][Three][Four] years of experience are required for operators of equipment used for centerline or edge markings with a demonstrated proficiency in meeting dimensional tolerance of markings. The Contracting Officer reserves the right to require additional proof of competency or to reject proposed personnel.

1.5   DELIVERY, STORAGE AND HANDLING

****

NOTE: Edit the brackets below as required to represent the location of the marking materials storage location.

****

[Provide a conditioned storage and staging area located off the installation][A conditioned storage space on the installation will be provided] for all materials intended to be used on the project. Ensure all materials delivered to the storage location are in the original container and clearly marked with the product name, compliance information, batch number, color, manufactured date, instructions for storage, instructions for application, and the name of the manufacturer. All materials are to be stored in conformance with the manufacturer instructions. Provide manufacturer instructions for; marking materials storage and application, reflective media storage and application, and the chemicals used in surface preparation.

1.6   PROJECT SPECIAL CONDITIONS

1.6.1   Environmental Requirements

1.6.1.1   Weather Limitations for Markings Application

Apply pavement markings to clean, dry surfaces only when the ambient temperature is at least 3 degrees C 5 degrees F above the dew point and the pavement surface temperatures are within limits recommended by the manufacturer unless otherwise noted. Allow the pavement surfaces to dry after the water has been used for surface preparation or after a precipitation event.

Do not perform marking applications when the wind carries overspray onto locations adjacent to the marking. Provide wind screens to shroud application equipment.

1.6.1.2   Testing Dry Surfaces

Do not commence marking until the pavement surface is dry. Use the plastic wrap method in accordance with paragraph PRE-APPLICATION TESTING to test the pavement surface for moisture. Do not proceed with marking until the Contracting Officer has observed the moisture test and has accepted the area prepared for marking.

1.6.1.3   Volatile Organic Compounds Compliance

Submit a manufacturer certificate stating that the proposed pavement marking paint meets the Volatile Organic Compound (VOC) regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Submit manufacturer certificate of conformance for volatile organic compliance.

1.6.2   Traffic Control for Airfields

****
NOTE: Edit the brackets in the paragraph below to identify the government representatives responsible for access to and operations of vehicles on the airfield. Provide proposed runway or helipad closures if known. Edit brackets and delete Table I when closure schedules are not available.
****

Coordinate performance of all work in the controlled zones of the airfield with the Contracting Officer and with the [Airfield Manager][Air Traffic Control Tower]. Neither equipment nor personnel can use any portion of the airfield without permission of the [Airfield Manager][and Air Traffic Control Tower] unless the feature is closed.[The runway(s) are scheduled for closure during the times provided in Table I.]

Table 1 - Scheduled Runway(s) Closure

Day or Date	Runway Closing Time	Runway Opening Time	Notes
[_____]	[_____]	[_____]	[_____]

1.6.2.1   Radio Communications

****
NOTE: Edit the brackets below to identify the entity responsible to provide radios, or other means of communication, and those responsible to provide direction to the Contractor.
****

No entry of equipment or personnel is allowed into controlled zones of the airfield until radio contact is established with the Air Traffic Control Tower and the Air Traffic Control Tower has granted permission.[When the Air Traffic Control Tower is closed, radio communication can be established with the Airfield Manager.] Radio contact with the [Air Traffic Control Tower][Airfield Manager] is to be maintained whenever the Contractor is on the active airfield. Notify the [Air Traffic Control Tower][Airfield Manager] when work is completed and all equipment, materials, and personnel are clear of the aircraft operating surface(s).

[

The Government will provide the radio(s). The Contractor is responsible for the radio(s) and must reimburse the Government for repair or replacement of the radio(s) if lost, damaged, destroyed, or stolen.]

[

Provide a minimum of three radios; one for the Air Traffic Control Tower, one for the Airfield Manager, and one for the Contractor. The radio frequency used is to be approved by the [Airfield Manager][Installation Communications Officer].]

1.6.2.2   Emergency Operations on the Airfield

Aircraft emergencies take precedence over all operations. Upon notification from the Air Traffic Control Tower of an emergency, stop all operations immediately and evacuate all personnel and equipment to an area not utilized for aircraft traffic. The evacuation point must be at least 75 m 250 feet measured perpendicular to the near edge of any runway or taxiway or as directed by the Air Traffic Control Tower. All personnel and equipment must be clear of the work area and at a designated evacuation location within 15 minutes.

1.6.2.3 Night Operations

Provide all lighting and equipment necessary to light the work area during night operations effectively. Direct or shade lighting to prevent interference with aircraft, the Air Traffic Control Tower, and other base operations. Provide lighting and related equipment capable of being removed from the runway within 15 minutes of an emergency notification. Coordinate night work with the [Flight Operations Manager][Airfield Manager]. The Government reserves the right to accept or reject material applications during night work on the day following night activities.

1.7 APPLICATION EQUIPMENT CALIBRATION

Before performing any marking application, calibrate the paint and glass bead application equipment at the necessary speed to execute the application. Calibration and application will be performed using paint that is not diluted or thinned. Paint will be used as formulated by the manufacturer. Calibrate paint and bead guns for each line width and color intended to be applied. Use a wet film gauge in accordance with ASTM D4414 to determine if the wet film thickness is the same at each edge and at the center of the marking. Adjust each paint gun to provide a uniform wet film thickness for the width of the marking.

Collect a sample of glass beads directly from the glass bead dispenser along a measured distance. Weigh the glass beads captured and determine the coverage by dividing the weight by the area of the line placed during the calibration. Adjust the glass bead dispenser to provide an application rate necessary to meet or exceed the reflectivity specified. After determining the application rate, apply a reflective marking using the wet film thickness to be used for the color and marking element. Using a magnifying glass, examine the distribution and embedment of the glass beads. Beads are to be distributed uniformly for the width of the marking. Adjust the wet film thickness if the beads are submerged or predominantly on the surface of the marking.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Surface Preparation for Airfields

****

NOTE: Edit the brackets in the following paragraph to delete or incorporate provision for new concrete pavement.

****

Submit data sheets for surface preparation equipment the Contractor intends to use to prepare the pavement surface for marking. In the submittal, include descriptive information on the means for adjusting coverage per each pass, water pressure adjustment range, and tank and flow capacities. The equipment must have a range of adjustments that, when used, result in an existing surface that is clean and free of dirt, dust, oil, grease, algae, mildew, mold, and loose paint. The equipment is not intended to be used to remove stable existing markings intentionally.[When preparing new portland cement concrete for marking, the equipment must be capable of removing the curing compound without damage to the concrete surface and joint seal materials.] Submit safety data sheets for chemicals used in surface preparation.

2.1.1.1 Water Blasting Equipment

Use mobile water blasting equipment capable of producing a pressurized stream of water that effectively cleans existing markings and pavement surfaces without damage to stable markings, pavement, or joint seals. Provide equipment, tools, and machinery which are safe and in good working order.

2.1.2 Markings Application Equipment

Submit a marking applications equipment list appropriate for the material(s) to be used. Include manufacturer's descriptive data and certification for the planned use that indicates the area of coverage per pass, pressure adjustment range, tank and flow capacities, and all safety precautions required for operating and maintaining the equipment. Provide and maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition, or remove equipment that is not providing satisfactory performance from the work site. Provide mobile and maneuverable application equipment to the extent that straight lines can be followed and normal curves can be made in a true arc.

2.1.2.1 Airless or Atomizing Equipment

Provide mobile airless or pneumatic air-atomized application equipment that is maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. Mount equipment on trucks, skids or tractors. Use equipment suitable for application of the marking material specified. Airless systems are used to only apply waterborne coatings. Pneumatic systems are used to apply waterborne coatings and durable materials. Provide equipment capable of applying a marking from 100mm to 900mm 4 inches to 36 inches wide in a single pass and applying two single solid or intermittent lines using a minimum of two colors.

Provide equipment with tanks or reservoirs equipped with mechanical agitators, pressure regulators, and gages in full view of the equipment operator. Use paint strainers suitable to screen paint flowing in all supply lines.

2.1.2.2 Hand-Operated Machines

Provide a hand-operated push-type applicator machine for applying water-based paint, or preformed tape, to pavement surfaces for small marking projects such as surface painted signs. Provide an applicator machine with the necessary tanks and spraying nozzles to apply paint uniformly at the specified wet film thickness. Provide spray guns for hand application of paint in areas where push-type machines cannot be used.

2.1.2.3 Reflective Media Dispenser

Mount glass bead dispensers that are automatically triggered when paint guns are activated. The dispensers may be pressurized or gravity-drop systems. Pressurized systems require moisture control.

2.2 AIRFIELD MATERIALS

****

NOTE: For Navy projects, refer to the MPI Manual for recommendations on uses and application rates of paints and select paint systems for the project in accordance with the MPI Architectural Painting Decision Tree available on the Whole Building Design Guide. Use this interactive paint system for the project. The MPI Decision Tree identifies paint systems for each interior and exterior coated surface in "Normal" or "Aggressive environmental conditions and lists the applicable paint systems in descending order of performance. The paint system at the top of each substrate list indicates the highest performing acceptable coating system.

NOTE: The Designer should review the Airfield Marking Handbook (Best Practices) in UFC 3-260-04, Appendix B1. The Designer is responsible for preparing drawings identifying where each marking element is located. The Designer is responsible for providing a table or notes that identify each marking element's paint type, color, and glass bead type. For non-reflective markings, mark the bead type as "NA" or not applicable. Refer to UFC 3-260-04 (2018) for more information in Paragraph 3-1.5 CONTRASTING MARKINGS to increase conspicuity; Paragraph 3-2 COLORS FOR PAVEMENT AND OBSTRUCTION MARKINGS; and Paragraph 3-3 for RETRO-REFLECTIVE PAVEMENT MARKINGS.

Waterborne paint is the most common material used on DoD and domestic airfields. Preformed Reflective Pavement Marking Tape is not permitted for application on airfield runways and helipad pavements due to FOD risk. Contact the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME) or Naval Facilities Engineering Command (NAVFAC) for guidance on interpreting and editing this specification section with regard to the use of preformed tape on airfield pavements other than areas specifically excluded.

For NAVFAC LANT projects only: When the use of pavement marking materials (epoxy, thermoplastic, and preformed tape), those that perform better than paint is desired for new pavement in Virginia and North Carolina. Contact NAVFAC LANT for the sample section.

****

Submit safety data sheets for each paint type[and preformed tape] as well as manufacturer data sheets for all marking materials and manufacturer data sheets for all reflective materials; include with the submittal a manufacturer certificate of compliance for marking materials and a manufacturer certificate of compliance for reflective materials.

2.2.1 Airfield Marking Colors

Provide markings for airfield pavements that conform to SAE AMS-STD-595A color numbers as listed in Table II.

Table II - SAE AMS-STD-595A Color Numbers

Paint Color	SAE AMS-STD-595A Color Number
White	37925
Yellow	33538
Black	37038
Green	34108
Red	33411

2.2.2 Waterborne Paint

****

NOTE: Waterborne paint can be applied to restripe over existing waterborne, solventborne, and thermoplastic paints. Do not restripe over preformed tape.

Specify FS TT-P-1952 for Air Force and Army projects.

Specify MPI 97 for Navy projects. A list of approved products conforming to MPI 97 is on the Master Painters Institute website.

FS TT-P-1952 covers three types of low VOC; ready-mixed, one-component, and 100 percent acrylic waterborne airfield and traffic marking paints.

Type I - For normal weather conditions. Not for use at the wet film thickness required for Type IV beads.

Type II - For use under adverse conditions (faster drying for high humidity environments). Not for use at the wet film thickness required for Type IV beads.

Type II - For use under normal weather conditions where higher durability and greater adhesion to glass beads is desired. Type III is recommended for use on asphalt pavement because of its higher elasticity, which impedes cracking of asphalt at the paint surface.

****

Use FS TT-P-1952, Type [I or II] [III] paint.Use MPI 97 paint.

[2.2.3 Preformed Reflective Pavement Marking Tape

****

NOTE: Preformed tape is not allowed for use on airfield runways and helipad pavements. It is not recommended for use on other airfield pavements unless the Designer coordinates with those entities with flying safety responsibilities. Preformed tape cannot be placed over markings made from other materials nor applied over existing preformed tape markings, and all existing markings must be removed when using preformed tape.

Delete this paragraph if preformed marking tape will not be incorporated into the project.

****

Provide adherent reflectorized strip preformed tape in accordance with ASTM D4505 Retro-reflectivity Level II, Class 1, 2 or 3, Skid Resistance Level B.

]2.2.4 Reflective Media for Airfields

****

NOTE: The installation facility management group(i.e. Director of Public Works, Base Civil Engineer, etc.) determines the type of beads used on DOD airfields taking into consideration local conditions, life-cycle cost maintenance, environmental impact, operational requirements, and the safety of flight in the life cycle cost analysis of the pavement markings.

The designer should read paragraph 3.4.2 of the Airfield Marking Handbook included as Appendix B1 in UFC 3-260-4, Marking Airfields and Heliports.

In accordance with Section 2872(b) of the 2018 National Defense Authorization Act, the Secretary of the Air Force has submitted a certification to the congressional defense committees that states whenever a proposed contract for airfield pavement markings includes the use of Type I or Type III glass beads, the assessment of the life-cycle costs associated with the use of such beads appropriately considers the local site conditions, life-cycle cost maintenance, environmental impact, operational requirements, and the safety of flight. Therefore, Type I glass beads or any glass beads with a 1.6 refractive index or less may be used on the airfield provided the lifecycle costs are assessed as stated above.

When selecting reflective media using FS TT-B-1325, use the following and consider the intended use. There are four bead types. Type I and Type IV each have two gradations of beads. The Type I and Type IV beads have a low Index of Reflectivity (IOR of 1.5) because both bead types return light in a

diffused pattern. The Type I beads are the smallest diameter of the bead types.

Type I, (Gradation A), low-index recycled glass beads for drop-on applications are intended for marking highways and any airfield markings. Type I beads require the lowest wet film thickness.

In accordance with Section 2872 of the 2018 National Defense Authorization Act and the Secretary of the Air Force certification to the congressional defense committees, this type of bead can be utilized on airfield markings provided assessment of the life-cycle costs associated with the use of such beads appropriately considers the local site conditions, life-cycle cost maintenance, environmental impact, operational requirements, and the safety of flight has been performed.

Type II beads are not used.

Type III, high index virgin material glass beads for drop-on applications are used where increased reflectivity is required, such as runways and high-speed turn-off taxiways, or where life-cycle costs are less than other beads. Type III beads may be used with any of the waterborne paint. The wet film thickness of the paint will be thicker than paint used with Type I beads because of the Type III bead size.

Type IV, Gradation B, large diameter, low index recycled glass beads for drop-on applications may be used on airfields. The wet film thickness must be increased compared to using Type I or Type III beads to provide proper anchoring (between 25 and 30mils). Type IV beads are not usually used on airfields.

In accordance with Section 2872 of the 2018National Defense Authorization Act and the Secretary of the Air Force certification to the congressional defense committees, this type of bead can be utilized on airfield markings provided assessment of the life-cycle costs associated with the use of such beads appropriately considers the local site conditions, life-cycle cost maintenance, environmental impact, operational requirements, and the safety of flight has been performed.

When using waterborne paint, Type I or Type III glass beads can be used with Type I, II, or III paint. Type IV glass beads can only be used with Type III paint.

Specify AASHTO M247 reflective media for Navy projects.

Edit the following sentence to delete those bead types that will not be used for the project.

****

Provide FS TT-B-1325 [Type I, Gradation A] [and] [Type III] [and] [Type IV, Gradation B] glass beads.Provide AASHTO M 247 reflective media. Paint and glass bead types used with markings are designated on the drawings. Provide glass beads with those coatings that promote adhesion, limit flotation, and absorb moisture to preclude bundling and dual coatings for waterborne materials.

PART 3 EXECUTION

3.1 TEST SECTIONS

Before the performance of any marking application, demonstrate to the Government, using the equipment, materials, and personnel identified in the approved quality control plan, that the requirements for acceptance of the final product(s) are attainable. The minimum length of the test section is 15 meters 50 feet of marking for each line width, color, and wet film thickness. Perform demonstrations in a location designated by the Contracting Officer within the project scope of work. Do not perform the test section(s) until the Contracting Officer is present to observe the test. Table III identifies minimum and maximum wet film thickness based on glass bead type. Each test section’s result is the standard of performance for the color, width, wet film thickness, and glass bead application rate for each marking element. Submit the width, color, wet film thickness, and measured reflectivity.

3.1.1 Surface Preparation Test Section

****

NOTE: Delete bracketed text if project does not include removal of existing markings.

****

[Perform a demonstration removal of pavement markings in an area designated by the Contracting Officer.]Prepare an area large enough to determine [cleanliness] [,adhesion of remaining markings], and cleaning rate. Use the means, methods, and equipment identified in the approved quality control plan. Adjust the means, methods, equipment, or equipment settings until the prepared surface is free of dirt, debris, oils and greases, algae, mold, mildew, and loose or flaking paint without damage to the pavement. Remove any equipment that fails to provide an acceptable product during the demonstration and provide new equipment that will produce an acceptable product.[Approved demonstration area establishes the standard for the work.]

3.1.2 Wet Film Thickness Test Section

****

NOTE: The purpose of providing glass beads embedded in a paint marking is to provide easy sight acquisition for aircraft pilots at night using diffused light. Embedment is critical. If beads are submerged (covered in paint) light will not be returned. If there is not enough paint to anchor beads then beads become fugitive materials. Determining proper embedment is critical to the performance and durability of the reflective marking.

Proper embedment is determined by providing a paint mil thickness that allows for the largest diameter bead in the distribution to be embedded to one-half of the bead diameter. The smaller beads will “float” and the wicking of the paint will coat the beads to a range of 50 to 60 percent of the diameter. The minimum wet film thickness threshold in Table III result in glass bead embedment at approximately 50 percent of the glass bead diameter for the specified bead type. Confirm the reflectivity of the marking using a retro-reflectometer at night under diffuse lighting using ASTM E1710 protocol. If the reflectivity exceeds the minimum at three locations from different directions then the embedment is correct.

****

Adjust the marking application rate for equipment speed, operating pressure, and line width, to provide a minimum wet film thickness, full coverage, and reflective media anchoring. Minimum and maximum wet film thickness is identified in Table III. Measure the wet film thickness using a wet film gauge at three points along the test section. Wet film thickness is determined using ASTM D4414 as the performance standard. When the average of the three readings is less than the minimum specified in Table III, repeat the test section. Submit the results of the marking application wet film thickness test to the Contracting Officer before proceeding with work on the project.

3.1.3 Reflective Value Test Section

Measure the reflectivity at three points, along the length of the marking placed for wet film thickness. After the application is cured, measure the retro-reflective value using a Retro-Reflectometer with a direct readout in millicandelas per square meter per lux (mcd/m2/lx) using ASTM E1710. Take three readings on each test section. When the average of the three readings is less than the minimum specified in Table V, repeat the test section. Document the application rate of the reflective media required to meet the specified minimum reflectivity. Submit the results of the reflective media reflectivity test to the Contracting Officer before proceeding with work on the project.

3.2 SURFACE PREPARATION

Clean surfaces before the application of marking materials. Remove all dirt, dust, oil, grease, algae, mildew, mold, loose paint and mineral deposits such as iron stains by use of water blasting or chemical removal. Follow the cleaning with sweeping, blowing or using water rinse. Do not begin painting in any location prepared for marking until surfaces are dry and clean.

Scrub areas with oil or grease present with applications of trisodium phosphate solution or other approved detergent or degreaser. Rinse thoroughly after each application to prevent staining of the new marking. After cleaning oil-soaked areas, seal with shellac or primer as the manufacturer recommends to prevent bleeding through the new paint.

3.3 PRE-APPLICATION TESTING

Test the pavement surface for moisture before beginning pavement marking after each period of rainfall, fog, high humidity, or cleaning or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the Contracting Officer has approved the pavement condition.

Employ the plastic wrap method, described as follows, to test the pavement for moisture:

a. Cover the pavement with a 300 mm by 300 mm 12 inch by 12 inchsection of clear plastic wrap and seal the edges with tape.

b. After 15 minutes, examine the plastic wrap for any visible moisture accumulation. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap.

c. Re-test surfaces when work has been stopped due to a precipitation event.

3.4 TEMPORARY MARKINGS

****

NOTE: New portland cement concrete and asphalt pavements require curing prior to the application of permanent markings. For permanent markings, a new asphalt pavement surface should be at least 30 days old. Markings applied before the cure period will result in asphalt bleed-through or poor bonding. All curing materials need to be completely removed from new concrete pavement before the application of marking materials.

Temporary pavement markings are applied conforming to the phasing plan provided in the Contract drawings.

Select the first set of brackets for temporary markings that do not require reflective media. Both location and flying safety must be considered.

Select the second set of brackets for temporary markings applied in airfield locations where there is aircraft traffic subject to jet blasts, turning movements and requirements for reflective media.

Select the third set of brackets in airfield locations not subject to jet blasts, turning movements, or Foreign Object Debris (FOD) risk.

Delete the bracketed paragraphs not used.

****

The dilution or thinning of paint prior to application is not allowed.

[Use FS TT-P-1952 [Type I] [Type II] paint to apply temporary pavement markings. Apply paint at one-half the wet film thickness used for permanent markings. Reflective media is not used with temporary markings. Apply a coat of wax-based curing compound conforming to COE CRD-C 300 prior to paint application.]

[

Use FS TT-P-1952 Type I waterborne paint applied at a wet film thickness of 14 to 16 mils. Apply beads at the rate of application required to provide the minimum specified reflectivity for the color being applied. Apply a coat of wax-based curing compound conforming to COE CRD-C 300 prior to paint application.]

[

Apply Preformed Retroreflective Pavement Marking Tape conforming to the specified materials and application requirements.]

3.4.1 New Portland Cement Concrete Pavement (PCC)

Regardless of concrete age, permanent markings may be placed when the concrete passes the pre-application test (plastic wrap test), after a 24 hour period. Temporary markings are to be used for concrete pavement that fails the plastic wrap test.

3.4.2 New Hot Mix Asphalt Pavement (HMA)

Temporary markings are to be used on HMA pavement less than 30 days old.

3.5 MARKINGS APPLICATION

3.5.1 Marking Materials for Airfield Pavement

3.5.1.1 Waterborne Paint

****

NOTE: Most waterborne paints can be applied at temperatures down to 10 degrees C 50 degrees F. Waterborne paints formulated to be applied at temperatures down to approximately 2 degrees C 35 degrees F are available.

The actual application rate for paint will vary because of the texture, age, and condition of the material being marked. The application rate is determined as a result of the TEST SECTIONS (Wet Film Thickness). The application rate is required to provide a wet film thickness approximately equal to provide a 50 percent embedment of the glass bead diameter being used. Edit Table III to delete content of those cells with paint wet film thickness or bead application rates not applicable to the scope of work.

Type I or Type III glass beads can be used with Type I, Type II, or Type III waterborne paint. Type IV glass beads can only be used with Type III waterborne paint. The expected wet film thickness when using Type I glass beads is 14 to 16 mils. The expected wet film thickness when using Type III glass beads is 16 to 20 mils. When using Type IV glass beads, the wet film thickness must be increased to the range of 25 to 30 mils because of the larger bead diameter.

Type I paint and Type I reflective media (subject to an economic analysis) are used on airfield pavements such as taxiways (non-primary), aprons, holding

pads, and maintenance pads. Type II paint and Type III reflective media are recommended for use on airfield runways, high-speed taxiways, and primary taxiways where flying safety is of primary concern. Type III waterborne paint must be used with Type IV reflective media. Type IV beads do not increase the reflectivity because they are low index beads. Type IV beads are only used where Type III paint is used to provide thicker paint.

Specify FS TT-P-1952 waterborne paint and FS TT-B-1325 reflective media for Air Force and Army projects.

Specify MPI 97 waterborne paint and AASHTO M 247 reflective media for Navy projects.

Edit the following paragraphs by deleting those that do not apply.
****

Dilution or thinning of paint prior to application is not allowed.

[Provide FS TT-P-1952 waterborne paint and FS TT-B-1325 glass beads. Apply [reflective][and][non-reflective] markings in accordance with Table III. Use the paint type[and bead type] as shown on the drawings.]
[
Provide MPI 97 waterborne paint and AASHTO M 247 glass beads. Apply [reflective][and][non-reflective] markings in accordance with Table III. Use the paint type [and bead type] as shown on the drawings.]

The paint wet film thickness and glass bead application rate is provided in Table III. Perform the marking and bead application test section beginning at the minimum value and adjust the application rate up or down until the requirements of paragraphs WET FILM THICKNESS TEST SECTION and REFLECTIVE VALUE TEST SECTION are satisfied. The values of wet film thickness and bead application rate established by the test section will be the standard of performance for the respective marking type and color.

Table III. Paint Wet Film Thickness and Bead Application Rate

Paint Type	Non-Reflectorized Marking Wet Film Thickness (mil)	Reflectorized Marking					
		Wet Film Thickness (mil) based on Glass			Minimum Bead Application Rate		
		Type I Gradation A	Type III	Type IV Gradation B	Type I Gradation A	Type III	Type IV Gradation B
Type I	14-16	14-16	--	--	0.8kg/L 7 lb/gal	--	--
Type II	14-16	14-16	16-20	--	0.8kg/L 7 lb/gal	1.2 kg/L 10 lb/gal	--
Type III	16-20	--	16-20	25-30	--	1.2 kg/L 10 lb/gal	1 kg/L 8 lb/gal

[3.5.1.2 Preformed Reflective Pavement Marking Tape

The pavement surface and ambient air temperature must be at a minimum of 15 degrees C 60 degrees F and rising. Place the preformed tape markings according to the written instructions provided by the manufacturer.

]3.6 FIELD QUALITY CONTROL AND ACCEPTANCE

3.6.1 Material Inspection

The Contractor is responsible to examine all materials accepted for delivery with the certificate of compliance.

3.6.2 Sampling and Testing

****

NOTE: It is recommended that samples of all marking materials be collected directly from the application equipment before or during the calibration of the equipment. Taking samples directly from the application equipment will avoid the possibility that marking materials have been thinned or altered from the time of manufacture until the time of application.

Certifications issued by the manufacturer can be used to determine if the marking materials meet the specified criteria. And samples of the materials can be collected and stored in the environment recommended by the manufacturer. Samples can be tested if there are problems with the markings before the end of the warranty period.

****

As soon as the marking materials are available for sampling, obtain materials by random selection directly from equipment already calibrated. Four liters Four quarts of paint are to be collected; two liters two quarts for the Contractor and two liters two quarts for the Government. Samples of marking materials and samples of each reflective media are to be collected by the Contractor in the presence of the Contracting Officer. Identify samples by project name and number, manufacture date, batch number, and the square yards of markings represented by the sample.

The Government will retain samples for the warranty period under storage conditions recommended by the manufacturer. If there is an issue with a material defect during the period of the warranty, the Contractor will incur the cost for an accredited independent laboratory to test the material(s) for conformance with the certifications and the contract specifications. If a sample fails to meet the specification, replace the material in the area represented by the sample and retest the replacement material as specified above. The Government reserves the right to test the samples for verification of materials.

3.6.3 Dimensional Tolerance

The Contractor responsible for layout markings. All layout markings are placed before the marking material application. The edges of markings will not vary from a straight line drawn between the beginning and end of the marking by more than 12 mm 1/2 inch in 15 meters 50 feet. Marking dimensions and spacing must be within the tolerances provided in Table IV.

Table IV - Dimensional Tolerance for Marking Elements

Dimension and Spacing	Tolerance
910 mm 36 inches or less	12 mm +/- 1/2 inch
Greater than 910 mm to 1.85 m 36 inches to 6 feet	25 mm +/- 1 inch
Greater than 1.85 m to 18.3 m 6 feet to 60 feet	50 mm +/- 2 inches
Greater than 18.3 m 60 feet	76 mm +/- 3 inches

3.6.4 Coating and Reflective Media Application Reporting

****

NOTE: When remove and replace is required use the protocol and provisions of UFGS Section 32 01 11.51 RUBBER AND PAINT REMOVAL FROM AIRFIELD PAVEMENTS.

****

3.6.4.1 Reporting Wet Film Thickness, Glass Bead Distribution, and Reflectivity

Submit documentation on the wet film thickness and reflectivity for each marking element. Provide a reading at the rate of one reading per 300 linear meters 1000 linear feet of line marking. For airfield marking elements, such as runway threshold bars or numerals, provide a reading for every 50 square meters 500 square feet of marking area. A reading is the average of 10 measurements at random locations within the marking element area. Submit the results of the Marking Application Wet Film Thickness test and Reflective Media Reflectivity Test to the Contracting Officer.

3.6.4.2 Wet Film Thickness

Conduct a Marking Application Wet Film Thickness test. Provide a wet film thickness gauge to measure the wet film thickness using ASTM D4414 at the edge(s) and one interior location of the marking. When more than 3 in 10 consecutive measurements of wet film thickness are outside of the tolerances in Table III, remove and replace areas not meeting the wet film thickness requirement.

3.6.4.3 Reflectivity

Conduct a Reflective Media Reflectivity Test. Provide documentation that records the readings for white, yellow and red reflective markings. Measure the reflectivity using a Retro-Reflectometer using ASTM E1710. The minimum reading for white, yellow, and red markings is provided in Table V in millicandelas per square meter per lux (mcd/m2/lx) at the time of marking. When more than 3 in 10 consecutive measurements of reflectivity are outside of the minimum in Table V, remove and replace the areas not meeting the minimum reflectivity requirements.

Table V - Minimum Reflectivity (millicandelas per square meter per lux)			
	Minimum Reflectivity at Time of Marking by Paint Color		
Bead Type	White	Yellow	Red
Type I	300	175	35
Type III	600	350	35
Type IV	300	200	35

[

Preformed Tape pavement markings will yield a minimum of 225 mcd/m2/lux on white markings at installation and a minimum of 100 mcd/m2/lux on yellow markings at installation.]

3.7 CLEANUP AND WASTE DISPOSAL

The worksite and the material staging area must be free of debris, dirt, and items that will blow away during periods of elevated wind speeds. Dispose of all materials at a site approved by the Contracting Officer. Dispose of waste from cleaning the marking equipment at a facility that is permitted to accept the material.

3.7.1 Cleanup Requirements

Provide a vacuum sweeper at each work area when markings are cured. Vacuum sweep the entire pavement surface to provide a clean pavement without fugitive glass beads and debris.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 18 16.13 (August 2017)**

Preparing Activity: USACE **Superseding**
UFGS-32 18 16.13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-32 18 16.13 (August 2017)**

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SECTION 32 18 16.13

PLAYGROUND PROTECTIVE SURFACING

08/17

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NOTE: This guide specification covers the requirements for furnishing and installing protective surfacing in children's outdoor play areas.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of recycling and conserve natural resources.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2047	(2017) Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine
ASTM D2261	(2013; R 2017) Standard Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure (Constant Rate-of-Extension Tensile Testing Machine)
ASTM D6112	(2013) Compressive and Flexural Creep and Creep-Rupture of Plastic Lumber and Shapes
ASTM F1015	(2003; R 2017) Standard Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces
ASTM F1292	(2022) Standard Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment
ASTM F1487	(2021) Standard Consumer Safety Performance Specification for Playground Equipment for Public Use
ASTM F1951	(2014) Standard Specification for

Determination of Accessibility of Surface Systems Under and Around Playground Equipment

CONSUMER PRODUCT SAFETY COMMISSION (CPSC)

CPSC Pub No 325	(2015) Public Playground Safety Handbook

1.2 DEFINITIONS

1.2.1 Critical Height

The fall height at which the protective surfacing meets the requirements of ASTM F1292.

1.2.2 Designated Play Surface

Any elevated surface for standing, walking, sitting, or climbing; or a flat surface a minimum 50 mm 2 inches wide having up to a maximum 30 degree angle from horizontal. In some play events the platform surface will be the same as the designated play surface. However, the terms should not be interchanged as they do not define the same point of measurement according to ASTM F1487.

1.2.3 Head Injury Criteria (HIC)

A measure of impact severity that considers the duration over which the most critical section of the deceleration pulse persists as well as the peak level of that deceleration. Head impact injuries are not believed to be life threatening if the HIC does not exceed a value of 1,000.

1.2.4 Impact Attenuation

The ability of protective surfacing to reduce and dissipate the energy of an impacting body.

1.2.5 Loose Fill

Consisting of small independent movable components such as sand, gravel, or wood chip. The percent of fine material in the loose fill affects its compression properties from rainfall.

1.2.6 Maximum Equipment Height

The highest point on the equipment (i.e.: roof ridge, top of support pole).

1.2.7 Play Event

A piece of manufactured playground equipment that supports one or more play activities.

1.3 SYSTEM DESCRIPTION

****

NOTE: Drawings will indicate the perimeters of the play event use zone defining fall height, platform height, and maximum equipment height; spot elevations; and details as required to install protective surfacing to meet child safety

requirements.

Accessibility: Drawings will indicate spot elevations; dimensions; ramp slope and rise; transfer platform height and transfer space; transfer step and height; and maneuvering space as required to install protective surfacing to meet child accessibility requirements.

****

Measure the perimeters of the play event use zone in accordance with the requirements of Section 11 68 13 PLAYGROUND EQUIPMENT.

1.3.1 Child Safety

Meet or exceed the impact attenuating performance requirements of synthetic surfacing and loose-fill surfacing systems, installed in the use zones, as follows. The surfacing critical height value must yield up to both a maximum 200 G's peak deceleration, and a maximum 1,000 Head Injury Criteria (HIC) value for a head-first fall from the play event in accordance with CPSC Pub No 325 and ASTM F1292. The protective surfacing should have a minimum critical height value equal to the height of the highest designated play surface. Measuring fall heights for play events is defined in paragraph FALL HEIGHT. Do not install sand, gravel, and wood products over a concrete or bituminous subsurface in accordance with CPSC Pub No 325.

1.3.2 Child Accessibility

****

NOTE: Facilities will be accessible in accordance with TI 800-01 and 36 CFR 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Ensure one access and egress point for a furnished play event meets accessibility. Ensure all children are accommodated on the playground in a 'play for all' socialization skill development environment. When children with disabilities are allowed to choose play events, they are more eager to learn the skills necessary to participate.

****

The accessibility requirement in accordance with ASTM F1487 includes the following: When the play event use zone consists of a protective surfacing rated as inaccessible, at least one accessible route must be provided from the use zone perimeter to the play event. When there is more than one of the same play activity provided, only one must meet accessibility requirements (i.e.: one swing seat or one spring rocking play event). When the access and egress points are not the same for a play event, an accessible route must be provided to both. The accessible route must access all accessible play events and elements. The protective surfacing materials that meet accessibility are synthetic surfacing and engineered wood fiber in accordance with ASTM F1951. When the accessible surface is within the use zone, it must meet the requirements of paragraph CHILD SAFETY.

1.3.3 Play Areas at CDC

The technical representative for outdoor play areas at CDC must be the installation Child Development Services (CDS) Coordinator. The design of the CDC outdoor play area must be based on the developmental play program for the age groups accommodated at the CDC. The play area is designed to support the CDC program and to provide a stage set for creative play. Developmental activities are selected which promote the intellectual, social, emotional and physical growth of the children. The developmental play program is developed by the MACOM CDS Director, installation CDS Coordinator and CDC Director. They are responsible for the developmental play program, child safety and accessibility to meet that program.

1.3.4 Sites Other than CDC

The technical representative for outdoor play areas on sites other than CDCs is the Director of Public Works or designated representative. The design of these outdoor play areas must be based on the play program and the age groups to be accommodated as determined by the play area committee.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

    Shop Drawings

    Finished Grade and Underground Utilities

SD-03 Product Data

    Synthetic Surfacing

    Loose Fill Surfacing

    Geotextile Fabric

    Wood

    Temperature Limitation

    Wood By-Products

    Wood Treatment

    Adhesive

    Color

SD-04 Samples

    Synthetic Surfacing

    Loose Fill Surfacing System

SD-06 Test Reports

    Percolation Test

    Recycled Plastic

    Synthetic Surfacing

    Sand

    Gravel

SD-07 Certificates

    Manufacturer's Qualification

    Manufacturer's Representative

    Installer's Qualification

    Substitution

    Protective Surfacing Acceptance

SD-10 Operation and Maintenance Data

Maintenance Instructions; G, [_____]

SD-11 Closeout Submittals

Protective Surfacing Acceptance

Certificate of Insurance

Warranty

1.5 QUALITY ASSURANCE

1.5.1 Manufacturer's Qualification

Submit name of the owner or user; service or preventive maintenance provider; date of the installation; point of contact and telephone number; and address for 10 sites. Protective surfacing should have been installed in a minimum 10 sites and been in successful service for a minimum 5 year calendar period. The manufacturer must provide a Certificate of Insurance AA rated for a minimum one million dollars covering both product and general liability.

1.5.2 Manufacturer's Representative

Submit the individual's name, company name and address, and playground safety training certificate. The manufacturer's certified playground safety inspector or the manufacturer's designated certified playground safety representative must supervise the installation and adjustment of the protective surfacing to verify the installation meets the requirements of the manufacturer, this specification, and paragraphs CHILD SAFETY and CHILD ACCESSIBILITY.

1.5.3 Installer's Qualification

Submit the installer's company name and address, training and experience certification. The installer must be certified by the manufacturer for training and experience installing the protective surfacing.

1.5.4 Shop Drawings

When the use zone perimeter and play event configuration conflict with the requirements and paragraphs CHILD SAFETY and CHILD ACCESSIBILITY, submit scale drawings defining corrective measures to include the following: Adjustment to the play event with the use zone perimeter; use zone perimeter overlaps; fall height and critical height value.

1.6 DELIVERY, STORAGE, AND HANDLING

Provide a delivery schedule at least 10 calendar days prior to the first day of delivery. Deliver, handle, and store protective surfacing material in accordance with the manufacturer's recommendations. The storage area must be as designated. Store the materials in a dry, covered area until installed. Inspect protective surfacing material, upon arrival at the job site, for meeting specified quality. Unacceptable materials must be removed from the job site.

1.7 WARRANTY

Furnish protective surfacing with a minimum 1 year calendar period warranty.

1.8 MAINTENANCE INSTRUCTIONS

Submit [2] [_____] bound copies of the manufacturer's operation and maintenance manual describing the recommended preventive maintenance, inspection frequency and techniques, periodic adjustments, lubricants, and cleaning requirements. Furnish protective surfacing spare parts provided by the manufacturer.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Before selecting a protective surfacing system, evaluate the different types of protective surfacing systems to determine the most appropriate surfacing for the climate, accessibility, play value, and cost. Consider life cycle maintenance cost.

Synthetic Surfacing System: Synthetic surfacing systems, either unified or combined, meet accessibility requirements and have less daily maintenance requirements than loose-fill surfacing systems. Synthetic surfacing systems have limited play value. These systems may be used to add color patterns to the playground to be used for play activities.

Loose Fill Surfacing System: The only loose fill surfacing that meets accessibility is engineered wood fiber. To maintain accessibility there needs to be a commitment to replenishing the material every month with the same engineered material. Some loose-fill materials such as sand, not only provide a good impact attenuation surface, but have excellent play value. Loose fill surfacing systems require daily maintenance to maintain impact attenuation performance due to material displacement, decomposition, and compression.

Depth of Material: Depth of the protective surfacing is determined by both the fall height and the type of protective surfacing system selected.

****

Prior to the delivery of materials, submit certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates must include composition and tests to which the material has been subjected. Submit manufacturer's descriptive data; catalogue cuts; and the latest edition of ASTM F1487 and CPSC Pub No 325. Provide materials which are the standard products of a manufacturer regularly engaged in the manufacture of protective surfacing and that are similar to surfacing in satisfactory use a minimum 5 year calendar period. Protective surfacing consists of two systems; synthetic surfacing and loose fill surfacing.

2.2 SYNTHETIC SURFACING

Submit a minimum 50 by 50 mm 2 by 2 inch sample. Submit impact attenuation and critical height performance for each thickness of synthetic surfacing and loose fill surfacing provided. Submit delivery schedule and manufacturer's name for synthetic surfacing and loose fill surfacing plus delivery, storage and handling information. Furnish a list to include part numbers of furnished protective surfacing materials and components for synthetic surfacing and loose fill surfacing and manufacturer's specifications, handling and storage requirements, installation procedures, and safety data sheets to include warnings and critical height performance standards for synthetic surfacing and loose fill surfacing. Synthetic surfacing includes the following: poured-in-place system; tile system; and combination system. The synthetic surfacing consists of either impact attenuating substrate covered by a wear surface bonded to produce a unified system; a shredded rubber or aggregate substrate covered by a polyethylene plastic woven sheet wear surface; or a uniform material manufactured in such a way that the top portion meets the requirements specified for wear surface. Submit chemical composition, color granule percentage, and test results to which material has been subjected, identifying each material and component containing recycled materials and showing the estimated percentage of recovered material content. Furnish freezing temperature life-cycle durability.

2.2.1 Subbase

The subbase for synthetic surfacing may be either concrete, aggregate, or bituminous material.

2.2.1.1 Concrete Subbase

Provide concrete material conforming to Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS.

2.2.1.2 Bituminous Subbase

Provide bituminous material conforming to Section 32 01 13.62 BITUMINOUS SURFACE TREATMENT [AND] [SAND SEAL].

2.2.1.3 Aggregate Subbase

Provide aggregate material conforming to Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING].

2.2.2 Impact Attenuating Substrate

Provide a substrate compatible with the wear surface, and consisting of modular units; poured-in-place; or loose fill.

****

NOTE: layground surface products are EPA designated recycled content products. Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement

Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research has shown that products are available among US national manufacturers meeting the recycled content percentage in the following substrate sections.

****

2.2.2.1 Poured-In-Place Substrate

Poured-in-place substrate must consist of a 100 percent recycled, shredded, styrene butadiene rubber (SBR) adhered with a 100 percent solid polyurethane binder to form a resilient, porous material or shredded rubber. Strands of SBR may vary from a minimum 0.5 mm 1/50 inch to a maximum 2 mm 2/25 inch thickness; by a minimum 3 mm 1/8 inch to a maximum 20 mm 4/5 inch length. Binder must be between a minimum 12 percent and a maximum 16 percent of the total weight of the mixture of rubber and urethane; and must provide 100 percent coating of the particles. Foam rubber will not be accepted in the substrate.

2.2.2.2 Loose Fill Substrate

The loose fill substrate must consist of 100 percent recycled shredded rubber produced from recycled vehicle tires without non-steel belts. Loose-fill strands may vary from a minimum 3 mm 1/8 inch to a maximum 6 mm 1/4 inch thickness; a minimum 3 mm 1/8 inch to a maximum 13 mm 1/2 inch width; and a minimum 13 mm 1/2 inch to a maximum 50 mm 2 inch length.

2.2.3 Wear Surface

Wear surfaces consist of the following: a poured-in-place durable, weather-resistant, ultraviolet stable, water permeable material top-coat; an integral component of a tile system; synthetic turf wear surface; rubber sheet wear surface; or a polyethylene woven plastic sheet wear surface. The wear surface must meet requirements of ASTM D2047 for a minimum 0.8 coefficient of friction.

2.2.3.1 Poured-in-Place Wear Surface

Poured-in-place wear surface consists of ethylene propylene diene monomer (EPDM) particles adhered with a polyurethane binder formulated to produce an even, uniform surface. Particles of EPDM must meet ASTM D412 for tensile strength and elongation, and contain a minimum 25 percent of rubber hydrocarbons. Particles of EPDM must be peroxide or sulfur cured in accordance with the manufacturer. Size of rubber particles must be between a minimum 1 mm 1/32 inch, and a maximum 3 mm 1/8 inch diameter. Binder must be between a minimum 16 percent and a maximum 21 percent total weight of rubber used in the wear surface, and must provide 100 percent coating of the particles. Wear surface must be a minimum 10 mm 3/8 inch thick. The wear surface must be porous.

2.2.3.2 Synthetic Turf Wear Surface

Synthetic turf wear surface must consist of nylon fibers a minimum 500 denier, or heavy face weight polypropylene fiber a minimum 5,000 denier;

and tufted construction conforming to ASTM F1015. Fibers in each roll must be from the same dye lot.

2.2.3.3 Rubber Sheet Wear Surface

Rubber sheet wear surface must consist of a smooth, uniform formulation of EPDM rubber granules bonded under pressure in the factory with polyurethane to form a continuous sheet, and must be a minimum 10 mm 3/8 inch thick. Up to a maximum 80 percent of the rubber may consist of SBR particles. Particle size must vary from a minimum 1 mm 1/32 inch to a maximum 5 mm 3/16 inch diameter.

2.2.3.4 Polyethylene Plastic Woven Sheet Wear Surface

Polyethylene plastic woven sheet wear surface must be lockstitched and meet the tear resistance test, ASTM D2261 and must have an accelerated ultra-violet degradation protection feature.

2.2.4 Synthetic Tile

Synthetic tile must be sized [as indicated] [_____]. Synthetic tile must be a factory-molded unit consisting of the following: combining impact attenuating substrate and wear surface meeting requirements specified for substrate and wear surface; or a dual-density, uniform material, the top portion of which must conform to wear surface requirements specified.

2.2.5 Color

****

NOTE: Specify the percentage of each color granule for a unified poured-in-place system. Recommend the overall color of the surfacing be light colors to reduce contact burn risk from solar heat buildup. An EPDM wear surface is preferred for color retention.

****

Submit [2] [_____] color charts displaying surfacing colors, color granule percentages and finishes. The color must be [as shown in Section 09 06 00 SCHEDULES FOR FINISHES] [as indicated] [_____]. An EPDM wear surface is preferred for color retention. Black or the following dark colored SBR wear surfaces retain heat and are not acceptable: color combinations containing more than 10 percent black; or color combinations averaging more than 10 percent dark colors.

2.2.6 Sealant

Sealant for tile or combined protective surface systems must be compatible with the protective surfacing, and must match the color of the wear surface.

2.2.7 Hardware

Hardware, anchors or fasteners must be corrosion resistant stainless steel or galvanized steel to anchor the surfacing system securely, in accordance with manufacturer's instructions. Hardware must provide or be recessed to provide a flat surface and must be covered by the required depth of protective surfacing.

2.2.8 Binder

Binder for synthetic surfacing must be nontoxic, weather-resistant, ultraviolet stable, non-hardening, and retaining impact-attenuating performance. It must be 100 percent solids containing polyurethane, methylene diphenel isocyanate (MDI), or as recommended by the manufacturer. The use of toluene diphenel isocyanate (TDI) must not exceed 2 percent. Weight of polyurethane must be between a minimum 1.02 kg/L 8.5 lbs/gal and a maximum 1.14 kg/L 9.5 lbs/gal. Coloring pigments must be inorganic oxides.

2.2.9 Adhesive

Provide a two component polyurethane adhesive as recommended by the manufacturer.

2.2.10 Containment Curbs

Containment curbs include the following: treated wood, concrete, recycled plastic, or recycled plastic molded as lumber. Containment curbs must provide a smooth and hazard-free transition from the protective surfacing to the adjacent surface. Curbs must be free of sharp vertical edges, protruding elements and trip hazards. Curbs must be as recommended by the manufacturer. Provide all edges with a minimum 13 mm 1/2 inch radius.

2.2.11 Transition Edge

The transition edge must be designed to maintain the protective surfacing performance, support the surfacing between changes of material, and must be concrete in accordance with paragraph CONCRETE CURB. The face of the edge to the subgrade must be covered with the impact attenuating surface and meet the requirements of paragraph CHILD SAFETY.

2.2.12 Combination System

Combination systems must consist of combined protective surfacing materials specified. Each component is a part of a manufactured surfacing system. Wear surface must be of the materials specified.

2.3 LOOSE-FILL SURFACING

Loose-fill surfacing installed in the use zone must consist of sand, gravel or wood by-products.

2.3.1 Sand

****

NOTE: Sand provides both a protective surface when installed to the recommended depth and play value as in deep digging. When selecting sand, the composition of fine to coarse particles becomes a factor as sand compresses from rainfall. Compressed sand no longer meets impact attenuation for the fall height specified. Also, sand is displaced from running, digging or dragging activities, requiring replenishment on a daily basis to maintain impact attenuation performance. "Uniformly graded" sand is to be specified as it has less tendency to compact than "well graded" sand. The specified sieve sizes

provide a range of passing percentages that meet paragraph CHILD SAFETY requirements. The range of sieve sizes provided give a sand composition that is locally available and reduce custom mixing.

In accordance with the US Army Community and Family Support Center (CFSC-FSCY) requirements for the Army developmental play program, sand is a required play element and must not be eliminated from the play area.

****

Submit sieve test results. Sand must be uniformly graded, washed, free of dust, clay, dirt, hazardous substances, or foreign objects. Sand particles must be rounded naturally or by mechanical means and sieved in accordance with ASTM C136/C136M to be in the following gradation range.

SIEVE SIZE, mm	PERCENT PASSING
2.36 No. 8	100
1.18 No. 16	80-100
0.60 No. 30	40-75
0.30 No. 50	0-25
0.15 No. 100	less than 2

2.3.2 Gravel

Gravel must be washed, free of dust, clay, dirt, hazardous substances or foreign objects. Gravel particles must be rounded naturally or by mechanical means and sieved in accordance with ASTM C136/C136M to be in the following gradation range.

SIEVE SIZE, mm	PERCENT PASSING
12.5 1/2 inch	100
9.5 3/8 inch	75-85

2.3.3 Wood By-Products

Wood by-products include wood mulch and engineered wood fiber. Wood by-products must be free of sharp or foreign objects or toxic chemicals; poisonous plant material; protrusions; or hazardous material; provide information regarding composition, source, and particle size. Wood by-products manufactured from recycled pallets or lumber containing nails or metal fasteners must be rejected.

2.3.3.1 Wood Mulch

Wood mulch must be untreated chipped bark or untreated chipped tree prunings a maximum 40 mm 1-1/2 inches long and must be free of twigs, leaves, branches, thorns, dirt, grass, yard clippings, soil, or poisonous plants.

2.3.3.2 Engineered Wood Fiber

Engineered wood fiber manufactured for the purpose of protective surfacing must consist of particles varying from a minimum 3 mm 1/8 inch wide to a maximum 13 mm 1/2 inch thick; and a minimum 25 mm 1 inch wide to a maximum 75 mm 3 inches long.

2.4 GEOTEXTILE FABRIC

Geotextile fabric consists of the following: nonwoven polypropylene sheet; nonwoven 100 percent polyester sheet; or nonwoven needle punched polyester sheet composed of recycled polyester resins.

2.5 RECYCLED PLASTIC

****

NOTE: Plastic lumber used for landscaping timbers and posts is an EPA designated product for recycled content. Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. A resource that can be used to identify products with recycled content is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov. Other products with recycled content are also acceptable when meeting all requirements of this specification.

Research shows products are available among US national manufacturers meeting the minimum recycled content of the percentage listed.

****

Provide the estimated percentage of recovered material content in the material and components; and life-cycle durability. Submit individual component and assembled unit structural integrity test; creep tolerance; deflection tolerance; and vertical load test results; and life-cycle durability. Recycled plastic must contain a minimum 85 percent of recycled content.

2.5.1 High Density Polyethylene

The material must be molded of ultraviolet (UV) and color stabilized polyethylene; and consist of a minimum 75 percent plastic profile of high-density polyethylene, low-density polyethylene, and polypropylene raw material. The material must be non-toxic and have no discernible contaminants such as paper, foil, or wood. The material must contain no more than 3 percent air voids. The material must be free of splinters, chips, peels, buckling, and cracks. Material must be resistant to deformation from solar heat gain. Material must have factory-drilled holes. Components with extra holes not filled by hardware or covered by other components must be rejected. The material must not be painted.

2.5.2 Structural Component

Recycled plastic materials will not be used as load bearing structural members.

2.5.3 Recycled Plastic Molded As Lumber

****

NOTE: Recycled plastic molded as lumber and wood-polymer lumber are susceptible to both creep and deflection; therefore, it cannot be used for a load bearing structural member of protective surfacing systems. To overcome creep and deflection, the product is increased in volume of material and dimension.

****

The component deflection must not exceed 1/360 of the span of the frame when exposed to a uniform live load of 585 N/m 40 lbs/ft. The product must meet the structural integrity test requirements set forth in ASTM F1487 and ASTM D6112.

2.6 CURBS

2.6.1 Concrete Curb

Concrete curbs must conform to Section 32 16 19 CONCRETE CURBS, GUTTERS AND SIDEWALKS.

2.6.2 Wood

2.6.2.1 Wood Components

Wood components must be exterior premium grade and free of knots. Wood components must have factory-drilled holes. Components with extra holes not filled by hardware or covered by other components must be rejected.

2.6.2.2 Wood Treatment

Wood components that are not naturally rot and insect resistant must be treated to resist rot and insect attack by using standard treatment procedures. Provide wood treatment chemical content, toxicity level, and life-cycle durability. Any wood placed up to a maximum 150 mm 6 inches above, or any portion below the top elevation of the protective surfacing, must be treated after fabrication. Creosote, pentachlorophenol, and tributyl tin oxide are prohibited according to ASTM F1487.

PART 3 EXECUTION

3.1 SITE PREPARATION

****

NOTE: Provide positive drainage for the proper functioning of protective surfacing. Ensure a minimum 2 percent slope is provided for the protective surfacing subgrade. Ensure ponding at the perimeter does not occur. To ensure proper drainage, provide a percolation test to establish the requirement for a subdrainage system.

****

Prior to installing the protective surfacing, verify the playground equipment and site furnishings are installed in accordance with Section 11 68 13 PLAYGROUND EQUIPMENT, and Section 12 93 00 SITE FURNISHINGS.

3.1.1 Finished Grade and Underground Utilities

Submit finished grade, underground utilities, storm-drainage system and irrigation system status; and location of underground utilities and facilities. Verify that finished grades are as indicated; the smooth grading has been completed in accordance with Section 31 00 00 EARTHWORK; installation of the underground utilities through the area has been completed in accordance with Section 31 00 00 EARTHWORK; installation of the storm-drainage system through the area has been completed in accordance with Section 33 40 00 STORMWATER UTILITIES; and the installation of underground sprinklers through the area has been completed in accordance with Section 32 84 24 UNDERGROUND SPRINKLER SYSTEMS. The location of underground utilities and facilities in the area of the operation must be verified. Damage to underground utilities and facilities must be repaired at the Contractor's expense.

3.1.2 Layout

The layout of the entire use zone perimeter must be staked before excavation begins. The location of all elements must be staked to include the following: All play event configuration access and egress points; and use zone perimeters. The use zone is defined as the area beneath and immediately adjacent to a play structure or equipment that is designated for unrestricted circulation around equipment; and on whose surface it is predicted that a user would land when falling from or exiting the equipment. Also, the use zone is associated with the following terms; "Clear Area," and "Fall Zone". The use zone must be free of hard surfaces, objects or obstacles that a child could run into or fall on top of and be injured. Use zone perimeters must not overlap hard surfaces. The use zone perimeter must meet or exceed the requirements of paragraphs CHILD SAFETY and CHILD ACCESSIBILITY. Use zone perimeters must not overlap except for certain play events as defined in ASTM F1487.

3.1.3 Obstructions Below Ground

When obstructions below ground affect the work, shop drawings showing proposed adjustments must be provided.

3.1.4 Percolation Test

Submit a certified report of inspection, test method used and compliance with recognized test standard must be described. A test for percolation must be done to determine positive drainage, to include the lowest elevation of the subgrade in the areas containing the following: sand; gravel; wood by-products; or synthetic surfacing installed over a pervious base. A positive percolation must consist of a minimum 25 mm 1 inch per 3 hour period. When a negative percolation test occurs, a shop drawing must be provided to indicate the corrective measures.

3.1.5 Substitution

Under no circumstances are substitutions to be allowed or protective surfacing to be selected without written approval from the technical representative. Evaluate manufacturer substitutions for the critical height value with meeting the site conditions and paragraph FALL HEIGHT.

3.1.6 Subgrade

Correct subgrade irregularities to ensure the required depth of protective surfacing is provided. The subgrade elevation must be as required by the manufacturer.

3.1.7 Subsurface

Install the subsurface in a true, even plane, and sloped to provide positive drainage as indicated.

3.1.8 Subbase

Tolerance of the concrete or bituminous subbase must be within a maximum 6 mm in 3 m 1/4 inch in 10 feet. Tolerance of aggregate subbase must be within a maximum similar to 6 mm in 3 m 1/4 inch in 10 feet. Compact aggregate subbase to a maximum 95 percent, ASTM D1557. The compaction must be completed in accordance with Section 31 00 00 EARTHWORK. Sand, gravel, and wood products must not be installed over a concrete, aggregate, or bituminous subbase, in accordance with paragraph CHILD SAFETY.

3.1.9 Concrete or Bituminous Curing

Bituminous or concrete subbase must be cured [a minimum of 7 days] [in accordance with the manufacturer's requirements]. Curing compounds and other deleterious substances that adversely affect adhesion must be removed. Surface must be clean and dry.

3.1.10 Fall Height

****

NOTE: To determine the required depth of protective surfacing, the fall height; maximum equipment height dimensions; and spot elevations for each play event must be shown on the drawings.

****

3.1.10.1 General Requirements

The fall height is defined as the vertical distance between the finished elevation of the designated play surface and the finished elevation of the protective surfacing beneath it. For some play events the fall height and platform height are the same, while for other play events the fall height and maximum equipment height are the same, Section 11 68 13 PLAYGROUND EQUIPMENT. When the furnished play event fall height varies from the play event shown, shop drawings must be provided defining the revised depth or type of protective surfacing to meet or exceed the requirements of paragraphs CHILD SAFETY and CHILD ACCESSIBILITY.

3.1.10.2 Measuring Fall Height

EQUIPMENT	MEASURING FALL HEIGHT
Composite Equipment Structure	For a platform surrounded by protective barriers, measure from the platform finished elevation.
	For a platform surrounded by guardrails, measure from the guardrail top elevation.
Infant Crawl Area	A maximum 600 mm 24 inches height, measured from the crawl wall or barrier finished elevation.
Playhouse, Nonclimbable	Measure from the designated play surface finished elevation.
Spring Rocking Equipment	Measure from the seat top elevation.
Stationary Equipment, Climbable	Measure from the maximum equipment height finished elevation.
Stationary Equipment, Nonclimbable	Measure from the designated play surface finished elevation.
Swing	Measure from the bottom of the pivot point.

3.2 INSTALLING SYNTHETIC SURFACING SYSTEM

Surfacing edges must fully adhere to the subsurface. Fully cover the subsurface to ensure no hard surfaces are exposed through displacement of loose fill. Rolled or beveled containment curb or transition edges must maintain the full thickness required to meet paragraphs CHILD SAFETY and CHILD ACCESSIBILITY. Material must cover foundation and cutouts around elements penetrating the surface. Seams must be the minimum necessary and must be tight.

3.2.1 Temperature Limitation

Provide temperature limitations for applying adhesive.

3.2.2 Poured-in-Place System

Components of the poured-in-place system must be mixed mechanically on site in accordance with manufacturer's recommendations. Hand-mixing is prohibited. Installation of poured-in-place surfacing must be seamless and completely bonded to subsurface. Material must cover foundations and must be tight around elements penetrating the surface. Add a minimum 2 mm 1/16 inch depth to the required surfacing depth to ensure the full depth of material is installed to meet paragraph CHILD SAFETY.

3.2.2.1 Geotextile Fabric for Poured-In-Place

Install geotextile fabric over a compacted aggregate base as indicated. Fabric must cover the entire area and must be lapped a minimum 100 mm 4 inch width at the seams. Seams must be adhered in accordance with manufacturer's recommendations. The aggregate base must be free of ruts or protruding objects. The fabric must be installed smooth; and free of tensile stresses, folds, and wrinkles. The fabric must be protected from clogging, tears, or other damage. Damaged fabric must be repaired or replaced as directed.

3.2.2.2 Poured-in-Place Substrate

The substrate layer of the poured-in-place system must be installed in one continuous pour on the same day. When a second pour is required, the edge of the previous work must be fully coated with polyurethane binder to ensure 100 percent bond with new work. Adhesive must be applied in small quantities so that new substrate can be placed before the adhesive dries.

3.2.2.3 Poured-in-Place Wear Surface

Wear surface must be bonded to substrate. Adhesive must be applied to substrate in small quantities so that wear surface can be applied before adhesive dries. Surface must be hand troweled to a smooth, even finish. When wear surface is composed of different color patterns, pour must be continuous and seamless. When seams are required due to color change or field conditions, the adjacent wear surface must be placed as soon as possible, before initial pour has cured. The edge of initial pour must be coated with adhesive and wear surface mixture must be immediately applied.

3.2.3 Tile System

Tile must be laid out to ensure that end cuts are equal. Tile must be installed in accordance with manufacturer's instructions. Hardware must be as recommended by the manufacturer. Tile must be bonded to the subsurface with an adhesive approved by the manufacturer. Cutouts must be filled with sealant according to manufacturer's instructions to eliminate voids at equipment. Sealant must be the minimum amount necessary, must not exceed a maximum 10 mm 3/8 inch width. Where excessive voids occur at cutouts, tile must be removed and refitted. The tile system must be installed throughout the play equipment use zone with the proper thickness.

3.2.4 Combination System

The combination system must consist of [modular impact attenuating substrate units, adhered to form a unified system], [shredded rubber tires over a gravel substrate] [_____]. The substrate must be covered with a wear surface as specified. Cutouts around equipment must be properly filled and sealed according to manufacturer's instructions to eliminate voids. Sealant must be the minimum amount necessary, must not exceed a maximum 10 mm 3/8 inch width. Where excessive voids occur at cutouts, the modular substrate must be removed and refitted. Construction methods must be employed to ensure full depth installation of specified surfacing material and the finished wear surface.

3.2.4.1 Geotextile Fabric

Geotextile fabric must be installed where a modular or shredded rubber substrate is installed over an aggregate base. It should be installed with poured-in-place wear surface or polyethylene plastic woven sheet wear surface installed over substrate. Fabric must cover the entire area to receive the tile system and must be lapped a minimum 100 mm 4 inch width at the seams. Seams must be adhered in accordance with manufacturer's recommendations.

3.2.4.2 Modular Substrate

Modular substrate must be laid out to minimize small end pieces. The substrate must be installed in accordance with manufacturer's instructions.

3.2.4.3 Poured-in-Place Substrate

Same as paragraph POURED-IN-PLACE SYSTEM.

3.2.4.4 Synthetic Turf Wear Surface

Wear surface must be bonded to substrate with 100 percent solids polyurethane adhesive. Surface irregularities and wrinkles must be corrected. Seams must be secured in accordance with manufacturer's recommendations. Wear surface roll width must be as wide as practical for the installation.

3.2.4.5 Rubber Sheet Wear Surface

Wear surface must be bonded to substrate with 100 percent solids polyurethane adhesive. Surface irregularities and wrinkles must be corrected. Seams must be secured in accordance with manufacturer's recommendations. Wear surface roll width must be as wide as practical for the installation.

3.2.4.6 Poured-in-Place Wear Surface

Same as paragraph POURED-IN-PLACE SYSTEM.

3.2.4.7 Polyethylene Plastic Woven Sheet Wear Surface

Wear surface must be securely anchored to a perimeter containment material with hardware in accordance with the manufacturer's instructions. Hardware must be appropriate for the type of system and secured to eliminate protrusions.

3.3 LOOSE FILL SURFACING SYSTEM

Submit a minimum 0.003 cubic m 0.125 cubic foot sample.

3.3.1 Sand Surfacing System

Sand must be installed over a compacted subgrade at a minimum 450 mm 18 inches depth throughout the use zone. The finished elevation of sand must be determined after sand has been settled by saturating with water and percolating. The sand depth in high play activity areas must be as indicated. Sand must meet the requirements of paragraph CHILD SAFETY.

3.3.2 Gravel Surfacing System

Gravel must be installed over a compacted subgrade at a minimum 300 mm 12 inch depth throughout the use zone. The depth of gravel in high play activity areas must be as indicated. Gravel must meet the requirements of paragraph CHILD SAFETY.

3.3.3 Wood By-Product Surfacing System

Engineered wood fiber protective surfacing must be installed according to manufacturer's instructions. Wood products must meet the requirements of paragraph CHILD SAFETY.

3.3.3.1 Wood Mulch Surfacing System

Wood mulch must be installed over a compacted subgrade covered with geotextile fabric. Wood mulch must meet the requirements of paragraph CHILD SAFETY.

3.3.3.2 Engineered Wood Fiber Surfacing System

Engineered wood fiber protective surfacing must be installed according to manufacturer's instructions. The surfacing must meet the requirements of paragraphs CHILD SAFETY and CHILD ACCESSIBILITY.

3.3.3.3 Geotextile Fabric for Wood By-Product

Geotextile fabric must cover the entire area and must be lapped a minimum 100 mm 4 inch width at the seams. Seams must be adhered in accordance with manufacturer's recommendations. Folds, wrinkles, or loose fabric must be smoothed. Fabric must be protected from damage during wood product placement.

3.3.3.4 Minimum Depth for Wood By-Product

Wood by-product must be installed at a minimum 300 mm12 inch depth throughout the use zone. The depth of wood products in high play activity areas must be as indicated.

3.4 RESTORATION AND CLEAN UP

When the operation has been completed, clean up and protect the site. Existing areas that have been damaged from the operation must be restored to original condition at the Contractor's expense.

3.4.1 Clean Up

The site and play events must be cleaned of all materials associated with the operation. Play events and surfaces must be cleaned of dirt, stains, filings, and other blemishes occurring from shipment and installation. Cleaning methods and agents must be as recommended by the manufacturer.

3.4.2 Protection

The area must be protected as required or directed by providing barricades and signage. Signage must be in accordance with Section 10 14 00.10 EXTERIOR SIGNAGE.

3.4.3 Disposal of Materials

Excess and waste material must be removed and disposed of off Government property.

3.5 PROTECTIVE SURFACING ACCEPTANCE

Submit record of measurements and findings by the certified playground safety inspector. When the protective surfacing is installed, the play events and protective surfacing must be thoroughly inspected and measured to verify the playground meets manufacturer's recommendations, paragraphs CHILD SAFETY and CHILD ACCESSIBILITY, and paragraph FALL HEIGHT as follows: 1) secure anchoring; 2) all hardware and connectors are tight and below the wear surface; 3) sharp points, edges, and protrusions; 4) entanglement; and

5) pinch, crush, and shear points.

a. Measure use zone distances to determine the area is free of hard surfaces, objects or obstacles. Determine exceptions to use zone overlaps occur in accordance with ASTM F1487. Measure play event fall height and compare to critical height value for the thickness of installed synthetic surfacing. Measure play event fall height and depth of loose fill protective surfacing.

b. Ensure installed chopped tire material is free from steel belts. Ensure the slide exit region has the required clear zone. Swing seat clearances are measured while occupied by a maximum user for the age group using the equipment.

c. The finished installation must have the appearance of a single covering. Protective surfacing that does not comply must be reinstalled. Hardware that does not comply must be replaced. Ensure positive drainage for the area and the lowest elevation of protective surfacing subgrade has been provided.

d. A written report describing the results of the evaluation must be provided.

3.6 RE-INSTALLATION

When re-installation is required, the following must be accomplished at no additional cost to the Government re-install the product as specified; provide new replacement materials supplied by the manufacturer; repair any damage caused by the failed installation.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 31 13 (November 2021)**

Preparing Activity: AFCEC **Superseding**
UFGS-32 31 13 (November 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-32 31 13 (November 2021)**

Preparing Activity: AFCEC **Superseding**
UFGS-32 31 13 (November 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 31 13

CHAIN LINK FENCES AND GATES

11/21

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NOTE: This guide specification covers the requirements for steel fencing, including posts, fabric, gates, and miscellaneous accessories. Colored fabric and accessories may be used if required. Edit specifications to suit the project scope.

Use Section 32 31 13.53 HIGH-SECURITY CHAIN LINK FENCES AND GATES when covering the requirements for chain link fence for high security applications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This Guide Specification and UFC 4-022-03 use the most generic term "zinc coating" in order not to conflict with requirements contained within referenced standards. The term "zinc coatings" encompasses a wide range of metallic and organic coatings including hot dip galvanizing, zinc plating, electroplating (sometimes called "electro-galvanizing"), metallizing, inorganic zinc paints and organic zinc paints. Detailed zinc

coating requirements for fencing components are called out in various references such as ASTM standards.

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NOTE: Select fencing materials throughout this Guide Specification as appropriate to protect against corrosion. Refer to the Corrosion Prevention & Control (CPC) Fencing Knowledge Area webpage on the Whole Building Design Guide website for additional information on making these selections (https://www.wbdg.org/ffc/dod/cpc-source/fencing-knowledge-area). This website contains a link to a Life Cycle Cost Analysis that was conducted for the DoD to identify the lowest cost materials over the service life of a fencing system.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A392	(2011; R 2022a) Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A491	(2011; R 2022) Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A780/A780M	(2020) Standard Practice for Repair of

	Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A824	(2001; R 2022) Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM F567	(2023) Standard Practice for Installation of Chain Link Fence
ASTM F626	(2014; R 2023) Standard Specification for Fence Fittings
ASTM F668	(2017; R 2022) Standard Specification for Polyvinyl Chloride (PVC) and Other Polymer-Coated Steel Chain Link Fence Fabric
ASTM F883	(2013; R 2022) Standard Performance Specification for Padlocks
ASTM F934	(2016; R 2022) Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials
ASTM F1043	(2018; R 2022) Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
ASTM F1183	(1996; R 2017) Standard Specification for Aluminum Alloy Chain Link Fence Fabric
ASTM F1345	(2010a; R 2019) Standard Specification for Zinc-5 percent Aluminum-Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric
ASTM F1664	(2008; R 2022) Standard Specification for Poly(Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G154	(2023) Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials
ASTM G155	(2021) Standard Practice for Operating

	Xenon Arc Lamp Apparatus for Exposure of Materials

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-F-191/1	(Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Fabric)
FS RR-F-191/2	(Rev E) Fencing, Wire and Post, Metal (Chain-Link Fence Gates)
FS RR-F-191/3	(2023; Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces)
FS RR-F-191/4	(Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fence Assembly; G, [_____]

Location of Gate, Corner, End, and Pull Posts; G, [_____]

Gate Assembly; G, [_____]

Gate Hardware and Accessories; G, [_____]

Erection/Installation Drawings; G, [_____]

SD-03 Product Data

Fence Assembly; G, [_____]

Gate Assembly; G, [_____]

Gate Hardware and Accessories; G, [_____]

Zinc Coating; G, [_____]

PVC Coating; G, [_____]

Aluminum Alloy Coating; G, [_____]

Fabric; G, [_____]

Stretcher Bars; G, [_____]

Concrete; G, [_____]

SD-04 Samples

Fabric; G, [_____]

Posts; G, [_____]

Braces; G, [_____]

Line Posts; G, [_____]

Sleeves; G, [_____]

Top Rail; G, [_____]

Bottom Rail; G, [_____]

Tension Wire; G, [_____]

Stretcher Bars; G, [_____]

Gate Posts; G, [_____]

Gate Hardware and Accessories; G, [_____]

[Padlocks; G, [_____]

] Wire Ties; G, [_____]

SD-07 Certificates

Certificates of Compliance

SD-08 Manufacturer's Instructions

Fence Assembly

Gate Assembly

Hardware Assembly

Accessories

SD-11 Closeout Submittals

Recycled Material Content[; S]

1.3 QUALITY CONTROL

1.3.1 Certificates of Compliance

Submit certificates of compliance in accordance with the applicable reference standards and descriptions of this section for the following:

a. Zinc coating

b. PVC coating

c. Aluminum alloy coating

d. Fabric

e. Stretcher bars

f. Gate hardware and accessories

g. Concrete

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit reports of listing chain-link fencing and accessories regarding weight in grams ounces for zinc coating[, thickness of PVC coating][, and chemical composition and thickness of aluminum alloy coating].

Submit manufacturer's catalog data for complete fence assembly, gate assembly, hardware assembly and accessories.

2.2 FENCES

2.2.1 Fabric

****

NOTE: Coordinate type of fabric with project requirements. The five types of fabric are not necessarily equivalent. Standard selvage treatment for fabric 1.52 m 60 inches and less is knuckled at both selvages. Use either Type II aluminum-coated steel fabric or Type IV Class 2b (fused and adhered) PVC-coated over zinc- or aluminum-coated steel fabric for project locations with Environmental Severity Classifications (ESC) C3 thru C5; ESC C1 and C2 locations can use other options. Use Type IV Class 2b PVC-coated over zinc-coated steel fabric in areas where coatings are prone to abrasion from blowing sand. It should be noted that DoD research has shown Type I (zinc-coated steel) to have lower first costs but significantly higher life-cycle costs in corrosive environments; when using Type I in ESC C1 and C2 locations, use 610 grams per square meter (2.0 ounces per square foot) of zinc coating for C2 project locations or where localized corrosive conditions are present or have been observed. See UFC 1-200-01 for determination of ESC for project locations.

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NOTE: Choose core wire gauge and mesh size appropriate for the design. Gauges are not the same for all materials. Most common applications can utilize a 9 gauge wire with 50 mm 2 inch mesh. Thicker gauges and smaller mesh sizes may be required for higher or heightened security zones such as an installation perimeter or restricted area fence. Fences around recreational areas may require smaller mesh sizes, such as tennis courts requiring a 44 mm 1-3/4 inch mesh; swimming pool areas and playgrounds may also require a smaller mesh opening. The use of thicker gauges increase the difficulty of cutting the fabric, and smaller mesh fabric is more difficult to climb. PVC coating of fencing for certain security applications and grounded fencing requires detailed design and specifying.

****

FS RR-F-191/1; Type [II, aluminum-coated steel, [9][_____] gauge, conforming to ASTM A491] [IV, Class 2b polyvinyl chloride (PVC) coated over zinc- or aluminum-coated steel, [9][_____]-gauge core wire size, conforming to ASTM F668. Color to be [dark green][olive green][brown][black] complying with ASTM F934.][I, zinc-coated steel, [9][_____] gauge conforming to ASTM A392, with [610] [370] gram per square meter [2.0] [1.20] ounces per square foot of coated surface] [III, aluminum alloy, [9][_____] gauge, conforming to ASTM F1183, alloy 6061-T94] [or] [V, Zinc-5% aluminum-mischmetal alloy coated steel wire, [9][____] gauge, conforming to ASTM F1345, with [183] [305] gram per square meter [0.6]

[1.0] ounces per square foot alloy coating]. Provide selvage [knuckled at one selvage and twisted and barbed at the other] [twisted and barbed at both selvages] [knuckled at both selvages]. Height of fabric, as indicated.

Provide fabric consisting of wires woven into a [25] [45] [50] millimeter [1 inch] [1-3/4 inch] [2 inch] diamond mesh. Provide one-piece fabric widths for fence heights up to[3658 millimeter 12 feet][_____].

2.2.1.1 Top and Bottom Selvages

Provide knuckled selvages at top and bottom for fabric with 51 millimeter 2 inch mesh and up to 1524 millimeter 60 inches high, and if over 1524 millimeter 60 inches high, provide [twisted and barbed top selvage and knuckled bottom selvage] [twisted and barbed on both selvages].

Knuckle top and bottom selvages for 45 millimeter and 25 millimeter 1-3/4 inch and 1 inch mesh fabric.

2.2.2 Posts

****

NOTE: Use either Class 2 aluminum pipe or include PVC coating on zinc-coated steel pipe posts and railings in locations with ESC C3 thru C5, and high humidity locations. When specifying steel pipe posts, use Grade A pipe which has the heavier zinc-coated interior in locations with ESC C3 thru C5, and high humidity locations. Also use Grade A steel pipe where steel posts are buried in direct contact with soil, regardless of the ESC of the project location. Grade A or Grade B steel pipe may be used in locations with ESC C1 or C2 and in low humidity locations, provided Grade B pipe meets the salt spray test. High humidity locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. Where aluminum-coated steel fabric is used, use Class 2 aluminum pipe. In areas where coatings are prone to abrasion from blowing sand, use PVC coating on zinc-coated steel pipe posts and railings. Allow as many of the pipe type options as possible consistent with functional requirements, ESC location requirements, and other local corrosion conditions. Allow Class 3, formed steel sections as an alternative if no other requirements prohibit their use on a particular job; however, formed steel sections may prohibit the use of PVC coatings. Certain security applications using intrusion detection sensors use steel pipe framework only.

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NOTE: Steel pipe is available in two grades: A or B. Grade A is zinc-coated with 0.54 kg per square meter 1.8 ounces per square foot of zinc. Grade B consists of a zinc-coating with 0.27 kg per square meter 0.9 ounce per square foot, a chromate conversion coating, followed by a clear acrylic or

polyester coating. The acrylic or polyester coatings used on Grade B pipe should not be confused with optional polyvinyl chloride (PVC) coatings available for framework.
****

2.2.2.1 Metal

2.2.2.1.1 Line Posts

****
NOTE: For Class I, grades A and B zinc-coated steel pipe, select "Regular Strength" when standard schedule 40 steel with a 207 MPa 30,000 psi yield strength is sufficient; select "High Strength" when the fence posts require 345 MPa 50,000 psi yield strength.
****

Provide line posts complying with FS RR-F-191/3. Provide [Class 1, steel pipe, Grade [[A][or][B], [Regular Strength][High Strength]]][Class 2, aluminum pipe] [Class 3, formed steel sections] [Class 4, steel H sections] or [Class 5, aluminum H sections], in [minimum sizes listed in FS RR-F-191/3 for each class and grade] [size [_____]].

2.2.2.1.2 End, Corner and Pull Posts

Provide end, corner, and pull posts in [minimum sizes listed in FS RR-F-191/3 for each class and grade] [size [_____]]. Provide [Class 1, steel pipe, Grade [A [Regular Strength][High Strength]] [or] [B]], [Class 2, aluminum pipe], [Class 6, steel square sections] [or Class 7, aluminum square sections].

[2.2.2.1.3 Steel Pipe, Class 1, Grade B Test Requirements

****
NOTE: Include this subparagraph when Class 1, Grade B pipe is included, or allowed for use, in the project.
****

Steel pipe, Class 1, Grade B meeting the following performance criteria when subjected to salt spray testing in accordance with ASTM B117:

a. Exterior: 1,000 hours with maximum 5 percent red rust.

b. Interior: 650 hours with maximum 5 percent red rust.

][2.2.2.1.4 PVC Coating on Posts and Rails

****
NOTE: Include this subparagraph when PVC Coating is required on zinc-coated posts. Include PVC coating where zinc-coated steel pipe posts and railings are used in locations with ESC C3 thru C5, and high humidity locations. Additionally, in areas where coatings are prone to abrasion from blowing sand, use PVC coating on zinc-coated steel pipe posts and railings.

****

Provide PVC color coating, minimum thickness, 0.25 mm 0.01 inch fused and adhered to the exterior coating of the posts and rails in accordance with ASTM F1043; color to match fabric in accordance with ASTM F934.

][2.2.2.2 Composite Posts

****

NOTE: Consider as alternative to PVC coated fence posts in project locations with ESC C4 or C5. See UFC 1-200-01 for determination of ESC for project locations. Designer must ensure these are readily available in the local area in the sizes needed for the project before specifying. Since posts are non-conductive, fence grounding procedures need to be detailed where grounding of the fence is required.

****

Produce resin reinforced posts from polyester or epoxy resin, reinforced with E-glass and filler material. Provide posts that meet the ASTM F1043 bending strength for heavy industrial fencing, and filled with 20 MPa 3,000 psi concrete. Protect posts from UV degradation by a veil of polyester cloth impregnated with resin and an acrylic based 1.46 mm 1.5 mil DFT coating system. The post can exhibit no structural failure (less than 10 percent loss of strength) as a result of exposure to moisture and UV lamps per ASTM G152, ASTM G153, ASTM G155, and ASTM G154, (3600 hours). Provide posts in color to match fabric. [Provide outside diameter as specified in FS RR-F-191/3 for round steel pipe.]

]2.2.2.3 Post Tops

****

NOTE: Use aluminum top where posts are aluminum. Include steel requirements where used. Include PVC coating where posts and rails are coated.

****

Provide [steel, wrought iron, or malleable iron][aluminum] tops [with PVC coating of minimum thickness of 0.152 mm 0.006 in] and designed as a weathertight closure cap. Post top to have finish and coating matching rails and posts.[Steel type to be pressed steel galvanized after fabrication having a minimum zinc coating of 366 grams per square meter 1.20 ounces per square foot.][Provide resin reinforced tops for resin reinforced posts.] Provide one cap for each post, unless equal protection is provided by a combination post-cap and wire supporting arm. Provide caps with an opening to permit through passage of the top rail.

2.2.3 Braces[and Rails]

****

NOTE: For rails and braces, use minimum sizes specified in FS RR-F-191/3 for each class and grade unless members are to be oversized. Use the same materials for braces and rails. For fences, use a top tension wire or a top rail, and a bottom tension wire or a bottom rail; where rails are utilized, include the "and rails" phrasing in the title of this paragraph.

****

****
NOTE: For Class I, grades A and B zinc-coated steel pipe, select "Regular Strength" when standard schedule 40 steel with a 207 MPa 30,000 psi yield strength is sufficient; select "High Strength" when 345 MPa 50,000 psi yield strength is required.
****

Class [1, steel pipe, Grade [[A][or][B], [Regular Strength][High Strength]]] [2, aluminum pipe] or [3, formed steel sections], in [minimum sizes listed in FS RR-F-191/3 for each class and grade] [size [_____]]. [Provide PVC color coating, minimum thickness, 0.25 mm 0.01 inch in accordance with ASTM F1043; color to match fabric in accordance with ASTM F934.]

2.2.3.1 Top Rail

Provide top rail conforming to minimum sizes specified in FS RR-F-191/3 for each class and grade unless members are to be oversized. Provide expansion couplings 150 millimeter 6 inches long at each joint in top rails.

[2.2.3.2 Center Rails Between Line Posts

****
NOTE: Center rails are not normally required for fencing less than 1829 millimeter 6 feet high. Edit as required.
****

Provide center rail conforming to minimum sizes specified in FS RR-F-191/3 for each class and grade unless members are to be oversized.

][2.2.3.3 Bottom Rail

****
NOTE: Fence design includes either a bottom tension wire or a bottom rail. Delete this paragraph if fence design does not include a bottom rail.
****

Provide bottom rail conforming to minimum sizes specified in FS RR-F-191/3 for each class and grade unless members are to be oversized.

]2.2.3.4 Post-Brace Assembly

Provide bracing conforming to minimum sizes specified in FS RR-F-191/3 for each class and grade, and 10 millimeter 3/8 inch adjustable truss rods and turnbuckles.

2.2.4 Wire Ties

****
NOTE: Choose the same size for wire ties as the fabric wire.
****

Provide[2.9 millimeter 9-gauge][2.3 millimeter 11-gauge][_____] wire for tying fabric to line posts,spaced 300 millimeter 12 inches on center. For tying fabric to rails and braces, space wire ties 600 millimeter 24 inches on center. For tying fabric to tension wire, space 2.7 millimeter 0.105-inch hog rings 600 millimeter 24 inches on center. Manufacturer's standard procedure will be accepted if of equal strength and durability.

FS RR-F-191/4. Provide wire ties constructed of the same material and coating as the fencing fabric.

2.2.5 Sleeves

Provide sleeves for setting into concrete construction of the same material as post sections, sized 25 millimeter 1 inch greater than the diameter or dimension of the post. Weld flat plates to each sleeve base to provide anchorage and prevent intrusion of concrete.

2.2.6 Stretcher Bars

Provide bars that have one-piece lengths equal to the full height of the fabric with a minimum cross section of 5 by 20 millimeter 3/16 by 3/4 inch, in accordance with ASTM F626.

2.2.7 Stretcher Bar Bands

Provide bar bands for securing stretcher bars to posts that are steel, wrought iron, or malleable iron spaced not over 381 millimeter 15 inches on center. Bands may also be used in conjunction with special fittings for securing rails to posts. Provide bands with projecting edges chamfered or eased.

2.2.8 Tension Wire

****

NOTE: Use tension wire material and coating to match fence fabric. Specify polyvinyl chloride (PVC) coated tension wire when PVC-coated fence fabric is used above.

****

Provide metallic coated steel marcelled tension wire,(No. 7-gauge) complying with ASTM A824.[Provide aluminum-coated (aluminized) steel wire with coating that weighs not less than 122 gram per square meter 0.4 ounces per square foot.][Provide PVC-coated tension wire of the same class and color as the fencing fabric complying with ASTM F1664.] [Provide zinc-coated steel wire with zinc coating that weighs not less than [370] [610] gram per square meter [1.2] [2.0] ounces per square foot.][Provide zinc-5% aluminum-mischmetal alloy coated steel wire, with [183] [305] gram per square meter [0.6] [1.0] ounces per square foot alloy coating.]

2.2.9 Miscellaneous Hardware

Provide miscellaneous hot-dip galvanized hardware as required.

2.3 GATES

****

NOTE: The gate frames and intermediate braces indicated are adequate for gate sizes less than or equal to 2.4 m 8 feet high and 4.3 m 14 feet wide.

Gate configurations larger than 2.4 m 8 feet high and 4.3 m 14 feet wide require special design consideration. Edit to provide gate framing and bracing member material and finish, to match those previously used for posts, rails and braces. Include PVC coating on steel latches, stops, hinges, keepers, and accessories where fence posts are also PVC coated; otherwise, use zinc coating (galvanized).

****

FS RR-F-191/2; Type [I, single swing] [II, double swing] [III, single cantilever sliding, wheel sliding gate] [IV, double cantilever sliding] [V, single overhead sliding] [VI, double overhead sliding] [VII, vertical lift] [VIII, special]. Shape and size of gate frame, [as indicated] [_____]. Framing and bracing members, [round][square] of [steel][aluminum] alloy. [Steel member finish, [zinc-coated] [or] [PVC-coated over zinc- or aluminum-coated steel].] Provide gate frames and braces of minimum sizes listed in FS RR-F-191/3 for each Class and Grade, except that steel pipe frames are a minimum of 48 mm 1.90 inches o.d., 3 mm 0.120 inches minimum wall thickness and aluminum pipe frames and intermediate braces are 47.5 mm 1.869 inches o.d. minimum, 1.4 kg per meter 0.940 lb/ft of length. [Provide intermediate members as necessary for gate leaves more than 2.4 m 8 feet wide, to provide rigid construction, free from sag or twist.] [Provide truss rods or intermediate braces for gate leaves less than 2.4 m 8 feet wide.]

2.3.1 Gate Posts

Provide gate posts for supporting each gate leaf in [minimum sizes listed in FS RR-F-191/3 for each material class and grade] [size [_____]]. Gate post material class, grade and finish to match other fence posts.

2.3.2 Gate Fabric

Gate fabric, is as specified for fencing fabric. Attach gate fabric to gate frame in accordance with manufacturer's standards, except that welding is not permitted.

2.3.3 Gate Frame

Provide gate frame assembly that is welded or assembled with special malleable or pressed-steel fittings and rivets to provide rigid connections. Install fabric with stretcher bars at vertical edges; stretcher bars may also be used at top and bottom edges. Attach stretcher bars and fabric to gate frames on all sides at intervals not exceeding 381 millimeter 15 inches. Attach hardware with rivets or by other means which provides equal security against breakage or removal.

[Provide special gate frames, [as indicated][_____].

]2.3.4 Gate Bracing

Provide diagonal cross-bracing, consisting of 10 millimeter 3/8 inch diameter adjustable-length truss rods on welded gate frames, where necessary to obtain frame rigidity without sag or twist. Provide nonwelded gate frames with diagonal bracing.

2.3.5 Padlocks

****
NOTE: Consult station regarding padlocks. Most stations will provide padlocks. If Contractor-furnished padlocks are required for certain security applications, a padlock conforming to an appropriate Military or Agency Specification may need to be specified. See referenced specification for types, grades, and options available.
****

Provide padlocks conforming to ASTM F883, with chain.

2.3.6 Gate Hardware and Accessories

Provide gate hardware and accessories that conforms to ASTM A392 and ASTM F626, and as specified. Coating for steel latches, stops, hinges, keepers, and accessories, is [galvanized] [PVC, minimum thickness of 0.25 mm 0.01 inch.]

a. Provide [malleable iron] [forged steel] [pressed steel] hinges to suit gate size, non-lift-off type, offset to permit 180-degree opening. Provide hinge with stainless steel pin.

b. Provide latch that permits accessibility and operation from either side of the gate regardless of the latching arrangement, and with a padlock eye provided as an integral part of the latch. Provide [fork] [plunger bar] type gate latches.

c. Provide stops and holders of malleable iron for vehicular gates. Provide stops that automatically engage the gate and hold it in the open position until manually released.

****
NOTE: Specify polyvinyl chloride (PVC) coated accessories when PVC-coated fence fabric is required. Specify aluminum alloy accessories with aluminum coated fabric and aluminum posts.
****

d. [Provide accessories with polyvinyl (PVC) coatings matching that specified for chain-link fabric or framework.][Provide accessories constructed of aluminum alloy in conformance with ASTM F626.]

****
NOTE: Delete the following paragraph when double gates are not required.
****

[e. Provide double gates with a cane bolt and ground-set keeper, with latch or locking device and padlock eye designed as an integral part.
]

****
NOTE: Delete the following paragraph if manual sliding gates are not required.
****

[f. Provide manufacturer's standard heavy-duty track ball bearing hanger sheaves, overhead framing and supports, guides, stays, bracing, and accessories as required for easy operation of manual sliding gates.

]2.4 MATERIALS

2.4.1 Zinc Coating

Provide zinc-coated ferrous metal components and accessories that are factory coated after fabrication, except as otherwise specified.

For galvanizing field repairs, provide material that is cold-applied zinc-rich coating conforming to ASTM A780/A780M.

2.4.2 Concrete

Provide concrete conforming to ASTM C94/C94M, and obtaining a minimum 28-day compressive strength of 20,685 kilopascal 3,000 psi.

2.4.3 Grout

Provide grout of proportions one part portland cement to three parts clean, well-graded sand and a minimum amount of water to produce a workable mix.

PART 3 EXECUTION

Submit manufacturer's erection/installation drawings and instructions that detail proper assembly and materials in the design for fence, gate, hardware and accessories.

Provide complete installation conforming to ASTM F567.

3.1 PREPARATION

Ensure final grading and established elevations are complete prior to commencing fence installation.

3.1.1 Clearing and Grading

Clear fence line of trees, brush, and other obstacles to install fencing for a distance of [_____] meters feet inside; and [_____] meters feet outside the fence. Establish a graded, compacted fence line prior to fencing installation.

3.2 INSTALLATION

[3.2.1 Security

****

NOTE: Delete this paragraph if new fencing does not involve relocation or replacement of existing fencing. Depending on nature of fence work, paragraph may need further elaboration regarding necessary construction to maintain perimeter.

****

Install new chain link fencing, remove existing fencing, and perform related work to provide continuous security for facility. Schedule and fully coordinate work with Contracting Officer and cognizant Security

Officer.

]3.2.2 Fence Installation

****

NOTE: Certain security applications require conformance to an applicable OPNAVINST. Use bracketed sentences as required by the applicable OPNAVINST.

****

Install fence on prepared surfaces to line and grade indicated. [Secure fastening and hinge hardware in place to fence framework by peening or welding. Allow for proper operation of components. Coat peened or welded areas with a repair coating matching original coating.] Install fence in accordance with fence manufacturer's written installation instructions except as modified herein.

3.2.2.1 Post Spacing

Provide line posts spaced equidistantly apart, not exceeding 3.048 m 10 feet on center. Provide gate posts spaced as necessary for size of gate openings. Do not exceed 152.4 m 500 feet on straight runs between braced posts. Provide corner or pull posts, with bracing in both directions, for changes in direction of 0.26 rad 15 degrees or more, or for abrupt changes in grade. Submit drawings showing location of gate, corner, end, and pull posts.

3.2.2.2 Top and Bottom Tension Wire

****

NOTE: Coordinate with requirements for top and bottom rails. Specify bottom tension wire to maintain fence alignment, except for designs requiring bottom rail.

****

Install [top] [and] [bottom] tension wires before installing chain-link fabric, and pull wires taut. Place top and bottom tension wires within 203 mm 8 inches of respective fabric line.

3.2.3 Excavation

Provide excavations for post footings which are [drilled holes] in virgin or compacted soil, of minimum sizes as indicated. Space footings for line posts 3048 millimeter 10 feet on center maximum and at closer intervals when indicated, with bottoms of the holes approximately 75 millimeter 3 inches below the bottoms of the posts. Set bottom of each post not less than 915 millimeter 36 inches below finished grade when in firm, undisturbed soil. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads.[Uniformly spread soil from excavations adjacent to the fence line or on areas of Government property, as directed.][Remove excavated soil from Government property.]

When solid rock is encountered near the surface, drill into the rock at least 305 millimeter 12 inches for line posts and at least 457 millimeter 18 inches for end, pull, corner, and gate posts. Drill holes at least 25.4 millimeter 1 inch greater in diameter than the largest dimension of the placed post. If solid rock is below the soil overburden, drill to the full depth required except that penetration into rock need not exceed the minimum depths specified above.

3.2.4 Setting Posts

Remove loose and foreign materials from holes and moisten the soil prior to placing concrete. Provide tops of footings that are trowel finished and sloped or domed to shed water away from posts. Set hold-open devices, sleeves, and other accessories in concrete.

Keep exposed concrete moist for at least 7 calendar days after placement or cured with a membrane curing material, as approved.[Grout all posts set into sleeved holes in concrete with an approved grouting material.] Maintain vertical alignment of posts in concrete construction until concrete has set.

3.2.4.1 Earth and Bedrock

****

NOTE: Alternate drive anchor method may be specified as an option where evidence indicates that optional method under similar ground conditions has satisfactory and proven performance record.

****

Provide concrete bases of dimensions indicated on the manufactures installation drawings[, except in bedrock]. Compact concrete to eliminate voids, and finish to a dome shape. [In bedrock, set posts with a minimum of 25.4 mm 1 inch of grout around each post. Work grout into hole to eliminate voids, and finish to a dome shape.]

[3.2.4.2 Concrete Slabs and Walls

****

NOTE: Use the following paragraph where required by the design, otherwise delete. Sleeve joints for non-removable fence sections are usually filled with lead or nonshrink grout. Removable fence sections may be useful as an economical means for providing access to equipment. Sleeve joints in removable fence sections may be a tight sliding type, or where moisture entry could be a problem, filled with pipe sulphur jointing compound.

****

Set posts into zinc-coated sleeves, set in concrete slab or wall, to a minimum depth of 305 mm 12 inches. Fill sleeve joint with lead, nonshrink grout, or other approved material. Set posts for support of removable fence sections into sleeves that provide a tight sliding joint and hold posts aligned and plumb without use of lead or setting material.

]3.2.4.3 Bracing

****

NOTE: Use a single diagonal truss rod for fences less than 3.7 m 12 feet high. Use two diagonal truss rods on fences 3.7 m 12 feet and higher.

****

Brace gate, corner, end, and pull posts to nearest post with a horizontal brace used as a compression member, placed at least 305 mm 12 inches below top of fence, and [a diagonal tension rod] [two diagonal tension rods].

3.2.4.4 Tolerances

Provide posts that are straight and plumb within a vertical tolerance of 6.35 millimeter 1/4 inch after the fabric has been stretched. Provide fencing and gates that are true to line with no more than 12.7 millimeter 1/2 inch deviation from the established centerline between line posts. Repair defects as directed.

3.2.5 Concrete Strength

Provide concrete that has attained at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than 7 calendar days after placement, before rails, tension wire, or fabric are installed. Do not stretch fabric and wires or hang gates until the concrete has attained its full design strength.

****

NOTE: Include the following paragraph if Section 03 30 00 CAST-IN-PLACE CONCRETE is included in the project specifications.

****

[Sample and test concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

]3.2.6 Top Rails

Provide top rails that run continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by the fencing manufacturer.

[3.2.7 Center Rails

Provide single piece center rails between posts set flush with posts on the fabric side, using special offset fittings where necessary.

]3.2.8 Brace Assembly

Provide bracing assemblies at end and gate posts and at both sides of corner and pull posts, with the horizontal brace located at midheight of the fabric.

Install brace assemblies so posts are plumb when the diagonal rod is under proper tension. Provide two complete brace assemblies at corner and pull posts where required for stiffness and as indicated.

3.2.9 Tension Wire Installation

Install tension wire by weaving them through the fabric and tying them to each post with not less than 3.9 millimeter 7-gauge galvanized wire or by securing the wire to the fabric with 3.5 millimeter 10-gauge ties or clips spaced 610 millimeter 24 inches on center.

3.2.10 Fabric Installation

Provide fabric in single lengths between stretch bars with bottom barbs placed approximately 38 millimeter 1-1/2 inches above the ground line. Pull fabric taut and tied to posts, rails, and tension wire with wire ties and bands.

Install fabric on the security side of fence, unless otherwise directed. Ensure fabric remains under tension after the pulling force is released.

3.2.11 Stretcher Bar Installation

Thread stretcher bars through or clamped to fabric 102 millimeter 4 inches on center and secured to posts with metal bands spaced 381 millimeter 15 inches on center.

3.2.12 Gate Installation

Install gates plumb, level, and secure, with full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricated where necessary.

3.2.13 Tie Wires

Provide tie wires that are U-shaped to the pipe diameters to which attached. Twist ends of tie wires not less than two full turns and bent so as not to present a hazard.

3.2.14 Fasteners

Install nuts for tension bands and hardware on the side of the fence opposite the fabric side. Peen ends of bolts to prevent removal of nuts.

3.2.15 Zinc-Coating Repair

Clean and repair galvanized surfaces damaged by welding or abrasion, and cut ends of fabric, or other cut sections with specified galvanizing repair material applied in strict conformance with the manufacturer's printed instructions.

3.2.16 Accessories Installation

3.2.16.1 Post Caps

****

NOTE: Coordinate with requirements for top rails or supporting arms.

****

[Design post caps to accommodate top rail.] Install post caps as recommended by the manufacturer.

3.2.16.2 Padlocks

Provide padlocks for gate openings and provide chains that are securely attached to gate or gate posts. Provide padlocks keyed alike, and provide two keys for each padlock.

[3.2.17 Grounding

****

NOTE: Delete this paragraph if grounding is not required. If grounding is required and lightning protection is not part of project design, use the requirements in the second paragraph in lieu of those in the first paragraph.

Provide fence grounding details when composite type posts are specified where grounding of the fence is required. Grounding requirements may be indicated on the drawings or included in this section.

When PVC coated fencing is a project requirement, take this into account when detailing the fence grounding system.

****

****

NOTE: Specify solid copper rod for project locations with soil resistivity less than 1,500 ohm-cm. Specify copper-clad steel rods for other locations.

****

Ground fencing as [indicated on drawings][and specified].

[Ground all fences crossed by overhead power lines in excess of 600 volts, and all electrical equipment attached to the fence.][Ground fences on each side of all gates, at each corner, at the closest approach to each building located within 15 m 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations can not exceed 198 m 650 feet. Bond each gate panel with a flexible bond strap to its gate post. Ground fences crossed by power lines of 600 volts or more at or near the point of crossing and at distances not exceeding 45 m 150 feet on each side of crossing. Provide ground conductor consisting of No. 6 AWG solid copper wire. Provide [copper-clad steel][solid copper] rod grounding electrodes 19 mm 3/4 inch by 3.05 m 10 foot long. Drive electrodes into the earth so that the top of the electrode is at least 152 mm 6 inches below the grade. Where driving is impracticable, bury electrodes a minimum of 305 mm 12 inches deep and radially from the fence, with top of the electrode not less than 610 mm 2 feet or more than 2.4 m 8 feet from the fence. Clamp ground conductor to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. Total resistance of the fence to ground cannot exceed 25 ohms.]

]3.3 CLOSEOUT ACTIVITIES

Remove waste fencing materials and other debris from the work site.

Submit manufacturer's data indicating percentage of recycled material content in protective fence materials, including chain link fence, fabric, and gates to verify affirmative procurement compliance.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 31 13.53 (November 2021)**

Preparing Activity: USACE **Superseding**
UFGS-32 31 13.53 (February 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-32 31 13.53 (November 2021)**

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SECTION 32 31 13.53

HIGH-SECURITY FENCES (CHAIN LINK AND ORNAMENTAL) AND GATES
11/21

****

NOTE: This guide specification covers the requirements for chain link and ornamental fencing for high security applications. Please review the UFC 4-022-03 "New Document Summary Sheet" that discusses Purpose, Application and Use, and Need. Document provides guidance and in some cases minimum requirements with the appropriate references.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)

****

****

NOTE: This Guide Specification and UFC 4-022-03 use the most generic term "zinc coating" in order not to conflict with requirements contained within referenced standards. The term "zinc coatings" encompasses a wide range of metallic and organic coatings including hot dip galvanizing, zinc plating, electroplating (sometimes called "electro-galvanizing"), metallizing, inorganic zinc paints and organic zinc paints. Detailed zinc coating requirements for fencing components are called out in various references such as ASTM

standards.
****

****
NOTE: Select fencing materials throughout this Guide Specification as appropriate to protect against corrosion. Refer to the Corrosion Prevention & Control (CPC) Fencing Knowledge Area webpage on the Whole Building Design Guide website for additional information on making these selections (https://www.wbdg.org/ffc/dod/cpc-source/fencing-knowledge-area). This website contains a link to a Life Cycle Cost Analysis that was conducted for the DoD to identify the lowest cost materials over the service life of a fencing system.
****

PART 1 GENERAL

****
NOTE: Where special fencing requirements exist, such as wolf-proofing, antiburrowing provisions, crossing drainage ditches, provisions for electrical installations, or special security installations, modify specifications and appropriate details included on the drawings. Modifications and details must afford security equal to that of the fence.

Where special entrance security requirements exist such as electronic locks, motor operated gates, or closed circuit video, add details and modify the specification accordingly.

Standard drawings are incorporated into UFC 4-022-03 Security Fences and Gates, Appendix C Fence and Gate Design Details. The details in this appendix illustrate general layouts for each type of fence or gate. Use the drawings in the UFC corresponding to the fence required, on all DoD fence projects. Drawings were developed from all available DoD fence drawings including Army, Navy and Air Force. These illustrations are not intended to depict the importance or size of each element. Provide details and drawings meeting the minimum mandatory requirements and modify for the specific application, environmental conditions, and local/project constraints. See paragraph titled "Integration With Other Requirements" for additional directional direction. Sizes and dimensions indicated are the minimum requirement that must be modified in accordance with Service policy and for the specific application, environmental conditions, and local constraints.

Show layout of fence including types and locations of gates, and gate sizes. Indicate on drawings the extent of clearing required.

Require test reports where closer product control is essential or where difficulty might be encountered determining quality of supplied materials.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A121	(2022) Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A392	(2011; R 2022a) Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A478	(1997; R 2019) Standard Specification for Chromium-Nickel Stainless Steel Weaving and Knitting Wire
ASTM A491	(2011; R 2022) Standard Specification for Aluminum-Coated Steel Chain-Link Fence

	Fabric
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A824	(2001; R 2022) Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM F567	(2023) Standard Practice for Installation of Chain Link Fence
ASTM F626	(2014; R 2023) Standard Specification for Fence Fittings
ASTM F668	(2017; R 2022) Standard Specification for Polyvinyl Chloride (PVC) and Other Polymer-Coated Steel Chain Link Fence Fabric
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F883	(2013; R 2022) Standard Performance Specification for Padlocks
ASTM F900	(2011; R 2017) Standard Specification for Industrial and Commercial Swing Gates
ASTM F934	(2016; R 2022) Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials
ASTM F1043	(2018; R 2022) Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
ASTM F1083	(2018; R 2022) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F1145	(2005; R 2017) Standard Specification for Turnbuckles, Swaged, Welded, Forged

ASTM F1184	(2023; E 2023) Standard Specification for Industrial and Commercial Horizontal Slide Gates
ASTM F1664	(2008; R 2022) Standard Specification for Poly(Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence
ASTM F1665	(2008; R 2022) Standard Specification for Poly(Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used With Chain-Link Fence
ASTM F1910	(1998; R 2018) Standard Specification for Long Barbed Tape Obstacles
ASTM F1911	(2005; R 2019) Standard Practice for Installation of Barbed Tape
ASTM F2408	(2016) Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets
ASTM F2814	(2009; R 2015) Standard Guide for Design and Construction of Ornamental Steel Picket Fence Systems for Security Purposes

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fence Installation Drawings; G, [_____]

SD-03 Product Data

Fabric

Posts

Post Caps

Chain Link Braces

Line Posts

Sleeves

Rails

Tension Wire

Barbed Wire

Barbed Wire Supporting Arms

Barbed Tape

Latches

Hinges

Stops

Keepers

Rollers

Turnstiles

Padlocks

Wire Ties

Ornamental Fence Systems

Swing Gates

Slide Gates

Fence Fabric Reinforcement

SD-07 Certificates

Chain Link Fence

Fabric

Barbed Wire

Gate Hardware and Accessories

Concrete

Gate Operator

SD-10 Operation and Maintenance Data

Electro-Mechanical Locks

Gate Operator

Operating and maintenance instructions

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials elevated off of the ground to protect against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 COMPONENTS

2.1.1 Chain Link Fence Fabric

****

NOTE: Use either aluminum-coated steel fabric or Class 2b (fused and adhered) PVC-coated over zinc-coated steel fabric for project locations with Environmental Severity Classifications (ESC) C3 thru C5; ESC C1 and C2 locations can use other options. Use Class 2b PVC-coated over zinc-coated steel fabric when fabric is being buried in soils and in areas where coatings are prone to abrasion from blowing sand. It should be noted that DoD research has shown zinc-coated steel fabric to have lower first costs but significantly higher life-cycle costs in corrosive environments; when using zinc-coated steel in ESC C1 and C2 locations, use Class 2 with 2.0 ounces per square foot of zinc coating for C2 project locations or where localized corrosive conditions are present or have been observed. See UFC 1-200-01 for determination of ESC for project locations. Fabric height must be as

shown on the contract drawings. Minimum fabric height must be 1.9 m 6 feet for controlled areas and 2.13 m 7 feet for restricted areas. Minimum fabric height requirement for security fences and gates is 2.13 m7 feet per UFC 4-022-03 - Unless otherwise directed all security and perimeter fencing must have a minimum fence fabric height of 2.13 m7 feet, excluding the top guard. Fence height including outriggers must be a minimum of 2.44 m8 feet. Modifications to existing fences are not required to meet this new UFC. Consult with current Service policies on specific requirements regarding fence height and assets that may require a higher level of protection. Certain security applications require fabric to be embedded into the ground or into a concrete curb.

****

2.1.1.1 General

Provide [ASTM A491, aluminum-coated steel wire.] [Class 2b polyvinyl chloride-coated steel fabric with 92 grams 0.3 ounces of zinc coating per square meter foot in accordance with ASTM F668. Provide manufacturer's standard [dark green][olive green][brown][black] in color for polyvinyl chloride coating for fabric and all other fence components complying with ASTM F934.][ASTM A392, [Class 1] [Class 2], zinc-coated steel wire with minimum coating weight of [370][610] grams [1.2][2.0] ounces of zinc per square meter foot of coated surface.]Fabricate fence fabric of 9 gauge wire woven in 50 mm 2 inch diamond mesh.[Provide twisted and barbed fabric on the top selvage and knuckled on the bottom selvage.]

[2.1.1.2 Approval Of Polyvinyl Chloride-Coated Fence Materials

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NOTE: Delete this paragraph if PVC Coated fencing is not within the project scope.

****

Inspect polyvinyl chloride-coated fence materials for cracking, peeling, and conformance with the specifications prior to installation. Replace any fence materials rejected by the Contracting Officer with approved materials at no additional cost to the Government.

][2.1.2 Ornamental Fence Systems

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NOTE: Delete this paragraph if ornamental fencing is not within the project scope. Use powder-coat finish in locations with ESC C3 thru C5, and high humidity locations. High humidity locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. In other ESC and humidity locations, a painted finish is allowed.

****

Submit manufacturer's catalog data. Provide ASTM F2814 structural components consisting of tubular steel ornamental pickets and rails.

Provide ASTM F2408 industrial class pickets with a minimum cross-sectional area of 2.5 sq cm 1 sq in and a minimum wall thickness of 6 mm 14 gauge. Provide pickets with spear-pointed tips extending a minimum of 15 cm 6 in above the top rail of the fence. Mount pickets to a top and bottom rail spaced a maximum of 2 m 80 inches apart. Space pickets along rails with a maximum gap not to exceed 5.5 cm 2.25 inches. Secure pickets to rails by [welding] [inaccessible, tamper-proof fasteners]. Provide all items and accessories finished by [PVC powder-coating][painting][_____] in [black][dark bronze][white][_____].

[Add the following accessories to further harden the Ornamental Fence System: [barbed wire on top of fence] [barbed wire along bottom of fence] [barbed wire along side of fence] [spiked railing along the top rail] [chain-link security mesh welded to the pickets and rails]. Accessories are specified separately in this section.

]]2.1.3 Posts

2.1.3.1 Metal Posts for Chain Link Fence

****

NOTE: For high security fences that are to be sensored, posts will be limited to Group IA or Group IC steel pipe only. Certain security applications using intrusion detection sensors, must use steel pipe framework only - see UFC 4-022-03 for additional information. Use last bracketed option that includes PVC coating on steel pipe posts in locations with ESC C3 thru C5, and high humidity locations; also use PVC coating on zinc-coated steel pipe posts in areas prone to metal loss caused by blowing sand. When specifying pipe-type posts, use Group IA pipe with additional PVC coating in locations with ESC C3 thru C5, and high humidity locations. Also use Group IA steel pipe where steel posts are buried in direct contact with soil, regardless of the ESC of the project location. Group IA or IC steel pipe may be used in locations with ESC C1 or C2 and in low humidity locations. High humidity locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

****

NOTE: For Group IA zinc-coated steel pipe, select "Regular Strength" when standard schedule 40 steel with a 207 MPa 30,000 psi yield strength is sufficient; select "High Strength" when the fence posts require 345 MPa 50,000 psi yield strength.

****

[Provide posts conforming to ASTM F1083, zinc-coated.[Group IA[Regular Strength][High Strength] steel pipe.][Group IC steel pipe, zinc-coated with PVC polymer overcoat[and Group II, roll-formed steel sections, with zinc [and PVC] coating meeting the strength and coating requirements of ASTM F1043.]] [Provide either Group IA steel pipe posts, Group IC, with PVC polymer overcoat, or Group II, roll-formed steel sections, and be coated conforming to the requirements of ASTM F1043.][Provide posts with polyvinyl chloride coating, minimum thickness, 0.25 mm 0.01 inch conforming to ASTM F1043; color of PVC coating to match that of fabric.]] Provide sizes as shown on the drawings. Use line posts and terminal (corner, gate, and pull) posts of the same designation throughout the fence. Provide gate post for the gate type specified subject to the limitation specified in ASTM F900 or ASTM F1184.

2.1.3.2 Accessories

****

NOTE: Use PVC coating for accessories and post caps to match fence fabric/posts in locations with ESC C3 thru C5, and high humidity locations. High humidity locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations. In areas where coatings are prone to abrasion from blowing sand, use PVC-coated accessories. Use zinc-coated accessories where zinc-coated steel fence posts (with no PVC coatings) are being used.

****

a. Provide accessories conforming to ASTM F626. Coat ferrous accessories with [zinc coating.] [polyvinyl chloride-coated, minimum thickness of 0.25 mm 0.01 inch. Match color coating of fittings to color coating of the fabric.]

b. Provide truss rods (with turnbuckles or other means of adjustment)for each terminal post.

c. Provide barbed wire supporting arms of the [single][45 degree outward angle 3-strand] [V 6 strand] arm type and of the design required for the post furnished. Secure arms by [top tension wire][top rail][bolting][riveting].

d. Furnish post caps in accordance with manufacturer's standard accessories [with coating matching that of fence posts].

e. Provide 9 gauge tie wire for attaching fabric to rails, braces, and posts and match the material and coating of the fence fabric. [Use tie wires for attaching fabric to tension wire on high security fences made from 1.6 mm 16 gauge stainless steel. Provide double loop tie wires 165 mm 6.5 inches in length.] Provide miscellaneous hardware coatings which conform to ASTM A153/A153M unless modified.

2.1.4 Chain Link Braces[and Rails]

****

NOTE: Normally rails will not be specified except where appearance is important and the added cost is justified. When top rails are not specified, top tension wire will be used. Bottom tension wire will be specified unless a bottom rail is required for high security fence. Where rails are utilized, include the "and rails" phrasing in the title of this paragraph.

NOTE: Use a single diagonal truss rod for fences less than 3.7 m 12 feet high. Use two diagonal truss rods on fences 3.7 m 12 feet and higher.

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NOTE: Include PVC coating on zinc-coated steel pipe railings in locations with ESC C3 thru C5, and high humidity locations; also use PVC coating on zinc-coated steel pipe railings in areas where coatings are prone to abrasion from blowing sand. When specifying pipe-type braces and rails, use Group IA pipe with additional PVC coating in locations with ESC C3 thru C5, and high humidity locations. Group IA or IC steel pipe may be used in locations with ESC C1 or C2 and in low humidity locations. High humidity locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

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NOTE: For Group IA zinc-coated steel pipe, select "Regular Strength" when standard schedule 40 steel with a 207 MPa 30,000 psi yield strength is sufficient; select "High Strength" when 345 MPa 50,000 psi yield strength is required.

****

[ASTM F1083, zinc-coated, Group IA[Regular Strength][High Strength], steel pipe, size NPS 1-1/4.][Provide Group IC steel pipe, zinc-coated, with PVC polymer overcoat that meets the strength and coating requirements of ASTM F1043.][Use braces and rails that are [Group IA[Regular Strength][High Strength]] [Group IC], steel pipe, size NPS 1-1/4 or Group II, formed steel sections, size 42 mm 1-21/32 inch and be zinc coated and polyvinyl chloride-coated, minimum thickness, 0.25 mm 0.01 inch conforming to the requirements of ASTM F1043. Group II, formed steel sections, size 42 mm 1-21/32 inch, conforming to ASTM F1043, may be used as braces and rails if Group II line posts are furnished.][Provide rails and braces with polyvinyl chloride coating, minimum thickness, 0.25 mm 0.01 inch conforming to ASTM F1043; color of PVC coating to match that of fabric.]

2.1.5 Chain Link Gates

****

NOTE: Show type of gates on the drawings, including degree of swing required. In heavy use conditions overhead slide gates should be considered if clearances permit, because these gates require less maintenance and repair than cantilever gates. Ground level track and roller systems should be avoided in climates where snow and ice may accumulate. Recessed tracks should never be used in climates where the recess may fill with ice and snow. Where gates are to receive electric locks, the gate post foundations should be lowered to frost depth to help prevent misalignment of the lock components.

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2.1.5.1 Gate Assembly

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NOTE: Edit to provide gate framing and bracing member material and finish to match those previously used for posts, rails and braces.

****

Provide gate assembly conforming to ASTM F900 and/or ASTM F1184 of the type and swing shown. [Provide gate frames conforming to strength and coating requirements of ASTM F1083 for Group IA[Regular Strength][High Strength], steel pipe, nominal pipe size (NPS) 1-1/2.][Provide gate frames conforming to strength and coating requirements of ASTM F1043, for Group IC, steel pipe with PVC polymer overcoat, nominal pipe size (NPS) 1-1/2.][Provide gate frames made of polyvinyl chloride-coated steel pipe (Group IA)(Group IC) a nominal pipe size (NPS) 1-1/2, conforming to ASTM F1043.] Use gate fabric that matches the specified chain link fabric.

2.1.5.2 Gate Leaves

For gate leaves, more than 2.44 m 8 feet wide, provide either intermediate members and diagonal truss rods or tubular members as necessary to provide rigid construction, free from sag or twist. For gate leaves less than 2.44 m 8 feet wide, provide truss rods or intermediate braces. Provide intermediate braces on all gate frames with an electro-mechanical lock. Attach fabric to the gate frame by method standard with the manufacturer. Welding is not an acceptable method for attaching fabric to gate frames.

2.1.5.3 Gate Hardware and Accessories

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NOTE: Include PVC coating on steel latches, stops, hinges, keepers, and accessories where fence posts are also PVC coated; otherwise, use galvanized coating.

****

Submit manufacturer's catalog data. Furnish and install latches, hinges, stops, keepers, rollers, and other hardware items as required for the operation of the gate. All items are required to match the material characteristics of the fence system being installed. Provide hinge with stainless steel pin. Arrange latches for padlocking so that the padlock will be accessible from both sides of the gate. Provide stops for holding the gates in the open position. For high security applications, extend each end member of gate frames sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence. Coating for steel latches, stops, hinges, keepers, and accessories, must be [galvanized] [PVC, minimum thickness of 0.25 mm 0.01 inch.]

2.1.6 Ornamental Fence Gates

2.1.6.1 Swing Gates

Submit manufacturer's catalog data. Fabricate swing gates by welding 5 sq cm 2 sq in tubular steel ends and rails. Use pickets that match the adjacent fence construction. Reinforce gates to ensure assembly sags no more than 1% of the gate leaf width or 5 cm 2 in, whichever is less. Size gate posts to accommodate the weight and width of each gate leaf. Mount gates to posts with weldable steel plates or blocks, pressed steel, or malleable iron hinges. Hot-dip galvanize all hinges with a minimum zinc weight of 66 g/sq m 1.20 oz/sq ft. Provide hinge with stainless steel pin. Secure all tamper points by welding or peening the threads. Use swing gate latches and drop bar guides manufactured of pressed steel, hot-dipped galvanized with a minimum zinc weight of 366 g/sq m 1.20 oz/sq ft. Finish all gate hardware in the same color/coating as the fence system.

2.1.6.2 Slide Gates

Submit manufacturer's catalog data. Fabricate slide gates by welding 5 sq cm 2 sq in tubular steel ends and rails. Use pickets that match the adjacent fence construction. Select the type and class of slide gate to comply with ASTM F1184. Size gate posts to accommodate the weight and width of each gate leaf in accordance with ASTM F1184, or per manufacturer's recommendations. [Specify Type II, Class 2, interior roller design for cantilever slide gates.]

2.1.7 Turnstiles

Provide [galvanized steel] [metal], three wing turnstile consisting of a rotor, cage, ceiling plate, and bottom bearing plate. [Provide electronic opening and closing [by card key] [_____].] Provide [continuous turn] [one way continuous turn] [one-third turn and stop] motion.

2.1.8 Padlocks

****

NOTE: Type P01 is key operated. Grade 6 is the top grade commercial lock; in Option A the key is captive in cylinder when padlock is unlocked; in Option B the cylinder is removable; Option 6 is environmentally resistant. For combination locks or other options and grades see ASTM F883.

****

Provide padlocks conforming to ASTM F883, Type [PO1] [_____], Option[s] [A, B, and G] [_____] [and] [_____], Grade [6][_____]. Size 44 mm 1-3/4 inch. [Key all padlocks alike]. [Key all padlocks into master key system as specified in Section 08 71 00 DOOR HARDWARE].

2.1.9 Gate Operator

Provide electric gate operators for sliding gates as follows: Provide electric gate operators with a right angle gearhead instantly reversing motor with magnetic drum-type brake, friction disc clutch, reversing starter with thermal overload protection, and a chain-driven geared rotary-type automatic limit switch. Use only hardened steel machine cut worm and mating bronze gears that operate in a bath of oil. Gate operators with V-belt pulleys are not allowed. Equip gate operators with an emergency release to allow the gate to be operated manually that is also capable of being locked in the engaged or disengaged position. Provide positive stops on the gate tracks as a backup to the limit switches.

2.1.10 Electro-Mechanical Locks

Provide electro-mechanical locking devices for sliding gates and personnel gates that are solenoid actuated such that the deadbolt retracts when the solenoid is energized and remains electrically retracted until the gate is closed. Provide continuous duty type solenoid, rated for 120V ac, 60Hz operation. Ensure the locking device is unlockable by key and keyed on both sides. Monitor status of the electro-mechanical lock by two limit switches (integral to the locking device) wired in series. Ensure one switch monitors the deadlock lever and the other monitors the locking tongue.

2.2 MATERIALS

2.2.1 Wire

2.2.1.1 Wire Ties

Submit samples as specified. Provide wire ties constructed of the same material and finish as the fencing fabric.

2.2.1.2 Barbed Wire

****

NOTE: Use barbed wire material and coating to match fence fabric.

****

Provide barbed wire conforming to [ASTM A121 aluminum-coated, Type A][ASTM F1665, PVC-coated, Class 2b][ASTM A121 zinc-coated, Type Z, Class 3], with 12.5 gauge wire with 14 gauge, round, 4-point barbs spaced no more than 125 mm 5 inches apart.

2.2.1.3 Tension Wire

****

NOTE: Use tension wire material and coating to match fence fabric. Specify polyvinyl chloride (PVC) coated tension wire when PVC-coated fence fabric is used above.

****

Provide metallic coated steel marcelled tension wire (No. 7-gauge), complying with ASTM A824. [Provide aluminum-coated (aluminized) steel wire with coating that weighs not less than 122 gram per square meter 0.4 ounces per square foot.][Provide zinc-coated steel wire with coating that weighs not less than [370] [610] gram per square meter [1.2] [2.0] ounces per square foot.][Provide PVC-coated tension wire of the same class and color as the fencing fabric complying with ASTM F1664.]

2.2.2 Barbed Tape

Provide reinforced barbed tape, [double coil] [single coil], for fence toppings fabricated from 430 series stainless steel with a hardness range of Rockwell (30N) 37-45 conforming to the requirements of ASTM A240/A240M. Provide stainless steel strip 0.6 mm thick by 25 mm 0.025 inch thick by 1 inch wide before fabrication. Provide barbs that are a minimum of 30.5 mm 1.2 inch in length, in groups of 4, spaced on 102 mm 4 inch centers. Use stainless steel core wire with a 2.5 mm 0.098 inch diameter and a minimum tensile strength of 9.68 MPa 140 psi and conforming to ASTM A478. [The above requirements also apply to reinforced barbed tape, single coil, for ground application.] [Fabricate non-reinforced barbed tape, single coil, for ground applications from 301 series stainless steel, with a hardness range of Rockwell (30N) 50-55, in accordance with ASTM A666. Provide stainless steel strips 0.6 mm thick by 31 mm 0.025 inch thick by 1.21 inches wide before fabrication. Use barbs with a minimum of 30.5 mm 1.2

inch in length, in groups of 4, spaced on 102 mm 4 inch centers.] Use 1.3 mm No. 16 AWG stainless steel twistable wire ties for attaching the barbed tape to the barbed wire[and to the fence for ground application].

Ensure long barbed tape obstacles conform to ASTM F1910.

2.2.3 Concrete

ASTM C94/C94M, using 19 mm 3/4 inch maximum size aggregate, and having minimum compressive strength of 21 MPa 3000 psi at 28 days. Use grout consisting of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

[2.3 FENCE FABRIC REINFORCEMENT

****

NOTE: Reinforcement for chain link and ornamental fencing is typically constructed with wire rope and concrete deadman anchor. Refer to UFC 4-022-02, Security Engineering: Design and Selection of Vehicle Barriers and UFC 4-022-03 Security Fences and Gates for guidance and details.

NOTE: Include PVC coating on structural wire rope in locations with ESC C3 thru C5, and high humidity locations. High humidity locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Provide galvanized [PVC-coated]structural wire rope as indicated and in accordance with ASTM A1023/A1023M, 20mm 3/4 inch nominal diameter of strand, 19 wire strand, regular lay, extra improved plow steel (EIPS), independent wire rope core (IWRC) and with a minimum breaking strength of 9,175 Newtons40,800 pound-force. Galvanize cable, Class A, in accordance with ASTM A1023/A1023M.

2.3.1 Wire Rope Accessories

Use hot-dipped galvanized structural steel members in cable anchoring system. Provide hot-dipped galvanized clamps, U-bolts, and associated hardware in accordance with ASTM A153/A153M.

2.3.2 Turnbuckles

Provide turnbuckles that are 30mm x 300mm x 300mm1-1/4 inches x 12 inches x inches Type I, Grade 1 galvanized, in accordance with ASTM F1145.

2.3.3 Rope Clamps

Provide hot-dipped galvanized rope clamps in accordance with ASTM A153/A153M.

2.3.4 Threaded Rods, U-Bolts, and Bolts

Provide all threaded rods, U-bolts conforming to ASTM A307 and install with ASTM F844 and ASTM A563 nuts. Galvanize the entire bolt assembly.

]PART 3 EXECUTION

3.1 PREPARATION

Perform complete installation conforming to ASTM F567.

3.1.1 Line and Grade

Install fence to the lines and grades indicated. Clear the area on either side of the fence line to the extent indicated. Space line posts equidistant at intervals not exceeding 3 m 10 feet. Set terminal (corner, gate, and pull) posts whenever abrupt changes in vertical and horizontal alignment are encountered. Provide continuous fabric between terminal posts; however, ensure runs between terminal posts do not exceed 152.4 m 500 feet. Repair any damage to galvanized surfaces, including welding, with paint containing zinc dust in accordance with ASTM A780/A780M.

3.1.2 Excavation

Excavate holes to depths indicated. Clear all post holes of loose material and spread waste material where directed. Eliminate ground surface irregularities along the fence line to the extent necessary to maintain a [25][50] mm [1][2] inch clearance between the bottom of the fabric and finish grade.

3.2 INSTALLATION

3.2.1 Installation Drawings

Submit complete Fence Installation Drawings for review and approval by the Contracting Officer prior to shipment. Submit drawing details that include, but are not limited to the following information: Fence Installation Drawings, Location of gate, corner, end, and pull posts, Gate Assembly, Turnstiles, and Gate Hardware and Accessories. Install fence system per approved drawings.

3.2.2 Security Fencing

Install new security fencing, remove existing security fencing, and perform related work to provide continuous security for facility. Schedule and fully coordinate work with Contracting Officer.

3.2.3 Posts

****

NOTE: For fences over 1.83 m 6 feet tall in areas of frequent high winds (113 kph (70 mph) or greater), specify hole diameters of 406 mm 16 inches for terminal posts and 305 mm 12 inches for line posts.

****

3.2.3.1 Earth and Bedrock

a. Set posts plumb and in alignment. Except where solid rock is encountered, set posts in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, set posts to a minimum depth of 457 mm 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, set posts to the minimum depth indicated on the drawing unless a penetration of 457 mm 18 inches in solid rock is achieved before reaching the indicated depth, in which case terminate depth of penetration. Grout all portions of posts set in rock.

b. Set portions of posts not set in rock in concrete from the rock to ground level. Set posts in holes not less than the diameter shown on the drawings. Make diameters of holes in solid rock at least 25 mm 1 inch greater than the largest cross section of the post. Thoroughly consolidate concrete and grout around each post, free of voids and finished to form a dome. Allow concrete and grout to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Set driven posts to a minimum depth of 914 mm 3 feet and protect with drive caps when setting.

c. Test fence post rigidity by applying a 222.4 newtons 50 pound force on the post, perpendicular to the fabric, at 1.52 m 5 feet above ground. Ensure post movement measured at the point where the force is applied is less than or equal to 19 mm 3/4 inch from the relaxed position. Test every tenth post for rigidity. When a post fails this test, make further tests on the next four posts on either side of the failed post. Remove, replace, and retest all failed parts at the Contractor's expense.

[3.2.3.2 Concrete Slabs and Walls

****

NOTE: Use the following paragraph where required by the design, otherwise delete. Sleeve joints for nonremovable fence sections are usually filled with lead or nonshrink grout. Removable fence sections may be useful as an economical means for providing access to equipment. Sleeve joints in removable fence sections may be a tight sliding type, or where moisture entry could be a problem, filled with pipe sulphur jointing compound.

****

When installed in concrete slabs or walls, set posts in zinc-coated sleeves, to a minimum depth of 300 mm 12 inches. Fill sleeve joint with lead, nonshrink grout, or other approved material. Set posts for support of removable fence sections in sleeves that provide a tight sliding joint and hold posts aligned and plumb without use of lead or setting material.

]3.2.4 Rails

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NOTE: Top Rails are normally not applicable to High Security Installations

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Bolt bottom rail to double rail ends and securely fasten double rail ends to the posts. Peen bolts to prevent easy removal. Install bottom rail before chain link fabric. [Provide 3/8" diameter eye hook anchored into concrete footing at midpoint.]

3.2.5 Fabric

****

NOTE: Normally the bottom of fence fabric will be installed no higher than 50 mm 2 inches from the ground. For Air Force projects, high security fence fabric will be installed no higher than 25 mm 1 inch from the ground. The height requirement for fence fabric will be verified with the user.

In areas where the soil along the fence line is prone to erosion, measures should be taken to maintain the level of security for which the fence is designed.

Tension requirements are for high security fence applications. Fabric fastening requirement of 300 mm 12 inch spacing to top tension wire and bottom rail is a high security fence requirement.

****

a. Set fabric height [at [1.8][2.1] m [6][7] feet] [_____] [as shown].

b. Install chain link fabric on the side of the post indicated. Attach fabric to terminal posts with stretcher bars and tension bands. Space bands at approximately 381 mm 15 inch intervals. Install fabric and pull taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fasten fabric to line posts at approximately 381 mm 15 inch intervals and fastened to all rails and tension wires at approximately [610][305] mm [24][12] inch intervals.

c. Cut fabric by untwisting and removing pickets. Accomplish splicing by weaving a single picket into the ends of the rolls to be joined. Install the bottom of the fabric [50][25] mm plus or minus 13 mm [2][1] plus or minus 1/2 inch above the ground.

d. After the fabric installation is complete, exercise the fabric by applying a 222 newton 50 pound push-pull force at the center of the fabric between posts; use a 133 newton 30 pound pull at the center of the panel to ensure fabric deflection of not more than 63.5 mm 2.5 inches when pulling fabric from the post side of the fence. Every second fence panel is required to meet this requirement. Resecure and retest all failed panels at the Contractor's expense.

3.2.6 Supporting Arms

Install barbed wire supporting arms and barbed wire as indicated on the drawings and as recommended by the manufacturer. Anchor supporting arms [to the posts in a manner to prevent easy removal with hand tools] [with 9.5 mm 3/8 inch diameter plain pin rivets or, at the Contractor's option, with studs driven by low-velocity explosive-actuated tools for steel, wrought iron, ductile iron, or malleable iron. Do not use explosive-actuated tool to drive studs into gray iron or other material that can be fractured. Use a minimum of two studs per support arm.] Pull barbed wire taut and attach to the arms with clips or other means that will prevent easy removal.

[3.2.7 Barbed Tape Installation

****

NOTE: Barbed tape is a high security fence option when required.

****

Install stainless steel reinforced barbed tape per ASTM F1911 and as detailed on the drawings. Stretch out barbed tape to its manufacturer's recommended length, set on top of the barbed wire and "V" shaped support arms, then secure it to the barbed wire. Secure the barbed tape to the barbed wire at the two points and at every spiral turn of both coils as shown on the drawings. Install stainless steel [reinforced][non-reinforced] barbed tape for ground applications [in accordance with manufacturer's recommendations][as shown on the drawings].

]3.2.8 Gate Installation

a. Install gates at the locations shown. Mount gates to swing as indicated. Install latches, stops, and keepers as required. Install [Slide] [Lift] gates as recommended by the manufacturer.

b. Attach padlocks to gates or gate posts with chains. Weld or otherwise secure hinge pins, and hardware assembly to prevent removal.

c. Submit [6][_____] copies of operating and maintenance instructions. Outline the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Include in the maintenance instructions routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. Also include the general gate layout, equipment layout and simplified wiring and control diagrams of the system as installed.

3.2.9 Grounding

****

NOTE: Delete this paragraph if grounding is not required. If grounding is required and lightning protection is not part of project design, use the requirements in the second set of brackets in lieu of those in the first set of brackets. Provide fence grounding details when composite type posts are specified where grounding of the fence is required.

****

****

NOTE: Specify solid copper rod for project locations with soil resistivity less than 1,500 ohm-cm. Specify copper clad steel rods for other conditions.

****

a. Ground fencing as [indicated on drawings][and][specified].

b. [Ground fences crossed by overhead powerlines in excess of 600 volts and ground all electrical equipment attached to the fence.]

c. [Ground fences on each side of all gates, at each corner, at the closest approach to each building located within 15 m 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Ensure grounding locations are located no more than 198 m 650 feet apart. Bond each gate panel with a flexible bond strap to its gate post. Ground fences crossed by powerlines of 600 volts or more at or near the point of crossing and at distances not exceeding 45 m 150 feet on each side of crossing.]

d. [Provide ground conductor consisting of 3.3 mmNo. 8 AWG solid copper wire. Use grounding electrodes that measures 19 mm 3/4 inch by 3.05 m 10 foot long and are a [copper-clad steel][solid copper] rod. Drive electrodes into the earth so that the top of the electrode is at least 152 mm 6 inches below the grade. Where driving is impracticable, bury electrodes a minimum of 305 mm 12 inches deep and radially from the fence. Install the top of the electrode to be less than 610 mm 2 feet or more than 2.4 m 8 feet from the fence. Clamp ground conductor to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. Measure total resistance of the fence to ground and ensure it is not greater than 25 ohms.]

[3.2.10 Cable Reinforcement Installation

Comply with the contract drawings. Install [1][2][___] strands of [1.9][2.5] cm [3/4][1] in steel aircraft cables mounted to the [chain link fence] [ornamental fence system] posts utilizing u-bolts and nuts. Peen the ends of the U-bolts to prevent removal. Tighten cables with galvanized steel turnbuckles with swaged fittings to the point there is no visible sag. Install [1 m x 1 m x .5 m][1.3 m x 1.3 m x 0.66 m][_________] [3 ft x 3 ft x 1.5 ft][4ft x 4 ft x 2ft][__________] concrete deadman anchors which are a minimum of [1][1.3][___] m [3][4][___] ft underground and installed in undisturbed surrounding soils. Space dead man anchors no more than 61 m 200 ft apart and on each side of gate openings. Connect steel aircraft cables to dead man anchors using swaged end fittings and turnbuckles attached to 3.2 cm 1.25 in galvanized threaded rod which is embedded into concrete anchor and held in place with two 10 cm x 10 cm x 0.66 cm 4 in x 4 in x ¼ in thick steel plates welded to the threaded rod. Place deadman anchors within 3 m 10 feet of last post and on each side of gate openings.

]3.3 CLOSEOUT ACTIVITIES

3.3.1 Cleanup

Remove waste fencing materials and other debris from the work site each workday.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 31 26 (November 2021)**

Preparing Activity: USACE **Superseding**

UFGS-32 31 26 (February 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-32 31 26 (November 2021)**

Preparing Activity: USACE **Superseding**
UFGS-32 31 26 (February 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 32 31 26

WIRE FENCES AND GATES
11/21

****

NOTE: This guide specification covers the requirements for Wire Fences and Gates.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: This Guide Specification and UFC 4-022-03 use the most generic term "zinc coating" in order not to conflict with requirements contained within referenced standards. The term "zinc coatings" encompasses a wide range of metallic and organic coatings including hot dip galvanizing, zinc plating, electroplating (sometimes called "electro-galvanizing"), metallizing, inorganic zinc paints and organic zinc paints. Detailed zinc coating requirements for fencing components are called out in various references such as ASTM standards.

****

****

NOTE: Select fencing materials throughout this Guide Specification as appropriate to protect

against corrosion. Refer to the Corrosion Prevention & Control (CPC) Fencing Knowledge Area webpage on the Whole Building Design Guide website for additional information on making these selections (https://www.wbdg.org/ffc/dod/cpc-source/fencing-knowledge-area). This website contains a link to a Life Cycle Cost Analysis that was conducted for the DoD to identify the lowest cost materials over the service life of a fencing system.

****

PART 1 GENERAL

****

NOTE: This section covers non security applications for farm style fences. Edit this section throughout for the applicable project.

Include standard drawings STD 872-90-02 through 872-90-13 of fence and gate types as part of the contract drawings; the standard drawings are available at https://pdc.usace.army.mil/library/drawings/fence. Show layout of fence including types and locations of gates, and gate sizes; also indicate the extent of clearing required.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA U1 (2024) Use Category System: User

	Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A116	(2022) Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric
ASTM A121	(2022) Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A702	(2022) Standard Specification for Steel Fence Posts, Hot Wrought
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM F626	(2014; R 2023) Standard Specification for Fence Fittings
ASTM F883	(2013; R 2022) Standard Performance Specification for Padlocks
ASTM F900	(2011; R 2017) Standard Specification for Industrial and Commercial Swing Gates
ASTM F1043	(2018; R 2022) Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
ASTM F1083	(2018; R 2022) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F1184	(2023; E 2023) Standard Specification for Industrial and Commercial Horizontal Slide Gates
ASTM F1665	(2008; R 2022) Standard Specification for Poly(Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used With Chain-Link Fence

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-F-191/3	(2023; Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails

and Braces)

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

Fence Fabric

Woven Wire

Barbed Wire

[Gates

] Posts

Braces and Rails

[Padlocks
]

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a fencing system as described herein.

Submit Installation Drawings clearly indicating fence installation, location of gates, corners, ends, and pull posts; gate assembly, gate hardware, catalog data and accessories.

2.2 COMPONENTS

2.2.1 Fence Fabric

Provide fence fabric conforming to the following requirements.

2.2.1.1 Woven Wire

ASTM A116 [No. 9 farm] [No. 12-1/2 close mesh] [No. 14-1/2 wolf-proof] [No. 13 poultry and garden] [No. 14-1/2 chick] fence; grade, size as indicated.[Provide fittings that conform to ASTM F626.]

2.2.1.2 Barbed Wire

****

NOTE: Use either aluminum-coated or PVC-coated barbed wire for project locations with Environmental Severity Classifications (ESC) C3 thru C5; ESC C1 and C2 locations can use zinc-coated steel. Use PVC-coated barbed wire in areas where coatings are prone to abrasion from blowing sand. See UFC 1-200-01 for determination of ESC for project locations.

****

[ASTM A121 aluminum-coated, Type A,][ASTM F1665 PVC-coated, Class 2b,][ASTM A121 zinc-coated, Type Z, Class 3] with 12.5 gauge wire with 14 gauge, round, 4-point barbs spaced no more than 125 mm 5 inches apart.

2.2.2 Gates

****

NOTE: Show type of gates on the drawings, including degree of swing required. In heavy use conditions overhead slide gates should be considered if clearances permit, because these gates require less maintenance and repair than cantilever gates.

Ground level track and roller systems should be avoided in climates where snow and ice may accumulate. Recessed tracks should never be used in climates where the recess may fill with ice and snow. Where gates are to receive electric locks, the gate post foundations should be lowered to frost depth to help prevent misalignment of the lock components.

****

****

NOTE: Include PVC coating on steel gate frames in locations with ESC C3 thru C5, and high humidity locations. Also, use PVC-coated steel gate frames in areas prone to metal loss caused by blowing sand. High humidity locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

Provide gate type and swing shown conforming to ASTM F900 or ASTM F1184, ASTM A153/A153M. Provide gate frames conforming to strength and coating requirements of ASTM F1083 for Group IA, steel pipe, nominal pipe size (NPS) 1-1/2. [Provide polyvinyl chloride-coated steel pipe gate frames(Group IA)(Group IC), a nominal pipe size (NPS) 1-1/2, conforming to ASTM F1043. Polyvinyl chloride coating to be minimum thickness 0.25 mm 0.01 inch, fused and adhered to the exterior zinc coating of the framing members.] Provide gate leaves more than 2.44 m 8 feet wide with either intermediate members and diagonal truss rods or tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 2.44 m 8 feet wide with truss rods or intermediate braces. Provide intermediate braces on all gate frames with an electro-mechanical lock. Attach gate fabric to the gate frame by method standard with the manufacturer. Welding is not permitted. Furnish latches, hinges, stops, keepers, rollers, and other hardware items as required for the operation of the gate. Arrange latches for padlocking so the padlock is accessible from both sides of the gate. Provide stops for holding the gates in the open position.

2.2.3 Posts

2.2.3.1 Metal Posts for Farm Style Fence

****

NOTE: For line posts: use zinc-coated finish on T-sections or U-sections in project locations with ESC C3 thru C5. Use enamel paint finish in project locations with ESC C1 or C2.

When using steel pipe end and corner posts: include PVC coating on zinc-coated steel pipe posts and railings in locations with ESC C3 thru C5, and high humidity locations. Also use PVC coating on zinc-coated steel pipe posts in areas where coatings are prone to abrasion from blowing sand and where posts are buried in direct contact with soil, regardless of the ESC of the project location. High humidity locations are those in ASHRAE climate zones

0A, 1A, 2A, 3A, 3C, 4C, and 5C (as identified in ASHRAE 90.1).

See UFC 1-200-01 for determination of ESC for project locations.

****

Provide metal line posts conforming to ASTM A702 [zinc-coated][enamel paint finish], [T-section] [U-Section], length as indicated, and accessories conforming to ASTM A702.[Provide FS RR-F-191/3 Steel pipe end and corner posts: Class 1, steel pipe, Grade A Regular Strength, in [minimum sizes listed in FS RR-F-191/3 for each class and grade] [size [_____]].[Provide PVC color coating, minimum thickness, 0.25 mm 0.01 inch fused and adhered to the exterior coating of the post or rail in accordance with ASTM F1043; color to match fabric in accordance with ASTM F934.]]

2.2.3.2 Composite Polyester Resin Reinforced Line Posts

****

NOTE: Consider composite posts as an alternative to PVC coated steel line posts in project locations with ESC C4 or C5. See UFC 1-200-01 for determination of ESC for project locations. It should be noted that DoD research has shown composite posts to provide corrosion protection benefits, but a life cycle cost analysis shows these posts do not overcome their higher first costs over the fencing system's service life. Additionally, posts made from these materials are not readily available in all locations; editor should ensure these are readily available in the local area in the sizes needed for the project before specifying. Since composite posts are non-conductive, fence grounding procedures need to be detailed where grounding of the fence is required.

****

Provide polyester resin reinforced line posts produced from unsaturated polyester resin reinforced with E-glass. Fill posts with an appropriate filler material to form a rigid structural support member. Provide posts that meet the strength requirements of ASTM F1043 for heavy industrial fencing. Protect posts from UV and moisture degradation by a protective veil impregnated with resin (0.2 to 0.3 mm 8 to 12 mil minimum) and an acrylic based (0.05 mm 2 mil minimum) coating system. Provide corrosion and ultraviolet resistant posts as demonstrated when exposed to accelerated environmental test chamber for a minimum of 3,600 hours. Ensure posts show no structural failure (i.e., less than 10 percent loss of strength) as a result of exposure to moisture. Test post coating system strength in accordance with ASTM D4541 for 90 percent adhesion strength. Supply posts that are [green] [black] [brown] in color. Provide outside diameter as specified in ASTM F1043 for round steel pipe.

2.2.3.3 Wood Posts

Provide wood posts cut from sound and solid trees free from short or reverse bends in more than one plane. Make tops convex rounded or inclined. Provide posts free of ring shake, season cracks more than 6 mm 1/4 inch wide, splits in the end, and unsound knots. Provide posts of size and shape indicated. Treat posts in accordance with AWPA U1.

[2.2.4 Braces and Rails

****

NOTE: Normally, rails will not be specified except where appearance is important and the added cost is justified. When top rails are not specified, use top tension wire. Use bottom tension wire unless a bottom rail is required for fence. Use brace and rail material and finish to match gate framing members. Use brace and rail material and finish to match gate framing members.

****

ASTM F1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, meeting the strength and coating requirements of ASTM F1043. [Provide braces and rails of [Group IA] [Group IC], steel pipe, size NPS 1-1/4 or Group II, formed steel sections, size 42 mm 1-21/32 inch and be zinc coated (Type A) and polyvinyl chloride-coated conforming to the requirements of ASTM F1043. Polyvinyl chloride coating to be minimum thickness 0.25 mm 0.01 inch, fused and adhered to the exterior zinc coating of the framing members.] Provide Group II, formed steel sections, size 42 mm 1-21/32 inch, that conform to ASTM F1043, if used as braces and rails when Group II line posts are furnished.

]2.2.5 Padlocks

****

NOTE: Type P01 is key operated. Grade 6 is the top grade commercial lock; in Option A the key is captive in cylinder when padlock is unlocked; in Option B the cylinder is removable; Option 6 is environmentally resistant. For combination locks or other options and grades see ASTM F883.

****

Provide padlocks conforming to ASTM F883, TYPE [EPB][_____], size [44 mm 1-3/4 inch][_____]. [Key all padlocks alike]. [Key all padlocks into master key system as specified in Section 08 71 00 DOOR HARDWARE].

2.3 MATERIALS

2.3.1 Concrete

ASTM C94/C94M, using 19 mm 3/4 inch maximum size aggregate, and having minimum compressive strength of 21 MPa 3000 psi at 28 days. Provide grout consisting of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Clearing

Clear the area on each side of the fence as indicated in the plans.

3.1.2 Line and Grade

Install fence to the lines and grades indicated. Space line posts equidistant at intervals not exceeding 3 m 10 feet. Set terminal (corner, gate, and pull) posts at abrupt changes in vertical and horizontal alignment. Provide continuous fabric between terminal posts; however, ensure runs between terminal posts do not exceed 152.4 m 500 feet. Repair any damage to galvanized surfaces, including welding, with paint containing zinc dust in accordance with ASTM A780/A780M.

3.1.3 Excavation

Clear loose material from all post holes. Spread waste material where directed. Eliminate ground surface irregularities along the fence line to the extent necessary to maintain a [25] [50] mm [1] [2] inch clearance between the bottom of the fabric and finish grade.

3.2 INSTALLATION

3.2.1 Installation

Install fence system per approved installation drawings.

3.2.2 Post

For wood posts (Farm Style Fence), excavate to depth indicated and brace post until backfill is completed. Place backfill in layers of 229 mm 9 inches or less, moistened to optimum condition, and compacted with hand tampers or other approved method. Set posts plumb and in proper alignment. Drive metal posts or set in concrete as indicated.

3.2.3 Barbed Wire

Install wire on the side of the post indicated. Pull wire taut to provide a smooth uniform appearance, free from sag. Fasten wire to line posts at approximately 381 mm 15 inch intervals unless indicated otherwise.

3.2.4 Gate Assembly

For farm style fencing, provide standard metal gate assemblies with frame and fittings necessary for complete installation or wood gates as shown.

[3.2.5 Grounding

****

NOTE: Delete this paragraph if grounding is not required. If grounding is required and lightning protection is not part of project design, use the requirements in the second set of brackets in lieu of those in the first set of brackets. Provide fence grounding details when composite type posts are specified where grounding of the fence is required.

****

****

NOTE: Specify solid copper rod for project locations with soil resistivity less than 1,500 ohm-cm. Specify copper clad steel rods for other conditions.

****

[Ground fences crossed by overhead powerlines in excess of 600 volts as specified in Section 26 41 00 LIGHTNING PROTECTION SYSTEM. Ground electrical equipment attached to the fence as specified in [Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION] [Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].] [Ground fences on each side of all gates, at each corner, at the closest approach to each building located within 15 m 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Space grounding locations so as not to exceed 198 m 650 feet. Bond each gate panel with a flexible bond strap to its gate post. Ground fences crossed by powerlines of 600 volts or more at or near the point of crossing and at distances not exceeding 45 m 150 feet on each side of crossing. Use a ground conductor consisting of No. 8 AWG solid copper wire. Use grounding electrodes 19 mm 3/4 inch by 3.05 m 10 foot long [copper-clad steel][solid copper] rod. Drive electrodes into the earth so that the top of the electrode is at least 152 mm 6 inches below the grade. Where driving is impracticable, bury electrodes a minimum of 305 mm 12 inches deep and radially from the fence. Ensure the top of the electrode is not less than 610 mm 2 feet or more than 2.4 m 8 feet from the fence. Clamp ground conductor to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. Test to ensure the maximum total resistance of fence to ground is no greater than 25 ohms.]

]3.3 CLEAN UP

Remove waste fencing materials and other debris from work site daily.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-32 32 23.13 (February 2020)**

Preparing Activity: USACE **Superseding**
UFGS-32 32 23 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SEGMENTAL CONCRETE BLOCK RETAINING WALL

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USACE / NAVFAC / AFCEC **UFGS-32 32 23.13 (February 2020)**

Preparing Activity: USACE **Superseding**
UFGS-32 32 23 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 32 32 23.13

SEGMENTAL CONCRETE BLOCK RETAINING WALL
02/20

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NOTE: This guide specification covers the requirements for segmental concrete block retaining walls. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The following is guidance in selecting the proposed tailoring options:

(1) Contractor Design. Many suppliers have designers that specialize in design of SRW's. Allowing the Contractor to design the system provides the most competitive bidding process. The Contractor has the capacity to select materials for the most efficient design. This is the most favorable design method for typical applications.

(2) Government Design. Non-typical applications

may be best designed before solicitation. Such projects would include applications where the design conditions are beyond the capabilities of commercial software available from SRW suppliers, or applications where the Contractor could not be expected to bid without performing stability calculations during the bidding process. Examples may include bin walls, or structures with unusual loading applications, such as coastal structures, blast resistant structures, or structures in high seismic regions.

(3) Hybrid Design. Much of the civil works Corps of Engineers projects involve conditions where the global stability requires analysis, but the internal, external and compound stability are routine. Such conditions are common on water front structures. Contractor analysis of global stability is not biddable since the analysis may indicate structure definition that could not be assumed during bid. While this could be handled though a modification to the contract, there is a risk that it will be overlooked. Also, experience has shown that it is difficult to specify the degree of work involved in the design analysis (the reason architect-engineer services are negotiated in accordance with the Federal Acquisition Regulation, Part 36). The hybrid design incorporates the advantages of the Contractor designed wall for internal, external and compound stability, while eliminating the conflict of interest in requiring Contractor design of global stability. Changes made to the wall during preparation of shop drawings, such as free standing height, footing embedment, or location could affect the global stability. If the hybrid design method is used, the submittal process should assure that the wall designer reviews the shop drawing submittals, regardless of a Contractor design check for global stability.

NOTE: This section does not address requirements for dewatering, shoring, or earthwork below foundation level.

Geometric requirements such as wall height, length, and construction limits should be shown on the drawings.

****

****

NOTE: For Navy: Use this guide specification for gravity segmental block retaining walls with a height not greater than 4 feet.

****

1.1 UNIT PRICES

1.1.1 Measurement

Measurement of segmental retaining wall for payment will be made on the basis of the face area in the vertical plane of segmental concrete units. The pay lines of the structure will be neat lines taken off the approved shop drawings; and will extend from the block-leveling pad interface to the top of wall, excluding any fencing or barrier. Payment will be made at the respective unit price per square meter (SM) foot (SF) listed on the Bidding Schedule.

1.1.2 Payment

Payment will be full compensation for engineering services, excavation and preparatory work, and furnishing all material, labor and equipment to complete the work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 252	(2009; R 2017) Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications

ASTM INTERNATIONAL (ASTM)

ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete

ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C140/C140M	(2024) Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C1262/C1262M	(2024) Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units
ASTM C1372	(2023) Standard Specification for Dry-Cast Segmental Retaining Wall Units
ASTM D448	(2012; R 2017) Standard Classification for Sizes of Aggregate for Road and Bridge Construction
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1241	(2015) Materials for Soil-Aggregate Subbase, Base, and Surface Courses
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M	(2017) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4595	(2017) Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2020) Standard Test Method for

	Determining Apparent Opening Size of a Geotextile
ASTM D4873/D4873M	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D5321/D5321M	(2020) Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
ASTM D6638	(2011) Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units (Modular Concrete Blocks)
ASTM D6706	(2001; R 2013) Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GG6	(1996) Grip Types for Use in Wide Width Testing of Geotextiles and Geogrids

NATIONAL CONCRETE MASONRY ASSOCIATION (NCMA)

NCMA TR127B	(2010) Design Manual for Segmental Retaining Walls

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA NHI-00-043	(2000) Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines (ISDDC)

1.3 DEFINITIONS

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NOTE: This guide specification only applies to geosynthetic (extensible) reinforcement. There are differences in design and construction applicable to steel soil (inextensible) reinforcement.

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1.3.1 Blocks

Blocks, for the purpose of this specification, refers to segmental concrete retaining wall units.

1.3.2 Drainage Aggregate

Granular soil or aggregate placed within, between, and/or immediately behind segmental concrete units.

1.3.3 Fill

Soil or aggregate placed in, behind, or below the wall.

1.3.4 Reinforced Fill

Soil placed and compacted within the neat line volume of reinforcement as outlined on the plans.

1.3.5 Retained Fill

Soil placed and compacted behind the reinforced fill.

1.3.6 Reinforcement

Geogrid or a geotextile products manufactured for use as reinforcing in segmental block retaining walls. Steel products are not allowed.

1.3.7 Long Term Design Strength

The long term design strength (LTDS) is:

$$LTDS = T_{ult} / (RF_D * RF_{ID} * RF_{CR})$$

where:

T_{ult} is the ultimate strength
RF_D is the reduction factor for chemical and biological durability
RF_{ID} is the reduction factor for installation damage
RF_{CR} is the reduction factor for creep

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G, [_____]

SD-03 Product Data

Segmental Concrete Units; G

SD-04 Samples

Segmental Concrete Units; G, [_____]

Geogrid Reinforcement; G, [_____]

SD-05 Design Data

Calculations; G, [_____]

Survey And Grade Results; G, [_____]

SD-06 Test Reports

Soil Testing; G, [_____]

Reinforcement Testing; G, [_____]

SD-07 Certificates

Supplier Qualifications

Manufacturer's Representative

Geogrid Reinforcement; G, [_____]

Geotextile Reinforcement; G, [_____]

1.5 QUALITY CONTROL

1.5.1 Contractor Qualifications

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NOTE: Modify the qualifications for the project's degree of difficulty. Enforceable project requirements are limited to the number of completed projects, or years experience.

****

Furnish components and equipment from a manufacturer regularly engaged in the manufacturing of products that are of similar material, design and workmanship. Submit descriptive technical data on the blocks, wall caps, masonry adhesive, reinforcement, geotextile filter materials and equipment to be used. Include all material properties specified under PART 2 PRODUCTS. Include a copy of any standard manufacturer's warranties for the products. Provide standard products with satisfactory commercial or industrial use for 2 years before award of this contract. Submit documentation to demonstrate the job foreman or the company directly responsible for the wall installation has[completed a minimum of 10 segmental concrete retaining wall projects][at least 2 years experience].

1.5.2 Supplier Qualifications

****

NOTE: The suggested text is recognized to be somewhat vague. It limits situations were a never-before-used product is proposed, or where a product is proposed for use outside the limitations (such as batter) listed in the manufacturer's literature. The qualifications should be modified for the project's degree of difficulty (e.g. walls over 10 m 30 feet height). Caution to avoid unreasonable qualifications should be exercised if modifying.

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[Submit documentation showing that the installer and supplier meet the qualifications listed. To be considered acceptable, demonstrate experience in the supply of similar size and types of segmental retaining walls on previous projects.]

1.5.3 Manufacturer's Representative

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NOTE: The geosynthetic manufacturers representatives generally have assumed involvement in construction; but that is not necessarily true in all localities. The number of site visits expected by the manufacturer's representative should be quantified if known.

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Provide a qualified and experienced representative from the block or reinforcement manufacturer who is available to consult and conduct site visits on an as-needed basis during the wall construction [at least once during construction] [as requested by the Contracting Officer].

1.6 DELIVERY, STORAGE, AND HANDLING

Check products upon delivery to ensure that the proper material has been received and is undamaged. For geosynthetics, follow the guidelines presented in ASTM D4873/D4873M.

1.6.1 Segmental Concrete Units and Wall Caps

Protect blocks from damage and exposure to cement, paint, excessive mud, and like materials. Check materials upon delivery to assure that the block dimensions are within the tolerances specified.

1.6.2 Geosynthetic Labeling

Label each roll with the manufacturer's name, product identification, roll dimensions, lot number, and date manufactured.

1.6.3 Geosynthetic Handling

Handle and unload geosynthetic rolls by hand, or with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Do not drag, lift by one end, lift by cables or chains, or drop to the ground any geosynthetic rolls.

1.6.4 Geosynthetic Storage

Protect geosynthetics from cement, paint, excessive mud, chemicals, sparks and flames, temperatures in excess of 70 degrees C 160 degrees F, and any other environmental condition that may degrade the physical properties. If stored outdoors, elevate rolls from the ground surface. Protect geosynthetics, except for extruded grids, with an opaque waterproof cover. Deliver to the site in a dry and undamaged condition. Do not expose geotextiles to direct sunlight for more than 7 days.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

This work element includes engineering services in addition to the construction requirements. Provide engineering services that include design of the wall in accordance with the National Concrete Masonry Association design method, and providing shop drawings indicating all features of the complete design.

The NCMA design method for segmental retaining walls considers potential failure modes categorized by external, internal, local, compound, and global stability. The Government has considered the global stability and has provided the minimum design requirements on the drawings. Provide engineering services that include analysis of the wall for all modes of stability and shop drawings indicating all features of the complete design.

2.1.1 Design Requirements

****

NOTE: The NCMA and FHWA design methods are nearly identical. They differ primarily in the treatment of the vertical component of active earth pressure and the connection strength. The current FHWA design results in a conservative connection strength

that only a small number of products meet. The FHWA design method is less commonly used, except in transportation related projects. The FHWA design method may be required for works within highway right-of-way.
****

Complete all stability analyses in accordance with either the NCMA TR127B, or the Federal Highway Administration/AASHTO method detailed in FHWA NHI-00-043. Follow only one method for the complete design, including reinforcement design strength, layout, stability calculations, and seismic effects. Design the segmental retaining wall system under the direction of a professional engineer. Affix engineer's stamp to all drawings.[At least one site visit by the engineer is required during the construction phase.] The design engineer must stamp all drawings and calculations.

2.1.2 Design Parameters

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NOTE: It is recommended that the designer insert the soil properties below for the purpose of establishing a common basis for bidding. Verify that the contract documents provide sufficient information for interpretation of soil conditions below the wall, behind the wall, and at Government furnished borrow locations. Listing soil properties in the specification is optional. An alternative is to provide testing results.

The soil properties listed commonly have a significant influence on the reinforcement design, but are not all inclusive. A soil test is recommended prior to entering data for these parameters. Limiting the parameters to the ones shown in the table is suggested as they are generally representative of a Contractors analysis during bidding. More control over the product can be obtained by specifying soil properties for retained fill, soil properties for foundation soils, and changes in water levels through the retained fill, reinforced fill, and drains. Indicate surcharge loads (live or dead) and location on drawings.

Government selected soil properties will give more control in procuring a prudent design for competitively bid projects. The Government usually has access to all the geologic information that will be available to the Contractor during construction, and often has invested more time in consideration of the data than the Contractor can afford during the bidding process. However, there is a disadvantage to listing the soil properties if the Contractor has the option to change conditions and void the assumptions. The soil properties should not be listed if the borrow source is uncertain.
****

Include in all calculations the determination of long term design strength of reinforcement specific to this project in accordance with the NCMA TR127B or FHWA NHI-00-043. Base the ultimate strength or index strength on the minimum average roll value tensile strength of the product using the wide width strength test in ASTM D4595. Submit design calculations, including computer output data, program documentation, and all items described under PARAGRAPH: SEGMENTAL RETAINING WALL DESIGN.Itemize list of each reduction factor and include backup data to justify each reduction factor included in the calculations. Include analysis of all failure modes listed in the NCMA TR127B. Include a clear outline of material properties and assumptions.[Use the following soil parameters and water elevation for stability analysis, and select additional soil parameters as required to complete the analysis.]

Moist Unit Weight of reinforced fill	[_____] kN/m^3 pcf
Saturated Unit Weight of reinforced fill	[_____] kN/m^3 pcf
Internal Friction Angle of reinforced fill	[30][_____] degrees
Cohesion of reinforced fill	[0][_____] kPa psf
Water Elevation in reinforced fill	[_____] meters feet

2.1.2.1 External Stability Design Requirements

****

NOTE: The minimum base width is an empirical constraint. The minimum base width of 0.7H is the same as FHWA requirements, but slightly exceeding the NCMA requirement of 0.6H.

****

As a minimum requirement, ensure the length of the reinforcing at the base of the wall is no less than 0.7 times the total height of the blocks.

[2.1.2.2 Seismic Design Requirements

****

NOTE: The pseudo static analysis method is only applicable up to A < 0.4 in the NCMA manual, and up to A < 0.29 in the FHWA method. The wall should be Government designed if A exceeds the recommendations of the design method, or if a dynamic analysis is considered necessary. The NCMA Seismic Design Manual references AASHTO and the Canadian Foundation Engineering Manual for sources of the A value. ER 1110-2-1806 (31 July 1995) also contains similar data obtained from the National Earthquake Hazard Reduction Program (NEHRP).

****

Complete the seismic stability analysis in accordance with NCMA TR127B or FHWA NHI-00-043. Assume the pseudo-acceleration value with a 10 percent probability of exceedance in 50 years (referred to as the A value by NCMA and FHWA) is [_____].

]2.1.2.3 Global Stability Design Requirements

Use the requirements listed in Table 1 to determine the minimum long term design strength of the lowest [_____] reinforcement layer[s]. Use reinforcement lengths at least as long as the lengths shown on the drawings.

2.1.3 Layout

Show on the shop drawings (fabrication and installation drawings) all information needed to fabricate and erect the walls including the leveling pad elevations; the shape and dimensions of wall elements; the number, size, type, and details of the soil reinforcing system and anchorage; and identification of areas requiring coping. Include with the shop drawings all items described under paragraph SEGMENTAL RETAINING WALL DESIGN. If approved by the Contracting Officer, shop drawings may consist of marked up contract drawings showing exact dimensions for the blocks supplied, required coping, and other minor revisions. The design and layout of the internal reinforcement are subject to the following:

a. Incorporate all features indicated in the contract documents in the final design and construction.

b. The leveling pad elevations may vary, as long as they are no higher than the embedment depth profile.

c. Run each reinforcement level as continuous as practical throughout the profile. If a geotextile filter is present, layout the reinforcement so that interference with the geotextile is minimized.

d. Identify any reinforcement not placed with the machine direction as the design reinforcement direction on the shop drawings.

e. Do not combine geogrid and geotextile, nor products from different manufacturers, within one wall. Limit the number of reinforcement products to avoid confusion in placement. For walls under 3.5 meters 12 feet high, use reinforcement of the same grade and strength (i.e. design with one reinforcement strength).

2.2 COMPONENTS

2.2.1 Segmental Concrete Units

Submit two samples of each proposed block which is typical of the size, texture, color, and finish.

2.2.1.1 Face color

****

NOTES: The block color or tint can sometimes change noticeably between production runs. If the block color is inconsistent, the wall may show an irregular visible line or pattern where blocks from different production runs merge. If this is important to the architect, it can be specified that all blocks within a wall must come from the same production run. Normally, this is an unnecessary restriction.

****

[Tan/Grey/Brown/Natural Limestone][_____]

2.2.1.2 Face Texture

[Split face typical of broken mortar/brick face][_____]

2.2.1.3 Face Appearance

****

NOTE: Use of blocks with a sculptured face (uneven, beveled, or rounded) usually requires maintaining a half-bond (stacking the vertical joint at the midpoint of the underlying block) for architectural reasons.

****

[Straight, single-surface face/sculptured with 3-surface beveled face/rounded, smooth-curved face][_____]

2.2.1.4 Block Size

A minimum of 0.06 square meters 2/3 square feet of face area, and minimum 150 mm 6 inch height

2.2.1.5 Bond Configuration

No bond configuration is required for straight face blocks. Design beveled or sculptured face blocks to stack with a half-bond (joints located at midpoint of vertically adjacent blocks). Finish the block edges so that vertical joints are flush.

2.2.1.6 Structural requirements

****

NOTES: Durability - AASHTO has proposed specifications for blocks that include compressive strength and absorption (Ref. 1997 Interim Revisions to the Standard Specifications for Highway Bridges). Additional options to increase resistance to chloride attack along roads includes a sloped cap block, surface sealing the completed wall, and higher compressive strength.

Freeze-thaw Testing - The first choice is the default requirement in ASTM C1372, but is not required by the ASTM test (1997) unless testing is required by the specifier. The second choice for 3 percent saline solution is used by the Minnesota Department of Transportation. The specifier should edit this based on the project's location since other states may have different requirements.

The block weight per unit face area is listed as an index statistic to limit pore area and face thickness. Blocks with thin faces and large pore spaces can be damaged by traffic or debris hitting the wall and are less durable. The face thickness and/or pore area can be specified, but the weight per face area is more readily available.

****

Use segmental concrete blocks meeting the requirements of ASTM C1372. or ASTM C94/C94M, except for the following modifications:

a. Minimum 28-day compressive strength of [31 MPa 4000 psi], based on net area in accordance with ASTM C140/C140M.

b. A maximum moisture absorption rate of 145 kg/m^3 9 pcf, in accordance with ASTM C140/C140M.

c. Provide concrete with a minimum oven dry density of 2000 kg/m^3 125 pcf.

d. Provide blocks with a minimum of 400 kg/square meter 80 psf of wall face area (determined without void filling).

e. For freeze-thaw durability tested in accordance with ASTM C1262/C1262M, comply with either of the following: (1) eight loss of each of 5 specimens after 100 cycles is 1 percent or less; or (2) weight loss of each of 5 specimens after 150 cycles is 1.5 percent or less. [when tested in a 3 percent saline solution: (1) weight loss of each of 5 specimens after 40 cycles is 1 percent or less; or (2) weight loss of 4 out of 5 specimens after 50 cycles is 1.5 percent or less.]

2.2.2 Wall Caps

Place segmental concrete block units as caps on top of all segmental concrete retaining walls. Provide cap blocks with a color and texture on exposed faces to match that of the other blocks and meet the requirements for the other blocks except that the minimum height 75 mm 3 inches. Provide cap blocks with abutting edges saw cut or formed to provide tight, flush abutting joints with no gaps in the joints when placed end to end in the alignment shown on the drawings.

2.2.3 Geogrid Reinforcement

****

NOTE: Polyester is susceptible to hydrolysis in alkaline conditions. A high molecular weight and low carboxyl end group number limit the hydrolysis. Normally, a mill certificate or certification of these properties is adequate. The molecular weight of polyester geosynthetics is determined from GSI GRI GG6, "Determination of the Number Average Molecular Weight of Polyethylene Terephthalate (PET) yarns Based on a Relative Viscosity Value", and ASTM D4603, "Determining Inherent Viscosity of Poly(Ethylene Terephthalate) (PET) by Glass Capillary Viscometer." The carboxyl end group number is determined from GSI GRI GG7, "Carboxyl End Group Content of Polyethylene Terephthalate (PET) Yarns."

****

Provide a geosynthetic manufactured for reinforcement applications consisting of a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil, aggregate, or other fill materials. Ensure the geogrid structure is dimensionally stable and able to retain its geometry under manufacture, transport and installation. Ensure the geogrid is manufactured with 100 percent virgin resin consisting of polyethylene, polypropylene, or polyester, and with a maximum of 5 percent in-plant regrind material. Provide polyester resin with a minimum molecular weight of 25,000 and a carboxyl end group number less than 30. Stabilize polyethylene and polypropylene with long term antioxidants.

2.2.4 Geotextile Reinforcement

****

NOTE: Survivability - The AASHTO M 288 requirements are minimum requirements and will not normally control in the product selection. The AASHTO reference can be avoided by listing the grab, tear, burst, and puncture strengths. These properties are listed in AASHTO M 288. The puncture strength (ASTM D4833/D4833M), the trapezoidal tear strength (ASTM D4533/D4533M) and the mullen burst strength (ASTM D3786) are recognized as important geotextile properties. For the intended application, the commonly specified values for puncture, burst and tear seldom control the product selection.

****

Provide geotextile consisting of a pervious sheet of polymeric material with long-chain synthetic polymers composed of at least 95 percent by weight polyethylene, polypropylene, or polyesters. Manufacture the geotextile with 100 percent virgin resin, and with a maximum of 5 percent in-plant regrind material. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages. Provide polyester resin with a minimum molecular weight of 20,000 and a carboxyl end group number less than 50. Stabilize polyethylene and polypropylene with long term antioxidants. For survivability during installation, and in addition to installation damage used in calculating the long term design strength, ensure the geotextile meets the minimum requirements in AASHTO M 288 Class 1, and has a minimum mass per unit area of 270 g/m^2 8 oz/sy.

2.2.5 Reinforcement Properties

****

NOTES: Permittivity - Reinforcement geotextiles should not puddle or impede infiltration or seepage. AASHTO M 288 provides some default guidance.

Geosynthetic Selection - The Federal Acquisition Regulations require full and open competition. Usually justification is not necessary if 3 products meet the specifications. In combining various material requirements, it is easy to specify a geosynthetic product that does not exist. Design utilizing geosynthetics should include a listing with the calculations that verify the specified products are commercially available. The Geosynthetics Fabrics Report magazine publishes an annual specifiers guide that is ideal for this purpose.

****

Provide the reinforcement as shown in the approved shop drawing submittal that meets the long term design strength requirements used in the design, and meets the properties listed in Table 1. Reinforcement strength requirements represent minimum average roll values in the machine direction.

The reinforcement indicated must meet the property requirements listed in Table 1. Reinforcement strength requirements represent minimum average roll values in the machine direction.

The reinforcement indicated must meet the property requirements listed in Table 1. Additional reinforcement shown in the approved shop drawing submittal must meet the long term design strength requirements used in the design as well as other properties listed in Table 1. Submit affidavit certifying that the reinforcement meets the project specifications. Ensure the affidavit is signed by an official authorized to certify on behalf of the manufacturer and is accompanied by a mill certificate that verifies physical properties were tested during manufacturing and lists the manufacturer's quality control testing. [If the affidavit is dated after award of the contract and/or is not specific to the project, attach a statement certifying that the affidavit addressed to the wholesale company is representative of the material supplied.] Include in the documents a statement confirming that all purchased resin used to produce reinforcement is virgin resin. Include in the mill certificate the tensile strength tested in accordance with ASTM D4595. Reinforcement strength requirements represent minimum average roll values in the machine direction.

TABLE 1. REINFORCEMENT PROPERTIES

PROPERTY	REQUIREMENT	TEST DESIGNATION
Permittivity (geotextiles)	[0.5][_____] per second	ASTM D4491/D4491M
UV Resistance	70 percent after 500 HOURS	ASTM D4355/D4355M
Long Term Design	[_____] kN/m lb/inch	NCMA TR127B, Method A
Coefficient of Interaction for Pullout	[.85][_____]	ASTM D6706
Coefficient for Direct Shear	[_____] degrees	ASTM D5321/D5321M

2.2.5.1 Long Term Design Strength

Base the long term design strength on reduction factors for installation damage and durability that are applicable to the fill that will be used. Minimum reduction factors for durability include: 1.1 for polyethylene and polypropylene geosynthetics, 1.15 for coated polyester geogrids, and 1.6 for polyester geotextiles. Use a creep reduction factor consistent with the test procedure used for determining the ultimate strength.

2.2.6 Geotextile Filter

Provide geotextiles used as filters that meet the requirements specified in Table 2. The property values (except for AOS) represent minimum average roll values (MARV) in the weakest principal direction. For survivability during installation, provide geotextile meeting the minimum requirements in AASHTO M 288 Class 2, and has a minimum mass per unit area of 270 g/m^2 8 oz/sy.

TABLE 2. GEOTEXTILE PHYSICAL PROPERTIES

PROPERTY	TEST REQUIREMENT	TEST METHOD
Grab Tensile, N lbs.	[700 160 nonwoven] [1100 250 woven]	ASTM D4632/D4632M
Apparent Opening Size (µm) (U.S. Sieve)	150 - 212 70 - 100	ASTM D4751
Permittivity, sec-1	0.5	ASTM D4491/D4491M

2.3 MATERIALS

2.3.1 Soils and Aggregates

****

NOTE: Drainage Aggregate and Aggregate Base - The designer may substitute a gradation readily available in the locality, such as state standard specifications for road construction.

****

For all material placed as fill, classify material by ASTM D2487 as GW, GP, GC, GM, SP, SM, SC, CL, ML, or SW. Ensure all material used is free of ice; snow; frozen earth; trash; debris; sod; roots; organic matter; contamination from hazardous, toxic or radiological substances; or stones larger than 3 inches in any dimension. Obtain material entirely from one borrow source, unless the Contracting Officer determines that quality control is adequate and the alternate source produces material that is similar in gradation, texture, and interaction with the reinforced and retained fill. Supply any testing required by the Contracting Officer to evaluate alternate sources. Provide materials of a character and quality satisfactory for the purpose intended.

2.3.1.1 Drainage Aggregate

Meet the requirements of ASTM D448, size No.7.

2.3.1.2 Aggregate Base Material

For the wall leveling pads, meet the requirements of ASTM D1241, gradation C.

2.3.1.3 Reinforced Fill

Provide soil placed in the reinforced fill zone consisting of granular material with less than [5][15] percent passing the 75 µm No. 200 sieve.

2.3.1.4 Retained Fill

Provide soil placed in the retained fill zone consisting of granular material with less than [5][15] percent passing the 75 µm No. 200 sieve.

2.3.2 Masonry Adhesive

Provide masonry adhesive meeting the following requirements:

a. ASTM C920, Type S, Grade NS, Class 25

b. Recommendations of the block manufacturer

2.3.3 Drainage Pipe

Provide corrugated polyethylene pipe drainage pipe meeting requirements of AASHTO M 252.

PART 3 EXECUTION

3.1 EXAMINATION

Examine site prior to installation. Perform classification of soil materials in accordance with ASTM D2488. The Contracting Officer reserves the right to revise the Contractor classifications. In the case of disagreement, the Contracting Officer's classification governs unless the soils are classified in accordance with ASTM D2487. All testing completed by the Contractor in conjunction with soil material classification is incidental to the contract work.

3.2 PREPARATION

Prepare the leveling pad and reinforced fill zone to bear on undisturbed native soils, or acceptably placed and compacted fill. In the event that it is necessary to remove material to a depth greater than specified or to place fill below the leveling pad not otherwise provided for in the contract, notify the Contracting Officer prior to work and an adjustment in the contract price will be considered in accordance with the contract.

3.2.1 Excavation

Excavate foundation soil as required for leveling pad dimensions and reinforcement placement shown on the construction drawings. Stockpile material for backfilling in a neat and orderly manner at a sufficient distance from the banks of the excavation to avoid overloading and to prevent slides or caving. Perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Dispose of surplus material, waste material, and material that does not meet specifications, including any soil which is disturbed by the Contractor's operations or softened due to exposure to the elements and water.

3.2.2 Stockpiles

Keep stockpiles of all material to be incorporated into the work in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grade and seal the ground surface at stockpile locations. Stockpile topsoil separately from suitable backfill material. Protect stockpiles of aggregates and granular soils from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes frozen, saturated, intermixed with other materials, or otherwise out of specification or unsatisfactory for the use intended, then remove and replace affected materials with new material from approved sources at no additional cost to the Government.

3.2.3 Leveling Pad

3.2.3.1 Aggregate Base Leveling Pad

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NOTE: Notification of the Contracting Officer - It is beyond the scope of a specification to provide remedies to all possible problems. If the specification indicates the Contracting Officer must be notified, it is assumed qualified assistance will be utilized to assess the situation when necessary.

****

Compact the subgrade below the leveling pad [90%][95%][100%] laboratory maximum density. Place the aggregate base material in lifts not exceeding 150 mm 6 inches. If the subgrade or aggregate base pumps, bleeds water, or cracks during compaction, notify the Contracting Officer and, if no other changes are directed, replace the aggregate with a concrete leveling pad.

3.2.3.2 Concrete Leveling Pad

Ensure tolerances in screeding are sufficient to place the blocks directly on the leveling pad without mortar, pointing, or leveling course between the blocks and leveling pad.

3.3 INSTALLATION

3.3.1 Block Installation

Construct the wall system components in accordance with the approved shop drawings. Do not incorporate damaged blocks into the retaining wall.

a. Begin block placement at the lowest leveling pad elevation. Place the blocks in full contact with the leveling pad. Place each course of block sequentially for the entire wall alignment to maintain a level working platform for layout of reinforcement and placement of fill.

b. Survey the grade and alignment of the first course and furnish the Survey and Grade Results to the Contracting Officer prior to placing the second course. Include a string line, offset from a base line, or suitable provisions that can be reproduced for quality assurance.

c. Place the blocks with the edges in tight contact. [No gaps are allowed for wall batter and curvature.] Maintain the vertical joints with a minimum 100 mm 4 inch overlap on the underlying block. Adjust coping as required to keep block alignment with a full depth saw cut. No splitting is allowed.

d. Stacking of blocks prior to filling any lower course of block with drainage aggregate is not allowed.

****

NOTE: Wall batter on curves changes the wall (arc) length between courses. Straight face blocks may be laid without maintaining half-bond and are better suited for curved walls. Steep wall batter reduces interference due to unconstant arc length on curves.

The NCMA design manual is only applicable to wall batter between 0 and 15 degrees (about 1H:4V).
****

e. Engage blocks to the block below by use of keys, lips, pins, clips, or other reliable mechanism to provide a consistent wall batter [between 1H:6V and 1H:16V][_____].

f. Join cap units [and the top two course of blocks] using masonry adhesive. Take care to keep adhesive from coming into contact with the face of wall units.

3.3.2 Reinforcement Installation

a. Before placing reinforcement, compact the subgrade or subsequent lift of fill and grade level with the top of the blocks. Ensure the surface is smooth and free of windrows, sheepsfoot impressions, and rocks.

b. Place reinforcement at the elevations and to the extent shown on the construction drawings and the approved shop drawing submittal. Orient reinforcement with the design strength axis perpendicular to the wall face. Spliced connections between shorter pieces of reinforcement are not allowed. Place reinforcement strips immediately next to adjacent strips to provide 100 percent coverage.

c. Install the reinforcement in tension. Pull the reinforcement taut and anchor with staples or stakes prior to placing the overlying lift of fill. Pull the reinforcement to ensure tension is uniform along the length of the wall and consistent between layers.

d. Cover all reinforcement completely with soil so that reinforcement panels do not contact in overlaps. Where the wall bends, place a veneer of fill to a nominal thickness of 75 mm 3 inches to separate overlapping reinforcement.

3.3.3 Fill Placement

****
NOTE: Subparagraph "c." below - Studies have documented rubber tired heavy equipment traveling on geogrids with minimal or no damage. However, it is regarded as poor practice and usually unnecessary. Problematic conditions include coarse crushed gravel and coated geogrids. The intent of the specification is to minimize equipment on the geogrid so that it occurs only when necessary.
****

a. Complete fill placement, including drainage aggregate, to the top of each course of facing blocks prior to stacking the subsequent course of blocks.

b. Place reinforced fill from the wall back toward the fill area to ensure that the reinforcement remains taut. Place, spread, and compact fill in such manner that minimizes the development of wrinkles in or movement of the reinforcement.

c. A minimum fill thickness of 150 mm 6 inches is required prior to operation of vehicles over the reinforcement. Avoid sudden braking and sharp turning. Do not turn tracked equipment within the reinforced fill zone to prevent tracks from displacing the fill and damaging the reinforcement. Do not operate construction equipment directly upon the reinforcement as part of the planned construction sequence. Rubber tired equipment may operate directly on the reinforcement if: the Contractor submits information documenting testing of equipment operating on a similar geogrid product on similar soils, the travel is infrequent, equipment travels slow, turning is minimized, and no damage or displacement to the reinforcement is observed.

d. Place and tamp drainage aggregate directly behind, between, and within the cells of the facing units. Achieve compaction of the drainage aggregate by at least two passes on each lift with a vibratory plate compactor. Take care not to contact or chip the blocks with the compactor. Compact aggregate placed within the block cores and recesses by hand tamping and rodding.

e. At the end of each day, slope the last lift of fill away from the wall in a manner that will allow drainage and direct runoff away from the wall face.

3.3.4 Compaction

Do not place fill on surfaces that contain mud, frost, organic soils, fill soils that have not met compaction requirements, or where the Contracting Officer determines that unsatisfactory material remains in or under the fill. Spread fill and compact in lifts not exceeding the height of one course of blocks.

Compact reinforced and retained fill to 95 percent of the Standard Proctor Density. Exercise care in the compaction process to avoid misalignment of the facing blocks. Do not use heavy compaction equipment (including vibratory drum rollers) within 900 mm3 feet from the wall face.

3.3.4.1 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D698. The maximum density is hereafter abbreviated as the "Standard Proctor" value.

3.3.4.2 Moisture Control

****

NOTE: Moisture content limits for compaction should be included in these paragraphs when necessary for obtaining strength and stability in embankments and fill, for controlling movement of expansive soils and when, in the opinion of the project geotechnical engineer, moisture control is required for the soils being used. Specify an acceptable variation from the optimum moisture if justified from experience with similar soils or where demonstrated from moisture-density tests for the borrow material during planning. Block alignment is sometimes difficult to maintain if cohesive soils are placed wet of optimum in the reinforced fill zone.

****

Maintain control of moisture in the fill to provide acceptable compaction.

Do not disk and plow in the reinforced fill zone. Adjust moisture content of cohesive soils at the borrow source before placement. Add water directly to the reinforced fill zone only under conditions where the soil has sufficient porosity and capillarity to provide uniform moisture throughout the fill during compaction.

3.4 FIELD QUALITY CONTROL

3.4.1 Soil Testing

All testing expenses are the Contractor's responsibility. Inspect and approve testing laboratories in accordance with Section 01 45 00 QUALITY CONTROL prior to commencement of testing. The Contracting Officer reserves the right to direct the location and select the material for samples to be tested and to direct where and when moisture-density tests are performed. Use nuclear density testing equipment in general accordance with ASTM D6938.

3.4.1.1 Transmittal

Submit test results to the Contracting Officer daily. Include test results as a part of contractor's daily report, taking care to note any deficiencies and ask for direction on corrective action required. Furnish of field testing results to the Contracting Officer on a frequent and regular basis, as directed.

3.4.1.2 Corrective Action.

Tests of materials which do not meet the contract requirements (failing test) do not count as part of the required testing. Retest each failure at the same location the failing test was taken. If testing indicates material does not meet the contract requirements, do not place the material represented by the failing test in the contract work or recompact the failing material. It is the responsibility of the Contracting Officer to determine quantity of material represented by the failing test up to the quantity represented by the testing frequency. The Contractor may increase testing frequency in the vicinity of a failing test in order to reduce removal requirements, as approved by the Contracting Officer. Such increases in testing frequency are at the Contractor's expense and at no additional cost to the Government.

3.4.1.3 Testing Schedule

3.4.1.3.1 Moisture-Density Relations

ASTM D698. One test for each material variation[, not less than [_____] tests total].

3.4.1.3.2 In-Place Densities

ASTM D1556/D1556M or ASTM D6938. Not less than 1 test for each 0.67 vertical meters per 100 linear meters 2 vertical feet per 300 linear feet along wall face.

3.4.1.3.3 Sieve Analysis

ASTM C136/C136M. Drainage Aggregate, 1 test for each source.

3.4.2 Reinforcement Testing

****

NOTES: Primary reasons for testing geosynthetics include verification of quality control by the manufacturer, detecting degradation during shipping and storage, and verifying the correct product is supplied. Verification of quality control by the manufacturer and detecting degradation during shipping and storage is not economically justified for small jobs. Unlike reinforcing steel for concrete, geosynthetics are difficult to identify in the field, and even experience personnel can sometimes mistake the product identity of unlabeled material. Testing after delivery to verify the correct product was supplied may be advisable for critical structures. The strength is usually the most critical property to verify an acceptable product is furnished.

For cohesive fill, testing the interaction coefficient in accordance with ASTM D6706 or ASTM D6706 may be justified. The interaction coefficient effects the length required to develop stress in the reinforcement, and thus the embedment length. For granular retained fill, there is very little difference between products so testing is not justified. For cohesive soil, the interaction coefficient is only significant for the upper courses (usually the top 1 m 3 feet). The test is expensive, and is not normally justified (the usual alternative is to make a conservative assumption).

****

All testing expenses are the Contractor's responsibility. Use a commercial testing laboratory selected by the Contractor and approved by the Contracting Officer for all testing. The Contracting Officer reserves the right to direct the location and select the material for samples. Testing data specific to the blocks and reinforcement to be supplied as follows:

a. The shear strength between blocks as established in accordance with NCMA TR127B.

b. The connection strength between the blocks and the reinforcement as established in accordance with ASTM D6638. If the FHWA design method is used, implement the modifications in FHWA NHI-00-043.

c. The coefficient for direct shear of the reinforcement on a soil similar in gradation and texture to the material that will be used for fill in the reinforced zone as established in accordance with ASTM D5321/D5321M.

d. The coefficient of interaction for pull-out resistance of the reinforcement in a soil similar in gradation and texture to the material that will be used for fill in the reinforced zone as established in accordance with ASTM D6706.

TABLE 3. REINFORCEMENT TESTING		
PROPERTY	TEST DESIGNATION	FREQUENCY
Wide Width Strip Tensile Strength	ASTM D4595	[_____]

Modify ASTM D4595 for geogrids considering recommendations in GSI GRI GG6; and express the tensile strength on a unit length basis by substituting n*a for Ws, where:

Ws = specimen width, (mm inches)
n = number of ribs in the sample (must be a whole number)
a = nominal rib spacing for the product tested, (mm inches)

3.4.3 Drainage Pipe

Place drain pipe as indicated on the drawings. Lay drain lines to true grades and alignment with a continuous fall in the direction of flow. Keep the interior of the pipe clean from soil and debris; and cap open ends as necessary.

3.4.4 Construction Tolerances

****

NOTE: The suggested tolerances represent the standard of practice. Tighter tolerances should be specified with caution. Loosen horizontal and vertical tolerance if acceptable. Plumbness and alignment will limit bulging.

****

3.4.4.1 Horizontal

Ensure the top of wall is within [75][__] mm [3][___] inches of the plan location.

3.4.4.2 Vertical

Ensure the top of wall elevations is within [30][___] mm [0.1][___] feet above to [30][___] mm [0.1][___] feet below the prescribed top of wall elevations indicated.

3.4.4.3 Plumbness and Alignment

Ensure the wall batter and alignment offset measured as deviation from a straight edge is within plus or minus [30 mm per 3 meter][_______] [1.25 inches per 10 feet][______] section. Ensure the batter measured from vertical is within [2][_____] degrees of the plan dimension.

3.4.4.4 Block Defects

The blocks will be accepted on the basis of tolerances specified in ASTM C1372.

3.4.4.5 Block Gaps

Ensure gaps between adjacent blocks do not exceed 3 mm 1/8 inches.

3.5 PROTECTION

Protect work against damage from subsequent operations. Remove disturbed or displaced blocks and replace to conform to all requirements of this section. Do not incorporate damaged material into the wall. Upon completion of wall erection, clean the wall face to remove any loose soil deposits or stains.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 84 23 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-32 84 23 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-32 84 23 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-32 84 23 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 32 84 23

UNDERGROUND SPRINKLERS
02/21

****

NOTE: This guide specification covers the requirements for underground sprinkler irrigation systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Irrigation system requirements depend upon rainfall factors for the project area, plant selections, the quality of growth desired, and budgetary constraints. The area factors will be determined by a registered landscape professional. Reference is made to UFC 3-201-02 Landscape Architecture. While the design of a system with pop-up heads may be justified in some geographic areas, bubbler type systems may be required in areas where water conservation methods are being practiced. If source of water supply is from base water main through a service line and water meter, determine amount of water available for irrigation

system from static pressure at point of connection to water main. In many cases, water supply is adequate for short durations only. The amount of water required is determined from the type of turf to be irrigated, climate, terrain, and soil conditions. System piping layout, pipe sizes, and selection and spacing of heads and emitters must provide the required amount of water and complete coverage of the irrigated areas. Provide valves to allow irrigation of each area separately.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.2	(1983; Errata 1992; R 2017) Gages and Gaging for Unified Inch Screw Threads
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1012	(2023) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent
ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C509	(2023) Resilient-Seated Gate Valves for Water Supply Service
AWWA C606	(2022) Grooved and Shouldered Joints
AWWA C901	(2020) Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19mm) Through 3 In. (76 mm), for Water Service

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

ASTM D2287	(2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2774	(2021a) Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	(2020) Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM F441/F441M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR Manual	(10th Edition) Manual of Cross-Connection Control

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(2010) Water Hammer Arresters Standard

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-51145	(Rev D; Notice 1; Notice 2; Notice 3; Notice 4) Flux, Soldering, Non-Electronic, Paste and Liquid

1.2 SYSTEM DESCRIPTION

****

NOTE: In the design of the sprinkler system reference will be made to UFC 3-230-01 Water Storage, Distribution, and Transmission. For a site where specific pipe or material is required or where certain material will not be acceptable, the requirements will be specified and any restricting locations will be shown on the drawings. The following information will be shown on the drawings:

a. An irrigation legend.

b. The extent, size, type, and location of underground sprinkler irrigation system and all appurtenances including all piping, sprinkler heads, emitters, control valves, and controllers. Indicate obstacles that might interfere with the layout or operation of the system. Indicate where pipe under walks and drives must be bored.

c. All required slopes and elevations.

d. Detail of drain pockets.

e. Flow rates and diameter of coverage for individual sprinkler heads and emitters.

f. Minimum irrigation rates.

g. Size, variety, and assembly of backflow prevention units.

h. Number and extent of electrical or hydraulic controller circuits, if required.

i. Automatic valve schedule and timing, along with valve identification key or legend.

****

Provide a system that operates with a minimum water pressure of [_____] kPa psi at connection to [main] [meter] [building] [backflow prevention device] and [_____] kPa psi at the last head in each zone. Submit Design Analysis and Calculations verifying that system will provide the irrigation requirements.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Sprinkler System

SD-03 Product Data

Framed Instructions

Field Training

Sprinkler System

Spare Parts

Design Analysis and Calculations

SD-06 Test Reports

Field Tests

SD-07 Certificates

Sprinkler System

SD-10 Operation and Maintenance Data

Sprinkler System; G, [_____]

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity, and temperature variation; direct sunlight (in the case of plastic or rubber materials); and dirt, dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than the start of the field tests. Include with the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer who has produced similar systems that have performed well for a minimum period of 2 years prior to bid opening. Furnish equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Secure a plate to each item of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.1.3 Additional Stock

Provide the following extra stock: Two sprinkler heads of each size and type, two valve keys for operating manual valves, two wrenches for removing and installing each type of head, two quick coupler keys and hose swivels, and four irrigation controller housing keys.

2.2 PIPING MATERIALS

****

NOTE: Select piping materials according to project requirements. Verify soil and water conditions onsite, use proper materials where corrosion

problems exist.
****

2.2.1 Copper Tubing and Associated Fittings

Provide tubing coforming to requirements of ASTM B88M ASTM B88, Type K. Provide fittings conforming to ASME B16.22 and ASME B16.18, solder joint. Provide solder conforming to ASTM B32, 95-5 tin-antimony. Provide flux conforming to CID A-A-51145, Type I. Design grooved mechanical joints and fittings for no less than 862 kPa 125 psig service and that are the product of the same manufacturer. Provide ductile iron grooved fitting and mechanical coupling housing conforming to ASTM A536. Use gaskets in grooved joints that are molded synthetic polymer of pressure responsive design and conforming to ASTM D2000 for circulating medium up to 110 degrees C 230 degrees F. Provide grooved joints conforming to AWWA C606. Use steel coupling nuts and bolts in grooved joints and conforming to ASTM A183.

2.2.2 Red Brass Pipe and Associated Fittings

Furnish pipe conforming to requirements of ASTM B43, regular. Provide fittings that are Class 250, cast bronze threaded conforming to the requirements of ASME B16.15.

2.2.3 Galvanized Steel Pipe and Associated Fittings

****
NOTE: Use of pipe is limited to fixed shrub head risers and reduced pressure type backflow preventers.
****

Provide pipe conforming to requirements of ASTM A53/A53M, Schedule 40. Provide Class 150 fittings conforming to requirements of ASME B16.3.

2.2.4 Polyvinyl Chloride (PVC) Pipe, Fittings and Solvent Cement

****
NOTE: PVC pipe may be used where frost line is less than 300 mm 12 inches deep or in areas where piping system can be winterized. Use Schedule 40 PVC fittings with solvent weld; do not use threaded Schedule 40 pipe. For risers use brass pipe or Schedule 80 PVC pipe with Schedule 80 PVC threaded fittings. Locate all risers away from walks. Use solvent cement for unthreaded PVC pipe and fittings. ASTM D1785, PVC 1120, Schedule 40 is Type I, Grade 1 and wall thickness of Schedule 40. ASTM D1785, PVC 1120, Schedule 80 is Type I, Grade 2 and wall thickness of Schedule 80. ASTM D2241, PVC 1120, SDR 21 is Type I, Grade 1 and standard dimension ratio of 21.
****

2.2.4.1 PVC Pipe

Provide pipe conforming to the requirements of ASTM D1785, PVC 1120 Schedule [40] [80]; or ASTM D2241, PVC 1120 SDR 21, Class 200.

2.2.4.2 PVC Fittings

Provide solvent welded socket type fittings conforming to requirements of ASTM D2466, Schedule 40. Provide threaded type fittings conforming to requirements of ASTM D2464, Schedule 80.

2.2.4.3 Solvent Cement

Provide solvent cement conforming to the requirements of ASTM D2564.

2.2.5 Polyethylene (PE) Plastic Piping

Provide pipe conforming to AWWA C901, outside diameter base with dimension ratio (DR) of 9.3 to provide 1034 kPa 150 psi minimum pressure rating. Provide fittings conforming to ASTM D3261, DR of 9.3.

2.2.6 Dielectric Fittings

****

NOTE: Provide dielectric fittings between copper and ferrous metal piping materials.

****

Provide dielectric fittings conforming to ASTM F441/F441M, Schedule 80, CPVC threaded pipe nipples, 100 mm 4 inch minimum length.

2.2.7 Emitter Hose and Distribution Tubing

Provide emitter hose and distribution tubing conforming to ASTM D2287, maximum inside diameter of 13 mm 1/2 inch, minimum wall thickness of 2.286 mm 90 mils, vinyl plastic extruded from non-rigid chloride, integrally algae-resistant, homogeneous throughout, smooth inside and outside, free from foreign materials, cracks, serrations, blisters and other effects. Provide slip fittings.

2.3 SPRINKLER AND EMITTER HEADS

2.3.1 Pop-Up Spray Heads

2.3.1.1 General Requirements

Pop-up spray heads lay flush with housing, then pop up when water pressure 138 kPa 20 psi is activated in system. The rising member supporting the nozzle must be identical on full, half, third or quarter pattern sprinklers so that nozzles will be interchangeable. Design the sprinkler head to be adjustable for coverage and flow. Provide removable nozzle so head does not have to be removed for flushing or cleaning. Nozzle rises a minimum of 100 mm 4 inches above the body. Construct the body with a 13 mm 1/2 inch female thread for installation in a fixed underground pipe system.

2.3.1.2 Shrubbery Sprinkler Heads

****

NOTE: Shrubbery sprinkler heads are recommended for flower beds, shrubs, and ground covers.

****

Provide conical spray sprinkler heads with adjustable or non-adjustable coverage and designed for permanent aboveground mounting on riser or pop-ups at a height compatible with ground covers. Provide brass nozzles.

2.3.2 Rotary Pop-Up Sprinklers

****

NOTE: Rotary pop-up sprinklers lay flush with housing, then pop up when water pressure is activated in system. Head rotates to direct water spray over a pattern of 360 degrees or a prescribed arc. Primarily used for watering large turf area.

****

Provide sprinklers that are capable of covering [_____] m feet diameter at [_____] kPa psi with a distribution rate of [_____] L/second gpm, [_____] pop-up, trajectory of [_____], and maximum height of spray of [_____]. Construction must be high impact molded plastic with filter screen, reducible watering radius, and choice of [_____] nozzles and have adjustable radius capabilities.

2.3.3 Bubbler Sprinkler Heads

****

NOTE: A water outlet that does not spray water but permits water to bubble and flow to surrounding plants.

****

Provide multiple-spray bubbler heads with adjustable flow and designed for permanent aboveground mounting on risers.

2.3.4 Surface Connected Lawn Sprinkler Heads

Provide impulse type heads with or without sled, ring, or wheel base; multiple T Type; a rotary type with sled, spike or wheel base; or oscillating type with wheel or sled base.

2.3.5 Emitter Heads

****

NOTE: Emitter head is an outlet device that permits water to drip or trickle from small tubings. Drip irrigation is frequent, slow application of water to specific root zone area of plants. The goal is to provide a constant level of subsurface moisture to the root ball of plant for most favorable growth.

****

Provide self-cleaning, pressure compensating diaphragm with one or six self-piercing barbed outlets emitter heads; each capable of emitting from 1 to 8 L/hour 1/4 to 2 gallons/hour flow. Flurnish emitter body ultraviolet stabilized, algae, and heat resistant plastic construction.

2.4 VALVES

2.4.1 Gate Valves, Less than 80 mm 3 Inches

Provide gate valves conforming to the requirements of MSS SP-80, Type 1, Class 150, [threaded] [soldered] ends.

2.4.2 Gate Valves, 80 mm 3 Inches and Larger

Provide gate valves conforming to the requirements of AWWA C509 and have encapsulated resilient wedge, parallel seats, non-rising stems, and open by counterclockwise turning. End connections must be flanged. Interior construction of valves must be bronze including stem containing a maximum 2 percent aluminum and maximum 16 percent zinc.

2.4.3 Angle Valves, Less Than 65 mm 2-1/2 Inches

Provide angle valves conforming to the requirements of MSS SP-80, Type 3, Class 150 [threaded] [soldered] ends.

2.4.4 Angle Valves, 65 mm 2-1/2 Inches and Larger

Provide angle valves conforming to the requirements of MSS SP-85, Type II, Class 250 [threaded] [flanged] ends.

2.4.5 Quick Coupling Valves

****

NOTE: A quick coupling device is an effective method of keeping sprinkler out of the way when not in use, eliminating the possibility of damage, injury or theft.

****

Provide quick coupling valves consisting of brass parts and is a two-piece unit consisting of a coupler water seal valve assembly and a removable upper body to allow spring and key track to be serviced without shutdown of main. Provide lockable vinyl lids with spring for positive closure on key removal.

2.4.6 Remote Control Valves, Electrical

****

NOTE: An activated open and shut-off device for controlling water flow to sprinkler branch line.

****

Provide remote control valves that are solenoid actuated globe valves of 19 to 80 mm 3/4 to 3 inch size, suitable for [24] [_____] volts, [60] [50] cycle, and designed to provide for shut-off in event of power failure. Valve must be cast bronze or brass or plastic housing suitable for service at 1034 kPa 150 psi operating pressure with external flow control adjustment for shut-off capability, external plug at diaphragm chamber to enable manual operation, filter in control chamber to prevent valve body clogging with debris, durable diaphragm, and accessibility to internal parts without removing valve from system.

2.4.7 Drain Valves

2.4.7.1 Manual Valves

Furnish manual valves conforming to requirements of MSS SP-80, Type 3, Class 150 [threaded] [soldered] ends for sizes less than 65 mm 2-1/2 inches and MSS SP-85, Type II, Class 250 [threaded] [flanged] ends for sizes 65 mm 2-1/2 inches and larger.

2.4.7.2 Automatic Valves

****

NOTE: This saves water to prevent draining 50 to 100 mm 2 to 4 inch diameter lines during irrigation cycles and avoid continuously saturated soil at drain joints. Automatic drains are necessary for cold climate areas to prevent freeze damage to sprinklers and pipes. PVC or ABS drain valves may be used with PVC systems.

Delete automatic drains for warm climate areas.

****

Furnish automatic valves that are brass or plastic, spring loaded ball drip type, Class 150 150 pounds and threaded ends, designed to close at 18 kPa 6 foot pressure head with positive seal at 21 kPa 3 psi pressure or greater and be open to drain at less than 21 kPa 3 psi pressure.

2.4.8 Pressure Regulating Master Valve

****

NOTE: Master valve automatically reduces a higher inlet pressure to a constant lower pressure regardless of supply fluctuations.

****

Provide pressure regulating master valve that is automatic mechanical self-cleaning, self-purging control system having an adjustable pressure setting operated by a solenoid on alternating current with [0.70] [_____] amperes at [18] [24] volts. Valve must close slowly and be free of chatter in each diaphragm position, have manual flow stem to adjust closing speed and internal flushing, and [one] [two] inlet tappings capable of being installed as a straight pattern valve. Provide cast bronze or brass body with removable brass seat serviceable from top without removing valve body from system. Operate valve at 1034 kPa 150 psi working pressure and pilot range from 70 to 875 kPa 10 to 125 psi.

2.4.9 Backflow Preventers

****

NOTE: Backflow preventer is designed to keep contaminated water from flowing back into potable water distribution system when some temporary abnormality in system causes higher pressure in contaminated part of system than in potable water piping.

****

Test, approve, and list reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers in accordance with FCCCHR Manual. Furnish backflow preventers with intermediate atmospheric vent in accordance with ASSE 1012. Furnish reduced pressure principle backflow preventers in accordance with ASSE 1013.

2.4.9.1 Pressure Type Vacuum Breaker

****

NOTE: Vacuum breaker is designed to prevent back siphonage only, and is not effective against backflow due to back pressure. A vacuum breaker located above flood elevation is adequate when located aboveground and higher than highest sprinkler head.
****

Provide vacuum breaker conforming to the requirements of ASSE 1020 and consisting of [bronze] [brass] construction, with one or two check valves, vacuum relief, inlet and discharge shut-offs valves, field test cocks, and vacuum relief opening of greater diameter than unit.

2.4.9.2 Reduced Pressure Type Backflow Preventers

****
NOTE: Reduced pressure type backflow preventer is designed to prevent either back siphonage or back pressure from causing a reverse flow and subsequent contamination of potable water piping. Delete this requirement when system is connected to non-potable water supply system, or when sewage is injected into sprinkler system. When effluent pumps are down, add a fresh water connection with a reduced pressure backflow preventer.
****

Provide backflow preventers that are Class [150] [_____] [150] [_____] pound flanged [cast iron], [bronze] [brass] mounted gate valve [and strainer], [304] [_____] stainless steel or bronze, internal parts. Total pressure drop through complete assembly must be a maximum of 70 kPa 10 psi at rated flow. Provide [red brass] [galvanized steel] pipe and fittings. Provide strainers consisting of bronze or brass construction with gasket caps. Provide units that have 200-mesh stainless steel screen elements.

2.5 ACCESSORIES AND APPURTENANCES

2.5.1 Valve Keys for Manually Operated Valves

Provide valve keys that are 13 mm 1/2 inch diameter by 1 m 3 feet long, tee handles and keyed to fit valves.

2.5.2 Valve Boxes and Concrete Pads

2.5.2.1 Valve Vaults

Provide valve boxes that are cast iron, plastic lockable, or precast concrete[manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION] for each gate valve, manual control valve and remote control valve. Use adjustable vault sizes. Cast the word "IRRIGATION" on the cover. Shaft diameter of vault must be minimum 130 mm5-1/4 inches. Cast iron vault must have bituminous coating.

2.5.2.2 Concrete Pads

Provide concrete pads that are precast[manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION] or cast-in-place reinforced concrete construction for reduced pressure type backflow preventers.

2.5.3 Pressure Gauges

Provide pressure gauges conforming to requirements of ASME B40.100, single style pressure gauge for water with 115 mm 4-1/2 inch dial brass or aluminum case, bronze tube, gauge cock, pressure snubber, and siphon. Scale range must be suitable for irrigation sprinkler systems.

2.5.4 Service Clamps

Provide service clamps that are bronze flat, double strap, with neoprene gasket or "O"-ring seal.

2.5.5 Water Hammer Arresters

Provide water hammer arrester conforming to the requirements of PDI WH 201; stainless steel construction with an encased and sealed bellows compression chamber.

2.5.6 Emitter Head Accessories

2.5.6.1 Strainer

Provide strainer at inlet to each drip line. Provide strainer with stainless steel screen having equivalent of 140-mesh filtration capacity and incorporate flush valves within strainer to clean screen without disassembling unit.

2.5.6.2 Pressure Regulator

Provide pressure regulator at each drip system if supply pressure exceeds 350 kPa 50 psi.

2.5.6.3 Riser Adapters

Provide riser adapters with a rigid piping system.

2.5.6.4 Tubing Stakes

Provide plastic coated steel tubing stakes, or other non-corrosive strong material to secure tubing.

2.5.6.5 Emitter Outlet Check Valve (Bug Cap)

Provide check valves at end of each emitter outlet distribution line. Permit free flow of water with minimum restriction; prevent back siphoning, entry of insects, and contamination into outlet ports.

2.5.6.6 Access Sleeve

Provide access sleeve at buried emitters placed in covered boxes. Secure lids of access sleeve with removable lugs. Secured drip hose in both vertical and horizontal axis.

2.5.6.7 Closure Caps

Provide closure caps in accordance with manufacturer's recommendations.

2.6 AUTOMATIC CONTROLLERS, ELECTRICAL

****

NOTE: Automatic electrical controller is used to control timing and quantity of water to sprinkler or emitter heads. Use 3 to 60 minutes for sprinkler heads and 0 to 3 hours for emitter heads.

****

Provide controller conforming to the requirements of NEMA ICS 2 with [120] [220]-volt single phase service, operating with indicated stations, and grounded chassis. Provide enclosure conforming to NEMA ICS 6 Type 3R, with locking hinged cover, [pedestal-mounted] [wall-mounted]. Program controller for various schedules by setting switches and dials equipped with the following features: A switch for each day of week for [one] [two] [three] schedules, allowing each station to be scheduled individually as to days of watering; a minute switch for each station with a positive increment range of [3 to 60 minutes] [0 to 3 hours], set time within one percent; a switch allowing selected schedules to be repeated after each completion of initial watering schedule and allowing each operation to be scheduled throughout a 24-hour day; a circuit breaker for surge protection; and circuit for a 9-volt rechargeable NiCad battery.

2.7 ELECTRICAL WORK

Provide wiring and rigid conduit for electrical power in accordance with NFPA 70, and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.8 CONCRETE MATERIALS

Furnish concrete with a compressive strength of [17] [_____] MPa [2500] [_____] psi at 28 days as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.9 WATER SUPPLY MAIN MATERIALS

Provide tapping sleeves, service cut off valves, and connections to water supply mains in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

2.10 INSULATING JOINTS

Provide insulating joints and dielectric fittings in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install Sprinkler System after site grading has been completed. Perform excavation, trenching, and backfilling for sprinkler system in accordance with the applicable provisions of Section 31 00 00 EARTHWORK, except as modified herein.

a. Submit detail drawings for valves, sprinkler heads, backflow preventers, automatic controllers, emitter heads, and water hammer arresters. Include on the drawings a complete list of equipment and materials, and manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Also show on the drawings complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function as a unit. Show on the drawings proposed system layout, type and number of heads and emitters, zone valves, drain pockets, backflow devices, controllers, and mounting details of controllers.

b. Submit detailed procedures defining the Contractor's provisions for accident prevention, health protection, and other safety precautions for the work to be done. Submit the material supplier's or equipment manufacturer's statement that the supplied material or equipment meets specified requirements. Each certificate must be signed by an official authorized to certify in behalf of material supplier or product manufacturer and must identify quantity and date or dates of shipment or delivery to which the certificates apply. Include As-built Drawings which provide current factual information showing locations of mains, heads, valves, and controllers including deviations from and amendments to the drawings and changes in the work.

c. Submit [6] [_____] copies of operation and [6] [_____] copies of maintenance manuals for the equipment furnished. One complete set prior to field testing and the remainder upon acceptance. Manuals must be approved prior to the field training course. Detail the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features.

d. List routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include piping and equipment layout, simplified wiring and control diagrams of the system as installed, and system programming schedule.

3.2.1 Trenching

Hand excavate trench around roots to pipe grade when roots of 50 mm 2 inches diameter or greater are encountered. Provide trench width of 100 mm 4 inches minimum or 1.5 times diameter of pipe, whichever is wider. Hand tamp backfill over excavation. When rock is encountered, excavate trench 100 mm 4 inchesdeeper and backfill with silty sand (SM) or well-graded sand (SW) to pipe grade. Keep trenches free of obstructions and debris that would damage pipe. Do not mix subsoil with topsoil. Bore existing concrete walks, drives and other obstacles at a depth conforming to bottom of adjacent trenches. Provide pipe sleeves for bored pipe that is two pipe diameters larger than sprinkler pipe.

3.2.2 Piping System

3.2.2.1 Cover

Install underground piping to meet the minimum depth of backfill cover specified.

3.2.2.2 Clearances

Provide minimum horizontal clearances between lines of 100 mm 4 inches for pipe 50 mm 2 inches and less; 300 mm 12 inches for 65 mm 2-1/2 inches and larger. Provide 25 mm 1 inch minimum vertical clearances between lines.

3.2.2.3 Minimum Slope

Provide minimum slope of 50 mm per 10 m 6 inches per 100 feet in direction of drain valves.

3.2.3 Piping Installation

3.2.3.1 Polyvinyl Chloride (PVC) Pipe

a. Provide solvent-cemented joints conforming to the requirements of ASTM D2855.

b. Provide full cut threaded joints with a maximum of three threads remaining exposed on pipe and nipples. Make threaded joints tight without recourse to wicks or fillers, other than polytetrafluoroethylene thread tape.

c. Join piping to conform with requirements of ASTM D2774 or ASTM D2855, and pipe manufacturer's instructions. Install pipe in a serpentine (snaked) manner to allow for expansion and contraction in trench before backfilling. Install pipes at temperatures over 5 degrees C 40 degrees F.

3.2.3.2 Soldered Copper Tubing

Ream pipe and remove burrs. Clean and polish surfaces of joint. Apply flux to male and female ends. Insert end of tube into fittings full depth of socket. After soldering, show a solder bead continuously around entire joint circumference. Remove excess acid flux from tubings and fittings.

3.2.3.3 Threaded Brass or Galvanized Steel Pipe

Prior to installation, ream pipe. Cut threads in conformance with ASME B1.2. Apply pipe joint compound to male end only.

3.2.3.4 Insulating Joints

Provide insulating and dielectric fittings where pipes of dissimilar metal are joined and at connections to water supply mains as shown. Install in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.2.3.5 Grooved Mechanical Joints

Prepare grooves according to the coupling manufacturer's instructions. Furnish grooved fittings, couplings, and grooving tools that are products of the same manufacturer. Provide pipe and groove dimensions complying with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Measure and record groove width and dimension of groove from end of pipe for each change in grooving tool setup to verify compliance with the coupling manufacturer's tolerances. Do not use grooved joints in concealed locations.

3.2.4 Installation of Valves

3.2.4.1 Manual Valves

Install valves in a valve box extending from grade to below valve body, with a minimum of 100 mm 4 inches cover measured from finish grade to top of valve stem.

3.2.4.2 Automatic Valves

Set valve plumb in a valve box extending from grade to below valve body, with minimum of 100 mm 4 inch cover measured from grade to top of valve. Install automatic valves beside sprinkler heads with a valve box.

3.2.4.3 Drain Valves

Entire system must be manually or automatically drainable. Equip low points of system with drain valve draining into an excavation containing 0.03 cubic meter 1 cubic foot gravel. Cover gravel with building paper then backfill with excavated material and 150 mm 6 inches of topsoil.

3.2.5 Sprinklers and Quick Coupling Valves

Install sprinklers and valves plumb and level with terrain.

3.2.6 Installation of Drip Irrigation System

3.2.6.1 Emitter Hose

Bury emitter laterals [150] [_____] mm [6] [_____] inches deep. Solvent weld connections in accordance with manufacturer's recommendation to standard weight Schedule 40 PVC fittings and bushings. Install hose in a serpentine manner. When cutting hose, use a shearing tool such as a pipe cutter, knife, or shears. Follow manufacturer's recommended tool and procedures when punching hose for emitters.

3.2.6.2 Emitter Heads

****

NOTE: Installation of water emission points of drip irrigation system above soil surface aids visual checking of system for proper operation and reduces system clogging caused by root intrusion.

****

Install emitters in a plastic emitter box. Connect emitter on a rigid PVC nipple to PVC drip lateral with a tee or elbow. Attach tubing to barbed fitting and daylight distribution tubing at root ball secured with stake, with bug cap at end of secured distribution tubing. After installing emitters and before operating system, open end of drip lateral and flush clean. Do not exceed manufacturer's recommendations for the number of emitters on a line for that hose or distribution tubing size and length.

3.2.6.3 Tubing Stakes

Secure main irrigation line with stakes where line is aboveground. Space stakes to ensure that hose does not shift location in presence of foot traffic, operations, gravity on slope installations, or environmental effects. Stake discharge of the emitter distribution tubing to ensure that discharge point of emitter will be maintained at specified position in relation to plant material to be irrigated.

3.2.7 Backflow Preventers

Install backflow preventer in new connection to existing water distribution system, between connection and control valves. Install backflow preventer with concrete pads.

3.2.7.1 Pressure Type Vacuum Breaker

****

NOTE: Install device in an accessible location to facilitate inspection and servicing. Device can be installed on main line to irrigation system upstream of shut-off valves (valves may be located downstream from device).

****

Install pressure type vacuum breaker 300 mm 12 inches above highest head.

3.2.7.2 Reduced Pressure Type

****

NOTE: Install device in an accessible location to facilitate inspection and servicing. To prevent freezing locate device inside a building and pipe the relief valve port through an air gap to a drain. Install the device 300 mm 12 inches, minimum, above grade.

****

Flush pipe lines prior to installing reduced pressure device; protect device by a strainer located upstream. Do not install device in pits or where any part of device could become submerged in standing water.

3.2.8 Control Wire and Conduit

3.2.8.1 Wires

Low voltage wires may be buried beside pipe in same trench. Provide rigid conduit where wires run under paving. Number tag wires at key locations along main to facilitate service. Provide one control circuit for each zone and a circuit to control sprinkler system.

3.2.8.2 Loops

Provide a 300 mm 12 inch loop of wire at each valve where controls are connected.

3.2.8.3 Expansion and Contraction

Bundle and tape multiple tubes or wires together at [3] [6] m [10] [20] foot intervals with 300 mm 12 inch loop for expansion and contraction.

3.2.8.4 Splices

Provide waterproof electrical splices.

3.2.9 Automatic Controller

Determine exact field location of controllers before installation. Coordinate the electrical service to these locations. Install in accordance with manufacturer's recommendations and NFPA 70.

3.2.10 Thrust Blocks

****

NOTE: Install thrust blocks at bends, tee plugs, and valves of 80 mm 3 inch minimum pipe size.

****

Place concrete so that sides subject to thrust or load are against undisturbed earth, and valves and fittings are serviceable after concrete has set. Provide thrust blocks as specified in Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.2.11 Backfill

3.2.11.1 Minimum Cover

****

NOTE: Depths of cover are 300 mm 12 inches for laterals and 450 mm 18 inches for mains in warm climate areas. Use 600 mm 24 inches for mains and laterals where piping can be drained in cold climate areas to protect pipe from frost. Consult local conditions in cold climates to protect against freezing of supply mains.

****

Depth of cover must be [300] [600] [_____] mm [12] [24] [_____] inches for 32 mm 1-1/4 inch pipe or smaller; [300] [450] [600] [_____] mm [12] [18] [24] [_____] inches for 40 to 50 mm 1-1/2 to 2 inch pipe; [450] [600] [_____] mm [18] [24] [_____] inches for 65 mm 2-1/2 inch pipe or larger; [1000] [_____] mm [36] [_____] inches for pipes under traffic loads, farm operations, and freezing temperatures; and [300] [450] mm [12] [18] inches for low-voltage wires. Fill remainder of trench or pipe cover to within 80 mm 3 inches of top with excavated soil, and compact soil with plate hand-held compactors to same density as undisturbed adjacent soil.

3.2.11.2 Restoration

****

NOTE: Insert the section number and title for the restoration of pavements.

****

Fill top 80 mm 3 inches topsoil and compact with same density as surrounding soil. Restore lawns and plants in accordance with Sections 32 92 19 SEEDING, 32 92 23 SODDING, 32 92 26 SPRIGGING, and Section 32 93 00 EXTERIOR PLANTS. Restore pavements in accordance with Section [_____].

3.2.12 Adjustment

After grading, seeding, and rolling of planted areas, adjust sprinkler heads flush with finished grade. Make adjustments by providing new nipples of proper length or by use of heads having an approved device, integral with head, which will permit adjustment in height of head without changing piping.

3.2.13 Disinfection

Disinfect sprinkler system fed from a potable water system upstream of backflow preventer in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.2.14 Cleaning of Piping

Prior to the hydrostatic and operation tests, flush the interior of the pipe with clean water until pipe is free of all foreign materials. Flushing and cleaning out of system pipe, valves, and components is not complete until witnessed and accepted by Contracting Officer.

3.3 FRAMED INSTRUCTIONS

Post framed instructions, containing wiring and control diagrams under glass or in laminated plastic, where directed. Frame condensed operating instructions, prepared in typed form, as specified above and posted beside the diagrams. Post the framed instructions before acceptance testing of the system. Submit labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation. After as-built drawings are approved by Contracting Officer, prepare controller charts and programming schedule. Supply one chart for each controller. Chart must be a reduced drawing of actual as-built system that will fit the maximum dimensions inside controller housing. Use black line print for chart and a different pastel or transparent color to indicate each station area of coverage. After chart is completed and approved for final acceptance, seal chart between two 0.505 mm 20 mil pieces of clear plastic.

3.4 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members for a total period of [_____] hours of normal working time and starting after the system is functionally complete but prior to final acceptance tests. Submit information describing training to be provided, training aids to be used, samples of training materials to be provided, and schedules and notification of training. Cover all of the items contained in the operating and maintenance manuals.

3.5 FIELD TESTS

****

NOTE: Delete leakage tests if water supply service main is not part of contract.

****

Provide all instruments, equipment, facilities, and labor required to conduct the tests. Submit performance test reports, in booklet form, showing all field tests performed to adjust each component; and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of control valves.

3.5.1 Hydrostatic Pressure Test

Test piping hydrostatically before backfilling and proved tight at a hydrostatic pressure of 1034 kPa 150 psi without pumping for a period of one hour with an allowable pressure drop of 35 kPa 5 psi. If hydrostatic pressure cannot be held for a minimum of 4 hours, make adjustments or replacements and repeat the tests until satisfactory results are achieved and accepted by the Contracting Officer.

3.5.2 Leakage Tests

Perform leakage tests for service main in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.5.3 Operation Test

At conclusion of pressure test, install sprinkler heads or emitter heads, quick coupling assemblies, and hose valves and test entire system for operation under normal operating pressure. Operation test consists of the system operating through at least one complete programmed cycle for all areas to be sprinkled.

3.6 CLEANUP

Upon completion of installation of system, remove all debris and surplus materials resulting from the work.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 84 24 (August 2011)**

Change 1 - 05/17

Preparing Activity: NAVFAC **Superseding**

UFGS-32 84 24 (May 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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IRRIGATION SPRINKLER SYSTEMS

08/11, CHG 1: 05/17

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 84 24 (August 2011)**
Change 1 - 05/17

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SECTION 32 84 24

IRRIGATION SPRINKLER SYSTEMS
08/11, CHG 1: 05/17

****

NOTE: This guide specification covers the requirements for irrigation sprinkler systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Some paragraphs may need to be supplemented to meet project requirements.

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Std 598	(2009) Valve Inspecting and Testing

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.2	(1983; Errata 1992; R 2017) Gages and Gaging for Unified Inch Screw Threads
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1010	(2021) Performance Requirements for Water Hammer Arresters
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies
ASSE Series 5000	(2022) Cross-Connection Control Professional Qualification Standard

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C511	(2017; R 2021) Reduced-Pressure Principle Backflow Prevention Assembly
AWWA C651	(2023) Standard for Disinfecting Water Mains
AWWA C901	(2020) Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19mm) Through 3 In. (76 mm), for Water Service
AWWA M14	(2024) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2287	(2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

ASTM D2774	(2021a) Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	(2020) Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM F441/F441M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR List	(continuously updated) List of Approved Backflow Prevention Assemblies

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-51145	(Rev D; Notice 1; Notice 2; Notice 3; Notice 4) Flux, Soldering, Non-Electronic,

Paste and Liquid

UL SOLUTIONS (UL)

UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

1.2 RELATED REQUIREMENTS

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NOTE: Use only when using water pumps.

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Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section, with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

This system is designed with a water pressure minimum of [_____] kPa pounds per square inch (psi) maximum of [_____] kPa psi at connection to main [meter] [building] [backflow prevention device] and [_____] kPa psi at the last head in each zone.[Provide a system pressure calculations and irrigation requirements of the area.] If pressure falls above or below indicated values, Contractor shall notify Contracting Officer. For Irrigation Sprinkler System, indicate the following:

a. Head, piping, valve, [controller], [sensor] layout. Provide separate hydrozones for plant materials with different water requirements.

b. Pipe, valve, backflow preventer, and controller.

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NOTE: Use the following in freeze-thaw climates only.

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c. Invert elevations. Indicate obstructions interfering with operation.

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NOTE: At the text below, if source of water supply is from station water system through a service line and water meter, determine amount of water required for station irrigation system from static pressure at point of connection of station main. These factors are essential in designing for system pressure. In many cases, water supply is adequate for short durations only. Provide adequate valves for each zone to irrigate an area effectively.

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d. Water source equipment, including existing mains, piping, valves and meters.

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NOTE: At the text below, the system pressure and irrigation requirements of the area are determined from water supply, static pressure, soil, plants, freezing conditions, elevation changes, and wind

direction and velocity.
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e. System and supply pressures.

f. Indicate wiring diagram between existing power source and controller/water pump.

g. Number and extent of control valve circuits.

h. Provide details of all irrigation components and accessories.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

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NOTE: Delete the following except in Design/Build

projects.
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Irrigation Sprinkler System

Drawings including irrigation legend prepared by a licensed, registered or certified Landscape Architect or Irrigation Specialist.

SD-03 Product Data

Piping Materials, tubing, and fittings

Valves and Accessories

Sprinkler Heads

Backflow Preventers

Automatic Controller

Controller Enclosure

Solvent Cement

Control Wiring

Drip Irrigation Equipment and ccessories

Water Hammer Arresters

Water Meter

Rain Shut-Off Device

Freeze Shut-Off Device

Soil Moisture Sensor

Tapping Tee

Valve Boxes and Lids

Drip Head Accessories

SD-05 Design Data

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NOTE: If source of water supply is from station water system through a service line and water meter, determine amount of water required for station irrigation system from static pressure at point of connection of station main. These factors are essential in designing for system pressure. In many cases, water supply is adequate for short durations only. Provide adequate valves for each zone to irrigate an area effectively.
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NOTE: The system pressure and irrigation requirements of the area are determined from water supply, static pressure, soil, plants, freezing conditions, elevation changes, and wind direction and velocity.

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System Pressure Calculations

Irrigation Requirements

SD-06 Test Reports

Valves, and Accessories Tests

Backflow Preventers

Pressure Test

Operation Test

Including verification of sprinkler head layout

Submit record of pressure tests conducted on recording gage.

SD-07 Certificates

Backflow Preventers

ASSE Series 5000, Submit a certificate of Full Approval or a current Certificate of Approval from FCCCHR List for size, and make of backflow preventer being provided for this project. A Certificate of Provisional Approval will not be acceptable.

SD-08 Manufacturer's Instructions

Automatic Controller

Sprinkler Heads

Piping Materials

Tubing and fittings.

Backflow Preventers

Valves

Solvent Cement

Control Wiring

Drip Irrigation and accessories

Water Hammer Arresters

Water Meter

Rain Shut-Off Device

Freeze Shut-Off Device

Soil Moisture Sensor

Submit mounting details for automatic controllers.

SD-10 Operation and Maintenance Data

Piping Materials and Fittings, Data Package 2; G, [_____]

Sprinkler Heads and Accessories, Data Package 2; G, [_____]

Backflow Preventers, Data Package 2; G, [_____]

Valves, Data Package 2; G, [_____]

Automatic Controller, Data Package 2; G, [_____]

Drip Irrigation and Accessories, Data Package 2; G, [_____]

Water Hammer Arresters, Data Package 2; G, [_____]

Water Meter, Data Package 2; G, [_____]

Rain Shut-Off Device, Data Package 2; G, [_____]

Freeze Shut-Off Device, Data Package 2; G, [_____]

Soil Moisture Sensor, Data Package 2; G, [_____]2

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Include troubleshooting procedures with respect to valve and controller problems.

SD-11 Closeout Submittals

Controller Charts

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver materials in original rolls, packages, cartons, and containers with the name of manufacturer, brand, and model. Inspect materials delivered to the site for damage.

1.5.2 Storage

Store materials on site in enclosures or under protective covering. Store [plastic piping and] rubber gaskets under cover out of direct sunlight. Do not store materials directly on ground. Keep inside of pipes and fittings free from dirt and debris.

1.5.3 Handling

Handle and carry pipe, fittings, valves, and accessories in such a manner as to ensure delivery to trench in sound undamaged condition. Do not drag pipe.

1.6 EXTRA STOCK

a. [2] [_____] additional sprinkler heads (nozzles, bodies, screens, pressure compensating devices) of each size and type;

[b. [2] [_____] valve keys for operating manual valves;

] c. [2] [_____] wrenches for removing and installing each type of head;

[d. [2] [_____] quick coupler keys and hose swivels;

] e. [4] [_____] irrigation controller housing keys.

f. [4] [_____] irrigation controller enclosure keys; and

g. [2] [_____] hand-held remotes compatible with controller system.

1.7 QUALITY ASSURANCE

1.7.1 Required Test

Submit tests signed by an authorized official of a testing laboratory of sprinkler head, valve, automatic controller, emitter heads, vacuum breaker, backflow preventer, and water hammer arrester.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

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NOTE: Select material with copper, brass, steel, PVC, and PE, according to project requirements. Verify soil and water conditions on site, use copper or plastic pipe where corrosion problems exist.

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2.1.1 Copper Tubing and Associated Fittings

2.1.1.1 Tubing

ASTM B88MASTM B88, Type K.

2.1.1.2 Fittings

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NOTE: Sn 95 and Sn 94 are alloy grades with 95 and 94 percent tin base alloy. Both grades composed of 0.10 percent lead intended for potable water systems. A maximum of 0.20 percent lead in alloy is suitable for drinking. Type I flux is used for tin-lead solders for joining metal except aluminum.

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ASME B16.22 and ASME B16.18, solder joint. Solder, ASTM B32 alloy Grade Sn95 or Sn94. Flux, CID A-A-51145, Type I.

2.1.2 Red Brass Pipe and Associated Fittings

2.1.2.1 Pipe

ASTM B43, regular.

2.1.2.2 Fittings

ASME B16.15, Class 250, cast bronze threaded.

2.1.3 Galvanized Steel Pipe and Associated Fittings

2.1.3.1 Pipe

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NOTE: Schedule 40 is standard weight pipe. Use of pipe is limited to fixed shrub head risers and reduced pressure type backflow preventers.

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ASTM A53/A53M, Schedule 40.

2.1.3.2 Fittings

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NOTE: Class 150 is pressure temperature rating of 1034 kPa at 177 degrees C 150 psi at 350 degrees F.

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ASME B16.3, Class 150.

2.1.4 Polyvinyl Chloride (PVC) Pipe, Fittings and Solvent Cement

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NOTE: PVC pipe may be used where frost line is less than 300 mm 12 inches deep.

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NSF/ANSI 14, seal of approval for potable water.

2.1.4.1 Pipe

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NOTE: ASTM D1785, PVC 1120, Schedule 40 is Type I, Grade 1 with 13.8 MPa 2.000 psi hydrostatic design stress, and wall thickness of Schedule 40. ASTM D1785, PVC 1120, Schedule 80 is Type I, Grade 2 with 13.8 MPa 2.000 psi hydrostatic design stress, and wall thickness of Schedule 80. ASTM D2241, PVC 1120, SDR 21 is Type I, Grade 1 with 13.8 MPa 2,000 psi hydrostatic design stress, and standard dimension ratio of 21.

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ASTM D1785, PVC 1120 Schedule [40] [80]; or ASTM D2241, PVC 1120 SDR 21, [Class 315][Class 200].[Provide integral lavender-color pipe for non-potable use.][Provide ultra-violet resistant piping for on-grade use.]

2.1.4.2 Fittings

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NOTE: At the text below, use Schedule 40 PVC fittings when solvent welded. Do not use threaded Schedule 40 pipe.

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a. Solvent Welded Socket Type: ASTM D2466, Schedule 40.[Provide lavender-colored fittings.][Provide ultra-violet resistant fittings.]

b. Threaded Type: ASTM D2464, Schedule 80.[Provide lavender-colored fittings.][Provide ultra-violet resistant fittings.]

2.1.4.3 Solvent Cement

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NOTE: Use for unthreaded PVC pipe and fittings.

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ASTM D2564.

2.1.5 Polyethylene (PE) Plastic Piping

2.1.5.1 Pipe

AWWA C901, outside diameter (od) base with dimension ratio (DR) of 9.3 to provide 1034 kPa 150 psi minimum pressure rating.

2.1.5.2 Fittings

ASTM D3261, DR of 9.3.

2.1.6 Dielectric Fittings

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NOTE: Provide dielectric fittings between copper and ferrous metal piping materials.

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ASTM F441/F441M, Schedule 80, CPVC threaded pipe nipples, 100 mm 4 inch length.

2.1.7 Drip Irrigation Tubing

ASTM D2287, maximum inside diameter (id) of [3] [6] [10] [13] [19] [25.40] mm [1/8] [1/4] [3/8] [1/2] [3/4] [one] inch, vinyl plastic extruded from non-rigid chloride, integrally algae-resistant, homogeneous throughout, smooth inside and outside, free from foreign materials, cracks, serrations, blisters and other effects. Provide [slip] [barbed] [compression] fittings.

2.1.8 Pipe Sleeving

a. Provide [PVC] [cast iron] [_____] piping two times the diameter of main or lateral piping.

b. Provide gray PVC electrical conduit sized according to number of control wires. Minimum 50 mm 2 inch size.

2.2 IRRIGATION AND DRIP SPRINKLER HEADS

[Provide lavender-colored body, nozzle, and/or cap indicator for non-potable use.

]2.2.1 Fixed Riser Irrigation Heads

2.2.1.1 Stream Rotors, Full or Part Circle

Sprinkler body, nozzle, and screen constructed of heavy-duty, ultra-violet resistant plastic. Heavy duty, stainless steel internal construction with plastic body.[Provide check valve below each sprinkler body on riser.]

2.2.1.2 Gear Rotor Irrigation Head, Full or Part Circle

Single-stream, water lubricated, gear drive type capable of covering [_____] mm feet radius [_____] kPa psi with distribution rate of [_____] L/s gpm. Part circle sprinkler with an adjustable arc coverage of 0.52 to 6.28 rad 30 to 360 degrees. Stainless steel internal construction with plastic body, with matched precipitation rate nozzles in standard /low/ flat angle trajectories, filter screen, reducible watering radius, and choice of [_____] nozzles.

2.2.1.3 Impact Irrigation Head

Capable of covering [_____] mm feet radius at [_____] kPa psi with a distribution rate of [_____] L/s gpm, and [_____] V pop-up. Provide one or two nozzles to distribute water, an inlet strainer to prevent debris from clogging nozzles, and non-corrosive [brass] [plastic] head and stainless steel assemblies. Seal bearing assembly from abrasives. Provide entire assembly including strainer removable from top of case without disturbing case installation. Provide plastic housing.

2.2.1.4 Spray Irrigation Heads, Full or Part Circle

Capable of covering [_____] mm feet radius at [_____] kPa psi with a discharge rate of [_____] L/s gpm. Sprinkler body, nozzle, and screen constructed of heavy-duty, ultra-violet resistant plastic. Matched precipitation rate [plastic] [brass] nozzle with an adjustable screw capable of regulating the radius and the flow. Capable of housing under the nozzle; protective, non-clogging filter screen and/or pressure compensating devices. Screen used in conjunction with the adjusting screw from regulating.[Provide check valve below each sprinkler body on riser.]

2.2.1.5 Adjustable Flood Bubbler Head

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NOTE: A water outlet that does not spray water but permits water to bubble and flow to the surrounding plants.

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Capable of providing a discharge rate of [_____] L/s at kPa [_____] gpm at psi, operating over a pressure range of 69 to 414 kPa 10 to 60 psi. Constructed of durable ultra-violet resistant plastic with a plastic inlet filter screen to protect the nozzle against clogging, and a stainless steel adjustable screw, capable of shutting off the bubbler and regulating the flow.

2.2.1.6 Pressure Compensating Flood Bubbler Head

Capable of providing a consistent discharge rate of [_____] L/s at kPa [_____] gpm at [_____] psi. Plastic inlet filter screen bubbler assembly to protect the nozzle against clogging. Permanently assembled design constructed of durable, ultra-violet resistant plastic with a integral rubber flow washer for regulating the discharge rate at an operating pressure range of 138 to 621 kPa 20 to 90 psi.

2.2.2 Pop-Up Irrigation Head

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NOTE: Pop-up heads lay flush with the housing, then pop up when the water pressure is activated in system.

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2.2.2.1 Stream Rotor Irrigation Head, Full or Part Circle

Sprinkler body, nozzle, and screen constructed of heavy-duty, ultra-violet resistant plastic. Heavy duty, stainless steel internal construction with plastic body. Pop-up height of [75] [100] [150] [300] mm [3] [4] [6] [12] inches as measured from top of cap at normal installation to middle of nozzle orifice.[Provide check valve in head.]

2.2.2.2 Gear Rotor Irrigation Head, Full or Part Circle

Sprinkler body, nozzle, and screen constructed of heavy-duty, ultra-violet resistant plastic. Heavy duty, stainless steel internal construction with plastic body and match precipitation rates for standard low or flat angle trajectories. Single-stream, water lubricated, gear drive type capable of covering [_____] mm feet radius [_____] kPa psi with distribution rate of [_____] L/s gpm. Part circle sprinkler with an adjustable arc coverage of 0.52 to 6.28 rad 30 to 360 degrees. Pop-up height of [75] [100] [150] [300] mm [3] [4] [6] [12] inches as measured from top of cap at normal installation to middle of nozzle orifice. Provide wiper seal that positively seals against nozzle flange to keep debris out of rotor and cleans debris from pop-up steam as it retracts.[Provide check valve in head.]

2.2.2.3 Impact Irrigation Head

Capable of covering [_____] mm feet radius at [_____] kPa psi with a distribution rate of [_____] L/s gpm. Provide one or two nozzles to distribute water, an inlet strainer to prevent debris from clogging nozzles, and non-corrosive [brass] [plastic] head and stainless steel assemblies. Seal bearing assembly from abrasives. Provide entire assembly including strainer removable from top of case without disturbing case installation. Provide plastic housing. Pop-up height of [75] [100] [150] [300] mm [3] [4] [6] [12] inches as measured from top of cap at normal installation to middle of nozzle orifice.

2.2.2.4 Spray Irrigation Head, Full or Part Circle

Capable of covering [_____] mm feet radius at [_____] kPa psi with a discharge rate of [_____] L/s gpm. Sprinkler body, nozzle, and screen constructed of heavy-duty, ultra-violet resistant plastic with wiper seal. [Brass] [Plastic] nozzle with matched precipitation rate and an adjustable screw capable of regulating the radius and flow. Capable of housing under the nozzle; protective, non-clogging filter screen and/or pressure compensating devices. Screen used in conjunction with the adjusting screw from regulating. Pop-up height of [75] [100] [150] [300] mm [3] [4] [6] [12] inches as measured from the top of cap at normal installation to middle of nozzle orifice.[Provide check valve below each sprinkler body on riser.]

2.2.3 Bubbler Irrigation Head

2.2.3.1 Adjustable Flood Bubbler

Capable of providing a discharge rate of [_____] L/s at kPa [_____] gpm psi. operating over a pressure range of 69 to 414 kPa 10 to 60 psi. Construct of durable ultra-violet resistant plastic with a plastic inlet filter screen to protect the nozzle against clogging, and a stainless steel adjusting screw, capable of shutting off the bubbler and regulating the flow. Pop-up height of [75] [100] [150] [300] mm [3] [4] [6] [12] inches as measured from top of cap at normal installation to middle of nozzle orifice.

2.2.3.2 Pressure Compensating Flood Bubbler

Capable of providing a consistent discharge rate of [_____] L/s at kPa [_____] gpm at psi. Plastic inlet filter screen bubbler assembly to protect the nozzle against clogging. Permanently assembled design constructed of durable, ultra-violet resistant plastic with an integral rubber flow washer for regulating the discharge rate at an operating pressure range of 138 to 621 kPa 20 to 90 psi. Pop-up height of [75] [100] [150] [300] mm [3] [4] [6] [12] inches as measured from top of cap at normal installation to middle of nozzle orifice.

2.2.4 Fixed Drip Head

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NOTE: Drip head is an outlet device that permits water to drip or trickle from small tubings. Drip irrigation is frequent, slow application of water to specific root zone area of plants. The goal is to provide a constant level of subsurface moisture to the root ball for most favorable growth.

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2.2.4.1 Multi-Port Outlet Device

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NOTE: Choose one of the following options

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[Multi-outlet, pressure compensating emitter manifold that is ultra-violet resistant, algae, and heat resistant, non-corrosive PVC material for above or below grade installation. Integral 75 micrometers 200 mesh fabric screen that can be serviced from the top of the unit by unscrewing the top cap. [Six] [eight] [twelve] [_____], [top] [bottom] mounted outlet ports that will accept [3] [6] mm [1/8] [1/4] inch vinyl tubing. The [six] [eight] [twelve] [_____] ports can be accessed through the top of the unit by unscrewing the lid from the base. Each outlet port accepts a pressure compensating emitter controlling the flow from 1.89 to 90.84 0.5 to 24.0 gph per outlet. Operating range of unit is 103 to 345 kPa with 13 mm 15 to 50 psi with 1/2 inch female national pipe thread (FNPT) inlet.

][Multi-outlet, pressure-compensating emitter constructed of a ultra-violet resistant algae and heat resistant, non-corrosive PVC material. Diaphragm/flap constructed of a silicone elastomer material. Pressure-compensated emitter with each outlet delivers a nominal flow of [1.89] [3.79] [7.57] L/h [0.5] [1.0] [2.0] gph at 103 to 345 kPa 15 to 50 psi. [Three] [four] [six] [_____] barbed outlet unit that will accept [3] [6] mm [1/8] [3/4] inch vinyl tubing with continuous "self flushing" emitter feature.

]2.2.4.2 Single Outlet Pressure Compensating Emission Device

[Pressure compensated] emitter body constructed of ultra-violet, algae, heat resistant and chemical resistant, non-corrosive PVC material. Diaphragm constructed of a silicone elastomer material. Capable of delivering a nominal flow rate of [1.89] [3.79] [7.57] [_____] L/h [0.5] [1.0] [2.0] [_____] gph at a pressure range of 103 to 345 kPa 15 to 50 psi. [A self piercing inlet barb type 13 mm 1/2 inch female national pipe thread (FNPT) inlet mounted onto a 13 mm 1/2 inch male national pipe thread (MNPT) riser.] Barbed emitter outlet configuration that will accept [3] [6] mm [1/8] [1/4] inch vinyl tubing.

2.2.4.3 Microspray Device

Capable of covering [0 to 4500] [_____] mm [0 to 15] [_____] feet radius at [_____] kPa psi with a discharge rate of [_____] L/h gph with overall pop-up height of [100] [150] [300] [_____] mm [4] [6] [12] [_____] inches. Sprinkler body, nozzle, and screen constructed of heavy-duty, ultra-violet resistant plastic with wiper seal on sprinkler. Matched precipitation rate [brass] [plastic] nozzle with an adjustable screw capable of regulating the radius and flow and capable of housing under the nozzle; protective, non-clogging filter screens and/or pressure compensating devices. Screen used in conjunction with the adjusting screw for regulating. Mount with 13 mm 1/2 inch female national pipe thread (FNPT) adapter [poly flex riser stake].

2.2.4.4 In-Line Tubing Device

Factory installed, heavy-walled flexible polyethylene (PE) tubing, pressure compensating, self-cleaning emitters at spacings of [300] [450] [600] [_____] mm [12] [18] [24] [36] [_____] inches. Emitter flow of [1.89] [3.79] [7.57] [_____] L/h [0.5] [1.0] [2.0] [_____] gph with inlet pressure of [_____] kPa psi. Tubing diameter of [13] [19] mm [1/2] [3/4] inch.

2.2.5 Pop-Up Drip Head

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NOTE: Drip head is an outlet device that permits water to drip or trickle from small tubings. Drip irrigation is frequent, slow application of water to specific root zone area of plants. The goal is to provide a constant level of subsurface moisture to the root ball of plant for most favorable growth.

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Capable of covering 0 to 4500 mm 0 to 15 feet radius at [_____] kPa psi with a discharge rate of [_____] L/h gph with overall pop-up height of [100] [150] [300] mm [4] [6] [12] inches. Sprinkler body, steam, nozzle, and screen constructed of heavy-duty, ultra-violet resistant plastic with wiper seal on sprinkler. Provide a heavy-duty, stainless steel retract spring for positive pop-down and a ratcheting system for easy alignment of the pattern. Matched precipitation rate [brass] [plastic] nozzle with an adjusting screw capable of regulating the radius and flow and capable housing under the nozzle; protective, non-clogging filter screens and/or pressure compensating devices. Screen used in conjunction with the adjusting screw for regulating. A side and bottom 12.70 mm 1/2 inch female national pipe thread (FNPT) inlet for the [150] [300] mm [6] [12] inch model. Mount with 12.70 mm 1/2 inch female national pipe thread (FNPT) adapter [poly flex riser stake].

2.3 VALVES

[Provide lavender-colored assembly for non-potable use.

]2.3.1 Isolation Valve

2.3.1.1 Ball Valves, Less than 75 mm 3 inches

API Std 598, [brass] [plastic] body, [threaded] [soldered] ends.

2.3.1.2 Gate Valves, 75 mm 3 inches and Larger

AWWA C500, bottom wedging double discs, parallel seats, non-rising stems, open by counterclockwise turning. Provide flanged end connections. Provide bronze interior construction of valves including stem containing a maximum 2 percent aluminum and maximum 16 percent zinc.

2.3.2 Control Valves

2.3.2.1 Pressure Regulating Master Control Valve

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NOTE: Master valve automatically reduces a higher inlet pressure to a constant lower pressure regardless of supply fluctuations

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Automatic mechanical self-cleaning, self-purging control system having an adjustable pressure setting operated by a solenoid on alternating current (ac) with [0.70] [_____] amperes at [18] [24] volts. [Direct current (dc) latching with [_____] amperes at [_____] volts.] Valve shall close slowly and be free of chatter in each diaphragm position. Provide a manual flow stem to adjust closing speed and internal flushing. Provide an adjusting screw for setting pressure and schrader valve for monitoring pressure. Provide [one] [two] inlet tappings capable of being installed as a straight pattern valve. Provide heavy duty [cast iron] [brass] [plastic] valve body with brass seat that is removable and serviceable from top without removing valve body from system. Maximum working pressure of valve is 1034 kPa 150 psi and pilot range from 69 to 862 kPa 10 to 125 psi.

2.3.2.2 Remote Control Valve, Electrical

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NOTE: An activated open and shut-off device for controlling water flow to sprinkler branch line.

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Solenoid actuated [globe] [angle] valves of 20 to 75 mm 3/4 to 3 inch size, [alternating current (ac), 60/50 cycle [_____] amps in rush current and [_____] amps holding current.] [Direct current (dc) latching with [_____] amperes at [_____] volts.] Provide [brass] [plastic] valve housing suitable for service at 1034 kPa 150 psi operating pressure.[Provide pressure regulating module capable of regulating outlet pressure between 103 to 172 kPa 15 to 25 psi (plus or minus) 34 kPa 5 psi and adjustable screw for setting pressure schrader valve connection for monitoring pressure.]

2.3.2.3 Manual Angle Control Valve, Manual Globe Control Valve

Less than 65 mm 2 1/2 inch MSS SP-80, type 3, Class 150 [threaded] [soldered] ends. [Angle] [globe] valve 65 mm 2 1/2 inch and larger MSS SP-85, Type II, Class 250 [threaded] [flanged] ends.

2.3.3 Quick Coupling Valves

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NOTE: A device that permits quick coupling and uncoupling of valves. It is an effective method of keeping sprinkler out of the way when not in use, eliminating the possibility of damage, injury or theft.

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Two piece unit consisting of a coupler water seal valve assembly and a removable upper body to allow spring and key track to be serviced without shutout of main. Provide brass parts. Provide [yellow] [lavender] [vinyl] [rubber] lockable lids with springs for positive closure on key removal.

2.3.4 Hose Bib

One piece consisting of all brass construction with full flow [13] [19] [25.40] mm [1/2] [3/4] [one] inch hose connection outlet and [with attached handle] [removable key handle] with gaskets and washers.

2.3.5 Drain Valves

[2.3.5.1 Manual

MSS SP-80, Type 3, Class 150 [threaded] [soldered] ends for sizes less than 65 mm 2 1/2 inches. MSS SP-85, Type II, Class 250 [threaded] [flanged] ends for sizes 65 mm 2 1/2 inches and larger.

][2.3.5.2 Automatic

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NOTE: Delete automatic drains for warm climate areas. This saves water to prevent draining 50 to 100 mm 2 to 4 inch diameter lines during irrigation cycles and avoid continuously saturated soil at drain joints. Automatic drains are necessary for cold climate areas to prevent freeze damage to sprinklers and pipes.

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Brass, spring loaded ball drip type, 1034 kPa 150 pounds and threaded ends, designed to close at 1.83 m 6 foot pressure head with positive seal at 21 kPa 3 psi pressure or greater and be open to drain at less than 21 kPa 3 psi pressure.

]2.3.6 Backflow Preventers

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NOTE: The purpose of a backflow preventer is to keep contaminated water from flowing back into a potable water distribution system when some abnormality in system causes pressure to be temporarily higher in contaminated part of system than in potable water piping.

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[2.3.6.1 Reduced Pressure Type Backflow Preventers

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NOTE: The purpose of reduced pressure type backflow preventer is to prevent either back siphonage or back pressure from causing a reverse flow and subsequent contamination of potable water supply.

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NOTE: Delete this requirement when system is connected to non-potable water supply system, or when sewage is injected into sprinkler system. When effluent pumps are down, add a fresh water connection with a reduced pressure backflow preventer.

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AWWA C511. Provide backflow preventers complete with 1034 kPa 150 psi rated flanged [cast iron], [bronze] [brass] mounted [gate] [ball] valve [and strainer], [304] [_____] stainless steel or bronze, internal parts. Total pressure drop through complete assembly shall be a maximum of 69 kPa 10 psi at rated flow. Listing of particular make, model/design, and size in FCCCHR List will be acceptable as required proof for testing and certification.

a. Piping Assembly: [Red brass pipe and fittings] [Galvanized steel pipe and fittings].

b. Strainers: Bronze or brass construction with gasket caps. Equip units with 75 micrometers No. 200 mesh stainless steel screen elements.

][2.3.6.2 Pressure Type Vacuum Breaker

****

NOTE: Vacuum breakers are designed to prevent back siphonage only, and are not effective against backflow due to back pressure. A vacuum breaker is adequate when it is located aboveground higher than highest irrigation head and its elevation is above areas which may be flooded.

****

ASSE 1020 [bronze] [brass] construction, with one or two check valves, vacuum relief, inlet and discharge shut-offs valves, and field test cocks, and with vacuum relief opening of greater diameter than unit.

][2.3.6.3 Atmospheric Vacuum Breaker

****

NOTE: Atmospheric Vacuum breakers are designed to prevent back siphonage only, and are not effective against backflow due to back pressure. A atmospheric vacuum breaker is adequate when it is located aboveground higher than highest irrigation head and its elevation is above areas which may be flooded. Locate atmospheric vacuum breaker downstream of the control valve.

****

AWWA M14, vacuum relief, inlet and discharge openings, and with vacuum relief opening of greater diameter than unit.

]2.4 ACCESSORIES AND APPURTENANCES

2.4.1 Tapping Tee

Bronze flat, double strap, with neoprene gasket or "O"-ring seal.

2.4.2 Water Meter

****

NOTE: ASHRAE 189.1 – 2014 requires a water meter with remote communication capabilities. Select the first bracketed option if total irrigated landscape area with controllers exceeds 2322.5 square meters 25,000 square feet.

****

[Provide a submeter in accordance with ASHRAE 189.1.]Meter to include roll sealed register, magnetic drive, straight reading (odometer shall indicate in liters gallons, large numerals, glass lens for legibility,) low flow indicator to detect leaks, tamper proof seal pin to detect theft; sturdy durable, corrosion resistant main case, electrical grounding continuity; nutating disc measuring chamber with minimum head loss.

2.4.3 Drip Head Accessories

2.4.3.1 Strainer

Provide strainer at inlet to each drip control valve assembly. Provide polyester fabric screen attached to a PVC frame having the equivalent of [56] [75] [_____] micrometers [150] [200] [_____] mesh filtration capacity. Compact "Y" body and cap configuration. Incorporate flush valves within strainer to clean screen without disassembling unit.

2.4.3.2 Riser Adapters

PVC material, [threaded] [barbed] [soldered] to attached drip heads to tubing, pop-up irrigation body, or rigid piping and tubing to rigid piping.

2.4.3.3 Tubing Stakes

Plastic, plastic coated steel, or other non-corrosive strong material to secure tubing.

2.4.3.4 Bug Cap

Provide check valves at end of each emitter outlet distribution line. Valves shall permit free flow of water with minimum restriction; prevent back siphoning, entry of insects, and contamination into outlet ports.

2.4.3.5 Subterranean Drip Box and Cover

Construct of ultra-violet resistant PVC. Two slots in bottom of box to allow for installation of distribution tubing onto the emission device.

2.4.3.6 Line Flushing Valve

Construct of PVC with maximum flow rate of 0.95 L/s 15 gpm with minimum flushing water volume of 3.79 liters one gallon at a minimum 28 kPa 4 psi to a maximum 172 kPa 25 psi at a point of discharge.

2.4.3.7 Valve Boxes

[Cast-iron] [precast concrete [manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION]] [plastic] valve box for each isolation valve, control valve, [quick coupling valve] [and] [drain valve]. Provide box sizes that are suitable and adjustable for valve used.

a. Cast the word "IRRIGATION" on cover.

b. Stencil, engrave, or brand controller and valve sequence on remote control valve cover. Letters minimum 10 mm 4 inches height.

2.4.4 Backflow Preventer Accessories

2.4.4.1 Pressure Gages

ASME B40.100, single style pressure gage for water with 113 mm 4 1/2 inch dial, brass or aluminum case, bronze tube, gage cock, pressure snubber, and siphon. Provide scale range suitable for irrigation systems.

2.4.4.2 Water Hammer Arresters

ASSE 1010; stainless steel construction with an encased and sealed bellows compression chamber.

2.4.4.3 Backflow Preventer Enclosure

Frame to be constructed of 4.76 mm 3/16 inch [stainless steel] [steel] angle iron with 38.10 mm 1 1/2 inch No. 9 expanded metal covering. Construct in a [one piece single swing] [two piece double] hinge configuration. Provisions for pad locking and lighting handles. Size to fit backflow assembly to installed. [Color to be [green] [_____].] Lock for enclosure provided by others.

2.4.4.4 Concrete Pads

Cast-in-place reinforced concrete construction for reduced pressure type backflow preventers.

2.4.5 Moisture Sensing Device

2.4.5.1 Automatic Rain Shut-Off Device

One piece, maintenance and adjustment free, reacts to a minimum 3.18 mm 1/8 inch of rain water, unaffected by humidity levels, commercial grade materials, no exposed mechanical switch or electrodes, solid state construction with internal relay operating voltage of 24 to 30 VAC, static charge pretested, maximum switch current of one amp.

2.4.5.2 Automatic Freeze Shut-Off Device

Construct of a PVC cylinder with a sensing element mounted at top of cylinder capable of interrupting the control valve common wire as temperatures approach 0 degrees C 32 degrees F. Operating voltage 24 VAC, maximum current one amp. Static charge protection with snubber network.

2.4.5.3 Soil Moisture Sensor Device

24 VAC, field adjustable and capable of interrupting irrigation cycles for pre-determined moisture level at moisture probe location. Waterproof field adjustment module with bypass switch.

2.4.6 Air/Vacuum Relief

Construct of PVC with a maximum operating pressure of 965 kPa 140 psi.

[2.4.7 Water Booster Package

Booster pump package to be a prefabricated system, pre-piped, pre-wired and mounted on a steel skid base minimum 75 mm 3 inch welded angle iron or channel brackets, hot dipped galvanized, with a minimum 14 mm 9/16 inch holes at each corner for bolting to concrete with anchors. Field assembled pump systems are not acceptable.

2.4.7.1 Pump

Pump to be end suction close coupled or in-line type, bronze impeller and wear rings, bronze shaft sleeve, mechanical seal with high-resist seat, integral flanged suction and discharge connections, keyed motor shaft, back pull-out type, with centerline discharge for automatic venting and Type 304 stainless steel internal parts and fittings.

2.4.7.2 Motor

Motor to be [_____] rpm, [_____] hp, [_____] phase, ball bearing design, stainless steel shaft, non-over loading on full range of the impeller curve without use of the service factor and including rodent and insect screens over the openings. Single phase motors to be totally enclosed fan cooled and open drip-proof with a minimum 1.15 service factor. Three phase motors to be totally enclosed fan cooled, open drip-proof with a minimum 1.15 service factor.

2.4.7.3 Piping and Fittings

Piping and fittings to be flanged spools of Schedule 40 steel and Class 150 weld flanges, hot dipped galvanized after fabrication. Spacer spools to be welded and galvanized. Companion flanges at suction and discharge header connections to be Schedule 40 steel and galvanized.

2.4.7.4 Gages

Gages shall be 65 mm 2 1/2 inch diameter, liquid filled for vibration dampering, 0-200 pounds, stainless steel casing, with brass needle valve shut-off cocks.

2.4.7.5 Butterfly Valve

Butterfly valves and adjustable handles to be sandblasted and epoxy coated, nuts and bolts to be cad plated, shut off valves to be centerline butterfly lug type, wafer style, drilled and tapped, with bronze disc, capable of remaining installed in the piping.

2.4.7.6 Check Valves

A combination pressure reducing and non-slam check valve to be installed with booster pump package to reduce effect of varying suction pressure.

[2.4.7.7 Pump Control Panels

Pump control panels to be 14 gage type UF, type 304 stainless steel with continuous welded seams, door with continuous hinge, all welds passivated to eliminate corrosion, UL listed, NEMA 3R enclosure with holes in bottom to allow for all inlet wiring for main power control accessories and louvers with insect screens on opposite sides for cross ventilation, deadfront, keylockable and padlockable, with main disconnect switch, circuit breaker with adjustable overloads on all legs and adjustable inrush current trip setting on units exceeding 41 amps, heavy duty contactor, 115 volt control circuit transformer with circuit breaker disconnect. A plug-in module type pump start relay shall be mounted and hard wired in the pump panel. A electronic flow switch with 0-60 seconds adjustable time delay relay, mounted and hard wired in the pump panel, to operate as a no-flow safety shut down. NEMA 3R non-fused main disconnect switch, mounted on exterior of pump panel, hard wired to panel circuit breaker.

]][2.4.8 Flow Meter

[25.40] [31] [38] [50] [75] mm[one] [1.25] [1.5] [2] [3] inch flow meter with a minimum [_____] L/s gpm, female national pipe threaded ends and replaceable metering insert. 9 volt direct current output with a pulse rate which is proportional to the L/s gpm, a 0.067 amperes fuse link to protect metering insert and 14 gage output feeder wire to be powered by the controller. Provide [brass] [plastic] meter housing suitable for service at 1034 kPa 150 psi operating pressure.

]2.5 AUTOMATIC CONTROLLER [ELECTRICAL] [SOLAR] [BATTERY]

****

NOTE: ASHRAE 189.1 requires that PERMANENT irrigation systems be controlled by smart controllers that use evapotranspiration (ET) and weather data to adjust irrigation schedules or utilize an on-site rain or moisture sensor that automatically shuts off the system after a predetermined amount of rainfall or moisture is sensed in the soil utlimately meeting the 80 percentminimum ETc for Irrigation Adequacy and not to exceed 10 percent for Irrigation Excess.

EXCEPTION: A temporary irrigation system used exclusively for the establishment of new landscape shall be exempt from this requirement. Temporary irrigation systems shall be removed or permanently disabled at such time that the plant materials are established.
****

Controller must be[as indicated on the Drawings]commercially/industrially rated, [hybid type] [solid state type], for [indoor location] [outdoor location] with [120-volt single phase service with surge protection] [24 VAC solar] [24 VDC solar] [24 VDC battery], operating with indicated stations, and grounded chassis. Provide in an enclosure with locking hinge cover.

2.5.1 Controller Features

a. [_____]-station controller with [_____] independent programs that can run concurrently.

b. Allows an [infinite] [4 to 8] [____] number of cycles per day by placing the program in a looping mode.

c. Ability to be programmed in one second increments, from [one second to 12 hours] [____].

d. A water budgeting capability in all stations within a program in one percent increments from [one percent to 255 percent] [____].

e. A programmable watering calendar ranging from [one to 16] [365 day calendar][[_____] to [_____] days].

f. A single-station timed manual feature that allows a station to be turned on manually for its programmed watering time.

g. A semi-automatic manual cycle feature.

h. A true manual operation with safety shut-off at midnight and indicate which station is on by means of L.E.D.S.i. UL listed, having a re-settable circuit breaker, cadmium plated, weatherproof steel case, and keyed lock.

[j. A qualifying smart controller utilizing [Evapotranspiration (ET) [with no service fees] and weather data to adjust watering schedules] [moisture sensors in the soil].

][k. Provide control for master valve or irrigation pump start up

][l. Have central computer control capability with [the existing central control system on the Base] [the Region's central control system] [_____].

]2.5.2 Controller Enclosure

Controller Enclosure must be [NEMA ICS 2] [NEMA ICS 6 Type 3R] [_____] mounted [as indicated on the Drawings] [on a concrete pad] [_____]. Enclosure must be [indoor wall mounted plastic cabinet] [outdoor pedestal mounted [plastic] [powder-coated metal, color to be [beige] [___]]

[stainless steel][____]].

2.6 ELECTRICAL CIRCUITS

2.6.1 Control Wiring for Electrically Operated Valves

NFPA 70, copper conductor [1.8] [_____] mm [14] [_____] gage wire, Type UF.

2.6.2 Conduit

UL 651, rigid polyvinyl chloride conduit, Schedule 40.

2.7 CONCRETE MATERIALS

[20] [_____] MPa[2500] [_____] psi compressive concrete strength at 28 days as specified under Section 03 30 00 CAST-IN-PLACE CONCRETE.

PART 3 EXECUTION

3.1 INSTALLATION

Install sprinkler system after site grading has been completed.

3.1.1 Trenching

Hand trench around roots to pipe grade when roots of 50 mm 2 inches diameter or greater are encountered. Make width of trench 100 mm 4 inches minimum or 1 1/2 times diameter of pipe, whichever is wider. Backfill and hand tamp over excavation. When rock is encountered, excavate 100 mm 4 inches deeper and backfill with silty sand (SM) or well-graded sand (SW) to pipe grade. Keep trenches free of obstructions and debris that would damage pipe. Do not mix subsoil with topsoil. Bore under existing concrete walks, drives and other obstacles at a depth conforming to bottom of adjacent trenches. Install pipe sleeve, two pipe diameters larger than sprinkler pipe, to fill bore.[Rock will be encountered. Excavate 100 mm 4 inches deeper and backfill with silty sand (SM) or well graded sand (SW) to pipe grade.] Prior to backfilling of trench, Contracting Officer shall verify and approve location of all irrigation heads.

3.1.2 Piping System

3.1.2.1 Clearances

a. Minimum horizontal clearances between lines: 100 mm for 50 mm 4 inches for 2 inch pipe and less; 300 mm for 50 mm 12 inches for 2 inch pipe and more.

b. Minimum vertical clearances between lines: 25 mm one inch.

3.1.2.2 Minimum Pitch

Down 150 mm per 30 m 6 inches per 100 feet in direction of drain valves.

[3.1.2.3 Thrust Blocks

Install thrust blocks at bends, tees, plugs and valves or [63] [_____] mm [2 1/2] [_____] inches and larger mainline piping. Place concrete so that sides subject to thrust or load are against undisturbed earth, and valves and fittings are serviceable after concrete has set.

]3.1.2.4 Minimum Backfill Cover

a. [450] [_____] mm [18] [_____] inches for pressure mainline pipe and valve control wire.

b. [300] [_____] mm [12] [_____] inches for non-pressure lateral pipe.

c. [600] [_____] mm [24] [_____] inches for all piping under paved or non-paved pedestrian paths.

d. [900] [_____] mm [36] [_____] inches for all piping under traffic loads, [farm operations], [freezing temperatures].

e. Install pipe sleeves at depths indicated in "c" and "d".

[Rock will be encountered. Provide minimum 100 mm 4 inches of silty sand (SM) or well graded sand (SW) cover on top of all piping.] Fill remainder of trench or pipe cover to within 75 mm 3 inches of top with excavated soil, and compact soil with plate hand-held compactors to same density as undisturbed adjacent soil.

3.1.2.5 Restoration

****

NOTE: Fill the section number and title for the restoration of pavements in the blank below using proper format per UFC 1-300-02, "Unified Facilities Guide Specifications (UFGS) Format Standard".

****

Fill top 75 mm 3 inches with topsoil and compact with same density as surrounding soil. Restore [turf] and [plants] according to [Section 32 92 19 SEEDING,][Section 32 92 23 SODDING,][Section 32 92 26 SPRIGGING,] [and] [Section 32 93 00 EXTERIOR PLANTS]. [Restore pavements according to [_____]].

3.1.2.6 Sterilization

Sprinkler system fed from a potable water system sterilized upstream of backflow preventer in accordance with AWWA C651. Sterilize new water lines for a minimum of 24 hours to meet [local] [state] [federal] health test requirements before placing in service. Minimum retention period shall be 3 hours.

3.1.3 Piping Installation

3.1.3.1 Polyvinyl Chloride (PVC) Pipe

a. Solvent-Cemented Joints: ASTM D2855.

b. Threaded Joints: full cut with a maximum of three threads remain exposed on pipe and nipples. Make threaded joints tight without recourse to wicks or fillers, other than polytetrafluoroethylene thread tape.

c. Piping: ASTM D2774 or ASTM D2855, and pipe manufacturer's instructions. Install pipe in a serpentine (snaked) manner to allow for expansion and contraction in trench before backfilling. Install pipes at temperatures over 4.5 degrees C 40 degrees F.

3.1.3.2 Soldered Copper Tubing

Ream pipe and remove burrs. Clean and polish contact surfaces of joint. Flux both male and female ends. Insert end of tube into fittings full depth of socket. After soldering, a solder bead shall show continuously around entire joint circumference. Remove excess acid flux from tubings and fittings.

3.1.3.3 Threaded Brass or Galvanized Steel Pipe

Prior to installation ream pipe. Cut threads as specified in ASME B1.2. Make joints with pipe joint compound applied to male end only.

3.1.3.4 Polyethylene (PE) Pipe and Drip Tubing

Bury [drip tubing] [and] [PE pipe] 300 mm 12 inches deep. [Solvent weld] [compression connection] [barbed connection] in accordance with manufacturers recommendation. Install hose in serpentine manner. When cutting hose, use a shearing tool such as a pipe cutter, knife or shears. Use only manufacturer's recommended tool and procedure when installing drip heads.

3.1.3.5 Dielectric Protection

Where pipes of dissimilar metal are joined, make connection with dielectric fitting.

3.1.4 Irrigation Heads

Install plumb and level with terrain. Irrigation heads must not spray directly on or within 1 meter 3-feet of building.

3.1.4.1 Fixed Riser Irrigation Heads

****

NOTE: Fixed risers allowed in planter beds only.

****

Nozzle mounted on fixed riser minimum 150 mm 6 inches above grade in mulched planter beds, 300 mm 12 inches above grade in planter beds with groundcover. Provide swing joint assembly attachment between lateral lines and fixed risers.

3.1.4.2 Pop-Up Irrigation Head

****

NOTE: Pop-ups required along all pedestrian and vehicular and turf edges. Pop-ups required in all turf areas.

****

Install plumb and level with terrain. Provide swing joint assembly attachment between lateral line and pop-up body. Top of irrigation head shall be flush wit surrounding finish grade.[In recreational fields, install all pop-up rotors with stainless steel risers 125 mm 5 inches below finish grade per manufacturer's recommendations.]

3.1.4.3   Drip Heads

****
NOTE: Actual water emission points of drip irrigation system installed above soil surface accomplishes two objectives. It aids visual checking of system for proper operation and it reduces system clogging that can be caused by root intrusion.
****

Install drip heads [in plastic drip box]. Connect drip head to a [rigid PVC nipple] [drip head stake] [directly to tubing]. Attach tubing to barbed fitting and daylight distribution tubing at rootball secured with stake. Add bug cap at end of secured distribution tubing. After installing drip heads and before operating system, open end of drop lateral and flush lines clean. The number of drip heads on a line shall not exceed manufacturer's recommendations for that hose or distribution tubing size and length.

3.1.5   Valves

3.1.5.1   Isolation Valves

Install in a valve box extending from grade to below valve body, with a minimum of 100 mm 4 inches cover measured from finish grade to top of valve stem.

3.1.5.2   Control Valves

Plumb valve in a valve box extending from grade to below valve body, with minimum of 100 mm 4 inch cover measured from grade to top of valve. Install automatic valves beside sprinkler heads with a valve box.

3.1.5.3   Quick Coupling Valves

[Install in a valve box extending from grade to below valve body, with a minimum of 100 mm 4 inches cover measured from finish grade to top of valve stem.][Install 50 mm 2 inches above finish grade in planter bed, level with finish grade in turf areas.]

3.1.5.4   Hose Bibb

Install [above grade] [below grade in valve box] with support.

3.1.5.5   Drain Valves

Entire system shall be manually or automatically drainable. Equip low point of each underground line with drain valve draining into an excavation containing gravel. Cover gravel with building paper. Backfill with excavated material and 150 mm 6 inches of topsoil.

3.1.6   Backflow Preventers

a. Install backflow preventer in new connection to existing water distribution system, between connection and control valves. Install with concrete pads. [Install with concrete pads in turf only.]

b. Flush pipe lines prior to installing device.

c. Device shall not be installed in pits or where any part of the device could become submerged in standing water

d. Install device a minimum of 300 mm 12 inches from trees, walls, fences, structures and other obstructions.

3.1.6.1 Reduced Pressure Backflow Preventer

a. Protect device by a strainer located upstream.

b. Install device a minimum of 300 mm 12 inches between finish grade and bottom of relief port.

[c. Where freezing conditions occur, locate device inside a building and pipe the relief valve port through an air gap to a drain.

][d. Install water meter above grade, upstream of unit of unit as a part of assembly. Provide galvanized steel support with concrete footing.

]3.1.6.2 Pressure Vacuum Breaker

****

NOTE: Install device in an accessible location to facilitate inspection and servicing. The device can be installed on a main line to irrigation system upstream of shut-off valves (valves may be located downstream from device).

****

a. Install device a minimum of 300 mm 12 inches between highest irrigation head and bottom of air relief valve.

[b. Where freezing conditions occur, locate device inside a building and pipe the relief valve port through an air gap to a drain.

]3.1.6.3 Atmospheric Vacuum Breaker

Install device minimum of 300 mm 12 inches between highest irrigation head and bottom of relief valve located downstream of irrigation control valve.

3.1.7 Accessories

3.1.7.1 Connection To Existing Water Supply Systems (Tapping Tee)

Use tapping or drilling machine valve and mechanical joint type sleeves for connections to be made under pressure. Bolt sleeves around mains; bolt valve conforming to AWWA C500 to the branch. Open valve, attach drilling machine, make tap, close valve, and remove drilling machine, without interruption of service. Notify Contracting Officer in writing at least 15 days prior to the date the connections are required; receive approval before any service is interrupted. Provide materials required to make connections into the existing water supply systems and perform excavating, backfilling, and other incidental labor as required. Furnish the labor and the tapping or drilling machine for making the actual connections to the existing systems.

3.1.7.2 Water Meter

Install meter upstream of backflow preventer per manufacturer's recommendations and local PWC Utility Department Instructions.[Plumb meter in a valve box extending from grade to below meter body, with a minimum of 100 mm 4 inch cover measured from top of grade to top of meter.]

3.1.7.3 Valve Boxes and Lids

a. Install with [0.0283] [_____] cubic meters [one] [_____] cu ft pea gravel sump below valve.

b. Support valve box with [brick] [concrete block] [_____].

[c. Provide wire screen between gravel sump and bottom of valve body for rodent protection.

] d. For turf areas, install flush with finish grade.

e. For planter beds, install 50 mm 2 inches above finish grade.

f. For sloped conditions, install valve box level with terrain.

3.1.7.4 Backflow Preventer Enclosure

a. Install with concrete pad.

b. Place hinges so direction of swing will not conflict with other site features.

3.1.7.5 Rain [and] [Freeze] Shut-Off Device[s]

a. Install as per manufacturer's recommendations.

b. For wall mounted controllers, attach device[s] to side of building or eave, minimum 2400 mm 8 feet above finish grade and a minimum of 300 mm 12 inches from building wall or eave.

c. For pedestal mounted controllers, mount [to side of controller housing] [on top of minimum [1050] [_____] mm [42] [_____] inches high pole outside of irrigation coverage in vandal-resistant enclosure].

3.1.7.6 Soil Moisture Sensing Device

a. Bury the device at depth per manufacturer's recommendation in the effective root zone of hydrozone to be monitored.

b. Place a sensor-protection [plate] [indicator] [valve box with cover] above the device.

c. Provide waterproof connection to all field splices in valve boxes.

3.1.7.7 Air/Vacuum Relief Valve

****

NOTE: Provide air relief/vacuum valve at highest point of all pressurized mainline systems. For drip systems, locate at highest point on drip lateral.

****

Locate at highest point in piping system.

3.1.8 Electrical Circuits

Bury wires beside mainline pipe in same trench. Provide gray electrical conduit where wires run under paved or non-paved pedestrian paths and vehicular roads. Tag wires at controller and control valve location with plastic tie wrapped tags. Provide one control wire to each control valve location and one common wire looped from controller to each control valve. Provide one separate control valve wire of a different color from controller to each control valve cluster.

3.1.8.1 Loops

Provide a 300 mm 12 inch loop of wire at each valve where controls are connected.

3.1.8.2 Expansion and Contraction

Bundle multiple tubes or wires and tape together at [3] [6] m [10] [20] foot intervals with 300 mm 12 inch loop for expansion and contraction.

3.1.8.3 Splices

Make electrical splices waterproof. Locate all field electrical splices in valve boxes.

3.1.9 Automatic Controller

Determine exact location of controllers in field before installation. Coordinate the electrical service to these locations. Install in accordance with manufacturer's recommendations and NFPA 70.

3.1.10 Flushing

After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads and valves, flush piping system under a full head of water. Maintain flushing for 3 minutes.

3.1.11 Adjustment

After grading, plant installation, and rolling of planted areas, adjust sprinkler heads flush with finished grade. Make adjustments by providing new nipples of proper length or by use of heads having an approved device, integral with head, which will permit adjustment in height of head without changing piping.

3.1.12 Sterilization

Sprinkler system fed from a potable water system shall be sterilized upstream of backflow preventer in accordance with AWWA C651. Sterilize new waterlines for a minimum of 24-hours, to meet [local], [state], [federal], health test requirements before placing in service. Minimum retention period shall be 3 hours.

3.2 FIELD QUALITY CONTROL

The Contractor will conduct and the Contracting Officer and the QC representative will witness field inspections and field tests specified in this section. Perform field tests, and provide labor, equipment, and incidentals required for testing.

3.2.1 Pressure Test

3.2.1.1 Duration

During pressure test, maintain a hydrostatic pressure of 1034 kPa 150 psi without pumping for a period of one hour with an allowable pressure drop of 35 kPa 5 psi before backfilling system.

3.2.1.2 Leaks

Correct leaks. Make necessary corrections to stop leakage.

3.2.1.3 Retest

Retest system twice until pressure can be maintained for duration of test.

3.2.2 Operation Test

3.2.2.1 Accessories

At conclusion of pressure test, install irrigation heads or drip heads, quick coupling assemblies, and hose bib, and test entire system for operation under normal operating pressure. Make necessary corrections or adjustments to raise or lower pressure for each system if tests results do not match pressure requirements.

3.2.2.2 Acceptance

Operation test is acceptable if system operates through at least one complete cycle for areas to be irrigated.

3.2.3 Controller Charts

Provide one chart for each controller supplied. Indicate in chart area controlled by automatic controller. The chart is a reduction of the actual plan[s] that will fit the maximum dimensions inside controller housing. Use black line print for chart and a different pastel or transparent color to indicate each station area of coverage. After chart is completed and approved for final acceptance, seal chart between two 0.5 mm 20 mil pieces of clear plastic.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-32 92 19 (August 2017)**
Change 1 - 08/21

Preparing Activity: NAVFAC **Superseding**
UFGS-32 92 19 (October 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SEEDING

08/17, CHG 1: 08/21

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-32 92 19 (August 2017)**
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****

SECTION 32 92 19

SEEDING

08/17, CHG 1: 08/21

****

NOTE: This guide specification covers the requirements for seeding.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: The following information must be shown on the project drawings:

1. Clearly indicate all areas to be turfed and if more than one type of turf is specified, delineate areas for each type.

2. All draft turf specifications must be submitted to the cognizant Landscape Architect/Natural Resources Specialist for review to ensure that the specifications are in accordance with environmental conditions peculiar to the project areas.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C602	(2023) Agricultural Liming Materials
ASTM D4427	(2018) Standard Classification of Peat Samples by Laboratory Testing
ASTM D4972	(2018) Standard Test Methods for pH of Soils

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R 1998) Federal Seed Act
DOA SSIR 42	(2022) Kellogg Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report, No. 42, Version 6.0

1.2 DEFINITIONS

1.2.1 Stand of [Turf][_____]

95 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

[Section 31 00 00 EARTHWORK,] [Section 32 84 24 IRRIGATION SPRINKLER SYSTEMS,] [Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS,] [Section 32 92 23 SODDING,] [Section 32 92 26 SPRIGGING,] [Section 32 93 00 EXTERIOR PLANTS,] and Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wood Cellulose Fiber Mulch

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

****

NOTE: In states that require certification, adjust testing requirements to suit local conditions.

****

Topsoil Composition Tests (reports and recommendations).

SD-07 Certificates

State Certification and Approval for Seed

[SD-08 Manufacturer's Instructions

Erosion Control Materials

]1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 [Fertilizer] [Gypsum] [Sulfur] [Iron] [and] [Lime] Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, [fertilizer] [gypsum] [sulphur] [iron] [and] [lime] may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Seed, [Fertilizer] [Gypsum] [Sulfur] [Iron] [and] [Lime] Storage

Store in cool, dry locations away from contaminants.

1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

****

NOTE: Check with the local Agriculture County Extension Service to determine proper planting seasons for specie specified, for the optimum cover depth, and for the proper rate of application for sowing and drilling seed as this rate varies with the specie of seed used and local conditions. Allow for planting period in the construction completion time. Delete time restrictions for continuous growing conditions.

****

1.6.1 Restrictions

Do not plant when the ground is [frozen,] [snow covered,] muddy, or when air temperature exceeds [32] [_____] degrees Celsius [90] [_____] degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 SEED

****

NOTE: The specific species and varieties used should be based on recommendations of the local Agriculture County Extension Service Office.

****

2.1.1 Classification

Provide [State-certified] [State-approved] [Endophyte-enhanced] seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Field mixes will be acceptable when field mix is performed on site in the presence of the [Contracting Officer] [_____].

2.1.2 Planting Dates

Planting Season	Planting Dates
[Season 1]	[_____]
[Season 2]	[_____]
[Temporary Seeding]	[_____]

2.1.3 Seed Purity

Botanical Name	Common Name	Minimum Percent Pure Seed	Minimum Percent Germination and Hard Seed	Maximum Percent Weed Seed
[_____]	[_____]	[_____]	[_____]	[_____]
[_____]	[_____]	[_____]	[_____]	[_____]
[_____]	[_____]	[_____]	[_____]	[_____]

2.1.4 Seed Mixture by Weight

Planting Season	Variety	Percent (by Weight)
[Season 1]	[_____]	[_____]
[Season 2]	[_____]	[_____]
[Temporary Seeding]	[_____]	[_____]

Proportion seed mixtures by weight. Temporary seeding must later be replaced by [Season 1][Season 2] plantings for a permanent stand of grass. The same requirements of turf establishment for [Season 1][Season 2] apply for temporary seeding.

2.2 TOPSOIL

****

NOTE: If topsoil properties are included in another section of Division 31, delete this paragraph and include a cross-reference to the appropriate section. Otherwise, select appropriate paragraphs on topsoil. Check with the local Agriculture County Extension Service Office for soil properties appropriate for the plant materials to be planted. Where suitable topsoil is available within limits of the work area, stripping and stockpiling of topsoil should be included in the applicable section of Division 31 of the specification. If suitable topsoil is not available within the limits of the work area, it should generally be the Contractor's option to either treat the soil of the graded areas with fertilizer and supplements so as to be conducive to turf establishment and maintenance, or to transport topsoil to the project site. Modify pH range for specified turf and geographical requirements.

****

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil must be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph COMPOSITION. Additional topsoil must be [furnished by the Contractor] [obtained from topsoil borrow areas indicated].

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 19 mm 3/4 inch, with maximum 3 percent retained on 6 mm 1/4 inch screen. The pH must be tested in accordance with ASTM D4972. Topsoil must be free of sticks, stones, roots, and other debris and objectionable materials. Other components must conform to the following limits:

Silt	[25-50][7 to 17][_____] percent
Clay	[10-30][4 to 12][_____] percent
Sand	[20-35][70 to 82][_____] percent
pH	[5.5 to 7.0][_____]
Soluble Salts	[600] [_____] ppm maximum

2.3 SOIL CONDITIONERS

****

NOTE: Prior to including these provisions in project specifications, perform tests of on-site topsoil to determine its suitability and the possible need of pH adjusters or soil conditioners. Delete these requirements in developed areas and on small projects where planting is minimal.

****

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Lime

****

NOTE: Use ASTM C602 calcium carbonate equivalent (C.C.E.) as specified in Table 1: for burnt lime, C.C.E. must not be less than 140 percent; for hydrated lime, C.C.E. must not be less than 110 percent; and for limestone, C.C.E. must not be less than 80 percent.

****

Commercial grade [hydrate] [or] [burnt] limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than [_____] percent.

2.3.2 Aluminum Sulfate

Commercial grade.

2.3.3 Sulfur

100 percent elemental

2.3.4 Iron

100 percent elemental

2.3.5 Peat

Natural product of [peat moss] derived from a freshwater site and conforming to [ASTM D4427] [as modified herein]. Shred and granulate peat to pass a 12.5 mm 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.

2.3.6 Sand

Clean and free of materials harmful to plants.

2.3.7 Perlite

Horticultural grade.

2.3.8 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.3.8.1 Particle Size

Minimum percent by weight passing:

4.75 mmNo. 4 mesh screen	95
2.36 mmNo. 8 mesh screen	80

2.3.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.3.9 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 80 percent, calcium 18 percent, sulfur 14 percent; minimum 96 percent passing through 850 micrometers 20 mesh screen, 100 percent passing thru 970 micrometers 16 mesh screen.

2.3.10 Calcined Clay

Calcined clay must be granular particles produced from montmorillonite clay calcined to a minimum temperature of 650 degrees C 1200 degrees F. Gradation: A minimum 90 percent must pass a 2.36 mm No. 8 sieve; a minimum 99 percent must be retained on a 0.250 mm No. 60 sieve; and material passing a 0.150 mm No. 100 sieve must not exceed 2 percent. Bulk density: A maximum 640 kilogram per cubic meter 40 pounds per cubic foot.

2.4 FERTILIZER

****

NOTE: Check with the local Agriculture County Extension Service Office for recommended fertilizer mixture for local conditions.

****

2.4.1   Granular Fertilizer

[Organic][synthetic], granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

[_____] percent available nitrogen
[_____] percent available phosphorus
[_____] percent available potassium
[_____] percent sulfur
[[_____] percent iron

]2.4.2   Hydroseeding Fertilizer

Controlled release fertilizer, to use with hydroseeding and composed of pills coated with plastic resin to provide a continuous release of nutrients for at least 6 months and containing the following minimum percentages, by weight, of plant food nutrients.

[_____] percent available nitrogen
[_____] percent available phosphorus
[_____] percent available potassium
[[_____] percent sulfur
][[_____] percent iron

]2.5   MULCH

****

NOTE: Check with the local Agriculture County Extension Service Office to determine choice of mulch most suitable for the project area. Specify only one type of mulch.

****

Mulch must be free from noxious weeds, mold, and other deleterious materials.

2.5.1   Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw must contain no fertile seed.

2.5.2   Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay must be sterile, containing no fertile seed.

2.5.3   Wood Cellulose Fiber Mulch

****

NOTE: Wood cellulose fiber mulches have been successful on level areas or on slopes with slight grades where sufficient moisture is present to obtain a quick germination of grass seed. The material should be hydraulically applied at the following rates: Areas up to and including 3 to 1 slopes, at the rate of 1,120 kg per 10,000 sq. m 1,000 pounds per acre; areas steeper than 3 to 1 at the rate of 1,568 kg per 10,000 sq. m 1,400 pounds

per acre. It should not be specified for slopes 2 to 1 or greater in areas where drought may prevent germination of the seed or where runoff from heavy rains may cut gullies through the fiber mulch. In these areas use erosion control materials such as specified in paragraph EROSION CONTROL MATERIAL.
****

****
NOTE: Hydraulic mulch is an EPA designated product for recycled content. Recycled content percentages listed are recommended by EPA; additional information can be found on the EPA's "Comprehensive Procurement Guidelines (CPG)" page within EPA's website at http://www.epa.gov.
****

Use recovered materials of either paper-based (100 percent post-consumer content) or wood-based (100 percent total recovered content) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2 [_____]. Use with hydraulic application of grass seed and fertilizer.

2.6 WATER

****
NOTE: When water is Government furnished, locate the source. Recycled or reclaimed irrigation water may be available through a tertiary treatment plant on or off site. It is preferred that this type of water be used for irrigation whenever possible. Check project specific conditions.

Unless otherwise directed, water is the responsibility of the Contractor. Water source must be potable or non-potable. If non-potable edit specification accordingly. Source of water must be approved by the Contracting Officer and must be of suitable quality for irrigation, containing no elements toxic to plant life.

Coordinate information presented here with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.
****

Source of water must be approved by Contracting Officer and of suitable quality for irrigation, containing no elements toxic to plant life.

[2.7 EROSION CONTROL MATERIALS

****
NOTE: The Contractor may propose other types of erosion control material, based on site conditions.
****

Erosion control material must conform to the following:

[2.7.1 Erosion Control Blanket

[100 percent agricultural straw][70 percent agricultural straw/30 percent coconut fiber matrix] stitched with a degradable nettings, designed to degrade within [12 months][18 months].

][2.7.2 Erosion Control Fabric

Fabric must be knitted construction of polypropylene yarn with uniform mesh openings 19 to 25 mm 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips must have a minimum life of 6 months.

][2.7.3 Erosion Control Net

Net must be heavy, twisted jute mesh, weighing approximately 605 grams per meter 1.22 pounds per linear yard and 1200 mm 4 feet wide with mesh openings of approximately 25 mm one inch square.

][2.7.4 Hydrophilic Colloids

Hydrophilic colloids must be physiologically harmless to plant and animal life without phytotoxic agents. Colloids must be naturally occurring, silicate powder based, and must form a water insoluble membrane after curing. Colloids must resist mold growth.

]2.7.5 Erosion Control Material Anchors

Erosion control anchors must be as recommended by the manufacturer.

]PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation prior to planting (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.1.1 Topsoil

Provide 102 mm 4 inches of [off-site topsoil][on-site topsoil][existing soil] to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate [fertilizer] [pH adjusters] [soil conditioners] into soil a minimum depth of [100] [_____] mm [4] [_____] inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 19 mm 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

[3.1.1.2 Soil Conditioner Application Rates

****

NOTE: Check with the local Agriculture County Extension Service and specify amounts applicable for

the project area.

****

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Lime [[_____] kg per square meter [_____] pounds per acre] [[_____] kg per 100 square meters [_____] pounds per 1000 square feet.]

][Sulfur [[_____] kg per square meter [_____] pounds per acre] [[_____] kg per 100 square meters [_____] pounds per 1000 square feet.]

][Iron [[_____] kg per square meter [_____] pounds per acre] [[_____] kg per 100 square meters [_____] pounds per 1000 square feet.]

][Aluminum Sulfate [[_____] kg per square meter [_____] pounds per acre] [[_____] kg per 100 square meters [_____] pounds per 1000 square feet.]

][Peat [[_____] cubic meters per square meter [_____] cubic yard per acre] [[_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet.]

][Sand [[_____] cubic meters per square meter [_____] cubic yard per acre] [[_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet.]

][Perlite [[_____] cubic meters per square meter [_____] cubic yard per acre] [[_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet.]

][Compost Derivatives [[_____] cubic meters per square meter [_____] cubic yard per acre] [[_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet.]

][Calcined Clay [[_____] cubic meters per square meter [_____] cubic yard per acre] [[_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet.]

][Gypsum [[_____] cubic meters per square meter [_____] cubic yard per acre] [[_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet.]

]][3.1.1.3 Fertilizer Application Rates

****

NOTE: Check with the local Agriculture County Extension Service and specify amounts applicable for the project area. Two fertilizer applications may be required when hydroseeding with wood fiber mulch.

****

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Organic Granular Fertilizer [[_____] kg per square meter [_____] pounds per acre] [[_____] kg per 100 square meters [_____] pounds per 1000 square feet.]

][Synthetic Fertilizer [[_____] kg per square meter [_____] pounds per acre] [[_____] kg per 100 square meters [_____] pounds per 1000 square feet.]

][Hydroseeding Fertilizer [[_____] kg per square meter [_____] pounds per acre] [[_____] kg per 100 square meters [_____] pounds per 1000 square feet.]

]]3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions

****

NOTE: Check with the local Agriculture County Extension Service to determine proper planting seasons for specie specified, for the optimum cover depth, and for the proper rate of application for sowing and drilling seed as this rate varies with the specie of seed used and local conditions. Allow for planting period in the construction completion time. Delete time restrictions for continuous growing conditions.

****

****

NOTE: Delete the last two lines of this paragraph when hydroseeding is selected as the only seed application method.

****

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy [frozen] [snow covered] or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Seed Application Method

Seeding method must be [broadcasted and drop seeding][drill seeding][hydroseeding].

[3.2.2.1 Broadcast and Drop Seeding

Seed must be uniformly broadcast at the rate of [_____] kilograms per hectare pounds per 1000 square feet. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of [6] [_____] mm 1/4 inch in clay soils and [13] [_____] mm [1/2] [_____] inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

][3.2.2.2 Drill Seeding

****

NOTE: Check with the local Agriculture County

Extension Service to determine proper planting seasons for specie specified, for the optimum cover depth, and for the proper rate of application for sowing and drilling seed as this rate varies with the specie of seed used and local conditions. Allow for planting period in the construction completion time. Delete time restrictions for continuous growing conditions.
****

Seed must be drilled at the rate of [_____] kilograms per hectare pounds per 1000 square feet. Use [cultipacker seeders] [grass seed drills] [_____]. Drill seed uniformly to average depth of [13] [_____] mm [1/2] [_____] inch.

][3.2.2.3 Hydroseeding

****
NOTE: Check with the local Agriculture County Extension Service to determine rate of application. This rate will vary due to site requirements for fertilizer, mulch material, and rates of seeding.
****

First, mix water and fiber. Wood cellulose fiber, paper fiber, or recycled paper must be applied as part of the hydroseeding operation. Fiber must be added at 11.2 kg per 100 square meter 1,000 pounds, dry weight, per acre. Then add and mix seed and fertilizer to produce a homogeneous slurry. Seed must be mixed to ensure broadcasting at the rate of [_____] kilograms per hectare pounds per 1000 square feet. When hydraulically sprayed on the ground, material must form a blotter like cover impregnated uniformly with grass seed. Spread with one application with no second application of mulch.

]3.2.3 Mulching

[3.2.3.1 Hay or Straw Mulch

Hay or straw mulch must be spread uniformly at the rate of 0.75 metric tons per hectare 2 tons per acre. Mulch must be spread by hand, blower-type mulch spreader, or other approved method. Mulching must be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch must not be bunched or clumped. Sunlight must not be completely excluded from penetrating to the ground surface. All areas installed with seed must be mulched on the same day as the seeding. Mulch must be anchored immediately following spreading.

][3.2.3.2 Mechanical Anchor

Mechanical anchor must be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

][3.2.3.3 Asphalt Adhesive Tackifier

Asphalt adhesive tackifier must be sprayed at a rate between 666 to 866 liters per hectare 10 to 13 gallons per 1000 square feet. Sunlight must not be completely excluded from penetrating to the ground surface.

][3.2.3.4   Non-Asphaltic Tackifier

Hydrophilic colloid must be applied at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. A uniform mixture must be applied over the area.

][3.2.3.5   Asphalt Adhesive Coated Mulch

Hay or straw mulch may be spread simultaneously with asphalt adhesive applied at a rate between 666 to 866 liters per hectare 10 to 13 gallons per 1000 square feet, using power mulch equipment which must be equipped with suitable asphalt pump and nozzle. The adhesive-coated mulch must be applied evenly over the surface. Sunlight must not be completely excluded from penetrating to the ground surface.

][3.2.4   Rolling

****

NOTE: Normally the roller weight should not exceed 134 kg per m 90 pounds per foot of roller width. Light rolling is needed on newly seeded and sprigged areas to firm the seed or sprigs into contact with the soil for optimum germination and growth. However, excessive soil compaction beyond this firming action will reduce the desirable percentages of air and water spaces in good growing topsoil.

****

Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding [134] [_____] kg per m [90] [_____] pounds for each foot of roller width.[If seeding is performed with cultipacker-type seeder or by hydroseeding, rolling may be eliminated.]

]3.2.5   Erosion Control Material

****

NOTE: Specify erosion control where water concentrates and flows across areas at velocities which create an erosion hazard. Allow Contractor option for type of erosion control material, unless project specific requirements dictate otherwise.

****

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.

3.2.6   Watering

Start watering areas seeded as required by temperature and wind conditions.   Apply water at a rate sufficient to insure thorough wetting of soil to a depth of [50] [_____] mm [2] [_____] inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

3.3   PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

[3.4 RENOVATION OF EXISTING TURF AREA

[3.4.1 Aeration

Upon completion of weed eradication operations and Contracting Officer's approval to proceed, aerate turf areas indicated , by approved device. Core, by pulling soil plugs, to a minimum depth of [_____] mm [_____] inches.[Leave all soil plugs, that are produced, in the turf area.][Remove all debris generated during this operation off site.][After aeration operations are complete, topdress entire area [6.35 mm1/4 inch] [12.70 mm 1/2 inch] depth with the following mixture:

[[_____] percent sand

][[_____] percent humus

][[_____] percent gypsum

][[_____] percent organic fertilizer

][[_____] percent synthetic fertilizer

] Blend all parts of topdressing mixture to a uniform consistency throughout.] Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean all soil plugs off of other paving when work is complete.

][3.4.2 Vertical Mowing

Upon completion of aerating operation and Contracting Officer's approval to proceed, vertical mow turf areas indicated, by approved device, to a depth of [6 mm1/4 inch] [13 mm1/2 inch] above existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all debris generated during this operation off site.

][3.4.3 Dethatching

Upon completion of aerating operation and Contracting Officer's approval to proceed, dethatch turf areas indicated, by approved device, to a depth of [6 mm1/4 inch] [13 mm1/2 inch] below existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all debris generated during this operation off site.

][3.4.4 Overseeding

****

NOTE: Drill seeding is the most viable method of overseeding when significant vegetation remains. Existing vegetative cover (live or dead) may prevent desired soil contact when seeded by other methods.

****

Apply seed in accordance with and at rates indicated in applicable portions of paragraph SEED APPLICATION METHOD.

]]3.5 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 92 23 (April 2006)**
Change 1 - 08/21

Preparing Activity: NAVFAC **Replacing without change**
UFGS-02922 (May 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-32 92 23 (April 2006)**
Change 1 - 08/21

Preparing Activity: NAVFAC **Replacing without change**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 32 92 23

SODDING

04/06, CHG 1: 08/21

****

NOTE: This guide specification covers the requirements for sod.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The following information shall be shown on the project drawings:

1. Clearly indicate all areas to be sodded and if more than one type of sod is specified, delineate areas for each type.

2. All draft sod specifications shall be submitted to the cognizant Landscape Architect/Natural Resources Specialist for review to ensure that the specifications are in accordance with environmental conditions peculiar to the project areas.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

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ASTM C602	(2023) Agricultural Liming Materials
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ASTM D4972	(2018) Standard Test Methods for pH of Soils

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI GSS	(1995) Guideline Specifications to Turfgrass Sodding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42	(2022) Kellogg Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report, No. 42, Version 6.0

1.2 DEFINITIONS

1.2.1 Stand of Turf

100 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

[Section 31 00 00 EARTHWORK], [Section 32 84 24 IRRIGATION SPRINKLER

SYSTEMS], [Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS], [Section 32 92 19 SEEDING], [Section 32 92 26 SPRIGGING], [Section 32 93 00 EXTERIOR PLANTS], and Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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SD-03 Product Data

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

****

NOTE: In states that require certification, adjust

testing requirements to suit local conditions.
****

Topsoil composition tests (reports and recommendations).

SD-07 Certificates

[Nursery][Sod farm]certification for sods. Indicate type of sod in accordance with TPI GSS.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Sod Protection

****
NOTE: If sod is to be delivered in quantity over considerable distance, specify trucking in vans equipped with temperature control.
****

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 [Fertilizer] [Gypsum] [Sulfur] [Iron] [and] [Lime] Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, [fertilizer] [gypsum] [sulphur] [iron] [and] [lime] may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Sod Storage

Lightly sprinkle with water, cover with moist burlap, straw, or other approved covering; and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that internal heat will not develop. Do not store sod longer than 24 hours. Do not store directly on concrete or bituminous surfaces.

1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

****
NOTE: Check with the local Agriculture County Extension Service to determine proper planting seasons for species specified.

****

1.6.1 Restrictions

Do not plant when the ground is [frozen,] [snow covered,] muddy, or when air temperature exceeds [32] [_____] degrees Celsius [90] [_____] degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Sod

Place sod a maximum of thirty six hours after initial harvesting, in accordance with TPI GSS as modified herein.

PART 2 PRODUCTS

2.1 SODS

****

NOTE: The specific species and varieties used should be based on recommendations of the local Agriculture County Extension Service Office. Modify sod thickness as required for species specified. State certified is usually more stringently monitored than State approved, and therefore more expensive.

****

2.1.1 Classification

Nursery grown, certified as classified in the TPI GSS. Machine cut sod at a uniform thickness of 19 mm 3/4 inch within a tolerance of 6 mm 1/4 inch, excluding top growth and thatch. Each individual sod piece shall be strong enough to support its own weight when lifted by the ends. Broken pads, irregularly shaped pieces, and torn or uneven ends will be rejected.[Wood pegs and wire staples for anchorage shall be as recommended by sod supplier.]

2.1.2 Purity

Sod species shall be genetically pure, free of weeds, pests, and disease.

2.1.3 Planting Dates

Lay sod from [_____] to [_____] for warm season spring planting and from [_____] to [_____] for cool season fall planting.

2.1.4 Composition

2.1.4.1 Proportion

Proportion grass species as follows.

Botanical Name	Common Name	Percent
[_____]	[_____]	[_____]

Botanical Name	Common Name	Percent
[_____]	[_____]	[_____]

[2.1.4.2 Sod Farm Overseeding

At the sod farm provide sod with overseeding of [annual rye grass seed][_____][type recommended by seed producer].

][2.2 WILDFLOWER SOD

****

NOTE: The specified species and varieties used should be based on recommendations of the local Agriculture County Extension Service Office. State certified is usually more stringently monitored than State approved, and therefore more expensive.

****

2.2.1 Classification

[Certified,] [Field grown] wildflower sod, machine cut at a uniform thickness of [25] [_____] mm [one] [_____] inch within a tolerance of 6 mm 1/4 inch, excluding top growth. Top growth shall be a maximum height of [75] [_____] mm [3] [_____] inches. Each individual wildflower sod piece shall be strong enough to support its own weight when lifted by the ends. Broken pads, irregular shaped pieces, and torn or uneven ends will be rejected. [Wood pegs and wire staples for anchorage on slope conditions, three to one or greater, shall be used as recommended by wildflower sod supplier.]

2.2.2 Composition

Proportion wildflower species as follows:

Botanical Name	Common Name	Percent
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

]2.3 TOPSOIL

****

NOTE: If topsoil properties are included in another section of Division 31, delete this paragraph and include a cross-reference to the appropriate section. Otherwise, select appropriate paragraphs on topsoil. Check with the local Agriculture County Extension Service Office for soil properties appropriate for the plant materials to be planted. Where suitable topsoil is available within limits of the work area, stripping and stockpiling of topsoil should be included in the applicable section of Division 31 of the specification. If suitable topsoil is not available within the limits of the work area, it should generally be the Contractor's

option to either treat the soil of the graded areas with fertilizer and supplements so as to be conducive to turf establishment and maintenance, or to transport topsoil to the project site. Modify pH range for specified turf and geographical requirements.
****

2.3.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.3.2 Off-Site Topsoil

Conform to requirements specified in paragraph COMPOSITION. Additional topsoil shall be [furnished by the Contractor] [obtained from topsoil borrow areas indicated].

2.3.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 19 mm 3/4 inch, with maximum 3 percent retained on 6 mm 1/4 inch screen. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

Silt	[25-50][7 to 17][_____] percent
Clay	[10-30][4 to 12][_____] percent
Sand	[20-35][70 to 82][_____] percent
pH	[5.5 to 7.0][_____]
Soluble Salts	[600] [_____] ppm maximum

2.4 SOIL CONDITIONERS

****
NOTE: Prior to including these provisions in project specifications, perform tests of on-site topsoil to determine its suitability and the possible need of pH adjusters or soil conditioners.
****

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.4.1 Lime

****
NOTE: Use ASTM C602 calcium carbonate equivalent

(C.C.E.) as specified in Table 1: for burnt lime, C.C.E. shall not be less than 140 percent; for hydrated lime, C.C.E. shall not be less than 110 percent; and for limestone, C.C.E. shall not be less than 80 percent.

****

Commercial grade [hydrate] [or] [burnt] limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than [_____] percent.

2.4.2 Aluminum Sulfate

Commercial grade.

2.4.3 Sulfur

100 percent elemental

2.4.4 Iron

100 percent elemental

2.4.5 Peat

Natural product of [peat moss] derived from a freshwater site and conforming to [ASTM D4427] [as modified herein]. Shred and granulate peat to pass a 12.5 mm 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.

2.4.6 Sand

Clean and free of materials harmful to plants.

2.4.7 Perlite

Horticultural grade.

2.4.8 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.4.8.1 Particle Size

Minimum percent by weight passing:

4.75 mmNo. 4 mesh screen	95
2.36 mmNo. 8 mesh screen	80

2.4.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.4.9 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 91 percent, calcium 22 percent, sulfur 17 percent; minimum 96 percent passing through 850 micrometers 20 mesh screen, 100 percent passing thru 970 micrometers 16 mesh screen.

2.4.10 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to a minimum temperature of 650 degrees C 1200 degrees F. Gradation: A minimum 90 percent shall pass a 2.36 mm No. 8 sieve; a minimum 99 percent shall be retained on a 0.250 mm No. 60 sieve; and a maximum 2 percent shall pass a 0.150 mm No. 100 sieve. Bulk density: A maximum 640 kilogram per cubic meter 40 pounds per cubic foot.

2.5 FERTILIZER

****

NOTE: Check with the local Agriculture County Extension Service Office for recommended fertilizer mixture for local conditions.

****

2.5.1 Granular Fertilizer

[Organic][synthetic], granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

[_____] percent available nitrogen
[_____] percent available phosphorus
[_____] percent available potassium
[_____] percent sulfur
[[_____] percent iron]

2.6 WATER

****

NOTE: When water is Government furnished, locate the source. Recycled or reclaimed irrigation water may be available through a tertiary treatment plant on or off site. It is preferred that this type of water be used for irrigation whenever possible. Check project specific conditions.

Unless otherwise directed, water shall be the responsibility of the Contractor. Water source shall be potable or non-potable. If non-potable edit specification accordingly. Source of water shall be approved by the Contracting Officer and shall be of suitable quality for irrigation, containing no elements toxic to plant life.

Coordinate information presented here with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.

****

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation containing no element toxic to plant life.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Extent Of Work

Provide soil preparation (including soil conditioners), fertilizing, and sodding of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.2 Soil Preparation

****

NOTE: Elevation of subgrade will vary depending upon the needs for additional topsoil, sod, or other treatment.

****

Provide 102 mm 4 inches of [off-site topsoil][on-site topsoil] to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate [fertilizer] [pH adjusters] [soil conditioners] into soil a minimum depth of [100] [_____] mm [4] [_____] inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 19 mm 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

[3.1.2.1 Soil Conditioner Application Rates

****

NOTE: Check with the local Agriculture County Extension Service and specify amounts applicable for the project area.

****

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Lime [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Sulfur [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Iron [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Aluminum Sulfate [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Peat [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Sand [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Perlite [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Compost Derivatives [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Calcined Clay [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Gypsum [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

]][3.1.2.2 Fertilizer Application Rates

****

NOTE: Check with the local Agriculture County Extension Service and specify amounts applicable for the project area.

****

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Organic Granular Fertilizer [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Synthetic Granular Fertilizer [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

]]3.2 SODDING

3.2.1 Finished Grade and Topsoil

****

NOTE: Coordinate the placement of topsoil with Section 31 00 00 EARTHWORK. Coordinate the topsoil requirements with Sections 32 92 19 SEEDING; 32 92 26 SPRIGGING; and 32 93 00 EXTERIOR PLANTS.

****

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 31 00 00 EARTHWORK.

The prepared surface shall be a maximum 25 mm 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove from the surface debris and stones over a minimum 16 mm 5/8 inch in any dimension.

3.2.2 Placing

Place sod a maximum of 36 hours after initial harvesting, in accordance with TPI GSS as modified herein.

3.2.3 Sodding Slopes and Ditches

For slopes 2:1 and greater, lay sod with long edge perpendicular to the contour. For V-ditches and flat bottomed ditches, lay sod with long edge perpendicular to flow of water. [Anchor each piece of sod with wood pegs or wire staples maximum 600 mm 2 feet on center.] [On slope areas, start sodding at bottom of the slope.]

3.2.4 Finishing

After completing sodding, blend edges of sodded area smoothly into surrounding area. Air pockets shall be eliminated and a true and even surface shall be provided. Frayed edges shall be trimmed and holes and missing corners shall be patched with sod.

3.2.5 Rolling

Immediately after sodding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding [134] [_____] kg per m [90] [_____] pounds for each foot of roller width.

3.2.6 Watering

Start watering areas sodded as required by daily temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to minimum depth of [150] [_____] mm [6] [_____] inches. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

[3.4 RENOVATION OF EXISTING TURF AREA

[3.4.1 Aeration

Upon completion of weed eradication operations and Contracting Officer's approval to proceed, aerate turf areas indicated , by approved device. Core, by pulling soil plugs, to a minimum depth of [_____] mm inches.[Leave all soil plugs, that are produced, in the turf area.][Remove all debris generated during this operation off site.][After aeration operations are complete, topdress entire area [6.35 mm 1/4 inch] [12.70 mm 1/2 inch] depth with the following mixture:

[[_____] percent sand

][[_____] percent humus

][[_____] percent gypsum

][[_____] percent organic fertilizer

][[_____] percent synthetic fertilizer

] Blend all parts of topdressing mixture to a uniform consistency throughout.]Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean all soil plugs off of other paving when work is complete.

][3.4.2 Vertical Mowing

Upon completion of aerating operation and Contracting Officer's approval to proceed, vertical mow turf areas indicated, by approved device, to a depth of [6 mm 1/4 inch] [13 mm 1/2 inch] above existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all debris generated during this operation off site.

][3.4.3 Dethatching

Upon completion of aerating operation and Contracting Officer's approval to proceed, dethatch turf areas indicated, by approved device, to a depth of [6 mm 1/4 inch] [13 mm 1/2 inch] below existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all debris generated during this operation off site.

]]3.5 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 92 26 (August 2017)**
Change 1 - 08/21

Preparing Activity: NAVFAC **Superseding**
UFGS-32 92 26 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SPRIGGING

08/17, CHG 1: 08/21

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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SECTION 32 92 26

SPRIGGING

08/17, CHG 1: 08/21

****

NOTE: This guide specification covers the requirements for sprigging.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: The following information must be shown on the project drawings:

1. Clearly indicate all areas to be turfed and if more than one type of turf is specified, delineate areas for each type.

2. All draft turf specifications must be submitted to the cognizant Landscape Architect/Natural Resources Specialist for review to ensure that the specifications are in accordance with environmental conditions peculiar to the project areas.

****

PART 1 GENERAL

1.1 REFERENCES

****

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TPI GSS	(1995) Guideline Specifications to Turfgrass Sodding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R 1998) Federal Seed Act
DOA SSIR 42	(2022) Kellogg Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report, No. 42, Version 6.0

1.2 DEFINITIONS

1.2.1 Stand of Turf

95 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

[Section 31 00 00 EARTHWORK,] [Section 32 84 24 IRRIGATION AND SPRINKLER SYSTEMS,] [Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS,] [Section 32 92 19 SEEDING,] [Section 32 92 23 SODDING,] [Section 32 93 00 EXTERIOR PLANTS,] and Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

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SD-03 Product Data

Wood Cellulose Fiber Mulch

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

****
NOTE: In states that require certification, adjust testing requirements to suit local conditions.
****

Topsoil Composition Tests (Reports and Recommendations).

SD-07 Certificates

State Certification and Approval for Seed

[Nursery] [Sod Farm] Certification for Sprigs. Indicate type of sprig in accordance with TPI GSS.

SD-08 Manufacturer's Instructions

Erosion Control Materials

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Sprig Protection

****
NOTE: If sprigs are to be delivered in quantity over considerable distance, specify trucking in vans equipped with temperature control.
****

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 [Fertilizer] [Gypsum] [Sulfur] [Iron] [and] [Lime] Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, [fertilizer] [gypsum] [sulphur] [iron] [and] [lime] may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Sprig Storage

****
NOTE: Check with the local Agriculture County Extension Service Office to determine if specie used requires more water than is average for the geographical area.
****

Lightly sprinkle with water, cover with moist burlap, straw, or other approved covering; and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that internal heat will not develop. Do not store longer than 24 hours. Do not store directly on concrete or bituminous surfaces.

1.5.2.2 Seed, [Fertilizer] [Gypsum] [Sulfur] [Iron] [and] [Lime] Storage

Store in cool, dry locations away from contaminants.

1.5.2.3 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.4 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is [frozen,] [snow covered,] muddy, or when air temperature exceeds [32] [_____] degrees Celsius [90] [_____] degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Sprigging

Perform sprigging a maximum of twenty four hours after initial harvesting.

PART 2 PRODUCTS

2.1 SPRIGS

****

NOTE: The specific species and varieties used should be based on recommendations of the local Agriculture County Extension Service Office.

****

2.1.1 Classification

Healthy living stems, stolons, or rhizomes and attached roots of locally adapted grass without adhering soil, including two to three nodes and from 100 to 150 mm 4 to 6 inches long. Obtain from heavy, dense certified sod as classified in the TPI GSS. [Obtain sprigs from designated areas on the project site.] Provide sprigs which have been grown under climatic conditions similar to those in the locality of the project. Coordinate harvesting and planting operations to prevent exposure of sprigs to the sun for more than 30 minutes before covering and moistening. Sprigs containing weeds or other detrimental material or that are heat damaged will be rejected.

2.1.2 Composition

Botanical and Common Name	Percent
[_____]	[_____]

2.1.3 Planting Dates

Sow sprigs from [_____] to [_____] for warm season planting and from [_____] to [_____] for cool season planting.

2.2 SEED

****

NOTE: When applying seed over sprigs as a specified method of establishing sprigs, select the annual seed species to be installed. State-certified seed is more stringently monitored than State-approved seed; and therefore, more expensive.

****

2.2.1 Seed Classification

[State-certified] [State-approved] seed of the latest season's crop must be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels must be in conformance with AMS Seed Act and applicable state seed laws.

2.2.2 Temporary Seed Species Composition

Botanical Name	Common Name	Minimum Percent Pure Seed	Minimum Percent Germination	Maximum Percent Weed Seed
[_____]	[_____]	[_____]	[_____]	[_____]

2.3 TOPSOIL

****

NOTE: If topsoil properties are included in another section of Division 31, delete this paragraph and include a cross-reference to the appropriate section. Otherwise, select appropriate paragraphs on topsoil. Check with the local Agriculture County Extension Service Office for soil properties appropriate for the plant materials to be planted. Where suitable topsoil is available within limits of the work area, stripping and stockpiling of topsoil should be included in the applicable section of Division 31 of the specification. If suitable topsoil is not available within the limits of the work area, it should generally be the Contractor's option to either treat the soil of the graded areas with fertilizer and supplements so as to be conducive to turf establishment and maintenance, or to transport topsoil to the project site. Modify pH

range for specified turf and geographical requirements.

****

2.3.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil must be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.3.2 Off-Site Topsoil

Conform to requirements specified in paragraph COMPOSITION. Additional topsoil must be [furnished by the Contractor][obtained from topsoil borrow areas indicated].

2.3.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 19 mm 3/4 inch, with maximum 3 percent retained on 6 mm 1/4 inch screen. The pH must be tested in accordance with ASTM D4972. Topsoil must be free of sticks, stones, roots, and other debris and objectionable materials. Other components must conform to the following limits:

Silt	[25-50][7 to 17][_____] percent
Clay	[10-30][4 to 12][_____] percent
Sand	[20-35][70 to 82][_____] percent
pH	[5.5 to 7.0][_____]
Soluble Salts	[600] [_____] ppm maximum

2.4 pH ADJUSTERS AND SOIL CONDITIONERS

****

NOTE: Prior to including these provisions in project specifications, perform tests of on-site topsoil to determine its suitability and the possible need of pH adjusters or soil conditioners.

****

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.4.1 Lime

****

NOTE: Use ASTM C602 calcium carbonate equivalent (C.C.E.) as specified in Table 1: for burnt lime, C.C.E. must not be less than 140 percent; for hydrated lime, C.C.E. must not be less than 110 percent; and for limestone, C.C.E. must not be less than 80 percent.

****

Commercial grade [hydrate] [or] [burnt] limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than [_____] percent.

2.4.2 Aluminum Sulfate

Commercial grade.

2.4.3 Sulfur

100 percent elemental

2.4.4 Iron

100 percent elemental

2.4.5 Peat

Natural product of [peat moss] derived from a freshwater site and conforming to [ASTM D4427] [as modified herein]. Shred and granulate peat to pass a 12.5 mm 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.

2.4.6 Sand

Clean and free of materials harmful to plants.

2.4.7 Perlite

Horticultural grade.

2.4.8 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.4.8.1 Particle Size

Minimum percent by weight passing:

4.75 mmNo. 4 mesh screen	95
2.36 mmNo. 8 mesh screen	80

2.4.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.4.9 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 80 percent, calcium 18 percent, sulfur 14 percent; minimum 96 percent passing through 850 micrometers 20 mesh screen, 100 percent passing thru 970 micrometers 16 mesh screen.

2.4.10 Calcined Clay

Calcined clay must be granular particles produced from montmorillonite clay calcined to a minimum temperature of 650 degrees C 1200 degrees F. Gradation: A minimum 90 percent must pass a 2.36 mm No. 8 sieve; a minimum 99 percent must be retained on a 0.250 mm No. 60 sieve; and material passing a 0.150 mm No. 100 sieve must not exceed 2 percent. Bulk density: A maximum 640 kilogram per cubic meter 40 pounds per cubic foot.

2.5 FERTILIZER

****

NOTE: Check with the local Agriculture County Extension Service Office for recommended fertilizer mixture for local conditions.

****

2.5.1 Granular Fertilizer

[Organic][synthetic], granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

[_____] percent available nitrogen
[_____] percent available phosphorus
[_____] percent available potassium
[_____] percent sulfur
[[_____] percent iron

]2.5.2 Hydrosprigging Fertilizer

Controlled release fertilizer, to use with hydrosprigging and composed of pills coated with plastic resin to provide a continuous release of nutrients for at least 6 months and containing the following minimum percentages, by weight, of plant food nutrients.

[_____] percent available nitrogen
[_____] percent available phosphorus
[_____] percent available potassium
[[_____] percent sulfur
][[_____] percent iron

]2.6 MULCH

****

NOTE: Check with the local Agriculture County Extension Service Office to determine choice of mulch most suitable for the project area. Specify only one type of mulch.

****

Mulch must be free from noxious weeds, mold, and other deleterious materials.

2.6.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw must contain no fertile seed.

2.6.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay must be sterile, containing no fertile seed.

2.6.3 Wood Cellulose Fiber Mulch

****

NOTE: Wood cellulose fiber mulches have been successful on level areas or on slopes with slight grades where sufficient moisture is present to obtain a quick germination of grass seed. The material should be hydraulically applied at the following rates: Areas up to and including 3 to 1 slopes, at the rate of 1,120 kg per 10,000 sq. m 1,000 pounds per acre; areas steeper than 3 to 1 at the rate of 1,568 kg per 10,000 sq. m 1,400 pounds per acre. It should not be specified for slopes 2 to 1 or greater in areas where drought may prevent germination of the seed or where runoff from heavy rains may cut gullies through the fiber mulch. In these areas use erosion control materials such as specified in paragraph EROSION CONTROL MATERIAL.

****

****

NOTE: Hydraulic mulch is an EPA designated product for recycled content. Recycled content percentages listed are recommended by EPA; additional information can be found on the EPA's "Comprehensive Procurement Guidelines (CPG)" page within EPA's website at http://www.epa.gov.

****

Use recovered materials of either paper-based (100 percent post-consumer content) or wood-based (100 percent total recovered content) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2 [_____]. Use with hydraulic application of grass [seed] and fertilizer.

2.7 WATER

****

NOTE: When water is Government furnished, locate the source. Recycled or reclaimed irrigation water may be available through a tertiary treatment plant on or off site. It is preferred that this type of water be used for irrigation whenever possible. Check project specific conditions.

Unless otherwise directed, water must be the responsibility of the Contractor. Water source must be potable or non-potable. If non-potable edit specification accordingly. Source of water must be approved by the Contracting Officer and must be of suitable quality for irrigation, containing no

elements toxic to plant life.

Coordinate information presented here with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS
****

Source of water must be approved by Contracting Officer and of suitable quality for irrigation containing no element toxic to plant life.

2.8 EROSION CONTROL MATERIALS

****
NOTE: Provide all erosion and sediment control measures in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS for Navy instead of here if used for project. The Contractor may propose other types of erosion control material, based on site conditions.
****

Erosion control material must conform to the following:

[2.8.1 Erosion Control Blanket

Blanket must be machine produced mat of wood excelsior formed from a web of interlocking wood fibers; covered on one side with either knitted straw blanket-like mat construction; covered with biodegradable plastic mesh; or interwoven biodegradable thread, plastic netting, or twisted kraft paper cord netting.

][2.8.2 Erosion Control Fabric

Fabric must be knitted construction of polypropylene yarn with uniform mesh openings 19 to 25 mm 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips must have a minimum life of 6 months.

][2.8.3 Erosion Control Net

Net must be heavy, twisted jute mesh, weighing approximately 605 grams per meter 1.22 pounds per linear yard and 1200 mm 4 feet wide with mesh openings of approximately 25 mm one inch square.

][2.8.4 Hydrophilic Colloids

Hydrophilic colloids must be physiologically harmless to plant and animal life without phytotoxic agents. Colloids must be naturally occurring, silicate powder based, and must form a water insoluble membrane after curing. Colloids must resist mold growth.

]2.8.5 Erosion Control Material Anchors

Erosion control anchors must be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation prior to planting (including soil conditioners), fertilizing, and sprigging,[temporary seeding] of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.2 Soil Preparation

****
NOTE: Choose one of the following options
****

****
NOTE: Elevation of subgrade will vary depending upon the needs for additional topsoil, sod, or other treatment.
****

Provide 102 mm 4 inches of [off-site topsoil][on-site topsoil][existing soil] to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate [fertilizer] [pH adjusters] [soil conditioners] into soil a minimum depth of [100] [_____] mm [4] [_____] inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 19 mm 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

[3.1.2.1 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Lime [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Sulfur [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Iron [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Aluminum Sulfate [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Peat [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Sand [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Perlite [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Compost Derivatives [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Calcined Clay [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

][Gypsum [[_____] cubic meters per square meter cubic yard per acre] [[_____] cubic meters per 100 square meters cubic yards per 1000 square feet.]

]][3.1.2.2 Fertilizer Application Rates

****

NOTE: Check with the local Agriculture County Extension Service and specify amounts applicable for the project area. Two fertilizer applications may be required when hydroseeding with wood fiber mulch.

****

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Organic Granular Fertilizer [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

][Hydrosprigging Fertilizer [[_____] kg per square meter pounds per acre] [[_____] kg per 100 square meters pounds per 1000 square feet.]

]]3.2 SPRIGGING INSTALLATION

****

NOTE: Allow the Contractor sprig installation options when installing areas larger than one acre. Define lawn areas and field areas on the drawings.

****

Prior to installing sprigs, any previously prepared surface compacted or damaged must be reworked to meet the requirements of paragraph SOIL PREPARATION. Areas must be sprigged as indicated.

3.2.1 Installing Sprigs

The sprigging method must be [Broadcast Sprigging] [Hydroplanting] [Row Sprigging] [applying seed-over-sprigs]. Sprigging procedure must ensure even coverage.

3.2.1.1 Broadcast Sprigging

Sprigs must be broadcast uniformly by hand, with mechanical equipment, or other approved method. Sprigs must be planted to provide a minimum number of 30 viable sprigs per square meter 25 viable sprigs per square yard. The distance between individual sprigs must be a maximum 300 mm 12 inch space. Sprigs must be forced into the soil to a minimum 25 mm one inch depth by disk-rolling, pressing with steel matting, or other approved method.

3.2.1.2 Hydroplanting

Sprigs must be mixed with water and uniformly applied under pressure over the entire area. Sprigs must be covered by distributing a topdressing uniformly and evenly to a minimum 25 mm one inch depth. Topdressing must conform to the paragraph TOPSOIL.

3.2.1.3 Row Sprigging

Sprigs must be planted in rows spaced a maximum of 300 mm 12 inches apart and to a minimum 25 mm one inch depth, with mechanical sprig planter or other methods. Sprigs must be placed in the rows a maximum 150 mm 6 inch distance apart.

3.2.2 Mulching

3.2.2.1 Hay or Straw Mulch

Hay or straw mulch must be spread uniformly at the rate of 0.75 metric tons per hectare 2 tons per acre. Mulch must be spread by hand, blower-type mulch spreader, or other approved method. Mulching must be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch must not be bunched or clumped. Sunlight must not be completely excluded from penetrating to the ground surface. All areas installed with seed must be mulched on the same day as the seeding. Mulch must be anchored immediately following spreading.

3.2.2.2 Mechanical Anchor

Mechanical anchor must be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

3.2.2.3 Wood Cellulose Fiber, Paper Fiber and Recycled Paper

Wood cellulose fiber, paper fiber, or recycled paper must be applied as part of the hydroseeding operation. The mulch must be mixed and applied in accordance with the manufacturer's recommendations.

[3.2.3 Applying Seed Over Sprigs

Seed must be applied using either [broadcast] [or] [hydroseeding] equipment and methods. Seeding procedure must ensure even coverage. Gravity feed applicators, which drop seed directly from a hopper onto the prepared soil, must not be used.

[3.2.3.1 Broadcast Seeding

Seed must be uniformly broadcast at the rate of [_____] kilograms per hectare pounds per 1000 square feet using broadcast seeders. Half the total rate of seed application must be broadcast in 1 direction, with the remainder of the seed rate broadcast at 90 degrees from the first direction. Seed must be covered to a minimum 6 mm 1/4 inch depth by disk harrow, steel mat drag, cultipacker, or other approved device. Seed must be broadcast and covered prior to sprigging operation.

][3.2.3.2 Hydroseeding

Seed must be mixed to ensure broadcast at the rate of [_____] kilograms per hectare pounds per 1000 square feet. Seed and fertilizer must be added to water and thoroughly mixed at the rates specified. The time period for the seed to be held in the slurry must not exceed 24 hours.[Wood cellulose fiber mulch and tackifier must be added at the rates recommended by the manufacturer after the seed, fertilizer, and water have been thoroughly mixed to produce a homogeneous slurry.] Slurry must be uniformly applied under pressure over the entire area. The hydroseeded area must not be rolled.

]]3.2.4 Rolling

The entire area must be firmed with a roller not exceeding 130 kilograms per meter 90 pounds per foot roller width. Slopes over a maximum 3-horizontal-to-1 vertical must not be rolled.

3.2.5 Finishing

A minimum 25 percent of the installed sprigs must extend above the ground surface upon completion of the sprigging operation.

3.2.6 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.

3.2.7 Watering Sprigs

Watering must be started immediately after completing each day of sprigging. Water must be applied at a rate sufficient to ensure moist soil conditions to a minimum 25 mm one inch depth. Run-off, puddling, and wilting must be prevented. Unless otherwise directed, watering trucks must not be driven over turf areas. Watering of other adjacent areas or plant material must be prevented.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.4 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 93 00 (August 2017)**
Change 1 - 08/21

Preparing Activity: NAVFAC **Superseding**
UFGS-32 93 00 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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EXTERIOR PLANTS

08/17, CHG 1: 08/21

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USACE / NAVFAC / AFCEC	**UFGS-32 93 00 (August 2017)**
	Change 1 - 08/21

Preparing Activity: NAVFAC	**Superseding**
	UFGS-32 93 00 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 32 93 00

EXTERIOR PLANTS

08/17, CHG 1: 08/21

****

NOTE: This guide specification covers the requirements for exterior planting.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: The following information must be shown on the project drawings:

1. All areas to be planted, with plant layout provided.

2. Plant list.

3. Subsurface drainage.

4. Planting accessories.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA P5	(2015) Standard for Waterborne Preservatives
AWPA T1	(2024) Use Category System: Processing and Treatment Standard
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

AMERICANHORT (AH)

ANSI/ANLA Z60.1	(2004) American Standard for Nursery Stock

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM C4	(2004; R 2023) Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile
ASTM C602	(2023) Agricultural Liming Materials
ASTM C700	(2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

ASTM D2729	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4427	(2018) Standard Classification of Peat Samples by Laboratory Testing
ASTM D4972	(2018) Standard Test Methods for pH of Soils
ASTM D5268	(2019) Topsoil Used for Landscaping Purposes
ASTM D5539	(2013) Seed Starter Mix
ASTM D5852	(2000; R 2007; E 2014) Standard Test Method for Erodibility Determination of Soil in the Field or in the Laboratory by the Jet Index Method
ASTM D6155	(2019) Nontraditional Coarse Aggregate for Bituminous Paving Mixtures
ASTM D6629	(2001; R 2012; E 2012) Selection of Methods for Estimating Soil Loss by Erosion
ASTM F667/F667M	(2016; R 2021) Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings

L.H. BAILEY HORTORIUM (LHBH)

LHBH	(1976) Hortus Third

TREE CARE INDUSTRY ASSOCIATION (TCIA)

TCIA A300P1	(2017) ANSI A300 Part1: Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance Standard Practices - Pruning
TCIA Z133	(2017) American National Standard for Arboricultural Operations - Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush - Safety Requirements

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42	(2022) Kellogg Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report, No. 42, Version 6.0

1.2 RELATED REQUIREMENTS

[Section 31 00 00 EARTHWORK,] [Section 32 84 24 IRRIGATION SPRINKLER SYSTEMS,] [Section 32 96 00 TRANSPLANTING EXTERIOR PLANTS,] [Section 32 92 19 SEEDING,] [Section 32 92 23 SODDING,] [Section 32 92 26 SPRIGGING,] and Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

State Landscape Contractor's License

Time Restrictions and Planting Conditions

Indicate anticipated dates and locations for each type of planting.

SD-03 Product Data

Peat

Composted Derivatives

Rotted Manure

Organic Mulch Materials

Gypsum

[Drainage Pipe

] Mulch; G, [_____]

Ground Stakes

Recycled Plastic Edging

Fertilizer

Weed Control Fabric; G, [_____]

[Root Control Barrier; G, [_____]

] Staking Material

Wood Edging

Metal Anchors

[Antidesiccants

][Erosion Control Materials

][Photographs; G, [_____]

] SD-04 Samples

[Mulch; G, [_____]

][Submit [0.5 literone pint] of mulch.

] SD-06 Test Reports

Topsoil Composition Tests; [Soil Test of current growing area]; [Soil Test of proposed area]; [Soil Test location map]

Percolation Test; [Percolation Test of current growing area]; [Percolation Test of proposed area]

SD-07 Certificates

Nursery Certifications

SD-10 Operation and Maintenance Data

Plastic Identification

When not labeled, identify types in Operation and Maintenance Manual.

1.4 QUALITY ASSURANCE

1.4.1 Topsoil Composition Tests

Commercial test from an independent testing laboratory including basic soil groups (moisture and saturation percentages, Nitrogen-Phosphorus-Potassium (N-P-K) ratio, pH (ASTM D4972), soil salinity), secondary nutrient groups (calcium, magnesium, sodium, Sodium Absorption Ratio (SAR)), micronutrients (zinc, manganese, iron, copper), toxic soil elements (boron, chloride, sulfate), cation exchange and base saturation percentages, and soil amendment and fertilizer recommendations with quantities for plant material being transplanted. Soil required for each test must include a maximum depth of 450 mm 18 inches of approximately one liter one quart volume for each test. Areas sampled should not be larger than 0.4 hectare one acre and should contain at least 6-8 cores for each sample area and be thoroughly mixed. Problem areas should be sampled separately and compared with samples taken from adjacent non-problem areas. The location of the sample areas should be noted and marked on a parcel or planting map for future reference.

1.4.2 Nursery Certifications

[a. Indicate on nursery letterhead the name of plants in accordance with the LHBH, including botanical common names, quality, and size.

][b. Inspection certificate.

][c. Mycorrhizal fungi inoculum for plant material treated

]1.4.3 State Landscape Contractor's License

Construction company must hold a landscape contractors license in the state where the work is performed and have a minimum of five years landscape construction experience. Submit copy of license and three references for similar work completed in the last five years.

[1.4.4 Plant Material Photographs

Contractor must submit nursery photographs, for government approval prior to ordering, for each tree larger than 600 mm 24-inch box/ 50 mm 2-inch caliper size.

]1.4.5 Percolation Test

Immediately following rough grading operation, identify a typical location for one of the largest trees and or shrubs and excavate a pit per the project details. Fill the pit with water to a depth of 300 mm 12 inches. The length of time required for the water to percolate into the soil, leaving the pit empty, must be measured by the project Landscape Architect and verified by the Contracting Officer. Within six hours of the time the water has drained from the pit, the Contractor, with the Contracting Officer and project Landscape Architect present, must again fill the pit with water to a depth of 300 mm 12 inches. If the water does not completely percolate into the soil within 9 hours, a determination must be made whether a drainage system or a soil penetrant will be required for each tree and or shrub being transplanted.

1.4.6 Erosion Assessment

****

NOTE: The erosion potential of a soil is of concern in vegetated channels, road embankments, dams, levees, spillways, construction sites, [_____].

****

Assess potential effects of soil management practices on soil loss in accordance with ASTM D6629. Assess erodibility of soil with dominant soil structure less than 70 to 80 mm 2.8 to 3.1 inches in accordance with ASTM D5852.

1.4.7 Pre-Installation Meeting

Convene a pre-installation meeting a minimum of one week prior to commencing work of this section. Require attendance of parties directly affecting work of this section. Review conditions of operations, procedures and coordination with related work. Agenda must include the following:

a. Tour, inspect, and discuss conditions of planting materials.

b. Review planting schedule and maintenance.

c. Review required inspections.

d. Review environmental procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Branched Plant Delivery

Deliver with branches tied and exposed branches covered with material which allows air circulation. Prevent damage to branches, trunks, root systems, and root balls and desiccation of leaves.

1.5.1.2 Soil Amendment Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and indication of conformance to state and federal laws. Instead of containers, [fertilizer,] [gypsum,] [sulfur,] [iron,] [and] [lime] may be furnished in bulk with a certificate indicating the above information. Store in dry locations away from contaminates.

1.5.1.3 Plant Labels

Deliver plants with durable waterproof labels in weather-resistant ink. Provide labels stating the correct botanical and common plant name and variety as applicable and size as specified in the list of required plants. Attach to plants, bundles, and containers of plants. Groups of plants may be labeled by tagging one plant. Labels must be legible for a minimum of 60 days after delivery to the planting site.

1.5.2 Storage

1.5.2.1 Plant Storage and Protection

Store and protect plants not planted on the day of arrival at the site as follows:

a. Shade and protect plants in outside storage areas from the wind and direct sunlight until planted.

b. Heel-in bare root plants.

c. Protect balled and burlapped plants from freezing or drying out by covering the balls or roots with moist burlap, sawdust, wood chips, shredded bark, peat moss, or other approved material. Provide covering which allows air circulation.

d. Keep plants in a moist condition until planted by watering with a fine mist spray.

e. Do not store plant material directly on concrete or bituminous surfaces.

1.5.2.2 [Fertilizer,] [Gypsum,] [pH Adjusters] and [Mulch] Storage

Store in dry locations away from contaminants.

1.5.2.3 Topsoil

Prior to stockpiling topsoil, eradicate on site undesirable growing vegetation. Clear and grub existing vegetation three to four weeks prior to stockpiling existing topsoil.

[1.5.2.4 [Root Control Barrier] [and] [Weed Control Fabric]

Store materials on site in enclosures or under protective covering in dry location. Store under cover out of direct sunlight. Do not store materials directly on ground.

]1.5.3 Handling

Do not drop or dump plants from vehicles. Avoid damaging plants being moved from nursery or storage area to planting site. Handle [boxed][balled and burlapped] [bare root] [balled and potted][processed balled][in-ground fabric bag grown] [container] plants carefully to avoid damaging or breaking the earth ball or root structure. Do not handle plants by the trunk or stem.[Puddle bare-root plants after removal from the heeling-in bed to protect roots from drying out.] Remove damaged plants from the site.

1.5.4 TIME LIMITATION

Except for container-grown plant material, the time limitation from digging to installing plant material must be a maximum of 90 days. The time limitation between installing the plant material and placing the mulch must be a maximum of 24 hours.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

****

NOTE: Check with the local Agriculture County Extension Service Office for recommended planting dates for the project area. Allow for planting period in the construction completion time provided in the Additional General Paragraphs. Delete time restrictions for continuous growing conditions.

****

Coordinate installation of planting materials during optimal planting seasons for each type of plant material required.

1.6.1 Planting Dates

[Plant all plants from [_____] to [_____].

][1.6.1.1 Deciduous Material

Deciduous material from [_____] to [_____] for spring [/summer] planting and from [_____] to [_____] for fall [/winter] planting.

][1.6.1.2 Evergreen Material

Evergreen material from [_____] to [_____] for spring [/summer] planting and from [_____] to [_____] for fall [/winter] planting.

]1.6.2 Restrictions

Do not plant when ground is [frozen,] [snow covered,] muddy, or when air temperature exceeds [32] [_____] degrees Celsius [90] [_____] degrees Fahrenheit

1.7 GUARANTEE

****

NOTE: This guarantee is premised on a fall planting season from approximately October 1 to December 15 and a spring planting season from the time ground can be worked to May 15.

****

****

NOTE: Choose one of the following options.

****

[[All plants must be guaranteed for [one year] [_____] beginning on the date of inspection by the Contracting Officer to commence the plant establishment period, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by the Government or by weather conditions unusual for the warranty period.][Transplanted plants require no guarantee.]

][Guarantee plants [except palms] installed during fall planting season until the following [August 1] [_____]; guarantee plants installed during spring planting season until the following [October 1] [_____].[Transplanted plants require no guarantee.][The minimum guarantee must be 90 days from the time of planting.] [Replace palms which are not alive at the end of a one-year period.]

] [Remove and replace dead planting materials immediately unless required to plant in the succeeding planting season.]At end of warranty period, replace planting materials that die or have 25 percent or more of their branches that die during the construction operations or the guarantee period.

1.8 PLASTIC IDENTIFICATION

****

NOTE: The marking system indicated below is intended to provide assistance in identification of products for making subsequent decisions as to handling, recycling, or disposal.

****

Provide product data indicating polymeric information in Operation and Maintenance Manual.

Type 1: Polyethylene Terephthalate (PET, PETE).

Type 2: High Density Polyethylene (HDPE).

Type 3: Vinyl (Polyvinyl Chloride or PVC).

Type 4: Low Density Polyethylene (LDPE).

Type 5: Polypropylene (PP).

Type 6: Polystyrene (PS).

Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

PART 2 PRODUCTS

2.1 PLANTS

****

NOTE: Check with local Agriculture County Extension Service Office for the species and varieties of plants recommended for the project area. Specify plants based on a xeriscaping approach, which utilizes indigenous plants and low maintenance plants tolerant of the site's existing soils and climate without supplemental irrigation or fertilization, once established. Indigenous plants typically will perform better than imported species and require less maintenance. It is advisable to sufficiently monitor imported species to determine the relative invasiveness. They can blend into the local ecosystem, but they can also overrun it, suffocating indigenous plants and crippling habitats.

Specify appropriate companion planting, seasonal mixes, and habitat vegetation. Companion planting takes advantage of complementary relationships

between some plants such as parsley and roses. Seasonal mixes utilize plants that thrive at various times of the year. Seasonal mixes are closely related to providing habitat vegetation. Many birds, animals, and insects - especially migratory creatures - depend upon certain plants flowering or seeding at specific times of the year and in certain regions.

Existing vegetation must be evaluated for appropriateness to remain. Existing vegetation may be native and require little maintenance. Utilizing existing site features minimizes site disturbance, which reduces erosion and habitat destruction. Items on site such as excavated rocks may also be considered for use as landscaping features.

****

2.1.1 Regulations and Varieties

Existing trees and shrubs to remain must be protected and a planting plan be arranged around them. Furnish nursery stock in accordance with ANSI/ANLA Z60.1, except as otherwise specified or indicated. Each plant or group of planting must have a "key" number indicated on the nursery certifications of the plant schedule. Furnish plants, including turf grass, grown under climatic conditions similar to those in the locality of the project. Plants specified must be [indigenous,] low maintenance varieties, tolerant of site's existing soils and climate [without supplemental irrigation or fertilization once established]. [Spray plants budding into leaf or having soft growth with an antidesiccant before digging]. Plants of the same specified size must be of uniform size and character of growth. Plants must be chosen with their mature size and growth habit in mind to avoid over-planting and conflict with other plants, structures or underground utility lines. All plants must comply with all Federal and State Laws requiring inspection for plant diseases and infestation.

2.1.2 Shape and Condition

Well-branched, well-formed, sound, vigorous, healthy planting stock free from disease, sunscald, windburn, abrasion, and harmful insects or insect eggs and having a healthy, normal, and undamaged root system.

2.1.2.1 Deciduous Trees and Shrubs

Symmetrically developed and of uniform habit of growth, with straight boles or stems, and free from objectionable disfigurements.

2.1.2.2 Evergreen Trees and Shrubs

Well developed symmetrical tops with typical spread of branches for each particular species or variety.

2.1.2.3 Ground Covers and Vines

Number and length of runners and clump sizes indicated, and of the proper age for the grade of plants indicated, furnished in removable containers, integral containers, or formed homogeneous soil section.

2.1.3 Plant Size

Minimum sizes measured after pruning and with branches in normal position, must conform to measurements indicated, based on the average width or height of the plant for the species as specified in ANSI/ANLA Z60.1. Plants larger in size than specified may be provided with approval of the [Contracting Officer] [_____]. When larger plants are provided, increase the ball of earth or spread of roots in accordance with ANSI/ANLA Z60.1.

2.1.4 Root Ball Size

All box-grown, field potted, field boxed, collected, plantation grown, bare root, balled and burlapped, container grown, processed-balled, and in-ground fabric bag-grown root balls must conform to ANSI/ANLA Z60.1. All wrappings and ties must be biodegradable. Root growth in container grown plants must be sufficient to hold earth intact when removed from containers. Root bound plants will not be accepted.

[2.1.4.1 Mycorrhizal fungi inoculum

Before shipment, root systems must contain mycorrhizal fungi inoculum.

]2.1.5 Growth of Trunk and Crown

****

NOTE: The form of growth desired for specimen or special purpose plant material must be described.

****

2.1.5.1 Deciduous Trees

A height to caliper relationship must be provided in accordance with ANSI/ANLA Z60.1. Height of branching must bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees must not be "poled" or the leader removed.

a. Single stem: The trunk must be reasonably straight and symmetrical with crown and have a persistent main leader.

b. Multi-stem: All countable stems, in aggregate, must average the size specified. To be considered a stem, there must be no division of the trunk which branches more than 150 mm 6 inches from ground level.

2.1.5.2 Palms

Palms must have the specified height as measured from the base of the trunk to the base of the fronds or foliage in accordance with ANSI/ANLA Z60.1. The palm must have straight trunk and healthy fronds or foliage as typical for the variety grown in the region of the project. Palms trimmed or pruned for delivery must retain a minimum of 150 mm 6 inches of foliage at the crown as a means of determining plant health.

2.1.5.3 Deciduous Shrubs

Deciduous shrubs must have the height and number of primary stems recommended by ANSI/ANLA Z60.1. Acceptable plant material must be well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the project.

2.1.5.4 Coniferous Evergreen Plant Material

Coniferous Evergreen plant material must have the height-to-spread ratio recommended by ANSI/ANLA Z60.1. The coniferous evergreen trees must not be "poled" or the leader removed. Acceptable plant material must be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired must be as indicated.

2.1.5.5 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material must have the height-to-spread ratio recommended by ANSI/ANLA Z60.1. Acceptable plant material must be well shaped and recognized by the trade as typical for the variety grown in the region of the project.

2.1.5.6 Ground Cover and Vine Plant Material

Ground cover and vine plant material must have the minimum number of runners and length of runner recommended by ANSI/ANLA Z60.1. Plant material must have heavy, well developed and balanced crown with vigorous, well developed root system and must be furnished in containers.

2.2 TOPSOIL

****

NOTE: If topsoil properties are included in another section of Division 31, delete this paragraph and include a cross-reference to the appropriate section. Otherwise, select appropriate paragraphs on topsoil. Check with the local Agriculture County Extension Service Office for soil properties appropriate for the plant materials to be planted. If existing topsoil is used, insert materials, if required, to properly condition for pH and friability. Where suitable topsoil is available within limits of the work area, include stripping and stockpiling of topsoil in the applicable section of Division 31 of the specification. If suitable topsoil is not available within the limits of the work area, consider whether it is more economical to treat the soil of the graded areas with fertilizer and supplements so as to be conducive for plant establishment and maintenance, to transport topsoil to the project site, or to use regionally native plants suited to the on-site soil. If treatment of the soil is more economical, include requirements for fertilizer and supplements. Prior to stockpiling topsoil, remove all weed-grasses. This should occur when the foliage is 150 to 250 mm 6 to 10 inches high and approximately 4 to 6 weeks prior to stockpiling.

****

[2.2.1 Existing Soil

Modify to conform to requirements specified in paragraph COMPOSITION.

][2.2.2 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil must be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

][2.2.3 Off-Site Topsoil

Conform to requirements specified in paragraph COMPOSITION. Additional topsoil must be [furnished by the Contractor][obtained from topsoil borrow areas indicated].

]2.2.4 Composition

Evaluate soil for use as topsoil in accordance with ASTM D5268. From 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 19 mm 3/4 inch, with maximum 3 percent retained on 6 mm 1/4 inch screen. The pH must be tested in accordance with ASTM D4972. Topsoil must be free of sticks, stones, roots, plants, and other debris and objectionable materials. Other components must conform to the following limits:

Silt	[25-50][7 to 17][_____] percent
Clay	[10-30][4 to 12][_____] percent
Sand	[20-35][70 to 82][_____] percent
pH	[5.5 to 7.0][_____]
Soluble Salts	[600] [_____] ppm maximum

2.3 SOIL CONDITIONERS

****

NOTE: Prior to including these provisions in project specifications, perform tests of on-site topsoil to determine its suitability and the possible need of pH adjusters or soil conditioners.

****

Provide singly or in combination as required to meet specified requirements for topsoil. Soil conditioners must be nontoxic to plants.

2.3.1 Lime

****

NOTE: Use ASTM C602 calcium carbonate equivalent (C.C.E.) as specified in Table 1: for burnt lime, C.C.E. must not be less than 140 percent; for hydrated lime, C.C.E. must not be less than 110 percent; and for limestone, C.C.E. must not be less than 80 percent.

****

Commercial grade [hydrated] [or] [burnt] limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than [80][_____] percent.

2.3.2 Aluminum Sulfate

Commercial grade.

2.3.3 Sulfur

100 percent elemental

2.3.4 Iron

100 percent elemental

2.3.5 Peat

Natural product of [peat moss] derived from a freshwater site and conforming to [ASTM D4427] [ASTM D5539] as modified herein. Shred and granulate peat to pass a 12.5 mm 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation. Peat must not contain invasive species, including seeds.

2.3.6 Sand

Clean and free of materials harmful to plants.

2.3.7 Perlite

Horticultural grade.

2.3.8 Compostеd Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, invasive species, including seeds, and soil stabilized with nitrogen and having the following properties:

2.3.8.1 Particle Size

Minimum percent by weight passing:

4.75 mmNo. 4 mesh screen	95
2.36 mmNo. 8 mesh screen	80

2.3.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.3.9 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 80 percent, calcium 18 percent, sulfur 14 percent; minimum 96 percent passing through 850 micrometers 20 mesh screen, 100 percent passing thru 970 micrometers 16 mesh screen.

2.3.10 Vermiculite

Horticultural grade for planters.

2.3.11 Rotted Manure

Well rotted horse or cattle manure containing maximum 25 percent by volume of straw, sawdust, or other bedding materials; free of seeds, stones, sticks, soil, and other invasive species.

2.4 PLANTING SOIL MIXTURES

****
NOTE: Choose one of the following options.
****

[100 percent topsoil as specified herein.

][100 percent on-site topsoil.

][[_____] parts topsoil, [_____] parts [_____], and [_____] parts [_____]. Thoroughly mix all parts of planting soil mixture to a uniform blend throughout.

][Sandy topsoil: one part topsoil to one part peat; clay topsoil: two parts topsoil to one part peat. Thoroughly mix all parts of planting soil mixture to a uniform blend throughout.

]2.5 FERTILIZER

****
NOTE: Check with the local Agriculture County Extension Service Office for recommended fertilizer mixture for local conditions.
****

Fertilizer for groundcover, wildflowers and grasses is not permitted. Fertilizer for trees, plants, and shrubs must be as recommended by plant supplier, except synthetic chemical fertilizers are not permitted. Fertilizers containing petrochemical additives or that have been treated with pesticides or herbicides are not permitted.

2.5.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

[______] percent available nitrogen
[______] percent available phosphorus
[______] percent available potassium
[______] percent sulfur
[[______] percent iron

]2.5.2 Fertilizer Tablets

Organic, plant tablets composed of tightly compressed fertilizer chips forming a tablet that is insoluble in water, is designed to provide a continuous release of nutrients for at least 24 months and contains the following minimum percentages, by weight, of plant food nutrients:

[20] [_____] percent available nitrogen
[20] [_____] percent available phosphorus
[5] [_____] percent available potassium

2.6 WEED CONTROL FABRIC

****

NOTE: Check with the local Agriculture County Extension Service Office for recommended type of membrane for the project area. Specify only one type of membrane for the project.

****

****

NOTE: Choose one of the following options.

****

[2.6.1 Roll Type Polypropylene or Polyester Mats

Fabric must be woven, needle punched or non-woven and treated for protection against deterioration due to ultraviolet radiation. Fabric must be minimum 99 percent opaque to prevent photosynthesis and seed germination from occurring, yet allowing air, water and nutrients to pass thru to the roots. Minimum weight must be 0.11 kg per square meter 5 ounces per square yard with a minimum thickness of 0.50 mm 20 mils with a 20 year (minimum) guarantee.

][2.7 DRAINAGE PIPE FOR PLANT PITS AND BEDS

****

NOTE: Check with the local Agriculture County Extension Service Office for recommended type of drainage pipe. Specify only one type of drainage pipe for the project.

****

****

NOTE: If Section 33 40 00 STORMWATER UTILITIES is utilized, delete requirements for "DRAINAGE PIPE FOR PLANT PITS AND BEDS."

****

[Plastic polyvinyl chloride pipe, [_____] mm inches in diameter, [unperforated] conforming to ASTM D3034 SDR 35 [perforated] conforming to ASTM D2729.][Plastic HDPE pipe, [_____] mm inches in diameter, [unperforated] [perforated].][Plastic ABS pipe, [_____] mm inches in diameter, [unperforated] [perforated].][Corrugated plastic drainage tubing, [_____] mm inches in diameter, [unperforated] [perforated] conforming to ASTM F667/F667M.][Clay drain tile, [_____] mm inches in diameter, [unperforated conforming to ASTM C4] [perforated conforming to ASTM C4] [[extra strength] [standard strength] conforming to ASTM C700].

]]2.8 MULCH

****

NOTE: Check with the local Agriculture County Extension Service Office for recommended and locally available mulch material. Examine installations

design guides if available for approve mulch list.
****

Free from noxious weeds, mold, pesticides, or other deleterious materials.

****
NOTE: Use inert mulch materials only when organic mulch is not available, or when site is located in a dry climate.
****

[2.8.1 Inert Mulch Materials

****
NOTE: Select desired mulch materials. Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying products with recycled content.
****

[Provide [recycled] [stone,] [riverbank stone,] [crushed pit-run rock,] [granite chips,] [_____,] [or other recycled material] complying with ASTM D6155, ranging in size from [___(____)] to [____(____)] mm (inches).[Provide materials from site and construction waste to the greatest extent possible.]

]]2.8.2 Organic Mulch Materials

****
NOTE: Hydraulic mulch is an EPA designated product for recycled content. Recycled content percentages listed are recommended by EPA; additional information can be found on the EPA's "Comprehensive Procurement Guidelines (CPG)" page within EPA's website at http://www.epa.gov.
****

Provide [wood cellulose fiber,] [wood chips,] [shredded hardwood,] [shredded redwood bark,] [pine straw mulch,] [pine needles,] or [recycled] [_____] from site when available. Wood cellulose fiber must be processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to an appropriate color to facilitate visual metering of materials application. Paper-based hydraulic mulch must contain 100 percent post-consumer recycled content. Wood-based hydraulic mulch must contain 100 percent total recovered materials content.

[2.8.3 Recycled Organic Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 65 by 65 mm 2-1/2 by 2-1/2 inch screen. It must be cleaned of all sticks a minimum 25 mm one inch in diameter and plastic materials a minimum 75 mm 3 inches length. The material must be treated to retard the growth of mold and fungi.

]2.9   STAKING AND GUYING MATERIAL

2.9.1   Staking Material

2.9.1.1   Tree Support Stakes

Rough sawn hard wood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Stakes must be minimum 50 mm 2 inches square or 64 mm 2-1/2 inch diameter by 2.4 m 8 feet long, pointed at one end.[Paint or stain wood stakes dark brown.].

2.9.1.2   Ground Stakes

Rough sawn hard wood or plastic, 50 mm 2 inches square are by 0.91 m 3 feet long, pointed at one end.

2.9.2   Guying Material

2.9.2.1   Guying Wire

12 gauge annealed galvanized steel, ASTM A580/A580M.

2.9.2.2   Guying Cable

Minimum five-strand, 5 mm 3/16 inch diameter galvanized steel cable [plastic coated].

2.9.3   Hose Chafing Guards

New or used 2 ply 19 mm 3/4 inch diameter reinforced rubber or plastic hose, black or dark green, all of same color.

2.9.4   Flags

White [surveyor's plastic tape,] [12.70 mm1/2 inch diameter PVC pipe], [150 mm6 inches] [300 mm12 inches] long, fastened to guying wires or cables.

2.9.5   Turnbuckles

Galvanized or cadmium-plated steel with minimum 75 mm 3 inch long openings fitted with screw eyes. Eye bolts must be galvanized or cadmium-plated steel with 25 mm one inch diameter eyes and screw length 38 mm 1-1/2 inches, minimum.

2.9.6   Deadmen

****

NOTE: Avoid the use of concrete or brick materials.

****

100 by 200 mm4 by 8 inch rectangular or 200 mm 8 inch diameter by 900 mm 36 inch long, [pine] [fir] [_____] wood material.

2.9.7   Metal Anchors

2.9.7.1   Driven Anchors

Malleable iron, arrow shaped, galvanized, sized as follows:

Tree Caliper	Anchor Size
50 mm	75 mm
75 to 150 mm	100 mm
150 to 200 mm	150 mm
200 to 250 mm	200 mm
250 to 300 mm	250 mm

Tree Caliper	Anchor Size
2 inches and under	3 inches
3 to 6 inches	4 inches
6 to 8 inches	6 inches
8 to 10 inches	8 inches
10 to 12 inches	10 inches

2.9.7.2 Screw Anchors

Steel, screw type with welded-on 75 mm 3 inch round helical steel plate, minimum 10 mm 3/8 inch diameter, 375 mm 15 inches long.

2.10 EDGING MATERIAL

2.10.1 Wood Edging

****

NOTE: Indicate type of wood, e.g., Redwood, Cypress, Western Red Cedar, [_____]. If a decay resistant species is specified, preservative treatment will not be required. Specify decay-resistant species when feasible.

****

As specified in Section 06 10 00 ROUGH CARPENTRY. [Redwood] [Cypress] [Western Red Cedar] [_____] wood edging must be free of solvent at time of delivery. Minimum 200 by 13 mm 8 by 1/2 inch [treated in accordance with AWPA U1 and AWPA T1 with preservatives conforming to AWPA P5 before installation]. Anchoring stakes must be the same material as wood edging, [13 by 50] [_____] mm [1/2 by 2] [_____] inches, 300 mm 12 inches long.

****

NOTE: Plastic or rubber garden edging, and plastic lumber, are EPA designated products for recycled content. Recycled content percentages listed are recommended by EPA; additional information can be found on the EPA's "Comprehensive Procurement Guidelines (CPG)" page within EPA's website at

http://www.epa.gov. Research shows that the product is commonly available via US national manufacturers meeting the percentage of recycled content listed below.
****

2.10.2 Recycled Plastic Edging

Plastic lumber as specified in Section 06 10 00 ROUGH CARPENTRY. 100 percent recycled [polyethylene][_____] edging, resistant to insects, termites, boring worms, splintering and rotting, and must not absorb moisture or promote bacterial growth. Minimum [1 by 4][1 by 6][2 by 4][2 by 6][_____] inch, capable of bending a minimum [24][36][_____] radius, integrally colored [brown][_____] with [slip joint][_____] connections. Anchors and stakes must be of the same manufacturer and color as the edging.

2.10.3 Concrete Edging

[Extruded] [Cast-in-place] [150 by 150] [_____] by [_____] mm [6 by 6] [_____] by [_____] inch concrete mowstrip. Provide [tooled] [saw cut] [_____] contraction joints to a depth of [19] [_____] mm [3/4] [_____] inch after the surface has been finished. Provide joints every [1500] [_____] lineal mm [5] [_____] lineal feet. Provide [12.70] [_____] mm [1/2] [_____] inch thick expansion joints at change of direction and where mowstrip abuts rigid pavement. [Provide [#4] [_____] reinforcement bar and other devices necessary to install and secure reinforcement.] Provide a floated finish, then finish with a flexible bristle broom. [20] [_____] MPa [2500] [_____] psi compressive concrete strength at 28 days as specified under Section 03 30 00 CAST-IN-PLACE CONCRETE.

[2.11 ANTIDESICCANTS

Sprayable, water insoluble vinyl-vinledine complex which produce a moisture retarding barrier not removable by rain or snow. Film must form at temperatures commonly encountered out of doors during planting season and have a moisture vapor transmission rate (MVT) of the resultant film of maximum 10 grams per 24 hours at 70 percent humidity.

][2.12 EROSION CONTROL MATERIALS

Erosion control material must conform to the following:

[2.12.1 Erosion Control Blanket

[100 percent agricultural straw][70 percent agricultural straw/30 percent coconut fiber matrix] stitched with a degradable nettings, designed to degrade within [12 months][18 months].

][2.12.2 Erosion Control Fabric

Fabric must be knitted construction of polypropylene yarn with uniform mesh openings 19 to 25 mm 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips must have a minimum life of 6 months.

][2.12.3 Erosion Control Net

Net must be heavy, twisted jute mesh, weighing approximately 605 grams per meter 1.22 pounds per linear yard and 1200 mm 4 feet wide with mesh openings of approximately 25 mm one inch square.

][2.12.4 Hydrophilic Colloids

Hydrophilic colloids must be physiologically harmless to plant and animal life without phytotoxic agents. Colloids must be naturally occurring, silicate powder based, and must form a water insoluble membrane after curing. Colloids must resist mold growth.

]2.12.5 Erosion Control Material Anchors

Erosion control anchors must be as recommended by the manufacturer.

][2.13 ROOT CONTROL BARRIER

[Flexible and permeable geotextile fabric with permanently attached time-released nodules. Color to be [black] [gray] [_____].] [Pre-formed, [round, tapered cylinder] [linear] barrier with integral vertical root deflecting ribs constructed of ultraviolet resistant polypropylene material. Color to be [black] [_____].

]]2.14 WATER

****

NOTE: When water is Government furnished, locate the source. Recycled or reclaimed irrigation water may be available through a tertiary treatment plant on or off site. It is preferred that this type of water be used for irrigation whenever possible. Check project specific conditions.

Unless otherwise directed, water must be the responsibility of the Contractor. Water source must be potable or non-potable. Non-potable is preferred. If non-potable edit specification accordingly. Source of water must be approved by the Contracting Officer and must be of suitable quality for irrigation, containing no elements toxic to plant life.

Coordinate information presented here with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.

****

Source of water to be approved by Contracting Officer and suitable quality for irrigation and must not contain elements toxic to plant life, including acids, alkalis, salts, chemical pollutants, and organic matter. Use collected storm water or graywater when available.

[2.15 MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum must be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

]2.16 SOURCE QUALITY CONTROL

The [Contracting Officer][and Landscape Architect of Record] [_____] will inspect plant materials at the [project] site and approve them. Tag plant materials for size and quality.

PART 3 EXECUTION

3.1 EXTENT OF WORK

Provide soil preparation, including [soil conditioners] [and] [soil amendments] prior to planting. Provide [tree,] [shrub,] [vine,] [groundcover,] [seed,] [and] [sod] planting, [post-planting fertilizer,] [edging,] [staking,] [guying,] [weed control fabric,] [erosion control material,] [root control barrier] installation,[_____,] [and] [mulch topdressing] of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.2 ALTERNATIVE HERBICIDE TREATMENT (SOLARIZING SOIL)

Within 48 hours of subsoil preparation, saturate soil with water to a depth of 914 mm 3 feet. Immediately stake polyethylene sheeting over area to be planted. Stake tightly to surface of soil. Maintain sheeting in place for a minimum of 6 weeks. Immediately after removing sheeting, cover area to be planted with topsoil. Do not till soil prior to applying topsoil.

3.3 PREPARATION

3.3.1 Protection

Protect existing and proposed landscape features, elements, and sites from damage or contamination. Protect trees, vegetation, and other designated features by erecting high-visibility, reusable construction fencing. Locate fence no closer to trees than the drip line. Plan equipment and vehicle access to minimize and confine soil disturbance and compaction to areas indicated on Drawings.

3.3.2 Layout

Stake out approved plant material locations and planter bed outlines on the project site before digging plant pits or beds. The Contracting Officer reserves the right to adjust plant material locations to meet field conditions. Do not plant closer than [300] [600] [900] [_____] mm [12] [24] [36] [_____] inches to a [building wall,] [pavement edge,] [fence or wall edge] [and] [other similar structures]. Provide on-site locations for excavated rock, soil, and vegetation.

3.3.3 Erosion Control

Provide erosion control and seeding with native plant species to protect slopes.

3.3.4 Soil Preparation

****

NOTE: Elevation of subgrade will vary depending upon the needs for additional topsoil, mulch topdressing, or other treatment.

****

[3.3.4.1 pH Adjuster Application Rates

****

NOTE: Check with the local Agriculture County Extension Service and specify amounts applicable for the project area.
****

Apply pH adjuster at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Lime [_____] kg per square meter pounds per acre [_____] kg per 100 square meters [_____] pounds per 1000 square feet

][Sulfur [_____] kg per square meter [_____] pounds per acre [_____] kg per 100 square meters [_____] pounds per 1000 square feet

][Iron [_____] kg per square meter [_____] pounds per acre [_____] kg per 100 square meters [_____] pounds per 1000 square feet

][Aluminum Sulfate [_____] kg per square meter [_____] pounds per acre [_____] kg per 100 square meters [_____] pounds per 1000 square feet

]][3.3.4.2 Soil Conditioner Application Rates

****
NOTE: Check with the local Agriculture County Extension Service and specify amounts applicable for the project area.
****

****
NOTE: Waste gypsum board must be pulverized and spread evenly over the entire site area. Do not deposit gypsum in areas that lack adequate drainage. Verify appropriate application rates with a landscaping consultant. Application rates may be as high as 22 tons per acre; however, in some areas there may be regulatory restrictions on the disposal of construction waste on site and a variance may be required.
****

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Peat [_____] cubic meters per square meter [_____] cubic yard per acre [_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet

][Sand [_____] cubic meters per square meter [_____] cubic yard per acre [_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet

][Compost Derivatives [_____] cubic meters per square meter [_____] cubic yard per acre [_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet

][Gypsum [_____] cubic meters per square meter [_____] cubic yard per acre [_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet

][Rotted Manure [_____] cubic meters per square meter[_____] cubic yard per acre[_____] cubic meters per 100 square meters [_____] cubic yards per 1000 square feet

]]3.3.4.3 Fertilizer Application Rates

****

NOTE: Check with the local Agriculture County Extension Service and specify amounts applicable for the project area.

****

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

[Organic granular fertilizer [[_____] kg per square meter[_____] pounds per acre] [[_____] kg per 100 square meters[_____] pounds per 1000 square feet].

]

[Fertilizer Tablets for Trees and Shrubs]			
	[Container/Caliper Size]	[Tablet Size]	[No. of Tablets]
[Shrub:]	[[_____]]	[[_____]]	[[_____]]
[Tree:]	[[_____]]	[[_____]]	[[_____]]

[3.3.5 Root Control Barrier

****

NOTE: Contact a local arborist or plant nursery person for projects involving root pruning of existing plant material to determine required amount of root structure to be removed.

****

[Install geotextile fabric in the soil in a [vertical] [horizontal] [and] [surrounding] application. Use appropriate holding device to assure fabric position. For vertical or horizontal application, a minimum [50] [_____] mm [2] [_____] inch soil cover is required over the top [surface] [edge]. A minimum [450] [_____] mm [18] [_____] inch extension of fabric beyond the structure area to be protected is required to prevent root growth from growing around fabric edges.][Install [cylindrical] [linear] polypropylene barrier a minimum [12.70] [25] [_____] mm [1/2] [one] [_____] inch above finish grade to prevent root growth over the barrier. Backfill the outside of the barrier with 19 to 25 mm 3/4 to one gravel a minimum width of [50] [_____] [2] [_____] inches. For linear barrier application use appropriate device to connect two pieces.]

][3.3.6 Subsoil Drainage for Plant Pits and Beds

****

NOTE: Drawings must indicate areas where subsoil drainage will be required to provide for adequate drainage of areas to be planted.

****

****

NOTE: If Section 33 40 00 STORMWATER UTILITIES is utilized, delete requirements for Subsoil Drainage for Plant Pits and Beds.

****

Provide as indicated.[Lay perforated drain pipe with perforations down.] Backfill trenches as specified in Section 31 00 00 EARTHWORK.

]3.4 PLANT BED PREPARATION

Verify location of underground utilities prior to excavation. Protect existing adjacent turf before excavations are made. Do not disturb topsoil and vegetation in areas outside those indicated on Drawings. Where planting beds occur in existing turf areas, remove turf to a depth that will ensure removal of entire root system. Measure depth of plant pits from finished grade. Depth of plant pit excavation must be as indicated and provide proper relation between top of root ball and finished grade. Install plant material as specified in paragraph PLANT INSTALLATION. Do not install trees within 10 feet of any utility lines or building walls.

3.5 PLANT INSTALLATION

3.5.1 Individual Plant Pit Excavation

Excavate pits at least [twice as large][[400] [_____] mm[16] [_____] inches larger] in diameter as the size of ball or container to depth shown.

3.5.2 Plant Beds with Multiple Plants

Excavate plant beds continuously throughout entire bed as outlined to depth shown.

3.5.3 Handling and Setting

Move plant materials only by supporting the [root ball] [container]. [Set plants on hand compacted layer of prepared backfill soil mixture [150] [_____] mm [6] [_____] inches thick][Set plants on native soil] and hold plumb in the center of the pit until soil has been tamped firmly around root ball. Set plant materials, in relation to surrounding finish grade, [[25 to 50] [_____] to [_____] mm[one to 2] [_____] to [_____] inches above] [[_____] mm inches below] depth at which they were grown in the nursery, collecting field or container. Replace plant material whose root balls are cracked or damaged either before or during the planting process.

Plant material must be set in plant beds according to the drawings. Backfill soil mixture must be placed on previously scarified subsoil to completely surround the root balls, and must be brought to a smooth and even surface, blending to existing areas.

3.5.3.1 Balled and Burlapped Stock

Backfill with [prepared soil mixture] [topsoil] to approximately half the depth of ball and then tamp and water. Carefully remove or fold back excess burlap and tying materials from the top a minimum 1/3 depth from the top of the rootball. Tamp and complete backfill, place mulch topdressing, and water. Remove wires and non-biodegradable materials from plant pit prior to backfill operations.

3.5.3.2 Bare-Root Stock

Plant so roots are arranged in a natural position. Place roots in water a minimum of 30 minutes prior to planting. Carefully work [prepared soil mixture] [topsoil] among roots. Tamp remainder of backfill, place mulch topdressing and water.

3.5.3.3 Container Grown Stock

Remove from container and prevent damage to plant or root system.

3.5.3.4 Ground Covers and Vines

****

NOTE: Choose one of the following options. Choose the second option for NAVFAC SE projects.

****

[Plant after placing mulch topdressing. Do not remove plant materials from flats or containers until immediately before planting. Space at intervals indicated. Plant at a depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of [150] [_____] mm [6] [_____] inches without run off or puddling. Smooth planting areas after planting to provide even, smooth finish. [Mulch as indicated.]

][Smooth planting areas before planting to provide even, smooth finish. Plant after placing weed control fabric and mulch topdressing. Do not remove plant material from flats or containers until immediately before planting. Space at the intervals indicated. Plant at a depth to sufficiently cover all roots. Start watering areas planted as required by temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of [150] [_____] mm [6] [_____] inches without run off or puddling. Add mulch topdressing as needed.

]3.5.4 Earth Mounded Watering Basin for Individual Plant Pits

[Form with topsoil around each plant by replacing a mound of topsoil around the edge of each plant pit. Watering basins must be 150 mm 6 inches deep for trees and 100 mm 4 inches deep for shrubs. Eliminate basins around plants in plant beds containing multiple plants.

][Form with topsoil around each plant by placing a mound of topsoil around the edge of each plant pit. Watering basins must be 150 mm 6 inches deep for trees and 100 mm 4 inches deep for shrubs. Construct watering basin in a 1.4 m 4-1/2 foot diameter circle around specimen (not planted in a close group) trees and shrubs.

][3.5.5 Weed Control Fabric Installation

Remove grass and weed vegetation, including roots, from within the area enclosed by edging. Completely cover areas enclosed by edging with specified weed control fabric prior to placing mulch layer. Overlap cut edges [150] [_____] mm [6] [_____] inches.

][3.5.6 Erosion Control Material

Install in accordance with manufacturer's instructions.

]3.5.7 Placement of Mulch Topdressing

Place specified mulch topdressing on top of weed control fabric covering total area enclosed by edging. Place mulch topdressing to a depth of [75] [_____] mm [3] [_____] inches.

3.5.8 Mulch Topdressing

Provide mulch topdressing over entire planter bed surfaces and individual plant surfaces including earth mound watering basin around plants to a depth of [75] [_____] mm [3] [_____] inches after completion of plant installation and before watering. Keep mulch out of the crowns of shrubs. Place mulch a minimum 50 to 75 mm 2 to 3 inches[_____] away from trunk of shrub or tree. Place on top of any weed control fabric.

[3.5.9 Installation of Edging

Uniformly edge beds of plants to provide a clear cut division line between planted area and adjacent lawn. Construct bed shapes as indicated. Install [wood] [plastic] [concrete] edging material [as indicated] [and] [as per manufacturer's instructions]. [Install edging material in a perfect 1.22 m 4 foot diameter circle inside the 1.37 m 4-1/2 foot watering basin, around individual specimen trees and shrubs not planted in a close group.] Install edging with minimum [25 mmone inch] [_____] left above ground level.

]3.5.10 Fertilization

****

NOTE: Fertilizer planting tablets are the most commonly used and convenient method of pre-planting fertilization. Other types of fertilizer including bone meal or other organic fertilizers or granular fertilizers may be specified when appropriate. Number of tablets or quantity of other fertilizers should be inserted in blanks and should be based on agronomist's recommendations.

****

3.5.10.1 Fertilizer Tablets

Place fertilizer planting tablets evenly spaced around the plant pits to the manufacturer's recommended depth.

3.5.10.2 Granular Fertilizer

Apply granular fertilizer as a top coat prior to placing mulch layer and water thoroughly.

3.5.11 Watering

Start watering areas planted as required by temperature and wind conditions. Slow deep watering must be used. Apply water at a rate sufficient to ensure thorough wetting of soil to a depth of [300] [_____] mm

[12] [_____] inches without run off or puddling. Watering of other plant material or adjacent areas must be prevented.

3.5.12 Staking and Guying

3.5.12.1 Staking

****

NOTE: Select methods of staking each tree based on the size and species of the tree and local wind conditions.

****

Stake plants with the number of stakes indicated complete with [double strand of 12 gage guy wire] [_____] as detailed. Attach [guy wire] [_____] half the tree height but not more than 1.5 m 5 feet high. Drive stakes to a depth of [0.80 to 0.91] [_____] m [2-1/2 to 3] [_____] feet into the ground outside the plant pit. Do not injure the root ball.[Use hose chafer guards where guy wire comes in contact with tree trunk.]

3.5.12.2 Guying

****

NOTE: Select methods of guying each tree based on the size and species of the tree and local wind conditions.

****

Guy plants as indicated. Attach [two strands of guying wire] [guying cable] around the tree trunk at an angle of 0.785 rad 45 degrees at approximately 1/2 of the trunk height [_____]. Protect tree trunks with chafing guards where guying [wire] [cable] contacts the tree trunk. Anchor guys to [deadmen wood blocks] [wood ground stakes] [malleable iron anchors] [steel screw anchors]. Fasten flags to each guying [wire] [cable] approximately 2/3 of the distance up from ground level.[Provide turnbuckles as indicated.]

3.5.12.3 Chafing Guards

Use hose chafing guards, as specified where guy [wire] [cable] will contact the plant.

[3.5.12.4 Deadmen

Place deadmen minimum 450 mm 18 inches below ground surface. Place equal distance from tree trunk and around the plant pit.

][3.5.12.5 Wood Ground Stakes

Drive wood ground stakes into firm ground outside of plant pit with top of stake flush with ground. Place equal distance from tree trunk and around the plant pit.

][3.5.12.6 Iron Anchors

Drive malleable iron anchors into firm ground outside of plant pit a minimum 750 mm 30 inches below finish grade. Place equal distance from tree trunk and around the plant pit.

][3.5.12.7 Steel Screw Anchors

Insert steel screw anchors as recommended in manufacturer's data. Place equal distance from tree trunk and around the plant pit.

][3.5.12.8 Flags

Securely fasten flags on each guy [wire] [and][cable] [approximately two-thirds of the distance up from ground level].

]3.5.13 Pruning

****

NOTE: Check with the local Agriculture county Extension Service Office for recommended pruning season for the project area. Insert the dates in the subject paragraph.

****

Prune in accordance with safety requirement of TCIA Z133.

3.5.13.1 Trees and Shrubs

Remove dead and broken branches. Prune to correct structural defects only. Retain typical growth shape of individual plants with as much height and spread as practical. Do not cut central leader on trees. Make cuts with sharp instruments. Do not flush cut with trunk or adjacent branches. Collars must remain in place. Pruning must be accomplished by trained and experienced personnel and must be accordance with TCIA A300P1.

3.5.13.2 Wound Dressing

Do not apply tree wound dressing to cuts.

3.6 RESTORATION AND CLEAN UP

3.6.1 Restoration

Turf areas, pavements and facilities that have been damaged from the planting operation must be restored to original condition at the Contractor's expense.

3.6.2 Clean Up

Excess and waste material must be removed from the installed area and must be [disposed offsite at an approved landfill, recycling center, or composting center][composted on site]. Separate and recycle or reuse the following landscape waste materials: [nylon straps,] [wire,] [ball wrap,] [burlap,] [wood stakes,] [_____]. Adjacent paved areas must be cleared.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-32 96 00 (August 2017)**
Change 1 - 08/21

Preparing Activity: NAVFAC **Superseding**
UFGS-32 96 00 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 32 96 00

TRANSPLANTING EXTERIOR PLANTS

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-- End of Section Table of Contents --

****

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****

SECTION 32 96 00

TRANSPLANTING EXTERIOR PLANTS
08/17, CHG 1: 08/21

****

NOTE: This guide specification covers the requirements for transplanting exterior plant material.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The contract drawings will delineate original and new transplanting locations for individual plant material.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICANHORT (AH)

ANSI/ANLA Z60.1	(2004) American Standard for Nursery Stock

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM C602	(2023) Agricultural Liming Materials
ASTM D4427	(2018) Standard Classification of Peat Samples by Laboratory Testing
ASTM D4972	(2018) Standard Test Methods for pH of Soils
ASTM D5539	(2013) Seed Starter Mix
ASTM D6155	(2019) Nontraditional Coarse Aggregate for Bituminous Paving Mixtures

TREE CARE INDUSTRY ASSOCIATION (TCIA)

TCIA A300P1	(2017) ANSI A300 Part1: Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance Standard Practices - Pruning
TCIA Z133	(2017) American National Standard for Arboricultural Operations - Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush - Safety Requirements

U.S. DEPARTMENT OF AGRICULTURE (USDA)

DOA SSIR 42	(2022) Kellogg Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report, No. 42, Version 6.0

1.2 RELATED REQUIREMENTS

Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION], [Section 31 00 00 EARTHWORK,] [Section 32 84 24 IRRIGATION SPRINKLER SYSTEMS,] [Section 32 92 19 SEEDING,] [Section 32 92 23 SODDING,] [Section 32 92 26 SPRIGGING,] [Section 32 93 00 EXTERIOR PLANTS,] and Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for requirements, with additions and modifications herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

State Landscape Contractor's License & Tree Relocation References

Permits

Photographs

SD-02 Shop Drawings

Transplanting Plan

SD-03 Product Data

Equipment

A listing of equipment to be used for the transplanting operation, including size model, year and type of mechanical tree transplanting equipment.

Gypsum

Mulches Topdressing

Ground Stakes

Peat

Composted Derivatives

Rotted Manure

Organic Mulch Materials

Staking Material

SD-06 Test Reports

Soil Test; [Soil Test of current growing area]; [Soil Test of proposed area]; [Soil Test location map]

Percolation Test; [Percolation Test of current growing area]; [Percolation Test of proposed area]

1.4 QUALITY ASSURANCE

1.4.1 State Landscape Contractor's License & Tree Relocation References

Contractor must be a professional tree moving company holding a landscape contractor's license in the state where the work is to be performed and have a minimum of 10 years tree relocation experience. Submit a copy of license and 3 references of tree relocation work in the past five years.

1.4.2 Permits

The Contractor must obtain and pay for permits and fees for the alteration of overhead lines or any other related moving permit or fee that requires compliance with Federal, State and local regulatory requirements.

1.4.3 Photographs

The contractor must provide a clear 100 mm by 150 mm 4 inch by 6 inch minimum size color photograph of the plant material to be relocated. Trees must be documented by an individual photograph of each. Photographs must indicate the date and species of each plant on the back or front of each photo.

1.4.4 Transplanting Plan

A transplanting plan must be submitted showing existing and proposed locations of transplanted material. The plan must also delineate methods, dates, and times for root pruning, digging, balling, removing, storing, transporting, planting, watering, and maintenance to ensure survivability. The plan must also include equipment and anti-desiccant to be used. A listing of the plant material to be transplanted must be provided by common name and botanical name as listed under "Nomenclature" in ANSI/ANLA Z60.1; classification; caliper; and height.

1.4.5 Pre-Installation Meeting

Convene a pre-installation meeting a minimum of one week prior to commencing work of this section. Require attendance of parties directly affecting work of this section. Review conditions of operations, procedures and coordination with related work. Agenda must include the following:

a. Tour, inspect, and discuss conditions of planting materials.

b. Review planting schedule and maintenance.

c. Review required inspections.

d. Review environmental procedures.

1.4.6 Soil Test

Commercial test from an independent testing laboratory according to the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42 including basic soil groups (sand, silt, clay, pH (ASTM D4972), soluble salts), secondary nutrient groups (calcium, magnesium, sodium, Sodium Absorption Ratio (SAR)), micronutrients (zinc, manganese, iron, copper). Soil required for each test must include a maximum depth of 450 mm 18 inches of approximately one liter one quart volume for each test. Areas sampled should not be larger than 0.4 hectare one acre and should contain at least 6-8 cores for each sample area and be thoroughly mixed. Problem areas should be sampled separately and compared with samples taken from adjacent non-problem areas. The location of the sample areas should be noted and marked on a parcel or planting map for future reference.

1.4.7 Percolation Test

Immediately following rough grading operation, identify a typical location for one of the largest trees and or shrubs and excavate a pit per the project details. Fill the pit with water to a depth of 300 mm 12 inches. The length of time required for the water to percolate into the soil, leaving the pit empty, must be measured by the project Landscape Architect and verified by the Contracting Officer. Within six hours of the time the water has drained from the pit, the Contractor, with the Contracting Officer and project Landscape Architect present, must again fill the pit with water to a depth of 300 mm 12 inches. If the water does not completely percolate into the soil within 9 hours, a determination must be made and submitted by the Contractor and verified and approved by the Contracting Officer, whether a drainage system or a soil penetrant will be required for each tree and or shrub being transplanted.

1.5 DELIVERY OF MATERIALS

1.5.1 Soil Conditioners Delivery and Storage

Soil conditioners must be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil conditioners may be furnished in bulk. A chemical analysis must be provided for bulk deliveries. Store in dry locations and away from contaminants.

1.6 PLANT MATERIAL IDENTIFICATION

Plant material to be transplanted must be tagged and/or shown on drawings. Transplanted plant material must be delivered with attached, durable, waterproof labels and weather-resistant ink or imprinted tags, stating the correct botanical and common plant name and size.

1.7 INSPECTION OF MATERIALS

Materials must be inspected for compliance with paragraph PRODUCTS and paragraph PLANT MATERIAL IDENTIFICATION. Open soil amendment containers or wet soil amendments must be rejected. Topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material larger than 40 mm 1-1/2 inch diameter must be rejected. Topsoil that contains viable plant material and plant parts must be rejected. Unacceptable material must be removed from the job site. The Contracting Officer reserves the right to refuse any unacceptable plant material. All rejected plant material must be removed from the job site on the day of rejection.

1.8 HANDLING OF PLANT MATERIALS

Materials must not be dropped from vehicles. Plant material must be transported without scarring trunks or deforming crown branching. Materials found to be in unacceptable condition must be replaced at no additional cost to the Government.

1.9 TIME LIMITATION

The time limitation from digging, removing, transporting, to installing transplanted plant material must be the same day. The time limitation between installing the plant material and placing the mulch must be a maximum 48 hours. If project conditions prevent the Contractor from transplanting and installing plant material on the same day, plant materials must be boxed or heeled in as required. Plant material must be maintained and protected by the Contractor.

1.10 GUARANTEE

Transplanted plant material must have a guarantee period of [365 days][_____]. All plants that die or have 25 percent or more of their branches that die during the construction operations or the guarantee period, must be replaced in kind in relation to size and species during the planting season from [_____] to [_____].

1.11 TRANSPLANTED PLANT MATERIAL TIME AND CONDITIONS

****

NOTE: Project specific climate and conditions, nationally or internationally, will dictate the

optimal times for transplanting. Contact the local agricultural office for this information.

Root pruning times should be planned a minimum of one year in advance for specimen trees and as recommended by the design professional for other plant materials and conditions.
****

Coordinate installation of planting materials during optimal planting seasons for each type of plant material required.

1.11.1 Deciduous Plant Material Time

Deciduous plant material must be transplanted from [_____] to [_____].

1.11.2 Evergreen Plant Material Time

Evergreen plant material must be transplanted from [_____] to [_____].

1.11.3 Transplanting Conditions

All transplanting operations must be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work must be stopped when directed. When special conditions warrant a variance to all transplanting operations, proposed transplanting times must be submitted for approval. The installing site for the plant material must be prepared and excavated in accordance with paragraph SITE EXCAVATION, prior to removing the plant material. If project conditions prevent the Contractor from transplanting and installing plant material on the same day, plant material must be boxed or heeled in as required. Plant material must be maintained by the Contractor until a suitable planting time.

1.11.4 Underground Utilities

The location of underground utilities and facilities at both the removal and installing sites must be verified and marked. Damage to underground utilities and facilities must be repaired at the Contractor's expense.

1.11.5 Protecting Existing Vegetation

When there are established lawns at either the removal or installing sites, the turf must be protected during the operation. Existing trees, shrubs, and plant beds at the [removal] [and][or] [installing site[s]] that are to be preserved must be barricaded and protected from damage by a tree barricade or other measure. Damage to existing plant material must be mitigated by the Contractor at no additional cost to the Government. Damage must be assessed by a state certified arborist or other approved professional using the National Arborist Association's tree valuation guideline.

1.11.6 Protection of Plant Material to be Transplanted

Protect plant material slated for transplanting that is not transplanted at the beginning of construction operations. Prior to construction operations, tag plants to be transplanted with plastic or vinyl tape tied to the plant caliper. Plants to be transplanted must be protected from root compaction and any other damage (with barrier of metal poles a maximum of 2.5 meters 8 feet on center with plastic fluorescent netting) at a minimum of 6 meter 20 foot diameter from outside of the plant's trunk prior to the start of any construction operations. Where tree drip lines are greater than 3 meter 10 feet from the tree's trunk, locate barrier fencing at the drip line of the tree. Plastic tape and barrier fencing must not be removed until transplanting operations are ready to begin and or instructed by the Contracting Officer. Water and prune plant material as necessary to keep healthy and vigorous, particularly when water is shut off. Water existing plant material to be transplanted from the start of construction operations until the maintenance period is over or until regular [irrigation] [water] service is in working order. Outside storage locations must be continually shaded and protected from the wind. Bare root plants must be heeled in. Plants stored on the project must be protected from any drying at all times covering the balls or roots with moist sawdust, wood chips, shredded bark, peat moss, or other similar mulching material.

1.11.7 Protection of Plant Material During Transplanting

Plant material must be protected during transplanting to prevent desiccation and damage to the branches, trunk, and root system. Branches of shrubs, palms, vines must be protected by tying-in. Exposed branches must be covered during transport. [The root area must be treated with mycorrhizal fungi inoculum.] Plant material must be undamaged, vigorous and healthy with a well-branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion after transplanting. Plant material showing desiccation, abrasion, sun scald injury or structural branching damage must be replaced at no cost to the government.

PART 2 PRODUCTS

2.1 TOPSOIL

****

NOTE: If topsoil properties are included in another section of Division 31, delete this paragraph and include a cross-reference to the appropriate section. Otherwise, select appropriate sources of topsoil. Check with the local Agriculture County Extension Service Office for soil properties appropriate for the plant materials to be planted. If existing topsoil is used, insert materials, if required, to properly condition for pH and friability. Where suitable topsoil is available within limits of the work area, include stripping and stockpiling of topsoil in the applicable section of Division 31. If suitable topsoil is not available within the limits of the work area, consider whether it is more economical to treat the soil of the graded areas with fertilizer and supplements so as to be conducive for plant establishment and maintenance, to transport topsoil to the project site, or to use regionally native plants suited to the on-site soil. If treatment of the soil is more economical, include requirements for fertilizer and supplements. Prior to stockpiling topsoil, remove all weed-grasses. This should occur when the foliage is 150 to 250 mm 6 to

10 inches high and approximately 4 to 6 weeks prior to stockpiling.
****

Topsoil to be placed around root balls of transplanted material at new planting site must match topsoil of existing site where material is transplanted from, based on soil tests taken at both the current growing area and the proposed growing site. Minimum matching characteristics must include: ph, organic matter, soluble salts, percentages of silt, clay and sand.[Existing soil must be used as topsoil.][Stockpiled on-site surface soil must be used as topsoil.][Additional topsoil must be [furnished by the Contractor] [obtained from topsoil borrow areas indicated]]. Soil conditioners may be added to topsoil to bring into compliance.

2.2 SOIL CONDITIONERS

****
NOTE: Prior to including these provisions in project specifications, perform tests of on-site topsoil to determine its suitability and the possible need of pH adjusters or soil conditioners.
****

Provide singly or in combination as required to meet specified requirements for topsoil. Soil conditioners must be nontoxic to plants.

2.2.1 Lime

****
NOTE: Use ASTM C602 calcium carbonate equivalent (C.C.E.) as specified in Table 1: for burnt lime, C.C.E. must not be less than 140 percent; for hydrated lime, C.C.E. must not be less than 110 percent; and for limestone, C.C.E. must not be less than 80 percent.
****

Commercial grade [hydrated] [or] [burnt] limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than [80][_____] percent.

2.2.2 Aluminum Sulfate

Commercial grade.

2.2.3 Sulfur

100 percent elemental

2.2.4 Iron

100 percent elemental

2.2.5 Peat

Natural product of [peat moss] derived from a freshwater site and conforming to [ASTM D4427] [ASTM D5539] as modified herein. Shred and granulate peat to pass a 12.5 mm 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation. Peat must not contain invasive species, including seeds.

2.2.6 Sand

Clean and free of materials harmful to plants.

2.2.7 Perlite

Horticultural grade.

2.2.8 Compost Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, invasive species, including seeds, and soil stabilized with nitrogen and having the following properties:

2.2.8.1 Particle Size

Minimum percent by weight passing:

4.75 mmNo. 4 mesh screen	95
2.36 mmNo. 8 mesh screen	80

2.2.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.2.9 Gypsum

****

NOTE: Gypsum must be spread evenly over the entire site area. Do not deposit gypsum in areas that lack adequate drainage. Verify appropriate application rates with a landscaping consultant. Application rates may be as high as 22 tons per acre; however, in some areas there may be regulatory restrictions on the disposal of construction waste on site and a variance may be required.

****

Coarsely ground gypsum comprised of calcium sulfate dihydrate 80 percent, calcium 18 percent, sulfur 14 percent; minimum 96 percent passing through 850 micrometers 20 mesh screen, 100 percent passing thru 970 micrometers 16 mesh screen.

2.2.10 Vermiculite

Horticultural grade for planters.

2.2.11 Rotted Manure

Well rotted horse or cattle manure containing maximum 25 percent by volume of straw, sawdust, or other bedding materials; free of seeds, stones, sticks, soil, and other invasive species.

2.3 MULCHES TOPDRESSING

****
NOTE: Check with the local Agriculture County Extension Service Office for recommended and locally available mulch material. Specify only one type of mulch for the project.
****

Free from noxious weeds, mold, pesticides, or other deleterious materials.

****
NOTE: Use inert mulch materials only when organic mulch is not available, or when site is located in a dry climate.
****

[2.3.1 Inert Mulch Materials

****
NOTE: Select desired mulch materials. Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.
****

Provide [recycled] [stone,] [riverbank stone,] [crushed pit-run rock,] [granite chips,] [_____,] [or other recycled material] complying with ASTM D6155, ranging in size from [___(____)] to [____(____)] mm inches.[Provide materials from site and construction waste to the greatest extent possible.]

]2.3.2 Organic Mulch Materials

****
NOTE: For projects at Camp Lejeune and New River, use pine straw mulch only. Delete all other options.
****

****
NOTE: Hydraulic mulch is an EPA designated product for recycled content. Recycled content percentages listed are recommended by EPA; additional information can be found on the EPA's "Comprehensive Procurement Guidelines (CPG)" page within EPA's website at http://www.epa.gov.
****

Provide [wood cellulose fiber,] [wood chips,] [shredded hardwood,] [shredded redwood bark,] [pine straw mulch,] [pine needles,] or [recycled] [_____] from site when available. Wood cellulose fiber must be processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to an appropriate color to facilitate visual metering of materials application. Paper-based hydraulic mulch must contain 100 percent post-consumer recycled content. Wood-based hydraulic mulch must contain 100 percent total recovered materials content.

2.3.3 Recycled Organic Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 65 mm by 65 mm 2-1/2 inch by 2-1/2 inch screen. It must be cleaned of all sticks a minimum 25 mm one inch in diameter and plastic materials a minimum 75 mm 3 inch length. The material must be pretreated to retard the growth of mold and fungi.

2.4 STAKING AND GUYING MATERIAL

2.4.1 Staking Material

2.4.1.1 Tree Support Stakes

Rough sawn hard wood free of knots, rot, cross grain, bark, long slivers, or other defects that impair strength. Stakes must be minimum 50 mm 2 inches square or 64 mm 2-1/2 inch diameter by 2.4 m 8 feet long, pointed at one end.[Paint or stain wood stakes dark brown.].

2.4.1.2 Ground Stakes

Rough sawn hard wood or plastic, 0.91 m 3 feet long.

2.4.2 Guying Material

2.4.2.1 Guying Wire

12 gauge annealed galvanized steel, ASTM A580/A580M.

2.4.2.2 Guying Cable

Minimum five-strand, 5 mm 3/16 inch diameter galvanized steel cable [plastic coated].

2.4.2.3 Hose Chafing Guards

New or used 2 ply 19 mm 3/4 inch diameter reinforced rubber or plastic hose, black or dark green, all of same color.

2.4.2.4 Flags

White [surveyor's plastic tape,] [12.70 mm1/2 inch diameter PVC pipe], [150 mm6 inches] [300 mm12 inches] long, fastened to guying wires or cables.

2.4.2.5 Turnbuckles

Galvanized or cadmium-plated steel with minimum 75 mm 3 inch long openings fitted with screw eyes. Eye bolts must be galvanized or cadmium-plated steel with 25 mm one inch diameter eyes and screw length 38 mm 1-1/2 inches, minimum.

2.4.2.6 Deadmen

****

NOTE: Avoid the use of concrete or brick materials.

****

100 by 200 mm4 by 8 inch rectangular or 200 mm 8 inch diameter by 900 mm 36 inch long, [pine] [fir] [_____] wood material.

2.4.2.7 Metal Anchors

a. Driven Anchors

b. Malleable iron, arrow shaped, galvanized, sized as follows:

Tree Caliper	Anchor Size
50 mm	75 mm
75 to 150 mm	100 mm
150 to 200 mm	150 mm
200 to 250 mm	200 mm
250 to 300 mm	250 mm
Tree Caliper	Anchor Size
2 inches and under	3 inches
3 to 6 inches	4 inches
6 to 8 inches	6 inches
8 to 10 inches	8 inches
10 to 12 inches	10 inches

c. Screw Anchors

d. Steel, screw type with welded-on 75 mm 3 inch round helical steel plate, minimum 10 mm 3/8 inch diameter, 375 mm 15 inches long.

[2.5 MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum must be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

]2.6 WATER

****

NOTE: When water is Government furnished, locate the source. Recycled or reclaimed irrigation water may be available through a tertiary treatment plant on or off site. It is preferred that this type of water be used for irrigation whenever possible. Check project specific conditions.

Unless otherwise directed, water must be the responsibility of the Contractor. Water source must be potable or non-potable. Non-potable is preferred. If non-potable edit specification accordingly. Source of water must be approved by the Contracting Officer and must be of suitable

quality for irrigation, containing no elements toxic to plant life.

Coordinate information presented here with Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.

****

Unless otherwise directed, water is the responsibility of the Contractor. Water must be [potable][non-potable], and may be supplied by an existing irrigation system or by collected storm water or a graywater system.

PART 3 EXECUTION

3.1 PLANT MATERIAL PREPARATION AND HANDLING

3.1.1 Pruning

****

NOTE: Root pruning should be scheduled well in advance of transplanting. Tree size, location and condition will determine specific requirements. Early root pruning will allow time for the plant to grow new roots inside the root ball to improve recovery.

****

3.1.1.1 Root Pruning

Large canopy and specimen plant material must be root pruned a minimum of 6 months before transplanting[_____]. Minimum root ball sizes must be in accordance with ANSI/ANLA Z60.1.

3.1.1.2 Canopy Pruning

Canopy pruning must conform to TCIA A300P1.

3.1.2 Plant Material Preparation

Plant material designated for transplanting must be watered thoroughly several days before root pruning, digging or moving. Broken or interfering growth must be pruned. Large canopy and specimen plant material must be [wire balled and burlapped] [boxed][bare rooted][spaded]. Mark north side of plants prior to excavation. Relocate in new location with north facing same direction.

3.1.3 Palms

In preparation for relocation, remove all dead and green fronds below a horizontal position with clean, sterilized equipment and tools. All fronds above horizontal must be lifted and tied together in two locations around the crown in an upright position with a light weight cotton rope. Removal of fronds and tying must be completed prior to digging the root ball. Palms trimmed or pruned must retain a minimum 150 mm 6 inches of foliage at the crown as a means of determining plant health.

3.2 SITE PREPARATION

3.2.1 Protection

Protect existing and proposed landscape features, elements, and sites from damage or contamination. Protect trees, vegetation, and other designated features by erecting high-visibility, reusable construction fencing. Locate fence no closer to trees than the drip line. Plan equipment and vehicle access to minimize and confine soil disturbance and compaction to areas indicated on Drawings.

3.2.2 Finish Grade and Topsoil

****

NOTE: Coordinate the placement of topsoil with Section 31 00 00 EARTHWORK. When stockpiled topsoil is limited, define the areas that will use this soil.

****

Verify that finish grades are as indicated on drawings, and that the placing of topsoil, the smooth grading, and the compaction requirements have been completed in accordance with Section 31 00 00 EARTHWORK, prior to the commencement of the transplanting operation.

3.2.3 Layout

Relocate plant material as shown on drawings. Plant material locations may be adjusted to meet field conditions, only with Contracting Officer approval. Provide on-site locations for excavated rock, soil, and vegetation.

3.2.4 Erosion Control

****

NOTE: The erosion potential of a soil is of concern in vegetated channels, road embankments, dams, levees, spillways, construction sites, etc.

****

Provide erosion control in accordance with Section 32 93 00 EXTERIOR PLANTS, and by seeding with native plant species to protect slopes.

3.3 SITE EXCAVATION

3.3.1 Obstructions Above or Below Ground

When obstructions above or below ground affect the work, shop drawings showing proposed adjustments to plant material location, and planting method must be submitted for Government approval.

3.3.2 Turf Removal and Replacement

Do not disturb topsoil and vegetation in areas outside those indicated on Drawings. Where the installation operation occurs in an existing lawn area, the turf must be removed from the excavation area to a depth that will ensure the removal of the entire root system.

3.3.3 Plant Pits

Plant pits must be dug to a depth equal to the height of the root ball as measured from the base of the ball to the base of the plant trunk. Plant pits must be dug a minimum of 2 times the diameter of the root system to allow for root expansion. The pit must be constructed with sides sloping towards the base as a cone, to encourage well-aerated soil to be available to the root system for favorable root growth. Cylindrical pits with vertical sides must not be used. Pits must be dug immediately before plants are placed in the pit.

3.4 INSTALLATION

3.4.1 Setting Plant Material

Plant material must be set plumb and held in position until sufficient top soil has been firmly placed around root system or ball. In relation to the surrounding grade, the plant material must be set even with the grade at which it was grown. The root system must be spread out and arranged in its natural position. Damaged or girdled roots must be removed with a clean cut. The beginning of the root flare must be visible at soil level when the tree is planted, since it is critical not to plant the tree too deep. The following must be performed:

a. Plumb plant materials and backfill half of the hole with topsoil.

b. Prior to backfilling, all metal, wood, and synthetic products must be removed from the ball or root system avoiding damage to the root system. Biodegradable burlap and tying material must be carefully opened and folded back from the top a minimum 1/3 depth from the top of the root ball.

c. Water the hole to collapse air pockets.

d. Backfill and gently firm topsoil.

e. Clear soil mounded against trunk.

f. An earth berm, consisting of backfill soil mixture, must be formed with a minimum 100 mm 4 inch height around the edge of the plant pit to aid in water retention and to provide soil for settling adjustments.

[3.4.2 Adding Mycorrhizal Fungi Inoculum

Mycorrhizal fungi inoculum must be added as recommended by the manufacturer for the plant material specified.

]3.4.3 Watering

A regular watering schedule must be established. Slow deep watering must be used. Plant pits and plant beds must be watered immediately after backfilling, until completely saturated. Run-off and puddling must be prevented. Watering of other plant material or adjacent areas must be prevented.

3.4.4 Staking and Guying

****

NOTE: The current trend in the horticultural trade

has established that staking and guying trees should not be provided unless there is high wind velocity at the project site. However, on military projects staking and guying serve an additional function of protecting the tree during establishment. The current trend in the horticultural trade has established that tree wrap should not be provided unless wind conditions require protection to the trunk.

****

Staking will be required when trees are unstable or will not remain set due to their size, shape, or exposure to high wind velocity. When required the following staking and guying procedures must apply:

3.4.4.1 One Bracing Stake

Trees 1200 to 1800 mm 4 to 6 feet high must be firmly anchored in place with one bracing stake. The bracing stake must be placed on the side of the tree facing the prevailing wind. The bracing stake must be driven vertically into firm ground and must not injure the ball or root system. The tree must be held firmly to the stake with a double strand of guying material. The guying material must be firmly anchored at a minimum 1/2 tree height and must prevent girdling. A chafing guard must be used when metal is the guying material.

3.4.4.2 Two Bracing Stakes

Trees from 1800 to 2400 mm 6 to 8 feet height must be firmly anchored in place with 2 bracing stakes placed on opposite sides. Bracing stakes must be driven vertically into firm ground and must not injure the ball or root system. The tree must be held firmly between the stakes with a double strand of guying material. The guying material must be firmly anchored at a minimum 1/2 tree height and must prevent girdling. Chafing guards must be used when metal is the guying material.

3.4.4.3 Three Bracing or Ground Stakes

Trees over a minimum 2400 mm 8 feet height and less than a maximum 150 mm 6 inch caliper must be held firmly in place with 3 bracing or ground stakes spaced at equal intervals around the tree. Ground stakes must be avoided in areas to be mowed. Stakes must be driven into firm ground outside the earth berm. The guying material must be firmly anchored at a minimum 1/2 tree height and must prevent girdling. For trees over a minimum 75 mm 3 inch diameter at breast height, turnbuckles must be used on the guying material for tree straightening purposes. One turnbuckle must be centered on each guy line. Chafing guards must be used when metal is the guying material.

3.4.5 Deadmen or Earth Anchors

Trees over a minimum 150 mm 6 inch caliper must be held firmly in place with wood deadmen buried a minimum 900 mm 3 feet in the ground or metal earth anchors. Multi-strand cable guying material must be firmly anchored at a minimum 1/2 tree height and must prevent girdling. Turnbuckles must be used on the guying material for tree straightening purposes. One turnbuckle must be centered on each guy line. Chafing guards must be used.

3.4.6 Flags

A flag must be securely fastened to each guy line between the tree, stake, deadmen, or earth anchor. The flag must be visible to pedestrians.

3.5 FINISHING

All planting operations must conform to TCIA Z133.

3.5.1 Plant Material

Prior to placing mulch, the installed area must be uniformly edged to provide a clear division line between the planted area and the adjacent turf area, shaped as indicated. The installed area must be raked and smoothed while maintaining the earth berms.

3.5.2 Placing Mulch

The placement of mulch must occur a maximum of 48 hours after planting. Mulch, used to reduce soil water loss, regulate soil temperature and prevent weed growth, must be spread to cover the installed area with a minimum 75 mm 3 inch uniform thickness. Mulch must be kept out of the crowns of shrubs, ground cover, and vines and must be kept off buildings, sidewalks and other facilities.

3.5.3 Pruning

****

NOTE: The current trend in the horticultural trade has established that wound dressing or pruning paint should not be provided. These procedures do not contribute to wound closure or the compartmentalization process.

****

Pruning must be accomplished by a certified arborist. The pruning of trees and palms must be in accordance with TCIA A300P1. Only dead or broken material must be pruned from installed plants. The typical growth habit of individual plant material must be retained. Broken branches must be removed.

3.6 MAINTENANCE

Plant maintenance must be in accordance with Section 32 05 33 LANDSCAPE ESTABLISHMENT.

3.7 RESTORATION AND CLEAN UP

3.7.1 Restoration

Turf areas containing ruts or dead turf, as a result of work under this contract, must be graded smooth and sodded with the same species. All pavements and facilities that have been damaged from the transplanting operation must be restored to original condition at the Contractor's expense.

3.7.2 Backfill Removal Site Plant Pits

Ensure that all remaining holes from the removal site have been backfilled with [on-site soil] [_____], tamped to [90 percent] [_____] compaction, leveled and finished to meet existing grade after settling. Adjacent trees, shrubs, vines and groundcover destroyed by transplanting or construction operations must be replaced in kind in relation to size and species and must be installed in accordance with Section 32 93 00 EXTERIOR PLANTS. Turf must be replaced with sod, and must be installed in accordance with Section 32 92 23 SODDING.

3.7.3 Clean Up

****

NOTE: While recycling programs are optional for government contractors the specifier should encourage the practice if the cost to the Government is reasonable. Information regarding location of recycling facilities is available from the local city or county waste management division.

****

Excess and waste material must be removed from both removal site and the installed site and must be [disposed offsite at an approved landfill, recycling center, or composting center][composted on site]. Separate and recycle or reuse the following landscape waste materials: [nylon straps,] [wire,] [ball wrap,] [burlap,] [wood stakes,] [_____]. Adjacent paved areas must be cleared.

3.8 PLANT ESTABLISHMENT PERIOD

The establishment period for transplanted materials must be the same as for newly planted exterior plants and must conform to the same requirements thereof as found in Section 32 05 33 LANDSCAPE ESTABLISHMENT, paragraph EXTERIOR PLANT ESTABLISHMENT PERIOD.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 01 30.16 (November 2021)**
Change 1 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-33 01 30.16 (August 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 33 - UTILITIES

SECTION 33 01 30.16

TV INSPECTION OF SEWER LINES

11/21, CHG 1: 02/24

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 01 30.16 (November 2021)**
Change 1 - 02/24

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****

SECTION 33 01 30.16

TV INSPECTION OF SEWER LINES

11/21, CHG 1: 02/24

****

NOTE: This guide specification covers the requirements for pipeline cleaning and TV inspection of sanitary or storm sewer pipelines. Use tailoring options SANITARY or HERBICIDE to select the appropriate system for the project.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: TV inspection of sewer pipelines is commonly referred to as closed circuit television inspection (CCTV). CCTV inspection is used to determine the condition of existing pipelines and to identify lateral connections prior to slip lining. It is also used to verify relining of existing piping conforms to project specifications, warranty requirements and to confirm lateral re-connections post-construction. CCTV inspections indicate the location of service connections along the main and the location of pipe conditions warranting further action.

Cleaning or heavy cleaning is always performed prior to CCTV inspection.

Point repairs may also be required prior to Pre-TV inspection; requirements for point repairs are not addressed in this section. Point repairs are typically less than 3.0 meters 10 feet in length.

Prior to conducting a Pre-TV inspection the engineer should conduct a field investigation to determine pipelines or sections of pipes requiring heavy cleaning and the potential for point repairs. Pre-TV inspections of mains and laterals are needed to assess existing conditions, confirm point repairs and assist in preparing project specifications for 33 01 30.72 RELINING SEWERS and may be done during field investigation. Once the contract is awarded, the contractor will need to do a second PRE-TV inspection before beginning slip lining work.

Post-TV and Warranty TV inspection portions of these specifications are needed to confirm work performed for slip lining sanitary sewer and storm drainage systems conforms to the project specifications.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 4150.07	(2019) DOD Pest Management Program

1.2 DEFINITIONS

1.2.1 CCTV Video

CD or DVD storage media containing the recorded video.

1.2.2 Cleaning

To remove soil or solid deposited materials from a pipe segment when the pipe is less than half full of deposited materials.

1.2.3 Defects

Defects in the pipe, manholes, structures, and services include cracks, separation of joints, collapsed pipe, grade irregularities, leaks, roots, grease buildup, offset joints, reverse grades, obstructions, delamination, missing pipe, restrictions, fractures and similar structural irregularities.

1.2.4 Entry Point

The leading edge of the access point or the manhole or structure wall where the pipe segment begins. Only the pipe is video inspected from manhole or structure wall to manhole or structure wall and does not include any portion of the manhole or structure.

1.2.5 Exit Point

The point where the downstream access manhole or structure wall is encountered. Only the pipe is video inspected from manhole or structure wall to manhole or structure wall and does not include any portion of the manhole or structure.

1.2.6 Heavy Cleaning

To remove soil or solid deposited materials from a pipe segment when the materials in the pipe are between half full to full.

1.2.7 Hydraulically Propelled Cleaning Tools

Tools that depend upon water pressure to provide their cleaning force.

1.2.8 National Association of Sewer Service Companies (NASSCO)

National Association of Sewer Service Companies (NASSCO) identifies the generally accepted industry standards for CCTV inspection, observation coding, and certification.

1.2.9 Pipe Segment

The length of pipe from entry point to exit point along the main or service.

1.2.10 Pipeline Assessment and Certification Program (PACP)

A CCTV Inspection standardization certification and observation coding system sponsored by NASSCO.

1.2.11 Point Repair

The location of a failure where a repair is has occurred.

1.2.12 Post-Installation CCTV (Post-TV)

Post-TV inspection is used to determine the slip lining of sanitary or storm sewers has been completed in accordance with the contract documents.

1.2.13 Pre-Installation CCTV (Pre-TV)

Pre-TV inspection is a video inspection of existing sewer lines to confirm cleaning activities, locations of service connections, and identify defects in the existing sewer system infrastructure prior to any work being performed.

1.2.14 Re-TV Inspection

Upon the completion of repairs made after performing a Post-TV Inspection or Warranty TV inspection, the mains or services are re-inspected by performing a Re-TV inspection. Also, refers to rework for a TV-Inspection that has video interruptions, gaps, or is not continuous.

1.2.15 TV Inspection Log

Information collected and recorded by the CCTV operator for each CCTV inspection effort and includes pertinent information for the respective inspection section; such as, date of inspection, location of site, CCTV technician, direction of CCTV inspection with manhole or structure identifiers, weather conditions, pipe size(s), pipe materials, conditions found, locations where the conditions were found.

1.2.16 Warranty CCTV (Warranty-TV)

Warranty-TV inspection is used to determine the slip lining of sanitary or storm sewers does not have any defects present, remains in compliance with project specifications and Post-TV inspection.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Disposal Plan

Submit a disposal plan prior to performing any work that might generate waste materials. Include a complete description of the materials that are expected to be encountered and their proposed disposal sites. No changes to the disposal plan will be made without prior written acceptance by the Contracting Officer.

1.3.2 Sewage Handling Permit

****

NOTE: This paragraph is tailored for SANITARY.

****

Prior to commencing application of herbicide, obtain and maintain a valid State sewage handling permit and permits required by local jurisdictions. Submit a copy of this permit to the Contracting Officer prior to beginning any cleaning or pump and haul operations.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Traffic Control Plan; G, [_____]

Disposal Plan; G, [_____]

****
NOTE: The following two submittals are tailored for HERBICIDE.
****

Herbicide Application Plan; G, [_____]

List of Equipment

****
NOTE: The following submittal is tailored for SANITARY.
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Sewage Handling Permit; G, [_____]

SD-03 Product Data

****

NOTE: The following submittal is tailored for HERBICIDE.

****

Herbicide; G, [_____]

Cleaning Products; G, [_____]

****

NOTE: SD-05 and SD-06 submittals are tailored for HERBICIDE.

****

SD-05 Design Data

Herbicide Application Records

SD-06 Test Reports

Calibration Test

SD-07 Certificates

****

NOTE: The following submittal is tailored for HERBICIDE.

****

Qualifications; G, [_____]

CCTV Technician's Qualifications; G, [_____]

Pre-TV Inspection; G, [_____]

Post-TV Inspection; G, [_____]

Warranty-TV Inspection; G, [_____]

RE-TV Inspection; G, [_____]

SD-11 Closeout Submittals

****

NOTE: The following two submittals are tailored for HERBICIDE.

****

Pest Management Report

Verification of Measurement

Records of Disposals

1.5 QUALITY CONTROL

1.5.1 Regulatory Requirements

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NOTE: Herbicides are a type of pesticide. Contact regional pest management consultant to obtain service specific reporting requirements for the use of herbicides.

For Navy projects, contact the cognizant NAVFAC Applied Biologist.

For Army projects, contact the cognizant Army Applied Biologist. Contact information can be found at https://aec.army.mil/index.php?cID=432

****

Comply with DODI 4150.07 for requirements on Contractor's licensing, certification, and record keeping. Maintain daily records using the Pest Management Maintenance Record, DD Form 1532-1, or a computer generated equivalent, and submit copies of records when requested by the Contracting Officer. These forms may be obtained from the Armed Forces Pest Management Board web site: https://www.acq.osd.mil/eie/afpmb/docs/standardlists/dd1532-1.xlsm

1.5.2 Qualifications

****

NOTE: This paragraph is tailored for HERBICIDE.

****

For the application of herbicides, use the services of an applicator who is commercially certified in the state where the work is to be performed as required by DODI 4150.07. Herbicide applicators must also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes sewer root pest control. Submit a copy of the pesticide applicator certificates.

1.5.3 CCTV Technician's Qualifications

Provide a CCTV technician with three years of total experience with the CCTV technology. Submit a current PACP Operator certification for personnel performing closed circuit television inspection and pipeline assessments.

1.6 DELIVERY, STORAGE, AND HANDLING

****

NOTE: This Article is tailored for HERBICIDE.

****

1.6.1 Delivery

Deliver herbicides to the site in the original unopened containers bearing legible labels indicating the EPA registration number, manufacturer's registered uses and in new or otherwise good condition as supplied by the manufacturer or formulator.

1.6.2 Inspection

Inspect herbicides upon arrival at the job site for conformity to type and quality in accordance with paragraph HERBICIDE. Each label must bear evidence of registration by the EPA or under appropriate regulations of the host county. Inspect other materials for conformance with specified requirements. Remove unacceptable materials from the job site.

1.6.3 Storage

Storage of herbicides on the installation will not be permitted unless it is written into the contract.

1.6.4 Handling

Handle and mix herbicides in accordance with the manufacturer's label. Prevent contamination by dirt, water, and organic material. Protect herbicides from weather and the elements as recommended by the manufacturer's label. Spill kits must be maintained on applicator vehicles and must be available at the mixing site. Conduct herbicide mixing at a site designated by the contracting officer with adequate spill containment.

1.7 PROJECT/SITE CONDITIONS

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NOTE: This Article is tailored for HERBICIDE.

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Application of herbicide will not be permitted during or immediately following heavy rains, when conditions may allow runoff, or when they may create an environmental hazard. Herbicide applications are not permitted when they may contaminate aquifers or endanger humans or animals.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

TV inspection of sewer pipelines encompasses cleaning, heavy cleaning, CCTV inspection and video recording of the existing sanitary or storm sewer mains included in the contract documents. This work includes by-pass pumping or diversion of sanitary sewer, sound reduction enclosure of by-pass pump, inspection logs, video requirements, permits, traffic control and the legal disposal of materials removed from the mains. It is typically used in coordination with slip lining existing piping.

It includes the mechanical equipment used to clean and dispose of the materials found in sewer pipes and structures, CCTV cameras and recording devices used to record the internal conditions of non-pressurized sewer piping.

2.2 EQUIPMENT

2.2.1 Cleaning Equipment

Utilize mechanically powered equipment necessary for the proper rodding, bucketing, brushing, root cutting, and flushing of the sewers, including a heavy duty power rodding machine that is compatible with the cleaning to be performed.

2.2.1.1 Rodding

Provide rodding equipment capable of rodding distances of up to 305 meters 1000 feet in one set-up and having the following capabilities:

a. The ability to spin the rod either clockwise or counter-clockwise, and be able to be pushed straight out or pulled back without rotating the machine.

b. The capability of pulling pipe-size swabs or brushes back through the pipeline for cleaning and flushing purposes.

2.2.1.2 Bucket Machine

Provide heavy-duty bucket machines for use on dragline work to clean the pipeline with buckets, brushes, scrapers, swabs or other similar devices in order to effectively remove debris and provide a clean sewer for the CCTV inspection, repair, or lining activities.

2.2.1.3 Hydraulic Flusher

Provide hydraulic high-pressure sewer cleaners used for sewer cleaning, specifically designed and constructed for such cleaning, that have a minimum usable water capacity of 2270 Liters 600 gallons and a pump capable of delivering at least 1.9 Liters per second (L/s) 30 gallons per minute (gpm) at 690 kPa 100 psi and having the following capabilities:

a. Pressure regulator nozzle capable of adjustment from 7 kPa 1 psi to 10 MPa 1500 psi.

b. Constructed for ease of use and safety of operation with two or more high-velocity nozzles capable of producing a scouring action from 15 to 45 degrees in lines designated to be cleaned.

c. A high-velocity gun for washing and scouring the manhole or structure walls and floor capable of producing flows from a fine spray to a solid stream.

d. Carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel.

2.2.1.4 Sanitary Sewer Cleaning Equipment

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NOTE: This paragraph is tailored for SANITARY.

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Provide movable dam type hydraulically propelled equipment constructed in such a way that a portion of the dam may be collapsed at any time during the cleaning operation to protect against flooding of the sanitary sewer and having the following capabilities:

a. A movable dam equal in diameter to the pipe being cleaned.

b. A flexible scraper around the periphery to ensure the removal of grease.

Sewer cleaning balls or other equipment, which cannot be collapsed, are not allowed when cleaning sanitary sewer.

2.2.2 CCTV Equipment

Provide a video system capable of producing a sharply focused, well-lit and color balanced picture in accordance with the following requirements:

2.2.2.1 Pipe Inspection Camera and Associated Equipment

a. Provide a pipe inspection camera system specifically designed for sewer inspection that produces a video using a color pan and tilt camera with radial viewing, that pans a minimum of 275 degrees and rotates 360 degrees or a side wall scanning (panoramic) camera capable of 360 degree image capture. Illumination sensitivity of 3 Lux or less and a minimum of 460 lines of resolution is required.

b. Utilize video cameras specifically designed and constructed for CCTV inspection.

c. Provide a camera that is operative in 100 percent humidity conditions.

d. Provide a camera with an accurate footage counter that displays on the monitor the exact distance of the camera to the nearest 3.0 centimeter 1/10 of a foot.

e. Provide a camera with a height adjustment so that the camera lens is typically centered in the pipe, or higher depending on water levels in the pipe.

f. Provide equipment that will produce digital color images and allows the CCTV technician to remotely balance the iris and color to produce a clear and true video of the pipeline.

g. Provide lighting for the camera that is suitable to provide a clear color picture of the entire periphery of the pipe.

h. Provide a reflector in front of the camera as necessary to enhance the lighting on dark or large diameter pipes.

i. Provide an accompanying computer and recording device capable of projecting and recording the facility location, project name, Contractor's name, date, line size, material type, line identification, manhole or structure ID numbers and ongoing footage counter onto the video screen.

2.3 MATERIALS

2.3.1 Herbicide

****

NOTE: This paragraph is tailored for HERBICIDE.

The herbicide must be pre-approved by regional pest management consultant and the wastewater treatment plant operator.

Herbicide may be applied to roots prior to mechanical removal or after mechanical removal to prohibit future root growth.

****

Provide herbicides currently registered by the EPA or approved for such use by the appropriate agency of the host county and approved by the Contracting Officer. Select herbicides that will eliminate root growth, [inhibit future root growth,]and are suitable for the wastewater treatment plant, and climatic conditions at the project site. Herbicides must be applied at the highest labeled rate. Submit manufacturer's label and Safety Data Sheet (SDS) for herbicides proposed for use.

2.3.2 Cleaning Products

Select cleaning products that do not present a health and safety concern, are allowed for use in the sewer system according to Federal and State regulations, will not adversely affect the water quality of the water being conveyed in the sewer system, are suitable for the wastewater treatment plant and the climatic conditions at the project site. Submit manufacturer's label and SDS for the cleaning products proposed for use.

PART 3 EXECUTION

3.1 PREPARATION

****

NOTE: Sewer line cleaning removes foreign materials from the pipes to prepare for CCTV inspection, repair operations, or installation of lining materials. The success of the CCTV, pipe repairs, or lining operations depends on the cleanliness of the lines and cannot be over emphasized.

****

3.1.1 Traffic Control

a. Submit a detailed Traffic Control Plan to the Contracting Officer at least 10 days in advance when the manholes used to perform the TV inspection are located in or adjacent to the road. Comply with all applicable State Highway, Local and Installation requirements when preparing the traffic control plan.

b. Provide labor, signs, barricades, cones, arrow boards, flaggers, and any additional equipment necessary to complete the work.

3.1.2 Herbicide Application Plan

****

NOTE: This paragraph is tailored for HERBICIDE.

****

Prior to commencing application of herbicides, submit a herbicide application plan with the proposed sequence of treatment including dates and times of application. Include the herbicide trade name, EPA registration number, chemical composition, formulation, application rate, method of application, area or volume treated, and amount applied. Include a copy of the pesticide applicator certificates.

3.1.3 Sewer Line Cleaning

****

NOTE: Indicate on the drawings the pipe segments requiring heavy cleaning. Heavy cleaning may not be

required if the field investigation cleaning and Pre-TV inspection were recently completed. Heavy cleaning may be needed for small diameter pipes in areas known to have frequent maintenance cleaning due to heavy grease or root intrusion. Larger diameter pipes (equal to or greater than 18 inches) will typically not require heavy cleaning unless previous problems have been observed or are known. This should be easily discernible when conducting field investigations.

****

Immediately prior to conducting CCTV activities, thoroughly clean the segment of sewer pipe to be video inspected. Clean the segments using hydraulically propelled, high-velocity jet, or mechanically powered equipment.

a. During cleaning and preparation operations, undertake precautions to protect the sewer system and property from damage. Restore property damaged as a result of such cleaning and preparation operations to pre-existing conditions.

b. During the course of normal cleaning operations immediately report pre-existing damage such as broken or missing pipe to the Contracting Officer.

c. When hydraulically propelled cleaning tools or tools which retard the flow in the sewer line are utilized, take precautions to ensure that the water pressure created does not damage or cause flooding on the adjacent site.

d. Maintain access to fire hydrants for the purpose of fire protection at all times.

e. If cleaning of an entire sewer section cannot be successfully performed from one manhole or structure, set up the equipment on the other entry or exit point and attempt cleaning again.

f. If successful cleaning cannot be performed from the opposite end or the equipment fails to traverse the entire pipeline section, cease cleaning those specific sewer sections, notify the Contracting Officer and CCTV inspect both sides of the pipeline section to determine the cause of the blockage.

3.1.3.1 Sanitary Sewer Cleaning

****

NOTE: This paragraph is tailored for SANITARY.

****

Minimize the interruptions to the existing flows to perform the cleaning of the sewers. Prevent sewage backups and immediately clear back-ups resulting from the cleaning operations. When possible, utilize the flow in the sewer system to provide the necessary pressure for the hydraulic cleaning devices. Return sewage diverted during cleaning operations to the sanitary system and do not discharge onto any surface, or into any water body or storm drain system.

[3.1.4 Manhole or Structure Cleaning

****

NOTE: Indicate on drawings manholes or structures to be cleaned.

****

Clean concrete and masonry surfaces prior to CCTV inspection. Completely remove grease, laitance, loose bricks, mortar, unsound concrete, loose or damaged wall mounted steps (cut flush with wall), and other materials.

Utilize water blasting (minimum 8.3 MPa 1200 psi) with compatible nozzles as the primary method of cleaning. It is acceptable to use other methods of cleaning such as concrete cleaners, degreasers or mechanical means to clean the surfaces. Thoroughly rinse, scrub, and neutralize the surfaces in order to remove cleaning agents and their reactant products. Do not allow material to pass to pipeline sections, which could adversely affect water quality, cause stoppages, accumulations of sand in wet wells, or damage to pumping equipment.

]3.1.5 Flow Control

Reduce the flow depth to allow a minimum of 80 percent of the pipe wall to be displayed at all times during inspection so that defects, features, and other notable information can be collected.

3.1.5.1 Flow Reduction

Flow depth reduction can be accomplished by:

a. Providing bypass pumping.

b. High-pressure jet nozzle.

c. Plugging or by pulling the camera with a swab.

d. Performing the CCTV inspection during periods of minimal flow.

3.1.5.2 Floating the Camera

Video inspection performed while floating the camera is not acceptable. Lower water levels as indicated in paragraph FLOW CONTROL.

3.1.6 Root Removal

****

NOTE: The existence of roots indicate pipe fractures, joint openings or other failures. Typical root removal is performed by use of cutting heads. Extreme conditions require the use of chemical root treatment in order to obtain clear, unobstructed video images.

Use the CCTV field investigation report to determine sections of pipe containing roots. Indicate on drawings sections of pipe, manholes or structures requiring root removal.

****

Remove roots in the designated sewer sections[and manholes or structures]. Ensure complete removal of roots to the joints. Use mechanical equipment that can be operated remotely, such as rodding machines, bucket machines, winches using root cutters and porcupines, and equipment such as high-velocity jet cleaners. Capture and remove roots from the sewerline at the downstream manhole or structure.

3.1.7 Material Removal and Disposal

Remove sludge, dirt, roots, grease, and other solid or semi-solid material resulting from cleaning operations at the downstream manhole or structure of the section being cleaned.

3.1.7.1 Dams or Weirs

When hydraulic cleaning equipment is used, place dam or weir in the downstream manhole or structure to trap such materials. Do not allow material to pass from pipeline section to pipeline section, which could cause stoppages, accumulations of sand in wet wells, or damage to pumping equipment.

3.1.7.2 Sludge and Debris Storage

Under no circumstances is sludge or other debris removed during these operations to be stored, dumped or spilled into streets, ditches, storm drains, or other sanitary sewer systems.

a. Dispose of solids and semi-solids resulting from the cleaning operations no less often than the end of each work day in accordance with the approved Disposal Plan.

b. Under no circumstances will debris be allowed to accumulate on the work site beyond the end of each work day, except in totally enclosed containers and as acceptable by the Contracting Officer.

c. Continuously maintain the haul route and work areas neat, clean, and reasonably free of odor. Cleanup any spill which occurs during the transport of cleaning or surface preparation by-products. Perform the cleanup of any such material pursuant to this Contract and in accordance with applicable law and environmental regulations.

d. Immediately notify the Contracting Officer of any spill and begin clean up any such spill or waste.

e. The Government will charge to the Contractor for any costs incurred or penalties imposed upon the Government as a result of the spill, dump or discard.

f. Under no circumstances is this material to be discharged into the waterways or any place other than where authorized to do so in accordance with the approved Disposal Plan.

3.1.7.3 Hauling of Waste Material

Provide vehicles hauling such waste material that meet the following requirements:

a. Provide transport vehicles of the type(s) approved for this application by the jurisdictions where those vehicles will be operated in the performance of activities associated with this Contract.

b. Provide transport vehicles with watertight bodies equipped and fitted with seals and covers to prohibit material spillage or drainage.

c. Clean vehicles to prevent deposits of material on roadways.

d. Load vehicles within legal weight limits and operate safely within traffic speed regulations.

e. The routes used for the conveyance of this material on a regular basis is subject to approval by the local governing bodies having jurisdiction over such routes.

3.2 APPLICATION

3.2.1 Chemical Root Treatment

****

NOTE: The following paragraph and subparagraphs are tailored for HERBICIDE.

****

Where permitted by the Contracting officer, State sewer regulations and the utility provider's requirements use a herbicide to aid in the removal of roots and treat pipeline sections that have root intrusion with an acceptable herbicide in accordance with the following conditions:

a. There can be no adverse effects on the performance of the wastewater treatment plant caused by the active ingredients of the herbicide. If adverse effects are identified in the wastewater treatment system, the Contractor must immediately suspend the application of the herbicide as directed by the Contracting Officer. Application of herbicides will be terminated, as directed by the Contracting Officer, if the adverse effects cannot be corrected to the satisfaction of the wastewater treatment plant operator.

b. Adhere to safety precautions as recommended by the manufacturer concerning handling and application of the herbicide.

c. Apply the herbicide to the roots in accordance with the manufacturer's recommendations and specifications.

3.2.1.1 Equipment Calibration and Tank Measurement

Submit a list of equipment to be used. Conduct calibration test on the application equipment to be used immediately prior to commencement of herbicide application. Measure the volume and contents of the application tank. Testing must confirm that the application equipment is operating within the manufacturer's specifications and meets the requirements of the herbicide label. Submit written certification of the equipment calibration test results within one week of testing. Where results from the equipment calibration and tank measurements tests are unsatisfactory, re-treatment will be required.

3.2.1.2 Mixing and Application

Perform all work related to formulating, mixing, and application in the presence of a DOD certified pesticide applicator, Pest Management QAE/PAR, or Integrated Pest Management Coordinator. Submit herbicide application records. Records will include the following information: date of application, location and site, type of operation, area treated, name of applicator, pesticide information (trade name, active ingredient, and formulation), amount of pesticide applied, and calculated pounds of active ingredient applied.

A closed system is recommended as it prevents the herbicide from coming into contact with the applicator or other persons. Only use water from designated sources. Fit filling hoses with a backflow preventer meeting local plumbing codes or standards. Prevent overflow during the filling operation. Spill kits must be maintained on applicator vehicles and must be available at the mixing site. Herbicide mixing must be conducted at a site that has been designated by the Contracting Officer and that has adequate spill containment. Inspect the application equipment prior to each day of use for leaks, clogging, wear, or damage. Immediately perform repairs on the application equipment to prevent or eliminate leaks and clogging.

3.2.1.3 Clean Up, Disposal, And Protection

Once application has been completed, proceed with clean up and protection of the site without delay. Clean the site of all material associated with the treatment measures, according to label instructions. Remove and dispose of excess and waste material off Government property.

3.2.1.3.1 Disposal of Herbicide

Dispose of residual herbicides and containers off Government property, and in accordance with the approved disposal plan, label instructions and EPA requirements.

3.2.2 Inspection of Sewer Lines

Inspection of sewer lines applies to Pre-TV inspection, Post-TV inspection, RE-TV inspection and Warranty-TV inspection. Perform inspections of sewer lines in the presence of the Contracting Officer.

[3.2.2.1 Communication

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NOTE: Ensure hand operated radios and cell phones are allowed in the project area.

****

Set up hand operated radios, telephones, or other means of communication between the entry and exit points being inspected to ensure uninterrupted communication between members of the CCTV crew when manually operated winches are used to pull the television camera through the line.

]3.2.2.2 Flush Main

Introduce a minimum of 3785 Liters 1000 gallons of clear, potable water into the upstream manhole or structure or access structure of the mains to be CCTV inspected just prior to inserting the camera. The Contractor is responsible for collecting and disposing of the water in accordance with the approved disposal plan.

3.2.2.3 Camera Operation

Set counter to 0.00 meters 0.00 feet at the entry point, which is the beginning manhole or structure wall. Move the camera through the line in either direction at a moderate speed, stopping to permit proper documentation of the sewer's condition or service connection locations. In no case will the camera be operated at a speed greater than 9.1 meters per minute 30 feet per minute. Move the pan and tilt camera slowly at the beginning and ending manhole, structure connections, service connections, joints, visible defects, and pipe arterial transitions. Provide a full 360 degree view of the pipe, joints, and service connections.

Utilize manual winches, power winches, cable, powered rewinds or other devices that do not obstruct the camera view or interfere with camera operation or CCTV inspection of the pipe conditions as the camera is moved through the sewer line.

3.2.2.3.1 Recording Defects

During CCTV inspection, temporarily stop the camera at each defect or feature along the line.

3.2.2.4 Documentation of CCTV Inspection

Documentation of CCTV inspection applies to Pre-TV inspection, Post-TV inspection, RE-TV inspection and Warranty-TV inspection.

Utilize a data logger and reporting system that is PACP compliant to make a video and audio recording of the CCTV inspections. Submit video recordings, inspection logs, and digital photographs as indicated in the following sub-paragraphs.

3.2.2.4.1 Video Recordings

****

NOTE: Video recordings supply a video and audio record of pipe segment inspections that may be replayed.

****

Provide a color video showing the completed work and document the inspection on a digital recorder. Capture inspection video in either MPEG-4 or Windows Media Video (WMV) format with a minimum resolution of 352 x 240 pixels and an interlaced frame rate at a minimum of 24 frames per second. Save video on CD or DVD. However, the CCTV inspection video of a segment must be wholly contained on a single CD or DVD. The video recording must meet the following requirements:

a. Provide a continuous and uninterrupted recorded video for the pipe segment being examined. Include the official project title, Contracting party, Contractor's name, street name, manhole or structure ID numbers, direction of video and flow, date and time video was recorded, continuous counter text, pipe size and material, material changes in the pipe segment, audio and text call outs of laterals, fixtures and problem areas in the recorded video.

b. Include an audio track recorded by the CCTV technician during the actual inspection work with a description of the parameters of the line being inspected on the video recordings.[The audio may be from the voice of the CCTV technician or it may be computer generated.]

c. Include the location, pipe diameter, pipe material, defects, service lateral locations and any unusual conditions found in PACP format.

d. Submit labeled CDs or DVDs of the video inspections.

e. Without exception, CCTV inspections must be continuous without video interruption or gaps for pipe segments.

f. Clean, flush, and RE-TV pipe segments with video interruptions or gaps.

3.2.2.4.2 TV Inspection Logs

Submit computer generated records that clearly show the location and orientation in relation to an adjacent manhole or structure of each infiltration point observed during the inspection.

Record other points of significance such as locations and orientations of service connections, missing or broken pipe, roots, the presence of grease, scale or corrosion, bellies, fractures, cracks, and other discernible features using PACP designations.

3.2.2.4.3 Digital Photographs

Submit JPEG images at a minimum resolution of 640 x 480 pixels. Save digital photographs in JPEG file format on CD or DVD. Document noted defects and lateral connections as color digital files and hard copy print-outs. Photo logs are to accompany each photo submitted.

3.2.3 Pre-TV Inspection

Immediately after cleaning has been performed, complete a Pre-TV inspection, in accordance with paragraph INSPECTION OF SEWER LINES. Submit Pre-TV inspection documentation in accordance with paragraph DOCUMENTATION OF CCTV INSPECTION.

3.2.4 Post-TV Inspection

****

NOTE: Post-TV inspection is performed to verify slip lining does not have any defects and to verify all lateral connections are open.

****

Immediately after visual, deflection, pressure and leak testing and service reconnections are complete on a pipe segment, complete Post-TV inspection accordance with paragraph INSPECTION OF SEWER LINES. Submit Post-TV inspection documentation in accordance with paragraph DOCUMENTATION OF CCTV INSPECTION. Provide post installation inspection documentation within 10 working days of the liner installation. The Contracting Officer may, at his or her discretion, suspend any further installation of lining materials if post-installation documentation is not submitted within 10 working days. As a result of this suspension, no additional working days will be added to the Contract, nor will any adjustment be made for increase in cost.

3.2.4.1 Post-TV Defects

If defects are found in the mains or services during the Post-TV inspection make repairs according to the specifications. RE-TV all repairs accordance with paragraph INSPECTION OF SEWER LINES. Provide additional RE-TV inspections of complete pipe segments as follows:

a. Perform a RE-TV inspection of the complete pipe segment. If no additional defects are found in the Re-TV inspections, then the Post-TV inspection is complete.

b. If defects are found in these additional inspections make repairs according to the specifications and provide Re-TV inspection for the complete pipe segment.

c. If defects are found in these additional inspections make repairs according to the specifications and Re-TV the repaired pipe segments until no Post-TV defects are found.

3.2.5 Warranty-TV Inspection

Submit Warranty-TV Inspection no later than [30][_____] days prior to the expiration of the warranty. Comply with paragraphs INSPECTION OF SEWER LINES and DOCUMENTATION OF CCTV INSPECTION. Complete Warranty-TV inspections in the presence of the Contracting Officer. The Contracting Officer has the option to select the pipe segments for the Warranty-TV inspection. Comply with the following requirements:

a. Provide a complete pipe segment Warranty-TV inspection of pipe segments where a liner repair was performed during Post-TV Inspection.

b. Provide a complete pipe segment Warranty-TV inspection of pipe segments where a point repair was performed.

c. Provide a Warranty-TV inspection of at least one full pipe segment of each size and type of slip lining installed.

d. Provide a Warranty-TV inspection of at least [10][_____] percent of the total length of all pipe segments.

All of Warranty-TV inspections above may be included to satisfy the percentage of total length requirement. If no defects are found in the mains and services in the above minimum pipe segments inspected, then the Warranty-TV inspection is complete.

3.2.5.1 Warranty-TV Defects

If defects are found in the mains or services during the Post-TV inspection make repairs according to the specifications. RE-TV all repairs. Provide additional Warranty-TV inspections of complete pipe segments as follows:

a. Warranty-TV inspect an additional 15 percent of the footage based on the length of the total project. If no additional defects are found in the additional Warranty-TV inspections, then the Warranty-TV inspection is complete.

b. If defects are found in these additional inspections make repairs according to the specifications, RE-TV all repairs and provide Warranty-TV inspections for the remaining pipe segments in the project.

c. If defects are found in these additional inspections make repairs according to the specifications and Re-TV the repaired pipe segments.

3.2.6 RE-TV Inspection

After repairs are made to a main or service, complete RE-TV inspection accordance with paragraph INSPECTION OF SEWER LINES and DOCUMENTATION OF CCTV INSPECTION.

3.3 FIELD QUALITY CONTROL

3.3.1 Verification of Measurement

****

NOTE: This paragraph is tailored for HERBICIDE.

****

Once herbicide applications have been completed, measure tank contents to determine the remaining volume. The total volume measurement of used contents for the application must equal the established application rate for the project site conditions. Submit written verification that the volume of herbicide used meets the application rate.

3.3.2 Inspection

3.3.2.1 Technical Representative

Provide a technical representative who is a DOD certified pesticide applicator or Pest Management Quality Assurance Evaluator (QAE)/Performance Assessment Representative (PAR). The technical representative must be present at all meetings concerning root removal and during treatment application. Contact the Integrated Pest Management Coordinator prior to starting work.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Sewer Cleaning

Submit copies of Records of Disposals indicating the disposal site, date, amount, and a brief description of the materials disposed.

3.4.2 Herbicides

****

NOTE: This paragraph is tailored for HERBICIDE.

****

Upon completion of work, submit the Pest Management Report DD Form 1532-1, or an equivalent computer product, to the Integrated Pest Management Coordinator. This form identifies the target pest, type of operation, brand name of pesticide, formulation, and concentration or rate of application used.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 01 30.72 (November 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 01 30.72 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 01 30.72

RELINING SEWERS

11/21

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 01 30.72 (November 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 01 30.72 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 01 30.72

RELINING SEWERS

11/21

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NOTE: This guide specification covers the requirements for storm sewer and sanitary sewer pipeline renewal utilizing Cured-In-Place Pipe (CIPP) and Fold-and-Form Pipe (FFP). Use tailoring options FOLD-AND-FORM PIPELINER or CURED-IN-PLACE PIPE to select the appropriate system for the project.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE MOP 120	(2009) Trenchless Renewal of Culverts and Storm Sewers

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA M45	(2013; 3rd Ed) Fiberglass Pipe Design

ASTM INTERNATIONAL (ASTM)

ASTM D790	(2017) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2412	(2021) Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D2990	(2017) Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
ASTM D5813	(2004; R 2018) Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems
ASTM F1216	(2024a) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
ASTM F1504	(2014) Standard Specification for Folded Poly(Vinyl Chloride) (PVC) Pipe for Existing Sewer and Conduit Rehabilitation
ASTM F1533	(2001; R 2009) Standard Specification for Deformed Polyethylene (PE) Liner
ASTM F1606	(2019) Standard Practice for Rehabilitation of Existing Sewers and

	Conduits with Deformed Polyethylene (PE) Liner
ASTM F1743	(2024) Standard Practice for Rehabilitation of Existing Pipeline and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)
ASTM F1867	(2006; R 2012) Standard Practice for Installation of Folded/Formed Poly (Vinyl Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation
ASTM F1871	(2011) Standard Specification for Folded/Formed Poly (Vinyl Chloride) Pipe Type A for Existing Sewer and Conduit Rehabilitation
ASTM F2019	(2011) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)

1.2 DEFINITIONS

Use the definitions in the applicable standard. When the the applicable standard does not have a definition, use ASCE MOP 120.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Scheduling

Minimize obstruction and inconvenience to traffic, pedestrians, and tenants.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor Quality Control (CQC) Plan; G, [_____]

Sequence Of Liner Installation; G, [_____]

Traffic Control Plan; G, [_____]

Bypass Plan; G, [_____]

Disposal Of Process Water; G, [_____]

SD-02 Shop Drawings

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NOTE: This submittal is tailored for FOLD-AND-FORM PIPELINER.
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FFP Repair Method; G, [_____]

SD-03 Product Data

Hydrophilic Seal; G, [_____]

Lubricant; G, [_____]

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NOTE: The following five submittals are tailored for CURED-IN-PLACE PIPE.
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Fabric Tube; G, [_____]

CIPP Product Data; G, [_____]

Catalyst; G, [_____]

Raw Resin Data; G, [_____]

Flexible Membrane; G, [_____]

SD-05 Design Data

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NOTE: The following two submittals are tailored for CURED-IN-PLACE PIPE.

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Engineering Design Calculations; G, [_____]

Resin To Tube Ratio; G, [_____]

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NOTE: The following submittal is tailored for FOLD-AND-FORM PIPELINER.

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FFP Engineering Design Calculations; G, [_____]

SD-06 Test Reports

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NOTE: The following four submittals are tailored for CURED-IN-PLACE PIPE.

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IR Analyses; G, [_____]

Temperature Logs; G, [_____]

Curing Logs; G, [_____]

CIPP Sample Test Results; G, [_____]

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NOTE: The following three submittals are tailored for FOLD-AND-FORM PIPELINER.

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FFP Temperature Logs; G, [_____]

FFP Curing Logs; G, [_____]

FFP Sample Test Results; G, [_____]

SD-07 Certificates

Contractor's Qualifications; G, [_____]

Superintendent's Qualifications; G, [_____]

Certificate of QC Laboratory Accreditation; G, [_____]

Resin Dye; G, [_____]

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NOTE: The following four submittals are tailored for CURED-IN-PLACE PIPE.
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Liner Manufacturer; G, [_____]

CIPP Installer's Qualifications; G, [_____]

Shipping Documents; G, [_____]

Manufacturing Certificate; G, [_____]

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G, [_____]

1.5 QUALITY CONTROL

1.5.1 Qualifications

1.5.1.1 Contractor's Qualifications

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NOTE: The following paragraphs are tailored. Select the first paragraph for CURED-IN-PLACE PIPE; select the second paragraph for FOLD-AND-FORM PIPELINER.
****

The Contractor is to have a minimum of three years of continuous experience installing Cured-In Place Pipe (CIPP) in pipe of a similar size, length and configuration. A minimum of 45,720 meters 150,000 linear feet of shop wet-out liner installation is required and a minimum of six onsite wet-out installations are required as specifically applicable to this Contract.

A minimum of three years experience using the proposed Fold-And-Form Pipe (FFP) rehabilitation of sewers' product is required as well as the installation of at least 15,240 meters 50,000 linear feet of the proposed FFP product(s). Employees and subcontractors performing work on the FFP rehabilitation are to be certified by the FFP rehabilitation system supplier as qualified to perform work with the proposed product. The firm performing the work is to be licensed by the liner process manufacturer.

1.5.1.2 CIPP Installer's Qualifications

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NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.
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The lead personnel including the superintendent, the foreman and the lead crew personnel for the resin wet-out, the CIPP installation, liner curing and the robotic service reconnections each are to have a minimum of three years of total experience with the CIPP technology utilized.

1.5.1.3 Superintendent's Qualifications

The superintendent for the Contract is to have supervised projects in which at least 7620 meters 25,000 linear feet of pipe has been rehabilitated using the product. The superintendent must be on-site during all phases of the work involving the insertion and processing of the liner.

1.5.1.4 Quality Control Specialist

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NOTE: The following paragraph contains tailoring options for FOLD-AND-FORM PIPELINER and CURED-IN-PLACE PIPE.

****

The Quality Control (QC) Specialist is responsible for monitoring and documenting activities related to QC of the liner system from manufacturing through installation. The QC Specialist is to have a minimum of three years of continuous experience installing FFP CIPP of similar size, length and configuration as contained in this contract. The QC Specialist is to be certified by the liner system supplier as qualified to perform work with the proposed liner system.

1.5.1.5 Liner Manufacturer

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NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

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Use felt material manufactured by companies specializing in felt production for CIPP. The manufacturer is to have manufactured felt material for CIPP for at least two years as documented by references. Submit felt manufacturer, references and location of the manufacturing facility. The felt material manufacturer and facility cannot change during construction unless specifically approved by the Contracting Officer in writing and in advance of its use.

1.5.1.6 Quality Control Laboratory

Select a QC Laboratory that has provided QC testing for at least three completed projects with the proposed liner system; and is independent from, and not associated with, the Contractor. QC Laboratory must be certified to perform testing in accordance with the following standards: ASTM D790, ASTM D2412, ASTM D2990, ASTM D5813, and ASTM F1216. Submit the Certificate of QC Laboratory Accreditation.

1.5.2 Quality Control Plan

Submit a detailed Contractor Quality Control (CQC) Plan that fully represents and conforms to the requirements of these specifications. At a minimum the CQC is to include the following:

a. Defined responsibilities, of the personnel, for assuring that quality requirements, for this Contract are met. Assign these responsibilities to specific personnel.

b. Submit clearly defined proposed procedures for quality control, product sampling and testing as part of the plan.

c. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form.

d. A scheduled performance and product test result review with the Contracting Officer at a regularly scheduled progress meeting.

e. Prepare Inspection Forms and guidelines for quality control inspections in accordance with the standards specified in this Contract and submitted with the QCP.

f. Outline specific repair or replacement procedures for potential defects that occur in the installed liner system, following repair or replacement procedures that are compatible with the system being used. Submit Repair or Replacement Procedures must adhere to the product manufacturer's written specifications for repair or replacement.

1.6 DELIVERY, STORAGE, AND HANDLING

Ship, store, and handle materials in a manner consistent with the written specifications of the liner system manufacturer to avoid damage. Damage may include, but is not limited to, gouging, abrasion, flattening, cutting, puncturing, or ultra-violet (UV) degradation. Select on site storage locations for approval by the Contracting Officer. Promptly remove and dispose of damaged materials.

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NOTE: The following paragraph is tailored for FOLD-AND-FORM PIPELINER.

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As a minimum the FFP delivered to the job site is to contain the manufacturers name or trademark, the nominal outside diameter, the cell classification, the DR designation, and the ASTM designation of the pipe.

1.6.1 Resin

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NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

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Ship the resin directly from the resin manufacturer's facility to the CIPP wet-out facility. Submit copies of the shipping documents from the resin manufacturer to the Contracting Officer showing dates of shipment, the originating location and the receiving location.

1.7 PROJECT/SITE CONDITIONS

The use of the product is not to result in the formation or production of any detrimental compounds or by-products including cuttings and pipe coupons, at the wastewater treatment plant or environment.

1.7.1 Environmental Requirements

Cool superheated water to below 38 degrees C 100 degrees F before discharge. Notify the Contracting Officer and identify any by-products produced as a result of the installation operations. Comply with local waste discharge requirements.

1.7.1.1 Disposal Of Process Water

Submit a procedure for the containment and disposal of process water for approval by the Contracting Officer.

1.8 WARRANTY

1.8.1 Warranty-TV Inspection

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NOTE: The default warranty is one year and the warranty-TV inspection is generally performed 10 months after liner installation or 60 days prior to warranty expiration. This inspection reveals flaws in material and workmanship not otherwise seen, such as settlement, leaks and delamination that need to be repaired prior to warranty expiration.

Consider adding Warranty-TV inspection to the commissioning requirements of the project. The benefits include a final internal examination of selected portions of the newly installed culverts and storm drain piping system.

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a. Complete a Warranty-TV inspection starting no earlier than [60][_____] days prior to expiration of the warranty. Perform Warranty-TV Inspection as specified in Section 33 01 30.16 TV INSPECTION OF SEWER LINES and at a time directed by the Contracting Officer. The specific locations will be selected by the Contracting Officer.

b. Repair any defects or abnormalities in lining, laterals or manhole connections which may materially affect the integrity, strength, function or operation of the pipe in accordance with Repair or Replacement Procedures.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

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NOTE: The following paragraph contains tailoring options for FOLD-AND-FORM PIPELINER and CURED-IN-PLACE PIPE.

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Rehabilitate sewer pipelines by the installation of FFP CIPP.

2.1.1 Design Requirements

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NOTE: Use ASCE MOP 120 as applicable.

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2.1.1.1 Structural Requirements

2.1.1.1.1 Cured-In-Place Pipe

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NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.
****

Design the CIPP in accordance with the applicable provisions of ASTM F1216 for [fully deteriorated][partially deteriorated] gravity pipe conditions. Provide engineering design calculations, performed and sealed by a qualified registered Professional Engineer in accordance with ASTM F1216 Appendix X1 Design Considerations for each length of liner to be installed including the thickness of each pipe segment. It is acceptable to submit a design for the most severe line condition and apply that design to all of the line sections of the same diameter. Provide a CIPP system which meets or exceeds the minimum properties specified herein:

a. Provide calculations supporting the liner thickness. The data is to include both the calculated thicknesses and the thicknesses proposed to be installed.

b. The installed, cured liner thickness is the largest thickness as determined by calculations for deflection, bending, buckling and minimum stiffness. The minimum installed, cured liner thickness is as follows, regardless of what the calculations indicate as the required minimum thickness:

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NOTE: Thickness values are stated in SI/metric units since they are regarded as the standard; therefore, English units are not provided for thickness values below.
****

150 mm 6 inch sewer: 4.5 mm

200 mm 8 inch sewer: 6 mm up to 5.2 meters 17 feet deep

200 mm 8 inch sewer: 7.5 mm up to 7.6 meters 25 feet deep

250 mm 10 inch sewer: 6 mm up to 3.4 meters 11 feet deep

250 mm 10 inch sewer: 7.5 mm up to 5.5 meters 18 feet deep

250 mm 10 inch sewer: 9 mm up to 7.6 meters 25 feet deep

300 mm 12 inch sewer: 7.5 mm up to 3.7 meters 12 feet deep

300 mm 12 inch sewer: 9 mm up to 5.5 meters 18 feet deep

300 mm 12 inch sewer: 10.5 mm up to 7.6 meters 25 feet deep

375 mm 15 inch sewer: 7.5 mm up to 3.0 meters 10 feet deep

375 mm 15 inch sewer: 9 mm up to 4.3 meters 14 feet deep

375 mm 15 inch sewer: 10.5 mm up to 6.1 meters 20 feet deep

c. The physical properties and characteristics of the finished liner will vary considerably, depending on the types and mixing proportions of the materials used, and the degree of cure executed. Control these variables and provide a CIPP system which meets or exceeds the minimum properties specified herein:

(1) Design the CIPP to meet or exceed ASTM F1216 Appendixes. The CIPP design is to assume no bonding to the original pipe wall.

(2) The CIPP design engineer is to set the long term (50 year extrapolated) Creep Retention Factor at 50 percent of the initial design flexural modulus as determined by ASTM D790 test method. Use this value unless long term test data ASTM D2990 substantiates a higher retention factor is required.

(3) At a minimum, the CIPP is to meet or exceed the structural properties, as listed below:

	MINIMUM PHYSICAL PROPERTIES	
Property	Test Method	Cured Composite (ASTM F1216)
Flexural Modulus of Elasticity (Short Term) (Felt Tubes) Felt/Fiberglass, Fiberglass meeting manufacturer's specifications	ASTM D790	1724 MPa 250,000 psi
Flexural Strength (Short Term) (Felt Tubes) Felt/Fiberglass, Fiberglass meeting Manufacturer's specifications	ASTM D790	31.0 MPa 4,500 psi

(4) As a minimum, base the required structural CIPP wall thickness on the physical properties of the cured composite and the design of the Contractor's Professional Engineer and in accordance with the Design Equations contained in the Appendix of the ASTM standards, and the following design parameters:

Design Safety Factor	2.0 (1.5 for pipes 900 mm 36 inch or larger)
Creep Retention Factor	50 percent
Ovality	2 percent or as measured by field inspection
Constrained Soil Modulus	AASHTO LRFD Section 12 and AWWA M45

Design Safety Factor	2.0 (1.5 for pipes 900 mm 36 inch or larger)
Groundwater Depth	As specified or indicated on the plans, in the specifications or geotechnical report
Soil Depth (above the crown)	As specified or indicated on the plans
Live Load	Highway, railroad or airport as applicable
Soil Load (assumed)	1922 kg/cu. m 120 lb/cu.ft.
Minimum service life	50 years

(5) Prior to installation of the lining materials, submit certification of compliance with these specifications or the requirements of the pre-approved CIPP system. Include certified material test results that confirm materials conform to these specifications. Materials not complying with these requirements will be rejected.

2.1.1.1.2 Fold and Form Pipe

****

NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.

****

Provide FFP engineering design calculations, performed and sealed by a qualified registered Professional Engineer in accordance with ASTM F1216 Appendix X1 Design Considerations for each length of liner to be installed including the thickness of each pipe segment. It is acceptable to submit a design for the most severe line condition and apply that design to all of the line sections of the same diameter.

a. The physical properties, wall thickness and characteristics of the finished FFP will vary according to the material installed. Provide a FFP system which meets or exceeds the minimum properties specified herein:

(1) Design the FFP in accordance with the applicable ASTM Standard, depending on the material being installed. The FFP design is not to assume bonding to the original pipe wall.

(2) The FFP design engineer is to set the long term (50 year extrapolated) Modulus Retention Factor as a percentage of the flexural modulus as determined by ASTM D790 test method. Base the Modulus Retention Factor on long term test data (ASTM D2990 or equal) submitted by the manufacturer of the product selected to substantiate the long term creep retention factor.

(3) The installed FFP material is to meet or exceed the structural properties, as listed below.

(a) As a minimum, base the required structural FFP wall thickness on the physical properties of the manufactured FFP and according to the design of the Professional Engineer and in accordance with ASTM F1504 and ASTM F1533.

Design Safety Factor	2.0
Modulus Retention Factor	As submitted and specific to type of pipe material
Ovality	2% or as measured by field inspection
Constrained Soil Modulus	Per AASHTO LRFD Section 12 and AWWA M45
Groundwater Depth	As specified or indicated on the Plans
Soil Depth (above the crown)	As specified or indicated on the Plans
Live Load	Highway, railroad or airport as applicable
Soil Load (assumed)	1922 kg/cu. m120 lb/cu. ft. (or data from specific project soil borings)
Minimum service life	50 years

MINIMUM PHYSICAL PROPERTIES

Property	Test Method	Per Applicable ASTM
Flexural Modulus of Elasticity	ASTM D790	HDPE - 814 MPa 118,000 psi PVC - 1931 MPa 280,000 psi PVC Type A - 1000 MPa 145,000 psi
Flexural Strength	ASTM D790	HDPE - N/A PVC - 34.5 MPa 5,000 psi PVC Type A - 28.3 MPa 4,100 psi

2.1.2 Performance Requirements

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NOTE: The following paragraph contains tailoring options for FOLD-AND-FORM PIPELINER and CURED-IN-PLACE PIPE.

****

Provide a continuous and tight-fitting liner throughout the entire length of the original pipe. Extend the FFP CIPP the full length of the original pipe, from entry point to exit point, and provide a structurally sound and water-tight new pipe within a pipe. Cleanup, restore existing surface conditions and structures, and repair portions of the FFPCIPP system determined to be defective.

2.1.2.1 Cured-In-Place Pipe

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.
****

a. Provide a continuous and jointless CIPP from manhole to manhole or access point to access point, free of defects that will affect the long term life and operation of the pipe.

b. Fit the CIPP sufficiently tight within the existing pipe so as to not leak at the manholes, at the service connections or through the wall of the installed pipe. Seal leaks at the manholes or the service connections using a material compatible with the CIPP. If leakage occurs through the wall of the pipe, repair or replace the liner.

c. Design the CIPP for a life expectancy of 50 years or greater and to have a 50 year corrosion resistance to the typical chemicals found in domestic sewage.

d. Robotically re-open existing and confirmed active service connections and any other service laterals to be reinstated as directed by the Contracting Officer to their original shape and to a minimum of 90 percent of their original capacity. Repair over-cut service connections to meet the requirements of these specifications. Re-establish the service openings utilizing a remotely controlled brushing device to smoothly cut and remove jagged edges, material and shavings resulting in the cutting operation.

2.1.2.2 Fold-And-Form Pipe

****
NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.
****

a. Provide continuous and jointless FFP from manhole to manhole, free of defects that will affect the long term life and operation of the pipe.

    (1) The FFP is to fit sufficiently tight within the existing pipe so as to not leak at the manholes, at the service connections, or through the wall of the installed pipe.

    (2) Seal these areas to stop leakage using a material compatible with the FFP. Repair or replace the liner if leakage occurs through the wall of the pipe. Final approval of the liner installation will be based on a leak tight pipe.

b. The installed FFP is to have a 50 year corrosion resistance to the typical chemicals found in domestic sewage.

2.1.3 Tolerances

Maintain the largest possible hydraulic capacity. At a minimum, the rehabilitated pipe is to equal or exceed the full flow capacity of the original pipe before rehabilitation.

All recommended values from the ASTM's referenced in this specification are required.

2.1.3.1 Cured-In-Place Pipe

****
NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.
****

The installed CIPP thickness tolerance is minus 5 percent to plus 10 percent as compared to the approved liner design.

2.1.3.2 Fold-And-Form Pipe

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NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.
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2.1.3.2.1 Fold-And-Form Poly (Vinyl Chloride) Pipe

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NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.
****

Comply with ASTM F1871, ASTM F1867 or ASTM F1504.

2.1.3.2.2 Polyethylene (PE) Liner

****
NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.
****

Comply with ASTM F1606 or ASTM F1533.

2.2 MATERIALS

2.2.1 Hydrophilic Seals

Submit Hydrophilic Seal information that specifically indicates that the seal material is compatible with the liner material being utilized and the hydrophilic seal will produce a tight fitting, waterproof seal between the liner and the host pipe at the manhole location.

2.2.2 Lubricant

Submit detailed description of the lubricant proposed for the insertion or inversion process. Ensure that the lubricant is compatible with the wastewater treatment plant operations and pre-treatment program.

2.2.3 Cured-In-Place Pipe

****
NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.
****

Provide a fabric tube manufactured of one or more layers of absorbent non-woven felt fabric, felt fiberglass composite or fiberglass and meet the requirements of ASTM F1216, ASTM F1743, ASTM D5813, and ASTM F2019 that is capable of absorbing and carrying resins, constructed to withstand installation pressures and curing temperatures and have sufficient strength to bridge missing pipe segments, and stretch to fit irregular pipe sections. Submit certified information from the felt manufacturer of the nominal void volume in the fabric tube that will be filled with resin.

When combined as a composite structure, the fabric tube, resins, tube coatings, and other materials must produce CIPP that meets the requirements of this specification. Fabricate the CIPP to a size that will tightly fit the internal circumference and the length of the original conduit when installed.

2.2.3.1 Resin-Impregnated Tube

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

CIPP can be used for structural and nonstructural purposes for pipes ranging from 2 to 108-in. diameter.

The installation of a resin-impregnated, flexible tube which is inverted into the existing conduit by use of a hydrostatic head or air pressure. The resin is cured by circulating hot water or introducing controlled steam within the tube. When cured, the finished pipe will be continuous and tight-fitting.

****

Provide ASTM F1216 resin-impregnated, flexible tube for installation by inversion. The flexible tube must consist of one or more layers of flexible needled felt, nonwoven or woven material, or a combination of nonwoven and woven materials, capable of carrying resin and withstanding installation pressures and curing temperatures. The tube must be compatible with the resin system used and have a plastic coated outside layer material that is compatible with the resin system used. Make allowance for circumferential stretching during inversion.

Use thermoset resin and catalyst system or an epoxy resin and hardener that is compatible with the inversion process. The resin must be able to cure in the presence of water and the initiation temperature for cure should be less than 82.2 deg. C 180 deg. F.

2.2.3.2 Thermosetting Resin Pipe

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NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

CIPP can be used for pipes ranging from 2 to 96-in. diameter.

The installation of a flexible tube capable of carrying resin which is pulled into the existing conduit and secondarily inflated by hydrostatic head or air pressure. The resin is cured by circulating

hot water or introducing controlled steam within the tube. When cured, the finished pipe will be continuous and tight-fitting.

****

Provide ASTM F1743 coated fabric tube filled with thermosetting resin installed by pull in place methods. The flexible tube must consist of one or more layers of flexible needled felt, nonwoven or woven material, or both, capable of carrying resin and withstanding installation pressures and curing temperatures. The outside layer of the fabric tube should have an impermeable flexible coating whose function is to contain the resin during and after fabric tube impregnation. The outer coating must facilitate monitoring of resin saturation. Allowance should be made for circumferential and longitudinal stretching of the fabric tube during installation. All of the materials used must be compatible with the resin system used and have a plastic coated outside layer material that is compatible with the resin system used.

Use a chemically resistant isophthalic based polyester or vinyl ester thermoset resin and catalyst system or an epoxy resin and hardner that is compatible with the installation process. The resin must be able to cure in the presence of water and the initiation temperature for cure should be less than 82.2 deg. C 180 deg. F.

2.2.3.3 Product Data

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NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

Submit CIPP product data from the CIPP manufacturer.

a. Submit product data for the Flexible Membrane (coating) material including the manufacturer's recommended repair (patching) procedure.

b. Include infrared spectrum (IR) analysis for proposed resin and confirmation that the resins meet ASTM D5813.

c. Catalyst product data and quantity.

d. Raw Resin Data, including the manufacturer and description of product components.

2.2.3.4 Test Reports

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

Include test reports certifying that the materials shipped to the project site conform to the applicable ASTM standards.

a. Submit results of IR analyses of the proposed resin and resin catalyst mixture, performed and certified by the resin manufacturer, prior to manufacturing CIPP.

b. The results of the IR analyses (the resin's chemical fingerprint) will be used to verify that the resin and the resin catalyst composition and mixture being used is the approved resin and resin catalyst system.

2.2.3.5 Certificates

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

a. Submit a manufacturing certificate that the CIPP was manufactured in accordance with these specifications and ASTM D5813 with each shipment. The certifications are to include:

b. A signed statement by the wet-out manager/supervisor that no fillers were added to the resin system during manufacture of the CIPP.

c. Wet-out forms documenting the wet-out for each section of CIPP manufactured without delay or claim to any confidentiality.

    (1) The wet-out forms are to document the date and time of wet-out, the wet-out supervisor, the wet-out facility address, the location where the CIPP will be installed (by work order and manhole numbers), the CIPP diameter, the length of wet-tube and dry-tube, the thickness of the CIPP, the roller gap setting for establishing the liner thickness, the felt manufacturer, the resin used (by product name and batch or shipment number) and quantity, the catalyst(s) used (by product name) and quantity, quality control samples taken, and other information pertinent to the wet-out process.

d. Submit a Certificate of Authenticity from the resin manufacturer for each shipment to the wet-out facility as part of the Catalyst product data submittal. Include the date of manufacture and the Heat Distortion Temperature.

e. Submit certification that the Resin Dye quantity and type is compatible with the components of the lining system.

2.2.3.6 Manufacturer's Instructions

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

Submit manufacturer's instruction for installation, repair and patching of the CIPP.

2.2.3.7 Resin

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

a. Provide a corrosion resistant polyester or vinyl ester resin and catalyst system or epoxy and hardener system that, when cured within the tube composite, meets the requirements of ASTM F1216, ASTM F1743, or ASTM F2019, the physical properties herein, and those, indicated in the design of the CIPP for this project. The resin is to produce CIPP which will comply with or exceed the structural and chemical resistance requirements of this specification.

b. Submit the resin to tube ratio, by volume, as determined by the Design Calculations.

c. Provide the polyester or vinyl ester resin that is PREMIUM, NON-RECYCLED resin only. Do not use Polyethylene Terephthalate (PET) resins, or those containing fillers, additives or enhancement agents. Old resin or reworked resin is not permitted.

d. Do not use Quick-cure or accelerated resin systems that cure in half the specified time or substantially quicker than the minimum three hours.

2.2.4 Fold-And-Form Pipe

****

NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.

****

Provide an FFP system that is chemical resistant to domestic sewage.

2.2.4.1 Manufacturer's Instructions

****

NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.

****

Submit manufacturer's instruction for installation and repair of the FFP.

PART 3 EXECUTION

3.1 EXAMINATION

Complete Pre-TV inspection in accordance with Section 33 01 30.16 TV INSPECTION OF SEWER LINES.

3.2 PREPARATION

3.2.1 Traffic Control

a. Submit a detailed Traffic Control Plan to the Contracting Officer at least 10 days in advance when the manholes used to access and install the liner are located in or adjacent to the road. Comply with all applicable State Highway, Local and Installation requirements when preparing the traffic control plan.

b. Provide labor, signs, barricades, cones, arrow boards, flaggers and any additional equipment necessary to complete the work.

3.2.2 Set-Up and Sequence

Submit a sewer Bypass Plan to the Contracting Officer at least [14] [_____] days in advance. Coordinate sewer bypass and flow interruptions with the

Contracting Officer before proceeding with liner installation.

Submit a Sequence of Liner Installation plan. Include proposed set-up locations in the plan that are coordinated with the Traffic Control Plan.

3.2.3 Sewer Flow Control

Plug the pipe or install a bypass pumping system to facilitate the proper cleaning of pipe lines. In the event of a spill, immediately notify the Contracting Officer and take appropriate actions to stop, contain and cleanup the spill. Immediately clean up raw sewage spills caused by the Contractor's operations and disinfect the spill area using methods and materials approved by the Contracting Officer.

3.2.3.1 Bypassing Existing Sewage Flows

a. Provide for the flow of existing mainline and service connection effluent around the section or sections of pipe designated for liner installation.

b. Provide pump(s) and bypass line(s) of adequate capacity and size to handle peak flows.

c. Plug service connections only after proper notification to the Contracting Officer. Service connections are not to remain plugged overnight.

d. Begin work after plugs or a sewage bypass system and pumping facilities have been installed and tested under full operating conditions, including the bypass of mainline and side sewer flows.

****

NOTE: The following is tailored for CURED-IN-PLACE PIPE.

****

e. Once the lining process has begun, maintain bypass flows until the resin/felt tube composite is fully cured, cooled down, fully televised and the CIPP ends finished.

3.2.4 Cleaning

****

NOTE: Types of cleaning may include hydraulic jetting, mechanical, hydromechanical, hand rodding, power rodding, or bucket machines. Consider the type of work to be performed and the condition of the existing pipe The type of cleaning used

****

Select a cleaning method that will prepare the surface for the type of point repair or renewal work being performed taking into consideration the condition of the existing pipeline. Sewer cleaning includes the removal of roots, sediment and debris, incrustations from sewer walls, and removing protruding objects or lateral connections.

a. Clean mains and services as indicated in SECTION 33 01 30.16 TV INSPECTION OF SEWER LINES.

b. Remove internal debris from the existing pipe line that will interfere with the installation of the liner.

3.2.4.1 Line Obstructions

****

NOTE: The vast majority of point repairs are made by the open cut method. No dig sectional point repairs are typically suited for high volume traffic areas and deeper mains.

****

Remove obstructions, correct misalignments, repair broken or collapsed sections and sags that will prohibit the installation or will interfere with the long-term performance of the lining materials by performing a point repair. Make point repairs by [open cut repair methods][or][sectional point repair methods in accordance with ASTM F1216].

3.2.5 Protection

Prevent damage to the existing piping during cleaning.

3.2.6 Surface Preparation

Perform Pre-TV inspections of the pipelines after cleaning has been completed in accordance with SECTION 33 01 30.16 TV INSPECTION OF SEWER LINES.

Confirm the locations of branch service connections prior to installing and curing the liner material. In the event the status of a service connection cannot be adequately defined, the Contracting Officer will make the final decision, prior to installation and curing of the liner, as to the status.

3.3 INSTALLATION

Stop or by-pass sewer flow prior to beginning renewal work such as cleaning, CCTV, installing liners, and re-instating service connections.

3.3.1 Cured-In-Place Pipe

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

a. Prior to the installation of the liner, place temperature sensors in the host pipe in order to monitor the temperature of the liner wall and to verify correct curing. Place temperature sensors between the host pipe and the liner in the bottom of the host pipe (invert) throughout its length and monitor the temperature on the outside of the liner during the curing process.

b. Place the temperature sensors at intervals as indicated in the sensor manufacturer's written specifications. Place additional sensors where significant heat sinks are likely or anticipated.

c. Monitor the sensors by a computer using a tamper proof data base that is capable of recording temperatures at the interface of the liner and the host pipe.

d. Install the liner in accordance with ASTM F1216 and ASTM F1743 with the following modification: Position the wet-out tube in the pipeline using the method indicated in the manufacturer's instructions. Pull-in or invert through an existing manhole or access point and fully extend to the next manhole or termination point. Prevent damage to the tube during installation.

e. Install and cure the CIPP in the host pipe as indicated in the manufacturer's specifications and as described in the approved submittals.

f. Accomplish curing by utilizing the medium in accordance with the cure schedule. Continuously monitor the curing source, or input and output temperatures and log the temperatures during the cure cycles. Use the manufacturer's recommended cure method and schedule for each line segment installed. Take the liner wall thickness and the existing ground conditions with regard to temperature, moisture level, and thermal conductivity of soil into account during the curing process.

g. For heat cured liners, if one or more temperature sensors do not reach the temperature specified by the manufacturer to achieve proper curing or cooling, the installer is to make necessary adjustments required to conform with the manufacturer's specifications.

h. For UV Cured Liners, record all light train sensor readings along the entire length of the installed liner into a tamper proof computer. Follow the cure procedure in accordance with the manufacturer's written product data.

i. Monitor and record temperatures and curing data throughout the installation process to ensure that each phase of the process is achieved in accordance with the product specifications. Provide curing logs from the system computer that specifically identifies each installed sensor station in the length of pipe, indicates the maximum temperature achieved and the sustained temperature time. Each sensor is to record both the maximum temperature and the minimum cool down temperature and comply with the manufacturer's written product data. Submit temperature logs and curing logs for each pipe segment.

j. Cool in accordance with the approved product specifications.

3.3.1.1 Finish

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

a. Provide a CIPP that is continuous over the entire length of a sewer line, is free from visual defects such as foreign inclusions, dry spots, pinholes, major wrinkles and de-lamination, and is impervious and free of leakage from the pipe to the surrounding ground or from the ground to inside the lined pipe.

b. Seal the beginning and end of the CIPP to the existing host pipe utilizing a hydrophilic end sealing material compatible with the existing (HOST) pipe and the liner.

c. Provide watertight service connections.

3.3.2 Fold-And-Form Pipe

****

NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.

****

a. Prior to installation of the FFP, place temperature sensors in the host pipe to monitor the temperatures during the processing of the FFP. Monitor and log temperatures during processing and cool down.

b. Install and process the FFP in the host pipe according to these specifications, ASTM F1867 or ASTM F1606 and the manufacturer's instructions.

c. Position the FFP in the pipeline using the method specified by the manufacturer. Pull-in the FFP through an existing manhole or access point and fully extend the FFP to the next designated manhole or termination point.

d. Complete the processing of the FFP by utilizing the appropriate medium in accordance with the manufacturer's instructions. Use ASTM F1867 or ASTM F1606 and the manufacturer's recommended processing procedure for each line segment installed. Evaluate all factors that may impact installation, such as FFP wall thickness and the existing ground conditions with regard to temperature, moisture level, and thermal conductivity of the host pipe and soil, during the installation of the FFP. Adjust pressures according to site conditions to ensure a tight expansion out against the host pipe.

e. Monitor and record temperatures and curing data throughout the installation process to ensure that each phase of the process is achieved in accordance with the product specifications. Submit FFP temperature logs and FFP curing logs for each pipe segment.

f. Cool in accordance with the approved product specifications.

3.3.2.1 Finish

****

NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.

****

a. Provide FFP that is fully expanded and continuous over the entire length of a sewer line section, is free from visual defects such as foreign inclusions, dry spots, pinholes, major wrinkles, is impervious and free of any leakage from the pipe to the surrounding ground or from the ground to inside the lined pipe.

b. Seal the beginning and end of the FFP to the existing host pipe using a hydrophilic end sealing material compatible with the existing (host) pipe and the FFP.

c. Provide watertight service connections.

3.3.3 Manhole Connections

Form a tight seal between the rehabilitation (lining) material and the host pipe at the pipe penetration of the manhole wall. Apply the seal consisting of a resin mixture or hydrophilic seal compatible with the installed liner at the manhole-wall interface in accordance with the liner system manufacturer's specifications. Seal annular spaces greater than 13 mm 1/2 inch with manhole wall repair material. Finish off the seal with non-shrink grout or cementitious liner material placed around the pipe opening from the inside of the manhole in a band at least 100 mm 4 inches wide. Provide an epoxy coating over the repair on the manhole walls.

Provide a continuous and smooth invert through manholes. If a liner is installed through a manhole, the bottom portion of the liner is to remain. Grout and shape the bench of the manhole as necessary to support the liner. If the liner terminates on either side of the manhole, build up the invert to remove flow restrictions and to form a continuous invert through the manhole.

3.3.4 Cured-In-Place Pipe

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

a. The wet-out fabric tube is to have a uniform thickness and excess resin distribution that, when compressed at installation pressures, will meet or exceed the design thickness after cure.

b. Install the fabric tube to a size and length that will tightly fit the internal circumference of the host pipe. Allowance for circumferential stretching during installation. Size the tube to the diameter of the existing pipe and the length to be rehabilitated, and be able to stretch to fit irregular pipe sections and negotiate bends. Prior to ordering, measure in the field the minimum tube length necessary to effectively span the designated run between manholes to ensure that the tube will have sufficient length to extend the entire length of the run. Measure the inside diameter of the existing pipelines in the field prior to ordering liner so that the liner can be installed in a tight-fitted condition.

c. Coat the outside or inside layer of the fabric tube (before inversion or pull-in, as applicable) with an impermeable, flexible membrane that contains the resin and facilitates, if applicable, vacuum impregnation and monitoring of the resin saturation during the resin impregnation (wet out) procedure.

d. Do not include material in the fabric tube that may cause delamination in the cured CIPP. Dry or unsaturated layers are not acceptable upon visual inspection as evident by color contrast between the tube fabric and the active resin containing a colorant.

e. Use a light reflective interior pipe surface color so that a clear detailed examination of the CIPP can be made with closed circuit television inspection equipment. Provide a hue of the color dark enough to distinguish a contrast between the fully resin saturated felt fabric and dry or resin lean areas.

f. When seams in the fabric are required, sew them so that the seams are stronger than unseamed felt.

g. Spirally form and sew where the length requires joining.

h. Mark the outside of the fabric tube every 1.5 meters 5 feet with the name of the manufacturer or CIPP system, manufacturing lot and production footage.

i. The installer will determine the minimum length of the fabric tube to effectively span the distance from the starting manhole to the terminating manhole or access point, plus that amount required to run-in and run-out for the installation process.

****

NOTE: Thickness values are stated in SI or metric units since they are regarded as the standard; therefore, English units are not provided for thickness values below. Refer to ASTM D790, paragraph 1.3.

****

j. As a minimum, provide the fabric tube wall thickness manufactured to the nearest 0.5 mm 0.02 in increment, rounded up from the design thickness for that section of installed CIPP. Wall thickness transitions, in 0.5 mm 0.02 in increments or greater as appropriate, may be fabricated into the fabric tube between installation entrance and exit access points. Provide a sufficient quantity of resin used in the impregnation to entirely fill the felt voids for the nominal felt thickness.

3.3.4.1 Resin

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

a. Do not change resins, catalysts, resin/catalysts, or mixing ratios during this Contract unless specifically approved by the Contracting Officer in writing in advance.

b. Use the resin as shipped. Do not add fillers or additives at the wet-out facility except for the required catalyst.

c. Apply the resin to the felt tubing (wet-out) under factory conditions. Protect the materials against ultraviolet (UV) light, excessive heat and contamination at all times.

3.3.5 Reconnections Of Existing Services

a. Make reconnections of existing services after the liner has been installed, fully cured, and cooled down.

****

NOTE: The following item contains tailoring options for CURED-IN-PLACE PIPE and FOLD-AND-FORM PIPELINER.

****

b. Make external reconnections with a tee fitting in accordance with the lining system manufacturer's written specifications. Seat and seal saddle connections to the new CIPP using grout or resin compatible with the CIPPFFP following manufacturer's specifications.

c. Utilize a CCTV camera and remote cutting tool for internal reconnections. The machined opening must be at least 90 percent of the service connection opening and the bottom of both openings are required to match. The opening cannot be more than 100 percent of the service connection opening. Smooth the edges of the opening and remove pipe or liner fragments, which may obstruct flow or snag debris. Cut the invert of the sewer connection flush with the invert entering the mainline.

d. In the event that service reinstatements result in openings that are greater than 100 percent of the service connection opening, install a repair, sufficient in size to completely cover the over-cut service connection according to the manufacturer's specifications.

e. Collect coupons of pipe material resulting from service tap cutting at the next manhole downstream of the pipe rehabilitation operation prior to leaving the site. Account for all pipe coupons and do not allow them to pass through the system.

3.4 FIELD QUALITY CONTROL

All costs associated with inspection and the collection, transportation and testing of samples are the responsibility of the Contractor.

3.4.1 Tests

3.4.1.1 Cured-In-Place Pipe

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

a. Verify the physical properties of the installed CIPP through field sampling and laboratory testing. Use an independent third party laboratory to test CIPP Samples. Test in accordance with ASTM F1216, ASTM F1743, and ASTM D5813 for chemical resistance. Test methods to confirm compliance with the requirements specified in these Contract documents. Measure the installed CIPP thickness for each line section installed. Submit a minimum of one CIPP sample for every line section of installed CIPP to be used to check the liner thickness. Replace sections where the CIPP thickness does not fall within the approved design thickness.

b. Collect samples from the installed CIPP. At a minimum, one sample for each 305 meters 1000 linear feet of CIPP installed; one sample for each size of CIPP installed; and one plate sample cured with CIPP on pipelines greater than 450 mm 18 inches in diameter. Cut the samples from a section of cured CIPP that has been inverted or pulled through a like diameter pipe which has been held in place by a heat sink, such as sandbags.

c. Process, cut, and label test samples in the presence of the Contracting Officer. Immediately package the samples in a pre-addressed, postage paid, pre-labeled, unsealed packing, addressed for delivery to the testing laboratory. Seal packages in the presence of the Contracting Officer; and ship or transport to the testing lab.

d. Submit CIPP sample test results.

3.4.1.2 Fold-And-Form Pipe

****
NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.
****

a. Verify the physical properties of the installed FFP through field sampling and laboratory testing. Use an independent laboratory that specializes in material testing to test FFP Samples. Test in accordance with ASTM F1871 and ASTM F1504 test methods to confirm compliance with the requirements specified in these Contract documents.

b. Take samples from the installed FFP. At a minimum, provide samples from one location per 762 meters 2500 linear feet of installed pipe. Cut the sample from a section of processed FFP that has been installed through a like diameter pipe which has been held in place by a suitable heat sink, such as sandbags. Process, cut, and label test samples in the presence of the Contracting Officer. Immediately package the samples in a pre-addressed, postage paid, pre-labeled, unsealed packing, addressed for delivery to the testing laboratory. Seal packages in the presence of the Contracting Officer; and ship or transport to the testing lab.

c. On pipelines greater in diameter than is practical to produce restrained samples, the Contracting Officer may at his or her discretion designate a location in the newly installed FFP where the Contractor is to take a sample.

d. Identify on the sample and as built drawings the test sample location as referenced to the nearest manhole and station. One re-testing of failed samples will be permitted for proper protocol compliance verification. If properties tested do not meet minimum requirements, repair or replace the FFP pipe section. Sample and test sections of the replaced FFP section.

e. Repair the opening produced from the sample, in accordance with manufacturer's specifications.

f. Submit FFP sample test results.

3.4.2 Inspection

Complete Post-TV, Re-TV and Warranty-TV inspections in accordance with Section 33 01 30.16 TV INSPECTION OF SEWER LINES.

3.4.2.1 Cured-In-Place Pipe

****
NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.
****

a. Provide the Contracting Officer the opportunity to examine operations during the installation and impregnation of the liner throughout the entire process.

b. Provide full access to witness the CIPP wet-out process and provide information related to the manufacturing as requested by the Contracting Officer, without delay and without claims of confidentiality or product privacy.

3.4.2.2 Fold-And-Form Pipe

****

NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.

****

a. Use non-destructive methods to measure the thickness for each section of installed FFP.

b. Where leakage is observed through the wall of the pipe, institute localized testing (weirs or similar) that will verify that the leakage rate of the installed liner does not exceed acceptable tolerances for new sanitary sewer installations for the local jurisdictions.

3.4.3 Inspections

Provide Pre-TV, Post-TV, Warranty-TV and Re-TV inspections in accordance with Section 33 01 30.16 TV INSPECTION OF SEWER LINES.

a. Complete Post-TV inspections and repairs to the installed liner before acceptance.

b. Submit as-built drawings for the portions of the sanitary sewer system that were rehabilitated showing complete detail with dimensions, both above and below grade, including invert elevations at the manholes in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS.

c. Include the identification of the work completed on one set of Contract Drawings. Keep legible as-built drawings on the project site at times and maintain them as the work progresses. Continuously update the as-built drawings with accurate dimensions and notations concerning locations, sizes, pipe lengths and specific material types. Include dimensional location, size and type of point repairs on the as-built drawings.

d. Within 10 working days of final acceptance of said work, provide As-built drawings and Inspection forms.

3.4.4 Repair Of Defects

3.4.4.1 Cured-In-Place Pipe

****

NOTE: This paragraph is tailored for CURED-IN-PLACE PIPE.

****

a. Locate and succinctly define defects in the installed CIPP that will not affect the operation and long term life of the product. The warranty CCTV inspection will include pipe segments with noted defects that were not repaired.

b. Locate and succinctly define repairable defects that occur in the installed CIPP based on approved product specifications, including a detailed step-by-step repair procedure.

c. Clearly locate and define un-repairable defects in the CIPP based on the approved product specifications, including a recommended procedure for the removal and replacement of the CIPP.

3.4.4.2 Fold-And-Form Pipe

****

NOTE: This paragraph is tailored for FOLD-AND-FORM PIPELINER.

****

a. Repair any of the FFP system determined to be defective.

b. Repair or replace any defects which, in the judgment of the Contracting Officer, will affect the integrity or strength of the lining.

c. Prior to the repair of defective work, submit a Shop Drawing indicating the FFP Repair Method.

d. Provide field or workshop demonstration of the method of repair if requested by the Contracting Officer.

e. Make the repairs in full compliance with the FFP manufacturer's specifications.

f. Re-TV repairs to FFP in accordance in accordance with Section 33 01 30.16 TV INSPECTION OF SEWER LINES.

3.5 ADJUSTING AND CLEANING

3.5.1 Lateral Connections

All active lateral connections must be re-opened and remain water tight.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 01 50.31 (February 2020)**

Preparing Activity: USACE **Superseding**
UFGS-33 58 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 33 - UTILITIES

SECTION 33 01 50.31

LEAK DETECTION FOR FUELING SYSTEMS

02/20

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PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 01 50.31 (February 2020)**

Preparing Activity: USACE **Superseding**
UFGS-33 58 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 33 01 50.31

LEAK DETECTION FOR FUELING SYSTEMS
02/20

****
NOTE: This guide specification outlines many of the requirements for leak detection systems for fueling applications.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This specification does not address the monitoring of tank bottoms for field-fabricated, vertical storage tanks.

Use this UFGS in conjunction with UFC 3-460-01 "Design: Petroleum Fuel Facilities". Include in this specification any additional equipment/devices necessary to meet state and local regulations.

UFC 3-460-01 requires underground storage tanks and underground piping to be monitored for leaks in accordance with 40 CFR 280, 40 CFR 281, 49 CFR 195, and any applicable state and local requirements.

In order to meet SPCC (40 CFR 112) program requirements and/or as a best management practice, all underground pipes associated with Aboveground Storage Tanks (ASTs) must meet the secondary containment and/or leak detection provisions of 40 CFR 280, 40 CFR 281, and any applicable state and local requirements - see spec writer notes under UNDERGROUND PIPING section.

Various methods can be used to conform to the leak detection and monitoring requirements of the CFRs. This specification covers the preferred methods related to tanks and piping. Variations from this specification must be coordinated with and approved by the Using Agency.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 1130	(2007; R 2017) Computational Pipeline Monitoring for Liquids
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 77	(2024; ERTA 1 2023) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 24-2) Standard for Aircraft Fuel Servicing
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Leak Detection System; G, [_____]

Electronic Monitoring/Alarm Panel

Computational Pipeline Monitoring System

SD-03 Product Data

Leak Detection System; G, [_____]

Electronic Monitoring/Alarm Panel

Computational Pipeline Monitoring System

SD-06 Test Reports

Leak Detection System Test

SD-07 Certificates

Demonstrations

SD-08 Manufacturer's Instructions

Leak Detection System

SD-10 Operation and Maintenance Data

Leak Detection System; G, [_____]

Electronic Monitoring/Alarm Panel; G, [_____]

Computational Pipeline Monitoring System; G, [_____]

1.3 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship, and that have been in satisfactory commercial or industrial use for a minimum 2 years prior to bid opening. Include applications of the equipment and materials under similar circumstances and of similar size. Materials and equipment must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.[Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours, exclusive of the manufacturer's factory tests, can be shown.]

2.1.1 Nameplates

****

NOTE: In a salt water environment, substitute acceptable non-corroding metal such as, but not limited to, nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

Require melamine plastic nameplates for all NAVFAC projects. Also for NAVFAC projects, require nameplates to be associated or keyed to system charts and schedules.

****

Attach nameplates to all specified equipment defined herein. List on each nameplate the manufacturer's name, address, [contract number,] [acceptance date,] component type or style, model or serial number, catalog number, capacity or size, and the system which is controlled. Construct plates of [anodized aluminum] [stainless steel] [melamine plastic, 3 mm 0.125 inch thick, UV resistance, black with white center core, matte finish surface and square corners] [_____]. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Provide nameplates with a minimum size of 25 by 65 mm one by 2.5 inches. Provide normal block style lettering with a minimum 6 mm 0.25 inch height. Accurately align all lettering on nameplates. [For plastic nameplates, engrave lettering into the white core.] [Key the nameplates to a chart and schedule for each system. Frame charts and schedule under glass, and locate where directed near each system. Furnish two copies of each chart and schedule. Provide nameplate identifying its function.]

2.1.2 Metallic Requirements

****

NOTE: Include the bracketed information if aviation fuel will be handled.

****

Do not construct internal parts and components of equipment, piping, piping components, and valves that could be exposed to fuel during system operation of zinc coated (galvanized) metal[, brass, bronze, or other copper bearing alloys]. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

2.2 ELECTRICAL WORK

****

NOTE: Coordinate the ignition temperature of the fuel(s) to be handled with the electrical design. Ignition temperatures will be as defined in NFPA 497M. Fuel ignition temperatures will dictate the maximum allowable temperature rating of the electrical equipment.

****

Provide controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of equipment. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide switches and devices necessary for controlling and protecting electrical equipment. Provide controllers and contactors that have a maximum of 120-volt control circuits and that have auxiliary contacts for use with the controls provided.

2.2.1 Underground Wiring

Enclose underground electrical wiring in PVC coated conduit. Dielectrically isolate conduit at any steel storage tank connection.

2.2.2 Grounding and Bonding

Perform grounding and bonding in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.3 LEAK DETECTION SYSTEM

****

NOTE: This paragraph and subsequent sub-paragraphs address primarily leak detection systems that conform to 40 CFR 280 and 40 CFR 281. For leak detection systems applicable to large fuel distribution systems (49 CFR 195), refer to paragraph COMPUTATIONAL PIPELINE MONITORING SYSTEM.

****

Provide a system, including sensors and detectors, that is intrinsically safe for use in a Class 1, Division 1, Group D environment as defined by NFPA 70. Provide system compatible with the fuel to be handled. Furnish sensors that distinguish and report the difference between hydrocarbons and water. Provide electronic output and transmission from sensors and detectors. Provide sensors that have a minimum probability of detection of 95 percent and a maximum probability of false alarm of 5 percent. Provide sensors and detectors that are compatible with the electronic monitoring/alarm panel. Reuse sensors after an alarm condition is sensed. Submit shop drawings for the leak detection system that include the following.

a. Wiring schematics for all parts of the system showing each operating device and listing their normal ranges of operating values (including pressures, temperatures, voltages, currents, speeds, etc.).

b. Single line diagrams of the entire system, including any required alterations to the existing piping and tank(s).

c. Diagrams for posting that include distance markings such that alarm indications can be correlated to leak location in plan view. Include a piping and wiring display map with schematic diagrams from the leak detection system manufacturer. Frame diagrams under glass or laminated plastic and be posted where indicated by the Contracting Officer.

2.3.1 Underground Storage Tanks

****

NOTE: 40 CFR 280 and 40 CFR 281 define and regulate underground storage tank (UST) systems. According to these CFRs, UST systems are defined as one or more combination of underground tanks (including underground pipes connected thereto) that are used to contain an accumulation of regulated substances, and the volume of which (including the volume of underground pipes connected thereto) is 10 percent or more beneath the surface of the ground.

Per the CFRs, UST systems do not cover underground tanks less than or equal to 416 L 110 gallons, uand tanks used for storing heating oil for consumptive use on the premises where stored. NOTE: Heating oil tanks must meet secondary containment and leak detection requirements of 40 CFR 280 / 281 to meet provisions of Spill Prevention Countermeasure and Control (SPCC) Program.

UFGS 33 56 10 requires all new underground storage tanks be the double-walled type. The required leak detection method for these type tanks is to continuously and automatically monitor the tank's interstitial space. The system used must be capable of detecting both fuel released through a tank's interior wall as well as the influx of ground water through a tank's exterior wall.

****

Furnish system that continuously and automatically monitors the interstitial space of an underground tank for breaches in the integrity of the inner and/or outer tank shells. Monitor the interstitial space by using either an electronic capacitance type liquid sensor or a positive pressure system. Monitoring the interstitial space of a fiberglass reinforced plastic (FRP) tank may be performed using a liquid-filled interstitial space monitoring system. Freeze protect (brine) the liquid solution used in a liquid-filled interstitial and contain appropriate corrosion inhibitors. Detect and discriminate between high and low brine level conditions.

2.3.2 Aboveground Vaulted Storage Tanks

****

All aboveground storage tanks require leak detection. This leak detection can be:

Visual - such as a dedicated indicator on a vaulted tank.

Manual - such as a manual access port used to stick the interstice.

Electronic - such as an electronic capacitance type, or similar.

NOTE: Provide electronic and/or visual interstitial monitoring if required by the Using Agency. Interstitial monitoring for aboveground tanks is not required.

As mentioned previously, this specification does not address the monitoring of tank bottoms for field-fabricated, vertical storage tanks. For these type applications refer to Standard Design AW 78-24-27 ABOVEGROUND VERTICAL STEEL TANKS W/FLOATING PANS AND FIXED ROOFS.

****

Furnish system that continuously and automatically monitors the interstitial space of a vaulted tank for breaches in the integrity of the primary tank and the exterior vaulted shell. Provide a manual access port that can be used to stick the interstice. In addition, provide either (1) a visual method that can automatically monitor the interstitial space such as a Pop-Up gauge, or (2) an electronic method such as an electronic capacitance type liquid sensor.

2.3.3 Underground Piping associated with tanks less than or equal to 50,000 gallons

****

NOTE: This section addresses the leak detection requirements associated with underground fuel pipes (both pressurized and suction) that are regulated by 40 CFR 280 and 40 CFR 281.

For pipes associated with tanks less than or equal to 50,000 gallons in capacity that are not part of an airport hydrant system, the following is required per 40 CFR 280 Subpart D:

Pressurized and suction piping must be double walled with interstitial monitoring - include CONTAINMENT SUMPS paragraph.

Pressurized piping must be equipped with an automatic line leak detection system - include paragraph from this UNDERGROUND PIPING section.

The use of integrally installed liquid and/or vapor sensors installed within the interstitial space of double-walled piping is discouraged and is not covered in this specification.

For UST systems with field-constructed tanks and airport hydrant fuel distribution systems, 40 CFR 280 Subpart K allows for alternative leak detection strategies. The specification writer must delineate leak detection system requirements for such systems under the COMPUTATIONAL PIPELINE MONITORING SYSTEM paragraph, and design a system that meets the Subpart K regulatory required leak rate. In order to do so the specification writer must consider pipe segment volumes, in conjunction with the specified achievable leak detection rate of the equipment.

****

Provide Leak Detection System associated with tanks less than or equal to 50,000 gallons that continuously and automatically monitors for piping leaks using an automatic line leak detector. Detect a minimum leak rate of 0.003 L/s 3 gallons per hour at 69 kPa 10 psig line pressure within 1 hour. Detect leaks against a minimum 1.8 m 6 feet of head pressure. Detect leaks from any portion of the underground product piping.

2.3.4 Containment Sumps

****

NOTE: Provide leak detection system on sumps if required by the approved SPCC plan and/or local regulatory requirements. Sumps may used in various locations (e.g., low drain points, high vent points, aboveground to belowground piping transitions, underneath fuel dispensers, above UST manways, etc.).

Within each sump, require liquid sensors to be installed to monitor for the influx of liquids (fuel or water). Where double-wall piping is used for the fuel distribution, slope the piping appropriately from sump to sump in order to assure immediate notification of any piping failure.

****

Provide Leak Detection System on sumps that continuously and automatically monitors each containment sump [and dispenser sump] with an electronic capacitance type liquid sensor. Furnish sensor that detects liquids within a minimum of 25 mm 1 inch above a sump's bottom. The leak detection system must be capable of triggering shutdown of the submersible turbine pump or the dispenser pump.

2.3.5 Monitoring Wells

****

NOTE: For wells where groundwater could possibly come in contact with the sensor being used, specify

a hydrocarbon/groundwater type sensor. For locations where groundwater is not a concern, specify a vapor type sensor.
****

Continuously and automatically monitor each monitoring well with a [hydrocarbon/groundwater] [vapor] sensor. [Hydrocarbon/groundwater sensor must distinguish the difference between hydrocarbons and water while totally immersed in groundwater. Sense when the groundwater level has reached a minimum definable setpoint.] [Provide vapor sensor to detect vapors of the fuel to be handled as well as sense the presence of liquid.]

2.4 ELECTRONIC MONITORING/ALARM PANEL FOR PIPELINES ASSOCIATED WITH TANKS GREATER THAN 50,000 GALLONS

****
NOTE: Use a single panel to monitor all applicable sensors and detectors if possible. Delete any of the items of this paragraph that are not applicable.
****

Perform continuous integrity checks on the status of each sensor's connections and wiring. Include a battery backup (rechargeable) that can operate the complete leak detection system during a power failure for a minimum period of 48 hours. Submit shop drawings of the panel layout along with panel mounting and support details. Provide panel that is compatible with and connected to the following:

a. Tank interstitial sensors and detectors.

b. Sump sensors and detectors.

c. Automatic line leak detectors.

d. Monitoring well sensors and detectors.

e. Digital tank gauge system as defined in Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.4.1 Panel Housing

****
NOTE: Panels located outdoors require NEMA 4 enclosures. Panels located indoors only require a standard industrial enclosure. Explosion-proof enclosures are currently unavailable.
****

Provide panel housing that is a [NEMA 4 rated enclosure in accordance with NEMA 250] [standard industrial enclosure]. Provide panel housing consisting of a hinged door to swing left or right (doors must not swing up or down).

2.4.2 Panel Alarms

****
NOTE: Delete any of the items of this paragraph that are not applicable.
****

Account for the effects of thermal expansion or contraction of the fuel product, vapor pockets, tank or piping deformation, evaporation or condensation, as well as groundwater levels (if applicable) prior to initiating an alarm condition. Panel must produce an audible and visual alarm in the event any of the following occur.

a. Sensing of a hydrocarbon liquid from a sensor or detector.

b. Sensing of a hydrocarbon vapor from a sensor or detector.

c. Sensing of water from a sensor or detector.

d. Failure of an automatic line leak test.

e. Loss of pressure in positively pressurized tank interstitial.

f. Sensing a high or low liquid level in liquid-filled tank interstitial.

g. Sensing minimum groundwater setpoint.

h. Failure of any integrity check.

i. Sensing tank high, high-high, or low level alarm conditions.

2.4.2.1 Audible Alarm

****

NOTE: If speakers external to the panel are necessary, indicate their location on the drawings.

****

Panel must have [internal] [external] speakers that produce a buzzer sound of [70] [_____] decibels or greater in the event of a detected alarm condition. The audible alarm must be located in an area easily heard [in the control room] [near the dispensers] [near the pumps] in the event of an alarm condition.

2.4.2.2 Visual Alarm

Provide a visual alarm that illuminates in the event of a detected alarm condition. Include either individual lights for each alarm condition or include a single light and a liquid crystal display (LCD) panel that displaces information regarding each alarm condition. The visual alarm must be located in an area where it can be seen [in the control room] [near the dispensers] [near the pumps] when illuminated in the event of an alarm condition.

2.4.3 Acknowledge Switch

Provide panel with a manual acknowledge switch that will deactivate the audible alarm. Do not deactivate subsequent audible alarms unless depressed manually again for each occurrence. Do not extinguish the visual alarms until the alarm condition has been corrected. Switches must be an integral component located on the front panel and be either a key switch or push button.

2.5 COMPUTATIONAL PIPELINE MONITORING SYSTEM

****

NOTE: EPA established minimum detectable leak rates for UST systems with field-constructed tanks and airport hydrant systems in 40 CFR 280 Subpart K. Specification writer must consider pipe segment volumes, in conjunction with the specified achievable leak detection rate of the equipment, in order to design a system that meets the regulatory required leak rate. Additional applicable requirements for large fuel distribution applications are in 49 CFR 195.

Pipeline systems must be designed so that they can meet the regulatory required minimum detectable leak rates in 40 CFR 280 Subpart K. This means the designer must consider pipe segment volumes in coordination with available leak detection equipment, and must install proper isolation valves, high point vents / low point drains, and pressure relief valves. The install of a permanent leak detection system versus the use of portable vendor equipment to conduct leak detection tests is at the discretion of the Using Agency. The designer should consider the life cycle cost of a permanent installed leak detection system versus the cost of testing systems using portable vendor provided equipment, in order to determine if the installation of a permanent system makes sense. The use of portable vendor provided equipment is often cheaper.

CPM system can be permanently mounted or can be configured to be portable. For permanently mounted systems, indicated the location of the system on the drawings. For portable systems, indicate the piping connection point(s) on the drawings.

****

Provide CPM system conforming to API RP 1130. Detect leaks as small as 0.004 percent of the pipeline volume within 1 hour. Account for thermal effects on the piping and fuel. System must be compatible with the fuel to be handled. [Permanently mount system where indicated.][Provide as a complete, portable system.]

2.6 FINISHES

2.6.1 Factory Coating

****

NOTE: For all Navy projects (regardless of location), the 500 hour salt spray test is required and must be specified.

For Army projects, a salt spray test is optional. The 125 hour test is suggested for mild or noncorrosive environments. The 500 hour test is suggested for extremely corrosive environments.

****

Unless otherwise specified, provide equipment and components fabricated from ferrous metal with the manufacturer's standard factory finish.[Each factory finish must be capable of withstanding [125][500] hours exposure to the salt spray test specified in ASTM B117. For test acceptance, the test specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark immediately after completion of the test.] For equipment and component surfaces subject to temperatures above 50 degrees C 120 degrees F, appropriately design the factory coating for the temperature service.

2.6.2 Field Painting

Field paint surfaces not otherwise specified as specified in [Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES][Section 09 90 00 PAINTING, GENERAL]. Do not paint stainless steel and aluminum surfaces. Do not coat equipment or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: During design, layout equipment and components to allow adequate access for routine maintenance. Do not rely solely on the Contractor to make these judgments. Show access doors where applicable for maintenance.

****

Install parts requiring periodic inspection, operation, maintenance, and repair in locations that allow ready access. Install leak detection system and components in accordance with manufacturer's installation instructions.

3.1.1 Storage Tank Sensors/Detectors

Install interstitial tank sensors and detectors at the tank's low end. Install sensors in accordance with the tank manufacturer's recommendations and do not compromise the tank's secondary containment in any manner. Provide sensors that are easily removed from a tank. Connect metal conduit to steel tanks with dielectric fittings.

3.1.2 Automatic Line Leak Detector

Install detector on discharge side of each submersible pump in accordance with the pump and detector manufacturer's recommendations.

3.1.3 Sensors in Sumps

Install sensors in the low point of a sump in accordance with sump and sensor manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

3.2.1 Leak Detection System Test

Activate and test the entire leak detection system in accordance with manufacturer's testing procedures. Use the electronic monitoring/alarm panel to record and present the results.

3.2.2 Storage Tank Tightness Tests

For tanks less than or equal to 50,000 gallons, storage tank tightness tests must be performed in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Use the electronic monitoring/alarm panel to record and present the results.

For tanks greater than 50,000 gallons, storage tank tightness test must be performed with a system that is certified to be able to detect leaks at no more than 0.5 gallons per hour.

3.2.3 Tank Fill Tests

Perform high liquid level alarm tests on storage tanks in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Use the electronic monitoring/alarm panel to record and present the results.

3.3 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the equipment/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/equipment/systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of [_____] hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 01 50.55 (February 2021)**

Preparing Activity: NAVFAC

Superseding
UFGS-33 01 50.60 (November 2018)
UFGS-33 65 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 33 01 50.55

CLEANING OF PETROLEUM STORAGE TANKS

02/21

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-33 01 50.55 (February 2021)**

Preparing Activity: NAVFAC **Superseding**
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References are in agreement with UMRL dated January 2025

****

SECTION 33 01 50.55

CLEANING OF PETROLEUM STORAGE TANKS

02/21

****

NOTE: This guide specification covers the requirements for clean-up of the interior of concrete or steel tanks used for petroleum storage.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The following information must be shown on the project drawings:

1. Site plan of project area showing surrounding area with tanks and other construction which affect safety distances from the tank to be cleaned.

2. Plan and elevation of tank to be cleaned with associated piping and appurtenances.

****

PART 1   GENERAL

1.1   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 500	(2012; Errata 2014) Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division and Division 2
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 2027	(2002; R 2012; 3rd Ed) Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service
API RP 2207	(2017; 7th Ed) Preparing Tank Bottoms for Hot Work
API Std 521	(2014; 6th Ed) Pressure-relieving and Depressuring Systems
API Std 2015	(2018) Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.48	(2015) Line Blanks

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 306	(2024) Standard for the Control of Gas Hazards on Vessels
NFPA 326	(2015) Standard for Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 99-109	(Latest) Certified Equipment List

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-22262	(1993; Rev B; Am 1 1994; Am 2 1996; Notice 1 2021) Abrasive Blasting Media Ship Hull Blast Cleaning
MIL-PRF-680	(2010; Rev C; Notice 1 2015) Degreasing Solvent

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS O-D-1276	(Rev B; Notice 1) Disinfectant-Detergent, General Purpose (Pine Oil)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.146	Permit-required Confined Spaces
29 CFR 1910.1025	Lead
29 CFR 1910.1028	Benzene
29 CFR 1910.1200	Hazard Communication
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts, and Mists
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste

40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities

UL SOLUTIONS (UL)

UL 844	(2012; Reprint Oct 2021) UL Standard for Safety Luminaires for Use in Hazardous (Classified) Locations

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Cleaning Agents

Abrasive for Blasting

Gasoline-Oil-Resisting Rubber Gloves and Boots

Cotton Coveralls and Hard Hat

Respiratory Protective Equipment

Disinfectant

SD-06 Test Reports

Blasting Abrasive Test

Tank Contents Tests

Cleaning Test Panel Results

Monitoring Results; G, [_____]

SD-07 Certificates

Qualifications of Marine Chemist

Qualifications of Certified Industrial Hygienist (CIH)

Testing Laboratory

Safety Plan

Training Certification

Work Plan

Hazardous Waste Disposal Plan

Tank Certification of Safety

Tank Exhaust Blower

Respiratory Protective Equipment

Breathing-Air Supply Source

Combustible Gas Indicator

[Lead-In-Air Analyzer

][Hydrogen-Sulfide (H2S) Indicator

][Benzene Indicator

] Oxygen Meter

Velometers

Lighting

First Aid Kit

[Plan for Pretreatment of Discharge to Sewer; G, [_____]

] Tank Exhaust Blower

SD-08 Manufacturer's Instructions

Tank Cleaning Agents

SD-11 Closeout Submittals

****

NOTE: Delete if hazardous waste is to be disposed of by the Government. Designer must verify that Government disposal is practical and make all arrangements for Government disposal.

****

Safety Permits

1.3 DEFINITIONS

1.3.1 Certified Industrial Hygienist (CIH)

As used in this section, refers to an Industrial Hygienist employed by the Contractor and is certified by the American Board of Industrial Hygiene in comprehensive practice.

1.3.2 Marine Chemist

The holder of a valid Certificate issued by the National Fire Protection Association in accordance with the "Rules for Certification of Marine Chemists," establishing him as a person qualified to determine whether construction, alteration, repair, or shipbreaking of vessels, which may involve hazards covered by NFPA 306 can be undertaken with safety.

1.3.3 Hazardous Areas

Hazardous areas must be defined as any area within 30 meters 100 feet of active aboveground storage tanks, areas within 30 meters 100 feet of leaking sections of fuel pipelines or other vapor sources, areas within 60 meters 200 feet of the downwind side of potential vapor emission sources (i.e., pressure-vacuum vents or open vents on active tanks, leaking sections of pipelines), areas within existing tanks, and areas within a dike.

1.3.4 Hot Work Operations

Hot work, for work covered by this section, includes: flame heating, welding, torch cutting, brazing, carbon arc gouging, or any work which produces heat, by any means, of 200 degrees C 400 degrees F or more; or in the presence of flammables or flammable atmospheres, other ignition sources such as spark or arc producing tools (except steel hand tools) or equipment, static discharges, friction, impact, open flames or embers, nonexplosion-proof lights, fixtures, motors or equipment. Prepare tank bottoms for hot work in accordance with API RP 2207.

1.3.5 Personal Monitoring

****

NOTE: Consult with cognizant industrial hygienist regarding deletion if no lead hazard is present in tanks.

****

Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with 29 CFR 1910.1025. Samples must be representative of the employee's work tasks. Breathing zone must be considered an area within a hemisphere, forward of the shoulders, with a radius of 150 to 225 mm 6 to 9 inches and the center at the nose or mouth of an employee.

1.3.6 Reproductive Hazard

A reproductive hazard is defined as any occupational stressor (biological, chemical, or physical) that has the potential to adversely affect the human reproductive process. For example, it is well known that central nervous system problems often occur in the offspring of mothers exposed to organic mercury during pregnancy. Therefore, based on the example cited, organic mercury can be classified as a reproductive stressor. Many reproductive hazards also cause other adverse health effects; for example, ethylene oxide is also known to be a carcinogen (i.e., produces cancer). Certain reproductive stressors can also have adverse effects on the male reproductive system. (If requested by the Contractor, the Contracting Officer will make available the Navy's standard on reproductive hazards.)

1.3.7 Flammable Liquid

Any liquid having a flash point below 38 degrees C 100 degrees F and a vapor pressure not exceeding 275 kPa 40 psia at 38 degrees C 100 degrees F.

1.3.8 Combustible Liquid

Any liquid having a flash point at or above 38 degrees C 100 degrees F.

1.4 QUALIFICATIONS

a. To Be Considered Qualified: Show proof of having completed work on three previous projects.

b. See certificate requirements for personnel as specified in paragraph CERTIFICATES.

1.5 QUALITY ASSURANCE

1.5.1 Modification of References

****
NOTE: Delete brackets and words within brackets if there is no leaded fuel in any tank.
****

Except as modified herein, the work must conform with the recommendations of NFPA 326, API RP 500, API RP 2003, and API Std 2015. Where the word "should" appears in these publications, substitute "must."

1.5.2 Copies of Standards

****
NOTE: Delete brackets and words within brackets if there is no leaded fuel in any tank.
****

Furnish four copies of NFPA 326, API RP 500, API RP 2003, and API Std 2015.

1.5.3 Safety Permits and Equipment

Acquire safety permits (specified by the facility safety authorities) and necessary safety equipment.

1.5.4 Regulatory Requirements

a. Obtain permits required to comply with local, State, and Federal regulations.

b. Submit copies of permits required to comply with local, State, and Federal regulations.

c. Hazardous wastes, such as water, sediment, and sludge, must be packaged, labeled, stored, transported, treated and disposed of in accordance with 40 CFR 260 through 40 CFR 266 and State and local regulations. Transporters, sorters, treaters and disposers must be certified and have EPA ID numbers. Payment for disposal of hazardous waste will not be made until a completed hazardous waste manifest from the treatment or disposal facility is returned, and a copy furnished to the Government.[Deliver hazardous waste to the Government for disposal[as directed by the Contracting Officer].]

1.5.5 Medical Examinations

****
NOTE: Delete if there is no lead hazard.
****

Before exposure to lead-contaminated fuel tank and at the completion of the work, provide workers with a comprehensive medical examination as required by 29 CFR 1910.1025 and 29 CFR 1910.1200. The initial examination will not be required if adequate records show that employees have been examined as required by 29 CFR 1910.1025 within the last year and the blood lead levels did not exceed 30 micrograms per 100 grams of whole blood.

1.5.6 Medical Records

****
NOTE: Delete if there is no lead hazard.
****

Maintain complete and accurate medical records of employees for a period of at least 40-years or for the duration of employment plus 20-years, whichever is longer.

1.5.7 CIH Responsibilities

a. Certify training.

b. Review and approve safety plans and work plan for conformance to the applicable referenced standards.

c. Inspect tank cleaning work for conformance with the approved safety and work plans.

d. Direct monitoring.

e. Ensure work is performed in strict accordance with specifications at all times.

f. Ensure hazardous exposure to personnel and to the environment are adequately controlled at all times.

1.5.8 Training

****
NOTE: Delete 29 CFR 1910.1025 if there is no lead hazard.
****

Train each employee performing tank cleaning, waste disposal, and air sampling operations prior to the time of initial job assignment, in accordance with API Std 2015, 29 CFR 1910.120, 29 CFR 1910.134, [29 CFR 1910.1025,] and 29 CFR 1910.1200. The training must also include counseling of each employee on reproductive hazards involved in the work.

[1.5.9 Respiratory Protection Program

****
NOTE: Delete if there is no lead hazard.
****

a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every 6 months thereafter as required by 29 CFR 1910.1025 where lead exposure is involved. Fit testing is not required for positive pressure respirators.

b. Establish and implement a respiratory protection program as required by 29 CFR 1910.134, and 29 CFR 1926.55. Also comply with 29 CFR 1910.1025 when exposure to lead is involved.

]1.5.10 Pre-Construction Conference

Along with the CIH, marine chemist, or gas-free engineer, meet with the Contracting Officer to discuss in detail the tank cleaning work plan, including work procedures and precautions for the work plan.

1.5.11 Certificates

Submit certificates for the items listed. Where equipment or materials are specified to conform with the standards of organizations, such as National Institute for Occupational Safety and Health (NIOSH), Underwriters Laboratories (UL), and American Petroleum Institute (API), include a label or listing indicating compliance. In lieu of the label or listing, the Contractor may submit a test report from an approved testing organization stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms with the organization's standard or code.

1.5.11.1 Qualifications of Marine Chemist

Submit name, address, and telephone number of the marine chemist selected to perform the required duties. Submit documentation that the marine chemist is certified by the National Fire Protection Association, including the certificate number and date of certification or recertification. The NFPA certification will be acceptable for non-ship work on this contract. Refer to NFPA 306 to determine when a marine chemist is required, how a marine certificate is issued and maintained, and what to expect during an inspection.

1.5.11.2 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, and telephone number of the CIH selected to perform responsibilities in paragraph CIH RESPONSIBILITIES. Provide previous experience of the CIH. Submit proper documentation that the Industrial Hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. The CIH must be familiar with the hazards involved in fuel systems work.

1.5.11.3 Testing Laboratory

Submit the name, address, and telephone number of the testing laboratory selected to perform the monitoring, testing, and reporting of airborne concentrations of lead and other contaminants. Provide proper documentation that persons performing the analysis have been judged proficient by successful participation within the last year in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) Program. The laboratory must be accredited by the American Industrial Hygiene Association (AIHA). Provide AIHA documentation along with date of accreditation/reaccreditation.

1.5.11.4 Safety Plan

Submit a safety plan within 45 calendar days after contract award and 30-days prior to commencing work. [The safety program must be reviewed and approved by the safety/health officer of the facility.] The safety plan must meet requirements of EM 385-1-1, OSHA, and address the following:

a. Identification and evaluation of the hazards and risks associated with each site being studied, including reproductive hazards and precautionary measures to be followed by workers for all hazards.

b. Names and qualifications of each Contractor's representative in charge of the work and present at the job site when tank cleaning and repair work will be performed.

c. Identification of supervisory personnel and alternates responsible for site safety/response operations.

d. Determination of levels of personal protection to be worn for various site operations.

e. List of equipment with adequate nomenclature by item, that will be used at the job site and the date and location where this equipment can be inspected by the Contracting Officer.

f. Establishment of work zones (exclusion area, contamination area, and support area).

g. Establishment of a tank entry and work permit program in accordance with 29 CFR 1910.146, EM 385-1-1, and NFPA 326.

h. Establishment of decontamination methods and procedures.

i. Determination of the number of people required to enter the contamination zones during the initial entries and subsequent operations.

j. Establishment of emergency procedures, such as: escape routes, fire protection, signals for withdrawing work parties from site, emergency communications, wind indicators, including Navy notification.

k. Identification and arrangements with nearest medical facility for emergency medical care for both routine-type injuries and toxicological problems. Submit name, location, and telephone number of this medical facility.

l. Establishment of continual air and personnel monitoring procedures.

m. Establishment of procedures for obtaining and handling potentially contaminated samples.

n. Identification of medical monitoring program, including respirator medical qualification examination for each individual at the work site.

o. Identification of training plan to be instituted, including contents of 29 CFR 1910.1200 and 29 CFR 1910.134; its training contents; and instructor with appropriate training certification. Training plan must also include counseling to each employee on reproductive hazards.

p. Establishment of a respiratory protection program conforming to 29 CFR 1910.134.

q. Establishment of a hazard communication program (29 CFR 1910.1200).

1.5.11.5 Work Plan

****

NOTE: Data for these paragraphs should be obtained from the Commanding Officer of the individual Naval facility having tanks for cleaning.

****

The shut down or interruption to normal operations or traffic must be listed on the progress schedule and submitted [to the Contracting Officer].

****

NOTE: Delete if there is no hazardous waste in the project. Edit if hazardous waste is to be disposed of by the Government. Designer must verify that Government disposal is practical and make all arrangements for Government disposal.

****

1.5.11.6 Hazardous Waste Disposal Plan

Prepare a Hazardous Waste Disposal Plan and submit within [45] [_____] calendar days after contract award for approval by the Contracting Officer, or if there are no hazardous wastes indicated by Government tests, submit the plan [21] [_____] days after the Contractor's tests indicate hazardous wastes. The Hazardous Waste Disposal Plan must comply with applicable requirements of Federal, State, and local hazardous waste regulations and must address the following:

a. Identification of hazardous wastes associated with the work, including a sampling and testing plan for each waste stream, the purpose of each test, and the rationale for evaluating the test results. Indicate the representative sampling and specific testing methods, number of samples, and the name and qualifications of the testing laboratory.

b. Estimated quantities of wastes to be disposed in the cleaning of each tank and a description of arrangements made for storage and disposal.

c. Names and qualifications of each Contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and a 24-hour point of contact. Furnish two copies of [EPA] [State] [and] [local] hazardous waste [permit applications] [permits] [and] [EPA Identification numbers].

d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.

e. List of waste handling equipment to be used in performing the work, to include cleaning, treatment, volume reduction, and transport equipment.

f. Spill prevention, containment, and cleanup contingency measures to be implemented.

g. Work plan and schedule for waste removal and disposal.

h. Cost for hazardous waste disposal according to this plan.

1.5.11.7 Tank Certification of Safety

****

NOTE: Designer must select either Marine Chemist or CIH.

****

Submit certification, in accordance with NFPA 326, from [an NFPA certified "Marine Chemist"] [a CIH] stating that tank is safe for hot work and that special precautionary measures have been taken for workers to enter the tank to perform the work.

1.5.11.8 Training Certification

****

NOTE: Delete words in bracket if there is no leaded gasoline hazard.

****

Submit certifications signed and dated by the CIH specified in the testing plan and by each employee stating that the employee has received training on work practices and received counseling on and fully understands the reproductive hazards involved with lead and toluene exposure and the work.

1.5.11.9 Hazardous Waste Permits

Submit copies of [EPA] [State] [and] [local] hazardous waste [permit applications] [permits] [and] [EPA Identification numbers] of the transporter, treatment, storage and disposal facility that will be accepting hazardous waste. Include the facility location and a 24-hour point of contact.

1.5.11.10 Non-Hazardous Waste Permits

Submit [EPA] [State] [local] permits for disposal site for non-hazardous residues and wastes.

1.5.12 Test Results

1.5.12.1 Required Test Reports

Submit test results required by MIL-A-22262, for blasting abrasive. Submit contractor's independent tests of tank contents (water, sediment, and sludge). Submit tank cleaning test panel results, including water pressure and temperature and nozzle distances used during tank washing procedure.

1.5.12.2 Air Monitoring

Submit monitoring results to the Contracting Officer within 2 working days after the samples are taken, signed by the testing laboratory employee performing the air monitoring, the employee that analyzed the sample, and the CIH.

1.6 DELIVERY AND STORAGE

Deliver equipment and materials to the site in an undamaged condition bearing the manufacturer's name and brand designation. Store equipment and materials off the ground to provide proper ventilation, drainage, and protection against dampness. Replace defective and damaged equipment and materials.

1.7 JOB CONDITIONS

1.7.1 Ventilation

Maintain a vapor-free condition throughout the course of the work inside the tank. The air movers must be non-sparking, explosion-proof, electrically operated or air-driven exhaust type. A rate of one air change per hour must be the lowest acceptable rate, for tanks under 3600 kL 30,000 BBL. For tanks greater than 3600 kL 30,000 BBL, use 4700 L/s 10,000 cfm. Air movers must be kept in operation whenever workers are in the tanks; except the air movers must be shut down 15 minutes before taking tests.

1.8 SCHEDULING AND SEQUENCING

1.8.1 Sequence of Primary Phases of the Cleaning Procedure

a. Planning the operations

b. Preparation for cleaning

c. Vapor-freeing of the tank

d. Cleaning the tank

e. Clean-up, residue disposal, inspection, and acceptance.

1.8.2 General Scheduling

Complete the work specified in this section before any other work in the tank is started. The work includes the complete interior cleaning of the storage tanks.

PART 2 PRODUCTS

2.1 MATERIALS

Submit identification for the items by designated name, specification number, project contracting number, and intended use. Submit Safety Data Sheets for materials to be used at the job site, in accordance with 29 CFR 1910.1200.

2.1.1 Cleaning Agents

****

NOTE: Coordinate listing of cleaning agents with paragraph WASHING on cleaning method.

****

a. Detergent: FS O-D-1276.

b. Solvent: MIL-PRF-680, Type II, minimum flashpoint of 60 degrees C 140 degrees F.

c. Approved commercial cleaning agent.

2.1.2 Abrasive

2.1.2.1 Abrasive for Blasting

Provide sharp, washed, salt-free [, angular] abrasive material, free from feldspar and other constituents that tend to break down and remain on the surface. Abrasive must not contain magnetic materials and must conform to MIL-A-22262, [except that Mohs' hardness must be 7 to 9] [and [_____]].

2.1.2.2 Recycled Abrasive

Screen and air wash abrasive that is recycled at the job site, to remove dirt and fines. Add new abrasive so that the combined new and recycled abrasive mixture meets specified abrasive requirements for chemical composition, moisture, friability, silica, anchor pattern and oil content. Do not recycle abrasive which has picked up toxic or hazardous material. Do not recycle nickel slag.

2.2 EQUIPMENT

Furnish necessary clothing and equipment for the work and protection of people entering the tank. Electrical equipment and wiring must be in accordance with NFPA 70, Class 1, Group D, Division 1. Provide any item or items for the protection of these people including but not limited to the following:

a. Gasoline-Oil-Resisting Rubber Gloves and Boots: Gauntlet type and conductive type respectively (acid-proof rubber is an acceptable material); furnished for each person entering or working inside the tank or handling sludge materials on the exterior of the tank, plus one extra pair each for emergency use.

b. Cotton Coveralls and Hard Hat: Light colored; one change per person per day, and an adequate supply of chemical-resistant disposable coveralls to be worn over cotton coveralls.

c. Respiratory Protection: Provide one of the following types of NIOSH-approved respiratory protective equipment for each person working inside the tank, plus one extra for emergency use. NIOSH 99-109 listing constitutes NIOSH approval.

    (1) Self-contained breathing apparatus with a full facepiece operated in a positive pressure mode.

    (2) A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in a positive pressure mode and an auxiliary positive pressure self-contained breathing apparatus.[Provide and use two-way communication equipment when cleaning underground tanks [larger than 190 kL 50,000 gallons capacity] [or] [where manhole accesses are deeper than 3 meters 10 feet from the working level].]

    (3) The CIH may specify airline (Type C) respirator in place of those specified above; however, the decision must be based on the results of personal monitoring.

    (4) Use Type CE respirator for abrasive blasting inside the tank.

    (5) CIH must specify respiratory protection if required for personnel

handling sludge material outside of the tank.

d. Safety Harness: For each person working inside tank, plus one extra for outside the tank.

e. 13 mm 1/2-inch Diameter Life Rope of Required Length: For each person working inside the tank.

f. Breathing-Air Supply Source: 29 CFR 1910.134.

g. Combustible Gas Indicator [,Lead-in-Air Analyzer] [, Hydrogen-Sulfide (H2S) Indicator] [, Benzene Indicator] and Oxygen Meter. [Recommend a portable gas chromatograph or other more accurate instrument for the benzene indicator.]

h. Shovels, Buckets, Brooms, Wrenches, Scrapers, Squeegees, Wire Brushes, Scrub-Brushes, Ladders, Staging, and Other Tools: Do not use brooms or brushes that have plastic or synthetic bristles.

i. Lighting: UL 844, explosion-proof, minimum 540 lx 50 footcandle, floodlight type, or Mining Enforcement and Safety Administration (MESA) approved, explosion-proof, portable battery-powered light.

j. Air Movers for Tank Ventilation: Explosion proof electrically operated or air driven. Nonferrous fan blades. Use velometers for measuring velocity.

k. Disinfectant for Cleaning Face Masks: Cleaner-sanitizer for cleaning and disinfecting respirator facepieces as specified in 29 CFR 1910.134, Appendix B-2.

l. Soap for Personnel Washing: Non-phosphate type.

m. A.B.C. Fire Extinguishers: UL listed 2A: 40B: C, 2A: 20B: C, or 4A: 30B: C; minimum 7 kg 15 pound capacity.

n. First Aid Kit: One 16-unit kit for each 25 persons.

PART 3 EXECUTION

3.1 PREPARATION FOR ENTRY

Prepare the tank for entry in accordance with NFPA 326. Isolate from sources of energy. Ensure vapors have been controlled or removed. Identify potential hazards and apply control measures to mitigate the hazards. Test and monitor atmospheric conditions to ensure conditions of the Marine Chemist Certificate safety designations have been met.

3.1.1 Isolation From Piping

For tank cleaning prior to out-of-service inspection and minor cold repairs, close the double block and bleed isolation valves and remove the body cavity plugs from the valves. Monitor the body cavity for fuel and maintain the valves in this condition for the duration of the cleaning, inspection, or minor cold repairs, not to exceed one month. Secure the valves in the closed position with mechanical means. Perform lockout tagout procedures on the valves.

For ordinary cleaning prior to out-of-service inspection and hot work or when nozzles are not equipped with double block and bleed valves, or for outages lasting longer than one month, disconnect piping connected to the tank. Provide a solid-plate line blank between two flanges near the tank in accordance with ASME B16.48, or remove a valve or piece of pipe and provide a blind flange compliant with ASME B16.5 to isolate tank.[For underground tanks where connected pipelines are buried, blind off the pipelines at the nearest valve box.] Isolation means must be of sufficient strength to withstand pressure which might be exerted by the product being blanked off, and must be gasketed on both sides if blind flange is inserted between two flanges. Do not disconnect piping or valves until it is certain the line has been defueled.

Isolate all piping connected to the tank. Perform lockout tagout procedures on any valve remaining connected to the tank.

3.1.1.1 Thermal Relief

Evaluate thermal relief capability on active facility piping isolated from the tank. Should isolation means result in a segment of active piping unprotected from thermal overpressure, provide temporary means consistent with API Std 521 to relieve the overpressure. Consult with operators to determine existing relief pressures and set temporary relief means to ensure overpressure does not occur.

3.1.2 Lockout Tagout

Perform lockout tagout on all electrical circuits and sources of energy to the tank in accordance with EM 385-1-1 and NFPA 326.

3.1.3 Removal of Ignition Sources

Remove sources of ignition from the cleaning area. Do not permit ignition producing devices, including matches, lighters or cigarettes, within 30 m 100 feet upwind and 60 m 200 feet downwind of a tank, or inside the tank farm, or within the tank firewall, whichever is farther.

3.1.4 Survey of Hazardous Areas

Carefully survey the entire area around the tank to be cleaned to ensure that there are no vapors present in the pit, low places, or hazardous areas and that all unauthorized personnel are cleared from the area. Ensure that there is no possibility of anyone smoking in the immediate vicinity. Hazardous areas are defined as follows:

a. Interior of tanks.

b. Areas within 30 meters 100 feet from points having flammable vapor emissions which, for example, are from the exhaust manholes of tanks under repair, open vents or pressure vacuum vents (breather valves) of active tanks in the vicinity of tanks under repairs or cleaning. CAUTION: Allowance must be made for 4 or more miles per hour winds by increasing the size of the hazardous area to a minimum of 60 meters 200 feet on the downward side.

[c. For aboveground tanks, all areas within a common impoundment dike up to the height of the dike walls and within 3 meters 10 feet in all directions of the exterior surfaces of tank shell and roof.

]3.2 PROJECT CONDITIONS

3.2.1 Cutting Tank Access Holes

****

NOTE: Use for tanks without manholes that are going to be demolished. For tanks that are going to remain in service contact the Contracting Officer if the tanks do not have a manhole. It may be more cost effective to install a new tank than cut a manhole in the shell.

****

Tanks in this project may not have manholes.

3.2.2 Permission for Each Entry Into a Tank

Obtain written permission from the Contracting Officer prior to each entry into a tank. Permission will be granted only under the following conditions:

a. The Contractor's qualified supervisor is present.

b. The Contractor's personnel have been briefed by the supervisor on the procedure and role of each employee in the event of an emergency.

c. Required equipment is approved and properly located.

d. Personnel are properly equipped with properly fitted protective equipment and have received adequate training from a qualified instructor.

e. The entire area adjacent to the tank is secured.

f. A minimum of two persons outside and two or more persons inside of each tank are provided at all times during cleaning operations.

****

NOTE: Lead limit of 50 micrograms per cubic meter is consistent with 29 CFR 1910.1025.

****

g. Tank air is monitored and corrective action is taken to ensure that the vapor concentration is less than 10 percent of the lower flammable limit (LFL) [, lead-in-air is less than 50 micrograms per cubic meter] [, hydrogen sulfide is less than 10 ppm permissible exposure level (PEL)] [, benzene is less than one ppm PEL] and oxygen content is a minimum of 19.5 percent.

h. An NFPA certified "Marine Chemist" or CIH has certified that the tank is safe for hot work, and that the required special precautionary measures have been taken due to the potential health hazard to the worker that still exists, even when the vapor concentration is well below the LFL. The Contractor must be responsible for reviewing the record drawing(s) of the tank to be cleaned.

i. People entering the area leave smoking materials such as cigarettes and flame-producing devices at a previously determined location.

j. When work involves handling and disposal of hazardous waste, the Contractor has a copy of 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, and 40 CFR 266 in his possession.

k. Permit only personnel authorized in the safety plan within 100 feet of the tank perimeter.

3.2.3 Traffic Control

Direct traffic minimum 60 meters 200 feet away from the tank cleaning area. Set up road blocks and warning signs. Do not operate vehicles in hazardous areas.

3.2.4 Lavatory Facilities

****

NOTE: Obtain data for these paragraphs from the Commanding Officer of the individual Naval facility having tanks for cleaning.

****

****

NOTE: Delete brackets and words within brackets if there is no leaded fuel in any tank.

****

Arrange for lavatory and toilet facilities [and, in the case of tanks for leaded fuel, provide showers for bathing].

3.2.5 Miscellaneous

Ensure that the manufacturers have labeled containers holding products involving hazards in use or storage, in accordance with 29 CFR 1910.1200. Label containers used to store, transport, or dispose of hazardous waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, and 40 CFR 266 [and State Regulations]. Remove small objects of ferrous metal within the working areas to prevent the accidental striking of a spark. Place equipment upwind of tank openings at highest elevation possible; do not place in a spot lower than the surrounding terrain. Review drawings of the tank to be cleaned and brief workers on the location of pits, sumps, piping, or other tank appurtenances which could be hazardous to personnel. Provide floodlights to illuminate the work area without the need for battery operated handlights. Provide scaffolding, platforms, and ladders for secure, safe accessibility to tank surfaces. Install electrical equipment in accordance with API RP 500. Provide floodlights to illuminate the work area without the need for battery operated handlights. Do not use artificial lights inside tank until the tank is vapor-free.[Unless otherwise approved by the Contracting Officer, do not heat tanks during winter to provide personnel comfort or melt ice.]

3.2.5.1 Grounding and Bonding for Equipment

Provide grounding and bonding for equipment which may generate static electricity [, including air hose to sandblast nozzle]. Do not pass the air hose through an area where flammable vapors may exist.

3.2.5.2 Fire Extinguishers

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NOTE: Coordinate with the local fire department to determine the minimum quantities of fire extinguishers for each specific job.

****

Furnish [two] [_____] carbon-dioxide fire extinguishers of minimum 7 kg 15 pounds capacity each, in the immediate vicinity of the work. Provide a continuous fire watch. CAUTION: Do not discharge high pressure carbon dioxide extinguishers where explosive vapors exist since the discharge can cause a spark which will ignite the vapors.

3.2.5.3 Disconnection of Pipelines

For normal tank cleaning prior to out-of-service (internal) inspection and minor cold repairs, close the double block and bleed valves on the tank nozzles connected to piping and remove the body cavity plugs from the bottoms of the valves and bleed the valves for the duration of the cleaning, inspection or minor cold repairs. Perform lock-out/tag-out procedures on the valves.

For cleaning prior to hot work or when nozzles are not equipped with double block and bleed valves, or for extended outages lasting longer than one month, disconnect pipelines connected to the tank. Provide a solid-plate blind flange between two flanges near the tank, or remove a valve or piece of pipe and provide a blind flange to prevent flammable material from entering the tank.[For underground tanks where connected pipelines are buried, blind off the pipelines at the nearest valve box.] Blind flanges must be of sufficient strength to withstand pressure which might be exerted by the material being blanked off, and must be gasketed on both sides if blind flange is inserted between two flanges. CAUTION: Do not disconnect piping or valves until it is certain the line has been emptied of fuel.

3.2.5.4 Removal of Ignition Sources

Remove sources of ignition from the cleaning area. Do not permit ignition producing devices, including matches, lighters or cigarettes, within 30 meters 100 feet upwind and 60 meters 200 feet downwind of a tank, or inside the tank farm, or within the tank firewall, whichever is farther.

3.2.5.5 Survey of Hazardous Areas

Carefully survey the entire area around the tank to be cleaned to ensure that there are no vapors present in the pit, low places, or hazardous areas and that all unauthorized personnel are cleared from the area. Ensure that there is no possibility of anyone smoking in the immediate vicinity. Hazardous areas are defined as follows:

a. Interior of tanks.

b. Areas within 30 meters 100 feet from points having flammable vapor emissions which, for example, are from the exhaust manholes of tanks under repair, open vents or pressure vacuum vents (breather valves) of active tanks in the vicinity of tanks under repairs or cleaning. CAUTION: Allowance must be made for 6 or more km/h 4 or more miles per hour winds by increasing the size of the hazardous area to a minimum of 60 meters 200 feet on the downwind side.

[c. For aboveground tanks, all areas within a common impoundment dike up to the height of the dike walls and within 3 meters 10 feet in all directions of the exterior surfaces of tank shell and roof.

]3.2.5.6 Exit from a Tank During Emergencies

To permit quick, free exit from a tank during emergencies, keep the area around the tank openings and emergency routes clear of obstructions.

3.3 INSPECTION

3.3.1 Inspection of Equipment

3.3.1.1 Respirators

Respirator users must inspect their respirators in strict accordance with the instructions provided by the manufacturer.

3.3.1.2 Air Hose from Breathing-Air Supply

If air line respirators are used, ensure that:

a. There are no breaks in outside covering;

b. Condition of gaskets is good;

c. Connections are tight; and

d. There are no restrictions in the hose.

3.3.1.3 Safety Harness and Life Line

Ensure that:

a. There is no frayed or weak material; and

b. Condition of harness is good.

3.3.1.4 Breathing-Air Supply Source

Ensure:

a. Good working condition;

b. Location in vapor-free area;

c. Compliance with 29 CFR 1910.134 for breathing air quality, frequency of air analysis, and presence of safety devices; and

d. Backup air supply source.

3.3.1.5 Monitoring Equipment

Calibrate each day before use:

a. Combustible gas indicator

b. Oxygen meter

[c. H2S Indicator

][d. Lead-in-Air Analyzer

]3.3.1.6 Other Equipment

Ensure:

a. Proper grounding and bonding;

b. Explosion-proof motors; and

c. Explosion-proof lighting.

3.3.2 Personnel Inspection

3.3.2.1 Clothing

Personnel for Proper Attire Commensurate with Hazards Involved: Check for:

a. Clean clothing in good condition (wear freshly laundered clothing at the beginning of the job and at the start of each workday thereafter).

b. Boots and gloves of approved type and in good condition.

3.3.2.2 Breathing-Air Supply

If air line respirators are used, ensure that air is supplied to the facepiece at a rate of 2 to 7 L/s 4 to 15 cfm. If self-contained breathing apparatus are used, ensure sufficient number of full replacement cylinders are available to last the duration of the job.

3.3.2.3 Harness and Lifeline

Harness and lifeline must be in good condition and properly attached.

3.3.2.4 Gum or Tobacco Chewing

Ensure that gum or tobacco chewing is prohibited.

3.3.2.5 Physical Defects or Injuries

Ensure that people have no physical defects or injuries which may prevent their wearing respirators or which may cause rescue to be difficult. No beards, sideburns, or large mustaches will be allowed on people who must wear respirators.

3.3.2.6 Alcoholic Beverages and Drugs

Ensure that people entering the tank are not under the influence of alcoholic beverages and drugs.

3.3.2.7 Counseling on Reproductive Hazards

Ensure that all employees have been counseled on and fully understand the reproductive hazards related to work in contaminated areas or in leaded gasoline or chemically contaminated tanks since they may be seriously affected by organic lead compounds or other chemical contaminants.

3.3.2.8 Hazardous Areas

Check hazardous areas as defined in paragraph SURVEY OF HAZARDOUS AREAS.

3.4 TABLE OF TANK HISTORY

****

NOTE: Data for these paragraphs should be obtained from the Commanding Officer of the individual facility having tanks for cleaning.

****

Tank Number	Tank Location	Tank Capacity	Date Constructed	Type of Lining (If Applicable)	Type of Fuel	Remarks from the Last Inspection

3.5 FUEL REMOVAL

****

NOTE: Contact the fuel department of the nearest Naval Supply Center or Depot to determine if dirty residual fuel can be accepted by the Government for reclamation. If not reclaimed by the Government, consider the following. Depending on the amount of residual fuel remaining in the tank after pump down by the Government and the degree of fuel emulsification, the designer, in consultation with the activity, should decide on whether to require fuel/water separation under the scope of this Contract, dispose of the mixture as hazardous wastes if tests show presence of hazardous constituents, or use other options available to the Government.

****

All possible fuel will be pumped or otherwise removed from the tank by the Government. Consider remaining fuel contaminated or waste fuel; [pump into 55 gallon drums or other suitable containers for disposal in accordance with approved procedures meeting [host nation,] local, State, and Federal regulations] [provide oil/water separators for further recovery of fuels and turn over to the Government for use]. Dispose of remaining fuel emulsions in accordance with applicable [host nation,] local, State, and Federal regulations. Drums or tanks used for containerizing waste fuel will be furnished by the [Contractor] [Government]. Oil/water separator for fuel separation will be furnished by the [Contractor] [Government].

3.6 IDENTIFICATION OF TANKS WITH HAZARDOUS WASTE SLUDGES AND RESIDUES

****

NOTE: Information on the hazardous waste characteristics of the sludge in the tanks should be provided by the activity. If not, sampling and analysis must be conducted during the 0-35 percent design stage to properly define scope and costs.

****

The following [tank is][tanks are] known or suspected to contain hazardous wastes:

Tank No.	Product	Hazardous Waste, Status, Type and Basis-known [or suspect]
[1]	[MOGAS]	[Sludge and sandblast residue; ignitability and lead]

3.7 TANK CLEANING

For the interior of tanks [with floating roofs, the bottom and up the shell to the height of the floating roof][without floating roofs, the shell, bottom, columns, roof, rafters, and interior accessory system components such as pumps, piping, and ladders] must be cleaned [to bare metal][not to bare metal but only to the surface of sound lining or coating], free of rust, dirt, scale, loose material, fuel, oil, grease, sludge, and other deleterious substances.[Do not damage sound existing lining material. Remove unsound or loose lining or coating, and clean surfaces which became exposed to bare substrate.] Immediately notify the Contracting Officer if lining or coating is deteriorated or loose.[For tanks with floating roofs, provide general cleaning of the top of the roof by means such as sweeping or vacuuming.]

3.7.1 Monitoring

****

NOTE: Use for tanks with leaded gasoline hazard. Consult cognizant industrial hygienist regarding deletion if there is not leaded gasoline hazard.

****

Monitoring of airborne concentrations of lead must be in accordance with 29 CFR 1910.1025 of benzene in accordance with 29 CFR 1910.1028, and as specified herein. Air monitoring, testing, and reporting must be performed by a CIH or an Industrial Hygiene (IH) Technician who is under the direction of the CIH.

a. The CIH or the IH Technician under the direction of the CIH must be on the jobsite directing the monitoring, and inspecting the work to ensure that the requirements of the Contract have been satisfied during the entire operation.[The CIH must be located [_____] during the entire tank cleaning operation.]

b. Take personal air monitoring samples on employees who are anticipated to have the greatest risk of exposure as determined by the CIH. In addition, take air monitoring samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.

c. Submit results of air monitoring samples, signed by the CIH, within 2 working days after the air samples are taken. Notify the Contracting Officer immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area, and 0.5 ppm for benzene.

3.7.1.1 Monitoring During Tank Cleaning Work

Perform personal and area monitoring during the entire tank cleaning operation. Sufficient area monitoring must be conducted at the physical boundary to ensure unprotected personnel are not exposed above 30 micrograms per cubic meter of air for lead and 0.5 ppm for benzene at all times. If the outside boundary lead levels are at or exceed 30 micrograms per cubic meter of air or the benzene levels are at or exceed 0.5 ppm, work must be stopped and the CIH must immediately correct the condition(s) causing the increased levels and notify the Contracting Officer immediately. The CIH must review the sampling data collected on that day to determine if condition(s) requires any further change in work methods. Tank cleaning work must resume when approval is given by the CIH. The Contractor must control the lead level outside of the work boundary to less than 30 micrograms per cubic meter of air and the benzene levels to less than 0.5 ppm at all times. As a minimum, conduct area monitoring daily on each shift in which tank cleaning operations are performed in areas immediately adjacent to the control area. For outdoor operations, at least one sample on each shift must be taken on the downwind side of the control area. If adjacent areas are contaminated, clean and visually inspect contaminated areas. The CIH must certify that the area has been cleaned of contamination.

[3.7.2 Lead Hazard Personnel Safety

****

NOTE: Delete brackets and words within brackets if there is no leaded fuel in any tank.

****

Due to the lead hazard (inorganic and organic (TEL)) associated with this tank, comply with API Std 2015, and the applicable rules and regulations of the State of [Hawaii] [_____] and Federal Occupational Safety and Health Standards. If there is conflict among the API Publications, State, and Federal regulations; the most stringent criteria must apply. Ensure that the requirements for protective clothing and equipment, monitoring to determine exposure levels, and all other relevant controls are complied with. Ensure that employees are counseled on the reproductive hazards associated with lead.

][3.7.3 Precautions for Airborne Lead

****

NOTE: Delete brackets and words within brackets if there is no leaded fuel in any tank.

****

****

NOTE: The following paragraphs can be inserted into the appropriate section (demolition, tank coating, or repair/modifications) for follow on work to the tank.

****

Since the tank is a known lead hazard, the Contractor must, in accordance with API Std 2015, ensure that the workers inside the tank wear the appropriate protective clothing and respiratory equipment as prescribed by API Std 2015 for the duration of the tank cleaning. Use only the types of respirators specified for "Respiratory Protection" under paragraph EQUIPMENT. After completion of the cleaning operation, the Contractor has the option of allowing people to enter the tank without respiratory protective equipment, only after lead-in-air analysis has been obtained in accordance with API Std 2015.

]3.7.4 Water, Sediment, and Sludge Analysis

****

NOTE: All wastes must be tested prior to tank cleaning, by the Government and by the Contractor, regardless of the tank's past history as to the storage of leaded fuel.

Use this paragraph if the Government has already tested the water, sediment, and sludge. If at all possible, the Government must perform the necessary tests to determine if the wastes are hazardous or nonhazardous prior to bid. The Government test results should be presented in the Specification and used as a basis for bidding. This does not preclude independent testing required of the Contractor to verify the Government analysis. For Air Force projects, check latest Air Force requirements for handling of hazardous waste materials.

40 CFR Part 261 is the EPA criteria for hazardous waste. The concern with leaded fuel or any other lead product is the characteristic of toxicity. If the sample contains 5 mg/liter or more of lead, then the sample is considered a hazardous waste. The test method to determine the lead concentration is specifically defined in 40 CFR Part 261 and does not distinguish between inorganic and organic (TEL) lead. The dangers associated with organic lead (TEL) is related to personnel safety (its absorption into the human body through the skin or respiratory system) and is of no concern to EPA with regards to the handling and disposal of hazardous wastes. The EPA test measures the concentration of total lead which leaches out into solution. Lead in its pure or stable forms, such as lead weights, that does not leach out into the test solution, is not a hazardous waste.

The EPA has a test procedure called Toxicity Characteristic Leaching Procedure (TCLP). Changes may be required to specifications and cost estimates because of expanded testing requirements.

****

****

NOTE: When Government disposal of hazardous waste has been determined to be the most practical method of disposal, include the option for delivery of waste to the Government. Add details if necessary.

****

The water, sediment, and sludge remaining in the tank contain the following quantities of leachable metals as analyzed by the Government in accordance with 40 CFR 261.

a. Water: [_____]

b. Sediment: [_____]

c. Sludge: [_____]

The Government analysis indicates that the water, sediment, and sludge are [nonhazardous] [hazardous]. The Contractor will be responsible for independently testing the water, sediment, and sludge in accordance with 40 CFR 261 to verify the above. Submit laboratory reports to the Contracting Officer describing sampling and testing procedures used, test results, and findings. If the results differ such that the Contractor must handle the waste differently from the method specified, notify the Contracting Officer, and the Contractor will be subject to an equitable adjustment to the Contract under the Changes clause of the Contract Clauses. If the Contractor's tests determine that the water, sediment, and sludge are hazardous, then the hazardous wastes must be packaged, labeled, stored, transported, treated and disposed of in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, and 40 CFR 266. Transporters, storers, treaters and disposers must be certified and have EPA ID numbers. Payment for disposal of hazardous waste will not be made until a completed hazardous waste manifest from the treatment or disposal facility is returned, and a copy furnished to the Government.[Deliver hazardous waste to the Government for disposal [as directed by the Contracting Officer.] [_____.]] Nonhazardous or hazardous wastes must be handled and disposed of as described below.

3.7.5 Water Removal and Disposal

****

NOTE: The Government should estimate and indicate the quantity of water, sludge, sediment, and fuel, if any, remaining in the tank so that the Contractor can be more responsive in his bidding. Verify availability of Government disposal facilities.

****

****

NOTE: When Government disposal of hazardous waste has been determined to be the most practical method of disposal, include the option for delivery of waste to the Government. Add details if necessary.

****

****

NOTE: Land application of non-hazardous wastes such as onto surrounding grounds or inside the berm may be subject to local, State, and Federal groundwater protection regulations. Designer must check for site-specific regulatory restrictions. Based on tests to determine the character of the wastewater, an assessment should be made for any need to pretreat the nonhazardous wastes through oil-water separators or filters prior to land application, when such disposal is allowed.

****

Pump or otherwise remove water from the tank. Ensure that the sludge and sediment are not pumped out or mixed with the water. There are [_____] gallons of [nonhazardous] [hazardous] water that [can be disposed of into the berm area.] [must be packaged, labeled, stored, transported, treated, and disposed of in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, and 40 CFR 266.][Deliver hazardous waste to the Government for disposal [as directed by the Contracting Officer] [_____].]

3.7.6 Sludge and Sediment Removal and Disposal

Squeegee or brush any sludge, sediment, or other loose material into piles, shovel into buckets or other suitable containers, and remove from the tank.

3.7.6.1 Sludge Disposal Using [Landfill] [Berm]

****

NOTE: Select the applicable paragraph(s) from the following:

****

****

NOTE: The Government should estimate and indicate the quantity of water, sludge, sediment, and fuel, if any, remaining in the tank so that the Contractor can be more responsive in his bidding. Verify availability of Government disposal facilities.

****

****

NOTE: Disposal of sludge and sediment in the berm area may interfere with the Contractor's operations if storage or lay down of materials within the berm is planned. State permit may be required for disposal in the berm area and should be obtained by the Government prior to advertising for bids.

****

There are [_____] barrels of nonhazardous sediment and sludge in the tank that can be disposed of in [the berm area] [sanitary landfill].[Spread nonhazardous sludge as uniformly as possible over the area in a maximum 3-inch thick layer for weathering in the berm area. Fence the area temporarily and mark with a wood or metal sign. When the ambient temperatures are above zero degrees C 32 degrees F, the weathering period must be a minimum of 4 weeks. For colder temperatures, the weathering period must be extended by the number of days the temperature falls below zero degrees C 32 degrees F. After the required time elapses, remove the signs and fences.]

[Sludge Disposal Using Reclamation Plant

****

NOTE: The Government should estimate and indicate the quantity of water, sludge, sediment, and fuel, if any, remaining in the tank so that the Contractor can be more responsive in his bidding. Verify availability of Government disposal facilities.

****

There are [_____] barrels of nonhazardous sediment and sludge in the tank that must be delivered to the Government for disposal in the Government operated oily waste reclamation plant.

][Removal of Sludge

****
NOTE: The Government should estimate and indicate the quantity of water, sludge, sediment, and fuel, if any, remaining in the tank so that the Contractor can be more responsive in his bidding. Verify availability of Government disposal facilities.
****

There are [_____] barrels of hazardous sediment and sludge in the tank that must be disposed of by the Contractor. Package, label, store, transport, treat, and dispose of hazardous sludge and sediment in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, and 40 CFR 266.

][Delivery of Sludge to the Government

****
NOTE: When Government disposal of hazardous waste has been determined to be the most practical method of disposal, include the option for delivery of waste to the Government. Add details if necessary.
****

****
NOTE: The Government should estimate and indicate the quantity of water, sludge, sediment, and fuel, if any, remaining in the tank so that the Contractor can be more responsive in his bidding. Verify availability of Government disposal facilities.
****

There are [_____] barrels of hazardous sediment and sludge in the tank that must be delivered to the Government for disposal. Package, label, accumulate, transport, treat, and dispose of hazardous sludge and sediment in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, and 40 CFR 266.

]3.7.7 Washing

****
NOTE: This paragraph is applicable to concrete or steel tanks. Only water must be used as the first preference. Steel tanks which have contained light products can normally be cleaned by washing down with fresh water under pressure. Detergent must be considered, if water by itself will be inadequate to remove all fuel residue. Use detergent, if the tank service will be changed from leaded fuel to unleaded fuel. The detergent and solvent solution should be specified only if the tank is expected to be heavily coated with fuel residue. The choice of cleaning agent must be based on the type of fuel stored in the tank and the conditions expected. Consider brush blasting to minimize the use of water.
****

After water, fuel, and sludge have been removed, thoroughly wash the tank interior. Contractor must limit the water pressure during washing so that it does not cause damage to the existing coating. Contractor must clean a representative test panel with their planned washing procedure. Test panel access must be provided to and examined by the Contracting Officer to determine whether coating damage is occurring as a result as a result of the Contractor's washing procedure. Contractor must modify water temperature and pressures based on cleaning test panel results. Maximum allowable pressure on coated surfaces must be [1380 Kpa] [200 psig] [_____] and maximum allowable temperature of wash water must be [57 degree C] [135 degrees F] [_____]. Prior to cleaning the tank, tests must be conducted to determine the minimum distance of the nozzle to the steel to prevent damage to the tank coating. Perform Quality Control to inspect the cleaning during the process to ensure the coating is not being removed. Minimize the use of water; substitute brush blasting when practical. Start washing at the top of the walls and columns and work down to the floor. Wash the floor last starting from the sides and working towards the sump. Wash to remove oil, sludge, wax, tar, and other fuel residue adhering to the surface. Wash by any one or a combination of the following methods:

****

NOTE: Select the applicable paragraph(s) from the following:

****

[a. Use only fresh water under pressure.

][a. Apply a detergent conforming to FS O-D-1276 by spray or brush and soak approximately 30 minutes.

][a. Apply a detergent cleaning solution by spray or brush and allow to soak approximately 30 minutes. The cleaning solution must be either a one-to-one ratio of detergent conforming to FS O-D-1276 and solvent conforming to MIL-PRF-680 or an equivalent commercial cleaning agent as approved by the Contracting Officer.

] b. Hand-scrub the surfaces vigorously with long-handled stiff-bristle brushes. Wet the brushes intermittently with fresh [cleaning agent] during scrubbing process. For heavily oil-soaked areas which still appear to retain some residue after first scrubbing, [give a second application of cleaning agent and repeat the scrub process a second time.] [scrub until clean.]

c. Rinse the surfaces thoroughly with fresh water.

d. Brush-off blast clean.

3.7.8 Wash Water, [Detergent Solution,] and Sediment Removal

During the washing process, operate a portable pump continuously with suction hose extended to the tank bottom to remove water, [detergent,] dirt, oil, or other loose materials washed off. Following the final rinse, pump, squeegee, and mop the tank dry.

a. Prior to discharge or disposal, test the wash water, sediment, and sludge in accordance with paragraph WATER, SEDIMENT, AND SLUDGE ANALYSIS. The Contractor must furnish temporary tanks to hold water and detergent solution until testing is completed.

****

NOTE: Select the applicable paragraph(s) from the

following:

****

****

NOTE: Use the first paragraph if only fresh water is used for washing.

****

[b. The wash water is [nonhazardous and can be disposed of in the berm area.] [hazardous and must be handled in accordance with paragraph WATER, SEDIMENT, AND SLUDGE ANALYSIS.]
]

****

NOTE: Use the second paragraph if detergent or solvent is used for washing or if wash water only is to be discharged to a sanitary sewer. Verify existence of industrial waste treatment and oil reclamation plants; if not available, revise wording and include list of pollutants and discharge limits for which discharge into local sanitary sewerage system is permissible.

****

****

NOTE: Designer should check with owner/operator of Navy or municipal sewer system if dumping waste water into sewers will be allowed and describe special conditions which Contractor must follow. Obtain necessary permits and permission to discharge to sanitary sewers prior to advertising for bids.

****

[c. The water and detergent solution is nonhazardous and can be disposed of into the [Navy] [municipal] sewer system. The Contractor must ensure that the wash water does not exceed the discharge limitations listed below. Notify the Contracting Officer and the [Navy] [municipal] sewage treatment plant operator at least 24-hours prior to discharge into the sanitary sewer at Phone No. [_____].

****

NOTE: Items and limits are given as an example only. The project designer must develop a list of items and limits which are specific for the project site.

****

TABLE 2. WASTE WATER DISCHARGE LIMITS TO SEWERS

Item	Limits
(1) pH	[5.5-9.5] [_____]
(2) Oil and Grease (Hydrocarbon)	[50] [_____] mg/l Max.
(3) Surfactant (MBAS)	[30] [_____] mg/l Max.

TABLE 2. WASTE WATER DISCHARGE LIMITS TO SEWERS

Item	Limits
(4) Lead	[0.6] [_____] mg/l Max.
(5) Total Identifiable Chlorinated Hydrocarbons	[0.04] [_____] mg/l Max.
(6) Benzene and Derivatives	[2.0] [_____] mg/l Max.
(7) Organic Solvents	[2.5] [_____] mg/1 Max.
(8) [_____]	[_____] mg/l Max.

If the discharge limits are exceeded for any of the above items, dispose of the water and detergent solution as directed by the Contracting Officer, at either the Navy's [Industrial Waste Treatment Plant] [or] [the Oil Reclamation Plant]. The Contractor may pretreat the wash water to make it suitable for discharge to the sanitary sewer system if approved by the Contracting Officer. Submit the plan for pretreatment to the Contracting Officer for approval [21] [_____] days prior to scheduled pretreated discharges.

] d. For bidding purposes, assume that the sediment is [nonhazardous and can be disposed of [in the berm area] [in a sanitary landfill]] [hazardous and must be handled in accordance with paragraph SLUDGE AND SEDIMENT REMOVAL AND DISPOSAL].

3.7.9 Removal of Scale and Other Tenaciously Adhering Materials

Perform [sandblast cleaning][or][power wire brushing].[The brush must be made of spark resistant bronze wire.] After [sandblasting][or][power wire brushing], clean the entire tank interior surfaces by brushing, blowing with dry compressed air, and vacuuming. Remove loose materials from the tank interior.[Perform abrasive blasting in accordance with API RP 2027.]

3.7.10 Disposal of Used Blasting Abrasive

****

NOTE: When Government disposal of hazardous waste has been determined to be the most practical method of disposal, include the option for delivery of waste to the Government. Add details if necessary.

****

Test used abrasive in accordance with 40 CFR 261 to determine if it is a hazardous waste using the EP toxicity test for metals. Handle and dispose of abrasive determined to be hazardous waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, and 40 CFR 266. Dispose of abrasive which is not hazardous waste at a landfill off Government property in accordance with applicable regulations. The contract price will be adjusted if the used abrasive is determined to be hazardous waste.[However, payment for disposal of hazardous waste will not be made until a completed manifest from the treatment or disposal facility is returned, and a copy furnished to the Government.][Deliver hazardous waste to the Government for disposal [as directed by the

Contracting Officer].]

3.7.11 Special Instructions for Cleaning Tank Storage JP-5 Fuel

a. Comply with the precautions and procedures outlined above for cleaning petroleum storage tanks.

****

NOTE: JP-5 has a relatively low Reid vapor pressure, and the combustible gas indicator will not ordinarily indicate any vapors present in the tank, at any time during the entire tank cleaning work. This does not mean that hazardous flammable fuel vapors are not present.

****

b. Use respiratory equipment specified for "Respiratory Protection" under paragraph EQUIPMENT, in this section, at all times, regardless whether or not combustible gas indicator indicates any vapors present in the tank. Wear the respiratory protective equipment continuously until the tank side and bottom has been thoroughly cleaned, washed and dried.

****

NOTE: Delete the paragraph, if there is no floating-roof tank.

****

[c. Thoroughly clean of fuel, rust and debris in the interior of each pontoon of the floating tanks.

]3.7.12 Special Precautions

****

NOTE: Delete, if not applicable.

****

Special Precautions for Tanks with Pipe Columns and Braces, Pontoons, and Leaking Bottoms:

a. Pipes used for columns and braces, pontoons and leaking bottoms are a potential source of explosive vapors even after the tank is cleaned. The tank may be determined to be vapor free below 4 percent of lower explosive limit; but after one or two hours, explosive readings must again be obtained from these sources. The Contractor must take readings at least every half hour when working in tanks after they have been cleaned and each floating roof or pan pontoon must be checked individually with a combustible gas indicator.

b. If the repair work is to be performed on floating roof tanks, the interior of each pontoon on the roof must be thoroughly cleaned of fuel, rust, water, and debris.

[3.7.13 Lead-Hazard-Free Tests

****

NOTE: Delete brackets and words within brackets if there is no leaded fuel in any tank.

****

In accordance with API Std 2015, perform lead-in-air tests to make sure that the tank is lead-hazard-free (CAUTION: Never perform lead-hazard-free tests before or during cleaning, only after).

]3.8 FINAL CLEAN-UP

After the Contracting Officer has inspected and accepted the tank cleaning and before final inspection, accomplish the following work:

3.8.1 Stenciling Tank

Stencil on the tank in 20 mm 3/4-inch letters adjacent to the manhole openings the following data:

Date Cleaned - [_____]

Contractor Name - [_____]

Address - [_____]

3.8.2 Restoration of Site to Original Condition

[Do not reconnect pipelines until application of interior and exterior coatings specified in other sections of this specification, have been completed.]Replace valves, piping, manhole covers, and similar items which were removed at the start of the job with new gasket material resistant to fuel not less than the thickness of the gasket removed. Pressure check valves and piping. Remove, from the site, debris, equipment and materials used for the cleaning operations. Restore the site to its original condition.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-33 01 50.65 (February 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 33 - UTILITIES

SECTION 33 01 50.65

INSPECTION OF FIELD FABRICATED FUEL STORAGE TANKS

02/21

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 01 50.65 (February 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 01 50.65

INSPECTION OF FIELD FABRICATED FUEL STORAGE TANKS

02/21

****

NOTE: This guide specification covers the requirements for an out of service Inspection of a Field Fabricated Fuel Storage Tank.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

For cases when inspection is followed by repair, use this Section with 33 01 50.75 REPAIR OF FIELD FABRICATED FUEL STORAGE TANK. Insert applicable requirements from 33 01 50.75 should this Section be used stand alone.

Make use of this Section in consultation with SMEs listed below. The Section requires considerable judgment and specialized professional engineering competence. There are substantial consequences to a fuel storage tank inspection. Do not use this Section unless professionally competent and proficient in the assessment of fuel storage tank integrity.

Knowledge and competence in topics covered in this

Section are maintained by each Service center of excellence. Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts:

Air Force - The Air Force Fuels Facilities Subject Matter Expert (AFCEC/COS)

Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC)

Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11)

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API 570	(2016; Addendum 1 2017; Addendum 2 2018; ERTA 1 2018) Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems
API MPMS 2.2A	(1995; R 2017) Manual of Petroleum Measurement Standards Chapter 2-Tank Calibration Section 2A-Measurement and Calibration of Upright Cylindrical Tanks by the Manual Tank Strapping Method
API MPMS 2.2B	(1989; R 2019) Manual of Petroleum Measurement Standards Chapter 2: Tank

	Calibration - Section 2B: Calibration of Upright Cylindrical Tanks Using the Optical Reference Line Method
API MPMS 2.2C	(2002; R 2013) Manual of Petroleum Measurement Standards Chapter 2: Tank Calibration - Section 2C - Calibration of Upright Cylindrical Tanks Using the Optical-Triangulation Method
API MPMS 2.2D	(2003; R 2014) Manual of Petroleum Measurement Standards Chapter 2: Tank Calibration - Section 2D Calibration of Upright Cylindrical Tanks Using the Internal Electro-Optical Distance-Ranging Method
API RP 571	(2020) Damage Mechanisms Affecting Fixed Equipment in the Refining Industry
API RP 574	(2016) Inspection Practices for Piping System Components
API RP 575	(2020) Inspection Practices for Atmospheric and Low-Pressure Storage Tanks
API RP 579-1	Fitness-For-Service
API RP 1110	(2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide
API RP 2207	(2017; 7th Ed) Preparing Tank Bottoms for Hot Work
API Std 521	(2014; 6th Ed) Pressure-relieving and Depressuring Systems
API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage
API Std 653	(2014; Addendum 1 2018) Tank Inspection, Repair, Alteration, and Reconstruction
API Std 2015	(2018) Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum

	Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.48	(2015) Line Blanks
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC V	(2017) BPVC Section V-Nondestructive Examination

ASTM INTERNATIONAL (ASTM)

ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM D610	(2008; R 2019) Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM E1316	(2020a) Standard Terminology for Nondestructive Examinations
ASTM E2807	(2011; R 2019) Standard Specification for 3D Imaging Data Exchange

ASTM F436	(2011) Hardened Steel Washers
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 326	(2015) Standard for Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 2	(2015; E 2018) Procedure for Determining Conformance to Dry Coating Thickness Requirements

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-907	(2020; Rev H) Antiseize Thread Compound, High Temperature
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-460-03	(2017; with Change 2, 2023) Petroleum Fuel Systems Maintenance

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.146	Permit-required Confined Spaces

1.2 DEFINITIONS

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NOTE: Requirements in this Section must be checked against requirements in the project Statement of Work or Project Program to ensure that there is not a conflict.

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1.2.1 DoD Tank Features List

As used in this Section, documentation of functional and physical attributes in the form of a spreadsheet which the Contracting Officer will provide after award. This document is in addition to the API Std 653 Annex C inspection checklist.

1.2.2 Hazardous Area

As used in this Section, any area within 30 meters 100 feet of active storage tanks, areas within 30 meters 100 feet of leaking sections of fuel pipelines or other vapor sources, areas within 60 meters 200 feet of the downwind side of potential vapor emission sources (i.e., pressure-vacuum vents, sample ports, or open vents on active tanks; leaking sections of pipelines), areas within existing tanks, and areas within a tunnel or adit.

1.2.3 Hot Work

For work covered by this section: drilling, boring, flame heating, welding, torch cutting, brazing, carbon arc gouging, grinding, abrasive blasting, or any work which produces heat, by any means, of 200 degrees C 400 degrees F or more; or in the presence of flammables or flammable atmospheres, other ignition sources such as spark or arc producing tools or equipment, static discharges, friction, impact, open flames or embers, nonexplosion-proof lights, fixtures, motors or equipment.

1.2.4 Independent

Impartial third party not a part or affiliated with Contractor or subcontractor principal or subsidiary businesses.

1.2.5 Inspector of Record

The individual, certified as a fuel storage tank inspector, in responsible charge of the storage tank inspection who will attest to the suitability for service. The recognized certification is API Std 653.

1.2.6 Mandatory Repair

Action necessary to preserve or restore the structural and hydraulic integrity of the tank or piping, or to mitigate a safety hazard. Includes any condition which has or may breach the hydraulic or structural integrity of the tank prior to the next integrity inspection.

1.2.7 Marine Chemist

The holder of a valid Certificate issued by the National Fire Protection Association in accordance with the "Rules for Certification of Marine Chemists" establishing the individual as a Qualified Person pursuant to NFPA 326.

1.2.8 MAWP

Maximum allowable working pressure: As used in this Section, maximum internal pressure in the piping system for continued operation at the most severe condition of coincident internal or external pressure and temperature expected during service.

1.2.9 Mil

A unit of length equal to 0.001 of an inch.

1.2.10 Progressive Indication

A response from a nondestructive examination interpreted to be relevant and evaluated to be time-dependent deterioration such as active corrosion.

1.2.11 Recommended Repair

Action intended to extend the service life of the tank or piping and to address conditions that currently, or within the next service interval, will not have an adverse affect on tank operability or integrity. Applicability is limited to exclude soft or elastomeric parts for any pressure containing system.

1.2.12 Tank Engineer

One or more licensed professional engineers, or an engineering firm acceptable to the Contracting Officer, knowledgeable and experienced in the engineering disciplines associated with the evaluation of mechanical and material characteristics that affect the integrity and reliability of storage tanks. The storage tank engineer is the tank inspection subject matter expert.

1.2.13 Tank Inspection

As used in this Section, a tank inspection is a multi-disciplinary engineering assessment of all petroleum, oil, and lubricant storage tank systems within or connected to the tank hydraulic boundary. Systems include nozzles, appurtenances and conveyance systems such as piping, stilling well, valve, flow control, cathodic protection, overfill protection, spill prevention, containment, leak detection, fire suppression, gauging, ventilation, lighting, and other electrical systems. Inspection includes a review of cathodic protection reports and relevant as-built records when available. Unless stated otherwise in the [Project Program][Statement of Work], the limits are the boundary of secondary containment.

1.2.14 Tank Inspector

An individual certified as a fuel storage tank inspector. The recognized certification is API Std 653.

1.3 ADMINISTRATIVE REQUIREMENTS

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NOTE: Piping hydrostatic test for use on cut and cover tank piping within the hydraulic boundary or on drain-dry AST piping.

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1.3.1 Sequencing

[Schedule hydrostatic test of nozzle piping to occur early during the inspection phase. Report results in the preliminary inspection report.

] Schedule tank inspection(s) to occur in accordance with Section 01 14 00 WORK RESTRICTIONS.

1.3.2 Safety Permits and Equipment

Acquire safety permits and necessary safety equipment in compliance with Installation Requirements, Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS, Section 33 01 50.55 CLEANING OF PETROLEUM STORAGE TANKS, and EM 385-1-1. A permit is required for all hot work. The storage tank is a confined space and entry must be made in accordance with requirements of EM 385-1-1 Section 34.

1.3.3 Regulatory Requirements

Obtain permits required to comply with local, State, and Federal regulations.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Tank Inspector Credentials; G, [_____]

[Piping Inspector Credentials; G, [_____]

] Tank Engineer Credentials; G, [_____]

NDE Examiner Credentials; G, [_____]

NDE Firm Credentials; G, [_____]

Hydrostatic Test Plan; G, [_____]

Inspection Plan; G, [_____]

Preliminary Inspection Report; G, [_____]

Inspection Report; G, [_____]

SD-06 Test Reports

Hydrostatic Test Report; G, [_____]

SD-07 Certificates

Instrument Calibration Certificate

SD-10 Operation and Maintenance Data

Electronic Tank Calibration Table; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Modification of References

Perform work in accordance with UFC 3-460-03. Except as modified herein, work must conform to [API 570, API RP 574,]API Std 653, and API RP 575.

1.5.2 Qualification and Certification

1.5.2.1 Tank Engineer

Qualification: Minimum [four][seven] years verifiable experience in evaluation, design, repair, and integrity assessment of [field fabricated][cut and cover] fuel storage tanks. Provide evidence of having completed tank inspections, inspections of repairs, or integrity assessments on at least five similar size and type tanks within the previous four years.

Certification: Licensed Professional Civil or Mechanical Engineer. [Certification as an API Std 653 tank inspector.]Provide Tank Engineer Credentials and qualification.

1.5.2.2 Tank Inspector

Qualification: Minimum [four][seven] years verifiable experience performing inspections[of bulk fuel storage tanks][of cut and cover fuel storage tanks]. Provide evidence of having completed inspections on at least five similar size and type storage tanks within the previous four years.

Certification: API Std 653 tank inspector. Provide Tank Inspector Credentials to include API Std 653 certification and qualification.

[1.5.2.3 Piping Inspector

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NOTE: Piping inspector for use if piping and nozzle inspection and piping hydrostatic test on cut and cover tank piping that is part of the tank hydraulic boundary or on drain-dry AST piping is within the purview of the inspection scope.

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Qualification: Minimum four years verifiable experience performing fuel piping inspections of the same size and type as required. Provide evidence of having completed at least five similar inspections within the previous four years.

Certification: API 570 piping inspector. Provide Piping Inspector Credentials to include API 570 certification and qualification.

]1.5.2.4 Non-Destructive Examination (NDE) Company

Qualification: [Independent third party company][Company] with minimum four years verifiable experience conducting:

a. Tank plate scanning for surface, subsurface, and backside indications

b. Weld examination for surface and subsurface indications

Certification: NDE Firm Credentials to include contact information, industry qualification, and experience.

1.5.2.5 Non-Destructive Examiner

Qualification: Examiners must be qualified to perform non-destructive examination in accordance with API Std 653 and API Std 650. Examiners must meet minimum requirements for qualification in ANSI/ASNT CP-189. Qualified examiners must have minimum five years verifiable experience performing non-destructive examination of fuel storage tanks. Experience is defined as work activity performing a specific NDE method under the direction of qualified supervision but does not include time spent in training programs.

Certification: Examiners certified to at least Level II requirements compliant with ANSI/ASNT CP-189 for the applicable method. Level II Limited certification does not meet this requirement. Provide NDE Examiner Credentials to include qualification and certification.

1.6 INSPECTION PLAN

Submit Inspection Plan pursuant to Section [01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES][01 33 00 SUBMITTAL PROCEDURES].

1.6.1 Desired Service Interval

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NOTE: Use judgment regarding Desired Service Interval. OOS repair durations can be lengthy. Goal is 20-year interval but must account for repair duration. If 24 years is infeasible or unnecessary, use 12 years. Ensure interval is consistent with requirements in work statement.

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Unless otherwise stated in the [Project Program][Statement of Work], use [12][24] years as the interval to the next inspection.

1.6.2 Environmental Conditions

Plan ventilation and tank entry means which will provide a gas-free environment suitable for safe entry. Comply with Section 33 01 50.55 CLEANING OF PETROLEUM STORAGE TANKS and API Std 2015. Prepare for tank bottom work consistent with API RP 2207.

1.6.2.1 Gas Test Holes

Liquid or hydrocarbon vapor might exist [in the tank shell to substrate interstice][below the bottom plates]. Should the space be required to be sampled or inerted, provide an engineered detail to install and repair test holes. Purge the interstice with inert gas if required to establish gas-free conditions and in accordance with API RP 2207. Provide test holes pursuant to paragraph GAS TEST HOLE INSTALLATION. Repair gas test holes in accordance with paragraph GAS TEST HOLE REPAIR.

[1.6.3 Tank Geometric Data

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NOTE: Use this paragraph in the event a qualitative data from a LIDAR survey of the tank interior is desired.

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Plan a survey regime which will result in a thorough, electronic dataset of tank interior surfaces and internal piping. Data must be non-proprietary and conform to ASTM E2807. Point density must be adequate to provide surface resolution of 0.20 inch each axis. Data are intended for use as a permanent set of baseline geometric information and to be registered with inspection data. Ensure point cloud is supported directly within AUTOCAD software.

][1.6.4 Destructive Testing

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NOTE: Use this paragraph should it be expected that confirmation of inspection NDE will be useful or required, if there are questions about weldability, or if metallurgical properties of the material need to be established. Do not use destructive testing unless warranted and repairs are programmed. Require in the Project Program or SOW the quantity, size, and location of coupons. If NDE confirmation is being performed, select locations based on

inspection thickness data.
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Provide destructive testing which will obtain test coupons, submit them to a laboratory for analysis, and report [metal loss,]chemical, mechanical, macrographic, and metallographic properties of the material. Use the services of an accredited test laboratory. Design the testing to inform the repair design and weld procedure qualification as required in Section 33 01 50.75 REPAIR OF FIELD FABRICATED FUEL STORAGE TANKS. [Compare and report the metal loss data with results of the NDE performed during inspection.]Coupon location, size, and quantity are pursuant to requirements in the [Project Program][Statement of Work].

]1.6.5 Actionable Indication Determination

Retroactive compliance with criteria such as UFC, DoD Standard Design, and API Std 650 is not required. Many vintage tank welds fully perform despite noncompliance with current weld profile or spacing criteria. Evaluate past performance of welds and assess the expectation for continued performance in structural and hydraulic integrity. Do not find a weld actionable solely for the purpose of current criteria compliance, unless the finding informs a recommendation that affects integrity or operability.

[1.6.6 Aboveground Storage Tank

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NOTE: Use this paragraph only for aboveground tanks.
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Plan the storage tank inspection and other specialized engineering services. Use the API Std 653 Annex C inspection checklist. In addition, incorporate inspection of components which fall outside the scope of API Std 653[and API 570], but which fall within the scope of this Section. Plan the inspection to validate storage tank conditions in order to fully inform a repair design.

Specify complementary examination methods capable of detecting and sizing surface and subsurface defects, as well as product and backside corrosion. Qualitative methods are acceptable for screening purposes as long as requirements of this Section are met and quantitative data are obtained by follow-on means.

Plan an inspection approach which will examine 100 percent, as interior appurtenances allow, of the tank bottom. Tailor plan to specific facility conditions. Address relevant damage mechanisms pursuant to engineering best practice and API RP 571. Do not use a risk-based approach.

1.6.6.1 Corrosion Rate

Screen inspection data to distinguish progressive versus non-progressive indications but use only progressive indications in rate calculations. Calculate corrosion rates per region per API Std 653 and include in preliminary report.

1.6.6.2 Remaining Thickness Analysis

Calculate minimum plate thickness for all regions. Assume product side corrosion rate for coated regions is zero if the expected life of the coating system equals or exceeds the service interval. Report the thickness required to achieve, at the end of the service interval, 100 mils of plate thickness.

1.6.6.3 Remaining Service Life

Classify relevant indications into mandatory and recommended categories. Apply requirements in paragraph SUITABILITY FOR SERVICE.

1.6.6.4 Atmospheric Vent Capability

Calculate the normal and emergency atmospheric vent requirements at maximum rates of fill and issue. Assess capability of vents and their conformance to NFPA 30.

][1.6.7 Cut and Cover Tank

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NOTE: Use this paragraph only for cut and cover tanks.

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Plan the storage tank inspection and other specialized engineering services. Incorporate inspection of components which fall outside the scope of API Std 653[and API 570], but which fall within the scope of this Section. Plan the inspection to validate storage tank conditions in order to fully inform a repair design.

Specify complementary examination methods capable of detecting and sizing surface and subsurface defects, as well as product and backside corrosion. Qualitative methods are acceptable for screening purposes as long as requirements of this Section are met and quantitative data are obtained by follow-on means.

Plan an inspection approach which will examine 100 percent, as interior appurtenances allow, of the tank shell and bottom. Tailor plan to specific facility conditions. Address relevant damage mechanisms pursuant to engineering best practice and API RP 571. Do not use a risk-based approach.

1.6.7.1 Modified Inspection Approach Analysis

Use a modified approach in order to apply principles of API Std 653 to the extent practicable, and also assess unique characteristics of cut and cover storage tanks. Evaluate tank conditions through a systematic approach led by the Tank Engineer. Many original construction welds are noncompliant with current standards and practices for geometry and spacing. Use engineering judgment when recommending repair of existing fully-performing but noncompliant welds.

Provide a Modified Inspection Approach Analysis (MIAA) which describes the engineering basis for the inspection. Adhere to principles of API Std 653. Take into account the tank design and construction methods. Incorporate best engineering practice. Analyze and submit the MIAA in accordance with Section [01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES][01 33 00 SUBMITTAL PROCEDURES].

1.6.7.2 Modified API Inspection

Use an inspection regime which implements this Section and principles of API Std 653, API RP 575[, API 570, and API RP 574].

1.6.7.3 Corrosion Rate

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NOTE: Calculate corrosion rate using two methods. Evaluate results to determine which is more conservative.

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Organize thickness data into bottom and shell regions. Screen inspection data to distinguish progressive versus non-progressive indications but use only progressive indications in rate calculations. Calculate long term corrosion rates per region as the quotient of metal loss and time. Calculate corrosion rates in accordance with API Std 653. Use assumptions in Table 1. Report thickness in mils and rates in mils per year.

Table 1 Corrosion and Remaining Thickness Assumptions

Minimum thickness, (mils) end of service interval	100
Original service start year	[_____]
Nominal thickness (mils, bottom)	[_____]
Nominal thickness (mils, other regions)	[_____]
Desired Service Interval (years)	See paragraph DESIRED SERVICE INTERVAL

1.6.7.4 Remaining Thickness Analysis

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NOTE: Use a factor of safety in the corrosion rate if needed to mitigate inspection uncertainty risk on tanks without RPB and/or leak detection, or if needed as a best practice.

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Use the corrosion rate calculated from values in Table 1 and the method in API Std 653. Report the required thickness to achieve 100 mils of plate thickness at the end of a service interval, using both the long term corrosion rate and with the API corrosion rate method.

]1.6.8 Non-Destructive Examination

Plan an examination to provide complementary non-destructive techniques. Do not rely on a single technology. Ensure techniques, in the aggregate, have the capability to detect backside corrosion at the minimum volume as well as through holes. Procedures must be compliant with ASME BPVC SEC V.

Qualitative methods are acceptable for screening as long as requirements of this Section are met and quantitative data are obtained by follow-on means.

Record associated geometric data for relevant indications. Identify examiner(s) used at each indication.

Specify VT, UT, and VBT techniques fully compliant with this Section, ASME BPVC SEC V, and API Std 650. Adhere to NDE terminology in ASTM E1316. Provide an NDE Plan which includes requirements of ASME BPVC SEC V.

1.6.8.1 Plate Scan

Provide bottom [and shell]plate scanning to screen surfaces for backside corrosion. Provide UT at regions where tank scanning cannot be conducted. Prove up backside indications with an ultrasonic method.

1.6.8.2 Weld Examination

Provide bottom [and shell]weld examination independent of plate scanning. Characterize indications as actionable based on hydraulic or structural integrity and not on criteria compliance. Identify conditions which are symptomatic of poor weld performance.

1.6.8.3 Vacuum Box Testing

Provide a procedure to test in two pressure increments. Start the test with a 3 psig differential. Maintain vacuum pressure for at least 10 seconds. Slowly increase to 8 psig differential and maintain for at least 10 seconds. Record examiner(s) and register test data with the geometric dataset.

1.6.8.4 NDE Reliability

If MFL is used, comply with API Std 653 Annex G requirements for qualification of tank bottom examiners. Only third-party companies, having no conflict of interest in tank bottom examination applications, may facilitate qualification tests. For any other technique, provide a qualified procedure and documentation that examiners are capable of reliably detecting backside metal loss with the procedure.

[1.6.9 Tank Piping

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NOTE: Piping inspection and piping hydrostatic test are for use on cut and cover tank piping that is part of the tank hydraulic boundary or on drain-dry AST piping.

Use judgment on which type of test to specify. Identify test boundaries and whether there are means for isolation. Hot work during the inspection phase may be required. Identify local test water disposition requirements.

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Plan an inspection of tank process piping, drain and water draw lines, nozzle necks, flanges, and valves. Inspect to provide condition information, identify deterioration, and establish geometric data. Incorporate into the inspection plan principles of API 570 and API RP 574.

1.6.9.1 Tank Piping Hydrostatic Test

[Plan a temperature compensated, volume and pressure reconciled hydrostatic test. Segments are drain-dry piping and any piping exposed to tank head. Test to the isolation valve flange. Plan the test consistent with API RP 1110. Isolate test segments with suitable means. Use water as the test medium. Test pressure must be meaningful and not less than 150 psig unless an alternative is authorized by the Contracting Officer. Do not exceed the rating of an ASME B16.5, carbon steel, ANSI Class 150 flange. Minimum test duration is four hours.

Test must analyze consistent and inconsistent error, the magnitude of lost volume, and data trends. Inconsistent error able to be reconciled to less than 0.25 degree F is an acceptable result unless an alternate threshold is authorized by the Contracting Officer.

Prepare Hydrostatic Test Plan consistent with API RP 1110 and this Section. Submit in accordance with Section [01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES][01 33 00 SUBMITTAL PROCEDURES]. Include:

a. Site specific test procedure and pressure

b. Description of equipment, piping, and valves to be used, including one line diagram(s)

c. Method to secure test segment

d. Test record form

e. Current instrument calibration certificates

f. List of test segments and intended test pressure for each

g. Acceptance criterion

h. Method to characterize test water to screen for contaminants

i. Method to transport, store, and dispose test water

j. Post-test engineering analysis

][Plan a combined strength and leak test consistent with principles of UFC 3-460-03 Appendix G. Strength test pressure component must be meaningful and not less than 150 psig unless an alternative is authorized by the Contracting Officer. Leak test component must use a method which has been third party certified by the National Work Group on Leak Detection Evaluations. Segments are drain-dry piping and any piping exposed to tank head. Test to the isolation valve flange. Provide tests early in the inspection evolution.

]]1.7 SUITABILITY FOR SERVICE

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NOTE: Program mechanical repairs to provide 24 years of service even if a State or local jurisdiction requires a shorter compliance inspection interval. Revisit this approach and apply judgment once condition data are received.

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Evaluate inspection data to determine suitability for continued use. Identify conditions which pose a risk to integrity. Determine a metal loss threshold for mandatory repairs.

In the determination of mandatory repairs:

a. Use a "first, do no harm" approach to classifying tank repairs.

b. Use Desired Service Interval as the time to next inspection unless notified otherwise by the Contracting Officer.

c. Use minimum remaining thickness (MRT) no less than 100 mils at the next inspection.

d. Do not classify as mandatory repair of conditions which are noncompliant with current standards but are un-related to structural or hydraulic integrity (e.g., gouge, improper weld spacing, weld profile).

e. Apply repair determination to individual indications. Do not average across an entire plate or course.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Preparation for Inspection

Develop written procedures in accordance with API Std 653 and API RP 575 for entry and re-entry into a storage tank. Ensure gas-generating, pyrophoric, or toxic residues have been removed. Review requirements in this Section and the inspection plan to test the interstice for hydrocarbons and purge as necessary. Do not start inspection until storage tank has been certified by the Marine Chemist to be safe for entry, and requirements of this Section, Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS, and EM 385-1-1 have been met.

PART 2 PRODUCTS

2.1 Gaskets

Composition ring, one piece factory cut, compliant with ASME B16.21, Buna-N. Gaskets must be composed of either graphite or synthetic fibers in a nitrile binder and must be resistant to the effects of aviation hydrocarbon fuels and manufactured of fire-resistant materials. Use full-faced gaskets for flat-face flanged joints. Use ring gaskets on raised-face flanged joints. Buna-N material must conform to SAE AMS3275. Select a gasket suitable for the work and test pressure of the fluid.

2.2 Fasteners

2.2.1 Flange Bolts, Nuts, and Washers

Bolts for pipe flanges, flanged fittings, manway covers, valves, and accessories must conform to ASME B18.2.1. Bolts must be of sufficient length to obtain full bearing on the nuts and must project no more than three full threads beyond the nuts with the bolts tightened to the required torque. Bolts must be regular hexagonal bolts conforming to ASME B18.2.1 with material conforming to ASTM A193/A193M, Class 2, Grade B8, stainless steel, when connections between steel and aluminum are made, and Grade B7 when only carbon steel components are involved. Bolts must be threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch. Where aluminum is bolted to steel, use stainless steel fasteners.

Nuts for pipe flanges, flanged fittings, valves and accessories must conform to ASME B18.2.2, hexagonal, heavy series with material conforming to ASTM A194/A194M, Grade 8, stainless steel for stainless steel bolts, and Grade 7 for carbon steel bolts. Nuts must be threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch.

Use chromium molybdenum alloy washers dimensioned to ASTM F436 flat circular for chromium molybdenum bolts. Use stainless steel washers dimensioned in accordance with ASTM F436 flat circular and fabricated from the same grade of stainless steel as the bolt. Use torque wrenches to tighten flange bolts to the torque recommended by the gasket manufacturer or to eliminate drips. Tighten in the pattern recommended by the gasket manufacturer. Use anti-seize compound on stainless steel bolts.

2.2.2 Structural Bolts, Nuts, and Washers

a. Bolts: ASTM F3125/F3125M (ASTM A325), Type 1, heavy hex style, plain finish. Ensure bolt heads are distinctively marked with the manufacturer unique identifier and grade. Bearing type connections are Type N unless determined otherwise.

b. Nuts: ASTM A563, Grade C, heavy hex style, plain finish. Ensure nuts are distinctively marked with the manufacturer's unique identifier and grade.

c. Washers: ASTM F436, Type 1, circular. When the outer face of the joint has a slope greater than 1:20 with respect to a plane normal to the bolt axis, use ASTM F436, Type 1, beveled to compensate for the lack of parallelism.

2.2.3 Thread Lubricant

Provide thread lubricant on fastener to minimize galling compliant with MIL-PRF-907 Anti-Seize Compound on fasteners external to the tank. On tank interior fasteners use SAE 30 oil.

PART 3 EXECUTION

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NOTE: This Section is not ordinarily intended to be used without Section 33 01 50.75 REPAIR OF FIELD FABRICATED FUEL STORAGE TANK. If used stand-alone, incorporate appropriate requirements from that section.

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3.1 CONTROL OF HAZARDOUS ENERGY

Prior to entry, provide proper lockout and tagout of the storage tank and appurtenances to completely isolate from sources of energy. Items to be isolated include nozzles, valves, pumps, and motor starters. Isolate tank and piping with physical means such as blind flanges compliant with ASME B16.5 or solid-plate line blanks compliant with ASME B16.48 to prevent fuel or vapor transfer into the tank or piping. Isolation means must be of sufficient strength to withstand pressure which might be exerted by the product being blanked off, and must be gasketed on both sides if line blank is inserted between two flanges. Do not use a valve as means of isolation. Execute in accordance with accepted Accident Prevention Plan, Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and EM 385-1-1. Coordinate lockout / tagout with site fuels operator.

3.1.1 Thermal Relief

Evaluate thermal relief capability on active facility piping isolated from the tank. Should isolation means result in a segment of active piping unprotected from thermal overpressure, provide temporary means consistent with API Std 521 to relieve the overpressure. Consult with operators to determine existing relief pressures and adjust temporary relief settings to ensure overpressure does not occur.

3.2 TANK PLATE ACCESS

Provide means of access to all areas of the tank envelope for personnel, materials, and equipment. Provide lighting, ventilation, and access to the work for the Contracting Officer representative while inspection is being performed.

3.3 GAS-FREE ENVIRONMENT

Degas tank until requirements of Section 33 01 50.55 CLEANING OF PETROLEUM STORAGE TANKS, the accepted Accident Prevention Plan, API Std 2015, 29 CFR 1910.146, and the certified Marine Chemist are met. Obtain gas-free certification from the Marine Chemist. Maintain the gas-free environment. Purge the interstice with inert gas as-needed to remove hydrocarbon vapors consistent with API RP 2207.

3.4 TANK CLEANING

Clean tank in accordance with this Section and Section 33 01 50.55 CLEANING OF PETROLEUM STORAGE TANKS. The interior surfaces must be cleaned not to bare metal but only to the surface of sound coating, free of rust, dirt, scale, loose material, fuel, oil, grease, sludge, and other deleterious material. Do not damage sound coating material. If coating is loose or disbonded and interferes with the tank inspection, remove it and clean the surfaces to bare [metal][concrete]. If tank coating repair or replacement is required in the [Project Program][Statement of Work], clean surfaces to the level of cleanliness necessary for coating removal and recoating work to proceed. Cleanliness requirements of this paragraph are not intended to meet coating surface preparation requirements.

3.5 DATA MANAGEMENT

Organize data in a non-proprietary management system such as a database or spreadsheet. Serialize all NDE and API inspection indications with a unique identifier. The system must have the capability to easily be searched to track the provenance of each inspection indication to repair. Cloud-based systems are not acceptable.

Categorize indications pursuant to definitions in ASTM E1316.

3.6 GAS TEST HOLE INSTALLATION

In the event verification of conditions in the interstice is required and pursuant to Marine Chemist requirements, install gas test holes in accordance with the inspection design and hot work permit. Drill with a pneumatic tool using cooling lubricant. Test hole diameter must not exceed 3/16 in. Record all gas test hole locations in the indications database with a serialized identifier. Mark all test hole locations adjacent to the hole in a neat and professional manner which will remain evident following the repair. Repair gas test holes in accordance with paragraph GAS TEST HOLE REPAIR.

3.7 PHOTOGRAPHIC DOCUMENTATION

Document conditions with well-illuminated photographic means and minimum capture resolution of 2560 x 1920. Only downsample images for reporting purposes. Provide full resolution images in electronic format on portable media. USB flash drives are not allowed. Include photographs which document the condition of the tank, general overall layout, and discrepancies.

3.8 STORAGE TANK INSPECTION

Arrive at site with all necessary equipment and material. Perform a thorough storage tank inspection in accordance with API Std 653, API RP 575, [API 570,]this Section, and pursuant to the engineered inspection plan. Scan 100 percent of tank [bottom][hydraulic surfaces] as interior appurtenances allow, to screen for discontinuities, flaws, anomalies, corrosion, cracks, gouges, laminations, and other conditions. Collect data to be used in the assessment of corrosion growth, structural integrity, brittle fracture, and hydraulic integrity. Complete the DoD Tank Features List and the API Std 653 checklist and provide them with the preliminary report.

Populate a database with inspection results. Distinguish between product-side and back-side indications. Categorize indications into corrosion-based and non corrosion-based indications.

3.8.1 Protect in Place

Protect in place motors, pumps, impellers, risers, floating roof, and ATG probe and conductors. Mark indications and inspection information on tank plates in a neat and professional manner. Do not use fluorescent paint in the tank.

3.8.2 Inspection Before and During Cleaning

Pressure washing can remove trace indications in areas requiring further examination. Perform a visual screening of the tank by the API Std 653 inspector prior to cleaning. Make a record of areas of disbonded or deteriorated coating. Provide oversight during cleaning to ensure excessive pressure is not applied to the coating system.

3.8.3 Appurtenances

Measure roof support columns and gauge tubes to determine whether they are plumb. Verify whether gauge tubes are slotted and centered over the datum plate. Verify operability of alarms, hatches, manway cover, davit arm, and tape gauge. Assess condition of miscellaneous conduit, tubing, product recovery system, hydraulic control valve and piloting, thermal relief, water drawoff system, floating roof seals, handrail, stairway, and landing. Pneumatically test repad telltale holes pursuant to requirements in API Std 650.

3.8.4 Structure

Examine the tank structure, joints, and columns. Assess whether there are signs of strain[or water intrusion]. Determine whether columns have thinned areas or metal loss, and whether tube columns have relief weepholes.

3.8.5 Atmospheric, Circulation, Emergency Vents

Assess condition of vent screen suitability. Verify emergency vent freely operates.

[3.8.6 Coating Condition Survey (CCS)

****

NOTE: Use this paragraph if coating is not planned to be removed and CCS is warranted.

****

Pursuant to [Project Program][Statement of Work] requirements, provide an [internal][external][internal and external] coating condition survey (CCS) by an independent NACE Certified Protective Coating Specialist (PCS). PCS minimum qualifications are provided in Section 01 45 00 QUALITY CONTROL. PCS who is providing the CCS must have verifiable experienced in the field of epoxy and (poly)urethane coating analysis, coating failure forensics, and coating system design. PCS must not be affiliated with, employed by, or have an ownership interest in a materials manufacturer or vendor, or with any subcontractor performing coating services in fulfillment of this [Project Program][Statement of Work]. Submit qualifications and experience of the proposed PCS, and the CCS report per Section [01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES][01 33 00 SUBMITTAL PROCEDURES].

Use visual observations and non-destructive testing in the survey. Provide objective ratings of coating system conditions at various tank regions. Evaluate the degree of rusting in accordance with ASTM D610. Assess coating adhesion, hardness, and measure dry film thickness (DFT) in accordance SSPC PA 2. Determine whether entire coating system or regions thereof are candidates to receive overcoating, spot repair, or a combination of both in order to extend the system service life. The intent of the CCS is for the Government to receive objective third-party information about the most cost-effective method of corrosion control. The Government will use that information to base decisions to extend the life of the facility. The CCS must contain detailed observations and analytical data about the coating, its condition, and the substrate. Cite industry criteria applied in the survey. Minimum CCS report contents are listed below.

a. Condition of existing coating system and film

b. Toxicity Characteristic Leaching Procedure test results that identify the existence of potentially hazardous substances which may impact coating management (e.g., lead, cadmium, chromium, arsenic, barium, mercury, selenium, silver).

c. Analysis of remaining life, suitability for overcoating, and basic technical requirements for overcoating

d. Basis information for cost-effective management of the coating system such as film thickness, and percentage areas of rust, checking, blistering, and chalking

e. Recommendations to achieve cost effective management of coating systems, including overcoating and spot repair quantities, dimensions, and limits

][3.8.7 Coating Assessment

****
NOTE: Use this paragraph if CCS is not warranted and ordinary inspection is desired.
****

Provide an assessment of the tank coating systems. Identify type and extent of existing systems. Identify extent of coating failure, disbondment, and blisters. Perform dry film thickness (DFT) measurements in accordance with SSPC PA 2. Measure DFT on the external shell and roof, and internal bottom regions. Organize and report the DFT data in tabular form. Identify the minimum, maximum, and average thickness obtained from the regions.

]3.8.8 Engineering Assessment

Use the data obtained during the inspections to perform an engineering assessment of the hydraulic and structural conditions of the storage tank and its appurtenances. Determine and report backside corrosion rates for regions of the tank. Calculate the remaining service life.

3.9 NDE TECHNIQUES

Mark relevant indications on tank surfaces in a neat and professional manner adjacent to the indication. Repair areas of removed coating in accordance with [Project Program][Statement of Work] requirements.

3.9.1 Visual Examination

Visually inspect the overall condition of the tank. Include manway cover, atmospheric vent system, sump, and floating roof. Assess corrosion, coating condition, welds, appurtenances, gauging tubes, nozzles. Apply API RP 575 recommended practices for performing a tank inspection. Enhance visual acuity with a magnifying lens of 5X to 10X power wherever required to discern indications otherwise not clear. Measure size and contour of welds with suitable gages. Minimum light intensity at the examination surface must be 100 foot-candles. The VT procedure must be compliant with ASME BPVC SEC V.

[3.9.2 Shell Examination

****
NOTE: Shell scan for use on cut and cover tanks
****

Scan tank shell hydraulic surfaces for indications such as metal loss, pits, cracks, gouges, and general corrosion. Distinguish between product and backside indications.

Quantify indications with an ultrasonic method. Be vigilant to detect large areas of uniformly-corroded metal and laminations. In areas inaccessible by scanning, use UT to characterize condition. Mark relevant indications on tank surfaces in a neat and professional manner adjacent to the indication.

]3.9.3 Bottom Examination

Scan 100 percent of the tank bottom, as interior appurtenances allow, for indications such as metal loss, pits, cracks, gouges, and general corrosion. Distinguish between product and backside indications.

Measure metal thickness with an ultrasonic method. Procedures must be compliant with ASME BPVC SEC V. Record measurements, exclusive of coating, for all tank bottom plates. Provide UT thickness measurement on no less than five locations per plate and at indications from the screening technologies determined to be relevant.

Mark relevant indications on tank surfaces in a neat and professional manner adjacent to the indication. Register UT data locations with geometric dataset.

3.9.4 Vacuum Box Testing

Perform VBT on locations in the tank where a breach in the hydraulic boundary is suspected. Use a procedure compliant with this Section and ASME BPVC SEC V. Evacuate the vacuum box slowly. Do not increase vacuum during active bubble formation. The VBT standard for acceptance is the no leak condition and API Std 650.

[3.10 PIPING AND NOZZLE INSPECTION

****

NOTE: Piping and nozzle inspection and piping hydrostatic test for use on cut and cover tank piping that is part of the tank hydraulic boundary or on drain-dry AST piping.

****

Pursuant to [Project Program][Statement of Work] requirements, perform an inspection of tank piping using the principles of API 570 and API RP 574. For areas determined to require further investigation, provide Fitness for Service evaluation pursuant to API RP 579-1 assessment methodology.

Examine nozzle necks, fittings, flanges, low points, thermal relief, expansion joints, slide pads, and vibration isolators. Assess suitability and serviceability.

3.10.1 Tank Piping Hydrostatic Test

Notify the Contracting Officer 14 days prior to hydrostatic test. Hydrotest piping in accordance with API RP 1110 and the Test Plan. Test the segment from inside the tank to the first accessible flange outside the tank. Utilize alternative means to isolate unflanged piping. Remove appurtenances within the test segment and isolate with blind flanges. Deploy components with pressure rating no less than existing flanges. Maintain the pressure within the piping for the test duration with no leakage or reduction in gauge pressure. Do not use an instrument without a calibration certificate.

Provide means to remove entrapped air. For inaccessible piping, account for the volume of any test medium added or removed by measuring with a calibrated meter. Provide means of communication between technicians at each end of the test segment. Ensure test water contains less than 50 ppm chloride content. Generate a test record contemporaneous with each test event.

3.10.1.1 Instruments

a. Instruments must be clean, in good working order, and within the interval of its calibration.

b. Calibrate all test instruments against a standard by an accredited laboratory. Calibration must have taken place no more than six months prior to the test. Calibration certificates must include the Model, Serial Number, date of certification, and must be signed by the calibrating company. Provide current Instrument Calibration Certificate for measurement instruments.

c. Provide indicating pressure test gauge connected directly to the segment and readily visible to the operator controlling pressure for the duration of the test. Analog type gauges must be compliant with ASME B40.100 Grade 3A, accurate to plus or minus 0.25 percent full scale, graduated over a range not less than 1-1/2 times nor more than four times the test pressure, and incremented no greater than 0.5 psi.

d. Digital type pressure gauge must be integral transducer type, compliant with ASME B40.100 Grade 3A, and accurate to plus or minus 0.25 percent full scale.

e. Provide digital contact thermometer incremented to 0.1 degree F or less. Memorialize pressure data with analog chart recorder. Transducers must have a range not less than 1.5 times and not greater than four times the pressure being tested.

f. Use calibrated continuous recorders (dataloggers) with adequate storage capacity to record temperature and pressure data. Synchronize temperature and pressure datalogger intervals.

g. Measure the volume of test medium with a calibrated meter.

3.10.1.2 Test Parameters

Maintain segment at a steady test pressure condition for a minimum of 15 minutes prior to initiation of examination for leakage. Examine piping, joints, and connections of accessible piping for leaks while maintaining test pressure. Leakage of temporary gaskets and seals, installed for the purpose of conducting the hydrostatic test and which will be replaced later, is permitted unless the leakage rate precludes maintenance of system test pressure for the required duration. Personnel performing the examination for leaks must be qualified for visual examination. Extend the test interval as needed to ensure positive reconciliation of test data. Monitor temperature and pressure. Analyze consistent error, inconsistent error, the magnitude of any lost volume, and pressure versus temperature data trends.

Measure test medium temperature independent of the environment. Provide instrument with output resolution of at least 0.1 degree F for water as the test medium. Ensure instrument accuracy exceeds the uncertainty required to achieve acceptance criteria.

Account for an accurate determination of fluid volume during a test. Provide volume measurements to the nearest fluid ounce.

3.10.1.3 Test Report

Provide test results and engineered analysis. Provide certification from the engineer the piping segments are either pass or fail. Inconclusive results are not acceptable. Submit Hydrostatic Test Report in accordance with Section [01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES][01 33 00 SUBMITTAL PROCEDURES].

]3.11 VALVES

Verify isolation and control valves are suitable and serviceable. Verify operation of valve appurtenances including motor and hand-operated equipment, pilot controls, body cavity relief, and position indicators.[Pursuant to [Project Program][Statement of Work] requirements, clean, recondition, test, and commission isolation valves and actuators back into service.]

3.12 GAS TEST HOLE REPAIR

****

NOTE: If Section 33 01 50.75 REPAIR OF FIELD FABRICATED FUEL STORAGE TANKS is being used in the contract concurrent with this Section, use repair of gas test hole requirements in Section 33 01 50.75.

If Section 33 01 50.75 REPAIR OF FIELD FABRICATED FUEL STORAGE TANKS is not being used in the contract, then repair must be performed pursuant to this Section.

****

Repair all gas test holes pursuant to Section 33 01 50.75 REPAIR OF FIELD FABRICATED FUEL STORAGE TANKS. Fill every gas test hole with weld metal. Temporarily plug the gas test holes between inspection and repair phases.

[3.13 DESTRUCTIVE TESTING

****

NOTE: Use this paragraph should it be expected that confirmation of inspection NDE will be useful or required, if there are questions about weldability, or if metallurgical properties of the material need to be established. Do not use destructive testing unless warranted and repairs are programmed.

****

After scanning has been performed and backside corrosion data reviewed, remove [two][five] 6 in diameter coupons of tank material for testing. Coupon locations will be identified by Government. Remove coupons with a straight, neat, distortion-free cutline and in accordance with Section 33 01 50.75 REPAIR OF FIELD FABRICATED FUEL STORAGE TANKS.

Mark coupon product side to identify orientation. Document coupon front and back side conditions with photography in accordance with paragraph PHOTOGRAPHIC DOCUMENTATION. Prepare samples and submit to laboratory for testing. In-situ testing is not acceptable as a substitute for laboratory testing. Use the services of an accredited laboratory to perform testing.

Repair holes from coupons pursuant to Section 33 01 50.75 REPAIR OF FIELD FABRICATED FUEL STORAGE TANKS.

][3.14 TANK CALIBRATION TABLE

****

NOTE: Strapping is not commonly required for inspections. Include this paragraph if existing strapping charts are believed to be inaccurate by the Government or if the tank under inspection is being returned to service. If Section 33 01 50.75 is being used concurrently, defer tank calibration requirements to that Section.

****

Calibrate tank in accordance with paragraph TANK CALIBRATION METHOD. Provide two hard copy laminated capacity tables, one in English units and one in SI units. Tables must show the volume of product at all liquid levels, from the lowest point of the tank bottom to the level of overflow. Include unit conversion notes on each table.

English unit table must show the volume of product in gallons and barrels, and the corresponding level of product in 1/16 inch increments. SI unit table must show the volume of product in liters and in cubic meters, and the corresponding level of product in 2.0 mm increments.

Volume calculations must be made in the smaller units. Larger units may be obtained by rounding. Use the top of the datum plate as level zero. Show levels below the top of the datum plate, including nozzle piping, in negative units. Tables must not include tank volume above the level of overflow.

On the calibration table (strapping chart), identify level points coincident with automatic tank gauge action or alarm settings.

Provide Electronic Tank Calibration Table on electronic media compatible with the Electronic Automatic Tank Gauging System. Also provide tables identical to the master gauge table in format compatible with Microsoft Excel. Contact Contracting Officer for direction on required format.

3.14.1 Tank Calibration Method

Calibrate storage tank in accordance with the API Manual of Petroleum Measurement Standards using the [API MPMS 2.2A][API MPMS 2.2B][API MPMS 2.2C][API MPMS 2.2D] method.

]3.15 DATABASE

Manage the indications database in a secure, auditable, and organized manner. Record visual and API inspection findings and associated geometric data in the system. Limit edit rights to individuals with a specific need.

3.16 INSPECTION REPORT

3.16.1 Preliminary Report

Upon completion of the inspection for each tank, prepare a preliminary report for the Government Technical Team. Identify mandatory and recommended repairs in itemized lists. Use a unique identifier (not bullets) for each item. State the methodology used to determine MRT. Submit Preliminary Inspection Report in accordance with Section [01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES][01 33 00 SUBMITTAL PROCEDURES]. Preliminary report contents are:

a. Tank ID, location, product service, and inspection date.

b. Suitability for service analysis pursuant to paragraph SUITABILITY FOR SERVICE, suitability for service statement identifying whether the tank is suitable for continued operation, reduce capacity, or complete removal from service. If tank is unsuitable for service or operating at a reduced capacity, provide a concise description of the reason(s).

c. Inspector of Record name, certification number, and date.

d. Summary of tank, nozzle, and appurtenance conditions.

e. Analysis of bottom examination and corrosion growth.

f. API Std 653 and DoD Tank Features List.

[g. Storage Tank Engineer name, profession engineer's license number, [API Std 653 certification number]and date.]

3.16.2 Full Inspection Report

Deliver a full report of inspection findings to the Contracting Officer. The report must include a record of NDE findings with drawings depicting plate layout and thickness measurement locations. Incorporate engineering analysis, suitability for service analysis pursuant to paragraph SUITABILITY FOR SERVICE, corrosion rate determinations, and remaining service life calculations. Include electronic appendices with inspection and geometric data. Provide separate report for each tank inspected. Provide Tank Inspection Summary Sheet for each tank inspected. Define all terms including adjectival descriptions. In addition, provide the NDE data as an electronic file as required in the paragraph DATA MANAGEMENT. Submit Inspection Report in accordance with Section [01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES][01 33 00 SUBMITTAL PROCEDURES].

3.16.2.1 Executive Summary

Provide a one page summary of the condition of the tank and concise recommendations for repairs.

3.16.2.2 Suitability for Service Statement

Statement must be a one page document. Specify the due date for the next inspection. Include the API Std 653 inspector of record certificate number and signature[as well as the tank engineer's seal and signature]. Provide a statement for each tank inspected. In the event the statement cannot be made, document the reason(s) and recommend corrective measures.

3.16.2.3 Wind or Rising Water Load Analysis

Pursuant to [Project Program][Statement of Work] requirements, perform a wind load calculation to determine the minimum ballast fill height required to withstand a severe wind event (i.e., to prevent overturning, sliding, buckling, or uplift) consistent with UFC 3-301-01 and ASCE 7-16. Review historical weather records applicable to the location.

3.16.2.4 Seismic Load Analysis

Pursuant to [Project Program][Statement of Work] requirements, perform a seismic load calculation to determine the maximum fill height and freeboard required to prevent overflow during a seismic event. Calculate loads consistent with UFC 3-301-01 using Risk Category III, unless notified otherwise by the Contracting Officer.

3.16.2.5 Tank History

Establish the known historical record of the tank. The record must include as much information as possible and include:

a. Nameplate information

b. Products previously and currently stored in the tank

c. List of previous inspections

d. List and describe significant environmental (earthquake, hurricane, flooding) or operational (over-pressure, vacuum, mechanical damage, fire, settlement) events

e. List and describe repairs or alterations performed (include significant drawings and executive summaries from other repair reports in the report appendices)

f. Other pertinent facts and data

3.16.2.6 Inspection Methodology

Provide a detailed description of the inspection methodology for each tank component inspected. Identify type of inspection, equipment, and methods. Discuss corrosion rates, MRT, remaining service life[, and hydrostatic testing methodology]. Explain how statistical significance was addressed and meaningful data were obtained.

3.16.2.7 Findings

Describe inspection and NDE findings for each region. Present corrosion rates, minimum thickness, and remaining service life calculations. Discuss all findings. Summarize NDE data in the report body and provide complete NDE data in appendices.

3.16.2.8 Recommendations

Report recommendations based on policy, criteria, standards, and regulations separately from those related to hydraulic and structural integrity.

3.16.2.9 Data

Include all data collected during the inspection. Data must be electronic, in tabular form, and be registered with tank geometric data.

3.16.2.10 Checklist/Features List

Prepare API Std 653 Appendix C and DoD Tank Features List. Annotate items which are not applicable. Provide checklist, features list, field notes, and measurements taken by the tank inspector. Provide the DoD Tank Features List in both portable document and spreadsheet formats.

3.16.2.11 Sketches

Include tank bottom, shell, and roof plate sketches depicting orientation, indications, appurtenances, nozzles and their purpose, manways, and other significant tank features. Include the sizes, dimensions, and lengths of significant tank features.

[For ASTs, include sketches of the dike, piping in the dike, locations of supports, stairs, ladders, cathodic protection stations, and monitoring wells. Include the sizes, dimensions, and lengths of significant dike features.

][For USTs, include sketches of the pumphouse and pits associated with the UST, piping in the pumphouse, information of piping and equipment in the pumphouse and pits, locations of supports, stairs, ladders, etc. Include the sizes, dimensions, and lengths of significant UST pumphouse and pit features.

]3.16.2.12 Photographs

Provide full resolution well-lit electronic color photographs which depict the area of interest. Provide a photoguide which contains descriptive caption for the photographs.

3.16.2.13 Calculations

Provide calculations consistent with API Std 653. Provide calculations for corrosion rates, MRT, next inspection date, settlement, seismic and wind load analysis, and estimated remaining service life. Provide a sample calculation for each determination along with assumptions and references used.

3.17 TANK RETURN TO SERVICE

****

NOTE: If Section 33 01 50.75 is being used concurrently, use return to service requirements in that Section.

Use first bracketed option for NAVFAC if tank is being returned to service after inspection.

Use second bracketed option for Army or Air Force.

****

[In order to return a storage tank to the operator fit for service, comply with NAVFAC Red Zone requirements in Section 01 45 00 QUALITY CONTROL, and requirements of UFC 3-460-03. Minimum return to service requirements are:

a. Inspection Report

b. Tank Suitability for Service Statement

c. List of Identified Repairs

d. List of Recommended Repairs

e. List of Pending (Actual) Repairs

f. Calibration (Strapping) Charts

g. Signed statement which declares custody of the tank is returned to the Activity and items a through f above have been provided to the Contracting Officer

][In order to return a storage tank to the operator fit for service, comply with requirements of UFC 3-460-03 and Section 01 45 00 QUALITY CONTROL.

] Provide adequate time for curing of coating. Use new gaskets on manway and flanged connections which were opened during the work. Replace fasteners which were removed during the work and are unsuitable for re-use. Verify the vents are not covered and are operating properly. Verify any temporary gas test hole plugs have been removed and all gas test holes have been repaired pursuant to paragraph GAS TEST HOLE REPAIR. Test valves to ensure they operate and cavities do not contain liquid. Tank cannot be returned to the operator until the suitability for service statement has been provided.

3.17.1 Cleanliness

3.17.1.1 Tank

After completion of the work, clean interior surfaces of the tank to remove all foreign matter such as blast material, dirt, debris, grease, and oils. Provide interior surfaces free from sources of product contamination, fit for service in [F-76][JP-5 / JP-8 turbine][_____] fuel storage, and to the satisfaction of the Contracting Officer. After removal of protective coverings, inspect motors, pumps, impellers, risers, floating roof, and gauges to ensure contamination or damage has not taken place. Should damage or contamination be found, remedy the finding to the satisfaction of the Contracting Officer.

3.17.1.2 Piping

Clean the interior of piping to ensure surfaces are free of contamination or foreign matter, and fit for [F-76][JP-5 / JP-8 turbine][_____] fuel service.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 01 98 (February 2023)**

Preparing Activity: USACE **Superseding**
UFGS-33 01 98 (May 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 01 98

SLIP LINING OF EXISTING PIPING FOR LEVEE APPLICATIONS

02/23

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USACE / NAVFAC / AFCEC **UFGS-33 01 98 (February 2023)**

Preparing Activity: USACE **Superseding**
UFGS-33 01 98 (May 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 01 98

SLIP LINING OF EXISTING PIPING FOR LEVEE APPLICATIONS

02/23

****

NOTE: This guide specification covers the requirements for the procurement, installation, and testing of slip lining for existing piping within levees only. Other specifications are available that cover the specific slip lining technologies provided here. It is encouraged to provide this specification to non-federal levee sponsors as an example to be used on rehabilitation projects associated with levee systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 SUMMARY

This section of the specification discusses the requirements and work needed to rehabilitate existing gravity pipes in a levee system related to pipe liner materials, bulkheads, annular space grouting between the host and liner pipe, performance testing, labor, and other materials and equipment necessary to accomplish the work as stated herein. Rehabilitation will most often consist of installing a liner pipe within an existing host pipe and grouting the annular space, but in some cases a close-fit or spray-on liner may be used which will render grouting unnecessary. The term "slip lining" is generic within this specification and includes sectional (HDPE, GFRP,) spiral-wound PVC, close-fit (CIPP, fold and form), and spray-on (cementitious, epoxy) liners. Although slip lining levee pump station discharge pipes may be possible, this specification will not endorse a material or method for it or any other pressurized pipe system. Submit details of the proposed slip lining materials and methods, including any necessary appurtenances for approval..

1.2 MEASUREMENT AND PAYMENT

Payment will be made for work performed under this item in accordance with [the][each] pipe lined as shown in the bid schedule. Payment includes all costs associated with labor, equipment, material, supervision, cleaning, inspection, sheeting, water control, installation, safety, dust/erosion control, testing, site restoration and all other work specified or not which is reasonably required to provide a completed installation. Items not specified are considered incidental to the work. Include all incidental cost in the bid price for the slip liner.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C403/C403M	(2023) Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

ASTM C581	(2020) Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures, Intended for Liquid Service
ASTM C939/C939M	(2022) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C942/C942M	(2021) Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM D2412	(2021) Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3262	(2020) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3681	(2012; E 2014) Standard Test Method for Chemical Resistance of “Fiberglass” (Glass–Fiber–Reinforced Thermosetting-Resin) Pipe in a Deflected Condition
ASTM D3839	(2014; R 2019) Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D4161	(2014; R 2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F585	(2016; R 2021) Standard Guide for Insertion of Flexible Polyethylene Pipe into Existing Sewers
ASTM F1735	(2021) Standard Specification for Poly (Vinyl Chloride)(PVC) Profile Strip for PVC Liners for Rehabilitation of Existing Man-Entry Sewers and Conduits

ASTM F1741	(2008; R 2016) Standard Practice for Installation of Machine Spiral Wound Poly (Vinyl Chloride) (PVC) Liner Pipe for Rehabilitation of Existing Sewers and Conduits
ASTM F1743	(2024) Standard Practice for Rehabilitation of Existing Pipeline and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)
ASTM F2019	(2011) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)
ASTM F2620	(2024) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
ASTM F3190	(2021) Standard Practice for Heat Fusion Equipment (HFE) Operator Qualification on Polyethylene (PE) and Polymide (PA) Pipe and Fittings

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements
EM 1110-2-1601	(1991; 1994 Change 1) Engineering and Design -- Hydraulic Design of Flood Control Channels

1.4 ADMINISTRATIVE REQUIREMENTS

1.4.1 Pre-Installation Conference

Within [_____] calendar days of notice to proceed, conduct a scope-validation meeting, including potential Sub-Contractors, and Contracting Officer to facilitate common agreement and understanding of the work to be performed. At this time, supply the resumes of Sub-Contractors, project superintendent or project manager to the Contracting Officer or be eliminate from consideration.

1.4.2 Detailed Work Plan

Submit a Detailed Work Plan not less than 30 days prior to commencement of work. The plan includes but is not limited to the following:

a. Proposed construction sequencing and scheduling

b. Plan for removal of any obstructions encountered

c. Detail Drawings in an approved form, for [each] slip lining system including pipe manufacturer's instructions for installation

d. List of proposed products showing new diameter[s] of slip lining pipe[s] to be installed along with existing pipe diameter[s]

e. Specify all mandrel dimensions for each pipe to be slip lined

f. Details for procedures of area requiring special construction techniques

g. Proposed methods for water flow control or diversion during the slip lining process

h. Proposed access and staging area[s]

i. Proposed method for permanently or temporarily plugging and re-establishing lateral connections to the pipe to be slip lined when applicable

j. Joints, gaskets, proposed resins, coatings, [_____], and other pertinent information as applicable

k. Dates of excavation and pipe placement, along with proposed work hours

l. Method for preventing damage to the host and liner pipe[s] using guide rails, pipe invert paving, or other applicable methods when the invert of the host pipe has deteriorated significantly

m. Method for waste grout recovery

n. Detailed plan for addressing buoyant forces of the liner pipe during grouting

o. Health & Safety Plan in compliance with applicable portions of EM 385-1-1.

p. Manufacturer's recommendation regarding methods for repair of damage to liner pipe following installation

q. List of proposed subcontractors with qualifications and work history

r. Written confirmation that the grouting procedures have been coordinated with the grout installer.

1.4.3 Sequencing and Scheduling

Installation can not proceed until the contractor's Construction Progress Schedule has been approved. The Contracting Officer must be provided 72 hours notice prior to placing liner pipe[s]. Do not proceed with slip lining operations for pipes that are likely to reach gauge operation elevation within 5 days as forecast by the National Weather Service. Sequence work to minimize stoppages as a result of high water. In the event high water threatens to inundate a lined pipe prior to annular grouting, make every effort to complete the bulkheads and plug all holes through the bulkheads or otherwise prepare the project so no water enters the annular space. In most cases, the majority of water can be drained and any remaining water "pushed" out during the grouting process, but the Contracting Officer will determine if any special effort to clean the annular space is required and to what degree.

1.5 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Superintendent and Contractor Qualifications; G, DO

Grout Contractor Qualifications; G, DO

Pipe Inspection Procedures; G, DO

Construction Progress Schedule; G, DO

CCTV Recordings and Report Logs; G, DO

Digital Photographs and Report Logs; G, DO

Detailed Work Plan; G, DO

Analyses and Calculations; G, DO

Bulkhead Mix Design; G, DO

Grout Trial Mix Tests; G, DO

Pre- And Post-Slip Lining Conveyance Capacity; G, DO

SD-02 Shop Drawings

Bulkheads; G, [_____]

SD-03 Product Data

Liner Pipe; G, [_____]

Soluble Reactive Silicate Concrete Treatment Product; G, DO

UV Protection; G, DO

SD-05 Design Data

Conveyance Capacity; G, [_____]

Downstream Scour Protection; G, [_____]

Structural Properties; G, [_____]

SD-06 Test Reports

Annular Space Grout Test Reports

SD-10 Operation and Maintenance Data

Maintenance; G, [_____]

SD-11 Closeout Submittals

Manufacturer's Warranty; G, DO

Post-Installation CCTV Recordings and Report Logs; G, DO

Post-Installation Digital Photographs and Report Logs; G, DO

1.6 QUALITY ASSURANCE

1.6.1 Qualifications and Supervision

Submit Superintendent and Contractor Qualifications for slip lining pipe lining systems for at least [_____] years. Provide a superintendent on site at all times and with full authority to direct the means, methods, equipment, and personnel and performance of the work.

1.6.2 Grout Contractor Qualifications

Submit Grout Contractor Qualifications in letter form from the foam manufacturer stating that they are an approved applicator for that product, as well as the grout mix design, and test break results for that particular design. Reference paragraph GROUT MATERIALS AND MIXES for grout mix design

requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

Pipe sections are to be handled and stored in such a way as to prevent damage to the pipe or creating a safety hazard to workers; this includes using restraining measures to prevent uncontrolled rolling or dropping. Handle and store in accordance with the manufacturer's published recommendations. Reference paragraph LINER PIPE for lists actions for damaged pipe sections.

1.8 WARRANTY

Submit [_____] copies of the signed Manufacturer's Warranty for all products within [_____] [days] [weeks] of final completion of the work.

PART 2 MATERIALS

2.1 DESIGN REQUIREMENTS

2.1.1 Conveyance Capacity

Meet or exceed the conveyance capacity of the host pipe with the liner pipe, while maintaining a minimum 25-mm 1-inch wide annular space between the host and liner pipes (for systems requiring grouting), unless a government-reviewed and approved study indicates a reduced capacity is allowed. In some cases, the capacity can be increased with improvements to the entrance geometry, but any such improvements must be submitted for approval. Submit all pre- and post-slip lining conveyance capacity calculations for approval, including supporting information for assumptions.

2.1.2 Downstream Scour Protection

Verify the existing scour protection is sufficient to prevent erosion at the outlet of slip lined pipes (understanding that slip lining a pipe usually increases the outflow velocity), or determine the new materials needed using current design guidance, such as EM 1110-2-1601, to prevent erosion.

2.1.3 Design Criteria

Furnish a slip liner pipe system designed by a licensed professional engineer meeting the standards outlined in the following sub-paragraphs. Submit calculations of the system's structural properties prior to construction. Support all assumptions utilized in calculations with product data, test reports, or referenced publications.

a. Structurally design the new slip liner pipe system using the fully flood-loaded levee elevation to establish external hydrostatic pressure. The Contractor can submit a request to the Contractor Officer to lower the design loading for circumstances such as a pipe within highly plastic clays subject to brief loadings, or portions of pipes that fill with flood water and provide equalization and pressure.

b. Design the new slip liner pipe system for maximum 5 percent ovality and a maximum allowable long-term deflection of 5 percent.

c. Design the new slip liner pipe system using a safety factor of 2.5 for buckling and 2.0 for bending, wall crushing and buoyancy. Perform separate buckling analyses for the pressures associated with grouting the annular space and for a full hydrostatic loading. Ignore the cross-sectional shape distortion of the host pipe in the buckling analysis.

2.1.4 Analysis and Calculations

Submit detailed analyses and calculations, stamped by a licensed P.E., not less than 30 days prior to commencement of work. Demonstrate suitable application of products based on the following parameters:

a. Deflection

b. Confined buckling (for both the grouting case and the full flood load case)

c. Long-term hydrostatic buckling (may be available from the pipe manufacturer)

d. Calculations verifying conveyance capacity and velocity of outlet flow meet the requirements as stated herein

e. Design calculations showing that the proposed pipe satisfies the current design criteria neglecting any contribution from the host pipe

f. Bulkhead designs and locations including vent and injection port location and proposed materials to be used in bulkhead construction

g. Buoyant force calculations during grouting

h. Grout mix designs per the requirements stated herein

i. Initial set time of grout

j. Estimated grout volume for each grouting stage to prevent buoyancy of the liner pipe and/or the volume of water required to counteract buoyancy in the event that the liner pipe floats and impacts the design flow of the pipe. Water can be used within the liner pipe to weigh down the floated sections before the grout sets.

k. The maximum grout injection pressure as limited by the pipe manufacturer.

2.2 LINER PIPE

Standard pipe lining materials include: solid wall High Density Polyethylene Pipe (HDPE), Machine Spiral Wound Poly Vinyl Chloride (PVC) Pipe, and Glass Fiber-Reinforced Plastic Pipe (GFRP). Close-fit liners such as cured-in-place-pipe (CIPP), fold and form PVC, and cementitious or epoxy spray on liners, are generally considered less desirable since they do not provide an annular space for grouting and may therefore only be used in cases where the host pipe has not experienced penetrating defects. The government will decide if close-fit liners are suitable based on the condition of the host pipe as determined using the post-cleaning camera inspection recording.

a. Select liner pipe material to ensure that the anticipated maximum thermal expansion or contraction does not interfere with closure devices or allow the liner to retreat into the host pipe past the headwall throughout the range of ambient air temperatures anticipated during the service life of the liner pipe[s]. Assume ambient air temperatures for this item to range from [___] degrees C F to [___] degrees C F.

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NOTE: Determining the temperature limits is somewhat speculative and using the extreme air temperatures for the area may be overly conservative considering the potential for latent heat/cooling from the ground and static air due to closed gates.

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b. Submit manufacturer's detailed product data with complete information on liner pipe materials (pipes, joints, gaskets, fittings, entrance bells), physical properties, dimensions, installation minimum/maximum allowable parameters such as maximum recommended external grout pressure, axial compressive stress, minimum bending radius or maximum joint angular deflection, etc. Include a manufacturer's certificate of compliance with specifications for proposed materials.

c. Pipe liner materials other than those stated below may be submitted for consideration and approval by the Contracting Officer based on meeting the design requirements as stated herein.

d. Repair slip liner pipes with cuts, gashes, nicks, abrasions, or other physical damage deeper than 10 percent of the wall thickness to the Government's satisfaction or replace at no additional cost to the Government. Pipes sections containing cracks or fractures that penetrate the full depth of the wall thickness will be rejected and replaced at no cost to the government.

2.2.1 PVC Pipe(Machine Spiral Wound)

2.2.1.1 Profile Strip

Provide extruded PVC profile strip in accordance with the requirements of ASTM F1735. Exposed ferrous elements on the outer side of the liner pipe are only allowed in cases where the annular space will be grouted.

2.2.1.2 Joints

a. The male portion of the joint is formed into one side of the profile of the PVC strip while the female portion is formed into the other side so they create a watertight seal when mechanically interlocked as it is wound into place. A sealant [may][must] be used to supplement the joint as [permitted][recommended][required] by the manufacturer..

b. Once wound into place within the host pipe, the spiral wound liner is not to be intentionally or otherwise expanded or contracted to change its diameter.

2.2.2 Solid-Wall High Density Polyethylene Pipe (HDPE)

2.2.2.1 Pipe

a. Manufacture pipe and pipe fittings from high density compounds in accordance with ASTM D3350, with a minimum designation of PE 3408, a minimum cell classification of 345464C, and a minimum Standard Dimension Ratio (SDR) of 32.5.

b. Provide solid wall pipe with a smooth interior and exterior with no corrugations or exposed ferrous elements.

c. Mark each pipe segment on the inside and outside with a coded number which identifies the manufacturer, SDR, size, materials, machine, date and shift on which the pipe was extruded.

2.2.2.2 Joints

a. Butt-fuse joints in accordance with ASTM F2620 and the manufacturer's recommendations or join into a continuous length by an interlocking method (typically proprietary) meeting the requirements of ASTM D3212. Screw-type or threaded joints will not be allowed unless a positive lock is included in the joint system or the exterior perimeter of the joint is extrusion welded prior to insertion.
b. Any external beads greater than 6 mm 0.25 inch in height as a result of butt-fusion welding at a joint will require that the corresponding internal bead be trimmed. External beads resulting from butt fusion need not be trimmed unless the bead projection will negatively impact pipe installation or migration of annulus grout.

2.2.3 Glass Fiber-Reinforced Plastic Pipe

2.2.3.1 Pipe

Provide centrifugally cast glass-fiber-reinforced (includes thermosetting-resin and polymer mortar) plastic pipe in accordance with ASTM D3262, cell classification Type 1, Liner 2, Grade 3.

a. Provide minimum pipe stiffness of [_____] kPa psi when tested in accordance with ASTM D2412.

b. Provide glass consisting of a commercial grade of E-type glass fibers with the amount, location and orientation of the chopped glass-fiber reinforcement specifically designed for each application.

c. Sand must be minimum 98 percent silica kiln-dried and graded.

d. Provide polyester wall resin that is an isophthalic, orthophthalic or other approved resin with a minimum tensile elongation of 2 percent.

e. Show by testing that the fiberglass liner is resistant to long-term corrosion. Perform testing in accordance with ASTM D3681 using 1.0N sulfuric acid for sanitary sewage, and ASTM C581 for industrial sewage.

f. Mark each pipe segment on the inside and outside to identify the manufacturer's number, diameter, stiffness, ASTM designation and lot number.

2.2.3.2 Joints

a. Provide pipe with joints designed so the internal diameter of the pipe is not decreased at the joint.

b. Meet the performance requirements of ASTM D4161. Field connect pipe[s] with low-profile, fiberglass bell-spigot joints or flush fiberglass bell-spigot joints, so that there is no less than 25 mm 1 inch of annular space between the outside face of the joint and host pipe. Utilize elastomeric sealing gaskets, meeting the requirements of ASTM F477, as the sole means to maintain joint water-tightness.

2.2.4 Cured-In-Place Pipe (CIPP)

It is recommended that CIPP be used primarily as an option to extend the life of a pipe that has no penetrating deterioration or at least no appreaciable soil loss, or for applications with limited access. CIPP is not recommended in cases where soil loss is substantial or indeterminate. Provide CIPP liner material manufactured in accordance with ASTM F1743 or ASTM F2019. Protect liners that conform to ASTM F2019 from UV exposure over the lifetime of the liner material.

2.2.5 Sprayed-In-Place Pipe (SIPP)

It is recommended that SIPP be used primarily as an option to extend the life of a pipe that has no penetrating deterioration or at least no appreaciable soil loss, or for applications with limited access. SIPP is not recommended, and may be prohibited, in cases where soil loss is substantial or indeterminate. Provide liner material manufactured in accordance with ASTM F3190ASTM F3182. Liners that contain polyurea or polyurethanes with methylene diphenyl diisocynate contain isocyanates and are prohibited.

2.2.6 UV Protection

For all slip liner pipes constructed of materials that are not UV stabilized that will be exposed to UV light, apply receive a field-applied coating on the end and interior surface of the pipe to resist deterioration from ultraviolet radiation. Apply the UV protective coating (white or light colored preferred) from the cut end of the pipe to a distance inside the pipe equal to two times the inside diameter of the liner pipe. Touch up nicks, scratches and minor abrasions to the coating in the field following final installation.

2.3 GROUT MATERIALS AND MIXES

2.3.1 Grout For Annular Space

Provide grout for the annular space in accordance with this Specification and with the pipe manufacturer's published recommendations, using the more stringent of the two when conflicting. If the chosen pipe liner cannot meet the minimum factor of safety against bending, buckling or crushing on its own, then a structural grout must be used so the combination of these two elements can achieve the minimum factor of safety requirements.

2.3.2 Mix for Annulus Grouting

2.3.2.1 Cement

Comply with ASTM C150/C150M.

2.3.2.2 Water

Use only potable water to prepare grout.

2.3.2.3 Admixtures

Select admixtures to meet performance requirements, improve pumpability, control shrinkage, set time, and reduce segregation. Do not use biodegradable admixtures.

2.3.2.4 Compressive Strength

2.3.2.4.1 Structural Grout

Use the grout 28-day compressive strength determined necessary for the pipe and grout composite design.

2.3.2.4.2 Non-structural Grout

No minimum compressive strength has been assigned for non-structural grouts.

2.3.2.5 Consideration for Mix Design

Design a grout mix and installation procedure to completely fill the annular space based upon, but not restricted to the list below, such that the slip liner pipe will not float (either by external restraint or internal weighting). Maintain an appropriate viscosity based on the maximum distance of flow required as tested in accordance with ASTM C939/C939M. Verify the density in conformance with ASTM C138/C138M or by other methods as approved by the Contracting Officer.

a. Volume of annular void

b. Minimum strength to achieve the design requirements as stated herein

c. Retarder admixture for extended placement times

d. Shrinkage-reducing admixture to limit shrinkage to 1 percent by volume

e. Distance between grout injection ports

f. Heat of hydration compatible with pipe material in accordance with pipe manufacturer's recommendation

2.3.2.6 Mixers and Pumps

Mix the materials in equipment of sufficient size and capacity to provide the desired amount of grout material for each stage of the grouting operation. Mix the grout to a homogeneous consistency and deliver grout to the injection point [under a normal range of operating conditions] [at a steady pressure with a non-pulsating pump at the mix tank]. Provide equipment capable of mixing the grout at densities required for the approved procedures and also be capable of changing mixing parameters as dictated by field conditions at any time during the grouting operation.

2.3.2.7 Pressure Gauges

a. Provide pressure gauges that are suitable for use in a grouting environment and have a working range between 1.5 and 2.0 times the maximum design grout pressures, and have accuracy within 0.5 percent of full range.

b. Provide, at a minimum, one pressure gauge at the point of injection through the bulkhead and one pressure gauge at the grout pump.

2.3.3 Grout Trial Mix Tests

a. Structural Grout: Provide Grout Trial Mix Test Results with viscosity, density, and 28-day minimum compressive strength. Also provide the grout working time before a 15 percent increase in viscosity occurs.

b. Non-structural Grout: Provide Grout Trial Mix Test Results with viscosity, density,and estimated initial set time to be used for subsequent lift placement timing. Also provide the grout working time before a 15 percent increase in density or viscosity occurs.

2.3.4 Bulkhead Concrete

Design a dry-pack concrete mix to form a bulkhead at each end of the pipe to retain the annular grout. Submit the bulkhead mix design for approval. Low slump concrete must consist of cement, fine and coarse aggregate, water, and an air-entraining admixture. Thoroughly compact concrete into the prepared void by tamping, rodding, ramming, etc. Forms may be used to confine the concrete. The temperature of the in situ concrete (i.e., headwall or gatewell structure), adjacent air, and bulkhead concrete must be above 4 degrees C 40 degrees F during placement.

PART 3 EXECUTION

3.1 PREPARATION AND INSPECTION

The Contracting Officer is not responsible for and makes no guarantees regarding the information, data, and physical condition of underground facilities or existing pipe[s]. Submit pipe inspection procedures to locate breaks, obstacles and connections in pre-construction submittals for approval. Note all connections and any conditions which may prevent proper installation of the liner. Correct these conditions prior to liner installation. Coordinate slip lining efforts with the Contracting Officer and the owner of the affected pipe. Submit the CCTV Recordings and Report Logs and/or Digital Photographs and Report Logs to the USACE for approval prior to pipe liner installation. Base the work plan on a thorough review of the inspection video and/or digital photographs and report logs.

3.1.1 Safety

Use remote CCTV inspections for small diameter or unsafe pipes, but walk-through inspections with digital photography are preferred over remote video inspections for pipes large enough and safe to enter when confined space entry procedures are followed. Note any areas that may involve entry and/or work in confined spaces and [address in][provide as a supplement to] the project Health and Safety Plan provided under Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS prior to ordering supplies or performing work in these areas.

3.1.2 Water Control

Submit the proposed means and methods as required to dewater the work area and divert flowing water around the work area, including berm dimensions, bypass pumping requirements (pump size as well as diameter and length of lines), and a dewatering plan, so that the work area remains satisfactorily dewatered to facilitate inspections, installation of the liner pipes, and placement of the grout.

3.1.3 Host Pipe Cleaning

Cleaning the host pipe is required prior to final visual inspection and installation of the slip liner pipe, but the host pipe should be visually inspected (by man-entry or CCTV camera) prior to cleaning to identify any areas of concern for the cleaning process (penetrating corrosion exposing erodable backfill or heavily corroded areas that may excessively delaminate during cleaning) where there's a potential to damage the pipe or the surrounding soil. Cleaning constitutes removal of all loose debris (soil, rocks, trash, etc.), roots, and other matter which would preclude proper installation of the slip liner pipe and annulus grout. Perform cleaning such that no damage occurs to the host pipe. If the integrity of the host pipe is suspect, a test section should be cleaned and re-inspected to see if damage to the pipe has occurred. Handle water used for flushing and cleaning [the] pipe[s] prior to slip liner system installation to comply with regulatory agencies having jurisdiction regarding erosion prevention and sediment control procedures for storm water discharge.

3.1.4 Insertion and Pulling of Mandrel

Prior to insertion of the segmental liner pipe segments, pull a properly sized mandrel through the host pipe to check for adequate clearances prior to submitting the full materials order. Provide a properly sized mandrel with an outside diameter at least 2.54 centimeters2 inches greater than the slip liner pipe, having a length no less than the segment length of the liner pipe, and having a stiffness equal to or greater than that of the slip liner pipe. Provide a mandrel no less than 3 meters10 feet long for host pipes receiving a spiral-wound PVC liner. Any segment of slip liner pipe used as a mandrel is prohibited from being used as a permanent slip liner pipe. If the host pipe fails to allow the mandrel to pass, the rehabilitation method will have to be redesigned.

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NOTE: The redesign could include a smaller liner pipe diameter (as long as the conveyance minimum is met) or the use of non-segmental liners such as CIPP, fold-and-form, or spray on liners (assuming the strength minimum is met by themselves since grout cannot be used with these liners).

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3.2 EXCAVATION

The installation of a liner pipe is anticipated to only use existing points of entry such as headwalls, manholes, and gatewells, but there may be a need in unusual circumstances to gain access to the host pipe through limited excavations along its length. Justify the need to excavate along the length of the host pipe in writing and submit to the Contracting Officer for approval. Any excavation will be limited in scope to only what is absolutely necessary to slip line the host pipe. Comply with local, State, and Federal regulations. Repair any excavation of levee material according to [USACE regulations][Section 31 00 00 EARTHWORK] regarding acceptable fill material, benching and compaction requirements.

3.3 INSTALLATION

3.3.1 General

a. Point repairs, deemed necessary at any location on the existing pipeline prior to slip lining must be approved by the Contracting Officer prior to start of work.

b. Plug lateral lines according to the details submitted in the work plan. Upon completion of insertion of the slip line pipe and a 24-hour pipe relaxation period, expedite the reconnection of cross connections as quickly as possible. Provide for temporary pumping and/or control of flow from each connection until final reconnection has been performed. Connections are to be reopened, trimmed, and sealed to a neat, clean opening concentric with the connection pipe in a manner that provides water tight seals on both ends of the reconnection (between the liner pipe and the connection pipe and between the connection pipe and the existing lateral line). This will require precise measurements from the bulkhead to the lateral connection and careful trimming to prevent removing material outside the connection area.

c. In all instances, the liner pipe must be a fixed diameter and must not be expanded intentionally or otherwise.

d. Provide maximum and minimum lay lengths in accordance with manufacturer's requirements and any constraints based on work limits [as prescribed by the Contracting Officer].

e. Insertion may proceed from either upstream or downstream as suitable access is available.

f. Use only sub-aqueous lubricants approved by the pipe manufacturer.

g. Correct conditions that would either prevent insertion of or cause unacceptable damage to the liner pipe during insertion, such as bulges or jagged edges protruding beyond the expected limits of the annular space.

h. Consider thermal expansion/contraction effects such that the ends of the slip liner pipe are flush with the existing headwall/manhole to within 12 mm 0.5 inch. Where a slip liner pipe meets a gatewell or flapgate, the slip liner pipe cannot project beyond the end of the host pipe. Make reasonable attempts to achieve a flush surface between the slip liner pipe and the host pipe. Delay trimming of the liner pipe[s] for 28 days after completion of grouting.

i. Construct all blocking, if used, of inert, non-ferrous material, and install in accordance with manufacturer's recommendations.

j. Prior to grouting, visually inspect all slip liner pipe joints to check the integrity of joints and verify that the liner has not been damaged during installation. Repair if needed using liner manufacturer's recommended procedure.

k. Sealing at manholes, if applicable: A tight seal is required at manholes, openings, or abutments with no annular gaps. Rebuild manholes between linear ends resulting in a smooth, continuous flow line through the manhole.

l. The grout must achieve 'initial set' before a succeeding grout lift can be placed so the additional vertical load does not transmit additional lateral load to the pipe.

m. At the completion of construction the exposed ends of [the][all] slip lined pipe[s] must have a clean, finished look with no visible signs of grout vents, injection tubes, etc.

n. Restore project site to original condition prior to final payment. Include the cost to repair all damages resulting from the work in the base bid.

3.3.2 Machine Spiral Wound PVC Pipe (Excluding close-fit)

a. Install machine Spiral Wound PVC Liner Pipe in accordance with ASTM F1741, manufacturer's recommendations and the provisions of this Section. In the event of a conflict, the most stringent of the three governs.

b. No mechanical pulling or pushing force (of the liner pipe (such as with a backhoe bucket or winch), other than that applied by the purpose-built installation machine, is allowed.

c. In all instances, insert the liner pipe as a fixed diameter with no subsequent expansion or contraction allowed.

3.3.3 Solid-Wall High Density Polyethylene Pipe (HDPE)

a. Install Solid-Wall High Density Polyethylene (HDPE) Liner Pipe in accordance with ASTM F585, manufacturer's recommendations and the provisions of this Section. In the event of a conflict, the most restrictive of the three governs.

b. Allow the installed pipe to relax and cool following installation in accordance with manufacturer's recommended time, but not less than 24 hours, prior to any reconnection of lines, constructing the bulkheads, or grouting the annulus. Inject grout according to the work plan so that the thermal limit is not exceeded and the pipe does not become buoyant.

c. Reconnection of lateral lines is accomplished using relatively short pieces of pipe of the same type of HDPE material used to slip line the main pipe and of a proper diameter to fit the lateral line such that grouting the annular space will not enter the lateral line. Extrusion welding is required to mate the lateral line stub to the main slip lining pipe.

d. Provide slip liner pipe free of foreign inclusions and visible defects such as cracks, creases, unpigmented or nonuniformly pigmented pipe. Cut the ends of the pipe squarely and cleanly so as not to adversely affect joining or connecting. Field cuts must be de-burred and free of defects.

e. Join sections of slip liner pipe and insert into the host pipe until a continuous liner pipe is created along the entire length of the host pipe, in accordance with pipe manufacturer's recommendations. Heating of the joints is allowed in cold weather to facilitate joining.

3.3.4 Glass Fiber-Reinforced Plastic Pipe

Install Glass Fiber-Reinforced Plastic Liner Pipe to the most restrictive requirements of ASTM D3839 or the manufacturer's recommendations.

3.3.5 Cured-In-Place Pipe

Follow the manufacturer's recommendations on the medium used to cure the liner (i.e. water, steam, or UV) and note special considerations regarding temperature, transport, and removal of the medium. Perform surface preparation of the host pipe according to the manufacturer's recommendations to ensure adhesion between the liner material and host pipe.

3.3.6 Sprayed-In-Place Pipe

Apply liner material radially onto the interior wall of the host pipe either mechanically or manually according to the manufacturer's requirements, including the necessary degree of cleanliness of the host pipe surface. Seamlessly apply lining material with no surface voids or ridges. Monitor viscosity and liner thickness closely to apply a uniform thickness throughout the host pipe.

3.3.7 Bulkheads for Annulus Grouting

a. Install the upstream bulkhead followed by the downstream bulkhead (to reduce the chance of collecting water within the host pipe) after waiting at least 24 hours between the minimum 24-hour and maximum 72-hour wait period after insertion of the liner pipe. Provide a bulkhead with a minimum thickness of 300 mm 1 foot, or the thickness of the headwall, whichever is greater.

b. Provide a sufficient number of staggered-length grout tubes so that the anticipated flow distance of the grout based on its viscosity can run the distance between the bulkheads before reaching initial set.

c. Shop drawings must include all locations of the grout/air ports and sketches of the proposed bulkheads, as well as the lengths of each grouting port. Include manufacturer's literature for accessories and form coating materials. Submit the proposed materials, dimensions, location of grout injection ports, vent tubes, etc.

d. Place vent holes at the crown and the invert in the downstream bulkhead. Place an access hole, sized to facilitate the method of grout input and an air vent at the crown in the upstream bulkhead. The vent holes in the downstream bulkhead are plugged as soon as grout begins to flow out each hole. The air vent in the upstream bulkhead is kept clear until grout begins to flow out of the vent.

e. Hand-finish the bulkheads to a professional quality appearance. After a curing period and pressure washing of the headwalls, apply a Soluble Reactive Silicate Concrete Treatment Product over the entire headwall surface, including the bulkheads.

3.3.8 Annulus Grouting

a. Notify the Contracting Officer at least 24 hours in advance of grouting operations.

b. Grout the pipe from downstream to upstream, unless prohibited by access, along its entire length with cementitious grout. Place the grout by either gravity flow or by low pressure pumping to completely fill all voids within the annular space without causing deformation of the liner.

c. Place annulus grout in lifts, as calculated and provided as a preconstruction submittal, to avoid floating of the liner and to ensure a uniform grout thickness.

d. A gauged grout pressure at the pipe exceeding that of the pipe manufacturer's recommendation or 35 kPa 5 psi, whichever is less, is not permitted. Regardless of the pressure, the Contractor is solely responsible for any damage or distortion to the slip liner pipe due to grouting.

e. Remove water in annular space immediately prior to grout pumping to maintain the correct water-cement ratio of the grout mixture.

f. Drilling injection holes from the surface to facilitate grouting is prohibited.

g. Continue injection of grout until the estimated volume of grout has been injected, as measured at the pump and the exhausted grout recovered at each vent is between 85 and 115 percent of the density of the freshly injected grout, or as otherwise approved by the Contracting Officer.

h. No hardened grout is permitted in the liner pipe invert after completion of grouting operations.

i. During cold weather grouting (0-5 degrees C 32-40 degrees F) the grout mix must be 15 degrees C 60 degrees F or higher at the time of pumping. Use concrete blankets for a period of not less than seven days over areas of the levee behind the headwalls where the minimum cover above the frost line is not met. The use of an internal heater is permitted if it does not exceed the pipe's maximum localized temperature for the first 24 hours after grouting.

j. Provide annular space grout test reports for approval.

3.4 TESTING AND ACCEPTANCE

3.4.1 Rework

Remove any material that has not received prior approval from the Contracting Officer or is not accepted as suitable work by the Contracting Officer and replaced or repaired to the satisfaction of the Contracting Officer with an approved method/material at the Contractor's expense. Materials left in place, but not meeting these Specifications, will be paid for at a reduced price.

3.4.2 Pressure Testing

If the liner pipe will experience gravity flow only and the annular space between it and the host pipe is grouted full, pressure testing the joints is not required unless the video inspection reveals concerning anomalies that may indicate a compromised joint.

3.4.3 Grout Testing

3.4.3.1 Density

Field measure grout density in accordance with ASTM C138/C138M no less than twice per batch during grouting. Reevaluate grout densities exceeding the design density by more than 48 kg/cubic meter 3 lb/cubic foot for flow and flotation before placement continues, otherwise reject.

3.4.3.2 Compressive Strength

Provide grout with a minimum penetration resistance of 1725 kPa 250 psi when tested in accordance with ASTM C403/C403M before a succeeding grout lift can be placed. Engage the services of an independent, ASTM/AASHTO accredited testing laboratory to collect and test specimens associated with the strength requirements of this Section.

3.4.3.2.1 Structural Grout

a. Collect, transport, cure, test and report samples in accordance with ASTM C942/C942M, except as stated below.

b. Collect and test specimens based on the more restrictive of the following criteria:

   (1) One specimen (a specimen being one 3-gang mold) for each grouting event for each pipe collected at approximately the mid-point of the grouting operations. Collect a specimen for each time period testing desired prior to the 28-day test.

   (2) One specimen (consisting of one, 3-gang mold) for each 14 cubic m 500 cubic feet of grout placed for each pipe.

c. Test all specimens for compressive strength at 28 days. Additional specimens and tests may be collected and performed at the Contractor's discretion. The Contracting Officer will determine the course of action, which may require the complete removal of the liner and grout, if samples do not meet the minimum required strength.

3.4.3.2.2 Non-structural Grout

Collect, transport, cure, test and report samples in accordance with the applicable ASTM for viscosity (ASTM C939/C939M), density (ASTM C138/C138M), and 24-hour penetration resistance (ASTM C403/C403M). Compression testing is not required for non-structural grout.

3.4.4 Acceptance Inspection

After all work is completed, perform an inspection of [the][each] pipe that received a pipe liner, documenting the post-installation conditions. For pipes large enough and safe to enter, a walk-through inspection with digital photography is preferred when confined space entry procedures are followed. Inspect small or unsafe pipes using CCTV. Submit the Post-Installation CCTV Recordings and Report Logs and/or Post-Installation Digital Photographs and Report Logs.

a. The Contracting Officer will determine if infiltration of ground water or annular grout through the liner pipe will be a basis for non-acceptance or if a repair will be satisfactory.

b. All connections must be accounted for and be unobstructed.

3.4.4.1 Defects

Correct all defects discovered during the post-installation inspection before the work under the Contract will be considered for Substantial Completion. After the defects, if any, are corrected in accordance with manufacturer's recommendations, inspect the affected pipe segments a second time as a follow-up inspection. All follow-up inspections will be performed by the Contractor, and all costs associated with such follow-up inspections associated with the correction of work must be borne by the Contractor.

3.4.4.2 Final Acceptance

Provide final digital photographs and/or video and report logs to the Contracting Officer for review and approval of finished work for [the][each] pipe slip lined prior to receiving final payment.

3.5 MAINTENANCE

Submit manufacturer's recommendations for care and maintenance upon completion of installation.

-- End of Section --

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USACE / NAVFAC / AFCEC UFGS-33 05 07.13 (February 2024)

Preparing Activity: AFCEC

Superseding
UFGS-33 05 23.13 (November 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025
****

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DIVISION 33 - UTILITIES

SECTION 33 05 07.13

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02/24

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USACE / NAVFAC / AFCEC **UFGS-33 05 07.13 (February 2024)**

Preparing Activity: AFCEC **Superseding**
UFGS-33 05 23.13 (November 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in Agreement with UMRL dated January 2025

****

SECTION 33 05 07.13

UTILITY DIRECTIONAL DRILLING

02/24

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NOTE: This guide specification covers the requirements for directional drilling systems, equipment, piping (PVC and HDPE), and procedures.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Refer to UFGS Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING for testing requirements for potable and non-potable water systems in which the largest pipe diameter is 152.4 cm60 inches and the maximum working pressure is 150 psi.

Refer to UFGS Section 33 31 23.00 10 SANITARY SEWER FORCE MAIN PIPING for testing requirements for sanitary sewer force mains.

Refer to UFGS Section 33 11 23 NATURAL GAS AND LIQUID PETROLEUM PIPING for testing requirements for polyethylene gas piping up to 20.32cm8 inches in nominal pipe size.

Use other pipe specifications as necessary for any other required pipe testing.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C605	(2021) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C900	(2022) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA C906	(2021) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. through 65 In. (100 mm Through 1,650 mm), for Waterworks

ASTM INTERNATIONAL (ASTM)

ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and

	Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2513	(2018a) Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM F714	(2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F1674	(2018) Standard Test Method for Joint Restraint Products for Use with PVC Pipe
ASTM F2160	(2022a) Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)
ASTM F2620	(2024) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI Z535.1	(2017) Safety Colors
NEMA TC 7	(2021) Smooth-Wall Coilable and Straight Electrical Polyethylene Conduit

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.652	Safety and Health Regulations for Construction; Subpart P, Excavations; Requirements for Protective Systems

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item,

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Statement of Qualifications and Records; G, [_____]

Horizontal Directional Drilling Plan; G, [_____]

SD-03 Product Data

Pipe; G, [_____]

Drilling Fluids; G, [_____]

Additives; G, [_____]

Tracer Wire; G, [_____]

SD-05 Design Data

Secondary Containment Plan; G, [_____]

SD-06 Test Reports

Soil Test Data

SD-07 Certificates

Drill Rod

Fusion Technician Qualifications

SD-11 Closeout Submittals

Record Drawings

Complete Work Logs of Guided Directional Drill Operations

1.3 QUALITY CONTROL

1.3.1 Qualifications

Ensure that the field supervisor and workers assigned to this project are experienced in work of this nature and have successfully completed similar projects of similar length, pipe type, pipe size, and soil type using directional drilling in the last three (3) years. As part of the bid submission, submit project descriptions which include, at a minimum, a listing of the location(s), date of project(s), owner, pipe type and material, size installed, length of installation, manufacturer of equipment used, and other information relevant to the successful completion of the project.

1.3.2 Safety

Include in directional drilling equipment machine safety requirements a common grounding system to prevent electrical shock in the event of underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operator's booth, worker grounding mats, and any other interconnected equipment to a common ground. Equip the drill with an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

1.3.3 Horizontal Directional Drilling Plan

Provide a plan prepared, signed, and sealed by a licensed Professional Engineer. Submit supporting calculations, certifications, and material product data demonstrating the strength of the product pipes for acceptance before the beginning of the installation. Demonstrate that the proposed material satisfies the purpose of the utility and withstands the design and construction stresses and pressures. The HDD Plan will include the following:

1.3.3.1 Layout Plan

Provide a plan location of the operation, including entry and exit points, discussing the relationship of the equipment, pipe assembly, and staging areas.

1.3.3.2 Utility Profile

Provide a profile of the utility plotted at a scale appropriate for the work.

1.3.3.3 Equipment List

Provide a directional drilling equipment list including: drilling rig, drill bit, back-reamer, mud mixing and pumping systems, down-hole tools, guidance system, and rig safety system. Provide calibration records for guidance system.

1.3.3.4 Drilling Fluid Management Plan

Provide a drilling fluid management plan to include drilling fluid types and specifications, cleaning and recycling equipment, estimated flow rates, procedures for minimizing drilling fluid escape, and the method/location for final disposal of waste drilling fluids. Provide a frac out control plan, including frac control materials that will be onsite and contact information for emergency personnel.

1.3.3.5 Pedestrian Access

When and where installations disrupt pedestrian use of sidewalk for periods exceeding two consecutive days, provide an alternate route that meets current ADA requirements.

1.3.3.6 Method and Procedures

Provide an outline of the methods and procedures, describing the pilot hole drilling procedure, the reaming operation, and the pullback procedure, including drawings, schedule of operations, specifications, and method of operation. Include pipe storage and handling details and pipeline assembly and installation procedures.

1.3.3.7 Safety Data Sheets

Submit safety data sheets for fluids and additives.

1.3.3.8 Revisions

If site conditions change and require modification to the HDD Plan, submit revised drilling plan to achieve successful installation. Explain, in the revised submittal, the anticipated and encountered conditions that mandated the change in plans.

1.3.4 Fusion Technician Qualifications

The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded, and submitted for review.

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, surface abrasions, or other defects will be rejected. Remove defective materials from the job site.

Protect stored piping from moisture and dirt and place on level surface. Store plastic piping protected from direct sunlight.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Drill Rod

Select the appropriate drill rod to be used. Submit certified statement that the drill rod has been inspected and is in satisfactory condition for its intended use.

2.2 MATERIALS

2.2.1 Pipe

[2.2.1.1 Fusible PVC

Install [_____] inch [(nominal)] diameter fusible polyvinyl chloride pipe [with a dimension ratio of [18 (DR 18)] [14 (DR 14)] [_____] conforming to AWWA C900] [with a standard dimension ratio of [17 (SDR 17)] [21 (SDR 21)] [26 (SDR 26)] [_____] conforming to ASTM D2241] [, [Schedule 40] [Schedule 80] [_____] conforming to ASTM D1785]. Provide pipe made from PVC compound meeting or exceeding cell classification 12454 per ASTM D1784. Provide fusible polyvinyl chloride pipe with plain ends. Pipe is [blue] [green] [purple] [_____] in color.

Use butt fusion jointing method for plain end PVC pipe. Comply with [AWWA C900] [AWWA C605] [ASTM F1674] [_____] for butt fusion joints.

][2.2.1.2 HDPE

Install [_____]-inch [(nominal)] diameter high density polyethylene pipe (HDPE) with a standard dimension ratio of [11 (SDR11)] [9 (SDR9)] [_____]. Provide pipe conforming to[ASTM D3350][ASTM F714][ASTM D2513][AWWA C906][ASTM F2160, NEMA TC 7] [_____]. [Pipe is [_____] in color.][Pipe is [_____] in color with [_____] striping.]

Use butt fusion jointing method for plain end HDPE pipe. Comply with[AWWA C906][ASTM F2620] [_____] for butt fusion joints.

]2.2.2 Drilling Fluids

Use a high quality [bentonite][_____] drilling fluid to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Use only fluid with a composition which complies with all Federal, State, and local environmental regulations.

2.2.3 Additives

Use admixtures as required to address soil conditions and water conditions such as water hardness, acidity, and alkalinity.

2.2.4 Tracer Wire

Use a continuous sheathed solid conductor copper wire line, minimum #12 AWG. Sheathing must be color coded to match the utility.

PART 3 EXECUTION

3.1 EXAMINATION

a. Soil Test Data

Provide written documentation of conformance with AASHTO T 180.

3.2 INSTALLATION

Ensure all utilities are located and clearly marked prior to start of excavation or drilling.

3.2.1 Drill Set-Up

Design and construct the drill entrance and exit pits.

3.2.1.1 Drilling Fluids

Mix the [bentonite][_____] drilling fluid with potable water (of proper pH) to ensure no contamination is introduced into the soil during the drilling, reaming, or pipe installation process. Make any required additive adjustments.

3.2.2 Drill Entrance and Exit Pits

Drill entrance and exit pits are required. Maintain at minimum size to allow only the minimum amount of drilling fluid storage prior to transfer to mud recycling or processing system or removal from the site.

Do not allow drilling mud to flow freely on the site or around the entrance or exit pits. Remove spilled mud and restore ground to original condition.[Provide shore pits in compliance with OSHA Standards, 29 CFR 1926.652].

[Drilling near wetlands or water courses requires secondary containment to prevent drilling fluids from entering the wetlands. Secure written approval of a secondary containment plan from the Contracting Officer.

]3.2.3 Drill Entrance and Exit Angle

Ensure entrance and exit angles and elevation profile maintains adequate cover to reduce risk of drilling fluid breakouts and ground exit occurs as specified herein. Ensure that entrance and exit angles generate pullback forces that do not exceed [5][7.5][_____] percent strain on the [high density polyethylene][fusible polyvinyl chloride] pipe.

3.2.4 Pilot Hole

The type and size of the pilot string cutting head and the diameter of the drill pipe are at the Contractor's discretion.

Drill the pilot hole along the path shown on the plan and profile drawings. Pilot hole tolerances are as follows:

a. Vertical Tolerance: Provide minimum cover below channel bottom as specified on the plans. Pilot hole may go deeper if necessary to prevent breakout.

b. Horizontal Tolerance: Plus or minus - 152.4 cm 60 inches [_____] from the centerline of the product pipe.

c. Curve Radius: No curve is acceptable with a radius less than 304.8 m 1,000 feet.

d. Entry Point Location: Make pilot hole entry point within plus or minus - 152.4 cm 60 inches [_____] of the location shown on the drawings or as directed by the Contracting Officer in the field.

e. Exit Point Location: Make the exit point location within plus/minus - 152.4 cm 60 inches [_____] of the location shown on the drawings or as directed by the Contracting Officer in the field.

f. Mandatory pipeline cover requirements are as shown on the drawings or as specified.

3.2.5 Guidance Systems

Allow walkover guidance systems where suitable for this project; use a magnetic survey tool locator installed behind the pilot string cutting head and an electric grid (tru-tracker) system for this project; shorter bores not under water ways. Ensure proper calibration of all equipment before commencing directional drilling operation.

3.2.6 Reaming

Conduct reaming operations at the Contractor's discretion. Determine the type of back reamer to be utilized by the type of subsurface soil conditions that are encountered during the pilot hole drilling operation. The reamer type is at the Contractor's discretion.

3.2.7 Pull Back

Fully assemble the entire pipeline to be installed via direction drill prior to commencement of pull back operations.[Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe in accordance with ANSI Z535.1. Attach wire to top of pipe in such a manner that it will not be displaced during construction operations.]

Support the pipeline during pullback operations in a manner to enable it to move freely and prevent damage. Install the pipeline in one continuous pull.

Minimize torsion stress by using a swivel to connect the pull section to the reaming assembly.

Maximum allowable tensile force imposed on the pull section is not to exceed [90][_____] percent of the pipe manufacturer's safe pull (or tensile) strength. If the pull section is made up of multiple pipe size or materials, the lowest safe pull strength value governs and the maximum allowable tensile force is not to exceed [90][_____] percent of this value.

Minimize external pressure during installation of the pullback section in the reamed hole. Replace damaged pipe resulting from external pressure at no cost to the Government. Buoyancy modification is at the discretion of the Contractor.

3.2.8 Drilling Fluids Disposal

Collect drilling fluid returns in the entrance pit, exit pit, or spoils recovery pit. Immediately clean up any drilling fluid spills or overflows from these pits.

Dispose of fluids in a manner that is in compliance with all permits and applicable Federal, State, and local regulations. Disposal of the drilling fluids may occur on approved land owned by the Government subject to written approval from the Contracting Officer. Spread the drilling slurry over the Government-approved disposal area and plow into the soil.

Conduct disposal in compliance with all relative environmental regulations, right-of-way and work space agreements, and permit requirements.

[3.2.9 Connection of Product Pipe to Pipeline

After the product pipe has been successfully installed, allow the product pipe to recover for 24 hours prior to connection of the pipeline. Ensure that a sufficient length of the product pipe has been pulled through the hole so that the pull-nose is not pulled back into bore hole due to stretch recovery of the product pipe.

]3.3 FIELD QUALITY CONTROL

3.3.1 Daily Work Log

Maintain a work log of construction events and operations including, but not limited to, the following for each day's work:

a. Hours worked.

b. Log of each drill rod added or withdrawn during drilling, reaming, and pull back.

c. Groundwater control operations.

d. Description of soil conditions encountered.

e. Tools and equipment in use, drilling fluid, fluid pumping rate, and drilling head location.

f. Any unusual conditions or events.

g. Reasons for operational shutdown in event work is halted.

3.3.2 Drill Logs

Maintain drilling logs that accurately provide drill bit location (both horizontally and vertically) at each rod, typically 3.048 m 10 feet along the drill path. In addition, keep logs that record, as a minimum the following, every 15 minutes throughout each drill pass, back ream pass, or pipe installation pass:

a. Drilling Fluid Pressure

b. Drilling Fluid Flow Rate

c. Drill Thrust Pressure

d. Drill Pullback Pressure

e. Drill Head Torque

Make all instrumentation, readings, and logs available to the Contracting Officer at all times during operation.

3.3.3 Field Tests

Perform field tests and provide labor, equipment, and incidentals required for testing. Submit test results, identifying any results that do not meet requirements, to the Contracting Officer within four days of test completion. Provide corrective action and retest pipe not meeting requirements. Provide corrective action as recommended by the pipe manufacturer and subject to approval by the Contracting Officer.

3.4 CLOSEOUT ACTIVITIES

Immediately upon completion of work, remove all rubbish and debris from the job site. Remove all construction equipment and implements of service leaving the entire area involved in a neat condition acceptable to the Contracting Officer.

Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and return the surface area to its original condition. Dispose of all drilling fluids, soils, and separated materials in compliance with Federal, State, and local environmental regulations.

[Provide a post-construction fusion report including the following data for each fusible connection:

a. Pipe Size and Thickness

b. Machine Size

c. Fusion Technician Identification

d. Job Identification

e. Fusion Joint Number

f. Fusion, Heating, and Drag Pressure Settings

g. Heat Plate Temperature

h. Time Stamp

i. Heating and Cool Down Time of Fusion

j. Ambient Temperature]

Submit an electronic copy and three hard copies of the record drawings to the Contracting Officer within five days after completing the pull back. Include in the record drawings a plan, profile, and all information recorded during the progress of the work. Clearly tie the record drawings to the project's survey control. Maintain, and submit upon completion, signed complete work logs of guided directional drill operations.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 05 23 (August 2015)**
Change 2 - 08/16

Preparing Activity: NAVFAC **Superseding**
UFGS-33 05 23.19 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 33 - UTILITIES

SECTION 33 05 23

TRENCHLESS UTILITY INSTALLATION

08/15, CHG 2: 08/16

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 05 23 (August 2015)**
Change 2 - 08/16

Preparing Activity: NAVFAC **Superseding**
UFGS-33 05 23.19 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 05 23

TRENCHLESS UTILITY INSTALLATION

08/15, CHG 2: 08/16

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NOTE: This guide specification covers the requirements for work related to the installation of utility pipelines (i.e., electrical power, communications, water, gas, oil, petroleum products, steam, sewage, drainage, irrigation, and similar facilities) utilizing microtunneling or boring and jacking trenchless construction methods.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS and Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, apply to this section with additions and modifications specified herein.

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NOTE: Boring and jacking is a term applied to a horizontal auger boring process characterized as mechanically boring and casing a hole through the soil with a cutting head on a continuous flight of augers mounted inside the casing pipe. The casing is advanced simultaneously with the boring operation via a hydraulic jacking system. Line and grade

accuracy may not be achieved to the degree of microtunneling, but this method is often used to economically install 100 mm to 1.8 m 4 inch to 72 inch diameter casing pipe under roads and railroads through a wide variety of soil types (including weathered rock and small cobbles/gravels) up to distances of 122 m 400 feet.

Microtunneling is a process characterized as a highly sophisticated, laser guided, remote controlled system using a microtunnel boring machine (MBTM) and providing the capability of continuous accurate monitoring and control of alignment and grade. MBTMs are categorized as being either slurry-type or auger-type, referring to the method in which spoil material is carried from the cutter head to the jacking pit area.

There are a limited number of manufacturers of equipment that can perform the work described in this specification; a few of those manufacturers are located in the United States.

Use ASCE Standard 36-15, Standard Construction Guidelines for Microtunneling for the planning, design, and construction of microtunneling projects.

Microtunneling can be used to install larger diameter gravity pipelines. Pipes used in microtunneling can range in diameter from a minimum of 300 mm 12 inches to a maximum of 3454 mm 136 inches. Microtunneling is ideally suited for placing 600 mm 24 inch to 2438 mm 96 inch diameter gravity carrier pipes and 600 to 2438 mm 24 to 96 inch casing pipe for containing utility lines. Distances can exceed 300 m 1000 linear feet. Large diameter, straight gravity pipelines under highly congested roadways, railroad crossings and wetlands are typical microtunneling projects. Section 33 05 07.13 UTILITY DIRECTIONAL DRILLING should be considered for use for smaller diameter pipelines.

Microtunneling is typically not suited for installations with soil cover less than 1.8 m 6 feet or twice the diameter of the pipe being installed due to concerns of heave or settlement of the ground surface or installations with numerous service laterals located between manholes.

Microtunneling is generally well suited for use in sands, clays, and gravel soils. In soils containing rock, cobbles, boulders, or in mixed-face soils (softer overlying harder material) in-depth consideration given to ground conditions, proper cutter head and guidance equipment selection is recommended in order to achieve desired results. When microtunneling is utilized, also include Section 33 01 30.16 TV INSPECTION OF SEWER LINES.

In microtunneling boring and jacking permanent pipe casing can be used as the carrier pipe or a separate pipe may be placed inside the casing. The Designer of Record specifies the pipe materials to be used. The Contractor is responsible for proper selection of equipment and methods for installation.

In microtunneling boring and jacking the Contractor typically uses a lubricating fluid to reduce friction on the pipe/soil interface. The possible damage to the exterior of the pipe due to stresses and friction should be accounted for in the design.

In "dry boring and jacking" operations, water or other fluids are not used in the removal of spoils. Dry boring and jacking is often specified for highway and railroad crossings.

Cathodic protection for steel pipes should be considered where the anticipated degree of corrosion is so great that coating systems are not adequate to protect the piping for the desired life of the system.

Jacking and receiving shafts are required to be clear of all obstructions in the shafts and above the shafts - including overhead lines.

Microtunneling Boring and jacking through contaminated soils or areas anticipated to have numerous underground obstructions is not recommended unless special provisions for handling, disposal, or treatment of contaminated soil or obstructions encountered are included in the contract documents.

Refer to ASCE Standard 36-15 for guidance on addressing obstructions anticipated during construction.

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NOTE: Project Drawings:

1. The following information should be shown on the project drawings:

a. Plan and location of all new pipelines, including size of pipe casing and carrier pipe.

b. Location and profiles of soil sampling and bore holes.

c. Location, size, and type of service of existing connecting, intersecting, and adjacent pipelines and other utilities.

d. Paved areas and railroads which pass over new pipelines.

e. New pipeline profiles, to show existing conditions.

f. Monitoring survey test locations to check for heave and settlement before, during and after microtunneling.

g. Manhole and lateral piping bedding conditions.

h. Details for the connection of the pipe casing to manholes and infiltration control.

i. Location of surrounding structures (including foundation type) and any sensitivity to settlement and any subsurface structures that could be affected by the operation.

j. Show traffic plans for work near roadways or railroads. Show possible equipment staging areas and spoil storage areas. Spoil storage and removal requires a relatively large area for dewatering and must be strictly controlled. This should be addressed in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. Refer to applicable sections for specific removal and disposal of hazardous materials. Spoil storage locations and construction operations need to consider possible runoff into wetlands, streams, or storm drains.

k. Class or thickness of pipe used in the work, including material identification, and limits for same where class or thickness will differ along length of pipeline.

l. Designate Shaft Locations. Most microtunneling boring and jacking equipment requires unobstructed overhead clearance, free of overhead lines and trees. Large equipment (excavators, cranes, etc.,) and vehicular access to the shafts as well as adequate surface workspace adjacent to jacking shaft work area, is critical. The microtunneling boring and jacking system requires adequate shaft construction areas to successfully complete the operations. For pipe diameters of less than 1200 mm 48 inches, a minimum area needed is approximately 650 square meters 7000 sf. For pipe diameters of 1200 mm 48 inches to 2438 mm 96 inches, the minimum jacking shaft work area is approximately 929 square meters 10,000 sf.

m. All construction requirements conforming to the standards of the railroad or highway owner. Indicate limits of right-of-way and any other site requirements or dimensions.

****

PART 1 GENERAL

Provide utility installation using microtunneling boring and jacking techniques at locations indicated. The Contractor is responsible for all work related to the provision of utilities installed, including assessing surface, subsurface, and environmental (seasonal) conditions.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 13A	(2010; Errata 1 2014; Errata 2-3 2015) Specification for Drilling-Fluid Materials

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2023) Manual for Railway Engineering

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 27-00	(2000) Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
ASCE 28-00	(2001) Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction
ASCE 36-15	(2015) Standard Design and Construction Guidelines for Microtunneling

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm)

	and Larger
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.5M/D1.5	(2020; Errata 1 2022) Bridge Welding Code

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A139/A139M	(2022) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A716	(2018; R 2022) Standard Specification for Ductile Iron Culvert Pipe
ASTM A746	(2018; R 2022) Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C76	(2022a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C76M	(2022a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C1091	(2003a; R 2013) Standard Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 DEFINITIONS

As used herein, the terms "shaft" and "pit" are synonymous.

1.2.1 Microtunneling

Unless otherwise specified or indicated, see ASCE 36-15 for definitions.

1.2.2 Jacking Precast Concrete Pipe

Unless otherwise specified or indicated, see ASCE 27-00 for definitions.

1.2.3 Jacking Precast Concrete Box Sections

Unless otherwise specified or indicated, see ASCE 28-00 for definitions.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Microtunneling Plan; G, [_____]

Boring and Jacking Plan; G, [_____]

Statement of Contractor Qualifications; G, [_____]

SD-03 Product Data

****

NOTE: Use other specifications to require submittals for the actual carrier pipe unless the pipe casing is going to act as the carrier pipe.

****

Pipe casing [and couplings]; G, [_____]

Lubricating Fluid for pipe exterior; G, [_____]

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on [and rubber-gasketed bell-and-spigot] joints. Include information concerning gaskets with submittal for joints and couplings.

SD-05 Design Data

****

NOTE: Suggested Submittals:

1. Submit the following for review by the designer:

a. Manufacturer's literature describing in detail the microtunneling boring and jacking system to be used. Detailed descriptions of projects on which this system has been successfully used, giving total pipe length, soil conditions, accuracy achieved, project duration, and number of restarts.

b. Method of spoil removal (from the boring to final disposition).

c. Anticipated jacking loads.

d. Method(s) of controlling surface and groundwater throughout the work, including at access shafts and adjacent surface workspaces.

e. Shaft dimensions, locations, surfaced construction, profile, depth, method of excavation, shoring bracing, and thrust block design.

f. Verification that the pipe complies with the specification.

****

Design calculations for pipe casing; G, [_____]

Access Shaft Construction Plan; G, [_____]

SD-06 Test Reports

Monitoring Survey; G, [_____]

SD-08 Manufacturer's Instructions

Installation procedures for pipe casing; G, [_____]

Safety Data Sheets; G, [_____]

SD-11 Closeout Submittals

Record Drawings; G, [_____]

Daily Work Logs of installation operations, including records of the volume of materials removed, daily progress and grout volumes used, and as-built drawings of location and alignment of [casing][pipeline]; G, [_____]

1.4 PRE-CONSTRUCTION

No later than 45 days prior to commencement of the work, submit the following to the Contracting Officer for review and approval:

Microtunneling Plan

Boring and Jacking Plan

Access Shaft Construction Plan

Statement of Contractor Qualifications

Submit a complete list of all drilling fluids, additives, and mixtures to be used along with Safety Data Sheets.

1.5 QUALITY CONTROL

1.5.1 STATEMENT OF CONTRACTOR QUALIFICATIONS

Contractors are required to have proven and successful experience in microtunneling boring and jacking. The experience is the successful completion of similar projects to the tolerances indicated for the size of pipe and quantities shown on the plans, in the anticipated soil conditions indicated in the geotechnical report included in the contract documents. Submit a description of at least three such projects which include, at a minimum, a listing of the location(s), date of projects, owner with contact information, pipe type, size installed, length of installation, type, and manufacturer of equipment used, and other information relevant to the successful completion of the project.

1.5.2 RECORDS

1.5.2.1 DAILY WORK LOG

Maintain a work log of construction events and observations. Include the following information for each days work:

a. Hours worked.

b. Location of boring machine face or shield by station and progress made in advancing pipe.

c. Completed field forms, such as steering control logs, for checking line and grade of boring operation, showing achieved alignment relative to design alignment.

d. Maximum pipe jacking pressures per drive.

e. Ground water control operations and piezometric levels.

f. Descriptions of soil conditions encountered.

g. Any unusual conditions or events, including observed ground movement.

h. Reasons for operational shutdown in event drive is halted.

1.6 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store [jointing materials and] rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes free of dirt and debris.

1.6.1 Handling

Handle pipe in a manner to ensure delivery to the excavation site in sound undamaged condition. Avoid damage to coatings and linings on pipe; make repairs if coatings or linings are damaged. Carry, do not drag pipe to the excavation site. [Store jointing materials and] [rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.] [Handle steel pipe with [coal-tar enamel] [coal-tar epoxy] coating in accordance with the provisions for handling coal-tar enamel coated pipe in AWWA C203. Handling coal-tar epoxy coated steel is not permitted below 4.4 degrees C 40 degrees F.]

1.7 SAFETY

1.7.1 General

Provide procedures for safe conduct of the work in accordance with EM 385-1-1. When and where installations temporarily disrupt pedestrian use of sidewalk areas for periods exceeding 2 consecutive work days, provide an alternate route that meets current ABA Accessibility Standard for Department of Defense Facilities.

1.7.2 Equipment

Utilize equipment that employs a common grounding system to prevent electrical shock in the event of underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operators booth, worker grounding mats, and any other interconnected equipment to a common ground. Utilize equipment having an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

1.7.3 Sheeting, Shoring and Dewatering

Provide sheeting, shoring and dewatering as specified in Section 31 00 00 EARTHWORK, and as specified herein.

1.7.4 Tunnel Bore

Unprotected mining of the tunnel bore is not permitted. Fully support the tunnel face and bore at all times.

1.8 QUALITY ASSURANCE

1.8.1 Microtunneling PlanBoring and Jacking Plan

Provide a plan prepared, signed and sealed by a licensed Professional Engineer and include the following:

1.8.1.1 Operational Layout

1.8.1.1.1 Layout Plan

Provide a plan location of the operation, discussing relationship of equipment, the method of construction and details for the following:

a. Access pits configurations and details, including equipment layout.

b. Location of intermediate jacking stations, if required.

c. Casing pipe with connection details.

1.8.1.1.2 Pedestrian Access Around Site

When and where installations disrupt pedestrian use of sidewalk areas for periods exceeding 2 consecutive days, provide an alternate route that meets current ADA requirements.

1.8.1.2 Method and Procedures

Provide an outline of the methods and procedures, including drawings, schedule of operations, specifications, and manufacturer's catalog data for products in lieu of specifications, methods of operation for microtunneling boring and jacking operations, and specifically the following:

a. Jacking Equipment and Methods: Provide drawings of the jacking frame, jacking head, reaction blocks, jacking installation, pipe guides, procedures for lubricating exterior of pipe during jacking (if applicable), maximum force that jacking equipment can deliver.

b. Boring Equipment and Methods: Provide a discussion of the methods of operation, design and specifications for boring operation, steerage control, line and grade control methods, proposed procedures for removing or clearing obstructions, and a description of proposed methods for ground stabilization and minimizing overexcavation and loss of ground. Submit safety data sheets for fluids, grout, or chemical products.

c. Casing Annulus and Interior Space Grouting: Identify casing insulators/spacers/centralizers/tiedowns (type, number, spacing and installation instructions,) grout materials and method of placement, description of equipment used and grout pressure employed.

d. Survey Alignment Control: Identify method and equipment to install pipe within specified tolerances.

e. Ground Stabilization: Discuss dewatering and grouting, identification of measures and methods used to stabilize face at heading (if necessary), narrative of equipment, procedure and grout mix, and identification of subcontractor who will perform any required stabilization grouting.

f. Excavation Support System Plan: Provide a plan and discussion of methods to be employed, including design drawings and calculations, sealed and signed by a licensed Professional Engineer.

g. Monitoring/Survey Plan: Develop and provide a discussion of the monitoring/survey plan to be employed to protect structures and utilities from settlement and/or heave, including the following. Incorporate into the plan any supplemental requirements specified in Part 3, paragraph entitled "Field Quality Control".

  (1) Structures Assessment: Provide a discussion of structures and utilities to be protected, and measures to be employed for preconstruction and postconstruction assessment of critical structures, namely those located within the [zone of active excavation][a distance equal to [5] [_____] times the depth of the boring from the ground surface] from proposed pipe centerline. Include photographs or video of existing damage to structures in the vicinity of sewer alignment in assessment reports.

  (2) Instrumentation Monitoring Plan: Describe of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

  (3) Surface Settlement Monitoring Plan: Identify on a plan the location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.

[h. Contingency Plan: Provide a plan and discuss protection of pavements, adjacent structures, and utilities affected by adverse movements detected by instrumentation. As a minimum, include the following:

  (1) Names, telephone numbers, and locations of persons responsible for implementation of contingency plans.

  (2) Materials and equipment required to implement contingency plans. Identify the location of all required materials and equipment.

  (3) Step-by-step procedure for performing work involved in implementation of the contingency plans.

  (4) Clear identification of the objectives of the contingency plans and methods to measure plan success.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The work includes providing labor, materials, and specialized equipment for the installation of utility pipelines utilizing the boring and jacking microtunneling methods of installation.

2.1.1 Design Requirements

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NOTE: Use ASCE 36-15, ASCE 27-00, ASCE 28-00 as applicable.

****

2.1.1.1 Excavations

Design excavations, including access shaft walls, considering loadings from reaction blocks, traffic loads and any surcharge loads.

2.1.1.1.1 Highway Crossing Criteria

For loadings under highways use HS20 vehicle loading distribution in accordance with AASHTO.

2.1.1.1.2 Railway Crossing Criteria

For pipe crossings under railways use Cooper E-80 locomotive loading distributions in accordance with AREMA Eng Man specifications for culverts. Account for loading due to any multiple tracks.

2.1.1.2 Design Calculations of Pipe Casing

Submit design calculations for pipe casing demonstrating that the equipment used in installing the pipe will not distort or otherwise damage the pipe. Provide calculations of maximum allowable jacking force to be used based on pipe materials to be used. The calculations are to be sealed by a licensed Professional Engineer using soil properties derived from subsurface investigations performed along the utility route.

2.2 EQUIPMENT

2.2.1 Microtunneling System

2.2.1.1 General Requirements

Utilize a continuously monitored laser guided Microtunneling Boring Machine (MTBM) system matched to the expected subsurface conditions, a hydraulic jacking system to jack the pipeline, a process to remove the slurry from the slurry water, a guidance system to provide installation accuracy to within the indicated tolerances, excavation equipment, material handling equipment, a dewatering system, and sheeting/shoring required to provide the work indicated and meet the following minimum performance requirements:

a. Capable of providing positive face support both during excavation and during shutdown regardless of the MTBM type.

b. Capable of handling and removing materials of high water content from the machine head.

c. All functions are controlled remotely from a surface control unit.

d. Capable of controlling rotation utilizing a bidirectional drive on the cutter head or by using anti-roll fins or grippers.

e. Capable of injecting lubricant around the exterior of the pipe being jacked.

f. Capable of controlling heave and settlement.

****

NOTE: Specify the maximum allowable overcut of the advancing equipment to satisfy settlement or heave tolerances. usually overcut is not to exceed 25 mm1 inch on the radius of the pipe.

****

g. Minimize overcut during the operation. Do not exceed 25 mm1 inch [_____] on the radius, unless approved by the Contracting Officer.

2.2.1.2 Control System

The main control system of the MTBM is to provide the following information to the operator, as the minimum, required for successful operation of the MTBM:

a. Deviation of the MTBM from the required line and grade of the pipeline (normally by reference to a laser beam).

b. Grade and roll of the MTBM.

c. Jacking load.

d. Torque and RPM of the cutter head.

e. Instantaneous jacking rate and total distance jacked.

f. Indication of steering direction.

g. Progress of pipe advancement via CCTV at the pipe head.

2.2.2 Boring and Jacking System

Utilize a continuously monitored boring and jacking system matched to the expected subsurface conditions, a hydraulic jacking system to jack the pipeline, an auger to remove boring spoils, a guidance system to provide installation accuracy within the indicated tolerances, excavation equipment, material handling equipment, a dewatering system, and sheeting/shoring required to provide the work indicated.

2.2.3 Pipe Jacking Equipment

Provide main jacking equipment with a capacity greater than the anticipated jacking load. Provide intermediate jacking stations when the total anticipated jacking force needed to complete the installation may exceed the capacity of the main jacks or the designed maximum jacking force for the pipe. The jacking system is to supply a uniform distribution of jacking forces on the end of the pipe by use of thruster rings and cushioning material.

2.3 MATERIALS

2.3.1 Pipe Casing

Provide straight wall pipe casing [of type and diameter indicated] of [reinforced concrete pipe (RCP)] [steel pipe].

[2.3.1.1 Reinforced Concrete Pipe

****

NOTE: This section covers tongue and groove, straight wall reinforced concrete pipe intended for use as conveyance systems of sewage and storm water, and for the construction of culverts and industrial casings installed and constructed by microtunneling boring and jacking methods.

****

2.3.1.1.1 Pipe

Pipe, [[_____] mm inch inside diameter,] class [_____], nominal length [_____] and concrete strength [_____] MPa psi in accordance with ASTM C76M ASTM C76.

2.3.1.1.2 Joints and Jointing Material

Form joints of concrete and as detailed in the Contract drawings. Utilize a rubber gasket or mastic to provide the seal. [Incorporate an assembly of [steel bands] [or] [steel bell ends] and spigot rings and rubber gaskets in accordance with Contract drawings.]

2.3.1.1.3 Internal Diameter

The internal diameter of [300 to 600 mm 12 to 24 inch pipe cannot vary by more than plus 6 mm 1/4 inch from the design diameter.][600 mm 24 inch and larger pipe cannot vary from the design diameter by more than plus one percent or plus 10 mm 3/8 inch, whichever is less.]

2.3.1.1.4 Wall Thickness

At any location along the length of the pipe, or at any point around its circumference, the wall thickness cannot vary by more than plus five percent of the design diameter.

2.3.1.1.5 End Squareness

Ensure that each pipe end lies within two planes perpendicular to the longitudinal center line of the pipe, spaced at 10 mm 3/8 inches apart. Square the tongue or spigot end to within 5 mm 3/16 inches and the groove or bell end of the pipe to within 5 mm 3/16 inches.

2.3.1.1.6 Roundness

Ensure that the outside diameter of the pipe does not vary from a true circle by more than one percent. Permissible out-of-round dimensions are one half the difference between the maximum and minimum outer diameter of the pipe at any one location along the barrel.

2.3.1.1.7 Length of Pipe

Do not deviate from the finished pipe design length by more than plus 3 mm per 300 mm 1/8 inch per foot with a maximum variation of plus 13 mm 1/2 inch in any length of pipe.

2.3.1.1.8 Length of Two Opposite Sides

Variations in laying length of two opposite sides of the pipe cannot exceed [6 mm1/4 inch for all sizes through 600 mm 24 inches internal diameter] [3 mm per 300 mm1/8 inch per foot for all sizes larger than 600 mm 24 inches in internal diameter], with a maximum of 10 mm 3/8 inches in any length of pipe.

][2.3.1.2 Steel Pipe

****

NOTE: This section covers steel pipe used as a casing pipe for other carrier pipes. This section also covers steel as the carrier pipe for stormwater, sanitary sewer or other utility lines.

****

2.3.1.2.1 Pipe

Provide steel pipe in conformance with [ASTM A139/A139M, Grade B with a minimum yield strength of 242 MPa 35,000 psi] [AWWA C200] [API Spec 5L Grade B] [ASTM A53/A53M] [ASTM A716] [ASTM A746]. [Weld steel pipe seamless, square cut with even lengths that complies with Articles 4.2, 4.3, and 4.4 of the API Spec 5L]. Pipe shall have an inside diameter of [_____] mm[_____] inches and a minimum wall thickness of [_____] mm[_____] inches [as indicated].

****

NOTE: Choose the first paragraph for microtunneling and the second for boring and jacking. Modify as needed.

****

2.3.1.2.2 Joints

[Accomplish the connection of adjacent pieces of microtunneling steel pipe by [field buttwelding,] [internal weld sleeves,] [integral press fit connectors,] by a certified welder, in compliance with AWS D1.1/D1.1M as long as loading and installation design criteria are met.

][Utilize casing pipe having beveled ends with a single V-groove for field welding. Butt weld joints using a full-penetration weld on the outside circumference of the pipe prior to jacking. The welds are to conform to the latest AWS Welding Code by a certified welder. Unless otherwise specified, inspect and test welds using a non-destructive testing method consisting of magnetic particle examination (MT), in compliance with the AWS code. Visually inspect in compliance with AWS D1.1/D1.1M visual inspection criteria by a certified welder and by the QC manager welds on casing pipe that is sacrificial (fully grouted internally). Non-destructive testing is not required on welds on casing pipe that is sacrificial.

] Grouting Plugs: On large pipe, (600-mm24-inch diameter or greater), provide pipe with 51-mm 2-inch diameter tapped holes with threaded plugs for exterior grouting.

2.3.1.2.3 Roundness

The maximum difference between the major and minor outside diameters cannot exceed one percent of the specified nominal outside diameter or 6 mm 0.25 inch, whichever is less. [For pipe exceeding 1200 mm 48 inches in diameter, a maximum deviation of 13 mm 1/2 inch is permitted provided the circumference tolerance is maintained within 6 mm 1/4 inch.]

2.3.1.2.4 Circumference

Ensure that the outside circumference is within plus one percent of the nominal circumference or within plus 13 mm 0.50 inches, whichever is less.

2.3.1.2.5 Straightness

The maximum allowable straightness deviation in any 3 m 10 foot length cannot exceed 3 mm 1/8 inch. [For lengths over 3 m 10 feet, the maximum allowable deviation of the entire pipe length is computed by the following formula, but not to exceed 10 mm 3/8 inch in any length exceeding 9.1 m 30 foot length: Maximum Allowable Deviation in mm equals (1/8) times (total length in meters) divided by 0.125 Maximum Allowable Deviation in inches equals (1/8) times (total length in feet) divided by 10.]

2.3.1.2.6 Pipe Ends

Ensure that the end of the pipe is perpendicular to the longitudinal axis of the pipe and within 5 mm per meter 1/16 inch per foot of diameter, with a maximum allowable deviation of 6 mm 1/4 inch measured with a square and straightedge across the end of the pipe.

]2.3.2 Grout

Provide cement grout for pressure grouting to fill the voids around the casing and for filling the interior annular space between carrier pipe and the casing composed of Portland cement conforming to ASTM C150/C150M, Type II, and sand meeting requirements of ASTM C33/C33Mfor fine aggregate, sufficiently fluid to inject through the casing and fill voids, with prompt setting to control grout flow. Utilize a grout with a minimum compressive strength of 0.70 MPa 100 psi attained within 24 hours. Admixtures are to be free of chlorides, corrosive or other material detrimental to the materials the grout contacts.

2.3.3 CONCRETE

Provide 25 MPa 3000 psi concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.3.4 Lubricating Fluid (Bentonite or Polymer)

Provide material for lubricating the exterior of pipe. Provide bentonite machine requirements of API Spec 13A and having the capacity of mixing with water to form a stable and homogeneous suspension.

2.3.5 SOIL MATERIALS

Provide soil materials in accordance with the requirements specified in Section 31 00 00 EARTHWORK.

2.4 Incidental Materials

2.4.1 Casing Insulators/Bore Spacers

Provide carbon steel with polyvinyl chloride coating or stainless steel casing insulators/bore spacers 200 mm 8 inches in length for pipe 300 mm 12 inches and less in diameter, and 300 mm 12 inches in length for pipe 350 mm 14 inches and greater in diameter, having a 51 mm 2 inch minimum runner width. Orient spacers to allow for grout to flow easily to completely fill the casing pipe with grout throughout its length.

****

NOTE: If casing pipe transitions to carrier pipe/utility duct without a structure, provide an end closure/bulkhead detail for the casing pipe transition and modify the following as to suit the detail.

****

2.4.2 End Closures/Bulkheads

Provide Temporary End Closures to contain grout used for filling the annular space between conduits and the casing. Provide Permanent End Closures of [_____] meters [_____] feet length as indicated consisting of brick and mortar (one part cement/two parts sand/water) to completely encapsulate the conduits transition into the casing. Center the closure on the casing pipe end.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Access Shaft and Pit Construction Plan

No later than 45 days prior to start of construction submit an Access Shaft Construction Plan. Include in the plan a discussion of the method of construction of access shafts used for microtunneling boring and jacking. Address the excavation methods, dewatering system, sheeting/shoring and bracing systems proposed for use, and any ground stabilization to be employed for the shaft work area or thrust block. Acceptable construction methods include the use of interlocked steel sheetpiling or precast circular concrete segments lowered in place during excavation.

3.1.1.1 Design Requirements

a. Construct shafts of a size commensurate with safe working practices [at locations indicated]. [Coordinate shaft locations with the Contracting Officer.] The Contractor may propose to relocate shafts to better suit the capabilities of the equipment/methods proposed, but may not alter either the indicated pipeline alignment or structures associated with the installed pipeline, nor result in additional claims for compensation.

b. To the extent possible, keep shaft locations clear of pavements [and within a single traffic lane,] in order to minimize disruption to the flow of traffic. Locate support equipment, spoil piles, and materials to minimize disruption to traffic.

c. Support all excavations and prevent movement of the soil, pavement, utilities or structures outside of the excavation. Furnish, place, and maintain sheeting, bracing, and lining required to support the sides of all shafts and to provide adequate protection of the work, personnel, and the general public. Provide a concrete floor in the jacking access shaft. Design loads on the sides of the jacking and receiving pit walls are dependent on the construction method and flexibility of the wall systems.

d. Consider the loading from boring or pipe jacking when preparing the design of the jacking and receiving pit supports as well as special provisions and reinforcement around the breakout location. Design the base of the pits to withstand uplift forces from the full design head of water, unless approved dewatering or other ground modification methods are employed.

e. Construct a thrust block to transfer jacking loads into the soil. Ensure that the backstop and the proposed pipe alignment are square to each other and are designed to withstand the maximum jacking pressure to be used with a factor of safety of at least 2.5. Also, design the thrust block to minimize excessive deflections in such a manner as to avoid disturbance of adjacent structures or utilities or excessive ground movement. Begin jacking operations only after concrete thrust block or treated soil has attained the required strength.

[f. If tremie concrete sealing slabs are placed within the earth support system to prevent groundwater inflow when access shafts are dewatered, furnish and install sealing slabs of sufficient thickness to provide a minimum factor of safety of 1.2 against hydrostatic uplift in order to prevent bottom blowout when the excavation is completely dewatered.

]3.2 CONSTRUCTION

3.2.1 Access Shafts

3.2.1.1 Construction Requirements

a. Provide ground stabilization in the work area and the thrust block as required to accomplish the work.

b. Construct a jacking access shaft to accommodate the installation of pipe casings, equipment and piping jacking device. Install thrust blocks(s) as required and consolidate the ground (grout) where the casings exit the shaft. Provide a dry jacking work area having a stable concrete floor that drains to a recessed sump pump to handle nuisance inflow. Groundwater inflows into the jacking shaft are not to exceed 0.32 Liter/second 5 gallons/minute; soil inflows are not to exceed a total volume of 57 Liters 2 cubic feet.

c. Construct a receiver shaft to accommodate the installation of pipe casings and the equipment used in the work. Consolidate the ground (grout) where the casings enter the shaft.

d. Furnish, install, and maintain equipment to keep the jacking shaft free of excess water. Provide surface protection during the period of construction to ensure that surface runoff does not enter shafts. Adhere to the dewatering plan and do not affect surrounding soils or structures beyond the tolerances stated in paragraph entitled "Tolerances."

e. Provide security fence around all access shaft areas and provide shaft cover(s) when the shaft area is not in use.

f. Pit Backfill and Compaction: Upon completion of the pipe jacking and all tests or inspections are complete remove all equipment, debris, and unacceptable materials from the pits and commence backfilling operation. Complete backfilling, compaction, and pavement repairs in accordance with Section 31 00 00 EARTHWORK.

3.3 INSTALLATION

3.3.1 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe in accordance with the American Public Works Association Uniform Color Code. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

3.3.2 Connections to Existing Lines

Schedule connections to existing lines with the Contracting Officer to cause a minimum interruption of service on the existing line. [Make connections to existing lines under pressure [in accordance with the recommended procedures of the manufacturer of the pipe being tapped] [as indicated].]

3.3.3 Advancing the Pipe

Jack each pipe casing section forward as the excavation progresses in such a way to provide complete and adequate, ground support at all times. Utilize a bentonite slurry applied to the external surface of the pipe to reduce skin friction. Provide a jacking frame for developing a uniform distribution of jacking forces around the periphery of the pipe. Place a plywood spacer on the outer shoulder of the pipe casing joint. Design and construct the thrust reaction backstop to withstand the jacking forces. Continuously maintain a square alignment between the backstop and pipe casing and support the maximum obtainable jacking pressure with a safety factor at least 2.0. Continuously monitor the jacking pressure and rate of cutter head advancement. Exercise special care when setting the pipe guard rails in the jacking pit to ensure correctness of the alignment, grade and stability.

3.3.3.1 Installation Requirements

a. Utilize boring equipment capable of fully supporting the face of the tunnel.

b. Maintain face pressure exerted at the heading by the MTBM as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface by balancing soils and groundwater pressures present.

c. Dewatering for groundwater control is allowed at the jacking and receiving pits only.

d. Do not jack pipe casing until the concrete thrust block and tremie seal (if selected), and grouted soil zone in jacking and receiving shafts have attained the required strength.

e. Jack the pipe into place without causing damage to the coatings, joints or completed pipe section.

f. After completion of the jacking operation between jacking and receiving shafts, displace the lubricate material from between the pipe casing exterior and the surrounding ground with a cement grout. Control pressure and the amount of grout to avoid pipe damage and displacement of the pipe and soil beyond the tolerances specified in paragraph "Tolerances." Grout within 48 hours after pipe installation has been completed to prevent any surface settlement due to movement of soil material into the void space or loosened zone around the pipe casing.

g. Replace pipe casings damaged during installation.

h. Ensure that the welds of steel pipe attain the full strength of the pipe and are watertight before jacking of the pipe section. Ensure that the inner face of the internal weld seam is flush with the pipe to facilitate the installation of the carrier pipe in the pipe casing.

i. Perform all welding in accordance with requirements for shielded metal arc welding of AWS D1.5M/D1.5 for bridges and AWS D1.1/D1.1M for buildings and other structures.

j. Provide a pipeline that has a consistent diameter across assembled joints.

k. Once the tunneling process has begun, continue with that process uninterrupted until the pipe reaches the receiving shaft. Continue to push any damaged pipe until that damaged pipe section is pushed into the receiving shaft and is removed. Notify the [Contracting Officer][Engineer] immediately if any pipe is known to be or believed to be damaged.

3.3.4 [Carrier Pipe] [Conduit] Installation

3.3.4.1 Cleaning

Clean the inside of the casing of all foreign matter by using a pipe cleaning plug.

3.3.4.2 [Carrier Pipe] [Conduit Joints]

[Bond all metallic conduit joints within the casing pipe.] Inspect with the Contracting Officer, prior to backfilling trenches, the transition of [carrier pipe] [conduit] within the casing to non-cased trenching.

3.3.4.3 Casing Insulators/Spacers

Install casing insulators/spacers in accordance with approved submittals and the drawings. On center spacing is not to exceed 1.2 meters 4 feet.

3.3.4.4 End Closures/Bulkheads and Grouting of Casing Pipe

a. Closures: Seal ends of casing with [brick and mortar][_____________].

b. After installing, inspecting and acceptance of the [carrier pipe][conduit] and spacers within the casing pipe, pressure fill the annular space between the [carrier pipe][conduit] and the casing pipe, with cement grout specified herein. Regulate pump pressures to refusal or in accordance with the approved grouting plan. Place grout in a sequence and manner that will preclude voids or pockets of entrapped air or water. Use a refusal pressure equal to 8.0 kg/sm per meter 0.5 psf per foot of overburden.

3.3.5 Ventilation

Provide adequate ventilation for all tunnels and shafts, following confined space entry procedures. Include such factors as the volume required to furnish fresh air in the shafts, and the volume to remove dust that may be caused by the cutting of the face and other operations which may impact the laser guidance system. In the design of the ventilation system, the minimum amount of fresh air to be supplied is [_____] cubic m/s CFM. [Routinely test the air in areas accessed by workers in accordance with the most current OSHA methods and standards. The current OSHA allowable gas concentrations or those presented below, whichever are more stringent, shall be met:

Carbon Monoxide	≤0.005 percent
Methane	≤0.25 percent
Hydrogen Sulfide	≤0.001 percent
Oxygen	≥20.0 percent

]

3.3.6 Lighting

Provide adequate lighting for the nature of the activity being conducted by workers. Separate and insulate with ground fault interrupters power and lighting circuits. Comply with requirements with regards to shatter resistance and illumination requirements.

3.3.7 Spoil Transportation

Match the excavation rate with rate of spoil removal. Utilize a system capable of balancing groundwater pressures and adjustment to maintain face stability for the particular soil conditions of the project.

3.4 TOLERANCES

****

NOTE TO DESIGNER - The tolerances for a typical MTBM project are 125 mm 5 inches on line and 38 mm 1 1/2 inches on grade in a 91.4 m 300 foot installation. In order to meet local sewerage regulations regarding slope, it is recommended to design at the desired slope plus tolerances. Also, consider adding between 30 - 75 mm 0.1 - 0.25 foot drop across manholes.

****

3.4.1 Tolerances

Maximum allowable lateral deviation is [125][_____] mm [5][_____] inches; maximum allowable vertical deviation is [_____] mm [_____] inches in the position of every completed 91.4 m 300 foot section of jacked pipe casings. [Water must be free draining between any two points at the pipe invert. Reverse grades are not permitted.]

3.5 FIELD QUALITY CONTROL

Employ the monitoring/survey plan. Maintain daily records in accordance with the paragraph titled RECORDS.

3.5.1 Instrumentation/Survey

****

NOTE: The Engineer should specify minimum monitoring requirements using the following, supplemental as required by the project specific conditions.

****

3.5.1.1 Mandatory Requirements

[Include the following, as a minimum, to supplement Contractor Quality Control measures employed to monitor ground surface heave or settlement in the monitoring/survey plan.

] a. Monitor ground movements associated with the project using established survey points and make changes in the construction methods that control ground movements and prevent damage or detrimental movement to the work and adjacent structures and pavements.

b. Record in the daily work log a summary of monitoring survey results. Clearly identify work not meeting specified requirements, out-of-tolerance results, and impacts on new or existing work from settlement or heave.

c. Install instrumentation and perform monitoring to determine ground settlement surrounding each jacking and receiving pit.

d. Prior to any excavation activities, perform a pre-construction survey of the areas in and surrounding excavations and along the proposed utility alignment to identify any structures, facilities, underground or above ground utilities to be protected within a radius of [five] [_____] times either the depth of any excavation or the depth of trenchless excavation.

3.5.1.2 Supplemental Requirements

[a. Prior to the start of advancing the pipe or any dewatering operation, install surface settlement markers along the trenchless excavation centerline using the following guidelines:

(1) Locate surface settlement markers in a grid, spaced 3.0 [_____] m by 3.0 [_____] m 10 [_____] feet by 10 [_____] feet extending not less than 9.1 [_____] m 30 [_____] feet on either side of the trenchless excavation centerline. Use wooden hubs in unpaved areas with the hubs driven flush with the surface and a tack driven in the top for level rod placement. Use temporary paint or other approved materials in pavement areas. Minimize the size of temporary markings to the greatest extent practical. Remove all markers and markings prior to completion of work.

b. Prior to the start of advancing the pipe or dewatering operations, survey all monitoring points a minimum of three times to establish baseline readings. Perform all surveys to an accuracy of 3.0 mm 0.01 foot. Survey [daily][every [_____]] m feet of casing pipe advancement. In addition, if settlement exceeds Limit Level 2 survey all monitoring points within 6.1 [_____] m 20 [_____] feet of the heading hourly when the heading is approaching or passing beneath the monitoring points.

c. Evaluate all monitoring survey data immediately to determine corrective or mitigation action should be taken using the following evaluation criteria:

TYPE OF MONITORING POINT	LIMIT LEVEL 1	LIMIT LEVEL 2
Surface - Unpaved	+/- 6 [_____] mm +/- 1/4 [_____] inch	+/- 19 [_____] mm +/- 3/4 [_____] inch
Surface - Paved	+/- 6 [_____] mm +/- 1/4 [_____] inch	+/- 13 [_____] mm +/- 1/2 [_____] inch

d. If the survey readings indicate settlement or heave is greater than Limit Level 1 in the above table, provide notification to the Contracting Officer immediately and increase the monitoring frequency of the instruments as directed. Proceed with advancing the pipe after providing mitigating measures to limit additional movements.

e. If the survey readings indicate settlement or heave is greater than Limit Level 2 in the above table, cease work and provide notification to the Contracting Officer immediately and implement the Contingency Plan.

f. Perform all repairs and/or rebuilding of the pavement or adjacent structures to their condition existing prior to settlement/lifting.

g. Continue to monitor by the survey at 2 week intervals for a period of 6 [_____] weeks after tunneling. When the survey identifies that heave or settlement has occurred that is greater than Limit Level 2 values, make repairs to new or existing work that is affected. Discontinue topographic surveys when settlement is no longer detected.

]3.5.2 Field Tests

****

NOTE: Indicate appropriate Section number and title in blank below. Specify testing of gravity mains in accordance with ASTM C1091.

****

Perform field tests, and provide labor, equipment, and incidentals required for testing [, except that water and electric power needed for field tests will be furnished as set forth in [_____]] Section. Submit test results, identifying any results that do not meet specified requirements, to the Contracting Officer within 4 days of test completion. Provide corrective action and retest pipe not meeting specified requirements. Provide corrective action as recommended by the pipe manufacturer and subject to approval by the Contracting Officer.

3.5.2.1 Pipe Casing

Inspect and verify that pipe material meets the dimensional tolerances specified prior to use. Record each days inspection results in the daily work log.

3.5.2.1.1 Testing Requirements for Gravity Mains

Perform low pressure air test of all gravity mains (structure to structure) in accordance with ASTM C1091 Standard Test method for Hydrostatic Infiltration testing of Vitrified Clay Pipe Lines.

3.5.2.1.2 Non-Standard Pipe Lengths

Cut non-standard joint lengths from full length pipe having satisfactorily passed the hydrostatic test.

3.5.2.1.3 Elevations

Prior to removal of MTBM equipment, sheeting, and backfilling of access shafts, collect invert information on pipeline installed. Confirm that the elevations meet stated tolerances.

3.5.3 Inspections

Prior to the removal of MTBM equipment, sheeting, and backfilling of access shafts, conduct CCTV inspection of the mains installed in accordance with Section 33 01 30.16 TV INSPECTION OF SEWER LINES.

3.6 CLEANUP AND FINAL CLOSEOUT

3.6.1 Site Cleanup

Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and fill depressions with satisfactory fill material. Dispose of all drilling fluids, soils, and separated materials in compliance with Federal, State, and local environmental regulations.

3.6.2 Drilling Fluid

Immediately upon completion of work of this section, remove all rubbish and debris from the job site. Remove all construction equipment and materials leaving the entire area involved in a neat condition equal to existing conditions prior to construction, unless indicated otherwise.

3.6.3 Record Drawings and Daily Work Logs

Submit an electronic copy and three hard copies of the record drawings to the Contracting Officer within 5 days after completing the work. Include in the record drawings a plan, profile, and all information recorded during the progress of the work. Clearly tie the record drawings to the project's survey control. Maintain and submit upon completion final Daily Work Logs of installation operations, signed by the superintendent.

3.7 DISPOSITION OF MATERIAL

[Dispose of waste in Government disposal area] [as indicated on the drawings] [which is located within a haul distance of [_____] kilometers miles]. Remove [from Government property] surplus or other soil material not required or suitable for fill or backfilling.

Store or legally dispose of excavated material and fluids used in the boring process and shaft construction [away from the construction site and] in compliance with all permits and applicable Federal, State, and local regulations.[Comply with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.][Only store or stockpile materials in areas shown on Contract drawings.][Stockpiling is permitted on the construction site provided material is removed at regular intervals not exceeding 48 hours.]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 08 53 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 08 53 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 08 53

AVIATION FUEL DISTRIBUTION SYSTEM START-UP

08/18

ATTACHMENTS:

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 08 53 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 08 53 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 08 53

AVIATION FUEL DISTRIBUTION SYSTEM START-UP
08/18

****

NOTE: This guide specification covers the requirements for the flushing, cleaning and performance testing of new and existing aircraft refueling systems constructed to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

To download the Attachments related to this section, go to http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms

****

PART 1 GENERAL

****

NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER.

Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 1110-1-8167	(2016) Engineering and Desig -- Petroleum, Oil, and Lubricants Mandatory Center Of Expertise

1.2 ADMINISTRATIVE REQUIREMENTS

****

NOTE: Insert number of days notice after consulting with SME(s).

Develop Performance Testing Plan as a function of the system layout. An example plan is provided, see Attachment 2 - Performance Testing.

****

1.2.1 System Start-up Plan

Submit a detailed written plan prepared by the System Supplier for implementation of System Start-Up. Submit the plan [60 (CONUS)][90 (OCONUS)][_____] days prior to System Start-Up. Include a list of personnel by trade, list of key personnel, safety equipment, list of miscellaneous equipment (such as two-way radios personnel transportation vehicles etc.) and detailed procedures and schedules. The Contractor and System Supplier are responsible for implementing System Start-Up in coordination with ongoing base operations.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

System Start-Up Plan; G, [_____]

Performance Testing Plan; G, [_____]

SD-06 Test Reports

Equipment Tests; G, [_____]

Final Reports; G, [_____]

Equipment Tests; G, [_____]

SD-11 Closeout Submittals

Certification of Entire System

1.4 CLOSEOUT SUBMITTALS

1.4.1 Final Reports

Submit a final report which includes the final settings of the valves and switches and a copy of the strip chart graphs and excel data and charts on CDR media with an explanation of what the graph indicates and what the system is doing.

1.5 QUALITY ASSURANCE

1.5.1 Definitions

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts. SME for this project is [Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS)[[Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC)] [Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11)]]].

1.5.2 Certification of Entire System

Prior to the acceptance of the newly constructed system by the Government, all installed mechanical and electrical equipment must be inspected and approved by the Contracting Officer. Provide the Contracting Officer [30][60 (overseas)][_____] days notice in order to schedule the Installation and SME for participation in the inspection, Performance Testing, and approval. Any deficiencies observed must be corrected by the Contractor without cost to the Government. ER 1110-1-8167 Engineering and Design Petroleum, Oil, and Lubricants Mandatory Center of Expertise must be followed..

PART 2 PRODUCTS

2.1 GOVERNMENT-FURNISHED MATERIAL AND EQUIPMENT

The Government will furnish the following materials, equipment and services during the performance of the work under this section.

2.1.1 Aircraft Turbine Fuel

****

NOTE: During the design process the Designer must investigate who is providing fuel to the project and identify that entity in this paragraph.

****

The Government will provide the fuel necessary for the System Start-Up. The Contractor must provide an approved copy of the System Start-Up Plan at least 60 days in advance for US locations and 90 days in advance for locations outside the Continental United States to the Government entity [(DLA)]providing fuel before any fuel is provided.

Fuel will not be delivered to the system until the Contractor has satisfactorily completed all work and, in particular, the cleaning and coating of the interior surfaces of the operating storage tanks and the removal of preservatives and foreign matter from those portions coming in contact with the fuel valves, pumps, filter separators and other such equipment.

The Contractor is responsible for reimburing the Executing Agent (EA) for any loss of fuel and contaminated fuel. The EA will reimburse DLA for lost and contaminatied fuel. The Contractor is responsible for the disposal of any contaminated fuel. Some fuel loss, 1 BBL (42 gallons), is expected during Flushing, Cleaning, Equipment Tests, and Performance Testing.

The System Start-Up Plan must specify what grade of fuel, volume (gallons), recommended delivery dates, and phase of System Start-Up (Initial Fuel Receipt, Fuel Filling and Packing, Flushing, Cleaning, Equipment Tests, and Performance Testing). Fuel used for Flushing and Cleaning will possibly become contaminated, the fuel must be isolated and is considered off-specification until the fuel sampling results are provided.

Upon satisfactory completion of the flushing and cleaning operations, the Government will supply the additional quantities of fuel required to complete the other work under this section.

An empty Operating Tank must never be filled at a velocity greater than 1 m/s 3 feet per second (fps) in the fill line until fuel is in contact with the floater (or 1 m 3 feet above the fill nozzle).

2.1.2 Tank Trucks

Refueler tank trucks and operation of same will be furnished by the Government.

2.1.3 Hydrant Hose Trucks

The Government will furnish and operate the hydrant hose trucks required for ground refueling and defueling of aircraft at hydrant pits.

2.1.4 Utilities

Electric power required for the performance of the work under this section will be furnished at no charge to the Contractor.

2.1.5 Defuel Cart

****

NOTE: Select defuel cart for systems using hydraulic pantographs.

****

The Government will provide a defuel cart for the defueling operation on systems using pantographs for these fueling and defueling operations.

2.1.6 Pantographs

The Government will provide and operate pantographs for systems not providing enough pantographs to accomplish the full flow startup.

2.2 MATERIAL AND EQUIPMENT

2.2.1 Contractor Furnished

Provide material, equipment and labor not specified to be Government-furnished and required for proper System Start-Up of the system. Equipment must include but not be limited to the following:

a. Temporary strainers.

b. Pipe spools.

c. Flow meters.

d. Pressure gages.

e. Electronic sensors and recorders for pressure and flow recording are included in the PCP, except a sensor and cable or RF will need to be provided by the Contractor for the data from the Hydrant Control Valve and plugged into the PCP. This equipment must be used to monitor and record the system during the "Equipment Test" and "Performance Testing" portions of this Specification Section. Recorded data must be used by the Contractor and equipment factory representatives to achieve final control valve and equipment adjustments. Recorded data must include:

   (1) Fueling pumps discharge pressures.
   (2) Supply Venturi flow rates.
   (3) Hydrant Control Valve pressures.
   (4) Back Pressure Control Valve upstream pressures.
   (5) Back Pressure Control Valve downstream pressures.
   (6) Return Venturi flow rates.

f. The Contractor must have on hand sufficient filter elements and coalescer cartridges to adequately clean the system. During cleaning operation, provide a flow versus pressure drop graph for each filter separator, as provided in Attachment 1 - Equipment Tests. Change coalescers and cartridges upon reaching a differential pressure of 100 kPa 15 psi or when pressure drop is less than previous graph or fails to increase properly. Isolate each filter separator, one at a time and use one fueling pump to obtain rated flow rate (38 L/s600 GPM). A minimum of one complete set of coalescer elements and separator cartridges for each filter separator must be turned over to the Government after new coalescer elements and separator cartridges are installed in each filter separator vessel after completion of Performance Testing.

[g. Pigging equipment and services as called out in paragraph PIPELINE PIGGING VERIFICATION, Section 33 52 43.13 AVIATION FUELING PIPING.]

2.2.2 Design Conditions

Use temporary flushing lines and equipment that are equal in strength, stability, and materials to the associated permanent components. However, spools may be carbon steel. Additional design conditions must be as specified in Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT.

PART 3 EXECUTION

3.1 PREPARATIONS FOR FLUSHING

Upon completion of the system to the satisfaction of the Contracting Officer and the SME, make the following preparations for flushing the system.

3.1.1 Protection of Equipment

The following items must be removed from the system prior to start of flushing operations and, where applicable, replaced with spools of pipe, diameter equal to the item removed.

a. Control valves,including hydrant pit control valves if flushing outlets into tank trucks.
b. Sensors which are exposed to the fluid.
c. Coalescer and separator elements in filter separators.
d. Venturi Tubes and Pressure Indicating Transmitters.
e. Meter.

After flushing, the above items must be reinstalled in the system and the spool sections turned over to the Contracting Officer.

3.1.2 Strainers

Temporary 150 um 100 mesh cone type strainers with minimum 300 percent open area must be installed in the suction line ahead of each fueling pump and will be left in place. Any damaged strainers must be replaced by the Contractor at no additional cost to the Government.

3.1.3 Water Draw-off

Remove any accumulated water from Operating Tanks' sumps and bottoms.

3.2 FLUSHING

****

NOTE: Select permanent pantograph, portable pantograph or hydrant hose truck.

****

Flushing procedures must precede cleaning procedures. The transfer line, pump house piping, apron loop, supply and return lines to the operating tanks, hydrant laterals, product recovery lines and [permanent pantograph][portable pantograph][hydrant hose truck] lines must be flushed with fuel until the fuel being delivered is free of construction debris to the satisfaction of the Contracting Officer. Samples of fuel must be taken and tested by the designated government agency and must be free of gross contamination, maximum of 8.0 mg/gallon solids and free water not to exceed 2 ml per quart.

3.2.1 Fueling System Piping

The flushing of apron system pipelines must be accomplished by pumping fuel from one of the operating tanks through the fueling system piping and back to another tank. Air must be bled from system high points. The procedure must be continued until the fuel being delivered into the tanks is acceptable to the Contracting Officer. After the system has been flushed to the satisfaction of the Contracting Officer, remove any water remaining in the low point drains and remove any accumulated water from Operating Tank sumps and bottoms by means of the Water Draw-off systems. Cone strainers must be kept clean in order to insure maximum flow rate. In addition, baskets from all strainers must be removed and cleaned.

3.2.1.1 Transfer Line

Flushing of the transfer line must occur during the filling operations. Samples of the incoming fuel must be taken at the point of connection with bulk storage supply line. These samples must be taken at one hour intervals and must be tested by the designated government agency and turned over to the Contracting Officer.

3.2.1.2 Pump House Piping

Remove equipment as specified in paragraph Protection of Equipment. Perform the following flushing operations by withdrawing fuel from one operating tank and returning it to another tank. Circulate a sufficient amount of fuel for each operation. Bleed air from high points.

a. Position manual valves to circulate fuel through one pump, filter separator combination.

[

b. Provide a temporary connection between the [pantograph,] [hydrant hose truck,] checkout connection and the single point receptacle. Position manual valves to circulate fuel through the checkout connection and back to the transfer line. Flush the checkout lines using one fueling pump.]

****

NOTE: Select this paragraph for type iii design.
Select pantograph or hydrant hose truck.

****

c. Position manual valves to circulate fuel through the bypass line. Flush this line using two fueling pumps.

3.2.1.3 Apron Loop Piping

Remove equipment as specified in paragraph Protection of Equipment. Position manual valves to circulate fuel through the apron loop and back to the operating tank. Begin flushing the apron loop at a flow rate of 38 L/s 600 gpm. Increase flushing flow rate one pump at a time to the maximum available number of pumps for a minimum of 8 hours.

3.2.1.4 Hydrant Outlets

****

NOTE: Delete this paragraph Type IV and V systems.

****

Position a tank truck at the hydrant outlet and flush each hydrant lateral. Sample the fuel at the connection to the truck.

3.2.1.5 Product Recovery Tank Lines

During the flushing of apron loop piping, operate all manual drain lines individually to flush their connection to the product recovery tank. Fill the tank a minimum three times, each time utilizing the fuel transfer pump to drain it by returning the fuel to storage.

3.2.1.6 Pantographs

****

NOTE: Delete this paragraph if pantographs are not required (Type III) or the first set of brackets if the specification is for a Type IV/V system.

****

Utilize the [pantograph check-out connection and single point receptacle][pantograph fueling station fueling adapter] to flush each pantograph. Sample the fuel at the pressure fueling nozzle with the kit provided for this purpose.

3.3 CLEANING

After initial flushing is completed, clean the pump house and apron loop piping in accordance with the procedure specified hereafter. Isolate Operating Tanks from the system and clean as specified in Section 33 01 50.55 CLEANING OF PETROLEUM STORAGE TANKS.

3.3.1 Preparation for Cleaning

Filter elements must be installed in the filter separators. Adjust filter separator flow control valve. Valves and equipment removed for flushing must be reinstalled. Operating Tanks must be drained, vapor freed and cleaned. Transfer the contents from one operating tank to the other for the purposes of cleaning.

3.3.2 Cleaning Requirements

****

NOTE: Select independent or DOD fuels laboratory, include in MOU. Select pantograph checkout station, pantograph fueling station, or hydrant hose truck check-out station.

****

Cleaning must continue until the Contracting Officer certifies that the fuel passes the color and particle assessment method as defined in T.O. 42B-1-1 or contains 2 milligrams per gallon (mg/gallon) or less of particulate. Fuel must also contain 10 parts per million (ppm) or less of free water. Sampling must be performed by the[Government][contractor] and testing must be done by[the Air Force][a DoD regional fuels testing laboratory][an approved independent testing laboratory].[Also take fuel samples at pantograph [check out station][fueling station].][Also take samples at Hydrant Hose Truck Check-out Station and the truck fill stand.]

3.3.3 Cleaning Procedure

During cleaning procedure periodically bleed air through high point vent and drain water through low point drains.

3.3.3.1 Transfer Line

Continue to receive fuel and circulate it until fuel samples taken at the tanks meet the requirements of paragraph Cleaning Requirements above.

3.3.3.2 Pump House Piping

Pump house piping must be cleaned as follows:

a. Position manual valves so that fuel is withdrawn from one operating tank, circulated through one fueling pump and filter separator, then returned to the operating tank through the receiving filter separators.

b. Clean the piping system using one pump at a time. Alternate the fueling pumps and filter separators during the operation to clean the individual fueling pump suction and discharge lines.

[

c. Provide a temporary connection between the [pantograph] [hydrant hose truck] connection and the nozzle adaptor. Position valves to circulate fuel through the checkout connection and back to the return line. Clean the checkout lines using two fueling pumps.]

****

NOTE: Select this paragraph for Type III design. Select pantograph or hydrant hose truck checkout.

****

d. Connect truck fill station to a tank truck and clean the line.

e. Monitor pressure drop through the filter separators during each cleaning operation and provide flow vs. pressure drop graphs as specified herein before.

f. Periodically take samples from all sample connections. Cleaning must continue until the fuel meets the specified requirements.

3.3.3.3 Apron Loop Piping

Apron loop piping must be cleaned as follows:

a. Position manual valves to circulate fuel through the apron loop and back to the operating tank through the receiving filter separators.

****

NOTE: Delete if pigging launchers and receivers are not in the design. In some cases the pig launcher and receiver is not permanently installed and the specifications will need to be written to indicate the contractor will need to provide temporary units.

****

[a. First clean the pipe using pigs as called out in paragraph PIPELINE PIGGING VERIFICATION, Section 33 52 43.13 AVIATION FUEL PIPING. During this, low point drains and high point vents must be blown clean. Monitor pressure drop through the filter separators during the cleaning operation.

b. Inspect the pipe as called out in paragraph PIPELINE PIGGING VERIFICATION, Section 33 52 43.13 AVIATION FUEL PIPING.]

c. Initially pump fuel through the apron loop at a flow rate of 38 L/s 600 gpm, then increase flow rate up to the full capacity (all pumps running) starting manually one pump at a time. When pumping at a rate greater than 75 L/s 1200 gpm, by-pass receiving filter separators.

d. Monitor pressure drop through the filter separators during the cleaning operation and provide flow vs. pressure drop graphs as specified herein before.

e. Position a tank truck at the hydrant outlet and clean each hydrant lateral, one at a time.

f. Periodically take samples from all sample connections. Continue cleaning until the fuel meets specified requirements of paragraph CLEANING REQUIREMENTS.

3.3.3.4 Product Recovery Lines

Repeat the process described under initial flushing until samples taken at the connection of the pipe line back to storage meet the requirements.

3.3.3.5 Pantographs

****

NOTE: Delete if pantographs are not used.

****

Repeat the process described under initial flushing until samples taken at the pressure fueling nozzle meet the requirements.

3.4 CONTROL VALVE[AND PANTOGRAPH] ADJUSTMENT

Check all control valve settings and field adjust from the factory settings at System Start-Up as necessary to provide a smooth operation. Check the filter separator control valves and fueling pump non-surge check valve[and needle valve on Pantograph venturi] and adjust as follows:

3.4.1 Rate of Flow Control Feature on Fueling Pump Non-Surge Check Valve

Run one pump at a time and adjust rate of flow feature (41 L/s (650 gpm).

3.4.2 Control Valves on Issue Filter Separator Downstream Side

a. Position valves so that one fueling pump can pump through only one filter separator. Close the valve at the entrance of the apron loop, and open the bypass valve, allowing discharge into the circulating line.

b. Start the pump and adjust the filter separator control valve for the rated flow capacity of the filter separator (38 L/s (600 gpm).

c. Repeat above for each remaining filter separator.

3.4.3 Venturi Needle Valve

****

NOTE: Delete if pantographs are not used.

****

Venturi needle valve must be adjusted to ensure a pressure equal to nozzle pressure at maximum flow possible. After initial setting, valve must be locked in adjusted position.

3.5 EQUIPMENT TESTS

****

NOTE: Designer to edit Equipment Tests (Attachment 1) for this project and provide to the contractor. Equipment Tests can be found with the Type III Standards on the WBDG.

****

After completion of flushing, cleaning, and control valve and electrical components adjusting operations, the tests specified hereinafter must be performed. After cleaning is complete and prior to Performance Testing, Equipment Tests must be performed. Field adjustment of automatic control valves and automatic pump controls while in operation must be made only by the valve manufacturer's authorized field test engineer. For final adjustment of installed electrical control equipment provide an experienced electrical engineer, factory representative of PCP manufacturer and factory representative of PIT and DPT manufacturers. Both the mechanical and electrical components must be adjusted concurrently. Record required data necessary to prepare Equipment Tests Report.

3.5.1 Equipment Tests

System Supplier must complete and submit the Equipment Tests, see Attachment 1 - Equipment Tests. Submit Equipment Tests prior to Performance Testing (Government approval not required prior to Performance Testing.)

3.5.2 Operating Tank Low Level Alarm

Position valves to transfer fuel between operating tanks. Start one fueling pump and pump sufficient fuel out of the first operating tank to allow the low level alarm (LLA) to stop the fueling pump. This procedure must be repeated for each fueling pump and each tank until the low level alarm stops the fueling pump due to low liquid level in operating tank.

3.5.3 Fuel Delivery

****

NOTE: Select valve size and verify flow rate with SME.

****

Deliver fuel to each fueling point against a backpressure at the outlet of the hydrant control valve created by the tank trucks and hoses used during the tests.[The flow rate must be not less than [38][_____] L/s [600][_____] gallons per minute for a 100 mm 4-inch valve.][The flow rate must be not less than [75][_____] L/s [1200][_____] gallons per minute for a 150 mm 6-inch valve]. Flow rates might be affected by aircraft capability.

3.5.4 Fueling Pump Operation

Demonstrate operation of all pressure and flow devices to start and stop the fueling pumps at the indicated pressure and flow rates in the presence of the Contracting Officer. Repeat the operating sequence with each of the pumps being selected as lead pump. For this test, measure the flow rates. Witness and record flow rates and test results.

3.5.5 Defueling Performance

To test the defueling operation in the "automatic" mode, the Government will furnish a defueling cart or a hydrant hose truck with a 19 L/s 300 gpm pump rated at 1140 kPa 165 psi to pump fuel from a government furnished tank truck or bladder back into the system. While this defueling test is in operation, operate one 38 L/s 600 gpm transfer pump providing flow into a tank truck through one hydrant control valve. Demonstrate capability of defueling into the system at the same time a fueling operation is in progress. Also test the defuel capability while in the "Flush" mode.

3.5.6 Emergency Shutdown

****
NOTE: Delete if not provided.
****

With one fueling pump circulating fuel through the system, test each "Emergency Stop" pushbutton station to verify that the pump stops [and the emergency shutoff solenoid activates and the control valve closes]. Repeat above procedure for each fueling pump and "Emergency Stop" pushbutton station. Conduct tests for both the automatic and manual modes. With all the fueling pumps circulating fuel through the system, push an "Emergency Stop" pushbutton station.

3.5.7 Hydrant Control Valve

Each Hydrant Control Valve must be operated to demonstrate the following:

3.5.7.1 Surge Shut-Down Capability

Surge from shut-off of on-board aircraft fill valve can be simulated by closing a fill line valve to the tank truck or bladder, use a 3 second closure.

3.5.7.2 Pressure Control at Setpoint + 15 kPa 2 psi

Requires use of a pressure gage at the pressure fueling nozzle

3.5.8 Filter Separator Float Control Valves with Manual Tester

Using the manual float control test level on each Filter Separator, lift the weight from the float ball slowly and observe the Operation and closure of the water slug shut-off feature on the Filter Separator Control Valve.

3.5.9 Overfill Valve

Place fuel transfer pump in the "off" position. Delivery quantity of fuel to Product Recovery Tank to demonstrate capability of valve to close. Place Fuel Transfer Pump in the "Automatic" position to demonstrate capability of valve to open when fuel level drops below set point.

3.6 PERFORMANCE TESTING

Performance testing is required to occur after the Contractor has performed the Equipment Tests. Performance testing must demonstrate to the satisfaction of the Contracting Officer and SME these portions of the fueling system are working as specified. Performance testing must consist of repeating the Equipment Tests (indicated in previous paragraphs) and operating the fueling system during actual fueling and defueling operations in the presence of Government Witnesses. The maximum rated capacity of the system must be demonstrated. The Contractor must notify the Contracting Officer 30 calendar days in advance of the test to permit arrangement for the use of Government-furnished items. During the time period of performance testing, no construction activities will be allowed on the project site. The project site must be considered an operational (fuel) zone (verses a construction zone) during this performance testing period. Personnel, dressed for fuel's operation, will be present to witness testing and participate in Contractor provided training.

3.6.1 Final Performance Test

A final performance test must consist of fueling aircraft if the installation has aircraft available.

3.6.1.1 Satisfactory Performance

In the event a portion of the system or any piece of equipment fails to meet the test, make the necessary repairs or adjustments and repeat the Performance Test until satisfactory performance is obtained. The determination of satisfactory performance must be made by the Contracting Officer and the SME.

3.6.2 Performance Testing Plan

****

NOTE: Designer to edit Performance Testing Plan (Attachment 2) for this project and provide to the contractor. Performance Testing plan can be found with the Type III Standards on the WBDG.

****

System Supplier must edit the example Performance Testing plan and submit for approval. An example Performance Testing plan can be found at the end of this Section as Attachment 2 - Performance Testing Plan. Submit plan a minimum of 60 days prior to performance testing.

3.6.3 Equipment Tests

System Supplier must provide 10 hard copies of the completed Equipment Tests to the SME at the start of Performance Testing for validation during Performance Testing.

3.6.4 Control Valve Tagging

After the performance testing and system acceptance, tag the control valves with their final adjustments.

3.6.5 Final Acceptance

Fill the system with fuel and operate leak-free prior for acceptance. Anything wet with fuel is considered to be leaking.

3.6.5.1 Operating Tank High Liquid Level Shut-Off Valve Test and Adjustments

During the final filling of operating tanks, check the tank automatic high liquid level shut-off valve for proper functioning at least three times by lowering the fuel level and refilling again. Adjust valve to achieve a safe fill level.

3.6.5.2 Tank Level Indicator Adjustments

Also during the final filling of operating tanks, adjust and calibrate the tank level indicators including the final setting of the high high level (HHLA) and high level (HLA) alarms. Since the HHLA is at a point higher than the High Liquid Level Shut-Off Valve float set point, an artificial method of simulating HHL must be used.

3.6.5.3 Water Draw-Off System Test

During the performance testing, fill Water Draw-off Systems from Operating Tank sump to ensure proper operation. After filling system, allow time for fuel/water mixture to separate. Verify liquid separation through system's sight glasses. Proper operation includes capability to drain separated water and capability to pump separated fuel back to a full Operating Tank.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 08 55 (August 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 08 55 (April 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 08 55

FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT)

08/19

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-33 08 55 (August 2019)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 08 55 (April 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 08 55

FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT)
08/19

****

NOTE: This guide specification covers the requirements for the start-up (flushing, cleaning, equipment tests), and performance testing of new and existing fuel systems that are dead head type. That is, systems where fuel is issued out of a tank, through a pump, and then into a dead-end piping system with an outlet such as a fueling pier, a truck fillstand or a transfer pipeline. The following types of systems are covered by this specification:The following types of systems are covered by this specification:

a. Tank truck, rail (tank) car, pipeline, and marine off-loading and loading systems.
b. Fuel transfer piping and pumphouses.
c. Installation pipelines, and interterminal pipelines.
d. Military Service Station (MSS) facilities handling gasoline, diesel, and/or jet fuel that refuel (that is, provide motive fuel for) commercial type government and military type tactical vehicles; and that load fuel into the storage tank of tactical refueler tank trucks.
e. Any "dead end" system. This system has only a supply line. There is no return line to return unused fuel to the storage system.
f. Any system that uses a "bypass" pressure control device (a relief valve or a control valve mounted directly downstream of the pumps) to relieve pressure from the downstream side of the pumps to the suction side of the pumps.

The following types of systems are not covered by this specification:

a. Private vehicle fueling stations such as military exchange service stations.
b. Looped aircraft direct fueling systems such as DoD Type III/IV/V hydrant systems, Cut and Cover

Tank hydrant systems.
c. Looped edge of apron and rotary wing aircraft direct refueling systems that are looped, plumbed, and controlled like a looped hydrant system.
d. Looped piping systems for loading trucks that are looped, plumbed and controlled like a hydrant system. These are often labelled as "super truck fill systems."
e. A "looped" piping system is a piping system with a permanent supply line and a return line. This system issues fuel out the supply line and returns and "unused" fuel, (not issued to a truck or aircraft(), back through the return line.
f. For "looped" systems use Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Designer must edit this specification section as required to perform a successful start-up and acceptance of the new, repaired, upgraded, or modified fuel system.

The startup process must be designed such that the cleanliness of the existing system can be verified prior to flushing, or flushing and cleaning the new system or system extension.

The startup process must be designed to the extent possible, to avoid contaminating or disrupting the existing fuel system when the new system is filled, flushed, cleaned, and tested with fuel.

****

1.1 SUMMARY/APPLICABILITY

This specification defines the requirements and procedures for startup and performance testing of all equipment, components, control systems, devices, and associated appurtenances which are used for the receipt, storage, transfer and issue of petroleum fuel products for non-hydrant fuel facility systems. It covers requirements for safety, Government scheduling and coordination, device testing, existing and new system cleanliness, system [flushing][flushing and cleaning], demonstration of indicated and specified system performance, and final acceptance and reporting. The types of fuel systems covered include:

a. tank truck, rail car, pipeline and marine off-loading and loading systems

b. fuel transfer pumphouses and systems

c. installation pipelines and interterminal pipelines

d. military service station facilities handling gasoline, diesel, and jet fuel that:

    (1) refuel (provide motive fuel for) commercial type government vehicles.

    (2) refuel (provide motive fuel for) military tactical vehicles.

    (3) load fuel into the storage tanks of tactical refueler tank trucks.

It does not cover private vehicle fueling stations such as exchange service stations, nor aircraft direct refueling hydrant systems.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API 570	(2016; Addendum 1 2017; Addendum 2 2018; ERTA 1 2018) Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems

API RP 1595	(2012; R 2019; 2nd Ed) Design, Construction, Operation, Maintenance, and Inspection of Aviation Pre-Airfield Storage Terminals

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 1110-1-8167	(2016) Engineering and Desig -- Petroleum, Oil, and Lubricants Mandatory Center Of Expertise

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-3004-1	(2018) Quality Assurance for Bulk Fuels, Lubricants and Related Products

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Plans

The Contractor must submit detailed written plans [(prepared by the System Supplier)] for implementation of the System Start-Up Plan, [the Existing System Cleanliness Confirmation Plan,] the Fuel Provisioning Plan, and the Performance Testing Plan. The plans must specify a detailed plan incorporating in a sequential manner all work specified in PART 3 EXECUTION of this specification section. Plan elements must include:

a. Personnel. List of Contractor's personnel by trade, list of key personnel, list of safety equipment, list of miscellaneous equipment such as two-way radios, and personnel transportation vehicles.

****

NOTE: Designer must identify what type of fluid is used for each section of the system.

****

b. Fluid Used for Hydrotesting,[and Cleaning Pigging,][and Verification Pigging,] [and Flushing][Flushing, and Cleaning]. Identify what fluid will be used for each operation in each system section.

****

NOTE: During the design process the Designer must investigate who is providing fuel to the project and identify that entity in this paragraph.

NOTE: The periods shown in this specification are nominal. The Designer must also investigate how long it will take for the fuel to arrive once the Plans have been approved by the Government and modify the periods listed in this specification accordingly. For CONUS locations, minimum period is 60 days. For OCONUS locations, the minimum period is normally 90 days but can sometimes take 120 days or even longer. This may, but does not necessarily, include approval time. Fuel delivery must be coordinated with the Installation and Service Headquarters.

****

c. Fuel. See the Fuel Provisioning Plan.

[d. Water. Specification and quantities of water needed for all system start-up activities and water delivery schedules. Water must meet the characteristics requirements specified. In cases where it is not specified, water must be potable and treated and must meet all the requirements of water used for hydrostatic testing in API 570. Plan must include requirements and schedules for Government-provided materials and equipment.

]

****

NOTE: Designer must identify where the piping system contents are going to be pushed into for hydrotesting, pigging, [and flushing][flushing and cleaning]. This may be a simple decision for permanently looped systems or for systems where temporary loops can be provided. It is more complex for "dead end" systems where the Government or Contractor must provide temporary or mobile tankage.

****

e. Storage-Into. Identify where the contents of the piping will be pushed into including the capacity required, how the storage vessel will be prepared for receiving the piping content, how it will be emptied and how it will be cleaned after the contents are removed.

f. Storage-From. Identify where the fluid that will be drained or pushed into the piping will come from including the capacity required, the number, size and type of the storage vessel, how the storage vessel is filled, how it will be emptied, and how it will be cleaned after the contents are removed.

g. Piping. Notwithstanding the requirements described elsewhere, every pipe section and individual component in the system covered by this specification section must be filled, vented, hydrostatically tested, flushed, cleaned, and tested for fuel quality. It must also be able to be isolated and drained if found that it needs repair. The Plans must detail how this is to be done.

h. Equipment Tests. Detailed procedures and schedules for each system component to perform all system tests under each operating scenario in accordance with paragraph EQUIPMENT TESTS.

i. Performance Testing. Detailed procedures and schedules for each system component to perform all system tests under each operating scenario in accordance with paragraph PERFORMANCE TESTING.

[j. Pigging Plans. See Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

][k. Hydrotesting Plans. See the Work Plan in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

] l. Schedule. Schedules must be generated with listing dates and durations of all system start-up activities as well as regular coordination and safety meetings and dates of key events for Government participation.

m. Contingency plans. Information on spill and fire contingencies, along with the required Government Fire and Safety Office involvement and approvals.

****

NOTE: Designer should identify all base-specific phasing and operational issues for incorporation in the Contract documents.

****

n. Coordination with Installation. Description of how Contractor [and System Supplier]must implement system start-up in coordination with ongoing operations at the Installation. Plan must incorporate all phasing and work restriction requirements of the Contract documents.

1.3.2 Copies of API Publication

Provide four copies of API RP 1595 to the Contracting Officer.

[1.3.3 Existing System Cleanliness Confirmation Plan

****

NOTE: Provide an Existing System Cleanliness Confirmation Plan when connecting into an existing system to confirm the fuel coming into the new system is clean.

Provide a method of checking the fuel quality at the entrance point into a new system and the exit point out of a new system to identify where the contamination is coming from during start-up. If there are no fuel sample points at these points, a method acceptable to the Contracting Officer must be provided. The use of piping connections such as vents, drains, reliefs, and gauges can sometimes be modified and used; existing flanged spool pieces that can be removed and new ones with fuel sample points provided is another method. Avoid to the fullest extent possible the introduction of permanent small piping connections in pipe that is to remain for temporary fuel sample points.

While the Designer does not prepare the plan, the Designer must design the project with at least one method for the Contractor to check the existing system cleanliness to serve as a Basis of Bid for the Contractor.

****

Submit a detailed written plan prepared by the [Contractor][System Supplier] for the Contractor to verify and confirm the cleanliness of the existing system before connecting it to the new system or extension. The cleanliness confirmation test of the existing system (pre-cleanliness test) must be per MIL-STD-3004-1. Submit the plan [60 (CONUS)][90 (OCONUS)][_____] days prior to making the connection to the existing system. The Contractor [and System Supplier]are responsible for implementing the Existing System Cleanliness Confirmation Plan in coordination with ongoing base operations.

]1.3.4 Fuel Testing Laboratory Qualifications

Contractor must submit the qualifications of the DoD Fuel Testing Laboratory which will be used to test the fuel samples.

1.3.5 System Start-up Plan

****

NOTE: Insert number of days of notice after consulting with the Contracting Officer.

The periods shown below are nominal and the Designer must coordinate through the Contracting Officer with facility personnel, required Government witnesses, and other stakeholders to determine the actual period required.

See paragraph FUEL for discussion on how long it may take for fuel to be available for Start-Up before setting period below. The periods below are probably only valid when the project does not require that additional fuel be brought in for start-up and performance testing.

****

Submit a detailed written plan prepared by the [Contractor][and System Supplier] for implementation of System Start-Up. Submit the plan [60 (CONUS)][90 (OCONUS)][_____] days prior to System Start-Up. The Contractor [and System Supplier] are responsible for implementing System Start-Up in coordination with ongoing operations.

1.3.6 Performance Testing Plan

****

NOTE: Develop Performance Testing Plan as a function of the system layout. An example plan is provided. See Attachment 2 - Performance Testing.

The periods shown below are nominal and the Designer must coordinate through the Contracting Officer with facility personnel, required Government witnesses, and other stakeholders to determine the actual period required.

See aragraph FUEL for discussion on how long it may take for fuel to be available for Start-Up before setting period below. The periods below are probably only valid when the project does not require that additional fuel be brought in for start-up and performance testing.

****

Submit a detailed written plan prepared by the [Contractor][Single System Supplier] for implementation of Performance Testing. Submit the plan [60 (CONUS)][90 (OCONUS)][_____] days prior to System Start-Up. The Contractor [and the System Supplier]are responsible for implementing the Performance Testing Plan in coordination with ongoing operations.

1.3.7 Fuel Provisioning Plan

Submit a detailed written Fuel Provisioning Plan prepared by the Contractor. The Fuel Provisioning Plan must include a timeline for the required receipt date(s), grade of fuel, and quantity of fuel on each receipt date required to execute the Start-up and the Performance Testing plans.

1.3.8 Certification (Ready for Start-Up and Performance Testing)

****

NOTE: The periods shown below are nominal and may be much longer for remote and/or complex projects. The Designer must coordinate through the Contracting Officer with facility personnel, required Government witnesses, and other stakeholders to determine the actual period required.

****

As a prerequisite to fuel system start-up, the Contractor must submit a certificate that certifies all work provided on the fuel system, except for touch-up field painting, has been inspected and approved by the specified approving authorities. Further, the Contractor must certify on this certificate that all specified checks and inspections have been successfully completed prior to start-up. Submit the plan [30 (CONUS)][45 (OCONUS)][_____] notice prior to commencement of fuel system start-up. The Contractor must submit the Certificate of Completion to the Contracting Officer at least [7][_____] calendar days prior to commencement of system start-up and performance testing. The Contracting Officer must then be responsible for scheduling the Government representatives [and appropriate military command authority] [and designers]for participation in the inspection, performance testing, and final approval activities. Any contractual deficiencies observed must be corrected by the Contractor without cost to the Government.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

****
NOTE: Select water options in this specification section for flushing pier piping only.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Copies of API RP 1595; G, [_____]

[Existing System Cleanliness Confirmation Plan; G, [_____]

] System Start-Up Plan; G, [_____]

Performance Testing Plan; G, [_____]

Fuel Provisioning Plan; G, [_____]

SD-06 Test Reports

Final Reports; G, [_____]

[Water for Flushing Pier Piping

] Cathodic Protection Reports; G, [_____]

Equipment Tests; G, [_____]

Piping Flushing Checklist; G, [_____]

Piping Cleaning Checklist; G, [_____]

SD-07 Certificates

Fuel Testing Laboratory Qualifications; G, [_____]

Certification (Ready for Start-Up and Performance Testing); G, [_____]

[Contractor Start-Up Qualifications; G, [_____]

] Certificate of Calibration; G, [_____]

Disposal Of Waste Materials

SD-11 Closeout Submittals

Certification of Entire System

1.5 CLOSEOUT SUBMITTALS

1.5.1 Final Reports

Contractor must prepare a final report that documents the execution of the approved start-up and performance testing plan. All items of work specified in the Start-up and Performance Testing plans must be carried out and reported in this report unless otherwise approved by the Contracting Officer. Include as a part of this report:

a. Verification letters of approved fuel storage tank hydrostatic tests and the approved piping hydrostatic tests, as generated under other specification sections.

b. Final settings of the valves and switches.

c. A copy of the flow and pressure output graphs and excel data and charts on CDR media with an explanation of what the graph indicates and what the system is doing.

d. A schematic flow diagram drawing of the resultant system showing major valves with the "normal" position of each manual valve noted, equipment, and the type, location, and setpoints of each safety relief valve and thermal relief valve.

e. A certified pipeline inventory - a detailed list with sizes, lengths, quantity, and volumes must be provided for the systems in this project. Such systems include, but are not limited to: marine receipt, pipeline receipt, truck off-loading receipt, pumphouse, pump pad, truck loading, marine loading, transfer pipeline, product recovery, and other miscellaneous piping systems. Fuel system volume must be calculated using as constructed pipe lengths, internal diameters, fittings, and components. Totals must be provided for all items containing fuel with the exception of tanks which is covered by other specifications.

1.6 QUALITY ASSURANCE

[1.6.1 Contractor Start-Up Qualifications

****

NOTE: If there is a System Supplier requirement, that entity will be responsible for the start-up of the system. In the case of systems where the System Supplier requirement is not included, include the bracketed text below to designate that the Contractor is responsible for start-up.

The System Supplier requirements and qualifications are defined in Specification 33 57 55 FUEL SYSTEMS COMPONENTS (NON-HYDRANT).

****

Submit the following data for approval:

a. Certification stating that the Contractor has provided start-up services (including start-up, existing system cleanliness confirmation, and performance testing experience) for five similar systems in the last five years.

b. Project names, locations, system description, and items provided at these installations. Include user point-of-contact and current telephone numbers.

][1.6.2 Water for Flushing Pier Piping

Submit results of water testing and amount of water required.

]1.6.3 Certification of Entire System

****

NOTE: The periods shown below are nominal and may be much longer for remote and/or complex projects.

****

Prior to the acceptance of the newly constructed system by the Government, all installed mechanical and electrical system components must be inspected and approved by the Contracting Officer. Provide the Contracting Officer [45] [60] [_____] days notice in order to schedule the Installation[, DLA] and Service Headquarters and/or their designated appointee for participation in the inspection, Performance Testing, and approval. Any deficiencies observed must be corrected by the Contractor without cost to the Government.

1.6.4 Service Headquarters Definition

SME is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (AFCEC/COS); Army - Headquarters, U.S. Army Corps of Engineers; POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC); Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11). ER 1110-1-8167 Engineering and Design Petroleum, Oil, and Lubricants Mandatory Center of Expertise must be followed.

The Service Control Point (SCP) is defined as follows: Army - Army Petroleum Center; Air Force - Air Force Petroleum Office; Navy/Marine Corps - Naval Supply Systems Command - Energy.

[1.7 SYSTEM SUPPLIER INVOLVEMENT

****

NOTE: In most projects, including those requiring control valves, motorized or alarmed isolation valves, wired sensors and controllers, pumps, control panels and other equipment and system components a System Supplier will be used to Start-Up and Performance Test a system. Include the bracketed text to require the use of a System Supplier for system components/controls supply, coordination and installation verification.

In the simplest of projects such as one with only simple piping modifications, the addition of thermal relief valves, the replacement of assorted manual valves, etc, the Contractor will cover that role. In that case, require the Contractor to demonstrate his qualifications in a Submittal.

****

The System Supplier is defined in Specification 33 57 55 FUEL SYSTEMS COMPONENTS (NON-HYDRANT). The Contractor and the System Supplier must work together to prepare the Start-Up Plan, [the Existing System Cleanliness Confirmation Plan,] Equipment Testing Plan, Performance Testing Plan, and the Final Reports. They must both be present during all activities described in this section. The System Supplier must be responsible to the Contractor for scheduling all Contractor, sub-Contractor, and manufacturer's service personnel during activities described in this specification section.

]1.8 DISPOSAL OF WASTE MATERIALS

The Contractor must be responsible for properly disposing of any sludge, debris, filtration elements,[waste water, contact water,] and waste fuel resulting from piping and tank [flushing] [flushing and cleaning] activities as specified in Section [_____].[Comply with all applicable Installation, local (city and county), State, and Federal Regulations for hazardous waste disposal.]

PART 2 PRODUCTS

2.1 GOVERNMENT-FURNISHED MATERIAL AND EQUIPMENT

The Government will furnish the following materials, equipment and services during the performance of the work under this section.

2.1.1 Fuel

****

NOTE: During the design process the Designer must determine if the fuel is DLA or Service funded.

NOTE: The Designer must also investigate how long it will take for the fuel to arrive once the Plan has been approved by the Government and modify the periods listed below accordingly. For CONUS locations, minimum period is 60 days. For OCONUS locations, the minimum period is normally 90 days but can sometimes take 120 days or even longer. This may, but does not necessarily, include approval time. Fuel delivery must be coordinated with the Installation and Service Headquarters.

NOTE: During the design process the Designer must investigate how much fuel can reasonably be expected to be "lost" during construction. Experience has shown that 200 gallons is a reasonable maximum amount for a new system (project that does not tie into an existing system). For projects tying into existing systems, and for very large new systems, the number may be larger.

****

Some fuel loss should be expected. Fuel that is lost during [flushing] [flushing and cleaning], equipment testing, and performance testing is viewed as a Start-up and Performance Testing expense and should be budgeted for in Contractor estimates. As Basis of Bid, the Contractor must allow for [200] [_____] gallons of fuel losses in the bid.

The Contractor is responsible for the disposal of any waste product.

The Contractor must establish a Department of Defense Activity Address Code and must reimburse the US Government for any US Government fuel lost resulting from poor workmanship or contamination.

The Government will provide fuel given that the requirements are submitted with sufficient lead time to allow the US Government to secure the grade and volume required and make the necessary transportation requirements. The Contractor must provide a copy of the Start-up, Fuel Provisioning, and Performance Testing plans a minimum of [60] [90][_____] days in advance of System Start-up.[When Defense Working Capital Fund (DLA Owned) fuel is used, provide a copy of the Start-up, Fuel Provisioning, and Performance Testing plans to DLA Energy at the same time.]

[FLUSHING, EQUIPMENT TESTS and PERFORMANCE TESTING][FLUSHING, CLEANING, EQUIPMENT TESTS and PERFORMANCE TESTING]: The [flushing], [flushing and cleaning] and testing phases will be identified separately in the start-up and Performance Testing plans. Fuel used for [flushing][flushing and cleaning], and testing will become contaminated, the fuel must be isolated and is considered off-specification until the quality can be verified. Fuel volumes required for [flushing][flushing and cleaning] and testing should be minimized to limit costs, so estimates should be made accordingly. The Contractor will be responsible for disposing of any waste product.

Upon satisfactory completion of the [flushing][flushing and cleaning] operations, the Government will supply the additional quantities of fuel required to complete the other work under this section. This larger volume of fuel will not be delivered to the system until the Contractor has satisfactorily completed all work and, in particular, [the cleaning and coating of the interior surfaces of the storage tanks and] the removal of preservatives and foreign matter from those portions coming in contact with the fuel valves, pumps, filter-separators and other such system components.

[2.1.2 Refueler Tank Trucks

****

NOTE: During the design process the Designer must investigate who is providing the refueler tank trucks for this project. If they are to be provided by the Contractor, add requirement under Contractor-furnished Equipment and delete this paragraph.

NOTE: If the refueler tank trucks are to be provided by the Fuel Facility Operator and they are not Government-owned vehicles, the Fuel Facility Operator's Contract will need modification to provide the equipment and the service if this is not already in the Contract.

****

The Government will furnish and operate the refueler tank trucks for the testing of truck fill stands.

][2.1.3 Vacuum Trucks

****

NOTE: During the design process the Designer must investigate who is providing the vacuum trucks for this project. If they are to be provided by the Contractor, add requirement under Contractor-furnished Equipment and delete this paragraph.

NOTE: If they are to be provided by the Fuel Farm Operator and they are not Government-owned vehicles, the Fuel farm Operator's Contract will need modification to provide the equipment and the service if this is not already in the Contract.

****

The Government will furnish and operate the vacuum trucks required for removing water and fuel from pits, drains, and other systems.

][2.1.4 Fuel Bowser

****

NOTE: A fuel bowser is a small towed tank often used for larger project to vent fuel vapor laden air into. During the design process the Designer must investigate if a fuel bowser is needed for this project and who is providing the fuel bowser for this project. If they are to be provided by the Contractor, add requirement under Contractor-furnished Equipment and delete this paragraph.

NOTE: If they are to be provided by the Fuel Farm Operator and they are not Government-owned vehicles, the Fuel Farm Operator's Contract will need modification to provide the equipment and the service if this is not already in the Contract.

****

The Government will furnish and operate the fuel bowser required for removing water and fuel from pits, drains, and other systems.

][2.1.5 [Barge(s)][Ship(s)]

****

NOTE: During the design process the Designer must investigate who is providing the barges/ships for this project. If they are to be provided by the Contractor, add requirement under Contractor-furnished Equipment and delete this paragraph.

****

[The Government will furnish and operate the [barge(s)][ship(s)] that provide the fuel required for system start-up activities.][The Government will furnish [Barge(s)][Ship(s)] for the use of water for pier piping hydrotesting and flushing.]

]2.2 CONTRACTOR-FURNISHED MATERIAL AND EQUIPMENT

2.2.1 Contractor-furnished

Provide material, equipment and labor not specified to be Government-furnished and required for proper System Start-Up of the system. Equipment being provided must be calibrated and the certificate of calibration be submitted to the Contracting Officer prior to use. Equipment must include but not be limited to the following:

a. Temporary strainers.

b. Pipe spools.

c. Flow meters.

****

NOTE: Include bracketed text for bottom loading of refueler truck loading systems using pressure fueling nozzles.

****

d. Pressure gauges[to include bayonet type gauge to be used on the single point receptacle (SPR) on the Government truck. Gauge must be turned over to the Government after startup is complete].

****

NOTE: All systems include fueling pumps. Most systems except military service stations include a pump control panel (PCP). Such systems may include a truck loading control valve, back pressure control valve, a bypass pressure control valve, and an issue venturi. Edit as appropriate for the particular project.

****

e. Electronic sensors and recorders for pressure [and flow recording]are included in the Pump Control Panel (PCP). This equipment must be used to monitor and record the system during the "Equipment Tests" and "Performance Testing" portions of this Specification Section. Recorded data must be used by the Contractor and equipment factory representatives to achieve final control valve and equipment adjustments. Recorded data must include:

(1) Fueling pumps discharge pressures.

(2) Storage Tank levels.

(3) Product Recovery Tank levels.

(4) Fueling pumps suction pressures.

[(5) Truck Loading Control Valve upstream pressures.

][(6) Truck Loading Control Valve downstream pressures.

][(7) Truck Fillstand Flowrate (measure flowrate at the fillstand using local instruments).

][(8) Supply Venturi flow rates.

][(9) Back Pressure Control Valve upstream pressures.

][(10) Back Pressure Control Valve downstream pressures.

][(11) Bypass Pressure Control Valve upstream pressures.

][(12) Bypass Pressure Control Valve downstream pressures.
]

****

NOTE: Delete below paragraph if project does not include filter-separators.

****

[f. The Contractor must have on hand sufficient filter elements [, spin-on filters,] and coalescer cartridges to adequately clean the system. During the cleaning operation, provide a flow versus pressure drop graph for each filter-separator, as provided in Attachment 1 - Equipment Tests. Change coalescers and cartridges upon reaching a differential pressure of 103 kPa 15 psi or when pressure drop is less than previous graph or fails to increase properly. Isolate each filter-separator, one at a time and use one fueling pump to obtain rated flow rate [19 lps 300 gpm] [38 lps 600 gpm]. A minimum of one complete set of coalescer elements and separator cartridges for each filter-separator must be turned over to the Government after new coalescer elements and separator cartridges are installed in each filter-separator vessel after completion of Performance Testing.

][g. Vacuum Trucks for removing water and fuel from pits, drains, and other systems.

][h. Fuel Bowser for removing water and fuel from pits, drains, and other systems.

][i. [Barge(s)][Ship(s)] to provide the fuel required for system start-up activities

][j. [Barge(s)][Ship(s)] for the use of water for pier piping hydrotesting and flushing.

][k. Over-the-road (OTR) tank trucks for [flushing,][flushing, cleaning] and draining of the system and for starting up and performance testing truck off-loading systems.

][l. Temporary Tankage for [flushing,][flushing, cleaning]and draining of the system and for starting up and performance testing.

][m. Temporary Piping to form a temporary "looped" piping system for [flushing,][flushing, cleaning]and draining of the system and for starting up and performance testing.
]

****

NOTE: During the design process the Designer must

investigate who is providing utilities for this project.
****

[n. The Contractor must be responsible for providing the electrical power from a source identified by the Government to the testing locations.

][o. Temporary filtration/strainers.
]
****
NOTE: Include bracketed text for systems indicated as piggable if they do not already have them.
****

[p. Pigging equipment and services per Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT) including pig launching and receiving barrels, kicker line, and receiver line.

]2.2.2 Design Conditions

Use temporary flushing lines and equipment that are equal in strength, stability, and materials to the associated permanent components. However, spools may be carbon steel. Additional design conditions must be as specified in Section 33 57 55 FUEL SYSTEMS COMPONENTS (NON-HYDRANT).

****
NOTE: During the design process the Designer must investigate who is providing electric power.
****

[2.2.3 Electric Power

Electric power required for the performance of the work under this section [will be furnished by the Government at no charge to the Contractor][must be furnished by the Contractor].

][2.3 WATER FOR FLUSHING PIER PIPING

****
NOTE: Water may only be used for work in this section for flushing pier piping. The use of water in hydrotesting and cleaning pigging is covered in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

Availability of water services and charges are established by the activity and should be stated in Division 1 of the contract specifications. Contact authority having jurisdiction to determine what kind of water can be used, what flow rate is available for filling, days and hours of availability, allowable disposal rate, required testing, and characteristics.

Include location regulatory requirements for water disposal permits, treatment, and testing of test water prior to disposal. Verify water discharge may be dumped without treatment.

During the design process the Designer must

investigate who is providing water.

****

Water [will be furnished by the Government at no charge to the Contractor][must be furnished by the Contractor] and must be potable and treated and must meet all the requirements of water used for hydrostatic testing in API 570.

]PART 3 EXECUTION

****

NOTE: There are essentially five kinds of piping and equipment systems covered by this specification. Tailor this specification section to suit the actual system:

a. Systems or parts of systems that have fixed storage tanks that fuel can be pushed into as part of the start-up and performance testing. Examples include receipt systems of all types, pump stations where the pump discharge can be directed back to the tank, systems that have been provided with permanent piping as a method of connecting discharge piping back into receipt or return piping (flushing connection at some truck fill stands, etc.).
It may be acceptable to allow the Contractor to construct a temporary piping system to convert one of the below systems into a "looped" system that can be flushed back into a storage tank. If so, the piping and fittings should be the same rating and strength as the system being flushed.

b. Relatively short, small volume, large diameter piping systems or parts of systems that do not have fixed storage tanks that fuel can be pushed into as part of the Start-up and Performance Testing. Examples include truck fillstands at Air National Guard bases where the piping is usually 200 mm 8-inch or less in diameter and are typically a few hundred feet long at most.

c. Relatively long, high volume, large diameter piping systems or parts of systems that do not have fixed storage tanks that fuel can be pushed into as part of the start-up and performance testing. Examples include pipelines and marine loading systems.

d. Small diameter piping systems that are within a larger system and it is not desirous to flush them back into an existing, clean system. Examples include thermal relief systems, and long vent and drain lines.

e. Relatively short sections of larger piping that are within a larger system, and it is not desirous to flush them back into an existing, clean system. Example include replacement sections of pipelines.

****

****

NOTE: Adjust the following to account for whether or not water is used for hydrotesting, pigging, or flushing (pier piping only). If water is used in any of these, it must take place before Initial Fuel Receipt into that section of piping. The use of water in hydrotesting and pigging is covered in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT) and is only mentioned here because of how it affects the timing of the initial fuel receipt.

****

****

NOTE: Delete pigging paragraphs if piping is not piggable.

****

3.1 SEQUENCE OF EVENTS

****

NOTE: Aviation fuel piping and equipment systems require flushing and cleaning. Non-aviation fuel piping and equipment systems require only flushing.

NOTE: Jet Fuel systems where the jet fuel is used as a ground product, and is not used for aircraft or helicopters require only flushing.

NOTE: Filter vessels (such as filter-separators, spin-on filters and micronic filters) and strainers that are designed to be opened for cleaning purpses must be opened and cleaned no matter the product.

****

****

NOTE: Adjust the following to account for whether or not water is used for hydrotesting, or pigging. If water is used in any of these, it must take place before Initial Fuel Receipt into that section of piping.

- The use of water in hydrotesting and pigging is covered in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT) and is only mentioned here because of how it affects the timing of the initial fuel receipt.

- The use of water in flushing pier piping is required and is covered in this section.

****

The following events take place in the Start-Up and Performance Testing of a system and their definitions:

a. System Start-Up Phase: The System Start-Up phase encompasses all of the events described below up to the Performance Tests Phase.

b. Preliminary Requirements: Confirms completion of the system before fuel is received[including verification of the cleanliness of the existing piping system being connected to].

c. Preparations for Flushing: Activities that take place before initial receipt of fuel.

d. Pneumatic Testing: Test for leaks in a piping system using air under pressure as the test medium. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

[e. Pipe Pigging - Pneumatic: Use of pneumatically propelled foam pigs to confirm that lines are clear and free of debris and obstructions. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT)

][f. Hydrostatic Testing - Water: Use of water to test for leaks in a piping system using liquid under pressure as the test medium. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

][g. Pipe Pigging - Cleaning with Water: Use of water propelled pigs to clean the line of gross contamination. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

][h. Pipe Pigging - Verification with Water: Use of water propelled pigs to inspect the condition of the pipeline. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

][i. Initial Fuel Receipt: The point in time at which fuel is introduced into the system with all that implies for safety, spill prevention and control, and inventory control.

][j. Hydrostatic testing - Fuel: Use of fuel to test for leaks in a piping system using liquid under pressure as the test medium. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

] k. Soak Testing: Perform "Soak Testing" of the piping system using fuel, as per Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT)

[l. Pipe Pigging - Cleaning with Fuel: Use of fuel propelled pigs to clean the line of gross contamination. Perform this as part of the work in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

][m. Pipe Pigging - Verification with Fuel: Use of fuel propelled pigs to inspect the condition of the pipeline. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

] n. Flushing: In this context, refers to removing gross contamination (free water and solids) from a fuel system using [fuel][water (fuel pier only)].

[o. Cleaning (except filter vessels and strainers): In this context, refers to removing the remaining water and contamination from aviation fuel to the quality (allowable) levels suitable for issuing the final product using fuel as the cleaning medium.

] p. Cleaning (filter vessels and strainers): Filter vessels and strainers that are designed to be opened for cleaning must be opened and cleaned.

q. Control Valve Adjustment: Control valve adjustment so that equipment can be safely tested and adjusted.

r. Equipment Tests: Tests performed by the Contractor [and the System Supplier] to confirm that individual components of the fuel system are correctly installed and are operational.

s. Performance Tests Phase: Government witnessed demonstration of the proper operation of the individual pieces of equipment and the system or systems as a whole.

3.2 PRELIMINARY REQUIREMENTS

****

NOTE: Delete bracketed text if system does not include an Oil/Water Separator.

****

All activities listed in paragraph PART 3 EXECUTION must be performed sequentially in the order they are presented. Prior to any on-site system start-up activities, the Contractor must ensure that all requirements of the paragraph SAFETY are satisfied. Project must be substantially complete, except for touch-up field painting, and Contractor's work area must be free of debris, trash and obstacles.[Correct functioning of oil/water separator(s) must be verified prior to receipt of fuel.] Perform the following activities prior to receipt of fuel:

3.2.1 Safety

Prior to any on-site system start-up activities, the following safety procedures must be accomplished in all fueling areas to be started up and performance tested under this specification section: testing/operation of emergency showers and eyewash stations, placement of Contractor-provided portable eyewash units within 31 meters 100 feet or 10 seconds from the fueling point, verification of proper grounding throughout system, coordination with Government Fire and Safety Office and Fuels personnel, placement of [Contractor-][Government-]provided spill pads[and containment booms], placement of [Contractor-][Government-]provided fire extinguishers capable of extinguishing a fuel fire. Ensure that all radios/devices at all Class I, Division 1 areas are intrinsically safe.

3.2.2 Electrical Preparations

Prior to energizing the electrical system components, verify that short-circuit links have been removed from current transformer and that secondary circuits have been connected. Confirm that all tests required for fire detection and suppression systems have been performed and accepted. Verify all electrical transmitter connections and ensure proper calibration. Verify all electrical system components meet the classification and division as required by the design. Verify correct rotation of all motors prior to testing. Verify paddle type flow switches by physically actuating vanes and checking outputs. Conduit explosion-proof sealoffs must be poured after initial electrical checks but before fuel receipt.

3.2.3 Emergency Fuel Shutoff (EFSO) System Testing

****

NOTE: Modify as required for actual system.

****

Prior to initial fuel receipt, verify that each switch will trip the circuit breaker of the fuel pump[s][and de-energize the EFSO relay and close the [main emergency fuel shut-off valve] [flow control valve of each filter-separator]].

[3.2.4 Storage Tanks

****

NOTE: Delete entire paragraph if project does not include fuel flowing into a tank. All of the features described below may not be needed if project does not include starting up a new tank or modifications to an existing tank.

****

Ensure approved performance of storage tank integrity testing, hydrostatic tests, leak detection system, and coating application/inspection per the applicable specifications. Include verification letter of approved test results for information in the Final Reports. Ensure that tank interior is clean and free of any fuel-contaminating debris. Verify operation of tank level alarms[by closing tank connection valves and filling housings with fuel to confirm action]. Ensure that certified strapping charts for all tanks are available for start-up personnel. [API][STI] tank inspections have been performed per applicable specifications and the reports are on hand prior to commencement with the initial fill and Performance Testing. [Ensure tank cathodic protection inspections are performed per applicable specifications and the cathodic protection reports are on hand prior to initial fill and performance testing.][Verify correct orientation of internal tank inlet diffuser.]

]3.2.5 Piping System

****

NOTE: Modify as required for the system. Ensure a method of assessing the quality of the fuel and that start and end of the piping and/or system to be started up is provided.

****

Ensure that all piping weld integrity, leak detection systems, and coating inspections have been performed per the applicable specifications. Provide statement that required testing has been completed in the Final Reports. Evacuate all accumulated water from piping low point drains, valve cavities, and equipment drains. Verify all bolted connections are tightness tested to required torque using a calibrated torque wrench. Verify that all pressure gauges are properly calibrated, located and installed. Ensure that piping's cathodic protection system is tested, calibrated and operational. [Ensure the cathodic protection inspections are performed per applicable specifications and the cathodic protection reports are on hand prior to initial fill and performance testing.] Ensure that pipe marking and identification are provided as specified. Ensure that piping system thermal relief provisions are installed as designed. Verify the correct installation of piping expansion loops[, joints,] and supports.

[3.2.5.1 Pier Piping Systems

For pier delivery/receipt systems or other over-water piping installations, ensure compliance with the Contractor's previously approved spill control plans.

][3.2.5.2 [Transfer][Installation][Interterminal] Pipeline Systems

For pipeline systems or any other piping running outside the fuel facility fence, ensure compliance with the Contractor's previously approved spill control plans.

][3.2.6 Existing System Cleanliness Confirmation

Contractor [and System Supplier]must conduct tests to confirm the cleanliness of the existing system before connecting it to the new system or an extension, upgrade or repair of the existing system. Confirm that the fuel in the existing system meets the intra-governmental receipt limits defined in MIL-STD-3004-1. Sampling must be performed by the[Government][Contractor] and testing must be done by[the Service][a DoD regional fuels testing laboratory] [an independent fuel testing laboratory approved by the Contracting Officer].

]3.3 PREPARATIONS FOR FLUSHING

Upon completion of the system to the satisfaction of the Contracting Officer and the Service Headquarters and/or their designated appointee, make the following preparations for flushing the system.

3.3.1 Protection of System Components

The following items must be removed from the system prior to start of flushing operations and, where applicable, replaced with spools of pipe, diameter equal to the item removed.

[a. Control valves. This also includes control valve tubing exterior to the valve such as that which runs from tank level control valves up to tank float pilots.

][b. Sensors which are exposed to the fluid such as pressure gauges and thermometers.

][c. Coalescer and separator elements in filter-separators.

][d. Venturi Tubes and Pressure Indicating Transmitters.

][e. Meters.

] After flushing, the above items must be reinstalled in the system and the spool sections turned over to the Contracting Officer.

3.3.2 Strainers

****

NOTE: Remove temporary strainers unless directed otherwise by Service Headquarters.

NOTE: Use temporary strainers ahead of the pumps only if there are no permanent basket strainers immediately upstream of the pump. Consult with Service Control Point to determine appropriate mesh size.

****

Ensure strainers are clean before flushing. Temporary [7] [40] [60] [100] [_____] mesh strainers with minimum 300 percent open area must be provided in the suction line ahead of each fueling pump [for the entire flushing operation] [to remain permanently in the system].[A temporary strainer should be installed immediately upstream of the product recovery tank overfill valve.] Any damaged permanent or temporary strainers must be replaced by the Contractor at no additional cost to the Government.

3.3.3 Water Draw-off

****

NOTE: Delete reference to returning through filtration if no filtration to return to is available as part of the project and-or if no storage tank is being used to push fuel through as part of the project.

****

Remove any accumulated water from piping,[equipment,][and storage tanks' sumps and bottoms].[Drain water and return fuel via filtration to storage tank.] Repeat process until all water is removed. Dispose of petroleum contaminated water in accordance with Installation, local, State, and Federal regulations.

****

NOTE: All projects involve fuel receipt. Choose either paragraph INITIAL FUEL RECEIPT INTO STORAGE TANK or INITIAL FUEL RECEIPT DIRECTLY INTO PIPING SYSTEM.

****

3.4 INITIAL FUEL RECEIPT INTO STORAGE TANK

3.4.1 General

****

NOTE: Description below is written for a system with piping and systems to be started up that are upstream of the fixed system storage tanks. These systems have their initial fuel receipt through receipt piping, receipt filtration, and then into a storage tank. It covers pipeline receipt and any kind of truck, railcar, ship, or barge offloading system. If the storage tank is existing and not started up as part of this project, and fuel is still pushed into a tank, the process is the same but without a storage tank.

NOTE: Edit as required to suit the actual system.

****

Utilize one storage tank for initial fuel receipt to isolate contaminated fuel. Initial receipt of fuel must be done by gravity if possible. The Contractor must station personnel throughout piping system at high point vents to bleed air. All flanges and system components will be periodically inspected for leaks during filling procedures.

3.4.2 Storage Tanks

****

NOTE: Delete bracket for horizontal tank or vertical tanks that do not have a floating pan.

NOTE: Delete paragraph for tanks where receipt is by gravity drop from an adjacent or nearby tank truck such as most service stations.

****

Receipt flow rate into an empty storage tank must not exceed 1 m/s 3 feet per second (FPS), as measured in the main receipt piping, until outlet of tank fill tube is submerged[and pan/roof legs are lifted].

3.4.3 Components

****

NOTE: Delete filter-separators and vessels if they are not being filled during this start-up. Delete strainer call-outs if the piping section is so short that using strainers is not possible. To use temporary strainers a flanged connection is normally needed.

NOTE: Provide either a differential pressure gauge or a pressure gauge on either side of the strainer.

****

[Ensure that [filter-separators and other]vessels are filled slowly by closing outlet valves and venting through air eliminators. [Fill filter vessels using slow-fill line][Fill vessels using throttled downstream valves] to maintain a packed condition in vessels throughout initial fill of piping system.]Differential pressure across strainers must be continuously monitored. Any time a strainer differential pressure reaches 138 kPa 20 psig, it must be cleaned.

3.4.4 Fuel Quality

****

NOTE: Provide fuel sample connection to allow for checking fuel quality. This may be difficult in some cases. See the Designer Notes in paragraph PLANS for a discussion of this. A method of checking fuel quality acceptable to the Contracting Officer must be provided.

****

Fuel used during initial receipt must be considered contaminated and must be positively isolated, with blind flanges or closed, padlocked manual valves, from any active transfer, or aircraft fueling or tank truck loading operations. Fuel isolation must continue until all [flushing][flushing and cleaning] is completed. A method of checking fuel quality that is acceptable to the Contracting Officer must be provided at the beginning and end of any new piping section.

3.4.5 Fuel Receipt

****

NOTE: Choose one of the following and modify as required for the particular project.
****

[3.4.5.1 Fuel Receipt by Pipeline

Start-up personnel must meet with Government personnel in charge of existing fuel storage to discuss fuel transfer procedures. Topics must include: methods of communication to start/stop remote transfer pumps; flow rate and head characteristics of transfer pumps; methods of restricting initial receipt flow rate; methods of straining and filtering initial receipt fuel; accommodating multiple pump starts resulting from required strainer and filter cleaning operations; required quantity of fuel to be transferred. Contractor must provide a written summary of pipeline receipt procedures to the Contracting Officer.

][3.4.5.2 Fuel Receipt by Commercial Truck

Start-up personnel must meet with Government personnel in charge of existing fuel storage to discuss fuel transfer procedures. Topics must include: methods of communication to start/stop pumps; flow rate and head characteristics of transfer pumps; methods of restricting initial receipt flow rate; methods of straining and filtering initial receipt fuel; accommodating multiple pump starts resulting from required strainer and filter cleaning operations; required quantity of fuel to be transferred. Coordinate with Government personnel to schedule quantity of trucks required. Contractor's personnel must be positioned at each offloading position, at the pumphouse and at the receipt tank, all in radio contact. Contractor must provide a written summary of truck receipt procedures to the Contracting Officer.[If truck unloading system is newly constructed, perform initial receipt, flushing, and testing prior to performance testing].

][3.4.5.3 Fuel Receipt from Piping System

Start-up personnel must meet with Government personnel in charge of existing fuel storage to discuss fuel transfer procedures. Topics must include: methods of communication to start/stop remote pumps; flow rate and head characteristics of pumps; methods of restricting initial receipt flow rate; methods of straining and filtering initial receipt fuel; accommodating multiple pump starts resulting from required strainer and filter cleaning operations; required quantity of fuel to be used. Contractor must provide a written summary of piping fill procedures to the Contracting Officer.

][3.4.5.4 Fuel Receipt from Pier

Start-up personnel must meet with Government personnel in charge of existing fuel storage to discuss fuel transfer procedures. Topics must include: methods of communication to start/stop pumps; flow rate and head characteristics of transfer pumps; methods of restricting initial receipt flow rate; methods of straining and filtering initial receipt fuel; accommodating multiple pump starts resulting from required strainer and filter cleaning operations; required quantity of fuel to be transferred. Contractor must provide a written summary of pipeline receipt procedures to the Contracting Officer.

]3.4.6 Initial Low Point Flush

Perform an initial low point flush operation by flushing each low point drain through a portable basket strainer for 10 seconds at a system pressure of 207 kPa 30 psig. Repeat flush until basket strainer collects no additional debris.

[3.4.7 Storage Tank Hydrostatic Tests

****

NOTE: Delete if API 650 Aboveground Storage Tanks are not being hydrotested as part of this project.

****

Hydrostatically test the storage tanks per Specification Section 33 56 21.17 SINGLE WALL ABOVE GROUND FIXED ROOF STEEL POL STORAGE TANK. Upon completion of hydrostatic testing, perform "Soak Testing" of the tanks per API RP 1595. Duration of the test must be a minimum of 4 days and maximum of 7 days.

][3.4.8 Storage Tank Tightness Tests

****

NOTE: Delete if Factory Fabricated Storage Tanks are not being tested as part of this project.

****

Perform tightness testing and manufacturer's tests of the storage tanks per Specification Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

][3.4.9 Piping Hydrostatic Tests

****

NOTE: Delete the following if piping is hydrostatically tested with water.

****

Hydrostatically test the piping system with fuel as required by Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

]3.4.10 Piping Soak Tests

****

NOTE: Select the first option if hydrostatically testing with fuel. Select the second option if hydrostatically testing with water.

****

[Upon completion of hydrostatic testing with fuel,][After initial receipt of fuel,] perform "Soak Testing" of the piping systems per API RP 1595. Duration of the test must be a minimum of 4 days and maximum of 7 days.

3.5 INITIAL FUEL RECEIPT DIRECTLY INTO PIPING SYSTEM

3.5.1 General

****

NOTE: Description below is written for a system where the project does not involve one of the fixed storage tanks to push product into.

NOTE: Edit as required to suit the actual system.
****

Initial receipt of fuel must be done by gravity if possible. The Contractor must station personnel throughout piping system at high point vents to bleed air. All flanges and system components will be periodically inspected for leaks during filling procedures.

3.5.2 Components

****
NOTE: Delete filter-separators and vessels if they are not being filled during this start-up. Delete strainer call-outs if the piping section is so short that using strainers is not possible. To use temporary strainers a flanged connection is normally needed.
****

[Ensure that [filter-separators and other]vessels are filled slowly by closing outlet valves and venting through air eliminators. Downstream valves must be throttled to maintain a packed condition in vessels throughout initial fill of piping system.]Differential pressure across strainers must be continuously monitored. Any time a strainer DP reaches 138 kPa 20 psig, it must be cleaned.

[3.5.3 Fuel Quality

****
NOTE: Provide fuel sample connection to allow for checking fuel quality. This may be difficult in some cases. See the Designer Notes in the paragraph PLANS for a discussion of this. A method of checking fuel quality acceptable to the Contracting Officer must be provided.
****

Fuel used during initial receipt must be considered contaminated and must be positively isolated, with blind flanges or closed, padlocked manual valves, from any active transfer, or aircraft fueling or truck loading operations. Fuel isolation must continue until all [flushing][flushing and cleaning]is completed. A method of checking fuel quality that is acceptable to the Contracting Officer must be provided at the beginning and end of any new piping section.

]3.5.4 Fuel Receipt

****
NOTE: Choose one of the following and modify as required for the particular project. If there is another method of receiving fuel, add it and modify accordingly.
****

[3.5.4.1 Fuel Receipt from Existing Piping System

Start-up personnel must meet with Government personnel in charge of existing fuel system to discuss fuel transfer procedures. Topics must include: methods of communication to start/stop remote pumps; flow rate and head characteristics of pumps; methods of restricting initial receipt flow rate; methods of straining and filtering initial receipt fuel; accommodating multiple pump starts resulting from required strainer and filter cleaning operations; required quantity of fuel to be used. Contractor must provide a written summary of piping fill procedures to the Contracting Officer.

][3.5.4.2 Fuel Receipt from Pier

Start-up personnel must meet with Government personnel in charge of existing fuel storage to discuss fuel transfer procedures. Include barge or tanker operator(s) in this meeting. Topics must include: methods of communication to start/stop pumps; flow rate and head characteristics of transfer pumps; methods of restricting initial receipt flow rate; methods of straining and filtering initial receipt fuel; accommodating multiple pump starts resulting from required strainer and filter cleaning operations; required quantity of fuel to be transferred. Contractor must provide a written summary of pipeline receipt procedures to the Contracting Officer.

]3.5.5 Initial Low Point Flush

****

NOTE: If the system cannot generate 207 kPa 30 psig (such as a gravity system), use the highest pressure possible. 207 kPa 30 psig is the desired minimum pressure.

****

Perform an initial low point flush operation by flushing each low point drain through a portable basket strainer for 10 seconds at a minimum system pressure of [200 kPa 30 psig]. Repeat flush until basket strainer collects no additional debris.

[3.5.6 Piping Hydrostatic Tests

Hydrostatically test the piping system with fuel as required by Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

]3.5.7 Piping Soak Tests

****

NOTE: Select the first option if hydrostatically testing with fuel. Select the second option if hydrostatically testing with water

****

[Upon completion of hydrostatic testing with fuel,][After initial receipt of fuel,] perform "Soak Testing" of the piping systems per API RP 1595. Duration of the test must be a minimum of 4 days and maximum of 7 days.

3.6 FLUSHING

****

NOTE: Delete and add names of piping segements and systems as needed.

NOTE: Flushing must be using fuel except for pier

piping, which must be flushed with fresh water.
****

Flushing procedures remove gross particulate and water contaminants[and must precede cleaning procedures]. All piping including but not limited to[receipt piping,][issue piping,][transfer piping,][pump house piping,][supply and return lines to the storage tanks,][product recovery lines,][truck off-loading lines,][truck loading lines,][railcar off-loading lines,][railcar loading lines,][installation pipelines,][interterminal pipelines,][thermal relief piping,][high point vents,][low point drains,][control valve tubing on the control valves,][control valve tubing exterior of the control valves,][_____] must be flushed with fuel.[Pier piping must be flushed with water.]

In the event flushing identifies the presence of clay or soil like material in the system, Contractor must immediately notify Contracting Officer for direction.

3.6.1 Flushing Requirements

****
NOTE: Select bracketed text based on available pumping capacity. Require temporary pumps only after A/E feasibility review; if used, provide detailed work sequence/limitations on contract documents.

Select volume of flush based on practicality. For systems that are not looped, the system must either be flushed into a tank truck, or a portable tank, or into another storage tank at the end of the line in the case of an installation or interterminal pipeline. For very large piping systems, dozens of over the road tank trucks may be necessary to flush a single pipeline volume. Consider as well where the flushed fuel will have to go to be cleaned and re-used again and whose equipment may have to be used to slean the fuel up. Contact the Service Headquarters for guidance.
****

Begin flushing of fuel system piping at low flow rates using [one pump in multiple pump systems][a throttled pump in single pump systems (using the downstream isolation valve to throttle the pump)] at [_____] percent of rated flow. Slowly increase flushing flow rate [until a plus or minus 3.5 m/s 12 FPS fuel velocity is achieved][to full flow capacity of [_____] lps gpm]. Flush for [a minimum of 30 minutes] [four piping volumes][one piping volume][_____]. [For gravity, suction, or other non-pumped piping segments, minimum flushing volume must be [four][_____] times the pipe volume.] Sampling must be performed by the[Government][Contractor] and testing must be done by[the Service][a DoD regional fuels testing laboratory] [an independent fuels testing laboratory approved by the Contracting Officer]. Fuel must be free of gross contamination and visible free water to the satisfaction of the Contracting Officer.

In the event flushing identifies the presence of clay or soil like material in the system, Contractor must immediately notify Contracting Officer for direction.

3.6.2 Fueling System Piping

During flushing procedure periodically bleed air through high point vent and drain water through low point drains.

****

NOTE: For many projects that only involve replacing piping the above paragraph alone may prove sufficient. For others, select one or more of the following paragraphs.

****

[3.6.2.1 General Fuel Lines

The flushing of all of the system piping segments must be accomplished by pumping fuel through the fueling system piping and [back into the same tank the fuel was withdrawn from][back to another tank in the fuel farm][into Over-the road (OTR) tank trucks][into refueler tank trucks][into temporary tankage][into an existing tank][_____].[After high-speed flush of main system piping, all piping laterals to fuel dispensing points must be flushed with at least [18,930 L 5000 gallons for 200mm 8-inch piping and smaller] [three pipe volumes] with fuel.] Air must be bled from system high points. The procedure must be continued until the fuel being delivered [into the tanks] [into OTR tank trucks][into temporary tanks][into [_____]] is acceptable to the Contracting Officer. After the piping system segments have been flushed to the satisfaction of the Contracting Officer (and periodically during the flushing operation), the Contractor must flush all high point vents and low point drains for a minimum of 10 seconds at a pressure of 207 kPa 30 psig.[Remove any accumulated water from tank sumps and bottoms by means of the Water Draw-off systems.] Flush all plug valves of debris using the drain port at the bottom of the valve. Cone strainers must be kept clean in order to insure maximum flow rate. All accumulated material from the strainers must be reviewed and identified, including source if possible. Upon completion of the first flushing operations, the cone strainers must be [removed from the system.][cleaned, reinstalled, and remain in the system.] In addition, baskets from all strainers must be removed and cleaned.

][3.6.2.2 [Receipt Pipeline][Transfer Line]

Flushing of the [receipt pipeline][transfer line] must occur during the initial receipt/filling operations. Samples of the incoming fuel must be taken at the point of connection with the upstream and downstream systems at the start and the end of the flushing and every [_____] minutes in between the two. These samples must be tested by the designated government agency and turned over to the Contracting Officer.

][3.6.2.3 Truck Offloading System Piping

Flushing of the truck offloading system and piping must occur during the receipt operations. Samples of the incoming fuel must be taken at the point of connection with the OTR tank truck. Sample the fuel into and out of each offloading station.

][3.6.2.4 Rail-Car Offloading System Piping

Flushing of the rail-car offloading system and piping must occur during the receipt operations. Samples of the incoming fuel must be taken at the point of connection with the rail car. Sample the fuel into and out of each offloading station.

][3.6.2.5 [Pump House][Pump Pad][Pump Shelter] Piping

****

NOTE: Create a procedure based on the system's actual characteristcs.

****

Remove system components as specified in paragraph PROTECTION OF SYSTEM COMPONENTS. Perform the following flushing operations by withdrawing fuel from one tank and [returning it to another tank][pumping it to Contractor-furnished tankage][pumping it to Contractor-furnished over-the-road tank trucks]. [Circulate][Transfer] a sufficient amount of fuel for each operation. Bleed air from high points.

a. Position manual valves to circulate fuel through one pump, filter-separator combination.

[b. Provide a temporary connection between each truck fillstand nozzle and its associated return line connection single point receptacle. Position manual valves to circulate fuel through the nozzle and back to the tanks, upstream of the receipt filter-separators. Flush each fillstand using one fueling pump.

][c. Position manual valves to circulate fuel through the bypass line. Flush this line using two fueling pumps.

]][3.6.2.6 [Interterminal Pipeline][Installation Pipeline]

Samples of the incoming fuel must be taken at the point of connection with the upstream and downstream systems at the start and the end of the flushing and every [_____] minutes between the two. These samples must be tested by the designated government agency and turned over to the Contracting Officer.

][3.6.2.7 Truck Fillstand Piping

****

NOTE: Delete this paragraph if fillstand piping can be looped back into permanent piping without going through an over-the-road tank truck.

****

Position an over-the-road tank truck at each fillstand position and flush each fillstand lateral into the tank truck. Sample the fuel at the connection to the truck.

][3.6.2.8 Rail-Car Loading System Piping

****

NOTE: Delete this paragraph if piping can be looped back into permanent piping without going through an over-the-road tank truck or a rail car.

****

Position an [OTR tank truck][rail car] at each position and flush each fillstand lateral into the [tank truck][rail car]. Sample the fuel at the connection to the [truck][rail car].

][3.6.2.9 Product Recovery Tank Lines

During the flushing of pumphouse piping, operate all manual drain lines individually to flush their connection to the product recovery tank. Fill the tank a minimum three times, each time utilizing [the fuel transfer][tank drain pump][vacuum truck][[_____] pump] to drain it by returning the fuel to storage.

****

NOTE: Amount of line changes will vary. It should be at least 10.

****

][3.6.2.10 [High Point Vent Lines][Low Point Drain Lines][Thermal Relief Piping][Instrumentation Piping and Tubing]

During the flushing of pumphouse piping, operate valves and connections on all lines individually to flush their connection to a tank. Put at least [25] [_____] times the volume of the line through each line.

][3.6.2.11 Pier Piping

****

NOTE: Modify to suit project-specific facilities/water availability at pier.

****

Pier piping and loading arms should be hydrostatically tested with fresh water per the requirements of Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). After testing, flush piping with fresh water at 3.5 m/s 12 FPS for 30 minutes. [The Contractor will be allowed to use Government-furnished hoses.]Drain all water from piping system and refill with product. Perform flushing with product at 3.5 m/s 12 FPS for [30 minutes][_____]. [Government barges/equipment may be used to facilitate system flushing.]At end of testing, drain pier piping of water.

]3.6.3 Piping Flushing Checklist

The Contractor must generate a comprehensive matrix of all new[and existing] piping sections in the system. Matrix must serve as an Owner's piping inventory and a checklist for all Contractor-provided flushing operations. Column entries must include pipe section name, location, diameter, approximate length, flushing fuel velocity and volume achieved and acceptable results of sampling.

****

NOTE: Delete cleaning if system is not for aviation fuel.

****

3.7 CLEANING

****

NOTE: This paragraph will most often be used for systems that issue aviation fuel to refueler trucks. Include this paragraph for any system with filter-separators. Delete this paragraph if system is for ground products. Delete this paragraph for

aviation jet fuel systems if the system being cleaned is bulk fuel handling farm, a marine loading and offloading operation, or an Interterminal or Installation pipeline without filter-separators.

Cleaning will always take place with fuel. Do not clean with water.

****

After initial flushing is completed, clean each piping segment with product in accordance with the procedure specified hereafter. Isolate Tanks from the system and clean them as specified in Section 33 01 50.55 CLEANING OF PETROLEUM STORAGE TANKS.

In the event cleaning identifies the presence of clay or soil like material in the system, Contractor must immediately notify Contracting Officer.

3.7.1 Preparation for Cleaning

****

NOTE: When two tanks are being used for this project, the Contracting Officer may want to allow the contractor to transfer fuel from a "dirty tank" to a "clean tank" through filtration in order to clean the "dirty fuel" of its water and/or solids contamination.

****

[Filter elements must be installed in the filter-separators. Adjust filter-separator flow control valve.]Valves and system components removed for flushing must be reinstalled. Tanks must be drained, vapor freed and cleaned.[Transfer the contents from one tank to the other for the purposes of cleaning where possible.]

3.7.2 Cleaning Requirements

****

NOTE: Select independent or DOD fuels laboratory, include in MOU.

****

Cleaning must continue until the Contracting Officer certifies that the fuel meets the intra-governmental receipt limits as defined in MIL-STD-3004-1. Sampling must be performed by the[Government][Contractor] and testing must be done by[the Service][a DoD regional fuels testing laboratory][an independent testing laboratory approved by the Contracting Officer].[Also take samples at truck fillstands.]

3.7.3 Cleaning Procedure

During cleaning procedure periodically bleed air through high point vent and drain water through low point drains.

****

NOTE: For many projects that only involve replacing piping this paragraph alone may prove sufficient. This paragraph covers piping that is not part of a looped system. For others, select one or more of the following paragraphs in addition to this one.

****

3.7.3.1 General Fuel Lines

General fuel lines must be cleaned as follows:

a. Position manual valves to circulate fuel through the piping and into [the receiving tank] [temporary tanks] [over the road tank trucks] [refueler tank trucks] [_____] at the discharge end [through the receiving filter-separators].

****

NOTE: The flowrates are nominal and must be adjusted to suit the individual system. It may be necessary to provide temporary filtration to achieve the desired goals although that is very seldom done and may prove prohibitively expensive.

****

b. Initially pump fuel at a flow rate of [38 lps 600 gpm] [_____] lps gpm, then increase flow rate up to the same velocity the line was flushed at using as many pumps and filter/separators as required, starting manually one pump at a time.[When pumping at a rate greater than [76 lps 1200 gpm] [_____] lps gpm, by-pass receiving filter-separators].

c. Monitor pressure drop through the filter-separators during the cleaning operation and provide flow vs. pressure drop graphs as specified herein before.

d. Periodically take samples from all sample connections. Continue cleaning until the fuel meets specified requirements of paragraph CLEANING REQUIREMENTS.

[3.7.3.2 [Receipt Pipeline][Transfer Line][Rail Car Offloading Line][Truck Off-Loading Line]

Continue to receive fuel until the fuel samples taken at the tanks meet the requirements of paragraph CLEANING REQUIREMENTS above.

][3.7.3.3 [Pump House][Pump Pad][Pump Shelter] Piping

Piping must be cleaned as follows:

a. Position manual valves so that fuel is withdrawn from one tank, circulated through one fueling pump and issue filter-separator, then returned to the tank through the receiving filter-separators.

b. Clean the piping system using one pump at a time. Alternate the fueling pumps and filter-separators during the operation to clean the individual fueling pump suction and discharge lines.

c. Monitor pressure drop through the filter-separators during each cleaning operation and provide flow vs. pressure drop graphs as specified herein before.

d. Periodically take samples from all sample connections. Cleaning must continue until the fuel meets the specified requirements.

][3.7.3.4 Truck Fillstands with a Return Line

Piping must be cleaned as follows:

a. Provide a temporary connection between the truck fillstand connection and the return line. Position valves to circulate fuel through the fill line and back to the return line. Clean each position using two fueling pumps, two issue filter separators and two return filter separators.

b. Monitor pressure drop through the filter-separators during each cleaning operation and provide flow vs. pressure drop graphs as specified herein before.

c. Periodically take samples from all sample connections. Cleaning must continue until the fuel meets the specified requirements.

][3.7.3.5 [Truck Fillstands][Rail Car Loading Positions] without a Return Line

Piping must be cleaned as follows:

a. Position a [OTR tank truck][refueler truck][rail car] at the [fillstands][railcar loading position] and clean each one, one at a time. Clean the lines using two fueling pumps, two issue filter separators and two return filter separators.

b. Monitor pressure drop through the filter-separators during each cleaning operation and provide flow vs. pressure drop graphs as specified herein before.

c. Periodically take samples from all sample connections. Cleaning must continue until the fuel meets the specified requirements.

][3.7.3.6 [Interterminal Pipeline][Installation Pipeline]

Pipelines must be cleaned as follows:

a. Position manual valves to circulate fuel through the piping and into [the receiving tank] [temporary tanks] [over the road tank trucks] [refueler tank trucks] [_____] at the discharge end[through the receiving filter-separators.]

****

NOTE: Delete if piping is not piggable. In some cases of a line designed to be piggable, the pig launcher and receiver is not permanently installed and the specifications will need to be written to indicate the contractor will need to provide temporary units.

****

[a. First clean the pipe using pigs as called out in paragraph PIPE PIGGING-VERIFICATION, Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). During this, low point drains and high point vents must be blown clean. Monitor pressure drop through the filter-separators during the cleaning operation.

][b. Inspect the pipe as called out in paragraph PIPE PIGGING -

VERIFICATION, Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).
]
****

NOTE: The flowrates are nominal and must be adjusted to suit the individual system. It may be necessary to provide temporary filtration to achieve the desired goals although that is very seldom done and may prove prohibitively expensive.

****

c. Initially pump fuel at a flow rate of [38 lps 600 gpm] [_____] lps gpm, then increase flow rate up to the full capacity (all pumps running) starting manually one pump at a time. When pumping at a rate greater than [76 lps 1200 gpm] [_____] lps gpm, by-pass receiving filter-separators.

d. Monitor pressure drop through the filter-separators during the cleaning operation and provide flow vs. pressure drop graphs as specified herein before.

[e. Periodically take samples from all sample connections. Continue cleaning until the fuel meets specified requirements of paragraph CLEANING REQUIREMENTS.

]][3.7.3.7 Looped Piping

****

NOTE: If piping is permanently looped consider using SECTION 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Delete this paragraph if the piping is not permanently looped or if the decision is made that it must not be temporarily looped.

****

Loop piping must be cleaned as follows:

a. Position manual valves to circulate fuel out the issue line and back to the tank through the return line and through the receiving filter-separators.

****

NOTE: Delete if piping is not piggable In some cases if a line designed to be piggable, the pig launcher and receiver is not permanently installed and the specifications will need to be written to indicate the contractor will need to provide temporary units.

****

[b. First clean the pipe using pigs as called out in paragraph PIPE PIGGING-VERIFICATION, Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). During this, low point drains and high point vents must be blown clean. Monitor pressure drop through the filter-separators during the cleaning operation.

][c. Inspect the pipe as called out in paragraph PIPE PIGGING - VERIFICATION, Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).
]
****

NOTE: The flowrates are nominal and must be adjusted to suit the individual system.
****

d. Initially pump fuel through the loop at a flow rate of [38 lps 600 gpm] [_____] lps gpm, then increase flow rate up to the full capacity (all pumps running) starting manually one pump at a time. When pumping at a rate greater than [76 lps 1200 gpm] [_____] lps gpm, by-pass receiving filter-separators.

e. Monitor pressure drop through the filter-separators during the cleaning operation and provide flow vs. pressure drop graphs as specified herein before.

[f. Periodically take samples from all sample connections. Continue cleaning until the fuel meets specified requirements of paragraph CLEANING REQUIREMENTS.

]][3.7.3.8 [Product Recovery Tank Lines][High Point Vent Lines][Low Point Drain Lines][Thermal Relief Piping][Instrumentation Piping and Tubing]

Repeat the process described under initial flushing until samples taken at the end of the piping meet the requirements.

]3.7.4 Piping Cleaning Checklist

The Contractor must generate a comprehensive matrix of all new[and existing] piping sections in the system. Matrix must serve as an Owner's piping inventory and a checklist for all Contractor-provided cleaning operations. Column entries must include pipe section name, location, diameter, approximate length, cleaning fuel velocity and volume achieved and acceptable results of sampling.

3.8 CONTROL VALVE ADJUSTMENT

Check all control valve settings and field adjust from the factory settings at System Start-Up as necessary to provide a smooth operation, devoid of pressure surges, spikes, and hunting. Check the [filter separator control valves][and][fueling pump non-surge check valve] and adjust as follows:

[3.8.1 Rate of Flow Control Feature on Fueling Pump Non-Surge Check Valve

Run one pump at a time and adjust rate of flow feature at nominal rated flow.

][3.8.2 Control Valves on Issue Filter-Separator Downstream Side

a. Position valves so that one fueling pump can pump through only one filter-separator. Close the valve at the entrance of the apron loop, and open the bypass valve, allowing discharge into the circulating line.

b. Start the pump and adjust the filter-separator control valve for the rated flow capacity of the filter-separator at nominal rated flow.

c. Repeat above for each remaining filter-separator.

]3.9 EQUIPMENT TESTS

****

NOTE: Designer to edit Equipment Tests (Attachment 1) for this project and provide to the Contractor.
****

After completion of flushing,[cleaning,][and control valve and electrical components adjusting operations], [Contractor][System Supplier] must complete and submit the Equipment Tests (see Attachment 1 - Equipment Tests). Equipment Tests must be submitted prior to Performance Testing [(Government approval not required prior to Performance Testing.)]

****
NOTE: Select from the following all those that apply. The only one that must be in every project is the Emergency Shutdown testing.
****

[3.9.1 Control System and Control Valves

Field adjustment of [automatic control valves][and][automatic pump controls] while in operation must be made only by the valve manufacturer's authorized field test engineer. [For final adjustment of installed electrical control equipment provide an experienced electrical engineer, factory representative of pump control panel manufacturer][and][factory representative of [pressure indicating transmitter (PIT) manufacturer]] [and] [differential pressure transmitter (DPT) manufacturer]. Both the mechanical and electrical components must be adjusted concurrently. Record required data necessary to prepare Equipment Tests Report.

][3.9.2 Tank Level Alarms

****
NOTE: Modify to suit adjustments for tanks in this project, if any. The critical level alarms in the tanks are the ones that that stop the fueling pumps (Low or Low-Level) as they protect the pumps from running dry at startup, and the ones that act to keep the tank from overflowing (High or High Level).
****

Position valves to transfer fuel between tanks.

Start fueling pump and pump sufficient fuel out of the first tank to allow the [low][low-low]level alarm [(LLA)][(LLLA)] to stop the fueling pump. Repeat procedure for each fueling pump and each tank until the [low][low-low]level alarm [(HLA)][(HHLA)] [stops the fueling pumps][sounds an alarm][closes the valve] due to low liquid level in tank.

Repeat testing for [high] [high-high] level alarm other alarms checking each one in turn. Repeat procedure for each fueling pump and each tank until the [high][high-high]level alarm [(HLA)][(HHLA)] [stops the fueling pumps][sounds an alarm][closes the valve] due to high liquid level in tank.

][3.9.3 Fuel Delivery with Loading Control Valve

****
NOTE: Select loading control valve size and verify flow rate with Service Headquarters and/or their designated appointee. Coordinate the flowrate with the control system setpoints.

****

Deliver fuel to each fueling point with a Loading Control Valve against a backpressure at the outlet of the control valve created by the [tank trucks and hoses][tank trucks and pantograph][_____] used during the tests. The flow rate must not be less than [_____] gallons per minute. Flow rates might be affected by the vehicle's being loaded capability.

][3.9.4 Fuel Delivery w/o Loading Control Valve

****

NOTE: Select valve size and verify flow rate with Service Headquarters and/or their designated appointee. Coordinate the flowrate with the control system setpoints.

****

Deliver fuel to each fueling point without a Loading Control Valve against a backpressure at the outlet set by modulating a manual downstream valve. The flow rate must not be less than [_____] gallons per minute. Flow rates might be affected by vehicle's being loaded capability. Ensure that the Loading Control Valve is tested per 33 52 43.14 AVIATION FUEL CONTROL VALVES.

][3.9.5 Fueling Pump Operation

Demonstrate operation of all [pressure and flow devices][pump control start/stop station] to start and stop the fueling pumps[at the indicated pressure and flow rates] in the presence of the Contracting Officer. Repeat the operating sequence with each of the pumps being selected as lead pump if the pumps are controlled by a Pump Control Panel or an automatic control system with a variable lead pump. For this test, measure the flow rates. Witness and record flow rates and test results.

]3.9.6 Emergency Shutdown

****

NOTE: Should be present in every project as it is either being worked on as part of the project, and/or its proper functioning is necessary to shut down the system during start-up and performance testing operations.

****

With one fueling pump circulating fuel through the system, test each "Emergency Stop" pushbutton station to verify that the pump stops [and the emergency shutoff solenoid activates and the control valve closes]. Repeat above procedure for each fueling pump and "Emergency Stop" pushbutton station. Conduct tests for both the automatic and manual modes. With all the fueling pumps circulating fuel through the system, push an "Emergency Stop" pushbutton station.

[3.9.7 Loading Control Valves

****

NOTE: Delete if no Loading Control Valves are provided.

****

Each Loading Control Valve must be operated to demonstrate the following:

[3.9.7.1 Surge Shut-Down Capability

Surge from shut-off of a downstream valve can be simulated by closing a quick turn valve downstream of the control valve, use a 3 second closure.

][3.9.7.2 Pressure Control at Setpoint Plus 15 kPa 2 psi

Requires use of a pressure gage downstream of the control valve.

]][3.9.8 Filter-Separator Float Control Valves with Manual Tester

Using the manual float control test level on each Filter-Separator, lift the weight from the float ball slowly and observe the operation and closure of the water slug shut-off feature on the Filter-Separator Control Valve.

][3.9.9 Overfill Valve

****

NOTE: Delete if no Overfill Valve.

****

Place fuel transfer pump in the "off" position. Delivery quantity of fuel to Product Recovery Tank to demonstrate capability of valve to close. Empty the tank pump to demonstrate capability of valve to open when fuel level drops below set point.

]3.10 PERFORMANCE TESTS

Performance testing must occur after the Contractor has performed the Equipment Tests. Performance testing must demonstrate to the satisfaction of the Contracting Officer and Service Headquarters and/or their designated appointee these portions of the fueling system are working as specified. Performance testing must consist of repeating the Equipment Tests (indicated in previous paragraphs) and operating the fueling system during actual operations in the presence of Government Witnesses. The maximum rated capacity of the system must be demonstrated. The Contractor must notify the Contracting Officer [30] [45] [60] [_____] calendar days in advance of the test to permit arrangement for the use of Government-furnished items. During the time period of performance testing, no construction activities will be allowed on the project site. The project site must be considered an operational (fuel) zone (verses a construction zone) during this performance testing period. Personnel, dressed for fuel's operation, will be present to witness testing and participate in Contractor provided training.

****

NOTE: Choose as many below as applicable to the project. Add ones not on the list.

****

3.10.1 Final Performance Test

A final performance test must consist of demonstrating the operation of the system for the purpose for which it is intended:

[a. loading refueler trucks
][b. loading over the road tank trucks

][c. loading rail cars
][d. loading marine vessels
][e. off-loading over the road tank trucks
][f. off-loading rail cars
][g. off-loading marine vessels
][h. transferring fuel through the[pipeline][piping system]
][i. loading motive fuel into vehicles

]3.10.2 Satisfactory Performance

In the event a portion of the system or any piece of equipment fails to meet the test, make the necessary repairs or adjustments and repeat the Performance Test until satisfactory performance is obtained. The determination of satisfactory performance must be made by the Contracting Officer and the Service Headquarters and/or their designated appointee.

3.10.3 Performance Testing Plan

****

NOTE: Designer to edit Performance Testing Plan (Attachment 2) for this project and provide to the Contractor.

****

[Contractor][System Supplier] must edit the example Performance Testing plan and submit for approval. An example Performance Testing plan can be found at the end of this Section as Attachment 2 - Performance Testing Plan. Submit plan a minimum of [60] [180][_____] days prior to performance testing.

[3.10.4 Equipment Tests

[Contractor][System Supplier] must provide [10 hard copies][and][electronic copies] of the completed Equipment Tests to the Service Headquarters and/or their designated appointee at the start of Performance Testing for validation during Performance Testing.

][3.10.5 Control Valve Tagging

After the performance testing and system acceptance, tag the control valves with their final adjustments.

]3.10.6 Final Acceptance

Fill the system with fuel and operate leak-free prior for acceptance. Anything wet with fuel is considered to be leaking.

[3.10.6.1 Tank High Liquid Level Shut-Off Valve Test and Adjustments

During the final filling of tanks, check the tank automatic high liquid level shut-off valve for proper functioning at least three times by lowering the fuel level and refilling again. Adjust valve to achieve a safe fill level.

][3.10.6.2 Tank Level Indicator Adjustments

Also, during the final filling of tanks, adjust and calibrate the tank level indicators including the final setting of the high high level (HHLA) and high level (HLA) alarms. Since the HHLA is at a point higher than the

High Liquid Level Shut-Off Valve float set point, an artificial method of simulating HHL must be used.

][3.10.6.3 Water Draw-Off System Test

During the performance testing, fill Water Draw-off Systems from tank sump to ensure proper operation. After filling system, allow time for fuel/water mixture to separate. Verify liquid separation through system's sight glasses. Proper operation includes capability to drain separated water and capability to pump separated fuel back to a full tank.

] -- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-33 09 52 (November 2018)**

\-------------------------------------

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 09 52

FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT)

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-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-33 09 52 (November 2018)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 09 52

FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT)

11/18

****

NOTE: This guide specification covers the requirements for the Pump Control and Annunciation System for fueling systems that are not Hydrant Systems and are not Military Service Stations.

Power requirements for equipment are to be in accordance with the available power at the Activity (such as OCONUS areas).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This specification is for pump control panels for systems that are not Hydrant Systems and are not Military Service Stations. Do not use this specification for super refueler fillstands. A typical facility using this specification will have two fuel storage tanks, two truck offloading positions, two truck fillstand loading positions, and a pump and filter building with a conditioned control room where this panel is located. Confirm

use of this specification with Service Headquarters or officially designated alternate.

Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS. Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 18.1	(2024) Annunciator Sequences and Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA IA 2	(2005) Programmable Controllers - Parts 1 thru 8
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 1012	(2010; Reprint Apr 2016; Rev Mar 2021) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 ADMINISTRATIVE REQUIREMENTS

a. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section, with the additions and modifications specified herein.

b. Programmable Logic Controllers (PLCs) receive information from pressure transmitters and other devices to control the pumps and control valves.

c. The control system must be furnished by a single supplier. See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT) for other required components of the control system. The control system supplier must be responsible for providing a fully functional control system, in accordance with the drawings and specifications, including the field devices. Installation must be in accordance with NFPA 70.

d. Submit six copies of Operation and Maintenance Manuals, within 7 calendar days following the completion of factory tests. Installation, Operation, and Maintenance manuals for all system components supplied must be furnished following the completion of shop tests and must include:

(1) Pump Control Panel including interior and exterior system components layout. Complete guide outlining step-by-step procedures for system startup and operation.

(2) All documents previously submitted and approved with all comments and field changes annotated. Complete description of the sequence of operation including that described in PART 3 and any subsystems not controlled by the PLC (e.g. alarm annunciator safety/circuit).

(3) Complete listing of all programming of the PLCs, laptop computer, and Personal Computer.

(4) Complete relay ladder logic diagrams, PLC input/output diagrams and control power distribution diagrams for the complete control system.

(5) Complete troubleshooting guide, which lists possible operational problems and corrective action to be taken, including all as-built conditions.

e. Submit documents demonstrating the accuracy and completeness of the list of material and components, that items proposed comply fully with contract requirements, and are otherwise suitable for the application indicated. Documents must consist of all data or drawings published by the manufacturer of individual items listed including manufacturer's descriptive and technical literature, performance data, catalog cuts, and installation instructions. Submit additional material if the listed items are not adequate to identify intent or conformance to technical requirements. Provide typed and electronic copies of these lists for approval. Any delays associated with resubmittals of incomplete or ambiguous initial submittals will be the Contractor's responsibility.

f. Documents must be bound in a suitable binder adequately marked or identified on the spine and front cover. A table of contents page must be included and marked with pertinent contract information and contents of the manual. Tabs must be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets must be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawing; G, [_____]

SD-03 Product Data

Tools and Spare Parts

Pump Control Panel (PCP) and Components; G, [_____]

Laptop Computer; G, [_____]

Personal Computer (PC); G, [_____]

Laser Printer; G, [_____]

FCC Computer; G, [_____]

Programmable Logical Controller (PLC) Hardware and Software; G, [_____]

Control Wiring Data Lists; G, [_____]

Graphics Display Screen; G, [_____]

SD-06 Test Reports

Certified Pump Control Panel (PCP) Shop Test Report

Record of Test

SD-07 Certificates

Experience and Qualifications; G, [_____]

Testing Plan; G, [_____]

Training Plan for Instructing Personnel; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

1.4 TOOLS AND SPARE PARTS

Provide the following:

a. Any special tools necessary for operation and maintenance of the system components providing supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

b. One spare set of fuses of each type and size.

c. Recommended manufacturer list of spare parts, including part number, current unit price, and source of supply.

d. One spare power supply module.

e. One spare I/O module for discrete devices and one for analog devices.

f. Two PLC RAM back-up batteries.

g. Two complete sets of spare ink cartridges for the laser printer.

h. Minimum of 10 spare lamps for the Alarm Annunciator.

i. Minimum of 10 spare lamps of each type of non-LED lamps used on the Pump Control Panel.

1.5 EXPERIENCE AND QUALIFICATIONS

Submit the following data for approval:

a. Certification stating that the manufacturer has manufactured, installed, and successfully completed at least five PLC-based systems for automatic cycling of pumps based upon varying dispensing demands ranging from 0 to 182 L/s 0 to 2400 GPM utilizing multiple pumps. At least two of the five PLC-based systems must be for dispensing jet fuel into a pressurized, constant pressure, flow demand aircraft hydrant system.

b. Certification that the control systems have successfully operated over the last 2-years and are currently in service.

c. Project names, locations, and system description of these installations. Include user point-of-contact and current telephone numbers.

1.6 WARRANTY

The Pump Control and Annunciation System including devices, hardware and software must be warranted for a period of one year from the date of acceptance of the system by the Government. This warranty service must include parts and labor service for system components supplied under this specification. Upon notification by the Government of system or component failure, respond at the site with necessary parts within 48-hours of notification.

PART 2 PRODUCTS

2.1 MATERIALS AND SYSTEM COMPONENTS

2.1.1 Pump Control Panel (PCP) and Components

****

NOTE: Panel size indicated is for a Type III hydrant system. Adjust as required to suit the project.

****

NEMA ICS 1, NEMA ICS 6, NEMA 250, and UL 508. The PCP enclosure must be a freestanding NEMA Type 12, smooth, gasketed enclosure constructed of 12 gauge steel. All seams must be continuously welded and there must be no drilled holes or knockout prior to delivery to the job site. The pump control panel dimensions must be a maximum of [2.3 m] [_____] [90-inches] [_____] high, maximum [1.8 m] [_____] [72-inches] [_____] wide, and a maximum of [610 mm] [_____] [24-inches] [_____] deep and must have removable lifting eyes. The interior surfaces of the panel must be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces must have standard factory finish. Access for the PCP must be front only and must consist of hinged doors having 3-point latching mechanisms. The doors must open approximately 120 degrees. Rack mounting angles, swing-out panels and other component mounting hardware must be installed such that servicing of one component must not require removal or disconnection of other components. No clearance will be required between the back of the panel and the room walls. Terminal facilities must be arranged for entrance of external conductors from the top or bottom of the enclosure.

2.1.2 Ventilation System

****

NOTE: For enclosures smaller than 1.8 m 72-inches wide, provide one supply fan, one exhaust grill, and two thermostats.

****

Provide [one] [two] supply fans, single phase, 115 volt. Each fan must supply a minimum of 47 L/s 100 CFM. The supply and exhaust grill must contain a filter that is easily removed from the exterior of the enclosure. Also provide [two] [three] thermostats with an adjustable set point range of 21 degrees C 70 degrees F to 60 degrees C 140 degrees F. Locate the thermostats near the top in the interior of the PCP.

2.1.3 Ground Bar

The control panel must have a tin-plated copper equipment ground bar. The bar must have a minimum of twenty grounding screws.

2.1.4 Standard Indicator Lights

NEMA ICS 1, NEMA ICS 2, and UL 508. Lights must be heavy duty, NEMA 13, 22.5 mm 1-inch mounting hole, round indicating lights operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs must be used. Indicator lights must have a legend plate with words as shown on drawings. Lens color as indicated on the drawings. Lights must be "push to test (lamp)" type. LED type lamps of comparable size and color may be substituted for standard indicator lights.

2.1.5 Selector Switches

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated lever operated selector switches must be heavy duty, NEMA 13, round, and utilize a 22.5 mm 7/8-inches mounting hole. They must have the number of positions as indicated on the drawings. Switches must be rated 600 volt, 10 amperes continuous. Legend plates must be provided with each switch with words as indicated on the drawings.

2.1.6 Pushbuttons

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated pushbuttons must be heavy duty, NEMA 13, round, utilize a 22.5 mm 7/8-inch mounting hole, and have the number and type of contacts as indicated on the drawings or elsewhere in the specifications. The emergency stop switch must be a red mushroom head, 38 mm 1.5inch diameter, momentary contact type. Pushbuttons must be rated 600 volt, 10 amperes continuous. Legend plates must be provided with each switch with words as indicated on the drawings.

2.1.7 Relays

IEEE C37.90, NEMA ICS 2, UL 508.

2.1.8 Nameplates

Nameplates must be made of laminated plastic with black outer layers and a white core. Edges must be chamfered. Nameplates must be fastened with black-finished round-head drive screws or approved nonadhesive metal fasteners.

2.1.9 Transient Voltage Surge Suppression Devices

IEEE C62.41 for Category "B" transients, UL 1449.

2.1.10 Terminal Blocks

NEMA ICS 4. Terminal blocks for conductors exiting the PCP must be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks must be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip must form part of the terminal block and each terminal must be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.1.11 Circuit Breakers

UL 508. Individual, appropriately sized, terminal block mounted, circuit breakers must be provided for all 120 volt PCP mounted system components and for the 120 volt terminal boards shown on the drawings.

2.1.12 Uninterruptible Power Supplies

****

NOTE: The power requirements are to be in accordance with the available power at the Activity (such as OCONUS regions).

****

UL 1012. Input voltage must be 120 volts (nominal), 1 phase, 60 Hertz. Output voltage regulation must be plus/minus 5.0 percent for the following conditions:

a. 20 to 100 percent load on output.

b. Input voltage variation of minus 15 to 10 percent.

c. Constant load power factor between 80 and 100 percent.

Response time must be 1.5 cycles or less. Battery capacity must be such as to provide an orderly shut down of operating programs or as a minimum 10 minutes.

2.1.13 Miscellaneous Power Supplies

UL 1012. Certain field devices may require power other than 120 VAC (i.e. 24 VDC). The power supplies must be convection cooled, have fully isolated independent outputs, have constant voltage, have short circuit and overvoltage protection, and have automatic current limiting.

2.1.14 Alarm Annunciator

UL 508 and ISA 18.1. The Alarm Annunciator must provide visual annunciation, local and remote monitoring, constant or flashing visual and audible alarm as specified herein. The annunciator must be completely solid state with no moving parts. The annunciator must be furnished with cabinet and hardware appropriate for flush mounting on the control panel. A power supply either integral or separately mounted must operate on 120 volts, 60 Hertz. The annunciator must have windows arranged in a matrix configuration (rows and columns). Each window must be at least 24 mm 15/16-inch high by 40 mm 1-5/8-inches wide and must have rear illuminated translucent engraved nameplate. Lettering must be at least 4 mm 5/32-inches high. System lamp voltage must be 24 to 28 volts dc. The cells must be individually addressable and not hardwired.

2.1.15 Alarm Horns

UL 508. The alarm horns must consist of 3-vibrating horns and 2-resonating horns. One vibrating horn is to be mounted in the PCP, and two vibrating and two resonating horns must be mounted outside of the pumphouse as shown on the drawings. The exterior horns must each produce 100 db at 3 m 10 feet and must be provided in a weather proof housing. The PCP horn must produce 70 db at 3 m 10 feet.

2.1.16 Laptop Computer

2.1.16.1 Hardware

The following are the minimum hardware requirements for the laptop computer:

a. Latest [Core i3] [_____] CPU operating at 3.9 GHz or faster

b. 8 GB RAM

c. 1 TB hard drive

d. 16X Read Write DVD drive

e. 381 mm 15-inch 1080p LED - Backlit Display

f. Keyboard

g. Pointing device (e.g. mouse, track ball)

h. 120VAC and Battery power supply

i. All cables and connectors for interfacing with PLC and personal computer

j. HDMI Port

k. Two USB 3.0 communications ports

l. Provide a carrying case for the Laptop Computer

2.1.16.2 Software

The following is the minimum software to be loaded on the laptop. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed (provide with software key) and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating system)

b. Software for programming the PLCs

c. Software for programming the personal computer

2.1.17 Personal Computer (PC)

2.1.17.1 Hardware

The following are the minimum hardware requirements for the personal computer:

a. Latest [Core i3] [_____] CPU operating at 2.4 GHZ or faster

b. 8 GB RAM

c. 1 TB hard drive

d. 16X Read Write DVD drive

e. Color 432 mm 17-inches 1080p LED-Backlit flat screen monitor

f. Keyboard

g. Pointing device (e.g. mouse)

h. Parallel communication port

i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)

j. 120 VAC operating power

k. All cables and connectors interfacing with PLC and Laser Printer

l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System

m. Two USB 3.0 communications ports

n. Two HDMI ports

2.1.17.2 Software

The following is the minimum software to be loaded on the personal computer. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed (provide with software key) and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating System).

b. Software for programming the PLCs.

c. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points.

d. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system on a real time basis.

e. MS Office Professional with Excel to allow the trending data described above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically.

2.1.18 Laser Printer

Provide color laser jet alarm/report printer. The unit must print in black at a minimum speed of twelve pages per minute. It must print in color at a minimum speed of ten pages per minute. As a minimum print color graphs of various system pressures, issue flow, and return flow vs. time in seven colors. Provide two sets of spare replacement ink cartridges.

2.1.19 FCC Computer

2.1.19.1 Hardware

The FCC computer must be a copy of the personal computer so that upon failure of the personal computer it could be relocated to the pumphouse to assume the personal computers duties. The normal duties of the FCC computer must be to serve as a remote monitor only of the screens that are available on the personal computer. The following are the minimum hardware requirements for the FCC computer:

a. Latest [Core i3] [_____] CPU operating at 3.9 GHZ or faster

b. 8 GB RAM

c. 1 TB hard drive

d. 16X Read Write DVD drive

e. Color 432 mm 17-inches 1080p LED-Backlit flat screen monitor

f. Keyboard

g. Pointing device (e.g. mouse)

h. Parallel communication port

i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)

j. 120 VAC operating power

k. All cables and connectors interfacing with PLC and Laser Printer

l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System

m. Two USB 3.0 communications ports

n. Two HDMI ports

2.1.19.2 Software

The following is the minimum software to be loaded on the FCC computer. The FCC computer must be capable of replacing the Personal computer in the pumphouse if the personal computer fails. It will be set up initially to serve only as a remote monitor of the system while located at the FCC. Should the personal computer fail, the FCC computer will be relocated to the pumphouse and then assume the role of the personal computer. The computer software must have a built in command to tell the computer whether it is serving as the personal computer or as the remote monitor only. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed (provide with software key) and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (the latest commercially available MS Operating System).

b. Software to tell the computer which mode it is to operate in, i.e. (personal computer or remote monitor).

c. Software to run as a remote monitor.

d. Software for programming the PLCs.

e. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points.

f. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system, on a real time basis.

g. MS Office Professional with Excel to allow the trending data described above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically.

2.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

****

NOTE: The number of PLCs is project specific. Without specific direction otherwise, provide one PLC. For large systems or systems in remote or austere locations, redundant hot back-up PLCs may be advisable. Confirm need for redundant systems with Service Headquarters or officially designated alternate. If you have the situation where it is desired to have a redundant "SYS-1/SYS-2" system, use Section 33 09 53 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III) and modify accordingly.

****

2.2.1 General

a. NEMA IA 2. PLC must be able to receive discrete and analog inputs and through its programming it must control discrete and analog output functions, perform data handling operations and communicate with external devices and remote I/O racks. PLC must be a modular, field expandable design allowing the system to be tailored to the process control application. The capability must exist to allow for expansion to the system by the addition of hardware [and][or] user software. At a minimum the PLC must include mounting backplanes, power supply modules, CPU module, communication modules, and I/O modules.

b. Design and test PLC provided for use in the high electrical noise environment of an industrial plant. PLC module must comply with the FCC Part 15 Part A for radio noise emissions. The programmable controller processor must be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2, IEEE C37.90.

c. PLC must function properly at temperatures between 0 and 50 degrees C 32 and 122 degrees F, at 5 to 95 percent relative humidity non-condensing and have storage temperatures between minus 40 to 60 degrees C minus 40 and 140 degrees F at 5 to 95 percent relative humidity non-condensing.

d. PLC must have manufacturer's standard system status indicators (e.g. power supply status, system fault, run mode status, back-up battery status).

2.2.2 Central Processing Unit Module

The CPU must be a modular self-contained unit that will provide time of day, scanning, application (ladder rung logic) program execution, storage of the application program, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self-diagnostics.

2.2.3 Power Supply Module

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NOTE: The power requirements are to be in accordance with the available power at the Activity (such as OCONUS regions).

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a. The power supply module must be plugged into the backplane not separately mounted. The power supply must be wired to utilize 120 VAC, 60 Hz power, the system must function properly within the range of minus 10 to plus 15 percent of nominal voltage. The power supply must provide an output to the backplane at a wattage and voltage necessary to support the attached modules. A single main power supply module must have the capability of supplying power to the CPU module and local communication and I/O modules. Auxiliary power supplies must provide power to remote racks.

b. Each power supply must have an integral on/off disconnect switch to the module. If the manufacturers standard power supply does not have an on/off disconnect switch a miniature toggle type switch must be installed near the PLC and clearly labeled as to its function.

c. The power supply must monitor the incoming AC line voltage for proper levels and have provisions for both over current and over voltage protection. If the voltage level is detected as being out of range the system must have adequate time to complete a safe and orderly shutdown.

2.2.4 Program Storage/Memory Requirements

a. The PLC must have the manufacturers standard nonvolatile executive memory for the operating system. The PLC must also have EEPROM (Electrically Erasable Programmable Read Only Memory) for storage of the user program and battery backup RAM for application memory. The EEPROM must be loaded by use of the laptop computer or the personal computer.

b. Submit a calculation of the required amount of EEPROM and RAM (random access memory) needed for this application plus an extra 50 percent.

c. The number of times a normally open (N.O.) [and][or] normally closed (N.C.) contact of an internal output can be programmed must be limited only by the memory capacity to store these instructions.

2.2.5 Input/Output (I/O) Modules

a. Provide all required I/O modules (analog input, analog output, discrete input, discrete output, and isolated discrete output) to manipulate the types of inputs and outputs as shown on the drawings and to comply with the sequence of operations. Also provide a minimum of 20 percent (round up for calculation) spare input and output points of each type provided, but not less than 2 of each type.

b. I/O modules must be a self-contained unit housed within an enclosure to facilitate easy replacement. All user wiring to I/O modules must be through a heavy-duty terminal strip. Pressure-type screw terminals must be used to provide fast, secure wire connections. The terminal block must be removable so it is possible to replace any input or output module without disturbing field wiring.

c. During normal operation, a malfunction in any remote input/output channel must affect the operation of only that channel and not the operation of the CPU or any other channel.

d. Isolation must be used between all internal logic and external power circuits. This isolation must meet the minimum specification of 1500 VRMS. Provide optically isolated I/O components which are compatible with field devices.

e. Each I/O module must contain visual indicators to display ON/OFF status of individual input or output points.

f. Discrete output modules must be provided with self-contained fuses for overload and short circuit protection of the module.

g. All input/output modules must be color coded and titled with a distinctive label.

2.2.6 Interfacing

The PLC must have communication ports and communication modules using the manufacturers standard communication architecture for connections of the Personal computer, and Laptop Computer.

2.2.7 Program Requirements

a. The programming format must be ladder diagram type as defined by NEMA IA 2.

b. There must be a means to indicate contact or output status of the contact or output on the monitor (of the personal computer) or LCD screen (of the laptop computer). Each element's status must be shown independently, regardless of circuit configuration.

c. The program must be full featured in its editing capabilities (e.g. change a contact from normally open to normally closed, add instructions, change addresses).

2.2.8 Diagnostics

The CPU must continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and I/O. The diagnostic routines must be regularly performed during normal system operation. A portion of the scan time of the controller should be dedicated to perform these housekeeping functions. In addition, a more extensive diagnostic routine should be performed at power up and during normal system shutdown. The CPU must log I/O and system faults in fault tables, which must be accessible for display. When a fault affects I/O or communication modules the CPU must shut down only the hardware affected and continue operation by utilizing healthy system components. All faults must be annunciated on the alarm annunciator.

PART 3 EXECUTION

3.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS

3.1.1 General

a. Where two or more system components performing the same function are required, they must be exact duplicates produced by the same manufacturer. All display instruments of each type must represent the same outward appearance, having the same physical size and shape, and the same size and style of numbers, characters, pointers, and lamp lenses.

b. The PCP must include all required resident software programs and hardware to provide the specified sequence of operation. All software optical discs, including programming manuals, must be turned over to the Government at the completion of start-up so modification can be done in the field with no outside assistance.

c. It is intended that process controlling devices except field devices, and motor controllers be attached to or mounted within the PCP enclosure and all interconnecting wiring installed prior to shipment to the job site. This is to allow shop testing of the system and to decrease field labor requirements.

d. The PCP must be shipped fully assembled in one piece after the completion of the shop tests and all defects corrected.

3.1.2 Wiring

Wiring methods and practices must be in conformance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 4, and NEMA ICS 6 recommendations as applicable. All wiring to instruments and control devices must be made with stranded wire, and wiring must be permanently labeled with conductor/wire numbers within one-inch of termination points. Labels must be tubular heat-shrinkable wire markers that remain legible after exposure to industrial fluids and abrasion. Position markers so that wire numbers can be read without disturbing or disconnecting wiring. Use of individual character-markers placed side-by-side is not acceptable. Numbers must match approved shop drawings. All wiring must be neatly laced from point of entry into enclosures to termination points with nylon lacing cord or plastic lacing ties. Lacing within wiring channels is not required. Where the PCP contains intrinsically safe wiring, barriers or other devices, the panel must be arranged so that all intrinsically safe wiring is separated from non-intrinsically safe wiring by approved methods. Wiring channels containing intrinsically safe wiring must be blue and be labeled as "Intrinsically Safe Wiring Only" on the cover. All conduit penetrations into the PCP containing intrinsically safe wiring must be separated from non-intrinsically safe conduit penetrations by a minimum of 50 mm 2-inches. Provide typed Control Wiring Data Lists within each terminal cabinet and the PCP. The data lists must include: conductor identification number, wire gauge, wire insulation type, "FROM" terminal identification, "TO" terminal identification, and remarks. The preliminary lists generated by the Contractor will be submitted for approval to the Contracting Officer and will be updated to As-Built conditions by the Contractor. The As-Built data lists must be placed in a document holder within each enclosure.

3.1.3 Certified Pump Control Panel (PCP) Shop Test Report

The manufacturer must shop test the PCP, Personal computer, and laptop computer. The procedure must include simulation of field components and must provide for fully testing the pump control and annunciator system as a unit before delivery to the project site. The test must, reveal system defects, including, but not limited to, functional deficiencies, operating program deficiencies, algorithm errors, timing problems, wiring errors, loose connections, short circuits, failed components and misapplication of components. The test must be performed prior to shipment to the site and problems detected must be corrected. The final testing and correction sequence must be repeated until no problems are revealed and then two additional successful tests must be performed. Submit certified test report within 15-days after completion of the test. The report must include a statement that the Pump Control Panel performs as specified. Notify the Contracting Officer and the Service Headquarters 30-days prior to the final shop testing date. The Contracting Officer may require a Government witness at the final test before the PCP is shipped to the site.

3.1.4 Ventilation System

Thermostat T-1, must control fan F-1 [and thermostat T-2 must control fan F-2]. T-1 [and T-2] must be set at 27 degrees C 80 degrees F to maintain interior air temperature to minus 7 degrees C 20 degrees F above ambient. Thermostat [T-2] [T-3], set at 38 degrees C 100 degrees F, must provide a non-critical PCP HIGH TEMPERATURE alarm to the alarm annunciator.

3.1.5 Grounding

The PCP ground bar must be connected to the building counterpoise via a #10 AWG conductor. Within the enclosure all I/O racks, processor racks, and power supplies must be grounded to meet the manufacturer's specifications.

3.1.6 Indicator Lights, Switches, and Pushbuttons

Indicator lights, switches, and pushbuttons must be mounted through the PCP enclosure and must be arranged to allow easy vision and operation of each device. Each device must have a nameplate [and][or] legend plate as indicated on the drawings. Nameplate wordings must be as indicated on the drawings.

3.1.7 Surge Protective Devices

Surge protective devices (SPD) must be installed in the PCP to minimize effects of nearby lightning strikes, switching on and off of motors and other inductive loads. SPD must be provided for each control circuit ladder. Each ladder may contain any combination of the following devices: PLCs, power supplies (e.g., 24 volt), fans, relays, lights, switches. SPD must also be provided for PLC I/O originating outside of the building.

3.1.8 Terminal Blocks

As a minimum, any PCP device that connects to a field device (devices not located in the PCP) must be connected to a terminal block. A connection diagram similar to the drawings must be provided to the field Contractor for field connections to the PCP.

3.1.9 Circuit Breakers

As a minimum, any 120 volt PCP device i.e. (fans, lights, power receptacles, 24 VDC power supplies, PLC CPUs, PLC I/O racks) must be provided with an individual circuit breaker. Additionally 120 volt terminal boards connecting to field devices (devices not located in the PCP) must be protected by a 120 volt circuit breaker.

3.1.10 Uninterruptible Power supplies

The PCP must contain two uninterruptible power supplies (UPS) (each connected to a dedicated circuit). As shown on the drawings one UPS must supply the PLC System , and the second UPS must supply the miscellaneous device power. The UPSs output capacity must be sufficient to drive all the system components connected plus 25 percent. The UPSs must be mounted on shelves near the bottom of the PCP but not rest on the floor of the PCP.

3.1.11 Power Supplies

Provide and install all 120 VAC and 24 VDC power supply. Interconnecting wiring between UPSs and PLC power supplies must be completely installed prior to shipment to the job site.

3.1.12 Alarm Annunciator and Horns

Signals must be initiated by hardwired field contacts or by PCP outputs as required. The annunciator must energize alarm horns, both an integral panel mounted vibrating horn and remote horns, and flash the appropriate annunciator lamp. The minimum number of windows must correspond to the number of alarm points, plus 15 percent spare. The drawings indicate panel layout and the alarms to be annunciated.

3.1.12.1 Non-critical Alarms

Non-critical alarm windows must be white with black lettering and must sound the PCP mounted vibrating horn and the exterior mounted vibrating horns.

3.1.12.2 Critical Alarms

Critical alarm windows must be red with white lettering and must sound the PCP mounted vibrating horn and the exterior mounted resonating horns. Critical alarms must also cancel all automatic pump starts in the PLC.

3.1.12.3 Alarm Sequence

Alarm sequence for each alarm must be as follows (ISA 18.1 sequence 'A').

a. For a normal condition, visual indicator and horns will be off.

b. For an alarm condition, visual indicator will flash, and horns will sound (this condition will be locked in).

c. Upon acknowledgment of the alarm condition, visual indicator will be steady on and the horns will be off.

d. If, after acknowledgment of an alarm condition, another alarm condition is established, the new alarm will cause the appropriate window to flash and the horn to sound.

e. When condition returns to normal after acknowledgment, the visual indicator and the horn will be off.

3.1.13 Personal Computer

The personal computer must be a stand alone, desk top mounted unit. The personal computer must download system parameters from the PLCs for display. The personal computer must also upload new set point values that the operator has changed using the personal computer keyboard, after a password has been entered.

3.1.13.1 Screen Number 1

This must be a general opening screen. As a minimum it must display the name and location of the installation (e.g. Selfridge Air National Guard Base, Michigan), name of the project (e.g., Aviation Fuel Farm) and screen navigation information.

3.1.13.2 Screen Number 2

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NOTE: The Designer of Record must select the parameters. See 33 09 53 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III) for a typical TYPE III Hydrant System PCP and adjust to suit the specific system.

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Screen number two must list the systems parameters monitored by the PCP and their current value. The values must be continuously updated, a 2 second delay maximum between updates will be acceptable.

Parameter	Value
Only one of the words separated by a slash (/) must be displayed. The xxxxx.x HOURS is the fuel pumps elapsed run time and the value must not be lost when the lead PLC is switched. The pump and valve status words must be color coded to match the colors used on the graphic display screen.	

3.1.13.3 Screen Number 3

The following table must be displayed. The table lists the set points that can be adjusted using the operator interface. A password must be entered before the "current value" can be adjusted. The value entered can only be a number within the "set point range". The "default value" is the value held in the program that is loaded into EEPROM memory (This screen may require more than one display screen).

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE

3.1.13.4 Screen Number 4

This screen must be a duplicate of the Graphic Display Drawing showing a schematic of the process flow. This screen must be referred to as the graphical display. Many operating parameters must be displayed here as required in later paragraphs of this specification.

3.1.13.5 Screen Number 5

This screen must be a duplicate of the Alarm Annunciator and it must be superimposed over the current active screen on the personal computer monitor when an alarm is activated.

3.1.13.6 Screen Number 6

This screen must be a screen designed solely for assisting the testing team during initial start up to watch all of the significant parameters of the systems operation simultaneously on one screen. This screen must include the system parameters i.e. (flows, pressures, status) from screen 2, the set points from screen 3, and timers for all of the actions that will take place following a delay function.

3.1.13.7 Screen Number 7

This screen must be an alarm history screen. This screen must be referred to as the Alarm History Display. This screen must be capable of storing and displaying all alarms that have occurred in the system for at least a period of 30-days.

3.1.13.8 Screen Number 8

This screen must be a screen designed solely for displaying the parameters and process involved in the Tightness Test as described in this specification and on the drawings. The following values must be displayed concurrently against time: Pressure (as sensed by PIT3). The system will be able to produce graphs on the screen of this data and be able to print the data in color on the laser printer.

3.1.14 Laptop Computer

The Laptop computer must be used to create, edit, and load the ladder logic program into the PLCs and the operator interface graphics control program into the personal computer. The Laptop must also be used to monitor the PLCs memory and ladder logic program. The computer must be stored in a lockable cabinet located within the Pump Control Panel.

3.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

3.2.1 General

The basic operation of the PLC system is (Reference "Control System Block Diagram" on the drawings):

a. The CPU and its associated I/O rack (I/O-1) sends system outputs to appropriate devices and receive input signals from field devices (PITs-1, DPTs-1, DPTs-3, flow switches, valve limit switches).

3.2.2 Programs

a. Provide two copies of all working programs (i.e. PLC logic, personal computer) on read only optical discs as well as a printed program listing.

b. Provide rung comments (documentation) in the ladder logic program. Each device, on the ladder, must be identified as to the type of device, i.e. limit switch XX, flow indicator XX, motor starter XX. Rung comments must be provided for input and output rungs. The programmer must also provide a comment describing the function of each rung or group of rungs that accomplish a specific function.

3.3 GRAPHICS DISPLAY SCREEN

3.3.1 General

The graphic display screen shall be capable of being displayed on the personal computer monitor.

3.3.2 Display Presentation

The Graphic Display shall depict the process fuel flow schematically as indicated on the drawings. Red, green, and amber symbols shall be integrated with the process schematic to provide current equipment status graphically. The symbols shall be located immediately adjacent to related equipment symbol.

3.3.3 Process Schematic

The process schematic graphic representation shall utilize conventional symbols when possible. Symbols and flow lines shall be sized and spaced so as to provide a clear representation of the system process. The Graphic Display shall be suitable for supervised field modification when future items are added. Minor changes may be incorporated to allow proper line width and spacing. Component arrangement, piping routing, and location of valves shall match the flow diagram. The Graphic Display layout shall be approved by the Government.

3.3.4 Digital Flow and Pressure Indicators

The graphics display screen shall have digital displays for the flows and pressures as indicated on the drawings.

3.4 INSTALLATION

Installation must conform to the manufacturer's drawings, written recommendations and directions.

3.4.1 Shop Drawing

The shop drawing must be clear and readable and preferably drawn using a computer aided drafting package. At the conclusion of the project the diagram drawings must be redrafted to include all as-built conditions. These updated drawings must be included in the O&M Manuals and appropriate section of the drawings placed in a data pocket located in each of the enclosures. The shop drawing at a minimum must show:

a. Overall dimensions, front, side and interior elevation views of the PCP showing size, location and labeling of each device.

b. Overall dimensions, front elevation of the GDP showing graphical layout and size, location and labeling of each device.

c. Power ladder diagram indicating power connections between SDP, power conditioners, PLCs, power supplies and field and panel devices. Any terminal block connection numbers used must be indicated.

d. Control ladder diagram indicating control connections between field and devices and PLC I/O modules. Terminal block connection numbers and PLC terminal numbers must be indicated.

e. Communication connections between PLCs and I/O racks. Communication channel numbers must be indicated.

f. Bill of materials.

g. Written control sequence covering all inputs, outputs, and control scheme.

3.4.2 System Start-Up and Testing

a. At PCP start-up and testing provide personnel, onsite, to provide technical assistance, program fine tuning, and to start-up and test the system. Start-up and testing must be coordinated with the overall fueling system start-up test specified in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). Prior to this test, all connections must have been made between the PCP, the personal computer, the motor control center, and all field devices. In addition, wiring must have been checked for continuity and short circuits. Adjust set point values, timing values, and program logic as required to provide a functional hydrant fuel control system. Once the system has been fine tuned and passed the system test, the new system default values, must be loaded into the PLC EEPROM and the personal computer screens adjusted to indicate the new values.

b. A step-by-step Testing Plan of the PCP must be submitted. The test must be designed to show that every device (lights, switches, personal computer display screens, alarms) on the PCP and personal computer is in working order and that the PLC program controls the system per specifications. The test must be performed in conjunction with Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). The plan must include a place for the Contractor and government representative to initial each step of the plan after satisfactory completion and acceptance of each step. The complete initialed Record of Test must be certified by the Contractor and then submitted.

3.4.3 Training Plan for Instructing Personnel

a. Upon completion of the system start-up a competent technician regularly employed by the PCP manufacturer must hold a training class for the instruction of Government personnel in the operation and maintenance of the system. Provide both classroom type theory instruction and hands-on instruction using operating system components provided. The period of instruction must be a minimum of three 8-hour working days. The training must be designed to accommodate 8 operators, 4 maintenance personnel, and 2 programmers. The Contracting Officer must receive written notice a minimum of 14-days prior to the date of the scheduled classes.

b. Furnish a written lesson plan and training schedule for Government approval at least 60-days prior to instructing operating, maintenance and programming personnel. Concurrently submit above to the Service Headquarters or officially designated alternate for their input into the review process. Approval of lesson plan will be based on both Government and Service Headquarters' concurrence. This plan must be tailored to suit the requirements of the Government. The training must be divided into three separate classes. Each class must be tailored to a specific group of personnel. The groups are: 1) Operators, those that will use the control system on a day-to-day basis; 2) Maintenance personnel, those that will perform routine and non-routine maintenance and trouble shooting of the control system; 3) Programmers, those that will make changes to and trouble shoot the PLC and personal computer programs. The training program must provide:

   (1) a detailed overview of the control system including the complete step-by-step procedures for start-up, operation and shut-down of the control system.

   (2) a general overview of programmable logic controllers.

   (3) the maintenance of system components installed.

   (4) the programming of the PLC and Personal Computer.

   (5) troubleshooting of the system.

c. Complete approved Operation and Maintenance manuals for this specification and 26 20 00 INTERIOR DISTRIBUTION SYSTEM (specifically pertaining to the motor control center and its relay ladder diagrams) must be used for instructing operating personnel. Training must include both classroom and hands-on field instruction. The class must be recorded in DVD format.

d. Provide training courses in DVD format covering system overview, operation, maintenance, trouble shooting, and programming. These DVDs must be produced onsite by the Contractor using the supplied Pump Control Panel as the teaching aid, or commercially produced DVDs by the PLC manufacturer or third party who specializes in training on PLC systems. Along with the DVDs, provide workbooks, which follow along with the DVDs.

3.5 PLC CONTROL SYSTEM SEQUENCE OF OPERATION

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NOTE: Only the most complicated systems will have redundant hot back-up PLCs and redundant field measuring sensors (dual pressure transmitters and dual differential pressure transmitters, UPSs, power supplies, CPUs, I/O modules, and inputs and outputs); they are typically only required for Type III Hydrant Systems. If you have the situation where it is desired to have a redundant "SYS-1/SYS-2" system, use Section 33 09 53 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III) and modify accordingly.

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NOTE: This specification assumes that the system uses manually actuated Pump Control Start/Stop Stations as described in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT) to control the pumps. If the system uses an automatic pump control system that starts and stops the pumps based on flow and/or pressure, use 33 09 53 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III) instead and modify accordingly.

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The following describes general functions of the fueling system components.

3.5.1 Abbreviations

[a. SYS: components of System including UPS, power supply, CPU, I/O, and system input and outputs.

b. CPU: SYS PLC CPU.

c. I/O: SYS PLC input/output modules.

] d. PCP: Pump Control Panel.

e. PC: Personal Computer.

f. UPS: Uninterruptible Power Supply.

3.5.2 Operating Tanks

3.5.2.1 Level Control

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NOTE: Use this and the following paragraphs if float switches rather than electronic level switches are used for determining tank level alarms.

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Each operating tank has four level float switches to measure low-low, low, high and high-high levels.

3.5.2.1.1 Low-Low Level

When the low-low level float is activated the associated tank's graphic display low-low level light must light up. If the selected tank's level drops below the low-low sensor the alarm annunciator's low-low level alarm sequence activates, issue pumps running in automatic mode must be disabled. If all tanks are at low-low level, no issue pumps in automatic mode must be enabled.

3.5.2.1.2 Low Level

When the low level float is activated the associated tank's graphic display low level light must light up and the alarm annunciator's non-critical low level alarm sequence activates.

3.5.2.1.3 High Level

When the high level float is activated the associated tank's graphic display high level light must light up and the alarm annunciator's non-critical high level alarm sequence activates.

3.5.2.1.4 High-High Level

When the high-high level float is activated the associated tank's graphic display high-high level light must light up, the alarm annunciator's critical high-high level alarm sequence activates, the pump control panel must de-energize the solenoid on the tank's high level shutoff valve to force it closed.

3.5.2.2 Level Control

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NOTE: Use this and the following paragraphs if electronic level switches rather than float switches are used for determining tank level alarms.

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Each operating tank has level switches to monitor low-low, low, high, and high-high fuel levels.

3.5.2.2.1 Low-Low Level

When the low-low level elevation is attained the associated tank's GDP low-low level light must light up. If the selected tank's level drops below the low-low sensor the alarm annunciator's low-low level alarm sequence activates, issue pumps running in automatic mode must be disabled. If all tanks are at low-low level, no issue pumps in automatic mode must be enabled.

3.5.2.2.2 Low Level

When the low level elevation is attained the associated tank's GDP low level light must light up and the alarm annunciator's non-critical low level alarm sequence activates.

3.5.2.2.3 High Level

When the high level elevation is attained the associated tank's GDP high level light must light up and the alarm annunciator's non-critical high level alarm sequence activates.

3.5.2.2.4 High-High Level

When the high-high level elevation is attained, the associated tank's GDP high-high level light must light up and the alarm annunciator's critical high-high level alarm sequence activates. The pump control panel must de-energize the solenoid on the tank's high level shutoff valve to force it closed.

3.5.2.3 Outlet Valve

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NOTE: Use when directed by Service Headquarters.

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Each operating tank's outlet valve has two limit switches to indicate valve position. The closed limit switch is DPDT. The closed limit switch must close when the valve is fully closed. When the closed limit switch is closed the associated tank's valve graphic display closed light must activate. When the valve is fully open, the open limit switch is closed. At this time the associated tank's valve graphic display open light must activate.

3.5.3 Product Recovery Tank

3.5.3.1 Fuel Transfer Pump (FTP)

The pump's motor controller has a status relay to indicate the on/off status of the pump. When status relay is open the pump's graphic display off light must activate. When the status relay is closed the pump's graphic display on light must light up. The status relay state must also be used to start and stop the pumps elapsed run time timer.

3.5.3.2 Overfill Valve (OV)

The tank's overfill valve has a limit switch to indicate valve position. The switch is SPST. The switch must close when the valve is fully closed. When the limit switch is closed, the tank's graphic display valve closed light must light up and the alarm annunciator's non-critical alarm sequence activates. When the limit switch is open the tank's graphic display valve open light must light up.

3.5.3.3 High Level Alarm

The tank has a high level alarm float switch. The switch is SPST. When the high level alarm float is activated the tank's graphic display high level light must light up and the alarm annunciator's critical alarm sequence activates.

3.5.3.4 High-High Level Alarm

The tank has a high-high level alarm float switch. When the high-high level alarm float is activated the tank's graphic display high-high level light must light up and the alarm annunciator's critical alarm sequence activates.

3.5.3.5 Leak Detection

The tank has a leak detection system. When the leak alarm is activated the alarm annunciator's non-critical alarm sequence activates.

3.5.4 Fueling Pumps (FP)

There are [three][_____] fueling pumps with a maximum of [two][_____] pumps running at one time. The lead pump selector switch must select the pump starting sequence. Each pump's motor controller has a status relay to indicate the on/off status of the pump. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. The status relay state must also be used to start and stop the pumps elapsed run time timer and must be displayed on screen number 2.

[3.5.5 Jockey Pump (JP)

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NOTE: Recommended for use in cases of long transfer lines or inter-terminal pipelines for Tightness Test System. Delete this option if existing system pumps are utilized for Tightness Test.

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There is one jockey pump. The jockey pump must not run concurrently with any of the fueling pumps. The jockey pump's motor controller has a status relay to indicate the on/off status of the pump. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. The status relay state must also be used to start and stop the elapsed run time timer and must be displayed on screen number 2.

]3.5.6 Flow Switch, Fueling Pump

On the discharge side of each pump is a flow switch to indicate positive flow (fail safe feature). If the PLC has given a signal to start a pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump must be in a failure state and it must be disabled (taken out of the starting sequence), the alarm annunciator's non-critical alarm sequence must also be activated, and the next pump in the start sequence started. After the PLC has stopped all of the pumps, any failed pump must be added back into the start sequence.

[3.5.7 Flow Switch, Jockey Pump

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NOTE: Recommended for use in cases of long transfer lines or inter-terminal pipelines for Tightness Test System. Delete this option if existing system pumps are utilized for Tightness Test.

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On the discharge side of the jockey pump is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT. If the PLC has given a signal to start the jockey pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running, then the pump must be in a failure state and it must be disabled. The alarm annunciator's non-critical alarm sequence must also be activated.

]3.5.8 Transmitters

3.5.8.1 Differential Pressure Transmitter (DPT)

The DPT's measure flow in L/s gpm. The net flow is sent to the personal computer display. The issue rate, return rate and net flow must be displayed on the personal computer.

3.5.9 Safety Circuit

3.5.9.1 Emergency Stop Status

The emergency stop circuit status relay (ER1) N.O. contact must be connected to I/O-1, I/O-2 and UPS#2 as indicated on the Terminal Block Connection drawing. When the circuit is activated the alarm annunciator's critical alarm sequence is activated and any calls to start fueling pumps must be canceled and no additional pump start signals must be sent until the circuit has been reset. The fueling pumps will actually be stopped by an emergency stop circuit status relay (ER2) N.O. contact in the fuel pump motor control circuit located in the motor control center.

3.5.9.2 Emergency Shutoff Valves (ESO) Status

The ESO status relay (ER2) N.O. contact must be connected to I/O and UPS#2 as indicated on the Terminal Block Connection drawing. When the ESO status relay is closed the [Filter Separator control valves (FSV)][_____] closed lights must light up.

3.5.9.3 Circuit Power Status

When the safety circuit power status relay is closed the PCP emergency circuit power on light must light up.

3.5.10 Pump Control Panel

3.5.10.1 CPU Faults

The PCP mounted CPU on light is connected to SYS. The associated CPU light must light when no system faults are detected. When a fault is detected by the CPU the faulted CPU's on light must be turned off and the alarm annunciator's non-critical alarm sequence must be activated.

3.5.10.2 Mode Select Switch

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NOTE: Typical switch selections are presented, adjust to suit the actual system.

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The 2-position switch selects what mode of fueling is active: issue, or off. The screen number 2 status must indicate the active mode.

[The 3-position switch selects what mode of fueling is active: issue, [tightness test][transfer] or off. The screen number 2 status must indicate the active mode.

][The 4-position switch selects what mode of fueling is active: issue, transfer, tightness Test or off. The screen number 2 status must indicate the active mode.

]3.5.10.3 Lead Pump Selector Switch

The [3][_____]-position switch selects which pump must be the lead pump. The switch position must fix the starting sequence for all pumps. The sequences must be 1-2-3, 2-3-1, and 3-1-2, 1-2-3 [_____]. The off sequence must be the reverse of the start sequence, therefore, first on will be last off. A maximum of [two] [_____] pumps will be allowed to run at one time. If a pump fails to start or fails during operation, that pump will be disabled and the next pump in the sequence started. The screen number 2 status display must indicate the lead pump.

3.5.10.4 PCP Temperature Alarm

The alarm thermostat when activated must activate the alarm annunciator's non-critical alarm sequence.

3.6 OPERATING PROGRAM REQUIREMENTS

The control system's logic program must be stored on a EEPROM chip. Default values of operator adjustable parameters must be permanently stored on the chip with the capability of resetting the values in RAM to the values within the range specified below. The default values can be changed through the use of the personal computer (after the correct password has been entered). After loss of power and battery failure the adjustable settings must revert back to the default values located on the chip. The default values shown here must be reset to the values determined during the system start up and test.

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
[Jockey] pump starting pressure	345 to 552 kPa 50 to 80 psi	65 psi
Timer to enable start-up of [Jockey] pump	0 to 120 seconds	15 seconds
System pressure to stop [Jockey] pump	345 to 552 kPa 50 to 80 psi	75 psi

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds
Should the operator enter a value not within the range for that parameter, the personal computer must indicate "INVALID ENTRY" and revert back to the previous value.		
A number inside braces, {x}, in the following paragraphs indicates that the number may be changed by the operator via the operator interface within the Set Point Range listed above.		

3.7 AUTOMATIC MODE - [ISSUE][ISSUE OR TRANSFER] CONDITION

a. The lead pump will start when a Pump Control Station start pushbutton is depressed.

b. Depressing an additional Pump Control Station pushbutton will bring on additional pumps.

c. Depress the Pump Control Station stop pushbutton will disable the lead pump.

d. Depressing an additional Pump Control Station stop pushbuttons will disable the pumps in the order they were brought on.

3.8 TIGHTNESS TEST MODE

This mode must be used in conjunction with the Tightness Monitoring Panel provided by Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT) to perform tightness tests. Placing the selector switch to "TIGHTNESS TEST" the PCP will send a signal to the Tightness Monitoring Panel telling it that it is ready to perform the tests. At this time it will also operate MOV valves, closing and opening as required to run tests. The PCP will then receive signals from the Tightness Monitoring Panel to prepare for High Pressure Test, run High Pressure Test, Prepare for Low Pressure Test, run Low Pressure Test, prepare for 2nd High Pressure Test, run 2nd High Pressure Test, and when the test is over. The following PCP actions will occur after the corresponding signal:

Prepare for High Pressure Test:

a. Automatically start the [jockey]pump to obtain pressure.

b. When the [jockey]pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

c. If the [jockey]pump's flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

d. If the [jockey]pump fails to establish flow, automatically start the lead fueling pump to obtain pressure.

e. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. MOV will be opened.

[h. The pump will continue to run until such time as the run High Pressure test signal is received. Note: The Tightness Monitoring Panel is monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the High Pressure test.

] <u>Run High Pressure Test</u>:

a. MOV will actuate as determined by the Tightness Test system manufacturer.

b. [Jockey]Fueling pump will be shut off.

<u>Prepare for Low Pressure Test</u>:

a. MOV will actuate as determined by the Tightness Test system manufacturer.

b. The system will remain in this status until such time as the PCP receives a Run Low Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will monitor the loop pressure until it reaches the 345 kPa 50 psi value. It will then instruct the PCP to run the Low pressure test.

<u>Run Low Pressure Test</u>:

a. MOV will actuate as determined by the Tightness Test system manufacturer.

b. The system will remain in this status until such time as the PCP receives a Prepare for 2nd High Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will wait for a ten minute settling period to expire, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP to prepare for 2nd High Pressure Test.

<u>Prepare for 2nd High Pressure Test</u>:

a. Automatically start the [jockey] pump to obtain pressure.

b. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

c. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

d. MOV will actuate as determined by the Tightness Test system manufacturer.

e. When the [jockey]pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the [jockey]pump's flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. If the [jockey]pump fails to establish flow, automatically start the lead fueling pump to obtain pressure.

h. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

i. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

j. MOV will actuate as determined by the Tightness Test system manufacturer.

k. Pump will continue to run until such time as the run 2nd High Pressure test signal is received. Note: The Tightness Monitoring Panel is monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the 2nd High Pressure test.

Run 2nd High Pressure Test:

a. MOV will actuate as determined by the Tightness Test system manufacturer.

b. [Jockey]Fueling pump will be shut off.

c. The PCP will leave the system as is until such time as the PCP selector switch is placed into a different mode.

3.9 OFF MODE

a. Automatic starting of fueling [and jockey] pumps must be disabled. All other functions (graphic display, alarm annunciator, personal computer, control valve solenoids) must be active to allow manual control of the fueling pumps using the Hand-Off-Auto or Hand-Auto switch.

b. The second, [third][and fourth] fueling pumps maybe started or stopped manually as needed by the operator.

3.10 MANUAL OPERATION OF FUELING PUMPS

a. If the PLC system is still active see paragraph OFF MODE.

b. If the PLC system has no power or the CPUs have faulted (CPU light on PCP off) the pumping system will be in a completely manual mode. The safety circuit will need power so that the ESO solenoids on the non-surge check valves will be open and fuel can flow. The solenoids on the other solenoid controlled valves will be de-energized so the valves will have to be manually opened or enabled for the system to run. Other valves may need to be opened or closed manually by the operators for the system to work properly.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 09 53 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-33 09 53 (August 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-33 09 53 (February 2021)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-33 09 53 (August 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 09 53

AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III)

02/21

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NOTE: This guide specification covers the requirements for the Pump Control and Annunciation System for aircraft refueling systems constructed to the requirements of the DOD Type III Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS. Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards**.**

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 18.1	(2024) Annunciator Sequences and Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA IA 2	(2005) Programmable Controllers - Parts 1

	thru 8
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 1012	(2010; Reprint Apr 2016; Rev Mar 2021) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 DEFINITIONS

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts. SME for this project is [Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS)][Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC)][Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11)].

1.3 ADMINISTRATIVE REQUIREMENTS

a. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section, with the additions and modifications specified herein. The Hydrant Fueling System consists of fueling pumps that pump fuel to a Hydrant Hose Truck Check-out Pad, Truck Fill Stands, and fuel pits located on the airfield apron. Automatic pump starts and stops are based on system pressure and flow.

b. Programmable Logic Controllers (PLCs) receive information from pressure transmitters and other devices to control the pumps and control valves. There are two PLCs that are connected in a redundant configuration, to assure continued operation of the Hydrant fueling System even if either

PLC (but not both) fails. The Hydrant Fueling System also includes above ground fuel storage tanks and a product recovery tank.

c. The pump control panel, personal computer, and annunciator are located in the Control Room of the Pumphouse. The control system must be furnished by a single supplier. See 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT for other required components of the control system. The control system supplier must be responsible for providing a fully functional control system, in accordance with the drawings and specifications, including the field devices. Installation must be in accordance with NFPA 70.

d. Submit six copies of Operation and Maintenance Manuals, within 7 calendar days following the completion of factory tests. Installation, Operation, and Maintenance manuals for all equipment supplied must be furnished following the completion of shop tests and must include:

    (1) . Pump Control Panel including interior and exterior equipment layout. Complete guide outlining step-by-step procedures for system startup and operation.

    (2) . All documents previously submitted and approved with all comments and field changes annotated. Complete description of the sequence of operation including that described in PART 3 and any subsystems not controlled by the PLC (e.g. annunciator panel, EPDS, etc.).

    (3) . Complete listing of all programming of the PLCs, laptop computer, and Personal Computer.

    (4) . Complete relay ladder logic diagrams, PLC input/output diagrams and control power distribution diagrams for the complete control system.

    (5) . Complete troubleshooting guide, which lists possible operational problems and corrective action to be taken, including all as-built conditions.

e. Submit documents demonstrating the accuracy and completeness of the list of material and components, that items proposed comply fully with contract requirements, and are otherwise suitable for the application indicated. Documents must consist of all data or drawings published by the manufacturer of individual items listed including manufacturer's descriptive and technical literature, performance data, catalog cuts, and installation instructions. Submit additional material if the listed items are not adequate to identify intent or conformance to technical requirements. Provide typed and electronic copies of these lists for approval. Any delays associated with resubmittals of incomplete or ambiguous initial submittals will be the Contractor's responsibility.

f. For hard copy submittals, documents must be bound in a suitable binder adequately marked or identified on the spine and front cover. A table of contents page must be included and marked with pertinent contract information and contents of the manual. Provide tabs to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets must be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawing; G, [_____].

SD-03 Product Data

Pump Control Panel (PCP) and Components; G, [_____]

Programmable Logical Controller (PLC) Hardware and Software; G, [_____].

Personal Computer (PC); G, [_____]

Laptop Computer; G, [_____]

FCC Computer; G, [_____]

Laser Printer; G, [_____]

Graphics Display Screen; G, [_____]

Control Wiring Data Lists; G, [_____]

Tools and Spare Parts

SD-06 Test Reports

Certified Pump Control Panel (PCP) Shop Test Report

Record of Test

SD-07 Certificates

Experience and Qualifications; G, [_____]

Training Plan for Instructing Personnel; G, [_____]

Testing Plan; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

1.5 TOOLS AND SPARE PARTS

Provide the following:

a. Any special tools necessary for operation and maintenance of the equipment providing supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

b. One spare set of fuses of each type and size

c. Recommended manufacturer list of spare parts, including part number, current unit price, and source of supply.

d. One spare power supply module

e. One spare I/O module for discrete devices and one for analog devices

f. Two PLC RAM back-up batteries

g. Two complete sets of ink cartridges for the laser printer

h. Minimum of 10 spare lamps for the Alarm Annunciator

i. Minimum of 10 spare lamps of each type of non-LED lamps used on the Pump Control Panel

1.6 EXPERIENCE AND QUALIFICATIONS

Submit the following data for approval:

a. Certification stating that the manufacturer has manufactured, installed, and successfully completed at least five PLC-based systems for automatic cycling of pumps based upon varying dispensing demands ranging from 0 to 182 L/s 0 to 2400 GPM utilizing multiple pumps. At least two of the five PLC-based systems must be for dispensing jet fuel into a pressurized, constant pressure, flow demand aircraft hydrant system.

b. Certification that the control systems have successfully operated over the last 2 years and are currently in service.

c. Project names, locations, and system description of these installations. Include user point-of-contact and current telephone numbers.

1.7 WARRANTY

The Pump Control and Annunciation System including devices, hardware and software must be warranted for a period of one year from the date of acceptance of the system by the Government. This warranty service must include parts and labor service for equipment supplied under this specification. Upon notification by the Government of system or component failure, respond at the site with necessary parts within 48 hours of notification.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Pump Control Panel (PCP) and Components

NEMA ICS 1, NEMA ICS 6, NEMA 250, and UL 508. The PCP enclosure must be a freestanding NEMA Type 12, smooth, gasketed enclosure constructed of 12 gauge steel. All seams must be continuously welded. All drilled holes or knockouts must be performed after delivery to the job site. The pump control panel dimensions must be a maximum of 2.3 m 90 inches high, maximum 1.8 m 72 inches wide, and a maximum of 610 mm 24 inches deep and must have removable lifting eyes. The interior surfaces of the panel must be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces must have standard factory finish. Access for the PCP must be front only and must consist of hinged doors having 3-point latching mechanisms. The doors must open approximately 120 degrees. Rack mounting angles, swing-out panels and other component mounting hardware must be installed such that servicing of one component must not require removal or disconnection of other components. No clearance must be required between the back of the panel and the room walls. Terminal facilities must be arranged for entrance of external conductors from the top or bottom of the enclosure.

2.1.2 Ventilation System

Provide two supply fans, single phase, 115 volt. Each fan must supply a minimum of 47 L/s 100 CFM. The supply and exhaust grill must contain a filter that is easily removed from the exterior of the enclosure. Also provide three thermostats with an adjustable set point range of 21 degrees C 70 degrees F to 60 degrees C 140 degrees F. Locate the thermostats near the top in the interior of the PCP.

2.1.3 Ground Bar

The control panel must have a tin plated copper equipment ground bar. The bar must have a minimum of twenty grounding screws.

2.1.4 Standard Indicator Lights

NEMA ICS 1, NEMA ICS 2, and UL 508. Lights must be heavy duty, NEMA 13, 22.5 mm 1 inch mounting hole, round indicating lights operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs must be used. Indicator lights must have a legend plate with words as shown on drawings. Lens color as indicated on the drawings. Lights must be "push to test (lamp)" type. LED type lamps of comparable size and color may be substituted for standard indicator lights.

2.1.5 Selector Switches

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated lever operated selector switches must be heavy duty, NEMA 13, round, and utilize a 22.5 mm 7/8 inches mounting hole. They must have the number of positions as indicated on the drawings. Switches must be rated 600 volt, 10 amperes continuous. Legend plates must be provided with each switch with words as indicated on the drawings.

2.1.6 Pushbuttons

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated pushbuttons must be heavy duty, NEMA 13, round, utilize a 22.5 mm 7/8 inch mounting hole, and have the number and type of contacts as indicated on the drawings or elsewhere in the specifications. The emergency stop switch must be a red mushroom head, 38 mm 1.5 inch diameter, momentary contact type. Pushbuttons must be rated 600 volt, 10 amperes continuous. Legend plates must be provided with each switch with words as indicated on the drawings.

2.1.7 Relays

IEEE C37.90, NEMA ICS 2, UL 508.

2.1.8 Nameplates

Nameplates must be made of laminated plastic with black outer layers and a white core. Edges must be chamfered. Nameplates must be fastened with black-finished round-head drive screws or approved nonadhesive metal fasteners.

2.1.9 Transient Voltage Surge Suppression Devices

IEEE C62.41 for Category "B" transients, UL 1449.

2.1.10 Terminal Blocks

NEMA ICS 4. Terminal blocks for conductors exiting the PCP must be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks must be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip must form part of the terminal block and each terminal must be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.1.11 Circuit Breakers

UL 508. Individual, appropriately sized, terminal block mounted, circuit breakers must be provided for all 120 volt PCP mounted equipment and for the 120 volt terminal boards shown on the drawings.

2.1.12 Uninterruptible Power Supplies

UL 1012. Input voltage must be 120 volts (nominal), 1 phase, 60 Hertz. Output voltage regulation must be +/-5.0 percent for the following conditions:

a. 20 to 100 percent load on output.
b. Input voltage variation of -15 to +10 percent.
c. Constant load power factor between 80 and 100 percent.

Response time must be 1.5 cycles or less. Battery capacity must be such as to provide an orderly shut down of operating programs or as a minimum 30 minutes.

2.1.13 Miscellaneous Power Supplies

UL 1012. Certain field devices may require power other than 120 VAC (i.e. 24 VDC). The power supplies must be convection cooled, have fully isolated independent outputs, have constant voltage, have short circuit and overvoltage protection, and have automatic current limiting.

2.1.14 Alarm Annunciator

UL 508 and ISA 18.1. The Alarm Annunciator must provide visual annunciation, local and remote monitoring, constant or flashing visual and audible alarm as specified herein. The annunciator must be completely solid state with no moving parts. The annunciator must be furnished with cabinet and hardware appropriate for flush mounting on the control panel. A power supply either integral or separately mounted must operate on 120 volts, 60 Hertz. The annunciator must have windows arranged in a matrix configuration (rows and columns). Each window must be at least 24 mm 15/16 inch high by 40 mm 1-5/8 inches wide and must have rear illuminated translucent engraved nameplate. Lettering must be at least4 mm5/32 inches high. System lamp voltage must be 24 to 28 volts dc. The cells must be individually addressable and not hardwired.

2.1.15 Alarm Horns

UL 508. The alarm horns must consist of 3-vibrating horns and 2-resonating horns. One vibrating horn is to be mounted in the PCP, and two vibrating and two resonating horns must be mounted outside of the pumphouse as shown on the drawings. The exterior horns must each produce 100 db at 3 m 10 feet and must be provided in a weather proof housing. The PCP horn must produce 70 db at 3 m 10 feet.

2.1.16 Laptop Computer

2.1.16.1 Hardware

The following are the minimum hardware requirements for the laptop computer:

a. Latest Pentium CPU operating at 2 GHz or faster
b. 2 GB RAM
c. 500 GB hard drive
d. 8X Read Write DVD drive
e. Color LCD screen 356 mm14 inches

f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120VAC and Battery power supply
k. All cables and connectors for interfacing with PLC and personal computer
l. Modem compatible for remote troubleshooting of the system
m. Two USB 2.0 communications ports
n. Provide a carrying case for the Laptop Computer

2.1.16.2 Software

The following is the minimum software to be loaded on the laptop. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating system)
b. Software for programming the PLCs
c. Software for programming the personal computer

2.1.17 Personal Computer (PC)

2.1.17.1 Hardware

The following are the minimum hardware requirements for the personal computer:

a. Latest Pentium CPU operating at 3.2 GHZ or faster
b. 4 GB RAM
c. 500 GB hard drive
d. 16X Read Write DVD drive
e. Color 610 mm 24 inches flat screen monitor
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120 VAC operating power
k. All cables and connectors interfacing with PLC and Laser Printer
l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System
m. Two USB 2.0 communications ports

2.1.17.2 Software

The following is the minimum software to be loaded on the personal computer. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating System)

b. Software for programming the PLCs

c. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points

d. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system on a real time basis

e. Provide MS Office Professional with Excel to allow the trending data described above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically

2.1.18 Laser Printer

Provide color laser jet alarm/report printer. The unit must print in black at a minimum speed of twelve pages per minute. It must print in color at a minimum speed of ten pages per minute. As a minimum print color graphs of various system pressures, issue flow, and return flow vs. time in seven colors. Provide one set of spare replacement ink cartridges.

2.1.19 FCC Computer

2.1.19.1 Hardware

The FCC computer must be a copy of the personal computer so that upon failure of the personal computer it could be relocated to the pumphouse to assume the personal computers duties. The normal duties of the FCC computer must be to serve as a remote monitor only of the screens that are available on the personal computer. The following are the minimum hardware requirements for the FCC computer:

a. Latest Pentium CPU operating at 3.2 GHZ or faster
b. 4 GB RAM
c. 500 GB hard drive
d. 16X Read Write DVD drive
e. Color 610 mm 24 inch flat screen monitor
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120 VAC operating power
k. All cables and connectors interfacing with PLC and Laser Printer
l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System
m. Two USB 2.0 communications ports

2.1.19.2 Software

The following is the minimum software to be loaded on the FCC computer. The FCC computer must be capable of replacing the Personal computer in the pumphouse if the personal computer fails. It will be set up initially to serve only as a remote monitor of the system while located at the FCC. Should the personal computer fail, the FCC computer will be relocated to the pumphouse and then assume the role of the personal computer. The computer software must have a built in command to tell the computer whether it is serving as the personal computer or as the remote monitor only. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (the latest commercially available MS Operating System)

b. Software to tell the computer which mode it is to operate in, i.e. (personal computer or remote monitor)

c. Software to run as a remote monitor

d. Software for programming the PLCs

e. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points

f. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system, on a real time basis

g. Provide MS Office Professional with Excel to allow the trending data described above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically

2.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

2.2.1 General

a. NEMA IA 2. Each PLC must be able to receive discrete and analog inputs and through its programming it must control discrete and analog output functions, perform data handling operations and communicate with external devices and remote I/O racks. The PLCs must be a modular, field expandable design allowing the system to be tailored to the process control application. The capability must exist to allow for expansion to the system by the addition of hardware and/or user software. At a minimum the PLCs must include mounting backplanes, power supply modules, CPU module, communication modules, and I/O modules.

b. Design and test each PLC provided for use in the high electrical noise environment of an industrial plant. The PLC modules must comply with the FCC Part 15 Part A for radio noise emissions. The programmable controller processor must be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2, IEEE C37.90.

c. The PLCs must function properly at temperatures between 0 and 50 degrees C 32 and 122 degrees F, at 5 to 95 percent relative humidity non-condensing and have storage temperatures between-40 to +60 degrees C -40 and +140 degrees F at 5 to 95 percent relative humidity non-condensing.

d. The PLCs must have manufacturer's standard system status indicators (e.g. power supply status, system fault, run mode status, back-up battery status).

2.2.2 Central Processing Unit Module

The CPU must be a modular self-contained unit that will provide time of day, scanning, application (ladder rung logic) program execution, storage of the application program, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self-diagnostics.

2.2.3 Power Supply Module

a. The power supply module must be plugged into the backplane not separately mounted. The power supply must be wired to utilize 120 VAC, 60 Hz power, the system must function properly within the range of -10 to +15 percent of nominal voltage. The power supply must provide an output to the backplane at a wattage and voltage necessary to support the attached modules. A single main power supply module must have the capability of supplying power to the CPU module and local communication and I/O modules. Auxiliary power supplies must provide power to remote racks.

b. Each power supply must have an integral on/off disconnect switch to the module. If the manufacturers standard power supply does not have an on/off disconnect switch a miniature toggle type switch must be installed near the PLC and clearly labeled as to its function.

c. The power supply must monitor the incoming AC line voltage for proper levels and have provisions for both over current and over voltage protection. If the voltage level is detected as being out of range the system must have adequate time to complete a safe and orderly shutdown.

2.2.4 Program Storage/Memory Requirements

a. The PLC must have the manufacturers standard nonvolatile executive memory for the operating system. The PLC must also have EEPROM (Electrically Erasable Programmable Read Only Memory) for storage of the user program and battery backup RAM for application memory. The EEPROM must be loaded by use of the laptop computer or the personal computer.

b. Submit a calculation of the required amount of EEPROM and RAM (random access memory) needed for this application plus an extra 50 percent.

c. The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed must be limited only by the memory capacity to store these instructions.

2.2.5 Input/Output (I/O) Modules

a. Provide all required I/O modules (analog input, analog output, discrete input, discrete output, and isolated discrete output) to manipulate the types of inputs and outputs as shown on the drawings and to comply with the sequence of operations. Also provide a minimum of 20 percent (round up for calculation) spare input and output points of each type provided, but not less than 2 of each type.

b. I/O modules must be a self-contained unit housed within an enclosure to facilitate easy replacement. All user wiring to I/O modules must be through a heavy-duty terminal strip. Pressure-type screw terminals must be used to provide fast, secure wire connections. The terminal block must be removable so it is possible to replace any input or output module without disturbing field wiring.

c. During normal operation, a malfunction in any remote input/output channel must affect the operation of only that channel and not the operation of the CPU or any other channel.

d d. Isolation must be used between all internal logic and external power circuits. This isolation must meet the minimum specification of 1500 VRMS. Provide optically isolated I/O components which are compatible with field devices.

e. Each I/O module must contain visual indicators to display ON/OFF status of individual input or output points.

f. Discrete output modules must be provided with self-contained fuses for overload and short circuit protection of the module.

g. All input/output modules must be color coded and titled with a distinctive label.

2.2.6 Interfacing

The PLC must have communication ports and communication modules using the manufacturers standard communication architecture for connections of the Personal computer, Laptop Computer, remote I/O racks and interconnections between SYS 1 PLC and SYS 2 PLC for the redundant backup system of the PLCs.

2.2.7 Program Requirements

a. The programming format must be ladder diagram type as defined by NEMA IA 2.

b. There must be a means to indicate contact or output status of the contact or output on the LCD (of the personal computer) or LCD screen (of the laptop computer). Each element's status must be shown independently, regardless of circuit configuration.

c. The program must be full featured in its editing capabilities (e.g. change a contact from normally open to normally closed, add instructions, change addresses, etc.).

2.2.8 Diagnostics

The CPU must continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and I/O. The diagnostic routines must be regularly performed during normal system operation. A portion of the scan time of the controller should be dedicated to perform these housekeeping functions. In addition, a more extensive diagnostic routine should be performed at power up and during normal system shutdown. The CPU must log I/O and system faults in fault tables, which must be accessible for display. When a fault shuts down a CPU, a sequence must be initiated that will automatically switch over to the other CPU. When a fault affects I/O or communication modules the CPU must shut down only the hardware affected and continue operation by utilizing healthy system components. All faults must be annunciated on the alarm annunciator.

PART 3 EXECUTION

3.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS

3.1.1 General

a. Where two or more pieces of equipment performing the same function are required, they must be exact duplicates produced by the same manufacturer. All display instruments of each type must represent the same outward appearance, having the same physical size and shape, and the same size and style of numbers, characters, pointers, and lamp lenses.

b. The PCP must include all required resident software programs and hardware to provide the specified sequence of operation. All software optical discs, including programming manuals, must be turned over to the Government at the completion of start-up so modification can be done in the field with no outside assistance.

c. It is intended that process controlling devices except field devices, and motor controllers be attached to or mounted within the PCP enclosure and all interconnecting wiring installed prior to shipment to the job site. This is to allow shop testing of the system and to decrease field labor requirements.

d. The PCP must be shipped fully assembled in one piece after the completion of the shop tests and all defects corrected.

3.1.2 Wiring

Wiring methods and practices must be in conformance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 4, and NEMA ICS 6 recommendations as applicable. All wiring to instruments and control devices must be made with stranded wire, and wiring must be permanently labeled with conductor/wire numbers within 1 inch of termination points. Labels must be tubular heat-shrinkable wire markers that remain legible after exposure to industrial fluids and abrasion. Position markers so that wire numbers can be read without disturbing or disconnecting wiring. Use of individual character-markers placed side-by-side is not acceptable. Numbers must match approved shop drawings. All wiring must be neatly laced from point of entry into enclosures to termination points with nylon lacing cord or plastic lacing ties. Lacing within wiring channels is not required. Provide typed Control Wiring Data Lists within each terminal cabinet and the PCP. The data lists must include: conductor identification number, wire gauge, wire insulation type, "FROM" terminal identification, "TO" terminal identification, and remarks. The preliminary lists generated by the Contractor will be submitted for approval to the Contracting Officer and will be updated to As-Built conditions by the Contractor. The As-Built data lists must be placed in a document holder within each enclosure for both hard copy and electronic submittal.

3.1.3 Certified Pump Control Panel (PCP) Shop Test Report

The manufacturer must shop test the PCP, Personal computer, and lap top computer. The procedure must include simulation of field components and must provide for fully testing the pump control and annunciator system as a unit before delivery to the project site. The test must, reveal system defects, including, but not limited to, functional deficiencies, operating program deficiencies, algorithm errors, timing problems, wiring errors, loose connections, short circuits, failed components and misapplication of components. The test must be performed prior to shipment to the site and problems detected must be corrected. The final testing and correction sequence must be repeated until no problems are revealed and then two additional successful tests must be performed. Submit certified test report within 15 days after completion of the test. The report must include a statement that the Pump Control Panel performs as specified. Notify the Contracting Officer and the SME 30 days prior to the final shop testing date. The Contracting Officer may require a Government witness at the final test before the PCP is shipped to the site.

3.1.4 Ventilation System

Thermostat T-1, must control fan F-1 and thermostat T-2 must control fan F-2. T-1 and T-2 must be set at 27 degrees C 80 degrees F to maintain interior air temperature to -7 degrees C 20 degrees F above ambient. Thermostat T-3, set at 38 degrees C 100 degrees F, must provide a non-critical PCP HIGH TEMPERATURE alarm to the alarm annunciator.

3.1.5 Grounding

The PCP ground bar must be connected to the building counterpoise via a #10 AWG conductor. Within the enclosure all I/O racks, processor racks, and power supplies, etc. must be grounded to meet the manufacturer's specifications.

3.1.6 Indicator Lights, Switches, and Pushbuttons

Indicator lights, switches, and pushbuttons must be mounted through the PCP enclosure and must be arranged to allow easy vision and operation of each device. Each device must have a nameplate and/or legend plate as indicated on the drawings. Nameplate wordings must be as indicated on the drawings.

3.1.7 Transient Voltage Surge Suppression Devices

Transient voltage surge suppression (TVSS) devices must be installed in the PCP to minimize effects of nearby lightning strikes, switching on and off of motors and other inductive loads. TVSS must be provided for each control circuit ladder. Each ladder may contain any combination of the following devices: PLCs, power supplies (e.g., 24 volt), fans, relays, lights, switches etc. TVSS must also be provided for PLC I/O originating outside of the building.

3.1.8 Terminal Blocks

As a minimum, any PCP device that connects to a field device (devices not located in the PCP) must be connected to a terminal block. A connection diagram similar to the drawings must be provided to the field Contractor for field connections to the PCP.

3.1.9 Circuit Breakers

As a minimum, any 120 volt PCP device i.e. (fans, lights, power receptacles, 24 VDC power supplies, PLC CPUs, PLC I/O racks) must be provided with an individual circuit breaker. Additionally 120 volt terminal boards connecting to field devices (devices not located in the PCP) must be protected by a 120 volt circuit breaker.

3.1.10 Uninterruptible Power supplies

The PCP must contain three uninterruptible power supplies (UPS) each connected to a dedicated circuit. As shown on the drawings one UPS must supply PLC System 1, one UPS must supply PLC System 2, and the third UPS must supply the miscellaneous device power. The UPSs output capacity must be sufficient to drive all the equipment connected plus 25 percent. The UPSs must be mounted on shelves near the bottom of the PCP but not rest on the floor of the PCP.

3.1.11 Power Supplies

Provide and install all 120 VAC and 24 VDC power supply. Interconnecting wiring between UPSs and PLC power supplies must be completely installed prior to shipment to the job site.

3.1.12 Alarm Annunciator and Horns

Signals must be initiated by hardwired field contacts or by PCP outputs as required. The annunciator must energize alarm horns, both an integral panel mounted vibrating horn and remote horns, and flash the appropriate annunciator lamp. The minimum number of windows must correspond to the number of alarm points, plus 15 percent spare. The drawings indicate panel layout and the alarms to be annunciated.

3.1.12.1 Non-critical Alarms

Non-critical alarm windows must be white with black lettering and must sound the PCP mounted vibrating horn and the exterior mounted vibrating horns.

3.1.12.2 Critical Alarms

Critical alarm windows must be red with white lettering and must sound the PCP mounted vibrating horn and the exterior mounted resonating horns. Critical alarms must also cancel all automatic pump starts in the PLC.

3.1.12.3 Alarm Sequence

Alarm sequence for each alarm must be as follows (ISA 18.1 sequence 'A').

a. For a normal condition, visual indicator and horns will be off.

b. For an alarm condition, visual indicator will flash and horns will sound (this condition will be locked in).

c. Upon acknowledgment of the alarm condition, visual indicator will be steady on and the horns will be off.

d. If, after acknowledgment of an alarm condition, another alarm condition is established, the new alarm will cause the appropriate window to flash and the horn to sound.

e. When condition returns to normal after acknowledgment, the visual indicator and the horn will be off.

3.1.13 Personal Computer

The personal computer must be a stand alone, desk top mounted unit. The personal computer must download system parameters from the PLCs for display. The personal computer must also upload new set point values that the operator has changed using the personal computer keyboard, after a password has been entered.

3.1.13.1 Screen Number 1

This must be a general opening screen. As a minimum it must display the name and location of the installation (e.g. Seymour Johnson Air Force Base, North Carolina), name of the project (e.g., Type III Hydrant Fueling System) and screen navigation information.

3.1.13.2 Screen Number 2

At a minimum the following items must be displayed. The values must be continuously updated, a 2 second delay maximum between updates will be acceptable.

System Issue Rate	xxxx L/sGPM
System Return Rate	xxxx L/sGPM
System Net Flow	xxxx L/sGPM
System Pressure	xxxx kPaPSI
System Operation Mode	Auto/Off/Flush/Tightness test
Active System	Sys-1/Sys-2
Lead Pump	1/2/3/4/5
Fuel Pump #1	On/Off xxxxx.x HOURS
Fuel Pump #2	On/Off xxxxx.x HOURS
Fuel Pump #3	On/Off xxxxx.x HOURS
Fuel Pump #4	On/Off xxxxx.x HOURS
Fuel Pump #5	On/Off xxxxx.x HOURS
Backpressure Control Valve	Closed/Enabled
Pressure Control Valve	Closed/Enabled
Defuel/Flush Valve	Closed/Enabled

Tank 1 Outlet Valve	Open/Closed
Tank 2 Outlet Valve	Open/Closed
Tank 1 Receipt Valve	Open/Closed
Tank 2 Receipt Valve	Open/Closed
Receipt Bypass Valve	Open/Closed
Manifold Setup Valve I34	Open/Closed
Manifold Setup Valve I35	Open/Closed
Manifold Setup Valve R10	Open/Closed
Manifold Setup Valve R11	Open/Closed
Only one of the words separated by a slash (/) must be displayed. The xxxxx.x HOURS is the fuel pumps elapsed run time and the value must not be lost when the lead PLC is switched. The pump and valve status words must be color coded to match the colors used on the graphic display screen.	

3.1.13.3 Screen Number 3

The following table must be displayed. The table lists the set points that can be adjusted using the operator interface. A password must be entered before the "current value" can be adjusted. The value entered can only be a number within the "set point range". The "default value" is the value held in the program that is loaded into EEPROM memory (This screen may require more than one display screen.).

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Lead pump starting pressure	205 to 1035 kPa 30 to 150 psi	415 kPa60 psi	xxx KpApsi
Issue flow to start second pump in the sequence	25 to 40 L/s450 to 650 gpm	35 L/s560 gpm	xxx L/sgpm

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Issue flow to start third pump in the sequence	65 to 80 L/s1000 to 1300 gpm	73 L/s1160 gpm	xxx L/sgpm
Issue flow to start fourth pump in the sequence	100 to 120 L/s 1600 to 1900 gpm	111 L/s1760 gpm	xxx L/sgpm
Return flow to enable next pump in sequence to start	0.5 to 6 L/s10 to 100 gpm	2.5 L/s40 gpm	xxx L/sgpm
Return flow to stop fourth, third, and second pump in the sequence (lag pump)	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm	xxx L/sgpm
Return flow to initiate lead pump shutdown sequence	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm	xxx L/sgpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds	xx seconds
Timer to enable second, third and fourth pumps to start	0 to 120 seconds	10 seconds	xx seconds
Timer to stop fourth, third, and second pumps	0 to 120 seconds	15 seconds	xx seconds
Timer to stop first pump	0 to 60 seconds	2 seconds	xx seconds
Timer to disable Back Pressure Control Valve	0 to 360 seconds	60 seconds	xx seconds
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds	xx seconds
System pressure to stop lead pump	895 to 1310 kPa 130 to 190 psig	965 kPa140 psig	xxx kPapsig

3.1.13.4 Screen Number 4

This screen must be a duplicate of the Graphic Display Drawing showing a schematic of the process flow. This screen must be referred to as the graphical display. Many operating parameters must be displayed here as required in later paragraphs of this specification.

3.1.13.5 Screen Number 5

This screen must be a duplicate of the Alarm Annunciator and it must be superimposed over the current active screen on the personal computer monitor when an alarm is activated.

3.1.13.6 Screen Number 6

This screen must be a screen designed solely for assisting the testing team during initial start up to watch all of the significant parameters of the systems operation simultaneously on one screen. This screen must include the system parameters i.e. (flows, pressures, and status) from screen 2, the set points from screen 3, and timers for all of the actions that will take place following a delay function.

3.1.13.7 Screen Number 7

This screen must be a screen designed solely for displaying the seven graphs as described in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. The following values must be displayed concurrently against time: Issue flow, Issue pressure, Return flow, Pump #1 discharge pressure, Pressure upstream of BPCV, Pressure downstream of BPCV, and Hydrant Pit Pressure. The personal computer must be capable of storing up to 1 week of data corresponding to the above values. The system will be able to produce graphs on the screen of this data and be able to print the data in seven colors on the laser printer.

3.1.13.8 Screen Number 8

This screen must be an alarm history screen. This screen must be referred to as the Alarm History Display. This screen must be capable of storing and displaying all alarms that have occurred in the system for at least a period of 30 days.

3.1.13.9 Screen Number 9

This screen must be a screen designed solely for displaying the parameters and process involved in the Tightness Test as described in this specification and on the drawings. The following values must be displayed concurrently against time: Pressure (as sensed by PIT3). The system will be able to produce graphs on the screen of this data and be able to print the data in color on the laser printer.

3.1.14 Laptop Computer

The Laptop computer must be used to create, edit, and load the ladder logic program into the PLCs and the operator interface graphics control program into the personal computer. The Laptop must also be used to monitor the PLCs memory and ladder logic program. The computer must be stored in a lockable cabinet located within the Pump Control Panel.

3.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

3.2.1 General

****

NOTE: The pressure indicating transmitters and the differential pressure transmitters are the only

devices that the PLC can monitor for a possible failure. Failures are defined in the following manners: When the pressure indicating transmitters differ with each other by more than 69 kPa 10 psig after a 10 second delay, assume the lower reading transmitter has failed. When the issue differential pressure transmitters differ from each other by more than 2 L/s 30 gpm after a ten second delay, assume the lower reading transmitter has failed. When the return differential pressure transmitters differ from each other by more than 1.5 L/s 20 gpm after a ten second delay, assume the lower reading transmitter has failed.

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The basic operation of the redundant PLC system is (Reference "Control System Block Diagram" on the drawings):

a. CPU-1 and it's associated I/O rack (I/O-1) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

b. CPU-2 and it's associated I/O rack (I/O-2) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

c. Within each rack (I/O-1 and I/O-2) System-1, System-2, and nonredundant inputs and outputs must not be mixed on the same input/output module.

d. Under normal operation: The system input select switch is in the "SYS-1" position. CPU-1 is controlling the system using System-1 and nonredundant inputs from I/O-1 and any set point changes from the personal computer. CPU-2 is being updated by CPU-1 or concurrently monitoring System-1 inputs from I/O-2.

e. If under normal operation CPU-1 recognizes that a System-1 input has failed (see note below) it must change over to the System-2 redundant input on I/O-1 and report the failure to the personal computer alarm screen.

Note: The pressure indicating transmitters and the differential pressure transmitters are the only devices that the PLC can monitor for a possible failure. Failures must be defined in the following manners: When the pressure indicating transmitters differ from each other by more than 69 kPa 10 psig after a ten second delay, assume the lower reading transmitter has failed. When the issue differential pressure transmitters differ from each other by more than 2 L/s 30 gpm after a ten second delay, assume the lower reading transmitter has failed. When the return differential pressure transmitters differ from each other by more than 1.5 L/s 20 gpm after a ten second delay, assume the lower reading transmitter has failed.

f. During normal operation there are two ways for CPU-2 to take control of the system: 1) CPU-1 identifies its own internal fault and hands over control to CPU-2. 2) CPU-2 identifies a fault in CPU-1 and takes control from CPU-1. When CPU-2 is in control of the system it must annunciate the fault condition and must be using any updated inputs from the personal computer and must use System-1 inputs. If CPU-2 senses a fault on a System-1 input it must then switch over to the appropriate System-2 input. If power is lost to System-1 inputs then CPU-2 must use all of the System-2 inputs.

g. CPU-2 must also report any of its internal faults to CPU-1 and CPU-1 must report any faults it detects in CPU-2.

h. When the operators think the system is not working and the PLCs do not detect any faults the operator can move the system input select switch from the "SYS-1" position to the "SYS-2" position. With the switch in the "SYS-2" position the PLCs are using System-2 inputs.

3.2.2 Programs

a. Provide two copies of all working programs (i.e. PLC logic, personal computer) on read only optical discs as well as a printed program listing.

b. Provide rung comments (documentation) in the ladder logic program. Each device, on the ladder, must be identified as to the type of device, i.e. limit switch XX, flow indicator XX, motor starter XX, etc. Rung comments must be provided for input and output rungs. The programmer must also provide a comment describing the function of each rung or group of rungs that accomplish a specific function.

3.3 GRAPHICS DISPLAY SCREEN

3.3.1 General

The graphic display screen must be capable of being displayed on the personal computer monitor.

3.3.2 Display Presentation

The Graphic Display must depict the process fuel flow schematically as indicated on the drawings. Red, green, and amber symbols must be integrated with the process schematic to provide current equipment status graphically. The symbols must be located immediately adjacent to related equipment symbol.

3.3.3 Process Schematic

The process schematic graphic representation must utilize conventional symbols when possible. Symbols and flow lines must be sized and spaced so as to provide a clear representation of the system process. The Graphic Display must be suitable for supervised field modification when future items are added. Minor changes may be incorporated to allow proper line width and spacing. Component arrangement, piping routing, and location of valves must match the flow diagram. The Graphic Display layout must be approved by the Government.

3.3.4 Digital Flow and Pressure Indicators

The graphics display screen must have digital displays for the flows and pressures as indicated on the drawings.

3.4 INSTALLATION

Installation must conform to the manufacturer's drawings, written recommendations and directions.

3.4.1 Shop Drawing

The shop drawing must be clear and readable and preferably drawn using a computer aided drafting package. At the conclusion of the project the diagram drawings must be redrafted to include all as-built conditions. These updated drawings must be included in the O&M Manuals and appropriate section of the drawings placed in a data pocket located in each of the enclosures. The shop drawing at a minimum must show:

a. Overall dimensions, front, side and interior elevation views of the PCP showing size, location and labeling of each device.

b. Overall dimensions, front elevation of the GDP showing graphical layout and size, location and labeling of each device.

c. Power ladder diagram indicating power connections between TVSS, power conditioners, PLCs, power supplies and field and panel devices. Any terminal block connection numbers used must be indicated.

d. Control ladder diagram indicating control connections between field and devices and PLC I/O modules. Terminal block connection numbers and PLC terminal numbers must be indicated.

e. Communication connections between PLCs and I/O racks. Communication channel numbers must be indicated.

f. Bill of materials.

g. Written control sequence covering all inputs, outputs, and control scheme.

3.4.2 System Start-Up and Testing

a. At PCP start-up and testing provide personnel, onsite, to provide technical assistance, program fine tuning, and to start-up and test the system. Start-up and testing must be coordinated with the overall fueling system start-up test specified in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Prior to this test, all connections must have been made between the PCP, the personal computer, the motor control center, and all field devices. In addition, wiring must have been checked for continuity and short circuits. Adjust set point values, timing values, and program logic as required to provide a functional hydrant fuel control system. Once the system has been fine tuned and passed the system test, the new system default values, must be loaded into the PLC EEPROM and the personal computer screens adjusted to indicate the new values.

b. A step-by-step Testing Plan of the PCP must be submitted. The test must be designed to show that every device (lights, switches, personal computer display screens, alarms, etc.) on the PCP and personal computer is in working order and that the PLC program controls the system per specifications. The test must be performed in conjunction with Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. The plan must include a place for the Contractor and government representative to initial each step of the plan after satisfactory completion and acceptance of each step. The complete initialed Record of Test must be certified by the Contractor and then submitted.

3.4.3 Training Plan for Instructing Personnel

a. Upon completion of the system start-up a competent technician regularly employed by the PCP manufacturer must hold a training class for the instruction of Government personnel in the operation and maintenance of the system. Provide both classroom type theory instruction and hands-on instruction using operating equipment provided. The period of instruction must be a minimum of three 8-hour working days. The training must be designed to accommodate 8 operators, 4 maintenance personnel, and 2 programmers. The Contracting Officer must receive written notice a minimum of 14 days prior to the date of the scheduled classes.

b. Furnish a written lesson plan and training schedule for Government approval at least 60 days prior to instructing operating, maintenance and programming personnel. Concurrently submit above to the SME for their input into the review process. Approval of lesson plan will be based on both Government and SME concurrence. This plan must be tailored to suit the requirements of the Government. The training must be divided into three separate classes. Each class must be tailored to a specific group of personnel. The groups are: 1) Operators, those that will use the control system on a day to day basis; 2) Maintenance personnel, those that will perform routine and non-routine maintenance and trouble shooting of the control system; 3) Programmers, those that will make changes to and trouble shoot the PLC and personal computer programs. The training program must provide:

  (1) a detailed overview of the control system including the complete step-by-step procedures for start-up, operation and shut-down of the control system.

  (2) a general overview of programmable logic controllers

  (3) the maintenance of equipment installed

  (4) the programming of the PLC and Personal Computer

  (5) trouble shooting of the system

c. Complete approved Operation and Maintenance manuals for Specification 33 09 53AVIATION PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III) and 26 20 00 INTERIOR DISTRIBUTION SYSTEM (specifically pertaining to the motor control center and its relay ladder diagrams) must be used for instructing operating personnel. Training must include both classroom and hands-on field instruction. The class must be recorded in DVD format.

d. Provide training courses in DVD format covering system overview, operation, maintenance, trouble shooting, and programming. These DVDs must be produced onsite by the Contractor using the supplied Pump Control Panel as the teaching aid, or commercially produced DVDs by the PLC manufacturer or third party who specializes in training on PLC systems. Along with the DVDs, provide workbooks, which follow along with the DVDs.

3.5 PLC CONTROL SYSTEM SEQUENCE OF OPERATION

The following describes general functions of the fueling system components.

3.5.1 Abbreviations

a. SYS-1: components of System #1 including UPS#1, power supplies, CPU-1, I/O-1, and system #1 input and outputs.

b. SYS-2: components of System #2 including UPS#2, power supplies, CPU-2, I/O-2, and system #2 input and outputs.

c. CPU-1: SYS-1 PLC CPU.

d. CPU-2: SYS-2 PLC CPU.

e. I/O-1: SYS-1 PLC input/output modules.

f. I/O-2: SYS-2 PLC input/output modules.

g. PCP: Pump Control Panel.

h. PC: Personal Computer.

i. UPS: Uninterruptible Power Supply.

3.5.2 Operating Tanks

3.5.2.1 Level Control

Each operating tank has four level float switches to measure low-low, low, high and high-high levels. The switches are DPDT for the redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing.

3.5.2.1.1 Low-Low Level

When the low-low level float is activated, the associated tank's graphic display low-low level light illuminates. The following must occur if the tank's outlet valve is not fully closed: activate the low-low level critical alarm sequence, fueling pumps are disabled in automatic mode and pumps are not allowed to start automatically. If all tanks are at low-low level, do not automatically start fueling pumps.

3.5.2.1.2 Low Level

When the low level float is activated the associated tank's graphic display low level light illuminates and the alarm annunciator's non-critical low level alarm sequence activates.

3.5.2.1.3 High Level

When the high level float is activated the associated tank's graphic display high level light illuminates and the alarm annunciator's non-critical high level alarm sequence activates.

3.5.2.1.4 High-High Level

When the high-high level float is activated the associated tank's graphic display high-high level light illuminates, the alarm annunciator's critical high-high level alarm sequence activates, fueling pumps running in automatic mode must be disabled and no pump must be allowed to start automatically.

3.5.2.2 Level Control

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NOTE: Use this and the following paragraphs if electronic level switches rather than float switches are used for determinig tank level alarms

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Each operating tank has level switches to monitor low-low, low, high, and high-high fuel levels. The switches must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The following alarms must be reported.

3.5.2.2.1 Low-Low Level

When the low-low level elevation is attained the associated tank's GDP low-low level light illuminates. The following must occur if the tank's outlet valve is not fully closed: activate the low-low level critical alarm sequence, fueling pumps are disabled in automatic mode and pumps are not allowed to start automatically. If all tanks are at low-low level, do not automatically start fueling pumps.

3.5.2.2.2 Low Level

When the low level elevation is attained the associated tank's GDP low level light illuminates and the alarm annunciator's non-critical low level alarm sequence activates.

3.5.2.2.3 High Level

When the high level elevation is attained the associated tank's GDP high level light illuminates and the alarm annunciator's non-critical high level alarm sequence activates.

3.5.2.2.4 High-High Level

When the high-high level elevation is attained the associated tank's GDP high-high level light illuminates, the alarm annunciator's critical high-high level alarm sequence activates, fueling pumps running in automatic mode must be disabled and no pump must be allowed to start automatically.

3.5.2.3 Outlet Valve

Each operating tank's outlet valve has two limit switches to indicate valve position. The closed limit switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The closed limit switch must close when the valve is fully closed. When the closed limit switch is closed the associated tank's valve graphic display closed light must activate. When the valve is fully open, the open limit switch is closed. At this time the associated tank's valve graphic display open light must activate.

3.5.3 Product Recovery Tank

3.5.3.1 Fuel Transfer Pump (FTP)

The pump's motor controller has a status relay to indicate the on/off status of the pump. The status relay must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the pump's graphic display off light must activate. When the status relay is closed the pump's graphic display on light illuminates. The status relay state must also be used to start and stop the pumps elapsed run time timer.

3.5.3.2 Overfill Valve (OV)

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NOTE: The automatic starting and stopping of the fuel transfer pump is accomplished by the actuation of tank float switches connected to the control circuit in the motor control center. The PLC system does not control the starting and stopping.

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The tank's overfill valve has a limit switch to indicate valve position. The switch is SPST and must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The switch must close when the valve is fully closed. When the limit switch is closed, the tank's graphic display valve closed light illuminates and the alarm annunciator's critical alarm sequence activates. When the limit switch is open the tank's graphic display valve open light illuminates.

3.5.3.3 High Level Alarm

The tank has a high level alarm float switch. The switch is SPST and must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the high level alarm float is activated the tank's graphic display high level light illuminates and the alarm annunciator's non-critical alarm sequence activates.

3.5.3.4 High-High Level Alarm

The tank has a high-high level alarm float switch. The switch is SPST and must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the high-high level alarm float is activated the tank's graphic display high-high level light illuminates, the alarm annunciator's critical alarm sequence activates, fueling pumps running in automatic mode must be disabled and no pump must be allowed to start automatically..

3.5.3.5 Leak Detection

The tank has a leak detection system. The leak detection systems alarm relay must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the leak alarm is activated the alarm annunciator's non-critical alarm sequence activates.

3.5.4 Fueling Pumps (FP)

There are five fueling pumps with a maximum of four pumps running at one time. The lead pump selector switch must select the pump starting sequence. Each pump's motor controller has a status relay to indicate the on/off status of the pump. The status relay must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. The status relay state must also be used to start and stop the pumps elapsed run time timer and must be displayed on screen number 2.

3.5.5 Jockey Pump (JP)

There is one jockey pump. The jockey pump must not run concurrently with any of the fueling pumps. The jockey pump's motor controller has a status relay to indicate the on/off status of the pump. The status relay must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. The status relay state must also be used to start and stop the elapsed run time timer and must be displayed on screen number 2.

3.5.6 Pumphouse Drain Pump (PDP)

There is one return pump. The return pump's motor controller (ON-OFF switch) has a status contact to indicate the on/off status of the pump. The status contact must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status contact is open the associated pump's graphic display off light must illuminate and screen number 2 must indicate on. When the status contact is closed, the associated pump's graphic display on light must illuminate and screen number 2 must indicate off.

3.5.7 Flow Switch, FP

On the discharge side of each pump is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. If the PLC has given a signal to start a pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump must be in a failure state and it must be disabled (taken out of the starting sequence), the alarm annunciator's non-critical alarm sequence must also be activated, and the next pump in the start sequence started. After the PLC has stopped all of the pumps, any failed pump must be added back into the start sequence.

3.5.8 Flow Switch, JP

On the discharge side of the jockey pump is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. If the PLC has given a signal to start the jockey pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump will be in a failure state so it must be disabled. The alarm annunciator's non-critical alarm sequence must also be activated.

3.5.9 Flow Switch, PDP

On the discharge side of the PDP is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing.

3.5.10 Transmitters

3.5.10.1 Pressure Indicating Transmitter (PIT)

The PIT's measure system pressure in kPa psi. There are two PITs connected to the PCP for redundancy. PIT-1 and PIT-2 are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The system pressure is sent to personal computer display. PIT-3 is connected directly to the Tightness Test Panel.

3.5.10.2 Differential Pressure Transmitter (DPT)

The DPT's measure flow in L/s gpm. There are two issue DPTs (DPT-1 and DPT-2) and two return DPTs (DPT-3 and DPT-4) for redundancy. The DPTs are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The net flow is sent to the personal computer display. The issue rate, return rate and net flow must be displayed on the personal computer.

3.5.10.3 Pressure Sensors (PS)

The PS's measure system pressure in kPa psi. There are three PSs installed on the system and there are PCP preparations made for a fourth PS to be temporarily wired in from a Hydrant Pit. PS-1, PS-2, PS-3, and PS-4 are connected to SYS-1 only as indicated on the Terminal Block Connection drawing. These sensors will report various system pressures to the personal computer to be used for the creation of the system graphs as required for screen 7 and described in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP.

3.5.11 Control Valves

3.5.11.1 Defuel/Flush Valve (D/FV)

The D/FV must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. The graphical display open and closed lights and screen number 2 status must activate based on the PLC's output status for the valve. The valve status must be based on the table listed below.

Defuel/Flush Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Flush Mode	Open	De-energized	Energized	Open
Automatic Mode Pump(s) On	Closed	De-energized	De-energized	Closed
Automatic Mode Pumps Off	Enabled	Energized	De-energized	Closed
Off Mode Pump(s) On	Closed	De-energized	De-energized	Closed
Off Mode Pumps Off	Enabled	Energized	De-energized	Closed
Tightness Test	Closed	De-energized	De-energized	Closed

3.5.11.2 Pressure Control Valve (PCV)

The PCV must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. The graphical display enabled and closed lights and screen number 2 status must activate based on the PLC's output status for the valve. The valve status must be based on the table listed below.

Pressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Automatic Mode Pumps Off	Enabled	De-energized	De-energized	Enabled
Automatic Mode Pump(s) On	Closed	Energized	De-energized	Closed
Flush Mode Pumps On	Closed	Energized	De-energized	Closed
Flush Mode Pumps Off	Enabled	De-energized	De-energized	Closed
Off Mode Pump(s) On	Closed	Energized	De-energized	Closed
Off Mode Pumps Off	Enabled	De-energized	De-energized	Enabled
Tight. Test-Hi Pres	Closed	Energized	De-energized	Closed
Tight. Test-Static	Enabled	De-energized	De-energized	Enabled
Tight. Test-Low Pres	Enabled	Energized	Energized	Enabled

3.5.11.3 Backpressure Control Valve (BPCV)

The BPCV must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. The graphical display enabled and closed lights and screen number 2 status must activate based on the PLC's output status for the valve. The valve status must be based on the table listed below.

Backpressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Automatic Mode Pump Start-Up	Enabled	Energized	De-energized	Enabled
Automatic Mode Prior to Lead Pump Shutoff	Closed	De-energized	De-energized	Closed
Flush Mode	Closed	De-energized	De-energized	Closed
Off Mode Pump(s) On	Enabled	Energized	De-energized	Enabled
Off Mode Pumps Off	Closed	De-energized	De-energized	Closed
Tight. Test-Hi Pres	Enabled	De-energized	Energized	Enabled
Tight. Test-Low Pres	Closed	De-energized	De-energized	Closed

3.5.12 Safety Circuit

3.5.12.1 Emergency Stop Status

The emergency stop circuit status relay (ER1) N.O. contact must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the circuit is activated the alarm annunciator's critical alarm sequence is activated and any calls to start fueling pumps must be canceled and no additional pump start signals must be sent until the circuit has been reset. The fueling pumps will actually be stopped by a emergency stop circuit status relay (ER2) N.O. contact in the fuel pump motor control circuit located in the motor control center.

3.5.12.2 Emergency Shutoff Valves (ESO) Status

The ESO status relay (ER2) N.O. contact must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the relay is closed the GDP valve open lights illuminates. When the relay is open the GDP valve closed lights must activate.

3.5.12.3 Circuit Power Status

The safety circuit power status relay (ER3) N.O. contact must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the relay is closed the PCP emergency circuit power on light illuminates.

3.5.13 Pump Control Panel

3.5.13.1 CPU Faults

The PCP mounted CPU-1 and CPU-2 on lights are connected to both SYS-1 and SYS-2. The associated CPU light must light when no system faults are detected. When a fault is detected by the CPU or it's redundant CPU the faulted CPU's on light must be turned off and the alarm annunciator's non-critical alarm sequence must be activated.

3.5.13.2 Input Select Switch

The 2-position input select switch must control which inputs (System-1 or System-2) are being used. Each switch position must be connected to both SYS-1 and SYS-2. The OI display must indicate the active system.

3.5.13.3 Mode Select Switch

The 4-position switch selects what mode of fueling is active: automatic, flush, Tightness Test or off. Each switch position must be connected to both SYS-1 and SYS-2. The screen number 2 status must indicate the active mode.

3.5.13.4 Lead Pump Selector Switch

The 5-position switch selects which pump must be the lead pump. The switch position must fix the starting sequence for all pumps. The sequences must be 1-2-3-4-5, 2-3-4-5-1, 3-4-5-1-2, 4-5-1-2-3, and 5-1-2-3-4. The off sequence must be the reverse of the start sequence, therefore, first on will be last off. A maximum of four pumps will be allowed to run at one time. If a pump fails to start or fails during operation, that pump will be disabled and the next pump in the sequence started. The screen number 2 status display must indicate the lead pump.

3.5.13.5 PCP Temperature Alarm

The alarm thermostat when activated must activate the alarm annunciator's non-critical alarm sequence.

3.6 OPERATING PROGRAM REQUIREMENTS

The control system's logic program must be stored on a EEPROM chip. Default values of operator adjustable parameters must be permanently stored on the chip with the capability of resetting the values in RAM to the values with in the range specified below. The default values can be changed through the use of the personal computer (after the correct password has been entered). After loss of power and battery failure the adjustable settings must revert back to the default values located on the chip. The default values shown here must be reset to the values determined during the system start up and test.

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Jockey pump starting pressure	345 to 552 kPa50 to 80 psi	448 kPa65 psi
Timer to enable start-up of jockey pump	0 to 120 seconds	15 seconds
System pressure to stop Jockey pump	345 to 552 kPa50 to 80 psi	517 kPa75 psi
Lead pump starting pressure	205 to 1035 kPa30 to 150 psi	415 kPa60 psi
Issue flow to start second pump in sequence	25 to 40 L/s450 to 650 gpm	35 L/s560 gpm

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Issue flow to start third pump in sequence	65 to 80 L/s1000 to 1300 gpm	73 L/s1160 gpm
Issue flow to start fourth pump in sequence	100 to 120 L/s1600 to 1900 gpm	111 L/s1760 gpm
Return flow to enable next pump in sequence to start	0.5 to 6 L/s10 to 100 gpm	2.5 L/s40 gpm
Return flow to stop fourth, third, and second pump in sequence (lag pump)	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm
Return flow to initiate lead pump shutdown sequence	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds
Timer to enable second, third, and fourth pumps to start	0 to 120 seconds	10 seconds
Timer to stop fourth, third, and second pumps	0 to 120 seconds	15 seconds
Timer to stop first pump	0 to 60 seconds	2 seconds
Timer to de-energize (close) Back Pressure Control Valve	0 to 360 seconds	300 seconds
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds
System pressure to stop lead pump	895 to 1310 kPa130 to 190 psig	965 kPa140 psig
Should the operator enter a value not within the range for that parameter, the personal computer must indicate "INVALID ENTRY" and revert back to the previous value.		
A number inside braces, {x}, in the following paragraphs indicates that the number may be changed by the operator via the operator interface within the Set Point Range listed above.		

3.7 AUTOMATIC MODE - IDLE CONDITION (GOOD JOCKEY PUMP)

The fueling system is intended to remain continuously pressurized while in the idle condition. This allows the system to respond immediately to aircraft refueling and defueling requirements. Periodically, in the idle condition, the system will lose minimal pressure. When this occurs, the control system will automatically repressurize in the following sequence:

a. The jockey pump will be commanded to start when the system pressure is less than {448} kPa {65} psig continuously for {5} seconds. If the pressure then rises above {448} kPa {65} psig before the timer expires, the timer must reset.

b. After the timer expires:

   (1) The jockey pump will be commanded start.

   (2) All valve positions will remain in the state they were in prior to jockey pump start.

c. With the jockey pump running, 0.31 L/s 5 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will gradually increase {517} kPa {75} psig. When the pressure reaches {517} kPa {75} psig the jockey pump will stop.

d. The conditions exist for a fueling pump to be called to start, the jockey pump will not start or continue to run.

e. When the jockey pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the jockey pump's flow switch opens after the pump has successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate.

3.8 AUTOMATIC MODE - IDLE CONDITION (FAILED JOCKEY PUMP)

The fueling system is intended to remain continuously pressurized while in the idle condition. This allows the system to respond immediately to aircraft refueling and defueling requirements. Periodically, in the idle condition, the system will lose minimal pressure. When this occurs, the control system will automatically repressurize in the following sequence:

a. The lead pump will start when the system pressure is less than {414} kPa {60} psig continuously for {0} seconds. If the pressure then rises above {414} kPa {60} psig before the timer expires, the timer must reset.

b. After the timer expires:

   (1) The BPCV solenoid 'A' must be energized to enable the valve to modulate the system pressure at it's set point.

   (2) The PCV solenoid 'A' must be energized to close the valve.

   (3) The D/FV solenoid 'A' must be de-energized so the valve is closed and solenoid 'B' must be de-energized.

c. With the lead pump running, 45 L/s 600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 896 kPa 130 psig. At this pressure the BPCV will start to open and the valve will modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

d. With the lead pump running and no fueling demand the return venturi flow rate will equal the issue venturi flow rate. When the return venturi flow rate is greater than {42} L/s {560} gpm a {300} second timer must start. If the flow rate drops below {42} L/s {560} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

e. After the timer expires:

  (1) The BPCV solenoid 'A' must be de-energized to close the valve.

  (2) The PCV solenoid 'A' must be de-energized to bleed system pressure to 517 kPa 75 psig.

  (3) When system pressure rises to 965 kPa 140 psig a {2} second timer must start. After the timer has expired, the lead pump must be stopped.

  (4) The Defuel/Flush valve solenoid "A" must be energized 30 seconds after lead pump shut down to allow it to open at 552 kPa 80 psig for defuel operations.

f. The system has now returned to a pressurized and idle condition.

g. When a fueling pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

h. If a fueling pump flow switch opens after the pump has successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

3.9 AUTOMATIC MODE - REFUELING CONDITION

To start an aircraft fueling operation, an operator connects fueling equipment such as a hydrant hose truck to an aircraft and to a hydrant control valve. When the operator opens the hydrant control valve by use of an hydraulic operated "Deadman", the following sequence occurs:

a. The lead pump will start when PIT-1 or PIT-2 senses a pressure less than {414} kPa {60} psig continuously for {0} seconds. If the pressure then rises above {414} kPa {60} psig before the timer expires, the timer must reset.

b. After the timer expires:

  (1) The BPCV solenoid 'A' must be energized to enable the valve to modulate the system pressure at its set point.

  (2) The PCV solenoid 'A' must be energized to close the valve.

  (3) The D/FV solenoid 'A' must be de-energized so the valve is closed and solenoid 'B' must be de-energized.

c. With the lead pump running, ± 45 L/s 600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 896 kPa 130 psig. At this pressure the BPCV will start to open and the valve will modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

d. With lead pump running and a issue venturi flow rate greater than {42} L/s {560} gpm and a return venturi flow rate greater than {3} L/s {40} gpm and less than {42} L/s {560} gpm the lead pump will continue to run and the BPCV will modulate to pass flow as necessary to maintain upstream system pressure.

e. With the lead pump running and a issue venturi flow rate greater than {42} L/s {560} gpm and a return venturi flow rate greater than {42} L/s {560} gpm a {300} second timer must start. If issue venturi flow rate falls below {42} L/s {560} gpm or the return venturi flow rate falls below {42} L/s {560} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

f. After the timer expires:

   (1) The BPCV solenoid 'A' must be de-energized to close the valve.

   (2) The PCV solenoid 'A' must be de-energized to bleed system pressure to 517 kPa 75 psig.

   (3) When system pressure rises to 965 kPa 140 psig a {2} second timer must start. After the timer has expired, the lead pump must be stopped.

   (4) The Defuel/Flush valve solenoid "A" must be energized 30 seconds after lead pump shut-down to allow it to open at 552 kPa 80 psig for defuel operations.

g. With the lead pump running and a issue venturi flow rate greater than {42} L/s {560} gpm and a return venturi flow rate less than {3} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {42} L/s {560} gpm or the return venturi flow rate rises above {3} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

h. After the timer expires: The second pump must start.

i. With the lead and second pumps running and a issue venturi flow rate greater than {88} L/s {1160} gpm and a return venturi flow rate of greater than {3} L/s {40} gpm and less than {53} L/s {700} gpm the lead and second pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

j. With the lead and second pumps running and a issue venturi flow rate greater than {88} L/s {1160} gpm and a return venturi flow rate greater than {53} L/s {700} gpm a (15) second timer must start. If issue venturi flow rate falls below {88} L/s {1160} gpm or the return venturi flow rate falls below {53} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

k. After the timer expires: The second pump must be stopped.

l. With the lead and second pump running and a issue venturi flow rate greater than {88} L/s {1160} gpm and a return venturi flow rate less than {3} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {88} L/s {1160} gpm or the return venturi flow rate rises above {3} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

m. After the timer expires: The third pump must start.

n. With the lead, second and third pumps running and a issue venturi flow rate greater than {133} L/s {1760} gpm and a return venturi flow rate of greater than {3} L/s {40} gpm and less than {53} L/s {700} gpm the lead, second and third pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

o. With the lead, second and third pumps running and issue venturi flow rate greater than {133} L/s {1760} gpm and a return venturi flow rate greater than {53} L/s {700} gpm a {15} second timer must start. If the issue venturi flow rate falls below {133} L/s {1760} gpm or the return venturi flow rate falls below {53} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

p. After the timer expires: The third pump must be stopped.

q. With the lead, second and third pumps running and a issue venturi flow rate greater than {133} L/s {1760} gpm and a return venturi flow rate less than {3} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {133} L/s {1760} gpm or the return venturi flow rate rises above {3} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

r. After the timer expires: The fourth pump must start.

s. With the lead, second, third and fourth pumps running and a issue venturi flow rate greater than 178 L/s 2360 gpm and a return venturi flow rate of greater than {3} L/s {40} gpm and less than {53} L/s {700>} gpm the lead, second, third and fourth pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

t. With the lead, second, third and fourth pumps running and a issue venturi flow rate greater than 179 L/s 2368 gpm and a return venturi flow rate greater than {53} L/s {700} gpm a {15} second timer must start. If the issue venturi flow rate falls below 179 L/s 2360 gpm or the return venturi flow rate falls below {53} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

u. After the timer expires: The fourth pump must be stopped.

v. When a fueling pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

w. If a fueling pumps flow switch opens after the pump successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

3.10 AUTOMATIC MODE - DEFUELING CONDITION

To start an aircraft defuel operation, an operator connects a hydrant hose truck to an aircraft and a fuel sense line and an air sense line to the hydrant control valve. The hydrant hose truck has an on-board defuel pump capable of delivering 23 L/s 300 gpm at 1.1 MPa 165 psig. When the operator starts the defuel operation one of the following occurs:

a. If the fueling pumps are running (D/FV closed) the fuel being removed from the aircraft will either go to the other aircraft(s) connected to the system or be returned to the pumphouse where the BPCV will modulate to control system pressure and the fuel will be returned to the operating tanks. The return venturi flow rate will control the number of pumps that are on as discussed in paragraph "AUTOMATIC MODE - FUELING CONDITION".

b. If the fueling pumps are off (D/FV enabled) the fuel being removed from the aircraft will be returned to the pumphouse and both the D/FV and the PCV will modulate to return the fuel to the operating tanks.

3.11 FLUSH MODE

This mode must be used when the system need to be flushed of water or sediment. The operators must first place the manual valve in the desired position to select the appropriate flow path. Placing the selector switch in "flush" the following must occur:

a. The BPCV solenoid 'A' must be de-energized to force it closed.

b. The D/FV solenoid 'A' must be de-energized to allow the valve to open and the D/FV solenoid 'B' must be energized to force it open.

c. Start the fueling pump(s) manually using the Hand-Off-Auto or Hand-Auto switch to obtain the desired flow rate. The automatic pump starts must be disabled in this mode.

d. The PCV solenoid 'A' must be energized when pump(s) are on and de-energized when the pumps are off.

e. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

3.12 TIGHTNESS TEST MODE

This mode must be used in conjunction with the Tightness Monitoring Panel provided by Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT to perform tightness tests. Placing the selector switch to "TIGHTNESS TEST" the PCP will send a signal to the Tightness Monitoring Panel telling it that it is ready to perform the tests. At this time it will also operate three MOV valves, closing I25 and I26 and opening I27. The PCP will then receive signals from the Tightness Monitoring Panel to prepare for High Pressure Test, run High Pressure Test, Prepare for Low Pressure Test, run Low Pressure Test, prepare for 2nd High Pressure Test, run 2nd High Pressure Test, and when the test is over. The following PCP actions will occur after the corresponding signal:

Prepare for High Pressure Test:

a. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be energized to enable the valve at the 1.1 MPa 160 psi value.

b. The D/FV solenoid "A" must be de-energized and the D/FV solenoid "B" must be de-energized to force it closed.

c. Automatically start the jockey pump to obtain pressure.

d. The PCV solenoid "A" must be Energized and PCV solenoid "B" must be de-energized to close the valve.

e. When the jockey pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the jockey pump's flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. If the jockey pump fails to establish flow, automatically start the lead fueling pump to obtain pressure.

h. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

i. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

j. MOV I32 will be opened.

k. . The pump will continue to run until such time as the run High Pressure test signal is received. Note: the Tightness Monitoring Panel is monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the High Pressure test.

Run High Pressure Test:

a. MOV I32 will be closed.

b. Jockey/Fueling pump will be shut off.

c. The BPCV solenoid "A" must be d-energized and the BPCV solenoid "B" must be de-energized to close valve.

d. The PCV solenoid "A" will be de-energized and the PCV solenoid "B" will be de-energized to enable the valve at the 517 kPa 75 psi value. Note: the Tightness Monitoring Panel will wait for a ten minute settling time to pass, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP to Prepare for the Low Pressure Test.

Prepare for Low Pressure Test:

a. MOV I32 will be opened.

b. The PCV solenoid "A" will be energized and the PCV solenoid "B" will be energized to enable the valve at the 345 kPa 50 psi value.

c. The system will remain in this status until such time as the PCP receives a Run Low Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will monitor the loop pressure until it reaches the 345 kPa 50 psi value. It will then instruct the PCP to run the Low pressure test.

Run Low Pressure Test:

a. MOV I32 will be closed.

b. The system will remain in this status until such time as the PCP receives a Prepare for 2nd High Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will wait for a ten minute settling period to expire, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP to prepare for 2nd High Pressure Test.

Prepare for 2nd High Pressure Test:

a. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be energized to enable the valve at the 1.1 MPa 160 psi value.

b. The D/FV solenoid "A" must be de-energized and the D/FV solenoid "B" must be de-energized to force it closed.

c. Automatically start the jockey pump to obtain pressure.

d. The PCV solenoid "A" must be de-energized and PCV solenoid "B" must be de-energized to close the valve.

e. When the jockey pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the jockey pump's flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. If the jockey pump fails to establish flow, automatically start the lead fueling pump to obtain pressure.

h. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

i. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

j. MOV I32 will be opened.

k. pump will continue to run until such time as the run 2nd High Pressure test signal is received. Note: the Tightness Monitoring Panel is monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the 2nd High Pressure test.

Run 2nd High Pressure Test:

a. MOV I32 will be closed.

b. Jockey/Fueling pump will be shut off.

c. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be de-energized to close valve.

d. The PCV solenoid "A" will be de-energized and the PCV solenoid "B" will be de-energized to enable the valve at the 517 kPa 75 psi value. Note: the Tightness Monitoring Panel will wait for a ten minute settling time to pass, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP that testing is finished.

e. The PCP will leave the system as is until such time as the PCP selector switch is placed into a different mode.

3.13 OFF MODE

a. Automatic starting of fueling and jockey pumps must be disabled. All other functions (GDP, alarm annunciator, personal computer, control valve solenoids, etc.) must be active to allow manual control of the fueling pumps using the Hand-Off-Auto or Hand-Auto switch.

b. When the first fueling pump has been started:

  (1) The BPCV solenoid "A" must be energized to enable the valve to modulate the system pressure at it's set point.

  (2) The PCV solenoid "A" must be energized to close the valve.

  (3) The D/FV solenoid 'A' must be de-energized so the valve is closed and solenoid 'B' must be de-energized.

c. The second, third and fourth fueling pumps maybe started or stopped manually as needed by the operator.

d. After the last fueling pump has been stopped:

  (1) The BPCV solenoid "A" must be de-energized.

  (2) The PCV solenoid "A" must be de-energized.

  (3) The D/FV solenoid 'A' must be energized and D/FV solenoid 'B' must be de-energized.

3.14 MANUAL OPERATION OF FUELING PUMPS

a. If the PLC system is still active see Paragraph "OFF MODE".

b. If the PLC system has no power or both CPUs have faulted (CPU lights on PCP off) the pumping system will be in a completely manual mode. The safety circuit will need power so that the ESO solenoids on the non-surge check valves will be open and fuel can flow. The solenoids on the other solenoid controlled valves will be de-energized so the valves will have to be manually opened or enabled for the system to run. Other valves may need to be opened or closed manually by the operators for the system to work properly.

3.15 4-VALVE MANIFOLD SUPERVISION

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NOTE: The drawing referenced below is from the DEPARTMENT OF DEFENSE PRESSURIZED HYDRANT FUELING SYSTEM (TYPE III) Standard Drawings. Add the drawing to the design package if applicable.

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a. Prior to initiating fueling operations in the automatic or in the test mode, the 4-valve manifold valves and the two tank outlet valves must be in the proper positions for successful fueling operations. The PLC must monitor valve positions of the 4-valve manifold (sensed by position limit switches for fully opened and fully closed status on valves I34, I35, R10, and R11) and by monitoring valve status on the tank outlet valves (sensed by position limit switches for fully opened and fully closed status on valves I1 and I2). Valve position must conform to the position table listed on drawing M-205 under "Storage Tank Selection".

b. If the system is placed in automatic or tightness test mode, the valve selections must conform to the position table on sheet M-205. If the valve positions do not conform to this table, the PCP will show a 4-Valve manifold error on the alarm annunciator and initiating a critical alarm. The alarm can be silenced, but will not reset until such time as the valve positions do conform to the table.

c. The 4-Valve manifold error critical alarm must be able to be by-passed. A 4-Valve manifold error by-pass 2-position selector switch must be located within the PCP. The 2-position selector switch must be provided with a nameplate "4-Valve Manifold Error". The two positions must be labeled "Enable" and "Bypass". The selector switch when placed in the bypass position must eliminate the critical alarm and allow the system to function. The bypass function must be equipped with a timer that disables the bypass after 12 hours. The timer must reset when the selector switch is returned to the "Enable" position.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 09 54 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 09 54 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 33 - UTILITIES

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AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE [IV][V])

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USACE / NAVFAC / AFCEC **UFGS-33 09 54 (August 2018)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 09 54

AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE [IV][V])

08/18

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NOTE: This guide specification covers the requirements for the Pump Control and Annunciation System for aircraft refueling systems constructed to the requirements of the DOD Type IV or V Direct Aircraft Refueling System Standards.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

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NOTE: NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

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1.1 SYSTEM OVERVIEW

The [Aircraft Direct Fueling System] [Aircraft In-Shelter Fueling System] consists of fueling pumps that pump fuel to pantograph type fueling stations located [on the airfield apron.] [in Aircraft Shelters.] [Using Scheme A, the lead pump is started manually by the start/stop station located at the fueling station. The other pump is started and stopped automatically by the PCP.] [Using Scheme B, all pumps are started and stopped automatically by the PCP.] Automatic pump starts and stops are based on system pressure and flow. Programmable Logic Controllers (PLCs) receive information from pressure transmitters and other devices to control the pumps and control valves. There are two PLCs that are connected in a redundant configuration, to assure continued operation of the Aircraft Fueling System even if either PLC (but not both) fails. The [Aircraft Direct Fueling System][Aircraft In-Shelter Fueling System] also includes [above ground fuel storage tanks] [cut-n-cover type fuel storage tanks] and a product recovery tank. The pump control panel, personal computer and annunciator are located in the Control Room of the [Pumphouse.][Filter Separator Building.]

1.2 GENERAL REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section, with the additions and modifications specified herein. The control system must be furnished by a single supplier. See specification 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT for other required components of the control system. The control system supplier must be responsible for providing a fully functional control system, in accordance with the drawings and specifications, including the field devices. Installation must be in accordance with NFPA 70.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts. SME for this project is [Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS)][Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC)][Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11)].

1.3 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 18.1	(2024) Annunciator Sequences and Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA IA 2	(2005) Programmable Controllers - Parts 1 thru 8
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 1012	(2010; Reprint Apr 2016; Rev Mar 2021) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawing; G, [[_____]].

SD-03 Product Data

Pump Control Panel (PCP) and Components; G, [[_____]].

Programmable Logical Controller (PLC) Hardware and Software; G, [[_____]].

Personal Computer (PC); G, [[_____]].

Laptop Computer; G, [[_____]].

FCC Computer; G, [[_____]].

Printer; G, [[_____]].

Graphics Display Screen; G, [[_____]].

Control Wiring Data Lists; G, [[_____]].

SD-06 Test Reports

Testing Plan; G, [[_____]].

Certified Pump Control Panel (PCP) Shop Test Report.

Record of Test.

SD-07 Certificates

Experience and Qualifications; G, [[_____]].

SD-10 Operation and Maintenance Data

Plan for Instructing Personnel; G, [[_____]].

Operation and Maintenance Manuals; G, [[_____]].

Tools and Spare Parts.

1.5 OPERATION AND MAINTENANCE MANUALS

1.5.1 Schedule and Content

Submit copies of operational and maintenance manuals, within 7 calendar days following the completion of factory tests. As a minimum, include the following in the manuals:

a. Pump Control Panel including interior and exterior equipment layout.

b. All documents previously submitted and approved with all comments and field changes annotated.

c. Complete description of the sequence of operation including that described in PART 3 and any subsystems not controlled by the PLC (e.g.

annunciator panel, EPDS, etc.)

d. Complete listing of all programming of the PLCs, laptop computer, and Personal Computer.

e. Complete relay ladder logic diagrams, PLC input/output diagrams and control power distribution diagrams for the complete control system.

f. Complete guide outlining step-by-step procedures for system startup and operation.

g. Complete troubleshooting guide, which lists possible operational problems and corrective action to be taken.

h. Complete maintenance and installation manual for all equipment supplied.

i. Spare parts data, which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

j. The above must incorporate all as-built conditions.

1.5.2 Assembly

For hard copy submittals, bind documents in a suitable binder adequately marked or identified on the spine and front cover. Include a table of contents page and mark with pertinent contract information and contents of the manual. Provide tabs to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets must be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers. Provide electronic copy, Adobe Acrobat 11.0 or later, of documents with bookmarks.

1.6 TOOLS AND SPARE PARTS

Provide the following:

a. Any special tools necessary for maintenance of the equipment

b. One spare set of fuses of each type and size

c. Recommended manufacturer list of spare parts. Include part number, current unit price, and source of supply.

d. One spare power supply module

e. One spare I/O module (for discrete devices)

f. One spare I/O module (for analog devices)

g. Two PLC RAM back-up batteries

h. Two complete sets of ink cartridges for the laser printer

i. Minimum of ten spare lamps for the Alarm Annunciator

j. Minimum of ten spare lamps of each type of non-LED lamps used on the Pump Control Panel

[k. [_____]
]

1.7 EXPERIENCE AND QUALIFICATIONS

Submit the following data for approval:

a. Certification stating that the manufacturer has manufactured, installed, and successfully completed at least three PLC-based systems for automatic cycling of pumps based upon varying dispensing demands ranging from 0 to 150 L/s 2400 gallons per minute utilizing multiple pumps. At least one of the three PLC-based systems must be for dispensing jet fuel into a pressurized, constant pressure, flow demand aircraft hydrant system.

b. Certification that the proposed control systems have successfully operated over the last 2 years and are currently in service.

c. Project names, locations, and system description of these installations. Include user point-of-contact and current telephone numbers.

1.8 WARRANTY

Warrant the Pump Control and Annunciation System including devices, hardware and software for a period of 1 year from the date of acceptance of the system by the Government. This warranty service must include parts and labor service for equipment supplied under this specification. Upon notification by the Government of system or component failure, respond at the site with necessary parts within 48 hours of notification.

PART 2 PRODUCTS

2.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS

2.1.1 Enclosure

NEMA ICS 1, NEMA ICS 6, NEMA 250, and UL 508. The PCP enclosure must be a freestanding NEMA Type 12, smooth, gasketed enclosure constructed of 12 gauge steel. All seams must be continuously welded and there must be no drilled holes or knockout prior to delivery to the job site. The pump control panel dimensions must be a maximum of 2290 mm 90 inches high, maximum 1830 mm 72 inches wide, and a maximum of 610 mm 24 inches deep and must have removable lifting eyes. The interior surfaces of the panel must be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces must have standard factory finish. Access for the PCP must be front only and must consist of hinged doors having 3-point latching mechanisms. The doors must open approximately 120 degrees. Rack mounting angles, swing-out panels and other component mounting hardware must be installed such that servicing of one component must not require removal or disconnection of other components. No clearance must be required between the back of the panel and the room walls. Terminal facilities must be arranged for entrance of external conductors from the top or bottom of the enclosure.

2.1.2 Ventilation System

Two supply fans, single phase, 115 volt, must be provided. Each fan must supply a minimum of 2.8 cubic meters/minute 100 CFM. The supply and exhaust grill must contain a filter that is easily removed from the exterior of the enclosure. Three thermostats with an adjustable set point range of 70 degrees F21 degrees C to 140 degrees F60 degrees C must also be provided. The thermostats must be located near the top in the interior of the PCP.

2.1.3 Ground Bar

The control panel must have a tin plated copper equipment ground bar. The bar must have a minimum of twenty grounding screws.

2.1.4 Standard Indicator Lights

NEMA ICS 1, NEMA ICS 2, and UL 508. Lights must be heavy duty, NEMA 13, 22.5 mm mounting hole, round indicating lights operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs must be used. Indicator lights must have a legend plate with words as shown on drawings. Lens color as indicated on the drawings. Lights must be "push to test (lamp)" type. LED type lamps of comparable size and color may be substituted for standard indicator lights.

2.1.5 Selector Switches

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated lever operated selector switches must be heavy duty, NEMA 13, round, and utilize a 22 mm 7/8-inch mounting hole. They must have the number of positions as indicated on the drawings. Switches must be rated 600 volt, 10 amperes continuous. Legend plates must be provided with each switch with words as indicated on the drawings.

2.1.6 Pushbuttons

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated pushbuttons must be heavy duty, NEMA 13, round, utilize a 22 mm7/8 inch mounting hole, and have the number and type of contacts as indicated on the drawings or elsewhere in the specifications. The emergency stop switch must be a red mushroom head, 38 mm 1.5 inch diameter, momentary contact type. Pushbuttons must be rated 600 volt, 10 amperes continuous. Provide legend plates with each switch with words as indicated on the drawings.

2.1.7 Relays

IEEE C37.90, NEMA ICS 2, UL 508.

2.1.8 Nameplates

Provide laminated plastic nameplates with black outer layers and a white core. Edges must be chamfered. Fasten the nameplates with black-finished round-head drive screws or approved nonadhesive metal fasteners.

2.1.9 Transient Voltage Surge Suppression Devices

IEEE C62.41 for Category "B" transients, UL 1449.

2.1.10 Terminal Blocks

NEMA ICS 4. Terminal blocks for conductors exiting the PCP must be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks must be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip must form part of the terminal block and each terminal must be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.1.11 Circuit Breakers

UL 508. Provide individual, appropriately sized, terminal block mounted, circuit breakers for all 120 volt PCP mounted equipment and for the 120 volt terminal boards shown on the drawings.

2.1.12 Uninterruptible Power Supplies

UL 1012. Input voltage must be 120 volts (nominal), 1 phase, 60 Hertz. Output voltage regulation must be +/-5.0 percent for the following conditions:

a. 20 percent to 100 percent load on output.
b. Input voltage variation of -15 percent to +10 percent.
c. Constant load power factor between 80 percent and 100 percent.

Response time must be 1.5 cycles or less. Battery capacity must be such as to provide an orderly shut down of operating programs or as a minimum 30 minutes.

2.1.13 Miscellaneous Power Supplies

UL 1012. Certain field devices may require power other than 120VAC (i.e. 24VDC). The power supplies must be convection cooled, have fully isolated independent outputs, have constant voltage, have short circuit and overvoltage protection, and have automatic current limiting.

2.1.14 Alarm Annunciator

UL 508 and ISA 18.1. The Alarm Annunciator must provide visual annunciation, local and remote monitoring, constant or flashing visual and audible alarm as specified herein. The annunciator must be completely solid state with no moving parts. Furnish the annunciator with cabinet and hardware appropriate for flush mounting on the control panel. A power supply either integral or separately mounted must operate on 120 volts, 60 Hertz. The annunciator must have windows arranged in a matrix configuration (rows and columns). Each window must be at least 25 mm 1 inch high by 40 mm 1-5/8 inches wide and must have rear illuminated translucent engraved nameplate. Lettering must be at least 4 mm 5/32 inches high. System lamp voltage must be 24 to 28 volts dc.

2.1.15 Alarm Horns

UL 508. The alarm horns must consist of 2-vibrating horns and 1-resonating horn. One vibrating horn is to be mounted in the PCP, and one vibrating and one resonating horn must be mounted outside of the control room as shown on the drawings. The exterior horns must each produce 100db at 3 m10 feet and must be provided in a weather proof housing. The PCP horn must produce 70db at 3 meters 10 feet.

2.1.16 Laptop Computer

2.1.16.1 Hardware

The following are the minimum hardware requirements for the laptop computer:

a. Latest Pentium CPU operating at 2 GHz or faster

b. 2 GB RAM
c. 500 GB hard drive
d. 16X Read-Write DVD drive
e. Color LCD screen 360 mm 14 inches
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120VAC and Battery power supply
k. All cables and connectors for interfacing with PLC and personal computer
l. Modem compatible for remote troubleshooting of the system
m. Two USB 2.0 communications ports
n. Provide a carrying case for the Laptop Computer

2.1.16.2 Software

The following is the minimum software to be loaded on the laptop. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating System)
b. Software for programming the PLC
c. Software for programming the personal computer

2.1.17 Personal Computer (PC)

2.1.17.1 Hardware

The following are the minimum hardware requirements for the personal computer:

a. Latest Pentium CPU operating at 2.4 GHZ or faster
b. 4 GB RAM
c. 500 GB hard drive
d. 16X Read-Write DVD drive
e. Color 610 mm 24 inches flat screen monitor
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120VAC operating power
k. All cables and connectors for interfacing with PLC and Laser Printer
l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System.
m. Two USB 2.0 communications ports

2.1.17.2 Software

The following is the minimum software to be loaded on the personal computer. The software must be the most current versions and compatible with each other to make a complete and usable system. All software must be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating System)

b. Software for programming the PLCs

c. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points.

d. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system on a real time basis.

e. MS Office Professional with Excel must be provided to allow the trending data described above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically.

2.1.18 Printer

The alarm/report printer must be a color laser jet printer. The unit must print in black at a minimum speed of twelve pages per minute. It must print in color at a minimum speed of ten pages per minute. It must as a minimum be capable of printing color graphs of various system pressures, issue flow, and return flow vs. time in seven colors. Provide one set of spare replacement ink cartridges.

2.1.19 FCC Computer

2.1.19.1 Hardware

The FCC computer must be a copy of the personal computer so that upon failure of the personal computer it could be relocated to the pumphouse to assume the personal computers duties. The normal duties of the FCC computer must be to serve as a remote monitor only of the screens that are available on the personal computer. The following are the minimum hardware requirements for the FCC computer:

a. Latest Pentium CPU operating at 2.4 GHZ or faster
b. 2 GB RAM
c. 250 GB hard drive
d. 16X Read-Write DVD drive
e. Color 430 mm 17 inches flat screen monitor
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120VAC operating power
k. All cables and connectors for interfacing with PLC and Laser Printer
l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System.
m. Two USB 2.0 communications ports

2.1.19.2 Software

The following is the minimum software to be loaded on the FCC computer. The FCC computer must be capable of replacing the Personal computer in the pumphouse if the personal computer fails. It will be set up initially to serve only as a remote monitor of the system while located at the FCC. Should the personal computer fail, the FCC computer will be relocated to the pumphouse and then assume the role of the personal computer. The computer software must have a built in command to tell the computer whether it is serving as the personal computer or as the remote monitor only. The software must be the most current versions and compatible with each other to make a complete and usable system.

a. Operating system (e.g. the latest commercially available MS Operating System)

b. Software to tell the computer which mode it is to operate in, i.e. (personal computer or remote monitor)

c. Software to run as a remote monitor

d. Software for programming the PLCs

e. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points.

f. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system, on a real time basis.

g. MS Office Professional with Excel must be provided to allow the trending data described in e. above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically.

2.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

2.2.1 General

a. NEMA IA 2. Each PLC must be able to receive discrete and analog inputs and through its programming it must control discrete and analog output functions, perform data handling operations and communicate with external devices and remote I/O racks. The PLCs must be a modular, field expandable design allowing the system to be tailored to the process control application. The capability must exist to allow for expansion to the system by the addition of hardware and/or user software. At a minimum the PLCs must include mounting backplanes, power supply modules, CPU module, communication modules, and I/O modules.

b. Each PLC provided must be designed and tested for use in the high electrical noise environment of an industrial plant. The PLC modules must comply with the FCC Part 15 Part A for radio noise emissions. The programmable controller processor must be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2, IEEE C37.90.

c. The PLCs must function properly at temperatures between 0 and 50 degrees C 32 and 122 degrees F, at 5 to 95 percent relative humidity non-condensing and have storage temperatures between -40 and 60 degrees C -40 and +140 degrees F at 5 to 95 percent relative humidity non-condensing.

d. The PLCs must have manufacturer's standard system status indicators (e.g. power supply status, system fault, run mode status, back-up battery status).

2.2.2 Central Processing Unit Module

The CPU must be a modular self-contained unit that provides time of day, scanning, application (ladder rung logic) program execution, storage of the application program, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self-diagnostics.

2.2.3 Power Supply Module

a. The power supply module must be plugged into the backplane not separately mounted. The power supply must be wired to utilize 120 VAC, 60 Hz power, the system must function properly within the range of -10 percent to +15 percent of nominal voltage. The power supply must provide an output to the backplane at a wattage and voltage necessary to support the attached modules. A single main power supply module must have the capability of supplying power to the CPU module and local communication and I/O modules. Auxiliary power supplies must provide power to remote racks.

b. Each power supply must have an integral on/off disconnect switch to the module. If the manufacturers standard power supply does not have an on/off disconnect switch a miniature toggle type switch must be installed near the PLC and clearly labeled as to its function.

c. The power supply must monitor the incoming AC line voltage for proper levels and have provisions for both over current and over voltage protection. If the voltage level is detected as being out of range the system must have adequate time to complete a safe and orderly shutdown.

2.2.4 Program Storage/Memory Requirements

a. The PLC must have the manufacturers standard nonvolatile executive memory for the operating system. The PLC must also have EEPROM (Electrically Erasable Programmable Read Only Memory) for storage of the user program and battery backup RAM for application memory. The EEPROM must be loaded by use of the laptop computer or the personal computer.

b. Submit a calculation of the required amount of EEPROM and RAM (random access memory) needed for this application plus an extra 50 percent.

c. The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed must be limited only by the memory capacity to store these instructions.

2.2.5 Input/Output (I/O) Modules

a. Provide all required I/O modules (analog input, analog output, discrete input, discrete output, and isolated discrete output) to manipulate the types of inputs and outputs as shown on the drawings and to comply with the sequence of operations. Also provide a minimum of 20 percent (round up for calculation) spare input and output points of each type provided, but not less than two of each type.

b. I/O modules must be a self-contained unit housed within an enclosure to facilitate easy replacement. All user wiring to I/O modules must be through a heavy-duty terminal strip. Pressure-type screw terminals must be used to provide fast, secure wire connections. The terminal block must be removable so it is possible to replace any input or output module without disturbing field wiring.

c. During normal operation, a malfunction in any remote input/output channel must affect the operation of only that channel and not the operation of the CPU or any other channel.

d. Isolation must be used between all internal logic and external power circuits. This isolation must meet the minimum specification of 1500 VRMS. Provide optically isolated I/O components which are compatible with field devices.

e. Each I/O module must contain visual indicators to display ON/OFF status of individual input or output points.

f. Discrete output modules must be provided with self-contained fuses for overload and short circuit protection of the module.

g. All input/output modules must be color coded and titled with a distinctive label.

2.2.6 Interfacing

The PLC must have communication ports and communication modules using the manufacturers standard communication architecture for connections of the Personal computer, Laptop Computer, remote I/O racks and interconnections between SYS 1 PLC and SYS 2 PLC for the redundant backup system of the PLCs.

2.2.7 Program Requirements

a. The programming format must be ladder diagram type as defined by NEMA IA 2.

b. There must be a means to indicate contact or output status of the contact or output on the CRT (of the personal computer) or LCD screen (of the laptop computer). Each element's status must be shown independently, regardless of circuit configuration.

c. The program must be full featured in its editing capabilities (e.g. change a contact from normally open to normally closed, add instructions, change addresses, etc.).

2.2.8 Diagnostics

The CPU must continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and I/O. The diagnostic routines must be regularly performed during normal system operation. A portion of the scan time of the controller should be dedicated to perform these housekeeping functions. In addition, a more extensive diagnostic routine should be performed at power up and during normal system shutdown. The CPU must log I/O and system faults in fault tables, which must be accessible for display. When a fault shuts down a CPU, a sequence must be initiated that will automatically switch over to the other CPU. When a fault affects I/O or communication modules the CPU must shut down only the hardware affected and continue operation by utilizing healthy system components. All faults must be annunciated on the alarm annunciator.

PART 3 EXECUTION

3.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS

3.1.1 General

a. Where two or more pieces of equipment performing the same function are required, they must be exact duplicates produced by the same manufacturer. All display instruments of each type must represent the same outward appearance, having the same physical size and shape, and the same size and style of numbers, characters, pointers, and lamp lenses.

b. The PCP must include all required resident software programs and hardware to provide the specified sequence of operation. All software optical disks including programming manuals must be turned over to the Government at the completion of start-up so modification can be done in the field with no outside assistance.

c. It is intended that process controlling devices except field devices, and motor controllers be attached to or mounted within the PCP enclosure and all interconnecting wiring installed prior to shipment to the job site. This is to allow shop testing of the system and to decrease field labor requirements.

d. The PCP must be shipped fully assembled in one piece after the completion of the shop tests and all defects corrected.

3.1.2 Wiring

3.1.2.1 Methods and Practices

Wiring methods and practices must be in conformance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 4 and NEMA ICS 6 recommendations as applicable. All wiring to instruments and control devices must be made with stranded wire, and wiring must be permanently labeled with conductor/wire numbers within 25 mm 1 inch of termination points. Labels must be tubular heat-shrinkable wire markers that remain legible after exposure to industrial fluids and abrasion. Position markers so that wire numbers can be read without disturbing or disconnecting wiring. Use of individual character-markers placed side-by-side is not acceptable. Numbers must match approved shop drawings. All wiring must be neatly laced from point of entry into enclosures to termination points with nylon lacing cord or plastic lacing ties. Lacing within wiring channels is not required.

3.1.2.2 Control Wiring Data Lists

Provide typed Control Wiring Data Lists within each terminal cabinet and the PCP. The data lists must include: conductor identification number, wire gauge, wire insulation type, "FROM" terminal identification, "TO" terminal identification, and remarks. Submit the preliminary lists and update to As-Built conditions.

3.1.3 Certified Pump Control Panel (PCP) Shop Test Report

The manufacturer must shop test the PCP, Personal computer, and lap top computer. Include simulation of field components and provide for fully testing the pump control and annunciator system as a unit before delivery to the project site. The test must, reveal system defects, including, but not limited to, functional deficiencies, operating program deficiencies, algorithm errors, timing problems, wiring errors, loose connections, short circuits, failed components and misapplication of components. Perform the test prior to shipment to the site and correct problems detected. Repeat the final testing and correction sequence until no problems are revealed and then perform two additional successful tests. Submit certified test report within 15 days after completion of the test. The report must include a statement that the Pump Control Panel performs as specified. Notify the Governments Contracting Officer and the SME 30 days prior to the final shop testing date. The Contracting Officer may require a Government witness at the final test before the PCP is shipped to the site.

3.1.4 Ventilation System

Thermostat T-1, must control fan F-1 and thermostat T-2 must control fan F-2. T-1 and T-2 must be set at 27 degrees C 80 degrees F to maintain interior air temperature to 11 degrees C 20 degrees F above ambient. Thermostat T-3, set at 38 degrees C 100 degrees F, must provide a non-critical PCP HIGH TEMPERATURE alarm to the alarm annunciator.

3.1.5 Grounding

Connect the PCP ground bar to the building counterpoise via a #10 AWG conductor. Within the enclosure all I/O racks, processor racks, and power supplies, etc. must be grounded to meet the manufacturer's specifications.

3.1.6 Indicator Lights, Switches, and Pushbuttons

Mount indicator lights, switches, and pushbuttons through the PCP enclosure and arrange to allow easy vision and operation of each device. Provide each device with a nameplate and/or legend plate as indicated on the drawings. Nameplate wordings must be as indicated on the drawings.

3.1.7 Transient Voltage Surge Suppression Devices

Transient voltage surge suppression (TVSS) devices must be installed in the PCP to minimize effects of nearby lightning strikes, switching on and off of motors and other inductive loads. TVSS must be provided for each control circuit ladder. Each ladder may contain any combination of the following devices: PLCs, power supplies (e.g., 24 volt), fans, relays, lights, switches etc. TVSS must also be provided for PLC I/O originating outside of the building.

3.1.8 Terminal Blocks

As a minimum, any PCP device that connects to a field device (devices not located in the PCP) must be connected to a terminal block. A connection diagram similar to the drawings must be provided to the field contractor for field connections to the PCP.

3.1.9 Circuit Breakers

As a minimum, any 120 volt PCP device i.e. (fans, lights, power receptacles, 24 VDC power supplies, PLC CPUs, PLC I/O racks) must be provided with an individual circuit breaker. Additionally 120 volt terminal boards connecting to field devices (devices not located in the PCP) must be protected by a 120 volt circuit breaker.

3.1.10 Uninterruptible Power supplies

The Pump Control Panel (PCP) must contain three uninterruptible power supplies (UPS) each connected to a dedicated circuit. As shown on the drawings one UPS must supply PLC System 1, one UPS must supply PLC System 2, and the third UPS must supply the miscellaneous device power. The UPSs output capacity must be sufficient to drive all the equipment connected plus 25 percent. The UPSs must be mounted on shelves near the bottom of the PCP but not rest on the floor of the PCP.

3.1.11 Power Supplies

Provide and install all 120VAC and 24VDC power supplies as required. Size the power supplies for the load plus 25 percent. Supply all field devices, which require power and are controlled or monitored from the PCP, from power supplies in the pump control panel. Provide a 120V receptacle in the PCP for use by the Laptop computer. Completely install interconnecting wiring between UPSs and PLC power supplies prior to shipment to the job site.

3.1.12 Alarm Annunciator and Horns

Initiate signals by hardwired field contacts or by PCP outputs as required. The annunciator must energize alarm horns, both an integral panel mounted vibrating horn and remote horns, and flash the appropriate annunciator lamp. The minimum number of windows must correspond to the number of alarm points, plus 15 percent spare. The drawings indicate panel layout and the alarms to be annunciated.

3.1.12.1 Non-critical Alarms

Non-critical alarm windows must be white with black lettering and must sound the PCP mounted vibrating horn and the exterior mounted vibrating horns.

3.1.12.2 Critical Alarms

Critical alarm windows must be red with white lettering and must sound the PCP mounted vibrating horn and the exterior mounted resonating horns. Critical alarms must also cancel all automatic pump starts in the PLC.

3.1.12.3 Alarm Sequence

Alarm sequence for each alarm must be as follows (ISA 18.1 sequence 'A').

a. For a normal condition, visual indicator and horns will be off.

b. For an alarm condition, visual indicator will flash and horns will sound (this condition will be locked in).

c. Upon acknowledgment of the alarm condition, visual indicator will be steady on and the horns will be off.

d. If, after acknowledgment of an alarm condition, another alarm condition is established, the new alarm will cause the appropriate window to flash and the horn to sound.

e. When condition returns to normal after acknowledgment, the visual indicator and the horn will be off.

3.1.13 Personal Computer

The personal computer must be a stand alone, desk top mounted unit. The personal computer must download system parameters from the PLCs for display. The personal computer must also upload new set point values that the operator has changed using the personal computer keyboard, after a password has been entered.

3.1.13.1 Screen Number 1

The general opening screen must as a minimum display the name and location of the installation (e.g. Seymour Johnson Air Force Base, North Carolina), name of the project (e.g., Type III Hydrant Fueling System) and screen navigation information.

****

NOTE: Include items below that are appropriate to the operating scheme (A or B) chosen.

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3.1.13.2 Screen Number 2

At a minimum display the following items. Continuously update the values; a 2 second delay maximum between updates is acceptable.

System Issue Rate	xxxx L/sGPM
System Return Rate	xxxx L/sGPM
System Net Flow	xxxx L/sGPM
System Pressure	xxxx kPaPSI
System Operation Mode	Auto/Off/Flush/Tightness test
Active System	Sys-1/Sys-2
Lead Pump	1/2/3
Fuel Pump #1	On/Off xxxxx.x HOURS
Fuel Pump #2	On/Off xxxxx.x HOURS
Fuel Pump #3	On/Off xxxxx.x HOURS

Backpressure Control Valve	[Closed/]Enabled/OPEN
[Pressure Control Valve	Closed/Enabled]
Flush Valve	Closed/Defuel
Tank 1 Outlet Valve	Open/Closed
Tank 2 Outlet Valve	Open/Closed
Tank 1 Receipt Valve	Open/Closed
Tank 2 Receipt Valve	Open/Closed
Receipt Bypass Valve	Open/Closed
Manifold Setup Valve I34	Open/Closed
Manifold Setup Valve I35	Open/Closed
Manifold Setup Valve R10	Open/Closed
Manifold Setup Valve R11	Open/Closed
Only one of the words separated by a slash (/) must be displayed. The xxxxx.x HOURS is the fuel pumps elapsed run time and the value must not be lost when the lead PLC is switched. The pump and valve status words must be color coded to match the colors used on the graphic display screen.	

3.1.13.3 Screen Number 3

The following table must be displayed. The table lists the set points that can be adjusted using the operator interface. A password must be entered before the "current value" can be adjusted. The value entered can only be a number within the "set point range". The "default value" is the value held in the program that is loaded into EEPROM memory (This screen may require more than one display screen.).

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Lead pump starting pressure	205 to 1035 kPa30 to 150 psi	415 kPa60 psi	xxx KpApsi
Issue flow to start second pump in the sequence	25 to 40 L/s450 to 650 gpm	35 L/s560 gpm	xxx L/sgpm
Return flow to enable next pump in sequence to start	0.5 to 6 L/s10 to 100 gpm	2.5 L/s40 gpm	xxx L/sgpm
Return flow to stop second pump in the sequence (lag pump)	30 to 50 L/s500 to 800 gpm	44 L/s700 gpm	xxx L/sgpm
Return flow to initiate lead pump shutdown sequence	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm	xxx L/sgpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds	xx seconds
Timer to enable second pump to start	0 to 120 seconds	10 seconds	xx seconds
Timer to stop second pump	0 to 120 seconds	15 seconds	xx seconds
Timer to stop first pump	0 to 60 seconds	2 seconds	xx seconds
Timer to disable Back Pressure Control Valve	0 to 360 seconds	60 seconds	xx seconds
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds	xx seconds
System pressure to stop lead pump	895 to 1310 kPa 130 to 190 psig	760 kPa110 psig	xxx kPapsig

3.1.13.4 Screen Number 4

Duplicate the Graphic Display Drawing showing a schematic of the process flow. Refer to this screen as the graphical display. Display many operating parameters here as required in later paragraphs of this specification.

3.1.13.5 Screen Number 5

This screen is a duplicate of the Alarm Annunciator and must be superimposed over the current active screen on the personal computer monitor when an alarm is activated.

3.1.13.6 Screen Number 6

This screen is designed solely for assisting the testing team during initial start up to watch all of the significant parameters of the systems operation simultaneously on one screen. Include the system parameters (i.e. flows, pressures, and status) from screen 2, the set points from screen 3, and timers for all of the actions that will take place following a delay function.

3.1.13.7 Screen Number 7

This screen is designed solely for displaying the seven graphs as described in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Display the following values concurrently against time: Issue flow, Issue pressure, Return flow, Pump #1 discharge pressure, Pressure upstream of BPCV, Pressure downstream of BPCV, and Hydrant Pit Pressure. The personal computer must be capable of storing up to 1 week of data corresponding to the above values. The system must be able to produce graphs on the screen of this data and print the data in seven colors on the laser printer.

3.1.13.8 Screen Number 8

This screen is an alarm history screen, referred to as the Alarm History Display. This screen must be capable of storing and displaying all alarms that have occurred in the system for at least a period of 30 days.

3.1.13.9 Screen Number 9

This screen is designed solely for displaying the parameters and process involved in the Tightness Test as described in this specification and on the drawings. Display the following values concurrently against time: Pressure (as sensed by PIT3) . The system must be able to produce graphs on the screen of this data and be able to print the data in color on the laser printer.

3.1.14 Laptop Computer

The Laptop computer is used to create, edit, and load the ladder logic program into the PLCs and the operator interface graphics control program into the personal computer. The Laptop is also used to monitor the PLCs memory and ladder logic program. Store the computer in a lockable cabinet located within the Pump Control Panel.

3.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

3.2.1 General

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NOTE: The pressure indicating transmitters and the differential pressure transmitters are the only devices that the PLC can monitor for a possible failure. Define failures in the following manners: When the pressure indicating transmitters differ with each other by more than 70 kPa (10 psig) after a 10 second delay, assume the lower reading transmitter has failed. When the issue differential pressure transmitters differ from each other by more than 2 L/s (30 gpm) after a ten second delay, assume

the lower reading transmitter has failed. When the return differential pressure transmitters differ from each other by more than 1.2 L/s (20 gpm) after a ten second delay, assume the lower reading transmitter has failed.
****

The basic operation of the redundant PLC system is (Reference "Control System Block Diagram" on the drawings):

a. CPU-1 and it's associated I/O rack (I/O-1) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

b. CPU-2 and it's associated I/O rack (I/O-2) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

c. Within each rack (I/O-1 and I/O-2) System-1, System-2, and nonredundant inputs and outputs must not be mixed on the same input/output module.

d. Under normal operation: The system input select switch is in the "SYS-1" position. CPU-1 is controlling the system using System-1 and nonredundant inputs from I/O-1 and any set point changes from the personal computer. CPU-2 is being updated by CPU-1 or concurrently monitoring System-1 inputs from I/O-2.

e. If under normal operation CPU-1 recognizes that a System-1 input has failed (see note below) it must change over to the System-2 redundant input on I/O-1 and report the failure to the personal computer alarm screen.

Note: The pressure indicating transmitters and the differential pressure transmitters are the only devices that the PLC can monitor for a possible failure. Failures must be defined in the following manners: When the pressure indicating transmitters differ from each other by more than 70 kPa 10 psig after a ten second delay, assume the lower reading transmitter has failed. When the issue differential pressure transmitters differ from each other by more than 2 L/s 30 gpm after a ten second delay, assume the lower reading transmitter has failed. When the return differential pressure transmitters differ from each other by more than 1.2 L/s 20 gpm after a ten second delay, assume the lower reading transmitter has failed.

f. During normal operation there are two ways for CPU-2 to take control of the system: 1) CPU-1 identifies its own internal fault and hands over control to CPU-2. 2) CPU-2 identifies a fault in CPU-1 and takes control from CPU-1. When CPU-2 is in control of the system it must annunciate the fault condition and must be using any updated inputs from the personal computer and must use System-1 inputs. If CPU-2 senses a fault on a System-1 input it must then switch over to the appropriate System-2 input. If power is lost to System-1 inputs then CPU-2 must use all of the System-2 inputs.

g. CPU-2 must also report any of its internal faults to CPU-1 and CPU-1 must report any faults it detects in CPU-2.

h. When the operators think the system is not working and the PLCs do not detect any faults the operator can move the system input select switch from the "SYS-1" position to the "SYS-2" position. With the switch in the "SYS-2" position the PLCs are using System-2 inputs.

3.2.2 Programs

a. Provide two copies of all working programs (i.e. PLC logic, personal computer) on read only CD or DVD as well as a printed program listing.

b. The Contractor (programmer) must provide rung comments (documentation) in the ladder logic program. Each device, on the ladder, must be identified as to the type of device, i.e. limit switch XX, flow indicator XX, motor starter XX, etc. Rung comments must be provided for input and output rungs. The programmer must also provide a comment describing the function of each rung or group of rungs that accomplish a specific function.

3.3 GRAPHICS DISPLAY SCREEN

3.3.1 General

The graphic display screen must be capable of being displayed on the personal computer monitor.

3.3.2 Display Presentation

Depict the process fuel flow schematically as indicated on the drawings. Integrate red, green, and amber symbols integrated with the process schematic to provide current equipment status graphically. Locate the symbols immediately adjacent to related equipment symbol.

3.3.3 Process Schematic

The process schematic graphic representation must utilize conventional symbols when possible. Size and space symbols and flow lines so as to provide a clear representation of the system process. The Graphic Display must be suitable for supervised field modification when future items are added. Minor changes may be incorporated to allow proper line width and spacing. Component arrangement, piping routing, and location of valves must match the flow diagram. The Graphic Display layout requires Government approval.

3.3.4 Digital Flow and Pressure Indicators

Provide digital displays for the flows, pressures, and levels as indicated on the drawings.

3.4 INSTALLATION

Installation must conform to the manufacturer's drawings, written recommendations and directions.

3.4.1 Shop Drawing

The shop drawing must be clear and readable and preferably drawn using a computer aided drafting package. At the conclusion of the project the diagram drawings must be redrafted to include all as-built conditions. These updated drawings must be included in the O&M Manuals and appropriate section of the drawings placed in a data pocket located in each of the enclosures. The shop drawing at a minimum must show:

a. Overall dimensions, front, side and interior elevation views of the PCP showing size, location and labeling of each device.

b. Overall dimensions, front elevation of the GDP showing graphical layout and size, location and labeling of each device.

c. Power ladder diagram indicating power connections between TVSS, power conditioners, PLCs, power supplies and field and panel devices. Any terminal block connection numbers used must be indicated.

d. Control ladder diagram indicating control connections between field and devices and PLC I/O modules. Terminal block connection numbers and PLC terminal numbers must be indicated.

e. Communication connections between PLCs and I/O racks. Communication channel numbers must be indicated.

f. Bill of materials.

g. Written control sequence covering all inputs, outputs, and control scheme.

3.4.2 System Start-Up and Testing

a. At PCP start-up and testing provide personnel, on site, to provide technical assistance, program fine tuning, and to start-up and test the system. Start-up and testing must be coordinated with the overall fueling system start-up test specified in Section 33 08 53, AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Prior to this test, all connections must have been made between the PCP, the personal computer, the motor control center, and all field devices. In addition, check wiring for continuity and short circuits. Adjust set point values, timing values, and program logic as required to provide a functional hydrant fuel control system. Once the system has been fine tuned and passed the system test, load the new system default values into the PLC EEPROM and adjust the personal computer screens to indicate the new values.

b. Submit a step-by-step testing procedure of the PCP, Testing Plan. Design the test to show that every device (lights, switches, personal computer display screens, alarms, etc.) on the PCP and personal computer is in working order and that the PLC program controls the system per specifications. Perform the test in conjunction with Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Include a place for the contractor and Government representative to initial each step of the plan after satisfactory completion and acceptance of each step. Certify and submit the complete initialed testing plan, Record of Test.

3.4.3 Training Plan for Instructing Personnel

Upon completion of the system start-up a competent technician regularly employed by the PCP manufacturer must hold a training class for the instruction of Government personnel in the operation and maintenance of the system. Provide both classroom type theory instruction and hands-on instruction using operating equipment provided. The period of instruction must be a minimum of three 8-hour working days. The training must be designed to accommodate 8 operators, four maintenance personnel, and two programmers. The Government must receive written notice (via Contracting Officer) a minimum of 14 days prior to the date of the scheduled classes.

a. Furnish a written lesson plan and training schedule for Government approval at least 60 days prior to instructing operating, maintenance and programming personnel. Concurrently submit above to the SME for their input into the review process. Approval of lesson plan will be based on both Government and SME concurrence. This plan must be tailored to suit the requirements of the Government. The training must be divided into three separate classes. Each class must be tailored to a specific group of personnel. The groups are: 1) Operators, those that will use the control system on a day to day basis; 2) Maintenance personnel, those that will perform routine and non-routine maintenance and trouble shooting of the control system; 3) Programmers, those that will make changes to and trouble shoot the PLC and personal computer programs. The training program must provide:

    (1) a detailed overview of the control system including the complete step-by-step procedures for start-up, operation and shut-down of the control system.
    (2) a general overview of programmable logic controllers
    (3) the maintenance of equipment installed
    (4) the programming of the PLC and Personal Computer
    (5) trouble shooting of the system

b. Use the complete approved Operation and Maintenance manuals for Section 33 09 54 PUMP CONTROL AND ANNUNCIATION SYSTEM (CUT-N-COVER TANKS) and 26 20 00 INTERIOR DISTRIBUTION SYSTEM (specifically pertaining to the motor control center and its relay ladder diagrams) for instructing operating personnel. Include both classroom and hands-on field instruction. Record the class in DVD format.

c. Also provide training courses in DVD format covering system overview, operation, maintenance, trouble shooting, and programming. Produce these DVDs on-site using the supplied Pump Control Panel as the teaching aid, or commercially produced DVDs by the PLC manufacturer or third party who specializes in training on PLC systems. In conjunction with the DVDs, provide O&M Manuals, which follow along with the DVDs.

3.5 PLC CONTROL SYSTEM SEQUENCE OF OPERATION

3.5.1 General

The following describes general functions of the fueling system components.

3.5.1.1 Abbreviations

a. SYS-1: components of System #1 including UPS#1, power supplies, CPU-1, I/O-1, and system #1 input and outputs.
b. SYS-2: components of System #2 including UPS#2, power supplies, CPU-2, I/O-2, and system #2 input and outputs.
c. CPU-1: SYS-1 PLC CPU.
d. CPU-2: SYS-2 PLC CPU.

e. I/O-1: SYS-1 PLC input/output modules.
f. I/O-2: SYS-2 PLC input/output modules.
g. PCP: Pump Control Panel.
h. PC: Personal Computer.
i. UPS: Uninterruptible Power Supply.

3.5.2 Operating Tanks

3.5.2.1 Level Control

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NOTE: Use this paragraph if float switches rather than electronic level switches are used for determining tank level alarms

****

Each operating tank has four level float switches to measure low-low, low, high and high-high levels. The switches are DPDT for the redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing.

a. Low-Low Level: When the low-low level float is activated the associated tank's graphic display low-low level light illuminates. The following must occur if the tank's outlet valve is not fully closed: activate the low-low level critical alarm sequence, fueling pumps are disabled in automatic mode and pumps are not allowed to start automatically. If all tanks are at low-low level, do not automatically start fueling pumps.

b. Low Level: When the low level float is activated the associated tank's graphic display low level light illuminates and the alarm annunciator's low level non-critical low level alarm sequence activates.

c. High Level: When the high level float is activated the associated tank's graphic display high level light illuminates and the alarm annunciator's non-critical high level alarm sequence activates.

d. High-High Level: When the high-high level float is activated the associated tank's graphic display high-high level light illuminates, the alarm annunciator's critical high-high level alarm sequence activates, fueling pumps running in automatic mode must be disabled and no pump must be allowed to start automatically.

3.5.2.2 Level Control

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NOTE: Use this paragraph if electronic level switches rather than float switches are used for determining tank level alarms

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Each operating tank has level switches to monitor low-low, low, high, and high-high fuel levels. Connect the switches to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The following alarms must be reported.

a. Low-Low Level: When the low-low level elevation is attained the associated tank's GDP low-low level light illuminates. The following must occur if the tank's outlet valve is not fully closed: activate the low-low level critical alarm sequence, fueling pumps are disabled in automatic mode and pumps are not allowed to start automatically. If all tanks are at low-low level, do not automatically start fueling pumps.

b. Low Level: When the low level elevation is attained the associated tank's GDP low level light illuminates. The alarm annunciator's non-critical alarm sequence activates.

c. High Level: When the high level elevation is attained the associated tank's GDP high level light illuminates and the alarm annunciator's non-critical alarm sequence activates.

d. High-High Level: When the high-high level elevation is attained the associated tank's GDP high-high level light illuminates, the alarm annunciator's critical alarm sequence activates, fueling pumps running in automatic mode must be disabled and no pump must be allowed to start automatically.

[3.5.2.3 Outlet Valve

Each operating tank's outlet valve has two limit switches to indicate valve position. The closed limit switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The closed limit switch must close when the valve is fully closed. When the closed limit switch is closed the associated tank's valve graphic display closed light must activate. When the valve is fully open, the open limit switch is closed. At this time the associated tank's valve graphic display open light must activate.

]3.5.3 Product Recovery Tank

3.5.3.1 Fuel Transfer Pump (FTP)

The pump's motor controller has a status relay to indicate the on/off status of the pump. Connect the status relay to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the pump's graphic display off light must light. When the status relay is closed the pump's graphic display on light must light. Also use the status relay state to start and stop the pumps elapsed run time timer.

3.5.3.2 Overfill Valve (OV)

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NOTE: The automatic starting and stopping of the fuel transfer pump is accomplished by the actuation of tank float switches connected to the control circuit in the motor control center. The PLC system does not control the starting and stopping.

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The tank's overfill valve has a limit switch to indicate valve position. The switch is SPST and must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The switch must close when the valve is fully closed. When the limit switch is closed the tank's graphic display valve closed light must light and the alarm annunciator's non-critical alarm sequence activates. When the limit switch is open the tank's graphic display valve open light must light.

3.5.3.3 High Level Alarm

The tank has a high level alarm float switch. Connect the switch, SPST, to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the high level alarm float is activated the tank's graphic display high level light must light and the alarm annunciator's critical alarm sequence activates.

3.5.3.4 High-High Level Alarm

The tank has a high-high level alarm float switch. Connect the switch, SPST, to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the high-high level alarm float is activated the tank's graphic display high-high level light must light and the alarm annunciator's critical alarm sequence activates.

3.5.3.5 Leak Detection

The tank has a leak detection system. Connect the leak detection systems alarm relay to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the leak alarm is activated the alarm annunciator's non-critical alarm sequence activates.

3.5.4 Fueling Pumps (FP)

There are three fueling pumps with a maximum of two pumps running at one time in the automatic mode. The lead pump selector switch selects the pump starting sequence. Each pump's motor controller has a status relay to indicate the on/off status of the pump. Connect the status relay to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. Also use the status relay state to start and stop the pumps elapsed run time timer and display on screen number 2.

3.5.5 Jockey Pump (JP)

There is one jockey pump. The jockey pump must not run concurrently with any of the fueling pumps. The jockey pump's motor controller has a status relay to indicate the on/off status of the pump. The status relay must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. The status relay state must also be used to start and stop the elapsed run time timer and must be displayed on screen number 2.

3.5.6 Pumphouse Drain Pump (PDP)

There is one return pump. The return pump's motor controller (ON-OFF switch) has a status contact to indicate the on/off status of the pump. The status contact must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status contact is open the associated pump's graphic display off light must illuminate and screen number 2 must indicate on. When the status contact is closed, the associated pump's graphic display on light must illuminate and screen number 2 must indicate off.

3.5.7 Flow Switch, FP

On the discharge side of each pump is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. If the PLC has given a signal to start a pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump must be in a failure state and it must be disabled (taken out of the starting sequence), the alarm annunciator's non-critical alarm sequence must also be activated, and the next pump in the start sequence started. After the PLC has stopped all of the pumps, any failed pump must be added back into the start sequence.

3.5.8 Flow Switch, JP

On the discharge side of the jockey pump is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. If the PLC has given a signal to start the jockey pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump will be in a failure state so it must be disabled. The alarm annunciator's non-critical alarm sequence must also be activated.

3.5.9 Flow Switch, PDP

On the discharge side of the PDP is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing.

3.5.10 Transmitters

3.5.10.1 Pressure Indicating Transmitter (PIT)

The PIT's measure system pressure in kiloPascals pounds per square inch. There are two PITs connected to the PCP for redundancy. PIT-1 and PIT-2 are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The system pressure is sent to personal computer display.[PIT-3 is connected directly to the Tightness Test Panel.]

3.5.10.2 Differential Pressure Transmitter (DPT)

he DPT's measure flow in liters per second gallons per minute. There are two issue DPTs (DPT-1 and DPT-2) and two return DPTs (DPT-3 and DPT-4) for redundancy. The DPTs are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The net flow is sent to the personal computer display. The issue rate, return rate and net flow must be displayed on the personal computer.

3.5.10.3 Pressure Sensors (PS)

The PS measure system pressure in kiloPascals pounds per square inch. There are three PS installed on the system and there are PCP preparations made for a fourth PS to be temporarily wired in from a Hydrant Pit. PS-1, PS-2, PS-3, and PS-4 are connected to SYS-1 only as indicated on the Terminal Block Connection drawing. These sensors must report various system pressures to the personal computer to be used for the creation of the system graphs as required for screen 7 and described in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP.

3.5.11 Control Valves

3.5.11.1 Flushing Valve (FV)

Connect the FV to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. Activate the graphical display open and closed lights and screen number 2 status based on the PLC's output status for the valve. Base the valve status on the table listed below.

Flushing Valve Operation - One Solenoid			
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid	Graphical Display
Re-Fuel or Auto Mode	Open	De-energized	Open
Loop Flush	Open	De-energized	Open
Pantograph Flush	Closed	Energized	Closed
Off Mode	Open	De-energized	Open
Tightness Test	Open	De-energized	Open

3.5.11.2 Pressure Control Valve (PCV)

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NOTE: Only include if Scheme B Control is utilized.
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Connect the PCV to I/O-1, I/O-2 and UPS #3 as indicated on the Terminal Block Connection drawing. Activate the graphical display enabled and closed lights and screen number 2 status based on the PLC's output status for the valve. Base the valve status on the table listed below.

Pressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Automatic Mode Pumps Off	Enabled	De-energized	De-energized	Enabled
Automatic Mode Pump(s) On	Closed	Energized	De-energized	Closed
Flush Mode Pumps On	Closed	Energized	De-energized	Closed
Flush Mode Pumps Off	Enabled	De-energized	De-energized	Closed

Pressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Off Mode Pump(s) On	Closed	Energized	De-energized	Closed
Off Mode Pumps Off	Enabled	De-energized	De-energized	Enabled
Tight. Test-Hi Pres	Closed	Energized	De-energized	Closed
Tight. Test-Static	Enabled	De-energized	De-energized	Enabled
Tight. Test-Low Pres	Enabled	Energized	Energized	Enabled

3.5.11.3 Backpressure Control Valve (BPCV)

The BPCV must be connected to I/O-1, I/O-2 and UPS #3 as indicated on the Terminal Block Connection drawing. The graphical display enabled and closed lights and screen number 2 status must activate based on the PLC's output status for the valve. The valve status must be based on the table listed below.

Backpressure Control Valve Operation - Solenoid			
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Graphical Display
Re-Fuel / Pumps on	Enabled	Energized	Enabled
Re-Fuel / Pumps off	Open	Energized	Open
Both Flush Modes	Open	De-energized	Open
Off Mode	Open	De-energized	Open

Backpressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Both Flush Modes	Open	Energized	Energized	Open
Automatic Mode Pump(s) On	Enabled	Energized	De-energized	Enabled

Backpressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Automatic Mode Pumps Off	Closed	De-energized	De-energized	Closed
Off Mode Pump(s) On	Enabled	Energized	De-energized	Enabled
Off Mode Pumps Off	Closed	De-energized	De-energized	Closed
Tightness Test	Enabled	De-energized	De-energized	Enabled

3.5.12 Safety Circuit

3.5.12.1 Emergency Stop Status

Connect the emergency stop circuit status relay (ER1) N.O. contact to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the circuit is activated the alarm annunciator's critical alarm sequence is activated and any calls to start fueling pumps must be canceled and no additional pump start signals must be sent until the circuit has been reset. The fueling pumps will actually be stopped by a emergency stop circuit status relay (ER2) N.O. contact in the fuel pump motor control circuit located in the motor control center.

3.5.12.2 Emergency Shutoff Valves (ESO) Status

Connect the ESO status relay (ER2) N.O. contact to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the relay is closed the GDP valve open lights must light. When the relay is open the GDP valve closed lights must light.

3.5.12.3 Circuit Power Status

Connect the safety circuit power status relay (ER3) N.O. contact to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the relay is closed the PCP emergency circuit power on light must light.

3.5.13 Pump Control Panel

3.5.13.1 CPU Faults

The PCP mounted CPU-1 and CPU-2 on lights are connected to both SYS-1 and SYS-2. The associated CPU light must light when no system faults are detected. When a fault is detected by the CPU or it's redundant CPU the faulted CPU's on light must be turned off and the alarm annunciator's non-critical alarm sequence must be activated.

3.5.13.2 Input Select Switch

The 2-position input select switch controls which inputs (System-1 or System-2) are being used. Connect each switch position to both SYS-1 and SYS-2. The OI display indicates the active system.

3.5.13.3 Mode Select Switch

The [5][4]-position switch selects what mode of fueling is active: automatic Re-Fueling, loop flush,[pantograph flush,] Tightness Test, or off. Each switch position must be connected to both SYS-1 and SYS-2. The screen number 2 status must indicate the active mode.

3.5.13.4 Lead Pump Selector Switch

The 3-position switch selects which pump is the lead pump. The switch position fixes the starting sequence for all pumps. The sequences must be 1-2-3, 2-3-1, and 3-1-2. The off sequence must be the reverse of the start sequence; therefore, first on will be last off. A maximum of two pumps are allowed to run at one time. If a pump fails to start or fails during operation, that pump must be disabled and the next pump in the sequence started. The screen number 2 status display must indicate the lead pump.

3.5.13.5 PCP Temperature Alarm

The alarm thermostat when activated must activate the alarm annunciator's non-critical alarm sequence.

3.6 OPERATING PROGRAM REQUIREMENTS

Store the control system's logic program on an EEPROM chip. Permanently store default values of operator adjustable parameters on the chip with the capability of resetting the values in RAM to the values within the range specified below. The default values can be changed through the use of the personal computer (after the correct password has been entered). After loss of power and battery failure the adjustable settings must revert back to the default values located on the chip. The default values shown here must be reset to the values determined during the system start up and test.

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NOTE: Delete the addressable parameter accompanied by an asterisk(*) for control Scheme "A". Addressable parameters accompanied by two asterisks(**) apply to Scheme "A" only.

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SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Lead pump starting pressure	205 to 1035 kPa30 to 150 psi	415 kPa60 psi
Issue flow to start second pump in sequence	25 to 40 L/s450 to 650 gpm	35 L/s560 gpm
Return flow to enable next pump in sequence to start	0.5 to 6 L/s10 to 100 gpm	2.5 L/s40 gpm

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Return flow to stop second pump in sequence (lag pump)	30 to 50 L/s500 to 800 gpm	44 L/s700 gpm
Return flow to initiate lead pump shutdown sequence	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds
Timer to enable second pump to start	0 to 120 seconds	10 seconds
Timer to stop second pump	0 to 120 seconds	15 seconds
Timer to stop first pump	0 to 60 seconds	2 seconds
Timer to stop first pump	0 to 15 minutes	10 minutes
Timer to de-energize (close) Back Pressure Control Valve	0 to 360 seconds	60 seconds
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
System pressure to stop lead pump	895 to 1310 kPa130 to 190 psig	760 kPa110 psig
Should the operator enter a value not within the range for that parameter, the personal computer must indicate "INVALID ENTRY" and revert back to the previous value.		
A number inside braces, {x}, in the following paragraphs indicates that the number may be changed by the operator via the operator interface within the Set Point Range listed above.		

[3.7 AUTOMATIC MODE - IDLE CONDITION (GOOD JOCKEY PUMP)

The fueling system is intended to remain continuously pressurized while in the idle condition. This allows the system to respond immediately to aircraft refueling and defueling requirements. Periodically, in the idle condition, the system will lose minimal pressure. When this occurs, the control system will automatically repressurize in the following sequence:

a. The jockey pump will start when the system pressure is less than {448} kPa {65} psig continuously for {5} seconds. If the pressure then rises above {448} kPa {65} psig before the timer expires, the timer must reset.

b. After the timer expires:

  (1) The jockey pump will start.

  (2) All valve positions will remain in the state they were in prior to jockey pump start.

c. With the jockey pump running, 0.31 L/s 5 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will gradually increase {517} kPa {75} psig. When the pressure reaches {517} kPa {75} psig the jockey pump will stop.

d. If the conditions exist for a fueling pump to be called to start, the jockey pump will not start or continue to run.

e. When the jockey pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the jockey pump's flow switch opens after the pump has successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate.

]3.8 AUTOMATIC MODE - IDLE CONDITION (FAILED JOCKEY PUMP)

The fueling system is intended to remain continuously pressurized while in the idle condition. This allows the system to respond immediately to aircraft refueling and defueling requirements. Periodically, in the idle condition, the system will lose minimal pressure. When this occurs, the control system will automatically repressurize in the following sequence:

a. The lead pump will start when the system pressure is less than {414} kPa {60} psig continuously for {0} seconds. If the pressure then rises above {414} kPa {60} psig before the timer expires, the timer must reset.

b. After the timer expires:

    (1) The BPCV solenoid 'A' must be energized to enable the valve to modulate the system pressure at it's set point.

    (2) The PCV solenoid 'A' must be energized to close the valve.

    (3) The D/FV solenoid 'A' must be de-energized so the valve is closed and solenoid 'B' must be de-energized.

c. With the lead pump running, 45 L/s 600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 896 kPa 130 psig. At this pressure the BPCV will start to open and the valve will modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

d. With the lead pump running and no fueling demand the return venturi flow rate will equal the issue venturi flow rate. When the return venturi flow rate is greater than {42} L/s {560} gpm a {300} second timer must start. If the flow rate drops below {42} L/s {560} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

e. After the timer expires:

    (1) The BPCV solenoid 'A' must be de-energized to close the valve.

    (2) The PCV solenoid 'A' must be de-energized to bleed system pressure to 517 kPa 75 psig.

    (3) When system pressure rises to 965 kPa 140 psig a {2} second timer must start. After the timer has expired, the lead pump must be stopped.

    (4) The Defuel/Flush valve solenoid "A" must be energized 30 seconds after lead pump shut down to allow it to open at 552 kPa 80 psig for defuel operations.

f. The system has now returned to a pressurized and idle condition.

g. When a fueling pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

h. If a fueling pump flow switch opens after the pump has successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

[3.9 AUTOMATIC MODE - REFUELING CONDITION

To start an aircraft fueling operation, an operator connects fueling equipment such as a pantograph to an aircraft and to a hydrant control valve. When the operator opens the hydrant control valve by use of an hydraulic operated "Deadman", the following sequence occurs:

a. The lead pump will start when the PIT senses a pressure less than {415} kPa {60} psig continuously for {0} seconds. If the pressure then rises above {415} kPa {60} psig before the timer expires, the timer must reset.

b. After the timer expires:

    (1) The BPCV solenoid 'A' must be energized to enable the valve to modulate the system pressure at it's set point.

    (2) The PCV solenoid 'A' must be energized to close the valve.

c. With the lead pump running, ±38 L/s600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 550 kPa 80 psig. At this pressure the BPCV will start to open and the valve will modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

d. With lead pump running and a issue venturi flow rate greater than {35} L/s {560} gpm and a return venturi flow rate greater than {2.5} L/s {40} gpm and less than {35} L/s {560} gpm the lead pump will continue to run and the BPCV will modulate to pass flow as necessary to maintain upstream system pressure.

e. With the lead pump running and a issue venturi flow rate greater than {35} L/s {560} gpm and a return venturi flow rate greater than {35} L/s {560} gpm a {300} second timer must start. If issue venturi flow rate falls below {35} L/s {560} gpm or the return venturi flow rate falls below {35} {560} before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

f. After the timer expires:

    (1) The BPCV solenoid 'A' must be de-energized to close the valve.

    (2) The PCV solenoid 'A' must be de-energized to bleed system pressure to 520 kPa 75 psig.

    (3) When system pressure rises to 760 kPa 110 psig a {2} second timer must start. After the timer has expired, the lead pump must be stopped.

g. With the lead pump running and a issue venturi flow rate greater than {35} L/s {560} gpm and a return venturi flow rate less than {2.5} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {35} L/s {560} gpm or the return venturi flow rate rises above {2.5} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

h. After the timer expires: The second pump must start.

i. With the lead and second pumps running and a issue venturi flow rate greater than {73} L/s {1160} gpm and a return venturi flow rate of greater than {2.5} L/s {40} gpm and less than {44} L/s {700} gpm the lead and second pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

j. With the lead and second pumps running and a issue venturi flow rate greater than {73} L/s {1160} gpm and a return venturi flow rate greater than {44} L/s {700} gpm a {15} second timer must start. If issue venturi flow rate falls below {73} L/s {1160} gpm or the return venturi flow rate falls below {44} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

k. After the timer expires: The second pump must be stopped.

l. When a fueling pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

m. If a fueling pumps flow switch opens after the pump successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

]3.10 RE-FUELING MODE - REFUELING CONDITION

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NOTE: Applicable to Scheme A operation

****

To start an aircraft fueling operation, an operator connects fueling equipment such as a pantograph to an aircraft and to a hydrant control valve. The operator opens the hydrant control valve by use of an hydraulic operated "Deadman":

a. The lead pump will start when the local Start pushbutton is pushed.

b. The BPCV solenoid must be energized to enable the valve to modulate the system pressure at it's set point.

c. With the lead pump running, ±38 L/s600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 900 kPa 130 psig. At this pressure the BPCV will start to open and the valve will modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

d. With lead pump running and an issue venturi flow rate greater than {35} L/s {560} gpm and a return venturi flow rate greater than {2.5} L/s {40} gpm the lead pump will continue to run and the BPCV will modulate to pass flow as necessary to maintain upstream system pressure.

e. With the lead pump running and an issue venturi flow rate greater than {35} L/s {560} gpm and a return venturi flow rate less than {2.5} L/s {40} gpm a {10} second timer must start. If issue venturi flow rate falls below {35} L/s {560} gpm or the return venturi flow rate rises above {2.5} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

f. After the timer expires: The second pump must start.

g. With the lead pump running and an issue venturi flow rate greater than {73} L/s {1160} gpm and a return venturi flow rate greater than {2.5} L/s {40} gpm and less that {44} L/s {700} gpm the lead and second pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

h. With the lead and second pumps running and an issue venturi flow rate greater than {73} L/s {1160} gpm and a return venturi flow rate greater than {44} L/s {700} gpm a {15} second timer must start. If issue venturi flow rate falls below {73} L/s {1160} gpm or the return venturi flow rate falls below {44} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

i. After the timer expires: The second pump must be stopped.

j. When a fueling pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

k. If a fueling pumps flow switch opens after the pump successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

l. When a fueling operation is complete the operators will depress the Stop button and the lead pump must stop and the BPCV must be de-energized.

m. If the operators forget to depress the stop button following completion of a fueling operation, a timer will be counting down at all times that the system is showing issue flow of greater than {35} L/s {560} gpm and a return flow of greater than {35} L/s {560} gpm. This timer will be 10 minutes and upon reaching 10 minutes the lead pump must be shut down and the BPCV must be de-energized.

3.11 LOOP FLUSH MODE

This mode must be used when the system needs to be flushed of water or sediment. The operators will first place the manual valves in the desired position to select the appropriate flow path. Placing the selector switch in "loop flush" the following must occur:

a. The BPCV solenoid must be de-energized to force it open. Both BPCV solenoids must be energized to force it open.

b. Start the fueling pump(s) manually using the Hand-Off-Auto or Hand-Auto switch to obtain the desired flow rate. The automatic pump starts must be disabled in this mode.

c. The PCV solenoid "A" must be energized when pump(s) are on and de-energized when the pumps are off. The PCV solenoid "B" is de-energized.

d. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

e. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

[3.12 PANTOGRAPH FLUSH MODE

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NOTE: This paragraph is not required if a separate flush line is provided for the system.

****

This mode must be used when pantographs need to be flushed of water or sediment. The operators will first place the manual valves in the desired positions to select the appropriate flow path. Placing the selector switch in "pantograph flush" the following must occur:

a. The BPCV solenoid must be de-energized to force it open.Both BPCV solenoids must be energized to force it open.

b. The Flushing valve solenoid must be energized to force it closed.

c. Start the fueling pump(s) manually using the Hand-Off-Auto or Hand-Auto switch to obtain the desired flow rate. The automatic pump starts must be disabled in this mode.

d. The PCV solenoid "A" must be energized when pump(s) are on and de-energized when the pumps are off. The PCV solenoid "B" is de-energized.

e. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

]3.13 TIGHTNESS TEST MODE

This mode must be used in conjunction with the Tightness Monitoring Panel provided by Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT to perform tightness tests. Placing the selector switch to "TIGHTNESS TEST" the PCP will send a signal to the Tightness Monitoring Panel telling it that it is ready to perform the tests. At this time it will also operate three MOV valves, closing I25 and I26 and opening I27. The PCP will then receive signals from the Tightness Monitoring Panel to prepare for High Pressure Test, run High Pressure Test, Prepare for Low Pressure Test, run Low Pressure Test, prepare for 2nd High Pressure Test, run 2nd High

Pressure Test, and when the test is over. The following PCP actions will occur after the corresponding signal:

Prepare for High Pressure Test:

a. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be energized to enable the valve at the 1.1 MPa 160 psi value.

b. The D/FV solenoid "A" must be de-energized and the D/FV solenoid "B" must be de-energized to force it closed.

c. Automatically start the jockey pump to obtain pressure.

d. The PCV solenoid "A" must be Energized and PCV solenoid "B" must be de-energized to close the valve.

e. When the jockey pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the jockey pump's flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. If the jockey pump fails to establish flow, automatically start the lead fueling pump to obtain pressure.

h. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

i. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

j. MOV I32 will be opened.

k. . The pump will continue to run until such time as the run High Pressure test signal is received. Note: the Tightness Monitoring Panel is monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the High Pressure test.

Run High Pressure Test:

a. MOV I32 will be closed.

b. Jockey/Fueling pump will be shut off.

c. The BPCV solenoid "A" must be d-energized and the BPCV solenoid "B" must be de-energized to close valve.

d. The PCV solenoid "A" will be de-energized and the PCV solenoid "B" will be de-energized to enable the valve at the 517 kPa 75 psi value. Note: the Tightness Monitoring Panel will wait for a ten minute settling time to pass, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP to Prepare for the Low Pressure Test.

Prepare for Low Pressure Test:

a. MOV I32 will be opened.

b. The PCV solenoid "A" will be energized and the PCV solenoid "B" will be energized to enable the valve at the 345 kPa 50 psi value.

c. The system will remain in this status until such time as the PCP receives a Run Low Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will monitor the loop pressure until it reaches the 345 kPa 50 psi value. It will then instruct the PCP to run the Low pressure test.

Run Low Pressure Test:

a. MOV I32 will be closed.

b. The system will remain in this status until such time as the PCP receives a Prepare for 2nd High Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will wait for a ten minute settling period to expire, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP to prepare for 2nd High Pressure Test.

Prepare for 2nd High Pressure Test:

a. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be energized to enable the valve at the 1.1 MPa 160 psi value.

b. The D/FV solenoid "A" must be de-energized and the D/FV solenoid "B" must be de-energized to force it closed.

c. Automatically start the jockey pump to obtain pressure.

d. The PCV solenoid "A" must be de-energized and PCV solenoid "B" must be de-energized to close the valve.

e. When the jockey pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the jockey pump's flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. If the jockey pump fails to establish flow, automatically start the lead fueling pump to obtain pressure.

h. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

i. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

j. MOV I32 will be opened.

k. pump will continue to run until such time as the run 2nd High Pressure test signal is received. Note: the Tightness Monitoring Panel is monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the 2nd High Pressure test.

Run 2nd High Pressure Test:

a. MOV I32 will be closed.

b. Jockey/Fueling pump will be shut off.

c. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be de-energized to close valve.

d. The PCV solenoid "A" will be de-energized and the PCV solenoid "B" will be de-energized to enable the valve at the 517 kPa 75 psi value. Note: the Tightness Monitoring Panel will wait for a ten minute settling time to pass, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP that testing is finished.

e. The PCP will leave the system as is until such time as the PCP selector switch is placed into a different mode.

3.14 OFF MODE

a. Automatic starting of fueling pumps must be disabled. All other functions (GDP, alarm annunciator, operator interface, control valve solenoids, etc.) must be active to allow manual control of the fueling pumps using the Hand-Off-Auto or Hand-Auto switch.

b. When the first pump has been started:

  (1) The BPCV solenoid 'A' must be energized to enable the valve to modulate the system pressure at it's set point.

  (2) The PCV solenoid 'A' must be energized to close the valve.

c. The second and third pumps maybe started or stopped manually as needed by the operator.

d. After the last pump has been stopped:

  (1) The BPCV solenoid 'A' must be de-energized.

  (2) The PCV solenoid 'A' must be de-energized.

3.15 MANUAL OPERATION OF FUELING PUMPS

a. If the PLC system is still active see paragraph OFF MODE.

b. If the PLC system has no power or both CPUs have faulted (CPU lights on PCP off) the pumping system will be in a completely manual mode. The safety circuit will need power so that the ESO solenoids on the non-surge check valves will be open and fuel can flow. The solenoids on the other solenoid controlled valves will be de-energized so the valves will have to be manually opened or enabled for the system to run. Other valves may need to be opened or closed manually by the operators for the system to work properly.

3.16 4-VALVE MANIFOLD SUPERVISION

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NOTE: The drawing referenced below is from the DEPARTMENT OF DEFENSE PRESSURIZED HYDRANT DIRECT FUELING SYSTEM Standard Drawings. Add the drawing to the design package if applicable.

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a. Prior to initiating fueling operations in the automatic or in the test mode, the 4-valve manifold valves and the two tank outlet valves must be in the proper positions for successful fueling operations. The PLC must monitor valve positions of the 4-valve manifold (sensed by position limit switches for fully opened and fully closed status on valves I34, I35, R10, and R11) and by monitoring valve status on the tank outlet valves (sensed by position limit switches for fully opened and fully closed status on valves I1 and I2). Valve position must conform to the position table listed on drawing M-204b under "Storage Tank Selection".

b. If the system is placed in automatic or test mode the valve selections must conform to the position table on sheet M-204b. If the valve positions do not conform to this table the PCP will show a 4-Valve manifold error on the alarm annunciator. The alarm can be silenced, but will not reset until such time as the valve positions do conform to the table.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 09 55 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 09 55 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 09 55

AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (CUT AND COVER TANKS)

08/18

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 09 55 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 09 55 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 33 09 55

AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (CUT AND COVER TANKS)

08/18

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NOTE: This guide specification covers the requirements for the Pump Control and Annunciation System for aircraft refueling systems constructed to the requirements of the DOD Cut and Cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

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NOTE: NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

The Cut-N-Cover style of tanks are primarily used in OCONUS. Therefore this standard was prepared using metric units that would apply to most OCONUS projects. 120 volts at 60Hz is used for control power. Adjust all units to meet local requirements.

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1.1 SYSTEM OVERVIEW

The Hydrant Fueling System consists of fueling pumps that pump fuel to a Hydrant Hose Truck Check-out Pad, Truck Fill Stands, and fuel pits located on the airfield apron. Automatic pump starts and stops are based on system pressure and flow. Programmable Logic Controllers (PLCs) receive information from pressure transmitters and other devices to control the pumps and control valves. There are two PLCs that are connected in a redundant configuration, to assure continued operation of the Hydrant Fueling System even if either PLC (but not both) fails. The Hydrant Fueling System also includes Cut-N-Cover fuel storage tanks and a product recovery tank. The pump control panel, personal computer, and annunciator are located in the Control Room of the Filter Separator Building.

1.2 GENERAL REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this project, with the additions and modifications specified herein. The control system must be furnished by a single supplier. See Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT for other required components of the control system. The control system supplier is responsible for providing a fully functional control system, in accordance with the drawings and specifications, including the field devices. Install in accordance with NFPA 70.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts. SME for this project is [Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS)][Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC)][Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11)].

1.3 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 18.1	(2024) Annunciator Sequences and Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA IA 2	(2005) Programmable Controllers - Parts 1 thru 8
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 1012	(2010; Reprint Apr 2016; Rev Mar 2021) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawing; G[, [_____]].

SD-03 Product Data

Pump Control Panel (PCP) and Components; G[, [_____]].

Programmable Logical Controller (PLC) Hardware and Software; G, [[_____]].

Personal Computer (PC); G, [[_____]].

Laptop Computer; G, [[_____]].

FCC Computer; G[, [_____]].

Printer; G, [[_____]].

Graphics Display Screen; G, [[_____]].

Control Wiring Data Lists; G, [[_____]].

SD-06 Test Reports

Testing Plan; G, [[_____]].

Certified Pump Control Panel (PCP) Shop Test Report.

Record of Test.

SD-07 Certificates

Experience and Qualifications; G, [[_____]].

SD-10 Operation and Maintenance Data

Plan for Instructing Personnel; G, [[_____]].

Operation and Maintenance Manuals; G, [[_____]].

Tools and Spare Parts.

1.5 OPERATION AND MAINTENANCE MANUALS

1.5.1 Schedule and Content

Submit copies of operational and maintenance manuals, within 7 calendar days following the completion of factory tests. As a minimum, include the following in the manuals:

a. Pump Control Panel including interior and exterior equipment layout.

b. All documents previously submitted and approved with all comments and field changes annotated.

c. Complete description of the sequence of operation including that described in Paragraphs 3.6 through 3.13 of this specification and any subsystems not controlled by the PLC (e.g. annunciator panel, EPDS, etc.)

d. Complete listing of all programming of the PLCs, laptop computer, and Personal Computer.

e. Complete relay ladder logic diagrams, PLC input/output diagrams and control power distribution diagrams for the complete control system.

f. Complete guide outlining step-by-step procedures for system startup and operation.

g. Complete troubleshooting guide, which lists possible operational problems and corrective action to be taken.

h. Complete maintenance and installation manual for all equipment supplied.

i. Spare parts data, which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

j. The above must incorporate all as-built conditions.

1.5.2 Assembly

For hard copy submittals, bind documents in a suitable binder adequately marked or identified on the spine and front cover. Include a table of contents page and mark with pertinent contract information and contents of the manual. Provide tabs to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Provide index sheets for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers. Provide electronic copy, Adobe Acrobat 11.0 or later, of documents with bookmarks.

1.6 TOOLS AND SPARE PARTS

Provide the following:

a. Any special tools necessary for maintenance of the equipment

b. One spare set of fuses of each type and size

c. Recommended manufacturer list of spare parts. Include part number, current unit price, and source of supply.

d. One spare power supply module

e. One spare I/O module (for discrete devices)

f. One spare I/O module (for analog devices)

g. Two PLC RAM back-up batteries

h. Two complete sets of ink cartridges for the laser printer

i. Minimum of ten spare lamps for the Alarm Annunciator

j. Minimum of ten spare lamps of each type of non-LED lamps used on the Pump Control Panel

[k. [_____]
]

1.7 EXPERIENCE AND QUALIFICATIONS

Submit the following data demonstrating experience and qualifications:

a. Certification stating that the manufacturer has manufactured, installed, and successfully completed at least three PLC-based systems for automatic cycling of pumps based upon varying dispensing demands ranging from 0 to 150 L/s 2400 gallons per minute utilizing multiple pumps. At least one of the three PLC-based systems must be for dispensing jet fuel into a pressurized, constant pressure, flow demand aircraft hydrant system.

b. Certification that the proposed control systems have successfully operated over the last 2 years and are currently in service.

c. Project names, locations, and system description of these installations. Include user point-of-contact and current telephone numbers.

1.8 WARRANTY

Warrant the Pump Control and Annunciation System including devices, hardware and software for a period of 1 year from the date of acceptance of the system by the Government. This warranty service must include parts and labor service for equipment supplied under this specification. Upon notification by the Government of system or component failure, respond at the site with necessary parts within 48 hours of notification.

PART 2 PRODUCTS

2.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS

2.1.1 Enclosure

NEMA ICS 1, NEMA ICS 6, NEMA 250, and UL 508. The PCP enclosure must be a freestanding NEMA Type 12, smooth, gasketed enclosure constructed of 12 gauge steel. All seams must be continuously welded and there must be no drilled holes or knockout prior to delivery to the job site. The pump control panel dimensions must be a maximum of 2300 mm 90 inches high, maximum 1830 mm 72 inches wide, and a maximum of 610 mm 24 inches deep and must have removable lifting eyes. The interior surfaces of the panel must be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces must have standard factory finish. Access for the PCP must be front only and must consist of hinged doors having 3-point latching mechanisms. The doors must open approximately 120 degrees. Rack mounting angles, swing-out panels and other component mounting hardware must be installed such that servicing of one component must not require removal or disconnection of other components. No clearance must be required between the back of the panel and the room walls. Terminal facilities must be arranged for entrance of external conductors from the top or bottom of the enclosure.

2.1.2 Ventilation System

Two supply fans, single phase, 115 volt, must be provided. Each fan must supply a minimum of2.8 cubic meters/minute 100 CFM. The supply and exhaust grill must contain a filter that is easily removed from the exterior of the enclosure. Three thermostats with an adjustable set point range of 21 degrees C 70 degrees F to 60 degrees C 140 degrees F must also be provided. Locate the thermostats near the top in the interior of the PCP.

2.1.3 Ground Bar

The control panel must have a tin plated copper equipment ground bar. The bar must have a minimum of twenty grounding screws.

2.1.4 Standard Indicator Lights

NEMA ICS 1, NEMA ICS 2, and UL 508. Lights must be heavy duty, NEMA 13, 22.5 mm mounting hole, round indicating lights operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs must be used. Indicator lights must have a legend plate with words as shown on drawings. Lens color as indicated on the drawings. Lights must be "push to test (lamp)" type. LED type lamps of comparable size and color may be substituted for standard indicator lights.

2.1.5 Selector Switches

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated lever operated selector switches must be heavy duty, NEMA 13, round, and utilize a 22 mm 7/8-inch mounting hole. They must have the number of positions as indicated on the drawings. Switches must be rated 600 volt, 10 amperes continuous. Provide legend plates with each switch with words as indicated on the drawings.

2.1.6 Pushbuttons

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated pushbuttons must be heavy duty, NEMA 13, round, utilize a 22 mm7/8 inch mounting hole, and have the number and type of contacts as indicated on the drawings or elsewhere in the specifications. The emergency stop switch must be a red mushroom head, 38 mm 1.5 inch diameter, momentary contact type.Pushbuttons must be rated 600 volt, 10 amperes continuous. Provide legend plates with each switch with words as indicated on the drawings.

2.1.7 Relays

IEEE C37.90, NEMA ICS 2, UL 508.

2.1.8 Nameplates

Provide laminated plastic nameplates with black outer layers and a white core. Edges must be chamfered. Fasten the nameplates with black-finished round-head drive screws or approved nonadhesive metal fasteners.

2.1.9 Transient Voltage Surge Suppression Devices

IEEE C62.41 for Category "B" transients, UL 1449.

2.1.10 Terminal Blocks

NEMA ICS 4. Terminal blocks for conductors exiting the PCP must be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks must be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip must form part of the terminal block and each terminal must be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.1.11 Circuit Breakers

UL 508. Provide individual, appropriately sized, terminal block mounted, circuit breakers for all 120 volt PCP mounted equipment and for the 120 volt terminal boards shown on the drawings.

2.1.12 Uninterruptible Power Supplies

UL 1012. Input voltage must be 120 volts (nominal), 1 phase, 60 Hertz. Output voltage regulation must be +/-5.0 percent for the following conditions:

a. 20 percent to 100 percent load on output.
b. Input voltage variation of -15 percent to +10 percent.
c. Constant load power factor between 80 percent and 100 percent.

Response time must be 1.5 cycles or less. Battery capacity must be such as to provide an orderly shut down of operating programs or as a minimum 30 minutes.

2.1.13 Miscellaneous Power Supplies

UL 1012. Certain field devices may require power other than 120VAC (i.e. 24VDC). The power supplies must be convection cooled, have fully isolated independent outputs, have constant voltage, have short circuit and overvoltage protection, and have automatic current limiting.

2.1.14 Alarm Annunciator

UL 508 and ISA 18.1. The Alarm Annunciator must provide visual annunciation, local and remote monitoring, constant or flashing visual and audible alarm as specified herein. The annunciator must be completely solid state with no moving parts. Furnish the annunciator with cabinet and hardware appropriate for flush mounting on the control panel. A power supply either integral or separately mounted must operate on 120 volts, 60 Hertz. The annunciator must have windows arranged in a matrix configuration (rows and columns). Each window must be at least 25 mm 1 inch high by 40 mm 1-5/8 inches wide and must have rear illuminated translucent engraved nameplate. Lettering must be at least 4 mm 5/32 inches high. System lamp voltage must be 24 to 28 volts dc.

2.1.15 Alarm Horns

UL 508. The alarm horns must consist of 2-vibrating horns and 1-resonating horn. One vibrating horn is to be mounted in the PCP, and one vibrating and one resonating horn must be mounted outside of the control room as shown on the drawings. The exterior horns must each produce 100db at 3 m10 feet and must be provided in a weather proof housing. The PCP horn must produce 70db at 3 meters 10 feet.

2.1.16 Laptop Computer

2.1.16.1 Hardware

The following are the minimum hardware requirements for the laptop computer:

a. Latest Pentium CPU operating at 2 GHz or faster

b. 2 GB RAM
c. 500 GB hard drive
d. 16X Read-Write DVD drive
e. Color LCD screen 360 mm 14 inches
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120VAC and Battery power supply
k. All cables and connectors for interfacing with PLC and personal computer
l. Modem compatible for remote troubleshooting of the system
m. Two USB 2.0 communications ports
n. Provide a carrying case for the Laptop Computer

2.1.16.2 Software

The following is the minimum software to be loaded on the laptop. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating System)
b. Software for programming the PLC
c. Software for programming the personal computer

2.1.17 Personal Computer (PC)

2.1.17.1 Hardware

The following are the minimum hardware requirements for the personal computer:

a. Latest Pentium CPU operating at 2.4 GHZ or faster
b. 4 GB RAM
c. 500 GB hard drive
d. 16X Read-Write DVD drive
e. Color 610 mm 24 inches flat screen monitor
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120VAC operating power
k. All cables and connectors for interfacing with PLC and Laser Printer
l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System.
m. Two USB 2.0 communications ports

2.1.17.2 Software

The following is the minimum software to be loaded on the personal computer. The software must be the most current versions and compatible with each other to make a complete and usable system. All software must be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating System)

b. Software for programming the PLCs

c. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points.

d. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system on a real time basis.

e. MS Office Professional with Excel must be provided to allow the trending data described above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically.

2.1.18 Printer

The alarm/report printer must be a color laser jet printer. The unit must print in black at a minimum speed of twelve pages per minute. It must print in color at a minimum speed of ten pages per minute. It must as a minimum be capable of printing color graphs of various system pressures, issue flow, and return flow vs. time in seven colors. Provide one set of spare replacement ink cartridges.

2.1.19 FCC Computer

2.1.19.1 Hardware

The FCC computer must be a copy of the personal computer so that upon failure of the personal computer it could be relocated to the pumphouse to assume the personal computers duties. The normal duties of the FCC computer must be to serve as a remote monitor only of the screens that are available on the personal computer. The following are the minimum hardware requirements for the FCC computer:

a. Latest Pentium CPU operating at 2.4 GHZ or faster
b. 2 GB RAM
c. 250 GB hard drive
d. 16X Read-Write DVD drive
e. Color 430 mm 17 inches flat screen monitor
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120VAC operating power
k. All cables and connectors for interfacing with PLC and Laser Printer
l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System.
m. Two USB 2.0 communications ports

2.1.19.2 Software

The following is the minimum software to be loaded on the FCC computer. The FCC computer must be capable of replacing the Personal computer in the pumphouse if the personal computer fails. It will be set up initially to serve only as a remote monitor of the system while located at the FCC. Should the personal computer fail, the FCC computer will be relocated to the pumphouse and then assume the role of the personal computer. The computer software must have a built in command to tell the computer whether it is serving as the personal computer or as the remote monitor only. The software must be the most current versions and compatible with each other to make a complete and usable system. All software must be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating System)

b. Software to tell the computer which mode it is to operate in, i.e. (personal computer or remote monitor)

c. Software to run as a remote monitor

d. Software for programming the PLCs

e. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points.

f. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system, on a real time basis.

g. MS Office Professional with Excel must be provided to allow the trending data described in e. above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically.

2.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

2.2.1 General

a. NEMA IA 2. Each PLC must be able to receive discrete and analog inputs and through its programming it must control discrete and analog output functions, perform data handling operations and communicate with external devices and remote I/O racks. The PLCs must be a modular, field expandable design allowing the system to be tailored to the process control application. The capability must exist to allow for expansion to the system by the addition of hardware and/or user software. At a minimum the PLCs must include mounting backplanes, power supply modules, CPU module, communication modules, and I/O modules.

b. Each PLC provided must be designed and tested for use in the high electrical noise environment of an industrial plant. The PLC modules must comply with the FCC Part 15 Part A for radio noise emissions. The programmable controller processor must be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2, IEEE C37.90.

c. The PLCs must function properly at temperatures between 0 and 50 degrees C 32 and 122 degrees F, at 5 to 95 percent relative humidity non-condensing and have storage temperatures between -40 and 60 degrees C -40 and +140 degrees F at 5 to 95 percent relative humidity non-condensing.

d. The PLCs must have manufacturer's standard system status indicators (e.g. power supply status, system fault, run mode status, back-up battery status).

2.2.2 Central Processing Unit Module

The CPU must be a modular self-contained unit that provides time of day, scanning, application (ladder rung logic) program execution, storage of the application program, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self-diagnostics.

2.2.3 Power Supply Module

a. The power supply module must be plugged into the backplane not separately mounted. The power supply must be wired to utilize 120 VAC, 60 Hz power, the system must function properly within the range of -10 percent to +15 percent of nominal voltage. The power supply must provide an output to the backplane at a wattage and voltage necessary to support the attached modules. A single main power supply module must have the capability of supplying power to the CPU module and local communication and I/O modules. Auxiliary power supplies must provide power to remote racks.

b. Each power supply must have an integral on/off disconnect switch to the module. If the manufacturers standard power supply does not have an on/off disconnect switch a miniature toggle type switch must be installed near the PLC and clearly labeled as to its function.

c. The power supply must monitor the incoming AC line voltage for proper levels and have provisions for both over current and over voltage protection. If the voltage level is detected as being out of range the system must have adequate time to complete a safe and orderly shutdown.

2.2.4 Program Storage/Memory Requirements

a. The PLC must have the manufacturers standard nonvolatile executive memory for the operating system. The PLC must also have EEPROM (Electrically Erasable Programmable Read Only Memory) for storage of the user program and battery backup RAM for application memory. The EEPROM must be loaded by use of the laptop computer or the personal computer.

b. Submit a calculation of the required amount of EEPROM and RAM (random access memory) needed for this application plus an extra 50 percent.

c. The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed must be limited only by the memory capacity to store these instructions.

2.2.5 Input/Output (I/O) Modules

a. Provide all required I/O modules (analog input, analog output, discrete input, discrete output, and isolated discrete output) to manipulate the types of inputs and outputs as shown on the drawings and to comply with the sequence of operations. Also provide a minimum of 20 percent (round up for calculation) spare input and output points of each type provided, but not less than two of each type.

b. I/O modules must be a self-contained unit housed within an enclosure to facilitate easy replacement. All user wiring to I/O modules must be through a heavy-duty terminal strip. Pressure-type screw terminals must be used to provide fast, secure wire connections. The terminal block must be removable so it is possible to replace any input or output module without disturbing field wiring.

c. During normal operation, a malfunction in any remote input/output channel must affect the operation of only that channel and not the operation of the CPU or any other channel.

d. Isolation must be used between all internal logic and external power circuits. This isolation must meet the minimum specification of 1500 VRMS. Provide optically isolated I/O components which are compatible with field devices.

e. Each I/O module must contain visual indicators to display ON/OFF status of individual input or output points.

f. Discrete output modules must be provided with self-contained fuses for overload and short circuit protection of the module.

g. All input/output modules must be color coded and titled with a distinctive label.

2.2.6 Interfacing

The PLC must have communication ports and communication modules using the manufacturers standard communication architecture for connections of the Personal computer, Laptop Computer, remote I/O racks and interconnections between SYS 1 PLC and SYS 2 PLC for the redundant backup system of the PLCs.

2.2.7 Program Requirements

a. The programming format must be ladder diagram type as defined by NEMA IA 2.

b. There must be a means to indicate contact or output status of the contact or output on the CRT (of the personal computer) or LCD screen (of the laptop computer). Each element's status must be shown independently, regardless of circuit configuration.

c. The program must be full featured in its editing capabilities (e.g. change a contact from normally open to normally closed, add instructions, change addresses, etc.).

2.2.8 Diagnostics

The CPU must continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and I/O. The diagnostic routines must be regularly performed during normal system operation. A portion of the scan time of the controller should be dedicated to perform these housekeeping functions. In addition, a more extensive diagnostic routine should be performed at power up and during normal system shutdown. The CPU must log I/O and system faults in fault tables, which must be accessible for display. When a fault shuts down a CPU, a sequence must be initiated that will automatically switch over to the other CPU. When a fault affects I/O or communication modules the CPU must shut down only the hardware affected and continue operation by utilizing healthy system components. All faults must be annunciated on the alarm annunciator.

PART 3 EXECUTION

3.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS

3.1.1 General

a. Where two or more pieces of equipment performing the same function are required, they must be exact duplicates produced by the same manufacturer. All display instruments of each type must represent the same outward appearance, having the same physical size and shape, and the same size and style of numbers, characters, pointers, and lamp lenses.

b. The PCP must include all required resident software programs and hardware to provide the specified sequence of operation. All software R/W optical disks including programming manuals must be turned over to the Government at the completion of start-up so modification can be done in the field with no outside assistance.

c. It is intended that process controlling devices except field devices, and motor controllers be attached to or mounted within the PCP enclosure and all interconnecting wiring installed prior to shipment to the job site. This is to allow shop testing of the system and to decrease field labor requirements.

d. The PCP must be shipped fully assembled in one piece after the completion of the shop tests and all defects corrected.

3.1.2 Wiring

3.1.2.1 Methods and Practices

Wiring methods and practices must be in conformance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 4 and NEMA ICS 6 recommendations as applicable. All wiring to instruments and control devices must be made with stranded wire, and wiring must be permanently labeled with conductor/wire numbers within 25 mm 1 inch of termination points. Labels must be tubular heat-shrinkable wire markers that remain legible after exposure to industrial fluids and abrasion. Position markers so that wire numbers can be read without disturbing or disconnecting wiring. Use of individual character-markers placed side-by-side is not acceptable. Numbers must match approved shop drawings. All wiring must be neatly laced from point of entry into enclosures to termination points with nylon lacing cord or plastic lacing ties. Lacing within wiring channels is not required.

3.1.2.2 Control Wiring Data Lists

Provide typed Control Wiring Data Lists within each terminal cabinet and the PCP. The data lists must include: conductor identification number, wire gauge, wire insulation type, "FROM" terminal identification, "TO" terminal identification, and remarks. Submit the preliminary lists and update to As-Built conditions.

3.1.3 Certified Pump Control Panel (PCP) Shop Test Report

The manufacturer must shop test the PCP, Personal computer, and lap top computer. Include simulation of field components and provide for fully testing the pump control and annunciator system as a unit before delivery to the project site. The test must, reveal system defects, including, but not limited to, functional deficiencies, operating program deficiencies, algorithm errors, timing problems, wiring errors, loose connections, short circuits, failed components and misapplication of components. Perform the test prior to shipment to the site and correct problems detected. Repeat the final testing and correction sequence until no problems are revealed and then perform two additional successful tests. Submit certified test report within 15 days after completion of the test. The report must include a statement that the Pump Control Panel performs as specified. Notify the Governments Contracting Officer and the SME 30 days prior to the final shop testing date. The Contracting Officer may require a Government witness at the final test before the PCP is shipped to the site.

3.1.4 Ventilation System

Thermostat T-1, must control fan F-1 and thermostat T-2 must control fan F-2. T-1 and T-2 must be set at 27 degrees C 80 degrees F to maintain interior air temperature to 11 degrees C 20 degrees F above ambient. Thermostat T-3, set at 38 degrees C 100 degrees F, must provide a non-critical PCP HIGH TEMPERATURE alarm to the alarm annunciator.

3.1.5 Grounding

The PCP ground bar must be connected to the building counterpoise via a #10 AWG conductor. Within the enclosure all I/O racks, processor racks, and power supplies, etc. must be grounded to meet the manufacturer's specifications.

3.1.6 Indicator Lights, Switches, and Pushbuttons

Mount indicator lights, switches, and pushbuttons through the PCP enclosure and arrange to allow easy vision and operation of each device. Provide each device with a nameplate and/or legend plate as indicated on the drawings. Nameplate wordings must be as indicated on the drawings.

3.1.7 Transient Voltage Surge Suppression Devices

Transient voltage surge suppression (TVSS) devices must be installed in the PCP to minimize effects of nearby lightning strikes, switching on and off of motors and other inductive loads. TVSS must be provided for each control circuit ladder. Each ladder may contain any combination of the following devices: PLCs, power supplies (e.g., 24 volt), fans, relays, lights, switches etc. TVSS must also be provided for PLC I/O originating outside of the building.

3.1.8 Terminal Blocks

As a minimum, any PCP device that connects to a field device (devices not located in the PCP) must be connected to a terminal block. A connection diagram similar to the drawings must be provided to the field contractor for field connections to the PCP.

3.1.9 Circuit Breakers

As a minimum, any 120 volt PCP device i.e. (fans, lights, power receptacles, 24 VDC power supplies, PLC CPUs, PLC I/O racks) must be provided with an individual circuit breaker. Additionally 120 volt terminal boards connecting to field devices (devices not located in the PCP) must be protected by a 120 volt circuit breaker.

3.1.10 Uninterruptible Power supplies

The Pump Control Panel (PCP) must contain three uninterruptible power supplies (UPS) each connected to a dedicated circuit. As shown on the drawings one UPS must supply PLC System 1, one UPS must supply PLC System 2, and the third UPS must supply the miscellaneous device power. The UPSs output capacity must be sufficient to drive all the equipment connected plus 25 percent. The UPSs must be mounted on shelves near the bottom of the PCP but not rest on the floor of the PCP.

3.1.11 Power Supplies

Provide and install all 120VAC and 24VDC power supplies as required. Size the power supplies for the load plus 25 percent. Supply all field devices, which require power and are controlled or monitored from the PCP, from power supplies in the pump control panel. Provide a 120V receptacle in the PCP for use by the Laptop computer. Completely install interconnecting wiring between UPSs and PLC power supplies prior to shipment to the job site.

3.1.12 Alarm Annunciator and Horns

Initiate signals by hardwired field contacts or by PCP outputs as required. The annunciator must energize alarm horns, both an integral panel mounted vibrating horn and remote horns, and flash the appropriate annunciator lamp. The minimum number of windows must correspond to the number of alarm points, plus 15 percent spare. The drawings indicate panel layout and the alarms to be annunciated.

3.1.12.1 Non-critical Alarms

Non-critical alarm windows must be white with black lettering and must sound the PCP mounted vibrating horn and the exterior mounted vibrating horns.

3.1.12.2 Critical Alarms

Critical alarm windows must be red with white lettering and must sound the PCP mounted vibrating horn and the exterior mounted resonating horns. Critical alarms must also cancel all automatic pump starts in the PLC.

3.1.12.3 Alarm Sequence

Alarm sequence for each alarm must be as follows (ISA 18.1 sequence 'A').

a. For a normal condition, visual indicator and horns will be off.

b. For an alarm condition, visual indicator will flash and horns will sound (this condition will be locked in).

c. Upon acknowledgment of the alarm condition, visual indicator will be steady on and the horns will be off.

d. If, after acknowledgment of an alarm condition, another alarm condition is established, the new alarm will cause the appropriate window to flash and the horn to sound.

e. When condition returns to normal after acknowledgment, the visual indicator and the horn will be off.

3.1.13 Personal Computer

The personal computer must be a stand alone, desk top mounted unit. The personal computer must download system parameters from the PLCs for display. The personal computer must also upload new set point values that the operator has changed using the personal computer keyboard, after a password has been entered.

3.1.13.1 Screen Number 1

The general opening screen must as a minimum display the name and location of the installation (e.g. Seymour Johnson Air Force Base, North Carolina), name of the project (e.g., Type III Hydrant Fueling System) and screen navigation information.

3.1.13.2 Screen Number 2

At a minimum display the following items. Continuously update the values; a 2 second delay maximum between updates is acceptable.

System Issue Rate	xxxx L/sGPM
System Return Rate	xxxx L/sGPM
System Net Flow	xxxx L/sGPM
System Pressure	xxxx kPaPSI
System Operation Mode	Auto/Off/Flush/Tightness test
Active System	Sys-1/Sys-2
Lead Pump in Tank 1	1/2/3/4/5
Fuel Pump #1	On/Off xxxxx.x HOURS
Fuel Pump #2	On/Off xxxxx.x HOURS
Fuel Pump #3	On/Off xxxxx.x HOURS
Fuel Pump #4	On/Off xxxxx.x HOURS
Fuel Pump #5	On/Off xxxxx.x HOURS
Backpressure Control Valve	Closed/Enabled
Pressure Control Valve	Closed/Enabled
Defuel/Flush Valve	Closed/Enabled
Lead Pump in Tank 2	6/7/8/9/10

Tank 1 Outlet Valve I11	Open/Closed
Tank 2 Outlet Valve I12	Open/Closed
Receipt Bypass Valve	Open/Closed
Manifold Setup Valve I34	Open/Closed
Manifold Setup Valve I35	Open/Closed
Manifold Setup Valve R10	Open/Closed
Manifold Setup Valve R11	Open/Closed
Lead Tank	1/2
Fuel Pump #6	On/Off xxxxx.x HOURS
Fuel Pump #7	On/Off xxxxx.x HOURS
Fuel Pump #8	On/Off xxxxx.x HOURS
Fuel Pump #9	On/Off xxxxx.x HOURS
Fuel Pump #10	On/Off xxxxx.x HOURS
Only one of the words separated by a slash (/) must be displayed. The xxxxx.x HOURS is the fuel pumps elapsed run time and the value must not be lost when the lead PLC is switched. The pump and valve status words must be color coded to match the colors used on the graphic display screen.	

3.1.13.3 Screen Number 3

Display the following table. The table lists the set points that can be adjusted using the operator interface. A password must be entered before the "current value" can be adjusted. The value entered can only be a number within the "set point range". The "default value" is the value held in the program that is loaded into EEPROM memory (This screen may require more than one display screen.).

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Lead pump starting pressure	205 to 1035 kPa30 to 150 psi	415 kPa60 psi	xxx KpApsi
Issue flow to start second pump in the sequence	25 to 40 L/s450 to 650 gpm	35 L/s560 gpm	xxx L/sgpm

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Issue flow to start third pump in the sequence	65 to 80 L/s1000 to 1300 gpm	73 L/s1160 gpm	xxx L/sgpm
Issue flow to start fourth pump in the sequence	100 to 120 L/s 1600 to 1900 gpm	111 L/s1760 gpm	xxx L/sgpm
Return flow to enable next pump in sequence to start	0.5 to 6 L/s10 to 100 gpm	2.5 L/s40 gpm	xxx L/sgpm
Return flow to stop fourth third, and second pump in the sequence (lag pump)	30 to 50 L/s500 to 800 gpm	44 L/s700 gpm	xxx L/sgpm
Return flow to initiate lead pump shutdown sequence	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm	xxx L/sgpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds	xx seconds
Timer to enable second, third and fourth pumps to start	0 to 120 seconds	10 seconds	xx seconds
Timer to stop fourth, third, and second pumps	0 to 120 seconds	15 seconds	xx seconds
Timer to stop first pump	0 to 60 seconds	2 seconds	xx seconds
Timer to disable Back Pressure Control Valve	0 to 360 seconds	60 seconds	xx seconds
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds	xx seconds
System pressure to stop lead pump	895 to 1310 kPa 130 to 190 psig	965 kPa140 psig	xxx kPapsig
Operating Tank No. 1 Low-Low Level Indication	0 to 2 m0 to 6 feet	500 mm1 foot 8 inches	x.x mfeet

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Operating Tank No. 2 Low-Low Level Indication	0 to 2 m0 to 6 feet	500 mm1 foot 8 inches	x.x mfeet
Operating Tank No. 1 Low Level Indication	0 to 2 m0 to 6 feet	600 mm2 feet	x.x mfeet
Operating Tank No. 2 Low Level Indication	0 to 2 m0 to 6 feet	600 mm2 feet	x.x mfeet
Operating Tank No. 1 High Level Indication	5 to 7.5 m18 to 24 feet	6.5 m21 feet 3 inches	x.x mfeet
Operating Tank No. 2 High Level Indication	5 to 7.5 m18 to 24 feet	6.5 m21 feet 3 inches	x.x mfeet
Operating Tank No. 1 High-High Level Indication	5 to 7.5 m18 to 24 feet	6.7 m22 feet	x.x mfeet
Operating Tank No. 2 High-High Level Indication	5 to 7.5 m18 to 24 feet	6.7 m22 feet	x.x mfeet

3.1.13.4 Screen Number 4

Duplicate the Graphic Display Drawing showing a schematic of the process flow. Refer to this screen as the graphical display. Display many operating parameters here as required in later paragraphs of this specification.

3.1.13.5 Screen Number 5

This screen is a duplicate of the Alarm Annunciator and must be superimposed over the current active screen on the personal computer when an alarm is activated.

3.1.13.6 Screen Number 6

This screen is designed solely for assisting the testing team during initial start up to watch all of the significant parameters of the systems operation simultaneously on one screen. Include the system parameters i.e. (flows, pressures, and status) from screen 2, the set points from screen 3, and timers for all of the actions that will take place following a delay function.

3.1.13.7 Screen Number 7

This screen is designed solely for displaying the seven graphs as described in Section 33 08 53, AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Display the following values concurrently against time: Issue flow, Issue pressure, Return flow, Pump #1 discharge pressure, Pressure upstream of BPCV, Pressure downstream of BPCV, and Hydrant Pit Pressure. The personal computer must be capable of storing up to 1 week of data corresponding to the above values. The system must be able to produce graphs on the screen of this data and print the data in seven colors on the laser printer.

3.1.13.8 Screen Number 8

This screen is an alarm history screen, referred to as the Alarm History Display. This screen must be capable of storing and displaying all alarms that have occurred in the system for at least a period of 30 days.

3.1.13.9 Screen Number 9

This screen is designed solely for displaying the parameters and process involved in the Tightness Test as described in this specification and on the drawings. Display the following values concurrently against time: Pressure (as sensed by PIT3). The system must be able to produce graphs on the screen of this data and be able to print the data in color on the laser printer.

3.1.14 Laptop Computer

The Laptop computer is used to create, edit, and load the ladder logic program into the PLCs and the operator interface graphics control program into the personal computer. The Laptop must also be used to monitor the PLCs memory and ladder logic program. Store the computer in a lockable cabinet provided and located within the Pump Control Panel.

3.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

3.2.1 General

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NOTE: The pressure indicating transmitters and the differential pressure transmitters are the only devices that the PLC can monitor for a possible failure. Define failures in the following manners: When the pressure indicating transmitters differ with each other by more than 70 kPa (10 psig) after a 10 second delay, assume the lower reading transmitter has failed. When the issue differential pressure transmitters differ from each other by more than 2 L/s (30 gpm) after a ten second delay, assume the lower reading transmitter has failed. When the return differential pressure transmitters differ from each other by more than 1.2 L/s (20 gpm) after a ten second delay, assume the lower reading transmitter has failed.

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The basic operation of the redundant PLC system is (Reference "Control System Block Diagram" on the drawings):

a. CPU-1 and it's associated I/O rack (I/O-1) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

b. CPU-2 and it's associated I/O rack (I/O-2) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

c. Within each rack (I/O-1 and I/O-2) System-1, System-2, and nonredundant inputs and outputs must not be mixed on the same input/output module.

d. Under normal operation: The system input select switch is in the "SYS-1" position. CPU-1 is controlling the system using System-1 and nonredundant inputs from I/O-1 and any set point changes from the personal computer. CPU-2 is being updated by CPU-1 or concurrently monitoring System-1 inputs from I/O-2.

e. If under normal operation CPU-1 recognizes that a System-1 input has failed (see note below) it must change over to the System-2 redundant input on I/O-1 and report the failure to the personal computer alarm screen.

Note: The pressure indicating transmitters and the differential pressure transmitters are the only devices that the PLC can monitor for a possible failure. Failures must be defined in the following manners: When the pressure indicating transmitters differ from each other by more than 70 kPa 10 psig after a ten second delay, assume the lower reading transmitter has failed. When the issue differential pressure transmitters differ from each other by more than 2 L/s 30 gpm after a ten second delay, assume the lower reading transmitter has failed. When the return differential pressure transmitters differ from each other by more than 1.2 L/s 20 gpm after a ten second delay, assume the lower reading transmitter has failed.

f. During normal operation there are two ways for CPU-2 to take control of the system: 1) CPU-1 identifies its own internal fault and hands over control to CPU-2. 2) CPU-2 identifies a fault in CPU-1 and takes control from CPU-1. When CPU-2 is in control of the system it must annunciate the fault condition and must be using any updated inputs from the personal computer and must use System-1 inputs. If CPU-2 senses a fault on a System-1 input it must then switch over to the appropriate System-2 input. If power is lost to System-1 inputs then CPU-2 must use all of the System-2 inputs.

g. CPU-2 must also report any of its internal faults to CPU-1 and CPU-1 must report any faults it detects in CPU-2.

h. When the operators think the system is not working and the PLCs do not detect any faults the operator can move the system input select switch from the "SYS-1" position to the "SYS-2" position. With the switch in the "SYS-2" position the PLCs are using System-2 inputs.

3.2.2 Programs

a. Provide two copies of all working programs (i.e. PLC logic, personal computer) on read only CD or DVD as well as a printed program listing.

b. The Contractor (programmer) must provide rung comments (documentation) in the ladder logic program. Each device, on the ladder, must be identified as to the type of device, i.e. limit switch XX, flow indicator XX, motor starter XX, etc. Rung comments must be provided for input and output rungs. The programmer must also provide a comment describing the function of each rung or group of rungs that accomplish a specific function.

3.3 GRAPHICS DISPLAY SCREEN

3.3.1 General

The graphic display screen must be capable of being displayed on the personal computer and the GDP.

3.3.2 Display Presentation

Depict the process fuel flow schematically as indicated on the drawings. Integrate red, green, and amber symbols integrated with the process schematic to provide current equipment status graphically. Locate the symbols immediately adjacent to related equipment symbol.

3.3.3 Process Schematic

The process schematic graphic representation must utilize conventional symbols when possible. Size and space symbols and flow lines so as to provide a clear representation of the system process. The Graphic Display must be suitable for supervised field modification when future items are added. Minor changes may be incorporated to allow proper line width and spacing. Component arrangement, piping routing, and location of valves must match the flow diagram.

3.3.4 Digital Flows, Pressures, and Level Indicators

Provide digital displays for the flows, pressures, and levels as indicated on the drawings.

3.4 INSTALLATION

Installation must conform to the manufacturer's drawings, written recommendations and directions.

3.4.1 Shop Drawing

The shop drawing must be clear and readable and preferably drawn using a computer aided drafting package. At the conclusion of the project the diagram drawings must be redrafted to include all as-built conditions.These updated drawings must be included in the O&M Manuals and appropriate section of the drawings placed in a data pocket located in each of the enclosures. The shop drawing at a minimum must show:

a. Overall dimensions, front, side and interior elevation views of the PCP showing size, location and labeling of each device.

b. Overall dimensions, front elevation of the GDP showing graphical layout and size, location and labeling of each device.

c. Power ladder diagram indicating power connections between TVSS, power conditioners, PLCs, power supplies and field and panel devices. Any terminal block connection numbers used must be indicated.

d. Control ladder diagram indicating control connections between field and devices and PLC I/O modules. Terminal block connection numbers and PLC terminal numbers must be indicated.

e. Communication connections between PLCs and I/O racks. Communication channel numbers must be indicated.

f. Bill of materials.

g. Written control sequence covering all inputs, outputs, and control scheme.

3.4.2 System Start-Up and Testing

a. At PCP start-up and testing provide personnel, on site, to provide technical assistance, program fine tuning, and to start-up and test the system. Start-up and testing must be coordinated with the overall fueling system start-up test specified in Section 33 08 53, AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Prior to this test, all connections must have been made between the PCP, the personal computer, the motor control center, and all field devices. In addition, check wiring for continuity and short circuits. Adjust set point values, timing values, and program logic as required to provide a functional hydrant fuel control system. Once the system has been fine tuned and passed the system test, load the new system default values into the PLC EEPROM and adjust the personal computer screens to indicate the new values.

b. Submit a step-by-step testing procedure of the PCP, Testing Plan. Design the test to show that every device (lights, switches, personal computer display screens, alarms, etc.) on the PCP and personal computer is in working order and that the PLC program controls the system per specifications. Perform the test in conjunction with Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Include a place for the contractor and Government representative to initial each step of the plan after satisfactory completion and acceptance of each step. Certify and submit the complete initialed testing plan, Record of Test.

3.4.3 Training Plan for Instructing Personnel

Upon completion of the system start-up a competent technician regularly employed by the PCP manufacturer must hold a training class for the instruction of Government personnel in the operation and maintenance of the system. Provide both classroom type theory instruction and hands-on instruction using operating equipment provided. The period of instruction must be a minimum of three 8-hour working days. The training must be designed to accommodate 8 operators, four maintenance personnel, and two programmers. The Government must receive written notice (via Contracting Officer) a minimum of 14 days prior to the date of the scheduled classes.

a. Furnish a written lesson plan and training schedule for Government approval at least 60 days prior to instructing operating, maintenance and programming personnel. Concurrently submit above to the SME for their input into the review process. Approval of lesson plan will be based on both Government and SME concurrence. This plan must be tailored to suit the requirements of the Government. The training must be divided into three separate classes. Each class must be tailored to a specific group of personnel. The groups are: 1) Operators, those that will use the control system on a day to day basis; 2) Maintenance personnel, those that will perform routine and non-routine maintenance and trouble shooting of the control system; 3) Programmers, those that will make changes to and trouble shoot the PLC and personal computer programs. The training program must provide:

(1) a detailed overview of the control system including the complete step-by-step procedures for start-up, operation and shut-down of the control system.
(2) a general overview of programmable logic controllers
(3) the maintenance of equipment installed
(4) the programming of the PLC and Personal Computer
(5) trouble shooting of the system

b. Use the complete approved Operation and Maintenance manuals for Section 33 09 54 PUMP CONTROL AND ANNUNCIATION SYSTEM (CUT-N-COVER TANKS) and 26 20 00 INTERIOR DISTRIBUTION SYSTEM (specifically pertaining to the motor control center and its relay ladder diagrams) for instructing operating personnel. Include both classroom and hands-on field instruction. Record the class in DVD format.

c. Also provide training courses in DVD format covering system overview, operation, maintenance, trouble shooting, and programming. Produce these DVDs on-site using the supplied Pump Control Panel as the teaching aid, or commercially produced DVDs by the PLC manufacturer or third party who specializes in training on PLC systems. In conjunction with the DVDs, provide O&M Manuals, which follow along with the DVDs.

3.5 PLC CONTROL SYSTEM SEQUENCE OF OPERATION

The following describes general functions of the fueling system components.

3.5.1 Abbreviations

a. SYS-1: components of System #1 including UPS#1, power supplies, CPU-1, I/O-1, and system #1 input and outputs.
b. SYS-2: components of System #2 including UPS#2, power supplies, CPU-2, I/O-2, and system #2 input and outputs.
c. CPU-1: SYS-1 PLC CPU.
d. CPU-2: SYS-2 PLC CPU.
e. I/O-1: SYS-1 PLC input/output modules.
f. I/O-2: SYS-2 PLC input/output modules.
g. PCP: Pump Control Panel.
h. PC: Personal Computer.
i. UPS: Uninterruptible Power Supply.

3.5.2 Operating Tanks

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NOTE: Use the following paragraphs for level alarms as electronic level switches are used for determining tank level alarms.

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3.5.2.1 Level Alarms

Each CUT-N-COVER tank has two level switches to monitor its fuel level. Connect the switches to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The following alarms must be reported.

a. Low-Low Level: When the low-low level elevation is attained the associated tank's GDP low-low level light illuminates. The alarm annunciator's critical alarm sequence activates, the tank's fueling pumps running in automatic mode must be disabled and these pumps must not be allowed to start automatically. If both tanks are at low-low level, automatic starting of fueling pumps must be disabled.

b. Low Level: When the low level elevation is attained the associated tank's GDP low level light illuminates. The alarm annunciator's non-critical alarm sequence activates.

c. High Level: When the high level elevation is attained the associated tank's GDP high level light illuminates and the alarm annunciator's non-critical alarm sequence activates.

d. High-High Level: When the high-high level elevation is attained the associated tank's GDP high-high level light illuminates, the alarm annunciator's critical alarm sequence activates, fueling pumps running in automatic mode must be disabled and no pump must be allowed to start automatically.

3.5.2.2 Tank Outlet Valves

Each operating tank's outlet valve (I11 & I12) has two limit switches to indicate valve position. The closed limit switch is connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. Close the closed limit switch when the valve is fully closed. When the closed limit switch is closed the associated tank's valve graphic display closed light must activate. When the valve is fully open, the open limit switch is closed. At this time the associated tank's valve graphic display open light must activate.

3.5.2.3 Level Annunciation

Each CUT-N-COVER tank has a level indicator/ATG (Automatic Tank Gauge) to measure its fuel level. Connect the ATG directly to the installation FAS System and additionally be connect to the PCP as shown on the drawings. Display the tank levels on the Graphic Screen.

3.5.3 Product Recovery Tank

3.5.3.1 Fuel Transfer Pump (FTP)

The pump's motor controller has a status relay to indicate the on/off status of the pump. Connect the status relay to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the pump's graphic display off light must light. When the status relay is closed the pump's graphic display on light must light. Also use the status relay state to start and stop the pumps elapsed run time timer.

3.5.3.2 Overfill Valve (OV)

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NOTE: The automatic starting and stopping of the fuel transfer pump is accomplished by the actuation of tank float switches connected to the control circuit in the motor control center. The PLC system does not control the starting and stopping.

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The tank's overfill valve has a limit switch to indicate valve position.

Connect the switch, SPST, to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The switch must close when the valve is fully closed. When the limit switch is closed the tank's graphic display valve closed light must light and the alarm annunciator's non-critical alarm sequence activates. When the limit switch is open the tank's graphic display valve open light must light.

3.5.3.3 High Level Alarm

The tank has a high level alarm float switch. Connect the switch, SPST, to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the high level alarm float is activated the tank's graphic display high level light must light and the alarm annunciator's critical alarm sequence activates.

3.5.3.4 Leak Detection

The tank has a leak detection system. Connect the leak detection systems alarm relay to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the leak alarm is activated the alarm annunciator's non-critical alarm sequence activates.

3.5.4 Fueling Pumps (FP)

There are ten fueling pumps with five being in each tank. A maximum of four fueling pumps could run concurrently from one tank. A lead tank selector switch determines which tanks pumps are active. The lead pump selector switches must select the pump starting sequence in each tank. Each pump's motor controller has a status relay to indicate the on/off status of the pump. Connect the status relay to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. The status relay state must also be used to start and stop the pumps elapsed run time timer and must be displayed on screen number 2.

3.5.5 Flow Switch, Fueling Pump

On the discharge side of each pump is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. If the PLC has given a signal to start a pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump must be in a failure state and it must be disabled (taken out of the starting sequence), the alarm annunciator's non-critical alarm sequence must also be activated, and the next pump in the start sequence started. After the PLC has stopped all of the pumps, any failed pump must be added back into the start sequence.

3.5.6 Transmitters

3.5.6.1 Pressure Indicating Transmitter (PIT)

The PIT's measure system pressure in kiloPascals pounds per square inch. There are two PITs for redundancy. PIT-1 and PIT-2 are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The system pressure is sent to personal computer display. PIT-3 is connected directly to the Tightness Test Panel.

3.5.6.2 Differential Pressure Transmitter (DPT)

The DPT's measure flow in liters per second gallons per minute. There are two issue DPTs (DPT-1 and DPT-2) and two return DPTs (DPT-3 and DPT-4) for redundancy. The DPTs are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The net flow is sent to the personal computer display. The issue rate, return rate and net flow must be displayed on the personal computer.

3.5.6.3 Pressure Sensors (PS)

The PS measure system pressure in kiloPascals pounds per square inch. There are three PS installed on the system and there are PCP preparations made for a fourth PS to be temporarily wired in from a Hydrant Pit. PS-1, PS-2, PS-3, and PS-4 are connected to SYS-1 only as indicated on the Terminal Block Connection drawing. These sensors must report various system pressures to the personal computer to be used for the system pressure test and for the creation of the system graphs as required for screen 7 and described in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP.

3.5.7 Control Valves

3.5.7.1 Defuel/Flush Valve (D/FV)

Connect the D/FV to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. Activate the graphical display open and closed lights and screen number 2 status based on the PLC's output status for the valve. Base the valve status on the table listed below.

Defuel/Flush Valve Operation - Two Solenoids

Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Flush Mode	Open	De-energized	Energized	Open
Automatic Mode Pump(s) On	Closed	De-energized	De-energized	Closed
Automatic Mode Pumps Off	Enabled	Energized	De-energized	Closed
Off Mode Pump(s) On	Closed	De-energized	De-energized	Closed
Off Mode Pumps Off	Enabled	Energized	De-energized	Closed
Tightness Test	Closed	De-energized	De-energized	Closed

3.5.7.2 Pressure Control Valve (PCV)

Connect the PCV to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. The graphical display enabled and closed lights and screen number 2 status must activate based on the PLC's output status for the valve. Base the valve status on the table listed below.

Pressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Automatic Mode Pumps Off	Enabled	De-energized	De-energized	Enabled
Automatic Mode Pump(s) On	Closed	Energized	De-energized	Closed
Flush Mode Pumps On	Closed	Energized	De-energized	Closed
Flush Mode Pumps Off	Enabled	De-energized	De-energized	Closed
Off Mode Pump(s) On	Closed	Energized	De-energized	Closed
Off Mode Pumps Off	Enabled	De-energized	De-energized	Enabled
Tight. Test-Hi Pres	Closed	Energized	De-energized	Closed
Tight. Test-Static	Enabled	De-energized	De-energized	Enabled
Tight. Test-Low Pres	Enabled	Energized	Energized	Enabled

3.5.7.3 Backpressure Control Valve (BPCV)

Connect the BPCV to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. The graphical display enabled and closed lights and screen number 2 status must activate based on the PLC's output status for the valve. Base the valve status on the table listed below.

Backpressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Automatic Mode Pump Start-Up	Enabled	Energized	De-energized	Enabled
Automatic Mode Prior to Lead Pump Shutoff	Closed	De-energized	De-energized	Closed
Flush Mode	Closed	De-energized	De-energized	Closed
Off Mode Pump(s) On	Enabled	Energized	De-energized	Enabled
Off Mode Pumps Off	Closed	De-energized	De-energized	Closed
Tight. Test-Hi Pres	Enabled	De-energized	Energized	Enabled
Tight. Test-Low Pres	Closed	De-energized	De-energized	Closed

3.5.8 Safety Circuit

3.5.8.1 Emergency Stop Status

Connect the emergency stop circuit status relay (ER1) N.O. contact to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the circuit is activated the alarm annunciator's critical alarm sequence is activated and any calls to start fueling pumps must be canceled and no additional pump start signals must be sent until the circuit has been reset. The fueling pumps must actually be stopped by a emergency stop circuit status relay (ER2) N.O. contact in the fuel pump motor control circuit located in the motor control center.

3.5.8.2   Emergency Shutoff Valves (ESO) Status

Connect the ESO status relay (ER2) N.O. contact to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the relay is closed the GDP valve open lights must light. When the relay is open the GDP valve closed lights must light.

3.5.8.3   Circuit Power Status

Connect the safety circuit power status relay (ER3) N.O. contact to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the relay is closed the PCP emergency circuit power on light must light.

3.5.9   Pump Control Panel

3.5.9.1   CPU Faults

The PCP mounted CPU-1 and CPU-2 on lights are connected to both SYS-1 and SYS-2. The associated CPU light must light when no system faults are detected. When a fault is detected by the CPU or it's redundant CPU the faulted CPU's on light must be turned off and the alarm annunciator's non-critical alarm sequence must be activated.

3.5.9.2   Input Select Switch

The 2-position input select switch must control which inputs (System-1 or System-2) are being used. Connect each switch position to both SYS-1 and SYS-2. The OI display must indicate the active system.

3.5.9.3   Mode Select Switch

The 4-position switch selects what mode of fueling is active: automatic, flush, Tightness Test or off. Connect each switch position to both SYS-1 and SYS-2. The screen number 2 status must indicate the active mode.

3.5.9.4   Lead Tank Selector Switch

The 2-position switch selects which tank must be the operating tank. The screen number 2 status display must indicate the operating tank.

3.5.9.5   Lead Pump Selector Switches

The two 5-position switches select which pump must be the lead pump in a given tank. The switch position must fix the starting sequence for all pumps. The sequences for tank one must be 1-2-3-4-5, 2-3-4-5-1, 3-4-5-1-2, 4-5-1-2-3, and 5-1-2-3-4. The sequences for tank two must be 6-7-8-9-10, 7-8-9-10-6, 8-9-10-6-7, 9-10-6-7-8, and 10-6-7-8-9. The off sequence must be the reverse of the start sequence; therefore, first on must be last off. A maximum of four pumps are allowed to run at one time. If a pump fails to start or fails during operation, disable that pump and start the next pump in the sequence. The screen number 2 status display must indicate the lead pump.

3.5.9.6 PCP Temperature Alarm

The alarm thermostat when activated must activate the alarm annunciator's non-critical alarm sequence.

3.6 OPERATING PROGRAM REQUIREMENTS

Store the control system's logic program on an EEPROM chip. Permanently store default values of operator adjustable parameters on the chip with the capability of resetting the values in RAM to the values within the range specified below. The default values can be changed through the use of the personal computer (after the correct password has been entered). After loss of power and battery failure the adjustable settings must revert back to the default values located on the chip. The default values shown here must be reset to the values determined during the system start up and test.

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Lead pump starting pressure	205 to 1035 kPa30 to 150 psi	415 kPa60 psi
Issue flow to start second pump in sequence	25 to 40 L/s450 to 650 gpm	35 L/s560 gpm
Issue flow to start third pump in sequence	65 to 80 L/s1000 to 1300 gpm	73 L/s1160 gpm
Issue flow to start fourth pump in sequence	100 to 120 L/s1600 to 1900 gpm	111 L/s1760 gpm
Return flow to enable next pump in sequence to start	0.5 to 6 L/s10 to 100 gpm	2.5 L/s40 gpm
Return flow to stop fourth, third, and second pump in sequence (lag pump)	30 to 50 L/s500 to 800 gpm	44 L/s700 gpm
Return flow to initiate lead pump shutdown sequence	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds
Timer to enable second, third, and fourth pumps to start	0 to 120 seconds	10 seconds
Timer to stop fourth, third, and second pumps	0 to 120 seconds	15 seconds
Timer to stop first pump	0 to 60 seconds	2 seconds
Timer to de-energize (close) Back Pressure Control Valve	0 to 360 seconds	300 seconds

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds
System pressure to stop lead pump	895 to 1310 kPa130 to 190 psig	965 kPa140 psig
Operating Tank No. 1 Low-Low level indication	0 to 2 m0 to 6 feet	510 mm1.6773 feet
Operating Tank No. 2 Low-Low level indication	0 to 2 m0 to 6 feet	510 mm1.6773 feet
Operating Tank No. 1 Low level indication	0 to 2 m0 to 6 feet	675 mm2.22 feet
Operating Tank No. 2 Low level indication	0 to 2 m0 to 6 feet	675 mm2.22 feet
Operating Tank No. 1 High level indication	5 to 7.5 m18 to 24 feet	6.5 m21 feet 3 inches
Operating Tank No. 2 High level indication	5 to 7.5 m18 to 24 feet	6.5 m21 feet 3 inches
Operating Tank No. 1 High-High level indication	5 to 7.5 m18 to 24 feet	6.85 m22 feet 5-1/2 inches
Operating Tank No. 2 High-High level indication	5 to 7.5 m18 to 24 feet	6.85 m22 feet 5-1/2 inches
Should the operator enter a value not within the range for that parameter, the personal computer must indicate "INVALID ENTRY" and revert back to the previous value.		
A number inside braces, {x}, in the following paragraphs indicates that the number may be changed by the operator via the operator interface within the Set Point Range listed above.		

3.7 AUTOMATIC MODE - IDLE CONDITION

The fueling system is intended to remain continuously pressurized while in the idle condition. This allows the system to respond immediately to aircraft refueling and defueling requirements. Periodically, in the idle condition, the system will lose minimal pressure. When this occurs, the control system must automatically repressurize in the following sequence:

a. Start the lead pump when the system pressure is less than 415 kPA 60 psig continuously for 0 seconds. Reset the timer if the pressure then rises above 415 kPA 60 psig before the timer expires.

b. After the timer expires:

   (1) Energize the BPCV solenoid 'A' to enable the valve to modulate the system pressure at it's set point.

   (2) Energize the PCV solenoid 'A' to close the valve.

   (3) De-energize the D/FV solenoid 'A' so the valve is closed and solenoid 'B' is de-energized.

c. With the lead pump running, 38 L/s 600 gpm flows through the issue venturi. The system pressure upstream of the BPCV must increase to the BPCV set point of 900 kPa 130 psig. At this pressure the BPCV must start to open and the valve modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

d. With the lead pump running and no fueling demand the return venturi flow rate must equal the issue venturi flow rate. When the return venturi flow rate is greater than 35 L/s 560 gpm a 300 second timer must start. If the flow rate drops below 35 L/s 560 gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

e. After the timer expires:

   (1) The BPCV solenoid 'A' must be de-energized to close the valve.

   (2) The PCV solenoid 'A' must be de-energized to bleed system pressure to 515 kPa 75 psig.

   (3) When system pressure rises to 965 kPA 140 psig a {2} second timer must start. After the timer has expired, the lead pump must be stopped.

   (4) The Defuel/Flush valve solenoid "A" must be energized 30 seconds after lead pump shut down to allow it to open at 550 kPa 80 psig for defuel operations.

f. The system has now returned to a pressurized and idle condition.

g. When a fueling pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

h. If a fueling pumps flow switch opens after the pump has successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

3.8 AUTOMATIC MODE - REFUELING CONDITION

To start an aircraft fueling operation, an operator connects fueling equipment such as a hydrant hose truck to an aircraft and to a hydrant control valve. When the operator opens the hydrant control valve by use of an hydraulic operated "Deadman", the following sequence occurs:

a. The lead pump will start when the PIT senses a pressure less than {415} kPa {60} psig continuously for {0} seconds. If the pressure then rises above {415} kPa {60} psig before the timer expires, the timer must reset.

b. After the timer expires:

    (1) The BPCV solenoid 'A' must be energized to enable the valve to modulate the system pressure at it's set point.

    (2) The PCV solenoid 'A' must be energized to close the valve.

    (3) The D/FV solenoid 'A' must be de-energized so the valve is closed and solenoid 'B' must be de-energized.

c. With the lead pump running, ±38 L/s600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 900 kPa 130 psig. At this pressure the BPCV will start to open and the valve will modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

d. With lead pump running and a issue venturi flow rate greater than {35} L/s {560} gpm and a return venturi flow rate greater than {2.5} L/s {40} gpm and less than {35} L/s {560} gpm the lead pump will continue to run and the BPCV will modulate to pass flow as necessary to maintain upstream system pressure.

e. With the lead pump running and a issue venturi flow rate greater than {35} L/s {560} gpm and a return venturi flow rate greater than {35} L/s {560} gpm a {300} second timer must start. If issue venturi flow rate falls below {35} L/s {560} gpm or the return venturi flow rate falls below {35} {560} before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

f. After the timer expires:

    (1) The BPCV solenoid 'A' must be de-energized to close the valve.

    (2) The PCV solenoid 'A' must be de-energized to bleed system pressure to 520 kPa 75 psig.

    (3) When system pressure rises to 965 kPa 140 psig a {2} second timer must start. After the timer has expired, the lead pump must be stopped.

    (4) The Defuel/Flush valve solenoid "A" must be energized 30 seconds after lead pump shut-down to allow it to open at 550 kPa 80 psig for defuel operations.

g. With the lead pump running and a issue venturi flow rate greater than {35} L/s {560} gpm and a return venturi flow rate less than {2.5} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {35} L/s {560} gpm or the return venturi flow rate rises above {2.5} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

h. After the timer expires: The second pump must start.

i. With the lead and second pumps running and a issue venturi flow rate greater than {73} L/s {1160} gpm and a return venturi flow rate of greater than {2.5} L/s {40} gpm and less than {44} L/s {700} gpm the lead and second pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

j. With the lead and second pumps running and a issue venturi flow rate greater than {73} L/s {1160} gpm and a return venturi flow rate greater than {44} L/s {700} gpm a {15} second timer must start. If issue venturi flow rate falls below {73} L/s {1160} gpm or the return venturi flow rate falls below {44} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

k. After the timer expires: The second pump must be stopped.

l. With the lead and second pump running and a issue venturi flow rate greater than {73} L/s {1160} gpm and a return venturi flow rate less than {2.5} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {73} L/s {1160} gpm or the return venturi flow rate rises above {2.5} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

m. After the timer expires: The third pump must start.

n. With the lead, second and third pumps running and a issue venturi flow rate greater than {111} L/s {1760} gpm and a return venturi flow rate of greater than {2.5} L/s {40} gpm and less than {44} L/s {700} gpm the lead, second and third pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

o. With the lead, second and third pumps running and issue venturi flow rate greater than {111} L/s {1760} gpm and a return venturi flow rate greater than {44} L/s {700} gpm a {15} second timer must start. If the issue venturi flow rate falls below {111} L/s {1760} gpm or the return venturi flow rate falls below {44} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

p. After the timer expires: The third pump must be stopped.

q. With the lead, second and third pumps running and a issue venturi flow rate greater than {111} L/s {1760} gpm and a return venturi flow rate less than {2.5} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {111} L/s {1760} gpm or the return venturi flow rate rises above {2.5} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

r. After the timer expires: The fourth pump must start.

s. With the lead, second, third and fourth pumps running and a issue venturi flow rate greater than 149 L/s 2360 gpm and a return venturi flow rate of greater than {2.5} L/s {40} gpm and less than {44} L/s

{700} gpm the lead, second, third and fourth pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

t. With the lead, second, third and fourth pumps running and a issue venturi flow rate greater than 149.4 L/s 2368 gpm and a return venturi flow rate greater than {44} L/s {700} gpm a {15} second timer must start. If the issue venturi flow rate falls below 149 L/s 2360 gpm or the return venturi flow rate falls below {44} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

u. After the timer expires: The fourth pump must be stopped.

v. When a fueling pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

w. If a fueling pumps flow switch opens after the pump successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

3.9 AUTOMATIC MODE - DEFUELING CONDITION

To start an aircraft defuel operation, an operator connects a hydrant hose truck to an aircraft and a fuel sense line and an air sense line to the hydrant control valve. The hydrant hose truck has an on-board defuel pump capable of delivering 19 L/s 300 gpm at 1140 kPa 165 psig. When the operator starts the defuel operation one of the following occurs:

a. If the fueling pumps are running (D/FV closed) the fuel being removed from the aircraft will either go to the other aircraft(s) connected to the system or be returned to the pumphouse where the BPCV will modulate to control system pressure and the fuel will be returned to the operating tanks. The return venturi flow rate will control the number of pumps that are on as discussed in paragraph "AUTOMATIC MODE - FUELING CONDITION".

b. If the fueling pumps are off (D/FV enabled) the fuel being removed from the aircraft will be returned to the pumphouse and both the D/FV and the PCV will modulate to return the fuel to the operating tanks.

3.10 FLUSH MODE

This mode must be used when the system need to be flushed of water or sediment. The operators will first place the manual valve in the desired position to select the appropriate flow path. Placing the selector switch in "flush" the following must occur:

a. The BPCV solenoid 'A' must be de-energized to force it closed.

b. The D/FV solenoid 'A' must be de-energized to allow the valve to open and the D/FV solenoid 'B' must be energized to force it open.

c. Start the fueling pump(s) manually using the Hand-Off-Auto or Hand-Auto switch to obtain the desired flow rate. The automatic pump starts must be disabled in this mode.

d. The PCV solenoid 'A' must be energized when pump(s) are on and de-energized when the pumps are off.

e. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

3.11 TIGHTNESS TEST MODE

This mode must be used in conjunction with the Tightness Monitoring Panel provided by Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT to perform tightness tests. Placing the selector switch to "TIGHTNESS TEST" the PCP must send a signal to the Tightness Monitoring Panel telling it that it is ready to perform the tests. At this time it also operates three MOV valves, closing I25 and I26 and opening I27. The PCP then receives signals from the Tightness Monitoring Panel to prepare for High Pressure Test, run High Pressure Test, Prepare for Low Pressure Test, run Low Pressure Test, prepare for Second High Pressure Test, run Second High Pressure Test, and when the test is over. The following PCP actions will occur after the corresponding signal:

3.11.1 High Pressure Test Preparation

a. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be energized to enable the valve at the 1100 kPa 160 psi value.

b. The D/FV solenoid "A" must be de-energized and the D/FV solenoid "B" must be de-energized to force it closed.

c. Automatically start the lead fueling pump to obtain pressure.

d. The PCV solenoid "A" must be Energized and PCV solenoid "B" must be de-energized to close the valve.

e. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. MOV I32 must be opened.

h. The pump will continue to run until such time as the run High Pressure test signal is received. Note: the Tightness Monitoring Panel is monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the High Pressure test.

3.11.2 Run High Pressure Test

a. MOV I32 will be closed.

b. Fueling pump will be shut off.

c. The BPCV solenoid "A" must be d-energized and the BPCV solenoid "B" must be de-energized to close valve.

d. The PCV solenoid "A" will be de-energized and the PCV solenoid "B" will be de-energized to enable the valve at the 515 kPa 75 psi value. Note: the Tightness Monitoring Panel will wait for a 10 minute settling time to pass, then it will monitor the loop pressure for 2 minutes. Upon finishing this test it will instruct the PCP to Prepare for the Low Pressure Test.

3.11.3 Low Pressure Test Preparation

a. MOV I32 will be opened.

b. The PCV solenoid "A" will be energized and the PCV solenoid "B" will be energized to enable the valve at the 345 kPa 50 psi value.

c. The system will remain in this status until such time as the PCP receives a Run Low Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will monitor the loop pressure until it reaches the 345 kPa 50 psi value. It will then instruct the PCP to run the Low pressure test.

3.11.4 Run Low Pressure Test

a. MOV I32 will be closed.

b. The system will remain in this status until such time as the PCP receives a Prepare for Second High Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will wait for a 10 minute settling period to expire, then it will monitor the loop pressure for 2 minutes. Upon finishing this test it will instruct the PCP to prepare for Second High Pressure Test.

3.11.5 Second High Pressure Test Preparation

a. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be energized to enable the valve at the 1100 kPa 160 psi value.

b. The D/FV solenoid "A" must be de-energized and the D/FV solenoid "B" must be de-energized to force it closed.

c. Automatically start the lead fueling pump to obtain pressure.

d. The PCV solenoid "A" must be de-energized and PCV solenoid "B" must be de-energized to close the valve.

e. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. MOV I32 will be opened.

h. The pump will continue to run until such time as the run Second High

Pressure test signal is received. Note: the Tightness Monitoring Panel is monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the Second High Pressure test.

3.11.6 Run Second High Pressure Test

a. MOV I32 will be closed.

b. Fueling pump will be shut off.

c. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be de-energized to close valve.

d. The PCV solenoid "A" will be de-energized and the PCV solenoid "B" will be de-energized to enable the valve at the 515 kPa 75 psi value. Note: the Tightness Monitoring Panel will wait for a 10 minute settling time to pass, then it will monitor the loop pressure for 2 minutes. Upon finishing this test it will instruct the PCP that testing is finished.

e. The PCP will leave the system as is until such time as the PCP selector switch is placed into a different mode.

3.12 OFF MODE

a. Automatic starting of fueling pumps must be disabled. All other functions (GDP, alarm annunciator, operator interface, control valve solenoids, etc.) must be active to allow manual control of the fueling pumps using the Hand-Off-Auto or Hand-Auto switch.

b. When the first pump has been started:

  (1) The BPCV solenoid 'A' must be energized to enable the valve to modulate the system pressure at it's set point.

  (2) The PCV solenoid 'A' must be energized to close the valve.

  (3) The D/FV solenoid 'A' must be de-energized so the valve is closed and solenoid 'B' must be de-energized.

c. The second, third and fourth pumps maybe started or stopped manually as needed by the operator.

d. After the last pump has been stopped:

  (1) The BPCV solenoid 'A' must be de-energized.

  (2) The PCV solenoid 'A' must be de-energized.

  (3) The D/FV solenoid 'A' must be energized and D/FV solenoid 'B' must be de-energized.

3.13 MANUAL OPERATION OF FUELING PUMPS

a. If the PLC system is still active see paragraph OFF MODE.

b. If the PLC system has no power or both CPUs have faulted (CPU lights on PCP off) the pumping system will be in a completely manual mode. The safety circuit will need power so that the ESO solenoids on the non-surge check valves will be open and fuel can flow. The solenoids on the other solenoid controlled valves will be de-energized so the valves will have to be manually opened or enabled for the system to run. Other valves may need to be opened or closed manually by the operators for the system to work properly.

3.14 4-VALVE MANIFOLD SUPERVISION

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NOTE: The drawing referenced below is from the DEPARTMENT OF DEFENSE CUT'N'COVER STANDARDS STORAGE TANK/PUMPHOUSE AND FILTER BUILDING Standard Drawings. Add the drawing to the design package if applicable.

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a. Prior to initiating fueling operations in the automatic or in the test mode, the 4-valve manifold valves and the two tank outlet valves must be in the proper positions for successful fueling operations. The PLC must monitor valve positions of the 4-valve manifold (sensed by position limit switches for fully opened and fully closed status on valves I34, I35, R10, and R11) and by monitoring valve status on the tank outlet valves (sensed by position limit switches for fully opened and fully closed status on valves I11 and I12). Valve position must conform to the valve position table listed on drawing M-204.

b. If the system is placed in automatic or test mode the valve selections must conform to the position table on sheet M-204. If the valve positions do not conform to this table the PCP will show a 4-Valve manifold error on the alarm annunciator. The alarm can be silenced, but will not reset until such time as the valve positions do conform to the table.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 11 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 11 00 (February 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING

08/24

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 11 00 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 11 00 (February 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING

08/24

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NOTE: This guide specification covers the requirements for potable and non-potable (i.e., raw water, sea, salt water) systems, in which the largest size pipe is 1200 mm 60 inches in diameter and the maximum system working pressure is 1000 kPa 150 psi. This maximum working pressure depends on piping materials and appurtenances listed in this specification. Ensure that the pressure class of piping materials and appurtenances exceeds the maximum working pressure of the system. The water system consists of topics such as water mains, transmission mains, water service lines, valves, water meters, and fire hydrants. The water system begins 1.5 m 5 feet from the perimeter of buildings or structures. Water lines within 1.5 m 5 feet of the building are typically covered by Division 22 specifications and occasionally Division 40 specifications.

When control systems are used to monitor water utility systems include Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

For areas outside of the United States (U.S.), U.S. Territories and Possessions determine if required materials are suitable or if an equivalent host nation standard is required. Design must comply with the applicable U.S. & Host Nation norms, regulations and all applicable U.S. Military criteria. Where a host nation standard is required, an equivalent host nation standard may supersede the required material indicated in this specification. Equivalency and compliance statement in duel languages must be provided and certified by the Host Nation engineer, registered on the country’s professional rolls.

For corrosive soils select materials, coatings or cathodic protection systems in accordance with UFC

3-230-01. When cathodic protection is used include Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM.

When piping is beneath open piers and other exposed locations is subject to freezing temperatures, include requirements for insulation and protective coverings in the project specification.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: For Army and Air Force, impress current cathodic protection(ICCP) may be used. When ICCP is used include Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM.

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For Navy Only: Comply with CNIC Instructions CNICINST 5090.1B for areas outside of the U.S.

****

PART 1 GENERAL

1.1 UNIT PRICES

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NOTE: This Article is tailored for AIR FORCE and ARMY.

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Measurement and payment will be based on completed work performed in accordance with the drawings, specifications, and the Contract payment schedules.

1.1.1 Measurement

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NOTE: The following paragraph contains additional tailoring for FIRE HYDRANTS.

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The length of water lines will be determined by measuring along the centerlines of the various sizes of pipe provided. Pipe will be measured from center of fitting to center of fitting, from center of water main to center of fire hydrant, and from center of water main to end of service connection. No deduction will be made for the space occupied by valves or fittings.

1.1.2 Payment

Payment will be made for water lines at the Contract unit price per linear meter foot for the various types and sizes of water lines, and will be full compensation for all pipes, joints, specials, and fittings, complete and in place. Payment for fire hydrants, valves, and valve boxes will be made at the respective Contract unit price each for such items complete and in place. Payment will include providing all testing, plant, labor, and material and incidentals necessary to complete the work, as specified and as shown.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2023) Manual for Railway Engineering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.3	(1976; R 2003; R 2008; R 2013; R 2018; R 2023) Dryseal Pipe Threads (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2024) Hypochlorites
AWWA B301	(2024) Liquid Chlorine
AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

AWWA C205	(2024) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied
AWWA C206	(2023) Field Welding of Steel Water Pipe
AWWA C207	(2023) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C208	(2022) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	(2019) Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fitting for Steel Water Pipelines
AWWA C210	(2024) Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C213	(2022) Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
AWWA C219	(2023) Bolted Sleeve-Type Couplings for Plain-End Pipe
AWWA C300	(2022) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C301	(2014; R 2019) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C303	(2024) Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C502	(2018) Dry-Barrel Fire Hydrants
AWWA C503	(2021) Wet-Barrel Fire Hydrants
AWWA C504	(2023) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C509	(2023) Resilient-Seated Gate Valves for Water Supply Service
AWWA C511	(2017; R 2021) Reduced-Pressure Principle Backflow Prevention Assembly
AWWA C512	(2015) Air-Release, Air/Vacuum, and Combination Air Valves for Water and

	Wastewater Service
AWWA C515	(2020) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C520	(2019) Knife Gate Valves, Sizes 2 In. (50 mm) Through 96 In. (2,400 mm)
AWWA C550	(2024) Protective Interior Coatings for Valves and Hydrants
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C602	(2023) Cement–Mortar Lining of Water Pipelines in Place—4 In. (100 mm) and Larger
AWWA C604	(2017) Installation of Buried Steel Water Pipe—4 In. (100 mm) and Larger
AWWA C605	(2021) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C606	(2022) Grooved and Shouldered Joints
AWWA C651	(2023) Standard for Disinfecting Water Mains
AWWA C655	(2018) Field Dechlorination
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C701	(2019) Cold-Water Meters - Turbine Type for Customer Service
AWWA C702	(2019) Cold-Water Meters - Compound Type
AWWA C703	(2019) Cold-Water Meters - Fire Service Type
AWWA C704	(2019) Propeller-Type Meters for Waterworks Applications
AWWA C707	(2022) Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C800	(2021) Underground Service Line Valves and Fittings
AWWA C900	(2022) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA C901	(2020) Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19mm) Through 3 In. (76

	mm), for Water Service
AWWA C906	(2021) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. through 65 In. (100 mm Through 1,650 mm), for Waterworks
AWWA C909	(2022) Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. (100 mm) and Larger
AWWA C950	(2020) Fiberglass Pressure Pipe
AWWA M6	(2012) Water Meters - Selection, Installation, Testing, and Maintenance
AWWA M9	(2008; Errata 2013) Manual: Concrete Pressure Pipe
AWWA M11	(2017; Errata 2018, Addendum 2019) Steel Pipe: A Guide for Design and Installation
AWWA M23	(2020) Manual: PVC Pipe - Design and Installation - Third Edition
AWWA M41	(2009; 3rd Ed) Ductile-Iron Pipe and Fittings
AWWA M45	(2013; 3rd Ed) Fiberglass Pipe Design
AWWA M55	(2020; 2nd Ed) PE Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A563/A563M	(2024) Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric)
ASTM A746	(2018; R 2022) Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM B32	(2020) Standard Specification for Solder Metal

ASTM B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C1433	(2024) Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM D1599	(2018) Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2683	(2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D2774	(2021a) Standard Practice for Underground

	Installation of Thermoplastic Pressure Piping
ASTM D2855	(2020) Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
ASTM D3035	(2022) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3839	(2014; R 2019) Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D4161	(2014; R 2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F714	(2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F1055	(2016; R 2022a) Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX)Pipe and Tubing
ASTM F1290	(2019) Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F1483	(2023) Standard Specification for Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe

ASTM F1674	(2018) Standard Test Method for Joint Restraint Products for Use with PVC Pipe
ASTM F1962	(2022) Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings
ASTM F2164	(2021) Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure
ASTM F2206	(2019) Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE)
ASTM F2620	(2024) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
ASTM F3190	(2021) Standard Practice for Heat Fusion Equipment (HFE) Operator Qualification on Polyethylene (PE) and Polymide (PA) Pipe and Fittings

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR List	(continuously updated) List of Approved Backflow Prevention Assemblies
FCCCHR Manual	(10th Edition) Manual of Cross-Connection Control

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8678	(1998) Cup Head Square Neck Bolts with Small Head and Short Neck-Product Grade B

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	(2025) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 1961	(2020) Standard on Fire Hose

NSF INTERNATIONAL (NSF)

NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities

UL SOLUTIONS (UL)

UL 246	(2011; Reprint Jul 2020) UL Standard for Safety Hydrants for Fire-Protection Service
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service
UL 312	(2022) UL Standard for Safety Check Valves for Fire-Protection Service

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-PUB-08	(2021) Tapping Guide for PVC Pressure Pipe

1.3 DEFINITIONS

1.3.1 Water Transmission Mains

****

NOTE: This paragraph is tailored for WATER TRANSMISSION.

****

Water transmission mains include water piping having diameters greater than 350 mm 14 inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.3.2 Water Mains

Water mains include water piping having diameters 100 through 350 mm 4 through 14 inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.3.3 Water Service Lines

****

NOTE: This paragraph is tailored for SERVICE LINES.

****

Water service lines include water piping from a water main to a building service connection 1.5 m 5 feet from the perimeter of buildings or structures, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.3.4 Additional Definitions

For additional definitions refer to the definitions in the applicable referenced standard.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Connections; G, [_____]

SD-03 Product Data

Pipe, Fittings, Joints and Couplings; G, [_____]

Ball And Socket Joint; G, [_____]

Valves; G, [_____]

Valve Boxes; G, [_____]

****
NOTE: The following submittal is tailored for HYDRANTS.
****

Fire Hydrants; G, [_____]

Pipe Restraint; G, [_____]

[Tapping Sleeves; G, [_____]

] **

NOTE: The following submittal is tailored for SERVICE LINES.

****

Corporation Stops; G, [_____]

****

NOTE: The following submittal is tailored for BACKFLOW PREVENTERS.

****

Backflow Preventer; G, [_____]

[Railroad Crossing Casing Pipe; G, [_____]

] Precast Concrete Thrust Blocks; G, [_____]

Disinfection Procedures; G, [_____]

Fusion Joining

SD-06 Test Reports

****

NOTE: The following submittal is tailored for BACKFLOW PREVENTERS.

****

Backflow Preventer Tests; G, [_____]

Bacteriological Samples; G, [_____]

Post-Construction Fusion Report; G, [_____]

****

NOTE: The following submittal is tailored for NAVY.

****

Hydrostatic Sewer Test

Leakage Test

Hydrostatic Test

SD-07 Certificates

Pipe, Fittings, Joints and Couplings

****

NOTE: The following submittal is tailored for AIR FORCE and ARMY.

****

Shop-Applied Lining[and Coating]

****
NOTE: The following submittal is tailored for DUCTILE IRON PIPING.
****

Lining

Lining for Fittings

****
NOTE: The following submittal is tailored for POLYETHYLENE PIPE.
****

Lining for Ductile Iron Fittings

Valves

****
NOTE: The following submittal is tailored for HYDRANTS.
****

Fire Hydrants

****
NOTE: The following three submittals are tailored for BACKFLOW PREVENTERS.
****

Backflow Prevention Training Certificate

[Backflow Tester Certification

][Backflow Certificate

] Fusion Technician Qualifications; G, [_____]

****
NOTE: The following five submittals are tailored for METERS.
****

[Turbine Type Meters

][Propeller Type Meters

][Displacement Type Meters

][Compound Type Meters

][Fire Service Type Meters

] SD-08 Manufacturer's Instructions

****
NOTE: The following submittal is tailored for

DUCTILE IRON PIPING.
****

Ductile-Iron Piping

PVC Piping

****
NOTE: The following submittal is tailored for PVCO PIPING.
****

PVCO Piping

****
NOTE: The following submittal is tailored for POLYETHYLENE PIPE.
****

Polyethylene (PE) Pipe

****
NOTE: The following submittal is tailored for AIR FORCE and ARMY.
****

Fiberglass Pipe, Fittings, Joints And Joint Materials

****
NOTE: The following three submittals are tailored for WATER TRANSMISSION.
****

[Concrete Pressure Pipe

][Prestressed Concrete Pressure Pipe

][Reinforced Concrete Cylinder Pipe

] **
NOTE: The following submittal is tailored for PVC SERVICE PIPING.
****

PVC Piping For Service Lines

****
NOTE: The following submittal is tailored for SERVICE LINES.
****

Copper Pipe For Service Lines

****
NOTE: The following submittal is tailored for POLYETHYLENE SERVICE PIPE AND TUBING.
****

Polyethylene (PE) Piping And Tubing For Service Lines

1.5 QUALITY CONTROL

1.5.1 Regulatory Requirements

****

NOTE: Effective January 2014, the Safe Drinking Water Act (SDWA) requirements for "lead free" were updated. The amended definition of "lead free*" is 0.20 percent max lead for solder and flux; 0.25 percent max lead for products by weighted average; Multiple component products are calculated to address total wetted exposure based upon wetted surface area of each component and that component's lead content by percentage.

Products that have been certified as being compliant with NSF 61 and having an NSF 61 mark, comply with the updated Safe Drinking Water Act lead free requirements and have a weighted average lead content less than or equal to 0.25 percent based on the average of their wetted surface areas. No lead is allowed to be added as an intentional ingredient in any product, material, ingredient or system component submitted for evaluation to this standard, with the exception of brass or bronze meeting the definition of "lead free" under the specific provisions of the Safe Drinking Water Act of the United States.

Select the NSF 61 paragraph for projects in the United States, Canada, and in countries where the NSF 61 Standard has been adopted for potable water.

Select the second paragraph in countries that have not adopted the NSF 61 Standard, the host nation standard may be used when it is determined to be equivalent to the NSF 61 standard.

Use NFPA 24 where water distribution systems provide both potable water and water for fire protection.

****

****

For Navy only: The host nation engineer, registered on the country’s professional rolls, must certify that the host nation standard is equivalent to the U.S. "lead free" requirement in accordance with the U.S. Safe Drinking Water Act. The certification must be provided on the cover sheet of project drawings and specifications, in dual languages. If the specifications coversheet does not have sufficient space for this certification, provide directly behind the coversheet on a separate page, including the project information from the coversheet. The code compliance certification must be provided as indicated in the following statement, dated, signed and stamped in accordance with the requirements set forth in Chapter 17 of of FC 1-300-09N. "HAVING

PARTICIPATED IN THE DESIGN OF PROJECT No. (Identify project number, project title, location), AND HAVING THOROUGHLY REVIEWED THE COMPLETED PROJECT DOCUMENTS, I DECLARE THAT THE HOST NATION STANDARD FOR POTABLE WATER MATERIALS IS EQUIVALENT TO THE U.S. SAFE DRINKING WATER ACT "LEAD FREE" REQUIREMENT.
****

[Use NSF/ANSI/CAN 61 materials for potable water systems to comply with lead free content requirements as defined by the U.S. Safe Drinking Water Act effective January 2014 and January 2022.

][Use [_____] for potable water materials for potable water systems.

][Comply with NFPA 24 for materials, installation, and testing of fire main piping and components.

]1.5.2 Qualifications

1.5.2.1 Backflow Preventers

****
NOTE: This paragraph and the following subparagraphs are tailored for BACKFLOW PREVENTERS.
****

1.5.2.1.1 Backflow Preventer Certificate

Certificate of Full Approval from FCCCHR List, University of Southern California, attesting that the design, size and make of each backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. Certificate of Provisional Approval will not be acceptable.

[1.5.2.1.1.1 Backflow Tester Certificate

****
NOTE: Keep the bracketed text when a third party backflow tester is required by State or local regulations or desired as a project specific requirement.
****

Prior to testing, submit to the Contracting Officer certification issued by the State or local regulatory agency attesting that the backflow tester has successfully completed a certification course sponsored by the regulatory agency.[Tester must not be affiliated with any company participating in any other phase of this Contract.]

]1.5.2.1.1.2 Backflow Prevention Training Certificate

Submit a certificate recognized by the State or local authority that states the Contractor has completed at least 10 hours of training in backflow preventer installations. The certificate must be current.

1.5.2.2 Fusion Technician Qualifications

Submit a certificate from the manufacturer of the fusible pipe that shows the fusion technician is fully qualified to install fusible pipe of the types and sizes being used. Qualification must be current as of the actual date of fusion performance on the project.

1.5.2.2.1 Fusion Technician Qualification on Polyethylene (PE) Pipe and Fittings

Provide certification for PE Pipe heat fusion in accordance with ASTM F3190.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery and Storage

****

NOTE: This paragraph contains tailoring for HYDRANTS.

****

Inspect materials delivered to site for required pipe markings and damage. Unload and store with minimum handling and in accordance with manufacturer's instructions to prevent cuts, scratches and other damage. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, fire hydrants, and other accessories free of dirt and debris or other contaminates.

1.6.2 Handling

****

NOTE: This paragraph contains tailoring for HYDRANTS.

****

Handle pipe, fittings, valves, fire hydrants, and other accessories in accordance with applicable AWWA standard, manufacturer's instructions and in a manner to ensure delivery to the trench in sound undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place other material, hooks, or pipe inside a pipe or fitting after the coating has been applied. Inspect the pipe for defects before installation. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. Clean the interior of pipe and accessories of foreign matter before being lowered into the trench and keep them clean during laying operations by plugging. Replace defective material without additional expense to the Government. Store rubber gaskets, not immediately installed, under cover or out of direct sunlight.

****

NOTE: This paragraph contains tailoring for DUCTILE IRON PIPING, PVCO PIPING, POLYETHYLENE PIPE, POLYETHYLENE SERVICE PIPE AND TUBING and AIR FORCE and ARMY.

****

Handle ductile iron pipe, fittings, and accessories in accordance with AWWA C600 and AWWA M41. Handle PVC and PVCO pipe, fittings, and accessories in accordance with AWWA C605. Handle PE pipe, fittings, and accessories in accordance with AWWA M55.[Handle fiberglass pipe, fittings, and accessories in accordance with AWWA M45.][Handle steel pipe, fittings and accessories in accordance with AWWA C604.]

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Specify fittings to withstand the hydrostatic test pressure specified in paragraphs HYDROSTATIC TEST, and SPECIAL TESTING REQUIREMENTS FOR FIRE SERVICE.

Show the following information on the project drawings:

Location of all new pipelines, diameter of pipe, fittings and appurtenances including but not limited to valves, fire hydrants, yard hydrants, thrust blocks, restrained joints and details where necessary;

Location, size, and type of service of existing connecting, intersecting, and adjacent pipelines and other utilities;

Paved areas and railroads which pass over new pipelines;

Connection of service line to water main, if different from that specified;

Where different materials are required, show the material, class or thickness of pipe and limits where class or thickness must be different for different sections of pipeline;

Bedding conditions;

Location of flanged joints, joints made with sleeve-type mechanical couplings, grooved and shouldered type joints, and insulating joints;

Size and shape of fire hydrant operating nut and cap nuts if nonstandard nuts are required; dimensions of threads (major diameter, minor diameter, pitch diameter, thread form, and number of threads per inch) on fire hydrant hose and pumper connections if nonstandard threads are required.

Refer to fire suppression Sections for items such as fire department connections and post indicator valves.

Select the NSF 61 paragraph for projects in the United States and Canada, and in countries where the NSF 61 Standard has been adopted for potable water.

Select the second paragraph in countries that have not adopted the NSF 61 Standard, the host nation

standard may be used when it is determined to be equivalent to the NSF 61 standard.

****

All materials are intended for potable water use unless otherwise indicated.[Comply with NSF/ANSI/CAN 61 for all potable water pipe, fittings and other applicable materials. Provide pipe, fittings and other applicable materials bearing NSF/ANSI/CAN 61 markings for potable water service.] [_____]

Provide all materials in accordance with AWWA C800 and as indicated herein. Provide valves and fittings with pressure ratings equivalent to the pressure ratings of the pipe.

2.1.1 Pipe, Fittings, Joints And Couplings

****

NOTE: Contaminated Areas:

AWWA Standards indicate that the selection of materials is critical for water pipe in locations where there is likelihood the pipe will be exposed to significant concentrations of pollutants composed of low-molecular-weight petroleum products or organic solvents or their vapors. Documented research has shown that pipe materials (such as polyethylene, polyvinyl chloride, and asbestos cement) and elastomers used in mechanically joined piping systems (such as those used in jointing gaskets and packing glands) may be subject to *permeation* by lower molecular weight organic solvents or petroleum products. If a water pipe must pass through such a contaminated area or an area subject to contamination, consult with the manufacturer regarding permeation of pipe walls, jointing materials, and so forth, *before* selecting materials for use in that area and refer to AWWA standards and AWWA, Water Research Foundation, report Number 91204 Impact of Hydrocarbons on PE/PVC Pipes and Gaskets.

Refer to the appropriate Unified Facilities Criteria, AWWA Standards and pipe manufacturer's information when evaluating suitability of materials.

Use tailoring options to select all piping materials for water transmission mains, water mains and water service lines which are suitable for use in the project.

Refer to the appropriate Unified Facilities Criteria, AWWA Standards and pipe manufacturer's information when evaluating suitability.

Pipe materials which are known to be unsuitable for particular local conditions (i.e., corrosion, deterioration, etc.) should not be deleted without consideration of protective coatings, where economically feasible.

****

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on[and rubber-gasketed bell-and-spigot] joints. Include information concerning gaskets with submittal for joints and couplings.

2.1.1.1 Ductile-Iron Piping

****

NOTE: This paragraph and the following subparagraphs are tailored for DUCTILE IRON PIPING.

****

****

NOTE: AWWA C151/A21.51, AWWA C115/A21.15 and AWWA C153/A21.53 include 80 mm through 1600 mm 3 in through 64 in ductile iron pipe or fittings, however, this guide specification covers requirements in which the largest size pipe is 1200 mm 60 inches. AWWA C110/A21.10 include 80 mm through 1200 mm 3 in through 48 in ductile iron fittings.

Insert the necessary Pressure Class/Thickness Class to meet project conditions, as determined from AWWA C151/A21.51, Tables for Pressure Class and Thickness Class.

Materials rated for a minimum of 1000 kPa 150 psi pipe will typically be specified for water systems. In some cases a higher classification may be required, comply with the minimum requirements in this specification and as required by the authority having jurisdiction.

Class 150 pipe is furnished with wall thickness suitable for installation with a standard design depth of cover and compacted backfill without blocks.

Cement-mortar linings with twice the standard thickness may be specified for ductile-iron pipe conveying unusually aggressive waters. Consideration will be given to the service life of the pipe and the potential for changes in treatment methods.

Use polyethylene encasement where soil conditions warrant, in accordance with AWWA C105/A21.5.

When pipe will be installed in contaminated ground conditions, select appropriate pipe and gasket material based on type and concentration of contaminants. Refer to AWWA C600.

For Army and Air Force: Coordinate with the cathodic protection engineer before using polyethylene encasement.

****

2.1.1.1.1 Pipe and Fittings

****

NOTE: Ductile iron piping may be used for transmission.

****

Pipe,[except flanged pipe,] AWWA C151/A21.51,[Pressure Class [_____]][Thickness Class [_____]].[Flanged pipe, AWWA C115/A21.15.] Fittings, AWWA C110/A21.10 or AWWA C153/A21.53[; fittings with push-on joint ends are to meet the same requirements as fittings with mechanical-joint ends, except for the factory modified bell design]. Provide fittings with pressure ratings equivalent to that of the pipe. Provide compatible pipe ends and fittings for the specified joints. Provide cement-mortar lining, AWWA C104/A21.4,[twice the] standard thickness on pipe and fittings.

2.1.1.1.2 Joints and Jointing Material

****

NOTE: Push-on joint or mechanical joint may be used except when the greater deflection afforded by the mechanical joint (as compared to the push-on joint) is considered necessary for all joints in the water system. See AWWA C600 for allowable deflection on each type of joint.

When mechanical joints, flanged joints, joints using sleeve-type mechanical couplings, grooved or shouldered type joints, and insulating joints are specified as exceptions to the basic jointing method, indicate their location(s) on the project drawings.

Show flanged joints, grooved joints, and shouldered joints on buried pipelines in valve pits or chambers on the drawings.

This subparagraph contains additional tailoring for AIR FORCE and ARMY.

****

[Provide[push-on joints[or mechanical joints]] for pipe and fittings[unless otherwise indicated].][Provide mechanical joints where indicated.][Provide flanged joints where indicated.][Provide mechanically coupled type joints using a sleeve-type mechanical coupling where indicated.][Provide [grooved][or][shouldered] type joints where indicated.][Provide insulating joints where indicated.][Sleeve-type mechanical couplings in lieu of push-on joints are acceptable, subject to the limitations specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS.][Utilize [grooved][or][shouldered] type joints in lieu of [flanged joint or]push-on joint, except where joint is buried.]

a. Push-On Joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly as recommended in AWWA C111/A21.11.

b. Mechanical Joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets as recommended in AWWA C111/A21.11.

c. Flanged Joints: Bolts, nuts, and gaskets for flanged connections as recommended in Appendix A of AWWA C115/A21.15. Provide AWWA C115/A21.15 ductile iron flanges and conform to ASME B16.1, Class 125.[Provide ASTM A536 epoxy coated steel set screw flanges. Gasket and lubricants for set screw flanges, in accordance with mechanical-joint gaskets specified in AWWA C111/A21.11.]

d. Insulating Joints: Designed to prevent metal-to-metal contact at the joint between adjacent sections of piping. Provide flanged type joint with insulating gasket, insulating bolt sleeves, and insulating washers. Provide full face dielectric type gaskets, as recommended in the Appendix to AWWA C115/A21.15. Bolts and nuts, as recommended in the Appendix to AWWA C115/A21.15.

e. Sleeve-Type Mechanical Coupled Joints: As specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS.

****

NOTE: The following list item is tailored for AIR FORCE and ARMY.

****

[f. [Grooved][and][Shouldered] Type Joints: [Grooved][and][shouldered] pipe ends and couplings, AWWA C606. Joint dimension as specified in AWWA C606 for rigid joints[, joint dimensions as specified in AWWA C606 for flexible joints].

]2.1.1.2 Plastic Piping

****

NOTE: Maximum working pressures are reduced for AWWA C900 pipe at temperatures greater than 23 degrees C 73.4 degrees F.

Maximum working pressures are reduced for AWWA C901 and AWWA C096 pipe at temperatures greater than 27 degrees C 80 degrees F.

In most locations, buried potable water systems typically operate below 23 degrees C 73.4 degrees F. Do not use plastic pipe when it will be subject to temperatures in excess of 37.8 degrees C 100 degrees F during installed usage or exposed to a source of heat from adjacent lines or equipment.

Do not use plastic piping in areas subject to potential spillage of aromatic hydrocarbons without consulting with the pipe manufacturer and referring to AWWA Standards. Aromatic hydrocarbons such as benzene and toluene will dissolve some types of plastic pipes.

When using plastic pipe in areas with contaminated soil or groundwater, consult with the manufacturer regarding permeation of pipe walls. When pipe is installed in contaminated soil or groundwater consult with the manufacturer regarding selection of appropriate gasket material based on type and concentration of contaminants and refer to AWWA

material standard.
****

2.1.1.2.1 PVC and PVCO Piping

2.1.1.2.1.1 PVC Piping

****
NOTE: AWWA C900 includes 100 mm through 1500 mm 4 in through 60 in PVC pipe and fabricated fittings. Use a minimum Pressure Class 150 (DR 27.55). See AWWA C900 Appendix A for surge information. Do not include PVC water main pipe when pipe of greater strength than Pressure Class 305 is required.

AWWA C905 has been withdrawn. AWWA C900 includes PVC pressure pipe up to a diameter of 1500 mm 60 in.

Ductile iron pipe size = cast iron pipe size; abbreviation DIOD=DIPS=CIOD=CIPS.
****

AWWA C900 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, with a minimum Pressure Class[150 (DR27.5),][165 (DR25),] [200 (DR21),][235 (DR 18),][250 (DR17)][305 (DR 14)] with ductile iron outside diameter (DIOD).

2.1.1.2.1.2 PVCO Piping

****
NOTE: This paragraph is tailored for PVCO PIPING.
****

****
NOTE: AWWA C909 includes 100 mm through 600 mm 4 in through 24 in PVCO pipe. Use a minimum Pressure Class 165. Do not include PVCO water main pipe when pipe of greater pressure class 305 is required.
****

AWWA C909, ASTM F1483 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, Pressure Class [165][_____] PVCO pressure pipe, with ductile iron outside diameter (DIOD).

2.1.1.2.1.3 Fittings for PVC and PVCO Pipe

Ductile iron fittings, AWWA C110/A21.10 or compact fittings in accordance with AWWA C153/A21.53, with cement-mortar lining for fittings, AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends are to conform to the same requirements as fittings with mechanical-joint ends, except for the factory modified bell design compatible for use with PVC pipe as specified.

****
NOTE: Delete this option when using ductile iron fittings.
****

[Fittings from material that meets or exceeds ASTM D1784 cell class 12454 and is the same material as the pipe with elastomeric gaskets, in conformance with AWWA C605 and AWWA C900.

]2.1.1.2.1.4 Joints and Jointing Material for PVC and PVCO Piping

a. Push-on joints: Use jointing material in accordance with ASTM D3139 and AWWA C111/A21.11 between pipes, pipes and metal fittings, valves, and other accessories or compression-type joints/mechanical joints. Provide each joint connection with an elastomeric gasket compatible for the bell or coupling used. Gaskets for push-on joints for pipe, ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, AWWA C111/A21.11, respectively, for push-on joints and mechanical joints.

b. Mechanical Joint: Use mechanically coupled joints having a sleeve-type mechanical coupling, as specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS, as an optional jointing method for plain-end PVC pipe, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling as specified for compression-type joints in ASTM D3139. Provide jointing material in accordance with AWWA C111/A21.11 between pipe and sleeve-type mechanical couplings.

2.1.1.2.2 PVC Piping for Service Lines

****

NOTE: This paragraph and the following subparagraphs are tailored for PVC SERVICE PIPING.

****

****

NOTE: Delete bracketed wording where piping will be installed at or exposed to temperatures below 4.5 degrees C 40 degrees F.

****

2.1.1.2.2.1 Pipe and Fittings

Provide ASTM D1784 cell class 12454 pipe and fittings of the same PVC material.

a. ASTM D1785, Schedule 40 with ASTM D2466 Schedule 40 or ASTM D2467 Schedule 80 fittings.

b. ASTM D2241 pipe and fittings with SDR as necessary to provide 1000 kPa 150 psi minimum pressure rating with ASTM D2466 Schedule 40 or ASTM D2467 Schedule 80 fittings.

2.1.1.2.2.2 Joints and Connections

Fittings may be joined by the solvent-cement method or threading.

2.1.1.2.2.3 Solvent Joining

Provide solvent joints in accordance with ASTM D2855.

2.1.1.2.3 Polyethylene (PE) Pipe

****

NOTE: This paragraph and the following subparagraphs are tailored for POLYETHYLENE PIPE.

****

****

NOTE: Polyethylene (PE) pipe is subject to oxidative degradation by many variables including pH, the concentration and type of disinfectant, water temperature, installation procedure and conditions. Disinfectants like chlorine, chloramines, chlorine dioxide, ozone and others may create an Oxidation Reduction Potential (ORP) in PE Pipe. Review PPI Technical Note, LONG TERM RESISTANCE OF AWWA C906 POLYETHYLENE (PE) PIPE TO POTABLE WATER DISINFECTANTS, TN-44/2015, and compute service life for potable water systems based on project conditions. Refer to PPI and HDPE Municipal Advisory Board (MAB) Position Paper on HDPE (PE 4710) Distribution Potable Water Pipe Sizes and Pressure Classes dated 18 May 2018 at https://www.plasticpipe.org/common/Uploaded%20files/1-PPI/Divisions/Municipal%20and%20Industrial/AWWA%20C906/ppi-position-paper-hdpe-potable-water-pc-pipe-size.pdf

For potable water piping systems with chlorine and chloramine residual disinfectant, use PE4710 with minimum cell class PE 445574C. CC3 provides the highest resistance to these disinfectants; refer to PPI TN44 for calculations. CC3 is not required for non-potable systems.

AWWA C906 includes 100 mm through 1650 mm 4 in through 65 in PE pipe and fittings. Use PE4710, with a minimum Pressure Class 160 (DR 13.5) for water at 80 degrees F and lower temperatures.

****

AWWA C906, ASTM F714, PE4710, minimum cell class PE 445574C, oxidative resistance classification CC3 with a minimum Pressure Class[160 (DR13.5)][200 (DR11)][250 (DR 9)] and ductile iron outside diameter (DIOD).

2.1.1.2.3.1 Fittings For PE Pipe

Ductile iron fittings, AWWA C110/A21.10 or compact ductile iron fittings in accordance with AWWA C153/A21.53, with cement-mortar lining for ductile iron fittings, AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends are to conform to the same requirements as fittings with mechanical-joint ends.

****

NOTE: Delete this option when using ductile iron fittings.

ASTM F2206 is the standard for fabricated fittings.

****

[AWWA C906, PE4710, ASTM D3035 minimum cell class PE 445574C, oxidative resistance classification CC3 with minimum Pressure Class[250][335], molded ASTM D2683[or fabricated ASTM F2206] meeting or exceeding the requirements in AWWA C906 for caps, reducers, couplings, elbows, and tees.

]2.1.1.2.3.2   Joints and Jointing Materials

Mechanical Joint: AWWA C111/A21.11 DIOD Mechanical joint adapter and gaskets for mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories.

2.1.1.2.4   Polyethylene (PE) Piping and Tubing for Service Lines

****

NOTE: This paragraph and the following subparagraphs are tailored for POLYETHYLENE SERVICE PIPE AND TUBING.

****

2.1.1.2.4.1   PE Service Line Pipe And Tubing

****

NOTE: For potable water piping systems with chlorine and chloramine residual disinfectant, use PE4710 with minimum cell class PE 445574C. CC3 provides the highest resistance to these disinfectants; refer to PPI TN49 for calculations. For non-potable HDPE systems, CC3 is not required for non-potable systems.

AWWA C901 includes 19 mm through 76 mm 3/4 in through 3 in PE pipe, tubing and fittings. Use PE4710, with a minimum Pressure Class 250 (SDR 9) for water at 80 degrees F and lower temperatures.

Iron pipe sizes (IPS) include 19 mm through 76 mm 3/4 in through 3 in outside diameter.

Copper tube size (CTS) include 19 mm through 51 mm 3/4 in through 2 in outside diameter.

****

AWWA C901, PE4710, ASTM D3035, ASTM D3350 minimum cell class PE 445574C, oxidative resistance classification CC3 with a minimum Pressure Class[250 (SDR 9)][outside diameter iron pipe size][outside diameter copper tube size].

2.1.1.2.4.2   PE Service Line Fittings

AWWA C901, PE4710, ASTM D3350 minimum cell class PE 445574C, oxidative resistance classification CC3 with a minimum Pressure Class 250, molded ASTM D2683 caps, reducers, couplings, elbows, and tees or compatible fittings in accordance with this specification.

2.1.1.3   Fiberglass Pipe, Fittings, Joints and Joint Materials

****

NOTE: This paragraph is tailored for AIR FORCE and

ARMY.
****

****

NOTE: AWWA C950 includes 25 mm through 4000 mm 1 in through 156 in fiberglass pipe. Both glass-fiber-reinforced thermosetting-resin pipe (RTRP; Grades 1 and 2) and glass-fiber-reinforced polymer-mortar pipe (RPMP; Grades 3 and 4) are included in this specification.

Fiberglass pipe can be used for potable water systems. Some advantages of fiberglass include durability, corrosion resistance, and eliminating the need for interior or exterior lining or coatings. However, special attention should be made to bedding and pipe support requirements. Pipe leaks are difficult to locate due to the manufacturing process. Refer to AWWA M45 for design considerations.

Types refer to the method of manufacturing. Type I is filament bound. Type II is centrifugally cast. Grade is determined by construction (glass-fiber-reinforced or glass-fiber-reinforced mortar) and bonding materials (epoxy or polyester). Grade 1 is glass-fiber reinforced epoxy (RTRP epoxy). Grade 2 is glass-fiber-reinforced polyester (RTRP polyester). Grade 3 is glass-fiber reinforced epoxy mortar (RPMP epoxy). Grade 4 is glass-fiber reinforced polyester mortar (RPMP polyester). Liner classification is determined by whether or not a liner is used and, if used, what type. Liner A is no liner. Liner B is a thermoplastic liner. Liner C is a reinforced thermoset polyester liner. Liner D is a nonreinforced thermoset polyester liner. Liner E is a reinforced thermoset epoxy liner. Liner F is a nonreinforced thermoset epoxy liner.
****

AWWA C950, Type [I][II], Pressure Class 150 with a minimum pipe stiffness of 248 kPa 36 psi, Grade [1][2][3][4], Liner [A][B][C][D][E][F].

a. Provide pipe with a quick-burst strength greater than or equal to four times the normal working pressure of the pipe. The quick-burst strength test is to meet the requirements of ASTM D1599.

b. Provide fittings and specials compatible with the pipe supplied. Filament wound or molded fittings up to 150 mm 6 inches are to conform to AWWA C950. Provide cement-mortar lined iron fittings in accordance with AWWA C104/A21.4 and conforming to AWWA C110/A21.10 and AWWA C111/A21.11.[Provide fittings and specials required for closures, curves, bends, branches and connections to valves, pipe, or structures consistent with the details furnished by the manufacturer and to AWWA C300, AWWA C301, or AWWA C303.] Provide fittings that will withstand working and testing pressures specified for the pipe.

c. Provide bell and spigot joints with elastomeric gaskets in accordance with ASTM D4161. Provide mechanically coupled joints with elastomeric gasket, flanged, threaded and bonded coupling, or bell and spigot with compatible adhesive, provided they are compatible with the pipe and convey water at the pressure and temperature of the pipe.

2.1.1.4 [Concrete Pressure Pipe][Prestressed Concrete Pressure Pipe (PCCP)][and][Reinforced Concrete Cylinder Pipe (RCCP)]

****

NOTE: This paragraph and the following subparagraphs are tailored for WATER TRANSMISSION.

****

****

NOTE: AWWA C300 includes Reinforced Concrete Cylinder Pipe (RCCP), steel-cylinder type, in sizes 760 mm to 3660 mm 30 in to 144 in.

AWWA C301 includes prestressed concrete pressure pipe (PCCP) manufactured with a steel cylinder and wire reinforcement in sizes 1350 mm to 3660 mm 54 in to 144 in.

AWWA C303 includes concrete pressure pipe, reinforced with a steel cylinder that is helically wrapped with mild steel bar reinforcement, in sizes 450 mm to 1830 mm 18 in to 72 in.

Verify pipe sizes required. In the Pacific Coast, Rocky Mountain, and Southwest States, concrete pipe is available in 250 mm 10 inch diameter and larger, pretensioned type only in sizes less than 400 mm 16 inches. In other parts of the country, concrete pipe may not be available in sizes below 400 mm 16 inch diameter.

For projects in the Pacific Coast, Rocky Mountain, and Southwest states where only piping of less than 400 mm 16 inch size is involved, delete requirements which are referenced to AWWA C300 and AWWA C301.

Use 1000 kPa 150 psi except when a higher pressure rating, up to 1380 kPa 200 psi is necessary.

AWWA recommends a minimum of 1.8 m 6 feet of earth cover above raw water transmission mains for ordinary conditions. Delete this information when depth is indicated on the drawings.

****

2.1.1.4.1 Piping, Fittings, Joints and Jointing Material

[Prestressed concrete pressure pipe (PCCP), AWWA C301.][Reinforced Concrete Cylinder Pipe (RCCP), steel-cylinder type AWWA C300.][Concrete pressure pipe, reinforced with a steel cylinder that is helically wrapped with mild steel bar reinforcement AWWA C303.]

****

NOTE: AWWA C301 pipe must be designed in accordance with ANSI/AWWA C304. AWWA C300 and AWWA 303 pipe

must be designed in accordance with AWWA M9.
****

[Pipe has been designed for the following minimum conditions:

a. Pressure rating - [_____] kPa psi

b. Earth cover - [_____] m feet

c. Water hammer - [_____] percent of pressure rating

d. Live load - [AASHTO H 20 truck loading][_____]

] **

NOTE: In those parts of the United States where concrete pipe will be carrying sulfate-bearing waters or where concrete pipe will be buried in soils containing sulfates specify concrete pipe manufactured using sulfate-resisting cement. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as SO4) in the soil are in the range of 0.1 and 0.2 percent and, for water, are in the range of 150 to 1000 parts per million. Specify Type V (sulfate resisting) cement when soils contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1000 parts per million sulfate. The availability of pipe made using Type V cement should be verified. In areas where reactive aggregates are known to occur, specify low alkali cement.
****

Provide fittings that match the same specification as that used for the pipe and are designed as specified for the pipe. [Utilize[Type II][Type V][low alkali cement] pipe and fittings that match the requirements of ASTM C150/C150M.] Include factory inscribed pressure rating identification markings for pipe and fittings.

Jointing Material: Provide rubber-gasket joints compatible with the type using a bell and spigot joint design of steel.

2.1.1.5 Steel Piping

****
NOTE: This paragraph and the following subparagraphs are tailored for AIR FORCE and ARMY.
****

****
NOTE: AWWA C200 includes steel water pipe, 150 mm 6 inch in nominal diameter and larger.

Verify availability of pipe sizes required. In the Pacific Coast, Rocky Mountain, and Southwest States, steel pipe is available in 125 mm 5 inch diameter and larger. In other parts of the country, steel pipe may not be available in sizes less than 600 mm 24 inch diameter since the major producer in those areas has discontinued production of steel water

pipe.

Delete coatings not allowed for the project. AWWA M11 in the chapter on protective coatings contains information on the relative merits of cement-mortar and coal-tar enamel coatings. See Foreword to AWWA C210 for information on coal-tar epoxy coating.

Delete requirements for lining of aboveground piping when aboveground piping is not included in project. When included, pipe and fittings for aboveground lines will be furnished with lining only. Exterior protection for aboveground piping should be specified in Section 09 90 00 PAINTS AND COATINGS.

Use of steel pipe is restricted to water supply lines only where future tapping is not anticipated. Use for sizes 80 mm 3 inches in diameter and larger.

****

2.1.1.5.1 Pipe and Fittings

Pipe, AWWA C200. Fittings, AWWA C208 and AWWA C200, with reference to the requirements specified therein for "Special Sections." Provide cement-mortar lining and[cement-mortar][coal-tar enamel][coal-tar epoxy] coating on pipe and fittings[for underground lines] in accordance with applicable AWWA standard. Provide cement-mortar lining[on pipe and fittings for aboveground lines]. Utilize pipe ends and fittings compatible for the joints and jointing materials used.

a. Utilize welded or seamless pipe with plain, or shouldered and grooved ends in accordance with AWWA C606 for use with mechanical couplings or bell-and-spigot ends with rubber gaskets. Provide bell-and-spigot ends for sizes less than 150 mm 6 inches diameter in accordance with AWWA C200.

b. Provide fittings and specials made of the same material as the pipe. Use specials and fittings made of standard steel tube turns or segmentally welded sections, with ends to accommodate the type of couplings or joints specified for the pipe. Match the thickness rating of pipe fittings and specials to the thickness specified and the pressure rating calculated for the pipe with which they are used. Provide identical protective materials for fittings and specials as specified for the pipe. Hand wrap, line, or coat specials and fittings that cannot be mechanically wrapped, lined, or coated using the same material used for the pipe with the same number of applications of each material, smoothly applied.

****

NOTE: Use 1000 kPa 150 psi except when a higher pressure rating, up to 1400 kPa 200 psi is necessary.

A minimum earth cover of 1.5 m 5 feet is recommended for ordinary conditions. Delete this information when depth is indicated on the drawings.

****

2.1.1.5.2 Wall Thickness for Pipe and Fittings

****
NOTE: Insert minimum acceptable thickness and yield strength in the blanks.
****

The minimum metal thickness for steel pipe wall is [_____] mm inches, based on steel having a yield strength of [_____] kPa psi. Pipe has been designed for the following minimum conditions:

Pressure rating	[_____] kPa psi
[Earth cover]	[[_____] m feet]
Water hammer	40 percent of pressure rating
Live load	AASHTO H 20 truck loading
Allowable deflection	2 percent of nominal pipe diameter

****
NOTE: In the calculation of wall thickness for steel water main pipe, base the value of E' (modulus of soil reaction) on realistic expectations of sidefill compaction rather than theoretical ones.

Calculate pipe wall thickness on the basis of an allowable fiber stress in the steel equal to 50 percent of the minimum yield strength of the steel used in the manufacture of the pipe. Design procedure in accordance with the methods given in AWWA M11, Chapter 4, "Determination of Pipe Wall Thickness," Chapter 3, "Hydraulics of Pipelines, Water Hammer, and Pressure Surge," Chapter 5, "External Loads of Buried Pipe."
****

Ensure that the wall thickness of fittings is equal to or greater than that required for the pipe. Reinforce fittings in accordance with methods given in AWWA M11 when necessary to meet the pressure test requirements.

2.1.1.5.3 Joints and Jointing Material

****
NOTE: AWWA M11, Chapter 6, "Pipe Joints," contains detailed information on the various field jointing methods for steel piping.

Delete requirements for and references to welded joints when not allowed for the project. Welded joints should not be allowed for piping less than 600 mm 24 inches in diameter, except when pipeline is cement-mortar lined in place after installation.
****

Provide rubber-gasketed pipe and fitting bell-and-spigot joints[, welded joints,] or the mechanically coupled type using a sleeve-type mechanical coupling[, unless otherwise specified].[Provide flanged joints where indicated.][Provide mechanically coupled type joints using a sleeve type mechanical coupling where indicated.][Provide [grooved][or][shouldered] type where indicated.][Provide insulating joints where indicated.][It is acceptable to use [grooved][or][shouldered] type joints in lieu of flanged joints.]

a. Rubber-Gasketed Bell-and-Spigot Joints: Provide joints and pipe ends in accordance with the pipe manufacturer's standard for this type of joint, except that the joint is to also meet the requirements specified for rubber-gasketed joints and rubber gaskets in AWWA C200.

****

NOTE: Delete requirements for and references to welded joints when not allowed for the project. Welded joints should not be allowed for piping less than 600 mm 24 inches in diameter, except when pipeline is cement mortar lined in place after installation.

****

b. Welded Joints: Provide electrodes of the quality specified in AWWA C206.

c. Sleeve-Type Mechanical Coupled Joints: As specified in paragraph SLEEVE-TYPE MECHANICAL COUPLINGS.

d. [Grooved][and][Shouldered] Type Joints: [Provide pipe ends grooved by roll grooving or with welded-on adapters and cut grooves. Provide grooves made by roll grooving with dimensions as recommended by the coupling manufacturer. Match dimensions for cut grooves in adapters to AWWA C606.]Couplings[and shouldered pipe ends], AWWA C606. Match the joint dimensions as specified in AWWA C606 for rigid joint[, joint dimensions as specified in AWWA C606 for flexible joints].

****

NOTE: Use Class D flanges when maximum working pressure is 1200 kPa 175 psi or less in lines 300 mm 12 inches in diameter and smaller, or 1000 kPa 150 psi or less in lines larger than 300 mm 12 inches in diameter. For higher working pressures, use Class E flanges.

****

e. Flanged Joints: Provide pipe ends with steel flanges, AWWA C207;[Class D][Class E]. Bolts and nuts for flanged connections, AWWA C207. Rubber gaskets, AWWA C207; asbestos gaskets are not allowed.

f. Insulating Joints: Designed to prevent metal-to-metal contact at the joint between adjacent sections of piping. Provide flange type joints with insulating gasket, insulating bolt sleeves, and insulating washers. Provide dielectric type gaskets, full face, and in other respects as recommended in the Appendix to AWWA C115/A21.15. Bolts and nuts as recommended in the Appendix to AWWA C115/A21.15.

2.1.1.5.4 Lining[and Coating]

****

NOTE: Under ordinary conditions, steel water pipe and fittings in the sizes included in water systems covered by this specification are furnished with

factory applied cement-mortar lining. In-place cement-mortar lining for new construction is required only under unusual conditions.

Delete bracketed text when lining is factory applied.

****

a. Cement-Mortar Lining: AWWA C205, shop-applied. Materials for cement mortar lining in place as specified in AWWA C602.

b. Cement-Mortar Coating: AWWA C205, shop-applied.

****

NOTE: Use coal-tar enamel coating with double felt wraps instead of single layer of felt wrap where trench soil is classified as Group IV, Unusually Corrosive (as defined in AWWA M11, Chapter 10, "Principles of Corrosion and Corrosion Control"); or where electrical resistivity of soil has been measured at less than 2,000 ohms/cc.

****

c. Coal-Tar Enamel Coating: Except as otherwise specified, prepare, prime, and coat piping with hot-applied coal-tar enamel and a bonded[single layer of felt wrap in accordance with AWWA C203][double felt wraps in accordance with AWWA C203]. Provide shop applied coating of fibrous-glass mat felt material as specified in Section 10 of AWWA C203. Do not use asbestos felt.

d. Coal-Tar Epoxy Coating: Clean, prime, and topcoat piping with coal-tar epoxy coating system in accordance with AWWA C210. Shop-apply coating.

[2.1.1.5.5 Steel Piping for Service Lines

Pipe, ASTM A53/A53M, Standard Weight, zinc-coated. Fittings, ASME B16.4, Class 125, zinc coated; or ASME B16.3, Class 150, zinc coated, threaded.

[**

NOTE: Protective materials for galvanized pipe less than 80 mm 3 inches in diameter will be required only where the pipe is within the zone of influence of adjacent buried cathodic protection systems.

****

Mechanically apply, in a factory or plant especially equipped for the purpose, the protective materials for steel pipe. Unless otherwise indicated, the materials consist of[one of the following][the following] for the indicated pipe material and size:

Clean pipe and fittings less than 80 mm 3 inches in diameter of foreign material by wire brushing and solvent cleaning, and apply one coat of coal-tar primer and two coats of coal-tar enamel matching the requirements of AWWA C203; protect threaded ends of pipe and fittings prior to coating.

]]2.1.1.6 Copper Pipe For Service Lines

****

NOTE: This paragraph is tailored for SERVICE LINES.

****

2.1.1.6.1 Copper Tubing and Associated Fittings

Provide ASTM B88M ASTM B88, Type K copper tubing. Provide AWWA C800 fittings. AWWA C800 includes ASME B1.20.3, ASME B1.20.1, ASME B16.18 solder-type joint fittings.

[2.1.1.7 Trenchless Piping

****

NOTE: Evaluate site specific conditions along with material properties, material availability, installation procedures, cost and a variety of other factors to determine if trenchless piping is suitable for a particular job and choose the best procedure for a particular job.

Where only one piping option is available to the contractor a justification and approval must be approved prior to project advertisement in accordance with FAR 6.3 Other Than Full and Open Competition.

When butt fusion is used as a jointing method, require properly qualified fusion technicians.

****

2.1.1.7.1 PVC Pipe

****

NOTE: Butt fused pipe is subject to rapid crack propagation (RCP) by many variables including pipe damage during construction and air in the water line. When RCP occurs in bell & spigot (B&S) pipe, the length of the failure is limited to the length of the pipe. Once pipes are fused together RCP can pass through the fused joints and may result in lengthy pipe failures. Ensuring air release valves are used where air may be trapped and pipe is adequately protected from damage during construction are two ways to help avoid RCP.

****

AWWA C900 plain end meeting or exceeding ASTM D1784 cell class 12454, plastic formulated for fusing with a minimum Pressure Class[235 (DR18)][305 (DR 14)] with ductile iron outside diameter (DIOD).

2.1.1.7.1.1 Butt Fusion

Use butt fusion jointing method for plain-end PVC pipe. Comply with AWWA C900 and AWWA C605 for butt fusion joints. No offset in alignment between adjacent pipe joints of fittings is permitted. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded and submitted for review and meet the requirements of ASTM F1674.

2.1.1.7.2   PE Pipe and Tubing

****

NOTE: This paragraph and the following subparagraphs are tailored for POLYETHYLENE TRENCHLESS PIPING.

****

Provide PE pipe in accordance with paragraphs POLYETHYLENE(PE) PIPE or POLYETHYLENE (PE) PIPING AND TUBING FOR SERVICE LINES in this specification. Submit fusion joining information including recommended fusion parameters, recommended product and environmental conditions for joining and documentation that these parameters and conditions have been validated by appropriate testing.

2.1.1.7.2.1   Butt and Socket Fusion Fittings

****

NOTE: Select pressure class meeting or exceeding the pipe pressure class.

****

Use Provide PE pipe fittings in accordance with paragraphs FITTINGS FOR PE PIPE or PE SERVICE LINE FITTINGS in this specification. Use ASTM D3261, socket fusion caps, reducers, couplings, elbows, and tees.

2.1.1.7.2.2   Butt and Socket Fusion

Use ASTM F2620 butt or socket fusion jointing method for plain-end PE pipe. Comply with AWWA C906, ASTM F3190, and ASTM F2620 for Butt Fusion joints. No offset in alignment between adjacent pipe joints of fittings is permitted. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded and submitted for review.

2.1.1.7.2.3   Electrofusion Fittings

Provide PE pipe fittings in accordance with paragraphs FITTINGS FOR PE PIPE or PE SERVICE LINE FITTINGS in this specification. Use ASTM F1055, socket fusion caps, reducers, couplings, elbows, and tees.

2.1.1.7.2.4   Electrofusion

Use AWWA M55 and ASTM F1290 electrofusion jointing method for PE pipe. No offset in alignment between adjacent pipe joints of fittings is permitted. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of pipe used at the time of fusion performance. Each joint must be datalogged, recorded and submitted for review.

2.1.1.7.3   Ductile Iron Ball and Socket Joint

Use centrifugally cast ductile iron pipe meeting the applicable requirements of AWWA C151/A21.51[Pressure Class [_____]][Thickness Class [_____]] and in accordance with pipe manufacturer's instructions. The separately cast Ductile-Iron ball, bell and retainer ring conforms with the requirements of ASTM A536, Grade 70-50-05. Critical surfaces of the ball, bell socket and retainer ring are machined.

2.1.1.7.3.1 Fittings

Ductile iron bell, ball and retainer ring meeting the applicable requirements of AWWA C110/A21.10and in accordance with pipe manufacturer's instructions for ball and socket joint pipe.

][2.1.1.8 Piping Beneath Railroad Right-of-Way

Piping passing under the right-of-way of a commercial railroad is to conform to the specifications for pipelines conveying nonflammable substances in AREMA Eng Man. Provide ductile-iron pipe in lieu of cast-iron pipe. Ductile-iron railroad crossing casing pipe is to conform to and have strength computed in accordance with ASTM A746.

]2.1.2 Valves

****

NOTE: Select the following requirement when a protective interior coating is considered necessary for corrosion protection. A protective interior coating is required on all valves whose interiors are exposed to sea water or salt water, or where there is a serious corrosion problem other than galvanic corrosion for water having a pH range from 4 to 9.

****

[Provide a protective interior coating in accordance with AWWA C550.

]2.1.2.1 Gate Valves 80 mm 3 Inch Size and Larger[on Buried Piping]

****

NOTE: AWWA C500 includes nonrising-stem (NRS) gate valves, 80 mm through 1200 mm 3 in through 48 in, and outside screw and yoke (OS&Y) rising-stem gate valves, 80 mm through 600 mm 3 in through 24 in. AWWA C509 includes sizes 75 mm through 900 mm 3 in through 36 in. AWWA C515 includes NRS gate valves, 75 mm through 1350 mm 3 in through 54 in, and OS&Y gate valves, 75 mm through 400 mm 3 in through 16 in.

For UL 262 gate valves in systems on which pipe is pressure rated at 1000 kPa 150 psi, use a working pressure of 1200 kPa 175 psi for valve sizes 300 mm 12 inches and smaller, and 1000 kPa 150 psi for valves larger than 300 mm 12 inches.

Indicator should be required for geared gate valves where valve is in location where gate position cannot readily be seen.

****

AWWA C500, AWWA C509, AWWA C515, or UL 262 and:

a. AWWA C500: nonrising stem type with double-disc gate and mechanical-joint ends or push-on joint ends compatible for the adjoining pipe.

b. AWWA C509 or AWWA C515: nonrising stem type with mechanical-joint ends[or resilient-seated gate valves 80 to 300 mm 3 to 12 inches in size]

c. UL 262: inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of 1200[_____] kPa 175[_____] psi, and have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined.

****

NOTE: The following paragraph contains tailoring for WATER TRANSMISSION and SERVICE LINES.

****

Match materials for UL 262 gate valves to the reference standards specified in AWWA C500. Gate valves open by counterclockwise rotation of the valve stem. Stuffing boxes have O-ring stem seals[, except for those valves for which gearing is specified, in which case use conventional packing in place of O-ring seal]. Stuffing boxes are bolted and constructed so as to permit easy removal of parts for repair.[Use gate valves with special ends for connection to[cement piping or] sleeve-type mechanical coupling in lieu of mechanical-joint ends and push-on joint ends.] Provide valve ends and gaskets for connection to[cement piping or to] sleeve-type mechanical couplings that conform to the requirements specified[respectively] for the[joint or] coupling.[Provide AWWA C500 [_____] mm inch gate valves with gearing[and indicator].][Where an indicator post are shown, provide an indicator post flange for AWWA C500, AWWA C509, or AWWA C515 gate valves conforming to the requirements of UL 262.][Provide AWWA C500 [_____] mm inch gate valves with bypasses.][Provide gate valves[on [_____] mm inch service lines] with threaded ends.][Gate valves[on [_____] mm inch service lines] have ends compatible with joining to the pipe used;[push-on joint ends or mechanical-joint ends for joining to ductile-iron pipe][or][push-on joint ends or mechanical-joint ends for joining to PVC water main pipe]; with AWWA C111/A21.11 gaskets and pipe ends.][When operating nut depth exceeds 900 mm 3 feet below finished grade, provide an extension stem with standard 50 mm 2 inch operating nut.] Provide all valves from one manufacturer.

2.1.2.2 Gate Valves 75 mm 3 Inch Size and Larger [in Valve Pit(s)][and][Aboveground Locations]

****

NOTE: For ordinary conditions, outside-screw-and-yoke rising-stem type is preferred to nonrising stem/inside-screw type.

For ordinary conditions, the double-disc or split-wedge type gate is preferred to the solid-wedge/solid or one-piece gate.

For UL 262 gate valves in system on which pipe is pressure rated at 1000 kPa 150 psi, use a working pressure of 1200 kPa 175 psi for valve sizes 300 mm 12 inches and smaller, and 1000 kPa 150 psi for gate valves larger than 300 mm 12 inches.

Indicator is required for geared valves where valve is in location where gate position cannot readily be seen.

****

AWWA C500, AWWA C509, AWWA C515, or UL 262 and:

a. AWWA C500: [outside-screw-and-yoke rising-stem][nonrising stem] type with[double-disc][solid-wedge] gates and flanged ends

b. AWWA C509 or AWWA C515: [outside-screw-and-yoke rising-stem][nonrising stem] type with flanged ends

c. UL 262: [outside-screw-and-yoke][inside-screw] type, with[double-disc or split-wedge][solid or one-piece] type gate and flanged ends, and designed for a hydraulic working pressure of 1200[_____] kPa 175[_____] psi

****

NOTE: The following paragraph contains tailoring for AIR FORCE, ARMY, and WATER TRANSMISSION.

****

Match materials for UL 262 gate valves to the reference standards specified in AWWA C500.[[[_____] mm inch]Gate valves are nonrising stem type or inside-screw type[where indicated].][[[_____] mm inch size]Gate valves are solid-wedge gates or solid or one-piece type gates[where indicated].] Provide gate valves with handwheels that open by counterclockwise rotation of the valve stem. Bolt and construct stuffing boxes so as to permit easy removal of parts for repair. In lieu of flanged ends, provide valves with [grooved][or][shouldered] ends compatible with [grooved][or][shouldered] type joints, as specified in the paragraph DUCTILE-IRON PIPING.[Provide valves [_____] mm inch size with gearing[and indicator], AWWA C500 or AWWA C509.][Provide [_____] mm inch size valve with bypasses, AWWA C500.] Provide all valves from one manufacturer.

2.1.2.3 Knife Gate Valves

****

NOTE: AWWA C520 includes 50 mm through 2400 mm 2 in through 96 in knife gate valves. Valves larger than 900 mm 36 in. are typically custom designed and manufactured for user-specified applications, including design pressure. The laying length of valves larger than 900 mm 36 in. will vary to accommodate the design pressure requirements. Knife gate valves are typically used in locations where there is limited space.

Select ductile iron or select other acceptable material as indicated in AWWA C520.

Select with bonnet if the gate and shaft need to enclosed in a bonnet or without bonnet or bonnetless if the gate and shaft can be exposed.

****

Provide AWWA C520 [ductile iron] [_____] knife gate valves[with bonnet][without bonnet].

2.1.2.4 Check Valves

****

NOTE: Select the following requirement when a protective interior coating is considered necessary for corrosion protection. A protective interior coating is required on all valves whose interiors are exposed to sea water or salt water, or where there is a serious corrosion problem other than galvanic corrosion for water having a pH range from 4 to 9.

****

[Provide a protective interior coating in accordance with AWWA C550.
]Swing-check type, AWWA C508 or UL 312 and:

a. AWWA C508: Iron or steel body and cover and flanged ends

b. UL 312: Cast iron or steel body and cover, flanged ends, and designed for a minimum working pressure of [1000][_____] kPa [150] [_____] psi.

****

NOTE: The following paragraph contains tailoring for AIR FORCE and ARMY.

****

Materials for UL 312 check valves are to match the reference standards specified in AWWA C508. Provide check valves with a clear port opening.[Provide[spring-loaded][weight-loaded] check valves[where indicated].][Class 125 flanges are to match ASME B16.1.] Provide [grooved][or][shouldered] ends [grooved][or][shouldered] type joints, as specified in the paragraph DUCTILE-IRON PIPING in lieu of flanged ends. Provide all check valves from one manufacturer.

2.1.2.5 Rubber-Seated Butterfly Valves

****

NOTE: Although butterfly valves are acceptable for use in 75 mm through 1,800 mm 3 in through 72 in sizes, they are typically used in sizes greater than 300 mm 12 inches.

****

Provide rubber-seated butterfly valves and wafer type valves that match the performance requirements of AWWA C504. Wafer type valves not meeting laying length requirements are acceptable if supplied and installed with a spacer, providing the specified laying length. Meet all tests required by AWWA C504. Flanged-end valves are required in a pit. Provide a union or sleeve-type coupling in the pit to permit removal. Direct-bury mechanical-end valves 80 through 250 mm 3 through 10 inches in diameter. Provide a valve box, means for manual operation, and an adjacent pipe joint to facilitate valve removal. Provide valve operators that restrict closing to a rate requiring approximately 60 seconds, from fully open to fully closed.

2.1.2.6 Pressure Reducing Valves

Maintain a constant downstream pressure regardless of fluctuations in demand. Using pressure reducing valves capable of providing [_____] kPa psi operating pressure on the inlet side, with outlet pressure set for [_____] kPa psi. Provide hydraulically-operated, pilot controlled, globe or angle type valves that are capable of being actuated either by diaphragm or piston. Provide diaphragm-operated, adjustable, spring-loaded type pilot controls made of lead-free bronze with stainless steel working parts, designed to permit flow when controlling pressure exceeds the spring setting. Construct the bodies of bronze, cast iron or cast steel with lead-free bronze trim; the valve stem of stainless steel; the seat of lead-free bronze; and the valve discs and diaphragms of synthetic rubber. Provide [threaded][flanged] ends.

2.1.2.7 Air Release, Air/Vacuum, and Combination Air Valves

****

NOTE: For transmission mains, provide air release, air/vacuum, and combination air valves as recommended from Transient Analysis.

****

Provide AWWA C512 air release[, air vacuum] and combination air valves that release air and prevent the formation of a vacuum. Provide valves with an iron body, lead-free bronze trim and stainless steel float that automatically releases air when the lines are being filled with water and admits air into the line when water is being withdrawn in excess of the inflow.

2.1.2.8 Water Service Valves

****

NOTE: This paragraph and the following subparagraphs are tailored for SERVICE LINES.

****

2.1.2.8.1 Gate Valves Smaller than 75 mm 3 Inch in Size[on Buried Piping]

Gate valves smaller than 75 mm 3 inch size[on Buried Piping] MSS SP-80, Class 150, solid wedge, nonrising stem, with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.

2.1.2.8.2 Gate Valves Smaller Than 75 mm 3 Inch Size in Valve Pits

MSS SP-80, Class 150, solid wedge, inside screw, rising stem. Provide valves with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.

2.1.2.8.3 Check Valves Smaller than 50 mm 2 Inch in Size

Provide check valves with a minimum working pressure of 1000 kPa 150 psi or as indicated with a clear waterway equal to the full nominal diameter of the valve. Valves open to permit flow when inlet pressure is greater than the discharge pressure, and close tightly to prevent return flow when discharge pressure exceeds inlet pressure. Cast the size of the valve, working pressure, manufacturer's name, initials, or trademark on the body of each valve.

Provide valves for screwed fittings, made of lead-free bronze and in conformance with MSS SP-80, Class 150, Types 3 and 4 compatible for the application.

2.1.2.9 Valve Boxes

****

NOTE: This paragraph contains tailoring for ARMY.
****

Provide a valve box for each gate valve[on buried piping][, except where indicator post is shown]. Construct adjustable valve boxes manufactured from [cast iron][or][precast concrete] of a size compatible for the valve on which it is used.[Provide cast iron valve boxes with a minimum cover and wall thickness of 5 mm 3/16 inch and conforming to ASTM A48/A48M, Class 35B. Coat the cast-iron box with a heavy coat of bituminous paint.][Provide a round head.] Cast the word "WATER" on the lid. The minimum diameter of the shaft of the box is [135 mm] [5 1/4 inches] [as indicated]. Provide[ASTM C1433] precast concrete valve box.[Provide precast concrete boxes installed in locations subjected to vehicular traffic[to withstand AASHTO load designation as outlined in AASHTO HB-17][_____].] [Manufacture precast concrete boxes in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.]

2.1.2.10 Valve Pits

Construct the valve pits at locations indicated or as required above and in accordance with the details shown.

2.1.3 Blowoff Valve Assemblies

****
NOTE: Show locations of blowoff valve assemblies on drawings and details.
****

Provide blowoff valve assemblies complete with all pipe, fittings, valve, valve box, riser box and lid, riser extension, discharge fitting and other materials required to connect to the water main. Provide blow off valve assemblies 100 mm 4 inches or larger with AWWA C110/A21.10 or AWWA C153/A21.53 fittings.[Provide a blowoff valve assembly with a removable riser.]

2.1.4 Fire Hydrants and Hose Houses

2.1.4.1 Fire Hydrants

****
NOTE: This paragraph and the following subparagraphs are tailored for FIRE HYDRANTS.
****

****
NOTE: For projects in all parts of the United States except California and Hawaii, delete requirements for and references to wet-barrel type fire hydrants. For projects in areas not subject to freezing temperatures ascertain from the local fire department serving the base or station (1) whether wet-barrel type fire hydrants are desired exclusively, (2) whether dry-barrel type fire hydrants are necessary (in areas having freezing temperatures), or (3) whether either type fire hydrant is acceptable. Only dry-barrel type fire hydrants have fire hydrant stem. For hose gate

valves in dry-barrel fire hydrants, use UL 246 as the standard reference.
****

Provide fire hydrants where indicated. Paint fire hydrants with at least one coat of primer and two coats of enamel paint. Paint barrel and bonnet colors in accordance with UFC 3-600-01. Stencil fire hydrant number and main size on the fire hydrant barrel using black stencil paint.

****
NOTE: When a protective interior coating is considered necessary for corrosion protection include the bracketed option below.
****

[Provide a protective epoxy interior coating conforming to AWWA C550 on those portions of the fire hydrant continuously in contact with sea water or salt water.

] **
NOTE: Use "as specified" wording under the following circumstances: (1) project at existing station where fire hydrants with standard threads and nuts are in use; (2) project at existing station where conversion to fire hydrants with standard threads and nuts is in progress; (3) project at new location where local fire department connects to fire hydrants with standard threads and nuts.

Indicate appropriate standard under the following circumstances: (1) project at existing station where fire hydrants with nonstandard threads and nuts are in use; (2) project at new location where local fire department connects to fire hydrants with nonstandard threads and nuts.
****

2.1.4.1.1 [Dry-Barrel Type][and][Wet-Barrel Type] Fire Hydrants

[Provide Dry-barrel type fire hydrants, AWWA C502 or UL 246, "Base Valve" with 150 mm 6 inch inlet, 135 mm 5 1/4 inch valve opening, one [115][_____] mm [4 1/2][_____] inch pumper connection, and two 65 mm 2 1/2 inch hose connections.][Provide Wet-barrel type fire hydrants, AWWA C503 or UL 246, "Wet Barrel" with 150 mm 6 inch inlet, one [115][_____] mm [4 1/2][_____] inch pumper connection, and two 65 mm 2 1/2 inch hose connections. Individually valve pumper connection and hose connections with independent nozzle gate valves.]

Provide[mechanical-joint or push-on joint end][mechanical-joint end only] inlet[, except where flanged end is indicated]; with end matching requirements[as specified in [AWWA C502][or][AWWA C503] or UL 246] [_____] for size and shape of operating nut, cap nuts, and threads on hose and pumper connections. Provide fire hydrants with[frangible sections as mentioned in AWWA C502][breakable features as mentioned in AWWA C503]. Provide fire hydrant with special couplings joining[upper and lower sections of fire hydrant barrel][and upper and lower sections of fire hydrant stem] that break from a force imposed by a moving vehicle.

2.1.4.2 Fire Hydrant Hose Houses

****

NOTE: This paragraph and the following subparagraphs are tailored for HOSE HOUSES.

****

****

NOTE: The fire hydrant hose house equipment listed is standard for areas such as family housing where mobile fire department response within approximately 15 minutes is unlikely. In other types of installations where lack of prompt fire department response necessitates fully equipped fire hydrant hose houses for use by station personnel, the type and amount of equipment needed for individual hose houses will be adjusted depending on the needs of the immediate area. Do not specify metal-hose houses, in salt water areas or other locations where there is a corrosive atmosphere.

****

Provide hose houses matching the requirements of NFPA 24 at each fire hydrant indicated on the drawings to have a fire hydrant hose house.

2.1.4.2.1 Additional Equipment

Provide the following equipment, in addition to that listed in NFPA 24, Hose Houses and Equipment, with each hose house:

a. 60 m 200 feet of 65 mm 2-1/2 inch woven jacketed, rubber lined hose matching the requirements of NFPA 1961 with a minimum service test pressure of 2.06 MPa 300 psi; 30 m 100 feet of 40 mm 1-1/2 inch woven jacketed, rubber lined hose matching the requirements of NFPA 1961 with a minimum service test pressure of 2.06 MPa 300 psi;

b. One gated 65 by 40 by 40 mm 2-1/2 by 1-1/2 by 1-1/2 inch wye;

c. One playpipe for 65 mm 2-1/2 inch hose with 25 mm 1 inch shutoff nozzle tip;

d. One playpipe for 40 mm 1-1/2 inch hose with 13 mm 1/2 inch shutoff nozzle or combination nozzle;

e. Two adapter fittings, 65 to 40 mm 2-1/2 to 1-1/2 inch;

f. Two spanners for 40 mm 1-1/2 inch hose.

2.1.5 Meters

****

NOTE: This paragraph and the following subparagraphs are tailored for METERS.

****

****

NOTE: Water meters are required to be installed for most facilities. Refer to UFC 1-200-02 High Performance and Sustainable Building Requirements

for criteria and guidance. In some situations, sub-metering may be required.

This specification is primarily written for outside meter settings used for measuring water consumption from potable water systems delivered to facilities such as those meters for buildings, structures, piers, and ships.

This specification is for meters with working pressures of 150 psi or less.

This specification is for cold water meters. Refer to the appropriate AWWA Standard for water temperature limitations.

This specification is not intended to cover other types of dedicated operational meters such as those used in booster pump stations or production sources.

Select meters according to AWWA M6.

Size meters according to AWWA M22. It is common that the needed meter size is smaller than the service line pipe size, to avoid over sizing.

Coordinate with the Installation's Public Works Department to determine Installation specific meter requirements. In some cases the Government may provide a water meter to be installed by the Contractor.

Meters used for residential fire sprinkler applications meeting the requirements of NFPA 13D, sizes 3/4 in. (20 mm) through 2 in. (50 mm), are found in AWWA C714.

Many utility operators or regions use different terms. Review the available features, options and compatibility and consult with manufacturers to ensure the registers will work as intended.

****

Submit certificates certifying all required and recommended tests set forth in the referenced standard and AWWA M6 have been performed and comply with all applicable requirements of the referenced standard and AWWA M6 within the past three years. Include certification that each meter has been tested for accuracy of registration and that each meter complies with the accuracy and capacity requirements of the referenced standard when tested in accordance with AWWA M6.

Include a register with all meters whether they are or are not connected to a remote reading system.

[2.1.5.1 Turbine Type Meters

****

NOTE: AWWA C701 covers cold water turbine meters sizes 20 mm 3/4 inch to 500 mm 20 inch for Customer

Service.

Class I meters are those meters previously covered by AWWA C701-70, 1970. Class II meters are in-line high velocity with lower head loss, greater flow sensitivity, tighter accuracy tolerances over a wider range of flow.

If large capacity is of primary importance, flows are usually above 10 percent of maximum rating, and low flow accuracy is secondary, the turbine meter should be used.

****

Provide AWWA C701[Class I][Class II][Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible] meter with a strainer screen. Main casing constructed of[copper alloy containing not less than 75 percent copper][[cast iron][fabricated steel] with protective coating in accordance with AWWA C213 or AWWA C550].

][2.1.5.2 Propeller Type Meters

****

NOTE: AWWA C704 covers various types and classes of propeller meters sizes 50 mm 2 inches to 1,800 mm 72 inches for waterworks applications.

****

Provide AWWA C704[Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible] meter. Flow tubes or main cases constructed of [cast iron] [fabricated steel][with protective coating in accordance with AWWA C153/A21.53, AWWA C210 or AWWA C213].

][2.1.5.3 Displacement Type Meters

****

NOTE: Displacement meters 2 inch (50 mm) and smaller. There are two variations of displacement meters, the nutating piston (disc) and the oscillating piston. Both are essentially equal in performance. These meters have a combination of accuracy, long life, simple design, moderate cost, and easy maintenance.

The meters described in AWWA C700 are not designed to be used in water service piping intended for extinguish fire.

Where highly aggressive water is encountered, the manufacturers should be consulted for recommendations concerning the use of materials that are more resistant to corrosive attack.

Refer to AWWA C700 for information on breakable and non-breakable covers.

****

Provide AWWA C700[Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible] meter with[nutating disk][

oscillating piston]. Pressure casings constructed of copper alloy containing not less than 75 percent copper.[Provide registers with[breakable][non-breakable] covers and straight-reading[permanently sealed][replaceable change gear] registers.][Provide non-breakable covers of copper alloy containing not less than 75 percent copper] copper alloy conforming to ASTM B584. For meter sizes 13mm 1/2 inch through 25 mm 1 inch provide[split-case][frost-protection-type design].

][2.1.5.4 Compound Type Meters

****

NOTE: AWWA C702 covers various types and classes of cold-water compound type meters in sizes 2 in. (50 mm) through 8 in. (200 mm).

****

Provide AWWA C702[Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible] meter[with strainers]. Main casing constructed of[copper alloy containing not less than 75 percent copper][[cast iron][fabricated steel][with protective coating in accordance with AWWA C213 or AWWA C550]]. Equip with tapped bosses near the outlet for field testing purposes.

][2.1.5.5 Fire Service Type Meters

****

NOTE: AWWA C703 covers various types and classes of cold-water fire service–type meters in sizes 75 mm through 250 mm 3 inches through 10 inches.

NSF/ANSI/CAN 61 is not required for non potable uses.

Strainers should be part of the meter assembly and not be interchangeable with other strainers that may be offered by the meter manufacturer.

****

Provide AWWA C703[Advanced Metering Infrastructure (AMI) and Direct Digital Communication (DDC) compatible][turbine type] meter[with strainers]. Main casing constructed of[copper alloy containing not less than 75 percent copper][cast iron with protective coating in accordance with AWWA C550]. Equip with a[mechanical display-type][electronic display-type] straight-reading register.

]2.1.5.6 Register

****

NOTE: Meter registers installed below grade, regardless of optional mechanical pumping features, must be suitable for submerged/pit environments. Such registers generally have a negligible increase in the metering cost. Also use a submergible type where exposure to wet environments is possible. The most common water meter register is a 6-wheel type mechanical display.

****

Provide[AWWA C700][AWWA C701][AWWA C702][AWWA C703][open][sealed][permanently sealed] straight-reading register[for use in a submerged environment] supplied by the meter manufacturer. Equip register with cubic meters [U.S. gallons][cubic feet] readings.[Use an encoder type remote register designed in accordance with AWWA C707].

[2.1.5.7 Strainers

Provide[AWWA C701][AWWA C702][AWWA C703] strainer recommended and supplied by the meter manufacturer. Provide strainer of the same material as the meter body (i.e., bronze, ductile, or stainless).

]2.1.5.8 Meter Connections

****

NOTE: This paragraph is written for meters located outside of the building. Inside meter settings as well as those used outside above ground or in hot-boxes, would follow the same principles.

****

[Provide[flanged][female screw threads] [_____] main case connection fittings.][Provide connections compatible with the type of pipe and conditions encountered.]

[2.1.5.9 Advanced Metering Infrastructure

****

NOTE: Advanced Metering Infrastructure (AMI) Water Meters are required per the Utility Meter Policy Memo from the Office of Under Secretary of Defense. Coordinate advance metering with the Installation AMI manager.

****

[The Government will supply][Provide] an Advanced Metering Infrastructure (AMI) compatible water meter(s)[for the Contractor to install] and connect to the existing AMI Data Acquisition System (DAS). Use the existing Government laptop computers to configure the meter using existing software loaded on the computer. Modifications to existing software on the computer or the addition of software to the computer is not allowed. The Contractor must ensure that the meter(s) transmit the metered data to the DAS. The current meters being used by [_____] are: [_____].[The Government will configure the meter(s), which must be compatible with the existing system, using existing software. Contractor is to ensure that the meter(s) transmit the specified data to the DAS. The current meters being used by [_____] are: [_____].]

][2.1.5.10 Direct Digital Control System Interface

Provide all meters with the capability of providing pulse output to the DDC system provided in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

][2.1.5.11 Meter Setter

****

NOTE: Meter setters are intended to allow the meter to be placed or removed in a meter box or vault. Meter setters may bought or assembled of separate components. Assembled meter setters usually increase construction costs and decrease uniformity

among meter settings.

Three basic styles of setters include yokes, copper setters, and yoke meter boxes. Variations could also include the meter setter being pre-assembled and piped into a plastic meter box.

****

[Provide AWWA C800 [manufactured] meter setter with [a bypass,]inlet and outlet valves.

] **

NOTE: By-passes should be provided for any meter greater than 2-inch to allow for meter testing and maintenance. In many instances, the size of the by-pass can be less than the size of the service line or meter.

****

[Provide a [_____] mm [_____] inch by-pass assembly[as shown on drawings] with the valve located[inside][outside] the vault.[Provide valve box for valve located outside of vault.]

]]2.1.5.12 Meter[Boxes][Vaults]

****

NOTE: Indicate traffic rated and non traffic rated meter boxes on the drawings.

Use cast iron and concrete meter boxes in traffic areas.

Meter Vaults are intended for large meters (i.e., 75 mm 3 inch and above). Meter boxes are intended for less than 75 mm 3 inch diameter pipes.

When meter vaults are used provide construction details of meter setting on the drawings.

Ensure meter boxes and vaults provide adequate clearance for meter removal, access for valve operation or maintenance.

Use rounds lids when possible. Round lids provide an advantage over other shapes since they do not fall down into the meter pit damaging the metering equipment below. When used in areas with foot traffic, a round lid can also reduce the risk for someone falling into the pit and causing an injury. The oval or rectangular meter box can sometimes provide an advantage since they can be used in a more narrow space while providing the needed length.

****

Provide meter[boxes][vaults] of sufficient size to completely enclose the meter and shutoff valve or service stop and in accordance with the details shown on the drawings. Provide a meter boxes or vaults with a height equal to the distance from invert of the service line to finished grade at the meter location.

2.1.5.12.1 Cast Iron

Provide ASTM A48/A48M, Class 25 cast iron meter box and lid. Provide a[round] lid[with precast holes for remote electronic meter reading modules] having the word "WATER" cast on the top surface.

[2.1.5.12.2 Precast Concrete Meter[Boxes][Vaults]

****

NOTE: This paragraph contains additional tailoring for ARMY.

****

Provide[ASTM C1433][precast concrete meter boxes in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.] precast concrete meter[boxes][vaults] with ASTM A48/A48M, Class 25 cast iron lid. Provide a ASTM A48/A48M, Class 25 cast iron[with precast holes for remote electronic meter reading modules][round] lid having the word "WATER" cast on it. Provide meter[boxes][vaults] of sufficient size to completely enclose the meter and shutoff valve or service stop and in accordance with the details shown on the drawings.

[2.1.5.12.2.1 Vault Access Door

Provide a[single-leaf][double-leaf] cast-in[aluminum][painted steel] diamond-plate access door with the following dimensions:

Width: [_____] mm feet

Length: [_____] mm feet

Include[stainless steel spring][pneumatic] lift assist, type 316 stainless steel slam locking latch, automatic hold-open arm with a red release handle, and flush mounted retractable lifting handle. Door must have a minimum load rating for[AASHTO HS-20] [6,800 kg] [15,000 lbs] load.[Center door[over meter assembly][over ladder and aligned with interior wall].]

]2.1.5.12.2.2 Fittings

Provide flanged fittings for pipe 75 mm 3 inches and larger.

2.1.5.12.2.3 Vault Valves

****

NOTE: Use indicating type valves inside the vault (i.e., OS&Y, ball, butterfly) so that the valve's position can be observed without entering the confined space.

****

Provide[ball][outside screw and yoke (OS&Y)][butterfly] valves in meter vault.

][2.1.5.12.3 Plastic Meter Boxes

****

NOTE: Plastic boxes and lids are acceptable for use

in unpaved areas or grass areas not subject to vehicular traffic.

Medium duty ratings include occasional vehicle traffic such as a stray vehicle or tractor use for mowing. Do not use medium duty ratings in areas where vehicle traffic is expected.

****

Provide manufactured plastic boxes[and lids] meeting the following requirements:

a. One-piece molded construction

b. Vertical load rating for medium duty use of [6,800 kg] [15,000 lbs] [_____]

c. Ultraviolet (UV) exterior surface protection

d. White interior surface

[Provide a ASTM A48/A48M, Class 25 cast iron ring and [round] lid.

]]2.1.6 Backflow Preventers

****

NOTE: This paragraph and the following subparagraphs are tailored for BACKFLOW PREVENTERS.

****

****

NOTE: This specification covers backflow preventers used to protect the potable water system in outside applications.

AWWA C511 requires a minimum working pressure of 1000 kPa 150 psi.

Backflow preventers (i.e., the double check valve assembly (DC) and the reduced pressure principle assembly (RP)) must be installed above ground to prevent cross contamination.

Locate backflow preventers assemblies in areas with adequate drainage. Double check valves may get the surrounding area wet when testing is being performed. RPs can discharge large quantities of water. A 25 mm 1 inch RP may discharge up to 125 gallons per minute of water, so having adequate drainage is crucial.

****

Provide a[bronze][cast iron][ductile iron] AWWA C511 reduced pressure principle type backflow preventer meeting the following requirements:

a. Size: [_____]

[b. Maximum Rated Flow: [_____]

][c. Allowable Pressure Loss: [_____]

] d. Flanged[cast iron],[bronze][brass] mounted gate valve

[e. Strainer of the same material as the backflow preventer

][f. Stainless steel alloys in accordance with ASTM A276/A276M, Type [304][_____]

] [The particular make, model, and size of backflow preventers to be installed must be included in the latest edition of the List of Approved Backflow Prevention Assemblies issued by the FCCCHR List and be accompanied by a backflow certificate of full approval from FCCCHR List.]Select materials for piping, strainers, and valves used in assembly installation that are galvanically compatible. Materials joined, connected, or otherwise in contact are to have no greater than 0.25 V difference on the Anodic Index, unless separated by a dielectric type union or fitting.

2.1.6.1 Backflow Preventer Enclosure

****

NOTE: Where freezing temperatures are possible include requirements for an enclosure to prevent freezing.

****

Provide an[insulated] enclosure[with heat].

2.1.7 Disinfection

Chlorinating materials are to conform to: Chlorine, Liquid: AWWA B301; Hypochlorite, Calcium and Sodium: AWWA B300.

2.2 ACCESSORIES

2.2.1 Pipe Restraint

****

NOTE: Design pipe anchorage for a minimum working pressure of 2.4 MPa 350 psi and in accordance with AWWA C600, AWWA C605, AWWA M9, AWWA M11, NFPA 24, Chapter 10 and ASTM F1674.

Use thrust blocks, joint restraint or a combination of thrust blocks and joint restraint as indicated by design analysis.

****

[2.2.1.1 Thrust Blocks

Use ASTM C94/C94M concrete having a minimum compressive strength of [15 MPa] [2,500 psi] [_____] at 28 days[or use concrete of a mix not leaner than one part cement, two and one half parts sand, and five parts gravel, having the same minimum compressive strength].

][2.2.1.2 Precast Thrust Blocks

Provide precast concrete thrust blocks.

][2.2.1.3 Joint Restraint

****
NOTE: Provide restrained joints in accordance with and in accordance with ASTM F1674
****

Provide restrained joints in accordance with NFPA 24, Chapter 10[and in accordance with ASTM F1674].

Provide[mechanical joint restraint][restraint devices with gripper wedges incorporated into a follower gland and specifically designed for the pipe material[and meeting the requirements of AWWA C110/A21.10]][or metal harness fabricated by the pipe manufacturer].

]2.2.2 Protective Enclosures

Provide Freeze-Protection Enclosures that are insulated and designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of [_____] degrees C F when external temperatures reach as low as [_____] degrees C F.

2.2.2.1 Housing

****
NOTE: Consider the enclosure materials and ensure that the material is compatible with the environment. Aluminum enclosures are acceptable in most environments and are recommended for harsh environments and areas subject to vandalism.
****

Reinforced and insulated [aluminum][or][fiberglass] construction; with anchoring devices for attaching housing to concrete base, access doors with locking devices, sized to allow access and service of the protected unit, drain openings, and an electric heating cable or heater with self-limiting temperature control.

[2.2.3 Tapping Sleeves

****
NOTE: Tapping sleeves are not allowed in many locations. Coordinate with the Installations utility department to see if this paragraph should be deleted.

Show size of tapping sleeve on drawings.
****

Provide cast gray, ductile, malleable iron or stainless steel, split-sleeve type tapping sleeves of the sizes indicated for connection to existing main with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Utilize similar metals for bolts, nuts, and washers to minimize the possibility of galvanic corrosion. Provide dielectric gaskets where dissimilar metals adjoin. Provide a tapping sleeve assembly with a maximum working pressure of [1000][_____] kPa [150][_____] psi. Provide bolts with square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, utilize an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pre-torqued to 67.8 Newton meters 50 foot-pound.

]2.2.4 Sleeve-Type Mechanical Couplings

****

NOTE: Delete "or steel" when middle ring of cast iron only is considered necessary due to anticipated corrosion problems.

Minimum numbers of bolts for each pipe size should be as follows: 80 mm 3 inch, 3; 100 mm 4 inch, 4; 150 mm 6 inch, 5; 200 mm 8 inch, 6; 250 mm 10 inch, 7; 300 mm 12 inch and 350 mm 14 inch, 8; 400 mm 16 inch, 9; 450 mm 18 inch, 10; 500 mm 20 inch, 12; 550 mm 22 inch, 13; 600 mm 24 inch, 14.

****

Use AWWA C219 couplings to join plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling consists of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. Provide true circular middle ring and the follower rings sections free from irregularities, flat spots, and surface defects; provide for confinement and compression of the gaskets.[For [ductile iron][and][PVC] pipe, use ASTM A536 ductile iron.][For steel piping, the middle ring is steel and the follower rings are steel.][Steel is to have a strength not less than that of the pipe.] Use gaskets for resistance to set after installation and to meet the requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Provide track-head type bolts ASTM A307, Grade A, with ASTM A563/A563M, Grade A nuts or round-head square-neck type ISO 8678 bolts with ASME B18.2.2 hex nuts. Provide 16 mm 5/8 inch diameter bolts.[Minimum number of bolts for each coupling is [_____][for [_____] mm inch pipe], [_____][for [_____] mm inch pipe,][and][_____] [for [_____] mm inch pipe].] Shape bolt holes in follower rings to hold fast to the necks of the bolts used. Do not use mechanically coupled joints using a sleeve-type mechanical coupling as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint. Provide a tight flexible joint with mechanical couplings under reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Match coupling strength to that of the adjoining pipeline.

2.2.5 Insulating Joints

Provide a rubber-gasketed insulating joint or dielectric coupling between pipe of dissimilar metals which will effectively prevent metal-to-metal contact between adjacent sections of piping.

[2.2.6 Bonded Joints

****

NOTE: Use bonded joints to maintain electrical

continuity in metallic pipeline where cathodic protection is provided during construction or where it is anticipated that cathodic protection will be provided in the future.

Coordinate bonded joints with nearby existing cathodic protection systems.

****

[Where indicated][For all ferrous pipe], provide a metallic bond at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous metallic piping to effect continuous conductivity. Provide Size 1/0 copper conductor thermal weld type bond wire designed for direct burial and shaped to stand clear of the joint.

]2.2.7 Dielectric Fittings

Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains to prevent metal-to-metal contact of dissimilar metallic piping elements and compatible with the indicated working pressure.

2.2.8 Tracer Wire for Nonmetallic Piping

****

NOTE: As an option, warning tape as specified in Section 31 00 00 EARTHWORK may be used. Specify non-metallic color coded 'warning tape' when used in conjunction with tracer wire.

****

Provide a continuous bare copper or aluminum wire not less than 2.5 mm 0.10 inch in diameter in sufficient length over each separate run of nonmetallic pipe.

2.2.9 Water Service Line Appurtenances

****

NOTE: This paragraph and the following subparagraphs are tailored for SERVICE LINES.

****

2.2.9.1 Corporation Stops

****

NOTE: Delete the paragraph when there is no water service piping of 50 mm 2 inch diameter or less included in the project.

****

Ground key type; lead-free bronze, ASTM B61 or ASTM B62; compatible with the working pressure of the system and solder-joint, or flared tube compression type joint. Threaded ends for inlet and outlet of corporation stops, AWWA C800; coupling nut for connection to flared copper tubing, ASME B16.26.

2.2.9.2 Curb or Service Stops

****

NOTE: Delete this paragraph when there is no water service piping of 40 mm 1 1/2 inch diameter or less included in the project.

****

Ground key, round way, inverted key type; made of lead-free bronze, ASTM B61 or ASTM B62; and compatible with the working pressure of the system. Provide compatible ends for connection to the service piping. Cast an arrow into body of the curb or service stop indicating direction of flow.

[2.2.9.3 Service Clamps

Provide single or double flattened strap type service clamps used for repairing damaged cast-iron, steel or PVC pipe with a pressure rating not less than that of the pipe being repaired. Provide clamps with a galvanized malleable-iron body with cadmium plated straps and nuts and a rubber gasket cemented to the body.

]2.2.9.4 Goosenecks

Manufacture goosenecks from Type K copper tubing; provide joint ends for goosenecks compatible with connecting to corporation stop and service line.[Where multiple gooseneck connections are required for an individual service, connect goosenecks to the service line through a compatible lead-free brass or bronze branch connection; the total clear area of the branches to be at least equal to the clear area of the service line.]

2.2.9.5 Curb Boxes

Provide a curb box for each curb or service stop manufactured from cast iron, size capable of containing the stop where it is used. Provide a round head. Cast the word "WATER" on the lid. Factory coat the box with a heavy coat of bituminous paint.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Connections to Existing System

Perform all connections to the existing water system in the presence of the Contracting Officer.

3.1.2 Operation of Existing Valves

Do not operate valves within or directly connected to the existing water system unless expressly directed to do so by the Contracting Officer.

3.1.3 Earthwork

****

NOTE: Earthwork requirements for pipe trenches, including bedding, are covered in Section 31 00 00 EARTHWORK. The applicable requirements for exterior water system which are set forth in Section 31 00 00 EARTHWORK must be incorporated into the project specification. The specifier should verify the current appropriate specification and revise as necessary if different.

****

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.2 INSTALLATION

Install all materials in accordance with the applicable reference standard, manufacturers instructions and as indicated herein.

3.2.1 Piping

3.2.1.1 General Requirements

Install pipe, fittings, joints and couplings in accordance with the applicable referenced standard, the manufacturer's instructions and as specified herein.

3.2.1.1.1 Termination of Water Lines

Terminate the work covered by this section at a point approximately 1.5 m 5 feet from the building, unless otherwise indicated.

****

NOTE: The following paragraph contains tailoring for COPPER.

****

Do not lay water lines in the same trench with gas lines, fuel lines, electric wiring, or any other utility. Do not install copper tubing in the same trench with ferrous piping materials. Where nonferrous metallic pipe (i.e., copper tubing) crosses any ferrous piping, provide a minimum vertical separation of 300 mm 12 inches between pipes.

3.2.1.1.2 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Under no circumstances is it permissible to drop or dump pipe, fittings, valves, or other water line material into trenches. Cut pipe cleanly, squarely, and accurately to the length established at the site and work into place without springing or forcing. Inspect pipe and fittings prior to backfilling and repair as required. Replace a pipe or fitting that does not allow sufficient space for installation of jointing material. Blocking or wedging between bells and spigots is not permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at the design elevation and grade. Secure firm, uniform support. Wood support blocking is not permitted. Lay pipe so that the full length of each section of pipe and each fitting rests solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports for fastening work into place. Make provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been assembled. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation.[Provide a minimum of 760 mm 2 1/2 feet depth of cover over top of pipe.]

3.2.1.1.3 Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

3.2.1.1.4 Connections to Existing Water Lines

****

NOTE: The following paragraph contains tailoring for WATER TRANSMISSION.

****

Make connections to existing water lines after coordination with the facility and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped and as indicated, except as otherwise specified, tap concrete pipe in accordance with AWWA M9 for tapping concrete pressure pipe.

****

NOTE: This paragraph is tailored for NAVFAC HAWAII. Use the following paragraph for PWC PEARL'S projects.

****

All connections to NAVFAC Hawaii's potable water lines 300 mm 12 inches in diameter and smaller using corporation stops or tapping sleeves and tapping valves are only to be made by NAVFAC Hawaii's forces. Coordinate this work, via the Contracting Officer, with NAVFAC Hawaii's and provide NAVFAC Hawaii, Utilities Department, PW65, telephone 473-2557, 14 calendar days advance notification of the date of connection. The Government will furnish, install and operate the tapping machine. Equipment necessary for the installation and operation of the tapping machine as well as necessary cutting blades will be provided by the Government. Disinfection of the tapping machine will be done by the Government. Provide[corporation stops,][tapping sleeves and tapping valves,] and all other material, labor, and equipment necessary for the connection. Perform all earthwork and disinfection work at the connection prior to installation of the tapping machine by the Government. Perform the disinfection work in the presence of the PWC PEARL Utilities Department personnel. Provide all other connections, including wet tapping mains larger than 300 mm 12 inches in diameter and installation of new pipe fittings in existing mains. Make connections to existing water lines in the presence of the NAVFAC Hawaii Utilities Department personnel. Provide NAVFAC Hawaii, Utilities Department, PW65, telephone 473-2557, 14 calendar days advance notification of the date of connection.

3.2.1.1.5 Sewer Manholes

No water piping is to pass through or come in contact with any part of a sewer manhole.

3.2.1.1.6 Water Piping Parallel With Sewer Piping

****

NOTE: The first paragraph is tailored for AIR FORCE and ARMY. The listed items are tailored for NAVY.

****

[Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer than 3.0 m 10 feet, horizontally, from any sewer line.

] a. Normal Conditions: Lay water piping at least 3.0 m 10 feet horizontally from sewer or sewer manhole whenever possible. Measure the distance from outside edge to outside edge of pipe or outside edge of manhole. When local conditions prevent horizontal separation install water piping in a separate trench with the bottom of the water piping at least 450 mm 18 inches above the top of the sewer piping.

b. Unusual Conditions: When local conditions prevent vertical separation, construct sewer piping of AWWA compliant ductile iron water piping and perform hydrostatic sewer test, without leakage, prior to backfilling. When local conditions prevent vertical separation, test the sewer manhole in place to ensure watertight construction.

3.2.1.1.7 Water Piping Crossing Sewer Piping

****

NOTE: The first paragraph is tailored for AIR FORCE and ARMY. The listed items are tailored for NAVY.

****

****

NOTE: Choose one of the following options.

****

[Provide at least 450 mm 18 inches above the top (crown) of the sewer piping and the bottom (invert) of the water piping whenever possible. Measure the distance edge-to-edge. Where water lines cross under gravity sewer lines, construct sewer line of AWWA compliant ductile iron water piping with rubber-gasketed joints and no joint located within 3 m 10 feet, horizontally, of the crossing.][Lay water lines which cross sewer force mains and inverted siphons at least 600 mm 2 feet above these sewer lines; when joints in the sewer line are closer than 900 mm 3 feet horizontally from the water line relay the sewer line to ensure no joint closer than 900 mm 3 feet.]

a. Normal Conditions: Provide a separation of at least 450 mm 18 inches between the bottom of the water piping and the top of the sewer piping in cases where water piping crosses above sewer piping.

b. Unusual Conditions: When local conditions prevent a vertical separation described above, construct sewer piping passing over or under water piping of AWWA compliant ductile iron water piping and perform hydrostatic sewer test, without leakage, prior to backfilling. Construct sewer crossing with a minimum 6.1 m 20 feet length of the AWWA compliant ductile iron water piping, centered at the point of the crossing so that joints are equidistant and as far as possible from the water piping. Protect water piping passing under sewer piping by providing a vertical separation of at least 450 mm 18 inches between the bottom of the sewer piping and the top of the water piping; adequate structural support for the sewer piping to prevent excessive deflection of the joints and the settling on or damage to the water piping.

3.2.1.1.8 Penetrations

Provide ductile-iron or Schedule 40 steel wall sleeves for pipe passing through walls of valve pits and structures. Fill annular space between walls and sleeves with rich cement mortar. Fill annular space between pipe and sleeves with mastic.

3.2.1.1.9 Flanged Pipe

****

NOTE: The following paragraph is tailored for DUCTILE IRON PIPING.

****

Only install flanged pipe aboveground or with the flanges in valve pits.

3.2.1.2 Ductile-Iron Piping

****

NOTE: The following paragraph is tailored for DUCTILE IRON PIPING.

****

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.

****

NOTE: The following list item contains additional tailoring for AIR FORCE and ARMY.

****

a. Jointing:[Make push-on joints with the gaskets and lubricant specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 and AWWA M41 for joint assembly.][Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 and AWWA M41 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.][Make flanged joints with the gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other[equipment and] accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fitting has dimensions that do not allow the making of a flanged joint as specified, replace it.[Use set screw flanges to make flanged joints where conditions prevent the use of full-length flanged pipe and assemble in accordance with the recommendations of the set screw flange manufacturer. During installation of set screw gasket provide for confinement and compression of gasket when joint to adjoining flange is made.]][Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer.] Make [grooved][and][shouldered] type joints with the couplings previously specified for this type joint connecting pipe with the [grooved][or][shouldered] ends specified for this type joint;

assemble in accordance with the recommendations of the coupling manufacturer.[Groove pipe in the field only with groove cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings; secure approval for field-cut grooves before assembling the joint.][Make insulating joints with the gaskets, sleeves, washers, bolts, and nuts previously specified for this type joint. Assemble insulating joints as specified for flanged joints, except that bolts with insulating sleeves are to be full size for the bolt holes. Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.]

b. Allowable Deflection: Follow AWWA C600 and AWWA M41 for the maximum allowable deflection. If the alignment requires deflection in excess of the above limitations, provide special bends or a sufficient number of shorter lengths of pipe to achieve angular deflections within the limit set forth.

****

NOTE: Delete the following paragraph except when required. See the AWWA M41 for ductile iron pipe and fittings for guidance.

Method A and B require polyethylene tubing and should be used as the default selection. Method C requires polyethylene sheeting.

****

[c. Exterior Protection: Completely encase buried ductile iron pipelines using[Method A or B][Method C], with polyethylene film, in accordance with AWWA C105/A21.5.

]3.2.1.3 PVC and PVCO Water Main Pipe

****

NOTE: The following paragraph contains tailoring for FIRE HYDRANTS.

****

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, setting of fire hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation in Trenches and Embankments."

a. Jointing: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use a lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation in Trenches and Embankments," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

b. Joint Offset: Construct joint offset in accordance AWWA C605. Do not exceed the minimum longitudinal bending as indicated by AWWA C605.

c. Fittings: Install in accordance with AWWA C605.

3.2.1.4 Polyethylene (PE) Piping

****

NOTE: This paragraph is tailored for POLYETHYLENE PIPE, POLYETHYLENE SERVICE PIPE AND TUBING, and POLYETHYLENE TRENCHLESS PIPING.

****

Install PE pipes in accordance with AWWA M55, ASTM D2774 and the manufacturer's installation instructions.

3.2.1.5 Fiberglass Piping

****

NOTE: This paragraph is tailored for AIR FORCE and ARMY.

****

Install fiberglass piping in accordance with AWWA M45, ASTM D3839 and the manufacturer's installation instructions.

3.2.1.5.1 RTRP I Jointing

Assemble the pipe in conformance with the manufacturer's written instruction and installation procedures. Prepare field bonding and curing of joints as specified by the pipe manufacturer (several pipe joints having interference-fit type couplings may be bonded and cured simultaneously). The pipe is not to be moved and additional joints are not to be made until the previously bonded joints are completely cured. Joints not having interference-fit type coupling are to be fitted with a clamp that will hold the joint rigidly in place until the joint cement has completely cured.

Provide a protective material on the inner surface of the clamp to prevent damage to the plastic pipe when the clamp is tightened in place. Provide a manufacturer recommended device or method to determine when the joint is pulled against the pipe stop. Provide a gauge from the pipe manufacturer to measure the diameter of the spigot ends to ensure the diameter conforms to the tolerances specified by the manufacturer. Gauge all pipe ends. At any ambient temperatures, cure field bonded epoxy-cemented joints with a self-regulating, thermostatically temperature controlled, electrical heating blanket for the time and temperature recommended by the manufacturer for the size and type of joint, or by an alternate heating method recommended by the manufacturer. Do not move the joint sections during heating, or until the joint has cooled to ambient temperature.

3.2.1.5.2 RTRP II Jointing

Utilize a reinforced overlay joint to join sections together through a placement of layers of reinforcement fiberglass roving, mat, tape or fabric saturated with compatible catalyzed resin.

3.2.1.5.3 RPMP Jointing

Utilize bell and spigot gasket-sealing couplings to connect pipes. Lubricate the spigot prior to push-together assembly.

3.2.1.5.4 Fittings and Specials for RTRP and RPMP Pipe

Assemble metal to RTRP and RPMP pipe connections by bolting steel flanges to RTRP and RPMP pipe flanges. Utilize cast-iron fittings with gasket bell or mechanical joint with RTRP if pipe has cast iron outside diameter. Steel flanges are to be flat-faced type. Use spacer rings to provide a flat-face seat for RTRP and RPMP pipe flanges where raised-face steel flanges are used. Provide a full-face Buna "N" gasket 3 mm 1/8 inch thick with a shore hardness of 50-60 between all flanged connections. The RTRP and RPMP pipe flange are to have raised sealing rings. Use flat washers under all nuts and bolts on RTRP and RPMP pipe flanges. Torque non-corrosive bolts and nuts to not more than 135 Newton meters 100 foot pounds. Do not direct bury flanges. Provide a concrete pit for all flanged connections.

3.2.1.5.5 Allowable Offsets

a. RTRP: Comply with manufacturer's recommendations for the maximum offset in alignment between adjacent pipe joints but do not exceed 5 degrees.

b. RPMP: Comply with manufacturer's recommendations for pipe with bell and spigot rubber gasket joints. Maximum allowable deflections from a straight line or grade is 4 degrees and determined by the diameter, unless a lesser amount is recommended by the manufacturer. Form short-radius curves and closures with short lengths of pipe or fabricated specials specified.

3.2.1.6 [Concrete Pressure Pipe] [PCCP] [RCCP] Piping

****

NOTE: This paragraph is tailored for WATER TRANSMISSION.

****

Except as otherwise specified in the following subparagraphs, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS, the laying and joining requirements specified in AWWA M9; and with the recommendations given in AWWA M9 "Design of Thrust Restraints for Buried Pipe".

****

NOTE: Some pipe joints eliminate the need for

additional pipe anchorage, such as full exterior joint welds, skip welds, clamp type harness, bell bolt harness and snap ring harnesses.
****

a. Jointing: Make joints with the gaskets specified for concrete pipe joints, using a lubricant recommended by the manufacturer. Assemble joints in accordance with the joining requirements specified in AWWA M9 and with the recommendations given for laying the pipe in AWWA M9, chapter entitled "Installation by Trenching or Tunneling--Methods and Equipment." Acceptable joint types are bell and spigot, structural welded, skip welded, clamp type harness, bell bolt harness and snap ring harnesses. Prior to backfilling, wrap joints with a joint wrapper and fill with grout as recommended by the manufacturer. For pipe large enough to accommodate a worker, point the interior joint space with a stiff mixture of portland cement and smooth finish with a hand trowel.

b. Allowable Offsets: To the extent possible, follow the manufacturer's laying schedule, which will indicate the use and location of joint gaps, spacers, beveled joints, short pipe lengths, fabricated specials and beveled adapters. Unless a lesser amount is recommended by the manufacturer, the maximum allowable offset in a joint is 5 degrees.

3.2.1.7 Steel Piping

****
NOTE: This paragraph is tailored for AIR FORCE and ARMY.
****

Unless otherwise specified, install pipe and fittings in accordance with AWWA C604 and AWWA M11, Chapter 12, "Transportation, Installation, and Testing."[Apply protective coating for aboveground piping as specified in Section [_____].]

a. Jointing: Make rubber-gasketed bell-and-spigot joints with the gaskets previously specified for this type joint, using a lubricant recommended by the pipe manufacturer; assemble in accordance with the recommendations of the pipe manufacturer.[Make welded joints in accordance with AWWA C206 and with the recommendations given for installation of pipe in AWWA M11, Chapter 12, "Transportation, Installation, and Testing."] Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer.[Make flanged joints with the gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other[equipment and] accessories. Align bolt holes for each flanged joint. Use full-size bolts for the bolt holes; use of undersized bolts is not permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without straining the flange. Replace flanged pipe or fittings with dimensions that do not allow the making of a flanged joint as specified.][[Make grooved type joints with the couplings specified for this type joint connecting pipe with roll-grooved ends or pipe with welded-on cut-grooved adapters, each with dimensions as previously specified for this type joint. Groove pipe ends in the field only with manufacturer recommended groove rolling equipment and manufacturer recommended groove adapters in the field only with manufacturer recommended groove cutting equipment; use groove rolling and groove cutting equipment especially for the purpose and produced by a manufacturer of grooved joint couplings. Obtain approval for field-cut grooves before assembling the joint.][Make shouldered type joints with the couplings specified for this type joint connecting pipe with the shouldered ends specified for this type joint.] Assemble [grooved][and][shouldered] type joints in accordance with the recommendations of the coupling manufacturer.][Make insulating joints with the gaskets, sleeves, washers, bolts, and nuts specified for this type joint. Assemble insulating joints as specified for flanged joints, except that bolts with insulating sleeves are to be full size for the bolt holes. Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.] Finish joints on piping with cement-mortar lining[and on piping with cement-mortar coating] as specified in Appendix on Field Joints in AWWA C205.[Finish joints on piping with [coal-tar enamel][or][coal-tar epoxy] coating by cleaning, priming, coating, and wrapping with a cold-applied tape coating matching the requirements of, and applied in accordance with AWWA C209.]

b. Allowable Offsets: For pipe with bell-and-spigot rubber-gasket joints, maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets is 5 degrees unless a lesser amount is recommended by the manufacturer. Form short-radius curves and closures with short lengths of pipe or fabricated specials specified.

****

NOTE: Under ordinary conditions, steel water pipe and fittings in the sizes included in water systems covered by this specification are furnished with factory-applied cement-mortar lining.

Under unusual circumstances add cement mortar lining after installation. Add the following note: "Provide cement mortar lining after installation in accordance with AWWA C602".

****

c. Cement Mortar Lining: AWWA C205, shop applied.

3.2.1.8 Metallic Piping for Service Lines

Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of AWWA C600 for pipe installation, unless otherwise specified.

3.2.1.8.1 Screwed Joints

Make screwed joints up tight with a stiff mixture of graphite and oil, inert filler and oil, or graphite compound; apply to male threads only or with PTFE Tape, for use with threaded pipe. Threads are to be full cut; do not leave more than three threads on the pipe exposed after assembling the joint.

3.2.1.8.2 Joints for Copper Tubing

****

NOTE: This paragraph is tailored for COPPER.

****

Cut copper tubing with square ends; remove fins and burrs. Replace dented, gouged, or otherwise damaged tubing with undamaged tubing. Make solder joints using ASTM B32, 95-5 tin-antimony or Grade Sn96 solder. Use solder and flux containing less than 0.2 percent lead. Before making joint, clean ends of tubing and inside of fitting or coupling with wire brush or abrasive. Apply a rosin flux to the tubing end and on recess inside of fitting or coupling. Insert tubing end into fitting or coupling for the full depth of the recess and solder. For compression joints on flared tubing, insert tubing through the coupling nut and flare tubing.

3.2.1.8.3 Flanged Joints

Make flanged joints up tight, avoid undue strain on flanges, valves, fittings, and accessories.

3.2.1.8.4 Protection of Buried Steel Service Line Piping

****

NOTE: This paragraph is tailored for AIR FORCE and ARMY.

****

****

NOTE: Use coal-tar enamel coating with double felt wraps instead of single layer of felt wrap where soil is classified as Group IV, Unusually Corrosive (as defined in AWWA M11, Chapter 10, "Principles of Corrosion and Corrosion Control"); or where electrical resistivity of soil has been measured at less than 2,000 ohms/cc.

****

[Unless otherwise specified,]Prepare, prime, and coat exterior surface of zinc-coated steel pipe and associated fittings to be buried with hot-applied coal-tar enamel with a bonded[single layer of felt wrap in accordance with AWWA C203][double felt wraps in accordance with AWWA C203]. For the felt wrap material, use fibrous-glass mat as specified in AWWA C203; use of asbestos felt will not be permitted. Use solvent wash only to remove oil, grease, and other extraneous matter from zinc-coated pipe and fittings.

3.2.1.9 Plastic Service Piping

****

NOTE: This paragraph and the following subparagraphs are tailored for PVC SERVICE PIPING.

****

Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of ASTM D2774[and ASTM D2855], unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with ASTM F402.

3.2.1.9.1 Jointing

[Make solvent-cemented joints for PVC piping using the solvent cement previously specified for this material; assemble joints in accordance with ASTM D2855.]Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.1.9.2 Plastic Pipe Connections to Appurtenances

Connect plastic service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.

3.2.1.10 Trenchless Piping

3.2.1.10.1 Butt Fusion

****

NOTE: This paragraph contains tailoring for POLYETHYLENE TRENCHLESS PIPING.

****

Fusible pipe will be fused by qualified fusion technicians, as required by manufacturer of the fusion equipment. Record and log each fusion joint by an electronic monitoring device (data logger) connected to the fusion machine. Log fusion data and create Post-Construction Fusion Report with software specifically developed for the pipe material being fused. Software must record the parameters required by the fusion equipment manufacturer and these specifications. Manual log data not logged by the data logger and be included in the Post-Construction Fusion Report. Assemble fusible PVC and PE pipe lengths in the field with butt-fused joints. Follow the manufacturer's fusion equipment procedures.

3.2.1.10.1.1 PVC Pipe

For butt fused PVC Pipe, provide joints meeting the requirements of ASTM F1674.

3.2.1.10.1.2 Polyethylene Pipe

****

NOTE: This paragraph is tailored for POLYETHYLENE TRENCHLESS PIPING.

****

Install butt fused PE Pipe in accordance with AWWA M55 and ASTM F1962.

3.2.1.10.2 Post-Construction Fusion Report

Include the following data for each fusible connection in the report:

a. Pipe Size and Thickness

b. Machine Size

c. Fusion Technician Identification

d. Job Identification

e. Fusion Joint Number

f. Fusion, Heating, and Drag Pressure Settings

g. Heat Plate Temperature

h. Time Stamp

i. Heating and Cool Down Time of Fusion

j. Ambient Temperature

3.2.1.10.3 Installation Ductile Iron Ball and Socket Joint

Install pipe and fittings in accordance with AWWA C600 and AWWA M41 for pipe installation, joint assembly, and thrust restraint.

a. Allowable Deflection: Meet the applicable requirements of AWWA C600, AWWA M41 and in accordance with pipe manufacturer's instructions for the maximum allowable deflection.

****

NOTE: Delete the following paragraph except when required. See the AWWA M41 for ductile iron pipe and fittings for guidance.

****

[b. Exterior Protection: Completely encase buried ductile iron pipelines using Method A or B, with polyethylene film, in accordance with AWWA C105/A21.5.

]3.2.1.11 Fire Protection Service Lines for Sprinkler Supplies

Connect water service lines used to supply building sprinkler systems for fire protection to the water main in accordance with NFPA 24.

3.2.1.12 Water Service Piping

****

NOTE: This paragraph and the following subparagraphs are tailored for SERVICE LINES.

****

3.2.1.12.1 Location

Connect water service piping to the building service where the building service has been installed. Where building service has not been installed, terminate water service lines approximately 1.5 m 5 feet from the building line at the points indicated; close such water service lines with plugs or caps.

3.2.1.12.2 Water Service Line Connections to Water Mains

****

NOTE: Use first optional sentence for service line piping less than 80 mm 3 inches in diameter. Use third optional sentence for service line piping 80 mm 3 inches in diameter or larger. Delete references to size except when more than one size range is present.

The following paragraph contains additional tailoring for AIR FORCE and ARMY.

****

[Connect[[_____] mm inch] water service lines to the main[by a corporation stop and gooseneck and install a service stop below the frostline][as indicated].][Connect water service lines 50 mm 2 inch size to the main[with a rigid connection or a corporation stop and gooseneck and install a gate valve on service line below the frostline][as indicated].][Connect[[_____] mm inch] water service lines to the main[with a rigid connection and install a gate valve on service line below the frostline][as indicated].][Connect water service lines to ductile-iron water mains in accordance with AWWA C600 for service taps.][Connect water service lines to PVC water mains in accordance with UBPPA UNI-PUB-08 and the recommendations of AWWA M23, Chapter 9, "Service Connections."][Connect water service lines to concrete water mains in accordance with the recommendations of AWWA M9, "Tapping Concrete Pressure Pipe."]Connect water service lines to steel water mains in accordance with the recommendations of the steel water main pipe manufacturer and with the recommendations for special and valve connections and other appurtenances in AWWA M11.

[3.2.2 Railroad Right-of-Way

Install piping passing under the right-of-way of a commercial railroad in accordance with the specifications for pipelines conveying nonflammable substances in Chapter 1, Part 5, of the AREMA Eng Man.[For PVC water main pipe, also install in accordance with the recommendations of AWWA M23 for installation of casings.]

]3.2.3 Meters

****

NOTE: This paragraph is tailored for METERS.

****

Install meters and meter[boxes][vaults] at the locations shown on the drawings. Center meters in the[boxes][vaults] to allow for reading and ease of removal or maintenance. Set top of box or vault at finished grade.

3.2.4 Backflow Preventers

****

NOTE: This paragraph and the following subparagraphs are tailored for BACKFLOW PREVENTERS.

****

Install backflow preventers of type, size, and capacity indicated a minimum of 300 mm 12 inch and a maximum of 900 mm 36 inch above concrete base. Include valves and test cocks. Install according to the manufacturers requirements and the requirements of plumbing and health department and authorities having jurisdiction. Support NPS 63 mm 2 1/2 inch and larger backflow preventers, valves, and piping near floor with 300 mm 12 inch minimum air gap, and on concrete piers or steel pipe supports. Do not install backflow preventers that have a relief drain in vault or in other spaces subject to flooding. Do not install by-pass piping around backflow preventers.

3.2.4.1 Backflow Preventer Enclosure

Install a level concrete base with top of concrete surface approximately [50][_____] mm [2] [_____] inches above grade. Install protective enclosure over valve and equipment. Anchor protective enclosure to concrete base.

3.2.5 Disinfection

[Disinfection of systems supplying non-potable water is not required.

] **

NOTE: The continuous-feed method of chlorination is recommended for disinfecting new water systems. Other methods may be selected in accordance with AWWA C651. Keep the bracketed text when using the continuous-feed method of chlorination.

****

Prior to disinfection, provide disinfection procedures, proposed neutralization and disposal methods of waste water from disinfection as part of the disinfection submittal. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Disinfect new water piping using the AWWA C651 [continuous-feed method of chlorination][_____].[Ensure a free chlorine residual of not less than 10 mg/L 10 parts per million after 24 hour holding period and prior to performing bacteriological tests.]

3.2.6 Flushing

Perform bacteriological tests prior to flushing. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 to 0.5 mg/L 0.2 to 0.5 parts per million, the residual chlorine content of the distribution system, or acceptable for domestic use. Use AWWA C655 neutralizing chemicals.

3.2.7 Pipe Restraint

3.2.7.1 Concrete Thrust Blocks

Install concrete thrust blocks where indicated.

3.2.7.2 Restrained Joints

Install restrained joints in accordance with[the manufacturer's instructions][NFPA 24] [_____] where indicated.[For metal harness use tie rods and clamps as shown in NFPA 24.][Provide structural welded, skip welded, clamp type harness, bell bolt harness, snap ring harness for pipe anchorage.][Provide metal harness fabricated by the pipe manufacturer and furnished with the pipe.]

3.2.8 Valves

3.2.8.1 Gate Valves

****

NOTE: This paragraph contains tailoring for PVCO PIPING.

****

Install gate valves, AWWA C500 and UL 262, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves, AWWA C509 or AWWA C515, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509 or AWWA C515. Install gate valves on PVC and PVCO water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation." Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.

3.2.8.2 Check Valves

Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation[, except as otherwise indicated]. Make and assemble joints to check valves as specified for making and assembling the same type joints between pipe and fittings.

3.2.8.3 Air Release, Air/Vacuum, and Combination Air Valves

Install pressure vacuum assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to the requirements of plumbing and health department and authorities having jurisdiction. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

3.2.9 Blowoff Valve Assemblies

Install blowoff valve assemblies as indicated on the drawings or in accordance with the manufactures recommendations. Install discharge fitting on the end of riser pipe to direct the flow of water so as to minimize damage to surrounding areas.

3.2.10 Fire Hydrants

****

NOTE: This paragraph is tailored for FIRE HYDRANTS.

****

Install fire hydrants[, except for metal harness,] in accordance with AWWA C600 for fire hydrant installation and as indicated. Make and assemble joints as specified for making and assembling the same type joints between pipe and fittings.[Provide metal harness as specified under pipe anchorage requirements for the respective pipeline material to which fire hydrant is attached.] Install fire hydrants with the 115 mm 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, install fire hydrants with the 115 mm 4 1/2 inch connection facing the paved surface where the connecting main is located.

3.3 FIELD QUALITY CONTROL

3.3.1 Tests

Notify the Contracting Officer a minimum of five days in advance of hydrostatic testing. Coordinate the proposed method for disposal of waste water from hydrostatic testing. Perform field tests, and provide labor, equipment, and incidentals required for testing[, except that water needed for field tests will be furnished as set forth in paragraph AVAILABILITY AND USE OF UTILITY SERVICES in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS]. Provide documentation that all items of work have been constructed in accordance with the Contract documents.

3.3.1.1 Hydrostatic Test

****

NOTE: NFPA 24 requires a minimum test pressure of 1,400 kPa 200 psi or 375 kPa 50 psi in excess of the system working pressure. Several of the AWWA standards do not meet the requirements of NFPA 24. Where water mains or water service lines provide fire service or water and fire service, they must be tested in accordance with NFPA 24.

If water mains or water service lines do not provide fire service delete the first bracketed option below.

This paragraph contains tailoring for DUCTILE IRON PIPING, PVC SERVICE PIPING, PVCO PIPING, POLYETHYLENE PIPE, POLYETHYLENE SERVICE PIPE AND TUBING, POLYETHYLENE TRENCHLESS PIPING, WATER TRANSMISSION, AIR FORCE and ARMY, SERVICE LINES, and COPPER.

****

Test the water system in accordance with the applicable AWWA standard specified below.[Where water mains provide fire service, test in accordance with the special testing requirements given in the paragraph SPECIAL TESTING REQUIREMENTS FOR FIRE SERVICE.] Test ductile-iron water mains in accordance with the requirements of AWWA C600 for hydrostatic testing. The amount of leakage on ductile-iron pipelines with mechanical-joints[or push-on joints] is not to exceed the amounts given in AWWA C600; no leakage will be allowed at joints made by any other methods. Test PVC and PVCO plastic water systems made with PVC pipe in accordance with the requirements of AWWA C605 for pressure and leakage tests. The amount of leakage on pipelines made of PVC water main pipe is not to exceed the amounts given in AWWA C605, except that at joints made with sleeve-type mechanical couplings, no leakage will be allowed. Test PE pipe in accordance with the requirements of AWWA M55 for hydrostatic testing. Test concrete water mains in accordance with the recommendations in AWWA M9, "Hydrostatic Testing and Disinfection of Mains." The amount of leakage on concrete pipelines is not to exceed 1.8 liters per 24 hours per millimeter 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline. Test steel water mains in accordance with applicable requirements of AWWA C600 for hydrostatic testing. The amount of leakage on steel pipelines with rubber-gasketed bell-and-spigot joints is not to exceed 1.8 liters per 24 hours per millimeter 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline; no leakage will be allowed at joints made by any other method. To stop leakage, repair welded joints only by welding. Test water service lines in accordance with requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at copper pipe joints, copper tubing joints (soldered, compression type, brazed), plastic service pipe joints, flanged joints[, and screwed joints]. Do not backfill utility trench or begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least [7][_____] days after placing of the concrete.

3.3.1.2 Hydrostatic Sewer Test

****

NOTE: This paragraph is tailored for NAVY.

****

****

NOTE: Refer to state standard for minimum test pressure or if state standards are not applicable use a minimum test pressure of 200 kPa 30 psi.

****

The hydrostatic pressure sewer test will be performed in accordance with the applicable AWWA standard for the piping material or AWWA C600[with a minimum test pressure of [_____]].

3.3.1.3 Leakage Test

****

NOTE: This paragraph contains tailoring for POLYETHYLENE PIPE, POLYETHYLENE SERVICE PIPE AND TUBING, and POLYETHYLENE TRENCHLESS PIPING.

****

For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

For PE pipe perform leak testing in accordance with AWWA M55, ASTM F2164.

3.3.1.4 Bacteriological Testing

****

NOTE: Option A is recommended for bacteriological tests. Delete Option A requirements and provide applicable requirements if Option B is preferred.

****

Perform bacteriological tests in accordance with AWWA C651[Option A][Option B].[For new water mains use Option A and obtain two sets of samples for coliform analysis, each sample being collected at least 16 hours apart. Take samples every 370 m 1,200 ft plus one set from the end of the line and at least one from each branch greater than one pipe length.] Analyze samples by a certified laboratory, and submit the results of the bacteriological samples.

3.3.1.5 Backflow Preventer Tests

****

NOTE: This paragraph is tailored for BACKFLOW PREVENTERS.

****

After installation conduct Backflow Preventer Tests and provide test reports verifying that the installation meets the FCCCHR Manual Standards.

3.3.1.6 Special Testing Requirements for Fire Service

****

NOTE: NFPA 24 requires a minimum test pressure of 1400 kPa 200 psi or 375 kPa 50 psi in excess of the system working pressure. Where water mains or water service lines provide fire service or water and fire service, they must be tested in accordance with NFPA

24.

****

Test water mains and water service lines providing fire service or water and fire service in accordance with NFPA 24. The additional water added to the system must not exceed the limits given in NFPA 24

3.3.1.7 Tracer Wire Continuity Test

****

NOTE: To ensure future ability to locate non-metallic mains, require tracer wire continuity verification. Delete this requirement for metallic mains, including concrete mains with steel cylinders.

****

Test tracer wire for continuity after service connections have been completed and prior to final pavement or restoration. Verify that tracer wire is locatable with electronic utility locating equipment. Repair breaks or separations and re-test for continuity.

3.4 SYSTEM STARTUP

Water mains and appurtenances must be completely installed, disinfected, flushed, and satisfactory bacteriological sample results received prior to permanent connections being made to the active distribution system. Obtain approval by the Contracting Officer prior to the new water piping being placed into service.

3.5 CLEANUP

Upon completion of the installation of water lines and appurtenances, remove all debris and surplus materials resulting from the work.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 11 13 (August 2017)**

Preparing Activity: USACE **Superseding**
UFGS-33 20 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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****

USACE / NAVFAC / AFCEC **UFGS-33 11 13 (August 2017)**

Preparing Activity: USACE **Superseding**
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****

SECTION 33 11 13

POTABLE WATER SUPPLY WELLS

08/17

****

NOTE: This guide specification covers the requirements for drilling of water supply wells, furnishing and installing the pump, and associated testing.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

DRAWINGS

Drawings should include the following and any other information necessary to indicate layout and general configuration of the well.

Diameter of drilled hole

Casing sizes - outside casing, inside casing

Well screen size

Minimum depth of outer casing and minimum depth

of well screen

Limits of gravel envelope around inside casing and screens

Limits of neat cement grout around outer casing

Location of air line and altitude gage

Type of cap, cover, or seal required at top of well

Required well capacity in gallons per minute.
****

1.1 UNIT PRICES

****
NOTE: Separate pay items for test holes and water wells must be included in the contract.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, appropriately edit this subpart and move into Section 01 20 00.
****

Payment for each specified item will be made at the contract unit price for that item. Payment includes full compensation for equipment, materials and labor for drilling; removal and disposal of temporary casing, cuttings, and drill fluid; preparation of borehole logs; and sample handling, containers, storage, and testing. Measure depth, logging, installation, casing, riser pipe, and well screen by linear distance. Payment is not allowed for test wells or wells abandoned due to construction practices not in accordance with this specification, faulty construction practices or for the convenience of the Contractor.

1.1.1 Test Well

Compensation for the test well will be made at the contract unit price and includes material, equipment, and labor required to drill and perform tests on the test well. Measure depth as the total linear distance between ground surface and bottom of hole. If the total depth of hole is greater than that specified on the contract for "Test Well," the additional depth will be paid for at the contract unit price for "Additional Test Well Depth." If the test well is developed into the permanent well with no increase in diameter, compensation will be as described below, and separate payment will not be made for the test well.

1.1.2 Water Well

Compensation for the water well will be made at the contract unit price and includes material, equipment, and labor required to drill, develop, perform tests, and complete the permanent well. Measure depth as the total linear distance between ground surface and bottom of hole. If the total depth of well is greater than that specified in the contract for "Water Well," the additional depth will be paid for at the contract unit price for "Additional Water Well Depth."

1.1.3 Observation Well

Compensation for an observation well will be made at the contract unit price and includes material, equipment and labor required to drill, install, and complete the observation well, as well as perform tests and permanently grout it after use. Measure depth as the total linear distance between ground surface and bottom of hole. If the total combined depth of observation wells is greater than that specified in the contract for "Observation Wells," the additional depth will be paid for at the contract unit price for "Additional Observation Well Depth."

[1.1.4 Geophysical Logging

****

NOTE: Delete this paragraph if not applicable for the project.

****

The "Geophysical Logging" unit price will include interpretation of the logs and their delivery to the Government.

]1.1.5 Well or Test Well Decommissioning or Abandonment

Permanent decommissioning or abandonment of wells or test wells will be paid for only if it becomes necessary to abandon a well or test well as specified, and only for work completed and accepted as specified. Payment includes compensation for drilling, casing removal, well sampling, materials, cement, mixing of cement, bentonite, and water, pumping of grout, equipment, removal of foreign objects, and transportation necessary to abandon the well or test well and for the required well or test well abandonment records.

1.1.6 Cleanup

Separate payment will not be made for cleanup of the site. Cleanup means restoring the site to its pre-construction condition, in accordance with paragraph SITE CLEANUP. Cleanup is considered part of and incidental to the drilling, construction, or decommissioning of the well.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile

references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA A100	(2020) Water Wells
AWWA B300	(2024) Hypochlorites
AWWA B301	(2024) Liquid Chlorine
AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C206	(2023) Field Welding of Steel Water Pipe
AWWA C654	(2021) Disinfection of Wells

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A139/A139M	(2022) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM D1586/D1586M	(2018) Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D1587/D1587M	(2015) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe,

	Schedules 40, 80, and 120
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2239	(2012) Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D5088	(2020) Decontamination of Field Equipment Used at Nonradioactive Waste Sites
ASTM D5299/D5299M	(2017) Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
ASTM D5521/D5521M	(2013) Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers
ASTM D5608	(2016) Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites
ASTM F480	(2014; R 2022) Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

U.S. ARMY CORPS OF ENGINEERS (USACE)

CED TR GL-85-3	(1985) Geotechnical Descriptions of Rock and Rock Masses

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Notification

Notify the [Installation Environmental Coordinator (IEC)][_____][and the] Contracting Officer [21][_____] days prior to drilling. The [Contracting

Officer][Contractor][Installation Environmental Coordinator (IEC)][_____] is responsible for contacting the [State of [_____]][USEPA] in accordance with the applicable reporting requirements. Before beginning work, notify the local United States Geological Survey office (USGS)[and the][State Environmental Protection office][State Geological Agency][state health department][local health department] of the type and location of wells to be constructed, the method of construction and anticipated schedule for construction of the wells.

1.3.2 Delivery, Storage, and Handling

Store and maintain well materials in a clean, uncontaminated condition throughout the course of the project. Do not allow filter pack material to freeze before installation.

1.3.3 Project and Site Conditions

Access to each well site, including any utility clearance, permits, licenses, or other requirements and the payment thereof necessary for execution of the work, is the responsibility of the [Contractor][Government]. Furnish a copy of all permits, licenses, and other legal requirements necessary for execution of the work [30][_____] working days before commencement of the work. Obtaining rights-of-entry is the responsibility of the [Contractor][Government]. Visit each proposed well location to observe any condition that may hamper transporting equipment or personnel to the site. [If clearing, or relocation is necessary, the Contractor, [Installation Environmental Coordinator,]and the Contracting Officer must agree on a suitable clearing, or relocation plan, and the location of any required access road.]

1.3.4 Water Well Design Requirements

1.3.4.1 Well Installation Plan

Submit a plan as specified herein describing the drilling methods, sampling, and well construction and well development [30][_____] calendar days prior to beginning drilling operations. Mobilization activities may start prior to submittal of the plan. The plan must be approved and signed by an experienced geologist as specified in paragraph QUALIFICATIONS. Incorporate the following requirements into the Well Installation Plan and follow them in the field. the design of the well is to be based on the various aspects analyzed and contained in this plan (boring log, geophysical log, geotechnical report, sieve analysis, etc.). The plan must include, but not be limited to, a discussion of the following:

a. Description of well drilling methods, and installation procedures, including any temporary casing used, placement of filter pack and seal materials, drill cuttings and fluids disposal, and soil and rock sample disposition.

b. Description of well construction materials, including well screen, riser pipe, centralizers, air line and gauge, tailpiece (if used), filter pack and filter pack gradation, bentonite or drilling mud, drilling fluid additives (if used), drilling water, cement, and well protective measures.

c. Description of quality control procedures to be used for placement of filter pack and seals in the boring, including depth measurements.

d. Forms intended for written boring logs, installation diagrams of wells, geophysical logs, well development records, well sampling data records, state well registration forms, and well abandonment records.

e. Description of contamination prevention and well materials and equipment decontamination procedures.

f. Description of protective cover surface completion procedures, including any special design criteria or features relating to frost heave prevention. Include the maximum frost penetration for the site in this description.

g. Description of intended well development methods.

h. List of applicable publications, including state and local regulations and standards.

i. List of personnel assignments for this project, and personnel qualifications.

j. Description of well decommissioning or abandonment procedures.

k. Description of well capacity testing techniques.

l. Description and discussion of geophysical techniques to be employed at the site.

m. Description of permanent pump to be installed, and discussion of pump operating tests to be employed at the site.

n. Description of specific methods to be employed to control potential contamination or pollution arising from well installation activities.

o. Description of plumbness and alignment testing.

p. Description of specific methods employed to test for sand.

1.3.4.2 Test Wells

****

NOTE: The test well and capacity test should be specified if there is reason to believe that the well may not produce the required yield at the design depth. If the required yield is not obtained, the test well may be drilled deeper or the location changed before the complete well is constructed. Requirements for the test well may be deleted if the well is to be constructed in an area where other wells of similar depth and design are performing adequately. However, a drill log should be made and capacity test should be performed for all wells to provide an "as-built" record.

****

Before starting construction of the well, drill a test well of at least [100][_____] mm[4][_____] inches in diameter at the location of the well into the target water bearing [stratum][strata]. Drill test wells in a manner to protect the subsurface from surface contamination. Carefully advance test wells and sample to determine the presence of the upper aquiclude if one exists. Properly case, grout and seal the boring into the aquiclude before the boring is advanced through the aquiclude into the aquifer. Use the test well to determine the expected flow, optimum depth for flow, water quality, and to identify the strata encountered. Before conducting a capacity test, case the well, and screen in accordance with these specifications. Log test wells in accordance with paragraph BOREHOLE LOGS. A temporary casing [may][must] be used. If used, seat the temporary casing [into the top of the rock][at the top of the stratum being tested]. The test well may be converted to the permanent well, in accordance with these specifications. If the test well is not used for the permanent well, abandon the test well as specified in paragraph WELL DECOMMISSIONING OR ABANDONMENT.

1.3.4.3 Sampling for Geotechnical Analysis

****

NOTE: Sampling for chemical and geotechnical analysis may be combined to allow for obtaining samples for both if that accomplishes project requirements. If rock is cored at the site, and it is determined that it should be retained, it should be boxed, and photographed. Its storage, and later disposal should be in accordance with ER 1110-1-1901, and the proper storage and handling protocol for such material as may be required by other Federal, state, or local laws, regulations and permits.

****

Take samples of all materials penetrated by each drilled well or test well. Obtain soil samples with a [split][thin-walled] tube sampler using standard sampling techniques in accordance with [ASTM D1586/D1586M][ASTM D1587/D1587M]. Extract samples from their in-situ environment in as near an intact, minimally disturbed condition as technically practical. Obtain samples continuously through the area expected to be screened. Provide sieve analyses of all drive-sampled material. Conduct sieve analyses in accordance with ASTM C136/C136M. Determine the gradation of the natural formation through the use of sieve analyses performed on formation samples taken from the areas to be screened. Place drive-sampled materials in airtight containers and label as specified in paragraph SAMPLE CONTAINERS. Deliver samples to the [Contracting Officer][designated facility]. Test representative soil samples for grain-size distribution by mechanical means (sieves down to the 0.074 mmNo. 200 size according to ASTM C136/C136M), moisture content according to ASTM D2216 and Atterberg limits according to ASTM D4318. Describe and identify soils in accordance with ASTM D2488. Perform laboratory classification of soils in accordance with ASTM D2487. Perform sampling to allow completion of the documents described in paragraph BOREHOLE LOGS.

1.3.4.4 Observation Wells

****

NOTE: In some cases an observation well or wells should be drilled an appropriate distance from the test hole or pump well. The observation wells (piezometers) should be monitored during the yield test of the test hole and/or capacity test of the pump well so that valid information of aquifer potential and character may be obtained. The

observation wells must be designed, installed and removed from service in a manner that precludes the possibility of future groundwater contamination resulting from their existence. If the decision is made to keep the observation well for future sampling, or for use in future pumping tests, the observation wells must be properly completed as specified in this section, or other USACE guidance, such as Section 33 51 39 GROUND-WATER MONITORING WELLS.
****

After completion of the [test well][pump well][_____], drill [one][_____] observation well(s)[, or more as directed], at least [45][_____] mm [1-3/4][_____] inches in diameter to the target water bearing stratum, [at the location(s) indicated][at a location [_____] mfeet from][at an appropriate location near] the [test well][pump well][_____]. Use the observation well[s] in conjunction with the [yield test of the test well][and][capacity test of the pump well]. After final acceptance of the pump well by the Contracting Officer, the observation well must be [abandoned as specified in paragraph WELL DECOMMISSIONING OR ABANDONMENT][left in place for future monitoring of the well system].

[1.3.4.5 Geophysical Logging

****
NOTE: The requirement to obtain borehole geophysical surveys is optional. While it may not be necessary to require a borehole geophysical survey at a site where a great deal is known about the subsurface, at another site, where very little, or nothing is known, it may be prudent to require a borehole geophysical survey. When it is deemed necessary to require a borehole geophysical survey, the specific type of survey should be specified. This recommendation is made by the project geologist. The project geologist should also determine what geophysical logging may not be allowed by state regulations, before specifying them. See EM 1110-1-1802, Geophysical Exploration. Guidance for planning and conducting borehole geophysical logging may be found in ASTM D5753.
****

Geophysically log the total depth of each test well drilled. Document geophysical logging in accordance with paragraph GEOPHYSICAL LOGS. Run [one successful natural gamma ray or gamma-gamma for the full depth, (top to bottom of test well);][one successful neutron in the fluid filled portion of the well, (top to bottom of test well);][one successful (top to bottom of test well) spontaneous potential (self-potential);][and,][one successful (top to bottom of test well) resistivity log], for each test well. Log analyses and interpretations must be made by a person qualified in accordance with paragraph QUALIFICATIONS.

]1.3.5 Qualifications

Submit personnel qualification documentation. A geologist with at least [3][_____] years experience in soil and rock logging, and well installation, [registered in the state of [_____],]must be on site during drilling, installation, and testing activities, and be responsible for all geophysical and borehole logging, drilling, well installation, developing and testing activities. Employ a driller licensed in the state of [_____], according to the state requirements. Geophysical logs must be interpreted by a qualified log analyst. Demonstrate the log analyst competence through background, training, and experience when so called upon. Document a minimum of [_____] years of well installation experience. [Have on staff appropriate health and safety personnel as specified in Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES, and personnel qualified to perform the necessary chemical sampling as presented in the approved Sampling and Analysis Plan.]

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Diagrams; G, [_____].

SD-03 Product Data

Well Material

Geophysical Logging

Cement and Bentonite Grout

Drilling Mud

Well Screens

SD-05 Design Data

Well Installation Plan; G, [_____]l

SD-06 Test Reports

Water Source; G, [_____].

Filter Pack

Capacity Test

Test For Plumbness And Alignment

Water Quality Test

Sand Test

Tests

SD-07 Certificates

Site Conditions

Project Photographs

Qualifications

Casing

Air Line and Gauge

Graveling Equipment list

Construction of Filter Pack

SD-11 Closeout Submittals

Survey Maps And Notes; G, [_____]

Well Development Records

Geophysical Logs

Decommissioning or Abandonment Record

PART 2 PRODUCTS

2.1 CASING

****

NOTE: Well components do not have to be made of the same materials to be compatible. With the proper connectors, different materials can be used together without causing detrimental results. When using different materials together, the manufacturer should be consulted.

Edit the submittal requirements based on the type of well (consolidated or unconsolidated). If the specification is written for a consolidated well, delete the well components which are not normally required in consolidated formations, such as inner casing, well screen, and gravel fill.

****

All casing, screen, and other well material must be of compatible materials to prevent galvanic reaction between components of the completed well. Submit catalog data, and name of supplier, for well screens (to include the screen slot size), casing, riser pipe, filter pack material, bentonite, cement, centralizers, surface protective covers, well vaults, locking caps, airline oil filters for pneumatic drilling, dedicated sampling equipment, pumps, and chemical specifications on drill lubricants, tracers, disinfecting agents, and drill fluid additives, if used. Catalog data must include any information, supplied by the manufacturers or suppliers of the above listed items.

2.1.1 Steel Casing and Couplings

Steel casing must be new [carbon steel, conforming to ASTM A139/A139M Grade B][standard weight [galvanized][black]steel pipe, conforming to ASTM A53/A53M][steel pipe conforming to AWWA C200][[type 304][or][type 316] stainless steel] and nominal [_____] mminch diameter, [_____] mminch wall thickness [schedule 5S meeting the requirements of ASTM A312/A312M], as applicable. Joints must be either threaded and coupled, or field welded in accordance with AWWA C206. [Provide casings with [drive shoes][_____].]

2.1.2 Plastic Casing and Couplings

****

NOTE: ASTM F480 covers several different types of pipe materials and coupling configurations. If any of these materials or couplings are to be prohibited, this paragraph should clearly point out which are or are not allowed.

****

Plastic casing pipe and couplings must be schedule [80][___], threaded flush joint[or other joint type as approved by the Contracting Officer]and conform to ASTM F480 and ASTM D1785.

2.2 WELL SCREENS

****

NOTE: Well screens will be specified when the

developed well requires assurance of relatively free entry of water into the casing at low velocity, when surrounding sand from the unconsolidated formation must be prevented from entering the intake, or when a structural retainer is required to support the borehole in the unconsolidated material. Type of screen and casing will be designer's option and nonapplicable type of screen will be deleted. Metal screens and casings will be specified when strength of screen and casing must be greater than that provided by plastic or when maximum open area for the screen diameter is required. Plastic screens and casing may be specified when water quality is such that screen selection requires corrosive-resistant materials, or when economy is of prime importance. Blanks in the well screen may be appropriate if more than one water bearing zone is encountered in an aquifer, or when it is necessary to place a centering device (centralizer) in the screened area. However, screening more than one aquifer in the same well should be avoided whenever possible due to the possibility of cross-contamination.

****

a. Well Screens must be a minimum of [100][_____] mm[4][_____] inches nominal diameter, and must be directly connected to the bottom of the inner casing by an approved method. The length of the screen must be sufficient to provide an intake area capable of passing not less than the minimum required yield of the well, at an entrance velocity not exceeding 30.5 mm/s0.1 fps.

b. The opening, or slot size of the screen, must be [[_____] mminch][determined by the Contractor][designed based on analysis of the distribution of the grain size of the[aquifer materials encountered during drilling][artificial filter pack]], be compatible with the material surrounding the screen. Submit as part of the well installation plan.

c. The well screen must be of sufficient size and design to hold back and support the [gravel used in the filter pack envelope][and][in-situ material surrounding the screen].

d. Use screen and all accessories required for satisfactory operation that are standard products of manufacturers regularly engaged in the production of such equipment. Field constructed screen is not acceptable.

e. "Blanks" in the well screen may be utilized in nonproductive zones, or where centering devices are needed in the screened area, and area considered "casing."

f. Seal the bottom section, below the screen, watertight by means of a [flush threaded][welded] end cap of the same material as the well screen.

2.2.1 Metal Screen

Metal screen must be an approved wire-wound type of [type 304][or][type

316]stainless steel, conforming to the applicable requirements of AWWA A100. A wire-wound screen manufactured with supporting bars or core of material different from the wire will not be acceptable. Make joints of threaded couplings of the same material as the screens or by brazing or welding in accordance with AWWA C206.

2.2.2 Plastic Screen

2.2.2.1 Plastic Pipe

Plastic pipe, and screen material must conform to ASTM F480. All PVC plastic pipe must conform to ASTM D1785.

2.2.2.2 Bonding Materials

****

NOTE: When sampling for trace level contaminants in a well, the use of any solvents to join casing should not be allowed.

****

Bonding materials, proportions and preparation of adhesives, the method of application, and the procedure used for making and curing the connections must conform to the recommendations of the plastic pipe manufacturer and ASTM F480. The pot life, initial setting time and external heating requirements for curing of the adhesive must be suitable for the procedure and climatic and other conditions and must be varied as required to suit changes in climatic and other conditions. Use a system for making joints at the well site that provides a curing period adequate to develop the ultimate strength of the completed joint. Self-tapping screws or other devices for holding adhesive-coated pipe in the couplings during the setting period [may][must not] be utilized. Do not stress newly-made joints in the casing, lower into the well, or submerge in water prior to complete curing of the adhesive.

2.2.2.3 Plastic Well Screen

Provide plastic well screen with perforations consisting of either machine-sawed slots, continuous wrap or wound, or drilled, formed, or molded openings, and have smooth, sharp-edged openings free of burns, chipped edges, or broken pieces on the interior and exterior surfaces of the pipe. The pattern of the openings must be uniformly spaced around the periphery of the well screen. Design and submit compatible slot sizes of screens and [filter-pack gradations][surrounding material] to the Contracting Officer[, with a representative sample of materials in which the screen is to be placed]. The plastic pipe screen strength properties must be equivalent to those for the plastic casing with which the screen is used. Plastic well screen is to be ASTM D1784 compliant.

2.3 FILTER PACK

****

NOTE: The use of artificial filter-pack construction is recommended in formations where the screen slot opening, selected on the basis of a naturally developed well, is smaller than 0.25 mm 0.010 inch (No. 10 slot). Artificial filter-pack material should also be specified when fine uniform material, or extensively laminated, non-homogenous

formations are encountered. Guidance for designing and selecting the screen slot size, and filter pack gradation may be found in EPA's "Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells", (EPA document number 160014-891034); or "Groundwater and Wells", by Fletcher G. Driscoll, published by Johnson Well Screens, 1986.

If the well is not a filter pack type, this paragraph should be deleted in its entirety, along with other references to filter pack wells throughout the specification. When requiring sterilization, the strength of the sterilizing agent should be stated, and how much is required per cubic yard of filter pack.

****

Provide filter pack material that is a product of a commercial sand and gravel supplier, sized and graded for the surrounding soil encountered, and composed of clean, round, hard, waterborne siliceous material, free of flat or elongated pieces, organic matter, or other foreign matter. Submit filter pack material test results; sieve and chemical analyses, within [5][_____] working days after completion of the test well. Size the filter material which will allow the maximum flow of water into the well and prevent the infiltration of sand and silt. The gradation of the filter material must have a uniformity coefficient of not more than 2.5. The filter material must be [thoroughly sterilized with chlorine or hypochlorite immediately before being placed][placed as directed]. Manufactured glass beads made of soda lime glass, SiLi beads, or similar products designed for use in potable water wells may be used as filter pack in lieu of natural quartz sand.

2.4 BENTONITE SEAL

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NOTE: Before installing an annular seal, the state regulatory agency should be consulted. The state, or local municipality, where the well is being installed, may have specific requirements for sanitary, and/or wellhead protection.

****

Provide bentonite seal, intended to keep grout from entering the filter pack, consisting of hydrated granular, or pelletized, sodium montmorillonite furnished in sacks or buckets from a commercial source, and free of impurities which adversely impact the water quality. If the bentonite seal is located above any borehole fluid levels, place a layer of fine sand at the top of the bentonite seal, to provide an additional barrier to any downward migration of grout.

2.5 CEMENT AND BENTONITE GROUT

2.5.1 Cement Grout

Provide cement grout consisting of Portland cement conforming to ASTM C150/C150M, Type I or II, sand and water. Proportion cement grout not to exceed 2 parts, by weight, of sand to 1 part of cement with not more than 23 liters6 gallons of water per 42.6 kg94 lb bag of Portland cement, with a mixture of such consistency that the well can be properly grouted. No more than 5 percent by weight of bentonite powder may be added to reduce shrinkage.

2.5.2 Bentonite Grout

Make high-solids bentonite grout from sodium bentonite powder, granules, or a combination of the two. Mix water from an approved source with these powders or granules to form a thick bentonite slurry. The slurry must consist of a mixture of bentonite and the manufacturer's recommended volume of water to achieve an optimal seal. The slurry must contain at least 20 percent solids by weight and have a density of 4.3 kg/L9.4 lb/gallon of water or greater.

2.6 PERMANENT PUMP

****

NOTE: The pump and motor diameter should be at least 25 mm1 inch smaller than the inside diameter of the well screen or casing, whichever is smaller, in order to allow it to be removed for servicing after buildup of scale on the outside of the pump and inside of the well screen and casing. A permanent pump should not be specified until it is known how much the well will produce. The installation of the permanent pump may need to be in a separate section, (refer to Section 23 21 23 HYDRONIC PUMPS).

****

Permanent pump must be an approved [submersible][jet][or][_____]type with a capacity sufficient to deliver [_____] L/sgpm. Connect the pump to the pump controls by a three-wire drop line. Provide [polyethylene plastic pipe conforming to ASTM D2239][galvanized steel pipe conforming to ASTM A53/A53M] piping for the well drop line. Operate the pump on [208][_____] volts, 60 Hz,[3][single]-phase power, with the motor of sufficient size to operate the pump under the maximum operating conditions without exceeding its rating. Equip the pump with necessary controls to provide for automatic operation of the pump. The pump and motor unit must be no larger than [_____] mminches in diameter at any point.

2.7 CONTAINERS FOR DRILL CUTTINGS AND CORED ROCK SAMPLES

2.7.1 Containers for Drill Cuttings

Drill cuttings and driven samples required for geotechnical purposes are to be sealed in air-tight literpint size [plastic][glass] containers. Place individual sample containers in partitioned [cardboard][_____] boxes.

2.7.2 Labelling of Drill Cutting Containers

Label individual sample containers with the project name, date of sample, well number and depth at which the sample was taken. Label both the container and lid in permanent indelible ink. Label partitioned cardboard box with project number and well number.

2.7.3 Packaging of Cored Rock Samples

Place cored rock samples in [wooden][_____] core boxes as indicated. Place spacers in the proper positions in the core boxes to show the location and actual extent of voids and core losses as clearly as possible. Make the spacers of [wood][_____] [or some other relatively light material] which is of sufficient strength to withstand jarring and crushing in handling. Spacers must be of a strongly contrasting color pattern so that core losses will be accented either by direct observation or in photographs. In the smaller sizes, up to and including 150 mm6 inches, provide spacers the same width as the cores. Place the core in the core box starting at the left hand corner on the hinge side and running to the right. Place successive cores down the hole in successive troughs, starting from the back and working toward the front of the box so that the core can be read in the same manner as a printed page, from left to right, when standing in front of the open box.

2.7.4 Labeling of Cored Rock Sample Containers

Label the outside and the inside of the core box lid with the project name, hole number, date sampled, location, surface elevation, core box number, and interval of depth of core. The information on the label must be such that it can clearly be read in photographs of the core box. Also, label both ends of the core box with the hole number and box number.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection of Existing Conditions

Maintain existing survey monuments and wells, and protect them from damage from equipment and vehicular traffic. Repair any items damaged during this work. Reinstall wells requiring replacement due to Contractor negligence according to these specifications. Protect wells scheduled for abandonment from damage so that abandonment may be performed according to these specifications. Prior to commencement of drilling, obtain written approval from the local utility companies to drill at each site, to avoid disturbing buried utilities.

[3.1.2 Decontamination

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NOTE: It may not be necessary to decontaminate the drilling equipment but the designer should consider whether it is prudent to require that the equipment be decontaminated before use since this well will be used for potable water. Delete this paragraph if it is not applicable for this project .

****

Clean the drill rig, drill rods, drill bits, augers, temporary casing, well developing equipment, tremie pipes, grout pumping lines, and other associated equipment with high-pressure hot water/steam prior to drilling at each well location. Decontaminate in accordance with ASTM D5088 or ASTM D5608. Decontaminate at a central decontamination station in an area that is remote from, and cross- or down-gradient from the well being drilled. Clean screen and well casing with high-pressure hot water immediately prior to installation in the well. The use of factory sealed (plastic wrapped) screen and well casing does not waive this requirement for pre-installation cleaning. Decontaminate samplers in accordance with the Sampling and Analysis Plan. Use water for cleaning from a Government approved source. Sample and test the water source used for cleaning for the constituents specified in the Sampling and Analysis Plan prior to use at the site.

3.1.3 Water Source

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NOTE: Delete this paragraph if not applicable for the project.
****

Submit decontamination and drilling water source analytical test results obtained from the Sampling and Analysis Plan, within [_____] working days before beginning drilling operations. The Contractor is responsible for locating the source, obtaining the water from the source, transporting it to, and storing it at the site.

]3.2 DRILLING, CONSTRUCTION AND TESTING

3.2.1 Well Drilling and Construction

****
NOTE: The geologist must be aware of the approximate depth of well and length of screen required to provide sufficient water to fulfill project requirements and the quality of water to be expected at that depth. (The Post, or Resident Engineers office, or local USGS office is a good source for this information.) This knowledge is necessary to estimate well drilling costs and to determine what type of treatment is required to make the water usable. Any such site-specific conditions or criteria for individual projects should be included in this paragraph. The geologist must ensure that well design meets or exceeds Federal, state, and local installation requirements. Guidance on water well construction may be found in Environmental Protection Agency (EPA) Manual of Water Well Construction Practices (570/9-75/001).
****

Locate the well [as indicated][where directed], and construct in accordance with these specifications. Install each well to prevent aquifer contamination by the drilling operation and equipment, intra- and inter-aquifer contamination, and vertical seepage of surface water adjacent to the well into the subsurface, especially the well intake zone.

If a well of the required capacity is not constructed, or if the well is abandoned because of loss of tools, or for any other cause, abandon the hole as specified in paragraph WELL DECOMMISSIONING OR ABANDONMENT.

3.2.1.1 General

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NOTE: Delete prohibition against organic drilling fluid, and grease, oil, and fuel leaks on equipment if not installing wells at an HTRW site, or if not applicable for the project.
****

a. Use the drilling method approved by the Contracting Officer and in conformance with all state and local standards for water well construction. Execute the work under the direct supervision of an experienced well driller. The drilling method must prevent the collapse of formation material against the well screen and casing during installation of the well.

b. The inside diameter of any temporary casing used must be sufficient to allow accurate placement of the screen, riser, centralizer(s), filter pack, seal and grout. [Any drilling fluid additive used must be inorganic in nature, but phosphate free. Grease or oil on drill rods, casing, or auger joints is not permitted; however, PTFE tape or vegetable oil (in solid phase form) are acceptable. The drill rig must be free from leaks of fuel, hydraulic fluid, and oil which could contaminate the borehole, ground surface or drill tools.]

c. Use casing pipe, well screens, and joint couplings of compatible materials throughout each well.

d. The well must be a [filter pack well][naturally developed well] activated in the [overburden][water-bearing stratum][stratum based on test well data].

e. Drill the well straight, plumb, and circular from top to bottom. Initially drill the well from the ground surface to the [uppermost level of the water bearing strata][top of rock][_____] and the bottom of the outer casing set at this elevation. The hole below the outer casing must penetrate the water bearing stratum a sufficient depth to produce the required amount of water without causing excessive velocities through the aquifer.

f. During construction of the wells, use precautions to prevent tampering with the well or entrance of foreign material. Prevent runoff from entering the well during construction.

g. If there is an interruption in work, such as overnight shutdown or inclement weather, close the well opening with a watertight uncontaminated cover. Secure the cover in place or weigh down so that it cannot be removed except with the aid of the drilling equipment or through the use of drill tools.

3.2.1.2 Setting Outer Casing

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NOTE: There is a provision for temporary casing, as extraction and/or injection wells may not require a permanent outer casing.

****

The outer casing must not be less than [200][_____] mm[8][_____] inches in diameter. The hole must be of sufficient size to leave a concentric annular space of not less than [65][_____] mm[2-1/2][_____]inches and not more than [150][_____] mm[6][_____]inches between the outside of the outer casing and the walls of the hole. Fill the annular space between the outer casing and the walls of the holes with cement grout. Acceptable methods of grouting are detailed in AWWA A100; select a method specifying the forcing of grout from the bottom of the space to be grouted towards the surface. Provide a suitable grout retainer, packer, or plug at the bottom of the outer casing so that grout will not leak into the bottom of the well. Continuously grout to ensure that the entire annular space is filled in one operation. After grouting is completed, do not resume drilling operations for at least [72][_____] hours to allow proper setting of the grout.

3.2.1.3 Temporary Casing

Have temporary well casing available at the construction site of either iron or steel of sufficient length to case to the bottom of all borings. The Contracting Officer will direct the use of a temporary casing to the bottom of the boring during drilling and placement of screen, riser, and filter pack when determined it is necessary to provide adequate support to the sides of the hole. When the walls of the boring require support only during development operations, provide a temporary casing to extend only to a depth 1 m3 feet below the top of the filter pack. The temporary casing, must have an inside diameter of not less than [_____] mminches, of sufficient thickness to retain its shape and maintain a true section throughout its depth, and in sections of any convenient length. The temporary casing must permit its removal without disturbing the filter pack, riser, or well screen. Set the temporary casing so that no cavity will be created outside of it at any point along its length. In the event the temporary casing should become unduly distorted or bent, discard it and use new casing during installation of any additional well.

3.2.1.4 Construction of Inner Casing and Screen

After the grout has set, ream the hole below the outer casing at the required diameter, to the required depth, by an approved method which prevents caving of the hole before or during installation of the filter pack, well screen and inner casing. Contractor may elect to increase the size of the outer casing and drill to the diameter of the filter pack with an annular space between the inner casing and outer casing equal to the thickness of the filter pack. Firmly attach the well screen and inner casing, and lower into the hole by a method which allows for control of the rate of fall of the well screen and inner casing at all times. Do not drop well screen and inner casing, or allow to fall uncontrolled into the hole. Extend the inner casing up through the outer casing to [_____] metersfeet [above][below] the ground surface. Install 3 approved centering devices spaced at 120 degrees between the outer casing and inner casing prior to well construction at [intervals not exceeding [8][_____] m[25][_____]feet along the length][the top of the inner casing and the bottom of the outer casing]. If the screen length is greater than [8][_____] meters[25][_____] feet, place a [1][_____] meter[3][_____] foot length of blank casing in the middle of the screen interval for placement of centering devices. Do not place centering devices on the screened interval, or within the bentonite seal, if used.

3.2.1.5 Construction of Filter Pack

****

NOTE: If the natural formation is developed as the well filter, then this paragraph may be deleted. If development of the well is done after the filter pack is installed, but before the bentonite, or annular seal is installed, additional filter pack material may have to be added, if the level of the top of the filter pack drops below the specified elevation for the top of the filter pack.

****

a. After the screen and inner casing have been concentrically set in the hole below the outer casing, construct the approved filter pack around the screen by filling the entire space (annulus) between the screen and the wall of the hole in the water bearing stratum with filter pack material.

b. Obtain any water added to the filter pack material in accordance with paragraph WATER SOURCE.

c. Lower a tremie pipe having an inside nominal diameter of not less than [40][_____] mm[1-1/2][_____] inches to the bottom of the well between the hole and screen (i.e., the annulus). Arrange and connect the tremie pipe, at the surface of the ground, to water pumping and graveling equipment so that water and filter material, fed at uniform rates, are discharged as the filter material fills the hole from the bottom up. Raise the tremie pipe at a rate that will keep the bottom of the pipe no more than [1][_____] m[3][_____] feet above the filter material level at all times.

d. If there is a desire to use methods of placing filter material other than those specified, submit the details of the method and equipment proposed to the Contracting Officer, before filter pack placement begins; however, dumping filter pack material from the surface of the ground and agitating the well in an effort to settle the filter will not be allowed.

e. Install the filter pack continuously and without interruption until the filter pack has been placed to within [300 mm1 foot of the top of the inner casing][1.5 m5 feet of the ground surface][[10][_____] m [30][_____] feet above the top of the screen]. Directly measure and record the depth to the top of the filter pack.

f. Protect filter pack material from contamination prior to placement by either storing it in plastic lined bags, or in a location protected from the weather and contamination on plastic sheeting. Do not allow filter pack material to freeze before installation. Transport filter pack material to the well site in a manner which prevents contamination by other soils, oils, grease, and other chemicals.

g. Temporary drill casing, if installed, or hollow stem auger, must be removed simultaneously with the above operation.

h. Place filter pack material in no greater than 1 m3 foot lifts prior to retraction of the temporary casing or auger. A minimum of 150 mm6 inches of filter pack must remain in the temporary casing or auger at all times during filter pack installation. Make frequent measurements inside the annulus during retraction to ensure that the filter pack is properly placed.

3.2.1.6 Bentonite Seal Placement

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NOTE: Sufficient time should be allowed for the bentonite seal to hydrate and form a low permeable seal before grout is placed in the annular space above the bentonite seal. By not allowing enough time, grout material could infiltrate into the seal and possibly into the filter pack. It is

recommended waiting a minimum of 3 to 4 hours for hydration of bentonite pellets, or tablets. If bentonite chips are used, the minimum hydration time could be twice as long. Normally bentonite chips should only be used if it is necessary to install a seal in a deep water column. Because of their high moisture content and slow swelling tendencies, chips can be dropped through a water column more readily than a material with low moisture content, such as pellets or tablets. It is recommended that the bentonite seal be placed in lifts, with each lift allowed to hydrate for a minimum period of time. Slurry seals may be used when the seal location is too far below water to allow for pellet or other containerized-bentonite placement, or within a narrow well-borehole annulus. For more guidance consult EM 1110-1-4000.

****

After the inner casing and [well screen][and filter pack]have been installed,[and after predevelopment of the well,] seal the annular space between the inner and outer casings by use of a bentonite seal. Place a minimum 1 m3 foot thick hydrated bentonite seal on top of the filter pack in a manner which prevents bridging of the bentonite in the annulus. The bottom of the bentonite seal must be a minimum of 2 m5 feet above the top of the well screen. Directly measure the depth to the top of the bentonite seal, and record immediately after placement, without allowance for swelling. If the bentonite seal is located above any borehole fluid levels, place a [300][_____] mm[1][_____] foot layer of fine sand at the top of the bentonite seal. Wait a minimum of [3][4][____] hours for hydration of bentonite pellets before proceeding.

3.2.1.7 Grout Placement

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NOTE: Before installing an annular seal, the state regulatory agency should be consulted. The state, or local municipality, where the well is being installed, may have specific requirements for sanitary, and/or wellhead protection. There is a provision for placing a high-solids bentonite grout in the annulus above the bentonite seal rather than cement grout. Advantages and disadvantages of using a bentonite grout instead of cement grout are discussed in EM 1110-1-4000. There may be a need for a provision to grout the annular space in lifts in deep wells to ensure that any PVC or other type casing will not be collapsed by the weight and/or heat created by the chemical reaction of cement grout. If grouting in lifts is for some reason not acceptable, the well should be designed to withstand greater external pressures. This may mean using higher schedule casing, or steel instead of PVC, for example.

****

a. After the inner casing and [well screen][filter pack][bentonite seal] have been installed, mechanically mix a [non-shrinking cement][high-solids bentonite] grout in accordance with paragraph

CEMENT AND BENTONITE GROUT, and place by tremie pipe, in one continuous operation without damaging the well casing into the annulus between the inner and outer casings above the bentonite seal to [within [_____] mm feet of][the ground surface][the maximum depth of frost penetration (frost line)]. Grout injection must be in accordance with AWWA A100.

b. If the casing interval to be grouted is less than 4.5 m15 feet, and without fluids after any drill casing is removed, the grout may be placed either by pouring or pumping.

c. Thoroughly clean the tremie pipe with high pressure hot water or steam before use in each well. Configure the bottom of the tremie pipe to direct the discharge to the sides rather than downward. Submerge the discharge end of the tremie pipe at all times.

d. Add additional grout from the surface to maintain the level of the grout [within [_____] mmfeet of the ground surface][at the land surface] as settlement occurs. Do not conduct work in the well within [24][_____] hours after cement grouting.

e. Verify the alignment of the well by passing a 1.5 m5 foot long section of rigid [PVC][stainless steel][PTFE][_____] pipe 6 mm1/4 inch smaller in diameter than the inside diameter of the casing through the entire well. The well will not be accepted if the pipe does not pass freely. Thoroughly clean the pipe section with high pressure hot water or steam prior to each test.

3.2.2 Well Development

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NOTE: There is a provision for predevelopment, or development after the filter pack is installed, but before the bentonite seal is installed.

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Develop the well within 7 days of completion of each well, but no sooner than [48][_____] hours after cement grouting is completed. The 48 hour period does not apply to well predevelopment or development after the filter pack has been installed, but before the annular seal is installed. Develop the well in accordance with the Well Installation Plan, by approved methods until the water pumped from the well is substantially free from sand, and until the turbidity is less than 5 on the Jackson Turbidity Scale specified in AWWA 10084. Developing equipment must be of an approved type and of sufficient capacity to remove all cutting fluids, sand, rock cuttings, and any other foreign material.

Thoroughly clean the well from top to bottom before beginning the well tests. Perform development using only mechanical surging, over pumping, or jetting, or a combination thereof in accordance with ASTM D5521/D5521M. Include details of the proposed development method in the Well Installation Plan. The well must be free of drawdown or surcharge effects due to pump testing, developing or drilling at another location at the time of development of any well.

3.2.2.1 Site Access and Predevelopment

Maintain the needed access and work area and clearance, necessary to accomplish development at the well site. Furnish, install, or construct the necessary discharge line and troughs to conduct and dispose of the discharge [a sufficient distance from the work areas to prevent damage]. Conduct development to achieve a stable well of maximum efficiency and continue until a satisfactory sand test, as specified in paragraph SAND TEST, is obtained. During predevelopment of the well, add filter pack material to the annular space around the screen to maintain the top elevation of the filter pack to the specified elevation. Provide an open tube or other approved means for accurately determining the water level in the well under all conditions. If, at any time during the development process it becomes apparent in the opinion of the Contracting Officer that the well may be damaged, immediately terminate development operations. The Contracting Officer may require a change in method if the method selected does not accomplish the desired results. The Contracting Officer may order that wells which continue to produce excessive amounts of fines after development for [6][___] hours be abandoned, plugged, and backfilled, and may require the Contractor to construct new wells nearby. Remove all materials pulled into the well by the development process prior to performing the pumping test.

3.2.2.2 Jetting

a. Perform jetting using either a single or double ring jet. If a double ring jet is used the rings should be 600 mm2 feet apart.

b. Construct the jetting tool of high-strength material and conservatively designed and proportioned so that it will withstand high pressures. The jetting tool must have [two [7][8][10] mm[3/16][1/4][3/8] inch diameter hydraulically balanced nozzles spaced 180 degrees][four [7][8][10] mm[3/16][1/4][3/8] inch diameter holes spaced 90 degrees] apart and exert the jetting force horizontally through the screen slots.

c. Construct the rings such that the tips of the jets are within 13 mm 1/2 inch from the inner surface of the well screen.

d. The pump used in conjunction with the jetting tool must be capable of providing [pressures up to [1700][_____] kPa[250][_____] psi.] [a minimum jetting fluid exit velocity of 45 m/s150 f/s].

e. Prior to commencing jetting, and following each jetting cycle, remove all sand and other materials from inside the screen. Start the jetting process at the bottom of the screen and rotate the jetting tool [slowly][1 cycle per 30 seconds][[_____] cycles per [_____] seconds] while rotating the pipe [180][90] degrees for two minutes at each location then raise the pipe [150][_____] mm[6][_____] inches.

f. Pump all wells, more than 100 mm4 inches in diameter, during the jetting cycle to remove incoming sand and other material. Pump at a rate not less than 115 percent of the rate at which fluid is introduced through the jetting tool. This will allow a flow of material into the well as it is being developed.

g. Ensure water introduced into the well during this jetting process is free of sand.

h. The Contracting Officer may require other means of developing the well such as intermittent pumping method, variation of the intermittent pumping method, or surge block if it appears that the development of the well is not producing the desired results.

3.2.2.3 Intermittent Pumping

****

NOTE: Backflow through the pump, while starting and stopping a pump intermittently, with the check valve removed, to produce rapid changes in the pressure head within the well during development, called "rawhiding," is allowed for developing wells. The alternate lifting and dropping of a column of water in the pump discharge pipe creates a surging action in the well. For more information on this development process, consult ASTM D5521/D5521M. Delete this requirement if it is not needed.

****

Pump the well at a capacity sufficient to produce a rapid drawdown of approximately [_____] mfeet stopping the pump (backflow through pump will not be permitted) to permit the water surface to rise to its former elevation, and repeat this procedure. Cycle time for this procedure will vary as directed but will not be more than 3 cycles per minute. A pump discharge in excess of [_____] L/sgpm is required. Use a deep well turbine pump, or electric submersible pump with check valve, with any attachment necessary to accomplish rapid starting and stopping for intermittent pumping. Set the intake at least 3 m10 feet below the maximum expected drawdown in the well. Prior to commencing intermittent pumping, and periodically during development by this method, remove all sand and other materials from inside the screen. The amount of drawdown may be decreased if, in the opinion of the Contracting Officer, the efficiency of the well might otherwise be impaired.

3.2.2.4 Surging

Surging of the well requires use of a circular block, or multiple blocks, which are approximately 25 mm1 inch smaller in diameter than the inside diameter of the well and is constructed of a material which will not damage the screen if the block comes in contact with the screen, and a bailer or pump to remove materials drawn into the well. Continue the surging for a period of approximately [one][_____] hour, or until little or no additional material from the foundation or filter pack can be pulled through the screen. Move the surge block by a steady motion up and down the full length of the well screen. Prior to commencing surging, and periodically during development by this method, remove all sand and other materials from inside the screen. Remove all materials pulled into the well by the surging process.

3.2.2.5 Well Development Criteria

Maintain a well development record in accordance with paragraph WELL DEVELOPMENT RECORDS. Development is complete when all of the following criteria are met:

a. Well water is clear to the unaided eye[, and turbidity less than or equal to [5][_____] Nephelometric Turbidity Units (NTUs)],

b. Sediment thickness in the well is less than [1 percent of the screen length][30 mm0.1 foot],

c. A minimum of three times the standing water volume in the well is removed plus three times the volume of all added water and drilling fluid lost during drilling and installation of the well is removed, and

d. [Temperature, specific conductivity, pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity readings, measured before, twice during and after development operations, have stabilized. Stabilization is defined as [variation of less than 0.2 pH units, variation of plus or minus ±0.5 degrees C1 degree F, ±3 percent change in specific conductance; and less than a ±10mV for ORP; and ±10 percent for DO, and turbidity, measured between three consecutive readings with one casing volume of water removed between each reading] [_____]. Determine ORP in accordance with AWWA 10084. Conduct temperature, specific conductance, DO, turbidity, and pH readings in accordance with EPA 600/4-79/020. At completion of well development, collect approximately 0.5 liter1 pint of well water in a clear glass jar. Label the jar with project name, well number and date; and digital photograph. The photograph (minimally 125 x 174 mm5 x 7 inch) must be a suitably backlit close-up which shows the clarity of the water and any suspended sediment. The photograph and digital copy become a part of the well development record. Water removed during development and testing operations must be [contained in D.O.T. approved drums, containers or vessels and disposed of by [_____], in accordance with paragraph Drilling Waste Disposal] [discharged to the ground surface at least [_____] mfeet from the well in a down gradient area].]

3.2.3 Tests

After the wells have been developed, notify the Government and make the necessary arrangements for conducting the capacity tests. The well must be free of drawdown or surcharge effects caused by pumping tests, well development, or well drilling at another location during capacity testing and the recovery testing after completion of capacity testing. If the capacity test indicates that the required capacity can be obtained, perform the tests for quality of water. If the capacity and quality tests indicate that the required capacity and quality can be obtained, complete the permanent well, as specified, at that depth. Submit Test Reports within [_____][24] hours following the conclusion of each test. Prior to making quality tests, clean drilling equipment, tools and pumps contacting well water with live steam.

3.2.3.1 Capacity Test

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NOTE: This test should be used to verify that the well is developed properly and will produce the required yield. Test pump should be capable of a range of pumping rates, varying from about 50 percent to about 200 percent of the design capacity of the well. Since there are a wide variety of pump test methods, the designer should refer to a good water wells reference book (such as "Ground Water and Wells," by Fletcher G. Driscoll, published by Johnson Well Screens, 1986) for test procedures which best apply.

****

a. Provide an approved temporary test pump, with discharge piping of sufficient size and length to conduct the water being pumped to [point of discharge][_____], and equipment necessary for measuring the rate of flow and water level in the well.

b. Run an [8][_____] hour [constant-rate][step-drawdown] capacity test with the pumping rate and drawdown at the pump well and observation wells recorded every [[30][_____] minutes][1/2 minute during the first 5 minutes after starting the pump; then every 5 minutes for an hour; then every 20 minutes for 2 hours].

c. [From this point on, readings taken at hourly intervals, until the water level stabilizes, are sufficient.] [Read observation wells (piezometers) on the same schedule as the pump well.] [During the step-drawdown test, increase the pumping rate in steps at [regular][[2][_____] hour] intervals. Measure specific capacity for each step.]

d. Begin the test at the rate of [the expected capacity of well] [[_____] L/sgpm] and at least that rate maintained throughout the duration of the [test][step interval]. [The well must be "step" tested at rates of approximately [1/2, 3/4, 1 and 1 1/2][_____] times the design capacity of [_____] L/sgpm.]

e. If this capacity cannot be maintained for the test period, terminate the capacity test and drill the test well deeper or relocate as directed.

f. When the pump is shut off, take water level readings during the rebound period for the same intervals of time as the drawdown test until static water level is reached.

g. Submit the record of the test.

3.2.3.2 Test for Plumbness and Alignment

Upon completion of the permanent well, test for plumbness and alignment by lowering into the well, to the total depth of the well, a plumb [12][_____] m[40][_____] feet long or a dummy of the same length. The outer diameter of the plumb must not be more than 13 mm1/2 inch smaller than the diameter of that part of the hole being tested. If a dummy is used, it must consist of a rigid spindle with three rings, each ring being [300][_____] mm [12][_____] inches wide. Use cylindrical rings spaced one at each end of the dummy and one in the center. The central member of the dummy must be rigid so that it will maintain the alignment of the axis of the rings. Decontaminate the dummy as specified in paragraph DECONTAMINATION, before use. If the plumb or dummy fail to move freely throughout the length of the casing or well screen for the depth of well or should the well vary from the vertical in excess of two-thirds the inside diameter of that part of the well being tested for each 30 m100 feet of depth, correct the plumbness and alignment of the well. If the faulty alignment and plumbness is not correctable, as determined by the Contracting Officer, abandon the well as specified in paragraph WELL DECOMMISSIONING OR ABANDONMENT and drill a new well at no additional cost to the Government.

3.2.3.3 Water Quality Test

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NOTE: The Post, or Resident Engineer, or the USGS should be consulted to determine if any additions or deletions should be made to the Water Quality Analysis table.

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When the capacity test in the test well has been completed, and again after the yield in the permanent well and drawdown test or capacity test have been completed, secure samples of the water in suitable containers, and of sufficient quantity, to have bacterial, physical, and chemical analyses made by [a recognized testing laboratory][_____], except that the bacterial analysis may be made by the applicable State Board of Health, if desired. Water Quality Analysis must address each item specified in the Water Quality Analysis Table at the end of this specification. Expenses incident to these analyses are borne by the Contractor and the results of the analyses submitted to the Contracting Officer. Perform all sampling and analyses using EPA and State approved methods, procedures, and holding times.

3.2.3.4 Sand Test

As part of each capacity test, or at the end of each intermittent pumping, perform a determination of the amount of sand (filter pack and foundation material) a well is producing. Remove all material from the bottom of the tailpipe prior to starting the sand test. Test each well by pumping at a rate [of [_____] L/sgpm] [sufficient to produce approximately [_____] mfeet of draw-down]. After the pump is at the desired pumping rate, divert the flow from the discharge [into a container that will collect all the sand being carried by the water][through a Rossum Sand Tester]. Development of the well is satisfactory if the amount of sand collected is less than 0.5 L per 100,000 L1 pint per 25,000 gallons of water pumped at the specified rate. Upon completion of the test, determine the amount of sand in the tailpipe to verify that no material is being deposited in the bottom of the well.

3.3 REQUIREMENTS AFTER TESTING

3.3.1 Installation of Permanent Pump

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NOTE: The yearly change in the regional water table should be determined before specifying the minimum pump depth.

****

Install the permanent well pump in the well at a minimum depth of [8][_____] m[25][_____] feet below the maximum drawdown groundwater level after the drawdown test has been completed. Secure the pump at the required elevation as recommended by the pump manufacturer. After installation of the pumping units and appurtenances is complete, carry out operating tests to assure that the pumping installation operates properly. Tests must assure that the pumping units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly.

3.3.2 Disinfecting

a. After completion of tests of well, or installation of permanent pump, or at time of tests for yield and drawdown test, whichever is later, disinfect the wells by adding chlorine, conforming to AWWA B301, or hypochlorite, conforming to AWWA B300, in sufficient quantity so that a concentration of at least 50 ppm of chlorine is obtained in all parts of the well.

b. Prepare chlorine solution and introduce into the well in an approved manner, and leave in the well for period of at least 12 hours but not more than 24 hours. Information on methods for preparing chlorine solution and introducing it into the well can be found in AWWA C654.

c. After the contact period, pump the well until the residual chlorine content is not greater than 1.0 ppm.

d. Pump the well to waste for an additional 15 minutes with less than 1 ppm chlorine residual, after which take two samples not less than 30 minutes apart and test for the presence of coliform bacteria.

e. Disinfect and re-disinfect the well as required until two consecutive samples are free from coliform bacteria.

3.3.3 Pumphouse and Slab

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NOTE: In some instances, a pumphouse and base slab may not be appropriate. In such cases, alternate designs must ensure that surface water cannot infiltrate into the well and that the pump and well head are protected.

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Provide a pumphouse and slab preventing the infiltration of surface water or precipitation into the well. The slab must be [1.2][_____] m square by [150][_____] mm thick[4][_____] feet square by [6][_____] inches thick and constructed of reinforced concrete. Extend the top of the outer casing [300][_____] mm[12][______] inches above the top of the slab. The top of the slab must be at elevation [_____] or higher. Construct the pumphouse on the slab and thermally insulate.

3.3.4 Site Clean-up

After completion of the work, remove tools, appliances, surplus materials, temporary drainage, rubbish, and debris incidental to work. Backfill and dress excavation and vehicular ruts to conform with the existing landscape. Repair of replace utilities, structures, roads, fences, or any other pre-existing item damaged due to the Contractor's negligence; this must be accomplished prior to completion of this contract.

3.3.5 Drilling Waste Disposal

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NOTE: The designer must address disposal of drill cuttings, rock core, grout or bentonite slurry, and other solid or liquid materials bailed, pumped, or otherwise removed from the borehole during drilling, well installation, completion, and well development procedures within all appropriate regulatory requirements. The nature of these wastes (whether hazardous or not) will potentially vary between well sites on a single project. In some instances, rock core may be determined to be contaminated and must be handled accordingly. Refer to EPA/540/G-91/009, Management of Investigation-Derived Waste From Site

Investigations and EPA OSWER Directive 9345.3-03FS, April 1992, Guide to Management of Investigation-Derived Wastes, for discussion of some issues relevant to Superfund projects. State/local regulations must also be considered.

****

Dispose of slurry, drill cuttings, rock core; other solid or liquid material bailed, pumped, or otherwise removed from the borehole during drilling, installation, completion, well development procedures and testing; and fluids from material and equipment decontamination activities by [_____].

3.3.6 Surveys

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NOTE: Guidance for installing survey markers can be found in EM 1110-1-1002 Survey Markers and Monumentation.

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Establish coordinates and elevations for each well or test well. Determine horizontal coordinates to the closest 300 mm1.0 foot and referenced to the State Plane Coordinate System, or Universal Transverse Mercator (UTM). If the State Plane Coordinate System or UTM is not readily available, use an existing local grid system. Obtain a ground elevation to the closest 30 mm 0.1 foot at each well. Use the highest point on the top of the riser pipe as a measurement point. The elevation of the well must reference this point, and be surveyed to the nearest 3 mm0.01 foot using the [National Geodetic Vertical Datum of 1929] [North American Vertical Datum of 1988]. If the datum is not readily available, use the existing local vertical datum. Plot the location, identification, coordinates, and elevations of the well and monuments on maps with a scale large enough to show their location with reference to other structures.

3.4 FIELD QUALITY CONTROL

3.4.1 Well Decommissioning or Abandonment

a. Any well disapproved by the Contracting Officer, or any well decommissioned or abandoned by the Contractor for any reason must be decommissioned or abandoned according to the requirements of the State of [_____], [ASTM D5299/D5299M,] and the requirements of these specifications.

b. Well decommissioning or abandonment includes the removal of all materials left in the borehole or well, excluding the filter pack, and including backfill materials, casing, screen, and any other material placed into the hole before the decision was made to abandon the borehole or well.

c. Grout test wells decommissioned or abandoned for any reason from the bottom to within [_____] mmfeet of the top of the ground surface according to the protocol for grout or bentonite placement established in paragraph GROUT PLACEMENT, using the grout mix specified in paragraph CEMENT AND BENTONITE GROUT. Backfill the top [_____] mmfeet with [material appropriate for the intended land use][_____].

d. Maintain a well decommissioning or abandonment record as specified herein.

e. If encountered before the decision is made for decommissioning or abandonment, measure groundwater levels in all borings prior to backfilling. Include these water levels in the well decommissioning or abandonment records.

f. No well may be decommissioned or abandoned without the approval of the Contracting Officer.

3.4.2 Documentation and Quality Control Reports

Establish and maintain documentation and quality control reports for well construction, development, and testing to record the desired information and to assure compliance with contract requirements, including, but not limited to, the following:

3.4.2.1 Borehole Logs

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NOTE: Borehole logging requirements can be found in EM 1110-1-4000. Requirements can also be found in ASTM D2113 and ASTM D5434. If rock is cored at the site, and it is deemed necessary to determine the rock quality designation (RQD) of the core for design purposes, the RQD should also be shown on the boring log. Guidance for determining the RQD may be found in ASTM D6032. Item o. has a provision for recording the level of non-aqueous phase liquids (NAPLs).

****

Complete a borehole log for each boring drilled. Borehole logs must be prepared by the geologist present onsite during all well drilling and installation activities. Use a log scale of [10][_____] mm equals [300][_____] mm[1][_____] inch equals [1][_____] foot. Keep copies of complete well logs current in the field at each well site and make available at all times for inspection by the Contracting Officer. As a minimum, provide the follow information on the logs:

a. Name of the project and site.

b. Boring or well identification number.

c. Location of boring (coordinates, if available).

d. Make and manufacturer's model designation of drilling equipment and name of drilling firm.

e. Date boring was drilled.

f. Reference data for all depth measurements.

g. Name of driller and name and signature of geologist preparing log.

h. Nominal hole diameter and depth at which hole diameter changes.

i. Total depth of boring.

j. Method of drilling, including sampling methods and sample depths, including those attempted with no recovery. Indication of penetration resistance such as drive hammer blows given in blows per 150 mm6 inches of driven sample tubes. Information must include hammer weight and drop distance. Record information such as rod size, bit type, and pump type. Include a description of any temporary casing used, drill fluids and fluid additives used, if any, including brand name and amount used, along with the reason for and start (by depth) of its use. If measured, record mud viscosities and weight.

k. Depth of each change of stratum. State if location of strata change is approximate.

l. Description of the material of which each stratum is composed, in accordance with [ASTM D2488][_____], or standard rock nomenclature in accordance with [CED TR GL-85-3][_____], as necessary. Soil parameters for logging must include, but not be limited to, classification, depositional environment and formation, if known, Unified Soil Classification Symbol, secondary components and estimated percentages, color, plasticity, consistency (cohesive soil), density (non-cohesive soil), moisture content, structure and orientation, and grain angularity. Rock core parameters for logging must include, but not be limited to, rock type, formation, modifier denoting variety (shaly, calcareous, siliceous, etc.), color, hardness, degree of cementation, texture, crystalline structure and orientation, degree of weathering, solution or void conditions, primary and secondary permeability, and lost core. Include the results of any chemical field screening on the boring log. Prepare classification in the field at the time of sampling. Also, duly note and record the results of visual observation of the material encountered, and any unusual odor detected.

m. Depth of any observed fractures, weathered zones, or any abnormalities encountered.

n. Depth and estimated percent of drill fluid loss or lost circulation. Measures taken to regain drill water circulation. Significant color changes in the drilling fluid return.

o. Box or sample number. Record depths and the number of the core boxes and samples at the proper interval.

p. Percent Rock Core Recovery. Show the percent core recovery for the individual drill runs, if rock is cored.

q. Submit [five][_____] prints of the graphic boring log prepared to scale showing the required details, within [_____] working days after completion of the test well. Use this drawing to aid in determining the well design, design of the filter pack, well screen location and screen openings.

3.4.2.2 Installation Diagrams

The well will not be accepted before the geologic logs and installation diagrams are received. Submit As-built installation diagram for each well installed, prepared by the geologist present during well installation operations, within [_____] working days of the completion of the well installation procedure. The diagram must illustrate the as-built condition of the well and include, but not be limited to, the following items:

a. Name of the project and site.

b. Well identification number.

c. Name of driller and name and signature of the geologist preparing diagram.

d. Date of well installation.

e. Description of material from which the well is constructed, including well casing or riser pipe and screen material, centralizer composition, if used, diameter and schedule of casing and screen, gradation of filter pack, lithologic description, brand name (if any), source, and processing method, and method of placement of the filter pack, bentonite seal type (pellets, granules, chips, or slurry), grout type (cement or high-solids bentonite) and type of protective cover (protective casing or flush-to-ground),if used.

f. Total depth of well.

g. Nominal hole diameter.

h. Depth to top and bottom of screen, and filter pack.

i. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).

j. Type of cement and bentonite used, mix ratios of grout, method of placement and quantities used.

k. Elevations, depths, and heights of key features of the well, such as top of well casing or riser pipe, top and bottom of protective casing (if used), ground surface, the depth of maximum frost penetration (frost line), bottom of well screen, top and bottom of filter pack, and top and bottom of seal.

l. Other pertinent construction details, such as slot size and percent open area of screen, type of screen, and manufacturer of screen.

m. Well location by coordinates. Include a plan sheet showing the coordinate system used and the location of each well. A plan sheet is not required for each well installation diagram; multiple wells may be shown on the same sheet.

n. Static water level upon completion of the well.

o. Special problems and their resolutions; e.g., grout in wells, lost casing, or screens, bridging, etc.

p. Description of surface completion.

3.4.2.3 Well Development Records

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NOTE: Delete item k. if not applicable for the project.

****

Prepare a well development record for each well, within [_____] working days of the completion of development under the supervision of the geologist present during well installation operations. Include, as a minimum, the following information on the well development record:

a. Date, time, and elevation of water level in the well, before development.

b. Depth to bottom of well, name of project and site, well identification number, and date of development.

c. Method used for development, to include size, type and make of equipment, bailer, and pump used during development.

d. Time spent developing the well by each method, to include typical pumping rate, if pump is used in development.

e. Volume and physical character of water removed, to include changes during development in clarity, color, particulates, and odor.

f. Volume of water added to the well, if any.

g. Volume and physical character of sediment removed, to include changes during development in color, and odor.

h. Source of any water added to the well.

i. Clarity of water before, during, and after development. Nephelometric turbidity unit (NTU) measurements.

j. Total depth of well and the static water level from top of the casing, immediately after pumping or development, and 24 hours after development.

[k. Readings of pH, specific conductance, DO, ORP, and temperature taken before, during, and after development.

] l. Name and job title of individual developing well.

m. Name and description of the disposal facility or area, for the waters removed during development.

[3.4.2.4 Geophysical Logs

****

NOTE: Delete this paragraph if not applicable for the project.

****

Prepare and complete geophysical logs for each well or test well installed. Submit interpreted geophysical logs, within [_____] working days of the completion of said logging. As a minimum, include the following information on the logs:

a. Project name.

b. Test well or well identification number.

c. Location of test well (coordinates, and state, and county name).

d. Date test well was drilled.

e. Fluid level in test well before logging.

f. Fluid type and temperature.

g. Fluid resistance in ohm-m.

h. Casing type, diameter, and elevation (top and bottom).

i. Cement type and elevation (top and bottom).

j. Screen type, diameter, and elevation (top and bottom).

k. Date and time test well was logged.

l. Reference elevation for all depth measurements.

m. Operator's name.

n. Equipment name and address.

o. Logger type and number.

p. Tool type.

q. Detector type (Nuclear Log only).

r. Source type (Nuclear Log only).

s. Source size (Nuclear Log only).

t. Source spacing (Nuclear Log only).

u. Tool length, cable head to detector.

v. Calibration.

w. Logging speed cm/minft/min.

x. Log vert. scale m/cmft/in.

y. Module settings.

z. Recorder settings.

aa. Document all field problems, including equipment malfunctions. Include the steps taken to solve the problem and how the log might have been affected.

]3.4.2.5 Well Decommissioning or Abandonment Records

As a minimum, include the following in the decommissioning or abandonment records:

a. Project name.

b. Well or test well number.

c. Well or boring location, depth and diameter.

d. Date of decommissioning or abandonment.

e. Method of decommissioning or abandonment.

f. All materials used in the decommissioning or abandonment procedure and the interval in which test materials were placed.

g. Casing, and or other items left in hole by depth, description, and composition.

h. Description and total quantity of grout used initially.

i. Description and daily quantities of grout used to compensate for settlement.

j. Water or mud level (specify) prior to grouting and date measured.

k. The reason for decommissioning or abandonment of the well or test well.

3.4.2.6 Tests

Prepare and submit a copy of all testing results from the well installation process. Include results of drawdown, well yield, sand, plumbness or alignment, etc. as well as any other test results in this submittal.

3.4.2.7 Project Photographs

Before, during, and after completion of work, take a minimum of [one view] [[_____] views] of each well installation. If rock is cored at the site, after the core has been logged, dampen the core if it has dried, arrange neatly in the core box, and photograph. Photographs must be [80][_____] by [120][_____] mm[3][_____] by [5][_____] inch color prints. Mount the photographs and enclose back-to-back in a double face clear plastic sleeve punched to fit standard three ring binders. Each color print must show an information box, [20][_____] by [50][_____] mm[1-1/2][_____] by [3-1/2][_____] inches. Submit digital copy of all photographs as well as color copy. The box must be labeled and arranged as follows:

Project No.	Contract No.
Contractor/Photographer:	
Photograph No.	Date/Time
Description:	
Direction of View:	

3.4.2.8 Survey Maps and Notes

Submit Survey maps and notes, including a tabulated list of all wells and monuments, copies of all field books, maps showing the locations, and elevations of all wells, datum used (e.g. state plane NAD27, NAD83, UTM, etc.), elevation datum, units of measurement, and all computation sheets, within [_____] working days after completion of the survey. Also, submit a diagram showing where on the top of the well the elevation was determined by the surveyor. The tabulation must consist of the designated number of the well or monument, the X and Y coordinates, and all the required elevations. Also, provide a diagram showing where on the top of the well the elevation was determined by the surveyor.

WATER QUALITY ANALYSIS TABLE	
Physical Characteristics	
________________________________	
Color	
Taste	
Threshold odor number	
Turbidity	
Resistivity in ohms per cubic	
pH value	
Temperature	

WATER QUALITY ANALYSIS TABLE	
Chemical Characteristics (Expressed as mg/L)	
________________________________	
Arsenic	
Barium	
Cadmium	
Chromium	
Copper	
Lead	
Mercury	
Selenium	
Silver	
Zinc	
Fluoride as F	
Manganese as Mn (dissolved and total)	
Iron as Fe (dissolved and total)	
Suspended Solids	
Total Dissolved Solids	
Calcium as Ca	
Magnesium as Mg	
Sodium and Potassium as Na	
Total Hardness as CaCO(3)	

Endrin	
Lindane	
Methoxychlor	
Toxaphene	
2-4-D	
2, 4, 5 TP Silvex	
Total Organic Halogens	
TOC	
Sulphates as SO(4)	
Chlorides as C1	
Bicarbonates as HCO(3)	
Carbonates as CO(3)	
Nitrates as NO(3)	
Alkalinity (methyl-orange)	
Phenolphthalein as CaCO(3)	
Silica as SiO(2)	
Carbonate Hardness	
Non-Carbonate Hardness	
H2S	
Total Ammonia	
Silt Density Index	
Langelier Saturation Index	

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 11 23 (November 2009)**
Change 1 - 08/17

Preparing Activity: NAVFAC **Superseding**
UFGS-33 11 23 (August 2008)
UFGS-33 23 00.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 11 23

NATURAL GAS AND LIQUID PETROLEUM PIPING

11/09, CHG 1: 08/17

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-33 11 23 (November 2009)**
Change 1 - 08/17

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 11 23

NATURAL GAS AND LIQUID PETROLEUM PIPING

11/09, CHG 1: 08/17

****

NOTE: This guide specification covers the requirements for exterior and interior fuel gas piping.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification is intended for use when specifying buried polyethylene piping of up to 200 mm 8 inches in nominal pipe size at pressures and other conditions governed by ASME B31.8, "Gas Transmission and Distribution Piping Systems," and aboveground steel piping both outside (up to 1.50 meters 5 feet beyond exterior walls) and within buildings in compliance with NFPA 54, "Fuel Gas Piping."

****

****

NOTE: The following information must be shown on the project drawings:

1. Layout and location of piping.

2. Location of appurtenances, valves, etc.

3. Details of method of mounting piping.

4. Capacity of pressure regulators

5. Location and capacity of LP gas containers.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA ANSI B109.1	(2000) Diaphragm Type Gas Displacement Meters (Under 500 cubic ft./hour Capacity)
AGA ANSI B109.2	(2000) Diaphragm Type Gas Displacement Meters (500 cubic ft./hour Capacity and Over)
AGA ANSI B109.3	(2019) Rotary-Type Gas Displacement Meters
AGA ANSI B109.4	(2016) Self-Operated Diaphragm-Type Natural Gas Service Regulators for Nominal Pipe Size 1¼ inches (32 mm) and Smaller with Outlet Pressures of 2 psig (13.8 kPa) and Less
AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.41/CSA 6.9	(2023) Quick-Disconnect Devices for Use with Gas Fuel Appliances
ANSI Z21.45	(1995) Flexible Connectors of Other Than All-Metal Construction for Gas Appliances
ANSI Z21.69/CSA 6.16	(2015; R 2020) Connectors for Movable Gas Appliances

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 25-16	(2016) Earthquake-Activated Automatic Gas Shutoff Devices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.33	(2024) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 175 psi, (Sizes NPS 1/2 Through NPS 2)
ASME B16.38	(2023) Large Metallic Valves for Gas Distribution Manually Operated, NPS 2 1/2 (DN 65) to NPS 12 (DN 300), 125 psig 8.6 bar) Maximum
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.40	(2024) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.8	(2022; Supplement 2022) Gas Transmission and Distribution Piping Systems
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM D2513	(2018a) Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
ASTM D2683	(2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards
49 CFR 195	Transportation of Hazardous Liquids by Pipeline

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section, with additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Valve Box

Pressure Regulator

Gas Equipment Connectors

Valves

Warning and Identification Tape

Risers

Transition Fittings

Gas meter

[LPG Containers and Accessories]

SD-07 Certificates

Welder's Qualifications

PE Welder's Qualifications

Welder's Identification Symbols

SD-08 Manufacturer's Instructions

PE Pipe and Fittings

Submit manufacturer's installation instructions and manufacturer's visual joint appearance chart.

1.4 QUALITY ASSURANCE

1.4.1 Welder's Qualifications

Comply with ASME B31.8. The steel welder must have a copy of a certified ASME B31.8 qualification test report. The PE welder must have a certificate from a PE pipe manufacturer's sponsored training course. Contractor must also conduct a qualification test. Submit each welder's identification symbols, assigned number, or letter, used to identify work of the welder. Affix symbols immediately upon completion of welds. Welders making defective welds after passing a qualification test must be given a requalification test and, upon failing to pass this test, must not be permitted to work this contract.

1.4.2 PE Welder's Qualifications

Prior to installation, Contractor must have supervising and installing personnel trained by a PE pipe manufacturer's sponsored course of not less than one week duration, or present proof satisfactory to the Contracting Officer that personnel are currently working in the installation of PE gas distribution lines.

1.4.3 Safety Standards

49 CFR 192 [and 49 CFR 195].

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, transport, and store plastic pipe and fittings carefully. Plug or cap pipe ends during transportation or storage to minimize dirt and moisture entry. Do not subject to abrasion or concentrated external loads. Discard PE pipe sections and fittings that have been damaged.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Conform to NFPA 54 and with requirements specified herein. Supply piping to appliances or equipment must be at least as large as the inlets thereof.

2.2 PIPE AND FITTINGS

2.2.1 Aboveground and Within Buildings and Vaults

****

NOTE: For steam electric generation stations, industrial and institutional plants, and central heating plants, use Schedule 80 black steel piping in accordance with ANSI B31.1 for threaded joints.

****

a. Pipe: Black steel in accordance with ASTM A53/A53M, Schedule [40] [80], threaded ends for sizes 50 mm 2 inches and smaller; otherwise, plain end beveled for butt welding.

b. Threaded Fittings: ASME B16.3, black malleable iron.

c. Socket-Welding Fittings: ASME B16.11, forged steel.

d. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.

e. Unions: ASME B16.39, black malleable iron.

f. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1. Flange faces must have integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

2.2.2 Underground Polyethylene (PE)

PE pipe and fittings are as follows:

a. Pipe: ASTM D2513, 690 kPa (gage) 100 psig working pressure, Standard Dimension Ratio (SDR), the ratio of pipe diameter to wall thickness, 11.5 maximum.

b. Socket Fittings: ASTM D2683.

c. Butt-Fusion Fittings: ASTM D2513, molded.

2.2.3 Risers

Manufacturer's standard riser, transition from plastic to steel pipe with 0.18 to 0.30 mm 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide [remote bolt-on or bracket] [or] [wall-mounted] riser supports [as indicated].

2.2.4 Transition Fittings

****

NOTE: Choose the applicable options from the following.

****

[a. Steel to Plastic (PE): As specified for "riser" except designed for steel-to-plastic with tapping tee or sleeve. Coat or wrap exposed steel pipe with heavy plastic coating.

][b. Plastic to Plastic: [Manufacturer's standard slip-on PE mechanical coupling, molded, with stainless-steel ring support, O-ring seals, and rated for 1035 kPa (gage) 150 psig gas service.] [Manufacturer's standard fused tapping (PE-to-PE) tee assembly with shut-off feature.]

]2.3 SHUTOFF VALVES, BELOW GROUND

[2.3.1 Metallic Ball Valves

****

NOTE: Choose this paragraph or the paragraph (below) PE BALL OR PLUG VALVES.

****

[ASME B16.33] [or] [ASME B16.38] corrosion-resisting steel, with threaded or flanged ends. Provide polytetrafluoroethylene (PTFE) seats.

][2.3.2 PE Ball or Plug Valves

****

NOTE: PE ball or plug valves: Class 1 location means not more than 10 living units, homes and separate living units within apartment buildings, along a 1600 meters one mile length of pipeline; Class 2 location means not more than 46 living units, along a 1600 meters one mile length of pipeline; Class 3 location means not more than 20 persons normally congregating in any one building or outdoor location; and Class 4 location means any location where Class 1 to 3 population densities are exceeded. The Class 4 class factor also applies where there are buildings of more than three stories.

****

ASME B16.40 and ASTM D2513, Class C materials (PE 2306 or PE 3406), strength rating of Class [1 location with class factor of 0.32] [2 location with class factor of 0.25] [3 location with class factor of 0.25] [4 location with class factor of 0.20], and SDR matching PE pipe dimensions and working pressure.

]2.4 VALVES, ABOVEGROUND

[Provide lockable valves where indicated.

]2.4.1 Shutoff Valves, Sizes Larger Than 50 Millimeters 2 Inches

****

NOTE: Choose one of the options below.

****

****

NOTE: Do not use cast-iron material for valve body or gas-meter body in seismic zones 3 and 4.

****

[[Cast-iron] [or] [steel] body ball valve with flanged ends in accordance with ASME B16.38. Provide PTFE seats.

][Cast-iron body plug valve in accordance with ASME B16.38, nonlubricated, wedge-mechanism or tapered lift plug, and flanged ends.

]2.4.2 Shutoff Valves, Sizes 50 Millimeters 2 Inches and Smaller

****

NOTE: Choose one of the options below.

****

[[Bronze] [Steel] body ball valve in accordance with ASME B16.33, full port pattern, reinforced PTFE seals, threaded ends, and PTFE seat.

][[Bronze] [Steel] body plug valve in accordance with ASME B16.33, straightway, taper plug, regular pattern with a port opening at least equal to the internal pipe area or round port full bore pattern, non-lubricated, PTFE packing, flat or square head stem with lever operator, 860 kPa (gage) 125 psig rating, threaded ends.

]2.4.3 Line Appliance Pressure Regulator and Shutoff Valve

Provide regulators conforming to [ANSI Z21.18/CSA 6.3 for appliances] [ANSI Z21.78/CSA 6.20 for combination gas controls for gas appliances] [, and ANSI Z21.80/CSA 6.22 for line pressure regulators]. Provide shutoff valves conforming to [ANSI Z21.15/CSA 9.1 for manually controlled gas shutoff valves] [and] [ANSI Z21.21/CSA 6.5 for automatic shutoff valves for gas appliances].

2.4.4 Service Regulators

a. Provide ferrous bodied pressure regulators for individual service lines, capable of reducing distribution line pressure to pressures required for users. Provide service regulators conforming to AGA ANSI B109.4 CGA-6.18-M95 with full capacity internal relief[and overpressure shutoff]. Set pressure relief at a lower pressure than would cause unsafe operation of any connected user.

b. Adjust regulators for liquified petroleum gas to 2.5 to 3 kPa 10 to 12 inches of water column, with pressure relief set at 4 kPa 16 inches of water column.

c. Provide regulator(s) having a single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas flow rate at the regulator inlet pressure. Provide regulator valve vent of resilient materials designed to withstand flow conditions when pressed against the valve port, capable of regulating downstream pressure within limits of accuracy and limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Provide a self-contained service regulator, and pipe not exceeding exceed 50 mm 2 inch size.

2.4.5 Earthquake Automatic Gas Shutoff Valve

****

NOTE: Provide this earthquake protective feature primarily for seismic zones 3 and 4.

****

ASCE 25-16 and UL listed or AGA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The valve may be either pendulum or ball construction with [remote [, pneumatic] [electronic] [or] [electric]] actuator.

2.5 GAS METER

****

NOTE: Do not use cast-iron material for valve body or gas-meter body in seismic zones 3 and 4.

****

[AGA ANSI B109.1] [AGA ANSI B109.2] [AGA ANSI B109.3] [pipe] [pedestal] mounted, [diaphragm] or [bellow] [style], [cast-iron] [enamel coated steel] [aluminum] case. [Provided with a strainer immediately upstream]. Provide [diaphragm-type meter conforming to AGA ANSI B109.1 for required flow rates less than 500 cfh, or AGA ANSI B109.2, for flow rates 500 cfh and above] [rotary-type displacement meter conforming to AGA ANSI B109.3] as required by local gas utility supplier. Provide combined [odometer-type] register totalizer index, UV-resistant index cover, water escape hole in housing, and means for sealing against tampering. Provide temperature-compensated type meters sized for the required volumetric flow rate and suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Provide meters with over-pressure protection as specified in 49 CFR 192 and ASME B31.8. Provide meters that are tamper-proof [with] [frost protection] [fungus protection][seismic protection].Provide meters with a pulse switch initiator capable of operating up to speeds of 500 maximum pulses per minute with no false pulses and requiring no field adjustments. Provide not less than one pulse per 2.83 cubic meters 100 cubic feet of gas. Minimum service life must be 30,000,000 cycles.

2.5.1 Utility Monitoring and Control System (UMCS) / Energy Monitoring and Control (EMCS) or Automatic Meter Reading Interfaces

Provide gas meters capable of interfacing the output signal, equivalent to volumetric flow rate, with the existing UMCS / EMCS for data gathering in units of cubic meters cubic feet. Provide meters that do not require power to function and deliver data. Output signal must be either a voltage or amperage signal that can be converted to volumetric flow by using an appropriate scaling factor.

2.5.2 Measurement Configuration

For buildings that already have a gas meter with a pulse output, ensure that the pulse output is connected to a data gathering device (i.e. electric meter). For buildings where a natural gas meter already exists but does not have a pulse output, add a pulse kit to the existing meter and tie the output to a data gathering device. If the existing gas meter will not accept a pulse kit or if no meter exists a new natural gas meter must be installed, also requiring a pulse output to a data gathering device. Ensure the pulse frequency and electronic characteristics are compatible with the existing data gathering device, if any.

2.6 GAS EQUIPMENT CONNECTORS

a. Flexible Connectors: ANSI Z21.45.

b. Quick Disconnect Couplings: ANSI Z21.41/CSA 6.9.

c. Semi-Rigid Tubing and Fittings: ANSI Z21.69/CSA 6.16.

2.7 VALVE BOX

Provide [street valve box with cast-iron cover and two-piece 130 mm 5 1/4 inch shaft-slip valve box extension] [rectangular concrete valve box, sized large enough for removal of valve without removing box]. Cast the word "Gas" into the box cover. Use valve box for areas as follows:

a. Roads and Traffic Areas: Heavy duty, cast iron cover.

b. Other Areas: Standard duty, concrete cover.

[c. Airfields and Special Loadings: As detailed.

]2.8 CASING

Where indicated at railroad or other crossing, provide ASTM A53/A53M, galvanized pipe, Schedule 40 [, with extruded polyethylene coating].

2.9 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

Provide detectable aluminum-foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape in rolls, 75 mm 3 inch minimum width, color-coded yellow for natural gas, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification must be "CAUTION BURIED GAS PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.10 HANGERS AND SUPPORTS

MSS SP-58.

2.11 WELDING FILLER METAL

ASME B31.8.

2.12 PIPE-THREAD TAPE

Antiseize and sealant tape of polytetrafluoroethylene (PTFE).

2.13 BOLTING (BOLTS AND NUTS)

Stainless steel bolting; ASTM A193/A193M, Grade B8M or B8MA, Type 316, for bolts; and ASTM A194/A194M, Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts must conform with ASME B18.2.1and ASME B18.2.2 with coarse threads conforming to ASME B1.1, with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs must extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts must have American Standard regular square or heavy hexagon heads; nuts must be American Standard heavy semifinished hexagonal.

2.14 GASKETS

Fluorinated elastomer, compatible with flange faces.

2.15 IDENTIFICATION FOR ABOVEGROUND PIPING

MIL-STD-101 for legends and type and size of characters. For pipes 19 mm 3/4 inch od and larger, provide printed legends to identify contents of pipes and arrows to show direction of flow. Color code label backgrounds to signify levels of hazard. Make labels of plastic sheet with pressure-sensitive adhesive suitable for the intended application. For pipes smaller than 19 mm 3/4 inch od, provide brass identification tags 40 mm 1 1/2 inches in diameter with legends in depressed black-filled characters.

[2.16 (LIQUEFIED PETROLEUM GAS) LPG CONTAINERS AND ACCESSORIES

****

NOTE: The maximum size permitted under DOT specifications is 0.50 cubic meter 1,000 pounds water capacity. Fuse plugs may be used in addition to the spring-loaded safety relief valves for aboveground ASME containers of 4 1/2 cubic meters 1,200 gallons water capacity or less.

****

NFPA 58, [DOT] [or] [ASME] containers with appurtenances, system working pressure, minimum design pressure, that is LPG vapor pressure at 38 degrees C 100 degrees F, and water capacity as indicated. Provide containers with piping and fittings, [fuse plugs], [hose and flexible hose connectors], [gas-air mixer], strainer, and marking conforming to NFPA 58.

]PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: To assist the designer in selecting the proper documents for a specific project, the following scope in accordance with documents is provided:

1. NFPA 54 Scope: "1.1.1 Applicability: ... Coverage of piping systems extends from the point of delivery to the connections with each gas utilization device. For other than indicated liquified petroleum gas systems, the point of delivery is the outlet of the service meter assembly, or the outlet of the service regulator or service shutoff valve when no gas meter is

provided. For undiluted liquified petroleum gas systems, the point of delivery is the outlet of the first stage pressure regulator..."

2. ASME B31.8 Scope: "802.11... This code covers the design, fabrication, installation, inspection, testing and safety aspects of operation and maintenance of gas transmission and distribution systems, including gas pipelines, gas compressor stations, gas metering and regulation stations, gas mains, and service lines up to the outlet of the customer's meter set assembly....802.14 This code does not apply to....(c) piping beyond the outlet of the customers meter set assembly..."

****

Install gas piping, appliances, and equipment in accordance with NFPA 54. [Install distribution piping in accordance with ASME B31.8.] [Install and store liquefied petroleum gas piping, appliances, and equipment in accordance with NFPA 58.]

3.1.1 Excavating and Backfilling

Perform excavating and backfilling of pipe trenches as specified in Section 31 00 00 EARTHWORK. Place pipe directly in trench bottom and cover with minimum 75 mm 3 inches of sand to top of pipe. If trench bottom is rocky, place pipe on a 75 mm 3 inch bed of sand and cover as above. Provide remaining backfilling. Coordinate provision of utility warning and identification tape with backfill operation. Bury utility warning and identification tape with printed side up at a depth of 305 mm 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

3.1.2 Piping

Cut pipe to actual dimensions and assemble to prevent residual stress. [Provide supply connections entering the buildings as indicated.] Within buildings, run piping parallel to structure lines and conceal in finished spaces. Terminate each vertical supply pipe to burner or appliance with tee, nipple and cap to form a sediment trap. To supply multiple items of gas-burning equipment, provide manifold with inlet connections at both ends.

3.1.2.1 Cleanliness

Clean inside of pipe and fittings before installation. Blow lines clear using 550 to 690 kPa (gage) 80 to 100 psig clean dry compressed air. Rap steel lines sharply along entire pipe length before blowing clear. Cap or plug pipe ends to maintain cleanliness throughout installation.

3.1.2.2 Aboveground Steel Piping

Determine and establish measurements for piping at the job site and accurately cut pipe lengths accordingly. For 50 mm 2 inch diameter and smaller, use threaded or socket-welded joints. For 65 mm 2 1/2 inch diameter and larger, use flanged or butt-welded joints.

a. Threaded Joints: Where possible use pipe with factory-cut threads, otherwise cut pipe ends square, remove fins and burrs, and cut taper pipe threads in accordance with ASME B1.20.1. Provide threads smooth, clean, and full-cut. Apply anti-seize paste or tape to male threads portion. Work piping into place without springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed. Use unions for connections to [valves] [meters] for which a means of disconnection is not otherwise provided.

b. Welded Joints: Weld by the shielded metal-arc process, using covered electrodes and in accordance with procedures established and qualified in accordance with ASME B31.8.

c. Flanged Joints: Use flanged joints for connecting welded joint pipe and fittings to valves to provide for disconnection. Install joints so that flange faces bear uniformly on gaskets. Engage bolts so that there is complete threading through the nuts and tighten so that bolts are uniformly stressed and equally torqued.

d. Pipe Size Changes: Use reducing fittings for changes in pipe size. Size changes made with bushings will not be accepted.

e. Painting: Paint new ferrous metal piping, including supports, in accordance with Section 09 90 00 PAINTS AND COATINGS. Do not apply paint until piping tests have been completed.

f. Identification of Piping: Identify piping aboveground in accordance with MIL-STD-101, using adhesive-backed or snap-on plastic labels and arrows. In lieu of labels, identification tags may be used. Apply labels or tags to finished paint at intervals of not more than 15 meters 50 feet. Provide two copies of the piping identification code framed under glass and install where directed.

3.1.2.3 Buried Plastic Lines

Provide totally PE piping. Prior to installation, obtain printed instructions and technical assistance in proper installation techniques from pipe manufacturer.[When joining new PE pipe to existing pipe line, ascertain what procedural changes in the fusion process is necessary to attain optimum bonding.]

a. Jointing Procedures: Use jointing procedures conforming to AGA XR0603 and 49 CFR 192 that have been qualified by test in accordance with 49 CFR 192.283 and proven to make satisfactory joints. Personnel make joints in plastic pipe must be qualified in accordance with 49 CFR 192.285, under the submitted and approved procedure by making a satisfactory specimen joint that passes the required inspection and test. Joints in plastic pipe must be inspected by a person qualified by 49 CFR 192.287 under the applicable procedure. Certificates that qualify the applicable procedures, joining personnel, and inspectors must be submitted and approved and must be on file with the Contracting Officer prior to making these joints.

b. PE Piping: Prior to installation, Contractor must have supervising and installing personnel, certified in accordance with paragraph WELDER'S QUALIFICATIONS. Provide fusion-welded joints except where transitions have been specified. Use electrically heated tools, thermostatically controlled and equipped with temperature indication. (Where connection must be made to existing plastic pipe, contractor must be responsible for determination of compatibility of materials and procedural changes in fusion process necessary to attain maximum integrity of bond.)

c. Laying PE Pipe: Bury pipe 600 mm 24 inches below finish grade [or deeper when indicated]. Lay in accordance with manufacturer's printed instructions.

3.1.2.4 Connections to Existing Pipeline

When making connections to live gas mains, use pressure tight installation equipment operated by workmen trained and experienced in making hot taps. For connections to existing underground pipeline or service branch, use transition fittings for dissimilar materials.

3.1.2.5 Wrapping

Where connection to existing steel line is made underground, tape wrap new steel transition fittings and exposed existing pipe having damaged coating. Clean pipe to bare metal. Initially stretch first layer of tape to conform to the surface while spirally half-lapping. Apply a second layer, half-lapped and spiraled as the first layer, but with spirals perpendicular to first wrapping. Use 0.025 mm 10 mil minimum thick polyethylene tape. In lieu of tape wrap, heat shrinkable 0.025 mm 10 mil minimum thick polyethylene sleeve may be used.

3.1.3 Valves

Install valves approximately at locations indicated. Orient stems vertically, with operators on top, or horizontally. [Provide support for valves to resist operating torque applied to PE pipes.]

3.1.3.1 Stop Valve and Shutoff Valve

Provide stop valve on service branch at connection to main and shut-off valve on riser outside of building.

3.1.4 Gas Service Installation

[Gas service line, service regulator and gas company meter must be installed in accordance with Section 33 51 15 NATURAL-GAS / LIQUID PETROLEUM GAS DISTRIBUTION PIPELINES.]Installations must be in accordance with 49 CFR 192 and ASME B31.8. Contractor must submit and use only tested and approved work procedures. Contractor must use only welders and jointers who have been recently qualified by training and test for joining and installing the gas pipe material used on this job. The finished product must be inspected by a person qualified to inspect joints made by the particular procedures used to make joints.

****

NOTE: This section specifies service line, service regulator, and gas company meter. These components must be installed in accordance with 49 CFR 192 and ASME B31.8 to allow gas systems to be accepted by Utility Privatization Contractors.

These installations are also specified is Section 33 51 15 NATURAL-GAS / LIQUID PETROLEUM GAS DISTRIBUTION PIPELINES. If that section is not included in the contract documents, delete the reference statement above and include the paragraphs below in this specification.

Where project documentation includes Section 33 51 15 NATURAL-GAS / LIQUID PETROLEUM GAS DISTRIBUTION PIPELINES, delete the paragraphs below and include the reference statement above.

****

[3.1.4.1 Service Line

Install service line, branch connection to the main, and riser in accordance with 49 CFR 192 and ASME B31.8. Provide a minimum of 485 mm 18 inches cover or encase the service line so that it is protected. Install service line so that no undue stress is applied to the pipe, connection, or riser. Install approved riser and terminate with an approved isolation valve, EFV and automatic shutoff device. After laying of pipe and testing, backfill the trench in accordance with Section 31 00 00 EARTHWORK.

Where steel pipe is used as service line, install corrosion prevention coating and cathodic protect for the steel service line. Where connected to an existing cathodically protected steel pipe, ensure electrical continuity from the riser to the branch connection to the main. Install a dielectric fitting on the riser to prevent electrical continuity to the above ground piping.

Where plastic pipe is used as the service line, make joints in accordance with procedures qualified by test. Personnel joining plastic pipe must be qualified by making a satisfactory specimen joint that passes the required inspection and test listed in 49 CFR 192.285. Inspection must be made by inspectors qualified in evaluating joints made under the specific joining procedure, as required by 49 CFR 192.287.

3.1.4.2 Service Regulator

Install service regulator in accordance with 49 CFR 192 and ASME B31.8 and this specification ensuring that the customer's piping is protected from over pressurization should the service regulator fail. A 3/8 inch tapped fitting equipped with a plug must be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. For inside installations, route the regulator vent pipe through the exterior wall to the atmosphere, and seal building penetrations for service line and vent. Terminate the regulator vent so that it is protected from precipitation and insect intrusion, so that it is not submerged during floods, and so that gas escaping will not create a hazard or enter the building through openings.

3.1.4.3 Gas Meter

Install shutoff valve, meter set assembly, and service regulator on the service line [outside the building] [inside the building, a minimum of one meter 3 feet from any potential ignition source], 18 inches above the [ground] [finished floor] on the riser. An insulating joint (dielectric connection) must be installed on the inlet side of the meter set assembly and service regulator and must be constructed to prevent flow of electrical current.

]3.1.5 Pipe Sleeves

[Comply with Section 07 84 00 FIRESTOPPING.]Where piping penetrates concrete or masonry wall, floor or firewall, provide pipe sleeve poured or grouted in place. Make sleeve of steel or cast-iron pipe of such size to provide 6 mm 1/4 inch or more annular clearance around pipe. Extend sleeve through wall or slab and terminate flush with both surfaces. Pack annular space with oakum, and caulk at ends with silicone construction sealant.

3.1.6 Piping Hangers and Supports

****

NOTE: In seismic zone 3 or 4, provide seismic restraints in accordance with SMACNA Seismic Restraint Mnl.

****

Selection, fabrication, and installation of piping hangers and supports must conform with MSS SP-58, unless otherwise indicated.[Provide seismic restraints in accordance with SMACNA 1981.]

3.1.7 Final Connections

Make final connections to equipment and appliances using rigid pipe and fittings, except for the following:

3.1.7.1 Domestic Water Heaters

Connect with AGA-Approved semi-rigid tubing and fittings.

3.1.7.2 Kitchen Equipment

Install AGA-Approved gas equipment connectors. Connectors must be long enough [to permit movement of equipment for cleaning] [and] [to afford access to coupling].

3.2 FIELD QUALITY CONTROL

3.2.1 Metal Welding Inspection

****

NOTE: To assist the designer in selecting the proper documents for a specific project, the following scope in accordance with documents is provided:

1. NFPA 54 Scope: "1.1.1 Applicability: ... Coverage of piping systems extends from the point of delivery to the connections with each gas utilization device. For other than indicated liquified petroleum gas systems, the point of delivery is the outlet of the service meter assembly, or the outlet of the service regulator or service shutoff valve when no gas meter is provided. For undiluted liquified petroleum gas systems, the point of delivery is the outlet of the first stage pressure regulator..."

2. ASME B31.8 Scope: "802.11... This code covers the design, fabrication, installation, inspection, testing and safety aspects of operation and maintenance of gas transmission and distribution systems, including gas pipelines, gas compressor

stations, gas metering and regulation stations, gas mains, and service lines up to the outlet of the customer's meter set assembly....802.14 This code does not apply to....(c) piping beyond the outlet of the customers meter set assembly..."

****

Inspect for compliance with [NFPA 54] [and] [ASME B31.8] and 49 CFR 192. Replace, repair, and then re-inspect defective welds.

3.2.2 PE Fusion Welding Inspection

Visually inspect butt joints by comparing with, manufacturer's visual joint appearance chart. Inspect fusion joints for proper fused connection. Replace defective joints by cutting out defective joints or replacing fittings. Inspect 100 percent of all joints and reinspect all corrections. Arrange with the pipe manufacturer's representative in the presence of the Contracting Officer to make first time inspection.

3.2.3 Pressure Tests

****

NOTE: To assist the designer in selecting the proper documents for a specific project, the following scope in accordance with documents is provided:

1. NFPA 54 Scope: "1.1.1 Applicability: ... Coverage of piping systems extends from the point of delivery to the connections with each gas utilization device. For other than indicated liquified petroleum gas systems, the point of delivery is the outlet of the service meter assembly, or the outlet of the service regulator or service shutoff valve when no gas meter is provided. For undiluted liquified petroleum gas systems, the point of delivery is the outlet of the first stage pressure regulator..."

2. ASME B31.8 Scope: "802.11... This code covers the design, fabrication, installation, inspection, testing and safety aspects of operation and maintenance of gas transmission and distribution systems, including gas pipelines, gas compressor stations, gas metering and regulation stations, gas mains, and service lines up to the outlet of the customer's meter set assembly....802.14 This code does not apply to....(c) piping beyond the outlet of the customers meter set assembly..."

****

Use test pressure of 1 1/2 times maximum working pressure, but in no case less than 350 kPa (gage) 50 psig. Do not test until every joint has set and cooled at least 8 hours at temperatures above 10 degrees C 50 degrees F. Conduct testing before backfilling; however, place sufficient backfill material between fittings to hold pipe in place during tests. Test system gas tight in accordance with [NFPA 54] [or] [ASME B31.8]. Use clean dry air or inert gas, such as nitrogen or carbon dioxide, for testing. Systems which may be contaminated by gas must first be purged as specified. Make tests on entire system or on sections that can be isolated by valves. After pressurization, isolate entire piping system from sources of air during test period. Maintain test pressure for at least 8 hours between times of first and last reading of pressure and temperature. Take first reading at least one hour after test pressure has been applied. Do not take test readings during rapid weather changes. Provide temperature same as actual trench conditions. There must be no reduction in the applied test pressure other than that due to a change in ambient temperature. Allow for ambient temperature change in accordance with the relationship PF + 101.32 = (P1 + 101.32) (T2 + 273) / T1 + 273) PF + 14.7 = (P1 + 14.7) (T2 + 460) / T1 + 460), in which "T" and "PF" represent Centigrade Fahrenheit temperature and gage pressure, respectively, subscripts "1" and "2" denote initial and final readings, and "PF" is the calculated final pressure. If "PF" exceeds the measured final pressure (final gage reading) by 3 1/2 kPa 1/2 psi or more, isolate sections of the piping system, retest each section individually, and apply a solution of warm soapy water to joints of each section for which a reduction in pressure occurs after allowing for ambient temperature change. Repair leaking joints and repeat test until no reduction in pressure occurs. In performing tests, use a test gage calibrated in 7 kPa one psi increments and readable to 3 1/2 kPa 1/2 psi.

3.2.4 System Purging

****

NOTE: To assist the designer in selecting the proper documents for a specific project, the following scope in accordance with documents is provided:

1. NFPA 54 Scope: "1.1.1 Applicability: ... Coverage of piping systems extends from the point of delivery to the connections with each gas utilization device. For other than indicated liquified petroleum gas systems, the point of delivery is the outlet of the service meter assembly, or the outlet of the service regulator or service shutoff valve when no gas meter is provided. For undiluted liquified petroleum gas systems, the point of delivery is the outlet of the first stage pressure regulator..."

2. ASME B31.8 Scope: "802.11... This code covers the design, fabrication, installation, inspection, testing and safety aspects of operation and maintenance of gas transmission and distribution systems, including gas pipelines, gas compressor stations, gas metering and regulation stations, gas mains, and service lines up to the outlet of the customer's meter set assembly....802.14 This code does not apply to....(c) piping beyond the outlet of the customers meter set assembly..."

****

After completing pressure tests, and before testing a gas contaminated line, purge line with nitrogen at junction with main line to remove all air and gas. Clear completed line by attaching a test pilot fixture at capped stub-in line at building location and let gas flow until test pilot ignites. Procedures must conform to [NFPA 54] [and] [ASME B31.8].

-CAUTION-
Failure to purge may result in explosion within line when air-to-gas is at correct mixture.

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. [_____]	[_____]	[_____]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-33 16 13.16 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-13208 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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WIRE-WOUND CIRCULAR PRESTRESSED-CONCRETE WATER TANK

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****

USACE / NAVFAC / AFCEC **UFGS-33 16 13.16 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-13208 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 16 13.16

WIRE-WOUND CIRCULAR PRESTRESSED-CONCRETE WATER TANK
04/06

****

NOTE: This guide specification covers the requirements for precast, wire wound prestressed concrete water tanks for potable water storage.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This covers tanks specified by the American Water Works Association in Standard D110.

****

****

NOTE: The drawings should include:

1. Site plan with existing topography and approximate tank centerline location. Include underground utility locations.

2. Tank overflow elevation, freeboard, approximate height and diameter of tank.

3. Soil information.

4. Loading conditions, such as snow, seismic, and other live loads.

5. Height of backfill, or earthcover, if any.

6. Size, material, location, and limits for all pipe connections.

7. Size, material, arrangement, and location for overflow pipe.

8. Subdrainage and overflow collection system.

9. Earth cover required of inlet, outlet, and drain piping.

10. Size, material, and location of vents and access hatches if manufacturer's standard will not be acceptable.

11. Special exterior architectural treatment, if any.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	(2020) Specifications for Structural Concrete

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA D110	(2013) Wire- and Strand Wound, Circular, Prestressed Concrete Water Tanks

ASTM INTERNATIONAL (ASTM)

ASTM A227/A227M	(2024) Standard Specification for Steel Wire, Cold-Drawn for Mechanical Springs
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM A586	(2018) Standard Specification for Metallic-Coated Parallel and Helical Steel Wire Structural Strand
ASTM A603	(2019) Standard Specification for Zinc-Coated Steel Structural Wire Rope
ASTM A648	(2018) Standard Specification for Steel Wire, Hard Drawn for Prestressed Concrete Pipe
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A821/A821M	(2021) Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks

1.2 SYSTEM DESCRIPTION

****

NOTE: AWWA D110 covers design and construction of wire- and strand-wound circular prestressed-concrete water-containing structures with the following three types of core walls:

Type I -- cast-in-place concrete with vertical prestressing;

Type II -- shotcrete with a steel diaphragm;

Type III -- precast concrete with a steel diaphragm

The type available varies in different parts of the country. Check with local contractors.

****

Construct concrete water tank AWWA D110, Type [I] [II] [III]. Provide tank, reinforced concrete floor slab, and roof.

a. Roof live load [_____] kg per square meter psf.

b. Allowable soil bearing pressure [_____] kPa psf, and equivalent lateral earth pressure [_____] kPa pcf.

c. Wind load [_____], importance factor [_____].

d. [d. Seismic Zone [_____], importance factor [_____], and soil profile coefficient [_____].]

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Concrete water tank

AWWA D110, design-construct requirements, stamped by a professional engineer.

SD-05 Design Data

Design calculations

SD-06 Test Reports

Prestressing process records

Leakage testing

SD-10 Operation and Maintenance Data

Concrete water tank, Data Package 1

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 QUALITY ASSURANCE

1.4.1 Design Calculations

AWWA D110, stamped by a professional engineer.

PART 2 PRODUCTS

2.1 CONCRETE

Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.1 Floor and Footings

Minimum 20 MPa 3000 psi 28 day strength.

2.1.2 Wall and Dome Roof

Minimum 29 MPa 4000 psi 28 day strength.

2.2 SHOTCRETE

Section 03 37 13 SHOTCRETE. Minimum 31 MPa 4500 psi 28 day strength or wall strength if greater.

2.2.1 Wire Coat

Provide shotcrete consisting of not more than three parts sand to one part portland cement by volume.

2.2.2 Additional Coats

Provide shotcrete consisting of not more than four parts sand to one part Portland cement by volume.

2.3 CEMENT MORTAR

ACI 301. In cases where mortar is to be used to encase the waterstop, mortar shall consist of not more than three parts sand to one part portland cement by weight.

2.4 REINFORCING

Galvanize all steel reinforcing.

2.4.1 Nonprestressed Reinforcement

ACI 301.

2.4.1.1 [Earthquake Cables

ASTM A416/A416M, GRADE 250 OR 270, ASTM A586, ASTM A603. Provide zinc coating ASTM A475, Table 4, class A, or ASTM A603, Table 2, class A.

]2.4.1.2 Steel Sheet Diaphragms

AWWA D110, galvanized ASTM A653/A653M, Z275 G90.

2.4.2 Prestressed Reinforcement

AWWA D110 and ACI 301. In addition, ASTM A648, ASTM A227/A227M, or ASTM A821/A821M.

2.5 ELASTOMERIC MATERIAL

AWWA D110 for waterstops, bearing pads, sealer, [sponge filler] and seal coat.

2.6 [DUCT MATERIAL

AWWA D110.

]PART 3 EXECUTION

3.1 INSPECTION

Ensure elevations of floor and footing excavation are within one-tenth foot of the indicated elevations and that excavation slopes are uniform and free of loose debris. Follow inspection procedures in accordance with AWWA D110.

3.2 INSTALLATION

Follow construction procedures in accordance with AWWA D110, with restrictions specified herein.

a. Do not use curing compound except in conjunction with water curing.

b. [b. AWWA D110, provide additional protection for reinforcing and prestressing strands for aggressive water conditions. [_____]].

3.3 FIELD QUALITY CONTROL

a. Keep prestressing process records in accordance with AWWA D110.

b. Perform leakage testing in accordance with AWWA D110.

3.4 REPAIRS

3.4.1 Leakage Cracks

Make repairs by pressure epoxy grouting in accordance with AWWA D110. Retest.

3.4.2 Honeycombed Concrete

If allowed by QC Representative, remove defective concrete and replace with nonshrinking aggregate grout from Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 BACKFILL

Section 31 00 00 EARTHWORK for backfill requirements. Backfill after tank testing is successfully completed. Avoid unbalanced backfill placement.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 16 15 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-13 16 15 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 16 15

WATER STORAGE STEEL TANKS

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****

USACE / NAVFAC / AFCEC **UFGS-33 16 15 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-13 16 15 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 16 15

WATER STORAGE STEEL TANKS
11/20

****

NOTE: This guide specification covers the requirements of ground-supported (flat-bottomed) bolted and welded standpipes and reservoirs, and elevated welded steel water storage tanks 190 to 3800 kL 50,000 to 1,000,000 gallon capacity. Bolted elevated tanks are uncommon so this guide specification only covers welded elevated tanks.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This Section covers welded and bolted steel water storage tanks and includes the design, fabrication, and erection of a complete new system or to augment an existing or future water distribution system. This specification must be edited to specify the required type of tank. See AWWA M42 "Steel Water Tanks" for general information on the selection, design, construction, maintenance, inspection, and repair of steel water tanks for potable water storage.

The following information will be shown on the project drawings:

1. Detail plans to show tank location, elevation, valve vault if required, and connection to system.

2. Accessories as depth indicator, telemetering automatic controls, protection against freezing, or other special project requirements.

3. Requirements of UFC 3-260-01 and the Federal Aviation Agency to determine if tank constitutes an obstruction and hazard to aerial navigation. If so, show pattern for orange and white painting. Detail obstruction lights or beacon and intermediate lights as required. Refer to Federal Aviation Agency Aviation Circular AC 70/7460-1M, "Obstruction Marking and Lighting", UFC 2-26-04 and UFC 3-535-01.

4. Requirements for cathodic protection system, including details of anodes, anode layout, wiring connections, and rectifier (as applicable).

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2024) Hypochlorites
AWWA B301	(2024) Liquid Chlorine
AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C150/A21.50	(2021; R 2023) Thickness Design of Ductile-Iron Pipe
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2023) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances

AWWA C652	(2019) Disinfection of Water-Storage Facilities
AWWA D100	(2021) Welded Steel Tanks for Water Storage
AWWA D103	(2019) Factory-Coated Bolted Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 22	(2023) Standard for Water Tanks for Private Fire Protection

NSF INTERNATIONAL (NSF)

NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 150/5345-43	(2019; Rev J) Specification for Obstruction Lighting Equipment

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Tank Installation; G, [_____]

Piping and Valve Installation; G, [_____]

SD-03 Product Data

Manufacturer's Technical Literature; G, [_____]

System Description; G, [_____]

Foundations; G, [_____]

Heating System; G, [_____]

Alarm System; G, [_____]

Disinfection Procedures; G, [_____]

Valves; G, [_____]

Pipe, Fittings, Joints and Couplings; G, [_____]

Joint Sealants and Gaskets; G, [_____]

SD-05 Design Data

Manufacturer's Design Analysis; G, [_____]

Foundation Design Analysis; G, [_____]

SD-06 Test Reports

Tank Installation; G, [_____]

Testing of Valves and Piping; G, [_____]

Hydrostatic Test; G, [_____]

Leak Test; G, [_____]

SD-07 Certificates

Tank Coating System; G, [_____]

Pipe Lining and Coating; G, [_____]

SD-08 Manufacturer's Instructions

Shipping, Handling, and Storage; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer's Qualifications

The manufacturer and installer must demonstrate a minimum 10 years of experience in the manufacturing and construction of [elevated] [standpipe] [reservoir] steel water storage tanks. Manufacturer must be able to demonstrate experience through the design and construction of at least 5 completed projects of similar type and size with references with current position, address, and contact information.

Provide certified manufacturer's design analysis, detail drawings, and foundation design analysis by an authorized licensed engineer in the geographical area where construction will take place, having a minimum 4 years of experience as an engineer knowledgeable in design and analyses of steel storage tanks and its foundations. Submit a certificate signed by a registered professional engineer, providing the following information:

a. Description of the structural design loading conditions used for the design of entire tank including the foundation.

b. Description of the structural design method and codes used in establishing the allowable stresses and safety factors applied in the design.

c. A statement verifying that the structural design has been checked by experienced engineers specializing in hydraulic structures.

d. A statement verifying that the detail drawings have been checked by experienced engineers specializing in hydraulic structures to determine that they agree with the design calculations in member sizes, dimensions, and fabricating process as prescribed by applicable AWWA, ACI, and other applicable standards.

1.3.2 Welding Qualifications

Qualification of welding procedures, welders, and welding operators must be in accordance with Section 8.2 of AWWA D100 or AWWA D103 and AWS D1.1/D1.1M and AWS D1.3/D1.3M.

1.3.3 Tank Coating System Certifications

Coating materials for interior applications and all other materials which will be in normal contact with potable water must conform to NSF/ANSI/CAN 61. Certification by an independent third-party organization that all interior coatings and materials that come in contact with potable water must comply with NSF/ANSI/CAN 61 must be provided.

1.4 SHIPPING, HANDLING, AND STORAGE

Deliver paint in unopened containers with unbroken seals and labels showing designated name, specification number, color, directions for use, manufacturer, and date of manufacture, legible and intact at time of use. Handle and store water storage tank systems, components, and parts to prevent distortions and other damage that could affect their structural, mechanical, or electrical integrity. Replace damaged items that cannot be restored to original condition. Store items subject to deterioration by exposure to elements, in a well-drained location, protected from weather, and accessible for inspection and handling.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

****

NOTE: When required by the corrosive nature of stored water, lack of proper maintenance facilities, or by climatic conditions, this paragraph will be modified to provide for a corrosion allowance per AWWA D100 or AWWA D103.

The capacity of the tank will be based on calculations according to UFC 3-230-01 WATER STORAGE, DISTRIBUTION, AND TRANSMISSION. The elevation at the top of the foundation will be not less than 200 mm 8 inches above the finished grade.

UFC 3-301-01 Chapter 5 "NON BUILDING STRUCTURES" Section 5-3 states the design of tanks for storage must be per AWWA. The design loads must be in accordance with AWWA, ASCE 7, IBC, and local codes whichever controls. Tanks for fire protection service must also conform to NFPA 22.

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The design, fabrication, and erection of the [elevated] [standpipe] [reservoir] steel water storage tank must be in accordance with the requirements of AWWA D100 or AWWA D103 and ASCE 7-16. Submit design analyses and manufacturer's technical literature.

The following data and information are supplied as a basis for design and erection of the tank and appurtenances:

Tank Capacity and Dimensions

a. Top Capacity Level (TCL) [_____]
b. Bottom Capacity Level (BCL) [_____]
c. Head Range [_____]
d. Diameter [_____]
e. Tank Height [_____]
f. Top of Foundation Elevation [_____]

Seismic Design Criteria

a. Seismic Use Group [_____]
b. Seismic Importance Factor, IF [_____]
c. Site Class [_____]
d. Ss [_____]
e. S1 [_____]

Design Wind Loading

a. Design Wind Speed, V [_____]
b. Gust Factor, G [_____]
c. Importance Factor [_____]
d. Exposure Category [_____]

Roof Design Loading

a. Roof Live Load [_____]
b. Ground Snow Load [_____]

2.1.2 Elevated Tank

Sizing and design of welded steel elevated tank must be in accordance with Section 4 of AWWA D100 and AISC 325. The tank must be a [multi-column] [pedosphere] [fluted column] of [double ellipsoidal type] [double-cone type] [spherical type] [spheroidal type] [the style shown] [or as approved]. [The welded steel tower supporting the tank must be constructed of structural shapes of the open type, or of tubular sections, to permit inspection and painting. The tower must be thoroughly braced with horizontal struts and diagonal ties. The tower columns may be vertical or inclined as the design may require. Main column splices must be as few as possible and must be located as near as practicable to the intersection of the centerline of the struts. Splice plates must be welded so as to hold the members in line and transmit any tension or shearing stresses to which the members may be subjected. The connections of the tank, with the columns must be made to distribute the load properly over the column sections and over the shell of the tank.] [The single-pedestal supporting the tank must be all welded steel, cylindrical column with the transition at the top and bottom of the pedestal in accordance with manufacturer standard.]

2.1.3 [Standpipe][Reservoir]

The [standpipe] [reservoir] must have such standard shell height and diameter that will meet the requirements for the selected standard capacity and for the high-water level specified. The range between high and low water levels will be approximately [_____] mm feet. The [standpipe] [reservoir] must have [column supported cone roof] [clear span self-supporting [cone roof,] [toriconical roof,] [umbrella roof,] [dome roof, or] [ellipsoidal roof,] [aluminum dome roof,] as approved]. The [standpipe] [reservoir] must be of welded or bolted construction designed in accordance with AWWA D100 or AWWA D103 and AISC 325.

2.1.4 Foundation

Foundation design and construction must be in accordance with [Section 12 of AWWA D100] [Section 13 of AWWA D103] and ACI 318. The foundation design must be based on recommendations provided in the Geotechnical investigation included with the Contract Documents. Recommendations for the foundation type, foundation depth, and design soil-bearing pressure are defined in this report.

2.2 MATERIALS

Provide materials conforming to the following requirements:

2.2.1 Steel

Comply with design requirements of Section 2 of AWWA D100 or Section 2 of AWWA D103 and AISC 325.

2.2.2 Shop Fabrication

Section 9 of AWWA D100 or Section 7 of AWWA D103.

2.2.3 Ductile-Iron Pipe

Pipe, fittings, joints and couplings for fluid conductors, except for overflow pipe, must be ductile-iron pipe and must be either of the following:

2.2.3.1 Bell-and-Plain End Pipe

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NOTE: See AWWA C150/A21.50 or C151 for thickness design of ductile iron pipe. Piping materials, other than ductile iron, conforming to Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING may be used when warranted.

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AWWA C150/A21.50 and AWWA C151/A21.51, for not less than 1035 kPa 150 psi working pressure, unless otherwise shown or specified. Joints must be push-on or mechanical-joint conforming to AWWA C111/A21.11 with pressure rating equivalent to that of the pipe. Provide standard thickness cement mortar lined in accordance with AWWA C104/A21.4.

2.2.3.2 Flanged Pipe

Flanged pipes must conform to the applicable portions of AWWA C110/A21.10, AWWA C115/A21.15 and AWWA C151/A21.51, for not less than 1035 kPa 150 psi working pressure, unless otherwise shown or specified. Pipe must have flanged ends in accordance with AWWA C115/A21.15. Provide standard thickness cement mortar lining in accordance with AWWA C104/A21.4.

2.2.4 Specials and Fittings (except for overflow pipe)

2.2.4.1 Ductile-Iron with Bell-and-Plain End

AWWA C110/A21.10 and AWWA C151/A21.51 for not less than 1035 kPa 150 psi working pressure, unless otherwise shown or specified. Provide standard thickness cement mortar lining in accordance with AWWA C104/A21.4.

2.2.4.2 Ductile-Iron with Flanged Ends

AWWA C110/A21.10 and AWWA C151/A21.51 for not less than 1035 kPa 150 psi working pressure unless otherwise shown or specified. Fittings must have flanged ends in accordance with AWWA C110/A21.10. Provide standard thickness cement mortar lining in accordance with AWWA C104/A21.4.

2.2.4.3 Steel Piping

Pipe, ASTM A53/A53M, Standard Weight, zinc-coated for not less than 1035 kPa 150 psi working pressure unless otherwise shown or specified. Fittings, ASME B16.4, Class 125, zinc coated; or ASME B16.3, Class 150, zinc coated, threaded.

2.2.4.4 Joints Inside Valve Chamber

All joints inside the valve chamber must be flanged.

2.2.5 Valves

Provide all valves from one manufacturer.

2.2.5.1 Gate Valves

Gate valves must be opened by turning counterclockwise. Valves 80 mm 3 inches and larger must be stem type with joint ends compatible for the adjoining pipe conforming to AWWA C500. Valves smaller than 80 mm 3 inches must be all bronze and must conform to MSS SP-80, Type 1, class 150. Valves 80 mm 3 inches or larger located in valve chambers must be equipped with hand-operating wheels and must be flanged.

2.2.5.2 Rubber-Seated Butterfly Valves

Rubber-seated butterfly valves must be opened by turning counterclockwise. Valves must conform to AWWA C504. Body and disc must be cast iron, conforming to ASTM A48/A48M. Shaft must be 18-8 stainless steel. Resilient seat must be bonded to the valve body. Butterfly valves must be stainless steel to rubber seated, tight closing type. Flanged-end valves are required in valve chamber. Provide a union or sleeve-type coupling in the chamber to permit removal.

2.2.5.3 Check Valves

Check valves must conform to AWWA C508 and be of the horizontal swing-check type, suitable for the purpose and the operating conditions. The body must be cast iron with flanged ends with pressure rating equivalent to that of the connecting pipe.

2.2.5.4 Altitude Valve

The supply to the [elevated tank] [standpipe] [reservoir] must be controlled by a one-way [_____] mm inch altitude valve, automatic in operation and accurately set to prevent overflow of the [elevated tank] [standpipe] [reservoir]. The valve must have flanged ends and a heavy cast iron body, must be bronze fitted with renewable cups and seats, and must be designed without metal-to-metal seats. The valve must be cushioned when opening and closing to prevent water hammer or shock. Valves must be provided with a travel indicator to determine operating position. All necessary repairs and/or modifications other than replacement of the main valve body must be made possible without removing the valve from the pipeline.

2.2.6 Pressure Gauge

Pressure gauge of the direct-reading type, equipped with a shutoff cock, must be provided, in the valve chamber, on the tank side and on the discharge side of the check or altitude valve. Gauges must have 150 mm 6 inch dials, must be stem mounted, and must conform to ASME B40.100. Accuracy of gauges must be Grade A or better. Gauges must be calibrated in kPa and psi psi in not more than10 kPa and psi 2 psi increments from 0 to 350 kPa and 0 to 50 psi 0 to 50 psi in excess of the normal operating pressure at the tank.

2.2.7 Joint Sealants and Gaskets

The lap joint sealant must be a one component, moisture cured, polyurethane compound in accordance with Section 4.10 of AWWA D103. The sealant must be suitable for contact with potable water must comply with NSF/ANSI/CAN 61. Neoprene gaskets and tape type sealer must not be used in liquid contacting surfaces.

2.3 ASSEMBLIES

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NOTE: The following tank accessories and assemblies must be coordinated for the specific type of tank being specified. Other components may need to be included based on service, maintenance, and operational needs of the facility.

Adequate accessibility must be provided to the exterior of the tank for maintenance, inspection and painting. This may include items such as walkways, safety railing, tie-off anchors for scaffolding or rope inspections.

Adequate access, ventilation, and supporting accessories to the interior of tank must be provided to facilitate tank maintenance, inspection, painting, and for sanitizing and cleaning for environmental contamination such as Legionella.

****

2.3.1 Tank Accessories

Section [5][7] of AWWA D100 or Section 7 of AWWA D103 and as specified. Additional requirements for accessories are as follows:

2.3.1.1 Steel Riser

****

NOTE: The minimum riser diameter must be 910 mm 36 inches in localities where freezing temperatures occur. Riser diameter equal to or greater than 36 inches must have a manhole located 3 feet above the base.

****

Center steel riser must conform to Section 5.1 of AWWA D100 must not be less than [_____] mm inches in diameter. A safety grill must be provided at the top of the riser with an 18 inch by 18 inch hinged door. [A minimum 18 x 24 inch elliptical access manhole must be provided approximately 3 feet above the base of the wet riser. The hatch must open inward.]

2.3.1.2 Roof Hatches

Provide two access hatches 180 degrees apart on the roof of the tank. One hatch must be 30 inch diameter and allow access from the roof to the interior of the tank. The hatch will be hinged and equipped with a hasp for locking. The hatch cover must have a 2 inch downward edge. The second hatch will be 24 inch diameter and flanged with a removable cover so constructed that an exhaust fan may be connected for ventilation during inspection, maintenance, painting, and cleaning operations. The openings must have a minimum 4 inch curb

2.3.1.3 Tank Vent

Clog resistant tank vent must be centrically located on the tank roof above the maximum weir crest elevation. The vent must conform to Section 5.5 or 7.5 of AWWA D100 or Section 7.7 of AWWA D103. The tank vent must have an intake and relief capacity sufficient to ensure that excessive pressure or vacuum, either entering or leaving the tank, will not be developed during maximum flow rate. The vent will be tank manufacturer's standard mushroom type constructed with corrosion resistant screen to prevent the ingress of wind driven debris, insects, birds and animals. The vent must be designed to ensure fail-safe operation in the event that screen frosts over or otherwise clogged and the bottom of the screen must be sufficiently elevated for snow consideration in the area

2.3.1.4 Overflow

The overflow for the tank must consist of an overflow weir box and [stub overflow] [outside drop pipe, adequately supported and] capable of discharging at a rate of [_____] L/second gpm with [_____] mm inches of head [, without the water level exceeding [_____]]. [The top of the weir must be [_____] mm inches below [_____].] [The weir must be located as indicated.] The [stub overflow must be steel, ASTM A53/A53M or equal, must project at least 12 inches from the shell, and must be fitted with a screen] [overflow pipe must be steel, ASTM A53/A53M or equal, and must terminate 300 to 600 mm 1 to 2 feet above grade not to be obstructed by snow or ground clutter and must be fitted with a flapper valve or course corrosion-resistant screen to prevent ingress of animals and insects].

2.3.1.5 Shell Access Manholes

Number, type, location, and size of manholes must be as shown on the drawings.

2.3.1.6 Pipe Connections

Number, type, location, load, and size of pipe connections must be as shown on the drawings. Inlet pipe connections to extend [_____] mm inches above tank bottom and must be provided with deflectors as shown on the drawings. Outlet pipe connections to extend [_____] mm inches above tank bottom and must be provided with vortex breakers as shown on the drawings. Pipe connections to the tank must include a flexible coupling outside the tank to allow for differential movement. Pipe connections through the shell must include protection from freezing and vandalism. Piping must allow for differential movement when the tank is filled and drained. Special flexible, extendable connections must be provided for tanks subject to seismic loads.

2.3.1.7 Ladders, Platforms, and Safety Devices

Ladders, platforms, and safety devices must be provided in accordance with Sections 7.4 of AWWA D100 or Sections 7.4 and 7.5 of AWWA D103. Location of ladders must be as shown on the drawings. Sections 7.4 of AWWA D100 and Sections 7.4 and 7.5 of AWWA D103 represent the minimum requirement. In addition, safety cage, rest platforms, roof platforms, roof ladder handrails, and other safety devices must be provided as required by federal or local laws or regulations.

2.3.1.8 Balconies

Provide a balcony a minimum of 600 mm 2 feet wide with a standard guard railing. Provide a structural steel railing with a top rail 1050 mm 42 inches above balcony platform with an intermediate rail halfway between. Guard rail must be capable of withstanding a force of 888 N 200 pounds applied in any direction. Install a steel toe board with minimum height of 100 mm 4 inches. Bottom of toe board must be a maximum 6 mm 1/4 inch from platform top. Extend guard rail and toe board entire length of balcony except where access openings are required. For balcony floors use diamond plates a minimum of 6 mm 1/4 inch thick, punched or drilled for drainage. [Equip access openings in guard rail with a gate which closes automatically.] Hatches through balcony floor must be counterbalanced or otherwise arranged to open from below.

2.3.2 Valve Chamber

Valve chamber must be sufficiently large to house all control valves and fittings; and allow for unobstructed maintenance and replacement. Pipes, valves, and fittings must be supported on concrete blocks where necessary. The valve chamber must be constructed to provide not less than [_____] mm feet of cover over the pipes. The valves and fittings must extend from the [standpipe] [reservoir] [riser pipe] connection to a point one length of pipe outside the valve chamber walls on the main or feed line to the [elevated tank] [standpipe] [reservoir]; the drain line will be carried to an outlet as indicated on the drawings. The access manhole must be not less than 760 mm 30 inches in diameter.

2.3.3 Anchors for [Standpipe] [Reservoirs]

The following requirements must be met:

a. An adequate number of anchors designed to prevent overturning for the maximum design uplift forces on the [standpipe] [reservoir] must be installed. If anchor bolts are used, the nominal diameter must not be less than 25 mm one inch, plus a corrosion allowance of at least 6 mm 1/4 inch on the diameter. If anchor straps are used, they must be pre-tensioned before welding to the tank shell.

b. The anchor bolts must be a right angle bend, hook, or plate washer, while anchor straps must have only a plate welded to the bottom. The anchors must be inserted into the foundation to resist the computed uplift.

c. Attachment of anchors to the shell must not add significant localized stresses to the shell. The method of attachment must consider the effects of deflection and rotation of the tank shell. Anchors must not be attached to the tank bottom. Attachment of the anchor bolts to the shell must be through stiffened chair-type assemblies or anchor rings of adequate size and height.

2.3.4 High and Low Water Level Alarm System

Provide high and low level devices for alarm monitoring and an intermediate device for tank water level status. All three water levels must be indicated by their respective pilot lights; green for high, amber for intermediate and red for low water levels, and a buzzer for low and high water levels. Buzzer and the respective pilot lights at high and low water levels must be energized while the high or low water level pilot device is actuated. Depressing a silencing button must silence the buzzer indicating the water level and must remain in OFF condition. The pilot light must remain energized. Resetting the pilot light must de-energize the pilot light and release the buzzer from its sealed-off condition.

2.3.5 Heating System

****

NOTE: Water tanks subject to freezing (tanks that primarily serve fire protection systems and those where the daily consumption is small) must be provided with heating facilities in accordance with NFPA 22. The heating system must be of such capacity that the temperature of the coldest water in the tank or tank riser, or both, is maintained at or above 5.6 degrees C 42 degrees F during the coldest weather.

****

Provide tank heating to comply with NFPA 22 and with capacity to maintain 5.6 degrees C 42 degrees F at all times including coldest temperatures and lowest consumption.

2.4 COATINGS

2.4.1 Tank Coating System for Welded Tanks

Provide exterior coating systems conforming to Section 09 97 13.27 HIGH

PERFORMANCE COATING FOR STEEL STRUCTURES and interior coating systems conforming to Section 09 97 13.16 INTERIOR COATING OF WELDED STEEL WATER TANKS.

2.4.2 Tank Coating System for Bolted Tanks

****

NOTE: Bolted tanks are factory coated, interior and exterior. No field painting is needed other than repair to damaged areas. Where cathodic protection will be installed, electrical continuity must be established across the bolted joints to ensure proper cathodic protection system operation

****

As supplied by the manufacturer.

2.5 CONCRETE WORK

Concrete work must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.6 CHLORINE

AWWA B300 for hypochlorites or AWWA B301 for liquid chlorine, mixed with water to give the solutions required in AWWA C652.

PART 3 EXECUTION

3.1 FOUNDATIONS

Foundations for the [standpipe] [reservoir] [tank columns and riser] and for the valve chamber must be constructed of concrete, reinforced where necessary, and designed in accordance with Sections 12 and 13.7 of AWWA D100 or Sections 13 and 14.5 of AWWA D103 for earth with a bearing value of [_____] MPa psf, at elevation [_____], and constructed in conformance with the applicable requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE, except as shown or specified herein. A Type 1 or Type 2 foundation per AWWA D100 or AWWA D103 must be provided for the [standpipe] [reservoir].

3.2 EXCAVATING, FILLING, AND GRADING

Excavating, filling, and grading must conform to the applicable requirements of Section 31 00 00 EARTHWORK.

3.3 CATHODIC PROTECTION

****

NOTE: Evaluate need for cathodic protection on an individual project basis.

****

Cathodic protection must be provided, conforming to Section 26 42 15 CATHODIC PROTECTION SYSTEM FOR THE INTERIOR OF STEEL WATER TANKS.

3.4 LIGHTNING PROTECTION

****

NOTE: Evaluate need for lightning protection on an individual project basis.

****

Lightning protection must be provided, conforming to Section 26 41 00 LIGHTNING PROTECTION SYSTEM.

3.5 OBSTRUCTION LIGHTING

****

NOTE: Obstruction lighting will be included in the contract specifications only when required and will be detailed on the drawings, in accordance with UFC 3-535-01 or FAA AC 70/7460-1.

****

Obstruction lighting must be provided and installed as shown, and must conform to Section 26 56 20 AIRFIELD AND HELIPORT LIGHTING AND VISUAL NAVIGATION AIDS and FAA AC 150/5345-43.

3.6 TANK INSTALLATION

Submit detailed erection drawings, before proceeding with any fabrication. Complete drawings with details of steel, piping and valve installation, and concrete work, and of the assembling of items required for the total installation. Use standard welding symbols in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M. Details of welded joints referenced on the drawings must be included. Tank installation must be in accordance with the following requirements:

3.6.1 Welding

Section 8 of AWWA D100 or AWWA D103 and AWS D1.1/D1.1M and AWS D1.3/D1.3M.

3.6.2 Erection

Section 10 of AWWA D100 or AWWA D103 and in accordance with manufacturer's procedures using factory trained and certified erectors.

3.6.3 Inspections and Testing

Tank inspection and testing must be in accordance with Section 11 of AWWA D100 AWWA D103. Mill and shop inspections [are not required] [are required and must be performed by an approved commercial inspection agency]. Perform the radiographic inspections of the welded tank shell, the hydrostatic test and the vacuum box leak test of the tank bottom. Final hydrostatic and leak tests must be performed before painting of welded tanks.

3.7 PIPING INSTALLATION (EXCEPT FOR OVERFLOW PIPING)

3.7.1 General Guidelines

Where details of fabrication or installation are not shown on the drawings, installation must conform to Section 1 and 4 of AWWA C600.

3.7.2 Testing of Valves and Piping

After the [elevated tank] [standpipe] [reservoir] has been erected and the valves and piping installed, and before field painting is begun, the valves and piping must be hydrostatically tested in accordance with Section 5 of

AWWA C600. Submit each coating manufacturer's technical data, application instructions, Safety Data Sheets (SDS), and certificate for compliance for VOC content. Submit copies of the following test results:

a. Manufacturer's mill test reports for plate material.

b. Mill and shop inspections by a commercial inspection agency.

c. After acceptance of the structure, the radiographic film and test segments.

At the conclusion of the work, a written report covering the hydrostatic test and certifying that the work was inspected in accordance with Section 11.2.1 of AWWA D100.

Replace with sound material any defective material disclosed by the pressure test; the test must be repeated until the test results are satisfactory.

3.7.3 Pipe Lining and Coating of Underground Ductile-Iron Piping

****

NOTE: Appendix A of AWWA C105/A21.5 will be utilized in determining whether polyethylene encasement should be used.

****

Polyethylene encasement in accordance with AWWA C105/A21.5 of underground ductile-iron piping must be provided in addition to cement-mortar lining.

3.7.4 Plugging Ends

Cap or plug pipe ends left for future connections as directed.

3.8 PAINTING AND COATING OF TANK

****

NOTE: Some state and local environmental agencies have enacted environmental regulations that may restrict the application of some coating systems. Content of the regulations varies widely. The designer must contact the appropriate state and local authorities to determine if the paint systems are acceptable. If these systems are not acceptable, the designer must determine the best acceptable system and revise this specification accordingly. However, any deviation from this specification and AWWA Standards must be submitted with justification to CEMP-ET for approval.

If the tank constitutes an obstruction to air navigation, the paint system applied to the exterior of the tank will be an orange and white pattern per AC 70/7460-1M and UFC 2-26-04 and UFC 3-535-01.

****

Each coating manufacturer's tank coating system technical data, application instructions, SDS, and certificate for compliance for VOC content must be submitted to the Contracting Officer. Application, curing time, mixing and thinning of the coating materials must be in strict accordance with the manufacturers instructions. The use of thinners must not alter the required minimum dry thickness or adversely affect the VOC content.

3.8.1 Exterior Surfaces (Welded Tanks)

Provide an exterior coating system conforming to Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES.

3.8.2 Interior Surfaces (Welded Tanks)

****

NOTE: Section 09 97 13.16 Part 2 identifies the interior coating system for both potable and non-potable water tanks as one based on military specification MIL-DTL-24441. This system may be used where the ambient temperatures are above 10 degrees C 50 degrees F. There are currently no products listed as meeting the NSF/ANSI/CAN 61 on the NSF/ANSI database for potable water applications but the navy has internally approved specific batches. A second option for potable water tanks allows any 3 coat epoxy polyamide coating system having NSF/ANSI/CAN 61 approval. The specifier may opt to edit this paragraph by referencing military specification MIL-PRF-23236. Class 9 of this specification is dedicated to potable or freshwater but not seawater tanks and has several products on the QPL listing. By specifying Class 9/18 an alternate high build coating system can be obtained that is applied using plural component application equipment. Plural component systems can typically be applied at quite low temperatures and cure rapidly allowing tanks to be put into service quickly however, they require specialized equipment and training that may not be available from small business contractors. Performance of the above MIL-PRF-23236 systems is considered similar to the MIL-DTL-24441 system. When MIL-PRF-23236 systems are specified the contract should require they be applied at a minimum as 2 coat systems and that they be applied in strict accordance with the manufacturer's recommendations.

****

Provide an interior coating system conforming to Section 09 97 13.16 INTERIOR COATING OF WELDED STEEL WATER TANKS.

3.8.3 Bolted Tanks

****

NOTE: AWWA D103 Section 12 identifies coating systems that are applied in the manufacturer's own facilities. Performance and cost of the various systems varies significantly. The specifier should select the system that is most appropriate for the specific application. Galvanized coatings are disallowed when the stored water is corrosive. Glass coatings typically provide the longest service

life but are only available as the manufacturer's standard color on both the interior and exterior of the tank. Thermoset liquid suspension coatings allow the greatest selection of exterior colors.
****

The surfaces of both the interior and exterior of the tank must be coated in accordance with [Section 12.3, Galvanized Coatings][Section 12.4, Glass Coatings][Section 12.5, Thermoset Liquid Suspension Coatings][Section 12.6, Thermoset Powder Coatings] of AWWA D103. Color must be [as indicated] [as approved]. Coating damage during transportation and construction must be repaired per manufacturer's recommendations.

3.9 DISINFECTION

The [elevated tank] [standpipe] [reservoir] and connecting lines thereto must be disinfected with chlorine before being placed in operation.

3.9.1 Tank

****
NOTE: In areas subject to regulations which are more stringent than requirements contained in AWWA C652, the local requirement will apply and will be specified.

AWWA C652 covers three methods for disinfection. Typically, only one method will be used for a given storage facility disinfection, but combinations of the methods may be used. The three methods are:

1. Chlorination of the full storage facility such that the end of the appropriate retention period the water will have a free chlorine residual of not less than 10 mg/L.

2. Spraying or painting of all storage facility water contact surfaces with a solution of 200 mg/L available chlorine.

3. 3. Two-step process of chlorinating the bottom portions of the storage facility with 50 mg/L free chlorine followed by filling to the overflow with potable water to be held not less than a period of 24 hours.

****

[After coating system has been cured, inspected, and approved cured, rinse tank with potable water.] After flushing, the [elevated tank] [standpipe] [reservoir] must be disinfected in accordance with [AWWA C652] [Method 1] [Method 2] [or] [Method 3]. After the chlorination procedure is completed and before the storage facility is placed in service, the Contracting Officer will collect samples of water in properly sterilized containers for bacteriological testing from the full facility in accordance with Section 5 of AWWA C652. The tank will not be accepted until satisfactory bacteriological results have been obtained.

3.9.2 Piping

The valves and piping must be disinfected in accordance with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-33 26 00.00 10 (April 2008)**

Preparing Activity: USACE **Superseding**
UFGS-33 26 00.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 26 00.00 10 (April 2008)**

Preparing Activity: USACE **Superseding**
UFGS-33 26 00.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 26 00.00 10

RELIEF WELLS
04/08

****

NOTE: This guide specification covers the requirements for relief wells, (except materials and equipment specified to be furnished by the Government) to be constructed near dams or levees to relieve the excess hydrostatic pressures created by the presence of pervious strata close to the surface. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Relief wells should be constructed of materials which will resist corrosion when installed and should, where practicable, be designed to have a service life equal to that of the structure they are designed to protect. Factors to be considered in determining selection of material for wells are:

1. Operating conditions of wells,
2. Corrosive characteristics of soil and water,

3. Method of installations,
4. Size and depth of wells,
5. Type of joints, and
6. External pressures on well casings.

The riser pipe and screen should be designed in all cases to withstand, with a suitable factor of safety, the crushing pressures at depths to which wells extend. Design of relief wells to be constructed under structures must consider loads that will be induced into the well pipe due to structural settlement. The wells, including screen and riser pipe, should have a diameter which will permit the maximum design flow without excessive head losses but in no instance should the inside diameter be less than 150 mm 6 inches. Based on design parameters it may require the designer to include a minimum collapse strength for the pipe and well screen and a minimum clear inside diameter through the fittings and screen to allow the installation of pumps at a later date.

Because of the large variation in design and wall thickness of the different types of well screen, no generic specifications have been included. For large contracts, specific necessary characteristics should be presented in detail. References to manufacturers should be eliminated.

Information on the design of filter packs and relief wells can be found in the Engineering Manual EM 1110-2-1901, "Seepage Analysis and Control for Dams". The filter criteria specified in EM 1110-2-1901 should be used to determine the gradation band of the filter material. To minimize segregation during installation of the filter pack, the filter should have a relatively uniform grain-size distribution band. The gradation band of the filter material should be more or less parallel to the gradation curve of the material being drained. No point on the coarser filter gradation curve should be greater than 25 times the corresponding size of the material being drained.

The filter material should have a minimum thickness of 150 mm 6 inches measured radially from the outer circumference of the screen section, and its gradation should depend upon the gradation of the strata being drained. Where unusual conditions are encountered, filter tests should be performed in the laboratory using the foundation sand and the selected filter. For examples of laboratory investigations refer to Technical Report GL-87-22, dated August 1987, "Laboratory Tests on Granular Filters for Embankment Dams (Includes Appendixes A-E)"; and Technical Memoranda (TM) 183-1, dated Nov 1941, Rev Dec 1941, "Investigation of Filter Requirements for Underdrains"; and Technical Memoranda (TM) 195-1, dated Oct 1942, "Field and

Laboratory Investigation of Design Criteria for Drainage Wells", U. S. Waterways Experiment Station. Because of the high potential for clogging by migrating fines or chemical precipitate, filter cloth should not be used to protect relief well screens.

In adapting this specification to any project the form and phraseology should be changed as necessary to properly specify the work contemplated. Changes should be made in the original form to the extent required to adapt the guide specification to local conditions. Work such as concrete for backfill, painting of exposed metal surfaces and seeding of construction areas will have to be specified in this section when such sections cannot be referenced as a part of the contract.

For projects on which subsurface information is not sufficiently developed to permit detailed design of each well, a section should be added to the specifications requiring the drilling of a small diameter pilot hole at the location of each well. Pilot holes should be sampled and logged in sufficient detail to define the gradation of pervious zones and the depths between which screens should be set. The specifications should require that samples of pervious materials be taken at 750 mm 2.5 foot intervals of depth. Grain-size distribution tests should be performed to provide a basis for the design of the filter pack and the screen openings. Samples taken by fishtail drilling and other wash boring methods will not be permitted. Where the subsurface information previously obtained is sufficient, pilot holes are not required.

****

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

****

1.1.1 Relief Wells

1.1.1.1 Payment

Payment will be made for costs associated with relief wells, which price will constitute full compensation for construction of relief wells. Wells ordered abandoned by the Contracting Officer before installation of well screen and riser due to no fault of the Contractor will be paid for at [_____] percent of the contract unit price per linear meter foot, for Bid Item No. [_____] "Relief Wells". Wells ordered abandoned by the

Contracting Officer due to no fault of the Contractor will be paid for at the full contract unit price for Bid Item No. [_____] "Relief Wells". No payment will be made for placement or replacement of temporary casings or repair of damage resulting from Contractor operations. No separate payment will be made for relief well screen, riser, check valves, gravel pack, development, backfill, discharge or outfall pipes. No payment will be made for any wells that, in the opinion of the Contracting Officer, are abandoned due to Contractor fault or neglect.

1.1.1.2 Measurement

Relief wells will be measured for payment by the linear meter foot of completed well between ground surface and 300 mm 1 foot below the bottom of the [well screen][tail pipe]. Wells ordered abandoned by the Contracting Officer, due to no fault of the Contractor, will be measured for payment.

1.1.1.3 Unit of measure

Unit of measure: linear meter foot.

1.1.2 Pump Tests

1.1.2.1 Payment

Payment will be made for costs associated with pump test, which price will constitute full compensation to perform a satisfactory pump test as specified. No payment will be made for pump test not successfully completed.

1.1.2.2 Measurement

Pump tests will be measured for payment for each hour, measured to the nearest 15 minutes, of pump test successfully performed as specified in paragraph PUMP TEST, and as otherwise directed. Testing time will not include time required to place and remove testing and pump equipment.

1.1.2.3 Unit of measure

Unit of measure: per hour.

1.1.3 Pump Installation/Removal

1.1.3.1 Payment

Payment will be made for costs associated with installation and removal of the pumps used in pay item "Pump Tests". No payment will be made for pump installation removal where pump test was not successfully completed.

1.1.3.2 Measurement

Pump installation/removal for pump test will be measured for payment on the base of the applicable contract unit price per relief well pump tested.

1.1.3.3 Unit of measure

Unit of measure: each.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B31.9	(2020) Building Services Piping

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C387/C387M	(2023) Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar

ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D297	(2015; R 2019) Rubber Products - Chemical Analysis
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G, [_____]

SD-03 Product Data

Well Screen; G, [_____]

Filter Pack; G, [_____]

Cement Grout Mixture Proportion; G, [_____]

SD-06 Test Reports

Tests

1.4 QUALITY ASSURANCE

****

NOTE: The Designer should select and/or insert the applicable obligations for compliance with specific code requirements of public authorities at the state and/or local level. Guidance is given in memorandum from CECW-EG, "State Regulation of Subsurface Drilling Activities", dated 21 February 91.

****

The [state statutory and regulatory] [_____] requirements listed herein form a part of this specification to the extent referenced: [_____].

1.4.1 Shop Drawings

Show details of the proposed methods for drilling, coupling well screen and riser sections together, placement of centralizers, installing the well screen and riser, and limit(s) of backfilling. Show on the shop drawings the type of screen and size; [perforation size] [or] [slot size], shape and pattern; [bottom plug] [tailpipe] material; and installation detail. Also show the riser pipe, check valve(s) and well discharge details on the shop drawings. Any Contractor-proposed substitutes or alternates in material construction details or methods must be presented in the shop drawings. No phase of the work will be initiated until all shop drawings concerning that activity have been approved.

1.4.2 Depth of Well

****

NOTES: The first bracketed paragraph, Alternate, 1 is recommended for use whenever the design of the system permits.

The second bracketed paragraph, Alternate, 2 should be used only when fully penetrating wells are necessary, and when it is impracticable to predetermine the depth of individual wells. The need for field cutting of screen or riser pipe should be avoided. The depth of the well can ordinarily be varied in the field to permit the use of predetermined length of screen and riser pipe without field cutting.

****

[The length of well screen, length of riser pipe and the well discharge elevation must conform to the [schedule shown] [elevations established in the field by the Contracting Officer].] [The depth of wells as indicated on the drawings is approximate. Penetration of [bedrock] [impervious layer] might be required. The maximum well depth will not exceed [_____] meters feet. Whenever the depth to [bedrock] [impervious layer] is less than the maximum well depth, the bottom elevation of each well will be as determined by the Contracting Officer after drilling of a pilot boring or the well boring.]

1.4.3 Well Design

****

NOTE: This paragraph should be deleted when well design data have been determined in advance of the contract. Economical well construction cannot be secured unless the design of the wells is established in advance of the bidding period.

****

From data obtained from exploratory drilling, the Contracting Officer will determine the diameter of the well screen, size of openings, the lengths and positions of the screens, and the gradation of the material for the filter pack which is to be installed around the well screen.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Location

The exact location of each well, [with respect to the toe of the embankment] [or] [with respect to distance from structure centerline], will be determined in the field by the Contracting Officer. The total number of wells and spacings may be modified by the Contracting Officer as the work proceeds.

1.5.2 Obstructions Encountered

If obstructions are encountered in the foundation which, in the opinion of the Contracting Officer, render it impracticable to complete the well to the directed depth, the Contracting Officer may adjust the depth. Alternatively, the Contracting Officer may direct the Contractor to abandon the well, plug the hole by backfilling with approved material by an approved procedure, and construct another well at an adjacent site.

PART 2 PRODUCTS

2.1 WELL SCREEN

[The Contractor may, as an option, furnish and install well screen of any of the alternate types specified.] [Provide well screen of the type and dimensions indicated.] Submit the proposed well screen prior to installation. Make screen openings that are uniform in size and pattern, and space approximately equally around the circumference of the pipe.

2.1.1 PVC Pipe Screen

Provide pipe, fittings, and screen of the size and types [specified][shown.] Provide pipe, fittings, and screen conforming to ASTM D1784, ASTM D1785, ASTM D2466, or ASTM D2467. Ensure all joints in the PVC pipe include couplings and are glued with a solvent cement conforming to ASTM D2564. Use PVC pipe strength properties that are equivalent to PVC 1120 Schedule [40] [80] unthreaded plastic pipe. [The well screen, pipe, and fittings must have a minimum collapse strength of [_____].] [The screen, pipe, and fittings must have a clear inside diameter of [_____].]

2.1.1.1 Couplings

Provide [bonded socket][threaded][certilock] type couplings. Produce fittings of the same material and equal quality as specified for plastic pipe screen. Bond socket type fitting connections of pipe sections with solvent cement. The determination of the proportions and preparation of adhesives, the method of application, and the procedure used for making and curing the connections are the responsibility of the Contractor. The system for making joints at the relief well site must provide a curing period adequate to develop the ultimate strength of the solvent cement. Self-tapping screws or other devices for holding pipe in the couplings during the setting period may be utilized as long as the screws do not penetrate the inside of the pipe. Do not stress a newly-made joint in the casing, nor lower it into the relief well, nor submerge it in water prior to complete curing of the solvent cement adhesive.

2.1.1.2 Perforations

The PVC well screen must be [mill slot][continuous wire wrapped rod base] [continuous wire wrapped rod base on perforated pipe] [continuous wire wrapped on perforated pipe screen] [similar to that manufactured by [_____] Johnson Well Equipment, Inc., Pensacola, FL, telephone (904) 453-3131]. Provide all well screen with smooth, sharp-edged openings free of burns, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. [The [_____] mm inch diameter well screen must have a number [_____] slot, [0.0_____] mm inch open slot.] [The length of the slots measured on the inside of the pipe must be [_____] mm inches.] Provide a total open area of no less than [_____] square millimeters inches per linear meter foot of [_____] mm inch diameter well screen. Distribute the slots or groups of slots in a uniform pattern around the periphery of the pipe and orient with the length of the slot, [parallel to,] [normal to,] [or] [diagonal with] the axis of the pipe.

2.1.2 Fiberglass Pipe Screen

Manufacture fiberglass pipe screen and fittings from thermosetting epoxy resins and glass fiber by either a centrifugal casting process or by a filament winding process. Use glass fiber consisting of continuous filament, electrical glass with a finish compatible with epoxy resins. Impregnate each glass fiber or filament be thoroughly with epoxy resin. Use resins that are diglycidyl ether of bisphenoa A or cycloaliphatic diepoxides, or blends of the two. Provide curing agents for these resins consisting of aromatic diamines, polycarboxylic acid anhydrides and eutectics therefrom. Cure the resin system at a temperature over 150 degrees C 300 degrees F for a minimum of one hour. Ensure fiberglass pipe wall thickness, strength and durability requirements are equivalent to [_____][the Fiberglass/Epoxy pipe produced by Fiberglass Resources Corporation of Farmingdale, New York or Burgess Well Company, Inc., Minden, Nebraska, telephone (308) 832-1642]. Ensure all fiberglass pipe and fittings are round and straight, of uniform quality and workmanship, and free from all defects including indentation, delamination, bends, cracks, blisters, porosity, dry spots, resin segregation and resin-starved areas. The inside of the pipe and fittings must be smooth and uniform. Impregnate the glass fiber with resin such that when the pipe is cut or slotted, no fraying or looseness of glass fiber occurs. [The well screen, pipe, and fittings must have a minimum collapse strength of [_____].] [The screen, pipe, and fittings must have a clear inside diameter of [_____].]

2.1.2.1 Couplings

Provide socket threaded or mechanical key-type couplings for fiberglass pipe sections. Manufacture couplings of the same materials used for the fiberglass pipe specified herein and may be either cast integrally with the pipe sections or as separate components for attachment to the pipe in the manufacturers plant. Proof test every coupling attached to the pipe section as a separate component in the manufacturer's plant with a tensile load of 9 kN 2000 lbs. Provide key-type couplings consisting of male and female halves designed for joining and locking together by means of a key strip inserted in grooves in the coupling halves. Ensure the minimum wall thickness remaining at any grooved section is no less than the minimum thickness specified for pipe. Provide key strips and locking strips consisting of fiberglass, plastic or other non-corrosive material capable of withstanding shearing and bearing stresses equivalent to the design load for the coupling. Bond socket type fitting connections of the pipe sections with epoxy adhesive. Provide epoxy materials and bonding agents as recommended by the pipe manufacturer. The determination of the proportions and preparation of adhesives, the method of application, and the procedures used for the making and curing of the joints are the responsibility of the Contractor. Use pot life, initial setting time and external heating requirements for curing of the adhesive which are suitable for the procedure and climatic and other conditions and vary as required to suit changes in climatic and other conditions. The system for making joints at the relief well site must provide a curing period adequate to develop the ultimate strength of the adhesive. Self-tapping screws or other devices for holding adhesive-joined pipe in the couplings during the curing period may be utilized. Do not lower a newly-made joint in the casing pipe into the relief well, nor submerge it in water prior to complete curing of the adhesive.

2.1.2.2 Perforations

All fiberglass well screen must be [mill slot][continuous wire wrapped rod base]. Provide all relief well screen with smooth, sharp-edged openings free of burrs, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. [The [_____] mm inch diameter well screen must have a number [_____] slot, [0.0__] mm inch open slot.] [The length of the slots measured on the inside of the pipe must be [_____] mm inches.] Provide a total open area no less than [_____] square millimeters inches per linear meter foot of [_____] mm inch diameter well screen. Distribute the slots or groups of slots in a uniform pattern around the periphery of the pipe and orient with the length of the slot [parallel to,] [normal to,] [or] [diagonal with] the axis of the pipe.

2.1.3 Steel Pipe Screen

****

NOTE: Metal pipes, plugs, screen and joints for most installations may require a coating to protect the metal from corrosive ground water and soil. The type of coating selected to accomplish this purpose will depend upon the corrosive characteristics of the ground water and soil. The Contracting Officer should therefore make complete analysis of the corrosive characteristics of the ground water and add to these specifications such requirements as are necessary to protect the pipe. The coating should be applied after perforating or slotting and should completely cover all exposed metal. Care should be taken to ensure that the openings are not closed or reduced in required size by the coating.

****

Provide steel well screen consisting of perforated or slotted sections of steel pipe conforming to the requirements of ASTM A53/A53M, Type [_____], Class [_____]. [Provide well screen, pipe, and fittings with a minimum collapse strength of [_____].] [Provide screen, pipe, and fittings with a clear inside diameter of [_____].]

2.1.3.1 Couplings

Provide welded joints or threaded couplings for steel pipe screen. Perform welding in accordance with requirements in ASME B31.9. Provide couplings meeting the material requirements specified for steel pipe screen, except omit perforations. Thread all threaded pipe and fittings in accordance with ASME B1.20.2MASME B1.20.1. All threaded pipe sections may be field connected. Give couplings the same protection against corrosion as specified for the well screen pipe. Recoat areas of protective coatings that are damaged while making couplings.

2.1.3.2 Perforations

Provide all steel pipe to be used as relief well screen with perforations consisting of either machine-cut slots; drilled or punched openings. Provide slots with a width of [_____] mm inch with a tolerance of plus or minus [_____] mm inch. The length of the slots measured on the inside of the pipe must be [_____] mm inches with a tolerance of plus or minus [_____] mm inch. Provide a total open area no less than [_____] square millimeters inches per linear meter foot of [_____] mm inch diameter relief well for slotted openings. Distribute the slots or groups of slots in a uniform pattern around the periphery of the pipe and orient with the length of the slot [parallel to,] [normal to,] [or] [diagonal with] the axis of the pipe. Drill or punch openings [_____] mm inch in diameter and provide a total open area no less than [_____] square millimeters inches per linear meter foot of [_____] mm inch diameter well screen. Space the pattern of the openings be uniformly around the periphery of the pipe.

2.1.4 Stainless Steel Well Screen

Fabricate well screen and fittings entirely from stainless steel conforming to ASTM A312/A312M, Type 304, 304-L, 316 or 316-L. Provide stainless stell well screen with a keystone wire-wrapped continuous slot strainer equivalent to [_____] [that manufactured by [Howard Smith Screen Company, Houston, TX, telephone (713) 869-5771] [Johnson Screens, St. Paul, MN 55164, telephone (612) 636-3900]]. [The well screen, pipe, and fittings must have a minimum collapse strength of [_____].] [The screen, pipe, and fittings must have a clear inside diameter of [_____].]

2.1.4.1 Couplings

Provide couplings for the stainless steel well screen consisting of the same material as the well screen and thread, flange, and/or fit with a welding ring. Ensure couplings conform in design to the couplings recommended by the manufacturer of the well screen.

2.1.4.2 Perforations

Provide [_____] mm inch diameter well screen with a number [_____] slot, [0.0_____] mm inch open slot. Provide a total opening of no less than [_____] square millimeters inches per meter foot of [_____] mm inch diameter well screen.

2.1.5 Tailpipe for Well Screen

Make the tailpipe for each well screen of the same material and at least the same minimum thickness as the riser pipe and include a bottom plug. Provide tailpipes that are a minimum of [1] [_____] m [3] [_____] feet in length and fasten to the bottom of the screen in an approved manner.

2.2 RISER PIPE

Provide relief well riser pipe material and method of manufacture conforming to the requirements specified in paragraph WELL SCREEN, except omit the screen perforations or opening. Provide relief well riser pipe diameter and discharge details as shown. Provide couplings to the well screen and between riser pipe sections as specified in paragraph COUPLING.

2.3 FILTER PACK

Submit proposed filter pack material and its gradation, before it is placed. Provide material for the filter pack around the riser pipes and screens consisting of [washed gravel] [washed sand] [dry processed sand] composed of hard, tough, and durable particles free from adherent coating. Do not use crushed stone for the filter pack. Do not use filter pack material that contains detrimental quantities of organic matter nor soft, friable, thin, or elongated particles in accordance with the quality requirements in ASTM C33/C33M, Table 1 and Table 3, Class 5S, and in ASTM E11, Table 1. Ensure filter pack meets the following gradation requirements:

SIEVE SIZEU.S. STANDARD U.S. STANDARD	PERCENT PASSING BY WEIGHT
[_____]	[_____]
[_____]	[_____]

2.4 CHECK VALVES

****

NOTE: Insert provisions describing the materials and construction of a well pit, collector pipe, or ditch or any other proposed outlet for the relief well. Discharge details should be clearly shown on the drawings.

The following requirements are for two different check valves that have been specified by the Vicksburg District. Details of the fabricated check valves are available upon request from CELMK-ED-G, telephone (601) 631-5208 or (601) 631-5633 . The soft sponge rubber should be used on valves which can be replaced on a regular basis and used under low head conditions. The medium sponge rubber should be used where access to the check valve is limited.

****

a. [Provide a one piece reinforced all rubber (neoprene) check valve with an integral elastomer flange similar and equal to the Red Valve Series [35][_____], Size [150][_____] mm [6][_____] inch, manufactured by Red Valve Company, Inc., 700 North Bell Ave., Pittsburgh, PA 15106, telephone (412) 279-0044. Design the check valve to withstand a maximum back pressure of [100][_____] kPa [15][_____] psi. Provide stainless steel backup ring for the check valve. Use stainless steel bolts, washers, and nuts to fasten the valves onto the flanged end of the pipes. Install the check valve with the flared end duck bill in a vertical position.]

b. [Fabricate check valves of [brass][stainless steel][aluminum] plate, threaded fasteners and rods as detailed on the drawings. Fabricate sealing disc of [10][_____] mm [3/8][_____] inch silicone sponge rubber free of porous areas, foreign materials, and visible defects.]

c. Provide silicone sponge rubber that meets the following specifications:
d.

PHYSICAL TEST	TEST VALUE		ASTM TEST METHOD
	SOFT	MEDIUM	
Compression Deflection (compressed 25 percent at room temperature)	15 to 50 kPa2 to 7 psi	40 to 100 kPa6 to 14 psi	ASTM D1056
Tensile Strength	345 kPa50 psi (min)	515 kPa75 psi (min)	ASTM D412
Elongation at break	75 percent (min)	100 percent (min)	ASTM D412
Compression Set (Compressed 50 percent for 22 hours at 100 C 212 F	15 percent (max)	5 percent (min)	ASTM D297
Density	0.33 g per cubic cm0.012 pci (min)	0.47 g per cubic cm0.017 pci (min)	ASTM D297 Hydrostatic Method

e. Perform workmanship and metalwork fabrication of check valves in accordance with the details shown. Install check valves accurately vertically and adjust to the required elevation.

2.5 CONCRETE

Provide concrete conforming to [the requirements specified in Section [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [_____]] [ASTM C94/C94M, Option A, with a [19][_____] mm [3/4][_____] inch Nominal Maximum Size of Aggregate, a maximum slump of 125 mm 5 inches, air content of [5] [_____] percent, and a compressive strength of [17.2][_____] MPa [2500][_____] psi] [packaged normal weight concrete conforming to ASTM C387/C387M].

PART 3 EXECUTION

3.1 DRILLING

Wells may be drilled by the reverse rotary circulation method or other method approved, which will insure proper placement of the well screen, riser pipe, and filter pack. Methods which involve radical displacement of the formation, or which may reduce the yield of the well, will not be permitted. Dispose of excavated material as directed.

3.1.1 Reverse Circulation Method

****

NOTE: Where the Contracting Officer approved use of drilling fluid, it will be a suspension of fine grained soil or commercial product of a recognized manufacturer, having the characteristic of being readily removable from the filter pack and the walls of the foundation by development as specified in

paragraph DEVELOPMENT.
****

If the reverse circulation method is used for drilling wells, remove all of the drilling fluid from the filter pack and the natural pervious formation. If in the opinion of the Contracting Officer the walls of the hole above the top of the filter pack require support during development operations, place a temporary casing similar to that specified in paragraph TEMPORARY CASING. Ensure the diameter of the hole permits the placement of the minimum thickness of filter pack as specified in paragraph FILTER PACK PLACEMENT. Provide drilling fluid that is a suspension of fine grained soil or a commercial product of a recognized manufacturer, approved by the Contracting Officer, and has the characteristic of being readily removable from the filter pack and the walls of the formation by development as specified in paragraph DEVELOPMENT. The use of bentonite will not be permitted.

3.1.2 Temporary Casing

Make temporary well casing of either iron or steel of sufficient length to case to the bottom of all borings available at the construction site. The Contracting Officer will direct the use of a temporary casing to the bottom of the boring during drilling and placement of screen, riser, and filter pack when he believes it is necessary to provide adequate support to the sides of the hole. When the walls of the boring will require support only during development operations a temporary casing will be required to extend only to a depth 1 m 3 feet below the top of the filter pack. Provide temporary casing, with an inside diameter of no less than [_____] mminches, a sufficient thickness to retain its shape and maintain a true section throughout its depth, and may be in sections of any convenient length. Ensure the temporary casing permits its removal without disturbing the filter pack, riser, or well screen. Set temporary casing such that no cavity will be created outside of it at any point along its length. In the event the temporary casing should become unduly distorted or bent it should be discarded and a new casing should be used during installation of any additional relief wells.

3.2 INSTALLATION OF RISER PIPE AND SCREEN

3.2.1 Assembly

Ensure all riser pipe and screen is in good condition before installation and all couplings and other accessory parts are securely fastened in place. Arrange successive lengths of pipe to provide accurate placement of the screen sections in the bore hole. [Provide riser-pipe with an approved cap and a flanged top section. Set the top at the elevation as directed or shown.] Attach centralizers to the assembled riser pipe and screen in such numbers and of a type that they will satisfactorily center the riser pipe and screen in the well and will hold it securely in position while the filter pack material is being placed.

3.2.2 Joints

Join sections of relief well pipe together as specified in paragraph COUPLINGS. Design and construct joints to have the strength of the pipe and where possible a strength capable to support the weight of the relief well stem as it is lowered into the hole. When not practicable to construct joints that will support the weight of the relief well stem, support the stem at the lower end by any approved means that will assure that the joints do not open while being lowered into place in the well.

3.2.3 Installation

Place the assembled riser pipe and screen in the bore hole in such manner as to avoid jarring impacts and to insure that the assembly is centered and not damaged or disconnected. The screen should be suspended in the hole and not resting on the bottom of the hole. After the screen and riser pipe have been placed, construct a filter pack around the screen section as specified in paragraph FILTER PACK PLACEMENT and develop the well as specified in paragraph DEVELOPMENT. Hold the top of the riser pipe at the designated elevation during placement of the filter pack.

3.2.4 Check for Plumbness and Alignment

****

NOTES: Alignment and plumbness tests are performed to determine if a pump will be able to be installed into the well at the end of development so that a pump test can be performed. The variation of the plumbness should not vary more than two-thirds of the inside diameter of the well in 30 m 100 feet.

Select appropriate alternate paragraph.

****

[Each well must be sufficiently straight and plumb, such that a cylinder [3][6][10][15] m [10][20][40] feet in length and with an outside diameter 13 mm 1/2 inch smaller than the inside diameter of the well may be lowered for the full depth of the well and withdrawn without binding against the sides of the well. Furnish the dummy cylinder and perform the alignment check and plumbness check in the presence of the Contracting Officer. A variation of [150][_____] mm [6][_____] inches per 30 m 100 feet of depth will be permitted in the plumbness of well from a plumb line at the top of the well; however, this will not relieve the Contractor of the responsibility of maintaining adequate clearance for installation of the surging and pumping equipment required for testing and pumping the wells. Perform at least one plumbness check and alignment check on each well after placement of the filter pack. Additional tests may be made during the performance of the work at the option of the Contractor.]

[Construct the well and set all casing round, plumb, and true. Perform the following tests after the installation of the well but prior to backfilling, and before its acceptance. Additional tests may be made during the performance of the work at the option of the Contractor. Should the Contractor fail to correct, at no additional cost to the Government, any faulty alignment or plumbness disclosed as a result of these tests, the Contracting Officer may refuse to accept the well. If in the judgement of the Contracting Officer the Contractor has exercised all possible care in constructing the well and the defect is due to circumstances beyond the Contractor's control or if the utility of the completed well is not materially affected or if the cost of necessary remedial measures will be excessive, the requirements for plumbness may be waived. In no event will the provisions with respect to alignment be waived.]

3.2.4.1 Plumbness

Test plumbness by use of a plumb line. Ensure the plummet is a short cylinder with an outside diameter approximately 6 mm 1/4 inch smaller than the inside of the well and/or temporary casing. Suspend it from a small diameter wire rope and with the point of suspension in the exact center of the plummet. Ensure the plummet is sufficiently heavy to stretch the wire rope taut. Pass the wire rope over a guide sheave which is positioned at least 3 m 10 feet above the top of the well and adjusted horizontally so that the plummet hangs in the center of the well. Measure displacement of the wire rope during the plumbness check by means of a transparent plastic sheet on which a number of concentric circles are scribed or drawn, and which is centered on the top of the well. Mark the exact center of these circles, and then cut a slot, slightly larger than the plumb line and extending from this center to the edge, in the plastic sheet. As the plummet is lowered, any out-of-plumb condition of the well will be indicated by the wire rope tending to drift away from the center, and rotate the plastic sheet until the slot is oriented in the direction of this drift, while at all times maintaining the center of the concentric circles coincident with the center of the well. Measure of the amount of drift along the edge of the slot for each increment by which the plummet is lowered into the well. Determine drift at any depth by multiplying the measured plumb line displacement by the total length of the plumb line and dividing the result by the fixed distance between the guide sheave and the top of the well. If desired, alignment may be calculated from the plumbness data in lieu of the alignment check described in paragraph ALIGNMENT. Should the well vary from the vertical in excess of [150][_____] mm [6][_____] inches per 30 m 100 feet of depth, correct the plumbness of the well by the Contractor at no additional cost to the Government.

3.2.4.2 Alignment

Test the alignment by lowering into the well a section of cylinder [3][6][10][15] m [10][20][40] feet long or a dummy of the same length. The outside diameter of cylinder must be no more than 13 mm 1/2 inch smaller than the inside diameter of the well. Should the cylinder fail to move freely throughout the length of the well, correctthe alignment of the well at no additional expense to the Government.

3.3 FILTER PACK PLACEMENT

After the well screen and riser pipe have been installed, place the filter pack material by tremie, when using a well graded material, in an approved manner such that segregation will not occur. When using a uniform graded filter material, the material may be poured around the well screen at a rate that will prevent bridging of the material. The material should be placed around all sides of the screen to assure that the screen is not pushed against the side of the bore hole causing the screen to come in contact with foundation material or prevent the proper thickness of filter from being placed uniformly around the screen. Provide filter pack with a minimum thickness of [_____] mm inches between the outside of the well screen and the natural formation. Place the filter pack at a constant rate from the start of placement until it has reached the elevation [shown], [directed] [a minimum of 600 mm 2 feet above the top of the well screen]. If a tremie is required, use a double string of tremie pipe. Place the pipes on opposite sides of the screen and/or casing, that is, 180 degrees apart, and guide in such a manner that they will remain in this position throughout the placing process. Set the tremie pipes in place, fill completely with filter pack prior to being lifted off the bottom of the hole. Keep filter pack in the tremie pipe a minimum of 300 mm 1 foot above the water surface in the well throughout the placing process. Do not allow the gradation of the filter pack to fall outside of the range specified in paragraph FILTER PACK.

3.4 DEVELOPMENT

****

NOTE: The method of surging specified may be modified to specify a procedure considered most suitable for the particular project. Violent surging, as with compressed air, should not be permitted.

****

Following placement of filter pack materials, develop the relief well by jetting, surging, intermittent pumping, or other approved methods as may be necessary to give the maximum yield of water per 300 mm foot of drawdown. At the time of development of any relief well, ensure the well is free of drawdown or surcharge effects due to pump testing, developing or drilling at another location. The Contractor is responsible for maintaining at the relief well the needed access and work area and clearance in the relief well necessary to accomplish development. Furnish, install, or construct the necessary discharge line and troughs to conduct and dispose of the discharge a sufficient distance from the work areas to prevent damage. Conduct development to achieve a stable well of maximum efficiency and continue until a satisfactory sand test, as specified in paragraph SAND TEST, is obtained. As development proceeds, add filter pack material to the annular space around the screen to maintain the top elevation of the filter pack to the specified elevation. Provide an open tube or other approved means for accurately determining the water level in the well under all conditions. If, at any time during the development process it becomes apparent in the opinion of the Contracting Officer that the well may be damaged, terminate development operations immediately. The Contracting Officer may require a change in method if the method selected does not accomplish the desired results. The Contracting Officer may order that wells which continue to produce excessive amounts of fines after development for 6 hours be abandoned, plugged, and backfilled, and may require the Contractor to construct new wells nearby. Remove all materials pulled into the well by the development process prior to performing the pumping test.

3.4.1 Jetting

Perform using either a single or double ring jet. If a double ring jet is used the rings should be 600 mm 2 feet apart. Construct the jetting tool of high-strength material and conservatively design and proportion so that it will withstand high pressures. Provide jetting tool with [two [7][8][10] mm [3/16] [1/4][3/8] inch diameter hydraulically balanced nozzles spaced 180 degrees] [four [7][8][10] mm [3/16][1/4][3/8] inch diameter holes spaced 90 degrees] apart and which exerts the jetting force horizontally through the screen slots. Construct the rings such that the tips of the jets are within 13 mm 1/2 inch from the inner surface of the well screen. Use pump in conjunction with the jetting tool which is capable of providing [pressures up to [1700] [_____] kPa [250][_____] psi.] [a minimum jetting fluid exit velocity of 45 meters per second 150 feet per second.] Prior to commencing jetting, and following each jetting cycle, remove all sand and/or other materials from inside the screen. Start the jetting process at the bottom of the screen and rotate the jetting tool [slowly] [1 cycle per 30 seconds] [[_____] cycles per [_____] seconds] while rotating the pipe [180][90] degrees for two minutes at each location then raising the pipe [150][_____] mm [6][_____] inches. Pump all wells, more than 100 mm 4 inches in diameter, during the jetting cycle to remove incoming sand and other material. Pump at a rate no less than 115 percent of the rate at which fluid is introduced through the jetting tool. This will allow a flow of material into the well as it is being developed. Use water that is free of sand for development. The contracting officer may require other means of developing the well such as intermittent pumping method, variation of the intermittent pumping method, or surge block if it appears that the development of the well is not producing the desired results.

3.4.2 Intermittent Pumping

Perform by pumping the well at a capacity sufficient to produce a rapid drawdown of approximately [_____] m feet stopping the pump (backflow through pump will not be permitted) to permit the water surface to rise to its former elevation, and repeating this procedure. Cycle time for this procedure will vary as directed but will not be more than 3 cycles per minute. A pump discharge in excess of [_____] L/s gpm will be required. Use a deep well turbine pump, or electric submersible pump with check valve, with any attachment necessary to accomplish rapid starting and stopping for intermittent pumping. Set the intake at least 3 m 10 feet below the maximum expected drawdown in the well. Prior to commencing intermittent pumping, and periodically during development by this method, remove all sand and/or other materials from inside the screen. The amount of drawdown may be decreased if, in the opinion of the Contracting Officer, the efficiency of the well might otherwise be impaired.

3.4.3 Surging

Use a circular block which is approximately 25 mm 1 inch smaller in diameter than the inside diameter of the relief well and is constructed of a material which will not damage the screen if the block comes in contact with the screen, and a bailer or pump to remove materials drawn into the well. Continue surging for a period of approximately one hour or until little or no additional material from the foundation or filter pack can be pulled through the screen. Move the surge block by a steady motion up and down the full length of the well screen. Prior to commencing surging, and periodically during development by this method, remove all sand and/or other materials from inside the screen. Remove all materials pulled into the well by the surging process.

3.5 BACKFILLING

[After the well has been developed, additional filter pack should be added if necessary to meet the requirements of paragraph FILTER PACK PLACEMENT. Then backfill the annular space above the filter pack first by placing a 300 mm 12 inch minimum layer of concrete sand on the filter pack and then filling the remainder of the space up to the [finished ground surface] [well pit] with grout or concrete. Place the concrete backfill to a depth at least equal to the existing impervious blanket, but in no case less than [_____] m feet.] [For PVC riser pipe, after the well has been developed, additional filter pack should be added if necessary for it to meet the requirements of paragraph FILTER PACK PLACEMENT. Then backfill the remaining annular space above the filter pack first by placing a 300 mm 12 inch minimum layer of concrete sand on the filter pack and then filling the remainder of the space up to the [finished ground surface] [well pit] with bentonite.] Withdraw the temporary casing, if used, in increments as the backfill is placed. Fill with impervious material, to original grade, all pits such as those incidental to the reverse rotary circulation method of drilling.

3.6 PLUGGING OF ABANDONED WELLS

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NOTE: State regulatory requirements along with applicable paragraphs to direct Contractor on how a well is to be abandoned. If there are no code requirements the following should be used.

****

[The Contractor has the option of attempting to remove the well screen. If the well screen can be removed, grout the bore hole starting from the bottom of the hole to within 1 m 3 feet of ground surface. Start grouting at the elevation of the bottom of the tailpipe of the well. If the well screen could not be removed or broke off during the removal attempt, the Contractor is still responsible for grouting the well from the bottom of the tailpipe to within 1 m 3 feet of ground surface. Either of the above abandonment procedures may require the Contractor to redrill the hole so that the bore hole can be grouted.][Grout the well from the bottom of the tailpipe to within 1 m 3 feet of ground surface. After the grout has setup, cut off the riser pipe 1 m 3 feet below ground. Then backfill the hole.] Submit the cement grout mixture proportion to be used for approval.

3.7 TESTS

Submit sampling and testing reports for each relief well, logs of the borings, well screen and riser pipe, backfill material, and pump tests. Register each well with the state as required by the state in which the well is installed.

3.7.1 Pump Test

****

NOTE: A six-hour continuous test is ordinarily adequate to determine that a well is performing properly. It is recommended that the specified draw-down (or discharge) during a routine test be approximately 1.5 times the estimated head (or discharge) for which the system is designed. In addition to the routine tests, the wells may be pumped for longer periods and at various draw-downs or discharges to secure, or to check, design data.

****

Upon completion but before acceptance, subject each well to a pump test of which a sand test will form a part. Provide a [deep well turbine] pump, capable of producing the specified drawdowns over periods of time sufficient to satisfactorily perform the pump test specified herein. Set the intake 3 m 10 feet below the maximum expected drawdown in the well. The amount of sand should be measured after each test. Provide pump complete with either gasoline, diesel, or electric motor of adequate size. In case an electric motor is used, provide, without additional cost to the Government, the electric power and the necessary wiring. Provide an open tube or other approved means for accurately determining the water level in the well. Furnish and install an orifice meter of approved design or other approved equipment for the purpose of measuring the discharge from the well during the pumping test. Furnish, install, or construct the necessary pipe discharge line, troughs, or ditches necessary to dispose of the pumping test discharge a sufficient distance from the work area to prevent damage. The tests will be conducted under the direction of the Contracting Officer and may be made as soon as each well is completed [and adjacent Government installed piezometer tubes are operational]. Test data will be recorded by Government personnel. Test each well by pumping continuously for a minimum of [6] [_____] hours. Prior to starting the pump test, remove all material from the bottom of the well. Pump at a rate [of [_____] L/s gpm][sufficient to produce approximately [_____] m feet of draw-down]. If the test is interrupted, other than by order of the Contracting Officer, prior to the completion of the specified period of continuous operation, re-run the test. In addition to the required pumping test, the Contracting Officer may direct the Contractor to perform additional pump tests. Ensure such additional testing conforms in general to the requirements specified herein except that the duration of the tests and the approximate draw-down will be determined by the Contracting Officer. In the event that sand or other material collects in the well as a result of the pump test, take accurate measurements as to the quantity of material in the well and remove all such material. Upon completion of the pump test, remove all equipment, discharge lines, electrical lines, lumber, and debris, and backfill any excavated areas with impervious material.

3.7.2 Sand Test

As part of each pump test or at the end of each intermittent pumping, determine the amount of sand (filter pack and/or foundation material) a well is producing. Prior to starting the sand test, remove all material from the bottom of the tailpipe. Test each well by pumping at a rate [of [_____] L/sgpm] [sufficient to produce approximately [_____] m feet of draw-down]. After the pump is at the desired pumping rate, divert the flow from the discharge [into a container that will collect all the sand being carried by the water][through a Rossum Sand Tester]. Development of the well is satisfactory if the amount of sand collected is less than 0.5 L per 100 000 L 1 pint per 25,000 gallons of water pumped at the specified rate. Upon completion of the test, determine the amount of sand in the tailpipe to verify that no material is being deposited in the bottom of the well.

3.7.3 Filter Pack Sampling and Testing

Verify that all materials conform to the specifications before delivery to the project. Sample and test the particle size distribution of the filter pack in accordance with ASTM C136/C136M and ASTM D75/D75M. [Prior to delivery to the project site, at least two samples of material should be collected and tested for every 700 metric tons 750 tons (2000 lb) produced under this contract.] [Within 48 hours before being placed in the relief well to be back-filled, sample the filter pack from the material stockpiled at the project site. Perform at least one particle size distribution test on the filter pack for [each well] [every [_____] wells].] Perform a pump test in accordance with technical provisions herein specified.

3.7.4 Reports

Include in the reports for each relief well, logs of the boring, elevations of the well screen, top of riser pipe, bottom of the tailpipe, filter pack gradation, quantity of filter pack added during development, pump test, sand test, and report of backfilling. Ensure the elevation of changes between materials on these logs are to the nearest 30 mm 0.1 foot. Include the filter pack particle size distribution test data and notes concerning installation and development of the relief well in the log of backfill material. Include the duration of the test and rate of flow in L/s gpm, and the draw-down response data with time in the pumped well, in adjacent wells, and in nearby piezometers in the test log. Submit the relief well log and the pump test log to the Contracting Officer as part of the weekly quality control report specified in Section 01 45 00 QUALITY CONTROL. Also submit a report of the well installation to the appropriate public agency and in the form required by state statutory and/or regulatory requirements specified in paragraph REGULATORY REQUIREMENTS.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 30 00 (May 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 30 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 30 00

SANITARY SEWERAGE

05/18

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NOTE: This guide specification covers the requirements for piping and appurtenant structures for an exterior sanitary sewer system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

For corrosive soils select materials, coatings or cathodic protection systems in accordance with UFC 3-230-01. When cathodic protection is used include Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM.

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NOTE: For Army and Air Force, impress current cathodic protection(ICCP) may be used. When ICCP is used include Section 26 42 17IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM.

****

PART 1 GENERAL

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NOTE: In areas where problems with root penetration

are anticipated, specify pipe which has the kind of joint which will successfully resist root penetration. Generally speaking, the more watertight the joint, the greater the resistance to root penetration will be. Rubber-gasketed and compression-type joints are considered to give the best performance for this application.

When using plastic pipe in areas with contaminated soil or groundwater, consult with the manufacturer regarding permeation of pipe walls. When pipe is installed in contaminated soil or groundwater consult with the manufacturer regarding selection of appropriate gasket material based on type and concentration of contaminants and refer to AWWA C605.

Plastic pipe is subject to temperature limitations which must be observed.

Use caution if considering concrete pipe for septic flows. Depending on septicity, these pipes may not be satisfactory.

Give special attention in the design stage of project to plastic pipe materials, particularly with respect to superimposed external loads which could cause excessive deflection of the pipe. The degree of sidefill compaction should be considered realistically, particularly in marginal cases.

Where different classes, strengths, etc., of pipe are required for different sections of long pipelines due to significant differences in external loading, expand or modify the applicable paragraphs of this specification accordingly. Show the limits for each class, strength, etc., either on the project drawings or appropriately describe them in the applicable paragraph of the project specification.

Pipe joints: When more than one type of joint is applicable for the specified piping, permit each as a Contractor's option except where watertight joints are necessary or in areas where root penetration problems are anticipated. In these cases, rubber-gasketed or compression-type, or solvent-cemented joints are preferred. Use fuel resistant joint gaskets when required.

It may be necessary to modify chemical requirements for cement under certain conditions. Sulfate resistance is required for concrete pipe when pipe is carrying sulfate-bearing waters, or when pipe is buried in soil containing sulfates. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as S04) in the soil are in the range of 0.1 to 0.2 percent and, for water, are in the range of 150 to 1000 parts per million. Specify Type V (sulfate resisting) cement when soils

contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1000 parts per million. In areas where reactive aggregates are known to occur, specify low alkali cement.

****

1.1   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

ACPA 01-102	(2000) Concrete Pipe Handbook
ACPA 01-103	(2000) Concrete Pipe Installation Manual

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2023) Manual for Railway Engineering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASME B18.5.2.1M	(2006; R 2011) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2010) Metric Round Head Square Neck Bolts

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C302	(2022) Reinforced Concrete Pressure Pipe, Noncylinder Type
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C605	(2021) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C606	(2022) Grooved and Shouldered Joints
AWWA C900	(2022) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA M9	(2008; Errata 2013) Manual: Concrete Pressure Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc

	(Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A746	(2018; R 2022) Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM C12	(2024) Standard Practice for Installing Vitrified Clay Pipe Lines
ASTM C14	(2020) Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C14M	(2020) Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C76	(2022a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C76M	(2022a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C361	(2022) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
ASTM C361M	(2022) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe (Metric)

ASTM C425	(2021) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C443	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C443M	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C478M	(2018) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C700	(2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C828	(2023) Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C923	(2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C923M	(2008b; R 2013) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric)
ASTM C969	(2024) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C969M	(2019) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)
ASTM C972	(2024) Standard Test Method for Compression-Recovery of Tape Sealant
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C990M	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed

	Flexible Joint Sealants (Metric)
ASTM C1214	(2013) Standard Test Method for Concrete Pipe Sewerlines by Negative Air Pressure (Vacuum) Test Method
ASTM C1214M	(2013) Standard Test Method for Concrete Pipe Sewerlines by Negative Air Pressure (Vacuum) Test Method (Metric)
ASTM C1227	(2013) Standard Specification for Precast Concrete Septic Tanks
ASTM C1244	(2020) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM C1244M	(2020) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill (Metric)
ASTM C1644	(2006; R 2017) Standard Specification for Resilient Connectors Between Reinforced Concrete On-Site Wastewater Tanks and Pipes
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2412	(2021) Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2997	(2015) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3262	(2020) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3753	(2019) Glass-Fiber-Reinforced Polyester Manholes and Wetwells
ASTM D3840	(2014) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
ASTM D4161	(2014; R 2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667/F667M	(2016; R 2021) Standard Specification for 3 through 24 in. Corrugated Polyethylene

	Pipe and Fittings
ASTM F714	(2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F758	(2014; R 2023) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F794	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F894	(2024) Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F1417	(2011a; E 2024) Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air
ASTM F2736	(2013; E 2014) Standard Specification for 6 to 30 in. (152 To 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe And Double Wall Pipe
ASTM F2764/F2764M	(2024) Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

IAPMO Z1000	(2013) Prefabricated Septic Tanks

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.27	(Nov 2016) Scaffolds and Roope Descent Systems

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's License; G, [_____]

SD-02 Shop Drawings

Installation Drawings; G, [_____]

SD-03 Product Data

Precast Concrete Manholes

Frames, Covers, and Gratings

Gravity Pipe

Pressure Pipe

Precast Concrete Septic Tanks; G, [_____]

SD-06 Test Reports

Precast Concrete Sewer Manhole Test; G, [_____]

Hydrostatic Sewer Test; G, [_____]

Infiltration Tests And Exfiltration Tests; G, [_____]

Negative Air Pressure Test; G, [_____]

Low-Pressure Air Tests; G, [_____]

Tests For Pressure Lines; G, [_____]

Deflection Testing

Concrete Pipe Test; G, [_____]

SD-07 Certificates

Portland Cement

Gaskets

Pre-Installation Inspection Request; G

Post-Installation Inspection; G

1.3 QUALITY CONTROL

1.3.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Verify installing Contractor's License is current and state certified or state registered.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.4.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

[1.4.1.2 Cement, Aggregate, and Reinforcement

****

NOTE: Delete this paragraphs if cast-in-place

concrete is not used.

Select 03 30 00 for projects with large amounts of cast-in-place concrete work.

Select 03 30 53 for projects with small amounts of cast-in-place concrete work.

For Army, Use 03 30 00.

****

As specified in Section [03 30 00 CAST-IN-PLACE CONCRETE][03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE].

]1.4.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. [Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs.] Carry, do not drag, pipe to trench. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe in accordance with the manufacturer's recommendation and discard those materials if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Sanitary Sewer Gravity Pipeline

[Provide [mains and laterals] [[_____] mm inch lines] of [clay pipe] [concrete pipe] [ductile-iron pipe] [polypropylene pipe] [or] [polyvinyl chloride (PVC) plastic pipe]. Provide building connections [[_____] mm inch lines] of [clay pipe] [concrete pipe] [or] [polyvinyl chloride (PVC) plastic pipe].] [Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 1.5 m 5 feet outside of building walls.]

2.1.2 Sanitary Sewer Pressure Lines

Provide pressure lines of [ductile iron pressure pipe] [concrete pressure pipe] [or] [polyvinyl chloride (PVC) plastic pressure pipe].

2.2 MATERIALS

****

NOTE: Show the following information on the project drawings:

Location of all new pipelines, diameter of pipe, fittings and appurtenances including but not limited to valves, fire hydrants, yard hydrants, thrust blocks, restrained joints and details where necessary;

Location, size, and type of service of existing connecting, intersecting, or adjacent pipelines and other utilities;

Paved areas and railroads which pass over new pipelines;

Profile, where necessary to show unusual conditions

Invert elevations at beginning and end of pipelines and at manholes or similar structures;

Where different materials are required, show the material, class or thickness of pipe and limits where class or thickness must be different for different sections of pipeline;

Details for manholes, septic tank(s), and sewage absorption trench;

Bedding conditions, where different from those specified in the appropriate specification ;

Location and size of thrust blocks on pressure lines

Location of flanged joints on pressure sewers;

Location of mechanical joints on ductile-iron piping (when used on only part of the system).

****

Provide materials conforming to the respective specifications and other requirements specified below. Submit manufacturer's product specification,standard drawings or catalog cuts.

2.2.1 Gravity Pipe

2.2.1.1 Clay Piping

2.2.1.1.1 Clay Pipe and Fittings

****

NOTE: Tables of trench loadings, trench backfill loads, and supporting strengths of clay pipe are included in the Vetrified Clay Pipe Engineering Manual (2015 edition) of the National Clay Pipe Institute. The required strength of clay pipe can be derived from these tables when depth of trench is known.

Specify "bell-and-spigot piping only" in areas where corrosion problems may be anticipated with the stainless steel parts of the couplings used for plain-end piping.

****

ASTM C700, [standard strength] [extra strength] [bell-and-spigot piping only].

2.2.1.1.2 Clay Piping Jointing Materials

Use ASTM C425.

2.2.1.2 Concrete Gravity Sewer Piping

2.2.1.2.1 Concrete Gravity Pipe and Fittings

****

NOTE: The D-load (load per linear meter foot of diameter) must be calculated on the basis of project conditions to determine the applicable Class or strength of pipe. The Concrete Pipe Design Manual (2011 edition) of the American Concrete Pipe Association contains design information and methods by which the applicable Class or strength of pipe can be determined when depth of trench is known.

It may be necessary to modify chemical requirements for cement under certain conditions. Sulfate resistance is required for concrete pipe when pipe is carrying sulfate-bearing waters, or when pipe is buried in soil containing sulfates. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as S04) in the soil are in the range of 0.1 to 0.2 percent and, for water, are in the range of 150 to 1000 parts per million. Specify Type V (sulfate resisting) cement when soils contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1000 parts per million. In areas where reactive aggregates are known to occur, specify low alkali cement.

Delete requirement for tongue-and-groove pipe (concrete pipe) when not allowed for the project.

****

Provide [nonreinforced concrete pipe conforming to ASTM C14M ASTM C14, Class [_____]][reinforced concrete pipe conforming to ASTM C76M ASTM C76, Class [_____]]. Provide circular pipe with elliptical reinforcement having a readily visible line at least 300 mm 12 inches long painted or otherwise applied on the inside and outside of the pipe at each end so that when the pipe is laid in the proper position, the line will be at the center of the top of the pipe. Provide fittings and specials conforming to the applicable requirements specified for the pipe including the strength of the pipe. [Use pipe and fittings containing [Type II] [Type V] [low alkali cement] cement conforming to ASTM C150/C150M.]

2.2.1.2.2 Jointing Materials for Concrete Gravity Piping

Provide gaskets and pipe ends for rubber gasket joint conforming to ASTM C443M ASTM C443. Use gaskets suitable for use with sewage.

Submit certificates of compliance stating that the fittings or gaskets used for waste drains or lines designated on the plans as [_____] are [oil] [_____] resistant.

2.2.1.3 Ductile Iron Gravity Sewer Pipe and Associated Fittings

2.2.1.3.1 Ductile Iron Gravity Pipe and Fittings

****

NOTE: ASTM A746 also contains design information and methods by which the required Thickness Class of Pipe can be determined when depth of trench is known.

Delete requirements for and references to push-on joints for ductile-iron gravity sewer pipe and associated fittings when the greater deflection afforded by the mechanical joint is considered necessary throughout.

****

Provide ductile iron pipe conforming to ASTM A746 with cement-mortar lining in conforming to AWWA C104/A21.4, Pressure Class [_____]. Provide push-on joints conforming to AWWA C111/A21.11.

2.2.1.4 PVC Gravity Sewer Piping

2.2.1.4.1 PVC Gravity Pipe and Fittings

[ASTM D3034, SDR 35, or ASTM F949 with ends suitable for elastomeric gasket joints.] [ASTM F794, Series 46, for ribbed sewer pipe with smooth interior, size 200 mm 8 inch through 1200 mm 48 inch diameters.]

2.2.1.4.2 PVC Gravity Joints and Jointing Material

Provide joints conforming to ASTM D3212. Gaskets are to conform to ASTM F477.

2.2.2 Pressure Pipe

2.2.2.1 Concrete Pressure Piping

2.2.2.1.1 Concrete Pressure Pipe and Fittings

****

NOTE: Delete reference to AWWA C302 within brackets when pressure rating greater than 310 kPa 45 psi is required.

It may be necessary to modify chemical requirements for cement under certain conditions. Sulfate resistance is required for concrete pipe when pipe is carrying sulfate-bearing waters, or when pipe is buried in soil containing sulfates. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as S04) in the soil are in the range of 0.1 to 0.2 percent and, for water, are in the range of 150 to 1000 parts per million. Specify Type V (sulfate resisting) cement when soils contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1000 parts per million. In areas where reactive aggregates are known to occur, specify low alkali cement.

For concrete pressure piping, ASTM C361M C361 covers pipe for up to 37.5 m 125 feet of hydrostatic head, approximately 379 kPa 55 psi; AWWA C302 covers pipe and fittings for 310 kPa 45 psi pressure rating, 30 m 100 feet of hydro-static head) only. ASTM C361M ASTM C361 contains tables giving design requirements for pipe in all combinations of 30 and 37.5 m 100 and 125 feet of hydrostatic head with 1.5, 3.0, 4.5, 6.0 m 5, 10, 15, and 20 feet of earth cover. Where higher pressure ratings are necessary, piping conforming to AWWA C300, C301, or C303 should be specified.

****

Provide pipe conforming to [AWWA C302 or to] ASTM C361M ASTM C361. Design pipe for hydrostatic head of [30] [38] m [100] [125] feet and external loading of [1.5] [3.0] [4.5] [6.0] m [5] [10] [15] [20] feet of earth cover. Provide circular pipe with elliptical reinforcement having a readily visible line at least 300 mm 12 inches long painted or otherwise applied on the inside and outside of the pipe at each end so that when the pipe is laid in the proper position, the line will be at the center of the top of the pipe. [Use [Type II] [Type V] [low alkali] cement conforming to AWWA C302 in manufacturing pipe and fittings] Provide fittings.

2.2.2.1.2 Jointing Materials for Concrete Pressure Piping

****

NOTE: Use first bracketed wording when pressure rating greater than 310 kPa 45 psi is not required. Use second bracketed wording when pressure rating greater than 310 kPa 45 psi is required.

****

Provide gaskets as specified in [the referenced specification for the pipe] [ASTM C361M ASTM C361] and are suitable for use with sewage.

2.2.2.2 Ductile Iron Pressure Piping

****

NOTE: Ductile iron pipe is used for sizes 75 mm 3 inches to 1600 mm 64 inches.

****

2.2.2.2.1 Ductile Iron Pressure Pipe and Fittings

Provide [push-on-joint] [mechanical joint] [flanged] ductile-iron pipe conforming to AWWA C151/A21.51, [Pressure Class [_____]] [Thickness Class [_____]]. Provide fittings conforming to AWWA C110/A21.10 or AWWA C153/A21.53. [Provide fittings with push-on joint ends conforming to AWWA C111/A21.11.] Use fittings which have a pressure rating at least equivalent to that of the pipe. Pipe and fittings are to have cement-mortar lining conforming to AWWA C104/A21.4, standard thickness.

2.2.2.2.2 Ductile Iron Pressure Joints and Jointing Materials

a. Joints, general: Use [push-on joints] [or] [mechanical joints]for pipe and fittings except as otherwise specified in this paragraph. [Use mechanical-joints where indicated.] [Use flanged joints where indicated.] [Joints made with sleeve-type mechanical coupling may be used in lieu of push-on joint.] [[Grooved] [or] [shouldered] type joints may be used in lieu of push-on joint [or flanged joint], except where joint is buried.]

b. Push-on joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly are to conform to AWWA C111/A21.11.

c. Mechanical joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets are to conform to AWWA C111/A21.11.

d. Flanged joints: Provide bolts, nuts, and gaskets for flanged connections as recommended in the Appendix to AWWA C115/A21.15. Provide flange for setscrewed flanges of ductile iron, ASTM A536, Grade 65-45-12, and conforming to the applicable requirements of ASME B16.1, Class 250. Provide 190,000 psi tensile strength, heat treated, and zinc-coated steel setscrews for setscrewed flanges. Conform gasket for setscrewed flanges to the applicable requirements for mechanical-joint gaskets specified in AWWA C111/A21.11. Design of setscrewed gasket are to provide for confinement and compression of gasket when joint to adjoining flange is made.

****

NOTE: At the text below, delete "or steel" when middle ring of cast iron only is considered necessary due to anticipated corrosion problems. Delete requirement for strength of steel when steel is not allowed as a material for middle ring.

At the text below, minimum numbers of bolts for each pipe size should be as follows:

75 mm 3 inch	**3**
100 mm 4 inch	**4**
150 mm 6 inch	**5**
200 mm 8 inch	**6**
250 mm 10 inch	**7**
300 and 350 mm 12 and 14 inch	**8**
400 mm 16 inch	**9**
450 mm 18 inch	**10**
500 mm 20 inch	**12**
550 mm 22 inch	**13**
600 mm 24 inch	**14**

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e. Joints made with sleeve-type mechanical couplings: Provide couplings designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. Provide couplings consisting of one middle ring flared or beveled at each end to provide a gasket seat, two follower rings, two resilient tapered rubber gaskets, and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings are to be true circular sections free from irregularities, flat spots, and surface defects; the design is to provide for confinement and compression of the gaskets. The middle ring is to be of cast-iron [or steel], and the follower rings are to be of malleable iron or ductile iron. Cast iron couplings are to conform to ASTM A48/A48M and not be less than Class 25. Malleable iron couplings are to conform to ASTM A47/A47M. Ductile iron couplings are to conform to ASTM A536. [Steel is to have a strength not less than that of the pipe.] Gaskets are to be designed for long life and resistance to set after installation and meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts are to be track-head type; bolts and nuts are to be either of the following: bolts conforming to the tensile requirements of ASTM A307, Grade A, with nuts conforming to the tensile requirements of ASTM A563M ASTM A563, Grade A; or round-head square-neck type bolts conforming to ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts conforming to ASME B18.2.2. Bolts are to be 16 mm 5/8 inch in diameter; minimum number of bolts for each coupling are to be [_____] [for [_____] mm inch pipe [,[_____] for [_____] mm inch pipe,] and [_____] for [_____] mm inch pipe]. Bolt holes in follower rings are to be of a shape to hold fast the necks of the bolts used. Sleeve-type mechanical couplings are not to be used as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint.

f. [Grooved] [and] [Shouldered] Type Joints: [Grooved pipe ends] [Shouldered pipe ends] and couplings are to conform to AWWA C606. Joint dimensions are to be as specified in AWWA C606 for rigid joints.

2.2.2.3 PVC Pressure Pipe and Associated Fittings

Pipe, couplings and fittings are to be manufactured of materials conforming to ASTM D1784, Class 12454B.

2.2.2.3.1 Pipe and Fittings Less Than 100 mm 4 inch Diameter

2.2.2.3.1.1 Screw-Joint

Provide pipe conforming to dimensional requirements of ASTM D1785, Schedule 80, with joints meeting requirements of 1.03 Mpa 150 psi working pressure, 1.38 Mpa 200 psi hydrostatic test pressure, unless otherwise shown or specified. Provide fittings for threaded pipe conforming to requirements of ASTM D2464, threaded to conform to the requirements of ASME B1.20.2MASME B1.20.1 for use with Schedule 80 pipe and fittings. Pipe couplings when used, are to be tested as required by ASTM D2464.

2.2.2.3.1.2 Push-On Joint

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NOTE: Use AWWA C110/A21.10 or AWWA C153/A21.53 and AWWA C111/A21.11, for joints on 3 inch or larger piping.

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ASTM D3139, with ASTM F477 gaskets.[Fittings for push-on joints are to be iron conforming to AWWA C110/A21.10 or AWWA C153/A21.53 and AWWA C111/A21.11 with a cement-mortar lining conforming to AWWA C104/A21.4, standard thickness.]

2.2.2.3.1.3 Solvent Cement Joint

Provide pipe conforming to dimensional requirements of ASTM D1785 or ASTM D2241 with joints meeting the requirements of 1.03 Mpa 150 psi working pressure and 1.38 Mpa 200 psi hydrostatic test pressure. Fittings for solvent cement jointing are to conform to ASTM D2466 or ASTM D2467.

2.2.2.3.2 Pipe and Fittings 100 mm 4 inch Diameter And Larger

Provide pipe conforming to AWWA C900 and be plain end or gasket bell end, Pressure Class [150 (DR 18)] [_____], with cast-iron-pipe-equivalent OD. Fittings are to be gray-iron or ductile-iron conforming to AWWA C110/A21.10 or AWWA C153/A21.53 and AWWA C111/A21.11 with a cement-mortar lining conforming to AWWA C104/A21.4, standard thickness. Fittings for pipe to pipe push-on joint ends are to conform with AWWA C900.

2.2.2.4 High Density Polyethylene Pipe (HDPE)

ASTM F894, Class 63, size 450 mm 18 inch through 3000 mm 120 inch. ASTM F714, size 100 mm 4 inch through 1200 mm 48 inch, will have pipe stiffness greater than or equal to 1170/D for cohesionless material pipe trench backfills. For all PE pipes, the polyethylene are to be certified by the resin producer as meeting the requirements of ASTM D3350, cell Class 334433C or higher. Fittings for High Density Polyethylene Pipe are to meet the same material specifications as the pipe class. Joints for HDPE meeting ASTM F894 will be rubber gasket joints conforming to ASTM F477. HDPE meeting ASTM F714 will have fused joints in accordance with manufacturer's instruction.

2.2.2.5 Reinforced Plastic Mortar Pipe (RPMP)

Reinforced plastic mortar pipe are to be produced be in accordance with ASTM D3262 and have an outside diameter equal to ductile iron pipe dimensions from 450 mm 18 inch to 1200 mm 48 inch. The inner surface of the pipe is to have a smooth uniform continuous resin-rich surface liner. The minimum pipe stiffness is to be 248 kPa 36 psi. RPMP is to be in accordance with ASTM D3262. Fittings for RPMP: ASTM D3840. Joints for RPMP: Bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with ASTM D4161 and ASTM F477.

2.2.2.6 Reinforced Thermosetting Resin Pipe (RTRP)

RTRP pipe: ASTM D3262. Fittings for RTRP: ASTM D3262. Joints for RTRP: Bell and spigot type utilizing an elastomeric gasket in accordance with ASTM F477.

2.2.2.6.1 Filament Wound RTRP-I

RTRP-I is to conform to ASTM D2996, except pipe is to have an outside diameter equal to cast iron outside diameter or standard weight steel pipe. The pipe is to be suitable for a normal working pressure of 1.03 MPa 150 psi at 22.8 degrees C 73 degrees F. The inner surface of the pipe is to have a smooth uniform continuous resin-rich surface liner conforming to ASTM D2996.

2.2.2.6.2 Centrifugally Cast RTRP-II

RTRP-II is to conform to ASTM D2997. Pipe is to have an outside diameter equal to standard weight steel pipe.

2.2.2.7 Dual Wall and Triple Wall Polypropylene

Provide 300 to 750 mm12 to 30 inch polypropylene pipe having a smooth interior and annular exterior corrugations, in compliance with ASTM F2736. Provide 750 to 1500 mm30 to 60 inch polypropylene pipe having a smooth interior and exterior surfaces with annular inner corrugations, in compliance with ASTM F2764/F2764M. Pipe is suitable for gravity flow only and is to have a minimum pipe stiffness of 46 psi when tested in accordance with ASTM D2412. Pipe sizes 300 to 1500 mm 12- through 60-inch diameters are to have a reinforced bell, manufacturer's pre-installed polymer composite band or a manufacturer's compatible pipe polymer composite band.

2.2.3 Piping Beneath Railroad Right-of-Way

Where pipeline passes under the right-of-way of a commercial railroad, piping is to conform to the specifications for pipelines conveying nonflammable substances in AREMA Eng Man, except as otherwise specified in this paragraph. For casing pipe provide ductile-iron pipe in lieu of cast-iron soil pipe. Ductile-iron pipe is to conform to and have strength computed in accordance with ASTM A746.

2.2.4 Cement Mortar

Provide cement mortar conforming to ASTM C270, Type M with Type II cement.

2.2.5 Portland Cement

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NOTE: Type II cement normally will be specified, but Type V cement will be specified when the soils contain in excess of 0.2 percent water-soluble sulfate as SO(4), or the waste water contains in excess of 1000 parts per million sulfates. Type I cement may be permitted when it can be assured that the water soluble sulfates in the soil will be less than 0.1 percent and the waste water will contain less than 150 parts per million sulfates over the design life of the project.

****

Submit certificates of compliance stating the type of cement used in manufacture of concrete pipe, fittings, septic tanks, and precast manholes. Provide portland cement conforming to ASTM C150/C150M, Type [II] [V] for concrete used in concrete pipe, concrete pipe fittings, septic tanks, and manholes and type optional for cement used in concrete cradle, concrete encasement, and thrust blocking. [Use air-entraining admixture conforming to ASTM C260/C260M with Type V cement.] [,Use a cement containing less than 0.60 percent alkalies where aggregates are alkali reactive, as determined by Appendix XI of ASTM C33/C33M.]

2.2.6 Portland Cement Concrete

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NOTE: When ready-mix concrete conforming to ASTM C94/C94M is not economically available, rewrite this paragraph to permit use of concrete mixed onsite. Specify concrete aggregates conforming to ASTM C33/C33M and concrete consisting of 1 part portland cement, 2-1/2 parts sand, and 5 parts gravel, with just enough water for workable consistency

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Provide portland cement concrete conforming to ASTM C94/C94M, compressive strength of 28 MPa 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement is to have a compressive strength of 17 MPa 2500 psi minimum at 28 days. Protect concrete in place from freezing and moisture loss for 7 days.

2.2.7 Precast Concrete Manholes

Provide precast concrete manholes, risers, base sections, and tops conforming to ASTM C478M ASTM C478[and be manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser are to be monolithic].

2.2.8 Glass-Fiber-Reinforced Polyester Manholes

Glass-Fiber-Reinforced Polyester Manholes are to conform to ASTM D3753.

2.2.9 Gaskets and Connectors

Provide gaskets for joints between [manhole] [wastewater tanks]sections conforming to ASTM C443M ASTM C443. Resilient connectors for making joints between [manhole] [wastewater tanks] and pipes entering manhole are to conform to ASTM C923M[ASTM C1644] [ASTM C923 or ASTM C990M ASTM C990].

2.2.10 External Preformed Rubber Joint Seals

An external preformed rubber joint seal is an accepted method of sealing cast iron covers to precast concrete sections to prevent ground water infiltration into sewer systems. All finished and sealed manholes constructed in accordance with paragraph entitled "Manhole Construction" are to be tested for leakage in the same manner as pipelines as described in paragraph entitled "Leakage Tests." The seal is to be multi-section with a neoprene rubber top section and all lower sections made of Ethylene Propylene Diene Monomer (EPDM) rubber with a minimum thickness of 1.5 mm 60 mils. Each unit is to consist of a top and bottom section and have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic is to be a non-hardening butyl rubber sealant and seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. Extension sections are to cover up to two more adjusting rings. Properties and values are listed in the following table:

Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals

Physical Properties	Test Methods	EPDM	Neoprene	Butyl Mastic
Tensile, kPa psi	ASTM D412	12,6841840	15,1322195	--

Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals				
Physical Properties	Test Methods	EPDM	Neoprene	Butyl Mastic
Elongation, percent	ASTM D412	553	295	350
Tear Resistance, N/mm ppi	ASTM D624 (Die B)	49280	29160	--
Rebound, percent, 5 minutes	ASTM C972 (mod.)	--	--	11
Rebound, percent, 2 hours	ASTM C972	--	--	12

[2.2.11 Precast Concrete Septic Tanks

Provide precast concrete septic tanks risers, base sections, and tops conforming to ASTM C478MASTM C1227 and be manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser are to be monolithic.

][2.2.12 Glass-Fiber-Reinforced Polyester Septic Tanks

Glass-Fiber-Reinforced Polyester Septic Tanks are to conform to IAPMO Z1000.

]2.2.13 Septic Tank Piping

PVC pipe and fittings. [Provide NSF/ANSI 46 certified effluent filter on the outlet pipe.]

2.2.14 Siphon for Septic Tank

PVC or Polyethylene,of an approved standard design, and prompt and positive in action.

2.2.15 Sewage Absorption Field Materials

[Pipe is to be perforated corrugated polyethylene tubing conforming to ASTM F667/F667M.] [Pipe is to be perforated PVC pipe conforming to ASTM F758.] [Chambers are to be high density polyethylene conforming to IAPMO PS 63]

2.2.16 Frames, Covers, and Gratings for Manholes

[Submit certification on the ability of frame and cover to carry the imposed live load.] Frame and cover are to be cast gray iron, ASTM A48/A48M, Class 35B, cast ductile iron, ASTM A536, Grade 65-45-12, or reinforced concrete, ASTM C478 ASTM C478M. Frames and covers are to be circular [with] [without] vent holes. Size are to be [as indicated on the plans] [for 24 inch opening]. Stamp or cast the words "Sanitary Sewer" into covers so that it is plainly visible.

2.2.17 Manhole Steps

[Zinc-coated steel] [as indicated] conforming to 29 CFR 1910.27 [with a plastic or rubber coating pressure-molded to the steel is to be used. Provide plastic coating conforming to ASTM D4101, copolymer polypropylene. Rubber is to conform to ASTM C443M ASTM C443, except shore A durometer hardness is to be 70 plus or minus 5.] Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 1.2 m 4 feet deep.

2.2.18 Manhole Ladders

Provide a steel ladder where the depth of a manhole exceeds 3.6 m 12 feet. The ladder is not to be less than 406 mm 16 inches in width, with 19 mm 3/4 inch diameter rungs spaced 305 mm 12 inches apart. The two stringers are to be a minimum 10 mm 3/8 inch thick and 51 mm 2 inches wide. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Installation Drawings

Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.

3.2 INSTALLATION

Backfill after inspection by the Contracting Officer. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer.

3.2.1 Connections to Existing Lines

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NOTE: For Navy, Use BMS B-5.2.19 to determine Installation requirements for connecting to existing sanitary sewer lines and incorporate into this paragraph. In accordance with BMS B-5.2.19 a Utility Connection Permit must be submitted during design.

****

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

3.2.2 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.2.2.1 Location

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NOTE: Horizontal and vertical separation distances

must be in accordance with the Recommended Standards for Wastewater Facilities, State or local requirements.
****

Terminate the work covered by this section at a point approximately 1.5 m 5 feet from the building[, unless otherwise indicated]. Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 0.60 m 2 feet below bottom of water line. When these separation distances can not be met, contact the Contracting Officer for direction.

3.2.2.1.1 Sanitary Piping Installation Parallel with Water Line

3.2.2.1.1.1 Normal Conditions

Install sanitary piping or manholes at least 3 m 10 feet horizontally from a water line whenever possible. Measure the distance from edge-to-edge.

3.2.2.1.1.2 Unusual Conditions

When local conditions prevent a horizontal separation of 3 m 10 feet, the sanitary piping or manhole may be laid closer to a water line provided that:

a. The top (crown) of the sanitary piping is to be at least 450 mm 18 inches below the bottom (invert) of the water main.

b. Where this vertical separation cannot be obtained, construct the sanitary piping with AWWA-approved ductile iron water pipe pressure and conduct a hydrostatic sewer test without leakage prior to backfilling.

c. The sewer manhole is to be of watertight construction and tested in place.

3.2.2.1.2 Installation of Sanitary Piping Crossing a Water Line

3.2.2.1.2.1 Normal Conditions

Lay sanitary sewer piping by crossing under water lines to provide a separation of at least 450 mm 18 inches between the top of the sanitary piping and the bottom of the water line whenever possible.

3.2.2.1.2.2 Unusual Conditions

When local conditions prevent a vertical separation described above, use the following construction:

a. Construct sanitary piping passing over or under water lines with AWWA-approved ductile iron water pressure piping and conduct a hydrostatic sewer test without leakage prior to backfilling.

b. Protect sanitary piping passing over water lines by providing:

    (1) A vertical separation of at least 450 mm 18 inches between the bottom of the sanitary piping and the top of the water line.

    (2) Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.

(3) That the length, minimum 6.1 m 20 feet, of the sanitary piping be centered at the point of the crossing so that joints are equidistant and as far as possible from the water line.

3.2.2.1.3 Sanitary Sewer Manholes

No water piping must pass through or come in contact with any part of a sanitary sewer manhole.

3.2.2.2 Earthwork

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NOTE: Earthwork requirements, including bedding, for pipe trenches and utility structures are covered in Section 31 00 00 EARTHWORK.

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NOTE: For Navy, earthwork requirements or pipe trenches, including bedding, are covered in Section 31 00 00 EARTHWORK. The applicable requirements which are set forth in Section 31 00 00 EARTHWORK must be incorporated into the project specification. The specifier should verify the current appropriate specification and revise as necessary.

****

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.2.2.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell [or groove] ends in the upgrade direction. Adjust spigots in bells [and tongues in grooves] to give a uniform space all around. Blocking or wedging between bells and spigots [or tongues and grooves] will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 7.50 m 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Construct branch connections by use of regular fittings or solvent cemented saddles as approved. Provide saddles for PVC pipe conforming to Table 4 of ASTM D3034.

3.2.3 Special Requirements

3.2.3.1 Installation of Clay Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM C12 for pipe laying. Make joints with a compression joint material specified for clay pipe joints and assemble in accordance with the recommendations of the manufacturer of the pipe.

3.2.3.2 Installation of Concrete Gravity Sewer Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the provisions for rubber gasket jointing and jointing procedures of ACPA 01-103 or of ACPA 01-102, Chapter 9, "Installation, Inspection and Construction Testing." Make joints with the gaskets specified for concrete gravity sewer pipe joints. Clean and dry surfaces receiving lubricants, cements, or adhesives. Affix gaskets to pipe not more than 24 hours prior to the installation of the pipe. Protect gaskets from sun, blowing dust, and other deleterious agents at all times. Before installation of the pipe, inspect gaskets and remove and replace loose or improperly affixed gaskets. Align each pipe section with the previously installed pipe section, and pull the joint together. If, while pulling the joint, the gasket becomes loose and can be seen through the exterior joint recess when the pipe is pulled up to within 25 mm 1 inch of closure, remove the pipe and remake the joint.

3.2.3.3 Installation of Concrete Pressure Lines

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the laying and joining requirements specified in the guide specifications for installation of pipe given in AWWA M9, Chapter 14, "Guide Specifications for Installation of Pipe."

3.2.3.3.1 Joints

Make joints with the gaskets specified for concrete pressure pipe joints, using an approved lubricant recommended by the pipe manufacturer. Assemble these joints in accordance with the joining requirements specified in the guide specifications for installation of pipe given in AWWA M9, Chapter 14, "Guide Specifications for Installation of Pipe," and with the recommendations given for laying the pipe in AWWA M9, Chapter 6, "Installation by Trenching or Tunneling -- Methods and Equipment."

3.2.3.3.2 Pipe Anchorage

Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 13.80 MPa 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.2.3.4 Installation of Ductile Iron Gravity Sewer Pipe

Unless otherwise specified, install pipe and associated fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of AWWA C600 for pipe installation and joint assembly.

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NOTE: At the text below, delete requirements for and references to push-on joints for ductile-iron gravity sewer pipe and associated fittings when the greater deflection afforded by the mechanical joint is considered necessary throughout.

****

a. [Make push-on joints with the gaskets and lubricant specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.] Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.

****

NOTE: At the text below, delete the paragraph except when required. See AWWA C105/A21.5 for guidance on selecting Class of polyethylene film.

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b. Exterior protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet in accordance with AWWA C105/A21.5, using [Class A] [Class C] polyethylene film.

3.2.3.5 Installation of Ductile-Iron Pressure Lines

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of AWWA C600 for pipe installation, joint assembly, and valve-and-fitting installation.

a. [Make push-on joints with the gaskets and lubricant specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.] Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11. [Make flanged joints with gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight, taking care to avoid undue strain on flanges, fittings, and other accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fittings have dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions.] [Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer, as approved.] [Make [grooved] [and] [shouldered] type joints with the couplings previously specified for this type joint connecting pipe with the [grooved] [or] [shouldered] ends specified for this type joint and assemble in accordance with the recommendations of the coupling manufacturer, as approved. [Groove pipe in the field only with approved groove cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings; secure approval for field-cut grooves before assembling the joint.]]

****

NOTE: Delete the text below except when required. See Foreword to AWWA C105/A21.5 for guidance on selecting Class of polyethylene film.

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b. Exterior protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet in accordance with AWWA C105/A21.5, using [Class A] [Class C] polyethylene film.

c. Pipe anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 13.80 MPa 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.2.3.6 Installation of PVC Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.3.7 Installation of PVC Pressure Pipe

Unless otherwise specified, install pipe and fittings in accordance with AWWA C605. AWWA C605 includes requirements such as excavation, installation, and placement of apputenances.

3.2.3.7.1 Pipe Less Than 100 mm 4 Inch Diameter

3.2.3.7.1.1 Threaded Joints

Make by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. Tighten the joints with strap wrenches which will not damage the pipe and fittings. Tighten the joint no more than 2 threads past hand-tight.

3.2.3.7.1.2 Push-On Joints

Bevel the ends of pipe for push-on joints to facilitate assembly. Mark pipe to indicate when the pipe is fully seated. Lubricate the gasket to prevent displacement. Exercise care to ensure that the gasket remains in proper position in the bell or coupling while making the joint.

3.2.3.7.1.3 Solvent-Weld Joints

Comply with the manufacturer's instructions.

3.2.3.7.2 Pipe 100 mm 4 inch Diameter And Larger

Make push-on joints with AWWA C900 pipe with intrgral elastomeric gasket . For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel. For push-on joint connections to fittings, use cut spigot end of pipe off square, marked to match the manufacturer's insertion line and beveled to match factory supplied bevel. . Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605. Assemble push-on joints for connection to fittings in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make mechanical-joints or flanged jointswith the gaskets, glands, bolts, nuts, and internal stiffeners specified for this type joint and assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories or with the applicable requirements of AWWA C600 for ductile iron joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for mechanical-joint or flanged jointconnections and do not bevel.

3.2.3.7.3   Pipe Anchorage

Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 13.80 MPa 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.2.3.8   Installation of Dual Wall and Triple Wall Polypropylene

Install pipe in accordance with "General Requirements for installation of Pipelines" of this section, with the polypropylene pipe manufacturer's recommendations, and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Place a minimum of 150 mm 6 inches of Class 1 or Class 2 backfill over the crown of the pipe with minimum 90 percent compaction.

3.2.3.9   Pipeline Installation Beneath Railroad Right-of-Way

Where pipeline passes under the right-of-way of a commercial railroad, install piping in accordance with the specifications for pipelines conveying nonflammable substances in AREMA Eng Man.

3.2.4   Concrete Work

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NOTE: Delete this paragraphs if cast-in-place concrete is not used.

Select 03 30 00 for projects with large amounts of cast-in-place concrete work.

Select 03 30 53 for projects with small amounts of cast-in-place concrete work.

For Army, Use 03 30 00.

****

Cast-in-place concrete is included in Section [03 30 00 CAST-IN-PLACE CONCRETE][03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE]. Support the pipe on a concrete cradle, or encased in concrete where indicated or directed.

3.2.5   Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Perform cast-in-place concrete work in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

3.2.6 Miscellaneous Construction and Installation

3.2.6.1 Connecting to Existing Manholes

Connect pipe to existing manholes such that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. Center the connection on the manhole. Holes for the new pipe are be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cut the manhole in a manner that will cause the least damage to the walls.

3.2.6.2 Metal Work

3.2.6.2.1 Workmanship and Finish

Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

3.2.6.2.2 Field Painting

After installation, clean cast-iron frames, covers, gratings, and steps not buried in concrete to bare metal, remove mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

3.2.7 Sewage Absorption Trench Construction

Grade trenches uniformly with no slope. [Lay perforated pipe with the perforations downward.] [Comply with the chamber manufacturer's instructions.]

3.2.8 Installations of Wye Branches

Install wye branches in an existing sewer using a method which does not damage the integrity of the existing sewer. Do not cutinto piping for connections except when approved by the Contracting Officer. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, support on a concrete cradle as directed by the Contracting Officer. Provide and install concrete required because of conditions resulting from faulty construction methods or negligence without any additional cost to the Government. Do not damage the existing sewer when installing wye branches in an existing sewer.

3.3 FIELD QUALITY CONTROL

The Contracting Officer will conduct field inspections and witness field tests specified in this section. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

[3.3.1 Tests

****

NOTE: Select the tests that are applicable to the work being performed and the desired testing standard. Delete the testing paragraphs that are not required or not applicable to the type of work being performed.

****

Perform field tests and provide labor, equipment, and incidentals required for testing[, except that water and electric power needed for field tests will be furnished as set forth in Section [_____]].

3.3.1.1 Hydrostatic Sewer Test

****

NOTE: This paragraph is for conflicts between the sanitary sewer line and waterline when unusual conditions are encountered.

Refer to state standard for minimum test pressure or if state standards are not applicable use a minimum test pressure of 200 kPa 30 psi.

****

When unusual conflicts are encountered between sanitary sewer and waterlines a hydrostatic pressure sewer test will be performed in accordance with the applicable AWWA standard for the piping material or AWWA C600[with a minimum test pressure of [_____]].

3.3.1.2 Leakage Tests for Nonpressure Lines

Test lines for leakage by either [infiltration tests and exfiltration tests,] [negative air pressure tests] [or by low-pressure air tests]. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

3.3.1.2.1 Infiltration Tests and Exfiltration Tests

[3.3.1.2.1.1 Precast Concrete Pipe Sewer Lines

Test leakage of precast concrete pipe in accordance with ASTM C969M ASTM C969. The allowable leakage limit is located in ASTM C969M ASTM C969. Make calculations in accordance with the Appendix to ASTM C969M ASTM C969.

][3.3.1.2.2 Negative Air Pressure Test

[3.3.1.2.2.1 Concrete Pipe

****

NOTE: This test method covers testing of 4 to 36-in. diameter circular concrete pipe sewerlines utilizing gasketed joints.

****

Test concrete pipe test in accordance with ASTM C1214M ASTM C1214. The allowable vacuum loss is located in ASTM C1214M ASTM C1214 Make calculations in accordance with the Appendix to ASTM C1214M ASTM C1214.

][3.3.1.2.2.2 Precast Concrete Manholes

****

NOTE: This test method is used for testing concrete manhole sections utilizing mortar, mastic, or gasketed joints.

This test method is intended to be used as a preliminary test to enable the installer to demonstrate the condition of the concrete manholes prior to backfill.

Misuse of the test criteria in ASTM C1244 or ASTM C1244M may cause permanent damage to the system being tested.

****

Test precast concrete sewer manhole test in accordance with ASTM C1244M ASTM C1244. The allowable vacuum drop is located in ASTM C1244M ASTM C1244 Make calculations in accordance with the Appendix to ASTM C1244M ASTM C1244.

]]3.3.1.2.3 Low-Pressure Air Tests

3.3.1.2.3.1 Clay Pipelines

Test clay pipe in accordance with ASTM C828. The allowable pressure drop is located in ASTM C828. Make calculations in accordance with the Appendix to ASTM C828.

3.3.1.2.3.2 PVC Pipelines

Test PVC pipe in accordance with UBPPA UNI-B-6. The allowable pressure drop is located in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

3.3.1.2.3.3 Dual Wall and Triple Wall Polypropylene

Test polypropylene pipe in accordance with ASTM F1417 or UBPPA UNI-B-6. The allowable pressure drop is located in ASTM F1417 or UBPPA UNI-B-6 depending on the chosen test procedure. Make calculations in accordance with the Appendix to ASTM F1417 or UBPPA UNI-B-6 depending on the chosen test procedure.

[3.3.1.3 Tests for Pressure Lines

Test pressure lines in accordance with the applicable standard specified in this paragraph[, except for test pressures. For hydrostatic pressure test, use a hydrostatic pressure 345 kPa 50 psi in excess of the maximum working pressure of the system, but not less than 690 kPa 100 psi, holding the pressure for a period of not less than one hour. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system]. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

[3.3.1.3.1 Ductile-Iron Pressure Pipe

Test ductile-iron pressure pipe in accordance with the requirements of AWWA C600 for hydrostatic testing. Leakage on ductile-iron pipelines with mechanical-joints [or push-on joints] are not to exceed the amounts given in AWWA C600[; no leakage will be allowed at joints made by any other methods].

][3.3.1.3.2 Concrete Pressure Pipe

Test concrete pressure pipes in accordance with the recommendations in AWWA M9. The leakage rate is dependent upon the type of concrete pressure used and the diameter of the pipe. The allowable leakage rate is indicated in AWWA M9, chapter titled, "Hydrostatic Testing and Disinfection of Mains".

][3.3.1.3.3 PVC Pressure Pipe

Test PVC pressure pipe in accordance with the requirements of AWWA C605 for hydrostatic and leakage tests. The quantity of water that must be supplied during testing is not to exceed the quantity of water calculated in accordance with AWWA C605 to maintain the specified test pressure within 34 kPa5 psi.

]]3.3.1.4 Deflection Testing

****

NOTE: Specify deflection testing only when warranted by scope or size of project.

****

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D2412. Deflection of pipe in the installed pipeline under external loads is not to exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

3.3.1.4.1   Pull-Through Device

This device is to be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Space circular sections on the shaft so that the distance from external faces of front and back sections will equal or exceed the diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections are to conform to the following:

a. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

b. Homogeneous material throughout, is to have a density greater than 1.0 as related to water at 4 degrees C 39.2 degrees F, and a surface Brinell hardness of not less than 150.

c. Center bored and through-bolted with a 6 mm 1/4 inch minimum diameter steel shaft having a yield strength of not less than 483 MPa 70,000 psi, with eyes or loops at each end for attaching pulling cables.

d. Suitably Back each eye or loop with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

3.3.1.4.2   Deflection Measuring Device

Sensitive to 1.0 percent of the diameter of the pipe being tested and be accurate to 1.0 percent of the indicated dimension. Prior approval is required for the deflection measuring device.

3.3.1.4.3   Pull-Through Device Procedure

Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.

3.3.1.4.4   Deflection measuring device procedure

Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.

[3.3.1.5   Dye Test

Perform a dye test from the projects sanitary sewer point of connection to the first downstream manhole on the next active sanitary sewer branch main. Use nontoxic non-staining sewer tracing dye. Test results are to be noted in the daily Construction Quality Control (CQC) Report as required in 01 45 00 Quality Control.

a. Continue testing until it can be visually confirmed by way of the dye that the sewer connection is appropriate or until deficiencies are discovered.

b. During the test, monitor the storm drainage system downstream from the project, either manholes or outfalls, for any sign of cross-connection.

][3.3.1.6 Smoke Test

Perform a smoke test on the relevant portion of the sewer system. Test results are to be noted in the daily Construction Quality Control (CQC) as required in 01 45 00 Quality Control.

a. Continue testing until it can be visually confirmed that the projects sanitary sewer point of connection has not been cross-connected to the storm drainage system.

b. During the test, monitor the storm drainage system, either manholes or outfalls, for any sign of cross-connection.

]][3.3.2 Field Tests for Cast-In-Place Concrete

****

NOTE: Delete this paragraphs if cast-in-place concrete is not used.

Select 03 30 00 for projects with large amounts of cast-in-place concrete work.

Select 03 30 53 for projects with small amounts of cast-in-place concrete work.

For Army, Use 03 30 00.

****

Field testing requirements are covered in Section [03 30 00 CAST-IN-PLACE CONCRETE][03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE]

][3.3.3 Inspection

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; the light must show a practically full circle of light through the pipeline when viewed from the adjoining end of line.

3.3.3.1 Pre-Installation Inspection

Prior to connecting the new service, perform pre-installation inspection after trenching and layout is complete. Submit pre-installation inspection request for field support at least [14] [_____] days in advance. The Installation's Utilities Field Support personnel will perform the pre-installation inspection.

3.3.3.2 Post-Installation Inspection

****

NOTE: For Navy, contact Installation staff to determine if dye testing or smoke testing is required by either state,local,or Navy requirements at the specific project location.

****

Perform a post-installation inspection after connection has been made and before the connection is buried. Submit post-installation inspection request for field support at least [14] [_____] days in advance. The Installation's Utilities Field Support personnel will perform the post-connection inspection.[During the post-installation inspection the Contractor will be responsible for performing a [dye test] [smoke test].]

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 31 23.00 10 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 34 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SANITARY SEWER FORCE MAIN PIPING

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USACE / NAVFAC / AFCEC **UFGS-33 31 23.00 10 (August 2018)**

Preparing Activity: USACE **Superseding**
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SECTION 33 31 23.00 10

SANITARY SEWER FORCE MAIN PIPING
08/18

****

NOTE: This guide specification covers the requirements for force mains and inverted siphons for sewage systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: See UFC 3-240-01 for additional design information on force mains and inverted siphons.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C105/A21.5	(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel

	and Tape - Hot-Applied
AWWA C207	(2023) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C208	(2022) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C210	(2024) Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C300	(2022) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C301	(2014; R 2019) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C303	(2024) Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C900	(2022) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA C909	(2022) Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. (100 mm) and Larger

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2122	(2016) Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2774	(2021a) Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3035	(2022) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3754	(2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
ASTM D4161	(2014; R 2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F1483	(2023) Standard Specification for Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA TRD	(2016) Thrust Restraint Design for Ductile Iron Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Disposal of Waste Water

Final Test Report

1.3 DELIVERY, STORAGE, AND HANDLING

Do not damage pipe, fittings and accessories, and pipe coatings during delivery, handling, and storage.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

****

NOTE: No type of pipe specified in this section will be deleted except:

a. As described throughout these notes.

b. Upon specific approval of HQUSACE (CEMP-ET).

c. As stipulated in specific directives.

d. When a certain type is required by a railroad company for piping passing under its right-of-way.

Generally, force mains less than 100 mm 4 inches in diameter will not be recommended; however, circumstances may require smaller force mains; in those cases, cutter pumps or other shredding devices will be required.

Class 150 pipe will normally be specified for force mains and inverted siphons except where local conditions require a higher class. Class 150 pipe is furnished with wall thickness suitable for laying with a standard design depth of cover, using a flat-bottom trench without blocks and with compacted backfill. For other conditions, the class or pressure, and loading will be specified accordingly. Cast-iron fittings can be used with most of the pipe materials specified. Flanged joints will not be used for buried installation because a flanged joint requires special construction considerations when buried.

****

Provide piping in locations and sizes as specified in the following table. Also conform to the respective specifications and other requirements specified below

Location	Piping Size Range	Piping Material
Force Mains	Less than 100 mm 4 inches in diameter	Galvanized Steel, Polyvinyl Chloride (PVC) Plastic, Polyethylene (PE) Plastic or Polypropylene Plastic
Inside Pump Stations	Less than 100 mm 4 inches	Galvanized Steel

Location	Piping Size Range	Piping Material
[Force Mains][and][Inverted Siphons]	100 mm 4 inches in diameter and larger	Ductile Iron, Steel, Concrete Pressure Pipe, PVC Plastic, Oriented PVC PE Plastic, or Reinforced Thermosetting Resin Pipe (RTRP)
[Force Mains][and][Inverted Siphons]	200 mm 8 inches in diameter and larger	May be Reinforced Plastic Mortar Pressure (RPMP)
Inside Pump Stations	100 mm 4 inches in diameter and larger	Ductile Iron Pipe with Bolted Flange Joints

2.1.1 Concrete Pressure Pipe

****

NOTE: Use reinforced and prestressed concrete pipe for water supply distribution lines. AWWA Standards do not include sizes less than 254 mm 10 inches in diameter. Applicable size ranges for publications referenced in this paragraph are as follows:

Publications	**mm Inches**
AWWA C303 (Reinforced)	**250 - 1050 10 - 42**
AWWA C300 (Reinforced)	**600 - 3600 24 - 144**
AWWA C301 (Prestressed)	**400 - 3600 16 - 144**

In localities where 150 and 200 mm 6-and 8-inch pipe conforming to AWWA C303 is available, the following will be included in the contract specification as appropriate. In addition to the data in TABLE 1 of AWWA C303, the following will be applicable:

Nominal inside diameter of pipe	**150 mm6 inches**	**200 mm8 inches**
Nominal lining thickness	**6 mm1/4 inch**	**6 mm1/4 inch**
Nominal coating thickness	**25 mm1 inch**	**25 mm1 inch**
Class 150		
Total steel area per mm foot	**1990 square mm 0.94 square inch**	**1990 square mm 0.94 square inch**
Gauge cylinder number	**16**	**16**

****

Provide concrete pressure pipe and fittings that conform to [AWWA C300,][AWWA C301,][or][AWWA C303,]as applicable for the service requirements, with rubber gasket joints of the type using steel bell and spigot joint rings.

2.1.2 Plastic Pipe

2.1.2.1 PE Pipe

ASTM D3350 and ASTM D3035, minimum pressure rating of 689 kPa 100 psi at 23 degrees C 73.4 degrees F.

2.1.2.2 Polypropylene Pipe

ASTM D2122 and ASTM D4101.

2.1.2.3 PVC Pressure Pipe

****

NOTE: ASTM D1785 will be used for threaded joints. The SDR (Pressure rating) system and PC (Pressure class) system are not directly related. Reference should be made to the pertinent standards for clarification. Pressure rated plastic pipe should be derated because water hammer and surges are not included in the design. It is suggested that the operating pressure not exceed 2/3 of the rated working pressure. Pressure class plastic pipe, meeting AWWA C900 standards, will not require a derating for instantaneous velocity change not exceeding 0.61 meters per second 2 fps and for temperature range not exceeding 23 degrees C 72 degrees F.

****

a. PVC Pressure Pipe and Fittings Less Than 100 mm 4 inches Diameter: ASTM D1785, Schedule [40][80][120], or ASTM D2241, SDR [21][26][32.5], with screw joints, push-on joints, or solvent weld joints.

b. PVC Pressure Pipe and Fittings 100 mm 4 inches Diameter and Larger: ASTM D2241, SDR [21][26][32.5], or AWWA C900, Class [100][150][200], with push-on joints.

2.1.2.4 Oriented Polyvinyl Chloride (PVCO) Plastic Pipe

Provide pipe, couplings, and fittings manufactured of material conforming to ASTM D1784, Class 12454-B. Provide pipe conforming to AWWA C909, Class 150, and to ASTM F1483 with an outside diameter equal to cast iron outside diameter.

2.1.3 RPMP Pipe

Provide RPMP in accordance with ASTM D3754 produced by centrifugal casting and with an outside diameter equal to ductile iron pipe dimensions from 450 mm 18 inch to 1200 mm 48 inch. Provide a smooth uniform continuous resin-rich surface liner coating the entire inner surface of the pipe. Ensure the minimum pipe stiffness provided is 248 kPa 36 psi.

2.1.4 RTRP Lines

ASTM D2996, 2413 kPa 350 psi rated, cast iron pipe dimensions only, with elastomeric gasket joints. Fittings: AWWA C110/A21.10, rated 1034 kPa 150 psi. Use inside sleeves provided by the manufacturer when mechanical joint fittings are used.

2.1.5 Ductile Iron Pipe

****

NOTE: The use of cast-iron fittings and specials with ductile iron pipe is generally acceptable. However, when required by unusually severe loading conditions, ductile iron fittings and specials conforming to AWWA C110/A21.10 will be specified.

****

2.1.5.1 Ductile Iron Pipe

AWWA C151/A21.51, working pressure not less than 1034 kPa 150 psi, unless otherwise shown or specified.

2.1.5.2 River Crossing Pipe

AWWA C151/A21.51, minimum thickness Class 54 with joints in compliance with applicable requirements of AWWA C110/A21.10.

2.1.5.3 Fittings, Mechanical

AWWA C110/A21.10, rated for 1034 kPa 150 psi.

2.1.5.4 Fittings, Push-On

AWWA C110/A21.10 and AWWA C111/A21.11, rated for 1034 kPa 150 psi.

2.1.6 Steel Pipe

2.1.6.1 Steel Pipe, 150 mm 6 inches Diameter and Larger

AWWA C200.

2.1.6.2 Steel Pipe Less Than 150 mm 6 inches Diameter

ASTM A53/A53M, standard weight, threaded end, galvanized.

2.1.6.3 Fittings, 150 mm 6 inches Diameter and Larger

AWWA C200, fabricated in compliance with AWWA C208.

2.1.6.4 Fittings Less Than 150 mm 6 inches Diameter

ASME B16.3, galvanized.

2.2 JOINTS

2.2.1 PE Piping

2.2.1.1 Heat Fusion Joints

ASTM D2657.

2.2.1.2 Flanged Joints

ASME B16.1 or AWWA C207.

2.2.1.3 Mechanical Joints

ASME B16.1.

2.2.2 Polypropylene Piping

Heat Fusion Joints: ASTM D2657.

2.2.3 PVC Piping

Provide centering rings or stops to ensure couplings used with plain end pipe are centered on the joint.

2.2.3.1 Screw Joint Fittings

ASTM D2464, Schedule 80

2.2.3.2 Push-On Joint Fittings

ASTM D3139, with ASTM F477gaskets

2.2.3.3 Solvent Cement

ASTM D2564

2.2.4 PVCO Pipe

Provide joints conforming to ASTM D3139 and elastomeric gaskets conforming to ASTM F477.

2.2.5 Ductile Iron Piping

2.2.5.1 Push-on Joints

AWWA C111/A21.11.

2.2.5.2 Mechanical Joints

AWWA C111/A21.11 as modified by AWWA C151/A21.51.

2.2.5.3 Flanged Joints

AWWA C115/A21.15.

2.2.6 Steel Piping

2.2.6.1 Push-on Joints

AWWA C200.

2.2.6.2 Mechanical Joints

AWWA C200.

2.2.6.3 Flanged Joints

AWWA C207.

2.2.7 RPMP Piping

Provide bell and spigot gasket coupling joints utilizing an elastomeric gasket in accordance with ASTM D4161 and ASTM F477.

2.3 VALVES

2.3.1 Gate Valves

Provide gate valves 80 mm 3 inches and larger in compliance with AWWA C500. Provide non-rising stem (NRS) valves for buried service, 50 mm 2 inch square nut operated with joints applicable to the pipe or installation. Furnish buried valves with extension stems comprising socket, extension stem and operating nut, and of an appropriate length to bring operating nut to within 150 mm 6 inches of grade. Provide one 1200 mm 4 foot "T" handle valve wrench for each quantity of 6 buried valves. Provide outside screw and yoke (OS&Y), handwheel operated with flange ends for gate valves that are exposed or installed inside unless otherwise indicated. Cast an arrow and the word "OPEN" on all gate valve operating nuts and handwheels in raised letters to indicate the direction of opening. Equip gate valves 350 mm 14 inches and larger with gearing to reduce operating effort. Equip gate valves 350 mm 14 inches and larger, installed in horizontal lines in horizontal position with stems horizontal, with bronze track, roller and scrapers to support the weight of the gate for its full length of travel. Fit gate valves 350 mm 14 inches and larger installed in vertical pipe lines with stems horizontal with slides to assist the travel of the gate assembly.

2.3.2 Check Valves

****

NOTE: When the design requires the use of check valves with outside balance levers, an appropriate descriptive statement will be added. Several types of swing check valves are available for several different job requirements and the manufacturer should be consulted for specific job applications. These valves include horizontal, lever and weight, lever and spring, air cushion, oil hydraulic, etc. The operating pressure and force main velocity will determine the type of swing check valve needed.

****

Provide iron-bodied check valves that permit free flow of sewage forward and provide a positive check against backflow. Design check valves for a minimum working pressure of 1034 kPa 150 psi or as indicated. Directly cast the manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow on the body.

2.3.2.1 Ball Check Valves

Provide iron-bodied ball check valves, with flanged ends, that are of the non-slam type. Provide Class 125 125 pound type flanges complying with ASME B16.1 with stainless steel ball unless otherwise specified.

2.3.2.2 Swing Check Valves

Comply with AWWA C508. Provide with iron body, bronze mounted, and flanged ends. Provide Class 125 125 pound type flanges, complying with ASME B16.1.

2.3.3 Plug Valves

Provide cast iron valves complying with MSS SP-78 or steel plug valves in compliance with API Spec 6D.

2.3.4 Pinch Valves

Provide double acting, jam-proof type pinch valves with unobstructed streamlined flows and built-in operator. Provide iron bodied valves with a non-rising handwheel. Provide a sleeve of pure gum rubber, neoprene, Buna N or hypalon as required for service. Provide a valve with flanged ends of Class 125125 pound type in compliances with ASME B16.1.

2.3.5 Air Release Valves

****

NOTE: When conditions indicate that vacuum conditions may exist in the line, the use of a sewage air and vacuum valve may be required. An appropriate paragraph will be added. Air vents will be specifically adapted for use with sewage.

****

Provide air release valves designed to permit release of air from an empty pipe during filling and capable of discharging accumulated air in the line while the line is in operation and under pressure. Attach valves by means of threaded pipe connections. Vent valves to the atmosphere.

2.3.5.1 Manual Air Release Valves

Consisting of an 80 mm 3 inch gate valve and 80 mm 3 inch ductile iron pipe and fittings. Install the valve with its line of flow in the horizontal position.

2.3.5.2 Automatic Air Release Valve

Compound lever type capable of withstanding operating pressures of 1034 kPa 150 psi, with a 13 mm 1/2 inch outlet. Provide with iron body and cover of the valve and a stainless steel float. Provide internal parts made entirely of stainless steel or bronze. Provide valve specifically adapted for use with sewage and complete with hose and blow-off valves to permit backflushing without dismantling the valve.

2.4 VALVE VAULTS

****

NOTE: Valve vaults will be required on all air vents installed on the buried force mains. Details will be shown on the drawings. When valve vaults are not required, this paragraph will be deleted.

****

Cast iron or concrete, except design concrete vaults installed in locations subject to vehicular traffic to withstand the following [_____] AASHTO load designation as outlined in AASHTO HB-17. Provide extension type cast iron vaults with slide type adjustment and flared base. Provide 5 mm 3/16 inch minimum metal. Ensure that the vault length is adaptable, without full extension, to the depth of cover over the pipe at the valve locations. Manufacture concrete vaults accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. Cast the word "SEWER" in the cover. [Provide secure latch/lock mechanism to prevent unauthorized entry or tampering with the components within.]

2.5 MISCELLANEOUS MATERIALS

Provide miscellaneous materials in compliance with the following requirements:

2.5.1 Pipe Coatings and Linings

****

NOTE: UFC 3-240-01 includes conditions requiring lining and coating of pipes. Protective materials for galvanized pipe less than 80 mm 3 inches in diameter will be required only where the pipe is within the zone of influence of adjacent buried cathodic protection systems.

****

a. Steel, interior: AWWA C203 or AWWA C210.

b. Steel, exterior, buried: AWWA C203.

c. Steel, exterior, exposed: AWWA C210.

2.5.2 Joint Lubricants

Provide joint lubricants as recommended by the pipe manufacturer.

2.5.3 Bolts, Nuts and Glands

AWWA C111/A21.11.

2.5.4 Joint Compound

A stiff mixture of graphite and oil or inert filler and oil.

2.5.5 Joint Tape

ASTM D3308.

2.5.6 Bond Wire

Bond wire type RHW or USE, Size 1/0 AWG, neoprene jacketed copper conductor shaped to stand clear of the joint.

PART 3 EXECUTION

3.1 INSTALLATION

Install pipe, pipe fittings, and appurtenances at the locations indicated. Perform excavation, trenching, and backfilling as specified in Section 31 00 00 EARTHWORK.

3.1.1 Cutting

Cut pipe in a neat manner with mechanical cutters. Use wheel cutters where practicable. Grind sharp and rough edges smooth and remove loose material from the pipe before laying.

3.1.2 Laying

Except where otherwise authorized, lay pipe with bells facing the direction of laying. Before lowering and while suspended, inspect the pipe for defects. Reject defective material. Lay pipe in compliance with the following:

Ductile Iron	AWWA C600
Steel	AWWA C600
Concrete	Manufacturer's instructions
Polyvinyl Chloride	Manufacturer's instructions
Polyethylene	ASTM D2774
Polypropylene	ASTM D2774
Reinforced Thermosetting Resin	Manufacturer's instructions
Reinforced Plastic Mortar	Manufacturer's instructions

3.1.3 Jointing

3.1.3.1 Concrete Pressure Pipe

Follow the manufacturer's instructions when lubricating and installing rubber gaskets. Provide joints that comply with the manufacturer's instructions. Fill the external annular space with cement mortar or with a portland cement-filled polyurethane loop. For pipe 600 mm 24 inch diameter and larger, fill the internal annular space with cement mortar and struck off to ensure a smooth and continuous surface between pipe sections. Pipe less than 600 mm 24 inch diameter must have a rope or trowelable mastic affixed to the concrete face of the bell socket before joining the sections of pipe. Ensure the mastic provided causes no problems with the rubber gasket and ensure the gasket fills the interior annular space when the pipe sections are pushed together.

3.1.3.2 Joints for PE Pipe

Provide heat fusion joints that comply with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time. Make flanged and mechanical joints in compliance with the manufacturer's instructions.

3.1.3.3 Joints for Polypropylene Pipe

Ensure heat fusion joints comply with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time.

3.1.3.4 Joints for PVC Pipe

a. Make threaded joints by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. Tighten the joint with strap wrenches taking care not to damage the pipe and fittings. Tighten the joint no more than 2 threads past hand-tight.

b. Bevel the ends of pipe for push-on joints to facilitate assembly. Mark pipe to indicate when the pipe is fully seated. Lubricate the gasket to prevent displacement. Ensure the gasket remains in proper position in the bell or coupling while the joint is made.

c. Ensure solvent-weld joints comply with the manufacturer's instructions.

3.1.3.5 Joints for RPMP Pipe

Use an elastomeric gasket in accordance with ASTM D4161.

3.1.3.6 Joints for RTRP Lines

Provide elastomeric gasket joints in compliance with the manufacturer's instructions.

3.1.3.7 Joints for Ductile Iron Pipe

Install mechanical and push-on type joints in compliance with AWWA C600 and the manufacturer's instructions. Install flanged joints in compliance with manufacturer's instructions.

3.1.3.8 Joints for Steel Pipe

Make screw joints tight with joint tape or joint compound applied with a brush to the male threads only. Install mechanical joints, push-on joints, and flanged joints in compliance with the manufacturer's instructions.

3.1.4 Coating and Lining

Field coat non-galvanized steel pipe in compliance with AWWA C203. Test the applied materials by means of a spark-type electrical device in compliance with AWWA C203. Repair flaws and holidays in the coating or lining of the pipe and the pipe joints; with the repaired areas at least equal in thickness to the minimum required for the pipe.

3.1.5 PE Pipe Encasement

****

NOTE: Loose polyethylene encasement is used in conjunction with ductile or cast iron pipe to protect the pipe from corrosive soils. Review AWWA 105 for design requirements and application.

****

[When installed underground, encase pipe with [_____] mm mil thick polyethylene in accordance with AWWA C105/A21.5.] [Encase in accordance with AWWA C105/A21.5.]

3.1.6 Installation of Valves

Prior to installation, clean valves of all foreign matter and inspect for damage and then fully open and close valves to ensure that all parts are properly operating. Install valves with the stem in the vertical position. [Install valves in valve vaults as indicated] [_____].

3.1.7 Installation of Valve Boxes

Install valve boxes over each outside gate valve, unless otherwise indicated. Center valve boxes over the valve. Carefully tamp fill around each valve box to a distance of 1.2 m 4 feet on all sides or to undisturbed trench face, if less than 1.2 m 4 feet.

3.1.8 Installation of Valve Vaults

Install valve vaults as indicated.

3.1.9 Drain Lines

Install drain lines where indicated. The drain line consists of a tee in the main line with a 100 mm 4 inch diameter branch, a 100 mm 4 inch diameter elbow, and a 100 mm 4 inch gate valve.

3.1.10 Thrust Restraint

[Provide thrust restraint as specified in Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.] [Provide plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, with thrust restraint.] Securely anchor valves or provide with thrust restraints to prevent movement. Install thrust restraints made from either thrust blocks or, for ductile-iron pipes, restrained joints.

3.1.10.1 Thrust Blocks

Provide concrete thrust blocking of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa 2000 psi after 28 days. Place blocking between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, place the base and thrust bearing sides of thrust blocks directly against undisturbed earth. Place the side of thrust blocks not subject to thrust against forms, if applicable. Provide the area of bearing as shown or as directed. Place blocking so that the fitting joints are accessible for repair. Use steel rods and clamps, protected by galvanizing or by coating with bituminous paint, to anchor vertical down bends into gravity thrust blocks.

3.1.10.2 Restrained Joints

****

NOTE: When the restrained length is specified by the designer, this paragraph will be modified to delete the design requirement. The Government's designer should use UFC 3-230-01 for guidance.

****

For ductile iron pipe, design restrained joints in accordance with DIPRA TRD.

3.1.11 Grout

Provide grout mix for exterior joint protection on concrete pipes of 1 part portland cement, 2 parts sand, and of sufficient liquid consistency to flow into the joint recess beneath the diaper. Provide grout mix for interior joint protection of 1 part portland cement and 1 part sand. Substitute a polyurethane foam loop, impregnated with portland cement, in lieu of grout for exterior joints, if directed.

3.1.12 Bonded Joints

****

NOTE: Bonded joints will be used to maintain electrical continuity in metallic pipelines where cathodic protection is provided during construction or where it is anticipated that cathodic protection will be provided in the future.

****

Where indicated, provide a thermally welded metallic bond at each joint, including joints made with flexible couplings or rubber gaskets, of ferrous-metallic piping to effect continuous conductivity.

3.2 FIELD QUALITY CONTROL

****

NOTE: Edit this paragraph to establish responsibility for tests.

****

Perform both a pressure test and a leakage test on all pipelines. [Obtain the Contracting Officer's approval of the method proposed for disposal of waste water from hydrostatic tests.] [The Contractor is responsible for all testing.] [Perform testing using an independent testing laboratory, subject to approval by the Contracting Officer.] [Contractor will coordinate all tests to ensure they are witnessed by the Contracting Officer.] Notify the Contracting Officer at least 7 days in advance of equipment tests. Submit the final test report to the Contracting Officer within 30 days after the test.

3.2.1 Pressure Test

After installing the pipe, joints, and thrust blocks, wait at least five days before pressure testing. For the pressure test, partially backfill the trench but leave the joints exposed for examination, then fill the pipe with water to expel all air. Subject the pipeline to a test pressure of 700 kPa 100 psi or 150 percent of the working pressure, whichever is greater, for a period of at least one hour. Open and close each valve several times during the test. Examine the exposed pipe, joints, fitting, and valves for leaks. Stop visible leaks or replace defective pipe, fittings, joints, or valves.

3.2.2 Leakage Test

****

NOTE: When the Contracting Officer determines that less stringent requirements would not have a detrimental impact on the environment, and would not violate Federal, state, or local requirements and would not contaminate any existing or potential water supply or habitable area, less stringent limits may be permitted. The maximum leakage permitted must not exceed 60 liters per 10 mm nominal diameter per kilometer 25 U.S. gallons per inch nominal diameter per mile of pipe per day, based on a pressure of 690 kPa 100 psi.

Allowable leakage at other test pressures will be the above limit multiplied by the product of the square root of the test pressure divided by 10. Inferior workmanship or defective material will not be accepted when less stringent requirements are allowed.

****

Conduct the leakage test subsequent to or concurrently with the pressure test. Place the amount of water permitted as leakage for the line in a sealed container attached to the supply side of the test pump. Apply no other source of supply to the pump or line under test. Pump the water into the line by the test pump as required to maintain the specified test pressure as described for a 2 hour period. The test will be considered a failure upon exhaustion of the supply or the inability to maintain the required pressure. PE pipe experiences diametric expansion and pressure elongation during initial testing. Consult the manufacturer prior to testing for special testing considerations. Determine allowable leakage by the following I-P formula:

$L = NDP/K$ Where:

L = Allowable leakage in gallons per hour.

N = Number of joints in length of pipeline tested.

D = Nominal diameter of the pipe in inches.

P = Square root of the test pressure in psig.

K = 7400 for pipe materials.

At the conclusion of the test, measure the amount of water remaining in the container and record the results in the test report.

[Test ductile iron pressure lines in accordance with the requirements of AWWA C600.]

[Test concrete pressure lines in accordance with the recommendations of

AWWA M9.]

[Test plastic pressure lines in accordance with the recommendations of AWWA C605.]

3.2.3 Retesting

If any deficiencies are revealed during any test, correct such deficiencies and repeat the tests until the results of the tests are within specified allowances, without additional cost to the Government.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 32 16 (November 2019)**
Change 1 - November 2023

Preparing Activity: AFCEC **Superseding**
UFGS 33 32 16 (August 2016)
UFGS 33 32 13.13 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 33 32 16

PACKAGED UTILITY WASTEWATER PUMPING STATIONS

11/19, CHG 1: 11/23

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 32 16 (November 2019)**
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SECTION 33 32 16

PACKAGED UTILITY WASTEWATER PUMPING STATIONS

11/19, CHG 1: 11/23

****

NOTE: This guide specification covers the requirements for Packaged Submersible Sewage Grinder Nonclog Pump Stations including alarm requirements, station piping, and O&M data packages.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C509	(2023) Resilient-Seated Gate Valves for Water Supply Service
AWWA C515	(2020) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C517	(2009) Resilent-Seated Cast-Iron Eccentric Plug Valves
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C605	(2021) Underground Installation of

	Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA M23	(2020) Manual: PVC Pipe - Design and Installation - Third Edition

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C443	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C443M	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C478M	(2018) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D883	(2020a) Standard Terminology Relating to Plastics
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for

	Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3753	(2019) Glass-Fiber-Reinforced Polyester Manholes and Wetwells
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 820	(2016) Standard for Fire Protection in Wastewater Treatment and Collection Facilities

UL SOLUTIONS (UL)

UL 67	(2018; Reprint Aug 2023) UL Standard for

Safety Panelboards

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force projects.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

Erection/Installation Drawings

SD-03 Product Data

Submersible Sewage Grindernonclog Pumps; G, [_____]

Pump Performance Curve; G, [_____]

Pump Motor; G, [_____]

Pump Control System; G, [_____]

Wet Well and Valve Vault; G, [_____]

Flexible Flanged Coupling; G, [_____]

Station Piping and fittings; G, [_____]

Valves; G, [_____]

Spare Parts Data; G, [_____]

Access Hatch Covers

SD-05 Design Data

Buoyancy Calculations; G, [_____]

SD-06 Test Reports

Pump Test[; G, [_____]]

[Pressure Sensor Test[; G, [_____]]

][Float Test[; G, [_____]]

] SD-07 Certificates

Submersible Sewage Grindernonclog Pumps; G, [_____]

Recycled Material Content[; G, [_____]]

Manhole Chamber[; G, [_____]]

Access Hatch Covers

Gate Valves[; G, [_____]]

Check Valves[; G, [_____]]

Blowers[; G, [_____]]

Dehumidifier[; G, [_____]]

Pump Motor[; G, [_____]]

SD-08 Manufacturer's Instructions

Manhole Chamber[; G, [_____]]

Access Hatch Covers

Pump Control System[; G, [_____]]

Gate Valves[; G, [_____]]

Check Valves[; G, [_____]]

Blowers[; G, [_____]]

Dehumidifier[; G, [_____]]

Pump Motor[; G, [_____]]

Special Tools[; G, [_____]]

Posted Instructions[; G, [_____]]

SD-10 Operation and Maintenance Data

Operation And Maintenance Manuals

SD-11 Closeout Submittals

Warranty[; G, [_____]]

1.3 QUALITY CONTROL

1.3.1 Installer Qualifications

Provide manufacturer's authorized pump representative who is trained and approved for installation of pumps and packaged pump station required for this project.

1.4 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials in enclosures or under protective covering. Store rubber gaskets which are not to be installed immediately under cover, out of direct sunlight. Do not store materials directly on the ground. Keep interior of pipes, valves and fittings free of dirt and debris.

1.4.2 Handling

Handle pipe, fittings, valves, and other accessories in such manner as to ensure delivery to the trench in sound, undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Carry pipe to the trench; do not drag it. Do not use any device or fitting inserted into (such as loader forks) or attached to (such as chain hooks) the bell or spigot ends of the pipe to transport pipe. Handle ductile iron pipe, fittings, and accessories in accordance with AWWA C600. Handle PVC pipe, fittings, and accessories in accordance with AWWA C605.

1.5 WARRANTY

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NOTE: Typical warranty of pumps, controls, wet well basin and accessories is for one year. Consider

extended warranty for pump stations utilized in critical mission facilities and for pump stations with flow rates greater than 300 gpm.
****

Provide manufacturer's standard warranty for a minimum of one year for package pump station including pumps, valves, controls, wet well basin and accessories.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a complete packaged sewage pump station with submersible grinder nonclog pumps including equipment and materials, installed and ready for operation. The pump supplier furnishes the controls, pumps and rail system to ensure unit integrity.

Submit fabrication drawings before installation. Submit drawings covering necessary or recommended changes to accommodate the equipment offered. Show on the drawings the design of the chamber, with dimensions, types, and thicknesses of materials, and elevation levels with reference to those elevations indicated.

Submit erection/installation drawings for the manhole chamber with the required equipment and accessories. Provide precast reinforced concrete manhole sections conforming to ASTM C478MASTM C478. Show the design of the chamber, with dimensions, types, and thicknesses of materials, and elevation levels with reference to those elevations indicated.

2.2 SUBMERSIBLE SEWAGE GRINDER NONCLOG PUMPS

Provide submersible sewage nonclog pumps with grinder units as indicated. Provide UL listed pumps for explosion proof Class 1, Division 1, Groups C and D hazardous locations. Provide submersible, centrifugal sewage pumps and grinder units capable of grinding the materials found in normal domestic sewage, including plastics, rubber, sanitary napkins, disposable diapers, animal hair and wooden articles into a finely ground slurry with particle dimensions no greater than [6][_____] mm [1/4][_____] inch of the nonclogging type with passageways designed to pass 75 mm 3 inch diameter spheres without clogging. Provide pump capacity, number of pumps and motor characteristics as indicated on the drawings. Select pumps to continuously operate in a submerged or partially submerged condition.

2.2.1 Pump Construction

2.2.1.1 Casing

Provide hard, close-grained cast iron casing or steel that is free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Provide casings permitting replacement of wearing parts. Ensure all joints are gasketed to prevent leakage. Ensure passageways permit smooth flow of sewage and are free of sharp turns and projections. Use free standing pump support legs of cast-iron providing enough clearance for the solids to get into the grinder.

2.2.1.2 Impeller

Provide a [stainless steel] [bronze] [_____] impeller for the grinder pump with stainless steel cutter, grinder, or slicer assembly. Provide nonclogging type cast-iron impeller, conforming to ASTM A48/A48M, Class 30, for a submersible nonclog pump. Ensure the impeller has a smooth surface and allows free flowing with the clearance to permit objects in the sewage to pass. Fit and key, spline, or thread impeller on shaft, and lock in such manner that lateral movement is prevented and reverse rotation will not cause loosening.

2.2.1.3 Bearings

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NOTE: Specify sealed bearings on motors. Properly installed sealed bearings with warranty for minimal maintenance requirements.

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Provide heavy duty ball thrust bearing or roller type bearing sized to withstand imposed loads. Oil lubricate bearings.

2.2.1.4 Lubrication

Provide [grease type lubrication with fittings for a grease gun and, if not easily accessible, with grease tubing extending to convenient locations.][the pump manufacturer's standard type grease fittings.] [self lubricating, permanently sealed bearings.]

2.2.1.5 Balance

Balance rotating parts of the equipment mechanically and hydraulically to operate throughout the required range without excessive end thrust, vibration, and noise. Conform allowable vibration limits with ISO 1940-1, Table 1. Existence of defects that cannot be eliminated by adjustment will be sufficient cause for rejection of the equipment.

2.3 PUMP MOTOR

Provide hermetically sealed electric motors with moisture and temperature-sensing probes in the wet well NEMA MG 1, [_____] RPM, [_____] volt, [_____] phase, and [_____] Hz cycle for submersible pumps. Motor horsepower must not be less than pump horsepower at any point on the pump performance curve. Fit motors with lifting "eyes" capable of supporting entire weight of pump and motor. Seal the power cable inside the motor end bell. Provide a waterproof power cable for its full length. Provide motors UL listed for explosion proof Class 1, Division 1, Groups C and D. Air filled motors are not acceptable. Ensure oil used may be disposed as non-hazardous waste.

2.4 PUMP CONTROL SYSTEM

2.4.1 General

Provide an automatic type pump operating control including all necessary components to function reliably. Mount controls in a NEMA [3R][_____] rated [stainless steel][_____] control panel. Ensure equipment subject to contact with sewage or sewage gases is corrosion-resistant metal. Provide an electronic controller that automatically activates and alternates the pump operation. If the liquid level continues to rise to the plans-specified level, the controller engages both pumps to operate simultaneously until both shut off at the specified low level. Provide hand-off-auto switches to choose the mode of operation for each pump. Provide controls with a 12 VDC powered float switch connected to the alarm contact of the battery charger to activate high-level alarms.

Protect pumping stations from lightning and transient voltage surges and equip with phase protection.

Provide the station with a three-wire, 4-pole (grounding) receptacle for a portable generator in case there is an external power outage.

Design the control system to operate pumps at the power characteristics as shown on the plans. Ensure all controls and wiring meet or exceed the requirements of NFPA 70.

For pumps specified as explosion proof, have pump power and control installation meets NEC requirements for Class 1, Division 1, Group D Hazardous Location, including intrinsically safe controls. Provide components that are UL listed or FM approved.

Require the control function to provide for the operation of the pumps under normal conditions and alternates the pumps on each pump down cycle.

In the event the incoming flow exceeds the pumping capacity of the lead pump, the offline pumps automatically start to handle the increased flow. As the flow decreases, the pumps cut off at the elevations set on the controller.

2.4.2 Enclosure

Provide a NEMA 3R rated enclosure manufactured from stainless steel. [The enclosure is a wall mount type suitable for mounting on strut or channel with a minimum depth sized to adequately house all the components.]Provide a rubber composition door gasket and assures a positive weatherproof seal. Provide a door that opens a minimum of 180 degrees and is equipped with a 3-point latch and padlockable handle.

Provide a dead front mounted in the panel to provide protection of personnel from live internal wiring. Install cutouts for breaker handles to allow operation of breakers without entering the compartment.

Mount all control switches, indicator pilot lights, elapsed time meters, duplex receptacle and other operational devices on the external surface of the dead front.

Ensure the dead front opens a minimum of 150 degrees to allow access to equipment for maintenance.

[Manufacture the back plate from 2.78 mm 12-gauge (minimum) steel and finished with a primer coat and two (2) coats of baked on white enamel.]Mount all hardware to the subpanel with machine thread tapped holes. Sheet metal screws are not acceptable. Permanently identify all devices to match the schematic diagram.

Provide an enclosure ventilator located near the top of the enclosure on the opposite side of the generator receptacle. Provide a rain and vermin proof ventilator and made of fire retardant thermoplastic material.

2.4.3 Level Control System

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NOTE: Select either the mercury-free float switch or the submersible pressure level sensor level control system.

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NOTE: Closed Float Switches:
Float switches that are configured to stay closed until liquid flips open the circuit, are referred to as a, "normally closed float switch." Once liquid reaches a certain level it then forces the circuit open and activates the next step, which could be a power shut off, or alarm sound off. As water levels rise in the tank, the float is lifted too and the circuits open. Common uses for a closed float switch would be to measure water, stop overfills and when avoiding high water levels is desired.

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NOTE: Open Float Switches:
When a float switch circuit is open, it is referred to as a, "normally open float switch" and is set to close when liquids reach a certain level. In the standard position when dry, this switch is above the liquid line and not floating. A common use for an open float switch would be in sump pumps, lift station pumps, and general pumping applications to signal a high level of liquid present and help operators to control the pumps.

****

[Provide a sealed, mercury-free float switch control system to sense variations of sewage level in the wet well.

Use a direct acting float switch consisting of a normally-open mercury switch enclosed in a float. Use float molded of rigid high-density polyurethane foam, color-coded and coated with a durable, water and corrosion-resistant jacket of clear urethane.

Provide stainless steel float brackets in accordance with manufacturer's recommendations.

Mount floats at fixed elevations as shown on the drawings.

Use floats designed to tilt and operate their switches causing sequential turn-on turn-off of the pump, when the liquid level being sensed rises or falls past the float.

Float switches must be intrinsically safe relays. Provide an intrinsically safe barrier relay between the wet well and the control panel.

][Provide the pump station with a submersible pressure type level sensor and an electronic pump controller. Sense levels by a 24 DVC, 1 percent submersible pressure transmitter provided by controller manufacturer.

Construct the system as follows:

a. The pressure type level sensor is a submersible type, suspended on its cable.

b. Install the sensor per manufacturer's instructions for wet well installations, including any recommended mounting accessories.

c. The level sensor is as follows:

    (1) Select the sensor range based on the wet well depth.

    (2) The sensor output is 4-20mA proportional to water level, 2-wire type.

    (3) Construct all exposed parts of [316 Stainless Steel][_____].

    (4) Fill the sensor with Silicon Oil.

    (5) Power the Sensor by 24 VDC output from electronic pump controller.

d. Mount the electronic pump controller in the starter panel enclosure, and be visible from the front of the swing-out panel, with the enclosure door opened. The electronic pump controller is as follows:

    (1) Accept a 4-20 mA, 2 wire level signal, and indicate the wet well level digitally in direct engineering units (meters) (feet).

    (2) Provide pump control outputs, with independent adjustment for each pump starting and stopping setpoint. Indicate each level setpoint digitally in direct engineering units.

    (3) Power to the unit is 120 VAC.

    (4) Equip controller with hand/off/auto (H.O.A.) switches and pump on indicating lights (one each per pump).

] Provide an intrinsically safe barrier relay between the wet well and the control panel.

2.4.4 Alternator

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NOTE: For the lag pump, incorporate time delay function and devices in the alternator controls such that both sewage pumps cannot be started simultaneously for an adjustable period of 10 to 120 seconds after shutdown.

****

Provide an alternator control switch to operate in connection with each float. Use an alternator control switch to alternate the operation of the pumps and operate both pumps if the water level rises above the second high water level. Incorporate time delay function and devices in the alternator controls such that both sewage pumps cannot be started simultaneously for an adjustable period of 10 to 120 seconds after shutdown. Use the delay function designed to operate in any condition of start-up in either normal or emergency operational mode.

2.4.5 Sewage Pump Alarm and Control Panel

Enclose alarm panel in NEMA [4X] [3R] enclosure and with a flashing red light that is visible from 15 m 50 feet away, with long life bulb in guarded enclosure and 150 mm 6 inch diameter horn. Use horns capable of emitting 120 DB at 3 meters 10 feet. Power alarm horn and light from 12V DC power supply with battery backup. Provide a rechargeable battery rated to power both the horn and light for a minimum of two hours upon loss of main power. Provide circuitry to automatically recharge the battery after main power is restored. Use batteries capable of being fully recharged in no more than 20 hours. Use panel with power on light, push to test button for horn and light and push to silence button for horn and light with automatic reset for next alarm.

2.4.5.1 Alarms

Provide a test function ability for the alarm system. Provide alarms to activate under the following conditions:

a. High liquid level as sensed by the level control system.

b. Loss of main power.

c. No flow light as sensed by limit switch on the check valve or as sensed by current sensors.

d. Pump failure via temperature overload or motor heat sensor trip; provide motor high temperature light.

e. Seal failure with indication light.

****

NOTE: Remote Alarm Monitoring Systems vary widely. Insert telemetry information consistent with facility requirements.

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2.4.5.2 Circuit Breakers

a. Provide an individual circuit breaker for each pump.

b. Include a control circuit breaker and an alarm circuit breaker in the control panel.

c. Allow for two additional spare 115V single phase 20A circuit breakers for local pole lighting and future spare.

d. Provide circuit breakers in accordance with UL 489

e. Conform to UL 67 for circuit breaker mounting.

2.4.5.3 Motor Starter and Overload Protection

Provide an International Electrotechnical Commission (IEC) rated motor starter and thermal overload protection located in the control panel for each pump. Include undervoltage release, manual reset buttons and hand-automatic selector switches.

2.4.5.4 Power Lugs

a. Size the incoming power lugs for the proper voltage, amperage, and horsepower for each pump station.

b. Include grounding lugs for the incoming power. Provide a dedicated grounding lug in the control panel for each pump.

c. Size ground lug and rod according to local and base electrical codes and install by a licensed electrician.

d. Use UL listed power lugs.

e. Conform to UL 67 for required power lug mounting.

2.4.5.5 Anti-Condensation Heater

a. Provide an anti-condensation heater in the control panel that is sized based upon the size of the particular pump station's control panel size.

b. Power the heater from the control voltage transformer for three phase pump motor units and from the incoming power for single phase pump motor units.

c. Control the heater by a thermostat, coming on at 16 degree C 50 degree F and going off at 18 degree C 65 degree F.

d. Clearly label panel directory for breakers.

2.4.5.6 Trouble Light

Provide a fluorescent trouble shooting light in the panel that is hard-wired into an appropriately sized circuit breaker. It is acceptable for the light and one of the convenience outlets to share the same circuit breaker.

2.4.5.7 Convenience Outlets

a. Place two duplex convenience outlets in the control panel; utilize one for the battery charger. The battery receives power from the control voltage transformer via the alarm fuse.

b. Upsize the alarm fuse to 1 to 1.5 amps for the battery charger.

c. Provide each outlet with its own 20 amp 115/1/60 circuit breaker.

[2.4.5.8 Connection for Portable Generator

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NOTE: Delete this paragraph if a permanent, onsite generator is provided for the pump station.

****

Provide receptacle for connection for portable generator. Provide manual transfer switch for receptacle matching generator electrical power requirements.

]2.4.5.9 Additional Requirements

a. Provide elapsed time meter for each pump that measures run time in hours to 9999.9.

b. Do not place junction boxes between pumps, control systems and control panels; provide conduit seals at all wet well penetrations. If this is unavoidable, use NEMA 7 construction.

2.4.6 Electrical Requirements

Install labels to identify switches and controls. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field installed equipment.

2.5 WET WELL AND VALVE VAULT

2.5.1 Wet Well and Valve Vault

Provide a fiberglass reinforced polyester resin basin with integral valve vault precast concrete wet well; include a separate precast concrete valve vault. Provide a wet well and valve vault with inside diameters [as indicated][of [_____] mm [_____] inch] and to the depths indicated on the drawings.[

Precast structures may be provided in lieu of cast-in-place structures.]

****

NOTE: Buoyancy calculations are required during design. Since design drawings typically only show one type of wet well, buoyancy calculations are required as a submittal to ensure submitted wet well basin incorporates manufacturer's recommended measures to prevent flotation.

****

2.5.1.1 Fiberglass Basins

a. Buoyancy Calculations: Submit buoyancy calculations sealed by a licensed professional engineer assuming seasonal high groundwater elevation at proposed finished grade. Prevent flotation in accordance with manufacturer's written instructions. Include manufacturer's written instructions with submitted calculations.

b. Select Fiberglass Reinforced Polyester (FRP) wet well in accordance with ASTM D883 relating to plastics and ASTM D3753.

    (1) Use commercial grade polyester resins evaluated as a laminate by test or determined by previous service to be acceptable for use in the wastewater environment.

    (2) Use a commercial grade continuous strand fiberglass reinforcement material.

    (3) Design FRP based on the following assumed conditions. Provide independent third party testing.

        (a) Hydrostatic pressure of 305 kilogram-force/square meter 62.4 pounds/square foot with water at ground surface.

(b) Saturated soil weight of 1,922 kilogram/cubic meter 120 pounds/cubic foot.

(c) Soil modulus of 3,418 kilogram-force/square meter 700 pounds/square foot.

(d) Pipe stiffness values as specified in ASTM D3753.

(e) Provide FRP laminate with a surface hardness of 90 percent Barcol.

2.5.1.2 Precast Concrete Structures

Submit manufacturer's data indicating percentage of recycled material content in packaged sewage lift stations to verify affirmative procurement compliance.

Fly ash is required as an admixture and is to conform to ASTM C618, Class [F][C]. Fly ash replacement of cement is not to exceed 20 percent (maximum one part fly ash to four parts cement) by weight.

****

NOTE: Ground granulated blast furnace slag and fly ash are materials listed in the EPA's Comprehensive Procurement Guidelines (CPG) (http://www.epa.gov/cpg/). If the Architect/Engineer determines that use of certain materials meeting the CPG content standards and guidelines would result in inadequate competition, do not meet quality/performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/Engineer may submit written justification and supporting documentation for not procuring designated items containing recovered material.

****

Ground granulated blast furnace slag [is required] [used] as an admixture [and] is to conform to ASTM C989/C989M, Grade [120] with between 25 to 50 percent maximum cement replacement by weight. Submit certificate to verify EPA-CPG compliance.

a. Buoyancy Calculations: Submit buoyancy calculations sealed by a licensed professional engineer assuming seasonal high groundwater elevation at proposed finished grade.

b. Construct precast concrete structures in accordance with ASTM C478M ASTM C478, except as specified herein. Provide precast concrete structures with a compressive strength of 30 MPa 4000 psi at 28 days and an air entrainment of 6 percent, plus or minus 2 percent, and a minimum wall thickness of 125 mm 5 inches. ASTM A615/A615M reinforcing bars. ASTM C443MASTM C443, Type B gaskets for joint connections. Use monolithic base and first riser.

2.5.2 Access Hatch Covers

Provide [aluminum][_____] access hatch covers as indicated. Include lifting mechanism, automatic hold open arm, slam lock with handle, and flush lift handle with vinyl grip. Use automatic hold open arm that locks in the 90 degree position. Use cover that is 6 mm 1/4 inch diamond plate with 6 mm 1/4 inch channel frame and continuous anchor flange. Use access hatch cover capable of withstanding a live load of 1500 kg/sq. meter 300 lb/sq. ft. Provide stainless steel cylinder lock with two keys per lock. Key all the locks the same.

2.5.3 Wet Well Base Material

Provide crushed stone as indicated and specified in Section 31 00 00 EARTHWORK.[Provide a polyethylene vapor barrier as indicated and specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.]

2.5.3.1 Ventilating Blower

Ensure blowers maintain air changes in accordance with[NFPA 820][every [5] [_____] minutes]. Mount a manual and automatic switch on the side of the entrance tube for operation of the blower. Provide vent to atmosphere with covers and screens to prevent the entrance of rain, insects, and rodents. Automatically actuate blower upon opening the entrance tube cover, unless overridden by the manual control.

2.5.3.2 Dehumidifier

Furnish and install a packaged dehumidifier in accordance with lift station manufacturer's recommendations. Include in controls a humidistat and low-temperature cutout/discharge condensate to the wet well.

2.6 STATION PIPING

Provide pressure piping, emergency pump connection, air release valves, and related accessories for force main piping outside the sewage wet well and valve vault in accordance with Section 33 30 00 SANITARY SEWERAGE.

2.6.1 Ductile-Iron Pressure Pipe and Associated Fittings

Conform to AWWA C151/A21.51, Pressure Class 350.

2.6.1.1 Flanged Pipe

Conform to AWWA C115/A21.15, ductile iron.

2.6.1.2 Fittings

AWWA C110/A21.10, flanged. Provide flanged joint fittings within wet well and valve vault as indicated. Provide mechanical joint fittings outside valve vault enclosure as indicated. Use fittings with pressure rating at least equivalent to that of the pipe.

2.6.1.3 Joints

AWWA C115/A21.15 for flanged joints. Use bolts, nuts, and gaskets for flanged connections recommended in the Appendix to AWWA C115/A21.15. Provide ductile iron flange for setscrewed flanges in accordance with ASTM A536, Grade 70-50-05 or 60-42-10, and meeting the applicable requirements of ASME B16.1, Class 125. Use 1310 MPa 190,000 psi tensile strength, heat treated, and zinc-coated steel setscrews for setscrewed flanges. Conform to the applicable requirements for mechanical-joint gaskets specified in AWWA C111/A21.11 for setscrewed flange gaskets. Use setscrewed gasket designed to provide for confinement and compression of gasket when joint to adjoining flange is made.

2.6.2 PVC Plastic Pressure Pipe and Associated Fittings

2.6.2.1 Pipe and Fittings Less Than 100 mm 4 inch Diameter

Use pipe, couplings and fittings manufactured of materials conforming to ASTM D1784, Class 12454-B.

a. Screw-Joint: Follow dimensional requirements of ASTM D1785 Schedule 80 pipe, with joints meeting requirements of 1.03 MPa 150 psi working pressure, 1.38 MPa 200 psi hydrostatic test pressure, unless otherwise shown or specified. Follow ASTM D2464 and ASME B1.20.1 for use with Schedule 80 threaded pipe and fittings. Test pipe couplings when used, as required by ASTM D2464.

b. Push-On Joint: ASTM D3139, with ASTM F477 gaskets. Fittings for push-on joints: AWWA C110/A21.10 or AWWA C111/A21.11. Iron fittings and specials: cement-mortar lined (standard thickness) in accordance with AWWA C104/A21.4.

c. Solvent Cement Joint: Use pipe that matches the dimensional requirements of ASTM D1785 or ASTM D2241 with joints meeting the requirements of 1.03 MPa 150 psi working pressure and 1.38 MPa 200 psi hydrostatic test pressure. Use fittings for solvent cement jointing that match the requirements of ASTM D2466 or ASTM D2467.

2.6.3 Insulating Joints

Provide between pipes of dissimilar metals a rubber gasket or other approved type of insulating joint or dielectric coupling to effectively prevent metal-to-metal contact between adjacent sections of piping.

2.6.4 Accessories

Provide flanges, connecting pieces, transition glands, transition sleeves, and other adapters as required.

2.6.5 Flexible Flanged Coupling

Provide flexible flanged couplings applicable for sewage as indicated. Use flexible flanged coupling designed for a working pressure of 2.41 MPa 350 psi.

2.7 VALVES AND OTHER PIPING ACCESSORIES

2.7.1 Isolation Gate Valves in Valve Vault

Conform to AWWA C500 for gate valves with outside-screw-and-yoke rising-stem type with double disc gates and flanged ends. Conform to AWWA C509 for valves with outside-screw-and-yoke rising-stem type with flanged ends. Provide valves that open by counterclockwise rotation of the valve stem. [Bolt and construct stuffing boxes to permit easy removal of parts for repair of gate valves.] Use valves from one manufacturer.

2.7.1.1 Valves Larger Than 50mm 2 Inches

[Resilient seat gate valves conforming to AWWA C509 with non-rising stems and flanged ends.

][Resilient seat eccentric plug valves conforming to AWWA C517 with operating handle and flanged ends.

]

2.7.1.2 Valves 50mm 2 Inches and Smaller

[Gate valves conforming to MSS SP-80 with non-rising stems and threaded ends.

][Ball valves with PTFE seats and seals, brass body and end cups, chrome plated brass ball and screwed ends.

]

2.7.2 Check Valves Less Than 100 mm 4 inch Diameter

Neoprene ball check valve with integral hydraulic sealing flange, designed for a hydraulic working pressure of 1.21 MPa 175 psi.

2.7.3 Check Valves 100 mm 4 inch and Larger Diameter

Provide nonclogging swing check valve rated for not less than 1210 kPa 175 psig working pressure capable of passing 76-mm 3-inch diameter solids. Match cast iron to ASTM A126 and flanged ends to AWWA C110/A21.10 Buna-N disc and integral seat.

Provide a positive horizontal, swing check type check valves. Provide valves that permit a free flow of sewage forward and a positive check against backflow. Provide iron body valves with a removable cover for inspection and removal of the gate assembly. Provide [bronze][_____] gate, gate seats, shaft, studs, and nuts.

2.7.4 Identification Tags and Plates

Provide the manufacturer's name or trademark on a corrosion-resistant identification plate or cast integrally, stamped, or otherwise permanently marked in a conspicuous place on each item of equipment. Include on the pump identification plate the pump capacity in liter per minute gpm, pump head in meter feet and speed of rotation. Cast on the body of the pump the direction of rotation.

2.7.5 Pipe Support

Use pipe support schedule 40 galvanized steel piping matching ASTM A53/A53M. Provide either ASME B16.3 or ASME B16.11 galvanized threaded fittings.

2.7.6 Miscellaneous Metals

Use stainless steel bolts, nuts, washers, anchors, and supports for installation of equipment.

2.7.7 Quick Disconnect System with Hydraulic Sealing Flange and Rail System

Use quick disconnect system consisting of a steel base plate for supporting the pumps, a hydraulic sealing flange, pump guide rails and the discharge pipe supports. Provide stainless steel guide rails, brackets and lifting chain for raising and lowering the pump in the basin. Build guides onto pump housing to fit the guide post to assure perfect alignment between pump and guide rails.

2.7.8 Wet Well Vent

Provide a [flanged ductile iron pipe and bend, conforming to AWWA C115/A21.15] [galvanized steel pipe and bend, conforming to ASTM A53/A53M] with insect screening.

2.8 EXCAVATION, TRENCHING, AND BACKFILLING

Provide in accordance with Section 31 00 00 EARTHWORK except as specified herein.

PART 3 EXECUTION

3.1 INSTALLATION

Provide pump station in accordance with drawings and requirements of the respective equipment manufacturers. Dampen and isolate equipment vibration.

3.1.1 Equipment Installation

Install equipment in accordance with these specifications and the manufacturer's installation instructions. Grout equipment mounted on concrete foundations before installing piping. Install piping to avoid imposing stress on equipment. Match flanges before securing bolts.

3.1.2 Installation of Ductile-Iron Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS FOR INSTALLATION OF PIPELINES of Section 33 30 00 SANITARY SEWERAGE, and with the requirements of AWWA C600 for pipe installation, joint assembly, and valve-and-fitting installation.

Make flanged joint with gaskets, bolts, and nuts specified for this type joint. Make flanged joints tight, avoid strain on flanges, fittings, and other accessories. Align bolt holes for each flanged joint. Use bolts sized for the bolt holes; use of undersized bolts is not permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange.

3.1.3 Installation of PVC Plastic Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS FOR INSTALLATION OF PIPELINES of Section 33 30 00 SANITARY SEWERAGE, with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, "Installation."

3.1.3.1 Pipe Less than 100 mm 4 Inch Diameter:

a. Make threaded joints by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. Tighten joints with strap wrenches that will not damage the pipe and fittings. Do not tighten joint more than 2 threads past hand-tight.

b. Push-On Joints: Bevel ends of pipe for push-on joints to facilitate assembly. Mark pipe to indicate when the pipe is fully seated. Lubricate gasket to prevent displacement. Ensure that the gasket remains in position in the bell or coupling while making the joint.

c. Solvent-weld joints: Comply with the manufacturer's instructions.

3.1.4 Valves

Make and assemble joints to gate valves and check valves as specified for making and assembling the same type joints between pipe and fittings.

Install valves in accordance with manufacturer's installation instructions. Install gate valves as described in AWWA C500, AWWA C509, and AWWA C515 and with AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500.

3.2 FIELD QUALITY CONTROL

Provide appliances, materials, water, and equipment for testing, [except that water and electric power needed for field tests will be provided as set forth in Division 01] [and bear full expenses in connection with the testing]. Conduct testing after equipment, electrical services, and piping are installed, and the pump station is ready for operation. Correct defects discovered to the satisfaction of the Contracting Officer, and tests repeated, at no expense to the Government, until the equipment functions as intended and designed.

3.2.1 Testing Procedure

Perform a pump test, [pressure sensor test][float test]. Submit the test results to the Contracting Officer.

Test all panels to the power requirements as shown on the plans to assure proper component operation. Activate each control function to check for proper operation and indication.

3.2.2 Field Representative

A representative of the pump manufacturer is to direct the startup of the station and instruct representatives of the Government in startup and operation procedures.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Operation and Maintenance

Submit operation and maintenance manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA for package lift stations, including Equipment Description, Assembly and Installation Procedures, Adjustment and Alignment, Checkout Procedures, Procedures of Operation and Troubleshooting. Include preventative maintenance and inspection procedures for package lift stations. Include in procedures the frequency of preventative maintenance, inspection, adjustment, lubrication, and cleaning necessary to minimize corrective maintenance and repair.

Supply special tools that are required for maintenance and testing of the package lift stations.

Submit spare parts data, including a complete list of parts and supplies with current unit prices and source of supply. List parts and supplies that are either normally furnished at no extra cost with the purchase of equipment, or specified to be furnished as a part of the contract, and list additional items recommended by the manufacturer to ensure an efficient operation for a period of one year.

Install on or near the package lift stations, a complete package of posted instructions, consisting of labels, signs, and templates of operating instructions.

Provide a list or reference all specific operation and maintenance procedures that are required to keep the warranty valid.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 34 56.00 10 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 34 13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 33 - UTILITIES

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DRAINAGE FIELD DOSING CHAMBERS

08/18

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 34 56.00 10 (August 2018)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 34 56.00 10

DRAINAGE FIELD DOSING CHAMBERS
08/18

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NOTE: This guide specification covers the requirements for automatic dosing siphons for sewage.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C605	(2021) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA M55	(2020; 2nd Ed) PE Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C443	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C443M	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using

	Rubber Gaskets (Metric)
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C478M	(2018) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM D883	(2020a) Standard Terminology Relating to Plastics
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3753	(2019) Glass-Fiber-Reinforced Polyester Manholes and Wetwells
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F714	(2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F794	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F894	(2024) Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G, [_____]

Dosing Tank

SD-05 Design Data

Buoyancy Calculations for Fiberglass Basins

Buoyancy Calculations For Precast Concrete Structures

SD-06 Test Reports

Rapid Inflow Test

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling and in accordance with manufacturer's instructions. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets and any other ultraviolet sensitive material under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, and other accessories free of dirt and debris.

1.3.2 Handling

Handle pipe, fittings, and other accessories in accordance with manufacturer's instructions and in a manner to ensure delivery to the final installed location in sound undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Clean the materials of foreign matter before being installed. Replace material found to be defective with sound material at no additional expense to the Government. Store rubber gaskets and other ultraviolet sensitive materials under cover out of direct sunlight until they are ready for installation.

Handle ductile iron pipe, fittings, and accessories in accordance with AWWA C600.

Handle PVC and PVCO pipe, fittings, and accessories in accordance with AWWA C605.

Handle PE pipe, fittings, and accessories in accordance with AWWA M55.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a [deep seal][trapless] type dosing siphon suitable for the service required, completely automatic in operation, starting promptly when the sewage has reached the predetermined high water level, and shutting off positively at the low water level. Accomplish the starting, stopping, and alternating operations without the use of electrical or mechanical devices having moving parts. Capacities of equipment and materials must be not less than those specified or indicated. Secure the manufacturer's name, address, and catalog or model number on a plate in a conspicuous place on each siphon bell. In lieu of nameplate, cast integrally the manufacturer's name or trademark with the equipment, or standard, or otherwise permanently marked.

2.2 MATERIAL

Provide materials and equipment conforming to the publications and other requirements specified below. Provide other material and equipment as specified and as shown on the approved detail drawings. Provide products from manufacturers regularly engaged in the manufacture of such products. Material and equipment must essentially duplicate items that have been in satisfactory use at least 2 years prior to [bid opening][installation] [source selection]. Submit complete drawings and other descriptive data as the Contracting Officer may require said data to demonstrate compliance with the contract documents, not less than [_____] days before starting installation of any material or equipment. Submit all detail drawings, catalog cutsheets, part numbers, and other material to document compliance with the specifications at one time. If departure from the contract drawings is deemed necessary, submit details of such departure, including changes in related portions of the project and the reasons therefore, with the drawings. Make approved departures at no additional cost to the Government. Submit a complete list in triplicate of parts and supplies for each different item of equipment listed, with current unit prices and sources of supply. Submit a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or are specified to be furnished as a part of the contract. Submit a list of additional items recommended by the manufacturer to assure efficient operation for a period of 120 days, not later than four months prior to the date of beneficial use.

2.2.1 Pipe and Fittings

2.2.1.1 Ductile Iron Pressure Pipe and Fittings

Provide ductile-iron pipe that conforms to AWWA C151/A21.51, Thickness Class [_____]. Provide fittings that conform to AWWA C110/A21.10 or AWWA C153/A21.53. [Provide fittings with push-on joint ends that conform to the same material and operational requirements as fittings with mechanical-joint ends, except for modifying the bell design, as approved, to function as a push-on joint.] Provide fittings with a pressure rating at least equivalent to that of the pipe. Ensure the ends of the pipe and fittings provided are suitable for the joints specified hereinafter. Provide pipe and fittings with cement-mortar lining conforming to AWWA C104/A21.4, standard thickness.

2.2.1.1.1 Ductile Iron Joints and Jointing Materials

a. Joints, general: Provide [push-on joints] [or] [mechanical joints] for pipe and fittings except as otherwise specificed in this paragraph. [Supply mechanical-joints where indicated.] [Provide Flanged Joints where indicated.] [Use of sleeve-type mechnical coupling joints in lieu of push-on joint is allowable.] [Use of [grooved] [or] [shouldered] type joints in lieu of push-on joint [or flanged joint], is allowable, except where joint is buried.]

b. Push-on joints: Supply pipe ends and fitting ends, gaskets, and lubricant for joint assembly which conform to AWWA C111/A21.11.

c. Mechanical joints: Supply dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets which conform to AWWA C111/A21.11.

2.2.1.2 PVC Plastic Gravity Sewer Piping

2.2.1.2.1 PVC Plastic Gravity Pipe and Fittings

[ASTM D3034, SDR 35, or ASTM F949 with ends suitable for elastomeric gasket joints.] [ASTM F794, Series 46, for ribbed sewer pipe with smooth interior, size 200 mm 8 inch through 1200 mm 48 inch diameters.]

2.2.1.2.2 PVC Plastic Gravity Joints and Jointing Material

Provide joints conforming to ASTM D3212. Provide gaskets conforming to ASTM F477.

2.2.1.3 High Density Polyethylene Pipe (HDPE)

ASTM F894, Class 63, size 450 mm 18 inch through 3000 mm 120 inch. ASTM F714, size 100 mm 4 inch through 1200 mm 48 inch, with pipe stiffness greater than or equal to 1170/D for cohesionless material pipe trench backfills. For all PE pipes, certify that the polyethylene meets the requirements of ASTM D3350, cell Class 334433C or higher. Provide fittings for High Density Polyethylene Pipe of the same material specifications as the pipe class. Provide rubber gasket joints conforming to ASTM F477 for all HDPE meeting ASTM F894. Use fused joints on all HDPE meeting ASTM F714 per manufacturer's instructions.

2.2.1.4 Pipe Fittings

2.2.1.4.1 Ductile Iron Fittings

AWWA C110/A21.10 and AWWA C111/A21.11 [_____] kPa psi working pressure.

2.2.1.4.2 Polyvinyl Chloride (PVC) Fittings

ASTM D3034.

2.2.1.4.3 Polyethylene Fittings

ASTM D3350.

2.2.1.4.4 Malleable-Iron Fittings

ASME B16.3.

2.2.1.4.5 Malleable-Iron Unions

ASME B16.39.

2.2.2 Siphon Bells, Inlet Castings, and Similar Equipment

Supply polyvinyl chloride (PVC) or polyethylene siphon bells, air bells, inlet castings, and similar equipment. Molded or fitted siphons are acceptable. Provide siphon bells with suitable connections for the air-control piping and mount the sniff pipe over the [_____] mm inch diameter feed pipe. Supply siphons that discharge at a maximum rate of flow of [_____] L/second gpm while operating under a drawing depth of [_____] mm inches, and under the head conditions as indicated. Provide for an average rate of inflow of [_____] L/second gpm and the minimum 4-hour average rate [_____] L/second gpm.2.2.2.1 Polyvinyl Chloride (PVC)

ASTM D3034.

2.2.2.2 Polyethylene

ASTM D3350.

2.2.3 Valves

Bronze, MSS SP-80, Type [_____].

2.2.4 Dosing Tank

2.2.4.1 Dosing Tank

Provide fiberglass reinforced polyester resin basin [or] precast concrete tank. Provide with inside diameters [as indicated][of [_____] mm [_____] inch] and to the depths indicated on the drawings.

****

NOTE: Buoyancy calculations are required during design. Since design drawings typically only show one type of wet well, buoyancy calculations are required as a submittal to ensure submitted wet well basin incorporates manufacturer's recommended measures to prevent flotation.

****

2.2.4.1.1 Fiberglass Basins

a. Buoyancy Calculations for Fiberglass Basins: Submit buoyancy calculations sealed by a licensed professional engineer. Prevent flotation in accordance with manufacturer's written instructions. Include manufacturer's written instructions with submitted calculations.

b. Provide Fiberglass Reinforced Polyester (FRP) dosing tanks in accordance with ASTM D883 relating to plastics.

   (1) Use commercial grade polyester resins evaluated as a laminate by test or determined by previous service to be acceptable for use in the wastewater environment.

   (2) Use a commercial grade continuous strand fiberglass reinforcement material.

   (3) Design FRP based on the following assumed conditions. Provide independent third party testing.

      (a) Hydrostatic pressure of 305 kilogram-force/square meter 62.4 pounds/square foot with water at ground surface.

      (b) Saturated soil weight of 1,922 kilogram/cubic meter 120 pounds/cubic foot.

      (c) Soil modulus of 3,418 kilogram-force/square meter 700 pounds/square foot.

      (d) Pipe stiffness values as specified in ASTM D3753.

      (e) Provide FRP laminate with a surface hardness of 90 percent Barcol.

2.2.4.2 Precast Concrete Structures

a. Buoyancy Calculations for Precast Concrete Structures: Submit buoyancy calculations sealed by a licensed professional engineer.

b. Construct precast concrete structures in accordance with ASTM C478M ASTM C478, except as specified herein. Provide precast concrete structures with a compressive strength of 30 MPa 4000 psi at 28 days and an air entrainment of 6 percent, plus or minus 2 percent, and a minimum wall thickness of 125 mm 5 inches. ASTM A615/A615M reinforcing bars. ASTM C443MASTM C443, Type B gaskets for joint connections.

2.2.4.3 Access Hatch Covers

Provide [aluminum][_____] access hatch covers as indicated. Include lifting mechanism, automatic hold open arm, slam lock with handle, and flush lift handle with vinyl grip. Use automatic hold open arm that locks in the 90 degree position. Use 6 mm 1/4 inch diamond plate cover with 6 mm 1/4 inch channel frame and continuous anchor flange. Use access hatch cover capable of withstanding a live load of 1500 kg/sq. meter 300 lb/sq. ft. Provide stainless steel cylinder lock with two keys per lock. Identically key the locks.

2.2.5 Cycle Counters

Provide a non-electric, mechanical cycle counter integrally mounted with the siphon that is adjustable to accurately count the fill/empty cycles for each siphon. Provide counter that operates by means of a gravity float switch.

2.2.6 Painting

[Factory powder coat][Factory paint][Field paint] all ferrous material installed under this specification. Thoroughly clean, prime, and finish painted any painted components in accordance with the recommendations of the manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

Install the Dosing Siphon System in accordance with the recommendations of the manufacturer as approved. Utilize workers experienced in the installation of this type of equipment.

3.1.1 Siphons

Install siphons in accordacne with the approved detail drawings. [Install each siphon with a seal trap in the discharge pipe of such depth to maintain an effective seal against blowing at all times.] [Discharge each siphon into an airtight piping system having a discharge point above the lowest point in the connecting pipe to form an effective seal.] [Install siphons for alternating operation from a common chamber with auxiliary equipment necessary for alteration in a predetermined sequence. Arrange and valve the air piping to permit removal of any number of the siphons from service without disturbing the alternating operation of the remaining siphons.] [Install equipment for twin dosing tanks including air bells, air-locking inflow connection, and all similar equipment that may be necessary to alternate the inflow from one tank to the other and to prevent flow into the tank when the siphon in the tank is discharging.]

3.1.2 Piping

Install piping with fittings and valves of similar material, with sufficient to facilitate maintenance or removal. [Assemble cast iron piping using a stiff mixture of graphite and oil, or an inert filler and oil, or an approved graphite compound, applied with a brush to the male threads only.]

3.2 SYSTEM STARTUP

Perform field tests, and provide labor, equipment, and incidentals required for testing, including water as needed for field tests. Produce evidence, when required, that items of work have been constructed in accordance with Contract requirements.

3.2.1 Testing Procedure

Test piping in accordance with Section 33 30 00 SANITARY SEWERS. Test in operation all equipment to demonstrate compliance with the Contract requirements.

3.2.2 Dosing Siphon System

3.2.2.1 Normal Operation

Test system in operation and in accordance with the authority having jurisdiction over sewage system, under design conditions to ensure operation of equipment. Provide appliances, materials, water, and equipment for testing, and bear full expenses in connection with the testing. Conduct testing after equipment is installed, piping is installed, liquid is flowing, and the system is ready for operation. Correct defects discovered to the satisfaction of the Contracting Officer, and tests repeated, at the expense of the Contractor, until the equipment functions as intended and designed.

3.2.2.2 Rapid Inflow Test

Test System as outlined above, but with an inflow equal to [2][3][____] times the average daily flow for [10][30][__] minutes. Record results and submit to the Contracting Officer.

3.3 PROTECTION

Field painting is specified in Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 40 00 (February 2021)**

Preparing Activity: USACE **Superseding**
UFGS-33 40 00 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 40 00

STORMWATER UTILITIES

11/21

PART 1 GENERAL

PART 2 PRODUCTS

ATTACHMENTS:

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 40 00 (February 2021)**

Preparing Activity: USACE **Superseding**
UFGS-33 40 00 (February 2010)

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SECTION 33 40 00

STORMWATER UTILITIES

11/21

****

NOTE: This guide specification covers the requirements for storm drainage piping systems using concrete, clay, steel, ductile iron, aluminum, polyvinyl chloride (PVC), polyethylene (PE), polypropylene (PP) pipe and steel reinforced polyethylene (SRPE) pipe.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

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****

PART 1 GENERAL

****

NOTE: On the project drawing, show:

1. Plan and location of all new pipelines, including type of service and size of pipe.

2. Location, size, and type of service of existing connecting, intersecting, or adjacent pipelines and other utilities.

3. Paved areas and railroads which pass over new pipelines.

4. Profile, where necessary to show unusual conditions.

5. Invert elevations at beginning and end of pipelines and at manholes or similar structures.

6. Class or strength of pipe and limits for same where class or strength will be different for different sections of pipeline. Provide shape requirements if different shapes are available.

7. Design details for pertinent manholes, catch basins, curb inlets, and head walls.

8. Storm drainage lines and culverts required to be watertight.

9. Bedding conditions, where different from those specified and location of cradle(s), when cradle is required if not covered under the appropriate specifications.

****

1.1 UNIT PRICES

****

NOTE: Delete this paragraph when the work specified is included in a lump sum contract price.

Separate bid may be required for each item for the construction of the various sizes of pipe culverts and storm drains and individual miscellaneous drainage structures, including all excavation, materials, backfilling, etc., for the completed work.

If separate bid items are used for the excavation, this fact should be clearly stated in the specifications and bid form, indicating that payment is to be made separately for earth excavation, rock excavation, borrow excavation, or other items that otherwise might be construed as the basis for a claim by the Contractor. Unit prices for rock excavation should be independent of, and not in addition to, the unit bid price for common excavation, unless so specified and so stated in the bid form.

****

1.1.1 Pipe Culverts and Storm Drains

The length of pipe installed will be measured along the centerlines of the pipe from end to end of pipe without deductions for diameter of manholes. Pipe will be paid for at the contract unit price for the number of linear meters feet of culverts or storm drains placed in the accepted work.

1.1.2 Box Culverts

The length of box culvert installed will be measured along the centerline of the box from end to end of the box culvert. Box Culvert will be paid for at the contract unit price for the number of linear meters feet of box culverts placed in the accepted work.

1.1.3 Storm Drainage Structures

****

NOTE: Fill brackets with depth requirements.

****

The quantity of manholes and inlets will be measured as the total number of manholes and inlets of the various types of construction, complete with frames and gratings or covers and, where indicated, with fixed side-rail ladders, constructed to the depth of [_____] meters feet in the accepted work. The depth of manholes and inlets will be measured from the top of grating or cover to invert of outlet pipe. Manholes and inlets constructed to depths greater than the depth specified above will be paid for as units at the contract unit price for manholes and inlets, plus an additional amount per linear meter foot for the measured depth beyond a depth of [_____] meters feet.

1.1.4 Walls and Headwalls

Walls and headwalls will be measured by the number of cubic meters yards of reinforced concrete, plain concrete, or masonry used in the construction of the walls and headwalls. Wall and headwalls will be paid for at the contract unit price for the number of walls and headwalls constructed in the completed work.

1.1.5 Flared End Sections

Flared end sections will be measured by the unit. Flared end sections will be paid for at the contract unit price for the various sizes in the accepted work.

1.1.6 Sheeting and Bracing

Payment will be made for that sheeting and bracing ordered to be left in place, based on the number of square meters feet of sheeting and bracing remaining below the surface of the ground.

1.1.7 Rock Excavation

****

NOTE: Reference should be made to other sections of the project specifications, as applicable, or pertinent requirements may be included in this section.

****

Payment will be made for the number of cubic meters yards of material acceptably excavated, as specified and defined as rock excavation in Section 31 00 00 EARTHWORK, measured in the original position, and computed by allowing actual width of rock excavation with the following limitations: maximum rock excavation width, 750 mm 30 inches for pipe of 300 mm 12 inch or less nominal diameter; maximum rock excavation width, 400 mm 16 inches greater than outside diameter of pipe of more than 300 mm 12 inch nominal diameter. Measurement will include authorized overdepth excavation. Payment will also include all necessary drilling and blasting, and all incidentals necessary for satisfactory excavation and disposal of authorized rock excavation. No separate payment will be made for backfill material required to replace rock excavation; include this cost in the unit price bid per cubic meter yard for rock excavation. In rock excavation for manholes and other appurtenances, 300 mm 1 foot will be allowed outside the wall lines of the structures.

1.1.8 Backfill Replacing Unstable Material

Payment will be made for the number of cubic meters yards of select granular material required to replace unstable material for foundations under pipes or drainage structures, which will constitute full compensation for this backfill material, including removal and disposal of unstable material and all excavating, hauling, placing, compacting, and all incidentals necessary to complete the construction of the foundation satisfactorily.

1.1.9 Concrete Ditch Lining

Payment will be made for the number of linear meters feet of concrete ditch lining including any steel reinforcing accepted in the completed work measured along the centerline of the ditch.

1.2 REFERENCES

****

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges
AASHTO M 43	(2005; R 2018) Standard Specification for Sizes of Aggregate for Road and Bridge

	Construction
AASHTO M 167M/M 167	(2017; R 2021) Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M 190	(2004; R 2019) Standard Specification for Asphalt-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 219	(1992; R 2021) Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M 243	(1996; R 2021) Standard Specification for Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications
AASHTO M 294	(2021) Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A716	(2018; R 2022) Standard Specification for Ductile Iron Culvert Pipe
ASTM A742/A742M	(2023a) Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
ASTM A760/A760M	(2015, R 2020) Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A762/A762M	(2019) Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A798/A798M	(2022) Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

ASTM A807/A807M	(2019) Standard Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM A929/A929M	(2024) Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B745/B745M	(2015; R 2021) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C12	(2024) Standard Practice for Installing Vitrified Clay Pipe Lines
ASTM C14	(2020) Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C14M	(2020) Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C32	(2023) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C55	(2023) Standard Specification for Concrete Building Brick
ASTM C62	(2023) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C76	(2022a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C76M	(2022a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C139	(2023) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C425	(2021) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C443	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C443M	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM C478/C478M	(2022) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C506	(2022a) Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C506M	(2022a) Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C507	(2022) Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C507M	(2022) Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C655	(2019a) Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C655M	(2019a) Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C700	(2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C828	(2023) Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C923/C923M	(2020) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed

	Flexible Joint Sealants
ASTM C990M	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)
ASTM C1103	(2022) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C1103M	(2019) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)
ASTM C1433	(2024) Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM C1433M	(2022) Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers (Metric)
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1171	(2018) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking Outdoors (Triangular Specimens)
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and

	Fittings
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F679	(2016) Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F714	(2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F794	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F894	(2024) Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F1417	(2011a; E 2024) Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air
ASTM F2418	(2019) Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers
ASTM F2562/F2562M	(2015; R 2019) Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2620	(2024) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
ASTM F2764/F2764M	(2024) Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881/F2881M	(2021; E 2021) Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer

	Applications
ASTM F2922	(2013; R 2018) Standard Specification for Polyethylene (PE) Corrugated Wall Stormwater Collection Chambers
ASTM F3219	(2019) Standard Specification for 3 to 30 in. (75 to 750 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Fittings

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Leakage Test; G[, [_____]]

SD-07 Certificates

Hydrostatic Test on Watertight Joints; G[, [_____]]

Frame and Cover or Gratings; G[, [_____]]

SD-08 Manufacturer's Instructions

Placing Pipe and Box Culvert; G[, [_____]]

SD-11 Closeout Submittals

Post-Installation Inspection Report; G[, [_____]]

LID Verification Report; G[, [_____]]

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage and unload and store materials with minimumal handling. Do not store materials directly on the ground. Keep the inside of pipes and fittings free of dirt and debris. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe in accordance with the manufacturer's recommendations and discard if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

1.4.2 Handling

Handle materials in a manner that ensures delivery to the trench in sound, undamaged condition. Carry pipe to the trench.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

****

NOTE: Where the type of pipe is to be the Contractor's option, the types (with size, class, shape, strength, sheet thickness, or gauge) that are acceptable should be listed. The inapplicable types of pipe will be deleted. In specifying plastic, clay, and concrete pipe or aluminum alloy and steel pipe for culverts and storm drains, pipe of comparable strength or stiffness for the various sizes should be specified.

Pipe materials which are known to be unsuitable for local conditions (i.e. corrosion, etc.) should not be permitted for the project. However, consideration should be given to the use of more effective protective coatings where economically feasible.

In areas where problems with root penetration are anticipated, specify pipe which has the kind of joint which will successfully resist root penetration. Generally speaking, the more watertight the joint, the greater will be the resistance to root penetration. Rubber-gasketed and compression-type joints are considered to give the best performance for this application.

American Society of Civil Engineers (ASCE) Manual of Practice No. 37, "Design and Construction of Sanitary and Storm Sewers," contains methods of calculation for structural requirements of pipe; from these, the required strengths for pipe of various materials may determined. Investigate external loads, including earth loads, truck loads, seismic loads, and impact, in the design stage of the project. Give special attention, in the design stage of the project, to plastic pipe materials, particularly with respect to superimposed external loads which could cause excessive deflection of the pipe. The degree of sidefill compaction should be considered realistically, particularly in marginal cases. See also the appendices to ASTM D2321.

UFC 3-201-01 does not allow plastic storm drain pipe to be used under any type of airfield pavement except for subsurface water collection and disposal.

****

Pipe sizes for culverts and storm drains are indicated on the drawings.

2.1.1 Concrete Pipe

****

NOTE: The various classes designate different D-loads. D-load is defined as the minimum required three-edge test load on a pipe to produce a 0.01 inch crack and/or ultimate failure in pounds per linear foot per foot (no metric definition) of inside diameter.

Where sulfate-resistant pipe is required and concrete pipe is to be an option, specify Type II or Type V cement. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as S04) in the soil are in the range of 0.1 to 0.2 percent and, for water, are in the range of 150 to 1,000 parts per million. Specify Type V (sulfate resisting) cement when soils contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1,000 parts per million. In areas where reactive aggregates are known to occur, specify low alkali cement.

Pipe sizes 300 mm (12 inch) diameter through 600 mm (24 inch) diameter may be either reinforced or nonreinforced concrete pipe.

****

2.1.1.1 Reinforced Culvert and Storm Drain Pipe

Manufactured in accordance with and conforming to ASTM C76M ASTM C76, Class [I] [II] [III] [IV] [V] [as indicated], or ASTM C655M ASTM C655, [_____] D-Load [as indicated].

2.1.1.2 Reinforced Arch Culvert and Storm Drain Pipe

Manufactured in accordance with and conforming to ASTM C506M ASTM C506, Class [A-II] [A-III] [A-IV] [as indicated].

2.1.1.3 Reinforced Elliptical Culvert and Storm Drain Pipe

Manufactured in accordance with and conforming to ASTM C507M ASTM C507, Class [HE-A] [HE-I] [HE-II] [HE-III] [HE-IV] [as indicated] for horizontal elliptical pipe and Class [VE-II] [VE-III] [VE-IV] [VE-V] [VE-VI] [as indicated] for vertical elliptical pipe.

2.1.1.4 Nonreinforced Culvert and Storm Drain Pipe

Manufactured in accordance with and conforming to ASTM C14M ASTM C14, Class [1] [2] [3] [as indicated].

2.1.2 Clay Pipe

****

NOTE: Specify "bell-and-spigot piping only" in areas where corrosion problems may be anticipated with the stainless steel parts of the couplings used for plain-end piping.

****

ASTM C700, [standard] [extra] strength, [bell-and-spigot piping only].

2.1.3 Corrugated Steel Pipe

****

NOTE: Corrugated steel pipe is manufactured from steel sheet with corrugations consisting of either cicular arcs and alternating tangent segments (arc and tangent) or alternating rectangular ribs and flat segments (spiral rib). Not all corrugated steel pipe manufacter's fabricate spiral rib pipe. In the past, pipe was fabricated by riveting sheets together to form pipe with annular corrugations. Today, most corrugated steel pipe is produced on a machine that forms helical corrugations. The steel sheets are joined together by either a continuous lock seam or welded seam.

The roughness coeffient of pipe with annular corrugations or helical spiral rib corrugations does not vary with increasing pipe diameter. The roughness coefficient of pipe with helical arc and tangent corrugations increases with increasing pipe diameter. Pipe with helical corrugations has a lower roughness coefficient than pipe with annular

corrugations. Corrugated pipe with helical corrugations should typically be specified for most projects.

Type I pipe has a full circular cross section and is fabricated with corrugated sheet. Type IR pipe has a full circular cross section and is fabricated from smooth sheet with helical ribs. Type II pipe is fabricated from Type I pipe that has been reformed into a pipe-arch. Type IIR pipe is fabricated from Type IR pipe that has been reformed into a pipe-arch.

The service life of a corrugated steel pipe is dependent on the pipe material and environmental conditions. The pipe material can vary with steel sheet thickness, metallic coating and non-metallic coating and paving. The available sheet thickness varies with the pipe diameter. Some manufacturers have the equipment to fabricate pipe using a heavier gage sheet than others. Typically either a zinc or aluminum (Type 2) metallic coating is specified. Pipe fabricated from corrugated steel sheet with a polymer coating (polymer precoated) can also be specified. The additional service life provided by asphalt coating and paving varies. A description of available coatings and durability guidelines is included in the National Corrugated Steel Pipe Association (NCSPA) publication "Modern Sewer Design".

To promote competitive bidding, polymer precoated pipe should generally be specified as an option if a non-metallic coating is required to provide the desired service life. Many pipe manufacturer's produce polymer precoated pipe in lieu of bituminous coated pipe. Polymer precoating provides greater additional service life than bituminous coating. Some severe environments may cause corrosion problems to accessory items such as rivets or coupling band hardware that do not have a polymer coating.

Corrugated steel piping with aramid fiber composite coating is recommended for use where severely corrosive conditions, such as highly acidic soils, tidal drainage, mine drainage, and certain industrial wastes, are present.

Other corrugation sizes are available and may be specified.

Sheet thickness of pipes should be indicated on the drawings. Select sheet thickness for each pipe that will support imposed loads and provide adequate protection from corrosion. The maximum thickness of metallic coated steel sheet that can be used to fabricated pipe will vary depending on the pipe diameter.

Perforated Type III pipe can be specified where pipe is used as an underdrain for underground disposal of water.
****

Provide Type [I] [and] [II] [or] [IR] [and] [IIR] corrugated steel pipe conforming to ASTM A760/A760M with [zinc] [or] [aluminum (Type 2)] coating. [Provide Type [I] [II] pipe with helical 68 by 13 mm 2-2/3 by 1/2 inch corrugations.] [Provide Type [IR] [IIR] pipe with helical 19 by 19 by 190 mm 3/4 by 3/4 by 7-1/2 inch corrugations.]

****
NOTE: Coatings, linings and paving can be applied to zinc or aluminum (Type 2) coated corrugated steel pipe to provide additional service life. Coatings, linings and paving are applied after fabrication of the pipe.

AASHTO M 190 covers four types of asphalt-coated corrugated metal pipe as follows:

Type A - Fully Asphalt-Coated
Type B - Half Asphalt-Coated with Paved-Invert
Type C - Fully Asphalt-Coated and Paved-Invert
Type D - Fully Asphalt-Coated and 100 Percent Paved or Lined
****

[Provide pipe that is fully asphalt coated [and [part] [fully] asphalt paved] conforming to AASHTO M 190 Type [A] [C] [D].] [Provide pipe that is polymer precoated in accordance with ASTM A762/A762M with pipe fabricated from ASTM A742/A742M Grade 10/10 polymer precoated sheet.]

2.1.4 Corrugated Aluminum Pipe

****

NOTE: Corrugated aluminum pipe has shown satisfactory corrosion resistance in clean granular materials even when seawater is present. However, corrugated aluminum pipe should not be used in highly acid (pH below 4) or highly alkaline (pH above 9) soils, or in organic silts and clays, identified as Types OH and OL in the Soil Classification Chart, ASTM D2487. This pipe should also not be used where it will be in contact with other metals or in metallic deposits.

Type I pipe has a full circular cross section and is fabricated with corrugated sheet. Type IR pipe has a full circular cross section and is fabricated from smooth sheet with helical ribs. Type II pipe is fabricated from Type I pipe that has been reformed into a pipe-arch. Type IIR pipe is fabricated from Type IR pipe that has been reformed into a pipe-arch.

Other corrugation sizes are available and may be

specified.

Sheet thickness of pipes should be indicated on the drawings.

Perforated Type III pipe can be specified where pipe is used as an underdrain for underground disposal of water.
****

Provide Type [I] [and] [II] [or] [IR] [and] [IIR] corrugated aluminum pipe conforming to ASTM B745/B745M. [Provide Type [I] [II] pipe with helical 68 by 13 mm 2-2/3 by 1/2 inch corrugations.] [Provide Type [IR] [IIR] pipe with helical 19 by 19 by 190 mm 3/4 by 3/4 by 7-1/2 inch corrugations.]

****
NOTE: Coatings, linings and paving can be applied to corrugated aluminum alloy pipe to provide additional service life. Coatings, linings and paving are applied after fabrication of the pipe.

AASHTO M 190 covers four types of asphalt-coated corrugated metal pipe as follows:

Type A - Fully Asphalt-Coated
Type B - Half Asphalt-Coated with Paved-Invert
Type C - Fully Asphalt-Coated and Paved-Invert
Type D - Fully Asphalt-Coated and 100 Percent Paved or Lined
****

[Provide pipe that is fully asphalt coated [and [part] [fully] asphalt paved] conforming to AASHTO M 190 Type [A] [C] [D].]

2.1.5 Structural Plate, Steel Pipe, Pipe Arches and Arches

****
NOTE: This paragraph includes options for providing a protective coating on the structural plate pipe. The designer will delete these options when protective coating is not a part of the project requirements. When protective coating on the structural-plate pipe is a project requirement, the designer will select the applicable option. Steel and aluminum pipe manufacturers state that it is impracticable in initial construction to provide a permanent paved invert of bituminous material in structural-plate corrugated steel and aluminum pipe.

Indicate the required sheet thickness of plates on the drawings.
****

Assembled with galvanized steel nuts and bolts, from galvanized corrugated steel plates conforming to AASHTO M 167M/M 167. [Provide pipe coating conforming to the requirements of [AASHTO M 190 Type A] [AASHTO M 243].]

2.1.6 Structural Plate, Aluminum Pipe, Pipe Arches and Arches

****

NOTE: Coordinate with paragraph Corrugated Steel Pipe and paragraph Structural Plate, Steel Pipe, Pipe Arches and Arches.

Indicate the required sheet thickness of plates on the drawings.

****

Assembled with either aluminum alloy, aluminum coated steel, stainless steel or zinc coated steel nuts and bolts. Provide nuts and bolts, and aluminum alloy plates conforming to AASHTO M 219. [Provide pipe coating conforming to the requirements of [AASHTO M 190, Type A] [AASHTO M 243].]

2.1.7 Ductile Iron Culvert Pipe

Provide ductile iron culvert pipe conforming to ASTM A716.

2.1.8 Poly Vinyl Chloride (PVC) Pipe

2.1.8.1 Type PSM PVC Pipe

ASTM D3034, maximum SDR 35.

2.1.8.2 Profile PVC Pipe

ASTM F794, Series 46.

2.1.8.3 Smooth Wall PVC Pipe

ASTM F679.

2.1.8.4 Corrugated PVC Pipe

****

NOTE: Perforated pipe can be specified where pipe is used as an underdrain for underground disposal of water.

****

ASTM F949.

2.1.9 Polyethylene (PE) Pipe

****

NOTE: For Navy projects, polyethylene pipe may only be used in non-traffic areas and beneath POV parking areas and must not be used beneath roads or heavy-duty military parking or hardstands.

****

2.1.9.1 Smooth Wall PE Pipe

ASTM F714, maximum DR of 21 for pipes 80 to 600 mm 3 to 24 inches in diameter and maximum DR of 26 for pipes 650 to 1200 mm 26 to 48 inches in diameter. Polyethylene compound material designation PE3608.

2.1.9.2 Corrugated PE Pipe

AASHTO M 294, Type S. Provide pipe walls having the following properties:

Nominal Size (mm) (inch)	Minimum Wall Area (square mm/m) (square in/ft)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm) (in. to the 4th/in.)
30012	32001.5	3900.024
37515	40001.91	8700.053
45018	49002.34	10200.062
60024	66003.14	19000.116
75030	83003.92	26700.163
90036	95004.50	36400.222
105042	99004.69	89000.543
120048	10,9005.15	89000.543
135054	12,0005.67	13,1100.800
150060	13,6506.45	13,1100.800

2.1.9.3 Profile Wall PE Pipe

ASTM F894, RSC 160. Provide pipe walls having the following properties:

Nominal Size (mm) (inch)	Minimum Wall Area (square mm/m) (square in/ft)	Minimum Moment (mm to the 4th/mm) (in to the 4th/in)	
		Cell Class 334433C	Cell Class 335434C
45018	63002.96	8500.052	6200.038
52521	88004.15	11500.070	8400.051
60024	99004.66	13300.081	9700.059
67527	12,5005.91	20500.125	14900.091
75030	12,5005.91	20500.125	14900.091
82533	14,8006.99	26400.161	21600.132
90036	17,1007.81	33100.202	27000.165
105042	16,5008.08	45400.277	37200.227

Nominal Size (mm) (inch)	Minimum Wall Area (square mm/m) (square in/ft)	Minimum Moment (mm to the 4th/mm) (in to the 4th/in)	
		Cell Class 334433C	Cell Class 335434C
120048	18,7008.82	55400.338	45400.277

2.1.10 Steel Reinforced Polyethylene (SRPE) Pipe

****

NOTE: Steel Reinforced Polyethylene Pipe is manufactured in 5 stiffness classes. The class of pipe should be specified or indicated on the drawings.

****

Provide SRPE pipe conforming to the requirements of ASTM F2562/F2562M, Class [____] [as indicated].

2.1.11 Polypropylene(PP) Pipe

****

NOTE: PP Pipe conforming to ASTM F2764/F2764M has a pipe stiffness of 320 KPA 46 psi for all diameters. The stiffness of PP Pipe conforming to ASTM F2881/F2881 varies with the diameter of the pipe. Pipe diameters range from 300 to 1,500 mm 12 to 60 inches.

Perforated pipe conforming to ASTM F2881/F2881M with Class II perforation patterns can be specified where pipe is used as an underdrain for underground disposal of water.

****

Provide double wall and triple wall pipe meeting the requirements of ASTM F2764/F2764M or ASTM F2881/F2881M, Class [I] [II].

2.2 PIPE JOINTS

****

NOTE: Watertight joints are typically specified in storm drains to prevent infiltration of water and fine-grained soil through joints when the water table is at or above the pipeline.

Watertight joints are required in pipes through levees in accordance with EM 1110-2-2902.

Delete sentence in brackets when watertight joints are not necessary.

****

[Provide joints that have been tested for and meet the requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.]

2.2.1 Concrete Pipe

****

NOTE: Where watertightness is essential, specify only rubber gasket joints. Where waterightness is not required, allow either rubber gasket joints or joints with preformed flexible joint sealant.

See EM 1110-2-2902 for joint requirements for pipe through levees.

Rubber gaskets are not available for arch or elliptical pipe.

****

2.2.1.1 Rubber Gasket Joints

Provide rubber gasket joints of a design and physical requirements conforming to ASTM C443M ASTM C443. [Provide rubber gaskets that meet the oil resistant gasket requirements of ASTM C443M ASTM C443.]

2.2.1.2 Preformed Flexible Sealant Joints

Provide joints made with preformed flexible joint sealant conforming to ASTM C990M ASTM C990.

2.2.2 Clay Pipe

Provide joints made with factory-fabricated resilient materials conforming to ASTM C425.

2.2.3 Corrugated Steel and Aluminum Pipe

****

NOTE: The annular and partially corrugated bands with gaskets specified below should be capable of providing a watertight joint. Other jointing systems (soil tight, silt tight, leak resistant, special design) as described in ASTM A760 can be specified when applicable.

When a specific joining system is necessary (band type and width, number and type of connectors, gasket type, etc.), the requirements should be specified and indicated on the drawings. See EM 1110-2-2902 for joint requirements for pipe through levees.

****

Factory reform each end of pipe with helical corrugations to create annular corrugations of the same dimensions as those in the pipe. Provide reformed ends with a width equal to at least half the width of the band being used. Join pipe using annular corrugated [or] [partially corrugated] coupling bands. Except as otherwise specified or indicated, provide annular corrugated [or] [partially corrugated] coupling bands including connectors and hardware conforming to [ASTM A760/A760M] [ASTM B745/B745M]. Provide coupling bands with either rod and lug or angle-bolt type connectors.

2.2.3.1 Annular Corrugated Bands

****

NOTE: Specify Type 2A1 gasket material when resistance to the action of petroleum base oils is not required. Specify Type 2B3 gasket material when oil resistance is required.

****

Provide sleeve type gaskets made of approximately 9.5 mm 3/8 inch thick by 178 mm 7 inch minimum width closed cell, expanded synthetic rubber, fabricated in the form of a cylinder with a diameter approximately 10 percent less than the nominal pipe size with annular corrugated type bands. Provide sleeve type gaskets that meet the requirements of ASTM D1056, Type 2 [A1] [B3] [_____], and have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D1171

2.2.3.2 Partially Corrugated Bands

****

NOTE: Partially corrugated bands are intended for use with helically corrugated steel pipe with ends rerolled to a 68 mm 2-2/3 inch by 13 mm 1/2-inch corrugation.

****

Provide partially corrugated type bands with two O-ring gaskets and a sealant strip where the band ends overlap. Provide rubber O-ring gaskets that are 21 mm 13/16 inch in diameter for pipe diameters of 914 mm 36 inches or smaller and 22 mm 7/8 inch in diameter for larger pipe having 13 mm 1/2 inch deep end corrugation.

2.2.4 Ductile Iron Pipe

Provide push-on type joints with rubber gaskets.

2.2.5 PVC Plastic Pipe

Provide solvent cement or elastomeric gasket type joints in accordance with the specification for the pipe and as recommended by the pipe manufacturer. Use solvent cement conforming to ASTM D2564. Provide gaskets for elastomeric joints conforming to ASTM F477.

2.2.6 Smooth Wall PE Plastic Pipe

Join pipe using butt fusion method conforming to ASTM F2620. No offset in alignment between adjacent pipe ends is permitted.

2.2.7 Corrugated PE Plastic Pipe

Provide [soil] [silt] [water] tight joints conforming to the requirements in AASHTO M 294. [Make water tight joints using a PE coupling and rubber gaskets as recommended by the pipe manufacturer. Provide rubber gaskets conforming to ASTM F477.]

2.2.8 Profile Wall PE Pipe

Provide gasketed or thermal weld type with integral bell joints in accordance with ASTM F894.

2.2.9 Steel Reinforced Polyethylene (SRPE) Pipe

Provide joints meeting the requirements of ASTM D3212.

2.2.10 Dual Wall and Triple Wall PP Pipe

Provide two gaskets conforming to ASTM F477 on the spigot. Gaskets must be installed by the pipe manufacturer and be covered with a removable, protective wrap to ensure the gaskets are free from debris. Use a joint lubricant available from the manufacturer on the gasket and bell during assembly. [ASTM F2881/F2881M for 300 to 1500 mm 12 to 60 inches pipe][ASTM F3219 for 300 to 750 mm 12 to 30 inches pipe][ASTM F2764/F2764M for 750 to 1500 mm 30 to 60 inches pipe] diameters must have a reinforced bell with a polymer composite band installed by the manufacturer. Provide fittings conforming to [ASTM F2881/F2881M] [ASTM F3219] [ASTM F2764/F2764M]. Utilize a spun-on, welded or integral bell and spigot with gaskets meeting ASTM F477 for bell and spigot connections.

2.3 PRECAST REINFORCED CONCRETE BOX CULVERT

Manufacture precast reinforced concrete box culverts in accordance with and conforming to ASTM C1433M ASTM C1433.

2.4 THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS

****

NOTE: Chambers must be installed as a system that includes, but is not limited to, rows of chambers, end caps, manifold piping, foundation stone, embedment stone, geotextile fabric, and a maintenance system.

Structural design of chambers must conform to ASTM F2787.

For Navy projects, thermoplastic collection chambers may only be used in non-traffic areas and beneath POV parking areas and must not be used beneath roads or heavy-duty military parking or hardstands.

****

Provide [perforated] [non-perforated] themoplastic corrugated wall stormwater collection chambers. Provide [polyethylene chambers conforming to ASTM F2922] [or] [polypropylene chambers conforming to ASTM F2418]. Provide chamber classification as indicated on the drawings.

2.5 UNDERGROUND STORMWATER RETENTION/DETENTION SYSTEM

****

NOTE: Underground stormwater retention/detention systems can be constructed using pipes, collection chambers, concrete vaults/arches/chambers, stackable modular structures, etc.

Delete inapplicable gradation sizes.

****

Provide an underground stormwater retention/detention system that includes [thermoplastic corrugated wall stormwater collection chambers and corrugated PE pipe manifolds] [corrugated PE pipe] [corrugated steel pipe] as indicated. Provide foundation and embedment stone that is washed, crushed and angular conforming to AASHTO M 43 size 3, 357, 4, 467, 5, 56, or 57. Provide initial fill material conforming to AASHTO M 43 size 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9 or 10. Provide geotextile conforming to AASHTO M 288.

2.6 MISCELLANEOUS MATERIALS

****

NOTE: The shape, size, thickness of sections, material, and weights for frames, covers, and gratings for inlets and manholes, as well as the amount of waterway opening for inlets and gratings should be indicated on the drawings. The covers and gratings should be designed to have ample strength for the traffic conditions to which they may be subjected. Fixed, straight-type galvanized steel ladders should be provided for manholes over 3.66 m 12 feet deep measured form top of grate to invert of outlet pipe.

****

2.6.1 Concrete

****

NOTE: Reference should be made to other sections of the project specifications, as applicable, or pertinent requirements may be included in this section.

The air contents specified are for concrete that will be subjected to freezing weather and the possible action of deicing chemicals. In climates where freezing is not a factor but where air entrainment is used in local commercial practice to improve the workability and placability of concrete, concrete having air content of 4.5 plus or minus 1.5 percent may be specified as Contractor's option to nonairentrained concrete.

****

Unless otherwise specified, provide concrete and reinforced concrete conforming to the requirements for [_____] MPa psi concrete under Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide air content by volume of concrete mixture, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 37.5 mm 1-1/2 inches. Determine air content in accordance with ASTM C231/C231M. Provide a minimum concrete covering over steel reinforcing of not less than 25 mm 1 inch thick for covers and not less than 40 mm 1-1/2 inches thick for walls and flooring. For concrete deposited directly against the ground, provide a covering thickness of at least 75 mm 3 inches between steel and ground. Provide expansion-joint filler material conforming to ASTM D1751, or ASTM D1752, or provide be resin-impregnated fiberboard conforming to the physical requirements of ASTM D1752.

2.6.2 Mortar

Mortar is not allowed for pipe joints. Provide mortar for pipe connections to drainage structures [and brick or block construction] conforming to ASTM C270, Type M, except that the maximum placement time will be 1 hour. Provide a sufficient quantity of water in the mixture to produce a stiff workable mortar but in no case may the quantity exceed [_____] [19] liters [5] gallons of water per sack of cement. Use water that is clean and free of harmful acids, alkalis, and organic impurities. Use the mortar within 30 minutes after the ingredients are mixed with water.

2.6.3 Precast Concrete Segmental Blocks

Provide precast concrete segmental block conforming to ASTM C139, not more than 200 mm 8 inches thick, not less than 200 mm 8 inches long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

2.6.4 Brick

Provide brick conforming to ASTM C62, Grade SW; ASTM C55, Grade S-I or S-II; or ASTM C32, Grade MS. Provide mortar for jointing and plastering consisting of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement. Provide joints that arecompletely filled and that are smooth and free from surplus mortar on the inside of the structure. Plaster brick structures with 13 mm 1/2 inch of mortar over the entire outside surface of the walls. Lay brick in stretcher courses with a header course every sixth course for square or rectangular structures. Lay brick radially with every sixth course a stretcher course for round structures.

2.6.5 Precast Reinforced Concrete Manholes

****

NOTE: Rubber-type gasket joints should be specified only where watertightness is essential.

****

Provide precast reinforced concrete manholes conforming to ASTM C478/C478M. Provide joints between precast concrete risers and tops that are [full-bedded in cement mortar and smoothed to a uniform surface on both interior and exterior of the structure] [or] [made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph PIPE JOINTS].

2.6.6 Frame and Cover or Gratings

****

NOTE: Consider the likelihood of bicycle traffic when selecting the type of inlet grate configuration.

****

[Submit certification on the ability of frame and cover or gratings to carry the imposed live load indicated on the drawings.] Provide frame and cover or gratings made of cast gray iron, ASTM A48/A48M, Class 35B; cast ductile iron, ASTM A536, Grade 65-45-12; or cast aluminum, ASTM B26/B26M, Alloy 356.0-T6. [Provide curb inlet grates conforming to the weight, shape, size, and waterway openings indicated on the plans.]Stamp or cast the word "Storm Sewer" into covers so that it is plainly visible.

2.6.7 Steel Ladder

Provide a steel ladder where the depth of the storm drainage structure exceeds 3.66 m 12 feet. Provide ladders not less than 406 mm 16 inches in width, with 19 mm 3/4 inch diameter rungs spaced 305 mm 12 inches apart. Provide two stringers that are a minimum 10 mm 3/8 inch thick and 63 mm 2-1/2 inches wide. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.

2.6.8 Resilient Connectors

****

NOTE: Delete the requirement for resilient connectors when a watertight connection between pipe and manholes and inlets is not required.

****

Provide flexible, watertight connectors conforming to ASTM C923/C923M for connecting pipe to manholes and inlets.

2.6.9 Flared End Sections

2.6.9.1 Metal Flared End Sections

Provide sections of a standard design fabricated from zinc or aluminum (Type 2) coated steel sheets meeting requirements of ASTM A929/A929M.

2.6.9.2 Concrete Flared End Sections

Provide sections of a standard design fabricated with reinforced concrete.

2.6.10 Modular Trench Drains

Provide modular trench drains consisting of [plastic] [or] [precast concrete] sections. Provide trench with width and invert slope as indicated on the drawings. Provide trench drain sections and grates rated for DIN Class [_____].

2.6.10.1 Plastic Sections

Provide polyethylene, polypropylene, polyester, PVC or HDPE sections with UV inhibitors and interlocking tongue and groove joints. Provide channels with [ductile iron] [cast iron] frames.

2.6.10.2 Precast Concrete Sections

Provide concrete sections made of fiber reinforced concrete or polyester polymer concrete with male/female connections between channel sections. Provide channels with [ductile iron] [or] [galvanized steel] [or] [stainless steel] edge rails.

2.6.10.3 Grates

Utilize [ductile iron] [cast iron] [galvanized steel] [stainless steel] trench grates. Attach trench grates to sections as recommended by the manufacturer.

2.6.11 Corrugated Steel Pipe Slotted Drain

****
NOTE: Slotted drain fabricated from Type IR corrugated steel pipe is available from some manufacturers.
****

Provide slotted drain consisting of galvanized steel grate welded in a continuous slot cut in the top of a corrugated steel pipe. Use Type I corrugated steel pipe conforming to ASTM A760/A760M with zinc coated [____] gage steel sheet and helical 68 by 13 mm 2-2/3 by 1/2 inch corrugations. Provide grates with a 45 mm 1-3/4 inch wide top opening and a [uniform height of [64 mm] [2-1/2 inches] [150 mm] [6 inches] [_____] mm [_____] inches] [variable height as indicated]. Fabricate grating using two [straight] [trapezoidal] sided 4.8 mm 3/16 inch thick steel bearing bars with 4.8 mm 3/16 inch thick steel solid web spacers spaced at 150 mm 6 inch centers. Fabricate grating using steel conforming to ASTM A1011/A1011M, grade 36. Galvanize steel grating in accordance with ASTM A123/A123M. Fillet weld grate to the corrugated steel pipe on each side of the grate at every other corrugation. Join pipe sections with coupling bands.

2.6.12 Downspout Boots

****
NOTE: Delete paragraph when downspout boots are not used to connect building downspouts to the storm drainage system.
****

Use boots conforming to ASTM A48/A48M, Class 30B or 35B of the size and shape indicated for connecting exterior downspouts to the storm-drainage system.

2.6.13 Flap Gates

Provide [medium] [or] [heavy]-duty flap gates with [circular] [rectangular] openings that are double-hinged. [Provide top pivot points that are adjustable.] Provide one-piece cast iron seats with a raised section around the perimeter of the waterway opening to provide the seating face. Provide [cast iron] [bronze] [stainless steel] [neoprene] seating face. Provide one-piece cast iron covers with necessary reinforcing rib, lifting eye for manual operation, and bosses to provide a pivot point connection with the links. Provide [cast iron] [bronze] [stainless steel] [neoprene] seating face on the cover. Provide cast or ductile iron links and hinge arms. Provide bronze bushings in the holes of pivot points. Provide fasteners that are either galvanized steel, bronze or stainless steel.

2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

2.7.1 Hydrostatic Test on Watertight Joints

****
NOTE: The hydrostatic tests specified in this paragraph are performed on a sample joint at the pipe manufacturer's plant or and independent laboratory to demonstrate that the proposed joint will be watertight if properly installed.

Retain this paragraph for pipe used in levees and other applications where watertight joints are required.

****

Perform a hydrostatic test on the watertight joint types as proposed. This test will be conducted at the plant or by an independent laboratory. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested.

2.7.1.1 Concrete, Clay, PVC, PE, SRPE and PP Pipe

Provide joints in reinforced and nonreinforced concrete pipe meeting the performance requirements in ASTM C990M ASTM C990 or ASTM C443M ASTM C443. Provide joints in clay pipe meeting the test requirements in ASTM C425. Provide joints in PVC, PE, SRPE, and PP plastic pipe meeting the test requirements in ASTM D3212.

2.7.1.2 Corrugated Steel and Aluminum Pipe

Perform a hydrostatic pressure test on the proposed joining system in accordance with ASTM A760/A760M. The joining system must not leak when subjected to an internal hydrostatic pressure of 69 kPa 10 psi for a 10 minute period

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, BOX CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

****

NOTE: Reference should be made to other sections of the project specifications, as applicable, or pertinent requirements may be included in this section.

****

Excavate trenches, excavate for appurtenances and backfill for culverts and storm drains, in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.

3.1.1 Trenching

****

NOTE: The earth load on rigid pipe is dependent on the installation type (trench, positive projecting, and negative projecting). The earth load on a rigid pipe installed in a trench is dependent on the width of the trench. The earth load in a trench can be reduced by minimizing the width of the trench. However, if the trench walls are overexcvated during construction and the trench width is greater than that used for design, the earth load on the pipe may exceed the strength of the pipe. Therefore, it is recommended that all rigid pipe for both embankment and trench conditions be designed for postive projection, embankment conditions.

****

Excavate trenches to the width indicated on the drawings or as specified herein. Trench width should permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Place sheeting and bracing, where required, within the trench width as specified, without any overexcavation.

3.1.2 Removal of Rock

****

NOTE: Unless otherwise specified, material used to replace unstable material or rock excavation should be compacted to a minimum density of 90 percent for cohesive soils and 95 percent for noncohesive soils, as determined by ASTM D1557.

****

Replace rock in either ledge or boulder formation with suitable materials to provide a compacted earth cushion. Provide a compacted earth cushion between unremoved rock and the pipe with a thickness of at least 200 mm 8 inches or 13 mm 1/2 inch for each meter foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Maintain the cushion under the bell as well as under the straight portion of the pipe where bell-and-spigot pipe is used. Provide a compacted earth cushion between unremoved rock and the box culvert of at least 200 mm 8 inches in thickness for concrete box culverts. Excavate rock as specified and defined in Section 31 00 00 EARTHWORK.

3.1.3 Removal of Unstable Material

****

NOTE: Coordinate with preceding paragraph.

****

Where wet or otherwise unstable soil incapable of properly supporting the pipe or box culvert, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, remove such material to the depth required and replace with select granular material to the proper grade. Compact select granular material as specified in paragraph FINAL BACKFILL. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, perform such removal and replacement at no additional cost to the Government.

3.2 BEDDING AND INITIAL BACKFILL

****

NOTE: Pipe cover requirements are different for different types of bedding.

****

Provide a firm bedding foundation of uniform density throughout the entire length of the pipe or box culvert.

3.2.1 Concrete Pipe

****

NOTE: See Section 16 of the AASHTO Bridge

Specifications or the American Concrete Pipe Association "Concrete Pipe Design Manual" for pipe installation details.
****

Use select granular material conforming to Section 31 00 00 EARTHWORK for haunch and bedding material. Compact haunch and outer bedding to at least [____] [90] percent laboratory maximum density and place in layers not exceeding 150 mm 6 inch loose thickness for compaction by hand-operated compactors and 200 mm 8 inches for other than hand-operated machines. Loosely place middle bedding and do not compact. After the pipe has been properly bedded, place haunch material, at a moisture content that will facilitate compaction, evenly along both sides of the pipe and thoroughly compact each layer with mechanical tampers or rammers to the springline of the pipe. Thoroughly compact the haunch material under the haunches of the pipe. For bell and spigot pipe, form a depression in bedding material for bells so entire barrel of pipe is uniformly supported. Minimize the length, depth, and width of bell depressions to that required for properly making the particular type of joint.

3.2.1.1 Trenches

After the pipe has been properly bedded and haunch material placed to the midpoint (springline) of the pipe, backfill and compact the remainder of the trench by spreading and rolling or compacting by mechanical rammers or tampers in layers not exceeding 150 mm 6 inches. Test for density as necessary to ensure conformance to the compaction requirements specified below. [Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly.] Leave untreated sheeting in place beneath structures or pavements.

3.2.1.2 Fill Sections

For pipe placed in fill sections, uniformly spread fill material longitudinally on both sides of the pipe in layers not exceeding 150 mm 6 inches in compacted depth, and compact by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 300 mm 12 inches above the top of the pipe must extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 4 m 12 feet, whichever is less. After the backfill has reached at least 300 mm 12 inches above the top of the pipe, place and thoroughly compact the remainder of the fill in layers not exceeding 200 mm 8 inches.

3.2.2 Clay Pipe

Provide bedding for clay pipe as specified by ASTM C12.

3.2.3 Corrugated Steel and Aluminum Pipe

Provide bedding and structural backfill for corrugated steel and aluminum pipe and pipe arch in accordance with ASTM A798/A798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Structural backfill material consists of materials classified by ASTM D2487 as either GW, GM, GP-GM, GW-GM, GC, GP-GC or SW. Provide bedding for corrugated structural plate pipe meeting the requirements of ASTM A807/A807M.

3.2.4 Ductile Iron Pipe

Provide bedding for ductile iron pipe as shown on the drawings.

3.2.5 Plastic Pipe

Provide bedding for PVC, PE, SRPE and PP pipe meeting the requirements of ASTM D2321. Use Class IB or II material for PVC, PE, SRPE pipe bedding, haunching, and initial backfill. Use Class I, II, or III material for PP pipe bedding, haunching and initial backfill.

3.2.6 Precast Reinforced Box Culvert

Use granular material a minimum of 150 mm 6 inches in depth for bedding precast concrete box culverts in trenches with soil foundation. Provide granular bedding in trenches with rock foundation that is 13 mm 1/2 inch in depth per 300 mm foot of depth of fill. The minimum depth of bedding will be 200 mm 8 inch up to a maximum depth of 600 mm 24 inches. Loosely place the granular bedding. Provide uniform support along the entire length of box culvert.

3.2.6.1 Trenches

After the box culvert has been properly bedded, place selected material from excavation or borrow, at a moisture content that will facilitate compaction, along both sides of box culvert in layers not exceeding 150 mm 6 inches in compacted depth. Bring the backfill up evenly on both sides of box culvert for the full length box culvert. Thoroughly compact each layer with mechanical tampers or rammers. Continue this method of filling and compacting until the fill has reached an elevation equal to the top of the box culvert. Backfill and compact the remainder of the trench by spreading and rolling or by compacting with mechanical rammers or tampers in layers not exceeding [_____] mm inches. Test density as necessary to ensure conformance to the compaction requirements specified below. [Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly.] Leave untreated sheeting in place beneath structures or pavements.

3.2.6.2 Fill Sections

Use backfill material and placement and compaction procedures for box culvert placed in fill sections as specified below. Uniformly spread the fill material longitudinally on both sides of the box in layers not exceeding 150 mm 6 inches in compacted depth. Compacted by rolling parallel with pipe or by using mechanical tamping or ramming. Prior to commencing normal filling operations, the width of the fill at a height of 300 mm 12 inches above the top of the box must extend a distance of not less than twice the outside width of the box culvert on each side of the box or 4 m 12 feet, whichever is less. After the backfill has reached at least 300 mm 12 inches above the top of the box, place and thoroughly compacte the remainder of the fill in layers not exceeding [_____] mm inches.

3.3 PLACING PIPE AND BOX CULVERT

****

NOTE: The Contractor should be required to perform deflection testing when warranted by the scope and

size of the project.
****

Submit printed copies of the pipe or box culvert manufacturer's recommended pipe or box culvert installation procedures prior to installation. Thoroughly examine each section of pipe or box culvert before being laid; do not use defective or damaged pipe. Protect plastic pipe, excluding SRPE pipe, from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Lay pipelines to the grades and alignment indicated. Provide proper facilities for lowering sections of pipe into trenches. [Place lifting lugs in vertically elongated corrugated steel or aluminum pipe in the same vertical plane as the major axis of the pipe.] Do not lay pipe in water or when trench conditions or weather are unsuitable for such work. Divert drainage or dewater trenches during construction as necessary. Deflection of installed flexible pipe must not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (percent)
Corrugated Steel and Aluminum	5
Ductile Iron Culvert	3
Plastic (PVC, HDPE, SRPE, and PP)	5

3.3.1 Concrete, Clay, PVC, Ribbed PVC, Ductile Iron Pipe

Lay pipe proceeding upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.3.2 Elliptical and Elliptical Reinforced Concrete Pipe

Place pipe so that the manufacturer's reference lines, designating the top of the pipe, are within 5 degrees of a vertical plane through the longitudinal axis of the pipe. Prevent damage to or misalignment of the pipe during backfilling operations.

3.3.3 PE, SRPE, and Dual Wall and Triple Wall PP Pipe

Lay on a bed shaped to line and grade and joint sections together in accordance with manufacturer's guidelines.

3.3.4 Corrugated Steel and Aluminum Pipe and Pipe Arch

****
NOTE: Coordinate with paragraph Corrugated Steel Pipe.
****

Lay pipe with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Install part paved pipe so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Provide fully paved steel pipe or pipe arch with the sheet thickness of the pipe or pipe arch painted or otherwise indicated on a label applied on the inside of the pipe or pipe arch. Coat any unprotected metal in the joints with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Protect interior coating against damage from insertion or removal of struts or tie wires. Use lifting lugs to facilitate moving pipe without damage to exterior or interior coatings. Handle pipe or pipe arch and coupling bands during transportation and installation with care to preclude damage to the coating, paving or lining. Repair damaged coatings, pavings and linings in accordance with the manufacturer's recommendations prior to placing backfill. Remove and replace pipe on with coating, paving or lining that has been damaged to such an extent that satisfactory field repairs cannot be made. Accomplish vertical elongation, where indicated, in the factory. Provide suitable markings or properly placed lifting lugs to ensure placement of factory elongated pipe in a vertical plane.

3.3.5 Structural-Plate Steel

Install structural plate in accordance with ASTM A807/A807M. Assemble structural plate in accordance with instructions furnished by the manufacturer. Instructions must show the position of each plate and the order of assembly. Tighten bolts progressively and uniformly, starting at one end of the structure after all plates are in place. Repeat the operation to ensure that all bolts are tightened to meet the torque requirements of 270 Newton meters 200 foot-pounds plus or minus 68 Newton meters 50 foot-pounds. Check power wrenches used by the use of hand torque wrenches or long-handled socket or structural wrenches for amount of torque produced. Check and adjust power wrenches frequently as needed, according to type or condition, to ensure proper adjustment to supply the required torque.

3.3.6 Structural-Plate Aluminum

Assemble structural plate in accordance with instructions furnished by the manufacturer. Instructions must show the position of each plate and the order of assembly. Tighten bolts progressively and uniformly, starting at one end of the structure after all plates are in place. Repeat the operation to ensure that all bolts are torqued to a minimum of 136 Newton meters 100 foot-pounds on aluminum alloy bolts and a minimum of 203 Newton meters 150 foot-pounds on galvanized steel bolts. Check power wrenches used by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque produced. Check and adjust power wrenches as frequently as needed, according to type or condition, to ensure that they are in proper adjustment to supply the required torque.

3.3.7 Multiple Culverts

****

NOTE: Where encasement or other special conditions are specified, minimum spacing as specified in this paragraph should not apply.

****

Where multiple lines of pipe are installed, adjacent sides of pipe must be at least half the nominal pipe diameter or 1 meter 3 feet apart, whichever is less.

3.3.8 Jacking Reinforced Concrete Pipe

Install jacking pipe and operate jacking equipment in accordance with Section 33 05 23 TRENCHLESS UTILITY INSTALLATION.

3.3.9 Precast Reinforced Concrete Box Culvert

Proceed upgrade with laying of sections and point tongue ends of tongue-and-groove box culvert section in the direction of flow.

3.4 JOINTING

****

NOTE: Where watertightness is not required, watertight and at least one other type of joint should be included for each type of pipe required.

****

3.4.1 Concrete and Clay Pipe

****

NOTE: Where watertightness is essential, delete paragraph Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe and Box Culverts below.

****

3.4.1.1 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe and Box Culverts

Follow the recommendation of the particular manufacturer in regard to sealing compound special installation requirements. When lubricants, primers, or adhesives are used, only apply on surfaces that are dry and clean. Affix sealing compounds to the pipe or box culvert not more than 3 hours prior to installation of the pipe or box culvert. Protect sealing compounds from the sun, blowing dust, and other deleterious agents at all times. Inspect sealing compounds before installation of the pipe or box culvert, and remove and replace any loose or improperly affixed sealing compound. Align the pipe or box culvert with the previously installed pipe or box culvert, and pull the joint together.

3.4.1.2 Flexible Watertight Joints

Use lubricants, cements, adhesives, and other special installation requirements for gaskets and jointing materials as recommended by the manufacturer. When lubricants, cements, or adhesives are used, only apply on surfaces that are clean and dry. Affix gaskets and jointing materials to the pipe not more than 24 hours prior to the installation of the pipe, and protect from the sun, blowing dust, and other deleterious agents at all times. Inspect gaskets and jointing materials before installing the pipe; remove and replace any loose or improperly affixed gaskets and jointing materials. Align the pipe with the previously installed pipe, and push the joint home. If the gasket becomes visibly dislocated when joining sections of pipe, remove the pipe and remake the joint.

3.4.2 Corrugated Steel and Aluminum Pipe

3.4.2.1 Field Joints

****

NOTE: Delete this paragraph where watertightness is essential.

In the text below, delete bracketed sentence, regarding filling of annular space, except when pipe 750 mm 30 inches in diameter and larger is included in the project. Delete reference to pipe size except when necessary to differentiate from corrugated metal pipe of less than 750 mm (30 inch) diameter which is also included in the project.

****

Provide transverse field joints designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. Provide joints meeting the general performance requirements described in ASTM A798/A798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. Keep the space between the pipe and connecting bands free from dirt and grit so that corrugations fit snugly. While being tightened, tap the connecting band with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. [Fill the annular space between abutting sections of part paved, and fully paved pipe and pipe arch, in sizes 750 mm 30 inches or larger, with a bituminous material after jointing.] Provide field joints for each type of corrugated metal pipe that maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. [Provide bands of the type, size, and sheet thickness indicated. Provide angles or lugs and bolts of the size indicated.] [Provide bands and angles or lugs and bolts as specified in the applicable standards or specifications for the pipe.]

3.4.2.2 Flexible Watertight, Gasketed Joints

Use lubricants or cements and other special installation requirements as recommended by the gasket manufacturer. Where sleeve type gaskets are used, place the gasket over one end of a section of pipe for half the width of the gasket. Then double over the other half over the end of the same pipe. When the adjoining section of pipe is in place, roll the doubled-over half of the gasket over the adjoining section. Correct any unevenness in overlap so that the gasket covers the end of pipe sections equally. Center connecting bands over adjoining sections of pipe, and place rods or bolts in position and tighten nuts. Band Tightening: Tighten the band evenly, keep even tension on the rods or bolts, and the gasket; properly seat the gasket in the corrugations. Keep watertight joints uncovered for a period of time designated by the Contracting Officer. Before covering joints, measure the tightness of the nuts with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, retighten the nut with a torque wrench and keep uncovered until a tight, permanent joint is assured.

3.5 DRAINAGE STRUCTURES

****

NOTE: Coordinate with paragraph MISCELLANEOUS MATERIALS.

****

3.5.1 Manholes and Inlets

****

NOTE: Prepare the required paragraph or section covering the essential requirements for reinforced concrete inlet construction and insert the required reference to the paragraph or section prepared to cover these items.

Delete the requirement for flexible watertight connectors (last sentence) when a watertight connection between pipe and manholes and inlets is not required.

Construct new manholes and inlets of reinforced concrete. Brick or precast concrete segmental block should typically not be used to construct new manholes.

****

Construct manholes of precast reinforced concrete. Construct inlets of [precast] [or] [cast in place] reinforced concrete. Provide manholes and inlets complete with frames and covers or gratings[; and with fixed galvanized steel ladders] as indicated. [The wall along the line where steel ladders are installed must be vertical for its entire length. Adequately anchor ladders to the wall by means of steel inserts spaced not more than 1.83 m 6 feet vertically, and install to provide at least 150 mm 6 inches of space between the wall and the rungs.] [Make pipe connections to concrete manholes and inlets with flexible, watertight connectors.]

3.5.2 Walls and Headwalls

****

NOTE: Dry-stone masonry may be specified and used for crib construction and/or sloping retaining walls that will sustain little or no earth pressure.

****

Construct [walls] [headwalls] as indicated.

3.6 INSTALLATION OF TRACER WIRE AND WARNING TAPE

****

NOTE: Delete paragraph when tracer wire or warning tape is not installed above storm drain pipe.

****

[Install a continous length of tracer wire for the full length of each run of nonmetallic pipe in accordance with Section 31 00 00 EARTHWORK. Attach wire to top of pipe in such a manner that it will not be displaced during construction operations.] [Install warning tape above all storm drain pipe in accordance with Section 31 00 00 EARTHWORK.]

3.7 UNDERGROUND STORMWATER RETENTION/DETENTION SYSTEM

Install [pipe] [and] [collection chambers] as recommended by the manufacturer. Place foundation and embedment stone as recommended by the manufacturer of the [pipe] [collection chambers]. Begin compaction of initial fill after 300 mm 12 inches of material have been placed over the [pipe] [chambers]. Compact initial fill in 150 mm 6 inch thick layers to 90 percent maximum density. Use roller with a gross vehicle weight not exceeding 53 kN 12,000 lbs and a dynamic force not exceeding 89 kN 20,000 lbs.

3.8 FINAL BACKFILL

****

NOTE: The thickness of layers of backfill and the degree of compaction required to prevent undesirable settlement should be determined by soil conditions and the job compaction requirements.

****

Backfill trenches with satisfactory material deposited in layers of a maximum of 200 mm 8 inches loose thickness and compacted to 90 percent of maximum density for cohesive soils and 95 percent of maximum density for cohesionless soils in accordance with Section 31 00 00 EARTHWORK. Testing is the responsibility of the Contractor and will be performed at no additional cost to the Government. Unless otherwise specified, determine field in-place density of final backfill at a frequency of one test per 15 linear meters 50 linear feet, or fraction thereof, of each lift of backfill. Submit test results in accordance with Section 31 00 00 EARTHWORK. Do not displace or damage pipe or box when compacting final backfill by rolling or operating heavy equipment parallel with the pipe or box. Movement of construction machinery over a culvert or storm drain at any stage of construction will be at the Contractor's risk. Repair or replace any damaged pipe. Protect concrete pipes with a minimum of 1 meter 3 feet of cover prior to permitting heavy construction equipment to pass over them during construction. Provide the minimum cover for construction loads over corrugated steel pipes as specified in Section 26, Division II of AASHTO HB-17. Provide minimum cover for construction loads over plastic pipes as specified in ASTM D2321.

3.9 FIELD QUALITY CONTROL

3.9.1 Tests

Testing is the responsibility of the Contractor. Perform all testing and retesting at no additional cost to the Government.

[3.9.1.1 Leakage Test

****

NOTE: Leakage tests can be performed to verify that watertight joints were installed correctly during placement of the pipe. Most projects will not warrant the use of a leakage test.

Field-test joints in pipe installed through levees for watertightness in accordance with EM 1110-2-2902.

Delete paragraph when watertight joints are not required. Also, delete the paragraph when watertight joints are required, but the quantity of pipe required for a project (except levees) is so small that the provisions for testing and

certification of watertightness of joints is economically unfeasible. Field testing of joints in pipe through levees for watertightness is required regardless of the size of the project.

****

Test pipe lines for leakage prior to completing backfill by performing either an exfiltration test, low pressure air pipeline test or by individual pipe joint testing. Submit leakage test results to the Contracting Officer.

3.9.1.1.1   Exfiltration Test

****

NOTE: Exfiltration tests can be difficult to perform, expecially with larger diameter pipes.

Select appropriate leakage rate.

****

Prior to exfiltration tests, backfill the trench up to at least the lower half of the pipe. If required, place sufficient additional backfill to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. When the water table is 600 mm 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, measure infiltration using a suitable weir or other device acceptable to the Contracting Officer. Perform exfiltration test by filling the line to be tested with water so that a head of at least 600 mm 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. Allow the filled line to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, reestablish the head. Measure the amount of water required to maintain this water level during a 2-hour test period. Leakage as measured by the exfiltration test must not exceed [23 liters per mm in diameter per kilometer250 gallons per inch in diameter per mile of pipeline per day] [98 mL per mm in diameter per 100 meters0.2 gallons per inch in diameter per 100 feet of pipeline per hour]. Correct visible leaks encountered regardless of leakage test results.

3.9.1.1.2   Low Pressure Air Pipeline Tests

****

NOTE: The integrity of joints in installed pipes can be determined by pressuring isolated segments of pipe with air and measuring pressure loss.

****

Perform low pressure air testing for vitrified clay pipes in accordance with ASTM C828. Perform low pressure air testing for plastic pipe in accordance with ASTM F1417. Perform low pressure air testing procedures for other pipe materials using the pressures and testing times prescribed in ASTM C828, after consultation with the pipe manufacturer.

3.9.1.1.3   Individual Pipe Joint Testing

****

NOTE: The integrity of joints in large (675 mm 27-inch and larger diameter) installed pipes can be

determined by testing each joint for leakage using air or water.

****

Testing of individual joints for leakage by low pressure air or water must conform to ASTM C1103M ASTM C1103.

][3.9.1.2 Deflection Testing

****

NOTE: Specify laser profiler or mandrel inspection of flexible pipes only when warranted by scope or size of project or when watertightness is required.

Do not use laser profiler inspections for Navy projects.

Delete this paragraph when no flexible piping has been allowed for the project.

****

Conduct deflection test no sooner than 30 days after completion of final backfill and compaction testing. Clean or flush all lines prior to testing. Perform a deflection test on entire length of installed flexible pipeline upon completion of work adjacent to and over the pipeline, including backfilling, placement of fill, grading, paving, placement of concrete, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads must not exceed the limits in paragraph PLACING PIPE AND BOX CULVERT above as percent of the average inside diameter of pipe. Use a [laser profiler or] mandrel to determine if allowable deflection has been exceeded.

[3.9.1.2.1 Laser Profiler

****

NOTE: Delete last sentence in brackets if pipes larger than 1200 mm 48 inches are not included in the project.

****

Inspect pipe interior with laser profiling equipment. Utilize low barrel distortion video equipment in accordance with UFGS 33 01 30.16 TV INSPECTION OF SEWER LINES for pipe diameters 1200 mm 48 inches or less. [For initial post installation inspections for pipe diameters larger than 1200 mm 48 inches, perform a visual inspection of the pipe interior.]

][3.9.1.2.2 Mandrel

Pass the mandrel through each run of pipe by pulling it by hand. If deflection readings in excess of the allowable deflection of average inside diameter of pipe are obtained, stop and begin test from the opposite direction. The mandrel must meet the pipe manufacturer's recommendations and the following requirements. Provide a mandrel that is rigid, nonadjustable, has a minimum of 9 fins, pulling rings at each end, and is engraved with the nominal pipe size and mandrel outside diameter. The mandrel must be 5 percent less that the ceritified-actual pipe diameter for plastic pipe, 5 percent less than the certified-actual pipe diameter for corrugated steel and aluminum, 3 percent less than the certified-actual pipe diameter for ductile iron culvert pipe. The Government will verify the outside diameter (OD) of the Contractor provided mandrell through the use of Contractor provided proving rings.

]]3.9.1.3 Tracer Wire Continuity

****

NOTE: Delete this paragraph when tracer wire is not being installed above storm drain pipe.

****

Test tracer wire for continuity after initial and final backfilling of pipes. Verify that tracer wire is locatable with electronic utility location equipement. Repair breaks or separations and re-test for continuity.

3.9.2 Inspection

[3.9.2.1 Post-Installation Inspection

****

NOTE: Delete the requirement for a post-installation CCTV inspection of pipes when the quantity of pipe required for a project is so small that it is economically unfeasible.

****

[Perform a CCTV inspection and video recording of pipes with diameters 1200 mm 48 inches or less in accordance with UFGS 33 01 30.16 TV INSPECTION OF SEWER LINES. Visually inspect pipes with diameters larger than 1200 mm 48 inches.] Inspect each segment of pipe for alignment, settlement, joint separations, soil migration through the joint, cracks, buckling, bulging and deflection. An engineer must evaluate all defects to determine if any remediation or repair is required.

[3.9.2.1.1 Concrete Pipe

An engineer must evaluate all pipes with cracks with a width greater than 0.25 mm 0.01 inches, but less than 2.5 mm 0.10 inches to determine if any remediation or repair is required.

][3.9.2.1.2 Flexible Pipe

Check each flexible pipe (PE, PVC, PP, corrugated steel and aluminum) for rips, tears, joint separations, soil migration throught the joint, cracks, localized buckling, bulges, settlement and alignment.

][3.9.2.1.3 Post-Installation Inspection Report

The deflection results and final post installation inspection report must include: [a copy of all video taken,] pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, deflection and deformation of flexible pipe, inspector notes, condition of joints, condition of pipe wall (e.g. distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

]]3.9.2.2 Low Impact Development Inspection

****

NOTE: For Navy, include a Low Impact Development

(LID) inspection to comply with UFC 3-210-10 and FC 1-300-09N Navy and Marine Corps Design Procedures.

Navy policy requires LID data to be reported annually. The LID Verification Report must be downloaded from the Whole Building Design Guide (WBDG) and attached to this specification section. The Designer of Record (DoR) is responsible for completing the design portion of the report prior to attaching it to this specification.

Government approval was added to ensure that the submittal is delivered to the Government and not the Contractor's DoR for Design Build projects.

The LID Verification Report referenced in this section is only listed as an attachment on the Section Table of Contents during Process Print/Publish. The LID Verification Report must be manually inserted to the printed Job or added to the PDF using Adobe Acrobat features.
****

Inspect Low Impact Development (LID) features indicated on the design portion of the LID Verification Report. Certify LID features were constructed according to plans and specifications or by submitting as-built drawings in accordance with UFGS 01 78 00 Closeout Submittals. When as-built drawings show deviations to the LID features, document the deviations on the LID Verification Report.

3.9.3 Repair of Defects

3.9.3.1 Leakage Test

When leakage exceeds the maximum amount specified, correct source of excess leakage by replacing damaged pipe and gaskets and retest.

3.9.3.2 Deflection Testing

When deflection readings are in excess of the allowable deflection of average inside diamater of pipe are obtained, remove pipe which has excessive deflection and replace with new pipe. Retest 30 days after completing backfill, leakage testing and compaction testing.

3.9.3.3 Inspection

Replace pipe or repair defects indicated in the Post-Installation Inspection Report.

3.9.3.3.1 Concrete Pipe

Replace pipes having cracks with a width greater than 2.5 mm 0.1 inches.

3.9.3.3.2 Flexible Pipe

Replace pipes having cracks or splits.

3.10 PROTECTION

Protect storm drainage piping and adjacent areas from superimposed and external loads during construction.

3.11 WARRANTY PERIOD

Pipe segments found to have defects during the warranty period must be replaced with new pipe and retested.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-33 46 13 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-33 46 13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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05/20

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USACE / NAVFAC / AFCEC **UFGS-33 46 13 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-33 46 13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 46 13

FOUNDATION DRAINAGE

05/20

****

NOTE: This guide specification covers the requirements for foundation drainage system using clay, concrete, cast iron, corrugated steel, corrugated aluminum, and plastic pipe.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The following information should be shown on the drawings:

Location, extent, type, and sizes of foundation drainage system, including designations of drainage lines and outlet lines.

Locations and invert elevations of cleanouts and drainage structures.

Cross section of system showing bedding and backfill with protective covering.

Jointing details.

Cleanout details.

Connections between foundation drainage and related storm drainage systems.

Outlet details.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 252	(2009; R 2017) Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M 294	(2021) Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

ASTM INTERNATIONAL (ASTM)

ASTM A74	(2021) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A760/A760M	(2015, R 2020) Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM B745/B745M	(2015; R 2021) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains

ASTM C4	(2004; R 2023) Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile
ASTM C14	(2020) Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C14M	(2020) Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C412	(2011) Concrete Drain Tile
ASTM C412M	(2011) Concrete Drain Tile (Metric)
ASTM C425	(2021) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C444	(2017) Standard Specification for Perforated Concrete Pipe
ASTM C444M	(2017) Standard Specification for Perforated Concrete Pipe (Metric)
ASTM C508/C508M	(2000; R 2015) Asbestos-Cement Underdrain Pipe
ASTM C654	(2011) Porous Concrete Pipe
ASTM C654M	(2011) Porous Concrete Pipe (Metric)
ASTM C700	(2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D2751	(2005) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F667/F667M	(2016; R 2021) Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
ASTM F758	(2014; R 2023) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems

	for Highway, Airport, and Similar Drainage
ASTM F949	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.2 SYSTEM DESCRIPTION

1.2.1 Extent

Furnish and install foundation drainage as a complete system [to 1.5 m 5 feet beyond the building] [as shown].

1.2.2 Outlet Connections

[Connect foundation pipe to the storm drainage system as shown and specified in Section 33 40 00 STORMWATER UTILITIES.] [Terminate foundation pipe as shown.]

1.2.3 Drainage Lines

Construct drainage lines of drain tile, perforated pipe, or porous pipe.

1.2.4 Outlet Lines

Construct outlet lines of closed-joint nonperforated, nonporous pipe.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification

and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Materials.

SD-07 Certificates

Materials.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect materials placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Do not expose plastic pipe to direct sunlight for more than 6 months from time of manufacturer to installation.

PART 2 PRODUCTS

2.1 MATERIALS

****
NOTE: Select materials for contract requirements. Correlate material with other sections. When design requires pipe to be of a particular quality, strength, or bituminous coated, acceptable options should be retained and specification requirements modified accordingly. Thickness of metal pipe will be shown on the drawings. Drain tile should not be used for drains crossing or adjacent to paved areas. Special-quality concrete drain tile should be specified for tile laid in soils that are acidic or contain unusual quantities of sulfates; porous concrete pipe and perforated corrugated aluminum alloy pipe will not be used. Where required by soil or water conditions, perforated asbestos-cement pipes should be specified by types.
****

Provide pipe for foundation drainage system of the type and size indicated. Use appropriate transitions, adapters, or joint details where pipes of different types or materials are connected. Submit two randomly selected samples of each type of pipe and fitting, prior to delivery of materials to the site, and certifications from the manufacturers attesting that materials meet specification requirements.

2.1.1 Clay Pipe

ASTM C700, standard or extra strength.

2.1.2 Perforated Clay Pipe

ASTM C700, standard or extra strength.

2.1.3 Concrete Pipe

Conform to ASTM C14MASTM C14, Class [1][2][3].

2.1.4 Perforated Concrete Pipe

Conform to ASTM C14MASTM C14, Class [1][2][3] with perforations conforming to ASTM C444MASTM C444, Type [I][II].

2.1.5 Porous Concrete Pipe

Conform to ASTM C654MASTM C654, standard or extra strength class.

2.1.6 Clay Drain Tile

ASTM C4, [standard][extra-quality][heavy-duty] class.

2.1.7 Perforated Clay Drain Tile

ASTM C4, [standard][extra-quality][heavy-duty] class.

2.1.8 Concrete Drain Tile

Conform to ASTM C412MASTM C412, [standard-][special-][extra-][heavy-duty-extra-]quality.

2.1.9 Cast-Iron Soil Pipe

ASTM A74, [extra-heavy][service].

2.1.10 Perforated Corrugated Steel Pipe

ASTM A760/A760M, Type III.

2.1.11 Perforated Corrugated Aluminum Alloy Pipe

ASTM B745/B745M Type III, Class [I] [II].

2.1.12 Perforated Asbestos-Cement Underdrain Pipe

ASTM C508/C508M.

2.1.13 Plastic Pipe

Provide plastic pipe containing ultraviolet inhibitor to provide protection from exposure to direct sunlight.

2.1.13.1 Corrugated Polyethylene (PE) Drainage Pipe

****

NOTE: AASHTO M 252 and AASHTO M 294 both provide for stiffer pipe than the equivalent ASTM standards. When pipe strength is a critical concern, use the AASHTO standard.

****

Furnish ASTM F667/F667M heavy duty for pipe 80 to 150 mm 3 to 6 inches in diameter inclusive, ASTM F667/F667M for pipe 200 to 600 mm 8 to 24 inches in diameter; or AASHTO M 252 for pipe 80 to 250 mm 3 to 10 inches in diameter or AASHTO M 294 for pipe 300 to 600 mm 12 to 24 inches in diameter. Furnish pipe manufacturer's standard fittings and conforming to the indicated specification.

2.1.13.2 Acrylonitrile-Butadiene-Styrene (ABS) Pipe

ASTM D2751, with a maximum SDR of 35.

2.1.13.3 Polyvinyl Chloride (PVC) Pipe

ASTM F758, Type PS 46, ASTM D3034, or ASTM F949 with a minimum pipe stiffness of 317 kPa46 psi.

2.1.13.4 Circular Perforations in Plastic Pipe

****

NOTE: Perforation and slot sizing is based on embedment gradation, flow requirements, and structural considerations. The embedment material gradation is in turn based on the gradation of the surrounding soil. To minimize the migration of fines into the coarser material, while maintaining adequate permeability, the following criteria should be met:

a. All soils except clays without a sand or silt fraction must meet the following requirements:

(15 percent size of drainage or filter material)/(85 percent size of material to be drained) less than or equal to 5

(50 percent size of drainage or filter material)/(50 percent size of material to be drained) less than or equal to 25

b. Clays without a sand or silt fraction must meet the following requirements:

(15 percent size of drainage or filter material)/(85 percent size of material to be drained) less than or equal to 5

15 percent size of drainage or filter material less than or equal to 0.4 mm

c. All soils, in addition to the previous requirements, must meet the following requirements:

(15 percent size of drainage or filter material)/(15 percent size of material to be drained) less than or equal to 5

(85 percent size of drainage or filter

material)/(slot width) greater than or equal to 1.2 mm

(85 percent size of drainage or filter material)/(hole diameter) greater than or equal to 1.0

****

Cleanly cut circular holes no more than 8 mm 5/16 inch or less than 5 mm 3/16 inch in diameter, and arrange in rows parallel to the longitudinal axis of the pipe. Place perforations approximately 75 mm 3 inches apart, center-to-center, along rows. Place rows approximately 38 mm 1-1/2 inches apart and arrange in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. Space rows no more than 155 degrees of circumference. Do not perforate the spigot or tongue end of the pipe for a length equal to the depth of the socket and continue perforations at uniform spacing over the entire length of the pipe. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.

2.1.13.5 Slotted Perforations in Plastic Pipe

Cleanly cut circumferential slots so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots exceeding 3 mm 1/8 inch or less than 0.79 mm 1/32 inch is not permitted. Length of individual slots exceeding 32 mm 1-1/4 inches on 75 mm 3 inch diameter tubing is not permitted; 10 percent of the tubing inside nominal circumference on 100 to 200 mm 4 to 8 inch diameter tubing; and 65 mm 2-1/2 inches on 250 mm 10 inch diameter tubing. Symmetrically space rows of slots so that they are fully contained in quadrants of the pipe. Center slots in the valleys of the corrugations of profile wall pipe. Provide water inlet area consisting of a minimum of 1058 square mm/linear meter 0.5 square inch/linear foot of tubing. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.

2.1.14 Fittings

Provide fittings consisting of compatible materials for pipe, of corresponding weight and quality, and as specified herein.

2.1.15 Cleanouts and Piping Through Walls

Provide cleanout pipe and fittings and piping through walls and footings consisting of cast-iron soil pipe. Each cleanout must have a brass ferrule and a cast-brass screw-jointed plug with socket or raised head for wrench.

2.1.16 Cover and Wrapping Materials for Open Joints in Drain Tile

Cover material may be tar paper, roofing paper, reinforced building paper, glass fiber fabric, or other similar type material. Wrapping material must be 18-14 mesh, 0.25 mm 0.01 inch diameter nonferrous wire cloth.

2.1.17 Bedding and Pervious Backfill for Foundation Drains

Provide bedding and pervious backfill [in accordance with Section 31 00 00 EARTHWORK] [coarse aggregate conforming to ASTM C33/C33M, size number [2.36] [4.75] mm [8] [4] inch] [_____].

2.1.18 Protective Covering for Pervious Backfill

Provide protective covering that is [building paper] [fiberglass mat of lime borosilicate glass fibers. Provide fibers that are 8 to 12 microns in average diameter, 50 to 102 mm 2 to 4 inches in length, and bond with phenol formaldehyde resin. Provide roll type, nonperforated, water permeable mat with thickness between 6 and 13 mm 1/4 and 1/2 inch and density of 12 Kg/cubic meter 3/4 pcf] [filter fabric conforming to Section 33 46 16 SUBDRAINAGE SYSTEM].

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Trenching and Excavation

Perform required trenching and excavation in accordance with Section 31 00 00 EARTHWORK. Keep trenches dry during installation of drainage system. Make changes in direction of drain lines with 1/8 bends. Use wye fittings at intersections.

3.1.2 Bedding

Place graded bedding, minimum 150 mm 6 inches in depth, in the bottom of trench for its full width and length compacted as specified prior to laying of foundation drain pipe. Rest each section firmly upon the bedding, through the entire length, with recesses formed for bell joints. Except for recesses for bell joints, fully support the lower quadrant of the pipe.

3.1.3 Pipe Laying

Lay drain lines to true grades and alignment with a continuous fall in the direction of flow. Face bells of pipe sections upgrade. Clean interior of pipe thoroughly before being laid. When drain lines are left open for connection to discharge lines, temporarily close the open ends and mark the location with wooden stakes. Lay perforated pipe with perforations facing down. Remove and relay any length that has had its grade or joints disturbed at no additional cost to the Government. Install perforated corrugated polyethylene drainage tubing and plastic piping in accordance with manufacturer's specifications and as specified herein. Do not install tubing and piping with physical imperfections.

3.1.4 Jointing

3.1.4.1 Perforated and Porous Pipes

Lay perforated and porous types of drain pipes with closed joints.

3.1.4.2 Nonperforated Drain Tile

Lay nonperforated and plain-end drain tile with 3 to 6 mm 1/8 to 1/4 inch open joints. Cover or wrap open joints. Place one thickness of the cover material over the joint of covered joints. Overlap the joint no less than 100 mm 4 inches on each side and cover the tile for no less than the upper half or more than the upper two-thirds of the circumference of the tile. Use strips of wire cloth wrapping material 75 mm3 inches wide for wrapped joints, with ends fastened together.

3.1.4.3 Perforated Corrugated Metal Pipe

Join perforated corrugated metal pipe sections with standard connecting bands and bolts furnished by the pipe manufacturer.

3.1.4.4 Joints of Concrete or Clay Sewer Pipe

Caulk joints of concrete or clay sewer pipe with oakum and fill solid with cement mortar except where compression joints conforming to ASTM C425 are used on vitrified clay pipe.

3.1.4.5 Joints of Cast-Iron Pipe

Caulk joints of cast-iron pipe or connections between cast-iron and porous concrete pipes with oakum gasket and fill with lead.

3.1.4.6 Perforated Asbestos-Cement Pipe Joints

Make perforated asbestos-cement pipe joints with tapered couplings or with sleeve-type couplings suitable for holding the pipe firmly in alignment without use of sealing compound or gaskets.

3.1.4.7 Plain-End Perforated Clay

Make plain-end perforated clay drain tile joints with spring-wire clips, coated with a rust preventive, that will maintain a taut but elastic joint between sections when laid.

3.1.4.8 ABS Pipe

Join ABS pipe using solvent cement or elastomeric joints and in accordance with ASTM D2751, with dimensions and tolerances in accordance with TABLE II therein.

3.1.4.9 PVC Pipe

Furnish PVC pipe joints in accordance with ASTM D3034, ASTM D3212, or ASTM F949.

3.1.4.10 Corrugated Polyethylene

Furnish corrugated polyethylene (PE) pipe joints in accordance with ASTM F667/F667M or ASTM F667/F667M.

3.1.5 Outlet Lines

The outlet end of drain lines connecting with an open gutter or outfall must be [covered with a removable wire basket of 16-mesh copper or bronze wire cloth fastened with brass or wire straps] [finished as shown].

3.1.6 Cleanouts

Provide cleanouts in locations indicated. Set cleanouts in unpaved areas in 305 by 305 by 102 mm 12 by 12 by 4 inch concrete blocks.

3.2 Backfilling

After joints and connections have been inspected and approved, place the specified pervious backfill material [a minimum width of 150 mm 6 inches on each side of the pipe or tile] [for the full width of the trench and full width between pipe and adjacent walls] and 300 mm 12 inches above the top of the pipe. Place the backfill preventing displacement of or injury to the pipe or tile. Place a protective covering, as specified, over the pervious backfill for the full width of the trench before regular backfill is placed. Compact backfill as specified in Section 31 00 00 EARTHWORK.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 46 16 (May 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 46 16 (Feburary 2017)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-33 46 16 (May 2018)**

Preparing Activity: USACE **Superseding**
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****

SECTION 33 46 16

SUBDRAINAGE PIPING
05/18

****

NOTE: This guide specification covers the requirements for subdrainage systems for drainage of water from under the ground using pipes less than 300 mm 12 inches in diameter.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 UNIT PRICES

****

The paragraph as written contemplates taking bids on a unit-price basis. When it is determined that a lump sum contract may be more advisable, the paragraph will be deleted.

Delete paragraph UNIT PRICES for Navy projects.

****

1.1.1 Pipe Subdrains

Measure the length of pipe installed from end to end along the centerlines without any deduction for the diameter of the manholes. Pipe will be paid for according to the number of linear meters feet of subdrains placed in the accepted work. Payment for bedding and [drainage layer] [filter] materials, except geotextiles, will be included in the payment for the pipe subdrain system.

1.1.2 Blind or French Drains

Blind or french drains will be paid for by the linear meter foot and measured from end to end along the centerlines of the completed drains.

1.1.3 Manholes

Manholes to be paid for will be the number of manholes completed with base, rungs or ladders, frames, and covers or gratings (where specified) constructed in the accepted work.

1.1.4 Flushing and Observation Risers

Flushing and observation risers to be paid for will be the number of flushing and observation risers completed with frames and covers (where specified) constructed in the accepted work.

1.1.5 Geotextile

Measure geotextile for payment by the square meter [yard][foot] in place. Measure overlapped joints and seams as a single layer of cloth.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 190	(2004; R 2019) Standard Specification for Asphalt-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 252	(2009; R 2017) Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A760/A760M	(2015, R 2020) Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A762/A762M	(2019) Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A798/A798M	(2022) Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM B745/B745M	(2015; R 2021) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C478M	(2018) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)

ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3753	(2019) Glass-Fiber-Reinforced Polyester Manholes and Wetwells
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM F758	(2014; R 2023) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F949	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Geotextile

Pipe and Pipe Fittings

SD-06 Test Reports

Geotextile JP-8 Fuel Resistance Test

SD-07 Certificates

Geotextile

Pipe and Pipe Fittings

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

****
NOTE: This time restriction applies to pipe containing normal quantities of ultraviolet (UV) inhibitors such as carbon black or titanium dioxide, in geographic areas receiving normal UV exposure. Delays in installation longer than 6 months, from time of manufacturer to time of installation, may be allowed when the Contractor can show that the pipe has been covered or stored indoors for the duration of the additional delay.
****

Inspect materials delivered to site for damage; unload, and store with minimum handling. Do not store materials directly on the ground. Keep the inside of pipes and fittings sfree of dirt and debris. Keep, during shipment and storage, geotextile wrapped in burlap or similar heavy duty protective covering. Protect the geotextile from mud, soil, dust, and debris. Do not store geotextile materials in direct sunlight. Install plastic pipe within 6 months from the date of manufacture unless otherwise approved.

1.4.2 Handling

Handle materials in such a manner as to ensure delivery to the trench in sound undamaged condition. Carry pipe to the trench.

PART 2 PRODUCTS

2.1 PIPE FOR SUBDRAINS

****

NOTE: Where the type of pipe is to be the Contractor's option, the types that are acceptable should be included in this specification. The inapplicable types of pipe should be deleted.

Perforation and slot sizing is based on embedment gradation, flow requirements, and structural considerations. The embedment material gradation is in turn based on the gradation of the surrounding soil. In order to minimize the migration of fines into the coarser material while maintaining adequate permeability, the following criteria should be met:

All soils (except clays without a sand or silt fraction):

(15 percent size of drainage or filter material)/(85 percent size of material to be drained) = 5 (max)

(50 percent size of drainage or filter material)/(50 percent size of material to be drained) = 25 (max)

(15 percent size of drainage or filter material = 0.4 (max)

All Soils

(15 percent size of drainage or filter material)/(15 percent size of material to be drained) = 5 (min)

(50 percent size of drainage or filter material)/(slot width) = 1.2 (min)

(50 percent size of drainage or filter material)/(hole diameter) = 1.0 (min)

The minimum recommended subdrain pipe diameter is 150 mm 6 inches.

The drawings should indicate which pipes must be perforated (collector pipes) and which pipes must not be perforated (outlet pipes).

****

Submit samples of pipe and pipe fittings, before starting the work. Provide type and sizes of subdrain pipe indicated. Submit certifications from the manufacturers attesting that materials meet specification requirements. Certificates are required for drain pipe and fittings.

2.1.1 Plastic

Provide plastic pipe containing ultraviolet inhibitor to provide protection from exposure to direct sunlight. Provide pipe with with bell and spigot or solvent cement joints. Provide manufacturer's standard type fittings conforming to the indicated specification.

2.1.1.1 Polyvinyl Chloride (PVC) and Fittings

ASTM D3034, ASTM F949 or ASTM F758, Type PS 46.

2.1.1.2 Corrugated Polyethylene (PE) and Fittings

****

NOTE: AASHTO M 252 Type S pipe has an outer corrugated pipe wall and a smooth liner. Type SP pipe is perforated Type S pipe.

****

AASHTO M 252, Type S or SP as indicated.

2.1.1.3 Pipe Perforations

Provide pipe perforations with a minimum water inlet area of 1,060 mm squared per linear meter 0.5 square inch per linear foot and as specified below.

2.1.1.3.1 Circular Perforations in Plastic Pipe

Cleanly cut circular holes not more than 9.5 mm 3/8 inch or less than 4.8 mm 3/16 inch in diameter and arrange in rows parallel to the longitudinal axis of the pipe. Provide pipe with perforations spaced uniformly along rows. Unless otherwise recommended by the pipe manufacturer, provide pipe with rows approximately 38 mm 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. Space the rows over not more than 155 degrees of circumference. Provide pipe that is not perforated for a length equal to the depth of the socket at the spigot or tongue end and provide perforations that continue at uniform spacing over the entire length of the pipe.

2.1.1.3.2 Slotted Perforations in Plastic Pipe

Cleanly cut circumferential slots so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the pipe. Provide pipe with slots not exceeding 3.2 mm 1/8 inch nor less than 0.8 mm 1/32 inch in width. Provide pipe with individual slot lengths not exceeding 10 percent of the pipe inside nominal circumference on 150 to 200 mm 6 to 8 inch diameter pipe, and 63.5 mm 2-1/2 inches on 250 mm 10 inch diameter pipe. Symmetrically space rows of slots so that they are fully contained in 2 quadrants of the pipe. Center slots in the valleys of the corrugations of profile wall pipe.

2.1.2 Corrugated Steel

****

NOTE: Corrugated steel pipe may be installed in soils with a pH range of 6.0 to 8.0 provided the resistivity is greater than 2,000 ohm-cm. A bituminous coating should be used when soil or ground-water conditions are at or near these limits.

150 to 200 mm 6 to 8 inch diameter pipe has 38 by 6.5 mm 1-1/2 by 1/4 inch corrugations. Type I pipe has a circular cross section. Type III pipe is Type I pipe that has been perforated. Class 1 perforations are 4.8 mm to 9.5 mm 3/16 to 3/8 inch in diameter with four rows of perforations. Each perforation is located on the inside crests or along the neutral axis of the corrugations.

****

ASTM A760/A760M, Type I or III, as indicated [with a coating conforming to AASHTO M 190, Type A]. Provide Class 1 perforations in Type III pipe. Pipe sheet thickness 1.63 mm 0.064 inch.

2.1.3 Corrugated Aluminum Alloy

****

NOTE: Corrugated aluminum pipe without bituminous coating may be installed in soil with pH range of 5.5 to 8.5 if the resistivity is greater than 500 ohm-cm or 5.0 to 9.0 where the resistivity is greater than 1,500 ohm-cm. This type of pipe should not be installed in material classified as OH or OL according to the Unified Soil Classification System as presented in ASTM D2487. Bare aluminum alloy pipe has satisfactory corrosion resistance in clean granular materials even when subjected to sea water.

Fully bituminous coated corrugated aluminum pipe may be considered in soils where the pH range is 6.0 to 8.0 and resistivity is greater than 2,000 ohm-cm.

150 to 200 mm 6 to 8 inch diameter pipe has 38 by 6.5 mm 1-1/2 by 1/4 inch corrugations. Type I pipe has a circular cross section. Type III pipe is Type I pipe that has been perforated. Class 1 perforations are 4.8 mm to 9.5 mm 3/16 to 3/8 inch in diameter with four rows of perforations. Each perforation is located on the inside crests or along the neutral axis of the corrugations.

****

ASTM B745/B745M, Type I or III, as indicated [with a bituminous coating conforming to AASHTO M 190, Type A]. Provide Class 1 perforations in Type III pipe. Pipe sheet thickness 1.63 mm 0.064 inch.

2.1.4 Precoated Corrugated Steel

****

NOTE: 150 to 200 mm 6 to 8 inch diameter pipe has 38 by 6.5 mm 1-1/2 by 1/4 inch corrugations. Type I pipe has a circular cross section. Type III pipe is Type I pipe that has been perforated. Class 1 perforations are 4.8 mm to 9.5 mm 3/16 to 3/8 inch in diameter with four rows of perforations. Each perforation is located on the inside crests or along the neutral axis of the corrugations.

****

ASTM A762/A762M, Type I or III, as indicated. Provide Class 1 perforations in Type III pipe.

2.2   GEOTEXTILE

****

NOTE: When geotextile is not used in the drainage system, the requirement for geotextile will be deleted from this specification. When geotextile is used in the drainage system it may be specified either by referencing AASHTO M 288,requirements in Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK (first set of brackets), or by specifying the requirements in this paragraph (remaining brackets).

Design criteria for geotextiles are based on the equivalent opening size (AOS), percent open area (POA), and geotextile permeability (Kg). The AOS is defined as the number of the US Standard Sieve having openings closest in size to the largest openings in the geotextile. The AOS specified should be based on the criteria described below. To perform piping criteria computations, express the AOS as the equivalent US standard sieve opening in millimeters. The AOS can be used for woven and nonwoven geotextiles Where a designer desires to use "percent open area," the percent open area should be based on the criteria below. The percent open area should be used only for woven fabrics. The permeability test can be used for nonwoven and woven geotextiles.

The AOS test is a means of evaluating the piping resistance of a geotextile, and the percent open area test is intended to assure adequate flow through the geotextile and adequate resistance to reduction in permeability over time (clogging). The percent open area test is an indirect test which has been shown to correlate with a woven geotextile's long term permeability. The permeability test measures the ability of the geotextile to pass water without any soil on the fabric. This test does not provide a direct measure of field performance of the geotextile.

Specify geotextile properties which will allow retention of the soil being protected, permit sufficient flow through the fabric, and prevent clogging. The designer should select the AOS, POA, and Kg, based on the following criteria:

Protected Soil Percent Passing 0.075 mm No. 200 Sieve	Piping (a.) Maximum AOS (mm)	Woven Minimum POA	Nonwoven Minimum POA
Less than 5 percent (b.)	D85 (c.)	10 percent	Ks (d.)
5 to 50 percent (b.)	D85	4 percent	Ks
50 to 85 percent	(a.) D85 (b.) Upper Limit on AOS is AOS - 0.212 mm No. 70	4 percent	Ks
More than 85 percent	(a.) D85 (b.) Lower Limit on AOS is AOS - 0.125 mm No. 120		Ks
a. When the protected soil contains appreciable quantities (20 to 30 percent) of material retained on the 4.75 mm, No. 4 sieve, use only the soil passing the 4.75 mm, No. 4 sieve in selecting the AOS of the filter fabric.			
b. These protected soils may have a large permeability and thus the POA of Kg may be a critical design factor.			
c. D85 is the grain size in millimeters for which 85 percent of the sample by weight has smaller grains.			
d. Kg is the permeability of the nonwoven fabric, and Ks is the permeability of the protected soil.			

The AOS requirement should be specified as a range to allow for manufacturing tolerances. The smallest sieve opening size of the AOS range should not be smaller than the openings of a 0.125 mm No. 120 US Standard Sieve. It is preferable to specify a geotextile with openings as large as allowed by the criteria.

Fabric strength requirements vary with intended use and construction procedures. Recommended values are:

Type	Minimum	Test
Tensile	444.8 N 100 lbs	ASTM D4632/D4632M grab test 25 mm 1 inch square and 300 mm 12 inches per minute constant rate at traverse.
Elongation	15 percent	ASTM D4632/D4632M determine apparent breaking elongation.
Puncture	177.8 N 40 lbs.	ASTM D3787 except polished steel ball replaced with a 8 mm 5/16 inch diameter solid steel cylinder with a hemispherical tip centered within the ring clamp.
Tear	177.8 N 40 lbs.	ASTM D4533 trapezoidal tear strength.

Collector pipes should not be wrapped with

geotextile. If the geotextile is used to line a trench, the collector pipe should be separated from the geotextile by a minimum of 150 mm 6 inches of granular backfill material.
****

[Provide geotextile conforming to AASHTO M 288 and meeting the subsurface drainage requirements.] [Provide geotextile meeting the requirements in Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK.][Provide geotextile that is a [woven] [nonwoven] pervious sheet of polymeric material consisting of long-chain synthetic polymers composed of at least 95 percent by weight polypropylene (PP) or polyester (PET). The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Add stabilizers and/or inhibitors to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. The equivalent opening size (AOS) will be no finer than US Standard Sieve No. [_____] and no coarser than US Standard Sieve No. [_____]. AOS is defined as the number of the US Standard sieve having openings closest in size to the filter fabric openings. [The percent open area will not be less than [_____] percent and not more than [_____] percent. Percent open area is defined as the summation of open areas divided by the total area of the filter fabric and expressed as a percent.] The minimum grab strength will be 160 pounds in accordance with ASTM D4632/D4632M. Provide geotextile with filaments constructed so as to retain their relative position with respect to each other. [Selvage or otherwise finish the edges of the geotextile to prevent the outer material from pulling away from the fabric.] [Provide geotextile that is woven into a width that may be installed as shown without longitudinal seams.]]

Submit samples of geotextile and certifications from the manufacturers attesting that geotextile meets specification requirements.

2.3 [DRAINAGE LAYER] [SUBDRAIN FILTER AND BEDDING] MATERIAL

****
NOTE: The thickness and gradation of the filter material for use with pipe subdrains and blind or french drains will be determined by soil conditions and subsoil drainage requirements. Filter material will be graded in accordance with the requirements of UFC 3-250-01, as applicable. The filter material placed adjacent to perforated pipe will be of a size that will prevent the entrance of any of the filter material into the drain. Graded (composite or layered) filters will be used where specified, and cross sections will be as indicated on the drawings. See UFC 3-250-01 for dimensions of filter and bedding material around pipe. Where site conditions require more than one filter gradation, the drawings will indicate areas of different gradation and the table expanded.
****

[Provide drainage layer material meeting the requirements in Section 32 11 23.23 BASE COURSE DRAINAGE LAYERS][Provide subdrain filter and bedding material composed of washed sand, sand and gravel, crushed stone, crushed stone screenings, or slag composed of hard, tough, durable particles free from adherent coatings. Filter material may not contain corrosive agents, organic matter, or soft, friable, thin, or elongated particles. Provide filter material that is evenly graded between the limits specified in TABLE I. Gradation curves will exhibit no abrupt changes in slope denoting skip or gap grading. Provide filter materials that are clean and free from soil and foreign materials. Remove and replace filter blankets found to be dirty or otherwise contaminated with material meeting the specific requirements, at no additional cost to the Government.

TABLE I

	Type I Gradation E 11 ASTM C33/C33M	Type II Gradation 57 ASTM C33/C33M	Type III Gradation [_____] [_____]
ASTM C136/C136M Sieve Size, mm	Percent Passing	Percent Passing	Percent Passing
37.5 1-1/2 inch	--	100	[_____]
25.0 1 inch	--	90 - 100	[_____]
9.5 3/8 inch	100	25 - 60	[_____]
4.75 No. 4	95 - 100	5 - 40	[_____]
2.36 No. 8	--	0 - 20	[_____]
1.18 No. 16	45 - 80	--	[_____]
0.30 No. 50	10 - 30	--	[_____]
0.15 No. 100	0 - 10	--	[_____]

]

2.4 DRAINAGE STRUCTURES

2.4.1 Concrete

Provide concrete and reinforced concrete conforming to the requirements for [21] [_____] MPa [3,000] [_____] psi concrete in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.4.2 Mortar

Provide mortar for connections to drainage structures that is composed of one part by volume of portland cement and two parts of sand. Provide sufficient quantity of water in the mixture to produce a stiff workable mortar. Use water that is clean and free of injurious acids, alkalies, and organic impurities. Use the mortar within 30 minutes from the time the ingredients are mixed with water.

2.4.3 Manholes and Appurtenances

2.4.3.1 Precast Reinforced Concrete Manhole Risers and Tops

ASTM C478M ASTM C478.

2.4.3.2 Precast Concrete Manhole Bases

ASTM C478MASTM C478. Provide bases that allow suitable connection with influent and effluent lines and to provide a suitable base structure for riser sections.

2.4.3.3 Glass Fiber-Reinforced Polyester (FRP)

ASTM D3753.

2.4.3.4 Frames and Covers or Gratings

Except as otherwise permitted, provide frames and gratings, or frames and covers of either cast iron with tensile strength test not less than ASTM A48/A48M Class 25 or steel conforming to ASTM A27/A27M, Class 65-35. Required weight, shape, and size are indicated on the drawings. Frames and covers not subjected to vehicular traffic or storage may be of malleable iron where indicated. Provide malleable-iron frames and covers conforming to ASTM A47/A47M and of the weight, shape, and size indicated.

2.4.3.5 Steel Ladder

Provide a steel ladder where the depth of a manhole exceeds 3.66 m 12 feet. The ladder will be not less than 400 mm 16 inches in width, with 19.1 mm 3/4 inch diameter rungs spaced 304.8 mm 12 inches apart. Provide two stringers that are a minimum 9.5 mm 3/8 inch thick and 50.8 mm 2 inches wide. Adequately anchor ladder to the wall by means of steel inserts spaced not more than 1.83 m 6 feet apart vertically, and install so as to provide at least 152.4 mm 6 inches of space between the wall and the rungs. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

2.5.1 Geotextile JP-8 Fuel Resistance Test

****

NOTE: Delete this paragraph when geotextile will not be exposed to JP-8 fuel.

****

Immerse five unaged geotextile samples, 97 to 107 mm by 147 to 157 mm 4 (plus or minus 0.2) by 6 (plus or minus 0.2) inches in JP-8 fuel at room temperature for a period of 7 days. Test each sample for tensile strength and elongation in accordance with ASTM D4632/D4632M. Provide geotextile with a strength in any direction of not less than 85 percent of the strength specified in paragraph GEOTEXTILE.

PART 3 EXECUTION

3.1 EXCAVATION AND BEDDING FOR SUBDRAIN SYSTEMS

Excavate trenches, including the removal of rock and unstable material, in accordance with Section 31 00 00 EARTHWORK. Place bedding material in the trench as indicated or as required as replacement materials used in those areas where unstable materials were removed. Compact bedding material as specified for cohesionless material in Section 31 00 00 EARTHWORK.

3.2 MANHOLES AND FLUSHING AND OBSERVATION RISERS

****

NOTE: The details indicating size, shape, materials, thickness of various sections, the finish required, and amounts or reinforcing, if any, for headwalls, and manholes will be shown in the drawings. Also, the shape, size, thickness of sections, kind of materials, and weight for frames and covers for subdrain manholes will be indicated in the drawings. The covers will be designed to have ample strength for the traffic conditions to which they may be subjected. Fixed ladders or ladder rungs will be provided for manholes 3.6 m 12 feet or deeper measured from top of grate to invert of outlet pipe.

****

3.2.1 Manholes

Install manholes complete with frames and covers or gratings at the locations and within the limits and sizes indicated. Construct manholes of one of the materials specified for manholes in paragraph DRAINAGE STRUCTURES. [Completely fill precast concrete manhole joints so that they are smooth and free of surplus mortar or mastic on the inside of the structure.] Use either precast or cast-in-place concrete manhole bases.

3.2.2 Flushing and Observation Risers

Install flushing and observation riser pipes with frames and covers at the locations indicated. Construct risers of non-perforated [plastic] [or] [galvanized] [bituminous coated] [corrugated metal] pipe. Join riser pipes to the subdrain system as indicated.

3.3 INSTALLATION OF GEOTEXTILE AND PIPE FOR SUBDRAINS

****

NOTE: Outlets for subdrains, if possible, within reasonable costs, will be designed so that severe rainstorms will neither submerge the drains nor back up water into the drains. Where outlets are not subject to backwater or flooding, the outlets will be provided with grates or heavy screens to prevent acts of vandalism or entrance by rodents. If suitable outlets for blind or french drains into pervious strata of gravel or sand with a lower water table are not obtainable, pipe outlets may be required. The perforated pipe will extend into the filter material of the blind or french drain a sufficient distance to provide ample waterway openings for the particular drain and non-perforated pipe will extend through the impervious material to a suitable outlet. Outlets subject to flooding will be provided with suitable and properly installed check valves or flap gates. If outlet pipes are necessary for blind or french drains, and are to be paid for as a separate item, such requirement will be clearly specified, giving the various kinds and sizes of pipe required.

****

3.3.1 Installation of Geotextile

****

NOTE: When geotextile is not used in the drainage system, the requirement for geotextile will be deleted from this specification.

****

3.3.1.1 Trench Lining and Overlaps

****

NOTE: The strength properties of most geotextiles composed of plastic materials are adversely affected by ultraviolet rays. Consequently, the geotextile should be exposed to sunlight as little as possible, and preferably should be covered the same day as installed. When geotextile is used to separate the drainage layer or filter material from the soil being drained, the gradation ratios of filter material to protected soil given in UFC 3-230-06A, do not apply; however, size the geotextile to filter the protected soil.

****

Grade trenches to be lined with geotextile to obtain smooth side and bottom surfaces so that the geotextile will not bridge cavities in the soil or be damaged by projecting rock. Lay the geotextile flat but not stretched on the soil, and secure it with anchor pins in accordance with manufacturer's instructions. Overlap at least 150 to 300 mm 6 to 12 inches, and secure with anchor pins along the overlaps.

3.3.2 Installation of Pipe for Subdrains

3.3.2.1 Pipelaying

Install pipe in accordance with the manufacturer's recommendations. Thoroughly examine each section of pipe before being laid; do not use defective or damaged pipe. Do not lay pipe when the trench conditions or weather is unsuitable for such work. Remove water from trenches by sump pumping or other approved methods. Lay the pipe to the grades and alignment as indicated. Bed the pipe to the established gradeline. Center perforations on the bottom of the pipe. Lay bell-and-spigot type with the bell ends upstream. Approval of all in-place pipes by the Contracting Officer is required prior to backfilling.

3.3.2.2 Jointings

3.3.2.2.1 Perforated Corrugated Metal Pipe or Bituminous Coated, Perforated Corrugated Metal Pipe

Securely fasten together the sections of perforated corrugated metal pipe or bituminous coated, perforated corrugated metal pipe standard connecting bands furnished by the manufacturer of the pipe.

3.3.2.2.2 Bituminous Coated or Uncoated Corrugated Aluminum Pipe

If aluminum pipe is to be connected to dissimilar metal, insulate the connection by bituminous coating or other nonconductive material. Securely fasten standard joints between corrugated aluminum pipe with standard connecting bands furnished by the manufacturer of the pipe.

3.4 INSTALLATION OF [DRAINAGE LAYER][FILTER] MATERIAL AND BACKFILLING FOR PERFORATED SUBDRAINS

After perforated pipe for subdrains has been laid, inspected, and approved, place [drainage layer] [filter] material around and over the pipe to the depth indicated. Place the [drainage layer] [filter] material in layers not to exceed 200 mm 8 inches thick. [Saturate by flooding.] [Thoroughly compact each layer using mechanical tampers or rammers.]

3.5 INSTALLATION OF BEDDING AND BACKFILL FOR NON-PERFORATED SUBRAIN OUTFALL PIPE

3.5.1 Plastic Pipe

Place and compact pipe embedment for plastic pipe in accordance with ASTM D2321. Use Class IB or II embedment materials.

3.5.2 Corrugated Metal Pipe

Place and compact bedding ans structural backfill for corrugated metal pipe in accordance with ASTM A798/A798M. Use structural backfill materials classified by ASTM D2487 as either GW, GM, GP-GM, GW-GM, GC, GP-GC or SW.

3.6 INSTALLATION OF AND BACKFILLING FOR BLIND OR FRENCH DRAINS

Place filter material as indicated and compact as specified for cohesionless materials in Section 31 00 00 EARTHWORK. Extend filter material to a suitable outlet or to an outlet through a pipeline as indicated. Place and compact overlying backfill material as specified in Section 31 00 00 EARTHWORK.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 47 13 (November 2014)**
Change 2 - 11/15

Preparing Activity: NAVFAC **Superseding**
UFGS-33 47 13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 47 13

POND AND RESERVOIR LINERS

11/14, CHG 2: 11/15

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-33 47 13 (November 2014)**
Change 2 - 11/15

Preparing Activity: NAVFAC **Superseding**
UFGS-33 47 13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 47 13

POND AND RESERVOIR LINERS
11/14, CHG 2: 11/15

****

NOTE: This guide specification covers the requirements for rubber and plastic flexible pond and reservoir liners.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: This guide specification does not cover clay or other types of earth liners. General site preparation must be covered in other sections, preferably Section 31 00 00 EARTHWORK and where required, Section 03 30 00 CAST-IN-PLACE CONCRETE.

****

****

NOTE: Show the following information on the project drawings:

1. Extent of liner.

2. Details of earth anchorage.

3. Details of anchorage to structures.

4. Thickness of earth cover.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D413	(1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM D4437/D4437M	(2016; R 2018) Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D6214/D6214M	(2013) Determining the Integrity of Field Seams Used in Joining Geomembranes by Chemical Fusion Methods
ASTM D6392	(2012; R 2018) Standard Test Method for Determining the Integrity of Nonreinforced

	Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D7002	(2016) Standard Practice for Leak Location on Exposed Geomembranes Using the Water Puddle System
ASTM D7006	(2013) Standard Practice for Ultrasonic Testing of Geomembranes
ASTM D7007	(2016) Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials
ASTM D7176	(2006; R 2011) Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications
ASTM D7272	(2006; R 2018) Standard Test Method for Determining the Integrity of Seams Used in Joining Geomembranes by Pre-manufactured Taped Methods
ASTM D7408	(2012; R 2020) Non Reinforced PVC (Polyvinyl Chloride) Geomembrane Seams
ASTM D7700	(2015) Standard Guide for Selecting Test Methods for Geomembrane Seams

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GM13	(2016) Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GSI GRI GM17	(2015) Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
GSI GRI GM18	(2015) Test Methods, Test Properties and Testing Frequencies for Flexible Polypropylene (fPP and fPP-R) Nonreinforced and Reinforced Geomembranes
GSI GRI GM19	(2002; R 2013) Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes
GSI GRI GM21	(2016) Test Methods, Properties and Frequencies for Ethylene Propylene Diene Terpolymer (EPDM) Nonreinforced and Scrim Reinforced Geomembranes
GSI GRI GM25	(2009; R 2012) Test Methods, Test Properties and Testing Frequency for Reinforced Linear Low Density Polyethylene (LLDPE-R) Geomembranes

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Liner System; G, [_____]

SD-03 Product Data

Liner; G, [_____]

Seaming Adhesive

Penetration Assemblies; G, [_____]

Filter Fabric; G, [_____]

Sealants

SD-07 Certificates

Liner; G, [_____]

Filter Fabric

SD-08 Manufacturer's Instructions

Liner; G, [_____]

Seaming Adhesive

Sealants

SD-11 Closeout Submittals

Manufacturer's Warranty; G, [_____]

Installation Warranty; G, [_____]

1.3 DELIVERY AND STORAGE

Deliver liner [and filter fabric] to site in largest sizes possible to minimize field seaming. Protect from sunlight and other ultraviolet light sources during storage. Keep cements and adhesives from extreme cold or heat. Keep materials clean and dry.

1.4 QUALITY ASSURANCE

1.4.1 Required Drawing

Submit drawing of liner system indicating sheet and seam layout, anchorage details, and penetration details.

1.5 WARRANTY

****

NOTE: Manufacturers typically provide prorated material warranties ranging from 1 to 30 years depending on the specific application. Installation warranties are generally specified as one to five years in length.

****

1.5.1 Manufacturer's Warranty

Provide the Manufacturer's Warranty to the Contracting Officer. Ensure Warranty is valid for a minimum of [2] [5] [_____] years from the date of project closeout, showing the Government as warranty recipient.

1.5.2 Installation Warranty

Provide the Installation Warranty to the Contracting Officer, along with final test reports. Ensure Warranty is valid for a minimum of [2] [5] [_____] years from the date of project closeout, showing the Government as warranty recipient.

PART 2 PRODUCTS

2.1 LINER

****

NOTE: This specification covers rubber and plastic reinforced and unreinforced geomembranes. Plastic liners include polyethylene, ethylene copolymer, High Density Polyethylene, Linear Low Density Polyethylethylen, Flexible Polypropylene. Rubber liners include Ethylene Propylene Diene Terpolymer. Allow use of as many of the above types of materials as design considerations allow. Such considerations include cost, foundation conditions, chemical compatibility between liner and stored product. Fabric reinforced liners are available and are useful where extra strength is needed. Do not use the extra strength of fabric reinforcement as a replacement for an appropriate thickness of subgrade or base.

****

2.1.1 High Density Polyethylene (HDPE)

[Smooth] [Textured] HDPE manufactured in accordance with and conforming to GSI GRI GM13, [_____] mm mils thick.

2.1.2 Linear Low Density Polyethylene (LLDPE)

[Smooth] [Textured] LLDPE manufactured in accordance with and conforming to GSI GRI GM17, [_____] mm mils thick.

2.1.3 Flexible Polypropylene (fPP and fPP-R)

[Unreinforced] [Reinforced] fPP manufactured in accordance with and conforming to GSI GRI GM18, [_____] mm mils thick.

2.1.4 Ethylene Propylene Diene Terpolymer(EPDM)

[Unreinforced] [Reinforced] EPDM manufactured in accordance with and conforming to GSI GRI GM21,[1.12 mm 45 mils][1.5 mm 60 mils] thick.

2.1.5 Reinforced Linear Low Density Polyethylene (LLDPE-R)

Reinforced LLDPE-R manufactured in accordance with and conforming to GSI GRI GM25, [_____] mm mils thick.

2.1.6 Polyvinyl Chloride (PVC)

PVC manufactured in accordance with and conforming to ASTM D7176, [_____] mm mils thick.

2.2 ACCESSORIES

2.2.1 ADHESIVE

Provide seaming adhesive compatible with type of liner used as recommended by manufacturer.

2.2.2 SEALANT

Provide sealants compatible with the type of liner used as recommended by manufacture. The use of silicone sealant is not allowed with PVC liner materials.

2.2.3 PENETRATIONS

Provide manufacturer's standard factory fabricated penetration assemblies. Make penetration assemblies of the same base material as liner and at least 1.12 mm 45 mils thick.

2.3 FILTER FABRIC

****

NOTE: Filter fabric is a useful material to provide: 1) a better subgrade; 2) a path for water or gas migration; 3) and a convenient material for drainage when a double liner system is used. Specify cloth that retains the soil being protected, yet has openings large enough to permit drainage and prevent clogging. Select the "equivalent opening sizes" (EOS) and "percent open area" based on the following criteria:

1. Filter cloth adjacent to granular materials containing 50 percent or less by weight fines (materials passing 75 micrometers (No. 200) sieve):

a. The 85 percent size of the soil, divided by the nearest opening size of EOS sieve (nearest U.S. Standard Sieve) is equal to or greater than one.

b. Open area not to exceed 36 percent.

2. Filter cloths adjacent to all other type soils:

a. EOS no larger than the openings in the U.S. Standard Sieve 212 micrometers No. 70.

b. Open area not to exceed 10 percent.

To reduce the chance of clogging, specify cloth with an open area equal to or greater than 4 percent or an EOS with openings equal to or greater than the openings of a U.S. Standard Sieve Sized 150 micrometers No. 100.

****

Provide a permeable, synthetic barrier sheet resistant to mildew, chemicals in soil, stable under freeze-thaw cycles, which will not shrink or expand under wet conditions, and will not unravel or become clogged during use. Filter cloth must have a minimum tensile strength of 534 N 120 pounds. Allowable open area must not exceed [36] [_____] percent and must not be less than [4] [_____] percent. Percent open area is defined as the summation of open areas divided by total area of filter cloth. Equivalent Opening Size (EOS) must not be finer than the U.S. Standard sieve [212] micrometers [_____] No. [70] [_____].

PART 3 EXECUTION

3.1 SURFACE PREPARATION

3.1.1 Soil or Granular Subgrade

****

NOTE: Earth subgrades should be sloped from 0.5 to 1.0 percent. Sloped subgrade provides a path for water or gas escape particularly if filter fabric or a double liner with drainage system is used.

****

Prepare subgrade in accordance with Section 31 00 00 EARTHWORK. Remove vegetation, boulders and rocks larger than 20 mm 3/4 inch in size and other sharp objects. Fill in holes, including stake holes. Inspect subgrade surface and correct defects prior to continuing construction.

3.1.2 Concrete

Provide concrete surfaces and pipe anchorages in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide smooth surfaces with no sharp projections or abrupt surface changes. Compact earth within 300 mm 12 inches of any concrete surfaces to 100 percent maximum density, in accordance with ASTM D698.

3.2 CLEANING OF LINER SHEET

****

NOTE: Some liner materials are manufactured with a surface bloom or surface cure that must be removed prior to making seams. Consult with liner manufacturers.

****

Clean liner sheets of dust, dirt, and other foreign matter. Carefully clean area (both mating surfaces) of seams. [Remove surface [bloom] or [cure] with solvent recommended by manufacturer.]

3.3 FILTER FABRIC INSTALLATION

****

NOTE: Use bracketed sentence when fill is placed between filter fabric and plastic or rubber liner.

****

Place synthetic fiber filter fabric on prepared subgrade. Repair damaged fabric by placing an additional layer of fabric to cover the damaged area a minimum of 900 mm 3 feet overlap in all directions. Overlap fabric at joints a minimum of 900 mm 3 feet. [Obtain approval of filter fabric installation before placing fill. Place fill on fabric in the direction of overlaps and compact as specified in Section 31 00 00 EARTHWORK.]Follow manufacturer's recommended installation procedures.

3.4 LINER INSTALLATION

3.4.1 Placement

****

NOTE: Additional wording may be needed when surface below liner could cause damage or areas where wind conditions or pond geometry will cause obvious problems during placement. Time in bracketed clause can be varied depending upon climatic conditions.

****

Position liner on previously prepared surface [or filter fabric] as indicated. Unroll or unfold carefully. Avoid stretching. Allow liner to lie in a relaxed state [for a minimum of 1/2 hour] prior to seaming.

3.4.2 Seams and Laps

****

NOTE: During design, consider configurations that require as few seams as possible, with no seams located in areas of maximum stress. Certain types of liners, particularly cured rubber sheeting, may require sealing edges of supported liners with seaming adhesive and liner. Sealing edges of supported liners with seaming adhesive is required where scrim is exposed. Include additional safety requirements appropriate for individual types of seaming adhesive specified.

****

Provide personnel handling or applying seaming adhesive with protective clothing and other appropriate safety equipment. Apply seaming adhesive and make field seam. Make lap or seam [_____] [150 mm 6 inches] wide. Seal lap or seam using rollers or hand pressure removing any wrinkles at that time. A plank or board may be used for back-up during sealing but remove prior to completion of installation. [For supported liners apply splicing cement to cut edges of liner and seal with a strip of unsupported liner of same material as liner.] [For supported liners apply splicing cement to cut edges (exposed scrim) of liner.]

3.4.3 Repairs

Make repairs to liner with same material as liner. Extend patch 150 mm 6 inches in all directions from puncture. Use same method as for seams.

3.5 ANCHORAGE

3.5.1 Earth Anchorage

****

NOTE: Earth anchorage at perimeter of reservoir is the preferred method of providing anchorage. Where concrete is used as trench backfill modify paragraph accordingly.

****

Make perimeter trench [a minimum of 300 mm 12 inches wide by 300 mm 12 inches deep] [as indicated]. After installation of liner in reservoir is complete, place liner in perimeter trench and backfill trench.

3.5.2 Anchorage to Structures

****

NOTE: Placement of structures within liner area and penetration of liner by piping is not recommended. Where such items are required, close attention to details of design and construction are required.

****

Remove curing compounds and coatings from structures in joint areas. Use bonding adhesive recommended by manufacturer to make joints. Make joint to structures [at least 300 mm 12 inches wide.] [the width indicated. Use batten strips of stainless steel bars to reinforce joint.]

3.6 BACKFILL OVER LINER

****

NOTE: Where earth covering is used, side slopes of 3:1 or less are generally required.

****

Cover installed liner with earth to depth [indicated.] [of 450 mm 18 inches.] [Cover liner within time limits specified by liner manufacturer.] Place earth on liner using rubber tired or tracked vehicles. Drive only on earth cover. Correct any damage to liner caused by covering operations.

3.7 FIELD QUALITY CONTROL

3.7.1 Tests

Use ASTM D7700 to determine appropriate test methods necessary to evaluate geomembrane seams for materials listed in this specification. [Take one destructive field seam sample per [500 meters 1640 feet] [_____] meters feet of seam.] [Perform an electrical leak detection survey.]

3.7.1.1 Nondestructive testing (NDT)

3.7.1.1.1 Nonreinforced testing

Perform NDT in accordance with ASTM D4437/D4437M. For HDPE, LLDPE, fPP and PVC use ASTM D7006 for ultrasonic testing of materials and seams. For PVC, ASTM D7006 is only applicable to factory seam testing.

3.7.1.1.2 Reinforced testing

Perform NDT in accordance with ASTM D4437/D4437M.

3.7.1.2 Destructive testing

Perform destructive testing in accordance with GSI GRI GM19.

3.7.1.2.1 Nonreinforced testing

For HDPE, LLDPE, and fPP perform destructive testing in accordance with ASTM D6392.

[For EPDM perform destructive testing in accordance with ASTM D7272.

][For PVC perform destructive testing in accordance with ASTM D7408.

]3.7.1.2.2 Reinforced testing

For reinforced geomembranes materials listed in this specification perform destructive testing in accordance with ASTM D751, ASTM D6214/D6214M, and ASTM D6392.

[3.7.1.3 Adhesion to Flexible Substrate

For EPDM perform adhesion test in accordance with ASTM D413.

]3.7.1.4 Electrical Leak Location

For HDPE, LLDPE, fPP and PVC provide electrical leak location in accordance with ASTM D7002 and ASTM D7007.

3.7.1.5 Leakage Testing

****

NOTE: Use this paragraph when required to determine whether liner has an acceptable amount of leakage. A liner with no leakage is in a practical sense, not possible. Also, the cost of performing leakage testing may be high depending on the size of the pond or reservoir.

****

Test pond or reservoir for leakage. Determine leakage rate. Leakage rate (Q) must not exceed the lesser of 4 liters 1 gallon per minute or the amount given by the following formula. Q (Leakage rate in gallons per minute) equals A (Area of liner in thousands of square feet) multiplied by the square root of H (Depth of liquid in feet), the product then divided by 80.

3.7.2 Inspection

Inspect completed liner for pinholes, punctures, and tears. Inspect seams and joints for unbonded areas. Repair defects as specified herein.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 51 15 (August 2019)**

Preparing Activity: USACE **Superseding**
UFGS-33 51 15 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 51 15

NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES

08/19

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 51 15 (August 2019)**

Preparing Activity: USACE **Superseding**
UFGS-33 51 15 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 51 15

NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES

08/19

****

NOTE: This guide specification provides requirements for distribution pipelines that convey natural gas, manufactured gas, or Liquefied Petroleum Gas (LPG) in the vapor phase in order to comply with the regulations written in 49 CFR 192. LPG vapor distribution pipelines must additionally comply with the requirements of NFPA 58, as is required by 49 CFR 192.

Where LPG tanks have remote filling piping system that can contain LPG in the liquid phase, please refer to UFC 4-60-01, Design: Petroleum Fuel Facilities, for required design elements.

Gas piping that serves a building, downstream from the 49 CFR 192 pipeline, is to be specified in Section 23 11 20 FACILITY GAS PIPING, and must be designed in accordance with NFPA 54.

LPG piping and storage tank that serves a single building are to be specified in Section 23 11 20 FACILITY GAS PIPING and must be designed in accordance with NFPA 58 and NFPA 54.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be

submitted as a Criteria Change Request (CCR).
****

PART 1   GENERAL

****
NOTE: This guide specification may be used for specifying liquefied petroleum gas (LPG) if the following modifications are made:

a. Delete all references to fiberglass and add the following to paragraph "Polyethylene Pipe, Tubing, Fittings and Joints" in PART 2: Polyethylene pipe, tubing, and fittings are recommended by the manufacturer for use with LPG.

b. Require, where applicable, the LPG distribution system to be in accordance with NFPA 58, Storage and Handling of Liquefied Petroleum Gases, instead of ASME B31.8.
****

1.1   SUMMARY

The gas distribution pipeline includes piping that conveys [natural gas] [manufactured gas] [liquefied petroleum gas (LPG) in its vapor phase] and all appurtenances from point of connection with existing system, to a point approximately [1500] [_____] mm [5] [_____] feet from the facility being served. The distribution pipeline, which must comply with 49 CFR 192, terminates at the isolation valve, service pressure regulator, or meter, whichever is the most downstream component before serving the facility gas piping. The facility gas piping that connects to this termination point is specified in Section 23 11 20 FACILITY GAS PIPING and must comply with NFPA 54.

Section 31 10 00 SITE CLEARING, applies to this section unless otherwise specified.

1.2   REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA ANSI B109.1	(2000) Diaphragm Type Gas Displacement Meters (Under 500 cubic ft./hour Capacity)
AGA ANSI B109.2	(2000) Diaphragm Type Gas Displacement Meters (500 cubic ft./hour Capacity and Over)
AGA ANSI B109.3	(2019) Rotary-Type Gas Displacement Meters
AGA ANSI B109.4	(2016) Self-Operated Diaphragm-Type Natural Gas Service Regulators for Nominal Pipe Size 1¼ inches (32 mm) and Smaller with Outlet Pressures of 2 psig (13.8 kPa) and Less
AGA XR0603	(2006; 8th Ed) AGA Plastic Pipe Manual for Gas Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.18/CSA 6.3	(2019; R 2024) Gas Appliance Pressure Regulators
ANSI Z21.80/CSA 6.22	(2019; R 2024) Line Pressure Regulators

AMERICAN PETROLEUM INSTITUTE (API)

API API-ASME CODE	(1951) Unfired Pressure Vessels for Petroleum Liquids and Gases
API RP 686	(2009) Recommended Practice for Machinery Installation and Installation Design
API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves
API Std 617	(2014; 8th Ed; ERTA 1 August 2016) Axial and Centrifugal Compressors and Expander-Compressors
API Std 618	(2007; R 2016) Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services
API Std 619	(2010) Rotary-Type Positive Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries

API Std 1104	(2013; Errata 1-3 2014; Addendum 1 2014; Errata 4 2015; Addendum 2 2016) Welding of Pipeline and Related Facilities

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.25	(2022) Buttwelding Ends
ASME B16.40	(2024) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
ASME B31.8	(2022; Supplement 2022) Gas Transmission and Distribution Piping Systems
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 25	(2023) Pressure Relief Devices

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe,

	Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A333/A333M	(2016) Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness
ASTM A395/A395M	(1999; R 2022) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM D2513	(2018a) Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
ASTM D2513-99	(1999) Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2517	(2018) Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
ASTM D2683	(2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D2774	(2021a) Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3839	(2014; R 2019) Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3892	(2015) Standard Practice for Packaging/Packing of Plastics

ASTM D4066	(2013) Standard Classification System for Nylon Injection and Extrusion Materials (PA)
ASTM D5685	(2019) Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings
ASTM F1055	(2016; R 2022a) Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX)Pipe and Tubing
ASTM F1802	(2022) Standard Test Method for Performance Testing of Excess Flow Valves
ASTM F1948	(2015) Standard Specification for Metallic Fittings for Use on Outside Diameter Controlled Thermoplastic Gas Distribution Pipe and Tubing
ASTM F1973	(2013; R 2018) Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems
ASTM F2138	(2012; R 2024) Standard Specification for Excess Flow Valves for Natural Gas Service
ASTM F2145	(2013; R 2018) Standard Specification for Polyamide 11 (PA 11) and Polyamide 12 (PA 12) Mechanical Fittings for Use on Outside Diameter Controlled Polyamide 11 and Polyamide 12 Pipe and Tubing
ASTM F2164	(2021) Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure
ASTM F2600	(2009; R 2018) Standard Specification for Electrofusion Type Polyamide-11 Fittings for Outside Diameter Controlled Polyamide-11 Pipe and Tubing
ASTM F2620	(2024) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
ASTM F2786	(2010) Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing)
ASTM F2897	(2015a) Standard Specification for Tracking and Traceability Encoding System of Natural Gas Distribution Components

	(Pipe, Tubing, Fittings, Valves, and Appurtenances)
ASTM F2945	(2018) Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-142	(2012) Excess Flow Valves for Fuel Gas Service, NPS 1 1/2 through 12

MASTER PAINTERS INSTITUTE (MPI)

MPI 9	(2016) Alkyd, Exterior Gloss (MPI Gloss Level 6)
MPI 10	(2016) Latex, Exterior Flat (MPI Gloss Level 1)
MPI 11	(2016) Latex, Exterior Semi-Gloss, MPI Gloss Level 5
MPI 119	(2016) Latex, Exterior, Gloss (MPI Gloss Level 6)

NACE INTERNATIONAL (NACE)

NACE SP0169	(2024) Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE SP0185	(2024) Extruded Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe
NACE SP0274	(1974; R 2011) High Voltage Electrical Inspection of Pipeline Coatings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2024) National Fuel Gas Code
NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC Paint 25	(1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II
SSPC SP 1	(2015) Solvent Cleaning

SSPC SP 3	(2024) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards
49 CFR 192.105	Design Formula for Steel Pipe
49 CFR 192.197	Control of the Pressure of Gas Delivered from High-Pressure Distribution Systems

UL SOLUTIONS (UL)

UL 125	(2020) UL Standard for Safety Flow Control Valves for Anhydrous Ammonia and LP-Gas
UL 132	(2015; Reprint Jan 2018) UL Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas
UL 144	(2012; Reprint Nov 2014) UL Standard for Safety LP-Gas Regulators
UL 569	(2013; Repring Jul 2017) UL Standard for Safety Pigtails and Flexible Hose Connectors for LP-Gas

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pipe, Fittings, and Associated Materials

SD-03 Product Data

Materials and Equipment; G, [_____]

Spare Parts; G, [_____]

Pipe and Accessory Coatings; G, [_____]

SD-05 Design Data

Connections to Existing Lines; G, [_____]

Connection and Abandonment Plan; G, [_____]

SD-06 Test Reports

Pressure and Leak Tests

SD-07 Certificates

Welder's training and qualifications

Jointing of Plastic Piping

Utility Work

SD-08 Manufacturer's Instructions

EFV Design and Installation Guide

SD-10 Operation and Maintenance Data

Gas Distribution System and Equipment Operation; G, [_____]

Gas Distribution System Maintenance; G, [_____]

Gas Distribution Equipment Maintenance; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

1.4.1.1 Welding General

a. Qualification of welding procedures and Welder's training and qualifications, including equipment used, detailed explanation of the procedure, and successfully making joints which pass tests must comply with Subpart E of 49 CFR 192.

b. Submit procedures for welding of metallic piping that comply with API Std 1104 section 5, 12, or App. A; or ASME BPVC SEC IX. Quality of test welds used to qualify a procedure must be determined by destructive test. Submit the results of destructive testing of each procedure qualification for Government record.

c. Submit a certificate of Welder's training and qualifications by test, requalification, or production work testing in conformance with API Std 1104 section 6, 12, or App. A; ASME BPVC SEC IX; or as allowed per 49 CFR 192 Appendix C.

d. Submit a list of names and identification symbols for all qualified welders and welding operators to be used on the project.

e. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

1.4.1.2 Jointing of Plastic Piping

a. Join piping by performance qualified plastic pipe joiners, qualified by a person who has been trained and certified by the manufacturer of the pipe, using manufacturer's pre-qualified joining procedures that have been tested in accordance with 49 CFR 192 Subpart F. Inspect joints by an inspector qualified in the joining procedures being used.

b. Submit manufacturer's pre-qualified joining procedures and the results of testing performed to 49 CFR 192 Section 283.

c. Plastic pipe joiners must be re-qualified at the beginning of each project by making specimen joints using the approve procedures and having those joints inspected by a qualified inspector and tested in accordance with 49 CFR 192 Section 285.

d. Submit a certificate of qualified jointing procedures, training procedures, qualifications of trainer, and training test results for joiners and inspectors. Notify the Contracting Officer at least [24] [_____] hours in advance of the date to qualify joiners and inspectors.

1.4.2 Pre-Installation Conference

1.4.2.1 Shop Drawings

Submit shop drawings, within [30] [_____] days of contract award, containing complete schematic and piping diagrams and any other details required to demonstrate that the system has been coordinated and functions properly as a unit. Show on the drawings proposed layout and anchorage of the system and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

1.4.2.2 Connecting and Abandonment Plan

Submit written notification of the method and schedule for making connections to existing gas lines, to the Contracting Officer at least 10 days in advance. Include gas line tie in, hot taps, abandonment/removal or demolition, purging, and plugging as applicable. ASME B31.8 may be used to help develop these plans, but the connection and abandonment must comply with 49 CFR 192. Include in submittal [connections to existing lines][connection and abandonment plan].

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to the site for damage, and store with a minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.5.2 Handling

Handle pipe and components carefully to ensure a sound, undamaged condition. Take particular care not to damage pipe coating. Repair damaged coatings to original finish. Do not place pipe or material of any kind inside another pipe or fitting after the coating has been applied, except as specified in paragraph INSTALLATION. Handle coated steel piping in accordance with its listing and the manufacturer's written procedures. Handle plastic pipe in conformance with AGA XR0603.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of equipment and material specified, after approval of the detail shop drawings and not later than [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

[2.1 LPG CONTAINERS

Provide containers for LPG that meet NFPA 58 requirements and are designed, fabricated, tested, and marked in accordance with the regulations of the department of transportation (DOT), ASME BPVC SEC VIII, or API API-ASME CODE. Provide LPG containers with all appurtenances as required by NFPA 58, qualified to UL 125, to include vapor shutoff valve, liquid shutoff valve, pressure relief valve, fixed maximum liquid level gauge, filler valve, [and overfilling protection device,][and actuated liquid withdrawal excess-flow valve]. Container appurtenances must have a minimum service pressure rating of 1.7 MPa250 psig.

]2.2 PIPE, FITTINGS, AND ASSOCIATED MATERIALS

[Provide only materials that are allowed for [natural gas][manufactured gas] by 49 CFR 192 for the specified distribution pipeline being installed.]

[Provide only materials that are allowed by LPG by NFPA 58 for the specified disbribution pipeline being installed.]

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos are not allowed. Provide written verification and point of contact for a supporting service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Mark all valves, flanges, and fittings in accordance with MSS SP-25. Submit a complete list of materials and equipment, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions, including, but not limited to the following:

a. Electrical Isolation Devices and Isolating Flange Kits.
b. Fittings
c. Piping
d. Pipe and Accessory coatings
e. Pressure Reducing Valves.
f. Meters
g. Regulators.
h. Shut-off Valves
i. Excess Flow Valve
[j. LPG Containers]

2.2.1 Steel Pipe for [Natural Gas][Manufactured Gas] Distribution

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NOTE: Delete all words in brackets when steel pipe is expected to be subjected to unusually severe conditions (including handling) such as impact stresses, seismic forces, burial beneath vehicle or railroad crossings, significant differential settlement, or underneath piers.

****

Provide steel piping that complies with API Spec 5L, Grade [A,] B, or X42; ASTM A53/A53M, Grade[A or] B; ASTM A106/A106M, Grade [A][B or] C; ASTM A333/A333M, Grade [1 or] 3. Determine minimum pipe wall thickness as specified in 49 CFR 192.105 section "Design Formula for Steel Pipe" for the specific design conditions. [Pipe wall thickness less than schedule 80 for pipes less than 2.5 inches diameter is not permitted.]

[2.2.2 Steel Pipe for LPG Distribution

****

NOTE: LPG piping systems covered by this specification must be designed to prevent LPG in the liquid phase from being trapped between isolation valves. NFPA 58 requires any LPG piping system that can trap liquid LPG to be rated for 2.4 MPa350 psig and to contain a hydrostatic pressure relief valve.

****

Provide steel piping that is approved within NFPA 58 and complies with ASTM A53/A53M, Grade [A or] B; ASTM A106/A106M, Grade [A,][B, or] C. Provide pipe wall thickness as specified on the design drawings, but in no case less than schedule 40. Provide schedule 80 pipe where threads are to be cut in order to connect threaded valves or appurtenances.

]2.2.3 Corrosion Protection for Steel Pipe for Underground Installation

2.2.3.1 External Coating Systems

****
NOTE: Delete this paragraph where steel pipe is not installed underground as neither a gas carrier pipe nor as an encasement for plastic pipe.
****

****
NOTE: This paragraph must be retained where steel pipe is used to encase a plastic gas carrier pipe.
****

Where steel pipe installation below ground is required by design of the gas carrier pipe, or as encasement for plastic pipe, provide pipe with a [factory applied][field plant applied] polyolefin resin coating system conforming to NACE SP0185, Type A. Pipe exterior must be cleaned to a commercial grade blast cleaning finish in accordance with SSPC SP 6/NACE No.3. Apply adhesive compound to the pipe with a nominal thickness of 0.25 mm10 mils (plus or minus 10 percent). Immediately after the adhesive is applied, extrude a seamless tube of polyolefin over the adhesive to produce a bonded seamless coating, with a nominal thickness of 1.0 mm40 mils (plus or minus 10 percent) of polyolefin resin for pipes up to 400 mm16 inches in diameter. For pipes 450 mm18 inches and larger in diameter, apply a minimum thickness of 60 mils (plus or minus 10 percent) polyolefin resin.

Do not coat pipe and fittings for aboveground lines.

2.2.3.2 Cathodic Protection Systems

Provide cathodic protection system in accordance with NACE SP0169 and the applicable UFGS DIV 26 specification for the designed type of cathodic protection.

2.2.4 Steel and Malleable Iron Fittings, 40 mm1-1/2 inches and Smaller

Provide steel butt-weld fittings conforming to ASME B16.9 [or threaded malleable iron fittings for [natural gas][manufactured gas] pipe conforming to ASME B16.11].

[Provide fittings for LPG piping systems that are rated for a minimum of [863 kPa125 psig][1725 kPa250 psig] and comply with NFPA 58. Threaded fittings must be qualified by the manufacturer for use with LPG. Use threaded fittings in an LPG pipeline only at connecting equipment and appurtenances that are provided by the manufacturer with threaded connections.]

2.2.5 Steel Fittings, 50 mm 2 inches and Larger

Provide weld neck pipe flanges and flanged fittings, including bolts, nuts, and bolt patterns in accordance with ASME B16.5, Class [150][_____]. Provide buttweld fittings in accordance with ASME B16.9.

[Provide fittings for LPG piping systems that are rated for a minimum of [863 kPa125 psig][1.7 MPa250 psig] and comply with NFPA 58.]

2.2.6 Steel Forged Branch Connections

Provide steel forged branch connections conforming to ASTM A181/A181M, Class 60, carbon steel.

2.2.7 Flange Gaskets

[Provide gaskets for [natural][manufactured] gas systems that are non-asbestos compressed material gaskets in accordance with ASME B16.21, 1.6 mm 1/16 inch minimum thickness, full face or self-centering flat ring type, containing aramid fibers bonded with nitrile butadiene rubber (NBR), or glass fibers bonded with polytetrafluoroethylene, suitable for maximum 315 degrees C 600 degrees F service.]

[Provide gaskets for LPG systems constructed of metal or confined by metal that has a melting point above 815 degrees C1,500 degrees F and is resistant to the action of LPG and in accordance with NFPA 58.]

2.2.8 Pipe Threads

[Provide pipe threads for [natural][manufactured] gas piping conforming to ASME B1.20.2MASME B1.20.1.]

[Provide only fittings manufactured for the purpose of threaded connections made in LPG piping systems. Design threaded fittings in LPG systems for no less than 250 psig operating pressure.]

****

NOTE: Delete the paragraph below where LPG distribution systems are specified. NFPA 58 does not allow thread sealant compounds or tape to be used in LPG piping systems. Where sealing at the threads of a connection in an LPG pipeline is necessary, specify back welding of the threaded joint using minimum schedule 80 piping and 1.7 MPa 250 psig rated fittings.

****

2.2.9 Sealants for Steel Pipe Threaded Joints in [Natural][Manufactured] Gas Systems

2.2.9.1 Sealing Compound

Provide joint sealing compound as listed in UL FLAMMABLE & COMBUSTIBLE, Class 20 or less that is qualified for use with [natural gas] [manufactured gas].

2.2.9.2 Tape

Provide polyetrafluoroethylene tape conforming to ASTM D3308 that is qualified for use with [natural gas][manufactured gas].

2.3 PLASTIC PIPE, TUBING, FITTINGS AND JOINTS

****

NOTE: Before selecting plastic pipe material, contact the gas supplier for a gas analysis to determine the types of chemicals which will be in

the gas to be supplied. Select suitable plastic pipe material based on the gas analysis.

Polyethylene, per ASTM D2513, is the preferred plastic pipe material. SDR-11 wall thickness is the minimum allowed on a Government Installation. SDR is the nominal pipe diameter divided by the wall thickness. Higher SDR-# means thinner wall. Lower SDR-# means thicker wall. Therefore, SDR-9 would be allowed; while SDR-13 must be disapproved.

Polyamide-11 (PA-11), per [ASTM D2513-99][ASTM F2945], may be used only to connect to existing pipelines constructed of PA-11. PA-11 plastic cannot be connected by heat fusion to any other plastic and the Government will not allow a mechanical connection for this purpose.

Reinforced epoxy resin pipe, per ASTM D2517, may be used only to connect to existing natural or manufactured gas pipelines constructed of reinforced epoxy resin pipe. Reinforced epoxy resin pipe is not qualified for use with LPG per NFPA 58.

Do not use plastic material for gas pipelines with design pressures above 690 kPa100 psig, unless the manufactured products meet the requirements specified 'Design Limitations for Plastic Pipe', Section 192.123 of 49 CFR 192.

Do not use plastic material in gas pipelines where operating temperatures may exceed the material's qualified temperature range. PE and PA-11 materials must not exceed the temperature used to determine the Hydrostatic Design Basis (HDB) that was used to calculate the design pressure of the pipeline per section 192.121 of 49 CFR 192. Reinforced epoxy resin pipelines must not exceed 66 degrees C150 degrees F.

Do not use plastic material in pipelines where operating temperature may be below -29 degrees C-20 degrees F without consulting section 192.123 of 49 CFR 192 and the manufacturer of the pipe and fittings.

****

2.3.1 Polyethylene Gas Pressure Pipe, Tubing, and Fittings

Provide polyethylene (PE) pipe, tubing, fittings conforming to ASTM D2513, as specified in 49 CFR 192 Appendix B and manufactured using material that complies with ASTM D3350. Pipe wall thickness must comply with the Standard Dimension Ratio, SDR-11, or lower value, meaning thicker wall. The Hydrostatic Design Basis (HDB) of the selected PE material must exceed the Maximum Allowable Operating Pressure (MAOP), at the anticipated operating temperature of the system in which it is installed. Mark pipe, tubing, and fittings as required by ASTM D2513 and with traceability code per ASTM F2897.

Provide polyethylene fittings that are constructed of polyethylene of the same material classification and SDR as the connecting pipe, and comply with ASTM D2513. Provide fittings with [butt-type fusion fittings complying with ASTM D3261][socket-type fusion fittings complying with ASTM D2683][electrofusion-type fittings complying with ASTM F1055].

Where mechanical fittings are specified on the engineering drawings, provide mechanical fittings that comply with ASTM F1948 and are category 1 for pressure integrity, gas tightness, and provide pull-out resistance equivalent to the pipe strength.

Provide heat fusion joints complying with ASTM F2620 and the manufacturer's written procedure approved by the contracting officer. Electro fusion joints fittings must comply with ASTM F1055 and the manufacturer's written procedure approved by the contracting officer. Perform underground installations in conformance with ASTM D2774.

2.3.2 Polyamide-11 Gas Pressure Pipe, Tubing, and Fittings

****

NOTE: Remove this paragraph where the existing distribution system that is being connected to is not Polyamide-11 pipe. Please note that 49 CFR 192 references ASTM D2513, revision dated 1999, i.e, ASTM D2513-99 for PA-11 pipe, tube, and fittings. This reference will remain until 49 CFR 192 recognizes ASTM F2945 as the standard for PA-11 pipe, tube, and fittings. It is recommended that a dual reference for ASTM D2513-99 and ASTM F2945 be retained until 49 CFR 192 is revised to reference ASTM F2945.

****

Use PA-11 pipe to connect only to existing gas distribution pipelines that are constructed of PA-11.

Provide PA-11 pipe, tubing, fittings and joints conforming to [ASTM D2513-99] [ASTM F2945], as specified in 49 CFR 192 Appendix B and manufactured using material that complies with ASTM D4066. Pipe wall thickness must comply with the Standard Dimension Ratio, SDR-11, or lower value, meaning thicker wall. The Hydrostatic Design Basis (HDB) of the selected PA-11 material must exceed the Maximum Allowable Operating Pressure (MAOP), at the anticipated operating temperature of the system in which it is installed. Mark pipe, tubing, and fittings as required by [ASTM D2513-99] [ASTM F2945] with traceability code per ASTM F2897.

Provide PA-11 fittings that are constructed of PA-11 of the same material classification and SDR as the connecting pipe and comply with [ASTM D2513-99] [ASTM F2945]. Provide [butt-type fusion fittings complying with [ASTM D2513-99] [ASTM F2945],[Annex A2] [electro fusion-type fusion fittings complying with ASTM F2600]].

Where mechanical fittings are specified on the engineering drawings, provide mechanical fittings that comply with [ASTM F1948 for metallic mechanical fittings] [ASTM F2145 for PA-11 bodied mechanical fittings] and are category 1 for pressure integrity, gas tightness, and provide pull-out resistance equivalent to the pipe strength.

Make heat fusion joints and electro fusion joints in accordance with the manufacturer's written procedure approved by the contracting officer. Perform underground installations in conformance with ASTM D2774.

[2.3.3 Reinforced Epoxy Resin Gas Pressure Pipe and Fittings

****

NOTE: Remove this paragraph when specifying LPG distribution pipelines or where the existing distribution system that is being connected to is not reinforced epoxy resin pipe complying with ASTM D2517.

****

Use reinforced epoxy resin pipe to connect only to existing [natural gas][manufactured gas] distribution pipelines that are constructed of reinforced epoxy resin.

Provide reinforced epoxy resin pipe, tubing, fittings conforming to ASTM D2517 and as specified in 49 CFR 192 Appendix B. Minimum wall thickness must comply with engineering drawings and 49 CFR 192. Mark pipe, tubing, and fittings as required by ASTM D3892.

Provide fittings conforming to ASTM D5685.

Adhesives used to join pipe and fitting must comply with ASTM D2517 and the manufacturer's written procedure approved by the contracting officer. Perform underground installations in conformance with ASTM D3839.

]2.3.4 Mechanical Fittings for use with Plastic Pipe

Use of mechanical fittings in distribution pipelines constructed of plastic requires the approval of Engineering and the Contracting Officer. Mechanical fittings may be approved only where others methods of connecting piping and appurtenances will produce a less reliable gas tight connection.

Mechanical fittings, their use, and installation must comply with 49 CFR 192. Mechanical fittings must meet the requirements of category 1 presented in [ASTM F1948 for metallic mechanical fittings] [ASTM F2145 for PA-11 mechanical fittings] to remain gas tight while resisting pull-out forces.

Mechanical fittings constructed of metal or plastic other than the plastic specified for piping must be approved base on submission of manufacturer's test data and historical service records indicating their acceptability for the intended service.

Submit all traceability information for each mechanical fittings to include, but not limited to, the manufacturer, part number, serial number, and geographic information system coordinates of the installed location.

[2.4 FLEXIBLE METALLIC CONNECTORS FOR LPG SERVICE

Where flexible piping is required for connection of LPG container regulator to the manual shut off valve at the start of the LPG pipeline, provide flexible metallic connectors complying with UL 569, rated for a working pressure not less than 2.4 MPa350 psig. Provide hose assembly with approved connectors that is designed for a pressure not less than 4.8 MPa 700 psig.

]2.5 VALVES

****

NOTE: Valves and pressure regulators are necessary at all points where design requires pressure reduction or regulation. Require a shut-off valve in compliance with the requirements of 49 CFR 192.197. A central regulating station is generally provided by the gas company and is usually located near the entrance to the installation. When valves, gas pressure regulators, and related devices are required in the contract, ensure that all necessary equipment will comply with the requirements of the gas company, and revise these paragraphs as required. Provide a detail of each regulating station and the following data for each pressure regulator: materials of construction, flow rate, type and specific gravity of the gas, inlet and outlet pressures, accuracy of control, and size and type of connections.

****

[2.5.1 Carbon Steel Valves for [Natural Gas][Manufactured Gas] Pipelines

Provide valves suitable for shutoff or isolation in [natural] [manufactured] gas pipelines conforming to the requirements of 49 CFR 192. All materials used in valve construction must be resistant to the action of the gas being distributed under the service conditions.

Provide carbon steel valves installed in [natural gas][manufactured gas] pipelines that comply with API Spec 6D. Provide ball, check, gate, and plug valves as specified in the design drawings.

Provide Class [150][_____] steel valves 40 mm1-1/2 inches and smaller installed underground with butt-weld ends complying with ASME B16.25, with square wrench operator adaptor and corrosion prevention.

Provide Class [150][_____] steel valves 40 mm1-1/2 inches and smaller installed aboveground with butt-weld complying with ASME B16.25 or threaded ends complying with ASME B1.20.1, with hand wheel or wrench operator.

Provide Class [150][_____] steel valves 50 mm2 inches and larger installed underground with butt-weld ends complying with ASME B16.25, and square wrench operator adaptor and corrosion prevention coating.

Provide Class [150][_____] steel valves 50 mm2 inches and larger installed aboveground with butt-weld complying with ASME B16.25 or flanged ends complying with ASME B16.5, with hand wheel or wrench operator.

Provide valves 200 mm8 inches and larger with worm or spur gear operators, totally enclosed, grease packed, and sealed, with operators having Open and Closed stops and position indicators. Provide locking feature where indicated. Wherever the lubricant connections are not conveniently accessible, provide extensions for the application of lubricant. Provide valves with lubricant compatible with gas service.

][2.5.2 Metallic Valves for LPG Pipelines

Provide manual shut-off valves, excess flow valves, and backflow check valves in LPG pipelines conforming to the requirements of NFPA 58 and UL 125. Provide valves constructed from [steel,] [ductile (nodular) iron complying with ASTM A395/A395M,] [malleable iron complying with ASTM A47/A47M,] [brass]. All materials used in valve construction must be resistant to the action of LPG under the service conditions. Valves must have a service pressure rating of [0.9 MPa125 psig for pipeline pressure of 0.9 MPa125 psig or less] [and] [1.7 MPa250 psig for pipelines operating above 0.9 MPa125 psig].

[Provide pressure spring loaded relief valves that comply with UL 132 with flow capability to limit the pressure in the pipeline to below the Maximum Allowable Operating Pressure (MAOP) for the system.]

]2.5.3 Plastic Valves for [Natural Gas][Manufactured Gas][LPG] Pipelines

[Provide valves installed in polyethylene distribution pipelines that are constructed of polyethylene of the same material classification and SDR as the connecting pipe. Comply with ASTM D2513 and ASME B16.40 for underground installation only. Provide valves with [butt-type fusion fittings complying with ASTM D3261] [socket-type fusion fittings complying with ASTM D2683][electro fusion-type fittings complying with ASTM F1055].]

[Provide valves installed in PA-11 distribution pipelines that are constructed of PA-11 of the same material classification and SDR as the connecting pipe. Comply with [ASTM D2513-99] [ASTM F2945] and ASME B16.40 for underground installation only. Provide valves with [butt-type fusion fittings complying with [ASTM D2513-99] [ASTM F2945], Annex A2] [electro fusion-type fusion fittings complying with ASTM F2600].]

2.5.4 Excess Flow Valve (EFV)

Provide [bypass type EFV with automatic reset][non-bypass type EFV with manual rest] that conforms to MSS SP-142 and ASTM F2138 and tested to ASTM F1802. Submit an EFV Design and Installation Guide which includes the manufacturer's product design data and installation instructions. Submit all traceability information for each EFV to include, but not limited to, the manufacturer, part number, serial number, and geographic information system coordinates of the installed location. Provide appropriate valve box where access for maintenance or reset is required.

2.5.5 Valve Box

Provide [street valve box with cast-iron cover and two-piece 130 mm5-1/4 inch shaft-slip valve box extension][rectangular concrete valve box, sized large enough for removal of valve without removing box]. Cast the word "Gas" into the box cover. Use valve box for areas as follows:

a. Roads and Traffic Areas: Heavy duty, cast iron cover.

b. Other Areas: Standard duty, concrete cover.

[c. Airfields and Special Loadings: As detailed.]

2.6 PRESSURE REGULATORS

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NOTE: Coordinate this paragraph with the specified requirements in paragraph VALVES.

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Provide ferrous bodied regulators with backflow protection, designed to meet the pressure, temperature, flow and other service conditions.

[2.6.1 LPG Main Regulators

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NOTE: There are several methods of reducing and regulating the pressure of LPG within the distribution pipeline. The designer must specify the NFPA 58 compliant regulator or regulator combination that is appropriate for the LPG service that is provided.

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LPG regulators must comply with UL 144 and NFPA 58. Line pressure regulators that comply with ANSI Z21.80/CSA 6.22 are not allowed in the LPG distribution pipeline, but are used in accordance with NFPA 54 to reduce a 17.8 kPa2 psig service line pressure to appliance regulator inlet pressure. Appliance regulators that comply with ANSI Z21.18/CSA 6.3 must not be used in an LPG distribution pipeline.

Provide LPG two stage regulator systems as required by NFPA 58:

a. Single stage regulators are not allowed in an LPG pipeline.

[b. Automatic changeover regulator incorporating an integral two stage regulator, with [integral pressure relief to limit second stage outlet pressure to 14 kPa2 psig when seat disc is remove and inlet pressure is 104 kPa15 psig][overpressure shutoff with manual reset] on the outlet of the second stage regulator, for use on multiple cylinder installation.]

[c. Integral two-stage regulator with means to determine the outlet pressure of the high pressure regulator, with [integral pressure relief to limit second stage outlet pressure to 14 kPa2 psig when seat disc is remove and inlet pressure is 104 kPa15 psig][overpressure shutoff with manual reset].]

[d. High pressure regulator installed on the LPG container with [integral][separate] relief valve, and a first stage regulator, with integral pressure relief, installed downstream of the high pressure regulator to serve multiple second stage regulators with [integral pressure relief to limit second stage outlet pressure to 14 kPa2 psig when seat disc is remove and inlet pressure is 104 kPa15 psig][overpressure shutoff with manual reset] on the outlet of the second stage regulator.]

[e. First stage regulator, 69 kPa10 psig maximum outlet pressure, with integral pressure relief, and a second stage regulator with [integral pressure relief to limit second stage outlet pressure to 14 kPa2 psig when seat disc is remove and inlet pressure is 104 kPa15 psig][overpressure shutoff with manual reset].]

[f. Integral 2 psi service regulator, 17 kPa2.5 psig maximum outlet pressure with [integral pressure relief to limit outlet pressure to 35 kPa5 psig when seat disc is remove and inlet pressure is 104 kPa15 psig][overpressure shutoff with manual reset].]

[g. 2 psi regulator system including a first stage regulator, 69 kPa10 psig maximum outlet pressure, with integral pressure relief, and a 2 psi regulator, 17 kPa2.5 psig maximum outlet pressure with [integral pressure relief to limit 2 psi regulator outlet pressure to 35 kPa5 psig when seat disc is remove and inlet pressure is 104 kPa15 psig][overpressure shutoff with manual reset].]

][2.6.2 [Natural][Manufactured] Gas Main Regulators

Provide pressure regulators for main gas distribution pipelines from a qualified manufacture of pipeline regulators. Equip distribution pipelines with regulators where that pipeline is supplied from a source of gas that is at higher pressure than the maximum allowable operating pressure of the distribution pipeline. Provide regulators of adequate capacity that are rated for the inlet pressure of the gas source and the anticipated operating temperature. In addition to the pressure regulating devices, provide a protective method to prevent overpressuring of the system in accordance with 49 CFR 192, Section 195. Suitable protective devices are as follows:

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NOTE: The designer may design and specify the method and device used to create overpressure protection that complies with 49 CFR 192, or the designer may include all of the methods allowed in 49 CFR 192 to allow the contractor to select a cost effective method. However, the designer must coordinate this decision with the authorized Distribution System Operator to ensure compliance with locally adopted requirements or standards.

****

a. Spring-loaded relief valve meeting the provisions of ASME BPVC SEC VIII D1.

b. Pilot-loaded back pressure regulator used as relief valve, so designed that failure of the pilot system causes the regulator to open.

c. Weight-loaded relief valves conforming to ASME PTC 25.

d. Monitoring relief valves conforming to ASME PTC 25.

e. Series regulator installed upstream from the primary regulator, set to limit the pressure on the inlet of the primary regulator continuously to the maximum allowable operating pressure of the system, or less.

f. Automatic shutoff device installed in series with the primary regulator, set to shut off when the pressure on the distribution system reaches the maximum allowable operating pressure of the system, or less, which remains closed until manually reset.

g. Spring-loaded, diaphragm type relief valves.

][2.6.3 [Natural][Manufactured]Service Regulators

****

NOTE: 49 CFR 192 allows service regulators installed on service lines operating at 414 kPa60 psig or less to omit pressure relief. However, it

is recommended that service regulators comply with the requirements of this UFGS paragraph, as written, to allow the natural gas distribution pipeline operator the maximum flexibility in selecting higher distribution pipeline operating pressures.

Select one of the three bracketed texts to allow distribution pipeline operation between 414 kPa60 psig and 862 kPa125 psig.

Where the service regulator pipe connection exceeds 50 mm2 inches, one of the overpressure protection methods presented in the three bracketed texts is required by 192.197(b)

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Provide ferrous bodied service regulators conforming to AGA ANSI B109.4 with [full capacity internal relief] [downstream pressure relief valve where distribution pipeline pressure does not exceed 862 kPa125 psig] [downstream automatic overpressure shut-off].

Service regulators must meet each of the following requirements.

a. Capable of reducing distribution line pressure to the safe pressure required by the connected equipment.

b. Capable of limiting, under no flow conditions, the build-up of downstream pressure that would cause unsafe operation of the connected equipment.

c. Pipe connections of 50 mm2 inches or less.

d. Single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet.

e. Valve seat of resilient materials designed to withstand flow conditions when pressed against the valve port.

f. Self-contained with no external static or control lines.

Set pressure relief at a lower pressure than would cause unsafe operation of any connected and properly adjusted gas utilization equipment.

][2.6.4 Overpressure Protection for Service Lines, Operating Pressure Greater than 414 kPa60 psig, but Less than 862 kPa125 psig

****

NOTE: Omit this paragraph where the service regulator specified above, para 2.4.2, contains internal pressure relief, a downstream relief valve, or downstream automatic shut-off; because the installation of any one of these devices complies with 192.197(c)(3).

49 CFR 192, Section 197(c) presents the minimum requirements for overpressure protection of customer piping and appliances that are connected to a distribution pipeline operated at greater than 414 kPa60 psig.

This UFGS paragraph offers the overpressure protection solutions allowed by 49 CFR 192.197(c).

The designer may design and specify the method and device used to create overpressure protection that complies with 49 CFR 192 or, the designer may include all of the methods allowed in 49 CFR 192 to allow the contractor to select a cost effective method. However, the designer must coordinate this decision with the authorized Distribution System Operator to ensure compliance with locally adopted requirements or standards.

****

Where the gas distribution system is operated at a pressure greater than 414 kPa60 psig, but less than 862 kPa125 psig, provide one of the following methods of overpressure protection for the service regulator and facility gas piping system:

a. Additional upstream regulator plus pressure relief or automatic shut-off.

b. Additional upstream monitoring regulator that, in the event of service regulator failure, prevents the pressure of gas supplied to the customer from exceeding a maximum safe value.

c. A service regulator with internal relief or downstream relief valve.

d. An automatic shut-off device with manual reset.

][2.6.5 Overpressure Protection for Service Lines, Operating Pressure Greater than 862 kPa125 psig

****

NOTE: Service regulators complying with ANSI B109.4 are limited to 862 kPa125 psig inlet pressure.

49 CFR 192, Section 197.(c)(3) further qualifies the minimum requirements for overpressure protection of service regulators connecting to a distribution pipeline operated at greater than 862 kPa125 psig. Section 197(c)(3) requires one of the overpressure protection solutions listed in the bracketed text of this specification paragraph.

Where the distribution system operates at a pressure, higher than 862 kPa125 psig, retain the following paragraph and select from the bracket text.

****

In addition to the required service regulator, provide an additional upstream [regulator that is set to maintain the inlet pressure to the service regulator to 414 kPa60 psig or less] [monitoring regulator to limit the pressure of gas supplied to the facility gas piping to the lowest, maximum inlet pressure of any appliance regulator connected to the facility gas piping].

]2.7 METERS

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NOTE: Meter selection must comply with the Advanced Metering Program being implemented at the specific Government Installation where work is being performed. The design engineer must contact the project Contracting Officer to determine the appropriate point of contact for this advanced metering program. The design engineer must then consult with the point of contact, approved by the Contracting Officer, to ensure that the specified natural gas metering system is compliant with the current requirements for the advanced metering program and the current, site applicable cybersecurity protection. Any metering selected must comply with the requirements of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

The gas meters specified in this paragraph are qualified for natural gas, manufactured gas and LPG in its vapor phase. Designer must specify the maximum allowable operating pressure of the meter at no less than 10 psig per 49 CFR 192 and must protect the meter from over pressurization IAW 49 CFR 192.197.

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Provide gas meters for [natural gas][manufactured gas][liquefied petroleum gas in the vapor phase] that comply with [AGA ANSI B109.1] [AGA ANSI B109.2] [AGA ANSI B109.3] [pipe] [pedestal] mounted, [diaphragm] or [bellow] [style], [cast-iron] [enamel-coated steel] [aluminum] case. Rate meters for a maximum allowable operating pressure of [69 kPa 10 psig][_____ psig] [Provide with a strainer immediately upstream]. Provide [diaphragm-type meter conforming to AGA ANSI B109.1 for required flow rates less than 500 cfh, or AGA ANSI B109.2, for flow rates 500 cfh and above] [rotary-type displacement meter conforming to AGA ANSI B109.3] as required by local gas utility supplier. Provide combined [odometer-type] register totalizer index, UV-resistant index cover, water escape hole in housing, and means for sealing against tampering. Provide temperature-compensated type meters sized for the required volumetric flow rate and suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Provide meters with over-pressure protection as specified in 49 CFR 192 and ASME B31.8. Provide meters that are tamper-proof [with] [frost protection] [fungus protection][seismic protection].Provide meters with a pulse switch initiator capable of operating up to speeds of 500 maximum pulses per minute with no false pulses and requiring no field adjustments. Provide not less than one pulse per 2.83 cubic meters 100 cubic feet of gas. Minimum service life must be 30,000,000 cycles.

2.7.1 Utility Monitoring and Control System (UMCS) or Automatic Meter Reading Interfaces

Provide gas meters capable of interfacing the output signal, equivalent to volumetric flow rate, with the existing UMCS for data gathering in units of cubic meters cubic feet. Provide meters that do not require power to function and deliver data. Output signal must be either a voltage or amperage signal that can be converted to volumetric flow by using an appropriate scaling factor. Meters installed must comply with Section

25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. Meters installed must comply with Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

2.7.2 Measurement Configuration

For buildings that already have a gas meter with a pulse output, ensure that the pulse output is connected to a data gathering device (i.e. electric meter). For buildings where a natural gas meter already exists but does not have a pulse output, add a pulse kit to the existing meter and tie the output to a data gathering device. If the existing gas meter will not accept a pulse kit or if no meter exists a new natural gas meter must be installed, also requiring a pulse output to a data gathering device. Ensure the pulse frequency and electronic characteristics are compatible with the existing data gathering device, if any.

2.8 TELEMETERING OR RECORDING GAUGES

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NOTE: On distribution systems supplied by a single district pressure regulating station, determine the necessity of installing telemetering or recording gauges in the supply line, taking into consideration the number of buildings supplied, the operating pressures, the capacity of installation, and other operating conditions.

****

Equip each distribution system supplied by more than one district pressure regulating station with telemetering or recording pressure gauges to indicate the gas pressure in the district line.

2.9 GAS TRANSITION FITTINGS

Provide manufactured steel-to-plastic gas transition fittings approved for jointing steel and polyethylene pipe, conforming to ASTM F1973 requirements for transition fittings.

Provide anodeless riser on service lines to transition from below grade plastic piping to above grade steel piping in accordance with 49 CFR 192. Polyethylene-to-steel anodeless risers must comply with ASTM F1973 and ASTM D2513 - Category 1 specifications for gas tight seal and pull-out resistance. Protect steel pipe from corrosion by a factory applied coating.

2.10 IDENTIFICATION

Provide pipe flow markings and metal tags for each valve, meter, and regulator as required by the Contracting Officer.

2.11 ELECTRICALLY ISOLATED JOINT MATERIALS

Provide insulating joint materials between flanged or threaded metallic pipe systems to electrically isolate piping that is protected by cathodic protection systems. Devices must comply with NACE requirements.

[2.12 NATURAL GAS COMPRESSORS

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NOTE: Delete this paragraph where natural gas

compressors are not installed in the project.

The Designer of Record must coordinate all operating conditions with the gas compressor manufacturer and adhere to this manufacturer's advice on necessary appurtenance, materials, and installation practices for piping systems connected both upstream and downstream of this compressor.

Code information is limited for natural gas compression system design and installation. Therefore, compliance with API standards and recommended practices and commercially available information for the compressor is mandatory for the design and construction of systems intended to compress natural gas.
****

Provide natural gas compressors that comply with [API Std 617][API Std 618][API Std 619].

Provide all devices necessary for safe operation and environmental protection to include snubbers, valves, fittings and other appurtenances as shown on the design drawings.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 EXCAVATION AND BACKFILLING

Earthwork is as specified in Section 31 00 00 EARTHWORK.

3.3 LPG CONTAINERS

Install LPG containers in accordance with NFPA 58 requirements for the type and volumetric capacity of the designed tank. Install each container with the required appurtenances as defined in NFPA 58. Mount each LPG tank on a concrete pad with anchor bolts or other tie down devices that provide resistance to tip over, caused by external forces defined in ASCE 7-16 and allow necessary movement to compensate for thermal expansion and contraction. Observe required separation distance from occupied buildings and building openings.

3.4 GAS MAINS

Provide steel pipe for aboveground installation. Provide polyethylene pipe for underground service..

[Where connection is made to an existing distribution pipeline constructed of Polyamide-11 pipe, construct new system using Polyamide-11 pipe or use approved connection fitting to connect new polyethylene pipe.]

[Where connection is made to an existing distribution pipeline constructed of Reinforced Epoxy Resin pipe, construct new system using Reinforced Epoxy

Resin pipe or use approved connection fitting to connect new polyethylene pipe.]

3.5 SERVICE LINES

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NOTE: Locate service line isolation valve as close to the supply main as possible, but at a safe distance from traffic lanes.

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Construct service lines of materials specified for gas mains and extend from a gas main to and including the point of delivery within 1.5 meters 5 feet of the building. The point of delivery is the [meter set assembly] [service regulator] [shutoff valve]. Connect the service lines to the gas mains [as indicated] [through service tees, with end of run plugged].

Where indicated, provide service line with an isolation valve of the same size as the service line, located in a valve box. Make the service lines as short and as straight as practicable between the point of delivery and the gas main, without bends or lateral curves unless necessary to avoid obstructions or otherwise permitted. Lay service lines with as few joints as practicable using standard lengths of pipe, use shorter lengths only for closures. Do not install polyethylene service lines aboveground.

3.6 WORKMANSHIP AND DEFECTS

Ensure pipe, tubing, and fittings are clear and free of cutting burrs and defects in structure or threading, and thoroughly brushed and blown free of chips and scale. Do not repair, but replace defective pipe, tubing, or fittings.

3.7 PROTECTIVE COATING

3.7.1 Protective Coating for Underground Steel Pipe

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NOTE: If casings are installed on plastic pipe installed below grade, then retain this paragraph. Remove this paragraph where no steel pipe is to be installed below grade.

****

Where steel pipe is installed below grade for either the gas carrier pipe or as a casing for plastic carrier pipe, protect this pipe from corrosion by an extruded polyolefin resin coating system over a soft adhesive applied to the steel pipe. This coating must be either factory applied or applied using a field plant especially equipped for the purpose. Hand apply protective covering to valves and fittings that cannot be coated and wrapped mechanically, preferably at the plant that applies the covering to the pipe. Coat and wrap joints by hand, in a manner and with materials that produce a covering equal in thickness to that of the covering applied mechanically.

3.7.1.1 Field Plant Applied Polyolefin Resin Coating System

Provide a polyolefin resin coating system conforming to NACE SP0185, Type A. Clean the exterior of the pipe to a commercial grade blast cleaning finish in accordance with SSPC SP 6/NACE No.3, and apply adhesive compound to the pipe with a nominal thickness of 0.25 mm10 mils (plus or minus 10 percent). Immediately after the adhesive is applied, extrude a seamless tube of polyolefin over the adhesive to produce a bonded seamless coating, with a nominal thickness of 1.0 mm 40 mils (plus or minus 10 percent) of polyolefin resin for pipes up to 400 mm 16 inches in diameter. For pipes 450 mm 18 inches and larger in diameter, apply a minimum thickness of 1.5 mm 60 mils (plus or minus 10 percent) polyolefin resin.

3.7.1.2 Pipe Joint and Field Repair Coating System

Apply joint coating and field repair material as recommended by the coating manufacturer, consisting of one the following:

a. Heat shrinkable polyethylene sleeves.

b. High density polyethylene/bituminous rubber compound tape.

Inspect the coating system for holes, voids, cracks, and other damage during installation.

3.7.1.3 Inspection of Pipe Coatings

Repair any damage to the protective covering during transit and handling before installation. After field coating and wrapping has been applied, inspect the entire pipe using an electric holiday detector with impressed current set at a value in accordance with NACE SP0274 using a full-ring, spring-type coil electrode. Equip the holiday detector with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Immediately repair all holidays in the protective covering upon detection. The Contracting Officer reserves the right to inspect and determine the suitability of the detector. Furnish labor, materials, and equipment necessary for conducting the inspection.

3.7.2 Protective Covering for Aboveground Piping Systems

Apply finish painting conforming to the applicable paragraphs of Section 09 90 00 PAINTS AND COATINGS and as follows:

3.7.2.1 Ferrous Surfaces

Touch up shop primed surfaces with ferrous metal primer of the same type paint as the shop primer. Solvent-clean surfaces that have not been shop primed in accordance with SSPC SP 1. Mechanically clean surfaces that contain loose rust, loose mill scale, and other foreign substances by power wire brushing in accordance with SSPC SP 3 or brush-off blast clean in accordance with SSPC 7/NACE No.4 and primed with ferrous metal primer in accordance with SSPC Paint 25. Finish primed surfaces with two coats of exterior alkyd paint conforming to MPI 9.

3.7.2.2 Nonferrous Surfaces

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NOTE: Retain only the first sentence for normal conditions. Delete the first sentence and retain the second sentence for corrosive conditions.

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[Do not paint nonferrous surfaces.] [Paint nonferrous surfaces to protect from the exposed corrosive conditions. Solvent-clean the surfaces in accordance with SSPC SP 1. Apply a first coat of MPI 10, and 2 coats of [MPI 119] [or] [MPI 11].]

3.7.3 Protective Covering for Piping in Valve Boxes and Manholes

Apply protective coating to piping in valve boxes or manholes as specified for underground steel pipe.

3.8 INSTALLATION

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NOTE: When existing gas piping is abandoned, show disconnect details on the drawings. Refer to ASME B31.8 for guidance on preparing the disconnect details. ASME B31.8 requires physical disconnection from gas sources. Shutoff valves are not an acceptable means of disconnect. ASME B31.8 may be used as a reference, but the disconnection and abandonment must comply with the requirements of 49 CFR 192, Section 727.

****

Install gas distribution system and equipment in conformance with the manufacturer's recommendations and applicable sections of 49 CFR 192.

3.8.1 Abandonment of Natural Gas Distribution Pipelines

Perform abandonment of existing gas piping in accordance with ASME B31.8, the contract drawing details and the requirements of 49 CFR 192, Section 727. Purge natural gas piping so that there is no potential hazard. Provide locking devices for the shut-off valve located at the end of the service line supplying gas to a discontinued customer. Cut the pipe without damaging the pipe. Unless otherwise authorized, use an approved type of mechanical cutter. Use wheel cutters where practicable. On steel pipe 150 mm6 inches and larger, an approved gas-cutting-and-beveling machine may be used. Cut plastic pipe in accordance with AGA XR0603. Fill abandoned vaults with suitable compacting material.[Record and submit to the COR the Geographic Information System (GIS) location of any abandoned distribution pipeline that crosses over, under, or through a navigable waterway.]

3.8.2 Installing Pipe Underground

****

NOTE: Indicate profile of gas lines on the drawing. If it is impractical to comply with the minimum cover specified for pipe, and necessary to prevent damage from external loads, the pipe will be installed in a casing. The locations of all casings and details of the installation will be indicated on the drawings and identified by Geospatial coordinates.

****

Grade gas mains and service lines as indicated. Grade service lines so as to drain back to the main or into drips as indicated. Weld joints in steel pipe except as otherwise permitted for installation of valves. Provide mains with 600 mm 24 inch minimum cover; service lines with 485 mm 18 inch minimum cover; and place both mains and service lines on firmly compacted select material for the full length.

Where indicated, encase, bridge, or design the main to withstand any anticipated external loads as specified in 49 CFR 192. Provide standard weight black steel pipe encasement material with a protective coating as specified. Separate the pipe from the casing by insulating spacers and seal the ends with casing bushings. Excavate the trench below pipe grade, bed with bank sand, and compact to provide full-length bearing. Laying pipe on blocks to produce uniform grade is not permitted. Ensure that the pipe is clean inside before it is lowered into the trench and keep free of water, soil, and all other foreign matter that might damage or obstruct the operation of the valves, regulators, meters, or other equipment. When work is not in progress, securely close open ends of pipe or fittings with expandable plugs or other suitable means. Minor changes in line or gradient of pipe that can be accomplished through the natural flexibility of the pipe material without producing permanent deformation and without overstressing joints may be made when approved.

Make changes in line or gradient that exceed the limitations specified with fittings. When cathodic protection is furnished, provide electrically insulated joints or flanges.

When polyethylene piping is installed underground and not encased in a metallic casing, place a tracer wire or other electrically conductive element above the pipe in accordance with 49 CFR 192 to permit locating with underground detection devices. After laying of pipe and testing, backfill the trench in accordance with Section 31 00 00 EARTHWORK, and in a manner provides firm support under the pipe and prevents damage to the pipe and pipe coating from equipment or from the backfill material.

3.8.3 Installing Pipe Aboveground

Protect aboveground piping against dirt and other foreign matter, as specified for underground piping. Weld joints in steel pipe; however, joints in pipe 40 mm 1-1/2 inches in diameter and smaller may be threaded; joints may also be threaded to accommodate the installation of valves. Provide flanges of the weld neck type to match wall thickness of pipe.

3.9 PIPE JOINTS

Provide pipe joints complying with the requirements of 49 CFR 192, Subpart E for welding of steel pipelines and Subpart F for joints other than welding. Design and install pipe joints to effectively sustain the longitudinal pullout forces and thrust forces caused by the contraction and expansion of piping or superimposed loads. Make each joint in accordance with the submitted and approved written joining procedure that has been proven to produce strong, gas-tight joints. Each joint must be inspected by the approved inspector.

3.9.1 Threaded Steel Joints

Provide threaded joints in steel pipe with tapered threads evenly cut, made with UL approved joint sealing compound approved for gas service or polytetrafluoroethylene tape approved for gas service applied to the male threads only. Caulking of threaded joints to stop or prevent leaks is not permitted.

3.9.2 Welded Steel Joints

Perform gas pipe weldments, as indicated, in accordance with the submitted and approved welding procedures, and by the approved qualified welders. Make changes in direction of piping by welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction is not permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Use forged or flared branch outlet fittings for improvement of flow where attached to the run, and reinforced against external strains. Perform all beveling, alignment, heat treatment, and inspection of welds conforming to API Std 1104 and the ASME Boiler and Pressure Vessel Code. Remove weld defects and repair the weld, or remove the weld joints entirely and reweld. After filler metal has been removed from its original package, protect it or store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating..

3.9.3 Plastic Pipe Jointing Procedures

Use jointing procedures that have been submitted and approved for this project. Joints in plastic pipe must be made by the qualified personnel submitted and approved for this project, who have the requalification requirements of 49 CFR 192, Section 285. Each joint made must be inspected by the qualified inspector that was submitted and approved for this project.

Heat fusion joining of plastic pipe or fittings made from different plastic resins by classification or by manufacturer are not allowed. If heat fusion joining of similar polyethylene resin classification is required in pipe made by different manufacturers, the procedure must be qualified by test in accordance with 49 CFR 192, Section 283 requirements and AGA XR0603. The personnel making these joints must be qualified using this procedure in accordance with 49 CFR 192, Section 285 requirements. Submit all data: written procedure, test specimens, test results, inspection reports, etc. to show complete jointing qualification per 49 CFR 192 requirements to the COR.

Where joining procedures for plastic pipes by heat fusion cannot be properly qualified, an alternative connection method must be used.

3.9.4 Mechanical Couplings for Plastic Pipe Jointing

Make mechanical joints in accordance with the procedures that have been qualified in accordance with 49 CFR 192, Section 283(b). Submit evidence that the five specimen joints configured and tested in accordance with 283(b)(1), (2) and (3) failed in a manner consistent with 283(b)(4), (5) and (6) as applicable. For the mechanical coupling, obtain the manufacturer's model number, serial number, and date of manufacture, record the date of installation and obtain the Geographical Information System (GIS) location of the installed mechanical coupling. Submit to the COR, this and all other data required by 49 CFR 192 to be submitted to the Pipeline and Hazardous Material Safety Administration (PHMSA).

3.9.5 Connections Between Metallic and Plastic Piping

Only make metallic to plastic connections outside, underground, and with approved transition fittings.

3.10 VALVES

Install valves in locations shown on the drawings and at locations required by 49 CFR 192. Design valve installation in plastic pipe to protect the plastic pipe against excessive torsional or shearing loads when the valve is operated and from other stresses which may be exerted through the valve or valve box.

For systems where the maximum distribution pressure exceeds 414 kPa60 psig operating pressure, provide a method to regulate and limit the pressure of the gas in the system that complies with 49 CFR 192.197 paragraphs (c)(1) through (4).

3.11 VALVE BOXES

Provide valve boxes of cast iron not less than 4.7 mm 3/16 inch thick at each underground valve except where concrete or other type of housing is indicated. Provide valve boxes with locking covers that require a special wrench for removal, and furnish the correctly marked wrench for each box. Cast the word "GAS" in the box cover. When the valve is located in a roadway, protect the valve box by a suitable concrete slab at least 1 square meter 3 square feet and install an access cover that is traffic rate cast iron of ample thickness to support expected traffic loads. When in a sidewalk, provide the top of the box as a removable concrete slab 600 mm 2 feet square and set flush with the sidewalk. Make the boxes adjustable extension type with screw or slide-type adjustments. Separately support valve boxes to not rest on the pipe, so that no traffic loads can be transmitted to the pipe. Only locate valves in valve boxes or inside of buildings.

3.12 DRIPS

****

NOTE: If gas mains are for the distribution of high-pressure natural gas (above 400 kPa 60 psig) only, delete the entire paragraph: DRIPS. Require drips for lines distributing natural gas at the low point immediately following reduction from high pressure (above 400 kPa 60 psig) to medium pressure (400 kPa (60 psig or less), and at occasional low points throughout the system, to provide for blowing out the lines. Require drips at all low points in lines transmitting manufactured gas or a mixture of manufactured and natural gas. Indicate locations of drips. Locate drip points to provide for proper drainage of pipe system. Detail drips and discharge terminal (outlet) piping. If the need to contain and dispose of liquids through the valve for environmental concerns is required, delete the first bracketed sentence.

****

Install drips conforming to the details, provide commercial units of approved type and capacity. Connect a blow off pipe 32 mm 1-1/4 inches or larger to each drip at its lowest point and extend to or near the ground surface at a convenient location away from traffic. Provide a reducing fitting for each discharge at each drip terminal (outlet), a plug valve, and a 15 mm 1/2 inch nipple turned down. Locate the discharge terminal (outlet) inside a length of 300 mm 12 inches or larger vitrified clay pipe, concrete sewer pipe or concrete terminal box [set vertically on a bed of coarse gravel 300 mm 1 foot thick and 1 m3 feet square,] [with concrete bottom to contain liquids and a connection to remove liquids for disposal,] and closed at the ground surface with a suitable replacement cover.

3.13 PRESSURE REGULATOR INSTALLATION

3.13.1 Main Distribution Line Regulators

****

NOTE: Remove reference to bypasses around pressure regulators for main distribution lines unless continuity of service is imperative and the bypass is regulated to prevent possible overpressure of downstream lines.

****

Install pressure regulators. Install a valve on each side of the regulator for isolating the regulator for maintenance.[Provide a bypass line with bypass valves or 3 way valves and an over-pressurization pressure regulating device.] Install regulators and valves in rectangular reinforced concrete boxes, large enough so that all required equipment can be properly installed, operated, and maintained, with box sidewalls extending above ground line. Provide the boxes with [steel door] [cast iron manhole] covers with locking provisions and 100 mm 4 inch diameter vents. Furnish one key or other unlocking device with each cover. Locate discharge stacks, vents, or outlet ports of all pressure relief devices where gas can be discharged into the atmosphere without undue hazard. Provide stacks and vents with fittings to preclude entry of water.

3.13.2 Service Line Regulators

****

NOTE: Delete inapplicable requirements.

****

Install a shutoff valve,[meter set assembly,] and service regulator on the service line outside the building, 450 mm 18 inches above the ground on the riser. Where steel service lines are used, install an insulating joint on the inlet side of the [meter set assembly and] service regulator and construct to prevent flow of electrical current. Provide a 10 mm 3/8 inch tapped fitting equipped with a plug on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. Terminate all service regulator vents and relief vents in the outside air in rain and insect resistant fittings. Locate the open end of the vent where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

3.14 METER INSTALLATION

****

NOTE: Air Force Engineering Technical Letter Number 87-5 "Utility Meters in New and Renovated Facilities" provides guidance for when to exclude meters from Air Force new and major renovation projects. Review the requirements for gas meters in TI 800-01 Design Criteria and 10 CFR 435.

****

Install meters in accordance with 49 CFR 192. Install permanent gas meters with provisions for isolation and removal for calibration and maintenance, and suitable for operation in conjunction with an energy monitoring and control system. Connect meter complying with the requirements of the Advanced Metering Program that is applied at the particular Government Installation of this project.

3.15 CONNECTIONS TO EXISTING LINES

****

NOTE: If connections to existing mains are required, retain this subparagraph, and select the appropriate Paragraph. Drawings will show existing gas lines when interface with the existing gas system is required.

****

Make connections between new work and existing gas lines, where required, in accordance with 49 CFR 192, using proper fittings to suit the actual conditions. When connections are made by tapping into a gas main, provide the same size connecting fittings as the pipe being connected.

3.15.1 Connections to Publicly or Privately Operated Gas Utility Lines

****

NOTE: Delete inapplicable requirements.

****

Provide materials for the connections to the existing gas lines. The Utility is to make final connections and turn on the gas. The Utility is to also disconnect, purge and cap, plug or otherwise effectively seal existing lines that are to be a abandoned or taken out of service. Notify the Contracting Officer, in writing, 10 days before final connections and turning on of gas lines. Make necessary arrangements with the Utility for tie in and activation of new gas lines. Only the Operating Agency/Utility Company may reactivate the system after tie in. Furnish a certification by the Operating Agency/Utility Company that all Utility work has been satisfactorily completed.

3.15.2 Connection to Government Owned/Operated Gas Lines

****

NOTE: Provide the name and location of the Utility or Operating Agency of the existing gas lines. Show on the drawings, the location of valves to be operated for existing system deactivation. When lines are to be abandoned, give consideration to any effects the abandonment may have on an active cathodic protection system and take appropriate action. If the segment is long and there are few line valves, give consideration to plugging the abandoned segment at intervals.

****

Provide connections to the existing gas lines in accordance with approved procedures. Only perform deactivation of any portion of the existing system at the valve location indicated. Reactivation of any existing gas lines will only be done by the [Government] [local Utility] [Operating Agency]. Submit the approved Connection and Abandonment Plan that is compliant with the requirements of 49 CFR 192, Section 727 prior to making any connections to existing gas lines, manicure the [Operating Agency's] [Utility's] required procedures which may be obtained from [_____]. Notify the Contracting Officer, in writing, 10 days before connections to existing lines are to be made.

For each pipeline that is to be abandoned in place, submit the approved Connection and Abandonment Plan that is compliant with the requirements of 49 CFR 192, Section 727. Ensure the following steps are taken at a minimum:

a. For each pipeline that is to be abandoned in place, physically disconnect that from all sources of gas. Purge, cap, plug or otherwise effectively seal the open ends of all abandoned pipelines. Do not complete abandonment until it has been determined that the volume of gas or condensed hydrocarbons contained within the abandoned section poses no potential hazard. Use air or inert gas for purging, or fill the facility with water or other inert material. If air is used for purging, ensure that a combustible mixture is not present after purging.

b. When a main is abandoned, together with the service lines connected to it, seal the disconnected end of the main and seal the customer's end of each service line as stipulated above.

c. Where service lines are to be abandoned in place, disconnect the abandoned service lines from the active mains as close to the main as practicable. 49 CFR 192 does not require individual service lines to be sealed.

d. Close all valves left in the abandoned segment.

e. Remove all above grade valves, risers, and vault and valve box covers. Fill vault and valve box voids with suitable compacted backfill material.

3.16 CATHODIC PROTECTION

****

NOTE: Cathodic protection is mandatory for underground metallic gas distribution lines. Select the type and design of cathodic protection in accordance with UFC 3-570-01. Provide testing stations for the cathodic protection system.

****

Provide cathodic protection in accordance with NACE SP0169 for all metallic gas piping installed underground and install as specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

3.17 TESTS

3.17.1 Destructive Tests of Plastic Pipe Joints

****

NOTE: Destructive tests of plastic pipe joints are provided as a designer option. Destructive tests are considered useful in assuring that good joints will be made. Delete the paragraph if this option is not exercised.

****

Prior to making heat fusion joints in plastic pipelines, make a joint of each size and type to be installed that day by each person performing joining of plastic pipe that day and destructively test. Make the specimen joint per the approved written procedure. Cut at least 3 longitudinal straps from each joint. Visually examine each strap for voids or discontinuities on the cut surfaces of the joint area. Deform each of the 3 straps by bending, torque, or impact. Failures are not permitted in the joint area. If a joint fails the visual or deformation test, the qualified joiner who made that joint is not allowed to make further field joints in plastic pipe on this job until that joiner has been retrained and re-qualified. Record and submit the results of the destructive tests including the date and time of the tests, size and type of the joints, ambient conditions, fusion iron temperature and names of inspectors and joiners.

3.17.2 Pressure and Leak Tests

****

NOTE: When selecting test pressure and test medium, observe the rules written in 49 CFR 192 Subpart J. The maximum test pressure and duration of pressure testing of plastic pipelines must be controlled in accordance with ASTM F2786 for pneumatic testing and ASTM F2164 for hydrostatic testing.

Specify correct test pressure (including Class Location) to be used for tests of gas line systems in accordance with 49 CFR 192 Subpart J. Specify correct test pressure (including Class Location) to be used for tests of gas line systems in accordance with NFPA 58. Test pressures should recognize the weakest component of each system tested for the design pressure, the maximum allowable operating pressure, and the gas supplier's maximum operating pressure.

For LPG distribution pipelines, follow the requirements of 49 CFR 192 Subpart J, as NFPA 58 yields these testing requirements.

49 CFR 192, Section 505 details the method of determining strength test pressures for steel pipelines operating at a hoop stress of 30% or more of the Specified Minimum Yield Strength (SMYS). The pressure necessary to achieve this hoop stress is higher than most distribution pipeline operating pressures. Remove the associated requirements where the pipeline is not operated at 30% of the SMYS.

49 CFR 192, Section 507 details leak test requirements for metallic mains operating at or above 689 kPa 100 psig.

49 CFR 192, Section 509 details leak test requirements for metallic mains operating below 689 kPa 100 psig.

49 CFR 192, Section 511 details leak test requirements for metallic service lines.

49 CFR 192, Section 513 details leak test requirements for plastic pipelines.
****

Test the system of gas mains and service lines after construction and before being placed in service, using a test pressure and test medium approved in 49 CFR 192 Subpart J for the applicable conditions of construction. In the event of conflict between the contract test pressure and medium and the test requirements of 49 CFR 192, refer conflict to the COR before continuing with testing. Follow all testing recommendations and safety precautions as recommended by the piping manufacturer's specifications and 49 CFR 192. Follow a written test procedure that ensures all potentially hazardous leaks are discovered. Submit data in booklet form from all pressure tests of the distribution system.

3.17.2.1 Test Pressure

Test each segment of the installed pipeline at the test pressure listed below for the applicable installation:

a. Strength test steel pipelines operated at a pressure that creates a hoop stress of 30% or more of the Specified Minimum Yield Strength (SMYS), in accordance with 49 CFR 192, Section 505, by hydrostatic testing at a minimum of 125 percent the Maximum Allowable Operating Pressure (MAOP). Maintain strength test pressure for a minimum of 8 hours.

b. For metallic mains operated at or above 689 kPa100 psig that produces a hoop stress less than 30 percent SMYS, leak test in accordance with 49 CFR 192, Section 507, by [pneumatic][hydrostatic] testing at a pressure between 689 kPa100 psig and the pressure required to produce a hoop stress of 20 percent of the SMYS. Maintain test pressure for a minimum of 24 hours.

c. For metallic mains operated below 689 kPa100 psig, leak test in accordance with 49 CFR 192, Section 509. Leak test mains operated below 6.9 kPa1 psig to a pressure not less than 69 kPa10 psig. Leak test mains operated at or above 6.9 kPa1 psig to a pressure not less than 621 kPa90 psig. Maintain test pressure for a minimum of 24 hours.

d. For metallic service lines, leak test in accordance with 49 CFR 192, Section 511. Leak test service lines operated at 276 kPa40 psig or less to a pressure not less than 345 kPa50 psig. Leak test service lines operated above 276 kPa40 psig to a pressure of 621 kPa90 psig. Ensure that the service line connection to the main is included in this test. Maintain test pressure for a minimum of 24 hours.

e. For plastic mains and service lines, leak test in accordance with 49 CFR 192, Section 513. Leak test to a pressure at least 150% of the Maximum Allowable Operating Pressure (MAOP) or 345 kPa50 psig, whichever is greater. Where a compressible gas is used as the test medium, perform pneumatic leak testing of polyethylene (PE) piping in accordance with ASTM F2786 observing the determination of Maximum Test Pressure, which is calculated using the PE material hydrostatic design stress, the pipe temperature reduction factor and the leak test duration factor. Submit a test procedure that identifies the MAOP of the pipeline, the temperature dependent maximum test pressure, and a step by step procedure for increasing the pipeline pressure as detailed in ASTM F2786 for pneumatic testing or ASTM F2164 for hydrostatic testing. From the beginning of pipeline pressurization to the depressurization of the pipeline the time duration must not exceed 8 hours. If testing must be restarted after maximum test pressure has been reached, depressurize the pipeline for a minimum of 8 hours before restart of pipeline pressurization.

3.17.2.2 Test Performance

Perform testing as follows:

a. Prior to testing the system, blow-out, clean, and clear the interior of all foreign materials. Remove all meters, regulators, and controls before blowing out and cleaning, and reinstall after clearing of all foreign materials.

b. Perform testing of gas mains and service lines with due regard for the safety of employees and the public during the test. Keep persons not working on the test operations out of the testing area during testing. Perform the test on the system as a whole or on sections that can be isolated.

c. Test joints in sections prior to backfilling when trenches are to be backfilled before the completion of other pipeline sections. Continue the test for at least 24 hours from the time of the initial readings to the final readings of pressure and temperature. Do not take the initial test readings of the instrument for at least 1 hour after the pipe has been subjected to the full test pressure. Do not take initial or final readings at times of rapid changes in atmospheric conditions, and temperatures are representative of the actual trench conditions. No indication of reduction of pressure is allowed during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship T(1)P(2)=T(2)P(1), in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial and final readings.

d. During the test, completely isolate the the entire system from all compressors and other sources of air pressure. Test each joint by means of soap and water or an equivalent nonflammable solution prior to backfilling or concealing any work. Secure approval of testing instruments from the Contracting Officer. Furnish all labor, materials and equipment for conducting the tests subject to inspection at all times during the tests. Maintain safety precautions for air pressure testing at all times during the tests.

3.17.3 Meter Test

Test meter to verify data transfer to data collection server and validate calibration of both meter and the data that is received by the data collection server.

3.18 NATURAL GAS COMPRESSORS

Natural gas compressors must be installed in accordance with all manufacturer's procedures and recommendation. Installations must comply with the design drawings and API RP 686.

3.19 MAINTENANCE

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, in three separate packages. Submit Data packages, as specified.

3.19.1 Gas Distribution System and Equipment Operation

Include maps showing piping layout, locations of system valves, gas line markers and cathodic protection system test stations; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system maps); isolation procedures including valve operation to shutdown or isolate each section of the system (index valves to the system maps and provide separate procedures for normal operation and emergency shutdown if required to be different). Submit Data Package No. 4 per Section 01 78 23.

3.19.2 Gas Distribution System Maintenance

Include maintenance procedures and frequency for system and equipment; identification of pipe materials and manufacturer by locations, pipe repair procedures, and jointing procedures at transitions to other piping material or material from a different manufacturer. Submit Data Package No. 4 per Section 01 78 23.

3.19.3 Gas Distribution Equipment Maintenance

Include identification of valves and other equipment by materials, manufacturer, vendor identification and location; maintenance procedures and recommended tool kits for valves and equipment; recommended repair methods (i.e., field repair, factory repair, or replacement) for each valve and piece of equipment; and preventive maintenance procedures, possible failure modes and troubleshooting guide. Submit Data Package No. 3 per Section 01 78 23.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS 33 51 39 (August 2017)**

Preparing Activity: AFCEC

Superseding
UFGS 33 24 00.00 20 (March 2006)
UFGS 33 24 13 August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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PART 2 PRODUCTS

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS 33 51 39 (August 2017)**

Preparing Activity: AFCEC

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References are in agreement with UMRL dated January 2025

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SECTION 33 51 39

MONITORING WELLS
08/17

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NOTE: This specification covers the requirements for monitoring well installation and testing at hazardous and non-hazardous waste sites.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification is not appropriate for vapor extraction and two phase extraction wells.

****

PART 1 GENERAL

****

NOTE: In most monitoring wells, because optimum yield from the well is not as critical to achieve as it is in production or extraction wells, and because extensive development is more difficult to accomplish in small diameter wells, screens are usually designed to have smaller openings, so that less formation material is pulled into the well during the development and sampling.

Use Section 33 11 13 WATER SUPPLY WELLS for water

supply wells and associated testing.

Use Section 33 26 00.00 10 RELIEF WELLS for projects relating to the relief of excess hydrostatic pressures adjacent to dams, locks, levees or other water retaining structures.

Coordinate and specify the appropriate pump for the specified well in a separate section.

Include the following in the drawings, and any other information necessary to indicate layout and general configuration of the well:

1. Diameter of drilled hole

2. Casing diameter

3. Well screen diameter, length, location, and slotted opening size

4. Minimum depth of casing and minimum depth well screen

5. Depth to primary and secondary filter packs

6. Depth to bentonite seal and grout seal

7. Type of cap, cover, or seal required at top of well.

Include the applicable state and local regulatory references where appropriate in the body of the specification.

Use the following specifications in conjunction with this section:

01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS

01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES

01 32 01.00 10 PROJECT SCHEDULE

01 32 16.00 20 SMALL PROJECT CONSTRUCTION PROGRESS SCHEDULES] or

[01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS)]

01 45 00 QUALITY CONTROL

02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS

****

1.1 UNIT PRICES

****

NOTE: Delete this paragraph if the work is in one lump-sum contract price. If it is retained and more detail is needed, items of consideration may include: test holes, monitoring well drilling and sampling, geophysical logging, non-hazardous sludge, pumpable liquids, analyticals for contaminated water, or PCB and asbestos, piping removal or capping and sealing, and remainder of work.

Coordinate this paragraph with the bidding schedule.

****

Payment for each specified item is made at the contract unit price for that item. Payment includes full compensation for equipment, materials and labor for drilling; removal and disposal of temporary casing, cuttings, and drill fluid; preparation of borehole logs; and sample handling, containers, storage, and testing. Measure depth, logging, installation, casing, riser pipe, and well screen by linear distance. Payment is not allowed for test holes or wells abandoned due to construction practices not in accordance with this specification, or for the convenience of the Contractor. Submit catalog data for the well screen (to include the screen slot size), well casing, riser pipe, filter pack material, Bentonite, cement, centralizers, surface protective covers, well vaults, locking caps, airline oil filters for pneumatic drilling, dedicated sampling equipment, and chemical specifications on drill lubricants and tracers, if used. Include any information, written or otherwise, supplied by the manufacturers or suppliers of the above listed items.

1.1.1 Test Holes

If the total depth of the test hole is greater than that specified in the contract for "Test Holes and Samples" due to justifiable site specific conditions and other justifiable reasons, the additional depth is paid for at the contract unit price for "Additional Test Hole Depth." If the test hole is developed into the permanent monitoring well, no separate payment is made for the test hole.

1.1.2 Well Drilling and Sampling

If the total depth of the well is greater than that specified in the contract for "Monitoring Wells and Samples," the additional depth is paid for at the contract unit price for "Additional Test Hole Depth."

1.1.3 Geophysical Logging

The "Geophysical Logging" unit price includes interpretation of the logs and their delivery to the Government.

1.1.4 Well Casing and Riser Pipe Selection and Installation

Payment is made for length of blank casing actually installed in the well. Payment includes compensation for decontamination and installation of the casing, riser pipe, cap, tail piece (if any), end cap and centralizers; and for the furnishing and installing of the well identification tag with information recorded thereon, or well marking in accordance with contract.

1.1.5 Monitoring Well Screen

Payment is made for monitoring well screen actually installed in the well.

1.1.6 Filter Pack Construction

Filter pack construction is measured by the cubic meter foot. Payment includes compensation for furnishing, delivering, storage, decontamination, analytical testing, and installing the filter pack.

1.1.7 Bentonite Seal

The bentonite seal is measured by the cubic meter foot. Payment includes full compensation for hydrating, and tremieing necessary for the work.

1.1.8 Grout Placement

The cement and/or bentonite grout,used in the annulus above the bentonite seal is paid by the cubic meter foot used. Payment includes compensation for cement, mixing of the grout, and pumping of grout, bentonite, mixing of bentonite grout, and pumping of bentonite grout, necessary for the work.

1.1.9 Monitoring Well Development

Payment for monitoring well development is made by the hour. Payment includes compensation for pumping, surging, sample photograph, discharge water containers, analysis, and disposal.

1.1.10 Monitoring Well Completion Aboveground

Payment includes compensation for protective covers, keyed-alike padlocks, locking caps, project photographs, concrete well pads, gravel, electrical components, lighting components, fencing, sign(s) and protective steel posts.

1.1.11 Monitoring Well or Test Hole Decommissioning/Abandonment

Permanent decommissioning/abandonment of monitoring wells or test holes is paid for only if it becomes necessary to abandon a well or test hole as specified, and only for work completed and accepted as specified. Payment includes compensation for drilling, casing removal, well sampling, materials, cement, mixing of cement, bentonite, and water, pumping of grout, equipment, removal of foreign objects, and transportation necessary to abandon the well or test hole and for the required well or test hole abandonment records.

1.1.12 Site Cleanup

Separate payment is not made for cleanup of the site. Cleanup means restoring the site to its pre-construction condition. Cleanup is considered part of and incidental to the drilling, construction, and/or decommissioning of the monitoring well.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

State and/or local regulations/requirements may also need to be referenced.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 306	(2010; R 2015) Standard Specification for Drainage, Sewer, Utility, and Related Castings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C387/C387M	(2023) Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar

ASTM D1452/D1452M	(2016) Standard Practice for Soil Exploration and Sampling by Auger Borings
ASTM D1586/D1586M	(2018) Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D1587/D1587M	(2015) Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4397	(2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D5088	(2020) Decontamination of Field Equipment Used at Nonradioactive Waste Sites
ASTM D5092	(2016) Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers
ASTM D5521/D5521M	(2013) Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers
ASTM D5608	(2016) Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites
ASTM D6725/D6725M	(2016) Standard Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers
ASTM F480	(2014; R 2022) Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

ASTM F883	(2013; R 2022) Standard Performance Specification for Padlocks

FORESTRY SUPPLIERS INC. (FSUP)

FSUP 77341	(2009) Munsell (R) Soil Color Book

GEOLOGICAL SOCIETY OF AMERICA (GeoSA)

GSA RCC00100R	(2009) Geological Rock Color Chart (Munsell)

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 530/F-93/004	(1993; Rev O; Updates I, II, IIA, IIB, and III) Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846)
EPA 600-4-89-034	(1990) Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells
EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes
EPA SW-846	(Third Edition; Update VII) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements

1.3 ADMINISTRATIVE REQUIREMENTS

Ensure each system, including equipment, materials, installation, and performance, is in accordance with local, State, and Federal regulations, ASTM D5092, EPA 600-4-89-034[and DoD policies and standards] except as modified herein. Consider the advisory or recommended provisions to be mandatory. Reference to the "Project Representative" and the "Owner" is interpreted to mean the Contracting Officer. Additional requirements are included under Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.

1.3.1 Notification

Notify the [Installation Environmental Coordinator (IEC)] [_____] [and] the Contracting Officer [_____] days prior to drilling. The [Contracting Officer] [Contractor] [Installation Environmental Coordinator (IEC)]

[_____] [is] [are] responsible for contacting the [State of [_____]] [USEPA] in accordance with the applicable reporting requirements.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Investigation-derived Waste Management Plan; G, [_____]

Installation Plan; G, [_____]

Health and Safety Plan; G, [_____]

Sampling and Analysis Plan; G, [_____]

Well Construction Permit

Treatment Facility Permit

Qualifications; G, [_____]

SD-02 Shop Drawings

Survey Maps and Notes; G, [_____]

Well Construction Drawings; G, [_____]

SD-03 Product Data

Riser Pipe; G, [_____]

Cement; G, [_____]

Centralizers; G, [_____]

Surface Protective Covers; G, [_____]

Well Vaults; G, [_____]

Locking Caps; G, [_____]

Oil Filters; G, [_____]

Sampling Equipment; G, [_____]

Chemical Specifications on Drill Lubricants and Tracers; G, [_____]

Well Casing; G, [_____]

Well Screen; G, [_____]

Filter Pack; G, [_____]

Neat Cement Grout; G, [_____]

Bentonite; G, [_____]

SD-06 Test Reports

Drilling Fluid Additive; G, [_____]

Well Development Record; G, [_____]

Filter Pack Material Test Results; G, [_____]

Sieve Analyses of Sampled Material; G, [_____]

Water Source Analytical Test Results; G, [_____]

SD-07 Certificates

Permits

Installation Survey Report

Well Development Report

Borehole Analysis Report

Shipment Manifests

Delivery Certificates

Correspondence

Photographs

Treatment and Disposal Certificates

SD-11 Closeout Submittals

Installation Diagram; G, [_____]

Well Decommissioning/Abandonment Record

Geophysical Logs

Borehole Logs; G, [_____]

1.5 QUALITY CONTROL

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NOTE: For projects on the National Priorities List(NPL) or RCRA sites, recommend using the EPA Uniform Federal Policy for Quality Assurance Project Plans worksheets for Quality Control.

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1.5.1 Qualifications

Submit personnel qualification documentation. Provide an onsite geologist with at least [3] [_____] years experience in hazardous waste projects, soil and rock logging, and monitoring well installation. Ensure the geologist is registered in the State of [_____], and responsible for all geophysical and borehole logging, drilling, well installation, developing and testing activities. Provide a driller licensed in the State of [_____], according to State requirements. Perform and provide geophysical log interpretation by a qualified log analyst, demonstrating competence through background, training, and experience when so called upon. Ensure the drill crew is experienced and trained in drilling, and health and safety requirements for contaminated sites.

Furnish documentation proving:

a. A minimum of [_____] years of monitor well installation experience

b. Appropriate health and safety personnel are on staff as specified in Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES

c. That qualified personnel are available to perform the necessary chemical sampling as presented in the approved Sampling and Analysis Plan.

1.5.2 Required Drawings

Submit well construction drawings showing components and details of well casing, well screen, filter pack, annular seal, and associated items. Ensure drawings are prepared and sealed by a State certified professional geologist, hydrogeologist, or a State registered professional civil engineer, hereafter referred to as the Contractor's Professional Consultant(CPC).

1.5.3 Investigation-derived Waste Management Plan

Furnish a material handling plan 15 days prior to initiation of the work that describes the plan for handling the investigation-derived waste, including the following: a schedule to be employed in the well drilling and development stages, a sequence of operations, the method of drilling and development, material hauling, proposed equipment, handling of the investigation-derived waste, testing requirements for the investigation-derived waste.

1.5.4 Health and Safety Plan (HASP)

Describe safety precautions for each phase of the project as specifically related to handling of soil and water removed during well drilling and development operations. Identify appropriate requirements of 29 CFR 1910 and EM 385-1-1. Identify safety equipment and procedures available for use during the project. Furnish the name and qualifications based on education, training, and work experience of the proposed Health and Safety Officer (HASO) and the members of the drill crew. The CPC may perform the responsibilities of the HASO if properly qualified.

1.5.5 Sampling and Analysis Plan (SAP)

Provide a sampling and analysis plan. Describe field sampling methods and quality control procedures. Identify a certified laboratory [approved by the Contracting Officer,]with laboratory methods to be used for contamination testing. Ensure sample reports show sample identification with location, date, time, sample method, contamination level, name of individual sampler, identification of laboratory, quality control procedures, and chain of custody information.

1.5.6 Installation Plan

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NOTE: The Monitoring Well Installation Plan may need to be included as a part of the Sampling and Analysis Plan (SAP).

****

Submit a plan, describing the drilling methods, sampling, and monitoring well construction and well development [30] [_____] calendar days prior to beginning drilling operations. Mobilization activities may start prior to submittal of the plan. Provide the plan approved and signed by a geologist [experienced in hazardous waste projects] as specified in the paragraph QUALIFICATIONS. Incorporate the following requirements into the Monitoring Well Installation Plan and follow in the field. Conduct sampling and testing in accordance with the guidelines as stated in: "Department of Defense Policy and Guidelines for Acquisitions Involving Environmental Sampling or Testing", November 2007. Include in the plan, but do not limit to a discussion of the following:

a. Description of well drilling methods, and installation procedures, including any temporary casing used, placement of filter pack and seal materials, drill cuttings and fluids disposal, and soil/rock sample disposition.

b. Description of well construction materials, including well screen, riser pipe, centralizers, tailpiece (if used), filter pack and filter pack gradation, bentonite, drilling fluid additives (if used), drilling water, cement, and well protective measures.

c. Description of quality control procedures to be used for placement of filter pack and seals in the boring, including depth measurements.

d. Include sample of forms used for written boring logs, installation diagrams of wells, geophysical logs, well development records, well sampling data records, State well registration forms, and well abandonment records.

e. Description of contamination prevention. Describe decontamination procedures for well materials and equipment.

f. Description of protective cover surface completion procedures, including any special design criteria/features relating to frost heave prevention. Include the maximum frost penetration for the site in this description.

g. Description of well development methods to be used.

h. List of applicable publications, including State and local regulations and standards.

i. List of personnel assignments for this project, and personnel qualifications.

j. Description of well decommissioning/abandonment procedures.

k. Description of in-situ permeability determination techniques, if testing is required.

l. Description and discussion of geophysical techniques to be employed at the site.

1.5.7 Treatment Facility Permit

Submit verification that the proposed treatment facility is permitted to accept the contaminated materials specified, prior to the start of drilling.

1.5.8 Well Development Report

Provide a report, containing the following data[for each well]: project name and location, well designation, date and time of well installation, date and time of well development, static water level from top of well casing before development and 24 hours after development, field measurements of pH, temperature, and specific conductivity, depth of well from top of casing to bottom of well, screen length, description of development methodology size/capacity of pump or bailer, pumping rate, and recharge rate.

1.5.9 Well Construction Permit

Submit a completed permit application and a proposed method of construction to[the appropriate state agency][Contracting Officer] prior to construction of the well. Well construction[s] [is][are] not allowed to start until the Contracting Officer has an approved Well Construction Permit.

1.5.10 Shipment Manifests

[Furnish copies of manifests and other documentation required for shipment of waste materials within 24 hours after removal of waste from the site.][Shipment manifests are signed by the Contracting Officer.]

1.5.11 Delivery Certificates

Submit verification that the wastes were actually delivered to the approved treatment facility, within 7 days of shipment.

1.5.12 Treatment and Disposal Certificates

Submit verification that the wastes were successfully treated and remediated to the levels specified herein.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in an undamaged condition. Unload and store with minimal handling. Store materials in on-site enclosures or under protective coverings. Store [plastic piping and jointing materials, and] rubber gaskets under cover, out of direct sunlight. Store materials off the ground. Keep insides of pipes and fittings free of dirt and debris. Replace defective or damaged materials with new materials.

1.7 PROJECTS/SITE CONDITIONS

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NOTE: If needed, edit and add Section 31 11 00 CLEARING AND GRUBBING.

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Access to each monitoring well site, including any utility clearance, permits, licenses, or other requirements and the payment thereof necessary for execution of the work is the responsibility of the [Contractor] [Government].

Submit a copy of all permits, licenses, or other requirements necessary for execution of the work to the Contracting Officer. Before beginning work,notify local United States Geological Survey office (USGS) [and the] [State Environmental Protection office] [State Geological Agency] [State health department] [local health department] [Department of Natural Resources] of the type and location of wells to be constructed, the method of construction and anticipated schedule for construction of the wells. Furnish a copy of all such well site correspondence to the Contracting Officer.

Obtaining rights-of-entry is the responsibility of the [Contractor] [Government]. Visit each proposed well location to observe any condition that may hamper transporting equipment or personnel to the site.[If clearing or relocation is necessary, the [Contractor,] [Installation

Environmental Coordinator,] and the Contracting Officer will agree on a suitable clearing, or relocation plan and the location of any required access road.]

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

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NOTE: Ensure that the well design meets or exceeds Federal, State, and local installation requirements. Additional criteria may apply for monitoring wells at radioactive, mixed, biological, solid, or medical waste sites.

****

Construct each monitoring well to yield chemically representative ground water samples from the screened interval for chemical analysis, and to allow for the accurate measurement of ground water depths relative to the top of the well riser, by use of electrical, wetted tape, or acoustical methods. The screened interval is that portion of a monitoring well which is directly open to the host aquifer by way of openings in the well screen and indirectly open to the aquifer by way of the filter pack (or other permeable material) extending continuously below and/or above the screen.

2.2 COMPONENTS

2.2.1 Well Casing

****

NOTE: Selection of casing and screen material type is critical to both the life of the well and the accuracy of the sampling data. Analysis of the existing groundwater chemistry is crucial to the designer making an appropriate material selection. In the absence of water quality data, it is prudent to choose conservative materials.

Stainless steel (SS) pipe offers high strength and rigidity sufficient to withstand virtually any subsurface condition, and is highly resistant to corrosion. SS is susceptible to degradation in long-term exposure to highly corrosive environments, including saline and certain acidic environments. This degradation results in the leaching of nickel and cadmium into the sampling regime.

PVC pipe is lightweight, corrosion resistant, durable, and generally chemically resistant but is not as strong as stainless steel pipe and is not recommended for deep wells. PVC is susceptible to degradation in long-term exposure to high concentrations of certain organic solvents. These include tetrahydrofuran (THF), methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), and cyclohexanone.

Additional materials such as aluminum, mild steel, polypropylene, and Teflon can be used for well

casings. The designer needs to be familiar with the advantages and disadvantages of each material.

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[2.2.1.1 Stainless Steel Pipe

Use ASTM A312/A312M, Type 304, Schedule 40S pipe, with flush threaded joint end fittings. Wrap threaded joints with fluoropolymer tape, and provide with nitrile O-ring gaskets.

][2.2.1.2 PVC Pipe

Use ASTM F480, Type 1, Grade 1, PVC 12454, NSF wc or NSF pw, Schedule [40] [80] pipe, with flush threaded joint fittings. Wrap threaded joints with fluoropolymer tape, and provide with nitrile O-ring gaskets.

]2.2.2 Well Screen

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NOTE: Well screens are located in the most reactive zone of the well environment. The material selection should be made based on similar criteria as the well casing materials. The designer should select the same material for the well screen as selected for the casing. However, in some situations, well screen material may be different from the material selected for the casing. Strength of the screen is important, as it has a large open area. Size the width of the slotted openings relative to the filter pack material, and should retain between 90 and 99 percent of that material. The open area of the screen should allow flow through the screen at approximately the same rate as the natural permeability of the aquifer.

NOTE: Continuous wrap screen is commonly used for monitoring wells; the type screen is not normally designated by schedule; however, the end fittings are selected for compatibility with the schedule of the well casing. Specify the schedule of the end fittings of the screen and the screen itself, if slotted pipe well screen is required.

The screen slot size for monitor wells is commonly 0.25 mm 0.010 inch for fine-grained formations or 0.5 mm 0.020 inch for coarser grained formations.

Monitoring well screen length is typically 1.5 to 3 meters 5 to 10 feet, but should be designed for the particular case to be monitored; however, when monitoring ground water quality at the top of the water table, screen lengths of 3 and 6 meters 10 and 20 feet are commonly used. Screens of more than 6 meters 20 feet are rarely used.

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2.2.2.1 Stainless Steel Screens

Provide a well screen consisting of new commercially fabricated flush-joint threaded [100] [_____] mm [4] [_____] inch nominal internal diameter Type [304][316][_____] stainless steel [_____][continuous wrap] [schedule [40] [_____] slotted], non-clogging design. Use screens conforming to ASTM A312/A312M, Type [316][_____], Schedule 40S, with continuous slot construction, wire wound, with flush threaded joint ends. [Provide schedule [40] [_____] end fittings on the continuous wrap screen.] Provide a screen slot size[approved by the Government] [[0.25] [0.50] [_____] mm [0.010] [0.020] [_____]-inch], and screen length of [[_____] meters feet]. Seal the bottom section of the screen watertight by means of a flush threaded end cap of the same material as the well screen, within 150 mm 6 inches of the open portion of the screen.

2.2.2.2 PVC Screens

Provide a well screen consisting of new commercially fabricated flush-joint threaded [100] [_____] mm [4] [_____] inch nominal internal diameter [polyvinyl chloride (PVC)] [_____][continuous wrap] [schedule [40] [_____] slotted], non-clogging design. Use screens conforming to ASTM D1785, PVC 1120, NSF wc or NSF pw, Schedule [40] [80], screen, Schedule 80, machine-slotted construction, flush threaded joint ends. Ensure slots are even in width, length, and separation. [Provide schedule [40] [_____] end fittings on the continuous wrap screen.] Provide required fittings conforming to ASTM F480, flush thread male by female. Provide a screen slot size[approved by the Government] [[0.25] [0.50] [_____] mm [0.010] [0.020] [_____]-inch], and screen length of [[_____] meters feet]. Seal the bottom section of the screen watertight by means of a flush threaded end cap of the same material as the well screen, within 150 mm 6 inches of the open portion of the screen.

[2.2.2.3 Prepacked Screen Monitoring Wells

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NOTE: For direct push installation of monitoring wells in unconsolidated aquifers, prepacked screen can be used.

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Ensure materials and installation of prepacked screen monitoring wells conform to the requirements of ASTM D6725/D6725M.

]2.2.3 Primary Filter Pack

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NOTE: The primary filter pack selected should have a 30 percent finer (d-30) grain size that is 4 to 10 times greater than the d-30 grain size of the aquifer. The uniformity coefficient (60 percent passing, d-60/10 percent passing, d-10) should be less than 2.5, and ideally in the 1.0 to 1.5 range. The primary filter should extend 600 to 1500 mm 2 to 5 feet above the top of the well screen. The secondary filter should be a minimum of 300 mm one foot thick, preferably 600 mm 2 feet thick.

****

[Provide clean, durable, well-rounded, and washed quartz or granite, with less than 5 percent non-siliceous material. Ensure the filter pack does not contain organic matter or friable materials and allow free flow of water in the well, and also prevent the infiltration of aquifer materials.

Ensure the filter pack has a 30 percent finer than (d-30) grain size of [_____] mm inch, and a uniformity coefficient less than [2.5] [_____], in accordance with ASTM C117 and ASTM C136/C136M.

][Provide a filter pack consisting of clean, washed, rounded to sub-rounded siliceous material free from calcareous grains or material. Submit filter pack material test results consisting of sieve and chemical analyses. Organic matter, soft, friable, thin, or elongated particles are not permissible. Determine the gradation of the filter pack using the grain size analysis data obtained from test results. Use a uniformity coefficient for the filter pack material not exceeding 2.5. Fill an airtight liter pint size [plastic] [glass] container with a sample of filter pack material and furnish to the Contracting Officer for each well to serve as a quality control.

]2.2.3.1 Secondary Filter Pack

Ensure gradation is in accordance with ASTM D5092. Provide clean, durable, well-rounded, and washed quartz or granite. Pack cannot contain organic matter or friable materials.

2.2.4 Annular Sealants

2.2.4.1 Bentonite Seal

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NOTE: Sodium bentonite is most widely used, however, calcium bentonite may be more appropriate for high calcium environments. Bentonite seal should be placed above the secondary filter and approximately 600 to 1500 mm 2 to 5 feet above the uppermost well screen.

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Provide powdered, granular, pelletized, or chipped [sodium] [calcium] montmorillonite in sealed containers from a commercial source, free of impurities. Ensure pellet size is less than one fifth the diameter of the borehole annular space to prevent bridging. Ensure bentonite base grout is in accordance with ASTM D5092.

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NOTE: Slurry seals can be used as when the seal location is too far below water to allow for pellet or containerized-bentonite placement, or within a narrow well-borehole annulus.

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If the bentonite seal is located above any borehole fluid levels, place a layer of fine sand at the top of the bentonite seal, to provide an additional barrier to any downward migration of grout.

2.2.4.2 Neat Cement Grout

Provide neat cement grout in accordance with ASTM D5092. Ensure cement is in accordance with ASTM C150/C150M. Quick setting admixtures are not allowed. Do not use drilling mud or cuttings as a sealing material.

2.2.4.3 Cement And Bentonite Grout

Provide cement grout with a mixture of a maximum of 26 liters of approved water per 42.6 kg 7 gallons of approved water per 94 lb bag of portland cement, conforming to ASTM C150/C150M, Type [I] [_____]. Add no more than 5 percent by weight of bentonite powder to reduce shrinkage and hold the cement in suspension prior to the grout set. Use sodium bentonite powder and/or granules for high-solids bentonite grout.

2.2.5 Bottom Plugs

Provide a flush threaded solid plug at the bottom of the well. Ensure plug material is the same as the well [casing] [screen] to which it is attached. Wrap joints with fluoropolymer tape and provide nitrile O-ring gaskets.

2.2.6 Locking Well Cap

Provide a flush threaded, weatherproof, and non-removable locking well cap on the top of the well. Ensure the well cap is the same material as the well casing to which it is attached.

2.2.7 Protective Outer Casing [and Bollards]

Install a protective outer casing[and bollards] with pipes conforming to ASTM A53/A53M, Type E or S, Grade B.

2.2.8 Polyethylene Sheeting

Ensure polyethylene sheeting conforms to ASTM D4397.

PART 3 EXECUTION

Notify the Contracting Officer at least 15 days prior to commencement of work. Well locations are as indicated. Drilling, installation, and development of the monitoring well[s] is supervised, directed, and monitored by the geologist in charge. Decontaminate equipment used for drilling, sampling, and well development before and after each use in accordance with ASTM D5088.

3.1 PREPARATION

3.1.1 Water Source

If well drilling and installation requires the use of water, prior to its use at the site, locate and obtain water from a source. Sample and test the water source for the constituents specified in the Sampling and Analysis Plan. Submit the water source analytical test results to the Contracting Officer and obtain approval to use the source water. Transport and store the water at the site.

3.1.2 Decontamination

Clean the drill rig, drill rods, drill bits, augers, temporary casing, well developing equipment, tremie pipes, grout pumping lines, and other associated equipment with high-pressure hot water/steam prior to drilling at each monitoring well location. Perform decontamination in accordance with [ASTM D5088][ASTM D5608], at a central decontamination station located in an area that is remote from, and cross- or down-gradient from the well being drilled.

Clean the screen and well casing with high-pressure hot water and detergent cleaning solution immediately prior to installation in the well. The use of factory sealed (plastic wrapped) screen and well casing does not waive this requirement for pre-installation cleaning. Decontaminate samplers in accordance with the Sampling and Analysis Plan.

3.1.3 Decontamination Station

a. Construct a temporary decontamination pad onsite, bermed and slightly inclined towards a sump located in one of the back corners of the pad. Line the pads and berms with plastic sheeting to contain decontamination water. Place exterior-grade plywood sheeting over the plastic sheeting to prevent damage to the plastic and allow the drill rig and heavy equipment to use the pad.

b. Make the minimum dimensions of the pad the length and width of the drill rig, plus 1.2 m 4 feet per side to allow access and steam cleaning. Use yellow ribbon to encircle the decontamination pad.

c. Pump water collected in the sump to a 200 liter 55 gallon drum labeled "Decontamination Pad Sump Water." Transfer solid waste to a separate 200 liter 55 gallon drum labeled "Decontamination Pad Sump Sludge."

3.1.4 Containerization Of Development Water, And Drill Cuttings

Furnish D.O.T. approved [polyethylene] [steel] drums or vessels with lids, lid gaskets, bolts, chain of custody forms and drum labels. Mark each drum label in accordance with 49 CFR 172 in addition to the following information:

a. Drum number,

b. Site name,

c. Well name and number,

d. Contents and date,

e. Approximate depth of material contained in each drum, and

f. The name and phone number of the [Installation Environmental Coordinator (IEC)] [Contracting Officer] [_____].

3.2 INSTALLATION

Install the well in accordance with ASTM D5092 and EPA 600-4-89-034, and as indicated on the well construction drawings submitted by the CPC and approved by the Contracting Officer.

Prevent aquifer contamination by the drilling operation and equipment, intra- and inter-aquifer contamination, and vertical [or horizontal] seepage of surface water adjacent to the well into the subsurface, especially the monitoring well intake zone. Perform work in conformance with EPA 530/F-93/004, EPA 600/4-79/020,[and] EPA SW-846[.][, and][EM 385-1-1.]

Ensure the borehole is stable and verified straight before beginning installation.

Prevent aquifer contamination by the drilling operation and equipment, intra- and inter-aquifer contamination, and vertical [or horizontal] seepage of surface water adjacent to the well into the subsurface, especially the monitoring well intake zone. Perform work in conformance with EPA 530/F-93/004, EPA 600/4-79/020,[and] EPA SW-846[.][, and][EM 385-1-1.]

3.2.1 Drilling Method

a. Use a drilling method which prevents the collapse of formation material against the well screen and casing during installation of the well. Size the inside diameter of any temporary casing used sufficient to allow accurate placement of the screen, riser, centralizer, filter pack, seal and grout.

b. The use of drilling aids such as bentonite, other clay-based agents, or any other foreign matter capable of affecting the characteristics of the ground water is prohibited. Ensure any drilling fluid additive used is inorganic in nature. Grease or oil on drill rods, casing, or auger joints are not permitted; however, PTFE tape or vegetable oil (in solid phase form) are acceptable. Submit manufacturer's data, if available, including analytical test results of the additive, if not a part of the manufacturer's data.

c. Provide a drill rig free from leaks of fuel, hydraulic fluid, and oil which may contaminate the borehole, ground surface or drill tools. During construction of the wells, use precautions to prevent tampering with the well or entrance of foreign material. Prevent runoff from entering the well during construction. If there is an interruption in work, such as overnight shutdown or inclement weather, close the well opening with a watertight uncontaminated cover. Secure the cover in place or weighted down so that it cannot be removed except with the aid of the drilling equipment or through the use of drill tools.

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NOTE: Type of drilling equipment is dependent upon site geology, hydrogeology, and intended use. If possible, utilize drilling methods that do not introduce water or drilling fluids into the borehole. If such methods are required, purge drilling fluid from the well during well development.

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Advance borehole using conventional [[250] [_____] mm [10] [_____] inch hollow-stem auger] [solid auger] [rotary wash] [_____] drilling methods. If it is the opinion of the geologist in charge that an alternate drilling method is required, submit justification for a boring method change to the Contracting Officer, and receive approval for the change granted prior to drilling.

3.2.2 Test Hole Requirements

Drill one test hole for every monitoring well or well cluster installed. A well cluster, as defined in this specification, is two or more wells completed (screened) to different depths in a single borehole or in a series of boreholes in close proximity (3 m 10 feet or less) to each other. The test hole may be converted to the permanent monitor well. Log test holes in accordance with paragraph BOREHOLE LOGS, and if temporary casing is used, use in accordance with paragraph DECONTAMINATION.

3.2.3 Borehole Diameter and Depth

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NOTE: State regulations may require more than 50 mm 2 inches of annular space between the boring wall and the sides of the entered riser pipe and screen.

****

Provide sufficient diameter in borings for monitoring well installation to allow at least 50 mm 2 inches of annular space between the borehole wall and all sides of the centered riser pipe and screen. Determine depths of individual borings [as specified in the approved Monitoring Well Installation Plan] [as indicated on the drawings] [_____], with actual depth adequate to allow for the collection of representative ground water samples for chemical analysis at the time of initial sampling.

3.2.4 Screen, Well Casing And Riser Pipe Placement

Locate well screens as indicated. Ensure the length of [each] [the] screen is as indicated. Distribute slotted openings uniformly around the circumference of the screen. Ensure the open areas approach the formation's natural porosity.

****

NOTE: Depending on the nature of the contaminants to be sampled, the screen may be required to be placed below or across the water table. Caps for the flush-to-ground, or manhole type surface completion should not be vented, or loose fitted. Caps for these type completions should be water tight. Delete the requirements for centralizers if they are not required.

****

Ensure personnel wear clean cotton or surgical gloves while handling the assembly. Ensure well casings, screens, plugs, and caps are decontaminated prior to delivery by the manufacturer and certified clean. Deliver, store, and handle materials in such a manner as to ensure that grease, oil, or other contaminants do not contact any portion of the well screen and casing assembly prior to installation.

a. Provide the monitoring well screen in length [as shown on the drawings] [[____] mm feet long] [as determined by the Contractor and approved by the Government], with specified bottom cap securely attached, set to the appropriate depth.

b. Place the bottom of the well screen no more than 1 m 3 feet above the bottom of the drilled borehole.

c. Clean the screen and well casing and riser pipe with high pressure hot water/steam just prior to installation; allowing no foreign material to remain on the screen and well casing before installation. The use of factory-sealed (plastic wrapped) screen, free from painted markings, does not waive requirements for pre-installation cleaning. Place the well screen [as specified on the drawings] [at [_____]]. Ensure the well casing and riser pipe extends upwards from the screen to an elevation appropriate for the surface completion described in paragraph PROTECTIVE COVER PLACEMENT. Do not allow the well screen and riser pipe to drop or fall uncontrolled into the borehole.

d. Join the screen and well casing and riser pipe sections by flush threaded watertight joints and fastenings. Solvent glue or set screws are not permitted.

e. Use centralizers to ensure that the well screen and casing assembly is installed concentrically in the borehole. [Center and plumb the well by the use of a minimum of [_____] stainless steel centralizers, spaced at intervals not exceeding [6] [_____] m [20] [_____] feet along the length of the casing. Do not place centralizers on the screened interval or within the bentonite seal.]Verify the alignment of the well by passing a 1500 mm 5 foot long section of rigid pipe 6 mm 1/4 inch smaller in diameter than the inside diameter of the casing through the entire well. If the pipe does not pass freely, the well is not accepted. Thoroughly clean the pipe section with high pressure hot water prior to each test. Use temporary casing, hollow stem augers or other measures, as necessary, to prevent collapse of the boring against the well screen and well casing and riser pipe prior to placement of the filter pack and sealing materials. Install a cap on the top of the riser pipe, either vented, or a telescopic fit, constructed to preclude binding to the well casing caused by tightness of fit, unclean surfaces, or weather conditions. Make cap secure enough to preclude the introduction of foreign material into the well, yet allow pressure equalization between the well and the atmosphere.

When the assembly has been installed at the appropriate elevation, adequately secure the assembly to preclude movement during placement of the filter packs and annular seals. Cap the top of the well casing during filter pack placement.

3.2.5 Filter Pack Placement

Protect filter pack material from contamination prior to placement by either storing it in plastic lined bags, or in a location protected from the weather and contamination on plastic sheeting. Transport filter pack material to the well site in a manner which prevents contamination by other soils, oils, grease, and other chemicals.

Prior to commencement of work, receive approval from the Contracting Officer for equipment and methods required to place filters. Place primary and secondary filter packs as indicated on the approved well construction drawings to fill the entire annular space between the screen and casing assembly and the outside wall of the borehole. Place both the primary and secondary filters with a tremie pipe in accordance with EPA 600-4-89-034 and ASTM D5092. Placement of the primary and secondary filters by gravity or free fall methods is not allowed. Control speed of filter placement to prevent bridging and to allow for settlement. Take frequent measurements inside the annulus during tremie pipe retraction to ensure that the filter pack is properly placed.

[After the screen and well casing have been concentrically placed in the hole, construct the approved filter pack around the screen by filling the entire space between the screen and the wall of the hole over the selected screened interval. Place the lowermost [300] [_____] mm [1] [_____] foot of filter pack in the boring prior to installation of the well screen, serving as a base on which to place the screen. Lower a tremie pipe having an inside nominal diameter of not less than 25 mm 1 inch, to the bottom of the annulus between the hole and well. Clean the tremie pipe with high pressure hot water/steam prior to each use. Arrange the tremie pipe so that water and filter pack material fed at uniform rates are discharged as the filter pack material fills the hole from the bottom up. Raise the tremie pipe at a rate that will keep the bottom of the pipe no more than [1500] [_____] mm [5] [_____] feet above the top of the surface of the filter pack level, and no more than [600] [_____] mm [2] [_____] feet below the surface of the filter pack level at all times.

] Dumping filter pack material from the surface of the ground and agitating the well in an effort to settle the filter material is not allowed. Install the filter pack continuously and without interruption until the filter pack has been placed [to a minimum of 1 meter 3 feet above the top of the screen in the monitoring well] [to a height equal to 20 percent of the length of the screen] [to within no more than [_____]meters[_____] feet of the top of the ground surface]. Directly measure the depth to the top of the filter pack and record. Obtain any additional water required to be added to the filter pack material in accordance with paragraph WATER SOURCE.

3.2.6 Bentonite Seal

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NOTE: Sufficient time should be allowed for the bentonite seal to hydrate and form a low permeable seal before grout is placed in the annular space above the bentonite seal. By not allowing enough time, grout material could infiltrate into the seal and possibly into the filter pack. Normally bentonite chips should only be used if it is necessary to install a seal in a deep water column. Because of their high moisture content and slow swelling tendencies, chips can be dropped through a water column more readily than a material with low moisture content such as pellets. If the proposed seal location is above the anticipated static ground water level, a bentonite seal should not be used unless a fine layer of sand is placed atop the seal. In this case, use a [30 to 60 cm] [1- to 2-foot] layer of fine-grained sand (secondary filter pack) placed atop the primary filter pack or the bentonite seal. A 0.15 to 0.30 m 6 in to 1 foot layer of fine sand placed atop the bentonite seal will further enhance barrier resistance to downward grout migration. It is recommended that the bentonite seal be placed in lifts of 0.15 to 0.30 m 6 in to 1 foot with each lift allowed to hydrate for a minimum of 30 minutes prior to placing the next lift. For more guidance consult EM 1110-1-4000.

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3.2.6.1 Bentonite Pellets

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NOTE: Pellets are compressed and shaped sodium bentonite available in 6, 9, and 12.5 mm 0.25, 0.375, and 0.5 inch sizes.

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Pouring of pellets is acceptable in shallow boreholes less than 12 meters 40 feet. In order to provide accurate measurement of bentonite pellet thickness in the well boring, tamp the pellet seal during measurement. If not placed in lifts, allow the seal a minimum hydration time of three hours, unless the manufacturer recommends a longer hydration time.

3.2.6.2 Bentonite Chips

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NOTE: Chips are graded and sized chip material made of sodium bentonite in two sizes, 9 and 19 mm 0.375 and 0.75 inch.

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Adequate annular space is required in the use of bentonite chips to reduce the risk of bridging. Chips are preferable to use over pellets when installing a seal in a deep water column. In order to provide accurate measurement of bentonite chip seal thickness in the well boring, tamp the seal during measurement. If not placed in lifts, allow the seal a minimum hydration time double the hydration time for pellets.

3.2.6.3 Bentonite Slurry

A bentonite slurry seal can be used when the seal location is too deep for the use of pellets or chips, or within a narrow borehole annulus. The slurry is made from granular or powder sodium bentonite. The specific gravity of cement grout placed atop a slurry seal will be greater than the bentonite slurry. Exercise care to preclude the grout from migrating downward into the slurry.

Mix water from an approved source with granular or powder bentonite to form a thick bentonite slurry, consisting of a mixture of bentonite and the manufacturer's recommended volume of water to achieve an optimal seal. A typical slurry mix contains at least 20 percent solids by weight and has a density of 4.3 kg per liter 9.4 lb per gallon of water or greater.

3.2.6.4 Bentonite Seal Thickness And Replacement

Place a minimum 1 m[3 foot][5 foot] thick hydrated bentonite seal on top of the filter pack. Control speed of bentonite placement to prevent bridging of pellets or chips, or segregation of slurry. Place Bentonite chips and pellets in lifts of 0.15 to 0.30 m 6 inches to 1 foot with each lift allowed to hydrate for a minimum of 30 minutes prior to placing the next lift. If not placed in lifts, the minimum hydration time for pellets is 3 hours, unless manufacturer recommendations for hydration are longer. The hydration time for chips can require twice the time required for pellets. Directly measure the depth to the top of the bentonite seal and record immediately after placement, without allowance for swelling. Add water to the annular space as directed by the geologist in charge to ensure complete hydration of the bentonite. If the bentonite seal is located above any borehole fluid levels, place a [300] [_____] mm [1] [_____] foot layer of fine sand at the top of the bentonite seal.

3.2.7 Grout Placement

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NOTE: There is a provision for placing a high-solids bentonite grout in the annulus above the

bentonite seal rather than cement grout. This may be better in areas of the country where the monitoring wells are susceptible to frost heave. If it is required that the protective casing be anchored in-place with cement grout, this should be conducted in accordance with paragraph PROTECTIVE COVER PLACEMENT. Determine the depth of maximum frost penetration before design of the monitoring well installation. The susceptibility of the soils to frost action should also be determined beforehand. Guidance for determining frost penetration may be found in UFC 3-130-06 or FM 5-430-00-1. There may be a need for a provision to grout the annular space in lifts in deep wells to ensure that any PVC or other type casing is not damaged by the weight and/or heat created by the chemical reaction of cement grout. If grouting in lifts is for some reason not acceptable, the well should be designed to withstand greater external pressures. This may mean using higher schedule casing, or steel instead of PVC, for example.

****

Mechanically mix a [non-shrinking cement] [high-solids bentonite] grout, and place in one continuous operation into the annulus above the bentonite seal to [within [_____] mm feet of] [the ground surface] [the maximum depth of frost penetration (frost line)]. Make grout injection in accordance with ASTM D5092.[If the casing interval for grouting is less than 4.5 m 15 feet, and without fluids after any drill casing is removed, place the grout either by pouring or pumping.]

Place cement grout in the annular space above the bentonite seal as indicated on the well construction drawings. Place the cement grout as a slurry through a tremie pipe, and inject from the bottom up. [Inject grout in one continuous operation until full strength grout flows out at the ground surface without evidence of drilling cuttings or fluid.][For deep wells, inject grout in lifts to ensure that the casing is not damaged.]Cure grout a minimum of 48 hours before beginning well development operations.

Add additional grout from the surface to maintain the level of the grout at the land surface as settlement occurs. Work is not permitted in the well within [48] [_____] hours after cement grouting.

Thoroughly clean the tremie pipe with high pressure hot water/steam before use in each well.

3.2.8 Concrete or Gravel Pad Placement

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NOTE: Some states may require that the surface seal extend to depths of 3 m (10 feet), or greater to ensure sanitary protection of the well. The surface seal may be an extension of the annular seal installed above the filter pack or it may be a separate "surface" seal emplaced on top of the annular seal. Also, in extreme cold climates, it may be better, if allowed by State and local regulations, to fill the annular space above the

bentonite well seal, or filter pack, with bentonite grout and construct the well "pad" of coarse gravel, rather than concrete. Concrete well pads sometimes have a tendency to crack and breakup in cold regions.
****

Construct a [concrete pad with a minimum radius of [600] [_____] mm [2] [_____] feet from the protective casing and 100 mm 4 inch] [coarse gravel blanket with a minimum radius of [1200] [_____] mm [4] [_____] feet from the protective casing and 150 mm 6 inch] thick, sloped away from the well around the well casing at the final ground level elevation. [Prior to placement of the gravel blanket, backfill any depression existing around the well borehole to the level of the surrounding ground surface with [near-surface drill cuttings from the well] [clay] [_____].] [Furnish pre-packaged, dry, combined concrete materials for the well pads conforming to ASTM C387/C387M normal weight, normal strength concrete. Combine the dry materials with potable water and mix in an approved mixer or container until uniform in consistency and color. Limit water to the minimum amount possible.]

3.2.9 Protective Cover Placement

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NOTE: If frost heave is not a concern at the site, the requirement for the annular space between the protective casing and the well riser to be filled with dry bentonite may be deleted. The cement grout may then be placed outside of, and inside the protective casing to the ground surface as would be specified in paragraph GROUT PLACEMENT.

It may be necessary to require that the protective posts be supplemented with barbed wire in livestock grazing areas. Additional guidance on monitoring well protection may be found in ASTM D5787
****

Provide all monitoring wells with a [steel] [_____] lockable protective enclosure set in the annular seal over the well casing with keyed-alike locks on the protective covers for all wells.

3.2.9.1 Aboveground Completions

Provide protective outer casing around the well casing extending above grade. The diameter of the protective outer casing is a minimum of 100 mm 4 inches larger than the well casing diameter. The top of the protective outer casing extends a minimum of 150 mm 6 inches above the top of the well casing cap. Set the protective outer casing in cement grout and extend the bottom of the protective well casing [below the depth of the frost line] [to the depth indicated]. Drill a 6 mm 1/4 inch diameter weep hole in the protective outer casing 75 mm 3 inches above the ground surface. Fill the annular space between the protective outer casing and the well casing with pea gravel or coarse sand to just below the level of the cap on the well casing.

[Provide 150 mm 6 inch diameter steel pipe bollards, filled with concrete as indicated to protect the exposed well head.

] Provide cap on top of the protective outer casing. Ensure cap is flush threaded and of the same material as the protective outer casing. Wrap threaded joints with fluoropolymer tape and provided with nitrile O-ring gaskets.

Ensure the well cap can accommodate a padlock. Provide a long shackled padlock in accordance with ASTM F883. Provide two padlock keys to the Contracting Officer. [Ensure locks at the well site are keyed alike.]

3.2.9.2 At-Grade Completions

Provide [cast iron] [aluminum] vault box, [750 by 750 mm 30 by 30 inches] [300 mm 12 inch diameter] [_____], with watertight frame and cover. Select vault loading support for[AASHTO M 306 H-20 loading for traffic areas] [a 45,360 kg 100,000 pound loading for a less than a 60 cm 2 foot span for airfield locations]. Depth of frame is 150 mm 6 inches. Set the frame in a concrete collar with a minimum thickness of 200 mm 8 inches, and extending 100 mm 4 inches beyond the edge of the frame in all directions. Ensure the frame and concrete collar is [set flush with the level of the existing pavement] [set 75 mm 3 inches above the existing grade]. Provide a locking well cap on top of the well casing, which terminates inside the vault as indicated.

[3.2.9.3 Protective Steel Casing

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NOTE: Delete this paragraph if not applicable for the project.

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a. Install a protective steel casing around the well casing and riser pipe by placing the protective casing into the annular seal. Clean the protective casing with high-pressure hot water/steam prior to installation to ensure that it is free of any contamination. Provide a protective casing with an inside diameter of at least 100 mm 4 inches greater than the nominal diameter of the well riser. Fit the protective casing with a locking cap and install so that there is a maximum 61 mm 0.2 foot clearance between the top of the in-place inner well casing cap and the bottom of the protective casing locking cap when in the locked position.

b. Position and maintain the protective casing in a plumb position. Extend the bottom of the protective casing a minimum of 750 mm 2.5 feet below the top of the ground surface; extending a minimum of [750] [_____] mm [2.5] [_____] feet below the maximum depth of frost penetration (frost line); and anchored into the cement grout annular seal; and also extending at least 750 mm 2.5 feet above the surface of the ground. Seal and immobilize the protective casing in concrete placed around the outside of the protective casing, then place dry bentonite pellets, or granules, in the annular space below ground level within the protective casing.

c. Provide the protective casing with a 6 mm 1/4 inch diameter drain hole installed just above the top of the [concrete pad] [gravel blanket]. Place coarse sand or pea gravel in the annular space between the protective casing and the riser pipe, above the drain hole, to within 75 mm 3 inches from the top of the riser pipe. [Install [four] [_____] protective steel posts, located 1200 mm 4 feet from the well, equally spaced around the [concrete pad] [gravel blanket]. Fill the steel posts with cement. Do not install the posts in the concrete pad, but a

150-300 mm 0.5-1.0 foot distance from the edge of the concrete pad. Set the posts in cement, and extending a minimum of 1 m 3 feet above the ground surface, with at least one third of the posts' total length below ground surface.]

[d. For wells deeper than 60 m 200 feet, verify that the well is plumb.

]][3.2.9.4 Flush-to-Ground Utility Vault

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NOTE: Delete this paragraph if not applicable for the project.

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Install a flush-to-ground protective steel utility vault or manhole around the well casing and riser pipe which has been cut off below grade. Construct the flush mounted protective utility vault or manhole with a concrete ground surface seal. Extend the ground surface seal to, but not beyond, the total depth of the flush mounted protective utility vault. Install the ground surface seal around the flush mounted protective utility vault but do not place between the flush mounted protective utility vault and the well casing. Do not install the flush mounted protective utility vault in areas subject to ponding or flooding. Provide the wording "ground water monitoring well" on the flush mounted protective cover's lid or manhole cover on its outer surface. Install flush mounted protective utility vaults through an impervious surface such as asphalt or concrete. If an impervious surface does not exist, create one to support the weight of the traffic in the area. Provide a flush mounted protective utility vault consisting of a watertight metal casing with an inside diameter at least 100 mm 4 inches greater than the inside diameter of the monitoring well casing, made of one continuous metal piece or two metal pieces which are joined with a continuous weld; and a minimum length of [300] [_____] mm [12] [_____] inches. Allow no more than 200 mm 8 inches between the top of the monitoring well casing and the top of the flush mounted protective utility vault after installation. Provide the flush mounted protective utility vault with an exterior flange or lugs. Do not allow the flush mounted protective utility vault to extend below the top of the cement/bentonite annular space seal. To prevent damage from frost heave, extend the concrete surrounding the utility vault a minimum of 300 mm 12 inches below the frost line. Provide the flush mounted protective utility vault or the monitoring well with a locking mechanism and a watertight cap.

]3.2.10 Well Identification

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NOTE: Local well identification requirements should be specified.

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Affix a corrosion resistant metal tag to the exterior and interior of the protective cover. [For concrete paved areas, affix the well identification tag to the concrete with four (4) hammer set nails.]Provide the metal tag stamped with the [U.S. Army Corps of Engineers CE [_____]] [_____], well identification number, elevation of the highest point on the rim of the well casing or riser pipe, elevation of the ground surface at the well, well coordinates, date of well installation, and the top of the protective casing elevation in meters feet as determined according to paragraph SURVEYS. Use identification numbers for the monitoring wells as indicated on the drawings.

Clearly mark and secure the well to avoid unauthorized access and tampering. Cast the words "MONITORING WELL" on the well head cover. Provide a sign reading, "WELL IS FOR MONITORING AND IS NOT SAFE FOR DRINKING." Provide stamped metal identification tag as follows:

DO NOT DISTURB
ID #: Date:
Installed By:
Total Depth:
Screened Interval:
TOC Elevation:
Other:
For Information, Call:

3.3 FIELD QUALITY CONTROL

3.3.1 Temporary Containment of Soil Removed from the Borehole

[Place soil removed from the borehole in the temporary containment area near the well site. Cover containment area with 0.25 mm 10 mil reinforced polyethylene sheeting. Place soil removed from the borehole[s] on the impervious barrier and cover with 0.15 mm 6 mil reinforced polyethylene sheeting. Provide a [straw bale berm][silt fence]around the outer limits of the containment area and cover with polyethylene sheets. Secure edges of sheets with weights to keep the polyethylene sheeting in place. Divert water runoff from the stockpiled material.

][Stockpile soil in trucks suitable for transporting contaminated soils as specified herein.

][3.3.2 Well Alignment

For wells deeper than 60 m 200 feet, verify that the well is plumb.

]3.3.3 Sampling

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NOTE: Sampling for chemical and geotechnical analysis may be combined to allow for obtaining samples for both if that accomplishes project requirements. If rock is cored at the site, and it is determined that it should be retained, it should be boxed, and photographed. Its storage, and later disposal should be in accordance with ER 1110-1-1803, and the proper storage and handling protocol for the material as may be required by other Federal, state, or local laws, regulations and permits.

****

Obtain soil samples in accordance with ASTM D1452/D1452M, [ASTM D1586/D1586M][ASTM D1587/D1587M], and the Sampling and Analysis Plan. Perform standard penetration tests at the following depths: 0 to 450 mm; 450 to 900 mm; 900 to 1350 mm; and 1500 mm 0.0 to 1.5 feet; 1.5 to 3.0 feet; 3.0 to 4.5 feet; and 5 foot centers or at changes in soil formation thereafter.

Screen soil samples in the field. Conduct sample screening in accordance with the Sampling and Analysis Plan.

Record boring information in accordance with ASTM D2487 and ASTM D2488. Indicate groundwater elevation in the log.

3.3.4 Sampling for Chemical Analysis

Include sampling requirements for obtaining and preserving samples for chemical analysis in the Sampling and Analysis Plan.

3.3.5 Sampling for Geotechnical Analysis

Take samples of all materials penetrated by each drilled well/test hole. Perform soil sampling with a stainless steel split tube sampler using standard sampling techniques in accordance with ASTM D1586/D1586M. Extract samples from their in-situ environment in as near an intact, minimally disturbed condition as technically practical. Retrieve samples according to ASTM D1586/D1586M at least every [1] [_____] meter [5] [_____] feet from each test hole. Obtain samples continuously through the area expected to be screened.

Provide a sieve analyses of sampled material, conducted in accordance with ASTM C136/C136M. Clean drive sample tools with high-pressure hot water/steam between sampling events within the same boring. Place drive-sampled materials in airtight containers and label as specified in paragraph CONTAINERIZATION OF DEVELOPMENT WATER, AND DRILL CUTTINGS, and deliver to the Contracting Officer's designated facility. Test representative soil samples for grain-size distribution by mechanical means (sieves down to the 0.074 mm No. 200 size according to ASTM C136/C136M), moisture content according to ASTM D2216 and Atterberg limits according to ASTM D4318. Prepare description and identification of soils in accordance with ASTM D2488, laboratory classification of soils in accordance with ASTM D2487, and perform sampling to allow completion of the documents described in paragraph BOREHOLE LOGS.

The geologist in charge reviews the log data from each borehole and compares the data with the well design requirements. The CPC verifies the adequacy of the well design, or offers a proposed modification to the design based on the geologic and hydrogeologic data obtained from the borehole. This review and analysis is conducted [for each borehole] [for one borehole considered representative of the entire project]. The geologist in charge submits the borehole boring logs, the well design analysis, and any proposed design modifications to the Contracting Officer in a Borehole Analysis Report.

[Any modifications to the well design approved by the Contracting Officer is considered a change to the contract documents and negotiated in accordance with the "CHANGES" clause.

][3.3.5.1 Geophysical Logging

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NOTE: The requirement to obtain borehole geophysical surveys is optional. While it may not be necessary to require a borehole geophysical survey at a site where a great deal is known about the subsurface, at another site, where very little, or nothing is known, it may be prudent to require a borehole geophysical survey. When it is deemed necessary to require a borehole geophysical survey,

the specific type of survey should be specified. This recommendation is made by the project geologist. The project geologist should also determine what geophysical logging is not allowed by State regulations, before specifying them. See EM 1110-1-1802, Geophysical Exploration. Guidance for planning and conducting borehole geophysical logging may be found in ASTM D5753.
****

Geophysically log the total depth of each test hole drilled. Document geophysical logging in accordance with Geophysical Logs. Run [one successful natural gamma ray or gamma-gamma for the full depth, (top to bottom of test hole);] [one successful neutron in the fluid filled portion of the hole, (top to bottom of test hole);] [one successful (top to bottom of test hole) spontaneous potential (self-potential);] [and,] [one successful (top to bottom of test hole) resistivity log], for each test hole. Perform log analyses and interpretations by a person qualified in accordance with paragraph QUALIFICATIONS.

]3.3.6 In-Situ Permeability Determination

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NOTE: In some fine grained aquifers, the period of time for the aquifer to reach equilibrium may exceed 24 hours and testing should be performed no sooner than 48 or more hours after the well is developed.
****

Determine the in-situ permeability for each well following development but no sooner than [48] [_____] hours after development. After the well is developed and allowed to equilibrate for at least 24 hours, and before in-situ permeability testing, measure and record the static water level in the well. Determine, for each well installed, the in-situ permeability of the screened formation using an appropriate method after the well has been developed. State proposed details of the methods expected to be used and references for those methods in the Well Installation Plan. Except for formation water from the well, do not introduce any other water or liquid into the well.

3.3.7 Well Development

Ensure well development is in accordance with EPA 600-4-89-034 and ASTM D5092 except as modified herein. Surging, and pumping/over pumping/backwashing are acceptable development methods. Air surging and jetting are prohibited. Method of development is chosen by the geologist in charge and approved by the Contracting Officer. Well development does not begin until the well installation is complete and accepted by the Contracting Officer. Conduct well development operations continuously until development water flows clear and free of drilling fluids, cuttings, or other materials. At such time, test representative water samples for pH, temperature, and specific conductivity in accordance with EPA 600/4-79/020. Take samples every 3 hours. When stabilized readings of these parameters, as accepted by the Contracting Officer, have been achieved for 12 consecutive hours, cease well development operations.

****
NOTE: Well development locally improves or restores the aquifer's hydraulic conductivity and removes

undesirable materials from the aquifer near the well screen, thus yielding a more representative ground water sample. The most appropriate development method and acceptance criteria to use varies according to the hydrologic characteristics of the aquifer, the drilling method used and the type of well completion. The following specification is performance based. The designer may specify a method which has been shown to work well in the project area. In some instances, e.g., very fine-grained sediments, some karst terrains, the well development criteria may not be obtainable. Development criteria should be modified if such conditions are known or suspected to exist. The U.S. Environmental Protection Agency (EPA) may, according to their Technical Enforcement Guidance Document (TEGD), 530/R-93/001, consider a well improperly completed if a well yields turbid samples (turbidity greater than or equal to 5 NTUs) after development. If the local EPA Region enforces this criteria, it may be necessary to include a requirement that the well be developed until a turbidity of less than or equal to 5 NTUs is achieved.

****

Within 7 days of completion of each well, but no sooner than [48] [_____] hours after cement grouting is completed, develop the well. Perform development using only mechanical surging or over pumping or a combination thereof in accordance with ASTM D5521/D5521M. Include details of the proposed development method in the Well Installation Plan. Maintain a well development record in accordance with paragraph WELL DEVELOPMENT RECORDS. Development is complete when:

a. Well water is clear to the unaided eye,

b. Sediment thickness in the well is less than [1 percent of the screen length] [30 mm 0.1 foot],

c. A minimum of three times the standing water volume in the well plus three times the volume of all added water and drilling fluid lost during drilling and installation of the well is removed, and

d. Stabilization has occurred for the following parameters: temperature, specific conductivity, pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity readings, measured before, twice during and after development operations. Stabilization means [variation of less than 0.2 pH units, variation of plus or minus 1 degree Celsius, 1 degree Fahrenheit, plus or minus 3 percent change in specific conductance; plus or minus 10mV for ORP; and plus or minus 10 percent for DO, and turbidity, measured between three consecutive readings with one casing volume of water removed between each reading] [_____]. Determine ORP in accordance with AWWA 10084. Conduct temperature, specific conductance, DO, turbidity, and pH readings in accordance with EPA 600/4-79/020. At completion of well development, collect approximately 0.5 liter 1 pint of well water in a clear glass jar. Label the jar with project name, well number and date; and digitally photograph. Suitably backlight the subject in the photograph close-up to show the clarity of the water and any suspended sediment.

The photograph is a part of the well development record. [Contain water removed during development and testing operations in D.O.T. approved drums, containers or vessels and dispose of by [_____], in accordance with paragraph CONTAINERIZATION OF DEVELOPMENT WATER, AND DRILL CUTTINGS, and DRILLING WASTE DISPOSAL.] [Discharge water removed during development and testing operations to the ground surface at least [_____] meters feet from the well in a down gradient area.]

3.3.7.1 Well Development Records

Prepare and submit a monitoring well development record for each monitoring well installed under the supervision of the geologist present during well installation operations, within [_____] working days of the completion of development. Include the following information on the well development record, but do not limit to the following:

a. Date, time, and elevation of water level in the well, before development.

b. Depth to bottom of well, name of project and site, well identification number, and date of development.

c. Method used for development, to include size, type and make of equipment, bailer, and/or pump used during development.

d. Time spent developing the well by each method, to include typical pumping rate, if pump is used in development.

e. Volume and physical character of water removed, to include changes during development in clarity, color, particulates, and odor.

f. Volume of water added to the well, if any.

g. Source of any water added to the well.

h. Volume and physical character of sediment removed, to include changes during development in color, and odor.

i. Clarity of water before, during, and after development. Nephelometric turbidity unit (NTU) measurements.

j. Total depth of well from top of the casing and the static water level, immediately after pumping/development, and 24 consecutive hours after development.

k. Readings of pH, specific conductance, DO, ORP, and temperature taken before, during, and after development.

l. Name and job title of individual developing well.

m. Name and/or description of the disposal facility/area, for the waters removed during development.

3.3.8 Surveys

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NOTE: Guidance for installing survey markers can be found in EM 1110-1-1002 Survey Markers and Monumentation.

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Establish coordinates and elevations for each monitoring well/test hole. Determine horizontal coordinates to the closest 300 mm 1.0 foot and referenced to the State Plane Coordinate System, or Universal Transverse Mercator (UTM). If the State Plane Coordinate System/UTM is not readily available, use an existing local grid system. Obtain a ground elevation to the closest 30 mm 0.1 foot at each well. The highest point on the top of the riser pipe serves as a measurement point; reference this elevation and survey to the nearest 3 mm 0.01 foot using the National Geodetic Vertical Datum of [1929] [1988]. If the datum is not readily available, use the existing local vertical datum. Plot the location, identification, coordinates, and elevations of the well and monuments on maps by a registered land surveyor licensed in the State of [_____], with a scale large enough to show their location with reference to other structures. Submit this data with a well location map as the Installation Survey Report.

3.3.8.1 Survey Maps and Notes

Prepare and submit a tabulated list of all monitoring wells and monuments, copies of all field books, maps showing the locations, and elevations of all monitoring wells, and all computation sheets, consisting of the designated number of the well or monument, the X and Y coordinates, and all the required elevations within [_____] working days after completion of the survey.

3.3.9 Project Photographs

Submit digital photographs taken before, during, and after completion of the work, of each well installation site. Also take photographs of any rock that is cored at the site; take a minimum of [one view] [[_____] views] of each well installation. If rock is cored at the site, after the core has been logged, dampen the core if it has dried, neatly arrange in the core box, and take color photographs. Document the following information:

Project No.	Contract No.
Contractor/Photographer:	
Photograph No.	Date/Time:
Description:	
Direction of View:	

3.4 ADJUSTING AND CLEANING

3.4.1 Site Cleanup

After completion of the work, remove tools, appliances, surplus materials, temporary drainage, rubbish, and debris incidental to work. Backfill excavation and vehicular ruts and dress to conform with the existing landscape or terrain. Repair or replace utilities, structures, roads, fences, or any other pre-existing item damaged due to negligence. Accomplish repair or replacement prior to completion of this contract.

3.4.2   Water From Well Development Operations

Water generated during well installation will be containerized and properly characterized in accordance with State and local regulations, the SAP, and as designated by the hazardous waste and wastewater Program Managers. Determine disposal method based on the characterization of the water and recommendations from the Program Managers.

3.4.2.1   Disposal of Containerized Water

Sample and analyze water as described in the SAP.

[a. Water exhibiting TPH less than [0.5] [_____] ppm and BTEX less than [1] [_____] ppb is considered clean. Dispose water [on-site] [on station] as directed by the Contracting Officer.

][b. If the concentration of total BTEX is greater than [1] [_____] ppb or TPH greater than [0.5] [_____] ppm, treat and dispose the water at a permitted facility.

][c. [_____].

]3.4.3   Drilling Waste Disposal

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NOTE: The designer must address disposal of drill cuttings, rock core, grout or bentonite slurry, and other solid or liquid materials bailed, pumped, or otherwise removed from the borehole during drilling, well installation, completion, and well development procedures within all appropriate regulatory requirements. The nature of these wastes (whether hazardous or not) potentially vary between well sites on a single project. On a remedial action project, it may be prudent to dispose of drilling and well installation waste in coordination with other project waste streams. In some instances, rock core may be determined to be contaminated and must be handled accordingly. Refer to EPA/540/G-91/009, Management of Investigation-Derived Waste From Site Investigations and EPA OSWER Directive 9345.3-03FS, April 1992, Guide to Management of Investigation-Derived Wastes, for discussion of some issues relevant to Superfund projects. State/local regulations must also be considered.

****

Dispose of slurry, drill cuttings, rock core; other solid or liquid material bailed, pumped, or otherwise removed from the borehole during drilling, installation, completion, and well development procedures; and fluids from material/equipment decontamination activities by [_____].

a. Soils exhibiting TPH less than [100] [_____] ppm, BTEX less than [10] [_____] ppm, TOX less than [100] [_____] ppm, passing TCLP tests, and testing negative for PCB's are considered clean dispose [on-site] [on station] as directed by the Contracting Officer.

b. Manage soils failing the TCLP test or exhibiting TOX greater than [100]

[_____] ppm accordance with [applicable State and local regulations] [_____].

c. If the concentration of total BTEX is greater than [10] [_____] ppm or TPH greater than [100] [_____] ppm, provide disposal and treatment of the soil at at a permitted soil recycling facility.

3.4.4 Transportation Of Contaminated Soil And Water

Comply with Federal, State, and local requirements for transporting contaminated materials through the applicable jurisdictions and bear responsibility and cost for any noncompliance. In addition to those requirements, do the following:

a. Inspect and document vehicles and containers for proper operation and covering.

b. Inspect vehicles and containers for proper markings, manifest documents, and other requirements for waste shipment.

c. Perform and document decontamination procedures prior to leaving the worksite and again before leaving the disposal site.

3.4.5 Disposal of Contaminated Soil And Water

Dispose contaminated materials removed from the site [in accordance with the SAP.][to a treatment/disposal facility permitted to accept such materials.]

3.5 CLOSEOUT ACTIVITIES

3.5.1 Well Acceptance

Properly construct, install, develop, and test all wells according to the requirements of this specification so that they are suitable for the intended purpose. If installed wells are not functional or not in accordance with these specifications, the Contracting Officer will disapprove the well and direct repair or replacement, and instruct abandonment of the disapproved well in accordance with this specification.

3.5.2 Documentation Reports

****

NOTE: For projects on the National Priorities List(NPL) or RCRA sites, recommend using the EPA Uniform Federal Policy for Quality Assurance Project Plans worksheets for Quality Control.

****

Submit reports for well construction and development. Establish and maintain documentation reports for well construction and development to record the desired information and to assure compliance with contract requirements, including, but not limited to: borehole logs, well construction diagrams, geophysical logs, and well decommissioning/abandonment records.

3.5.2.1 Borehole Logs

****

NOTE: Borehole logging requirements can be found in EM 1110-1-4000, Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites. Requirements can also be found in ASTM D2113 and ASTM D5434. If rock is cored at the site, and it is deemed necessary to determine the rock quality designation (RQD) of the core for design purposes, the RQD should also be shown on the boring log. Guidance for determining the RQD may be found in ASTM D6032.

****

Submit original borehole logs, within [_____] working days after completion of the boring and well installation procedures. Prepare and complete a borehole log for each boring drilled, prepared by the geologist present onsite during all well drilling and installation activities. Provide the log scale at [10] [_____] mm equals [300] [_____] mm [1] [_____] inch equals [1] [_____] foot. Keep copies current and complete all well logs in the field at each well site and make available at all times for inspection by the Contracting Officer. Include, as a minimum, the following:

a. Name of the project and site.

b. Boring/well identification number.

c. Location of boring (coordinates, if available).

d. Make and manufacturer's model designation of drilling equipment and name of drilling firm.

e. Date boring was drilled.

f. Reference data for all depth measurements.

g. Name of driller and name and signature of geologist preparing log.

h. Nominal hole diameter and depth at which hole diameter changes.

i. Total depth of boring.

****

NOTE: Split spoon sampling can be used in many cases.

****

j. Method of drilling, including sampling methods and sample depths, including those attempted with no recovery. Indication of penetration resistance such as drive hammer blows given in blows per 150 mm 6 inches of driven sample tubes. Include in information hammer weight and drop distance. Record information such as rod size, bit type, pump type, etc.. Also include a description of any temporary casing used, drill fluids and fluid additives used, if any, including brand name and amount used, along with the reason for and start (by depth) of its use, and, if measured, mud viscosities and weight.

k. Depth of each change of stratum. If location of strata change is approximate, so state in the report.

l. Description of the material of which each stratum is composed, in accordance with [ASTM D2488] [_____], and/or standard rock nomenclature, as necessary. Include in soil parameters for logging, but do not limit to: classification, depositional environment and formation, if known, Unified Soil Classification Symbol, secondary components and estimated percentages, color (using FSUP 77341 or GSA RCC00100R), plasticity, consistency (cohesive soil), density (non-cohesive soil), moisture content, structure and orientation, and grain angularity.

m. Include in rock core parameters for logging , but do not limit to: rock type, formation, modifier denoting variety (shaly, calcareous, siliceous, etc.), color (using GSA RCC00100R), hardness, degree of cementation, texture, crystalline structure and orientation, degree of weathering, solution or void conditions, primary and secondary permeability, and lost core.

n. Include the results of any chemical field screening on the boring log. Prepare classification in the field at the time of sampling. Also duly note and record the results of visual observation of the material encountered, and any unusual odor detected.

o. Depth of any observed fractures, with strike and dip, weathered zones, or any abnormalities encountered.

p. Depth and estimated percent of drill fluid loss or lost circulation. Measures taken to regain drill water circulation. Significant color changes in the drilling fluid return.

q. Depth to water, and any non-aqueous phase liquids (NAPLs) and date measured before, during, and after each drilling shift, and prior to well installation. Provide and maintain at each well under construction a portable water, and NAPL level measuring device of sufficient length to measure the water/NAPL level to [50] [_____] meter [165] [_____] foot depth. Make the device onsite at all times and provide graduated measuring wire in mm 0.01 foot. Take water and NAPL level measurements to the nearest mm 0.01 foot.

r. Box or sample number. Record depths and the number of the core boxes and/or samples at the proper interval.

s. Percent Rock Core Recovery. If rock is cored, show the percent core recovery for the individual drill runs.

3.5.2.2 Installation Diagrams

Submit as-built installation diagram for each monitoring well installed within [_____] working days of the completion of the installation, prepared by the geologist present during well installation operations. The well will not be accepted by the Contracting Officer before the geologic logs and installation diagrams are received. Clearly illustrate in the diagram the as-built condition of the well and include, but do not limit to the following items:

a. Name of the project and site.

b. Well identification number.

c. Name of driller and name and signature of the geologist preparing diagram.

d. Date of well installation.

e. Description of material from which the well is constructed, including well casing and riser pipe and screen material, centralizer composition, if used, diameter and schedule of casing and screen, gradation of filter pack, lithologic description, brand name (if any), source, and processing method, and method of placement of the filter pack, bentonite seal type (pellets, granules, chips, or slurry), grout type (cement or high-solids bentonite) and type of protective cover (protective casing or flush-to-ground).

f. Total depth of well.

g. Nominal hole diameter.

h. Depth to top and bottom of screen, and filter pack.

i. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).

j. Type of cement and/or bentonite used, mix ratios of grout, method of placement and quantities used.

k. Elevations/depths/heights of key features of the well, such as top of well casing and riser pipe, top and bottom of protective casing, ground surface, the depth of maximum frost penetration (frost line), bottom of well screen, top and bottom of filter pack, and top and bottom of seal.

l. Other pertinent construction details, such as slot size and percent open area of screen, type of screen, and manufacturer of screen.

m. Well location by coordinates. Include a plan sheet showing the coordinate system used and the location of each well. A plan sheet is not required for each well installation diagram; multiple wells may be shown on the same sheet.

n. Static water level upon completion of the well.

o. Special problems and their resolutions; e.g., grout in wells, lost casing, or screens, bridging, etc.

p. Description of surface completion.

3.5.3 Geophysical Logs

Prepare, complete, and submit geophysical logs for each monitoring well/test hole installed, within [_____] working days of the completion of said logging. Include the following information on the logs as a minimum:

a. Project name.

b. Test hole/monitoring well identification number.

c. Location of test hole (coordinates, and state, and county name).

d. Date test hole was drilled.

e. Fluid level in test hole before logging.

f. Fluid type and temperature.

g. Fluid resistance in ohm-m.

h. Casing type, diameter, and elevation (top and bottom).

i. Cement type and elevation (top and bottom).

j. Screen type, diameter, and elevation (top and bottom).

k. Date and time test hole was logged.

l. Reference elevation for all depth measurements.

m. Operator's name.

n. Equipment name and address.

o. Logger type and number.

p. Tool type.

q. Detector type (Nuclear Log only).

r. Source type (Nuclear Log only).

s. Source size (Nuclear Log only).

t. Source spacing (Nuclear Log only).

u. Tool length, cable head to detector.

v. Calibration.

w. Logging speed cm/min ft/min.

x. Log vertical scale m/cm ft/in.

y. Module settings.

z. Recorder settings.

aa. Document all field problems, including equipment malfunctions. This should include the steps taken to solve the problem and how the log might have been affected.

3.5.4 Well Decommissioning/Abandonment Records

Submit a well decommissioning/abandonment record, for each well, or test hole abandoned, within [_____] working days of the completion of the abandonment procedure. Include in decommissioning/abandonment records, as a minimum, the following:

a. Project name.

b. Well or test hole number.

c. Well/boring location, depth and diameter.

d. Date of decommissioning/abandonment.

e. Method of decommissioning/abandonment.

f. All materials used in the decommissioning/abandonment procedure and the interval in which test materials were placed.

g. Casing, and or other items left in hole by depth, description, and composition.

h. Description and total quantity of grout used initially.

i. Description and daily quantities of grout used to compensate for settlement.

j. Water or mud level (specify) prior to grouting and date measured.

k. The reason for decommissioning/abandonment of the monitoring well/test hole.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-33 51 43 (May 2022)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 51 43

INSTRUMENTATION AND PERFORMANCE MONITORING OF STRUCTURES

05/22

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-33 51 43 (May 2022)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 51 43

INSTRUMENTATION AND PERFORMANCE MONITORING OF STRUCTURES

05/22

****

NOTE: This guide specification covers the requirements for instrumentation and monitoring for geotechnical and hydraulic structures.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

This guide specification is intended for use with construction contracts in which installation of instruments for monitoring performance of geotechnical and hydraulic structures (dams, levees, foundations, retaining structures, etc.) is required either during and/or following their construction or modification. It also includes data collection, management, and interpretation requirements. Typical items to monitor include, but are not limited to, water level, pore pressure, earth pressure, deformation, and load and strain in structural members. This section was originally developed for USACE Civil Works Projects.

Although not all instruments for monitoring geotechnical and hydraulic structures are included in this guide specification, and the state of practice continues to develop with new technologies,

more common instruments have been included.
****

PART 1   GENERAL

1.1   DESCRIPTION

Provide all plant, labor, equipment, and materials for the installation and maintenance of performance monitoring instrumentation for the duration of the contract. Provide all labor, equipment, and materials for data collection, data management, interpretation, and reporting unless otherwise specified.

1.1.1   Instrumentation and Monitoring Plan

Develop an Instrumentation and Monitoring Plan that outlines the project performance monitoring requirements, recommended thresholds values and response actions, as well as roles and responsibilities based on the requirements of this scope.

1.1.2   Supervision and Quality Control

Provide supervision and quality control to assure the accuracy, quality, timeliness, and completeness of the work. Provide all related and miscellaneous components and appurtenances to make the specified systems complete and functional. Perform all work in strict accordance with this section of the specifications and the applicable contract drawings.

1.1.3   Scope of Work

****
NOTE: The following tables have been included to summarize the scope of work. Edit these tables, and remove information and requirements not required in respective project, whether or not brackets are present.
****

The following tables summarize the instrumentation that is currently installed within the project area (Existing Instruments), instrumentation to be installed as part of the contract work (New Instruments), and instrumentation that is currently installed within the project area that is to be modified (Existing Instruments to be Modified).

Existing Instruments					
Instrument	Type	Model No.	Data Collection Method	Data Collection Frequency	Existing Quantity
[Piezometer]	[Vibrating Wire Piezometer]	[_____]	[Automated]	[Hourly]	[12]
[Piezometer]	[Standpipe]	[N/A]	[Manual]	[Monthly]	[5]
[Inclinometer]	[Traversing]	[_____]	[Manual]	[Quarterly]	[3]
[Rain Gauge]	[Tipping Bucket]	[_____]	[Automated]	[Daily]	[1]

New Instruments to be Installed				
Instrument	Type	Data Collection Method	Data Collection Frequency	Existing Quantity
[Piezometer]	[Vibrating Wire Piezometer]	[Automated]	[Hourly]	[20]
[Piezometer]	[Standpipe]	[Manual]	[Monthly]	[5]
[Inclinometer]	[Traversing]	[Manual]	[Quarterly]	[2]
[Tilt Meter]	[Biaxial MEMS]	[Automated]	[Daily]	[1]

Existing Instruments to be Modified		
General Description	Data Collection Method	Quantity
[Retrofit existing standpipe piezometer with vibrating wire transducer]	[Automated]	[3]
[Change riser elevation of standpipe piezometer]	[Manual]	[2]
[Change riser elevation of manual inclinometer]	[Manual]	[2]
[Decommission inclinometer]	[Manual]	[1]

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge

Attachments

ASTM INTERNATIONAL (ASTM)

ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D5640	(1995; R 2008) Standard Guide for Selection of Weirs and Flumes for Open-Channel Flow Measurement of Water
ASTM F480	(2014; R 2022) Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-1-1002	(2012) Survey Markers and Monumentations
EM 1110-2-1908	(2020) Instrumentation of Embankment Dams and Levees
ER 1110-1-1807	(2014) Drilling in Earth Embankment Dams and Levees

1.3 DEFINITIONS

****

NOTE: Only use this paragraph to define terms used in this specification section that are not defined by a commercial or Government standard and to provide a common interpretation of a term for Contractual purposes. Remove any terms listed that are not used within this section and add terms as needed.

****

1.3.1 Automated Data Acquisition System (ADAS)

An Automated Data Acquisition System (ADAS) is a system of electronic devices that automatically collect, process, store, and transmit measurements from instrument sensors. An ADAS may include, but is not limited to the following components: dataloggers, vibrating wire analyzer, LMU/RMU, RIO, multiplexer, power, and communication hardware and service. The system also includes enclosures and mounts, software, and transient voltage surge suppressors.

1.3.2 Readout Unit

A readout unit is a device used to display measurements from an instrument. Some readout units also have data collection capability. The readout unit may be portable and connected to instrument terminals when monitoring is required (e.g. notebook computer, datalogger, or a proprietary system), or may be an on-line connection (fixed line or wireless) to a remote monitoring system.

1.3.3 Data Collector

A data collector is a device used to collect, store, and transfer recorded data from an instrument. A data collector may be a portable device or be located in-place at the instrument location. Data collectors may be equipped with remote data access.

1.3.4 Data Logger

A data logger is a device that can perform measurements at a prescribed interval, process the data from raw values to engineering units, store time-stamped data, and communicate with other devices.

1.3.5 LMU/RMU

Local monitoring unit (LMU) and remote monitoring unit (RMU) are electronic units comprised of a datalogger along with, but not limited to, associated power, communication equipment, and enclosure. They have both inputs to read sensors and outputs to control other devices. LMU/RMU can perform calculations, run programs that have been uploaded to it, and can interface with other LMUs and RMUs and a central control unit via some means of communications. It can hold and store data and then transmit it upon individual data calls or can be retrieved by a remote server via FTP on an as needed basis. LMU and RMU differ only in communication method. RMUs communicate via radio or some other method that designates them as remote from the central control unit.

1.3.6 RIO

A remote input output (RIO) unit is an automated measurement device without onboard data storage. It is comprised of a power supply, communication equipment (for transferring data to LMU/RMU), and enclosure. RIOs report instrumentation readings upon request from a LMU/RMU. A RIO unit may have a multiplexer attached to it.

1.3.7 Multiplexer

A multiplexer is a device used to allow several sensors to share one input channel of the LMU/RMU. This allows many more sensors to be read by one LMU/RMU. A multiplexer is used in conjunction with LMU/RMU software that controls which input channel is being read so that each sensor value is stored in the correct memory location.

1.3.8 Communications

Communications is a method used to allow two devices to "talk" to or exchange information with one another. This can be by wire, fiber optic cable, satellite, radio or other means. In every case there is a preferred "language" for sending the data. This is often referred to as the "protocol". The protocol may be different for each sending method.

1.4 QUALITY ASSURANCE

In addition to using the current state of practice in the field of geotechnical and structural instrumentation and all manufacturer's recommendations for installation and operation; the following Codes, standards, regulations, and references apply for all features of the instrumentation system with the most stringent being applicable: NFPA 70[, EM 1110-2-1908][_____].

1.5 MEASUREMENT AND PAYMENT

****

NOTE: When lump sum payment for work under this section is desired, revise these paragraphs accordingly. Delete these paragraphs when the work covered by this section is included in one lump sum contract price for the entire work covered by the Invitation for Bids.

If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, appropriately edit this subpart, and move into Section 01 20 00. For bracketed items, choose applicable item(s) or insert appropriate information.

****

1.5.1 Method of Measurement

1.5.1.1 Readout Units

Readout unit quantities will be measured by each complete readout unit provided and any peripheral equipment or materials needed for them to perform their data collection function, such as batteries and terminal clips.

1.5.1.2 Data Collector

Data collector quantities will be measured by each complete data collector provided and any peripheral equipment or materials needed for them to perform their data collection function, such as batteries and terminal clips.

1.5.1.3 Instruments

Instrument quantities will be measured as follows:

a. [Open Tube Piezometer][Observation/Monitoring well]: by the linear foot from the instrument tip to the riser top. Any required length over a foot will be counted to the next foot for measurement. All materials for the installation, to include at a minimum, cap, screen, connectors, [PVC][steel] pipe, [vibrating wire instrument and wiring][_____], sand pack, bentonite for zone sealing, grout fill in rock; and granular fill in soil must be included in the payment per linear foot. Drilling of borehole is a separate pay item. Linear Foot (LF) per borehole location.

b. [Fully Grouted Piezometer][Closed Tube Piezometer] [one] [two]: per borehole, by the linear foot from the bottom of the piezometer to the ground surface. Any required length over a foot will be counted to the next foot for measurement. All materials for the installation, to include at a minimum, the cap, screen, connectors, PVC pipe, vibrating wire instruments and wiring, and grout must be included in the payment per linear foot. Drilling of borehole is a separate pay item. Linear Foot (LF) per borehole location.

For the following instruments a complete installation means: All materials necessary to provide a fully functioning unit to include, but not be limited to, connection to surfaces, wiring and or wireless communication equipment, enclosures, batteries, as required to fully function with the specified readout and/or data collector device.

c. Vibrating wire instrument: by each complete installation. Each (EA)

d. Water level sensor: by each complete installation. Each (EA)

e. Staff gauge: by each complete installation. Each (EA)

f. Pipe Flow Meter: by each complete installation. Each (EA)

g. Weir: by each complete installation. Each (EA)

h. Flume: by each complete installation. Each (EA)

i. Weather station: by each complete installation. Each (EA)

j. Barometer: by each complete installation. Each (EA)

k. Automated Multiparameter Sonde: by each complete installation. Each (EA)

l. pH sensor: by each complete installation. Each (EA)

m. Turbidity meter: by each complete installation. Each (EA)

n. Temperature sensor: by each complete installation. Each (EA)

o. Conductivity meter: by each complete installation. Each (EA)

p. [Probe][Fixed Borehole]Extensometer: by the linear foot from the bottom of the borehole anchor to the top of the extensometer. Any required length over a foot will be counted to the next foot for measurement. Include all installation materials in the payment per linear foot. Drilling of borehole is a separate pay item Linear Foot (LF)

q. Settlement [Surface Points][Plates]: by each complete installation. Each (EA)

r. Borros Type Anchor: by the linear foot from the bottom of the point to the ground surface. Linear Foot (LF)

s. [Portable (Traversing)][Automated In-Place] Inclinometer Casing: by the linear foot from the bottom cap to the ground surface. Any required length over a foot will be counted to the next foot for measurement. All materials for the installation to include casing, cap, grout, inclinometer, and cable, and covers. Drilling of borehole is a separate pay item. Linear Foot (LF) per borehole location.

t. [Portable (Traversing) Probe][Automated In-Place Sensors]: Each (EA)

u. Crackmeter/Jointmeter: by each complete installation. Each (EA)

v. Tiltmeter: by each complete installation. Each (EA)

w. Terrestrial Positioning System: by each complete installation. Each (EA)

x. Surface Monument: by each complete installation. Each (EA)

y. Survey Prism: by each complete installation. Each (EA)

z. Earth pressure cell: by each complete installation. Each (EA)

aa. Load cell: by each complete installation. Each (EA)

ab. Strain Gauge: by each complete installation. Each (EA)

ac. Signal Cable, Linear Foot (LF)

ad. Outdoor camera: by each complete installation. Each (EA)

ae. Seismograph: by each complete installation. Each (EA)

af. Time Domain Reflectometer, Linear Foot (LF)

ag. Pendulum, Each (EA)

1.5.1.4 ADAS

The Automated Data Acquisition System (ADAS) will be measured on a lump sum basis. This does not include the individual instruments listed in the prior paragraph. This item includes all equipment, supplies, materials, and programming/configuration necessary for a fully functional ADAS which polls and communicates successfully with those data collection devices identified separately above. This item includes, but is not limited to, the following components:

a. Enclosures and mounts.

b. Data loggers.

c. LMU/RMU.

d. RIO.

e. Multiplexer.

f. Power.

g. Software.

h. Transient voltage surge suppressors.

i. Communication hardware and services.

1.5.1.5 General Instrumentation Requirements

General instrumentation requirements will be measured on a [lump sum][per month] basis.

1.5.1.6 Vibration Monitoring

Vibration monitoring will be measured on a [lump sum][per month] basis.

1.5.2 Basis of Payment

1.5.2.1 Readout Units

Payment will be made at the Base Bid contract line item price for each readout unit listed below, which price will constitute full compensation for providing the readout unit including factory calibrations, pre installation acceptance testing, any peripheral equipment or materials needed for them to perform their data collection function, instruction manuals, and delivery to the Government as specified:

****

NOTE: Revise the following list to only include readout units specified for your project.

****

a. [Open tube piezometer][Observation well]: water level indicator.

b. [Fully grouted piezometer][Closed tube Piezometer]: readout unit.

c. Water level sensor: readout unit.

d. pH sensor: readout unit.

e. Turbidity meter: readout unit.

f. Temperature sensor: readout unit.

g. Conductivity meter: readout unit.

h. [Probe][Fixed Borehole] Extensometer: reed switch probe, tape, and reel.

i. [Portable (Traversing)][Automated In-Place] Inclinometer: probe, carrying case, cable, readout unit, and software.

j. Crackmeter/Jointmeter: readout unit.

k. Tiltmeter: readout unit.

l. Earth pressure cells: readout unit.

m. Load cells: readout unit.

n. Strain Gauge: portable readout unit.

o. Signal Cable: readout unit.

p. Seismograph.

1.5.2.2 Data Collector

Payment will be made at the Base Bid contract line item price for each data collector listed below, which price will constitute full compensation for providing the data collector including factory calibrations, any peripheral equipment or materials needed for them to perform their data collection function, instruction manuals, and delivery to the Government as specified:

****

NOTE: Include a list of data collectors specified for your project. See prior paragraph for example format.

****

[_____]

1.5.2.3 Instruments

Payment will be made at the Base Bid contract line item price for each instrument listed below, which price will constitute full compensation for all materials left in place, all cable, labor, tools and equipment, instruction manuals, [drilling,][sampling,]pre installation acceptance testing, installation, post installation acceptance testing, installation of surface and other protection, determination of as-built location, and all incidentals necessary to complete the work in accordance with the plans and in every respect to the satisfaction of the Government:

a. [Open tube piezometer][Observation well]

b. [Fully grouted piezometer][Closed tube Piezometer]

c. Water level sensor

d. Staff gauge

e. Pipe Flow Meter

f. Weir

g. Flume

h. Weather station

i. Barometer

j. pH sensor

k. Turbidity meter

l. Temperature sensor

m. Conductivity meter

n. [Probe][Fixed Borehole] Extensometer

o. Settlement [Surface Points][Plates]

p. Borros Type Anchor

q. [Portable (Traversing)][Automated In-Place] Inclinometer

r. Crackmeter/Jointmeter

s. Tiltmeter

t. High Precision GPS Unit

u. Terrestrial Positioning System

v. Surface Monument

w. Survey Prism

x. Earth pressure cell

y. Load cell

z. Strain Gauge

aa. Signal Cable

ab. Outdoor camera

ac. Seismograph

1.5.2.4 ADAS

The Automated Data Acquisition System (ADAS) will be paid for at the base bid contract lump sum price. This item includes all equipment, supplies, materials, programming/configuration, and labor to have a fully functional ADAS. This system must poll and communicate successfully with those data collection devices identified separately above such as fully grouted piezometers, weather stations, etc. This item includes, but is not limited to, the following components:

a. Enclosures and mounts

b. Data loggers

c. LMU/RMU

d. RIO

e. Multiplexer

f. Power

g. Software

h. Architecture

i. Transient voltage surge suppressors

j. Communication hardware and services

1.5.2.5 General Instrumentation Requirements

General instrumentation requirements provided will be paid for at the base bid contract [lump sum price][line item price per month]. This item includes the following:

a. Protecting and maintaining all instruments.

b. Repairing or replacing damaged instruments.

c. Storing and disposing of instruments.

d. Providing safe access to instruments for data collection by the Government.

e. Monitoring and data collection.

f. Interpreting data.

g. Presenting data.

h. All other items of work specified in this Section for which no separate bid item is provided.

1.5.2.6 Vibration Monitoring

Vibration monitoring will be paid for at the base bid contract [lump sum price][line item price per month] and includes provision of all material, labor, and equipment necessary to meet the requirements in this section, including, but not limited to the following:

a. Vibration Test Program and Report

b. Public meeting

c. Preconstruction and Postconstruction Condition surveys

d. Vibration monitoring and reports

e. Monitoring instruments for structural movement or settlement, vibration, and noise reduction mitigation measures

1.6 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy

and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Instrumentation Specialist; G, [_____], RO

Instrumentation and Monitoring Plan; G, [_____], RO

Permit Documentation; G, [_____], RO

Backups, Archiving, And Disaster Recovery Plan; G, [_____], RO

Seismologist/Vibration Consultant; G, [_____], RO

Vibration Monitoring Plan; G, [_____], RO

Preconstruction Condition Survey; G, [_____], RO

Drilling Program Plan; G[, [_____]], RO

Grounding And Lightning Protection Plan; G, [_____], RO

Quick Reference Guide; G, [_____], RO

Web Interface; G, [_____], RO

SD-02 Shop Drawings

Instrument Modification Report; G, [_____], RO

SD-03 Product Data

Factory Test Reports; G, [_____], RO

Riser Pipe; G, [_____], RO

Filter Pack Material; G, [_____], RO

Proprietary Data Determination Request; G, [_____], RO

Raw Data; G, [_____], RO

SD-05 Design Data

Method Statements; G, [_____], RO

Grout Mix Design; G, [_____], RO

SD-06 Test Reports

Pre-Installation Acceptance Tests; G, [_____], RO

Vibration Test Program And Report; G, [_____], RO

Vibration Complaint Report; G, [_____], RO

Monitoring Data Reports; G, [_____], RO

Deficiency Correction Report; G, [_____], RO

Instrument Alert Assessment; G, [_____], RO

Action Threshold Exceedance Report; G, [_____], RO

Daily Vibration Monitoring Reports; G, [_____], RO

Postconstruction Condition Survey; G, [_____], RO

Installation Record; G, [_____], RO

SD-07 Certificates

Seismologist/Vibration Consultant Qualifications; G, [_____], RO

Instrumentation Specialist Qualifications; G, [_____], RO

SD-08 Manufacturer's Instructions

Factory Test Reports; G, [_____], RO

SD-10 Operation and Maintenance Data

Installation; G, [_____], RO

Instrument Modification Report; G, [_____], RO

Operations Manual; G, [_____], RO

SD-11 Closeout Submittals

Instrument Removal List; G, [_____], RO

As-Built Drawings; G, [_____], RO

ADAS Final Report; G, [_____], RO

1.7 INSTRUMENTATION SPECIALIST

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NOTE: This position is essential for the successful completion of an instrumentation monitoring program. Geotechnical instrumentation is a specialized field and as such, a specialist is

highly recommended for involvement in all aspects of the instrumentation program from selecting and purchasing instruments, installing them, collecting data, and analyzing that data. Typically, general construction contractors do not possess the in-house instrumentation expertise, and consequently often provide insufficient attention and resources to an instrumentation and monitoring program required during construction. Inclusion of an experienced instrumentation specialist often results in cost savings for both the contractor and the owner. The contract requirement for an experienced instrumentation specialist signals the importance of this work to the owner, and helps ensure all potential bidders include sufficient cost in their bids for this work. Further, the bid schedule could be configured to include estimated equipment costs and specialist labor hours instead of "1 Job" listing, or a lump sum cost developed by the owner could be included in the bid schedule to ensure adequate funding is allocated to this work after contract award. More preferably, this specialist would instead be acquired under separate contract by the owner and the general construction contractor required to coordinate work activities with this individual. In this case, the owner would pay the specialist for instrument selection and purchase, installation, and collection of data. The analysis of the data would then be the responsibility of the construction contractor, with review of their interpretation and recommendation being conducted by the instrumentation specialist on behalf of the owner. An instrumentation specialist may not be justified or required for smaller contracts.

For larger projects, consider also utilizing a Data Manager or Instrumentation Data Manager position. Requirements for these positions are described in Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION.

For bracketed items, choose applicable item(s) or insert appropriate information.

****

1.7.1 General

Acquisition of reliable and high-quality data is the primary objective of the instrumentation specialist. This individual must be retained by the contractor for the duration of the work. Approval of an equivalent backup is required prior to the start of the work. Duties of the instrumentation specialist include selection of the instruments to be purchased by the Contractor; installation, calibration, and maintenance of that specialized equipment in the field; and acquisition and reporting of readings. Supporting work, which does not require specialized skills, may be performed by the construction contractor. See Section [01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZAION][_____] for requirements of the [Data Manager][Instrumentation Data Manager][_____] position.

1.7.2 Qualifications

The individual assigned as lead instrumentation specialist must be a registered Professional Engineer (PE) and recognized professional in the field of instrumentation and monitoring of geotechnical and hydraulic structures with over [5][10] years of work experience relevant to the scope and magnitude of work specified in this contract. An experienced alternate individual, not meeting the PE license requirement, may work under the direction and supervision of the PE to carry out all tasks of the instrumentation specialist, with exception of the selection of alert values, analysis of reported instrument readings, and directed response actions. A detailed, concise narrative describing the instrumentation specialist qualifications and relevant work completed by those experienced alternate individuals on a minimum of [3][_____] projects, within the last [7][_____] years, is required for Government review and approval. Likewise, equivalent backups meeting the aforementioned qualifications must be identified and included with the required submittal of the instrumentation specialist(s).

The responsibilities of the instrumentation specialist are selection of the instruments required for purchase for the work; installation, calibration, and performing necessary maintenance of that specialized equipment in the field; and compiling readings and reporting them. Supporting work, which does not require specialized skills, may be performed by the construction contractor, with prior approval of the Government.

1.7.3 Instrumentation and Monitoring Plan

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NOTE: EM 1110-2-1908 currently does not address concrete structures but is being updated to include.

****

An Instrumentation and Monitoring Plan must be prepared by the Instrumentation Specialist and submitted for Government approval a minimum of 30 days prior to any work being completed at the site. No physical work is to start at the site until this plan is approved by the Government. At a minimum, the Instrumentation and Monitoring Plan must address the following: responsibilities and authority for all phase of the monitoring program; types (including detailed manufacturer data), purpose, and location of each instrument; installation procedures (detailed below) and documentation; instrument reliability and limitations; calibration and maintenance, in accordance with manufacturer's requirements and EM 1110-2-1908; redundancy; backup instruments/parts; baseline data; procedures for ensuring data validity; data collection frequency; visual observation; data processing and reporting including example tables and plots; and threshold values and response actions.

Include detailed method statements for installation of each type of instrument. Method statements must list the sequence of carrying out the work and include such dimensioned sketches, completed using computer-aided design and drafting (CADD) software, as may be required to illustrate the spatial or temporal relationship of the various components of the work. The method statements must include:

a. Method of pre-installation acceptance tests.

b. Description of quality control procedures.

c. Full details of both type and quantity of any equipment to be used.

d. Drillhole diameter, drill casing size, the method and sequence of withdrawing drilling casing.

e. Method of cleaning the inside of casing, where applicable.

f. Specifications for proposed grout mixes, including commercial names, proportions of admixtures and water, mixing sequence, mixing methods and duration, pumping methods and tremie pipe type, size and quantity and means of grout quality control.

g. Depth increments for backfilling drillholes with sand and/ or granular bentonite.

h. Method of overcoming buoyancy of instrumentation components during grouting.

i. Method of sealing joints in pipes, tubes, and inclinometer casing to prevent ingress of grout.

j. Method of conducting post-installation acceptance tests.

k. Method of protecting instruments from damage.

l. Method of determining as-built locations.

m. Method of field calibration and maintenance of each type of instrument.

n. Calibration and maintenance schedule for each type of instrument.

o. Method of supplying power, when applicable.

p. Method of monitoring each type of instrument, including method of identifying and eliminating any reading errors.

q. Method of carrying out temperature corrections and/or barometric pressure corrections, when applicable.

r. Method of data reporting for each type of instrument, including method of transmitting and storing data.

s. Drillhole record forms.

1.8 SEISMOLOGIST/VIBRATION CONSULTANT

****

NOTE: Remove this individual and related paragraphs from this section if vibration monitoring is not included in the scope of your project.

****

1.8.1 General

An independent Seismologist/Vibration Consultant is required to monitor, record, analyze, and report the ground and noise vibrations being generated by construction activities. Such construction activities include, but are not limited to, [hauling,][excavation,][trenching,][blasting,][drilling,][fill and backfill placement,][compaction,][pile driving,

]and other activities which may generate ground vibrations and noise. Within [60 calendar][_____] days of the Notice to Proceed, the Contractor must submit the Seismologist/Vibration Consultant along with names and resume of qualifications of the personnel dedicated to this project.

1.8.2 Qualifications

The Seismologist/Vibration Consultant must be a registered Professional Engineer with a minimum of [5][_____] years of experience, including a minimum of four projects of similar magnitude and subsurface conditions. This individual must have experience with assessing vibration monitoring and recording operations, interpreting ground vibration and sound data, determining parameter values for vibration attenuation through soil, analyzing ground motion spectra, and assessing the structural responses to vibrations. The Seismologist/Vibration Consultant qualifications also include experience with pre- and post-construction condition surveys of structures, familiarity with construction methods and materials, and knowledge of structural response to ground vibrations generated by construction activities. The Professional Engineer must sign and seal all reports, results, interpretations, and assessments obtained from vibration monitoring and structural condition surveys. The Professional Engineer must be on site and supervise the initial installation of each vibration monitoring instrument, [the Vibration Test Program][_____], [Public Meeting][_____], and [Preconstruction and Postconstruction Condition Surveys][_____].

A minimum of one on-site technician, working under direct supervision of the Seismologist/Vibration Consultant, must be on site full-time during the construction. The on-site technician must have a minimum of five years of experience in controlling and monitoring vibrations originating from construction activities and be experienced and trained to install and use vibration monitoring instrumentation and interpret the instrumentation data. Their experience and training must also include analyzing ground and sound vibration parameters, implementing proper monitoring and recording methods, knowledge of proper vibration control methods, capability to install and read supplemental instrumentation to monitor movement and settlement of structures.

1.8.3 Vibration Monitoring Plan

A Vibration Monitoring plan must be prepared by the Seismologist/Vibration Consultant and submitted by the Contractor [60 calendar][_____] days prior to any on-site work.

The Vibration Monitoring Plan must include, but is not limited to, the following:

a. A description of the organizations and individuals that will be involved in the vibration monitoring activities, including planned duties, responsibilities and authorities of the organizations and individuals, and contact information for organizations and key individuals.

b. A description of the monitoring equipment in accordance with Paragraph VIBRATION MONITORING INSTRUMENTATION with example data output.

c. List established or estimated vibration limits (peak particle velocity at [25-foot][_____] distance) for the particular construction equipment and methods proposed. Provide evidence or justification that the proposed construction equipment and methods meets the specified vibration limits, in accordance with paragraph CONSTRUCTION VIBRATION CONTROL AND MONITORING.

d. A description of the location, methods, equipment, and procedures that will be used to perform Vibration Test Program on various construction equipment in accordance with paragraph VIBRATION TEST PROGRAM AND REPORT.

e. Provide an initial plan for typical setup and location of vibration monitoring equipment during various construction activities.

f. Provide description of any separate measures or methods required to reduce vibrations.

g. Provide procedure for addressing public complaints pertaining to construction vibrations, noise levels and potential damages. Include an example of a Vibration Complaint Report. Include a vibration screening procedure that includes both defining the problem and actions required to be taken.

1.9 SEQUENCING AND SCHEDULING

1.9.1 Scheduling Work

Install instruments and receive Government concurrence on formal initial readings prior to the start of related construction activities as detailed in paragraph BASELINE READINGS.

1.9.2 Vibration Monitoring Schedule

The frequency and duration of vibration monitoring for any construction activity must be performed in accordance with the approved Vibration Monitoring Plan. The Contractor must make all necessary arrangements for scheduling the Seismologist/Vibration Consultant. Construction activities requiring monitoring must not begin until the approved Seismologist/Vibration Consultant's on-site technician is onsite.

1.10 DATA REQUIREMENTS

1.10.1 Data Ownership

All data generated on site by instrumentation, monitoring, construction equipment, sampling, testing, and other data associated with the construction of the project is the property of the Government. For any data the Contractor wishes to exclude from the system, submit a Proprietary Data Determination Request including detailed justification to the Government for determination of whether data can be classified as proprietary. No data source is exempt from these data requirements unless a specific exemption is requested of and granted by the Government. Do not allow "proprietary data" to impede the Government's ability to monitor construction, perform analyses, or evaluate the effectiveness of construction.

1.10.2 Data Integrity

Maintain the integrity of data such that records are accurate and internally consistent. Ensure that all data and records reflect the quality of the data gathered on the site and that all data is preserved and archived for future use.

1.10.3 Backups, Archiving, and Disaster Recovery

Minimize data loss by backup and archival of all digital and paper data records from the time of data generation until final data turnover. This includes having specific policies, workflows, and infrastructure in place to archive and have redundant backups on servers in either the cloud or multiple locations according to industry standard practice. Detail this information in a Backups, Archiving, and Disaster Recovery Plan submittal for Government review and approval prior to the start of work.

If a data loss occurs, the Contractor is responsible for regeneration of the data. Any data which is re-generated from a non-primary source must be clearly noted in the record shown in the [EDB][_____]. Backup data within [24 hours][_____] of generation. Should a data loss occur, even if it is within this [24-hour][_____] window, the Contractor is responsible for all steps necessary to recover from this data loss and will receive no additional payment for these data recovery efforts.

1.10.4 Disclosure of Data or Advertisement of Project

Do not disclose any project data to third parties, and do not publish any data without prior written approval of the Government. This includes, but is not limited to, published papers or presentations to any third parties not associated with this contract.

1.11 DELIVERY, STORAGE, AND HANDLING

Deliver all instrumentation materials to the site in undamaged condition and store in an indoor, clean, dry, and secure storage space, that is approved by the Government, after receipt at the site and prior to installation. Instrument components must not be exposed to temperatures outside the manufacturer's stated working temperature range. The materials, instruments, and hardware must be stored, handled, and installed in such a manner as to preclude damage. The Contractor must restore or replace, at no cost to the Government, any items damaged or lost during storage, handling, or installation.

PART 2 PRODUCTS

****

NOTE: The Buy American Act (BAA), which will be included in the non-technical portion of the contract, will preclude the use of nondomestic products, with the exception of those produced in Canada and 46 other countries covered by the revised World Trade Organization Agreement on Government Procurement (WTO GPA). The Buy American Act applies to all U.S. federal government agency purchases of goods valued over the U.S. micro-purchase threshold (currently set at US $10,000). Ensure that all products listed below meet the requirements of the BAA.

For bracketed items, choose applicable item(s) or insert appropriate information.

****

2.1 GENERAL

All products in this section must conform to the requirements indicated on the Drawings, or specified herein, to adequately monitor the condition and record data to ensure performance parameters are met. A summary of existing instruments at [_____], including those to be modified, as well as new instruments to be installed as part of this contract are included in tabular format in paragraph DESCRIPTION above.

All products must be the standard products of a manufacturer regularly engaged in the manufacture of such.

All components provided for connection with an existing automated data acquisition system (ADAS) must function properly with that system, if it's specified to remain in operation, or with a new system, if one is specified for installation.

2.2 MATERIALS

2.2.1 General

All materials must conform to the Buy American Act. They must be new and meeting the requirements indicated on the drawings or referred to herein, and, when not covered thereby, materials and equipment of commercial grade quality suited to the intended use and as approved by the Government must be furnished. All materials must be compatible and match the existing equipment at the project location, if applicable. If multiples of the same instrument are required, use the same manufacturer for each.

2.2.2 Instrument Factory Calibration

A factory calibration must be conducted on all instruments at the place of manufacture prior to shipment. For each factory calibration include a calibration curve with data points clearly marked and a tabulation of the data and required formulae for data reduction. Ensure each instrument is marked with a unique identification number or serial number. Provide the manufacturer's [warranty][extended warranty] for each instrument and readout unit. Submit required factory test reports to the Government for approval.

2.3 PORE-PRESSURE AND GROUNDWATER MONITORING

2.3.1 [Open-Tube Piezometer][Observation/Monitoring Well]

****

NOTE: Open-tube piezometer construction is similar to observation/monitoring well construction and are included together herein. Piezometers represent a point water pressure measurement while observation/monitoring wells represent an integrated water pressure measurement over the screened interval. Piezometers can have an open bottom or short screen interval (porous tube). A Vibrating Wire or Pressure Transducer can be installed within the open-tube to allow remote reading.

****

[2.3.1.1 Porous Tip/Casagrande Filter

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NOTE: A porous tip is commonly used for open-tube piezometer sensing (water intake) zone but can also be slotted or perforated screens as included below in brackets. Slotted screens are more commonly used for observation/monitoring wells.

****

For porous tip or Casagrande filter, provide high-density polyethylene plastic with 60 micron pores meeting the requirements shown on the drawings. Each porous tube must be free from contamination by dirt, mud, oil, or any other substance which in the Government's opinion may contribute to the reduced performance of the instrument. Porous tips with any oil or mud smears will be considered unsatisfactory for installation and must be replaced at the Contractor's expense. Instruments, which have been contaminated, must be properly abandoned and replaced at the Contractor's expense. Immerse each tip in water for not less than 24 hours before installation. No glues or primers are permitted on the porous portion of the tips.

[2.3.1.1.1 Stainless Steel Screen

Provide [continuous wire-wound non-clogging stainless steel screen][drive-in stainless steel filter] with threaded couplings of the specified screen length, [slot width][opening size] and screen diameter as shown on the drawings. For PVC wire wrapped screen, it must be continuous, wire-wound PVC, non-solvent welded with threaded couplings which must mate with the PVC casing.

][2.3.1.1.2 Slotted Screen

Construct slotted screens of flush-joint Schedule [40][80] PVC conforming to the requirements of ASTM D1785 and ASTM F480. Determine slot diameter, spacing, and screen length based on hydrologic conditions, analysis of formation materials, or interpretation of geotechnical logs, if no specific requirements are included on the drawings.

][2.3.1.1.3 Perforated Screen

Provide perforated screens consisting of Schedule [40][80] high-density polyethylene plastic conforming to the requirements of ASTM D1785 and ASTM F480 and as detailed on the drawings. Each screen must be free from contamination of dirt, mud, oil, or any other substance which in the Government's opinion may contribute to the reduced performance of the instrument. Any screen material with mud smears will be considered unsatisfactory for installation and must be replaced at the Contractor's expense. Instruments, which have been contaminated, must be properly abandoned and replaced at the Contractor's expense.

]]2.3.1.2 Riser Pipe

Provide riser pipe consisting of PVC or stainless-steel well casing. PVC pipe must be watertight, flush-joint schedule [40][80] conforming to the requirements of ASTM D1785 and ASTM F480 and as detailed on the drawings. Provide glue and primer for assembly of the piezometer tip and pipe as recommended by the manufacturer.. Steel well casing must be threaded and coupled black carbon steel pipe with no mill coating and a minimum wall thickness of 6 mm 0.237 inches.

2.3.1.3 Sump or Cap/Bottom Plug

For bottom plug, provide Schedule [40][80] PVC with a flush-joint coupling, or approved equivalent. For a steel bottom plug, provide a threaded and coupled black carbon steel Schedule 40 with no mill coating. An end cap may also be attached directly to the bottom of the screen or sump.

2.3.1.4 Centralizers

Attach centralizers, constructed of PVC or stainless steel, to the riser pipe with clamps. Centralizer ribs must have sufficient strength to adequately center the riser pipe in the drill hole. Centralizers for steel surface casing may be carbon steel and welded to the casing.

2.3.1.5 Filter Pack Material

****

NOTE: Provide the required gradation of filter pack material based on the screen size of the instrument being installed. Typically, an allowable range is given for each sieve size listed for a particular gradation. Common gradations for silica sand from manufacturers are 6-9, 8-12, 8-16F, 10-20, 16-30, 20-40; modify these tables as needed.

****

Provide filter pack material of uniformly graded silica sand of grade [_____] provided below and dimensioned as shown on the drawings. Filter material must consist of washed, clean, uniform, tough, and durable particles free from any coating. The filter material must not contain any detrimental impurities or soft, friable, thin, or elongated particles. Submit filter pack material source, gradation, and quality test result information to the Government for review and approval prior to installation.

GRADE 6/9 TYPICAL SIEVE ANALYSIS			GRADE 8/12 TYPICAL SIEVE ANALYSIS		
SIEVE	PERCENT RETAINED	PERCENT PASSING	SIEVE	PERCENT RETAINED	PERCENT PASSING
No. 4	0.1	99.9	No. 4	0.49	99.5
No. 6	1.4	98.5	No. 6	23.85	75.7
No. 7	19.2	79.3	No. 7	38.39	37.3
No. 8	64.1	15.2	No. 8	29.94	7.3
No. 10	14.1	1.1	No. 10	6.73	0.6
No. 12	0.9	0.2	No. 12	0.52	0.1
PAN	0.2	0.0	PAN	0.058	0.0

GRADE 8/16F TYPICAL SIEVE ANALYSIS			GRADE 10/20 TYPICAL SIEVE ANALYSIS		
SIEVE	PERCENT RETAINED	PERCENT PASSING	SIEVE	PERCENT RETAINED	PERCENT PASSING
No. 6	0.0	100.0	No. 8	0.0	100.0
No. 8	2.6	97.4	No. 12	0.1	99.9
No. 10	23.5	73.9	No. 14	12.1	87.8
No. 12	29.4	44.5	No. 16	31.4	56.4
No. 14	30.3	14.2	No. 18	32.8	23.6
No. 16	12.5	1.7	No. 20	17.3	6.3
No. 18	1.5	0.2	No. 30	5.9	0.4
PAN	0.2	0.0	PAN	0.4	0.0

GRADE 16/30 TYPICAL SIEVE ANALYSIS			GRADE 20/40 TYPICAL SIEVE ANALYSIS		
SIEVE	PERCENT RETAINED	PERCENT PASSING	SIEVE	PERCENT RETAINED	PERCENT PASSING
No. 12	0.0	100.0	No. 16	0.0	100.0
No. 16	0.4	99.6	No. 20	0.6	99.4
No. 18	4.3	95.2	No. 25	8.1	91.4
No. 20	50.8	44.4	No. 30	40.8	50.6
No. 25	39.3	5.1	No. 35	39.8	10.8
No. 30	4.8	0.4	No. 40	9.3	1.6
No. 40	0.4	0.0	No. 50	1.5	0.1
PAN	0.0	0.0	PAN	0.0	0.0

2.3.1.6 Seal Material

Seal material must be coated bentonite pellets, from naturally occurring sodium bentonite, sized 3/8 to 1/2-inch in diameter. Angular chips, uncoated pellets, or other bentonite products may be used with prior approval from the Government.

2.3.1.7 Backfill Material

Backfill material may be impervious clay, bentonite, or a nonshrinking, low permeability grout, placed by tremie method. Place backfill material to the depth and thickness identified in the drawings. Grout must have a mix specific gravity, prior to placement in the borehole, of between [1.03 and 1.10][_____]. If used, bentonite must be hydrated in accordance with the manufacturer's recommendation.

2.3.1.8 Protective Casing

Provide protective casing of either [eight][twelve]-inch diameter or square steel pipe with a minimum 0.250-inch wall thickness, with threaded and coupled ends with no mill coating and a locking flip cap of either steel or aluminum [square]. Steel protective casing must be painted [_____]. Casings must be cleaned by power tool or wire brush prior to painting. The first coat must be brush or spray applied in the shop or field, as indicated, with a Steel Structures Painting Council Paint 25 (Zinc Oxide, Alkyd, Linseed Oil Primer) and touched up in the field as necessary during installation. Apply second and third coats in the field using P-38 (aluminum, ready mixed) type paint.

2.3.1.9 Protective Bollards

Dome capped protective bollards must be [76 mm][152 mm] [3-inch][6-inch] diameter [steel] [galvanized] pipe with a minimum 6 mm 0.250-inch wall thickness. Embed bollards a minimum depth of 76 cm 30 inches below the final grade. Paint steel bollards [_____].

2.3.2 Fully Grouted Vibrating Wire Piezometer

****

NOTE: There are several methods of installing vibrating wire piezometers, A: in a sand filter with a bentonite seal above, then grouted to fill the hole, B: in a sand filter with grout to the top of the hole, C: fully grouted with a cement bentonite grout, D: lowered into a conventional porous tip or slotted screen and associated standpipe. Method D is useful for retrofitting existing instruments or for long term monitoring. It also allows for calibration or replacement of the vibrating wire sensor as needed. Method C is the most responsive and is good for shorter term monitoring and has the benefit of not being able to have the filter sand or tip contaminated with grout. Methods A, B and C, cannot be re-calibrated or verified and are a total loss if damaged.

****

2.3.2.1 Vibrating Wire Piezometer

Provide quality pore pressure monitoring devices (vibrating wire pore pressure piezometer) including all cables, wiring connections, splice kits, desiccant chambers (if vented sensors are used), vibrating wire transducer, readout unit, and [data logger][data collector] from a reputable manufacturer that has been in the business for [5][_____] years or more. Each vibrating wire transducer must be pressure sized to the expected load range and dimensioned to the specified location. Transducer resolution and accuracy requirements are 0.025 percent (minimum) and plus or minus 0.1 percent, respectively, of full scale range.

2.3.2.2 Grout Mixture

Provide a cement-bentonite grout designed to match the properties of the surrounding in-situ materials, with respect to strength and deformation characteristics, and as recommended by the manufacturer of the vibrating wire transducer. Use Type I or II Portland cement. Marsh Funnel viscosity of the grout prior to placement must be between [50 and 60][_____] seconds. Submit the proposed grout mix design to the Government for review and approval prior to start of the work.

2.3.2.3 Grout/Carrier Pipe (PVC)

Provide sacrificial grout/carrier pipe consisting of PVC conforming to the requirements of ASTM D1785 and as detailed on the drawings. Use PVC 32-mm 1-1/4 inch Schedule 80 threaded pipe for all grout pipe and connections. Utilize manufacturer recommended materials for securing the vibrating wire transducer and cable to the pipe.

2.3.3 [Uplift Cells][Closed Tube Piezometer]

2.3.3.1 Tubing and Fittings for Tubing

Tubing utilized in the construction of uplift cells must conform to the requirements for [PVC or]Crosslinked Polyethylene (PEX) Tubing. Fittings to be used with PEX tubing must be of the Cold Expansion type for use with PEX Reinforcing Rings. Tubing must be compatible with fittings.

2.3.3.2 Fittings

Fittings must be brass or bronze, and compatible with PEX tubing, as recommended by the manufacturer.

2.3.3.3 Conduit

Conduit for uplift cell tubing must be of a size large enough such that the uplift cell tubing can be pulled through the entire length of conduit without damage to the tubing.

2.3.3.4 Gauges

Gauges for uplift cells must be dual scale, ASME B40.100 Grade 2A, brass process connection, bronze tube, solid case, dry. Mark scales in pounds per square inch (PSI) with a range of [_____] meters [_____] feet of water (FT H_2O). Face diameter must be 114 mm 4-1/2 inches.

2.3.3.5 Mounting Hardware and Brackets

Hardware and other components necessary to fix uplift cell tubing, gauges, valves, and ancillary fitting securely to the wall must be 300 series stainless steel or approved equal. The clamps must hold the tubing and/or pipes firmly in place without deformation of the tubing or pipe.

2.3.3.6 Valves

Valves for uplift cells must be full port ball valves of either stainless steel or brass.

2.3.3.7 Cable Gland Seals

Cable glands must meet requirements for cable diameter, pressure rating, and mounting hole diameter. Cable gland mounting may include adhesive or compound, flanged or bolted, threaded or nut mount. The Cable gland material must be compatible with cable material to prevent corrosion, excessive wear, or damage and must be liquid tight.

2.4 SURFACE WATER LEVEL

****

NOTE: Common instruments for measuring surface water levels consist of manually read and automated gages. Manually read gages are numerous and include, but are not limited to, staff, weight, and float Automated gages include weir monitors and laser or non-contact radar level sensors.

For bracketed items, choose applicable item(s) or insert appropriate information.

****

2.4.1 Water Level Sensor

2.4.1.1 Laser Water Level Sensor

Provide water level sensors as indicated in the contract plans. Install all water level sensors in accordance with the manufacturer's recommendations. Perform operation and field calibration checks of all instruments. Factory-calibration curves are required for each laser water level sensor, including individual gage factor and temperature correction factor. Protect each instrument against short-duration, high voltage surges with an external surge protection board, which uses tripolar plasma surge arrestors, transient suppression diodes, and inductors.

2.4.2 Staff Gauges

Provide [porcelain enameled steel][fiberglass] staff gauges graduated to centimeters, marked every 10 centimeters and meter hundredths and marked at every foot and every tenth.

2.5 FLOW MEASUREMENT

2.5.1 Flow Meters

2.5.1.1 Pipe Flow Meter

Provide in line [magnetic flowmeters] [ultrasonic (doppler)] [mechanical-impeller or nutating disk] in accordance with the plans. Accuracy must be [_____] percent. Care must be taken to ensure the pipe is full and flow is not turbulent per manufactures directions. Provide electronic gauges showing flow rate and accumulated flow and with communications to a datalogger. Mechanical meters must show total flow.

2.5.1.2 Open Channel Flow Meter

Open channel flow meter must be [ultrasonic][_____] and use the depth of water along with the flow rate to calculate total flow. The open channel flow meter must communicate with an approved datalogger and include a gauge that shows the flow rate and accumulated flow.

2.5.2 Weirs

Provide a [v-notch][trapezoidal][rectangular] weir plate made of 304 stainless steel meeting the dimension requirements [as specified on the drawings][_____]. Include proper mounting hardware as provided by the manufacturer and meeting requirements of ASTM D5640.

2.5.3 Flumes

Provide a [Parshall][trapezoidal][cutthroat][H] flume made of [fiberglass reinforced plastic][304 stainless steel] for measurement of flow range from [_____] to [_____] meeting the dimension requirements [as specified on the drawings][_____]. The inside of the flume must be smooth and free of any irregularities. Provide all anchorage hardware in accordance with the manufacturer's recommendations and submit documentation showing the proposed flume meets all specified requirements.

2.6 ENVIRONMENTAL MONITORING

****

NOTE: Environmental factors such as rainfall, can affect lake and river elevations, increase flow in monitored streams, and infiltrate into piezometers and cracks. Rainfall may be correlated to changes in these parameters and that is why it is important to monitor. Temperature may affect expansion and contraction of materials leading to changes in crack displacements.

If you are in an extremely cold climate, consider a heated rain gauge and/or a snowfall sonic distance sensor if these parameters are import to your project.

You may want to monitor other environmental parameters that affect your project, such as air temperature, barometric pressure, humidity, wind speed/direction, evaporation, solar radiation.

****

2.6.1 Precipitation

Monitor precipitation with a tipping bucket rain gauge with an accuracy of 1 percent up to 2 inches per hour. Rainfall per tip of the bucket is to be 0.01 inch.

2.6.2 Barometer

Provide a barometer with accuracy to 0.6 Hpa or better for correction of sealed vibrating wire pressure transducers. The barometer must be read by the automated data acquisition system.

2.6.3 Water Quality

Monitor water quality parameters such as temperature, pH, turbidity, and conductivity. The readings must be taken by [grab samples] [automated multiparameter sonde] at the specified locations, depths, and frequency.

2.6.3.1 pH

Provide a pH sensor with an accuracy of plus or minus 0.1 units. Calibrate instruments per manufactures directions for the expected range.

****

NOTE: Common pH calibration solutions are 4, 7, and 10, but if monitoring for grout (Portland cement) pH will likely be higher, so calibration at 12.45 is also required.
****

2.6.3.2 Turbidity

Provide a turbidity meter that reports in NTUs with an accuracy of plus or minus 2 percent and plus or minus 2 units. Calibrate instruments per manufactures directions for the expected range.

2.6.3.3 Temperature

Provide a temperature sensor that reports in degrees C F with an accuracy plus or minus 0.5 degrees.

2.6.3.4 Conductivity

Provide a conductivity meter that reports in µS/cm with an accuracy of plus or minus one percent. Calibrate instruments per manufactures directions for the expected range.

2.7 DEFORMATION/DISPLACEMENT

Monitor for deformation or displacement using the instruments described below:

2.7.1 Extensometer

****
NOTE: Provide extensometers based on the application and need of the project. Select extensometer type based on soil type, reading type, reading frequency, data transmission, open/sealed hole, etc.
****

2.7.1.1 Probe Extensometer

Provide probe extensometers consisting of induction coils or magnet/reed switch transducers. Provide a telescoping access pipe when the predicted vertical strain is greater than about 1 percent

****
NOTE: The diameter of the access pipe is typically 33 mm 1.3 inches, and the borehole diameter typically 76-230 mm 3.0-9.0 inches.
****

2.7.1.2 Fixed Borehole Extensometer

Select fixed borehole extensometers based on anchor type, transducer type and extensometer head. Provide either a single-point borehole extensometer (SPBX) or multipoint borehole extensometer (MPBX). For MPBX, provide a maximum of six anchors and rods in a 150 mm 6-inch diameter borehole.

Provide [stainless steel][fiberglass][carbon composite] rods. Provide vibrating wire transducer capable of measuring over a range between 0 - 100 mm to 0 - 300 mm and frequency range between 1200 - 2800 Hz and operable at temperatures ranging from minus 20 to plus 80 degrees Celsius.

2.7.2 Settlement [Surface Points][Survey Monuments][Plates]

2.7.2.1 Surface Points

Provide surface points consisting of [25 mm] [1 inch] long survey nails designed for installation in [concrete][asphalt]. Include a suitable metal washer or plastic disc hub for high visible marking of each surface point.

2.7.2.2 Survey Monuments

Provide survey monument consisting of [90 mm] [3-1/2 inch] diameter domed bronze marker designed for installation in [concrete], unless otherwise provided by the Government.

2.7.2.3 Settlement Plates

Provide 610-mm 24-inch square settlement plates consisting of a [steel][wood][concrete] base. Provide connectable riser pipes consisting of [galvanized][stainless] steel. Clearly mark and protect the riser pipes from impact during fill operations and other construction activities.

2.7.3 Settlement/Heave Points

2.7.3.1 Borros Type Anchor

Provide [settlement][heave] measurement points consisting of a three-pronged Borros type anchor, 6 mm 0.25 inch steel inner pipes with couplers, and 25 mm 1 inch steel outer pipe with couplers. Connect inner and outer pipes using standard couplers as recommended by the manufacturer. Anchors prongs may be manual or hydraulically actuated.

2.7.4 Inclinometers

2.7.4.1 Portable (Traversing) Inclinometer

Provide ABS plastic inclinometer casing in [3-meter][1.5-meter] [10-foot][5-foot] long sections with a minimum outside diameter of [48 millimeters][70 millimeters][85 millimeters] [1.9 inches][2.75 inches][3.3 inches]. Provide casing section connections in accordance with the inclinometer manufacturer's recommendation. Ensure the casing has high quality flat surface grooves to permit free passage of the probe through curves in the casing without the wheel of the probe coming out of the groove. Casing anchors and grout valves are to be used if required. Grout the casing in place with grout that approximates the subsurface formation strength in accordance with ER 1110-1-1807. At a minimum, equipment and supplies for monitoring and processing inclinometer data must include a probe at wheelbase of 500 mm 24 inches. The cable must be a [30][60][90]-meter [100][200][300]-foot cable graduated into 500 mm two foot intervals. Other equipment required includes a cable gate system for accurate positioning of the probe, a digital readout device, and graphing software. Calibrate the sensor for plus or minus 30 degree range with a resolution of 0.005 mm 0.0002 inch. Submit the selected inclinometer sensor type, including manufacturer and methods for data retrieval, for Government approval a minimum of 30 days prior to inclinometer casing installation. All inclinometer devices and accessories must be on the job site prior to installation of the first inclinometer. Monitoring equipment must be new and maintained in complete, fully functional operating conditions throughout the duration of the contract; this equipment becomes the property of the Government at the conclusion of the contract.

Applicable instruction manuals published by the inclinometer manufacturer are considered part of these specifications. Use these instructions for detailed installation procedures, calibration, and monitoring.

2.7.4.2 Automated In-Place Inclinometer (IPI)

Provide [ABS plastic] inclinometer casing in [3-meter][1.5-meter] [10-foot][5-foot] long sections with a minimum outside diameter of [48][70][85] millimeters [1.9][2.75][3.3] inches. Provide casing section connections in accordance with the inclinometer manufacturer's recommendation. Ensure the casing has high quality flat surface grooves to permit free passage of the probe through curves in the casing without the wheel of the senor coming out of the groove. Casing anchors and grout valves are to be used if required. Grout the casing in place with grout that approximates the formation strength in accordance with ER 1110-1-1807.

Document casing installation with traversing inclinometer and document two baseline readings prior to installation of IPIs. Baseline readings must be performed at least [seven][28] days after grouting the casing. Provide [biaxial MEMS][Triaxial MEMS Shape Accelerometer Array (SAA)][uniaxial VW] IPI sensors with an accuracy of plus or minus one percent of full scale. Replace casing that exceeds the accuracy of [_____] or spiral limitations of [_____] at the contractor's expense.

2.7.4.3 Shape Accelerometer Array

Provide [250][500]-mm [10][20]-inch segmented shape array sensors of the length(s) shown in the plans. The device must have MEMS sensors and be accurate to approximately plus or minus 1/16th of an inch in 100 feet. They must connect to existing ADAS systems. Casing must be [27][47][100]-mm [1][2][4]-inch inside diameter. In accordance with ER 1110-1-1807, select grout strength for backfill which approximates the formation strength.

2.7.5 Crackmeter/Jointmeter

Provide crackmeters consisting of a vibrating wire or potentiometer displacement transducer within a stainless steel telescopic body with two anchoring points. Vibrating wire crackmeters must measure over a range of [0-12.5 mm], [0-25 mm], [0-50 mm], [0-100 mm], [0-150 mm], with a total accuracy ranging from plus or minus 0.50 percent to 0.30 percent full scale depending on range capability of the instrument. The vibrating wire crackmeter's frequency range must be between 2250 - 3000 Hz and operable at temperatures ranging from minus 20 to plus 80 degrees Celsius. Electrical crackmeters must measure over a range of [0-100 mm][0-200 mm], with a total accuracy ranging from plus or minus 0.30 percent to 0.15 percent full scale depending on range capability of the crackmeter.

Manual crackmeters must be clear polymer with [+-20mm][+-25mm][-55+105mm] range on the x axis and high contrast grid. They must have a unique serial number for tracking and be attached to the surface with epoxy and screws.

2.7.6 Tiltmeter

****

NOTE: Select tiltmeters based on the application

and need of the project. Consider the need for uniaxial or biaxial monitoring, temperature correction, measuring range, sensor type and waterproofness. Ensure tiltmeters are compatible with IPI if applicable.

****

Provide a [vibrating wire][MEMS] waterproof [uniaxial][biaxial] tiltmeter. Standard operating range must be [plus or minus 10][plus or minus 20] degrees. Resolution must be [08][_____] arc seconds. Operating temperature must range from minus [20][_____] to plus [80][_____] degrees Celsius.

2.7.7 High Precision GPS Unit

Provide high precision GPS unit, with wireless communication capability, that provides three-dimensional displacement and tilt measurements for deformation monitoring. Units must provide plus or minus [1][2] centimeter positioning accuracy.

2.7.8 Survey

Complete surveys to provide accurate positioning of instrumentation. Use horizontal and vertical datums specific to the project in which instrumentation is being installed. Critical points for surveys at a minimum must include horizontal and vertical data collection at the top of protective casings, interior pipes, and a ground shot near the base of the instrument using equipment that can report collect to within at least plus or minus .03 cm .01 feet accuracy.

2.7.8.1 Terrestrial Positioning System (TPS)

Provide an automated robotic total station with an aiming range of 1 m to 1000m, distance accuracy of 1mm + 2 ppm, angular accuracy of 1 arcsec (0.3 mgon), and programmable to collect and transmit survey data at [hourly][daily][15 minute][_____] intervals. The TPS must also include any environmental protection and communications necessary.

2.7.8.2 Surface Monuments

Select surface monuments based on the application and need of each project. Select horizontal and vertical control monuments in accordance with EM 1110-1-1002.

Each monument must have a [brass][bronze][aluminum] disk that [will][will not] be provided by the Government. Each monument must be stamped by the Contractor with all corresponding monument details such as project name, monument ID, and elevation. Stamp the majority of information on the cap prior to installation.

2.7.8.3 Survey Prisms

Select surveying prisms, also known as retro-reflectors, based on size, range, holder accuracy and offset. Beam deviation must be less than [5][_____] seconds. Holder accuracy must be [1][_____] mm or less. Prism offset must be [0][minus 17.5][minus 30][minus 34][minus 40] mm.

2.8 LOAD/STRESS

****

NOTE: The more common instruments for load and stress measuring have been included below and consist of pressure cells, load cells, and strain gauges.

Pressure Cells are used to monitor total pressure in earth fill dams and embankments, rock stress changes, dynamic pressures, etc. They can be vibrating wire pressure transducers, semiconductor type transducers, or use a stainless steel pressure gauge.

Load Cells are used to monitor load and strain by measuring structural extension and compression that pass through the load cell.

Strain Gauges are also used to measure load and strain in a structure by attachment directly to the structure surface or embedment within the structure itself, or in situations where a load cell cannot be utilized.

For bracketed items, choose applicable item(s) or insert appropriate information.

****

2.8.1 Earth Pressure Cells

Provide [standard][contact][jackout][push-in][pile tip] type pressure cells with a rated load of [_____] [kPa][MPa].

2.8.2 Load Cells

****

NOTE: The throat diameter and load range will be determined by the designer, the Contractor, or the Government depending on the specific project and application. Vibrating wire cells are used in most applications. Electrical resistance cells are primarily used in tiebacks and rock bolts.

****

Provide [solid][center hole][vibrating wire][electrical resistance] type load cells with an inside or throat diameter of [_____] inches and a rated load of [_____] to [_____] metric tons [_____] to [_____] kips. Alternatively, based on the actual diameter of the object material being monitored, and on the manufacturer recommendations, the throat diameter may be as indicated by the [Contractor][Government]. Provide centralizer bushings to center the load cell, if necessary. The load cell must be specially hardened to withstand embedment in concrete for long-term monitoring requirements.

2.8.2.1 Load Bearing Plates

Provide load cell bearing plates consisting of [_____] mm [_____] inch thick plated ground steel based on the [_____] metric ton [_____] kip load and the [_____] center hole.

2.8.2.2 Calibration

Calibrate load cells under the following two conditions: 1) normal factory calibration of the load cell itself and 2) group or set calibration of the load cell with the bearing plates and lock-off assembly assigned to that load cell. Switching or transfer of bearing plates/lock-off assemblies is not allowed in the field without factory calibration.

2.8.3 Strain Gauge

Provide [electrical] [vibrating wire] [fiber] strain gauges with a rated load of [_____] to [_____] μ.

2.8.4 Signal Cable

Provide signal cables, as recommended by manufacturer, which are factory-connected to the measuring device in one continuous length. Mark and properly identify all signal cable at the device and at the cable termination as delivered. Each cable connection to the device must be independent of the other. Splicing of cables that are embedded in concrete or otherwise not accessible must have prior approval of the Government. For splices not in a climate-controlled enclosure, use a [stainless steel][plastic] sleeve with [compression fittings][soldered and heat shrink splices] for securing each cable section and use factory supplied epoxy filling materials.

2.8.5 Instrument Readout

Provide required readout device(s) and obtain initial, calibration, and subsequent manual readings of the sensor output. The readout device(s) must be compatible with the instrument and signal cables, and existing sensors and data logging equipment on site. Data formats must be [.csv][.dat] [.json] and compatible with [_____] software.

2.9 VISUAL OBSERVATION

2.9.1 Outdoor Cameras

Provide [HD] [daytime] [nighttime] camera(s) accessible by an Internet-based software and a secure connection. Cameras must provide [color] [color and black and white] images. Cameras must meet or exceed the following:

a. Image Size: [_____] Megapixels [_____] x [_____]

    b. Lens: [_____] mm in., [_____] x optical zoom, F-Stop [_____]

b. Pan/Tilt: Pan Range [_____] degrees Continuous Pan, Tilt: [_____] degrees to [_____] degrees

c. [4K][_____] broadcast quality video

d. [4G][_____] cellular modem

e. [On-Board Data Backup][4 GB (microSD)]

f. Ambient Temperature Range: [_____] degrees C F

The Internet based online interface must include the following features:

a. Display project name

b. Real-time live video viewing

c. Daily auto-generated 360 degrees panoramas up to [_____] megapixels

d. Digital pan, tilt and zoom capability within a high definition image

The service must be available for the duration of the contract and allow the viewing of live video and high-definition digital still images captured of the project and stored on both mobile and desktop platforms. Capture and upload images every [30][_____] minutes, 24 hours per day. Provide all service and maintenance, including cleaning of the camera system throughout the life of the project including making appropriate arrangements for camera to remain in operation up to and through project completion.

2.10 VIBRATION MONITORING INSTRUMENTATION

Provide a minimum of [_____] vibration monitoring instruments at the location shown on the drawings or as directed by the authorized representative of the Government. Operate these instruments during construction activities that are within [_____] meters feet of the construction, or in the opinion of the Government would be a source of ground vibration.

The location of the instrument(s) may vary daily, based on the location of construction activities, condition of structures in the vicinity of construction activities, and response to public and government interest.

2.10.1 Seismograph/Seismometer

Provide [_____] vibration monitoring instruments and in accordance with the following:

a. Capability to measure, display, and provide a digital graph of particle velocity and frequency components.

b. Capability to measure the 3 mutually perpendicular components of particle velocity in directions vertical, radial, and perpendicular to the vibration source.

c. Possess a seismic range of 0.01 in/sec to 4 in/sec with an accuracy of 5 percent of the measured peak particle velocity or better at frequencies between 10 Hz and 100 Hz, and with a resolution of 0.01 in/sec or less.

d. Possess a frequency response range of 2 Hz to 150 Hz.

e. Display the date of the most recent calibration. Calibration must have been performed within the last 12 months to a standard traceable to the National Institute of Standards and Technology.

f. Possess a reliable power source or battery for required duration of recordings, equipment suitable for site and weather conditions, and suitable length of geophone and microphone cables.

g. Continuous monitoring mode must be capable of recording single-component peak particle velocities and frequency of peaks with an interval of 1 minute or less.

h. Capability of measuring continuous sound levels ranging from 30 dBA to 140 dBA with 0.05 dB resolution.

i. Produce plots showing particle velocity and frequency relative to current OSM and USBM standards.

2.11 SURFACE PROTECTION

****

NOTE: Surface protection considerations are bollards, locking well caps, flush mount vs raised, vandalism, freeze thaw, construction access.

****

Provide temporary or permanent surface protection in accordance with the plans. Use caution and provide all means necessary to protect the instrumentation from construction activity performed on the construction site. This includes monitoring settlement of fill material in and around the buried conduits, concrete protective blocks at the instrument heads, concrete pads, and related items. Immediately replace any instrumentation equipment that is damaged by construction activities including damage caused by settlement of fill material due to improper placement or compaction. Access must be maintained to permit periodic measurements and observation by the Government.

2.12 INSTRUMENTATION ENTERPRISE DATABASE (EDB)

****

NOTE: This paragraph may only apply to large geotechnical projects. Until/unless the Government is capable of ingesting and hosting its own instrumentation data real time during construction, regardless of if other data viewers are built and maintained internally, the contractor will host an enterprise SQL instrumentation database for large geotechnical projects. Because of the need for real-time reporting of data, which cannot be accomplished across the firewall, the Contractor may also need to provide an instrumentation web interface capable of plotting, and visualizing the instruments and data. In order for the government to provide this on an internally built web interface, the Contractor would need to utilize Microsoft Azure, and/or host the data to a restful service or API for Government ingestion.

****

Set-up, maintain and update a documented SQL enterprise database (EDB) for the duration of the contract in which to store all automated and manual instrumentation data. This can be the same database as the project database if one is utilized.

Store the EDB on the Contractor's servers or the Contractor's cloud storage account for the duration of the contract.[Update .csv files of the most current version of the database tables to the SFTP site by [midnight daily]. Update the most current version of these .csv files to the SFTP site at any time requested by the COR.]

[Make data available in HTTP (API) or sFTP for automated inclusion in external databases.

][Import relevant hydrologic data using publicly available datasets such as USACE CWMS RADAR or Access2Water APIs.

] Import all data for existing, active instrumentation in place prior to the contract into the EDB. The Government will provide the data for this purpose. Replace all historical survey coordinates and station offsets in the EDB for any instrument locations surveyed as a part of this Contract. Ensure all coordinates in the EDB are in the project coordinate system utilizing the correct datums.

Upon completion of the contract and before final demobilization, submit to the Government the final EDB .csv files and EDB documentation prior to final payment.

2.13 AUTOMATED DATA ACQUISITION SYSTEM (ADAS)

****

NOTE: Ensure contract plans include a minimum required elevation for above-ground ADAS boxes/equipment locations to prevent potential inundation by high water events.

****

Provide an Automated Data Acquisition System (ADAS) to collect, process, store and communicate data with other systems. This system is generally to be comprised of sensors/transducers, dataloggers, communications devices, and associated accessories - see contract drawings. Automatically read and store instrumentation data at preset time intervals and reading frequencies. Provide the capability to modify reading frequency and provide ability to increase reading frequency during a [storm event]. Automatically scan all instruments for threshold exceedance. Have the ability to trigger alarms based on any of the following types of conditions: static level exceedance, rate of change, moving window rate of change, and time delay with multiple values verification.

Furnish all components and complete installation of all system components, cable, conduit, instruments, transducers, sensors, enclosures, power connections, grounding, and miscellaneous items to make the ADAS completely operational. Submit system design and components for Government approval.

2.13.1 Data Loggers

Provide data loggers that are capable of reading [vibrating wire][MEMs][_____] sensors, store data internally for [10][100][1000][10,000] readings, and communicate with [_____] protocols. Data loggers must be compatible with data collection devices and other data loggers on site and be capable of storing at least [3 months][1 year] data in local memory.

Program the data loggers to read the sensors. Annotate the programs with comments pertaining to its function. Data logger communications may be encrypted for security, but the program must be accessible by the Government on systems that will be owned or operated by the Government.

Store programs on the data logger in non-volatile memory.

2.13.2 Enclosures

****

NOTE: Material type depends on application lifespan and vandalism potential.

****

Provide enclosures to protect ADAS components from the environment. Properly size enclosures so components can be neat and organized. (Check NEC requirement for capacity). Construct enclosures of [fiberglass reinforced polyester][stainless steel] and use water resistant gaskets at all entry points to sealed enclosures. For enclosures housing electronics, maintain a low humidity level within by using desiccants or heaters.

2.13.3 Conduit

Provide [PVC][rigid][EMT] conduit. Surface conduit must be resistant to UV and rugged to minimize or eliminate damage.

2.13.3.1 Underground Conduit

Bury underground conduit [46 cm18 inches below the surface][61 cm24 inches below the surface][below the frost line]. Install in accordance with NEC regulations.

2.13.4 Locations

****

NOTE: Specify locations of instrumentation and readout boxes. Consider: inundation, line of sight communications, weather freeze/thaw, accessibility, power(solar), vandalism, artesian conditions and access.

****

[_____]

2.13.5 LMU/RMU

Provide Local Monitoring Unit(s) (LMU)/Remote Monitoring Unit(s) (RMU) as shown in the contract plans. The LMU/RMU must poll sensors at a specified interval, record raw values, be capable of reducing raw values to engineering units, and communicate data to other systems.

2.13.6 RIO

Provide Remote Input Output (RIO) device(s) as shown in the contract plans. The RIO must poll sensors, as requested by a LMU/RMU, and communicate raw values back to the LMU/RMU.

2.13.7 Vibrating Wire Analyzer

Provide vibrating wire analyzers that poll vibrating wire transducers and measure the resulting frequency and associated data. The analyzer may be a stand-alone unit or integrated into a datalogger but must have a communications method for transferring data to other devices. The vibrating wire analyzer must use a [swept frequency method][Fourier transform and spectral analysis method] to determine the frequency of the vibrating wire with an accuracy of plus or minus 0.05 percent or better and read the thermistor of equipped sensors.

2.13.8 Multiplexer

****

NOTE: Multiplexers increase the number of sensors measurement devices can read.

****

Provide multiplexers that are compatible with the [existing][new] sensors/transducers and measurement devices on site.

2.13.9 Power

****

NOTE: Some installations may be powered by a non-rechargeable battery that lasts for x day, also consider snow covering solar panels and shorter recharge periods in northern latitudes.

****

Size power supply batteries appropriately to power the equipment for [3 days][10 days][6 months][12 months] without recharge. Power supply batteries are to be comprised of a rechargeable battery or batteries, charge controller, and power source. Power sources can be solar panels, wind turbines, 110 volt wall outlets, or combinations of these sources. Batteries must be of [sealed lead acid][lithium iron phosphate] chemistry.

2.13.10 Grounding

Grounding and lightning protection must be designed by an electrical engineer with experience in lightning protection. Include this design, with Professional Engineer's signature and stamp, in a Grounding and Lightning Protection Plan submitted for Government approved. Ground all enclosures and equipment that have grounding terminals. Install ground rods in accordance with the electrical engineer's recommendations regarding construction, size, spacing and allowable resistance . Install and maintain the transient voltage surge suppressor in accordance with the Electrical Engineer's grounding and lightning protection plan. Special care should be taken to protect sensors that are grouted in a borehole, or other inaccessible sensors.

2.13.11 Communications

Provide [wired][wireless radio][wireless cell modem][fiber optics] [satellite] communications between data logging devices and for transferring data files to local and remote Government offices.

2.13.12 Software

[Provide instrumentation software that communicates with the automated data acquisition system [and a windows-based PC][_____]. The software must allow remote retrieval of data, updating of programs and configuration, and viewing of data from the automated systems.

][Provide inclinometer software that communicates with the manual traversing data collection device. The software must plot greater than three cumulative displacement plots referenced back to a baseline survey and allow for corrections of the data for spiral and bias.

]2.13.13 Architecture

****
NOTE: Specify datalogger locations or allow the contractor to propose.
****

The Automated Data Acquisition System Architecture must be [centralized] [distributed] at the site.

2.13.14 Wiring Diagram

Submit full color wiring diagrams of the ADAS enclosures in the ADAS Final Report. Conduit, trenching, and cabling locations must be surveyed during installation and survey used in preparation of the required as-built drawings submittal.

2.13.15 Instrumentation Schedule

****
NOTE: Insert a chart here with desired data such as instrument type, location, depth, cable length, or reference contract drawings.
****

[_____]

2.13.16 System Maintenance and Spare Parts

Provide all hardware and/or other necessary item(s) required to ensure the entire instrumentation and data acquisition/reporting system is functioning according to manufacturer's specifications, and for maintaining the system in satisfactory working order for the length of the contract. This includes appropriate spares for repairing or replacing inoperable or unreliable components according to the expected replacement rate in the list below, or as otherwise as directed by the contract. All system maintenance must be performed in accordance with the manufacturer's requirements and EM 1110-2-1908.

Before work begins, prepare a list of all extra components required for continuous operation of the system and quantities to be stockpiled on-site according to the estimated replacement rate per the manufacturer. Submit this list to the Government for approval. The items on the approved list must be made available at the site during the entire period of the delivery order. If a stockpiled item is used, it must be replaced immediately. In the event of a malfunction or breakdown beyond the frequency below or beyond the control of the Contractor, notify the Government of the nature of the malfunction or breakdown within [12 hours][_____], and provide an estimate of when that part of the system will be back in service if the Government approves a replacement. Depending upon the status of the construction at that time, the Government will decide whether or not a manual backup system must be implemented by the Contractor.

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NOTE: Tailor the text for the monitoring purposes of the instruments. If the system is for monitoring

for life safety during construction, then the Contractor must have the system fully operational within 12 hours and have sufficient backups on site to meet this requirement.

****

Sensor or board replacements must be of the same model (manufacturer) and type as installed in the field at award of this contract unless a newer technology can be provided that meets the same or better requirements and performance. All deviations require approval of the Government prior to replacement. Replaced instrumentation components must be programmed and shown to functionally work with the system prior to Government acceptance.

PART 3 EXECUTION

3.1 PRE-INSTALLATION ACCEPTANCE TESTING

Perform pre-installation acceptance tests to ensure sensors and readout units are functioning correctly prior to installation. Blank pre-installation acceptance test record forms for each instrument type must be provided by the Instrumentation Specialist. For pre-installation acceptance tests, include relevant items from the following list:

a. Examine factory calibration curve and tabulated data to verify completeness.

b. Examine manufacturer's final quality assurance inspection checklist to verify completeness.

c. Check cable length.

d. Check serial numbers on instrument and cable.

e. Check, by comparing with procurement document, that model, dimensions, and materials are correct.

f. Perform resistance and insulation testing, according to criteria provided by the instrument manufacturer, using a gage insulation or circuit tester that applies two volts or less for resistance testing and 15 volts or less for insulation testing.

g. Verify that all components fit together in the correct configuration.

h. Check all components for signs of damage in transit.

i. Check that quantities received correspond to quantities ordered.

Repair or replace any instrument that fails the specified pre-installation acceptance test.

3.2 PRODUCT HANDLING

3.2.1 Transportation and Handling

Pack, transport, and handle all monitoring equipment in accordance with the manufacturer's instructions. Arrange deliveries of monitoring equipment with proper sequencing and scheduling in accordance with the approved Project Schedule. Coordinate deliveries to avoid conflict with work, conditions at the site, and availability of personnel and handling equipment.

3.2.2 Storage and Protection

Use all means necessary to protect monitoring equipment before, during, and after installation and to protect installed work and materials including existing instrumentation installed by others. Store all monitoring equipment in strict accordance with the manufacturer's recommendation with all labels and seals intact and legible. Arrange storage of monitoring equipment to permit access for inspection. Periodically inspect to assure monitoring equipment is undamaged and is properly maintained. Replace in kind any equipment lost, damaged or stolen due to negligence on the part of the Contractor at no additional cost to the Government.

3.3 INSTALLATION

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NOTE: Installation specifications have not been provided for all the instruments included in Part 2 - Products. Only a few of the most common instruments are detailed below, for example only, due to variable project/site conditions and product specific requirements. As noted in paragraph INSTALLATION PLANS below, detailed method statements for installation of each type of instrument are required for Government review and approval as part of the INSTRUMENTATION AND MONITORING PLAN submittal. If chosen by the spec. writer, this approach enables the Instrumentation Specialist, who is selecting the specific instruments for purchase, to provide a comprehensive installation plan consistent with the contract specifications, site specific conditions/constraints, and instrument manufacturer's recommendations and requirements. The designer should include project specific installation requirements for each instrument they include in Part 2 - Products.

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3.3.1 General

Provide all labor, equipment, materials, and incidentals required to install and read the instruments as shown on the Contract Drawings. Install instruments in accordance with approved method statements and the manufacturer's recommendations. Upon completion of the installation, test each instrument in accordance with the recommendations of the manufacturer. The Contractor is solely responsible for installation and the performance of the instrumentation after installation. After installation replace any inoperative or poorly performing (not within an acceptable range/calibrations) instrumentation at no additional cost to the Government. Obtain all necessary permits and pay associated fees required to construct the project. Implement the terms and requirements of the permits. Submit Permit Documentation to the Government for record.

3.3.2 Installation Plans

As outlined in paragraph INSTRUMENTATION AND MONITORING PLAN, detailed method statements for installation of each type of instrument must be submitted for Government review and approval prior to commencing installation.

3.3.3 Notification and Documentation

All installations may be monitored by the Government's Representative. Notify the Government Point of Contact at least [24][_____] hours prior to the installation of each instrument. For each instrument installed, prepare, and submit an Installation Record in PDF format, including but not limited to items listed below. Enter all as-built metadata for each instrument into the enterprise database for the project detailed in paragraph AVAILABILITY OF MONITORING DATA.

3.3.4 Instrument Coordinates

Survey final location of all installed instruments utilizing the survey control precision and accuracy requirements required by this Contract. Provide [easting and northing][_____] survey coordinates in accordance with the system and datums for the project. Provide all relevant elevations for installed components and sensing regions, and hole inclination and azimuth as directed by the Government. Ensure all station and offset measurements for new instruments utilize the established station line of the project.

3.3.5 Borehole Installations

Perform borehole drilling in accordance with the [Section 02 32 13 SUBSURFACE DRILLING AND SAMPLING][the Government standard drilling specification provided].[Adhere to ER 1110-1-1807 for any borehole drilling in earthen embankment dams or levees or those with soil foundations. No drilling or excavation can occur on a constructed embankment dam or levee until a Drilling Program Plan has been approved by the Government. Appendix B of ER 1110-1-1807 defines the format of the Drilling Program Plan.]

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NOTE: ER 1110-1-1807 applies to in-house and contracted drilling efforts for earth embankments or foundations associated with all dams and levees that have a federal interest. Drilling into, in close proximity to, or through embankment dams and levees and their foundations may pose significant risk to the structures. Water, compressed air, and various drilling fluids have been used as circulating media while drilling through earth embankments and their foundations. Although these methods have been successful in accomplishing the intended purposes, there have been incidents of damage to embankments and foundations. Ideally, it is best if the Government completes the Drilling Program Plan (DPP), with input from the Contractor on proposed items such as drill method, driller experience However, if the Contractor is to prepare the DPP it is recommended that the Government indicate they will furnish certain deliverables for use in development of the plan - items such as justification of need for drilling/instrumentation, PFM's, existing drawings/foundation information.

****

Installation procedures for instruments in boreholes must be performed in such a manner that all steps in the procedure can be quality assured. For each hole, maintain a detailed log, recording soil/rock and groundwater conditions encountered. Prior to installing any instrument through drill casing or augers, thoroughly remove all cutting and material adhering to the inside of the casing or augers. Instrument installation in a borehole must be completed in a continuous operation. Partially completed instrument installations must not be left in unsupported boreholes overnight. For boreholes in which piezometers are to be installed, bentonitic drilling muds must not be used. For holes where instrument casing is installed, verify that the drilled hole within two degrees of vertical (plumb) throughout its length and is at the correct depth.[When drilling below the water table or when the drill hole must not remain open, advance the drill hole using a steel outer casing and approved drilling fluid. Withdraw outer casing after instrument casing is installed and as the hole is being backfilled. Do not rotate the casing during removal. Steel outer casings remain the property of the Contractor. Fill annular void between drill hole and instrument casing as indicated. Backfill each instrument specifically as indicated in its installation specification below or as indicate on the drawings. Backfill must be brought up in an equal fashion surrounding the instrument and/or casing. Measure the depth to fill surface as the work progresses (at top of each material increment) and confirm the depth reasonably matches the expected depth based on the volume of material placed.] Record the backfill quantities on the installation record.

****

NOTE: Instrumentation installation details presented below are to be project specific and should be developed further by the design engineers. Drilling, grouting or well installation may be described in further detail in a separate specification such as Section 02 32 13 SUBSURFACE DRILLING AND SAMPLING or Section 33 51 39 MONITORING WELLS. Also see above NOTE under paragraph INSTALLATION.

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3.3.6 Pore-Pressure and Groundwater Monitoring

3.3.6.1 [Open Tube Piezometer][Observation/Monitoring Well]

Install the [open tube piezometer][observation well][monitoring well] immediately after each boring is complete to the design depth specified and as close to vertical as possible. Secure the screen to the riser casing by flush-jointed threads and place using centralizers. Before the screen and casing are placed on the bottom of the borehole, place at least 15 cm 6 inches of filter material at the bottom of the borehole. Place filter material around the screen to at least 61 cm 2 feet above the top of the screen unless otherwise specified. If hollow stem augers are used, place the filter material in 15 to 30 cm 6 to 12 inch lifts. If the borehole is open, place filter material by tremie methods, using water to wash the sand through the pipe. After the filter material has been installed, place a minimum 1-meter 3-foot thick bentonite seal above the filter pack. Granular bentonite must be placed in depth increments not exceeding 30 cm 1 foot. Check the depth to the top of each increment of sand or granular bentonite after placement. The bentonite seal must be allowed to hydrate a minimum of eight hours or the manufacturer's recommended hydration time, whichever is longer. After the seal has hydrated, pump well-mixed grout by tremie method into the annular space around the casing. Record the volume of grout used and compare to expected to evaluate excessive grout loss. Grout must set for a minimum of 24 hours before surface pad and protective casings are installed. Construct concrete pad or surface completion as shown on drawings. For above ground completions, install a painted lockable protective casing extending a minimum of two feet above the ground surface. For flush mount completions, install a waterproof and watertight protective casing even with the ground surface. All watertight protective hand holes or above ground casing must be the same and use the same locking or unlocking mechanism which must be provided to the Government at the end of construction.

After completion of installation, record an initial reading of the open standpipe piezometer. An initial reading consists of the average of three readings taken with a water level indicator where the indicator is removed from the riser pipe between each reading. Then, conduct a post-installation acceptance test by performing a falling head or rising head permeability test. Conduct the test in accordance with procedures outlined in Appendix C of EM 1110-2-1908, including report of data and results.

3.3.6.2 Fully Grouted Vibrating Wire Piezometer

Install the vibrating wire (VW) transducer immediately after each boring is complete to the depth specified or shown on the drawings. Maintain the VW transducer in a bucket of water to keep the filter saturated for a minimum of 30 minutes until it must be removed to attach to the grout pipe. Immediately prior to attaching the transducer to the PVC grout pipe, remove the transducer porous tip and fill with clean water. After replacing the porous tip, use electrical tape to attach the transducer to the grout pipe upside down with the porous tip facing up. The porous tip must not be covered with electrical tape. Secure the transducer cable to the casing just below the transducer. Loop the cable to run up the casing past the VW transducer and eventually to the surface. The cable must be rotated around the casing to minimize bridging of grout. Avoid sharp bends in the cable. Lower the grout pipe with attached VB transducer and cable into the hole to the required depth. Read the piezometer to ensure it agrees (within plus or minus 10 mm 0.4 inch) with the water head as determined by a water level indicator, and record the elevation of the diaphragm. Use a drill rig pump or similar to first thoroughly mix the cement into the water for the cement-bentonite grout, and then carefully add the bentonite to ensure that clumps do not form and the required viscosity is attained. Perform a Marsh Funnel viscosity test to verify the target viscosity of [50 to 60][_____] seconds is obtained prior to grout placement. Do not pump grout into the borehole, but place grout using a tremie pipe with side discharge ports that remain submerged in the grout during the entire grouting process. Inject grout to within 30 cm 1 foot of the ground surface and allow to settle. After settlement has occurred, top off the grout to 30 cm 1 foot below top of ground surface. Mound natural soil at the ground surface to promote water drainage away from the piezometer.

After completion of installation, take a baseline reading. A baseline reading will consist of the average of a minimum of three stable readings. Construct surface components and piezometer cable routing and burial as specified and/or shown on the drawings. Protect instrument cables from mechanical or weather related damage. Free ends of cables must be protected at all times. Accurately record and clearly mark the position of all buried cables. Include any issues or changes that occurred during the construction in the Installation Record submittal, along with all required installation documentation detailed in paragraph NOTIFICATION AND

DOCUMENTATION.

3.3.7 Deformation/Displacement

3.3.7.1 Inclinometer Casing

Install inclinometer casing immediately after each boring is complete to the design depth specified and as close to vertical as possible. Anchor casing prior to grouting to prevent excess deformation. Orient inclinometer casings such that one axis of the internal grooves are perpendicular to the expected direction of movement. Maintain groove orientation throughout installation. During and after installation, casing groove spiral must not exceed one degree per3 meters 10 feet of length.

After completion of installation, complete a post-installation acceptance test to verify that there is no grout in the inclinometer casing, that groove orientation, spiral limitations, and verticality satisfy the specifications, and that the inclinometer probe tracks correctly in all four orientations. Perform a vertical survey of the installed inclinometer casing at 60-cm 2-foot depth intervals using the standard probe, to determine the vertical profile of the casing, and develop an initial data set. Include any issues or changes that occurred during the construction in the Installation Record submittal, along with all required installation documentation detailed in paragraph NOTIFICATION AND DOCUMENTATION.

3.3.8 Load/Stress

3.3.8.1 Load Cells

Conduct a minimum of three sequential lift-off tests to determine the correlation between the actual hydraulic jack load and the measured load in the load cell following lock-off. Following lock-off and lift-off testing, read the load cell twice daily for a period of at least one week to document drift or changes in the load cell readings. If readings do not stabilize within approximately 1 percent of the lock-off load, provide an assessment in writing for approval of the possible reasons for the drift and the results submitted. Contractor must not backfill around the load cells until drift characteristics have been documented, submitted in writing, and approved by the Government.

3.4 DATA COLLECTION

At a minimum, collect the following data as applicable to each type of instrument installed:

a. Instrument ID Name

b. Instrument Type

c. Date and Time

d. Reservoir Pool Elevation

e. Tailwater Elevation

f. Observer

g. Readout unit number and last calibration date if appropriate.

h. Readings

i. Visual Observations (e.g. loose mounting materials, rusting, battery leakage, UV damage to instrument, wire or casing)

j. Other pertinent data, including weather, temperature, construction activities, and any events that could influence change in the data.

3.4.1 Baseline Readings

****

NOTE: It is recommended that baseline readings be recorded for at least 6 months prior to the construction starting for projects involving life safety. This longer duration of baseline readings helps identify diurnal and seasonal effects, which can improve interpretation of "unusual" readings. However, this is not always allowable and shorter time frames are often considered.

****

Obtain initial readings from all instruments immediately after their installation and enough times (see reading frequencies in table of paragraph Frequency of Monitoring) before construction begins in order to verify that the instrument readings have stabilized, and initial (ambient) conditions are established. Collect initial or baseline readings for a minimum of [6 months][1 month][2 weeks]. Evaluate baseline readings and determine the cause of any data anomalies recorded. Those instruments that are to be installed with the purpose of monitoring the effect of the construction works on surrounding structures/ buildings/ utilities or terrain must be installed, tested for acceptance and fully operational at least [10 days][_____] prior to the commencement of the construction works whose effects are to be monitored, with the additional requirements as listed.

3.4.2 Frequency of Monitoring

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NOTE: The table below includes general minimum recommended monitoring frequencies adapted from Table 8.1 of EM 1110-2-1908 for the enhanced or during construction monitoring condition. When defining the reading frequency of an instrument, also consider the frequency used in the data evaluation calculations, particularly for a rate of change evaluation method. For example, if a rate of change evaluation method is used, the difference between consecutive 15 minute readings may not raise a flag, but a rate of change calculated over a 1 hour period might.

****

The minimum frequency of monitoring presented herein (see table below) may be subject to adjustment in accordance with field behavior, or as requested by the Government. The frequency and extent of monitoring are subject to change in accordance with the threshold and limiting levels described herein or as established in the approved Instrumentation and Monitoring Plan.

Instrument Type	Data Collection Method	Reading Frequency (Minimum)
Crack Pins	Manual Automated	Weekly Weekly/Daily
Extensometers	Manual Automated	Weekly Weekly/Daily
Inclinometers	Manual Automated	Weekly Weekly/Daily
Piezometers or Observation Wells	Manual Automated	Daily Every 15 minutes
Pressure Relief Wells or Well Points	Manual Automated	Weekly/Daily Daily
Seepage Measurement Devices	Manual Automated	Weekly Daily
Settlement Gauges	Manual Automated	Monthly N/A
Surface Monuments and Survey Points	Manual Automated	Monthly Daily
Tiltmeters	Manual Automated	Weekly Daily/Hourly

3.4.3 Manual Readings

Collect and reconcile manual instrumentation data to the [instrumentation EDB][_____] within [4][_____] hours of data collection. Digital data collection devices may be used to facilitate rapid input of data without redundant manual data entry.

3.4.4 Instrumentation Metadata

At a minimum, collect the following data for each instrument installed and add to the appropriate table of the instrumentation EDB:

a. Instrument ID

b. Instrument type

c. Instrument manufacturer

d. Date of installation

e. Automation status

f. Instrument easting and northing coordinates in the same coordinate system and datums as existing instrumentation.

g. Instrumentation surface elevation

h. Instrument bottom of installation elevation

i. Top and bottom elevations of all instrument sensing zones (as applicable)

j. Top and bottom elevations of all relevant installed features (i.e. concrete, filter, sensors, standpipe)

3.4.5 Automated Data Acquisition System (ADAS)

3.4.5.1 Cyber Security Compliance (ECB 2018-11)

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NOTE: There is a cyber security UFGS that may be referenced if used - it's Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

****

Automated data acquisition systems collect, process, store and transmit data. They are not SCADA systems and thus they will not control any critical infrastructure including but not limited to gates, valves, utilities, traffic control, security, fire, or life safety systems.

3.4.5.2 Programming

Programming of dataloggers must be performed in a logical, well-annotated way. Data logger communications may be encrypted for security, but the program must be accessible by the Government on systems that will be owned or operated by the Government. Provide a copy of the program with the code annotated. The annotations must be descriptive and explain the different sections and clearly define constants.

3.4.5.3 Testing

Install and test the automation system in the presence of the Government's designated representative.

3.4.5.4 Project Specific Operations Manual

Submit an operations manual including wiring diagrams, photos of the inside of each Data Logger, RIO, LMU, RMU, or other boxed transmission device as well as each instrument location with clear views of the instrument showing wiring and location of all components, cut sheets, calibration sheets, datalogger programs, component configuration settings, troubleshooting, as-built drawings, and maintenance requirements.

3.4.5.5 As-Builts

Provide as-built drawings including installation/construction diagrams as well as instrument locations, datalogger or other readout devices, conduit, trenching and cabling. In addition to full scale drawing as-builts required as part of the construction contract, include 28 by 43-cm 11 x 17-inch size as-builts as an appendix in the Project Specific Operations Manual.

3.5 ANALYSIS, REPORTING, AND PRESENTATION OF MONITORING DATA

If not explicitly stated herein, analysis, reporting, and presentation of monitoring data must be consistent with the guidance provided in EM 1110-2-1908.

3.5.1 Analysis of Monitoring Data

Compare each acquired instrument reading with the previous readings of that instrument and the expected reading based on site conditions and in reference to baseline readings. Interpretation of data also includes making correlations between instrumentation data and specific construction activities. Determine whether the instrumentation response to construction activities is reasonable. Data interpretation and analysis should consider instrument precision levels and errors, data capturing errors and necessary corrections in accordance with the manufacturer's instructions. In addition, data analysis should consider connections to records of construction and weather-related activities at the site. Perform analyses in a timely manner to capture indications of distress development, the possible need for instrument maintenance, and to check for proper functioning. Determine if a threshold value has been exceeded, and if so, proceed in accordance with paragraph RESPONSE ACTIONS. If the comparison indicates that changes are not typical of previous changes, determine whether the reading is erroneous or legitimate. Erroneous readings include readings outside the accuracies, repeatability, standard deviations, and tolerances specified herein or as indicated by the manufacturer. Ensure, and document, proper quality control is being conducted on the analyses and results.

3.5.2 Monitoring Data Reports

Submit monitoring data reports, consisting of all processed instrumentation data converted to standard English units of measure, to the Government's Representative at defined intervals throughout the construction period. Include readings for all instruments. Readings are to be cumulative for the reporting period. NO DAILY AVERAGING OF AUTOMATED DATA WILL BE ALLOWED.

a. For the duration of the contract, submit [monthly][weekly] Monitoring Data Reports within [24 hours][_____] from the last day covered in the report. Each report must include analysis of that [month's][week's] data collection and findings in relationship to work performed on-site which may impact readings. Provide cumulative plots of data for the reporting period. Plotted values must be discrete - no daily averaging between successive data points. Reports may be requested at a higher frequency by the Government for special instrumentation evaluation purposes. Provide such reports following the same format as [monthy][weekly] reports or as directed by the Government's authorized representative.

b. Ensure all erroneous data is masked from plots, but it must remain in the raw data file and be flagged as erroneous data in the database within a specifically designated field.

c. Reduce all automated sensor readings in accordance with the manufacturer's recommendations and equations.

3.5.3 Presentation of Monitoring Data

****

NOTE: It is recommended that Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION be included in the contract specifications package for the project and referenced herein. If included, review the following paragraphs and remove redundant information that is included in Section 01 31 20.

If the web interface needs to have a geospatial component, that language must be added - this language will only get a graphical display output of the instrumentation readings according to the

requirements specified in "Graphics".

Ensure that the format can be readily uploaded into the system you are using as your final storage location. The best way to accomplish this would be to provide the data dictionary of the final database schema to the Contractor and require they use the same tables, fields, field types and relationships.

Once projects are fully integrated to MIDAS, the web interface may become obsolete because MIDAS will offer most plotting functionality needed. If the Government will retrieve and host its own data through MIDAS or another web-based dashboard platform, remove this requirement.

****

3.5.3.1 Web Interface of Interactive and Static Reports of Data

Through the use of a secure web interface, establish interactive and static reports generated from the instrumentation data gathered at the site. Establish the web interface within 30 days following Notice to Proceed. Provide backups for the website in accordance with the requirements stated in paragraph DATA REQUIREMENTS. The interface must be intuitive, easy to navigate, and include all graphical plots and displays as detailed in this section. Within [60][_____] days of the notice to proceed, provide a presentation (for training purposes) of all components of the web interface for submittal approval by the Government.

3.5.3.2 Quick Reference Guide

Within [60][_____] days of the Notice to Proceed, produce and submit a digital and paper Quick Reference Guide for use of the website that meets the following minimum criteria:

a. Describes in detail the website structure and contents.

b. Describes in detail the location and steps to use the features and functionality.

c. Describes in detail how to download plots and other graphical displays.

d. Is designed in a simplified, indexed, and well-organized manner.

e. Includes web addresses of web-hosted sites in use, and POC information for administrators who can provide user-access to the Government.

3.5.3.3 Training

Within [60][_____] days of the Notice to Proceed, provide training sessions, on site or at the Government office - as coordinated with the Government, to familiarize and train Government users on the web interface. Provide [2] sessions, [2 hours] in length each.

3.5.3.4 Graphics

a. Reduce piezometric data to elevation in meters feet and plot it, along with headwater and tailwater elevations, versus time.. The Y axis showing elevation must not be a dynamic axis. Plot values together on one scale range of the X axis.

b. Reduce alignment pin readings to total horizontal and vertical movement (in cm inches) from the initial positions and plot versus time.

c. Reduce and plot inclinometer data vs depth.

d. Reduce weir data and plot as a time series.

e. For weekly reports, the data plotted versus time must be shown in plots spanning the one-month report period, one year period, and lifetime period. Indicate on the plots maximum and minimum instrument readings spanning the life of the instrument. Include the following information for the reading data:

(1) instrument location number,
(2) date of reading,
(3) reduced readings,
(4) all remarks from any field observations,
(5) water elevation,
(6) other work completed within the vicinity plotted on the date in which it took place,
(7) excavation elevation near that instrument, and
(8) ambient temperature.

f. Plot Automated Robotic Total Station Monitoring system data as x, y, z and resultant displacement versus time, and provide in tabular format.

3.5.3.5 Discussion

All automated data must include corrections for temperature and/or barometric pressures changes, as recommended by the manufacturer (and necessary for calculations). In all reports generated, include a written description of how the data was reduced, including any equations utilized.

3.6 AVAILABILITY OF MONITORING DATA

****

NOTE: It is recommended that Section 01 31 20 PROJECT TECHNICAL DATA MANAGEMENT AND VISUALIZATION be included in the contract specifications package for the project and referenced herein. If included, review the following paragraphs and remove redundant information that is included in Section 01 31 20.

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3.6.1 Website Access

3.6.1.1 Security Credentials

Provide 24/7 read access to the data to the Government, the Contractor, and any related subcontractors for the duration of this contract. Within 30 days of Notice to Proceed, provide the COR any necessary username and password or other security credential for access. For new personnel requested by the Government throughout the contract, grant access and provide security credentials within 48 hours of the request.

3.6.1.2 Data Update and Display

The website must update all automated data within [10 minutes][_____] of data collection at a specific instrument. Post all manually read instruments and surveyed instrument data to the website within [4 hours][_____] of data collection on that specific instrument. Plot scales, offset, and layouts must be editable by users, with the new selected defaults saved for each user.

Displays must include automatically updated plots from all instrumentation as outlined in ANALYSIS, REPORTING AND PRESENTATION OF DATA.

3.6.1.3 Site Operability and Useability

The website must be fully functional, current, easy to navigate, accessible through Government VPN, and complete with all instrumentation data available for retrieval by both automated and manual methods. Demonstrate the system to the Government prior to System/Website Training. If the website is not functional, with data available and easy to read, pertinent payments will be withheld until the issue is resolved and acceptable to the Government.

3.6.2 Raw Data

Furnish all collected data in a native CSV or TOA5 Data Format. Data must have, at a minimum, Instrument Id, timestamp, and value. Submit raw data files via the [project SFTP][_____] within [24 hours][_____] of generation.

3.7 THRESHOLDS AND RESPONSE ACTIONS

3.7.1 Threshold Values

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NOTE: See Table 8.2 of USACE EM 1110-2-1908 (30 Nov. 2020) for example thresholds to trigger response evaluation for various geotechnical instruments.

****

Monitor instrument readings against the Alert and Action Threshold Values as defined individually for instruments [in the table below] [as outlined in the Instrumentation and Monitoring Plan prepared by the Instrumentation Specialist and approved by the Government]. The actions to be implemented when these Threshold Values are reached are referred to as Response Actions and are explained in paragraph RESPONSE ACTIONS. Threshold values must be identified on respective plots.

THRESHOLD VALUES				
Instrument Type	Instrument IDs	Unit of Measure	Alert Threshold Value	Action Threshold Value
Piezometer	[_____]	m ft	[_____] m ft, or rate of change	

THRESHOLD VALUES				

3.7.2 Response Actions

If an Alert Threshold Value is reached, the Contractor's Instrumentation Specialist must immediately evaluate the instrument response by collecting a manual reading if possible, and also in relation to weather and physical conditions at the location of the instrument and provide an update to the Contractor and Government.

Within [24 hours][_____], analyze the instrument response and submit an Instrument Alert Assessment providing an assessment of the cause of the alert and predict further responses and their effect based on the trend to date. Include recommendation for any corrective action, if needed.

If an Action Threshold Value is reached, the Contractor must immediately stop work, remove personnel from the affected work area, and implement the emergency response actions included in the Instrumentation and Monitoring Plan previously approved by the Government. The Instrumentation Specialist must immediately evaluate the instrument response with respect to physical conditions at the location of the instrument.

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NOTE: Consider adding a note to the Plans to bring this to the construction contractor's attention and/or include in Section 01 14 00 WORK RESTRICTIONS.

****

Submit a detailed Action Threshold Exceedance Report documenting the site conditions, such as weather, and construction activities when the action threshold value was reached, analysis of the cause(s) for exceedance, and recommendations for any corrective actions needed. Resume suspended activities only after receiving written instruction from the Government.

3.8 VISUAL INSPECTION

Conduct routine visual observations of the site and instruments by selected individuals and at intervals defined in the approved Instrumentation and Monitoring Plan. Submit written and site photo documentation of these routine visual observations to the Government within [48 hours][_____] of completion. Areas that have been identified as potentially concerning should be noted and monitored at prescribed visual observation frequencies. While monitoring instruments, examine installed instrumentation for evidence of damage, malfunction and possible future damage caused by construction activities, and report any such issues, along with photos, to the Government. Submit this information, along with any site photos, to the Government. Also record nearby construction activities, such as pile driving, stockpiling, excavation or water control and environmental conditions, such as the weather or presence of floodwater and all other events that may influence instrumentation data.

Perform visual inspection at the location of any instrument that is producing unexpected or unusual readings. Immediately perform inspection of an instrument that has exceeded an Alert Threshold as further detailed in paragraph THRESHOLD VALUES.

3.9 SYSTEM RELIABILITY

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NOTE: The content of this paragraph applies to instruments installed for the purpose of monitoring active construction.

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The entire instrumentation system including datalogging equipment, servers, sensors, wiring, etc. must be maintained at all times. If in the Government's opinion the instrumentation system is not functioning properly, as demonstrated by unreliable and/or questionable readings, all construction work must cease immediately and not resume until the system is performing as specified. No additional compensation will be made by the Government for any cessation of work. The Government will determine whether the performance of the instrumentation system is satisfactory to resume work.

3.10 MAINTENANCE AND REPLACEMENT

Before work begins on a delivery order, prepare a list of all extra components that are required for continuous operation of the system and quantities to be stockpiled on-site according to the estimated replacement rate per the manufacturer recommendation. Submit this list to the Government for approval. The items on the approved list must then be available at the site during the entire period of the delivery order. If a stockpiled item is used, immediately replace it with the same item that was used.

If an instrument is repaired, replaced, or moved subsequent to installation, record new: instrumentation type, as-built location, and calibration sheets. Submit an Instrument Modification Report to the Government detailing the reason the original instrument was altered and the date the new instrument was operational.

For the duration of the contract period, maintain all instrumentation installations in progress and all completed instrumentation installations. In the event of a malfunction or breakdown, notify the Government of the nature of the malfunction or breakdown within 12 hours of initial observation of its occurrence, and provide an estimate of when that part of the system will be back in service if the Government approves a replacement. Depending upon the status of the construction at that time, the Government will determine whether a manual backup system must be implemented by the Contractor. If an instrument does not function properly for a cumulative total of [10][_____] calendar days or more within any 30 consecutive calendar day period, the Contractor will not be provided the [monthly][_____] payment for item General Instrumentation Requirements until repairs have been made and approved by the Government.

3.11 PROJECT CLOSEOUT AND RESTORATION

Upon completion of construction, as determined by the Contracting Officer, the Contractor must remove and properly dispose of all instruments and devices from the site, except for those instruments identified for long term monitoring [as detailed on the contract drawings][_____]. Confirm these instruments with the Government prior to initiation of removal activities by submitting an Instrument Removal List for Government review and approval a minimum of [30 days][_____] prior to the removal of any instruments. Retrieve all removable equipment and backfill holes with an approved grout mix. Any protruding parts, which cannot be removed completely without damage to the structure must be cut off flush with the surface. Remove all sharp edges. Repair any damage to existing structures from removal of instrumentation devices to the satisfaction of the Government and at no additional cost to the Government.

3.12 VIBRATION MONITORING

3.12.1 Preconstruction Condition Survey

The Seismologist/Vibration Consultant must conduct a Preconstruction Condition Survey of all existing structures and utilities within the area designated in the plans. The Contractor must have both letter and personal contact with residents, owners and operators of the structures and must notify them a minimum of two weeks prior to performing the survey.

Obtain Right-Of-Entry or permissions for all properties entered as part of this survey. Any owners refusing the Preconstruction Condition Survey must be given the opportunity to sign a statement, produced and provided by the Contractor, stating any reasons for non-participation.

a. The Preconstruction Condition Survey must be performed by an experienced Professional Engineer familiar with construction methods and materials, and structural response to ground vibrations generated by construction activities.

b. The Preconstruction Condition Survey must consist of a description of the interior and exterior condition of each of the structures examined, including: above ground structures, foundations, basements, driveways, walkways, electrical, plumbing, utilities (overhead and buried), transmission lines, drains, wells and water systems. Describe any signs of existing distress, cracks, damage, spalling, settlement, leakage, or other defects. The survey must include such information to make it possible to determine the effect, if any, of the construction operations on the existing defect. Where significant cracks or damage exist, or for defects too complicated to document in words and sketches only, photographs must be taken or a good quality video survey with appropriate audio description of locations, conditions, and defects must be performed to supplement the written description. Survey must include a list of vibration sensitive equipment or furnishings, and potential falling debris hazards.

c. Install crack displacement monitoring gages as appropriate across any significant existing cracks and read [periodically][after the conclusion of blasting][after each blast][_____] to verify if any additional distress should develop. Include the crack gauge readings, recommendations for additional instrumentation types or survey monuments, if needed, in the report. Identify structures or elements that are potentially susceptible to damage and recommend, if warranted, potential: support, repair, vibration mitigation measures, or reduced ground vibration limits.

d. The Seismologist/Vibration Consultant must give written notice to the owner of any inspected structure, tenants, and any representative of local authorities required to be present at the Preconstruction Condition Survey. The notice must state the coordinated dates and time on which surveys are to be made.

e. Owners of the structures must be given a copy of the survey of their particular structure and be given the opportunity to comment on its accuracy. Submit the Preconstruction Condition Survey to the Government 30 days prior to construction activities that, in the opinion of the Government, would be a source of ground vibrations.

3.12.2 Postconstruction Condition Survey

Conduct a Postconstruction Condition Survey within 30 calendar days upon the completion of all construction work that, in the opinion of the Government, generate ground vibration. Postconstruction Condition Surveys must be conducted on all structures and utilities that previously had a Preconstruction Condition Survey, and on any additional properties, structures, and conditions for which complaints of damage have been received or damage claims have been filed. Give notice to all parties, as identified in paragraph PRECONSTRUCTION CONDITION SURVEY, subparagraph d., so that they may be present during the final examination. Distribute records of the final examination in the same manner as the original Preconstruction Condition Survey. The Postconstruction Condition Survey must have the same requirements as the Preconstruction Condition Survey and must consist of a description with any measurements, surveys, photographs, and other information needed to document the postconstruction condition of surveyed structures. Preconstruction and postconstruction comparisons must be made of surveyed areas, including photographs and other measurements. The Seismologist/Vibration Consultant must include an evaluation of whether any noted differences between the Preconstruction and Postconstruction Condition Surveys are the result of construction vibrations or due to other causes.

3.12.3 Vibration Test Program and Report

Upon completion of the Preconstruction Condition Survey, a Vibration Test Program and Report must be directed and completed by the Seismologist/Vibration Consultant. The completed Vibration Test Program and Report must be submitted and approved prior to full production phase of any proposed construction activity that, in the opinion of the Government, could be a source of ground vibration. These construction activities include, but are not limited to: trenching, hauling, backfilling, compacting, and pile driving. The vibration test program must be conducted, in part, to verify vibration levels for proposed construction equipment listed in the Vibration Monitoring Plan.

Obtain ambient or baseline ground vibration values prior to vibration testing of construction equipment. Vibration monitoring must be performed for 12 daylight hours to obtain the ambient or baseline ground vibration values at [_____].

Perform the Vibration Test Program(s) in a remote area of the project, at a distance of at least [30 meters] [100 feet] [_____] from the nearest structure. Components of the Vibration Test Program must be established and directed by the Seismologist/Vibration Consultant. The vibration tests must include, but are not limited to: vibration monitoring at various distances from the vibration source, determination of the ground vibration source level for the construction equipment and methods (minimum requirement includes peak particle velocity and frequency values at various distances from the source), and establishing the attenuation rate through the project soil.

The Vibration Test Programs and Report must state the suitability of the proposed construction equipment and methods to perform within the specified vibration criteria. If it is determined, by the Vibration Consultant or Government, that the proposed construction equipment and methods cannot satisfy the specified vibration criteria, then alternative or supplemental equipment/methods, or vibration mitigation measures must be tested and report resubmitted for approval, at no additional cost to the Government.

The report must also include any recommendations to reduce construction impacts from ground vibrations or noise. Base recommendations on an analysis from the results of the Vibration Test Program, Preconstruction Condition Surveys, and site specific conditions. Recommendations could include, but are not limited to, the following: requirement for additional instrumentation to document potential settlement or displacement; requirement for more restrictive vibration criteria; ground vibration or noise reduction measures.

3.12.4 Seismologist/Vibration Consultant Duties

The Seismologist/Vibration Consultant duties are as follows: direct and instruct the Contractor in operations to control vibrations within specified levels; participate in a public meeting; facilitate and complete the preconstruction and postconstruction surveys; perform Vibration Test Program(s) and complete report; provide, install, and use all necessary equipment to observe and record vibrations to ascertain that acceptable levels of vibrations are not exceeded; and monitor benchmarks, deflections, cracks, and other critical conditions on the existing structures. Obtain Rights-of-entry and permissions from landowners for access to perform vibration monitoring. Monitor vibrations, report findings, and furnish recommendations on a daily basis to the Contractor and Government, determine the level of observed vibrations attributed to the project's construction activities, and determine their subsequent effect on surrounding structures.

If the monitoring equipment can be operated automatically and monitored remotely, the Seismologist/Vibration Consultant must be present at the site for the start of new construction activities that require vibration monitoring, movement and setup of vibration monitoring instruments, monitoring devices for structural movement and settlement, and at other key times in the project as approved in the Vibration Monitoring Plan. Otherwise, the Seismologist/Vibration Consultant must be onsite during all applicable construction activities. The Seismologist/Vibration Consultant must be readily available if issues requiring attention arise during construction. When monitoring is occurring, the Seismologist/Vibration Consultant must check all equipment at the start of each work day to confirm that it is working properly.

3.12.5 Daily Vibration Monitoring Reports

At the end of each day of monitoring, the Seismologist/Vibration Consultant must record the following information on a form developed by the Seismologist/Vibration Consultant, and submit final signed reports electronically to the Government within 24 hours:

a. The name of the Contractor and/or Subcontractors responsible for the primary construction activities generating vibrations.

b. The name of the Seismologist/Vibration Consultant.

c. The name of the operator of the vibration monitoring equipment.

d. A sketch indicating the location of the vibration monitors and the construction activities generating vibrations.

e. Complete details of the particular construction activities which are being monitored, including all related equipment, operating frequencies, piling or excavation depths, distance from the construction activities to the monitoring equipment, and all other related information as requested by the Government.

f. Results of monitored vibrations and noise levels for the particular construction activity, including the frequencies of the measured peak particle velocities.

g. Identification of any activity resulting in the ground vibration or noise limits being exceeded and the time of day that the limits were exceeded. List time of day that the Contractor and Government were notified. List time of day that the construction activity was halted. Include corrective actions taken to reduce ground vibration and noise levels.

h. A summary of any vibration related complaints received during the day.

i. Reports must be reviewed and signed by the Seismologist/Vibration Consultant's experienced Registered Professional Engineer.

3.12.6 Web Interface of Interactive and Static Reports of Data

Through the use of a secure web interface, establish interactive and static reports generated from the vibration monitoring data gathered at the site. Establish the web interface within 30 days following Notice to Proceed. Provide backups for the website in accordance with the requirements stated in paragraph DATA REQUIREMENTS. The interface must be intuitive, easy to navigate, and include real-time monitoring data. Within 60 days of the notice to proceed, provide a presentation of all components of the web interface for submittal approval by the Government.

3.12.7 Adjustments in Construction Procedures

If the Contractor receives complaints by the public during construction, or during the Preconstruction and Postconstruction Condition Survey process, the Contractor must follow a Vibration Screening Procedure and fill out a Vibration Complaint Report, in accordance with the approved Vibration Monitoring Plan. The Contractor must notify the Government of any complaint within 24 hours and must submit a copy of the completed Vibration Complaint Report within one week of the complaint.

If the monitoring data indicates that the ground vibration limits for any of the three mutually perpendicular components, or noise limit, have been exceeded, the construction activity generating those vibrations must be halted immediately. A deficiency correction report, giving corrective actions or mitigation measures to reduce ground vibrations or noise levels, must be submitted by the Contractor. Construction activity may not resume until the report has been approved by the Government and corrective actions or mitigation measures are completed by the Contractor. Vibration or noise mitigation or reduction measures must be constructed or implemented at no additional cost to the Government.

3.12.8 Government Quality Assurance

The Government may check the vibration monitoring operations at any time and may perform independent vibration monitoring.

3.12.9 Ownership

At the end of this contract, on a date specified by the Government's Representative, all instrumentation components become the property of the Government. All data collection and recording devices must be calibrated and certified by the manufacturer or a certified laboratory prior to being delivered to the Government's Representative. The Contractor is responsible for all costs for the recalibration, shipping, and verification of these data recorders.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 52 10 (November 2018)**
Change 1 - 11/20

Preparing Activity: NAVFAC **Superseding**
UFGS-33 52 10 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 52 10

FUEL SYSTEMS PIPING (SERVICE STATION)

11/18, CHG 1: 11/20

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USACE / NAVFAC / AFCEC **UFGS-33 52 10 (November 2018)**
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SECTION 33 52 10

FUEL SYSTEMS PIPING (SERVICE STATION)

11/18, CHG 1: 11/20

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NOTE: This guide specification covers the requirements of interior and exterior fuel piping and accessories for small, non-aviation fueling applications (i.e., gasoline fueling, diesel fueling, fuel oil systems) and service station type aviation fuel systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: Use this UFGS in conjunction with UFC 3-460-01 "Design: Petroleum Fuel Facilities". Include in this specification any additional system components/devices necessary to meet state and local regulations.

Stage I vapor recovery is the process of recovering vapors when a storage tank is filled. Stage I vapor recovery is mandatory on all Army Facilities. Stage II vapor recovery is the process of recovering vapors during vehicle fueling operations. Stage II

vapor recovery is optional and will be included if required by state and local clean air regulations.

The specification is written around ASME's standard Class 150 rating. For applications requiring higher pressure ratings (e.g., Class 300), the designer will have to modify this specification appropriately.
****

1.1 SUMMARY

This section defines the requirements for pipe, piping components, and valves as related to small fuel distribution systems (non-aviation type). Provide the entire fuel distribution system as a complete and fully operational system. Size, select, construct, and install system components to operate together as a complete system. Substitutions of functions specified herein will not be acceptable. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system. Design system components and piping specified herein to handle a working pressure of 1900 kPa 275 psig at 38 deg C 100 deg F. System components specified herein must be compatible with the fuel to be handled. Components must be suitable for outside, unsheltered location, and to function normally in ambient temperatures between [_____] degrees C and [_____] degrees C [_____] degrees F and [_____] degrees F.

1.1.1 Related Sections

1.1.1.1 Welding

****
NOTE: Use Section 33 52 23.15 POL SERVICE PIPING WELDING to define all welding requirements for pressure piping. Edit Section 33 52 23.15 POL SERVICE PIPING WELDING around the requirements of ASME B31.3.

Within Section 33 52 23.15 POL SERVICE PIPING WELDING, require 100 percent radiographic testing on all underground steel piping as well as all piping downstream of pumps (See UFC 3-460-01). For all other piping, require random radiographic testing per ASME B31.3, Category M fluid service (20 percent).
****

Welding activities for pipe and piping components must be in accordance with Section 33 52 23.15 POL SERVICE PIPING WELDING.

1.1.1.2 Earthwork

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NOTE: Require backfill for aluminum, stainless steel, or carbon steel pipe to be sand.

Require sand to be a fine aggregate that is washed and thoroughly dried, contains no more than 500 ppm chlorides, contains no more than 500 ppm sulfates, and has a pH greater than 7.

Suggest horizontal sections of belowground piping be installed with a minimum of 915 mm 36 inch of backfill between the top of the pipe and the ground surface.

****

Excavate and backfill piping as specified in Section 31 00 00 EARTHWORK.

1.1.1.3 Cathodic Protection

Provide buried metallic components including pipe, anchors, and conduit with a cathodic protection system as specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM][and][Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Cathodic protection for metal components that attach to a tank must be coordinated and compatible with the tank corrosion control system.

1.1.1.4 Concrete Manholes

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NOTE: The design of manholes including size, reinforcing, arrangement, penetrations, system components and piping within the valve manholes is the responsibility of the designer. Design manholes to provide proper venting and drainage and adequate room for maintenance without stepping on or over any piping/system components. When electric manhole sump pumps are used, the electrical distribution and tie in points must be designed and shown on the drawings.

Require in the referenced section below that concrete be 30 MPa 4000 psi minimum 28-day compressive strength, air-entrained admixture (133 grams per cubic meter 3.6 ounces per cubic yard), with water-reducing admixture (814 grams per cubic meter 22 ounces per cubic yard), reinforced with deformed steel bars. Require manhole sides to be constructed by one monolithic pour. Require cast-iron steps with nonslip surfaces, spaced 300 to 400 mm 12 to 16 inches on centers to be firmly embedded in the concrete walls for access to bottom of manholes.

Note that the interior walls of a typical concrete manhole are not fuel resistant. Fuel that is collected within a manhole will eventually, if not removed, wick through the concrete to the surrounding soil. Consider protecting the interior manhole walls with some type of fuel resistant coating.

****

Construct manhole of concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 1110	(2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API STD 600	(2015) Steel Gate Valves-Flanged and Butt-welding Ends, Bolted Bonnets
API STD 608	(2012) Metal Ball Valves - Flanged, Threaded, And Welding End
API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves
API Spec 6FA	(1999; R 2006; Errata 2006; Errata 2008; R 2011) Specification for Fire Test for Valves
API Spec 17J	(2016; Errata 2 2017; ADD 1 2017)

	Specification for Unbonded Flexible Pipe
API Std 594	(2017) Check Valves: Flanged, Lug, Wafer and Butt-Welding
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.3	(2022; Errata 2023) Process Piping
ASME B40.200	(2008; R 2013) Thermometers, Direct Reading and Remote Reading
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for

Construction of Pressure Vessels Division 1

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C209	(2019) Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fitting for Steel Water Pipelines
AWWA C215	(2022) Extruded Polyolefin Coatings for Steel Water Pipe
AWWA C216	(2022) Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C217	(2023) Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A358/A358M	(2024) Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B247	(2020) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM B687	(1999; R 2023) Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples

ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D229	(2019) Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F436	(2011) Hardened Steel Washers
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1172	(1988; R 2024) Standard Specification for Fuel Oil Meters of the Volumetric Positive Displacement Type

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NACE INTERNATIONAL (NACE)

NACE SP0185	(2024) Extruded Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe
NACE SP0188	(2024) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 30A	(2024; ERTA 1 2023) Code for Motor Fuel Dispensing Facilities and Repair Garages

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 77	(2024; ERTA 1 2023) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 24-2) Standard for Aircraft Fuel Servicing
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J514	(2012) Hydraulic Tube Fittings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-13789	(1999; Rev E; Notice 1 2008; Notice 2 1016; Notice 3 2021) Strainers, Sediment: Pipeline, Basket Type

UL SOLUTIONS (UL)

UL 971	(1995; Reprint Mar 2006) UL Standard for Safety Nonmetallic Underground Piping for Flammable Liquids

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding

Pipe Supports

SD-03 Product Data

Insulating Flange Kits; G, [_____]

Flange Protectors; G, [_____]

Fuel Piping Flange Bolts, Nuts, and Washers; G, [_____]

Carbon Steel Pipe; G, [_____]

Stainless Steel Pipe; G, [_____]

Flexible Non-Metallic Pipe; G, [_____]

Double Wall Carbon Steel Piping; G, [_____]

Steel Reinforced Flexible Pipe; G, [_____]

Copper Piping; G, [_____]

Joint Compound; G, [_____]

Flexible Connector; G, [_____]

Strainer; G, [_____]

Thermometers; G, [_____]

Pressure Gauge; G, [_____]

Flexible Ball Joint; G, [_____]

Bellows Expansion Joint; G, [_____]

Flow Meter; G, [_____]

Ball Valves; G, [_____]

Plug (Double Block and Bleed) Valves; G, [_____]

Swing Type Check Valves; G, [_____]

Wafer Type Check Valve; G, [_____]

Globe Valve; G, [_____]

Thermal Relief Valve; G, [_____]

Pressure\Vacuum Relief Valve; G, [_____]

Foot Valve; G, [_____]

Tank Overfill Prevention Valve (Gravity Fill); G, [_____]

Tank Overfill Prevention Valve (Pumped Fuel Receipt); G, [_____]

Anti-Siphon Valves; G, [_____]

Submersible Pump; G, [_____]

ANSI Type Centrifugal Pump; G, [_____]

Sliding Vane Rotary Pump; G, [_____]

Self-Priming Centrifugal Pump; G, [_____]

Pump Control Panel; G, [_____]

FRP Containment Sump; G, [_____]

Pipeline Markers; G, [_____]

SD-06 Test Reports

Exterior Coating Holiday Test

Preliminary Pneumatic Test

Final Pneumatic Test

Hydrostatic Test

Exterior Containment Piping Tests

SD-07 Certificates

Contractor Qualifications; G, [_____]

Licensed Personnel

Stage II Vapor Recovery System

Pipeline Inventory; G, [_____]

Demonstrations

SD-08 Manufacturer's Instructions

Flexible Ball Joint

Bellows Expansion Joint

SD-10 Operation and Maintenance Data

Insulating Flange Kits; G, [_____]

Flange Protectors; G, [_____]

Strainer; G, [_____]

Thermometers; G, [_____]

Flexible Ball Joint; G, [_____]

Bellows Expansion Joint; G, [_____]

Flow Meter; G, [_____]

Ball Valves; G, [_____]

Plug (Double Block and Bleed) Valves; G, [_____]

Swing Type Check Valves; G, [_____]

Wafer Type Check Valve; G, [_____]

Globe Valve; G, [_____]

Thermal Relief Valve; G, [_____]

Pressure\Vacuum Relief Valve; G, [_____]

Foot Valve; G, [_____]

Tank Overfill Prevention Valve (Gravity Fill); G, [_____]

Tank Overfill Prevention Valve (Pumped Fuel Receipt); G, [_____]

Anti-Siphon Valves; G, [_____]

Submersible Pump; G, [_____]

ANSI Type Centrifugal Pump; G, [_____]

Sliding Vane Rotary Pump; G, [_____]

Self-Priming Centrifugal Pump; G, [_____]

Pump Control Panel; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Contractor Qualifications

****

NOTE: Include any state or local regulatory requirements or certification that must be met by the Contractor.

****

Each installation Contractor must have successfully completed at least 3 projects of the same scope and the same size, or larger, within the last 6-years; demonstrate specific installation experience in regard to the specific system installation to be performed; have taken, if applicable, manufacturer's training courses on the installation of piping; and meet the licensing requirements in the state. Experience must include the erection of piping systems in compliance with the requirements of ASME B31.3, NFPA 30, and NFPA 30A. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed providing in the letter evidence of prior manufacturer's training and state licensing.

1.4.2 Regulatory Requirements

1.4.2.1 Licensed Personnel

Pipe installers must be licensed/certified when the state, city or locality requires licensed installers.

1.4.2.2 Stage II Vapor Recovery System

****

NOTE: Delete this paragraph if stage II vapor recovery is not specified.

****

System must meet the air quality laws of the State of [_____] as well as applicable local regulations. Submit certification of the stage II vapor recovery systems from the California Air Resources Board (CARB). Test and validate the recovery system to be 95 percent efficient in controlling VOC emissions during refueling of motor vehicles.

1.4.3 Design Data

1.4.3.1 Pipeline Inventory

Fuel system volume must be calculated using as constructed pipe lengths, internal diameters, fittings, and components. Totals must be provided for all items containing fuel with the exception of tanks which is covered by other specifications. A certified pipeline inventory with sizes, lengths, quantity, and volumes must be provided for the systems in this project.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 PROJECT/SITE CONDITIONS

Fuel required for the testing, flushing and cleaning efforts, as specified in this section, will be provided and delivered by the Contracting Officer. Fuel used in the system will remain the property of the Government. Fuel shortages not attributable to normal handling losses must be reimbursed to the Government.

PART 2 PRODUCTS

2.1 ELECTRICAL WORK

****

NOTE: Show electrical characteristics on the drawings.

Coordinate the ignition temperature of the fuel(s) to be handled with the electrical design. Ignition temperatures will be as defined in NFPA 497M. Fuel ignition temperatures will dictate the maximum allowable temperature rating of the electrical system components. Coordinate the area classification and the electrical design with UFC 3-460-01.

Coordinate piping, valve, system components and other systems bonding and grounding requirements with UFC 3-460-01. Include also in the design a bonding and grounding plan to relieve and control static electricity buildup as described in UFC 3-460-01.

****

2.1.1 General

Motors, manual or automatic motor control system components except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM[, Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION][, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

2.1.2 Grounding and Bonding

Ground and bond in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.2 MATERIALS AND SYSTEM COMPONENTS

Internal parts and components of system components, piping, piping components, and valves that could be exposed to fuel during system operation must not be constructed of zinc coated (galvanized) metal, brass, bronze, or other copper bearing alloys. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

2.2.1 Standard Products

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products; that are of a similar material, design and workmanship; and that have been in satisfactory commercial or industrial use for a minimum 2-years prior to bid opening. The 2-year period must include applications of the system components and materials under similar circumstances and of similar size. Materials and system components must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.[Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours, exclusive of the manufacturer's factory tests, can be shown.]

2.2.2 Nameplates

****

NOTE: In a salt water environment, substitute acceptable non-corroding metal such as, but not limited to, nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

Require melamine plastic nameplates for all NAVFAC projects. Also for NAVFAC projects, require nameplates to be associated or keyed to system charts and schedules.

****

Attach nameplates to all specified system components, thermometers, gauges, and valves defined herein. List on each nameplate the manufacturer's name, address, [contract number,] [acceptance date,] component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of [anodized aluminum] [stainless steel] [melamine plastic, 3 mm 0.125 inch thick, UV resistance, black with white center core, matte finish surface and square corners] [_____]. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 25 by 65 mm 1 by 2.5 inches. Lettering must be the normal block style with a minimum 6 mm 0.25 inch height. Accurately align all lettering on nameplates.[For plastic nameplates, engrave lettering into the white core.][Key the nameplates to a chart and schedule for each system. Frame charts and schedule under glass, and locate where directed near each system. Furnish two copies of each chart and schedule. Each nameplate description must identify its function.]

2.2.3 Flange Gaskets, Non-Electrically Isolating

ASME B16.21, composition ring, using a Nitrile Rubber such as Buna-N and NBR, or a fluoro rubber such as FKM, FPM and Viton©. The gasket must be 3 mm 0.1250-inch thick. Gaskets must be resistant to the effects of aviation and non-aviation hydrocarbon fuels and manufactured of fire-resistant materials. Use fluoro rubber gaskets for biofuel blend fluids. Full-face gaskets must be used for flat-face flanged joints. Ring gaskets must be used for raised-face flanged joints. Gaskets must be of one piece factory cut material. Select a gasket suitable for the working and test pressure of the fluid.

2.3 FLANGED END CONNECTIONS

2.3.1 Flanges

Provide flanged end connections on system components, fittings, piping, piping components, adapters, couplers,and valves that conform to ASME B16.5, Class 150.

2.3.1.1 Carbon Steel

Carbon steel flanges must conform to ASTM A105/A105M.

2.3.1.2 Stainless Steel

Stainless steel flanges must conform to ASTM A182/A182M, Grade F304, forged type.

2.3.1.3 Aluminum

Aluminum flanges must conform to ASTM B247, Alloy 6061-T6.

2.3.2 Insulating Flange Kits, (Electrically Isolating)

****

NOTE: Use in the following locations to avoid affecting the underground piping cathodic protection system:

a. Where piping transitions from aboveground to underground;

b. Below drain and vent valves in underground pits and valve vaults;

c. On both sides of motorized valves in underground valve vaults.

Provide weatherproof lightning surge arrester around insulating flange kits where piping transitions from aboveground to underground.

These gaskets are often installed to prevent corrosion between two flanges constructed of dissimilar metals such as carbon steel and stainless steel. Experience in even extremely corrosive marine environments shows them to be of little use in preventing flange to flange corrosion; the corrosion in those cases are usually the flange face and/or fasteners corroding to themselves. Before using to prevent flange to flange corrosion, contact Base personnel and try and determine what kind of corrosion they have and how severe it is.

Provide flange protectors where indicated and at cathodic protection insulating flanges.

****

Provide ASTM D229 electrical insulating material of 1,000 ohms minimum resistance or 500 Volts per mil (VPM) minimum dielectric strength; material must be resistant to the effects of aviation and non-aviation hydrocarbon fuels. Provide full face insulating gaskets between flanges with fluoroelastomer (FKM), commonly referred to as Viton, O-ring sealing surfaces. Provide full surface 0.76 mm 0.03-inch thick wall thickness, spiral-wound mylar insulating sleeves between the bolts and the holes in flanges; bolts may have reduced shanks of a diameter not less than the diameter at the root of threads. Provide 3.18 mm 0.125-inch thick high-strength phenolic insulating washers next to flanges and provide flat circular stainless steel washers over insulating washers and under bolt heads and nuts. Provide bolts 12 mm 0.5-inch longer than standard length to compensate for the thicker insulating gaskets and the washers under bolt heads and nuts. Above grade flanges separated by electrically insulating flange kits must be provided with weatherproof lightning surge arrester devices. The surge arrester must bolt across flanges separated by insulating gasket kits per detail on contract drawings. Provide with flange protector as described in this section. The arrestor must have the following features:

a. Weatherproof NEMA 6P enclosure.

b. Bidirectional and bipolar protection.

c. Constructed of solid state components, no lights, fuses or relays and used without required maintenance or replacement.

d. Withstand unlimited number of surges at 50,000 Amperes.

e. Maximum clamping voltage of 700 Volts based on a IEEE C62.41.2 8x20 microsecond wave form at 50,000 Amperes peak measured at the device terminals (zero lead length).

f. A UL listed arrester for installation in Class 1, Division 1 or Class 1, Division 2, Group D, hazardous areas.

Install the mounting bracket and leads on the flange side of the bolt insulating sleeve and washer, and size in accordance with this schedule:

Line Size	Bolt Size
50.8 mm 2 inch	16 mm 5/8 inch
63.5 mm 2.5 inch	16 mm 5/8 inch
76 mm 3 inch	16 mm 5/8 inch
102 mm 4 inch	16 mm 5/8 inch
152 mm 6 inch	19 mm 3/4 inch
203 mm 8 inch	19 mm 3/4 inch
254 mm 10 inch	22 mm 7/8 inch

305 mm 12 inch	22 mm 7/8 inch
356 mm 14 inch	25 mm 1 inch
406 mm 16 inch	25 mm 1 inch
Note: Make allowance for the 0.79 mm 1/32-inch thickness of the insulating sleeve around the bolts when sizing the mounting lugs.	

2.3.3 Flange Protectors

****

NOTE: Provide flange protectors at all cathodic protection insulating flanges to prevent from shorting out due to debris collecting in/on flange. Use stainless steel flange protector bands. Caution should be used when installing stainless steel bands to avoid "grounding out" the insulating flanges.

Use in tropics and waterfront locations for all size flanges to minimize/prevent water migration between the flange faces and prevent corrosion.

****

Protectors must protect the bolts, studs, nuts, and gaskets of a flanged end connection from corrosion or damage due to exposure to the environment. Protectors must be weather and ultraviolet (UV) resistant and constructed with stainless steel bands and rubber lining. Protectors must allow for quick and easy removal and re-installation by maintenance personnel. Provide grease filled bolt caps. Corrosion Prevention grease must be non-expansive and designed for the service.[Provide protectors that allow visual inspection of the flange gasket without requiring removal.][For electrically isolating flange connections, provide protectors with grease fittings that allow the injection of grease into the flange cavity.]

2.3.4 Fuel Piping Flange Bolts, Nuts, and Washers

a. Bolts and nuts for pipe flanges, flanged fittings, valves and accessories must conform to ASME B18.2.1 and ASME B18.2.2, except as otherwise specified.

b. Bolts must be of sufficient length to obtain full bearing on the nuts and must project no more than three full threads and no less than two full threads beyond the nuts with the bolts tightened to the required torque.

c. Bolts must be regular hexagonal bolts conforming to ASME B18.2.1 with material conforming to ASTM A193/A193M, Class 2, Grade B8, stainless steel, when connections are made where a stainless steel flange is involved, and Grade B7, chromium molybdenum alloy, when only carbon steel flanges are involved. Bolts and nuts chosen must have sufficient strength to seat gasket types chosen. Bolts must be threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch.

d. Nuts must conform to ASME B18.2.2, hexagonal, heavy series with material conforming to ASTM A194/A194M, Grade 8, stainless steel for stainless steel bolts, and Grade 7, chromium molybdenum allow for chromium molybdenum alloy bolts. Nuts must be threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch.

e. Provide washers under bolt heads and nuts. Use chromium molybdenum alloy washers dimensioned to ASTM F436 flat circular for chromium molybdenum bolts. Stainless steel washer dimensioned similar to ASTM F436 flat circular, use material the same as the bolt.

f. Use torque wrenches to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tighten in the pattern recommended by the gasket manufacturer. Use anti-seize compound on stainless steel bolts.

2.4 PIPE

****

NOTE: Indicate on the drawings all piping configurations, slopes, sizes, and piping materials (i.e. carbon steel, stainless steel, or double walled flexible piping) permitted for each piping system. Coordinate these requirements with UFC 3-460-01.

As stated in UFC 3-460-01, use threaded end connections only where unavoidable. Never require a threaded end connection to be direct buried. Specifically indicate the location of each threaded end connection on the drawings.

****

Pipe must meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein.

2.4.1 Carbon Steel Pipe

Provide carbon steel pipe that complies with one of the following:

a. Pipe must conform to ASTM A53/A53M, Type E or S, Grade B, seamless or electric welded. Pipe smaller than 65 mm 2-1/2 inches must be Schedule 80. Pipe 65 mm 2-1/2 inches and larger must be Schedule 40.

b. Pipe must conform to API Spec 5L, Product Specification Level (PSL) 1, Grade B, [submerged-arc welded or gas metal-arc welded] [seamless or electric welded].

End connections for pipe or fittings smaller than 65 mm 2-1/2 inches must be forged, socket weld type conforming to ASTM A182/A182M and ASME B16.11, unless indicated otherwise. End connections for pipe or fittings 65 mm 2-1/2 inches and larger must be buttweld type conforming to ASTM A234/A234M, Grade WPB and ASME B16.9 of the same wall thickness as the adjoining pipe.[Where threaded end connections are indicated, provide connections that conform to ASME B16.3, Class 150 or ASME B16.11.]

2.4.2 Stainless Steel Pipe

Provide stainless steel pipe that complies with one of the following:

a. Pipe must conform to ASTM A312/A312M, Type TP304L, seamless only. Pipe smaller than 200 mm 8 inches must be Schedule 40S. Pipe 200 mm 8 inches or larger must be Schedule 10S.

b. Pipe must conform to ASTM A358/A358M, Grade 304L, Class 1 or 3, longitudinally welded. Radiographically inspect 100 percent of factory longitudinal welds in accordance with ASME BPVC SEC VIII D1. Minimum pipe wall thickness must be 6 mm 0.25 inch for pipe 300 mm 12 inches and smaller; 8 mm 0.312 inch for pipe larger than 300 mm 12 inches.

2.4.2.1 Fittings 65 mm 2-1/2-inch and Larger

Provide buttwelded type fittings that complies with one of the following:

a. Stainless steel conforming to ASTM A403/A403M, Class WP-S, Grade WP 304L, seamless only and ASME B16.9 of the same thickness as the adjoining pipe.

b. Stainless steel conforming to ASTM A403/A403M, Class WP-XX, Grade WP 304L, of wall thickness as indicated. Do not fabricate starting material by the fusion welding process without addition of filler metal. Forming will not be allowed using fusion welding process without addition of filler metal. Radiographically inspect all factory longitudinal welds in accordance with ASME BPVC SEC VIII D1.

2.4.2.2 Fittings 50 mm 2-inch and Smaller

Socket welded type fittings, unless indicated otherwise, must conform to ASME B16.11. Fitting materials must be stainless steel that conforms to ASTM A182/A182M, Type F304L.

2.4.2.3 Control Tubing

Piping must be seamless, fully annealed stainless steel tubing conforming to ASTM A269/A269M, Grade TP316, with a hardness number not exceeding 80 HRB. For 15 mm 1/2-inch tubing, provide a minimum 1.3 mm 0.049 inch tubing wall thickness.

2.4.2.4 Control Tubing Fittings

Fittings must be the flareless, Type 316 stainless steel type conforming to SAE J514.

2.4.3 Flexible Non-Metallic Pipe

****

NOTE: Standard commercial service station piping used for a flow rate of 100 GPM or less.

****

Piping must conform to UL 971. Piping must be installed in manufacturers supplied corrugated, flexible, access piping. Size is limited to 76.2 mm 3-inch diameter or less. For piping larger than 76.2 mm 3 inches use the carbon steel piping system described in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

2.4.4 Double Wall Carbon Steel Piping

****
NOTE: Use this piping for a flow rate of greater than 100 GPM and if required by State or Local regulations.
****

Piping system must be of pre-engineered double-wall construction with both the internal pipe (primary product pipe) and the exterior pipe (containment pipe) of carbon steel. The exterior containment piping must allow for complete inspection of the primary piping before the exterior piping is sealed. The exterior piping for the secondary containment system for underground piping must be:

a. Pipe material must be carbon steel as specified.

b. Capable of withstanding a minimum 5 psi 35 kPa air pressure.

c. Evenly separated from the primary pipe using pipe spacers which are designed based on pipe size, pipe and fuel weight, and operating conditions. The supports must be constructed of non-metallic and non-conductive material and must be designed so that no point loading occurs on the primary or exterior pipe. The exterior piping and supports must allow for the installation of any necessary leak detection equipment or cables.

d. Externally coat primary product pipe and containment pipe as specified in Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEMS.

[2.4.5 Steel Reinforced Flexible Pipe

****
NOTE: Service Headquarters must approve use of HDPE steel reinforced flexible pipe. Do not use HDPE steel reinforced flexible pipe aboveground. Use this piping for a flow rate of greater than 100 GPM only.

The use of steel reinforced flexible pipe in lieu of traditional double-walled underground piping on projects in states that require double-walled underground piping needs to be coordinated between the system designer and the state agency that regulates underground piping. The test protocol to be used for testing the integrity of steel reinforced flexible pipe will need to be provided by the piping supplier and be accepted by the state regulatory agency as equivalent to the traditional double-walled underground piping test protocol required by that agency.
****

Steel Reinforced High Density Polyethylene (HDPE) flexible piping must be manufactured in accordance with API Spec 17J and consist of an inner layer of HDPE material, a steel reinforcing layer and an outer HDPE protective layer.

2.4.5.1 Steel Reinforced Flexible Pipe Fittings

End connections and mid-line connections for steel reinforced high density polyethylene (HDPE) flexible pipe must be of stainless steel swaged onto the pipe ends.

End connections must terminate in flanged end or weld ends as indicated. Mid-line connections must terminate in flanged fittings if they are in a pit or double swage type if they are not.

]2.4.6 Copper Piping

****

NOTE: Specify copper piping only for small fuel oil applications, lubricating oil applications, etc. Copper alloy piping materials must not be used within a boiler plant structure.

****

Pipe and tubing must conform to ASTM B88M ASTM B88, Type K or L.

2.4.6.1 Fittings and End Connections

Wrought copper and bronze solder-joint pressure fittings must conform to ASME B16.22 and ASTM B75/B75M. Cast copper alloy solder-joint pressure fittings must conform to ASME B16.18. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and system components. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.4.6.2 Solder

Solder must conform to ASTM B32, grade Sb5, tin-antimony alloy for service pressures up to 1034 kPa 150 psig. Solder flux must be liquid or paste form, non-corrosive and conform to ASTM B813.

2.4.6.3 Brazing Filler Metal

Filler metal must conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.5 PIPING COMPONENTS

Provide piping components that meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein. Pressure design class for piping components must be Class 150 as defined in ASME B16.5.

2.5.1 Welded Nipples

Nipples must conform to ASTM A733 or ASTM B687 and be constructed of the same material as the connecting pipe.

2.5.2 Steel Couplings

Couplings must conform to API Spec 5L, seamless, extra heavy, wrought steel with recessed ends.

2.5.3 Threaded Unions

****

NOTE: Avoid threaded unions if possible. Threaded unions may be used in certain aboveground applications if specifically indicated on the drawings. As stated previously, never required a threaded end connection to be direct buried. Typically, threaded end connections are only to be used on piping 50 mm 2 inches or less in size.

NOTE: Indicate the locations of each electrically isolating connection on the drawings.

****

Unions must conform to ASME B16.39, Class 150. Unions materials must conform to ASTM A312/A312M, Grade 304 or 316. Dielectric unions must conform to dimensional, strength, and pressure requirements of ASME B16.39, Class 150. Steel parts must be galvanized or plated. Union must have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, union must be able to withstand a 600-volt breakdown test.

2.5.4 Joint Compound

Joint compounds must be resistant to water and be suitable for use with fuel containing 40 percent aromatics.

2.5.5 Flexible Connector

****

NOTE: Identify on the drawings the nominal pipe size and required length for each flexible pipe connector. Connectors smaller than 65 mm 2-1/2 inches are typically not available with flanged end connections. If small connectors are required, specifically indicated the location of the threaded connections on the drawings.

****

Flexible connectors for fueling pumps must have ANSI Class 300 or 150 flanges to mate directly to the pump and Class 150 flanges to the system flanges. Flanges must be stainless steel and must conform to ASME B16.5. These units must have an inner stainless steel or Inconel, corrugated tube with external stainless steel braid, and all components must be rated for not less than 275 psig @ 100°F. Face by Face dimension must be as recommended by the manufacturer. Use Inconel 625 inner bellows in coastal environments or where chlorides are present in the atmosphere.

For sizes larger than 152 mm 6 inches, connectors must incorporate the use of Lo-corr, multi-ply bellows, without external braid, with bellows rating of 300 psig and overall rating consistent with the flange ANSI class. Flanges must be plate type, Vanstone design, with axial movement control rods.

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system. The use of flexible connectors in permanently mounted pump suction and discharge lines as a method of compensating for piping misalignment is not acceptable.

2.5.6 Strainer

****

NOTE: Duplex strainers have at least two basket or element chambers separated by a valve that permits continuous flow of fluid through one chamber while the other is accessible of cleaning.

****

Strainer must be single, basket type, arranged in a [simplex] [duplex] configuration as indicated in compliance with MIL-PRF-13789, except as specified otherwise. Strainer end connections must be designed in accordance with ASME B16.5, Class 150. Strainer body material must be the same as the material specified for manual valves. Strainers must have removable baskets of [7][40][60][100][_____] mesh wire screen with larger wire mesh reinforcement; wire must be stainless steel, Type 316. Pressure drop for clean strainer must not exceed 3 psig at maximum design flow rate. The ratio of net effective strainer area to the area of the connecting pipe must be not less than three to one. Each strainer must be provided with a suitable drain at the bottom, equipped with a ball valve. The strainer must be equipped with a direct-reading, piston type differential pressure gauge that measures the differential pressure across the basket as per Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.5.7 Thermometers

****

NOTE: Used for Burner Fuel Oils and Lubricating Oils that require heating before pumping. Indicate the scale range for each thermometer on the drawings.

****

Analog, dial-type bimetallic actuated type that conforms to ASME B40.200. Thermometer must have a 125 mm 5 inch diameter dial, a hermetically sealed stainless steel case, a stainless steel stem, a safety glass face, a fixed threaded connection, and a scale range as indicated. Thermometer accuracy must be within one percent of the scale range.

2.5.8 Pressure Gauge

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.5.9 Pipe Supports

****

NOTE: Indicate installation details (including anchorage and spacing) of all hangers on the drawings. Include applicable seismic zone design requirements.

****

Supports must be the adjustable type conforming to MSS SP-58, except as modified herein. Provide hot-dipped galvanized finish on rods, nuts, bolts, washers, hangers, and supports. [Provide Type 316 stainless steel nuts, bolts, washers, and screws when located under a pier.] Provide miscellaneous metal that conforms to ASTM A36/A36M, standard mill finished structural steel shapes, hot-dipped galvanized.

2.5.9.1 Pipe Protection Shields

Shields must conform to MSS SP-58, Type 40, except material must be Type 316 stainless steel. Provide shields at each slide type pipe hanger and support.

2.5.9.2 Low Friction Supports

Supports must have self-lubricating anti-friction bearing elements composed of 100 percent virgin tetrafluoroethylene polymer and reinforcing aggregates, prebonded to appropriate backing steel members. The coefficient of static friction between bearing elements must be 0.06 from initial installation for both vertical and horizontal loads and deformation must not exceed 51 micrometers 0.002 inch under allowable static loads. Bonds between material and steel must be heat cured, high temperature epoxy. Design pipe hangers and support elements for the loads applied. Provide anti-friction material with a minimum of 2.3 mm 0.09 inch thick. Provide hot-dipped galvanized steel supports. Provide supports that are factory designed and manufactured.

2.5.10 Escutcheon

Escutcheon must be the chrome plated, stamped steel, hinged, split ring type. Inside diameter must closely fit pipe outside diameter. Outside diameter must completely cover the corresponding floor, wall, or ceiling opening. Provided each escutcheon with necessary set screws.

2.5.11 Flexible Ball Joint

****

NOTE: Indicate the location and details of each pipe expansion joint, amount of pipe movement, and pipe anchors on the drawings.

****

Flexible ball joints must be [stainless steel] [carbon steel with electroless nickel-plating to a minimum of 3 mils thickness], capable of 360-degree rotation plus 15-degree angular flex movement, ASME B16.5, Class 150 flanged end connections. Provide either pressure molded composition, PEEK, or polytetrafluoroethylene (PTFM) gaskets designed for continuous operation temperature of 275 degrees F. Joints must be designed for minimum working pressure of ANSI Class 150. Injectable packing will not be allowed.

2.5.12 Bellows Expansion Joint

****

NOTE: Indicate the location and details of each pipe expansion joint, amount of pipe movement, and pipe anchors on the drawings.

Where joints are to be installed on piers or anywhere in direct contact with salt water is a possibility, then require the bellows to be constructed of inconel.

****

The expansion joints must be for axial compression and extension with capacity as per the design documents. Units must be[of the externally pressurized design with internal and external integral guides, and] manufactured by an Expansion Joint Manufacturers Association certified manufacturer. They must incorporate multi-ply, Lo-corr bellows of [ASTM A240/A240M 321-304 stainless steel][Inconel 625] if chlorides are present in the atmosphere. Unit must be equipped with travel limit stops, and internal guides vented to reduce the effects of sudden pressure changes. Flanges and housing must be stainless steel or carbon steel to match piping materials. Flanges must conform to ASME B16.5. Dual Expansion Joints must incorporate an intermediate anchor base. Housing must include lifting lug and drain port. Joints must be capable of 10,000 cycles over a period of 20-years.

Cold set joints to compensate for the temperature at the time of installation. Provide initial alignment guides on the connecting piping no more than 4 pipe diameters from the expansion joint. Provide additional alignment guides on the connecting piping no more than 14 pipe diameters from the first guide.

2.5.13 Flow Meter

****

NOTE: Flow meters are mandatory for all Air Force fuel oil projects. For each meter indicate the maximum flow rate to be metered as well as the allowable pressure drop at the maximum flow rate.

****

Provide volumetric positive displacement type meter that conforms to ASTM F1172, except as modified herein. Meter must indicate the fuel oil flow rate in L/s gpm. Meter must be provided with overspeed protection and a water escape hole. If meter is not mounted in-line with the piping, then an appropriate pedestal for mounting must be provided. Install meter in accordance with manufacturer's recommendations. Meter must be capable of providing a 4-20 mA analog output signal for the fuel flow rate.[The output signals must be compatible with the base's existing Energy Monitoring and Control, System (EMCS).]

2.6 MANUAL VALVES

****

NOTE: Per Service Headquarters or officially designated alternate for marine environment, provide stainless steel valves on exterior (aboveground and in pits) piping.

****

All portions of a valve coming in contact with fuel must be of noncorrosive material. Valves in stainless steel pipe lines or epoxy lined carbon steel pipe lines must be Type 304 or Type 316 stainless steel or carbon steel internally plated with chromium or nickel or internally electroless nickel plated. Valves in unlined carbon steel pipelines must have carbon steel body. Stem and trim must be stainless steel for all valves. Manually operated valves 150 mm 6 inches and larger must be worm-gear operated and valves smaller than 150 mm 6 inches must be lever operated or handwheel operated. Valves smaller than 50 mm 2 inches must have lever-type handles. Handles installed more than 1.5 m 6 feet above finished floor must have chain operators. Valve indicators installed higher than 5 feet must have a position indicator visible from ground level. Sprocket wheel for chain operator must be aluminum.

2.6.1 Ball Valves

Ball valves must be fire tested and qualified in accordance with the requirements of API Std 607 and API STD 608. Seal material for the fire test must be graphite, seal material for the project must be as indicated below. Ball valves must be nonlubricated valves that operate from fully open to fully closed with 90 degree rotation of the ball. Valves 2 inches and larger must conform to applicable construction and dimension requirements of API Spec 6D, ANSI Class 150 and must have flanged ends. Valves smaller than 50 mm 2 inches must be ANSI class 150 valves with flanged ends, unless noted otherwise. The balls in valves 250 mm 10 inches and larger full port and 300 mm 12 inch and larger regular port and larger must have trunnion type support bearings. Except as otherwise specified or indicated, reduced port or full port valves may be provided at the Contractor's option. Balls must be solid, not hollow cavity.

2.6.1.1 Materials

Ball must be stainless steel. Ball valves must have polytetrafluoroethylene (PTFM) or fluoroelastomer (FKM), commonly referred to as Viton seats, body seals and stem seals. Valves 100 mm 4 inches and smaller must have a locking mechanism.

2.6.1.2 V-Port Ball Valve

****

NOTE: Primarily used on Truck Offloading System to set minimum offload flow rate.

****

Valve must conform to requirements as specified for BALL VALVES paragraph in this section. Valve must be provided with characterized linear v-port for flow rate control, and with infinite position lever bracket with locking bolt for set position.

2.6.1.3 Electric Valve Actuator

Electric valve actuator must be as indicated for Plug (Double Block and Bleed) Valves, electric valve actuator.

2.6.2 Plug (Double Block and Bleed) Valves

API Spec 6D, API Spec 6FA, ANSI Class 150, non-lubricated, resilient, double seated, trunnion mounted, tapered lift plug capable of two-way shutoff. Valve must have tapered plug of steel or ductile iron with chrome or nickel plating and plug supported on upper and lower trunnions. Sealing slips must be steel or ductile iron, with Viton seals which are held in place by dovetail connections. Valve design must permit sealing slips to be replaced from the bottom with the valve mounted in the piping. Valves must operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves must have weatherproof operators with mechanical position indicators. Indicator shaft must be stainless steel. Minimum bore size must be not less than 65 percent of the internal cross sectional area of a pipe of the same nominal diameter unless bore height of plug equals the nominal pipe diameter and manufacturer can show equal or better flow characteristics of the reduced bore size design.

2.6.2.1 Valve Operation

Rotation of the handwheel toward open must lift the plug without wiping the seals and retract the sealing slips so that during rotation of the plug clearance is maintained between the sealing slips and the valve body. Rotation of the handwheel toward closed must lower the plug after the sealing slips are aligned with the valve body and force the sealing slips against the valve body for positive closure. When valve is closed, the slips must form a secondary fire-safe metal-to-metal seat on both sides of the resilient seal. Plug valves located in Isolation Valve Pits or vaults must be provided with handwheel extensions.

2.6.2.2 Integral Cavity Valves

ANSI Class 150. Provide plug valves with automatic thermal relief valves to relieve the pressure build up in the internal body cavity when the plug valve is closed. Relief valves must open at 172 kPa 25 psi differential pressure and must discharge to the throat of, and to the upstream side, of the plug valve.

2.6.2.3 Bleed Valves

ANSI Class 150, stainless steel body valve. Provide manually operated bleed valves that can be opened to verify that the plug valves are not leaking when in the closed position.

2.6.2.4 Electric Valve Actuator

****

NOTE: Maximum available temperature ranges for a regular actuator is minus 30 degrees C to 70 degrees C minus 22 degrees F to 158 degrees F. A lower temperature rating than that will result in an actuator encapsulated in insulation making access to manual controls and the handwheel difficult.

****

The actuator, controls and accessories must be the responsibility of the valve-actuator supplier for sizing, assembly, certification, field-testing and any adjustments necessary to operate the valve as specified. The electric valve actuator must include as an integral unit the electric motor, actuator unit gearing, limit switch gearing, position limit switches, torque switches, drive bushing or stem nut, declutch lever, wiring terminals for power, remote control indication connections and handwheel. The electrically actuated plug valve must be set to open and close completely in 30 to 60 seconds against a differential pressure of 275 PSIG. The actuator settings of torque and limit contacts must be adjustable. The valve actuator must be suitable for mounting in a vertical or horizontal position and be rated for 30 starts per hour. The valve actuator must be capable of functioning in an ambient environment temperature ranging from minus 30 degrees C to 70 degrees C [minus 22 to 158] [_____] degrees F.

a. The electrical enclosure must be specifically approved by UL or Factory Mutual for installation in Class I, Division 1, Group D locations.

b. The electric motor must be specifically designed for valve actuator service and must be totally enclosed, non-ventilated construction. The motor must be capable of complete operation at plus or minus 10 percent of specified voltage. Motor insulation must be a minimum NEMA Class F. The motor must be a removable subassembly to allow for motor or gear ratio changes as dictated by system operational requirements. The motor must be equipped with an embedded thermostat to protect against motor overload and also be equipped with space heaters. It must de-energize when encountering a jammed valve.

c. The reversing starter, control transformer and local controls must be integral with the valve actuator and suitably housed to prevent breathing or condensation buildup. The electromechanical starter must be suitable for 30 starts per hour. The windings must have short circuit and overload protection. A transformer, if needed, must be provided to supply all internal circuits with 24 VDC or 110 VAC may be used for remote controls.

d. The actuator gearing must be totally enclosed in an oil-filled or grease-filled gearcase. Standard gear oil or grease must be used to lubricate the gearcase.

e. The actuator must integrally contain local controls for Open, Close and Stop and a local/remote three position selector switch: Local Control Only, Off, and Remote Control plus Local Stop Only. A metallic handwheel must be provided for emergency operation. The handwheel drive must be mechanically independent of the motor drive. The remote control capability must be to open and close. Rim pull to operate valve manually must not exceed 36 kg 80 pounds.

f. Position limit switches must be functional regardless of main power failure or manual operation. Four contacts must be provided with each selectable as normally open or normally closed. The contacts must be rated at 5A, 120 VAC, 30 VDC.

g. Each valve actuator must be connected to a PLC supplied by "others".

h. The actuator must have a local display of position even when power has been lost.

i. The actuator must be supplied with a start-up kit comprising installation instruction, electrical wiring diagram and spare cover screws and seals.

j. The actuator must be performance tested and a test certificate must be supplied at no extra charge. The test should simulate a typical valve load with current, voltage, and speed measured.

2.6.3 Swing Type Check Valves

****

NOTE: Swing Type Check Valves are limited to 50 mm 2 inch size and below. These valves are used in underground PRT fill line.

****

Swing check valves must conform to API STD 600, regular type, ANSI Class 150 with flanged end connections. Discs and seating rings must be renewable without removing the valve from the line. The disc must be guided and controlled to contact the entire seating surface.

2.6.4 Wafer Type Check Valve

Spring assisted, wafer/tapped lug pattern, butterfly check or globe type with FKM or PTFE seat ring, designed to prevent flow reversal slamming of valve, dual plate, and must conform to ASME B16.34, API Std 594, except face to face dimensions may deviate from standard. Valves must be suitable for installation in any orientation. Valve body and trim material must be as previously indicated herein.

2.6.5 Globe Valve

Valve must conform to ASME B16.34, Class 150.

2.6.6 Thermal Relief Valve

****

NOTE: Indicate on the drawings the operating pressure required for each valve. Thermal relief valves will typically be placed down stream of control valves to relieve the pressure buildup created when the control valve is closed. Relief valves are also used to relieve possible thermal expansion in a pipe line if no other provisions exist.

****

2.6.6.1 Valve Materials

Valves must have carbon steel bodies (stainless steel on stainless steel pipelines) and bonnets with stainless steel springs and trim. Valves must be Class 150 flanged end connections.

2.6.6.2 Thermal Relief Valve (ASME Type)

Thermal relief valves must be the fully enclosed, spring loaded, angle pattern, single port, hydraulically operated type with plain caps, and must be labeled in accordance with ASME BPVC (GPM). Valve stems must be fully guided between the closed and fully opened positions. The valves must be factory-set to open at pressures indicated on the drawings. Operating pressure must be adjustable by means of an enclosed adjusting screw. The valves must have a minimum capacity of 20 GPM at 10 percent overpressure. Valves must have a replaceable seat. Relief valves that do not relieve to a zone of atmospheric pressure or tank must be a balanced type relief valve.

2.6.6.3 Thermal Relief Valve (Balanced Type)

Thermal relief valves that do not relieve to a zone of atmospheric pressure or atmospheric tank must be a balanced type relief or regulator valve.

Thermal relief valves must be the fully enclosed, spring loaded, angle pattern, single port, fully balanced type (back pressure must not affect relief pressure) back pressure regulator/relief valve. Set valve at pressure indicated on drawings. Valve body must have 25 mm one inch (minimum) raised face flange connections unless otherwise indicated. Orifice must have a minimum orifice size of 15 millimeter .500 inch in diameter. Valve must have bubble-tight piston and seat design with stainless steel piston and Viton seat. Valve must be selected for the nominal flow condition of: pass a minimum of [18] liters per minute [5] gallons per minute, at a differential pressure of [380] kPa [55] psig, with a nominal set pressure of [345] kPa [50] psig. Valve must be factory configured to open at required set pressure but must be field adjustable by means of an enclosed adjusting screw.

2.6.7 Pressure\Vacuum Relief Valve

****

NOTE: Provide the aboveground termination point of a storage tank's vent piping with either a pressure\vacuum relief valve or a vent cap. The decision on which item to use will be based upon the characteristics of the fuel to be handled (refer to NFPA 30, 30A, and UL 142 as applicable). Indicate on the drawings the pressure and vacuum settings that each valve will be required to operate. A valve's typically operating pressure is 5.2 kPa 12 oz per in^2. A valves's typical operating vacuum is 215 Pa 0.5 oz per in^2.

****

Valve must be the pressure\vacuum vent relief type that conforms to NFPA 30. Valve pressure and vacuum relief settings must be set at the factory. Pressure and vacuum relief must be provided by a single valve. Valve body must be constructed of either cast steel or aluminum. Valve trim must be stainless steel. Inner valve pallet assemblies must have a knife-edged drip ring around the periphery of the pallet to preclude condensation collection at the seats. Pallet seat inserts must be of a material compatible with the fuel specified to be stored. Valve intake must be covered with a 40 mesh stainless steel wire screen.

2.6.8 Foot Valve

****

NOTE: Foot valves are most commonly used in conjunction with small underground storage tanks and remote pumping systems (e.g., the pump is not located within the tank). The function of the valve is to hold prime in the suction line following a pump shutdown. Foot valves are typically located at the termination of the suction line within a tank.

****

Valve must be the self-activating, double-poppet, shutoff type that prevents fuel flow from reversing. Valve must conform to NFPA 30. Valve body must be constructed of either cast steel or aluminum. Valve must be provided with a minimum 20 mesh stainless steel screen on the intake. Valve seats must be the replaceable type. Valve must be capable of passing through a 75 mm 3 inch pipe or tank flange.

2.6.9 Tank Overfill Prevention Valve (Gravity Fill)

****

NOTE: Specify these valves only in combination with a gravity unloading system that feeds an underground storage tank. Do not specify these valves in combination with any type of unloading pump (including truck mounted pumps). Do not specify

these valves in conjunction with aboveground storage tanks.

****

Valve must be the two-stage, float-activated, shutoff type that is an integral part of the drop tube used for gravity filling. The first stage must restrict the flow of fuel into the tank to approximately 0.3 L/s 5 gpm when the liquid level rises above 87.5 percent of tank capacity. The second stage must completely stop the flow of fuel into the tank when the liquid level rises above 92.5 percent of tank capacity. Valve must be constructed of the same material as the fill tube.

2.6.10 Tank Overfill Prevention Valve (Pumped Fuel Receipt)

****

NOTE: Specify these valves when used for pressure filled tanks (e.g.in combination with any type of unloading pump that feeds an aboveground storage tank). For aboveground storage tanks, set the overfill valve to actuate at 96.5 percent tank volume. Refer to DoD Military Service Station and Factory Fabricated Tank Standard, STD 123-335-03.

****

Valve must be the two-stage, float-activated, shutoff type that is an integral part of the drop tube used for pressurized fill systems. The valve must completely stop the flow of fuel into the tank, when the liquid level rises above [96.5 percent][_____] of tank capacity. Valve must be constructed of the same material as the fill tube.

2.6.11 Anti-Siphon Valves

2.6.11.1 Solenoid Controlled Anti-Siphon Ball Valve

Anti-siphon valves must be solenoid controlled, normally closed, spring loaded valves. Solenoid must be housed in an integral, watertight, explosion proof housing and suitable for installation in Class I, Division I hazardous area locations. Valve body and trim material must be as previously indicated herein.

2.6.11.2 Anti-Siphon Valve

Anti-siphon valves must be normally closed, spring loaded, angle pattern type valves. Valves must be suitable for installation in any orientation and compatible with suction or pressurized systems. Valve must be UL listed. Valve body and trim material must be as previously indicated herein.

2.7 PUMPS

****

NOTE: Indicate the control sequences for pumps on the drawings.

****

2.7.1 Submersible Pump

****

NOTE: Delete this paragraph if dispenser suction

pumps are used in place of submersible pumps. Submersible pumps may be used for both above and belowground tanks. Check manufacturer's data since these type pumps may only be capable of handling gasoline or diesel fuels.
****

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.7.2 ANSI Type Centrifugal Pump

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.7.3 Sliding Vane Rotary Pump

****
NOTE: Specify sliding vane rotary pumps for fuel oil applications, lubricating oil applications, etc. Maximum suction lift for rotary pump will not exceed 34 kPa 10 inches Hg.
****

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.7.4 Self-priming Centrifugal Pump

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.7.5 Pump Control Panel

Panel must include on and off indication lights for each pump. Panel must contain an adjustable control logic for pump operation in accordance with the indicated operation. Panel must also have a manual override switch for each pump to allow for the activation or deactivation of each pump. See Section 33 09 52 FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT).

2.8 FRP CONTAINMENT SUMP

See Section 33 57 55 FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT).

2.9 ACCESSORIES

2.9.1 Concrete Anchor Bolts

Concrete anchors must conform to ASTM A307, Grade C, hot-dipped galvanized.

2.9.2 Bolts and Studs

Carbon steel bolts and studs must conform to ASTM A307, Grade B, hot-dipped galvanized. Stainless steel bolts and studs must conform to ASTM A193/A193M, Class 2, Grade 8.

2.9.3 Nuts

Carbon steel nuts must conform to ASTM A563, Grade A, hex style, hot-dipped galvanized. Stainless steel nuts must conform to ASTM A194/A194M, Grade 8.

2.9.4 Washers

Provide flat circular washers under each bolt head and each nut. Washer materials must be the same as the connecting bolt and nut. Carbon steel washers must conform to ASTM F844, hot-dipped galvanized. Stainless steel washers must conform to ASTM A194/A194M, Grade 8.

2.9.5 Polytetrafluoroethylene (PTFE) Tape

Tape must conform to ASTM D3308.

2.9.6 Pipe Sleeves

Provided sleeves constructed of [hot-dipped galvanized steel, ductile iron, or cast-iron pipe] [uncoated carbon steel pipe, conforming to ASTM A53/A53M, [Schedule 30] [Schedule 20] [Standard weight]].

2.9.7 Buried Utility Tape

Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape in minimum 75 mm 3 inches width rolls, color coded for the utility involved, with warning identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning identification must be at least 25 mm one inch high and must state as a minimum "BURIED JET FUEL PIPING BELOW". Provide permanent code and letter coloring that is unaffected by moisture and other substances contained in trench backfill material.

2.9.8 Pipeline Markers

Provide pipeline markers constructed of 150 mm 6 inches diameter, one-half inch thick bronze disk with a 75 mm 3 inch long bronze headed bolt welded to the back of the disk. Engrave the front of the disk with the words "UNDERGROUND FUEL LINE" in the case of one line and "UNDERGROUND FUEL LINES" in the case of multiple fuel lines.

2.10 FINISHES

Ship, store, and handle coating materials as well as apply and cure coatings in accordance with SSPC PA 1.

2.10.1 Exterior Coating, Direct Buried Piping

2.10.1.1 Factory Coating

Provide direct buried pipe and piping components with a factory-applied, adhesive undercoat and continuously extruded plastic resin coating in accordance with NACE SP0185 or AWWA C215; minimum thickness of plastic resin must be 36 mils for pipe sizes 150 mm 6 inches and larger.

2.10.1.2 Girth Welds

Coat girth welds using one of the following processes.

a. Heat shrink sleeves in accordance with AWWA C216.

b. Wax tape coatings in accordance with AWWA C217.

c. Cold applied tape coatings in accordance with AWWA C209.

2.10.1.3 Damaged Coatings

Repair damaged coating areas using one of the following processes.

a. Wax tape coatings in accordance with AWWA C217.

b. Cold applied tape coatings in with AWWA C209.

2.10.1.4 Rock Shield

****

NOTE: Specify rock shields where select fill is not available and the possibility of damage from rock fill exists. Delete this paragraph if not applicable.

****

Provide a minimum 10 mm 3/8 inch thick perforated rock shield around buried piping. Rock shield must consist of a polyethylene outer surface bonded to a closed cell foam substrate with uniform perforations intended for use with cathodic protection systems. Rock shield must overlap on itself no less than 150 mm 6 inches. Secure rock shield tightly to the pipe using either strapping tape or plastic ties. Air filled cell type rock shields are prohibited.

2.10.2 Exterior Coating, Aboveground Piping

****

NOTE: Piping identification as required by the using agency will be developed and inserted in either Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES or Section 09 90 00 PAINTS AND COATINGS as applicable.

For Air Force Installations, piping will be color-coded in accordance with Attachment 4 of AFM 88-15.

Specify exterior, aboveground coatings per Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES if SSPC QP 1 contractor certification is required for any other coatings on the project. Specify Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES if more than 500 square feet of piping is to be coated. Section 09 90 00 PAINTS AND COATINGS may be specified for other situations. If Section 09 90 00 PAINTS AND COATINGS is specified, consider choosing the option for the contractor to be certified to SSPC QP 1, as certified contractors are likely to have more experience working around fuel facilities.

****

Coat the exterior of aboveground steel piping, flanges, fittings, nuts, bolts, washers, valves, and piping components, as defined in this specification, in accordance with [Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES][Section 09 90 00 PAINTS AND COATINGS].

2.10.3 New System Components

2.10.3.1 Factory Coating

****

NOTE: For all Navy projects (regardless of location), the 500 hour salt spray test is required and must be specified.

For Army projects, a salt spray test is optional. The 125 hour test is suggested for mild or noncorrosive environments. The 500 hour test is suggested for extremely corrosive environments.

****

Unless otherwise specified, provide system components fabricated from ferrous metal with the manufacturer's standard factory finish.[Each factory finish must withstand [125] [500] hours exposure to the salt spray test specified in ASTM B117. For test acceptance, the test specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark immediately after completion of the test.] For system component surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory coating must be appropriately designed for the temperature service.

2.10.3.2 Field Painting

****

NOTE: Specify exterior, aboveground coatings per Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES if SSPC QP 1 contractor certification is required for any other coatings on the project. If Section 09 90 00 PAINTS AND COATINGS is specified, consider choosing the option for the contractor to be certified to SSPC QP 1, as certified contractors are likely to have more experience working around fuel facilities.

****

Painting required for surfaces not otherwise specified must be field painted as specified in [Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES][Section 09 90 00 PAINTS AND COATINGS]. Do not paint aboveground stainless steel and aluminum surfaces. Do not coat system components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Show belowground valves, flanges, air vents and drains to be installed in a containment sump or manhole as required. Never require these items to be direct buried.

During design, layout system components to allow for adequate access for routine maintenance. Do not

rely solely on the Contractor to make these judgments. Show access doors where applicable for maintenance.

Indicate all steel reinforced flexible pipe connection points on the drawings.
****

Installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.3 and NFPA 30, except as modified herein. Safety rules as specified in NFPA 30 must be strictly observed. Never direct bury threaded connections, socket welded connections, unions, flanges, valves, air vents, or drains. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

3.1.1 Pumps

Properly level, align, and secure pumps in place in accordance with manufacturer's instructions. Support, anchor, and guide so that no strains are imposed on a pump by weight or thermal movement of piping.[Provide floor-mounted pumps with mechanical vibration isolators or a vibration isolation foundation.]

3.1.2 Piping

****
NOTE: For belowground piping, indicate on the drawings the minimum required piping slope for each piping run (suggest using 25 mm per 15 m 1 inch per 50 feet.
****

3.1.2.1 General

Thoroughly clean pipe of all scale and foreign matter before the piping is assembled. Cut pipe accurately to measurements established at the jobsite, and worked into place without springing or forcing. Cut pipe square and have burrs removed by reaming. Install pipe to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval.

a. Use reducing fittings for changes in pipe sizes. Install system components and piping into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Provide electric isolation fittings between dissimilar metals. Install piping straight and true to bear evenly on supports. Piping must be free of traps, must not be embedded in concrete pavement, and must drain as indicated. Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted.

b. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. When work is not in progress, securely close open ends of pipe and fittings with an expandable pipe plug so that water, earth, or other substances cannot enter the pipe or fittings. For belowground piping, the full length of each pipe must rest solidly on the underlying pipe bed.

3.1.2.2 Double-Wall Flexible Non-Metallic Piping

Install double-wall flexible non-metallic piping in accordance with manufacturer's instructions.

3.1.2.3 Pipeline Markers

Provide above underground fuel piping spaced every 90 meters 300 feet, at tees, and at changes in direction. For sections of underground piping less than 90 meters 300 feet long, place at midpoint. Provide directly above pipe for single lines and between pipes where pipes run in pairs. Provide additional marker over each mid-line fitting connections for steel reinforced flexible pipe. Cast marker into 457 mm 18-inch diameter, 305 mm 12-inch thick concrete plug unless it is set in an area with concrete paving in which case it must be cast into the concrete paving.

3.1.2.4 Steel Reinforced Flexible Pipe

****

NOTE: Steel reinforced flexible pipe comes in reels. To the extent possible, design piping system such that the entire length of underground piping can be accommodated with one reel.

****

Connections between steel pipe and steel reinforced flexible pipe and between separate lengths of steel reinforced flexible pipe must not be made aboveground but must be made either inside a pit or vault, or direct bury them. Where practicable, end-line and mid-line connections must be located inside pit type enclosures of an appropriate size. Where it is not practicable to locate mid-line connections inside pit type enclosures, mid-line connections may be wrapped with a suitable waterproof protective substance and direct buried underground. The location of direct buried mid-line connections must be indicated on the final drawings and provided with a pipeline marker.

3.1.2.5 Welded Connections

Unless otherwise indicated on the drawings, pipe joints must be welded. Construct branch connections with welding tees or forged welding branch outlets. Do not weld stainless steel pipe to carbon steel pipe.

3.1.2.6 Threaded End Connections

****

NOTE: As stated previously, avoid threaded end connections if possible. Threaded end connections may be used in certain aboveground applications if specifically indicated on the drawings. As stated previously, never required a threaded end connection to be direct buried.

****

Provide threaded end connections only on piping 50 mm 2 inches in nominal size or smaller and only where indicated on the drawings. Provide threaded connections with PTFE tape or equivalent thread-joint compound applied to the male threads only. Not more than three threads must show after the joint is tighten.

3.1.2.7 Brazed Connections

Provide brazing in accordance with AWS BRH, except as modified herein. During brazing, fill pipe and fittings with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, clean both the outside of the tube and the inside of the fitting with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Remove surplus brazing material at all joints. Support piping prior to brazing and do not be spring or force piping.

3.1.2.8 Existing Piping Systems

****

NOTE: Delete this paragraph if connections to existing piping systems are not required. Indicate on the drawings the approximate location of each connection point between new and existing piping systems.

****

No interruptions or isolation of an existing fuel handling service or system must be performed unless the actions are approved by the Contracting Officer. Perform initial cutting of existing fuel pipe with a multiwheel pipe cutter, using a nonflammable lubricant. After cut is made, seal interior of piping with a gas barrier plug. Purge interior of piping with carbon dioxide or nitrogen prior to performing any welding process.

3.1.3 Bolted Connections

For each bolted connection of stainless steel components (e.g., pipes, piping components, valves, and system components) use stainless steel bolts or studs, nuts, and washers. For each bolted connection of carbon steel components, use carbon steel bolts or studs, nuts, and washers. Bolts to project no more than three full threads and no less than two full threads beyond the nuts with the bolts tightened to the required torque. Prior to installing nuts, apply a compatible anti-seize compound to the male threads.

3.1.4 Flanges and Unions

Except where threaded end connections [and][or] unions are indicated, provide flanged joints in each line immediately preceding the connection to a system component or material requiring maintenance such as pumps, general valves, control valves, strainers, and other similar items and as indicated. Assemble flanged joints square and tight with matched flanges, gaskets, and bolts. For flanges, provide washers under each bolt head and nut. Torque wrenches must be used to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tightening pattern must be as recommended by the gasket manufacturer. Use anti-seize compound on threads for stainless steel bolts.

3.1.5 Flange Protectors

****

NOTE: See Note on FLANGE PROTECTORS paragraph in this section.
****

Provide flange protectors [on each electrically isolating flange connection][on each flanged end connection, including valves and system components][where indicated on the drawings].[Fill the flange cavity of electrically isolating flange connections with corrosion inhibitor type grease.] Provide grease filled bolt caps. Caution should be used when installing stainless steel bands to avoid "grounding out" the insulating flanges.

3.1.6 Valves

Install isolation plug or ball valves on each side of each system component, at the midpoint of looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Install valves with stems vertically up unless otherwise indicated. Provide individual supports and anchors for each valve.

3.1.7 Air Vents

Provide [_____] [40 mm] [1-1/2 inches] air vents at all high points and where indicated to ensure adequate venting of the piping system.

3.1.8 Drains

Provide [_____] [50 mm] [2 inches] drains at all low points and where indicated to ensure complete drainage of the piping. Drains must by schedule 120.Drains must be accessible, and must consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.9 Bellows Expansion Joints

Cold set joints to compensate for the temperature at the time of installation. Provide initial alignment guides on the connecting piping no more than 4 pipe diameters from the expansion joint. Provide additional alignment guides on the connecting piping no more than 14 pipe diameters from the first guide.

3.1.10 Thermometers

Provide thermometers with separable sockets. Install separable sockets in pipe lines in such a manner to sense the temperature of flowing fluid and minimize obstruction to flow.

3.1.11 Pipe Sleeves

Provide a pipe sleeve around any pipe that penetrates a wall, floor, or crosses under a roadway. Do not install sleeves in structural members except where indicated or approved. Install pipe sleeves in masonry structures at the time of the masonry construction. Sleeves must be of such size as to provide a minimum of 12 mm 1/2 inch all-around clearance between bare pipe and the sleeve. Align sleeve and piping such that the pipe is accurately centered within the sleeve by a nonconductive centering element. Securely anchor the sleeve to prevent dislocation. Closure of the space between the pipe and the pipe sleeve must be by means of a mechanically adjustable segmented elastomeric seal. The seal must be installed so as to be flush. For wall or floor penetrations, extend each sleeve through its respective wall or floor and cut flush with each surface. For roadway crossings, pipe sleeves must be continuous for the entire crossing as well as extend a minimum of 150 mm 6 inches beyond both sides of the crossing. Seal around sleeves that penetrate through valve or fuel related pits with a Buna-N casing seal. Seal around sleeves that penetrate through non-fire-rated walls and floors in accordance with Section 07 92 00 JOINT SEALANTS. Seal around sleeves that penetrate through fire-rated walls and floors as specified in Section 07 84 00 FIRESTOPPING.

3.1.12 Escutcheons

Except for utility or equipment rooms, provide finished surfaces where exposed piping pass through floors, walls, or ceilings with escutcheons. Secure escutcheon to pipe or pipe covering.

3.1.13 Access Panels

Provide access panels for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels must be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.1.14 Buried Utility Tape

Bury tape with the printed side up at a depth of 300 mm 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

3.1.15 Framed Instructions

Framed instructions must include system components layout, wiring and control diagrams, piping, valves, control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. Frame under glass or laminated plastic the framed instructions and post where directed by the Contracting Officer. Post the framed instructions before the system performance tests.

3.2 PIPE SUPPORTS

Install supports with a maximum spacing as defined in Table 1 below, except where indicated otherwise. In addition to meeting the requirements of Table 1, provide additional supports where concentrated piping loads exist (e.g., valves).

Table 1. Maximum Support Spacing

Nominal Pipe Size (mm) (Inches)	25 One and Under	40 1.5	50 2	80 3	100 4	150 6	200 8	250 10	300 12

Table 1. Maximum Support Spacing

Maximum Support Spacing (m) (ft)	2 7	2.75 9	3 10	3.5 12	4.25 14	5 17	5.75 19	6.50 22	7 23

3.2.1 Seismic Requirements

****

NOTE: Include applicable seismic design requirements on the drawings. Delete this paragraph if there are no specific seismic design requirements.

****

Support and brace piping and attach valves to resist seismic loads as specified under Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT[and Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS] and as shown on the drawings. Structural steel required for reinforcement to properly support piping, headers, and system components but not shown must be provided under this section. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.2.2 Structural Attachments

Provide attachments to building structure concrete and masonry by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Apply inserts and anchors with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead applications of ferrous materials only. Structural steel brackets required to support piping, headers, and system components, but not shown, must be provided under this section. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.3 FIELD QUALITY CONTROLS

3.3.1 System Commissioning

System commissioning must conform to Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

3.3.2 Tests

Furnish labor, materials, equipment, electricity, repairs, and retesting necessary for any of the tests required herein. Perform piping test in accordance with the applicable requirements of ASME B31.3 except as modified herein. To facilitate the tests, various sections of the piping system may be isolated and tested separately. Where piping sections terminate at flanged valve points, close the line by means of blind flanges in lieu of relying on the valve. Provide tapped flanges to allow a direct connection between the piping and the air compressor [and][or] pressurizing pump. Use tapped flanges for gauge connections. Taps in the permanent line will not be permitted. Gauges will be subject to testing and approval. Provide provisions to prevent displacement of the piping during testing. Keep personnel clear of the piping during pneumatic testing. Only authorized personnel must be permitted in the area during pneumatic and hydrostatic testing. Isolate system components such as pumps, tanks and meters from the piping system during the testing. Do not exceed the pressure rating of any component in the piping system during the testing. Following satisfactory completion of each test, relieve the test pressure and seal the pipe immediately. Piping to be installed underground must not receive field applied exterior coatings at the joints or be covered by backfill until the piping has passed the final pneumatic tests described herein.

3.3.2.1 Exterior Coating Holiday Test

Following installation, test the exterior coating of direct buried piping for holidays using high-voltage spark testing in accordance with NACE SP0188. Repair holidays and retest to confirm holiday-free coating. Text must include all existing underground piping exposed for this project.

3.3.2.2 Preliminary Pneumatic Test

Apply a 170 kPa 25 psig pneumatic test to product piping. Maintain the pressure while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). If leaks are discovered, repair the leaks accordingly and retest.

3.3.2.3 Final Pneumatic Test

Following the preliminary pneumatic test, apply a 345 kPa 50 psig pneumatic test to all product piping and hold for a period not less than 2-hours. During the test period, there must be no drop in pressure in the pipe greater than that allowed for thermal expansion and contraction. Disconnect the pressure source during the final test period. If leaks are discovered, repair the leaks accordingly and retest.

3.3.2.4 Hydrostatic Test

****

NOTE: Pressure testing of new Mogas, Avgas, and JP-4 pipelines must be with water.

****

Testing must comply with the requirements in ASME B31.3, except as modified herein. Hydrostatically test product piping with the fuel to be handled to the lesser of 1-1/2 times operating pressure or 1896 kPa 275 psig in accordance with API RP 1110. Maintain the pressure within the piping for 4-hours with no leakage or reduction in gauge pressure. If leaks are discovered, repair the leaks accordingly and retest.

3.3.2.5 Exterior Containment Piping Tests

****

NOTE: Delete this paragraph if exterior containment piping is not specified.

****

Apply a minimum pneumatic pressure of 35 kPa 5 psig to the exterior containment piping. Maintain the pressure for at least 1-hour while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). Repair leaks discovered in accordance with manufacturer's instructions and retest. Perform testing in compliance with the manufacturer's published installation instructions.

3.4 SYSTEM PERFORMANCE TESTS

****

NOTE: If applicable, edit Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT) to include the following.

a. Verify vent piping is clear of debris and each pressure/vacuum relief vent is operating properly.

b. Vapor recovery systems performs as designed.

c. Dispensing units are operational and performs as designed.

****

Conform tests to Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

3.5 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components and specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components/systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of [_____] hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-33 52 23.15 (November 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 52 90.00 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-33 52 23.15 (November 2018)**

Preparing Activity: NAVFAC **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 52 23.15

POL SERVICE PIPING WELDING
11/18

****

NOTE: This guide specification covers the requirements for welding of piping and piping system components used for petroleum, oil and lubricants (POL) under pressure, including modification to existing hydrant fueling systems.

The following guidance is offered the designer. ASME B31.3 - Process Piping.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC V	(2017) BPVC Section V-Nondestructive Examination

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0M/A3.0	(2025) Standard Welding Terms and Definitions
AWS A5.1/A5.1M	(2025) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS A5.3/A5.3M	(2023) Specification for Aluminum and Aluminum-Alloy Electrodes for Shielded Metal Arc Welding
AWS A5.4/A5.4M	(2012; R 2022) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
AWS A5.9/A5.9M	(2022) Welding Consumables-Wire Electrodes, Strip Electrodes, Wires, and Rods for Arc Welding of Stainless and Heat

	Resisting Steels- Classification
AWS A5.10/A5.10M	(2023) Welding Consumables - Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys - Classification
AWS A5.18/A5.18M	(2023) Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding
AWS A5.22/A5.22M	(2024) Specification for Stainless Steel Flux Cored and Metal Cored Welding Electrodes and Rods
AWS A5.32/A5.32M	(2021) Welding Consumables-Gases and Gas Mixtures for Fusion Welding and Allied Processess
AWS C5.5/C5.5M	(2003) Recommended Practices for Gas Tungsten Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D10.4	(1986; R 2000) Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing
AWS D10.7/D10.7M	(2008) Guide for the Gas Shielded Arc Welding of Aluminum and Aluminum Alloy Pipe
AWS D10.10/D10.10M	(2021) Recommended Practices for Local Heating of Welds in Piping and Tubing
AWS D10.11M/D10.11	(2007) Guide for Root Pass Welding of Pipe Without Backing
AWS D10.12M/D10.12	(2000) Guideline for Welding Mild Steel Pipe
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors
AWS WHB-4.9	(2010) Welding Handbook, Volume 4 - Materials and Applications Part 1
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM E2700	(2014) Standard Practice for Contact Ultrasonic Testing of Welds Using Phased Arrays

1.2 DEFINITIONS

Definitions must be in accordance with AWS A3.0M/A3.0 except as follows:

a. Weld slag is defined as the crystalline residue remaining on the weld surface following a weld procedure which uses flux as a shielding method.

b. POL service piping consists of piping and components used for petroleum, oil and lubricants (POL) under pressure or gravity force including modifications to existing hydrant fueling systems.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welding Procedure Specifications (WPS); G, [_____]

Welder Performance Qualification (WPQ); G, [_____]

Procedure Qualification Record (PQR); G, [_____]

Welding Operations; G, [_____]

SD-02 Shop Drawings

POL Service Piping; G, [_____]

Pigging Plan; G, [_____]

SD-06 Test Reports

Welding Reports

Examinations, Inspections and Tests

SD-07 Certificates

Qualifications; G, [_____]

1.4 GENERAL REQUIREMENTS

****

NOTE: The drawings should be checked to ensure that any supplementary information required has been shown and that there is no conflict between the drawings and the specifications.

Project drawings must indicate, or text of project specifications must specify, the welding procedures, and size, length, type, and location of the welds, as necessary. Project drawings and/or specifications must indicate that factory applied internal and external coatings be stopped one inch from a girth weld leaving a 2 inch uncoated area for welding.

****

This section covers the welding of Petroleum, Oil and Lubricant (POL) Service systems. Deviations from applicable codes, approved procedures, and approved detail drawings will not be permitted without prior written approval by the Contracting Officer. Materials or components with welds made offsite will not be accepted if the welding does not conform to the requirements of this specification, unless otherwise specified. Procedures must be developed by the Contractor for welding all metals included in the work. Welding must not be started until welding procedures, welders, and welding operators have been qualified. Qualification testing must be performed by an approved testing laboratory, or by the Contractor if approved by the Contracting Officer. Costs of such testing must be borne by the Contractor. The Contracting Officer must be notified at least one week in advance of the time and place of the tests. If the Contracting Officer elects to witness the tests, the qualification tests must be performed at or near the worksite. The Contractor must maintain current records of the test results obtained in the welding procedure, welding operator, welder performance qualifications, and nondestructive examination (NDE) procedures readily available at the site for examination by the Contracting Officer. The procedures for making transition welds between different materials or between plates or pipes of different wall thicknesses must be qualified. Unless otherwise specified, the choice of welding process must be the responsibility of the Contractor. It should be noted that ASME B31.3 incorporates by reference, other requirements of ASME Section V, Section IX and specific AWS requirements.

1.5 PERFORMANCE

****

NOTE: The paragraphs will be edited and bracketed portions inserted if necessary to ensure proper implementation of the CONTRACTOR QUALITY CONTROL PROGRAM. The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible; i.e., primarily the Contractor or the Government.

In many cases a project may not require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing, and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, NDE symbols, or other means. The referenced applicable publications will be used for guidance in determining inspection and testing requirements.

The specifications or drawings must clearly indicate which joints require 100 percent NDE inspection (all underground joints require 100 percent radiographic testing (RT) or phased array ultrasonic testing (PAUT)), which joints require random NDE inspection, and which NDE methods are to be employed for each joint.

Phased array ultrasonic testing must be used when radiography is not permitted and with Service Headquarters approval only.

****

The Contractor will be responsible for the quality of all joint preparation, welding, and examination. All materials used in the welding operations must be clearly identified and recorded. The inspection and testing defined in this specification are minimum requirements. Additional inspection and testing must be the responsibility of the Contractor when he deems it necessary to achieve the quality required.

1.6 QUALIFICATIONS

Welding procedures, welders, and welding operators previously qualified by test may be accepted for the work without requalification, provided that all of the following conditions are fulfilled:

a. Copies of the welding procedure specifications (WPS), the procedure qualification record (PQR) record, and the welder performance qualification (WPQ) are submitted and approved in accordance with paragraph SUBMITTALS.

b. Testing was performed by an approved testing laboratory or approved technical consultant or by the Contractor's approved quality assurance organization.

c. The welding procedures, welders, and welding operators were qualified in accordance with ASME B31.3 and base materials, filler materials, electrodes, equipment, and processes conformed to the applicable requirements of this specification.

d. The requirements of paragraph RENEWAL OF QUALIFICATION below are met and records showing name of employer and period of employment using the process for which qualified are submitted as evidence of conformance.

1.6.1 Welding Operations

The Contractor must provide a description of how the critical welding operations will be accomplished. Provide the welding procedures to be used for each operation, the sequence of welding to minimize heat distortion, sequence of welding piping sections both in the trench and outside, machine welding if used, and multiple welders on same pipe weld. Submit detailed procedures which define methods of compliance to contract drawings and specifications.

1.6.2 Welding Procedure Specification and Procedure Qualification Records

The Contractor must record in detail and must qualify the Welding Procedure Specifications for every proposed welding procedure. Qualification for each welding procedure must conform to the requirements of ASME B31.3 and to this specification. The welding procedures must specify back purge gas requirements, end preparation for butt welds including cleaning, alignment, and root openings. Preheat, interpass temperature control, and postheat treatment of welds must be as required by approved welding procedures, unless otherwise indicated or specified. Copies of the welding procedure specifications and weld procedure qualification record results for each type of welding required must be submitted in accordance with paragraph SUBMITTALS. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds. Welding procedures must be identified individually and must be referenced on the POL service piping shop drawings. Submit detail drawings showing location, length, and type of welds; and indicating preweld and postweld heat treatment and NDE as required. The drawings must show the welding procedure specification (WPS) to be used at each weld location.

1.6.3 Welder and Welding Operator Performance

Each welder and welding operator assigned to work must be qualified in accordance with ASME B31.3.

1.6.3.1 Certification

Before assigning welders or welding operators to the work, the Contractor must provide the Contracting Officer with their names together with certification that each individual is performance-qualified as specified. The certification must state the type of welding and positions for which each is qualified, the code and welding procedure specification under which each is qualified, date qualified, and the firm and individual certifying the qualification tests. The Contractor must provide a summary table showing all welders and the WPS with which they are qualified to weld.

1.6.3.2 Identification

Each particular weld must be identified with the personal number, letter, or symbol assigned to each welder or welding operator. To identify welds, written records indicating the location of welds made by each welder or welding operator must be submitted, and each welder or welding operator must apply the personal mark adjacent to the welds using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Contracting Officer that do not deform the metal. Identification by die stamps or electric etchers will not be allowed.

1.6.3.3 Renewal of Qualification

Requalification of a welder or welding operator must be required under any of the following conditions:

a. When a welder or welding operator has not used the specific welding procedure for a period of 3 months; the period may be extended to 6 months if the welder or welding operator has been employed on another welding procedure.

b. When a welder or welding operator has not welded with any procedure during a period of 3 months, all the personal qualifications must be considered expired, including any extension by virtue of a. above.

c. There is specific reason to question the person's ability to make welds that will meet the requirements of the specifications.

d. The welder or welding operator was qualified by an employer, other than those firms performing work under this contract, and a qualification test has not been taken within the preceding 12 months.

e. Renewal of qualification for a specific welding procedure under conditions a., b., and d., above, needs to be made on only a single test joint or pipe of a thickness, position, or material required by the welding procedure specifications to reestablish the welder's or welding operator's qualification for the previous qualification.

1.6.4 Test Reports

Test reports must consist of the following.

a. Records made by the AWS certified inspector for all duties performed per paragraph 4.2 of AWS QC1.

b. All NDE (radiograph, [PAUT]) reports with unique weld ID for each weld tested.

c. "Weld Maps". These maps/drawings correlate the shop drawings submitted to the NDE reports. The NDE report that shows a weld number as acceptable is correlated with weld number on the drawings.

d. Provide the location of each weld, what procedure was used, which welder did the weld, the results of the visual test, and the results of the NDE.

1.6.5 Inspection and NDE Personnel

****

NOTE: Coordinate with paragraph PERFORMANCE.

****

Contractor must provide a commercially independent organization for all weld examinations. All inspection and NDE personnel must be qualified in accordance with the following requirements. The contractor must submit the qualifications of all the testing personnel that will perform all field tests for review by the Contracting Officer. The qualifications of all personnel on the job site that will perform welding inspections and NDE must be submitted for approval. All inspectors and NDE personnel must have a minimum of one year experience inspecting the piping material being used and five years in military or commercial aircraft hydrant fueling systems or truck fueling systems, petroleum refineries, power generating plants, or chemical process plants.[In addition, all PAUT personnel must meet ASNT Level III requirements.]

1.6.5.1 Inspector Certification

Visual welding inspectors must be qualified in accordance with AWS QC1.

1.6.5.2 NDE Personnel

NDE personnel must be certified Level II in accordance with ASME Section V, ASME B31.3 and ASNT SNT-TC-1A for each NDE procedure he is required to use, and a written procedure for the control and administration of NDE personnel training, examination, and certification must be established. The procedures must be based on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A. Should the NDE examiner also be a welder, that individual is disqualified from examining their own work.[Examiners performing PAUT must be qualified in accordance with ASME Section 5, Article 4, Mandatory Appendix VII.]

1.7 DELIVERY, STORAGE, AND HANDLING

All filler metals, electrodes, and other welding materials must be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages must be properly labeled and designed to give maximum protection from moisture and to insure safe handling.

1.7.1 Material Control

****

NOTE: If additional requirements are necessary regarding limits on out-of-oven exposure time, refer to AWS D1.1/D1.1M.

****

Materials must be stored in a controlled access and clean, dry area that is weathertight and is maintained at a temperature recommended by the manufacturer. The materials must not be in contact with the floor and must be stored on wooden pallets or cribbing.

1.7.1.1 Damaged Containers

Low-hydrogen steel electrodes must be stored in their sealed shipping container. If the seal is damaged during shipment or storage, and the damage is not immediately detected, the covered electrodes in that container must be rebaked in accordance with the manufacturer's instructions prior to issuance or must be discarded. If a container is damaged in storage and the damage is witnessed, the electrodes from that container must be immediately placed in a storage oven. The storage oven temperature must be as recommended by the manufacturer or the welding material specification.

1.7.1.2 Partial Issues

When a container of covered electrodes is opened and only a portion of the content is issued, the remaining portion must, [within 1/2-hour]; [within the limits established by AWS D1.1/D1.1M] be placed in a storage oven.

1.7.2 Damaged Materials

Materials which are damaged must be discarded. Covered electrodes which are oil or water-soaked, dirty, or on which the flux has separated from the wire must be discarded.

1.8 SYMBOLS

Symbols must be in accordance with AWS A2.4.

1.9 SAFETY

Safety precautions must conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 WELDING MATERIALS

****

NOTE: Normally, selection of the electrodes is done by the Contractor. In special cases, if the selection of the proper electrode is critical to the design, the designer may specify the electrodes to be used. In special cases it also may be necessary to specify the welding process.

The selection of electrodes should be limited to non covered for all root passes. Covered electrodes may be allowed for fill passes after the root pass is completed. This will eliminate formation of weld slag on the interior of the pipe. Weld process for root passes is restricted to Gas Tungsten to provide for a clean weld on the initial pass.

In tight or confined spaces where oxygen supply may be a concern, use of a back purge gas may be re-evaluated and a covered electrode may be allowed. This condition should be addressed by the Designer and the Contracting Officer on a case by case basis.

****

Welding materials for carbon steel, stainless steel and aluminum must comply with AWS WHB-4.9. Welding equipment, electrodes, welding wire, shielding and backing gas, and fluxes must be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures. All field girth root pass welds must be made with non-covered electrodes or welding wire. All root passes must be made with shielding and backing gas. External welds on the pipe such as attaching pipe supports may be made with covered electrodes or welding wire. Electrodes, welding wire [and][or] fluxes must be in accordance with Table 1. Welding materials for aluminum and aluminum alloy must comply with AWS D10.7/D10.7M.

TABLE I

AWS	Process	Alloy	Consumable	Use
			(Examples) (1)	
AWS A5.1/A5.1M	SMAW	Low Carbon	E7018	Fill
AWS A5.4/A5.4M	SMAW	Stainless	E308L, E309L	Fill
AWS A5.3/A5.3M	SMAW	Aluminum		Fill
AWS A5.9/A5.9M	GTAW	Stainless	ER308L,ER309L	Root and Fill
AWS A5.10/A5.10M	GTAW	Aluminum		Root and Fill
AWS A5.18/A5.18M	GTAW	Low Carbon	E70S-3,E70S-6	Root and Fill
AWS A5.22/A5.22M	GTAW	Stainless	E308LT1-1	Root (Backing and Shielding Gas Required)
AWS A5.32/A5.32M	GTAW	All		Shielding Gas

Note(1): The consumable material designations shown are examples only and are not intended to limit the Contractor's selection of consumable materials.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

Welding must be performed in accordance with qualified procedures using qualified welders and welding operators. Welding must not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Contracting Officer must determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural members must conform to Section 05 05 23.16 STRUCTURAL WELDING.

Welding must be performed in accordance with ASME B31.3 and the applicable portions of AWS D10.4, AWS D10.7/D10.7M, AWS D10.10/D10.10M, AWS D10.11M/D10.11, AWS D10.12M/D10.12, and AWS C5.5/C5.5M.

All joints unless indicated otherwise, in carbon steel, aluminum and stainless steel piping systems must be welded. Unless otherwise approved, all girth welds must be complete penetration groove welds made in accordance with qualified welding procedures. The root pass on stainless steel, aluminum, and carbon steel pipe must be by the GTAW process.

a. Weld Preparation must comply with the requirements of ASME B31.3 and the qualified Welding Procedure Specification. The use of "rice paper" as purge blocks is not permitted. Contractor must submit alternate method for approval.

b. Backing Rings. The use of backing rings for making or repairing welds will not be permitted.

3.1.1 Base Metal Preparation

Oxy-fuel cutting must not be used on austenitic stainless steel or nonferrous materials.

Mechanical grinding of thermal cut ends must be used to remove the heat affected area but should be limited to maximum 1/8 inch.

3.1.2 Weld Joint Fit-Up

Parts that are to be joined by welding must be fitted, aligned, and retained in position during the welding operation by the use of bars, jacks, clamps, or other mechanical fixtures. End welds must be properly aligned prior to welding in accordance with Chapter V of ASME B31.3. All socket-welded joints must be properly fitted with gaps between the pipe and the bottom of the socket in accordance with ASME B31.3. Contractor must implement a program to ensure gaps are properly measured and documented. Welded temporary attachments must not be used except when it is impractical to use mechanical fixtures. When temporary attachments are used, they must be the same material as the base metal, and must be completely removed by grinding or thermal cutting after the welding operation is completed. If thermal cutting is used, the attachment must be cut to not less than 6 mm 1/4 inch from the member and the balance removed by grinding. After the temporary attachment has been removed, the area must be visually examined.

3.1.3 Butt Weld Joint Spacing

Butt weld joints must be spaced a minimum of 150 mm 6 inches apart. Measurement must be taken from the toe of the first weld to the toe of the second weld. The measurement must be taken at the closest point between the welds when visually inspected. If spacing is not possible due to existing conditions, a reduction in spacing to not less than 50 mm 2 inches may be made.

3.1.4 Preheat and Interpass Temperatures

Preheat temperatures must meet the requirements specified by ASME B31.3. However, in no case will the preheat be below 10 degrees C 50 degrees F for ferritic steel or austenitic stainless steel, or 0 degrees C 32 degrees F for nonferrous alloys. The maximum interpass temperatures must not exceed 149 degrees C 300 degrees F for austenitic stainless steels, nickel alloys, and copper alloys; and 260 degrees C 500 degrees F for carbon steels. Preheat techniques must be such as to ensure that the full thickness of the weld joint preparation [and][or] adjacent base material, at least 75 mm 3 inches in all directions, is at the specified temperature. Preheating by induction or resistance methods is preferred. When flame heating is used, only a neutral flame must be employed. Oxy-fuel heating must not be used on austenitic stainless steel; however, air-fuel heating is acceptable if controlled to ensure that the surface temperature does not exceed 66 degrees C 150 degrees F. Interpass temperatures must be checked on the surface of the component within 25 mm one inch of the weld groove and at the starting location of the next weld pass, and for a distance of about 150 mm 6 inches ahead of the weld, but not on the area to be welded.

3.1.5 Production Welding Instructions

a. Welding must not be done when the ambient temperature is lower than minus 18 degrees C 0 degrees F.

b. Welding is not permitted on surfaces that are wet or covered with ice, when snow or rain is falling on the surfaces to be welded, or during periods of high winds, unless the welders and the work are properly protected.

c. Gases for purging and shielding must be welding grade and must have a dew point of minus 40 degrees C minus 40 degrees F or lower.

d. Back purges are required for austenitic stainless steels and nonferrous alloys welded from one side and must be set up such that the flow of gas from the inlet to the outlet orifice passes across the area to be welded. The oxygen content of the gas exiting from the purge vent must be less than 2 percent prior to welding. The flow rate must be that required by the approved weld procedure specification.

e. The purge on groove welds must be maintained for at least two passes or 5 mm 3/16 inch whichever is greater.

f. Removable purge dam materials must be made of expandable or flexible plugs, such as Plexiglas, plywood (which must be dry when used). Wood dams must be kiln-dried quality. Purge dams must not be made of polyvinyl alcohol.

g. Any welding process which requires the use of external gas shielding must not be done in a draft or wind unless the weld area is protected by a shelter. This shelter must be of material and shape appropriate to reduce wind velocity in the vicinity of the weld to a maximum of 8 km/hour 5 mph (440 fpm).

h. Tack welds to be incorporated in the final welds must have their ends tapered by grinding or welding technique. Tack welds that are cracked or defective must be removed and the groove must be retacked prior to welding. Temporary tack welds must be removed, the surface ground smooth, and visually inspected. For low-alloy and hardenable high-alloy steels, the area must be magnetic particle examination inspected.

i. Grinding of completed welds is to be performed only to the extent required for NDE, including any inservice examination, and to provide weld reinforcement within the requirements of ASME B31.3. If the surface of the weld requires grinding, reducing the weld or base material below the minimum required thickness must be avoided. Minimum weld external reinforcement must be flush between external surfaces.

j. Each qualified welder must be assigned an identification symbol. All welds must be permanently marked with the symbol of the individual who made the weld.

****

NOTE: Designer to include Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT) and Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION) if carbon steel and stainless steel are to be connected.

****

k. Direct welded connection of carbon steel and stainless steel must not be made.[See Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT) and

Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION) for method of connection.]

3.1.6 Postweld Heat Treatment

a. When required postweld heat treatment must be performed in accordance with ASME B31.3. Temperatures for local postweld heat treatment must be measured continuously by thermocouples in contact with the weldment.

b. Postweld heat treatment of low-alloy steels, when required, must be performed immediately upon completion of welding and prior to the temperature of the weld falling below the preheat temperature. However, postweld heat treatment may be postponed after the completion of the weld, if, immediately after the weld is completed, it is maintained at a minimum temperature of 149 degrees C 300 degrees F or the preheat temperature, whichever is greater, for 2-hours per 25 mm one inch of weld thickness.

3.2 EXAMINATIONS, INSPECTIONS AND TESTS

****

NOTE: PAUT is only permitted at locations that prohibit the use of radiography and locations where it is impractical due to physical location or other constraints. PAUT is only permitted with approval of the Service Headquarters. In all cases where PAUT is used, all welds must be recorded and the results reviewed by an ASNT Level III certified inspector and the requirements in this section.

Coordinate with paragraph PERFORMANCE.

****

Weld inspection and NDE must be performed by the Contractor to detect surface and internal discontinuities in completed welds. The services of a qualified commercial inspection or testing laboratory or technical consultant meeting the requirements of paragraph INSPECTION AND NDE PERSONNEL, approved by the Contracting Officer, must be employed by the Contractor. All completed welds must be visually inspected in accordance with the visual inspection requirements of ASME B31.3 and AWS D1.1/D1.1M. [Radiographic] [Liquid penetrant] [Magnetic particle] [or] [PAUT] examination must be required as indicated below. When in-process weld quality control is required for tie-in welds, it must be performed in accordance with ASME B31.3. When inspection and testing indicates disqualifying defects in a weld joint, the weld must be repaired by a qualified welder in accordance with paragraph CORRECTIONS AND REPAIRS. The Contractor must submit weld inspection and NDE field testing reports to the Contracting Officer.[In all cases where PAUT is used, all welds must be recorded and the results reviewed by an ASNT Level III certified inspector and the requirements in this section.]

The person performing the weld inspection must perform the following:

a. Verify that the base materials and consumable welding materials conform to the specifications and that welding filler metals used are as specified for each base material.

b. Verify that the welding equipment to be used for the work is appropriate for use with the welding procedure specification and has the capability to meet the applicable requirements of the welding procedure.

c. Verify that only approved or qualified welding procedures are used for the work.

d. Verify that the edge preparation or joint geometry meet the requirements of the welding procedure and drawings.

e. Verify that the specified filler metals are used and that filler metals are maintained in proper condition, per requirements, or as recommended by the manufacturer.

f. Verify that the technique and performance of each welder, welding operator, and tack welder are as specified.

g. Verify that the work conforms to requirements of the applicable standards, drawings, or other documents.

h. Verify that the work inspected is identified and documented in accordance with specified requirements.

i. Prepare clear and concise reports and verify that records of the results of examinations are maintained.

j. Verify the approved WPS pre-heat and post heat procedures are being used.

****

NOTE: For modifications to existing stainless steel hydrant systems insert the following paragraph:

****

[Welders found making defective welds must be removed from the work or must be required to be requalified in accordance with ASME B31.3.
]

****

NOTE: Coordinate with paragraph PERFORMANCE.

This paragraph is to be edited based on the piping code used for design. Both ASME B31.3 and ASME B31.4 allow for different percentages of additional testing with ASME B31.3 generally being more stringent. The selection of ASME B31.3 or ASME B31.4 should be consistent with the application. See UFC 3-460-01, "Design: Petroleum Fuel Facilities". For modification to existing hydrant systems at paragraph NDE TESTTING FREQUENCY insert the following first paragraph.

****

3.2.1 Visual Inspection

Weld joints must be inspected visually as follows:

a. Before welding - for compliance with requirements for joint preparation, alignment and fit-up, and cleanliness in accordance with ASME B31.3.

b. During welding - for cracks and conformance to the approved welding procedure only when in-process weld quality control is required by ASME ASME B31.3.

c. After welding - for cracks, contour and finish, bead reinforcement, undercutting, overlap, weld slag on the interior of the pipe and size of welds in accordance with ASME B31.3 and AWS D1.1/D1.1M. Visual examination of the interior of the pipe may be performed by any of the remote means allowed by ASME BPVC SEC V, visual inspection. Visual examination of the weld must be performed prior to any other NDE examinations as required by this specification.

3.2.2 NDE Testing Frequency

All pipe field welds, including high point vent pipe tees, insert butt welded weld-o-lets, and low point drain pipe, must be examined by [radiographic] methods to determine conformance to the paragraph ACCEPTANCE STANDARDS. All socket welds and sock-o-lets or weld-o-lets to pipe welds must be examined with either magnetic particle or liquid penetrant methods, in addition to the visual examinations. The services of a qualified commercial or testing laboratory approved by the Contracting Officer must be employed by the Contractor for testing of piping welds. Costs of testing, including retesting of repaired welds, must be borne by the Contractor.

a. Provide 100 percent [radiographic testing] [PAUT] for all underground piping and hydrant pump discharge piping.

b. Provide select [radiographic testing] [PAUT] in accordance with [ASME B31.3] for all aboveground piping. The inspection must include an examination of welds made by each welding operator or welder.[Not less than [_____] percent of total welds shall be examined.] If the testing reveals that any welds fail to meet minimum quality requirements, an additional percent of the welds in that same group must be inspected in accordance with ASME B31.3. If all of the additional welds inspected meet the quality requirements, the entire group of welds represented must be accepted and the defective welds must be repaired. If any of the additional welds inspected also fail to meet the quality requirements, that entire group of welds must be rejected. The rejected welds must be removed and rewelded, or the rejected welds must be 100 percent inspected and all defective weld areas removed and rewelded.

3.2.3 NDE Testing

****

NOTE: Delete any NDE method not required. If magnetic particle inspection is required, specify whether wet or dry particle method is appropriate.

For modifications to existing Hydrant Systems choose only radiographic or PAUT from the first paragraph and include the 2nd paragraph.

Phased array ultrasonic testing must be used when radiography is not permitted and with Service Headquarters approval only.

****

NDE must be as required by ASME B31.3 and in accordance with written procedures. Procedures for [radiographic] [liquid penetrant] [magnetic particle] [ultrasonic] [or] [PAUT] tests and methods must conform to ASME BPVC SEC V. Only Radiography [or PAUT] are acceptable test methods for butt welded joints.[Refer to ASTM E2700 for PAUT.] The approved procedure must be demonstrated to the satisfaction of the Contracting Officer. In addition to the information required in ASME BPVC SEC V, the written procedures must include the timing of the NDE in relation to the welding operations and safety precautions.

[The services of a commercially independent qualified testing agency approved by the Contracting Officer must be employed by the Contractor for testing of piping welds. Costs of testing, including retesting of repaired welds, must be borne by the Contractor. Weld ripples or surface irregularities that might mask or be confused with the radiographic image of any objectionable defect must be removed by grinding [and], [or] other suitable mechanical means. The weld surface must be merged smoothly with the base metal surface.

][3.2.4 Special Requirements for PAUT Testing

Phased array inspection must meet the review requirements of API Std 650 Twelfth Edition, Annex U, Section U5 and the Inspection requirements of ASME Section V 2017.

Calibration standards must meet the requirements of ASME Section V 2017 figure T-434.3-1, T-434.3-2.

The final data package shall be reviewed by a UT Level-III individual qualified in accordance with their employer's written practice. ASNT SNT-TC-1A or CP-189 shall be used as a guideline. Only Level-II or Level-III personnel shall perform UT examinations, analyze the data, or interpret the result. Alternatively, the review may be achieved by arranging for a data acquisition and initial interpretation by a Level-II individual, and a final interpretation and evaluation shall be performed by a Level-III individual qualified. The review shall include the following:

3.2.4.1 Essential Variables

Essential variables are listed below. Changes in any one of them beyond that allowed in the specification must require procedure requalification.

a. Weld configurations to be examined, including thickness dimensions and base material product form (pipe, plate)

b. The surfaces from which the examination shall be performed Technique(s) Angle(s) and mode(s) of wave propagation in the material

c. Search unit type(s), frequency(ies), and element size(s)/shape(s) element size and number, and pitch and gap dimensions

d. Focal range (identify plane, depth, or sound path)

e. Virtual aperture size (i.e., number of elements, effective height, and element width)

f. Angular range used (i.e., 40 deg. to 50 deg., 50 deg. to 70 deg.)

g. Angle incremental change (i.e., 12 deg , 1 deg.)

h. Element incremental change (i.e., 1,2)

i. Additional S-scan, E-scan requirements Range of element numbers used (i.e., 1-126, 10-50)

j. Scan plan

k. Weld axis reference point marking

l. Rastering angle(s)

m. Aperture start and stop element numbers

n. Aperture incremental change(s) (number of elements stepped)

o. Additional S-scan requirements: Sweep angular range(s)

p. Angular sweep increment (incremental angle change, deg)

q. Aperture element numbers (first and last)

r. Calibration [calibration block(s) and technique(s)]

s. Scanning technique (automated vs. semi-automated)

t. Scanner adhering and guiding mechanism

u. Method for discriminating geometric from flaw indications

v. Method for sizing indications

w. Computer enhanced data acquisition, when used Scan overlap

x. Computer software revision

y. Personnel performance requirements, Personnel qualification requirements

z. Surface condition (examination surface, calibration block)

3.2.4.2 Non-Essential Variables

a. Couplant: brand name or type

b. Post-examination cleaning technique

c. Automatic alarm [and][or] recording equipment, when applicable Records, including minimum calibration data to be recorded (e.g., instrument settings)

]3.2.5 Inspection and Tests by the Government

The Government may perform inspection and supplemental nondestructive or destructive tests as deemed necessary. The cost of supplemental NDE will be borne by the Government. The correction and repair of defects and the reexamination of weld repairs must be performed by the Contractor at no additional cost to the Government. Inspection and tests will be performed as required for visual inspection and NDE, except that destructive tests may be required also. When destructive tests are ordered by the

Contracting Officer and performed by the Contractor and the specimens or other supplemental examinations indicate that the materials and workmanship do not conform to the contract requirements, the cost of the tests, corrections, and repairs must be borne by the Contractor. When the specimens or other supplemental examinations of destructive tests indicate that materials or workmanship do conform to the specification requirements, the cost of the tests and repairs will be borne by the Government. When destructive tests are made, repairs must be made by qualified welders or welding operators using welding procedures which will develop the full strength of the members cut. Welding must be subject to inspection and tests in the mill, shop, and field. When materials or workmanship do not conform to the specification requirements, the work may be rejected at any time before final acceptance of the system containing the weldment.

3.3 ACCEPTANCE STANDARDS

****

NOTE: These acceptance standards were taken from ASME B31.3 and ASME B31.4 and are suitable for most jobs. Evaluations of indications, as given in ASME B31.3 and ASME B31.4, are applicable to these standards. Specific project design requirements may necessitate revision or expansion to cover different items of work and varying standards of acceptance. In no case must the acceptance criteria be less conservative than the criteria specified by the standard applicable to the work. If actual conditions exceed these limits of ASME B31.3 or ASME B31.4, this requirement must be expanded or revised as required. For modifications to existing hydrant systems and stainless steel systems select the 2nd paragraph below and delete the first paragraph.

****

[Acceptance standards must be in accordance with ASME B31.3 paragraph 341.3.2, Chapter VI in addition to the following specified items.

][Interpretation of test results and limitations on imperfections in welds must comply with the requirements of 100 percent radiography, per ASME B31.3, paragraph 341.3.2, Chapter VI. For hydrant systems and stainless steel systems the evaluation must be based on severe cyclic conditions in addition to the following-specified items.

]3.3.1 Visual

The following indications are unacceptable:

Weld Slag on the interior of the pipe.

3.3.2 Magnetic Particle Examination

The following relevant indications are unacceptable:

a. Any linear indications.

b. Rounded indications with dimensions greater than 5 mm 3/16 inch.

c. Four or more rounded indications in a line separated by 2 mm 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 3870 square mm 6 square inches of surface with the major dimension of this area not to exceed 150 mm 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

3.3.3 Liquid Penetrant Examination

Indications with major dimensions greater than 2 mm 1/16 of an inch must be considered relevant. The following relevant indications are unacceptable:

a. Any cracks or linear indications.

b. Rounded indications with dimensions greater than 5 mm 3/16 inch.

c. Four or more rounded indications in a line separated by 2 mm 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 3870 square mm 6 square inches of surface with the major dimension of this area not to exceed 150 mm 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

3.4 CORRECTIONS AND REPAIRS

Disqualifying defects must be removed and repaired as specified in ASME B31.3 unless otherwise specified. Disqualifying defects discovered between weld passes must be repaired before additional weld material is deposited. After defect removal is complete and before rewelding, the area must be examined by the same test method which first revealed the defect to ensure that the defect has been eliminated. After rewelding, the repaired area must be reexamined by the same test method originally used for that area. Any indication of a defect must be regarded as a defect unless reevaluation by NDE or by surface conditioning shows that no disqualifying defects are present.

3.4.1 Defect Removal

Defective or unsound weld joints must be corrected by removing and replacing the entire weld joint, or for the following defects corrections must be made as follows:

a. Excessive Convexity and Overlap: Reduce by removal of excess metal.

b. Excessive Concavity of Weld, Undersized Welds, Undercutting: Clean and deposit additional weld metal.

c. Excessive Weld Porosity, Inclusions, Lack of Fusion, Incomplete Penetration: Remove defective portions and reweld.

d. Cracks or liner indications in Weld or Base Metal: Remove crack throughout its length, including sound weld metal for a distance of twice the thickness of the base metal or two inches, whichever is less, beyond each end of the crack, followed by the required rewelding. Complete removal must be confirmed by magnetic particle inspection for carbon steel or liquid penetrant inspection for stainless steel. Inspection procedures must comply with the requirements of ASME B31.3.

e. Poor Fit-Up: Cut apart improperly fitted parts, and reweld.

3.4.1.1 Methods of Defect Removal

The removal of weld metal or portions of the base metal must be done preferably by chipping, grinding, sawing, machining, or other mechanical means. Defects also may be removed by thermal cutting techniques. If thermal cutting techniques are used, the cut surfaces must be cleaned and smoothed by mechanical means to remove the heat affected zone. In addition, a maximum of 1/8-inch of metal must be removed by mechanical means from the cut surfaces of stainless steel.

Wherever a defect is removed, and repair by welding is not required, the affected area must be blended into the surrounding surface eliminating sharp notches, crevices, or corners.

3.4.1.2 Rewelding

Repair welds must be made using an electrode or filler wire smaller than that used in making the original weld. Rewelding must be done using qualified welding procedures. The surface must be cleaned before rewelding. Repair welds must meet the requirements of this specification.

3.4.1.3 Peening or Caulking

The use of force (peening) or foreign materials to mask, fill in, seal, or disguise any welding defects must not be permitted.

3.5 MAINTAINING CLEANLINESS OF PIPING

****

NOTE: The intent of the following paragraph is to require cleaning of the piping system as it is being installed. The designer must include Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP for modifications to hydrant systems and Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT) for other POL service piping systems.

****

The Contractor must keep the interior and ends of all new piping affected by the Contractor's operations thoroughly cleaned of foreign matter and water before and after being installed. Piping systems must be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of piping and fittings must be closed so that no water or other foreign substance will enter the pipes or fittings. Piping must be inspected before placing into position. The interior of each length of pipe must be cleaned after welding; A swab, with a leather or canvas belt disc to fit the inside diameter of pipe, must be pulled through each length of pipe after welding in place. It must be the Contractor's responsibility for insuring that the interior of the piping is free of foreign matter including weld slag when it is connected into the system.

[3.5.1 Pigging Plan

****

NOTE: Select the following paragraph if a high degree of cleanliness is required such as modifications to an existing hydrant fueling

system. For existing systems review piping details and devices to determine if the system can be pigged or modified so it can be pigged.

****

The pigging plan must be submitted for approval by the Contracting Officer. The pigging plan must provide a minimum of two runs through the system with each set of pigs. There must be a minimum of two types of pigs, polyurethane and foam. More types of pigs (brushes, scrapers) or runs may be required depending on the type of debris found in the system. The pigging plan must be submitted to the Contracting Officer for approval.

]3.6 COMMISSIONING

For commissioning of POL service piping systems see Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). For repairs or modifications to hydrant systems see Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 52 40 (November 2018)**
Change 2 - 11/20

Preparing Activity: NAVFAC **Superseding**
UFGS-33 52 43 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 52 40

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USACE / NAVFAC / AFCEC **UFGS-33 52 40 (November 2018)**
Change 2 - 11/20

Preparing Activity: NAVFAC **Superseding**
UFGS-33 52 43 (May 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 52 40

FUEL SYSTEMS PIPING (NON-HYDRANT)

11/18, CHG 2: 11/20

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NOTE: This guide specification covers the requirements for piping, piping components, valving and miscellaneous accessories for general fueling systems, non-hydrant type and non-service station. Do not use this specification for designs related to pressurized hydrant fueling systems and super refueler fillstands. For such systems, refer to the requirements of the DOD Type III/IV/V, and Cut and cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: Use this UFGS in conjunction with UFC 3-460-01 "Design: Petroleum Fuel Facilities". Include in this specification any additional equipment/devices necessary to meet state and local regulations.

The specification is written around ASME's standard Class 150 rating. For applications requiring higher

pressure ratings (e.g., Class 300), the designer will have to modify this specification appropriately.

Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS. Standards can be found on the Whole Building Design Guide at the following location: http://www.wbdg.org/ffc/dod/non-cos-standards.

****

1.1 SUMMARY

This section defines the requirements for pipe, piping components, and valves as related to an non-hydrant, non-service station, fuel distribution system. Such systems include, but are not limited to: marine receipt, pipeline receipt, truck off-loading receipt, pump house, pump pad, truck loading, marine loading, transfer pipeline, product recovery, and other miscellaneous piping systems. Provide the entire fuel distribution system as a complete and fully operational system. Size, select, construct, and install equipment and system components to operate together as a complete system. Substitutions of functions specified herein will not be acceptable. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system. System components and piping specified herein must be designed to handle a working pressure of [1900] [_____] kPa [275] [_____] psig at 38 deg C 100 deg F. Components specified herein must be compatible with the fuel to be handled. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between [_____] degrees C degrees F and [_____] degrees C degrees F.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API 570	(2016; Addendum 1 2017; Addendum 2 2018; ERTA 1 2018) Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems
API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 1110	(2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide
API RP 1595	(2012; R 2019; 2nd Ed) Design, Construction, Operation, Maintenance, and Inspection of Aviation Pre-Airfield Storage Terminals
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API RP 2200	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API STD 600	(2015) Steel Gate Valves-Flanged and Butt-welding Ends, Bolted Bonnets
API STD 608	(2012) Metal Ball Valves - Flanged, Threaded, And Welding End
API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves
API Spec 6FA	(1999; R 2006; Errata 2006; Errata 2008; R 2011) Specification for Fire Test for Valves
API Spec 17J	(2016; Errata 2 2017; ADD 1 2017) Specification for Unbonded Flexible Pipe
API Std 594	(2017) Check Valves: Flanged, Lug, Wafer and Butt-Welding
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats

API Std 609	(2016; ERTA 2017) Butterfly Valves: Double Flanged, Lug-and-Wafer Type

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.20	(2023) Metallic Gaskets for Pipe Flanges
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C210	(2024) Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and

	Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A358/A358M	(2024) Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A961/A961M	(2024b) Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B696	(2000; R 2023) Standard Specification for Coatings of Cadmium Mechanically Deposited
ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM D229	(2019) Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation
ASTM D1418	(2010; R 2016) Standard Practice for Rubber and Rubber Lattices - Nomenclature
ASTM D1655	(2018a) Standard Specification for Aviation Turbine Fuels
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F336	(2002; R 2023) Standard Practice for Design and Construction of Nonmetallic Enveloped Gaskets for Corrosive Service
ASTM F436	(2011) Hardened Steel Washers

BRITISH STANDARDS INSTITUTION (BSI)

BS EN ISO 10497	(2022) Testing of Valves Fire Type-Testing Requirements

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1629	(2013) Rubber and Latices - Nomenclature

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NACE INTERNATIONAL (NACE)

NACE SP0188	(2024) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 77	(2024; ERTA 1 2023) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 24-2) Standard for Aircraft Fuel Servicing
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant
SAE J514	(2012) Hydraulic Tube Fittings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5624	(2024; Rev X) Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-PRF-4556	(1998; Rev F; Am 1 1999; CANC Notice 1 2011) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
MIL-PRF-13789	(1999; Rev E; Notice 1 2008; Notice 2 1016; Notice 3 2021) Strainers, Sediment: Pipeline, Basket Type

MIL-STD-161	(2005; Rev G; Notice 1 2010) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels
MIL-STD-3004-1	(2018) Quality Assurance for Bulk Fuels, Lubricants and Related Products

1.3 ADMINISTRATIVE REQUIREMENTS

Design conditions must be as specified in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT). Refer to Section 01 78 23 OPERATION MAINTENANCE DATA.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G, [_____]

[Pigging Plan; G, [_____]

] Hydrotesting Plan; G, [_____]

Quality Assurance Plan; G, [_____]

SD-02 Shop Drawings

Grounding and Bonding

Pipe Supports; G, [_____]

Pigging System Components; G, [_____]

SD-03 Product Data

Carbon Steel Piping; G, [_____]

[Stainless Steel Piping; G, [_____]

][Steel Reinforced Flexible Pipe; G, [_____]

] External Protective Coatings For Aboveground Piping; G, [_____]

[External Protective Coatings For Buried Steel Piping; G, [_____]

][Rock Shield; G, [_____]

] Fittings; G, [_____]

Carbon Steel Fittings; G, [_____]

Insulating Flange Kits; G, [_____]

Lightning Surge Arrester; G, [_____]

Bolts, Nuts And Washers; G, [_____]

Flange Protectors; G, [_____]

Ball Valves; G, [_____]

V Port Ball Valve; G, [_____]

Full Port Ball (DBBV) Valves; G, [_____]

Plug (Double Block and Bleed) Valves; G, [_____]

Electric Valve Actuator

Swing Check Valves

Silent Check Valves

Butterfly Valve with Fusible Link Operator

Globe Valve; G, [_____]

Thermal Relief Valve; G, [_____]

Flexible Ball Joints; G, [_____]

Mechanically Adjustable Segmented Elastomeric Seal; G, [_____]

Pipe Sleeves; G, [_____]

Strainers; G, [_____]

Thermometer; G, [_____]

Sample Connections; G, [_____]

Sight Flow Indicators; G, [_____]

Flexible Hose Connectors; G, [_____]

Automatic Air Vent; G, [_____]

Surge Suppressor Tank And Valve; G, [_____]

Pipe Casings; G, [_____]

Buried Utility Tape; G, [_____]

Pipeline Markers; G, [_____]

Bellows Expansion Joints; G, [_____]

Flange Gaskets, Non-Metallic, Non-Electrically Isolating; G, [_____]

Flange Gaskets, Metallic; G, [_____]

SD-06 Test Reports

Exterior Coating Holiday Test

Pneumatic Test

Hydrostatic Test

Piping Dehydration Test

Performance Testing

Pipe Pigging Verification

SD-07 Certificates

[Water for [Hydrotesting][Pigging]; G, [_____]

] Contractor Qualifications; G, [_____]

System Supplier; G, [_____]

Pipeline Inventory; G, [_____]

Qualifications of Owner's Inspector; G, [_____]

Survey Final Elevations; G, [_____]

Demonstrations

SD-08 Manufacturer's Instructions

Flexible Ball Joints; G, [_____]

Bellows Expansion Joints; G, [_____]

SD-10 Operation and Maintenance Data

Insulating Flange Kits; G, [_____]

Lightning Surge Arrester; G, [_____]

Ball Valves; G, [_____]

V Port Ball Valve; G, [_____]

Full Port Ball (DBBV) Valves; G, [_____]

Plug (Double Block and Bleed) Valves; G, [_____]

Electric Valve Actuator; G, [_____]

Swing Check Valves; G, [_____]

Butterfly Valve with Fusible Link Operator; G, [_____]

Globe Valve; G, [_____]

Thermal Relief Valve; G, [_____]

Flexible Ball Joints; G, [_____]

Mechanically Adjustable Segmented Elastomeric Seal; G, [_____]

Strainers; G, [_____]

Thermometer; G, [_____]

Sample Connections; G, [_____]

Sight Flow Indicators; G, [_____]

Automatic Air Vent; G, [_____]

Surge Suppressor Tank And Valve; G, [_____]

Bellows Expansion Joints; G, [_____]

1.5 QUALITY ASSURANCE

****

NOTE: Specify as directed by the Service

Headquarters.
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1.5.1 Contractor Qualifications

Each installation Contractor must have successfully completed at least 3 projects of the similar scope and the same size or larger within the last 6 years. Each installation Contractor must demonstrate specific installation experience in regard to the specific system installation to be performed. Each installation Contractor must have taken, if applicable, manufacturer's training courses on the installation of piping and must meet the licensing requirements in the state. Experience must include the erection of piping systems in compliance with the requirements of ASME B31.3, and NFPA 30. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. Provide in the letter evidence of prior manufacturer's training and state licensing.

1.5.2 System Supplier

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

1.5.3 Work Plan

Submit a comprehensive work plan that provides sufficient detail to demonstrate a thorough understanding of the project. Document that all components to be provided will function together and produce the result expected by the Government. Include any proposed dates for piping system shutdowns as well as the Contractor's ability to complete the work within the allotted shutdown periods. Show proposed dates and nature of piping system operations required of the Government. Include a list of manpower, spare piping and system component that will be on hand for each phase of the work. Describe, in detail, the means of:

a. Coordinating work with Government and third parties.

b. Preparing for safe piping repair work.

c. Pneumatic pressure testing new piping sections.

d. Hydrostatic pressure testing new piping sections.

[e. Drying lines after water was introduced for [hydrotesting][hydrotesting and pigging][pigging].

][f. Interrupting or isolating an existing fuel service or system.

] g. Purging piping.

h. Vapor monitoring.

i. Preparations for containing and disposing of residual fuel.

j. Cutting, sealing, and welding into existing piping systems.

k. Welding tie-ins in place.

l. Examining repair section tie-in welds.

m. Collecting, storing and disposing of waste fuel generated during work.

[1.5.4 Pigging Plan

****

NOTE: Provide if piping is piggable.

****

The Contractor must submit a detailed written plan covering all aspects of the pipeline pigging operation, including anticipated pig runs, types of pigs, sequence of work, and retrieval/repair procedures. The Contractor must identify for each pigging evolution, the characteristics of the pig (type/purpose) and method/medium for propulsion.

]1.5.5 Hydrotesting Plan

The Contractor must submit a detailed written plan covering all aspects of the pipeline hydrostatic testing operations, including procedures and sequencing of testing, segments of piping to be tested, fluid to be used during testing, equipment removal and isolation, hydrostatic testing pressures, safety protocols, etc.

[1.5.6 Water for [Hydrotesting][Pigging]

Submit results of water testing and amount of water required.

]1.5.7 Design Data

1.5.7.1 Pipeline Inventory

Fuel system volume must be calculated using as constructed pipe lengths, internal diameters, fittings, and components. Totals must be provided for all items containing fuel with the exception of tanks which is covered by other specifications. A certified pipeline inventory - a detailed list with sizes, lengths, quantity, and volumes must be provided for the systems in this project. Such systems include, but are not limited to: marine receipt, pipeline receipt, truck off-loading receipt, pump house, pump pad, truck loading, marine loading, transfer pipeline, product recovery, and other miscellaneous piping systems.

1.5.8 Material and System Components Qualifications

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

1.5.9 Nameplates

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

1.5.10 Delivery, Storage, and Handling

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT). If fuel is used for [hydrotesting] [and] [or] [cleaning pigging], comply with all the requirements in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

PART 2 PRODUCTS

2.1 ELECTRICAL WORK

****

NOTE: Show electrical characteristics on the drawings.

Coordinate the ignition temperature of the fuel(s) to be handled with the electrical design. Ignition temperatures will be as defined in NFPA 497M. Fuel ignition temperatures will dictate the maximum allowable temperature rating of the electrical system components. Coordinate the area classification and the electrical design with UFC 3-460-01.

Coordinate piping, valve, system components and other systems bonding and grounding requirements with UFC 3-460-01. Include also in the design a bonding and grounding plan to relieve and control static electricity buildup as described in UFC 3-460-01.

****

2.1.1 General

Motors, manual or automatic motor control system components except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM [, Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION] [, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

2.1.2 Grounding and Bonding

Ground and bond as indicated on the drawings and in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.2 MATERIALS

****

NOTE: Contact Service Headquarters Cathodic Protection Expert for direction on pipeline cathodic protection.

****

Pipe and fittings in contact with fuel must be stainless steel, interior epoxy coated carbon steel, or interior uncoated carbon steel as indicated on the drawings or as specified herein. No zinc coated metals, brass, bronze or other copper bearing alloys must be used in contact with the fuel. All carbon steel and stainless steel underground piping must have an exterior protective coating and must be cathodically protected in accordance with Section [26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC

PROTECTION (GACP) SYSTEM] [26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Cathodic protection for metal components that attach to a tank must be coordinated and compatible with the tank corrosion control system. Identification of piping must be in accordance with MIL-STD-161 unless specified otherwise. Material for manual valves must be as specified hereinafter. Do not use aluminum valves.

2.2.1 Types of Fuel

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NOTE: Select type of fuel and insert expected temperature extremes.

****

Components must be suitable for use with [F-24 turbine fuel (Jet A with additives FSII, CI/LE, and SDA); specific gravity 0.81 at 16 degrees C 60 degrees F; viscosity 1.62 CS at 16 degrees C 60 degrees F; Reid vapor pressure less than 0.35 kPa 0.05 psi, ASTM D1655] [JP-4 turbine fuel; specific gravity 0.76 at 16 degrees C 60 degrees F; viscosity 0.92 CS at 16 degrees C 60 degrees F; Reid vapor pressure 14 to 21 kPa 2 to 3 psi, MIL-DTL-5624] [JP-5 turbine fuel; specific gravity 0.82 at 16 degrees C 60 degrees F; viscosity 1.62 CS at 16 degrees C 60 degrees F; Reid Vapor pressure less than 0.35 kPa 0.05 psi, MIL-DTL-5624] [_____].

2.2.2 Carbon Steel Piping

Subject each length of pipe to factory hydrostatic testing and ultrasonic testing in accordance with their respective pipe specification.

a. Piping 300 mm 12-inches and Larger: API Spec 5L Product Specification Level (PSL) 1, Grade B, [seamless] [seamless or electric welded] [submerged-arc welded or gas metal-arc welded]; or ASTM A53/A53M Grade B, [seamless] [seamless or electric welded] [submerged-arc welded or gas metal-arc welded]; all having a wall thickness of 9 mm 0.375-inch.

b. Piping 65 through 250 mm 2-1/2 through 10 inches: Schedule 40, API Spec 5L Product Specification Level (PSL) 1, Grade B, [seamless] [seamless or electric welded] [submerged-arc welded or gas metal-arc welded] Grade B; or Schedule 40, Seamless, ASTM A53/A53M Grade B.

****

NOTE: Use schedule 80 for most piping 2 inches and smaller; except for extreme/high corrosion environments such as the tropics use Schedule 160 for aboveground and underground piping.

****

c. Piping 50 mm 2-inches and Smaller: Schedule [80][160], API Spec 5L Product Specification Level (PSL) 1, Grade B, [seamless] [seamless or electric welded] [submerged-arc welded or gas metal-arc welded] Grade B; or Seamless, Schedule [80] [160] ASTM A53/A53M Grade B.

****

NOTE: Unless otherwise directed by the Service Headquarters, interior coat the piping as follows:

Do not interior coat carbon steel piping for fuels other than aviation jet fuels.

Do not interior coat carbon steel piping for jet fuel service in bulk fuel operations like Bulk Fuel Farms, Defense Fuel Support Points (DFSPs), Marine Pier Receipt/Issue, intraterminal transfer pipelines, and interterminal transfer pipelines.

Interior coat all carbon steel piping for jet fuel service in systems that directly load aircraft or that fill aircraft refueler trucks after receipt filtration. Do not interior coat carbon steel piping before receipt filtration.
****

d. Internal Pipe Coating (Epoxy Lining) for piping 90 mm 3.5 inches and larger must be internally coated with an epoxy coating in accordance with MIL-PRF-4556 and in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEMS. The ends of the pipe must be masked or wiped back a minimum of 25 mm one-inch but not more than 40 mm 1-1/2 inches.

2.2.3 Stainless Steel Piping

a. Piping:

(1) ASTM A358/A358M, Grade 304L, Class 1 or Class 3 with supplementary requirements of S1, S2 and S3, or ASTM A312/A312M Type 304L, seamless (only). Any agreements between the purchaser and the manufacturer or supplier as referenced in the applicable ASTM must include the Contracting Officer as a party to the agreement. All longitudinal piping welds will receive 100 percent radiographic inspection, 100 percent liquid penetrant inspection, 100 percent visual inspection and all tests as required by the applicable ASTM Standard. All other welds must be inspected per Section 33 52 23.15 POL SERVICE PIPING WELDING. ASTM A312/A312M seamless piping must be provided with a minimum schedule 10S wall thickness for pipe 200 mm 8 inches and larger; minimum schedule 40S for pipe smaller than 200 mm 8 inches (except for threaded pipe which must be minimum Schedule 80S).

(2) Pipe Ends: All Piping must be provided with beveled ends per Chapter V, ASME B31.3, and must be shipped with the ends capped.

****
NOTE: Do not require Factory Testing and Inspection Records be provided if calculations show that the maximum normal system operating pressure, pump deadhead pressure, or any thermal relief valve setpoint is 100 psig or less and the system surge pressure does not exceed 150 psig.
****

(3) Factory Testing and Inspection Records: Per Table K341.3.2 of Chapter IX of ASME B31.3, visual, radiographic and liquid penetrant tests must be performed for each section of piping provided as all sections are subjected to cyclic conditions. All testing and inspections records must be submitted to the Contracting Officer and must indicate the pipe mark and installed location of each piping section on the project site. Observation by the Contracting Officer of the manufacturers and the fields testing and inspection procedures must be allowed under this

contract. Pipe certification along with pipe markings must be submitted before the pipe arrives on the job site.

(4) Qualifications of Owner's Inspector: Provide a qualified inspector in accordance with Chapter VI of ASME B31.3. to act as the owner's inspector (for the Government) at the pipe manufacturer's facility in addition to the manufacturer's inspector.

(5) Quality Assurance Plan: Submit Quality Assurance Plan for the welding, inspecting and testing of the welded seam pipe.

b. Stainless Steel Control Tubing: Seamless, fully annealed tubing conforming to ASTM A269/A269M, Grade TP316, Rockwell hardness B80 or less. Wall thickness for 13 mm 1/2-inch tubing to be a minimum of 1.2 mm 0.049-inch.

[2.2.4 Steel Reinforced Flexible Pipe

****

NOTE: Service Headquarters must approve use of HDPE steel reinforced flexible pipe. Do not use HDPE steel reinforced flexible pipe aboveground.

The use of steel reinforced flexible pipe in lieu of traditional double-walled underground piping on projects in states that require double-walled underground piping needs to be coordinated between the system designer and the state agency that regulates underground piping. The test protocol to be used for testing the integrity of steel reinforced flexible pipe will need to be provided by the piping supplier and be accepted by the state regulatory agency as equivalent to the traditional double-walled underground piping test protocol required by that agency.

****

Steel Reinforced High Density Polyethylene (HDPE) flexible piping must be manufactured in accordance with API Spec 17J and consist of an inner layer of HDPE material, a steel reinforcing layer and an outer HDPE protective layer.

]2.2.5 External Protective Coatings for Aboveground Piping

Provide exterior coating of aboveground piping and fittings, piping in pits, pipe supports, filter separators, and miscellaneous metal and system components in accordance with Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. Color of finish coat must be [white][beige]. Do not coat aboveground stainless steel or aluminum surfaces.

[2.2.6 External Protective Coatings for Buried Steel Piping

2.2.6.1 Carbon Steel Piping

a. New pipe and fittings must be factory coated in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

b. Field joints and repairs must be in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEMS.

c. Field joints and repairs in tight spots (valve pits when heaters are too big) must be liquid epoxy in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEMS.

d. Existing systems must match existing coating system and must be in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEMS.

[e. Abrasion-resistant topcoat. Following the initial FBE coating application, provide a 20 mil thick abrasion-resistant FBE topcoat. Abrasion-resistant topcoat must be specifically suited for directional boring piping installation.

]2.2.6.2 Stainless Steel Piping

****

NOTE: Use AWWA C210 liquid-epoxy coating system when piping is to be installed in non-fuel contaminated soil. For fuel contaminated soil, external coating system must be in accordance with 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES, however, application of the polyurethane top coat is not required.

****

Provide exterior coating of piping with factory coated AWWA C210 Liquid-Epoxy Coating System.[Provide exterior coating of piping with a zinc-rich epoxy/epoxy coating system in accordance with 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. For buried piping systems omit the polyurethane top coat.]

Damaged Areas of Pipe Coating: Provide exterior coating of piping with AWWA C210 Liquid-Epoxy Coating System.[Provide exterior coating of piping with a zinc-rich epoxy/epoxy coating system in accordance with 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. For buried piping systems omit the polyurethane top coat.]

Fittings, Couplings, and Regular Surfaces: Provide exterior coating of piping with AWWA C210 Liquid-Epoxy Coating System.[Provide exterior coating of piping with a zinc-rich epoxy/epoxy coating system in accordance with 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. For buried piping systems omit the polyurethane top coat.]

Testing of Protective Coatings: Perform tests with an approved silicone rubber electric wire brush or an approved electric spring coil flaw tester. Tester must be equipped with an operating bell, buzzer, or other audible signal which will sound when a holiday is detected at minimum testing voltage equal to 6,275 times the square root of the average coating thickness in mils. Tester must be a type so fixed that field adjustment cannot be made. Calibration by tester manufacturer must be required at six-month intervals or at such time as crest voltage is questionable. Certify in writing the calibration date and crest voltage setting. Maintain the battery at ample charge to produce the crest voltage during tests. Areas where arcing occurs must be repaired by using material identical to original coating or coating used for field joints. After installation, retest the exterior surfaces, including field joints, for holidays. Promptly repair holidays.

[2.2.6.3 Rock Shield, Direct Buried Piping

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NOTE: Specify rock shield where select fill is not available and possibility of damage from rock fill exists.

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Provide a minimum 10 mm 3/8-inch-thick perforated rock shield around buried piping. Rock shield must consist of a polyethylene outer surface bonded to a closed cell foam substrate with uniform perforations intended for use with cathodic protection systems. Rock shield must overlap on itself no less than 152 mm 6 inches. Secure rock shield tightly to the pipe using either strapping tape or plastic ties. Air filled cell type rock shield is prohibited.

]]2.2.7 Fittings

2.2.7.1 General

Welding ells, caps, tees, reducers, must be of materials compatible for welding to the pipeline in which they are installed, and wall thickness, pressure and temperature ratings of the fittings must be not less than the adjoining pipeline. Unless otherwise specified herein or required by the conditions of installation, all elbows must be the 1.5 diameter (D) type. Miter joints are not acceptable. Make odd angle offsets with pipe bends or elbows cut to the proper angle. Butt weld fittings must be factory-made wrought fittings manufactured by forging or shaping. Fabricated fittings will not be permitted. Welding branch fittings must be insert type suitable for radiographic inspections specified herein.

Make branch connections with butt-welded tees except where the branch is at least two pipe sizes smaller than the run, in which case the branch connection can be made with a forged or seamless branch outlet fitting. The branch outlet fitting must be designed in such a way that the connection can be radiographed. The branch outlet fittings may be a non-radiographicable if: the piping it is connected to is aboveground, the branch outlet size is 2.5 inches or less in diameter, and the branch outlet is located in contained pumphouses, contained truck offloads, contained truck fill stands, and other visibly contained areas equipped with containment curb.

2.2.7.2 Carbon Steel Fittings

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NOTE: Select option for piggable fittings if line is piggable.

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NOTE: Include the radiographicable examination of the fitting welds if calculations show that the maximum normal system operating pressure, pump deadhead pressure or any thermal relief setpoint is 689 kPa 100 psig or more, or if the system surge pressure exceeds 1034 kPa 150 psig.

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a. Fittings 65 mm 2.5 inches and Larger: Butt weld, conforming to

ASTM A234/A234M, grade WPB and ASME B16.9 of the same wall thickness as the adjoining pipe.[All welds must be radiographically examined throughout the entire length of each weld. Each fitting must be subjected to the Supplementary Requirements S3 and S4, Liquid Penetration examination and Magnetic-Particle Examination. Detectable flaws will not be accepted in the supplementary examinations. Fittings must be identified to relate them to their respective radiograph.]

b. Fittings 50 mm 2 inches and Smaller: Forged, butt weld or socket welded (except flanges, see below). If specifically indicated on drawings, non-flange fittings may be threaded. Socket welded or threaded fittings must be Class 3000, conforming to ASTM A105/A105M, Grade 2 and ASME B16.11. Threaded fittings must only be used for above grade applications. Underground and in pits, low point drain pipe, and high point vent pipe must be butt welded.

c. Flanges: Class 150 weld neck, butt weld, forged flanges conforming to ASTM A105/A105M, and ASME B16.5 except flanges that are to be connected to pumps must match the pump flanges rating. Threaded and slip-on flanges are not allowed. Flanges to be 2 mm 1/16-inch raised face with modified spiral serrated gasket surface finish, except where required otherwise to match system components furnished. Match flange face to valves or system components furnished. Flange face must be machined to match valves or system components furnished. Use of spacing rings or gaskets discs are not allowed. Flanges must be subjected to the Supplementary Requirements S56, Liquid Penetrant Examination as outlined in ASTM A961/A961M. Detectable flaws will not be accepted. For flanges 50 mm 2 inches and smaller located in contained pumphouses, contained truck offloads, contained truck fill stands, and other visibly contained areas the fitting may be forged (socket welded), Class 150, conforming to ASTM A105/A105M, Grade 2 and ASME B16.5. In pits, vaults, on thermal relief valve piping for pipeline routes, and other uncontained locations the flanges must be radiographicable, butt welded, weld neck type.

[d. Piggable System

(1) Provide barred tees on all branch outlets 50 mm 2-inch and larger when within 6.1 meters 20 feet of pig launcher or receiver barrel, including the barrels. Provide barred tees on all size outlets greater than 50 mm 2-inch in size with any part of the outlet on the bottom half of the pipe. Provide barred tees on all branch connections equal to or greater than 50 percent of piggable line size.

(2) Use 1.5 D elbows, or 3 D sweeps between pig launchers and receivers. Do not place 1.5 D elbows back to back.

] e. Interior Epoxy Coating System must be applied to the fittings as specified in paragraph CARBON STEEL PIPING.

2.2.7.3 Stainless Steel Fittings

****

NOTE: Select option for piggable fitting if line is piggable.

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a. Fittings 65 mm 2.5 inches and Larger: Butt weld stainless steel conforming to ASTM A403/A403M, Class WP, Type 304L, seamless or welded, and ASME B16.9 of the same minimum wall thickness as the adjoining pipe. Welded fittings must be tested and inspected the same as the welded seam pipe and meet the same requirements as for the pipe.

b. Fittings 50 mm 2 inches and Smaller: Forged Type 304 or 304L , butt weld, or socket welded (except flanges, see below). If specifically indicated on drawings, non-flange fittings may be threaded. Socket welded or threaded fittings must be Class 3000 conforming to ASTM A182/A182M and ASME B16.11. Threaded fittings must only be used for above grade applications. Underground and in pits, low point drain pipe, and high point vent pipe must be butt welded.

c. Unions: Conforming to ASTM A182/A182M, Grade 304 or 316.

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NOTE: Type 304L stainless steel flanges are prohibited and must not be specified.

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d. Flanges. Class 150 weld neck, butt weld, forged Type 304 stainless steel flanges conforming to ASTM A182/A182M and ASME B16.5, except flange that are to be connected to pumps must match the pump flanges rating. Threaded and slip-on flanges are not allowed. Flanges to be 2mm 1/16-inch raised-face with modified spiral serrated gasket surface finish, except where required otherwise to match system components furnished. Flange face must be machined to match valves or system components furnished. Match flange face to valves or system components furnished. Flanges must be subjected to the Supplementary Requirements S56, Liquid Penetrant Examination as outlined in ASTM A961/A961M. Detectable flaws will not be acceptable. For flanges 50 mm 2 inches and smaller located in contained pumphouses, contained truck offloads, contained truck fill stands, and other visibly contained areas the fitting may be forged (socket welded), Class 150, conforming to ASTM A182/A182M and ASME B16.5. In pits, vaults, on thermal relief valve piping for pipeline routes, and other uncontained locations the flanges must be radiographicable, butt welded, weld neck type.

[e. Piggable System:

(1) Provide barred tees on all branch outlets 50 mm 2-inch and larger when within 6 m 20 feet of pig launcher or receiver barrel, including the barrels. Provide barred tees on all size outlets greater than 50 mm 2-inch in size with any part of the outlet on the bottom half of the pipe. Provide barred tees on all branch connections equal to or greater than 50 percent of piggable line size.

(2) Use 1.5 D elbows, or 3 D sweeps between pig launchers and receivers. Do not place 1.5 D elbows back to back.

] f. Stainless Steel Tube Fittings. Flareless, 316 stainless steel fittings conforming to SAE J514.

[2.2.7.4 Steel Reinforced Flexible Pipe Fittings

End connections and mid-line connections for steel reinforced high density polyethylene (HDPE) flexible pipe must be of stainless steel swaged onto the pipe ends.

End connections must terminate in either flanged or weld ends as indicated. Mid-line connections must terminate in flanged fittings if they are in a pit or double swage type if they are not.

]2.2.8 Insulating Flange Kits (Electrically Isolating)

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NOTE: Use in the following locations to avoid affecting the underground piping cathodic protection system:

a. Where piping transitions from aboveground to underground.

b. Below drain and vent valves in underground pits and valve vaults.

c. On both sides of motorized valves in underground valve vaults.

NOTE: Provide weatherproof lightning surge arrester around insulating flange kits where piping transitions from aboveground to underground.

NOTE: These gaskets are often installed to prevent corrosion between two flanges constructed of dissimilar metals such as carbon steel and stainless steel. Experience in even extremely corrosive marine environments shows them to be of little use in preventing flange to flange corrosion; the corrosion in those cases are usually the flange face and/or fasteners corroding to themselves. Before using to prevent flange to flange corrosion, contact Base Personnel and try and determine what kind of corrosion they have and how severe it is.

NOTE: Provide flange protectors where indicated and at cathodic protection isolating flanges.

****

Provide ASTM D229 electrical insulating material of 1,000 ohms minimum resistance or 500 Volts per mil (VPM) minimum dielectric strength; material must be resistant to the effects of aviation and non-aviation hydrocarbon fuels. Provide full face insulating gaskets between flanges. Provide full surface 0.75 mm 0.03-inch thick wall thickness, spiral-wound mylar insulating sleeves between the bolts and the holes in flanges; bolts may have reduced shanks of a diameter not less than the diameter at the root of threads. Provide 3 mm 0.125-inch thick high-strength phenolic insulating washers next to flanges and provide flat circular stainless steel washers over insulating washers and under bolt heads and nuts. Provide bolts 12 mm 0.5-inch longer than standard length to compensate for the thicker insulating gaskets and the washers under bolt heads and nuts. Above grade flanges separated by electrically insulating flange kits must be provided with weatherproof lightning surge arrester devices. The surge arrester must bolt across flanges separated by insulating gasket kits per detail on contract drawings. Provide with flange protector as described in this section. The arrestor must have the following features:

a. Weatherproof NEMA 4 enclosure.

b. Bidirectional and bipolar protection.

c. Constructed of solid state components, no lights, fuses or relays and used without required maintenance or replacement.

d. Withstand unlimited number of surges at 50,000 Amperes.

e. Maximum clamping voltage of 700 Volts based on a IEEE C62.41.2 8x20 microsecond wave form at 50,000 Amperes peak measured at the device terminals (zero lead length).

f. A UL listed arrester for installation in Class 1, Division 1 and Division 2, Group D, hazardous areas.

Install the mounting bracket and leads on the flange side of the bolt insulating sleeve and washer, and size in accordance with this schedule:

Line Size	Bolt Size
50 mm 2 inch	16 mm 5/8 inch
65 mm 2.5 inch	16 mm 5/8 inch
80 mm 3 inch	16 mm 5/8 inch
100 mm 4 inch	16 mm 5/8 inch
150 mm 6 inch	19 mm 3/4 inch
200 mm 8 inch	19 mm 3/4 inch
250 mm 10 inch	22 mm 7/8 inch
300 mm 12 inch	22 mm 7/8 inch
350 mm 14 inch	25 mm 1 inch
400 mm 16 inch	25 mm 1 inch
Note: Make allowance for the1 mm 1/32-inch thickness of the insulating sleeve around the bolts when sizing the mounting lugs.	

2.2.9 Bolts, Nuts and Washers

a. Bolts and nuts for pipe flanges, flanged fittings, valves and accessories must conform to ASME B18.2.1 and ASME B18.2.2, except as otherwise specified.

b. Bolts must be of sufficient length to obtain full bearing on the nuts and must project no more than three full threads and no less than two full threads beyond the nuts with the bolts tightened to the required torque.

c. Bolts must be regular hexagonal bolts conforming to ASME B18.2.1 with material conforming to ASTM A193/A193M, Class 2, Grade B8, stainless steel, when connections are made where a stainless steel flange is involved, and Grade B7, chromium molybdenum alloy, when only carbon steel flanges are involved. Bolts and nuts chosen must have sufficient strength to seat gasket types chosen. Bolts must be threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes 25 mm one-inch and smaller and Eight-Pitch Thread Series for sizes larger than 25 mm one-inch.

d. Nuts must conform to ASME B18.2.2, hexagonal, heavy series with material conforming to ASTM A194/A194M, Grade 8, stainless steel for stainless steel bolts, and Grade 7, chromium molybdenum allow for chromium molybdenum alloy bolts. Nuts must be threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes 25 mm one-inch and smaller and Eight-Pitch Thread Series for sizes larger than 25 mm one-inch.

e. Provide washers under bolt heads and nuts. Use chromium molybdenum alloy washers dimensioned to ASTM F436 flat circular for chromium molybdenum bolts. Stainless steel washer dimensioned similar to ASTM F436 flat circular, use material the same as the bolt.

f. Use torque wrenches to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tight in the pattern recommended by the gasket manufacturer. Use anti-seize compound on stainless steel bolts.

2.2.10 Flange Gaskets, Non-Metallic, Non-Electrically Isolating

ASME B16.21, composition ring, using a Nitrile Rubber such as Buna-N and NBR, polytetrafluoroethylene (PTFE), or a fluoro rubber such as FKM, FPM and Viton©. The gasket must be 3 mm 0.1250-inch thick. Gaskets must be resistant to the effects of aviation and non-aviation hydrocarbon fuels and manufactured of fire-resistant materials. Full-face gaskets must be used for flat-face flanged joints. Ring gaskets must be used for raised-face flanged joints. Gaskets must be of one piece factory cut. Select a gasket suitable for the working and test pressure of the fluid.

2.2.10.1 Nitrile Butadiene (Buna-N)

Provide Buna-N material that conforms to SAE AMS3275.

2.2.10.2 Acrylonitrile Butadiene Rubber (NBR)

Provide NBR material that conforms to SAE AMS3275.

2.2.10.3 Polytetrafluoroethylene (PTFE)

Provide PTFE material that conforms to ASTM F336.

2.2.10.4 Fluoro Rubber FKM

Provide FKM material that conforms to ASTM D1418.

2.2.10.5 Fluoroelastomer FPM

Provide FPM material that conforms to ISO 1629.

2.2.11 Flange Gaskets, Metallic

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NOTE: Inner rings are mandatory for Class 900 and higher flanges.

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NOTE: Metallic Gaskets are not to be used where electrical isolation is required.

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ASME B16.20, spiral-wound metal gaskets with [inner and] outer rings. Gaskets must be suitable for use on flat-face and raised-face flanges. The winding material is stainless steel 304 or 316L. The filler material is graphite or PTFE. The gasket must be in accordance with Military Specification MIL-G-24716. Select a gasket suitable for the working and test pressure of the fluid.

2.2.12 Flange Protectors

****

NOTE: Provide at all cathodic protection isolation flanges from shorting out due to debris collecting in/on flange. Use the UV plastic type if possible as the stainless steel bands sometimes "ground out" the insulating flange.

Use in tropics and waterfront locations for all size flanges to minimize/prevent water migration between the flange faces and prevent corrosion.

****

Protectors must protect the bolts, studs, nuts, and gaskets of a flanged end connection from corrosion or damage due to exposure to the environment. Protectors must be weather and ultraviolet (UV) resistant. Protectors must allow for quick and easy removal and re-installation by maintenance personnel. Provide grease filled bolt caps. Corrosion Prevention grease must be non-expansive and designed for the service.[Provide protectors that allow visual inspection of the flange gasket without requiring removal.][For electrically insulating flange connections, provide protectors with grease fittings that allow the injection of grease into the flange cavity.]

2.3 MANUAL VALVES

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NOTE: Per Service Headquarters or officially designated alternate for marine environment, provide stainless steel valves on exterior (aboveground and in pits) piping.

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NOTE: Select option for piggable valves if line is piggable.

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All portions of a valve coming in contact with fuel in stainless steel pipelines or epoxy lined carbon steel pipelines must be of noncorrosive material. Valves in stainless steel pipelines or epoxy lined carbon steel pipelines must be Type 304 or Type 316 stainless steel or carbon steel internally plated with chromium or nickel or internally electroless nickel plated. Valves in unlined carbon steel pipelines must have carbon steel body. Stem and trim must be stainless steel for all valves. Manually operated valves 150 mm 6 inches and larger must be worm-gear operated and valves smaller than 150 mm 6 inches must be lever operated or handwheel operated. Valves smaller than 50 mm 2 inches must have lever-type handles. Valves installed more than 2.4 m 8 feet above finished floor must have chain operators and a position indicators visible from ground level. Sprocket wheel for chain operator must be aluminum.[Valves in the piggable line flow path between the pig launchers and the pig receivers, including the valves in the isolation valve pits must be full bore, piggable, double block and bleed type. The full bore piggable valves at the launcher and the receiver must be ball type. Valves must be true full bore with no projections extending into the flow path of the pig train.]

2.3.1 Ball Valves

Ball valves must be fire tested and qualified in accordance with the requirements of API Std 607 and API STD 608. Seal material for the fire test must be graphite, seal material for the project must be as as indicated below. Ball valves must be nonlubricated valves that operate from fully open to fully closed with 90-degree rotation of the ball. Valves 2 inches and larger must conform to applicable construction and dimension requirements of API Spec 6D, ANSI Class 150 and must have flanged ends. Valves 50 mm 2 inches and larger must conform to applicable construction and dimension requirements of API Spec 6D, ANSI Class 150 and must have flanged ends. The balls in valves 250 mm 10 inches and larger full port and 300 mm 12 inches and larger regular port and larger must have trunnion type support bearings. Except as otherwise specified or indicated, reduced port or full port valves may be provided at the Contractor's option. Balls must be solid, not hollow cavity.

2.3.1.1 Materials

Ball must be stainless steel. Ball valves must have tetrafluoroethylene (TFE) or fluoroelastetomer (FKM), commonly referred to as Viton seats, body seals and stem seals. Valves 100 mm 4 inches and smaller must have a locking mechanism.

2.3.1.2 V-Port Ball Valve

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NOTE: Primarily used on Truck Offloading System to set minimum offload flow rate.

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Valve must conform to requirements as specified for BALL VALVES paragraph in this section. Valve must be provided with characterized linear v-port for flow rate control, and with infinite position lever bracket with locking bolt for set position.

2.3.1.3 Full Port Ball (DBBV) Valves for Piggable Lines

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NOTE: Select option for piggable valves if line is piggable.

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Required for piggable lines, and where indicated elsewhere. Ball valves must be designed, manufactured, and tested to API Spec 6D, fire-safe and tested to API Spec 6FA, and BS EN ISO 10497 (BS 6755, Part 2). Seal material for the fire test must be graphite, seal material for the project must be as as indicated below. Valves must be trunnion-mounted with independent spring and hydraulically actuated, floating, single piston effect, self-relieving seat rings, with bi-directional sealing. Ball must be solid type with full through-conduit opening, suitable for passage of pipeline pigs. Stem must be anti-static, blow-out-proof design with o-ring seals and provided with an emergency sealant injection fitting. Valves must be 3-piece, bolted body design with raised-faced ANSI Class 150 flanged connections, equipped with body drain/bleed valve and vent fitting, and suitable for double block and bleed service in the closed and open positions. Valves must be all stainless steel construction, or carbon steel with stainless steel stem, and all wetted parts electroless nickel-plated. Valves must have nylon, devlon, or polytetrafluoroethylene (TFM) seat inserts, FKM B body, stem, and seat o-rings, with stainless steel and graphite body gaskets and graphite secondary stem seals. Valves located in vaults or pits must be equipped with actuator extensions.

2.3.1.4 Electric Valve Actuator

Electric valve actuator must be as indicated for Plug (Double Block and Bleed) Valves, electric valve actuator.

2.3.2 Plug (Double Block and Bleed) Valves

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NOTE: Select option for piggable valves if line is piggable.

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API Spec 6D, API Spec 6FA, ANSI Class 150, non-lubricated, resilient, double seated, trunnion mounted, tapered lift plug capable of two-way shutoff. Valve must have tapered plug of steel or ductile iron with chrome or nickel plating and plug supported on upper and lower trunnions. Sealing slips must be steel or ductile iron, with Viton seals which are held in place by dovetail connections. Valve design must permit sealing slips to be replaced from the bottom with the valve mounted in the piping. Valves must operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves must have weatherproof operators with mechanical position indicators. Indicator shaft must be stainless steel. Minimum bore size must be not less than 65 percent of the internal cross sectional area of a pipe of the same nominal diameter unless bore height of plug equals the nominal pipe diameter and manufacturer can show equal or better flow characteristics of the reduced bore size design.[Valves in the piggable line flow path between the pig launchers and the pig receivers, including the valves in the isolation valve pits, in fuel piping between the pig launchers and the pig receivers must be full bore, piggable. Valves must be true full bore with no projections extending into the flow path of the pig train. Full port plug valves in distribution piping must be provided with a 15 mm 1/2-inch threaded body drain.]

2.3.2.1 General

Valves in the operating tank suction and fill lines and the valves at the four valve manifold in the pump room in the tank fill lines must be provided with a factory-installed limit switch that is actuated by the valve closure. Tank fill line valve and four valve manifold limit switches must be provided with one double pole double throw contacts or four single pole, double throw contracts, two for open, two for closed. Tank suction line valve limit switches must be provided with one double pole double throw contacts or four single pole, double throw contacts, for closed, and one single pole double throw contact or two single pole, double throw contacts for open. All components must be watertight and U.L. listed for Class I, Division 1, Group D hazardous areas.

2.3.2.2 Valve Operation

Rotation of the handwheel toward open must lift the plug without wiping the seals and retract the sealing slips so that during rotation of the plug clearance is maintained between the sealing slips and the valve body. Rotation of the handwheel toward closed must lower the plug after the sealing slips are aligned with the valve body and force the sealing slips against the valve body for positive closure. When valve is closed, the slips must form a secondary fire-safe metal-to-metal seat on both sides of the resilient seal. Plug valves located in Isolation Valve Pits or vaults must be provided with handwheel extensions.

2.3.2.3 Relief Valves

ANSI Class 150. Provide plug valves with automatic thermal relief valves to relieve the pressure build up in the internal body cavity when the plug valve is closed. Relief valves must open at 175 kPa 25 psi differential pressure and must discharge to the throat of, and to the upstream side, of the plug valve.

2.3.2.4 Bleed Valves

ANSI Class 150, stainless steel body valve. Provide manually operated bleed valves that can be opened to verify that the plug valves are not leaking when in the closed position.

2.3.2.5 Electric Valve Actuator

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NOTE: Maximum available temperature ranges for a regular actuator is minus 30 degrees C to 70 degrees C minus 22 to 158 degrees F. A lower temperature rating than that will result in an actuator encapsulated in insulation making access top manual controls and the handwheel difficult.

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The actuator, controls and accessories must be the responsibility of the valve-actuator supplier for sizing, assembly, certification, field-testing and any adjustments necessary to operate the valve as specified. The electric valve actuator must include as an integral unit the electric motor, actuator unit gearing, limit switch gearing, position limit switches, torque switches, drive bushing or stem nut, declutch lever, wiring terminals for power, remote control, indication connections and handwheel. The electrically actuated plug valve must be set to open and close completely in 30 to 60 seconds against a differential pressure of 2 MPa 275 psig. The actuator settings of torque and limit contacts must be adjustable. The valve actuator must be suitable for mounting in a vertical or horizontal position and be rated for 30 starts per hour. The valve actuator must be capable of functioning in an ambient environment temperature ranging from [_____] [minus 38 to 70 degrees C] [minus 22 to 158 degrees F].

a. The electrical enclosure must be specifically approved by UL or Factory Mutual for installation in Class I, Division 1, Group D locations.

b. The electric motor must be specifically designed for valve actuator service and must be totally enclosed, non-ventilated construction. The motor must be capable of complete operation at plus/minus 10 percent of specified voltage. Motor insulation must be a minimum NEMA Class F. The motor must be a removable subassembly to allow for motor or gear ratio changes as dictated by system operational requirements. The motor must be equipped with an embedded thermostat to protect against motor overload and also be equipped with space heaters. It must de-energize when encountering a jammed valve.

c. The reversing starter, control transformer and local controls must be integral with the valve actuator and suitably housed to prevent breathing or condensation buildup. The electromechanical starter must be suitable for 30 starts per hour. The windings must have short circuit and overload protection. A transformer, if needed, must be provided to supply all internal circuits with 24 VDC or 110 VAC may be used for remote controls.

d. The actuator gearing must be totally enclosed in an oil-filled or grease-filled gearcase. Standard gear oil or grease must be used to lubricate the gearcase.

e. The actuator must integrally contain local controls for Open, Close and Stop and a local/remote three position selector switch: Local Control Only, Off, and Remote Control plus Local Stop Only. A metallic handwheel must be provided for emergency operation. The handwheel drive must be mechanically independent of the motor drive. The remote control capability must be to open and close. Rim pull to operate valve manually must not exceed 28 kg 80 pounds.

f. Position limit switches must be functional regardless of main power failure or manual operation. Four contacts must be provided with each selectable as normally open or normally closed. The contacts must be rated at 5A, 120 VAC, 30 VDC.

g. Each valve actuator must be connected to a PLC supplied by "others".

h. The actuator must have a local display of position even when power has been lost.

i. The actuator must be supplied with a start-up kit comprising installation instruction, electrical wiring diagram and spare cover screws and seals.

j. The actuator must be performance tested and a test certificate must be supplied at no extra charge. The test should simulate a typical valve load with current, voltage, and speed measured.

2.3.3 Swing Check Valves

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NOTE: Limited to 2-inch size and below. Used in underground PRT fill line.

****

Swing check valves must conform to API STD 600, regular type, ANSI Class 150 with flanged end connections. Discs and seating rings must be renewable without removing the valve from the line. The disc must be guided and controlled to contact the entire seating surface.

2.3.4 Silent Check Valves

Spring assisted, wafer/tapped lug pattern, butterfly check with or globe type FKM or PTFE seat ring, designed to prevent flow reversal slamming of valve, dual plate, and must conform to ASME B16.34, API Std 594, except face to face dimensions may deviate from standard. Valves must be suitable for installation in any orientation. Valve body and trim material must be as previously indicated herein.

2.3.5 Butterfly Valve with Fusible Link Operator

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NOTE: Consult with Service Headquarters or officially designated alternate before using this valve. Not permitted on Air Force projects. There are specific locations this valve is to be used on Navy projects in accordance with UFC 3-460-01. The sole function of the valve is to provide a separate shutoff of the supply and return piping at each pantograph assembly in the event of a fire.

****

Valve must conform to API Std 609. Valve must meet the fire test requirements of API Std 607. Valve must be designed for bubble tight bidirectional shutoff service at operating conditions. Disc must be Type 304L or Type 316, stainless steel. Stem must be ASTM A276/A276M Type 416 or ASTM A564/A564M Type 630 stainless steel. Seal ring must be Teflon with metal backup. Stem seals must be capable of withstanding the rated pressure and temperature of the valve seat. Provide valves 6 inches and larger and valves at pump discharge with weatherproof gear operators with handwheel; other valves must have minimum 10 position throttling handles. Valve must have a fusible link type valve operator. The fusible link and spring assembly must close the valve automatically when the link material melts at 71 degrees C 165 degrees F and lock the valve in the closed position. Spring assembly must be fully enclosed to ensure safety. Provide valve with flanged end connections independent of other flanged end connections provided on items such as system components, piping, piping components, or valves.

2.3.6 Globe Valve

Valve must conform to ASME B16.34, Class 150.

2.4 THERMAL RELIEF VALVE

2.4.1 Valve Material

Valves must have carbon steel bodies (stainless steel on stainless steel pipelines) and bonnets with stainless steel springs and trim. Valves must be Class 150 flanged end connections.

2.4.2 Thermal Relief Valve (ASME Type)

Thermal relief valves must be the fully enclosed, spring loaded, angle pattern, single port, hydraulically operated type with plain caps, and must be labeled in accordance with ASME BPVC SEC VIII D1. Valve stems must be fully guided between the closed and fully opened positions. The valves must be factory-set to open at pressures indicated on the drawings. Operating pressure must be adjustable by means of an enclosed adjusting screw. The valves must have a minimum capacity of 20 GPM at 10 percent overpressure. Valves must have a replaceable seat. Relief valves that do not relieve to a zone of atmospheric pressure or tank must be a balanced type relief valve.

2.4.3 Thermal Relief Valve (Balanced Type)

Thermal relief valves that do not relieve to a zone of atmospheric pressure or atmospheric tank must be a balanced type relief or regulator valve.

Thermal relief valves must be the fully enclosed, spring loaded, angle pattern, single port, fully balanced type (back pressure must not affect relief pressure) back pressure regulator/relief valve. Set valve at pressure indicated on drawings. Valve body must have 25 mm one-inch (minimum) raised face flange connections unless otherwise indicated. Orifice must have a minimum orifice size of 15 mm 0.500-inch in diameter. Valve must have bubble-tight piston and seat design with stainless steel piston and Viton seat. Valve must be selected for the nominal flow condition of: pass a minimum of [18] liters per minute [5] gallons per minute, at a differential pressure of [380] kilopascal [55] psig, with a nominal set pressure of [345] kilopascal [50] psig. Valve must be factory configured to open at required set pressure but must be field adjustable by means of an enclosed adjusting screw.

2.5 PIPING ACCESSORIES

2.5.1 Flexible Ball Joints

****

NOTE: Indicate the location and details of each pipe expansion joint, amount of pipe movement, and pipe anchors on the drawings.

****

Flexible ball joints must be [stainless steel] [carbon steel with electroless nickel-plating to a minimum of 0.075 mm 3 mils thickness], capable of 360-degree rotation plus 15-degree angular flex movement, ASME B16.5, Class 150 flanged end connections. Provide pressure molded composition gaskets designed for continuous operation temperature of 135 degrees C 275 degrees F. Joints must be designed for minimum working pressure of ANSI Class 150. Injectable packing will not be allowed.

2.5.2 Bellows Expansion Joints for Axial Movement

****

NOTE: Indicate the location and details of each pipe expansion joint, amount of pipe movement, and pipe anchors on the drawings.

Where joints are to be installed on piers or anywhere in direct contact with salt water is a possibility, then require the bellows to be constructed of inconel.

****

The expansion joints must be for axial compression and extension with capacity as per the design documents. Units must be of the externally pressurized design with internal and external integral guides and manufactured by an Expansion Joint Manufacturers Association certified manufacturer. They must incorporate multi-ply, Lo-corr bellows of [ASTM A240/A240M, 321/304 stainless steel] or[Inconel 625] if chlorides are present in the atmosphere. Unit must be equipped with travel limit stops, and internal guides vented to reduce the effects of sudden pressure changes. Flanges and housing must be stainless steel or carbon steel to match piping materials. Flanges must conform to ASME B16.5. Dual Expansion Joints must incorporate an intermediate anchor base. Housing must include lifting lug and drain port. Joints must be capable of 10,000 cycles over a period of 20 years.

Cold set joints to compensate for the temperature at the time of installation. Provide initial alignment guides on the connecting piping no more than 4 pipe diameters from the expansion joint. Provide additional alignment guides on the connecting piping no more than 14 pipe diameters from the first guide.

2.5.3 Mechanically Adjustable Segmented Elastomeric Seal

Mechanically adjustable segmented elastomeric seals must be constructed of fuel resistant Buna-N elastomers and Type 316 stainless steel fasteners and hardware.

2.5.4 Pipe Sleeves

Pipe sleeves must be installed where indicated and at all points where the piping passes through concrete construction. Such sleeves must be of sufficient inside diameter to provide a minimum clear distance between the pipe and the sleeve of 13 mm 1/2-inch. Sleeves through concrete pits or slabs must be standard weight carbon steel pipe with a protective coating. Each sleeve must extend through the respective pit wall or slab and must be provided with a wrap around Buna-N end seal (boot). (Viton when exposed to sunlight) and secured to the pipe sleeve and piping with adjustable stainless steel hose clamps. Sleeves where piping passes under roads or piping indicated to be double walled must be standard weight carbon steel pipe with a protective coating as previously specified. Alignment of the sleeve and piping must be such that the pipe is accurately centered within the sleeve by a nonconductive centering element. The sleeve must be securely anchored to prevent dislocation. Closure of space between the pipe and the pipe sleeve must be by means of a mechanically adjustable segmented elastomeric seal. The seal must be installed so as to be flush.

2.5.5 Strainers

2.5.5.1 Basket Type

****

NOTE: Provide 4-basket type at receipt line when that line is receiving fuel: from a interterminal pipeline, from a installation pipeline from Bulk Storage, from a marine receipt (barge or ship), and all other applications when receipt of fuel with large amounts of particulates is expected.

Provide single basket strainer when relatively clean fuel is expected.

Arrange two strainers in duplex fashion when

relatively dirty fuel is expected.
****

Strainer must be [single][multi (four)] basket type arranged in a [simplex][duplex] configuration as indicated in compliance with MIL-PRF-13789, except as specified otherwise. Strainer end connections must be designed in accordance with ASME B16.5, Class 150. Strainer body material must be the same as the material specified for manual valves. Strainers must have removable baskets of [7][40][60][100][_____] mesh wire screen with larger wire mesh reinforcement; wire must be stainless steel, Type 316. Pressure drop for clean strainer must not exceed 21 kPa 3 psig at maximum design flow rate. The ratio of net effective strainer area to the area of the connecting pipe must be not less than three to one. Each strainer must be provided with a suitable drain at the bottom, equipped with a ball valve. The strainer must be equipped with a direct-reading, piston type differential pressure gauge that measures the differential pressure across the basket as perin accordance with Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.5.5.2 Cone Type

Strainer must be stainless steel type 304 or 316, [7][40][60][100][_____] 100 mesh screen with the ratio of net open area of strainer to the area of the connecting pipe must be not less than three to one at the pump suction. Pump suction strainer must have a [7][40][60][100][_____]100 mesh screen with not less than 300 percent open area (ratio of the strainer open area to the cross section of pipe).

2.5.6 Thermometer

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NOTE: Used for Burner Fuels Oils and Lubricating Oils that require heating before pumping. Indicate the scale range for each thermometer on the drawings.
****

Analog, dial-type bimetallic actuated type that conforms to ASME B40.200. Thermometer must have a 125 mm 5 inches diameter dial, a hermetically sealed stainless steel case, a stainless steel stem, a safety glass face, a fixed threaded connection, and a scale range as indicated. Thermometer accuracy must be within one percent of the scale range.

2.5.7 Pressure Gauge

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.5.8 Pipe Supports

****
NOTE: Indicate installation details (including anchorage and spacing) of all supports on the drawings. Include applicable seismic zone design requirements.

For waterfront and projects in the tropics with condensing chloride environments, select galvanized options.
****

2.5.8.1 General

Pipe supports must conform to MSS SP-58. Design pipe supports to meet the applicable requirements of ANSI/ASME B31.3 or ANSI/ASME B31.4. Provide hot-dip galvanized finish on rods, nuts, bolts, washers, and supports.[Provide Type 316 stainless steel nuts, bolts, washers, and screws when located at a pier.] Provide miscellaneous metal that conforms to ASTM A36/A36M, standard mill finished structural steel shapes, hot-dipped galvanized.[Provide galvanizing in accordance with ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, Z275 G90.]

2.5.8.2 Adjustable Pipe Supports

Adjustable pipe supports must consist of a cast iron saddle and a threaded nipple connected to a carbon steel pipe by means of a special reducer conforming to MSS SP-58. The supports must be provided with PTFE insulation strips.

2.5.8.3 Low Friction Supports

Supports must have self-lubricating anti-friction bearing elements composed of 100 percent virgin tetrafluoroethylene polymer and reinforcing aggregates, prebonded to appropriate backing steel members. The coefficient of static friction between bearing elements must be 0.06 from initial installation for both vertical and horizontal loads and deformation must not exceed 51 micrometers 0.002-inch under allowable static loads. Bonds between material and steel must be heat cured, high temperature epoxy. Design pipe support elements for the loads applied. Provide anti-friction material with a minimum of 2.3 mm 0.09-inch thick. Provide hot-dipped galvanized steel supports. Provide supports that are factory designed and manufactured.

2.5.8.4 U-bolt Half Round Supports

Supports must have anti-friction bearing half-round in contact with the bottom of the pipe. Provide Polytetrafluoroethylene or like hydrophobic, anti-corrosive material half-round with a compressive strength of at least 69 mPa 10 ksi or greater as required. U-bolts must be installed in either a loose or limited guide configuration as indicated on the design drawings. Provide hot-dip galvanized u-bolts with seamless non-metallic low friction coating. U-bolt connection must be double nutted on the bottom and single bolted on top.

2.5.8.5 Concrete and Grout

Concrete and grout for anchors and supports must comply with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.5.9 Sample Connections

a. Sample connections must be factory assembled units specifically designed for obtaining representative samples from fuel pipelines. Each connection must include a 6 mm 1/4-inch sampling probe where the probe faces upstream, ball valve and 6 mm 1/4-inch quick disconnect coupling with dust plug, all assembled into a unit that is suitable for installation in a pipe nipple. The sampling probe must extend not less than 25 mm one-inch into the fuel pipe. All materials in the sample connections must be stainless steel or aluminum.

b. Furnish two sampling hose assemblies to the Contracting Officer at the project site. Each assembly must consist of a 1.8 m 6-foot length of 6 mm 1/4-inch clear plastic tubing with internal bonding/grounding wire. One end of the tubing will contain a male connector that actuates flow when inserted into the quick disconnect coupler. Each end of the bonding/grounding wire must be equipped with clips for attaching to the pipe and metal sample container.

[2.5.10 Sight Flow Indicators

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NOTE: Sight flow indicators are seldom used as they tend to leak when subjected to cyclic pressure spikes. Do not use without permission of the Service Headquarters or officially designated alternate.

****

Sight flow indicators must be ANSI Class 150 and must have flanged end connections. Sight flow indicators must consist of a housing containing a rotating propeller that is visible through a glass observation port. The housing must be stainless steel when installed in stainless steel lines and carbon steel when installed in carbon steel lines. The glass in the indicator must also meet the Class 150 rating.

]2.6 PIGGING SYSTEM COMPONENTS

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NOTE: Select option for piggable system components if line is piggable.

****

2.6.1 Maintenance Pig Launchers and Receivers

Construct of the same materials as the pipe, valves and fittings for a Class 150 system. The length of the straight barrel and the line size section must be 1.5 meters 5 feet each. Provide associated launcher kicker piping and receipt bypass piping, not less than 80 mm 3-inch in size for 150 mm 6-inch lines and 100 mm 4-inch for up to 250 mm 10-inch and 150 mm 6-inch for up to 350 mm 14-inch pipelines.

2.6.2 Smart Pig Launchers and Receivers

Construct of the same materials as the pipe, valves and fittings for a Class 150 system. The length of the straight barrel and the line size section must each be 4.5 meter 15-feet. Provide associated launcher kicker piping and receipt bypass piping, not less than 80 mm 3-inch in size for 150 mm 6-inch lines and 100 mm 4-inch for up to 250 mm 10-inch and 150 mm 6-inch for up to 350 mm 14-inch pipelines.

2.6.3 Launcher and Receiver Closure Door

The closure must be hinged, swing bolted closure of the same material as the pipe and for a Class 150 system. Gasket must be nitrile or viton. Eye bolts must be pinned to lugs on the hub.

2.6.4 Signaler

****

NOTE: Units suitable for removal under pressure are expensive and are not needed if they are serviced after the pig is launched or received. Consider their use before specifying.

****

The pig signaler must be mechanical flag type with manual reset, and be located on the pig launcher and the pig receiver. Material in contact with the fuel must be stainless steel. Units must be suitable for removal and installation under line pressure of 1.90 mPa 275 psig. Signaler must be capable of withstanding line pressure of a Class 150 system.

2.7 FLEXIBLE HOSE CONNECTORS

Flexible hoses connectors for fueling pumps must have ANSI Class 300 or 150 flanges to mate directly to the pump and Class 150 flanges to the system flanges. Flanges must be stainless steel and must conform to ASME B16.5. These units must have an inner stainless steel or Inconel, corrugated tube with external stainless steel braid, and all components must be rated for not less than 1.90 mPa 275 psig at 37 degrees C 100 degrees F. Face to Face dimension must be as recommended by the manufacturer. Use Inconel 625 inner bellows in coastal environments or where chlorides are present in the atmosphere.

For sizes larger than 150 mm 6 inches, connectors must incorporate the use of Lo-corr, multi-ply bellows, without external braid, with bellows rating of 300 psig and overall rating consistent with the flange ANSI class. Flanges must be plate type, Vanstone design, with axial movement control rods.

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system. The use of flexible connectors in permanently mounted pump suction and discharge lines as a method of compensating for piping misalignment is not acceptable.

2.8 AUTOMATIC AIR VENT

Unit must have 25 mm one-inch connections and automatically vent air under pressure, and prevent a vacuum when pressure drops below a positive pressure. As fuel fills the vent, a float must rise and form a drip-tight closure. The unit pressure rating must be a minimum of 2 MPa 275 psi. The float must be stainless steel. Body and cover be carbon steel or ductile iron and be internally epoxy coated.

2.9 SURGE SUPPRESSOR TANK AND VALVE

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NOTE: Seldom used device, typically on truck fillstands that are located a very long way from the pump house on a dead end line. Seek guidance from the Service Headquarters or officially designated alternate.

****

The unit must be fabricated from carbon steel, internally coated pressure vessel with a rubber bladder or a stainless steel diaphragm separating the fuel from the gas charge. The epoxy coating must be in accordance with

MIL-PRF-4556. The rubber bladder must be molded synthetic nitrile rubber (Buna-N). The unit must be constructed and labeled in accordance with ASME BPVC SEC VIII D1. The housing must be designed for a working pressure of 2 MPa 275 PSIG. The gas precharge must be dry nitrogen and must have a pressure gauge, gas valve, and an adapter for field charging. Bladder precharge pressure must be 550 KPa 80 PSIG [_____]. The connection to the piping system must be Class 150 ANSI flange, size as indicated on the drawings. The connection must have a check valve to provide unrestricted flow into the vessel and restricted flow from the vessel. The flange must have a 13 mm 1/2-inch NPT connection with a valve and adapter to relieve fluid pressure during gas recharging and to drain the vessel during removal. A charging assembly must be provided. The surge suppressor supplier must furnish a service person trained to provide installation check-out assistance and to supervise operation and testing necessary to place the surge control system into service and to provide training on charging, recharging, and checking the surge suppressor.

2.10 MISCELLANEOUS ACCESSORIES

2.10.1 Concrete Anchor Bolts

Concrete anchors must conform to ASTM A307, Grade C, hot-dipped galvanized.

2.10.2 Coatings for Bolts, Studs, Nuts, and Washers

Carbon steel bolts, studs, nuts, and washers must be provided with a factory applied [cadmium coating that conforms to ASTM B696 or ASTM B766] [hot-dipped zinc coating that conforms to ASTM F2329].

2.10.3 Polytetrafluoroethylene (PTFE) Tape

Tape must conform to ASTM D3308.

2.10.4 Pipe Sleeves

Provided sleeves constructed of [hot-dipped galvanized steel, ductile iron, or cast-iron pipe] [uncoated carbon steel pipe] conforming to ASTM A53/A53M, [Schedule 30] [Schedule 20] [Standard weight].

2.10.5 Escutcheon

Escutcheon must be the chrome plated, stamped steel, hinged, split ring type. Inside diameter must closely fit pipe outside diameter. Outside diameter must completely cover the corresponding floor, wall, or ceiling opening. Provided each escutcheon with necessary set screws.

2.10.6 Pipe Casings

****

NOTE: Cased pipe crossings must be specifically designed for the purpose, including depth of burial versus pipe wall thickness calculations using API criteria and pipe wall thickness required for installation method (such as jack and bore). Appropriate exterior coatings must be considered for the casing. Casings must be designed to be isolated from the piping cathodic protection system, and include a test station for confirmation testing of isolation between pipeline and casing. Project

drawings must fully detail method of centering pipe in casing, use of casing segmented seals, and boot to protect the segmented seal from soil backfill.

****

Provide carbon steel casings in accordance with paragraph MATERIALS. Provide coating in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEMS. Alignment of the casing and piping must be such that the pipe is accurately centered within the sleeve by a nonconductive centering device specifically manufactured for the purpose. Closure of space between the pipe and the casing must be by means of a mechanically adjustable segmented elastomeric seal. The casing must be provided with a wraparound Buna-N end seal (boot),(Viton when exposed to sunlight) and be secured to the piping with adjustable stainless steel hose clamps. Sleeves where piping passes under roads must be not less than standard weight carbon steel pipe with a protective coating. Provide cathodic test station, leads and bonding to the pipe and casing such that the isolation between the casing and piping CP system can be verified.

2.10.7 Buried Utility Tape

Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape in minimum 75 mm 3 inches width rolls, color coded for the utility involved, with warning identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning identification must be at least 25 mm one-inch high and must state as a minimum "BURIED JET FUEL PIPING BELOW". Provide permanent code and letter coloring that is unaffected by moisture and other substances contained in trench backfill material.

2.10.8 Pipeline Markers

Provide pipeline markers constructed of 150 mm 6 inches diameter, one-half inch thick bronze disk with a 75 mm 3-inch long bronze headed bolt welded to the back of the disk. Engrave the front of the disk with the words "UNDERGROUND FUEL LINE" in the case of one line and "UNDERGROUND FUEL LINES" in the case of multiple fuel lines.

2.11 FINISHES

2.11.1 Factory Coating

2.11.1.1 Valves

Valve surfaces must be blasted clean according to SSPC SP 5/NACE No. 1. Valve surfaces must be primed and coated in accordance with Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES.

2.11.1.2 Equipment and Components

****

NOTE: For all Navy projects (regardless of location), the 500 hour salt spray test is required and must be specified.

For Army projects, a salt spray test is optional. The 125 hour test is suggested for mild or noncorrosive environments. The 500 hour test is

suggested for extremely corrosive environments.
****

Unless otherwise specified, provide equipment and components fabricated from ferrous metal with the manufacturer's standard factory finish.[Each factory finish must withstand [125] [500] hours exposure to the salt spray test specified in ASTM B117. For test acceptance, the test specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8-inch on either side of the scratch mark immediately after completion of the test.] For equipment and component surfaces subject to temperatures above 50 degrees C 120 degrees F, the factory coating must be appropriately designed for the temperature service.

2.11.2 Field Painting

****
NOTE: Specify exterior, aboveground coatings per Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES if SSPC QP 1 contractor certification is required for any other coatings on the project. If Section 09 90 00 PAINTS AND COATINGS is specified, consider choosing the option for the contractor to be certified to SSPC QP 1, as certified contractors are likely to have more experience working around fuel facilities.
****

Painting required for surfaces not otherwise specified must be field painted as specified in [Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES][Section 09 90 00 PAINTS AND COATINGS]. Do not paint aboveground stainless steel and aluminum surfaces. Do not coat equipment or components provided with a complete factory coating. Hot dip galvanized pipe support steel must not receive the Zinc-Rich Epoxy Primer Coat only the Epoxy Intermediate Coat and Polyurethane Topcoat must be applied to these surfaces. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

PART 3 EXECUTION

****
NOTE: Specify as directed by the Service Headquarters or officially designated alternate.
****

3.1 GENERAL

Installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.3 and NFPA 30, except as modified herein. Safety rules as specified in NFPA 30 and NFPA 407 must be strictly observed. Never direct bury threaded connections, socket welded connections, unions, flanges, valves, air vents, or drains. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

3.2 VERIFICATION OF DIMENSIONS

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.3 CLEANING OF PIPING

Keep the interior and ends of all new piping, affected by construction operations, thoroughly cleaned of foreign matter and water before and after being installed. Piping systems must be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of piping and fittings must be closed so that no water or other foreign substance will enter the pipes or fittings. Piping must be inspected before placing into position. The interior of each length of pipe must be cleaned after welding ensuring that the interior of the piping is free of foreign matter when it is connected into the system.

3.4 TRENCHING AND BACKFILLING

Trenching and backfilling must conform to Section 31 00 00 EARTHWORK, and the following bedding and backfill requirements. The pipe must be laid in a bed of sand 150 mm 6 inches deep, compacted in accordance with Section 31 00 00 EARTHWORK, paragraph BACKFILLING AND COMPACTION. Sand must meet the requirements of Section 31 00 00 EARTHWORK, paragraph SELECT GRANULAR MATERIAL. The full length of each section of pipe without any protective covering must be excavated to permit installation of the protective covering. Pipe that has the grade or joint disturbed after laying, must be taken up and relaid. Pipe must not be laid in water or when the trench or weather conditions are unsuitable for such work. After testing and application of protective covering to joints, sand backfill must be placed and compacted around the pipe or protective coating to a depth of 300 mm one foot above top of pipe. The remainder of the backfill must be the same as for other types of pipe.

3.5 PIPING LAYOUT REQUIREMENTS

3.5.1 Pipe Fabrication

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system. The use of flexible connectors in permanently mounted pump suction and discharge lines as a method of compensating for piping misalignment is not acceptable.

3.5.2 Interferences and Measurements

Provide offsets, fittings, and accessories required to eliminate interferences and to match actual system components connection locations and arrangements. Verify measurements before commencing work. Submit discrepancies for clarification before proceeding with the installations to the Contracting Officer.

3.5.3 Space and Access

Keep piping, control tubing, which is not detailed close to structures and columns so as to take up a minimum amount of space. Ensure that access is provided for maintenance of system components, valves and gauges.

3.5.4 Location

Do not place unions in locations that will be inaccessible after the completion of the work. Place unions on each side of equipment.

3.5.5 Pipe Supports

Where provided hot dip galvanized pipe support steel must be surface prepped to SSPC SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals. Once the steel is prepped, apply only the Epoxy Intermediate Coat and Polyurethane Topcoat per manufacturer's instructions.

Provide pipe supports with the maximum spacing as defined in Table 1 below, unless otherwise indicated. At the indicated locations. Provide additional pipe supports at concentrated piping loads (valves).

Table 1. Maximum Support Spacing

Nominal Pipe Size (mm) (Inches)	25 mm one-inc and under	40 mm 1.5-in	50 mm 2-in	80 mm 3-in	100 mm 4-in	150 mm 6-in	200 mm 8-in	250 mm 10-in	300 mm 12-in
Maximum Support Spacing (m) (ft)	2 m 7-ft	2.75 mm 9-ft	3 m 10-ft	3.5 m 12-ft	4.25 m 14-ft	5 m 17-ft	5.75 m 19-ft	6.50 m 22-ft	7 m 23-ft

Provide anchors where required to absorb or transmit thrust or eliminate vibration or pulsation. Provide supports near each change of direction. Select support components which do not restrict the movement of the pipe due to thermal expansion. Space supports uniformly and arrange symmetrically.

3.5.6 Structural Support

Provide supplementary or intermediate steel or other structural members as required for transmission of loads to members forming part of the supporting structure. Piping must not be supported from other piping.

3.5.7 Grade

Where profiles of piping lines are shown on the drawings, grade the line uniformly between changes in slope or direction. Maintain gradient to within 6 mm 1/4-inch over the entire length of pipe. When backfilling has been completed to the top of the pipe, the pipe must be surveyed at each joint, and logged by station number. Submit to the Contracting Officer for approval the survey final elevations before backfilling can continue.

3.5.8 Size Changes

Make changes in pipe size with reducing fittings. Do not use bushings. Make branch connections with butt-welded tees except where the branch is at least two pipe sizes smaller than the run, in which case the branch connection can be made with a forged or seamless branch outlet fitting. The branch outlet fitting must be designed in such a way that the connection can be radiographed. The branch outlet fittings may be a non-radiographicable if: the piping it is connected to is aboveground, the branch outlet size is 65 mm 2.5 inches or less in diameter, and the branch outlet is located either in a pump house or on a system component pad equipped with containment curb.

3.5.9 Direction Changes

Make changes in direction of pipes with 1.5 D fittings. Where piping is to be piggable, make changes in direction with 1.5 D fittings [and][or] 3 D sweeps as indicated. For piggable pipelines, do not place 1.5 D fittings back to back.Provide special fittings when required. Make odd-angle offsets with pipe bends or elbows cut to the proper angle. Make changes in direction with fittings, except that bending of pipe 100 mm 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends must not be less than 6 diameters of the pipe if a pipe bender is used.

3.5.10 Threaded End Connections

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NOTE: As stated previously, avoid threaded end connections if possible. Threaded end connections may be used in certain aboveground applications if specifically indicated on the drawings. As stated previously, never require a threaded end connection to be direct buried.

****

Provide threaded end connections only on piping 50 mm2 inches in nominal size or smaller and only where indicated on the drawings. Provide threaded connections with PTFE tape or equivalent thread-joint compound applied to the male threads only. Not more than three threads must show after the joint is tightened.

3.5.11 Existing Pipe Systems

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NOTE: Delete this paragraph if connections to existing piping systems are not required. Indicate on the drawings the approximate location of each connection point between new and existing piping systems.

****

No interruptions or isolation of an existing fuel handling service or system may be performed unless the actions are appropriately documented in the approved work plan. Perform initial cutting of existing fuel pipe with a multiwheel pipe cutter, using a nonflammable lubricant. After cut is made, seal interior of piping with a gas barrier plug. Refer to API RP 2009 and API RP 2200. Purge interior of piping with carbon dioxide or nitrogen prior to performing any welding process.

3.5.12 Bolted Connections

For each bolted connection of stainless steel components (e.g., pipes, piping components, valves, and system components) use stainless steel bolts or studs, nuts, and washers. For each bolted connection of carbon steel components, use carbon steel bolts or studs, nuts, and washers. Bolts project no more than three full threads and no less than two full threads beyond the nuts with the bolts tightened to the required torque. Prior to installing nuts, apply a compatible anti-seize compound to the male threads.

3.5.13 Flanges and Unions

Except where threaded end connections [and][or] unions are indicated, provide flanged joints in each line immediately preceding the connection to system components or material requiring maintenance such as pumps, general valves, control valves, strainers, and other similar items and as indicated. Assemble flanged joints square and tight with matched flanges, gaskets, and bolts.

3.5.14 Flange Protector

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NOTE: See Note on FLANGE PROTECTORS paragraph in this section.

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Provide flange protectors [on each electrically insulating flange connection][on each flanged end connection, including valves and system components][where indicated on the drawings].[Fill the flange cavity of electrically insulating flange connections with a corrosion inhibitor type grease.] Provide grease filled bolt caps.

3.5.15 Manual Valves

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NOTE: Show on the drawings double block and bleed plug valves installed upstream of each pump strainer as well as downstream of each filter separator control valve.

****

Install isolation plug or ball valves on each side of each system equipment, at the midpoint of looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Install valves with stems vertically up unless otherwise indicated. Provide individual supports and anchors for each valve.

3.5.16 Air Vents

Provide [_____] [40 mm] [1-1/2 inches] air vents at all high points and where indicated to ensure adequate venting of the piping system.

3.5.17 Drains

Provide [_____] [50 mm] [2 inches] drains at all low points and where indicated to ensure complete drainage of the piping. Drains must be schedule 120.

3.5.18 Bellows Expansion Joints

Cold set joints to compensate for the temperature at the time of installation. Provide initial alignment guides on the connecting piping no more than 4 pipe diameters from the expansion joint. Provide additional alignment guides on the connecting piping no more than 14 pipe diameters from the first guide.

3.5.19 Thermometers

Provide thermometers with separable sockets. Install separable sockets in pipelines in such a manner to sense the temperature of flowing fluid and minimize obstruction to flow.

3.5.20 Pipe Sleeves

Provide a pipe sleeve around any pipe that penetrates a wall, floor, or slab. Do not install sleeves in structural members except where indicated or approved. Install pipe sleeves in masonry structures at the time of the masonry construction. Sleeves must be of such size as to provide a minimum of 12 mm 1/2-inch all-around clearance between bare pipe and the sleeve. Align sleeve and piping such that the pipe is accurately centered within the sleeve by a nonconductive centering element. Securely anchor the sleeve to prevent dislocation. Closure of the space between the pipe and the pipe sleeve must be by means of a mechanically adjustable segmented elastomeric seal. The seal must be installed so as to be flush. For wall or floor penetrations, extend each sleeve through its respective wall or floor and cut flush with each surface. Seal around sleeves that penetrate through valve or fuel related pits with a Buna-N casing seal. Seal around sleeves that penetrate through non-fire-rated walls and floors in accordance with Section 07 92 00 JOINT SEALANTS. Seal around sleeves that penetrate through fire-rated walls and floors as specified in Section 07 84 00 FIRESTOPPING.

3.5.21 Escutcheons

Except for utility or equipment rooms, provide finished surfaces where exposed piping pass through floors, walls, or ceilings with escutcheons. Secure escutcheon to pipe or pipe covering.

3.6 SEISMIC REQUIREMENTS

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NOTE: Include applicable seismic design requirements on the drawings. Delete this paragraph if there are no specific seismic design requirements.

****

Support and brace piping and attach valves to resist seismic loads as specified under Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT[, 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS] and as shown on the drawings. Structural steel required for reinforcement to properly support piping, headers, and system components but not shown must be provided under this section. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.7 STRUCTURAL ATTACHMENTS

Provide attachment to building structure concrete and masonry by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Apply inserts and anchors with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead applications of ferrous materials only. Structural steel brackets required to support piping, headers, and system components, but not shown, must be provided under this section. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.8 WELDING

3.8.1 General

All joints, unless indicated otherwise, in carbon steel and stainless steel piping systems must be welded. Do not weld carbon steel to stainless steel. Welding of fuel pipe joints must comply with Section 33 52 23.15 POL SERVICE PIPING WELDING.

3.9 INSTALLATION

3.9.1 Precautions

Take special care to ensure that the protective coating on buried pipe is not damaged during installation and that the completed system is free of rocks, sand, dirt, water, weld slag, and foreign objects including construction debris. Take the following steps to ensure these conditions.

a. Coated pipe must be handled only with canvas or nylon slings or padded clamps. Any coating damaged by improper handling or storage must be repaired as specified.

b. Pipe brought to the site must be stored on blocks or horses at least 450 mm 18 inches above the ground and adequately supported to prevent sagging. Padded blocks or horses must be used for coated pipe. The method and height of storing coated pipe must be in accordance with the coating manufacturer's instructions. Pipe ends must be protected and capped against weather at all times, except to accommodate immediate installation.

c. Visual inspection must be made of the inside of each length of pipe to ensure that it is clear and clean prior to installation.

d. The open ends of the pipe system must be closed at the end of each day's work or when work is not in progress by use of expansion plugs and must not be opened until the work is resumed.

e. A swab, with a leather or canvas belt disc to fit the inside diameter of pipe, must be pulled through each length of pipe after welding in place.

f. Obstruction remaining in the pipe after completion of the system must be removed at the expense of the Contractor.

g. Plasma cutters and torches are not to be used to make penetrations in the pipe or to cut pipe.

****

NOTE: Select option for swab pig run if line is piggable.

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h. After installation and backfill of the piggable piping is complete and before fuel is put in the pipe, the pipe will be cleaned per the paragraph[s] [CLEANING PIG RUN][WIRE BRUSH RUN] [CLEANING PIG RUN and WIRE BRUSH RUN] in this Section.

3.9.2 Protective Coatings for Buried Piping Including Stainless Steel Piping

3.9.2.1 Application of Coating System

Application of coating system must be in accordance with 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEMS.[Application of coating system must be in accordance with 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES.]

3.9.2.2 Inspection and Testing

The condition of factory field coated piping must be the responsibility of the Contractor and all damage to the protective covering during transit and handling must be repaired at no additional cost to the Government. All field coating must be subject to approval by the Contracting Officer. The entire pipe must be inspected as specified in sub-paragraph TESTING OF PROTECTIVE COATINGS under paragraph PROTECTIVE COATINGS FOR BURIED STEEL PIPING. The inspection for holidays must be performed just prior to lowering the pipe into the ditch and every precaution must be taken during lowering and backfilling to prevent damage to the protective covering.

3.9.2.3 Damage Repair

Damaged areas of coating must be repaired as specified in the preceding paragraph for fittings.

3.10 INTERIOR EPOXY COATING

When internally epoxy lined pipe is cut, the lining must be ground back from the end a minimum of 25 mm one-inch but not more than 38 mm 1-1/2 inches.

3.11 INSTALLATION OF UNDERGROUND PIPE

Underground fuel pipelines must be pitched as shown on the drawings. Where not indicated they must be pitched a minimum of 50 mm 2 inches per 30.5 m 100 feet. 50 mm Two-inch pipe size valved drain connections must be provided at all low points and 38 mm 1-1/2-inch pipe size valved outlet vent connections must be provided at all high points. Vent and drain lines must terminate in male cam-type locking end connectors with matching female dust covers and installed in pits. The pipe must have cover as shown on the drawings. Drain lines must be installed at the slopes indicated.

3.11.1 Pipe Assembly

Pipe must be strung parallel and adjacent to or above a trench. The pipe must be supported on padded skids during welding and inspection of joints. Protective coating must be inspected and repaired prior to lowering the pipe into the trench. The pipe must be lowered using only canvas or nylon slings. The sling must be dug from underneath the pipe after placements and must not be pulled from underneath the pipe while in contact with it. Care must be taken to prevent damage to the pipe, welded joints or coating and any such damage must be repaired as directed by the Contracting Officer. Pressure testing of the pipe must be done after it has been placed in final position in the trench.

3.11.2 Warning Tapes in Earth Trenches

For the purpose of early warning and identification of buried pipes outside of building walls during future trenching or other excavation, continuous identification tapes must be provided in the trench. Provide metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured for the purpose of early warning and identification of utilities buried below the tape. Tape must be at least 80 mm 3 inches in width. Color of tape must be as standard with the manufacturer with respect to the type of utility buried below the tape. Tape must have lettering at least 25 mm one-inch high with warning and identification imprinted in bold black letters continuously over the entire tape length with not less than the following identification on the tape: BURIED JET FUEL PIPING BELOW. Tape must be installed in accordance with the printed recommendations of the tape manufacturer, as modified herein. Tapes must be buried at a depth of 150 mm 6 inches from the top of the subgrade or 300 mm 12 inches below the top surface of earth. Provide permanent color and printing, unaffected by moisture or soil.

3.11.3 Clearances

Install pipe to be clear of contact with other pipes, pipe sleeves, casings, reinforcing steel, conduits, cables, or other metallic structures. Where pipes cross other pipes or structures with a separation of less than 150 mm 6 inches, install an insulating separator. Protect the pipe from contact with a 300 mm 12-inch square by 25 mm one-inch thick bituminous-impregnated canefiber board.

3.11.4 Protective Coating

When the protective coating on pipe is damaged, the Contracting Officer must be notified and must inspect the pipe before the coating is patched. If the damage to the pipe is deeper than 1.2 mm 0.050-inch, the damage must be repaired by welding in accordance with paragraph WELDING. If the pipe is dented, out of round or damaged to the point that welding will not make it good as new, the length of pipe must be rejected.

3.11.5 Pipe Casing

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NOTE: Design casing vents to prevent the influx of rain or groundwater into the casing.

The use of casings on underground pipelines is highly discouraged due to increase problems with pipe corrosion and inability to provide cathodic protection to the pipe in the sleeve. Use steel casing sleeves only for those crossings where sleeves are required by authorities having jurisdiction (i.e.: Airfield Managers), or where it is necessary to place stainless steel lines bore under the roadway or railroad tracks to while avoiding interference with traffic, or where boring is the most economical construction method. Consider installing carbon steel and stainless steel pipelines under roadways by the traditional trenching method, or use alternative trenchless pipe construction methods for carbon steel pipelines to avoid the need for a casing. Do not use directional drilling for stainless steel lines. When using alternative trenchless methods for carbon steel lines, provide supplemental abrasion resistant coatings applied in addition to the fusion bonded

epoxy exterior pipe coating. When required to construct planning construction of open trench cased crossings, consider the economics of installing spare casing sleeves to eliminate excavating for future fuel lines.

Locate crossings at a minimum depth of 36 inches (900 mm) beneath the bottom of drainage ditches. If this depth cannot be obtained, install above, but not in contact with, the casing or pipe, a 6-inch (150 mm) thick reinforced concrete slab of adequate length and width to protect the casing or pipe from damage by equipment such as ditch graders and mowers.

In areas with high normal or seasonal groundwater tables consider the use of a water excluding casing fill material. Refer to API RP 1102 for additional information on the use of casings.

****

Casing must be continuous for the entire crossing as well as extend a minimum of 150 mm 6 inches beyond both sides of the crossing. Casings must be of such size as to provide a minimum of 12 mm 1/2-inch all-around clearance between bare pipe and the casing. Alignment of the casing and piping must be such that the pipe is accurately centered within the casing by nonconductive centering spacers properly spaced in the casing, and within 300 mm 12 inches of casing ends. Provide seals at each end of the casing. Include a vent on the higher end of each casing and a low point drain on the lower end of the casing. Ensure that the casing design electrically isolates fuel-carrying pipes from contact with the casing pipes. Provide cathodic protection test leads to the pipe and casing to monitor for electrical isolation.[Fill casing with water excluding casing fill material]

3.11.6 Pipeline Markers

Provide above underground fuel piping spaced every 90 meters 300 feet, at tees, and at changes in direction. For sections of underground piping less than 90 meters 300 feet long, place at midpoint. Provide directly above pipe for single lines and between pipes where pipes run in pairs. Provide additional marker over each mid-line fitting connections for steel reinforced flexible pipe. Cast marker into 450 mm 18-inch diameter, 300 mm 12-inch thick concrete plug unless it is set in an area with concrete paving in which case it must be cast into the concrete paving.

3.11.7 Steel Reinforced Flexible Pipe

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NOTE: Steel reinforced flexible pipe comes in reels. To the extent possible, design piping system such that the entire length of underground piping can be accommodated with one reel.

****

Connections between steel pipe and steel reinforced flexible pipe and between separate lengths of steel reinforced flexible pipe must not be made aboveground but must be made either inside a pit or vault, or direct bury them. Where practicable, end-line and mid-line connections must be located inside pit type enclosures of an appropriate size. Where it is not practicable to locate mid-line connections inside pit type enclosures, mid-line connections may be wrapped with a suitable waterproof protective substance and direct buried underground. The location of direct buried mid-line connections must be indicated on the final drawings and provided with a pipeline marker and monitoring well. Record GPS coordinates of all installed direct buried joints on as-built drawings.

3.12 SYSTEM COMMISSIONING

Conform to Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

3.13 TESTING

****

NOTE: Hydrostatic testing with water requires explicit, written Service Headquarters approval except in the case of fuel piping systems containing fuels with a flash point of less than 38 degrees C 100 degrees F (i.e. JP-4, Mogas, Avgas, etc.); without that approval, hydrotesting with water is forbidden. Pressure testing of new Mogas, Avgas, and JP-4 pipelines must be with water.

****

Piping must be tested by pneumatic and hydrostatic pressure. Testing must comply with applicable requirements of ASME B31.3, NFPA 30 and the requirements specified herein. Hydrostatic testing must be performed using [fuel] [water] as the liquid[with Service Headquarters approval]. Pressure and hydrostatic testing must be performed only after welding inspection has been completed. Labor, materials, equipment, electricity, repairs, and retesting necessary for any of the tests required herein must be furnished by the Contractor. Provide provisions to prevent displacement of the piping during testing. Keep personnel clear of the piping during pneumatic testing. Only authorized personnel must be permitted in the area during pneumatic and hydrostatic testing. Isolate system components such as pumps, tanks, filter separators, and meters from the piping system during the testing. Do not exceed the pressure rating of any component in the piping system during the testing. Following satisfactory completion of each test, relieve the test pressure and seal the pipe immediately.[When water is authorized for hydrostatic testing [and] [or] pigging of fuel piping, ensure that all water is removed from the piping by a combination of pigging the piping, followed by dehydrating the line either with dehumidified air or vacuum extraction. Verification of pipeline dehydrating must be confirmed by measuring dew point of exhausted air. Do not allow water to remain in piping for more than 48 hours after testing. Schedule hydrotesting such that the pipeline can be filled with fuel as soon as possible (no more than two weeks) after testing is complete as it is nearly impossible to assuredly remove all water and corrosion can occur if the time to fuel introduction is extended. The Contractor must submit the piping dehydration test prior to filling pipelines with fuel.] Piping to be installed underground must not receive field applied exterior coatings at the joints or be covered by backfill until the piping has passed the final pneumatic tests described herein.

3.13.1 Before Backfilling

Fuel piping must not be backfilled without completing the coating, pneumatic, weld radiograph and other piping examinations and approvals. Fuel piping in trench must not have exposed welds for longer than 30 days.

3.13.1.1 Exterior Coating Holiday Test

Following installation, test the exterior coating of direct buried piping for holidays using high-voltage spark testing in accordance with NACE SP0188. Repair holidays and retest to confirm holiday-free coating. Text must include all existing underground piping exposed for this project.

3.13.2 Pneumatic Test

Piping to be installed underground must not receive field applied protective covering at the joints or be covered by backfill until the piping has passed the pneumatic test described herein. To facilitate the tests, isolate various sections of the piping system and test each one separately. Where such sections terminate at flanged valve points, the line must be closed by means of blind flanges in lieu of relying on the valve. Furnish tapped flanges that can be attached to the end of the section of line being tested, and that will permit a direct connection between the piping and the air compressor [and][or] pressurizing pump. No taps in the permanent line will be permitted. Furnish all necessary equipment for testing; all gauges must be subject to testing and approval of the Contracting Officer. The air used for pneumatic testing must have a dew point of no more than 5 degrees C 41 degrees F. Provide dehumidifying equipment on the suction or discharge side of the air compressor used to provide air for testing. Pressurizing pump must not exceed 4.7 L/s 10 cfm.

3.13.2.1 Pneumatic Test Procedure

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NOTE: Use 50 psig final test pressure unless permission to go higher is secured from the Service Headquarters and the Contracting Officer.

****

Special safety measures, including the wearing of face mask, must be taken during testing under pressure. Only authorized personnel must be permitted in the area during testing. The pneumatic test pressure must be applied in increments. A preliminary 167 kPa 25 psig test must be applied. Maintain the pressure while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). If leaks are discovered, repair the leaks accordingly and retest. Repeat process until system is leak-free at 25 psig. The full test pressure must then be applied. Unless otherwise directed by the Contracting Officer, all piping must be tested at a pressure of [667] [333] kPa [50] [100] psig for not less than 2-hours, during which time there must be no drop in pressure, only pressure rises with temperature. The pressure source must be disconnected during the final test period. Any leaks revealed by the test must be repaired and the test repeated.

3.13.3 Hydrostatic Test

****

NOTE: Unless otherwise directed by the Service Headquarters, hydrostatically test aboveground piping systems to the maximum allowable working pressure of the ASME B16.5 piping system flanges at 38 degrees C 100 degrees F and hydrostatically test underground piping systems to 1.5 times the maximum

allowable working pressure of the ASME B16.5 piping system flanges at 38 degrees C 100 degrees F. Refer to UFC 3-460-01 for more guidance.

Hydrostatically testing the system to 1.5 times the flange rating, will require the designer to write the commissioning hydrostatic testing procedures, which will consider the removal of system components (i.e.: ball valves, control valves, meters), and provide procedures of the hydrostatic test which should include what valves to close, where to install the hydrostatic test pump, blind flange placements, high point vents and low point drains, and other requirements.

NOTE: Hydrostatic testing with water requires explicit, written Service Headquarters approval except in the case of fuel piping systems containing fuels with a flash point of less that 38 degrees C 100 degrees F (i.e. JP-4, Mogas, Avgas, etc.); without that approval, hydrotesting with water is forbidden.

NOTE: If hydrostatic testing with water, perform soak test after initial introduction of fuel as described in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

****

Upon completion of pneumatic testing and after backfilling, hydrostatically test each underground piping system with [fuel] [water] at [1.9] [2] [2.9] [3.1] [_____] MPa [275] [285] [425] [450] [_____] psig in accordance with ASME B31.3 and API RP 1110, with no leakage or reduction in gauge pressure for four hours. Upon completion of pneumatic testing, hydrostatically test each aboveground piping system with fuel at [1.9] [2] [2.9] [3.1] [_____] MPa [275] [285] [425] [450] [_____] psig in accordance with ASME B31.3 and API RP 1110, with no leakage or reduction in gauge pressure for four hours. Furnish electricity, instruments, connecting devices, and personnel for test.[Fuel must be furnished by the Government.][If fuel is used for testing, comply with all the requirements in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).][In cases where it is not specified, water must be potable and treated and must meet all the requirements of water used for hydrostatic testing in API 570.][Upon completion of hydrostatic testing, perform "Soak Testing" of the piping systems per API RP 1595. Duration of the test must be a minimum of 4 days and maximum of 7 days.] Defects in work must be corrected at the Contractor's expense, and the test repeated until the work is proven to be in compliance with the Contract requirements.

3.13.4 Soak Testing

****

NOTE: Perform soak test after initial receipt of fuel as described in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). The timing of the initial receipt of fuel will depend on where water is used for just hydrotesting, or hydrotesting and pigging.

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[Upon completion of hydrostatic testing with fuel, perform "Soak Testing" of the piping systems per API RP 1595. Duration of the test must be a minimum of 4 days and maximum of 7 days.] [Upon completion of initial receipt of fuel, perform "Soak Testing" of the piping systems per API RP 1595. Duration of the test must be a minimum of 4 days and maximum of 7 days.]

3.13.5 Performance Testing

After the fuel system testing is completed (including pneumatic and hydrostatic testing) the fuel system must be flushed, cleaned and performance tested as specified in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). All control valves, both manual and automatic, must be checked for leaks (any area wetted with fuel) and proper operation and adjusted, repaired or replaced to correct any defects.

[3.14 PIPE PIGGING - CLEANING

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NOTE: Select bracketed paragraph if system is designed to be piggable. Standard cleaning pig runs are recommended on all systems.

****

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NOTE: Pigging with water requires explicit, written Service Headquarters approval and is not allowed in systems which contained fuel previously.

NOTE: The choice of the fluid used to propel cleaning pigs will vary greatly from project to project.
a. Pneumatic propelled cleaning pigs will almost always be used before any other pigs are run.
b. Water propelled pigs will be allowed only after securing explicit, written Service Headquarters approval.
c. Fuel propelled pigs may always be used.

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3.14.1 General

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NOTE: Include bracketed text for non-stainless piping systems, or if excessive contamination is anticipated.

****

Track all pigs, using transmitter and receivers, at no less than 805 m 1/2-mile increments, but no less than at four locations. The Contractor must prepare a contingency plan for retrieving a stuck pig and repairing any piping deformations. After pigging, plug valves must be flushed of all debris using the drain port at the bottom of the valve.

[3.14.2 Use of Fuel in Cleaning Pigging

Cleaning pigging with fuel will take place after the initial receipt of fuel as per Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). Ensure that the fuel that is returned to the storage tanks during the pig runs is free of gross contamination and passes the color assessment method, and meets the requirements of MIL-STD-3004-1. Provide temporary storage tanks for the high particulate and dark color fuel that accumulates in front of and behind each pig. The contractor is responsible for [cleaning the off-spec fuel in order to meet the requirements of MIL-STD-3004-1] [,dispose of the off-spec fuel off-base][,obtain permission from the Contracting officer to downgrade the fuel and dispose of it in the appropriate tank].

][3.14.3 Use of Water in Cleaning Pigging

Ensure that the water, in cases where it is not specified, must be potable and treated and must meet all the requirements of water used for hydrostatic testing in API 570. Dispose of the water in accordance with applicable Installation, city, county, state, and federal regulations.

]3.14.4 Cleaning Pig Run

[Contractor-provided pig launching and receiving barrels must be installed.]Initially, a proving pig run (foam density 32 kg/m^3 2 lb/ft^3 should be performed to ensure the system is fully piggable. Upon completion of the successful proving pig run, the piping system must be cleaned with a standard cleaning pig. This will provide thorough cleaning of the interior of the piping system. Cleaning pig must be the bi-directional disk scraper style with steel body and replaceable polyurethane guiding and sealing disks, as well as gauge plates of 80 percent pipe diameter with 3 mm 1/8-inch segmented aluminum fins. The pig body should include bypass nozzles and transmitter cavity. Propellant must be pressurized [fuel][water] using [the main system delivery pumps][portable pumps]. The pig must be examined after the initial run for signs of possible pipe damage, interior slag or other adhered particles. Additional runs must be performed until the amount of collected sludge or debris is minimized, as determined by the [Contracting Officer][System Supplier].

3.14.5 Wire Brush Pig Run

****

NOTE: Select wire brush cleaning pig option if excessive slag or other adhered particles are suspected on the pipe interior. Require stainless steel brushes on stainless steel piping systems.

Never perform wire brush cleaning pig on interior epoxy coated piping systems.

****

After the cleaning pig runs, the piping system must be cleaned with a wire brush style pig. This will remove weld slag and adhered particles from the system. Wire brush pig must be the bi-directional disk style or directional cup style with two circular [stainless] steel wire brushes. The pig body should include bypass nozzles and transmitter cavity. Perform wire brush pig runs until the amount of collected weld slag or debris is minimized, as determined by the [Contracting Officer][System Supplier].

]3.15 PIPE PIGGING VERIFICATION

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NOTE: Pigging with water requires explicit, written Service Headquarters approval and is not allowed in systems which contained fuel previously.

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[3.15.1 Use of Water in Pipe Pigging Verification

Ensure that the water, in cases where it is not specified, must be potable and treated and must meet all the requirements of water used for hydrostatic testing in API 570. Dispose of the water in accordance with applicable Installation, city, county, state, and federal regulations.

]3.15.2 Geometry/Ultrasonic Tool Reports

After the system is installed and prior to performance testing, a field/preliminary report must be issued and a debrief given to Government personnel onsite on the condition of the piping system that was pigged. This must be comprised of raw data in the form of a PC download or equivalent which shows a continuous scan of each data unit output. Results of a preliminary interpretation of the data must be reported. These must include as a minimum all critical anomalies. A final report must include a description of the principle of operation, explanation of raw data, presentation of raw data, data to be clearly marked with distance traveled scale with classified anomaly location and all identifiable pipeline features, and all anomalies to be classified with locations in summary tabular form, pipe wall thickness survey, as well as the software necessary to read the data. Submittal must be in the form of digital media copied to a CD or DVD (flash drives are unacceptable).

3.15.3 Pipeline Internal Inspection Operations

3.15.3.1 General

The following pigs will be propelled through the pipeline with [fuel][water] in order to inspect the pipeline: 1.7 kg 5 pound density foam swab, combination poly scraper-magnetic, stainless steel wire brush (plastic brush for internally lined piping), aluminum plate gauge, and geometry/ultrasonic tool. Tracking devices must be used on all pigs. At a minimum, the sequence of pig runs must be as follows: 1) foam swab for proving and cleaning, 2) wire brush for cleaning, 3) scraper-magnetic for cleaning, 4) aluminum plate gauge for gauging internal anomalies, 5) scraper-magnetic for cleaning, 6) wire brush for cleaning, 7) scraper-magnetic for cleaning, 8) foam swab for cleaning, (Note: the number of pig flights of each type of cleaning pigs must be determined by the amount and type of debris removed. The conclusion of the cleaning process must be when debris recovered is only that from the pigs themselves. This determination will be determined by the project's System Supplier and the Contracting Officer), 9) geometry/ultrasonic tool. The pipe wall must be continuously monitored on a real-time basis during the geometry/ultrasonic pig run. Anomalies such as patches, couplings, or flanges must also be identified, and the wall thickness given. The geometry/ultrasonic pig's technician will determine if additional runs are necessary. A permanent data set of internal inspection survey findings must be generated.

3.15.3.2 Preparatory Work

The Government will bring to the attention of the Contractor all statutes, rules and regulations relevant to the performance of the work on the site (on Government property) and will also provide the Contractor with a copy of its own site regulations (if any). Provide the pigging vendors with all-available pipeline records and drawings.

3.15.3.3 Pig Load And Launch

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NOTE: If pig a launcher and a receiver are not provided in the contract, portable ones will be by the Contractor during pigging operations.

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The pig must be loaded into the pig launcher by the Contractor. The method of loading and lodging the front pig cup into the launcher must not involve the use of uncontrolled mechanical force applied to the rear of the pig.

3.15.3.4 Pipeline Operation During Pigging

All pig runs must be made with the line packed with product. The system pumps will be used to propel the pig. The new pig traps will be used for pig launch and retrieval.

3.15.3.5 Brush and Gauging Survey

Run a brush pig at least as often as previously indicated. The brush pig must be designed and provided by the geometry/ultrasonic pig vendor. Additional runs may be required based upon the amount of debris found in the pipeline. The onsite geometry/ultrasonic pig vendor's personnel must determine if additional runs are required. Immediately following the brush pig run and immediately prior to the geometry/ultrasonic survey, run, as a minimum, a single batching pig fitted with a gauge plate equal to 90 percent of the pipeline normal inside diameter. The plate is to be a segmented aluminum disk of 3 mm 1/8-inch thickness. The plate gauge pig must also include a tracker and tracking equipment. Track the pig assembly above ground during the operation.

3.15.3.6 Geometry/Ultrasonic Survey

After a satisfactory gauging pig run, the pipeline geometric defects must be determined by a geometry/ultrasonic tool. The geometry/ultrasonic tool must provide accuracy geometric anomaly detection, and bend radius measuring capability. The data obtained must be presented in a PC software format to allow user friendly analysis and presentation. The geometry/ultrasonic tool assembly must be capable of:

a. Operating in [hydrocarbon liquid environment, specifically [jet fuel][_____]][water], at a pressure of up to ANSI 300 rating.

b. Traversing the pipeline with nominal wall thickness and possible bore restrictions down to 90 percent of nominal pipe inside diameter.

c. Traversing the pipeline length at a speed of between 60 and 100 m/min 3 and 5 ft/sec when propelled by pumped [jet fuel][water]. Pressure differential across pig not to exceed 34 kPa 50 psi.

d. Traversing through smooth pipe bends as small as 3D (3 pipe diameters) radius and single miter bends of up to 10 degrees change of direction.

e. Include a tracker and tracking equipment. Track the pig assembly above ground during the operation. The battery life of the tracker must not be less than 72-hours.

f. Manual loading into the new horizontal pig trap.

The geometry/ultrasonic tool assembly instrumentation performance must be capable of:

a. Battery life to be minimum 18-hours at operating conditions.

b. Principle of operation to be electronically stored geometry system.

c. Geometry sensing to span full circumference and length of pipe, with associated distance measuring method.

d. Geometry system must be capable of:

    (1) positive location and identification of each geometric anomaly.

    (2) positive location and identification of each bend.

    (3) positive location and identification of distance marker reference points of either magnetic or electronic type placed on or above the pipe.

e. Classification of geometric anomalies to be as minimum:

    (1) discrimination between ovality and intrusion anomalies.

    (2) mechanical damage such as mill defects, dents, internal gouges, and buckles.

    (3) pipeline weld defects (such as excess weld penetration).

    (4) geometric thickness anomalies. As a minimum, these must be reported in the following categories within the listed accuracy.

        (a) magnitude of anomaly (plus/minus 25 mm one-inch)

        (b) span of anomaly (plus/minus 25 mm one-inch)

        (c) ovality (plus/minus 2.5 mm 0.1-inch)

        (d) span of ovality (plus/minus 25 mm one-inch)

        (e) anomaly station (plus/minus 1:2,000)

3.15.3.7 Pipe Wall Thickness Survey

The geometry/ultrasonic tool must provide accuracy measurement of pipe wall thickness (plus/minus 0.25 mm 0.01-inch). The data obtained must be presented in a PC software format to allow user friendly analysis and presentation.

3.15.3.8 Lost Pig

The Contractor is responsible for a lost pig, finding the pig, retrieval of the pig, and all repairs, radiographs to the pipeline system and the pig.

3.16 DEMONSTRATIONS

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

3.17 POSTED OPERATING INSTRUCTIONS

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

-- End of Section --

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UFGS-33 52 43.11 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-33 52 43.11 (August 2018)**

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UFGS-33 52 43.11 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 33 52 43.11

AVIATION FUEL MECHANICAL EQUIPMENT
08/18

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NOTE: This guide specification covers the requirements for general equipment required for aircraft refueling systems constructed to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
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PART 1 GENERAL

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NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards**.**

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 1615	(2011) Installation of Underground Petroleum Storage Systems

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM C827/C827M	(2023) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

ASTM D1655	(2018a) Standard Specification for Aviation Turbine Fuels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant

STEEL TANK INSTITUTE (STI)

STI 010-50-1000	(2011) Specification and Manual for External Corrosion Protection of Underground Steel Storage Tanks

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5624	(2024; Rev X) Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-DTL-83413	(2012; Rev C; AMD 1 2017; AMD 2 2019) Connectors and Assemblies, Electrical, Aircraft Grounding, General Specification for
MIL-DTL-83413/4	(2019; Rev E; AMD 2 2019; Notice 1 2024) Connectors and Assemblies, Electrical, Aircraft Grounding: Plugs, for Types I and II Grounding Assemblies
MIL-DTL-83413/7	(2018; Rev F; AMD 1 2018; Notice 1) Connectors and Assemblies, Electrical, Aircraft Grounding: Clamp Connector for Types I and III Grounding Assemblies, Clip, Electrical
MIL-PRF-4556	(1998; Rev F; Am 1 1999; CANC Notice 1 2011) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
MIL-STD-130	(2007; Rev N; Change 1 2012) Identification Marking of U.S. Military Property
MIL-STD-161	(2005; Rev G; Notice 1 2010) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50696	(2016; Rev D) Reels, Static Discharge, Grounding, 50 and 75 Foot Cable Lengths

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)

UL SOLUTIONS (UL)

UL 58	(2018) UL Standard for Safety Steel Underground Tanks for Flammable and Combustible Liquids
UL 142	(2006; Reprint Jan 2021) UL Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 2085	(1997; Reprint Sep 2010) Protected Aboveground Tanks for Flammable and Combustible Liquids

1.2 ADMINISTRATIVE REQUIREMENTS

Submit detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the equipment and systems. Provide the drawings as one package with the design analysis. Shop fabrication drawings must include type of material, configuration, thickness, and necessary details of construction of the steel tank and vault. Shop drawings must also show the steel grating and supports. Submit Manufacturer's Catalog Data and Certificates of Compliance. Operation and maintenance information must be submitted for the equipment items or systems listed in PART 2. Automatic pump controls must include step-by-step procedures required for system startup, operation, and shutdown. Refer to Section 01 78 23.33 OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS for the information to be submitted for various types of equipment and systems.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

em 385

Meters; G, [_____]

Venturi Tubes; G, [_____]

Water Draw-Off System; G, [_____]

Truck Offload System; G, [_____]

Operating Tank Vent; G, [_____]

Hydrant Outlet Pits and Isolation Valve Pits; G, [_____]

High Point Vent and Low Point Drain Pits; G, [_____]

Underground Product Recovery Tank and Accessories; G, [_____]

Aboveground Product Recovery Tank and Accessories; G, [_____]

Bowser Pumpoff Pump; G, [_____]

Jockey Pump; G, [_____]

Pumphouse Drain Pump; G, [_____]

Truck Fillstand Overfill Protection and Ground Verification Unit; G, [_____]

Tightness Monitoring System; G, [_____]

SD-03 Product Data

Pressure Gauges; G, [_____]

Automatic Pump Controls; G, [_____]

Meters; G, [_____].

Underground Product Recovery Tank and Accessories; G, [_____]

Aboveground Product Recovery Tank and Accessories; G, [_____]

Truck Offload System; G, [_____].

Operating Tank Vent; G, [_____].

Hydrant Outlet Pits and Isolation Valve Pits; G, [_____]

High Point Vent and Low Point Drain Pits; G, [_____]

Operating Tank Level Indicator; G, [_____]

Operating Tank Level Switches; G, [_____]

Water Draw-Off System; G, [_____]

Venturi Tubes; G, [_____].

Bowser Pumpoff Pump; G, [_____]

Jockey Pump; G, [_____]

Pumphouse Drain Pump; G, [_____]

Truck Fillstand Overfill Protection and Ground Verification Unit; G, [_____]

Tightness Monitoring System; G, [_____]

SD-06 Test Reports

Leak Detection Monitor; G, [_____]

Tightness Monitoring System; G, [_____]

Coating Testing; G, [_____]

SD-07 Certificates

System Supplier; G, [_____]

Tightness Monitoring System; G, [_____]

SD-10 Operation and Maintenance Data

Automatic Pump Controls; G, [_____]

Underground Product Recovery Tank and Accessories; G, [_____]

Aboveground Product Recovery Tank and Accessories; G, [_____]

Truck Offload System; G, [_____]

Operating Tank Vent; G, [_____].

Operating Tank Level Indicator; G, [_____]

Water Draw-off System; G, [_____].

Bowser Pumpoff Pump; G, [_____]

Jockey Pump; G, [_____]

Pumphouse Drain Pump; G, [_____]

Truck Fillstand Overfill Protection and Ground Verification Unit; G, [_____]

Tightness Monitoring System; G, [_____]

1.4 QUALITY ASSURANCE

Submit the following data for approval:

a. Certification stating that the system supplier has provided and installed at least five PLC-based pump control systems in the last five years, for automatic cycling of pumps based upon varying dispensing demands, utilizing multiple pumps. These systems must be for dispensing jet fuel.

b. Certification that six systems have been successfully operated over the last three years and are currently in service.

c. Project names, locations, system description, and items provided at these installations. Include user point-of-contact and current telephone numbers.

PART 2 PRODUCTS

2.1 MATERIALS

Materials of construction must be stainless steel, aluminum or nonferrous material except meter case may be steel with electrolyses nickel plated internals coated to 0.075 mm 3 mil thickness. No ferrous or zinc-coated material bronze, brass or other copper bearing alloys must be used in contact with the fuel.

2.1.1 Types of Fuel

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NOTE: Select type of fuel and insert expected temperature extremes.

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Components must be suitable for use with [F-24 turbine fuel (Jet A with additives FSII, CI/LE, and SDA); specific gravity 0.81 at 16 degrees C 60 degrees F; viscosity 1.62 CS at 16 degrees C 60 degrees F; Reid vapor pressure less than 0.35 kPa 0.05 psi, ASTM D1655][JP-4 turbine fuel; specific gravity 0.76 at 16 degrees C 60 degrees F; viscosity 0.92 CS at 16 degrees C 60 degrees F; Reid vapor pressure 14 to 21 kPa 2 to 3 psi, MIL-DTL-5624][JP-5 turbine fuel; specific gravity 0.82 at 16 degrees C 60 degrees F; viscosity 1.62 CS at 16 degrees C 60 degrees F; Reid Vapor pressure less than 0.35 kPa 0.05 psi, MIL-DTL-5624]. Components to be ANSI Class 150 (1920 kPa at 38 degrees C 275 PSIG at 100 degrees F.) unless noted otherwise. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between [_____] degrees C F and [_____] degrees C F.

2.1.2 Composition of Materials

Materials in contact with the fuel must be noncorrosive. No zinc-coated metals, brass, bronze, iron, lead or lead alloys, copper or copper alloys, or other light metal alloys containing more than 4 percent copper must be used in contact with the fuel.

2.1.3 Gaskets

Gaskets must be in accordance with Section 33 52 43.13 AVIATION FUELING PIPING.

2.1.4 Bolts and Nuts

Bolts and nuts must be in accordance with Section 33 52 43.13 AVIATION FUELING PIPING.

2.2 EQUIPMENT AND MATERIAL

2.2.1 General

All items of equipment and material must be new and of the best quality used for the purpose in commercial practice and must be products of reputable manufacturers. Each major component of equipment must have the manufacturer's name, address and catalog number on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable. The gears, couplings, projecting set screws, keys and other rotating parts located so that any person may come in close proximity thereto must be fully enclosed or properly guarded. Equipment, assemblies and parts must be marked for identification in accordance with MIL-STD-130 and MIL-STD-161. Pump and filter vessel numbers must be as indicated on the drawings. In addition, filter vessels must include stenciled or embossing tape letters 19 to 25 mm3/4 to 1 inch tall which indicate element numbers, date element changed, due date of the next element change, and maximum differential pressure. Identification (ID) tags made of brass, stainless steel, or engraved anodized aluminum, indicating valve number and normally open (NO) or normally closed (NC) must be installed on valves. Tags must be 35 mm 1-3/8 inch minimum diameter, and marking must be stamped or engraved. Indentations must be black, for reading clarity. Tags must be attached to valves with No 12 AWG, copper wire, stainless or aluminum hanging wires, or chrome-plated beaded chain designed for that purpose.

2.2.2 Supplier

Since the pump control system, including but not limited to pump control panel, venturi tubes, transmitters, flow switches, fueling system pumps, all field instrumentation, tightness monitoring system, and control valves with all hardware and software, is an integrated system it must be furnished by a single systems supplier regularly engaged in the supplying of this equipment. System Supplier must be a company whose regular, normal, and primary business is representing manufacturers in the distribution and start-up of aviation fueling facilities, and have no affiliation with the Contractor other than as a seller to the Contractor. Supplier must provide all equipment and appurtenances regardless of manufacture, be a factory authorized certified representative, and be responsible to the Contractor for satisfactory operation of the entire system, and must oversee the installation of the equipment. Substitutions of functions specified will not be acceptable. The Contractor and the System Supplier must be present at the system commissioning, and must coordinate and schedule the work during construction, testing, calibration, and acceptance of the system. The System Supplier must be on-site with their mechanical and control personnel to supervise and assist the contractor during pre-commissioning check-out of the mechanical systems and control systems, initial fuel receipt, initial filling, hydrostatic testing, pigging, flushing, cleaning, Equipment Tests, Performance Testing, and training all for the owner's representatives. The System Supplier must be responsible to the Contractor for scheduling all Contractor, Sub-contractor, and manufacturer's service personnel during system start-up, Equipment Tests, Performance Testing, and training.

2.3 ELECTRICAL EQUIPMENT

Motors, manual or automatic motor control equipment except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.4 PRESSURE GAUGES

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NOTE: For arctic conditions (less than -50 deg F) gauges must be immersed (filled) with silicone.

****

Pressure gauges must conform to ASME B40.100 with metal cases and 100 mm 4-inch diameter white dials. Gauges must be bottom connected, without back flanges. A pulsation dampener, adjustable to the degree of dampening required, must be provided for each gauge. Range of gauges must be as indicated. A ball valve must be provided for each pressure gauge. [Gauges must have all parts immersed in silicone oil.]Gauges must be labeled with the calibration date.

2.4.1 Quick Disconnect

If indicated on drawings provide quick disconnect on pressure gauge. Quick disconnects must be double shut-off, dry-break design, 316 stainless steel construction, with Fluorocarbon (Viton) seals, minimum working pressure of 1000 psig at 100°F., with ½" female NPT threaded connections for both coupler and adapter, manufactured in accordance with ISO 7241, Series B. The quick disconnect assembly must consist of a coupler, half to be connected to the pressure snubber under the pressure gauge, and a nipple/adapter half to be connected above the pressure gauge isolation ball valve. The coupler and nipple/adapter are to be provided with aluminum dust caps to protect the fittings when the gauge is removed.

2.5 AUTOMATIC PUMP CONTROLS

The pressure and flow transmitters specified in this paragraph must be obtained from a single supplier of such products. The same supplier must also furnish the associated venturi tubes and GPM meter. The supplier must be responsible for furnishing components that are compatible and that operate as a system to perform the required pump control functions. Control tubing between controls/instruments and fuel lines must be installed to eliminate air entrapment. Control tubing must be as specified in Section 33 52 43.13 AVIATION FUELING PIPING. Each item of equipment specified hereafter must have manufacturer's authorized service personnel present to assist in PERFORMANCE TESTING as specified in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Items specified under this paragraph must be submitted for approval concurrently with items specified in Section 33 09 53 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III).

2.5.1 Pressure Indicating Transmitters

Pressure indicating transmitters must consist of a capacitance sensor operating on a differential in pressure of fuel (one side being open to atmospheric pressure). The output must be a 4 - 20 mA dc, linear signal between 0 - 100 percent of the input. It simultaneously will produce a digital HART (Highway Addressable Remote Transducer) output signal. Loop power must be provided from remote power supply located in the pump control panel (PCP).

a. Transmitter body must be stainless steel with stainless steel diaphragm capsule process connecting to a 13 mm 1/2 inch NPT. Drain and vent valves to be stainless steel. Accuracy must be ± 0.20 percent of calibrated span including combined effects of linearity, hysteresis and repeatability.

b. [b. One pressure indicating dial must be supplied with each pair of transmitters. Pressure indicating dials must consist of a bellows type pressure sensing element operating on a differential in pressure of fuel (one side being open to atmospheric pressure) and a mechanical indicator (driven by the bellows unit). The bellows must be dual opposed, liquid filled, rupture-proof type with bellows movement converted to rotation and transmitted by a torque tube. Bellows housing must be stainless steel and must have a rated working pressure of not less than 3.MPa 500 psi with a minimum differential pressure range of 0 to 1.5 MPa 0 to 250 psi. Liquid used to fill the bellows must be suitable for the expected minimum ambient temperature. The indicating dial must be at least 150 mm 6 inches in diameter with a weatherproof glass cover. The case must be finished with a weather resistant epoxy resin enamel. The indicating pointer must traverse a 270 degrees arc. The scales must be graduated over the selected pressure ranges so that the pressure can be read in kPa psig. Indicator accuracy must be 0.75 percent of full scale. Pressure indicating dial must be provided with suitable over-range protection.]

c. [c. Display at the pressure transmitter must be LCD, one per each transmitter. The digital scale must be a 4 digit LCD capable of being read in low light/no light conditions. Indicator scale must be in kPa psig.]

****
NOTE: Select type of display per directions from the SME.
****

d. Pressure transmitters must be UL, FM, or CSA listed for Class 1, Division 1, Group D hazardous environment as defined by NFPA 70, with maximum temperature rating T2D (216 degrees C 419 degrees F). Each transmitter and dial must be supplied with a factory assembled two valve stainless steel manifold. Vent valves must be furnished on upper ports of each transmitter and dial. Pressure transmitters and the indicating dial must be suitable for mounting on a 50 mm 2-inch pipe stand. Complete installation must be in accordance with manufacturer's recommendations.

e. Provide a HART (Highway Addressable Remote Transducer) protocol interface handheld calibration device. Communicator to be intrinsically safe and have Class 1, Div 1, Group C and D approval. Device to include NIST traceable modules, one 0 to 3.5 MPa 0-500 psig range, one 0-2000 wc, and also one protection module for open sensor bay. Unit must be furnished in hard carrying case and to include 250 ohm shunt for HART communicator, A900 HART test lead kit, 1 MPa 145 psig pressure pump with variator, low pressure fittings and tubing kit. Hand-held pump capable of producing a minimum of 2 MPa 300 psig pressure.

2.5.2 Flow Switches

Switches must be actuating vane type flow switch with single adjustable set-point. Switches must mount on ASME B16.5 Class 150 raised face flange. Flange material must match the piping material at their connection to the system. Provide snap action switch mechanism U.L. listed for Class I, Division 1, Group D hazardous locations. Switches to be double pole double throw (DPDT). Switch power must be 120 volts, single phase, 60 hertz, 10 amps minimum. Units installed on 50 mm 2 inch piping and smaller may be threaded.

2.5.3 Venturi Tubes

a. The venturi tubes must be provided in conjunction with Section 33 09 53 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III).

b. Start-up, adjustments and calibration, and instruction of personnel in the operation and maintenance of the venturi tubes must be considered as a required portion of the controls package.

****
NOTE: Select type of Fuel.
****

c. The venturi tubes must be low loss differential pressure producers consisting of a short housing piece and a fully machined, contoured throat section providing a restriction at the center, with both inlet approach and exit having geometrically symmetrical curves. They must be velocity head, impact, differential producing devices designed to measure differential pressure of [F-24][F-35][JP-4][JP-5][JP-8] fuel. They must be constructed of 304L stainless steel with ANSI Class 150 flanges on each end and be suitable for operation of 2 MPa 275 psig at 212 degrees C 100 degrees F. They must be of sufficient thickness to with-stand the same stresses as the upstream and downstream piping. Each venturi tube must have a minimum of four 13 mm 1/2-inch connections. An individual head-capacity curve must be furnished for each venturi tube.

d. Operating conditions for the venturi tubes must be as follows:

****

NOTE: Select based on System and PUMP capacity.

****

(1) Issue Venturi Tube. Minimum inlet-to-throat differential pressure at [144] [_____] L/s: 8 mm [2,400] [_____] gpm: 200 in H2O.

(2) Return Venturi Tube. Minimum inlet-to-throat differential pressure at [36] [_____] L/s: 8 mm [600] [_____] gpm: 200 in H2O.

(3) Venturi tubes discharge coefficient "C" to be greater than or equal to 0.97 over pipe Reynolds number range between 200,000 and 1,000,000 and must be independent of Beta over a Beta range of 0.4 to 0.75. Pressure loss must be less than 24 percent of differential pressure generated by the venturi tube. Repeatability of the discharge coefficient "C" must be 2 percent for Reynolds number range of 10,000 to 1,000,000.

(4) Provide two portable GPM Meters, one for each size of venturi. The meters must be complete with valves, hoses and connecting disconnects, and carrying case. The meters must have stainless steel bellows, mounting bracket, 3.5 MPa 500 psi swp, 150 mm6-inch dial with 270 degrees arc. Dial must read GPM Jet Fuel. Range of scale must match the flow transmitter for issue and return. The venturi manufacturer must provide the portable meters with the venturi in order to be compatible. The venturi tubes must also be provided with a suitable table to convert inches differential pressure to L gallons per minute.

2.5.4 Differential Pressure Transmitter

Differential pressure transmitter must consist of a capacitance sensor operating on a differential in pressure of fuel. The output must be a 4 - 20mA dc, square root signal between a minimum of 4 - 100 percent of the input. It may be linear between 0 - 4 percent. It simultaneously will produce a digital HART (Highway Addressable Remote Transducer) output signal. Loop power must be provided from remote power supply located in the pump control panel (PCP).

a. Transmitter body must be stainless steel with stainless steel diaphragm capsule process connecting to a 13 mm 1/2 inch NPT. Drain and vent valves to be stainless steel. Accuracy must be ± 0.20 percent of calibrated span including combined effects of linearity, hysteresis and repeatability.

b. [b. One differential pressure dial must be supplied with each pair of transmitters. Differential pressure dial must consist of a bellows type pressure sensing element, operating on a differential in pressure of fuel, and a mechanical indicator, driven by the bellows unit. The bellows must be dual opposed, liquid filled, rupture-proof type with bellows movement converted to rotation and transmitted by a torque tube. Displacement of bellows must be 24,000 cubic mm 1.5 cubic inches for full scale travel. Bellows housing must be stainless steel and must have a rated working pressure of not less than 3.5 MPa 500 psi. Liquid used to fill the bellows must be suitable for the expected minimum ambient temperature. The indicating dial must be at least 150 mm 6 inches in diameter with a weatherproof glass cover. The case must be finished with a weather resistant epoxy resin enamel. The indicating pointer must traverse a 270 degree arc. The scales must be graduated over the selected pressure ranges so that the flow rate can be accurately read in L gallons per minute. Indicator accuracy must be 0.5 percent of full scale. Differential pressure indicating dial must be provided with built-in pulsation damper and suitable over-range protection.]

****

NOTE: Select type of display per directions from SME.

****

c. [c. Display at the transmitter must be LCD, one per each differential pressure transmitter. The digital scale must be a 4 digit LCD, capable of being read in low light/no light conditions. Indicator scale must be in L gallons per minute.]

****

NOTE: Select based on System and Pump capacity. Systems greater than 150 L/s 2400 gpm require issue Venturi Tube to have low range (0-95 L/s (0-1500 gpm) and high range (0- maximum system flow in L/s gpm) transmitters versus one single full range transmitter.

****

d. Each venturi tube must have two transmitters and one indicating dial per function and must be installed as indicated on the drawings. Differential pressure ranges must be selected as necessary to operate in conjunction with associated venturi tube:

(1) Issue Venturi Tube - 0 to [144] [_____] L/s0 to [2400] [_____] GPM (full range)

(2) Return Venturi Tube - 0 to [36] [_____] L/s0 to [800] [_____] GPM (full range)

e. [e. Differential pressure transmitters must be UL, FM, or CSA listed for Class 1, Division 1, Group D hazardous environment as defined by NFPA 70, with maximum temperature rating T2D (215 degrees C 419 degrees F). Each transmitter and indicating dial must be supplied with a factory assembled five valve stainless steel manifold. Vent valves must be furnished on upper ports of each transmitter and indicating dial. Differential pressure transmitters and the indicating dial must be suitable for mounting on a 50 mm 2-inch pipe stand. Complete installation must be in accordance with manufacturer's recommendations.]

2.5.5 Pressure Sensor

Sensor must be UL, FM, or CSA listed for Class 1, Division 1, Group D hazardous environment as defined by NFPA 70, with maximum temperature rating T2D (215 degrees C 419 degrees F). Excitation voltage must be 12-28 VDC. Output signal must be 4-20 mA. Unit must have 0.25 percent accuracy and have built-in high pressure snubbers, minimum pressure range must be 0-2.1 MPa 0-300 PSI. Wetted material must be stainless steel.

2.6 METERS

****
NOTE: Select type of fuel.
****

Meter must be a one-way flow, temperature compensating, positive displacement type meter designed for a continuous flow of 36 L/s 600 GPM [18 L/s 300 GPM]at the truck fill stand. Meter must have ANSI Class 150 flanges and body working pressure of not less than 2 MPa 275 psig and must be suitable for hydrostatic testing of 2 MPa 275 psig. Meter must be factory calibrated for [F-24][F-35][JP-4][JP-5][JP-8]jet fuel and capable of being calibrated in the field. The register must have a non-setback total indicator and a setback type run indicator so that individual runs can be registered without affecting the total of all runs as shown on the indicator. The total indicator must have a minimum of eight figures and the setback run indicator must have a minimum of five figures. The register must read in gallons and the smallest unit of indicated delivery must be 4 L 1 gallon. Accuracy must be within +0.3 percent between ten percent and maximum rated flow. Meters must be provided with a suitable drain at the bottom, equipped with a ball valve. Pressure loss through the meter must not exceed 20 kPa 3 psi at 36 L/s 600 GPM [18 L/s 300 GPM]flow rate.

[2.7 RECEIPT FLOW METER

****
NOTE: Select per SME.
****

Meter must consist of corner tapped orifice flanges, orifice flange plate, differential pressure gauge, and associated flow chart. The normal flow range is 0 to 36 L/s 600 gpm. Orifice flanges must be ANSI Class 150 and must be constructed of Type 304 or 304L stainless steel. Orifice Beta value must be 0.7, with a maximum pressure loss of no more than 20 kPa 3 psi at 36 L/s 600 gpm. Differential pressure gauge must have a display of 0-30 m 0-100 feet water column. A hand chart must be provided which shows the flow (L/s) (gpm) for the pressure drop indicated on the differential pressure gauge. A note must be added: Tank must not be filled faster than 30 L/s (1 m/s) 450 gpm (3 fps) when ever the fuel is not in contact with the floater (tank fuel receipt outlet is covered by 1 meter 3 feet of fuel when no floater is present).

][2.8 UNDERGROUND PRODUCT RECOVERY TANK AND ACCESSORIES

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NOTE: Use fiberglass TANK if directed by SME, reference Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. PRT must be underground for Cut and Cover systems
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2.8.1 Tank Construction

Tank and appurtenances must be in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Product recovery tank must be a U.L.

labeled, double wall, steel tank, with interstitial monitor. Tank must be provided with calibrated gage stick, strapping chart, and a steel vault attached to tank. Vault must be provided with a rolling pit cover and removable access grating. Minimum inner and outer tank wall thickness must be 4 mm 0.167 inches.

2.8.1.1 Steel Tank With Vault

a. The design, fabrication, erection, testing, and inspection of the double wall tank must conform to the requirements of UL 58, Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids, Type II. The exterior tank walls must be separated from the interior walls by standoffs.

b. Material must be carbon steel plate.

c. Lifting lugs must be located at the balance points.

d. Provide anchor straps to attach tank to hold down slab. Straps must be separated from the tank by a pad made of inert insulating material. Number and location of straps must be as indicated on the drawings. Metal straps, turnbuckles, and anchors must be coated to resist corrosion.

e. Tank capacity, connections and appurtenance must be as shown on the drawings and as described.

f. Provide a complete system of cathodic protection for the tank and vault in accordance with Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM.

g. The interior and exterior surfaces of tank and vault must be coated for corrosion protection. The interior surface must be coated in accordance with Section 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS. The exterior surface must be coated in accordance with STI 010-50-1000 and the tank must bear the STI 010-50-1000 label.

2.8.1.2 Automatic Tank Gauging (ATG) and Leak Detection Monitor

2.8.1.2.1 ATG

ATG must be the mechanically or electronically actuated type that can continuously monitor a tank's usable liquid level storage capacity. The system must provide a digital readout of a tank's liquid level in terms of mm inches and liters gallons. The system must be accurate to plus or minus 2 mm 1/16 inch. The system must measure water accumulation in mm inches from 19 to 125 mm 3/4 to 5 inches off the bottom of a storage tank. Construct system components to be chemically compatible with the fuel to be handled.

2.8.1.2.2 Leak Detection

a. Provide an annular space between the primary and secondary shells to allow for the free flow and containment of all leaked product from the primary tank.

b. Provide the tank with a leak monitoring system capable of sensing leaks in the secondary containment space and in the vault. The system must detect a leak of fuel through the inner shell to the area between the inner and outer shells or a leak of ground water through the outer shell into the area between the inner and outer shells. The detector and any equipment in the area of the fuel tanks and valve pits must be rated for the environment in which it is installed. The system must be a continuous surveillance type. The sensor must be electronic or hydraulic type and must be connected to a control panel. Totally flooded containment space reservoir system must not be permitted. The alarm must be manually reset at the control panel. Use an inert gas that is heavier than air in containment space of the tanks to prevent the forming of condensation. The tank monitoring system must be compatible with the tank furnished and must be as recommended by the tank manufacturer. Provide instructions and equipment required for calibration of the monitoring system and calibration maintenance schedule. Access must be provided to the tank sensor for testing and maintenance.

2.8.1.2.3 Control Panel

The control panel must be located where shown on the plans. Panel must be a standard industrial enclosure. Panel doors must swing left or right. The panel must display the digital readout of each monitored tank on an LCD mounted exterior to the panel. The panel must also have external controls to allow operators to toggle between information on the LCD without having to open the panel. The panel must provide an audible and visible alarm if a leak or preset high or high-high level is detected. Panel must discrimiate and indicate if the leak is fuel or water. Leak detection, high level and high-high level alarms must be provided to the pump control panel(PCP), see Section 33 09 55 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (CUT-N-COVER TANKS). Provide system operating instructions inside of the control panel. Unit must be Veeder-Root ATG TLS, or Government approved equal and compatible with the Base Fuels Automated System (FAS).

2.8.1.3 Tank Appurtenances and Fittings

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NOTE: Provide devices in accordance with the recommendation of NFPA 30, Federal, State and Local Codes as applicable in this and following paragraphs.

****

Provide tank appurtenances and fittings as indicated. Nozzles for appurtenances and steel vault must be as indicated or per manufacturer's recommendations and installed plumb with all above grade flange faces level. Gravity fill line must be provided with locking cap. The flange on the Fuel Transfer Pump pumpway must be an ASME Class 150 flange.

2.8.1.4 Tank Vents

Tank vents must be standard weight steel pipe with malleable iron fittings. Vent outlets must be equipped with [flame arresters] [pressure-vacuum vents] [flame arresters and pressure-vacuum vents] [flare stacks].

2.8.1.5 Manway

A 914 mm 36-inch round manway must have U.L. listed gasket with bolted cover. A fiberglass or stainless steel ladder must be provided inside the tank at the manway.

2.8.1.6 Sampling and Gauging hatch

A sampling and gauging hatch must be provided and must consist of a foot-operated, hinged cover with a flexible sealing ring and provision for padlocking. The hatch must be non-sparking and must have a flanged connection for installation on 100 mm 4-inch steel pipe. Provide a datum plate beneath gauge opening, and stencil reference height on gauge/sampling hatch piping.

2.8.1.7 Float Switch Assembly

The float switch assembly must be the top mounted, float operated type with vertical float rod. The switch assembly must be suitable for flange mounting and float and trim must be stainless steel. The switch must be magnetically latching reed. Rating of the switch contacts must be adequate for the indicated functions shown on the drawings. This float switch assembly must be used to start and stop the Fuel Transfer Pump and to indicate a high and high-high level and activate an alarm in the PCP.

2.8.1.8 Fuel Transfer Pump (FTP-1)

Refer to Section 33 52 43.23 AVIATION FUEL PUMPS

2.8.1.9 Electric Pump

The electric pump must be a sliding vane type rotary pump. The pump construction must permit the removal of the rotor and sliding vanes without disconnecting the pump. Pump capacity must be 20 L 5 gal per minute with a differential head of [_____] m feet. The pump and motor must be mounted on a cast iron or steel subbase. The motor must have sufficient power for the service required, must be of a type approved by the manufacturer of the pump, must be suitable for available electric service, must be totally enclosed, fan cooled, TEFC, and must conform to the requirements specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Pump must be provided with stainless suction screen, foot valve, stainless steel pipe, and aluminum 13 mm 1-1/2-inch cam type quick disconnect with dust cap.

2.8.1.10 Lockable Cap

Provide a lockable cap for the 50 mm 2-inch gravity fill line.

2.8.1.11 Spill Containment Basin

Container must be constructed of fiberglass reinforced plastic, be compatible with the type of fuel being handled, have a minimum 14 L 3 gal fuel storage capacity, and form a water-tight seal around the fuel piping to prevent spilled fuel from entering the soil. Container must be provided with a drain and have an easily removable cover constructed of either cast aluminum or cast iron. Covers must be weather-resistant and must prevent the influx of water.

2.8.1.12 Overfill Valve (OV-1)

Refer to Section 33 52 43.14 AVIATION FUEL CONTROL VALVES

2.8.1.13 Tank Calibration

Provide a certified tank calibration chart in 2 mm increments reading in L gal. Tank certification must be done onsite and stamped by a P.E.

][2.9 ABOVEGROUND PRODUCT RECOVERY TANK AND ACCESSORIES

2.9.1 Tank Construction

Tank and appurtenances must be in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Product recovery tank must be a U.L. labeled, double wall, steel tank, with interstitial monitor. Tank must be provided with calibrated gage stick and strapping chart.

2.9.1.1 Steel Tank

a. The design, fabrication, erection, testing, and inspection of the double wall tank must conform to the requirements of UL 2085.

b. Material must be carbon steel plate.

c. Lifting lugs must be located at the balance points.

d. Tank capacity, connections and appurtenance must be as shown on the drawings and as described under "Leak Detection Monitor."

e. The interior and exterior surfaces of tank and vault must be coated for corrosion protection. The interior surface must be coated in accordance with Section 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS. The exterior surface must be coated in accordance with Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES.

2.9.1.2 Automatic Tank Gauging (ATG) and Leak Detection Monitor

2.9.1.2.1 ATG

ATG must be the mechanically or electronically actuated type that can continuously monitor a tank's usable liquid level storage capacity. The system must provide a digital readout of a tank's liquid level in terms of mm inches and liters gallons. The system must be accurate to plus or minus 2 mm 1/16 inch. The system must measure water accumulation in mm inches from 19 to 125 mm 3/4 to 5 inches off the bottom of a storage tank. Construct system components to be chemically compatible with the fuel to be handled.

2.9.1.2.2 Leak Detection

a. Provide an annular space between the primary and secondary shells to allow for the free flow and containment of all leaked product from the primary tank.

b. Provide the tank with a leak monitoring system capable of sensing leaks in the secondary containment space. The system must detect a leak of fuel through the inner shell to the area between the inner and outer shells. The detector and any equipment in the area of the fuel tanks must be rated for the environment in which it is installed. The system must be a continuous surveillance type. The sensor must be electronic or hydraulic type and must be connected to a control panel. Totally flooded containment space reservoir system must not be permitted. The alarm must be manually reset at the control panel. Use an inert gas that is heavier than air in containment space of the tanks to prevent the forming of condensation. The tank monitoring system must be compatible with the tank furnished and must be as recommended by the tank manufacturer. Provide instructions and equipment required for calibration of the monitoring system and calibration maintenance schedule. Access must be provided to the tank sensor for testing and maintenance.

2.9.1.2.3 Control Panel

The control panel must be located where shown on the plans. Panel must be a standard industrial enclosure. Panel doors must swing left or right. The panel must display the digital readout of each monitored tank on an LCD mounted exterior to the panel. The panel must also have external controls to allow operators to toggle between information on the LCD without having to open the panel. The panel must provide an audible and visible alarm if a leak or preset high or high-high level is detected. Panel must discrimiate and indicate if the leak is fuel or water. Leak detection, high level and high-high level alarms must be provided to the pump control panel(PCP), see Section [33 09 53 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III)] [33 09 54 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE [IV][V])]. Provide system operating instructions inside of the control panel. Unit must be Veeder-Root ATG TLS, or Government approved equal and compatible with the Base Fuels Automated System (FAS).

2.9.1.3 Tank Appurtenances and Fittings

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NOTE: Provide devices in accordance with the recommendation of NFPA 30, Federal, State and Local Codes as applicable in this and following paragraphs.

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Provide tank appurtenances and fittings as indicated. Nozzles for appurtenances must be as indicated or per manufacturer's recommendations and installed plumb. Spill bucket must be provided with locking cap. The flange on the Fuel Transfer Pump pumpway must be an ASME Class 150 flange.

2.9.1.4 Tank Vents

Tank vents must be standard weight steel pipe with malleable iron fittings. Vent outlets must be equipped with [flame arresters] [pressure-vacuum vents] [flame arresters and pressure-vacuum vents] [flare stacks].

2.9.1.5 Manway

A 914 mm 36-inch round manway must have U.L. listed gasket with bolted cover. A fiberglass or stainless steel ladder must be provided inside the tank at the manway.

2.9.1.6 Sampling and Gauging hatch

A sampling and gauging hatch must be provided and must consist of a foot-operated, hinged cover with a flexible sealing ring and provision for padlocking. The hatch must be non-sparking and must have a flanged connection for installation on 100 mm 4-inch steel pipe. Provide a datum plate beneath gauge opening, and stencil reference height on gauge/sampling hatch piping.

2.9.1.7 Float Switch Assembly

The float switch assembly must be the top mounted, float operated type with vertical float rod. The switch assembly must be suitable for flange mounting and float and trim must be stainless steel. The switch must be magnetically latching reed. Rating of the switch contacts must be adequate for the indicated functions shown on the drawings. This float switch assembly must be used to start and stop the Fuel Transfer Pump and to indicate a high and high-high level and activate an alarm in the PCP.

2.9.1.8 Fuel Transfer Pump (FTP-1)

Refer to Section 33 52 43.23 AVIATION FUEL PUMPS

2.9.1.9 Electric Pump

The electric pump must be a sliding vane type rotary pump. The pump construction must permit the removal of the rotor and sliding vanes without disconnecting the pump. Pump capacity must be 20 L 5 gal per minute with a differential head of [_____] m feet. The pump and motor must be mounted on a cast iron or steel subbase. The motor must have sufficient power for the service required, must be of a type approved by the manufacturer of the pump, must be suitable for available electric service, must be totally enclosed, fan cooled, TEFC, and must conform to the requirements specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Pump must be provided with stainless suction screen, foot valve, stainless steel pipe, and aluminum 13 mm 1-1/2-inch cam type quick disconnect with dust cap.

2.9.1.10 Lockable Cap

Provide a lockable cap for the 50 mm 2-inch gravity fill line.

2.9.1.11 Spill Containment Basin

Container must be constructed of carbon steel, be compatible with the type of fuel being handled, have a minimum 14 L 3 gal fuel storage capacity, and form a water-tight seal around the fuel piping to prevent spilled fuel. Container must be provided with a drain and have an easily removable cover constructed of either cast aluminum or cast iron. Covers must be weather-resistant and must prevent the influx of water.

2.9.1.12 Overfill Valve (OV-1)

Refer to Section 33 52 43.14 AVIATION FUEL CONTROL VALVES

2.9.1.13 Tank Calibration

Provide a certified tank calibration chart in 2 mm increments reading in L gal. Tank certification must be done onsite and stamped by a P.E.

2.9.1.14 Tank Catwalk

Provide a platform, complete with guardrails in accordance with Section 05 52 00 METAL RAILINGS, centered above and along the full length of the tank. Provide a minimum clear distance of 25 mm1 inch between the bottom of the platform beams and the top of the tank. Live load deflections must be limited to the clear span divided by 360 (L/360).

The platform must be wide enough to satisfy OSHA 29 CFR 1910 requirements and allow protected access to the tank manholes and gauges. The catwalk must be designed with removable grates that allow access to the tank appurtenances. Grating elevation must be set below the manway hatches. Any appurtenances or manways, which stick above the grating, must be painted yellow. Refer to Section 05 51 00 METAL STAIRS for additional platform requirements.

The catwalk system may be directly attached to the tank if a structural analysis and a letter stamped by the manufacturer states that the tank adequately supports the additional loads without yielding or failing. Field welding on the tank shell must not be permitted as a means to attach the catwalk system directly to the tank or to perform any other feature of work. Any and all attachments to a newly installed AST must be achieved through pre-fabricated features of the AST. Any field modification to a newly installed AST, which impacts its current UL certification or which presents a violation of any other pertinent code or standard, is not allowed. If not approved or supplied by the manufacturer, the platforms must not be supported off of the tank and will require individual foundations.

[Provide a stairway for accessing one end of the tank platform in accordance with Section 05 51 00 METAL STAIRS and OSHA 29 CFR 1910.]
[Provide a ladder for accessing one end of the tank platform in accordance with Section 05 51 33 METAL LADDERS and OSHA 29 CFR 1910.]

][2.10 FUEL SYSTEM WASTE WATER TANK AND ACCESSORIES

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NOTE: Use fiberglass tank if directed by SME, reference Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Use a fuel system waste water tank when designing a cut and cover system if directed by SME.

****

2.10.1 Tank Construction

Waste water tank must be a U.L. labeled, double wall, steel tank, with interstitial monitor. Tank must be provided with calibrated gage stick, strapping chart and a steel vault attached to tank. Vault must be provided with a rolling pit cover and removable access grating. Minimum inner and outer tank wall thickness must be 4 mm 0.167 inches.

2.10.1.1 Steel Tank With Vault

a. The design, fabrication, erection, testing, and inspection of the double wall tank must conform to the requirements of UL 58, Standard for Safety, Steel Underground Tanks for Flammable and Combustible

Liquids, Type II. The exterior tank walls must be separated from the interior walls by standoffs.

b. Material must be carbon steel plate.

c. Lifting lugs must be located at the balance points.

d. Provide anchor straps to attach tank to hold down slab. Straps must be separated from the tank by a pad made of inert insulating material. Number and location of straps must be as indicated on the drawings. Metal straps, turnbuckles, and anchors must be coated to resist corrosion.

e. Tank capacity, connections and appurtenance must be as shown on the drawings and as described under "Monitor."

f. A complete system of cathodic protection must be provided for the tank and vault in accordance with Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM.

g. The interior and exterior surfaces of tank and vault must be coated for corrosion protection. The interior surface must be coated in accordance with Section 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS. The exterior surface must be coated in accordance with STI 010-50-1000 and the tank must bear the STI 010-50-1000 label.

2.10.1.2 Automatic Tank Gauging (ATG) and Leak Detection Monitor

2.10.1.2.1 ATG

ATG must be the mechanically or electronically actuated type that can continuously monitor a tank's usable liquid level storage capacity. The system must provide a digital readout of a tank's liquid level in terms of mm inches and liters gallons. The system must be accurate to plus or minus 2 mm 1/16 inch. The system must measure water accumulation in mm inches from 19 to 125 mm 3/4 to 5 inches off the bottom of a storage tank. Construct system components to be chemically compatible with the fuel to be handled.

2.10.1.2.2 Leak Detection

a. Provide an annular space between the primary and secondary shells to allow for the free flow and containment of all leaked product from the primary tank.

b. Provide the tank with a leak monitoring system capable of sensing leaks in the secondary containment space and in the vault. The system must detect a leak of fuel through the inner shell to the area between the inner and outer shells or a leak of ground water through the outer shell into the area between the inner and outer shells. The detector and any equipment in the area of the fuel tanks and valve pits must be rated for the environment in which it is installed. The system must be a continuous surveillance type. The sensor must be electronic or hydraulic type and must be connected to a control panel. Totally flooded containment space reservoir system must not be permitted. The alarm must be manually reset at the control panel. Use an inert gas that is heavier than air in containment space of the tanks to prevent the forming of condensation. The tank monitoring system must be compatible with the tank furnished and must be as recommended by the tank manufacturer. Provide instructions and equipment required for calibration of the monitoring system and calibration maintenance schedule. Access must be provided to the tank sensor for testing and maintenance.

2.10.1.2.3 Control Panel

The control panel must be located where shown on the plans. Panel must be a standard industrial enclosure. Panel doors must swing left or right. The panel must display the digital readout of each monitored tank on an LCD mounted exterior to the panel. The panel must also have external controls to allow operators to toggle between information on the LCD without having to open the panel. The panel must provide an audible and visible alarm if a leak or preset high or high-high level is detected. Panel must discrimiate and indicate if the leak is fuel or water. Leak detection, high level and high-high level alarms must be provided to the pump control panel(PCP), see Section 33 09 55 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (CUT-N-COVER TANKS). Provide system operating instructions inside of the control panel. Unit must be Veeder-Root ATG TLS, or Government approved equal and compatible with the Base Fuels Automated System (FAS).

2.10.1.3 Tank Appurtenances and Fittings

****

NOTE: Provide devices in accordance with the recommendation of NFPA 30, Federal, State and Local Codes as applicable in this and following paragraphs.

****

Provide tank appurtenances and fittings as indicated. Nozzles for appurtenances and steel vault must be as indicated or per manufacturer's recommendations and installed plumb with all above grade flange faces level.

2.10.1.4 Tank Vents

Tank vents must be standard weight steel pipe with malleable iron fittings. Vent outlets must be equipped with pressure-vacuum vents.

2.10.1.5 Manway

A 914 mm 36-inch round manway must have U.L. listed gasket with bolted cover. A fiberglass or stainless steel ladder must be provided inside the tank at the manway.

2.10.1.6 Sampling and Gauging hatch

Provide a sampling and gauging hatch consisting of a foot-operated, hinged cover with a flexible sealing ring and provision for padlocking. The hatch must be non-sparking and must have a flanged connection for installation on 100 mm 4-inch steel pipe. Provide a datum plate beneath gauge opening, and stencil reference height on gauge/sampling hatch piping.

2.10.1.7 Electric Pump

The electric pump must be a sliding vane type rotary pump. The pump construction must permit the removal of the rotor and sliding vanes without disconnecting the pump. Pump capacity must be 200 L 50 gal per minute with a differential head of 8.7 m 57 feet. The pump and motor must be mounted on a cast iron or steel subbase. The motor must have sufficient power for the service required, be of a type approved by the manufacturer of the pump, be suitable for available electric service, be totally enclosed, fan cooled, TEFC, and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Pump must be provided with stainless suction screen, stainless steel pipe, and aluminum 50 mm 2-inch cam type quick disconnect with dust cap.

2.10.1.8 Overfill Valve (OV-1)

Refer to Section 33 52 43.14 AVIATION FUEL CONTROL VALVES.

2.10.1.9 Tank Calibration

Provide a certified tank calibration chart in 2 mm 1/16 inch increments reading in L gal. Tank certification must be done onsite and stamped by a P.E.

]2.11 TRUCK OFFLOAD SYSTEM

The truck offload system must be a factory fabricated and skid mounted unit.

2.11.1 Offload Pump (OP)

Refer to Section 33 52 43.23 AVIATION FUEL PUMPS

2.11.2 Air Eliminator Tank

2.11.2.1 Tank Housing

Each Tank housing must be fabricated from carbon steel and must be internally coated with an epoxy coating in accordance with MIL-PRF-4556. Coat the exterior with alkyd resin primer (universal metal primer). Each unit must be constructed and labeled in accordance with ASME BPVC SEC VIII D1. The housing must be designed for a working pressure of 600 kPa 90 psig. The inlet and outlet connections must be provided with raised face flanges faced and drilled in compliance with ASME B16.5, Class 150. Tank outlet must contain a anti-vortex plate. The configuration of the air eliminator tanks must be as shown on the drawings.

2.11.2.2 Sight Gauge

Provide a 125 mm 5-inch armored, clear borosilicate (Pyrex) glass liquid level gauge for observing fuel level in the tank. The gauge must be equipped with stainless steel ball checks in both the upper and lower fittings, an upper and lower shutoff valve, and a bottom blowoff cock. The gauge will contain a colored density sensitive ball. Glass must be protected by a minimum of four guard rods.

2.11.2.3 High Level Shutoff

The vent connection must have a stainless steel high level shutoff mechanism to act as an overfill prevention device to keep fuel from going out the vent.

2.11.2.4 Level Sensors

The level sensors must be ultrasonic tip sensitive level control switches, NEMA 7/9, weatherproof, explosion proof for Class I, Div I, Group D, temperature T2D (215 degrees C419 degrees F), 120-volt input power, SPST relay output, 25 mm1-inch flanged mounting.

2.11.2.5 Vent

Tank vent outlet must be equipped with pressure-vacuum breather vent, aluminum construction with weather hood and with fluoroelastomer pallet seat inserts, high density screens, stainless steel internals, with pressure relief setting at 20 grams 0.5 oz per square mm inch, and vacuum relief set at 1350 grams 32 oz per square mm inch. Pressure venting capacity must be 151 cubic m 5400 cubic feet per hour, vacuum capacity must be 136 cubic m 5000 cubic feet per hour.

2.11.3 Non-Surge Check/Air Block Valve

Refer to Section 33 52 43.14 AVIATION FUEL CONTROL VALVES

2.11.4 Offload Fuel Hose

The offload fuel hose must be 100 mm 4-inch, lightweight, flexible, minimum 200 mm 8-inch bend radius, non-pressurized offloading hose constructed of nitrile rubber, rigid PVC helix, synthetic braiding, smooth bore, corrugated outer diameter, non-collapsible, threaded, male NPT, both ends, and have UV protection.

2.11.5 Offload Sight Flow Indicator

The Truck Offload sight flow indicator must be 100 mm four inch wafer pattern sight glass, plane indicator aluminum construction.

2.11.6 Flood Lights

Mount three floodlights on the off load skid, approximately 3.66 m 12 foot high, two on one pole, one on another pole to provide 10 fc of illuminance at the offload connection point and 1 fc of general illumination in the offload area. Fixtures must operate on 277 volts, single phase, 60 Hz. Luminaires must be rated for installation in wet locations and have narrow vertical and wide horizontal beam spread. Luminaires must be bronze in color and accept 50 mm 2-inch knuckle mounting.Provide a manual switch for control. See Section 26 56 00 EXTERIOR LIGHTING for applicable requirements.

2.11.7 Flowmeter

Meter must be as indicated in paragraph METERS, designed for a continuous flow of [36][18] L/s[600][300] GPM.

[2.11.8 Grounding

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NOTE: Delete this paragraph if the tank trucks to be loaded/unloaded have a plug-in connection for such a system. Indicate on the drawings the type of connection required for a Grounding Verification Unit. Delete the second paragraph if a grounding cable and clamp connection will be sufficient.

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The skid must be equipped with a self winding grounding cable reel. The cable must be at least 15 m 50 feet long. The cable reel, the grounding cable and the connection clamp must be in accordance with CID A-A-50696.

][2.11.9 Grounding Verification Unit

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NOTE: System can connect to a tank truck by using either a grounding clamp or plug. For a grounding plug to work, the tank trucks must have an appropriate receptacle. Coordinate with the Using Agency to determine if plugs are needed and if so what type.

The switch contact in the control module can be used to initiate various interlock functions (e.g., stop pumps, close valves, initiate alarms, etc.). Indicate the desire interlock control functions on the drawings.

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System must include grounding [clamp] [plug], grounding cable, and monitoring and control module. System must automatically and continually monitor and verify a low-resistance static dissipation path (less than [10 Ohms] [_____]) between connecting tanker and the designated ground point. [Grounding clamp must conform to MIL-DTL-83413 and MIL-DTL-83413/7.] [Grounding plug must [conform to MIL-DTL-83413 and MIL-DTL-83413/4.] [______].] Grounding cable must be corrosion resistant steel strands sheathed in a Hytrel jacket. Cable must be the spiral, self-retracting type. Cable must be a minimum 9 m 30 feet in length. Monitoring and control module must be rated for an explosion-proof environment in accordance with NFPA 70 for Class I, Division I, Group D locations. Module must include status lights (red for no ground verification and green for positive ground verification) and a lockable bypass switch. Module must include a switch contact to allow interlock functions.

]2.11.10 Other Offload Equipment

For other equipment shown on the drawings as part of the offload system, refer to this Section and refer to Section 33 52 43.13 AVIATION FUELING PIPING

2.12 HYDRANT OUTLET PITS AND ISOLATION VALVE PITS

Use this paragraph for On-shoulder and On-apron installation. Pantograph and hydrant hose truck hydrant outlet pits and isolation valve pits must be prefabricated units that are the standard products of a firm regularly engaged in the manufacture of such products and must essentially duplicate items that have been in satisfactory use for at least (3) years prior to bid opening. The basic pit must consist of a 1.25 m 0.50-inch thick fiberglass walls and floor with main body dimensions as shown on the drawings. The pit must contain twelve (minimum) integral concrete anchors or two integral anchors that run continuous on three sides of pit. The integral fiberglass top flange must require no exposed corrosive material, weldments, or strongbacks within the pit to support the aluminum cover assembly. The manufacturer must have had a minimum of three years successful experience in the production and usage of their fiberglass service pits and must supply proof of experience at time of submittals. Pits must be provided with a 50 mm 2-inch pump-out line terminating with a male cam type bronze connector with female dust cap. Pits must be provided with removable aluminum grating platform suitable for loading of 150 kg 400 pounds per square foot. The grating must cover the entire opening when the lid is in the open position. The grating platform must have outside edges and cut-outs framed. The inside of the lid must have a 356 by 254 mm 14 by 10 inch permanently attached sign which says "DANGER CONFINED SPACE ENTER BY PERMIT ONLY". The sign must be white with black letters, made of PVC, completely and permanently encapsulated 1.25 mm 50-mil plastic.

2.12.1 Pit Cover

The pit cover assembly must consist of a completely removable one-piece aluminum lid attached to a rigid frame which is an integral part of the fiberglass pit. The lid must be attached to the frame with hinges which do not carry wheel loads applied to the top surface of the lid in its closed position. The lid must be equipped with a device to hold the lid in its fully-opened position. This lid-staying device must automatically engage when the lid is opened to its fully-opened position. The device must also be provided with a quick-release mechanism designed to be operated with one hand. The lid must be considered fully-open when it is rotated approximately 90 degrees from its closed position. Each cover lid must move smoothly through its entire range of motion and must be counterbalanced sufficiently to require an externally-applied opening force of 35 pounds (maximum) to be applied to the center of the long side of the cover (opposite the hinge side). Similarly, the maximum closing force required to be applied at the same point must be approximately 18 kg 50 pounds. In addition, the cover must be counterbalanced in such a fashion that the cover will not close under its own weight if released when open to any angle greater than 70 degrees (from its closed position). Operation of the lid will not have spring assist. Lifting handles (two minimum) must be provided for each lid. Each handle must provide comfortable, secure grip for and average adult male's full (gloved) hand. All covers must be provided with a latch, operable from the exterior of the vault, to securely hold the lid to the frame in the closed position. The latch will be capable of being released from either lifting handle. Tools must not be required to engage (or disengage) the latch or the lid lifting handles. Latch and handle designs must be weather-resistant with features to prelude freeze-up and the collection of dirt and precipitation. Projections of the lid's hinges, lifting handles, or latches above the plane of the lid, whether temporary or permanent, must not be allowed. The weight bearing flange surfaces of both the fiberglass pit liner and the aluminum cover lid must be machined flat to assure uniform weight distribution. The word FUEL must be integrally cast in raised letters on the top surface of each lid. The lettering must be a minimum of 25 mm 1-inch high and 1.6 mm 0.0625-inch deep. [The pantograph pit cover must include an interior center 457 mm 18-inch diameter (clear opening) twist and turn lid that fully opens and is attached with a stainless steel cable.] [Pit lid must be designed for resisting debris and water accumulation at seals, load bearing surfaces, hinges, and handle pockets. Seal must be an elastomeric perimeter seal, easy to replace, secured to lid by dovetail grooves, no adhesive. Push buttons are not allowed.]

2.12.2 Pit Cover Materials, Design, and Testing

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NOTE: Provide center opening per SME. Provide water resistant lid per SMEat northern bases.

****

All cover lids and frames must be designed using an appropriate cast aluminum alloy or rolled aluminum plate to support an aircraft wheel load simulated by a roving 90,720 kg 200,000-pound test-load applied perpendicular to a 129,000 square mm 200-square-inch contact area(254 by 508 mm 10 by 20 inches) of the cover's top surface. The aluminum alloy material selected for design must be ductile, corrosion-resistant, impact-resistant, and suitable for the intended use. All covers must be non-skid surface construction and free of injurious defects. Welding for the purpose of structural repair of casting defects must not be allowed. Minor cosmetic welding is acceptable. The cover must be capable of supporting the test-load without failure regardless of the location or orientation of the load. Localized yielding or cracking or excessive deformations must be considered as failure. Actual load-tests must be performed on a minimum of 10 percent of all the covers supplied. Load-tested units must be randomly selected. Load-test conditions must model field-installed conditions as nearly as practicable. The 800 kN 200 Kip test-load must be applied to the cover for a minimum duration of 5 minutes. Absolute maximum deflection of the cover lid under the test-load must not exceed 1/180th of the minimum interior opening dimension of the fiberglass pit body. Maximum deflection of the cover lids, remaining after removal of the test load, must be + 0.25 mm 0.010-inches to assure that no permanent set has taken place. Upon removal of the test-load, the cover lid and frame must be carefully examined for cracks or localized areas of permanent deformation. All results must be submitted for review and approval. A single failure to meet any of the stated criteria must be considered sufficient grounds for the testing of 50 percent of the units.

2.12.3 Pipe Seal

The pipe penetrations through the pit floor or wall must be sealed by means of a Buna-N boot. The boot must be secured to the pipe and to a steel sleeve bonded to the pit wall at the pit penetration by stainless steel clamps. Buna-N (Nitrile Butadiene) material must be in accordance with SAE AMS3275.

2.12.4 Hydrant Outlet Pit Equipment

At the Contractor's option, hydrant pits may be furnished complete with hydrant control valves and shutoff valves assembled in a pipe riser. All valves and piping furnished by the pit manufacturer must comply with the requirements specified herein. All control valves must be of the same manufacturer.

2.13 HIGH POINT VENT AND LOW POINT DRAIN PITS

Use for On-Shoulder and On-Apron installations.

2.13.1 Pit Assembly

Each pit must incorporate the following items built into a self-contained assembly.

2.13.2 Pit

The basic pit must consist of 6.25 mm 0.25-inch wall fiberglass liner with a main body approximately 575 mm 23-inches in diameter and a minimum of 925 mm 37-inches deep. The pit must contain two integral concrete anchors. The fiberglass top flange must require no exposed corrosive material, weldments, or strongbacks within the pit to support the cast aluminum ring and cover assembly. The pits must be the standard products of a firm regularly engaged in the manufacture of such product and must essentially duplicate items that have been in satisfactory use for at least three (3) years prior to bid opening. Proof of experience will be submitted.

2.13.3 Pit Cover, General Requirements

The pit cover must include a removable outer ring frame and an interior 457 mm 18-inch diameter (clear opening) hinged lid that opens 160 degrees. [The pit must have a tamperproof cover. The removable outer ring must have anchors to provide for means to secure the manhole and its moveable cover and lid to the "concrete" fiberglass containment. The inner hinged lid must have a means of being locked.] Each cover lid must move smoothly through its entire range of motion and must require a maximum opening force of 150 N 35 pound-force to be applied at a single lifting handle. Each handle must provide a comfortable, secure grip for an average adult male's full gloved hand. Tools must not be required to engage the lifting handle. Projections of the lid's hinges or handles above the plane of the lid, whether temporary or permanent, must not be allowed. The pit service must be integrally cast in raised letters on the top surface of each lid. The lettering must be a minimum of 25 mm 1-inch high and 1.6 mm 0.0625-inch deep. The weight bearing flanges of the fiberglass pit liner and the aluminum cover frame (and lid) must be machined to assure uniform weight distribution.

2.13.4 Pit Cover Materials, Design, and Testing

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NOTE: Select per SME direction.

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The cover frames and lids must be designed and manufactured by a qualified company having a minimum of five years successful experience in the production of similar airport apron slab fixtures. All cover lids and frames must be designed using an appropriate cast aluminum alloy or rolled aluminum plate to support an aircraft wheel load simulated by a roving 90,720 kg 200,000-pound test-load applied perpendicular to a 129,000 square mm 200-square-inch contact area(254 by 508 mm 10 by 20 inches) of the cover's top surface. The aluminum alloy material selected for design must be ductile, corrosion-resistant, impact-resistant, and suitable for the intended use. All covers must be non-skid surface construction and free of injurious defects. Welding for the purpose of structural repair of casting defects must not be allowed. Minor cosmetic welding is acceptable. The cover must be capable of supporting the test-load without failure regardless of the location or orientation of the load. Localized yielding or cracking or excessive deformations must be considered as failure. Actual load-tests must be performed on a minimum of 10 percent of all the covers supplied. Load-tested units must be randomly selected. Load-test conditions must model field-installed conditions as nearly as practicable. The 800 kN 200 Kip test-load must be applied to the cover for a minimum duration of 5 minutes. Absolute maximum deflection of the cover lid under the test-load must not exceed 1/180th of the interior diameter of the fiberglass pit body. Maximum deflection of the cover lids, remaining after removal of the test load must be + 0.25 mm 0.010-inches to assure that no permanent set has taken place. Upon removal of the test-load, the cover lid and frame must be carefully examined for cracks or localized areas of permanent deformation. All results must be submitted for review and approval. A single failure to meet any of the stated criteria must be considered sufficient grounds for the testing of 50 percent of the units.

2.13.5 Pipe Riser Seal

The riser pipe penetration through the pit floor must be sealed by means of a Buna-N boot. The boot must be secured to a metal collar welded to the pipe riser and to a flange at the floor opening by stainless steel clamps. Collar must be fabricated from the same material as the pipe.

2.14 OPERATING TANK LEVEL INDICATOR

The level indicating system must perform tank gauging and have local tank readout. The level indicating system must use a servo to measure all the various locations required for the primary measurement. The level indicating system must be able to measure and compute fuel level, fuel density, fuel actual volume, fuel and water corrected volume, and fuel ambient temperature. The reference point for all level measurements must be from the tank's datum plate. The servo system must attach to the tank's [203] [254] [303] mm [8] [10] [12] inch riser/[254 mm 10-inch] stilling well to minimize the effects of turbulence on the measurements and still allow the government access to take quality control samples. The level indicating system must be able to measure in underground, aboveground and cut and cover tanks with all floor and roof types. The level indicating system must be able to measure multiple tanks with a single field interface unit. The level indicating system must be able to determine whether the tank is issuing or receiving fuel while in the transfer mode and also with the same unit be able to perform leak detection. The level indicating system must require no periodic calibration after installation is complete. The level indicating system must be approved for installation in a hazardous area and certified intrinsically safe by an approved agency and provide lightning protection. The level indicating system must be able to interface with government owned information systems. The level indicating system must provide five sets of alarm outputs; high intermediate high, low, intermediate low and static tank movement alarm.

****
NOTE: Select per SME direction.
****

Level accuracy ± 1.25 mm 0.05 inches
Corrected volume accuracy ± 0.1 percent
Density accuracy ± 1 percent
Temperature accuracy ± -0.6 degrees C 1 degrees F
Detect water in the tank sump to a level equal to or slightly above the water draw-off pipe

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NOTE: This paragraph specifies provision of proprietary products. A J&A must be obtained for these products if the paragraph is included in the project specification.
****

[It will be an ENRAF Servo Gauge Model 854 Automatic Tank Gauging System or approved equal. Equality being determined by compatibility with the Base FAS System.. The system must include an ENDRESS+HAUSER RTU 8130 and a local display similar or equal to a CP/2500. The RTU must transmit data to the Base FAS System located in the RCC via telephone lines as shown on the drawings. Base personnel must coordinate reprogramming of the FAS System to accept this new data.

]2.15 OPERATING TANK LEVEL SWITCHES

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NOTE: Select per SME direction.
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The switches must be an external mount liquid level switch with a stainless steel float chamber and stainless steel, type 304 or 316, float and trim. Switch contacts must be two single pole double throw switches factory mutual approved or U.L. listed for use in Class I, Division 1, Group D hazardous location with a maximum temperature rating of T2D (216 degrees C 419 degrees F). Units must have provisions to check level switch operations without increasing the fuel level in the tanks as shown on the contract drawings.

2.16 OPERATING TANK LEVEL SWITCHES

****
NOTE: Select per SME direction.
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a. System must be designed and installed in such a way that the system must be continuously and automatically self-checking. Switches must be an external mount with a stainless steel fluid chamber. Electronic level sensors must be thermistors or optic type, and be intrinsically safe Class I, Division 1, Group D for hazardous environments, with recognized FM, CSA or UL approval. The sensor holder/junction box must be accessible from the stairway. Units must have provisions to check level switch operations without increasing the fuel level in the tanks as shown on the contract drawings.

b. Level alarms must be mechanically and electrically independent and be totally isolated from the gauging system. The level switches must receive power and send their signal to the Pump Control Panel. Circuitry and cables from the PCP to the electronic level sensors in the tank must be intrinsically safe.

[2.17 OPERATING TANK LEVEL SWITCHES

****
NOTE: Select when using a cut and cover Tank.
****

a. System must be designed and installed in such a way that the system must be continuously and automatically self-checking. Switches must be mounted on top of the tank, in the pump house, as indicated. Electronic level sensors must be thermistors or optic type, and be intrinsically safe Class I, Division 1, Group D for hazardous environments, with recognized FM, CSA or UL approval. The sensor holder/junction box must be accessible.

b. Level alarms must be mechanically and electrically independent and be totally isolated from the gauging system. The level switches must receive power and send their signal to the Pump Control Panel. Circuitry and cables from the PCP to the electronic level sensors in the tank must be intrinsically safe.

]2.18 WATER DRAW-OFF SYSTEM

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NOTE: Use a FUEL SYSTEM WASTE WATER TANK when designing a CUT AND COVER SYSTEM if directed by SME.

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A water draw-off system must be provided for each Operating Tank. Water draw-off system must gravity drain. Each system must include tank, product return pump and all necessary pipe, pressure relief system, valves, and fittings.

2.18.1 Tank

Water draw-off tank must be a 210 L 55-gal fabricated stainless steel tank with supporting legs as shown. Tank and support legs must be fabricated from Type 304 stainless steel.

2.18.2 Sight Glass

Sight glasses for tank must be standard tubular gages with density ball and shut-off valves on each end. Wetted parts other than sight glass must be stainless steel. If glass breakage should occur, a stainless steel ball in the valve must close preventing product loss. Glass must be protected by minimum of four guard rods.

2.18.3 Return Pump

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NOTE: Insert site specific Pump requirements.

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Product return pump (PRP-1 and PRP-2) must have the capacity of not less than 0.60 L/s 10 gpm against a total head of [___][3.0] m[___][10] feet when driven at [_____] rpm. The pump must have flange connections and must be constructed of stainless steel or aluminum so as to have no zinc, brass or other copper bearing alloys in contact with the fuel. The unit must be explosion-proof, Class I, Division 1, Group D with maximum temperature rating of "T2D" (216 degrees C 419 degrees F). The motor must not be overloading at any point on the pump curve. Contractor has the option of selecting either centrifugal or positive displacement type pump with the restriction of the positive displacement type pump must include a pressure relief between the discharge and suction protecting the pump from overloading.

2.18.4 Anchoring

All units of the water draw-off system must be installed plumb and level and secured in place by anchor bolts.

2.19 BOWSER PUMPOFF PUMP

The pump must be a sliding vane type rotary pump. The pump construction must permit the removal of the rotor and sliding vanes without disconnecting the pump. Pump capacity must be 0.6 L/s 10 gpm with a differential head of [_____] mm feet when driven at 1800 rpm. The pump and motor must be mounted on a cast iron or steel subbase. The motor must have sufficient power for the service required, must be of a type approved by the manufacturer of the pump, must be suitable for available electric service, must be totally enclosed, fan cooled, TEFC, and must conform to the requirements specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Pump must be provided with stainless suction side basket strainer.

2.20 JOCKEY PUMP

Pump capacity of not less than 0.3 L/s 5 gpm against a total head of 73 m 240 feet when driven at 3600 rpm and be a centrifugal type. The pump must have flange connections and must be constructed of stainless steel or aluminum so as to have no zinc, brass or other copper bearing alloys in contact with the fuel. The unit must be explosion-proof, Class I, Division 1, Group D with maximum temperature rating of T3 (200 degrees C 392 degrees F). The motor must not be overloading at any point on the pump curve.

2.21 PUMPHOUSE DRAIN PUMP

The pump must be a sliding vane type rotary pump. The pump construction must permit the removal of the rotor and sliding vanes without disconnecting the pump. Pump capacity must be 0.3 L/s 5 gpm with a differential head of 1.3 m 50 feet when driven at 1800 rpm. The pump and motor must be mounted on a cast iron or steel subbase. The motor must have sufficient power for the service required, must be of a type approved by the manufacturer of the pump, must be suitable for available electric service, must be totally enclosed, fan cooled, TEFC, and must conform to the requirements specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.22 TIGHTNESS MONITORING SYSTEM

The system must be a permanent, fully automated, pressure step (no volume measurement)leak detection system, and will be used for tightness testing the hydrant loop pipeline. System must have a guaranteed accuracy to detect a leak of less than 0.0004 mL/s 0.0004 gal/h per cubic m foot at 1 MPa 150 PSI. The system must be US EPA Third Party Certified to the above sensitivity with a Probability of Detection greater than or equal to 95 percent and a Probability of False Alarm of less than or equal to 5 percent. System will have performed satisfactorily on at least five (5) projects involving quantities and complexities at least equal to those required under this Contract. Equipment must be compatible with equipment furnished and installed under Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT, and Section 33 09 53 AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III), where the individual equipment components are common to both the Tightness Monitoring System functional operation, and the Hydrant Fuel Control System functional operation. Test results must be unaffected by the temperature change of the fuel, and have a maximum test period of one hour. A local controller must implement and analyze data, store data and be capable of printing results, and be located in the control room of the pumphouse building. Printer must be provided. Controller must utilize 120V, single phase power. Any additional utilities or equipment needed to be added to the fuel system in addition to what is shown on the drawings to allow the Tightness Monitoring System to meet the requirements, will be the requirement of the Tightness Monitoring System. Provide calculations, design, and proof of compliance. Upon completion of 72 hours of continuous system operation and before final acceptance of work, test the Tightness Monitoring System in service to demonstrate compliance with contract requirements. Performance verification must be coordinated with overall fuel system start-up, and commissioning of fueling facilities. Perform performance verification in such a way as to obtain complete tightness information within the required accuracy stated herein and provided Tightness Certification on each pipe section tested.

2.23 TRUCK FILLSTAND OVERFILL PROTECTION AND GROUND VERIFICATION UNIT

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NOTE: Delete this paragraph if the tank trucks to be loaded do not have an overfill system installed (e.g., liquid level sensors, wiring, and plug receptacle). Indicate the type of plug required for the system.

The switch contact in the control module can be used to initiate various interlock functions (e.g., stop pumps, close valves, initiate alarms, etc.). Indicate the desire interlock control functions on the drawings.

****

System must include connection plug, control cable, and monitoring and control module. System must be the self-checking type that automatically and continually monitors the liquid-level within a tank truck's storage compartment during fueling. [Connection plug must conform to [______].] [The system must be compatible with the Scully Duocept w/Truck Identification Module (T.I.M.) P/N 09061 to monitor truck liquid level, provide ground verification and provide a method to electronically prevent product commingling.] System must be rated for an explosion-proof environment in accordance with NFPA 70 for Class I, Division I, Group D locations. Module must include status lights and a switch contact to allow interlock functions. Control cable must be the spiral, self-retracting type. Cable must be a minimum 9 m 30 feet in length. The fillstand tank level sensor must signal the fillstand control valves to shutdown and must serve as the primary fill stand overfill system.

[2.24 JP-8+100 INJECTION SYSTEM AND STORAGE TANK

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NOTE: Select per SME direction.

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The JP-8+100 Injection System must incorporate and include all components necessary to mechanically inject the JP-8+100 additive into the fuel stream at an adjustable rate of 250 ppm.

2.24.1 Injector Assembly

The injector assembly must be a completely self contained 100 mm 4-inch flanged unit rated for 150 ANSI service and installed at each truck fill stand. Three units will be government furnished. The main housing must be constructed of aluminum and contain a "swing vane" positive displacement fluid motor driven by polytetrafluoroethyliene (PTFE) vanes. No externally driven pump must be accepted. All components must be compatible with JP-8 and the JP-8+100 additive. The unit must be passive in operation in that the injection stops when the fuel flow stops. A minimum flow of 4.5 L/s 75 GPM must be required to start the additive injection. The injector pump must be adjustable from 0 to 1,000 ppm minimum. The assembly must include a flow indicator/suction strainer, inlet valve, outlet valve and piping all manufactured from stainless steel materials.

2.24.2 Injector Storage Tanks

The injector storage tanks (two each) must be horizontal double wall steel tanks with a 1500 L 400 gal capacity and a horizontal cylindrical design. The tank must met all requirements of NFPA 30 and UL 142 for flammable/combustible liquids and must include a 30 year warranty against defects in material or workmanship. The tank and all components must be suitable for JP-8+100 additive. The tank must be equipped with standard accessories including mounting supports, a 606 mm 24-inch manway, normal venting, mechanical level indication, a 50 mm 2-inch NPT plugged drain fitting, primary and secondary containment emergency venting, manual interstitial space monitoring, 50 mm two-inch product drop tube, a manual level sticking port, interior epoxy coating as per Section 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS and exterior epoxy coating as per Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. All materials mounted inside the tank must be 304 SS minimum. The storage tanks must be mounted on a 1.5 m 5-foot high steel structural stand. The injector storage tank gauge must be a vertical direct read with an 200 mm 8 inch minimum dial face calibrated in L gal. The gauge assembly must mount on a 50 mm 2-inch NPT fitting. The float, float arm and all wetted parts are to be 304 SS minimum.

2.24.3 JP-8+100 Additive Tubing and Conduit

The additive supply header feeding the fuel injection stations must be manufactured of one 25 mm 1 inch nylon flexible tubing natural colored. The tubing must have an inner diameter of 21 mm 13/16-inches, a working pressure of 1.4 MPa 205 PSIG and a minimum bend radius of 175 mm 7 inches. All tube fittings must be of stainless steel ferrule compression design. Support aboveground tubing as required to mount securely.

2.24.4 JP-8+100 Additive Ball Valves and Strainer

The valves and strainer in the tanks supply line must meet the requirements of Section 33 52 43.13 AVIATION FUELING PIPING plus be equipped with gaskets, seals, seats and packing that are compatible with the JP-8+100 additive. PTFE and fluorocarbon (Viton) -litharge cured are recommended by the additive manufacturer. The strainer must include a stainless steel 50 mesh screen.

][2.25 OPERATING TANK VENT

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NOTE: Select when using a cut and cover Tank.

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a. System must be designed and installed in such a way that the system must be continuously and automatically self-checking. Switches must be mounted on top of the tank, in the pump house, as indicated. Electronic level sensors must be thermistors or optic type, and be intrinsically safe Class I, Division 1, Group D for hazardous environments, with recognized FM, CSA or UL approval. The sensor holder/junction box must be accessible.

b. Tank vent outlet must be equipped with pressure-vacuum breather vent, aluminum construction with weather hood and with fluoroelastomer (FKM, Viton)pallet seat inserts, high density screens, stainless steel internals, with pressure relief setting at 215 Pa 0.5 oz/sq inch , and vacuum relief set at 215 Pa 0.5 oz/sq inch . Pressure venting capacity must be 190 L/s 400 cubic feet/minute, vacuum capacity must be 190 L/s 400 cubic feet/minute.

]PART 3 EXECUTION

3.1 GENERAL

3.1.1 Installation

Install equipment and components in position, true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearances between equipment components. Equipment, apparatus, and accessories requiring normal servicing or maintenance to be accessible.

3.1.2 Anchoring

Anchor equipment in place. Check alignment of anchor bolts before installing equipment and clean-out associated sleeves. Do not cut bolts because of misalignment. Notify Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate self-drilling type anchors for construction condition.

3.1.3 Grouting

Equipment which is anchored to a pad is to be grouted in place. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, and coatings which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide necessary formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting must be in accordance with ASTM C827/C827M. Perform all grouting in accordance with equipment manufacturer's and grout manufacturer's published specifications and recommendations.

3.1.4 Leveling and Aligning

Level and align equipment in accordance with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.1.5 Direct Drives

Alignment procedure follows:

3.1.5.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.1.5.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.1.5.3 Shaft Leveling and Radial Alignment

Pump alignment must be accomplished by the factory technician or a millwright trained in pump alignment, and with the use of dial gauges or laser alignment equipment.

3.1.5.4 Angular Alignment and End Clearance

Check angular alignment and end clearance by inserting a feeler gage at 4 points, 90 degrees apart around outer edges of coupling halves.

3.1.5.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.025 mm 0.001 inch tolerance, except as other-wise required by more stringent requirements of equipment manufacturer.

3.1.6 Precautions

Special care must be taken to ensure that equipment and materials are stored properly to prevent damage and maintain cleanliness, and that the completed system is free of rocks, sand, dirt, and foreign objects. Take the following steps to insure these conditions.

a. Equipment brought to the site and not stored inside, must be stored on blocks or horses at least 450 mm 18 inches above ground.

b. Visual inspection must be made of each piece of equipment to ensure that it is clean prior to installation.

c. The open ends of equipment must be closed when work with that piece of equipment is not in progress.

3.2 INSTALLATION OF UNDERGROUND TANKS

Installation must be per tank manufacturer's recommendations, API RP 1615, NFPA 30, 40 CFR 280, state and local codes and as specified herein. If recommendations require tank to be filled, only fuel will be allowed in tanks. Water filling is not acceptable. Before being placed in service, tank must be tightness tested in accordance with NFPA 30.

3.2.1 Coating Testing

The coating must be examined for flaws and tested for thickness. Provide the facilities, personnel, and equipment for testing for flaws and thickness. Thickness must be measured electronically. Coating must be tested directly before placement of the tank with an electric flaw detector, equipped with a bell, buzzer, or other type of audible signal that operates when a flaw is detected. The detector for the type of coating used must have an operating voltage of 10,000 to 35,000 volts. Check of the holiday detector potential may be made by the Contracting Officer at any time to determine the suitability of the detector. Damaged areas must be repaired with materials identical to those used originally, and after drying, must be retested electrically. Submit test results.

3.2.2 Steel Tanks

a. Cover the concrete hold down slab with 150 mm 6 inches of tank bedding backfill evenly graded and thoroughly compacted, prior to tank placement.

b. Each tank is to be unloaded and placed on the sand bed using cranes and the rigging procedures provided by the tank manufacturer. Use the tank lifting lugs for lifting the tank into place. The use of slings around the tank is not permitted, nor is the use of chock blocks of any sort. During handling, carefully inspect the tanks for coating damage and repair any damage whatsoever before proceeding. After placement, check each tank to ensure it is sloped as required. The elevation must be confirmed.

c. Before proceeding with backfill, install the hold down straps and tighten the turnbuckles securely and evenly throughout the length of the tanks. The bottom and sides of the tanks to be fully and evenly supported by hand shoveling and tamping. Use tank bedding backfill up to 303 mm 12 inches above the top of tank. Hand-guided power equipment can be used to place fill in 150 mm 6-inch layers, compacted to a minimum of 95 percent maximum density, after the bottom quadrant is filled. A minimum of four density tests per tank to be performed. Clean, noncorrosive, well tamped gravel to be used for backfill from a point 303 mm 12 inches above the tanks to finished grade.

d. Do not fill the tank, even partially, before the bottom quadrant is backfilled. The level of fuel product not to exceed the level of compacted backfill at any time.

e. Coordinate tank installation with the installation of cathodic protection.

3.3 INSTALLATION OF FIBERGLASS PITS

Submit recommended installation procedures and setting tolerances from the pit manufacturer/supplier for the fiberglass pit and the aluminum cover. These procedures must indicate recommended methods of supporting the pit in its proper position in the open excavation prior to and during concrete placement operations. Also, required installation tolerances, especially for flatness/levelness of the fiberglass pit lip, must be provided. Follow these recommendations and apply other procedures as required to ensure the integrity of the pit liner and cover assemblies in their installed positions. All penetrations through the fiberglass pit liner must be tightly sealed by suitable means to preclude water infiltration, with consideration for potential relative movements between the penetrating objects and the pit liner. Reference the Contract drawings for additional installation requirements.

3.4 POSTED OPERATING INSTRUCTIONS

For each designated system or equipment item, provide instructions for guidance of operating and maintenance personnel. Following approval of content, prepare these instructions in a form and scale that will be readily legible when displayed in appropriate locations, to be designated by the Contracting Officer and meet the following requirements:

3.4.1 Each System

For each system, include diagrams of equipment, piping, wiring and control. Define control sequences.

3.4.2 Each Tank

For each tank provide a P.E. stamped certified tank calibration chart in 1/16-inch increments reading in gallons.

3.4.3 Each Item

For each equipment item, include starting, adjustment, operation, lubrication, safety precautions and shut-down procedures. Identify procedures to be performed in event of equipment failure. Provide other instructions recommended by the manufacturer.

3.4.4 Diagrams

Provide a professionally prepared isometric piping diagram of the fueling system apparatus. Diagram must be 914 by 1370 mm 36 by 54 inches and must be color coded to match PCP color diagrams. Diagram must show the entire facility and must include all equipment and the operational sequences of all equipment with equipment numbers displayed. Diagram must show all valves along with the valve numbers shown on the drawings and listed as normally open/closed. It must be wall mounted under glass.

3.4.5 Volume of Fuel

Provide a certified system inventory of fuel in the pipe, tank, pumphouse, etc. The piping will show length of pipe, size of pipe, L/s gal/foot, and total L gal. Verify during initial fill.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 52 43.12 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 52 43.12 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-33 52 43.12 (August 2018)**

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****

SECTION 33 52 43.12

AVIATION FUEL PANTOGRAPHS
08/18

****
NOTE: This guide specification covers the requirements for Pantographs used in aircraft refueling systems or at truck fill stands constructed to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location

https://www.wbdg.org/ffc/dod/non-cos-standards.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes

ENERGY INSTITUTE (EI)

EI 1529	(2014; 7th Ed) Aviation Fueling Hose and

	Hose Assemblies
EI 1584	(2017; 4th Ed) Four-Inch Hydrant System Components and Arrangements

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AS5877	(2016; Rev B) Detailed Specification for Aircraft Pressure Refueling Nozzle
SAE J517	(2020) Hydraulic Hose

U.S. AIR FORCE (USAF)

AFI 91-202	(2020) US Air Force Mishap Prevention Program

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-C-83260	(1972; Rev A; Notice 3 2024) Coupler, Hydrant Valve GRU-16/e
MIL-DTL-24788	(2017; Rev B; Notice 1 2023) Coupling Assembly, Semi-Dry-Break, Quick-Disconnect Fuel With or Without Continuity Switch

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50696	(2016; Rev D) Reels, Static Discharge, Grounding, 50 and 75 Foot Cable Lengths

1.2 ADMINISTRATIVE REQUIREMENTS

Provide aircraft pantograph approved by the [Air Force System Safety Engineer Analysis (AFSSEA) Team in accordance with AFI 91-202] [Navy (NAVAIR (AIR 4.4.5.1)] [APC]. Submit scaled assembly drawings identifying components and showing dimensions and tolerances. Complete technical literature must be submitted on specific function equipment. OMSI information must be submitted for the equipment items or systems specified. Refer to Section 01 78 23.33 OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS for the information to be submitted for various types of equipment and systems. Emergency dry breakaway coupler (EDBC) is required for USN/USMC projects.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Scaled Assembly Drawings; G, [_____]

SD-03 Product Data

Flow Meter; G, [_____]

Hydrant Coupler; G, [_____]

Shut-Off Valve; G, [_____]

Automatic Pressure Equalizing System; G, [_____]

Pressure Fueling Nozzle; G, [_____]

Venturi; G, [_____]

Flanged Swivel Joints; G, [_____]

Pressure Gage Assembly[; G][; G, [_____]]

[Emergency Dry Breakaway Coupler (EDBC); G, [_____]
]

SD-07 Certificates

Materials; G, [_____]

SD-10 Operation and Maintenance Data

Flow Meter; G, [_____]

Hydrant Coupler; G, [_____]

Shut-Off Valve; G, [_____]

Automatic Pressure Equalizing System; G, [_____]

Pressure Fueling Nozzle; G, [_____]

Venturi; G, [_____]

Flanged Swivel Joints; G, [_____]

Pressure Gage Assembly; G, [_____]

[Emergency Dry Breakaway Coupler (EDBC); G, [_____]
]

1.4 QUALITY ASSURANCE

1.4.1 Design Conditions

Design must be as specified in Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT. Components must be ASME B16.5 Class 150 (9 MPa 275 psig at 38 degrees C 100 degrees F, except that swivel joints and pressure fueling nozzles must be 824 kPa 125 psig at 58 degrees C 100 degrees F). Nominal diameters must be as follows:

Hydrant coupler	100 mm4 inch
Piping sections	75 and 100 mm3 and 4 inch
Flanged connection	ASME B16.5 60 kg125 LB
Flow meter	100 mm4 inch ASME B16.5 70 kg150 LB
Shut-off valve/40 mesh strainer	62 or 75 mm2-1/2 or 3 inch
Dry break quick disconnects	62 or 75 mm2-1/2 or 3 inch
Flanged pantograph swivel joints	75 and 100 mm3 and 4 inch
Pressure fueling nozzle	62 mm2-1/2 inch outlet

PART 2 PRODUCTS

2.1 MATERIALS

The type of materials which come in contact with the fuel must be noncorrosive. No zinc coated metals, brass, bronze or other copper bearing alloys must be used in contact with the fuel. Additional requirements are as follows:

2.1.1 Piping

Construct all pipe and piping components of Schedule 10S, Grade TP304L, stainless steel conforming to ASTM A312/A312M. Only seamless pipe must be used.

2.1.2 Fitting and Bends

Same thickness as adjoining pipe.

2.1.3 Components

Aluminum alloy or stainless steel.

2.1.4 Structural Steel

Structural steel must conform to ASTM A36/A36M, hot dipped galvanized after fabrication and painted a factory standard color.

2.2 EQUIPMENT AND MATERIAL

2.2.1 Detachable Aircraft Pantograph

a. Detachable pantographs must be designed in such a way that all wheel supports rest upon the apron regardless of the different terrain conditions.

****

NOTE: Insert required Pantograph length obtained from SME.

****

b. Provide detachable pantographs consisting of three main sections, plus one connecting section and one dispensing end. Total length of the three main sections must be [_____] mm feet.

c. The connecting section must consist of a hydrant coupler and flanged swivel joints, which allow the coupler to be connected to the hydrant control valve at levels of +/- 150 mm 6 inches from the level of the apron.

d. The connecting section must be supported by an adjustable spring, counterweight or hydraulically actuated cylinders which balance the weight of the hydrant coupler, flanged swivel joints and pipe connecting section.

e. Design the dispensing end to be coupled to the aircraft at heights of 0.305 to 2.4 m 12 inches to 8 feet above the apron.

f. The dispensing end must be supported by an adjustable spring, counterbalance or hydraulically actuated cylinder which balances the weight of the pressure fueling nozzle, shut-off valve, flanged swivel joints and connecting pipes to ensure that only minimum force occurs when connecting the detachable pantograph to the aircraft. One person must be able to operate the dispensing end.

g. Hoses (except fuel sensing hose) must not be permitted as a part of the detachable pantographs.

h. Detachable pantographs must be equipped with an adjustable automatic pressure equalizing system, relieving at 824 kPa 125 psig to an equalizing reservoir, to compensate for thermal expansion and contraction.

i. The equalizing reservoir's vent must be equipped with a flame arrestor. The reservoir must be sized for a maximum temperature differential of 62 degrees C 144 degrees F.

j. The pantograph must be equipped with supporting structures each mounted on two spring-loaded casters.

k. To avoid sagging, reinforcing must be welded to the underside of the pipe sections.

l. A tow bar must be attached to the front support of the pantograph. Maximum tow speed is 8 km/h 5 mph. Tow bar to be suitable for mounting to pintle hook.

m. The connecting section and the dispensing end must be locked to the main sections of the pantograph when in the stored or towing mode. Pantograph must be provided with a nozzle hanging support.

n. The three main sections of the pantograph must be locked together when in the stored or towing mode.

o. The overall electrical resistance between the hydrant coupler and the pressure fueling nozzle must not exceed 1 kilo Ohm. Grounding straps across the flanged swivel joints are not permitted.

p. The pantograph must be equipped with two self winding grounding cable reels. The cable must be at least 15 m 50 feet long. Each cable reel, the grounding cable and the connection clamp must be in accordance with CID A-A-50696.

q. The pantograph must be equipped with a permanent sampling, pressure gage, drain and vent assemblies.

r. Detachable pantographs must be provided with 7.5 m 25 feet of [hydraulic] [nitrogen powered] deadman control hose. Hose must be provided with stainless steel fittings, nylon stop ball and aluminum deadman control handle. Hose must be dual type with Buna-N tube, vertically braided textile body with fuel resistant neoprene cover.

****

NOTE: Per SME.

****

s. Detachable pantographs must be equipped with a flow meter, pantograph control valve,[fuel filter separator,][filter,][control valve,][additive injector,] and a venturi. The flow meter must be provided with additional support.

****

NOTE: Per SME.

****

t. The pantograph must be equipped with a minimum of eight (8) terrain spring loaded casters made of steel or cast steel, galvanized or hot-dip galvanized. The caster swivel head must be equipped with two lubricated ball bearings with grease nipples. The wheels must have an overall diameter of at least 305 mm 12 inches and must be equipped with two lubricated grooved ball bearings with grease nipples. The wheels must be coated with rubber. Two of the casters must be equipped with brakes which positively lock the unit in place once at rest. Two casters must be equipped with an additional device which can be adjusted to lock automatically for towing the pantograph.

2.2.2 High Reach Pantographs

a. The high reach pantograph unit consists of a steel frame with spring loaded casters and a lifting platform. The pipe sections are interconnected by swivel joints.

b. The platform with the dispensing end must be easily extended up to a connection height of 2.1 to 4.8 m 7 to 16 feet above ground level operated by hand. No electric energy must be used. An extensionable ladder fixed at the frame allows to reach the platform at any position.

c. The platform must be secured with a railing and automatically closing door.

d. The high reach pantograph must be equipped with devices for draining, pressure gauging and venting.

e. Support structures, counter balance systems and all other equipment made of steel must not be welded to the stainless steel pipe. It must be only bolted by clamps to the pipe and must be easily replaceable by common tools in case of repair or maintenance.

f. A tow bar must be attached to the front support of the pantograph. Maximum tow speed is 8 km/h 5 mph. Tow bar to be suitable for mounting to pintle hook.

g. The connecting section and the dispensing end must be locked to the main sections of the pantograph when in the stored or towing mode. Pantograph must be provided with a nozzle hanging support.

h. The overall electrical resistance between the hydrant coupler and the pressure fueling nozzle must not exceed 1 kilo Ohm. Grounding straps across the flanged swivel joints are not permitted.

i. The pantograph must be equipped with two self winding grounding cable reels. The cable must be at least 15 m 50 feet long. Each cable reel, the grounding cable and the connection clamp must be in accordance with CID A-A-50696.

j. The pantograph must be equipped with a permanent sampling, pressure gage, drain and vent assemblies.

k. The pantograph must be equipped with labeling to provide safety warnings such as don't use around power lines, and use limits such as weight limitations.

l. The pantograph must be equipped with a minimum of four (4) terrain spring loaded casters made of steel or cast steel, galvanized or hot-dip galvanized. The caster swivel head must be equipped with two lubricated ball bearings with grease nipples. The wheels must have an overall diameter of at least 305 mm 12 inches and must be equipped with two lubricated grooved ball bearings with grease nipples. The wheels must be coated with rubber. Two of the casters must be equipped with brakes which positively lock the unit in place once at rest. Two casters must be equipped with an additional device which can be adjusted to lock automatically for towing the pantograph.

2.2.3 Permanent Pantograph Fabrication - [Hoseless][Hose End] Type

****

NOTE: The requirements of this paragraph should be added for KC-10, E-4, and other aircraft that incorporate fueling adapters located more than 2.4 m 8 feet above the apron.

Per SME.

****

a. The permanent pantograph must be designed in such a way that all wheel supports rest upon the apron regardless of the different terrain conditions.

****

NOTE: Insert required Pantograph number of sections and length obtained from SME

****

b. The permanent pantograph must consist of [two] [three] main sections, plus one connecting section and one dispensing end. Total length of the main sections must be [_____] mm feet.

****

NOTE: Insert required height reach of Pantograph obtained from SME

****

c. The dispensing end must be designed to be coupled to the aircraft at heights of 305 mm 12 inches to [_____] mm feet above the apron.

d. The dispensing end must be supported by an adjustable spring, weight device or hydraulically actuated cylinder to counter balance the weight of the pressure fueling nozzle, shut-off valve, flanged swivel joints and connecting pipes to ensure that only minimum force occurs when connecting pantograph to aircraft. One person must be able to operate the dispensing end.

e. Hoses (except fuel sensing hose) must not be permitted as a part of the pantograph.

f. The dispensing end must consist of a 3 m 10 foot section of aviation fueling hose, as specified herein after, a [D-1] [D-1R] [D-2] [D-2R] pressure refueling nozzle and a bonding wire wrapped a minimum of 10 coils around the exterior of the hose and connected to both hose-end NTP fittings. A shut-off valve between the hose end and the pressure refueling nozzle must not be provided.

g. A suitable trough for storing the fueling hose must be provided on top of the final pantograph leg.

h. Provide a draw bar or pull cable with handle for positioning the pantograph.

i. To avoid sagging, reinforcing must be welded to the underside of the pipe sections.

j. The main sections of the pantograph must be locked together and to the non-movable portion of the pantograph when in the stored mode.

k. The overall electrical resistance between the pantograph control valve and the pressure fueling nozzle must not exceed 1 kilo Ohm. Grounding straps across the flanged swivel joints are not permitted.

l. The pantograph must be equipped with a permanent sampling, pressure gage, drain and vent assemblies.

m. The fixed portion of the pantograph must include a pantograph control valve, venturi, and flow meter.

n. A refueling adapter meeting the requirements of MIL-DTL-24788 must be mounted to the return piping for the purpose of flushing the permanent pantograph. The refueling adapter must have a 100 mm 4-inch flange mounting and be equipped with a metal vacuum tight locking dust cap that mates with the lugs of the refueling adapter.

o. Intermediate and end swivel joints must have 200 mm 8 inch diameter solid oil resistant tires and must be equipped with two lubricated grooved ball bearings with grease nipples. The wheels must be coated with rubber.

****

NOTE: EDBC required for NAVY/MARINE CORPS projects.

****

p. Install an emergency dry breakaway coupler (EDBC) between the last swivel and the dispensing hose.

2.2.4 Truck Fill Stand Pantograph Fabrication - (Non-Recessable)

a. Truck fill stand pantographs must consist of three main sections, plus one connecting section and one dispensing end. Total length of the three main sections must be 3 m 10 feet.

b. The dispensing end must be designed to be coupled to the refueling truck at heights of 395 to 1400 mm 12 to 55 inches above the road.

c. The dispensing end must be supported by an adjustable spring, weight device or hydraulically actuated cylinder to counter balance the weight of the pressure fueling nozzle, shut-off valve, flanged swivel joints and connecting pipes to ensure that only minimum force occurs when connecting pantograph to tank trucks. One person must be able to operate the dispensing end. Pantograph must be provided with a nozzle hanging support.

d. Hoses must not be permitted as a part of the truck fill stand pantograph.

e. The three main sections of the pantograph must be locked together when stored.

f. The overall electrical resistance between the flanged end and the pressure fueling nozzle must not exceed 1 kilo Ohm. Grounding straps across the swivel joints are not permitted.

g. The connecting section and the dispensing end must be locked to the main sections of the pantograph when in the stored mode.

2.2.5 Truck Fill Stand Pantograph Fabrication (Recessable)

a. The truck fill stand pantograph must be designed for bottom loading of refueling trucks and must be designed in such a way that it can be completely lowered into the pit. Pantograph construction and pit configuration must be coordinated such that interferences and restrictions in operation of the pantograph are eliminated.

b. A combination of flanged swivel joints and pipe sections must permit the required vertical and horizontal adjustments. The pantograph must automatically lock in the up position.

c. The guiding unit for vertical adjustment must be maintenance free.

d. The pantograph must consist of three main sections, plus one connecting section and one dispensing end. Total length of the three main sections must be 3 m 10 feet.

e. The dispensing end must be designed to be coupled to the refueling truck at heights of 305 to 1380 mm 12 to 55 inches above the road.

f. The dispensing end must be supported by an adjustable spring, weight device or hydraulically actuated cylinder to counter balance the weight of the pressure fueling nozzle, shut-off valve, flanged swivel joints and connecting pipes to ensure that only minimum force occurs when connecting pantograph to tank trucks. One person must be able to operate the dispensing end.

g. Hoses must not be permitted as a part of the truck fill stand pantograph.

h. The three main sections of the pantograph must be locked together when stored.

i. The overall electrical resistance between the flanged end and the pressure fueling nozzle must not exceed 1 kilo Ohm. Grounding straps across the swivel joints are not permitted.

j. The pantograph must be equipped with a permanent sampling, pressure gage, drain and vent assemblies.

2.2.6 Flanged Swivel Joints

a. Anchor end, intermediate, and hose end pantograph swivel joints must be stainless steel, [single plane,] flanged capable of rotating 360 degrees. Welded swivel joints and welding of swivel joints to the pipe and/or elbow is not permitted. Welding of swivel joints to flange joints is permitted. Swivel joints must be of the non-lubricated, maintenance free type with sealed bearings and no lubricating fittings[, and must be arctic-grade].

b. No leakage must be permitted under positive or negative pressure conditions. No leakage must be permitted under high or low temperature conditions. The swivel joints must be warranted for three years against leakage due to both positive and negative pressure conditions.

c. There must be electrical continuity from one flange to the other without the use of ground straps. The electrical continuity from one flange to another (without the use of ground straps) must be less than 1000 ohms. Each swivel joint must have at least two ball bearings and one roller bearing and two seals.

****

NOTE: Include Item 'd' for NAVY/MARINE CORPS projects and delete [SINGLE PLANE,] in Item 'a' above.

****

d. Only NAVAIR approved swivels (Aeroequip single plane; EMCO-Wheaton single plane; CLA-VAL 2-plane; and Carter Ground Fueling single and 2-plane) must be used.

2.2.7 Flow Meter

The flow meter must be stainless steel or aluminum, positive displacement, rotor type, bi-directional, temperature compensating. Provide an adjustor for calibrating the meter. Meter must have large visible 5-digit reset totalizer and small visible 8-digit non-reset totalizer. [Meter readout must be mounted on a swivel.] The unit of measurement must be L gal and the increment of measurement must be one L gal.

[2.2.8 Emergency Dry Breakaway Coupler (EDBC)

****

NOTE: EDBC required for NAVY/MARINE CORPS Projects.

****

The EDBC unit must operate independently of internal pressure and separate at a nominal +/- 18 kg 50 pound tensile pull. The EDBC must be capable of reinstallation without replacement parts or the use of special tools. The NAVAIR approved EDBCs for use on aircraft refueling pantographs are the Aeroquip AE1284U, Cla-Val 346GF, and the Carter Ground Fueling 64227.

]2.2.9 Sampling Connection

Sampling connection must be provided when indicated. Materials must be Type 316 stainless steel. Material for ball valve, quick disconnect coupling must be Type 316 stainless steel. Each sampling connection must consist of a 6 mm 1/4-inch sampling probe where the probe faces upstream, ball valve, a quick disconnect coupling and aluminum dust cap. The sampling connections must be capable of accepting a sampling kit for drawing the samples required to assure fuel quality. Provide a 1 m 3-foot, fuel resistant sampling hose with mating quick disconnect fitting.

2.2.10 Pressure gage assembly

Assembly must consist of 100 mm 4-inch ASME B40.100 pressure gage and pressure gage stop cock. Pressure gage must be liquid filled type with an indicating range 0-1.8 MPa 0-275 psig. Material must be Type 316 stainless steel.

2.2.11 Drain and Vent Assemblies

Assemblies must consist of a 13 mm 1/2 inch ball valve and must terminate with a 180 degree pipe gooseneck and screwed cap for the vent, and the drain must have a 13mm 1/2 inch ball valve and must terminate with a cam type quick disconnect.

2.2.12 Hydrant Coupler

****

NOTE: Select either Military Specification Pantographs or Commercial Specification for use with hose trucks or as directed by SME. For new designs use the Commercial Specification. Some installations and countries use the Military Specification couplers and adaptors even though the specification is inactive. Some companies make couplers and adaptors to this specification. Hydrant Control Valve Adapter must match selection. Delete this paragraph if only permanent Pantographs are to be used.

****

The hydrant coupler is the connection between the hydrant system and the pantograph. It must comply with [MIL-C-83260] [EI 1584]. The coupler must be provided with suitable, non-lubricated 360 degree rotation swivel joint and must be suitable for mounting to flanged connection. In addition to the bicycle handle grips, the nozzle must be provided with a half circle ring handle.

2.2.13 Shut-Off Valve

****

NOTE: Delete this paragraph for NAVY/MARINE CORPS projects. For AIR FORCE projects this paragraph will be deleted at the direction of the SME if only hose end Pantographs are to be used.

****

A [64 mm 2-1/2 inch] [75 mm 3-inch] shutoff valve must be mounted upstream of the pressure fueling nozzle and must provide safe shutoff of the pantograph for inspection of the dry break quick disconnect strainer.

2.2.14 Dry Break Quick Disconnect

A [64 mm 2-1/2 inch] [75 mm 3-inch] semi-dry break quick disconnect (MIL-DTL-24788, Class 1 or equivalent) must be mounted between the [shut-off valve] [hose end] and the pressure fueling nozzle. The semi-dry break quick disconnect must be capable of swiveling through 360 degrees and must incorporate a 60 mesh strainer in the portion attached to the pressure refueling nozzle (also known as the male half).

2.2.15 Pressure Fueling Nozzle

****

NOTE: D-1R, D-2R and D-3R Nozzles incorporate either a 380 kPa 55 psi (NAVY/MARINE CORPS) or 311 kPa 45 psi (ARMY) hose end pressure regulator. Provide the type of nozzle directed by the SME or Service Headquarters. For NAVY/MARINE CORPS projects provide D-1R Nozzles having 380 kPa 55 psig hose end regulators unless specific approval for a different

nozzle type is received from NAVAIR. Secondary control must be provided on all aircraft fueling connections, typical configurations are: (hydrant control valve primary & HHT secondary, HCV & pantograph control valve, Pantograph control valve and hose end regulator).

****

SAE AS5877, 64 mm 2-1/2-inch nozzle [D-1][D-2][D-1R (D-1 with [0.38][0.31]MPa [55][45]psig hose end pressure regulator)][D-2R (D-2 with [0.38][0.31]MPa [55][45]psig hose end pressure regulator)][D-3R (D-3 with [0.38][0.31]MPa [55][45]psig hose end regulator)]must be provided for the connection between pantograph and aircraft. Design must be for single point fueling of [aircraft][and][truck]at a flow rate of 36 L/s 600 gpm with maximum pressure drop of 2 kPa 30 psig. Nozzle must be provided with a permanently installed quick disconnect sampling coupler. (Gammon GTP-235-3/8 Jet Test QD meets this requirement.) Provide pressure gage with 0-7 MPa 0-100 psig indicating range mounted on actuator for use with quick disconnect sampling coupler.

[2.2.16 Aviation Fuel Hose

Fueling hose must conform to EI 1529, Grade 2, Type C, semi-hardwall, [75] [62] mm [3] [2.5]-inch nominal hose designed for use with specified fuel for a working pressure of 2 MPa 300 PSIG over a working temperature range of 0 to 55 degrees C -22 to 131 degrees F. Hose must be constructed of braided synthetic cord surrounded by an interior rubber tube and an exterior rubber cover. Provide permanent brass, threaded, male NPT, both ends.

]2.2.17 Venturi

a. The venturi provides for compensated pressure regulation to each permanent aircraft pantograph control valve and on each hydrant control valve. Venturi must be constructed of stainless steel. The venturi must be sized to compensate for pressure drop of entire pantograph assembly at minimum through maximum design flow rate. The amount of recovery must be adjustable and the maximum unrecoverable pressure drop at 36 L/s 600 gpm must be less than 69 kPa 10 psi.

b. Provide venturi control lines with needle valve to be used during final adjustment of pantograph. Venturi control lines must be provided with pressure gauge and pressure gauge stop cock. Indicating range must be 0-667 kPa 0-100 psig. Material must be Type 316 stainless steel.

c. Detachable pantograph venturi must be provided with a 10 mm 3/8 inch stainless steel fuel sensing line and 2.4 m 8 feet of 8 mm 5/16-inch fuel sensing hose. Fuel sensing line and hose must be provided with a stainless steel plug and socket type quick disconnect for coupling together at the pantograph and opposite end of fuel sensing hose suitable for connection to hydrant control valve's pilot system.

d. Fuel sensing hose tube and cover must be resistant to the effects of hydrocarbon fuels and must conform to SAE J517-100R7.

2.2.18 Pantograph Control Valve

****

NOTE: Per SME.

****

Refer to Section 33 52 43.14 AVIATION FUEL CONTROL VALVES.

[2.2.19 Fuel Separator

****
NOTE: Per SME.
****

Refer to Section 33 52 43.28 FILTER SEPARATOR, AVIATION FUELING SYSTEM.

][2.2.20 Additive Injector

****
NOTE: Per SME.
****

Refer to Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT.

]2.2.21 Nitrogen Powered Deadman Control System

****
NOTE: Include only if selected in paragraph DETACHABLE AIRCRAFT PANTOGRAPH, in PART 1.
****

Provide pantographs with a 1.09 cubic m 39 cubic foot nitrogen cylinder, adjustable pressure regulator, quick release shuttle for the nitrogen, interconnecting control tubing, pressure gauge, and all necessary hardware to operate the pneumatic deadman pilot system on the hydrant control valve. The nitrogen bottle must be mounted to the pantograph. Provide 3 m 10 feet of air/nitrogen control hose to connect the deadman control system to the hydrant control valve air deadman connection. Provide stainless steel plug and socket type quick disconnect for coupling together the air control hose at the pantograph and a quick disconnect suitable for connection to the hydrant control valve's pilot system at the other end.

PART 3 EXECUTION

3.1 ASSEMBLY

The pantograph must be delivered completely assembled.

3.2 TESTING

The pantograph must be tested as described in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 52 43.13 (August 2018)**
Change 1 - 02/21

Preparing Activity: USACE **Superseding**
UFGS-33 52 43.13 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 52 43.13 (August 2018)**
Change 1 - 02/21

Preparing Activity: USACE **Superseding**
UFGS-33 52 43.13 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 52 43.13

AVIATION FUEL PIPING

08/18, CHG 1: 02/21

****

NOTE: This guide specification covers the requirements for piping and valves for aircraft refueling systems constructed to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location

https://www.wbdg.org/ffc/dod/non-cos-standards.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 1110	(2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide
API STD 600	(2015) Steel Gate Valves-Flanged and Butt-welding Ends, Bolted Bonnets
API STD 608	(2012) Metal Ball Valves - Flanged, Threaded, And Welding End
API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves

API Spec 6FA	(1999; R 2006; Errata 2006; Errata 2008; R 2011) Specification for Fire Test for Valves
API Std 594	(2017) Check Valves: Flanged, Lug, Wafer and Butt-Welding
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats
API Std 609	(2016; ERTA 2017) Butterfly Valves: Double Flanged, Lug-and-Wafer Type

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C209	(2019) Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fitting for Steel Water Pipelines
AWWA C215	(2022) Extruded Polyolefin Coatings for Steel Water Pipe

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2025) Specification for Carbon Steel

	Electrodes for Shielded Metal Arc Welding
AWS A5.5/A5.5M	(2022) Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding
AWS A5.9/A5.9M	(2022) Welding Consumables-Wire Electrodes, Strip Electrodes, Wires, and Rods for Arc Welding of Stainless and Heat Resisting Steels- Classification

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A358/A358M	(2024) Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A960/A960M	(2018a) Standard Specification for Common Requirements for Wrought Steel Pipe Fittings
ASTM A961/A961M	(2024b) Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications
ASTM D229	(2019) Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation
ASTM F436	(2011) Hardened Steel Washers

BRITISH STANDARDS INSTITUTION (BSI)

BS EN ISO 10497	(2022) Testing of Valves Fire Type-Testing Requirements

ENERGY INSTITUTE (EI)

EI 1529	(2014; 7th Ed) Aviation Fueling Hose and Hose Assemblies

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 1	(2015) Solvent Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AS5877	(2016; Rev B) Detailed Specification for Aircraft Pressure Refueling Nozzle
SAE J514	(2012) Hydraulic Tube Fittings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-25896	(1983; Rev E; Notice 1 1989; Notice 3 2003) Adapter, Pressure Fuel Servicing, Nominal 2.5 inch diameter
MIL-PRF-4556	(1998; Rev F; Am 1 1999; CANC Notice 1 2011) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
MIL-PRF-13789	(1999; Rev E; Notice 1 2008; Notice 2 1016; Notice 3 2021) Strainers, Sediment: Pipeline, Basket Type
MIL-STD-161	(2005; Rev G; Notice 1 2010) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

1.2 ADMINISTRATIVE REQUIREMENTS

Design conditions must be as specified in Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT. Submit Operation and Maintenance Manuals for the equipment items or systems listed below. Refer to Section 01 78 23.33 OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS for the information to be submitted for various type of equipment and systems.

Manual Valves
Flexible Ball Joints
Surge Suppressor Tank and Valve
Strainers
Protective Coatings
Sample Connections
Isolating Gasket Kits
Gaskets
Flexible Hoses
Top Loading Arms

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor Qualifications; G, [_____]

SD-03 Product Data

Carbon Steel Piping; G, [_____]

Stainless Steel Piping; G, [_____]

Protective Coatings for Buried Stainless Steel Piping; G, [_____]

Fittings; G, [_____]

Isolating Gasket Kits; G, [_____]

Flange Protectors; G, [_____]

Lightning Surge Arrester; G, [_____]

Nuts and Bolts; G, [_____]

Gaskets; G, [_____].

Ball Valves; G, [_____].

Plug (Double Block and Bleed) Valves; G, [_____].

Swing Check Valves; G, [_____].

Silent Check Valves; G, [_____].

Butterfly Valve with Fusible Link Operator; G, [_____].

Relief Valves; G, [_____].

Flexible Ball Joints; G, [_____]

Strainers; G, [_____]

Sample Connections; G, [_____]

Flanged Swivel Joints; G, [_____]

Fuel Hose; G, [_____]

Nozzle Adapter (SPR); G, [_____]

Pigging Accessories; G, [_____]

Flexible Hoses; G, [_____]

Top Loading Arms; G, [_____]

Automatic Air Vent; G, [_____]

Surge Suppressor Tank and Valve; G, [_____]

SD-05 Design Data

Pipeline Inventory; G, [_____]

SD-06 Test Reports

Pneumatic Test

Hydrostatic Test

Geometry/Ultrasonic Tool Reports; G, [_____]

SD-07 Certificates

Carbon Steel Piping

Stainless Steel Piping

Protective Coatings for Buried Stainless Steel Piping

Fittings

Isolating Gasket Kits

Lightning Surge Arrester

Nuts and Bolts

Gaskets

Ball Valves

Plug (Double Block and Bleed) Valves

Swing Check Valves

Silent Check Valves

Butterfly Valve with Fusible Link Operator

Relief Valves.

Flexible Ball Joints

Strainers

Sample Connections

Flanged Swivel Joints

Fuel Hose

Nozzle Adapter (SPR)

Pigging Accessories

Flexible Hoses

Automatic Air Vent

Surge Suppressor Tank and Valve

Survey Final Elevations

Pipeline Pigging Verification; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Design Data

1.4.1.1 Pipeline Inventory

Fuel system volume must be calculated using as constructed pipe lengths, internal diameters, fittings, and components. Totals must be provided for all items containing fuel with the exception of tanks which is covered by other specifications. A detailed list with sizes, lengths, quantity, and volumes must be provided for pumphouse, hydrant loop, etc.

1.4.2 Contractor Qualifications

Each installation Contractor must have successfully completed at least 3 projects of the similar scope and the same size or larger within the last 6 years. Each installation Contractor must demonstrate specific installation experience in regard to the specific system installation to be performed. Each installation Contractor must have taken, if applicable, manufacturer's training courses on the installation of piping and must meet the licensing requirements in the state. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. Provide in the letter evidence of prior manufacturer's training and state licensing.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

****
NOTE: Per SME.
****

Pipe and fittings in contact with fuel must be stainless steel, interior epoxy coated carbon steel, or carbon steel as indicated on the drawings. No zinc coated metals, brass, bronze or other copper bearing alloys must be used in contact with the fuel. All carbon steel and stainless steel underground piping must have an exterior protective coating and must be cathodically protected in accordance with Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM. Identification of piping must be in accordance with MIL-STD-161 unless specified otherwise. Material for manual valves must be as specified hereinafter.

2.1.1 Carbon Steel Piping

Subject each length of pipe to factory hydrostatic testing and ultrasonic testing in accordance with their respective pipe specification.

a. Piping 305 mm 12-Inches and Larger: Seamless, ASTM A53/A53M Grade B having a wall thickness of 9 mm 0.375-inch.

b. Piping 62 through 250 mm 2 1/2 through 10-Inches: Seamless, Schedule 40 API Spec 5L Grade B or ASTM A53/A53M Grade B.

c. Piping 50 mm 2-Inches and Smaller: Seamless, Schedule 80 API Spec 5L Grade B or ASTM A53/A53M Grade B.

d. Welding Electrodes (Factory Fabrication): E70XX low hydrogen electrodes conforming to AWS A5.1/A5.1M or AWS A5.5/A5.5M.

e. Internal Pipe Coating (Epoxy Lining) for piping 90 mm 3.5 inches and larger must be fusion bonded epoxy coated in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM. The ends of the pipe must be masked or wiped back a minimum of 25 mm one inch but not more than 37 mm 1-1/2 inches.

2.1.2 Stainless Steel Piping

****
NOTE: A cyclic fatigue analysis need not be made by the designer to determine wall thickness of welded pipe as long as the pipe meets the sizes listed in TABLE A. The minimum wall thickness that welded pipe can be is the Schedule 20 listed in TABLE A. Pressures found in the surge analysis will be used.
****

a. Piping 62 mm 2-1/2-Inches and Larger:

    (1) ASTM A358/A358M, Grade 304L, Class 1 or Class 3 with supplementary requirements of S1, S2 and S3, or ASTM A312/A312M Type 304L, seamless (only). Any agreements between the purchaser and the manufacturer or supplier as referenced in the applicable ASTM must include the Contracting Officer as a party to the agreement. All

piping welds will receive 100 percent radiographic inspection, 100 percent liquid penetrant inspection, 100 percent visual inspection and all tests as required by the applicable ASTM Standard. Piping must be provided with a nominal wall thickness as shown in Table A for ASTM A358/A358M with the deviation from the nominal wall thickness less than 0.25 mm 0.01-inch. ASTM A312/A312M seamless piping must be provided with a minimum schedule 10S wall thickness.

(2)

TABLE A

Nominal Pipe Size	Nominal (Average) Pipe O.D.	Wall Thickness(tn)
405 mm 16 inches	405 mm 16.000 inches	7.8 mm 0.312 inch
356 mm 14 inches	356 mm 14.000 inches	7.8 mm 0.312 inch
305 mm 12 inches	322 mm 12.750 inches	6.2 mm 0.250 inch
254 mm 10 inches	273 mm 10.750 inches	6.2 mm 0.250 inch
203 mm 8 inches	218 mm 8.625 inches	6.2 mm 0.250 inch
152 mm 6 inches	167 mm 6.625 inches	5.5 mm 0.219 inch
100 mm 4 inches	114 mm 4.500 inches	5.5 mm 0.219 inch
64 mm 2.5 inches	72 mm 2.875 inches	3.9 mm 0.156 inch

(3) Pipe Ends: All Piping must be provided with beveled ends per Chapter V, ASME B31.3, and must be shipped with the ends capped.

(4) Factory Testing and Inspection Records: Per Table K341.3.2 of Chapter IX of ASME B31.3, visual, radiographic and liquid penetrant tests must be performed for each section of piping provided as all sections are subjected to cyclic conditions. All testing and inspections records must be submitted to the Contracting Officer and must indicate the pipe mark and installed location of each piping section on the project site. Observation by the Contracting Officer of the manufacturers and the fields testing and inspection procedures must be allowed under this contract. Pipe certification along with pipe markings must be submitted before the pipe arrives on the job site.

(5) Provide a qualified inspector in accordance with Chapter VI of ASME B31.3. to act as the owner's inspector (for the Government) at the pipe manufacturer's facility in addition to the manufacturer's inspector.

(6) Submit Quality Assurance Plan for the welding, inspecting and testing of the welded seam pipe.

b. Piping 50 mm 2-inches and Smaller: Schedule 80 ASTM A312/A312M seamless Type 304L for threaded piping and schedule 40 (unless otherwise indicated) ASTM A312/A312M seamless Type 304L for welded piping.

c. Stainless Steel Control Tubing: Seamless, fully annealed tubing conforming to ASTM A269/A269M, Grade TP316, Rockwell hardness B80 or less. Wall thickness for 13 mm 1/2-inch tubing to be 1.2 mm 0.049-inch.

d. Welding Electrodes (Factory Fabrication): E308L conforming to AWS A5.9/A5.9M.

2.1.3 Protective Coatings for Aboveground Piping

Provide coating of aboveground piping, piping in pits, pipe supports, filter separators, and miscellaneous metal and equipment in accordance with Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. Color of finish coat must be [white][beige]. Do not paint stainless steel or aluminum surfaces.

2.1.4 External Protective Coatings for Buried Steel Piping

2.1.4.1 Protective Coatings for Buried Carbon Steel Piping

a. New pipe and fittings must be factory coated fusion bonded epoxy (FBE) in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

b. Field joints and repairs must be fusion bonded epoxy (FBE) in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

c. Field joints and repairs in tight spots (valve pits, etc. when heaters are too big) must be liquid epoxy in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

d. Existing systems must match existing coating system and must be in accordance with Section 33 52 80 LIQUID FUELS PIPELINE COATING SYSTEM.

[e. Abrasion-resistant topcoat. Following the initial FBE coating application, provide a 20 mil thick abrasion-resistant FBE topcoat. Abrasion-resistant topcoat must be specifically suited for directional boring piping installation.

]2.1.4.2 Protective Coatings for Buried Stainless Steel Piping

Provide pipe with AWWA C215 Type B coating system of factory-applied adhesive undercoat and continuously extruded plastic resin coating; minimum thickness of plastic resin must be 0.9 mm 36 mils for pipe sizes 150 mm 6 inches and larger. Surface preparation must follow SSPC SP 1. Adhesion to steel substrate test must be a minimum of 5 lb/in0.875 N/mm. Cathodic disbondment test is not required. Fittings, couplings, irregular surfaces, damaged areas of pipe coating, and existing piping affected by the Contractor's operations must be clean, dry, grease free, and primed before application of tape. Tape must overlap the pipe coating not less than 75 mm 3 inches . Waterproof shrink sleeves may be provided in lieu of tape and must overlap the pipe coating not less than 150 mm 6 inches . Pipe coating and adhesive undercoat surfaces to be wrapped with tape must be primed with a compatible primer prior to application of tape. Primer must be as recommended by tape manufacturer and approved by pipe coating manufacturer.

a. Damaged Areas of Pipe Coating: Provide AWWA C209, 0.5 mm 20 mils nominal thickness of tape over damaged areas. Residual material from damaged areas of pipe coating must be pressed into the break or trimmed off. Apply tape spirally with one-third overlap as tape is applied. A double wrap of one full width of tape must be applied at right angles to the axis to seal each end of the spiral wrapping.

b. Fittings, Couplings, and Regular Surfaces: Provide AWWA C209, 0.25 mm 10 mils nominal thickness tape overlapped not less than 25 mm 1.0 inch over damaged areas. Initially stretch and apply first layer of tape to conform to component's surface. Then apply and press a second layer of tape over first layer of tape.

c. Testing of Protective Coatings: Perform tests with an approved silicone rubber electric wire brush or an approved electric spring coil flaw tester. Tester must be equipped with an operating bell, buzzer, or other audible signal which will sound when a holiday is detected at minimum testing voltage equal to 1,000 6,275 times the square root of the average coating thickness in mm. mils. Tester must be a type so fixed that field adjustment cannot be made. Calibration by tester manufacturer must be required at six-month intervals or at such time as crest voltage is questionable. Certify in writing the calibration date and crest voltage setting. Maintain the battery at ample charge to produce the crest voltage during tests. Areas where arcing occurs must be repaired by using material identical to original coating or coating used for field joints. After installation, retest the exterior surfaces, including field joints, for holidays. Promptly repair holidays.

2.1.5 Fittings

2.1.5.1 General

Welding ells, caps, tees, reducers, etc., must be of materials compatible for welding to the pipe line in which they are installed, and wall thickness, pressure and temperature ratings of the fittings must be not less than the adjoining pipe line. Unless otherwise required by the conditions of installation, all elbows must be the long radius type. Miter joints are not acceptable. Make odd angle offsets with pipe bends or elbows cut to the proper angle. Butt weld fittings must be factory-made wrought fittings manufactured by forging or shaping. Fabricated fittings will not be permitted. Welding branch fittings must be insert type suitable for radiographic inspections specified herein, unless indicated otherwise on the drawings.

2.1.5.2 Carbon Steel Fittings

****

NOTE: Tees with branch lines 50 percent of the main line size or more should have guide bars in piggable systems.

****

a. Fittings 62 mm 2.5 Inches and Larger: Butt weld, conforming to ASTM A234/A234M, grade WPB and ASME B16.9 of the same wall thickness as the adjoining pipe. All welds must be radiographically examined throughout the entire length of each weld. Each fitting must be subjected to the Supplementary Requirements S52 and S53, Liquid Penetration examination and Magnetic-Particle Examination per ASTM A960/A960M. Detectable flaws will not be accepted in the supplementary examinations. Fittings must be identified to relate them to their respective radiograph. Elbows located between the pig launcher and the receiver, must have a radius 1.5 times the pipe diameter. Tees with branches 150 mm 6-inches and larger, must have guide bars as detailed on the drawings.

b. Fittings 50 mm 2 Inches and Smaller. Forged (socket welded or if indicated on drawings, threaded), 900 kg 2,000-pound W.O.G., conforming to ASTM A105/A105M, Grade 2 and ASME B16.11. Threaded fittings must only be used for above grade applications. Underground and in pits low point drain pipe and high point vent pipe must be butt welded.

c. Flanges: 68 kg 150 pound weld neck, forged flanges conforming to ASTM A105/A105M, and ASME B16.5. For flanges 2" and smaller located in contained pumphouses, contained truck offloads, contained truck fill stands, and other visibly contained areas the fitting may be forged (socket welded), 900 kg 2,000-pound W.O.G., conforming to ASTM A105/A105M, Grade 2 and ASME B16.11. In pits, vaults, on PRV piping for pipeline routes, and other uncontained locations the connection must be butt welded. Flanges to be 2 mm 1/16-inch raised face with phonographic finish, except where required otherwise to match equipment furnished. Match flange face to valves or equipment furnished. Flange face must be machined to match valves or equipment furnished. Use of spacing rings or gaskets discs are not allowed. Flanges must be subjected to the Supplementary Requirements S56, Liquid Penetrant Examination as outlined in ASTM A961/A961M. Detectable flaws will not be accepted.

d. Interior Epoxy Coating System must be applied to the fittings as specified in paragraph "Carbon Steel Piping."

2.1.5.3 Stainless Steel Fittings

a. Fittings 62 mm 2.5 Inches and Larger: Butt weld stainless steel conforming to ASTM A403/A403M, Class WP, Type 304L, seamless or welded, and ASME B16.9 of the same minimum wall thickness as the adjoining pipe. Welded fittings must be tested and inspected the same as the welded seam pipe and meet the same requirements as for the pipe. Elbows located between the pig launcher and the receiver, must have a radius 1.5 times the pipe diameter. Tees with branches 150 mm 6-inches and larger, must have guide bars as detailed on the drawings.

b. Fittings 50 mm 2-Inches and Smaller: Forged Type 304 or 304L (socket welded or if indicated on drawings, threaded), 900 kg 2,000-pound W.O.G. conforming to ASTM A182/A182M and ASME B16.11. Threaded fittings must only be used for above grade applications. Underground and in pits low point drain pipe and high point vent pipe must be butt welded.

c. Unions. Conforming to ASTM A312/A312M, Grade 304 or 316.

d. Flanges. 68 kg 150 pound weld neck, forged Type 304 stainless steel flanges conforming to ASTM A182/A182M and ASME B16.5, except flanges that are to be connected to the fueling/defueling pumps must be 135 kg 300-pound. For flanges 2" and smaller located in contained pumphouses, contained truck offloads, contained truck fill stands, and other visibly contained areas the fitting may be forged (socket welded), 900 kg 2,000-pound W.O.G., conforming to ASTM A182/A182M and ASME B16.11. In pits, vaults, on PRV piping for pipeline routes, and other uncontained locations the connection must be butt welded. Flanges to be

2mm 1/16-inch raised-face with phonographic finish, except where required otherwise to match equipment furnished. Match flange face to valves or equipment furnished. Flanges must be subjected to the Supplementary Requirements S56, Liquid Penetrant Examination as outlined in ASTM A961/A961M. Detectable flaws will not be acceptable.

e. Stainless Steel Tube Fittings. Flareless, 316 stainless steel fittings conforming to SAE J514.

2.1.5.4 Isolating Gasket Kits (Insulating) for Flanges

Provide ASTM D229 electrical insulating material of 1,000 ohms minimum resistance or 500 Volts per Mil (VPM) minimum dielectric strength; material must be resistant to the effects of aviation hydrocarbon fuels. Provide full face insulating gaskets between flanges with fluoroelastomer (FKM), commonly referred to as Viton, O-ring sealing surfaces. Provide full surface 0.75 mm 0.03-inch thick wall thickness, spiral-wound mylar insulating sleeves between the bolts and the holes in flanges; bolts may have reduced shanks of a diameter not less than the diameter at the root of threads. Provide 3 mm 0.125-inch thick high-strength phenolic insulating washers next to flanges and provide flat circular stainless steel washers over insulating washers and under bolt heads and nuts. Provide bolts 12 mm 0.5-inch longer than standard length to compensate for the thicker insulating gaskets and the washers under bolt heads and nuts. Above grade flanges separated by electrically isolating gasket kits must be provided with weatherproof lightning surge arrester devices. The surge arrester must bolt across flanges separated by insulating gasket kits per detail on contract drawings. The arrestor must have the following features:

a. Weatherproof NEMA 6P enclosure.
b. Bidirectional and bipolar protection.
c. Constructed of solid state components, no lights, fuses or relays and used without required maintenance or replacement.
d. Withstand unlimited number of surges at 50,000 Amperes.
e. Maximum clamping voltage of 700 Volts based on a IEEE C62.41 8x20 microsecond wave form at 50,000 Amperes peak measured at the device terminals (zero lead length).
f. A UL listed arrester for installation in Class 1, Division 1 or Class 1, Division 2, Group D, hazardous areas.

Install the mounting bracket and leads on the flange side of the bolt insulating sleeve and washer, and size in accordance with this schedule:

Line Size	Bolt Size
50 mm2 inch	16 mm5/8 inch
62 mm2.5 inch	16 mm5/8 inch
75 mm3 inch	16 mm5/8 inch
100 mm4 inch	16 mm5/8 inch
150 mm6 inch	19 mm 3/4 inch
203 mm8 inch	19 mm3/4 inch
254 mm10 inch	22 mm7/8 inch
305 mm12 inch	22 mm 7/8 inch
355 mm14 inch	25 mm 1 inch

Line Size	Bolt Size
406 mm 16 inch	25 mm 1 inch
Note: Make allowance for the1 mm 1/32-inch thickness of the insulating sleeve around the bolts when sizing the mounting lugs.	

2.1.5.5 Flange Protectors

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NOTE: Use near coastal areas and in wet locations (valve pits).

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Protect the bolts, studs, nuts, and gaskets of a flanged end connection from corrosion or damage due to exposure to the environment. Protectors must be weather and ultraviolet (UP) resistant. Protectors must allow for quick and easy removal and re-installation by maintenance personnel. Provide grease filled bolt caps. Provide non-expansive corrosion prevention grease and design for the service. Provide protectors that allow for visual inspection of the flange gasket without requiring removal. Provide protectors with grease fittings which allow the injection of grease into the flange cavity.

2.1.6 Nuts and Bolts

Bolts and nuts for pipe flanges, flanged fittings, valves and accessories must conform to ASME B18.2.1 and ASME B18.2.2, except as otherwise specified. Bolts must be of sufficient length to obtain full bearing on the nuts and must project no more than three full threads beyond the nuts with the bolts tightened to the required torque. Bolts must be regular hexagonal bolts conforming to ASME B18.2.1 with material conforming to ASTM A193/A193M, Class 2, Grade B8, stainless steel, when connections are made where a stainless steel flange is involved, and Grade B7, chromium molybdenum alloy, when only carbon steel flanges are involved. Bolts must be threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes 25 mm one inch and smaller and Eight-Pitch Thread Series for sizes larger than 25 mm one inch. Nuts must conform to ASME B18.2.2, hexagonal, heavy series with material conforming to ASTM A194/A194M, Grade 8, stainless steel for stainless steel bolts, and Grade 7, chromium molybdenum allow for chromium molybdenum alloy bolts. Nuts must be threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes 25 mm one inch and smaller and Eight-Pitch Thread Series for sizes larger than 25 mm one inch. Provide washers under bolt heads and nuts. Use chromium molybdenum alloy washers dimensioned to ASTM F436 flat circular for chromium molybdenum bolts. Stainless steel washer dimensioned in accordance with ASTM F436 flat circular, use material the same as the bolt. Use torque wrenches to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tight in the pattern recommended by the gasket manufacturer. Use anti-seize compound on stainless steel bolts.

2.1.7 Gaskets

ASME B16.21, composition ring, using a Buna-N, polytetrafluoroethylene (PTFE), or a protein and glycerin binder, 3 mm0.1250-inch thick. Gaskets must be resistant to the effects of aviation hydrocarbon fuels and manufactured of fire-resistant materials. Full-face gaskets must be used for flat-face flanged joints. Ring gaskets must be used for raised-face flanged joints. Gaskets must be of one piece factory cut.

2.1.8 Relief and Drain System Piping

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NOTE: Per SME.

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Pressure relief valve discharge lines and drain lines to the product recovery tank must be Schedule 40 [API Spec 5L Grade B or ASTM A53/A53M Grade B Carbon Steel] [ASTM A312/A312M seamless Type 304L Stainless Steel]. See Gaskets specified herein before.

2.1.9 Relief and Drain System Protective Coating

Pipe must be factory coated as specified herein before for steel piping.

2.1.10 Stainless Steel Field Applied Protective Coatings

The field joints and fittings of all underground piping must be coated as herein specified.

2.1.10.1 Welded Joints

Heat shrinkable radiation-cross-linked polyolefin wraparound type sleeves must be applied to all welded joints. Joints must not be coated until pressure testing is complete. Apply sleeves consisting of 1 mm 40 mil polyolefin backing and 1 mm 40 mil thermoplastic mastic adhesive in accordance with the manufacturer's instructions.

2.1.10.2 Tape for Fittings

Fittings and other irregular surfaces must be tape wrapped. The tape must be a plastic mastic laminated tape having 0.15 mm 6 mil plastic backing of either polyethylene or polyvinylchloride and 0.72 to 2.4 mm 29 to 44 mil of synthetic elastomer.

2.1.11 Threaded Joints

Threaded joints, if indicated on the drawings, must be made tight with manufacturer recommended PTFE tape or a mixture of graphite and oil, inert filler and oil, or with a graphite compound, applied with a brush to the male threads. Not more than three threads must show on made up joints. Threaded joints, mechanical couplings and flanges will not be permitted in buried piping. Threaded joints must not get welded.

2.1.12 Welded Joints

Welded joints in steel pipe must be as specified in Part 3.

2.2 MANUAL VALVES

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NOTE: Per SME for marine environment, provide stainless steel valves on exterior (aboveground and in pits) piping.

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All portions of a valve coming in contact with fuel in stainless steel pipe lines or epoxy lined carbon steel pipe lines must be of noncorrosive material. Valves in stainless steel pipe lines or epoxy lined carbon steel pipe lines must be Type 304 or Type 316 stainless steel or carbon steel internally plated with chromium or nickel or internally electroless nickel plated. Valves in unlined carbon steel pipelines must have carbon steel body. Stem and trim must be stainless steel for all valves. Manually operated valves 150 mm 6 inches and larger must be worm-gear operated and valves smaller than 150 mm 6 inches must be lever operated or handwheel operated. Valves smaller than 50 mm 2 inches must have lever-type handles. Handles installed more than 1.8 m 6 feet above finished floor must have chain operators. Valve indicators installed higher than 1.5 m 5 feet must have a position indicator visible from ground level. Sprocket wheel for chain operator must be aluminum. Valves in the isolation pits in fuel piping between the pig launchers and the pig receivers must be full bore, piggable, double block and bleed type. The full bore piggable valves at the launcher and the receiver must be ball type.

2.2.1 Ball Valves

Ball valves must be fire tested and qualified in accordance with the requirements of API Std 607 and API STD 608. Seal material for the fire test must be graphite, seal material for the project must be as as indicated below. Ball valves must be nonlubricated valves that operate from fully open to fully closed with 90 degree rotation of the ball. Valves 50 mm 2 inches and larger must conform to applicable construction and dimension requirements of API Spec 6D, ANSI Class 150 and must have flanged ends. Valves smaller than 50 mm 2 inches must be ANSI class 150 valves with flanged ends, unless noted otherwise. The balls in valves 254 mm 10 inches full port and 305 mm 12 inch regular port and larger must have trunnion type support bearings. Except as otherwise specified, reduced port or full port valves may be provided at the Contractor's option. Balls must be solid, not hollow cavity.

2.2.1.1 Materials

Ball must be stainless steel. Ball valves must have polytetrafluoroethylene (TFM) or fluoroelastomer (FKM), commonly referred to as Viton seats, body seals and stem seals. Valves 100 mm 4 inches and smaller must have a locking mechanism.

2.2.1.2 Full Port Ball (DBBV) Valves for Piggable Lines

Ball valves must be designed, manufactured, and tested to API Spec 6D, fire-safe and tested to API Spec 6FA, and BS EN ISO 10497 (BS 6755, Part 2). Seal material for the fire test must be graphite, seal material for the project must be as as indicated below. Valves must be trunnion-mounted with independent spring and hydraulically actuated, floating, single piston effect, self-relieving seat rings, with bi-directional sealing. Ball must be solid type with full through-conduit opening, suitable for passage of pipeline pigs. Stem must be anti-static, blow-out-proof design with o-ring seals and provided with an emergency sealant injection fitting. Valves must be 3-piece, bolted body design with raised-faced ANSI Class 150 flanged connections, equipped with body drain/bleed valve and vent fitting, and suitable for double block and bleed service in the closed and open positions. Valves must be all stainless steel construction, or carbon steel with stainless steel stem, and all wetted parts electroless nickel-plated. Valves must have nylon or polytetrafluoroethylene (TFM) seat inserts, FKM B body, stem, and seat o-rings, with stainless steel and graphite body gaskets and graphite secondary stem seals. Valves located in vaults or pits must be equipped with actuator extensions.

2.2.1.3 Electric Valve Actuator

Electric valve actuator must be as indicated for Plug (Double Block and Bleed) Valves, electric valve actuator.

2.2.2 Plug (Double Block and Bleed) Valves

API Spec 6D, ANSI Class 150, non-lubricated, resilient, double seated, trunnion mounted, tapered lift plug capable of two-way shutoff. Valve must have tapered plug of steel or ductile iron with chrome or nickel plating and plug supported on upper and lower trunnions. Sealing slips must be steel or ductile iron, with Viton seals which are held in place by dovetail connections. Valve design must permit sealing slips to be replaced from the bottom with the valve mounted in the piping. Valves must operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves must have weatherproof operators with mechanical position indicators. Indicator shaft must be stainless steel. Minimum bore size must be not less than 65 percent of the internal cross sectional area of a pipe of the same nominal diameter unless bore height of plug equals the nominal pipe diameter and manufacturer can show equal or better flow characteristics of the reduced bore size design. Full port plug valves in distribution piping must be provided with a 13 mm 1/2-inch threaded body drain.

2.2.2.1 General

Valves in the operating tank suction and fill lines and the valves at the four valve manifold in the pump room in the tank fill lines must be provided with a factory-installed limit switch that is actuated by the valve closure. Tank fill line valve and four valve manifold limit switches must be provided with one double pole double throw contacts or four single pole, double throw contracts, two for open, two for closed. Tank suction line valve limit switches must be provided with one double pole double throw contacts or four single pole, double throw contacts, for closed, and one single pole double throw contact or two single pole, double throw contacts for open. All components must be watertight and U.L. listed for Class I, Division 1, Group D hazardous areas.

2.2.2.2 Valve Operation

Rotation of the handwheel toward open must lift the plug without wiping the seals and retract the sealing slips so that during rotation of the plug clearance is maintained between the sealing slips and the valve body. Rotation of the handwheel toward closed must lower the plug after the sealing slips are aligned with the valve body and force the sealing slips against the valve body for positive closure. When valve is closed, the slips must form a secondary fire-safe metal-to-metal seat on both sides of the resilient seal. Plug valves located in Isolation Valve Pits or vaults must be provided with handwheel extensions.

2.2.2.3 Relief Valves

ANSI Class 150. Provide plug valves with automatic thermal relief valves to relieve the pressure build up in the internal body cavity when the plug valve is closed. Relief valves must open at 175 kPa 25 psi differential pressure and must discharge to the throat of, and to the upstream side, of the plug valve.

2.2.2.4 Bleed Valves

ANSI Class 150, stainless steel body valve. Provide manually operated bleed valves that can be opened to verify that the plug valves are not leaking when in the closed position.

2.2.2.5 Electric Valve Actuator

The actuator, controls and accessories must be the responsibility of the valve-actuator supplier for sizing, assembly, certification, field-testing and any adjustments necessary to operate the valve as specified. The electric valve actuator must include as an integral unit the electric motor, actuator unit gearing, limit switch gearing, position limit switches, torque switches, drive bushing or stem nut, declutch lever, wiring terminals for power, remote control,indication connections and handwheel. The electrically actuated plug valve must be set to open and close completely in 30 to 60 seconds against a differential pressure of 2 MPa 275 PSIG. The actuator settings of torque and limit contacts must be adjustable. The valve actuator must be suitable for mounting in a vertical or horizontal position and be rated for 30 starts per hour. The valve actuator must be capable of functioning in an ambient environment temperature ranging from -38 to 70 degrees C -32 to 158 degrees F.

a. The electrical enclosure must be specifically approved by UL or Factory Mutual for installation in Class I, Division 1, Group D locations.

b. The electric motor must be specifically designed for valve actuator service and must be totally enclosed, non-ventilated construction. The motor must be capable of complete operation at plus or minus 10 percent of specified voltage. Motor insulation must be a minimum NEMA Class F. The motor must be a removable subassembly to allow for motor or gear ratio changes as dictated by system operational requirements. The motor must be equipped with an embedded thermostat to protect against motor overload and also be equipped with space heaters. It must de-energize when encountering a jammed valve.

c. The reversing starter, control transformer and local controls must be integral with the valve actuator and suitably housed to prevent breathing or condensation buildup. The electromechanical starter must be suitable for 30 starts per hour. The windings must have short circuit and overload protection. A transformer, if needed, must be provided to supply all internal circuits with 24 VDC or 110 VAC may be used for remote controls.

d. The actuator gearing must be totally enclosed in an oil-filled or grease-filled gearcase. Standard gear oil or grease must be used to lubricate the gearcase.

e. The actuator must integrally contain local controls for Open, Close and

Stop and a local/remote three position selector switch: Local Control Only, Off, and Remote Control plus Local Stop Only. A metallic handwheel must be provided for emergency operation. The handwheel drive must be mechanically independent of the motor drive. The remote control capability must be to open and close. Rim pull to operate valve manually must not exceed 28 kg 80 pounds.

f. Position limit switches must be functional regardless of main power failure or manual operation. Four contacts must be provided with each selectable as normally open or normally closed. The contacts must be rated at 5A, 120 VAC, 30 VDC.

g. Each valve actuator must be connected to a PLC supplied by "others".

h. The actuator must have a local display of position even when power has been lost.

i. The actuator must be supplied with a start-up kit comprising installation instruction, electrical wiring diagram and spare cover screws and seals.

j. The actuator must be performance tested and a test certificate must be supplied at no extra charge. The test should simulate a typical valve load with current, voltage, and speed measured.

2.2.3 Swing Check Valves

Swing check valves must conform to dimensional requirements of API Spec 6D, regular type, ANSI Class 150 with flanged end connections. Check valves must conform to API STD 600 and be swing type with material as previously indicated herein. Discs and seating rings must be renewable without removing the valve from the line. The disc must be guided and controlled to contact the entire seating surface.

2.2.4 Silent Check Valves

Spring assisted, wafer/lug pattern, butterfly check with FKM or PTFE seat ring, designed to prevent flow reversal slamming of valve, dual plate, and must conform to ASME B16.34, API Std 594, except face to face dimensions may deviate from standard. Valves must be suitable for installation in any orientation. Valve body and trim material must be as previously indicated herein.

2.2.5 Butterfly Valve with Fusible Link Operator

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NOTE: Consult with SME before using this valve. Not permitted on Air Force projects. There are specific locations this valve is to be used on Navy projects in accordance with UFC 3-460-01.

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Valve must conform to API Std 609. Valve must meet the fire test requirements of API Std 607. Valve must be designed for bubble tight bidirectional shutoff service at operating conditions. Disc must be Type 304L or Type 316, stainless steel. Stem must be ASTM A276/A276M Type 416 or ASTM A564/A564M Type 630 stainless steel. Seal ring must be Teflon with metal backup. Stem seals must be capable of withstanding the rated pressure and temperature of the valve seat. Provide valves 150 mm 6 inches and larger and valves at pump discharge with weatherproof gear operators with handwheel; other valves must have minimum 10 position throttling handles. Valve must have a fusible link type valve operator. The fusible link and spring assembly must close the valve automatically when the link material melts at 75 degrees C 165 degrees F and lock the valve in the closed position. Spring assembly must be fully enclosed to ensure safety. Provide valve with flanged end connections independent of other flanged end connections provided on items such as equipment, piping, piping components, or valves.

2.3 RELIEF VALVES

Relief valves must be the fully enclosed, spring loaded, angle pattern, single port, hydraulically operated type with plain caps, and must be labeled in accordance with ASME BPVC SEC VIII D1 (L/sGPM). Valve stems must be fully guided between the closed and fully opened positions. The valves must be factory-set to open at 1.8 MPa 265 psi unless otherwise indicated on the drawings. Operating pressure must be adjustable by means of an enclosed adjusting screw. The valves must have a minimum capacity of 1.3 L/s 20 GPM at 10 percent overpressure. Valves must have a replaceable seat. Relief valves that do not relieve to a zone of atmospheric pressure or tank must be a balanced (non-ASME) type relief or regulator valve.

2.3.1 Valve Materials

Valves must have carbon steel bodies (stainless steel on SS pipelines) and bonnets with stainless steel springs and trim. Valves must be Class 150 flanged end connections.

2.3.2 Quick Disconnect

If indicated on drawings provide quick disconnect on relief valve system. Quick disconnects must be double shut-off, dry-break design, 316 stainless steel construction, with Fluorocarbon (Viton) seals, minimum working pressure of 1000 psig at 100°F., with ½" female NPT threaded connections for both coupler and adapter, manufactured in accordance with ISO 7241, Series B. The couplers and nipple/adapters are to be provided with aluminum dust caps to protect the fitting when not in use. Five nipple/adapters are to be provided to the installation for connecting to government test equipment.

2.4 PIPING ACCESSORIES

2.4.1 Flexible Ball Joints

Flexible ball joints must be [stainless steel] [carbon steel with electroless nickel-plating to a minimum of 0.075 mm 3 mils thickness], capable of 360-degree rotation plus 15-degree angular flex movement, ASME B16.5, Class 150 flanged end connections. Provide either pressure molded composition, PEEK, or polytetrafluoroethylene (TFM) gaskets designed for continuous operation temperature of 135 degrees C 275 degrees F. Joints must be designed for minimum working pressure of ANSI Class 150. Injectable packing will not be allowed.

2.4.2 Pipe Sleeves

Pipe sleeves must be installed where indicated and at all points where the piping passes through concrete construction. Such sleeves must be of sufficient inside diameter to provide a minimum clear distance between the pipe and the sleeve of 13 mm 1/2-inch. Sleeves through concrete pits or slabs must be standard weight carbon steel pipe with a protective coating. Each sleeve must extend through the respective pit wall or slab and must be provided with a Buna-N casing seal (Viton when exposed to sunlight). Sleeves where piping passes under roads or piping indicated to be double walled must be standard weight carbon steel pipe with a protective coating as previously specified. Alignment of the sleeve and piping must be such that the pipe is accurately centered within the sleeve by a nonconductive centering element. The sleeve must be securely anchored to prevent dislocation. Closure of space between the pipe and the pipe sleeve must be by means of a mechanically adjustable segmented elastomeric seal. The seal must be installed so as to be flush.

2.4.3 Strainers

2.4.3.1 Basket Type

Strainer must be single or multi (four) basket type as indicated in compliance with MIL-PRF-13789, except as specified otherwise. Strainer end connections must be designed in accordance with ASME B16.5, Class 150. Strainer body material must be the same as the material specified for manual valves. Strainers must have removable baskets of 60 mesh wire screen with larger wire mesh reinforcement; wire must be stainless steel, Type 316. Pressure drop for clean strainer must not exceed 20 kPa 3 psig at maximum design flow rate. The ratio of net effective strainer area to the area of the connecting pipe must be not less than three to one. Each strainer must be provided with a suitable drain at the bottom, equipped with a ball valve. The strainer must be equipped with a direct-reading, piston type differential pressure gauge that measures the differential pressure across the basket. The gauge must consist of a spring-supported, corrosion resistant piston moving inside a glass cylinder, with high pressure applied on top of the piston and low pressure applied below it. Under a differential pressure of 21 kPa 30 PSI, leakage past the piston must not exceed 120 drops per minute. The cylinder and flanges must be stainless steel with Viton O-ring seals. The high pressure inlet of the gauge must have a 10-micron pleated paper filter and the low pressure connection must have a fine mesh stainless steel strainer. The gauge must have an operating pressure of 210 kPa 300 PSI. Differential pressure range of the gauge through approximately 75 mm 3 inches of piston movement must be 0-21 kPa 0-30 PSI with an accuracy of ± 0.034 0.5 PSI, calibrated linearly with one kPa PSI scale graduations. High and low pressure connections must be 6 mm 1/4 inch NPT female with a stainless steel bar stock valve at each connection. Construction of the gauge must be such that a 3-valve manifold is not necessary. If only one bar stock valve is closed, the gauge must not be damaged by up to 210 kPa 300 PSI differential pressure in either direction. A pressure gauge must be attached to the differential pressure gauge to indicate the high pressure and have a range of 210 kPa 300 psi.

2.4.3.2 Cone Type

Strainer must be stainless steel type 304 or 316, 100 mesh screen with the ratio of net open area of strainer to the area of the connecting pipe must be not less than three to one at the pump suction, and 4 mm 5/32-inch perforations and suitable for bi-directional flow at the inlet to the hydrant pit control valves.Pump suction strainer must have a 100 mesh screen with not less than 300% open area (ratio of the strainer open area to the cross section of pipe). Hydrant pit control valve strainer must be the basket type, have 5/32 inch perforations, suitable for bidirectional flow, and have a minimum 200% open area.

2.4.4 Pipe Supports

2.4.4.1 General

Pipe supports must conform to MSS SP-58. Supports must be provided at the indicated locations. Support channels for drain lines must be epoxy coated on all surfaces or hot-dip galvanized after the channels are cut to length. Coated supports must be coated with fusion bonded epoxy resin applied by the fluidized bed method. Thickness of the coating must be not less than 0.25 mm 10 mils. Surface preparation and coating application must be in accordance with the epoxy manufacturer's instructions. The coating must be pinhole free when tested with a low voltage holiday detector set at no more than 100 times the mm mil thickness of the coating. All pinholes must be marked, repaired and retested to ensure a pinhole free film. The coating material must be a 100 percent solids, thermosetting, fusion-bonded, dry powder epoxy resin. The manufacturer must certify that the material is suitable for fluidized bed application and that it is approved by the Environmental Protection Agency. A PTFE pad must be installed between the pipe and the u-bolt.

2.4.4.2 Adjustable Pipe Supports

Adjustable pipe supports must consist of a cast iron saddle and a threaded nipple connected to a carbon steel pipe by means of a special reducer conforming to MSS SP-58. The supports must be provided with PTFE insulation strips.

2.4.4.3 Low Friction Supports

Low friction supports must be self-lubricating antifriction element composed of reinforced PTFE. Units must be factory designed and manufactured.

2.4.4.4 Concrete and Grout

Concrete and grout for anchors and supports must comply with SECTION 03 30 00 CAST-IN-PLACE CONCRETE.

2.4.5 Sample Connections

a. Sample connections must be factory assembled units specifically designed for obtaining representative samples from fuel pipelines. Each connection must include a 6 mm 1/4-inch sampling probe where the probe faces upstream, ball valve and 6 mm 1/4-inch quick disconnect coupling with dust plug, all assembled into a unit that is suitable for installation in a pipe nipple. The sampling probe must extend not less than one inch into the fuel pipe. All materials in the sample connections must be stainless steel or aluminum.

b. Furnish two sampling hose assemblies to the Contracting Officer at the project site. Each assembly must consist of a 1.8 m 6-foot length of 6 mm 1/4-inch clear plastic tubing with internal bonding/grounding wire. One end of the tubing will contain a male connector that actuates flow when inserted into the quick disconnect coupler. Each end of the bonding/grounding wire must be equipped with clips for attaching to the pipe and metal sample container.

2.4.6 Flanged Swivel Joints

Flanged swivel joints must be stainless steel, single plane, capable of rotating 360 degrees. Welded swivel joints and welding of swivel joints to the pipe and/or elbow is not permitted. Swivel joints must be of the non-lubricated, maintenance free type with sealed bearings and no lubricating fitting. Swivel joint must be flanged at the end connecting to the piping system and threaded (female NPT) at the end connecting to the fuel hose. No leakage must be permitted under positive or negative pressure conditions. No leakage must be permitted under high or low temperature conditions. Welding of swivel joint to six-bolt flange connector is permitted. The swivel joints must be warranted for three years against leakage. There must be electrical continuity from one flange to the other without the use of ground straps. The electrical continuity from one flange to another (without the use of ground straps) must be less than 1000 ohms. Each swivel joint must have two ball bearing raceways, primary and secondary seals with leak detection port, and dust seal.

2.4.7 Monitoring Points

At the following locations, provide 13 mm half-inch pipe, flanged ball valve, and blind flange for future test equipment connections:

a. On the filter separator discharge header in the pumphouse.

b. At the Hydrant Hose Truck Checkout, inlet to Hydrant Valve.

c. At the inlet to the Back Pressure Control Valve in the Pumphouse.

d. At both sides of the isolation valve in all the isolation valve pits.

2.4.8 Fuel Hose

Fuel hose must conform to EI 1529, Grade 2, Type C, threaded, male NPT, both ends.

2.4.9 Top Loading Arms

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NOTE: Top loading is discouraged (safety) and should be used only when equipment is incapable of bottom loading and only when approved by the SME.

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Top loading arm ([2"-100][3"-200][4"-300]gpm) must have sufficient horizontal reach and pivot points to assure the vehicle does not have to be re-spotted. Drop pipe length must be able to reach fill tank bottom and be at a safe elevation for refueler operation. Loading arm must have four planes of movement: up-down (to allow drop pipe to enter tank), side to side (to allow arm to rotate out to tank and back out of position), drop-tube (to assure drop-tube remains vertical), scissor arm pivot (which allows 360 degree rotation of secondary arm allowing the drop-tube to reach further out thus allows a larger spotting distance). Materials of construction must be stainless steel. Arm must be counterweight or spring assisted for effortless operation of loading arm. Swivel joints must be of the non-lubricated, maintenance free type with sealed bearings and no lubricating fittings. Assembly must be a regular product for the purpose of top loading fuel from a manufacturer who has successfully provided the product for at least the past five years.

2.4.10 Pressure Fueling Nozzle

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NOTE: Specify type of nozzle as directed by the SME.
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Nozzles must conform to SAE AS5877, Type [D-1] [D-2] [D-3]. Nozzles and nozzle components must be compatible with the fuel to be handled. Nozzles must be provided with an internal 60 mesh stainless steel strainer and a fuel sample connection tapping. Nozzle design must be for single point fueling of aircraft. Nozzles must be provided with a compatible dry break quick disconnect swivel. Coupler must allow for quick disconnect and reconnect of fueling nozzles with corresponding adapters. Coupler and adapter must provide a positive, leak proof connection under constant or surge flow. Coupler must be designed to prevent blowout of internal poppet.

2.4.11 Nozzle Adapter (SPR)

Adapter must be a nominal 62 mm 2-1/2 inches with self-closing valve in accordance with MIL-A-25896. Adapter must have a 100 mm 4 inch flange mounting and vacuum tight, locking dust cap using the SPR lugs.

2.4.12 Pigging Accessories

2.4.12.1 Closure Door

The closure must be hinged, swing bolted closure of the same material as the pipe and for a Class 150 system. Gasket must be nitrile. Eye bolts must be pinned to lugs on the hub.

2.4.12.2 Signaler

The pig signaler must be mechanical flag type with manual reset, and be located on the pig launcher and the pig receiver. Material in contact with the fuel must be stainless steel. Units must be suitable for removal and installation under line pressure of 275 psig. Signaler must be capable of withstanding line pressure of a Class 150 system.

2.5 FLEXIBLE HOSES

Flexible hoses for fueling pumps must have ANSI Class 300 flanges to mate to the pump and Class 150 to connect to the system flanges of stainless steel construction conforming to ASME B16.5. Flexible hoses must be of stainless steel flexible metal hose consisting of an inner corrugated stainless steel tube with stainless steel braid cover and stainless steel flanges. All components to be suitable for not less than 2 MPa 275 psig. Length and application of flexible hoses must be per manufacturer's written recommendations.

2.6 AUTOMATIC AIR VENT

Unit must have 25 mm one-inch connections and automatically vent air under pressure, and prevent a vacuum when pressure drops below a positive pressure. As fuel fills the vent, a float must rise and form a drip-tight closure. The unit pressure rating must be a minimum of 2 MPa 275 psi. The float must be stainless steel. Body and cover be carbon steel or ductile iron and be internally epoxy coated.

2.7 SURGE SUPPRESSOR TANK AND VALVE

The unit must be fabricated from carbon steel, internally coated pressure vessel with a rubber bladder or a stainless steel diaphragm separating the fuel from the gas charge. The epoxy coating must be in accordance with MIL-PRF-4556. The rubber bladder must be molded synthetic nitrile rubber (Buna-N). The unit must be constructed and labeled in accordance with ASME BPVC SEC VIII D1. The housing must be designed for a working pressure of 2 MPa 275 PSIG. The gas precharge must be dry nitrogen and must have a pressure gauge, gas valve, and an adapter for field charging. Bladder precharge pressure must be 1 MPa 80 PSIG. The connection to the piping system must be Class 150 ANSI flange, size as indicated on the drawings. The connection must have a check valve to provide unrestricted flow into the vessel and restricted flow from the vessel. The flange must have a 13 mm 1/2-inch NPT connection with a valve and adapter to relieve fluid pressure during gas recharging and to drain the vessel during removal. A charging assembly must be provided. The surge control supplier must furnish a service person trained to provide installation check-out assistance and to supervise operation and testing necessary to place the surge control system into service and to provide training on charging, recharging, and checking the surge suppressor.

PART 3 EXECUTION

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NOTE: Specify as directed by the SME.

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3.1 VERIFICATION OF DIMENSIONS

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 CLEANING OF PIPING

Keep the interior and ends of all new piping, affected by construction operations, thoroughly cleaned of foreign matter and water before and after being installed. Piping systems must be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of piping and fittings must be closed so that no water or other foreign substance will enter the pipes or fittings. Piping must be inspected before placing into position. The interior of each length of pipe must be cleaned after welding insuring that the interior of the piping is free of foreign matter when it is connected into the system.

3.3 TRENCHING AND BACKFILLING

Trenching and backfilling must conform to Section 31 00 00 EARTHWORK, and the following bedding and backfill requirements. The pipe must be laid in a bed of sand 150 mm 6 inches deep, compacted in accordance with Section 31 00 00 EARTHWORK, paragraph "Backfilling and Compaction". Sand must meet the requirements of Section 31 00 00 EARTHWORK, paragraph "Select Granular Material". The full length of each section of pipe without any protective covering must be excavated to permit installation of the protective covering. Pipe that has the grade or joint disturbed after laying, must be taken up and relaid. Pipe must not be laid in water or when the trench or weather conditions are unsuitable for such work. After testing and application of protective covering to joints, sand backfill must be placed and compacted around the pipe or protective coating to a depth of 305 mm 1 foot above top of pipe. The remainder of the backfill must be the same as for other types of pipe.

3.4 PIPING LAYOUT REQUIREMENTS

3.4.1 Pipe Fabrication

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system. The use of flexible hoses in permanently mounted pump suction and discharge lines as a method of compensating for piping misalignment is not acceptable.

3.4.2 Interferences and Measurements

Provide offsets, fittings, and accessories required to eliminate interferences and to match actual equipment connection locations and arrangements. Verify measurements before commencing work. Submit discrepancies for clarification before proceeding with the installations to the Contracting Officer.

3.4.3 Space and Access

Keep piping, control tubing, which is not detailed close to structures and columns so as to take up a minimum amount of space. Ensure that access is provided for maintenance of equipment, valves and gauges.

3.4.4 Location

Do not place unions in locations that will be inaccessible after the completion of the work. Place unions on each side of equipment.

3.4.5 Piping and Equipment

Provide anchors where required to absorb or transmit thrust or eliminate vibration or pulsation. Provide hangers and supports near each change of direction. Select support components which do not restrict the movement of the pipe due to thermal expansion. Space hangers uniformly and arrange symmetrically.

3.4.6 Structural Support

Provide supplementary or intermediate steel or other structural members as required for transmission of loads to members forming part of the supporting structure. Piping must not be supported from other piping.

3.4.7 Grade

Where profiles of piping lines are shown on the drawings, grade the line uniformly between changes in slope or direction. Maintain gradient to within ± 6 mm 1/4-inch over the entire length of pipe. When backfilling has been completed to the top of the pipe, the pipe must be surveyed at each joint, and logged by station number. Submit to the Contracting Officer for approval the survey final elevations before backfilling can continue.

3.4.8 Size Changes

Make changes in pipe size with reducing fittings. Do not use bushings. In lieu of welding reducing outlet tees for piping 50 mm 2 inches and larger, welding branches suitable for 100 percent radiographic inspection may be used. Do not use weldolets unless specifically called out (labeled) on the drawings.

3.4.9 Direction Changes

Make changes in direction of pipes with long radius fittings. Provide special fittings when required. Do not make miter welds. Make odd-angle offsets with pipe bends or elbows cut to the proper angle.

3.5 WELDING

3.5.1 General

All joints, unless indicated otherwise, in carbon steel and stainless steel piping systems must be welded. Welding of fuel pipe joints must comply with Section 33 52 23.15 SERVICE PIPING WELDING.

3.6 INSTALLATION

3.6.1 Precautions

Take special care to ensure that the protective coating on buried pipe is not damaged during installation and that the completed system is free of rocks, sand, dirt, water, weld slag, and foreign objects including construction debris. Take the following steps to ensure these conditions.

a. Coated pipe must be handled only with canvas or nylon slings or padded clamps. Any coating damaged by improper handling or storage must be repaired as specified.

b. Pipe brought to the site must be stored on blocks or horses at least 458 mm 18 inches above the ground and adequately supported to prevent sagging. Padded blocks or horses must be used for coated pipe. The method and height of storing coated pipe must be in accordance with the coating manufacturer's instructions. Pipe ends must be protected and capped against weather at all times, except to accommodate immediate installation.

c. Visual inspection must be made of the inside of each length of pipe to ensure that it is clear and clean prior to installation.

d. The open ends of the pipe system must be closed at the end of each day's work or when work is not in progress by use of expansion plugs and must not be opened until the work is resumed.

e. A swab, with a leather or canvas belt disc to fit the inside diameter of pipe, must be pulled through each length of pipe after welding in place.

f. Obstruction remaining in the pipe after completion of the system must be removed at the expense of the Contractor.

g. Plasma cutters and torches are not to be used to make penetrations in the pipe or to cut pipe.

h. After installation and backfill of the hydrant loop is complete and before fuel is put in the pipe, the pipe will be cleaned using foam swabs and poly coated wire brush pigs and compressed dry gas, residual humidity of not over 20 percent. Ten flights of a combination of swab and brush pigs must be run. During this, low point drains and high point vents must be blown clean.

[3.6.2 Protective Coatings for Buried Stainless Steel Piping

3.6.2.1 Application of Tape Wrapping

Surfaces to receive tape must be clean, dry, grease-free and dust-free. Extruded polyethylene coating and adhesive undercoat surfaces to be tape wrapped must be primed with a compatible primer prior to application of the tape. The primer must be as recommended by the tape manufacturer and approved by the extruded polyethylene coating manufacturer. Weld beads must be wire brushed. Burrs and weld spatter must be removed. Weld beads must be covered with one wrap of tape prior to spiral wrapping. Fittings must be wrapped spirally beginning with one complete wrap three inches back from each edge of the extruded polyethylene coating. For pipe less than four-inch size, one layer half-lapped must be used. For pipe 100 mm 4-inch size and larger, two layers half-lapped must be used, with the second layer wrapped opposite hand to the first. On irregular surfaces one layer must be applied half-lapped and stretched to conform to the surface, followed by a second layer half-lapped and applied with the tension as it comes off the roll.

3.6.2.2 Inspection and Testing

The condition of factory field coated and wrapped piping must be the responsibility of the Contractor and all damage to the protective covering during transit and handling must be repaired at no additional cost to the Government. All field coating and wrapping must be subject to approval by the Contracting Officer. The entire pipe must be inspected as specified in sub-paragraph "Testing of Protective Coatings" under paragraph "Protective Coatings for Buried Steel Piping." The inspection for holidays must be performed just prior to lowering the pipe into the ditch and every precaution must be taken during lowering and backfilling to prevent damage to the protective covering.

3.6.2.3 Damage Repair

Damaged areas of extruded polyethylene coating must be repaired by tape wrapping as specified in the preceding paragraph for fittings. Residual material from the extruded polyethylene coating must be pressed into the break or must be trimmed off; all areas to be taped must be primed, and the tape must be applied half-lapped.

]3.7 INTERIOR EPOXY COATING

When internally epoxy lined pipe is cut, the lining must be ground back from the end a minimum of one inch but not more than 38 mm 1-1/2 inches.

3.8 INSTALLATION OF UNDERGROUND PIPE

Underground fuel pipelines must be pitched as shown on the drawings. Where not indicated they must be pitched a minimum of 50 mm 2 inches per 30.5 m 100 feet. Branch lines to the hydrant pits must slope up to the pit. 50

mmTwo-inch pipe size valved drain connections must be provided at all low points and 38 mm 1-1/2-inch pipe size valved outlet vent connections must be provided at all high points. Vent and drain lines must terminate in male cam-type locking end connectors with matching female dust covers and installed in pits. The pipe must have cover as shown on the drawings. Drain lines must be installed at the slopes indicated.

3.8.1 Pipe Assembly

Pipe must be strung parallel and adjacent to or above a trench. The pipe must be supported on padded skids during welding and inspection of joints. Protective coating must be inspected and repaired prior to lowering the pipe into the trench. The pipe must be lowered using only canvas or nylon slings. The sling must be dug from underneath the pipe after placements and must not be pulled from underneath the pipe while in contact with it. Care must be taken to prevent damage to the pipe, welded joints or coating and any such damage must be repaired as directed by the Contracting Officer. Pressure testing of the pipe must be done after it has been placed in final position in the trench.

3.8.2 Warning Tapes in Earth Trenches

For the purpose of early warning and identification of buried pipes outside of building walls during future trenching or other excavation, continuous identification tapes must be provided in the trench. Provide metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured for the purpose of early warning and identification of utilities buried below the tape. Tape must be at least 75 mm 3 inches in width. Color of tape must be as standard with the manufacturer with respect to the type of utility buried below the tape. Tape must have lettering at least 25 mm 1 inch high with warning and identification imprinted in bold black letters continuously over the entire tape length with not less than the following identification on the tape: BURIED JET FUEL PIPING BELOW. Tape must be installed in accordance with the printed recommendations of the tape manufacturer, as modified herein. Tapes must be buried at a depth of 150 mm 6 inches from the top of the subgrade or 305 mm 12 inches below the top surface of earth. Provide permanent color and printing, unaffected by moisture or soil.

3.8.3 Clearances

Install pipe to be clear of contact with other pipes, pipe sleeves, casings, reinforcing steel, conduits, cables, or other metallic structures. Where pipes cross other pipes or structures with a separation of less than 150 mm 6 inches, install an insulating separator. Protect the pipe from contact with a 305 mm 12-inch square by 25 mm 1 inch thick bituminous-impregnated cane fiber board.

3.8.4 Protective Coating

When the protective coating on pipe is damaged, the Contracting Officer must be notified and must inspect the pipe before the coating is patched. If the damage to the pipe is deeper than 1.2 mm 0.050-inch, the damage must be repaired by welding in accordance with paragraph "WELDING". If the pipe is dented, out of round or damaged to the point that welding will not make it good as new, the length of pipe must be rejected.

3.9 TESTING

Piping must be tested by pneumatic and hydrostatic pressure. Testing must comply with applicable requirements of ASME B31.3, NFPA 30 and the requirements specified herein. Hydrostatic testing must be performed using fuel as the liquid. Water must not be introduced into the system for testing. Pneumatic and hydrostatic testing must be performed only after welding inspection has been completed.

3.9.1 Pneumatic Test

Piping to be installed underground must not receive field applied protective covering at the joints or be covered by backfill until the piping has passed the pneumatic test described herein. To facilitate the tests, isolate various sections of the piping system and test each one separately. Where such sections terminate at flanged valve points, the line must be closed by means of blind flanges in lieu of relying on the valve. Furnish tapped flanges that can be attached to the end of the section of line being tested, and that will permit a direct connection between the piping and the air compressor and/or pressurizing pump. No taps in the permanent line will be permitted. Furnish all necessary equipment for testing; all gauges must be subject to testing and approval of the Contracting Officer. The air used for pneumatic testing must have a dew point of no more than 5 degrees C. 41 degrees F. Provide dehumidifying equipment on the suction or discharge side of the air compressor used to provide air for testing. Pressurizing pump must not exceed 4.7 L/s 10 cfm.

3.9.1.1 Pneumatic Test Procedure

Special safety measures, including the wearing of face mask, must be taken during testing under pressure. Only authorized personnel must be permitted in the area during testing. The pneumatic test pressure must be applied in increments. A preliminary 167 kPa 25 psig test must be applied. Examine joints with soap solution. Leaks revealed by this test must be repaired. The full test pressure must then be applied. Unless otherwise directed by the Contracting Officer, all piping must be tested at a pressure of [333][667]kPa[50][100]psig for not less than 2 hours, during which time there must be no drop in pressure, only pressure rises with temperature. The pressure source must be disconnected during the final test period. Any leaks revealed by the test must be repaired and the test repeated.

3.9.1.2 Hydrostatic Test

Upon completion of pneumatic testing and after backfilling, hydrostatically test each piping system with fuel at [2][____]MPa[275][_____]psig in accordance with ASME B31.3 and API RP 1110, with no leakage or reduction in gauge pressure for four hours. Furnish electricity, instruments, connecting devices, and personnel for test. Fuel must be furnished by the Government. Defects in work must be corrected at the Contractor's expense, and the test repeated until the work is proven to be in compliance with the Contract requirements.

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NOTE: If the SME directs the Designer to hydrostatically test the system to 1.5 times the design pressure, exceeding the flange rating, the Designer will be required to write the commissioning hydrostatic testing procedures; removing all ball valves, control valves, and instructing the testing

people what valves to close, where to connect the hydrostatic test pump, blind flange placements, and other safety requirements.
****

3.9.2 Performance Testing

After the system is completed (including pneumatic and hydrostatic testing) the fuel system must be cleaned and performance tested as specified in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START UP. All control valves, both manual and automatic, must be checked for leaks (any area wetted with fuel) and proper operation and adjusted, repaired or replaced to correct any defects.

3.10 PIPELINE PIGGING VERIFICATION

3.10.1 Geometry/Ultrasonic Tool Reports

After the system is installed and prior to performance testing, a field/preliminary report must be issued and a debrief given to Government personnel onsite on the condition of the fuel hydrant loop. This must be comprised of raw data in the form of a PC download or equivalent which shows a continuous scan of each data unit output. Results of a preliminary interpretation of the data must be reported. These must include as a minimum all critical anomalies. A final report must include a description of the principle of operation, explanation of raw data, presentation of raw data, data to be clearly marked with distance traveled scale with classified anomaly location and all identifiable pipeline features, and all anomalies to be classified with locations in summary tabular form, pipe wall thickness survey, as well as the software necessary to read the data. Submittal must be in the form of digital media copied to a CD or DVD (flash drives are unacceptable).

3.10.2 Pipeline Internal Inspection Operations

3.10.2.1 General

The following pigs will be propelled through the pipeline with product in order to inspect the pipeline: 1.7 kg 5 pound density foam swab, combination poly scraper-magnetic, stainless steel wire brush (plastic brush for internally lined piping), aluminum plate gauge, and geometry/ultrasonic tool. Tracking devices must be used on all pigs. At a minimum, the sequence of pig runs must be as follows: 1) foam swab for proving and cleaning, 2) wire brush for cleaning, 3) scraper-magnetic for cleaning, 4) aluminum plate gauge for gauging internal anomalies, 5) scraper-magnetic for cleaning, 6) wire brush for cleaning, 7) scraper-magnetic for cleaning, 8) foam swab for cleaning, (Note: the number of pig flights of each type of cleaning pigs must be determined by the amount and type of debris removed. The conclusion of the cleaning process must be when debris recovered is only that from the pigs themselves. This determination will be determined by the project's system supplier and the Contracting Officer), 9) geometry/ultrasonic tool. The pipe wall must be continuously monitored on a real-time basis during the geometry/ultrasonic pig run. Anomalies such as patches, couplings, or flanges must also be identified, and the wall thickness given. The geometry/ultrasonic pig's technician will determine if additional runs are necessary. A permanent data set of internal inspection survey findings must be generated.

3.10.2.2 Preparatory Work

The Government will bring to the attention of the Contractor all statutes, rules and regulations relevant to the performance of the work on the site (on Government property) and will also provide the Contractor with a copy of its own site regulations (if any). Provide the pigging vendors with all-available pipeline records and drawings.

3.10.2.3 Pig Load And Launch

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NOTE: If pig a launcher and a receiver are not provided in the contract, portable ones will be by the Contractor during pigging operations.

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The pig must be loaded into the pig launcher by the Contractor. The method of loading and lodging the front pig cup into the launcher must not involve the use of uncontrolled mechanical force applied to the rear of the pig.

3.10.2.4 Pipeline Operation During Pigging

All pig runs must be made with the line packed with product. The system pumps will be used to propel the pig. The new pig traps will be used for pig launch and retrieval.

3.10.2.5 Brush and Gauging Survey

Run a brush pig at least as often as previously indicated. The brush pig must be designed and provided by the geometry/ultrasonic pig vendor. Additional runs may be required based upon the amount of debris found in the pipeline. The onsite geometry/ultrasonic pig vendor's personnel and COR must determine if additional runs are required. Immediately following the brush pig run and immediately prior to the geometry/ultrasonic survey, run, as a minimum, a single batching pig fitted with a gauge plate equal to 90 percent of the pipeline normal inside diameter. The plate is to be a segmented aluminum disk of 3 mm 1/8 inch thickness. The plate gauge pig must also include a tracker and tracking equipment. Track the pig assembly above ground during the operation.

3.10.2.6 Geometry/Ultrasonic Survey

After a satisfactory gauging pig run, the pipeline geometric defects must be determined by a geometry/ultrasonic tool. The geometry/ultrasonic tool must provide accurate geometric anomaly detection, and bend radius measuring capability. The data obtained must be presented in a PC software format to allow user friendly analysis and presentation. The geometry/ultrasonic tool assembly must be capable of:

a. Operating in hydrocarbon liquid environment, specifically jet fuel, at a pressure of up to ANSI 300 rating.

b. Traversing the pipeline with nominal wall thickness and possible bore restrictions down to 90 percent of nominal pipe inside diameter.

c. Traversing the pipeline length at a speed of between 60 and 100 m/min 3 and 5 ft/sec when propelled by pumped jet fuel. Pressure differential across pig not to exceed 34 kPa 50 psi.

d. Traversing through smooth pipe bends as small as 1.5D (1.5 pipe diameters) radius and single miter bends of up to 10 degrees change of direction.

e. Include a tracker and tracking equipment. Track the pig assembly above ground during the operation. The battery life of the tracker must not be less than 72 hours.

f. Manual loading into the new horizontal pig trap.

The geometry/ultrasonic tool assembly instrumentation performance must be capable of:

a. Battery life to be minimum 18 hours at operating conditions.

b. Principle of operation to be electronically stored geometry system.

c. Geometry sensing to span full circumference and length of pipe, with associated distance measuring method.

d. Geometry system must be capable of:

    (1) positive location and identification of each geometric anomaly.

    (2) positive location and identification of each bend.

    (3) positive location and identification of distance marker reference points of either magnetic or electronic type placed on or above the pipe.

e. Classification of geometric anomalies to be as minimum:

    (1) discrimination between ovality and intrusion anomalies.

    (2) mechanical damage such as mill defects, dents, internal gouges, and buckles.

    (3) pipeline weld defects (such as excess weld penetration).

    (4) geometric thickness anomalies. As a minimum, these must be reported in the following categories within the listed accuracy.

        (a) magnitude of anomaly (+/- 25 mm1 inch)
        (b) span of anomaly (+/- 25 mm1 inch)
        (c) ovality (+/- 2.5 mm0.1 inch)
        (d) span of ovality (+/- 25 mm1 inch)
        (e) anomaly station (+/- 1:2,000)

f. Pipe Wall Thickness Survey:

The geometry/ultrasonic tool must provide accurate measurement of pipe wall thickness (+/- 0.25 mm). 0.01 inch). The data obtained must be presented in a PC software format to allow user friendly analysis and presentation.

3.10.2.7 Lost Pig

The Contractor is responsible for a lost pig, finding the pig, retrieval of the pig, and all repairs, radiographs to the pipeline system and the pig.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 52 43.14 (August 2018)**
Change 1 - 02/21

Preparing Activity: USACE **Superseding**
UFGS-33 52 43.14 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 52 43.14

AVIATION FUEL CONTROL VALVES

08/18, CHG 1: 02/21

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NOTE: This guide specification covers the requirements for diaphragm type automatic control valves used in aircraft refueling systems constructed to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location

https://www.wbdg.org/ffc/dod/non-cos-standards.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2021) Standard Specification for Steel

	Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A352/A352M	(2021) Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications

ENERGY INSTITUTE (EI)

EI 1570	(2012) Handbook on Electronic Sensors for the Detection of Particulate Matter and/or Free Water During Aircraft Refueling
EI 1598	(2012) Design Functional Requirements and Laboratory Testing Protocols for Electronic Sensors to Monitor Free Water And/or Particulate Matter in Aviation Fuel

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS 3216	(2023; Rev J) Fluorocarbon (FKM) Rubber High-Temperature - Fluid Resistant Low Compression Set 70 To 80
SAE J200	(2023) Classification System for Rubber Materials
SAE J429	(2014) Mechanical and Material Requirements for Externally Threaded Fasteners

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-8625	(1993; Rev F; Am 1 2003) Anodic Coatings, for Aluminum and Aluminum Alloys

1.2 ADMINISTRATIVE REQUIREMENTS

Design conditions must be as specified in Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT. Components must be suitable for ANSI Class 150 (2 MPa 275 psig at 38 degrees C 100 degrees F).

a. Control valves specified herein must be of one manufacturer. The valve manufacturer must also produce the hydraulically-operated pilots. For each type control valve required and specified, submit the following:

  (1) . Flow diagrams.
  (2) . Operational description of the control valve and pilot control system.
  (3) . Complete valve assembly list of materials, along with material Certificates of Conformance, used in the manufacture of the control valves and pilot systems.
  (4) . sectional drawings of main valve and control pilot systems.

b. Before shipment, each individual control valve must be operationally tested and adjusted by manufacturer under actual flow conditions utilizing a hydrocarbon test fluid with a specific gravity comparable to [Jet A (F-24)][Jet A-1 (F-35)][JP-4 (F-40)][JP-5 (F-44)][JP-8 (F-34)]fuel. Manufacturer must submit certified records of test data.

c. Operation and maintenance information must be submitted for each individual type control valve specified herein. Refer to Section 01 78 23.33 OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS for the information to be submitted.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Control Valves; G, [_____].

SD-03 Product Data

Control Valves; G, [_____].

SD-06 Test Reports

Control Valves; .

SD-07 Certificates

Previous Air Force/Military Projects; G, [_____].

Qualified Engineers; G, [_____].

Field Assistance; G, [_____].

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____].

1.4 QUALITY ASSURANCE

1.4.1 Field Assistance

Provide the following:

a. Proof of experience on previous Air Force/Military projects.

b. Number of qualified engineers (factory trained)available to provide startup support.

c. Written assurance as to ability to respond to specified time for field assistance.

1.4.2 Training

The manufacturer must conduct two eight hour training classes for Liquid Fuels Maintenance Technicians which include valve overhaul procedures, pilot overhaul procedures, valve adjustments, and valve diagnostics. The manufacturer must provide a 100 mm 4-inch valve mock-up with various trim components (i.e., rate of flow, solenoid control, and speed control features) to be used during training. Video recording of training must be allowed or provided at the time of the class, and an attendance roster maintained by the Contractor. The 100 mm 4-inch valve mock-up must become the property of the Government and must be turned over to the Contracting Officer. Submit copies of the Operation and Maintenance Manuals for approval.

1.5 WARRANTY

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NOTE: Modify hours for projects outside the UNITED STATES.

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[For this section, Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts. SME for this project is [Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS)[[Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC)] [Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11)]]].]

If a problem attributable to the valve's manufacturer or installation arises after the initial system start-up has been accomplished, and after system final acceptance date, [48] [_____] hours from the time of notification that a problem exists is allowed to solve the problem. The problem must be solved to the satisfaction of the [Contracting Officer, the Base Civil Engineer and/or the SME] [Contracting Officer]. If the Contractor cannot effectuate a proper resolution to the problem as outlined above in the [48] [_____] hour period, provide a factory trained engineer from the manufacturer of the valve within [48] [_____] hours after the expiration of the Contractor's initial [48] [_____] hour period to effectuate a resolution of the problem above. All services provided by the valve manufacturer must be at no cost to the Government. When it has been determined by the Contractor, Contracting Officer, and the valve manufacturer's representative that the valve(s) cannot be repaired in its installed position in the fuel system, it must be replaced with a new valve and pilot assembly within [48][_____] hours after the initial 96-hour period listed above expires and at no cost to the Government.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

The type of materials which come in contact with the fuel, if not specified herein before, must be noncorrosive.

2.2 CONTROL VALVES

2.2.1 General

Control valves must be single-seated globe type, diaphragm actuated, hydraulically operated valves. Valves must consist of 3 major components:

the valve body, valve cover, and diaphragm assembly. The diaphragm assembly must be the only moving part. In the event of diaphragm failure, valve must fail closed against flow, unless otherwise indicated. The main valve must be drip-tight when closed. Each valve must have an external indicator to show the position of the valve disc at all times. Control valves must be shipped from the factory as a complete assembly with all pilot controls and pilot auxiliary piping properly installed on the main valve. Materials which come in contact with the fuel must be resistant to the effects of and not harmful to aircraft engine fuel and must be stainless steel, or electroless nickel plated cast steel unless noted otherwise. [High level shut-off valve bodies must be electroless nickel plated.] [Valves at exterior locations must be stainless steel. Open canopies are considered an exterior location.] Materials for control valves, and items to be mounted on the valves must be as follows:

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NOTE: Provide per SME direction.

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2.2.1.1 Bodies, Bonnets, and Covers

Bodies, bonnets, and covers must be constructed of one of the following materials:

a. Cast steel conforming to ASTM A216/A216M, Grade WCB internally plated with chromium, nickel or internally electroless nickel plated.

b. Cast stainless steel conforming to ASTM A743/A743M.

c. Cast steel conforming to ASTM A352/A352M Grade LCB internally plated with chromium, nickel, or internally electroless nickel plated.

d. Bodies must have flanged inlet and outlet connections. Valve must have a screwed bottom drain plug.

2.2.1.2 Valve Seats

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NOTE: Provide per SME direction.

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Valve seats must be stainless steel in accordance with ASTM A743/A743M. It must be possible to remove the valve seat while the valve is connected in the line. Valve seat and upper stem bearing must be removable and screwed in the body and/or cover. The lower stem bearing must be concentrically contained in the valve seat and must be exposed to flow on all sides. The diameter of the valve seat must be the same size as the inlet and/or outlet flanges of the main valve.

2.2.1.3 Valve Discs

Valve discs must contain a resilient, fluoroelastomer (FKM), commonly referred to as Viton disc conforming to SAE AMS 3216 having a rectangular cross section, contained on 3.5 sides by a disc retainer and a disc guide, forming a drip tight seal against the seat. The disc must be usable on either side. The disc guide must be the contoured type capable of holding disc firmly in place during high differential pressure conditions that may develop across the seating surface. The disc retainer must be capable of withstanding rapid closing shocks.

2.2.1.4 Diaphragm Assembly

Diaphragm Assembly must form a sealed chamber in the upper portion of the valve, separating the operating fluid from the line pressure. The diaphragm assembly must contain a valve stem which is fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. Valve body and cover must be sealed by the diaphragm. Valve stem must be stainless steel. The bearing material must be compatible with the fuel specified and must not contain zinc coated metals, brass, bronze, or other copper bearing alloys. The diaphragm must be of a nonwicking material or design, with a minimum of 2 layers of nylon fabric bonded with a minimum of 3 layers of synthetic rubber (valves 62 mm 2-1/2 inches and smaller one layer of nylon fabric). The edge area of the center hole for the valve stem must be sealed by vulcanization. Materials to be resistant to aromatics of up to 50 percent in accordance with ASTM D2000 (SAE J200). The diaphragm must have a MULLINS-burst rating according to ASTM D751 of a minimum of 4.14 MPa 600 psi per layer of nylon fabric. All diaphragm sizes must be cycle tested to a minimum of 100,000 cycles, by alternately applying pressure under the diaphragm (main valve pressure) and above the diaphragm (cover chamber pressure). That test must be certified by the manufacturer. The diaphragm must not be used as a seating surface. The diaphragm must be fully supported by the body and cover in either the open or closed position.

2.2.1.5 Bolts, Screws and Nuts

a. For Ductile Iron, and Cast Steel Body Valves.

    (1) Bolts and Screws, cadmium plated steel in accordance with SAE J429, Grade 5.

    (2) Nuts, cadmium plated steel in accordance with ASTM A194/A194M, Grade 2 H.

b. For Stainless Steel Body Valves. Bolts, Screws and Nuts, ASTM A320/A320M, Grade B8M C.1.1.

2.2.1.6 Pilot Control System and Auxiliary Piping

Pilot Control System and auxiliary piping must be stainless steel, seamless, fully annealed tubing conforming to ASTM A269/A269M, Grade TP316, Rockwell hardness B80 or less. Wall thickness for 13 mm 1/2-inch tubing to be 0.9 mm 0.035-inch. Threaded connections must be used in pilot system piping and unions must be o-ring type with FKM o-rings. Tubing connections must not be welded.

2.2.1.7 Pilot Valves

Pilot valves must have [stainless steel bodies conforming to ASTM A743/A743M] [aluminum bodies conforming to ASTM B26/B26M Type 356-T6 anodized in accordance with MIL-A-8625] with stainless steel internal working parts. Disc and diaphragm assemblies must be as specified herein before. The setting of adjustable type pressure operated pilot valves must be easily adjusted by means of a single adjusting screw. The adjusting screw must be protected by a threaded cap drilled to accommodate a lead-seal wire and a lock nut must be provided on the adjusting screw to lock it in position at the desired setting. The lead seal wire must be installed after final acceptance of the system. Spare wire seals and the "embossing" tool will be turned over to the Contracting Officer for the installation.

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NOTE: Per SME direction.

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2.2.1.8 Solenoids

Solenoids for operation of pilot valves must be housed in an explosion-proof case suitable for Class I, Division 1, Group D with maximum temperature rating of T3 (200 degrees C 392 degrees F), hazardous locations as defined in NFPA 70. Solenoids must be provided at voltage and frequency as shown on plans. A manual type operator or needle valve to bypass the solenoid valve must be provided for emergency manual operation.

2.2.2 Serviceability of Main Valve Internal Parts

Main valve movable parts including strainers, valve seat, stem bearings, and control system must be replaceable without removing the main valve from the line. All nonmetallic parts must be replaceable.

2.2.3 Total Lengths

The total valve length does not include the orifice plate flange (when used). If the control valve being supplied has the orifice plate built into its flange, the spacer provided must bring the valve face-to-face dimension equal to those listed below plus 2.2 mm 0.0875 inch. The lengths of the valves must be equal for the following materials: cast stainless steel, and cast steel.

SIZE mminches	VALVE LENGTH mminches
381-1/2	2168.5
502	2349.375
753	30512
1004	38115
1506	50020
2008	63525.4
25010	74529.8
30512	85034
35014	97539
40016	103441.375
Note: Tolerance must be ±0.75 mm0.03 inch for size 38 mm 1-1/2 inches through 200 mm 8 inches and ±1.5 mm0.06 inch for size 250 thru 400 mm 10 thru 16 inches.	

Control valves not meeting these face to face dimensions must be supplied with spacers suitable for the proper installation of the valve.

2.2.4 Flanges

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NOTE: Per SME direction.

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MATERIAL	SEALING SURFACE
Cast Steel, ASME B16.5 Class 150	Raised Face
Cast Stainless Steel, ASME B16.5	Raised Face Class 150
Ductile Iron, ASME B16.24 Class 150	Flat Face
Note: The mating flange must be made the same as above.	

2.2.5 Identification

2.2.5.1 Main Valve Body

The following must be cast into the main valve body:

a. Pressure Class
b. Size
c. Material
d. Foundry Heat Number and Identification
e. Manufacturer
f. Flow Pattern

2.2.5.2 Main Valve Cover

The following must be cast into the main valve cover:

a. Size
b. Material
c. Foundry Heat Number and Identification

2.2.5.3 Brass Name Plates

Brass name plates must be fastened to the valve. Body name plates must list the following:

a. Size
b. Model Number
c. Stock Number
d. Manufacturer/Supplier
e. Manufacturer's Inspection Stamp

2.2.5.4 Inlet Name Plate

Inlet name plate must list the following:

a. Size
b. "Inlet" Marking
c. Assembly Model Number
d. Part Number

2.2.5.5 Outlet Name Plate

Outlet name plate must list the "Outlet" Marking.

2.2.5.6 Pilot Valves

Pilot valves must be tag identified. The valve must have the field adjusted start up setting engraved on a plastic tag, white with black lettering.

2.3 INDIVIDUAL CONTROL VALVE OPERATIONAL REQUIREMENTS

Operation, performance, and special features of the individual control valves must be as specified herein.

2.3.1 High Liquid Level Shut-Off Valve (HLV-1 AND HLV-2)

2.3.1.1 Size

200 mm 8-inch

2.3.1.2 Flow

75 L/s 1200 GPM

2.3.1.3 Operation

High liquid level shut-off valve must be hydraulically operated and must be provided with a tank exterior mounted float. Activation point of the float for opening and closing the high liquid level shut-off valve must be as shown on the drawings. Upon a rise in fluid level to the float activation point, the float control system must cause the main valve to close tightly. The main valve must remain closed until a drop in tank fluid level occurs. Upon a drop in fluid level beneath the float activation point, the float control must cause the main valve to open completely.

2.3.1.4 Check Valve Feature

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NOTE: Delete for Cut and Cover Tanks.

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Valve must close rapidly when outlet pressure exceeds inlet pressure.

2.3.1.5 Manual Test Feature

Manual testing of high level shut-off valve and exterior mounted float's automatic opening and closing feature must be possible.

2.3.1.6 Strainer

A 40-mesh stainless steel wire, self-cleaning strainer must be provided in the pilot valve supply piping.

2.3.1.7 Pressure Sensitive Close Feature

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NOTE: Set the pressure to 10% over pump dead head

pressure.
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If the upstream pressure rises to 1 MPa 150 psi [____] or above while closing, the valve will stop closing or open slightly until the pressure is less than 1 MPa 150 psi [____].

[2.3.1.8 Minimum Differential Pressure Feature

The valve must be equipped with a minimum differential pressure pilot to maintain a differential pressure across the valve. Pressure must be adjustable with a range of 34 to 170 kPa 5 to 25 psi.

][2.3.1.9 Opening and Closing Feature

The valve must be equipped with an adjustable differential pressure pilot and a quick cover exhaust system to allow the valve to open in 3-4 seconds when pressure is greater than [____][207] kPa [____][30] psig.

][2.3.1.10 Solenoid Control

The valve must be provided with solenoid control. The solenoid must close the HLV upon high-high level alarm activation. The solenoid must be energized to close. .

]2.3.2 Non-Surge Check Valve (CV-1 THRU CV-7)

2.3.2.1 Size

150 mm 6-inch; 50 mm 2-inch for FTP-1 and Jockey Pump

2.3.2.2 Flow

[60][40]L/s [950][650]GPM; 13 L/s 50 GPM for FTP-1; 1.3 L/s 5 GPM for Jockey Pump.

2.3.2.3 Operation

Non-surge check valve must open slowly. Opening speed must be adjustable from two (2) to 30 seconds without affecting closing of valve. Factory set for 15 seconds. The nonsurge check valves must fail closed against reverse flow in check condition.

2.3.2.4 Quick closure

Valve closure to be rapid, closing quickly when outlet pressure exceeds inlet pressure.

2.3.2.5 Flow Control

Valve to limit flow to [60] [40] L/s [950] [650] GPM (CV-1 thru CV-5), 13 L/s 50 GPM (CV-6 and CV-7). Sensing must be by orifice. Valve to modulate to limit flow without hunting. Rate of flow to be manually adjustable and utilize a downstream orifice plate holder.

2.3.2.6 Strainer

A 40-mesh, stainless steel wire, self-cleaning strainer must be provided in the pilot valve supply piping.

2.3.2.7 Emergency Shut-off Operation

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NOTE: To be added only to the pumps on Cut and Cover Tanks.

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Open/closed valve, solenoid operated (CV-1 thru CV-5). Closure must be accomplished within 10 seconds upon power failure or activation of an emergency-stop pushbutton.

2.3.3 Non-Surge Check/Air Block Valve (AB/CV-1 THRU AB/CV-[ ])

2.3.3.1 Size

100 mm 4 inch and 50 mm 2 inch

2.3.3.2 Flow

0-[21.4][38.5]L/s 0-[310][610]GPM and 9.5 L/s for 50 mm 150 gpm for 2 inch.

2.3.3.3 Operation

Backpressure control pilots will cause main valve to modulate to maintain constant inlet pressure. There must be 3 backpressure control pilots, A, B, and C. Pilot A must be solenoid enabled and set at pressure which corresponds with unloading pump flow rate of 38 L/s 600 GPM. Pilot B must be solenoid enabled and set at pressure which corresponds with unloading pump flow rate of 19 L/s 300 GPM. Pilot C must be set at pressure corresponding with unloading pump flow rate of 10 L/sec 150 GPM through the secondary control valve. All pilots are to have 125-1250 kPa 20-200 PSIG range.

2.3.3.4 Speed Control

Valve must open slowly. Opening speed must be adjustable from two (2) to 30 seconds without affecting closing of valve. Factory set for 15 seconds. The valves must fail closed against reverse flow in check condition.

2.3.3.5 Check Feature

Valve closure to be rapid, closing quickly when outlet pressure exceeds inlet pressure.

2.3.3.6 Solenoid Control

Solenoid control of valve must be as indicated on the drawings.

2.3.3.7 Strainer

A 40-mesh, stainless steel wire, self-cleaning strainer must be provided in the pilot valve supply piping.

2.3.4 Filter Separator Control Valve (FSCV-1 Thru FSCV-7)

2.3.4.1 Size

150 mm 6-inch

2.3.4.2 Flow

[56] [36] L/s [900] [600] GPM

2.3.4.3 Operation

Filter Separator Control Valve must limit flow to [56] [36] L/s [900] [600] GPM. Controlling to be by orifice. Rate of flow to be manually adjustable and utilize a downstream orifice plate holder.

2.3.4.4 Check Valve Feature

Valve must close rapidly when outlet pressure exceeds inlet pressure.

2.3.4.5 Water Slug Shut-Off

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NOTE: Do a hydraulic analysis on the transfer line to see if the water slug shut-off should be deleted from the receipt filter separators.

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Valve must close rapidly when water is sensed at filter separator sump high level as indicated by Float Control Valve float position. Manual testing of operation must be possible.

[2.3.4.6 Shut-Off Feature at Maximum Differential Pressure

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NOTE: Coordinate selection of this feature with the SME. For use on long transfer lines.

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Valve must close rapidly when differential control pilot increases to preset point. Resetting of the differential control pilot must be manually reset after each shutoff.

]2.3.4.7 Emergency Shut-off Operation

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NOTE: Delete from this location for Cut and Cover Tanks.

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Open/closed valve, solenoid operated. Closure must be accomplished within 10 seconds upon power failure or activation of an emergency-stop pushbutton.

2.3.4.8 Solenoid Control

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NOTE: Per SME direction. Function can also be done via a manual valve.

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Solenoid control must be as indicated on the drawings.

2.3.4.9 Minimum Differential Pressure Feature

Valve must be equipped with a minimum differential pressure pilot to maintain a differential pressure across the valve. Pressure must be adjustable with a range of 34 to 170 kPa 5 to 25 psi.

2.3.5 Filter Separator Float Control Valve and Tester (FC-1 THRU FC-7)

2.3.5.1 Operation

Float must ride on the fuel-water interface inside filter separator sump. Activation must initiate water slug shutoff of filter separator valve.

2.3.5.2 Float Control Pilot and Tester

The filter separator housing sump must be fitted with a float control pilot valve assembly made of stainless steel. The pilot valve is connected to the filter separator control valve. An integral float control tester must provide a means to remove a portion of the float ball ballast allowing the float to rise, verifying operation of the water slug and flow control valve, and the integrity of the float ball.

2.3.6 Back Pressure Control Valve (BPCV-1)

2.3.6.1 Size

150 mm 6-inch

2.3.6.2 Flow

0-[151] [170] L/s0-[2400][2700] GPM

2.3.6.3 Operation

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NOTE: To be determined by system hydraulics. For the Type IV System, pantograph is required, inlet pressure will vary based on manufacturer, size, and number of legs.

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Back pressure control valve must modulate to maintain constant inlet pressure. Set-point must be adjustable with a range of 1.3 to 13 MPa 20 to 200 psig. Factory set at [860] [550] [_____] kPa [130] [80] [_____] psig, and 1.1 MPa 160 psig. Valve must fail in the open position.

2.3.6.4 Check Valve Feature

Valve must close rapidly when outlet pressure exceeds inlet pressure.

2.3.6.5 Solenoid Control

The valve must be provided with 2 solenoid controls and must operate as indicated on the drawings.

2.3.6.6 Speed Control

Valve must close slowly without affecting the opening speed and must be factory set for 8 seconds. Closing time must be adjustable with a range of 2 to 30 seconds. Valve opening time must be 1.0 second maximum.

[2.3.6.7 Opening Feature

The valve must be equipped with cover quick exhaust system to allow the valve to open in 3-4 seconds when pressure is greater than [_____] [1.1] MPa [_____] [170] psig.

]2.3.7 Pressure Control Valve (PCV-1)

2.3.7.1 Size

50 mm 2-inch.

2.3.7.2 Flow

3 L/s 50 GPM under normal operating conditions.

2.3.7.3 Operation

Pressure control valve must modulate to control inlet pressure and must have adjustable set-point with a range[s] of 0.13 to 1.3 MPa 20 to 200 psig. Factory set at 500 kPa 75 psig[, and 667 kPa 50 psig].

2.3.7.4 Check Valve Feature

Valve must close rapidly when outlet pressure exceeds inlet pressure.

2.3.7.5 Solenoid Control

The valve must be provided with 2 solenoid controls and must operate as indicated on drawings.

2.3.7.6 Speed Control

Provide separate opening and closing speed controls each adjustable between 1 and 30 seconds. Factory set at 3 seconds for opening speed and 1 second for closing speed.

2.3.8 Defuel/Flush Valve (D/FV-1)

2.3.8.1 Size

203 mm 8-inch.

2.3.8.2 Flow

19 to [151] [170] L/s 300 to [2400] [2700] GPM.

2.3.8.3 Operation

Valve must modulate to control inlet pressure and must have adjustable set-point with a range of 0.125 to 1.25 MPa 20 to 200 psig. Factory set at 550 kPa 80 psig.

2.3.8.4 Check Valve Feature

Valve must close rapidly when outlet pressure exceeds inlet pressure.

2.3.8.5 Solenoid Control

The valve must be provided with 2 solenoid controls and must operate as indicated on drawings.

2.3.8.6 Speed Control

Valve must open slowly without affecting the closing speed and must be factory set for 3 seconds. Opening time to be adjustable with a range of 2 to 30 seconds.

2.3.9 Hydrant Control Valve (HCV)

2.3.9.1 Size

100 mm 4 inch

2.3.9.2 Flow

38 L/s 600 GPM.

2.3.9.3 Operation

Hydrant control valve must modulate, by use of a liquid sensing line from [pantograph] [refueler] venturi, and regulate at a maximum pressure at the skin of the aircraft of 330 kPa 45 psig at any flow rate from 3 to 38 L/s 50 to 600 GPM. Pressure to be adjustable with a range of 103 to 515 kPa 15 to 75 psi. Valve, adapter and 90-degree hydrant coupler pressure drop must not exceed 7 MPa at 38 L/s 9 psi at 600 GPM with the valve fully open.

2.3.9.4 Quick Closure

Valve must close rapidly when outlet pressure exceeds control set-point. Valve must limit the surge pressure on the aircraft to a maximum of 800 kPa 120 psig when fueling at 38 L/s 600 GPM with an aircraft tank valve closure of 0.5 second. The valve must reopen when the outlet pressure drops below the set-point of the pilot if the deadman control lever is still depressed.

2.3.9.5 Deadman Control

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NOTE: Select deadman control option, hydraulic for pantograph, pneumatic for refueler trucks. Verify type of deadman control to select with the SME.

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Deadman must be [hydraulically] [pneumatically] connected to the pilot system of main valve. Valve must open when deadman control lever is pressed and must close valve when the lever is released to bleed air from the hydrant hose truck. On rupture of the deadman hose between outlet of deadman control and main valve pilot system, there must be no fuel leakage. Main valve must close in 5 seconds maximum when deadman is released or when one of the deadman hose couplers is disconnected.

2.3.9.6 Defuel

Valve must be capable of reverse flow at the rate of 19 L/s 300 GPM at 1.1 MPa 165 psig. Valve must be capable of defueling regardless of nozzle pressure created by the R-12.

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2.3.9.7 Speed Control

Valve must open slowly without affecting the closure rate. Provide adjustable speed control with a range of 2 to 30 seconds.

2.3.9.8 Thermal Relief

Valve to open for pressure equalization and return flow when downstream pressure exceeds upstream pressure.

2.3.9.9 Adapter

Valves must be provided with type adapter as indicated on drawings. Adapter must have pressure equalizing feature and have a vacuum tight dust cap.

2.3.9.10 Strainer

A 40-mesh stainless steel wire, self-cleaning strainer must be provided in the pilot valve supply piping.

[2.3.9.11 Minimum Differential Pressure Feature

The valve must be equipped with a minimum differential pressure pilot to maintain a differential pressure across the valve. Pressure must be adjustable with a range of 34 to 170 kPa 5 psi to 25 psi.

][2.3.9.12 Contaminant Analyzer

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NOTE: The use of contaminant analyzers must be only when approved by Service Headquarter.

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The contaminant analyzer must use laser sensing technology to detect contaminants in the fuel. The complete contaminant analyzer component (including valve) must be in compliance with EI 1570 and EI 1598.

A. Sensor

1. Sensor must sense the presence of free water and solid particles entrained in fuel by sensing a change in electrical properties or light scatter patterns. No chemical means must be allowed. No use of consumables must be allowed.

2. Sensor must be capable of quantifying the concentration of contamination with the fuel. Contamination is defined as solid particles and undissolved or free water.

3. Sensor must differentiate between free water and solids. Sensor must quantify amount of each type of contamination within the fuel supply.

a. Sensor must be able to detect a high water "slug" defined as a free water measurement between 0 and 20 parts per million (ppm) (volume/volume) and have an accuracy of +/- 2 ppm or less; +/- 10% error or less. Factory set at 10 ppm.

b. Sensor must be able to provide solids measurement between 0.0 and 2.0 milligrams per liter, mg/L (ppm weight/volume is also acceptable), and have an accuracy of +/- 10% error or less. Factory setting based on end customer established issue requirements. Unless otherwise specified by customer, for US Army, 1.0 mg/L, for US Navy, 2.0 mg/L, and for US Air Force, 0.5 mg/L.

c. Sensor must be able to sense free water and solids independently and simultaneously to the accuracy stated in a and b.

4. Sensor must be able to start automatically on the initiation of fueling and once the fueling is over sensor must automatically shut off.

5. Sensor must sense high water "slug" and give an alarm output within 3 seconds of the event.

6. Sensor must recover from 50% water slug event within 30 minutes of clean fuel flow and 5 minutes for a high water "slug". Sensor must be able to recover automatically. Removal from piping must not be allowed. Fuel is defined as clean fuel when the water and solid measurements are below the thresholds listed in A.3.a an A.3.b

7. Calibration report must be included with sensor and must include detailed calibration method description.

B. Mechanical/Design

1. Sensor must use the full flow of product; i.e. sensor must be full flow, no sample lines must be allowed.

2. Sensor must be able to operate on rated flow of the system, and provide less than 5 psi loss of pressure at rated flow.

3. Valve and sensor must have a design pressure of 275 psi (gauge) or higher, an operation pressure of -1.5 psi to 200 psi pressure and a proof (test) pressure in excess of 415 psi.

4. Power to the system must be in the form of Alternating Current (AC). AC voltage requirements: 110-240 VAC, 50/60Hz; 40 Watt maximum power draw.

a. Sensor must be designed for and constructed to standards for operation in hazardous locations, minimum of Class 1, Division 2, per NFPA 497.

C. Output

1. Sensor must output a digital data stream that can be imported to a data acquisition system. Analog signals must not be allowed.

2. Sensor must be able to send data signals over long distances (greater than 50 feet,) which may be accomplished by data signal

conversion.

D. Controls

1. A three position switch with the following functions must be provided: Bypass, Alarm, Alarm and Closure.

2. Bypass position must allow the alarm and closure to be deactivated and continue with fueling, completely disregarding the quality alerts being given.

a. In the event that the alarm system is bypassed, fuel quality information must continue to be collected. The bypass of the sensor may not be by powering down, or turning off the sensor.

3. Alarm position must sound an alarm and illuminate a red light upon detection of contamination.

4. Alarm and Closure position must perform the alarm functions and close the valve upon detection of contamination.

5. Alarm thresholds must be field adjustable.

6. Alarm system must be set up in a ‘Fail Safe’ manner so that in the event of

a. Incorrect or impaired functioning of the equipment, caused by reduction in supply voltage, or by any other means, the equipment must go into alarm and provide an alert to its condition

b. Loss of power, the equipment must go into closure position and when the power is restored, the equipment must go into the alarm condition.

7. A green light must be illuminated when the system is on and operational.

E. Valve Configuration

1. Sensors meeting the above requirements must be configured as a part of the control valve.

2. Sensing must be initiated by the opening of the control valve.

3. Sensor power down sequence must be initiated by closure of control valve.

4. Sensor must be capable of affecting the alarm shutdown condition directly on the control valve, stopping flow of fuel at the sensing location.

a. Sensor must retain ability to have an alarm override, and allow normal function of the control valve in event the sensor is impaired.

F. Modular User Readout - Sensor must interface to a modular user readout with the following features:

1. User readout consisting of a backlit LCD display indicating free water content in PPM and particulate solids in mg/L.

2. A visual alarm indicator lamp viewable from 50 feet.

3. A key operated by-pass switch.

4. Data logging feature to capture historical data on a flash memory card.

5. A real-time RS-232 data port for connection to a laptop computer equipped with compatible software.

6. A real time PC-based graphical user interface for data capture and viewing.

]2.3.10 Overfill Valve for Product Recovery Tank (OV-1)

2.3.10.1 Size

50 mm 2-inch.

2.3.10.2 Capacity

3 L/s50 GPM.

2.3.10.3 Operation

Hydraulically operated overfill valve must close automatically upon rising to Product Recovery Tank 95 percent fill level. Valve must open automatically upon falling below level as indicated on the drawings.

2.3.10.4 Control Float

Automatic opening and closing of the valve must be initiated by a control float located within the Product Recovery Tank. Control float must be provided with a manual tester, mounted external to the tank, for testing of overfill valve operation.

2.3.10.5 Pressure Reservoir

Valve must be provided with a pressure reservoir to supply required hydraulic pressure for operation. Reservoir pressure to be supplied by Fuel Transfer Pump (FTP-1)using 13 mm 0.5-inch tubing connected upstream of the pump non-surge check valve. Valve must close upon loss of reservoir pressure. Reservoir must be a 4 L 1 gal capacity bladder-type tank, carbon steel constructed, tested and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 800 kPa 125 psi and precharged with air of 80-100 kPa 13-15 psig. The tank will be epoxy lined. The tank will be fitted with an air charging valve and pressure gauge.

2.3.10.6 Thermal Relief

Overfill valve must be provided with a pressure sustaining control valve that must automatically, upon inlet pressure rising to 1.3 MPa 200 psig, open allowing thermal relief around overfill valve. Pressure sustaining valve must automatically close upon inlet pressure dropping below 1.3 MPa 200 psig.

2.3.10.7 Limit Switch

Limit switch must be single pole, single throw contract (SPST) and provided with valve for remote indication of valve open or closed position. Valve closed position will become an alarm condition at the pump control panel (PCP).

2.3.10.8 Strainer

Pressure reservoir inlet line must be provided with a shut-off valve, strainer and check valve.

2.3.11 Truck Fill Stand Control Valve (TFV)

2.3.11.1 Size

100 mm 4-inch.

2.3.11.2 Flow

33 L/s525 GPM.

2.3.11.3 Operation

Valve must modulate to regulate downstream pressure to 200 kPa 35 psig at a flow rate of 3 to 33 L/s 50 to 525 GPM. Pressure must be adjustable with a range of 100 to 518 kPa 15 TO 75 psi. Valve solenoid must be connected to the overfill protection system.

2.3.11.4 Quick Closure

Valve must close rapidly when outlet pressure exceeds control set-point. Valve must limit the surge pressure on the bottom loader of a tank truck to a maximum of 585 kPa 85 psig when filling at 38 L/s 600 GPM with a tank truck valve closure of 0.5 second. The valve must reopen when the outlet pressure drops below the set-point of the pilot if the deadman control lever is still depressed.

2.3.11.5 Opening Speed Control

Valve must control the opening speed of the main valve. The control must be adjustable with a range of 2 to 30 seconds. Factory set at 10 seconds.

2.3.11.6 Deadman Control

Deadman must be hydraulically [electronically (Navy Ships)] connected to the pilot system of the main valve. Valve must open when deadman control lever is pressed and must close the valve when the lever is released. On rupture of the deadman hose between outlet of deadman control and main valve pilot system, there must be no fuel leakage. Main valve must close in 2 seconds maximum when one of the deadman hose couplers is disconnected. Length of hose must be 4.6 m 15 feet.

2.3.11.7 Thermal Relief

Valve to open for pressure equalization and return flow when downstream pressure exceeds upstream pressure.

2.3.11.8 Strainer

A 40-mesh stainless steel wire, self-cleaning strainer must be provided in the pilot valve supply piping.

2.3.11.9 Solenoid Control

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NOTE: For use with ground proving system.

****

Solenoid control of valve must operate as indicated on drawings.

2.3.12 Pantograph Control Valve (PTCV)

****

NOTE: Select use of pantograph control valve per SMEdirection.

****

2.3.12.1 Size

100 mm4-inch.

2.3.12.2 Flow

38 L/s 600 GPM.

2.3.12.3 Operation

Valve must modulate, by use of a liquid sensing line from the pantograph venturi, and regulate downstream to 379 kPa 55 psig at a flow rate of 3.8 to 38 L/s 50 to 600 GPM. Pressure must be adjustable with a range of 103 to 517 kPa 15 to 75 psi.

2.3.12.4 Opening Speed Control

Valve must control the opening speed of the main valve. The control must be adjustable with a range of 2 to 30 seconds. Factory set at 10 seconds.

[2.3.12.5 Thermal Relief

****

NOTE: For use Type IV Aircraft direct Fueling stations.

****

Valve to open for pressure equalization and return flow when downstream pressure exceeds upstream pressure.

][2.3.12.6 Strainer

A 40-mesh stainless steel wire, self-cleaning strainer must be provided in the pilot valve supply piping.

]2.3.12.7 Minimum Differential Pressure Feature

The valve must be equipped with a minimum differential pressure pilot to maintain a differential pressure across the valve. Pressure must be adjustable with a range of 34 to 170 kPa 5 to 25 psi.

2.3.13 Flushing Valve (FV-1)

2.3.13.1 Size

150 mm6-inch.

2.3.13.2 Flow

0-91 L/s0-1200 GPM.

2.3.13.3 Operation

Valve must open and close by means of hydraulic line pressure.

2.3.13.4 Solenoid Control

Solenoid control of valve must operate as indicated on drawings.

2.3.14 Pantograph Pressure Control Valve (PPCV-1 thru PPCV-[ ])

****

NOTE: Quantity based on number of Aircraft direct Fueling stations. One per station.

****

2.3.14.1 Size

38 mm1-1/2-inch.

2.3.14.2 Operation

Valve must open and close by means of hydraulic line pressure. Initial setting must be 517 kPa 75 PSIG and must be field adjustable between 345-690 kPa 50-100 PSIG. Final field pressure setting of valve must be equal to 10 percent above recorded line pressure at 45 L/s 600 GPM flow rate.

2.3.14.3 Check Valve Feature

Valve must close rapidly when outlet pressure exceeds inlet pressure.

PART 3 EXECUTION

3.1 VALVE TESTING AND START-UP SUPPORT

Provide the services of a factory trained and certified service engineer authorized/sanctioned/certified by the valve manufacturer to verify that each valve has been properly installed and to verify valves were factory operationally tested, adjusted and set per these specifications. The service engineer must assist the Contractor in the valve start-up adjustment process and will remain on site until all control valves function as required by the contract documents.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 52 43.23 (August 2018)**
Change 1 - 02/21

Preparing Activity: USACE **Superseding**
UFGS-33 52 43.23 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

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USACE / NAVFAC / AFCEC **UFGS-33 52 43.23 (August 2018)**
Change 1 - 02/21

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SECTION 33 52 43.23

AVIATION FUEL PUMPS

08/18, CHG 1: 02/21

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NOTE: This guide specification covers the requirements for refueling pumps used in aircraft refueling systems constructed to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards**.**

Subject Matter Expert (SME) must be defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 7	(1995; Stabilized (S) 2013) Shaft and Housing Fits for Metric Radial Ball and Roller Bearings (Except Tapered Roller Bearings) Conforming to Basic Boundary Plan

AMERICAN PETROLEUM INSTITUTE (API)

API STD 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries
API STD 682	(2014) Pumps Shaft Sealing Systems For Centrifugal and Rotary Pumps

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A487/A487M	(2024) Standard Specification for Steel Castings Suitable for Pressure Service
ASTM A582/A582M	(2022) Standard Specification for Free-Machining Stainless Steel Bars
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM C827/C827M	(2023) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

HYDRAULIC INSTITUTE (HI)

HI M100	(2009) HI Pump Standards Set

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for
MIL-PRF-4556	(1998; Rev F; Am 1 1999; CANC Notice 1 2011) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks

1.2 ADMINISTRATIVE REQUIREMENTS

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NOTE: Add number of days below. For COE Projects, include in MOU specific AIR FORCE REPRESENTATIVES to be notified when factory test dates are submitted by the CONTRACTING OFFICER.

****

Design conditions must be as specified in Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT.

a. Tests: Hydrostatic, performance, vibration, and NPSH tests must be conducted at the factory on each pump in accord with API 610. Test each pump with the actual motor which will drive the pump in the field, unless the water test media will cause overload of the motor. If so, provide vibration test report for motor separately. Vertical turbine pump vibration test must be run with field driver. All tests will be observed by the Contracting Officer or the designated representative. Provide the Contracting Officer 30 [_____] days notice prior to performance of factory tests in order to schedule observing such tests. Remote access via web cam must be made available. Performance testing must not occur prior to acceptance of shop drawing submittal.

b. Test reports must bear the serial number of both pump and driver. Submit manufacturer's certified reports of hydrostatic, performance, and NPSH tests. Submit manufacturer's certified test curves..

c. Operation and Maintenance Manuals must be submitted for the pumps and appurtenance specified herein. Refer to Section 01 78 23.33OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS for the information to be submitted.

d. Motors, manual or automatic motor control equipment, except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Motors must be high efficiency type and in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fueling Pumps (FP-1 through FP-5); G, [_____].

Offload Pumps; G, [_____].

Fuel Transfer Pump; G, [_____].

Water Draw-Off Pump; G, [_____].

SD-03 Product Data

Fueling Pumps (FP-1 through FP-5); G, [_____].

Offload Pumps; G, [_____].

Fuel Transfer Pump; G, [_____].

Water Draw-off Pump; G, [_____].

SD-06 Test Reports

Certified Test Curves

SD-07 Certificates

Fueling Pumps (FP-1 through FP-5); G, [_____].

Offload Pumps; G, [_____].

Fuel Transfer Pump; G, [_____].

Water Draw-off Pump; G, [_____].

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____].

PART 2 PRODUCTS

2.1 FUELING PUMPS (FP-1 through FP-5)

2.1.1 Capacity

****

NOTE: Insert site specific pump requirements.

****

Capacity must be 45 L/s 600 gpm against a total head of [_____] m feet when driven at 3600 rpm. Overall efficiency at design conditions of pump and driver, connected, must be minimum of [_____] percent. Pump head capacity must be continually rising and must be free of dips and valleys from design point to shut-off head. Pump shut-off head must have a 10 to 20 percent head rise to shut off. Pump must be capable of at least a 10 percent head increase at rated conditions by installing a new impeller. Pumps must not overheat or be damaged in any way while operating continuously at a minimum flow condition of 11 L/s 150 gpm and continuously at a maximum flow condition of 125 percent required capacity. The unit will also be required to operate at a flow of 12.5 percent required capacity GPM without exceeding the vibration limits given in API STD 610 at that flow rate. These pumps are for parallel operation and must have equal head at minimum continuous stable flow, plus or minus 2 percent.

2.1.2 General Requirements

a. The pumps must meet the requirements of API STD 610, latest edition. Whenever the information contained herein conflicts with said standard, the information herein must govern. The pumps must run at a nominal 3600 rpm and must be single stage centrifugals, horizontally mounted, vertical or radial split case, enclosed impeller, with end suction and top vertical discharge. Pumps must be of the back pull-out design to permit removing case half from rear for access to internal parts without disturbing the suction or discharge piping or the driver. All parts must be factory inspected so that parts are interchangeable. Pumps and motors must be furnished as complete units as herein specified. Pump assembly must be statically and dynamically balanced for all flow rates from minimum flow to 120 percent of design flow.

b. The pump must require no more than 5.5 m 18-feet of net positive suction head (NPSHR) when it is operated with water at a capacity of 45 L/s 600 gpm at rated head and speed. A hydrocarbon reduction or correction factor must not be used. Pump suction specific speed must be less than 12,000.

c. The pump must be horizontal, single stage, single suction with double volute construction to assure radial balance. It must be designed to permit removal of the impeller, shaft, bearings and bearing housing as an assembly, without disconnecting the suction or discharge piping.

d. The pump case must be end suction, centerline discharge type for ease of piping alignment. Flange ratings must be class 105 kg 300-pound per ASME B16.5. The case must be designed for maximum discharge pressure at pumping temperature but not less than 3.8 MPa 550 psig, with a minimum corrosion allowance of 3 mm 1/8-inch. The suction and discharge flanges as well as the cover bolting surfaces must be backfaced or spotfaced for positive bolt seating. The radial case to cover split must be a metal-to-metal fit with a confined, controlled compression gasket.

e. The pump cover must contain a stuffing box designed to accept an unbalanced mechanical seal. The stuffing box must have a minimum of 75 mm 3-inch studs for seal gland bolting. The gasket fit for seal gland to stuffing box must be of the controlled compression type with metal-to-metal joint contact.

f. Both case and cover are to be fitted with renewable wear rings.

g. The impeller must be of the enclosed type, dynamically and hydraulically balanced. It must be key driven, held in place by a positive lock, threaded against rotation. The running clearance between the impeller and case-cover wear rings must be as required by API STD 610.

h. Mechanical Seal: A single unbalanced mechanical seal per API STD 610 code USTHN, unbalanced single seal with throttle bushing seal gland, a nitrile seal-ring-to-sleeve gasket and carbon against silicon carbide faces, of multiple spring design must be supplied. The seal gland must be tapped for three connections and each must be stamped for identification as follows: Q for quench; F for flush; and D for drain. A non-sparking throttle bushing pressed into the seal end plate against an outside shoulder must be provided to minimize leakage on complete seal failure.

i. Bearing Housing: Oil lubricated anti-friction, radial and thrust bearings of standard design must be supplied. The bearings must be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Bearings must be retained on the shaft and fitted into housings in accordance with ABMA 7. Locking of the ball thrust bearing to the shaft must be by series W tank type washer. Minimum spacing between bearing centerlines must be 162 mm 6.5-inches.

j. A sight glass for checking oil level with a permanent indication of proper oil level must be supplied.

k. Bearing housings must be equipped with labyrinth type end seals and deflectors where the shaft passes through the housing; lip-type seals must not be used. Deflectors must be made of non-sparking material. The deflector design must effectively retain oil in the housing and prevent entry of foreign material into the housing.

l. Shafts must be of ample size to transmit the maximum torque required under specified operating conditions, and to withstand continuously all stresses resulting from supported weights, thrusts and starting, including across-the-line motor starting. It must be key seated to provide positive drive for the coupling, shaft sleeve and impeller. The shaft stiffness factor must be under[70 for Type III][88 for Cut and Cover]. The radial bearing centerline to impeller centerline, distance and the pump shaft diameter under the sleeve must be provided to calculate the factor.

m. A spacer coupling must be supplied. The spacer length must permit the removal of the assembled pullout element without disturbing the driver or the suction and discharge piping. Couplings must be properly keyed in place. Cylindrical fits must be light enough to permit easy removal of the hub in the field without the need for heating. A service factor of at least 1.5 must be used in selecting couplings based on manufacturer's ratings.

n. Removable coupling guards of the non-sparking type must be supplied. They must comply with the requirements of OSHA.

o. Total indicated shaft runout at coupling end must be 0.025 mm 0.001-inches or less. Total shaft deflection must be no more than 0.050 mm 0.002-inches at face of stuffing box.

p. Baseplate: The baseplate must be of fabricated steel construction. It must be of the drain pan style, sloping from back to front. Connections for a drain must be tapped (25 mm (1-inch minimum) at the pump end and located to accomplish complete drainage. A sufficient number of grout holes of at least 125 mm 5-inches minimum diameter must be supplied and must have 13 mm 1/2-inch minimum raised lip edge. Pump pedestals must be trapezoidal in design.

q. Materials: No zinc, brass, bronze or other copper bearing alloy must come in contact with the fuel. Materials must be material class C-6, unless otherwise noted.

r. The case and cover must be constructed of stainless steel ASTM A487/A487M GR CF8M or ASTM A487/A487M GR CA6NM.

s. Impeller material must be stainless steel ASTM A487/A487M GR CF8M or ASTM A743/A743M CA 6NM or CA 15.

t. Wear rings must be stainless steel ASTM A182/A182M GR F6 or ASTM A276/A276M TP410 or 416.

u. Shaft must be stainless steel ASTM A276/A276M type 410 or 416 or ASTM A582/A582M Type 410 or 416 or ASTM A743/A743M CA15 HT-403.

v. Testing: All shop testing must be performed in accordance with the API STD 610.

2.1.3 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the pump, must be furnished in addition to the identification nameplate. The pump service nameplate must be stamped with the following information:

Manufacturer's name

Serial number of pump
Capacity, L/sgpm
Pumping head, mft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.1.4 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel must be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 6 mm 1/4-inch high must bear the equipment number as shown on the drawings.

2.1.5 Exterior Primer Coat

Exterior surfaces of the baseplate must be primed by the manufacturer. Coating must be applied meeting requirements of SSPC PA 1. Surface cleaning must meet requirements of SSPC SP 10/NACE No. 2. Metal primer must be zinc rich paint conforming to specification MIL-DTL-24441, Type 1, Class 3. Dry film thickness must be 0.05 to 0.10 mm 2 to 4 mils.

2.1.6 Exterior Topcoat

Manufacturer's standard exterior topcoat must be applied at factory to the base plate.

2.1.7 Motors

a. Motor must be furnished by the pump manufacturer and must be non-overloading with 10 percent head increase, and suitable for the environment and operating conditions to which it will be subjected. The motors unity service factor may be used to conform to the non-overloading through-out the curve requirement for the 10% head increase condition only. Select the lowest horsepower for the motors that will meet the non-overloading requirement and co-ordinate the MCC if different than shown. Motors for vertical turbine pumps must be provided with anti-reversing ratchet. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor must be UL listed for use in Class 1, Division 1, Group D hazardous areas, and must have a maximum temperature rating of T2D (218 degrees C 419 degrees F) as defined by NFPA 70. The motor nameplate must include the temperature rating of the motor and locked-rotor indicating code letters in accordance with NFPA 70, Table 430-7(b).

b. Voltage rating must be 460 volts, 3 phase, 60HZ. Motor nominal speed must match pump. Motors must be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10 percent above or below rated voltage.

c. Pump manufacturer must assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve. In addition to having sufficient horsepower-output rating at rated speed, motor must have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of 10 starts per hour. Attention is specifically directed to the fact that thermal characteristics of motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors must conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to variation, service factors above unity must not be applied in sizing motor.

d. Motor must be squirrel-cage induction type. Motor must be NEMA Design B (normal-torque, low starting current).

e. Motor insulation must be non-hydroscopic, NEMA Class H, 180 degrees C 82 degrees F for motors over 7.5 kW 10 hp and NEMA Class F, 150 degrees C 302 degrees F for 7.5 kW 10 hp and smaller. Stator windings must be epoxy impregnated. The impregnations must be applied by the vacuum and pressure process.

f. Winding temperature rise, (based on a maximum ambient temperature of 40 degrees C 104 degrees F at 1006 m 3300-feet altitude) must not exceed 80 degrees C 176 degrees F.

g. Bearings must be ABMA minimum L10 life of 60,000 hours or L50 life of 300,000 hours suitable for the size, type, and application when the pump is operating at the specified flow and head.

h. Motor enclosures must be totally enclosed, weather sealed, fan cooled, explosion-proof and must be listed and labeled for Class 1, Group D areas. Provide bronze ground bolt on motor enclosure. All motor external electrical connections must be terminated within a single terminal housing.

i. The dynamic balance, overspeed withstand capability, and sound power levels of the motor must conform with NEMA standard requirements.

j. The pump manufacturer must furnish the Contracting Officer with the recommended minimum run time for the motor.

k. Pump motor must be provided with temperature limiting thermostats within the motor frame when required to meet Class 1, Group D requirements.

l. Pump motor must be furnished with lifting lugs on the motor casing.

m. Unless indicated otherwise, motors for conventional applications over 15 horsepower must be the premium efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors, motors specified as part of energy efficient equipment, wound rotor motors, or any application involving special construction or performance. Guaranteed minimum full load efficiencies must be (based on 3600, 2 pole, totally enclosed):

n.

15 kW20 hp	92.0 percent	56 kW75 hp	95.5 percent
19 kW25 hp	92.0 percent	75 kW100 hp	93.5 percent

22 kW30 hp	92.0 percent	93 kW125 hp	94.5 percent
30 kW40 hp	92.0 percent	112 kW150 hp	94.5 percent
37 kW50 hp	92.5 percent	149 kW200 hp	94.5 percent
45 kW60 hp	92.5 percent	447 kW600 hp	94.5 percent

o. Other motors of different speed or housing classification must also be of the premium efficient type, as advertised by the motor manufacturer, with efficiency greater than the standard line. Motor efficiencies must have been verified in accordance with NEMA MG 1, 12.53.a., and determined using the dynamometer method as described in IEEE 112, Method B. All shop drawing submittals on motor driven equipment must include the motor efficiency.

2.2 FUELING PUMP (VERTICAL TURBINE) (FP)

2.2.1 Capacity

****

NOTE: Insert site specific pump requirements.

****

Capacity must be [45][68] L/s [600][900] gpm against a total head of [_____] m feet for the Fueling Pump, when driven at 1800 rpm. Overall efficiency at design conditions of pump and driver, connected, must be minimum [_____] percent. Pump head capacity must be continually rising and must be free of dips and valleys from design point to shut-off head. Pump must be capable of at least 5 percent head increase at rated conditions by installing a new impeller.

2.2.2 Assembly

The pump for this service must meet the requirements of API STD 610, latest edition, seventh edition for vibration. Wherever the information contained herein conflicts with said standard, the information herein must govern. The pump for this service must run at a nominal 1800 rpm and must be a multi-stage, vertical turbine pump. Pump and motor must be furnished as a complete unit as herein specified. Pump assembly must be statically and dynamically balanced for all flow rates from minimum flow to 120 percent of design flow. Flanged column, shaft, and bearing spacing must not exceed 1.5 m 5-foot sections to facilitate pump disassembly within pump room.

2.2.3 Materials

The materials of construction for the pump shaft and the impeller must be stainless steel. All other materials must be material class S-1 with the wetted ferrous parts such as the bowl interiors enamel-lined, bowl exteriors, column interior and exterior, discharge head interior epoxy-coated per MIL-PRF-4556, and discharge head exterior epoxy-coated per MIL-DTL-24441.

2.2.3.1 Mechanical Seal

API STD 682, balanced type, API Class Code BSTHN.

2.2.4 Construction

Castings used for any part of pumps must be sound and free of shrink or blow holes, scale, blisters, and other similar casting defects. The surfaces of casting must be cleaned by sand or shot blasting, pickling, or other standard methods used by the manufacturer. All mold parting fins and remains of gates and risers must be either chipped, filed, or ground flush with the surface of the casting. The repair of casting leaks and defects by peening or by the use of cement compounds is prohibited. All welding to be per ASME BPVC SEC IX.

2.2.4.1 Couplings

Couplings must be flanged, rigid spacer type, CPAT or equal. The couplings must be of the spacer-type with a spacer of sufficient length to permit replacement of the mechanical seal assembly without removing the motor. The pump half coupling must be of such design that it can be removed without the use of heat. Coupling halves must fit tightly to the shafts of the pump and the driver so as not to become loose during operation. The coupling must be provided with an OSHA approved coupling guard.

2.2.4.2 Impeller

Impeller must be enclosed and double keyed to the shaft for radial loads and fixed in the axial position by shaft sleeve nuts, or other positive positioning device. Impellers must be held to the shaft so that the impeller will not become loose should the pump accidentally rotate in reverse direction. The impeller must be statically and dynamically balanced to 8 W/N.

2.2.4.3 Wear Rings

Renewable stainless steel wearing rings must be positively locked on the impeller. Wearing rings must fit with close tolerances so as to permit a minimum of recirculation. Wear ring hardened surfaces differential must be at least Brinell 50. Positive locking case wearing rings must be provided so that the case wearing rings will not rotate or change position in the case. Clearances must be established for hydrocarbon (Jet Fuel) service.

2.2.4.4 Shaft

Shaft must be designed with a high safety factor to easily withstand the torsional loads and other stresses to which it may be subjected. It must be so designed that there will be no detrimental vibration stresses. Surfaces must be ground to accurate dimensions. Shaft deflection must be limited to 0.05 mm 0.0020-inch maximum when measured at the face of the mechanical seal under the operating condition of zero flow at shut off head. Seal piping from the discharge to the mechanical seal must be provided. The pump shaft must be in maximum 1.5 m 5 foot sections, and couplings must be keyed and split ring type, not threaded.

2.2.4.5 Finishing

Passageways and impellers must be finished to permit maximum efficiency and provide noise reduction. Overall sound levels must not exceed OSHA limits.

2.2.4.6 Bearings

Bearings must be product-lubricated. Sleeve type, carbon graphite must be provided. Bearing spacing must be per API STD 610, eight edition, but must not exceed 1.5 m 5-foot in any case.

2.2.4.7 Drilling and Tapping

Casting must be drilled and tapped for drain and seal recirculation lines. All connections must be provided with plugs.

2.2.4.8 Mounting Flange

Mounting flange must be coordinated with the tank's mounting flange, and must be ANSI or API pattern, and contain a 25 mm 1-inch tapping for air eliminator discharge.

2.2.4.9 Pump Discharge

Pump discharge head must include a 25 mm 1 inch tapping at the highest point with valve, 100 mesh strainer, and air eliminator valve, as specified in Section 33 52 43.13, AVIATION FUEL PIPING, with check valve on outlet.

2.2.4.10 Special Tools

Pumps must be furnished with special tools necessary to dismantle and reassemble the unit.

2.2.4.11 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, securely attached by stainless steel pins at an easily accessible point on the pump, must be furnished in addition to the identification nameplate. The pump service nameplate must be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, L/s gpm
Pumping head, m ft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.2.4.12 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel must be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 6 mm 1/4-inch high must be the equipment number as shown on the drawings.

2.2.4.13 Primer Coat

Surfaces of the pump and baseplate must be primed by the manufacturer. Surface cleaning must meet requirements of SSPC SP 10/NACE No. 2. Metal primer must be zinc rich paint conforming to specification MIL-DTL-24441 Type 1, Class 3. Dry film thickness must be 0.05 to 0.2 mm 2 to 4 mils.

2.2.4.14 Topcoat

Topcoat must be factory applied and must be white and conforming to specification MIL-DTL-24441.

2.2.5 Motor

a. Motor must be furnished by the pump manufacturer and must be suitable for the environment and operating conditions to which it will be subjected and be provided with anti-reversing ratchet. The motors unity service factor may be used to conform to the non-overloading through-out the curve requirement for the 10% head increase condition only. Select the lowest horsepower for the motors that will meet the non-overloading requirement and co-ordinate the MCC if different than shown. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor must be UL listed for use in Class 1, Division 1, Group D hazardous areas, and must have a maximum temperature rating of "T2D 216 degrees C 419 degrees F " as defined by NFPA 70. The motor nameplate must include the temperature rating of the motor and locked-rotor indicating code letters in accordance with NFPA 70, Table 430-7(b).

b. Voltage rating must be 460 volts, 3 phase, 60HZ. Motor nominal speed must match pump. Motors must be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10 percent above or below rated voltage.

c. Pump manufacturer must assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve based on the future potential of a 5 percent head increase. In addition to having sufficient horsepower-output rating at rated speed, motor must have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of 10 starts per hour. Attention is specifically directed to the fact that thermal characteristics of motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors must conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to variation, service factors above unity must not be applied in sizing motor.

d. Motor must be squirrel-cage induction type, high thrust vertical P base, unless bearing frame pump is utilized. Motor must be NEMA Design B (normal-torque, low starting current).

e. Motor insulation must be non-hydroscopic, NEMA Class F, 150 degrees C 302 degrees F for motors. Motor windings must be supplied with extra dips and bakes.

f. Winding temperature rise, (based on a maximum ambient temperature of 40 degrees C 104 degrees F at 1006 m 3300-feet altitude) must not exceed 80 degrees C 176 degrees F.

g. Bearings must be ABMA minimum L10 life of 60,000 hours or L50 life of 300,000 hours suitable for the size, type, and application when the pump is operating at the specified flow and head.

h. Motor enclosures must be totally enclosed, weather sealed, fan cooled, explosion-proof and must be listed and labeled for Class 1, Group D areas. Provide bronze ground bolt on motor enclosure. All motor external electrical connections must be terminated within a single terminal housing.

i. The motors must be dynamically balanced and vibration measured per NEMA MG 1, vibration and balance under category "precision". Motor overspeed withstand capability and sound power levels of the motor must conform with NEMA standard requirements.

j. The pump manufacturer must furnish the Contracting Officer with the recommended minimum run time for the motor.

k. Pump motor must be provided with temperature limiting thermostats within the motor frame when required to meet Class 1, Group D requirements.

l. Pump motor must be furnished with lifting lugs on the motor casing.

m. Unless indicated otherwise, motors for conventional applications over 15 horsepower must be the premium efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors, motors specified as part of energy efficient equipment, wound rotor motors, or any application involving special construction or performance. Guaranteed minimum full load efficiencies must be (based on 1800 rpm, 4 pole, totally enclosed):

n.

15 kW20 hp	92.0 percent	56 kW75 hp	95.5 percent
19 kW25 hp	92.0 percent	75 kW100 hp	93.5 percent
22 kW30 hp	92.0 percent	93 kW125 hp	94.5 percent
30 kW40 hp	92.0 percent	112 kW150 hp	94.5 percent
37 kW50 hp	92.5 percent	149 kW200 hp	94.5 percent
45 kW60 hp	92.5 percent	447 kW600 hp	94.5 percent

o. Other motors of different speed or housing classification must also be of the premium efficient type, as advertised by the motor manufacturer, with efficiency greater than the standard line. Motor efficiencies must have been verified in accordance with NEMA MG 1, 12.53.a., and determined using the dynamometer method as described in IEEE 112, Method B. All shop drawing submittals on motor driven equipment must include the motor efficiency.

2.3 OFFLOAD PUMPS

2.3.1 Capacity

****

NOTE: Insert site specific pump requirements. Pump capacity to be provided by SME.

****

Capacity must be [45] [23] L/s [600] [300] gpm against a total head of [_____] m feet when driven at 3600 rpm. Overall efficiency at design conditions of pump and driver, connected, must be minimum of 60 percent. Pump head capacity must be continually rising and must be free of dips and valleys from design point to shut-off head. Pump shut-off head must have a 10 to 20 percent head rise to shut off. Pump must be capable of at least a 10 percent head increase at rated conditions by installing a new impeller. Pumps must not overheat or be damaged in any way while operating continuously at a minimum flow condition of 11 L/s 150 gpm and continuously at a maximum flow condition of 125 percent required capacity L/s GPM. The unit will also be required to operate at a flow of 12.5 percent required capacity without exceeding the vibration limits given in API STD 610. These pumps are for parallel operation and must have equal head at minimum continuous stable flow, plus or minus 2 percent.

2.3.2 General Requirements

a. The pumps for this service must meet the requirements of API STD 610, latest edition. Whenever the information contained herein conflicts with said standard, the information here in must govern. The pumps for this service must run at a nominal 3600 rpm and must be single stage centrifugals, horizontally mounted, vertical or radial split case, enclosed impeller, vertical-in-line with end suction and discharge. All parts must be factory inspected so that parts are interchangeable. Pumps and motors must be furnished as complete units as herein specified. Pump assembly must be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow.

b. The pump must require no more than 4.7 m 15.5-feet of net positive suction head (NPSHR) when it is operated with water at a capacity of [45] [23] L/s [600] [300] gpm at rated head and speed. A hydrocarbon reduction or correction factor must not be used. Pump suction specific speed must be less than 12,000.

c. The pump must be vertical in-line, single stage, single suction with double volute construction to assure radial balance. It must be designed to permit removal of the impeller, shaft, bearings and bearing housing as an assembly, without disconnecting the suction or discharge piping. Pump must be designed to remove the mechanical cartridge seal without removing the motor.

d. The pump case must be vertical in-line type for ease of piping alignment. Flange ratings must be class 100 kg 300-pound per ASME B16.5. The case must be designed for maximum discharge pressure at pumping temperature but not less than 3.8 MPa 550 psig, with a minimum corrosion allowance of 3mm 1/8-inch. The suction and discharge flanges as well as the cover bolting surfaces must be backfaced or spotfaced for positive bolt seating. The radial case to cover split must be a metal-to-metal fit with a confined, controlled compression gasket.

e. The pump cover must contain a stuffing box designed to accept an unbalanced mechanical seal. The stuffing box must have a minimum of 75 mm 3-inch studs for seal gland bolting. The gasket fit for seal gland to stuffing box must be of the controlled compression type with metal-to-metal joint contact.

f. Both case and cover are to be fitted with renewable wear rings.

g. The impeller must be of the enclosed type, dynamically and hydraulically balanced. It must be key driven, held in place by a positive lock, threaded against rotation.

h. Mechanical Seal. A single unbalanced mechanical seal per API STD 610 code USTHN of multiple spring design must be supplied. The seal gland must be tapped for three connections and each must be stamped for identification as follows: Q for quench; F for flush; and D for drain. A non-sparking throttle bushing pressed into the seal end plate against an outside shoulder must be provided to minimize leakage on complete seal failure.

i. Bearing Housing. Grease lubricated anti-friction, radial and thrust bearings of standard design must be supplied. The bearings must be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Pumps may be provided with or without bearing brackets.

j. Shafts must be of ample size to transmit the maximum torque required under specified operating conditions, and to withstand continuously all stresses resulting from supported weights, thrusts and starting, including across-the-line motor starting. It must be key seated to provide positive drive for the line motor starting. It must be key seated to provide positive drive for the coupling, shaft sleeve and impeller. The shaft stiffness factor must be under 70. The radial bearing centerline to impeller centerline, distance and the pump shaft diameter under the sleeve must be provided to calculate the factor.

k. A rigid type spacer coupling must be supplied. The spacer length must permit the removal of the assembled pullout element without disturbing the driver or the suction and discharge piping. Couplings must be properly keyed in place. Cylindrical fits must be light enough to permit easy removal of the hub in the field without the need for heating. A service factor of at least 1.5 must be used in selecting couplings based on manufacturer's ratings.

l. Removable coupling guards of the non-sparking type must be supplied. They must comply with the requirements of OSHA.

m. Total indicated shaft runout at coupling end must be 0.025 mm 0.001-inches or less. Total shaft deflection must be no more than 0.05 mm 0.002-inches at face of stuffing box.

n. Materials. No zinc, brass, bronze or other copper bearing alloy must come in contact with the fuel.

o. The case and cover must be constructed of stainless steel ASTM A487/A487M GR CF8M or ASTM A487/A487M GR CA6NM

p. Impeller material must be stainless steel ASTM A487/A487M GR CF8M or ASTM A743/A743M CA 6NM.

q. Wear rings must be stainless steel ASTM A182/A182M GR F6 or ASTM A276/A276M TP410 or 416 or ASTM A743/A743M CA15 HT-403.

r. Shaft must be stainless steel ASTM A276/A276M type 410 or 416 or ASTM A582/A582M Type 410 or 416 with renewable shaft sleeve of ASTM A276/A276M type 316L with hard facing under mechanical seal gasket.

s. Testing. All shop testing must be performed in accordance with the HI M100.

2.3.3 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the pump, must be furnished in addition to the identification nameplate. The pump service nameplate must be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, L/s gpm
Pumping head, m ft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.3.4 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel must be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 6 mm 1/4-inch high must bear the equipment number as shown on the drawings.

2.3.5 Exterior Primer Coat

Exterior surfaces of the baseplate must be primed by the manufacturer. Coating must be applied meeting requirements of SSPC PA 1. Surface cleaning must meet requirements of SSPC SP 10/NACE No. 2. Metal primer must be zinc rich paint conforming to specification MIL-DTL-24441, Type 1, Class 3. Dry film thickness must be 0.05 to 0.1 mm 2 to 4 mils.

2.3.6 Exterior Topcoat

Manufacturer's standard exterior topcoat must be applied at factory to the base plate.

2.3.7 Motors

a. Motor must be furnished by the pump manufacturer and must be suitable for the environment and operating conditions to which it will be subjected. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor must be UL listed for use in Class 1, Division 1, Group D hazardous areas, and must have a maximum temperature rating of T2D (216 degrees C 419 degrees F) as defined by NFPA 70. The motor nameplate must include the temperature rating of the motor and locked-rotor indicating code letters in accordance with NFPA 70, Table 430-7(b).

b. Voltage rating must be 460 volts, 3 phase, 60HZ. Motor nominal speed must match pump. Motors must be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10 percent above or below rated voltage.

c. Pump manufacturer must assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve. In addition to having sufficient horsepower-output rating at rated speed, motor must have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of 10 starts per hour. Attention is specifically directed to the fact that thermal characteristics of motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors must conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to variation, service factors above unity must not be applied in sizing motor.

d. Motor must be squirrel-cage induction type. Motor must be NEMA Design B (normal-torque, low starting current).

e. Motor insulation must be non-hydroscopic, NEMA Class F, 150 degrees C 300 degrees F for motors. Stator windings must be epoxy impregnated. The impregnations must be applied by the vacuum and pressure process.

f. Winding temperature rise, (based on a maximum ambient temperature of 40 degrees C 104 degrees F at 1006 m 3300-feet altitude) must not exceed 80 degrees C 176 degrees F.

g. Bearings must be ABMA minimum L10 life of 60,000 hours or L50 life of 300,000 hours suitable for the size, type, and application when the pump is operating at the specified flow and head.

h. Motor enclosures must be totally enclosed, weather sealed, fan cooled, explosion-proof and must be listed and labeled for Class 1, Group D areas. Provide bronze ground bolt on motor enclosure. All motor external electrical connections must be terminated within a single terminal housing.

i. The dynamic balance, overspeed withstand capability, and sound power levels of the motor must conform with NEMA standard requirements.

j. The pump manufacturer must furnish the Contracting Officer with the recommended minimum run time for the motor.

k. Pump motor must be provided with temperature limiting thermostats within the motor frame when required to meet Class 1, Group D requirements.

l. Pump motor must be furnished with lifting lugs on the motor casing.

m. Unless indicated otherwise, motors for conventional applications over 15 horsepower must be the premium efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors, motors specified as part of energy efficient equipment, wound rotor motors, or any application involving special construction or performance. Guaranteed minimum full load efficiencies must be (based on 3600 rpm, 2 pole totally enclosed):

n.

15 kW20 hp	92.0 percent	56 kW75 hp	95.5 percent
19 kW25 hp	92.0 percent	75 kW100 hp	93.5 percent

22 kW30 hp	92.0 percent	93 kW125 hp	94.5 percent
30 kW40 hp	92.0 percent	112 kW150 hp	94.5 percent
37 kW50 hp	92.5 percent	149 kW200 hp	94.5 percent
45 kW60 hp	92.5 percent	373 kW500 hp	94.5 percent

o. Other motors of different speed or housing classification must also be of the premium efficient type, as advertised by the motor manufacturer, with efficiency greater than the standard line. Motor efficiencies must have been verified in accordance with NEMA MG 1, 12.53.a., and determined using the dynamometer method as described in IEEE 112, Method B. All shop drawing submittals on motor driven equipment must include the motor efficiency.

2.4 FUEL TRANSFER PUMP (FTP-1) AND WATER DRAW-OFF PUMP (WSP-1 AND WSP-2)

2.4.1 Capacity

****

NOTE: Insert site specific pump requirements.

****

Capacity must be 3.8 L/s 50 gpm against a total head of [_____] m feet for the Fuel Transfer Pump, and 3.8 L/s 50 gpm against a total head of [_____] m feet for the Water Draw-off Pump, when driven at 1800 rpm. Overall efficiency at design conditions of pump and driver, connected, must be minimum [_____] percent. Pump head capacity must be continually rising and must be free of dips and valleys from design point to shut-off head. Pump must be capable of at least 10 percent head increase at rated conditions by installing a new impeller.

2.4.2 Assembly

****

NOTE: Select pump stage requirements.

****

The pump for this service must meet the requirements of API STD 610, latest edition, seventh edition for vibration. Wherever the information contained herein conflicts with said standard, the information herein must govern. The pump for this service must run at a nominal 1800 rpm and must be a [single stage] [multi-stage], vertical turbine pump. Pump and motor must be furnished as a complete unit as herein specified. Pump assembly must be statically and dynamically balanced for all flow rates from minimum flow to 120 percent of design flow.

2.4.3 Materials

The materials of construction for the pump shaft and the impeller must be stainless steel. All other materials must be material class S-1 with the wetted ferrous parts such as the bowl interiors enamel-lined, bowl exteriors, column interior and exterior, discharge head interior epoxy-coated per MIL-PRF-4556, and discharge head exterior epoxy-coated per MIL-DTL-24441.

2.4.3.1 Mechanical Seal

API STD 682, balanced type, API Class Code BSTHN.

2.4.4 Construction

Castings used for any part of pumps must be sound and free of shrink or blow holes, scale, blisters, and other similar casting defects. The surfaces of casting must be cleaned by sand or shot blasting, pickling, or other standard methods used by the manufacturer. All mold parting fins and remains of gates and risers must be either chipped, filed, or ground flush with the surface of the casting. The repair of casting leaks and defects by peening or by the use of cement compounds is prohibited.by ASME BPVC SEC VIII D1.

2.4.4.1 Couplings

Couplings must be flanged, rigid spacer type, CPAT or equal. The couplings must be of the spacer-type with a spacer of sufficient length to permit replacement of the mechanical seal assembly without removing the motor. The pump half coupling must be of such design that it can be removed without the use of heat. Coupling halves must fit tightly to the shafts of the pump and the driver so as not to become loose during operation. The coupling must be provided with an OSHA approved coupling guard.

2.4.4.2 Impeller

Impeller must be keyed to the shaft for radial loads and fixed in the axial position by shaft sleeve nuts, or other positive positioning device. Impellers must be held to the shaft so that the impeller will not become loose should the pump accidentally rotate in reverse direction. The impeller must be statically and dynamically balanced.

2.4.4.3 Wear Rings

Renewable wearing rings must be positively locked on the impeller. Wearing rings must fit with close tolerances so as to permit a minimum of recirculation. Positive locking case wearing rings must be provided so that the case wearing rings will not rotate or change position in the case.

2.4.4.4 Shaft

Shaft must be designed with a high safety factor to easily withstand the torsional loads and other stresses to which it may be subjected. It must be so designed that there will be no detrimental vibration stresses. Surfaces must be ground to accurate dimensions. Shaft deflection must be limited to 0.05 0.0020-inch maximum when measured at the face of the mechanical seal under the operating condition of zero flow at shut off head. Shaft must be protected through the mechanical seal by means of a shaft sleeve. Seal piping from the discharge to the mechanical seal must be provided.

2.4.4.5 Finishing

Passageways and impellers must be finished to permit maximum efficiency and provide noise reduction. Overall sound levels must not exceed OSHA limits.

2.4.4.6 Bearings

Bearings must be product-lubricated. Sleeve type, carbon graphite must be provided. Bearing spacing must be per API STD 610.

2.4.4.7 Drilling and Tapping

Casting must be drilled and tapped for drain and seal recirculation lines. All connections must be provided with plugs.

2.4.4.8 Mounting Flange

Mounting flange must be coordinated with the tank's mounting flange, and must be ANSI or API pattern.

2.4.4.9 Special Tools

Pumps must be furnished with special tools necessary to dismantle and reassemble the unit.

2.4.4.10 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, securely attached by stainless steel pins at an easily accessible point on the pump, must be furnished in addition to the identification nameplate. The pump service nameplate must be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, L/s gpm
Pumping head, m ft
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.4.4.11 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel must be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 6 mm 1/4-inch high must be the equipment number as shown on the drawings.

2.4.4.12 Exterior Primer Coat

Exterior surfaces of the pump and baseplate must be primed by the manufacturer. Surface cleaning must meet requirements of SSPC SP 10/NACE No. 2. Metal primer must be zinc rich paint conforming to specification MIL-DTL-24441 Type 1, Class 3. Dry film thickness must be 0.05 to 0.1 mm 2 to 4 mils.

2.4.4.13 Exterior Topcoat

Manufacturer's standard exterior topcoat must be factory applied and must be white.

2.4.5 Motor

Refer to paragraph, Motors for the Fueling Pumps.

PART 3 EXECUTION

3.1 PREPARATION FOR SHIPMENT

3.1.1 Rust Preventative

Exterior machine surfaces must be coated with a rust preventative. Pumps must be disassembled after the shop running tests and inspected, and internal parts must be coated with a rust preventative before reassembling.

3.1.2 Closure of Openings

Threaded openings must be provided with metallic plugs or caps. Flanges must be gasketed with rubber and closed with 4.8 mm 3/16-inch thick plate of the same outside diameter as the match flange. A minimum of four full-diameter bolts must hold closure in place.

3.1.3 Assembly

Pumps must be shipped assembled or a field service engineer must be furnished to supervise the field assembly at no additional cost to the Government.

3.1.4 Bracing

Each unit must be suitably prepared for shipment, supported and braced, with auxiliary equipment secured to prevent damage during shipment.

3.1.5 Vapor Inhibiting Wraps

Exposed shafts and shaft couplings must be wrapped with waterproof moldable waxed cloth or vapor inhibitor paper. The seams must be sealed with adhesive tape.

3.1.6 Shipping Identification

Each pump must be identified with a metal tag showing the item number. Material shipped separately must be marked with a metal tag indicating the item number for which it is intended.

3.2 INSTALLATION

Install equipment and components true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearances between equipment components. Equipment, apparatus, and accessories requiring normal servicing or maintenance must be easily accessible.

3.2.1 Anchoring

Anchor equipment in place as indicated on the drawings or per manufacturer's recommendations. Minimum anchor bolt size is 127 mm 5 inch. Check alignment of anchor bolts and/or bolt holes before installing equipment and clean-out associated sleeves. Do not cut bolts due to misalignment. Notify the Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads.

3.2.2 Grouting

Equipment which is anchored to a pad must be grouted in place. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, coatings and other materials which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting to meet requirements of ASTM C827/C827M. Perform all grouting in accord with equipment manufacturer's and grout manufacturer's published specifications and recommendations.

3.2.3 Leveling and Aligning

Level and align equipment in accord with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.2.4 Direct Drives

Alignment procedure follows.

3.2.4.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.2.4.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.2.4.3 Shaft Leveling and Radial Alignment

Check shaft leveling by placing a straightedge across the two coupling half faces in both horizontal and vertical planes.

3.2.4.4 Angular Alignment and End Clearance

Pump alignment must be accomplished by the factory technician or a millwright trained in pump alignment, and with the use of dial gauges or laser alignment equipment.

3.2.4.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.05 0.002-inch tolerance, except as otherwise required by more stringent requirements of equipment manufacturer.

3.2.5 Start-up Representative

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NOTE: Consult with SME to determine if additional training is required.

****

A manufacturer's field service representative must be provided at no additional cost to the Government to check the pumps for proper operation prior to start-up and also to witness, as a minimum, the first two days of operation. Any additional time required due to delays or corrections must be provided at no additional cost to the Government. The manufacturer's field service representative must also instruct the required personnel in the proper operation and maintenance of the pumps.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 52 43.28 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-33 52 43.28 (November 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-33 52 43.28 (August 2018)**

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References are in agreement with UMRL dated January 2025
****

SECTION 33 52 43.28

FILTER SEPARATOR, AVIATION FUELING SYSTEM
08/18

****
NOTE: This guide specification covers the requirements for filter separators and fuel quality monitors used in aircraft refueling systems constructed to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS.Standards can be found on the Whole Building Design Guide at the following location

https://www.wbdg.org/ffc/dod/non-cos-standards.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM C827/C827M	(2023) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

ENERGY INSTITUTE (EI)

EI 1541	(2016) Requirements for Internal Protective Coating Systems Used in

	Aviation Fuel Handling Systems
EI 1581	(2016) Specifications and Laboratory Qualification Procedures for Aviation Jet Fuel Filter/Separators
EI 1590	(2014) Specifications And Qualification Procedures For Aviation Fuel Microfilters

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-P-5315	(2022, Rev B) Butadiene - Acrylonitrile (NBR) Rubber For Fuel-Resistant Seals 60 To 70

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-HDBK-831	(2013; Rev A; Notice 1 2018) Preparation of Test Reports
MIL-PRF-4556	(1998; Rev F; Am 1 1999; CANC Notice 1 2011) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
MIL-STD-130	(2007; Rev N; Change 1 2012) Identification Marking of U.S. Military Property

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1923	(Rev A; Notice 1; Notice 2; Notice 3; Notice 4) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Filter Separator; G, [_____].

Micronic Pre-Filter; G, [_____].

SD-03 Product Data

Filter Separator; G, [_____].

Micronic Pre-Filter; G, [_____].

SD-07 Certificates

Filter Separator.

Micronic Pre-Filter.

SD-10 Operation and Maintenance Data

Filter Separator; G, [_____].

Micronic Pre-Filter; G, [_____].

1.3 PREPRODUCTION TESTING

****

NOTE: Contact the Naval Facilities Engineering Systems Command (NAVFACENGCOM) or the Corps of Engineers (COE) for direction on selection. For COE projects, include in the MOU the specific Air Force representatives to be notified when factory filter separator test dates are submitted to the Contracting Officer.

****

Prior to construction of filter separators (FSI-1 THROUGH FSI-[_____], FSR-[_____], THROUGH FSR-[_____]) for the project, preproduction tests must have been conducted in the presence of [Det 3, WR-ALC/AFTH Technical Assistance Team Air Force Petroleum Office Wright-Patterson AFB, OH] [NAVAIR/NAFAC] [Army Petroleum Center] representative. Notify the

Contracting Officer [_____] days prior to conductance of factory tests in order to schedule witnessing by representative.

1.3.1 Inspection and Testing

The inspection and testing of the preproduction filter separator must be conducted on a full-scale test system in accordance with EI 1581 and as specified herein. The test sample must consist of a complete filter separator with elements installed. Elements must be representative of a production lot. The filter separator, coalescers, and separator screens must be identified with the manufacturer's part number.

1.3.2 Deviations from EI 1581

No deviations are allowed.

1.3.3 Data Required Prior to Tests

Submit installation data to enable Government representative to verify that the equipment has been installed and operated correctly. Submit certification from the manufacturer that the test vessel has passed a hydrostatic pressure test, and that the design conforms to EI 1581, Category M, Type S. The test vessel represents the original model from the manufacturer. Re-certification would be required for a change to the model and or as required by EI 1581. Submit assembled drawings of the test vessel and accessories for approval.

1.3.4 Submittal of Test Documents

****

NOTE: Contact NAVFACENGCOM or COE for direction on selection. For NAVFACENGCOM Projects, the designer must consult with the engineer in charge (EIC) to determine the review input of the appropriate service. For COE projects, coordinate with appropriate service to determine which service agency will review test documents and ensure that MOU and submittal register contain these requirements.

****

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts. SME for this project is [Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS)[[Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC)] [Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11)]]].

The test report must be submitted to the SME. Prepare report in accordance with MIL-HDBK-831. In addition to results, the report must contain complete records of the tests including data sheets, performance curves, chronological test records, photographs, sample calculations, test procedures, and a description of the test apparatus. Submit color photographs of the sample elements before and after tests. Submit one new coalescer element and one new separator element.

1.3.5 Required Preproduction Tests

a. Examination. A visual examination of the filter separator housing and each element must be performed to ensure compliance with the drawings and verify workmanship requirements.

b. Hydrostatic Pressure Tests. The filter separator must be subjected to a hydrostatic pressure test in accordance with EI 1581, Section 3.2.2.11.1.

c. Full Scale Performance Test. EI 1581 The filter/separator with a full set of coalescer and separator elements must be tested in accordance with EI 1581 section 4.4 at [38] [_____] L/s [600] [_____] gpm (FSI-1 through FSI-[_____] ; [FSR-1 and FSR-2]) [and[75] [_____] L/s [1200] [_____] gpm (FSR-1 and FSR-2)].

d. Coalescer Structural Test. A coalescer structural test must be conducted in accordance with EI 1581 Section 4.5.

e. Disassembly Inspection. Upon completion of the tests specified above, the filter separator must be disassembled and inspected to determine the condition of the coalescer and separator elements. Defects in the element such as swelling of the elements, or damaged gaskets must be noted. Swelling of or damage to the elements or other parts must be cause for rejection.

1.4 DESIGN CONDITIONS

Design conditions must be as specified in Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT and as modified herein.

1.5 WORKMANSHIP

Each filter separator, including all parts and accessories, must be free from blemishes, defects, burrs and sharp edges. The vessel must exhibit accuracy of dimensions, accurate radii of fillets and complete marking of parts and assemblies.

1.6 CLEANING

Components of the filter separators must be cleaned to remove dirt; excess soldering; brazing, and welding flux; welding slag; loose, spattered, or excess solder; metal chips; and other foreign materials before, during and after assembly.

PART 2 PRODUCTS

2.1 WELDING

Welding must be in accordance with ASME B31.3.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Housing

a. [Carbon steel with internal epoxy coating][AL5083-0 or 6061 aluminum alloy][Type 304 or 316 stainless steel].

b. Float Assembly. Stainless steel.

c. Manual Drain Valve. Stainless steel.

d. Sight Glass. Armored clear Pyrex with nickel-copper alloy ball checks.

e. Differential Gauge. Corrosion resistant piston with stainless steel valves.

f. Separators. 75 um 200 mesh stainless steel wire cloth, polytetrafluorethylene (PTFE) coated on both sides, or synthetic mesh cloth.

2.3 FILTER SEPARATOR CONSTRUCTION

****

NOTE: As required by the SME. Coated carbon steel must not be used for filter separator vessels on Navy/Marine Corps projects. Specify internally coated carbon steel vessel construction for Air Force projects.

Indicate the operating height of the unit on the drawings. Note that the unit's support system (legs) may have to be structurally designed to meet project requirements.

****

2.3.1 Housing Vessel

Each filter separator housing must be fabricated from [carbon steel and must be internally coated with an epoxy coating in accordance with MIL-PRF-4556 [and EI 1541]][AL5083-0 or 6061 aluminum alloy][Type 304 or 316 stainless steel].[Coat the exterior with alkalyd resin primer (universal metal primer).] Each unit must be constructed and labeled in accordance with ASME BPVC SEC VIII D1. The housing must be designed for a working pressure of 1725 kPa275 psig. Each unit must be [horizontal, end-opening type with coalescers and separators mounted side-by-side (coalescers at the bottom of the vessel and separators at the top)][vertical, top-opening type with coalescers and separators mounted side-by-side (coalescers at the inlet of the vessel and separators at the outlet)]. The head opening must be equipped with a hinged or pivoting device to facilitate swinging the head to one side for servicing. The hinges or pivots must support the head during servicing without distortion or misalignment. Swing-type bolts must be used on all main closures. Unit must be provided with 75 mm3-inch inside diameter lifting eyes spaced to support a weight of 2-1/2 times the gross weight of the filter separator. The configuration of the pressure vessel must be as shown on the drawings. The housing must be provided with a 19 mm 3/4-inch inlet compartment fuel drain plug. A hand hole access plate must be provided in the inlet compartment. The head must be sealed to the body by means of an O-ring, meeting requirements of SAE AMS-P-5315, mounted in a circular groove at the point of closure. Threaded base mounting adapters must be provided for the coalescers. The separators must be mounted on adapters with blunted Vee-type knife edges. Height of Vee section to be 1.5 mm0.06 inches, plus or minus 10 percent. Weld ridges must not prevent liquid from draining. The filter separator vessel must be able to withstand a force of 10 kN 2400 pounds and a moment of 3250 J 2400 foot-pounds at the flanges.

2.3.2 Legs

Four 75 x 75 x 6 mm 3 x 3 x 1/4 inch angle-shaped legs must be welded to the housing. Each leg must be fitted with a 100 x 100 x 13 mm 4 x 4 x 1/2-inch base plate drilled through with a 19 mm 3/4-inch hole.

2.3.3 Inlet and Outlet Connections

The inlet and outlet connections must be 150 mm 6 inch nominal pipe size and must be located parallel to each other as shown on the drawings. Inlet connection must be provided with raised face flanges, faced and drilled in compliance with ASME B16.5, Class 150. Outlet connection flange face must match Filter Separator Control Valve (FSCV).

2.3.4 Manual Drain Valve

As specified in paragraph ACCESSORIES.

2.3.5 Sight Gauge

As specified in paragraph ACCESSORIES.

2.3.6 Differential Pressure Gauge

****

NOTE: Coordinate selection of this feature with the SME.

****

As specified in paragraph ACCESSORIES.

2.3.7 Automatic Air Eliminator and Pressure Relief Valves

As specified in paragraph ACCESSORIES.

2.3.8 Sampling Connections

As specified in paragraph ACCESSORIES.

2.3.9 Spider Assembly

Each filter separator must contain a spider assembly to hold the coalescers and separators in position, to support them firmly against vibration. The method of stabilization must assure an electrical bond between the spider and the vessel.

2.3.10 Coalescer and Separator Cartridges

****

NOTE: The Designer indicates appropriate identification (FSR or FSI). Filter separators must be flow-rated in 19 L/s 300 gpm increments.

****

Each filter separator must be provided with coalescers and separators that have been qualified to the performance requirements of EI 1581, Category M, Type S. Filter separators must use coalescers 150 mm 6-inch in diameter and 1090 mm 43-inch long for a flow-rate of[19 L/s 300 gpm] [38 L/s 600 gpm] [57 L/s 900 gpm] [_____].

2.3.11 Control Valve Accessories

Provide each filter separator with a control valve (FSCV), manual water drain valve, and float control valve (FC) with manual tester as specified in Section33 52 43.14 AVIATION FUEL CONTROL VALVES and must be of the same manufacturer.

2.3.11.1 Float Control Pilot and Tester

Each housing sump must be fitted with a float control pilot and tester specified in Section 33 52 43.14 AVIATION FUEL CONTROL VALVES and must be of the same manufacturer as the control valves. The drain port "D" must be tubed to the drain piping to the product recovery tank.

2.3.12 Identification of Product

Equipment, assemblies, and parts must be marked for identification in accordance with MIL-STD-130. The main equipment nameplate must be mounted on the housing, and in addition to the usual MIL-STD-130 requirements, must include the following markings in letters 0.09 mm 3/32 inch high or larger:

Filter Separator, Liquid Fuel			
Design Flow-Rate			
Design Pressure			
Elements			
First Stage		Mfg. Part No. *	
Second Stage		Mfg. Part No. *	
Contract No. *			
Manufacturer *			
Specification*			
*Applicable information must be entered by the Contractor.			
*Applicable information must be stenciled by LFM personnel.			

2.3.13 Assembly

Each filter separator must come assembled with all accessories and must be ready for use. The functions of all components must be tested prior to shipment and no assembly or field adjustment of valves or components must be required.

2.4 MICRONIC PRE-FILTER CONSTRUCTION

****

NOTE: As required by the SME.

****

2.4.1 Product Submittals

a. If product has been previously tested and approved by the Government, submit certification of qualification under EI 1590. Include the description of qualification, which contains element types and quantities, and provide details of the configurations of vessels tested. Also, include the name of the Government Agency and the date of approval.

b. Submit scaled drawings showing dimensions, tolerances, connection sizes of the vessel and accessories. Submit shop drawings for elements. Shop drawings must include number and arrangement of elements. Submit technical literature on the vessel, elements, and accessories, which is the manufacturer's published literature.

c. Refer to Section 01 78 23.33 OPERATION AND MAINTENANCE MANUALS FOR AVIATION FUEL SYSTEMS for specifics on the required operation and maintenance information.

2.4.2 Housing Vessel

Each pre-filter housing must be fabricated from carbon steel and must be internally coated with an epoxy coating in accord with MIL-PRF-4556. Coat the exterior with alkalyd resin primer (universal metal primer). Each unit must be constructed and labeled in accordance with ASME BPVC SEC VIII D1. The housing must be designed for a working pressure of 1725 kPa 275 psig. Each unit must be horizontal, end-opening type with filters mounted side-by-side. The head opening must be equipped with a hinged or pivoting device to facilitate swinging the head to one side for servicing. The hinges or pivots must support the head during servicing without distortion or misalignment. Swing-type bolts must be used on all main closures. Unit must be provided with 75 mm 3-inch inside diameter lifting eyes spaced to support a weight of 2-1/2 times the gross weight of the filter separator. The configuration of the pressure vessel must be as shown on the drawings. The housing must be provided with a 19 mm 3/4-inch inlet compartment fuel drain plug. A hand hole access plate must be provided in the inlet compartment. The head must be sealed to the body by means of an O-ring, meeting requirements of SAE AMS-P-5315, mounted in a circular groove at the point of closure. The filter cartridges must be mounted on adapters with blunted Vee-type knife edges. Height of Vee section to be 1.5 mm 0.06 inches, plus or minus 10 percent.

2.4.3 Legs

Four 75 x 75 x 6 mm 3 x 3 x 1/4 inch angle-shaped legs must be welded to the housing. Each leg must be fitted with a 100 x 100 x 13 mm 4 x 4 x 1/2-inch base plate drilled through with a 19 mm 3/4-inch hole.

2.4.4 Inlet and Outlet Connections

The inlet and outlet connections must be 200 mm 8 inch nominal pipe size and must be located parallel to each other as shown on the drawings. Connections must be provided with raised face flanges, faced and drilled in compliance with ASME B16.5, Class 150.

2.4.5 Manual Drain Valve

As specified in paragraph ACCESSORIES.

2.4.6 Differential Pressure Gauge

As specified in paragraph ACCESSORIES.

2.4.7 Automatic Air Eliminator and Pressure Relief Valves

As specified in paragraph ACCESSORIES.

2.4.8 Sampling Connections

As specified in paragraph ACCESSORIES.

2.4.9 Spider Assembly

The prefilter must contain a spider assembly to hold the filter cartridges in position, to support them firmly against vibration. The method of stabilization must assure an electrical bond between the spider and the vessel.

2.4.10 Filter Cartridges

The prefilter must be provided with 5 um5 micron pleated media filter cartridges. Filter cartridges must have a minimum efficiency of 98 percent and a minimum collapse strength of 520 kPa 75 psig.

2.4.11 Identification of Product

Equipment, assemblies, and parts must be marked for identification in accordance with MIL-STD-130. The main equipment nameplate must be mounted on the housing, and in addition to the usual MIL-STD-130 requirements, must include the following markings in letters 2 mm 3/32 inch high or larger:

Micronic Prefilter, Liquid Fuel			
Design Flow-Rate			
Design Pressure			
Elements			
First Stage		Mfg. Part No. *	
Second Stage		Mfg. Part No. *	
Contract No. *			
Manufacturer *			
Specification*			
*Applicable information must be entered by the Contractor.			
*Applicable information must be stenciled by LFM personnel.			

2.4.12 Assembly

The prefilter must come assembled with all accessories and must be ready for use. The functions of all components must be tested prior to shipment and no assembly or field adjustment of valves or components must be required.

2.5 ACCESSORIES

2.5.1 Manual Drain Valve

Each filter separator must be equipped with a 25 mm 1-inch stainless steel manual ball valve water and fuel drain. The valve must be capable of draining all water, fuel and sediment from the filter separator by gravity. The valve must be installed below the sump of the housing as shown on the drawings.

2.5.2 Sight Gauge

A[13 mm 1/2-inch armored, clear borosilicate (Pyrex)][or][magnetic level type] liquid level gauge must be provided for observing the water accumulation in the sump. The gauge must be equipped with stainless steel ball checks in both the upper and lower fittings, an upper and lower shutoff valve, and a bottom blowoff cock.[The gauge will contain a colored density sensitive ball.] Liquid level gauges must be rated for a maximum pressure of 1035 kPa 150 psi.

2.5.3 Differential Pressure Gauge

****

NOTE: Coordinate selection of this feature with the SME.

****

The housing must be equipped with a direct-reading, piston type differential pressure gauge that measures the differential pressure across both coalescers and separators. The gauge must consist of a spring-supported, corrosion resistant piston moving inside a glass cylinder, with high pressure applied on top of the piston and low pressure applied below it. The gauge must have a peak-hold reading that locks the piston to indicate the maximum differential pressure that is measured until the piston is released by turning a knob, a push button test valve to relieve pressure under the piston, and a pressure relief feature set at 2070 kPa 300 psi to protect the gauge if isolation valves have been left closed. Under a differential pressure of 205 kPa 30 psi, leakage past the piston must not exceed 120 drops per minute. The cylinder and flanges must be stainless steel with fluoroelastomer (FCM), commonly referred to as Viton, O-ring seals. The high pressure inlet of the gauge must have a 10 um 10-micron pleated paper filter and the low pressure connection must have a fine mesh stainless steel strainer. The gauge must have an operating pressure of 2070 kPa 300 psi. Differential pressure range of the gauge through approximately 75 mm 3 inches of piston movement must be 0-205 kPa 0-30 psi with an accuracy of ± 3 kPa0.5 psi, calibrated linearly with 5 kPa 1 PSI scale graduations. High and low pressure connections must be 6 mm 1/4 inch NPT female with a stainless steel bar stock valve at each connection. Construction of the gauge must be such that a 3-valve manifold is not necessary. If only one bar stock valve is closed, the gauge must not be damaged by up to 2070 kPa 300 psi differential pressure in either direction. The differential pressure gauge must be attached to the filter separator by a gauge panel.[Differential pressure gauge must control the filter separator control valve (FSCV) to automatically shut down flow when 140 kPa 20 psi differential pressure is exceeded.] A pressure gauge must be attached to the differential pressure gauge to indicate the high pressure and have a range of 2070 kPa 300 psi.

2.5.4 Automatic Air Eliminator and Pressure Relief Valves

A 25 mm 1-inch angle pattern pressure relief valve must be provided on top of each vessel. An automatic air eliminator must be installed on the highest point of the vessel and must have check valve feature. The air eliminator must release at pressures up to 1035 kPa 150 psi with no fuel leakage allowed.

2.5.5 Sampling Connections

Sampling connections must be provided at the inlet and outlet connections to the housing. Each sampling connection must consist of a 6 mm 1/4-inch sampling probe where the probe faces upstream, ball valve, a quick disconnect coupling and aluminum dust cap. The sampling connections must be capable of accepting a sampling kit for drawing the samples required to assure fuel quality.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and components in position, true to line, level and plumb and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearance between equipment components. Equipment apparatus, and accessories requiring normal servicing or maintenance to be accessible.

3.1.1 Anchoring

Anchor equipment in place. Check alignment of anchor bolts before installing equipment and cleanout associated sleeves. Do not cut bolts because of misalignment. Notify Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate self-drilling type anchors for construction condition. Expansion bolt anchors provided must be in accordance with CID A-A-1923, Type 4, Class One, 13 mm 1/2 inch size.

3.1.2 Grouting

Equipment, which is anchored to a pad, must be grouted in place where applicable. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, coatings and other materials which impair bond. Clean contaminated concrete by grinding or other acceptable means. Provide necessary formwork for placing and retaining grout. Grout to be nonmetallic, nonshrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum power agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, premixed and packaged at factory with only the addition of water required at the project site. Grouting to meeting requirements of ASTM C827/C827M. Perform grouting in accord with ACI, equipment manufacturer's, and grout manufacturer's published specifications and recommendations.

3.1.3 Leveling and Aligning

Level and align equipment in accordance with respective manufacturer's published data. Do not use anchor bolts, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shims to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.1.4 Painting

Equipment painting must be as specified in Section 33 52 43.13 AVIATION FUEL PIPING. Equipment labeling must be as specified in Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 52 80 (August 2022)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 52 80 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC UFGS-33 52 80 (August 2022)

Preparing Activity: NAVFAC Superseding
UFGS-33 52 80 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 52 80

LIQUID FUELS PIPELINE COATING SYSTEMS
08/22

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NOTE: This guide specification covers the requirements for interior and exterior coating of aboveground and buried carbon steel liquid fuel pipelines and exterior coating of aboveground and buried stainless steel liquid fuel pipelines. The exterior coating system for aboveground pipelines is the same as used on the exterior of fuel tanks, Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. The exterior coating system for buried pipelines is an extruded polyolefin system, a fusion bonded epoxy (FBE) system, or a liquid epoxy system. An optional FBE coating or liquid applied epoxy coating system is provided for the interior of carbon steel pipe to protect aviation fuel from iron contamination.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: This guide specification is intended for coating of new pipe and localized field repairs only. For maintenance coating of existing buried or aboveground pipe, a coating inspection, or coating

condition survey (CCS), as described in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES, should be accomplished prior to designing the coating project. Without a competent inspection, there is no reliable way to determine the type or condition of the existing coating system. If existing conditions are not known, proper (effective and financially supportable) surface preparation or coating system selection cannot be made.

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NOTE: This specification is the result of much experience and expertise of Association for Materials Protection and Performance (AMPP) (previously SSPC) certified Protective Coatings Specialists.

A specifier, in adapting this specification to a project, should not alter the products and processes specified herein without thorough knowledge of the need for the changes and the implications of those changes.

Prior to changing or altering the products or processes specified herein, it is recommended that the specifier consult with the NAVFAC Paints and Coatings Subject Matter Expert at Naval Facilities Engineering Service Center.

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NOTE: SSPC and NACE have merged to become AMPP. The merger was still in progress at the time this section was released.

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NOTE: The metric standard for measuring coating thickness is microns (25.4 microns=1 mil; use nominal 25 microns=1 mil).

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NOTE: Designers are encouraged to contact Robert Jamond (robert.jamond@navy.mil) prior to beginning a new Navy design.

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NOTE: Designers are encouraged to contact the Air Force Civil Engineer Reachback Center (afcec.rbc@us.af.mil) prior to beginning a new Air Force design.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C209	(2019) Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fitting for Steel Water Pipelines
AWWA C210	(2024) Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C213	(2022) Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
AWWA C215	(2022) Extruded Polyolefin Coatings for Steel Water Pipe
AWWA C216	(2022) Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C217	(2023) Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings

ASTM INTERNATIONAL (ASTM)

ASTM D3276	(2015; E 2016) Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D3335	(1985a; R 2020) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D3718	(1985a; R 2015) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings
ASTM D4285	(1983; R 2018) Indicating Oil or Water in Compressed Air
ASTM D4417	(2021) Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8502-3	(2017) Preparation of Steel Substrates Before Application of Paints and Related Products - Tests for the Assessment of Surface Cleanliness - Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)
ISO 9001	(2015) Quality Management Systems-Requirements

MASTER PAINTERS INSTITUTE (MPI)

MPI 500	(2020) Epoxy, Interior Steel Fuel Tank Coating, Primer
MPI 501	(2020) Epoxy, Interior Steel Fuel Tank Coating, Contrast Topcoat

NACE INTERNATIONAL (NACE)

NACE RP0402	(2002) Field-Applied Fusion-Bonded Epoxy (FBE) Pipe Coating Systems for Girth Weld Joints: Application, Performance, and Quality Control

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC AB 1	(2015; E 2017) Mineral and Slag Abrasives
SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2023; R 2023) Ferrous Metallic Abrasive

SSPC Guide 6	(2021) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
SSPC Guide 12	(2023) Guide for Illumination of Industrial Painting Projects
SSPC PA 1	(2024) Shop, Field, and Maintenance Coating of Metals
SSPC PA 2	(2015; E 2018) Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC QP 3	(2010) Standard Procedure for Evaluating Qualifications of Shop Painting Applicators
SSPC QP 5	(2022) Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning
SSPC SP 17	(2019) Thorough Abrasive Blast Cleaning of Non-Ferrous Metals
SSPC VIS 1	(2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART Z	Toxic and Hazardous Substances
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1000	Air Contaminants
29 CFR 1926.59	Hazard Communication

1.2 SYSTEM DESCRIPTION

This section specifies the requirements for[interior and] exterior coating of aboveground and buried carbon steel liquid fuel pipelines and exterior coating of aboveground and buried stainless steel liquid fuel pipelines. The exterior coating system for aboveground, carbon steel pipelines is specified with the same requirements as the exterior coating system for the exterior of fuel tanks, Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. The exterior coating system for buried pipelines is an extruded polyolefin system, a fusion bonded epoxy (FBE) system, or a liquid epoxy system.[The interior coating system for carbon steel pipelines is an FBE coating system or liquid applied epoxy system coating. An interior coating system is specified for the interior of carbon steel pipe containing aviation fuel to protect the fuel from iron contamination.]

1.3 DEFINITIONS

Definitions are generally provided throughout this Section in the paragraphs where used and denoted by capital letters. The following definition is used throughout this Section:

a. INDEPENDENT THIRD-PARTY - Impartial third-party not a part or affiliated with Contractor or subcontractor principal or subsidiary businesses, and not a materials supplier.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contract Errors, Omissions, and Other Discrepancies

Corrective Action Procedures

Corrective Action Request (CAR) Form

Coatings Work Plan

Inspection Report Forms

SD-05, Design Data

Containment System

SD-06 Test Reports

Daily Inspection Reports

Coatings Qualification Test Reports

Ferrous Metallic Abrasive Qualification Test Reports

Non-Metallic Abrasive Qualification Test Reports

Coating Field Test Reports

Abrasive Field Test Reports

Recycled Ferrous Metallic Abrasive Field Test Reports (Daily and Weekly)

SD-07 Certificates

Qualifications of Certified Industrial Hygienist (CIH)

Qualifications of Pipe Coating Shop

Qualifications of Certified Protective Coatings Specialist (PCS)

Qualifications of Coatings Inspection Company

Qualifications of Quality Assurance Coatings Inspector

Qualifications of Coatings Contractors for Field Coating

Qualifications of Individuals Performing Abrasive Blasting for Field Coating

Qualifications of Individuals Performing Coating Application for Field Coating

Qualifications of Testing Laboratory for Coatings

Qualifications of Testing Laboratory for Abrasive

Coating Materials Certificate of Conformance

Ferrous Metallic Abrasive Certificate of Conformance

Non-Metallic Abrasive Certificate of Conformance

SD-08 Manufacturer's Instructions

Coating System Instructions

SD-11 Closeout Submittals

Disposal of Used Abrasive Shop Applied Coating

Disposal of Used Abrasive Field Applied Coating

Inspection Logbook

Corrective Action Log; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Contract Errors, Omissions, and Other Discrepancies

Submit all errors, omissions, and other discrepancies in contract documents to the Contracting Officer within 30 days of contract award for all work covered in this Section, other than the work that will not be uncovered until a later date. All such discrepancies must be addressed and resolved, and the Coatings Work Plan modified, prior to beginning the Initial and Follow-Up phases of work. Discrepancies that become apparent only after work is uncovered must be identified at the earliest discoverable time and submitted for resolution. Schedule time (float) must be built into the project schedule at those points where old work is to be uncovered or where access is not available during the first 30 days after award, to allow for resolution of contract discrepancies.

1.5.2 Corrective Action (CA)

CA must be included in the Contractor Quality Control Plan as outlined in Section 01 45 00 QUALITY CONTROL.

1.5.2.1 Corrective Action Procedures

Develop procedures for determining the root cause of each non-compliance, developing a plan to eliminate the root cause so that the non-compliance does not recur, and following up to ensure that the root cause was eliminated.

1.5.2.2 Corrective Action Request (CAR) Form

Develop Corrective Action Request (CAR) forms for initiating CA and for tracking and documenting each step. The CAR should be included with the Corrective Action Procedures. A CAR must be initiated by either the Contractor or the Contracting Officer. The Protective Coatings Specialist (PCS) must approve each CAR at the root cause identification stage, the plan for elimination stage, and the close out stage after verification that the root cause has been eliminated.

1.5.2.3 Corrective Action Log

When a CAR is initiated, Contractor must take action to identify and eliminate the root cause of each non-compliance so as to prevent recurrence. These actions must apply to non-compliance in the work, and to non-compliance in the Quality Control (QC) System. Corrective actions must be appropriate to the effects of the non-compliance encountered. The corrective action must be documented in a report that is serialized and tracked in the Corrective Action Log until project completion and its acceptance by the Contracting Officer. All corrective action reports must be retained in project records. The Corrective Action Log, showing status of each CAR, must be submitted to the Contracting Officer monthly.

1.5.3 Coatings Work Plan

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NOTE: Ensure coordination between all parties, including the welder, weld inspector, coatings Contractor, Quality Assurance Coatings Inspector, and Coatings Contractor QC Coatings Inspector, on weld preparation and surface profile requirements.

****

This work plan must be considered as part of the Contractor Quality Control Plan as outlined in Section 01 45 00 QUALITY CONTROL.

The Coatings Work Plan must be submitted and approved by the PCS prior to mobilization. The Coatings Work Plan must explain in detail all procedures including, but not limited to, all sequential processes, quality control for each process, quality assurance for each process, and safety considerations. Subsections must include at least the following:

a. Purpose;

b. Introduction[(including the scope of work (SOW) project program)];

c. Safety, fire, and health information;

d. Contractor and worker qualifications with certifications;

e. Project management organization and documents;

f. Timeline in a Gantt chart;

g. Project document references;

h. Reference to all applicable standards (e.g., AMPP, NACE, SSPC, ISO, and ASTM);

i. Coatings manufacturer's supporting documentation;

j. Descriptions and explanations of any exceptions from the coating manufacturer[(including those specific to stainless steel piping];

k. Coating and blasting equipment, model names, and, if applicable, calibration dates;

l. Containment design and/or details;

m. Environmental testing;

n. Material delivery, storage, and handling details;

o. Surface preparation;

p. Pre-application test panel validation for field-applied external coating as outlined in SURFACE STANDARD;

q. Coating materials, mixing, application, recoat windows, and coating curing times, if applicable;

r. Coating repairs and rework;

s. Non-conformance;

t. Spent material handling and effluent discharge containment and disposal;

u. Inspection test plan (as outlined in FIELD INSPECTION, and including inspection hold points, both Quality Assurance and Coating Contractor QC Coatings Inspector's responsibilities, and daily documentation and delivery);

v. Instruments and test kits;

w. Warranty (in writing, signed by the Contractor and the coating manufacturer's representative);

x. Demobilization;

y. PCS and PM approval;

1.5.4 Design Data

1.5.4.1 Containment System for Field Coating

Submit complete design drawings and calculations for the scaffolding and containment system, including an analysis of the loads which will be added to the structure by the containment system and waste materials. A registered engineer must approve calculations and scaffold system design.

1.5.5 Test Reports

1.5.5.1 Coatings Qualification Test Reports

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NOTE: Delete the bracketed coating systems that will not be used for this project. All coating systems, including shop applied external coatings, shop applied internal coatings, and field repair coatings, must be listed for qualification testing.

****

Submit test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each coating material. U.S. Department of Defense laboratories are considered to be INDEPENDENT THIRD-PARTY laboratories. Samples must have been tested within the last three years. The purpose of qualification testing is to pre-qualify the coatings used on buried pipe. Provide qualification testing results for exterior coatings used for repairs or girth welds on buried pipe in conformance with [AWWA C203][AWWA C209][AWWA C210][AWWA C216][AWWA C217][NACE RP0402]. Provide qualification testing results for shop applied exterior coatings for buried pipe in conformance with [AWWA C210][AWWA C213][AWWA C215].[Provide qualification testing results for shop applied internal coatings for buried pipe in conformance with [AWWA C213][MPI 500 and MPI 501].]

Qualification testing must be based on all required production verification testing required by [AWWA C203][AWWA C209][AWWA C210][AWWA C216][AWWA C217][NACE RP0402][AWWA C213][AWWA C215][MPI 500 and MPI 501].[For AWWA C213, provide test reports for production verification testing described in paragraph OPTIONAL EPOXY PERFORMANCE TESTING OF COATED PIPE of AWWA C213, including cross-section porosity, interface porosity, thermal analysis (DSC), permanent strain (bendability), and interfacial contamination. Perform production verification testing on a minimum of one pipe joint in the first half hour of production each day, and on a minimum of one pipe joint in the last half hour of production each day. Perform additional testing as required to segregate any non-compliant material.]

1.5.5.2 Ferrous Metallic Abrasive Qualification Test Reports

Submit qualification testing results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 3. Submit test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of pre-qualifying the abrasive.

1.5.5.3 Non-Metallic Abrasive Qualification Test Reports

Submit results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 1. Submit test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of pre-qualifying the abrasive.

1.5.5.4 Recycled Ferrous Metallic Abrasive Field Test Reports (Daily and Weekly)

Submit test results from an INDEPENDENT THIRD-PARTY laboratory of daily and weekly Quality Control testing required by SSPC AB 2, as modified in paragraph ABRASIVE.

1.5.6 Qualifications

The qualifications specified in this Section must be met throughout the duration of this contract. Personnel and corporate entities must provide proof of active certification to all qualifications specified in this Section. Work must not be provided by personnel and corporate entities unless all specified qualifications are met.

1.5.6.1 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY CIH. Submit documentation that the hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. The CIH must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. If a CIH's certification expires, the hygienist will not be allowed to perform any hygienist functions, and all hygienist work must stop, until the certification is reissued or another CIH is approved. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Provide evidence of experience with hazards involved in industrial coating application work.

1.5.6.2 Qualifications of Pipe Coating Shop

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NOTE: Solicitations requiring certification for pre-qualification must point out the existence and location of the certification requirement on the PROJECT INFORMATION FORM. This requirement must be pointed out in the solicitation documents for the "prior to contract award" requirement to be enforceable. Certification is a special responsibility requirement pursuant to FAR 9.104-2 Special Standards. This is analogous to requiring bidders to have a specified level of experience or expertise and GAO has sustained these types of special requirements.

****

Each shop that applies coatings to pipe must be certified to SSPC QP 3 prior to contract award and must remain certified while accomplishing any surface preparation or coating application. If a shop's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in the shop's certification status within 10 days of the change. If a shop's qualification expires, the shop will not be allowed to perform any coatings related functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports.

[For shops located outside the United States, Guam, and Puerto Rico, the certifications for the shop (SSPC QP 3) can be substituted if the coatings Contractor meets all of the below requirements:

a. ISO 9001 certified;

b. Eight years of experience with industrial coatings;

c. Evidence of recent work that has Contractor Performance Assessment Report System (CPARS) ratings, and/or other quality/performance ratings, that are equivalent to, or exceed, "Above Average";

d. Evidence of an INDEPENDENT THIRD-PARTY audit from AMPP demonstrating equivalency to SSPC QP 3 within the last two years.

The shop must be certified to ISO 9001 prior to contract award and must remain so certified for the duration of the project. Notify the

Contracting Officer of any change in the shop's certification status within 10 days of the change. If a Contractor's qualification expires, the shop will not be allowed to perform any coatings related functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from the ISO certifying organization and furnish a copy of all inspection reports.

]1.5.6.3 Qualifications of Certified Protective Coatings Specialist (PCS)

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY PCS. Submit documentation that the PCS is certified by the Association for Materials Protection and Performance (AMPP) (formerly SSPC: The Society for Protective Coatings (SSPC)), including certification number and date of certification/recertification. If the PCS is employed by the same coatings inspection company to which the Quality Assurance Coatings Inspector is employed, this does not violate the INDEPENDENT THIRD-PARTY requirements. The PCS must be an INDEPENDENT THIRD-PARTY to the pipe coating shop. The PCS must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. If a PCS's certification expires, the PCS will not be allowed to perform any PCS functions, and all coatings work must stop, until the certification is reissued or another PCS is approved. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. The PCS must not be the designated Quality Assurance Coatings Inspector. The PCS's responsibilities are outlined in PROTECTIVE COATINGS SPECIALIST (PCS).

1.5.6.4 Qualifications of Coatings Inspection Company

Submit documentation that the selected quality assurance coatings inspection company is accredited by AMPP to the requirements of SSPC QP 5 prior to contract award. The coatings inspection company that is submitted and approved, must remain and cannot be changed through completion of the contract. The coatings inspection company must remain SSPC QP 5 certified for the duration of the coatings work. If a coatings inspection company's certification expires, the firm will not be allowed to perform any inspection functions, and all surface preparation and coating application work must stop, until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in the coatings inspection company certification status within 10 days of the change. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports. The coatings inspection company must not engage in any activities that may conflict with their independence of judgment and integrity in relation to their inspection activities. In particular, they must not be engaged in the manufacture, supply, application, surface preparation, purchase, or maintenance of the applied coating in this project.

1.5.6.5 Qualifications of Quality Assurance Coatings Inspector

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NOTE: Although the Quality Assurance Coatings Inspector may be a certified NACE CIP Level III inspector, the Quality Assurance Coatings Inspector

must be employed by a certified QP 5 coatings inspection company.
****

Submit documentation that each Quality Assurance Coatings Inspector is employed by the SSPC QP 5 company and is qualified to a minimum certification of NACE CIP Level II. Each inspector must remain employed by the coatings inspection company while performing any coatings inspection functions. The Quality Assurance Coatings Inspector's responsibilities are outlined in QUALITY ASSURANCE COATINGS INSPECTOR'S FIELD RESPONSIBILITIES. The roles of the Quality Assurance Coatings Inspector are in addition to, and distinct from, the role of the QC Coatings Inspector employed by the coatings Contractor and the Coatings Inspector for Shop Coating.

1.5.6.6 Qualifications of Coatings Contractors for Field Coating

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NOTE: If project involves removal of paint containing hazardous materials, add requirement for SSPC QP 2 certification in section of specification where the hazardous paint removal is specified, generally Section 02 83 00 LEAD REMEDIATION.
****

All Contractors and Subcontractors that perform surface preparation or coatings application must be certified to SSPC QP 1 and SSPC QS 1 prior to contract award and must remain certified while accomplishing any surface preparation or coating application. If a Contractor's or Subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in Contractor certification status within 10 days of the change. If a Contractor's qualification expires, the Contractor will not be allowed to perform any coatings related functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports.

[For projects located outside the United States, Guam, and Puerto Rico, the certifications for the coatings Contractor (SSPC QP 1 and SSPC QS 1) can be substituted if the coatings Contractor meets all of the below requirements:

a. ISO 9001 certified;

b. Eight years of experience with industrial coatings;

c. Evidence of recent work that has Contractor Performance Assessment Report System (CPARS) ratings, and/or other quality/performance ratings, that are equivalent to, or exceed, "Above Average";

d. Evidence of an INDEPENDENT THIRD-PARTY audit from AMPP demonstrating equivalency to SSPC QP 1 and SSPC QS 1 within the last two years.

The coatings Contractors and coatings Subcontractors must be certified to ISO 9001 prior to contract award and must remain so certified for the duration of the project. Notify the Contracting Officer of any change in

Contractor certification status within 10 days of the change. If a Contractor's qualification expires, the Contractor will not be allowed to perform any coatings related functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from the ISO certifying organization and furnish a copy of all inspection reports.

]1.5.6.7 Qualifications of Individuals Performing Abrasive Blasting for Field Coating

Submit name, address, and telephone number of each person that will be performing abrasive blasting. All individuals performing abrasive blasting must be certified by AMPP to the SSPC C7 Dry Abrasive Blaster Qualification Program or CAS Coating Application Specialist Level 2 Certification Program (Interim Status), and must remain certified during the entire period of abrasive blasting. The Contracting Officer must be notified of any change in qualification status within 10 days of the change. If a blaster's qualification expires, the blaster will not be allowed to perform any blasting functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply.

This requirement applies to all manual abrasive blasting performed in shop and field locations. This requirement does not apply to automated abrasive blasting performed in the shop.

1.5.6.8 Qualifications of Individuals Performing Coating Application for Field Coating

Submit name, address, telephone number, and evidence of certification of each person that will be performing coatings application by any method. All individuals performing coatings application must be certified by AMPP to the SSPC CAS Coating Application Specialist Level 2 Certification Program (Interim Status) or SSPC C12 Spray Application Program. Each applicator must remain certified during the entire period of coatings application, and the Contracting Officer must be notified of any change in qualification status within 10 days of the change. If an applicator's qualification expires, the applicator will not be allowed to perform any coatings application functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply.

1.5.6.9 Qualifications of Testing Laboratory for Coatings

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY laboratory or laboratories selected to perform testing of coating samples for qualification testing and for field sample testing for compliance with this Section. Submit documentation that the laboratory is regularly engaged in testing of paint samples for conformance with specifications and that the employees performing testing are qualified.

1.5.6.10 Qualifications of Testing Laboratory for Abrasive

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY laboratory or laboratories selected to perform testing of abrasive for compliance with this section. Submit documentation that the laboratory has experience in testing samples of abrasive for conformance with specifications and that the employees performing testing are qualified.

1.5.6.11 Coating Materials Certificate of Conformance

Provide manufacturer's certification of conformance to [AWWA C203][AWWA C209][AWWA C210][AWWA C216][AWWA C217][NACE RP0402] for exterior coatings used for repairs or girth welds on buried pipe. Provide manufacturer's certification of conformance to [AWWA C210][AWWA C213][AWWA C215] for shop applied exterior coatings for buried pipe.[Provide manufacturer's certification of conformance to [AWWA C213][MPI 500 and MPI 501] for shop applied internal coatings for buried pipe.]

[For carbon steel internal liners ([AWWA C213][MPI 500 and MPI 501]), a certification must be provided from the coating manufacturer stating that the coating system is suitable for immersion service in aviation fuel.

]1.5.6.12 Ferrous Metallic Abrasive Certificate of Conformance

Provide manufacturer's certification of conformance that the materials are currently in conformance with SSPC AB 3 and as modified in this Section, and have been tested within the last three years.

1.5.6.13 Non-Metallic Abrasive Certificate of Conformance

Provide manufacturer's certification that the materials are currently in conformance with SSPC AB 1 and as modified in this Section, and have been tested within the last three years.

1.5.7 QA and QC Personnel

1.5.7.1 QC Manager

The QC Manager is as defined in Section 01 45 00 QUALITY CONTROL.

1.5.7.2 Protective Coatings Specialist (PCS)

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NOTE: Specifier of this section shall ensure coordination with the related "QC Specialist" specification in Section 01 45 00 QUALITY CONTROL, as applicable. Provide the required data to complete the "QC Specialist" specifications of that Section.

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The PCS must be considered a QC Specialist and must report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The PCS must approve all submittals prior to submission to the QC Manager for approval or submission to the government for approval.

The PCS's responsibilities include, but are not limited to, the following:

a. Obtain, review, and understand all project documentation including, but not limited to, this Section, scope of work (SOW) project program, Coatings Work Plan, inspection and testing plan (ITP), and all submittals before the project starts, during the project, and all coatings related re-work;

b. Attend all pre-job coatings meetings (in-person, phone, or virtually);

c. Attend pre-final coatings walk-through (mandatory) and attend final coatings walk-through (as required).

1.5.7.3 Quality Assurance Coatings Inspector

The Quality Assurance Coatings Inspector must be considered a QC Specialist and must report to the QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The Quality Assurance Coatings Inspector must be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, during all coating repair work, and during completion activities. The Quality Assurance Coatings Inspector must provide complete documentation of conditions and occurrences on the job site, and be aware of conditions and occurrences that are potentially detrimental to the coating system. The responsibilities of the Quality Assurance Coatings Inspector are defined in QUALITY ASSURANCE COATING INSPECTOR'S RESPONSIBILITIES. These responsibilities are separate and distinct from the responsibilities of the Coatings Contractor QC Coatings Inspector and Coatings Inspector for Shop Coating.

1.5.7.4 Coatings Inspector for Shop Coating

The coatings inspector must be the shop Quality Manager or appropriate designee. The coatings inspector must be considered a QC Specialist and must report to the prime Contractor's QC Manager, as specified in Section 01 45 00 QUALITY CONTROL. The coatings inspector must be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, and during all coating repair work required of the shop. The coatings inspector must provide complete documentation of conditions and occurrences on the job site, and be aware of conditions and occurrences that are potentially detrimental to the coating system.

1.5.7.5 Coatings Contractor QC Coatings Inspector

The Coatings Contractor QC Coatings Inspector must stop non-compliant work. The responsibilities of the Coatings Contractor QC Coatings Inspector are defined in COATINGS CONTRACTOR QC COATINGS INSPECTOR'S RESPONSIBILITIES. These responsibilities are separate and distinct from the responsibilities of the Quality Assurance Coatings Inspector.

1.5.8 Pre-Application Meeting for Field Coating

After approval of submittals, but prior to the initiation of coatings work, Contractor representatives, including at a minimum, project superintendent, QC manager, paint foreman, Quality Assurance Coatings Inspector, and PCS must have a pre-application coating preparatory meeting. This meeting must be in addition to the pre-construction conference. Specific items addressed must include: corrective action requirements and procedures, coatings work plan, safety plan, coordination with other Sections, inspection standards, inspection requirements and tools, test procedures, environmental control system, safety plan, and test logs. Notify Contracting Officer at least ten days prior to meeting.

1.6   PRODUCT DATA

1.6.1   Coating System Instructions

Submit manufacturer's printed instructions, including detailed mixing and application procedures, number and types of coats required, minimum and maximum application temperatures, and curing procedures of all coating materials. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.7   DELIVERY AND STORAGE

Ship, store, and handle materials in accordance with SSPC PA 1, applicable standards, and as modified in this Section. Maintain temperature in storage spaces between 5 and 24 degrees C 40 and 75 degrees F, and air temperature more than 3 degrees C 5 degrees F above the dew-point at all times. Inspect materials for damage and return non-compliant materials to manufacturer. Remove materials with expired shelf life from government property immediately and notify the Contracting Officer.

If materials are approaching shelf life expiration and an extension is desired, samples must be sent to the manufacturer, along with complete records of storage conditions, with a request for shelf life extension. If the manufacturer finds the samples and storage data suitable for shelf life extension, the manufacturer must issue an extension, referencing the product evaluation and the review of storage records. Products must not be extended longer than allowed in the product specification.

1.8   COATING HAZARDS

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NOTE: This specification Section must be used with Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS.

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Ensure that employees are trained in all aspects of the safety plan. Specified coatings may have potential health hazards if ingested or improperly handled. The coating manufacturer's written safety precautions must be followed throughout mixing, application, and curing of the coatings. During cleaning, cleanup, surface preparation, and paint application phases, ensure that employees are protected from toxic and hazardous chemical agents which exceed concentrations in 29 CFR 1910.1000. Comply with respiratory protection requirements in 29 CFR 1910.134. The CIH must approve work procedures and personal protective equipment.

1.9   JOB SITE REFERENCES - SHOP

Make available to the Contracting Officer a copy of each standard to which the shop will be applying coatings under this Section.

1.10   JOB SITE REFERENCES - FIELD

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NOTE: Include any other references that might be added during design.

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Make available to the Contracting Officer a copy of each standard to which field coatings will be applied to under this Section, and an SSPC Certified

Contractor Evaluation Form at the job site.

PART 2 PRODUCTS

2.1 SHOP-APPLIED COATING FOR BURIED PIPING

2.1.1 External Pipe Coating

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NOTE: For carbon steel, use the first bracketed option (AWWA C215 Extruded Polyolefin Coatings for Steel Water Pipe) for normal situations, or the second option (AWWA C213 Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings) where fuel contaminated soil is anticipated.

For stainless steel, use the bracketed first bracketed option (AWWA C210 Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings or AWWA C215 Extruded Polyolefin Coatings for Steel Water Pipe) for normal situations, or the second bracketed option (AWWA C213 Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings) where fuel contaminated soil is anticipated.

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NOTE: When using AWWA standards for stainless steel, most coating manufacturers will require exceptions. Some of these exceptions will include a lower rating for cathodic disbondment. Ensure that this lower rating will not alter the warranty and will be sufficient to protect the pipe in the environment it is exposed to.

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[For carbon steel, extruded polyolefin coating over soft adhesive: AWWA C215.][For carbon steel, FBE coating: AWWA C213.]

[For stainless steel, liquid applied epoxy coating: AWWA C210.][For stainless steel, FBE coating: AWWA C213.][For stainless steel, extruded polyolefin: AWWA C215.]

[2.1.2 Internal Pipe Coating (Lining)

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NOTE: Delete requirement for lining where not required to protect aviation fuel. Internal linings and coatings must not be used for stainless steel piping.

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[For carbon steel, FBE coating: AWWA C213.][For carbon steel, liquid applied epoxy coating system: MPI 500 and MPI 501.] A certification must be provided from the coating manufacturer stating that the coating system is suitable for immersion service in aviation fuel.

]2.2 FIELD-APPLIED EXTERNAL PIPE COATING

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NOTE: Use the first bracketed portion where the shop-applied exterior coating is the AWWA C215 coating. Use the second bracketed portion when the exterior coating is the AWWA C213 coating. Use the third bracketed portion where the shop-applied exterior coating is the AWWA C210 coating.

While other methods of repairing/girth weld coating of FBE coatings are usable according to the standard, the options allowed here are limited to those that will provide satisfactory service in fuel contaminated soil.

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All coating materials used to coat external girth welds or repair existing coating must be from the same manufacture as the shop applied coating. Use one or more of the following repair methods, as modified herein, to repair shop applied coatings and coat external girth welds:

[a. Coal Tar Enamel: AWWA C203, Type II enamel, Type III outerwrap

b. Coal Tar Tape: AWWA C203

c. Cold Applied Tape: AWWA C209

d. Petrolatum or Petroleum Wax Tape Coating: AWWA C217

e. Heat Shrink Sleeve: AWWA C216

][a. Fusion-Bonded Epoxy (FBE) Coating: NACE RP0402, coating material to be same as applied to pipe in shop

b. Liquid-Epoxy Coating System: AWWA C210

][a. Liquid-Epoxy Coating System: AWWA C210

]2.3 COATING FIELD SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit for each sample to be collected. For FBE coatings, each kit must contain: a one liter quart can for the dry/powder; dipping cups for sampling; a shipping box sized for the samples to be shipped; and packing material. For liquid coatings, each kit must contain: a one liter quart can for the base of each liquid coatings material; one appropriately sized can for the activator of each liquid coatings material; dipping cups for each component to be sampled; a shipping box sized for the samples to be shipped; and packing material. Mark cans for the appropriate components (powder, base, or activator), including manufacturer's name, address, batch numbers, batch size shipped to the project site, and date of manufacture. Provide shipping documents, including either pre-paid shipping or a shipping number that can be used by the QC Manager to arrange pickup, addressed to the INDEPENDENT THIRD-PARTY coating testing laboratory.

2.4 ABRASIVE FIELD SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit for each sample to be collected. Each kit must contain: one suitable plastic bag or container for each sample to be collected. Mark containers with manufacturer's name, address, batch number, batch size, and date of manufacture. Provide shipping documents, including either pre-paid shipping label or a shipping number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

2.5 INSPECTION TEST KITS

2.5.1 Test Kit for Measuring Chloride, Sulfate, and Nitrate Ions on Steel and Coated Surfaces

Provide test kits that meet the following requirements:

a. Contains all materials, supplies, tools, and instructions for field testing and on-site quantitative evaluation of chloride, sulfate, and nitrate ions;

b. Extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Components and solutions are mercury free and environmentally friendly;

d. Contains new materials and solutions for each test extraction;

e. Contains an extraction test container (vessel, sleeve, cell) creates a sealed, encapsulated environment during salt ion extraction;

f. Contains a test extract container is suitable for testing the following steel surfaces: horizontal (up/down configuration), vertical, flat, curved, smooth, pitted, and rough;

g. All salt ion concentrations are directly measured in micrograms per square centimeter.

2.5.2 Test Kit for Measuring Chlorides in Abrasives

Provide test kits that meet all of the following requirements:

a. Be a completely self-contained test kit with all materials, supplies, tools, and instructions to take tests and identify results;

b. Use identifiable, consistent, factory pre-measured test extract solution;

c. Provide for testing equal volumes of abrasive and test solution;

d. Provide for taking direct measurements of the chloride ion in parts per million (PPM), without using conversion charts or tables;

e. Provide all new components for extraction and titration for each test;

f. Provide a factory sealed titration device for each test;

g. Use the extract sampling container as the titration container.

2.5.3 Test Kit for Identifying Amine Blush on Epoxy Surfaces

Provide test kits that meet all of the following requirements:

a. Be a completely self-contained field test kit with all materials, supplies, tools, and instructions to perform tests and indicate the presence of unreacted amines;

b. Use an identifiable, consistent, uniform, pre-packaged, factory pre-measured indicating solution;

c. Contains no mercury or lead and is environmentally friendly;

d. Contains a solution of an unreacted amine for the purpose of "self checking" the indicator solution.

2.6 ABRASIVE

Use abrasive that is specifically selected to provide a sharp, angular profile to the specified depth. Abrasive must meet all requirements of this Section each time that it is placed in the blast pot. The referenced abrasive specifications have maximum limits for soluble salts contamination; however, this maximum level of contamination does not guarantee that contamination will not be transferred to the steel surface during abrasive blasting. Other factors, such as on-site handling and recycling, can allow contamination of abrasive that can be transferred to the steel surface. Contractors are cautioned to verify that the chosen abrasive, along with work and storage processes, allow the final surface cleanliness requirements to be achieved. Successful testing of contamination in abrasive does not negate the final acceptance testing of steel surfaces.

Non-ferrous abrasives must be used for abrasive blasting stainless steel piping.

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NOTE: The following paragraph is mandatory for all PACNAVFACENGCOM projects. All other agencies may use it after checking applicability.

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[Abrasive material must contain a maximum of one percent by weight of any toxic substance listed in either Table Z-1, Z-2, or Z-3 of 29 CFR 1910-SUBPART Z, with the exception of inert or nuisance dust materials, arsenic, beryllium, cadmium, cobalt, lead, mercury, rhodium, silver, tellurium, thallium, and uranium.

] **

NOTE: Reduce allowable gross gamma radioactivity to 5 picocuries per gram for all PACDIV projects. Reduce in other areas if states or localities require.

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[Gross gamma radioactivity must not exceed 5 picocuries per gram.

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2.6.1 Ferrous Abrasive

2.6.1.1 New and Remanufactured Steel Grit

New and remanufactured steel grit abrasive must conform to the chemical and physical properties of SSPC AB 3 Class 1 (Steel) only; Class 2 (Iron) abrasive must not be used. Modify the requirements of SSPC AB 3 to substitute the requirement in paragraph 4.2.2 CONDUCTIVITY for one chloride test as measured using the test kit described in this Section (paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES). The maximum allowable chloride content is 25 parts per million (PPM).

To develop a suitable work mix from new steel abrasive, a minimum of 200 to 400 recycles is required; therefore, it may be advantageous for a Contractor to use remanufactured steel grit or grit reclaimed from a previous project. Such grit must be traced to new grit conforming to SSPC AB 3 Class 1 and it meets all cleanliness requirements of SSPC AB 3 Class 1 when brought to the current jobsite. Submit one representative sample of this work mix to the INDEPENDENT THIRD-PARTY laboratory for testing, along with samples of new material. Acceptance and use of this work mix must not be used to justify any deviation from surface preparation requirements.

2.6.1.2 Recycled Steel Grit

Recycled steel grit abrasive media must conform to the chemical and physical properties of SSPC AB 2 except that:

a. The maximum allowable chromium and cadmium content of the work mix must be 0.1 percent by weight when tested in accordance with ASTM D3718 for chromium and ASTM D3335 for cadmium. Modify the requirements of SSPC AB 2 to add requirement for one chromate test and one cadmium test for each "LEAD" test required.

b. The maximum allowable chloride content is 25 parts per million (PPM) as measured with the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES. Modify the requirements of SSPC AB 2 to substitute requirement for one chloride test for each "WATER SOLUBLE CONTAMINANTS" test.

2.6.2 Non-Metallic Abrasive

Non-metallic abrasive must be graded to the appropriate surface profile range and must conform to the chemical and physical properties of SSPC AB 1, Class A except that:

a. The maximum allowable chromium and cadmium content of the work mix must be less than 0.1 percent by weight when tested in accordance with ASTM D3718 for chromium and ASTM D3335 for cadmium.

b. Must contain less than 7 PPM chlorides when tested with the kit provided in paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES. Modify the requirements of SSPC AB 1 to substitute requirement for one chloride test for each "CONDUCTIVITY TEST" required in SSPC AB 1 (one random sample per 50 bags of abrasive or three random samples from each shipment, if abrasive is delivered in bulk).

PART 3 EXECUTION

Perform all work, rework, and repair in accordance with approved procedures in the Coatings Work Plan. The Coatings Work Plan must be submitted and approved by the PCS prior to mobilization in accordance with the paragraph entitled COATINGS WORK PLAN.

3.1 FIELD SAMPLE COLLECTION AND TESTING

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NOTE: For shop applied coatings, only the QC Manager and either the PCS or the Quality Assurance Coatings Inspector must witness sampling. For field applied coatings, the QC Manager and either the PCS or the Quality Assurance Coatings Inspector must witness sampling.

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Sample and test materials delivered to the jobsite as required in the subsequent subparagraphs. Notify Contracting Officer three days in advance of sampling. The QC Manager, and either the PCS or the Quality Assurance Coatings Inspector, must witness all sampling.

3.1.1 Coating Field Sample Collection

All coatings/resins applied in the shop and in the field require one sample to be collected from each coating type used. This sample must be collected and set aside for the duration of the project, and must be tested if unforeseen coatings issues arise or if testing is requested by the Contracting Officer.

Field applied coatings require a random field sample from each lot of coating material used on-site in accordance with ASTM D3925. Each random sample must be tested. Utilize sample collection kits as outlined in the paragraph entitled COATING FIELD SAMPLE COLLECTION AND SHIPPING KIT. For powder based coatings, collect a one liter quart sample from each lot by random selection. For two component liquid coatings, obtain a one liter quart sample of each base material, and proportional samples of each activator based on mix ratio, by random selection from sealed containers from each lot. Prior to sampling, mix contents of each sealed container to ensure uniformity. As an alternative to collecting small samples from kits, entire kits may be randomly selected and shipped to the THIRD-PARTY INDEPENDENT laboratory, observing all requirements for witnessing and traceability. For purposes of quality conformance inspection, a lot is defined as that quantity of materials from a single, uniform batch produced and offered for delivery at one time. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Identify samples by designated name, specification number, batch number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and ship one complete sample of each material in question (including powder or base and activator) with all batch information to the INDEPENDENT THIRD-PARTY laboratory for testing as required in paragraph COATING FIELD TESTING REPORTS.

3.1.2 Abrasive Field Sample Collection

Utilize the sample collection kits as required in paragraph ABRASIVE FIELD SAMPLE COLLECTION AND SHIPPING KIT to obtain samples from each lot of abrasive delivered to site using the sampling techniques and schedule of one sample per every 50 bags for ferrous metallic abrasive, paragraph 4 REQUIREMENTS FOR RECYCLED WORK MIX ABRASIVES of SSPC AB 2 for recycled ferrous metallic abrasives, or paragraph 5.3 SAMPLING FOR QUALITY CONTROL TESTS of SSPC AB 1 for non-metallic abrasives.

For purposes of quality conformance inspection, a lot must consist of all abrasive materials of the same type from a single, uniform batch produced and offered for delivery at one time. The addition of any substance to a batch must constitute a new lot. Identify samples by designated name, specification number, lot number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved INDEPENDENT THIRD-PARTY laboratory for testing required in paragraph ABRASIVE SAMPLE TEST REPORTS.

3.1.3 Coating Field Test Reports

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NOTE: Delete the bracketed coating systems that will not be used for this project.

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Submit test results for each sample that requires testing in the paragraph COATINGS FIELD SAMPLE COLLECTION. Test samples of coating material for compliance with requirements of [AWWA C203][AWWA C209][AWWA C210][AWWA C216][AWWA C217][NACE RP0402]. Reject entire batch represented by samples that fail one or more tests, select new lots, and test samples.

3.1.4 Abrasive Field Test Reports

Submit test results for each lot of abrasive delivered to the jobsite. Test samples of ferrous metallic abrasive to the requirements of paragraph 5.2 TEST PARAMETERS of SSPC AB 3, excluding paragraph 5.2.4 DURABILITY. Test samples of recycled ferrous metallic abrasives to the requirements of paragraph 4 REQUIREMENTS FOR RECYCLED WORK MIX ABRASIVES of SSPC AB 2. Test samples of non-metallic abrasive to the requirements of paragraph 5.3 SAMPLING FOR QUALITY CONTROL TESTS of SSPC AB 1. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

3.2 LIGHTING

Provide lighting for all work areas as prescribed in SSPC Guide 12.

3.3 ENVIRONMENTAL CONDITIONS

3.3.1 Automated Monitoring Requirements for Shop Applied Coating

Provide continuous monitoring of temperature, relative humidity, and dew point data at pertinent points in the shop, during surface preparation, coating application, and initial cure. This data does not suffice for documentation of conformity to surface conditions during application and cure of coating. Locate sensors to provide pertinent data for the surface preparation and coating application being performed, as well as the temperature extremes on the structure. Describe the location plan in the Coatings Work Plan. Monitor any heating, cooling, or dehumidification equipment used. Provide monitoring equipment to perform as follows:

a. Data is collected in 15-minute increments, and available for download (on-site) in a standard database format. Contractor must collect these data and make available to the Contracting Officer and QC Manager;

b. Monitoring equipment must have backup power such that data collection will be uninterrupted during the entire period of the dehumidification requirement;

c. Monitoring equipment must have capability to measure interior and exterior dry bulb temperature (DB), relative humidity (RH), and dewpoint temperature (DP).

There is no requirement for connectivity of the monitoring system to control the dehumidification equipment; therefore, any combination of equipment having the required functionality will be accepted.

3.3.2 Containment for Field Coating

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NOTE: Experience has shown that containment provides cost-effective control of environmental conditions, and the better conditions result in a better coating product.

SSPC Guide 6, has four classes of containment, from Class 1 being the highest level of control. Generally, Classes 1 and 2 are only required for removal of hazardous materials, while Class 3 is probably satisfactory for most coating operations. Class 4 requires minimal "knockdown" of airborne debris, and is not generally usable as an airborne particulate control measure.

****

Design and provide a containment system for the capture, containment, collection, storage, and disposal of the waste materials generated by the work under this Section, to meet the requirements of SSPC Guide 6, Class [1][2][3]. Vapor concentrations must be kept at or below 10 percent of Lower Explosive Limit (LEL) at all times. Containment may be designed as fixed containment for complete structure or portable containment for sections of structure; however, containment must remain in any one place from beginning of abrasive blasting through initial cure of coating. Waste materials covered by this paragraph must not include any material or residue from removal of coatings containing lead, chromium, cadmium, PCB, or any other hazardous material.

It is the Contractors responsibility to insure the feasibility and workability of the containment system. The Contractor must perform their operations and work schedule in a manner as to minimize leakage of the containment system. The containment system must be properly maintained and must not deviate from the approved drawings. If the containment system fails to function satisfactorily, the Contractor must suspend all operations, except those required to minimize adverse impact on the environment or government property. Operations must not resume until modifications have been made to correct the cause of the failure.

3.3.3 Automated Monitoring Requirements for Field Coating

Provide continuous monitoring of temperature, relative humidity, and dew point data at pertinent points on the structure, during surface preparation, coating application, and initial cure. This data does not suffice for documentation of conformity to surface conditions during application and cure of coating. Locate sensors to provide pertinent data for the surface preparation and coating application being performed, as well as the temperature extremes on the structure. Describe the location plan, including required moves, in the Coatings Work Plan. Monitor any heating, cooling, or dehumidification equipment used. Provide monitoring equipment to perform as follows:

a. Data is collected in the field unit in 15-minute increments, and available for download (on-site) in a standard database format. Contractor must collect these data and make available to the Contracting Officer, Quality Assurance Coatings Inspector, and QC Manager;

b. Monitoring equipment must have backup power such that data collection will be uninterrupted during the entire period of the dehumidification requirement;

c. Monitoring equipment must have capability to measure surface temperatures at a minimum of four locations anywhere on a structure, regardless of the size of the structure;

d. Monitoring equipment must have capability to measure interior and exterior dry bulb temperature (DB), relative humidity (RH), and dewpoint temperature (DP).

There is no requirement for connectivity of the monitoring system to control the dehumidification equipment; therefore, any combination of equipment having the required functionality will be accepted.

3.4 SHOP APPLIED COATING OF BURIED PIPING

3.4.1 Surface Preparation for Shop Applied Coating

Prepare exterior steel surfaces in accordance with [AWWA C210][AWWA C213][AWWA C215].

3.4.1.1 Abrasive Blasting Equipment for Shop Applied Coating of Buried Piping

Confirm that air supply for abrasive blasting is free of oil and moisture when tested in accordance with ASTM D4285. Test air quality at each startup, but in no case, less often than every five operating hours.

3.4.1.2 Contamination Evaluation of Abrasive for Shop Applied Coating of Buried Piping

Test abrasive for salt contamination and oil contamination as required SSPC AB 1 for non-metallic abrasives, SSPC AB 2 for recycled ferrous abrasives, and SSPC AB 3 for ferrous metallic abrasives. Modify the schedule of testing to be daily, at startup, and every five operating hours thereafter.

3.4.1.3 Pre-Preparation Testing for Surface Contamination for Shop Applied Coating of Buried Piping

3.4.1.3.1 Pre-Preparation Testing for Oil and Grease Contamination for Shop Applied Coating of Buried Piping

Inspect all surfaces for oil or grease contamination using two or more of the following inspection techniques:

(1) VISUAL INSPECTION - Observe surface for evidence of dirt or oil.

(2) WATER BREAK TEST - Spray atomized mist of distilled water onto surface and observe for water beading. If water wets surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.

(3) CLOTH RUB TEST - Rub a clean, white, lint-free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

Reject oil or grease contaminated surfaces, clean [using a water based pH neutral degreaser]in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.

3.4.1.3.2 Pre-Preparation Testing for Soluble Salts Contamination for Shop Applied Coating of Buried Piping

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NOTE: The testing for chlorides, sulfates, and nitrates (CSN) is especially important if there was evidence of corrosion production or if the bare surface has been contaminated prior to surface preparation.

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Test each lot of pipe for soluble salt contamination on the [internal and external]surfaces using the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDE, SULFATE, AND NITRATE IONS ON STEEL AND COATED SURFACES. For pipes with an outer diameter (OD) of less than 2.54 centimeters 6 inches, one test per 6.09 meters 20 lineal feet is required. For pipes with an OD of more than 2.54 centimeters 6 inches, three tests per 9.29 square meters 100 square feet must be taken, with a minimum of one test per section of pipe. Label all test tubes and retain for test verification. Reject and wash surfaces of the entire lot if one or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is measured.

Effective washing and removal of soluble salts will require removal of any barrier to the steel surface, including rust or mill scale. This procedure may necessitate combinations of wet abrasive blasting, high pressure water rinsing, and cleaning using a solution of water and soluble salt remover. The soluble salt remover must be acidic, biodegradable, non-toxic, non-corrosive, and after application, will not interfere with primer adhesion. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting.[Additional testing is required when there are delays between testing and preparation or testing and coating application.] Test methods and equipment used in this phase must be included in the Coatings Work Plan.

This phase is required because pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Soluble salt testing is also required in paragraph PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION as a final acceptance test of prepared surfaces after abrasive blasting. Successful completion of pre-preparation testing and washing does not negate the requirement for pre-application testing.

3.4.1.4 Abrasive Blasting External Surfaces for Shop Applied Coating of Buried Piping

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NOTE: Select bracketed coating system consistent with the external coating system selected in SHOP-APPLIED COATING FOR BURIED PIPING.

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[For carbon steel, prepare surfaces in accordance with SSPC SP 10/NACE No. 2.][For stainless steel, prepare surfaces in accordance with SSPC SP 17. The surface profile must be in accordance with the coating manufacturer's recommended range. Non-ferrous abrasives must be used.]The surface profile must be in accordance with [AWWA C210][AWWA C213][AWWA C215] and measured in accordance with ASTM D4417, Method A and Method C. The appearance of the surface after blasting must have the appearance of a Sand or Grit comparator. A rounded profile shape or peened surface is not acceptable. Measure profile at a rate of three measurements per lot at the beginning of the day.

[3.4.1.5 Abrasive Blasting Internal Surfaces for Shop Applied Coating of Buried Piping

For carbon steel, prepare surfaces in accordance with SSPC SP 10/NACE No. 2. The surface profile must be in accordance with the coating manufacturer's recommended range. Measure surface profile in accordance with ASTM D4417, Method A and Method C. The appearance of the surface after blasting must have the appearance of a Sand or Grit comparator. A rounded profile shape or peened surface is not acceptable. For pipes with an outer diameter (OD) of less than 2.54 centimeters 6 inches, one test per 6.09 meters 20 lineal feet is required. For pipes with an OD of more than 2.54 centimeters 6 inches, three tests per 9.29 square meters 100 square feet must be taken, with a minimum of one test per section of pipe. Internal lining must not be used for stainless steel piping.

]3.4.1.6 Disposal of Used Abrasive for Shop Applied Coating of Buried Piping

Provide Disposal of Used Abrasive Shop Applied Coating, in accordance with Federal, State, and Local mandated regulations.

3.4.1.7 Pre-Application Testing for Surface Contamination for Shop Applied Coating of Buried Piping

3.4.1.7.1 Pre-Application Testing for Oil and Grease Contamination for Shop Applied Coating of Buried Piping

Ensure surfaces are free of contamination as described in paragraph PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, except that only questionable areas need be checked for beading of water misted onto surface.

3.4.1.7.2 Pre-Application Testing for Surface Cleanliness for Shop Applied Coating of Buried Piping

Apply coatings to dust free surfaces. To test surfaces, use ISO 8502-3. Use a kit that is compliant with ISO 8502-3. A rating of 2 or better must be achieved for acceptance. If a test does not result in a rating of 2 or better, reject contaminated surfaces, clean by vacuum cleaning, and retest. Test surfaces at rate of one test per joint or repair area where application will be performed. Provide two additional tests for each failed test or questionable test. Document test results in the Daily Inspection Report and attach tape to the Inspection Logbook.

Ferrous abrasives may become magnetized and difficult to remove from the steel substrate. If ferrous abrasives are used, additional visual inspection must be performed to ensure no surface contamination by the abrasive is present.

3.4.2 Mixing and Application of Shop Applied Coating of Buried Piping

[3.4.2.1 Mixing Liquid Epoxy Coatings

Mix materials as stated in coating system instructions. Mix materials in same temperature and humidity conditions specified in paragraph DELIVERY AND STORAGE. Allow mixed material to stand for the required induction time.

Apply mixed products within stated pot life for each product. Stop applying when material becomes difficult to apply in a smooth, uniform wet film. Do not add solvent to extend pot life. Add all required solvent, if allowable by the coating manufacturer, at time of mixing.

]3.4.2.2 External Pipe Shop Applied Coating Application

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NOTE: Select bracketed coating system consistent with the external coating system selected in SHOP-APPLIED COATING FOR BURIED PIPING.

****

Apply coatings in accordance with SSPC PA 1 and as specified in [AWWA C210][AWWA C213][AWWA C215]. Apply coatings to surfaces that meet all stated surface preparation requirements.

[For the application of AWWA C210, the dry film thickness (DFT) must be a minimum of 400 microns 16 mils. The coating thickness must not exceed the manufacturers recommendations.

][For the application of AWWA C213, the DFT must be a minimum of 300 microns 12 mils. The coating thickness must not exceed the manufacturers recommendations.

][For the application of AWWA C215, the total coating thickness must be a minimum of as shown in the below table:

Pipe Diameter (mm)	Adhesive (mm)	Polyolefin (mm)	Total Thickness (mm)
0 to 50	0.20	0.56	0.76
75 to 150	0.20	0.76	0.96
200 to 400	0.20	0.92	1.12
450 to 900	0.20	1.02	1.22

Pipe Diameter (mm)	Adhesive (mm)	Polyolefin (mm)	Total Thickness (mm)
Greater than 950	0.20	1.52	1.72

Pipe Diameter (in)	Adhesive (mils)	Polyolefin (mils)	Total Thickness (mils)
0 to 2	8	22	30
3 to 6	8	30	38
8 to 16	8	36	44
18 to 36	8	40	48
Greater than 38	8	60	68

The coating thickness must not exceed the manufacturers recommendations.

][3.4.2.3 Internal Pipe Coating Application

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NOTE: Select bracketed coating system consistent with the internal coating system selected in SHOP-APPLIED COATING FOR BURIED PIPING.

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NOTE: Internal coatings must not be used with stainless steel piping.

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[For AWWA C213, apply coatings in accordance with SSPC PA 1 and as specified in AWWA C213.][For MPI 500 and MPI 501, apply coating in accordance with SSPC PA 1 and as directed by the coating manufacturer.]Apply coatings to surfaces that meet all stated surface preparation requirements.

[For the application of AWWA C213, the DFT must be a minimum of 300 microns 12 mils. The coating thickness must not exceed the manufacturers recommendations.

][For the application of MPI 500 and MPI 501, the coatings must be applied at the DFT specified in the coating system instructions.

]]3.4.2.4 Holiday Testing and Shop Repair

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NOTE: Select bracketed coating system consistent with the coating system selected in SHOP-APPLIED COATING FOR BURIED PIPING.

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Perform holiday testing on all shop-applied, externally coated areas and repair as outlined in [AWWA C210][AWWA C213][AWWA C215].

3.5 FIELD EXTERIOR COATING OF ABOVEGROUND PIPING

Coat aboveground, carbon steel piping in accordance with Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES.

3.6 FIELD REPAIRS TO EXTERNAL COATING OF BURIED PIPING

Field repairs must only be performed when repairing shop applied coatings in the field and coating external girth welds.

3.6.1 Surface Preparation for Field Coating of Buried Piping

Block or suspended pipeline at a height that will allow the blast nozzle to be perpendicular to the surface being blasted, and at the proper standoff distance, at all times.

3.6.1.1 Abrasive Blasting Equipment for Field Coating of Buried Piping

Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 650 kPa 95 psig at nozzle. Confirm that air supply for abrasive blasting is free of oil and moisture when tested in accordance with ASTM D4285. Test air quality at each startup, but in no case, less often than every five operating hours.

3.6.1.2 Contamination Evaluation of Abrasive for Field Coating of Buried Piping

Test abrasive for salt contamination and oil contamination as required SSPC AB 1 for non-ferrous abrasives, SSPC AB 2 for recycled ferrous abrasives, and SSPC AB 3 for ferrous abrasives. Modify the schedule of testing to be daily, at startup, and every five operating hours thereafter.

3.6.1.3 Surface Standard

Inspect surfaces to be coated, and select plate with similar properties and surface characteristics for use as a surface standard. Blast clean one or more 300 mm one foot square steel panels in the manner specified in paragraph ABRASIVE BLASTING FOR FIELD COATING OF BURIED PIPING. Record blast nozzle type and size, air pressure at nozzle and compressor, distance of nozzle from panel, and angle of blast to establish procedures for blast cleaning. Measure surface profile in accordance with ASTM D4417, Method C. When the surface standard complies with all specified requirements, seal with a clearcoat protectant. Use the surface standard for comparison to abrasive blasted surfaces throughout the course of work.

3.6.1.4 Pre-Preparation Testing for Surface Contamination for Field Coating of Buried Piping

3.6.1.4.1 Pre-Preparation Testing for Oil and Grease Contamination for Field Coating of Buried Piping

Inspect all surfaces for oil or grease contamination using two or more of the following inspection techniques:

(1) VISUAL INSPECTION - Observe surface for evidence of dirt or oil.

(2) WATER BREAK TEST - Spray atomized mist of distilled water onto surface and observe for water beading. If water wets surface rather than beading up, surface can be considered free of oil or

grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.

(3) CLOTH RUB TEST - Rub a clean, white, lint-free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

Reject oil or grease contaminated surfaces, clean using a water based pH neutral degreaser in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.

3.6.1.4.2 Pre-Preparation Testing for Soluble Salts Contamination for Field Coating of Buried Piping

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NOTE: The testing for chlorides, sulfates, and nitrates (CSN) is especially important if there was evidence of corrosion production or if the bare surface has been contaminated prior to surface preparation.

****

Prior to abrasive blasting, test all exposed girth welds and areas to be recoated for soluble salt contamination using the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDE, SULFATE, AND NITRATE IONS ON STEEL AND COATED SURFACES. Label all test tubes and retain for test verification. Reject and wash surfaces if one or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is measured.

Effective washing and removal of soluble salts will require removal of any barrier to the steel surface, including rust. This procedure may necessitate combinations of wet abrasive blasting, high pressure water rinsing, and cleaning using a solution of water and soluble salts remover. The soluble salts remover must be acidic, biodegradable, non-toxic, non-corrosive, and after application, will not interfere with coating adhesion. Delays between testing and preparation, or testing and coating application, may allow for the formation of new contamination. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Test methods and equipment used in this phase must be included in the Coatings Work Plan.

This phase is required because pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Soluble salt testing is also required in paragraph PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION FOR FIELD COATING OF BURIED PIPING as a final acceptance test of prepared surfaces after abrasive blasting. Successful completion of pre-preparation testing and washing does not negate the requirement for pre-application testing.

3.6.1.5 Abrasive Blasting for Field Coating of Buried Piping

[For carbon steel, prepare girth welds and repairs to bare steel to SSPC SP 10/NACE No. 2 immediately prior to coating application. Verify that prepared surfaces comply with SSPC VIS 1 and match the prepared test-panels from the paragraph SURFACE STANDARD at the time of coating application. The surface profile must be in accordance with the coating manufacturer's recommended range. Measure the surface profile in accordance with ASTM D4417, Method A and Method C. The appearance of the surface after blasting must have the appearance of a Sand or Grit comparator. A rounded profile shape or peened surface is not acceptable. For pipes with an outer diameter (OD) of less than 2.54 centimeters 6 inches, one test per 6.09 meters 20 lineal feet is required. For pipes with an OD of more than 2.54 centimeters 6 inches, three tests per 9.29 square meters 100 square feet must be taken, with a minimum of one test per section of pipe. Internal lining must not be used for stainless steel piping. When surfaces are re-blasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Dust and debris tend to collect at welds, plate overlaps, and surface irregularities. Do not attempt to wipe surface clean.][For stainless steel, prepare girth welds and repairs to bare steel to SSPC SP 17 immediately prior to coating application. Verify that prepared surfaces comply with SSPC VIS 1 at time of coating application. All other surfaces must be prepared in accordance with the appropriate coating standard referenced herein. The surface profile must be in accordance with the coating manufacturer's recommended range. Measure the surface profile in accordance with ASTM D4417, Method A and Method C. The appearance of the surface after blasting must have the appearance of a Sand or Grit comparator. A rounded profile shape or peened surface is not acceptable. For pipes with an outer diameter (OD) of less than 2.54 centimeters6 inches, one test per 6.09 meters 20 lineal feet is required. For pipes with an OD of more than 2.54 centimeters 6 inches, three tests per 9.29 square meters 100 square feet must be taken, with a minimum of one test per section of pipe. Internal lining must not be used for stainless steel piping. Non-ferrous abrasive must be used. When surfaces are re-blasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Dust and debris tend to collect at welds, plate overlaps, and surface irregularities. Do not attempt to wipe surface clean.]

3.6.1.6 Disposal of Used Abrasive for Field Coating of Buried Piping

Provide Disposal of Used Abrasive Field Applied Coating off Government property in accordance with Federal, State, and Local mandated regulations.

3.6.1.7 Pre-Application Testing for Surface Contamination for Field Coating of Buried Piping

3.6.1.7.1 Pre-Application Testing for Oil and Grease Contamination for Field Coating of Buried Piping

Ensure surfaces are free of contamination as described in paragraph PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION FOR FIELD COATING OF BURIED PIPING, except that only questionable areas need to be checked for beading of water misted onto surface.

3.6.1.7.2 Pre-Application Testing for Soluble Salts Contamination for Field Coating of Buried Piping

****

NOTE: The testing for chlorides, sulfates, and nitrates (CSN) is especially important if there was evidence of corrosion production or if the bare surface has been contaminated prior to coating

application.
****

Test surfaces for soluble salts using the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDE, SULFATE, AND NITRATE IONS ON STEEL AND COATED SURFACES, test girth welds and areas to be recoated for soluble salts. Label all test tubes and retain for test verification. One or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is evidence of soluble salt contamination. Reject contaminated surfaces, wash as required in paragraph PRE-PREPARATION TESTING FOR SOLUBLE SALTS CONTAMINATION FOR FIELD COATING OF BURIED PIPING, allow to dry, and re-test, and re-wash until all required tests show allowable results. Re-blast tested areas using vacuum equipped blast equipment.

3.6.1.7.3 Pre-Application Testing for Surface Cleanliness for Field Coating of Buried Piping

Apply coatings to dust free surfaces. To test surfaces, use ISO 8502-3. Use a kit that is compliant with ISO 8502-3. A rating of 2 or better must be achieved for acceptance. If a test does not result in a rating of 2 or better, reject contaminated surfaces, clean by vacuum cleaning, and retest. Test surfaces at rate of one test per joint or repair area where application will be performed. Provide two additional tests for each failed test or questionable test. Document test results in the Daily Inspection Reports and attach tape to the Inspection Logbook.

Ferrous abrasives may become magnetized and difficult to remove from the steel substrate. If ferrous abrasives are used, additional visual inspection must be performed to ensure no surface contamination by the abrasive is present.

3.6.2 Coating Mixing and Application for Field Coating of Buried Piping

3.6.2.1 Mixing Coating Materials for Field Coating of Buried Piping

a. Mix and apply coating materials in accordance with the approved coating system instructions, which may differ for each product. Do not mix partial kits unless standardized measuring cups are utilized. Do not alter mix ratios. Mix materials in same temperature and humidity conditions specified in paragraph DELIVERY AND STORAGE. Allow mixed material to stand for the required induction time. All mixing processes must be witnessed by the Quality Assurance Coatings Inspector.

b. Apply mixed products within stated pot life for each product. Stop applying when material becomes difficult to apply in a smooth, uniform wet film. Do not add solvent to extend pot life. Add all required solvent at time of mixing, as allowable per the coating system instructions.

c. If coating materials are not liquid materials (i.e., powder or extrusion materials), this paragraph may not apply. Follow the recommended instructions per the approved coating system instructions.

3.6.2.2 Application Conditions and Recoat Windows for Field Coating of Buried Piping

The application condition requirements for coatings are time and temperature sensitive. Plan coating application to ensure that specified temperature, humidity, and condensation conditions are met. If conditions do not allow for proper application of the coating materials, use appropriate means of controlling air and surface temperatures, as required. Partial or total enclosures, insulation, heating, cooling, or other appropriate measures may be required to control conditions to allow for orderly application of all required coats.

Maintain air and steel surface temperature within the range allowable by the approved coating system instructions during application and initial cure. Maintain steel surface temperature more than 3 degrees C 5 degrees F above the dew-point of the ambient air for the same period. These conditions may require environmental controls through containment.

3.6.2.3 Coating Application for Field Coating of Buried Piping

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NOTE: Select bracketed coating system consistent with the coating system selected in FIELD-APPLIED EXTERNAL PIPE COATING.

****

Apply coatings in accordance with SSPC PA 1 and as specified in [AWWA C203][AWWA C209][AWWA C210][AWWA C216][AWWA C217][NACE RP0402]. Apply coatings to surfaces that meet all stated surface preparation requirements.

3.6.2.4 Holiday Testing and Field Repair

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NOTE: Select bracketed coating system consistent with the coating system selected in FIELD-APPLIED EXTERNAL PIPE COATING.

****

Perform holiday testing on all field coated areas and repair as outlined in [AWWA C203][AWWA C209][AWWA C210][AWWA C216][AWWA C217][NACE RP0402].

3.6.3 Final Inspection of Pipeline Prior to Burial

Verify that all surfaces of the pipeline are holiday-free at time of placement of backfill over pipe. Use holiday inspection requirements and acceptance criteria of the standards applicable to the coatings being tested.

3.6.4 Final Cleanup

Following completion of the work, remove debris, equipment, and materials from the site. Remove all foreign matter such as blast media, dust, dirt, debris, grease, and oils. Wipe all dry to handle coated surfaces with damp lint-free cloth. Remove temporary connections to Government- or Contractor-furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

3.7 FIELD AND SHOP QUALITY CONTROL

For marking of surfaces, use chalk for marking bare steel and water based markers for marking coated surfaces. Remove marks prior to coating. Do not use any wax or grease based markers, or any other markers that leave a residue or stain.

3.7.1 Inspection

3.7.1.1 Inspection Requirements

a. Perform inspections in accordance with ASTM D3276 and the approved Coatings Work Plan.

b. Provide all tools and instruments required to perform the required testing, as well as any tools or instruments that the inspector considers necessary to perform the required inspections and tests. Document each inspection and test, including required hold points and other required inspections and tests, as well as those inspections and tests deemed prudent from on-site evaluation to document a particular process or condition, as follows:

  (1) Location or area;

  (2) Purpose (required or special);

  (3) Method;

  (4) Criteria for evaluation;

  (5) Results;

  (6) Determination of compliance;

  (7) List of required rework;

  (8) Observations.

c. Collect and record environmental conditions as described in ASTM D3276 on a 24 hour basis, as follows:

  (1) During surface preparation, every hour, or when changes occur;

  (2) During coating application and the first four days of initial cure, every hour, or when changes occur;

  (3) Note location, time, and temperature of the highest and lowest surface temperatures each day;

  (4) Use a non-contact thermometer to locate temperature extremes, then verify with contact thermometers.

d. Data collected on environmental conditions in AUTOMATED MONITORING REQUIREMENTS may be used for overnight data; however, the data must be constantly verified as to location of sensors and validity of data with respect to the coating work being accomplished.

e. Document all equipment used in inspections and testing, including manufacturer, model number, serial number, last calibration date and future calibration date, and results of on-site calibration performed. Work documented using data from equipment found to be out of calibration must be considered as non-compliant since last calibration or calibration check, as required.

f. Document Contractors compliance with the Coatings Work Plan.

3.7.1.2 Inspection Report Forms

Develop project-specific report forms as required to report measurements, test results, and observations being complete and conforming to contract requirements. This includes all direct requirements of the contract documents and indirect requirements of referenced documents. Show acceptance criteria with each requirement and indication of conformity of each inspected item. The data may be in any format, but must be legible and presented so that entered data can be quickly compared to the appropriate requirement.

3.7.1.3 Daily Inspection Reports

Submit one copy of daily inspection report completed each day when performing work under this Section, to the Contracting Officer. Note all non-compliance issues, and all issues that were reported for rework in accordance with QC procedures of Section 01 45 00 QUALITY CONTROL. Each report must be signed by the Quality Assurance Coatings Inspector and the QC Manager. Submit report within 24 hours of date recorded on the report.

3.7.1.4 Inspection Logbook

A continuous record of all activity related to this Section must be maintained in an Inspection Logbook on a daily basis. The logbook must be hard or spiral-bound book or digital program with consecutively numbered pages, and must be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information. Submit the original Inspection Logbook to the Contracting Officer upon completion of the project and prior to final payment.

3.7.1.5 Inspection Equipment

All equipment must be in good condition, operational within its design range, and calibrated as required by the specified standard for use of each device.

3.7.2 Coatings Contractor QC Coatings Inspector's Responsibilities

The Coatings Contractor QC Coatings Inspector responsibilities include complete documentation of all daily inspection and production activities for the entire coatings project as outlined in the Coatings Work Plan, scope of work (SOW) project program, and this Section. This includes, but is not limited to, the following:

a. Attending and documenting the pre-job meeting and acquiring the scope of work (SOW) project program, inspection and testing plan (ITP), schedule, and a list of who will receive the QC daily inspection reports;

b. Performing a project site walk-through with the Quality Assurance Evaluator (QAE) or asset owner, Coatings Contractor QC, QC Manager, and Quality Assurance Coatings Inspector, inspecting at least the following:

    (1) Asset(s) to be coated;

    (2) Equipment and placement of equipment;

    (3) Materials delivery and storage;

(4) Facility operational requirements during the project.

c. Perform all daily and hold point inspections including, but not limited to, the following:

(1) Check equipment, including blotter test to verify compressed air cleanliness;

(2) Perform non-visible contaminants testing (in accordance with PRE-PREPARATION TESTING FOR SOLUBLE SALT CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, PRE-APPLICATION TESTING FOR SOLUBLE SALT CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, PRE-PREPARATION TESTING FOR SOLUBLE SALT CONTAMINATION FOR FIELD COATING OF BURIED PIPING, and PRE-APPLICATION TESTING FOR SOLUBLE SALT CONTAMINATION FOR FIELD COATING OF BURIED PIPING);

(3) Perform visible contaminants testing (in accordance with PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, PRE-APPLICATION TESTING FOR OIL AND GREASE CONTAMINATION FOR SHOP APPLIED COATING OF BURIED PIPING, PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION FOR FIELD COATING OF BURIED PIPING, and PRE-APPLICATION TESTING FOR OIL AND GREASE CONTAMINATION FOR FIELD COATING OF BURIED PIPING);

(4) Obtain environmental readings;

(5) Perform abrasive testing per SSPC AB 1, SSPC AB 2, or SSPC AB 3;

(6) Perform surface preparation monitoring and testing;

(7) Perform surface cleanliness testing;

(8) Perform dust quantity testing;

(9) Record materials storage documentation (record all coatings and abrasive materials information, batch numbers, segregation, and storage temperature);

(10) Witness all coatings materials mixing and record mix materials temperatures, with verification of time of coatings pot life;

(11) Verify, witness, and record application method;

(12) Perform random wet film thickness (WFT) readings;

(13) Perform inspection of coatings application;

(14) Obtain dry film thickness (DFT) readings per SSPC PA 2;

(15) Perform holiday testing in accordance with HOLIDAY TESTING AND SHOP REPAIR and HOLIDAY TESTING AND FIELD REPAIR;

(16) Label asset identification (label stickers);

(17) Write Correction Action Reports (CAR), if needed;

(18) Write Non-Conformance Reports (NCR), if needed.

d. Writing a daily detailed summary of the work shift inspections, testing, and the day's events, including any meetings and prevalent conversations. The final daily report must include a project summary that must be part of the daily coatings inspection report.

e. The Coatings Contractor QC Coatings Inspector must stop all non-compliant work.

3.7.3 Quality Assurance Coatings Inspector's Responsibilities

The Quality Assurance Coatings Inspector's responsibilities include complete documentation of all on-site work associated with the coatings project. These responsibilities include, but are not limited to, the following:

a. Attending and documenting the pre-job meeting and acquiring the scope of work (SOW) project program, inspection and testing plan (ITP), schedule, and a list of who will receive the QC daily inspection reports;

b. Performing a project site walk-through with the Quality Assurance Evaluator (QAE) or asset owner, prime Contractor, and coatings Contractor (QC Coatings Inspector and QC Manager), inspecting at least the following:

    (1) Asset(s) to be coated;

    (2) Equipment and placement of equipment;

    (3) Materials delivery and storage;

    (4) Facility operational requirements during the project.

c. Verifying all daily and hold point inspections performed by the Coatings Contractor QC Coatings Inspector or QC Manager by performing mirror inspections including, but not limited to, the following:

    (1) Verify equipment check, including blotter test to verify compressed air cleanliness;

    (2) Verify visible contaminants testing;

    (3) Take environmental readings;

    (4) Perform surface preparation monitoring and testing;

    (5) Perform surface cleanliness testing;

    (6) Perform dust quantity test;

    (7) Record materials storage documentation (record all coating and abrasive information, batch numbers, segregation, and storage temperature);

    (8) Witness all coatings materials mixing and record mix materials temperatures, with verification of time of coatings pot life;

    (9) Verify, witness, and record application method;

(10) Inspect coatings application;

(11) Perform dry film thickness (DFT) readings per SSPC PA 2;

(12) Inspect asset identification (label stickers);

(13) Write Correction Action Reports (CAR), if needed;

(14) Write Non-Conformance Reports (NCR), if needed.

d. The following testing is witnessed by the Quality Assurance Coatings Inspector and performed by the Coatings Contractor QC Coatings Inspector or QC Manager:

(1) Wet film thickness (WFT) readings by coatings applicator(s);

(2) Non-visible contaminants testing for chlorides, sulfates, and nitrates (CSN);

(3) Abrasive testing per SSPC AB 1, SSPC AB 2, or SSPC AB 3;

(4) Holiday testing.

e. Writing a daily detailed summary of the work shift inspections, testing, and the day's events, including any meetings and prevalent conversations. The final daily report must include a project summary that will be part of the last daily coatings inspection report.

3.8 PROJECT IDENTIFICATION

At the completion of the work, affix pertinent coating data on structure at a location that is readily accessible and visible from the ground. Use either stencils or nameplates. The following list generally describes the pertinent coating data, but should be modified as required to describe the coating systems.

Date coated/accepted: __________/___________

Project Number: ____________________________

Contractor: ________________________________

Address: ___________________________________

Coating System

Manufacturer: ____________________________

Surface Prep: SSPC SP ____ Profile: ______

Primer: __________________ Thickness: ____

Intermediate: ____________ Thickness: ____

Topcoat: _________________ Thickness: ____

Total Thickness: _________

3.8.1 Stencils

Use stencils on piping 203 mm 8 in or larger. Use stencils with 3/4- to one-inch Helvetica style letters and acrylic stencil paint of contrasting color.

3.8.2 Nameplates

****

NOTE: In a salt water environment, substitute acceptable non-corroding metal such as, but not limited to, nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer. Require melamine plastic nameplates for all NAVFAC projects.

****

Use nameplates for piping smaller than 8 inches. Construct plates of [anodized aluminum][stainless steel][melamine plastic, 3 mm 0.125 in thick, UV resistance, black with white center core, matte finish surface and square corners][_____]. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 25 by 65 mm one by 2.5 in. Lettering must be the normal block style with a minimum 6 mm 0.25 in height. Accurately align all lettering on nameplates.[For plastic nameplates, engrave lettering into the white core.]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 56 10 (May 2019)**
Change 1 - 11/20

Preparing Activity: USACE **Superseding**
UFGS-33 56 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-33 56 10 (May 2019)**
Change 1 - 11/20

Preparing Activity: USACE **Superseding**
UFGS-33 56 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 56 10

FACTORY-FABRICATED FUEL STORAGE TANKS

05/19, CHG 1: 11/20

****

NOTE: This guide specification covers the requirements for factory-fabricated fuel storage tanks. Tanks associated with equipment like generators but not integral to the equipment are also covered by this specification. Generator base tanks or belly tanks are not covered by this specification and must meet the requirements of Section 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This specification is intended for systems using factory-fabricated storage tanks with capacities less than or equal to 200,000 L 50,000 gal. For larger tank sizes, contact Service Headquarters. Additional system components/devices necessary to meet state and local regulations must be added by the designer. Design and install tank storage applications in accordance with UFC 3-460-01

"Design: Petroleum Fuel Facilities."

The design and installation of all aboveground and underground factory-fabricated fuel storage tanks must be coordinated with Base Environmental.

****

1.1 SUMMARY

This section defines the requirements for factory-fabricated fuel storage tanks.

1.1.1 Related Sections

1.1.1.1 Earthwork

****

NOTE: For underground tank installations, the designer developing the earthwork specifications will evaluate the need for a filter fabric to be installed between the native soil and the new backfill material. The intent of a filter fabric would be to prevent the displacement of new backfill material with native soil due to a high water table. If the new backfill material is displaced, it could affect the structural integrity of the tank specifically if the new tank(s) is the FRP type. If a filter fabric is determined to be necessary, include the requirements for the new fabric in the excavation and backfilling specifications.

Require backfill for Fiberglass Reinforced Plastic (FRP) tanks to be pea gravel or crushed stone. Require backfill for steel tanks to be pea gravel, crushed stone, or sand.

Require pea gravel to be between 3 and 20 mm 1/8 and 3/4 inch in diameter. Require crushed stone to be between 3 and 13 mm 1/8 and 1/2 inch in diameter. Require sand to be a fine aggregate that is washed and thoroughly dried, contains no more than 500 ppm chlorides, contains no more than 500 ppm sulfates, and has a pH greater than 7.

****

Excavation and backfilling for tanks must be as specified in Section 31 00 00 EARTHWORK.

1.1.1.2 Leak Detection

Leak detection must be as specified in Section 33 01 50.31 LEAK DETECTION FOR FUELING SYSTEMS.

1.1.1.3 Cathodic Protection

Provide buried metallic components including pipe, anchors, conduit, etc., with a cathodic protection system as specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [and] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

Cathodic protection for metal components that attach to a tank must be coordinated and compatible with the tank corrosion control system.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN PETROLEUM INSTITUTE (API)

API MPMS 2.2A	(1995; R 2017) Manual of Petroleum Measurement Standards Chapter 2-Tank Calibration Section 2A-Measurement and Calibration of Upright Cylindrical Tanks by the Manual Tank Strapping Method
API MPMS 2.2E	(2004; Errata 2009; R 2009) Petroleum and Liquid Petroleum Products - Calibration of Horizontal Cylindrical Tanks - Part 1: Manual Methods
API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 1615	(2011) Installation of Underground Petroleum Storage Systems
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F436	(2011) Hardened Steel Washers
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 30A	(2024; ERTA 1 2023) Code for Motor Fuel Dispensing Facilities and Repair Garages
NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 77	(2024; ERTA 1 2023) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 24-2) Standard for Aircraft Fuel Servicing
NFPA 704	(2022) Standard System for the Identification of the Hazards of Materials for Emergency Response
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC QP 3	(2010) Standard Procedure for Evaluating Qualifications of Shop Painting Applicators
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System

STEEL TANK INSTITUTE (STI)

STI 020-50-1000	(2010) ACT-100 Specification for External Corrosion Protection of FRP Composite Steel USTs
STI 700-50-5007	(2010) Installation Instructions for Shop Fabricated Aboveground Tanks for Flammable, Combustible Liquids
STI F911	(1998; Reissued 2009) Standard for Diked Aboveground Storage Tanks
STI P3	(2011) Specification and Manual for External Corrosion Protection of Underground Steel Storage Tanks

STI SP001	(2018, 6th Ed) SP001 Standard for The Inspection of Aboveground Storage Tanks
STI SP131	(2014) SP131 Standard for Inspection & Repair Underground Steel Tanks

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-161	(2005; Rev G; Notice 1 2010) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

UL SOLUTIONS (UL)

UL 58	(2018) UL Standard for Safety Steel Underground Tanks for Flammable and Combustible Liquids
UL 80	(2007; Reprint Oct 2024) Standard for Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids
UL 142	(2006; Reprint Jan 2021) UL Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 1316	(2018; Reprint Mar 2019) UL Standard for Safety Fiber Reinforced Underground Tanks for Flammable and Combustible Liquids
UL 1746	(2007; Reprint Dec 2014) External Corrosion Protection Systems for Steel Underground Storage Tanks
UL 2085	(1997; Reprint Sep 2010) Protected Aboveground Tanks for Flammable and Combustible Liquids

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the

Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding

SD-03 Product Data

Aboveground Storage Tank (Single Wall Steel); G, [_____]

Aboveground Storage Tank (Double Wall Steel); G, [_____]

Aboveground Storage Tank (Double Wall, Concrete Encased); G, [_____]

Underground Storage Tank; G, [_____]

Tank Protective Coatings; G, [_____]

Atmospheric Vent; G, [_____]

Pressure/Vacuum Vent; G, [_____]

Emergency Vent; G, [_____]

Independent Level Alarm System; G, [_____]

Tank Gauges; G, [_____]

Manhole Containment Sump; G, [_____]

Tank Mounted Fuel Dispensing Unit; G, [_____]

Fuel Heaters; G, [_____]

SD-06 Test Reports

Aboveground Storage Tank Tightness Tests; G, [_____]

Underground Storage Tank Tightness Tests; G, [_____]

Tank Manufacturer's Tests

Tank Fill Tests

Tank Inspection Reports; G, [_____]

SD-07 Certificates

Contractor Qualifications; G, [_____]

Manufacturer's Certification; G, [_____]

State Certification; G, [_____]

Pollution Liability Insurance

Permitting

Registration

Licensed Personnel

Demonstrations

STI SP001 Inspector's Certification; G, [_____]

SD-08 Manufacturer's Instructions

Aboveground Storage Tank

Underground Storage Tank

Independent Level Alarm System

Tank Gauges

Fuel Heaters

SD-10 Operation and Maintenance Data

Aboveground Storage Tank; G, [_____]

Underground Storage Tank; G, [_____]

Independent Level Alarm System; G, [_____]

Tank Gauges; G, [_____]

Fuel Heaters; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Contractor Qualifications

****

NOTE: Include specific local regulatory

requirements into the specification as applicable.
****

Each installation Contractor must have successfully completed at least 5 projects of the same scope, and the same size or larger within the last 3 years and demonstrated specific installation experience in regard to the specific system installation to be performed. Each installation Contractor must have taken, if applicable, manufacturer's training courses on the installation of storage tanks and must meet all applicable licensing requirements in the state. If applicable, state certified installers must be provided by the Contractor. Installers must also be trained and certified by the manufacturer to install the equipment and materials being installed and must be STI certified. Installers must submit certification from the [manufacturer][and][State]. If installing underground storage tanks and piping systems, installation Contractor must have Pollution Liability Insurance. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. The letter must also provide evidence of prior manufacturer's training, state licensing, and other related information.

1.4.2 Regulatory Requirements

1.4.2.1 Permitting

Obtain necessary permits in conjunction with the installation of storage tanks as required by federal, state, or local authority.

1.4.2.2 Registration

****
NOTE: The designer must confirm with the DoD Installation the number of days required to obtain the permit documentation.
****

Obtain and complete all tank registration forms required by federal, state, and local authorities. Submit all completed tank registration forms within [30][_____] days after contract award to the Contracting Officer. The Contracting Officer will ensure the Base Environmental staff for the DoD Installation submits the forms to the proper regulatory agencies.

1.4.2.3 Licensed Personnel

Tank installers must be licensed/certified by the state when the state requires licensed installers.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer, upon recommendation by Base Environmental for the DoD Installation. Replace damaged or defective items.

1.6 PROJECT/SITE CONDITIONS

Exposed moving parts, parts that produce high operating temperatures and pressures, parts that may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired.

1.7 WARRANTY

All factory-fabricated storage tanks must come with a manufacturer's warranty of a minimum period of 30 years. All warranty paperwork will be completed and submitted by Contractor to both the tank and system component manufacturers, the Contracting Officer, and the Base Environmental for the DoD Installation. This includes all applicable completed manufacturers' equipment installation checklists.

PART 2 PRODUCTS

2.1 ELECTRICAL WORK

****

NOTE: Coordinate the ignition temperature of the fuel(s) to be handled with the electrical design. Ignition temperatures will be as defined in NFPA 497. Fuel ignition temperatures will dictate the maximum allowable temperature rating of the electrical system components.

****

Provide controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of system components. Provide electrical system components, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM[, Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION][, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

2.1.1 Grounding and Bonding

Grounding and bonding must be in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.2 MATERIALS AND SYSTEM COMPONENTS

****

NOTE: Include the bracketed information if aviation fuel will be handled.

****

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Provide materials and system components that have been in satisfactory commercial or industrial use for a minimum 3 years prior to bid opening. The 3 year period must include applications of the system components and materials under similar circumstances and of similar size. Provide materials and system components that have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 3 year period.

Internal parts and components of system components, piping, piping components, and valves that could be exposed to fuel during system operation must not be constructed of zinc coated (galvanized) metal [, brass, bronze, or other copper alloys]. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

2.3 NAMEPLATES

****

NOTE: In a salt water environment, substitute acceptable non-corroding metal such as, but not limited to, nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

Require melamine plastic nameplates for all NAVFAC projects. Also, for NAVFAC projects, require nameplates to be associated or keyed to system charts and schedules.

****

Attach nameplates to all specified system components defined herein. List on each nameplate the manufacturer's name, address, [contract number,] [acceptance date,] component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of [anodized aluminum] [stainless steel] [melamine plastic, 3 mm 0.125 inch thick, UV resistance, black with white center core, matte finish surface and square corners] [_____]. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 25 by 65 mm one by 2.5 inches. Provide manufacturer's storage tank nameplates as required. [On concrete-encased tanks, provide a minimum smooth flat mounting surface of 300 by 300 mm 12 by 12 inches for attaching nameplates.] Lettering must be the normal block style with a minimum 6 mm 0.25 inch height. Accurately align all lettering on nameplates. [For plastic nameplates, engrave lettering into the white core.] [Key the nameplates to a chart and schedule for each system. Frame charts and schedule under glass, and locate where directed near each system. Furnish two copies of each chart and schedule. Each nameplate description must identify its function.]

2.4 ABOVEGROUND STORAGE TANK

****

NOTE: Two types of aboveground storage tanks are defined herein: single wall tanks and double wall tanks.

A single wall steel tank has no inherent integral secondary spill containment and can be mounted either on saddles or skids. Single wall steel tanks are required to be installed within a secondary containment system (e.g. dike area or integral skid mounted containment). For dike or spill containment designs refer to UFC 3-460-01 "Design: Petroleum Fuel Facilities" and/or 40 CFR 112 as applicable. When evaluating the application of a dike, note that

a dike offers poor aesthetics and requires extensive maintenance following rainfall. The water and water/fuel mix contained in a diked area must be evaluated after each rain and then properly disposed.

Double wall tanks are provided from the manufacturer with some type of integral secondary containment. Additional dikes and containment systems are not required for these tanks. Three types of double wall tanks are defined herein: double wall steel tank (non-fire resistant, non-protected), double wall steel tank (fire resistant, protected), and double wall tank (concrete encased).

Note that used or waste oil and hazardous wastes should be stored in aboveground storage tanks. Even though EPA allows the storage of these products below ground, a majority of state and local regulations prohibit underground storage of such products. If a design requires underground storage of used oil, waste oil, or hazardous wastes, confirm that the storage is allowed by state and local regulations. The storage of used or waste oil and hazardous wastes is bound by the same EPA requirements as is the storage of any other petroleum product. Contact the Base Environmental for storage of used oil, waste oil, or hazardous wastes.

****

2.4.1 Aboveground Storage Tank (Single Wall Steel)

****

NOTE: UL 80 tanks are typically 60 to 660 gallon storage tanks primarily used to store heating oil. These tanks are not very common in DoD fuel system.

****

Provide a factory-welded, single wall [stainless] steel tank manufactured to [UL 80][UL 142] and equipped to comply with [NFPA 30 for use as a flammable or combustible liquid storage tank][NFPA 30A for use as a motor vehicle dispensing tank][NFPA 31 for use as a heating oil tank]. Tank must be designed and manufactured for a [horizontal cylindrical] [vertical cylindrical] installation. Tank must be mounted on the tank manufacturer's standard UL listed [tank saddles] [support skid] that elevates the tank above the underlying concrete slab and/or concrete support a maximum of 305 mm 12 inches. [Support skid must span the entire length of the tank.] Tank assembly must have lifting lugs that allow tank relocation. [Provide tank assembly with the manufacturer's standard [stairway][external ladder] and catwalk assembly, except as modified herein. The [stairway][ladder] and catwalk assembly must be constructed of structural steel and must allow personal access to the top of the entire length of the tank system.] [The catwalk must have protective railings on tanks higher than 4 feet1.3 m.] [Provide a minimal 19 L 5 gal overfill containment box on the tank fill line. The containment box must be lockable and must contain any spillage encountered at the tank during tank filling operations.]

2.4.1.1 Integral Skid Mounted Containment

****
NOTE: Limit the use of these tanks to locations with lower amount of rainfall. For other areas, it is recommended that these tanks be installed under a canopy.
****

The secondary containment reservoir system (diked containment) must be the factory-fabricated, open-top, [stainless] steel type that conforms to STI F911. The primary storage tank must be supported within the containment with steel tank saddles, or other similar supports, fabricated and attached by the tank manufacturer. [The containment must be designed to minimize entry of rainwater or blowing debris.] The secondary containment system reservoir must be equipped with a 75 mm (3 inch) drain that includes a full line size carbon [stainless] steel drain line and a full line size lockable ball valve.

2.4.2 Aboveground Storage Tank (Double Wall Steel)

****
NOTE: Include one of the double wall tank subparagraphs listed below: double wall steel tank or double wall steel tank (fire-resistant, protected) and delete the others according to the project requirements.

UL 80 tanks are typically 60 to 660 gallon storage tanks primarily used to store heating oil. These tanks are not very common in DoD fuel system.
****

Provide a factory-assembled unit that includes a factory-fabricated primary storage tank and an integral secondary containment. Tank assembly must be in accordance with [NFPA 30] [NFPA 30A] [NFPA 31] and be designed and manufactured for a [horizontal cylindrical] [rectangular] [vertical cylindrical] installation. Primary storage tank must be factory-welded, [stainless] steel that conforms to [UL 80] [UL 142]. [Tank assembly must be mounted on [the tank manufacturer's standard UL listed support skid that elevates the tank assembly above the underlying concrete slab [or][support saddles] a maximum of 305 mm 12 inches].] Tank assembly must have lifting lugs that allow tank relocation. [Provide tank assembly with the manufacturer's standard [stairway][external ladder] and platform assembly, except as modified herein.] [The [stairway] [ladder] and platform assembly must be constructed of structural steel and must allow personal access to the top of the tank system.] [Provide [stairway][ladder] and platform as indicated on the drawings.] [Provide a minimal 19 L 5 gal spill container on the tank fill line. The container must be lockable and must contain any spillage encountered at the tank during tank filling operations.]

2.4.2.1 Double Wall Steel Tank

****
NOTE: These tanks do not conform to UL 2085. They are not fire-resistant or ballistic/vehicular impact resistant. The UL listing also includes minimum requirements for the assembly supports.

These type tanks should always require a pressure testable and verifiable interstitial space between the primary tank and the secondary containment (outer) tank.

****

The secondary containment (outer) tank must be a factory-fabricated, [stainless] steel type that fully-encloses the primary storage (inner) tank. The entire tank assembly must conform to UL 142 and bear the UL 142 label. The interstitial space between the primary tank and the secondary containment tank must be both pressure testable and verifiable. The primary storage tank must be supported within the secondary containment tank reservoir with steel tank saddles, or other similar supports, fabricated and installed by the tank manufacturer.

2.4.2.2 Double Wall Steel Tank (Fire-Resistant, Protected)

****

NOTE: Tanks that conform to UL2085 are referred to as protected tanks by NFPA 30A (2-hour fire rating when exposed to temperatures up to 1093 degrees C (2000 degrees F)). Manufacturer's typically meet this 2-hour rating by using either concrete or some type of lightweight thermal insulation between the primary tank and the outer containment reservoir. The UL listing also includes minimum requirements for the assembly supports. Delete the bracketed information in this paragraph if a protected type assembly is not required.

These type tanks should always require a pressure testable and verifiable interstitial space between the primary tank and the containment reservoir regardless if the 2-hour rating is specified or not.

****

The secondary containment (outer) tank must be a factory-fabricated, [stainless] steel, tank that fully-encloses the primary storage tank and must conform to UL 142. The interstitial space between the primary tank and the containment tank must be both pressure testable and verifiable. The entire tank assembly must conform to UL 2085 and bear the UL 2085 label. The primary storage tank must be supported within the containment tank with steel tank saddles, or other similar supports, fabricated and installed by the tank manufacturer.

2.4.3 Aboveground Storage Tank (Double Wall, Concrete Encased)

****

NOTE: These tanks are fire-resistant and ballistic/vehicular impact resistant conforming to UL 2085. These tanks have a primary (inner) steel tank surrounded by insulation and HDPE liner. The entire assembly is encased in concrete. These tanks are designed and manufactured for a rectangular installation. Per UFC 3-460-01, these tanks are limited to 5,000 gallons and below. Delete this paragraph if these tanks are not being provided.

****

The primary (inner) storage tank must be a factory-fabricated [stainless] steel tank and must conform to UL 142. The primary storage tank must be insulated. The secondary containment must be a minimum of 30 mil thick high density polyethylene (HDPE) liner encased in concrete that fully-encloses the primary storage tank. Concrete must have a minimum 27.57 MPa 4000 psi strength, be monolithically poured, and be properly reinforced for the application. The primary storage tank and insulation must be isolated from the exterior concrete encasement. The interstitial space between the primary tank and the containment reservoir must be verifiable for leaks. The entire tank assembly must conform to UL 2085 and bear the UL 2085 label.

2.5 UNDERGROUND STORAGE TANK

****

NOTE: Include one of the underground storage tank subparagraphs listed below: double wall steel tank (STI P3), double wall tank (steel with non-metallic jacket), and double wall FRP tank and delete the others according to the project requirements.

Provide a concrete anchor pad(s) or deadmen for any tank that will be installed in areas subject to high water tables or flooding. Size the pad(s) or deadmen in accordance with API RP 1615. Buoyant restraint must be obtained by using properly designed hold-down straps in conjunction with a concrete hold-down pad. Assume design conditions with the soil 100% saturated (water table at finished grade) and an empty tank. Design the hold-down pad with a factor of safety of 1.50 for resisting buoyant forces. Require the tank to be connected to the pad(s) or deadmen in accordance with the tank manufacturer's recommendations.

Delete the bracketed sentences if concrete anchor pads or deadmen are not required.

****

Provide a factory-fabricated, double wall type storage tank that conforms to NFPA 30, NFPA 30A, or NFPA 31. Tank must be designed and manufactured for an underground, horizontal installation. The exterior tank walls must be separated from the interior tank walls by standoffs; thus creating an open or interstitial space (Type II). The entire interstitial space must be monitorable for leaks. [For tanks requiring concrete anchor pads or concrete deadmen, provide holddown straps and accessories as recommended by the tank manufacturer. Use filler strips between the tank shell and any metal holddown straps that conform to the tank manufacturer's requirements.]

2.5.1 Double Wall Steel Tank (STI P3 Tank)

Tank must be constructed of steel and must conform to UL 58 Type II, UL 1746 Part I, and STI P3. Tanks must be cathodically protected and allow on-going monitoring of corrosion protection. Tanks constructed with lap welded shell or head joints must be continuous fillet welded; on both the interior and exterior surfaces. The UL 58 and STI P3label must be affixed to the exterior surface of the tank.

2.5.2 Double Wall Tank (Steel with Non-Metallic Jacket)

The primary tank must be constructed of steel and jacketed with a non-metallic secondary containment tank. The entire tank assembly must conform to UL 58 Type II and UL 1746 Part III. The UL 58 label must be affixed to the exterior surface of the tank.

2.5.3 Double Wall FRP Tank

Tank must be constructed of fiberglass reinforced plastic (FRP) and must conform to UL 1316. The UL 1316 label must be affixed to the exterior surface of the tank.

2.6 TANK PROTECTIVE COATINGS

[For tanks coated in California and where required by the State or local regulations, provide tank coating system in accordance with California Air Resources Board (CARB).]

2.6.1 Interior Surfaces

****

NOTE: Delete this paragraph if FRP tanks are the only type tanks specified. E-85 tanks must not be internally coated.

For Air Force projects, reference Section 09 97 13.17. For Army projects handling aviation fuel, reference Section 09 97 13.17 as applicable.

For miscellaneous use tanks, consider using standard manufacturer's coating system.

For all products, except for stainless steel tanks, tank interiors must be 100 percent coated. Tanks containing E85 are not to be coated internally unless otherwise approved by Service Headquarters. For all products, coat the interior of 3 inch and larger carbon steel piping and exterior of all carbon steel piping located inside the tank, and steel appurtenances inside all tanks. Carbon steel piping, and carbon steel appurtenances located inside of tanks containing E85 are not to be coated internally unless otherwise approved by Service Headquarters.

****

Coat 100 percent of a metal tank's interior surfaces including all metal piping and metal appurtenances as specified in [Section 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS][with the manufacturer's standard coating system] as modified herein.

2.6.1.1 Certifications of Coating Contractors

All Contractors and Subcontractors that perform surface preparation or coating application must be certified to SSPC QP 3 and SSPC QS 1 prior to contract award, and must remain certified while accomplishing any surface preparation or coating application. Painting contractors and painting subcontractors must remain so certified for the duration of the project. If a contractor or subcontractor certification expires, the firm is not allowed to perform any work until the certification is reissued. Requests for extension of time due to delay as a result of an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in certification status. Notify the Contracting Officer of all scheduled or unannounced on site audits from SSPC and furnish a copy of all audit reports.

2.6.2 Exterior Surfaces, Aboveground Tanks

****

NOTE: For Navy and Air Force projects, reference Section 09 97 13.27.

For miscellaneous use tanks, consider using standard manufacturer's coating system.

****

Protect the exterior surfaces of each aboveground tank [as specified in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES] [with the manufacturer's standard coating system as modified herein] [as specified in Section 09 90 00 PAINTS AND COATINGS] as modified herein.

2.6.2.1 Certifications of Coating Contractors

All Contractors and Subcontractors that perform surface preparation or coating application must be certified to SSPC QP 3 and SSPC QS 1 prior to contract award, and must remain certified while accomplishing any surface preparation or coating application. Painting contractors and painting subcontractors must remain so certified for the duration of the project. If a contractor or subcontractor certification expires, the firm is not allowed to perform any work until the certification is reissued. Requests for extension of time due to delay as a result of an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in certification status. Notify the Contracting Officer of all scheduled or unannounced on site audits from SSPC and furnish a copy of all audit reports.

2.6.3 Exterior Surfaces, Underground Tanks

****

NOTE: Delete this paragraph if FRP tanks are the only type tanks specified.

****

Provide steel tanks with one of the following corrosion protection systems.

2.6.3.1 FRP Coating System

****

NOTE: Steel tanks using an FRP coating system do not require any additional cathodic protection systems.

****

Coating system must be in accordance with UL 1746 Part IV and UL 58. The integrity of the coating must be certified by the manufacturer as meeting the thickness requirements and having no flaws prior to shipment. The UL label must be affixed and visible on the exterior surface of each coated tank.

2.6.3.2 STI P3 Coating System

****

NOTE: This system provides an exterior protective coating, cathodic protection, and electrical isolation for corrosion protection. Electrical designer will verify that standard STI P3 protection is adequate for the site.

****

Exterior tank must be coated with a dielectric coating system, cathodically protected, and electrically isolated. Coating system must be in accordance with STI P3, UL 1746 Part I, and UL 58. Tank manufacturer must be licensed by the Steel Tank Institute as an applicator of the STI P3 system. The STI label must be affixed and visible on the exterior surface of each coated tank.

2.6.4 Tank Labeling

****

NOTE: Applicable to aboveground storage tanks (ASTs) only.

****

Tank must be labelled with the following information at a minimum:

a. Product Stored and Tank Capacity (Per MIL-STD-161).

b. Tank Number and Facility Number.

c. NFPA 704 Diamond Hazmat Label.

2.7 TANK COMPONENTS

****

NOTE: The following tank components are for aboveground and underground storage tanks, unless specifically stated otherwise.

****

2.7.1 Tank Manhole

****

NOTE: Indicate the number, size, and location of each tank manhole required.

Provide tanks 18,900 L 5,000 gallons and smaller with a minimum of one 760 mm 30 inch tank manhole to allow for internal tank access. Provide tanks larger than 18,900 L 5,000 gallons with a minimum of two 915 mm (36 inch) tank manholes (one manhole for access). Diesel and bio-diesel tanks at military service stations are to be provided with a 813 mm (32 inch) access manhole. Piping will not penetrate through access manholes.

****

Tank manholes must have an internal diameter of [760 mm 30 inches] [813 mm 32 inches] [915 mm 36 inches]. Provide each manhole with a matching flanged watertight manhole cover. Manhole covers must be UL listed, be constructed of pressed or mild steel, and include a UL listed gasket. [Frame and cover assembly must be rated to withstand H-20 highway loading as defined by AASHTO HB-17.]

2.7.2 Tank Piping Penetrations

****

NOTE: For underground storage tanks, use tank manholes as the primary point of entry for piping penetrations unless unfeasible. Pipe penetrations into an underground storage tank are the most likely place for a leak to occur. Designing pipe penetrations to enter through a tank manhole allows each of the penetrations to be contained in a manholecontainment sump. The piping that penetrates the manhole must be flanged on both sides of the manhole hatch. This will allow the piping to be removed from the manhole and allow removal of the manhole without having to cut the piping. Note the aboveground piping may be required to be a spool piece.

Where stand alone tank piping penetrations are required, indicate on the drawings the required number, size, and location of each penetration.

Flanged nozzles must be installed in locations with ISO Corrosivity Categories C3, C4, and C5 while threaded nozzles can be installed in locations with ISO Corrosivity Categories C1 and C2.

****

Provide a welded-in-place [double tapered National Pipe Thread (NPT) coupling] [flanged pipe nozzle] for each tank piping connection. All unused or spare tank piping penetrations must be sealed with [malleable iron plugs] [steel plugs] [steel flanges] [or] [as indicated].

2.7.3 Tank Striker/Impact Plates

****

NOTE: Striker plates under all openings used for manual gauging in steel tanks and all openings in fiberglass tanks.

****

Provide an interior striker/impact plate under each tank manhole and pipe connection. Each plate must be a minimum of 6 mm 1/4 inch in thickness, be larger in diameter than the tank penetration, fit the curvature of the tank bottom, and be completely coated in the same fashion as the interior tank bottom coating. Each plate must be welded to the tank bottom at the factory (full circumference connection). The welds must be non-destructive tested using the appropriate means.

2.7.4 Manual Gauging/Sampling Hatch

Provide a combination gauging and sampling hatch assembly. The assembly must include a bronze top-seal type adapter with a corresponding locking type cap (adapter and cap both externally-mounted to the top of the tank) [and a [steel] or [aluminum] stilling well pipe.] [The stilling well pipe must be a minimum 100 mm 4 inches in size and extend downward through the top of the tank to within 75 mm 3 inches of the tank bottom. Provide the entire length of pipe inside the tank with 13 mm 1/2 inch wide by 300 mm 12 inches long slots at alternate locations. Coat the pipe in the same fashion as the interior tank bottom coating.]

2.7.5 Tank Ladder

****

NOTE: Coordinate the need of an internal ladder with the user. Recommend providing tanks larger than 18,900 L 5,000 gallons with an internal tank ladder. Internal ladders may not be appropriate on smaller tanks with only one manhole. Indicate on the drawings which tank manhole is to be provided with an internal ladder.

****

Provide interior tank ladders constructed of either fiberglass or steel. If steel, coat the ladder in the same fashion as the tank interior. The two stringers must be a minimum 10 mm 3/8 inch thick and a minimum 50 mm 2 inches wide. The rungs must be a minimum 20 mm 3/4 inch rod on 300 mm 12 inches centers. Members of the ladder must be securely affixed. Ladder must be of sufficient length to extend from the bottom of the tank to the top surface of the tank. Ladder must be rigidly connected to the tank bottom in accordance with the tank manufacturer's standard. Ladder must be connected to the top of the tank with pipe guides or slip bars to accommodate expansion of the two stringers.

2.7.6 Tank Venting

****

NOTE: The aboveground termination point of a storage tank's vent piping will be provided with either an atmospheric vent or a pressure\vacuum vent. The decision on which item to use will be based upon the characteristics of the fuel to be handled (refer to NFPA 30, 30A and UL 142 as applicable). Delete paragraphs as required.

****

2.7.6.1 Atmospheric Vent

Provide atmospheric, updraft type cap. Cap must be constructed of aluminum or carbon steel. Cap must have an internal brass or bronze insect screen, minimum 40-mesh. Cap must prevent rain, snow, or ice from entering the vent piping.

2.7.6.2 Pressure/Vacuum Vent

Tank vent outlet must be equipped with pressure-vacuum breather vent, aluminum construction with weather hood and with fluoroelastomer (FKM, Viton) pallet seat inserts, high density screens, stainless steel internals, with pressure relief setting, vacuum relief setting, and venting/vacuum capacity per tank manufacturer.

2.7.6.3 Emergency Vent

****

NOTE: Delete this paragraph if underground storage tanks are specified. Emergency venting is not required for underground tanks. Refer to NFPA 30, UL 142, and API Std 2000 for vent sizing. The use of long-bolt manhole covers is not permitted for emergency venting.

****

Vent must be the normally-closed, UL listed type that vents outward and upward. Vent must conform with NFPA 30 and UL 142 and must be sized by the tank manufacturer. Provide vent with the Liters per second (L/s) cubic feet per minute (cfm) rating permanently labeled on the vent's exterior. [For double wall or protected type tanks, provide a second emergency vent to protect the interstitial space.] [This second emergency vent is not to be provided on concrete encased tanks.]

2.8 INDEPENDENT LEVEL ALARM SYSTEM

****

NOTE: UFC 3-460-01 requires an automatic level alarm system for both aboveground and underground tanks. Include the first bracketed sentence if multiple tanks are to be monitored as part of the design. Alarms for tanks less than 112,500 L 30,000 gallons must be provided by an automatic tank gauging system. Alarms for tanks equal to or greater than 112,500 L 30,000 gallons must be provided by an independent level alarm system (see below) in addition to an automatic tank gauging system.

Coordinate the use of overfill valves with Section 33 57 55 or Section 33 52 10 as applicable.

****

Provide an independent level alarm system that will monitor 4 programmable liquid level setpoints. The system must delineate between each individual setpoint [as well as each individual tank]. The system must produce an audible and visible alarm in the event of monitoring an alarm condition. Mechanically-actuated float assemblies must be field adjustable. The system must be totally independent of the tank gauging system.

2.8.1 Setpoints

****

NOTE: For underground tanks, require the high and high-high setpoints to be 90 and 95 percent tank capacity respectively. For aboveground tanks, require the high and high-high setpoints to be 95 and 98 percent tank capacity respectively. Since horizontal tanks fill extremely fast in the last 5 percent of their volume, closely consider choosing lower setpoints based upon actual filling rates, tank size, and time needed to react.

The suggested low level alarm setpoint for both

aboveground and underground tanks is 15 percent tank capacity. Modify this level accordingly in order to insure that air will not be drawn into the piping system.
****

Configure the alarm system's 4 setpoints in accordance with the following.

a. High Level Setpoint. Produce an alarm condition when a tank's liquid level rises above [90] [95] [_____] percent capacity.

b. High-High Level Setpoint. Produce an alarm condition when a tank's liquid level rises above [95] [98] [_____] percent capacity.

c. Low Level Setpoint. Produce an alarm condition when a tank's liquid level drops below [15] [_____] percent capacity.

d. Low-Low Level Setpoint. Produce an alarm condition when a tank's liquid level drops below [the minimum pump submergence level at] [______] percent capacity.

2.8.2 Independent Level Alarm Control Panel

****
NOTE: Indicate on the drawings the location of the system control panel. Panels located outdoors will require NEMA 4 enclosures. Panels located indoors will only require a standard industrial enclosure. Explosion-proof enclosures are typically unavailable.
****

Install the control panel for the alarm system in a [NEMA 4 rated enclosure in accordance with NEMA 250] [standard industrial enclosure]. Panel doors must swing left or right.

2.8.2.1 Audible Alarm

****
NOTE: If speakers external to the panel are necessary, indicate their location on the drawings.
****

Panel must have [internal] [external] speakers that produce a buzzer sound of [70] [_____] decibels or greater in the event of a detected alarm condition.

2.8.2.2 Visual Alarm

Panel must have a visual alarm that illuminates in the event of a detected alarm condition. The visual alarm must include either individual lights for each alarm condition or must include a single light and a liquid crystal display (LCD) panel that displaces information regarding each alarm condition.

2.8.2.3 Acknowledge Switch

Panel must have a manual acknowledge switch that will deactivate the audible alarm. The acknowledge switch must not deactivate subsequent audible alarms unless depressed manually again for each occurrence. Under no circumstance must this acknowledgement switch extinguish the visual alarms until the alarm condition has been corrected. The acknowledge switch must be an integral component located on the front of the control panel. The switch must be either a key switch or push button.

2.8.2.4 Test Pushbutton

Panel must have a manual test pushbutton that will enable operators to verify that the panel is powered, and the visual and audible alarms are working properly.

2.9 TANK GAUGES

****

NOTE: Provide each tank with a stick gauge and tank calibration chart. Provide a minimum of one additional gauge for each tank. The additional gauge can be either the analog, or digital type. Indicate on the drawings the location of each gauge display.

Provide tank gauges that meet federal, state and local requirements for aboveground and underground tanks. Provide tank gauging to comply with UFC 3-460-01 and STD 123-335-03. Automatic tank gauges may be used as the primary alternative for meeting the regulatory requirements; however, for small fueling systems (i.e. single building's heating system) where a digital tank gauge and panel are not economical, analog should be used. For underground tanks, new tank gauge alternatives must follow the requirements of 40 CFR 280.

****

2.9.1 Stick Gauge

For each tank, provide 2 wooden stick gauges. Gauge length must allow the measurement of the entire level of fuel in the corresponding tank. Gauges must be compatible with the fuel to be measured (no swelling or damage from fuel contact). Provide gauge with non-sparking caps on each end. Mark gauges in m and mm feet and inches. The smallest unit of measure on the gauge must be 1 mm 1/16 inch.

2.9.2 Tank Strapping Table

****

NOTE: Choose the reference API MPMS 2.2E for horizontal tank applications. Choose API MPMS 2.2A for vertical tank applications. For tanks smaller than 19,000 L 5,000 gallons, choose tank manufacturer certified strapping tables.

****

Furnish [2] [_____] [API MPMS 2.2E] [API MPMS 2.2A] [tank manufacturer]certified strapping tables (calibration charts) for each tank. One of the tables must indicate the liquid contents in L for each 1 mm of tank depth and the other in gallons for 1/16 inch of tank depth. Strapping table volumes for all tanks 19,000 L 5,000 gallons and larger must be determined using physical measurements and not calculated values.

For each tank, provide an electronic media file of each strapping table. [For tanks larger than 19,000 L 5,000 gallons tank strapping must be performed after installation at the site.]

2.9.3 Mechanical Clock Gauge

Gauge must be the level sensing, mechanically actuated type that provides the tank level readout in a sealed glass cap contained in a gauge box. Gauge must be accurate to plus or minus 6 mm 1/4 inch and must measure the liquid level over the full range of a tank's height. Gauge must have vapor tight seals to prevent condensation from fogging the viewing glass.

2.9.4 Automatic Tank Gauge System (ATG)

****

NOTE: The digital readout provided by a digital tank system can be sent to a stand-alone electronic panel or the signal can be sent to the same panel that is used for leak detection monitoring.

If both leak detection monitoring and digital tank gauge systems are to be used in the same project, then require the digital readout from both systems be sent to the same electronic monitoring/alarm panel provided under Section 33 01 50.31.

If a leak detection system is not required as part of the project, then require a stand-alone electronic panel to present the digital readout from the gauge system. Indicate the location of the panel on the drawings. Panels located outdoors will require NEMA 4 enclosures. Panels located indoors will only require a standard industrial enclosure.

****

Gauge system must be the mechanically or electronically actuated type that can continuously monitor a tank's usable liquid level storage capacity. The system must provide a digital readout of a tank's liquid level in terms of mm and L inches and gallons. The system must be accurate to plus or minus 2 mm 1/16 inch. The system must measure water accumulation in mm inches from 20 to 125 mm 3/4 to 5 inches off the bottom of a storage tank. Construct system components to be chemically compatible with the fuel to be handled. For each tank monitored, provide a sending unit that transmits the digital readout from a tank to [the electronic monitoring/alarm panel defined in Section 33 01 50.31 LEAK DETECTION FOR FUELING SYSTEMS] [an electronic display panel. Panel must be [a NEMA 4 enclosure as defined by NEMA 250] [standard industrial enclosure]. Panel doors must swing left or right. The panel must display the digital readout of each monitored tank on an LCD mounted exterior to the panel. The panel must also have external controls to allow operators to toggle between information on the LCD without having to open the panel.]

2.10 MANHOLE CONTAINMENT SUMP

****

NOTE: Delete this paragraph if underground storage tanks are not specified.

Require on the drawings a containment sump to be

installed directly above each tank manhole. Do not require the sump to be connected in any way to the surfaces above (e.g., street manhole cover, concrete, etc.).

Typical installations include a street manhole cover to be installed directly above each sump in order to allow access to the sump and the tank manhole below. Size the manhole cover large enough to allow the removal of the sump access cover below.
****

Sump must be the factory-fabricated, direct-buried type that provides a watertight connection either directly to the exterior of the tank or to a flanged manhole opening. Sump must be constructed of fiberglass reinforced plastic. Sump construction must be chemically compatible with the type of products being handled within the connecting tank. Sump must allow access to a tank manhole cover without disturbing surrounding backfill. Sump must be larger in diameter than the connecting tank manhole. Sump must be designed to withstand the underground burial loads. Sump assembly must prevent the influx of rainfall drainage or ground water.

2.10.1 Piping Penetrations

Sump sides must allow the penetration of carrier pipes, exterior containment pipes, conduits, and vapor pipes as required. Sump penetrations must be booted or sealed to ensure that liquid will not escape from the sump in the event that the liquid level within the sump rises above the pipe penetration. Boots and seals used must be compatible with the fuel to be handled. Boots and seals must be water resistant to the influx of water from outside the sump. Boots and seals must be designed and installed to accommodate the anticipated amount of thermal expansion and contraction in the piping system.

2.10.2 Access Cover

****
NOTE: Require watertight covers if high ground water is a problem and frequent access to the manhole below is not necessary. Watertight covers are generally bolted or strapped down. Strapped down covers provide easy access to the sumps without the use of tools. Friction fit covers will prevent the influx of rainwater and are easily removable by hand.
****

Where indicated, the entire top of a containment sump must be capped with a [friction fit] [bolted down, watertight] [strapped down, watertight] access cover that allows water to flow away from the manhole. Cover must be constructed of the same material as the sump. Cover must have a larger diameter than the tank manhole cover below. Cover must be lightweight and not exceed 35 pounds 16 kilograms.

2.11 TANK MOUNTED FUEL DISPENSING UNIT

****
NOTE: Tank mounted dispensing units are optional systems that are typically provided directly from

the tank manufacturer. The units are mounted directly to aboveground storage tank assemblies and are intended for use in low-volume, simple fueling applications where detailed fuel metering is not a concern.

Per NFPA 30A, only specify these type dispensing units if they are used in conjunction with a protected aboveground tank that conforms to UL 2085 (fully-enclosed concrete contained aboveground tank or fully-enclosed steel contained aboveground tank). These type dispensing units will not be used with any other type storage tank.
****

Provide fuel dispensing unit with integral UL labeled suction pump as supplied by the tank manufacturer. Unit must include all necessary appurtenances for operation. Unit must include a visible register to indicate individual deliveries up to 999.9 liters 99.9 gallons with a reset meter. Pump must have a delivery capacity of 0.95 liters/sec 15 gpm. Hose must be a minimum 20 mm 3/4 inch inside diameter, 4.6 meters 15 ft long, and fuel resistant. The dispensing nozzle must be of the automatic shutoff type with graduated notches for various delivery speeds. Dispensing unit must provide a means for locking of the nozzle to the pump when the pump is shutoff. [Diesel fuel dispensing unit cabinet must be painted yellow from the manufacturer.] [Gasoline dispensing unit must be painted red from the manufacturer.] Units must be clearly marked for the fuel they are dispensing.

2.12 FUEL HEATERS

****
NOTE: Indicate on the drawings the maximum temperature fuel is to be heated as well as the recovery rate required of the fuel heater. If steam or hot water are to be used as the heating medium, indicate their corresponding supply temperature, pressure, and flow rate on the drawings.

Electric type heaters are typically mounted at the bottom level of a tank. Require the tank manufacturer to provide a properly sized pipe nozzle at the bottom end of a tank to accommodate the heater.
****

2.12.1 In-Tank Heater

2.12.1.1 Fintube Type

Provide a vertical, manhole-mounted, fintube immersion heater. Construct entire assembly to be compatible with the product to be heated. Entire assembly must be removable as a unit. Construct heater's coil of [carbon steel] [stainless steel] tubes and fins. Construct heater to work with a heating medium of [steam] [hot water] supplied at [_____] degrees C degrees F and [_____] kPa (gage) psig. Construct heater's tank mounting flange of steel with a bolt pattern to match the corresponding tank manhole. Provide ASME B16.5, Class 150 flanges on the heating medium inlet and outlet. Extend assembly within 150 mm 6 inches of the tank bottom.

2.12.1.2 Electric Type

Provide a flanged, horizontally-mounted, immersion type electric heater. Heater must be UL listed and be compatible with the product to be heated. Construct heater's mounting flange of steel with a bolt pattern to match the corresponding tank nozzle. Heating element must be non-coking for the intended application. Entire assembly must be removable as a unit. If support brackets are required internally in a tank to mount the heating element above the tank bottom, provide heater manufacturer's standard support brackets. Install support brackets directly on a tank's internal striker plates. Mounting a heater's support brackets directly to a tank's bottom will not be allowed.

2.12.2 Tank Suction Heater

2.12.2.1 Shell-and-Tube Type

Provide a vertical, manhole-mounted, shell-and-tube type suction heater. Construct heater in accordance with ASME BPVC SEC VIII D1 with a rated working pressure of 1034 kPa (gage) 150 psig. Assembly must be compatible with the product to be heated. Entire assembly must be removable as a unit. Construct heater's shell and tube bundle of [carbon steel] [stainless steel]. Construct heater to work with a heating medium of [steam] [hot water] supplied at [_____] degrees C degrees F and [_____] kPag psig. Construct heater's tank mounting flange of steel with a bolt pattern to match the corresponding tank manhole. Provide ASME B16.5, Class 150 flanges on the heating medium inlet and outlet as well as the suction discharge piping. Extend assembly within 150 mm 6 inches of the tank bottom. Provide heater with drain, vent, thermometer, and pressure gage.

2.12.2.2 Electric Type

Provide a flanged, horizontally-mounted, electric type suction heater. Heater must be UL listed and be compatible with the product to be heated. Construct heater's mounting flange of steel with a bolt pattern to match the corresponding tank nozzle. Heating element must be non-coking for the intended application. Entire assembly must be removable as a unit. Provide ASME B16.5, Class 150 flanges on the suction discharge piping. Provide heater with drain, vent, thermometer, and pressure gage. If support brackets are required internally in a tank to mount the heating element up off the tank bottom, provide heater manufacturer's standard support brackets. Install support brackets directly on a tank's internal striker plates. Mounting a heater's support brackets directly to a tank's bottom will not be allowed.

2.12.3 Pipe In-Line Heater

Provide a horizontal, shell-and-tube type in-line heater. Construct heater in accordance with ASME BPVC SEC VIII D1 with a rated working pressure of 1034 kPa (gage) 150 psig. Construct entire assembly to be compatible with the product to be heated. Construct heater's shell and tube bundle of [carbon steel] [stainless steel]. Construct heater to work with a heating medium of [steam] [hot water] supplied at [_____] degrees C degrees F and [_____] kPag psig. Provide ASME B16.5, Class 150 flanges on the heating medium inlet and outlet as well as the fuel inlet and outlet connections. Provide heater with manufacturer's standard support brackets. Provide heater with drain, vent, thermometer, and pressure gage.

2.12.4 Temperature Controls

Provide heater with automatic temperature controls that can regulate the discharge product temperature as indicated. Provide necessary sensors and wiring needed for a fully functional control system. Construct controls to allow for adjustable discharge product temperatures. Provide an automatic high limit safety heater shutoff that is field adjustable. Provide a manual "on-off" switch in series with the automatic temperature controls in order to allow manual shutdown/startup. Provide temperature control components in a mountable and prewired NEMA 4 enclosure that conforms to NEMA 250.

2.13 INSPECTION WELL

****

NOTE: Delete this paragraph if underground storage tanks are not included in the project. Each site should have a maximum of two inspection wells located at opposing corners of the storage tank site. Sites with one storage tank should only require one inspection well. Inspection wells will not be used as monitoring wells. Inspection wells can serve as an inexpensive means of providing secondary verification of a leak as well as serving as a pump-out well for contaminated sites.

****

Inspection well must be constructed of Schedule 40 PVC pipe that is 150 mm 6 inches in diameter. Pipe must be factory slotted from the bottom to within 300 mm 12 inches of grade. With the pipe installed vertically, slots must be horizontal and have a width of 0.5 mm 0.02 inch with not less than 30 slots per 300 mm ft. Slots must encompass at least 80 percent of the pipe's 360 degree perimeter with the pipe maintaining its structural integrity. Slots must allow fluid within the soil to infiltrate into the pipe without allowing sediment to fill the pipe. Each well must extend down 600 mm 2 ft below the deepest buried storage tank. Well must have a permanently fixed bottom cap. Well must have a removable top cap that is protected from traffic with a watertight street manhole and cover as indicated. Well must have a 10 mm 3/8 inch vent hole located directly below the top cap to vent the well. The top cap of each well must be accessible from the surface through a 300 mm 12 inches diameter manhole. The manhole ring must be constructed of steel, cast iron, or fiberglass, have a cast iron cover, be a minimum of 300 mm 12 inches deep, and withstand H-20 highway loading as defined by AASHTO HB-17. Each manhole cover must have the words "DO NOT FILL - INSPECTION WELL" cast permanently into the top. The letters must be a minimum of 13 mm 1/2 inch in size. Each manhole cover must have a white circle with a black triangle painted on the surface.

2.14 ACCESSORIES

2.14.1 Concrete Anchor Bolts

Concrete anchors must conform to ASTM F1554, hot-dipped galvanized.

2.14.2 Bolts and Studs

Carbon steel bolts and studs must conform to ASTM A307, Grade B, hot-dipped galvanized. Stainless steel bolts and studs that conform to ASTM A193/A193M, Grade 8.

2.14.3 Nuts

Carbon steel nuts must conform to ASTM A563, Grade A, hex style, hot-dipped galvanized. Stainless steel nuts must conform to ASTM A194/A194M, Grade 8.

2.14.4 Washers

Provide flat circular washers under each bolt head and each nut. Washer materials must be the same as the connecting bolt and nut. For ASTM F1554 concrete anchors, use ASTM F436, Type 1, hot-dipped galvanized washers. For ASTM A307 bolts and studs, carbon steel washers must conform to ASTM F844, hot-dipped galvanized. Stainless steel washers must conform to ASTM A194/A194M, Grade 8.

2.14.5 Polytetrafluoroethylene (PTFE) Tape

Tape must conform to ASTM D3308.

2.14.6 Street Manhole Assembly

****

NOTE: Delete this paragraph if street manhole assemblies are address in the Civil specifications.

Style A frames are for manholes up to 760 mm 30 inches in diameter. Style B frames are for manholes between 915 and 1070 mm 36 and 42 inches in diameter.

****

Round street manhole frames and covers must be the straight traffic type. Frames and covers must be constructed of [cast steel in accordance with ASTM A27/A27M, grade 60-30 as a minimum] [cast iron in accordance with ASTM A48/A48M] [aluminum in accordance with ASTM B26/B26M] [or] [a engineered lightweight laminate material]. [Covers must be the solid plate type with a checker pattern.] Covers must form a watertight seal with the manhole frame to prevent surface water inflow. Frame and cover assembly must be rated to withstand H-20 highway loading as defined by AASHTO HB-17.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: During design, layout system components to allow adequate access for routine maintenance. Do not rely solely on the Contractor to make these judgments. Show access doors where applicable for maintenance.

****

Install work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Handle storage tanks with extreme care to prevent damage during placement and install in accordance with the manufacturer's installation instructions and NFPA 30, NFPA 30A, or NFPA 31 as applicable. Inspect the exterior surface of each tank for obvious visual damage prior to and during the placement of each storage tank. Repair surface damage to a storage tank according to manufacturer's requirements before proceeding with the system installation. Provide the termination of fill lines within a tank with an antisplash deflector. Provide nylon dielectric bushings on pipe connections to a steel tank.

3.1.1 Underground Storage Tank

Install underground storage tanks in accordance with API RP 1615 except as modified herein. Place tank on a 3 mm per 30 mm 1/8 inch per foot slope with the fill point at the low end and the vent connection at the high end. Locate tank so that the fuel discharge pipes slope up uniformly toward the fuel outlet. Install containment sumps prior to any backfill being added above the storage tanks.

3.1.1.1 Steel Underground Storage Tank Handling

Store, handle, and place externally coated steel tanks with care and in a manner that will minimize damage to the coating and will not reduce its protective value. Place coated tanks in position carefully and with a minimum of handling. Prior to backfilling a tank, visually inspect the tank exterior protective coating for damage. Repair any damaged tank coating in accordance with the appropriate UL or STI standard (UL 1746, STI 020-50-1000, or UL 58).

3.1.1.2 Steel Underground Storage Tank Installation Procedures

****

NOTE: Provide straps and anchors designed to prevent flotation of underground tanks located in areas with high groundwater level or subject to flooding. Provide electrical isolation strips between hold-down straps and metal tanks. Anchors may be concrete anchor slab under the tank or concrete deadmen. Tailor paragraph to suit design. Underground storage tanks occasionally rely on backfill and top slab to hold the tank in place in addition to the hold down straps and concrete deadman. When new or existing USTs are exposed, the contractor must take steps to ensure the tank remains safely in place without damage. Manufacturer's suggestions for installation of new tanks must be followed (ballast added to the tank etc.) and used on existing tanks until the tank is safe from damage due to a sudden or slow influx of water. Existing hold down straps must be inspected to assure they are adequate for holding the tank in place and compromised hold downs reported to the Resident Engineer with a suggested solution. The recommendations of API 1615 must also be followed.

****

[Set tank on a minimum of 150 mm 6 inches of backfill material.] [Anchor tank to a reinforced concrete anchor pad as indicated using manufacturer's supplied holddown straps. Separate tank from an anchor pad by a minimum of 300 mm 12 inches of backfill material. Coat metal straps, turnbuckles, anchors, and accessories to resist corrosion.] Uniformly place backfill material around the entire tank and extend to grade level. Inspect tank cathodic protection anodes, if applicable, to ensure integrity during backfill operations.

3.1.1.3 FRP Underground Storage Tank Handling

Handle tank with extreme care to prevent damage during installation and transportation to the site. Any damaged tank must be replaced or repaired and tested under direct supervision and advice of the tank manufacturer, using the manufacturer's written procedures.

3.1.1.4 FRP Underground Storage Tank Installation Procedures

****

NOTE: Provide straps and anchors designed to prevent flotation of underground tanks located in areas with high groundwater levels or subject to flooding. Anchors may be a concrete anchor slab under the tank or concrete deadmen. Tailor paragraph to suit design. Underground storage tanks occasionally rely on backfill and top slab to hold the tank in place in addition to the hold down straps and concrete deadman. When new or existing USTs are exposed, the contractor must take steps to ensure the tank remains safely in place without damage. Manufacturer's suggestions for installation of new tanks must be followed (ballast added to the tank etc.) and used on existing tanks until the tank is safe from damage due to a sudden or slow influx of water. Existing hold down straps must be inspected to assure they are adequate for holding the tank in place and compromised hold downs reported to the Resident Engineer with a suggested solution. The recommendations of API 1615 must also be followed.

****

[Set tank on a minimum of 150 mm 6 inches of backfill material.] [Anchor tank to a reinforced concrete anchor pad as indicated through the use of manufacturer's supplied holddown straps. Separate tank from an anchor pad by a minimum of 300 mm 12 inches of backfill material.]

3.1.2 Aboveground Storage Tank

Install aboveground storage tanks in accordance with STI 700-50-5007 (STI R912) except as modified herein. Place tank that is equal to or greater than 18,900 L 5,000 gallons on a 3 mm per 30 mm 1/8 inch per foot slope with the fill point at the low end and the vent connection and issue pump at the high end. [Place tank that is less than 18,900 L 5,000 gallons on a level surface.]

3.1.2.1 Steel Aboveground Storage Tank Handling

Store, handle, and place externally coated steel tanks with care and in a manner that will minimize damage to the coating and will not reduce its protective value. Place coated tanks in position carefully and with a minimum amount of handling. Repair any damaged tank coating in accordance with the appropriate UL or STI standard (UL 1746, STI 020-50-1000, or UL 58). Do not move the tank unless it is empty.

[3.1.2.1.1 Concrete Encased Aboveground Storage Tank Handling

Store, handle, and place concrete encased aboveground storage tanks with care and in a manner that will minimize damage to the tank. Place tanks in position carefully and with a minimum of handling. Do not move the tank unless it is empty.

]3.1.2.2 Steel Aboveground Tank Installation Procedures

****

NOTE: Provide anchors designed to prevent flotation of tanks located in areas subject to flooding and in high seismic areas. Tailor paragraph to suit design.

****

Tanks should be secured to the associated tank pad per tank manufacturer's recommendations using fasteners installed through the tank saddle base plate.

[3.1.2.2.1 Concrete Encased Aboveground Storage Tank Installation Procedures

****

NOTE: Concrete encased tanks are not typically anchored. Tailor paragraph to suit design.

****

Concrete encased tanks do not need to be secured.

]3.1.3 System Components

Properly level, align, and secure system components in place in accordance with manufacturer's instructions. Provide supports for system components, appurtenances, and pipe as required. Install anchors, bolts, nuts, washers, and screws where required for securing the work in place. Sizes, types, and spacings of anchors and bolts not indicated or specified must be as required for proper installation.

3.2 FIELD QUALITY CONTROL

3.2.1 Aboveground Storage Tank Tightness Tests

Perform tightness tests on each aboveground storage tank prior to making piping connections. Perform testing in accordance with STI 700-50-5007 (STI R912)except as modified herein. Gauges used to monitor the tests must have a scale with a maximum limit of 103 kPa 15 psig. Repair leaks discovered during the tightness tests in accordance with tank manufacturer's instructions. Following any repair, re-test the tank until the tank successfully passes the testing requirements of this paragraph.

3.2.2 Underground Storage Tank Tightness Tests

****

NOTE: Pneumatic tests are the preferred type of tightness tests. Brine level tests will only be specified for FRP tanks. Delete the inapplicable tests.

****

Perform a tightness test on each underground storage tank on-site just prior to their placement into the ground. Pneumatically pressurize each storage tank's primary chamber to 35 kPa 5 psig and monitor for a drop in pressure over a 2-hour period during which there must be no drop in pressure in the tank greater than that allowed for thermal expansion and contraction. Following the successful completion of the primary chamber test, bleed the pressure from the primary chamber into the interstitial space. Maintain this pressure while applying soapsuds or equivalent material over the exterior of the tank. While applying the soapsuds, visually inspect the entire tank, including the bottom surfaces, for leaks (bubble formations). Inspection of the bottom surfaces of a tank may be performed by rotating the tank; however, a tank must only be rotated in strict accordance with the manufacturer's recommendations. Do not rotate a tank more than 90 degrees from the upright position. During testing, install a pressure relief device that relieves at the tank manufacturer's suggested pneumatic pressure limit. Gauges used in pneumatic tests must have a scale with a maximum limit of 103 kPa 15 psig.

3.2.2.1 Brine Level Test

In lieu of the pneumatic testing procedures described above, a brine level test may be performed on the interstitial space of double-walled FRP tanks (not applicable to steel tanks). For a brine level test, completely fill a FRP tank's interstitial space with a brine solution. Connect a riser pipe to the interstitial space that will allow the solution to rise within the riser at least 300 mm 12 inches. After filling the interstitial space, the tank must set approximately 3 hours. Following the 3-hour period, measure and record the level of solution within the riser. After a subsequent 4-hour period, again measure and record the level of solution within the riser. If the level of solution within the interstitial decreases anytime during the test, the tank is considered leaking and therefore fails the test.

3.2.2.2 Repairs

Repair leaks discovered in either the primary chamber or the interstitial space in accordance with the tank manufacturer's instructions. Following any tank repairs, re-test the tank until the tank successfully passes the testing requirements defined herein.

3.2.3 Tank Manufacturer's Tests

In addition to the tests required herein, perform any additional tests (i.e., leak tests, cathodic protection verification tests, etc.) on each storage test that is required by the tank manufacturer's written test procedures. Manufacturer's tests that are redundant to tests already required by this specification will only be performed once per tank. Repair all leaks discovered during the tests in accordance with manufacturer's instructions. Following tank repairs, re-test the tank until the tank successfully passes the manufacturer's testing requirements.

3.2.4 System Commissioning

System commissioning must conform to [Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT)] [Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP].

3.2.5 Tank Inspection Reports

****

NOTE: Underground storage tanks must be inspected in accordance with STI SP131.
****

Prior to system commissioning, a STI SP001 certified inspector must inspect the completed [aboveground] [underground] tank in accordance with [STI SP001] [STI SP131] and deliver a full report to the Contracting Officer. The report must include a record of ultrasonic thickness measurements (UTMs), exclusive of the coating, of each single wall [aboveground] [underground] tank shell. The report must include the tank dataplate information and photograph of the tank data plate. Provide electronic copies of the tank inspection reports to Service Headquarters, Service Control Points, and DLA-Energy. The paper and electronic copies of the report and UTMs must be provided to the Contracting Officer for filing with the tank's "as-built drawings." Refer to Section 01 45 00 QUALITY CONTROL for STI SP001 Inspector's Certification requirements.

3.3 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components and systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components and systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of [_____] hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

3.4 Tank Fill Tests

Tank fill tests must not be performed until after the flushing, cleaning, and adjusting requirements defined in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). For the tank fill tests, initially fill each storage tank with fuel in order to verify the tank level alarm system operates properly and the tank overfill protection device functions as designed. Stop filling each tank immediately once the overfill devices operates. Do not overfill any storage tank more than the 98 percent level. Drain the system below the low liquid level setpoint to verify operation of the low level alarm. Correct and retest any problems with the level alarm system or the overfill device until each operate as specified herein. During the tests, verify that all tank gauges are calibrated and operating appropriately.

3.5 FIELD PAINTING

Painting required for surfaces not otherwise specified must be field painted as specified in [Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES][Section 09 90 00 PAINTING, GENERAL]. Do not paint stainless steel and aluminum surfaces. Do not coat system components or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 56 19 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-33 56 19 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 56 19

FUEL IMPERMEABLE LINER SYSTEM

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PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 56 19 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-33 56 19 (May 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 33 56 19

FUEL IMPERMEABLE LINER SYSTEM
11/22

****
NOTE: This guide specification covers the requirements for a fuel impermeable liner system intended to serve a diked tank enclosure (petroleum applications only). The liner system typically consists of a combination of a geomembrane (to provide liquid tight containment) and geotextile (to protect the geomembrane). This specification includes requirements for two types of geomembrane: Non-reinforced (HDPE - high-density polyethylene) and fabric reinforced (FML - flexible membrane liner). Non-reinforced (HDPE) is only acceptable for use where completely covered with a material (concrete, aggregate, etc) to avoid the effects of thermal expansion from temperature change, degradation from UV light and environmental stress cracking.

For liner to be installed under tank bottoms, see UFGS 33 56 21.18 SINGLE WALL POL TANK UNDERTANK INTERSTITIAL SPACE.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: Coordinate specific dike and liner installation requirements with the latest published version of UFC 3-460-01.
****

1.1 MEASUREMENT AND PAYMENT

****
NOTE: Delete this paragraph when lump sum bidding is used.
****

Measure the total surface area in square meters feet covered by liner system. Final quantities will be based on as-built conditions. Allowance will be made for liner system in anchor and drainage trenches; however, no allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor. Liner system installed and accepted by the Contracting Officer will be paid for at the respective contract unit price in the bidding schedule.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D413	(1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate

ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D696	(2016) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM D1004	(2013) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1505	(2018) Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	(2020) Carbon Black Content in Olefin Plastics
ASTM D2136	(2002; R 2012) Coated Fabrics - Low-Temperature Bend Test
ASTM D3776/D3776M	(2009a; R 2017) Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
ASTM D3895	(2014) Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D4218	(2020) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4437/D4437M	(2016; R 2018) Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D4533	(2011) Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4833/D4833M	(2007; R 2020) Standard Test Method forIndex Puncture Resistance of Geomembranes and Related Products
ASTM D5199	(2012) Measuring Nominal Thickness of Geosynthetics
ASTM D5261	(2010; R 2018) Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
ASTM D5397	(2019a) Standard Test Method for

	Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D5596	(2003; R 2016) Standard Test Method For Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5641/D5641M	(2016) Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D5721	(2008; R 2013) Air-Oven Aging of Polyolefin Geomembranes
ASTM D5820	(1995; R 2018) Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
ASTM D5884/D5884M	(2004a; R 2015; E 2015) Standard Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes
ASTM D5885/D5885M	(2017) Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D5893/D5893M	(2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
ASTM D5994/D5994M	(2010; R 2015; E2015) Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D6241	(2014) Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
ASTM D6392	(2012; R 2018) Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D6693/D6693M	(2004; R 2015; E 2015) Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
ASTM D7238	(2006; R 2012) Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
ASTM D7466	(2010) Standard Test Method for Measuring Asperity Height of Textured Geomembranes

ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E228	(2022) Standard Test Method for Linear Thermal Expansion of Solid Materials with a Push-Rod Dilatometer
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for

the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, [_____]

Liner Projections; G, [_____]

As-Built Drawings; G, [_____]

SD-03 Product Data

Fabric Reinforced Geomembrane Liner; G, [_____]

Non-Reinforced Smooth Geomembrane Liner; G, [_____]

Non-Reinforced Textured Geomembrane Liner; G, [_____]

Nonwoven Geotextile; G, [_____]

Liner Fittings; G, [_____]

Embedment Strips; G, [_____]

Mounting Strip System; G, [_____]

Sealant; G, [_____]

Permanent Sand Bags; G, [_____]

Precast Concrete Pavers

Rock Ballast

Slip Resistant Walking Surface

Manufacturer's Warranty

Installer's Warranty

SD-04 Samples

Destructive Field Seam Test Sample; G, [_____]

SD-05 Design Data

Wind Uplift Calculations; G, [_____]

SD-06 Test Reports

Trial Seam Logs

Non-Destructive Field Seam

Destructive Field Seam

SD-07 Certificates

Field Engineer Qualifications

Installer Qualifications

Fabricator Certification

Liner Manufacturer's Certification

Surface Preparation

SD-08 Manufacturer's Instructions

Liner Manufacturer's Installation Instructions

SD-10 Operation and Maintenance Data

Geomembrane Liner; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Materials and equipment must have been in satisfactory commercial or industrial use for a minimum 2 years prior to bid opening. The 2 year period must include applications of the equipment and materials under similar circumstances and of similar size. Materials and equipment must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours, exclusive of the manufacturer's factory tests, can be shown.

1.4.2 Field Engineer Qualifications

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NOTE: Include any local regulatory requirements that must be met by the Contractor.

****

Provide a field engineer who has successfully completed manufacturer's training on handling and installing of the fuel impermeable liner to be installed. Demonstrate that the engineer has at least one million square feet of liner installation experience. Submit a letter providing evidence of the field engineer's experience, training, and licensing. In regard to the field engineer's experience, include in the submittal a point of contact, a phone number, the address, the type of installation, and the current status of each installation mentioned.

1.4.3 Installer Qualifications

The installer is responsible for field handling, deploying, seaming, anchoring, and field Quality Control (QC) testing of the geomembrane. Demonstrate that the installer has installed the proposed geomembrane material for at least 5 completed projects and a total minimum area of [93,000] [_____] square meters [1] [_____] million square feet. At least one seamer must have experience seaming a minimum of [46,500] [_____] square meters [500,000] [_____] square feet of the proposed geomembrane using the same type of seaming equipment and same geomembrane specified for this project.

1.4.4 Factory Seams

****

NOTE: Factory seaming only applies to fabric reinforced geomembranes which can be rolled or folded after fabrication prior to shipping to the project site for deployment. Due to the stiff nature of non-reinforced (HDPE) geomembranes, factory seaming/fabrication is not possible.

****

Where possible, use geomembrane factory fabricated to project specific panels in order to minimize field seams. Fabricator must conduct visual inspections on completed seams, as well as non-destructive and destructive testing to verify compliance with the seam strength requirements stated in Table [1][2][3]. Provide fabricator certification of factory seams, including documentation of and results from quality control testing conducted.

1.4.5 Liner Manufacturer's Certification

Following the successful installation and testing of the liner, an authorized representative from the liner manufacturer must submit a letter certifying that the liner installation and testing results are satisfactory and that each meets the company's quality expectations and warranty. The letter must also certify that the liner installed is compatible with and recommend for use with the fuel to be stored. Include in the letter the representative's name, address, phone number, and qualifications for being a manufacturer's representative.

1.5 DESIGN REQUIREMENTS

****

NOTE: Include the following paragraph where the liner is intended to be left exposed without full coverage by concrete, aggregate, or other ballast material.

****

Provide certified engineering wind uplift calculations to determine required placement of permanent [sandbags] [precast concrete pavers] [_____] based upon the proposed liner and ballast materials.

1.6 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer.

1.6.1 Delivery

The QC inspector must be present during delivery and unloading of the geomembrane. Label each geomembrane roll/panel with the manufacturer's name, product identification number, roll/panel number, and roll/panel dimensions.

1.6.2 Storage

Store geomembranes and geotextiles elevated off of the ground and covered to provide protection from precipitation, sunlight/ultraviolet light, puncture/abrasion, undesirable chemicals (as recommended by the manufacturer), and flames/welding sparks. Storage in temperatures between 32 degrees F 0 degrees C and 160 degrees F 71 degrees C, or as recommended by the manufacturer. Storage must not result in crushing the core of roll goods or flattening of the rolls. Do not store rolls more than two high. Store palleted materials on level surfaces and not stacked on top of one another. Remove damaged geomembrane from the site and replace with geomembrane that meets the specified requirements.

1.6.3 Handling

Do not drag, lift by one end, or drop rolls and panels. Use a pipe or solid bar, of sufficient strength to support the full weight of a roll without significant bending but small enough to be easily inserted through the core of the roll, for all handling activities. Link the ends of the pipe or bar to the ends of a spreader bar with chains. Use a spreader bar wide enough to prevent the chains from rubbing against the ends of the roll. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. Use a stinger bar at least three-fourths the length of the core and capable of supporting the full weight of the roll without significant bending. If recommended by the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

1.7 AMBIENT CONDITIONS

Do not deploy or field-seam geomembrane in the presence of excess moisture (i.e., rain, fog, dew), in areas of ponded water, or in the presence of winds above 20km/hr 12 mph. The relative humidity must be less than 80 percent, and temperature above the dew point. Unless authorized by the Contracting Officer, do not attempt placement or seaming at ambient temperatures below 5 degrees C 40 degrees F or above 40 degrees C 104 degrees F. Measure ambient temperature at a height no greater than 150 mm 6 inches above the ground or geomembrane surface. Seaming is only allowed below 5 degrees C 40 degrees F if recommended by the geomembrane manufacturer and if destructive tests of trial seams at the proposed temperature meet the seam property requirements listed in Table [1][2][3].

1.8 WARRANTY

State in the manufacturer's warranty that the installed geomembrane liner is warranted for 10 years against deterioration as installed for containment of the intended liquid. State in the installer's warranty that the geomembrane liner won't fail due to improper installation within 2 years.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Indicate on the drawings the exact type of fuel that each liner system will be expected to contain.

The liner types specified herein is compatible with a variety of fuels and liquids. Note that the liner is specifically compatible with Jet A, JP-4, JP-5, JP-8, diesel fuel, motor gasoline, kerosene, No. 2 Fuel Oil, and No. 6 Fuel Oil. If any other fuel is to be contained by the liner system, specifically coordinate with the liner manufacturers for any additional requirements that may need to be added.

If multiple liner systems are required, clearly indicate where each liner system is required.

****

2.1.1 Fabric Reinforced Geomembrane Liner

Provide a flexible, internally fabric reinforced geomembrane liner that is factory fabricated into widths that are designed to minimize field fabricated seams. Make factory seams with a 50 mm 2 inch overlap plus or minus 6 mm 1/4-inch. Provide liner that, as a minimum, meets the physical properties in Table 1. Include liner's routine maintenance requirements as well as procedures for liner repair and troubleshooting.

TABLE 1 - FABRIC REINFORCED GEOMEMBRANE PROPERTIES (ENGLISH)

PROPERTY	TEST VALUE	TEST METHOD
Overall Finished Thickness (minimum)	0.76 mm30 mils	ASTM D751 or ASTM D5199
Base Fabric Material	aramid fibre, polyester, or nylon	
Base Fabric Weight (minimum)	254 g/m27.5 oz/yd2	ASTM D3776/D3776M
Fabric Coating Adhesion (minimum)	2.6 kN/m15 lbf/inch	ASTM D751 or ASTM D413
Tensile Strength, Grab (minimum)	2.67 kN 600 lbf in both warp and fill	ASTM D751, Grab Test Method
Bursting Strength (minimum)	3.55 kN800 lbf	ASTM D751, Ball Tip Method
Hydrostatic Resistance	5515 kN/m2800 psi	ASTM D751, Procedure A
Trapizoid Tearing Strength (minimum)	0.22 kN 50 lbf in both the warp and fill directions	ASTM D4533 or ASTM D751, Trapazoidal Tear Method
Puncture Strength (minimum)	1.11 kN250 lbf	ASTM D4833/D4833M
Tearing Resistance (minimum)	0.53 kN120 lbf	ASTM D5884/D5884M
Low Temperature Bend (minimum)	-34 degrees C-30 degrees F	ASTM D2136
Vapor Transmission (maximum)	3.78 ml/m2 0.0119 oz/ft2 over 24 hours	ASTM E96/E96M, Procedure BW, Inverted Water Method, using kerosene instead of water

TABLE 1 - FABRIC REINFORCED GEOMEMBRANE PROPERTIES (ENGLISH)

PROPERTY	TEST VALUE	TEST METHOD
Coefficient of Thermal Expansion (maximum)	0.000038 cm/cm/degree C 0.000021 in/in/degree F	ASTM E228 or ASTM D696
Weathering Resistance	No appreciable changes, stiffening or cracking of coating for a minimum of 8000	ASTM G152 or ASTM G153
Bonded Seam Shear Strength(minimum)	2.33 kN525 lbf	ASTM D751
Bonded Seam Peel Strength (minimum)	88.9 N20 lbf	ASTM D413
Dead Load Seam Shear Strength (minimum)	1110 N at 21 degrees C; 555 N at 71 degrees C250 lbf at 70 degrees F; 125 lbf at 160 degrees F	ASTM D751

2.1.2 Non-Reinforced Smooth Geomembrane Liner

****

NOTE: Non-reinforced (HDPE) is only acceptable for use where completely covered with a material to avoid the effects of thermal expansion from temperature change and degradation from UV light.

****

Provide non-reinforced smooth geomembrane liner of unreinforced high density polyethylene (HDPE), manufactured as wide as possible to minimize factory and field seams. Geomembrane sheets must be uniform in color, thickness, and surface texture. The sheets must be free of and resistant to fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants and other imperfections. Provide liner meeting the physical properties of Table 2.

Make resin used in manufacturing geomembrane sheets of virgin uncontaminated ingredients. Use no more than [10] [_____] percent regrind, reworked, or trim material in the form of chips or edge strips to manufacture the geomembrane sheets. All regrind, reworked, or trim materials must be from the same manufacturer and exactly the same formulation as the geomembrane sheet being produced. Do not use post consumer materials or water-soluble ingredients to produce the geomembrane. For geomembranes with plasticizers, use only primary plasticizers that are resistant to migration. Submit a copy of the test reports and QC certificates for materials used in the manufacturing of the geomembrane shipped to the site.

TABLE 2 - SMOOTH HDPE GEOMEMBRANE PROPERTIES (ENGLISH)

PROPERTY	TEST VALUE	TEST METHOD
Thickness (min ave)	[1.50] [_____] mm [60] [_____] mils	ASTM D5199
Lowest individual of 10 values	-10 percent	ASTM D5199
Density (min)	0.940 g/cc	ASTM D1505
Tensile Properties(1)(min ave)		ASTM D6693/D6693M Type IV
Yield Strength	[22] [_____] kN/m [126] [_____] lb/in	
Break Strength	[40] [_____] kN/m [228] [_____] lb/in	
Yield Elongation	[12] [_____] percent	
Break Elongation	[700] [_____] percent	
Tear Resistance (min ave)	[187] [_____] N[42] [_____] lb	ASTM D1004
Puncture Resistance(min ave)	[480] [_____] N[108] [_____] lb	ASTM D4833/D4833M
Stress Crack Resistance (2)	[300] [_____] hr	ASTM D5397 (Appendix)
Carbon Black Content	2.0-3.0 percent	ASTM D1603 (3)
Carbon Black Dispersion	Note (4)	ASTM D5596
Oxidative Induction Time (OIT)(min ave)(5)		
Std OIT	100 min	ASTM D3895
High Pres OIT	400 min	ASTM D5885/D5885M
Oven Aging at 85 deg C 185 deg F (min ave) (5), (6)		ASTM D5721
Std OIT	55 percent at 90 days	ASTM D3895
or High Pres OIT	80 percent at 90 days	ASTM D5885/D5885M
UV Resistance (min ave) (7)		ASTM D7238
High Pres OIT(8)(9)	50 percent at 1600 hours	ASTM D5885/D5885M
Seam Shear Strength (min) Hot Wedge, Hot Air, Ultrasonic, Extrusion Fillet (10)(12)	[525] [_____] N/25mm [120] [_____] lb/in	ASTM D6392
Seam Peel Strength (min) Hot Wedge, Hot Air, Ultrasonic (10)(11)(12)	[398] [_____] N/25mm [91] [_____] lb/in	ASTM D6392

<table>
<tr><th colspan="3">TABLE 2 - SMOOTH HDPE GEOMEMBRANE PROPERTIES (ENGLISH)</th></tr>
<tr><th>PROPERTY</th><th>TEST VALUE</th><th>TEST METHOD</th></tr>
<tr><td>Seam Peel Strength (min)
Extrusion Fillet (10)(11)(12)</td><td>[340] [_____] N/25mm
[78] [_____] lb/in</td><td>ASTM D6392</td></tr>
<tr><td colspan="3">(1) Base minimum average machine direction and minimum average cross machine direction values on 5 test specimens in each direction. For HDPE geomembrane, yield elongation is calculated using a gauge length of 33 mm 1.3 inches. For HDPE geomembrane, break elongation is calculated using a gauge length of 50 mm 2.0 inches.</td></tr>
<tr><td colspan="3">(2) For HDPE geomembrane, use the manufacturer's mean value yield stress used to calculate the applied load for test method ASTM D5397 (Appendix).</td></tr>
<tr><td colspan="3">(3) Other methods such as ASTM D4218 or microwave methods are acceptable if an appropriate correlation to ASTM D1603 can be established.</td></tr>
<tr><td colspan="3">(4) Carbon black dispersion for 10 different views:
- minimum 8 of 10 in Categories 1 or 2
- all 10 in Categories 1,2, or 3</td></tr>
<tr><td colspan="3">(5) The manufacturer has the option to select either one of the OIT methods to evaluate the antioxidant content.</td></tr>
<tr><td colspan="3">(6) Evaluate samples at 30 and 60 days and compare with the 90 day response.</td></tr>
<tr><td colspan="3">(7) The condition of the test must be a 20 hour UV cycle at 75 degrees C 167 degrees F followed by a 4 hour condensation cycle at 60 degrees C 140 degrees F.</td></tr>
<tr><td colspan="3">(8) Do not use the standard OIT test (ASTM D3895) in determining UV resistance.</td></tr>
<tr><td colspan="3">(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.</td></tr>
<tr><td colspan="3">(10) Seam tests for peel and shear must fail in the Film Tear Bond mode. This is a failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area.</td></tr>
<tr><td colspan="3">(11) Where applicable, test both tracks of a double hot wedge seam for peel adhesion.</td></tr>
<tr><td colspan="3">(12) For five samples tested, four must meet or exceed the given value, with the fifth within 80 percent of the given value.</td></tr>
</table>

2.1.3 Non-Reinforced Textured Geomembrane Liner

****

NOTE: Non-reinforced (HDPE) is only acceptable for

use where completely covered with a material to avoid the effects of thermal expansion from temperature change and degradation from UV light.

Specify textured geomembrane where slopes are 1V on 5H or greater, such as on sloped dikes.
****

Provide non-reinforced textured geomembrane liner composed of unreinforced high density polyethylene (HDPE), uniform in color, thickness, and surface texture, manufactured as wide as possible to minimize factory and field seams. For slopes greater than or equal to 1V on 5H, texture sheets on both faces. Provide textured surface features consisting of raw materials identical to that of the parent sheet material and uniform over the entire face of the geomembrane. The sheets must be free of and resistant to fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants and other imperfections. Provide liner meeting the physical properties of Table 3.

Use virgin uncontaminated ingredients resin in manufacturing geomembrane sheets. Use no more than [10] [_____] percent regrind, reworked, or trim material in the form of chips or edge strips to manufacture the geomembrane sheets. The same manufacturer regrinds, reworks, or trims materials, using exactly the same formulation as the geomembrane sheet being produced. No post consumer materials or water-soluble ingredients may be used to produce the geomembrane. For geomembranes with plasticizers, use only primary plasticizers that are resistant to migration. Submit a copy of the test reports and QC certificates for materials used in the manufacturing of the geomembrane shipped to the site.

TABLE 3 - TEXTURED HDPE GEOMEMBRANE PROPERTIES (ENGLISH)

PROPERTY	TEST VALUE	TEST METHOD
Nominal Thickness	[1.50] [_____] mm[60] [_____] mils	
Thickness (min ave)	-5 percent of nominal	ASTM D5994/D5994M
Lowest individual for 8 out of 10 values	-10 percent of nominal	ASTM D5994/D5994M
Lowest individual of 10 values	-15 percent of nominal	ASTM D5994/D5994M
Asperity Height (min ave) (13)	0.25 mm10 mils	ASTM D7466 (14)
Density (min)	0.940 g/cc	ASTM D1505
Tensile Properties(1)(min ave)		ASTM D638 Type IV or ASTM D6693/D6693M
Yield Strength	[22] [_____] kN/m[126] [_____] lb/in	
Break Strength	[16] [_____] kN/m[90] [_____] lb/in	

TABLE 3 - TEXTURED HDPE GEOMEMBRANE PROPERTIES (ENGLISH)

PROPERTY	TEST VALUE	TEST METHOD
Yield Elongation	[12] [_____] percent	
Break Elongation	[100] [_____] percent	
Tear Resistance (min ave)	[187] [_____] N[42] [_____] lb	ASTM D1004
Puncture Resistance(min ave)	[400] [_____] N[90] [_____] lb	ASTM D4833/D4833M
Stress Crack Resistance (2)	[300] [_____] hr	ASTM D5397 (Appendix)
Carbon Black Content	2.0-3.0 percent	ASTM D1603 (3)
Carbon Black Dispersion	Note (4)	ASTM D5596
Oxidative Induction Time (OIT)(min ave)(5)		
Std OIT	100 min	ASTM D3895
or High Pres OIT	400 min	ASTM D5885/D5885M
Oven Aging at 85 deg C 185 deg F (min ave) (5), (6)		ASTM D5721
Std OIT	55 percent at 90 days	ASTM D3895
or High Pres OIT	80 percent at 90 days	ASTM D5885/D5885M
UV Resistance (min ave) (7)		ASTM D7238
High Pres OIT(8)(9)	50 percent at 1600 hours	ASTM D5885/D5885M
Seam Shear Strength (min) Hot Wedge, Hot Air, Ultrasonic, Extrusion Fillet (10)(12)	[525] [_____] N/25mm [120] [_____] lb/in	ASTM D6392
Seam Peel Strength (min) Hot Wedge, Hot Air, Ultrasonic (10)(11)(12)	[398] [_____] N/25mm [91] [_____] lb/in	ASTM D6392
Seam Peel Strength (min) Extrusion Fillet (10)(11)(12)	[340] [_____] N/25mm [78] [_____] lb/in	ASTM D6392

TABLE 3 - TEXTURED HDPE GEOMEMBRANE PROPERTIES (ENGLISH)

PROPERTY	TEST VALUE	TEST METHOD
(1) Base minimum average machine direction and minimum average cross machine direction values on 5 test specimens in each direction. For HDPE geomembrane, yield elongation is calculated using a gauge length of 33 mm 1.3 inches. For HDPE geomembrane, break elongation is calculated using a gauge length of 50 mm 2.0 inches.		
(2) For HDPE geomembrane, use the manufacturer's mean value yield stress to calculate the applied load for test method ASTM D5397 (Appendix).		
(3) Other methods such as ASTM D4218 or microwave methods are acceptable if an appropriate correlation to ASTM D1603 can be established.		
(4) Carbon black dispersion for 10 different views: - minimum 8 of 10 in Categories 1 or 2 - all 10 in Categories 1,2, or 3		
(5) The manufacturer has the option to select either one of the OIT methods to evaluate the antioxidant content.		
(6) Evaluate samples at 30 and 60 days and compare with the 90 day response.		
(7) The condition of the test must be a 20 hour UV cycle at 75 degrees C 167 degrees F followed by a 4 hour condensation cycle at 60 degrees C 140 degrees F.		
(8) Do not use the standard OIT test (ASTM D3895) in determining UV resistance.		
(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.		
(10) Seam tests for peel and shear must fail in the Film Tear Bond mode. This is a failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area.		
(11) Where applicable, test both tracks of a double hot wedge seam for peel adhesion.		
(12) For five samples tested, four must meet or exceed the given value, with the fifth within 80 percent of the given value.		
(13) Of 10 readings; 8 out of 10 must be equal to or greater than 0.18 mm 7 mil, and lowest individual reading must not be less than 0.13 mm 5		
(14) Alternate the measurement side for double sided textured sheet.		

2.1.4 Nonwoven Geotextile

****

NOTE: Include the following paragraphs where a geotextile is required above or below the geomembrane liner system. Installation of a geotextile underneath the secondary containment liner is required if the subgrade is rough or sharp in nature (i.e., sharp limestone or granite rock, rough gunnite, rough or exposed concrete aggregate, etc.). Include the installation of a geotextile above the secondary containment liner where the liner is not left exposed to protect the liner from cover materials and from equipment during the placement of cover material.

****

Provide a nonwoven, polypropylene, needle punched geotextile fabric. Provide geotextile having the following physical properties as a minimum. No substitute methods are allowed for verification of any property.

2.1.4.1 General Properties

Retard the growth of mildew and be compatible with the soil in contact.

2.1.4.2 Nominal Unit Weight

Provide a nominal unit weight of 407 g/m2 12 oz/yd2 as measured in accordance with ASTM D5261.

2.1.4.3 Grab Tensile Strength

Provide a minimum grab tensile strength of 1335 N 300 lbf when tested in accordance with ASTM D4632/D4632M.

2.1.4.4 Grab Tensile Elongation

Provide a minimum grab tensile elongation of 50 percent when tested in accordance with ASTM D4632/D4632M.

2.1.4.5 Puncture Strength

Provide a minimum puncture strength of 620 N 140 lbf when tested in accordance with the pin strength methods of ASTM D4833/D4833M, or 3.56 kN 800 lbf when tested in accordance with the CBR methods of ASTM D6241.

2.1.4.6 Trapezoid Tear Strength

Provide a minimum trapezoid tear strength of 512 N 115 lbf when tested in accordance with ASTM D4533.

2.1.4.7 Ultraviolet (UV) Resistance

Maintain 70 percent of its original strength after 500 hours of testing in accordance with ASTM D4533.

2.2 ACCESSORIES

2.2.1 Liner Fittings

Provide liner fittings (for example, boots and sleeves) that are factory prefabricated components produced from the same manufacturer that produces the fuel impermeable liner and having the same fabrication characteristics as the liner.

2.2.2 Embedment Strip

Provide embedment strips for attachment to new cast-in-place concrete structures by the same manufacturer as the geomembrane, and made of the same materials as the geomembrane to be used or otherwise be certified by the manufacturer for use with the geomembrane.

2.2.3 Batten / Mounting Strip System

****

NOTE: Show mounting strips around the perimeter of liner terminations on existing or precast concrete structures. The strips prevent the nut on the concrete anchor from penetrating and damaging the liner.

****

Provide [minimum 5 mm 1/4-inch thick by 50 mm 2 inches wide stainless steel] [or] [minimum 9 mm 3/8-inch thick by 50 mm 2 inches wide aluminum] mounting strips. Provide pre-punched bolt holes in the strip at maximum 300 mm 12 inches on center to accommodate the concrete anchor bolts.

2.2.3.1 Gasket

Provide a minimum 6 mm 1/4-inch thick by 50 mm 2-inches wide nitrile gasket on one or both sides of the geomembrane as recommended by the geomembrane manufacturer at mounting strip locations to seal and protect the geomembrane from the concrete and the mounting strip.

2.2.3.2 Concrete Anchor Bolts

Use minimum 9 mm 3/8-inch diameter mechanical wedge-type concrete anchors, constructed of type 304 or 316 stainless steel. Provide nuts, washers, and other accessories of the same materials.

2.2.4 Sealant

Use sealant conforming to ASTM C920, Type S, Grade NS, Class 25 or better, or ASTM D5893/D5893M, Type NS, or other sealant recommended by the geomembrane manufacturer. Sealant used must be compatible with the material being stored, as recommended by the sealant manufacturer.

2.2.5 Temporary Ballast

Temporary ballast used during geomembrane installation may include sandbags, tires, or other material as recommended by the geomembrane manufacturer. Use non-abrasive material, free of sharp edges or other features that may damage the geomembrane liner.

2.2.6 Permanent Ballast

Provide permanent ballast as indicated [below].

****

NOTE: Select permanent ballast materials from the following section. Delete options that are not desired on this project. If alternate ballast materials are desired, include specific requirements, and ensure that the proposed material provides adequate ballast without damaging the geomembrane liner.

****

****

NOTE:Some jurisdictions require periodic inspection, testing, or certification of secondary spill containment systems. Designers must verify State and local requirements and specify appropriate ballast materials to accommodate the requirements. I.E. Do not specify ballast materials that cannot be readily removed when the liner underneath will need to be visually inspected.

****

2.2.6.1 Sand Bags

****

NOTE: Suggest bags be filled with dry, clean sand however if sand is not readily available at the project site, then require the bags to be filled with another more indigenous material. The material selected should not have any sharp points or edges.

****

Permanent sand bags fabricated of the same material as the liner. Provide approximately 23 kg 50 lbs of [dry, clean sand] [_____] inside of each bag. Completely seal each bag using the same field seam weld procedures used on the liner's field seams.

2.2.6.2 Precast Concrete Pavers

Provide precast concrete pavers that have a smooth finish with rounded edges where in contact with the liner and are free of sharp points or protrusions that may damage the geomembrane liner.

2.2.6.3 Cast in Place Concrete

Provide concrete cover over the containment geomembrane in accordance with Section 32 13 15.20 CONCRETE PAVEMENTS FOR CONTAINMENT DIKES.

2.2.6.4 Rock Ballast

Provide rock ballast consisting of clean, well graded river rock or cobble stone, sized 3.81 cm to 7.62 cm 1-1/2 inch to 3 inch. Use rock free of sharp points, protrusions, or edges.

2.2.7 Slip Resistant Walking Surface

****

NOTE: Include the following paragraph where the liner is intended to be left exposed without full coverage by concrete, aggregate, or other ballast material. Ensure that the design drawings indicate the pathways where non-slip surfaces are required

****

Provide an additional layer of geomembrane with an integral slip-resistant coating or sprayed on slip-resistant coating for slip resistant walking surfaces. Weld additional geomembrane layers to the base geomembrane. Use pprayed on coatings recommended by both the geomembrane and coating manufacturer for combined use and adhesion.

2.3 EQUIPMENT

Utilize equipment in performance of the work in accordance with the geomembrane manufacturer's recommendations and maintain in satisfactory working condition.

PART 3 EXECUTION

3.1 INSTALLATION

Make equipment/parts subject to degradation or requiring adjustment, inspection or repair accessible and capable of convenient removal. Prior to any fabrication or erection, submit detailed installation drawings that show the proposed panel layout of the liner over the entire containment area. As a minimum, indicate the direction and location of factory and field fabricated seams, the termination of the panels at the perimeter of lined areas, details and methods of sealing around penetrations, details and methods for anchoring, [placement of permanent [sandbags][precast concrete pavers] [______] for ballast,]and any applicable site specific installation instructions.

3.1.1 Field Engineer

Provide a field engineer to supervise the complete installation of the liner and perform each liner inspection and test.

3.1.2 Surface Preparation

****

NOTE: Include the bracketed sentences if a geotextile is required beneath the geomembrane for the project.

****

Prepare surfaces in accordance with Section 31 00 00 EARTHWORK. Surfaces to be covered must be free of vegetation, gravel, rocks, debris, etc., graded true, compacted, and be smooth with no abrupt projections. [Install the geotextile in direct contact with the existing subgrade to be covered. Install the geotextile in strict accordance with manufacturer's recommendations. Install geotextile to closely fit around projections (for example, pipe penetrations, concrete foundations/pads, conduit penetrations, etc.).] Submit a signed letter from the field engineer, prior to placing any geotextile or liner, that states the subgrade and surface preparation were adequate and in accordance with the liner manufacturer's recommendations.

3.1.3 Anchor Trenches

Where an anchor trench is required, place it [610] [_____] mm [24] [_____] inches back from the edge of the slope to be covered. Make the anchor trench [600] [_____] mm [24] [_____] inches deep and [300] [_____] mm [12] [_____] inches wide, unless otherwise recommended by the geomembrane manufacturer. If the anchor trench is excavated in cohesive soil susceptible to desiccation, excavate only the amount of anchor trench required for placement of geomembrane in a single day. Remove ponded water from the anchor trench while the trench is open. Slightly round trench corners to avoid sharp bends in the geomembrane. Remove loose soil, rocks larger than [13] [_____] mm [1/2] [_____] inch in diameter, and any other material which could damage the geomembrane from the surfaces of the trench. Extend the geomembrane down the front wall and across the bottom of the anchor trench. Backfill and compact the anchor trench in accordance with Section 31 00 00 EARTHWORK.

3.1.4 Embedment Strip Installation

Install embedment strips in new cast-in-place concrete structures using methods and materials recommended by the embedment strip/geomembrane manufacturer. Extrusion weld all joints and intersections of embedment material together or otherwise join as recommended by the manufacturer to provided a continuous surface for attachment of the geomembrane. Fill any holes through the face of the embed material resulting from the concrete forming or placement process with material recommended by the manufacturer.

3.1.5 Liner Installation

See paragraph AMBIENT CONDITIONS. Place the liner over the prepared surface in accordance with the liner manufacturer's installation instructions. The procedures and equipment used cannot elongate, wrinkle, scratch, or otherwise damage the geomembrane, [geotextile,]or the underlying subgrade. Place the liner in such a manner as to assure minimum handling and field seams. Use sand bags (or other manufacturer approved means) to hold the lining down in position during installation. Do not drag or slide materials, equipment or other items across the surface of the liner at anytime. Do not allow personnel walking or working on the lining to damage it. Replace or repair geomembrane damaged during installation. Allow adequate slack in the geomembrane to prevent the creation of tensile stress and avoid "trampolining" or "bridging". Do not exceed a wrinkle height to width ratio of 0.5 for installed geomembrane. In addition, geomembrane wrinkles must not exceed 75 mm 3 inches in height. Cut and repair wrinkles that do not meet the above criteria in accordance with paragraph REPAIRS.

3.1.5.1 Liner Projections

Install lining sheets to closely fit around liner projections (for example, pipe penetrations, concrete foundations/pads, conduit penetrations, etc.). Install and center manufacturer supplied sleeves/boots around liner projections in strict accordance with manufacturer's recommendations. Compress the end of pipe sleeves to a pipe with a stainless steel band clamp assembly. For liner anchorage to precast or existing concrete, install a batten / mounting strip around the liner edge and mount with concrete anchor bolts. Apply sealant to the perimeter edge of exposed liner to include the edge of sleeves/boots. For liner anchorage to new cast-in-place concrete, install an embedment strip in the concrete using methods and materials recommended by the embedment strip/geomembrane manufacturer.

3.2 FIELD SEAMING

3.2.1 Trial Seams

Make trial seams under field conditions on strips of excess geomembrane. Make trial seams each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment settings, whenever environmental conditions change significantly (more than 10 degrees 25 degrees), and at least once every four hours, by each seamer and each piece of seaming equipment used that day. Collect and test trial seam samples in accordance with [ASTM D6392 for non-reinforced liner] [or] [ASTM D751 and ASTM D413 for fabric-reinforced liner]. Obtain one sample from each trial seam. This sample must be at least 450 mm long by 305 mm wide 18 inches long by 12 inches wide with the seam centered lengthwise. Cut ten random specimens from the sample, 25.4 mm 1 inch wide. Field test five seam specimens for seam shear strength and field test 5 seam specimens for seam peel adhesion. To be acceptable, 4 out of 5 replicate test specimens must meet seam strength requirements specified in Table [1][2][3]. If the field tests fail to meet these requirements, repeat the entire operation. If the additional trial seam fails, do not use the seaming apparatus or seamer until the deficiencies are corrected by the installer and 2 consecutive successful trial seams are achieved. Maintain logs of trial seams, which include date, time, weather, seaming personnel, seaming equipment, equipment settings, and trail seam field test results. Submit trial seam logs following the completion of installation.

3.2.2 Field Seams

Seam panels in accordance with the geomembrane manufacturer's recommendations. Comply with the geomembrane manufacturer's recommnedation for the overlap between panels being seamed together; however, in no overlap less than 50 mm 2 inches. In sumps, corners and odd-shaped geometric locations, minimize the number of field seams. Extend seaming to the outside edge of panels. Compact soft subgrades prior to seaming. Provide a clean and free of moisture, dust, dirt, debris, markings, and foreign material area at the time of seaming. Completely unroll and layout adjacent liner panels/sheets before performing field seam welds. Repair fish mouths in seams.

3.3 FIELD QUALITY CONTROL

3.3.1 Visual Inspection of Field Seams

Visually inspect each field seam to confirm that the seams are tightly bonded. Perform the inspection of a seam within 30 hours after the manufacturer's suggested application, curing, and cooling time. Repair and re-inspect seams found to be defective in accordance with manufacturer's recommendations.

3.3.2 Non-Destructive Field Seam Testing

Perform non-destructive testing on all field seams over the full seam length and on any other areas showing damage or other distresses. Allowable methods are stated below. Alternate methods approved by the geomembrane manufacturer may be submitted upon approval by the Contracting Officer. Submit non-destructive field seam test reports following the completion of installation and prior to covering the geomembrane liner.

3.3.2.1 Liner Vacuum Box Test

Perform a vacuum box test in accordance with ASTM D5641/D5641M on each field seam, the area around the seams, and each liner surface showing injury due to scuffing, penetration by foreign objects, or distress from rough subgrade. If the vacuum box test indicates a continuous stream of bubbles on repeated testing at the same location, then the area being tested is considered damaged and must be repaired and retested. Perform repairs in accordance with manufacturer's recommendations.

3.3.2.2 Liner Air Lance Test

Perform an air lance test on seams to detect an unbonded area in accordance with ASTM D4437/D4437M. Perform the test using a minimum 345 kPa 50 psig jet of air regulated and directed through a 5 mm 3/16-inch diameter nozzle. Apply the jet of air to the lip of a seam in a near perpendicular direction to the length of the seam. Hold the nozzle a maximum of 100 mm 2 inches from the seam and travel at a rate of not to exceed 12 mpm 40 fpm. Inflation of any section of the seam by the impinging air stream is indicative of an unbonded area. Repair unbonded areas in accordance with manufacturer's recommendations and retest.

3.3.2.3 Liner Air Pressure Test

Perform air pressure testing in accordance with ASTM D5820. Upon completion of the test, relieve pressure from the opposite end of the seam being tested to verify continuity of the seam.

3.3.2.4 Liner Point Stress Test

Where other non-destructive test methods are not possible, perform point stress testing in accordance with ASTM D4437/D4437M.

3.3.3 Destructive Field Seam Testing

Obtain a minimum of one destructive test sample per [230] [_____] m [500] [_____] feet of field seam at locations specified by the Contracting Officer. Recommended locations include the ends of seams or anchor trenches, so as to minimize the impact of required repairs to the geomembrane; however, final sample locations will be determined by the Contracting Officer. Sample locations will not be identified prior to seaming. Collect samples a minimum of 305 mm 12 inches wide by 910 mm 36 inches long with the seam centered lengthwise. Cit each sample into two equal pieces, with one piece retained by the installer for field testing and the remaining destructive field seam test sample given to the Contracting Officer for QA testing and/or permanent record. Number each sample and cross reference to a field log which identifies: (1) panel number; (2) seam number; (3) date and time cut; (4) ambient temperature within 150 mm 6 inches above the geomembrane; (5) seaming unit designation; (6) name of seamer; and (7) seaming apparatus temperature and pressures (where applicable). Field test in accordance with [ASTM D6392 for non-reinforced liner] [or] [ASTM D751 and ASTM D413 for fabric-reinforced liner]. Cut ten 25 mm 1 inch wide replicate specimens from the installer's sample. Test five specimens for shear strength and 5 for peel adhesion. Jaw separation speed must be in accordance with the approved QC manual. To be acceptable, 4 out of 5 replicate test specimens must meet the seam strength requirements specified in Table [1][2][3]. If the field tests fail, repair the seam in accordance with paragraph REPAIRS. Repair holes for destructive seam samples the same day they are cut. Submit destructive field seam test reports following completion of installation and prior to covering the geomembrane liner.

3.4 REPAIRS

Patch damaged areas, destructive testing areas, or other areas requiring repair with the geomembrane material. Round the corners of the patch material and extend a minimum of 150 mm 6 inches in each direction from the damaged area. Small holes or snags less than 6 mm 1/4 inch in diameter may be repaired by extrusion welding where such process is approved by the geomembrane manufacturer.

3.5 PROTECTION AND BACKFILLING

****

NOTE: Retain the bracketed paragraph if the geomembrane liner is to be covered with permanent ballast material, such as concrete or river rock.

****

Prior to installation of permanent ballast material, the deployed geomembrane must be in intimate contact with the underlying surface, with no areas in sufficient tension to form "bridges" or "trampolines". Minimize waves/wrinkles in the geomembrane prior to placement of ballast materials; in no case allow wrinkles to fold over during placement of ballast materials.[Install the cover geotextile in direct contact with the geomembrane liner to be covered, in strict accordance with manufacturer's recommendations. Install geotextile to closely fit around projections (for example, pipe penetrations, concrete foundations/pads, conduit penetrations, etc.). Cover the deployed and seamed geomembrane with the specified permanent ballast material within [14] [_____] calendar days of acceptance. Do not drop ballast material onto the geomembrane or overlying geotextile from a height greater than 1 m 3 feet. Push the material out over the geomembrane in an outward/upward tumbling motion. Place ballast material from the bottom of the slope upward.]

3.5.1 Ballast Placement Equipment

****

NOTE: Avoid the use of construction equipment on the deployed geomembrane as much as possible to avoid potential damage. Include the first bracketed option where geomembrane is to be left uncovered or where the covered containment areas are sufficiently small to allow placement of cover material utilizing equipment positioned outside of the geomembrane covered area, such as a crane, backhoe, or concrete pump truck. Include the second bracketed option where use of small equipment (skidloader or similar) for placement of the cover material is necessary.

****

[Place ballast material utilizing construction equipment that is positioned off of the deployed geomembrane. Do not drive construction equipment on or above the geomembrane at any time.][Equipment with ground pressures less than 50 kPa 7 psi may be used to place the ballast material over the geomembrane; do not drive equipment exceeding this pressure on the geomembrane. Do not abruptly stop equipment placing ballast material, make sharp turns, spin wheels, or travel at speeds exceeding [2.2] [_____] m/s [5] [_____] mph. Operate equipment driving on the geomembrane on a cushion layer of ballast material with a minimum thickness of 150 mm 6 in over the geomembrane; at no time operate equipment directly on the geomembrane or geotextile.]

3.6 PERMANENT BALLAST

****

NOTE: Delete inapplicable ballast materials.

****

3.6.1 Sand Bags

****

NOTE: For liners exposed to the elements, show bags to be permanently placed on top of the liner at regularly spaced intervals in order to keep the liner held down in the event of strong winds. A typical location for such bags would be at the base of a dike wall/berm.

****

Determine sand bag placement and spacing by wind uplift calculations as specified in paragraph DESIGN REQUIREMENTS.

3.6.2 Precast Concrete Pavers

Determine paver placement and spacing by wind uplift calculations as specified in paragraph DESIGN REQUIREMENTS. Install an additional layer of geomembrane under each paver, welded to the base geomembrane.

3.6.3 Cast in Place Concrete

Place concrete cover over containment geomembrane in accordance with Section 32 13 15.20 CONCRETE PAVEMENTS FOR CONTAINMENT DIKES.

3.6.4 Rock Ballast

Compact rock ballast with two passes of a walk-behind vibratory compactor. Provide ballast thickness[as indicated][200 mm 8 inches for the containment area floor][and][150 mm 6 inches for dike slopes].

3.7 SLIP RESISTANT WALKING SURFACE

****

NOTE: Include the following paragraph where the liner is intended to be left exposed without full coverage by concrete, aggregate, or other ballast material. Ensure that the design drawings indicate the pathways where non-slip surfaces are required.

****

Install slip resistant walking surface materials [in the areas indicated] [on top of dike slopes and between the dike stairs and tank concrete apron].

3.8 PROJECT CLOSEOUT

Provide As-Built Drawings which show the as constructed panel layout, factory and field seam locations, penetrations, destructive field seam testing location, and repair locations. Provide operation and maintenance data package for the geomembrane liner to include material cut sheets, liner's routine maintenance requirements as well as procedures for liner repair and troubleshooting.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 56 21.17 (November 2018)**
Change 2 - 11/22

Preparing Activity: NAVFAC **Superseding**
UFGS-33 56 13.13 (August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 33 - UTILITIES

SECTION 33 56 21.17

SINGLE WALL ABOVEGROUND FIXED ROOF STEEL POL STORAGE TANK

11/18, CHG 2: 11/22

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-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-33 56 21.17 (November 2018)**
Change 2 - 11/22

Preparing Activity: NAVFAC **Superseding**
UFGS-33 56 13.13 (August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 56 21.17

SINGLE WALL ABOVEGROUND FIXED ROOF STEEL POL STORAGE TANK

11/18, CHG 2: 11/22

****

NOTE: This guide specification covers the requirements for design and installation of atmospheric aboveground steel tanks with fixed cone roofs.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Coordinate use of floating pans with UFC 3-460-01 prior to editing this specification.

****

****

NOTE: Earthwork, concrete work, piping, and other work in connection with the tanks should be included in the appropriate sections of the project specification or in a separate project specification.

****

****

NOTE: The following information must be shown on the project drawings:

1. The extent of the work included in the project should be indicated on drawings showing the site layout, location of outlets and inlets, water draw off connection, manholes, other tank appurtenances, and other data required for design by the Contractor.

2. If concrete foundation work is provided under a separate contract, Government work should include foundations, setting anchor bolts, concrete retaining ring, and other pertinent work such as sand for sand cushion, water for testing, and furnishing and installing any tank accessories not a part of this specification.

****

****

NOTE: This section is not intended for tanks with aluminum geodesic dome roofs.

NOTE: This section is not intended to be used without Section 33 56 21.18 SINGLE WALL POL TANK UNDERTANK INTERSTITIAL SPACE and Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). For piping, pipe fittings, flanges, gaskets, and bolting, refer to Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI E 1	(2011) Steel Plate Engineering Data Series - Design of Plate Structures, Volumes I & II

AMERICAN PETROLEUM INSTITUTE (API)

API MPMS 2.2A	(1995; R 2017) Manual of Petroleum Measurement Standards Chapter 2-Tank Calibration Section 2A-Measurement and Calibration of Upright Cylindrical Tanks by the Manual Tank Strapping Method
API MPMS 2.2B	(1989; R 2019) Manual of Petroleum Measurement Standards Chapter 2: Tank Calibration - Section 2B: Calibration of Upright Cylindrical Tanks Using the Optical Reference Line Method
API MPMS 2.2C	(2002; R 2013) Manual of Petroleum Measurement Standards Chapter 2: Tank Calibration - Section 2C - Calibration of Upright Cylindrical Tanks Using the Optical-Triangulation Method
API MPMS 2.2D	(2003; R 2014) Manual of Petroleum Measurement Standards Chapter 2: Tank Calibration - Section 2D Calibration of Upright Cylindrical Tanks Using the Internal Electro-Optical Distance-Ranging Method
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage
API Std 653	(2014; Addendum 1 2018) Tank Inspection, Repair, Alteration, and Reconstruction
API Std 2000	(2014) Venting Atmospheric and Low-Pressure Storage Tanks

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B31.3	(2022; Errata 2023) Process Piping
ASME B73.1	(2020) Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process
ASME B73.2	(2023) Specification for Vertical In-Line Centrifugal Pumps for Chemical Process
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS A5.10/A5.10M	(2023) Welding Consumables - Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys - Classification
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A492	(1995; R 2019) Standard Specification for Stainless Steel Rope Wire
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B241/B241M	(2022) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B247	(2020) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings

ASTM B247M	(2020) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings (Metric)
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D3489	(2017) Standard Test Method for Microcellular Urethane Materials
ASTM D4065	(2012) Standard Practice for Plastics: Dynamic Mechanical Properties: Determination and Report of Procedures
ASTM D4814	(2020a) Standard Specification for Automotive Spark-Ignition Engine Fuel
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

NACE INTERNATIONAL (NACE)

NACE SP0178	(2007) Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to be Lined for Immersion Service

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NORTH ATLANTIC TREATY ORGANIZATION (NATO)

AFLP-3747	(2013; Rev 9) Guide Specifications (Minimum Quality Standards) for Aviation Turbine Fuels (F-24, F-27, F-34, F-35, F-37, F-40 And F-44)

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5624	(2024; Rev X) Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-DTL-83133	(2015; Rev J) Turbine Fuels, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35 and JP-8 + 100 (NATO F-37)
MIL-PRF-23236	(2009; Rev D; Notice 1 2023) Coating Systems for Ship Structures

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23	(Nov 2016) Ladders
29 CFR 1910.25	(Dec 2019)Stairways

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

****

NOTE: Include emergency vent in SD-03 and SD-05 only on tanks smaller than 15.24 meters 50 feet in diameter and without a floating pan.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Copies of API Publications; G, [_____]

Acknowledgement of API Std 650; G, [_____]

NACE Visual Comparator; G, [_____]

Acknowledgement of Surface Finish Requirements; G, [_____]

SD-02 Shop Drawings

Steel Tank; G, [_____]

[Tank Bottom Shimming and Grouting Plan; G, [_____]

] Floating Pan; G, [_____]

Overflow/Circulation Vents; G, [_____]

Water Draw-Off System; G, [_____]

Product Saver Tank; G, [_____]

[Side Stream Filtration System; G, [_____]

] Channel Mounting Pads; G, [_____]

SD-03 Product Data

Structural Steel; G, [_____]

Carbon Steel, Pipe Fittings, Flanges, Gaskets, and Bolting; G, [_____]

Aluminum Piping; G, [_____]

Aluminum Flanges; G, [_____]

Gaskets for Manhole Covers, Stilling Well Flanges, and Roof Center Vent; G, [_____]

[Tank Bottom to Foundation Gasket; G, [_____]

][Tank Grout; G, [_____]

][Tank Shims; G, [_____]

] Floating Pan; G, [_____]

Sample Gauge Hatch; G, [_____]

Floating Seal and Retrieval Winch; G, [_____]

Mechanical Tape Level Gauge; G, [_____]

Center Roof Vent; G, [_____]

Stairway Step and Platform Tread Grating; G, [_____]

Stairway Bolting; G, [_____]

[Emergency Vent; G, [_____]

][Side Stream Filtration System; G, [_____]

] Antiseize Compound; G, [_____]

SD-04 Samples

[Tank Bottom to Foundation Gasket; G, [_____]

] SD-05 Design Data

[Emergency Ventilation Calculations; G, [_____]

] Steel Tank Design; G, [_____]

Floating Pan Design; G, [_____]

SD-06 Test Reports

API Std 653 Inspection Reports; G, [_____]

Visual Examination of Vertical Shell-Seam Tack Welds

Visual Examination of Initial Pass of Internal Shell-to-Bottom Weld

Vacuum Box Testing of Internal Shell-to-Bottom Initial Weld Pass

Visual Examination of Completed Internal and External Shell-to-Bottom Welds

Radiographic Examination of Shell Butt Weld

Visual Examination of Shell Butt Welds

Visual Examination of Fillet Welds

Visual Examination of Tank Bottom Plates

Vacuum Box Testing of Tank Bottom Fillet Weld

Pneumatic Tests of Reinforcing Plates

Hydrostatic Testing

Approval of Professional Engineer in Lieu of Hydrostatic Testing

Shell Settlement Measurements Taken Before, During, and After Hydrostatic Testing

Internal Bottom Elevation Readings Taken Before and After Hydrostatic Testing

Shell Plumbness

Shell Roundness

Maximum Local Deviations, Shell

Tightness Test Records

Tank Bottom Puddle Test

Roof Puddle Test

Stilling Well Plumbness Test

SD-07 Certificates

Qualifications of Tank Erector

Welding Procedure Specifications (WPS)

Welding Procedure Qualification Records (PQRs)

Welder Performance Qualification Records (WPQ)

Tank Calibration Experience

Qualifications of Floating Pan Manufacturer

Weld Inspector Certification

NDE Personnel Certification

Qualifications of Testing Agency

Qualifications of API Std 653 Inspector

SD-09 Manufacturer's Field Reports

Mill Test Reports; G, [_____]

Impact Test Data; G, [_____]

Floating Pan Prototype Fire Test; G, [_____]

SD-10 Operation and Maintenance Data

API Std 653 Inspection Reports, Data Package 2

Tank Calibration Table, Data Package 2

Electronic Calibration Table, Data Package 2

Maintenance Instructions, Data Package 2

Operator Instructions, Data Package 2

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 COPIES OF API PUBLICATIONS

Provide four copies of API RP 2009, API Std 650, and API MPMS 2.2A, API MPMS 2.2B, API MPMS 2.2C and API MPMS 2.2D to the Contracting Officer.

1.4 RELATED REQUIREMENTS

****

NOTE: If fuel used is not listed in this section, consult UFC 3-460-01, "Design: Petroleum Fuel Facilities", Chapter 2-2 for ASTM or MIL-DTL specification number, and list below.

In the electrical design, include the following: potted explosion proof MI cable for connections to electric actuators in the dike area; tank grounding system; conduit routing such that it cannot be stepped upon; supporting conduit on cast-in-place concrete supports inside the secondary containment area; considering conduit supports during design and addressing aboveground and belowground conduit and locations of boxes, lights, etc.

****

Materials, design, fabrication, welding, erection, testing, and appurtenances must be in accordance with API Std 650 and as indicated and specified herein. Submit acknowledgement of API Std 650 as required standard. Product[s] to be stored in the tank [is][are] [_____] [MIL-DTL-5624 Grade JP-4][and][MIL-DTL-5624 Grade JP-5][and][MIL-DTL-83133 JP-8][and][AFLP-3747 Jet A F-24][and][ASTM D4814 Mogas(F-46)][and][Diesel (F-76)]. Section [23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS] [05 50 13 MISCELLANEOUS METAL FABRICATIONS] and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM apply to this section except as specified otherwise.

1.5 DESIGN REQUIREMENTS

****

NOTE: Insert design information for loads on tanks as given in UFC 3-460-01, "Design: Petroleum Fuel Facilities". Insert the size and volume of the tank. Edit as required for project. Coordinate with structural drawing notes.

****

Design tank [repairs] to resist the[following] loads and forces[:][listed on the structural drawings and for the following:]

[a. Wind: [_____] kilometers per hour [_____] mph.

] b. Design specify gravity of liquid is [_____] to [_____].

c. Design shell and nozzles for a design liquid level equal to overflow condition.

1.5.1 Seismic Design Requirements

Seismic loads and forces must be in accordance with API Std 650 Appendix E.

1.5.1.1 Columns

****

NOTE: Allow only one roof support column in floating roof tanks of 80,000 bbls and larger.

Do not allow roof support columns in floating pan tanks smaller than 80,000 bbls nominal size.
****

[Provide tank with no more than one roof support column. Design roof support columns to resist the forces caused by sloshing of the liquid contents during a seismic event.] [Provide exterior epoxy coated roof support column.] [Roof support columns are not allowed.]

1.5.1.2 Shell Height

Shell height must provide clearance between the pan at full overflow (bottom of pan at top of overflow) and the fixed roof that includes an allowance of at least 300 mm 12 inches for sloshing due to seismic event or the minimum freeboard as calculated in accordance with API Std 650 for the sloshing wave height, whichever is greater.

1.5.2 Tank Nozzles

Design tank nozzles to accommodate external piping loads in accordance with API Std 650.

1.5.3 Tank Roof

Provide tank roof plates, lap welded with inner plates on top, and at least 6 mm 1/4 inch thick (includes 1.5 mm 1/16 inch corrosion allowance). Support beams must be designed so as to minimize uncoatable surfaces. Provide solid web or HSS (Hollow Structural Section) type roof beams. Open web trusses are not permitted. Do not attach roof support members to the roof plate. Provide a roof with every part having a slope of 1-1/2:12.

****
NOTE: On tanks 15.24 m 50 feet or more in diameter that do not have a floating pan, include the first bracketed paragraph. On tanks less than 15.24 m 50 feet in diameter that do not have a floating pan, include the second bracketed paragraph. On tanks with floating pans, delete both paragraphs.
****

[1.5.3.1 Emergency Ventilation

Provide emergency ventilation by a frangible roof design. The weld attaching the roof plate to the top angle must not be greater than 5 mm 3/16 inch.

][1.5.3.2 Emergency Vent Devices

Submit emergency ventilation calculations for selection of emergency vents.

]1.5.4 Corrosion Allowance

Provide corrosion allowance of 1.6 mm 1/16 inch in thickness of steel for the interior of the shell, roof, and interior structural members.

1.5.5 Design Metal Temperature

****

NOTE: Insert design metal temperature for locations not covered by API Std 650. Obtain low temperature from weather data. Determine the design metal temperature in accordance with API Std 650.
****

API Std 650 [[_____] degrees C] [[_____] degrees F].

1.5.6 Tank Bottom

Tank bottom [and annular ring] must be as indicated. Bottom plates must be lap welded with inner plates on bottom.

1.6 QUALIFICATIONS OF TANK ERECTOR

****
NOTE: For NAVFAC projects, include the following requirement in the Project Information Form (PIF).
****

The Contractor must be regularly engaged in the erection of API Std 650 tanks. The Contractor must certify successful completion of at least 12 field erected API Std 650 aboveground tanks in the past three years. The information provided in the Contractor's certification must include the date of the notice to proceed, date of completion, location of tank, Owner, Owner's point of contact, tank size, configuration (e.g., vertical AST, horizontal AST), product stored, and material of construction.

1.6.1 Welding Qualifications

All welders on site must be qualified in accordance with ASME BPVC SEC IX. Submit Welding Procedure Specifications (WPS), Welding Procedure Qualification Records (PQRs), and Welder Performance Qualification Records (WPQ). Complete all WPQs specifically for this project. Give the Contracting Officer notice and opportunity to witness each of the welder performance qualification tests 24 hours in advance of the performance of each of the tests.

1.7 TANK CALIBRATION EXPERIENCE

Perform calibration of the tank using a qualified organization that can certify to having performed successful and accurate calibration of at least eight tanks of comparable type and size within the last two years. Submit certified data on tank calibration experience.

1.8 QUALIFICATIONS OF FLOATING PAN MANUFACTURER

****
NOTE: For NAVFAC projects include the following requirement in the Project Information Form (PIF).
****

The floating pan manufacturer must be regularly engaged in the manufacture and installation of floating pans in API Std 650 tanks. The manufacturer must certify successful manufacture and installation by the manufacturer of at least 10 floating pans of the type specified in field erected API Std 650 aboveground tanks within the past five years. A minimum of five of those installations must have been performed on US military installations. The information provided in the manufacturer's certification must include the date of the notice to proceed, date of completion, location of tank, customer project number or construction contract number, owner's point of contact, tank size, and construction type.

1.9 QUALITY ASSURANCE

1.9.1 Delivery and Storage Handling

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.9.2 Steel Tank Drawing Requirements

****

NOTE: See FC 1-300-09N Navy and Marine Corps Design Procedures for professional engineer requirements.

****

Drawings for the steel tank and floating pan must be prepared, sealed, signed, and dated by a registered professional engineer. Include erection diagrams and detail drawings of the tank roof, shell plates, wind girders, openings, and connections for fittings and appurtenances. The steel tank drawings must include the following:

a. Tank erection details showing dimensions, sizes, thickness, gages, materials, finishes, and erection procedures.

b. Tank component details to include as a minimum:

(1) Floating pan (including details of support legs, manways, periphery seals, joint attachments, anti-rotation cables, and grounding cables).

(2) Locations of floating pan pressure/vacuum vents and rim seals.

(3) Internal pipe and fittings, including supports and bearing plates.

[(4) Tank Bottom to foundation gasket.

][(5) Tank Bottom Shimming and Grouting plan and details.

(6) Tank Anchors.

]

(7) Location of alarm and control switches.

(8) Location of nozzles including nozzles for gauges and alarms.

(9) Roof support system details.

(10) Roof manhole.

(11) Circulation vents/inspection hatches.

(12) Center roof vent.

(13) Overflow port/circulation vent.

(14) Shell manholes and davits.

(15) Stairway, including replaceable stair tread installation and platforms.

(16) Channel mounting pads.

(17) Tank Data Plate Plan and Information.

(18) Shell to bottom connection.

(19) Tank bottom to ringwall interface.

(20) Stilling wells.

(21) Grounding lugs.

(22) Sump.

(23) Scaffold Cable Support.

(24) Shell circulation vents.

1.9.3 Data Requirements

Calculations for the steel tank design and floating pan design must be prepared by a State registered Professional Engineer. Include calculations for the buoyancy of the floating pan and the structural stability of the floating pan when resting on the support legs. Steel tank design calculations must include calculations for the design of the shell, as well as calculations for the design of the roof [frangible roof connection], [tank anchorage] [emergency vent] and roof support.

1.9.4 Weld Inspector Certification

Contractor must arrange for the services of an independent (impartial third party not a part or affiliated with Contractor or subcontractor principal or subsidiary businesses) weld inspector certified by the American Welding Society to oversee all weld tests and examinations required by API Std 650.

1.9.5 Test Reports

Test Reports must consist of the following:

a. Records made by the AWS certified inspector for all duties performed per paragraph 4.2 of AWS QC1.

b. All Nondestructive Examination (NDE) (e.g., radiograph, ultrasound, etc.) reports with unique weld ID for each weld tested.

c. "Weld Map". These maps/drawings correlate the shop drawings submitted to the NDE reports. The NDE report that shows a weld number as acceptable is correlated with weld number on the drawings.

Provide the location of each weld, what procedure was used, which welder made the weld, the results of the visual test, and the results of the NDE.

1.9.6 Inspection and NDE Personnel

All inspection and NDE personnel must be qualified in accordance with the following requirements. The Contractor must submit the qualifications of all the testing personnel that will perform all field tests for review by the Contracting Officer. The qualifications of all personnel on the job site that will perform welding inspections and NDE must be submitted for approval. All inspectors and NDE examiners must have a minimum of one-year experience inspecting the piping or plate material being used and five-years in military or commercial fueling systems or petroleum refineries, power generating plants, paper mills, or chemical process plants.

1.9.6.1 NDE Personnel Certification

A written procedure/quality assurance program for the training, examination, certification, control and administration of NDE personnel must be established. The procedures must be based on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A. Submit proof of compliance of nondestructive test examiners with API Std 650 including, but not limited to, examiners performing radiographic (RT), visual (VT), penetrant (PT), ultrasonic (UT), [and][or] magnetic particle (MT) testing.

1.9.6.2 Qualifications of Testing Agency

The testing agency, testing laboratory, technical consultant or contractor's approved quality assurance organization must meet the requirements of ASTM E329.

1.9.7 Qualifications of API Std 653 Inspector

Contractor must arrange for the services of an independent (impartial third party not a part or affiliated with Contractor or subcontractor principal or subsidiary businesses) API Std 653 inspector. API Std 653 Inspector must have a minimum of five years of experience. Submit copy of current certificate.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the following requirements except that materials not definitely specified must conform to API Std 650. All materials must be carbon steel unless otherwise noted.

2.1.1 Materials for System Components, Pipe, and Fittings

****

NOTE: Unless otherwise specified: In corrosive environments (such as near the ocean or humid locations) select the first option; in non-corrosive environments select the second option.

****

a. [All piping and fittings outside the tank (except for the tank fill line, tank issue line, and tank low suction line) must be stainless steel. The tank fill line, tank issue line, and tank low suction line piping and fittings must be interior and exterior coated carbon steel.

All valves (except DBB valves) and ball joints must be stainless steel. DBB valves must be as specified.] [All piping, and fittings 63 mm 2.5 inches and larger must be interior and exterior coated carbon steel. All piping and fittings 50 mm 2 inches and smaller must be stainless steel. All valves larger than 63 mm 2.5 inches must be carbon steel with stainless steel trim. All valves 50 mm 2 inches and smaller must be stainless steel. DBB valves must be as specified.]

b. All piping and fittings inside the tank must be exterior and interior epoxy coated carbon steel except for piping 50 mm 2 inches and smaller which must have an uncoated interior. Stilling well and ladder material must be as indicated.

c. Do not weld stainless steel to carbon steel, except where specifically indicated or specified.

d. If materials for system components are not specified, they must be stainless steel.

e. Provide stainless steel HLV float control chamber, pilot, level switch housings, and level switch probe holders.

2.2 STRUCTURAL STEEL

API Std 650. Provide mill test reports for shell plates, shell nozzle reinforcing plates, shell insert plates, and all steel plate used in construction of shell penetrations. Provide impact test data when required by API Std 650 for the material group and thickness provided.

2.3 CARBON STEEL, PIPE FITTINGS, FLANGES, GASKETS, AND BOLTING

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NOTE: Ensure bolting on interior of tank is stainless steel.

****

Carbon steel, pipe fittings, flanges, gaskets, and bolting must be provided in accordance with Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT), except gaskets inside tank and on roof nozzles must be non-asbestos, fuel resistant composition, or preformed type. Flanges must be weld-neck type in accordance with ASME B16.5. Threaded fittings must conform to ASME B16.11 (Class 3000), and butt-welded fittings must conform to ASME B16.9.

2.4 STAINLESS STEEL PIPE, FITTINGS, FLANGES, GASKETS, AND BOLTING

Stainless steel pipe, pipe fittings, flanges, gaskets, and bolting must be provided in accordance with Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT) and API Std 650, except: flanges must be weld-neck type in accordance with ASME B16.5, threaded fittings must conform to ASME B16.11 (Class 3000), and butt-welded fittings must conform to ASME B16.9.

2.5 ALUMINUM PIPING FOR STILLING WELLS

Aluminum pipe must be ASTM B241/B241M, alloy 6061-T6, Schedule 40 for pipe sizes 50 mm 2 inches through 300 mm 12 inches; Schedule 80 for pipe sizes 50 mm 2 inches and smaller.

2.6 BOLTING AND ALUMINUM FLANGES FOR STILLING WELLS

Aluminum flanges must be ASME B16.5, Class 150 or Class 300 where indicated, Flat Face Type, except aluminum must conform to ASTM B247M ASTM B247, alloy 6061-T6 or alloy 356-T6. Aluminum flanges may be welding neck or slip-on type. Provide bolting in accordance with Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). Provide electrical isolation for separation of dissimilar metals.

2.7 WELDING FOR ALUMINUM PIPING

2.7.1 Process for Aluminum

ASME B31.3, Gas Tungsten Arc Welding (GTAW) Process or Gas Metal Arc Welding (GMAW) Process. Backing rings are not permitted.

2.7.2 Aluminum Welding Electrodes and Rods

AWS A5.10/A5.10M, ER5356 electrodes.

2.8 BOLTING FOR SHELL MANHOLE COVERS

Bolting for shell manholes must be in accordance with Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

2.9 GASKETS FOR MANHOLE COVERS, STILLING WELL FLANGES, AND ROOF CENTER VENT

Provide composition asbestos-free, fuel and fire-resistant gaskets for shell manhole covers, stilling well flanges, and roof center vent.

2.10 TANK BOTTOM TO FOUNDATION SEAL

****

NOTE: Include the first bracketed paragraph for self anchored tanks. Include the second bracket paragraph for anchored tanks.

****

[2.10.1 Tank Bottom to Foundation Gasket - Self Anchored Tanks

Tank bottom to foundation gasket for self anchored tanks must be 12 mm 1/2-inch thick, nonporous Buna-N with a Shore A Durometer Hardness of not more than 40 and a rated tensile strength of at least 10,300 kPa 1,500 psi. The inside and outside edge of the gasket must be cut on a radius. Provide gasket in segments at least 2.4 meters 8 feet long. Provide three samples of the tank bottom-to-foundation gasket material measuring 13 mm 1/2-inch by 75 mm 3 inches by 225 mm 9 inches.

][2.10.2 Tank Shims and Tank Grout - Anchored Tanks

Grout must be non-shrink type and consist of 1 part Portland cement to 1-1/2 parts sand by volume. Do not use calcium chloride admixtures. When the ambient temperature is expected to fall below 16 degrees C 60 degrees F within the next 48 hours, the cement used must be "high early strength" type.

****

NOTE: Include the following in the products section

of the exterior coating specification and require product data submittal:

"X.X.X. Tank Bottom to Foundation Sealant

The tank bottom perimeter to foundation ring wall mastic sealant must be liquid applied non-sagging, two part polysulfide rubber joint sealant composed of 100 percent solids, and conforming to ASTM C920, Class 25. The sealant must be suitable for use on steel, epoxy coated surfaces and concrete. The sealant must be rated with a Shore A Hardness of not more than 30, a minimum tensile strength of 1,000 kPa 150 psi, a minimum elongation of 100 percent at 350kPa 50 psi without breaking, and a minimum elongation of 200 percent at 550 kPa 80 psi without breaking. The sealant must be resistant to jet fuel, sunlight, cold, and ozone without shrinking; and must have a rated life expectancy of at least 15 years. Use with bond breaker tape recommended by the manufacturer."

****

]2.11 INTERIOR PROTECTIVE COATING SYSTEM

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NOTE: In order to protect product quality and to extend the life of the tank, the prescribed interior surfaces of steel petroleum storage tanks must be coated in accordance with UFC 3-460-01, "DESIGN; PETROLEUM FUEL FACILITIES".

NOTE: Other guidance as to interior surface treatment is as follows:

1. Specify bare interior metal surfaces and coating with SAE-30 weight oil if the coating is to be done at a later date. Uncoated surfaces must be cleaned of contaminants, including mill scale.

2. Include instructions in the coating specification to seal all uncoatable areas of the roof support structure by caulking all gaps and joints in roof beams including between coated beams and roof plates. Problems can arise when the roof plates are welded in cooler weather and the underside coated in warmer sunny weather as the roof plate expands and pulls away from the roof rafters leaving a gap that is too large to caulk. For example, Roof plate on a 15 meter 50 feet diameter tank welded in winter may lift at center in the summer by as much as 40 mm 1-1/2 inches. Consider local geographical conditions at the time of construction when caulking roof support beams, roof plates etc. It is recommended for locations like Seattle and Guam, that have more stable year-round temperatures and condensation.

3. Include instructions in coating specification to

caulk the underside of roof plate seams that are not welded on the underside.
****

Interior of the tank must be bare steel. Coat interior of tank with SAE 30 oil for temporary protection.

2.12 EXTERIOR PROTECTIVE COATING SYSTEM

Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES.

2.13 APPURTENANCES

2.13.1 Floating Pan Installation Hatch

Provide permanent floating pan installation hatch on the tank roof. Provide with bolted cover and water tight gasket.

2.13.2 Floating Pan

The floating pan must be naturally buoyant by means of honeycomb cell aluminum sandwich panels, be suitable for operation with liquids having a specific gravity of 0.70, be internal to the tank, have full surface contact with the fuel, be equipped with a seal at each penetration, and meet the requirements of API Std 650 Appendix H. A rim must be provided around the floating pan periphery and extend a minimum of 150 mm 6 inches above the free liquid surface. The rim must contain turbulence and prevent fuel from splashing up onto the top surface of the floating pan.

2.13.2.1 Pan Integrity

The floating pan must support the following loading conditions without causing damage to the pan, sinking the pan, or allowing product to spill onto the top surface of the pan in the event the pan is punctured.

a. A uniform load of three times the weight of the pan.

****
NOTE: Include the first bracketed sentence for tanks larger than 9144 mm 30 feet in diameter, and the second for smaller tanks.
****

[b. A point load of 227 kg on a 93,000 sq mm 500 pounds on a one square foot area anywhere on the floating pan while it is floating or resting on the legs.

][c. A point load of 113 kg on a 93,000 sq mm 250 pounds on a one square foot area anywhere on the floating pan while it is floating or resting on the legs.

]2.13.2.2 Floating Pan Prototype Fire Test

Perform a fire test on another floating pan design of the same manufacturer that is constructed from the same materials and joining method of the pan being proposed and that meets the floating pan specification in aviation turbine fuel or motor gasoline with a flash point of less than minus 7 degrees C 20 degrees F. Submit manufacturer's certification of fire test indicating the manufacturer's floating pan design has been successfully fire tested and that both of the following tests were successfully performed, without significant damage to the pan, sinking the pan or the fire spreading to the whole surface of the fuel.

a. Hole Fire: The test-floating pan must have a 300 mm 12 inch or larger diameter hole cut through it. After being lit, the fuel in the hole must burn for a minimum of 2 hours.

b. Rim Fire: After being lit, the fuel around the test rim section must burn for a minimum of 2 hours.

2.13.2.3 Joint Connections

Aluminum sandwich panels must be joined together by means of a gasketed joint that transmits loads without structural failure or leakage.

2.13.2.4 Aluminum Extrusions

Extrusions must be made from alloy 6063-T6 in accordance with ASTM B209M ASTM B209.

2.13.2.5 Aluminum Sandwich Panels

Panels must be made from alloy 3003 H14, 3003 H16, 3105 H14, or 5010 H24 in accordance ASTM B209M ASTM B209. The skin of the panels must have a minimum thickness of 0.356 mm 0.014 inches. The core of the panels must be 25 mm one-inch aluminum honeycomb.

2.13.2.6 Support Legs

Floating pan must be provided with two position self-draining aluminum legs that are designed to support a uniform load of 600 Pa 12.5 pounds per square foot. Stainless steel support legs are not allowed. The legs must be tubular structural members at least 50 mm 2 inches in diameter and ride with the pan when the fuel level is above the high leg position. The low position must be as indicated and the high position must be 1950 mm 78 inches above the shell-to-bottom joint. The exact location and number of the support legs must be as recommended by the floating pan manufacturer. Provide each support leg with a 63 mm 2.5 inch polytetrafluoroethylene (PTFE) foot securely fastened to the bottom end of the leg. The portion of the PTFE foot below the metal leg must be 25 mm one-inch thick. The PTFE foot must be slotted on one side to allow for drainage. The legs must be capable of allowing a person, standing on top of the floating pan while the tank is in service, to perform the following functions:

a. Change from the high to the low position.

b. Change from the low to the high position.

c. Completely remove the legs.

d. Adjust the legs vertically a distance equal of plus or minus 75 mm 3 inches.

2.13.2.7 Periphery Seals

Periphery seals must be flexible wiper squeegee and made of closed cell cast urethane. The periphery seal must fit the space between the tank shell and the outer edge of the floating pan with two flexible seals, a primary and a secondary. The seals, primary and secondary as a unit, must accommodate a deviation between the path of the floating pan relative to the tank shell of an additional 100 mm 4 inches of compression and an additional extension of 50 mm 2 inches from its normal compressed position at any fluid level. The primary seal must be above the liquid level. Foam filled coated-fabric seals must not be accepted. The secondary seal must be above the primary seal. Seals must be capable of being replaced during tank operations, be durable in the tank's environment, be abrasion resistant, and not discolor or contaminate the liquid stored in the tank. Seals must be manufactured in the United States and must be provided in minimum continuous lengths of 8.54 meter 28 feet with no factory splices. Seals must be compatible with avgas, fuel oil, gasoline/ethanol, gasoline/MTBE 80/20, gasoline (unleaded), aviation turbine fuels, kerosene, and sea water. The following tables list the required physical properties of periphery seals:

TABLE 1: PHYSICAL PROPERTIES OF PERIPHERY SEALS

Physical Properties	Test Method	Values
Maximum operating temperature	Dynamic mechanical analysis per ASTM D4065	82 C 180 F (min)
Tensile strength	ASTM D412	39130 kPa 5675 psi (min)
Elongation at break	ASTM D412	640 percent (min)
Tear resistance (Die C)	ASTM D624	61.30 N/mm 350 PLI (min)
Abrasion resistance	Tabor, mg loss at 100 cycles per ASTM D3489	8 mg 0.00028 ounce (max)
Compression set	ASTM D575A	25 percent (max)

TABLE 2: JET FUEL SOAK TEST PARAMETERS

Jet Fuel Soak Test 96 hrs. at 67.2 C 153 F	Before Immersion	After Immersion	Percent Change
Tensile strength	37895 kPa 5496 psi	36440 kPa 5285 psi	minus 3.8 percent (min)
Elongation at break	640 percent	729 percent	plus 13.9 percent (min)
Hardness	73 Shore A	66 Shore A	minus 7.0 percent (min)
Volume change	-	-	plus 6.0 percent (max)

2.13.2.8 Penetrations

All penetrations must have a rim that extends a minimum of 150 mm 6 inches above the free liquid to contain product turbulence and prevent the tank product from splashing up onto the top surface of the floating pan.

2.13.2.9 Manhole

****

NOTE: Review Federal, State, and local regulations to ensure compliance with air emission regulations.

Consider the slotted stilling wells in the review. At least one 900 mm 36 inch diameter manhole must be provided for each floating pan to provide access to the tank interior when the floating pan is on its supports and the tank is empty; provide two for tanks larger than 50,000 bbl.
****

Provide [_____] 900 mm 36 inch floating pan manhole[s]. Manhole must have a clear inside diameter of at least 900 mm 36 inches. Manhole must have a rim that extends a minimum of 150 mm 6 inches above the free liquid to contain product turbulence and prevent the tank product from splashing up onto the top surface of the floating pan. The manhole cover must be equipped with a ground cable connected to the floating pan.

2.13.2.9.1 Pressure/Vacuum Vent

The pressure/vacuum (PV) vent must be sized by the internal floating pan manufacturer for the maximum fill rate of [_____] L/s gpm and the maximum withdrawal rate of [_____] L/s gpm. When the PV vent is in the open position, the float must hang from a strap.

2.13.2.10 Grounding Cables

Provide two or more 3 mm 1/8-inch diameter, stranded, extra-flexible, stainless steel, wire rope ground cables. Each cable must extend from the top of the floating pan to the fixed roof and must be long enough to accommodate the full travel of the pan. The exact location, number, and size of grounding cables must be as recommended by the floating pan manufacturer.

2.13.2.11 Anti-Rotation Cable

Provide 6 mm 1/4-inch diameter anti-rotation cables made of 304 stainless steel conforming to ASTM A492. Fittings for anti-rotation cables including cable clamps, pins, sockets, turnbuckles, U-bolts and nuts must be 304 stainless steel. Cable must be made taut by means of the turnbuckle. The exact location, number, and size of the anti-rotation cables must be as recommended by the floating pan manufacturer.

2.13.3 Sample Gauge Hatch

Provide sample gauge hatch on top of stilling well where indicated for manual gauging. Provide gasket for dissimilar metal protection. The tank erector must measure the stilling well gauge hatch hold-off distance with the tank empty, half full, and full, and place the information on a permanently affixed marker attached to the sample gauge hatch. This must be performed during tank [fill] [hydrostatic] testing. The stilling well gauge hatch hold-off distance is defined as the distance from the tank bottom datum plate to the top of the gauge hatch.

2.13.4 Floating Seal and Retrieval Winch

Provide a floating seal, retrieval cable, weight, and a retrieval winch on sample gauge roof nozzle equipped with fully slotted stilling well. Floating seal must move freely inside the stilling well with the rise or fall in liquid level while providing a double seal against the escape of vapors from the stilling well. Seal elastomers must be Buna-N and must seal at approximately the same level as the stilling well floating pan penetration seal (approximately 150 mm 6 inches above the level of the liquid). Retrieval winch and cable must be capable of retrieving floating seal into a storage compartment mounted on top of the stilling well nozzle. All fasteners must be stainless steel; all other metallic components of float and seal must be aluminum. Storage compartment and components, except for bearings, must be stainless steel. The retrieval cable must be 3 mm 1/8 inch stainless steel. Storage compartment must be equipped with a latch and hinge so that the compartment (with a fully retrieved float, cable, and weight) and winch can be temporarily moved out of the way to provide access to the stilling well. Latch and hinge must be designed to hold the compartment securely to the nozzle in winds up to 200 km/h 125 mph. Storage compartment flange must also be provided with a rain lip to provide a weather tight seal around the top of the roof nozzle. Winch must be hand operated, must require no more than 22 N 5 pounds of force to operate, and must be equipped with an anti-reverse mechanism and operator that may be disengaged from the retrieval spool when not being operated manually. When disengaged from the winch, the retrieval spool must maintain tension on the retrieval cable not exceeding the weight of the cable and the weight.

2.13.5 Mechanical Tape Level Gauge

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NOTE: Edit paragraph accordingly based on whether tank has an internal floating pan.

****

The mechanical tape level gauge must be attached to [a floating roof anchor weight provided by the manufacturer] [the tank floor by guidewire anchors] and complete with all necessary incidental pipe, pulleys, fittings, supports, support brackets, tension springs, and guide wire assemblies.[The floating roof anchor weight rests on the floating roof pan, but is not attached to the pan.] The gauge must automatically provide the location of the [floating pan] [product level] within plus or minus 1.6 mm 1/8 inch of the actual liquid level. The head must be made of aluminum and must be mounted on the exterior of the tank shell approximately 1370 mm 54 inches above the tank bottom. The head must contain a glass covered window. The seals must be made of Teflon. The shafts and graduated tape assembly must be made of non-corrosive and non-sparking materials. The tape drum must be made of a non-corrosive material. The tape must be of sufficient length to measure the liquid level from the bottom to the top of the storage tank. Gauge measurements must be graduated in 1.6 mm 1/16 inch increments. The tape must be carried over pulleys housed in elbow assemblies at each change of direction.

[2.13.6 Mechanical Tape Level Gauge

****

NOTE: For Cut and Cover Tanks.

****

The mechanical tape level gauge must be complete with all necessary components to be flange mounted and extend down into the tank via a stilling well. The gauge must automatically provide the location of the fuel level within plus or minus 1.6 mm 1/8 inch of the actual liquid level. The head must be made of aluminum and must be mounted in the pump house as shown on the drawings. The head must contain a glass covered window. The seals must be made of Teflon. The shafts, graduated tape, and tape drum assembly must be made of non-corrosive and non-sparking materials. The tape must be of sufficient length to measure the liquid level from the bottom to the top of the storage tank. Gauge measurements must be graduated in 1.6 mm 1/16 inch increments.

]2.13.7 Venting

Provide tank venting as indicated.

2.13.7.1 Overflow/Circulation Vents

****

NOTE: Ensure overflow capacity is adequate to protect the tank from damage in the event of an overflow with all receipt pumps running.

****

Provide open overflow/circulation vents on the upper shell as indicated and in accordance with API Std 650, Appendix H and API Std 2000. Provide vents with stainless steel bird screen with 0.2 square meters 2.0 square feet of net open area minimum. Insect screens are not allowed.

2.13.7.2 Center Roof Vent

****

NOTE: In non-corrosive environments (e.g., desert locations), include text to provide center roof vent welded directly to the tank roof and coat stairway in accordance with the coating specification for the exterior of the tank.

****

Provide open vent at the center or at the highest elevation of the roof. Open vent must have a [stainless steel] weatherhood as indicated and stainless steel bird screen as indicated on the drawings with openings welded in place. Weatherhood must be removable. Insect screens are not allowed.

2.13.8 Circumferential Stairway and Platforms

****

NOTE: In corrosive environments include bracketed text to provide bolt-on, removable, hot dip galvanized, double stringer stairway as indicated.

For the remote locations only (e.g., Guam), provide alternate text to allow thermal spray/metalizing as an alternative to hot dip galvanizing only with Government approval of an acceptable process, approach, materials, and system components.

In non-corrosive environments (e.g., desert locations), include specification paragraph text and modify the drawing details to indicate the portion of the appurtenance that is not welded to the tank roof or shell is to be made of carbon steel and coated in accordance with the coating specifications for the exterior of the tank.

****

OSHA 29 CFR 1910.25 Stairways. Provide [bolt-on removable double stringer]circumferential stairways as indicated.[Hot-dip galvanize stairway in accordance with ASTM A123/A123M Grade 100. All bolted connections must be galvanized prior to erection. Hot dip galvanize stairway and platform sections after all welding is complete. No welding on the stairway will be permitted after galvanizing. Cold spray-on galvanizing is not allowed as a substitute for hot dip galvanizing or its repair. Provide stairway with replaceable galvanized stairway step and platform tread grating. The stairway must be of bolted construction to allow for complete removal after construction to avoid interference with coating operations. Stairway bolting must be ASTM A325M ASTM A325, hot dipped galvanized. All mounting brackets, used to connect the stairway to the tank, must be welded to the tank using seal welded mounting plates and must be coated with the tank.][Coat stairway in accordance with the tank exterior coating specification.] Provide one approach step on the secondary containment concrete as indicated. Provide shell mounted metal bar stairway step and platform tread grating with non-slip nosings. Support the stairway and platforms completely on the shell of the tank with bottom-of-shell-mounted portion clear of and not structurally supported or connected to the ground or approach steps. Provide rise and run of stairway steps as indicated, adjusting slightly to suit final layout of the tank and its appurtenances, but with rise and run consistent from the ground level to the top platform. Construct stairway entirely of steel. Provide landings for accessing the upper manhole, high level alarm switches, level control float pilot chamber, and tank roof. Railings must be continuous around the platforms, except for access openings, and must be constructed similar to the roof perimeter guardrail. At access openings, any space wider than 25 mm one inch between the tank and the platform must be floored. Ends of handrails, guardrails, and posts must be sealed by welding.[Guardrails must be constructed in welded sections and their posts seal welded or bolted to the stringers]. Continuously butt-weld platform guardrail toeboards to guard rail posts. Do not field weld galvanized materials.

[2.13.9 Manhole Access Platforms

****

NOTE: The following paragraph is intended for use when no berm is provided and the ring wall is elevated. Delete manhole access platform paragraph if berm is provided.

****

Provide platform for accessing the lower shell manhole and circumferential stairway as indicated and in accordance with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

]2.13.10 Roof Perimeter Guardrail

****

NOTE: In corrosive environments include bracketed text to provide bolt-on, removable, hot-dip galvanized, guardrails as indicated.

For the remote locations only (e.g., Guam), provide alternate text to allow thermal spray/metalizing as an alternative to hot-dip galvanizing only with Government approval of an acceptable process, approach, materials, and system components.

In non-corrosive environments (e.g., desert locations), include specification paragraph text and modify the drawing details to indicate the portion of the guardrail that is not welded to the tank roof is to be made of carbon steel and coated in accordance with the coating specifications for the exterior of the tank.

****

Construction of roof perimeter guardrail must be as-detailed on the drawings and in accordance with OSHA. Provide [bolt-on removable]roof perimeter guardrails as indicated.[Hot-dip galvanize guardrails in accordance with ASTM A123/A123M Grade 100. All bolted connections must be galvanized prior to erection. Hot dip galvanize guardrail sections after all welding is complete. No welding on the guardrails will be permitted after galvanizing. Cold spray-on galvanizing is not allowed as a substitute for hot dip galvanizing or its repair. The guardrail must be of bolted construction to allow for complete removal after construction to avoid interference with coating operations. Guardrail bolting must be ASTM A325M ASTM A325, hot dipped galvanized. All mounting brackets, used to connect the guardrails to the tank, must be welded to the tank using seal welded mounting plates and must be coated with the tank.][Coat guardrails in accordance with the tank exterior coating specification.]

2.13.11 Internal Ladders

OSHA 29 CFR 1910.23. Provide an internal ladder extending from the internal ladder access hatch to the tank bottom as indicated. Provide with aluminum safety rail as indicated. Provide removable aluminum safety rail extension as indicated. Provide two 63 mm 2-1/2 inch sch 40 pipe 2-1/2 inches long. Weld one of the pipes (align vertically)to the top rail of the roof perimeter guardrail near the internal ladder access hatch. Weld the second pipe (align vertically) to the toeboard directly below the first for storing the removable safety rail extension.

2.13.12 Internal Ladder Access Hatch

****

NOTE: In non-corrosive environments (e.g., desert locations), include text to provide internal ladder access hatch welded directly to the tank roof and coat stairway in accordance with the coating specification for the exterior of the tank.

****

Provide internal ladder access hatch and 6 mm 0.25 inches [stainless steel] cover with rain lip as indicated for access to the interior of the tank through the roof. Provide with stainless steel hardware (flat bar, round bar, eyebolt).

[2.13.13 Emergency Vent

****

NOTE: On tanks 15.24 meters 50 feet or more in diameter that do not have a floating pan, delete the bracketed paragraph. On tanks less than 15.24 meters 50 feet in diameter that do not have a floating pan, include the bracketed paragraph. On tanks with floating pans, delete the bracketed paragraph.

****

Provide emergency vent devices in accordance with API Std 2000 and NFPA 30.

]2.13.14 Roof Circulation Vent/Inspection Hatches

****

NOTE: In non-corrosive environments (e.g., desert locations), include text to provide roof manhole welded directly to the tank roof and coat stairway in accordance with the coating specification for the exterior of the tank.

****

Provide [stainless steel] roof vent/inspection hatches in the fixed roofs of aboveground storage tanks as indicated and in accordance with API Std 650, Appendix H. Each roof vent/inspection hatch must be provided with a roof reinforcing plate the same thickness as the roof plate. Provide with stainless steel bird screen as indicated on the drawings and 0.2 square meters 2.0 square feet of net open area minimum. Insect screens are not allowed.

2.13.15 Water Draw-Off System

Provide a water draw-off system complete with all system components and controls and connected to the AST as indicated. System must remove fuel from its associated storage tank, separate the fuel and water by gravity, return the fuel back to the storage tank, and discharge the water. The system and its components must meet the requirements of the specification herein. The system must include, but is not limited to, the following piping, fittings, valves, system components, and controls:

****

NOTE: In cold climates with a lowest one day mean temperature less than minus 26 degrees C minus 15 degrees F (see API Std 650 Fig. 4.2) include the "In Cold Climates" option.

****

a. Product Saver Tank: Provide a product saver tank with the tank, piping and fittings packaged and fabricated as a single system. Fabricate from Type 304 stainless steel with tank volume as indicated. Provide tank with removable top, 25 mm one-inch inlet line, 25 mm one-inch drain line, and other lines as indicated, all with full port ball valves and cam-type connections. Provide concrete mounting pad and anchor tank to it. Ground to dedicated grounding system.

[b. In Cold Climates: In cold climates provide the product saver tank system with a sump heater and insulate and heat trace the piping.

] c. Product Saver Pump: Pump must be a close coupled centrifugal having a capacity of 0.6 lps 10 gpm at not less 18 meters 60 feet of head and a required Net Positive Suction Head of not more than one meter 3 feet. Pump motor must be in accordance with NEMA MG 1. All pump components in contact with fuel must be stainless steel. The unit must be UL listed and labeled for use in Class I, Division 2, Group D hazardous environments as defined by NFPA 70, with a maximum temperature rating of ["T2D"-419 degrees F] [_____]. The motor must be non-overloading at every point on the pump curve.

d. Piping, Valves, Fittings, and Instruments,: Pipe, pipe fittings, flanges, manual valves, gaskets, and bolting must be in accordance with Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). Materials of construction must be as described in this specification paragraph MATERIALS FOR SYSTEM COMPONENTS, PIPE, AND FITTINGS except as modified herein.

e. Controls: Provide a pump start/stop pushbutton station with red (run) and green (stop) lights. All lights must be to push to test type. All system components must be rated for Class I, Division 1, Group D service.

f. Electrical: Provide completely prewired with single point of service connection at horsepower rated disconnect switch. Provide combination motor/starter with HOA switch for pump motor. Provide suitable for Class I, Division 1, Group D service.

2.13.15.1 Basis of Design of Water Draw-Off System

The system must be arranged in the same general configuration as indicated. However, these are not fabrication drawings and are for basis of design only. The Contractor must be responsible for providing a complete and usable system.

2.13.15.1.1 Detail Drawing

Submit detailed drawings showing the Water Draw-Off System, including types, sizes, location, and installation details for:

a. Pipe hangers and supports

b. Grounding

c. Tank

d. Pump

e. Controls

f. Valves

g. Piping

[2.13.16 Side Stream Filtration System

****

NOTE: As an option, provide additional side stream filtration system. Delete bracketed paragraph if side stream filtration system is not provided.

****

Provide a packaged, skid mounted, pre-engineered, factory assembled, factory tested, side stream filtration system complete with all system components and controls. System must remove fuel from its associated storage tank at 6.3 lps 100 gpm, filter the fuel to remove particulate matter and water, and then return the clean, dry fuel back to the storage tank. The system and its components must meet the requirements of the specification herein. The system must include, but is not limited to, the following piping, fittings, valves, system components, and controls:

****

NOTE: In cold climates with a lowest one day mean temperature less than minus 26 degrees C minus 15 degrees F (see API Std 650 Fig. 4.2) include the "In Cold Climates" option.

****

a. Filter Separator: 6.3 lps 100 gpm, horizontal construction, EI 1581 Fifth Edition, Category M100, Type S, 1034 KPa 150 psi ASME code compliant construction, raised face flanged connections, carbon steel construction, MIL-PRF-23236 epoxy coated interior in accordance with Section 33 52 43.28 FILTER SEPARATOR, AVIATION FUELING SYSTEM. Provide with automatic air vent, safety relief valve, differential pressure gage, sampling probes, water interface control, ASME code stamp, water slug flow control valve (with check feature), high water level conductance probe, manual drain full port ball valve with Kamlock connection and sight glass with density ball and isolation valves. Provide two sets of spare elements. Coalescer and Separator element length must be 1092 mm 43 inches.

b. Water Slug Control Valve: must be of same manufacturer as HLV.

[c. In Cold Climates: In cold climates provide the filter/separator with a sump heater and insulate and heat trace the drain piping.

] d. Pumps: In-line ASME B73.1 or ASME B73.2 chemical process pump, cast steel construction with stainless steel impeller, shaft and trim, and with mechanical seals. Capacity must be 6.3 lps 100 gpm at 30.5 meters 100 feet TDH (minimum). Motor must be explosion proof, 7.5 KW 10 HP (maximum), 1800 RPM, 460 volts, 3 phase, 60 hertz and must be non-overloading at any point on the curve with a 1.0 service factor.

e. Basket Strainer: The basket strainer must be carbon steel with ANSI Class 150 raised-face flanges and with side drain port. Provide with same differential pressure gage used for filter/separator; use stainless steel tubing and ball valves. Mount DP gage to SS heavy gage mounting channel and securely support from skid frame.

f. Piping, Valves, Fittings, and Instruments: Pipe, pipe fittings, flanges, manual valves, thermal relief valves, pressure indicators, flow switches, gaskets, and bolting must be in accordance with Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). Materials of construction must be as described in this specification paragraph MATERIALS FOR SYSTEM COMPONENTS, PIPE, AND FITTINGS except as modified herein.

g. Suction Hose: Smooth bore, corrugated hose with static wire. Hose must be suitable for [JP-4] [JP-5] [JP-8] [Jet A F-24] [Mogas (F-54)] [Diesel (F-76)] [_____] service, vacuum rated, with a minimum of 200 mm 8 inches bend radius. End connections must be as indicated.

h. Water Draw-Off System: must be as described in this specification. Product saver tank must be provided with a high and high-high level switch system; sensors must be electronic (either thermistor or optic type).

i. Mounting Skid: Mounting skid must be fabricated from carbon steel and epoxy coated. Provide concrete mounting pad. Anchor mounting skid to mounting pad.

j. Controls: Provide with integral side stream filtration system control panel with start/stop pushbuttons, audible horn, visual alarm light, and with acknowledge and reset pushbuttons. Provide a pump start/stop pushbutton station with green (run) and red (stop) lights. Provide a paddle type flow switch downstream of the pump to energize the alarm circuits as indicated and de-energize the pump motor if flow is blocked. Provide a conductance probe in the filter/separator sump to energize the alarm circuits as indicated and de-energize the pump motor in the presence of water. Provide the product saver tank with high and high-high level alarms, which must energize the alarm circuits and de-energize the pump as indicated. Interlock the limit switches on the low suction line double block and bleed valve and on the tank fill line double block and bleed valve to allow the pump to be started only if both limit switches indicate the valves are in the open position. Interlock the skid control panel with the Emergency Fuel Shutdown system to de-energize the skid if any ESD pushbutton is depressed. All lights must be the push to test type. All system components must be rated for Class I, Division 1, Group D service.

k. Electrical: Provide complete prewired with single point of service connection at horsepower rated disconnect switch. Provide combination motor/starter with HOA switch for pump motor. Provide all electrical system components, conduit and fittings suitable for Class I, Division 1, Group D service.

2.13.16.1 Basis of Design of Side stream Filtration System

The system must be arranged in the same general configuration as indicated. However, these are not fabrication drawings and are for basis of design only. The Contractor must be responsible for providing a complete and usable system.

2.13.16.2 Detail Drawing

Submit detailed drawings showing the Side stream Filtration System including types, sizes, location, and installation details for:

a. Pipe hangers and supports

b. Bonding and Grounding

c. Filter/Separator

d. Fuel pump

e. Tank truck off-loading control valve

f. Flow switches

g. Air eliminator assembly

h. Hoses

i. Valves

j. Piping

]2.13.17 Shell Manholes

Provide shell manholes, manhole covers with filler drums, and davits as indicated. Hinged covers are not allowed.

2.13.18 Scaffold Cable Support

Provide two scaffold cable supports on the tank roof in accordance with API Std 650. Locate the support near the center of the tank and in a manner that supported cables will have maximum range and flexibility of operation with minimum interference with other tank fittings.

2.13.19 Antiseize Compound

Provide marine grade antiseize compound for fasteners on tank exterior flanges and bolted connections and covers. On tank interior fasteners, use oil only.

2.13.20 Channel Mounting

Provide seal welded channel mounting pads with seal welded stainless steel bolting studs for mounting channel to support conduit, tubing, and level alarm test/drain piping. Rack tubing, small piping, and conduit parallel to the shell as indicated. Do not mount within 2 meters 7 feet above stairway.

2.13.21 Anchors

When anchors are required by API Std 650 provide with anchor bolt chairs conforming to AISI E 1 Steel Plate Engineering Data and as indicated.

PART 3 EXECUTION

3.1 SAFETY PRECAUTIONS

API RP 2009 for fire and explosion hazard areas.

3.2 API Std 653 INSPECTION REPORTS

****

NOTE: The intent of the requirement for an API Std 653 Inspection of a newly erected tank is to assure full compliance with API Std 650, the design, and tank manufacturer shop drawings, such that at the next (first) out-of-service inspection, it can reasonably be assured there are no latent violations of API Std 650 and API Std 653 from construction. The purpose of the plate UT measurements is to assure every plate installed meets the design thickness for location.

In the event this paragraph is used to obtain an API Std 653 Post-Repair Inspection, it must be edited accordingly to consider the following:

a. If it is the intent to "reset the clock" on the floor corrosion assessment a full floor scan and corrosion calculation to next inspection interval is

required.

b. Consider the alternative of using the most recent full floor scan, if less than 3 years old, and project the condition of the floor out 20 years from expected return to service date, (more than 20 years from scan) and permitted API Std 653 factors of floor life in excess of 20 years.

c. If a floor scan is to be provided, it should be conducted before the floor is coated, as a floor scan on a new coating system can damage the system.

****

The API Std 653 inspector must inspect the completed tank in accordance with API Std 653 and deliver a full report to the Contracting Officer. The report must include a record of ultrasonic thickness measurements (UTMs), exclusive of the coating, of each tank bottom plate, each bottom shell course plate at 5 random locations per plate, the shell along the circumferential stairway at 5 locations per shell course. The record of UTMs must include sketches of the tank bottom plate and shell plate layouts. The location on each plate, where each ultrasonic thickness measurement (UTM) is taken, must be recorded. Five UTMs must be recorded on each tank bottom plate and on each lowest shell course plate. Five UTMs must be recorded for each of the shell courses above the lowest shell course and must be taken along the circumferential stairway. The report must include the tank dataplate information and photograph of the tank data plate. Provide electronic copies of the tank inspection reports to Service Headquarters or officially designated alternate, Service Control Points, and DLA-Energy. The paper and electronic copies of the report and UTMs must be provided to the Contracting Officer for filing with the tank's "as-built drawings." Refer to Section 01 45 00 QUALITY CONTROL for API Std 653 inspector certification requirements.

3.3 CONSTRUCTION

3.3.1 Accessibility

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and system components requiring access in locations freely accessible through access doors.

3.3.2 Tank Erector Site Superintendent

Tank erector site superintendent must be on site at all times during any work by that crew.

3.3.3 Floating Pan Superintendent

Floating pan superintendent must be on site at all times during any work by the crew.

3.3.4 Tank

****

NOTE: Provide a reinforced concrete ring wall for all tanks, regardless of size. Include reference to API Std 650 requirement for level tolerances in

concrete specification.
****

Provide tank of welded construction and support tank on a concrete ring wall. On the side of the tank furthest from the sump, slope the tank bottom down to the sump approximately 150 mm 6 inches for each 3.00 meters 10 feet of tank radius. Butt weld or lap weld bottom plates with the outer plates on top. Lap annular ring on top of bottom plates or butt weld to the bottom plates. Reinforce openings larger than 50 mm 2 inches in diameter through plating of the tank shell and roof. Provide structural stiffening, consisting of rings, thicker plates, or other approved means, to maintain roundness when the tank is subjected to wind or seismic loads.

****
NOTE: Include tank data plate information in as-built drawings.
****

3.3.5 Roof Plate Seams

****
NOTE: Include the second (bracketed) sentence below in corrosive environments (e.g., the Pacific and all other humid locations where condensation may regularly collect on the underside of the roof).
****

Tank roof plate must be lap welded with the plates closer to the center of the tank on top.[Seal weld the underside of all roof plate lap welded seams.]

3.3.5.1 Prohibition of Protective Coatings on Surfaces to be Welded

Remove protective coatings on surfaces to be welded and on surfaces within 25 mm one inch from weld preparation. "Weld-through" inorganic zinc coatings and similar coatings will not be permitted.

3.3.6 Roof Supports

[When columns are provided in the tank, provide column base plates and 13 mm 1/2 inch thick bearing plates. Weld the columns to the column base plates. Center the column base plates on the bearing plates and weld the column base clip-guides to the bearing plates. Do not weld the column base plates to their bearing plates. Continuously seal weld the bearing plates to the tank bottom so as to provide a seal against the entry of water or other liquids into the space between the column bearing plates and the tank bottom. Bearing plates must be larger than the base plates by at least 150 mm 6 inches in either direction. Provide seal-welded cap plates on all columns. Roof support columns must be of pipe or round structural tubing.][Roof support columns are not allowed.]

3.3.7 Surface Finishing

Provide Contracting Officer with NACE visual comparator as described in NACE SP0178 Section 5. Finish interior surfaces before hydrotesting, in accordance with Section 5 of NACE SP0178 and accompanying Visual Comparator, to the condition described and shown for NACE Weld Designation "C" welds. Finish exterior surfaces, in accordance with Section 5 of NACE SP0178 and accompanying Visual Comparator, to the condition described and shown for NACE Weld Designation "D" welds. Submit acknowledgement of surface finish requirements. Remove all weld splatter, sharp corners, edges and points from all carbon steel surfaces before coating.

3.3.8 Tank Bottom To Foundation Seal

****

NOTE: Include the first bracketed paragraph for self anchored tanks. Include the second bracket paragraph for anchored tanks.

****

[After welding of tank bottom annular ring butt welds of self anchoring tanks are complete, provide specified tank bottom to foundation gasket between the top of the foundation and the tank bottom with no gaps or overlaps between segments.

][All anchored tanks are to be grouted before loading with water or product and before tightening anchor bolts. Prepare the top of the foundation for shimming and grouting by removing all dirt, sand, and loose material. Provide 25 mm one-inch shim on top of foundation at high point and develop all other shim stacks to match the elevation of the shim at the high point of the foundation. Place shims a minimum of 38 mm 1 1/2 inches inside the perimeter of the tank bottom and under the tank shell. Do not retemper (add water) to a stiffening grout mix. Place grout within 30 minutes after mixing with water or discard the mix.

]3.3.9 Attachments

****

NOTE: For non-anchored tanks only, include the following instructions in the execution section of the exterior coating specification:

After the exterior coating is cured, provide specified bond breaker tape on the outer perimeter of the tank bottom to foundation gasket as recommended. Seal the outer edge of the joint between the concrete foundation and the tank bottom plate by caulking with specified polysulfide sealant.

****

All exterior shell and roof attachments must be connected to the tank using continuously welded mounting plates. Mounting plates must exceed the size of the attachment by a minimum of 25 mm one-inch. All mounting plate corners must have a 50 mm 2 inch radius. Attachment must be seal welded to the mounting plate with structurally sound welds of sufficient size to support the intended loads.

3.3.10 Nozzles

All shell nozzles must be flanged type. Shell nozzles sizes larger than 50 mm 2 inches must have a reinforcing plate. Nozzles for pipe connections inside the tank must be flanged inside near the shell. Reinforcing plates for shell nozzles must be rolled to the curvature of the shell.

3.3.11 Tank Bottom Sump

Weld sump to the underside of the tank bottom at the lowest point of the tank bottom as indicated.

3.4 INSTALLATION OF INTERNAL FLOATING PAN

****

NOTE: Modify the coating specification to provide additional coating inspection after the floating pan is installed to ensure damage to the coating that may result from installation of the pan is properly repaired by the contractor.

****

Install floating pan after coating of the interior of the tank is complete. Protect tank coatings during installation of floating pan to prevent damage. Repair damage to the coating that may occur during the installation of the pan. Adjust the floating pan support legs to the pan low level position after commissioning.

3.5 END CONNECTIONS FOR SYSTEM COMPONENTS, VALVES, PIPE, AND FITTINGS

All valve, system components, pipe and fitting connections including, but not limited to, piping for the Water Draw-Off System, Side stream Filtration System, drains, thermal reliefs, HLV float pilot chamber, and level switches must be welded or flanged except as indicated. Piping and fittings 63 mm 2.5 inches and larger must be butt welded. Piping and fittings 50 mm 2 inches and smaller may be butt welded or socket welded. Threaded connections are not allowed except where welded or flanged connections to appurtenances are not available, e.g., pressure gauges, fuel sample connections, level switch probes, HLV float pilot chamber.

3.6 FIELD QUALITY CONTROL

The Contracting Officer will conduct field inspections and witness field tests and trial operations specified in this section. The Contractor must perform all trial operations and field tests and provide all labor, equipment and incidentals required for testing.

3.6.1 Tank Calibration Table

****

NOTE: Delete paragraph if it is in the best interest of the Government to enter into a separate contract for tank calibration.

****

After installation of the tank is complete, provide two calibration tables stamped by a Professional Engineer, one in English units and one in metric units. Tables must be laminated. Both tables must show the volume of the fuel for all liquid levels in the tank starting at the bottom of the sump and going up to the level of the overflow. The English unit calibration table must show the volume of fuel in gallons and in barrels of 42 gallons and the level of the fuel in 1/16-inch increments. The metric table must show the volume of the fuel in liters and in m3 and the level of the fuel in 2.0 mm increments. The table must include notes at the bottom indicating 42 gallons = 1 barrel; and one kiloliter = one cubic meter. Volume calculations must be in the smaller units. Larger units may be obtained by rounding off. The 0 mm 0 inch level must be the level of the bottom of the shell. Level below the bottom of the shell must be shown in negative units starting at the bottom of the shell. The level of the bottom of the shell, alarm set points, high level shut off valve actuation point, and the level of the overflows must be identified on the calibration table (strapping chart). The table must not include tank volume above the level of the overflows. Also, provide Electronic Calibration Table compatible with the Electronic Automatic Tank Gauging System. Contact Contracting Officer for direction on required format.

3.6.1.1 Tank Calibration Method

The tank gauging systems must be calibrated in accordance with the API Manual of Petroleum Measurement Standards (API MPMS) for critical measurement using methods outlined in one of the following chapters.

a. API MPMS 2.2A, Measurement and Calibration of Upright Cylindrical Tanks by the Manual Strapping Method.

b. API MPMS 2.2B, Calibration of Upright Cylindrical Tanks Using the Optical Reference Line Method.

c. API MPMS 2.2C, Calibration of Upright Cylindrical Tanks Using the Optical Triangulation Method.

d. API MPMS 2.2D, Calibration of Upright Cylindrical Tanks Using the Internal Electro-Optical Distance Ranging Method.

3.6.2 Weld Inspection

Perform inspection of welds in accordance with API Std 650. Inspect butt welds requiring complete penetration and complete fusion by the radiographic method. Inspect roof support column welds below design liquid level by visual and dye penetrant methods. Submit the following weld inspection reports to the Contracting Officer:

a. Visual examination of vertical shell-seam tack welds, if left in place, in butt welds.

b. Visual examination of initial pass of internal shell-to-bottom weld.

c. Vacuum box testing of internal shell-to-bottom initial weld pass.

d. Visual examination of completed internal and external shell-to-bottom welds.

e. Radiographic examination of shell butt weld.

f. Submit reports for inspection of welds and radiographs to the Contracting Officer.

g. Visual examination of shell butt welds.

h. Visual examination of fillet welds.

i. Visual examination of tank bottom plates after welding.

j. Vacuum box testing of tank bottom fillet weld.

k. Pneumatic tests of reinforcing plates.

3.6.3 Reports of Other Tests and Examinations

Submit reports of the results of the following examinations and tests required by API Std 650 to the contracting officer:

a. Hydrostatic testing.

b. Shell settlement measurements taken before, during, and after hydrostatic testing.

c. Internal bottom elevation readings taken before and after hydrostatic testing.

d. Shell plumbness.

e. Shell roundness.

f. Maximum local deviations, shell.

3.6.4 Tightness Tests

Perform tightness tests described under this paragraph in accordance with API Std 650, as modified herein. Perform the tests after finishing welds in accordance with the paragraph SURFACE FINISHING, but prior to blast cleaning and application of the protective coating. Submit tightness test records to the Contracting Officer.

3.6.4.1 Penetrating Oil Test

Inspect tank shell-to-bottom, inside corner welds using the penetrating oil test prior to any vacuum box testing. After the initial inside fillet weld is made, apply No. 2 Diesel to the outside of the inside corner weld (before the outside weld is made). After 4 hours, inspect the inside fillet weld for oil penetration through defects. The contractor must correct any defects. Remove oil completely prior to finishing weld joint. Then, complete the remainder of the shell-to-bottom weld joint.

3.6.4.2 Vacuum Box Test of Tank Bottom

Perform a vacuum box test of the tank bottom immediately after installation and after completion of the penetrating oil test[and prior to installing any columns]. Test seams in bottom of tank and shell-to-bottom joint by applying a commercial soap film and subjecting the seam to a vacuum. Use a glass top vacuum box with hypalon or neoprene sealing gasket. Apply a commercial bubble forming solution to the weld or area to be tested; position the vacuum box over the area and slowly pull a partial vacuum. Observe the solution film for bubble formation between 0-14 kPa 0-2 psi differential pressure. Continue to open the valve until a differential pressure of 34.5 kPa 5 psi or 3.50 meters 11.5 feet of water or 259 mm 10.2 inches of mercury is achieved and hold for at least 20 seconds while continuing to observe the solution for bubbles.

3.6.4.3 [Hydrostatic Test and] Settlement [During Fill Test]

****

NOTE: Check geotechnical report for expected tank settlement and adjust duration of hydrostatic testing to maintain tank full of water until the remainder of the expected consolidated settlement is

within limits of flexibility designed into piping systems.
****

****
NOTE: Availability of utilities services and charges are established by the activity and should be stated in Division 1 of the contract specifications. Contact authority having jurisdiction to determine what kind of water can be used, what flow rate is available for filling, days and hours of availability, allowable disposal rate, required testing, and characteristics.

Use alternate test methods for testing shell, only if water supply is inadequate for filling the tank, only if tank is located outside the CONUS, and only with Service Headquarters approval.

Include location regulatory requirements for water disposal permits, treatment, and testing of test water prior to disposal. Verify water discharge may be dumped without treatment.
****

Perform hydrostatic test with fresh water only. Prior to [hydrostatic] [fill] testing, check the capacity and condition of the tank venting and overflows to ensure they are adequate to handle the potential rate of fill. This procedure must be accomplished prior to application of coatings and before connecting product/operating piping to the tank. Shell settlement must be measured before, during, and after [hydrostatic testing] [fill testing] in accordance with API Std 650. Hydrostatic test the shell by filling tank with water and maintaining it full for a period of not less than [24][_____] hours or until the settlement of the tank stabilizes, then inspect shell for leaks. The appearance of damp spots must be considered evidence of leakage. Minimize water retention time to limit rusting of tank interior.[Adequate water for hydrostatic testing is not expected to be available. Contractor must obtain approval of professional engineer in lieu of hydrostatic testing and must perform alternate testing of shell in accordance with API Std 650 in addition to testing specified in the paragraph FILL TEST.] Repair leaks disclosed by the test; then, retest the tank to prove the tank is leak-free. [Sufficient] water to hydrostatically test [the tanks] [one tank] will [not] be provided free of charge by the Government [at a maximum rate of [_____]]. Water used on one tank must be recycled to the fullest extent possible for use in testing subsequent tanks. No water must be released to the sanitary or storm sewer systems without the expressed, written approval of the Contracting Officer.

3.6.5 Tank Bottom Puddle Test

Test slope of the tank bottom in the presence of the Contracting Officer by examining the plate immediately after hydrotesting. Puddling deeper than 5 mm 3/16 inch anywhere on the tank bottom plates must not be accepted.

3.6.6 Fill Test and Related Miscellaneous Tests

3.6.6.1 Fill Test

****

NOTE: Coordinate fuel lead time to allow the US Government to secure the grade and volume required and make the necessary transportation requirements. Also, coordinate with fuel lead time requirements in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

****

After other tightness testing is complete and after application and cure of the interior and exterior coatings, fill test the tank using fuel. Tank piping and appurtenances must be ready for service. The Government will provide the necessary fuel and labor to fill the tank with fuel. The Government will provide a fill test plan to fill the tanks. The Contractor must remain on standby during fill test to assist in witnessing leaks [and][or] performing necessary repair activities. Advise the Contracting Officer, in writing, at least [60] [90][_____] calendar days in advance of the need for this service and provide access to the interior of the tank for the Contracting Officer's inspection to ensure the tank is clean and dry to the Government's satisfaction prior to receiving fuel.

****

NOTE: In the specification containing level alarms, include instructions to check the operation of the low-low, low, high, and high-high level alarms and verify operation of the alarm horn and light during the fill test, shut-off of pump at low level, and closure of issue MOV at low-low level.

****

a. Floating Pan Tests

b. Following the installation of a floating pan, the deck penetrations and rim area must be subjected to a visual inspection for seal tightness. Leaks or seal deformations must be corrected according to manufacturer's recommendations. Following the seal inspection, the floating pan must be subjected to a flotation test. The tank must be filled to the 3 meter 10 foot level with fuel and the top of the floating pan must be visually inspected for fuel leakage. The appearance of damp spots on the top of the floating pan must be considered evidence of leakage; the Contracting Officer must be notified and the fuel removed immediately. Leaks must be repaired and the flotation test performed again.

c. Fill Test Stages

d. The Government will fill tank at increments as indicated within fill test plan. The fill test plan is generally comprised of the various tank filling activities, fuel quantities needed, hold points at different tank levels and duration, and inspection activities to be performed during the test. Before the tank fill test, check to ensure drain valves are closed. Padlock drain valves closed for the duration of the test and provide one set of keys to the Contracting Officer. If there are no damp spots, discoloration, leaks or a measurable drop in the fuel level during the fill test period, the tank will be accepted. If leakage becomes apparent during the filling or the test period, immediately notify the Contracting Officer and Government personnel will pump the fuel from the tank. Free the tank of vapor, clean it, and then carefully inspect the tank for evidence of failures at the Contractor's expense. Repair defects found and repeat fill tests.

e. Tank High Level Shutoff Valve

****

NOTE: Ensure systems that include new pumps or modifications that include pumps and piping are designed with pump overpressure recirculating relief. On projects that connect to existing receipt systems, operation of the high level shutoff valve must be verified.

****

f. Check the operation of the high level shutoff valve on the inlet to the tank to ensure that the valve closes completely and as indicated, no later than the high-high level. [Check closing by the float valve.]Before the tank high level is reached, verify operation of the valve by[the manual operation of the float][as well as by] filling the level switch chamber[and again by filling the float chamber] with fuel. Check for proper operation when the tank is filled using appropriate safety measures.

g. Water Draw-Off System

h. Check System Operation

i. Side-Stream Filtration System

j. Check System Operation

k. Consider the consequences of closing the valve against active pumps and take precautions to avoid damaging the system. Ensure receipt pumps used to perform the test are equipped with overpressure recirculation relief or other means to protect the system from damage. If the test cannot be performed without risk of damage, notify the Contracting Officer.

3.6.7 Roof Puddle Test

After coating, test slope of the finished tank roof plate in the presence of the Contracting Officer by applying water for five minutes, evenly in all directions, at a rate of not more than 20 liters 5 gallons per minute, near the center of the roof, and examining the roof plate for puddling. Puddling deeper than 5 mm 3/16 inch anywhere on the tank roof plates will not be accepted.

3.6.7.1 Stilling Well Plumbness Test

All stilling wells must be aligned vertically and tested with a plumb bob in the presence of the Contracting Officer to ensure that they are plumb and are directly centered over the datum plates or sump.

3.6.8 Retesting

Deficiencies found must be rectified and work effected by such deficiencies must be completely retested at the Contractor's expense.

3.6.9 Maintenance Instructions

Provide the following instructions in the Operation and Maintenance Data as follows: Schedule periodic recalibration of ATG at 15 year intervals in accordance with API Manual of Petroleum Measurement Standard (API MPMS) Chapter 2.0 for tanks in custody transfer service and at 15-20 year intervals for all others, or when operating variables of the storage tank change, or when internal dimensions and structural variables of the tank change.

3.6.10 Operator Instructions

Provide the following instructions in the Operation and Maintenance Data as follows:

a. Inspect the tank bottom to foundation perimeter mastic seal monthly for deterioration and request maintenance when deterioration is found.

b. Keep the leak detection tell-tale valve/valves normally closed. Temporarily open the valves to check for tank bottom leaks on a monthly basis.

c. Test the low-low, low, high and high-high level alarm switches semiannually. Test level switches by simulating product levels either manually or by operating the water stripping system pump and level alarm/control test/drain header valves.

d. Examine and clear the tank venting semi-annually to ensure the vents have not become plugged.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-33 56 21.18 (November 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 56 13.15 (August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 33 - UTILITIES

SECTION 33 56 21.18

SINGLE WALL POL TANK UNDERTANK INTERSTITIAL SPACE

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 56 21.18 (November 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 56 13.15 (August 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 56 21.18

SINGLE WALL POL TANK UNDERTANK INTERSTITIAL SPACE
11/18

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NOTE: This guide specification is intended to be used in conjunction with Section 33 56 21.17 SINGLE WALL ABOVE GROUND FIXED ROOF STEEL POL STORAGE TANK.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The following information must be shown on the project drawings:

1. The extent of the work included in the project should be indicated on drawings showing the site layout and other data required for design by the Contractor.

2. If concrete foundation work is provided under a separate contract, Government work should include foundations, setting anchor bolts and other pertinent work such as piles and ringwall penetrations.

****

****

NOTE: For steel and stainless steel piping, pipe fittings, flanges, gaskets, and bolting, refer to Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

ASTM INTERNATIONAL (ASTM)

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C1218/C1218M	(2020c) Standard Test Method for

	Water-Soluble Chloride in Mortar and Concrete
ASTM C1580	(2015) Standard Test Method for Water-Soluble Sulfate in Soil
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D751	(2019) Standard Test Methods for Coated Fabrics
ASTM D814	(1995; R 2020) Rubber Property - Vapor Transmission of Volatile Liquids
ASTM D2136	(2002; R 2012) Coated Fabrics - Low-Temperature Bend Test
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3389	(2016) Standard Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform, Double-Head Abrader)
ASTM D4354	(2012; R 2020) Sampling of Geosynthetics for Testing
ASTM D4491/D4491M	(2017) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533/D4533M	(2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2020) Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4759	(2011; R 2018) Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4814	(2020a) Standard Specification for Automotive Spark-Ignition Engine Fuel
ASTM D4972	(2018) Standard Test Methods for pH of Soils
ASTM D5261	(2010; R 2018) Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
ASTM D6241	(2014) Standard Test Method for the Static Puncture Strength of Geotextiles and

	Geotextile-Related Products Using a 50-mm Probe
ASTM G187	(2018) Standard Test Method for Measurement of Soil Resistivity Using the Two-Electrode Soil Box Method

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5624	(2024; Rev X) Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-DTL-38219	(1998; Rev D; Notice 1 2016) Turbine Fuel, Low Volatility, JP-7
MIL-DTL-83133	(2015; Rev J) Turbine Fuels, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35 and JP-8 + 100 (NATO F-37)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-52557	(2001; Rev A; Notice 1) Fuel Oil, Diesel; for Posts, Camps and Stations

UL SOLUTIONS (UL)

UL 971	(1995; Reprint Mar 2006) UL Standard for Safety Nonmetallic Underground Piping for Flammable Liquids

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required

as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Flexible Membrane Liner; G, [_____]

SD-03 Product Data

Fiberglass Pipe, Fittings, and Adhesive; G, [_____]

Leak Detection Tell-Tale Pipe Well Screen; G, [_____]

PVC Pipe, Fittings, and Adhesive; G, [_____]

CP/Tracer Pipe Well Screen; G, [_____]

Flexible Membrane Liner (FML); G, [_____]

Geotextile Fabric; G, [_____]

Filter Fabric; G, [_____]

Aluminum Flat Bar; G, [_____]

FML Ringwall Sealant; G, [_____]

Sand Cushion; G, [_____]

SD-04 Samples

FML Samples; G, [_____]

SD-06 Test Reports

CP/Tracer Pipe Installation Test

FML Inspections

FML Tests

Sand Cushion Tests - Prior to Delivery

Sand Cushion Tests - Post Delivery

Photographic Construction Documentation of the Undertank Interstitial Space

SD-07 Certificates

Qualifications of FML Field Engineer

FML Manufacturer's Representative

Liner Manufacturer's Certification; G, [_____]

Certificate of Surface Preparation; G, [_____]

SD-08 Manufacturer's Instructions

Flexible Membrane Liner (FML)

SD-09 Manufacturer's Field Reports

FML Factory Test; G, [_____]

1.3 RELATED REQUIREMENTS

Product to be stored in the tank is [JP-5] [JP-8] [_____].

1.4 QUALIFICATIONS

1.4.1 Qualifications of FML Field Engineer

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NOTE: Include any local regulatory requirements that must be met by the Contractor.

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The Contractor must meet the licensing requirements of the State in which the work is to be performed. The Contractor must provide a field engineer full time to this project during FML installation and testing. The field engineer must have successfully completed manufacturer's training for handling and installing FML systems, as well as have at least 100,000 square meter one-million square feet of installation experience. Submit a letter providing evidence of the Contractor's and the field engineer's experience, training, and licensing. Statements of previous FML job experience must be provided with a point of contact, a phone number, address, the type of installation, and the current status of the installation.

1.5 QUALITY ASSURANCE

1.5.1 Flexible Membrane Liner Drawing Requirements

Submit drawings of the FML installation indicating the locations of field seams, penetrations, contours, and transitions and details of penetrations, boots, and miscellaneous components.

1.5.2 FML Manufacturer's Representative

Submit a letter, prior to placing the FML, from the FML manufacturer naming their authorized representative complete with their address, phone number, and a point of contact.

1.6 LINER MANUFACTURER'S CERTIFICATION

Following the successful installation and testing of the liner, submit a letter signed by the liner manufacturer's authorized representative certifying that the liner installation and testing results are satisfactory and that each meets the company's quality expectations and warranty. Include in the letter the representative's name, address, phone number, and qualifications for being a manufacturer's representative.

PART 2 PRODUCTS

2.1 STEEL PIPE AND FITTINGS

Steel and stainless steel pipe and fittings must be provided in accordance with Section 33 52 43.13 AVIATION FUEL PIPING or Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT) and API Std 650.

2.2 LEAK DETECTION TELL-TALE PIPE

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NOTE: Since a leak in the undertank tell-tale pipe could result in contamination of ground water and PVC manufacturers have been unable to certify that PVC adhesive is suitable for use in jet fuel, PVC is not an acceptable material for the undertank drain tell-tale pipe.

****

2.2.1 Fiberglass Pipe, Fittings, and Adhesive

Fiberglass pipe and fittings must be fiber reinforced plastic pipe per UL 971 Standard for Safety Nonmetallic Underground Piping for Flammable Liquids. Fiberglass adhesives must be as recommended by the manufacturer for use with jet fuel and water.

2.2.2 Leak Detection Tell-Tale Pipe Well Screen

Well screen must be fiberglass pipe as specified above. The 100 mm 4-inch well screen must have four rows of 0.25 mm 0.010-inch wide slots with a net open area of at least 102 square centimeters/meter 4.8 square inches/foot.

2.3 CP/TRACER PIPE

2.3.1 PVC Pipe, Fittings, and Adhesive

CP/tracer pipe and leak simulation probe pipe, fittings, and well screen must be ASTM D2665 SCH 40 PVC Pipe. PVC adhesives must be as recommended by the manufacturer.

2.3.2 CP/Tracer Pipe Well Screen

CP/Tracer Gas Detection well screen must be PVC pipe as specified above and must have three rows of 0.25 mm 0.010-inch wide slots. CP/Tracer Gas Detection piping must be slotted, starting at 600 mm 2 feet within the ringwall on one side of the tank and continuing under the tank bottom to within 600 mm 2 feet of the foundation ringwall on the other side of the tank.

2.4 FLEXIBLE MEMBRANE LINER (FML)

The secondary containment (under-tank-bottom) FML must demonstrate the acceptable limits of the properties listed under Table 1. The FML must be factory produced from a base fabric that is completely covered with a polymer. The base fabric must be made of aramid (kevlar), polyester, or nylon. Factory seams must be made with a 50 mm 2-inch overlap, plus or minus 6 mm 1/4-inch, by an automatic thermal high-pressure welding process. The FML must retard the growth of mildew and be capable of containing the liquid stored, withstanding temperatures up to 71 degrees C 160 degrees F, and withstanding humidity up to 100 percent relative humidity.

2.4.1 Job Lot of FML

A job lot of FML is defined by this specification as the amount of FML product that can be produced from a singular mixture of chemicals. Any FML material created from a new or altered mixture of chemicals must be considered a new job lot.

2.4.2 FML Samples

Twenty four samples must be cut from every job lot of FML. Each sample must be approximately 216 by 280 mm 8-1/2 by 11 inches in size. Eight of the samples must be cut across factory seams.

2.4.3 FML Factory Test

Each manufacturer's job lot of FML must have each of the FML properties verified by the factory test procedures and methods listed below. No substitute methods are allowed for verification of any property. Each separate verification of a property must be made on a separate sample. The FML must demonstrate through factory testing the acceptable limits of the following properties listed in Table 1. The properties must be verified by each of the test standards listed.

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NOTE: Include testing for permeability using the liquid stored in addition to Fuel B.

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TABLE 1. Standards and Limits for FML Properties (Metric)

Property	Minimum Acceptable Value
Base Fabric Weight (nominal)	441 g/m^2
Finished Coated Weight ASTM D751	1085 g/m^2 plus 70 g/m^2
Thickness ASTM D751	0.86 mm

TABLE 1. Standards and Limits for FML Properties (Metric)	
Property	Minimum Acceptable Value
Grab Tensile ASTM D751	3338 N
Strip Tensile ASTM D751 Procedure B	490 daN/5cm
Adhesion ASTM D751 Dielectric Weld	18 daN/5cm
Hydrostatic Resistance ASTM D751 Procedure A	5.52 MPa
Bursting Strength ASTM D751 Ball Tip	5340 N
Low Temperature ASTM D2136 3 mm mandrel, 4 hour	Pass minus 46 degrees C
Abrasion Resistance ASTM D3389 H22 wheel/1000 g load	10,000 cycles (min) before fabric exposure
Permeability ASTM D814 Fuel B and [_____]	19.1 mL/m^2/24 hr

TABLE 1. Standards and Limits for FML Properties (English)	
Property	Minimum Acceptable Value
Base Fabric Weight (minimum)	13.0 oz/yd^2
Finished Coated Weight ASTM D751	30 oz/yd^2
Thickness ASTM D751	0.034 inches
Grab Tensile ASTM D751	750 lb$_f$/in
Strip Tensile ASTM D751 Procedure B	550 lb$_f$/in
Adhesion ASTM D751 Dielectric Weld	20 lb$_f$/in
Hydrostatic Resistance ASTM D751 Procedure A	800psi
Bursting Strength ASTM D751 Ball Tip	1200 lb$_f$
Low Temperature ASTM D2136 1/8 inch mandrel, 4 hour	Pass minus 50 degrees F

TABLE 1. Standards and Limits for FML Properties (English)

Property	Minimum Acceptable Value
Abrasion Resistance ASTM D3389 H22 wheel/1000 g load	10,000 cycles (min) before fabric exposure
Permeability ASTM D814 Fuel B and [_____]	0.05 fl. oz/ft^2/24 hr

2.4.4 FML Components

Components, such as sleeves, boots, must be factory prefabricated from the FML material and have the same fabrication characteristics.

2.4.5 Fuels for Testing FML

Other materials, in addition to the FML, must be resistant to the fuel or fuels being stored. Fuels, as required or mentioned by this specification, must be in accordance with the following:

2.4.5.1 Motor Gasoline (Mogas)

Mogas must be in accordance with ASTM D4814 REV B.

2.4.5.2 Diesel

Diesel must be in accordance with CID A-A-52557.

2.4.5.3 No. 2 and No. 4 Fuel Oils

Oils must be in accordance with ASTM D396.

2.4.5.4 JP-4 and JP-5

Fuels must be in accordance with MIL-DTL-5624.

2.4.5.5 JP-7

Fuel must be in accordance with MIL-DTL-38219.

2.4.5.6 JP-8

Fuel must be in accordance with MIL-DTL-83133.

2.4.5.7 ASTM Fuel B

ASTM Fuel B as referenced in this section must be in accordance with ASTM D471.

2.5 GEOTEXTILE FABRIC

Provide geotextile fabric between sand and underside of flexible membrane liner under the tank bottom with the following properties:

PROPERTY	TEST VALUE	TEST METHOD
Unit Weight g/sq. meter (oz/yd^2)	335 min. (10)	ASTM D5261
Elongation at Break, Percent	50	ASTM D4632/D4632M
Apparent Opening, mm (mil)	0.15 max. (6)	ASTM D4751
Permittivity, sec-1	1.2 max.	ASTM D4491/D4491M
Puncture, N (lbs)	710 min. (160)	ASTM D6241
Grab Tensile, N (lbs)	1110 min. (250)	ASTM D4632/D4632M
Trapezoidal Tear, N (lbs)	445 min. (100)	ASTM D4533/D4533M

2.5.1 Geotextile

Geotextile must be a woven or nonwoven (as noted) pervious sheet of polymeric material and must consist of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven, slit-film geotextiles (i.e., geotextiles made from yarns of a flat, tape-like character) will not be allowed. Stabilizers [and][or] inhibitors must be added to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile. Post-consumer recycled material may also be used. Geotextile must be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages. Geotextiles and factory seams must meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction.

2.5.2 Manufacturing Quality Control Sampling and Testing

Manufacturing quality control sampling and testing must be performed in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles must be randomly sampled for testing in accordance with ASTM D4354 Procedure A. Acceptance of geotextile must be in accordance with ASTM D4759. Tests not meeting the specified requirements must result in the rejection of applicable rolls.

2.6 FILTER FABRIC

Wrap Leak Detection Tell-Tale and CP/Tracer Pipe well screen, with filter fabric. Filter fabric must be needle-punched, non-woven geotextile with a typical weight of 200 g/square meter 6 oz/square yard with the following qualities:

PROPERTY	TEST VALUE	TEST METHOD
Elongation at Break, Percent	50	ASTM D4632/D4632M

PROPERTY	TEST VALUE	TEST METHOD
Apparent Opening, mm (U.S. Sieve)	0.212 max. (70)	ASTM D4751
Permittivity, sec-1	2.1 max.	ASTM D4491/D4491M
Puncture, N (lbs)	240 min. (55)	ASTM D6241
Grab Tensile, N (lbs)	400 min. (90)	ASTM D4632/D4632M
Trapezoidal Tear, N (lbs)	175 min. (40)	ASTM D4533/D4533M

2.7 BATTEN BAR

The FML must be installed using a batten bar bolted to the concrete ringwall as indicated. Batten bar must be ASTM B221M ASTM B221 aluminum flat bar rolled to the inside diameter of the ringwall foundation. Anchor bolt, nut, and washer must be galvanized steel. Neoprene mounting pad must be rated with a Shore A hardness of not more than 40.

2.8 FML RINGWALL SEALANT

The FML-to-ringwall sealant must be fuel and water resistant and as recommended by the FML manufacturer.

2.9 SAND CUSHION

Sand must be fine sand aggregate in accordance with ASTM C33/C33M, except maximum allowable percentage passing a 150 micron sieve and a 300 micron sieve must be reduced to 5 and 15 percent, respectively. Cushion must contain no more than 300 parts per million (ppm) chlorides in accordance with ASTM C1218/C1218M, no more than 150 ppm sulfates in accordance with ASTM C1580, and have a pH greater than 7 in accordance with ASTM D4972. Cushion must have a minimum electrical resistivity of 35,000 ohm-cm 13,780 ohm-inch in accordance with ASTM G187. Magnesium sulfate must be used in the ASTM C88 soundness test.

PART 3 EXECUTION

3.1 CONSTRUCTION

3.1.1 Sand Cushion

Provide compacted clean sand above and below the FML as indicated. Thoroughly compact the sand cushion below each of the interstitial space components (i.e. liner, CP anodes, leak detection tell-tale pipe, CP/tracer pipe). Grade sand to match slope of the tank bottom and protect from contamination and disturbance until after the tank bottom is installed. Provide self-draining protective covering over the top of any sand placed on top of FML and keep sand dry at all times during construction.

****

NOTE: Include the first bracketed paragraph for self anchored tanks. Include the second bracket paragraph for anchored tanks.

****

[For anchored tanks, build up the sloped sand pad so that the tank bottom will rest on the sand and the foundation ringwall shims.] [For unanchored tanks, build up the sand so that the tank bottom will rest on the sand and the foundation ringwall gasket.] Do not use or place fiberboard on top of the foundation ringwall or on top of the sand.

3.1.2 INSTALLATION OF FML

3.1.2.1 Field Engineer

The field engineer must supervise the complete installation of the FML and perform each FML inspection and test.

3.1.2.2 Preparation

Prior to laying out the FML, three sample field seams must be performed. Each seam must be 1500 mm 5 feet in length. Seams must be made only when the ambient temperature and the temperature of the FML are both minus 4 degrees C 25 degrees F or higher.

3.1.2.3 Surface Preparation

The surfaces to be covered must be concrete or clean sand, as specified in the paragraph SAND CUSHION, free of rocks, debris, and smooth with no abrupt projections of any kind. Submit a certificate of surface preparation signed by the field engineer, prior to placing any geotextile or liner, stating the subgrade was adequately prepared per the specification and the liner manufacturer's recommendations. Prior to laying the FML, cover prepared surfaces with geotextile fabric as indicated.

3.1.2.4 FML Layout and Installation

After successful completion of the FML visual inspection, the FML must be laid out. Install FML over geotextile fabric. Laying out and welding of FML must only be done when the ambient temperature and the temperature of the FML are both minus 4 degrees C 25 degrees F or higher. Field seams must have a 50 mm 2-inch overlap, plus or minus 6 mm 1/4-inch. Panels or sheets of FML to be seam welded together must be laid out prior to welding field seams. The overlapped areas must be cleaned and prepared according to the installation instructions and procedures. Welds must be tightly bonded. Seal the FML around the penetrations using preformed boots. Use fuel resistant adhesive sealant between the boot and the penetration. Clamp the boots to the penetrations using stainless steel hose clamps as indicated. Prepare and weld the boots to the FML using the same preparation and welding methods used to weld the FML seams.

3.1.3 Cathodic Protection

Provide the underside of the tank bottom with impressed current cathodic protection. Install the cathodic protection anodes, slotted PVC tube for portable reference cell, and portable reference cell in the sand between the FML and the tank bottom in accordance with Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM.

3.1.4 Leak Detection Tell-Tale Pipe

****

NOTE: Include verbiage in the coating specification and on the drawing to provide, on the lower 300 mm one foot of the shell, 50 mm 2-inch high black

stencil lettering with an arrow, pointing down, over the "Leak Detection Tell-Tale", the "Leak Simulation Probe", and the CP/Tracer Pipe. Identify the later as "Tracer Gas/CP Slider Tube" and identify the CP/Tracer pipe by its unique number. Refer to paragraph CP/TRACER PIPE INSTALLATION for additional information on CP/Tracer Pipe identification.

****

Prior to steel tank construction, install leak detection tell-tale pipe through the ringwall and in the sand below the planned location of the tank bottom as indicated. System piping must slope evenly downward (gravity draining) from the interior termination point at the tank bottom FML sump to the exterior termination point as indicated. Interior termination point must be fiberglass well screen as indicated and covered with two wraps of filter fabric held in place with nylon ties or straps. Exterior termination point must be as indicated.

3.1.5 CP/Tracer Pipe

****

NOTE: Locate the CP/Tracer gas detection well screens, with one well screen at 600 mm 2 feet off from tank center, no greater than 13411 mm 44 feet apart and with all areas of the tank bottom within 6700 mm 22 feet of at least one well screen.

****

Prior to steel tank construction, install the CP/tracer pipe and well screen piping through the ringwall and in the sand below the tank bottom as indicated. Cover with two wraps of filter fabric held in place with nylon ties or straps. The material, number, and lengths of the well screens and pipe must be as indicated.

3.1.6 Leak Simulation Probe

****

NOTE: Locate the end of the leak simulation probe under the tank approximately 3000 mm 10 feet from the ringwall foundation and as far from a CP/Tracer gas well screen as practical.

****

Prior to steel tank construction, install the leak simulation probe through the ringwall and in the sand below the tank bottom as indicated. Interior termination point (under tank bottom) must be an open ended coupling with two wraps of filter fabric held in place with nylon ties or straps.

3.1.7 Filter Fabric Wrap

Prior to steel tank construction, cover all of the well screen pipe segments with two wraps of filter fabric held in place with nylon ties or straps placed 300 mm one foot on center.

3.1.8 CP/Tracer Pipe Installation Test

After installation of the CP/tracer pipe and well screen is complete, prove that each of the CP/tracer pipes is clear (without obstructions or bends) in the presence of the contracting officer using a continuous length (including couplings) of 25 mm one-inch PVC pipe at least as long as the pipe being tested plus 1 meter 3 feet. The test must be performed by passing the 25 mm one-inch PVC pipe through each of the 50 mm 2-inch CP/tracer pipes and removing the 25 mm one-inch PVC pipe from the opposite end of the 50 mm 2-inch pipe on the other side of the ringwall. Notify the contracting officer at least 24 hours prior to the test.

3.1.9 Leak Simulation Probe[and Leak Detection Tell-Tale Pipe] Test[s]

Repeat the "CP/Tracer Pipe Installation Test" for the Leak Simulation Probe; exercise care not to damage the filter fabric wrap at the end.[For elevated foundation type tanks, repeat the "CP/Tracer Pipe Installation Test" for the Leak Detection Tell-Tale Pipe but use a 65 mm 2-1/2 inch PVC pipe. Exercise care not to damage the end.]

3.2 FIELD QUALITY CONTROL

The Contractor must perform all trial operations and field tests and provide all labor, equipment, and incidentals required for testing. The FML manufacturer authorized representative must be present for all FML tests. The representative must supervise and approve all FML tests. The representative must provide detailed test results. Notify and provide the Contracting Officer with the opportunity to witness all field tests at least 24 hours in advance of their performance.

3.2.1 FML Inspections

3.2.1.1 FML Initial Visual Inspection

The visual inspection must verify the finished surface to be covered with the FML is properly graded and compacted. A visual inspection of the FML must be performed on each FML panel or sheet as it is unrolled. The Contracting Officer must be notified of any damage detected.

3.2.1.2 Sample Field Seam Inspection

Field seam samples must be subjected to a visual inspection performed within 30 hours after the seam has been made, cured, and cooled.

3.2.2 FML Tests

3.2.2.1 FML Seam Pull Test

Just prior to vacuum box testing the FML field seams, perform manual pull testing of the FML field seams at ten locations selected by the Contracting Officer. The test must be performed by applying at least 222 N 50 pounds of force across the selected seams and maintaining for at least 60 seconds.

3.2.2.2 FML Vacuum Box Test

After successful completion of the FML visual inspection, a vacuum box test must be performed on all field seams, the area around the seams, and all FML surfaces showing scuffing, penetration by foreign objects, or distress from rough subgrade. A glass topped vacuum box, which has a neoprene sealing gasket, must be used. The vacuum box test must be performed as follows:

a. A commercial bubble forming solution must be applied to the area to be tested.

b. The vacuum box must be positioned over the area and a vacuum slowly applied until a differential pressure of 7 kPa one psi is achieved and held for at least 5 seconds while observing the solution for bubble formation.

c. If the vacuum box test indicates a continuous stream of bubbles on repeated testing at the same location, then the area being tested must be considered damaged and must be repaired and retested.

d. If the vacuum box test does not indicate a leak, then the vacuum must be slowly increased until a maximum differential pressure of 14 kPa plus 0.0 or minus 2 kPa 2 psi plus 0.0 or minus 0.25 psi is achieved and held for at least 20 seconds. If the test indicates a continuous stream of bubbles on repeated testing at the same location, then the area being tested must be considered damaged and must be repaired and retested. Care must be taken to limit the vacuum to no more than the maximum differential pressure because, if it is exceeded by more than 2 kPa 0.25 psi, the FML must be considered damaged and must be replaced and retested.

3.2.2.3 FML Air Lance Tests

After successful completion of the FML vacuum box test, an air lance test must be performed on all seams not accessible with a vacuum box test (i.e. small seams around penetrations, irregular patches). The air lance test will be performed using a 345 kPa 50 psig jet of air regulated and directed through a 5 mm 3/16-inch diameter nozzle, applied to the upper edge of an overlapped seam or repaired area to detect an unbonded area. Inflation of any section of the seam by the impinging air stream must be indicative of an unbonded area. Unbonded areas must be repaired and retested.

3.2.3 FML Acceptance Inspection

As soon as practicable after successful completion of the FML vacuum box test and the air lance tests, an acceptance inspection must be performed. If the inspection reveals any defects in the work, such defects must be repaired or the unsatisfactory work replaced before acceptance. The cost of such repairs and replacements must be borne by the Contractor. The Contractor must notify the Contracting Officer at least 48 hours in advance of the acceptance inspection.

3.2.4 Manufacturer's Field Service

If any problems are noticed in any inspection of an FML seam, the Contracting Officer must be notified immediately. The FML manufacturer's point of contact must also be contacted by telephone and e-mail and informed that the installation of their product cannot be adequately completed. After the FML manufacturer and their authorized representative have identified the problem and developed and exercised a solution, another set of sample field seams must be made and reinspected.

3.2.5 Sand Cushion Tests - Prior to Delivery

Sample and test the sand prior to delivery and demonstrate that the sand meets the requirements of ASTM C33/C33M as well as for other properties described under the paragraph SAND CUSHION.

For each sample, along with the requirements of ASTM C33/C33M, verify the amount of chlorides (ppm) and sulfates (ppm) and determine the pH value of the sand and the resistivity.

3.2.6 Sand Cushion Tests - Post Delivery

Sample and test the sand after delivery and demonstrate that the sand meets the requirements of ASTM C33/C33M as well as for other properties described under the paragraph SAND CUSHION.

During delivery, stockpile the sand for each individual storage tank bottom into separate stockpiles.

Take one sample from each tank bottom stockpile, and test. The Contractor must notify the Contracting Officer at least 48 hours in advance of the sand delivery for each tank in order to allow the Contracting Officer the opportunity to witness the sampling. The sand cushion(s) may be placed before the results of the past delivery testing have been submitted.

For each sample, along with the requirements of ASTM C33/C33M, verify the amount of chlorides (ppm) and sulfates (ppm) and determine the pH value of the sand and the resistivity.

Deliveries and stockpiles of sand found not to conform to the requirements specified in the paragraph SAND CUSHION must not be used to construct the sand cushion, but must be promptly removed from the site. This must be the case even if the stockpiled sand has been placed and the tank is partially or completely constructed.

3.2.7 Retesting

Deficiencies found must be rectified and work effected by such deficiencies must be completely retested.

3.2.8 Photographic Construction Documentation of the Undertank Interstitial Space

Provide photographic documentation of the construction of the undertank interstitial space and the installation of the FML liner. Mark-up a plan view of the liner ringwall penetrations identifying each penetration by a unique number starting clockwise of the fill nozzle and proceeding clockwise. Identify the FML penetration in each photograph by the same number shown for that penetration on the marked-up drawing specified above. Submit the marked-up plan review of the penetrations and all photographs to the Contracting Officer in digital form at high resolution (1MB per picture, minimum) on the media type chosen by the Contracting Officer. As Basis of Bid, provide them on compact disc(s) in JPEG format. Take the photographs prior to placement of the sand cushion. Include photographs of the installation of all ringwall penetrations by undertank piping, [including foundation drains,] and cathodic protection. Particular attention must be paid to the way the FML is sealed to the pipe and conduit penetrations. Number all ringwall penetrations clockwise from tank fill line nozzle and document all penetrations using the penetration number. Each penetration must have at least three photographs: left side, right side, and close-up from the open end of the boot seal, showing the caulk and clamp arrangement.

Particular attention must also be paid to the way the FML is sealed to the interior tank ringwall [and to the tank column base]; photograph the completed FML/batten bar installation at 1 meter 3 foot intervals.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 56 53 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-33 56 53 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 56 53

COMPRESSED GASES STORAGE TANKS

05/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 56 53 (May 2020)**

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SECTION 33 56 53

COMPRESSED GASES STORAGE TANKS

05/20

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NOTE: This guide specification covers the requirements for pressure vessels for the storage of compressed gases.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification is intended to be used for installation of unfired pressure vessels for the storage of compressed gases such as helium, nitrogen, oxygen, and air in the temperature range of plus 49 degrees C to minus 40 degrees C plus 120 degrees F to minus 40 degrees F. Its use is not intended for cryogenic fluids nor for commercial compressed air receivers operating at pressures of approximately 2.1 MPa 300 psig or below. If corrosive gases are stored, special treatment for the interior of the vessel will be specified. Lining materials such as alloy or epoxy coatings may be used for the interior of the vessels. The drawings will show all piping connection points both

in physical location and size.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.20	(2023) Metallic Gaskets for Pipe Flanges
ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC V	(2017) BPVC Section V-Nondestructive Examination
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A370	(2024) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A376/A376M	(2022) Standard Specification for Seamless Austenitic Steel Pipe for High-Temperature Service
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 21	(1982; E 2004) White or Colored Silicone Alkyd Paint (Type I, High Gloss and Type II, Medium Gloss)
SSPC Paint 25	(1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AS598	(2018; Rev A; R 2024) Aerospace Microscopic Sizing and Counting of Particulate Contamination for Fluid Power Systems

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, [_____]

SD-06 Test Reports

Test

Procedure for Welding Vessels and Manifolds

SD-07 Certificates

Cleaning

PART 2 PRODUCTS

2.1 MATERIALS

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NOTE: The vessel design pressure will determine the schedule of pipe, type of flange facing, and whether pipe or tubing and flanges or high-pressure fittings are required.

****

Use a nameplate on vessels except when stamping is directly applied. Permanently attach a nameplate plainly stamped in letters no less than 10 mm 3/8 inch high to vessel or vessel assembly structure at a conspicuous location. Weld, braze, or solder attachment to shell or head portions or around the nozzle openings of vessel, or attach by tamper-resistant mechanical fasteners of suitable metal construction. Attachment by pressure sensitive adhesives of any type is not acceptable. Show serial number, symbols of the manufacturer, specification number, date of manufacture, design pressure, test pressure, maximum allowable working pressure at operating temperature, minimum working temperature for vessels that operate, and water volume capacity in cubic feet to nearest tenth. Identify manifolds by a stainless steel plate or tag attached by stainless steel bands or clamps and show serial number, if any, symbols of the manufacturer, specification number, date of manufacture, design pressure, and test pressure. Code stamp vessels in accordance with ASME BPVC SEC VIII D1. Asbestos and asbestos-containing products will not be allowed.

2.1.1 Piping for Manifolds

Provide seamless stainless steel pipe or stainless steel tubing suitable for service and pressure through a temperature range of plus 49 to minus 87 degrees C plus 120 to minus 125 degrees F, in accordance with ASME B31.3. Provide stainless steel pipe in thicknesses up to and including Schedule 80S in conformance to ASTM A312/A312M, Grade TP 304L or ASTM A376/A376M, Grade TP 304; ensure thicknesses greater than Schedule 80S conform to ASTM A376/A376M, Grade TP 304.

2.1.2 Fittings for Manifolds

Provide seamless buttweld or socket-weld type fittings for manifolds consisting of material conforming to ASTM A403/A403M, Grade WP 304L, or if tubing is used, provide stainless steel positive mechanical high-pressure threaded type fittings. Ensure fittings are suitable for pressures specified for vessels and are compatible with manifold piping or tubing.

2.1.3 Flanges for Manifolds

Provide flanges for manifolds consisting of forged stainless steel conforming to ASTM A182/A182M, Grades F 304, F 316, or F 347. Ensure flanges conform to ASME B16.5 where pressure-temperature ratings fall within limits established therein. For pressure-temperature outside such limits, flanges must conform to Appendix 2 of ASME BPVC SEC VIII D1.

2.1.4 Bolts, Studs, and Nuts for Flanges

Provide strain hardened bolts and studs for flanges for stainless steel manifolds conforming to ASTM A320/A320M, Grade B8 or equivalent age-hardened material. Provide nuts conforming to ASTM A194/A194M, Grade 4, that are hexagonal American Standard Heavy Series. For manways and for other than stainless steel flanges, use bolts and studs conforming to ASTM A193/A193M, Grade B7, and nuts conforming to ASTM A194/A194M, Grade 2H.

2.1.5 Flange Gaskets

Provide octagonal, fully annealed stainless steel ring type gaskets with dimensions conforming to ASME B16.20 for ring type joint flanges. Provide oval type gaskets for helium service.

2.1.6 Supports and Attachments

Provide structural steel for supports or structural attachments conforming to requirements specified for vessel or to ASTM A36/A36M. Where legs of ASTM A36/A36M steel are attached to stainless steel vessels, use pads of ASTM A240/A240M steel to make the attachment.

2.1.7 Vessels

Construct vessels of steels which meet the requirements for design pressure and temperatures. Do not use steel which does not meet the following minimum requirements at room temperature: elongation in 50 mm 2 inches, minimum 15 percent; reduction of area, minimum 40 percent. Where heat treatment is employed, reheat treatment will be permitted. Furnish supporting information attesting to chemical composition and mechanical properties based on test results of the steel used for the design of the vessels. Where ASME BPVC SEC VIII D1 is applicable to material from which the pressure vessels are fabricated, adhere to requirements of ASME BPVC SEC VIII D1, except as modified in this section.

2.2 SPECIAL REQUIREMENTS

2.2.1 Multiple-Layered or Banded Vessels

Space longitudinally-welded seams in individual layers in an offset pattern so that centers of the welded longitudinal joints of adjacent layers are separated circumferentially by a distance of at least 5 times the layer thickness. Ensure thickness of circumferential welds for attaching heads or flanges, and the combined thickness of circumferential welds for layers, is not less than minimum required thickness of a hemispherical head divided by the efficiency of head-to-shell joint. Longitudinal seam welds on inner shell and all intermediate layers must be ground flush before application of next layer.

2.2.1.1 Slag

Remove slag after each weld layer in both longitudinal and circumferential weld joints, and visually inspect each layer of weld for undercut, lack of fusion, irregularity of weld deposit, slag inclusions, and porosity. Make corrections before next weld layer is deposited.

2.2.1.2 Post-Weld Heat Treatment

Accomplish post-weld heat treatment in accordance with ASME BPVC SEC VIII D1. Stress relieve heads after forming operations and attachments by welding have been completed, and before assembly to vessel. Stress relieve inner shell after completion of longitudinal welds.

2.2.1.3 Inner Shell Thickness Less Than One-Half Head Thickness

Where thickness of inner shell is less than one-half the required head thickness and layers are 10 mm 3/8 inch thick or less, provide vessel conforming to the following:

a. Provide multiple-layered shells in which layers are welded circumferentially in which each layer may be made of one or more plates with holes drilled radially from the outside of vessel to inner shell. Provide each layer plate with at least two vent holes of 6 mm 1/4 inch minimum diameter. Holes are not allowed topenetrate inner shell of vessel. Show such holes in detail on drawings.

b. After longitudinal seam of each layer has been welded, hammer test the layer for contact with layer underneath. A loose area greater than 300 mm 12 inches circumferentially and 600 mm 24 inches longitudinally will not be accepted. A maximum single radial gap of 3 mm 0.120 inch between any two layers, as measured at the ends of the shell sections at right angles to vessel axis, will be acceptable. Limit a gap of 1.5 mm 0.060 inch to a length of 100 mm 4 inches; limit a gap of 1 mm 0.040 inch to 150 mm 6 inches; limit a gap of 0.508 mm 0.020 inch to 300 mm 12 inches. In event of more than one loose area circumferentially in any 600 mm 24 inch length, ensure total of such areas does not exceed the area prescribed by the above limits.

2.2.1.4 Inner Shell Thickness Greater Than One-Half Head Thickness

Where thickness of inner shell is greater than one-half required head thickness, ensure vessel conforms to one of the following requirements, as applicable.

a. Establish tightness of layers having a nominal thickness of 10 mm 3/8 inch and under as specified.

b. Determine tightness of vessels with layers over 10 mm 3/8 inch nominal thickness, in which inner layer is expanded to outer layer, by demonstrated elastic behavior as substantiated by pressure volume curve during repressurization, after expansion to the design pressure to demonstrate that the layers act together.

c. Determine the tightness of vessels with layers over 10 mm 3/8 inch nominal thickness, in which outer layer or layers are shrunk over inner layer or layers, by measuring the diameter or circumference of layers in cold condition to show that there is sufficient interference between layers to demonstrate that the layers act together.

2.2.2 Seamless Cylinders

****

NOTE: End connections will be determined by piping system to which vessels will be connected and by the design pressure.

****

Provide seamless cylinders of a type and size suitable for manifolding together to meet gaseous-storage volume requirements. Provide seamless cylinders with two outlets, one at each end on longitudinal centerline; each outlet must be a minimum of 50 mm 2 inches in diameter for connection to piping or manifold and for inspection purposes. Make vessel connections for seamless vessels that are [adapted for and connected to in accordance with ASME B16.5] [suitable for connection of stainless steel positive mechanical high-pressure threaded type fittings]. Make connections that are suitable for pressures specified for vessels. After fabrication, normalize or liquid-quench and temper seamless cylinders.

2.3 DESIGN AND FABRICATION

Design and fabricate vessels conforming to ASME BPVC SEC VIII D1, except as modified herein. Provide vessels consisting of welded cylinders or spheres, seamless cylinders, or cylinders of multiple-layered or banded construction. Ensure vessels are suitable for stationary, aboveground [horizontal] [vertical] installation, exposed to atmospheric elements. Provide vessels with capacities as shown.

2.3.1 Design Pressure

Design vessels for a pressure of [_____] kPa psig.

2.3.2 Design Temperature

Design vessels for a temperature range of plus 49 to minus 40 degrees C plus 120 to minus 40 degrees F.

2.3.3 Outlets

****

NOTE: The drawings will indicate high-pressure threaded type fittings where required, based on design pressure.

****

2.3.3.1 Nozzles

Nozzles or outlets for welded monobloc, multiple-layered, and banded vessels must be a minimum of two in number, one at each end on the longitudinal centerline for connection to piping or manifold, and for inspection purposes and must have a minimum diameter of 50 mm 2 inches. Reinforce nozzles and outlets fully regardless of size. Provide flanged outlets conforming to ASME B16.5 or to ASME BPVC SEC VIII D1. Provide nozzles or outlets suitable for the pressures specified for vessels. Use material for nozzles, outlets and flanges that is preferably the same as that of the vessel, but may be of any other material that is compatible with vessel material. [Where shown, provide outlets suitable for connection to stainless steel positive mechanical high-pressure threaded type fittings.]

2.3.3.2 Manholes and Handholes

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NOTE: Manholes and handholes for internal inspection of the vessels will be specified if

required.

****

Provide manholes and handholes conforming to the requirements of subsections UG-36 through UG-46 of ASME BPVC SEC VIII D1 as applicable.

2.3.3.3 Drains and Vents

****

NOTE: Drains and vents to facilitate cleaning of the vessels will be specified if required.

****

Provide leakproof drains and vents to facilitate cleaning of vessels.

2.3.4 Multiple Vessels

****

NOTE: To provide for maximum competition and latitude by the Contractor in sizing the pressure vessels, the total volume of each system will be specified in cubic feet (water volume) and ample physical space allocated to accommodate various arrangements and sizes of pressure vessels.

The drawings will show the piping connection point both in physical location and size.

****

Manifold multiple-vessel assemblies together to furnish required gaseous-storage volume. Terminate manifold at the piping connection point as indicated. The total cross-sectional area of manifold piping in a system must be not less than 1.5 times the cross-sectional area of the piping connection point.

2.3.5 Structural Attachments

Do not weld permanent structural attachments, including lifting lugs and erection brackets, to vessel parts subject to pressure stress, unless otherwise approved. If approved, ensure such welds are full penetration and have welded layers inspected progressively by the magnetic particle method. Do not perform welding after final stress relief or hydrostatic testing.

2.3.6 Shell and Head Thickness

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NOTE: If vessels are used for the storage of compressed air, an appropriate corrosion allowance on the shell and head thickness will be included.

****

Calculate shell and head thickness in conformance with ASME BPVC SEC VIII D1.

2.3.7 Procedure for Welding Vessels and Manifolds

Use welding procedures conforming to requirements of ASME BPVC SEC IX and to requirements specified below. Submit information required by recommended Form QW-483, Article IV, of ASME BPVC SEC IX for approval.

Submit certified copies of performance test records indicating that the welders have passed qualification test in conformance with ASME BPVC SEC IX, prior to work on piping or vessel fabrication. Where such test records are not furnished, perform qualification tests witnessed by Contracting Officer. Ensure each welder is qualified for the position and type of material assigned. Requalification tests will be required when work of the welder creates a reasonable doubt as to the welder's proficiency. Such a retest may include both radiographic and mechanical tests. Welders failing a requalification test will not be permitted to work. Use an inert-gas shielded welding process with an inert-gas backup for the first pass of all manifold welds. Make separate qualification tests on maximum joint thickness of each material and use each procedure in production of double-welded butt joints and single-welded joints. Procedures qualified for thickness greater than those specified are acceptable without requalification. Use joint design in test plates which is the same design used for joints in production. Make a requalification test for any change in the nominal weld metal composition and for changes in any essential variables listed in ASME BPVC SEC IX. Make a separate qualification test for each joint design. For multiple-layered or banded vessels, perform the tension and guided-bend tests on inner shell and outer layer thicknesses. For girth welds between multiple-layered shells and heads, include head material as well as layered shell material with the test specimen. In addition to tests specified in ASME BPVC SEC IX, radiograph procedure qualification test plates following the same heat-treating procedure used in production. Using radiographic procedures specified for production welds, ensure radiographs conform to requirements specified.

2.3.7.1 Weld Layer Thickness

Individual layer thickness of production welds must not exceed 1.1 times that of individual layer thickness deposited in the performance qualification.

2.3.7.2 Continuity of Backing Ring

Backing rings are permitted only for circumferential weld joints which, due to access limitations, cannot be welded from both sides. If a backing bar, strap, or ring is used on inside of single buttweld joints, weld ends of backing bar to produce a continuous backing element.

2.3.8 Joint Efficiency

Use a joint efficiency no greater than 0.95 for staggered buttwelded longitudinal seams of multiple-layered or banded vessels, provided welds in inner shell and adjacent layer are fully radiographed and the finished weld in each of the subsequent layers is fully magnetic-particle inspected and is 7 mm 9/32 inch or less in thickness. Use a penetrometer thickness no more than 1 percent of total wall thickness being radiographed when radiographing adjacent layer. Joint efficiency for other buttwelded seams must conform to ASME BPVC SEC VIII D1.

2.3.9 Pressure Relief Devices

Provide all vessels, regardless of size or internal pressure, with protective pressure relief devices conforming to the design requirements of parts UG-125 through UG-136 of ASME BPVC SEC VIII D1.

2.4 TESTING

Notify the Contracting Officer [_____] days before the performance and fabrication tests are to be conducted. Perform tests in the presence of the Contracting Officer.

2.4.1 Notched-Bar Impact Tests for Material

Impact test materials for shells, heads, nozzles, and other vessel parts subject to stress due to pressure at minus 40 degrees C minus 40 degrees F in accordance with requirements of ASME BPVC SEC VIII D1, with the following modifications:

2.4.1.1 Impact Specimens

2.4.1.1.1 Test Plates for Welded Vessels

In addition to requirements of ASME BPVC SEC VIII D1, take one set of impact specimens from the head-to-shell weld with notch in adjacent head metal in heat-affected zone. Take test specimens from mid-length of test plates.

2.4.1.1.2 Multiple-Layered Plate Material

In multiple-layered vessels which use plates 10 mm 3/8 inch or less in thickness, exclusive of the inner shell, meet the requirements for testing plates by testing at least one set of impact specimens for each 600 mm 2 feet of cylindrical length of each vessel.

2.4.1.1.3 Seamless Vessels

Meet requirements for testing impact specimens by testing one set of specimens from a test sample of the lot it represents. A lot consists of a maximum of six vessels having the same inside diameter and wall thickness in a heat-treat furnace charge from the same heat of steel. Subject the minimum 600 mm 24 inches long test sample to the same working, normalizing or quenching, and tempering and heat with the lot of production vessels. Cut impact test specimens from the central 300 mm 12 inchesof the test sample.

2.4.1.2 Minimum Impact Value

In lieu of requirements in ASME BPVC SEC VIII D1, each specimen of the set of three 10 by 10 mm 3/8 by 3/8 inch specimens must have a specified minimum impact value of 20 J 15 foot pounds for material thickness of 13 mm 1/2 inch or greater. For thinner material, use a similar specimen, except reduce the dimension along the axis of the notch and the specified minimum impact value to the largest possible of:

7.5 mm and 17 J 12.5 foot pounds minimum.

5.0 mm and 14 J 10 foot pounds minimum.

2.5 mm and 7 J 5 foot pounds minimum.

If the value of only one of the specimen is less than the specified value, a retest will be permitted, in which case all three retest specimens must have an impact value of not less than the specified value.

2.4.1.3 Additional Tests of Welded and Seamless Vessels

a. Test materials and weld metal at the lowest temperature at which pressure will be applied to the vessel, or the design temperature, whichever is lower, and meet the following:

   (1) Provide specimen in accordance with ASTM A370 for Charpy Impact Test.

   (2) Minimum values are as given below:
   (3)

Size of Speciment	Base Metal and Heat-Affected Zone (joules) (foot-pound)	Weld Metal (joules) (foot-pound)
10 mm x 10 mm	41 30	34 25
10 mm x 7.5 mm	34 25	27 20
10 mm x 5 mm	27 20	22 16
10 mm x 2.5 mm	14 10	11 8
If the value of only one of the specimens is less than the specified value, a retest will be permitted, in which case all three retest specimens must have an impact value of not less than the specified value.		

b. For welded vessels, make one set of Charpy Tests with notch located in base metal at least 50 mm 2 inches from weld, one set with notch located in heat-affected zone of shell, and one set with notch located in weld metal.

c. For seamless vessels, perform tests on base metal only, in the same quantities as required above for seamless vessels.

2.4.2 Mechanical Property Tests

2.4.2.1 Welded Vessels

Make two tension tests and one bend test from each parent plate as rolled from a slab or ingot. Test plates which are quenched and tempered by steel supplier by performing one bend test from each parent plate as rolled from a slab or ingot, and two tension tests from each plate as heat-treated. In addition, make one tension test on each quenched and tempered plate used for vessel shells and heads when the heat-treatment is performed by fabricator.

2.4.2.2 Seamless Vessels

Make one impact specimen tension test from test sample for each lot. Take test specimen from the central 300 mm 12 inches of test sample.

2.4.3 Hydrostatic Testing

Perform hydrostatic testing after fabrication and heat treatment. Hydrostatically test pressure vessels and manifolds in accordance with

ASME BPVC SEC VIII D1, except use a holding time at test pressure no less than 6 hours.

2.5 INSPECTION AND REPAIR OF DEFECTS

2.5.1 Personnel Qualifications

Perform radiographic, liquid penetrant and magnetic particle inspections of buttwelded pipe joints and welded vessels listed below by personnel qualified in accordance with applicable portion of ASME BPVC SEC V as appropriate. Submit certified test results by the reviewing inspector. Submit test reports for radiographic, magnetic particle, liquid penetrant, impact, and hydrostatic tests performed to prove compliance with specified criteria, upon completion and testing of the installed system.

2.5.2 Radiography of Buttwelded Pipe Joints

Buttwelded pipe joints must be radiographed 100 percent. Use radiographic technique and interpretation conforming to ASME B31.3, except as modified. Submit negatives and interpretation report for examination within 24 hours after taking radiographs. Unacceptable areas of joints must be cut out, remade, and reradiographed. Ensure negatives are accessible for examination by the Contracting Officer.

2.5.3 Radiography of Welded Vessels

Base extent of radiography on joint efficiencies used for design purposes. Use radiographic technique and interpretation conforming to ASME BPVC SEC VIII D1. Provide fine grain or extra fine type radiographic film. Submit radiographic negatives and interpretation for approval at fabricator's plant. Repair and reradiograph unacceptable welds. Ensure a complete set of radiographs and records for each vessel or vessel part is retained by the manufacturer until the Manufacturer's Data Report has been signed by the inspector.

2.5.4 Magnetic Particle Inspection

Except for inside surface of closing girth seam, magnetic-particle inspect accessible surfaces of welds, including all layers of multiple-layered or banded vessels, in accordance with ASTM E709, using dc direct probe only. In addition, inspect accessible outside surface of welds after hydrostatic testing. Magnetic-particle inspect swaged ends of seamless vessels after forming and heat treatment. Repair cracks. Repair linear defects, except linear inclusions not exceeding 6 mm 1/4 inch for thicknesses up to 19 mm 3/4 inch, 8 mm 1/3 inch for thicknesses 19 mm 3/4 inch to 57 mm 2-1/4 inches, and 19 mm 3/4 inch for thicknesses over 57 mm 2-1/4 inches.

2.5.5 Inspection for Laminations

Chip or grind out laminations found at edges of plates to depth of the lamination or 13 mm 1/2 inch, whichever is less, and repair the resulting groove by welding. Linear defects 75 mm 3 inches or less in length which are parallel to plate surface are not considered as laminations and are acceptable. Consider linear defects over 75 mm 3 inches in length which are parallel to plate surface as laminations and repair.

2.5.6 Dye Penetrant Inspection

Liquid-penetrant inspect piping and seal at the root and final weld layers. Eliminate cracks and linear indications, except minor inclusions. Use inspection procedure in conformance with ASTM E165/E165M.

2.5.7 Repair of Defects

Repair defects in accordance with approved procedures. Wherever a defect is removed and repair by welding is not required, blend affected area into the surrounding surface so as to avoid sharp notches, crevices, or corners. After a defect is removed, and prior to making repairs, examine the area by suitable methods to ensure that the defect has been eliminated. After repairs have been made, re-examine the repaired area by the same methods that were originally required for the area. Any indication of a defect is regarded as a defect unless reevaluation by nondestructive methods and/or by surface conditioning shows that no unacceptable defect is present.

2.6 CLEANING

Submit a certified record of satisfactory cleaning of similar vessels or a record certifying not less than 2 years of experience in chemical cleaning to similar standards and for similar service. No organization performing cleaning will be considered qualified unless such proof of cleaning experience is submitted.

2.6.1 Internal Cleaning

****

NOTE: If this specification is used for the procurement of vessels, but not for installation, the time of final inspection will be revised.

****

Clean internal surfaces of each vessel and manifold until permissible contamination limits are complied with and then dry and protect. Employ cleaning procedures as necessary to comply with the specified permissible contamination limits. Perform cleaning, except during fabrication, at place of manufacture or at installation site. Do not use cleaning solvents that contain chlorine on stainless steel vessels. Inspection and tests will be witnessed by the Contracting Officer at time of final acceptance.

2.6.2 Permissible Contamination Limits

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NOTE: Each individual vessel and its application has to be considered from the standpoint of the control system and end use of the product. Permissible contamination limits will be inserted to suit requirements. The limits specified will not be more stringent; for economical reasons, the limits will be relaxed wherever possible.

****

Permissible contamination limits for vessels and manifolds must not exceed the following:

a. No hydrocarbon as evidenced by visual and ultraviolet light inspections.

b. No solid or fibrous particle concentration greater than [54] [_____] mg/square m [5] [_____] mg/psf as measured in effluent on final rinse or [10] [_____] ppm by weight of sample.

c. No particles greater than [150] [_____]-micrometer size.

d. No fibers greater in size than [150] [_____]-micrometer diameter by [1,000] [_____]-micrometer length.

2.6.3 Miscellaneous Requirements

2.6.3.1 Nominal-Rated Filters

Provide filters that remove 98 percent by weight of particles whose two smallest dimensions are greater than openings in filter media. Do not use filters made by powder metallurgy processes.

2.6.3.2 Clean Water

Use color free water containing no visible suspended particles or hydrocarbons.

2.6.3.3 Dry Air

Ensure air is oil-free and processed through a dehydrator so that the dew point is minus 53 degrees C minus 63.5 degrees F at 101 kPa (one atmosphere) one atmosphere or a maximum of 26.3 ppm water vapor by volume.

2.6.3.4 Nitrogen

Nitrogen must have been filtered through a 40-micrometer absolute-rated filter with an element constructed of stainless steel dutch twill weave. Clean filter so as not to contaminate the system in excess of filter rating.

2.6.3.5 Hydrocarbon

Hydrocarbon must be a combustible compound containing carbon and hydrogen.

2.6.3.6 Solid Particle

Provide solid material which cannot be classified as a fiber. Determine size of a solid particle by longest dimension.

2.6.3.7 Fiber

Ensure fiber is a threadlike structure composed of any material.

2.6.3.8 White Metal

"White metal" must have surface of a gray white, uniform metallic color. Surface, when viewed without magnification, must be found free of visible mill scale, rust, corrosion, oxides, paint, or other foreign matter.

2.6.4 Cleaning Procedures

Cleaning procedures are as follows, and employ additional procedures as necessary to comply with the permissible contamination limits.

2.6.4.1 Cleaning During Fabrication

During vessel fabrication, clean surfaces and welds of vessels and manifolds which will be exposed to gas thoroughly to white metal. Use stainless steel wire brushes on stainless steel. Do not use grinding discs that have been used on carbon steel on stainless steel vessels. Descaling may be accomplished prior to welding of final seam. When performed after cleaning, use an inert gas within the vessel to relieve stress .

2.6.4.2 After Cleaning

After cleaning, treat surfaces to inhibit rust.

2.6.5 Drying

Dry vessels by heating or vacuum evacuation. Dry manifolds by purge with gaseous nitrogen or dry air at a minimum of 60 degrees C 140 degrees F. Vessels and manifolds are considered dry when the dew point apparatus shows that the purging medium has a dew point no higher than the dew point of influent gas which is not above minus 53 degrees C minus 63.5 degrees F at 101 kPa (one atmosphere) one atmosphere or 26.3 ppm water vapor by volume. If vacuum evacuation is used, vessel is considered dry when pressure is maintained at 1.69 kPa (0.5 inch of mercury absolute) 0.5 inch of mercury absolute for a minimum of 5 minutes at a temperature of 15.6 degrees C 60 degrees F or higher temperature or at such lower pressure which is 96 percent of the vapor pressure of water for the vessel temperature. For example, for a vessel at 4 degrees C 40 degrees F maintain a pressure of 804 Pa (0.238 inch of mercury absolute) 0.238 inch of mercury absolute 5 minutes. Filter dry gas used for purging and drying through a 10-micron nominal rated filter.

2.6.6 Testing of Cleaned Vessels and Manifolds

Do not contaminate vessels or manifolds during tests or after cleaning. Reclean contaminated vessels and manifolds.

2.6.7 Inspection

Inspect each vessel and manifold for compliance with permissible contamination limits specified herein. Submit certified results of such inspections for approval. Perform inspections, tests, and sampling in the order listed below. Reclean or rework any vessel or manifold which is rejected in any one of these inspection procedures to the extent necessary to meet requirements specified.

2.6.7.1 Inspection No. 1, Final Rinse

During final rinse and prior to drying operation, examine a 1-liter sample of effluent by Millipore method or equivalent method in accordance with SAE AS598. For this purpose, rinse using clean water and a pressure spray nozzle on interior surfaces to ensure dislodgement of particles. Effluents containing contamination in excess of permissible contamination limits are cause for recleaning and reinspection.

2.6.7.2 Inspection No. 2, Visual

Examine vessels and manifolds for evidence of corrosion products including rust, metal chips, scale, weld scale, oil, grease, paints, preservatives, decals, or other foreign matter. Use special devices such as inspection mirrors or bore scopes to visually examine inaccessible areas of vessels or manifolds. Contamination in excess of permissible contamination limits is cause for recleaning and reinspection.

2.6.7.3 Inspection No. 3, Ultraviolet Light

Visually inspect, with aid of an ultraviolet light, accessible surfaces to determine the presence of petroleum type hydrocarbons. Also inspect wipe pads by ultraviolet light. Ensure inspectors are qualified to use the ultraviolet light. Contamination in excess of permissible contamination limits are cause for recleaning and reinspection. Use ultraviolet light for this inspection and light-intensity meter conforming to the following:

a. Provide light source consisting of 100-watt spot mercury and bulb 250 to 370 nanometers (2500 to 3700 Angstrom units) 2500 to 3700 Angstrom units.

b. Prvide transformer meeting the recommendations of bulb manufacturer.

c. Provide filter approximately 127 mm 5 inches in diameter, convex and round.

d. Replace bulb when intensity of ultraviolet light through filter is less than 550 microwatts per square centimeter when measured 600 mm 24 inches from outside surface of filter, or after 500 hours of use, whichever occurs first.

2.6.7.4 Inspection No. 4, Wipe Test

Make wipe test at each end of each cleaned section of pipe and on interior surfaces of vessels and manifolds which are accessible with a probe. Use clean filter paper. Interior surfaces are to be wiped on a random basis or as indicated by the results of visual inspection. Perform test consisting of a linear movement of filter paper over a distance approximately 600 mm 2 feet long when large areas are being tested. Perform a full circular wipe on smaller areas such as manifold ends. Then examine filter paper under clean-room conditions. Contamination in excess of permissible contamination limits is cause for recleaning and reinspection.

2.7 SEALING

2.7.1 Seals

Seal vessels and manifolds immediately after passing the cleaning inspections. Ensure seals are tight enough to prevent contamination and protect so that they will not be broken or warped. Use tape for sealing procedures that does not leave any residue on connections when removed.

2.7.2 Flanged Openings

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NOTE: Comparable type closures will be specified for other type connections.

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Seal flanged openings with a suitable full-face blank gasket 3.2 mm 1/8 inch thick or disk at least 1.6 mm 1/16 inch thick consisting of polytetrafluorethylene or other nonflammable, noncontaminating material and a bolted blank flange of aluminum or corrosion-resisting steel at least 6 mm 1/4 inch thick. Use stainless steel bolts in contact with stainless steels. Cadmium-plated bolts may be used in contact with aluminum, but do not use cadmium-plated bolts in contact with stainless steels. Place a bolt correctly torqued to correspond to particular blank flange and gasket design in each bolt hole. Clean gaskets and flanges as specified.

2.7.3 Threaded Openings

Seal threaded openings with appropriately cleaned caps or plugs made of corrosion-resisting steel.

2.8 CERTIFICATE

Attach certificate of inspection indicating conformance to requirements specified to each item. Show the date of inspection and the signature of the Contractor's inspector.

2.9 PRESSURIZING

Pressurize vessels to 103 kPa 15 psig with nitrogen immediately following cleaning inspections and sealing of vessels. Maintain vessels at positive pressure up to and during the time of final acceptance. Equip vessels with a shutoff valve and gauge for pressurizing. Ensure gauge is capable of 103 kPa 15 psig minimum with 10 kPa 1.5 psig increments between 0 to 34 kPa 0 to 5 psig. Provide a protective metal cover around the gauge and valving. Complete loss of pressure is cause for reinspection and recleaning as necessary to meet permissible contamination limits by and at the expense of the Contractor.

2.10 PAINTING

2.10.1 Exterior Surfaces

Clean and paint exterior surfaces of all vessels, including supports but excluding stainless steel surfaces, in the shop. Wire bruch abraded or corroded spots and touch up with the same material as the paint coat.

2.10.2 Cleaning and Preparation of Surfaces

Clean exterior surfaces before applying paint. Remove oil, grease, dirt, loose dust, loose mill scale, and other foreign substances. Remove oil and grease before mechanical cleaning is started, using mineral spirits or other paraffin-free solvents having a flash point higher than 37 degrees C 100 degrees F. Clean with clean cloths, fluid emulsions, steam, flame cleaning, high-speed power wire brushing, blast cleaning, or other approved methods. Do not use chipping tools that produce cuts, burrs, and other forms of excessive roughness. Tight mill scale that cannot be removed by applying a sharp knife to any edge and minor amounts of residual rust not removable except by thorough blast cleaning will be permitted.

2.10.3 Painting of Surfaces

Apply a primer coat of paint conforming to SSPC Paint 25 to exterior surfaces of the vessel. Finish vessel with two coats of gray enamel conforming to SSPC Paint 21. Apply paint under dry and dust-free conditions when an ambient temperature is not below 4 degrees C 40 degrees F. Paint an even film of uniform thickness. Apply the three-coat paint system so that their dry film thickness at any point is no less than 0.10 mm 4.0 mils, with the primer having a minimum dry film thickness of 0.04 mm 1.5 mils. Edges, corners, crevices, and thoroughly clean and paint joints.

PART 3 EXECUTION

3.1 FOUNDATIONS

Foundations must be designed by the Contractor. Base design on the soils investigation provided by the Government. Any additional information required must be specified by the Contractor and obtained by the Government. Construct foundations for the pressure vessel [and manifold] of [21] [_____] MPa [3000] [_____] psi concrete, reinforced where necessary, and construct in conformance with the applicable requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE, except as shown or specified herein.

3.1.1 Excavation, Filling, and Grading

Perform excavating, filling, and grading in conformance to the applicable requirements of Section 31 00 00 EARTHWORK.

3.1.2 Anchor Bolts

Accurately set anchor bolts of adequate length to install the pressure vessel. When embedded in concrete, provide anchor bolts with plates welded on the head and protect against damage until the equipment is installed.

3.2 INSTALLATION

Submit drawings showing the locations of weld seams, sizes and types of welds, piping arrangements, nozzle reinforcement, method of nozzle attachment, plate and head thicknesses, vessel weights, details of gas relief holes in multiple-layered shells, lifting lugs [manways] [details of drains and vents] details required for fabrication of the vessels, and a complete list of materials. Include design calculations for vessels and manifolds with the drawings, including chemical composition and mechanical properties of the steels used, and including reference to ASME BPVC SEC VIII D1. Loading, lifting, shipping, unloading, field testing, and installation instructions, prior to completion of fabrication. [Installation drawings for piping manifolds showing field piece markings.] [The pressure vessel foundation design drawings.]

3.2.1 Equipment

Install all tanks and equipment in accordance with fabricator's instructions and recommendations. Bolt all vessels in place on concrete foundations. Exercise care during the placement of vessel on foundation so as not to scratch or dent vessel, or crack foundation.

3.2.2 Piping

Assemble all interconnecting piping in accordance with fabricator's drawings and instructions. Provide all piping conforming to the requirements of ASME B31.3. Adequately support interconnecting piping to avoid producing large stresses on the pipe or the vessel nozzles. Provide pipe hangers and supports conforming to MSS SP-58. Use piping supports that allow for movement of the pipe from thermal expansion or contraction. Ensure pipe support spacing and installation conform to the requirements of MSS SP-58.

3.3 FIELD TESTING

Upon completion of all related work and prior to acceptance, subject the pressure vessel and associated piping and instrumentation to a pressure test to demonstrate system performance. Notify the Contracting Officer [_____] days prior to conducting the test. The Contracting Officer will be present during the testing.

3.3.1 Testing Materials

Furnish all equipment, instruments, materials, and personnel required to perform the test. The Government will supply the utilities to perform the test such as [nitrogen,] [water,] [and] electric power.

3.3.2 Procedure

The test medium must be clean, dry nitrogen. Piping test pressure must be no less than 1.2 nor more than 1.5 times the design pressure. Maintain test pressure continuously for a minimum of 10 minutes, and ensure the required test procedure is in accordance with ASME B31.3. To pass the pressure test, the piping system must show no evidence of leaking at all joints and connections by soap bubble or equivalent method. If system does not pass the pressure test, the problem will be corrected and the system will be retested. Any retesting will be performed by the Contractor at the Contractor's expense. If piping test pressure is above the pressure vessel test pressure, the pressure vessel will be isolated from the piping test.

3.4 TOUCHUP PAINTING

Perform touchup painting to equipment [and piping manifold] as required from the inspection of the Contracting Officer. Painting materials and procedure must conform to the requirements of paragraph PAINTING.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 57 55 (November 2018)**
Change 1 - 11/20

Preparing Activity: NAVFAC **Superseding**
UFGS-33 57 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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DIVISION 33 - UTILITIES

SECTION 33 57 55

FUEL SYSTEM COMPONENTS (NON-HYDRANT)

11/18, CHG 1: 11/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 57 55 (November 2018)**
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SECTION 33 57 55

FUEL SYSTEM COMPONENTS (NON-HYDRANT)

11/18, CHG 1: 11/20

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NOTE: This guide specification covers the requirements for general system components for fuel systems (non-hydrant type). Do not use this specification for designs related to pressurized hydrant fueling systems. For such systems, refer to the requirements of the DoD Type III/IV/V, and Cut and Cover Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: Use this UFGS in conjunction with UFC 3-460-01 "Design: Petroleum Fuel Facilities". Include in this specification any additional system components/devices necessary to meet state and local regulations.

The specification is written around ASME's standard Class 150 rating. For applications requiring higher pressure ratings (e.g., Class 300), the designer will have to modify this specification appropriately.

Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS. Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards.

****

1.1 SUMMARY

This section defines the requirements for system components as related to a non-hydrant fuel distribution system. Provide the entire fuel distribution system as a complete and fully operational system. Size, select, construct, and install equipment and system components to operate together as a complete system. Substitutions of functions specified herein will not be acceptable. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system. System components and piping specified herein must be designed to handle a working pressure of [1900 kPa 275 psig for stainless steel systems][1965 kPa 285 psig for carbon steel systems] at 38 deg C 100 deg F. Components specified herein must be compatible with the fuel to be handled. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between [_____] degrees F and [_____] degrees F.[If gasoline is being handled, refer to 40 CFR Part 60 Subpart Kb and XX, 40 CFR Part 63 Subpart R, BBBBBB, and CCCCCC for design, installation, and testing requirements.]

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 1004	(2003) Bottom Loading and Vapor Recovery for MC-306 and DOT-406 Tank Motor Vehicles
API RP 1615	(2011) Installation of Underground Petroleum Storage Systems
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API STD 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME B73.1	(2020) Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM C827/C827M	(2023) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM D1655	(2018a) Standard Specification for Aviation Turbine Fuels

ENERGY INSTITUTE (EI)

EI 1529	(2014; 7th Ed) Aviation Fueling Hose and Hose Assemblies

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 77	(2024; ERTA 1 2023) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 24-2) Standard for Aircraft Fuel Servicing
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant
SAE AS5877	(2016; Rev B) Detailed Specification for Aircraft Pressure Refueling Nozzle

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-25896	(1983; Rev E; Notice 1 1989; Notice 3 2003) Adapter, Pressure Fuel Servicing, Nominal 2.5 inch diameter
MIL-DTL-5624	(2024; Rev X) Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-DTL-83413	(2012; Rev C; AMD 1 2017; AMD 2 2019) Connectors and Assemblies, Electrical, Aircraft Grounding, General Specification for
MIL-DTL-83413/4	(2019; Rev E; AMD 2 2019; Notice 1 2024) Connectors and Assemblies, Electrical, Aircraft Grounding: Plugs, for Types I and II Grounding Assemblies
MIL-DTL-83413/7	(2018; Rev F; AMD 1 2018; Notice 1) Connectors and Assemblies, Electrical, Aircraft Grounding: Clamp Connector for Types I and III Grounding Assemblies, Clip, Electrical
MIL-P-52327C	(1990) Military Specification Pumps, Centrifugal, Electric-Motor-driven, Positive Prime, Petroleum Products, Airfield Defueling and Receiving
MIL-PRF-4556	(1998; Rev F; Am 1 1999; CANC Notice 1 2011) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks

MIL-STD-130	(2007; Rev N; Change 1 2012) Identification Marking of U.S. Military Property
MIL-STD-161	(2005; Rev G; Notice 1 2010) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50696	(2016; Rev D) Reels, Static Discharge, Grounding, 50 and 75 Foot Cable Lengths
CID A-A-59326	(Rev D) General Specification For Coupling Halves, Quick-Disconnect, Cam-Locking Type

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)

UL SOLUTIONS (UL)

UL 87	(2016) UL Standard for Safety Power-Operated Dispensing Devices for Petroleum Products
UL 87A	(2015; Reprint Jan 2020) UL Standard for Safety Power-Operated Dispensing Devices for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations up to 85 Percent (E0 – E85)
UL 330	(2017; Reprint Feb 2019) UL Standard for Safety Hose and Hose Assemblies for Dispensing Flammable Liquids
UL 842	(2015; Reprint Oct 2017) UL Standard for Safety Valves for Flammable Fluids

1.3 ADMINISTRATIVE REQUIREMENTS

Submit detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system components and systems. Provide the drawings as one package with the design analysis. Shop fabrication drawings must include type of material, configuration, thickness, and necessary details of construction of the steel tank and vault. Shop drawings must also show the steel grating and supports. Submit Manufacturer's Catalog Data and Certificates of Compliance. Operation and maintenance information must be submitted for the system components items or systems listed in PART 2. Automatic pump controls must include step-by-step procedures required for system startup, operation, and shutdown.

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding; G, [_____]

[Tightness Monitoring System; G, [_____]

][Truck Fillstand Overfill Protection and Ground Verification Unit; G, [_____]

][Venturi Tubes; G, [_____]

] Meters; G, [_____]

[Jockey Pump; G, [_____]

] Packaged Truck Offload System; G, [_____]

High Point Vent and Low Point Drain Pits; G, [_____]

Water Draw-Off System; G, [_____]

Operating Tank Vent; G, [_____]

SD-03 Product Data

Pressure Gages; G, [_____]

Differential Pressure Gauge; G, [_____]

Automatic Pump Controls; G, [_____]

[Tightness Monitoring System; G, [_____]

][Truck Fillstand Overfill Protection and Ground Verification Unit; G, [_____]

] Flow Switches; G, [_____]

[Venturi Tubes; G, [_____]

][Differential Pressure Transmitter; G, [_____]

] Pressure Sensor; G, [_____]

Relaxation Tank; G, [_____]

Meters; G, [_____]

Submersible Pump; G, [_____]

ANSI Type Centrifugal Pump; G, [_____]

Sliding Vane Rotary Pump; G, [_____]

Self-Priming Centrifugal Pump; G, [_____]

[Jockey Pump; G, [_____]

] Packaged Truck Offload System; G, [_____]

Deaerator Tank; G, [_____]

Truck Fillstand Hose; G, [_____]

Truck Fillstand Swivel Joints; G, [_____]

Tank Truck Bottom Loading Arm; G, [_____]

Top Loading Arm; G, [_____]

Filter/Separator; G, [_____]

High Point Vent and Low Point Drain Pits; G, [_____]

FRP Containment Sump; G, [_____]

Liquid Level Gauge; G, [_____]

Operating Tank Level Indicator; G, [_____]

Operating Tank Level Switches; G, [_____]

Water Draw-Off System; G, [_____]

Operating Tank Vent; G, [_____]

Product Dispensing Unit; G, [_____]

SD-06 Test Reports

[Tightness Monitoring System; G, [_____]

] Coating Testing; G, [_____]

SD-07 Certificates

System Supplier; G, [_____]

[Tightness Monitoring System; G, [_____]

] SD-10 Operation and Maintenance Data

Automatic Pump Controls; G, [_____]

[Tightness Monitoring System; G, [_____]

][Truck Fillstand Overfill Protection and Ground Verification Unit; G, [_____]

] Relaxation Tank; G, [_____]

Meters; G, [_____]

Submersible Pump; G, [_____]

ANSI Type Centrifugal Pump; G, [_____]

Sliding Vane Rotary Pump; G, [_____]

Self-Priming Centrifugal Pump; G, [_____]

[Jockey Pump; G, [_____]

] Packaged Truck Offload System; G, [_____]

Deaerator Tank; G, [_____]

Filter/Separator; G, [_____]

Operating Tank Level Indicator; G, [_____]

Water Draw-off System; G, [_____]

Operating Tank Vent; G, [_____]

Product Dispensing Unit; G, [_____]

1.5 QUALITY ASSURANCE

Submit the following data for approval:

a. Certification stating that the System Supplier has provided and installed at least five Programmable Logic Control (PLC)-based pump control systems in the last five years, for automatic cycling of pumps based upon varying dispensing demands, utilizing multiple pumps. These systems must be for dispensing [jet fuel] [mogas] [avgas] [diesel] [bio-diesel] [E-85] [burner fuel oils] [_____].

b. Certification that six systems have been successfully operated over the last three years and are currently in service.

c. Project names, locations, system description, and items provided at these installations. Include user point-of-contact and current telephone numbers.

1.5.1 Material and Equipment Qualifications

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Materials and system components must have been in satisfactory commercial or industrial use for a minimum two years prior to bid opening. The two year period must include applications of the system components and materials under similar circumstances and of similar size. Materials and system components must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two year period.[Products having less than a two year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours, exclusive of the manufacturer's factory tests, can be shown.]

1.5.2 Nameplates

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NOTE: In a salt water environment, substitute acceptable non-corroding metal such as, but not limited to, nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

Require melamine plastic nameplates for all NAVFAC projects. Also for NAVFAC projects, require nameplates to be associated or keyed to system charts and schedules.

****

Attach nameplates to all specified system components, thermometers, gauges, and valves defined herein. List on each nameplate the manufacturer's name, address, [contract number,] [acceptance date,] component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of [anodized aluminum] [stainless steel] [melamine plastic, 3 mm 1/8-inch thick, UV resistant, black with white center core, matte finish surface and square corners] [_____]. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 25 by 65 mm 1 by 2-1/2 inches. Lettering must be the normal block style with a minimum 6 mm 1/4-inch height. Accurately align all lettering on nameplates.[For plastic nameplates, engrave lettering into the white core.][Key the nameplates to a chart and schedule for each system. Frame charts and schedule under glass, and locate where directed near each system. Furnish two copies of each chart and schedule. Each nameplate description must identify its function.]

1.6 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

PART 2 PRODUCTS

If gasoline is being handled, refer to 40 CFR Part 60 Subpart Kb and XX, 40 CFR Part 63 Subpart R, BBBBBB, and CCCCCC for design, installation, and testing requirements.

2.1 MATERIALS

Materials of construction must be stainless steel, aluminum or nonferrous material except positive displacement meter case may be steel with electroless nickel plated internals coated to 0.075 mm 3 mil thickness, or interior epoxy coating. No ferrous or zinc-coated material bronze, brass or other copper bearing alloys must be used in contact with the fuel. Do not install cast iron bodied valves or system components. Do not use aluminum valves.

2.1.1 Types of Fuel

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NOTE: Select type of fuel and insert expected temperature extremes.

****

Components must be suitable for use with [F-24 turbine fuel (Jet-A with additives FSII, CI/LE, and SDA); specific gravity 0.81 at 16 degrees C 60 degrees F; viscosity 1.62 CS at 16 degrees C 60 degrees F; Reid vapor pressure less than 0.35 kPa 0.05 psi; ASTM D1655] [JP-4 turbine fuel; specific gravity 0.76 at 16 degrees C 60 degrees F; viscosity 0.92 CS at 16 degrees C 60 degrees F; Reid vapor pressure 14 to 21 kPa 2 to 3 psi, MIL-DTL-5624] [JP-5 turbine fuel; specific gravity 0.82 at 16 degrees C 60 degrees F; viscosity 1.62 CS at 16 degrees C 60 degrees F; Reid vapor pressure less than 0.35 kPa 0.05 psi, MIL-DTL-5624]. Components to be ANSI Class 150 (1920 kPa at 38 degrees C 275 psig at 100 degrees F) unless noted otherwise. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between [_____] degrees C F and [_____] degrees C F.

2.1.2 Composition of Materials

Materials in contact with the fuel must be noncorrosive. No zinc-coated metals, brass, bronze, iron, lead or lead alloys, copper or copper alloys, or other light metal alloys containing more than 4 percent copper must be used in contact with the fuel.

2.1.3 Gaskets

Gaskets must be in accordance with Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

2.1.4 Bolts and Nuts

Bolts and nuts must be in accordance with Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

2.1.5 Flanges

Flanges and flanged end system components must be in accordance with Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

2.1.6 Nitrile Butadiene (Buna-N)

Provide Buna-N material that conforms to SAE AMS3275.

2.1.7 Acrylonitrile Butadiene Rubber (NBR)

Provide NBR material that conforms to SAE AMS3275.

2.2 SYSTEM COMPONENTS AND MATERIAL

2.2.1 General

All items of system components and material must be new and of the best quality used for the purpose in commercial practice and must be products of reputable manufacturers. Each major component of the system components must have the manufacturer's name, address and catalog number on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable. The gears, couplings, projecting set screws, keys and other rotating parts located so that any person may come in close proximity thereto must be fully enclosed or properly guarded. System Components, assemblies and parts must be marked for identification in accordance with MIL-STD-130 and MIL-STD-161. Pump and filter vessel numbers must be as indicated on the drawings. In addition, filter vessels must include element numbers and the date of the next element change. Identification tags made of brass, stainless steel, or engraved anodized aluminum, indicating valve number and normally open (NO) or normally closed (NC) must be installed on valves. Tags must be 35 mm 1-3/8 inch minimum diameter, and marking must be stamped or engraved. Indentations must be black, for reading clarity. Tags must be attached to valves with No 12 AWG, copper wire, stainless or aluminum hanging wires, or chrome-plated beaded chain designed for that purpose.

2.2.2 System Supplier

Since the pump control system, including but not limited to pump control panel, [venturi tubes], transmitters, flow switches, fueling system pumps, all field instrumentation, [tightness monitoring system,] and control valves with all hardware and software, is an integrated system it must be furnished by a single systems supplier regularly engaged in the supplying of these system components. System Supplier must be a company whose regular, normal, and primary business is representing manufacturers in the distribution and start-up of aviation fueling facilities, and have no affiliation with the Contractor other than as a seller to the Contractor. Supplier must provide all system components and appurtenances regardless of manufacture, be a factory authorized certified representative, and be responsible to the Contractor for satisfactory operation of the entire system, and must oversee the installation of the system components. Substitutions of functions specified will not be acceptable. The Contractor and the System Supplier must be present at the system commissioning, and must coordinate and schedule the work during construction, testing, calibration, and acceptance of the system. The System Supplier must be on-site with their mechanical and control personnel to supervise and assist the contractor during pre-commissioning check-out of the mechanical systems and control systems, initial fuel receipt, initial filing, hydrostatic testing, pigging, flushing, cleaning, system component tests, performance testing and all training for the owner's representatives. The System Supplier must be responsible to the Contractor for scheduling all Contractor, Sub-contractor, and manufacturer's service personnel during system start-up and final commissioning.

2.3 ELECTRICAL

****

NOTE: Show electrical characteristics on the drawings.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other electrical system components and circuits and when recommended by the manufacturer. Where adjustable speed drives (ASD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01 DESIGN: INTERIOR ELECTRICAL SYSTEMS.

Coordinate the ignition temperature of the fuel(s) to be handled with the electrical design. Ignition temperatures will be as defined in NFPA 497M. Fuel ignition temperatures will dictate the maximum allowable temperature rating of the electrical system components. Coordinate the area classification and the electrical design with UFC 3-460-01.

Coordinate piping, valve, system components and other systems bonding and grounding requirements with UFC 3-460-01. Include also in the design a bonding and grounding plan to relieve and control static electricity buildup as described in UFC 3-460-01.

****

Motors, manual or automatic motor control system components except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.3.1 Grounding and Bonding

Ground and bond in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.4 PRESSURE GAGES

****

NOTE: For arctic conditions (less than minus 50 deg F) gauges must be immersed (filled) with silicone. Indicate the scale range for each gauge on the drawings.

****

Pressure gages must conform to ASME B40.100 with metal cases and 100 mm 4-inch diameter white dials. Gages must be bottom connected, without back flanges. A pulsation dampener, adjustable to the degree of dampening required, must be provided for each gage. Range of gages must be as indicated. A ball valve must be provided for each pressure gage. Gages must have all parts immersed in [silicone] [glycerin] oil. Gages must be labeled with the calibration date.

2.4.1 Quick Disconnect

If indicated on drawings provide quick disconnect on pressure gauge. Quick disconnects for pressure gauges must be double shut-off, dry-break design, 316 stainless steel construction, with Fluorocarbon (Viton) seals, minimum working pressure of 6.89 mPa 1000 psig at 38 degrees C 100 degrees F, with 12.7 mm 1/2-inch female NPT threaded connections for both coupler and adapter, manufactured in accordance with ISO 7241, Series B. The quick disconnect assembly must consist of a coupler, half to be connected to the pressure snubber under the pressure gauge, and a nipple/adapter half to be connected above the pressure gauge isolation ball valve. The nipple/adapter is to be provided with an aluminum dust cap to protect the fitting when the gauge is removed.

2.5 DIFFERENTIAL PRESSURE GAUGE

****

NOTE: Piston type differential pressure gauges do not require calibration. Suggest showing on the drawings a pressure gauge installed on the high pressure side of the differential pressure gauge. The pressure gauge should have a scale range from 0 to 2068 kPa (300 psi).

****

The gauge must consist of a spring-supported, corrosion resistant piston moving inside a glass cylinder, with high pressure applied on top of the piston and low pressure applied below it. Under a differential pressure of 206.8 kPa 30 psi, leakage past the piston must not exceed 120 drops per minute. The cylinder and flanges must be stainless steel with Viton O-ring seals. The high pressure inlet of the gauge must have a 10-micron pleated paper filter and the low pressure connection must have a fine mesh stainless steel strainer. The gauge must have an operating pressure of 2068 kPa 300 psi. Differential pressure range of the gauge through approximately 75 mm 3-inches of piston movement must be 0-2068 kPa 0-30 psi with an accuracy of plus 34.5 kPa 0.5 psi, calibrated linearly with one PSI scale graduations. High and low pressure connections must be 1/4-inch NPT female with a stainless steel bar stock valve at each connection. Construction of the gauge must be such that a 3-valve manifold is not necessary. If only one bar stock valve is closed, the gauge must not be damaged by up to 206.8 kPa 300 psi differential pressure in either direction. A pressure gauge must be attached to the differential pressure gauge to indicate the high pressure and have a range of 2068 kPa 300 psi.

2.6 AUTOMATIC PUMP CONTROLS

****

NOTE: Fuel systems that include pumps to receive, transfer, and issue fuel may be provided with an Automatic Pump Control system with a Programmable Logic Controller (PLC) driven Pump Control Panel (PCP) to control the system. The exceptions where a PCP is not required are:

(a) Motive fuel filling stations and that only dispense motive fuel into vehicles.

(b) Motive fuel filling stations that also include attached tactical refueler truck loading station(s) whose flow rate is under 200 gpm for each station.

(c) Pumps serving miscellaneous use tanks.

(d) Isolated miscellaneous pumps that are not part of a larger system. These 5 HP or less size pumps act as sump pumps, pier stripping pumps, etc.

Every fuel system larger than a Filling Station for dispensing motive fuel that includes pumps to receive, transfer, and issue fuel may be provided with an Automatic Pump Control system with a Programmable Logic Controller (PLC) driven Pump Control Panel to control the pumps, run tightness tests, prevent tank overflow, etc. Provide an Automatic Pump Control System when required by Service Headquarters.

Only the most complicated systems use the measurement of pressure and flow to start and stop pumps; this is typically only required for hydrant systems. This specification section assumes that the system for this project uses manually actuated Pump Control Start/Stop Stations to control the pumps. To specify a system that uses an automatic pump control system that starts and stops the pumps based on flow and/or pressure, use Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT instead and modify accordingly.

****

The control system components specified in this paragraph must be obtained from a single supplier of such products (see the paragraph SYSTEM SUPPLIER in this section for the requirements). The supplier must be responsible for furnishing components that are compatible and that operate as a system to perform the required pump control functions. Control tubing between controls/instruments and fuel lines must be installed to eliminate air entrapment. Control tubing must be as specified in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). Each system component specified hereafter must have manufacturer's authorized service personnel present to assist in PERFORMANCE TESTING as specified in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). Items specified under this paragraph must be submitted for approval concurrently with items specified in Section 33 09 52 FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT).

Electrical supply and electrical control system components must be suitable for the location and area classification in which they are installed. All mounting hardware must be corrosion resistant.

2.6.1 Pump Control System

****

NOTE: Provide a pump control system with a Programmable Logic Controller (PLC) driven Pump Control Panel on every project larger than a Military Service Station.

NOTE: Delete any of the below listed systems that are inapplicable.

****

Provide a system that is furnished by a Single System supplier. System must include all required hardware and software in an integrated system. System must include the operator's interface computer and all required transmitters. System must monitor and control the following as a minimum:

a. Control valves

b. Refueler truck loading system

c. Over the road tank truck loading system

d. Railcar loading system

e. Over the road tank truck offloading system

f. Railcar offloading system

g. Tank truck overfill protection and ground verification unit

h. Vehicle dispensing system

i. Marine loading system

j. Marine offloading system

k. Transfer pipeline pumping system

2.6.2 Pump Control Panel

****

NOTE: Indicate the control sequences for all equipment and system components on the drawings.

****

See Section 33 09 52 FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT).

2.6.3 Control Stations

****

NOTE: Indicate the location and approximate configuration of each station. Mount all the control system components on a single system component rack next to the corresponding receiving/dispensing system components. Include the sequence of operation for each station on the drawings.

****

Electrical supply and electrical control system components must be suitable for the location and area classification in which they are installed. All mounting hardware must be corrosion resistant.

2.6.3.1 Pump Control Start/Stop Station

****

NOTE: Indicate the sequence of operation for the station on the drawings. Indicate the location of each station on the drawing. Provide a station for each loading or offloading position.

****

Station must consist of an enclosure, start/stop pushbuttons and green indicator lights as required. Enclosure must be corrosion resistant. In hazardous areas, enclosure must be electrogalvanized iron alloy with factory coating or copper-free aluminum. In non-hazardous areas, enclosures must be galvanized steel, stainless steel, electrogalvanized iron alloy with a factory coating or copper-free aluminum. Pushbutton contacts must have a minimum rating of 10 A, 125/250 VAC. Contact configuration must be as required or indicated. Indicator lights must be LED.

2.6.3.2 Emergency Fuel Shut-Off (EFSO) Station

****

NOTE: Indicate on the drawings the sequence of control to occur once an emergency pushbutton is activated. Typically, during activation, power to the entire fueling system is shutdown and an alarm signal is sent to the local fire department.

****

Enclosure must be corrosion resistant. In hazardous areas, enclosure must be electrogalvanized iron alloy with factory coating or copper-free aluminum. In non-hazardous areas, enclosures must be galvanized steel, stainless steel, electrogalvanized iron alloy with a factory coating or copper-free aluminum. All enclosures must be provided with a hinged glass or polycarbonate front and an open bottom. Paint the enclosure red. Mounting hardware must be corrosion resistant. Mount an emergency pushbutton inside the station housing. Pushbutton must be accessible through the hinged front. Pushbutton must be a momentary contact single unit with a jumbo mushroom operator, 1-NC and 1-NO contact. Mount a caution sign beside the emergency shutdown station, with red 50 mm 2-inch letters stating "EMERGENCY SHUTDOWN". The sign must have white background and be of noncorrosive construction.

[2.6.4 Tightness Monitoring System

****

NOTE: These are always provided when required by Regulators. These are almost always provided for Installation Pipeline projects. These are often provided for Interterminal Pipelines projects. These may be provided on large underground receipt or issue pipelines if the pipe volume is large enough to justify it. Contact Service Headquarters or officially designated alternate for guidance on when to provide.

Edit paragraph with location of local controller. If location is not specified, add location of local controller. Location must also be shown on drawings.

****

The system must be a permanent, fully automated, pressure step (no volume measurement) leak detection system, and will be used for tightness testing piping systems. System must have a guaranteed accuracy to detect a leak of less than 0.0004 mL/s 0.0004 gal/h per cubic meter foot at 1 mPa 150 PSI. The system must be US EPA Third Party Certified to the above sensitivity with a Probability of Detection greater than or equal to 95 percent and a Probability of False Alarm of less than or equal to 5 percent. System will have performed satisfactorily on at least five projects involving quantities and complexities at least equal to those required under this Contract. System components must be compatible with system components furnished and installed under this Section and Section 33 09 52 FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT), where the individual system components are common to both the Tightness Monitoring System functional operation, and the Fuel Control System functional operation. Test results must be unaffected by the temperature change of the fuel, and have a maximum test period of one hour. A local controller must implement and analyze data, store data and be capable of printing results, and be located in the the [pumphouse building] [conditioned enclosure] [_____]. Printer must be provided. Controller must utilize 120V, single phase power. Any additional utilities or system components needed to be added to the fuel system in addition to what is shown on the drawings to allow the Tightness Monitoring System to meet the requirements, will be the requirement of the Tightness Monitoring System Supplier. Provide calculations, design, and proof of compliance. Upon completion of 72-hours of continuous system operation and before final acceptance of work, test the Tightness Monitoring System in service to demonstrate compliance with contract requirements. Performance verification must be coordinated with overall fuel system start-up, and commissioning of fueling facilities. Perform performance verification in such a way as to obtain complete tightness information within the required accuracy stated herein and provided Tightness Certification on each pipe section tested.

][2.6.5 Truck Fillstand Overfill Protection and Ground Verification Unit

****

NOTE: Delete this paragraph if the tank trucks to be loaded do not have an overfill system installed (e.g., liquid level sensors, wiring, and plug receptacle). Indicate the type of plug required for the system.

The switch contact in the control module can be used to initiate various interlock functions (e.g., stop pumps, close valves, initiate alarms). Indicate the desired interlock control functions on the drawings.

****

System must include connection plug, control cable, and monitoring and control module. System must be the self-checking type that automatically and continually monitors the liquid-level within a tank truck's storage compartment during fueling.[Connection plug must conform to [______].][The system must be compatible with the Scully Duocept w/Truck Identification Module (T.I.M.) P/N 09061 to monitor truck liquid level, provide ground verification and provide a method to electronically prevent product commingling.] System must be rated for an explosion-proof environment in accordance with NFPA 70 for Class I, Division I, Group D locations. Module must include status lights and a switch contact to allow interlock functions. Control cable must be the spiral, self-retracting type. Cable must be a minimum 30 feet in length. The fillstand tank level sensor must signal the fillstand control valves to shutdown and must serve as the primary fill stand overfill system.

]2.6.6 Flow Switches

Switches must be actuating vane type flow switch with single adjustable set-point. Switches must mount on ASME B16.5 Class 150 raised face flange. Flange material must match the piping material at their connection to the system. Provide snap action switch mechanism U.L. listed for Class I, Division 1, Group D hazardous locations. Switches to be double pole double throw (DPDT). Switch power must be 120 volts, single phase, 60 hertz, 10 amps minimum. Units installed on 50 mm 2-inch piping and smaller may be threaded.

[2.6.7 Venturi Tubes

****

NOTE: Venturi tubes and their associated differential pressure transmitters are used in these systems to indicate flow rate on the control panel and not for control of the pumps like in a hydrant system. Seek guidance from the Service Headquarters or officially designated alternate before using.

****

a. The venturi tubes must be provided in conjunction with Section 33 09 52 FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT).

b. Start-up, adjustments and calibration, and instruction of personnel in the operation and maintenance of the venturi tubes must be considered as a required portion of the controls package.

****

NOTE: Select type of Fuel.

****

c. The venturi tubes must be low loss differential pressure producers consisting of a short housing piece and a fully machined, contoured throat section providing a restriction at the center, with both inlet approach and exit having geometrically symmetrical curves. They must be velocity head, impact, differential producing devices designed to measure differential pressure of [jet fuel] [mogas] [avgas] [diesel] [bio-diesel] [E-85] [burner fuel oils][_____]. They must be constructed of [304L stainless steel][carbon steel] with ANSI Class 150 flanges on each end and be suitable for operation of [1900 kPa] [1965 kPa] [275 psig] [285 psig] at 37.8 degrees C 100 degrees F. They must be of sufficient thickness to with-stand the same stresses as the upstream and downstream piping. Each venturi tube must have a minimum of four 13 mm 1/2-inch connections. An individual head-capacity curve must be furnished for each venturi tube.

d. Each venturi tube must be specifically custom manufactured for the specific flow conditions. Off the shelf designs are not acceptable. Date of manufacture must be stamped on the tube.

e. Operating conditions for the venturi tubes must be as follows:

****

NOTE: Select based on System and pump capacity.

****

(1) Issue Venturi Tube. Minimum inlet-to-throat differential pressure at [144] [_____] L/s: 8 mm [2,400] [_____] gpm: 200 in H2O.

(2) Return Venturi Tube. Minimum inlet-to-throat differential pressure at [36] [_____] L/s: 8 mm [600] [_____] gpm: 200 in H2O.

(3) Venturi tubes discharge coefficient "C" to be greater than or equal to 0.97 over pipe Reynolds number range between 200,000 and 1,000,000 and must be independent of Beta over a Beta range of 0.4 to 0.75. Pressure loss must be less than 24 percent of differential pressure generated by the venturi tube. Repeatability of the discharge coefficient "C" must be 2 percent for Reynolds number range of 10,000 to 1,000,000.

(4) Provide two portable GPM Meters, one for each size of venturi. The meters must be complete with valves, hoses and connecting disconnects, and carrying case. The meters must have stainless steel bellows, mounting bracket, 3.5 MPa 500 psi swp, 150 mm 6-inch dial with 270 degrees arc. Dial must read GPM Jet Fuel. Range of scale must match the flow transmitter for issue and return. The venturi manufacturer must provide the portable meters with the venturi in order to be compatible. The venturi tubes must also be provided with a suitable table to convert inches differential pressure to liter gallons per minute.

][2.6.8 Differential Pressure Transmitter

Differential pressure transmitter must consist of a capacitance sensor operating on a differential in pressure of fuel. The output must be a 4 - 20mA dc, square root signal between a minimum of 4 - 100 percent of the input. It may be linear between 0 - 4 percent. It simultaneously will produce a digital HART (Highway Addressable Remote Transducer) output signal. Loop power must be provided from remote power supply located in the pump control panel (PCP).

a. Transmitter body must be stainless steel with stainless steel diaphragm capsule process connecting to a 13 mm 1/2-inch NPT. Drain and vent valves to be stainless steel. Accuracy must be plus/minus 0.20 percent of calibrated span including combined effects of linearity, hysteresis and repeatability.

[b. One differential pressure dial must be supplied with each pair of transmitters. Differential pressure dial must consist of a bellows type pressure sensing element, operating on a differential in pressure of fuel, and a mechanical indicator, driven by the bellows unit. The bellows must be dual opposed, liquid filled, rupture-proof type with bellows movement converted to rotation and transmitted by a torque tube. Displacement of bellows must be 24,000 cubic mm 1.5 cubic inches for full scale travel. Bellows housing must be stainless steel and must have a rated working pressure of not less than 3.5 MPa 500 psi. Liquid used to fill the bellows must be suitable for the expected minimum ambient temperature. The indicating dial must be at least 150 mm 6-inches in diameter with a weatherproof glass cover. The case must be finished with a weather resistant epoxy resin enamel. The indicating pointer must traverse a 270-degree arc. The scales must be graduated over the selected pressure ranges so that the flow rate can be accurately read in L gallons per minute. Indicator accuracy must be 0.5 percent of full scale. Differential pressure indicating dial must be provided with built-in pulsation damper and suitable over-range protection.
]

****

NOTE: Select type of display per directions from Service Headquarters or officially designated alternate.

****

[c. Display at the transmitter must be LCD, one per each differential pressure transmitter. The digital scale must be a 4-digit LCD, capable of being read in low light/no light conditions. Indicator scale must be in L gallons per minute.
]

****

NOTE: Select based on System and Pump capacity. Systems greater than 150 L/s 2400 gpm require issue Venturi Tube to have low range (0-95 L/s) (0-1500 gpm) and high range (0- maximum system flow in L/s) gpm) transmitters versus one single full range transmitter.

****

d. Each venturi tube must have one transmitter and one indicating dial per function and must be installed as indicated on the drawings. Differential pressure ranges must be selected as necessary to operate in conjunction with associated venturi tube:

(1) Issue Venturi Tube - 0 to [_____] L/s GPM (full range)

(2) [Return][Bypass] Venturi Tube - 0 to [_____] L/s GPM (full range)

[e. Differential pressure transmitters must be UL, FM, or CSA listed for Class 1, Division 1, Group D hazardous environment as defined by NFPA 70, with maximum temperature rating T2D (215 degrees C 419 degrees F). Each transmitter and indicating dial must be supplied with a factory assembled five valve stainless steel manifold. Vent valves must be furnished on upper ports of each transmitter and indicating dial. Differential pressure transmitters and the indicating dial must be suitable for mounting on a 50 mm 2-inch pipe stand. Complete installation must be in accordance with manufacturer's recommendations.

]]2.6.9 Pressure Sensor

****

NOTE: Provide on every project that has a Pump Control Panel. It must be ordered with the right range, and is a sensor only. It is used simply to monitor systems, not control them. Indicate their exact installation locations on the drawings.

****

Sensor must be UL, FM, or CSA listed for Class 1, Division 1, Group D hazardous environment as defined by NFPA 70, with maximum temperature rating T2D (215 degrees C 419 degrees F). Excitation voltage must be 12-28 VDC. Output signal must be 4-20 mA. Unit must have 0.25 percent accuracy and have built-in high pressure snubbers, minimum pressure range must be 0-2.1 MPa 0-300 PSI. Wetted material must be stainless steel.

Provide pressure sensors at pump suction header, pump discharge header, [bypass pressure control valve inlet,][bypass pressure control valve outlet,][backpressure control valve inlet,][backpressure control valve outlet,][truck fillstand manifold,][and,][_____].

2.7 RELAXATION TANK

****

NOTE: Include a relaxation tank in a design only when required by UFC 3-460-01. Size each relaxation tank in accordance with UFC 3-460-01. When included in a design, provide a relaxation tank schedule on the drawings to detail the requirements for each tank required (e.g., volume, connection sizes).

****

Tank must conform to API RP 2003 and ASME BPVC SEC VIII D1. Tank housing must be constructed of 3003 or 6061 aluminum alloy. Provide each tank with an ASME pressure vessel seal. Provide tank with internal baffling to prevent flow short-circuiting. Provide tank with an air release tap, a pressure relief tap and a drain tap. Provide flanged end connections on all piping connections (inlet piping, outlet piping, pressure relief piping, vent piping, and drain piping).

2.8 METERS

****

NOTE: Select type of fuel and flow rate. Not all materials are available at all sizes. Aluminum

meters for example at a 1900 kPa 275 psig working pressure are only available in 2270 lpm 600 gpm size.

For OCONUS locations, consider meter registers to read in liters.

****

2.8.1 Positive Displacement Meters

Meter must be a one-way flow, temperature compensating, positive displacement type meter designed for a continuous flow of [2270 lpm] [1135 lpm] [600 GPM] [300 GPM] [_____] at the truck fillstand. Meter must have ANSI Class 150 flanges and body working pressure of not less than [1900 kPa] [1965 kPa] [275 psig] [285 psig] and must be suitable for hydrostatic testing of [1900 kPa] [1965 kPa] [275 psig] [285 psig]. Meter must be factory calibrated for [jet fuel] [mogas] [avgas] [diesel] [bio-diesel] [E-85] [burner fuel oils] [_____] and capable of being calibrated in the field. The register must have a non-setback total indicator and a setback type run indicator so that individual runs can be registered without affecting the total of all runs as shown on the indicator. The total indicator must have a minimum of eight figures and the setback run indicator must have a minimum of five figures. The register must read in liters gallons and the smallest unit of indicated delivery must be one liter one gallon. Accuracy must be within plus/minus 0.3 percent between ten percent and maximum rated flow. Meters must be provided with a suitable drain at the bottom, equipped with a ball valve. Pressure loss through the meter must not exceed 6.9 kPa 3 psi at [2270 lpm] [1135 lpm] [600 GPM] [300 GPM] [_____] flow rate.[Meter must have mechanical head.][Meter must have electronic head with means to remotely transmit the quantities passing through it by electronic pulse transmitters mounted on each meter.][Meter must have card-operated or key-operated data acquisition system to identify the receiver of the fuel and to allow access to the fuel.] Materials of construction must be stainless steel, aluminum, or carbon steel with electroless nickel plated or interior epoxy coated internals. The epoxy coating must be in accordance with MIL-PRF-4556.

[2.8.2 Turbine Meter

****

NOTE: These meters are seldom used as they have several issues (see below). However, they are allowed throughout UFC 3-460-01 at truck, railcar, and marine offloading and loading systems; and at pipeline receipt stations. They are very useful on marine and pipeline receipt applications with flow rates greater than 4540 lpm 1,200 gpm as positive displacement meters are prohibitively expensive over that size. Do not use at truck or railcar loading or offloading, or on any receipt or issue application where the volume to be measured is less than 100,000 gallons without permission of the Service Headquarters or officially designated alternate. For OCONUS locations, consider meter registers to read in liters. For installations with less than 10 pipe diameters of straight pipe upstream of the meter and 5 pipe diameters downstream of the meter, provide flow straighteners before turbine meters.

****

****

NOTE: Turbine meters have several issues:

a. They cannot be field calibrated using a meter prover. Most are removed and sent back to the factory for calibration.

b. They continue to spin for a few seconds after flow stops, and keep measuring while they spin. They therefore cannot meet the custody transfer requirements for truck or railcar loading and offloading as the quantities are too small.

NOTE: Consider on smaller pumping systems (600 gpm or less) in the pumphouse in lieu of venturi tubes.

****

Volumetric Turbine Flow Meter must be a turbine type meter designed for a continuous flow of [4540] [_____] lpm [1200] [_____] GPM, constructed of 316 stainless steel. The turbine meter must be supplied with Class 150 stainless steel ASME flanges, be capable of [1900] [1965] kPa [275] [285] psig system pressure, and must be suitable for hydrostatic testing of [1900] [1965] kPa [275] [285] psig. Meter must be factory calibrated for [F-24] [JP-4] [JP-5] [JP-7] [JP-8] [jet fuel] [mogas] [avgas] [diesel] [bio-diesel] [E-85] [burner fuel oils] [_____]. The measuring element of the turbine will consist of a straight blade, un-rimmed central rotor, rotating about a central rotor shaft that is supported bilaterally within the inside diameter of the meter body by cylindrical shaped spring clips that maintain the shaft and turbine rotor on the center line of the meter body independent of system pressures and temperatures. The cylindrical shaft clips also will counteract swirl and present a uniform fully turbulent flow profile and uniform boundary layer to the cones and turbine rotor. The turbine meter will have an accuracy of plus/minus 0.5 percent over a 10:1 range and a linearity of up to plus/minus 0.25 percent may be attained with premium calibration. Repeatability of the turbine meter will be 0.1 percent of reading over the entire range of the size of the turbine selected. The turbine meter must be approved by US NIST for solvent, gasoline, diesel fuel, fuel oil, and ethanol for use on custody transfer applications.[Provide turbine meter with flow straightener.]

The turbine meter will be supplied complete with an integrally mounted Multi-Function Microprocessor Based Rate Indicator / Totalizer with Field Programmability and Backlit Display in an Aluminum Enclosure. The enclosure must be rated for explosion proof environments. Input power must be self- contained battery, 10-14 VDC or 20-28 VDC. Outputs must include 4-20mA output and pulse output. A reset magnet, aluminum union, and 2-wire Molex signal cable will also be included with the Indicator/Totalizer. The Indicator/Totalizer must have temperature compensation with a four wire RTD input as well as the ability for RS232 data logging.

][2.9 TANK RECEIPT SLOWFILL FLOWRATE INDICATOR

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NOTE: Select per Service Headquarters or officially designated alternate. Use to ensure that a fuel storage tank is filled at low velocity until the

inlet is covered in order to minimize fuel splashing and static charge buildup.
****

Meter must consist of corner tapped orifice flanges, orifice flange plate, differential pressure gauge, and associated flow chart. The normal flow range is 0 to 36 L/s 600 gpm. Orifice flanges must be ANSI Class 150 and must be constructed of Type 304 or 304L stainless steel. Orifice Beta value must be 0.7, with a maximum pressure loss of no more than 20 kPa at 36 L/s 3 psi at 600 gpm. Differential pressure gauge must have a display of 0-30 meters 0-100 feet water column. A hand chart must be provided which shows the flow (L/s gpm) for the pressure drop indicated on the differential pressure gauge. A note must be added: Tank must not be filled faster than [_____] lpm [_____] gpm (one m/s 3 fps) whenever the fuel is not in contact with the floating pan (tank fuel receipt outlet is covered by one meters 3 feet of fuel when no floating pan is present).

]2.10 MISCELLANEOUS USE PUMPS

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NOTE: API-610 pumps (refer to Section 33 52 43.23 AVIATION FUEL PUMPS) must be used for the prime movers in systems that load and offload trucks, railcars, ships, barges, and for pipeline transfer. Pumps used here are for miscellaneous use only unless otherwise directed by the Service Headquarters or officially designated alternate. See UFC 3-460-01 for guidance.

Self-priming centrifugal pumps are primarily used for systems that occasionally off-load over the road tank trucks using the direct off-loading type system. See UFC 3-460-01 on the limited times when this type of systems is used.

ANSI Type pumps are used for jockey pumps.

Submersible pumps are used at gas stations when the dispenser does not have its own pump. They are also sometimes used as transfer pumps from fuel tanks to day tanks for generators and other similar light duty pumping situations.

Do not use sliding vane rotary pumps to load or offload trucks as they can generate too much pressure and cannot be throttled to limit flow rate.

Indicate the capacity, discharge head pressure, Net positive suction head available, overall efficiency, Voltage, phase, frequency, etc., required for each pump.

Indicate the control sequences for pumps on the drawings.
****

Pumps must be driven by an explosion-proof motor for Class I, Division l, Group D hazardous locations as defined in NFPA 70. Pump assemblies must be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow. Pump motors must be non-overloading throughout their entire pump curve.

2.10.1 Submersible Pump

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NOTE: Submersible pumps may be used for both above and belowground tanks. Check manufacturer's data since these type pumps may only be capable of handling gasoline or diesel fuels.

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Pump must be the [single-][multi-]stage, vertical type. Pump and motor combination must operate totally submerged in the product of the storage tank. Pump must extend within 150 mm 6-inches of the storage tank bottom. Pump fuel inlets must be horizontal. Pump mounting must completely support both the weight and vibration of the pump. Pump must include a steel lifting lug capable of supporting the weight of the entire pump and motor assembly. Pump must include a vertical solid shaft motor, base mounting flange, horizontal pump discharge, low net positive suction head (NPSH) first stage impellers, and dynamic and thrust balancing of impellers. Pump must be accessible for servicing without disturbing connecting piping. Pump baseplate, casing, and bearing housing must be of cast iron construction. Pump must be provided with a stainless steel one piece pump shaft. Internal pump components in direct contact with the fuel to be handled must be of compatible construction. Pump bearings must be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Provide pump with [threaded][flanged] end piping connections.

2.10.2 ANSI Type Centrifugal Pump

a. Overloading, horizontal, centrifugal type. Pump must have a radially split casing with an open impeller and Class 300 flanged connections. The pump suction and discharge flange arrangement must conform to ASME B73.1.

b. Casing discharge must be vertical centerline discharge. Medium and large frame pump casings must incorporate centerline support feet as required by API STD 610. Small frame pumps must not have casing feet. The casing and back cover wall thickness will include 3.2 mm 1/8-inch corrosion allowance. The suction and discharge neck must be drilled and tapped with 6.4 mm 1/4-inch NPT connections, for pressure gauges [and][or] auxiliary piping. A rotation arrow will be cast on the surface of the casing to indicate the proper direction of rotation.

c. Repelling vanes must be cast on the back side of the impeller. The impeller hubs must incorporate a threaded fit to the pump shaft sealed by a Teflon O ring in the hub. The impeller must be balanced to ISO specification G.6.3, with option for G2.5, unless otherwise specified. Balancing must, unless detrimental to the component or its performance, be attained by the removal of material.

d. The back cover must be fastened to the pump casing with a confined type gasket inert to the fluid being pumped. Seals must be cartridge type end face mechanical seals. The method of lubrication must be oil bath. The thrust bearings must be locked into the cartridge by a bolt-on retainer cover. Snap ring bearing retainers are not acceptable. The radial bearing must be permitted to slide within the inside diameter of the bearing frame to prevent axial load and permit radial load only. Double row filled slot bearings are not acceptable. Bearings must be designed for a minimum L-10 life of 60,000 hours. Angular contact thrust bearings, as required by API STD 610, are required. The pumps must at minimum be fitted with the following bearings:

(1) Small Frame Pumps (ANSI AA through A50):

(a) The thrust bearing: a 5308, AHC3 clearance, double row, deep groove bearing. A pair of 7308 BEGAY, back to back angular contact bearings must be provided as an option when required.

(b) The radial bearing: a 6308, C3 clearance, single row, deep groove.

(2) Medium Frame Pumps (ANSI A60 through A80):

(a) The thrust bearing: a pair of 7310 BEGAY clearance, back to back angular contact bearings.

(b) The radial bearing: a 6310 C3 clearance, single row, deep groove.

(3) Large Frame Pumps (ANSI A90 through A120:

(a) The thrust bearing: a pair of 7314 BEGAY clearance, back to back angular contact bearings.

(b) The radial bearing: a 6314 C3 clearance single row, deep groove.

e. The pump shaft must be of solid construction. Shaft sleeves are not acceptable. In order to establish satisfactory mechanical seal life, the total shaft deflection at the primary seal faces, under the most severe dynamic conditions, must be limited to 0.05 mm 0.002-inch, as required by API STD 610. To achieve this, the stiffness ratios (L3/D4), where L= length of shaft from impeller centerline to nearest bearing in inches and D= shaft diameter under the seal in millimeters inches, must not exceed the following values:

Shaft Size at Seal	L3/D4
Shafts 38 mm 1.5 inch	46
Shafts greater than 38 mm 1.5 inch, 50 mm 2.0 inch	20
Shafts greater than 50 mm 2 inch	19

f. The bearing frame must be cast iron, with radial fins for maximum cooling. The oil sump must contain a minimum of .23L 8 ounces of oil for small frame pumps, .71 L 24 ounces of oil for mid-frames and .94 L 32 ounces of oil for large. The oil level within the bearing frame must be monitored by an oil sight glass. Two magnetic pipe plugs must be located near the bottom of the bearing frame. The oil fill fitting at the top must be of nylon with an easily removable cap for adding oil. Trico or bottle type constant level oilers are not acceptable. Each end of the bearing frame assembly must incorporate non-contacting labyrinth oil seals. This type of seal is required by API STD 610 to eliminate shaft damage due to fretting and to eliminate the heat generated by the use of contact type lip seals. Other seal systems will be considered only if they are non-fretting. Shaft contacting type lip seals will not be accepted.

g. The thrust bearing end of the bearing frame must be capable of precision impeller adjustments without the need to add or remove shims. The minimum delineation must be .08 mm 0.003-inch and permit impeller clearance settings or readjustments without the need to remove the bearing frame from the volute section and without requiring shims, dial indicators, feeler gauges or disassembly.

h. The pump must be of the back pull-out design to permit the removal of the entire bearing frame assembly, including shaft, mechanical seal, and impeller, without disturbing the pump discharge and suction piping and without disturbing the motor (except for pumps equipped with C-Frame motor adaptors). Small frame and medium frame pumps must have a bearing frame foot that will support the power end in an upright position when removed from the wet end for service. A spacer type coupling must be furnished on non-motor adapter pumps to allow removal of the power end without disturbing the motor.

i. The pump must have the capability of incorporating a C-Frame motor adapter, which permits mounting of motors up to NEMA frame size 256TC for small frame, 405TC (447TSC) for medium frame, and 449T(S)C for large frame, without the need for parallel and angular alignment measurements and adjustments. The motor adapter may be equipped with adjustable feet in order to avoid frame soft foot and eliminate the need to use shims under the adapter assembly.

j. The pump must be constructed of the following materials:

    (1) The pump casing and back cover/seal chamber must be constructed of ASTM A743 CF8M.

    (2) The impeller must be open type, cast in ASTM A351 CD4MCU.

    (3) The pump shaft must be constructed of solid 316SS (ASTM A276 T316) or 17-4PH (ASTM A 564 T630) as required by the application. Bimetallic shafts are acceptable.

2.10.3 Sliding Vane Rotary Pump

Pump must be a sliding vane type rotary pump. The pump construction must permit the removal of the rotor and sliding vanes without disconnecting the pump. Pump capacity must be 189 liters [50][_____] gal per minute with a differential head of 17.4 meters [57][_____] feet. The pump and motor must be mounted on a steel subbase. The motor must have sufficient power for the service required, be of a type approved by the manufacturer of the pump, be suitable for available electric service, be totally enclosed, fan cooled, TEFC, and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Pump must be provided with stainless suction screen.

2.10.4 Self-priming Centrifugal Pump

a. The pump must be a single-stage, horizontal, centrifugal type consisting of a centrifugal impeller combined with a vane-type rotary, positive evacuating, volumetric-displacement priming unit, mounted on a common shaft. Pump must meet MIL-P-52327C.

b. The pump must be such that all rotating parts may be removed without disconnection of the suction or discharge piping.

c. The pump must operate dry for not less than 1-hour without damage or permanent deformation of moving parts after the pump has been operated by the petroleum products.

d. The priming unit must be a vane-type rotary, positive, volumetric-displacement unit mounted on the same shaft as the centrifugal impeller. The priming unit must evacuate air from the suction piping and thereby initially priming the centrifugal impeller and restoring lost prime during the operation of the pump. A stainless steel self-cleaning strainer must be provided in the priming-unit intake line.

e. The motor must have sufficient power for the service required, be of a type approved by the manufacturer of the pump, be suitable for available electric service, be totally enclosed, fan cooled, TEFC, and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

f. Capacity must be [1135] [_____] liters [300][_____] gpm against a total head of [46] [_____] meters [150][_____] feet when driven at 3600 rpm. Pump head capacity must be continually rising and must be free of dips and valleys from design point to shut-off head. Pump shut-off head must have a 10 to 20 percent head rise to shut off. Pump must be capable of at least a 10 percent head increase at rated conditions by installing a new impeller. Pumps must not overheat or be damaged in any way while operating continuously at a minimum flow condition of 50 percent of rated flow continuously at a maximum flow condition of 125 percent required capacity. The net positive suction head required at the center of the impeller must not exceed 2 meters 6 feet.

g. Pump must consist of a centrifugal impeller combined with an integral variable-capacity vane type priming unit located within the main centrifugal housing. The vane type positive priming unit must be capable of initially priming the pump and of restoring prime during operation against back pressures to 55 kPa 8 psi. The air release must enable the pump to prime at any discharge head pressure from zero feet to maximum discharge head and must release drip-free to the atmosphere and drain any liquid back into the centrifugal pump.

h. The vane pump must be positively driven by the main pump shaft. No gears or pumps must be required to operate the primary pump. All parts must be factory inspected so that parts are interchangeable. Pumps and motors must be furnished as complete units as herein specified. Pump assembly must be statically and dynamically balanced for all flow rates from minimum flow to 120 percent of design flow.

i. Pump must include provisions for attaching a vacuum gauge on the suction side and a pressure gauge on the discharge side.

j. The pump must be fitted with a mechanical-type pump shaft seal for closure between the stationary pump case and the pump shaft. The seal must be capable of effectively sealing a pressure equal to 1-1/2 times the pump shut off head. The mechanical-type shaft deal must be a standard product of proven material and design. The sealing surface must be self-aligning and must be readily removable for repair or replacement without removing the electric motor from the base. The sealing surfaces must be constructed of carbon/ni-resist, and the elastomers must be viton. The rotating member must be pin driven by the pump shaft, or must be firmly retained on the pump shaft by a snap ring or other suitable means. Materials used as sealing members or elastomers must be impervious to the deleterious action of the specified product. All parts of the seal must be resistant to corrosion and oxidation.

k. The pump shaft must be fabricated from 410 stainless steel. The shaft must be turned, ground and polished, and hardened to resist wear where the shaft passes through the seal and bearings. The shaft must be supported in the shaft housing by means of heavy duty, anti-friction, sealed type ball bearings.

l. The pump shaft must be coupled to the motor shaft by means of a flexible coupling having sufficient torsional strength to accommodate the rated motor horsepower. The coupling must be capable of handling angular and non-parallel alignment.

m. The pump case must be ductile iron. Flange ratings must be class 105 kg 125-pound per ANSI Standard, and flanges must be faced and drilled.

n. The impeller must be of the closed type, and must be statically and dynamically balanced. The impeller must be constructed of aluminum 356-T6.

[2.10.5 Jockey Pump

The pump must have the capacity of not less than 19 lpm 5 gpm against a total head of 73 meters 240 feet when driven at 3600 rpm and be an ANSI type centrifugal pump.

]2.11 PACKAGED TRUCK OFFLOAD SYSTEM

The truck offload system must be a factory fabricated and skid mounted unit.

2.11.1 Offload Pump (OP)

Refer to Section 33 52 43.23 AVIATION FUEL PUMPS.

2.11.2 Air Eliminator Tank

2.11.2.1 Tank Housing

Each Tank housing must be fabricated from carbon steel and must be internally coated with an epoxy coating in accordance with MIL-PRF-4556. Coat the exterior with alkyd resin primer (universal metal primer). Each unit must be constructed and labeled in accordance with ASME BPVC SEC VIII D1. The housing must be designed for a working pressure of 600 kPa 90 psig. The inlet and outlet connections must be provided with raised face flanges faced and drilled in compliance with ASME B16.5, Class 150. The configuration of the air eliminator tanks must be as shown on the drawings.

2.11.2.2 Sight Gauge

Provide a 125 mm 5-inch armored, clear borosilicate (Pyrex) glass liquid level gauge for observing fuel level in the tank. The gauge must be equipped with stainless steel ball checks in both the upper and lower fittings, an upper and lower shutoff valve, and a bottom blowoff cock. The gauge will contain a colored density sensitive ball. Glass must be protected by a minimum of four guard rods.

2.11.2.3 High Level Shutoff

The vent connection must have a stainless steel high level shutoff mechanism to act as an overfill prevention device to keep fuel from going out the vent.

2.11.2.4 Level Sensors

The level sensors must be ultrasonic tip sensitive level control switches, NEMA 7/9, weatherproof, explosion proof for Class I, Div I, Group D, temperature T2D (215 degrees C 419 degrees F), 120-volt input power, SPST relay output, 25 mm one-inch flanged mounting.

2.11.2.5 Vent

Tank vent outlet must be equipped with pressure-vacuum breather vent, aluminum construction with weather hood and with fluoroelastomer pallet seat inserts, high density screens, stainless steel internals, with pressure relief setting at 20 grams 0.5 oz per square mm inch, and vacuum relief set at 1350 grams 32 oz per square mm inch. Pressure venting capacity must be 151 cubic m 5400 cubic feet per hour, vacuum capacity must be 136 cubic m 5000 cubic feet per hour.

2.11.3 Non-Surge Check/Air Block Valve

Refer to Section 33 52 43.14 AVIATION FUEL CONTROL VALVES.

2.11.4 Offload Fuel Hose

The offload fuel hose must be 100 mm 4-inch, lightweight, flexible, minimum 200 mm 8-inch bend radius, non-pressurized offloading hose constructed of nitrile rubber, rigid PVC helix, synthetic braiding, smooth bore, corrugated outer diameter, non-collapsible, threaded, male NPT, both ends, and have UV protection.

2.11.5 Offload Sight Flow Indicator

The Truck Offload sight flow indicator must be 100 mm 4-inch wafer pattern sight glass, plane indicator aluminum construction.

[2.11.6 Flood Lights

Mount three floodlights on the off load skid, approximately 3.66 m 12 foot high, two on one pole, one on another pole to provide 10 fc of illuminance at the offload connection point and 1 fc of general illumination in the offload area. Fixtures must operate on 277 volts, single phase, 60 Hz. Luminaires must be rated for installation in wet locations and have narrow vertical and wide horizontal beam spread. Luminaires must be bronze in color and accept 50 mm 2-inch knuckle mounting. Provide a manual switch for control. See Section 26 56 00 EXTERIOR LIGHTING for applicable requirements.

]2.11.7 Flowmeter

Meter must be positive displacement type as indicated in paragraph METERS, designed for a continuous flow of [600][300] GPM.

[2.11.8 Grounding

****

NOTE: Delete this paragraph if the tank trucks to be loaded/unloaded have a plug-in connection for such a system. Indicate on the drawings the type of connection required for a Grounding Verification Unit. Delete the second paragraph if a grounding cable and clamp connection will be sufficient.

****

The skid must be equipped with a self winding grounding cable reel. The cable must be at least 15 m 50 feet long. The cable reel, the grounding cable and the connection clamp must be in accordance with CID A-A-50696.

][2.11.9 Grounding Verification Unit

****

NOTE: System can connect to a tank truck by using either a grounding clamp or plug. For a grounding plug to work, the tank trucks must have an appropriate receptacle. Coordinate with the Using Agency to determine if plugs are needed and if so what type.

The switch contact in the control module can be used to initiate various interlock functions (e.g., stop pumps, close valves, initiate alarms). Indicate the desire interlock control functions on the drawings.

****

System must include grounding [clamp][plug], grounding cable, and monitoring and control module. System must automatically and continually monitor and verify a low-resistance static dissipation path (less than [10 Ohms][_____]) between connecting tanker and the designated ground point.[Grounding clamp must conform to MIL-DTL-83413 and MIL-DTL-83413/7.][Grounding plug must [conform to MIL-DTL-83413 and MIL-DTL-83413/4] [______].] Grounding cable must be corrosion resistant steel strands sheathed in a Hytrel jacket. Cable must be the spiral, self-retracting type. Cable must be a minimum 9 m 30 feet in length. Monitoring and control module must be rated for an explosion-proof environment in accordance with NFPA 70 for Class I, Division I, Group D locations. Module must include status lights (red for no ground verification and green for positive ground verification) and a lockable bypass switch. Module must include a switch contact to allow interlock functions.

]2.11.10 Other Offload System Components

For other system components shown on the drawings as part of the offload system, refer to this Section and refer to this Section.

2.12 DEAERATOR TANK

****

NOTE: For off-loading over the road tank trucks using a direct off-loading system. See UFC 3-460-01 for when this is used.

Note: If the deaerator tank and downstream meter are followed by a filter separator in reasonably close proximity, the air block function can be added to the filter separator control valve by adding solenoid enable feature to that valve.

****

Deaerator tank must be constructed of carbon steel, designed, constructed and labeled in accordance with ASME Code, Section VIII, Division I, and must be interior epoxy coated in accordance with MIL-PRF-4556. No ferrous or zinc-coated material bronze, brass or other copper bearing alloys must be used in contact with the fuel. It must be rated for a working pressure of [1.90 Mpa] [1.97 Mpa] [275 psig] [285 psig]. Unit must be sized for a flow rate of [_____] lpm gpm and incorporate 100 mm 4-inch Class 150 flanges per ASME B16.5. Unit must incorporate an internal baffle/diffuser plate to inhibit the passage of air through its outlet flange. The unit is intended to prevent the passage of air through the downstream flow meter, and requires the use of a downstream air/block valve. Unit to be complete with the following accessories:

a. A 13 mm 1/2-inch stainless steel sight gauge for level indication.

b. A 50 mm 2-inch FNPT, two-stage, automatic air vent with outlet check.

c. A 50 mm 2-inch FNPT, stainless steel, 100 mesh, strainer for under Automatic Air Vent (AAV).

d. A 25 mm one-inch by 25.4 mm one-inch flanged relief valve, ASME Code, set at working pressure.

e. A 50 mm 2-inch MNPT, Explosion-proof, Class I, Div. I, Group D, side mount, float type level switch, SPDT, mounted a minimum of 635 mm 25-inches above the tank's outlet flange, to be wired to the air/block valve.

f. A 12.7 mm 1/2-inch flanged drain valve.

2.12.1 Deaerator Tank Air Block Valve (DTBV)

Refer to Section 33 52 43.14 AVIATION FUEL CONTROL VALVES.

2.12.1.1 Size

As indicated.

2.12.1.2 Flow

As indicated.

2.12.1.3 Operation

Deaerator block valve must be hydraulically operated. Upon a rise in air level in the deaerator tank as indicated by the level switch, the main valve must close tightly. The main valve must remain closed until a rise in tank fluid level above the level switch occurs.

2.12.1.4 Check Valve Feature

Valve must close rapidly when outlet pressure exceeds inlet pressure.

2.12.1.5 Flow Control

Valve to limit flow to [_____] lpm gpm. Sensing must be by orifice. Valve to modulate to limit flow without hunting. Rate of flow to be manually adjustable and utilize a downstream orifice plate holder.

2.12.1.6 Strainer

A 40-mesh stainless steel wire, self-cleaning strainer must be provided in the pilot valve supply piping.

2.12.1.7 Minimum Differential Pressure Feature

The valve must be equipped with a minimum differential pressure pilot to maintain a differential pressure across the valve. Pressure must be adjustable with a range of 34 to 172 kPa 5 to 25 psi.

2.12.1.8 Opening Feature

The valve must be equipped with an adjustable differential pressure pilot and a quick cover exhaust system to allow the valve to open in 3-4 seconds when pressure is greater than [_____][207] kPa [_____][30] psig.

2.12.1.9 Solenoid Control

The valve must be provided with solenoid control. The solenoid must close the DTBV upon low level alarm activation. The solenoid must be energized to close.

2.13 REFUELER TRUCK FILLSTAND (PANTOGRAPH TYPE)

For pantograph style fillstands, provide refueler and tactical refueler truck fillstand pantographs as specified in Section 33 52 43.12 AVIATION FUEL PANTOGRAPHS.

2.14 REFUELER TRUCK FILLSTAND (HOSE TYPE)

2.14.1 Truck Fillstand Hose

****

NOTE: For bottom loading applications of refuelers and tactical refuelers that uses hoses instead of pantographs, include this paragraph. Indicate the size and length of each hose on the drawings.

EI 1529, as referenced below, covers hoses that vary in diameter from 25 to 100 mm one to 4-inches. Per the API standard, hoses are to be cut to length by the hose manufacturer and not spliced in the field. In addition, couplings are to be installed on both ends of each hose by the hose manufacturer. Specifically indicate on the drawings the size of the couplers required.

For unsupported hose applications, suggest designing a hose tray and nozzle holder or some type of hose hanging rack.

a. Hose Tray and Nozzle Holder. Construct the tray and holder of either aluminum or stainless steel to be compatible with the piping. Design trays to support the entire length of the fueling hose, allow for draining of rainwater, support the fueling hose at the proper height, protect the hose from the sun's ultraviolet rays, and allow for easy insertion and removal of the hose. Suggest designing hose trays with a hinged cover when the trays are not located under a canopy or roof.

b. Hose Hanging Rack. These type racks are most commonly provided for Tank Truck Off-Loading Assemblies. Refer to DoD Standard Design AW 078-24-28 "Pressurized Hydrant Fueling System Type III" for details.

****

Provide hose that conforms to EI 1529, Grade 2, Type C, semi-hardwall. Provide each hose end with a coupler that conforms to paragraph [DRY-BREAK COUPLER][QUICK DISCONNECT COUPLER].

2.14.2 Truck Fillstand Swivel Joints

Flanged swivel joints must be stainless steel, single plane, capable of rotating 360 degrees. Welded swivel joints and welding of swivel joints to the pipe [and][or] elbow is not permitted. Swivel joints must be of the non-lubricated, maintenance free type with sealed bearings and no lubricating fitting. Swivel joint must be flanged at the end connecting to the piping system and threaded (female NPT) at the end connecting to the fuel hose. No leakage must be permitted under positive or negative pressure conditions. No leakage must be permitted under high or low temperature conditions. Welding of swivel joint to six-bolt flange connector is permitted. The swivel joints must be warranted for three years against leakage. There must be electrical continuity from one flange to the other without the use of ground straps. The electrical continuity from one flange to another (without the use of ground straps) must be less than 1000 ohms. Each swivel joint must have two ball bearing raceways, primary and secondary seals with leak detection port, and dust seal.

2.15 TANK TRUCK BOTTOM LOADING ARM

****

NOTE: This section covers loading arm assemblies used to load bulk fuel into over-the-road tank trucks and rail cars. These have also been used to load specialty lube oils into tank trucks for distribution to aircraft carriers and submarines.

These systems are not used to load refueler trucks.

These are bottom loading systems.

This specification covers two types of loading arms;

the hose loader type and the A-frame type. Delete either type if not applicable.

a. Hose loader type arms are designed to reach a fueling connection at a certain fixed distance. The drop hose in the assembly provides a little flexibility in the connection distance, but not significantly. These type arms do not collapse, but instead swivel on a riser swivel.

b. The A-frame type arms are expandable and collapsible and therefore can accommodate a fueling connection from varying distances and heights.

Where multiple loading arm assemblies are installed adjacent to one another, consider requiring each assembly to have crossover capabilities in order to provide the user with the most operational flexibility possible.

As a minimum, show on the drawings the following construction requirements for each loading arm specified.

a. Size of all loading arm piping. Pipe sizes are typically 50, 75, or 100 mm 2, 3, or 4-inches.

b. The maximum distance the assembly is required to fully expand during operation. Also show the collapsible envelope in which the loading arm is expected to be contained.

c. The minimum elevation above grade that the assembly's dispensing end is required to couple with a tank truck or tank car. This elevation is typically 300 mm 12-inches.

d. The maximum elevation above grade that the assembly's dispensing end is required to couple with a tank truck or tank car. This elevation is typically 1400 mm 55-inches.
****

Loading arm must be the factory fabricated, factory assembled, bottom loading type. Loading arm must include swivel joints, boom assemblies, and riser standpipe. Loading arm's pipe and fittings must be Schedule 10S, Grade TP304L, stainless steel in accordance with ASTM A312/A312M.[Provide adjacent loading arm assemblies with the ability to crossover one another during operation.]

2.15.1 Dispensing End

The weight of the loading arm's dispensing end (includes piping, valves, nozzles, miscellaneous components, and fuel weight) must be counteracted by a counterbalance system. The counterbalance system must be the [hydraulically actuated cylinder][or][spring counterweight] type. The counterbalance system must allow one operator to manually maneuver and control the dispensing end at all times. The counterbalance system must ensure that minimum force is transferred from the dispensing end to a fueling connection. Nozzle in the dispensing end must be in accordance with paragraph PRESSURE FUELING NOZZLE.

2.15.1.1 Hose Loader Type

Dispensing end must be the fixed reach, hose loader type. Hose used in the loading arm assembly must be in accordance with the paragraph in this Section TRUCK FILLSTAND HOSE.

2.15.1.2 A-Frame Type

Dispensing end must be the rigidly piped, variable reach, A-frame type.

2.15.2 Truck Loading Arm Swivel Joints

Swivel joints must be the flanged, non-lubricated type with sealed bearings. Swivel joints must come from the manufacturer with required flanged bodies and flanged elbows. Welded swivel joints and welding of swivel joints to the pipe [and][or] elbow will not be permitted. Welding of swivel joints to flange joints will not be permitted. Swivel joints must be warranted for two years against leakage due to both positive and negative pressure conditions. Swivel joints must be capable of 360-degree rotation.

****

NOTE: For bottom loading applications of refuelers and tactical refuelers that use pantographs instead of hoses, include this paragraph. Indicate the size and length of each pipe section on the drawings.

****

2.16 TOP LOADING ARM

****

NOTE: Top loading is not allowed by UFC 3-460-01 and is actively discouraged for safety reasons. It should only be used when the trucks being filled are incapable of bottom loading. Use of a top loading arm must be approved by the Service Headquarters or officially designated alternate.

****

Top loading arm [50 mm- 379] [75 mm- 757] [100 mm- 1135]lpm [2-inch-100] [3-inch-200] [4-inch-300]gpm must have sufficient horizontal reach and pivot points to assure the vehicle does not have to be re-spotted. Drop pipe length must be able to reach fill tank bottom and be at a safe elevation for refueler operation. Loading arm must have four planes of movement: up-down (to allow drop pipe to enter tank), side to side (to allow arm to rotate out to tank and back out of position), drop-tube (to assure drop-tube remains vertical), scissor arm pivot (which allows 360 degree rotation of secondary arm allowing the drop-tube to reach further out thus allows a larger spotting distance). Materials of construction must be stainless steel. Arm must be counterweight or spring assisted for effortless operation of loading arm. Swivel joints must be of the non-lubricated, maintenance free type with sealed bearings and no lubricating fittings. Assembly must be a regular product for the purpose of top loading fuel from a manufacturer who has successfully provided the product for at least the past five years.

2.17 NOZZLES AND ADAPTERS

2.17.1 Pressure Fueling Nozzle

****

NOTE: Specify type of nozzle as directed by the Service Headquarters or officially designated alternate.

****

Nozzles must conform to SAE AS5877, Type [D-1] [D-2] [D-3]. Nozzles and nozzle components must be compatible with the fuel to be handled. Nozzles must be provided with an internal 60 mesh stainless steel strainer and a fuel sample connection tapping. Nozzle design must be for single point fueling of aircraft. Nozzles must be provided with a compatible dry break quick disconnect swivel. Coupler must allow for quick disconnect and reconnect of fueling nozzles with corresponding adapters. Coupler and adapter must provide a positive, leak proof connection under constant or surge flow. Coupler must be designed to prevent blowout of internal poppet.

2.17.2 Nozzle Adapter (SPR)

Adapter must be a nominal 63.5 mm 2-1/2-inches with self-closing valve in accordance with MIL-A-25896. Adapter must have a 100 mm 4-inch flange mounting and vacuum tight, locking dust cap using the SPR lugs.

2.17.3 Tight-Fit Fill Adapter

****

NOTE: Tight-fit fill adapters are commonly used on the inlet fill piping for horizontal fuel tanks and on the piping connections for tank truck load/unloading facilities.

Show the nominal size of each required adapter on the drawings. Adapters are typical available in either 75 or 100 mm 3 or 4-inches. Coordinate the size of each adapter with the size of the connecting coupler.

Select the type of adapter seal (top or side) based upon the type of the connecting coupler.

****

Adapter must be the [top seal] [side seal] type. Adapter must provide a tight-fit connection to prevent vapor emissions during fuel transfer. Adapter must be bronze and be fitted with a Buna-N or Viton gasket. Provide a locking cap with each adapter. Cap must mate with the adapter and have a latching mechanism that provides a watertight seal. Cap must provide some type of locking provision and be easily attachable and removable. Cap must be attached to the tight-fit vapor recovery adapter by a minimum 300 mm 12-inch section of brass cable or fuel resistant rope.

2.17.4 Tight-Fit Vapor Recovery Adapter

****

NOTE: Tight-fit vapor recovery adapters are commonly used on the inlet fill piping for

horizontal fuel tanks and on the piping connections for tank truck load/unloading facilities. Delete this paragraph if a vapor recovery system is included in the design.

Show the nominal size of each required adapter on the drawings. Adapter are typical available in either 75 or 100 mm 3 or 4-inches. Coordinate the size of each adapter with the size of the connecting coupler.

Select the type of adapter seal (top or side) based upon the type of the connecting coupler.

****

Adapter must be the [top seal] [side seal] type that includes an internal self-closing valve or poppet. Adapter must provide a tight-fit connection to prevent vapor emissions during fuel transfer. Adapter must be bronze and be fitted with a Buna-N or Viton gasket. The adapter's internal valve or poppet must be driptight throughout the entire specified temperature range. The adapter's internal valve or poppet must prevent vapor emissions when the locking cap is removed yet must open immediately when the adapter is connected to an appropriate coupler. The adapter's internal valve or poppet must operate at a lower pressure/vacuum than the system's pressure/vacuum relief vent in order for vapors to flow as designed instead of exiting to the atmosphere through the vent piping. Provide a locking cap with each adapter. Cap must mate with the adapter and have a latching mechanism that provides a watertight seal. Cap must provide some type of locking provision and be easily attachable and removable. Cap must be attached to the tight-fit vapor recovery adapter by a minimum 300 mm 12-inch section of brass cable or fuel resistant rope.

2.17.5 Dry Break Coupler

****

NOTE: Dry break couplers must be for over the road tank truck loading and offloading only.

****

API RP 1004 coupler must be compatible with the connecting adaptor. Coupler must provide a positive, leakproof connection when under constant or surge fuel flow. Coupler must prevent vapor emissions during fuel flow. Seals within the coupler must be Buna-N or Viton. Coupler must have an internal, manually operated shutoff valve. The valve must have an external operating handle with the valve's position (open or closed) clearly labeled. The internal valve must not be capable of being manually opened unless the coupler is properly connected to its connecting adapter. After connecting coupler and adapter, opening of the coupler valve must in turn open the poppet of the adjoining adapter to allow fuel flow.

2.17.6 Quick Disconnect Coupler

Coupler must be the quick disconnect, cam type that conforms to CID A-A-59326.[Provide coupler with a stainless steel dust plug and a stainless steel hanging eye for truck offloading systems.]

2.18 FILTER/SEPARATOR

Provide filter/separator as specified in Section 33 52 43.28 FILTER SEPARATOR, AVIATION FUELING SYSTEM.

2.19 HIGH POINT VENT AND LOW POINT DRAIN PITS

****

NOTE: Pits must be used at each high point vent as well as each low point drain. Use this aircraft rated pit at every location on the "Airside" of an airfield, even where it is unlikely an aircraft may stray, such as behind blast fences and small buildings. Indicate pit details along with internal piping details.

****

2.19.1 Pit Assembly

Each pit must incorporate the following items built into a self-contained assembly.

2.19.2 Pit

The basic pit must consist of 6.25 mm 0.25-inch wall fiberglass liner with a main body approximately 575 mm 23-inches in diameter and a minimum of 925 mm 37-inches deep. The pit must contain two integral concrete anchors. The fiberglass top flange must require no exposed corrosive material, weldments, or strongbacks within the pit to support the cast aluminum ring and cover assembly. The pits must be the standard products of a firm regularly engaged in the manufacture of such product and must essentially duplicate items that have been in satisfactory use for at least three years prior to bid opening. Proof of experience will be submitted.

2.19.3 Pit Cover, General Requirements

The pit cover must include a removable outer ring frame and an interior 457 mm 18-inch diameter (clear opening) hinged lid that opens 160 degrees.[The pit must have a tamperproof cover. The removable outer ring must have anchors to provide for means to secure the manhole and its moveable cover and lid to the "concrete" fiberglass containment. The inner hinged lid must have a means of being locked.] Each cover lid must move smoothly through its entire range of motion and must require a maximum opening force of 150 N 35 pound-force to be applied at a single lifting handle. Each handle must provide a comfortable, secure grip for an average adult male's full gloved hand. Tools must not be required to engage the lifting handle. Projections of the lid's hinges or handles above the plane of the lid, whether temporary or permanent, must not be allowed. The pit service must be integrally cast in raised letters on the top surface of each lid. The lettering must be a minimum of 25 mm one-inch high and 1.6 mm 0.0625-inch deep. The weight bearing flanges of the fiberglass pit liner and the aluminum cover frame (and lid) must be machined to assure uniform weight distribution.

2.19.4 Pit Cover Materials, Design, and Testing

****

NOTE: Select per direction from Service Headquarters or officially designated alternate.

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The cover frames and lids must be designed and manufactured by a qualified company having a minimum of five years successful experience in the production of similar airport apron slab fixtures. All cover lids and frames must be designed using an appropriate cast aluminum alloy or rolled aluminum plate to support an aircraft wheel load simulated by a roving 700,000 kg 200,000-pound test-load applied perpendicular to a 129,000 square mm 200-square-inch contact area(254 by 508 mm 10 by 20 inches) of the cover's top surface. The aluminum alloy material selected for design must be ductile, corrosion-resistant, impact-resistant, and suitable for the intended use. All covers must be non-skid surface construction and free of injurious defects. Welding for the purpose of structural repair of casting defects must not be allowed. Minor cosmetic welding is acceptable. The cover must be capable of supporting the test-load without failure regardless of the location or orientation of the load. Localized yielding or cracking or excessive deformations must be considered as failure. Actual load-tests must be performed on a minimum of 10 percent of all the covers supplied. Load-tested units must be randomly selected. Load-test conditions must model field-installed conditions as nearly as practicable. The 800 kN 200 Kip test-load must be applied to the cover for a minimum duration of 5-minutes. Absolute maximum deflection of the cover lid under the test-load must not exceed 1/180th of the interior diameter of the fiberglass pit body. Maximum deflection of the cover lids, remaining after removal of the test load must be plus 0.25 mm 0.010-inches to assure that no permanent set has taken place. Upon removal of the test-load, the cover lid and frame must be carefully examined for cracks or localized areas of permanent deformation. All results must be submitted for review and approval. A single failure to meet any of the stated criteria must be considered sufficient grounds for the testing of 50 percent of the units.

2.19.5 Pipe Riser Seal

The riser pipe penetration through the pit floor must be sealed by means of a Buna-N boot. The boot must be secured to a metal collar welded to the pipe riser and to a flange at the floor opening by stainless steel clamps. Collar must be fabricated from the same material as the pipe.

2.20 FRP CONTAINMENT SUMP

****

NOTE: FRP sumps may be used as an alternative to the vent and drain pits defined above, except that these sumps are non-load bearing and will not be used under an aviation apron.

Sumps may also be used as a leak collection point in belowground secondarily contained piping systems. In this application, sumps will be used in combination with leak sensors to make up the belowground pipe monitoring system.

Sumps may also be used at low drain points, high vent points, and at aboveground to belowground transitions. In addition, sumps may also be used to house belowground valves or system components.

Indicate on the drawings the size, location, and depth required for each FRP containment sump.

****

Sump must be constructed of fiberglass reinforced plastic (FRP) that is chemically compatible with the fuels to be handled. Do not connect sump in any way to the manway cover or concrete above. Cap the top of each containment sump with a [friction fit] [watertight] access cover. Construct cover of the same material as the sump. Cover must have a minimum diameter of 550 mm 22-inches. Cover must be easily removable through the manway above.

a. Rainfall drainage must not drain into a sump. Sump must be capable of withstanding underground burial loads to be encountered. Container must have a minimum 19 L 5 gal fuel storage capacity. Container must not contain any type of drain.

b. The sides of a containment sump must allow the penetration of carrier pipes, exterior containment pipes, conduits, and vapor pipes as required. Boot or seal penetrations in the containment sump sides to ensure that liquid will not escape from the sump in the event that the liquid level within the sump rises above the pipe penetration. Provide boots and seals that are chemically compatible with the fuel to be handled and that are water resistant to the influx of ground water. Boots and seals must be designed and installed to accommodate the anticipated amount of thermal expansion and contraction in the piping system.

2.21 LIQUID LEVEL GAUGE

****

NOTE: Included the bracketed sentence if required by the using agency. Use with caution as if the glass breaks the tank will drain down to the break point.

****

Gauge must be the factory fabricated, sight glass assembly type designed to allow visual observation of liquid levels within a vessel. Assembly must include a 15 mm 1/2-inch [glass] [fully shielded glass] tube, a ball check in both the upper and lower fittings, a shutoff valve in both the upper and lower fittings, guard rods, and a blowoff cock in the lower fitting. Gauge's body must be constructed of stainless steel.[The gauge must contain a colored density sensitive ball.]

2.22 OPERATING TANK LEVEL INDICATOR

The level indicating system must perform tank gauging and have local tank readout. The level indicating system must use a servo to measure all the various locations required for the primary measurement. The level indicating system must be able to measure and compute fuel level, fuel density, fuel actual volume, fuel and water corrected volume, and fuel ambient temperature. The reference point for all level measurements must be from the tank's datum plate. The servo system must attach to the tank's [203] [254] [303] mm [8] [10] [12] inch riser/[254 mm 10-inch] stilling well to minimize the effects of turbulence on the measurements and still allow the government access to take quality control samples. The level indicating system must be able to measure in underground, aboveground and cut and cover tanks with all floor and roof types. The level indicating system must be able to measure multiple tanks with a single field interface unit. The level indicating system must be able to determine whether the tank is issuing or receiving fuel while in the transfer mode. The level indicating system must require no periodic calibration after installation is complete. The level indicating system must be approved for installation in a hazardous area and certified intrinsically safe by an approved agency and provide lightning protection. The level indicating system must be able to interface with government owned information systems. The level indicating system must provide five sets of alarm outputs; high intermediate high, low, intermediate low and static tank movement alarm.

****

NOTE: Select per direction from Service Headquarters or officially designate alternate.

****

Level accuracy plus/minus 1.25 mm 0.05-inches

Corrected volume accuracy plus/minus 0.1 percent

Density accuracy plus/minus 1 percent

Temperature accuracy plus/minus minus 18 degrees C 1 degrees F

Detect water in the tank sump to a level equal to or slightly above the water draw-off pipe

****

NOTE: This paragraph specifies provision of proprietary products. A J&A must be obtained for these products if the paragraph is included in the project specification.

****

[It will be an ENRAF Servo Gauge Model 854 Automatic Tank Gauging System or approved equal. Equality being determined by compatibility with the Base FAS System. The system must include an ENDRESS+HAUSER RTU 8130 and a local display similar or equal to a CP/2500. The RTU must transmit data to the Base FAS System located in the RCC via telephone lines as shown on the drawings. Base personnel must coordinate reprogramming of the FAS System to accept this new data.

]

2.23 OPERATING TANK LEVEL SWITCHES

****

NOTE: Select per direction from Service Headquarters or officially designate alternate.

****

The switches must be an external mount liquid level switch with a stainless steel float chamber and stainless steel, type 304 or 316, float and trim. Switch contacts must be two single pole double throw switches factory mutual approved or U.L. listed for use in Class I, Division 1, Group D hazardous location with a maximum temperature rating of T2D (216 degrees C 419 degrees F). Units must have provisions to check level switch operations without increasing the fuel level in the tanks as shown on the contract drawings.

2.24 OPERATING TANK LEVEL SWITCHES

****
NOTE: Select per direction from Service Headquarters or officially designate alternate.
****

a. System must be designed and installed in such a way that the system must be continuously and automatically self-checking. Switches must be an external mount with a stainless steel fluid chamber. Electronic level sensors must be thermistors or optic type, and be intrinsically safe Class I, Division 1, Group D for hazardous environments, with recognized FM, CSA or UL approval. The sensor holder/junction box must be accessible from the stairway. Units must have provisions to check level switch operations without increasing the fuel level in the tanks as shown on the contract drawings.

b. Level alarms must be mechanically and electrically independent and be totally isolated from the gauging system. The level switches must receive power and send their signal to the Pump Control Panel. Circuitry and cables from the PCP to the electronic level sensors in the tank must be intrinsically safe.

[2.25 OPERATING TANK LEVEL SWITCHES

****
NOTE: Select when using a cut and cover Tank.
****

a. System must be designed and installed in such a way that the system must be continuously and automatically self-checking. Switches must be mounted on top of the tank, in the pump house, as indicated. Electronic level sensors must be thermistors or optic type, and be intrinsically safe Class I, Division 1, Group D for hazardous environments, with recognized FM, CSA or UL approval. The sensor holder/junction box must be accessible.

b. Level alarms must be mechanically and electrically independent and be totally isolated from the gauging system. The level switches must receive power and send their signal to the Pump Control Panel. Circuitry and cables from the PCP to the electronic level sensors in the tank must be intrinsically safe.

]2.26 WATER DRAW-OFF SYSTEM

****
NOTE: Use a FUEL SYSTEM WASTE WATER TANK when designing a CUT AND COVER SYSTEM if directed by Service Headquarters or officially designate alternate.
****

A water draw-off system must be provided for each Operating Tank. Water draw-off system must gravity drain. Each system must include tank, product return pump and all necessary pipe, pressure relief system, valves, and fittings.

2.26.1 Tank

Water draw-off tank must be a 210 L 55-gal fabricated stainless steel tank with supporting legs as shown. Tank and support legs must be fabricated from Type 304 stainless steel.

2.26.2 Sight Glass

Sight glasses for tank must be standard tubular gages with density ball and shut-off valves on each end. Wetted parts other than sight glass must be stainless steel. If glass breakage should occur, a stainless steel ball in the valve must close preventing product loss. Glass must be protected by minimum of four guard rods.

2.26.3 Return Pump

****

NOTE: Insert site specific Pump requirements.

****

Product return pump (PRP-1 and PRP-2) must have the capacity of not less than 0.30 L/s 5 gpm against a total head of [_____] mm feet when driven at 3600 rpm. The pump must have flange connections and must be constructed of stainless steel or aluminum so as to have no zinc, brass or other copper bearing alloys in contact with the fuel. The unit must be explosion-proof, Class I, Division 1, Group D with maximum temperature rating of "T2D" (216 degrees C 419 degrees F). The motor must not be overloading at any point on the pump curve. Contractor has the option of selecting either centrifugal or positive displacement type pump with the restriction of the positive displacement type pump must include a pressure relief between the discharge and suction protecting the pump from overloading.

2.26.4 Anchoring

All units of the water draw-off system must be installed plumb and level and secured in place by anchor bolts.

2.27 GROUNDING CABLE AND CLAMP

****

NOTE: Type I systems have 23 m 75 foot cable lengths. Type II systems have 15 m 50 foot cable lengths.

****

Grounding system must conform to CID A-A-50696, Type [I] [II].

[2.28 OPERATING TANK VENT

****

NOTE: Select when using a cut and cover Tank.

****

Tank vent outlet must be equipped with pressure-vacuum breather vent, aluminum construction with weather hood and with fluoroelastomer (FKM, Viton) pallet seat inserts, high density screens, stainless steel internals, with pressure relief setting at 215 Pa 0.5 oz psi, and vacuum relief set at 215 Pa 0.5 oz psi. Pressure venting capacity must be 75 L/s 9700 cubic feet/hour, vacuum capacity must be 115 L/s 14500 cubic feet/hour.

]2.29 GROUND VEHICLE FUELING SYSTEM COMPONENTS

2.29.1 Product Dispensing Unit

****

NOTE: Per UL 87, there are two types of dispensing units (remote control type or a self-contained type). Self-contained units include a power operated pump as part of the assembly (remote control type units do not). Self-contained units are commonly referred to as suction dispensers.

Dispensing units to be used with E85 fuel must be specifically designed and warranted as E85 compatible. Reference UL 87A if the use of E85 fuel is possible, otherwise reference UL 87. Materials that will be in direct contact with the E85 fuel must be either stainless steel or nickel plated aluminum.

****

Unit and unit hardware must be the factory fabricated type that conforms to [UL 87][UL 87A], except as modified herein.[Unit housing and housing top must be constructed of stainless steel or aluminum in accordance with [UL 87][UL 87A].][Materials for unit components that will be in direct contact with the fuel must be stainless steel or nickel plated aluminum.] Unit must be computer controlled, lighted, [single] [double] sided, with [one] [two] [three] [four] [_____] hose outlets [each] suitable for single product delivery flow rate of 0.76 liter per second 12 gallons per minute from each nozzle. Unit must be the [remote control] [self-contained] type. Unit housing must include a locking mechanism for each nozzle to allow securing each nozzle to the housing during non-operational periods.

2.29.1.1 Self-Contained Pump

****

NOTE: Delete this paragraph if remote control type units are to be specified. Remote control type units will be used in conjunction with pumps as defined in either Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT) or Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION) as applicable. Self-contained pumps will only be used in conjunction with belowground storage tanks.

****

Provide internal gear-type rotary suction pumps with adjustable bypass valves and suction strainers.

2.29.1.2 Accounting Meter and Display

Provide unit with positive displacement type meter and the manufacturer's standard microprocessor that has the following functions:

a. Displays: Solid state liquid crystal displays (LCD'S)[, five-digit cash display to $999.99], with automatic shutdown, and four-digit volume display to 999.9 liters 999.9 gallons.

b. Totalizer: Eight-digit (999,999.99) electronic totalization with identification for each product volume in liters gallons.

[c. Price setting: Price-jog keyswitch on each computer housing to enable remote price setting from management control system.

]2.29.1.3 Filters

Provide a replaceable filter element on each product line with a nominal filtration efficiency of 0.005 mm 5 micron or smaller porosity filters for gasoline and ethanol products, and 0.025 mm 25 micron or smaller porosity filters for diesel and biodiesel product with a flow rating equal to the rate of the dispensing unit.

2.29.1.4 Battery Backup

Provide battery backup with automatic charging circuits to hold data for a minimum of three months without recharging. Sales display must remain visible for 15 minutes after power failure.

2.29.1.5 Interlocks

Provide nozzle supports interlocked to pump motor control switch to start and stop the pump by nozzle removal and replacement. Provide each unit with interlock switch and valve arrangement that prevents flow of product until meter is reset after dispensing nozzle is returned to holder.

2.29.1.6 Hose

Provide dispensing hose [conforming to UL 330] [of the coaxial vapor recovery type certified by the California Air Resources Board (CARB)], gasoline and oil resistant, statically grounded, flexible in sub-zero temperatures.[Hose must be compatible with E85 fuel.] Provide a minimum of [3] [3.7] meters [10] [12] feet of hose for each product line on the dispenser. Provide each hose with spring loaded cable to return device attached near mid-length of hose.

2.29.1.7 Nozzles

Provide manually activated, automatic shutoff type nozzles [with][without] a latch-open device. Nozzles must have full hand insulator to prevent splash-back.[Nozzles must be CARB certified for Stage II vapor recovery, contain an integral vapor valve[and evacuator], and be of the [bellows] [bellowless] design.][Vapor recovery nozzles are not required for diesel dispensing systems.]

2.29.1.8 Breakaway Device

Provide each product hose with UL listed[and CARB certified] emergency breakaway device designed to retain liquid on both sides of breakaway point. Breakaway device must have pressure balancing chamber to override line pressure to prevent nuisance breaks caused by a restriction in delivery hose diameter.

2.29.1.9 Emergency Shutoff Valve

Provide valve that conforms to UL 842. Valve must provide complete shutoff of a fuel line in the event a dispenser is dislocated or overturned due to a sudden impact. Valve must include a secondary poppet to limit spillage from the dispenser after a knockdown or during installation.

2.29.1.10 Dispenser Sump

Provide a sump under each dispensing unit. Each sump must provide convenient service access to piping components enclosed in the sump. Sump must be constructed of fiberglass-reinforced plastic. Sump must be chemically compatible with the fuel to be handled by the dispensing unit and any connecting piping. Sump must prevent fuel from escaping to the soil and ground water from entering the sump. Sump must provide a liquidtight termination point for secondary containment piping that allows for the anticipated expansion and contraction of the piping system. Sump must withstand maximum burial loads. Sump must mount directly to the bottom of the dispensing unit with a centering ring or stabilizer bar to assure proper shearing action for the emergency shutoff valve.

2.29.1.11 Accessories

Equip each assembly with accessories such as built-in air eliminators, line check valves, and lockable housing.

2.29.2 Management Control System

Provide management control system that furnishes computerized control of station fuel dispensing system including operational, control, and management functions from a central control console with displays and separately mounted electronics and data cabinets. Provide functions to provide receipt and report printout types.

2.29.2.1 Operating Functions

System must operate up to [_____] fueling positions with up to [_____] different products. System must operate prepay on preset volume or dollar operation. System must display grade, dispenser number, volume, and sales amount in one sequence. Provide audible signals and flashing indicators to alert operator to customer needs and dispenser status. Provide functions to calculate change if tank is too full to accept prepaid amount.

2.29.2.2 Control and Management Functions

System must accumulate, store, and deliver full range of management information including pricing by grades and types of service. System must provide totals for up to four shifts by product volume, cash and credit sales, and declining balance inventory.

2.29.2.3 Control Console

System must provide the following:

a. Indicators: Call, ready, in-use, used, stopped, unpaid

b. Manager's keyswitch: Key protection for setting operating modes

c. Keyboard: Standard international 11-pad numerical

d. Clock: Real-time operating, showing year, month, day, hour, minute, second

e. Function keys: Pump stop, pump start, mode, unit price, refund, recall, cash/credit, volume, print/enter, clear, credit paid, cash paid, authorize

2.29.2.4 Display

System must provide the following with light emitting diodes (LED'S):

a. Operating: Grade, pump number, volume, cash

b. Mode or memory: Mode number, sub-mode, memory data

c. Display indicators: Water, low inventory, new data, mode, prepay/preset, volume, cash, credit, return, price

2.29.2.5 Power

System must operate at 115 volts, 60 hertz.

2.29.3 Receipt and Totals Printer

****

NOTE: Include a receipt and totals printer only if required by the Using Agency.

****

Provide printer with the following characteristics:

a. Minimum print speed: 1.25 lines per second

b. Line length: 40 column, 12 characters per 25 mm inch

c. Paper: Roll, one- or two-ply, 86 mm 3-3/8 inches wide

d. Spacing: 6 lines per vertical 25 mm inch

e. Character types: Upper and lower case, 96-character alpha-numeric, normal and double-width

f. Printing mechanism life: 10 million cycles

g. Power: 115 volts, 60 Hz

2.29.3.1 Customer Receipt

Configure printer and system functions to print the following customer receipts.

a. Time, date, and day of week

b. Name and grade of fuel product

c. Pump number and unit price

d. Total sale by payment method (cash or credit)

e. Total sales volume in gallons or liters

f. Prepaid deposit

g. Discount amount where applicable

h. Transaction number

i. Three line customizable heading

j. Customer receipt available only after dispensing

2.29.3.2 Shift Change Totals

Configure printer and system functions to print the dollar and volume totals and totalizer readings for current, first, second, and third shift totals.

2.29.3.3 Unit Price Summary

Configure printer and system functions to print the dollar and volume totals and totalizer readings for current, first, second, and third shift totals.

2.29.3.4 Station Programming Data

Configure printer and system functions to print the list parameters that determine which station dispensing system will operate.

a. Prepay or post pay

b. Cash or credit pricing

c. Sales and volume ration limits

2.29.3.5 Diagnostic Messages

Include printer test, last mode entries, system power ON/OFF records, and other information for diagnosing problems by station personnel.

2.30 VALVE AND SYSTEM COMPONENTS EXTERIOR PROTECTIVE COATINGS

2.30.1 Factory Coating

Valves, system components, and components must be blasted clean according to SSPC SP 5/NACE No. 1, and must be primed and coated in accordance with Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES.

2.30.2 Field Coating

Painting required for surfaces not otherwise specified must be field painted as specified in Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES. Do not paint aboveground stainless steel and aluminum surfaces. Do not coat system components or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Installation

Install equipment and components in position, true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for system components installation. Provide required clearances between equipment components, system components, apparatus, and accessories requiring normal servicing or maintenance to be accessible.

3.1.2 Anchoring

Anchor system components in place. Check alignment of anchor bolts before installing system components and clean-out associated sleeves. Do not cut bolts because of misalignment. Notify Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate self-drilling type anchors for construction condition.

3.1.3 Grouting

System components which are anchored to a pad is to be grouted in place. Before setting system components in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, and coatings which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide necessary formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting must be in accordance with ASTM C827/C827M. Perform all grouting in accordance with system components manufacturer's and grout manufacturer's published specifications and recommendations.

3.1.4 Leveling and Aligning

Level and align system components in accordance with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align system components. Install only flat shims for leveling system components. Place shims to fully support system components. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than system components bearing surface. Shims to provide for full system components support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.1.5 Direct Drives

Alignment procedure follows:

3.1.5.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.1.5.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.1.5.3 Shaft Leveling and Radial Alignment

Pump alignment must be accomplished by the factory technician or a millwright trained in pump alignment, and with the use of dial gauges or laser alignment equipment.

3.1.5.4 Angular Alignment and End Clearance

Check angular alignment and end clearance by inserting a feeler gage at 4 points, 90 degrees apart around outer edges of coupling halves.

3.1.5.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.025 mm 0.001-inch tolerance, except as other-wise required by more stringent requirements of system components manufacturer.

3.1.6 Precautions

Special care must be taken to ensure that system components and materials are stored properly to prevent damage and maintain cleanliness, and that the completed system is free of rocks, sand, dirt, and foreign objects. Take the following steps to insure these conditions.

a. System components brought to the site and not stored inside, must be stored on blocks or horses at least 450 mm 18-inches above ground.

b. Visual inspection must be made of each piece of system components to ensure that it is clean prior to installation.

c. The open ends of system components must be closed when work with that piece of system components is not in progress.

3.2 INSTALLATION OF UNDERGROUND TANKS

Installation must be per tank manufacturer's recommendations, API RP 1615, NFPA 30, 40 CFR 280, state and local codes and as specified herein. If recommendations require tank to be filled, only fuel will be allowed in tanks. Water filling is not acceptable. Before being placed in service, tank must be tightness tested in accordance with NFPA 30.

3.2.1 Coating Testing

The coating must be examined for flaws and tested for thickness. Provide the facilities, personnel, and equipment for testing for flaws and thickness. Thickness must be measured electronically. Coating must be tested directly before placement of the tank with an electric flaw detector, equipped with a bell, buzzer, or other type of audible signal that operates when a flaw is detected. The detector for the type of coating used must have an operating voltage of 10,000 to 35,000 volts. Check of the holiday detector potential may be made by the Contracting Officer at any time to determine the suitability of the detector. Damaged areas must be repaired with materials identical to those used originally, and after drying, must be retested electrically. Submit test results.

3.2.2 Steel Tanks

a. Cover the concrete hold down slab with 150 mm 6-inches of tank bedding backfill evenly graded and thoroughly compacted, prior to tank placement.

b. Each tank is to be unloaded and placed on the sand bed using cranes and the rigging procedures provided by the tank manufacturer. Use the tank lifting lugs for lifting the tank into place. The use of slings around the tank is not permitted, nor is the use of chock blocks of any sort. During handling, carefully inspect the tanks for coating damage and repair any damage whatsoever before proceeding. After placement, check each tank to ensure it is sloped as required. The elevation must be confirmed.

c. Before proceeding with backfill, install the hold down straps and tighten the turnbuckles securely and evenly throughout the length of the tanks. The bottom and sides of the tanks to be fully and evenly supported by hand shoveling and tamping. Use tank bedding backfill up to 303 mm 12-inches above the top of tank. Hand-guided power equipment can be used to place fill in 150 mm 6-inch layers, compacted to a minimum of 95 percent maximum density, after the bottom quadrant is filled. A minimum of four density tests per tank to be performed. Clean, noncorrosive, well tamped gravel to be used for backfill from a point 303 mm 12-inches above the tanks to finished grade.

d. Do not fill the tank, even partially, before the bottom quadrant is backfilled. The level of fuel product not to exceed the level of compacted backfill at any time.

e. Coordinate tank installation with the installation of cathodic protection.

3.3 INSTALLATION OF FIBERGLASS PITS

Submit recommended installation procedures and setting tolerances from the pit manufacturer/supplier for the fiberglass pit and the aluminum cover. These procedures must indicate recommended methods of supporting the pit in its proper position in the open excavation prior to and during concrete placement operations. Also, required installation tolerances, especially for flatness/levelness of the fiberglass pit lip, must be provided. Follow these recommendations and apply other procedures as required to ensure the integrity of the pit liner and cover assemblies in their installed positions. All penetrations through the fiberglass pit liner must be tightly sealed by suitable means to preclude water infiltration, with consideration for potential relative movements between the penetrating objects and the pit liner. Reference the Contract drawings for additional installation requirements.

3.4 VEHICLE DISPENSING UNIT

Following installation, fill island riser holes with clean sand. Install emergency shut-off valves with breaking point level with island surface. Isolate dispensing units from piping during flushing and cleaning operations.

3.5 POSTED OPERATING INSTRUCTIONS

For each designated system or system components item, provide instructions for guidance of operating and maintenance personnel. Following approval of content, prepare these instructions in a form and scale that will be readily legible when displayed in appropriate locations, to be designated by the Contracting Officer and meet the following requirements:

3.5.1 Each System

For each system, include diagrams of system components, piping, wiring and control. Define control sequences.

3.5.2 Each Tank

For each tank provide a P.E. stamped certified tank calibration chart in 1/16-inch increments reading in gallons, except for tanks less than 5,000 gallons.

3.5.3 Each Item

For each system components item, include starting, adjustment, operation, lubrication, safety precautions and shut-down procedures. Identify procedures to be performed in event of system components failure. Provide other instructions recommended by the manufacturer.

3.5.4 Diagrams

Provide a professionally prepared isometric piping diagram of the fueling system apparatus. Diagram must be 914 by 1370 mm 36 by 54 inches and must be color coded to match PCP color diagrams. Diagram must show the entire facility and must include all system components and the operational sequences of all system components with equipment numbers displayed. Diagram must show all valves along with the valve numbers shown on the drawings and listed as normally open/closed. It must be wall mounted under glass.

3.5.5 Volume of Fuel

Provide a certified system inventory of fuel in the pipe, tank, pumphouse, etc. The piping will show length of pipe, size of pipe, L/s gal/foot, and total L gal. Verify during initial fill.

3.6 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components/systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of [_____] hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the on-site training.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 60 02 (August 2024)**

Preparing Activity: USACE **Superseding**
UFGS-33 60 02 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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ABOVEGROUND HEAT DISTRIBUTION SYSTEM

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USACE / NAVFAC / AFCEC **UFGS-33 60 02 (August 2024)**

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****

SECTION 33 60 02

ABOVEGROUND HEAT DISTRIBUTION SYSTEM
08/24

****
NOTE: This guide specification covers the requirements for insulated aboveground heat distribution systems as covered in UFC 3-430-09 "Mechanical Utility Distribution" (hot water systems to 216 degrees C 420 degrees F and steam systems to 1.72 MPa 250 psig).

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: Aboveground heat distribution system should be considered for use in lieu of underground heat distribution systems due generally to longer life and lower maintenance and should be utilized wherever operations and local conditions permit.

Due to the similarity of a high temperature hot water system and a steam system, no attempt was made to enclose in brackets all information which may differentiate one system from the other. In the event that only one type of distribution system is

required this guide specification must be edited to ensure that all information not applicable to the design is deleted. This may require that some paragraphs be deleted and others renumbered.

The Contract drawings will provide the following information on the aboveground heat distribution system as applicable: (1) dimensions on all runs of pipe; (2) elevation of the pipe along the systems path; (3) sizes of pipes; (4) system operating temperature and pressure; (5)types of check valves used; (6) cold set dimensions of expansion loops and Z-and L-bends; (7) how changes in pipe direction are to be made; (8) any changes in pipe pitch from the usual 20 mm per 10 m 1 inch per 40 feet; (9) aboveground heat distribution system support and pipe support spacing, locations and details; (10) vent and drain locations and details; and (11) other pertinent information and details required to clearly show the intent of the aboveground heat distribution system. Also indicate any obstructions and interferences in the path of the aboveground heat distribution system the Contractor may have to work around.

****

1.1 SUMMARY

This specification covers the furnishing of materials for and the installation of an insulated aboveground heat distribution system. The contract drawings show the arrangement of piping, supports and the routing of the heat distribution system. Other details, such as sizes of piping, location of expansion loops, location of valves and items of equipment, are also shown on the contract drawings. This specification covers the installation of the system 150 mm 6 inches into the building which it serves.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B31.1	(2024) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand

ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B650	(1995; R 2023) Standard Specification for Electrodeposited Engineering Chromium Coatings on Ferrous Substrates
ASTM C195	(2007; R 2024) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C449	(2007; R 2024) Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F1139	(1988; R 2024) Steam Traps and Drains

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-45	(2020) Bypass and Drain Connections
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(2014) Class 3000 Steel Pipe Unions Socket Welding and Threaded

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of

Building Materials

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Materials and Equipment

SD-03 Product Data

Materials and Equipment; G, [_____]

Procedures and Welders

Piping

Fittings

Valves

Steam Traps

Insulation

SD-04 Samples

Insulation Systems

SD-10 Operation and Maintenance Data

Distribution System; G, [_____]

1.4 QUALITY ASSURANCE

****

NOTE: If the need exists for more stringent welding requirements, such as nondestructive testing, delete the sentences within the first set of brackets.

If the referenced specification sections are not to be included in the project specifications, applicable paragraphs from the referenced sections must be incorporated into this specification.

****

[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Qualify procedures and welders in accordance with ASME BPVC SEC IX. Submit [6][_____] copies of qualified procedures and lists of names and identification symbols of qualified welders and welding operators, prior to welding operations. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify Contracting Officer 24 hours in advance of tests to be performed at the work site, if possible. The welder or welding operator must apply the personally assigned symbol near each weld made as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.5 DELIVERY, STORAGE, AND HANDLING

After delivery to the jobsite, protect materials and equipment from anything which could cause damage to the material or equipment. Seal pipe at each end to keep the interior clean and free of dirt and debris. Keep fittings together with their interior surfaces clean at all times. Keep all stored insulation dry and clean.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of manufacturers regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use at least 2 years prior to bid opening. Submit complete fabrication and assembly drawings for all parts of the work in sufficient detail to check conformity with the requirements of the contract documents. Show the proposed layout for the aboveground heat distribution system, including provisions for pipe expansion, pipe anchors and guides, and supports in plan views and pipe profile elevations. Include data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope, details and calculations, with expansion stress calculations, required to demonstrate that the system has been coordinated and will properly function as a unit. Ensure equipment is supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2 PIPING

2.2.1 General

Unless otherwise specified, provide steel pipe, fittings, valves, and piping accessories conforming to the requirements of ASME B31.1, and suitable for the indicated pressure and temperature requirements. Weld joints for ferrous piping, except that joints 19 mm 3/4 inches and smaller may be threaded. Seal weld high temperature hot water system threaded joints. Provide seamless or electric resistance welded pipe conforming to ASTM A53/A53M or ASTM A106/A106M, Grade B. Provide seamless steel pipe 40 mm 1-1/2 inches in diameter and smaller conforming to ASTM A106/A106M, Grade B.

2.2.2 Supply Pipe

[Steam] [Hot water] [Hot water return] [Steam and hot water] pipes must be black steel Schedule 40 with plain end beveled. Nominal pipe sizes 25 mm 1 inch and below must be Schedule 80.

2.2.3 Condensate Return Pipes

Provide condensate return pipes consisting of black steel, Schedule 80 with plain end beveled.

2.2.4 Drip, Vent, Relief, and Gauge Pipe

Provide drip, vent, relief, and gauge connecting pipe and threaded pipe consisting of black steel, Schedule 80.

2.3 FITTINGS

2.3.1 Threaded Fittings

Provide threaded fittings conforming to the requirements of ASME B16.11, Pressure Class 3000.

2.3.2 Unions

Provide unions conforming to the requirements of MSS SP-83.

2.3.3 Welding Fittings

Provide welding fittings conforming to the requirements of ASTM A105/A105M/ or ASTM A234/A234M. Also conform to ASME B16.9 for buttweld fittings and ASME B16.11 for socket-weld fittings. Use long radius buttwelding elbows conforming to ASME B16.9 whenever space permits.

2.3.4 Pipe Threads

Provide pipe threads conforming to ASME B1.20.2M ASME B1.20.1. Ensure pipe to be threaded is Schedule 80.

2.4 VALVES

2.4.1 General

****

NOTE: Select the appropriate valves for the operating temperatures and pressures of all systems in the project. Delete valve types not included in project.

Use not less than Class 150 for up to 862 kPa 125 psig steam and not less than Class 300 for 863 kPa 126 psig steam and higher. For isolation and shutoff, use gate valves only. Steam pressure reducing valves are not normally part of the system. If needed, the designer should refer to Section 23 52 30.01 10 CENTRAL COAL-FIRED STEAM-GENERATING SYSTEM.

****

Unless otherwise specified, provide ferrous and nonferrous valves meeting the material, fabrication and operating requirements of ASME B31.1. Provide valves that are suitable for the temperature and pressure requirements of the system on which they are to be installed. Provide valves for [steam] [hot water] conforming to ASME B31.1 Class [150] [and] [or] [300] as suitable for the application. [Provide valves for condensate services conforming to ASME B31.1 Class 150.] Provide valves 150 mm 6 inches and larger with a 25 mm 1 inch minimum gate or globe [integral] bypass valve sized in conformance with MSS SP-45. Valves must have the manufacturer's trademark.

2.4.2 Bronze Valves

2.4.2.1 Globe, Gate and Angle Valves

Provide globe, gate and angle valves conforming to the requirements of MSS SP-80.

2.4.2.2 Check Valves

Provide check valves conforming to the requirements of MSS SP-80.

2.4.3 Steel Valves

Provide steel globe, gate, angle and check valves conforming to the requirements of ASME B16.34 and ASME B31.1 for the temperature and pressure requirements of the system.

2.4.4 Packing

Packing used with valves must not contain asbestos. Use die-formed, ring type valve stem packing specifically designated as suitable for the temperature and pressure of the service and compatible with the fluid in the system. Packing rings must be polytetrafluoroethylene with minimum 50 percent graphite filament top and bottom rings. Provide valves 40 mm 1-1/2 inches and smaller with 4 or 5 packing rings, and valves 50 mm 2 inches and larger with at least 6 packing rings. Spiral or continuous packing will not be acceptable. Provide a metal insert having proper clearance around the valve stem at the bottom of the stuffing box and acting as a base for the packing material. Furnish packing glands with a liner of noncorrosive material and consisting of 1 piece construction with provisions for no less than 2 bolts for packing adjustment.

2.5 STEAM TRAPS

****

NOTE: The following paragraphs are applicable to steam systems only. Only these two types of steam traps will be used. A schedule of steam trap selections will be shown on the drawings.

Trap capacity (kilograms per hour (pounds per hour during normal operation), pressure drop kPa psi, and pressure rating kPa psi of each trap will be included in schedule on the drawings. Additionally, show on the drawings a vent valve or test valve connection downstream of the traps for test of trap operation, a strainer ahead of the trap, a check valve in the outlet piping, unions and shut-off valves on both sides of the trap for trap changeout. Provide a means of bypassing the trap for system warm-up.

****

2.5.1 General

Class of trap bodies must be suitable for a working pressure of no less than 1.5 times the steam supply pressure, but no less than 1.38 MPa 200 psi, and traps must be capable of operation under a steam-supply pressure as indicated. Ensure traps have capacities as shown when operating under the specified working conditions. Traps must fail open.

2.5.2 Bucket Traps

Provide bucket traps consisting of an inverted-bucket type with automatic air discharge conforming to the requirements of ASTM F1139.

2.5.3 Thermostatic Traps

****

NOTE: Specify thermostatic traps where the trap location is subject to freezing.

****

Provide thermostatic type, bimetallic element traps with automatic air discharge conforming to ASTM F1139.

2.6 STRAINERS

Basket or Y-type strainer body connections must be the same size as the pipelines in which the strainers are installed. The strainer bodies for steam systems must be heavy and durable, of cast steel, with bottoms drilled and plugged. Provide strainers that are suitable for the temperature and pressure requirements of the system on which they are installed. Clearly cast arrows on the sides of the bodies to indicate the direction of flow. Equip each strainer with an easily removable cover and sediment basket. Equip the body or bottom opening with nipple and gate valve for blowdown. Provide basket for steam systems that is no less than 0.6350 mm 0.025 inch thick stainless steel, Monel or sheet brass, with small perforations of sufficient number to provide a net free area through the basket of at least 2.5 times that of the entering pipe. The flow must be into the basket and out through the perforations. For high temperature hot water systems, use only cast steel bodies and stainless or Monel baskets.

2.7 ABOVEGROUND PIPE SUPPORTS

****

NOTE: If the referenced specification sections are not to be included in the project specifications, applicable paragraphs from the referenced sections must be incorporated into this specification.

****

2.7.1 Concrete

Use concrete in the formation of poles or foundation for the supports conforming to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.7.2 Steel

****

NOTE: Steel pipe supports must be protected from corrosion. Corrosion-resistant steel, such as stainless or hot-dipped galvanized should be used in the construction of the pipe supports. If paint is to be used to prevent corrosion of the steel pipe supports, then additional consideration should be given to the manpower needed, the future costs, and the time involved in maintaining the painted system. Specifications should be modified to indicate how corrosion protection is to be accomplished.

****

Use steel as support members or as part of the pipe support structure conforming to the requirements of Section 05 12 00 STRUCTURAL STEEL. To the maximum extent possible, the pipe supports must be hot-dipped galvanized after they have been fabricated.

2.7.3 Accessories

Furnish the following accessories as needed to maintain the alignment of the aboveground structure. Provide materials with a hot-dipped galvanized finish.

2.7.3.1 Guy Wires

Provide guy wires conforming to the requirements of ASTM A475, extra high strength grade, extra galvanized, stranded with 7 or 19 wires in each strand. Provide thimbles at each end of guy wires.

2.7.3.2 Anchor Rods

Provide anchor rods that are 32 mm 1-1/4 inch diameter threaded rod with oval eye.

2.7.3.3 Screw Anchors

Provide screw anchors with 250 mm 10 inch diameter.

2.7.3.4 Turnbuckles

Provide open type, forged body, turnbuckles with jaw and jaw end pulls, 10 mm 3/8 inch size and hot-dipped galvanized.

2.7.3.5 Clamps

Provide forged high carbon steel clamps fitted with galvanized heat treated bolts of best commercial grade. Ensure clamps are capable of developing full strength of the guy wire. Provide two clamps at each connection of the guy wire.

2.8 INSULATION SYSTEMS

Display sample sections for insulation of pipe, elbow, tee, valve, support point, and terminating points. After approval of materials and prior to insulation of piping, prepare a display of insulated sections showing compliance with specifications, including fastening, sealing, jacketing, straps, waterproofing, supports, hangers, anchors, and saddles. Keep approved display sample sections on display at the jobsite during the construction period until no longer needed by Contracting Officer, then remove.

2.8.1 Insulation

****

NOTE: If ASHRAE 90.1 is more stringent for insulation thickness, the Table 1 and 2 will be updated to match ASHRAE 90.1 requirements.

****

Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Ensure insulation for piping, fittings, and valves is molded mineral fiber insulation conforming to the requirements of ASTM C547, Class 2, asbestos free, molded calcium silicate conforming to the requirements of ASTM C533, Type I, asbestos free or cellular glass insulation conforming to ASTM C552. Provide insulation thickness used on aboveground piping as shown in Tables 1 and 2.

TABLE 1 Minimum Pipe Insulation Thickness (mm) (inches)			
For steam up to 1.72 MPa 250 psig and high temperature hot water supply and return piping up to 232 degrees C 450 degrees F			
Nominal Pipe Diameter (mm) (inches)	Insulation Thermal Conductivity (k)		
	k less than 0.29	k from 0.29 to 0.40	k greater than 0.40
25 1.0	50 2.0	63 2.5	100 4.0
40 1.5	50 2.0	63 2.5	100 4.0

TABLE 1
Minimum Pipe Insulation Thickness (mm) (inches)

For steam up to 1.72 MPa 250 psig and high temperature hot water supply and return piping up to 232 degrees C 450 degrees F

50 2.0	63 2.5	85 3.5	110 4.5
65 2.5	63 2.5	85 3.5	110 4.5
80 3.0	75 3.0	100 4.0	125 5.0
100 4.0	75 3.0	100 4.0	125 5.0
125 5.0	75 3.0	100 4.0	125 5.0
150 6.0	85 3.5	110 4.5	135 5.5
200 8.0	85 3.5	110 4.5	135 5.5
250 10.0	100 4.0	125 5.0	150 6.0
300 12.0	100 4.0	125 5.0	150 6.0
350 14.0	100 4.0	125 5.0	150 6.0
400 16.0	100 4.0	125 5.0	150 6.0
450 18.0	100 4.0	125 5.0	150 6.0

NOTE: Insulation thermal conductivity (k-value) is in units of watt per meter-degree K at 93 degrees C Btu-inches/hour-square-feet-degrees F at 200 degrees F mean temperature.

TABLE 2
Minimum Pipe Insulation Thickness (mm) (inches)

For Low Pressure Steam (less than 110 kPa (gage) 16 psig), Condensate Return and Low Temperature Hot Water (less than 120 degrees C 250 degrees F) supply and return piping.

Nominal Pipe Diameter (mm) (inches)	Insulation Thermal Conductivity (k)		
	k less than 0.29	k from 0.29 to 0.40	k greater than 0.40
25 1.0	35 1.5	50 2.0	75 3.0
40 1.5	35 1.5	50 2.0	75 3.0
50 2.0	35 1.5	50 2.0	75 3.0
65 2.5	35 1.5	50 2.0	75 3.0
80 3.0	50 2.0	63 2.5	85 3.5

TABLE 2
Minimum Pipe Insulation Thickness (mm) (inches)

For Low Pressure Steam (less than 110 kPa (gage) 16 psig), Condensate Return and Low Temperature Hot Water (less than 120 degrees C 250 degrees F) supply and return piping.

100 4.0	50 2.0	63 2.5	85 3.5
125 5.0	50 2.0	63 2.5	85 3.5
150 6.0	63 2.5	75 3.0	110 4.5
200 8.0	63 2.5	75 3.0	110 4.5
250 10.0	75 3.0	100 4.0	125 5.0
300 12.0	75 3.0	100 4.0	125 5.0
350 14.0	75 3.0	100 4.0	125 5.0
400 16.0	75 3.0	100 4.0	125 5.0
450 18.0	75 3.0	100 4.0	125 5.0

NOTE: Insulation thermal conductivity (k-value) is in units of watt per meter-degree K at 93 degrees C Btu-inches/hour-square-feet-degrees F at 200 degrees F mean temperature.

2.8.2 Insulation Jackets

2.8.2.1 Nonmetallic Jackets

Provide nonmetallic jacketing consisting of a 200 grams per square meter 6 ounces per square yard fiberglass fabric impregnated with chlorosulfonated polyethylene (Hypalon) and a 0.038 mm 1.5 mil polyvinyl fluoride film (Tedlar) bonded to it. Overall thickness of the composite must be 0.254 mm 0.010 inch and weigh approximately 356 grams per square meter 10.5 ounces per square yard. Jackets may be either field or factory applied to the insulation. Use nonmetallic jackets with molded mineral fiber insulation.

2.8.2.2 Aluminum Jackets

Provide smooth sheet aluminum jackets meeting the requirements of ASTM B209/B209M, Alloys 3003, 3105 or 5005. Provide aluminum jackets that are no less than 0.406 mm 0.016 inch thick and secure with aluminum or Type 304 annealed stainless steel securing bands. Use securing bands that are at least 13 mm 1/2 inch wide for jackets with less than a 500 mm 20 inch circumference and 19 mm 3/4 inch wide for jacket circumferences 500 mm 20 inches and greater. The jacket may, at the option of the Contractor, be provided with a factory fabricated "Pittsburgh" or "Z" type longitudinal joint. When the "Z" joint is used, design the circumferential joints by the manufacturer to seal the joints and hold the jacket in place. Supply jacket with a factory installed moisture barrier. This moisture barrier must consist of at least 18 kg 40 pound kraft paper coated on 1 side with a 0.025 mm 1 mil polyethylene film. Adhere the moisture barrier to the aluminum jacket over 100 percent of the aluminum jacket surface. Jacket may be either field or factory applied to the insulation. Use aluminum jackets with calcium silicate insulation.

2.8.3 Finishing Materials

2.8.3.1 Wire

Use wire to secure the insulation prior to the installation of the jacket consisting of [soft annealed Type 302, 304 or 316 stainless steel, 1.56 or 1.25 mm 16 or 18 gauge] [soft annealed galvanized, 1.56 mm 16 gauge].

2.8.3.2 Staples

Provide outward clinching type staples [made of monel] [conforming to the requirements of ASTM A240/A240M, Type 304 or 316].

2.8.3.3 Insulating and Finishing Cement

Mineral fiber hydraulic-setting thermal insulating and finishing cement must conform to the requirements of ASTM C449.

2.8.3.4 Glass Tape

Provide glass tape meeting the requirements of UL 723 and ASTM E84. There must be no distortion of the tape when a sample 610 mm 24 inches in length is spread across a flat horizontal surface and observed for evidence of distortion (such as tendency to curl rather than lie flat). The width tolerance is plus or minus 3.175 mm 1/8 inch.

2.8.3.4.1 Plain Weave, Untreated

Properly interlock the ends with the picks to ensure that there is no raveling of the tape edges. It must have an average weight of 196.7 grams per square meter, plus or minus 10 percent 5.8 ounces per square yard, plus or minus 10 percent. An average thickness of 0.1778 mm plus or minus 0.0254 mm 0.007 inches plus or minus 0.001 inches, warp ends/wales of 17 plus or minus 1 per centimeter 42 plus or minus 2 per inch or filling picks/courses of 13 plus or minus 1 per centimeter 32 plus or minus 2 per inch, a minimum breaking strength of 2679 grams per mm 150 pounds per inch of width, and after heating to 482 degrees C 900 degrees F for 2 hours, a minimum breaking strength of 714 grams per mm 40 pounds per inch of width.

2.8.3.4.2 Knitted, Untreated

Properly interlock the wales with the courses to ensure that there is no raveling of the tape edges. It must have an average weight of 153 grams per square meter 4.5 ounces per square yard, plus or minus 10 percent. An average thickness of 0.1778 mm plus or minus 0.0254 mm 0.007 inches plus or minus 0.001 inches, warp ends/wales of 6 plus or minus 1 per centimeter 16 plus or minus 2 per inch. A minimum breaking strength of 714 grams per mm 40 pounds per inch of width, and after heating to 482 degrees C 900 degrees F for 2 hours, a minimum breaking strength of 375 grams per mm 21 pounds per inch of width.

2.8.3.4.3 Open-Weave Type

Use open-weave type tape with an average weight of [1.08][_____] kg per square meter [2][_____] ounce per square yard for embedding between coats of adhesive or coating materials.

2.8.3.5 Glass Cloth

Provide an untreated light weight satin weave glass cloth, woven with an 8-harness satin weave and fabricated from fibrous glass yarn. Make the yarn from low twist continuous filament glass fiber. The maximum average diameter of the glass fibers used for the yarns must not exceed 0.00761 mm 0.000299 inch. Provide cloth meeting the requirements of UL 723 and the following properties:

a. Average weight 302 grams/square meter 8.9 ounces/square yard.

b. Fabric count-warp 56 yarns/25 mm 57 yarns/inch ends.

c. Filling picks 53 yarns/25 mm 54 yarns/inch.

d. Minimum breaking strength:

    (1) Warp 3572 grams/mm 200 lb/inch.
    (2) Filling 3214 grams/mm 180 lb/inch.

e. After heating to 482 degrees C 900 degrees F for 2 hours:

    (1) Warp 1071 grams/mm 60 lb/inch.
    (2) Filling 1071 grams/mm 60 lb/inch.

f. Cloth must meet the following tolerances:

    (1) Up to and including 1016 mm, tolerance of plus or minus 13 mm 40 inches, tolerance of plus or minus 1/2 inch.

    (2) Over 1016 mm and up to 1524 mm, tolerance of plus or minus 19 mm 40 inches and less than 60 inches, tolerance of plus or minus 3/4 inch.

    (3) Over 1524 mm, tolerance of plus or minus 25 mm 60 inches, tolerance of plus or minus 1 inch.

g. Furnish the cloth in 45.72 meter, plus or minus 4.572 meter 50 yard, plus or minus 5 yard rolls. The minimum length in a spliced roll must be 3.658 meters 4 yards, and a spliced roll must contain no more than 3 pieces for each 45.72 meter 50 yard length. Open-weave type of [1.08][_____] kilogram per square meter [2][_____] ounce per square yard may be used for embedding between coats of adhesive or coating materials.

2.8.4 Adhesives

2.8.4.1 Mineral Fiber Insulation Cement

Provide cement in accordance with ASTM C195.

2.8.4.2 Contact Adhesive

Contact adhesive may be dispersed in a non-halogenated organic solvent with a low flash point (flash point less than minus 3.9 degrees C 25 degrees F) or, dispersed in a nonflammable organic solvent which must not have a fire point below 93.3 degrees C 200 degrees F. Ensure adhesive does not adversely affect, initially or in service, the insulation to which it is applied, nor cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive must have no objectionable odor and must not contain any benzene or carbon tetrachloride. The dried adhesive must not emit nauseous, irritating, or toxic volatile matter or aerosols when the adhesive is heated to any temperature up to 100 degrees C 212 degrees F. Provide nonflammable, fire resistant adhesive conforming to ASTM E84.

2.8.4.3 Lagging Adhesive

Provide nonflammable, fire-resistant lagging adhesives in accordance with NFPA 90A, UL 723, and ASTM E84. Provide either the Class 1 or Class 2 type adhesives. Use Class 1 adhesives which are pigmented [white] [red] and suitable for: bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; bonding cotton batiste cloth to faced and unfaced fibrous glass insulation board; sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; or bonding lagging cloth to thermal insulation. Use pigmented white Class 2 adhesive suitable for attaching fibrous glass insulation to metal surfaces. Apply lagging adhesives in accordance with the manufacturer's recommendations.

2.9 PIPE SLEEVES

Sleeves in masonry and concrete walls, floors, and roofs must be Schedule 40 galvanized steel pipe conforming to ASTM A53/A53M. Fabricate sleeves in nonmasonry and nonconcrete walls, floors, and ceilings of 0.47 mm 26 gauge galvanized steel.

[2.10 Bellows-Type Joints

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NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the planning phase of the piping layout, prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location.

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Select bellows-type or slip-type to satisfy specific design conditions. Joints must be flexible, guided expansion joints. Expansion element must be of stainless steel. Provide bellows-type expansion joints in accordance with the applicable requirements of EJMA Stds and ASME B31.1 with internal liners.

2.11 Expansion Joints

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NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be

justified by a design analysis and approved in the planning phase of the piping layout, prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location.

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Use expansion joints that provide for either single or double slip of connected pipes, as required or indicated, and for no less than the traverse indicated. Design joints for hot water working pressure no less than [_____] kPa[_____] psig and in accordance with applicable requirements of EJMA Stds and ASME B31.1. Design joints for packing injection under full line pressure. End connections must be flanged or beveled for welding as indicated. Provide joints with anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip must be seamless steel plated with a minimum of 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Fabricate joint components from material equivalent to that of the pipeline. Make initial settings in accordance with manufacturer's recommendations to compensate for ambient temperature at time of installation. Install pipe alignment guides as recommended by joint manufacturer, but in any case no more than 1.5 m 5 feet from expansion joint except for lines 100 mm 4 inches or smaller, install guides no more than 600 mm 2 feet from the joint. Provide service outlets where indicated.

2.12 Flexible Ball Joints

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NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the planning phase of the piping layout, prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location.

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Construct flexible ball joints of alloys as appropriate for the service intended. Where so indicated, design the ball joint for packing injection under full line pressure to contain leakage. Ensure joint ends are threaded (to 50 mm 2 inches only), grooved, flanged or beveled for welding as indicated or required and capable of absorbing a minimum of 15-degree angular flex and 360-degree rotation. Provide balls and sockets of equivalent material as the adjoining pipeline. Ensure exterior spherical surface of carbon steel balls is plated with 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Design and construct ball type joints in accordance with ASME B31.1 and ASME BPVC SEC VIII D1, where applicable. Provide flanges where required conforming to ASME B16.5. Gaskets and compression seals must be compatible with the service intended.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

Each major item of equipment must have the manufacturer's name, address, type or style, model or serial number on a plate secured to the item of equipment.

3.2.1 Support Structures

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NOTE: If the referenced specification sections are not to be included in the project specifications, applicable paragraphs from the referenced sections must be incorporated into this specification.

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Support pipes by concrete or steel structures as indicated. Set, plumb and guy structures as required. Stress guy wires until taut. Elevation of the structures must be as indicated on the drawings. Paint structural steel members as specified in Section 09 90 00 PAINTS AND COATINGS.

3.2.2 Piping and Valves

3.2.2.1 Piping

Install the heat distribution system in accordance with ASME B31.1, unless otherwise specified or indicated. Submit [6][_____] copies of operation and [6][_____] copies of maintenance manuals for the equipment furnished; one complete set prior to performance testing and the remainder furnished upon acceptance. Detail in the operation manuals the step-by-step procedures required for equipment startup, operation, and shutdown. Include in the operation manuals the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the maintenance manuals piping and equipment layout and simplified wiring and control diagrams of the equipment as installed. Obtain approval of manuals prior to the field performance testing. Install piping straight and true to bear evenly on supports. Make changes in direction by pipe fittings. Make changes in horizontal steam piping sizes using eccentric reducing fittings to keep bottom of pipe at the same level. Pitch horizontal steam piping, unless otherwise indicated, with a grade of no less than 25 mm in 6 m 1 inch in 20 feet in the direction of flow. Pitch all other piping, unless otherwise indicated, with a grade of no less than 20 mm in 10 m 1 inch in 40 feet toward the drain points. Accurately cut pipe to measurements established at the construction site and work into place without springing or forcing, properly clearing all openings and equipment. Excessive cutting or other weakening of structural members to facilitate piping installation will not be permitted. Remove burrs from pipe ends by reaming and install to permit free expansion and contraction without damage to joints or hangers. Properly cap or plug open ends of pipe lines and equipment during installation to keep dirt or other foreign matter out of the system.

3.2.2.2 Valves

Install valves with stems horizontal or above. Weld valves, except sizes smaller than 19 mm 3/4 inch may have threaded end connections with a union on one side of the valve.

3.2.3 Joints

3.2.3.1 Welded Joints

Weld joints between sections of pipe and between pipe and fittings, except where threaded fittings are allowed and used. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitations. Where branch outlet fittings are used, they must be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Seal weld threaded joints in high temperature water systems.

3.2.3.2 Threaded Joints

Make threaded joints tight with polytetrafluoroethylene tape applied to the male pipe threads only. Seal weld threaded joints in high temperature water systems.

3.2.4 Branch Connections

Install branch connections from supply and return mains as indicated or as approved. Make connections carefully to ensure unrestricted circulation, eliminate air pockets, and permit the complete drainage of the system.

3.2.5 Pipe Supports

Support horizontal and vertical runs of pipe securely. Support suspended pipe by adjustable pipe hangers having bolted hinged loops and turnbuckles or by other approved devices, conforming to MSS SP-58. Chain or flat steel strap hangers or single point supports will not be accepted. Provide pipe hangers, guides, brackets, supports and anchors as detailed on the drawings. Space pipe supports in accordance with MSS SP-58, Table 3, Column 1. For hangers located on the outside of the insulation, position a preformed, minimum 450 mm 18 inches long, full round, 2 mm 14 gauge, galvanized steel saddle between the hanger and the insulation. Ensure saddle is of sufficient size and thickness to limit the compressive load on the insulation to 228 kPa 33 psi.

3.2.6 Pipe Sleeves

Provide pipe sleeves where piping passes through walls or floor slabs. Secure sleeves in proper position and location during construction. Ensure sleeves are of sufficient length to pass through the entire thickness of walls or floor slabs. Extend sleeves in floor slabs 75 mm 3 inches above the finished floor. The annular space between the exterior of piping or pipe insulation and the interior of the sleeve must be no less than 8 mm 1/4 inch; and pack the space firmly with insulation and caulk both ends of the sleeve with plastic waterproof cement which will cure to a firm but pliable mass.

3.3 INSULATION

3.3.1 General

Install insulation in a manner that prevents damage by pipe expansion or contraction. Groove insulation installed over welds to assure a snug fit. Hold insulation in place with stainless steel straps or wire. Insulate all flanges, unions, valves, and fittings with premolded, prefabricated, or field fabricated segments of insulation of the same material and thickness as the adjoining pipe insulation.

3.3.2 Installation

Except as otherwise specified, install material in accordance with the recommendations of the manufacturer. Do not apply insulation materials until tests specified are completed, foreign material such as rust, scale, or dirt has been removed, and the surfaces are clean and dry. Keep insulation clean and dry at all times.

3.3.3 Wet Insulation

3.3.3.1 Prior to Installation

Dry insulation which has become wet prior to installation thoroughly before proceeding with the installation. After drying, take a representative cross section of the insulation, as determined by the Contracting Officer, and quickly place in an airtight container for a moisture determination. Weigh the sample in the airtight container on an accurate balance or scale, after which open the container and place in an oven at 102 degrees C 215 degrees F until its weight becomes constant. Determine the percentage of water by weight from the initial and final weight of the container and the sample after appropriate corrections are made for the weight of the empty container. The average water content of the sample must not exceed 5 percent by weight. If the average water content of the insulation exceeds 5 percent by weight, replace the insulation with dry insulation.

3.3.3.2 After Installation

Dry insulation which becomes wet during or after installation thoroughly by applying heat through the carrier pipe and allowing the moisture to evaporate to the atmosphere. Check a sample of the insulation for water content in accordance with the guidance in the preceding paragraph. Dry the insulation until it is found to contain an average water content of less than 5 percent by weight. If approved by the Contracting Officer, installed insulation may be removed and dried in accordance with the guidance in the preceding paragraph and after drying, reinstalled.

3.3.4 Covering of Insulation

Cover insulation for pipe, flanges, valves, and fittings with a jacket as specified by one of the following methods.

3.3.4.1 Aluminum Jacket

Do not lap longitudinal and circumferential seams less than 75 mm 3 inches. Secure jackets with bands installed at least every 300 mm 12 inches. Install jackets on horizontal lines so that the longitudinal seams are on the bottom side of the pipe with the seam of each jacket slightly offset from the seam of the adjacent jackets. Place the seams of jackets installed on vertical lines on the off-weather side of the pipe and slightly offset as on horizontal lines. Install jackets on vertical lines and lines pitched from the horizontal from low point to high point so that the lower circumferential edge of each jacket overlaps the upper circumferential edge of the jacket below it. Seal joints with a moisture barrier. Special fitting jackets conforming to the above, with the exception of longitudinal lapping dimensions and location of seams, may be used for fittings, valves, and flanges. Properly overlap and secure jackets for fittings, valves, and flanges. Do not allow jacketing to become electrically coupled to the piping.

3.3.4.2 Nonmetallic Jacket

Match the color of the jacket to the nearest existing piping insulation nonmetallic jacket. However, if no piping exists, the jacket must be gray in color. Overlap the jacket no less than 50 mm 2 inches at longitudinal and circumferential joints, except butt factory applied jacket systems at the circumferential joint; and apply a 75 mm 3 inch matching butt strip furnished by the manufacturer. Ensure the butt strip is at least 50 mm 2 inches longer than the insulation circumference and secured by outward clinching staples (2 located at the beginning of the strip overlap and 2 at the end of the strip overlap). Close the edges of the butt strip with 50 mm 2 inches wide 0.038 mm 1.5 mil polyvinyl fluoride (TEDLAR PVF) pressure sensitive tape made from a similar material and color as the jacket. Overlap longitudinal joints down to shed water and locate at the bottom of the pipe. Staple the overlap on 50 mm 2 inch centers, working from the center toward the ends to eliminate any wrinkles. Apply matching PVF tape (50 mm 2 inches wide for 300 mm 12 inch and less diameter insulation, and 75 mm 3 inches wide for insulation diameters greater than 300 mm 12 inches) to the clean and dry overlap, covering the seam and the staples. Use matching PVF tape to weatherproof the clean and dry circumferential lap between sections. Rub down tape with a plastic squeegee.

3.3.4.3 Flanges, Unions, Valves, Fittings and Accessories

Insulate flanges, unions, valves, fittings and accessories with premolded, prefabricated, or field fabricated segments of insulation. Provide removable and reusable insulation with essentially the same thermal characteristics and thickness as the adjoining piping.

3.4 PIPE GUIDES AND SUPPORTS

Provide pipe supports and alignment guides as indicated or necessary that permit pipe expansion and contraction without damage to the insulation. Design supports, anchors, and guides to permit complete drainage of the system, with rigid steel frames of adequate strength and corrosion resistance for the service, and securely embed in concrete or securely attach to the piping supports. Equip pipe supports with steel bars and cast-iron rollers.

3.5 PIPE EXPANSION

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NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the

planning phase of the piping layout, prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location.
****

Accommodate expansion by loops and bends as indicated on the drawings and as specified. Ensure pipe in the loops and bends accommodate expansion while maintaining required insulation clearance from other pipes; avoid crushing or breaking of insulation. Expansion loops will be designed around obstacles such as structures, or trees to avoid construction conflicts. Maintain slopes of pipe. Contractor will have the option to adjust the loop dimensions around obstacles based on final field measurements, if approved by the Contracting Officer. Submit pipe stress calculations for each revised expansion loop or bend based on the final actual measured lengths, or submit dimensions to the Contracting Officer for verification of loop and bend sizes before proceeding with that segment of work. Ensure allowable pipe stresses are in accordance with ASME B31.1. Submit final expansion loop insulation method for approval to the Contracting Officer.

3.6 TESTS

3.6.1 General

Conduct tests before, during, and after the installation of the system. Provide instruments, equipment, facilities, and labor required to properly conduct the tests. Test pressure gauges for a specific test must be approved by the Contracting Officer and must have dials indicating no less than 1.5 times nor more than 2 times the test pressure. Correct any deficiencies found and retest the system.

3.6.2 Cleaning of Piping

Prior to the hydrostatic and operating tests, clean the interior of the pipe of all foreign material by thorough flushing with clean water. Provide supplementary pumps to circulate the flushing liquid at a velocity between 2 and 3 meters per second 7 and 10 feet per second for a minimum of 4 hours. Install temporary strainers as required. After flushing, drain the flushing liquid out of the piping system and fill the piping system with clean water.

3.6.3 Field Tests

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NOTE: Compressed air will not be used in lieu of the hydrostatic tests of the service piping.
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3.6.3.1 Hydrostatic Tests of Service Piping

Test service piping hydrostatically before insulation is applied at the joints and prove tight at a pressure 1-1/2 times the working pressure or at 1.38 MPa 200 psig, whichever is greater, except do not test high temperature water lines at more than 3.48 MPa 500 psig. Hold hydrostatic test pressures for a minimum of 4 hours. If any failures occur, make such adjustments, repairs or replacements as the Contracting Officer may direct, and repeat the tests until satisfactory installation and operation are achieved.

3.6.3.2 Equipment

Check valves, traps, alarms, controls and other operable items of equipment that are a part of the aboveground heat distribution system to show proper operation. Perform these checks in the presence of the Contracting Officer or his representative.

3.6.3.3 Operational Tests

Perform operational test on the complete system or testable portions thereof. Conduct the test with full design flows and operating temperatures in all runs of piping as if in service, to demonstrate satisfactory function and operating effectiveness. The operational test must have 2 cycles. Each cycle must consist of a 6-hour period with water in the system at the maximum operating temperature and maximum flow rate; and a period of at least 6 hours with no flow rate. For dual temperature systems, the first cycle must use the heating temperature and the second cycle the cooling temperature of the designed system. Supply all items necessary to perform the test including temporary pumps, piping connections, boilers, chillers and the gauges required to circulate the water at the desired temperatures and flow rates. Circulate water through supply lines and return through the return piping to demonstrate that the pressure drop is compatible with the flow rate and size of pipe; and to show that obstructions do not exist in the piping system. Investigate any unusual indicated pressure drop and any remove obstructions. Repair leaks. After obstructions have been removed and leaks repaired, repeat the carrier piping tests.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 61 13 (August 2024)**

Preparing Activity: USACE **Superseding**
UFGS-33 61 13 (April 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-33 61 13 (August 2024)**

Preparing Activity: USACE **Superseding**
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SECTION 33 61 13

PRE-ENGINEERED UNDERGROUND HEAT DISTRIBUTION SYSTEM
08/24

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NOTE: This guide specification covers the requirements for an insulated underground heat distribution system (UHDS) and/or condensate return system of the pre-engineered type as covered in UFC 3-430-09 "Exterior Mechanical Utility Distribution", for steam and high temperature hot water up to 230 degrees C 450 degrees F.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

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NOTE: Notes are to the Government designer or design Architect/Engineer firm and will not be seen by the Contractor or its Subcontractors. The designer will carefully review all Notes; when submitting the "draft" specification for review, Notes will remain intact.

This specification requires coordination with other design disciplines (examples: cathodic protection, trenching and backfill, structural for coordinating

manhole structures). The specified systems are capable of transporting steam, condensate, or high temperature hot water. This specification is for systems operating above 120 degrees C 250 degrees F to a maximum acceptable pressure and temperature of approximately 2.800 Mpa (gage) 408 psig and 230 degrees C 450 degrees F, respectively. It should be noted that not all UHDS are acceptable for all site classifications, temperatures, and pressure ratings.

The Government designer will establish the site, soil and groundwater conditions. The contract drawings will show the size, proposed routing (including construction limits) and estimated length of the system. The contract drawings will establish the elevations and show the profiles of the pipe and the existing and finished earth surfaces. Indicate and identify all obstructions within 8 m 25 feet of the system centerline, including adjacent or crossing utilities.

This guide specification is not for the design of the valve manhole and associated piping and equipment in the valve manhole. Valve manholes and the piping and equipment inside the valve manholes will be designed and detailed on the contract drawings. Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES will be included as part of this project. Include on the drawings a log of soil conditions along the pipe line right-of-way, at pipe depth, which gives, as a minimum, soil classification, moisture content, soil resistivity and pH, bearing strength and unstable conditions.

Details at building entries will be provided on the contract drawings to show pipe elevation, floor and grade elevation, building wall construction and existing equipment. Include location of valve manhole and/or valve boxes, branch runouts, and isolation valves on the contract drawings. Provide details at manhole entries on the contract drawings to show pipe elevations; floor, top, entrance, and grade elevations; manhole wall construction; anchor location and construction; and existing equipment and piping.

All connections to the UHDS distribution will occur only in manholes.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 300	(2003; R 2017) Standard Specification for Inorganic Zinc-Rich Primer

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A134/A134M	(2019) Standard Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A139/A139M	(2022) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe

	(NPS 4 and over)
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM C177	(2019; E 2023) Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C1728	(2023) Standard Specification for Flexible Insulation
ASTM D1895	(2017) Standard Test Methods for Apparent Density, Bulk Factor, and Pourability of Plastic Materials
ASTM D2310	(2006; R 2012) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

NACE INTERNATIONAL (NACE)

NACE SP0169	(2024) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

1.2 DEFINITIONS

The following definitions apply to the work.

1.2.1 Heat Distribution System

A complete pre-engineered, underground [heat distribution] [and] [condensate return] system including all required components such as carrier pipes, [steam pipe,] [hot water supply pipe,] [condensate return pipe,] [hot water return pipe,] and fittings, anchors, pipe supports, insulation, protective casing, and cathodic protection, for the system supplied. The pre-engineered system does not include valve manholes and the piping and equipment inside the valve manholes; use Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES for pertinent requirements. Include all piping and components to a point at least 150 mm 6 inches inside the building and valve manhole walls. Do not use any part of the building or valve manhole structure as an anchor point.

1.2.2 Direct-Buried

A system which is buried, without the need for a field-fabricated protective enclosure such as a concrete trench or tunnel.

1.2.3 UHDS Types

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N0TE: From the following subparagraphs, select the applicable type of system to be allowed and remove the others.

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1.2.3.1 Drainable-Dryable-Testable (DDT) Direct-Buried

A factory-fabricated system including an air and water-tight outer protective casing, air space and an insulated carrier pipe. Drains and vents are provided at the end plates of the system (in manholes or buildings). The drains are normally capped but the caps can be removed to drain water which can leak into the air space if there is a failure in the casing or the carrier pipe. The vents allow water vapor to escape and provide a tell-tale sign of leakage.

1.2.3.1.1 Piping Design Variation

An available variation of the DDT pre-engineered piping design is characterized by use of a smaller thickness of high-temperature insulation and an annular air space contained within a metallic conduit. The metallic conduit is coated on the outside with lower-temperature insulation and the entire system is encased in a thick, non-metallic exterior jacket. This variation of the DDT system is not recommended for implementation.

1.2.3.2 Water Spread Limiting (WSL) Direct-Buried

A factory fabricated system including an outer protective casing and an insulated carrier pipe. The system is fabricated in sections which are independent from each other; ground water or condensate which leaks from or into one section cannot travel into the next section. Field-assembly of the sections requires no welding as the sections push together and are sealed with a system of couplings and seals.

1.2.3.3 Water Spread Limiting Poured-In-Place Insulation (PIPI)

A field fabricated system consisting of steel carrier pipes and supports encased in the poured-in-place insulation (PIPI). The PIPI consists of chemically modified calcium carbonate powder. The particles cohesively bond with each other to form a closed-cell insulation that thermally insulates the pipes and provides corrosion protection.

1.3 SYSTEM DESCRIPTION

1.3.1 Scope

The work includes the design and fabrication; furnishing; installing, and testing of a direct buried underground [insulated heat-distribution system] [and] [insulated steam pipe,] [insulated high temperature hot water supply pipe,] [insulated steel condensate return pipe,] [insulated high temperature hot water return pipe] consisting of piping as indicated, cathodic protection system (where required by this specification and UFC 3-430-09), together with fittings and appurtenances necessary for a complete and operable system. Gland type end seals will not be permitted. DDT systems with fiberglass casings will not be permitted.

1.3.2 UHDS Design

Submit a Certificate of Satisfactory Operation certifying that at least three systems installed by the UHDS manufacturer within the previous 5 years are operating satisfactorily, not later than [30][40][_____] days after notice to proceed. The UHDS manufacturer is responsible for the complete design of the UHDS, the product to be supplied, fabrication, witnessing installation and testing of the system within the design parameters established by the contract drawings and specifications, and in compliance with the detailed design. The complete design of the UHDS must be sealed by a Professional Engineer in the employ of the UHDS manufacturer.

1.3.3 Cathodic Protection

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NOTE: Cathodic protection system will meet the requirements of UFC 3-570-01 Cathodic Protection.

Cathodic protection system design will include the requirements of UFC 3-430-09.

For Army projects only: these projects require cathodic protection Center of Expertise (CX) review of the proposed design.

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Provide cathodic protection for systems with coated steel casings in accordance with paragraph Cathodic Protection Installation.

1.3.4 Operating Characteristics

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NOTE: The operating and the rated characteristics must be supplied. Operating characteristics should be based on the capabilities of the system. The

operating characteristics should not exceed the values for the "Rated Characteristics" of the system. Rated characteristics are to be used for calculations for the system design and represent a "worst case". For rated characteristics for DDT systems insert 260 degrees C 500 degrees F and 4.585 MPa gage 665 psig. For rated characteristics for WSL systems, which are only allowed for steam and condensate return systems, insert 208 degrees C 406 degrees F and 1.723 MPa gage 250 psig. For rated characteristics of the PIPI system insert 249 degrees C 480 degrees F and 3.81 MPa gage 551 psig. The design conditions for the condensate and hot water return piping will be the same as for the steam and hot water supply.
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Provide [steam] [high temperature hot water] supply system with an operating temperature of [_____] degrees C[_____] degrees F and an operating pressure of [_____] kPa[_____] psig. [Condensate] [high temperature hot water] return system with an operating temperature of [_____] degrees C[_____] degrees F and an operating pressure of [_____] kPa [_____] psig.

1.3.5 Rated Characteristics

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NOTE: The rated characteristics are to be used in the calculations for the system design and represent a "worst case". The rated conditions for the high temperature hot water return piping will be the same as for the supply. For "Installation Temperature" use the 99 percent Dry Bulb Temperature Winter Design Heating Data from the weather tables in UFC 3-400-02, Engineering Weather Data.
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Provide thermal expansion calculations for the supply and return piping using the following design characteristics and installation temperature. The system design conditions for [steam] [condensate] [high temperature hot water] supply and/or return must be a temperature of 232 degrees C 450 degrees F and a pressure of 4.58 kPa 665 psig. For calculation purposes, ensure the installation temperature is not higher than the ambient temperature at the site: [_____] degrees C F.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Heat Distribution System; G, [_____]

SD-03 Product Data

Interruption of Existing Service; G, [_____]

Work Plan; G, [_____]

Quality Assurance Plan; G, [_____]

UHDS Manufacturer's Representative Reports

Piping, Pipe Fittings, and Insulation

SD-05 Design Data

Pipe-Stress and System-Expansion Calculations; G, [_____]

Design Life Calculations for the Cathodic Protection System; G, [_____]

Manufacturer's Data Sheets; G, [_____]

SD-06 Test Reports

Thermal Performance Test; G, [_____]

Operational Test; G, [_____]

Tests; G, [_____]

Test of WSL Systems for Steam Service; G, [_____]

Test of WSL Systems for Condensate Return Service; G, [_____]

SD-07 Certificates

Manufacturer; G, [_____]

Manufacturer's Representative; G, [_____]

UHDS Design; G, [_____]

Certificate of Compliance; G, [_____]

Testing Firm; G, [_____]

Welding; G, [_____]

SD-10 Operation and Maintenance Data

Heat Distribution System; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Manufacturer

The UHDS manufacturer is the company responsible for the design and manufacture of the pre-engineered system. Submit certification of past experience stating that the UHDS manufacturer regularly and currently manufactures direct-buried systems, and that the designs of the system and equipment to be provided for this project conform to specification requirements. Submit an original certification signed by a principal officer of the UHDS manufacturer at least [2 weeks][_____] prior to the start of work; indicate the location, type of system, size of system, point of contact (POC) including phone number, for information verification. The UHDS manufacturer directs the installation of the system and has a representative on the jobsite; submit a Work Plan indicating when various items of work and tests are to be carried out and when its representative will be present at the job site. The Contractor must submit a proposed schedule of activities, no later than [7][_____] days after notice to proceed. The manufacturer must submit a list of characteristics indicating what defects or damage will necessitate replacement. The manufacturer must submit a Quality Assurance Plan not later than [7][_____] days after notice to proceed for fabrication, delivery, storage, installation and testing of the system. The manufacturer must submit manufacturer's data sheets for all coatings and indicating thicknesses of insulation for carrier pipes.

1.5.2 Manufacturer's Representative

Submit a letter from the system manufacturer, at least [2 weeks][_____] prior to the start of work, listing the experience and training of the manufacturer's representative, who must be a person who regularly performs the duties specified, is certified in writing by the UHDS manufacturer to be technically qualified and experienced in the installation of the system, and authorized by the manufacturer to make and sign the daily reports specified. The UHDS manufacturer's representative must be under the direct employ and supervision of the UHDS manufacturer.

1.5.3 Corrosion Engineer

Corrosion engineer refers to a person who, by knowledge of the physical sciences and the principles of engineering and mathematics acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control. Such person is permitted to be a licensed professional corrosion engineer or certified as being qualified by the National Association of Corrosion Engineers (NACE), if such licensing or certification includes 3 years experience in corrosion control on underground metallic surfaces of the type under this contract. NACE certification must be technologist, corrosion specialist, or cathodic protection specialist. The corrosion engineer must make at least 3 visits to the project site. The first of these visits must include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the Contractor the type of cathodic protection required. Once the submittals are approved and the materials delivered, the corrosion engineer must revisit the site to ensure the Contractor understands installation practices and laying out the components. The third visit must involve testing the installed cathodic protection systems and training applicable personnel on proper maintenance techniques. The corrosion engineer must supervise, inspect, and test the installation and performance of the cathodic protection system.

1.5.4 Testing Firm

Submit a Certificate of Qualification from the independent testing firm or firms, not later than [7][_____] days after notice to proceed. The Testing Firm must be able to certify that: weld examination methods and procedures, and the interpretation of radiographic films will be performed in accordance with ASME B31.1; the firm intends to utilize the proper film exposure, techniques, and penetrameter to produce density and geometric sharpness in sufficient clarity to determine presence of defects; and that all radiographic films will be reviewed and interpreted, and reading reports signed, by not less than a Certified American Society for Nondestructive Testing Level III Radiographer.

1.5.5 Contract drawings

The contract drawings accompanying this specification provide information on:

a. The size of carrier pipes, approximate length, and site location of the system.

b. The routing and elevation of the piping along the route.

c. Location and design of manholes.

d. The obstacles that must be avoided along the path.

e. Location of piping anchors.

f. Operating pressure and temperature of system.

1.6 DELIVERY, STORAGE, AND HANDLING

Maintain equipment and material placed on the job in the custody of the

Contractor until final acceptance whether or not the Contractor has been reimbursed for the equipment and material by the Government. The Contractor is solely responsible for the protection of the equipment and material against damage from any source while stored or during installation. Protect materials against damage from UV light, and entry of water and mud, by installing watertight protection on open ends at all times. Immediately replace sections of the casing or carrier piping found to have been subjected to full or partial submergence in water (which would allow the insulation to become wet). Cover materials awaiting installation to protect from UV degradation.

1.7 SITE CONDITIONS

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NOTE: A site survey must be made of the proposed routing of the UHDS. It is important that the site survey report include the identification, location, and depth of all existing underground utilities and structures as well as all aboveground utilities, roadways, structures, etc. Classification of the site conditions will be used to determine the type of system to be used: a drainable, dryable, testable (DDT) system should be allowed in severe, bad, and moderate site conditions; a water-spread-limiting (WSL) system should be allowed in bad and moderate site conditions for steam and condensate return systems only. Check with CECW-ETV before including WSL system in a project specification. A PIPI system should be allowed in moderate site conditions. PIPI systems may also be used in bad sites where the water table is expected to never rise above the system. Remove these paragraphs if the survey will be done by the Government.

A soils engineer, familiar with the underground water conditions onsite, should be employed to establish the site classification. Site parameters are defined in the UFC 3-430-09 "Exterior Mechanical Utility Distribution" Chapter 3 Site Classification Criteria Table. If underground water conditions at the site are not available, a detailed site classification survey will be made and the UFC 3-430-09 "Exterior Mechanical Utility Distribution" Chapter 3 Site Classification Criteria Table will be utilized to establish the site classification. This survey should be conducted within the framework of the requirements in UFC 3-430-09.

The results from the completed site survey are to be indicated below.

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Classification of the site conditions for the UHDS are based on ASTM D2487 and the site classification criteria indicated in UFC 3-430-01. The project Site Classification is Class [A-Severe][B-Bad][C-Moderate][D-Mild].

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide for this project a designed system and equipment which is of current production and that essentially duplicate systems that have been in satisfactory use for at least 5 years prior to bid opening at 3 locations. Provide systems that have been operated under pressure, temperature and site characteristics which are equal to or more severe than the operating conditions in this specification and that have distributed the same medium. Ensure the system is supported by a service organization that can reach the site after a service call within [48][_____] hours. Submit cut sheets for piping, pipe fittings, and insulation to be used in this system.

2.2 FACTORY FABRICATED, DIRECT-BURIED DDT SYSTEMS

2.2.1 DDT Steam and High Temperature Hot Water Carrier Pipes

Requirements are in accordance with paragraph HEAT DISTRIBUTION PIPING.

2.2.2 DDT Condensate Carrier Pipes

Provide steel, schedule 80 carrier piping for condensate return systems. Pipe requirements are in accordance with paragraph HEAT DISTRIBUTION PIPING. Do not locate condensate carrier pipes in conduit casings which contain steam pipes or any other piping.

2.2.3 DDT Carrier Pipe Insulation

Provide carrier pipe insulation conforming to minimum thicknesses and type listed in Tables 1 and 2 as required for temperature specified under paragraph Rated Characteristics.

2.2.4 Insulation Banding and Scrim

Use stainless steel bands and clips, at least 13 mm 1/2 inch wide, conforming to ASTM A240/A240M (304 stainless steel), at a maximum spacing of 460 mm 18 inches over the scrim to secure the insulation onto the carrier pipe; use a minimum of two bands for each 1300 mm 4 foot section of insulation. Scrim must be vinyl-coated fiberglass with 18 x 16 mesh (number of filaments per 25 mm 1 inch) and made of 0.335 mm 0.013 inch diameter vinyl-coated fibrous glass yarn.

2.2.5 Casing

Provide casing consisting of smooth-wall steel, electric resistance spiral welded, conforming to ASTM A134/A134M, ASTM A135/A135M, or ASTM A139/A139M and the values tabulated below. Provide eccentric connectors between casing sections as needed to provide drainage of casing section between manholes and between manholes and buildings.

Casing Diameter (mm) (inches)	Minimum Thickness (mm) (inch)
150 - 660 6 - 26	6.35 0.250
675 - 900 27 - 36	6.35 0.250
940 - 1050 37 - 42	6.35 0.250

Casing Diameter (mm) (inches)	Minimum Thickness (mm) (inch)
1170 46	6.35 0.250

2.2.6 Casing End Plates, Vents, and Drains

****

NOTE: Designer must accommodate 25 mm 1 inch vent pipe in the design of the manhole.

****

Make end plates of ASTM A36/A36M steel, minimum thickness 13 mm 1/2 inch for conduit pipe sizes above 300 mm 12 inches and 9.5 mm 0.375 inches for conduit pipe sizes 300 mm 12 inches and less. Provide a 25 mm 1 inch ASTM A53/A53M, schedule 40, galvanized vent riser pipe on the end plate, vent opening. Extend vent pipe to top of manhole and terminate 300 mm 12 inches above grade with a 180 degree bend. Provide a 25 mm 1 inch drain at the bottom and vent at the top. Provide brass plugs and half coupling, constructed with welded steel and weld to the end plate; plug drains; do not plug vents.

2.2.7 Air Space

Provide continuous 25 mm 1 inch minimum air space between carrier pipe insulation and casing.

2.2.8 Casing Coating

Coating must be rated for a minimum of 25 years by the manufacturer for continuous service at a temperature of 110 degrees C 230 degrees F. Apply coating in accordance with the coating manufacturer's instructions, factory inspect for holidays and repair as necessary.

2.2.8.1 Fusion-Bonded Epoxy

Use fusion-bonded epoxy casing coating with a minimum thickness of 1 mm 0.04 inches.

2.2.8.2 Urethane Elastomer

Use urethane elastomer coating with a minimum thickness of 1 mm 0.04 inches.

2.2.9 Coating of End Plates and Conduit Extending into Manholes

Coat end plates and conduit extending into manholes with a zinc-rich coating conforming to AASHTO M 300 Type IA, except that volatile organic compounds must not exceed 0.34 kg/L 2.8 pounds/gallon. Apply zinc-rich coating in accordance with the coating manufacturer's requirements including surface preparation. Do not apply additional top coat.

2.2.10 Carrier Pipe Guides

Space carrier pipe guides 3 m 10 feet on centers maximum, no more than 1.5 m 5 feet from pipe ends, with a minimum of three guides per elbow section. Design guides to allow thermal expansion without damage, provide proper pipe guiding, and to allow horizontal movement in two directions as required at expansion loops and bends. Design supports to permit flow of water and air vapor through the support. Extend pipe insulation through the pipe guides and protect by steel sleeves. Design guides to negate metal-to-metal contact between the casing and the carrier pipe. Do not compress insulation or non-metallic material used to ensure no metal-to-metal contact by the weight of the carrier pipe when full of water.

2.2.11 Anchor Plates

Anchor plate must be ASTM A36/A36M steel, welded to carrier pipe and casing, 13 mm 1/2 inch minimum thickness, with passages for air flow and water drainage through the annular air space in the system. Coat exterior surface of the anchor plate with the same coating material as the casing.

2.2.12 Field Connection of Casing Sections

Field connect casing using a compatible steel section, welded to casing sections, coated on all surfaces with UHDS manufacturer's coating field repair compound, and covered with a 1.3 mm 0.05 inch minimum thickness polyethylene shrink sleeve designed for a service temperature exceeding 80 degrees C 176 degrees F.

2.2.13 Manufacturer's Identification

Provide embossed brass or stainless steel tag, hung by brass or stainless steel chain at each end of each conduit or insulated piping in the manholes and buildings. Identify UHDS manufacturer's name, date of installation, Government contract number, and manufacturer's project number.

2.3 FACTORY FABRICATED, DIRECT-BURIED WSL SYSTEM

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NOTE: Contact HQ before allowing this system to be in the contract.

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2.3.1 WSL Steam and Carrier Pipes

Pipe material requirements must be in accordance with paragraph HEAT DISTRIBUTION PIPING. Provide steel pipe with the ends machined and metallized to provide a satisfactory sealing surface for the sealing rings. The metallizing must be a high nickel alloy applied to an excess thickness and then machined to the required OD.

2.3.2 WSL Condensate Carrier Pipes

Carrier piping for condensate return systems must be steel, schedule 80. Pipe requirements must be in accordance with paragraph HEAT DISTRIBUTION PIPING. Do not locate condensate piping in casings which contain any other piping.

2.3.3 Casing for Steam and Condensate

Provide casing consisting of reinforced thermosetting resin pipe (RTRP) manufactured by the filament winding process. Ensure casing pipe is wound to meet ASTM D2310 classification RTRP and ASTM D2996. Provide a polyester isothalic resin. Coat the outer surface with a pigmented, protected resin containing a paraffinated wax and ultraviolet inhibitors. Casing thickness is as follows:

Carrier Pipe Size (mm) (Inches)	Casing Thickness (mm) (Inches)
50 2	5 0.185
80 3	5 0.185
100 4	5 0.185
150 6	6.5 0.250
200 8	6.5 0.250
250 10	6.5 0.250
300 12	6.5 0.250

2.3.4 Pipe Coupling, Steam

Provide a multi-stage seal coupling designed to accommodate the expansion and contraction of the system in the coupling. Provide coupling consisting of corrosion resistant materials capable of handling the design characteristics of the system listed in paragraph Rated Characteristics. Specifically design the annular seals and carrier pipe ends to protect the seals and resist abrasion due to lateral loads in the system.

2.3.5 Pipe Coupling, Condensate

Provide coupling of a single stage seal design to accommodate the expansion and contraction of the adjacent pipes. Provide coupling consisting of corrosion resistant materials capable of handling the design characteristics of the system listed in paragraph Rated Characteristics. Specifically design the annular seals and carrier pipe ends to protect the seals and resist abrasion due to lateral loads in the system.

2.3.6 WSL Carrier Pipe Insulation

Provide insulation conforming to minimum thicknesses and type listed for WSL systems in Tables 1 and 2 as required for temperature in carrier pipe. Provide insulation consisting of an inner layer of high temperature calcium silicate and an outer layer of polyurethane foam.

2.3.6.1 Calcium Silicate for Steam Systems

Provide calcium silicate insulation consisting of a hydrous material satisfactory for temperatures to 650 degrees C 1200 degrees F. Ensure calcium silicate insulation conforms to ASTM C533. The physical properties are as follows:

a. Density (dry): 208 kg/cubic meter 13 pcf (minimum).

b. Compressive Strength to produce 5 percent compression: 1723 kPa 250 psi (For 37 mm 1.5 inch thick sample).

c. Maximum linear shrinkage after 24 hour soaking period at 650 degrees C 1200 degrees F: 1.1 percent

d. Maximum Thermal Conductivity k: k = W/(meter*K) k =

e. BTU-IN/HR-FT2-DEG.F). Where k varies with temperature as shown:

Mean Temp (degrees C F)	k
38 100	0.04 0.38
93 200	0.04 0.41
149 300	0.04 0.44
204 400	0.04 0.48

2.3.6.2 Polyurethane Foam for Steam and Condensate Systems

Provide polyurethane foam conforming to ASTM C591. Completely fill the annular space between the calcium silicate insulation and the casing for the steam pipe and between the carrier pipe and the casing for condensate return system with the polyurethane foam. Use polyurethane foam insulation that meets the following requirements:

a. Type: Two component urethane.

b. Compressive Strength: 172 kPa 25 psi parallel to rise (minimum at 50 percent compression).

c. Shrinkage: None at -1 to 21 degrees C 30 to 70 degrees F.

d. Free Rise Density: 32 kg/cubic meter 2 pcf.

e. Maximum aged k (32 degrees C 90 degrees F at 90 percent RH for 72 hours): 0.02 W/mK 0.14 (BTU-IN/HR FT2-DEG. F) at 24 degrees C 75 degrees F, when tested in accordance with ASTM C518.

f. Minimum Closed Cell Content: 90 percent

2.3.6.3 Insulation Concentricity

Ensure carrier pipe is concentric in relation to the casing pipe. The allowable maximum deviation from center line of the carrier pipe is plus or minus 6 mm 1/4 inch at the casing center point and plus or minus 1.5 mm 1/16 inch at the end seals.

2.3.6.4 Insulated Fittings

Provide fittings that are pre-insulated by manufacturer using the same insulation thickness and casing as the straight sections.

2.3.6.5 Coupling Insulation for Steam Systems

Use material composed of refractory composite to lock the bronze coupling in the casing. Ensure the approximate minimum conductivity of this material is 0.2 W/(m*K) 1.6 (BTU/HR/F/IN DEG.F) at a mean temperature of 1260 degrees C 2300 degrees F.

2.3.6.6 Coupling Insulation for Condensate

Insulate the coupling with polyurethane foam as specified. Use an insulation thickness equal to the carrier pipe insulation. Encase the coupling in the same casing as the pipe.

2.3.7 Manufacturer's Identification

Provide an embossed brass tag hung by a brass chain, or a stainless steel tag hung by a stainless steel chain, at each end of each casing or insulated piping in the manholes and buildings. Identify UHDS manufacturer's name and date of installation.

2.3.8 End Seals

Each preinsulated section of piping must completely seal the insulation, providing a permanent water and vapor seal at each end. Provide preinsulated factory fabricated sections of piping modified in the field with an end seal which is equivalent to the end seals furnished with the preinsulated section of piping. Conduct tests by the UHDS manufacturer to demonstrate that casings, couplings and end seals are capable of resisting penetration of water into the casing and insulation under rated conditions. Perform tests on each type of pre-fabricated system to be furnished, and verify the test results by an independent testing laboratory. Test and certify the steam systems in accordance with paragraph Test of WSL Systems for Steam Service. Test and certify the condensate return system in accordance with paragraph Test of WSL Systems for Condensate Return Service.

2.3.8.1 End Seals for Steam Service

Provide elastomer-ring type end seals designed and dimensioned to fit in the annular space between the casing and the carrier pipe. Use multi-polymer alloy film type tape, which is compatible with synthetic elastomeric tape and suitable for cold application, for covering field repair joints.

2.3.8.2 End Seals for Condensate Return Service

Provide one of the following types of end seals:

a. Carrying the outer casing over tapered pipe insulation ends and extending it to the carrier pipe. Provide sufficient surface bonding area between the casing and the carrier pipe.

b. Using specially designed molded caps made of polyethylene or rubber of standard manufactured thickness. Provide a minimum 40 mm 1-1/2 inch surface bonding area between the cap and both the casing and carrier pipe.

c. Using elastomer-ring end seals designed and dimensioned to fit in the annular space between the casing and the carrier pipe.

d. Using a waterproof mastic seal vapor barrier over the exposed insulation ends.

e. Shrink sleeves.

2.3.9 Test of WSL Systems for Steam Service

Demonstrate that the WSL system will operate successfully for 25 years under typical operating conditions. Conduct tests in both a dry and wet environment. Provide WSL system as described in the manufacturer's brochure. Conduct the testing program described below at the expense of the WSL system manufacturer. Ensure tests are witnessed and verified by an independent testing laboratory. Hydrostatically test the entire pre-insulated test section with water to 2600 kPa 375 psig (1.5 times the rated pressure) before and after temperature cycling. Conduct tests in a dry environment for 60 cycles followed by a test in a wet environment for 60 cycles for a total of 120 cycles. The test in the wet environment demonstrates resistance to ground water infiltration. Conduct all tests on one test section and complete all testing in one time period (approximately 6 weeks) and continue the 120 testing cycles except for weekend time periods.

2.3.9.1 Apparatus

Use a curved bottom test tank at least 3.7 m 12 feet long, 0.8 m 32 inches wide, 0.8 m 32 inches deep. Fit the tank with a gasketed and bolted cover to pressurize the tank to 60 kPa 8.67 psig. Provide a drain at the lowest point and a vent at the highest point. Centrally locate manhole entrance sleeves (i.e. wall sleeves through the ends of the tank to simulate manhole entries in actual field conditions) on each end of the tank. Include the following auxiliary equipment: Steam supply with sufficient capacity to satisfy testing requirements, makeup water tank and pump, and a means for continuously recording temperatures and pressures at needed locations. Use thermocouples to record temperatures at the following points:

a. Carrier pipe at tank inlet (in thermowell).

b. Casing at mid-point in pipe length (on casing).

c. Casing at anchor point (above FRP overwrap on plate).

d. Casing at field joint (repair, on casing).

e. Casing at coupling mid-point (on casing).

f. End seal flange at coupling (on elastomer).

g. Outer edge of new end plate (at steel plate and FRP wrap).

h. Carrier pipe at specimen outlet end (in thermowell).

i. Interface of calcium-silicate and polyurethane insulations.

Ensure surface thermocouples are epoxied to the surface of the casing. Check and record the calibration of the thermocouples prior to installation and record within 0.06 degree C 0.1 degree F resolution. Provide pressure transmitter(s) to record pressure in the test tank and carrier pipe internal pressure, at the inlet to test specimen.

2.3.9.2 Test Section

Provide a 100 mm 4 inch steel carrier pipe test section consisting of 8 m 27 feet of pre-insulated pipe meeting specified materials and design requirements. Encase approximately 3.7 m 12 feet of the test section within the tank as described below. Provide test section within the tank consisting of an expansion coupling, field repair joint, anchor plate, anchor block and end seals. Install the test section (as directed) on at least 280 mm 11 inches of firmly tamped sand. Surround the casing with sand, and ensure the top surface of the sand is no farther than 100 mm 4 inches from the top of the tank. Anchor the test section to the tank wall at one end and the building floor at the other end on the portion of the pipe external to the tank. The expansion coupling must be misaligned by 1.5 degrees in the horizontal plane. Introduce sand (118 mL 4 fluid oz) into the carrier pipe and disburse throughout the test loop at startup.

2.3.9.3 Resistance to Water Damage and Joint Leakage

This test must simulate the operation of the WSL system to assure the system will provide successful service life through its expected life span. Test the system in steam service by cycling for an extended period of time, as described below. Deem system performance successful if there is no joint leakage, deformation of the casing, deterioration of the end seals, or any other deleterious effects.

a. Subject the piping system to 60 cycles of steam introduced into the system while at ambient temperature 38 degrees C 100 degrees F up to a temperature of 207 degrees C 406 degrees F (as measured at the core pipe at the tank inlet and tank outlet) and back to ambient temperature. Hold the system at 207 degrees C 406 degrees F minimum for a minimum of 30 minutes, each cycle. Continue this cycling for 60 cycles in dry sand followed by 60 cycles in a saturated environment. Allow the reduction in temperature to 38 degrees C 100 degrees F to occur naturally with no artificial means of cooling used.

b. Ensure results conform to paragraph Criteria for Satisfactory Results and Reporting.

2.3.9.4 Resistance to Mechanical or Structural Damage

This test must simulate loads induced by truck traffic over pipe, which can occur under actual operating conditions. Conduct this test commencing with the 41st cycle of the resistance to water damage and joint leakage test and continue through the 60th cycle. Continue other aspects of the resistance to water damage and joint leakage test simultaneously with this test.

2.3.9.4.1 Apparatus

Same as for apparatus used in resistance to ground water infiltration test with the addition of a 96 kPa 2000 psf loading device. Use a hydraulic jack to apply the test pressure against a 500 by 500 mm 18 by 18 inch plate bearing on the sand directly over the coupling in the tank.

2.3.9.4.2 Procedure

Apply a steady and constant vertical load of 96 kPa 2000 psf to the plate for 14 days during the test. Install the test section as in the resistance to ground water infiltration test. During the 14 day loading period, circulate steam through the carrier pipe alternately at ambient and 207 degrees C 406 degrees F as in earlier test.

2.3.9.4.3 Results

Requirements must be in accordance with paragraph Criteria for Satisfactory Results and Reporting.

2.3.9.5 Resistance to Ground Water Infiltration

This test is the wet environment test conducted during the second 3 weeks (61st to 120th cycles) of the test period to show that the WSL system will resist the penetration of ground water into the system.

2.3.9.5.1 Apparatus

Same as for basic apparatus used in Resistance to Water Damage and Joint Leakage phase test, plus the following:

a. One 200 L 50 gallon water reservoir with a 0 to 206 kPa 0 to 30 psig pressure gauge and compressed air connection.

b. Provisions to introduce pressurized red dye into the curved bottom test tank. Mix the water/dye solution to a concentration in accordance with the dye manufacturer's recommendation for maximum detectability.

c. One pressure tank with 0 to 206 kPa 0 to 30 psig static pressure gauge.

2.3.9.5.2 Procedure

Start this phase on the 61st cycle and continue until the 120th cycle. The test section of pipe must be the same test segment used in the previous tests. Bolt the tank cover in place and begin the resistance to ground water infiltration test. Attach the water/dye source to the fill fitting and attach a surge tank to the vent with a tee fitting. Attach a 0 to 206 kPa 0 to 30 psig static pressure gauge to the pressure tank. The other branch of the tee fitting must employ a shut-off valve. With the shut-off valve open, admit the water/dye mixture into the tank through the fill fitting until the tank is full and water/dye runs freely from the open valve. Close the valve and continue filling until the pressure reaches 60 kPa 8.67 psig. Maintain the tank pressure throughout the test period. Circulate steam through the carrier pipe and cycle from ambient to 207 degrees C 406 degrees F as in the previous test. At the end of the test, relieve the pressure by opening the vent valve and drain the water/dye from the tank through the drain fitting.

2.3.9.5.3 Results

Requirements must be in accordance with paragraph Criteria for Satisfactory Results and Reporting.

2.3.9.6 Criteria for Satisfactory Results and Reporting

2.3.9.6.1 Reporting

Record logs of times and temperature to assure compliance with test requirements and procedures. Produce complete photographic documentation of the construction and operation of the test facility, as well as the piping system components before and after testing. Analyze data to assure complete compliance with test objectives.

2.3.9.6.2 Drawing

Provide a drawing showing details of the test apparatus and test specimen.

2.3.9.6.3 Resistance to Water Damage and Joint Leakage Test

Remove joints and end seals for examination, immediately upon completion of all test cycles. Successful results must show that steam has not leaked out of the carrier pipe and that the components show no signs of deterioration.

2.3.9.6.4 Resistance to Mechanical or Structural Damage Test

At the end of testing, inspect the casing for damage or deformation which would impair the functionality of the system. Successful test results consist of no ruptures in the casing, the casing has not deformed more than 25 mm 1 inch in any direction, and no separation has occurred between the casing and the pipe anchor interface.

2.3.9.6.5 Resistance to Ground Water Infiltration Test

Determine no water/dye solution has penetrated the insulation. This test is determined by removing and inspecting all joints and seals for dye penetration at the end of the test. Results will be deemed successful if no dye solution is evident in the insulation.

2.3.9.6.6 Evidence of Test Results

After completion of all tests, dismantle the test apparatus for visual inspection of all critical components subjected to the heat cycling, water infiltration and loading tests. All parts will be examined thoroughly for any detrimental affects. Conduct identified examinations. Keep log sheets, test data and color photographs on file and make available as required to document and substantiate compliance to the test requirements.

2.3.9.6.7 Report

Submit a report from the independent testing agency. The report must include the laboratory analysis of the condition of the test section and attest that the testing conditions were followed.

2.3.10 Test of WSL Systems for Condensate Return Service

Submit test reports in booklet form showing all factory and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Use testing and certification procedures by an independent testing laboratory to demonstrate that casings and end seals are capable of resisting penetration of water into the casing and insulation. Perform the test on the type of prefabricated system to be furnished. If more than one type of prefabricated system is to be used, perform the tests on each type. Perform test consisting of hot and cold cycle testing followed by immersion in a water filled chamber with a head pressure. The hot and cold cycle testing must consist of 14 days of temperature cycling.

a. Circulate a fluid with a temperature of 5 degrees C 40 degrees F through the carrier pipe, alternating every 24 hours with a fluid with a temperature of 95 degrees C 200 degrees F circulating through the carrier pipe for a low temperature hot water or dual temperature service, or 24 degrees C 75 degrees F for a chilled water service.

b. While the hot and cold cycle test is being performed, either bury or encase the test sample in dry bedding sand with a minimum of 300 mm 12 inches of sand all around the test sample. Ensure the carrier pipe size of the test sample is 75 mm 3 inches in diameter and restrain during the test period. The insulation thickness must not exceed the maximum thickness provided for the piping in the project.

c. Transition time for temperature cycle testing must not exceed 15 minutes in going from cold to hot and 30 minutes in going from hot to cold. The fluid in the carrier pipe may be water, oil or heat transfer fluid. Following the hot and cold cycling test, immerse the test sample in a water filled chamber. The pressure on the highest point of the test sample must not be less than 60 kPa 20 feet of water head pressure subjected over the entire length of the 2.4 m 8 foot test sample of prefabricated pipe.

d. Use water containing a dye penetrant to check for end seal leakage. Hold the pressure in the chamber for no less than 48 hours. Upon completion of this pressure test, cut open the test sample. With the use of a light that will readily show the presence of the dye that was in the water, inspect the test sample. Evidence of the dye inside the test sample indicates that the end seal is not acceptable and cannot be certified.

2.4 WATER SPREAD LIMITING POURED-IN-PLACE INSULATION (PIPI) SYSTEM

2.4.1 PIPI Steam and High Temperature Hot Water Carrier Pipes

Requirements must be in accordance with paragraph HEAT DISTRIBUTION PIPING.

2.4.2 PIPI Condensate Carrier Pipes

Provide steel, schedule 80 carrier piping for condensate return systems. Ensure pipe requirements are in accordance with paragraph HEAT DISTRIBUTION PIPING.

2.4.3 PIPI Carrier Pipe Insulation

Provide carrier pipe PIPI conforming to minimum thickness and type listed in Tables 1, 1A, 2, and 2A as required for temperature specified under paragraph Rated Characteristics.

2.4.4 Poured-in-Place Insulation - Physical Properties

Provide poured-in-place insulation consisting of calcium carbonate powder chemically modified to be hydrophobic with no particles exceeding 1 mm in any dimension. The installed density must fall in the range of 960 to 992 kg/cubic meter 40 to 62 lb/cubic foot when tested in accordance with ASTM D1895. Perform additional product testing at the identified installed density in accordance with ASTM C177.

2.4.5 Poured-in-Place Insulation - Thermal Properties

The thermal conductivity of the PIPI must not exceed 0.083 W/mK 0.58 Btu-in/hr-square foot-degree F at 37.8 degrees C 100 degrees F, and 0.099 W/mK 0.68 Btu-in/hr-square foot-degree F at 149 degrees C 300 degrees F, when tested in accordance with ASTM C177.

2.4.6 Poured-in-Place Insulation - Electrical Properties

Ensure the electrical resistivity of the PIPI is not less than 1 by 10 to the 12th power ohm-cm.

2.4.7 PIPI System Piping Anchors, Supports, and Guides

Ensure the design and location of pipe anchors, pipe supports, pipe guides, and expansion cushions are in compliance with the most recent design manual available from the PIPI manufacturer.

2.4.8 PIPI Envelope Penetrations

Design penetrations through the PIPI envelope in compliance with the most recent design manual available from the PIPI manufacturer. Coat all pipe anchors, pipe supports, pipe guides and manhole walls that come in contact with the PIPI with a mastic compound. For pipe service temperatures up to 204 degrees C 400 degrees F, use a mastic compound consisting of bitumastic coal tar. For pipe service temperatures in excess of 204 degrees C 400 degrees F, use silicone grease.

2.5 PIPE INSULATION TYPE AND MINIMUM THICKNESS

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NOTE: Delete inapplicable columns in Tables 1 and 2.

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Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Materials containing asbestos will not be permitted. The minimum thickness of insulation for the heat distribution system must be in accordance with Tables 1, 1A, 2, and 2A in which the insulations listed have passed the 96 hour boiling water test. If PIPI Manufacturer has installation requirements which exceed minimum thickness of material within Tables 1A and Table 2A. Comply with the Manufacturers installation requirements.

TABLE 1
MINIMUM PIPE INSULATION THICKNESS (mm) (Inches)

For Steam (100 to 2,800 kPa (gage)) (16 to 408 psig) and High Temperature Hot Water Supply and Return (120 to 230 degrees C) (250 to 450 degrees F)

	INSULATIONS for Drainable/Dryable Systems		INSULATIONS for Other Pre-Engineered Systems	
Nominal Pipe Diameter (mm) (inches)	Aerogel ASTM C1728 Type III Grade 1A	Mineral Wool ASTM C547 Type III Grade A	Calcium Silicate	WSL Polyurethane
25 1.0	25 1.0	75 3.0	N/A	N/A
40 1.5	35 1.5	75 3.0	N/A	N/A
50 2.0	35 1.5	75 3.0	N/A	N/A
65 2.5	35 1.5	75 3.0	N/A	N/A
80 3.0	35 1.5	75 3.0	35 1.5	+31 +1.23

TABLE 1
MINIMUM PIPE INSULATION THICKNESS (mm) (Inches)

For Steam (100 to 2,800 kPa (gage)) (16 to 408 psig) and High Temperature Hot Water Supply and Return (120 to 230 degrees C) (250 to 450 degrees F)

	INSULATIONS for Drainable/Dryable Systems		INSULATIONS for Other Pre-Engineered Systems	
Nominal Pipe Diameter (mm) (inches)	Aerogel ASTM C1728 Type III Grade 1A	Mineral Wool ASTM C547 Type III Grade A	Calcium Silicate	WSL Polyurethane
100 4.0	50 2.0	85 3.5	35 1.5	+31 +1.23
125 5.0	50 2.0	85 3.5	N/A	N/A
150 6.0	50 2.0	85 3.5	35 1.5	+34 +1.34
200 8.0	50 2.0	85 3.5	50 2.0	+30 +1.21
250 10.0	50 2.0	100 4.0	65 2.5	+33 +1.31
300 12.0	50 2.0	100 4.0	50 2.0	+32 +1.29
350 14.0	50 2.0	100 4.0	N/A	N/A
400 16.0	50 2.0	100 4.0	N/A	N/A
450 18.0	50 2.0	100 4.0	N/A	N/A

TABLE 1A
MINIMUM PIPI THICKNESS (mm) (Inches)

For Steam (100 to 2,800 kPa (gage)) (16 to 408 psig) and High Temperature Hot Water Supply and Return (120 to 230 degrees C) (250 to 450 degrees F)

Nominal Pipe Diameter (mm) (inches)	Sides and Bottom	Between Pipes	Above Pipes
25 1.0	100 4.0	50 2.0	200 8.0
40 1.5	100 4.0	50 2.0	210 8.5
50 2.0	100 4.0	50 2.0	210 8.5
65 2.5	100 4.0	50 2.0	225 9.0
80 3.0	100 4.0	50 2.0	225 9.0

TABLE 1A MINIMUM PIPI THICKNESS (mm) (Inches)			
For Steam (100 to 2,800 kPa (gage)) (16 to 408 psig) and High Temperature Hot Water Supply and Return (120 to 230 degrees C) (250 to 450 degrees F)			
Nominal Pipe Diameter (mm) (inches)	Sides and Bottom	Between Pipes	Above Pipes
100 4.0	125 5.0	50 2.0	275 11.0
125 5.0	125 5.0	75 3.0	275 11.0
150 6.0	150 6.0	75 3.0	340 13.5
200 8.0	150 6.0	100 4.0	350 14.0
250 10.0	150 6.0	100 4.0	360 14.5
300 12.0	175 7.0	100 4.0	425 17.0
350 14.0	175 7.0	100 4.0	425 17.0
400 16.0	200 8.0	125 5.0	490 19.5
450 18.0	200 8.0	125 5.0	490 19.5

TABLE 2 MINIMUM PIPE INSULATION THICKNESS (mm) (Inches) CONDENSATE RETURN			
	INSULATIONS for Drainable/Dryable Systems		INSULATIONS for Other Pre-Engineered Systems
Nominal Pipe Diameter (mm) (inches)	Aerogel ASTM C1728 Type III Grade 1A	Mineral Wool ASTM C547 Type III Grade A	Polyurethane
25 1.0	25 1.0	35 1.5	N/A
40 1.5	25 1.0	35 1.5	N/A
50 2.0	25 1.0	35 1.5	19 0.77
65 2.5	25 1.0	35 1.5	N/A
80 3.0	25 1.0	50 2.0	26 1.05

TABLE 2 MINIMUM PIPE INSULATION THICKNESS (mm) (Inches) CONDENSATE RETURN			
	INSULATIONS for Drainable/Dryable Systems		INSULATIONS for Other Pre-Engineered Systems
Nominal Pipe Diameter (mm) (inches)	Aerogel ASTM C1728 Type III Grade 1A	Mineral Wool ASTM C547 Type III Grade A	Polyurethane
100 4.0	25 1.0	50 2.0	26 1.05
125 5.0	25 1.0	50 2.0	N/A
150 6.0	25 1.0	63 2.5	30 1.32
200 8.0	25 1.0	63 2.5	N/A
250 10.0	25 1.0	76 3.0	N/A
300 12.0	25 1.0	76 3.0	N/A
350 14.0	25 1.0	76 3.0	N/A
400 16.0	25 1.0	76 3.0	N/A
450 18.0	25 1.0	76 3.0	N/A

TABLE 2A MINIMUM PIPI THICKNESS (mm) (Inches) CONDENSATE RETURN		
Nominal Pipe Diameter (mm) (inches)	Sides and Bottom	Above
25 1.0	75 3.0	160 6.5
40 1.5	75 3.0	160 6.5
50 2.0	75 3.0	160 6.5
65 2.5	100 4.0	175 7.0
80 3.0	100 4.0	175 7.0
100 4.0	100 4.0	225 9.0
125 5.0	100 4.0	240 9.5

TABLE 2A
MINIMUM PIPI THICKNESS (mm) (Inches)
CONDENSATE RETURN

Nominal Pipe Diameter (mm) (inches)	Sides and Bottom	Above
150 6.0	100 4.0	240 9.5
200 8.0	125 5.0	300 12.0
250 10.0	150 6.0	310 12.5
300 12.0	150 6.0	360 14.5
350 14.0	175 7.0	375 15.0
400 16.0	175 7.0	375 15.0
450 18.0	175 7.0	440 17.5

2.6 HEAT DISTRIBUTION PIPING

2.6.1 Steam and High Temperature Hot Water Pipe

Pipe material must be steel; seamless ASTM A53/A53M, Grade B or ASTM A106/A106M, Grade B; or electric resistance welded ASTM A53/A53M, Grade B; Schedule 40. Standard weight will be permitted for pipe sizes 300 mm 12 inches and above. ASTM A53/A53M, Type F furnace butt welded pipe will not be allowed. Joints will not be allowed in factory fabricated straight section of carrier pipes. Provide factory fabricated piping sections, as part of an expansion loop or bend, with all welded joints 100 percent radiographically inspected in accordance with ASME B31.1. Ensure radiographs are reviewed and interpreted by a Certified American Society for Nondestructive Testing (ASNT) Level III radiographer, employed by the testing firm, who will sign the reading report.

2.6.2 Condensate Pipe

Pipe must be steel; seamless ASTM A53/A53M, Grade B or ASTM A106/A106M, Grade B, schedule 80; electric resistance welded ASTM A53/A53M, Grade B; Schedule 80. ASTM A53/A53M, Type F furnace butt welded pipe will not be allowed. Joints will not be allowed in the factory fabricated straight section of the carrier pipe. Provide factory fabricated piping sections, as part of an expansion loop or bend with all welded joints 100 percent radiographically inspected in accordance with ASME B31.1. Ensure radiographs are reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who will sign the reading report.

2.6.3 Joints

Provide butt-weld joints except socket-weld joints are permitted for pipe sizes 50 mm 2 inches and smaller. Dye penetrant may be used in place of 100 percent radiographic inspection for pipe sizes 50 mm 2 inches and below. Indicate location and elevation of all field joints on detailed design layout drawings. Split-ring welding rings may be used.

2.6.4 Fittings

Radiographically inspect welds in factory fittings. Ensure radiographs are reviewed and interpreted by a Certified ASNT Level III radiographer, employed by the testing firm, who will sign the reading report. The Contracting Officer may review all inspection records, and if any welds inspected are found unacceptable in accordance with ASME B31.1, remove, replace, and radiographically reexamine the fitting at no cost to the Government.

2.6.4.1 Butt-Welded

Fittings must be steel; ASTM A234/A234M, Grade B or ASME B16.9, same schedule as adjoining pipe. Provide long radius elbows unless otherwise indicated. Provide full size or reducing tees as required, with interior surfaces smoothly contoured. Split-ring welding rings may be used.

2.6.4.2 Socket-Welded

Use forged steel ASME B16.11; 13,800 kPa 2000 pound class fittings for pipe sizes 50 mm 2 inch and below. Dye penetrant inspection may be used in lieu of radiographic inspection of welded fittings for pipe sizes 50 mm 2 inches and below.

2.7 EXPANSION LOOPS AND BENDS

Ensure stresses are less than the maximum allowable stress from the Power Piping Code (ASME B31.1). Submit pipe-stress and system-expansion calculations for each expansion compensation elbow using a finite element computer generated 3 dimensional analysis, no later than [7 days] after notice to proceed. Demonstrate with calculations that pipe stresses from temperature changes are within the allowable requirements in ASME B31.1 and that the anchors and the guides will withstand the resultant forces. Include all analysis node points in the detailed design layout drawings. As a minimum, include node stresses, forces, moments and displacements in computer analysis results. Ensure calculations are stamped by a registered Professional Engineer in the employ of the UHDS manufacturer. Provide detailed design layout drawings and stress and anchor force calculations for all loops and bends. Show locations of all anchors, guides and supports. Base calculations on design characteristics (pressures and temperatures) specified for both the supply and return lines.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Job Conditions

Phasing of [demolition and construction] [construction] must be as shown on contract drawings.

3.1.2 Interruption of Existing Service

Submit schedule of proposed outages and interruptions of existing services, [14 days][_____] in advance. Arrange, phase and perform work and provide temporary facilities, materials, equipment, and connections to utilities, to ensure adequate heat distribution service for existing installations at all times. Only necessary interruptions required for making connections will be permitted, and only at times when approval is obtained from the Contracting Officer. All interruptions are to be scheduled with and approved by the Contracting Officer.

3.1.3 Grading

Unless otherwise shown on the contract drawings or the detailed design layout drawings, grade steam/condensate and high temperature hot water supply/return lines uniformly downward no less than 25.4 mm in 6.10 meters 1.0 inches in 20 feet to the lower point of entry between manholes and/or building entries.

3.1.4 Connecting to Existing Work

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NOTE: Any connections to the UHDS distribution will only occur in manholes. Designer must ensure that a thorough survey of the aboveground and underground conditions is performed. The contract drawings must identify all potential interferences or conflicts.

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Submit changes required to the UHDS design due to interferences or conflicts, upon realization of interferences or conflicts. Connect new work to existing work to complete piping connections that enable pressure tests with successful outcomes per the requirements of this specification. Make connections only in manholes. Where an existing structure must be cut or existing utilities interfere, bypass, remove, replace or relocate, restore and repair such obstructions. Obtain approval from the UHDS designer and the Contracting Officer for any changes required to the UHDS design as a result of interferences or conflicts. Restore disturbed or damaged work to its prior condition.

3.1.5 Coordination

Coordinate the location of all items of equipment and work of all trades. Maintain operability and maintainability of the equipment and systems.

3.1.6 Variations

Submit any variations from the approved detailed design layout drawings to the Contracting Officer for approval. Ensure variations are signed and sealed by the UHDS manufacturers' professional engineer responsible for the complete design of the UHDS.

3.2 DEMOLITION

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NOTE: Ensure that Section 02 41 00 DEMOLITION AND DECONSTRUCTION is included in project specifications. Demolition work should be well defined in the drawings and specifications; photographs should be included in the contract package, if available.

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3.2.1 Demolition Procedures

Perform work in accordance with requirements for phasing. Remove pipe, valves, fittings, insulation, and hangers, including the connection to the structure and any fastenings. Seal openings in manhole or building walls after removal of piping. Material and equipment removed is the property of the Contractor and will be removed from the Government property within 1 week and do not store in operating areas. Perform flame cutting with adequate fire protection facilities available as required by safety codes and Contracting Officer.

3.2.2 Asbestos Removal

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NOTE: Existing systems may include asbestos containing materials. Provisions must be made for an asbestos survey to be performed and abatement measures to be included in project specification if necessary.

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Remove asbestos in conformance with Section 02 82 00 ASBESTOS REMEDIATION.

3.3 PIPE, PIPING JOINTS AND FITTINGS

3.3.1 Joint Preparation

Clean pipe and fittings inside and outside before and after assembly. Remove dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe pig before connecting pipe sections, valves, equipment or fittings. Use eccentric connectors as needed between casing sections to provide drainage of casing section between manholes and between manholes and buildings.

3.3.2 Direction Changes

Make changes in direction with factory-built reinforced fittings. Field-fabricated fittings and miters are not permitted.

3.4 WELDING

Submit Certification of Acceptability of all welds made in the field, upon completion of the project. This certification consists of a letter, signed by an official of the independent testing firm or firms examining welds, stating that all provisions of this specification have been complied with, and that all welds inspected radiographically have met the specified acceptability standards. The Contractor will be responsible for welding quality and must:

a. Conduct tests of the welding procedures used in the work, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and determine that the welding operators have the ability to make sound welds under standard conditions.

b. Comply with ASME B31.1.

c. Perform all welding operations required for construction and installation of the heat distribution system.

3.4.1 Qualification of Welders

Rules of procedure for qualification of all welders and general requirements for fusion welding must conform with the applicable portions of ASME B31.1, and as outlined below.

3.4.2 Examining Welders

Examine each welder to determine the ability of the welder to meet the required qualifications. Test welders for welds in all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder must:

a. Weld only in positions in which they have qualified.

b. Identify welds with the specific code marking signifying name and number assigned.

3.4.3 Examination Results

Provide a list of welder's names and corresponding code markings. Retest welders who fail to meet the prescribed welding qualifications. Welders who fail the second test sre disqualified for work on this project.

3.4.4 Beveling

Make field and shop bevels by mechanical means or by flame cutting. Where beveling is done by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding.

3.4.5 Alignment

Use split welding rings for field joints on carrier pipes above 50 mm 2 inches to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe. Make field joints 50 mm 2 inches and smaller with welding sockets.

3.4.6 Erection

Do not split, bend, flatten, or otherwise damage piping before, during, or after installation. Where the pipe temperature falls to 0 degrees C 32 degrees F or lower, heat the pipe to approximately 38 degrees C 100 degrees F for a distance of 300 mm 1 foot on each side of the weld before welding, and finish the weld before the pipe cools to 0 degrees C 32 degrees F.

3.4.7 Defective Welds

Replace and reinspect defective welds in accordance with ASME B31.1. Repairing defective welds by adding weld material over the defect or by peening is not permitted. Ensure welders responsible for defective welds are tested for qualification.

3.4.8 Electrodes

Store electrodes in a dry, heated area, and keep free of moisture and dampness during fabrication operations. Do not use electrodes that have lost part of their coating.

3.4.9 Radiographic Testing

An approved independent testing firm regularly engaged in radiographic testing must perform radiographic examination of 100 percent of the field welds in the carrier piping of direct-buried systems in accordance with ASME B31.1. Provide the following: a set of films showing each weld inspected, a reading report evaluating the quality of each weld, and a location plan showing the physical location where each weld is to be found in the completed project, prior to installing casing field joints, backfilling and hydrostatic testing. Ensure all radiographs are reviewed and interpreted by a Certified American Society for Nondestructive Testing Level III radiographer, employed by the testing firm, who will sign the reading report. The Contracting Officer may review all inspection records, and if any welds inspected are found unacceptable, the Contractor must remove, reweld, and radiographically reexamine welds at no cost to the Government.

3.5 HEAT DISTRIBUTION SYSTEM INSTALLATION

Submit a complete description of the design and assembly of the system, materials of construction and field installation instructions, not later than [21 days][_____] prior to the start of field measurements. Include sufficient system details to show that the specified minimum insulation thickness has been met. A detailed design layout of the system (plan and elevation views) showing size, type, elevations and location of each component to be used in the system, the design and location of anchors, pipe guides, pipe supports, expansion loops, Z-bends, L-bends, end seals, leak plates, joint locations, pipe and insulation thickness and sizes, types, and movements, connection to manhole and building wall penetrations, and including, if applicable, details of transition point to aboveground or other type systems. Also, if applicable, type and details of the cathodic protection system to be used. Ensure detailed design layout drawings are stamped by a registered Professional Engineer. The UHDS manufacturer's representative will oversee the delivery, storage, installation and testing of the system. Perform work in accordance with the requirements specified and with the printed instructions of the manufacturer. These specifications take precedence over the printed instructions if conflicts arise. Submit printed instructions to the Contracting Officer prior to system installation. Submit operation and maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, procedures for recording conduit temperatures biannually, and troubleshooting guides, before completion of work. Include in the Manual as-built piping layout of the system with final elevations. Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.5.1 Verification of Final Elevations

After all temporary supports have been removed and prior to covering the top of the pipe with [backfill] [PIPI] material, measure and record the elevation of the top of each pipe at each field joint, 1/3 points along each pipe section, and the top of each elbow. Check these measurements against the contract drawings and confirm that the conduit system has been installed to the elevations shown on the contract drawings. Ensure slope is uniform to within 0.1 percent. Record these measurements, include in the UHDS manufacturer's representative daily report, and give to the Contracting Officer prior to covering the casing with backfill material.

3.5.2 Excavation, Trenching, and Backfilling

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NOTE: The designer must coordinate the type of sand to be used with Section 31 00 00 EARTHWORK. Do not allow beach sand or any sand with large amounts of

chlorides to be specified.
****

Perform excavation, trenching, and backfilling as required by the UHDS manufacturer's design and as specified in Section 31 00 00 EARTHWORK. Lay pipe on a 305 mm 12 inch minimum sand bed and backfill with sand on all sides to a minimum of 150 mm 6 inches as measured from outside of casing. This sand bedding requirement does not apply to the PIPI system. Provide a firm and stable foundation for the system. Ensure foundation and backfill is free from rocks or substances which could damage the system coating. Install concrete anchor and thrust blocks in undisturbed earth. Do not commence backfilling until system has been satisfactorily pressure tested (both hydrostatic test of carrier and air test of casing). Minimum depth of burial to the top of the casing (or PIPI envelope) is 1 m 39 inches or depth required for piping to be below the frost line, whichever is greater. Maximum depth of burial to the top of the casing (or PIPI envelope) must be 3 m 10 feet.

3.5.3 UHDS Manufacturer's Representative Responsibilities

The UHDS Manufacturer's representative must be present at the job site and witness when the following types of work are being performed:

a. Inspection, unloading and storage (not applicable to PIPI).

b. Inspection of trench prior to commencing installation of system.

c. Inspection of concrete anchors and thrust blocks.

d. Pneumatic and Hydrostatic testing.

e. Field joint closure work (not applicable to PIPI).

f. Air test of casing (not applicable to all WSL systems).

g. Holiday test of conduit coating (not applicable to all WSL systems).

h. Repair of any coating (not applicable to all WSL systems).

i. Installation of cathodic protection system (not applicable to all WSL systems).

j. Initial backfill up to 254 mm 10 inches above the top of the casing.

k. Verification of final elevations. Elevation readings must be witnessed and recorded.

l. Testing of cathodic protection system (not applicable to all WSL systems).

m. Startup and operational tests.

n. Radiographic weld examination.

Notify the Contractor immediately of any problems. Notify the Contracting Officer of problems requiring immediate action; otherwise, note any problems encountered and indicate the corrective actions taken in the daily reports.

3.5.4 UHDS Manufacturer's Representative Reports

The UHDS manufacturer's representative must: prepare and sign a written daily report; present the original daily report to the Contracting Officer no later than one working day after it is prepared; and forward 1 copy to the manufacturer's main office. State whether or not the condition and quality of the materials used and the delivery, storage, installation and testing of the system are in accordance with the drawings, specifications, and manufacturer's printed instructions and are satisfactory in all respects. When any work connected with the installation is unsatisfactory, state what corrective action has been taken or list the UHDS manufacturer's recommendations for corrective action. Identify any condition that could result in an unsatisfactory installation, including such items as open conduit ends left in the trench overnight and improper manhole entries. Ensure daily reports are reviewed, signed and sealed, on a weekly basis, by the registered engineer responsible for the system design. Submit signed and sealed copies of the daily reports with the payment request. Requests for payment will be denied if the weekly review is not accomplished. Upon completion of the work and before final acceptance, submit a notarized Certificate of Compliance, signed by a principal officer of both the manufacturing and the contracting firms, stating that the installation is satisfactory and in accordance with drawings, specifications, and manufacturer's instructions to the Contracting Officer. Retain a copy of all daily reports and the Certificate of Compliance for 5 years after final acceptance of the system by the Government.

3.5.5 Protection

Protect casing coating from damage during unloading, storage, rigging and installation. Protect casing and carrier pipe ends from water intrusion during unloading, storage, rigging and installation. Protect piping and accessories from damage due to exposure to UV light.

3.5.6 Defective Material

The UHDS manufacturer's representative must take prompt action to remove from the site all damaged or defective material, subject to rejection in accordance with the quality assurance provisions included in the manufacturer's submittals and printed instructions, and must order prompt replacement of such material.

3.5.7 Cathodic Protection Installation

****

NOTE: Designer must indicate on the contract drawings that dielectric separation is shown where UHDS enter buildings or above transition from underground to aboveground piping.

****

Provide cathodic protection for all steel casing systems and all buried exposed metal. Assume that 25 percent of the exterior of the UHDS is exposed metal. Submit design life calculations for the cathodic protection system in accordance with NACE SP0169, not later than [7 days][_____] after notice to proceed. Ensure calculations are stamped by an NACE qualified corrosion engineer. Provide cathodic protection systems with a minimum design life of 25 years and conforming to [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [or] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Provide dielectric pipe flanges and waterways, and isolation devices at all points necessary. Provide test stations at grade on each section of the piping system. Provide dielectric waterways with temperature and pressure rating equal to or greater than that specified for the connecting piping. Provide waterways with metal connections on both ends suited to match the connecting piping. Line dielectric waterways internally with an insulator specifically designed to prevent current flow between dissimilar metals. Provide dielectric flanges meeting the performance requirements described herein for dielectric waterways.

3.6 TESTS

Submit a proposed test procedure and proposed samples of test data sheets for each required test, 30 days prior to the proposed test date. The procedure must contain a complete description of the proposed test with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. Do not commence test until the procedure has been approved. Perform pressure tests (hydrostatic, pneumatic) and operational tests to demonstrate leak-tightness of all piping systems. Pressure test heat distribution system in conformance with specified requirements and printed instructions for the system supplied; include carrier piping and casing. Test the carrier pipe hydrostatically. Test casings of DDT systems pneumatically. Test casing and end seals of WSL system for intrusion of water into the casing and insulation. Do not use mercury in thermometers required for the tests.

3.6.1 Holiday Testing of Direct-buried System Steel Casings

Test entire exterior surface of the casing, including the bottom exterior surface, for faults in coating after installation in trench, prior to backfilling, using test method and voltage recommended by coating manufacturer. If any holidays are found, repair them and retest the coating. Do not backfill the system until all holidays are eliminated.

3.6.2 Pneumatic, Hydrostatic and Operational Tests

Before conducting heat distribution system tests, flush lines with high pressure water until [discharge shows no foreign matter] [the Contracting Officer, after examining the discharge, stops the flush].

3.6.2.1 Pneumatic Test

Pneumatically test the casing of DDT systems after welding and before field coating using air as the test medium. Use a test pressure of 103 kPa 15 psig. Keep persons not working on the test operations out of the testing area while testing is proceeding. Make the test on the system as a whole or on sections that can be isolated. Test joints in sections prior to backfilling when trenches must be backfilled before the completion of other pipeline sections. Continue the test for 24 hours from the time of the initial readings to the final readings of pressure and temperature. Do not make the initial test readings of the instrument for at least 1 hour after the casing has been subjected to the full test pressure, and make neither the initial nor final readings at times of rapid changes in atmospheric conditions. There must be no indication of reduction of pressure during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship T(1)P(2) = T(2)P(1), in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial (1) and final (2) readings. Measure pressure with a pressure gauge conforming to ASME B40.100. A throttling type needle valve or a pulsation dampener and shutoff valve may be included. The diameter of the face must be at least 114 mm 4.5 inches with a measurable range of 0 to 103 kPa 0 to 15 psig and graduations of at least 0.5 kPa 0.1 psig. During the test, isolate the entire system from all compressors and other sources of air pressure. Test each joint while under test pressure by means of soap and water or an equivalent nonflammable solution prior to backfilling or concealing any work. All labor, materials and equipment for conducting the tests must be furnished by the Contractor and are subject to inspection at all times during the tests. Maintain proper safety precautions for air pressure testing at all times during the tests.

****

NOTE: Input the heat distribution design pressure for the supply line. Design pressure to equal or exceed the operating pressure of the system.

****

3.6.2.2 Hydrostatic Test

Test carrier piping hydrostatically before insulation is applied at field joints and prove tight at a pressure 1.5 times the heat distribution supply design pressure of [_____] kPa [_____] psig for 2 hours. There must be no indication of reduction of pressure during the test. Measure pressure with a device calibrated to be read in increments not greater than 1 kPa 0.1 psi.

3.6.2.3 Operational Test

Prior to acceptance of the installation, subject system to operating tests simulating actual operating conditions to demonstrate satisfactory functional and operating efficiency. Cover a period of no less than 6 hours for each portion of system tested. Submit for approval a schedule of the tests to be performed [14 days][_____] in advance. Provide calibrated instruments, equipment, facilities and labor, at no additional cost to the Government. When failures occur, repair problems and repeat test.

3.6.3 Deficiencies

Correct deficiencies discovered at the Contractor's expense. Major deficiencies, or failure to correct deficiencies, can be considered cause for rejecting the entire installation.

3.7 VALVE MANHOLES

****

NOTE: Include Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES as part of the contract specifications for this job. Include sealing of pipe penetrations through manhole walls in the design of the manhole.

****

Provide valve manholes, piping, and equipment in valve manholes in accordance with the contract drawings and Section 33 61 13.19 VALVES,PIPING, AND EQUIPMENT IN VALVE MANHOLES.

3.8 BURIED UTILITY WARNING AND IDENTIFICATION

3.8.1 Plastic Marking Tape

Supply and install polyethylene plastic tape manufactured specifically for warning and identifying buried utility lines. Bury tape above the pipe during the trench backfilling operation and bury approximately 300 mm 12 inches below grade. Tape must be [0.1 mm 0.004 inch thick polyethylene] [polyethylene with a metallic core]. Use tape that is acid- and alkali-resistant with a minimum strength of 12 MPa 1750 psi lengthwise and 10.3 MPa 1500 psi crosswise with an elongation factor of 350 percent. Ensure tape is manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 1 m 3 feet deep. Encase the metallic core of the tape in a protective jacket or provide with other means to protect it from corrosion. Ensure tape is a type specifically manufactured for marking and locating metallic underground utilities. Provide tape that is 150 mm 6 inches wide and printed with a caution and identification of the piping system over the entire tape length. Tape must be yellow with bold black letters. Tape color and lettering must be unaffected by moisture and other substances contained in the backfill material.

3.8.2 Markers for Underground Piping

****

NOTE: Indicate the location of the markers on the contract drawings for projects that require markers. Delete the paragraph if not needed in the project.

****

Locate markers for underground piping along the distribution and service lines. Place markers as indicated approximately 600 mm 2 feet to the right of the distribution system when facing in direction of flow in the supply line. Provide concrete marker that is 150 mm 6 inch square or round section [600] [900] mm [2] [3] feet long. The top edge of the marker must have a minimum 13 mm 1/2 inch chamfer all around. Impress or cast the letters [STEAM] [HTHW] [CONDENSATE] on the top, and on one side of the markers to indicate the type of system that is being identified. Form each letter with a V-shaped groove and with a width of stroke at least 6 mm 1/4 inch at the top and depth of 6 mm 1/4 inch. Do not allow the top of the marker to protrude more than [25] [50] [75] [100] mm [1] [2] [3] [4] inches above finished grade.

3.9 THERMAL PERFORMANCE TESTING

****

NOTE: The temperatures in Table 3 are based on calculations that assume 85 percent of the thermal resistance of a new properly functioning system is in the insulation and that a degradation of up to 50 percent of the original thermal resistance will be allowed. A soil temperature of 15 degrees C 60 degrees F was also assumed in the calculations.

****

Use the equipment and procedures specified to ensure acceptable thermal performance of the installed system. Submit manufacturer's data sheets on all UHDS components and the instrumentation required for thermal performance testing, [7][_____] days after notice to proceed. Because of its geometry, the PIPI system is exempt from the thermal performance test requirement; submit the test results for approval. Include all materials and procedures described for this test as deliverables of the construction contract for the system, unless otherwise noted. Due to its geometry, the PIPI system is exempt from this requirement.

3.9.1 Equipment

3.9.1.1 Casing Temperature Measurement

Before backfilling, and after field joint closures have been welded to the casing and the coating has been applied and cured, attach temperature sensors to the exterior of every other field joint closure. Attach the sensors with epoxy suitable for use at 260 degrees C 500 degrees F. adhere a sensor with epoxy to the coated casing near the midpoint of every other pipe section between field joints. Do not locate the sensor closer than 1.5 m 5 feet from any guide in the interior of the casing. After the sensors have been adhered to the casing, use two complete wraps of duct tape to secure and protect the sensor. Locate the radial position of the sensors 45 degrees from the top center of the casing, at either the 1:30 or 10:30 position, away from the adjacent heat distribution system pipe if present. Ensure all sensors are type T copper constantan 20 gauge thermocouples, made from special limits grade thermocouple wire, 0.5 degrees C 0.9 degrees F or 0.4 percent maximum error, with each conductor insulated and an overall jacket on both conductors. Use insulation on the thermocouple wires suitable for service at 260 degrees C 500 degrees F. Ensure the thermocouple wire between sensor location and termination point is continuous with no splicing or other connections. Show each sensor with a special symbol on the detailed design layout drawings and identify by a number and/or letter code, starting from the upstream manhole.

3.9.1.2 Carrier Pipe Temperature Measurement

Measure carrier pipe temperature within the manhole where the panel box is located. Measure carrier pipe temperature by a sensor adhered with epoxy directly to the exterior of the carrier pipe. Ensure all sensors are type T copper constantan 20 gauge thermocouples, made from special limits grade thermocouple wire, 0.5 degrees C or 0.4 percent maximum error, with each conductor insulated and an overall jacket on both conductors. Use insulation on the thermocouple wires suitable for service at 260 degrees C 500 degrees F. Ensure the thermocouple wire between sensor location and termination point is continuous with no splicing or other connections. Locate this sensor at either the 1:30 or 10:30 position. At the location of the sensor, insulate the carrier pipe with calcium silicate insulation at least 125 mm 5 inches thick. Extend this insulation at least 150 mm 6 inches on each side of the actual sensor location and must be clad with an aluminum jacket.

3.9.1.3 Terminals

Extend the wires from each casing or carrier pipe temperature sensor into the nearest manhole and terminate in a panel box. The panel box must be a NEMA Type 4 waterproof enclosure, of suitable size, mounted near the top of the manhole at a location near the manhole entrance, accessible without entrance into the manhole, where possible. Terminate the sensor wires with an approved connector of type [OMEGA Miniature Jack Panel (MJP-*-*-T)]. Mount the thermocouple jack panel to the back plate of the panel box. Label the temperature sensors at their termination within the panel box;

laminate and attach a drawing showing the location of each temperature sensor to the inside of the panel box. Ensure all temperature sensors are verified as operational by an independent laboratory, hired by the Contractor, after backfilling is complete but before the system is accepted.

3.9.2 Thermal Performance Test

After the system construction is complete, including backfilling, and the system has reached operating condition for at least 30 days, all of the temperature sensors must be read by an independent laboratory with experience and equipment appropriate for the sensors used. Record the temperature for each sensor. Tabulate and submit the temperatures in accordance with specified requirements. If temperatures exceed values in Table 3, repair that portion and measure and record temperatures again.

TABLE 3

Carrier Pipe Temperature - TP (degrees C F)	Acceptable Casing Temperature - TC (degrees C F)
121 250	43 110
135 275	47 116
149 300	50 123
163 325	54 129
177 350	58 136
204 400	65 149
218 425	68 155
232 450	72 162

The following equations were used to calculate the above values:

TC, <(0.261) X (TP) + 11.5 TC <(0.261) X (TP) + 44.3

For carrier pipe temperatures between those given in Table 3, the maximum acceptable casing temperature may be either interpolated from the values in Table 3 or calculated using the equations above.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 61 13.13 (February 2016)**

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Preparing Activity: USACE **Superseding**
UFGS-33 61 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 33 - UTILITIES

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PREFABRICATED UNDERGROUND HYDRONIC ENERGY DISTRIBUTION

02/16

PART 3 EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 61 13.13 (February 2016)**

Preparing Activity: USACE **Superseding**
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SECTION 33 61 13.13

PREFABRICATED UNDERGROUND HYDRONIC ENERGY DISTRIBUTION

02/16

****

NOTE: This guide specification covers the requirements for prefabricated underground distribution system for chilled water, low temperature hot water (less than 95 degrees C 200 degrees F) or dual temperature water.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: Provide one or two sump pumps in valve manholes. Units should discharge by buried piping to the nearest storm sewer if possible. Where not economical to discharge to a storm sewer, pumps are to discharge above grade. Plan discharge locations carefully so water will not be discharged over valve manhole tops, sidewalks, etc. Check available NPSH versus required NPSH for pump selected. Coordinate power requirements with electrical designer and provide tell-tale light above ground to indicate sump pump failure. Drawings will show the following:

(a) a dedicated circuit

(b) lockable switches and circuit breakers that can both be locked "ON"

(c) permanent labels at key positions indicated on the drawings so that personnel can understand that the circuit should be left "ON".

The label must be on a corrosion resistant metal plate and must read as follows: "THIS CIRCUIT SUPPLIES POWER TO THE ELECTRIC SUMP PUMPS IN THE UNDERGROUND HEAT DISTRIBUTION SYSTEM. THIS CIRCUIT MUST BE "ON" AT ALL TIMES, OTHERWISE EXTENSIVE DAMAGE WILL OCCUR TO THE UNDERGROUND HEAT DISTRIBUTION SYSTEM AND PREMATURE FAILURE WILL OCCUR".

Where plastic chilled water piping is interconnected with heating system changeover valves, ensure that design includes means to preclude damage to plastic chilled water piping. This can be accomplished either by using changeover valves that ensure tight shut-off or by using enough metal piping on chilled water side of changeover valve to prevent damage to plastic chilled water piping.

****

1.1 SUMMARY

The system consists of a buried prefabricated [chilled water] [and] [low temperature hot water] [dual temperature] distribution system including service connections to a point 150 mm 6 inches inside of the building. The contract drawings show the specific arrangement of piping, sizes and grades of pipe, and other details. The system is designed for an operating pressure of [_____] kPa psig and an operating temperature of [[_____] degrees C F for hot water] [and] [[_____] degrees C F for chilled water].

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	(2024) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2022) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS B2.2/B2.2M	(2016) Specification for Brazing Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts

ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM D1384	(2005; R 2019) Corrosion Test for Engine Coolants in Glassware
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2997	(2015) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D5685	(2019) Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication and Assembly Drawings

SD-03 Product Data

Support of the Equipment

Markers For Underground Piping

SD-07 Certificates

Welding

Written Certification

SD-10 Operation and Maintenance Data

Maintenance; G, [_____]

1.4 QUALITY ASSURANCE

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NOTE: If need exists for more stringent requirements for weldments, delete the first bracketed statement.

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[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Prior to welding operations, submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Notify the Contracting Officer 24 hours in advance of tests performed at the work site, if practicable. Apply welder's personal assigned symbol near each weld made as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.5 DELIVERY, STORAGE, AND HANDLING

After delivery to the jobsite, protect all materials and equipment from anything which could cause damage to the material or equipment. Seal piping at each end to keep the interior clean and free of dirt and debris. Keep fittings together and keep their interior surfaces clean at all times. Keep insulation dry and clean.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide system components which are standard products of a manufacturer regularly engaged in the manufacture of the product and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide a service organization that is, in the opinion of the Contracting Officer, convenient to the site.

Equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

a. Submit detail drawings consisting of fabrication and assembly drawings, for all parts of the work in sufficient detail to check conformity with the requirements of the contract documents, prior to installation. In the detail drawings show complete piping, wiring and schematic diagrams and any other details to demonstrate that the system has been coordinated and will properly function as a unit. Show on the drawings proposed layout, method of compensation for pipe expansion and contraction, anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances required for maintenance and operation.

b. Submit the manufacturer's or system fabricator's written certification stating that the distribution system furnished meets all the requirements of this specification. Clearly identify on the drawings any proposed deviations from the requirements of the contract documents.

2.2 PIPING AND CASING MATERIALS

2.2.1 General

Provide metallic pressure pipe, fittings, and piping accessories that conform to the requirements of ASME B31.1 and are types suitable for the temperature and pressure of the water.

2.2.2 Piping

****

NOTE: Designer will eliminate only the materials which are not satisfactory for his design. All carrier pipe is acceptable for chilled water systems. All carrier pipe except PVC is acceptable for low temperature hot water. Do not allow Reinforced Thermosetting Resin Pipe (RTRP) in locations where heating water temperature cannot be assured to be less than 93 degrees C (200 degrees F).

****

2.2.2.1 Steel Pipe

Provide piping conforming to ASTM A53/A53M, Grade B, standard weight, black or to ASTM A106/A106M, Grade B, standard weight.

2.2.2.2 Copper Tubing

Provide tubing conforming to ASTM B88M ASTM B88, Type K or L.

2.2.2.3 Reinforced Thermosetting Resin Pipe (RTRP)

Provide RTRP conforming to [ASTM D2996][ASTM D2997].

2.2.2.4 Polyvinyl Chloride (PVC) Pipe

****

NOTE: PVC carrier pipe is limited to 24 degrees C 75 degrees F service. Pressure rating of plastic piping varies with temperature and must be considered in design. PVC pipe with SDR 26 is rated for 1100 kPa 160 psi working pressure at 23 degrees C 73 degrees F.

****

Provide PVC piping conforming to ASTM D2241 with a Standard Thermoplastic Pipe Dimension Ratio (SDR) of 26 and PVC 1120 or 1220 as the material.

2.2.2.5 Joints and Fittings for Copper Tubing

Provide wrought copper and bronze solder-joint pressure fittings that conform to ASME B16.22 and ASTM B75/B75M. Provide cast copper alloy solder-joint pressure fittings conforming to ASME B16.18. Provide cast copper alloy fittings for flared copper tube conforming to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Design grooved mechanical joints and fittings for not less than 862 kPa 125 psig service. Provide grooved mechanical joints and fittings that are the product of the same manufacturer. Provide grooved fitting and mechanical coupling housing of ductile iron conforming to ASTM A536, with molded synthetic polymer of pressure responsive design conforming to ASTM D2000 for circulating medium up to 110 degrees C230 degrees F and grooved joints conforming to AWWA C606. Provide steel nuts and bolts conforming to ASTM A183 for coupling for use in grooved joints..

2.2.3 Casings

2.2.3.1 Polyvinyl Chloride (PVC) Casing

Provide PVC casings that conform to ASTM D1784, Class 12454-B with a minimum thickness equal to the greater of 1/100 the diameter of the casing or 1.50 mm 60 mils.

2.2.3.2 Polyethylene (PE) Casing

****

NOTE: If the distribution system is to be installed when the temperature is cold, the polyethylene casing is less susceptible to cracking from the cold.

****

Provide polyethylene casings conforming to ASTM D3350, Type III, Class C, Category 3 or 4, Grade P 34 with thickness as follows:

Casing Diameter (mm) (inches)	Minimum Thickness (mm) (mils)
250 10 and smaller	3 125
250 to 450 10 to 18	4 150

Casing Diameter (mm) (inches)	Minimum Thickness (mm) (mils)
450 through 600 18 through 24	5 200
over 600 24	6 225

2.2.3.3 Reinforced Thermosetting Resin Pipe (RTRP) Casing

Provide RTRP casing of the same material as the pipe, with casing thickness as follows:

Casing Diameter (mm) (inches)	Minimum Thickness (mm) (mils)
200 8 and smaller	1.2 70
250 10	2 80
300 12	2.7 105
350 14	2.9 115
400 to 450 16 to 18	3 120
500 20	3.2 125
600 24	3.9 155

2.3 PIPING CONNECTIONS

2.3.1 Steel Pipe

For pipe smaller than 19 mm 0.75 inch, provide Schedule 80 steel pipe with threaded end connections conforming to ASME B1.20.2M ASME B1.20.1. Weld all steel pipe 19 mm 0.75 inch and larger. Provide steel welding fittings conforming to the requirements of ASTM A105/A105M or ASTM A234/A234M. Provide welding fittings conforming to ASME B16.9 for buttweld fittings and ASME B16.11 for socket-weld fittings. Use long radius buttwelding elbows conforming to ASME B16.9 whenever space permits.

2.3.2 Copper Pipe

Braze or provide insulated pipe couplings for copper pipe connections with wrought copper or cast copper alloy solder joint pressure fittings conforming to AWS B2.2/B2.2M and CDA A4015. Provide cast bronze containing an O-ring seal on each end, jacketed and sealed, to act as an expansion joint for insulated pipe couplings for copper pipe.

2.3.3 Plastic Pipe

a. Provide adhesive bell and spigot type end connections for pipe, fittings, flanges, and couplings. Threaded piping, including pipe, fittings, flanges, and couplings, will not be permitted.

b. Flanged Connections: Provide flat face flanged connections between plastic piping and metal piping suitable for connection to ASME Class 150 flanges.

c. RTRP Piping Sizes: Provide the next larger size where piping sizes other than 50, 75, 100, 150, and 200 mm 2, 3, 4, 6, and 8 inches are indicated with piping connections of the same size or increased to meet the next size of RTRP piping.

2.3.3.1 Plastic Fittings

Provide plastic fittings of the same type and grade of material as the piping to which they will be connected and furnished by the manufacturer who supplies the pipe. Provide temperature and pressure rating for fittings not less than those of the connecting piping.

2.3.3.2 Polyvinyl Chloride (PVC)

Provide solvent welded or connected using bell and spigot connections for polyvinyl chloride (PVC) pipe with solvent used to connect fittings and pipe conforming to the requirements of ASTM D2564. Bell and spigot joints utilizing elastomeric seals conforming to the requirements of ASTM D3139. The elastomeric seals must conform to ASTM F477.

2.3.3.3 Reinforced Thermosetting Resin Plastic (RTRP)

Join reinforced thermosetting resin plastic pipe using fittings and adhesive furnished by the pipe manufacturer in accordance with ASTM D5685.

2.4 END SEALS

Provide pre-insulated sections of pipe with complete sealing of the insulation to provide a permanent water and vapor seal at each end of the pre-insulated section of piping. Provide field modified pre-insulated sections of piping with an end seal which is equivalent to the end seals furnished with the pre-insulated section of piping. Test and certify end seals in accordance with paragraph Casing and End Seal Testing and Certification.

2.4.1 Types

Provide end seals of one of the following types:

a. Carrying the outer casing over tapered pipe insulation ends and extending it to the carrier pipe. Provide sufficient surface bonding area between the casing and the carrier pipe.

b. Using specially designed molded caps made of polyethylene or rubber of standard manufactured thickness. Provide a minimum of 40 mm 1.5 inch surface bonding area between the cap and both the casing and carrier pipe.

c. Using elastomeric-ring end seals designed and dimensioned to fit in the annular space between the casing and the carrier pipe.

d. Using a waterproof mastic seal vapor barrier over the exposed insulation ends.

e. Shrink sleeves.

2.4.2 Casing and End Seal Testing and Certification

Demonstrate that testing and certification procedures by an independent testing laboratory, for casings and end seals, are capable of resisting penetration of water into the casing and insulation. Perform the test on each type of prefabricated system to be furnished. Provide hot and cold cycle testing followed by immersion in a water filled chamber with a head pressure, consisting of 14 days of temperature cycling. Circulate a fluid with a temperature of 5 degrees C 40 degrees F through the carrier pipe alternating every 24-hours with a fluid with a temperature of 95 degrees C 200 degrees F circulating through the carrier pipe for a low temperature hot water or dual temperature service or 24 degrees C 75 degrees F for a chilled water service. While the hot and cold cycle test is being performed, the test sample is either buried or encased in dry bedding sand with a minimum of 300 mm 12 inches of sand all around the test sample. Restrain the 80 mm 3 inches diameter carrier pipe of the test sample during the test period. Provide an insulation thickness not to exceed the maximum thickness provided for the piping in the project. Do not exceed transition times for temperature cycle testing of 15 minutes in going from cold to hot and 30 minutes in going from hot to cold. The fluid in the carrier pipe may be water, oil or heat transfer fluid. Immerse the test sample in a water filled chamber following the hot and cold cycling test. Provide a pressure of not less than 60 kPa 20 feet of water head pressure at the highest point over the entire length of the 2.4 m 8 foot test sample for a minimum of the 48 hour test period. Provide water containing a dye penetrant to check for end seal leakage. Upon completion of the pressure test, cut the test sample open using a light that will readily show the presence of the dye that was in the water, inspect the test sample. Evidence of the dye inside the test sample indicates that the end seal is not acceptable and cannot be certified.

2.5 INSULATION

2.5.1 Factory Applied Insulation

****

NOTE: An insulation thickness of 20 mm 0.9 inch is normally sufficient for these systems. However, in cases where the cost of energy used for these systems is high, a life cycle cost analysis should be performed to determine whether additional insulation is cost effective.

****

Provide factory insulated pre-fabricated pipe and fittings with polyurethane (polyisocyanurate) foam meeting the requirements of ASTM C591 having a density not less than 32 kg per cubic meter 2 pounds per cubic foot (pcf). Provide the polyurethane (polyisocyanurate) foam completely filling the annular space between the carrier pipe and the casing with an insulation thickness of a minimum of [20] [_____] mm [0.9] [_____] inches. Provide an insulation thermal conductivity factor not exceeding the numerical value of 0.02 W/mK 0.15 Btu-inch/square foot-degree F-hour at 24 degrees C 75 degrees F, when tested in accordance with ASTM C518. Provide a manufacturer's certification that the insulated pipe is free of insulation voids.

2.5.2 Field Applied Insulation

Provide polyurethane (polyisocyanurate) field applied insulation for fittings, and field casing closures and other piping system accessories, as required, with thickness matching adjacent piping insulation thickness. For buried fittings and accessories, provide field applied polyurethane (polyisocyanurate) insulation to match adjacent piping with a protective covering matching the pipe casing. Provide shrink sleeves with a minimum thickness of 1.3 mm 50 mils over casing connection joints.

2.6 CONCRETE VALVE MANHOLES

****

NOTE: Valve manholes must be detailed on the drawings with complete concrete structural details including details of any waterproofing.

****

Provide concrete valve manholes in accordance with Section 33 61 13.19 VALVES, PIPING AND EQUIPMENT IN VALVE MANHOLES and manufactured in accordance with [Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION][Section 03 41 16.08 PRECAST CONCRETE SLABS (MAX. SPAN 8 FEET O.C.)].

2.7 PIPING AND EQUIPMENT IN VALVE MANHOLES

Provide piping and equipment in valve manholes in accordance with Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

2.8 TREATED WATER

****

NOTE: If freeze protection for chilled water is not required, this paragraph should be deleted. When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC Systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient or operating temperature.

****

Provide a [_____] percent glycol concentration, by volume, of industrial grade [ethylene] [propylene] for the system. Test glycol in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. Provide corrosion inhibitors in glycol solution compatible with pump seals, water treatment chemicals used within the system, and other elements of the system. Silicate based inhibitors are not allowed.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the project, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the project.

3.2 INSTALLATION

For all pre-insulated, prefabricated systems, obtain the services of a trained representative of the pipe system manufacturer to instruct the Contractor's work forces in the installation procedures to ensure that the system is installed in accordance with the manufacturer's published instructions and the plans and specifications. Provide a manufacturer's representative who regularly performs such duties for the manufacturer. Furnish the Contracting Officer a list of names of personnel trained and certified by the pipe system manufacturer in the installation of this system. Only personnel whose names appear on a less than one year old list will be allowed to install the system.

3.3 PIPING SYSTEMS

3.3.1 Buried Insulated Systems

Provide carrier pipe, insulation, casing, end seals, fittings and accessories for buried insulated systems.

3.3.2 Buried Un-insulated Systems

****

NOTE: Buried un-insulated piping systems must be used only where justified by a life cycle cost analysis that includes the decreased initial cost of the distribution system, increased operating energy cost due to the heat gain or heat loss in the piping system, leakage and the cost of any increased heating or cooling equipment capacity. Buried uninsulated steel pipe must have a protective coating in all cases and cathodic protection where required by soil conditions.

****

Provide carrier pipe, fittings and accessories for buried un-insulated systems.

3.4 VALVE MANHOLES AND PIPING EQUIPMENT IN VALVE MANHOLES

Install valve manholes and piping and equipment in valve manholes in accordance with Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

3.5 THRUST BLOCKS

****

NOTE: Designer will indicate dimensions and locations of required thrust blocks on the drawings. Blocks will be sized for specific fittings and for allowable in situ soil pressures. Thrust blocks must be designed for the maximum test pressure specified.

****

Install thrust blocks at the locations shown or recommended by the pipe system manufacturer. Provide thrust blocks in accordance with manufacturer's recommendations. For systems requiring thrust blocks, at a minimum, provide thrust blocks at all changes in direction, changes in size, valves and terminal ends, such as plugs, caps and tees with concrete having a compressive strength of not less than 14 MPa 2000 psi after 28 days in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Place thrust blocks between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, pour the base and the thrust bearing sides of the thrust blocks directly against undisturbed earth. The sides of the thrust blocks not subject to thrust may be poured against forms. Locate thrust blocks so that the joints for all fittings will be accessible for repair wherever possible. Do not embed joints in concrete unless the assembly has previously been hydrostatically tested. Provide thrust blocks resisted by piles or tie rods to solid foundations in muck or peat, or replace peat or muck with ballast of sufficient stability to resist the thrust blocks.

3.6 INSTALLATION OF PIPING SYSTEMS

Prepare pipe ends to match factory coated ends and install the piping system in accordance with the manufacturer's instructions without springing or forcing other than what has been calculated for cold spring allowing free expansion and contraction without damage to joints or hangers. Do not install copper tubing in a trench with ferrous piping materials. Maintain a minimum vertical separation of 300 mm12 inches between pipes when nonferrous metallic pipe (e.g., copper tubing) crosses any ferrous piping material. Provide transition fittings approved by the manufacturer of the piping system for connections between different types of pipe and system components.

3.6.1 Pitching of Horizontal Piping

Pitch horizontal pipe at a grade of not less than 40 mm in 1 m1 inch in 20 feet toward the drain points unless otherwise indicated.

3.6.2 Open Ends

Provide an approved cap or plug for open ends of pipelines and equipment during installation.

3.6.3 Cutting Prefabricated Piping Sections

Provide new end seals similar to factory applied end seal for field cut prefabricated pipe sections in accordance with the manufacturer's instructions.

3.6.4 Joints

3.6.4.1 Welded Joints

Provide welded joints between sections of pipe and between pipe and fittings where specified or indicated.

3.6.4.2 Threaded Joints

No threaded joints are allowed to be used belowground. Make joints tight with polytetrafluoroethylene tape applied to the male threads only with no more than 3 threads showing after the joint is made up.

3.6.4.3 Grooved Mechanical Joints

Provide grooved fittings, couplings, and grooving tools with products of the same manufacturer. Prepare grooves complying with the tolerances specified by the coupling manufacturer in accordance with the coupling manufacturer's instructions. Measure field made groove diameters using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Measure and record each groove width and dimension from end of pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints are not allowed in concealed locations.

3.6.4.4 Brazed Joints

Brazed joints for copper pipe and fittings must conform to CDA A4015. Utilize brazing alloys melting above 593.3 degrees C 1100 degrees F.

3.6.4.5 Nonmetallic Pipe Joints

Install nonmetallic pipe joints in accordance with the written instructions of the manufacturer.

3.6.5 Expansion Loops

****

NOTE: In the design for expansion compensation, strive to use L- and Z-bends in lieu of expansion loops wherever possible.

****

If expansion compensation is needed, provide expansion loops and expansion bends (Z- and L- type) factory fabricated of casing, insulation, and carrier piping identical to that furnished for straight runs. Properly design expansion loops and bends in accordance with the allowable stress limits indicated in ASME B31.1 for the type of pipe used, and size to accommodate pipe movement. Ship expansion loops and bends to the jobsite in the maximum size sections feasible to minimize the number of field joints. Make field joints in straight runs of the expansion loops and bends, keeping the number to a minimum. For steel pipe, cold springing is not allowed when sizing the expansion loops and bends. Cold spring piping one-half the calculated maximum operational expansion during field assembly is allowed. Pipe stress in expansion loops and bends must conform to ASME B31.1.

3.6.6 Anchors

Provide factory fabricated, by the prefabricated system manufacturer, anchor design in accordance with the published data of the manufacturer and for prefabricated systems. Prevent water penetration, condensation, or vapor transmission from wetting/contacting the insulation.

3.6.7 Field Casing Closures

****

NOTE: Whether or not to insulate the exposed section of pipe and cover with a casing at the joint between the sections of the pipe must be determined by a life cycle cost analysis. Factors to consider

include heat loss/heat gain through the uninsulated section, cost to insulate and cover the uninsulated section, and the usage per year of the prefabricated system. Normally the exposed section is insulated and covered. The joint between the sections of pipe must be protected from corrosion.

****

Execution of field insulation and encasement of joints are to be accomplished after the visual and pressure tests specified are completed and in accordance with the manufacturer's written instructions. Provide foamed in place polyurethane insulation with thickness dimensions and casing materials not less than those of the adjoining prefabricated section. Install a standard polyethylene heat shrink sleeve with a 150 mm 6 inch minimum overlap at each end of the casing.

3.6.8 Underground Warning Tape

****

NOTE: Select the proper tape for the project. Tape with metallic core is utilized for nonferrous pipe systems to locate piping with pipe location devices.

****

Provide underground 0.1 mm 0.004 inch thick, 150 mm 6 inches wide, printed with repetitive caution warnings along its length, [polyethylene tape] [polyethylene tape with metallic core] warning tape buried above the piping during the trench backfilling approximately 300 mm12 inchesdeep. Provide tapes, yellow in color with black letters; color and lettering must not be affected by moisture or other substances contained in the backfill material.

3.6.9 Markers for Underground Piping

****

NOTE: Indicate the location of the markers on the drawings for projects that require markers. Delete the paragraph if not needed in the project.

****

Submit catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents. Place markers for underground piping approximately 600 mm 2 feet to the right of the distribution system in reference to the fluid flow direction.

Provide concrete markers 150 mm 6 inch square or round section [600] [900] mm [2] [3] feet long with the top edge of the marker chamfered at a minimum of 13 mm .5 inch all around. Impress of cast letters on the top of the marker with letters [CHW] [LHW] [DTW] to indicate the type of system that is being identified. Form each letter with a V-shaped groove with a width of stroke at least 6 mm .25 inch at the top and depth of 6 mm .25 inch. Provide elevation of markers no more than [25] [50] [75] [100] mm [1] [2] [3] [4] inches above finished grade.

3.7 EARTHWORK

Perform earthwork in accordance with Section 31 00 00 EARTHWORK.

3.8 ELECTRICAL WORK

Perform electrical work in accordance with either Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION or Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.

3.9 TESTING

Conduct tests before, during, and after installation of the system. Provide all instruments, equipment, facilities, and labor required to properly conduct the tests. Provide test pressure gauges for a specific test with dials indicating not less than 1.5 times nor more than 2 times the test pressure.

3.9.1 Metallic Pipe Welds

****

NOTE: Where welding of piping is not required or there are no prior experiences which may warrant radiographic inspection of the welded joints this entire paragraph should be deleted.

****

Perform radiographic testing in accordance with ASME B31.1. Perform radiographic examination of field welds by an approved independent testing firm or firms regularly engaged in radiographic testing, and interpreted by a Certified Level III Radiographer employed by the testing firm. Review and interpretation of all radiographs must be by a Certified Level III Radiographer employed by the testing firm. Remove, reweld and radiographically examine any welds found to be unacceptable in accordance with the above criteria.

3.9.2 Carrier Pipe Cleaning and Testing

Test distribution piping as required before backfilling, with all joints exposed. The area between joints may be backfilled as necessary to prevent pipe movement.

3.9.2.1 Cleaning Carrier Pipe

Prior to testing, clean the interior of the carrier pipe of foreign materials by thorough flushing with clean water with a circulating water velocity between 2 and 3 m/s (7 and 10 feet per second) for a minimum of 4 hours. Provide temporary and/or supplementary pumps if required to ensure that required velocity is achieved. Clean system strainers after the flushing operation is complete. Temporary strainers must be installed as required. Leave water in the system after flushing for testing of the system to ensure the pipe will maintain pressure and is not leaking.

3.9.2.2 Hydrostatic Pressure Cycling and Tests

Hydrostatic pressure tests consist of 4 cycles; .each cycle consisting of a 10 minute period with the first cycle at 1000 kPa 150 psig followed by a 5 minute period at a pressure less than 350 kPa 50 psig. Begin the next cycle immediately following the completion of the previous cycle with the pressure rise and drop no more than 690 kPa 100 psi per minute. Locate the pressure gauge and take the pressure measurement at the opposite end of the system from where the pressure is applied. After completion of the hydrostatic pressure cycling, perform the first hydrostatic pressure test proving the system tight at a pressure of 1.5 times the working pressure up to 1000 kPa 150 psig and held for a minimum of 1 hour. Disconnect the pressurizing apparatus from the system before starting the 1 hour pressure holding period. Correct any test failures and repeat the hydrostatic pressure cycling and first hydrostatic pressure test until the system can hold the required pressure for at least 1 hour. After successful completion of the first hydrostatic pressure test, drain piping system and fill the piping system as defined in paragraph TREATED WATER for the remaining tests and for permanent operation of the system. Repeat the hydrostatic pressure cycling and tests for the system after the system has been filled with treated water, using the same test conditions and criteria.

3.9.2.3 Operational Test

Perform operational test on the complete system or testable portions thereof and conduct with full design flows and operating temperatures in all runs of piping as if in service, to demonstrate satisfactory function and operating effectiveness. The operational test will have two cycles. Each cycle must consist of a 6-hour period with treated water in the system at the maximum operating temperature of [_____] degrees C F and maximum flow rate, and a period of at least 6-hours with no flow. For dual temperature systems, the first cycle must use the heating temperature of [_____] degrees C F and the second cycle the cooling temperature of [_____] degrees C F of the designed system. Supply temporary pumps, piping connections, boilers, chillers and the gauges required to circulate the water at the desired temperatures and flow rates. Re-circulate water through supply lines and return through the return piping to demonstrate that the pressure drop is compatible with the flow rate and size of pipe and to show that obstructions do not exist in the piping system. Any unusual indicated pressure drop will be investigated and any obstructions removed. Repair any leaks found. After any obstructions have been removed and any leaks repaired, repeat the operational test until successfully passed.

3.9.2.4 Final Hydrostatic Test

After successful completion of the operational test, pressurize system to 1.5 times the working pressure up to 1000 kPa 150 psig and hold for a minimum of 4 hours. Disconnect pressurizing apparatus prior to the start of the 4-hour pressure holding period. Upon test failure, determine the cause of the failure, correct and repeat all of the hydrostatic pressure cycling and pressure tests.

3.10 MAINTENANCE

Submit [6] [_____] [hard] [optic disk] copies of operation and [6] [_____] copies of maintenance manuals for the equipment furnished, 1 complete set prior to performance testing and the remainder upon acceptance. Provide details in the operation manuals showing the step-by-step procedures required for equipment startup, operation, and shutdown. Include in the operation manuals the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the maintenance manuals piping and equipment layout and simplified wiring and control diagrams of the equipment system as installed. Provide approved manuals prior to the field performance testing.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 61 13.19 (February 2016)**

Preparing Activity: USACE **Superseding**
UFGS-33 60 01 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 33 - UTILITIES

SECTION 33 61 13.19

VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES

02/16

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 61 13.19 (February 2016)**

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SECTION 33 61 13.19

VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES
02/16

****
NOTE: This guide specification covers the requirements for valves, piping and equipment in valve manholes that form a part of an underground heat distribution system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: Design manual UFC 3-430-01FA HEATING AND COOLING DISTRIBUTION SYSTEMS contains information that will assist the designer. Do not allow chilled water lines or other plastic piping to be routed through manholes where high temperature piping systems (above 110 degrees C 230 degrees F) are installed.

Provide the following information on the contract drawings: (1) valve manhole dimensions, (2) location of all valve manholes, (3) sizes of the pipe in the valve manholes, (4) location of all valves in the valve manholes, (5) thickness of the

insulation on the pipe, (6) valve manhole details, (7) final elevations of the valve manholes, (8) valve manhole cover details including manway access details, (9) how valve manholes are drained and vented, (10) sump pump piping details, (11) valve manhole equipment dimensions and details, (12) sump pump capacity, (13) electrical wiring details for the equipment (dedicated service for sump pump), (14) steam drip trap locations with access and capacities, (15) steam main drip leg sizes.

This guide specification is to be included as a part of a contract which includes Sections 33 61 13.13 PREFABRICATED UNDERGROUND HYDRONIC ENERGY DISTRIBUTION or 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT); 33 61 13 PRE-ENGINEERED UNDERGROUND HEAT DISTRIBUTION SYSTEM or 33 63 16 EXTERIOR SHALLOW TRENCH STEAM DISTRIBUTION; 33 63 13.19 CONCRETE TRENCH HYDRONIC AND STEAM ENERGY DISTRIBUTION or 33 63 13EXTERIOR UNDERGROUND STEAM DISTRIBUTION SYSTEM. Include the following Sections as part of this contract: 31 00 00 EARTHWORK; 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION; 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION; 03 30 00 CAST-IN-PLACE CONCRETE; 05 05 23.16 STRUCTURAL WELDING; 07 13 53 ELASTOMERIC SHEET WATERPROOFING; 08 31 00 ACCESS DOORS AND PANELS; 09 90 00 PAINTS AND COATINGS; 40 05 13.96 or 40 17 26.00 20 WELDING PROCESS PIPING; 26 20 00 INTERIOR DISTRIBUTION SYSTEM or 26 51 00 INTERIOR LIGHTING; and others as applicable to the project.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA H35.1/35.1M	(2024) American National Standard Alloy and Temper Designation Systems for Aluminum

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.20	(2023) Metallic Gaskets for Pipe Flanges
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting

	Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C449	(2007; R 2024) Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C647	(2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM D2822/D2822M	(2005; R 2011; E 2011) Standard Specification for Asphalt Roof Cement, Asbestos-Containing
ASTM D3278	(2021) Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM F1139	(1988; R 2024) Steam Traps and Drains

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-45	(2020) Bypass and Drain Connections
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(2014) Class 3000 Steel Pipe Unions Socket Welding and Threaded
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 16	(2023) Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint
SSPC Paint 29	(2002; E 2004) Zinc Dust Sacrificial Primer, Performance-Based
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Support of the Equipment

Piping and Fittings

Valves

Insulating Flanges

Insulation

Sump Pumps and Drainers

Expansion Joints

SD-04 Samples

Insulated Sections; G, [_____]

SD-10 Operation and Maintenance Data

Valve Manholes and Accessories; G, [_____]

Data Package 2; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Detail Drawings

Submit detail drawings [_____] days after notice to proceed for valve manholes and the piping and equipment in the valve manholes, such as steam traps, valves, sump pumps, pressure gauges, thermometers and insulation, including a complete list of equipment and materials, manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, installation instructions, and complete wiring and schematic diagrams. Show on the drawings pipe anchors and guides, and layout and anchorage of equipment and appurtenances in valve manholes, and equipment relationship to other parts of the work including clearances for maintenance and operation.

1.3.2 Insulated Sections

Submit sample sections, [_____] days after notice to proceed, for insulation of pipe, elbow, tee, valve, support point, and terminating points. After approval of materials and prior to insulation of piping, prepare a display of insulated sections showing compliance with specifications and showing fastening, sealing, jacketing, straps, waterproofing, supports, hangers, anchors, and saddles. Display approved display sample sections at the jobsite during the construction period until no longer needed by Contracting Officer, then removed.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all materials and equipment delivered and placed in storage from the weather, excessive humidity, and excessive temperature variation; dirt, dust, or other contaminants.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

Equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.2 NAMEPLATES

Supply each major item of equipment such as sump pump, motor, steam trap, and pressure reducing valve with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.3 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products are not allowed.

2.4 ELECTRICAL WORK

Provide motors, manual or automatic motor control equipment, and protective or signal devices required for the operation specified under this section in accordance with NFPA 70 and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.5 PIPING AND FITTINGS

2.5.1 General Requirements

Provide piping, fittings and piping accessories inside the valve manholes suitable for the working pressure and temperature requirements of the system conforming to ASME B31.1. To the greatest extent possible, match the piping and fittings inside the valve manholes to the piping and fittings located on the outside of the valve manhole. Provide steel piping in valve manholes with joints welded except that joints 19 mm 3/4 inch and smaller may be threaded. When threaded joints are used on High Temperature Water Systems, seal weld (continuous fillet weld) the interface area where the pipe threads meet the threaded fittings to preclude any water leakage. Do not attach supports, anchors, or stays to any piping system in places where either the installation of or the movement of the pipe and its contents will cause damage to the construction.

2.5.2 Steel Pipe

Provide black steel, seamless or electric-resistance welded, conforming to the requirements of ASTM A53/A53M, Grade B or ASTM A106/A106M, Grade B. Provide schedule 40 type for pipe up to and including 250 mm 10 inches in diameter. Provide 10 mm 0.375 inch nominal wall thickness for pipe 300 mm 12 inches in diameter and greater. Provide schedule 80 type for gauge piping [, condensate piping,] [drip piping,] [sump pump discharge] and piping 19 mm 3/4 inch in diameter and smaller.

2.5.2.1 Nipples

Provide nipples that conform to ASTM A733 as required to match adjacent piping.

2.5.2.2 Pipe Threads

Provide pipe threads that conform to ASME B1.20.2MASME B1.20.1. Use pipe threads only on pipe 19 mm 3/4 inch or smaller.

2.5.3 Fittings

Provide fittings, valves, flanges and unions with the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.5.3.1 Welded Fittings

Provide welded fittings to match connecting pipes with butt welded fittings, conforming to ASME B16.9, and socket welded fittings, conforming to ASME B16.11.

2.5.3.2 Unions

Provide unions that conform to MSS SP-83 as required to match adjacent piping.

2.5.3.3 Ball Valves

Provide ball valves having flanged or buttwelded end connections conforming to MSS SP-72; provide ball valves having threaded end connections conforming to MSS SP-110.

2.5.4 Insulating Flanges and Dielectric Waterways

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NOTE: Electrically insulating flanges or dielectric waterways must be shown in manholes where piping is connected to a system that is not cathodically protected. Insulating flanges and dielectric waterways must be in accessible locations, such as valve manholes or buildings.

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2.5.4.1 Insulating Flanges

For systems in which cathodic protection is used, provide insulating flanges or flange gasket kits in the valve manhole at the pipe connection to or from the heat distribution system, at the interface of dissimilar metals, and when the carrier pipe and appurtenances are supported in such a way as to electrically ground or alter the cathodic protection system voltages or currents. Provide a kit that consists of flanges, a flange gasket, nuts and bolts, bolt sleeves, and one insulating washer and one steel washer for both ends of each bolt. Provide manufacturer certified gasket kits capable of electrically isolating the pipe at the [_____] kPa psig pressure and [_____] degrees C F temperature of the heating medium at the point of application. Submit evidence of satisfactory installations operating not less than 2 years, in accordance with paragraph SUBMITTALS, before materials are delivered. Ensure that these kits are provided and properly installed according to manufacturer's published instructions. Provide bolts torqued to the correct tightness and in the correct bolt pattern as recommended by the manufacturer's published instructions. Provide steel flanges that conform to ASME B16.5 Class [150] [and] [or] [300] and that match valves or flanged fittings on which used. Provide flat faced steel flanges. Provide non-asbestos compressed material gaskets in accordance with ASME B16.21. Provide bolts that conform to the requirements of ASTM A193/A193M, Grade B7. Provide bolt heads marked to identify the manufacturer and the standard to which the bolt complies. Extend bolt lengths to no less then 2 full threads beyond the nut at the required tension with the washer seated. Provide nuts that conform to the requirements of ASTM A194/A194M, Grade 7.

2.5.4.2 Dielectric Waterways

Provide dielectric waterways that have temperature and pressure rating equal to or greater than that specified for the connecting piping and used for joining dissimilar metals on 19 mm 3/4 inch and smaller threaded pipe. Provide waterways that have metal connections on both ends suited to match connecting piping. Provide dielectric waterways that are internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Provide dielectric flanges that meet the performance requirements described herein for dielectric waterways.

2.5.4.3 Gaskets Non-Insulating

Provide spiral wound, non-asbestos gasket with centering ring that conform to ASME B16.20.

2.6 VALVES

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NOTE: Select the appropriate valves for the operating temperatures and pressures of all systems in the project. Delete valve types not included in project.

Use not less than Class 150 for up to 862 kPa 125 psig steam, and not less than Class 300 for 863 kPa to 1724 kPa 126 to 250 psig steam and high temperature water. For isolation and shutoff, use gate valves only. Steam pressure reducing valves are not normally part of the system. If needed, designer should refer to Section 23 52 30.01 10 CENTRAL COAL-FIRED STEAM-GENERATING SYSTEM or Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS for Navy jobs.

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Provide valves that conform to the material, fabrication, and operating requirements of ASME B31.1, unless otherwise specified. Provide valves suitable for the service temperatures and pressures utilized. Provide valves for [steam] [hot water] that conform to ASME B31.1 Class [150] [and] [or] [300], as suitable for service temperatures and pressures utilized. [Provide valves for condensate services that conform to ASME B31.1 Class 150.] Valves 19 mm 3/4 inch and smaller may be bronze where seal welding is not required. Provide valves 150 mm 6 inches and larger with a 25 mm 1 inch minimum gate or globe bypass valve sized in conformance with MSS SP-45.

2.6.1 Steel Valves

Provide steel globe, gate, angle, and check valves that conform to the requirements of ASME B16.34 and ASME B31.1 for the service temperatures and pressures utilized. Provide gate valves 65 mm 2-1/2 inches and smaller with a rising stem. Provide gate valves 80 mm 3 inches and larger with an outside screw and yoke.

2.6.2 Bronze Valves

2.6.2.1 Globe, Gate, and Angle Valves

Provide bronze globe, gate, and angle valves that conform to MSS SP-80, union bonnet type.

2.6.2.2 Check Valves

Provide bronze check valves that conform to MSS SP-80.

2.6.3 Packing

Provide asbestos free valve packing. Provide die-formed, ring type specifically designated valve stem packing suitable for service temperatures and pressures utilized. Provide polytetrafluoroethylene packing that has a with minimum 50 percent graphite filament. Provide valves 40 mm 1-1/2 inches and smaller with four or five packing rings and provide valves 50 mm 2 inches and larger with at least six packing rings. Spiral or continuous packing will not be acceptable. Provide a metal insert having proper clearance around the valve stem at the bottom of the stuffing box and acting as a base for the packing material. Provide one piece construction with provisions for not less than two bolts for packing adjustment, with a liner of noncorrosive material for packing glands.

2.7 STEAM TRAPS

****

NOTE: The following paragraphs are applicable to steam systems only. Only these two types will be used. Delete these paragraphs when the distribution system is not a steam system.

A schedule of steam trap selection will be shown on the drawings. Trap capacity (kg per second (pounds per hour) during normal operation, pressure drop (kPa (psi), and pressure rating (kPa (psi) of each trap will be included in this schedule. Also, show on the drawings a vent valve or test valve connection downstream of traps for test of trap operation, a strainer ahead of traps, a union, a check valve in the outlet piping, and shut-off valves on both sides of trap for trap changeout. A means of bypassing the trap must be provided for system warm-up.

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Provide fail open traps with trap bodies suitable for a working pressure of not less than 1.5 times the steam supply pressure, but not less than 1379 kPa 200 psi.

2.7.1 Bucket Traps

Provide inverted-bucket type bucket traps with automatic air discharge conforming to ASTM F1139.

2.7.2 Thermostatic Traps

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NOTE: Specify thermostatic traps where the trap location is subject to freezing.

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Provide thermostatic traps that have a bimetallic element with automatic air discharge conforming to ASTM F1139.

[2.8 STRAINERS

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NOTE: Delete this paragraph for high temperature water systems.

****

Provide basket or y-type strainers with connections the same size as the pipe lines in which the connections are installed. Provide heavy and durable strainer bodies, of cast steel, with bottoms drilled and plugged suitable for service temperatures and pressures utilized. Provide each strainer body with arrows clearly cast on the sides to indicate the direction of flow. Provide each strainer with an easily removable cover and sediment basket. Provide each strainer body or bottom opening with a nipple and gate valve for blowdown. Provide 0.6350 mm 0.025 inch thick stainless steel, monel or sheet brass strainer basket with small perforations of sufficient number to provide a net free area at least 2.5 times that of the entering pipe. Provide cast steel bodies and stainless or Monel baskets for high temperature hot water systems.

]2.9 PRESSURE GAUGES

Provide pressure gauges that conform to ASME B40.100 with a minimum dial size of 110 mm 4-1/4 inches. Provide each gauge with a throttling type needle valve or a pulsation dampener and shut-off valve.

2.10 DIAL THERMOMETERS

Provide dial type thermometers 90 mm 3-1/2 inches in diameter with stainless steel case, remote-type bulb or direct-type bulb as required. Provide thermometers that have an accuracy of plus or minus 1 degree C 2 degrees F. Provide thermometer wells of the separable socket type for each thermometer with a direct-type bulb. Provide thermometer with a white face with black digits graduated in 1 degree C 2 degrees F increments.

2.11 COATINGS

Coat steel manhole piping with an organic zinc undercoat that conforms to SSPC Paint 29 Type II followed by a thermal barrier coating having a manufacturer’s documented minimum thermal conductivity of 0.100 W/m•K 0.058 Btu/hr•ft•°F. Provide the undercoat and thermal barrier coating with a continuous use service temperature rating that exceeds the nominal system operating temperature by a minimum of 28 degrees C 50 degrees F.

2.12 INSULATION AND JACKETING

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NOTE: All piping, valves and fittings for steam, hot water and dual temperature heat distribution systems in valve manholes require insulation for the protection of operating and maintenance personnel as well as for the conservation of energy; whether or not to insulate chilled water lines, valves, and fittings in the manholes can be determined by the necessity to prevent condensation on the piping and energy conservation.

The energy savings will vary with the ambient temperature but will be a factor in warm climates. There may be some isolated cases where the chilled water distribution pipes entering the manhole are not insulated; therefore, the piping in the manhole would not normally be insulated unless condensation from the air forming on the chilled water pipes

causes a problem.
****

2.12.1 General Provisions

Insulate piping, fittings, valves, etc., in the valve manholes. Provide insulation premolded, precut or job fabricated to fit and be removable and reusable. Provide thickness of insulation in accordance with Tables 1 and 2. Provide insulation jackets for all pipe and fitting insulation. Provide insulation that conforms to EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.12.2 Insulation

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NOTE: The insulations allowed in this paragraph have passed a 96 hour boiling test which indicates that satisfactory performance is expected.
****

Provide piping, fittings, and valves with molded calcium silicate insulation conforming to ASTM C533, Type I, or molded mineral fiber insulation conforming to ASTM C547, Class 2, or cellular glass insulation conforming to ASTM C552. Do not use laminated construction unless the thickness exceeds 100 mm 4 inches. Insulation manufacturers approved for use are:

a. Delta, available from Rockwool in Leeds, Alabama.

b. MPT-PC and MPT-PF, available from Mineral Products of Texas in Houston, TX.

c. Thermo-12, Super Caltemp, available from Johns Manville in Denver, Colorado.

d. Foamglass (cellular glass), available from Pittsburgh Corning Corporation.

2.12.3 Aluminum Jackets

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NOTE: Vapor barrier requirements are only to be included for chilled water systems.
****

Provide aluminum jackets of smooth sheet, 0.4064 mm 0.016 inch nominal thickness, that conform to the requirements of ASTM B209M ASTM B209, Type 3003, 3105, or 5005.[Supply aluminum jackets that have a factory installed moisture barrier that consists of at least 18.1 kg 40 pound kraft paper coated on one side with a 0.025 mm 1 mil thick polyethylene film. ProviDe a jacket with the moisture barrier adhered to the jacket over the entire area of the insulation-side surface.]

2.12.4 Bands

Provide bands for aluminum jacket 10 mm 3/8 inch wide and 32 gauge thickness made of aluminum or annealed stainless steel. Provide bands for insulation 13 mm 1/2 inch wide and 32 gauge thickness made of annealed stainless steel.

2.12.5 Insulation for Flanges, Unions, Valves, and Fittings

Insulate flanges, unions, valves, and fittings with premolded, prefabricated, or field fabricated segments of insulation of the same material and thickness as the manhole pipe insulation. Provide insulation with essentially the same thermal characteristics and thickness as the adjoining piping.

2.12.6 Vapor Barrier Coating

Provide insulation with a vapor barrier coating that is water resistant, appropriately selected for either outdoor or indoor service, colored white, and has a water vapor permeance of the compound not exceeding 0.05 perm as determined according to Procedure B of ASTM E96/E96M. Provide a coating that is the nonflammable, fire resistant type conforming to ASTM E84, NFPA 90A and UL 723 and has a flash point not less than 26.7 degrees C 80 degrees F as determined in accordance with ASTM D3278. Provide a coating that conforms to ASTM C647; excluding the previous fire resistant requirements.

2.12.7 Finishing Cement

Provide mineral fiber hydraulic-setting thermal insulating cement that conforms with ASTM C449.

2.12.8 Glass Tape

Provide tape that conforms to the requirements of UL 723 and ASTM E84.

2.12.9 Plain Weave, Untreated

Provide with the ends interlocked with the picks to ensure no raveling of the tape edges. Provide tape that is an average weight of 196.7 plus or minus 10 percent grams per square meter 5.8 plus or minus 10 percent ounces per square yard, and average thickness of 0.1778 plus or minus 0.0254 mm 0.007 plus or minus 0.001 inches. Provide with warp ends or wales of 17 plus or minus 1 per centimeter 42 plus or minus 2 per inch or filling picks or courses of 13 plus or minus 1 per centimeter 32 plus or minus 2 per inch; a minimum breaking strength of 2679 grams per mm 150 pounds per inch of width; and after heating to 482 degrees C 900 degrees F for 2 hours, a minimum breaking strength of 714 grams per mm 40 pounds per inch of width.

2.12.10 Knitted, Untreated

Provide with the wales interlocked with the courses to ensure no raveling of the tape edges. Provide tape that is an average weight of 153 plus or minus 10 percent grams per square meter 4.5 plus or minus 10 percent ounces per square yard; average thickness of 0.1778 plus or minus 0.0254 mm 0.007 plus or minus 0.001 inches; and warp ends/wales of 6 plus or minus per 1 centimeter 16 plus or minus 2 per inch. Use material with minimum breaking strength of 714 grams per mm 40 pounds per inch of width and, after heating to 482 degrees C 900 degrees F for 2 hours, minimum breaking strength of 375 grams per mm 21 pounds per inch of width.

2.12.11 Distortion Requirements

Distortion of the tape when a sample 610 mm 24 inches in length is spread across a flat horizontal surface and observed for evidence of distortion (such as tendency to curl rather than lie flat) is not acceptable. The width tolerance is plus or minus 3 mm 1/8 inch.

2.12.12 Open-Weave Tape

Provide open-weave type tape, used for embedding between coats of adhesive or coating materials, that has an average weight of [_____] kg per square meter ounce per square yard.

2.13 SUMP PUMPS AND DRAINERS

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NOTE: The application would be for a submersible sump pump in a manhole serving an underground heat distribution system. Flow range 1.6 L/s 25 to 50 gpm, head of 4.5 to 9 TDH 15 to 30 TDH, fluid temp of 93 degrees C 200 deg F. When pump performance is outside the flow, head or temperature range identified herein, materials of construction need to be validated with a pump supplier and specification written whereby multiple vendors can meet both performance and material construction as specified. Delete this paragraph when positive drainage of the valve manhole is provided and sump pumps are not needed. Use of duplex sump pumps is encouraged. Delete text in brackets if a single sump pump is specified.

Provide one or two sump pumps in valve manholes. Units should discharge by buried piping to the nearest storm sewer if possible. Where not economical to discharge to a storm sewer, pumps are to discharge above grade. Plan discharge locations carefully so water will not be discharged over valve manhole tops, sidewalks, etc. Check available NPSH versus required NPSH for pump selected. Coordinate power requirements with electrical designer and provide tell-tale light above ground to indicate sump pump failure. Drawings will show the following: (a) a dedicated circuit; (b) lockable switches and circuit breakers that can both be locked ON; (c) permanent labels at key positions indicated on the drawings so that personnel can understand that the circuit should be left ON. The label must be on a corrosion resistant metal plate and must read as follows:
THIS CIRCUIT SUPPLIES POWER TO THE ELECTRIC SUMP PUMPS IN THE UNDERGROUND HEAT DISTRIBUTION SYSTEM. THIS CIRCUIT MUST BE ON AT ALL TIMES; OTHERWISE EXTENSIVE DAMAGE WILL OCCUR TO THE UNDERGROUND HEAT DISTRIBUTION SYSTEM AND PREMATURE FAILURE WILL OCCUR.

****

2.13.1 Sump Pumps

Provide a manufacturer's standard commercial product that is electrically driven and submersible, capable of operating while completely submerged, and capable of running without damage when not submerged. The pumps and motors must be capable of continuously pumping liquids at a temperature of 93 degrees C 200 degrees F. Provide sump pumps with permanently lubricated bearings, [monel] [stainless steel] shafts, [bronze] [stainless steel] [cast iron] impellers, screened inlets and housings of [bronze] [stainless steel] [cast iron]. Each sump pump must be capable of passing a 10 mm 3/8 inch sphere.

2.13.1.1 Motors

Provide motors with overload protection. Provide pump[s] that are automatically controlled, using control components provided by the pump manufacturer, by a submersible switch assembly with pump wiring and switch suitable for submersion in 93 degrees C 200 degrees F liquids.[Provide duplex (one on - one standby) arrangement with automatic alternating lead-lag controller.] Provide [cord and plug] [hardwired] motor electrical connections.

2.13.1.2 Controls

Provide controls, controllers, water level switches, and electrical connections suitable for service at 100 percent humidity, at 93 degrees C 200 degrees F temperature, and occasional water submersion. The sump pumps automatic control switches must have demonstrated 200,000 cycles at 93 degrees C 200 degrees F and 100 percent relative humidity while totally submersed in water at 93 degrees C 200 degrees F.

2.13.2 High Level Alarm Indicator

Provide another switch to indicate high water level, connected to an emergency warning light mounted on or adjacent to the valve manhole. Set this high water level alarm at a level which is below the bottom of any pipe in the valve manhole. Provide auxiliary contacts in a separate junction box to permit connection to a [future] Energy Monitoring and Control System (EMCS) for monitoring the operation of each pump motor and the high water level alarm system.

2.13.3 Drainers

Provide automatic type drainers to operate on 862 kPa (gage) 125 psig steam supply pressure and actuating when the water level rises sufficiently in the sump, raising the float opening the steam control valve to admit steam to the drainer, resulting in pumping the water from the sump. When the float is lowered by the pumping action, it closes the steam valve, stopping the pumping action until the rising water causes the to float rise again and open the steam valve, starting the cycle over again. Provide each drainer with controls to accomplish the above sequence of operation. Design the automatic float-operated steam valve to prevent dead centering under field conditions and to lengthen the life of the valve seat. Provide the valve with a high grade, renewable composition disc and a stainless steel or hard, noncorrosive bronze renewable seat inserted in the valve body with the drainer constructed of corrosion-resistant copper and bronze. Provide piping from manhole drainers that conforms to ASTM A53/A53M, Weight Class XS (Extra Strong), hot-dip galvanized steel pipe with ASME B16.11 or ASME B16.3, Class 300, hot-dip galvanized threaded fittings. Provide a steam pressure regulating valve assembly for manhole drainers for operation on steam system above 862 kPa (gage) 125 psig.

2.14 CONCRETE VALVE MANHOLES AND ACCESSORIES

****

NOTE: If the referenced sections are not to be included in the project specifications, applicable paragraphs from the referenced sections must be incorporated into this specification. The designer is also advised that, for Army projects, Section 31 00 00 EARTHWORK, and if electrically operated sump pumps are installed, either Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION or Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, or applicable portions of the above specifications, must be included as part of the project specifications. For Navy jobs, Section 31 00 00 EARTHWORK, and if electrically operated sump pumps are installed, either Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION or Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, or applicable portions of the above specifications must be included as part of the project specifications.

The design of manholes including size, reinforcing, arrangement, penetrations, equipment and piping within the valve manholes is the responsibility of the designer. Valve manholes must be designed to provide proper venting and drainage and adequate room for maintenance without stepping on or over any equipment. When electric sump pumps are used, the electrical distribution and tie in points must be designed and shown on the drawings.

In most cases, valve manhole covers will consist of open grates. If manhole top is to be used as part of a sidewalk and valve manhole is not deep, a solid plate cover may be used without special provisions for manhole ventilation. These tops must be designed to be removed or opened completely during maintenance operations. For larger and deeper valve manholes, raised frame solid plate cover must be required.

Edit Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION to require manholes be constructed of 27 MPa 4000 psi minimum compressive strength concrete.

****

2.14.1 Wall and Floor Construction

Provide manhole in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. Construct walls and floors of reinforced concrete not less than 200 mm 8 inches thick. Construct walls using one monolithic pour. Extend walls [not less than 150 mm 6 inches above grade][flush with finished grade][flush with trench top][_____]. Provide floor with an internal sump; slope the floor in all directions to the sump to allow water collection. Provide construction joints with water stops. Waterproof manhole exterior in accordance with Section 07 13 53 ELASTOMERIC SHEET WATERPROOFING.

2.14.2 Manhole Supported Cover(s)

****

NOTE: Indicate in the design the sectional requirements of the cover. When used in conjunction with concrete shallow trenches, set the top of cover flush with the concrete trench top. When used in conjunction with direct buried conduit systems, set the top of the cover a minimum of 150 mm 6 inches above grade.

Include the checkered plate cover over the top of open grates in cold climates and where trash accumulation is a concern.

****

Provide [a hot-dipped galvanized steel open grate] [an 8 mm 5/16 inch thick checker pattern, aluminum solid plate cover that conforms to AA H35.1/35.1M] [_____] cover that is supported by and is flush with the top of the manhole walls. Construct cover(s) to be removable and sectionalized as indicated. Provide hot-dipped galvanized structural steel supports, anchor bolts, nuts, and washers. Provide a cover and support system that can support a load up to[7.2 kPa 150 psf] [_____]. [Install an 8 mm 5/16 inch thick checker pattern, aluminum solid plate cover that conforms to AA H35.1/35.1M on top of the open grating. Attach the checkered plate to the grating with removable, galvanized steel fasteners.]

2.14.3 Raised Frame Cover(s)

****

NOTE: Do not use a raised frame and cover when connected to a shallow concrete trench system due to interference issues. A raised frame and cover is best suited for direct buried conduit type systems.

Indicate in the design the sectional requirements of the cover as well as the ventilation opening sizing.

****

Provide a raised support structure constructed out of hot-dipped galvanized steel that is designed to sit on top of the manhole walls. Provide an 8 mm 5/16 inch thick checker pattern, aluminum solid plate cover that conforms to AA H35.1/35.1M. Construct cover(s) to be removable and sectionalized as indicated. Provide ventilation openings as indicated around the entire perimeter below the raised top. Provide hot-dipped galvanized steel lifting lugs on the cover.

2.14.4 Concrete Cover

****

NOTE: The use of concrete covers is discouraged unless specifically requested by the user or if specific design conditions exist that require them.

For ventilation choose the brackets for the dual goosenecks if a direct buried system is used. Choose the brackets for the single gooseneck if a concrete shallow trench system is used.

****

Provide a[150 mm 6 inches] [_____] thick cast concrete cover designed to support loads up to[7.2 kPa 150 psf] [_____]. Provide a[1220 by 1220 mm 4 by 4 foot aluminum access door] [762 mm 30 inch diameter standard cast iron manhole frame and removable cover] [900 by 900 mm 36 by 36 inch watertight, hinged steel cover not less than 13 mm 1/2 inch thick] in the concrete top. [Provide two 150 mm 6 inch goosenecks; terminate one gooseneck inside the manhole within 600 mm 2 feet of the manhole's floor; terminate the other gooseneck inside the manhole just below the manhole top.] [Provide a single 150 mm 6 inch gooseneck pipe to allow heat/steam to exit the valve manhole; install the gooseneck off to one side of the valve manhole concrete top to minimize pedestrian traffic interference. Terminate gooseneck within 600 mm 2 feet above finished grade.]

2.14.5 Ladders

Provide steel valve manhole ladders, with nonslip surfaces, and consisting of uprights with steps or rungs. fabricate ladders with two stringers a minimum 9.5 mm 3/8 inch thick and 64 mm 2-1/2 inches wide, and rungs not be less than 406.4 mm 16 inches in width, 19.1 mm 3/4 inch diameter, spaced 304.8 mm 12 inches apart. Anchor the ladders to the wall by means of steel inserts spaced not more than 2 m 6 feet apart vertically, and install to provide at least 150 mm 6 inches of space between the wall and rungs. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.

2.14.6 Pipe Sleeves

Provide zinc-coated steel pipe, conforming to ASTM A53/A53M, Schedule 40 or standard weight. Install so there is no electrical continuity between the pipe sleeve and the pipe casing.

2.14.6.1 Pipe Sleeves Through Valve Manhole Cover

Provide insulation continuously through sleeves and provide aluminum jacket over the insulation. Provide smooth sheet 0.4064 mm 0.016 inch nominal thickness aluminum jacket conforming to ASTM B209M ASTM B209. Where penetrations in valve manhole tops are required, insulate piping and seal with waterproof coating up to a point flush with the top of the flashing and the end of the insulation. Butt insulation exposed to the weather tightly against the flashing and valve manhole insulation, and extend the aluminum jacket required for piping exposed to the weather 50 mm 2 inches beyond the insulation to form a counterflashing. Flash and counterflash valve manhole penetrations and apply waterproof coating conforming to ASTM D2822/D2822M, Type I.

2.14.6.2 Pipe Sleeves for Conduit Penetrations

Provide a modular mechanical type sealing assembly between the valve manhole pipe sleeve and the [conduit casing] [or] [uninsulated chilled water pipe]. The mechanical seal consists of interlocking elastomeric links shaped to continuously fill the annular space between the [casing] [or] [uninsulated chilled water pipe] and sleeve. The link material is a synthetic elastomeric capable of withstanding long term exposure at 205 degrees C 400 degrees F without deterioration. Attach the links to each other with corrosion resistant steel bolts, nuts and pressure plates. The link, bolts, nuts and pressure plates must be the product of single manufacturer and furnished as the product of single manufacturer as a package or kit.

2.14.7 Pipe Supports

Provide pipe supports in accordance with MSS SP-58. Galvanize all pipe supports, including structural cross support members, in accordance with Section 08 31 00 ACCESS DOORS AND PANELS. Chains, straps, or single point supports are not allowed.

2.15 EXPANSION JOINTS

****

NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the planning phase of the piping layout, prior to including expansion joints in the specifications. Cold spring (pipe expansion) will be shown on the drawings. Sizing of expansion loops and bends will not be based on cold spring.

If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, they must be located in a readily accessible location. Type I and III slip joint, packed expansion joints are adjustable gland type and require continuing maintenance to contain leakage and are now manufactured by only one company making them proprietary. For these reasons, these types are not specified.

Coordinate this paragraph with paragraph PIPING in PART 3; remove this whole paragraph or subparagraphs not required in the project.

****

Submit manufacturer's descriptive data and technical literature, performance charts, catalog cuts and installation instructions.

[2.15.1 Guided Slip Tube

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NOTE: Expansion joints must provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the traverse indicated. The joints must be designed for hot water working pressure in accordance with applicable requirements of EJMA-01 and ASME B31.1. This joint is designed for packing injection under full line pressure.

****

Internally-externally guided type, injected semiplastic type packing, with service outlets. Construct joints for minimum working pressure of ASME Class 150. Provide single or double slip tube type as indicated. Provide flanged or buttwelding end connections as indicated.

][2.15.2 Flexible Ball

****

NOTE: The ball joint will be designed for packing injection under full line pressure to contain leakage. Balls and sockets will be of equivalent material as the adjoining pipeline. The exterior spherical surface of carbon steel balls will be plated with 0.051 mm 2 mils of hard chrome in accordance with ASTM B650. The ball type joints will be designed and constructed in accordance with ASME B31.1 and Section VIII, Boiler and Pressure Vessel Code, where applicable. Flanges where required will conform to ASME B16.5. Gaskets and compression seals will be compatible with the service intended.

****

Provide chromium plated steel balls capable of 360-degree rotation plus 15-degree angular flex movement. Provide pressure molded composition gaskets designed for continuous operation temperature of 274 degrees C 525 degrees F. Construct joints for minimum working pressure of ASME Class 150. Provide flanged or buttwelding end connections as indicated.

][2.15.3 Bellows-Type

****

NOTE: Bellows type joints must be flexible, guided expansion joints. The expansion element will be stabilized corrosion resistant steel. Bellows type expansion joints will conform to the applicable requirements of EJMA-01 and ASME B31.1 with internal liners. The joints will be designed for the working temperature and pressure suitable for the application but will not be less than 1034 kPa 150 psig.

****

Type 304 stainless steel corrugated bellows, reinforced with rings, internal sleeves, and external protective covers, designed to withstand 10,000 cycles over a 20 year period and a minimum working pressure of ASME Class 150. Provide limit stops to limit total movement in both directions. Cold set the joints to compensate for temperature at time of installation. Provide single or double bellows expansion joint as indicated. Provide first pipe alignment guide no more than four pipe diameters from the expansion joint; provide second pipe alignment guide no more than 14 pipe diameters from the first guide. Provide flanged or buttwelding end connections as indicated.

]2.16 MISCELLANEOUS METAL

****

NOTE: Include miscellaneous metals located in trenches or valve manholes in Section 08 31 00 ACCESS DOORS AND PANELS.

****

Conform miscellaneous metal, not otherwise specified, to Section 08 31 00 ACCESS DOORS AND PANELS. Hot-dip galvanize miscellaneous metal bolted together, shop welded, or assembled in the field, and pipe supports, including structural cross support members and anchors, in accordance with Section 08 31 00 ACCESS DOORS AND PANELS.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 SITE WORK

3.2.1 Excavation, Trenching, and Backfilling

Excavate, trench, and backfill the valve manholes as indicated and in accordance with Section 31 00 00 EARTHWORK.

3.2.2 Electric Work

Provide any wiring required for the operation of the equipment specified, but not indicated on the electrical drawings or under this section, in accordance with Sections 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.3 Painting

Clean the heat affected zone of field welded galvanized surfaces and other galvanized surfaces damaged during installation in compliance with SSPC SP 10/NACE No. 2, and paint in accordance with Section 09 90 00 PAINTS AND COATINGS. Clean steel and iron appurtenances, piping, and supports in compliance with SSPC SP 10/NACE No. 2, and paint in accordance with SSPC Paint 16.

3.3 PIPING

3.3.1 General

****

NOTE: Delete provisions in brackets and all other references to threaded connections for high temperature water systems.

If expansion joints are required, coordinate this paragraph with paragraph EXPANSION JOINTS in PART 2.

For Guided Slip Tube expansion joints the end connections will be flanged or beveled for welding as indicated. Joint must be provided with an anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip must be seamless steel plated with a minimum of 0.051 mm 2 mils of hard chrome in accordance with ASTM B650. All joint components must be fabricated from material equal to that of the pipeline. Initial setting must be made in accordance with the

manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides must be installed as recommended by the joint manufacturer, but in any case must not be more than 1.5 m 5 feet from expansion joint except that in lines 100 mm 4 inches or smaller, guides will be installed not more than 600 mm 2 feet from the joint. Service outlets will be provided where indicated.

Flexible ball joints will be constructed of alloys as appropriate for the service intended. Joint ends will be threaded (to 50 mm 2 inches only), grooved, flanged or beveled for welding as indicated or required, and must be capable of absorbing a minimum of 15-degree angular flex and 360-degree rotation.

For Bellows-Type joints, guiding of piping on both sides of expansion joint will be in accordance with the published recommendations of the manufacturer of the expansion joint. When a joint is installed within four pipe diameters of an anchor, only one side needs guiding.

****

Use steel piping and insulate in valve manholes. Protect insulation with [an aluminum] [a galvanized steel] jacket [, except for chilled water lines where indicated not to be insulated.] Cut pipe to measurements established at the site and work into place without springing or forcing. Clear all openings and equipment, and avoid cutting or other weakening of structural members to facilitate piping installation. Remove burrs from ends of pipe by reaming. Install to permit free expansion and contraction without damage to joints or hangers and in accordance with ASME B31.1. Do not attach supports, anchors, or stays where either expansion or the weight of the pipe could cause damage to permanent construction. The method of attaching supports must not interfere with the operation of the cathodic protection system.

3.3.2 Welded Joints

Weld all pipe joints for piping in valve manholes[, except joints at traps, strainers, and at valves and piping 19 mm 3/4 inch and smaller which may be threaded]. Conform welding to the requirements specified in paragraph WELDING.

3.3.3 Flanged and Threaded Joints

3.3.3.1 Flanged Joints

[Flanged joints are permitted for dielectric isolation only.]Construct flanged joints to be faced true, provided with gaskets, and made perfectly square and tight. Use flanged joints only for electrical isolation and in other special cases where connected equipment is available with only flanged joints, or when specifically indicated. Provide electrically isolated flange joints at all connections to or from the heat distribution system and between dissimilar metals.

3.3.3.2 Threaded Joints

Apply graphite or inert filler and oil, graphite compound, or polytetrafluoroethylene tape to the male threads only. Provide unions at all screwed valves, strainers and connections to equipment 19 mm 3/4 inch and smaller. Use dielectric unions at connections of dissimilar metals in 19 mm 3/4 inch and smaller piping. When used on High Temperature Water Systems, seal weld threaded joints.

3.3.4 Reducing Fittings

3.3.4.1 Horizontal Water Heating Lines

Provide eccentric reducers for all pipe size changes. Provide eccentric type reducing fittings to maintain the tops of adjoining pipes at the same level.

3.3.4.2 Horizontal Steam Lines

Provide eccentric reducers for all pipe size changes. Provide eccentric type reducing fittings to maintain the bottoms of adjoining pipes at the same level.

3.3.5 Branch Connections

Branch off top of mains as indicated providing unrestricted circulation, elimination of air pockets, and permitting the complete drainage of the system. Branch connections may be made with either welding tees or forged branch outlet fittings. If branch outlet fittings are used, provide forged fittings no larger than two nominal pipe sizes smaller than the main run. Reinforce branch outlet fittings to withstand external strains and designed to withstand full pipe bursting strength.

3.3.6 Pipe Supports in Valve Manholes

Securely support horizontal and vertical runs of pipe in valve manholes.

3.4 WELDING

****

NOTE: If the need exists for more stringent pipe welding requirements, delete the sentences in the first set of brackets.

****

[Weld pipe in accordance with qualified procedures, using performance qualified welders and welding operators. Procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform the tests at the work site. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record.] [Perform welding and nondestructive testing procedures for piping as specified in Section [40 05 13.96] [40 17 26.00 20] WELDING PROCESS PIPING.] Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

3.5 COATINGS

Prepare the steel piping surface by abrasive blasting to the near-white metal grade in conformance with SSPC SP 10/NACE No. 2. Within eight hours of blasting, or prior to any condensation of moisture or other surface deterioration whichever occurs first, coat all surfaces with an organic zinc primer conforming to SSPC Paint 29 Type II. Spray apply the primer to a minimum thickness at any point of 0.10 mm 4 mils. Allow the primer to cure according to the manufacturer’s recommendations prior to overcoating with the thermal barrier coating. Provide thermal barrier coating having film forming properties, an adhesion value of 5 when tested according to ASTM D3359 and a minimum thermal conductivity of 0.100 W/m•K 0.058 Btu/hr•ft•°F. Spray apply the thermal barrier coating in accordance with manufacturers recommendations to a minimum thickness at any point of 1.3 mm 50 mils.

3.6 INSULATION

Install insulation so that it is not damaged by pipe expansion or contraction. Keep insulation drybefore, during, and after installation. Groove insulation installed over welds to assure a snug fit. Hold insulation in place with stainless steel straps. Install a minimum of 2 bands on each individual length of insulation, with maximum spacing not exceeding 450 mm 18 inch centers.

3.6.1 Installation

Install material in accordance with published installation instructions of the manufacturer. Do not apply insulation materials until piping tests are complete. Prior to application, thoroughly clean surfaces of moisture, grease, dirt, rust, and scale; paint where required.

3.6.2 Insulation on Pipes Passing Through Sleeves

Provide continuous insulation, as required by paragraph PIPE SLEEVES THROUGH VALVE MANHOLE COVER. Provide aluminum jackets over the insulation. When penetrating valve manhole walls, extend aluminum jacket not less than 50 mm 2 inches beyond the sleeve on each side of the wall and secure with an aluminum band on each side of the wall. Where flashing is provided, secure the jacket with not less than one band located not more than 25 mm 1 inch from the end of the jacket. When penetrating valve manhole tops, insulate pipe as required for valve manhole service.

3.6.3 Covering of Insulation in Valve Manholes

Cover insulation for pipe, flanges, valves, and fittings with [aluminum] [galvanized steel] jackets.

3.6.4 Insulation of Piping Accessories in Valve Manholes

Insulate flanges, couplings, unions, valves, fittings, and other pipe accessories, unless otherwise indicated, with removable and reusable factory premolded, prefabricated, or field fabricated insulation. Provide [aluminum] [galvanized steel] sheet over insulation manholes and neatly terminate for accessories that are not to be insulated.

3.6.5 Insulation Sealing for Chilled Water Systems

Seal the ends of insulation with vapor barrier, caulk penetrations and apply caulking to parting line between equipment and removable section insulation. Upon completion of installation of the insulation, including removable sections, apply two coats of vapor barrier coating with a layer of glass cloth embedded between the coats, providing a total dry thickness of the finish of 1.6 mm 1/16 inch while maintaining removability of the sections as designed. Apply coating to flanges, unions, valves, anchors, fittings and accessories, all terminations, and all insulation not protected by factory vapor barrier jackets or PVC fitting covers. Overlap tape seams 25 mm 1 inch. Extend the coating out onto the adjoining pipe insulation 50 mm 2 inches. Taper insulation terminations to unions at a 45-degree angle.

3.6.6 Insulation Thickness

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NOTE: Delete inapplicable columns in Tables 1 and 2.

****

Provide the minimum thickness of insulation for [the heat distribution system] [and] [condensate return system] [each section of pipe] in accordance with Tables 1 and 2.

TABLE 1
Minimum Pipe Insulation Thickness (In mm) (In inches)

For steam (110 to 2,800 kPa (gage)) (16 to 408 psig) and High Temperature Hot Water Supply and Return (120 to 230 degrees C) (250 to

Nominal Pipe Diameter (mm) (inches)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp	Foamglass
25 1.0	50 2.0	63 2.5	100 4.0	115 4.5
40 1.5	50 2.0	63 2.5	100 4.0	115 4.5
50 2.0	65 2.5	85 3.5	110 4.5	125 5.0
65 2.5	65 2.5	85 3.5	110 4.5	125 5.0
80 3.0	75 3.0	100 4.0	125 5.0	150 6.0
100 4.0	75 3.0	100 4.0	125 5.0	150 6.0
125 5.0	75 3.0	100 4.0	125 5.0	150 6.0
150 6.0	85 3.5	110 4.5	135 5.5	150 6.0
200 8.0	85 3.5	110 4.5	135 5.5	150 6.0
250 10.0	100 4.0	125 5.0	150 6.0	165 6.5
300 12.0	100 4.0	125 5.0	150 6.0	165 6.5
350 14.0	100 4.0	125 5.0	150 6.0	165 6.5
400 16.0	100 4.0	125 5.0	150 6.0	165 6.5

TABLE 1 Minimum Pipe Insulation Thickness (In mm) (In inches)				
For steam (110 to 2,800 kPa (gage)) (16 to 408 psig) and High Temperature Hot Water Supply and Return (120 to 230 degrees C) (250 to				
450 18.0	100 4.0	125 5.0	150 6.0	165 6.5

TABLE 2 Minimum Pipe Insulation Thickness (In mm) (In inches)				
For Low Pressure Steam (less than 110 kPa (gage) 16 psig), Condensate Return and Low Temperature Hot Water (less than 120 degrees C 250 degrees F)				
Nominal Pipe Diameter (mm) (inches)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp	Foamglass
25 1.0	40 1.5	50 2.0	80 3.0	80 3.0
40 1.5	40 1.5	50 2.0	80 3.0	80 3.0
50 2.0	40 1.5	50 2.0	80 3.0	80 3.0
65 2.5	40 1.5	50 2.0	80 3.0	80 3.0
80 3.0	50 2.0	65 2.5	85 3.5	85 3.5
100 4.0	50 2.0	65 2.5	85 3.5	85 3.5
125 5.0	50 2.0	65 2.5	85 3.5	85 3.5
150 6.0	65 2.5	80 3.0	110 4.5	110 4.5
200 8.0	65 2.5	80 3.0	110 4.5	110 4.5
250 10.0	80 3.0	100 4.0	125 5.0	125 5.0
300 12.0	80 3.0	100 4.0	125 5.0	125 5.0
350 14.0	80 3.0	100 4.0	125 5.0	125 5.0
400 16.0	80 3.0	100 4.0	125 5.0	125 5.0
450 18.0	80 3.0	100 4.0	125 5.0	125 5.0

3.7 VALVE MANHOLES AND ACCESSORIES

****

NOTE: Provide design details on drawings of concrete reinforcing, size, dimensions of valve manhole, piping arrangements, type of removable cover, valve manhole penetrations, pipe and equipment supports, etc.

****

3.7.1 Piping and Equipment in Valve Manholes

Provide easy access in valve manholes without stepping on piping or equipment, and allow sufficient working area for maintenance work. Refer to drawings of piping and equipment in valve manholes for installation and support details. Install all globe, angle and gate valves with the stems horizontal or above.

Submit Data Package 2 as related to all equipment provided for the project in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Detail in the operation manuals the step-by-step procedures required for equipment startup, operation, and shutdown. Include in the operation manuals the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the maintenance manuals piping and equipment layout and simplified wiring and control diagrams indicating location of electrical components with terminals designated for wiring, as installed.

3.7.2 Sump Pumps Installation

****

NOTE: Coordinate this paragraph with the specified requirements in paragraph SUMP PUMPS.

****

Install sump pumps as indicated, with all electrical connections hard wired.[Connect monitoring of each pump motor and the high water alarm to the Energy Monitoring and Control System (EMCS). Coordinate electrical requirements of EMCS with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM]. Provide dedicated electrical circuits to the sump pumps. Provide all circuit breakers and switches in the electrical power distribution to the sump pumps with the capability of being locked in the "ON" position to be signed as follows. Stamp the words for the sign on a corrosion resistant metal plate with letters 10 mm 3/8 inch high, and affix the plate permanently near the switch or circuit breaker.

THIS CIRCUIT SUPPLIES POWER TO THE ELECTRIC SUMP PUMPS IN THE UNDERGROUND DISTRIBUTION SYSTEM. THIS CIRCUIT MUST BE "ON" AT ALL TIMES; OTHERWISE EXTENSIVE DAMAGE WILL OCCUR TO THE UNDERGROUND HEAT DISTRIBUTION SYSTEM AND PREMATURE FAILURE WILL OCCUR.

3.8 TESTS

Perform tests of piping in the valve manholes as part of the testing of the direct buried conduit system. Iinclude the piping in the valve manhole in these tests and perform in accordance with the system supplier's Approved Brochure or the contract specifications.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 61 14 (February 2010)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 61 14 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 61 14

EXTERIOR BURIED PREINSULATED WATER PIPING

02/10

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 61 14 (February 2010)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 61 14 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 33 61 14

EXTERIOR BURIED PREINSULATED WATER PIPING
02/10

****
NOTE: This guide specification covers the requirements for exterior buried factory-prefabricated preinsulated water piping system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: This guide specification includes requirements for hot domestic water piping, recirculating hot domestic water piping, chilled water piping, chilled-hot (dual temperature) water piping, and hot water piping from heat exchangers to each building. System design must conform to UFC 3-430-09, "Exterior Mechanical Utility Distribution."
****

****
NOTE: On the drawings, show:

1. Configuration, slope, and sizes of each piping system;

2. Locations and details of expansion loops, thrust blocks, anchors, and connections between metal flanges and plastic carrier piping;

3. Trench cross section, sand bedding, and depth of bury; and

4. Detail sections of piping through manholes, walls, floors, entrance to buildings, and watershed to aboveground piping.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges,

	Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B31.1	(2024) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D229	(2019) Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation
ASTM D1330	(2004; R 2010) Rubber Sheet Gaskets
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass"

(Glass-Fiber-Reinforced
Thermosetting-Resin) Pipe

1.2 SYSTEM DESCRIPTION

****

NOTE: For NAVFAC LANT projects that use the regional specifications, refer to NAVFAC LANT regional specification NFGS 23 73 33.00 22 HEATING, VENTILATING AND COOLING SYSTEMS.

****

Provide [new and modify existing] exterior buried factory-prefabricated preinsulated water piping system to the first piping connection aboveground or within each building complete and ready for operation. Piping system includes [hot domestic water piping,] [recirculating hot domestic water piping,] [chilled water piping,] [chilled-hot (dual temperature) water piping,] [hot water piping,] and related work [from heat exchanges to each building]. [Hot domestic water piping within each building is specified under Section 22 00 00 PLUMBING, GENERAL PURPOSE.] [Chilled water piping, chilled-hot water piping, and hot water piping within each building is specified under] [Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS].

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Factory-prefabricated preinsulated water piping system

Preinsulated plastic pipe field joints

Show layout of piping system. Drawings must have Professional Engineer Seal.

SD-03 Product Data

Pipe, fittings, and end connections

Factory-prefabricated preinsulated water piping system

Plastic reinforced thermosetting resin (RTR) piping

SD-07 Certificates

Certification of welders' qualifications

SD-08 Manufacturer's Instructions

Installation manual for buried factory-prefabricated preinsulated water piping system

1.4 QUALITY ASSURANCE

1.4.1 Certification of Welders' Qualifications

Submit prior to site welding of steel piping; certifications must be not more than one year old.

PART 2 PRODUCTS

2.1 BURIED FACTORY-PREFABRICATED PREINSULATED WATER PIPING SYSTEM

Piping (pipe, fittings, and end connections) system must be suitable for working pressure of 862 kPag at 121 degrees C 125 psig at 250 degrees F, except plastic polyvinyl chloride (PVC) chilled water piping must be suitable for working pressure of 862 kPag at 24 degrees C 125 psig at 75 degrees F. Piping system must withstand H-20 highway loading with 600 mm 2 feet of compacted backfill over top of conduit. Mark each section of conduit with fabricator's name, product identification, and publications to which the items conform. Provide each section of carrier pipe including factory-applied insulation and conduit, with waterproof conduit ends at both ends of each section of carrier pipe, except for piping systems which have the field joints insulated and covered with waterproof shrink sleeves.

2.1.1 Factory-Applied Insulation

Polyurethane or polyisocyanate insulation, minimum density of 27.2 kg per cubic meter 1.7 pcf, rated for not less than 121 degrees C 250 degrees F, completely filling space between carrier pipe and conduit.

2.1.2 Factory-Applied Conduit

Conduit material, size, and thickness must be as follows:

Carrier Pipe (mm)	Minimum Conduit Size (mm)	Minimum Conduit Thickness (mm)
50 mm	100 mm	1.5 mm
75 mm	150 mm	1.5 mm
100 mm	200 mm	2.0 mm
150 mm	250 mm	2.5 mm
200 mm	300 mm	3.0 mm
250 mm	350 mm	3.0 mm

Carrier Pipe (Inches)	Minimum Conduit Size (Inches)	Minimum Conduit Thickness (Inches)
2	4	0.060
3	6	0.060
4	8	0.080
6	10	0.100
8	12	0.120
10	14	0.120

a. Plastic PVC pipe conduit: ASTM D1784, Class 12454-B compound extruded seamless PVC plastic pipe.

b. Plastic RTR pipe conduit: ASTM D2996, filament-wound, fiberglass RTR plastic pipe, without liner.

c. Plastic RTR factory lay-up conduit: Conduit must be machine-applied continuous rovings of fiberglass strands saturated with isophthalic polyester or epoxy resin filament wound in helical pattern directly to the outer surface of the pipe insulation. In lieu of minimum conduit size for each size of carrier pipe, provide minimum of 25 mm one inch thick insulation for 50 mm 2 inch carrier pipe and provide minimum of 38 mm 1.5 inch thick insulation for 75 mm 3 inch and larger carrier pipe.

2.1.3 Factory-Applied End Seals

Provide watertight end seal, or factory lay-up type end seal between carrier pipe and conduit. Provide sufficient surface bonding area between carrier pipe and conduit to ensure permanent watertight end seal suitable for use with temperature limits of carrier pipe.

2.1.4 Factory-Prefabricated Carrier Piping

Pipe, fittings, flanges, and couplings must be marked with manufacturer's name, product identification, and publication to which items conform. Carrier piping must be as specified in this section. Buried carrier pipe connections between straight sections of pipe beyond 1.5 m 5 feetexterior of buildings may be manufacturer's standard O-ring connections designed to absorb pipe expansion and contraction at working pressure of 862 kPag 125 psig with no leakage. Connections at elbows and tees must be other than O-ring connections.

2.2 CARRIER PIPING

2.2.1 Copper Tubing

Provide copper tubing for hot domestic water piping, recirculating hot domestic water piping, chilled water piping, chilled-hot water piping, and hot water piping.

a. Copper tubing: Provide ASTM B88M ASTM B88, Type L or M copper tubing for buried factory-prefabricated preinsulated piping and for aboveground piping. Provide ASME B16.18 or ASME B16.22 solder joint fittings, unions, and flanges; provide adapters as required.

b. Solder for copper tubing: Provide ASTM B32, 95-5 tin-antimony solder or provide Plumbing Code approved lead-free solder.

c. Flanged connections: Provide ASME B16.24, Class 150, solder joint flat face flanged connections.

d. O-ring connections: Provide between straight sections of pipe beyond 1.5 m 5 feet of exterior of buildings.

2.2.2 Steel Piping

Provide steel piping for chilled water piping, chilled-hot water piping, and hot water piping.

a. Steel pipe: Provide ASTM A53/A53M, Type E (electric-resistance welded, Grade A or B), ASTM A53/A53M, Type S (seamless, Grade A or B), or ASTM A106/A106M (seamless, Grade A or B). Provide Weight Class STD (Standard) or Schedule No. 40 black steel pipe for welding end connections. Provide Weight Class XS (Extra Strong) or Schedule No. 80 black steel pipe for threaded end connections.

b. Steel pipe fittings: Provide ASME B16.9 buttwelding fittings of the same material and weight as the piping in which fittings are installed. Provide ASME B16.11 socket welding fittings.

c. Steel pipe flanges: Provide ASME B16.5, Class 150 flanges.

d. O-ring connections: Provide between straight sections of pipe beyond

1.5 m 5 feet of exterior of buildings.

2.2.3 Plastic Reinforced Thermosetting Resin (RTR) Piping

Provide plastic RTR piping for hot domestic water piping, recirculating hot domestic water piping, chilled water piping, chilled-hot water piping, and hot water piping.

a. Plastic carrier pipe, fittings, and adhesive: Provide plastic carrier piping conforming to the Federal Agency Approved Brochure. Pipe, fittings, and adhesive must be supplied by same manufacturer. Pipe, fittings, flanges, and couplings must have end connections of the adhesive bell and spigot type. Threaded piping, including pipe, fittings, flanges, and couplings, will not be permitted.

b. Flanged connections: Provide flat face flanged connections between plastic piping and metal piping. Plastic flanges must be suitable for connecting to ASME Class 150 flanges.

c. Plastic RTR piping sizes: When piping sizes other than 50, 75, 100, 150, 200 mm 2, 3, 4, 6, and 8 inches are indicated, provide next larger piping size. The connecting system piping must be of the same size or increased to meet next size of RTR piping.

2.2.4 Plastic PVC Piping

Provide plastic PVC piping only for chilled water piping.

a. Plastic PVC carrier pipe, fittings, and cement: ASTM D1785pipe, ASTM D2466 socket type fittings, and ASTM D2564solvent cement must be supplied by the same manufacturer. Pipe, fittings, flanges, and couplings must have solvent cement socket end connections, except piping beyond 1.5 m 5 feet outside of buildings must have O-ring connections. Plastic PVC piping must be suitable for working pressure of 862 kPag at 24 degrees C 125 psig at 75 degrees F.

b. Flanged connections: Provide flat face flanged connections between plastic piping and metal piping. Plastic flanges must be suitable for connecting to ASME Class 150 flanges.

c. O-ring connections: Provide between straight sections of pipe beyond 1.5 m 5 feet of exterior of buildings.

2.3 FLANGED CONNECTIONS

Provide ASME Class 150 flat face flanged connections.

a. Gaskets: ASTM D1330, except Shore A durometer hardness must be 55 to 65, 3 mm 0.125 inch thick ethylene propylene. Provide one piece factory cut full-face gaskets.

b. Bolts: ASTM A193/A193M, Grade B7. Extend minimum of two full threads beyond nut with bolts tightened to required torque.

c. Nuts: ASTM A194/A194M, Grade 7, with Teflon coated threads.

d. Washers: Provide galvanized steel flat circular washers under bolt heads and nuts.

e. Electrically isolating (insulating) gaskets for connections between metal flanges: Provide ASTM D229 electrical insulating material of 1000 ohms minimum resistance. Provide one piece factory cut insulating gaskets between flanges. Provide silicon-coated fiberglass insulating sleeves between bolts and holes in flanges; bolts may have reduced shanks of diameter not less than diameter at root of threads. Provide 3 mm 0.125 inch thick high-strength insulating washers next to flanges and provide stainless steel flat circular steel washers over insulating washers and under bolt heads and nuts. Provide bolts 13 mm 0.5 inch longer than standard length to compensate for thicker insulating gaskets and washers under bolt heads and nuts.

2.4 BURIED WARNING AND IDENTIFICATION TAPE

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape in rolls, 75 mm 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification must read "CAUTION BURIED PREINSULATED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.5 CONCRETE THRUST BLOCKS

Provide concrete thrust blocks as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Concrete must be of 27.6 MPa 4000 psi minimum 28 day compressive strength, air-entrained admixture (0.13 kg per cubic meter) (3.6 ounces per cubic yard) with water-reducing admixture (0.81 kg per cubic meter) (22 ounces per cubic yard).

2.6 PIPE SLEEVES

Provide where piping passes entirely through walls and floors. Provide sleeves of sufficient length to pass through entire thickness of walls and floors. Provide 25 mm one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

a. Sleeves in masonry and concrete walls and floors: Provide hot-dip galvanized steel, ductile-iron, or cast-iron sleeves. Core drilling of masonry and concrete may be provided in lieu of sleeves when cavities in the core-drilled hole are grouted smooth.

b. Sleeves in other than masonry and Concrete walls and floors: Provide 0.5 mm 26 gage galvanized steel sheet.

2.7 ESCUTCHEON PLATES

Provide split hinge type metal plates for piping entering walls and floors in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

PART 3 EXECUTION

3.1 INSTALLATION

Installation of exterior buried factory-prefabricated preinsulated water piping systems must be in accordance with manufacturer's installation manual. Welding of steel piping including qualification of welders must be in accordance with ASME B31.1, metallic arc process. Deviations must not be permitted unless authorized in writing by Contracting Officer. Install piping straight and true to bear evenly on sand bedding material. Installation and field assembly of plastic RTR piping must be in accordance with the Federal Agency Approved Brochure.

a. Cleaning of piping: Keep interior and ends of new piping and existing piping affected by the Contractor's operations, cleaned of water and foreign matter during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

b. Demolition: Remove materials so as not to damage materials which are to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

3.2 FIELD JOINTS

a. Carrier piping joints without concrete anchor: Pressure test and approve piping joints. Provide joints with polyurethane or polyisocyanate insulation of same type and thickness as insulation on carrier piping. Provide waterproof shrink sleeves to cover insulation and overlap not less than 150 mm 6 inches of each end of conduit section.

b. Carrier piping joints with concrete anchor: Pressure test and approve piping joints. Provide each elbow and tee with concrete anchors (thrust blocks). Provide waterproof end seals between carrier piping and conduit adjacent to each carrier pipe fitting. Encase carrier pipe fitting and at least 50 mm 2 inches of each end of conduit with a minimum of 150 mm 6 inches of concrete.

3.3 BURIED FACTORY-PREFABRICATED PREINSULATED PIPE INSTALLATION

a. Assembly and alignment: Assemble carrier pipe and fittings according to manufacturer's installation manual; assemble plastic RTR piping in accordance with the Federal Agency Approved Brochure. Maintain proper alignment during assembly of joints.

b. Bedding: Accurately grade trench bedding with a minimum of 150 mm 6 inches of manufactured or natural sand. Backfill sand to a minimum of 150 mm 6 inches above and below conduit. Lay bedding to firmly support conduit along entire length.

c. Concrete thrust blocks: Encase each elbow and tee of carrier pipe in thrust block with minimum of 0.28 square meter 3 square feet of thrust-bearing surface cast against undisturbed soil, minimum pipe-to-bearing surface single dimension of 250 mm 10 inches perpendicular to bearing surface, and minimum volume of 0.25 cubic meter 9 cubic feet, except as indicated otherwise. Disturbed soil under and around thrust blocks must be compacted.

3.4 FIELD QUALITY CONTROL

Before final acceptance of work, test each system to demonstrate compliance with contract requirements. Thoroughly flush and clean piping before placing in operation. Flush piping at minimum velocity of 2.4 meters per second 8 fps. Correct defects in the work and repeat tests until work is in compliance with contract requirements. Furnish potable water, electricity, instruments, connecting devices, and personnel for tests.

a. Field tests of carrier piping: Do not cover carrier piping joints with insulation or concrete anchors (thrust blocks), until carrier piping joints pass field tests.

b. Hydrostatic pressure test: Test piping system at 1379 kPag 200 psig for minimum holding period of 2 hours during which time pressure must not drop more than 28 kPa 4 psi; test plastic RTR piping in accordance with Federal Agency Approved Brochure. Pressure drop greater than 28 kPag 4 psicorrected for temperature variation constitutes failure. Valve off piping system and disconnect method of piping system pressurization before starting the 2 hour pressure holding period. During hydrostatic pressure test, examine piping system for leaks. Repair leaking joints, replace damaged and porous pipe and fittings with new materials, and repeat tests.

c. Thrust blocks: If O-ring connections are used, provide temporary thrust blocks prior to hydrostatic pressure testing of piping system. Place bedding and backfill around center portion of piping system, leaving thrust blocks and field joints clear for observation. After successful completion of hydrostatic pressure test, cast concrete thrust blocks.

d. Field inspections: Prior to initial operation, inspect piping system for compliance with drawings, specifications, and manufacturer's submittals.

3.5 DISINFECTION

Disinfect new hot domestic water piping under Section 22 00 00 PLUMBING, GENERAL PURPOSE.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 63 13 (February 2025)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 63 13 April 2006

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-33 63 13 (February 2025)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 63 13 April 2006

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SECTION 33 63 13

EXTERIOR UNDERGROUND STEAM DISTRIBUTION SYSTEM
02/25

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NOTE: This guide specification covers the requirements for an insulated underground heat distribution system (UHDS) and/or condensate return system of the pre-engineered type as covered in UFC 3-430-09 "Exterior Mechanical Utility Distribution".

Adher to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

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NOTE: Notes are to the Government designer or design Architect/Engineer firm and will not be seen by the Contractor or its Subcontractors. The designer will carefully review all Notes; when submitting the "draft" specification for review, Notes will remain intact.

This specification requires coordination with other design disciplines (examples: cathodic protection,

trenching and backfill, structural for coordinating manhole structures). The specified systems are capable of transporting steam, condensate, or high temperature hot water. This specification is for systems operating above 120 degrees C 250 degrees F to a maximum acceptable pressure and temperature of approximately 4.551 Mpa (gage) 660 psig and 260 degrees C 500 degrees F, respectively. It should be noted that not all UHDS are acceptable for all site classifications, temperatures, and pressure ratings.

The Government designer will establish the site, soil and groundwater conditions. The contract drawings will show the size, proposed routing (including construction limits) and estimated length of the system. The contract drawings will establish the elevations and show the profiles of the pipe and the existing and finished earth surfaces. Indicate and identify all obstructions within 8 m 25 feet of the system centerline, including adjacent or crossing utilities.

This guide specification is not for the design of the valve manhole and associated piping and equipment in the valve manhole. Valve manholes and the piping and equipment inside the valve manholes will be designed and detailed on the contract drawings. Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES will be included as part of this project.

Include on the drawings a log of soil conditions along the pipe line right-of-way, at pipe depth which gives, as a minimum, soil classification, moisture content, soil resistivity and pH, bearing strength and unstable conditions.

Details at building entries will be provided on the contract drawings to show pipe elevation, floor and grade elevation, building wall construction and existing equipment. Include location of valve manhole and-or valve boxes, branch runouts, and isolation valves on the contract drawings. Provide details at manhole entries on the contract drawings to show pipe elevations; floor, top, entrance, and grade elevations; manhole wall construction; anchor location and construction; and existing equipment and piping.

All connections to the UHDS distribution will occur only in manholes.

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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 300	(2003; R 2017) Standard Specification for Inorganic Zinc-Rich Primer

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A134/A134M	(2019) Standard Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe

ASTM A139/A139M	(2022) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C1728	(2023) Standard Specification for Flexible Insulation
ASTM D2310	(2006; R 2012) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

NACE INTERNATIONAL (NACE)

NACE SP0169	(2024) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

1.2 DEFINITIONS

The following definitions are applicable:

1.2.1 Pre-engineered System

A complete underground[heat distribution][and][condensate return] system including all required components such as carrier pipes,[steam pipe,][high temperature hot water supply pipe,][condensate return pipe,][high temperature hot water return pipe,] and fittings, anchors, pipe supports, insulation, protective casing, and cathodic protection, for the system supplied. The pre-engineered system does not include valve manholes and the piping and equipment inside the valve manholes; use Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES. Include all piping and components to a point at least 150 mm 6 inches inside the building and valve manhole. Do not use any part of the building or valve manhole structure as an anchor point.

1.2.2 Direct-Buried

A system which is buried without the need for a field-fabricated protective enclosure such as a concrete trench or tunnel.

1.2.3 UHDS Types

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NOTE: Select from the following two paragraphs as applicable to the type of system to be allowed. See paragraph SITE CLASSIFICATION for assistance in selecting system types.

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1.2.3.1 Drainable-Dryable-Testable (DDT) Direct-Buried System

A factory-fabricated system including an air and water-tight outer protective casing, air space and an insulated carrier pipe. Drains and vents are provided at the end plates of the system (in manholes or buildings). The drains are normally capped but the caps can be removed to drain water which can leak into the air space if there is a failure in the casing or the carrier pipe. The vents allow water vapor to escape and provide a tell-tale sign of leakage.

1.2.3.1.1 Piping Design Variation

An available variation of the DDT pre-engineered piping design is characterized by use of a smaller thickness of high-temperature insulation and an annular air space contained within a metallic conduit. The metallic conduit is coated on the outside with lower-temperature insulation and the entire system is encased in a thick, non-metallic exterior jacket. This variation of the DDT system is not permitted.

1.2.3.2 Water Spread Limiting (WSL) Direct-Buried System

A factory fabricated system including an outer protective casing and an insulated carrier pipe. The system is fabricated in sections which are independent from each other; ground water or condensate which leaks from or into one section cannot travel into the next section. Field-assembly of the sections requires no welding as the sections push together and are sealed with a system of couplings and seals.

1.3 DESCRIPTION

1.3.1 Scope

The work includes the design and fabrication; furnishing; installing, and testing of a direct buried underground[insulated heat-distribution system][and][insulated steam pipe,][insulated high temperature hot water supply pipe,][insulated steel condensate return pipe,][insulated high temperature hot water return pipe] consisting of piping as indicated, cathodic protection system(where required by this specification), together with all fittings and appurtenances necessary for a complete and operable system. Gland type end seals will not be permitted. Drainable, dryable, testable (DDT) systems with fiberglass casings will not be permitted.

1.3.2 UHDS Design

Submit a Certificate of Satisfactory Operation certifying that at least three systems installed by the UHDS manufacturer within the previous 5 years have and are operating satisfactorily, not later than[30][40][_____] days after notice to proceed. The UHDS manufacturer must be responsible for the complete design of the UHDS, the product to be supplied, fabrication, witnessing installation and testing of the system within the design parameters established by the contract drawings and specifications, and in compliance with the detailed design. The complete design of the UHDS must be sealed by a Professional Engineer in the employ of the UHDS manufacturer.

1.3.3 Cathodic Protection

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NOTE: Cathodic protection system will meet the requirements of UFC 3-570-01 Cathodic Protection.

Cathodic protection system design will include the requirements of UFC 3-430-09.

For Army projects only: these projects require cathodic protection Center of Expertise (CX) review of the proposed design.

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Provide cathodic protection for systems with coated steel casings in accordance with paragraph CATHODIC PROTECTION INSTALLATION.

1.3.4 Operating Characteristics

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NOTE: The operating and the rated characteristics must be supplied. Operating characteristics should be based on the capabilities of the system. The operating characteristics should not exceed the values for the "Rated Characteristics" of the system. Rated characteristics are to be used for calculations for the system design and represent a "worst case". For rated characteristics for DDT systems insert 260 degrees C 500 degrees F and 4.585 MPa (gage) 665 psig. For rated characteristics for WSL systems which are only allowed for steam and condensate return systems, insert 208 degrees C 406

degrees F and 1.723 MPa (gage) 250 psig. The design conditions for the condensate and hot water return piping will be the same as for the steam and hot water supply.
****

Provide[steam][high temperature hot water] supply system with an operating temperature of [_____] degrees C [_____] degrees F and an operating pressure of [_____] kPa [_____] psig.[Condensate][High Temperature hot water] return system with an operating temperature of [_____] degrees C [_____] degrees F and an operating pressure of [_____] kPa [_____] psig.

1.3.5 Rated Characteristics

****
NOTE: The rated characteristics are to be used in the calculations for the system design and represent a "worst case". The rated conditions for the high temperature hot water return piping will be the same as for the supply. For "Installation Temperature" use the 99 Percent Dry Bulb Temperature Winter Design Heating Data from the weather tables in UFC 3-400-02, Engineering Weather Data.
****

Provide thermal expansion calculations for the supply and return piping using the following design characteristics and installation temperature. The system design conditions for[steam,][condensate,][high temperature hot water] supply [and][or] return must be a temperature of 260 degrees C 500 degrees F and a pressure of 4.585 kPa 665 psig. For calculation purposes, ensure the installation temperature is not higher than the ambient temperature at the site: [_____] degrees C [_____] degrees F.

1.4 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Heat Distribution System; G, [_____]

SD-03 Product Data

Interruption of Existing Service; G, [_____]

UHDS Manufacturer's Representative Reports

Work Plan; G, [_____]

Quality Assurance Plan; G, [_____]

Piping, Pipe Fittings, and Insulation

Data Sheets; G, [_____]

SD-05 Design Data

Pipe-stress and System Expansion Calculations; G, [_____]

Design Life Calculations for the Cathodic Protection System; G, [_____]

Manufacturer's Data Sheets; G, [_____]

SD-06 Test Reports

Tests; G, [_____]

Thermal Performance Test; G, [_____]

Operational Test; G, [_____]

Test of WSL Systems for Steam Service; G, [_____]

Test of WSL Systems for Condensate Return Service; G, [_____]

SD-07 Certificates

Manufacturer; G, [_____]

Manufacturer's Representative; G, [_____]

UHDS Design; G, [_____]

Certificate of Compliance; G, [_____]

Testing Firm; G, [_____]

Welding; G, [_____]

SD-10 Operation and Maintenance Data

Heat Distribution System; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Manufacturer

The UHDS manufacturer is the company responsible for the design and manufacture of the pre-engineered system. Submit certification of past experience stating that the UHDS manufacturer regularly and currently manufactures direct-buried systems, and that the designs of the system and equipment to be provided for this project conform to specification requirements. Submit an original certification signed by a principal officer of the UHDS manufacturer at least[2 weeks] [_____] prior to the start of work; indicate the location, type of system, size of system, point of contact (POC) including phone number, for information verification. The UHDS manufacturer directs the installation of the system and has a representative on the jobsite; submit a Work Plan indicating when various items of work and tests are to be carried out and when its representative will be present at the job site. The Contractor must submit a proposed schedule of activities, no later than[7] [_____] days after notice to proceed. The manufacturer must submit a list of characteristics indicating what defects or damage will necessitate replacement. The manufacturer must submit a Quality Assurance Plan not later than[7] [_____] days after notice to proceed for fabrication, delivery, storage, installation and testing of the system. The manufacturer must submit manufacturer's data sheets for all coatings and indicating thicknesses of insulation for carrier pipes.

1.5.2 Manufacturer's Representative

Submit a letter from the system manufacturer, at least[2 weeks] [_____] prior to the start of work, listing the experience and training of the manufacturer's representative, who must be a person who regularly performs the duties specified, is certified in writing by the UHDS manufacturer to be technically qualified and experienced in the installation of the system, and authorized by the manufacturer to make and sign the daily reports specified. The UHDS manufacturer's representative must be under the direct employ and supervision of the UHDS manufacturer.

1.5.3 Corrosion Engineer

Corrosion engineer refers to a person who by knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control. Such person is permitted to be a licensed professional corrosion engineer or certified as being qualified by the National Association of Corrosion Engineers (NACE), if such licensing or certification includes 3 years experience in corrosion control on underground metallic surfaces of the type under this contract. NACE certification must be technologist, corrosion specialist, or cathodic protection specialist. The corrosion engineer must make at least three visits to the project site. The first of these visits must include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used, and reporting to the Contractor the type of cathodic protection required. Once the submittals are approved and the materials delivered, the corrosion engineer must revisit the site to ensure the Contractor understands installation practices and laying out the components. The third visit must involve testing the installed cathodic protection systems and training applicable personnel on proper maintenance techniques. The corrosion engineer must supervise, inspect, and test the installation and performance of the cathodic protection system.

1.5.4 Testing Firm

Submit a Certificate of Qualification from the independent testing firm or firms, not later than[7] [_____] days after notice to proceed. The Testing Firm must be able to certify that: weld examination methods and procedures, and the interpretation of radiographic films, will be performed in accordance with ASME B31.1; the firm intends to utilize the proper film exposure, techniques, and penetrameter to produce density and geometric sharpness in sufficient clarity to determine presence of defects; and that all radiographic films will be reviewed and interpreted, and reading reports signed, by not less than a Certified American Society for Nondestructive Testing Level III Radiographer.

1.5.5 Contract Drawings

The contract drawings accompanying this specification provide information on:

a. The size of carrier pipes, approximate length, and site location of the system.

b. The routing and elevation of the piping along the route.

c. Location and design of manholes.

d. The obstacles that must be avoided along the path.

e. Location of piping anchors.

f. Operating pressure and temperature of system.

1.5.6 Delivery, Storage, and Handling

Maintain equipment and material placed on the job in the custody of the Contractor until final acceptance whether or not the Contractor has been reimbursed for the equipment and material by the Government. The Contractor is solely responsible for the protection of the equipment and material against damage from any source while stored or during installation. Protect materials against damage from UV light, and entry of water and mud, by installing watertight protection on open ends at all times. Immediately replace sections of the casing or carrier piping found to have been subjected to full or partial submergence in water (which would allow the insulation to become wet). Cover materials awaiting installation to protect from UV degradation.

1.6 SITE CLASSIFICATION

****

NOTE: A site survey must be made of the proposed routing of the UHDS. It is important that the site survey report include the identification, location, and depth of all existing underground utilities and structures as well as all aboveground utilities, roadways, structures, etc. Classification of the site conditions will be used to determine the type of system to be used: a drainable, dryable, testable (DDT) system should be allowed in severe, bad, and moderate site conditions; a water-spread-limiting (WSL) system should be allowed in bad and moderate site conditions for steam and condensate return systems only. Remove these paragraphs if the survey will be done by the Government.

A soils engineer, familiar with the underground water conditions onsite, should be employed to establish the site classification. Site parameters are defined in the UFC 3-430-09 "Exterior Mechanical Utility Distribution" Chapter 3 Site Classification Criteria Table. If underground water conditions at the site are not available, a detailed site classification survey will be made and the UFC 3-430-09 "Exterior Mechanical Utility Distribution" Chapter 3 Site Classification Criteria Table will be utilized to establish the site classification. This survey should be conducted within the framework of the requirements in UFC 3-430-09.

The results from the completed site survey are to be indicated below.

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Classification of the site conditions for the UHDS are based on ASTM D2487 and the site classification criteria indicated in UFC 3-430-01. The project Site Classification is Class[A-Severe][B-Bad][C-Moderate][D-Mild].

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Approval by Contracting Officer is required for products or services of the UHDS manufacturer. Provide for this project a designed system and equipment which is of current production and that essentially duplicate systems that have been in satisfactory use for at least 5 years prior to bid opening at three locations. Provide systems that have been operated under pressure, temperature, and site characteristics which are equal to or more severe than the operating conditions in this specification and that have distributed the same medium. Ensure the system is supported by a service organization that can reach the site after a service call within[48] [_____] hours. Submit cut sheets for piping, pipe fittings, and insulation to be used in this system.

2.2 FACTORY FABRICATED, DIRECT-BURIED DDT SYSTEMS

2.2.1 DDT Steam and High Temperature Hot Water Carrier Pipes

Requirements are in accordance with paragraph HEAT DISTRIBUTION PIPING.

2.2.2 DDT Condensate Carrier Pipes

Provide steel, schedule 80 carrier piping for condensate return systems. Pipe requirements are in accordance with the paragraph HEAT DISTRIBUTION PIPING. Do not locate condensate pipes in conduit casings which contain steam pipes or any other piping.

2.2.3 DDT Carrier Pipe Insulation

Provide carrier pipe insulation conforming to minimum thicknesses and type listed in Tables 1 and 2 as required for temperature specified under paragraph RATED CHARACTERISTICS.

2.2.4 Insulation Banding and Scrim

Stainless steel bands and clips, at least 13 mm 0.5 inches wide, conforming to ASTM A240/A240M (304 stainless steel), at a maximum spacing 460 mm 18 inches over the scrim to secure the insulation onto the carrier pipe; use a minimum of two bands for each 1300 mm 4 foot section of insulation. Scrim must be vinyl-coated fiberglass with 18 by 16 mesh (number of filaments per 25 mm 1 inch) and made of 0.335 mm 0.013 inch diameter vinyl-coated fibrous glass yarn.

2.2.5 Casing

Provide casing consisting of smooth-wall steel, electric resistance spiral welded, conforming to ASTM A134/A134M, ASTM A135/A135M, or ASTM A139/A139M and the values tabulated below. Provide eccentric connectors between casing sections as needed to provide drainage of casing section between manholes and between manholes and buildings.

Casing Diameter (mm)	Minimum Thickness (mm)
150 - 660 6 - 26	6.35 0.250
675 - 900 27 - 36	6.35 0.250
940 - 1050 37 - 42	6.35 0.250
1170 46	6.35 0.250

2.2.6 Casing End Plates, Vents, and Drains

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NOTE: Designer must accommodate 25 mm 1 inch vent pipe in the design of the manhole.

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Make end plates of ASTM A36/A36M steel, minimum thickness 13 mm 0.5 inches for conduit pipe sizes above 300 mm 12 inches and 9.5 mm 0.375 inches for conduit pipe sizes 300 mm 12 inches and less. Provide 25 mm 1 inch ASTM A53/A53M, Schedule 40, galvanized vent riser pipe on the end plate, vent opening. Extend vent pipe to top of manhole and terminate 300 mm 12 inches above grade with a 180 degree bend. Provide a 25 mm 1 inch drain at the bottom and vent at the top. Provide brass plugs and half coupling, constructed with welded steel and weld to the end plate; plug drains; do not plug vents.

2.2.7 Air Space

Provide continuous 25 mm 1 inch minimum air space between carrier pipe insulation and casing.

2.2.8 Casing Coating

Coating must be rated for a minimum of 25 years by the manufacturer for continuous service at a temperature of 110 degrees C 230 degrees F. Apply coating in accordance with the coating manufacturer's instructions, factory-inspect for holidays and make repairs as necessary.

2.2.8.1 Fusion-Bonded Epoxy

Use fusion-bonded epoxy casing coating with a minimum thickness of 1 mm 0.04 inches.

2.2.8.2 Urethane Elastomer

Use urethane elastomer coating with a minimum thickness of 1 mm 0.04 inches.

2.2.9 Coating of End Plates and conduit Sections Extending in Manholes

Coat end plates and conduit extending into manholes with a zinc-rich coating conforming to AASHTO M 300, Type IA except that volatile organic compounds must not exceed 0.34 kg/L 2.8 pounds/gallon. Apply zinc-rich coating in accordance with the coating manufacturer's requirements including surface preparation. Do not apply additional top coat.

2.2.10 Carrier Pipe Guides

Space carrier pipe guides 3 m 10 feet on centers maximum, no more than 1.5 m 5 feet from pipe ends, with a minimum of three guides per elbow section. Design guides to allow thermal expansion without damage, provide proper pipe guiding, and to allow horizontal movement in two directions as required at expansion loops and bends. Design supports to permit flow of water and air vapor through the support. Extend pipe insulation through the pipe guides and protect by steel sleeves. Design guides to negate metal-to-metal contact between the casing and the carrier pipe. Do not compress insulation or non-metallic material used to ensure no metal-to-metal contact by the weight of the carrier pipe when full of water.

2.2.11 Anchor Plates

Anchor plate must be ASTM A36/A36M steel, welded to carrier pipe and casing, 13 mm 0.5 inches minimum thickness, with passages for air flow and water drainage through the annular air space in the system. Coat exterior surface of the anchor plate with the same coating material as the casing.

2.2.12 Field Connection of Casing Sections

Field connect casing using a compatible steel section, welded to casing sections, coated on all surfaces with UHDS manufacturer's coating field repair compound, and covered with a 1.3 mm 0.05 inch minimum thickness polyethylene shrink sleeve designed for a service temperature exceeding 260 degrees C 500 degrees F.

2.2.13 Manufacturer's Identification

Provide embossed brass or stainless steel tag, hung by brass or stainless steel chain at each end of each conduit or insulated piping in the manholes and buildings. Identify UHDS manufacturer's name, date of installation, Government contract number, and manufacturer's project number.

2.3 FACTORY FABRICATED, DIRECT-BURIED, WSL SYSTEM

2.3.1 [WSL Steam][/High Temperature] Hot Water Carrier Pipes

Pipe material requirements must be in accordance with paragraph HEAT DISTRIBUTION PIPING. Provide steel pipe with the ends machined and metallized to provide a satisfactory sealing surface for the sealing rings. The metallizing must be a high nickel alloy applied to an excess thickness and then machined to the required OD.

2.3.2 WSL Condensate Carrier Pipes

Carrier piping for condensate return systems must be steel, Schedule 80. Pipe requirements must be in accordance with paragraph HEAT DISTRIBUTION PIPING. Do not locate condensate piping in casings which contain any other piping.

2.3.3 Casing for Steam and Condensate

Provide casing consisting of reinforced thermosetting resin plastic pipe (RTRP) manufactured by the filament winding process. Ensure casing pipe is wound to meet ASTM D2310 classification RTRP and ASTM D2996. Provide a polyester isothalic resin. Coat the outer surface with a pigmented, protected resin containing a paraffinated wax and ultraviolet inhibitors. Casing thickness is as follows:

Carrier Pipe Size, mm inches	Casing Thickness, mm inches
50 2	5 0.185
80 3	5 0.185
100 4	5 0.185
150 6	6.5 0.250
200 8	6.5 0.250
250 10	6.5 0.250
300 12	6.5 0.250

2.3.4 Pipe Coupling, Steam

Provide a multi-stage seal designed to accommodate the expansion and contraction of the system in the coupling. Provide coupling consisting of corrosion resistant materials capable of handling the design characteristics of the system listed in paragraph RATED CHARACTERISTICS.

Specifically design the annular seals and carrier pipe ends to protect the seals and resist abrasion due to lateral loads in the system.

2.3.5 Pipe Coupling, Condensate

Provide coupling of a single stage seal design to accommodate the expansion and contraction of the adjacent pipes. Provide coupling consisting of corrosion resistance materials capable of handling the design characteristics of the system listed in paragraph RATED CHARACTERISTICS. Specifically design the annular seals and carrier pipe ends to protect the seals and resist abrasion due to lateral loads in the system.

2.3.6 Carrier Pipe Insulation

Provide insulation conforming to minimum thicknesses and type listed for WSL systems in Tables 1 and 2 as required for temperature in carrier pipe. Provide insulation consisting of an inner layer of high temperature calcium silicate and an outer layer of polyurethane foam.

2.3.6.1 Calcium Silicate Insulation for Steam Systems

Provide calcium silicate insulation consisting of a hydrous material satisfactory for temperatures to 650 degrees C 1200 degrees F. Calcium Silicate insulation conforms to ASTM C533. The physical properties as follows:

a. Density (dry): 208 kg/cubic meter 13 pcf (minimum)

b. Compressive Strength to produce 5 percent compression: 1723 kPa 250 psi (for 37 mm 1.5 inch thick sample)

c. Maximum Linear shrinkage after 24 hour soaking period at 650 degrees C 1200 degrees F: 1.1 percent

d. Maximum Thermal Conductivity k: k = W/(meter*K) k = BTU-IN/HR-FT2-DEG.F). Where k varies with temperature as shown:

Mean Temp (degrees C F)	k
38 100	0.04 0.38
93 200	0.04 0.41
149 300	0.04 0.44
204 400	0.04 0.48

2.3.6.2 Polyurethane Foam Insulation for Steam and Condensate Systems

Provide polyurethane foam conforming to ASTM C591. Completely fill the annular space between the calcium silicate insulation and the casing for the steam pipe and between the carrier pipe and the casing for condensate return system with the polyurethane foam. Use polyurethane foam insulation that meets the following requirements:

a. Type: Two component urethane.

b. Compressive Strength: 172 kPa 25 psi parallel to rise (minimum at 50 percent compression).

c. Shrinkage: None at -1 to 21 degrees C 30 to 70 degrees F.

d. Free Rise Density: 32 kg/cubic meter 2 pcf.

e. Maximum aged k (32 degrees C 90 degrees F at 90 percent RH for 72 hours):

0.02 W/mK at 24 degrees C 0.14 (BTU-IN/HR FT-2-DEG. F) at 75 degrees F, when tested in accordance with ASTM C518.

f. Minimum Closed Cell Content: 90 percent.

2.3.6.3 Insulation Concentricity

Ensure carrier pipe is concentric in relation to the casing pipe. The allowable maximum deviation from center line of the carrier pipe is plus or minus 6 mm 0.25 inch at the casing center point and plus or minus 1.5 mm 1/16 inch at the end seals.

2.3.6.4 Insulated Fittings

Provide fittings that are pre-insulated by manufacturer using the same insulation thickness and casing as the straight sections.

2.3.6.5 Coupling Insulation for Steam Systems

Use material composed of refractory composite to lock the bronze coupling in the casing. Ensure approximate minimum conductivity of this material is 0.2 W/(m/K) 1.6 (BTU/HR/F/IN DEG.F) at a mean temperature of 1260 degrees C 2300 degrees F.

2.3.6.6 Coupling Insulation for Condensate Systems

Insulate the coupling with polyurethane foam as specified. Use an insulation thickness equal to the carrier pipe insulation. Encase the coupling in the same casing as the pipe.

2.3.7 Manufacturer's Identification

Provide an embossed brass tag hung by a brass chain, or a stainless steel tag hung by a stainless steel chain, at each end of each casing or insulated piping in the manholes and buildings. Identify UHDS manufacturer's name and date of installation.

2.3.8 End Seals

Each preinsulated section of piping must completely seal the insulation, providing a permanent water and vapor seal at each end. Provide preinsulated factory fabricated sections of piping modified in the field with an end seal which is equivalent to the end seals provided with the preinsulated section of piping. Conduct tests by the UHDS manufacturer to demonstrate that casings, couplings, and end seals are capable of resisting penetration of water into the casing and insulation under rated conditions. Perform tests on each type of pre-fabricated system to be furnished, and verify the test results by an independent testing laboratory. Test and certify the steam system in accordance with paragraph TEST OF WSL SYSTEMS FOR STEAM SERVICE. Test and certify the condensate return system in accordance with paragraph TEST OF WSL SYSTEMS FOR

CONDENSATE RETURN SERVICE.

2.3.8.1 End Seals for Steam Service

Provide elastomer-ring type end seals designed and dimensioned to fit in the annular space between the casing and the carrier pipe. Use multi-polymer alloy film type, which is compatible with synthetic elastomeric tape and suitable for cold application, for covering field repair joints.

2.3.8.2 End Seals for Condensate Return Service Types

Provide one of the following types of end seals:

a. Carrying the outer casing over tapered pipe insulation ends and extending it to the carrier pipe. Provide sufficient surface bonding area between the casing and the carrier pipe.

b. Using specially designed molded caps made of polyethylene or rubber of standard manufactured thickness. Provide a minimum 40 mm 1-1/2 inch surface bonding area between the cap and both the casing and carrier pipe.

c. Using elastomer-ring end seals designed and dimensioned to fit in the annular space between the casing and the carrier pipe.

d. Using a waterproof mastic seal vapor barrier over the exposed insulation ends.

e. Shrink sleeves.

2.3.9 Test of WSL Systems for Steam Service

Demonstrate that the WSL system will operate successfully for 25 years under typical operating conditions. Conduct tests in both a dry and wet environment. Provide WSL system as described in the manufacturer's brochure. Conduct the testing program described below at the expense of the WSL system manufacturer. Ensure tests are witnessed and verified by an independent testing laboratory. Hydrostatically test the entire pre-insulated test section, with water, to 2600 kPa 375 psig (1.5 times the rated pressure) before and after temperature cycling. Conduct tests in a dry environment for 60 cycles followed by a test in a wet environment for 60 cycles for a total of 120 cycles. The test in the wet environment demonstrates resistance to ground water infiltration. Conduct all tests on one test section and complete all testing in one time period (approximately 6 weeks) and continue the 120 testing cycles except for weekend time periods.

2.3.9.1 Apparatus

Use a curved bottom test tank at least 3.7 m 12 feet long, 0.8 m 32 inches wide, 0.8 m 32 inches deep. Fit the tank with a gasketed and bolted cover to pressurize the tank to 60 kPa 8.67 psig. Provide a drain at the lowest point and a vent at the highest point. Centrally locate manhole entrance sleeves (i.e., wall sleeves through the ends of the tank to simulate manhole entries in actual field conditions) on each end of the tank. Include the following auxiliary equipment: Steam supply with sufficient capacity to satisfy testing requirements, makeup water tank and pump, and a means for continuously recording temperatures and pressures at needed locations. Use thermocouples to record temperatures at the following points:

a. Carrier pipe at tank inlet (in thermowell).

b. Casing at mid-point in pipe length (on casing).

c. Casing at anchor point (above FRP overwrap on plate).

d. Casing at field joint (repair, on casing).

e. Casing at coupling mid-point (on casing).

f. End seal flange at coupling (on elastomer).

g. Outer edge of new end plate (at steel plate and FRP wrap).

h. Carrier pipe at specimen outlet end (in thermowell).

i. Interface of calcium-silicate and polyurethane insulations.

Ensure surface thermocouples are epoxied to the surface of the casing. Check and record the calibration of the thermocouples prior to installation and record within 0.06 degrees C 0.1 degrees F resolution. Provide pressure transmitter(s) to record pressure in the test tank and carrier pipe internal pressure, at the inlet to test specimen.

2.3.9.2 Test Section

Provide a 100 mm 4 inch steel carrier pipe test section consisting of 8 m 27 feet of pre-insulated pipe meeting specified materials and design requirements. Encase approximately 3.7 m 12 feet of the test section within the tank as described below. Provide test section within the tank consisting of an expansion coupling, field repair joint, anchor plate, anchor block and end seals. Install the test section (as directed) on at least 280 mm 11 inches of firmly tamped sand. Surround the casing with sand, ensure the top surface of the sand is not farther than 100 mm 4 inches from the top of the tank. Anchor the test section to the tank wall at one end and the building floor at the other end on the portion of the pipe external to the tank. The expansion coupling must be misaligned by 1.5 degrees in the horizontal plane. Introduce sand (118 mL) (4 fluid oz.) into the carrier pipe and disbursed throughout the test loop at startup.

2.3.9.3 Resistance to Water Damage and Joint Leakage

This test must simulate the operation of the WSL system to assure the system will provide successful service life through its expected life span. Test the system in steam service by cycling for an extended period of time, as described below. Deem system performance successful if there is no joint leakage, deformation of the casing, deterioration of the end seals, or any other deleterious effects.

a. Subject the piping system to 60 cycles of steam introduced into the system while at an ambient temperature 38 degrees C 100 degrees F, up to a temperature of 207 degrees C 406 degrees F (as measured at the core pipe at the tank inlet and tank outlet) and back to ambient temperature. Hold the system at 207 degrees C 406 degrees F minimum for a minimum of 30 minutes, each cycle. Continue this cycling for 60 cycles in dry sand followed by 60 cycles in a saturated environment.

Allow the reduction in temperature to 38 degrees C 100 degrees F to occur naturally with no artificial means of cooling used.

b. Ensure results conform to paragraph CRITERIA FOR SATISFACTORY RESULTS AND REPORTING.

2.3.9.4 Resistance to Mechanical or Structural Damage

This test must simulate loads induced by truck traffic over pipe, which can occur under actual operating conditions. Conduct this test commencing with the 41st cycle of the resistance to water damage and joint leakage test and continue through the 60th cycle. Continue other aspects of the resistance to water damage and joint leakage test simultaneously with this test.

2.3.9.4.1 Apparatus

Same as for apparatus used in resistance to ground water infiltration test, with the addition of a 96 kPa 2000 psf loading device. Use a hydraulic jack to apply the test pressure against a 500 by 500 mm 18 by 18 inch plate bearing on the sand directly over the coupling in the tank.

2.3.9.4.2 Procedure

Apply a steady and constant vertical load of 96 kPa 2000 psf to the plate for 14 days during the test. Install the test section as in the resistance to ground water infiltration test. During the 14 day loading period, circulate steam through the carrier pipe alternately at ambient and 207 degrees C 406 degrees F as in earlier test

2.3.9.4.3 Results

Requirements must be in accordance with paragraph CRITERIA FOR SATISFACTORY RESULTS AND REPORTING.

2.3.9.5 Resistance to Ground Water Infiltration

This test is the wet environment test conducted during the second 3 weeks (61st to 120th cycles) of the test period to show that the WSL system will resist the penetration of ground water into the system.

2.3.9.5.1 Apparatus

Same as for basic apparatus used in Resistance to Water Damage and Joint Leakage phase test, plus the following:

(1) One 200 L 50 gallon water reservoir with a 0 to 206 kPa 0 to 30 psig pressure gauge and compressed air connection.

(2) Provisions to introduce pressurized red dye into the curved bottom test tank. Mix the water/dye solution to a concentration in accordance with the dye manufacturer's recommendation for maximum detectability.

(3) One pressure tank with 0 to 206 kPa 0 to 30 psig static pressure gauge.

2.3.9.5.2 Procedure

Start this phase on the 61st cycle and continue until the 120th cycle. The test section of pipe must be the same test segment used in the previous tests. Bolt the tank cover in place and the begin the resistance to ground water infiltration test. Attach the water/dye source to the fill fitting and attach a surge tank to the vent with a tee fitting. Attach a 0 to 206 kPa 0 to 30 psig static pressure gauge to the pressure tank. The other branch of the tee fitting must employ a shut-off valve. With the shut-off valve open, admit the water/dye mixture into the tank through the fill fitting until the tank is full and water/dye runs freely from the open valve. Close the valve and continue filling until the pressure reaches 60 kPa 8.67 psig. Maintain the tank pressure throughout the test period. Circulate steam through the carrier pipe and cycle from ambient to 207 degrees C 406 degrees F as in the previous test. At the end of the test, relieve the pressure by opening the vent valve and drain the water/dye from the tank through the drain fitting.

2.3.9.5.3 Results

Requirements must be in accordance with paragraph CRITERIA FOR SATISFACTORY RESULTS AND REPORTING.

2.3.9.6 Criteria for Satisfactory Results and Reporting

2.3.9.6.1 Reporting

Record logs of times and temperature to assure compliance with test requirements and procedures. Produce complete photographic documentation of the construction and operation of the test facility, as well as the piping system components before and after testing. Analyze data to assure complete compliance with test objectives.

2.3.9.6.2 Drawing

Provide a drawing showing details of the test apparatus and test specimen.

2.3.9.6.3 Resistance to Water Damage and Joint Leakage Test

Remove joints and end seals for examination immediately upon completion of all test cycles. Successful results must show that steam has not leaked out of the carrier pipe and that the components show no signs of deterioration.

2.3.9.6.4 Resistance to Mechanical or Structural Damage Test

At the end of testing, inspect the casing for damage or deformation which would impair the functionality of the system. Successful test results consist of no ruptures in the casing, the casing has not deformed more than 25 mm 1 inch in any direction, and no separation has occurred between the casing and the pipe anchor interface.

2.3.9.6.5 Resistance to Ground Water Infiltration Test

Determine no water/dye solution has penetrated the insulation. This is determined by removing and inspecting all joints and seals for dye penetration at the end of the test. Results will be deemed successful if no dye solution is evident in the insulation.

2.3.9.6.6 Evidence of Test Results

After completion of all tests, dismantle the test apparatus for visual inspection of all critical components subjected to the heat cycling, water infiltration and loading tests. All parts will be examined thoroughly for any detrimental affects. Conduct identified examinations. Keep log sheets, test data, and color photographs on file and make available as required to document and substantiate compliance to the test requirements.

2.3.9.6.7 Report

Submit a report from the independent testing agency. The report must include the laboratory analysis of the condition of the test section and attest that the testing conditions were followed.

2.3.10 Test of WSL Systems for Condensate Return Service

Submit test reports in booklet form showing all factory and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Use testing and certification procedures by an independent testing laboratory to demonstrate that casings and end seals are capable of resisting penetration of water into the casing and insulation. Perform test on the type of prefabricated system to be provided. If more than one type of prefabricated system is to be used, perform the tests on each type. Perform test consisting of hot and cold cycle testing followed by immersion in a water filled chamber with a head pressure. The hot and cold cycle testing must consist of a minimum of 14 days of temperature cycling.

a. Circulate a fluid with a temperature of 5 degrees C 40 degrees F through the carrier pipe, alternating every 24 hours with a fluid with a temperature of 95 degrees C 200 degrees F circulating through the carrier pipe for a low temperature hot water or dual temperature service, or 24 degrees C 75 degrees F for a chilled water service.

b. While the hot and cold cycle test is being performed, either bury or encase the test sample in dry bedding sand with a minimum of 300 mm 12 inches of sand all around the test sample. Ensure the carrier pipe size of the test sample is 75 mm 3 inches in diameter and restrain during the test period. The insulation thickness must not exceed the maximum thickness provided for the piping in the project.

c. Transition time for temperature cycle testing must not exceed 15 minutes in going from cold to hot, and 30 minutes in going from hot to cold. The fluid in the carrier pipe may be water, oil, or heat transfer fluid. Following the hot and cold cycling test, immerse the test sample in a water filled chamber. The pressure on the highest point of the test sample must not be less than 60 kPa 20 feet of water head pressure subjected over the entire length of the 2.4 m 8 foot test sample of prefabricated pipe.

d. Use water containing a dye penetrant to check for end seal leakage. Hold the pressure in the chamber for no less than 48 hours. Upon completion of this pressure test, cut open the test sample. With the use of a light that will readily show the presence of the dye that was in the water, inspect the test sample. Evidence of the dye inside the test sample indicates that the end seal is not acceptable and cannot be certified.

2.4 PIPE INSULATION TYPE AND MINIMUM THICKNESS

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NOTE: Delete inapplicable columns in Tables 1 and 2.
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Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Materials containing asbestos will not be permitted. The minimum thickness of insulation for the heat distribution system must be in accordance with Tables 1 and 2 in which the insulations listed have passed the 96 hour boiling water test.

TABLE 1 - MINIMUM PIPE INSULATION THICKNESS (mm) (inches)				
For Steam (100 to 2.800 kPa (gage)) (16 to 408 psig) and High Temperature Hot Water Supply and Return (120 to 230 degrees C) (250 to 450 degrees F)				
INSULATIONS For Drainable/Dryable Systems			INSULATIONS For other Pre-Engineered Systems	
Nominal Pipe Diameter (mm) (inches)	Mineral Wool ASTM C547 Type III Grade A	Aerogel ASTM C1728 Type III Grade 1A	WSL	
			Calcium Silicate	Polyurethane
25 1.0	75 3.0	25 1.0	N/A	N/A
40 1.5	75 3.0	35 1.5	N/A	N/A
50 2.0	75 3.0	35 1.5	N/A	N/A
65 2.5	75 3.0	35 1.5	N/A	N/A
80 3.0	75 3.0	35 1.5	35 1.5	+31 1.22
100 4.0	85 3.5	50 2.0	35 1.5	+31 1.22
125 5.0	85 3.5	50 2.0	N/A	N/A
150 6.0	85 3.5	50 2.0	35 1.5	+34 +1.34
200 8.0	85 3.5	50 2.0	50 2.0	+30 +1.21
250 10.0	100 4.0	50 2.0	63 2.5	+33 +1.31
300 12.0	100 4.0	50 2.0	50 2.0	+32 +1.29
350 14.0	100 4.0	50 2.0	N/A	N/A
400 16.0	100 4.0	50 2.0	N/A	N/A
450 18.0	100 4.0	50 2.0	N/A	N/A

TABLE 2 - MINIMUM PIPE INSULATION THICKNESS (mm) (inches) CONDENSATE RETURN			
INSULATIONS For Drainable/Dryable Systems			INSULATIONS For other Pre-Engineered Systems
Nominal Pipe Diameter (mm) (inches)	Mineral Wool ASTM C547 Type III Grade A	Aerogel ASTM C1728 Type III Grade 1A	Polyurethane
25 1.0	35 1.5	25 1.0	N/A
40 1.5	35 1.5	25 1.0	N/A
50 2.0	35 1.5	25 1.0	19 0.77
65 2.5	35 1.5	25 1.0	N/A
80 3.0	50 2.0	25 1.0	26 1.05
100 4.0	50 2.0	25 1.0	26 1.05
125 5.0	50 2.0	25 1.0	N/A
150 6.0	63 2.5	25 1.0	36 1.32
200 8.0	63 2.5	25 1.0	N/A
250 10.0	76 3.0	25 1.0	N/A
300 12.0	76 3.0	25 1.0	N/A
350 14.0	76 3.0	25 1.0	N/A
400 16.0	76 3.0	25 1.0	N/A
450 18.0	76 3.0	25 1.0	N/A

2.5 HEAT DISTRIBUTION PIPING

2.5.1 Steam and High Temperature Hot Water Pipe

Pipe material must be steel; seamless, ASTM A53/A53M, Grade B or ASTM A106/A106M, Grade B; or electric resistance welded ASTM A53/A53M, Grade B; Schedule 40. Standard weight will be permitted for pipe sizes 300 mm 12 inches and above. ASTM A53/A53M, Type F furnace butt welded pipe will not be allowed. Joints will not be allowed in factory fabricated straight section of the carrier pipe. Provide factory fabricated piping sections as part of an expansion loop or bend with all welded joints 100 percent radiographed inspected in accordance with ASME B31.1. Ensure radiographs are reviewed and interpreted by a Certified American Society for Nondestructive Testing (ASNT) Level III radiographer, employed by the testing firm, who will sign the reading report.

2.5.2 Condensate Pipe

Pipe material must be steel; seamless, ASTM A53/A53M, Grade B or ASTM A106/A106M, Grade B, schedule 80; electric resistance welded ASTM A53/A53M, Grade B; Schedule 80. ASTM A53/A53M, Type F furnace butt welded pipe is not allowed. Joints will not be allowed in the factory fabricated straight section of the carrier pipe. Provide factory fabricated piping sections, as part of an expansion loop or bend with all welded joints 100 percent radiographed inspected in accordance with ASME B31.1. Ensure radiographs are reviewed and interpreted by an ASNT Certified Level II radiographer, employed by the testing firm, who will sign the reading report.

2.5.3 Joints

Provide butt-weld joints, except socket-weld joints are permitted for pipe sizes 50 mm 2 inches and smaller. Dye penetrant inspection may be used in place of 100 percent radiographic inspection for pipe sizes 50 mm 2 inches and below. Indicate location and elevation of all field joints on detailed design layout drawings. Split-ring welding rings may be used.

2.5.4 Fittings

Radiographically inspect welds in factory fittings. Ensure radiographs are reviewed and interpreted by a Certified ASNT Level III radiographer, employed by the testing firm, who will sign the reading report. The Contracting Officer may review all inspection records, and if any welds inspected are found unacceptable in accordance with ASME B31.1, remove, replace, and radiographically reexamine the fitting at no cost to the government.

2.5.4.1 Butt-Welded

Fittings must be steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe. Provide long radius elbows unless otherwise indicated. Provide full size or reducing tees as required, with interior surfaces smoothly contoured. Split-ring welding rings may be used.

2.5.4.2 Socket-Welded

Use forged steel ASME B16.11; 13,800 kPa 2000 pound class fittings for pipe sizes 50 mm 2 inch and below. Dye penetrant inspection may be used in lieu of radiographic inspection of welded fittings for pipe sizes 50 mm 2 inch and below.

2.6 EXPANSION JOINTS, LOOPS AND BENDS

Ensure stresses are less than the maximum allowable stress from the Power Piping Code (ASME B31.1). Submit pipe-stress and system-expansion calculations for each expansion compensation elbow using a finite element computer generated three-dimensional analysis, no later than[7 days][_____] after notice to proceed. Demonstrate with calculations that pipe stresses from temperature changes are within the allowable requirements in ASME B31.1 and that the anchors and the guides will withstand the resultant forces. Include all analysis node points in the detailed design layout drawings. As a minimum, include node stresses, forces, moments, and displacements in computer analysis results. Ensure calculations are stamped by a registered Professional Engineer in the employ of the UHDS manufacturer. Provide detailed design layout drawings and stress and anchor force calculations for all loops and bends. Show locations of all anchors, guides, and supports. Base the calculations on design characteristics (pressures and temperatures), specified, for both the supply and return lines.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Job Conditions

Phasing of[demolition and construction][construction] must be as shown on contract drawings.

3.1.2 Interruption of Existing Service

Submit schedule of proposed outages and interruptions of existing services,[14 days] [_____] in advance. Arrange, phase, and perform work and provide temporary facilities, materials, equipment, and connections to utilities, to assure adequate heat distribution service for existing installations at all times. Only necessary interruptions required for making connections will be permitted, and only at times when approval is obtained from the Contracting Officer. All interruptions are to be scheduled with and approved by the Contracting Officer.

3.1.3 Connecting to Existing Work

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NOTE: Any connections to the UHDS distribution will only occur in manholes. Designer must ensure that a thorough survey of the aboveground and underground conditions is performed. The contract drawings must identify all potential interferences or conflicts.

****

Submit changes required to the UHDS design due to interferences or conflicts upon realization of interferences or conflicts. Connect new work to existing work to complete piping connections that enable pressure tests with successful outcomes per the requirements of this specification. Make connection only in manholes. Where an existing structure must be cut or existing utilities interfere, bypass, remove, replace or relocate, restore and repair such obstructions. Obtain approval from the UHDS designer and the Contracting Officer for any changes required to the UHDS design as a result of interferences or conflicts. Restore disturbed or damaged work to its prior condition.

3.1.4 Coordination

Coordinate the location of all items of equipment and work of all trades. Maintain operability and maintainability of the equipment and systems.

3.1.5 Grading

Unless otherwise shown on the contract drawings or the detailed design layout drawings, grade steam/condensate and high temperature hot water supply/return lines uniformly downward no less than 25.4 mm in 6.10 meters 1.0 inch in 20 feet to the lower point of entry between manholes [and][or] building entries.

3.1.6 Variations

Submit any variations from the approved detailed design layout drawings to the Contracting Officer for approval. Ensure variations are signed and sealed by the UHDS manufacturers' professional engineer responsible for the complete design of the UHDS.

3.2 DEMOLITION

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NOTE: Ensure that Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION] is included in project specifications. Demolition work should be well defined in the drawings and specifications; photographs should be included in the contract package, if available.

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3.2.1 Demolition Procedures

Perform work in accordance with requirements for phasing. Remove pipe, valves, fittings, insulation, and hangers, including the connection to the structure and any fastenings. Seal openings in manhole or building walls after removal of piping. Material and equipment removed is the property of the Contractor and will be removed from the Government property within 1 week and do not store in operating areas. Perform flame cutting with adequate fire protection facilities available as required by safety codes and Contracting Officer.

3.2.2 Asbestos Removal

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NOTE: Existing systems may include asbestos containing materials. Provisions must be made for an asbestos survey to be performed and abatement measures to be included in project specification if necessary.

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Remove asbestos in conformance with Section 02 82 00 ASBESTOS REMEDIATION.

3.3 PIPE, PIPING JOINTS AND FITTINGS

3.3.1 Joint Preparation

Clean pipe and fittings inside and outside before and after assembly. Remove dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe pig before connecting pipe sections, valves, equipment, or fittings. Use eccentric connectors as needed between casing sections to provide drainage of casing section between manholes and between manholes and buildings.

3.3.2 Direction Changes

Make changes in direction with factory-built reinforced fittings. Field-fabricated fittings and miters are not permitted.

3.4 WELDING

A Certification of Acceptability of all welds made in the field, upon completion of the project. This certification consists of a letter signed by an official of the independent testing firm or firms examining welds, stating that all provisions of this specification have been complied with, and that all welds inspected radiographically have met the acceptability standards specified. The Contractor will be responsible for welding quality and must:

a. Conduct tests of the welding procedures used in the work, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and determine that the welding operators have the ability to make sound welds under standard conditions.

b. Comply with ASME B31.1.

c. Perform all welding operations required for construction and installation of the heat distribution system.

3.4.1 Qualification of Welders

Rules of procedure for qualification of all welders and general requirements for fusion welding must conform with the applicable portions of ASME B31.1 and also as outlined below.

3.4.2 Examining Welders

Examine each welder to determine the ability of the welder to meet the required qualifications. Test welders for welds in all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder must:

a. Weld only in positions in which they have qualified.

b. Identify welds with the specific code marking signifying name and number assigned.

3.4.3 Examination Results

Furnish a list of welders' names and corresponding code markings. Retest welders which fail to meet the prescribed welding qualifications. Welders who fail the second test are disqualified for work on this project.

3.4.4 Beveling

Make field and shop bevels by mechanical means or by flame cutting. Where beveling is done by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding.

3.4.5 Alignment

Utilize split welding rings for field joints on carrier pipes above 50 mm 2 inches to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe. Make field joints 50 mm 2 inches and smaller with welding sockets.

3.4.6 Erection

Do not split, bend, flatten, or otherwise damage piping before, during, or after installation. Where the pipe temperature falls to 0 degrees C 32 degrees F or lower, heat the pipe to approximately 38 degrees C 100 degrees F for a distance of 300 mm 1 foot on each side of the weld before welding, and finish the weld before the pipe cools to 0 degrees C 32 degrees F.

3.4.7 Defective Welds

Replace and reinspect defective welds in accordance with ASME B31.1. Repairing defective welds by adding weld material over the defect or by peening is not be permitted. Ensure welders responsible for defective welds are tested for qualification.

3.4.8 Electrodes

Store electrodes in a dry, heated area, and keep free of moisture and dampness during fabrication operations. Do not use electrodes that have lost part of their coating.

3.4.9 Radiographic Testing

An approved independent testing firm regularly engaged in radiographic testing must perform radiographic examination of 100 percent of the field welds in the carrier piping of direct-buried systems in accordance with ASME B31.1. Provide the following: a set of films showing each weld inspected, a reading report evaluating the quality of each weld, and a location plan showing the physical location where each weld is to be found in the completed project, prior to installing casing field joints, backfilling, and hydrostatic testing. Ensure all radiographs are reviewed and interpreted by a Certified American Society for Nondestructive Testing Level III radiographer, employed by the testing firm, who will sign the reading report. The Contracting Officer may review all inspection records, and if any welds inspected are found unacceptable, the Contractor must remove, reweld, and radiographically reexamine at no cost to the Government.

3.5 HEAT DISTRIBUTION SYSTEM INSTALLATION

Submit a complete description of the design and assembly of the system, materials of construction and field installation instructions, not later than[21] [_____] days prior to the start of field measurements. Include sufficient system details to show that the specified minimum insulation thickness has been met. A detailed design layout of the system (plan and elevation views) showing size, type, elevations, and location of each component to be used in the system, the design and location of anchors, pipe guides, pipe supports, expansion loops, Z-bends, L-bends, end seals, leak plates, joint locations, pipe and insulation thickness and sizes, types, and movements, connection to manhole and building wall penetrations, and including, if applicable, transition point design to aboveground or other type systems. Also, if applicable, type and details of the cathodic protection system to be used. Ensure detailed design layout drawings are stamped by a registered Professional Engineer. The UHDS manufacturer's representative will oversee the delivery, storage, and installation and testing of the system. Perform work in accordance with the requirements specified and with the printed instructions of the manufacturer. These specifications take precedence over the printed instructions if conflicts arise. Submit printed instructions to the Contracting Officer prior to system installation. Submit operation and maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, procedures for recording conduit temperatures biannually, and troubleshooting guides, before completion of work. Include in the Manual as-built piping layout of the system with final elevations. Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.5.1 Verification of Final Elevations

After all temporary supports have been removed, and prior to covering the top of the casing with backfill material, measure and record the elevation of the top of the casing in the trench at every completed field joint, 1/3 points along each pipe section and top of elbows. Check these measurements against the contract drawings and confirm that the conduit system has been installed to the elevations shown on the contract drawings. Ensure slope is uniform to within 0.1 percent. Record these measurements, include in the UHDS manufacturer's representative daily report, and give to the Contracting Officer prior to covering the casing with backfill material.

3.5.2 Excavation, Trenching, and Backfilling

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NOTE: The designer must coordinate the type of sand to be used with Section 31 00 00 EARTHWORK. Do not allow beach sand or any sand with large amounts of chlorides to be specified.

****

Perform excavation, trenching, and backfilling as required by the UHDS manufacturer's design and as specified in Section 31 00 00 EARTHWORK. Lay pipe on a 305 mm 12 inch minimum sand bed and backfill with sand on all sides to a minimum of 150 mm 6 inches as measured from outside of casing. Provide a firm and stable foundation for the system. Ensure foundation and backfill is free from rocks or substances which could damage the system coating. Install concrete anchor and thrust blocks in undisturbed earth. Do not commence backfilling until system has been satisfactorily pressure tested (both hydrostatic test of carrier and, for DDT systems, pneumatic test of casing). Minimum depth of burial to the top of the casing is 600 mm 24 inches or depth required for piping to be below the frost line, whichever is greater. Maximum depth of burial to the top of the casing is 3 meters 10 feet.

3.5.3 UHDS Manufacturer's Representative Responsibilities

The UHDS Manufacturer's representative must be present at the job site and witness when the following types of work are being performed:

a. Inspection, unloading, and storage.

b. Inspection of trench prior to commencing installation of system.

c. Inspection of concrete anchors and thrust blocks.

d. Hydrostatic testing of carrier piping.

e. Field joint closure work.

f. Pneumatic testing of DDT system casing.

g. Holiday test of conduit coating.

h. Repair of any coating.

i. Installation of cathodic protection system.

j. Initial backfill up to 254 mm 10 inches above the top of the casing.

k. Verification of final elevations. Elevation readings must be witnessed and recorded.

l. Testing of cathodic protection system.

m. Startup and operational tests

Notify the Contractor immediately of any problems. Notify the Contracting Officer of problems requiring immediate action; otherwise, note any problems encountered and indicate the corrective actions taken in the daily reports.

3.5.4 UHDS Manufacturer's Representative Reports

The UHDS manufacturer representative must: prepare and sign a written daily report; present the original daily report to the Contracting Officer no later than one working day after it is prepared, and forward one copy to the manufacturer's main office. State whether or not the condition and quality of the materials used and the delivery, storage, installation and testing of the system are in accordance with the drawings, specifications, and manufacturer's printed instructions and are satisfactory in all respects. When any work connected with the installation is unsatisfactory, state what corrective action has been taken or list the UHDS manufacturer's recommendations for corrective action. Identify any condition that could result in an unsatisfactory installation, including such items as open conduit ends left in the trench overnight and improper manhole entries. Ensure daily reports are to be reviewed, signed and sealed, on a weekly basis, by the registered engineer responsible for the system design. Submit signed and sealed copies of the daily reports with the payment request. Requests for payment will be denied if the weekly review is not accomplished. Upon completion of the work and before final acceptance, submit notarized Certificate of Compliance signed by a principal officer of both the manufacturing and the contracting firm, stating that the installation is satisfactory and in accordance with plans, specifications, and manufacturer's instructions to the Contracting Officer. Retain a copy of all daily reports and the Certificate of Compliance for 5 years after final acceptance of the system by the Government.

3.5.5 Protection

Protect casing coating from damage during unloading, storage, rigging and installation. Protect casing and carrier pipe ends from water intrusion during unloading, storage, rigging and installation. Protect piping and all accessories from damage due to exposure to UV light.

3.5.6 Defective Material

The UHDS Manufacturer's Representative must take prompt action to remove from the site all damaged or defective material, subject to rejection in accordance with the quality assurance provisions included in the manufacturer's submittals and printed instructions, and must order prompt replacement of such material.

3.5.7 Cathodic Protection Installation

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NOTE: Designer must indicate on the contract drawings that dielectric separation is shown where

UHDS enter buildings or at or above transition from underground to aboveground piping.
****

Provide cathodic protection for all steel casing systems and all buried exposed metal. Assume that 25 percent of the exterior of the UHDS is exposed metal. Submit design life calculations for the cathodic protection system in accordance with NACE SP0169, not later than[7 days] [_____] after notice to proceed. Ensure calculations are stamped by an NACE qualified corrosion engineer. Provide cathodic protection systems with a minimum design life of 25 years and conforming to[Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM][or][Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Provide dielectric pipe flanges and unions and isolation devices at all points necessary. Provide test stations at grade on each section of the piping system. Isolation flanges and unions must be rated for the service temperature and pressure.

3.6 TESTS

Submit a proposed test procedure and proposed samples of test data sheets for each required test, 30 days prior to the proposed test date. The procedure must contain a complete description of the proposed test with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. Do not commence test until the procedure has been approved. Perform pressure tests (hydrostatic, pneumatic) and operational tests to demonstrate leak-tightness of all piping systems. Pressure test heat distribution system in conformance with specified requirements and printed instructions for the system supplied; include carrier piping and casing. Test the carrier pipe hydrostatically. Test casings of DDT systems pneumatically. Test casing and end seals of WSL system for intrusion of water into the casing and insulation. Do not use mercury in thermometers required for the tests.

3.6.1 Holiday Testing of Direct-Buried System Steel Casings

Test entire exterior surface of the casing including the bottom exterior surface for faults in coating after installation in trench prior to backfilling, using test method and voltage recommended by coating manufacturer. If any holidays are found, repair them and retest the coating. Do not backfill the system until all holidays are eliminated.

3.6.2 Pneumatic, Hydrostatic and Operational Tests

Before conducting heat distribution system tests, flush lines with high pressure water until[discharge shows no foreign matter][the Contracting Officer, after examining the discharge, stops the flush].

3.6.2.1 Pneumatic Test

Pneumatically test the casing of DDT systems after welding and before field coating using air as the test medium. Use a test pressure of 103 kPa 15 psig. Keep persons not working on the test operations out of the testing area while testing is proceeding. Make the test on the system as a whole or on sections that can be isolated. Test joints in sections prior to backfilling when trenches must be backfilled before the completion of other pipeline sections. Continue the test for 24 hours from the time of the initial readings to the final readings of pressure and temperature. Do not make the initial test readings of the instrument for at least 1 hour after the casing has been subjected to the full test pressure, and make neither the initial nor final readings at times of rapid changes in atmospheric conditions. There must no indication of reduction of pressure during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship T(1)P(2)=T(2)P(1), in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial (1) and final (2) readings. Measure pressure with a pressure gauge conforming to ASME B40.100. A throttling type needle valve or a pulsation dampener and shutoff valve may be included. The diameter of the face must be at least 114 mm 4.5 inches with a measurable range of 0 to 103 kPa 0 to 15 psig and graduations of not greater than 0.5 kPa 0.1 psig. During the test, isolate the entire system from all compressors and other sources of air pressure. Test each joint while under test pressure by means of soap and water or an equivalent nonflammable solution prior to backfilling or concealing any work. All labor, materials and equipment for conducting the tests must be furnished by the Contractor and are subject to inspection at all times during the tests. Maintain proper safety precautions for air pressure testing at all times during the tests.

3.6.2.2 Hydrostatic Test

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NOTE: Input the heat distribution design pressure for the supply line. Design pressure to equal or exceed the operating pressure of the system.

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Test carrier piping hydrostatically before insulation is applied at field joints and prove tight at a pressure 1.5 times the heat distribution supply design pressure of [_____] kPa [_____] psig for 2 hours. There must be no indication of reduction of pressure during the test. Measure pressure with a device calibrated as to be read in increments of not greater than 1 kPa 0.1 psi.

3.6.2.3 Operational Test

Prior to acceptance of the installation, subject system to operating tests simulating actual operating conditions to demonstrate satisfactory functional and operating efficiency. Cover a period of no less than 6 hours for each portion of system tested. Submit for approval a schedule of the tests to be performed[14 days] [_____] in advance. Provide calibrated instruments, equipment, facilities, and labor at no additional cost to the Government. When failures occur, repair problems and repeat test.

3.6.3 Deficiencies

Correct deficiencies discovered at the Contractor's expense. Major deficiencies, or failure to correct deficiencies, can be considered cause for rejecting the entire installation.

3.7 VALVE MANHOLES

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NOTE: Include Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES as part of the contract specifications for this job when there are manhole or steam pits. Include sealing of pipe penetrations through manhole walls in the design of

the manhole.

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Provide valve manholes, piping, and equipment in valve manholes in accordance with the contract drawings and Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

3.8 BURIED UTILITY WARNING AND IDENTIFICATION

3.8.1 Plastic Marking Tape

Supply and install polyethylene plastic tape manufactured specifically for warning and identifying buried utility lines. Bury tape above the pipe during the trench backfilling operation and bury approximately 300 mm 12 inches below grade. Tape must be[0.1 mm 0.004 inch thick polyethylene][polyethylene with a metallic core]. Use tape that is acid- and alkali-resistant with a minimum strength of 12 MPa 1750 psi lengthwise and 10.3 MPa 1500 psi crosswise with an elongation factor of 350 percent. Ensure tape is manufactured with integral wires, foil backing, or other means to enable detection by a metal detector when the tape is buried up to 1 meter 3 feet deep. Encase the metallic core of the tape in a protective jacket or provide with other means to protect it from corrosion. Ensure tape is a type specifically manufactured for marking and locating metallic underground utilities. Provide tape that is 150 mm 6 inches wide and printed with a caution and identification of the piping system over the entire tape length. Tape must be yellow with bold black letters. Tape color and lettering must be unaffected by moisture and other substances contained in the backfill material.

[3.8.2 Markers for Underground Piping

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NOTE: Indicate the location of the markers on the contract drawings for projects that require markers. Delete the paragraph if not needed in the project

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Locate markers for underground piping along the distribution and service lines. Place markers as indicated approximately 600 mm 2 feet to the right of the distribution system when facing in direction of flow in the supply line. Provide concrete marker that is 150 mm 6 inch square or round section [600][900] mm [2][3] feet long. The top edge of the marker must have a minimum 13 mm 1/2 inch chamfer all around. Impress or cast the letters[STEAM][HTHW][CONDENSATE] on the top, and on one side of the markers to indicate the type of system that is being identified. Form each letter with a V-shaped groove and with a width of stroke at least 6 mm 1/4 inch at the top and depth of 6 mm 1/4 inch. Do not allow the top of the marker to protrude more than [25][50][75][100] mm [1][2][3][4] inches above finished grade.

]3.9 THERMAL PERFORMANCE TESTING

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NOTE: The temperatures in Table 3 are based on calculations that assume 85 percent of the thermal resistance of a new, properly functioning system is in the insulation, and that a degradation of up to 50 percent of the original thermal resistance will

be allowed. A soil temperature of 15 degrees C 60 degrees F was also assumed in the calculations.
****

Use the equipment and procedures specified to ensure acceptable thermal performance of the installed system. Submit manufacturer's data sheets on all UHDS components and the instrumentation required for thermal performance testing,[7] [_____] days after notice to proceed. Include all materials and procedures described for this test as deliverables of the construction contract for the system unless otherwise noted.

3.9.1 Equipment

3.9.1.1 Casing Temperature Measurement

Before backfilling, and after field joint closures have been welded to the casing and the coating has been applied and cured, attach temperature sensors to the exterior of every other field joint closure. Attach the sensors with epoxy suitable for use at 260 degrees C 500 degrees F. Adhere a sensor with epoxy to the coated casing near the midpoint of every other pipe section between field joints. Do not locate the sensor closer than 1.5 m 5 feet from any guide in the interior of the casing. After the sensors have been adhered to the casing, use two complete wraps of duct tape to secure and protect the sensor. Attach the sensors with epoxy suitable for use at 260 degrees C 500 degrees F. Locate the radial position of the sensors 45 degrees from the top center of the casing, at either the 1:30 or 10:30 position, away from the adjacent heat distribution system pipe, if present. Ensure all sensors are type T, copper constantan 20 gauge thermocouples, made from special limits grade thermocouple wire (accuracy plus or minus 0.5 degrees C 0.9 degrees F) or 0.4 percent maximum error, with each conductor insulated and an overall jacket on all conductors. Use insulation on the thermocouple wires suitable for service at 260 degrees C 500 degrees F. Ensure the thermocouple wire between sensor location and termination point is continuous with no splicing or other connections. Show each sensor with a special symbol on the detailed design layout drawings and identify by a number [and][or] letter code, starting from the upstream manhole.

3.9.1.2 Carrier Pipe Temperature Measurement

Measure carrier pipe temperature within the manhole where the panel box is located. Measure carrier pipe temperature by a sensor adhered with epoxy directly to the exterior of the carrier pipe. Ensure all sensors are copper constantan, 20 gauge, type T thermocouples made from special limits grade thermocouple wire (accuracy plus or minus 0.5 degrees C 0.9 degrees F or 0.4 percent maximum error), with each conductor insulated and an overall jacket on both conductors. Use insulation on the thermocouple wires suitable for service at 260 degrees C 500 degrees F. Ensure the thermocouple wire between sensor location and termination point is continuous with no splicing or other connections. Locate this sensor at either the 1:30 or 10:30 position. At the location of the sensor, insulate the carrier pipe with calcium silicate insulation at least 125 mm 5 inches thick. Extend this insulation at least 150 mm 6 inches on each side of the actual sensor location and must be clad with an aluminum jacket.

3.9.1.3 Terminals

Extend the wires from each casing or carrier pipe temperature sensor into the nearest manhole and terminated in a panel box. The panel box must be a

NEMA Type 4 waterproof enclosure, of suitable size, mounted near the top of the manhole at a location near the manhole entrance, accessible without entrance into the manhole, where possible. Terminate the sensor wires with an approved connector type[OMEGA Miniature Jack Panel (MJP-*-*-T)]. Mount the thermocouple jack panel to the back plate of the panel box. Label the temperature sensors at their termination within the panel box; laminate and attach a drawing showing the location of each temperature sensor to the inside of the panel box. Ensure all temperature sensors are verified as operational by an independent laboratory, hired by the Contractor, after backfilling is complete but before the system is accepted.

3.9.2 Thermal Performance Test

After the system construction is complete, including all backfilling, and the system has reached operating condition for at least 30 days, all of the temperature sensors must be read by an independent laboratory with experience and equipment appropriate for the sensors used. Record the temperature for each sensor. Tabulate and submit the temperatures in accordance with specified requirements. If temperatures exceed values in Table 3, repair that portion and measure and record temperatures again.

TABLE 3

Carrier pipe Temperature TP (degrees C) (degrees F)	Acceptable Casing Temperature TC (degrees C) (degrees F)
121 250	43 110
135 275	47 116
149 300	50 123
163 325	54 129
177 350	58 136
204 400	65 149
218 425	68 155
232 450	72 162
The following equations were used to calculate the above values:	
TC, (0.261) X (TP) + 11.5 TC, (0.261) X (TP) + 44.3	
For carrier pipe temperatures between those given in Table 3, the maximum acceptable casing temperature may be either interpolated from the values in Table 3 or calculated using the equations above.	

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 63 13.19 (February 2016)**

Preparing Activity: USACE **Superseding**
UFGS-33 61 15 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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CONCRETE TRENCH HYDRONIC AND STEAM ENERGY DISTRIBUTION

02/16

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USACE / NAVFAC / AFCEC **UFGS-33 63 13.19 (February 2016)**

Preparing Activity: USACE **Superseding**
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****

SECTION 33 63 13.19

CONCRETE TRENCH HYDRONIC AND STEAM ENERGY DISTRIBUTION
02/16

****
NOTE: This guide specification covers the requirements for heat distribution systems of the concrete trench type for water systems from 66 to 232 degrees C 150 to 450 degrees F and steam systems up to 1.72 MPa 250 psig.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: For a complete system include Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES. The designer will comply with the procedure as outlined in the following paragraphs 1 through 5 in determining site conditions and trench system design. If specific site conditions are not suitable for a concrete trench system in accordance with following guidance, refer to Section 33 63 23 EXTERIOR ABOVEGROUND STEAM DISTRIBUTION or Section 33 61 13 PRE-ENGINEERED UNDERGROUND HEAT DISTRIBUTION SYSTEM.

SITE CLASSIFICATION AND CONCRETE TRENCH DESIGN GUIDANCE

1. Classification of the Site: A detailed site classification survey will be conducted by a geotechnical engineer using the following guidelines:

a. The survey will be made after the general layout of the system has been determined and will cover the entire length of the proposed system. The geotechnical engineer must be a registered professional engineer with a minimum of 3 years of experience in the field of soil mechanics and foundation design.

b. The survey should be conducted during the time of the year when the groundwater table is historically at its highest point; if this is not possible, water table measurements will be corrected, on the basis of professional judgment, to indicate the highest seasonal water table when water table is at its highest point.

c. As a minimum, information on groundwater conditions, soil types, terrain, and precipitation rates and irrigation practices in the area of the system will be collected. This information will be obtained from available records at the installation.

d. Information on groundwater conditions and soil types will be obtained through borings, test pits, or other suitable exploratory means. Generally, in areas of prior construction, a boring or test pit will be made at least every 30 m 100 feet along the line of the proposed system. In open undisturbed natural areas, the spacing of borings may be increased. Each exploratory hole should extend to a level at least 1.5 m 5 feet below the bottom of the tunnel. If a significant difference in underground conditions is found at adjacent exploratory points, additional explorations will be made between those points in order to determine where the change occurs. Upon completion of the survey, each exploration point will be classified on the basis of the criteria presented in Table 1, ALLOWABLE SOIL CHARACTERISTICS and the soil classification system in ASTM D2487. If the criteria of Table 1 is not met, the site conditions are not suitable for the use of a concrete trench.

TABLE 1
ALLOWABLE SOIL CHARACTERISTICS FOR CONCRETE TRENCH APPLICATION
(SEE NOTE 1.)

Site Soil Conditions	General Conditions of Ground Water During the Wettest Period of the Year	Surface Water Accumulation Rainfall/ Irrigation	Trench Construction
A. Fine Grained Impervious or Semipervious and Coarse Grained Impervious	Water table generally 300 mm 1 foot below lowest point of water entry (See Note 4) with not more than 25 percent of the proposed concrete trench system showing water within 300 mm 1 foot but no higher than lowest point of water entry	5 year - 7 day rainfall equal to or less than 250 mm 10 inches (See Note 2.)	Continuous wall and bottom
B. Coarse Grained Semipervious	Same as for A., above	5 year - 7 day rainfall equal to or less than 250 mm 10 inches (See Note 2.)	Continuous wall and bottom
	Water table generally 600 mm 2 foot or more below lowest point of water entry with not more than 10 percent of the proposed concrete trench system showing water within 600 mm 2 feet but no closer than 300 mm 1 foot to lowest point of water entry	5 year - 7 day rainfall equal to or less than 200 mm 8 inches (See Note 2.)	Continuous wall; opening may be provided in trench bottom to provide drainage

TABLE 1
ALLOWABLE SOIL CHARACTERISTICS FOR CONCRETE TRENCH APPLICATION
(SEE NOTE 1.)

Site Soil Conditions	General Conditions of Ground Water During the Wettest Period of the Year	Surface Water Accumulation Rainfall/ Irrigation	Trench Construction
C. Swelling Soils	Same as for A., above (See Note 3.)	Same as for A., above	Same as for A., above plus design of joint spacing and joint details to accommodate

1. Concrete trench systems will not be used if any of the conditions defined by these criteria are exceeded.

2. As shown in U.S. Weather Bureau (USWB) Tech. Paper 40 and confirmed with local data and local weather patterns.

3. Swelling soils are defined as those which experience large volume changes with changes in moisture content.

4. Lowest point of water entry is defined as the joint between trench wall and trench bottom.

2. DESIGN: The design will be completed based on the following soil conditions:

a. Fine grained impervious soils. The highest groundwater level evident during the wettest period of the year should be a minimum of 300 mm 1 foot below the lowest point of water entry into the concrete trench system. The lowest point of entry is defined as the joint between the concrete trench wall and concrete trench bottom. The concrete trench bottom will be continuous with no openings. The above condition will allow the concrete trench to be constructed and will minimize potential infiltration of water into the trench. Open drainage ways, swales, or swampy/boggy areas will preclude use of a concrete trench system because of ground water level guidance in Table 1. The concrete trench system must be rerouted or regraded to bring the concrete trench out of the unsuitable conditions. The geotechnical engineer who performed the detailed site classification survey will provide regrading instructions and will select fill that will remain stable and will not be subject to future wash-outs.

b. Coarse grained semipervious/pervious soils. The groundwater level during the wettest period of the year should be at least 300 mm 1 foot below the lowest point of water entry into the concrete trench system. For a water table 300 to 600 mm 1 to 2 feet below the lowest point of water entry the criteria of paragraph 2.a., above apply.

c. Swelling Soils with high swell potential. The design of the concrete trench system in materials having high swell potential will be in accordance with paragraph 2.a., above. Soils having a liquid limit (LL) greater than 50 and a plasticity index (PI) greater than 25 will require testing (consolidation swell) to determine the swell characteristics. When the results of the swell test indicate high swell potential, special considerations such as over excavation (width and depth) and replacement with nonexpansive fill, under-trench drainage system, or other methods of minimizing differential heave will be provided. The design of special features such as described above will be in accordance with instructions provided by the geotechnical engineer who performed the detailed site classification survey. Design of joint spacing and joint details to accommodate movements will be provided when required.

3. SETTLEMENT OF TRENCHES: Generally, settlement of concrete trenches will not be a problem since the unit load of the trench system will be similar to the existing unit overburden load. Backfill adjacent to the concrete trench must be compacted to prevent settlement which would create ponding. Positive slopes away from the concrete trench are required. Special care of backfill and compaction will be required where the system crosses existing streets to preclude settlement and cracking of the roadway adjacent to the trench from repeated traffic loads.

4. LOAD-BEARING QUALITIES: The soil in which the system will be installed should be investigated by an experienced geotechnical engineer responsible for other soils engineering work, and the location and nature of potential soils problems should be identified. Depending on the nature of the problem, the designer may choose to reroute the line, use a combination of concrete trench or aboveground low-profile systems, or elect to over-excavate and replace with nonexpansive fill.

5. CONCRETE TRENCH DESIGN: The concrete trench design will consist of poured concrete sides and floor with removable tops. Portions of the floor may be omitted at locations specified under course grained soils with water table 600 mm 2 feet or more below lowest point of water entry.

The depth of the concrete trench will be sufficient to provide adequate protection to the piping system and the floor of the trench must be sloped to provide adequate internal drainage, but in all cases will not be less than 150 mm 6 inches from the bottom surface of the suspended pipe insulation to the floor of the trench. There will also be a minimum of 75 mm 3 inches between the surface of the

pipe insulation and the adjoining trench walls, and a minimum of 100 mm 4 inches between surfaces of adjacent pipe insulation.

For those instances where natural drainage cannot be provided (storm water drainage system at least 600 mm 2 feet below trench bottom at all times), a dual sump pump will be provided with failure annunciator. This signal will be tied-in to the EMCS system, if any.

The tops of the concrete trenches will serve as sidewalks, if practical, and will be removable by use of a forklift or backhoe. Earth must not cover the tops. Covers will be close tolerance fit with a maximum gap tolerance build up of 3 mm 1/8 inch from all causes.

The pipes will be supported within the trenches by pipe supports fastened to the walls. In no case will they be supported from either the floor of the trench or from the removable top. All noninsulated ferrous parts of the piping, piping support system, or equipment will be hot-dipped galvanized. The pipe hanger design must provide for adequate system expansion and contraction.

Use minimum of 25 mm 1 inch pipe size for piping in trench system with all joints welded. Smaller pipe sizes and screwed joints are allowable in valve manholes.

Provide the following information on the contract drawings for the concrete Trench System, as applicable: (1) dimension on all runs of pipe; (2) pipe support spacings; (3) pipe support spacing at changes in direction and changes in elevation (MSS SP-58 is not applicable); (4) elevations of the pipe along the systems path; (5) sizes of the pipe; (6) location of all valve manholes; (7) location and details of all expansion loops, Z-and L-bends; (8) location of pipe anchors; (9) how changes in pipe direction are made; (10) thickness of the insulation on the pipe; (11) concrete trench details; (12) final elevations of concrete trench; (13) profile of trench showing all existing utilities; (14) valve manhole dimensions; (15) valve manhole cover details, including manway access details; (16) how valve manholes are drained and vented; (17) sump pump piping details; (18) sump pump capacity; (19) locations of inspection ports; (20) include specific requirements for modification to existing and new electrical wiring, devices, or equipment (dedicated service for sump pump); (21) steam drip trap locations with access and capacities; (22) system pipe vent locations with access details; (23) steam main drip leg sizes; and (24) other pertinent information and details required to clearly show the intent of the Concrete Trench Heat Distribution

System. Also, indicate any obstructions in the path of the distribution system that the Contractor may have to work around.

Provide and edit for the project all other guide specifications as applicable to the trench design, and include and edit for the project the following Sections: 31 00 00 EARTHWORK; 32 12 13 BITUMINOUS TACK AND PRIME COATS; 33 63 23 EXTERIOR ABOVEGROUND STEAM DISTRIBUTION; 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION; 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION; 03 30 00 CAST-IN-PLACE CONCRETE; 05 05 23.16 STRUCTURAL WELDING; 07 13 53 ELASTOMERIC SHEET WATERPROOFING; 08 31 00 ACCESS DOORS AND PANELS; 09 90 00 PAINTS AND COATINGS; 40 05 13.96 WELDING PROCESS PIPING; 26 20 00 INTERIOR DISTRIBUTION SYSTEM; and others as applicable to the project.

****

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings

	NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B650	(1995; R 2023) Standard Specification for Electrodeposited Engineering Chromium Coatings on Ferrous Substrates

ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM F1139	(1988; R 2024) Steam Traps and Drains

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-45	(2020) Bypass and Drain Connections
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Heat Distribution System

SD-03 Product Data

Spare Parts

Support of the Equipment

SD-04 Samples

Insulation

SD-05 Design Data

Expansion Loop Insulation Method; G, [_____]

SD-06 Test Reports

Tests

SD-07 Certificates

Flange Gasket Kits

SD-10 Operation and Maintenance Data

Maintenance; G, [_____]

1.3 DELIVERY, STORAGE, AND HANDLING

Store all materials and equipment delivered and placed in storage with protection from the weather; excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.4 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than the start of the field tests. Include in the data a complete list of parts and supplies and source of supply.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

Equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.1.2 Nameplates

Ensure each major item of equipment such as sump pumps, motors, steam traps, and pressure reducing valves is provided with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.3 Asbestos Prohibition

Asbestos and asbestos-containing products are not allowed.

2.1.4 Electrical Work

Provide motors, manual or automatic motor control equipment, and protective or signal devices required for the operation specified under this section in accordance with NFPA 70 and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.2 PIPING AND FITTINGS

Unless otherwise specified, provide all pipe, fittings, valves, and piping accessories conforming to the requirements of ASME B31.1, and be the proper type, class, and grade for pressure and temperature of the heating medium.

2.2.1 Steel Pipe

Provide steel pipe 50 mm 2 inches in diameter and larger that are seamless or electric-resistance welded conforming to ASTM A53/A53M, Grade B, Type E or S; or to ASTM A106/A106M, Grade B. Provide steel pipe 40 mm 1-1/2 inches in diameter and smaller that are seamless conforming to ASTM A106/A106M, Grade B. Provide condensate piping, gauge piping, and piping 19 mm 0.75 inch in diameter and smaller that are extra strong. Provide all other pipe that are standard weight.

2.2.1.1 Nipples

Provide nipples conforming to ASTM A733 as required to match adjacent piping.

2.2.1.2 Steel Flanges

****

NOTE: Use not less than Class 150 for steam up to 862 kPa 125 psig, not less than Class 300 for steam 863 to 1724 kPa 126 to 250 psig, and for high temperature hot water.

****

Provide steel flanges conforming to ASME B16.5 Class [150] [and] [or] [300] and matching valves or flanged fittings on which used. Ensure flanges have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.2.1.3 Pipe Threads

Provide pipe threads conforming to ASME B1.20.2M ASME B1.20.1. Pipe threads may be used only on pipe 19 mm 0.75 inch or smaller.

2.2.2 Fittings

Provide fittings, valves, flanges and unions that have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.2.2.1 Welded Fittings

Provide welded fittings conforming to ASTM A234/A234M, buttwelded or socket welded, standard weight or extra strong, as required to match connecting piping. Provide buttwelded fittings conforming to ASME B16.9, and socket welded fittings conforming to ASME B16.11.

2.2.2.2 Malleable Iron Fittings

Provide fittings conforming to ASME B16.3, ASTM A47/A47M, class as required to match connecting piping.

2.2.2.3 Unions

Provide unions conforming to ASME B16.39 as required to match adjacent piping.

2.2.3 Insulating Flanges and Dielectric Waterways

****

NOTE: Where dissimilar metals are to be joined, or when connecting to cathodically protected systems, electrically insulating flanges or dielectric waterways will be provided.

For flanges, use not less than Class 150 for up to 862 kPa 125 psig steam, not less than Class 300 for 863 to 1724 kPa 126 to 250 psig steam, and for high temperature hot water. Gaskets must have the following characteristics: (1) Impermeability with respect to the fluid/gas contained by the system; (2) Chemical stability with respect to the fluid/gas contained by the system; (3) Sufficient deformability so as to flow into the imperfections on the seating surfaces and provide intimate contact between the gasket and these surfaces; (4) Thermal stability with respect to the fluid/gas contained by the system; (5) Sufficient resiliency so as to support an adequate portion of the applied load when joint movements are not completely eliminated by the system design; (6) Sufficient strength to resist crushing under the applied load and blow-out under the system pressure; (7) Contain no products that could contaminate the fluid/gas contained by the system; (8) Contain no products that could cause corrosion of the seating surfaces; (9) Able to maintain integrity during handling and installation; (10) Able to be readily removed at the time of replacement; (11) Must have a sufficiently high dielectric strength; (12) Gaskets containing metallic graphite or wire cannot be used for this application; and (13) Must not contain asbestos.

****

Submit certificate from the material supplier of the electrically insulating flange gasket kits stating that the supplied material meets specified requirements and that provides evidence that satisfactory operating requirements have been met, before the materials are delivered. Certificate must be signed by an official authorized to certify in behalf of material supplier or product manufacturer and must identify quantity and date or dates of shipment or delivery to which the certificates apply. Install insulating flanges or flange gasket kits at every pipe connection from the trench system to an underground system and at dissimilar metals. Provide a kit consisting of a flange gasket, bolt sleeves, and one insulating washer and one steel washer for both ends of each bolt. Ensure the gasket kits are capable of electrically isolating the pipe at the pressure and temperature of the heating medium at the point of application. Material of the type being used must have been installed in an installation which has been satisfactorily operating for not less than 2 years. Ensure that these kits are provided and properly installed according to manufacturer published instructions as indicated. Provide dielectric waterways with temperature and pressure rating equal to or greater than that specified for the connecting piping used for joining dissimilar metals, 19 mm 0.75 inch and smaller threaded pipe. Ensure waterways have metal connections on both ends suited to match connecting piping. Provide dielectric waterways internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Ensure dielectric flanges meet the performance requirements described herein for dielectric waterways.

2.3 VALVES

****

NOTE: Select the appropriate valves for the operating temperatures and pressures of all systems in the project. Delete valve types not included in project.

Use not less than Class 150 for up to 862 kPa 125 psig steam, not less than Class 300 for 863 to 1724 kPa 126 to 250 psig steam, and for high temperature hot water. For isolation and shutoff, use gate valves only. Steam pressure reducing valves are not normally part of the system. If needed, designer should refer to Section 23 52 30.01 10 CENTRAL COAL-FIRED STEAM-GENERATING SYSTEM.

****

Unless otherwise specified, provide valves that comply with the material, fabrication, and operating requirements of ASME B31.1. Provide valves suitable for the temperature and pressure requirements of the system on which used. Provide valves for [steam] [hot water] conforming to ASME B31.1 Class [150] [and] [or] [300], as suitable for the application. [Provide valves for condensate services conforming to ASME B31.1 Class 150.] Provide valves 150 mm 6 inches and larger with a 25 mm 1 inch minimum gate or globe [integral] bypass valve sized in conformance with MSS SP-45. Provide valves that have the manufacturer's trademark.

2.3.1 Steel Valves

Provide globe, gate, angle, and check valves conforming to the requirements of ASME B16.34 and ASME B31.1 for the temperature and pressure requirements of the system. Provide gate valves 65 mm 2-1/2 inches and smaller with a rising stem. Provide gate valves 80 mm 3 inches and larger with an outside screw and yoke.

2.3.2 Bronze Valves

2.3.2.1 Globe, Gate, and Angle Valves

Provide globe, gate, and angle valves conforming to requirements of MSS SP-80.

2.3.2.2 Check Valves

Provide check valves conforming to the requirements of MSS SP-80.

2.3.3 Packing

Provide valves with packing that does not contain asbestos. Provide valve stem packing that is die-formed, ring type specifically designated as suitable for the temperature and pressure of the service and compatible with the fluid in the system. Provide packing rings that are polytetrafluoroethylene with minimum 50 percent graphite filament top and bottom rings. Provide valves 40 mm 1-1/2 inches and smaller that have four or five packing rings. Provide valves 50 mm 2 inches and larger with at least six packing rings. Spiral or continuous packing will not be acceptable. Provide a metal insert having proper clearance around the valve stem at the bottom of the stuffing box and acting as a base for the packing material. Provide packing glands furnished with a liner of noncorrosive material and one piece construction with provisions for not less than two bolts for packing adjustment.

2.4 STEAM TRAPS

****

NOTE: The following paragraphs are applicable to steam systems only. Only these two types will be used. A schedule of steam trap selections will be shown on the drawings.

Trap capacity (kg per hour (pounds per hour during normal operation), pressure drop kPa psi, and pressure rating kPa psi of each trap will be included in this schedule. Show on drawings a vent valve or test valve connection downstream of traps for test of trap operation, a strainer ahead of trap, a check valve in outlet piping, and shut-off valves on both sides of trap for trap changeout. A means of bypassing the trap must be provided for system warm-up.

****

Provide class of trap bodies suitable for a working pressure of not less than 1.5 times the steam supply pressure, but not less than 1.38 MPa 200 psi, and traps capable of operation under a steam-supply pressure as indicated with trap capacities as shown when operating under the specified working conditions. Provide traps that fail open.

2.4.1 Bucket Traps

Provide inverted-bucket type bucket traps with automatic air discharge conforming to ASTM F1139.

2.4.2 Thermostatic Traps

****

NOTE: Specify thermostatic traps where the trap location is subject to freezing. Style B traps are bimetallic element traps.

****

Provide thermostatic type thermostatic traps with bimetallic element automatic air discharge conforming to ASTM F1139.

2.5 STRAINERS

****

NOTE: Delete for high temperature water systems.

****

Provide basket or Y-type strainers with connections the same size as the pipe lines in which the connections are installed. Provide heavy and durable strainer bodies of cast steel with bottoms drilled and plugged suitable for service temperatures and pressures utilized with arrows clearly cast on the sides to indicate the direction of flow. Each strainer is equipped with an easily removable cover and sediment basket with the body or bottom opening equipped with nipple and gate valve for blowdown. Provide 0.6350 mm 0.025 inch thick stainless steel, Monel or sheet brass strainer basket with small perforations of sufficient number to provide a net free area at least 2.5 times the area of the entering pipe. Provide cast steel bodies and stainless or Monel baskets for high temperature hot water systems.

2.6 PRESSURE GAUGES

****

NOTE: Delete if not required.

****

Provide pressure gauges conforming to ASME B40.100 with a minimum dial size of 110 mm 4-1/4 inches, a throttling type needle valve or a pulsation dampener, and shut-off valve.

2.7 THERMOMETERS

****

NOTE: Delete if not required.

****

Do not provide thermometers containing mercury.

2.7.1 Liquid in Glass

Provide liquid in glass type thermometer with well and separable corrosion-resistant steel socket. Provide thermometer on insulated pipe with an insulation stand-off provision. Provide thermometer with minimum scale length of 178 mm 7 inches.

2.7.2 Dial

Provide a dial type thermometer with a dial size of 90 mm 3.5 inches in diameter with stainless steel case, remote-type bulb or direct-type bulb as applicable, with an accuracy of plus or minus 1 degree C 2 degrees F and white face with black digits graduated in 1 degree C 2 degrees F increments.Provide thermometer wells of the separable socket type for each thermometer with direct-type bulb.

2.8 INSULATION AND JACKETING

2.8.1 Insulation for Piping in Concrete Trenches

Provide molded calcium silicate insulation for all piping, fittings, and valves conforming to ASTM C533, Type I, or molded mineral fiber insulation conforming to ASTM C547, Class 2, or cellular glass insulation conforming to ASTM C552. Provide factory or field applied insulation. Other than FOAMGLAS, do not use laminated construction in thicknesses less than 102 mm 4 inches. Provide insulation on piping in concrete trenches covered with aluminum or nonmetallic jacket.

2.8.2 Aluminum Jacket

Provide smooth sheet jacket, 0.4064 mm 0.016 inch nominal thickness;

ASTM B209M ASTM B209, Type 3003, 3105, or 5005. Use aluminum jacket over calcium silicate insulation.

2.8.3 Nonmetallic Jacket

Provide nonmetallic jacket consisting of a 203 grams/square meter 6 ounces per square yard fiberglass fabric impregnated with chlorosulfanated polyethylene (Hypalon) and a 0.038 mm 1.5 mils polyvinyl fluoride film (Tedlar) bonded to it. Ensure overall thickness of the composite is 0.254 mm 0.010 inch and weigh approximately 356 grams/square meter 10.5 ounces per square yard. Jacket may be either field or factory applied to the insulation. Do not use the jacket with any calcium silicate insulation. Use nonmetallic jacket with molded mineral fiber insulation.

2.8.4 Bands

Provide bands for aluminum jackets that are 10 mm .38 inch wide and 0.8128 mm 32 gauge thickness made of aluminum or annealed stainless steel. Provide bands for insulation that are 13 mm 0.5 inch wide and 0.8128 mm 32 gauge thickness made of annealed stainless steel.

2.8.5 Insulation for Flanges, Unions, Valves, and Fittings

Provide flanges, unions, valves, and fittings insulated with premolded prefabricated, or field fabricated segments of removable and reusable insulation of the same material and thickness as the manhole pipe insulation with the same thermal characteristics and thickness as the adjoining piping.

2.9 CONCRETE WORK

****

NOTE: Specify concrete work in detail in Section 03 30 00 CAST-IN-PLACE CONCRETE. Specify precast concrete work in detail in SECTION 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. Use applicable requirements of, and edit the above guide specifications and include all specific requirements pertinent to local conditions.

****

2.9.1 Concrete

2.9.1.1 Cast-in-Place Concrete

Provide as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.9.1.2 Precast Concrete Products

Provide as specified in [Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION][Section 03 41 16.08 PRECAST CONCRETE SLABS (MAX. SPAN 8 FEET O.C.)].

2.9.2 Concrete Joint Sealants

Provide concrete joint sealants conforming to ASTM C920, Type M (multicomponent), Class 25, grade NS (nonsag) for vertical surfaces or grade P (pourable self-leveling).

2.9.3 Gasket Material

Provide gasket material used between concrete trench covers and trench wall tops that is 6 mm 0.25 inch thick neoprene pad with a minimum width of 50 mm 2 inches conforming to ASTM D1056.

2.9.4 Concrete Expansion Joints, Contraction Joints, and Waterstops

Provide concrete expansion joints, contraction joints, and waterstops as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.10 BITUMINOUS PAVING

****

NOTE: Delete if not required or if roads are constructed after tunnel crossings.

****

Provice bituminous course and tack coat used at street crossings as specified in Section 32 12 16.16 ROAD-MIX ASPHALT PAVING and Section 32 12 13 BITUMINOUS TACK AND PRIME COATS.

2.11 MISCELLANEOUS METAL

****

NOTE: Include miscellaneous metals located in trenches or valve manholes in Section 08 31 00 ACCESS DOORS AND PANELS.

****

Provide miscellaneous metal not otherwise specified conforming to Section 08 31 00 ACCESS DOORS AND PANELS. Provide miscellaneous metal bolted together, shop welded, or assembled in the field, and pipe supports including structural cross support members and anchors that is hot-dip galvanized in accordance with Section 08 31 00 ACCESS DOORS AND PANELS.

2.12 INSPECTION PORTS AND ACCESS COVERS

Provide inspection ports and access covers in concrete tops that are standard cast iron frame and cover. Provide inspection ports that are 300 mm 12 inch nominal diameter and access covers that are 600 mm 24 inch nominal diameter unless otherwise indicated.

****

NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the planning phase of the piping layout prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location. The following requirements tailored as EXPANSION

JOINTS must be included in this specification section.
****

2.13 BELLOWS TYPE JOINTS

Select bellows type or slip-type to satisfy specific design conditions. Provide joints that are flexible, guided expansion joints. Ensure the expansion element is stainless steel. Provide bellows type expansion joints that are in accordance with the applicable requirements of EJMA Stds and ASME B31.1 with internal liners.

2.14 EXPANSION JOINTS

Provide expansion joints for either single or double slip of connected pipes, as required or indicated, and for not less than the traverse indicated. Provide joints designed for hot water working pressure and are in accordance with applicable requirements of EJMA Stds and ASME B31.1. Provide joints designed for packing injection under full line pressure. Provide end connections flanged or beveled for welding as indicated. Provide joints with anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip must be seamless steel plated with a minimum of 0.0508 mm 2 mils of hard chrome in accordance with ASTM B650. Provide joint components fabricated from material equivalent to that of the pipeline. Ensure initial setting are made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Install pipe alignment guides as recommended by the joint manufacturer, but in any case not be more than 1.5 m 5 feet from expansion joint except for lines 100 mm 4 inches or smaller; guides must be installed not more than 600 mm 2 feet from the joint. Provide service outlets where indicated.

2.15 FLEXIBLE BALL JOINTS

Provide flexible ball joints constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint must be designed for packing injection under full line pressure to contain leakage. Provide joint ends threaded to 50 mm 2 inches only, grooved, flanged or beveled for welding as indicated or required, and be capable of absorbing a minimum of 15 degrees angular flex and 360 degrees rotation. Provide balls and sockets of equivalent material as the adjoining pipeline. Exterior spherical surface of carbon steel balls must be plated with 0.0508 mm 2 mils of hard chrome in accordance with ASTM B650. Provide ball type joints designed and constructed in accordance with ASME B31.1 and ASME BPVC SEC VIII D1, where applicable. Provide flanges conforming to ASME B16.5. Provide gaskets and compression seals compatible with the service intended.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 SITEWORK

3.2.1 Excavation, Trenching, and Backfilling

Provide excavation, trenching, and backfilling of concrete trench systems, [and relocation of interferences and modifications to existing facilities] in accordance with Section 31 00 00 EARTHWORK.

3.2.2 Removal, Replacement, or Relocation of Interferences

Remove, replace, or relocate interferences indicated or found during construction. Removal, replacement, or relocation must be as shown, or as approved by the Contracting Officer. Examples of interferences include:

a. Storm and sanitary sewers and manholes.

b. Water lines, gas lines, fire hydrants, and lawn sprinkler systems.

c. Power and communication lines, conduits, poles, and guys.

d. Fences, sidewalks, and signs.

e. Grass, shrubs, trees, and rocks.

3.2.3 Modifications to Existing Facilities

Modifications to existing facilities must be made as indicated. Examples of modifications include:

a. Removal and replacement of street or parking area pavements.

b. Removal and replacement of curbs, gutters, and sidewalks.

c. Reconstruction of existing valve manholes.

d. New heat distribution piping entrances to buildings, valve manholes, or trenches.

3.2.4 Electric Work

Provide any wiring required for the operation of the equipment specified, but not shown on the electrical drawings, in this section in accordance with Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION, and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.5 Painting

Clean the heat affected zone of field welded galvanized surfaces and other galvanized surfaces damaged during installation in compliance with SSPC SP 10/NACE No. 2 and painted in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.3 PIPING

3.3.1 General Piping Requirements

****

NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other

method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the planning phase of the piping layout prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location. EXPANSION JOINTS tailoring requirements must be included in this specification section.

****

Accurately cut pipe to measurements established at the site and worked into place without springing or forcing. Ensure pipe is clear of all openings and equipment. Excessive cutting or other weakening of structural members to facilitate piping installation will not be permitted. Remove burrs from ends of pipe by reaming. Ensure installation permits free expansion and contraction without damage to joints or hangers. Install piping in accordance with ASME B31.1. Weld joints for piping in concrete trenches [, except joints at traps, strainers, and at valves 19 mm 0.75 inch and smaller in steam, condensate, and drip lines, which may use unions or may be threaded]. Do not attach supports, anchors, or stays where either expansion or the weight of the pipe will cause damage to permanent construction. Provide noninsulated ferrous parts of the piping, piping support system, or equipment that are hot-dip galvanized after fabrication in conformance with ASTM A123/A123M.

a. Ensure expansion of piping provide for by changes in the direction of the run of pipe or by expansion loops as shown.

b. Changes in direction may be made by bending the pipe, provided that a hydraulic pipe bender is used. Pipe to be bent must be steel conforming to ASTM A53/A53M or ASTM A106/A106M type and grade for bending, and class required to match adjoining pipe. Bent pipe showing kinks, wrinkles, or malformations will not be acceptable.

c. Pitch all piping, unless otherwise indicated, with a grade of not less than 25 mm in 6 m 1 inch in 20 feet toward drain points with slope maintained throughout the system, including through each leg of each expansion loop.

d. Properly cap or plug open ends of pipe lines and equipment during installation to keep dirt and other foreign matter out of the system.

3.3.2 Welded Joints

Weld joints between sections of pipe and between pipe and fittings in accordance to the requirements specified in paragraph WELDING. Branch connections may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings where used, must be forged and must be no larger than two nominal pipe sizes smaller than the main run. Branch outlet fittings must be flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.

3.3.3 Flanged and Threaded Joints

****

NOTE: Flanged joints will be permitted for dielectric isolation only.

****

3.3.3.1 Flanged Joints

Provide true faced joints with gaskets, square and tight. Provide electrically isolated flange joints at all connections to building underground systems and between dissimilar metals.

3.3.3.2 Threaded Joints

Provide joints with graphite or inert filler and oil, graphite compound, or polytetrafluoroethylene tape applied to the male threads only. Provide dielectric unions at connections of dissimilar metals in 19 mm 0.75 inch and smaller piping.

3.3.4 Reducing Fittings

3.3.4.1 Horizontal Water Heating Lines

In horizontal hot water heating lines, provide eccentric type reducing fittings to maintain the tops of adjoining pipes at the same level.

3.3.4.2 Horizontal Steam Lines

In horizontal steam lines, provide eccentric type reducing fittings to maintain the bottom of adjoining pipes at the same level.

3.3.5 Branch Connections

Ensure branches from mains branch off top of mains as indicated or as approved. Ensure connections allow unrestricted circulation, elimination of air pockets, and permit the complete drainage of the system.

3.3.6 Pipe Supports Exposed in Concrete Trenches

Securely support horizontal and vertical runs of pipe in concrete trenches . Provide adjustable pipe hangers having bolted hinged loops and turnbuckles or by other approved devices as shown on the drawings, and all conforming to MSS SP-58 for suspended pipe. Chain or flat steel strap hangers or single point supports will not be acceptable. Provide all pipe supports including the structural cross support member in accordance with Section 08 31 00 ACCESS DOORS AND PANELS.

3.4 WELDING

Perform welding and radiographic examination of all steel carrier pipe welds in accordance with Section 40 05 13.96 WELDING PROCESS PIPING. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

3.5 RADIOGRAPHIC TESTING

Submit detail drawings for steam traps, valves, sump pumps, pressure gauges, thermometers and insulation, including a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Show on the drawings complete wiring and schematic diagrams, pipe stress calculations for any revised expansion loops, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show on the drawings proposed system layout, provisions for expansion, pipe anchors and guides, and layout and anchorage of equipment and appurtenances in valve manholes, and equipment relationship to other parts of the work including clearances for maintenance and operation.

a. Provide radiographic examination of all field welds in the steel carrier piping of the heat distribution system in accordance with ASME B31.1 performed as specified in Section 40 05 13.96 WELDING PROCESS PIPING. Provide an approved independent testing firm or firms regularly engaged in radiographic testing to perform a radiographic examination of all field welds in accordance with ASME B31.1.

b. Furnish a set of films showing each weld inspected, a reading report evaluating the quality of each weld, and a location plan showing the physical location where each weld is to be found in the completed project, prior to backfilling and hydrostatic testing. Provide a report that is reviewed and interpreted by a Certified Level III Radiographer employed by the testing firm with signature of reviewer/interpreter on the report readings for all radiographs.

c. The Contracting Officer reserves the right to review all inspection records, and if any welds inspected are found unacceptable they will be removed, rewelded, and radiographically examined at no cost to the Government.

3.6 INSULATION

Submit display sample sections for insulation of pipe, elbow, tee, valve, support point, and terminating points. After approval of material and prior to insulation of piping, prepare a display of insulated sections showing compliance with specifications, including fastening, sealing, jacketing, straps, waterproofing, supports, hangers, anchors, and saddles. Keep sample sections on display at the jobsite during the construction period until no longer needed. Install insulation so that it is not damaged by pipe expansion or contraction. Groove insulation installed over welds to assure a snug fit. Hold insulation in place with stainless steel straps. Install a minimum of 2 bands on each individual length of insulation with maximum spacing not exceeding 450 mm 18 inch centers. Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate on each test report the final position of controls and valves.

3.6.1 Installation

Install material in accordance with published installation instructions of the manufacturer. Apply insulation materials only after piping tests are satisfied completed.

3.6.1.1 Preparation

Prior to application, thoroughly clean surfaces of moisture, grease, dirt, rust, and scale, and paint where required.

3.6.1.2 Thickness

****

NOTE: Delete inapplicable columns in Tables 1 and 2.

****

Provide the minimum thickness of insulation for [the heat distribution system] [and] [condensate return system] [each section of pipe] in accordance with Tables 1 and 2.

TABLE 1
Minimum Pipe Insulation Thickness (mm) (inches)

For steam up to 1.10 MPa to 1.72 MPa 16 psig to 250 psig and high temperature hot water supply and return piping up to 232 degrees C 450 degrees F

Nominal Pipe Diameter (mm) (inches)	Insulation Thermal Conductivity (k)		
	k less than 0.29	k from 0.29 to 0.40	k greater than 0.40
25 1.0	50 2.0	63 2.5	100 4.0
40 1.5	50 2.0	63 2.5	100 4.0
50 2.0	63 2.5	85 3.5	110 4.5
65 2.5	63 2.5	85 3.5	110 4.5
80 3.0	75 3.0	100 4.0	125 5.0
100 4.0	75 3.0	100 4.0	125 5.0
125 5.0	75 3.0	100 4.0	125 5.0
150 6.0	85 3.5	110 4.5	135 5.5
200 8.0	85 3.5	110 4.5	135 5.5
250 10.0	100 4.0	125 5.0	150 6.0
300 12.0	100 4.0	125 5.0	150 6.0
350 14.0	100 4.0	125 5.0	150 6.0
400 16.0	100 4.0	125 5.0	150 6.0
450 18.0	100 4.0	125 5.0	150 6.0

NOTE: Insulation thermal conductivity (k-value) is in units of watt per meter-degree K at 93 degrees C Btu-inches/hour-square-feet-degrees F at 200 degrees F mean temperature.

TABLE 2 Minimum Pipe Insulation Thickness (mm) (inches)			
For Low Pressure Steam (less than 110 kPa (gage) 16 psig), Condensate Return and Low Temperature Hot Water (less than 121 degrees C 250 degrees F) supply and return piping.			
Nominal Pipe Diameter (mm) (inches)	Insulation Thermal Conductivity (k)		
	k less than 0.29	k from 0.29 to 0.40	k greater than 0.40
25 1.0	35 1.5	50 2.0	75 3.0
40 1.5	35 1.5	50 2.0	75 3.0
50 2.0	35 1.5	50 2.0	75 3.0
65 2.5	35 1.5	50 2.0	75 3.0
80 3.0	50 2.0	63 2.5	85 3.5
100 4.0	50 2.0	63 2.5	85 3.5
125 5.0	50 2.0	63 2.5	85 3.5
150 6.0	63 2.5	75 3.0	110 4.5
200 8.0	63 2.5	75 3.0	110 4.5
250 10.0	75 3.0	100 4.0	125 5.0
300 12.0	75 3.0	100 4.0	125 5.0
350 14.0	75 3.0	100 4.0	125 5.0
400 16.0	75 3.0	100 4.0	125 5.0
450 18.0	75 3.0	100 4.0	125 5.0
NOTE: Insulation thermal conductivity (k-value) is in units of watt per meter-degree K at 93 degrees C Btu-inches/hour-square-feet-degrees F at 200 degrees F mean temperature.			

3.6.2 Insulation on Pipes Passing Through Sleeves

Install insulation continuously through sleeves. Provide aluminum jackets over the insulation. When penetrating building walls, extend aluminum jackets not less than 50 mm 2 inches beyond the sleeve on each side of the wall and be secured with an aluminum band on each side of the wall. Where flashing is provided, secure the jacket with one band not more than 25 mm 1 inch from the end of the jacket.

3.6.3 Covering of Insulation in Concrete Trenches

Provide aluminum jackets for pipe insulation, flanges, valves, and fittings.

3.7 CONCRETE TRENCH SYSTEM

****
NOTE: Provide details on plan/profile drawings showing concrete trench size, profile of existing grade, grading and drainage problems along trench route, elevations of trench floor and piping, and thickness of trench concrete cover.
****

Provide and install a concrete cast-in-place trench system with a removable top as shown on the drawings.

3.7.1 Concrete

****
NOTE: Concrete work will be specified in detail in Section 03 30 00 CAST-IN-PLACE CONCRETE, edit the spec and include all specific requirements pertinent to local conditions and designers General Notes.
****

Provide materials and methods for mixing and placing of concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.7.2 Joint Sealants

Seal concrete joints as indicated. Provide type II sealant (non-sagging) for vertical joints. Provide type I sealant for trench top butt joints. For all other joints, seal with Type I or Type II sealant. Provice trench bottom sealant finish flush with floor.

3.7.3 Concrete Trench Tops

****
NOTE: Tops must be square and not out of plane, and must be cast to lay flat in all directions. Provide notes on drawings.
****

Provide precast or cast-in-place concrete trench tops. Provide concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Ensure tops are flat and true and lay flat at all locations where contact on trench wall is to be made. Tolerances must be true planes within 4 mm in 3 m 0.012 inch in 8 feet as determined by 2.44 m 8 foot straight edge placed diagonally on top. Deviation from square or designated skew (difference in length of the two diagonal measurements) must be 3 mm in 2 m 0.012 inch in 6 feet or 6 mm 0.25 inch total, whichever is greater. Maximum permissible warpage of one corner out of the plane of the other three must be 5 mm per meter 0.06 inch per foot distance from the nearest adjacent corner. Do not install concrete trench tops with defects which affect the strength of the cover unit, or which are warped, honeycombed, contain visible air pockets, exposed aggregate, or other surface defects such as spalled, chipped, or broken edges, . Place neoprene gasket material on the top of concrete trench walls so as to provide a seal between the wall and the concrete trench covers. Surfaces of joints to be in contact with gasket material must be dry and free of oil, grease, dirt, loose concrete particles, or other foreign substances. Place gasket material in a continuous length along the wall as much as practical. Butt gasket ends tightly together at splices. Construct concrete trench tops in maximum lengths of 2.4 m 8 feet and minimum lengths of 1.2 m 4 feet and must be a minimum of 100 mm 4 inches thick, unless otherwise indicated. Provide each top section with means to accept a lifting device for removal of slab, as indicated on the drawings.

3.7.4 Concrete Trench Construction

****

NOTE: Provide details on the drawings of the concrete trenches and concrete walks. Provide details of the various trench sizes for the different sizes of heat distribution piping anticipated for this contract.

Where concrete trench tops are used in conjunction with sidewalks, provide sidewalk sections on the drawings between loop legs to maintain a continuous sidewalk.

****

Ensure inside edge and top of walls has smooth and even surfaces to accommodate trench tops.

3.7.5 Final Elevations

Slope the concrete trench floor continuously and drain toward valve manholes. Construct the concrete trench at the elevation shown on the drawings and grade the adjacent areas. Grade any cut or fill areas adjacent to the concrete trench back to the existing grade at a 1 to 10 slope, or as indicated. Take care to avoid forming pockets adjacent to the concrete trench; thereby, preventing surface drainage. Install the concrete trench floor and pipe parallel and maintain constant slope toward the drain points indicated.

3.7.6 Coordination with Existing Utilities

Before beginning work in a given area, all utility information must be field verified by surface markings made by the affected utility Owner's Representative. Notify the Contracting Officer in advance, and receive prior approval before excavating in any areas. The actual concrete trench routing may be offset or changed if approved by the Contracting Officer in order to reduce conflicts, interruptions, expedite the work, or for any other reason to the mutual benefit of the Contractor and the Government. Utility conflicts may be cast into the floor of the trench providing they do not interfere with concrete trench drainage and are approved by the Contracting Officer. [After the new heat distribution system is cut-in, the existing system can be [removed.] [abandoned in place if not in conflict with the new construction and not shown to be removed on the drawings.]]

3.7.7 Piping Support System

****

NOTE: Provide design details of pipe supports on drawings. Show sizes, shapes and means of how the system is to function. Supports may consist of welded plates, channels, structural tees, pipes or other support means.

****

Do not install pipes, pipe supports, or other related items on the floor of the concrete trench system. Pipe support members spanning traversely across the tunnel must allow a minimum of 100 mm 4 inches clearance between structural member and concrete trench floor. Additional minimum clearances required from the pipe insulation surface must be as follows: 200 mm 8 inches to concrete trench floor, 150 mm 6 inches to side walls, 150 mm 6 inches to trench cover, and 150 mm 6 inches between adjoining pipes.

3.7.8 Pipe Expansion

****

NOTE: Coordinate this paragraph with the specified requirements in paragraph General Piping Requirements.

****

Expansion must be accommodated by loops and bends as indicated on the drawings and specified. Pipe in the loops and bends must accommodate expansion while maintaining required insulation clearance from floors, walls, tops, and other pipes to avoid crushing or breaking of insulation. Expansion loops may be designed around obstacles such as utility manholes, structures, or trees to avoid construction conflicts. Maintain slopes of pipe and trench bottoms Contractor must have the option to adjust the loop dimensions around obstacles based on final field measurements, if approved by the Contracting Officer. Submit pipe stress calculations for each revised expansion loop or bend based on the final actual measured lengths, or must submit dimensions to the Contracting Officer for verification of loop and bend sizes before proceeding with that segment of work. Ensure allowable pipe stresses are in accordance with ASME B31.1. Submit final expansion loop insulation method for approval to the Contracting Officer.

3.7.9 Concrete Trench Inspection Ports

****

NOTE: Show inspection ports on plan view and detail them on the drawings.

Provide inspection ports at appropriate locations to enable the user to observe elbows in expansion loops and bends, at high point pipe vents, approximately every 30 m (100 feet) of straight run, and at locations requiring frequent (monthly) observation.

****

3.7.10 Road/Drive Crossings

Install handicap ramp style curb cuts at all street and drive crossings as indicated.

3.7.11 Railroad Crossings

****

NOTE: Review railroad track removal/replacement with respective authority and coordinate all activities.

****

Restore tracks to their original condition as approved by the Contracting Officer after construction is complete.

3.8 TESTS

Conduct tests before, during, and after the installation of the system. Provide all instruments, equipment, facilities, and labor required to properly conduct the tests. Test pressure gauges for a specific test must be approved by the Contracting Officer and must have dials indicating not less than 1.5 times, nor more than 3 times the test pressure.

3.8.1 Cleaning of Piping

Prior to the hydrostatic and operating tests, flush the interior of the piping with clean water until the piping is free of all foreign materials. Flushing and cleaning out of system pipe, equipment, and components must not be considered completed until witnessed and accepted by the Contracting Officer. After flushing the system is completed, drain and fill the system with clean water. Provide temporary bypasses or temporary strainers around equipment and control valves to prevent clogging.

3.8.2 Field Tests

Conduct the following field tests when applicable to the system involved. If any failures occur, ensure adjustments or replacements as directed by the Contracting Officer and repeat the tests until satisfactory tests are completed.

3.8.2.1 Hydrostatic Tests of Service Piping

Hydrostaically test service piping before insulation is applied at field joints, and be proved tight at a pressure 1.5 times the working pressure of [_____] kPa psig or at 1.38 MPa 200 psig, whichever is greater. Hydrostatic test pressure must not exceed 3.45 MPa 500 psig. Hydrostatic test pressures must be held for a minimum of 4 hours. If the hydrostatic test pressure cannot be held, make necessary adjustments or replacements and repeat the tests until satisfactory results are achieved.

3.8.2.2 Equipment Tests

Operate all pumps, valves, traps, alarms, controls, and any other operable item of equipment to verify proper operation and compliance with the specifications. Record and submit pump voltage, current, and discharge readings for approval in accordance with SUBMITTALS paragraph (SD-06).

3.8.2.3 Insulating Flange Test

Test insulating flanges for electrical isolation in accordance with the insulating flange manufacturer's standard test. This test must be witnessed and approved by the Contracting Officer.

3.8.2.4 Operational Tests

After installation of the concrete trench system, or testable portion thereof, conduct operational tests. Do not place trench covers prior to completion of operational tests. Operational tests must consist of operating the system at the pressure and temperature expected for the system when in normal service, and must demonstrate satisfactory operating effectiveness. Ensure the test on each system, or portion thereof, last a minimum of 24 hours.

3.8.2.5 Trench Water Removal Tests

After the above tests are completed, and before concrete trench and valve manhole covers are placed, clean the concrete trenches, sumps, and valve manholes of dirt and debris. Test concrete trench system to ensure gravity drainage of water is maintained in trench bottom from high points to drained low points. Verify water does not pond between high and low points, and that drained low points are operational either by use of sump pumps or by gravity drainage to storm drains, as indicated. Test must not be considered completed until witnessed and accepted by the Contracting Officer. Place trench tops and sealed immediately after approval by the Contracting Officer.

3.9 MAINTENANCE

Provide [six] [_____] [hard] [optical disc] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. Provide one complete set prior to performance testing, and the remainder upon acceptance. Detail in the operation manuals the step-by-step procedures required for system startup, operation, and shutdown and include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides and include piping and equipment layout and simplified wiring and control diagrams indicating location of electrical components with terminals designated for wiring, as installed. Operation and maintenance manuals must be approved prior to performance testing.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 63 14 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-02556 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-33 63 14 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
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****

SECTION 33 63 14

EXTERIOR BURIED PUMPED CONDENSATE RETURN
04/06

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NOTE: This guide specification covers the requirements for Contractor designing and providing buried factory-prefabricated preinsulated pumped condensate piping systems for server ground water conditions.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
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NOTE: This guide specification includes requirements for concrete pipe anchors exterior of manholes, interface with each manhole, and the watershed to aboveground piping. The plastic carrier piping should be used for sizes 50, 80, 100, 150, 200, and 250 mm 2, 3, 4, 6, 8, and 10 inches. Therefore, the connecting system piping should be of equal size or increased to the next size of the plastic carrier piping. System design must conform to UFC 3-430-09, "Exterior Mechanical Utility Distribution".
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NOTE: The following information must be shown on the project drawings:

1. Only drawings (not specifications) must indicate capacity, efficiency, dimensions, details, sections, elevations, and location of equipment; space required for equipment maintenance.

2. Configuration, slope, and sizes for each piping system

3. Locations, sizes, and type of each valve and each trap

4. Details of manholes, piping within manholes, piping aboveground, and piping not in approved factory-prefabricated insulated conduit systems

5. Locations and details of thrust blocks, anchors, and connections between metal piping and plastic carrier piping

6. Trench cross section, sand bedding, and depth of bury

7. Details, sections, and elevations of piping through manholes, walls, floors, and entrance to buildings

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NOTE: Exterior buried factory-prefabricated insulated piping system including concrete pipe anchors exterior of manholes, interface with each manhole, and the watershed to aboveground piping must be designed by the Contractor. Manholes, piping within manholes, piping aboveground, and piping not in approved conduit systems must be designed on the project drawings.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both

ASTM D1330	(2004; R 2010) Rubber Sheet Gaskets

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

1.2 SYSTEM DESCRIPTION

Design and provide [new and modify existing] exterior buried factory-prefabricated preinsulated pumped condensate (hot water) return piping system complete and ready for operation. Provide identical buried factory-prefabricated insulated piping material up to the first flanged connection in manholes and aboveground. Design pressure and temperature ratings of system components must be for working pressure of 862 kPa (gage) 125 psig condensate at 121 degrees C 250 degrees F.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cooling tanks

Manholes

Federal Agency buried piping system

Show design and layout of piping system. Drawings must have Professional Engineer Seal.

SD-03 Product Data

Pipe and fittings

Valves

Strainers

Pipe hangers and supports

Traps

Gages

Federal Agency Approved Brochure for plastic carrier piping

Thermometers

SD-05 Design Data

Federal Agency buried piping system

Submit calculations of system design. Calculations must have Professional Engineer Seal.

SD-07 Certificates

Certification of welder's qualifications

1.4 QUALITY ASSURANCE

1.4.1 Certification of Welder's Qualifications

Submit prior to site welding. Certifications must not be more than one year old.

PART 2 PRODUCTS

2.1 PLASTIC CARRIER PIPING

2.1.1 Plastic Carrier Pipe and Fittings

Provide plastic carrier piping conforming to the Federal Agency Approved Brochure. Pipe, fittings, and adhesive must be supplied by the same manufacturer. Pipe, fittings, flanges, and couplings must have end connections of the adhesive bell and spigot type. Threaded piping, including pipe, fittings, flanges, and couplings, will not be permitted.

2.1.2 Flanged Connections

Provide flat face type flanged connections between plastic piping and metal piping. Plastic flanges must be for connecting to ASME B16.5, Class 150 flanges.

2.1.3 Gaskets, Bolts, Nuts, and Washers

a. Gaskets: ASTM D1330, except the Shore A durometer hardness must be 55 to 65, 3.20 mm 0.125 inch thick ethylene propylene, full face of flange. Provide one piece factory cut gaskets.

b. Bolts: ASTM A193/A193M, Grade B7. Extend a minimum of two full threads beyond the nut with the bolts tightened to the torque recommended by plastic pipe manufacturer.

c. Nuts: ASTM A194/A194M, Grade 7, with Teflon coated threads.

d. Washers: Provide steel flat circular washers under bolt heads and nuts.

2.2 STEEL PIPING

Provide steel piping in manholes and aboveground. Steam piping includes piping upstream of steam traps. Condensate piping includes piping downstream of steam traps.

2.2.1 Steam Pipe

a. ASTM A53/A53M: Type E (electric-resistance welded, Grade A or B) or Type S (seamless, Grade A or B), black steel. Provide Weight Class STD (Standard) for welding end connections. Provide Weight Class XS (Extra Strong) for threaded end connections.

b. ASTM A106/A106M: Grade A or B, black steel, Schedule No. 40 for pipe sizes through 250 mm 10 inches, and minimum pipe wall thickness of 9.50 mm 0.375 inch for pipe sizes 300 mm 12 inches and larger for welding end connections. Provide Schedule 80 for threaded end connections.

2.2.2 Condensate Pipe

Provide steel piping for other than exterior buried factory-prefabricated insulated pumped condensate return piping.

a. ASTM A53/A53M: Type E (electric-resistance welded, Grade A or B) or Type S (seamless, Grade A or B); black steel, Weight Class XS (Extra Strong).

b. ASTM A106/A106M: Grade A or B, black steel, Schedule No. 80.

2.2.3 Buried Steel Piping to Cooling Well or Drain

Provide direct buried steel condensate pipe and fittings with exterior coal tar epoxy painting system.

2.2.4 Threaded Fittings

ASME B16.11, or ASME B16.3, Class 150 for steam, Class 300 for condensate.

2.2.5 Socket Welding Fittings

ASME B16.11.

2.2.6 Buttwelding Fittings

ASME B16.9. Provide the same material and weight as the piping in which fittings are installed. Provide backing rings conforming to ASME B31.1 and be compatible with materials being welded.

2.2.7 Eccentric Reducing Fittings

ASME B16.9. Provide the same material and weight as the piping in which fittings are installed. Provide for changes in horizontal steam piping sizes.

2.2.8 Flanges and Unions

Provide flanges at connections to plastic piping.

2.2.8.1 Flanges

ASME B16.5, Class 150. Provide flat face flanged connections between plastic piping and metal piping.

2.2.8.2 Unions

ASME B16.39, Class 150 for steam, Class 250 for condensate.

2.2.9 Gaskets, Bolts, Nuts, and Washers

a. Gaskets: Provide ASME B16.21, composition ring 1.60 mm 0.0625 inch thick for steam and gravity condensate (steam) piping. Provide ASTM D1330, except the Shore A durometer hardness must be 55 to 65, 3.20 mm 0.125 inch thick, full face of flange for pumped condensate (hot water) piping. Provide one piece factory cut gaskets.

b. Bolts: ASTM A193/A193M, Grade B7. Extend a minimum of two full threads beyond the nut with the bolts tightened to the required torque.

c. Nuts: ASTM A194/A194M, Grade 7, with Teflon coated threads.

d. Washers: Provide steel flat circular washers under bolt heads and nuts.

2.3 VALVES

Provide with stems in the horizontal position or not greater than 45 degrees above the horizontal position. Valves must have flanged end connections, except sizes smaller than 65 mm 2.5 inches in steel piping may have union end connections, or threaded end connections with a union on one side of the valve.

2.3.1 Valves for Condensate Service

Valves downstream of steam traps must be for minimum working pressures of ASME Class 125.

2.3.1.1 Gate Valves

MSS SP-80, except sizes 65 mm 2.5 inches and larger must conform to MSS SP-70.

2.3.1.2 Globe and Angle Valves

MSS SP-80, except sizes 65 mm 2.5 inches and larger must conform to MSS SP-85.

2.3.1.3 Check Valves

MSS SP-80, except sizes 65 mm 2.5 inches and larger must conform to MSS SP-71. Provide swing check valves.

2.3.2 Valves for Steam Service

Valves upstream of steam traps must be steel body for minimum working pressures of ASME Class 150.

2.3.2.1 Gate, Globe, and Angle Valves

ASME B16.34.

2.3.2.2 Check Valves

ASME B16.34, swing check.

2.4 PIPING ACCESSORIES

2.4.1 Pipe Hangers and Supports

Provide MSS SP-58, of the adjustable type, except as specified or indicated otherwise. Tack-weld Type 39 pipe covering protection saddles to steel pipe for insulated piping. Provide steel support rods. The finish of rods, nuts, bolts, washers, hangers, and supports must be hot-dip galvanized after fabrication. Rollers, bases, and saddles may be painted with two coats of aluminum or light gray paint rated for use on hot metal surfaces up to 232 degrees C 450 degrees F in lieu of hot-dip galvanized. Provide stainless steel axles for rollers. Miscellaneous metal must conform to ASTM A36/A36M, hot-dip galvanized after fabrication.

2.4.2 Strainers

Steel body in accordance with ASME B16.5 for minimum of ASME Class 150. Provide stainless steel strainer element with minimum diameter perforations of 0.40 mm 0.016 inch for steam, 0.80 mm 0.031 inch for steam mixed with condensate, and 1.20 mm 0.047 inch for condensate (hot water). Provide blow-off outlet with pipe nipple, gate valve, and discharge pipe nipple.

2.4.3 Traps

Steel body, internals of stainless steel, minimum of ASME Class 150, and of the types indicated.

2.4.4 Pipe Sleeves

Provide where piping passes entirely through walls and floors. Provide sleeves of sufficient length to pass through entire thickness of walls and floors. Provide 25 mm one inch minimum clearance between exterior of piping or pipe insulation or conduit and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

a. Sleeves in Masonry and Concrete Walls and Floors: Provide hot-dip galvanized steel, ductile-iron, or cast-iron sleeves. Core drilling of masonry and concrete may be provided in lieu of sleeves when cavities in the core-drilled hole are grouted smooth.

b. Sleeves in Other Than Masonry and Concrete Walls and Floors: Provide 26 gage galvanized steel sheet.

2.4.5 Escutcheon Plates

Provide split hinge type metal plates for piping entering walls and floors in exposed spaces. Provide polished stainless steel plates or chromium-plated copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.4.6 Cooling Tanks

Construct of steel for minimum working pressure of ASME Class 150.

a. Thermometers: Provide bimetal dial-type thermometers with stainless steel case, stem, and fixed thread connection; 125 mm 5 inch diameter dial with glass face gasketed within the case; accuracy within one percent of scale range. Provide scale range for the intended service.

b. Gages: Provide single style pressure gage for steam with 115 mm 4.5 inch dial, brass or aluminum case, bronze tube, gage cock, pressure snubbers, and syphon. Provide scale range for the intended service.

c. Self-Powered Cooling Valve: Provide Spirax Sarco T-44 or Ogontz 3\4-AFR-255-CRB self-powered cooling valve with special factory setting to automatically open at 121 degrees C 250 degrees F. Notwithstanding any other provision of this contract, no other product will be acceptable.

2.4.7 Couplings

Provide special couplings for joining plastic condensate return pipe to ASTM A106/A106M steel pipe. Couplings must be for working pressure of 862 kPa (gage) 125 psig hot water at 121 degrees C 250 degrees F. Couplings must include carbon steel sleeve flared at each end, two Viton gaskets, two steel follower rings, and set of steel track bolts to properly compress the gaskets. Tighten bolts to torque recommended by coupling manufacturer. Provide 178 mm 7 inch long carbon steel sleeves for use with each nominal pipe size with minimum wall thickness as follows:

MINIMUM WALL THICKNESS (mm)						
Nominal Pipe Sizes (mm)	50	80	100	150	200	250
Wall Thickness	3.80	5.10	5.10	6.40	6.40	6.40
NOTE: Rockwell 411 couplings for steel pipe with Viton gaskets and Dresser 38 couplings for steel pipe with Viton gaskets will meet this specification.						

MINIMUM WALL THICKNESS (inches)						
Nominal Pipe Sizes (inches)	2	3	4	6	8	10
Wall Thickness	0.15	0.20	0.20	0.25	0.25	0.25
NOTE: Rockwell 411 couplings for steel pipe with Viton gaskets and Dresser 38 couplings for steel pipe with Viton gaskets will meet this specification.						

2.5 BURIED PIPING SYSTEM

Design and provide exterior buried factory-prefabricated preinsulated pumped condensate return piping in a conduit for which a Federal Agency Approved Brochure has been issued. In case of differences between the Approved Brochure and the project specification and drawings, the project specifications and drawings must govern. Design, equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, testing, and repair requirements must be in accordance with the Approved Brochure.

2.5.1 System Design

Design the underground piping system including trench bed and pipe anchors in accordance with the Approved Brochure. Pipe expansion loops will not be permitted. Expansion design having lateral movement through manholes will not be permitted. Design must include buried prefabricated preinsulated piping system including concrete pipe anchors exterior of manholes, interface with each manhole, and the watershed to aboveground piping. Provide manholes, piping within manholes, piping aboveground, and piping not in approved conduit systems as indicated; redesign will not be permitted. Earth horizontal resistant loading is 95.8 kPa 2000 psf.

2.5.2 System Requirements

Provide system approved for Class A [or Class B] ground water conditions. Minimum depth of burial must be [914 mm] [36 inches] [_____] from center of carrier pipe to final ground surface. Provide insulation, completely filling the space between the carrier pipe and the conduit in accordance with the Approved Brochure.

2.5.3 Buried Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape in rolls, 80 mm 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification must read CAUTION BURIED STEAM PIPING BELOW or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Bury tape with the printed side up at a depth of 300 mm 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

PART 3 EXECUTION

3.1 INSTALLATION

Installation of exterior buried pumped condensate return piping system including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.1, except as modified herein. Field assembly must be in accordance with the Federal Agency Approved Brochure. Install piping straight and true to bear evenly on sand bedding material. Install valves with stems horizontal or above. Provide flanges and unions at valves, traps, strainers, connections to equipment, and as indicated.

3.1.1 Cleaning of Piping

Keep the interior and ends of new piping and existing piping affected by the Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

3.1.2 Demolition

Remove materials so as not to damage materials which are to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

3.2 PLASTIC CARRIER PIPING

Exterior buried factory-prefabricated insulated pumped condensate (hot water) return piping system, including field joints, bedding, and initial backfill must be in accordance with the Approved Brochure, except as modified herein.

3.2.1 Connections to Metal Pipe

Connections between plastic carrier pipe and metal pipe must be flanged, with metal pipe anchored within 1500 mm 5 feet of the connection. Expansion and load forces of metal piping must not be transmitted to the plastic carrier pipe or conduit. Do not bury flanged pipe connections. Provide flat circular steel washers under bolt heads and nuts on flanges; tighten bolts to the torque recommended by the plastic pipe manufacturer.

3.2.2 Field Joints

3.2.2.1 Plastic Carrier Piping Joints Without Concrete Anchor

Pressure test and approve piping joints. Provide with polyurethane or polyisocyanate insulation of the same type and thickness as the insulation on the carrier piping. Provide waterproof shrink sleeves to cover the insulation and overlap not less than 150 mm 6 inches of each end of conduit section.

3.2.2.2 Plastic Carrier Piping Joints With Concrete Anchor

Pressure test and approve piping joints. Provide concrete anchors (thrust blocks) for each elbow and tee. Provide waterproof end seals between the carrier piping and the conduit adjacent to each carrier pipe fitting. Encase the carrier pipe fitting and at least 50 mm 2 inches of each end of the conduit with a minimum of 150 mm 6 inches of concrete.

3.2.3 Concrete Thrust Blocks

Cast thrust blocks after completion of hydrostatic testing. Encase each elbow and tee of the carrier pipe in a concrete thrust block with a minimum of 0.30 square meter 3 square feet of thrust-bearing surface cast against undisturbed soil, a minimum pipe-to-bearing surface single dimension of 250 mm 10 inches perpendicular to the bearing surface, and a minimum volume of 0.25 cubic meter 9 cubic feet, except as indicated otherwise. Disturbed soil under and around thrust blocks must be compacted. Provide concrete thrust blocks under this section as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE except the concrete must be of 30 MPa 4000 psi minimum 28 day compressive strength, air entrained admixture (133 grams per cubic meter 3.6 ounces per cubic yard), with water-reducing admixture (814 grams per cubic meter 22 ounces per cubic yard).

3.3 STEEL PIPING

Test, inspect, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for connections. Stab type connections will not be permitted. Make changes in piping sizes through tapered reducing fittings; bushings will not be permitted. Jointing compound for pipe threads must be Teflon pipe thread paste. Pipe nipples 150 mm 6 inches long and shorter must be Schedule 80 steel pipe. Condensate piping must include drip, vent, relief, and gage connecting piping.

3.3.1 Fittings and End Connections

For sizes less than 25 mm one inch provide threaded fittings and end connections. For sizes 25 to 50 mm 1 to 2 inches provide threaded or socket-welding or buttwelding fittings and end connections; provide threaded connections for threaded valves, traps, strainers, and threaded connections to equipment. For sizes 65 mm 2.5 inches and larger provide buttwelding fittings and end connections; provide flanged connections for flanged valves, traps, strainers, and flanged connections to equipment.

3.3.2 Welding

ASME B31.1, metallic arc process, including qualification of welders.

3.3.3 Pipe Hangers and Supports

Provide additional hangers and supports for concentrated loads in piping between hangers and supports, such as for valves.

3.4 NAMEPLATES

Provide laminated plastic nameplates for equipment, gages, thermometers, and valves. Nameplates must be melamine plastic, 3.20 mm 0.125 inch thick, black with white center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the white core. Minimum size of nameplates must be 25 to 65 mm 1 by 2.5 inches. Lettering must be minimum of 6.40 mm 0.25 inch high normal block style. Key the nameplates to a chart and schedule for each system. Frame charts and schedules under glass, and locate where directed near each system. Furnish two copies of each chart and schedule.

3.5 FIELD QUALITY CONTROL

Before final acceptance of the work, test each system to demonstrate compliance with contract requirements. Flush and clean piping before placing in operation. Flush piping at a minimum velocity of 2.40 meters per second 8 fps. Correct defects in work provided by Contractor and repeat tests until work is in compliance with contract requirements. Furnish potable water, electricity, instruments, connecting devices, and personnel for the tests.

3.5.1 Field Inspections

Prior to initial operation, inspect piping system for compliance with drawings, specifications, and manufacturer's submittals.

3.5.2 Field Tests of Carrier Piping

Do not cover the carrier piping joints with insulation or concrete anchors (thrust blocks), until the carrier piping joints have passed all field tests and testing requirements in the Approved Brochure for exterior buried factory-prefabricated insulated condensate return piping system.

3.5.3 Field Repairs of Plastic Carrier Pipe and Joints

Repair leaking and porous sections of pipe or joints by removing and replacing with new materials. Do not overwrap the fault with any type of patch or other material. If a joint is damaged during laying operation, cut off the joint, bond a coupling to the severed end, and lay in the piping as a normal pipe. If damage occurs to a new pipe section after pipe has been laid, cut out damaged section and replace with a new pipe section in accordance with manufacturer's instructions.

3.6 FIELD PAINTING

After completion of field inspections and tests, clean and paint metal surfaces exposed to the weather and in manholes, including valves, strainers, traps, flow meters, pipe flanges, bolts, nuts, washers, pipe hangers and supports, expansion joints, and miscellaneous metal. Do not paint piping prior to the application of field-applied insulation. Do not paint stainless steel or aluminum jackets. Apply paint to clean dry surfaces. Clean surfaces to remove dust, dirt, rust, oil, and grease. Provide surfaces with two coats of enamel paint applied to a total minimum dry film thickness of 0.05 mm 2 mils. Apply the second coat of paint after the preceding coat is thoroughly dry. Color of finish coat must be aluminum or light gray. Paint must be rated for use on hot metal surfaces up to 232 degrees C 450 degrees F and for use on surfaces exposed to the weather.

3.7 CONNECTIONS TO EXISTING SYSTEMS

Notify the Contracting Officer in writing at least 15 days prior to the date the connections are required; receive approval before interrupting service. Provide materials required to make connections into existing systems and perform excavating, backfilling, and other incidental labor as required.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 63 16 (July 2006)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 63 16 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 63 16

EXTERIOR SHALLOW TRENCH STEAM DISTRIBUTION

07/06

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USACE / NAVFAC / AFCEC **UFGS-33 63 16 (July 2006)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 63 16 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 63 16

EXTERIOR SHALLOW TRENCH STEAM DISTRIBUTION
07/06

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NOTE: This guide specification covers the requirements for exterior shallow trench heat distribution systems including concrete trench, manholes, piping, pipe anchors, pipe supports, interface with each manhole, and the watershed to aboveground piping.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: System design must conform to UFC 3-430-09, "Exterior Mechanical Utility Distribution."

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NOTE: Following information must be shown on project drawings:

1. Only drawings (not specifications) must indicate capacity, efficiency, dimensions, details, plan view, sections, elevations, and location of equipment; and space required for equipment maintenance.

2. Configuration, slope, and sizes for concrete trench and for each piping system.

3. Location, sizes, and type of each valve and each trap.

4. Details of expansion joints and expansion loops for piping.

5. Capacity, sizes, bypass valves, and piping for steam flow meters and pressure regulating valves.

6. Scale ranges for pressure gages and thermometers.

7. Whether piping is run in shallow concrete trenches, aboveground on pedestals or poles, on piers, under piers, in trenches on piers, or in manholes.

8. Details, sections, and elevations of shallow concrete trenches and manholes, piping within trenches and manholes, and piping aboveground.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.20	(2023) Metallic Gaskets for Pipe Flanges
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D229	(2019) Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture,

	Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

1.2 SYSTEM DESCRIPTION

Provide [new and modify existing] exterior [steam and condensate] [hot water] piping system of shallow concrete trench type, complete and ready for operation. [Provide piping to and including main steam pressure regulating valves, bypass valves, safety-relief valves, and high pressure traps within each building.] Design pressure and temperature ratings of system components must be for [working pressure of 1034 kPa (gage) 150 psig steam at 186 degrees C 366 degrees F and 862 kPa (gage) 125 psig condensate at 121 degrees C 250 degrees F] [hot water at 232 degrees C 450 degrees F].

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Piping system; G, [_____]

Pipe hangers and supports; G, [_____]

Manholes; G, [_____]

Shallow concrete trench; G, [_____]

SD-03 Product Data

Pipe

Valves; G, [_____]

Strainers; G, [_____]

Pipe hangers and supports

Traps

Gages

Steam flow meters; G, [_____]

Expansion joints; G, [_____]

Manhole drainers; G, [_____]

Sealant

SD-07 Certificates

Certification of welder's qualifications

SD-10 Operation and Maintenance Data

Manhole drainers, Data Package 2; ; G, [_____]

Steam flow meters, Data Package 2; ; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 QUALITY ASSURANCE

1.4.1 Certification of Welder's Qualifications

Submit prior to site welding. Certification must not be more than one year old.

PART 2 PRODUCTS

2.1 PIPE

[Steam piping includes piping upstream of steam traps. Condensate piping includes piping downstream of steam traps.]

2.1.1 [Steam] [Hot Water] Pipe

a. ASTM A53/A53M: Type E (electric-resistance welded, Grade A or B) or Type S (seamless, Grade A or B), black steel. Provide Weight Class STD (Standard) for welding end connections. Provide Weight Class XS (Extra Strong) for threaded end connections.

b. ASTM A106/A106M: Grade A or B, black steel, Schedule No. 40 for pipe sizes through 250 mm 10 inches, and minimum pipe wall thickness of 9.50 mm 0.375 inch for pipe sizes 300 mm 12 inches and larger for welding end connections. Provide Schedule No. 80 for threaded end connections.

2.1.2 Condensate Pipe

a. ASTM A53/A53M: Type E (electric-resistance welded, Grade A or B) or Type S (seamless, Grade A or B); black steel, Weight Class XS (Extra Strong).

b. ASTM A106/A106M: Grade A or B, black steel, Schedule No. 80.

2.1.3 Buried Steel Piping to Cooling Well or Drain

Provide direct buried steel condensate pipe and fittings with exterior coal tar epoxy painting system.

2.2 FITTINGS

2.2.1 Threaded Fittings

ASME B16.11, or ASME B16.3, Class [150 for steam, Class 300 for condensate] [300 for hot water].

2.2.2 Socket-Welding Fittings

ASME B16.11.

2.2.3 Buttwelding Fittings

ASME B16.9. Provide same material and weight as piping in which fittings are installed. Backing rings must conform to ASME B31.1 and be compatible with materials being welded.

2.2.4 Eccentric Reducing Fittings

ASME B16.9. Provide same material and weight as piping in which fittings are installed.

2.2.5 Flanges and Unions

a. Flanges: ASME B16.5, Class [150 or Class 300 as required] [300 for hot water].

b. Unions: ASME B16.39, Class [150 for steam, Class 250 for condensate] [300 for hot water].

2.2.6 Gaskets, Bolts, Nuts, and Washers

a. Gaskets: Provide gaskets suitable for the intended service. Provide spiral wound, non-asbestos gasket with centering ring per ASME B16.20.

b. Bolts: ASTM A193/A193M, Grade B7. Extend a minimum of two full threads beyond the nut with the bolts tightened to the required torque.

c. Nuts: ASTM A194/A194M, Grade 7, with Teflon coated threads.

d. Washers: Provide steel flat circular washers under bolt heads and nuts.

e. Electrically Isolating (Insulating) Gaskets for Flanges: Provide ASTM D229 electrical insulating material of 1000 ohms minimum resistance. Provide one piece factory cut insulating gaskets between flanges. Provide silicon-coated fiberglass insulating sleeves between bolts and holes in flanges; bolts may have reduced shanks of a diameter not less than diameter at root of threads. Provide 3.20 mm 0.125 inch thick high-strength insulating washers next to flanges and provide stainless steel flat circular washers over insulating washers and under bolt heads and nuts. Provide bolts 13 mm 0.5 inch longer than standard length to compensate for thicker insulating gaskets and washers under bolt heads and nuts.

2.3 VALVES

Provide with stems in the horizontal position or not greater than 45 degrees above the horizontal position. Valves must have flanged end connections, except sizes smaller than 65 mm 2.5 inches may have union end connections, or threaded end connections with a union on one side of valve.

2.3.1 Valves for [Steam] [Hot Water] Service

Valves [upstream of steam traps] must be steel body for minimum working pressure of ASME Class [150] [300 for hot water].

a. Gate Valves, Globe Valves, Angle Valves, and Check Valves: ASME B16.34, steel body, minimum of ASME Class [150] [300 for hot water]. Provide swing check valves.

b. Steam Pressure Regulating Valves: Steel body, minimum of ASME Class 150, except as modified herein. Valve seats and disc must be of replaceable heat-treated stainless steel. Valves must be single seated; seat tight under dead end conditions, and move to the closed position in the event of pressure failure of the operating (controlling) medium. Provide strainer in inlet from external operating (controlling) medium. Valves must be controlled by pilot valve with strainer at inlet from external pressure sensing piping. Valves must be internally or externally steam traced for freeze protection. Valves must be piston operated type or spring loaded diaphragm operated type with stainless steel springs.

c. Safety-Relief Valve: Minimum of ASME Class [150] [300 for hot water], with test lever. Valves must have steel [or copper alloy] body with flanged inlet and outlet connections or threaded connections attached to threaded ASME Class [150] [300 for hot water] flanges. Valves must be ASME rated for capacity indicated.

2.3.2 Valves for Condensate Service

Valves downstream of steam traps must be for minimum working pressures of ASME Class 125.

a. Gate Valves: MSS SP-80, except sizes 65 mm 2.5 inches and larger must conform to MSS SP-70.

b. Globe and Angle Valves: MSS SP-80, except sizes 65 mm 2.5 inches and larger must conform to MSS SP-85.

c. Check Valves: MSS SP-80, except sizes 65 mm 2.5 inches and larger must conform to MSS SP-71. Provide swing check valves.

2.4 PIPING ACCESSORIES

2.4.1 Pipe Hangers and Supports

Provide MSS SP-58, Type 46, of the adjustable type, except as specified or indicated otherwise. Tack-welded Type 39 pipe covering protection saddles to steel pipe for insulated piping. Provide steel support rods. Finish of rods, nuts, bolts, washers, hangers, and supports must be hot-dip galvanized after fabrication. Rollers, bases, and saddles may be painted with two coats of aluminum or light gray paint rated for use on hot metal surfaces up to 232 degrees C 450 degrees F in lieu of hot-dip galvanized. Axles for rollers must be stainless steel. Miscellaneous metal must conform to ASTM A36/A36M, hot-dip galvanized after fabrication.

2.4.2 Strainers

Construct of steel in accordance with ASME B16.5 for minimum of ASME Class [150] [300 for hot water]. Provide stainless steel strainer element with perforations of [0.40 mm 0.016 inch for steam, 0.80 mm 0.031 inch for steam mixed with condensate, and] 1.20 mm 0.047 inch for [condensate (hot water)] [hot water]. Provide blow-off outlet with pipe nipple, gate valve, and discharge pipe nipple.

2.4.3 Traps

Steel body, internals of stainless steel, minimum of ASME Class 150, and of the types indicated.

2.4.4 Gages

Provide single style pressure gage with 115 mm 4.5 inch dial, brass or aluminum case, bronze tube, gage cock, pressure snubbers, and syphon. Provide scale range for the intended service.

2.4.5 Pipe Sleeves

Provide where piping passes entirely through walls and floors. Provide sleeves of sufficient length to pass through entire thickness of walls and floors. Provide 25 mm one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

a. Sleeves in Masonry and Concrete Walls and Floors: Provide hot-dip galvanized steel, ductile-iron, or cast-iron sleeves. Core drilling of masonry and concrete may be provided in lieu of sleeves when cavities in the core-drilled hole are completely grouted smooth.

b. Sleeves in Other Than Masonry and Concrete Walls and Floors: Provide 26 gage galvanized steel sheet.

2.4.6 Escutcheon Plates

Provide split hinge type metal plates for piping entering walls and floors in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.4.7 Electronic Steam Flow Meters

Meter must be for minimum working pressure of ASME Class [150] [300]. Meter must include an orifice plate, pressure transmitter, indicator, and totalizer. Provide meter for measuring steam flow in kg per second pounds per hour. Meter must be for installation and operation in horizontal position.

a. Orifice Plate: Provide differential producing type orifice plate with circular hole for insertion into steam piping between two ASME B16.5 Class 300 welding neck orifice flanges. Orifice plate must be Type 304 stainless steel. Furnish a dimensional report and flow versus differential curve with accuracy of plus or minus one percent over a 5 to 1 flow range. Orifice flanges must have at least two radially-drilled and tapered holes for metering and two jack screws.

b. Pressure Transmitter: Provide solid state electronic type differential pressure transmitter. Transmitter must utilize Type 316 stainless steel dual opposed rupture-proof bellows converted to produce a 4 to 20 mA dc output. Transmitter must have a flow range of 0 to 0.40 kg per second 3000 pounds per hour of steam flow with accuracy of plus or minus 2 percent of full scale over a 5 to 1 flow range. House transmitter in a weatherproof enclosure designed for wall mounting. Bellows body must be rated for not less than 6894 kPa (gage) 1000 psig. Power requirements are 120 volts ac. Provide transmitter complete with condensate reservoirs, steel three-valve manifold for isolation and nulling, and blowdown valves.

c. Indicator: Provide electric indicator to continuously indicate steam flow by means of a 4 to 20 mA dc electrical input signal. Indicator must have pivot and jewel suspension and a mirrored scale with uniform graduations over a steam flow range of 0 to 0.40 kg per second 3000 pounds per hour.

d. Totalizer: Provide totalizer that linearizes a 4 to 20 mA dc electrical input signal into digital signal scaled in kg pounds of steam flow, displays totalized steam flow on a six-digit nonresettable counter, and transmits each totalizer count to the output.

e. Output: An isolated, 500 volt minimum, ac or dc switch closure rated at 50 volts dc or 40 volts RMS ac, one ampere minimum capacity. Duration of closure must be not less than 0.04 second or more than 0.06 second.

2.4.8 Steam Flow Meters

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NOTE: Meters can have (a) six-dial counter, or (b) pressure compensated six-dial counter, or (c) remote totalizer, or (a) and (c). Meters cannot have (a) and (b), or (b) and (c).

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Meter must be for minimum working pressure of ASME Class [150] [300] with steel pressure chambers [or ASME Class 250 with cast-iron pressure chambers]. Provide meter in horizontal pipe between two ASME B16.5 welding neck flanges. Provide rotary type meter for flow integration. Working parts must be stainless steel or brass. Steam flow must cause rotation of a rotor assembly at a speed directly proportional to rate of steam flow, as controlled by a damping liquid. Rotational speed of rotor assembly must be reduced by gearing in damping liquid chamber. Final drive to exterior counter must be by driving magnets; stuffing box must not be allowed. Counter must be enclosed in dust-tight cast-aluminum housing attached to, but easily removable from, meter. For steam pipe main sizes 100 mm 4 inches and smaller, provide meter directly in steam piping. For steam pipe main sizes larger than 100 mm 4 inches, provide meter in shunt bypass piping with two ASME B16.5 Class 300 welding neck orifice flanges in steam pipe main. In shunt bypass piping, provide two flanged gate valves calibrated by meter manufacturer. In steam pipe main, provide 3.20 mm 0.125 inch thick stainless steel orifice plate sized to suit meter capacity between two ASME B16.5 Class 300 welding neck orifice flanges. [Provide six-dial counter with electrical contactor to transmit signal to data terminal cabinet (DTC) for indicating steam flow in kg pounds.] [Provide pressure compensated six-dial counter to automatically and continuously correct steam flow meter readings for steam pressure variations.] [Provide remote totalizer for recording steam flow in kg pounds.]

2.4.9 Guided Slip Tube Expansion Joints

Internally-externally guided type, injected semiplastic type packing, with service outlets. Joints must be for minimum working pressure of ASME Class [150] [300]. Provide single or double slip tube type as indicated. Provide flanged or buttwelding end connections as indicated.

2.4.10 Flexible Ball Expansion Joints

Provide chromium plated steel balls capable of 360 degree rotation plus 15-degree angular flex movement. Provide pressure molded composition gaskets for continuous operation temperature of 274 degrees C 525 degrees F. Joints must be designed for minimum working pressure of ASME Class [150] [300]. Provide flanged or buttwelding end connections as indicated.

2.4.11 Bellows Expansion Joints

Type 304 stainless steel corrugated bellows, reinforced with rings, internal sleeves, and external protective covers or externally pressurized joints. Provide limit stops to limit total movement in both directions. Cold set joints to compensate for temperature at time of installation.

Joints must withstand 10,000 cycles over a 20 year period. Joints must be for minimum working pressure of ASME Class [150] [300]. Provide single or double bellows expansion joint as indicated. Provide first pipe alignment guide no more than four pipe diameters from expansion joints; provide second pipe alignment guide no more than 14 pipe diameters from the first guide. Provide flanged or buttwelding end connections as indicated.

2.5 MANHOLE DRAINERS (EJECTORS)

Provide automatic type drainers to operate on 862 kPa (gage) 125 psig steam supply. Drainer must operate when water level rises sufficiently in the sump and must pump water from the sump. When water level is lowered by pumping action, pumping action must stop until water again gathers in sump. Provide each drainer with controls to accomplish above sequence of operation. Drainer must be constructed of stainless steel or corrosion-resistant copper and bronze. Piping from manhole drainers must be ASTM A53/A53M, Weight Class XS (Extra Strong), hot-dip galvanized steel pipe with ASME B16.11 or ASME B16.3 Class 300, hot-dip galvanized threaded fittings. Provide steam pressure regulating valve assembly for manhole drainers for operation on steam system above 862 kPa (gage) 125 psig.

2.6 CONCRETE MANHOLES

Provide under this section as specified in Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION, except as modified herein. Concrete must be of 30 MPa 4000 psi minimum 28 day compressive strength, air-entrained admixture (133 grams per cubic meter 3.6 ounces per cubic yard), with water-reducing admixture (814 grams per cubic meter 22 ounces per cubic yard), reinforced with deformed steel bars. Construct manhole sides by one monolithic pour. Cast-iron steps with non-slip surfaces and spaces 300 to 400 mm 12 to 16 inches apart on centers must be firmly embedded in concrete walls for access to bottom of manholes. Provide top of manhole as indicated.

2.7 NAMEPLATES

Provide laminated plastic nameplates for equipment, gages, thermometers, and valves. Nameplates must be melamine plastic, 3.20 mm 0.125 inch thick, black with white center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the white core. Minimum size of nameplates must be 25 by 65 mm 1 by 2.5 inches. Lettering must be minimum of 6.40 mm 0.25 inch high normal block style. Key the nameplates to a chart and schedule for each system to identify its function. Frame charts and schedules under glass, and locate where directed near each system. Furnish two copies of each chart and schedule.

2.8 SHALLOW CONCRETE TRENCH

a. Cast-in-Place Concrete: Provide concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE, except as modified herein. Concrete must be 30 MPa 4000 psi minimum 28 day compressive strength, air entrained admixture (133 grams per cubic meter 3.6 ounces per cubic yard), with water-reducing admixture (814 grams per cubic meter 22 ounces per cubic yard), reinforced with ASTM A615/A615M deformed steel bars.

b. Precast Concrete: Provide as specified in Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION, except as modified herein. Concrete must be 30 MPa 4000 psi minimum 28 day compressive strength, air-entrained.

c. Gasket Material: Provide neoprene pad, not less than 50 mm 2 inch wide by 6.40 mm 0.25 inch thick, between concrete trench covers and concrete trench wall tops.

d. Backing Rods: Provide compressible, nonshrinkable, nonreactive with joint sealant and nonabsorptive type such as upholstery cord, cotton, jute, or plastic rod, all free of oils or bitumens.

e. Separating Tape: Provide polyethylene or polyester tape, 0.08 mm 3 mil minimum thickness or masking tape, rubber tape, or other barrier sheet, nonreactive, nonabsorptive, adhesive-back tape, 3.20 mm 0.12 inch wider than normal width of the joint.

f. Dowel Bars: Provide ASTM A615/A615M including supplementary requirements (S1), Grade 40 or 60 for plain billet-steel concrete reinforcement bars. Coat sliding portion of each bar with lacquer resisting primer. Remove burrs and projections from the bars. Fit the outer end of the sliding portion of each dowel with a tight-fitting metal sleeve which conforms to manufacturer's recommendation for the dowel bars.

g. Exterior Sealant: ASTM C920, Type S or Type M, Class 25. Provide Grade NS, Use NT, sealant for joints in vertical surfaces. Provide Grade P, Use T, sealant for joints in horizontal surfaces.

PART 3 EXECUTION

3.1 INSTALLATION

Installation of exterior heat distribution system including equipment, materials, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.1, except as modified herein. Install piping straight and true to bear evenly on supports and sand bedding material. Install valves with stems horizontal or above centerline of pipe. Provide flanges or unions at valves, traps, strainers, connections to equipment, and as indicated.

a. Cleaning of Piping: Keep the interior and ends of new piping and existing piping affected by the Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

b. Demolition: Remove materials so as not to damage materials which are to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

3.2 PIPING

Test, inspect, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for connections. Reducing branch connections in steel piping may be made with forged branch outlet reducing fittings for branches two or more pipe sizes smaller than mains. Branch outlet fittings must be forged, flared for improved flow where attached to pipe, reinforced against external strains, and designed to withstand full pipe bursting strength. Stab type connections will not be permitted. Jointing compound for pipe threads must be Teflon pipe thread paste. Pipe nipples 150 mm 6 inches long and shorter must be Schedule 80 steel pipe. Make changes in piping sizes through tapered reducing fittings; bushings will not be permitted.

a. Fittings and End Connections: For sizes less than 25 mm 1 inch provide threaded fittings and end connections. For sizes 25 to 50 mm 1 to 2 inches provide threaded or socket-welding or buttwelding fittings and end connections; provide threaded connections for threaded valves, traps, strainers, and threaded connections to equipment. For sizes 65 mm 2.5 inches and larger provide buttwelding fittings and end connections; provide flanged connections for flanged valves, traps, strainers, and flanged connections to equipment.

b. Welding: ASME B31.1, metallic arc process, including qualification of welders.

c. Pipe Hangers and Supports: Provide additional hangers and supports for concentrated loads in piping between hangers and supports, such as for valves. Support steel piping as follows:

MAXIMUM SPACING (METER)									
Pipe Size (mm)	25 and under	40	50	80	100	150	200	250	300
Steel Piping	2.70	3.70	4.00	4.60	5.20	6.40	7.30	8.00	9.20

MAXIMUM SPACING (FEET)									
Pipe Size (inches)	one and under	1.5	2	3	4	6	8	10	12
Steel Piping	9	12	13	15	17	21	24	26	30

3.3 FIELD QUALITY CONTROL

3.3.1 Inspections

Prior to initial operation, inspect piping system for compliance with drawings, specifications, and manufacturer's submittals.

3.3.2 Piping Tests

Before final acceptance of the work, test each system as in service to demonstrate compliance with contract requirements. Before insulation is applied, hydrostatically test each piping system at not less than [1551] [3447] kPa (gage) [225] [500] psig in accordance with ASME B31.1, with no leakage or reduction in gage pressure for 2 hours. Flush and clean piping before placing in operation. Flush piping at a minimum velocity of 2.40 meters per second 8 fps. Correct defects in work provided by Contractor and repeat tests until work is compliance with contract requirements.

Furnish potable water, electricity, instruments, connecting devices, and personnel for tests.

3.4 FIELD PAINTING

After completion of field inspections and tests, clean and paint metal surfaces exposed to weather and in manholes, including valves, strainers, traps, flow meters, pipe flanges, bolts, nuts, washers, pipe hangers, support, expansion joints, manhole drainers, and miscellaneous metal. Do not paint piping prior to the application of field-applied insulation. Do not paint stainless steel or aluminum jackets. Apply paint to clean dry surfaces. Clean surfaces to remove dust, dirt, rust, oil, and grease. Provide surfaces with two coats of enamel paint applied to a total minimum dry film thickness of 0.05 mm 2 mils. Apply the second coat of paint after the preceding coat is thoroughly dry. Color of finish coat must be aluminum or light gray. Paint must be rated for use on hot metal surfaces up to 232 degrees C 450 degrees F and for use on surfaces exposed to weather.

3.5 CONNECTIONS TO EXISTING SYSTEMS

Notify Contracting Officer in writing at least 15 days prior to date the connections are required. Obtain approval before interrupting service. Provide materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 63 23 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-02554 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 63 23

EXTERIOR ABOVEGROUND STEAM DISTRIBUTION

04/06

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 63 23 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-02554 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 63 23

EXTERIOR ABOVEGROUND STEAM DISTRIBUTION
04/06

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NOTE: This guide specification covers the requirements for exterior aboveground steam and condensate piping systems and buried factory-prefabricated preinsulated steam and condensate piping under roads.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Piping systems include piping exposed to the weather exterior of buildings and supported on pedestals or poles; on piers, under piers, and in trenches on piers; in tunnels, in manholes, and related work. System design must conform to UFC 3-430-09, "Exterior Mechanical Utility Distribution."

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NOTE: The following information must be shown on the project drawings:

1. Only drawings (not specifications) must indicate capacity, efficiency, dimensions, details, plan

view, sections, elevations, and location of equipment; and space required for equipment maintenance.

2. Configuration, slope, and sizes for each piping system

3. Locations, sizes, and type of each valve and each trap

4. Details of expansion joints and expansion loops for aboveground piping

5. Locations and installation details of poles supporting aboveground piping, including anchors and guy wires

6. Capacity, sizes, bypass valves, and piping for steam flow meters and pressure regulating valves

7. Scale ranges for pressure gages and thermometers

8. Whether piping is run aboveground on pedestals or poles, on piers, under piers, in trenches on piers, or in manholes

9. Details, sections, and elevations, of manholes, piping within manholes, piping aboveground, and piping under roads in approved factory-prefabricated insulated conduit systems (see note below).

10. Details of sacrificial anode type cathodic protection system for metal conduit

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NOTE: Design on project drawings the buried factory-prefabricated insulated piping in a conduit for which approval has been issued.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.20	(2023) Metallic Gaskets for Pipe Flanges
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and

	Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM D229	(2019) Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

1.2 SYSTEM DESCRIPTION

Provide [new and modify existing] exterior aboveground steam and condensate piping system complete and ready for operation. Provide piping to and including the main steam pressure regulating valves, bypass valves, safety-relief valves, and high pressure traps within each building. Design pressure and temperature ratings of system components must be for working pressure of 1034 kPa-gage 150 psig steam at 186 degrees C 366 degrees F and 862 kPa-gage 125 psig condensate at 121 degrees C 250 degrees F. [Provide [new and modify existing] exterior buried factory-prefabricated preinsulated steam and condensate piping under roads as specified in paragraph entitled "Buried Piping Under Roads."]

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

- Piping
- Valves
- Strainers
- Pipe hangers and supports
- Traps
- Gages
- Steam flow meters
- Expansion joints
- Manhole drainers

SD-07 Certificates

- Certification of welder's qualifications

SD-10 Operation and Maintenance Data

Manhole drainers, Data Package 2; G, [_____]

Steam flow meters, Data Package 2; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 QUALITY ASSURANCE

1.4.1 Certification of Welder's Qualifications

Submit prior to site welding. Certifications must not be more than one year old.

PART 2 PRODUCTS

2.1 PIPING

Steam piping includes piping upstream of steam traps. Condensate piping includes piping downstream of steam traps.

2.1.1 Steam Pipe

a. ASTM A53/A53M, Type E (electric-resistance welded, Grade A or B) or Type S (seamless, Grade A or B); black steel. Provide Weight STD (Standard) for welding end connections. Provide Weight Class XS (Extra Strong) for threaded end connections.

b. ASTM A106/A106M, Grade A or B, black steel, Schedule No. 40 for pipe sizes through 250 mm 10 inches, and minimum pipe wall thickness of 9.50 mm 0.375 inch for pipe sizes 300 mm 12 inches and larger for welding end connections. Provide Schedule 80 for threaded end connections.

2.1.2 Condensate Pipe

a. ASTM A53/A53M, Type E (electric-resistance welded, Grade A or B) or Type S (seamless, Grade A or B); black steel, Weight Class XS (Extra Strong).

b. ASTM A106/A106M, Grade A or B, black steel, Schedule No. 80.

2.1.3 Buried Steel Piping to Cooling Well or Drain

Provide direct buried steel condensate pipe and fittings with exterior coal tar epoxy painting system.

2.2 FITTINGS

2.2.1 Threaded Fittings

ASME B16.11, or ASME B16.3, Class 150 for steam, Class 300 for condensate.

2.2.2 Socket Welding Fittings

ASME B16.11.

2.2.3 Buttwelding Fittings

ASME B16.9. Provide the same material and weight as the piping in which fittings are installed. Backing rings must conform to ASME B31.1 and be compatible with materials being welded.

2.2.4 Eccentric Reducing Fittings

ASME B16.9. Provide the same material and weight as the piping in which fittings are installed. Provide for changes in horizontal steam piping sizes.

2.2.5 Flanges and Unions

2.2.5.1 Flanges

ASME B16.5, Class 150 or 300 as required.

2.2.5.2 Unions

ASME B16.39, Class 150 for steam, Class 250 for condensate.

2.2.6 Gaskets, Bolts, Nuts, and Washers

a. Gaskets: Provide spiral wound, non-asbestos gasket with centering ring per ASME B16.20. [ASME B16.21, composition ring 1.60 mm 0.0625 inch thick. Provide one piece factory cut ring gaskets for raised-face flanged joints, and full-face gaskets for flat-face flanged joints.]

b. Bolts: ASTM A193/A193M, Grade B7. Extend a minimum of two full threads beyond the nut with the bolts tightened to the required torque.

c. Nuts: ASTM A194/A194M, Grade 7, with Teflon coated threads.

d. Washers: Provide steel flat circular washers under bolt heads and nuts.

e. Electrically isolating (insulating) gaskets for flanges: Provide ASTM D229 electrical insulating material of 1000 ohms minimum resistance. Provide one piece factory cut insulating gaskets between flanges. Provide silicon-coated fiberglass insulating sleeves between the bolts and the holes in flanges; bolts may have reduced shanks of a diameter not less than the diameter at the root of threads. Provide 3.20 mm 0.125 inch thick high-strength insulating washers next to flanges and provide stainless steel flat circular washers over insulating washers and under bolt heads and nuts. Provide bolts 13 mm 0.5 inch longer than standard length to compensate for the thicker insulating gaskets and the washers under bolt heads and nuts in the horizontal position or not greater than 45 degrees above the horizontal position.

2.3 VALVES

Provide with stems in the horizontal position or not greater than 45 degrees above the horizontal position. Valves must have flanged end connections, except sizes smaller than 65 mm 2.5 inches may have union end connections, or threaded end connections with a union on one side of the valve.

2.3.1 Valves for Steam Service

Valves upstream of steam traps must be steel body for minimum working pressure of ASME Class 150.

2.3.1.1 Gate Valves, Globe Valves, Angle Valves, and Check Valves

ASME B16.34, steel body, minimum of ASME Class 150. Provide swing check valves.

2.3.1.2 Steam Pressure Regulating Valves

Steel body, minimum of ASME Class 150, except as modified herein. Valve seats and disc must be of replaceable heat-treated stainless steel. Valves must be single seated, seat tight under dead end conditions, and move to the closed position in the event of pressure failure of the operating (controlling) medium. Provide strainer in inlet from external operating (controlling) medium. Valves must be controlled by pilot valve with strainer at inlet from external pressure sensing piping. Valves must be internally or externally steam traced for freeze protection. Valves must be piston operated type or spring loaded diaphragm operated type with stainless steel springs.

2.3.1.3 Safety-Relief Valves

Minimum of ASME Class 150, with test lever. Valves must have steel or copper alloy body. Valves must have flanged inlet and outlet connections or threaded connections attached to threaded ASME Class 150 flanges. Valves must be ASME rated for capacity indicated.

2.3.2 Valves for Condensate Service

Valves downstream of steam traps must be for minimum working pressures of ASME Class 125.

2.3.2.1 Gate Valves

MSS SP-80, except sizes 65 mm 2.5 inches and larger must conform to MSS SP-70.

2.3.2.2 Globe and Angle Valves

MSS SP-80, except sizes 65 mm 2.5 inches and larger must conform to MSS SP-85.

2.3.2.3 Check Valves

MSS SP-80, except sizes 65 mm 2.5 inches and larger must conform to MSS SP-71. Provide swing check valves.

2.4 PIPING ACCESSORIES

2.4.1 Pipe Hangers and Supports

Provide MSS SP-58, Type 43, of the adjustable type, except as specified or indicated otherwise. Tack-weld Type 39 pipe covering protection saddles to steel pipe for insulated piping. Provide steel support rods. The finish of rods, nuts, bolts, washers, hangers, and supports must be hot-dip galvanized after fabrication. Rollers, bases, and saddles may be painted with two coats of aluminum or light gray paint rated for use on hot metal surfaces up to 232 degrees C 450 degrees F in lieu of hot-dip galvanized. Provide stainless steel axles for rollers. Miscellaneous metal must conform to ASTM A36/A36M, hot-dip galvanized after fabrication.

2.4.2 Strainers

Construct of steel in accordance with ASME B16.5 for minimum of ASME Class 150. Provide stainless steel strainer element with perforations of 0.40 mm 0.016 inch for steam, 0.80 mm 0.031 inch for steam mixed with condensate, and 1.20 mm 0.047 inch for condensate (hot water). Provide blow-off outlet with pipe nipple, gate valve, and discharge pipe nipple.

2.4.3 Traps

Steel body, internals of stainless steel, minimum of ASME Class 150, and of the types indicated.

2.4.4 Gages

Provide single style pressure gage for steam with 115 mm 4.5 inch dial, brass or aluminum case, bronze tube, gage cock, pressure snubbers, and syphon. Provide scale range for the intended service.

2.4.5 Pipe Sleeves

Provide where piping passes entirely through walls and floors. Provide sleeves of sufficient length to pass through entire thickness of walls and floors. Provide 25 mm one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

a. Sleeves in Masonry and Concrete Walls and Floors: Provide hot-dip galvanized steel, ductile-iron, or cast-iron sleeves. Core drilling of masonry and concrete may be provided in lieu of sleeves when cavities in the core-drilled hole are grouted smooth.

b. Sleeves in Other Than Masonry and Concrete Walls and Floors: Provide 26 gage galvanized steel sheet.

2.4.6 Escutcheon Plates

Provide split hinge type metal plates for piping entering walls and floors in exposed spaces. Provide polished stainless steel plates or chromium-plated copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.4.7 Electronic Steam Flow Meter

Meter must be for minimum working pressure of ASME Class 150. Meter must include an orifice plate, pressure transmitter, indicator, and totalizer. Provide meter for measuring steam flow in kg per second pounds per hour. Meter must be for installation and operation in horizontal position.

2.4.7.1 Orifice Plate

Provide differential producing type orifice plate with circular hole for insertion into the steam piping between two ASME B16.5 Class 300 welding neck orifice flanges. Orifice plate must be Type 304 stainless steel. Furnish a dimensional report and flow versus differential curve with accuracy of plus or minus one percent over a 5 to 1 flow range. Orifice flanges must have at least two radially-drilled and tapped holes for metering and two jack screws.

2.4.7.2 Pressure Transmitter

Provide solid state electronic type differential pressure transmitter. Transmitter must utilize Type 316 stainless steel dual opposed rupture-proof bellows converted to produce a 4 to 20 mA dc output. Transmitter must have a flow range of zero to 0.40 kg per second 3000 pounds per hour of steam flow with accuracy of plus or minus 2 percent of the full scale over a 5 to 1 flow range. House transmitter in a weatherproof enclosure designed for wall mounting. Bellows body must be rated for not less than 6894 kPa (gage) 1000 psig. Power requirements are 120 volts ac. Provide transmitter complete with condensate reservoirs, steel three-valve manifold for isolation and nulling, and blowdown valves.

2.4.7.3 Indicator

Provide electric indicator to continuously indicate steam flow by means of a 4 to 20 mA dc electrical input signal. Indicator must have pivot and jewel suspension and a mirrored scale with uniform graduations over a steam flow range of zero to 0.40 kg per second 3000 pounds per hour.

2.4.7.4 Totalizer

Provide totalizer that linearizes a 4 to 20 mA dc electrical input signal into a digital signal scaled in kg pounds of steam flow, displays totalized steam flow on a six-digit nonresettable counter, and transmits each totalizer count to the output.

2.4.7.5 Output

An isolated (500 volts minimum) ac or dc switch closure rated at 50 volts dc or 40 volts RMS ac, one ampere minimum capacity. Duration of closure must be not less than 0.04 second or more than 0.06 second.

2.4.7.6 Adjustments

Upon completion of the work, furnish the services of a competent technician regularly employed by the manufacturer of the flow meter to make the necessary adjustments to place the steam flow meter in operation and to conduct performance tests which demonstrate that the flow measuring equipment is functioning. Install the steam flow meter in accordance with manufacturer's recommendations.

2.4.8 Steam Flow Meters

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NOTE: Meters can have (a) six-dial counter, or (b) remote totalizer, or (c) pressure compensated six-dial counter, or (a) and (b). Meters cannot have (a) and (c), or (b) and (c).

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Meter must be for minimum working pressure of ASME Class 150 with steel pressure chambers or ASME Class 250 with cast-iron pressure chambers. Provide meter in horizontal pipe between two ASME B16.5 welding neck flanges. Provide rotary type meter for flow integration. Working parts must be stainless steel. Steam flow must cause rotation of a rotor assembly at a speed directly proportional to the rate of steam flow, as controlled by a damping liquid. The rotational speed of the rotor assembly must be reduced by gearing in the damping liquid chamber. Final drive to the exterior counter must be by driving magnets; stuffing box must not be allowed. Counter must be enclosed in a dust-tight cast-aluminum housing attached to, but easily removable from the meter. For steam pipe main sizes 100 mm 4 inches and smaller, provide meter directly in the steam piping. For steam pipe main sizes larger than 100 mm 4 inches, provide meter in shunt bypass piping with two ASME B16.5 Class 300 welding neck orifice flanges in the steam pipe main. In the shunt bypass piping, provide two flanged gate valves calibrated by the meter manufacturer. In the steam pipe main, provide 3.20 mm 0.125 inch thick stainless steel orifice plate sized to suit meter capacity between two ASME B16.5 Class 300 welding neck orifice flanges. [Provide six-dial counter with an electrical contactor to transmit signal to data terminal cabinet (DTC) for indicating steam flow in kg pounds.] [Provide remote totalizer for recording steam flow in kg pounds.] [Provide pressure compensated six-dial counter to automatically and continuously correct steam flow meter readings for steam pressure variations.]

2.4.9 Steam Meter-Strain Gage Target Flow Type

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NOTE: Refer to UFC 3-430-09, "Exterior Mechanical Utility Distribution" for selection of steam flow meter type.

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a. Operation: The steam meter must have four interconnected strain gages attached to the sensing tube, two in the forward side of flow, two on the reverse side of the flow, producing a four-active arm, bridge circuit. At zero flow, the bridge circuit is balanced and produces zero output. Forces from the fluid are transferred from the target to the sensing tube producing strain on the sensing tube. The bridge circuit becomes unbalanced producing an output to a microprocessor sending unit. A mass flow computer is connected to the sending unit for visual display.

b. Valve Body: ANSI Class 150; Inline type body with flanged ends - 303/304 stainless steel.

c. Sensing Element: 316 Stainless Steel.

d. Seals: Teflon, Vitron, Buna-N, Grafoil.

e. Sending Unit: Microprocessor design with 24-bit speed and accuracy, 4-20 mA output, programmable cutoff, two programmable open collector output hi/lo set points, RS-232 communications, open collector 0-1000hz square wave output.

Accuracy: 0.02 percent of rate.
Repeatability: 0.01 percent of rate.

Power: 16-30vdc, 24vdc at 100mA maximum with current loop connected at 4.00maDC.
Temperature: 0-60 degrees C 32-140 degrees F
Enclosure: Explosion proof type watertight housing.

f. Mass Flow Computer: Wall mounted. The mass flow computer indicates mass rate, mass totalization, flow rate, temperature, pressure and density.

  (1) Flow: Square wave digital pulse with plus or minus 0.057 percent accuracy.

  (2) Temperature: 4-wire RTD: 100 ohm platinum to European alpha 3850 curve;

  (3) Current loop; 4-20 mA; Accuracy: plus or minus 0.1 percent at 25 degrees C 77 degrees F.

  (4) Pressure: Current Loop: 4-20mA; Accuracy: plus or minus 0.1 percent at25 degrees C 77 degrees F.

  (5) Power: 120/240vac plus 10 percent to 15 percent. 50/60 Hz at .2amps. Temperature: 0-55 degrees C 32-131 degrees F.

2.4.10 Guided Slip Tube Expansion Joints

Internally-externally guided type, injected semiplastic type packing, with service outlets. Joints must be for minimum working pressure of ASME Class 150. Provide single or double slip tube type as indicated. Provide flanged or buttwelding end connections as indicated.

2.4.11 Flexible Ball Expansion Joints

Provide chromium plated steel balls capable of 360-degree rotation plus 15-degree angular flex movement. Provide pressure molded composition gaskets designed for continuous operation temperature of 274 degrees C 525 degrees F. Joints must be for minimum working pressure of ASME Class 150. Provide flanged or buttwelding end connections as indicated.

2.4.12 Bellows Expansion Joints

Type 304 stainless steel corrugated bellows, reinforced with rings, internal sleeves, and external protective covers. Provide limit stops to limit total movement in both directions. Cold set the joints to compensate for temperature at time of installation. Joints must withstand 10,000 cycles over a 20 year period. Joints must be for minimum working pressure of ASME Class 150. Provide single or double bellows expansion joint as indicated. Provide first pipe alignment guide no more than four pipe diameters from the expansion joint; provide second pipe alignment guide no more than 14 pipe diameters from the first guide. Provide flanged or buttwelding end connections as indicated.

2.5 POLES SUPPORTING ABOVEGROUND PIPING

2.5.1 Concrete Poles

Provide under this section as specified in Section 03 45 33 PRECAST[PRESTRESSED] STRUCTURAL CONCRETE. Accurately set the top fittings to grade by means of adjusting screws, and grout in place. Provide high-strength grout consisting of one part portland cement and two parts clean, sharp sand with minimal water to make a workable grout. Wet tops of poles before placing the grout. Prevent grout leaks around the bottom of the fittings which streak or disfigure the concrete. Discoloration or disfiguring of concrete will not be permitted.

2.5.2 Steel Pipe Poles

a. ASTM A53/A53M: Type E (electric-resistance welded, Grade A or B) or Type S (seamless, Grade A or B; hot-dip galvanized, Weight Class STD (Standard).

b. ASTM A106/A106M: Grade A or B, hot-dip galvanized, Schedule No. 40 for pipe sizes through 250 mm 10 inches, and minimum pipe wall thickness of 9.50 mm 0.375 inch for pipe sizes 300 mm 12 inches and larger.

2.5.3 Guy Wires, Fittings, and Hardware

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NOTE: Use a minimum factor of safety of 3.0 . Use 9.5 mm 3/8 inch minimum wire strand thickness.

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a. Guy Wires: ASTM A475, high strength grade, extra galvanized, stranded with seven wires in each strand. Wire must be a minimum of 9.5 mm 3/8 inch diameter. Provide thimbles at each end of guy wire. Prestress guy wires until taut.

b. Anchor Rods and Anchors: Provide thimble-eye, 32 mm 1.25 inch diameter steel rod with 250 mm 10 inch diameter screw anchor, hot-dip galvanized.

c. Turnbuckles: Provide open turnbuckles, forged steel body, with jaw and jaw end pulls, 9.50 mm 0.375 inch size, hot-dip galvanized.

d. Clamps: Provide hot-dip galvanized forged high carbon steel clamps capable of developing full strength of guy wire, and fitted with galvanized heat-treated bolts. Provide two clamps at each connection of guy wire.

2.5.4 Miscellaneous Metal

ASTM A36/A36M, standard mill finished structural shapes, hot-dip galvanized after fabrication.

2.5.5 Fastenings

Provide steel bolts and oversized nuts conforming to ASTM A307. Galvanize in accordance with ASTM A153/A153M. Provide nuts with an approved means for locking to ensure nuts remain tight under severe service, including vibrations. Drive bolts to a tight fit without injury to the threads. Bolts with injured threads will not be permitted. Drill holes 1.60 mm 1/16 inch larger than bolts; burning of holes will not be permitted. Tighten bolts to the required torque.

2.6 MANHOLE DRAINERS (EJECTORS)

Provide automatic type drainers to operate on 862 kPa (gage) 125 psig steam supply. The drainer must operate when the water level rises sufficiently in the sump, the float must rise and open the steam control valve to admit steam to the drainer, which in turn must pump the water from the sump. When the water level is lowered by the pumping action, the float must lower and close the steam valve to stop the pumping action until water again gathers in the sump. Provide each drainer with controls to accomplish the above sequence of operation. The automatic float-operated steam valve must be designed to prevent dead centering under field conditions and to lengthen the life of the valve seat. The valve must have a high grade, renewable composition disc and a stainless steel or hard, noncorrosive bronze renewable seat inserted in the valve body. The drainer must be constructed of corrosion-resistant copper and bronze. Piping from manhole drainers must be ASTM A53/A53M, Weight Class XS (Extra Strong), hot-dip galvanized steel pipe with ASME B16.11 or ASME B16.3, Class 300, hot-dip galvanized threaded fittings. Provide a steam pressure regulating valve assembly for manhole drainers for operation on steam system above 862 kPa (gage) 125 psig.

2.7 CONCRETE MANHOLES

Provide under this section as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE, except as modified herein. Concrete must be of 30 MPa 4000 psi minimum 28 day compressive strength, air entrained admixture (133 grams per cubic meter 3.6 ounces per cubic yard), with water-reducing admixture (814 grams per cubic meter 22 ounces per cubic yard), reinforced with deformed steel bars. Construct manhole sides by one monolithic pour. Cast-iron steps with nonslip surfaces, and spaced 300 to 400 mm 12 to 16 inches apart on centers must be firmly embedded in concrete walls for access to bottom of manholes. Provide top of manhole as indicated. [Steel grating covers for manholes must be welded parallel bearing bars, with right angle cross members, zinc coated after fabrication; size as indicated.]

2.8 BURIED PIPING UNDER ROADS

Provide [new and modify existing] buried factory-prefabricated preinsulated steam and condensate piping in accordance with Section 33 63 13 EXTERIOR UNDERGROUND STEAM DISTRIBUTION SYSTEM.

2.8.1 Carrier Piping

2.8.1.1 Steam Piping

Provide steel piping.

2.8.1.2 Condensate Piping

Provide steel piping.

2.8.2 Piping Insulation for Carrier Piping

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NOTE: The insulation thickness indicated is suitable for most geographical regions. However, if the project is located in a region where extreme annual temperatures occur, the design engineer should evaluate the insulation thickness based on an economical analysis, with the approval of the Mechanical Engineering Branch.

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Products containing asbestos will not be permitted.

2.8.2.1 Insulation for Steam Piping

Nominal Pipe Sizes (mm)	Calcium Silicate Insulation Cellular Glass Insulation (mm)	Mineral Fiber Insulation (mm)
less than 80	76.20	63.50
80 thru 100	88.90	76.20
125 thru 150	101.60	88.90
200 and larger	127.00	114.30

Nominal Pipe Sizes (inches)	Calcium Silicate Insulation Cellular Glass Insulation (inches)	Mineral Fiber Insulation (inches)
less than 3	3.0	2.5
3 thru 4	3.5	3.0
5 thru 6	4.0	3.5
8 and larger	5.0	4.5

2.8.2.2 Insulation for Steam Condensate Carrier Piping

Nominal Pipe Sizes (mm)	Calcium Silicate Insulation Cellular Glass Insulation (mm)	Mineral Fiber Insulation (mm)
less than 80	50.80	38.10
80 thru 100	63.50	50.80
125 and larger	76.20	63.50

Nominal Pipe Sizes (inches)	Calcium Silicate Insulation Cellular Glass Insulation (inches)	Mineral Fiber Insulation (inches)
less than 3	2.0	1.5

Nominal Pipe Sizes (inches)	Calcium Silicate Insulation Cellular Glass Insulation (inches)	Mineral Fiber Insulation (inches)
3 thru 4	2.5	2.0
5 and larger	3.0	2.5

2.8.3 Cathodic Protection

Provide sacrificial anode type cathodic protection system for metal conduits.

2.8.4 Buried Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape in rolls, 80 mm 3 inches minimum width, color coded for the utility involved, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification must read CAUTION BURIED STEAM PIPING BELOW OR similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

PART 3 EXECUTION

3.1 INSTALLATION

Installation of exterior steam distribution system including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.1, except as modified herein. Install piping straight and true to bear evenly on supports and sand bedding material. Install valves with stems horizontal or above. Provide flanges or unions at valves, traps, strainers, connections to equipment, and as indicated.

3.1.1 Cleaning of Piping

Keep the interior and ends of new piping and existing piping affected by the Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

3.1.2 Demolition

Remove materials so as not to damage materials which are to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

3.2 PIPING

Test, inspect, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for connections. Reducing branch connections in steel piping may be made with forged branch outlet reducing fittings for branches two or more pipe sizes smaller than mains. Branch outlet fittings must be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Stab type connections will not be permitted. Jointing compound for pipe threads must be Teflon pipe thread paste. Pipe nipples 150 mm 6 inches long and shorter must be Schedule 80 steel pipe. Make changes in piping sizes through tapered reducing fittings; bushings will not be permitted. Condensate piping must include drip, vent, relief, and gage connecting piping.

3.2.1 Fittings and End Connections

For sizes less than 25 mm one inch provide threaded fittings and end connections. For sizes 25 to 50 mm one to 2 inches provide threaded or socket-welding or buttwelding fittings and end connections; provide threaded connections for threaded valves, traps, strainers, and threaded connections to equipment. For sizes 65 mm 2.5 inches and larger provide buttwelding fittings and end connections; provide flanged connections for flanged valves, traps, strainers, and flanged connections to equipment.

3.2.2 Welding

ASME B31.1, metallic arc process, including qualification of welders.

3.2.3 Pipe Hangers and Supports

Provide additional hangers and supports for concentrated loads in piping between hangers and supports, such as for valves. Support steel piping as follows:

MAXIMUM SPACING (METER)									
Pipe Size (mm)	25 and under	40	50	80	100	150	200	250	300
Steel Piping	2.70	3.70	4.00	4.60	5.20	6.40	7.30	8.00	9.20

MAXIMUM SPACING (FEET)									
Pipe Size (inches)	one and under	1.5	2	3	4	6	8	10	12
Steel Piping	9	12	13	15	17	21	24	26	30

3.2.4 Buried Piping Under Roads

Installation including field joints, bedding, and initial backfill must be in accordance with the Approved Brochure.

3.3 NAMEPLATES

Provide laminated plastic nameplates for equipment, gages, thermometers, and valves. Nameplates must be melamine plastic, 3.20 mm 0.125 inch thick, black with white center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the white core. Minimum size of nameplates must be 25 by 65 mm one by 2.5 inches. Lettering must be minimum of 6.40 mm 0.25 inch high normal block style. Key the nameplates to a chart and schedule for each system. Frame charts and schedules under glass, and locate where directed near each system. Furnish two copies of each chart and schedule.

3.4 FIELD QUALITY CONTROL

3.4.1 Inspections

Prior to initial operation, inspect piping system for compliance with drawings, specifications, and manufacturer's submittals.

3.4.2 Piping Tests

Before final acceptance of the work, test each system as in service to demonstrate compliance with contract requirements. Before insulation is applied, hydrostatically test each piping system at not less than 1551 kPa (gage) 225 psig in accordance with ASME B31.1, with no leakage or reduction in gage pressure for 2 hours. Flush and clean piping before placing in operation. Flush piping at a minimum velocity of 2.40 meters per second 8 fps. Correct defects in work provided by Contractor and repeat tests until work is in compliance with contract requirements. Furnish potable water, electricity, instruments, connecting devices, and personnel for the tests.

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NOTE: On projects that provide modifications to existing piping systems, pneumatic pressure testing and hydraulic pressure testing of newly installed piping is much more difficult than the same testing on a complete new system. Therefore, by means of the following design techniques, provide for the Contractor a piping modification design that facilitates acceptance testing: piping design which includes flanges at appropriate locations for flanged blanks to be installed for testing; specifications which include requirements for how the modified piping must be pressure tested; specifications which specify which pipe sections must be pressure tested in the shop if absolutely necessary.

****

3.4.3 Buried Piping Under Roads

Installation including field joints, bedding, and initial backfill must be in accordance with the Section 33 63 13 EXTERIOR UNDERGROUND STEAM DISTRIBUTION SYSTEM. Bury tape with the printed side up at a depth of 300 mm 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

3.4.3.1 Conduit Coating

Test conduit coating of buried piping under roads prior to backfill in accordance with the approved brochure.

3.4.3.2 Cathodic Protection

Test cathodic protection of buried piping under roads to prove continuity of electrical connections prior to backfill.

3.5 FIELD PAINTING

After completion of field inspections and tests, clean and paint metal surfaces exposed to the weather and in manholes, including valves, strainers, traps, flow meters, pipe flanges, bolts, nuts, washers, pipe hangers, supports, expansion joints, and miscellaneous metal. Do not paint piping prior to the application of field-applied insulation. Do not paint stainless steel or aluminum jackets. Apply paint to clean dry surfaces. Clean surfaces to remove dust, dirt, rust, oil, and grease. Provide surfaces with two coats of enamel paint applied to a total minimum dry film thickness of 0.05 mm 2 mils. Apply the second coat of paint after the preceding coat is thoroughly dry. Color of finish coat must be aluminum or light gray. Paint must be rated for use on hot metal surfaces up to 232 degrees C 450 degrees F and for use on surfaces exposed to the weather.

3.6 CONNECTIONS TO EXISTING SYSTEMS

Notify the Contracting Officer in writing at least 15 days prior to the date the connections are required. Obtain approval before interrupting service. Provide materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 71 01 (May 2019)**
Change 1 - 11/19

Preparing Activity: NAVFAC **Superseding**
UFGS-33 71 01 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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05/19, CHG 1: 11/19

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 71 01 (May 2019)**

Change 1 - 11/19

Preparing Activity: NAVFAC **Superseding**
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References are in agreement with UMRL dated January 2025

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SECTION 33 71 01

OVERHEAD TRANSMISSION AND DISTRIBUTION
05/19, CHG 1: 11/19

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NOTE: This guide specification covers the requirements for overhead electrical work and utility poles.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: This guide specification is for 0-35 kV Overhead Transmission and Distribution and does not cover all possible methods or requirements for providing overhead facilities. To do so would be to produce an involved, confusing document. This guide specification presents the usual methods and the most used alternatives. Different materials and methods, properly specified, indicated, and economically used will be acceptable when approved by cognizant authority.

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NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

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NOTE: The following information should be shown on the drawings:

1. Conductor sizes, types, and materials.

2. Guy strand type, size, and length.

3. Primary fused cutout; give voltage rating and state fusing (ampere rating) and "K" quick or "T" tardy required for coordination with existing upstream sectionalizing equipment.

4. Pole top switch. State voltage, current, and other operating characteristics. The applicable switch ratings are stated in IEEE C37.30.

5. Meter connections (can be determined from NEMA/ANSI C12.10 or similar source).

6. Anchor type, description, and dimensions suitable for the ultimate load and the specific soil at location.

7. Indicate ruling span (average span length plus 2/3 of the difference between the longest and the average span).

8. Sag table(s) for the specific conductor, the ruling span(s) and the loading zone.

9. The mechanical strength of crossarms, insulators, pins, guys and anchors must be engineered for each job and the dimensions, materials, and other descriptions covered by drawings. Strength requirements of IEEE C2 are minimum.

10. Avian protection on power lines as required by the Federal, State, and Local Land Management or Wildlife Conservation Agencies.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of

the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

ATIS ANSI O5.1	(2017) Wood Poles -- Specifications & Dimensions

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C4	(2003) Poles - Preservative Treatment by Pressure Processes
AWPA C25	(2003) Sawn Crossarms - Preservative Treatment by Pressure Processes

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2024b) Standard Specification for

	Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A576	(2023) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B2	(2013) Standard Specification for Medium-Hard-Drawn Copper Wire
ASTM B3	(2013; R 2024) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B230/B230M	(2022) Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes
ASTM B231/B231M	(2023) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B232/B232M	(2024) Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ASTM B398/B398M	(2022) Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes
ASTM B399/B399M	(2023) Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
ASTM B857	(2018) Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Alunimum Conductors, Coated-Steel Supported (ACSS/TW)
ASTM D92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97	(2017b) Standard Test Method for Pour Point of Petroleum Products

ASTM D117	(2018) Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D877/D877M	(2019) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D3487	(2016; E2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 18	(2012) Standard for Shunt Power Capacitors
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.30.1	(2011)Standard Requirements for AC High-Voltage Air Switches Rated Above 1000 V
IEEE C37.41	(2016; Corr 2017) Design Tests for High-Voltage (>1000 V) Fuses and Accessories
IEEE C37.42	(2016) Specifications for High-Voltage (> 1000 V) Fuses and Accessories
IEEE C37.63	(2024) Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers for AC Systems
IEEE C57.12.00	(2021) General Requirements for Liquid-Immersed Distribution, Power, and

	Regulating Transformers
IEEE C57.12.20	(2023) Overhead-Type Distribution Transformers, 500 KVA and Smaller: High Voltage, 34 500 Volts and Below; Low Voltage, 7970/13,800 Y V and Below
IEEE C57.12.28	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.31	(2010; Corr 2014) Standard for Pole-Mounted Equipment - Enclosure Integrity
IEEE C57.12.90	(2021) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C57.15	(2018) Standard Requirements, Terminology, and Test Code for Step-Voltage Regulators
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE C135.1	(1999) Standard for Zinc-Coated Steel Bolts and Nuts for Overhead Line Construction
IEEE C135.2	(1999) Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction
IEEE C135.22	(1988) Standard for Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
IEEE C135.30	(1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-111	(2019) High Voltage Switchgear And Controlgear - Part 111: Automatic Circuit Reclosers for Alternating Current Systems up to and including 38 kV

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7	(2022) Requirements for Watthour Meter Sockets
ANSI C29.2	(2020) American National Standard for Insulators - Wet-Process Porcelain and Toughened Glass - Distribution Suspension Type
ANSI C29.3	(2015; R 2022) American National Standard for Wet Process Porcelain Insulators - Spool Type
ANSI C29.4	(2022) Standard for Wet-Process Porcelain Insulators - Strain Type
ANSI C29.5	(2022) Wet-Process Porcelain Insulators (Low and Medium Voltage Pin Type)
ANSI/NEMA WC 71/ICEA S-96-659	(2014; R 2022) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
NEMA/ANSI C12.10	(2011; R 2021) Physical Aspects of Watthour Meters - Safety Standard
NEMA/ANSI C29.7	(1996; 2002) American National Standard for Wet Process Porcelain Insulators - High-Voltage Line Post Type

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 202-1	(2004) List of Materials Acceptable for Use on Systems of RUS Electrification Borrowers
RUS Bull 1728H-701	(1993) Wood Crossarms (Solid and Laminated), Transmission Timbers and Pole

Keys

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 712-C-98-075	(1998) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
EPA 821-R-02-012	(2002) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section with additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Conductors; G, [_____]

Insulators; G, [_____]

Concrete Poles; G, [_____]

Steel Poles; G, [_____]

Wood Poles

Nameplates; G, [_____]

Pole Top Switch; G, [_____]

Recloser; G, [_____]

Sectionalizer; G, [_____]

Cutouts; G, [_____]

Transformer; G, [_____]

Metering Equipment; G, [_____]

Meters; G, [_____]

Surge Arresters; G, [_____]

Capacitors; G, [_____]

Voltage Regulator; G, [_____]

Guy Strand

Anchors

SD-05 Design Data

Concrete Poles; G, [_____]

Steel Poles; G, [_____]

Power-Installed Screw Foundations; G, [_____]

SD-06 Test Reports

Wood Crossarm Inspection Report

Field Test Plan; G, [_____]

Field Quality Control; G, [_____]

Ground Resistance Test Reports; G, [_____]

Medium-Voltage Preassembled Cable Test; G, [_____]

Sag and Tension Test; G, [_____]

Low-Voltage Cable Test; G, [_____]

Acceptance Checks and Tests; G, [_____]

SD-07 Certificates

Concrete Poles; G, [_____]

Steel Poles; G, [_____]

Wood Poles; G, [_____]

Wood Crossarms; G, [_____]

Transformer Efficiencies; G, [_____]

SD-09 Manufacturer's Field Reports

Operation and Maintenance Manuals; G, [_____]

Transformer Test Schedule; G, [_____]

Overhead-type Distribution Transformer Routine and Other Tests; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 5; G, [_____]

[1.4.1 Government Submittal Review

****

NOTE: Use the following paragraph and subparagraphs regarding transformer submittals for NAVFAC projects. In the bracketed option, insert your appropriate NAVFAC Component organization and code. For other projects, submittal review must be performed by the designer of record. If submittal review by NAVFAC LANT is specifically desired, the responsible Government agency must coordinate with NAVFAC LANT, Code C144 during the design process. Add appropriate information in Section titled "Submittal Procedures" to coordinate with the special requirements.

****

[Code [C144][_____], NAVFAC [Atlantic] [_____] will review and approve transformer submittals.] As an exception to this paragraph, transformers manufactured by ABB in Athens, GA; by Cooper Power Systems in Lumberton, MS; by ERMCO in Dyersburg, TN; or by Howard Industries in Laurel, MS need not meet the submittal requirements of this contract. Instead, the following must be submitted.

a. A certification, from the manufacturer stating, that the manufacturer will meet the technical requirements of this specification.

b. Provide transformer test schedule and routine and other tests required by submittal item "SD-09 Manufacturer's Field Reports."

c. Provide Provide acceptance test reports received by submittal item "SD-06 Test Reports."

d. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data."

]1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory except of NFPA 70 when more stringent requirements are specified or indicated, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and IEEE C2 unless more stringent requirements are specified or indicated.

1.5.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 2-years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site must not be used, unless specified otherwise.

1.5.3 Ground Resistance Test Reports

Submit the measured ground resistance of grounding system. When testing grounding electrodes and grounding systems, identify each grounding electrode and each grounding system for testing. Include the test method and test setup (i.e. pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

1.5.4 Wood Crossarm Inspection Report

Furnish an inspection report from an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with applicable AWPA and RUS standards. The RUS approved Quality Mark "WQC" on each crossarm will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.5.4.1 Field Test Plan

Provide a proposed field test plan [20] [30] [_____] days prior to testing the installed system. No field test must be performed until the test plan is approved. The test plan must consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

1.6 OPERATIONS AND MAINTENANCE DATA

Provide operation and maintenance manuals for systems in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provides basic data relating to the design, operation, and maintenance of the electrical distribution system.

1.6.1 Additions to Operations and Maintenance Data

In addition to requirements of Data Package 5, include the following in the operation and maintenance manuals provided:

a. Assembly and installation drawings

b. Prices for spare parts and supply list

c. Date of purchase

1.7 DELIVERY, STORAGE, AND HANDLING

Devices and equipment must be visually inspected by the Contractor when received and prior to acceptance from conveyance. Protect stored items from the environment in accordance with the manufacturer's published instructions. Replace damaged items. Store oil filled transformers and switches in accordance with the manufacturer's requirements. Store wood poles held in storage for more than 2 weeks in accordance with ATIS ANSI O5.1. Handle wood poles in accordance with ATIS ANSI O5.1, except that pointed tools capable of producing indentations more than inch in depth must not be used. Nails and holes are not permitted in top of poles. Handle and store metal poles in accordance with the manufacturer's instructions.

1.8 WARRANTY

The equipment items must be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

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NOTE: A 120-hour test will be specified in a noncorrosive environment and a 480-hour test will be specified in a corrosive environment.

****

Consider materials specified herein or shown on contract drawings which are identical to materials listed in RUS 202-1 as conforming to requirements. Provide equipment and component items, not hot-dip galvanized or porcelain enamel finished, with corrosion-resistant finishes which must withstand [120] [480] hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm 1/16 inch from the test mark. Provide the described test mark and test evaluation in accordance with ASTM D1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Coat cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel with a zinc rich paint conforming to the manufacturer's standard.

2.2 POLES

****

NOTE: Use "class" for wood poles and "strength" for concrete and steel poles. Follow local utility practice regarding grounding metallic items on poles, after coordination with local DPW/BCE. Specify clearances and climbing space in accordance with IEEE C2 or applicable state code.

****

Provide poles of lengths and [classes] [strengths] indicated.

2.2.1 Wood Poles

****
NOTE: For NAVFAC LANT projects, do not use lodgepole pine or Western Larch poles.
****

Wood poles machine trimmed by turning, [Douglas Fir] [Lodgepole Pine] [Western Larch] [Southern Yellow Pine] [_____] conforming to ATIS ANSI O5.1. Gain, bore and roof poles before treatment. Should additional gains be required subsequent to treatment, metal gain plates must be provided. Pressure treat poles with [pentachlorophenol,] [ammoniacal copper arsenate (ACA),] [chromated copper arsenate (CCA)], except that Douglas Fir and Western Larch poles must not be treated with CCA in accordance with AWPA C1 and AWPA C4. Ensure the quality of each pole with "WQC" (wood quality control) brand on each piece, or by an approved inspection agency report.

2.2.2 Steel Poles

Design steel poles to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors, hot-dip galvanized in accordance with ASTM A123/A123M and not painted. Poles must have tapered tubular members, either round in cross-section or polygonal, and comply with strength calculations performed by a registered professional engineer. Submit calculations in accordance with the design data portion of paragraph SUBMITTALS. Provide certification, from the manufacturer, that the technical requirements of this specification must be met. Pole shafts must be one piece. Poles must be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings must be approximately 900 to 1270 mm 3 to 4 feet above grade and must include manufacturer, year of manufacture, top and bottom diameters, length, and a loading tree. Provide attachment requirements as indicated, including grounding provisions. Climbing facilities are not required. Bases must be of the anchor-bolt-mounted type.

2.2.3 Concrete Poles

****
NOTE: In areas where freezing temperatures occur, the minimum compressive strength given for concrete in spun poles should be increased in line with concrete design for such temperatures.
****

Design concrete poles to withstand the loads specified in IEEE C2 multiplied by the appropriate overload capacity factors. Poles must be reinforced or prestressed, either cast or spun. Spun poles must be manufactured by a centrifugal spinning process with concrete pumped into a polished round tapered metal mold. Concrete for spun poles must have a compressive strength of at least 34.5 MPa 5000 psi at 28 days; steel wire must have an ultimate tensile strength of at least 827 MPa; 120,000 psi; and reinforcing bars must have an ultimate tensile strength of at least 276 MPa 40,000 psi. After the high speed spinning action is completed, a spun pole must be cured by a suitable wet steam process. Spun poles must have a water absorption of not greater than three percent to eliminate cracking and to prevent erosion. Concrete poles must have hollow shafts. Poles must have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost. Poles must not be installed for at least 15 days after manufacture. Provide fittings and brackets that conform to the concrete pole design. Poles must conform to strength calculations performed by a registered professional engineer and submitted in accordance with design data portion of paragraph SUBMITTALS. Provide certification, from the manufacturer, that the technical requirements of this specification must be met.

2.3 CROSSARMS AND BRACKETS

2.3.1 Wood Crossarms

Conform to RUS Bull 1728H-701. Pressure treat crossarms with pentachlorophenol, chromated copper arsenate (CCA), or ammoniacal copper arsenate (ACA). Treatment must conform to AWPA C25. Crossarms must be solid wood, distribution type, and a 6.4 mm 1/4 inch 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions must be 108.0 mm 4-1/4 inches in height by 82.6 mm 3-1/4 inches in depth in accordance with IEEE C2 for Grade B construction. Crossarms must be 2.4 m 8 feet in length, except that 3.1 m 10 foot crossarms must be used for crossarm-mounted banked single-phase transformers or elsewhere as indicated. Crossarms must be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling must be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling must provide required climbing space and wire clearances. Crossarms must be straight and free of twists to within 2.5 mm per 304.8 mm 1/10 inch per foot of length. Bend or twist must be in one direction only.

2.3.2 Crossarm Braces

Provide [flat steel][or][steel angle] as indicated. Provide braces with [965 mm span with 2440 mm crossarms][and][1520 mm span with 3050 mm crossarms] [38 inch span for 8 foot crossarms][and][60 inch span for 10 foot crossarms].

2.3.3 Armless Construction

Pole mounting brackets for line-post or pin insulators and eye bolts for suspension insulators must be as indicated. Brackets must be attached to poles with a minimum of two bolts. Brackets may be either provided integrally as part of an insulator or attached to an insulator with a suitable stud. Bracket mounting surface must be suitable for the shape of the pole. Brackets for wood poles must have wood gripping members. Horizontal offset brackets must have a 5-degree uplift angle. Pole top brackets must conform to IEEE C135.22, except for modifications necessary to provide support for a line-post insulator. Brackets must provide a strength exceeding that of the required insulator strength, but in no case less than a 12.5 kN 2800 pound cantilever strength.

2.4 HARDWARE

****

NOTE: In corrosive environments, galvanized steel pole-line hardware may not be acceptable and only hot-dip galvanized malleable or ductile iron should be permitted. Utilize the following sentence requiring hot-dip galvanized hardware in corrosive environments defined as those project locations in Environmental Severity Classification (ESC) C3 thru

C5. See UFC 1-200-01 for determination of ESC for project locations. For other locations, local usage should be checked. Navy projects require hot-dip galvanized hardware only.

****

Hardware must be hot-dip galvanized in accordance with ASTM A153/A153M and ASTM A123/A123M.

****

NOTE: Do not use this paragraph for Navy projects. The pole line construction criteria for the Navy, including the listing of materials, is covered in the pole plates.

****

[Zinc-coated hardware must comply with IEEE C135.1, IEEE C135.2, IEEE C135.22. Steel hardware must comply with ASTM A575 and ASTM A576. Pole-line hardware must be hot-dip galvanized[steel.][steel, except anchor rods of the copper-molten welded-to-steel type with nonferrous corrosion-resistant fittings must be used.] Intall washers under boltheads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts must be approximately 57.2 mm square 2-1/4 inches square and 4.8 mm 3/16 inch thick. The diameter of holes in washers must be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts must be of the proper size to fit over square shanks of bolts. Use eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators.

]2.5 INSULATORS

****

NOTE: Stipulate insulator class required for each application. The following table suggests insulator types from specific ANSI Standards for application under normal conditions. Number followed by diagonal slash indicates quantity of insulators when other than one. Environments with unusual contaminant conditions would require special treatment. Spool insulators for use with brackets, or devices to support the neutral-messenger of triplex or quadruplex, secondary or service cables should conform to ANSI C29.3 Class 53-2. Use the values in Table II for NAVFAC LANT projects.

TABLE I

Voltage kV	NESC min. dry flashover kV	ANSI C29.5 Pin	NEMA/ANSI C29.7 Post ("L" or "S")	ANSI C29.2A and ANSI C29.2B Suspension	ANSI C29.4 Guy Strain
5. or less	20	55-1	57-1	52-1	54-1

TABLE I

Voltage kV	NESC min. dry flashover kV	ANSI C29.5 Pin	NEMA/ANSI C29.7 Post ("L" or "S")	ANSI C29.2A and ANSI C29.2B Suspension	ANSI C29.4 Guy Strain
7.2	39	55-3	57-1	2/52-1 or 2/52-9	54-1
15	55	55-3	57-1	2/52-1 or 2/52-9	54-2
25	75	55-6 C29.6	57-2	2/52-4	54-3
35	100	56-3	57-2	3/52-4	54-3

TABLE II

Voltage kV	NEMA C29.3 Spool	ANSI C29.5 Pin	NEMA/ANSI C29.7 Post ("L" or "S")	ANSI C29.2A and ANSI C29.2B Suspension	ANSI C29.4 Guy Strain
5. or less	53-2	55-3	57-1	52-1	54-4
15	53-2	55-3	57-1	2/52-1	54-4
35	53-2	--	57-4	3/52-4	54-4

When specifying or indicating post insulators, add the appropriate "L" or "S" designation indicating "L" long studs or "S" short. Example: "57-1L" would indicate an insulator for wood crossarms and "57-1S" would indicate an insulator for use on must members. When the engineer determines that station policy differs from these requirements, insulators which match the policy in effect at the station must be specified by ANSI reference and class. Insulator flashover values must be determined from Table 273-1, IEEE C2. In areas with severe lightning problems, transmission line corners and dead ends should be provided with special pressure-treated wood-guy insulators having arcing horns for lighting discharge. In addition to being used with underground terminals, use fiberglass guy strain insulators where other interference problems exist.

****

Provide wet-process porcelain insulators which are radio interference free.

[a. Line post type insulators: NEMA/ANSI C29.7, Class [_____].

][b. Suspension insulators: ANSI C29.2 [4/52-4 for 34.5 kV on NAVSTA NORVA], Quantity per Phase, [_____], Class [_____].

][c. Spool insulators: ANSI C29.3, Class [_____].

][d. Guy strain insulators: ANSI C29.4, Class [_____], [except provide fiberglass type when used with underground terminal or when other interference problems exist].

][e. Pin insulators: ANSI C29.5, Class [_____].

]2.6 OVERHEAD CONDUCTORS, CONNECTORS AND SPLICES

****

NOTE: For NAVFAC LANT projects, do not use "aluminum conductor steel reinforced (ACSR)."

****

Conductors of bare [copper] [aluminum (AAC)] [aluminum alloy (AAAC)] [aluminum conductor steel reinforced (ACSR)] [aluminum conductor steel supported (ACSS)] of sizes and types indicated.[Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486A-486B must be used.]

2.6.1 Solid Copper

ASTM B1, ASTM B2, and ASTM B3, hard-drawn, medium-hard-drawn, and soft-drawn, respectively. ASTM B8, stranded.

2.6.2 Aluminum (AAC)

ASTM B230/B230M and ASTM B231/B231M.

2.6.3 Aluminum Alloy (AAAC)

ASTM B398/B398M or ASTM B399/B399M.

2.6.4 Aluminum Conductor Steel Reinforced (ACSR)

ASTM B232/B232M, aluminum.

2.6.5 Aluminum Conductor Steel Supported (ACSS)

ASTM B857, aluminum.

2.6.6 Connectors and Splices

Connectors and splices must be of copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors. Aluminum-composition, aluminum-composition to copper, and copper-to-copper must comply with UL 486A-486B.

2.7 NEUTRAL-SUPPORTED SECONDARY AND SERVICE DROP CABLES

****

NOTE: The term "secondary," for our general purpose, means either bare or insulated conductors

installed between poles and operated at the utilization voltage. Bare conductors should be utilized on long span, open wire design when a neutral-supported secondary cable is not appropriate due to weight. When using bare conductors for secondary applications use the above paragraph entitled "Overhead Conductors". "Services" are insulated conductors extending from a pole to the metering point or service entrance connection at the utilization point. Minimum conductor size for aluminum, aluminum alloy, ACSR, or ACSS must be No. 4 AWG and for copper, No. 6 AWG. For NAVFAC LANT projects, do not use ACSR.

****

[Service][Secondary] cables must be [aluminum] [copper], [triplex] [quadruplex] with cross-linked polyethylene insulation on the phase conductors. Neutral must be bare [ACSR] [ACSS] [aluminum alloy] [hard drawn copper] and must be the same size as the phase conductors unless otherwise indicated. Cables shall conform to [NEMA WC 70][and][ANSI/NEMA WC 71/ICEA S-96-659] [ASTM B857] for cross-linked polyethylene insulation.

2.8 GUY STRAND

[ASTM A475, [high-strength] [extra high-strength], Class A or B, galvanized strand steel cable][Class 30 [high-strength] [extra high-strength] copper-clad steel]. Guy strand must be [_____] mm inch in diameter with a minimum breaking strength of [_____] Newton pounds. Provide guy terminations designed for use with the particular strand and developing at least the ultimate breaking strength of the strand.

2.9 ROUND GUY MARKERS

Vinyl or PVC material, [white] [yellow] colored, 2440 mm 8 feet long and shatter resistant at sub-zero temperatures.

2.9.1 Guy Attachment

Thimble eye guy attachment.

2.10 ANCHORS AND ANCHOR RODS

****

NOTE: Complete guy-anchor assembly must provide strength conforming to IEEE C2 for the grade of construction of the line. Designated maximum holding power rating assumes proper installation in Class 5 soil (medium dense coarse sand and sandy gravels; stiff to very stiff and slays). When the anchor is installed in poorer soils, the holding power of the anchor must be derated by 25 percent in Class 6 soil, 50 percent in Class 7 soil. For Class 8 soil it is usually necessary to use power driven screw anchors which can penetrate the poor soil into firmer soil. In areas of extremely high chemical activity of the soil, anchor rods and ground rods must be completely encased in concrete to point 100 mm 4 inches above finished grade. Anchors must be a

special unit to be indicated.

****

Anchors must present holding area indicated on drawings as a minimum. Anchor rods must be triple thimble-eye, [19] [25] mm diameter by 2440 mm [3/4] [one] inch diameter by 8 feet long. Anchors and anchor rods must be hot dip galvanized.

2.10.1 Screw Anchors

****

NOTE: For NAVFAC LANT projects normally use screw type anchors. Provide Newton pound rating and leave out "[fitting Class 6000]."

****

Screw type [swamp] anchors having a manufacturer's rating [of not less than [_____] Newton pounds in loose to medium sand/clay soil, Class 6] [at least equal to rating indicated] and extra heavy pipe rods conforming to ASTM A53/A53M, Schedule 80, and couplings conforming to ASME B16.11, [fitting Class 6000.]

2.10.2 Plate Anchors

Minimum area of [_____] square mm inches and rated by manufacturer for [_____] Newton pounds or more in soils classified as medium dense coarse sand and sandy gravels; firm to stiff clays and silts.

2.10.3 Rock Anchors

Rock anchors having a manufacturer's rating of [102,310][160,130] Newtons [23,000][36,000] pounds.

2.11 GROUNDING AND BONDING

2.11.1 Driven Ground Rods

****

NOTE: Use "copper-clad steel" ground rods for NAVFAC LANT projects.

****

Provide cone pointed [copper-clad steel ground rods conforming to UL 467][zinc-coated steel ground rods conforming to IEEE C135.30][solid stainless steel ground rods] not less than 19 mm 3/4 inch in diameter by 3.1 m 10 feet in length. Sectional type rods may be used for rods 6.1 m 20 feet or longer.

2.11.2 Grounding Conductors

ASTM B3. Provide soft drawn copper wire ground conductors a minimum No. 4 AWG. Ground wire protectors must be PVC. Keep ground conductors straight and short. Minimize bends in all ground connections.

2.11.3 Grounding Connections

UL 467. Exothermic weld or compression connector.

2.12 SURGE ARRESTERS

****

NOTE: Rating of lightning (surge) arresters should be 125 percent of the nominal line-to-ground voltage of four-wire, multi-grounded neutral systems; 80 percent of the nominal line-to-line voltage for three-wire, solidly grounded neutral systems; or nominal line-to-line voltage for delta and ungrounded-wye systems. Distribution class arresters should normally be used. However, use intermediate class on the 34.5 kV system at Naval Base, Norfolk, VA.

****

IEEE C62.11, metal oxide, polymeric-housed, surge arresters arranged for [crossarm] [equipment] mounting. RMS voltage rating must be [3] [6] [9] [10] [12] [15] [27] [30] [36] kV. Arresters must be [Distribution] [Intermediate] [Station] class.

2.13 FUSED CUTOUTS

****

NOTE: For NAVFAC LANT projects, use "open type" cutouts with Type "K" fuses as indicated.

Provide IEEE C37.41 rated backup current limiting fuses in series with Type K (fast-acting) expulsion fuses on systems that are: greater than 15 kV; 15 kV and lower that have available fault currents equal to or greater than 7,000 asymmetrical amperes. Expulsion fuses and backup current limiting fuse must be properly coordinated with other protective devices on the system. Expulsion fuses will interrupt current in 0.01 second or greater. Backup current limiting fuse will interrupt current in less than 0.01 seconds. Existing systems must continue to use the expulsion fuse link type that represents the standard for that system.

****

[Open][Enclosed] type fused cutouts rated [100] [200] amperes and [_____] amperes symmetrical interrupting current at [[7.8] [15] kV ungrounded] [8.3/15 kV gnd Y] [15/26 kV gnd Y] [27/34.5 kV gnd Y], conforming to IEEE C37.42. [IEEE C37.41 rated backup current limiting fuses in series with Type K expulsion fuses.]Type [K] [T] fuses conforming to IEEE C37.42 with ampere ratings [as indicated] [equal to 150 percent of the transformer full load rating]. Open link type fuse cutouts are not acceptable.[Provide heavy duty open drop-out type, rated 15 kV, 200 Amp, 7,100 Amp I.C. (Sym.).]

2.14 CONDUIT RISERS AND CONDUCTORS

The riser shield must be PVC containing a PVC back plate and PVC extension shield or a rigid galvanized steel conduit, as indicated, and conforming to UL 6. Provide conductors and terminations as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.15 TRANSFORMER (OVERHEAD-TYPE DISTRIBUTION)

****

NOTE: Use the following guidelines for specifying transformers.

1. Use IEEE C57.12.00, Figure 3 (a), voltage designations, such as 4160 V - 120/240 V.

2. Fully self-protected transformers must not be used.

****

a. IEEE C57.12.20.

b. Single phase, self-cooled, 65 degrees C. continuous temperature rise, two winding, 60 Hertz.

c. Insulating liquid:

****

NOTE: Choose one of the following options. For the Navy, choose less-flammable transformer liquids for all projects unless there is a specific requirement to do otherwise.

****

[d. Mineral oil: ASTM D3487, Type II, tested in accordance with ASTM D117. Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

][e. Less-flammable transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D92 and a dielectric strength not less than 33 kV tested per ASTM D877/D877M. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid on the nameplate.

f. The fluid must be a biodegradable electrical insulating and cooling liquid classified by UL and approved by FM as "less flammable fluids. The fluid must meet the following fluid properties:

(1) Pour point: ASTM D97, less than -15 degrees C

(2) Aquatic biodegradation: EPA 712-C-98-075, 100 percent.

(3) Trout toxicity: OECD Test 203, zero mortality of EPA 821-R-02-012, pass.

] g. Ratings:

(1) kVA: [_____].

(2) BIL: [95] [75] [60] kV.

(3) Primary voltage: [_____] kV.

(4) Secondary voltage: [_____] volts.

(5) Minimum Tested Impedance at 85 degrees C: [_____] percent.

[h. Single-phase connections:

(1) Connect primary: [Phase-to-phase] [Phase-to-ground].

(2) Provide transformer with [_____] high voltage bushing(s).

][i. Three-phase connections:

(1) Connect primary: [Grounded wye] [Ungrounded wye] [Delta].

(2) Connect secondary: [Grounded wye] [Delta], for [_____] volt, three phase, [_____] wire service.

(3) Provide transformer with [_____] high voltage bushings.

] j. Taps:

(1) Provide four 2-1/2 percent full capacity taps, 2 above and 2 below rated primary voltage. Tap changer must have external handle.

****

NOTE: The "series-multiple voltage-changing switch" would be in the primary winding of the transformer and is for dual-voltage systems. It is normally used when a base is planning a voltage upgrade of its primary distribution system or when there are multiple systems on base and they would like the transformer to be interchangeable. Caution: If this option is indicated, the BIL level must be specified for the higher voltage and actual transformer losses would have to be coordinated with multiple manufacturers and be specified to obtain an energy efficient transformer.

****

[k. Externally operated Series-Multiple Voltage-Changing Switch.

] l. Corrosion Protection:

****

NOTE: In hostile environments, the additional cost of stainless steel tanks and covers may be justified.

****

m. [Transformer tanks and covers must be corrosion resistant and must be fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L.]Paint coating system must comply with IEEE C57.12.28 regardless of tank and cover material. Finish coat must be light gray, ANSI color No. 70.

n. Show transformer kVA capacity using 65 mm 2 1/2 inch Arabic numerals placed near the low-voltage bushings.

2.15.1 Specified Transformer Efficiencies

****

NOTE: Single phase transformer losses and efficiency requirements have been modified into the

table included within the specification and the previous Navy loss tables have been deleted.

10 CFR 431, Subpart K is a result of the Energy Policy and Conservation Act (EPACT) of 2005 and is the "minimum" industry standard for distribution transformers manufactured on or after January 1, 2016.

****

Provide single phase transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K, for a liquid-immersed distribution transformer. Submit certification, including supporting calculations, from the manufacturer indicating conformance.

kVA Single	EFFICIENCY (percent)
10	98.70
15	98.82
25	98.95
37.50	99.05
50	99.11
75	99.19

[2.16 GROUP-OPERATED LOAD INTERRUPTER SWITCHES

2.16.1 Manually Operated Type (Switch Handle Operated)

Manually operated (switch handle operated) load interrupter switches must comply with IEEE C37.30.1 and must be of the outdoor, manually-operated, three-pole, single-throw type with either tilting or rotating insulators. Switches must be equipped with interrupters capable of interrupting currents equal to the switch's continuous current rating. Each switch must be preassembled for the indicated configuration and mounting. Moving contacts must be of the high-pressure, limited-area type, designed to ensure continuous surface contact. Switches must be fused or non-fused as indicated. Switches must be complete with necessary operating mechanisms, handles, and other items required for manual operation from the ground. Switch operating handles must be located approximately 1.1 meters 3 feet 6 inches above final grade. Insulation of switch operating mechanisms must include both insulated interphase rod sections and insulated vertical shafts. Provide each handle must be provided with a padlock arranged to lock the switch in both the open and the closed position.

[2.16.2 Remotely Operated Type (Stored-Energy Actuator)

****

NOTE: SF6 switches are available for nominal voltages of 15 kV through 34.5 kV in 600 ampere continuous and load-break ratings. Delete SCADA

equipment and remote telemetry when not required.
****

Remotely-operated, [air-insulated] [SF6 insulated] load interrupter switches must be rated in accordance with and comply with the requirements of IEEE C37.30.1 and must be of the outdoor, three-pole, [pole-mounted] [crossarm-mounted] type. Interrupter devices must be [air-insulated] [SF6-insulated, puffer-type] switches capable of interrupting currents equal to the switch continuous current ratings indicated. Switches must utilize an electric motor-charged, stored-energy (spring-driven) operator to simultaneously trip all phases. A switch-control unit must be provided [for push-button operation from the ground] [for push-button operation from the ground and remote switch actuation via telemetry]. The switch-control unit must be pad-lockable, tamper-resistant, in a NEMA ICS 6, Type [3R] [4] [4X] [4X-SS] enclosure, which is connected to the switch actuator by a shielded control cable. Control power for closing and tripping must be provided by a battery mounted in the control unit enclosure. The switch control unit must be provided with a separate 120 volt ac circuit for the battery powered. Power for charging the operator mechanism may be 120 volt ac or battery powered. If operator mechanism charging power is from a battery, capacity must be provided for a minimum of [_____] [four] sequential opening and closing operation without battery charging. The switch control unit must be configured for supervisory, control, and data acquisition (SCADA) function, including local and remote operation. Provide voltage and current sensors, one set for each phase, for monitoring of both normal and fault conditions. Provide switches with visual indication of open switch contact for clearance and isolation purposes. Provide switch mechanisms with provisions for grounding of nonenergized metal parts. Provide the switch control unit with a switch operations.

]][2.17 RECLOSER

****
NOTE: Manufacturers information or catalog information is required to edit this paragraph.
****

IEC 62271-111, IEEE C37.60. Operating temperature range of minus 40 degree C to 55 degree C. Paint the reclosure tank Munsell 5BG7.0/0.4 sky gray (ANSI 70), with paint coateing system compying with IEEE C57.12.31. The Munsell color notation is specified in ASTM D1535.

a. [Electronically] [Hydraulically] operated, in [air] [epoxy] [oil] insulating medium with [oil] [vacuum] interruption.

b. [Three-phase][Single-phase].

c. [15.5kV] [27kV] [38kV] maximum design voltage. [2.4kV] [4.8kV] [8.32kV] [14.4kV] [24.9kV] [34.5kV][_____] nominal operating voltage.

d. [100A] [200A] [400A] [600A] [800A] [1200A] [_____] continuous current.

e. [50] [60] hertz.

f. [8kA] [10kA] [12kA] [16kA] [20kA] [_____] interrupting rating, symmetrical.

g. [110] [125] [150] [170] kV BIL.

h. [Form 6][Form 4D] recloser control.

][2.18 SECTIONALIZER

****

NOTE: Manufacturers information or catalog information is required to edit this paragraph.

****

IEEE C37.63. Operating temperature range of minus 40 degree C to 55 degree C. Paint the reclosure tank Munsell 5BG7.0/0.4 sky gray (ANSI 70), with paint coateing system compying with IEEE C57.12.31. The Munsell color notation is specified in ASTM D1535.

a. [Electronically][Hydraulically] operated, oil-insulated.

b. Three-phase.

c. [15.5 kV] [27 kV] [38 kV] maximum design voltage. [2.4 kV] [4.8 kV] [8.32 kV] [14.4 kV] [24.9 kV][_____] nominal operating voltage.

d. 200 A continuous current. 440 A interrupting loadbreak current.

e. [50] [60] Hertz.

f. 9 kV maximum momentary and making current, asymmetrical.

g. [110] [125] [150] kV BIL.

][2.19 METERING EQUIPMENT

****

NOTE: "Metering Equipment" paragraph and its subparagraphs are for primary metering and should only be used when primary metering is required by the local utility company and specific metering requirements have been properly coordinated with the cognizant Activity.

****

Pole mounted metering equipment must include current transformers, potential transformers, watthour meter, [meter test switch block,] metering enclosure, wire, conduit and fittings.

2.19.1 Potential Transformers

Potential transformers must be rated for outdoor service fitted for crossarm mounting and secondary connection box for conduit connection. Voltage rating must be [2.4] [4.16] [7.2] [12.0] [12.47] [_____] kV to 120 volts ac, 60 Hz. Transformers must conform to the requirements of IEEE C57.13 BIL [45] [60] [75] [95] kV and accuracy Class 0.3 (min.) of [75 VA] [burden Y].

2.19.2 Current Transformers

Current transformers must be rated for outdoor service with crossarm mounting and secondary connection box for conduit connection. Voltage rating must be [2.4] [4.16] [7.2] [12.47] [12.0] [_____] kV. Current rating must be [_____] to 5 amperes. Transformers must conform to requirements of IEEE C57.13, BIL [45] [60] [75] [95] kV and accuracy Class 0.3 at [B2.0] [50 VA].

2.19.3 Watthour Meter

Provide meter with provisions for future pulse initiation.

a. Meters: NEMA/ANSI C12.10 and ANSI C12.1; when providing meter with electronic time-of-use register.

    (1) Form: [5A] [5S] [6A] [6S].

    (2) Element: [2] [2 1/2] [3].

    (3) Voltage: 120 volts.

    (4) Current: 2 1/2 amperes.

    (5) Frequency: 60 hertz.

    (6) Kilowatt hour register: 5 dial or 5 digit type.

b. Demand register:

    (1) Solid state type.

    (2) Meter reading multiplier:

        (a) Indicate multiplier on the meter face.

        (b) Provide multiplier in even hundreds.

    (3) Demand interval length: must be programmed for [15] [30] [60] minutes with rolling demand up to six subintervals per interval.

c. Mounting:

    (1) Provide meter with [matching socket per ANSI C12.7 with [manual] [automatic] current short-circulating device.]["A" base type mounting].

[2.19.4 Meter Test Block

Provide meter test block with [T] [10] pole group of open knife type switches designed for the isolation of metering devices at meter location by opening each circuit individually. Current switches must short circuit current supply before opening meter circuit. Switch handles of potential switches must be black. Switch handles of current switches must be red.

]2.19.5 Metering Enclosure

Metering enclosure must be of galvanized steel, weatherproof construction with pole mounting bracket, and 19 mm 3/4 inch exterior plywood, full size backboard and hinged door arranged for padlocking in closed position. Internal space must be adequate to house equipment and wiring but not smaller than 510 by 760 by 280 mm 20 by 30 by 11 inches deep. Paint metal manufacturer's standard finish.

]2.20 CAPACITORS

IEEE 18. Operating temperature range of minus 40 degrees C to 46 degrees C. Provide capacitor tank fabricated of stainless steel conforming to ASTM A240/A240M, Type 409. Paint the capacitor tank Munsell 5BG7.0/0.4 sky gray (ANSI 70), with paint coating system complying with IEEE C57.12.31. The Munsell color notation is specified in ASTM D1535. Capacitor equipment must comply with IEEE 18 and must be of the three-phase, grounded-wye, outdoor type rated for continuous operation and automatically switched. Equipment must be suitable for mounting on a single pole. Polychlorinated biphenyl and tetrachloroethylene (perchloroethylene) must not be used as the dielectric. Equipment must be rated for the system voltage. The indicated kvars must be automatically switched by [single-step] [time switch] [voltage] [current] [kilovar] [control] [multiple-step] [voltage] [kilovar] [control providing the indicated number of steps and switching the indicated kvar]. Provide necessary transformers for sensing circuit variations and for low-voltage control. Provide oil-immersed switches for automatic switching of capacitors, and must be electrically separate from ungrounded capacitor enclosures and metal frames. Installations must include one primary fuse cutout and one surge arrester for each ungrounded phase conductor. Fuse link ratings must be in accordance with the manufacturer's recommendations. Capacitor equipment, except for low-voltage control and primary fuse cutouts, must be subassembled and coordinated by one manufacturer. Ship units, including metal pole-mounting supports and hardware, in complete sections ready for connection at the site. Low-voltage equipment must be socket or cabinet type, mounted on the pole approximately 1.2 m 4 feet above grade, must be connected with the necessary wiring in conduit to capacitor equipment, and must be provided with secondary arrester protection against switching surges when recommended by the manufacturer.

2.21 VOLTAGE REGULATOR

****

NOTE: Bypass arresters are normally standard equipment. Incoming line arresters may not be needed. Coordinate with the manufacturer.

****

Voltage regulators must comply with IEEE C57.15 and must be of the outdoor, self-cooled, 55/65 degrees C temperature rise, single-phase type. Windings and the load-tap-changing mechanism must be mineral-oil-immersed. When operating under load, a regulator must provide plus and minus 10 percent automatic voltage regulation in approximately 5/8 percent steps, with 16 steps above and 16 steps below rated voltage. Automatic control equipment must provide Class 1 accuracy. Bypass surge arresters must be suitable for [a grounded] [an ungrounded] system and for the associated regulator voltage.[[Station][Intermediate] class surge arresters must be mounted next to each incoming line bushing on a regulator tank-mounted bracket and connected to a surge arrester ground pad-mounted on the regulator tank].

2.21.1 Ratings

Ratings at 60 Hz must be

Maximum voltage..[_____]

Basic Insulation Level (BIL).............................[_____]

Current..[_____]

2.21.2 Bypass and Isolation Switches

Switches must be of the outdoor, stickhook-operated, single-pole, single-throw, vertical-break type suitable for the indicated mounting. Switches must be of a type designed to provide bypass of a single-phase regulator circuit by an integral sequence which always occurs when each switch is opened or closed. Each opening sequence must initially bypass the single-phase regulator circuit, then open the input and output circuits, and finally interrupt the exciting current. Opening any single-phase regulator circuit must not be possible until after the bypass circuit is closed. Ratings at 60 Hz must be in accordance with IEEE C37.41 and as follows:

Maximum voltage..[_____]

Nominal voltage class....................................[_____]

BIL..[_____]

Momentary asymmetrical current in the closed position.....[_____]

Momentary asymmetrical current in the bypass position.....[_____]

Continuous and interrupting current......................[_____]

2.21.3 Miscellaneous

Standard accessories and components in accordance with IEEE C57.15 must be provided. Single-phase units must be provided with additional components and accessories required by IEEE C57.15 for three-phase units. Install regulator control approximately 1.5 m 5 feet from ground on field side of pole. Control cable must be properly shielded or installed in suitable conduit.

2.22 ELECTRICAL TAPES

Tapes must be UL listed for electrical insulation and other purposes in wire and cable splices. Terminations, repairs and miscellaneous purposes, electrical tapes must comply with UL 510.

2.23 CAULKING COMPOUND

Compound for sealing of conduit risers must be of a puttylike consistency workable with hands at temperatures as low as 2 degrees C 35 degrees F, must not slump at a temperature of 150 degrees C 300 degrees F, and must not harden materially when exposed to air. Compound must readily caulking or adhere to clean surfaces of the materials with which it is designed to be used. Compound must have no injurious effects upon the workmen or upon the materials.

2.24 NAMEPLATES

2.24.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. Equipment containing liquid-dielectrics must have the type of dielectric on the nameplate.

2.24.2 Field Fabricated Nameplates

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 by 65 mm one by 2.5 inches. Lettering must be a minimum of 6.35 mm 0.25 inch high normal block style.

2.25 SOURCE QUALITY CONTROL

2.25.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

b. (1) The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

c. (2) The accuracy shall be directly traceable to the National Institute of Standards and Technology.

d. (3) Instrument calibration frequency schedule must not exceed 12 months for both test floor instruments and leased specialty equipment.

e. (4) Dated calibration labels must be visible on all test equipment.

f. (5) Calibrating standard must be of higher accuracy than that of the instrument tested.

g. (6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

    (1) a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

    (2) b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.25.2 Routine and Other Tests

IEEE C57.12.00 and IEEE C57.12.90. Routine and other tests must be performed by the manufacturer on [each of] the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests must be as follows:

a. Polarity

b. Ratio

c. No-load losses (NLL) and excitation current

d. Load losses (LL) and impedance voltage

e. Dielectric

    (1) Impulse

    (2) Applied voltage

    (3) Induced voltage

f. Leak

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: In areas where the applicable State code is more stringent, substitute it for IEEE C2 and make the required changes under paragraph REFERENCES. In California, use CALPUC G.O.95, State of California Public Utilities Commission.

****

Provide overhead pole line installation conforming to requirements of [_____] [IEEE C2] [CALPUC G.O. 95] for Grade [B] [C] construction of overhead lines in [light] [medium] [heavy] loading districts and NFPA 70 for overhead services. Provide material required to make connections into existing system and perform excavating, backfilling, and other incidental labor. Consider street, alleys, roads and drives "public." Pole configuration must be as indicated.

3.1.1 Overhead Service

Terminate overhead service conductors into buildings at service entrance fittings or weatherhead outside building. Installation and connection of service entrance equipment to overhead service conductor is included in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Nearby support bracket for overhead wires must be not less than [_____] meters feet above finished grade at building. Drip loops must be formed on conductors at entrances to buildings, cabinets, or conduits.

3.1.2 Tree Trimming

Where lines pass through trees, trees must be trimmed at least [4.5 meters 15 feet] [_____] clear on both sides horizontally and below for medium-voltage lines, and [1.5 meters5 feet] [_____] clear on both sides horizontally and below for other lines. No branch must overhang horizontal clearances. Where trees are indicated to be removed to provide a clear right-of-way, clearing is specified in Section 31 11 00 CLEARING AND GRUBBING.

3.1.3 Wood Pole Installation

****

NOTE: Include the bracketed sentence for projects where poles will be set in tropical areas including tropical areas of the Pacific Ocean, that are infested by the Formosan termite, coptotermes formosanus shirake. Delete it in other projects. Coordinate termiticide treatment, both chemical and application quantity selected, with the installation pest management coordinator.

****

Provide pole holes at least as large at the top as at the bottom and large enough to provide 100 mm 4 inch clearance between the pole and side of the hole.[Provide a 150 mm 6 inch band of soil around and down to the base of the pole treated with [_____] liters gallons of a termiticide solution. Treatment requirements are specified in Section 31 31 16.13 Chemical Termite Control.]

3.1.3.1 Setting Depth of Pole

Pole setting depths must be as follows:

Length of Pole (mm)	Setting in Soil (mm)	Setting in Solid Rock (mm)
6095	1520	910
7600	1675	1065
9120	1675	1065
10640	1825	1215
12160	1825	1215
13680	1980	1370
15200	2130	1370
16720	2280	1520
18240	2440	1520
19810	2590	1675
21340	2740	1675
22860	2895	1825

Length of Pole (mm)	Setting in Soil (mm)	Setting in Solid Rock (mm)
24380	3050	1825
25910	3200	1980
27430	3350	1980
28950	3500	2130
30480	3810	2280

Length of Pole (feet)	Setting in Soil (feet)	Setting in Solid Rock (feet)
20	5.0	3.0
25	5.5	3.5
30	5.5	3.5
35	6.0	4.0
40	6.0	4.0
45	6.5	4.5
50	7.0	4.5
55	7.5	5.0
60	8.0	5.0
65	8.5	5.5
70	9.0	5.5
75	9.5	6.0
80	10.0	6.0
85	10.5	6.5
90	11.0	6.5
95	11.5	7.0
100	12.5	7.5

3.1.3.2 Setting in Soil, Sand, and Gravel

"Setting in Soil" depths, as specified in paragraph entitled "Setting Depth of Pole," apply where the following occurs:

a. Where pole holes are in soil, sand, or gravel or any combination of these;

b. Where soil layer over solid rock is more than 610 mm 2 feet deep;

c. Where hole in solid rock is not substantially vertical; or

d. Where diameter of hole at surface of rock exceeds approximately twice the diameter of pole at same level.[At corners, dead ends and other points of extra strain, poles 12160 mm 40 feet or more long must be set 150 mm 6 inches deeper.]

3.1.3.3 Setting in Solid Rock

"Setting in Solid Rock," as specified in paragraph SETTING DEPTH OF POLE, applies where poles are to be set in solid rock and where hole is substantially vertical, approximately uniform in diameter and large enough to permit use of tamping bars the full depth of hole.

3.1.3.4 Setting With Soil Over Solid Rock

Where a layer of soil 610 mm 2 feet or less in depth over solid rock exists, depth of hole must be depth of soil in addition to depth specified under "Setting in Solid Rock" in paragraph SETTING DEPTH OF POLE, provided, however, that such depth must not exceed depth specified under "Setting in Soil."

3.1.3.5 Setting on Sloping Ground

On sloping ground, always measure hole depth from low side of hole.

3.1.3.6 Backfill

Thoroughly tamp pole backfill for full depth of the hole and mound excess fill around the pole.

3.1.3.7 Setting Poles

Set poles so that alternate crossarm gains face in opposite directions, except at terminals and dead ends where gains of last two poles must be on side facing terminal or dead end. On unusually long spans, set poles so that crossarm comes on side of pole away from long span. Where pole top pins are used, they must be on opposite side of pole from gain, with flat side against pole.

3.1.3.8 Alignment of Poles

Set poles in alignment and plumb except at corners, terminals, angles, junctions, or other points of strain, where they must be set and raked against the strain. Set not less than 50 mm 2 inches for each 3050 mm 10 feet of pole length above grade, nor more than 100 mm 4 inches for each 3050 mm 10 feet of pole length after conductors are installed at required tension. When average ground run is level, consecutive poles must not vary more than 1525 mm 5 feet in height. When ground is uneven, poles differing in length must be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece must be sawed off the top. Holes must be dug large enough to permit the proper use of tampers to full depth of hole.

3.1.3.9 Pole Caps

****

NOTE: Pole caps are not necessary for ACA/CCA treated poles.

****

Provide plastic pole caps with 6.35 mm 1/4 inch sealing rings and four nailing tabs. Fill sealing area with either a bituminous, elastigum roof cement or an acceptable preservative paste to level of sealing ring to eliminate possibility of condensation. Place on pole top and nail each tab down with a 31.75 mm 1 1/4 inch nail.

3.1.4 Steel and Concrete Pole Setting

Poles must be mounted on cast-in-place or power-installed screw foundations. [Concrete poles must be embedded in accordance with the details indicated.] Provide conduit elbows for cable entrances into pole interiors.

3.1.4.1 Cast-In-Place Foundations

Concrete foundations, sized as indicated, must have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. Concrete work and grouting is specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. After the concrete has cured, pole anchor bases must be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles must be set plumb. Anchor bolts must be the manufacturer's standard, and not less than necessary to meet the pole wind loading specified herein and other design requirements.

3.1.4.2 Power-Installed Screw Foundations

Power-installed screw foundations may be used if they have the required strength, mounting-bolt, and top plate dimensions. Screw foundations must be of at least 6.4 mm 1/4 inch thick structural steel conforming to ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M. Mark conduit slots in screw foundation shafts and top plates to indicate orientation. Design calculations indicating adequate strength must be approved before installation of screw foundation is permitted.

3.1.5 Anchors and Guys

Place anchors in line with strain. Indicate the length of the guy lead (distance from base of pole to the top of the anchor rod).

3.1.5.1 Setting Anchors

Set anchors in place with anchor rod aligned with, and pointing directly at, guy attachment on the pole with the anchor rod projecting 150 to 230 mm 6 to 9 inches out of ground to prevent burial of rod eye.

3.1.5.2 Backfilling Near [Plate] Anchors

****

NOTE: If plate anchors are chosen, for NAVFAC LANT projects, include the bracketed option in the title of the paragraph and use the second bracketed

sentence.

****

[Backfill plate, expanding, concrete, or cone type anchors with tightly tamped coarse rock 610 mm 2 feet immediately above anchor and then with tightly tamped earth filling remainder of hole.

][Backfill plate anchors with tightly tamped earth for full depth of hole.

]3.1.5.3 Screw Anchors

Install screw anchors by torquing with boring machine.

3.1.5.4 Swamp Anchors

Install swamp anchors by torquing with boring machine or wrenches, adding sections of pipe as required until anchor helix is fully engaged in firm soil.

3.1.5.5 Rock Anchors

Install rock anchors minimum depth 305 mm 12 inches in solid rock.

3.1.5.6 Guy Installation

****

NOTE: Guy strand must be insulated or grounded in conformance with IEEE C2 or local practice.

A soil survey should be completed early in the design to properly select the type of anchor.

****

Provide guys where indicated, with loads and strengths as indicated, and wherever conductor tensions are not balanced, such as at angles, corners and dead-ends. Where single guy will not provide the required strength, provide two or more guys. Where guys are wrapped around poles, at least two guy hooks must be provided. Provide pole shims where guy tension exceeds 27,000 Newtons 6000 pounds. Provide guy clamps 152 mm 6 inches in length with three 16 mm 5/8 inch bolts, or offset-type guy clamps, or approved guy grips at each guy terminal. Securely clamp plastic guy marker to the guy or anchor at the bottom and top of marker.Complete anchor and guy installation, dead end to dead end, and tighten guy before wire stringing and sagging is begun on that line section.[Provide strain insulators at a point on guy strand 2435 mm 8 feet minimum from the ground and 1825 mm 6 feet minimum from the surface of pole.][Effectively ground and bond guys to the system neutral.]

3.1.6 Hardware

Provide hardware with washer against wood and with nuts and lock nuts applied wrench tight. Provide locknuts on threaded hardware connections. Locknuts must be M-F style and not palnut style.

3.1.7 Grounding

****

NOTE: For Army projects, the designer will specify the grounding configuration and the number and type

of electrodes required. See TM 5-811-1 for guidance. Coordinate with NFPA 70 and IEEE C2.

Delete the bracketed sentence for Army projects.

****

Unless otherwise indicated, grounding must conform to IEEE C2 and NFPA 70.[Pole grounding electrodes must have a resistance to ground not exceeding 25 ohms. When work in addition to that indicated or specified is directed in order to obtain specified ground resistance, provisions of the contract covering changes must apply.]

3.1.7.1 Grounding Electrode Installation

****

NOTE: Modify and/or delete paragraphs in accordance with project requirements.

The designer should investigate the soil resistivity during the preliminary design phase to determine the design required to ensure that the grounding values are obtained. For areas where the water table is low and/or the soil resistivity is high (such as volcanic soils, sand, or rock), delete the additional electrode provisions and provide a design to meet the site requirements.

****

Install grounding electrodes as follows:

a. Driven rod electrodes - Unless otherwise indicated, locate ground rods approximately 900 mm 3 feet out from base of the pole and drive into the earth until the tops of the rods are approximately 300 mm one foot below finished grade. Evenly spaced multiple rods at least 3 m 10 feet apart and connected together 600 mm 2 feet below grade with a minimum No. 6 bare copper conductor.

b. Plate electrodes - Install plate electrodes in accordance with the manufacturer's instructions and IEEE C2 and NFPA 70.

****

NOTE: Use the following paragraph for Army projects only.

****

[c. Ground resistance - The maximum resistance of a [driven ground rod] [plate electrode] must not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes [interconnected with grounding conductors] [as indicated], to achieve the specified ground resistance. The additional electrodes will be [up to three, [2.4] [3] m [8] [10] feet rods spaced a minimum of 3 m 10 feet apart] [a single extension-type rod, [15.9] [19.1] mm [5/8] [3/4] inch diameter, up to 9.1 m 30 feet long, [driven perpendicular to grade] [coupled and driven with the first rod]]. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.

]3.1.7.2 Grounding Electrode Conductors

****

NOTE: If grounding details are provided on the drawings, delete the bracketed information.

****

[On multi-grounded circuits, as defined in IEEE C2, provide a single continuous vertical grounding electrode conductor. Bond neutrals, surge arresters, and equipment grounding conductors to this conductor. For single-grounded or ungrounded systems, provide a grounding electrode conductor for the surge arrester and equipment grounding conductors and a separate grounding electrode conductor for the secondary neutrals. Staple grounding electrode conductors to wood poles at intervals not exceeding 600 mm 2 feet. On metal poles, a preformed galvanized steel strap, 15.9 mm 5/8 inch wide by 0.853 22 gaugeminimum by length, secured by a preformed locking method standard with the manufacturer, must be used to support a grounding electrode conductor installation on the pole and spaced at intervals not exceeding 1.5 m 5 feet with one band not more than 75 mm 3 inches from each end of the vertical grounding electrode conductor.]Size grounding electrode conductors as indicated. Connect secondary system neutral conductors directly to the transformer neutral bushings, then connected with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor as indicated. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

3.1.7.3 Grounding Electrode Connections

Make above grade grounding connections on pole lines by exothermic weld or by using a compression connector. Make below grade grounding connections by exothermic weld. Make exothermic welds strictly in accordance with manufacturer's written recommendations. Welds which have puffed up or which show convex surfaces indicating improper cleaning, are not acceptable. No mechanical connectors are required at exothermic weldments. Compression connectors must be type that uses a hydraulic compression tool to provide correct pressure. Provide tools and dies recommended by compression connector manufacturer. An embossing die code or similar method must provide visible indication that a connector has been fully compressed on ground wire.

3.1.7.4 Grounding and Grounded Connections

a. Where no primary or common neutral exists, bond surge arresters and frames of equipment operating at over 750 volts together and connected to a dedicated primary grounding electrode.

b. Where no primary or common neutral exists, bond transformer secondary neutral bushing, secondary neutral conductor, and frames of equipment operating at under 750 volts together and connected to a dedicated secondary grounding electrode.

c. When a primary or common neutral exists, the neutral must be connected to a grounding electrode. Transformer secondary neutral bushing and frames of equipment operating at under 750 volts must be bonded together and connected to a common neutral and to a common grounding electrode.

3.1.7.5 Protective Molding

Protect grounding conductors which are run on surface of wood poles by PVC molding extending from ground line throughout communication and transformer spaces.

3.1.8 CONDUCTOR INSTALLATION

3.1.8.1 Line Conductors

****

NOTE: Do not use bracketed sentence for Navy projects. Instead, sag and tension tables should be provided and values indicated on the drawings.

****

[Unless otherwise indicated, install conductors in compliance with IEEE C2 Grade B requirements and in accordance with revised manufacturer's approved tables of sags and tensions.]Handle conductors with care necessary to prevent nicking, kinking, gouging, abrasions, sharp bends, cuts, flattening, or otherwise deforming or weakening conductor or any damage to insulation or impairing its conductivity. Remove damaged sections of conductor and splice conductor. Conductors must be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor must not be less than the applicable NEMA specification recommendation. Conductors must not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors must be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension must be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

3.1.8.2 Connectors and Splices

Conductor splices, as installed, must exceed ultimate rated strength of conductor and must be of type recommended by conductor manufacturer. No splice must be permitted within 3050 mm 10 feet of a support. Connectors and splices must be mechanically and electrically secure under tension and must be of the nonbolted compression type. The tensile strength of any splice must be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors must be noncorrosive and must not adversely affect conductors. Aluminum-composition conductors must be wire brushed and an oxide inhibitor applied before making a compression connection. Connectors which are factory-filled with an inhibitor are acceptable. Inhibitors and compression tools must be of types recommended by the connector manufacturer. Primary line apparatus taps must be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors must be of the solderless pressure type. Noninsulated connectors must be smoothly taped to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors. On overhead connections of aluminum and copper, the aluminum must be installed above the copper.

3.1.8.3 Conductor-To-Insulator Attachments

Conductors must be attached to insulators by means of clamps, shoes or tie wires, in accordance with the type of insulator. For insulators requiring conductor tie-wire attachments, tie-wire sizes must be as specified in TABLE I.

TABLE I - TIE-WIRE REQUIREMENTS	
CONDUCTOR Copper (AWG)	TIE WIRE Soft-Drawn Copper (AWG)
6	8
4 and 2	6
1 through 3/0	4
4/0 and larger	2
AAC, AAAC, or ACSR (AWG	AAAC OR AAC (AWG)
Any size	6 or 4

3.1.8.4 Armor Rods

Provide armor rods for AAC, AAAC, and ACSR conductors. Armor rods must be installed at supports, except armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods must be in accordance with the manufacturer's recommendations. For span lengths of less than 61 m, 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 762.0 micrometers by 6.4 mm 0.03 by 0.25 inch must be used on No. 1 AWG AAC and AAAC and smaller conductors and on No. 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods must be not less than 1.3 by 7.6 mm 0.05 by 0.30 inches. For span lengths of 61 m 200 feet or more, preformed round armor rods must be used.

3.1.8.5 Ties

Provide ties on pin insulators tight against conductor and insulator and ends turned down flat against conductor so that no wire ends project.

3.1.8.6 Low-Voltage Insulated Cables

Support low-voltage cables on clevis fittings using spool insulators. Provide dead-end clevis fittings and suspensions insulators where required for adequate strength. Dead-end construction must provide a strength exceeding the rated breaking strength of the neutral messenger. Provide clevis attachments with not less than 15.9 mm 5/8 inch through-bolts. Secondary racks may be used when installed on wood poles and where the span length does not exceed 61 m 200 feet. Secondary racks must be two-, three-, or four-wire, complete with spool insulators. Racks must meet strength and deflection requirements for heavy-duty steel racks, and must be rounded and smooth to avoid damage to conductor insulation. Each insulator must be held in place with a 15.9 mm 5/8 inch button-head bolt equipped with a nonferrous cotter pin, or equivalent, at the bottom. Attach racks for dead-ending four No. 4/0 AWG or four larger conductors to poles with three 15.9 mm 5/8 inch through-bolts. Attach other secondary racks to poles with at least two 15.9 mm 5/8 inch through-bolts. Minimum vertical spacing between conductors must not be less than 200 mm 8 inches.

3.1.8.7 Reinstalling Conductors

****

NOTE: Sag tables are usually available from conductor manufacturers. For projects which entail considerable length of overhead line, sag tables for the particular line as designed must be indicated.

****

Existing conductors to be reinstalled or resagged must be strung to "final" sag table values indicated for the particular conductor type and size involved.

3.1.8.8 New Conductor Installation

****

NOTE: Sag tables are usually available from conductor manufacturers. For projects which entail considerable length of overhead line, sag tables for the particular line as designed should be indicated. Use "indicated" on NAVFAC LANT projects.

****

String new conductors to "initial" sag table values [indicated] [recommended by the manufacturer] for conductor type and size of conductor and ruling span indicated.

3.1.8.9 Fittings

Dead end fittings[, clamp or compression type,] must conform to written recommendations of conductor manufacturer and must develop full ultimate strength of conductor.

3.1.8.10 Aluminum Connections

Make aluminum connections to copper or other material using only splices, connectors, lugs, or fittings designed for that specific purpose. Keep a copy of manufacturer's instructions for applying these fittings at job site for use of the inspector.

[3.1.9 Pole Mounted Metering Equipment

3.1.9.1 Primary Meters

Install primary metering transformers [as indicated] [according to manufacturer's drawings]. Make connections to metering circuits within each transformer conduit connection box.

3.1.9.2 Installing Meter System

Metering enclosure must house kWh meter [and meter test block]. Secure the enclosure to pole at a height of 1825 mm 6 feet above grade to center of the enclosure. Ground enclosure.

a. Connect meter as indicated.

[b. Connect meter test block between meter and metering transformers to isolate meter for removal, test or adjustment.

] c. Indicate phase sequence and color code of potential and current leads. Mark wires which are connected to transformer terminals identified with polarity marks (dots) by a colored plastic tape around the wire at each end.

d. No splices are permissible in metering circuits. Train wire at sides and bottom of enclosure back board and secured by plastic wraps.

]3.1.10 Pole Top Switch Installation

Install pole top switch strictly according to manufacturer's installation drawings and information.

3.1.10.1 Operating Handle

Locate approximately 1520 mm 5 feet above ground on field side of pole.

[3.1.11 Recloser

Install recloser(s) strictly in accordance with manufacturer's instructions.

][3.1.12 Sectionalizer

Install sectionalizer(s) strictly in accordance with manufacturer's instructions.

]3.1.13 Risers

[Secure galvanized steel conduits on poles by two hole galvanized steel pipe straps spaced as indicated and within 910 mm 3 feet of any outlet or termination. Ground metallic conduits.][Secure PVC riser shields on poles as indicated.]

3.2 TRANSFORMER INSTALLATION

****

NOTE: Specify phase sequence in accordance with the local practice.

****

Transformers must be carefully installed so as not to scratch finishes or damage bushings. Transformers must be installed in accordance with the manufacturer's instructions. After installation, surfaces must be inspected and scratches must be touched up with a finish provided by the transformer manufacturer for this purpose.

[3.3 CROSSARM MOUNTING

****

NOTE: Do not use this paragraph and subparagraphs for Navy projects. The Navy provides this information on the drawings. Utilize Navy plates during design of Navy projects. Refer to "Instructions to view/print graphics" for access to Navy plates.

****

****

NOTE: Normally flat braces will be specified for 2.4 m 8 foot crossarms and angle braces for 3.1 m (10 foot) crossarms to agree with REA construction. An angle brace is also required on 2.4 m 8 foot arms where conductors have a breaking strength of more than 20.0 kN 4500 pounds. Extreme loading conditions may also warrant the extra cost of the stronger angle brace under other circumstances.

Metal crossarm braces will reduce the effective BIL rating of the pole. In high lightning areas specify fiberglass braces.

Consult REA Bulletin 61-10, "Protection of Bald and Golden Eagles from Power lines." The requirement for wooden crossarm braces should be verified for each state and land area in accordance with the Bald Eagle Protection Act of 1940, (16 U.S.C. 703 et seq.) as amended; Endangered Species Act of 1973 (87 Stat. 1064); Migratory Bird Treaty of 1918 (16 U.S.C 703 et. seq.); IEEE 1651 IEEE Guide for Reducing Bird-Related Outages; and IEEE 1656 IEEE Guide for Testing the Electrical, Mechanical, and Durability Performance of Wildlife Protective Devices on Overhead Power Distribution Systems Rated up to 38 kV as amended. Potential requirement sources are the Bureau of Land Management, U.S. Department of the Interior, and Federal, State, and Local Land Management or Wildlife Conservation Agencies.

****

Bolt crossarms to poles with 15.9 mm 5/8 inch through-bolts with square washers at each end. Extend bolts not less than 3 mm 1/8 inch nor more than 50 mm 2 inches beyond nuts. On single crossarm construction, install the bolt head on the crossarm side of the pole. [Fiberglass][Metal][Wood] crossarm braces must be provided on crossarms. Flat braces may be provided for 2.4 m 8 foot crossarms and must be 6.4 by 31.8 mm 1/4 by 1-1/4 inches, not less than 700 mm 28 inches in length. Bolt flat braces to arms with 9.5 mm 3/8 inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 50.8 by 101.6 mm 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 3.1 m 10 foot crossarms and must be 1.5 m 60 inch span by 457.2 mm 18 inch drop formed in one piece from 38.1 by 38.1 by 4.8 mm 1-1/2 by 1-1/2 by 3/16 inch angle. Bolt angle braces to crossarms with 50.8 mm 1/2 inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 15.9 mm 5/8 inch through-bolts. Double crossarms must be securely held in position by means of 15.9 mm 5/8 inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

3.3.1 Line Arms and Buck Arms

Set line arms and buck arms at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms must bisect angles of turns of less than 45 degrees. Use dead-end assemblies for turns where shown. Install buck arms , as shown on the pole plate(s), at corners and junction poles. Provide double crossarms at ends of joint use or conflict sections, at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Provide double crossarms at each line-crossing structure and where lines not attached to the same pole cross each other.

3.3.2 Equipment Arms

Set equipment arms parallel or at right angles to lines as required to provide climbing space. Locate equipment arms below line construction to provide necessary wire and equipment clearances.

]3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting must be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.5 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.6 FIELD QUALITY CONTROL

****

NOTE: Select types to suit project conditions and delete all others. Delete all paragraphs not applicable. Tests must be justified.

****

3.6.1 General

[Perform field testing in the presence of the Contracting Officer.]The Contractor must notify the Contracting Officer [_____] days prior to conducting tests. The Contractor must furnish materials, labor, and equipment necessary to conduct field tests. The Contractor must perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor must maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field reports will be signed and dated by the Contractor.

3.6.2 Safety

The Contractor must provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor must replace any devices or equipment which are damaged due to improper test procedures or handling.

3.6.3 Medium-Voltage Preassembled Cable Test

****

NOTE: If the installation is tapping a new feeder to an existing feeder using a "T" splice, modify the paragraph to indicate that when existing cable cannot be readily disconnected, the system should only be tested to the lower (after installation) voltage. Delete the test if no cable is installed

in the project.
****

After installation, prior to connection to an existing system, and before the operating test, the medium-voltage preassembled cable system must be given a high potential test. Apply direct-current voltage on each phase conductor of the system by connecting conductors at one terminal and connecting grounds or metallic shieldings or sheaths of the cable at the other terminal for each test. Prior to the test, the cables must be isolated by opening applicable protective devices and disconnecting equipment. The method, voltage, length of time, and other characteristics of the test for initial installation must be in accordance with NEMA WC 74/ICEA S-93-639 for the particular type of cable installed, and must not exceed the recommendations of IEEE 404 for cable joints unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor must make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3.6.4 Sag and Tension Test

The Contracting Officer must be given prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits and reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading district and cable weight.

3.6.5 Low-Voltage Cable Test

****
NOTE: The insulation resistance test (dielectric test) value is based on the recommendation contained in IEEE 525. Delete the cable test if no low voltage cables are in the project.
****

For underground secondary or service laterals from overhead lines, the low-voltage cable, complete with splices, must be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage must be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations of conductors in the same trench, duct, or cable, with other conductors in the same trench, duct, or conduit. The minimum value of insulation must be:

R in megohms = (rated voltage in kV + 1) x 304,800/(length of cable in meters)R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Repair each cable failing this test or replace. The repaired cable must then be retested until failures have been eliminated.

3.6.6 Pre-Energization Services

Perform the following services on the equipment listed below. Perform these services subsequent to testing but prior to the initial energization. Inspect the equipment to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Inspect terminations of conductors at major equipment to ensure the adequacy of connections. Inspect bare and insulated conductors between such terminations to detect possible damage during installation. If factory tests were not performed on completed assemblies, perform tests after the installation of completed assemblies. Inspect components for damage caused during installation or shipment and to ensure that packaging materials have been removed. Components capable of being both manually and electrically operated must be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested must be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services must be provided, but are not limited to, are the following:

Capacitors.

Switches.

3.6.7 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.6.7.1 Overhead-Type Distribution Transformers

a. Visual and mechanical inspection

   (1) Compare equipment nameplate information with specifications and approved shop drawings.

   (2) Inspect physical and mechanical condition.

   (3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is not required.

   (4) Perform specific inspections and mechanical tests as recommended by manufacturer.

   (5) Verify correct equipment grounding.

b. Electrical tests

****

NOTE: Coordinate the option on series-multiple voltage-changing switch with the option in paragraph entitled "Transformers (Overhead-Type Distribution)" herein.

****

[(1) Insure that the series-multiple voltage-changing switch is in the correct position. Transformers are normally shipped in the series position.

] (2) Perform insulation-resistance tests.

   (3) Perform continuity test.

(4) Set tap changer to provide a secondary voltage of [120/240] [120/208] [_____].

3.6.7.2 Pole Top Interrupter Switch

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify appropriate equipment grounding.

(4) Perform mechanical operator tests in accordance with manufacturer's instructions.

(5) Verify correct blade alignment, blade penetration, travel stops, arc interrupter operation, and mechanical operation.

b. Electrical Tests

(1) Perform insulation-resistance tests.

(2) Perform dc over-potential tests.

(3) Perform contact-resistance tests across each switch blade.

[3.6.7.3 Reclosers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect alignment and grounding.

(4) Perform mechanical operation and contact alignment tests on both the recloser and its operating mechanism in accordance with manufacturer's instructions.

(5) Verify tightness of accessible bolted electrical connections.

(6) Inspect for correct insulating liquid level.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

(2) Perform a contact resistance test

(3) Sample insulating liquid. Test sample for:

(a) Dielectric breakdown voltage

(b) Color

        (c) Visual condition

    (4) Test protective functions.

[(5) Perform vacuum bottle integrity test (overpotential) across each vacuum bottle with the recloser in the open position in strict accordance with manufacturer's instructions.

]   (6) Perform overpotential tests.

    (7) Determine time delay for each programmed reclosing interval.

    (8) Verify lockout for unsuccessful reclosing.

    (9) Determine reset time.

    (10) Verify instantaneous overcurrent lockout.

][3.6.7.4   Sectionalizers

a. Visual and Mechanical inspection

    (1) Compare equipment nameplate data with approved shop drawings.

    (2) Inspect physical and mechanical condition.

    (3) Inspect alignment and grounding.

    (4) Perform mechanical operation and contact alignment tests on both the sectionalizer and its operating mechanism in accordance with manufacturer's instructions.

    (5) Verify tightness of accessible bolted electrical connections.

    (6) Inspect for correct insulating liquid level.

b. Electrical Tests

    (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

    (2) Perform a contact resistance test.

    (3) Sample insulating liquid. Test sample for:

        (a) Dielectric breakdown voltage

        (b) Color

        (c) Visual condition

    (4) Perform overpotential tests.

    (5) Test sectionalizer counting function.

    (6) Test sectionalizer lockout function.

    (7) Test for reset timing on trip actuator.

][3.6.7.5 Potential Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Verify correct connection.

(3) Verify that adequate clearances exist between primary and secondary circuit wiring.

(4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(5) Verify that all required grounding and shorting connections provide good contact.

(6) Verify correct fuse sizes.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter

(2) Perform insulation-resistance tests.

(3) Perform polarity tests.

(4) Perform turns-ratio tests.

][3.6.7.6 Current Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(5) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter

(2) Perform insulation-resistance tests.

(3) Perform polarity tests.

(4) Perform ratio-verification tests.

][3.6.7.7 Metering

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Verify accuracy of meters at 25 percent, 50 percent, 75 percent, and 100 percent of full scale.

(2) Calibrate watthour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

]3.6.7.8 Grounding System

a. Visual and mechanical inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e. pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.6.8 Devices Subject to Manual Operation

Each device subject to manual operation must be operated at least three times, demonstrating satisfactory operation each time.

3.6.9 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-33 71 02 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 71 02 (February 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 33 71 02

UNDERGROUND ELECTRICAL DISTRIBUTION

08/21

PART 3   EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-33 71 02 (August 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-33 71 02 (February 2015)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 71 02

UNDERGROUND ELECTRICAL DISTRIBUTION

08/21

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NOTE: This guide specification covers the requirements for underground electrical work.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification does not cover all possible methods or requirements for providing underground facilities. To do so would be to produce an involved, confusing document. This guide specification presents the minimally acceptable material, usual methods and some of the most used alternatives. Different materials and methods, properly specified, indicated, and economically used will be acceptable when approved by the Contracting Officer.

****

****

Note: This section use the following manhole / handhole sketches.

NOTE: To download UFGS Forms, Graphics, and Tables, go to: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables

LIST OF SKETCHES

Sketches are available in metric (SI) and U.S. Customary (IP) system dimensions. Sketch titles and style numbers are unchanged for both types.

The metric values indicated are a conversion of the IP system dimensions.

Do not include list of sketches, or sketches themselves, in project specifications. Use manhole / handhole sketches as details on drawings whenever possible. If special features are required for a project, do not modify sketches, but indicate these changes on notes below the sketch. The "UG" style numbers and dates should remain on the drawing details.

SKETCH NUMBER	**TITLE**
UG - 1	**Standard Electrical Manhole (Nontraffic), Types 1 and 2**
UG - 2	**Standard Electrical Manhole (Traffic), Types 3 and 4**
UG - 3	**Standard Electrical Manhole (Airfield), Types 5 and 6**
UG - 4	**Standard Electrical Handhole (Nontraffic), Types 1 and 2**
UG - 5	**Standard Electrical Handhole (Traffic/Airfield), Types 3 and 4**
UG - 6	**Standard Electrical Handhole (Nontraffic),(Composite/Fiberglass) Types 5, 6, 7, 8 and 9**
UG - 7	**Details (Pulling-In Irons, Cable Rack, and Duct Entrance)**

****

NOTE: Ensure the following information is shown on the project drawings:

1. Where specification identifies type, size, color, finish, or other definitive information to be "as indicated," include the information on the drawings.

2. Location of ducts, and cables.

3. Types of wire and cable; number and sizes of conductors.

4. Ground rods and ground rings.

5. Locations of faulted circuit indicators, when used.

6. Special conditions, including live end caps and ductbank reinforcing, as required.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI MNL-66	(2020) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2013) Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B3	(2013; R 2024) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B231/B231M	(2023) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B400/B400M	(2023) Standard Specification for Compact Round Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B496	(2016; R 2021) Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors
ASTM B609/B609M	(2012; R 2021) Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical purposes
ASTM B800	(2005; R 2021) Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers
ASTM B801	(2018; R 2023) Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
ASTM C32	(2023) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C139	(2023) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C478M	(2018) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C857	(2016) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C990M	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)
ASTM F512	(2019; R 2024) Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation
ASTM F2160	(2022a) Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE 400.2	(2024) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE 495	(2007) Guide for Testing Faulted Circuit Indicators

IEEE C2	(2023) National Electrical Safety Code
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-94-649	(2021) Concentric Neutral Cables Rated 5 Through 46 KV

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI/NEMA WC 71/ICEA S-96-659	(2014; R 2022) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA C119.4	(2011) Electric Connectors - Connectors for Use Between Aluminum-to-Aluminum or Aluminum-to-Copper Conductors Designed for Normal Operation at or Below 93 Degrees C and Copper-to-Copper Conductors Designed for Normal Operation at or Below 100 Degrees C
NEMA RN 1	(2018) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TC 6 & 8	(2020) Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
NEMA TC 7	(2021) Smooth-Wall Coilable and Straight Electrical Polyethylene Conduit
NEMA TC 9	(2020) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY OF CABLE TELECOMMUNICATIONS ENGINEERS (SCTE)

ANSI/SCTE 77	(2013) Specification for Underground Enclosure Integrity

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-758	(2012b) Customer-Owned Outside Plant Telecommunications Infrastructure Standard

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS Bull 1751F-644	(2002) Underground Plant Construction

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005	(Basic; Notice 2) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape

UL 514A	(2024) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Mar 2024) UL Standard for Safety Conduit, Tubing and Cable Fittings
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 854	(2020; Reprint Jul 2024) Standard for Service-Entrance Cables
UL 1072	(2006; Reprint Oct 2024) Medium-Voltage Power Cables
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel

[1.2 SYSTEM DESCRIPTION

****

NOTE: Do not use this paragraph for Navy projects.

For Army projects, select the features and fill in blanks with selections appropriate for the design condition and in accordance with guidance contained in UFC 3-550-01, "Exterior Electrical Power Distribution".

See UFC 3-550-01 for guidance regarding service conditions. Retain or add the required conditions.

Provide seismic requirements, if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Pertinent portions of UFC 3-301-01, "Structural Engineering" and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT properly edited, must be included in the contract documents.

****

Items provided under this section must be specifically suitable for the following service conditions. Seismic details must [conform to UFC 3-301-01, "Structural Engineering" and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT] [be as indicated].

a. Fungus Control [_____]

b. Altitude [_____] m feet.

c. Ambient Temperature [_____] degrees C F.

d. Frequency [_____]

e. Ventilation [_____]

f. Seismic Parameters [_____]

g. Humidity Control [_____]

h. Corrosive Areas [_____]

i. [_____]

]1.3 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and grounding systems.

****

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.4 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

c. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

****

NOTE: For Navy projects, areas subject to aircraft loading are generally defined as follows:

1. For fixed wing aircraft facilities:
a) On or within 61 m 200 feet of runway sideline
b) On or within 15 m 50 feet of taxiway or apron sideline
c) Within Type 1 clear zone area as defined by UFC 3-260-01, "Airfield and Heliport Planning and Design".

2. For rotary wing aircraft facilities:
On landing surfaces, primary surfaces, or within areas defined as "paved and unpaved shoulders" in UFC 3-260-01, "Airfield and Heliport Planning and Design".

****

[d. Underground structures subject to aircraft loading are indicated on the drawings.

]1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Aluminum Conductors; G, [_____]

][Submit modified drawings and engineering calculations associated with design changes required for use of aluminum conductors.

] Precast Underground Structures; G, [_____]

SD-03 Product Data

****

NOTE: Submittals are required for each kind, voltage, or type used on the project.

****

Medium Voltage Cable; G, [_____]

Medium Voltage Cable Joints; G, [_____]

Medium Voltage Cable Terminations; G, [_____]

[Live End Caps; G, [_____]

] Precast Concrete Structures; G, [_____]

Sealing Material

Pulling-In Irons

Manhole Frames and Covers; G, [_____]

Handhole Frames and Covers; G, [_____]

[Frames and Covers for Airfield Facilities; G, [_____]

][Ductile Iron Frames and Covers for Airfield Facilities; G, [_____]

] Composite/Fiberglass Handholes; G, [_____]

Cable Supports (racks, arms and insulators); G, [_____]

****

NOTE: For Navy projects, do not use protective device coordination studies.

****

[Protective Devices and Coordination Study; G, [_____]

][Submit the study with protective device equipment submittals. No time extension or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government will not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered or procured prior to approval of the study.

] SD-06 Test Reports

Medium Voltage Cable Qualification and Production Tests; G, [_____]

Field Acceptance Checks and Tests; G, [_____]

Arc-proofing Test for cable fireproofing tape; G, [_____]

****

NOTE: Use Cable Installation only when pulling cable between manholes; do not use for pulling from pole riser to manhole only.

****

[Cable Installation Plan and Procedure; G, [_____]

][[Six][_____] copies of the information described below in 215.9

by 279.4 mm 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Separate sections by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

][a. Site layout drawing with cable pulls numerically identified.

][b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.

][c. The cable manufacturer and type of cable.

][d. The dates of cable pulls, time of day, and ambient temperature.

][e. The length of cable pull and calculated cable pulling tensions.

][f. The actual cable pulling tensions encountered during pull.

] SD-07 Certificates

Cable splicer/terminator; G, [_____]

Cable Installer Qualifications; G, [_____]

[Directional Boring Certificate of Conformance; G, [_____]

]1.6 QUALITY ASSURANCE

1.6.1 Precast Underground Structures

Submittal required for each type used. Provide calculations and drawings for precast manholes and handholes bearing the seal of a registered professional engineer including:

a. Material description (i.e., f'c and Fy)

b. Manufacturer's printed assembly and installation instructions

c. Design calculations

d. Reinforcing shop drawings in accordance with ACI MNL-66

e. Plans and elevations showing opening and pulling-in iron locations and details

[1.6.2 Certificate of Competency for Cable Splicer/Terminator

****

NOTE: Delete this paragraph if there is no medium voltage work required for the project. For CONUS projects, select the first bracketed paragraph. For OCONUS projects, select the second bracketed paragraph.

****

[The cable splicer/terminator must have a certification from the National

Cable Splicing Certification Board (NCSCB) in the field of splicing and terminating shielded medium voltage (5 kV to 35 kV) power cable using pre-manufactured kits (pre-molded, heat-shrink, cold shrink). Submit "Proof of Certification" for approval, for the individuals that will be performing cable splicer and termination work, 30 days before splices or terminations are to be made.

][Submit certification of the qualification of the cable splicer/terminator for approval, 30 days before splices or terminations are to be made in medium voltage (5 kV to 35 kV) cables. Include the training, and experience of the individual on the specific type and classification of cable to be provided under this contract. Indicate that the individual has had three or more years recent experience splicing and terminating medium voltage cables. List a minimum of three splices/terminations that have been in operation for more than one year. In addition, the individual may be required to perform a dummy or practice splice/termination in the presence of the Contracting Officer, before being approved as a qualified cable splicer. If that additional requirement is imposed, the Contractor must provide short sections of the approved types of cables along with the approved type of splice/termination kit, and detailed manufacturer's instructions for the cable to be spliced. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for certification of an alternate cable splicer.

]]1.6.3 Cable Installer Qualifications

Provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. Provide a resume showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers. Cable installer must demonstrate experience with a minimum of three medium voltage cable installations. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for an alternate qualified cable installer.

[1.6.4 Directional Boring Certificate of Conformance

****

NOTE: Delete this paragraph if there is no directional boring work required for the project.

****

Provide certification of compliance with the registered Professional Engineer's design requirements for each directional bore, including: HDPE conduit size and type, bend radius, elevation changes, vertical and horizontal path deviations, conductor size and type and any conductor derating due to depth of conduit. Record location and depth of all directional-bore installed HDPE conduits using Global Positioning System (GPS) recording means with "resource grade" accuracy.

]1.6.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of IEEE C2 and NFPA 70 unless more stringent requirements are specified or indicated.

1.6.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.6.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.6.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable, unless specified otherwise.

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

2.1.1 Rigid Metal Conduit

UL 6.

2.1.1.1 Rigid Metallic Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 15.75 kV per mm 400 volts per mil at 60 Hz, and tensile strength must be minimum 25 MPa 3500 psi.

2.1.2 Intermediate Metal Conduit

UL 1242.

2.1.2.1 Intermediate Metal Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 15.75 kV per mm 400 volts per mil at 60 Hz, and tensile strength must be minimum 25 MPa 3500 psi.

2.1.3 Plastic Conduit for Direct Burial and Riser Applications

****

NOTE: Specify EPC-40-PVC or EPC-80-PVC for direct-burial and riser applications.

****

UL 651 and NEMA TC 2,[EPC-40][or][EPC-80][as indicated].

2.1.4 Plastic Duct for Concrete Encasement

****

NOTE: Choose EB-35 where conduit deformity is a concern. Choose EPC-40 where required by the activity. Include "as indicated" when drawings designate different applications, such as, Type EB for primary distribution and Type EPC for secondary distribution to avoid transitions for risers.

****

Provide[[Type EB-20][Type EB-35] per UL 651, ASTM F512, and NEMA TC 6 & 8][or][Type EPC-40 per UL 651 and NEMA TC 2][, as indicated].

[2.1.5 High Density Polyethylene (HDPE) Electrical Conduit for Directional Boring

****

NOTE: Delete this paragraph if there is no directional boring work required for the project.

****

Smoothwall, approved/listed for directional boring, minimum Schedule 80, ASTM F2160, NEMA TC 7.

]2.1.6 Duct Sealant

UL 94, Class HBF. Provide high-expansion urethane foam duct sealant that expands and hardens to form a closed, chemically and water resistant, rigid structure. Sealant must be compatible with common cable and wire jackets and capable of adhering to metals, plastics and concrete. Sealant must be capable of curing in temperature ranges of 2 degrees C to 35 degrees C 35 degrees F to 95 degrees F. Cured sealant must withstand temperature ranges of -29 degrees C to 93 degrees C -20 degrees F to 200 degrees F without loss of function.

2.1.7 Fittings

2.1.7.1 Metal Fittings

UL 514B.

2.1.7.2 PVC Conduit Fittings

****

NOTE: Choose UL listed fittings for most applications and where conduit is required to comply with NFPA 70.

****

[UL 514B, UL 651][NEMA TC 3].

2.1.7.3 PVC Duct Fittings

NEMA TC 9.

[2.1.7.4 Outlet Boxes for Steel Conduit

Outlet boxes for use with rigid or flexible steel conduit must be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and must conform to UL 514A.

]2.2 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES

****

NOTE: In most cases NFPA 70 requires listed conductors and cable. Choose bracketed item for NEMA WC 70 only when compliance with NFPA 70 is not required.

****

Insulated conductors must be rated 600 volts and conform to the requirements of NFPA 70, including listing requirements[, or in accordance with NEMA WC 70]. Wires and cables manufactured more than [24][12] months prior to date of delivery to the site are not acceptable. Service entrance conductors must conform to UL 854, type USE.

2.2.1 Conductor Types

****

NOTE: Allow aluminum conductors for new underground lines.

****

Cable and duct sizes indicated are for copper conductors and THHN/THWN unless otherwise noted. Conductors No. 10 AWG and smaller must be solid. Conductors No. 8 AWG and larger must be stranded.[Conductors No. 6 AWG and smaller must be copper. Conductors No. 4 AWG and larger may be either copper or aluminum, at the Contractor's option. Do not substitute aluminum for copper if the equivalent aluminum conductor size would exceed 500 kcmil. When the Contractor chooses to use aluminum for conductors No. 4 AWG and larger, the Contractor must: increase the conductor size to have the same ampacity as the copper size indicated; increase the conduit and pull box sizes to accommodate the larger size aluminum conductors in accordance with NFPA 70; ensure that the pulling tension rating of the aluminum conductor is sufficient; relocate equipment, modify equipment terminations, resize equipment, and resolve to the satisfaction of the Contracting Officer problems that are direct results of the use of aluminum conductors in lieu of copper.][All conductors must be copper.]

2.2.2 Conductor Material

****

NOTE: For project applications which require a different insulation than those listed below, reference a Government or industry standard that the cable or conductor must meet. For projects which require multiple types of insulations, indicate the type for each cable on the project drawings. Refer to UFC 3-550-01, "Exterior Electrical Power Distribution" for further guidance.

****

Unless specified or indicated otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt,[Type THWN/THHN conforming to UL 83][or][Type[XHHW][or][RHW] conforming to UL 44]. Copper conductors must be annealed copper complying with ASTM B3 and ASTM B8.[Aluminum conductors must be Type AA-8000 aluminum conductors complying with ASTM B800 and ASTM B801, and must be of an aluminum alloy listed or labeled by UL as "component aluminum-wire stock (conductor material). Type 1350 is not acceptable. Intermixing of copper and aluminum conductors in the same raceway is not permitted.]

[2.2.3 Jackets

Provide multiconductor cables with an overall PVC outer jacket.

][2.2.4 Direct Buried

Provide single-conductor [and multi-conductor]cables identified for direct burial.

]2.2.5 In Duct

****

NOTE: For Army and Air Force projects only, coilable plastic duct may be used as an alternative to direct burial where extra physical protection is required.

****

Cables must be single-conductor cable.[Cables in factory-installed, coilable-plastic-duct assemblies must conform to NEMA TC 7.]

2.2.6 Cable Marking

Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length.

Identify each cable by means of a fiber, laminated plastic, or non-ferrous metal tags in each manhole, handhole, junction box, and each terminal. Each tag must contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

Color code conductors. Provide conductor identification within each enclosure where a tap, splice, or termination is made. Conductor identification must be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, heat shrink type sleeves,or colored electrical tape. Properly identify control circuit terminations. Color must be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals may be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems are as follows:

a. 208/120 volt, three-phase

    (1) Phase A - black

    (2) Phase B - red

    (3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase: Black and red

[d. On three-phase, four-wire delta system, high leg must be orange, as required by NFPA 70.

]2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS

Provide a uniform compression over the entire conductor contact surface. Use solderless terminal lugs on stranded conductors.

a. For use with copper conductors: UL 486A-486B.

[b. For use with aluminum conductors: UL 486A-486B. For connecting aluminum to copper, connectors must be the circumferentially compressed, metallurgically bonded type.

]2.4 LOW VOLTAGE SPLICES

****

NOTE: ANSI C119.1 Section 6.2.1.3 requires all connector systems be immersed in water for 24 hours at a minimum depth of 12 inches. Select splices that conform to this requirement.

****

Provide splices in conductors with a compression connector on the conductor and by insulating and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

2.4.1 Heat Shrinkable Splice

Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material applied in accordance with the manufacturer's written instructions.

2.4.2 Cold Shrink Rubber Splice

Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation must not require heat or flame, or any additional materials such as covering or adhesive. It must be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.5 MEDIUM VOLTAGE CABLE

Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than [24][12] months prior to date of delivery to the site are not acceptable. Provide single conductor type cables unless otherwise indicated.

2.5.1 Cable Configuration

****

NOTE: For Navy projects, use type MV only and delete requirements for concentric neutrals throughout.

****

****

NOTE: For Army and Air Force projects:

The two most commonly produced/specified medium voltage cables are Type MV (as described in UL 1072) and underground distribution ("UD/URD"), commonly used by electrical utilities. Type MV is a type designation recognized by NFPA 70 because it is UL listed. "UD/URD" is not a recognized type designation because it is utilized primarily by electrical utilities, who are not governed by NFPA 70 and for whom a UL listed cable adds unnecessary expense. Both type MV and "UD/URD" can be specified for use in duct or direct buried. In addition to the standard MV-90, NFPA 70 also lists an MV-105 temperature rating. However, MV-105 is not available from all manufacturers. Provide MV-105, only if needed.

Use either Type MV or "UD/URD" in ducts, keeping in mind that the concentric neutral affects bending radius and pulling tensions, therefore limiting the maximum pull and distance between manholes. Use "UD" for direct buried applications.

Choose 133 percent insulation level on 5 kV, 15 kV and 25 kV rated cables.

****

Provide [Type MV cable, conforming to NEMA WC 74/ICEA S-93-639 and UL 1072][concentric neutral underground distribution cable conforming to ICEA S-94-649][metallic armored cables, consisting of three-conductor, multi-conductor cables, with insulation and shielding, as specified, using [a galvanized steel][an aluminum] interlocked tape armor and thermoplastic jacket]. Provide cables manufactured for use in[duct][or][direct burial] applications[as indicated]. Cable must be rated [5 kV][15 kV][25 kV][28 kV][35 kV][as indicated] with [100][133] percent insulation level.

2.5.2 Conductor Material

****

NOTE: Provide aluminum conductors for new underground circuits and extensions of existing circuits. Select Type AA-8000 for type MV cable. Select 1350 for "UD/URD" cable. This includes all

new medium voltage systems designs that do not require interface (splicing copper to aluminum in underground structures) with existing copper infrastructure. Refer to UFC 3-550-01, "Exterior Electrical Power Distribution" paragraph entitled "Underground Electrical Systems" for additional guidance.
****

****
NOTE: A concentric compressed conductor has a diameter that is 3 percent less than a regular concentric conductor. A compact conductor has a diameter that is 10 percent less than a regular concentric conductor. Edit to specify compact conductors where necessary to limit duct fill (i.e. where new conductors are installed in existing ducts).
****

Provide concentric-lay-stranded, Class B[compact round] conductors. Provide[aluminum alloy Type AA-8000 aluminum conductors complying with ASTM B800 and ASTM B801][aluminum alloy 1350 cables, 3/4 hard minimum complying with ASTM B609/B609M and ASTM B231/B231M for regular concentric and compressed stranding or ASTM B400/B400M for compacted stranding][soft drawn copper cables complying with ASTM B3 and ASTM B8 for regular concentric and compressed stranding or ASTM B496 for compact stranding].

2.5.3 Insulation

****
NOTE: For projects which require multiple types of insulations, or special types of cables, such as submarine cable, indicate the type for each cable on the project drawings. Choose XLP or tree retardant XLP for "UD or URD" cable and either XLP or EPR for Type MV cable for Army and Air Force project. XLP Type MV cable is not allowed for Navy or Marine Corps projects.

For non-shielded cables rated 2001-5000 volts, choose ANSI/NEMA WC 71/ICEA S-96-659. For cables rated >15kV, choose ANSI/NEMA WC 74/ICEA S-93-639.

Choose AEIC CS8, except for concentric neutral cable only, choose ICEA S-94-649.
****

Provide [ethylene-propylene-rubber (EPR) insulation conforming to the requirements of [ANSI/NEMA WC 71/ICEA S-96-659][ANSI/NEMA WC 74/ICEA S-93-639] and [AEIC CS8][ICEA S-94-649]][tree-retardant cross-linked thermosetting polyethylene (XLP) insulation conforming to the requirements of NEMA WC 74/ICEA S-93-639 and [AEIC CS8][ICEA S-94-649]].

2.5.4 Shielding

****
NOTE: Choose tape shielding unless wire shielding is allowed or required by the Activity.

****

Cables rated for 2 kV and above must have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper[tape][or][wire] shield for each phase.

2.5.5 Neutrals

****

NOTE: Use first bracketed sentence for type MV cable and second bracketed sentence for type UD/URD cable.

In second bracketed sentence tailored for ARMY and AIR FORCE, select full ampacity concentric neutral for single-phase applications and one-third ampacity for three-phase applications.

Include the last bracketed sentence where high impedance grounded neutral systems are employed.

****

[Neutral conductors must be [copper][aluminum], employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.][Concentric neutrals conductors must be copper, having a combined ampacity [equal to][1/3 of] the phase conductor ampacity rating.][For high impedance grounded neutral systems, the neutral conductors from the neutral point of the transformer or generator to the connection point at the impedance must utilize [copper][aluminum] conductors, employing the same insulation level and construction as the phase conductors.]

2.5.6 Jackets

****

NOTE: PVC is acceptable for duct applications. Polyethylene (LLDPE) is exceptional for direct burial and in duct applications where there is significant amounts of water. There are many other types of jacket materials available (neoprene, hypalon, thermoplastic CPE) for special environments involving exposure to sunlight, petroleum products, and corrosive chemicals. Consult local cable representatives to specify the appropriate jacket for the application.

Choose the last bracketed sentence when PVC is specified.

****

Provide cables with a [PVC][_____] jacket.[Direct buried cables must be rated for direct burial.][Provide type UD cables with an overall jacket.] [Provide PVC jackets with a separator that prevents contact with underlying semiconducting insulating shield.]

2.6 MEDIUM VOLTAGE CABLE TERMINATIONS

****

NOTE: Specification sections for equipment, such as

pad-mounted transformers, SF-6 switches, and unit substations, contain paragraphs for terminations, and have not been updated to coordinate with this specification section. When this paragraph is used only for that equipment, specify terminations either in that section or in this section, and delete paragraph from the other section.

****

****

NOTE: Provide indoor terminator/outdoor terminations with skirts. By including skirts for "indoor" and "within equipment" locations, tracking resistance is significantly improved. Provision of skirts for indoor terminations automatically makes them IEEE 48 Class 1.

****

IEEE 48 Class 1; of the molded elastomer, prestretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Provide terminations, where required, with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Provide terminations in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

2.6.1 Cold-Shrink Type

Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all necessary materials (except for the lugs). Design termination for installation in low or highly contaminated indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

2.6.2 Heat Shrinkable Type

Terminator must consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is nontracking, resists heavy atmospheric contaminants, ultra violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Design termination for installation in low or highly contaminated indoor or outdoor locations.

[2.6.3 Separable Insulated Connector Type

****

NOTE: Coordinate the connector ratings required with the equipment specification for transformers and switches.

Separable connectors may not be used in manholes.
****

IEEE 386. Provide connector with steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide connectors of the loadbreak or deadbreak type as indicated, of suitable construction for the application and the type of cable connected, and that include cable shield adaptors. Provide external clamping points and test points. Do no use separable connectors in manholes/handholes.

[a. 200 Ampere loadbreak connector ratings: Voltage: [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Short time rating: 10,000 rms symmetrical amperes.
]
****
NOTE: For Navy projects, provide 200 ampere bushing interface on all 600 ampere connectors.
****

[b. 600 Ampere deadbreak connector ratings: Voltage: [15 kV, 95 kV BIL][25 kV, 125 kV BIL][35 kV, 150 kV BIL]. Short time rating: 25,000 rms symmetrical amperes.[Connectors must have 200 ampere bushing interface[for surge arresters][as indicated].]
]
****
NOTE: Include the following paragraph only when the activity requires additional grounding elbows and feed-thru inserts.
****

[c. Provide[[one][_____] set[s] of three grounding elbows][and][[one][_____] set[s] of three feed-thru inserts]. Deliver [grounding elbows][and][feed-thru inserts] to the Contracting Officer.
]
****
NOTE: Include the following paragraph only when the activity requires faulted circuit indicators.
****

[d. Install one set of faulted circuit indicators, complying with IEEE 495, on the test points of each set of separable insulated connectors. Indicators must be self powered; with automatic trip with mechanical flag indication upon overcurrent followed by loss of system voltage, and automatic reset upon restoration of system voltage. Indicators must be compact, sealed corrosion resistant construction with provision for hotstick installation and operation.

]]2.7 MEDIUM VOLTAGE CABLE JOINTS

Provide joints (splices) in accordance with IEEE 404 suitable for the rated voltage, insulation level, insulation type, and construction of the cable. Joints must be certified by the manufacturer for waterproof, submersible applications. Upon request, supply manufacturer's design qualification test report in accordance with IEEE 404. Connectors for joint must be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

2.7.1 Heat-Shrinkable Joint

Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.

2.7.2 Cold-Shrink Rubber-Type Joint

Joint must be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket must be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice should be packaged three splices per kit, including complete installation instructions.

2.8 TELECOMMUNICATIONS CABLING

Provide telecommunications cabling in accordance with Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

[2.9 LIVE END CAPS

****

NOTE: Live end caps are only required when cable is required to remain unterminated, but energized. Live end cap locations must be indicated on the drawings.

****

Provide live end caps using a "kit" including a heat-shrinkable tube and a high dielectric strength, polymeric plug overlapping the conductor. Conform to applicable portions of IEEE 48.

]2.10 TAPE

2.10.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

2.10.2 Buried Warning and Identification Tape

Provide detectable tape in accordance with Section 31 00 00 EARTHWORK.

2.10.3 Fireproofing Tape

****

NOTE: Provide the following paragraph where medium voltage cable (2200 volts or greater) is installed in manholes, handholes and vaults.

****

Provide tape composed of a flexible, conformable, unsupported intumescent elastomer. Tape must be not less than 0.762 mm .030 inch thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, adhesive-free, and must not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

2.11 PULL ROPE

Plastic or flat pull line (bull line) having a minimum tensile strength of 890 N 200 pounds.

2.12 GROUNDING AND BONDING

2.12.1 Driven Ground Rods

****

NOTE: Provide solid copper ground rods when soil conditions are corrosive.

****

Provide [copper-clad steel ground rods conforming to UL 467][solid copper ground rods conforming to UL 467][solid stainless steel ground rods] not less than 19 mm 3/4 inch in diameter by 3.1 m 10 feet in length. Sectional type rods may be used for rods62 m 20 feet or longer.

2.12.2 Grounding Conductors

Stranded-bare copper conductors must conform to ASTM B8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors must conform to ASTM B1 for sizes No. 8 and smaller. Insulated conductors must be of the same material as phase conductors and green color-coded, except that conductors must be rated no more than 600 volts. Aluminum is not acceptable.

2.13 CAST-IN-PLACE CONCRETE

****

NOTE: Retain Section 03 30 00 CAST-IN-PLACE CONCRETE for Navy projects and Section 03 30 00 CAST-IN-PLACE CONCRETE for Army projects.

****

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. In addition, provide concrete for encasement of underground ducts with 20 MPa 3000 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts must be 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise.

2.14 UNDERGROUND STRUCTURES

****

NOTE: Edit this paragraph to comply with project requirements concerning the type of structure or duct, strength of concrete, concrete mix, metal accessories, and excavating and grading. Indicate special reinforcing where required, particularly with duct banks of non-rectangular cross-section. Contact local telephone company, where applicable, concerning the size of all signal manholes and the number and type of signal duct required. Determine availability since aircraft or H20 highway loadings may not be available in precast.

For Navy projects only, see standard sketches UG-1

through UG-7, covering manholes and handholes located at http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables. Include the required sketches on the project drawings.
****

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C857 and ASTM C478M ASTM C478. Top, walls, and bottom must consist of reinforced concrete. Walls and bottom must be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, must be adequate to accommodate the cable.

2.14.1 Cast-In-Place Concrete Structures

****
NOTE: Edit bracketed items at designer's discretion and as required where aircraft loading is in project.
****

Concrete must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.[Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.][Concrete block must conform to ASTM C139 and Section 04 20 00, MASONRY.][Concrete block is not allowed in areas subject to aircraft loading.]

2.14.2 Precast Concrete Structures, Risers and Tops

Precast concrete underground structures may be provided in lieu of cast-in-place subject to the requirements specified below. Precast units must be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.

2.14.2.1 General

Precast concrete structures must have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures must have plan area and clear heights not less than those of cast-in-place structures. Concrete materials and methods of construction must be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work must have a 28-day compressive strength of not less than 30 MPa 4000 psi. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. Structures must be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

2.14.2.2 Design for Precast Structures

ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:

a. Angle of Internal Friction (phi) = 0.523 rad 30 degrees

b. Unit Weight of Soil (Dry) = 1760 kg/m^3 110 pcf, (Saturated) = 2080 kg/m^3 130 pcf

c. Coefficient of Lateral Earth Pressure (Ka) = 0.33

d. Ground Water Level = 915 mm 3 feet below ground elevation

****

NOTE: Specify H20 highway loading for most locations. Revise as required if loading in excess of H20 highway loading is required.

Indicate structures subject to aircraft loading on the drawings. Also show structure design requirements on the drawings. Design decks and covers subject to aircraft loadings for loadings per FAA AC-150/5320-6 except as follows:

a. Design covers for 45 000 kg 100,000 lb wheel loads with 1.72 MPa 250 psi tire pressure.

b. For spans of less than 0.6 m 2 feet in the least direction, use a uniform live load of 2.24 Mpa 325 psi.

c. For spans of 0.6 m 2 feet or greater in the least direction, base the design on the number of wheels which will fit the span. Use wheel loads of 34,000 kg 75,000 pounds.

****

e. Vertical design loads must include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads must consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered. The minimum design vertical load must be for H20 highway loading per AASHTO HB-17.

f. Horizontal design loads must include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, must be considered, along with a pulling-in iron design load of 26,700 N 6000 pounds.

g. Each structural component must be designed for the load combination and positioning resulting in the maximum shear and moment for that particular component.

h. Design must also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

2.14.2.3 Construction

Provide a uniform thickness for structure top, bottom, and wall not less than 150 mm 6 inches. Thin-walled knock-out panels for designed or future duct bank entrances are not permitted. Provide quantity, size, and location of duct bank entrance windows as directed, and cast completely open by the precaster. Size of windows must exceed the nominal duct bank envelope dimensions by at least 305 mm 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows must be a minimum of 150 mm 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of 305 mm 12 inches in diameter and 100 mm 4 inches deep for precast structures.

2.14.2.4 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to ASTM C990M ASTM C990. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.14.3 Manhole Frames and Covers

****

NOTE: CID A-A-60005 is used below as a requirement for manhole frames and covers. Although this document has been withdrawn by GSA, it is still used as a requirement because manufacturers still use it as a design guide.

****

Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the words "ELECTRIC" or "TELECOMMUNICATIONS" in the top face of power and telecommunications manhole covers, respectively.

2.14.4 Handhole Frames and Covers

Frames and covers of steel must be welded by qualified welders in accordance with standard commercial practice. Provide rolled-steel floor plate covers having an approved antislip surface. Hinges must be of [stainless steel with bronze hinge pin] [wrought steel], 125 by 125 mm 5 by 5 inches by approximately 4.75 mm 3/16 inch thick, without screw holes, and must be for full surface application by fillet welding. Hinges must have nonremovable pins and five knuckles. The surfaces of plates under hinges must be true after the removal of raised antislip surface, by grinding or other approved method.

[2.14.5 Frames and Covers for Airfield Facilities

****
NOTE: Use this paragraph for structures subject to aircraft loading.
****

Fabricate frames and covers for airfield use of standard commercial grade steel welded by qualified welders in accordance with AWS D1.1/D1.1M. Provide rolled steel floor plate covers having an approved anti-slip surface. Steel frames and covers must be hot dipped galvanized after fabrication.

][2.14.6 Ductile Iron Frames and Covers for Airfield Facilities

****
NOTE: As an option, the designer may also allow the use of this paragraph for structures subject to aircraft loading.
****

At the Contractor's option, ductile iron covers and frames designed for a minimum proof load of 45,000 kg 100,000 pounds may be provided in lieu of the steel frames and covers indicated. Covers must be of the same material as the frames (i.e. ductile iron frame with ductile iron cover, galvanized steel frame with galvanized steel cover). Perform proof loading in accordance with CID A-A-60005 and ASTM A48/A48M. Proof loads must be physically stamped into the cover. Provide the Contracting Officer copies of previous proof load test results performed on the same frames and covers as proposed for this contract. Modify the top of the structure to accept the ductile iron structure in lieu of the steel structure indicated. The finished structure must be level and non-rocking, with the top flush with the surrounding pavement.

]2.14.7 Brick for Manhole Collar

Provide sewer and manhole brick conforming to ASTM C32, Grade MS.

2.14.8 Composite/Fiberglass Handholes and Covers

ANSI/SCTE 77. Provide handholes and covers of polymer concrete, reinforced with heavy weave fiberglass with a design load (Tier rating) appropriate for or greater than the intended use. All covers are required to have the Tier level rating embossed on the surface which must not exceed the design load of the box.

2.15 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

Zinc coat the metal portion of racks and arms after fabrication.

2.15.1 Cable Rack Stanchions

The wall bracket or stanchion must be 100 mm 4 inches by approximately 38 mm by 4.76 mm 1-1/2 inch by 3/16 inch channel steel, or 100 mm 4 inches by approximately 25 mm 1 inch glass-reinforced nylon with recessed bolt mounting holes, 1220 mm 48 inches long (minimum) in manholes. Space slots for mounting cable rack arms at 200 mm 8 inch intervals.

2.15.2 Rack Arms

Cable rack arms must be steel or malleable iron or glass reinforced nylon and must be of the removable type. Rack arm length must be a minimum of 200 mm 8 inches and a maximum of 305 mm 12 inches.

2.15.3 Insulators

Insulators for metal rack arms must be dry-process glazed porcelain. Insulators are not required for nylon arms.

2.16 CABLE TAGS IN MANHOLES

****

NOTE: Verify cable labeling requirements with the local Activity.

****

Provide polyethylene tags for each power cable located in manholes. Do not provide handwritten letters. The first position on the power cable tag denotes the voltage. The second through sixth positions on the tag identifies the circuit. The next to last position denotes the phase of the circuit and include the Greek "phi" symbol. The last position denotes the cable size. As an example, a tag could have the following designation: "11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

2.16.1 Polyethylene Cable Tags

Provide tags of polyethylene having an average tensile strength of 22.4 MPa 3250 pounds per square inch; and that are 2 millimeter 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 77 degrees C 170 degrees F. Provide 1.3 mm 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag, having a minimum loop tensile strength of 778.75 N 175 pounds and black block letters, numbers, and symbols 25 mm one inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags' orientation.

2.17 MEDIUM VOLTAGE ABOVE GROUND CABLE TERMINATING CABINETS

****

NOTE: Cable terminating cabinets may be used for above ground applications only. They may be utilized in place of manholes for cable splicing where the local water table does not allow for manhole drainage, or in limited applications where it is desirable to provide a dead-break circuit sectionalizing point for circuit isolation. Loadbreak connectors are not available for applications above 200 A.

****

Cable terminating cabinets must be hook-stick operable, deadfront construction conforming to the requirements of IEEE C37.20.3, Category A. Provide cabinets with [200 A. loadbreak junctions and elbow-type separable loadbreak connectors, cable parking stands, and grounding lugs][600 A. dead-break junctions and elbow-type separable dead-break connectors, cable parking stands, and grounding lugs]. Provide cable terminating equipment in conformance with IEEE 386.

Ratings at 60 Hz must be:

Nominal voltage (kV)	[_____]
Rated maximum voltage (kV)	[[15][25][35]]
Rated continuous current (A)	[[200][600]]
One-second short-time current-carrying capacity (kA)	[_____]
BIL (kV)	[_____]

2.18 LOW VOLTAGE ABOVE GROUND TERMINATION PEDESTAL

Provide copolymer polypropylene, low voltage above ground termination pedestal manufactured through an injection molding process. Pedestals must resist fertilizers, salt air environments and ultra-violet radiation. Pedestal top must be imprinted with a "WARNING" and "ELECTRIC" identification. Pedestal must contain [three][four] lay-in six port connectors, NEMA C119.4, Class "A", dual rated for aluminum or copper, and capable of terminating conductors ranging from 10 AWG to 500 kcmil. Protect each connector with a clear, hard lexan (plastic) cover. Provide pedestal with rust-free material and stainless steel hardware that is lockable.

2.19 PROTECTIVE DEVICES AND COORDINATION

****

NOTE: Do not use on Navy Projects. Per UFC 3-501-01, "Electrical Engineering", the designer of record is responsible for providing a design stage and a final coordination study based on as built conditions.

For the Army and Air Force, the designer is responsible for specifying the requirement for fuses, circuit breakers, protective relays, or other protective devices associated with the project and depicting them on the drawings. Select and specify the protective devices to protect electrical power system conductors or equipment against sustained overloads, in-rush conditions, electrical faults, or other abnormal power system or equipment operating conditions, in accordance with IEEE 242, and IEEE 141. Utilize section 26 05 73 POWER SYSTEM STUDIES and coordinate the incorporation of the protective device requirements identified in the other equipment specification sections.

****

Provide protective devices and coordination as specified in Section 26 05 73 POWER SYSTEM STUDIES.

2.20 SOURCE QUALITY CONTROL

2.20.1 Arc-Proofing Test for Cable Fireproofing Tape

Manufacturer must test one sample assembly consisting of a straight lead tube 305 mm 12 inches long with a 65.5 mm 2 1/2 inch outside diameter, and a 3.175 mm 1/8 inch thick wall, and covered with one-half lap layer of arc and fireproofing tape per manufacturer's instructions. The arc and fireproofing tape must withstand extreme temperature of a high-current fault arc 13,000 degrees K for 70 cycles as determined by using an argon directed plasma jet capable of constantly producing and maintaining an arc temperature of 13,000 degrees K. Temperature (13,000 degrees K) of the ignited arc between the cathode and anode must be obtained from a dc power source of 305 (plus or minus 5) amperes and 20 (plus or minus 1) volts. Direct the arc toward the sample assembly accurately positioned 5 (plus or minus 1) millimeters downstream in the plasma from the anode orifice by fixed flow rate of argon gas (0.18 g per second). Test each sample assembly at three unrelated points. Start time for tests must be taken from recorded peak current when the specimen is exposed to the full test temperature. Surface heat on the specimen prior to that time must be minimal. The end point is established when the plasma or conductive arc penetrates the protective tape and strikes the lead tube. Submittals for arc-proofing tape must indicate that the test has been performed and passed by the manufacturer.

2.20.2 Medium Voltage Cable Qualification and Production Tests

Results of AEIC CS8 qualification and production tests as applicable for each type of medium voltage cable.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Soil treatment for termite control should conform to Section 31 31 16.13 CHEMICAL TERMITE CONTROL, except that application to direct burial cable installation should be as specified. In lieu of soil poisoning, cable in direct-buried EPC-40-PVC conduit can be a more economical and practical way of protecting cable from termites. For projects with direct-buried cable (not in conduit) and at project locations in Environmental Severity Classifications (ESC) C4 and C5, treat soil a minimum 305 mm 12 inches on each side for the entire length of the cable. For these projects include the last bracketed sentence in the paragraph below, and edit and include Section 31 31 16.13 CHEMICAL TERMITE CONTROL. See UFC 1-200-01 for determination of ESC for project location.

****

****

NOTE: CALPUC publication applies only to State of California Public Utilities Commission CALPUC G.O.128, "Construction of Underground Electric Supply and Communication System" for underground electrical work. For other states, delete this

publication and insert other publications which govern underground electrical work for that state. Revise reference paragraph to include deletion or addition of state publication.
****

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70[and IEEE C2][and CALPUC G.O.128] as applicable. In addition to these requirements, install telecommunications in accordance with TIA-758 and RUS Bull 1751F-644.[Treat soil a minimum 305 mm 12 inches on each side of the installed cable for the entire length in accordance with Section 31 31 16.13 CHEMICAL TERMITE CONTROL.]

3.2 CABLE INSPECTION

Inspect each cable reel for correct storage positions, signs of physical damage, and broken end seals prior to installation. If end seal is broken, remove moisture from cable prior to installation in accordance with the cable manufacturer's recommendations.

[3.3 CABLE INSTALLATION PLAN AND PROCEDURE

****
NOTE: Use this paragraph when pulling cable between manholes. Do not use this paragraph when only installing between poles and manholes.

Choose checklist for small electrical distribution jobs, and calculations for large jobs.
****

Obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature limits for installation, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, maximum allowable pulling tension, and maximum allowable sidewall bearing pressure. [Prepare a checklist of significant requirements][Perform pulling calculations and prepare a pulling plan]and submit along with the manufacturer's instructions in accordance with SUBMITTALS. Install cable strictly in accordance with the cable manufacturer's recommendations and the approved installation plan.

[Calculations and pulling plan must include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall bearing pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

]]3.4 UNDERGROUND FEEDERS SUPPLYING BUILDINGS

****

NOTE: For Navy only, choose PVC. Do not specify IMC/aluminum in corrosive locations. Corrosive locations are those with Environmental Severity Classifications (ESC) of C3 thru C5. See UFC 1-200-01 for determination of ESC for project locations.

****

Terminate underground feeders supplying building at a point 1525 mm 5 feet outside the building and projections thereof, except that conductors must be continuous to the terminating point indicated. Coordinate connections of the feeders to the service entrance equipment with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide [PVC, Type EPC-40][IMC][RGS] conduit from the supply equipment to a point 1525 mm 5 feet outside the building and projections thereof. Protect ends of underground conduit with plastic plugs until connections are made.

[Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement.

]3.5 UNDERGROUND STRUCTURE CONSTRUCTION

****

NOTE: Edit this paragraph to comply with project requirements concerning the type of structure, strength of concrete, concrete mix, metal accessories, and excavating and grading. Indicate special reinforcing where required. Contact local telephone company, where applicable, concerning the size of all signal manholes and the number and type of signal duct required. Determine availability since H20 or aircraft loadings may not be available in precast.

For Navy projects, see standard sketches UG-1 through UG-7 covering manholes and handholes. Include the required sketches on the project drawings.

****

Provide standard type cast-in-place construction as specified herein and as indicated, or precast construction as specified herein. Horizontal concrete surfaces of floors must have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound must conform to ASTM C309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Manhole locations, as indicated, are approximate. Coordinate exact manhole locations with other utilities and finished grading and paving.

3.5.1 Cast-In-Place Concrete Structures

[Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.] [Provide concrete block conforming to ASTM C139 and Section 04 20 00 MASONRY.] [Concrete block is not allowed in areas subject to aircraft loading.]

3.5.2 Precast Concrete Construction

Set commercial precast structures on 150 mm 6 inches of level, 90 percent compacted granular fill, 19 mm to 25 mm 3/4 inch to 1 inch size, extending 305 mm 12 inches beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation must additionally conform to the manufacturer's instructions.

3.5.3 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices must be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor, locate the irons a minimum of 150 mm 6 inches from the edge of the sump, and in the walls, locate the irons within 150 mm 6 inches of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron must not be located within 150 mm 6 inches of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 150 mm 6 inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 915 mm 3 foot length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner must be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 75 mm 3 inches from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons must have a clear projection into the structure of approximately 100 mm 4 inches and must be designed to withstand a minimum pulling-in load of

26,700 N 6000 pounds. Hot-dip galvanize irons after fabrication.

3.5.4 Cable Racks, Arms and Insulators

Cable racks, arms and insulators must be sufficient to accommodate the cables. Space racks in power manholes not more than 915 mm 3 feet apart, and provide each manhole wall with a minimum of two racks. Space racks in signal manholes not more than 420 mm 16 1/2 inches apart with the end rack being no further than 305 mm 12 inches from the adjacent wall. Methods of anchoring cable racks are as follows:

a. Provide a 15 mm diameter by 125 mm 5/8 inch diameter by 5 inch long anchor bolt with 75 mm 3 inch foot cast in structure wall with 50 mm 2 inch protrusion of threaded portion of bolt into structure. Provide 15 mm 5/8 inch steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of 1192 kg per meter 800 pounds per foot. Insert channel must be steel of the same length as "vertical rack channel;" and cast flush in structure wall. Provide 15 mm 5/8 inch steel nuts in channel insert to receive 15 mm diameter by 75 mm 5/8 inch diameter by 3 inch long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert must have minimum 365 kg 800 pound load rating. Provide 15 mm diameter by 75 mm 5/8 inch diameter by 3 inch long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

3.5.5 Field Painting

****

NOTE: Edit to match products contained in Part 2. Choose cast-iron for most applications. Ductile iron or steel may be required for areas subject to heavy loading such as airfields or industrial areas.

****

Clean cast-iron frames and covers not buried in concrete or masonry of mortar, rust, grease, dirt and other deleterious materials, and coat with bituminous paint.

[3.6 DIRECT BURIAL CABLE SYSTEM

****

NOTE: Refer to UFC 3-550-01, "Exterior Electrical Power Distribution", for guidance on when direct buried wiring may be permitted.

****

Direct-bury cables in the earth below the frostline [as indicated][to the requirements of NFPA 70 and IEEE C2, whichever is more stringent].

3.6.1 Trenching

Excavate trenches for direct-burial cables to provide a minimum cable cover of 610 mm 24 inches below finished grade for power conductors operated at

600 volts or less, and 765 mm 30 inches below finished grade for over 600 volts in accordance with IEEE C2. When rock is encountered, remove to a depth of at least 75 mm 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 6 mm 1/4 inch. Bottoms of trenches must be smooth and free of stones and sharp objects. Where materials in bottoms of trenches are other than sand, a 75 mm 3 inch layer of sand must be laid first and compacted to approximate densities of surrounding firm soil. Trenches must be not less than [150][200] mm [6][8] inches wide, and must be in straight lines between cable markers.[Do not use cable plows.] Bends in trenches must have a radius [of not less than 915 mm 36 inches][consistent with the cable manufacturer's published minimum cable bending radius for the cable installed].

3.6.2 Cable Installation

****

NOTE: Where soil is known to be rocky, provide selected backfill for cable protection. Specify bend radius in accordance with NFPA 70.

****

Unreel cables along the sides of or in trenches and carefully place on sand or earth bottoms. Pulling cables into direct-burial trenches from a fixed reel position is not permitted, except as required to pull cables through conduits under paving or railroad tracks.

Where two or more cables are laid parallel in the same trench, space cables laterally at not less than 75 mm 3 inches apart, except that communication cable must be separated from power cable by a minimum distance of 305 mm 12 inches.

Where direct-burial cables cross under roads or other paving exceeding 1.5 m 5 feet in width, install such cables in[concrete-encased] ducts. Where direct-burial cables cross under railroad tracks, install such cables in [reinforced concrete-encased ducts][ducts installed through rigid galvanized steel sleeves]. Extend ducts at least 1.5 m 5 feet beyond each edge of any paving and at least 1.5 m 5 feet beyond each side of any railroad tracks. Cables may be pulled into duct from a fixed reel where suitable rollers are provided in the trench. Where direct burial cable transitions to duct-enclosed cable, center direct-burial cables in duct entrances, and a waterproof nonhardening mastic compound must be used to facilitate such centering. If paving or railroad tracks are in place where cables are to be installed, coated rigid steel conduits driven under the paving or railroad tracks may be used in lieu of concrete-encased ducts. Prevent damage to conduit coatings by providing ferrous pipe jackets or by predrilling. Where cuts are made in any paving, restore the paving and subbase to their original condition. Where cable is placed in duct(e.g. under paved areas, roads, or railroads), slope ducts to drain.

3.6.3 Splicing

****

NOTE: Direct earth burial cables generally require direct burial splices. Observe marker slab requirements previously covered in this specification. Direct burial splices are allowable for NAVFAC projects only, do not specify for Army and Air Force Projects. For Army and Air Force projects, use the second bracketed option.

****

Provide cables in one piece without splices between connections except where the distance exceeds the lengths in which cables are manufactured.[Where splices are required, provide splices designed and rated for direct burial.][Where splices are required, install splices only in maintenance manholes/handholes or cabinets/pedestals.]

3.6.4 Bends

Bends in cables must have an inner radius not less than those specified in NFPA 70 for the type of cable, or manufacturer's recommendation.

3.6.5 Horizontal Slack

Leave approximately 915 mm 3 feet of horizontal slack in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought above ground. Where cable is brought above ground, leave additional slack to make necessary connections.[Enclose splices in lead-sheathed or armored cables in split-type cast-iron splice boxes; after completion of the connection, fill with insulating filler compound and tightly clamp the box.]

3.6.6 Identification Slabs[or Markers]

Provide a slab at each change of direction of cable, over the ends of ducts or conduits which are installed under paved areas and roadways[, over the ends of ducts or conduits stubbed out for future use][, and over each splice]. Identification slabs must be concrete, approximately 500 mm square by 150 mm 20 inches square by 6 inches thick, set flat in the ground so that top surface projects not less than 20 mm 3/4 inch, nor more than 30 mm 1 1/4 inches above ground. Concrete must have a compressive strength of not less than 20 MPa 3000 psi and have a smooth troweled finish on exposed surface. Inscribe an identifying legend such as "electric cable," "telephone cable," "splice," or other applicable designation on the top surface of the slab before concrete hardens. Inscribe circuit identification symbols on slabs as indicated. Letters or figures must be approximately 50 mm 2 inches high and grooves must be approximately 6 mm 1/4 inch in width and depth. Install slabs so that the side nearest the inscription on top includes an arrow indicating the side nearest the cable. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

]3.7 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.7.1 Requirements

****

NOTE: Indicate direct buried conduit and concrete encased conduit on drawings. Ensure that duct is specified to be installed below the frost line depth. Placement of grounding conductor below duct bank is preferred since it will be physically protected by the concrete encasement; however, coordinate with the Activity regarding placement below or above duct bank.

****

Run conduit in straight lines except where a change of direction is necessary. Provide numbers and sizes of ducts as indicated. Provide a 4/0 AWG bare copper grounding conductor [below][above] medium-voltage distribution duct banks. Bond bare copper grounding conductor to ground rings (loops) in all manholes and to ground rings (loops) at all equipment slabs (pads). Route grounding conductor into manholes with the duct bank (sleeving is not required). Ducts must have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of [75 mm][100 mm] per 30 m [3][4] inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Terminate all PVC conduit end points in utility holes, switching cabinets, transform handholes and buildings with end bells. The bell end of the conduits that enter manholes and handholes must be flush with the wall.

Perform changes in ductbank direction as follows:

a. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable.

b. The minimum manufactured bend radius must be 450 mm 18 inches for ducts of less than 80 mm 3 inch diameter, and 900 mm 36 inches for ducts 80 mm 3 inches or greater in diameter.

c. As an exception to the bend radius required above, provide field manufactured longsweep bends having a minimum radius of 7.6 m 25 feet for a change of direction of more than 5 degrees, either horizontally or vertically, using a combination of curved and straight sections. Maximum manufactured curved sections allowed for use in field manufactured longsweep bend: 30 degrees.

3.7.2 Treatment

Keep ducts clean of concrete, dirt, or foreign substances during construction. Make field cuts requiring tapers with proper tools and match factory tapers. Use a coupling recommended by the duct manufacturer whenever an existing duct is connected to a duct of different material or shape. Store ducts to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Thoroughly clean ducts before being laid. Store plastic ducts on a flat surface and protected from the direct rays of the sun.

3.7.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 75 mm 3 inches and larger, draw a flexible testing mandrel approximately 305 mm 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than 75 mm 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.7.4 Jacking and Drilling Under Roads and Structures

Conduits to be installed under existing paved areas which are not to be disturbed, and under roads and railroad tracks, must be zinc-coated, rigid steel, jacked into place. Where ducts are jacked under existing pavement, install rigid steel conduit because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 15 m 50 feet in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks must be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 1.2 m 4 feet on centers.[Hydraulic jet method must not be used.]

[3.7.5 Galvanized Conduit Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations must be PVC coated and extend from at least 50 mm 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of 150 mm 6 inches from penetration).

]3.7.6 Multiple Conduits

Separate multiple conduits by a minimum distance of 75 mm 3 inches[, except that light and power conduits must be separated from control, signal, and telephone conduits by a minimum distance of [300] mm [12] inches]. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly must consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 3050 mm 10 feet of conduit assembly.

3.7.7 Conduit Plugs and Pull Rope

Provide new conduit indicated as being unused or empty with plugs on each end. Plugs must contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 915 mm 3 feet of slack at each end of unused or empty conduits.

3.7.8 Conduit and Duct Without Concrete Encasement

Depths to top of the conduit must be not less than 610 mm 24 inches below finished grade. Provide not less than 75 mm 3 inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 75 mm 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 6.25 mm 1/4 inch sieve. The first 150 mm 6 inch layer of backfill cover must be sand compacted as previously specified. The rest of the excavation must be backfilled and compacted in 75 to 150 mm 3 to 6 inch layers. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.7.8.1 Encasement Under Roads and Structures

Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 75 mm 3 inch concrete cover around ducts. Extend concrete encasement at least 1525 mm 5 feet beyond the edges of paved areas and roads, and 3660 mm 12 feet beyond the rails on each side of railroad tracks. Depths to top of the concrete envelope must be not less than 610 mm 24 inches below finished grade[, and under railroad tracks not less than 1270 mm 50 inches below the top of the rails].

[3.7.8.2 Directional Boring

HDPE conduits must be installed below the frostline and as specified herein.

[For distribution voltages greater than 1000 volts and less than 34,500 volts, depths to the top of the conduit must not be less than 1220 mm 48 inches in pavement-covered areas and not less than 3050 mm 120 inches in non-pavement-covered areas.][For distribution voltages less than 1000 volts, depths to the top of the conduit must not be less than 1220 mm 48 inches in pavement- or non-pavement-covered areas.][For branch circuit wiring less than 600 volts, depths to the top of the conduit must not be less than 610 mm 24 inches in pavement- or non-pavement-covered areas.]

]3.7.9 Duct Encased in Concrete

****

NOTE: Edit this paragraph to comply with project requirements concerning type of structure or duct, strength of concrete, concrete mix, metal accessories, and excavating and grading. Indicate special reinforcing where required, particularly with duct banks of non-rectangular cross-section, and for ductbanks under road crossings, railroad crossings and airfield paving crossings. Reinforcing should extend at least 1.5 m 5 feet beyond the edge of pavement or railroad tracks.

Medium voltage cables and campus distribution cables of telecommunications backbone distribution system must be in duct encased in concrete, unless otherwise required by local Activity. Contact local telephone company, where applicable, concerning size of signal manholes and number and type of signal duct required.

****

****

NOTE: Provide steel reinforcing per the following table:

COVER	**UNREINFORCED**	**REINFORCED***
≥450 mm 18 in and <1220 mm 48 in	**Undeveloped areas.**	**Transition from good to poor soil conditions where differential settlement is anticipated.**

COVER	**UNREINFORCED**	**REINFORCED***
≥610 mm 24 in and <1220 mm 48 in	**Roads/paved areas for light to moderate traffic loads.**	**Other roads/paved areas (i.e. supporting trucks, cranes, ultra-heavy loads.)**
≥1220 mm 48 in	**All ductbanks (except as noted).**	**Under railroad tracks. Transition from good to poor soil conditions where differential settlement is anticipated.**

*** Use minimum reinforcement of 4 #13 #4 w/ #10 #3 ties at 915 mm 3 feet o/c for ductbanks 760 mm 30 inches or less wide.**
*** Use minimum reinforcement of 6 #13 #4 w/ #10 #3 ties at 915 mm 3 feet o/c for ductbanks greater than 760 mm 30 inches wide.**
*** Consult with structural or geotechnical engineer for assistance.**
****

Construct underground duct lines of individual conduits encased in concrete. Depths to top of the concrete envelope must be not less than 450 mm 18 inches below finished grade[, except under roads and pavement, concrete envelope must be not less than 610 mm 24 inches below finished grade][, and under railroad tracks not less than 1270 mm 50 inches below the top of the rails]. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank must be rectangular in cross-section and provide at least 75 mm 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 75 mm 3 inches. Before pouring concrete, anchor duct bank assemblies, prevent floating during concrete pouring by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly.[Provide steel reinforcing in the concrete envelope as indicated.][Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.]

3.7.9.1 Connections to Manholes

Duct bank envelopes connecting to underground structures must be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section must be larger than the corresponding manhole opening dimensions by no less than 300 mm 12 inches in each direction. Perimeter of the duct bank opening in the underground structure must be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

3.7.9.2 Connections to Existing Underground Structures

For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and [extend into][bend out to tie into the reinforcing of] the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

3.7.9.3 Connections to Existing Concrete Pads

****

NOTE: Choose second bracketed option where existing concrete is reinforced.

****

For duct bank connections to concrete pads, break an opening in the pad out to the dimensions required and preserve steel in pad. Cut the steel and [extend into][bend out to tie into the reinforcing of] the duct bank envelope. Chip out the opening in the pad to form a key for the duct bank envelope.

3.7.9.4 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks.[Remove existing cables which constitute interference with the work.][Abandon in place those no longer used ducts and cables which do not interfere with the work.]

3.7.9.5 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 610 mm 2 feet back into the envelope and a minimum of 610 mm 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 75 mm 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 305 mm one foot apart. Restrain reinforcing assembly from moving during concrete pouring.

[3.7.9.6 Removal of Ducts

Where duct lines are removed from existing underground structures, close the openings to waterproof the structure. Chip out the wall opening to provide a key for the new section of wall.

]3.7.10 Duct Sealing

Seal all electrical penetrations for radon mitigation, maintaining integrity of the vapor barrier, and to prevent infiltration of air, insects, and vermin.

3.8 CABLE PULLING

****

NOTE: For Navy projects, choose bracketed item for tape shielding and coordinate with Part 2 PRODUCTS.

****

[Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables.]Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. Cable with[tape][or][wire] shield must have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

3.8.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.9 CABLES IN UNDERGROUND STRUCTURES

Do not install cables utilizing the shortest path between penetrations, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure.

3.9.1 Cable Tag Installation

****

NOTE: On contracts where existing cables are recircuited special attention should be given to changing existing cable identification tags in each manhole to reflect new circuit numbers.

****

Install cable tags in each manhole as specified, including each splice. Tag wire and cable provided by this contract. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes.

3.10 CONDUCTORS INSTALLED IN PARALLEL

Group conductors such that each conduit of a parallel run contains one Phase A conductor, one Phase B conductor, one Phase C conductor, and one neutral conductor.

3.11 LOW VOLTAGE CABLE SPLICING AND TERMINATING

Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set.[Make splices in underground distribution systems only in accessible locations such as manholes, handholes, or aboveground termination pedestals.]

[3.11.1 Terminating Aluminum Conductors

a. Use particular care in making up joints and terminations. Remove surface oxides by cleaning with a wire brush or emery cloth. Apply joint compound to conductors, and use UL-listed solid aluminum connectors for connecting aluminum conductors. When connecting aluminum to copper conductors, use connectors specifically designed for this purpose.

b. Terminate aluminum conductors to copper bus either by: (1) in line splicing a copper pigtail to the aluminum conductor (copper pigtail must have a ampacity at least that of the aluminum conductor); or (2) using a circumferential compression type, aluminum bodied terminal lug UL listed for AL/CU and steel Belleville spring washers, flat washers, bolts, and nuts. Belleville spring washers must be cadmium-plated hardened steel. Install the Belleville spring washers with the crown up toward the nut or bolt head, with the concave side of the Belleville bearing on a heavy-duty, wide series flat washer of larger diameter than the Belleville. Tighten nuts sufficient to flatten Belleville and leave in that position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.

c. Terminate aluminum conductors to aluminum bus by using all-aluminum nuts, bolts, washers, and lugs. Wire brush and apply inhibiting compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection; if bus contact surface is unplated, scratch-brush and coat with joint compound (without grit).

]3.12 MEDIUM VOLTAGE CABLE TERMINATIONS

Make terminations in accordance with the written instruction of the termination kit manufacturer.

3.13 MEDIUM VOLTAGE CABLE JOINTS

Provide power cable joints (splices) suitable for continuous immersion in water. Make joints only in accessible locations in manholes or handholes by using materials and methods in accordance with the written instructions of the joint kit manufacturer.

3.13.1 Joints in Shielded Cables

Cover the joined area with metallic tape, or material like the original cable shield and connect it to the cable shield on each side of the splice. Provide a bare copper ground connection brought out in a watertight manner and grounded to the manhole grounding loop as part of the splice installation. Ground conductors, connections, and rods must be as specified elsewhere in this section. Wire must be trained to the sides of the enclosure to prevent interference with the working area.

[3.13.2 Joints in Armored Cables

Enclose armored cable joints in compound-filled, cast-iron or alloy splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

]3.14 CABLE END CAPS

Cable ends must be sealed at all times with coated heat shrinkable end caps. Cables ends must be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps must remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

[3.15 LIVE END CAPS

****

NOTE: Live end caps are only required when cable is required to remain unterminated, but energized. Live end cap locations must be indicated on the drawings.

****

Provide live end caps for single conductor medium voltage cables where indicated.

]3.16 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES

Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in underground structures.

3.16.1 Fireproofing Tape

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Install tape in accordance with manufacturer's instructions.

[3.16.2 Tape-Wrap

Tape-wrap metallic-sheathed or metallic armored cables without a nonmetallic protective covering over the sheath or armor prior to application of fireproofing. Wrap must be in the form of two tightly applied half-lapped layers of a pressure-sensitive 0.254 mm 10 mil thick plastic tape, and must extend not less than 25 mm one inch into the duct. Even out irregularities of the cable, such as at splices, with insulation putty before applying tape.

]3.17 GROUNDING SYSTEMS

****

NOTE: Determine the grounding requirements for each project. Show all necessary ground rods and ground rings on the drawings.

****

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding [25][_____] ohms.

3.17.1 Grounding Electrodes

****

NOTE: Investigate the soil resistivity during the preliminary design phase to determine the design required to ensure that the grounding values are obtained. For areas where the water table is low or the soil resistivity is high (such as volcanic soils, sand, or rock), delete the additional electrode provisions and provide a design to meet the site requirements.

****

Provide cone pointed driven ground rods driven full depth plus[150 mm 6 inches][300 mm 12 inches], installed to provide an earth ground of the appropriate value for the particular equipment being grounded.
If the specified ground resistance is not met, provide an additional ground rod in accordance with the requirements of NFPA 70 (placed not less than 6 feet from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.

3.17.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies must be as recommended by the manufacturer. An embossing die code or other standard method must provide visible indication that a connector has been adequately compressed on the ground wire.

3.17.3 Grounding Conductors

Provide bare grounding conductors, except where installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 6 AWG.[Provide direct connections to the grounding conductor with 600 v insulated, full-size conductor for each grounded neutral of each feeder circuit, which is spliced within the manhole.]

3.17.4 Ground Cable Crossing Expansion Joints

Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

3.17.5 Manhole Grounding

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 305 mm 12 inches above finished floor. Secure the conductor to the manhole walls at intervals not exceeding 914 mm 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 6 AWG conductor.

[3.17.6 Fence Grounding

****

NOTE: Use this paragraph only when fence is required to be grounded in accordance with IEEE C2, NFPA 70, or other requirements.

****

[Provide grounding for fences as indicated.][Provide grounding for fences with a ground rod at each fixed gate post and at each corner post.] Drive ground rods until the top is 305 mm 12 inches below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 305 mm 12 inches of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence. Bond each gate section to its gatepost by a 3 by 25 mm 1/8 by one inch flexible braided copper strap and ground post clamps. Clamps must be of the anti-electrolysis type.

][3.17.7 Metal Splice Case Grounding

Ground metal splice cases for medium-voltage direct-burial cable by connection to a driven ground rod located within 600 mm 2 feet of each splice box using a grounding electrode conductor having a current-carrying capacity of at least 20 percent of the individual phase conductors in the associated splice box, but not less than No. 6 AWG.

]3.18 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70 and Section 31 00 00 EARTHWORK.

3.18.1 Reconditioning of Surfaces

3.18.1.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct [or direct burial cable]. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.[Provide work in accordance with Section 32 92 19 SEEDING and Section 32 93 00 EXTERIOR PLANTS.]

3.18.1.2 Paving Repairs

****

NOTE: Where paving repairs are a very minor part of project, the first bracketed paragraph may be used; otherwise, use the second bracketed paragraph and include other sections as needed (also include necessary cutting and patching details on the drawings.)

****

****

NOTE: Insert appropriate Section number and title in the blank below.

****

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists [, restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.][Make repairs as specified in Section [32 13 13.06 PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES][_____].]

3.19 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.19.1 Concrete Slabs (Pads) for Equipment

Unless otherwise indicated, the slab must be at least 200 mm 8 inches thick, reinforced with a 152 mm by 152 mm - MW19 by MW19 (6 by 6 - W2.9 by W2.9) 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 100 mm 4 inches from the top of the slab. Place slab on a 150 mm 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 100 mm 4 inches above finished grade with gradual slope for drainage. Edges above grade must have 15 mm 1/2 inch chamfer. Slab must be of adequate size to project at least 200 mm 8 inches beyond the equipment.

Stub up conduits, with bushings, 50 mm 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

[3.19.2 Sealing

****

NOTE: Require sealing of holes (windows) in the concrete pad if rodent intrusion is a problem.

****

When the installation is complete, seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

]3.20 FIELD QUALITY CONTROL

3.20.1 Performance of Field Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.20.1.1 Medium Voltage Cables

Perform tests after installation of cable, splices, and terminators and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

    (1) Inspect exposed cable sections for physical damage.

    (2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

    (3) Inspect for proper shield grounding, cable support, and cable termination.

    (4) Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.

    (5) Inspect for proper fireproofing.

    (6) Visually inspect jacket and insulation condition.

    (7) Inspect for proper phase identification and arrangement.

b. Electrical Tests

    (1) Perform a shield continuity test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified.

    (2) Perform acceptance test on new cables before the new cables are connected to existing cables and placed into service, including terminations and joints. Perform maintenance test on complete cable system after the new cables are connected to existing cables and placed into service, including existing cable, terminations, and joints. Tests must be very low frequency (VLF) alternating voltage withstand tests in accordance with IEEE 400.2. VLF test frequency must be 0.05 Hz minimum for a duration of 60 minutes using a sinusoidal waveform. Test voltages must be as follows:

CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING	
5 kV	10kV rms(peak)
8 kV	13kV rms(peak)
15 kV	20kV rms(peak)

CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING	
25 kV	31kV rms(peak)
35 kV	44kV rms(peak)

CABLE RATING AC TEST VOLTAGE for MAINTENANCE TESTING	
5 kV	7kV rms(peak)
8 kV	10kV rms(peak)
15 kV	16kV rms(peak)
25 kV	23kV rms(peak)
35 kV	33kV rms(peak)

3.20.1.2 Low Voltage Cables, 600-Volt

Perform tests after installation of cable, splices and terminations and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Verify tightness of accessible bolted electrical connections.

(4) Inspect compression-applied connectors for correct cable match and indentation.

(5) Visually inspect jacket and insulation condition.

(6) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 1000 volts dc for one minute.

(2) Perform continuity tests to insure correct cable connection.

3.20.1.3 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.20.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer must be given 5 working days advance notice of the dates and times of checking and testing.

.... -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-33 82 00 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-16711 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 33 82 00

TELECOMMUNICATIONS OUTSIDE PLANT (OSP)
04/06

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NOTE: This guide specification covers exterior telecommunications Outside Plant consisting of the campus distributor, outside copper and fiber optic (FO) cable media, and associated hardware necessary to support communications systems at facility installations including permanently constructed buildings. This specification covers outside plant (OSP) campus fiber optic and copper cable media for supporting information technology transfer systems to include voice, data, video, imaging, security, and audio systems used by various facilities. This guide specification is to be used in the preparation of project construction specifications.

Coordinate with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM and ensure that copper cable and fiber optic cable interconnecting components and patch cord assemblies mechanically intermate.

Use Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

For Navy projects use UFC 3-580-01, "Telecommunications Interior Infrastructure Planning and Design" for design guidance related to telecommunications infrastructure. Confirm specific system requirements with the using Activity.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: This section will be used in conjunction with any other guide specifications required by the design. Show following information on project drawings:

1. Where specification identifies type, size, color, finish, or other definitive information to be "as indicated" the engineer shall show the information on the drawings.

2. Location and dimensions of manholes, handholes, ducts, and location and size of cables.

3. Types of wire and cable; number and sizes of conductors and conduits.

4. Special conditions.

5. Include tensioning and sag data on drawings in tabular form for aerial cable installation.

Provide a minimum of 12 single-mode fibers per fiber optic cable. Coordinate with activity and Base Communications Office (BCO) to determine fiber optic cabling requirements. Provide fiber optic cabling to piers in accordance with UFC 4-150-02, "Design: Dockside Utilities for Ship Service" for Navy projects only.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-87-640	(2023) Optical Fiber Outside Plant Communications Cable; 4th Edition
ICEA S-98-688	(2012) Broadband Twisted Pair Telecommunication Cable, Aircore, Polyolefin Insulated, Copper Conductors Technical Requirements
ICEA S-99-689	(2012) Broadband Twisted Pair Telecommunication Cable Filled, Polyolefin Insulated, Copper Conductors Technical Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C62.61	(1993) American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National

	Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-46A	(1990) FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers
TIA-455-78-B	(2020c; R 2024) FOTP-78 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation
TIA-455-107	(1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Set
TIA-472D000	(2007b) Fiber Optic Communications Cable for Outside Plant Use
TIA-492AAAA	(2009b) 62.5-um Core Diameter/125-um Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers
TIA-492AAAB	(2009a) 50-Um Core Diameter/125-Um Cladding Diameter Class IA Graded-Index Multimode Optical Fibers
TIA-492CAAA	(1998; R 2002) Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers
TIA-492E000	(1996; R 2002) Sectional Specification for Class IVd Nonzero-Dispersion Single-Mode Optical Fibers for the 1550 nm Window
TIA-526-7	(2015a; R 2022) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures - Part 4-2: Installed Cable Plant - Single-Mode Attenuation and Optical Return Loss Measurement
TIA-526-14	(2023d) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2024e) Balanced Twisted-Pair Telecommunications Cabling and Components Standards

TIA-568.3	(2022e) Optical Fiber Cabling Components Standard
TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces
TIA-590	(1997a) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-758	(2012b) Customer-Owned Outside Plant Telecommunications Infrastructure Standard
TIA/EIA-455	(1998b) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
TIA/EIA-455-204	(2024b) Standard for Measurement of Bandwidth on Multimode Fiber
TIA/EIA-598	(2014D; Add 2 2018) Optical Fiber Cable Color Coding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 1755	Telecommunications Standards and Specifications for Materials, Equipment and Construction
RUS Bull 345-50	(1979) Trunk Carrier Systems (PE-60)
RUS Bull 345-65	(1985) Shield Bonding Connectors (PE-65)
RUS Bull 345-72	(1985) Filled Splice Closures (PE-74)
RUS Bull 345-83	(1979; Rev Oct 1982) Gas Tube Surge Arrestors (PE-80)
RUS Bull 1751F-630	(1996) Design of Aerial Plant
RUS Bull 1751F-640	(1995) Design of Buried Plant, Physical Considerations
RUS Bull 1751F-643	(2002) Underground Plant Design
RUS Bull 1751F-815	(1979) Electrical Protection of Outside Plant
RUS Bull 1753F-201	(1997) Acceptance Tests of Telecommunications Plant (PC-4)

RUS Bull 1753F-401	(1995) Splicing Copper and Fiber Optic Cables (PC-2)

UL SOLUTIONS (UL)

UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 497	(2001; Reprint Jul 2022) UL Standard for Safety Protectors for Paired Conductor Communication Circuits
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape

1.2 RELATED REQUIREMENTS

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NOTE: Choose Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM if it is used on the project. Choose Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION, and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

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[Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM,][Section 33 71 01, OVERHEAD TRANSMISSION AND DISTRIBUTION, and[Section 33 71 02, UNDERGROUND ELECTRICAL DISTRIBUTION] apply to this section with additions and modifications specified herein.

]1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568.1, TIA-568.2, TIA-568.3, TIA-569, TIA-606, and IEEE 100 and herein.

1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect - (MC).)

1.3.2 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

1.3.3 Entrance Room (ER) (Telecommunications)

A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.4 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect - (IC).)

1.3.5 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

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For Army projects only: For MCA projects, telephone switch upgrades and line cards are procured and installed using funds provided by ISEC outside of the construction contract. Other types of projects, such as Army Reserve, DOD and work for others, may require that the switch upgrade and line cards be added to this section to be procured and installed as part of the construction contract. Choose the last bracketed sentences for Navy and Marine Corps projects only.

****

The telecommunications outside plant consists of cable, conduit, manholes, poles, etc. required to provide signal paths from the closest point of presence to the new facility, including free standing frames or backboards, interconnecting hardware, terminating cables, lightning and surge protection modules at the entrance facility. The work consists of providing, testing and making operational cabling, interconnecting hardware and lightning and surge protection necessary to form a complete outside plant telecommunications system for continuous use.[The telecommunications contractor must coordinate with the NMCI contractor concerning layout and configuration of the EF telecommunications and OSP. The telecommunications contractor may be required to coordinate work effort for access to the EF telecommunications and OSP with the NMCI contractor.]

1.5 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications Outside Plant; G, [_____]

Telecommunications Entrance Facility Drawings; G, [_____]

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Wire and Cable; G, [_____]

Cable Splices, and Connectors; G, [_____]

Closures; G, [_____]

Building Protector Assemblies; G, [_____]

Protector Modules; G, [_____]

Cross-Connect Terminal Cabinets; G, [_____]

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NOTE: Delete submittal for spare parts on Navy projects. Spare parts requirements are provided in Section 01 78 23 OPERATION AND MAINTENANCE DATA on Navy projects.
****

[Spare Parts; G, [_____]

] Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required for certificates in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Pre-installation Tests; G, [_____]

Acceptance Tests; G, [_____]

Outside Plant Test Plan; G, [_____]

SD-07 Certificates

Telecommunications Contractor Qualifications; G, [_____]

Key Personnel Qualifications; G, [_____]

Minimum Manufacturer's Qualifications; G, [_____]

SD-08 Manufacturer's Instructions

Building Protector Assembly Installation; G, [_____]

Cable Tensions; G, [_____]

Fiber Optic Splices; G, [_____]

Submit instructions prior to installation.

SD-09 Manufacturer's Field Reports

Factory Reel Test Data; G, [_____]

SD-10 Operation and Maintenance Data

Telecommunications Outside Plant (OSP), Data Package 5; G, [_____]

Commercial off-the-shelf manuals shall be provided for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications outside plant (OSP). Submit operations and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein not later than[2][_____] months prior to the date of beneficial occupancy. In addition to requirements of Data package 5, include the requirements of paragraphs TELECOMMUNICATIONS OUTSIDE PLANT SHOP DRAWINGS and TELECOMMUNICATIONS ENTRANCE FACILITY DRAWINGS.

SD-11 Closeout Submittals

Record Documentation; G, [_____]

In addition to other requirements, provide in accordance with paragraph RECORD DOCUMENTATION.

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Outside Plant Shop Drawings

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NOTE: Coordinate drawings with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM, if used, to ensure activity responsible for telecommunications system maintenance and administration maintains a single complete and accurate set of drawings for the entire telecommunications system.

Choose bracketed option for RCDD approved drawings on Navy projects where multiple splices in the outside cable plant are required or when more than one telecommunications manhole and associated ductbanks are required. Choose the last bracketed sentence for facilities that currently have telecommunications outside plant drawings that require updating as a result of project installation.

****

Provide Outside Plant Design in accordance with TIA-758, RUS Bull 1751F-630 for aerial system design, and RUS Bull 1751F-643 for underground system design. Provide T0 shop drawings that show the physical and logical connections from the perspective of an entire campus, such as actual building locations, exterior pathways and campus backbone cabling on plan view drawings, major system nodes, and related connections on the logical system drawings in accordance with TIA-606. Drawings shall include wiring and schematic diagrams for fiber optic and copper cabling and splices, copper conductor gauge and pair count, fiber pair count and type, pathway duct and innerduct arrangement, associated construction materials, and any details required to demonstrate that cable system has been coordinated and will properly support the switching and transmission system identified in specification and drawings.[Provide Registered Communications Distribution Designer (RCDD) approved drawings of the telecommunications outside plant.][Update existing telecommunication Outside Plant T0 drawings to include information modified, deleted or added as a result of this installation in accordance with TIA-606.] The telecommunications outside plant (OSP) shop drawings shall be included in the operation and maintenance manuals.

1.6.1.2 Telecommunications Entrance Facility Drawings

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NOTE: Choose the last bracketed sentence when Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS is included in the specifications.

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[Provide T3 drawings for EF Telecommunications in accordance with TIA-606 that include telecommunications entrance facility plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and[cabinet][, rack][, backboard][and] wall elevations. Drawings shall show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 or T2 drawings.][Provide T3 drawings for EF Telecommunications as specified in the paragraph TELECOMMUNICATIONS SPACE DRAWINGS of Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS.] The telecommunications entrance facility shop drawings shall be included in the operation and maintenance manuals.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, the supervisor (if different from the installer), and the cable splicing and terminating personnel. A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor Qualifications

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems that include outside plant and broadband cabling within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems in accordance with TIA-758 within the past 3 years.

1.6.2.2 Key Personnel Qualifications

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Cable splicing and terminating personnel assigned to the installation of this system or any of its components shall have training in the proper techniques and have a minimum of 3 years experience in splicing and terminating the specified cables. Modular splices shall be performed by factory certified personnel or under direct supervision of factory trained personnel for products used.

Supervisors and installers assigned to the installation of this system or any of its components shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.

Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications outside plant systems, including broadband cabling, and provide the names and locations of at least two project installations successfully completed using[optical fiber and] copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

1.6.2.3 Minimum Manufacturer's Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of[3][_____] years experience in the manufacturing, assembly, and factory testing of components which comply with, TIA-568.1, TIA-568.2 and TIA-568.3. In addition, cabling manufacturers shall have a minimum of[3][_____] years experience in the manufacturing and factory testing of cabling which comply with ICEA S-87-640, ICEA S-98-688, and ICEA S-99-689.

1.6.3 Outside Plant Test Plan

Prepare and provide a complete and detailed test plan for field tests of the outside plant including a complete list of test equipment for the[copper conductor][and][optical fiber] cables, components, and accessories for approval by the Contracting Officer. Include a cut-over plan with procedures and schedules for relocation of facility station numbers without interrupting service to any active location. Submit the plan at least[30][_____] days prior to tests for Contracting Officer approval. Provide outside plant testing and performance measurement criteria in accordance with TIA-568.1 and RUS Bull 1753F-201. Include procedures for certification, validation, and testing that includes fiber optic link performance criteria.

1.6.4 Standard Products

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NOTE: Choose 2 years and 6000 hours for Navy projects and 1 year and 3000 hours for Army projects.

****

Provide materials and equipment that are standard products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and shall be the manufacturer's latest standard design that has been in satisfactory commercial or industrial use for at least[2][1] year[s] prior to bid opening. The[2][1]-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the[2][1]-year period. Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.4.1 Alternative Qualifications

Products having less than a[2][1]-year field service record will be acceptable if a certified record of satisfactory field operation for not less than[6000][3000] hours, exclusive of the manufacturers' factory or laboratory tests, is provided.

1.6.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.5.1 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.7 DELIVERY, STORAGE, AND HANDLING

Ship cable on reels in [152][305][_____] meter ([500][1000][_____] feet) [500][1000][_____] feet length with a minimum overage of 10 percent. Radius of the reel drum shall not be smaller than the minimum bend radius of the cable. Wind cable on the reel so that unwinding can be done without kinking the cable. Two meters of cable at both ends of the cable shall be accessible for testing. Attach permanent label on each reel showing length, cable identification number, cable size, cable type, and date of manufacture. Provide water resistant label and the indelible writing on the labels. Apply end seals to each end of the cables to prevent moisture from entering the cable. Reels with cable shall be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent. Equipment, other than cable, delivered and placed in storage shall be stored with protection from weather, humidity and temperature variation, dirt and dust, or other contaminants in accordance with manufacturer's requirements.

1.8 MAINTENANCE

1.8.1 Record Documentation

****

NOTE: Coordinate record documentation with Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM and choose the second bracketed paragraph if Section 27 10 00 is used on the project. TIA-606 describes the necessary data fields and reports for hard copy, spreadsheet and electronic media as well as cable management software requirements. Check with activity to determine if cable management software is currently employed at the activity and ensure contractor is required to provide necessary data input to update the existing system with information associated with project installation.

****

Provide the activity responsible for telecommunications system maintenance and administration a single complete and accurate set of record documentation for the entire telecommunications system with respect to this project.

[Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA-606. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts, cross-connect information and connecting terminal layout as a minimum. T5 drawings shall be provided[in hard copy format][on electronic media using Windows based computer cable management software.][A licensed copy of the cable management software including documentation, shall be provided.][Update existing record documentation to reflect campus distribution T0 drawings and T3 drawing schedule information modified, deleted or added as a result of this installation.] Provide the following T5 drawing documentation as a minimum:

a. Cables - A record of installed cable shall be provided in accordance with TIA-606. The cable records shall [include only the required data fields][include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility]in accordance with TIA-606. Include manufacture date of cable with submittal.

b. Termination Hardware - Provide a record of installed patch panels, cross-connect points, campus distributor and terminating block arrangements and type in accordance with TIA-606. Documentation shall include [only]the required data fields[as a minimum] in accordance with TIA-606.

][Provide record documentation as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

][1.8.2 Spare Parts

****

NOTE: Do not use this paragraph for Navy projects.

****

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking. Spare parts shall be provided no later than the start of field testing.

]1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems.

2.2 TELECOMMUNICATIONS ENTRANCE FACILITY

****

NOTE: The EF Telecommunications consists of the telecommunications service entrance to the building, including the entrance through the building wall, and continuing to the ER Telecommunications (if required). The EF Telecommunications contains the backbone pathways and campus distributor that link the building distributors (BD)s in the main terminal space and to other buildings in campus situations. Antenna entrances, if used, also constitute part of the EF Telecommunications.

The EF Telecommunications may contain both the CD and BD for the building. Facilities with few telecommunications requirements may house all telecommunications cabling and equipment required for that facility in the EF Telecommunications. Coordinate this section with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM and provider of building telecommunications cabling system when Section 27 10 00 is used on a project. Other than building protector assemblies and modules, components for telecommunications spaces are specified in Section 27 10 00. If Section 27 10 00 is not used, copy the required components

from Section 27 10 00 and paste them under this paragraph. Edit the component requirements as necessary.
****

2.2.1 Building Protector Assemblies

****
NOTE: Interbuilding backbone cables shall be terminated on protected entrance terminals and in a housing (when so directed) using current industry standard practice. Certain types of terminals are mounted on the outside walls of buildings. Outside terminal should be the exception and not the norm, and should only be installed on small buildings (e.g., storage sheds, small warehouses, guard gates, etc.). Copper cable termination components are specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. If the project does not include Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM copy connector blocks or patch panel information and paste information into this section under this paragraph heading and edit as necessary.
****

Provide self-contained[5 pin][screw type] unit supplied with a field cable stub factory connected to protector socket blocks to terminate and accept protector modules for [_____] pairs of outside cable. Building protector assembly shall have interconnecting hardware for connection to interior cabling at full capacity. Provide manufacturers instructions for building protector assembly installation. Provide copper cable interconnecting hardware as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.2.2 Protector Modules

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NOTE: Protector modules are not required for interbuilding cable runs of 42.7 m (140 feet) or less, directly buried or in underground conduit, where a continuous metallic cable shield or a continuous metallic conduit containing the cable is bonded to each building grounding electrode system.

Solid-state surge protectors provide protection for sensitive equipment because it incorporates a fast semiconductor switch with operating voltage nearly independent of transient rise time. Otherwise, use heavy duty gas tube protection modules unless area lightning damage probability is very high. Select the type of protector module required depending on their performance in categories of impulse life, maximum surge impulse and 60 Hz current carrying capacity.
****

Provide in accordance with UL 497[three][two]-electrode gas tube or solid state type[5 pin][screw type] rated for the application. Provide gas tube protection modules in accordance with RUS Bull 345-83 and shall be[heavy duty, A>10kA, B>400, C>65A][maximum duty, A>20kA, B>1000, C>200A] where A is the maximum single impulse discharge current, B is the impulse life and C is the AC discharge current in accordance with ANSI C62.61. The gas modules shall shunt high voltage to ground, fail short, and be equipped with an external spark gap and heat coils in accordance with UL 497. Provide the number of surge protection modules equal to the number of pairs of exterior cable of the building protector assembly.

2.2.3 Fiber Optic Terminations

****

NOTE: Fiber Optic termination components are specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. If the project does not include Section 27 10 00 copy enclosure type connectors and adapters and paste information into this section under this paragraph heading and edit as necessary.

****

Provide fiber optic cable terminations as specified in 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.3 CLOSURES

2.3.1 Copper Conductor Closures

2.3.1.1 Aerial Cable Closures

****

NOTE: Design of aerial plant should be in accordance with RUS Bull 1751F-630, Design of Aerial Plant. Indicate sizes on drawings.

****

Provide cable closure assembly consisting of a frame with clamps, a lift-off polyethylene cover, cable nozzles, and drop wire rings. Closure shall be suitable for use on Figure 8 cables. Closures shall be free breathing and suitable for housing[straight-through type][branch type][of the type indicated] splices of non-pressurized communications cables and shall be sized as indicated. The closure shall be constructed with ultraviolet resistant PVC.

2.3.1.2 Underground Cable Closures

****

NOTE: Indicate sizes on drawings.

****

a. Aboveground: Provide aboveground closures constructed of[not less than 14 gauge steel][ultraviolet resistant PVC] and acceptable for[pole][stake] mounting in accordance with RUS 1755.910. Closures shall be sized and contain a marker as indicated. Covers shall be secured to prevent unauthorized entry.

b. Direct burial: Provide buried closure suitable for enclosing a straight, butt, and branch splice in a container into which can be poured an encapsulating compound. Closure shall have adequate strength to protect the splice and maintain cable shield electrical continuity in the buried environment. Encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure. Provide filled splice cases in accordance with RUS Bull 345-72.

c. In vault or manhole: Provide underground closure suitable to house a straight, butt, and branch splice in a protective housing into which can be poured an encapsulating compound. Closure shall be of suitable thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure. Provide filled splice cases in accordance with RUS Bull 345-72.

2.3.2 Fiber Optic Closures

2.3.2.1 Aerial

Provide aerial closure that is free breathing and suitable for housing splice organizer of non -pressurized cables. Closure shall be constructed from heavy PVC with ultraviolet resistance.

2.3.2.2 Direct Burial

Provide buried closure suitable to house splice organizer in protective housing into which can be poured an encapsulating compound. Closure shall have adequate strength to protect the splice and maintain cable shield electrical continuity, when metallic, in buried environment. Encapsulating compound shall be reenterable and shall not alter chemical stability of the closure.

2.3.2.3 In Vault or Manhole

Provide underground closure suitable to house splice organizer in a protective housing into which can be poured an encapsulating compound. Closure shall be of thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure.

2.4 PAD MOUNTED CROSS-CONNECT TERMINAL CABINETS

****

NOTE: Indicate size on the drawings.

****

Provide in accordance with RUS 1755.910 and the following:

a. Constructed of 14 gauge steel or [_____].

b. Equipped with a double set of hinged doors with closed-cell foam weatherstripping. Doors shall be locked and contain a marker as indicated.

c. Equipped with spool spindle bracket, mounting frames, binding post log,[and] jumpering instruction label[, and load coil mounting provisions].

d. Complete with cross connect modules to terminate number of pairs as indicated.

e. Sized as indicated.

2.5 CABLE SPLICES, AND CONNECTORS

2.5.1 Copper Cable Splices

****

NOTE: Multipair splices are insulation displacement (IDC) type splices.

****

Provide[multipair,[foldback][in-line]][single pair,[in-line][butt][box tap]] splices of a moisture resistant,[two][three][_____]-wire [insulation displacement] connector held rigidly in place to assure maximum continuity in accordance with RUS Bull 1753F-401. Cables greater than 25 pairs shall be spliced using multipair splicing connectors, which accommodate 25 pairs of conductors at a time. Provide correct connector size to accommodate the cable gauge of the supplied cable.

[2.5.2 Copper Cable Splice Connector

Provide splice connectors with a polycarbonate body and cap and a tin-plated brass contact element. Connector shall accommodate 22 to 26 AWG solid wire with a maximum insulation diameter of 1.65 mm 0.065 inch. Fill connector with sealant grease to make a moisture resistant connection, in accordance with RUS Bull 1753F-401.

][2.5.3 Fiber Optic Cable Splices

Provide fiber optic cable splices and splicing materials for[fusion][mechanical] methods at locations shown on the construction drawings. The splice insertion loss shall be 0.3 dB maximum when measured in accordance with TIA-455-78-B using an Optical Time Domain Reflectometer (OTDR). Splices shall be designed for a return loss of 40.0 db max for single mode fiber when tested in accordance with TIA-455-107. Physically protect each fiber optic splice by a splice kit specially designed for the splice.

][2.5.4 Fiber Optic Splice Organizer

Provide splice organizer suitable for housing fiber optic splices in a neat and orderly fashion. Splice organizer shall allow for a minimum of 1 m 3 feet of fiber for each fiber within the cable to be neatly stored without kinks or twists. Splice organizer shall accommodate individual strain relief for each splice and allow for future maintenance or modification, without damage to the cable or splices. Provide splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors in a splice organizer kit.

]2.5.5 Shield Connectors

Provide connectors with a stable, low-impedance electrical connection between the cable shield and the bonding conductor in accordance with RUS Bull 345-65.

2.6 CONDUIT

****
NOTE: Use Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.
****

Provide conduit as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7 PLASTIC INSULATING TAPE

UL 510.

2.8 WIRE AND CABLE

****
NOTE: For Army projects follow guidelines set forth in USAISEC Technical Guide for Installation Information Infrastructure Architecture (I3A) or The Army Common User Information Transport Network (CUITN). Army ECB 2007-22 is available electronically at . Interbuilding backbone cabling is the cable (optical fiber and copper) media between the campus distributors of multiple buildings within a base complex (campus environment). Interbuilding backbone cable plant terminates in the telecommunications entrance facility, the first terminating point in a building. Cable may be direct buried, aerial, or underground (in conduit and ducts). The preferred method is underground with the cable terminating in the telecommunications entrance facility.
****

2.8.1 Copper Conductor Cable

Solid copper conductors, covered with an extruded solid insulating compound. Insulated conductors shall be twisted into pairs which are then stranded or oscillated to form a cylindrical core. For special high frequency applications, the cable core shall be separated into compartments. Cable shall be completed by the application of a suitable core wrapping material, a corrugated copper or plastic coated aluminum shield, and an overall extruded jacket. Telecommunications contractor shall verify distances between splice points prior to ordering cable in specific cut lengths. Gauge of conductor shall determine the range of numbers of pairs specified; 19 gauge (6 to 400 pairs), 22 gauge (6 to 1200 pairs), 24 gauge (6 to 2100 pairs), and 26 gauge (6 to 3000 pairs). Copper conductor shall conform to the following:

2.8.1.1 Underground

****
NOTE: For WESTNAVFACENGCOM projects, delete this paragraph.

Use RUS 1755.390 for filled cable and RUS 1755.890 for filled cable with expanded insulation.
****

Provide filled cable meeting the requirements of ICEA S-99-689 and [RUS 1755.390][RUS 1755.890].

2.8.1.2 Aerial

Provide filled cable meeting the requirements of[ICEA S-99-689][ICEA S-98-688], and RUS 1755.390 except that it shall be suitable for aerial installation and shall be Figure 8 distribution wire with 26,700 N 6,000 pound Class A galvanized steel or 26,700 N 6,000 pound aluminum-clad steel strand.

2.8.1.3 Screen

Provide screen-compartmental core cable filled cable meeting the requirements of ICEA S-99-689 and RUS 1755.390.

2.8.2 Fiber Optic Cable

****

NOTE: Single-mode fiber optic cable is recommended for all fiber optic cable runs. Designer should identify whether multimode will be used. Multimode fiber system may be installed only if an existing communication network is being extended. If multimode fiber is used, single-mode fiber should also be placed for future use. Designer will indicate on the drawings the number of optical fibers required.

****

Provide[single-mode, 8/125-um, 0.10 aperture 1310 nm fiber optic cable in accordance with TIA-492CAAA][single-mode, 8/125-um, 0.10 aperture 1550 nm fiber optic cable in accordance with TIA-492E000][and][multimode 62.5/125-um, 0.275 aperture fiber optic cable in accordance with TIA-492AAAA][multimode 50/125-um, 0.275 aperture fiber optic cable in accordance with TIA-492AAAB], TIA-472D000, and ICEA S-87-640 including any special requirements made necessary by a specialized design. Provide[12][____] optical fibers[as indicated]. Fiber optic cable shall be specifically designed for outside use with loose buffer construction. Provide fiber optic color code in accordance with TIA/EIA-598

2.8.2.1 Strength Members

Provide[central][non-central],[non-metallic][metallic] strength members with sufficient tensile strength for installation and residual rated loads to meet the applicable performance requirements in accordance with ICEA S-87-640. The strength member is included to serve as a cable core foundation to reduce strain on the fibers, and shall not serve as a pulling strength member.

[2.8.2.2 Shielding or Other Metallic Covering

****

NOTE: Delete this paragraph if no additional physical protection is required or if aerial cable is specified. Designer must select the shield or metallic covering material required. Bare aluminum, coated aluminum, copper, copper alloy and copper and

steel laminate are used as shielding tapes. Copper and stainless steel, coated stainless steel and bare low carbon steel are use for cable armoring. The copper alloy or stainless steel should be used for rodent protection. If additional physical protection is required use the dual aluminum and steel tape shield. Dual tape construction is normally used for armor protection of cables.

****

Provide[copper, copper alloy or copper and steel laminate][copper and stainless steel, coated stainless steel or bare low carbon steel][bare aluminum or coated aluminum],[single][dual] tape covering or shield in accordance with ICEA S-87-640.

]2.8.2.3 Performance Requirements

Provide fiber optic cable with optical and mechanical performance requirements in accordance with ICEA S-87-640.

2.8.3 Grounding and Bonding Conductors

Provide grounding and bonding conductors in accordance with RUS 1755.200, TIA-607, IEEE C2, and NFPA 70. Solid bare copper wire meeting the requirements of ASTM B1 for sizes No. 8 AWG and smaller and stranded bare copper wire meeting the requirements of ASTM B8, for sizes No. 6 AWG and larger. Insulated conductors shall have 600-volt, Type TW insulation meeting the requirements of UL 83.

2.9 T-SPAN LINE TREATMENT REPEATERS

Provide as indicated. Repeaters shall be pedestal mounted with non-pressurized housings, sized as indicated and shall meet the requirements of RUS Bull 345-50.

2.10 POLES AND HARDWARE

Provide poles and hardware as specified in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.

2.11 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS

****

NOTE: Designer must coordinate with the base communications office and use the current base standard for labeling, if one exists and choose the as indicated bracketed option. Show the labeling scheme on the drawings that the telecommunications contractor is required to follow. If no labeling standard exists provide labeling for cable tags in accordance with TIA-606 and choose the bracketed option for TIA-606 labeling.

****

Provide tags for each telecommunications cable or wire located in manholes, handholes, and vaults. Cable tags shall be[stainless steel][or][polyethylene] and labeled[as indicated][in accordance with TIA-606]. Handwritten labeling is unacceptable.

[2.11.1 Stainless Steel

Provide stainless steel, cable tags 41.25 mm 1 5/8 inches in diameter 1.58 mm 1/16 inch thick minimum, and circular in shape. Tags shall be die stamped with numbers, letters, and symbols not less than 6.35 mm 0.25 inch high and approximately 0.38 mm 0.015 inch deep in normal block style.

][2.11.2 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 22.4 MPa 3250 pounds per square inch; and that are two millimeter 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 77 degrees C 170 degrees F. Provide 1.3 mm 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 778.75 N 175 pounds. The cable tags shall have black block letters, numbers, and symbols 25 mm one inch high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.

]2.12 BURIED WARNING AND IDENTIFICATION TAPE

****

NOTE: Buried warning tape requirements are specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 00 00 EARTHWORK.

****

Provide fiber optic media marking and protection in accordance with TIA-590. Provide color, type and depth of tape as specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 00 00, EARTHWORK.

2.13 GROUNDING BRAID

Provide grounding braid that provides low electrical impedance connections for dependable shield bonding in accordance with RUS 1755.200. Braid shall be made from flat tin-plated copper.

2.14 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.15 FIELD FABRICATED NAMEPLATES

Provide laminated plastic nameplates in accordance with ASTM D709 for each patch panel, protector assembly, rack, cabinet and other equipment or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm 0.125 inch thick, white with[black][_____] center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm one by 2.5 inches. Lettering shall be a minimum of 6.35 mm 0.25 inch high normal block style.

2.16 TESTS, INSPECTIONS, AND VERIFICATIONS

2.16.1 Factory Reel Test Data

Test 100 percent OTDR test of FO media at the factory in accordance with TIA-568.1 and TIA-568.3. Use TIA-526-7 for single mode fiber and TIA-526-14 Method B for multi mode fiber measurements. Calibrate OTDR to show anomalies of 0.2 dB minimum. Enhanced performance filled OSP copper cables, referred to as Broadband Outside Plant (BBOSP), shall meet the requirements of ICEA S-99-689. Enhanced performance air core OSP copper cables shall meet the requirements of ICEA S-98-688. Submit test reports, including manufacture date for each cable reel and receive approval before delivery of cable to the project site.

PART 3 EXECUTION

3.1 INSTALLATION

Install all system components and appurtenances in accordance with manufacturer's instructions IEEE C2, NFPA 70, and as indicated. Provide all necessary interconnections, services, and adjustments required for a complete and operable telecommunications system.

3.1.1 Contractor Damage

Promptly repair indicated utility lines or systems damaged during site preparation and construction. Damages to lines or systems not indicated, which are caused by Contractor operations, shall be treated as "Changes" under the terms of the Contract Clauses. When Contractor is advised in writing of the location of a nonindicated line or system, such notice shall provide that portion of the line or system with "indicated" status in determining liability for damages. In every event, immediately notify the Contracting Officer of damage.

3.1.2 Cable Inspection and Repair

Handle cable and wire provided in the construction of this project with care. Inspect cable reels for cuts, nicks or other damage. Damaged cable shall be replaced or repaired to the satisfaction of the Contracting Officer. Reel wraps shall remain intact on the reel until the cable is ready for placement.

3.1.3 Direct Burial System

****

NOTE: Indicate minimum radius allowed. Buried warning tape requirements are specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 00 00 EARTHWORK.

****

Installation shall be in accordance with RUS Bull 1751F-640. Under railroad tracks, paved areas, and roadways install cable in conduit encased in concrete. Slope ducts to drain. Excavate trenches by hand or mechanical trenching equipment. Provide a minimum cable cover of 610 mm 24 inches below finished grade. Trenches shall be not less than 155 mm 6 inches wide and in straight lines between cable markers. Do not use cable plows. Bends in trenches shall have a radius of not less than [915][_____] mm [36][_____] inches. Where two or more cables are laid parallel in the same trench, space laterally at least 78 mm 3 inches apart. When rock is encountered, remove it to a depth of at least 78 mm 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 6 mm 1/4 inch. Do not unreel and pull cables into the trench from one end. Cable may be unreeled on grade and lifted into position. Provide color, type and depth of warning tape as specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 00 00 EARTHWORK.

3.1.3.1 Cable Placement

a. Separate cables crossing other cables or metal piping from the other cables or pipe by not less than [78][_____] mm [3][_____] inches of well tamped earth. Do not install circuits for communications under or above traffic signal loops.

b. Cables shall be in one piece without splices between connections except where the distance exceeds the lengths in which the cable is furnished.

c. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

d. Leave a horizontal slack of approximately 915 mm 3 feet in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought aboveground. Where cable is brought aboveground, leave additional slack to make necessary connections.

3.1.3.2 Identification Slabs [Markers]

Provide a marker at each change of direction of the cable, over the ends of ducts or conduits which are installed under paved areas and roadways and over each splice. Identification markers shall be of concrete, approximately 508 mm 20 inches square by 155 mm 6 inches thick.

3.1.3.3 Backfill for Rocky Soil

When placing cable in a trench in rocky soil, the cable shall be cushioned by a fill of sand or selected soil at least 53 mm 2 inches thick on the floor of the trench before placing the cable or wire. The backfill for at least 103 mm 4 inches above the wire or cable shall be free from stones, rocks, or other hard or sharp materials which might damage the cable or wire. If the buried cable is placed less than 610 mm 24 inches in depth[, a protective cover of[metal][concrete] shall be used].

3.1.4 Cable Protection

****

NOTE: Use Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

****

Provide direct burial cable protection in accordance with NFPA 70 and as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Galvanized conduits which penetrate concrete (slabs, pavement, and walls) shall be PVC coated and shall extend from the first coupling or fitting outside either side of the concrete minimum of 155 mm per 305 mm 6 inches per 12 inches burial depth beyond the edge of the surface where cable protection is required; all conduits shall be sealed on each end. Where additional protection is required, cable may be placed in galvanized iron pipe (GIP) sized on a maximum fill of 40 percent of cross-sectional area, or in concrete encased 103 mm 4 inches PVC pipe. Conduit may be installed by jacking or trenching. Trenches shall be backfilled with earth and mechanically tamped at 155 mm 6 inches lift so that the earth is restored to the same density, grade and vegetation as adjacent undisturbed material.

3.1.4.1 Cable End Caps

Cable ends shall be sealed at all times with coated heat shrinkable end caps. Cables ends shall be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps shall remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.1.5 Underground Duct

****

NOTE: Use Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

****

Provide underground duct and connections to existing[manholes,][handholes,][concrete pads,][and][existing ducts] as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION with any additional requirements as specified herein.

3.1.6 Reconditioning of Surfaces

****

NOTE: Use Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

****

Provide reconditioning of surfaces as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.1.7 Penetrations

Caulk and seal cable access penetrations in walls, ceilings and other parts of the building. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.8 Cable Pulling

Test duct lines with a mandrel and swab out to remove foreign material before the pulling of cables. Avoid damage to cables in setting up pulling apparatus or in placing tools or hardware. Do not step on cables when entering or leaving the manhole. Do not place cables in ducts other than those shown without prior written approval of the Contracting Officer. Roll cable reels in the direction indicated by the arrows painted on the reel flanges. Set up cable reels on the same side of the manhole as the conduit section in which the cable is to be placed. Level the reel and bring into proper alignment with the conduit section so that the cable pays off from the top of the reel in a long smooth bend into the duct without twisting. Under no circumstances shall the cable be paid off from the bottom of a reel. Check the equipment set up prior to beginning the cable pulling to avoid an interruption once pulling has started. Use a cable feeder guide of suitable dimensions between cable reel and face of duct to protect cable and guide cable into the duct as it is paid off the reel. As cable is paid off the reel, lubricate and inspect cable for sheath defects. When defects are noticed, stop pulling operations and notify the Contracting Officer to determine required corrective action. Cable pulling shall also be stopped when reel binds or does not pay off freely. Rectify cause of binding before resuming pulling operations. Provide cable lubricants recommended by the cable manufacturer. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

3.1.8.1 Cable Tensions

Obtain from the cable manufacturer and provide to the Contracting Officer, the maximum allowable pulling tension. This tension shall not be exceeded.

3.1.8.2 Pulling Eyes

Equip cables 32 mm 1.25 inches in diameter and larger with cable manufacturer's factory installed pulling-in eyes. Provide cables with diameter smaller than 32 mm 1.25 inches with heat shrinkable type end caps or seals on cable ends when using cable pulling grips. Rings to prevent grip from slipping shall not be beaten into the cable sheath. Use a swivel of 19 mm 3/4 inch links between pulling-in eyes or grips and pulling strand.

3.1.8.3 Installation of Cables in Manholes, Handholes, and Vaults

Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support cables on brackets and cable insulators at a maximum of 1220 mm 4 feet. In existing manholes, handholes, and vaults where new ducts are to be terminated, or where new cables are to be installed, modify the existing installation of cables, cable supports, and grounding as required with cables arranged and supported as specified for new cables. Identify each cable with corrosion-resistant embossed metal tags.

3.1.9 Aerial Cable Installation

****

NOTE: Include tensioning and sag data on drawings in tabular form.

****

Pole installation shall be as specified in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION. Where physical obstructions make it necessary to pull distribution wire along the line from a stationary reel, use cable stringing blocks to support wire during placing and tensioning operations. Do not place ladders, cable coils, and other equipment on or against the distribution wire. Wire shall be sagged in accordance with the data shown. Protect cable installed outside of building less than 2.5 meters 8 feet above finished grade against physical damage.

3.1.9.1 Figure 8 Distribution Wire

Perform spiraling of the wire within 24 hours of the tensioning operation. Perform spiraling operations at alternate poles with the approximate length of the spiral being 4575 mm 15 feet. Do not remove insulation from support members except at bonding and grounding points and at points where ends of support members are terminated in splicing and dead-end devices. Ground support wire at poles to the pole ground.

3.1.9.2 Suspension Strand

****
NOTE: Include tensioning and sag data on drawings in tabular form.
****

Place suspension strand as indicated. Tension in accordance with the data indicated. When tensioning strand, loosen cable suspension clamps enough to allow free movement of the strand. Place suspension strand on the road side of the pole line. In tangent construction, point the lip of the suspension strand clamp toward the pole. At angles in the line, point the suspension strand clamp lip away from the load. In level construction place the suspension strand clamp in such a manner that it will hold the strand below the through-bolt. At points where there is an up-pull on the strand, place clamp so that it will support strand above the through-bolt. Make suspension strand electrically continuous throughout its entire length, bond to other bare cables suspension strands and connect to pole ground at each pole.

3.1.9.3 Aerial Cable

Keep cable ends sealed at all times using cable end caps. Take cable from reel only as it is placed. During placing operations, do not bend cables in a radius less than 10 times the outside diameter of cable. Place temporary supports sufficiently close together and properly tension the cable where necessary to prevent excessive bending. In those instances where spiraling of cabling is involved, accomplish mounting of enclosures for purposes of loading, splicing, and distribution after the spiraling operation has been completed.

3.1.10 Cable Splicing

3.1.10.1 Copper Conductor Splices

Perform splicing in accordance with requirements of RUS Bull 1753F-401 except that direct buried splices and twisted and soldered splices are not allowed. Exception does not apply for pairs assigned for carrier application.

3.1.10.2 Fiber Optic Splices

Fiber optic splicing shall be in accordance with manufacturer's recommendation and shall exhibit an insertion loss[not greater than 0.2 dB for fusion splices][not greater than 0.4 db for mechanical splices].

3.1.11 Surge Protection

All cables and conductors, except fiber optic cable, which serve as communication lines through off-premise lines, shall have surge protection installed at each end which meet the requirements of RUS Bull 1751F-815.

3.1.12 Grounding

****

NOTE: Designer should verify the existence of grounding facilities. It is essential that all grounding facilities, new and existing, conform with IEEE C2, NFPA 70, MIL-HDBK-419, and MIL-STD-188-124.

****

Provide grounding and bonding in accordance with RUS 1755.200, TIA-607, IEEE C2, and NFPA 70. Ground exposed noncurrent carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals.

3.1.12.1 Telecommunications Master Ground Bar (TMGB)

The TMGB is the hub of the basic telecommunications grounding system providing a common point of connection for ground from outside cable, CD, and equipment. Establish a TMGB for connection point for cable stub shields to connector blocks and CD protector assemblies as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.12.2 Incoming Cable Shields

Shields shall not be bonded across the splice to the cable stubs. Ground shields of incoming cables in the EF Telecommunications to the TMGB.

3.1.12.3 Campus Distributor Grounding

a. Protection assemblies: Mount CD protector assemblies directly[on the telecommunications backboard][in the telecommunications [rack][cabinet]]. Connect assemblies mounted on each vertical frame with No. 6 AWG copper conductor to provide a low resistance path to TMGB.

[b. TMGB connection: Connect TMGB to TGB with copper conductor with a total resistance of less than 0.01 ohms.

][3.1.13 Cut-Over

All necessary transfers and cut-overs, shall be accomplished by the telecommunications contractor.

]3.2 LABELING

3.2.1 Labels

****

NOTE: Provide labeling in accordance with TIA-606 using a mechanical device for printing.

****

Provide labeling for new cabling and termination hardware located within the facility in accordance with TIA-606. Handwritten labeling is unacceptable. Stenciled lettering for cable and termination hardware shall be provided using[thermal ink transfer process][laser printer][_____].

3.2.2 Cable Tag Installation

****

NOTE: Verify cable labeling requirements with the local Activity. Label in accordance with TIA-606 for activities without current labeling standards. Choose appropriate cable labeling requirements based on verification results.

****

Install cable tags for each telecommunications cable or wire located in manholes, handholes, and vaults including each splice.[Tag only new wire and cable provided by this contract.][Tag new wire and cable provided under this contract and existing wire and cable which are indicated to have splices and terminations provided by this contract.] The labeling of telecommunications cable tag identifiers shall be[as indicated][in accordance with TIA-606].[Tag legend shall be as indicated.] Do not provide handwritten letters. Install cable tags so that they are clearly visible without disturbing any cabling or wiring in the manholes, handholes, and vaults.

3.2.3 Termination Hardware

Label patch panels, distribution panels, connector blocks and protection modules using color coded labels with identifiers in accordance with TIA-606.

3.3 FIELD APPLIED PAINTING

****

NOTE: Select the second bracketed sentence if Section 09 90 00 PAINTS AND COATINGS is used on the project and delete the subparagraphs for CLEANING, PRIMING, and FINISH COAT.

****

[Provide ferrous metallic enclosure finishes in accordance with the following procedures. Ensure that surfaces are dry and clean when the coating is applied. Coat joints and crevices. Prior to assembly, paint surfaces which will be concealed or inaccessible after assembly. Apply primer and finish coat in accordance with the manufacturer's recommendations.][Provide ferrous metallic enclosure finishes as specified in Section 09 90 00 PAINTS AND COATINGS.]

[3.3.1 Cleaning

Clean surfaces in accordance with SSPC SP 6/NACE No.3.

][3.3.2 Priming

Prime with a two component polyamide epoxy primer which has a bisphenol-A base, a minimum of 60 percent solids by volume, and an ability to build up a minimum dry film thickness on a vertical surface of 0.127 mm 5.0 mils. Apply in two coats to a total dry film thickness of 0.127 to 0.2 mm 5 to 8 mils.

][3.3.3 Finish Coat

Finish with a two component urethane consisting of saturated polyester polyol resin mixed with aliphatic isocyanate which has a minimum of 50 percent solids by volume. Apply to a minimum dry film thickness of 0.05 to 0.076 mm 2 to 3 mils. Color shall be the manufacturer's standard.

]3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 FIELD QUALITY CONTROL

Provide the Contracting Officer[10][_____] working days notice prior to[each][_____] test. Provide labor, equipment, and incidentals required for testing. Correct defective material and workmanship disclosed as the results of the tests. Furnish a signed copy of the test results to the Contracting Officer within 3 working days after the tests for each segment of construction are completed. Perform testing as construction progresses and do not wait until all construction is complete before starting field tests.

3.5.1 Pre-Installation Tests

Perform the following tests on cable at the job site before it is removed from the cable reel. For cables with factory installed pulling eyes, these tests shall be performed at the factory and certified test results shall accompany the cable.

3.5.1.1 Cable Capacitance

Perform capacitance tests on at least 10 percent of the pairs within a cable to determine if cable capacitance is within the limits specified.

3.5.1.2 Loop Resistance

Perform DC-loop resistance on at least 10 percent of the pairs within a cable to determine if DC-loop resistance is within the manufacturer's calculated resistance.

3.5.1.3 Pre-Installation Test Results

Provide results of pre-installation tests to the Contracting Officer at least[5][_____] working days before installation is to start. Results shall indicate reel number of the cable, manufacturer, size of cable, pairs tested, and recorded readings. When pre-installation tests indicate that cable does not meet specifications, remove cable from the job site.

3.5.2 Acceptance Tests

****

NOTE: Designer should delete tests that are not required.

****

Perform acceptance testing in accordance with RUS Bull 1753F-201 and as further specified in this section. Provide personnel, equipment, instrumentation, and supplies necessary to perform required testing. Notification of any planned testing shall be given to the Contracting Officer at least[14][_____] days prior to any test unless specified otherwise. Testing shall not proceed until after the Contractor has received written Contracting Officer's approval of the test plans as specified. Test plans shall define the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested. Provide test reports in booklet form showing all field tests performed, upon completion and testing of the installed system. Measurements shall be tabulated on a pair by pair or strand by strand basis.

3.5.2.1 Copper Conductor Cable

Perform the following acceptance tests in accordance with TIA-758:

a. Wire map (pin to pin continuity)

b. Continuity to remote end

c. Crossed pairs

d. Reversed pairs

e. Split pairs

f. Shorts between two or more conductors

3.5.2.2 Fiber Optic Cable

****

NOTE: The OTDR works on the principal of the amount of light that is reflected back to the source and therefore gives an estimated loss value. Typically, the OTDR can be used for locating problems causing high attenuation. It should be noted, however, that the distances needed for accurate OTDR readings must exceed 100 m 328 ft. To overcome the long tail on the trace due to the initial reflection at the OTDR connector, a "dead-zone fiber" with a length exceeding the displayed pulse duration may be used between the OTDR connector and the specimen. (Numerically, pulse length in meters corresponds to approximately one-tenth the pulse duration in ns.) To avoid the tail, the dead-zone fiber length may be up to 20 times the pulse length, depending upon characteristics of the individual OTDR. Recommend a 20 meter 66 feet jumper minimum, for testing fiber optic cabling using the OTDR, however on long cabling runs this length may be inadequate to overcome the dead-zone and potentially skew test results. Select 850 or 1300 nanometer light source for multimode fiber and 1310 or 1550 nanometer light source for single-mode fiber.

****

Test fiber optic cable in accordance with TIA/EIA-455 and as further specified in this section. Two optical tests shall be performed on all optical fibers: Optical Time Domain Reflectometry (OTDR) Test, and Attenuation Test. In addition, a Bandwidth Test shall be performed on all multimode optical fibers. These tests shall be performed on the completed end-to-end spans which include the near-end pre-connectorized single fiber cable assembly, outside plant as specified, and the far-end pre-connectorized single fiber cable assembly.

a. OTDR Test: The OTDR test shall be used to determine the adequacy of the cable installations by showing any irregularities, such as discontinuities, micro-bendings or improper splices for the cable span under test. Hard copy fiber signature records shall be obtained from the OTDR for each fiber in each span and shall be included in the test results. The OTDR test shall be measured in both directions. A reference length of fiber,[20][____] m[66][____] feet minimum, used as the delay line shall be placed before the new end connector and after the far end patch panel connectors for inspection of connector signature. Conduct OTDR test and provide calculation or interpretation of results in accordance with TIA-526-7 for single-mode fiber and TIA-526-14 for multimode fiber. Splice losses shall not exceed 0.3 db.

b. Attenuation Test: End-to-end attenuation measurements shall be made on all fibers, in both directions, using a[850][1300][1310][1550] nanometer light source at one end and the optical power meter on the other end to verify that the cable system attenuation requirements are met in accordance with[TIA-455-46A for multimode][and][TIA-526-7 for single-mode] fiber optic cables. The measurement method shall be in accordance with TIA-455-78-B. Attenuation losses shall not exceed 0.5 db/km at 1310 nm and 1550 nm for single-mode fiber. Attenuation losses shall not exceed 5.0 db/km at 850 nm and 1.5 db/km at 1300 nm for multimode fiber.

c. Bandwidth Test: The end-to-end bandwidth of all multimode fiber span links shall be measured by the frequency domain method. The bandwidth shall be measured in both directions on all fibers. The bandwidth measurements shall be in accordance with TIA/EIA-455-204.

3.5.3 Soil Density Tests

****

NOTE: Choose one of the following options.

****

[a. Determine soil-density relationships for compaction of backfill material in accordance with ASTM D1557, Method D.

][b. Determine soil-density relationships as specified for soil tests in Section 31 00 00 EARTHWORK.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-34 11 00 (April 2008)**

Preparing Activity: USACE **Superseding**
UFGS-34 11 00 (January 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 34 - TRANSPORTATION

SECTION 34 11 00

RAILROAD TRACK AND ACCESSORIES

04/08

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-34 11 00 (April 2008)**

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SECTION 34 11 00

RAILROAD TRACK AND ACCESSORIES

04/08

****

NOTE: This guide specification covers the requirements for new railroads after the roadbed has been prepared, and railroad rehabilitation.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This section will be used only for railroad construction after the roadbed has been prepared. Sections 31 11 00 CLEARING AND GRUBBING and 31 00 00 EARTHWORK will be used for specifying roadbed preparation. CAUTION: Coordination of this section with other sections of the specifications and with the project drawings is required.

The following information should be shown on the drawings:

a. Location of various sizes of rail if required.

b. Approximate location of compromise joints.

c. Locations of accessories such as welded joints, rail anchors, guard rails, gage rods, bonded and grounded track, etc.

d. Locations of items of equipment such as derails and car bumpers.

e. Location of turnouts, including dimensions from point of switch and center of last switch tie. Also type of switch stand and quantity and location of switch ties.

f. Track section with all needed dimensions.

g. Superelevation locations and amounts.

h. Highway grade crossing location, type, and details (cross-sections) as required. Standard details for each type of crossing are available on CADD through the PCASE program.

****

1.1 UNIT PRICES

****

NOTE: When lump sum payment is desired in the Invitation for Bids for work covered under this section the UNIT PRICES paragraphs will be deleted and subsequent paragraphs renumbered.

****

Each bid item will be measured by the unit listed in the Bid Schedule. Materials must be actually used or installed in the completed work. No measurement will be made for wasted materials or materials used for the convenience of the Contractor. The quantities thus determined will be paid for at their respective unit prices as shown in the Unit Price Schedule. This payment will constitute full compensation for furnishing materials, equipment, and labor and incidentals necessary to complete the work required, and for removing and properly disposing of replaced materials. Any required work or materials, such as lubricants and creosote, which are not listed on the Unit Price Schedule, are considered subsidiary to the items listed, and include their cost in the costs for the listed items. Bid items are self-explanatory except as described below.

1.1.1 Rail

****

NOTE: Use the following paragraph for new track construction. Use paragraphs Out-of-Face Rail Replacement and Spot Rail Replacement below for rehabilitation work.

****

Rail will be paid for on a unit price per linear meter ft of rail weight shown in the Unit Price Schedule. Stock rails and closure rails will be included for payment in the turnout unit price. The rails in road crossings will be included for payment for rail. Payment [will] [will not] include such items as [furnishing the rail,] [cutting and drilling the rail,] [installing the rail,] [and] [delivering the old rail removed from track to the designated storage area].

1.1.1.1 Out-of-Face Rail Replacement

Measurement will be by the linear meter of 30.5 m ft of 100 ft or more of contiguous replacement rail acceptably installed. Payment will be at the contract unit price per linear meter ft for "Out-of-Face Rail Replacement".

1.1.1.2 Spot Rail Replacement

Measurement will be by the linear meter of less than 30.5 m ft of less than 100 ft of contiguous replacement rail acceptably installed. Existing rails which are adjusted in the track during spot rail replacement will not be measured for payment. Existing rails which must be transposed or exchanged during spot rail replacement, as determined by the Contracting Officer, [will] [will not] be measured for payment. Payment will be at the contract unit price per linear meter ft for "Spot Rail Replacement".

1.1.2 Joint Bars

****
NOTE: List joint bars required.
****

Joint bars will be paid for at the unit price per pair under "Furnish Joint Bars" for the following items: [_____].

1.1.3 Compromise Joints

Compromise joints will be paid for at the contract unit price per joint for "Furnish Compromise Joint".

1.1.4 Turnouts

1.1.4.1 New Turnouts

Turnout construction will be measured and paid for at the contract unit price for "Furnish and Install New Turnouts". Include the complete switch, switch stand, connecting rod, switch rods, attachments, switch points, slide plates, rail braces, frog, fillers, joint bars and track bolts for the switch and frog, switch ties, and all other required items, including rail, rail anchors, standard tie plates, and spikes. Ballast will be paid for at the unit price for ballast. The pay limit for turnout construction begins at the center of the No. "0" tie at the front of the turnout to the last long switch tie of the rear of the turnout.

1.1.4.2 Turnout Repair

The following are turnout and track crossing unit price pay items:

1.1.4.2.1 "Switch Repair"

(1) "Replace Switch Stand" - Each
(2) "Replace Switch Points" - Each
(3) "Install or Replace Heel Fillers" - Each
(4) "Install or Replace Heel Filler Bolt Assembly" - Each
(5) "Install or Replace Switch Plates" - Each
(6) "Install or Replace Switch Braces" - Each

(7) "Remove and Respike Braces and Plates" - Each
(8) "Adjust Adjustable Braces" - Each
(9) "Install or Replace Switch Rods and Clips" - Each
(10) "Replace Connecting Rod" - Each
(11) "Grind and Dress Switch Point and Adjacent Stockrail" - Each
(12) "Clean, Adjust, and Lubricate Switch" - Each
(13) "Rebuild Switch Point Protector" - Each
(14) "Rebuild Switch Point" - Each
(15) "Paint Switch Stand

1.1.4.2.2 "Frog Repair"

(1) "Replace Frog" - Each
(2) "Install or Replace Frog Plates or Hook Plates" - Each
(3) "Rebuild Frog" - Each
(4) "Grind and Dress Frog, Install or Replace Frog Bolt Assembly" - Each

1.1.4.2.3 "Guard Rail Repair"

(1) "Replace Guard Rail" - Each
(2) "Install or Replace Guard Rail Plates" - Each
(3) "Install or Replace Guard Rail Bolt Assembly" - Each
(4) "Install or Replace Guard Rail Fillers" - Each
(5) "Install or Replace Clamp Assembly including Fillers and Wedges" - Each
(6) "Tighten all Bolts in Turnouts" - Each

1.1.5 Track Crossing

Track crossings will be paid for at the contract unit price for "Furnish and Install Track Crossing".

1.1.6 Crossties and Switch Ties

****

NOTE: If only one of the AREMA Manual standard crosstie grades listed below is to be used, list only the specified grade and delete the other grade.

****

Crossties will be measured for each defective crosstie removed and for each new crosstie acceptably furnished and installed as indicated. Switch ties will be measured for each length of defective switch tie removed and for each length of new switch tie acceptably furnished and installed as indicated. Defective crossties and switch ties removed become the property of the Contractor. Crossties will be paid for at the contract unit price for each type listed below:

"152 by 203 mm 6 by 8 in Grade Crosstie"
"178 by 229 mm 7 by 9 in Grade Crosstie"

Switch ties will be paid for at the contract unit price each for the length of switch tie listed below:

"2.74 m 9 ft 0 in Switch Tie"
"3.05 m 10 ft 0 in Switch Tie"
"3.35 m 11 ft 0 in Switch Tie"
"3.66 m 12 ft 0 in Switch Tie"

"3.96 m 13 ft 0 in Switch Tie"
"4.27 m 14 ft 0 in Switch Tie"
"4.57 m 15 ft 0 in Switch Tie"
"4.88 m 16 ft 0 in Switch Tie"
"5.18 m 17 ft 0 in Switch Tie"

1.1.7 Geotextiles

****
NOTE: Remove this paragraph when Geotextiles are not required.
****

Geotextile quantities will be paid for at the unit price as shown on the Unit Price Schedule. Payment for material used in laps, seams, or extra lengths such as anchorage and for associated equipment such as securing pins along with the associated materials, equipment, labor, and operations is included in the contract unit price for "geotextile" and do not pay for separately. For payment purposes, installed geotextile will be measured in place to the nearest square meter square yard of placement area. Only material must be actually used or installed in the completed work will be paid for.

1.1.8 Ballast, Out-of-Face Surface and Aligning

Measure ballast based upon certified scale tickets for railcars or other delivery vehicles. Payment for ballast material will be made at the contract unit price per net metric ton ton of each gradation acceptably furnished and placed in track for "Furnish and Place Ballast". Submit copies of waybills and delivery tickets during the progress of work. Before the final statement is allowed, file certified waybills and delivery tickets for ballast actually used. Out-of-Face Surface and Aligning will be measured by the unit track-meter track-ft for each track-meter track-ft of raise of each type or fraction thereof, acceptably performed. Payment will be at the contract unit price per track meter ft for each item given below:

"Out-of-Face Surface and Aligning - skin Lift"
"Out-of-Face Surface and Aligning - 51 mm 2 in Raise"
"Out-of-Face Surface and Aligning - 102 mm 4 in Raise"
"Out-of-Face Surface and Aligning - 152 mm 6 in Raise"
"Out-of-Face Surface and Aligning - [_____] mm [_____] in Raise"

1.1.9 Subballast

****
NOTE: Remove this paragraph when Subballast is not required.
****

Measure subballastbased upon certified scale tickets. Payment for subballast material will be made at the contract unit price per net metric ton ton of each gradation acceptably furnished and placed and compacted on the track bed for "Furnish, Place, and Compact Subballast." Submit copies of waybills and delivery tickets during the progress of work. Before the final statement is allowed, file certified waybills and delivery tickets for subballast actually used.

1.1.10 Bridge Work

****

NOTES: Remove this paragraph when Bridge Work is not required in the contract. This paragraph should be edited to include payment for the items shown if they are not paid for separately under the Bidding Schedule.

Open deck bridge repair would not be track construction. Repair would require bridge tie renewals and wood guard rail renewals as separate items.

****

The following items relating to bridge repair will be measured separately for payment and are described under other sections of these specifications.

ITEM DESCRIPTION	UNIT
Timber Pile Repair	Linear m feet
Timber Pile Replacement	Linear m feet
Shotcrete Repair	Square m feet
Bridge Tie Replacement (Open-deck)	Each
Rivet Replacement	Each
Gabion and Gabion Mattress	Cubic m yard

All other work relating to bridge repairs will not be measured but will be paid for under the contract lump sum prices listed below for work at the following locations: [_____].

1.1.10.1 Lump Sum Payment

Payment for each lump sum is full compensation for all material, labor, equipment, and incidentals necessary to complete the work as shown on the drawings and as specified herein. Lump sum payment will be exclusive of those items specifically covered by the unit prices referenced above. The lump sum payment items include, but are not limited to, permitting, traffic maintenance, demolition, excavation, excavation supports, backfill, clearing, grubbing, protection of utilities and signals, timber repairs, temporary supports, jacking bridges, concrete construction, ballast retaining walls, pipe, end walls, removal and reinstallation of existing track, surface preparation, and painting.

1.1.10.2 Track over Ballasted-deck Bridges

Repair of track over ballasted-deck bridges will be measured and paid for at the contract unit price for the applicable repair item. Removal of track over ballasted-deck bridges which are to be repaired is considered incidental to the bridge repair. Reconstruction of track over open deck bridges will be measured per track m ft and paid for at the contract unit price for TRACK CONSTRUCTION AND OUT-OF-FACE RELAY.

1.1.11 Track Spikes

Measurement will be by the unit keg for each keg of spikes acceptably furnished. Payment will be at the contract unit price per keg under "Furnished Track Spikes". Payment [will] [will not] be made for installation incidental to tie replacement or rail relay.

1.1.12 Track Bolt Assemblies

****

NOTE: List required bolt sizes.

****

Track bolt assemblies include bolt, spring washer (nutlock and nut). Measurement will be for each bolt furnished of the following sizes: [_____]. Payment will be at the contract unit price per each "Furnished Track Bolt Assembly". Payment [will] [will not] be made for installation incidental to rail joint repair or rail relay.

1.1.13 Tie Plates

****

NOTE: List tie plate sizes required.

****

Measurement will be for each tie plate acceptably furnished of the following size: [_____]. Payment will be at the contract unit price per each under "Furnish Tie Plates". Payment [will] [will not] be made for installation incidental to tie replacement or rail relay.

1.1.14 Rail Anchors

****

NOTE: List rail weight and section for which anchors are required.

****

Measurement will be for each anchor of the following weight [_____] and section [_____] acceptably furnished and installed. Payment will be at the contract unit price for "Furnish and Install Rail Anchors".

1.1.15 Insulated Joints

****

NOTE: List rail weight and section for which insulated joints are required.

****

Insulated joints will be measured for each insulated joint acceptably furnished and installed and will be paid for at the contract unit price for "Furnished and Installed Insulated Joints". Insulated joints will be required for the following rail weight [_____] and section [_____].

1.1.16 New Bumpers

****

NOTE: List type of bumpers required.

****

New bumpers of [_____] type will be measured for each bumper acceptably furnished and installed. Payment for furnishing and installing new bumpers will be at the contract unit price per each under "Furnish and Install New Bumpers".

1.1.17 New Wheelstops

****

NOTE: List type of wheelstops required.

****

New wheelstops of [_____] type will be measured by the unit pair for each pair of wheelstops acceptably furnished and installed. Payment for furnishing and installing new wheelstops will be at the contract unit price for each pair for "Furnish and Install New Wheelstops".

1.1.18 Salvaged Bumpers and Wheelstops

Salvage of existing track bumpers and wheelstops will be measured and paid for each bumper or pair of wheel stops salvaged.

1.1.19 Install Bumpers

Installation of salvaged bumpers will be measured for each bumper under "Install Track Bumper".

1.1.20 Install Wheelstops

Installation of salvaged wheelstops will be measured for each pair of wheelstops acceptably installed and will be paid for at the contract unit price for "Install Wheelstops".

1.1.21 Cushion Head for Bumper

Payment for furnishing and installing cushion head will be at the contract unit price per each new cushion bumper head.

1.1.22 Fastenings

Payment for fastenings used in the installation or reinstallation of bumping post, wheelstops, or cushion head for bumpers are considered incidental and included in the installation pay item for each.

1.1.23 Inner Guard Rail

Inner guard rail will be measured by the linear m ft of rail acceptably furnished and installed and will be paid for at the contract unit price for furnished and installed "Inner Guard Rail". Each rail of dual guard rail installations will be measured separately. The other track materials (OTM, i.e., joint bars, bolt assemblies, tie plates and spikes) will be included with the guard rail.

1.1.24 Adjusted gage Rods

Readjusting existing gage rods, as designated by the Contracting Officer, will be measured for each and be paid for at the contract unit price per each under "Adjust gage Rods".

1.1.25 New gage Rods

New gage rods will be measured for each gage rod acceptably furnished and installed and will be paid for at the contract unit price for "Furnish and Install gage Rods".

1.1.26 Salvaged gage Rods

Removal and salvage of existing gage rods will be measured and paid for at the contract unit price for each under "Salvage gage Rod".

1.1.27 Installed Salvaged gage Rods

Installation of salvaged gage rods will be measured for each gauge rod acceptably installed and will be paid for at the contract unit price for each under "Install Salvaged gage Rods".

1.1.28 New Derails

New derails will be measured and paid for at the contract unit price per each new derail acceptably furnished and installed under the bid item "Furnish and Install New Derail".

1.1.29 Installed Derails

Installation of salvaged derails will be measured for each derail acceptably installed and will be paid for at the contract unit price for each under "Install Derail".

1.1.30 Rail Welding

1.1.30.1 Rail Welding Thermite

Thermite rail welding to eliminate joints will be measured for payment based upon the number of rails welded and accepted by the Contracting Officer. Payment will be made for costs associated with rail welding of Government furnished and Contractor furnished rails. No payment will be made for replacement welds found unacceptable by ultrasonic testing.

1.1.30.2 Rail Welding Electric Arc

Electric Arc rail welding of [rebuilt rail ends] [engine burns] [_____] will be measured for payment based upon the number of rails welded and accepted by the Contracting Officer. Payment will be made for costs associated with rail welding of Government furnished and Contractor furnished rails. No payment will be made for replacement rails or replacement welds found unacceptable by ultrasonic testing.

1.1.31 Rail Joint Gap Adjustment

Measurement will be by the unit for each rail gap acceptably adjusted by replacing rail. Rail gaps which are created by rail adjusting (pulling or bumping) operations will not be measured for payment. Payment will be at the contract unit price per each under "Spot Rail Replacement".

1.1.32 Rail Joint Repair

Measurement will be by the unit for each joint acceptably repaired (disassembly, cleaning, inspection, repairing any rail end mismatch, and reassembly with new bolt assemblies). Joints which are repaired coincident with adjacent other repair work, such as spot rail replacement, will not be measured for payment. Payment will be at the contract unit price per each under "Rail Joint Repair".

1.1.33 Respiking

Measurement will be by the unit for each 90.7 kg 200 pound keg utilized in track respiking. Respiking of joints located in a rail which is being shifted as part of a regaging operation will not be measured for payment. Spiking of ties installed under this contract will not be measured for payment. Respiking of ties in areas of "Rail Joint Repair" will not be measured for payment. Payment will be made at the contract unit price per tie under "Respiking".

1.1.34 Rail Cropping

Measurement will be by the unit for each rail end acceptably cropped and redrilled. Payment will be at the contract unit price for "Rail Cropping".

1.1.35 Tighten Bolts

Measurement will be made by the track km mile of bolts tightened, or removing and installing bolts that cannot be tightened, or replacing bolts that are missing. Payment will be made at the contract unit price for km mile or portion thereof under "Tighten Bolts".

1.1.36 Bolt Assembly Replacement

Measurement will be by the unit for each bolt assembly acceptably replaced. Payment will be at the contract unit price for "Bolt Assembly Replacement".

1.1.37 Track Construction

Track construction is defined as the initial construction of track or total reconstruction of track from the subgrade up. The pay item "Track Construction" includes all plant, equipment, and labor necessary to install rail, ties, and track materials and construct the track in accordance with this specification. Furnish track materials under their respective pay items in the contract Unit Price Schedule. Track construction will be measured and paid for by the track m ft for construction acceptably performed at the contract unit price for "Track Construction".

a. Reconstruction of track through grade crossings and between points 6 meters 20 ft beyond the outside limits of the crossing surface as shown will be considered to be track construction.

b. Track relocation or realignment of existing track by more than 1 meter 3 ft when associated with the relocation of turnouts or other work will be measured and paid for as "Track Construction".

c. Minor shifting of existing track associated with the replacement of turnouts, or any shifting less than 1 meter 3 ft is considered to be minor work incidental to related lining and surfacing work.

d. Where track construction abuts a turnout, the pay limit for construction of various items will be the center of the No. "0" tie in front of the turnout and the last long switch tie at the rear of the turnout and does not include turnout.

e. Rail, ties, and other track materials for use in track construction will be included for measurement and payment under the respective contract unit prices for furnishing that material. Ballast and subballast will be measured and paid for at the contract unit prices for "Furnish and Install Ballast" and "Furnish, Place, and Compact Subballast". Costs for surfacing and alignment will be included in the contract unit price for "Track Construction".

1.1.38 Track Removal and Salvage

Removal of track will be measured by the track-meter track-ft, acceptably removed, and materials salvaged, inspected, inventoried, marked, stacked, and transported to designated storage sites. Track removal and salvage will be paid at the contract unit price per track meter ft under "Track Removal and Salvage".

1.1.39 Track Removal and Scrap

Track removal and scrap will be measured by the track meter ft of track acceptably removed and all of the scrap materials removed from the installation. Track removal and scrap will be paid for at the contract unit price per track meter ft of "Track Removed and Scraped".

1.1.40 Turnout Removal and Salvage

Turnout removal and salvage consist of removing all turnout materials, including switch ties. Limits of the turnout removal and salvage will be from the switch point to the last long switch tie. Also, included is the transportation of the materials to the designated storage site. The removal and salvage will be measured for each turnout removed and turnout material salvaged.

1.1.41 Straight Rail Turnout

****

NOTE: Straight rail turnout is performed when a turnout is removed, but one track is to remain in service.

****

Straight rail turnout consists of installing crossties in place of switch ties and replacing the previously removed switch and frog with rail and other track materials. The straight rail turnout will be measured for each turnout removed.

1.1.42 Rail Bonds

Rail bonds will be measured for each bond acceptably furnished and installed and will be paid for at the contract unit price for each of the following:

a. "Furnish and Install Railhead Bonds"
b. "Furnish and Install Duplex Web Bonds"

1.1.43 Rail Grounds

Rail grounds, including grounding rods, connecting cables, and hardware will be measured by the unit for each rail ground assembly acceptably furnished and installed and will be paid for at the contract unit price for each "Ground Assembly" furnished and installed.

1.1.44 Removal of Existing Crossing Surfaces

Removal and disposal of existing crossing surfaces and adjacent pavements will be measured by the square meter yard of surface or pavement acceptably removed and will be paid for at the contract unit price for "Pavement Removal". Removal of aggregate crossings will not be measured for payment as this work is considered incidental to "Track Construction".

1.1.45 Salvage of Grade Crossing Panel

Salvage of existing grade crossing panels and other materials will be measured by the track meter ft of crossing surface acceptably salvaged and will be paid for at the contract unit price per track m ft under "Grade Crossing Panel Salvage".

1.1.46 Track Removal and Track Construction Through Crossings

Track removal through crossings will be measured by the track meter ft and paid for as "Track Removal". Track construction using existing rail through crossings will be measured and paid for at the contract unit prices as specified in the appropriate sections of this specification. Track construction furnishing rail and other track material will be measured and paid for at the unit prices as specified in the appropriate sections of this specification.

1.1.47 Grade Crossing Surface Installation

****

NOTE: Throughout this section, delete crossing types not applicable to the work by coordinating with the project standard drawings and cross sections. Designer should add a separate bid item for signs if required.

****

Grade crossing surface installation will be measured by the track meter ft of crossing surface acceptably installed and paid for at the contract unit prices for the items listed below:

TYPE	DESCRIPTION
1	GRAVEL: (SEMI-PERMANENT)
1A	GRAVEL: WITH TIMBER HEADERS
2	TIMBER: FULL DEPTH
2A	TIMBER: FULL DEPTH, PREFABRICATED TIMBER SECTIONAL
3	ASPHALT: FULL-DEPTH WITH TIMBER HEADERS
4	CONCRETE: CAST-IN-PLACE

TYPE	DESCRIPTION
4A	CONCRETE: PRECAST CROSSING PANELS/SYSTEMS
5	RUBBER (ELASTOMERIC)

1.1.48 Subdrains

Subdrains acceptably installed will be measured and paid for by the linear meter ft at the contract unit price for "Grade Crossing Subdrains".

1.1.49 Conduit

****

NOTE: Delete this paragraph if grade crossing conduit is not required for automatic crossing protection warning devices. Installation should be considered if future crossing signal installation is anticipated.

****

PVC cable conduit of 100 mm 4 in diameter acceptably installed will be measured and paid for by the linear m ft at the contract unit price for "Grade Crossing Conduit".

1.1.50 Cleaning Flangeways

Cleaning the gage side flangeways in grade crossings are considered incidental work.

1.1.51 Ultrasonic Testing of Rail

Ultrasonic testing will be measured by the track meter ft and will be paid for as "Ultrasonic Testing".

1.1.52 Electric Arc Welding

Electric arc welding will be measured and paid for by the item, rebuilt in the track or in the shop and installed in the track. Items to be included are as follows:

a. "Switch point", each.
b. "Frog", each.
c. "Batter rail end", each.
d. "Guard rail", each.
e. "Engine burn", each.
f. "Railroad crossing", each.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges
AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2023) Manual for Railway Engineering

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M2	(2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use
AWPA M6	(2024) Brands Used on Preservative Treated Materials
AWPA P2	(2024) Standard for Creosote Solutions
AWPA U1	(2024) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A490M	(2014a) Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C535	(2016; R 2024) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C702/C702M	(2018) Standard Practice for Reducing Samples of Aggregate to Testing Size
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates

ASTM D217	(2021a) Standard Test Methods for Cone Penetration of Lubricating Grease
ASTM D402/D402M	(2014) Distillation of Cut-Back Asphaltic (Bituminous) Products
ASTM D445	(2019a) Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D566	(2017) Standard Test Method for Dropping Point of Lubricating Grease
ASTM D1241	(2015) Materials for Soil-Aggregate Subbase, Base, and Surface Courses
ASTM D1310	(2014) Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2171/D2171M	(2018) Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer
ASTM D3740	(2019) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D3776/D3776M	(2009a; R 2017) Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
ASTM D4354	(2012; R 2020) Sampling of Geosynthetics for Testing
ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M	(2017) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4595	(2017) Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D4751	(2020) Standard Test Method for Determining Apparent Opening Size of a Geotextile

ASTM D4759	(2011; R 2018) Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM E11	(2024) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM F667/F667M	(2016; R 2021) Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices

UL SOLUTIONS (UL)

UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Bridge Repair; G, [_____]

SD-03 Product Data

Wood Ties

Engineered Polymer Composite Ties

Steel Ties

Concrete Ties

New Jointed Rail; G, [_____]

Relay Rail; G, [_____]

Joint Bars

Compromise Joint Bars

Miscellaneous Track Materials

Crossing Material or Surface

Acceptable Replacement Materials; G, [_____]

Traffic Maintenance and Detour Plans; G, [_____]

Thermite Welding Procedures; G, [_____]

Electric Arc Welding

Materials and Samples

SD-04 Samples

Geotextile

Ballast

Subballast

SD-06 Test Reports

Sampling and Testing

Wood Ties

Engineered Polymer Composite Ties

Concrete Ties

Geotextiles

Ultrasonic Test

SD-07 Certificates

Wood Ties

Engineered Polymer Composite Ties

Ballast

Subballast

Materials and Samples

SD-10 Operation and Maintenance Data

Rail; G, [_____]

Turnouts and Track Crossings; G, [_____]

Switches; G, [_____]

Grade Crossings; G, [_____]

SD-11 Closeout Submittals

As-Built Drawings; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Track Construction

Perform track construction under the direction of qualified and competent supervisory personnel experienced in railroad construction.

1.4.2 Welding

Perform welding under the direct supervision of an experienced welding supervisor or foreman.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Materials and Samples

Submit a complete schedule of the materials proposed for installation within 60 days of receipt of notice to proceed, and before installation of the materials; include a list of equipment proposed for the work. The

Contracting Officer will notify the Contractor of the materials approved or disapproved. Promptly segregate disapproved materials that have already been delivered to the project site from the approved materials and remove from the premises. If materials are disapproved, provide acceptable replacement materials at no additional cost to the Government. Submit performance data for components or products proposed as an equivalent to those specified. The Contracting Officer's written approval is required for any such equivalent type component or product proposed to be used. Initial approval by the Contracting Officer will not prevent the removal and replacement of materials that are materially defective or materials not meeting this specification that are discovered during construction and/or routine quality control/quality assurance operations. Submit manufacturer's certificates of conformance for the following materials:

a. Rail.
b. Tie plates.
c. Track bolts, nuts, and spring washers.
d. Joint bars.
e. Rail anchors.
f. Track spikes.
g. Turnouts.
h. Rail welding process.
i. Premanufactured car bumpers.
j. Premanufactured road crossings and/or crossing surfaces.

1.5.2 Geotextiles

Ship and store geotextiles in their original ultraviolet resistant cover until the day of installation. Protect geotextiles from vandalism, temperatures greater than 60 degrees C 140 degrees F, dirt, dust, mud, debris, moisture, sunlight, and ultraviolet rays. Clearly label geotextiles delivered to the project site on the material cover to show the manufacturer's name, brand name, fabric type, location and date manufactured, lot identification, width, and length. Submit independent testing laboratory's certified test reports for geotextiles, including necessary analysis and interpretation. Provide results of the laboratory testing performed on samples of the geotextile material delivered to the jobsite. Submit test reports at least [5] [_____] working days prior to the installation of the geotextile.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Temporary Work

Provide, during construction, suitable roads and crossings with all necessary lights, signs, drainage, and other appurtenances required for safe public and local travel. Erect and maintain suitable temporary fences where required to prevent trespass upon work or damage to adjoining property. Maintain drainage, and the accumulation of water that might affect the stability of the roadbed is not permitted.

1.6.2 Traffic Control

Provide traffic control that comply with MUTCD. Place suitable warning signs near the beginning of the work site and well ahead of the work site for alerting approaching traffic from both directions. Place small markers along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation.

1.6.3 Welding

Do not perform welding in rain, snow, or other inclement weather without adequately protecting the weld from the elements.

1.6.4 License Agreement

****

NOTE: The Designer should assess the need to include this paragraph and its subparagraphs in the project specifications. Delete if not applicable.

****

The work under this contract is being accomplished under a license agreement between the [_____] RAIL CORPORATION (hereinafter referred to as the Railroad Company) and the UNITED STATES OF AMERICA executed on [_____].

1.6.4.1 Provisions and Requirements

The following provisions and requirements are made a part of this contract in order for the UNITED STATES OF AMERICA to perform its obligations under the License agreement:

a. Perform the work in conformance with the standards of care and practice appropriate to the nature of the work.

b. Allow the Railroad Company to view and inspect the work at any time.

c. Do not enter the Railroad Company's premises until specifically authorized by the Contracting Officer. Notify the Contracting Officer at least 7 days prior to the planned date for entering the premises of the Railroad Company.

d. Take any safety precautions that the Railroad Company deems necessary. Do not locate equipment, unless being utilized to perform work on the railroad track, within 3.5 m 12 ft of the centerline of the nearest railroad track. Attend such equipment allowed within 3.5 m 12 ft of the centerline of the nearest railroad track at all times.

e. Furnish evidence of Workmen's Compensation coverage for both itself and for all subContractors.

f. Maintain at all times during any construction, maintenance, or removal work, the following insurance coverages:

    (1) Contractor's Public Liability and Property Damage Liability Insurance, including automobile coverage, with a combined single limit of $2,000,000 per occurrence;

    (2) For each subcontractor, Contractor's Protective Public Liability and Property Damage Liability Insurance, including automobile coverage, with a combined single limit of $2,000,000 per occurrence;

    (3) Railroad Protective Public Liability and Property Damage Liability Insurance with a combined single limit of $2,000,000 per occurrence.

1.6.4.2 Insurance Policy Requirements

The Railroad Protective Liability policy must name the [_____] Rail Corporation, [_____] Corporation, and [_____] as the named insureds and include an endorsement in the form appearing in the Standard Provisions of the contract documents. Furnish to the Railroad Company, the Railroad Protective Liability policy and the certificates evidencing the other insurance coverage required in this section. Each policy and/or certificate must provide that cancellation of the insurance cannot be accomplished unless at least ten (10) days notice is given to the Railroad Company.

PART 2 PRODUCTS

2.1 BALLAST

****

NOTE: No. 5 ballast should only be used around turnouts and other areas requiring a smooth walking surface. Depth of ballast will be indicated on the drawings.

A wide choice of materials may be used for ballast, depending on economics and availability. Prepared ballast is preferred since production can be controlled. The use of unprepared ballast for heavy-duty track will increase maintenance requirements. The inapplicable types of ballast will be deleted, and brackets will be removed. The size number will be indicated in this paragraph. Normally, prepared ballast will be used conforming to sizes of gradations established by AREMA Manual. Ballast, crushed stone and slag numbers 4, 4A, or 5 are acceptable. Size numbers 4 and 4A are typically mainline ballast materials. Size number 5 is typically used on yard and house tracks. Any or all of these sizes can be specified, with a Contractor's option. The depth and other details of the ballast section will be shown on the contract drawings.

Blast furnace slag should be considered a last choice or limited to areas with low rainfall and moisture and obtained from a source that is known to have provided good performing ballast in recent years. Most slag ballast tend to cement together over time or otherwise disintegrate more rapidly than better quality crushed rock. Water seems to accelerate this process. (This behavior is much like some poorer quality limestones.) Thus, unless its performance is already well known, using slag for ballast is much riskier than using crushed rock.

****

Submit samples of the ballast [and subballast] material for testing. Submit samples a minimum of [30] [60] [90] [_____] days prior to the installation of the material. Obtain samples from the quarry, supplier, or other source that will be used to provide the ballast [and subballast] materials for this project using the methods described in ASTM D75/D75M.

[Submit one representative sample no less than 90.6 kg 200 lbs of ballast material for each 9070 MT 10,000 ton of ballast to be installed.] [Submit one representative sample no less than 90.6 kg 200 lbs of subballast material for each 9070 MT 10,000 ton of subballast to be installed.]Prepared ballast must be crushed stone, [crushed air-cooled blast-furnace slag,][or][crushed steel furnace slag] Size No. [4,][4A,][or][5] conforming to Chapter 1, Part 2, of AREMA Eng Man for quality, soundness and gradation. In the portion retained on each sieve specified, the crushed gravel must contain at least 90 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the plane. When two fractures are contiguous, ensure the angle between planes of the fractures is at least 30 degrees in order to count as two fractured faces. Flat and elongated particle dimension ratio used in ASTM D4791 must be 1:3. Submit certificates of Compliance for the ballast [and] [subballast] materials to be installed in this project. Ballast materials must meet the property requirements shown in TABLE I.

TABLE I. MINIMUM PROPERTY REQUIREMENTS - BALLAST

Property	Maximum Value	Minimum Value	Test Method
Percent passing 0.075 mm No. 200 sieve	1.0 percent	--	ASTM C136/C136M ASTM C117
Bulk specific gravity			
Rock	--	2.60	ASTM C127
Blast furnace slag	--	2.30	
Absorption			
Rock	2.0 percent	--	ASTM C127
Blast furnace slag	5.0 percent	--	
Clay lumps and friable particles	0.5 percent	--	ASTM C142/C142M
Degradation Soundness	35 percent	--	ASTM C535
Sodium sulfate - 5 cycles	10 percent	--	ASTM C88
Flat or elongated particles	5 percent	--	ASTM D4791

2.2 SUBBALLAST

****

NOTE: Subballast should be used in frost areas where the ballast thickness requirement exceeds 250 mm 10 inches. Where subballast in necessary, indicate the kind of subballast to be used; the depth and other details of subballast section will be shown on the contract drawings. In some cases, the subballast material may be substituted for the lower portion of the ballast layer. The subballast

is often constructed as a filter layer between the ballast and subgrade. Gradation of subballast generally ranges from the largest subgrade particles to the smaller or middle ballast particle sizes. Where practical, subballast should be placed in layers and thoroughly compacted to form a stable foundation for the ballast. AREMA Manual has a procedure for selecting gradation based on gradation of ballast and subgrade.

****

Provide subballast consisting of aggregate-soil materials conforming to an ASTM D1241 Type I, Gradation [A] [B] [C] [D] mixture.

2.3 GEOTEXTILE

****

NOTE: Requirements for geotextile will be deleted unless a thorough investigation indicates that geotextile is necessary. Where geotextile is necessary, subballast is recommended and the following information should be shown on the drawings:

a. Locations for geotextile installation.

b. Locations for drainage work, including subdrains to provide drainage for the geotextile.

c. Typical cross-section through track showing rail, tie, ballast, subballast, geotextile, and subgrade with dimensions.

d. Locations for disposal of spoil materials.

Numerical values listed in TABLE II, except AOS, represent Minimum Average Roll Values (MARV) and are the value in the weaker principal direction as defined in AASHTO M 288.

Color should be grey or tinted to prevent "snow blindness" of personnel during installation.

The permeability of the geotextile should be at least five times greater than the permeability of the subgrade soil, but not less than the specified value. The pressure used to measure the nominal thickness (necessary to calculate the permeability) in ASTM D1777 should be based on the pressure expected to be placed on the geotextile in the installation.

Most railroad applications use overlap as a method of joining separate pieces of geotextile.

See UFC 3-230-01 for additional information on subsurface drainage and filtration criteria.

The minimum depth of ballast for the track section

being constructed/reconstructed is to be specified. However, where geotextiles are used in the track structure, the minimum depth of ballast/subballast between the tie and the geotextile of 300 mm 12 in. should be enforced to avoid severe damage to the geotextile.
****

Submit geotextile samples for testing. Submit samples a minimum of [30] [60] [90] [_____] days prior to the beginning of installation of the geotextiles. Provide one sample for each 20 units (rolls, panels, etc.) of geotextile to be used in the contract. Ensure all samples are from the same production lot as will be supplied for the contract. Identify samples by the manufacturer's name, brand name, lot designation, and project name. Ensure the minimum size of sample submitted for testing is the full width of the geotextile by [1.7] [9] [_____] m [5] [30] [______] ft.

2.3.1 Physical Property Requirements

Provide a nonwoven, pervious sheet of polymeric material consisting of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Provide geotextile that contains stabilizers and/or inhibitors as necessary to make the filaments resistant to deterioration from ultraviolet light and heat exposure, particularly prior to placement and coverage. Ensure the fibers are formed into a network which is dimensionally stable. Finish the edges of the geotextile in a way to prevent the outer fibers from being pulled away from the geotextile. Provide geotextile that exceeds the applicability property requirements stated in TABLE II.

TABLE II - PROPERTY REQUIREMENTS-GEOTEXTILE

PROPERTY	MINIMUM REQUIREMENTS*	TEST METHOD
Weight**	0.57 kg/0.836 sq m15 oz/sq yd	ASTM D3776/D3776M Option B
Color	Grey or tinted	--
Strength	Class 1	AASHTO M 288
Apparent opening size (AOS) (maximum required valve)	Less than 0.22 mm No. 70 sieve	ASTM D4751
Permittivity	0.1 per sec	ASTM D4491/D4491M
Ultraviolet degredation at 500 hours	50 percent strength retained	ASTM D4355/D4355M
*These property requirements are Minimum Average Roll Values in the weaker principal direction.		
**Do not limit geotextile selection by the minimum weight shown. Base selection on the other property requirements listed. Heavier geotextiles have shown greater resistance to abrasion.		

2.3.2 Dimensional Requirements

Match each roll of geotextile to the roadbed width. Ensure each roll of geotextile is at least 3.6 m 12 ft.

2.4 JOINT BARS

****

NOTE: Lone toe joint bars are not recommended for high used tracks.

****

Provide joint bars of the size, shape, and punching pattern to fit the rail being joined.

2.4.1 New Joint Bars

Use new joint bars with new rail. Use joint bars of the "toeless" and "head free design" to match rail section. Ensure new joint bars conform to the requirements of "Specifications For High-Carbon Steel Joint Bars" or "Specifications For Quenched Carbon-Steel Joint Bars and Forged Compromise Joint Bars" found in Chapter 4, Part 2 of AREMA Eng Man for the joint bar and assemblies recommended in Chapter 4, Part 1 of AREMA Eng Man.

2.4.2 Used Joint Bars

Ensure used joint bars in good condition are used with relay rail only. Provide "toeless" type joint bar. Do not employ the used "long toe" type of joint bar where, because of the tie plate punching pattern, the spike slots are used to spike the rail to alignment at the joints. Ensure used joint bars are straight, free from cracks, breaks, and other visual defects. Excessive rust, dirt, and other foreign materials on the joint bars are not permitted. Used joint bars must be of the proper size to make good contact with the underside of the rail head and the top of the rail base on the rails being joined. Provide joint bars with alternating round and oval bolt holes. Bolt holes must not show excessive wear that would prevent use of the oval neck track bolt normally used with that joint bar. Joint bars that have been flame-gouged, flame cut, or otherwise altered are considered scrap and do not use.

2.4.3 Compromise Joint Bars

Ensure compromise joint bars are of the size, shape, and punching pattern to fit the rail sizes and sections being joined. Use only factory designed and constructed (forged or cast) compromise joint bars to join rails of different sizes.

2.4.3.1 New Compromise Joint Bars

Provide compromise joint bars conforming to the requirements of "Specifications For Quenched Carbon-Steel Joint Bars and Forged Compromise Joint Bars" found in Chapter 4, Part 2 of AREMA Eng Man.

2.4.3.2 Used Compromise Joint Bars

Requirements for joint bars in paragraph Used Joint Bars also apply to used compromise joint bars.

2.5 GREASE

Use grease for lubricating moving parts in turnouts and other trackwork with the following typical characteristics:

Calcium Soap, percent	9.0
Solid Additive (Graphite),percent	11.5
Penetration, ASTM D217 at 25 degrees C 77 degrees F worked	340
Dropping Point ASTM D566 at 25 degrees C 77 degrees F	101/214
Oil Viscosity, square mm/record at 40 degrees C cSt at 104 degrees F	81.8
ASTM D445 SUS at 38 degrees C 100 degrees F	379

Other types of grease or lubricating oil (like SoyTrak) may be used provided that the grease or oil has been used successfully by local commercial railroads and has the approval of the Contracting Officer.

2.6 OIL FOR CORROSION PROTECTION

Provide oil for protecting rail and other track materials from corrosion, except joints, conforming to the following general specification:

Asphalt, 100 penetration minimum 45 percent	ASTM D402/D402M
Flash point, minimum 55 degrees C 130 degrees F	ASTM D1310
Viscosity, kinematic, 60 degrees C 480 to 700 sq mm/s 140 degrees F 480 to 700 centistokes	ASTM D2171/D2171M

2.7 RAIL

Submit manufacturer's data on new rail including: rail weight, rail section, drilling, rail length, date rolled, and the name of the mill where the rail was rolled. Include chemical analysis for Industrial Grade Rail. For relay rail the required information includes weight, section, lengths, and the name of the supplier. Provide the maximum allowable vertical wear on the rail head and the maximum allowable horizontal wear on the side of the rail. Also provide the design of the joint bars and compromise joint bars proposed to be furnished with each rail section.

2.7.1 New Jointed Rail

****

NOTES: Designer will indicate the desired rail weight and section. Rail weights/sections recommended for new rail purchases include: 115 RE, 132 RE, 133 RE, and 136 RE.

The designer will insert the rail section and the drilling pattern for each rail section required. Recommended rail drillings and joint bar punchings are found in Chapter 4, Part 1 of AREMA Manual. An

example specification for 57 kg 115 lbs rail and a 6-hole joint bar would be:

RAIL	**DRILLING**
115RE	**89-152-152 mm (3-1/2, 6, 6 inch)**

****

2.7.1.1 General Requirements

Comply with the following:

2.7.1.1.1 Rail Lengths

Provide new rail consisting of a [_____] kg/m lbs/yd section or heavier and conforming to the specifications in Chapter 4, Parts 1 and 2 of AREMA Eng Man that were in effect at the time of its manufacture. Provide new rail in [11.9][24.4] m [39][80] ft lengths.

2.7.1.1.2 Rail Drilling

Provide new rail with the rail ends drilled. Drilluniformly and to the patterns specified.

RAIL	DRILLING
[_____]	[_____]

2.7.1.2 New Industrial Grade Rail

Produce all steel in an electric furnace. Ensure steel is continuous cast and free of hydrogen. Cull out and eliminate all injurious hot marks, or surface imperfections. Control cool rail to AREMA specifications. Provide rolled rail in accordance with the general physical dimensional requirements of AREMA design and meeting the Section tolerances and Chemical Composition listed below.

SECTION TOLERANCES	
Height	+1.5 to -0.7 mm+0.060 to -0.025 inch
Head Width	+1.2 to -1.1 mm+0.045 to -0.045 inch
Base Width	+1.5 to -1.5 mm+0.060 to -0.060 inch
Web Width	+1.5 to -0.7 mm+0.060 to -0.025 inch

GENERAL COMPOSITION			
		PRODUCT ANALYSIS PERCENT	
ELEMENT	CHEMICAL ANALYSIS PERCENT	UNDER MINIMUM	OVER MAXIMUM
Carbon	0.65 to 0.85	0.04	0.04
Manganese	0.70 to 1.30	0.06	0.06
Phosphorus Maximum	0.040		0.008
Sulfur Maximum	0.050		0.008
Silicon	0.10 to 0.50		0.50

2.7.1.2.1 Testing

Test rail ultrasonically to the following calibration guidelines:

CALIBRATION GUIDLINES	
Head	2.4 mm0.10 inch Flat bottom Hole
Web	3.2 mm0.13 inch Flat Bottom Hole
Base	3.2 mm X 12.7 mm.013 x 0.50 inch Slot

2.7.1.2.2 Straightness

Straighten rail for line in a press or roller straightener. End straightness must meet the following guidelines:

Droop	1.0 mm 0.040 inch Maximum
Dip	1.0 mm 0.040 inch Maximum
Hook	1.0 mm 0.040 inch Maximum

2.7.2 Used Jointed Rail

****

NOTES: Due to the ever-changing markets for used rail, it may be beneficial to allow the Contractor the option to provide an acceptable rail section for relay. Hence, the list of acceptable rail sections, acceptable rail weights, and sections should be chosen for compatibility with the existing rail and to minimize the number of different rail weights and sections on the installation. Delete unacceptable weights/sections from the list. Normally, rail less than 115 lbs should not be purchased for DOD track.

The designer will insert the rail section and the drilling pattern for each rail section required. To the greatest extent practical, the specified drillings should match the drilling pattern in the existing rail that is to remain in track. Recommended rail drillings and joint bar punchings are found in Chapter 4, Part 1 of AREMA Manual. An example specification for 57 kg 115 lbs rail and a 6-hole joint bar would be:

RAIL	**DRILLING**
115RE	**89-152-152 mm 3-1/2, 6, 6 inch**

****

2.7.2.1 Relief Rail

Used rail for spot rail replacement of defective rails (relief rail) must be the same weight, section, drilling, and length as the rail being replaced. Relief rail must meet the requirements specified for relay rail.

2.7.2.2 Relay Rail

****

NOTE: Relay rail is typically available in nominal lengths of 10 and 12 meters 33 and 39 ft. Relay rail can be justified if the construction cost is substantially below that of new rail.

A comparison of the usable metal in the heads of a new 57 kg/m 115-lbs RE rail and a 57 kg/m 115-lbs relay rail shows that the relay rail has about 32 percent less usable metal. Based on construction cost, the rail constitutes about 47 percent of the total track above roadbed; therefore, for economy, track constructed with 57 kg/m 115-lbs relay rail should cost at least 15 percent (33 percent times 0.47 equals about 15 percent) less than track constructed with new 57 kg/m 115-lbs rail. Other conditions can be evaluated in a similar manner.

Specifying relay rail that meets AREMA is not adequate for military track. AREMA permits excessive end batter because rail ends are intended to be cropped off before welding. All relay rail should have ultrasonic inspection after it is installed. For Army projects the default values in Table IV are the maximum values. For Navy projects, the maximum wear must be 5 mm 3/16 inch for the top and 3 mm 1/8 inch for the side.

FORSCOM projects require the used of 115RE, 132RE, 133RE or 136RE rail sections.

****

Control cool relay rail. [Ensure used rail for out of face replacement and new construction is 45 kg/m 90 lb/yd or heavier and has the same section and drilling pattern for each rail weight. Acceptable rail weights and sections are: [90 ARA-A,] [100 ARA-B,] [112 AREA,] [115 AREA,] [130 AREA,] [132 AREA,] [133 AREA,] [136 AREA,] [_____]] [All relay rail provided must be the same section.]Do not cut relay rail into jointed rail from continuous welded rail.

2.7.2.2.1 Rail Drilling

Provide relay rail with the rail ends drilled. Drill uniformly and to the patterns specified.

RAIL	DRILLING
[_____]	[_____]

2.7.2.2.2 Length

Relay rail must be standard [10.1] [11.9] m [33] [39] ft lengths. Not more than 10 percent of the lot may be shorts. No rail shorter than 8.2 m 27 ft will be accepted.

2.7.2.2.3 Maximum Allowable Wear

For each rail, the average top wear must meet the requirements on Table IV, except rail in turnouts which must conform to paragraph Maximum Wear Used Rails Installed in Turnouts. Measure side wear 16 mm 5/8 in below the original top of rail.

TABLE IV. ALLOWABLE WEAR LIMITS FOR RELAY RAIL

Nominal Rail Weight, kg/m lbs/yds	Maximum Allowable Wear, mm inch	
	Top	Side
57.0 or lessLess than 115	3.21/8	6.41/4
Greater than 57.0115 or Greater	6.41/4	9.53/8

2.7.2.2.4 Condition and Appearance

Provide relay rail that is free from obvious defects and clean in appearance. Rail that has severe pitting and corrosion or has been flame-gouged, or spike nipped will not be accepted. Ensure rail is straight from line and surface and free from any kinks or bends. Ensure rail bases are solid and free from visual defects such as plate wear, spike notching, pitting, and flame-gouging. Remove all existing bond wires from relay rail by shear cutting old cables immediately adjacent to the weld or pin. Remove bond wire heads completely from the gage side.

2.7.2.2.4.1 Maximum Allowable Lip

Lip or overflow must not exceed 3 mm 1/8 inch on either side of the rail head.

2.7.2.2.4.2 Engine Burns

Engine burns must not be greater than 13 mm 1/2 inch diameter and 0.8 mm

1/32 inch deep. A maximum of 6 engine burns is allowed per rail and engine burns must not affect more than 25 percent of the total order.

2.7.2.2.4.3 End Batter and Chipping

Rail end batter must not exceed a maximum of 3 mm 1/8 inch when measured 13 mm 1/2 inch from the rail end with a 460 mm 18 inch straightedge laid only on the rail being measured. Chipped or broken rail ends will not be accepted.

2.7.2.2.4.4 Running Surface Damage

Running surface damage must not exceed 6 mm 1/4 inch long by 13 mm 1/2 inch wide, and must be no greater than 1.5 mm 1/32 inch deep. Flat spots are not permitted on the rail head.

2.7.2.2.4.5 Defects Not Permitted

Relay rail having any of the following defects is not acceptable: bolt hole cracks or breaks, broken base, breaks, crushed head, detail fracture, engine burn fracture, head-web separation, piped rail, horizontal split head, vertical split head, torch cut rail ends, torch cut bolt holes, and compound or transverse fissures. The presence of any of these defects in the rail render that rail as scrap.

2.7.3 Welded Rail

****

NOTE: While the use of continuously welded rail and concrete ties may be beneficial in some situations, the cost effectiveness for general use for DOD track has not been proven at this time. A thorough life-cycle cost analysis should be performed prior to specifying these materials.

****

Provide new rail consisting of, [_____] kg/m lbs, [_____] section and conforming to Chapter 4, Part 2 of AREMA Eng Man. Provide relay rail conforming to TABLE IV, [_____] kg/m lbs. Ensure relay rail that is to be welded meets the criteria specified in Chapter 4, Part 2 of AREMA Eng Man for welded rail. Mingling of new and relay rail will not be permitted.

2.8 TIE PLATES

2.8.1 General

Provide tie plates of the dimensions and punching pattern (A or B) to fit the rail. Use new tie plates conforming to Chapter 5, Part 1 of AREMA Eng Man with new rail. Used tie plates in good condition may be used with relay rail and ensure they are the dimensions as originally specified by AREMA Eng Man. Used tie plates smaller than 190.5 by 254 mm 7-1/2 by 10 inch are not allowed for use with relay rail having nominal weights less than 49.6 kg/m 100 lbs/yd, or no smaller than 190.5 by 279 mm 7-1/2 by 11 inch double-shoulder for use with relay rail having nominal weights of 49.6 kg/m 100 lbs/yd and greater. Both flat and canted plates will be required to match the existing tie plates that are in track. Use canted tie plates in all new rail and relay out-of-face rail replacements.

2.8.2 Used Tie Plates

Ensure used tie plates are free from excessive rust, pitting, mechanical damage, and dirt and other foreign materials. Cracked or broken plates are considered as scrap and do not use. Ensure shoulders on the tie plates project a minimum of 6 mm 1/4 inch above the plane of the rail seat. The thickness of the tie plate must be at least 13 mm 1/2 inch when measured anywhere in the rail seat area. Provide square spike holes which are not corroded, worn, or mechanically enlarged.

2.9 WOOD TIES

****

NOTE: Because of differences in treatability of the many species of wood used to manufacture railroad ties, installations should limit the number of acceptable species to those most commonly used in their geographic area. Red Oak, White Oak, and Southern Pine will provide good service in the eastern states while Douglas Fir will generally be more available in the western states. Southern Pine should not be used as mainline ties or as switch ties. Gum and pine ties are not recommended for use in areas having high humidity, such as the southeastern states. If unsure about the most appropriate species of wood for timber ties in the job geographic area, the engineering department of the local commercial railroad should be consulted.

The size and form of the crossties will be inserted in this paragraph using the following guidance.

a. For main lines, access tracks, or other tracks where the movement may be classified as heavy or the desired speed is in excess of 64.4 km/hr 40 miles per hour, crossties will be not less than 178 mm 7 in.) thick by 229 mm 9 in. wide. The length of crossties will be 2.591 m 8 ft 6 in. or 2.743 m 9 ft.

b. For yard or body, industrial, storage, siding, and running tracks, and for access tracks where the movement is not classified as heavy, crossties not less than 152 mm 6 in. thick by 203 mm 8 in. wide can be used. The length of crossties will either be 2.438 m 8 ft or 2.591 m 8 ft 6 in..

c. For road crossings, ties 178 mm 7 in. thick by 229 mm 9 in. wide and 2.743 m 9 ft long will be required, unless the manufacturer recommends a different length.

d. If locally available, oak is preferred for switch ties. A bill of material for switch ties should be provided on the drawings for each proposed type of turnout. AREMA PORTFOLIO SET, Plan 912 contains bills of switch ties for various size turnouts and crossovers.

Other local species may be listed if used by

railroads in the area.
****

Submit name of the tie manufacturer, Rail Tie Association membership, the wood species proposed, the quantities of ties for each specie proposed, and product data for the ties to be furnished, including the type of seasoning to be utilized, prior to ordering the ties. Ensure all ties are new. Provide Ash, Beech, Red and White Oak, [Gum,] [Spruces] [_____] [Pine,] [Douglas Fir,] [and] [other Fir] species.

a. Provide Ash or Oak switch ties. Ensure conditioning and seasoning conform to the requirements of AWPA U1 for the individual wood species. Provide well seasoned ties. Prior to preservative treatment, dry wood ties to the oven dry moisture content, or less, as specified in paragraph 3.14 of AWPA U1. The wood may be air dried, vapor dried, or boultonized.

b. Condition and treat ties which are to be dried by artificial means as soon as possible after sawing, but no more than 30 days later. Ensure the temperature used for boultonizing is as high as possible but in no case less than 94 degrees C 200 degrees F. Transfer vapor dried ties from drying cylinders to treatment cylinders as quickly as possible to avoid loss of heat from the seasoned ties. Pressure treat ties in accordance with Chapter 30, Part 3 of AREMA Eng Man by the empty cell process with a 60/40 creosote/coal tar solution (Grade C) in accordance with AWPA P2 to a minimum retention of 128 kg/cu m 8 lbs/cu ft of wood.

c. Treat bridge ties in accordance with paragraph BRIDGE TIES. Record treatment as specified in AWPA M2. Permanently mark or brand treated ties by the producer in accordance with AWPA M6. Provide ties that are produced by a member of the Railway Tie Association. Incise all ties, except Southern, Red, and Ponderosa Pine, on all four sides in the pattern specified in AREMA Eng Man, Chapter 30, Part 3, prior to treatment.

d. Provide splits that are longer than 100 mm 4 inch and no wider than 5 mm 1/4 in at either end. Splits longer than 100 mm 4 inch but no longer than the width of the face in which the split appears, will be acceptable if specified anti-splitting devices are installed with the splits compressed. Perform any required adzing and drilling for spikes prior to treatment.

e. Notify the Contracting Officer at least 15 days prior to the shipment of any treated ties or timbers from the manufacturer's plant, to provide the Government the opportunity to inspect the materials before shipment. When inspections of onsite materials result in product rejection, promptly segregate and remove rejected material from the premises. The Government may also charge the Contractor any additional cost of inspection or test when prior rejection makes reinspection or retesting necessary.

f. Submit certified [test] [and] [inspection] reports for crossties and switch ties subsequent to treatment, a minimum of seven calendar days prior to any ties being installed in track. [Test] [and] [inspection] reports must contain the information required by Part 7 of AWPA M2. Submit certificates of compliance prior to any ties being installed in track.

2.9.1 Crossties

Provide wood crossties conforming to Chapter 30, Part 3 of AREMA Eng Man.

2.9.1.1 Except at Road Crossings

Provide sawed wood ties no less than [_____] mm inch thick and [_____] mm inch wide, with a length of [2.44] [2.6] [2.75] m [8.0] [8.5] [9.0] ft.

2.9.1.2 At Road Crossings

Provide sawed wood ties no less than 178 mm thick and 229 mm wide 7 inch thick and 9 inch wide with a length of 2.75 m 9 ft, unless recommended otherwise by the manufacturer of crossing surface materials.

2.9.2 Switch Ties

Provide sawed switch ties conforming to Chapter 30, Part 3 of AREMA Eng Man that are 178 mm 7 inch thick and 229 mm 9 inch wide. Provide length and quantities as shown.

2.9.3 Bridge Ties

****

NOTE: Delete this paragraph and paragraphs Ballasted-Deck Bridge Ties and Open-Deck Bridge Ties if bridge work is not included in the contract.

****

Use method for treatment of bridge ties in accordance with AWPA U1. Base treatment standards on the type of deck on the bridge. Drill bolt holes prior to treatment. Saw ties to dimensions and furnish the quantities indicated on the contract drawings. Field verify all dimensions and quantities prior to furnishing timber bridge ties.

2.9.3.1 Ballasted-Deck Bridge Ties

Use standard crossties in track over ballasted deck bridges.

2.9.3.2 Open-Deck Bridge Ties

Bridge ties for open-deck bridges must be sized on two sides and of adequate size to distribute the track load to all stress-carrying stringers. Preservative treatment must be in accordance with AWPA U1 for above-ground exposure.

2.9.4 Tie Plugs

Tie plugs must fit holes from which spikes are drawn. The plugs must comply and be treated in accordance with Chapter 30, Part 3 Section 3.1.5 of AREMA Eng Man.

2.9.5 Anti-splitting Devices

Equip crossties and switch ties on each end with gang nail end plates anti-splitting devices of the type specified, regardless of whether or not the wood has shown any tendency to split. Use products conforming to Chapter 30, Part 3 Sections 3.1.6 and 3.1.7 of AREMA Eng Man.

2.10 BRIDGE TIMBERS

****

NOTE: Delete this paragraph if bridge work is not included in the contract.

****

Bridge timbers include all structural members such as stringers, caps, and posts. Incise timbers on two sides. Ensure creosote preservative treatment is in accordance with AWPA U1 for above ground exposure and has fire-retardant coating for creosoted wood in accordance with AREMA Eng Man, Chapter 7 Section 1.11.

2.11 BRIDGE LUMBER

****

NOTE: Delete this paragraph if bridge work is not included in the contract.

****

Treate lumber used in decks and bracing above the waterline for above ground exposure. Treat lumber used in retaining walls, fender systems, and bracing below the high waterline for soil contact exposure. Ensure preservative treatment is in accordance with AREMA Eng Man, Chapter 73.

2.12 BRIDGE PILES

****

NOTE: Delete this paragraph if bridge work is not included in the contract.

****

Preservative treatment of piles must conform to AREMA Eng Man, Chapter 7, Part 1, Section 1.9 for piles. Piles used as friction or end-bearing piles must be a First-Class pile in accordance with AREMA Eng Man, Chapter 7, Part 1, Section 1.9.4. Second-class piles can be used in retaining walls, dolphins, and fender systems supports.

2.13 ENGINEERED POLYMER COMPOSITE TIES

****

NOTE: Engineered polymer composite ties, also commonly known as plastic ties, are a relatively new technology compared to the more conventional sawn wood and concrete ties. Engineered polymer composite ties are inherently resistant to moisture, rot, and insects and may be preferred for certain locations. Besides out-of-face applications, engineered polymer composite ties can be used for maintenance (intermingled) replacement of deteriorated wood crossties.

Recommended size requirements for engineered polymer composite ties follow the same basic guidance as in the NOTE for paragraph WOOD TIES above pertaining to wood tie sizes.

Engineered composite ties are designed to use the same tie spacing and ballast structure as wood

ties. The ties can be installed using conventional hardware and installation equipment. Specific installation detials, such as which fasteners work best, size of pre-drill holes, etc., should be based on the manufacturer's recommendations.

For increased lateral and longitudinal track stability, engineered polymer composite ties can be manufactured with specially designed surface patterns to create a mechanical interlock between the tie and the ballast. Individual manufacturers have different proprietary designs to provide a range of lateral track stability. Experinece has shown that this interlock (track stability) can be achieved with little or no train traffic commonly needed upon replacement of wood ties.

****

Submit name of the tie manufacturer, dimensions, and the pre-drill size as recommended by the tie manufacturer for the type and size fastening system being used. Use engineered polymer composite ties conforming to Chapter 30, Part 5 of AREMA Eng Man. Incorporate a surface pattern to provide a minimum single tie lateral push result of 11.1 kN 2,500 lbf after no more than 100,000 gross tons of accumulated traffic. Submit certified test reports for crossties and switch ties, a minimum of seven calendar days prior to any ties being installed in track. Document compliance of the ties to the performance criteria in Chapter 30, Part 5 of AREMA Eng Man. Submit certificates of compliance prior to any ties being installed in track.

2.13.1 Crossties

2.13.1.1 Except at Road Crossings

Provide engineered polymer composite crossties, except at road crossings, which are no less than [_____] mm inch thick and [_____] mm inch wide, with a length of [2.44] [2.6] [2.75] m [8.0] [8.5] [9.0] ft.

2.13.1.2 At Road Crossings

Provide engineered polymer composite crossties at road crossings which are no less than 178 mm thick and 229 mm wide 7 inch thick and 9 inch wide. Use a length of 2.75 m 9 ft, unless recommended otherwise by the manufacturer of the crossing surface materials.

2.13.2 Switch Ties

Provide switch ties conforming to Chapter 30, Part 5 of AREMA Eng Man that are 178 mm 7 inch thick and 229 mm 9 inch wide. Provide length and quantities as shown.

2.13.3 Ballasted-Deck Bridge Ties

Engineered composite ties for use in track over ballasted deck bridges must be standard crossties.

2.13.4 Tie Plugs

Tie plugging may be utilized in engineered polymer composite ties in similar fashion as they are used in sawn wood ties. Polymer-based plugging compounds (e.g., polyurethane) are recommended.

2.14 STEEL TIES

****

NOTE: AREMA has a lighter weight steel tie section than specified below that can be used for yard tracks subject to light loads. Change section minimum properties to:

Length	**2540 mm 100 inch**
Width	**260 mm 10.2 inch**
Thickness	**10 mm 0.4 inch**
Section Depth	**97 mm 3.8 inch**
Moment of Inertia	**316 cm^4 7.6 in^4**

****

Submit name of the tie manufacturer, dimensions, type of fixation and the chemical analysis of the steel. Provide steel ties conforming to Chapter 30 of AREMA Eng Man. Construct steel ties with hook-in shoulders of a 178 mm 7 inch minimum spade. Design and furnish ties with elastic type rail fixation system for Pandrol E clips or safelock, or an approved equal. Provide ties with a brand rolled into the material indicating the section and manufacturer. Provide steel ties with the following minimum section:

Steel Ties	
Length	2590 mm 102 inch
Width	300 mm 11.8 inch
Thickness	10 mm 0.4 inch
Section Depth	118 mm 4.6 inch
Moment of Inertia	610 cm^4 14.6 in^4

Manufacture ties from steel free of injurious segregation with a minimum tensile strength of 312 MPa 45,000 psi. Use steel with the chemical composition conforming to ASTM A242/A242M or ASTM A992/A992M

2.15 CONCRETE TIES

****

NOTE: Delete if concrete ties are not required. Concrete ties may be preferred for certain locations.

****

Submit name of the tie manufacturer, dimensions, type of fixation and the chemical analysis of the concrete mix. Provide concrete ties and fastening system complying with the material and strength requirements specified in Chapter 30 of AREMA Eng Man for [monoblock] [reinforced two-block] [prestressed two-block] ties. Ensure concrete ties are a minimum of [2.44 m 8 ft] [_____] in length, width of [_____], and height of [_____]. Provide concrete ties with a factored design positive bending moment of [_____] kN-m Inch-kips at center of seat. Furnish concrete with dual durometer rubber pads, which have 50 to 60 shore A durometer on the bottom surface and 75 to 85 Shore A durometer reinforced rubber on the top surface. Submit certified test reports for ties and fastening system, a minimum of seven calendar days prior to any ties being installed in track. Document the testing required by Chapter 30 of AREMA Eng Man.

2.16 TURNOUTS AND TRACK CROSSINGS

****

NOTE: Detailed information on frogs may be found in AREMA PORTFOLIO SET. Self-guarded frogs, in accordance with AREMA Track Work Plan No. 641 and Notes, may be specified in place of rigid-bolted frogs except: (1) for tracks where the design speed exceeds 48.3 km/hr 30 miles per hour, or (2) for track installations outside the United States. Do not use spring rail frogs on military track. The type of switch lamp required will be indicated on the drawings. The type or types required will be retained in the contract specification and those not required will be deleted. Those lamps with reflector units only are preferred and will be specified where possible. Those lamps with reflectors and daylight disks will be used only at important crossovers or turnouts from main running tracks. Illuminated switch lamps will not be specified except for special main track movements, or as required by the serving railroad or by special regulations.

****

Ensure component parts of the turnouts to be furnished are the products of manufacturers regularly engaged in the manufacture of such products which essentially duplicate items that have been in satisfactory use at least 2 years prior to bid opening. The parts need not all be made by the same manufacturer, but ensure each turnout is the product of a single firm. Provide switch assemblies, stands, frogs, and guardrails assemblies conforming to the requirements of AREMA Eng Man.

2.16.1 Rail and Joint Bars

****

NOTE: The rail weight and section to be used in each turnout and track crossing constructed, reconstructed, or having steel replaced will be shown on the Contract Drawings and/or listed in this paragraph along with the turnout or crossing identification number and turnout size number. Example:

TURNOUT TRACK OR CROSSING ID	**SIZE OR CROSSING ANGLE**	**RAIL**	**DRILLING**
T51	**No. 8**	**90RA**	**72-138 mm 2-11/16-5-1/2 inch**

Designer may want new rail in turnouts to match new switch points.
****

Furnish and install rail, joint bars, and miscellaneous track materials used in turnout and track crossing construction as part of the complete turnout or crossing. Use rail and miscellaneous track materials in turnout and track crossing construction of the the weight and section [shown on the contract drawings] [as listed:

TURNOUT TRACK OR CROSSING ID	SIZE OR CROSSING ANGLE	RAIL	DRILLING
[_____]	[_____]	[_____]	[_____]

]

2.16.2 Maximum Wear Used Rails Installed in Turnouts

[The average top (vertical) wear must be 3 mm 1/8 in or less. Gage side head wear must not exceed 3 mm 1/8 inch] [Ensure all rail installed in turnouts is new].

2.16.3 Frogs, Switches, Guardrails and Appurtenances

Provide frogs, switches, guardrails and appurtenances consisting of materials suitable for use in heavy tonnage main track. Ensure used turnout materials are fully reconditioned and within plus or minus 3 mm 1/8 inch of the original specification for that turnout design. Use materials in the turnout of the same weight and section. Provide materials in good condition and free from excessive rust, dirt, and other foreign materials. Provide rail weight and section as specified.

2.16.3.1 Switches

****
NOTE: List length, type, and quantity of switch points and size, type, and quantity of other turnout materials required for turnout repairs in the drawings schedule. If new switch points are required, edit the following paragraphs accordingly. Switch point Detail 5000 can also be used. Designer may want new rail in turnouts to match new switch points. The Navy recommends the use of manganese tipped switch points on the side opposite the turnout side of the switch.

****

Usewitches for new turnout construction or complete turnout replacement consisting of 5029 mm 16 feet and 6 inches reinforced straight split switches with graduated risers generally conforming to AREMA Eng Man, Plan Number 112. Use switch materials to replace defective materials as indicated.

a. Ensure switch points are new. Ensure switch point detail is AREMA Eng Man, Plan No. 221, Detail 4000 or 6100. [Ensure one switch point in each turnout is manganese tipped in accordance with AREMA Eng Man, Plan No. 220-52-E-82, installed on the side opposite the turnout side of the switch (example the right switch point is manganese tipped on a left hand turnout).]

b. Provide new switch rods and connecting rods.

c. Provide new or used gage plates, switch plates, slide plates, and heel plates in good condition and not worn or corroded. Provide either rigid or adjustable rail braces. For a given turnout all rail braces must be of the same design.

d. Provide heel blocks that are either cast or forged steel, either new or used, and in good condition. Provide new, heat treated heel block bolt assemblies. Provide either new or used heel joint bars good condition which are manufactured for the purpose. If floating heel blocks are used, use special no. 5 double shoulder plates to maintain 160 mm6.25 inch heel spread.

2.16.3.2 Frogs

Provide [bolted rail] [railbound manganese] [solid manganese self-guarded] frogs in the sizes indicated.

a. Provide [new] [remanufactured] frogs. Do not use cracked or broken used frog castings. Cracked or broken frog castings that have been repaired by welding are not acceptable and do not use. Ensure remanufactured frogs meet the following wear requirements:

    (1) Provide frog points that are in good condition and not worn, chipped, or broken.

    (2) Maximum allowable wear on used or reconditioned frogs is:

Frog Point	3 mm 1/8 in
Top Surface	3 mm 1/8 in
Raised Guarding Face (Self-Guarded)	3 mm 1/8 in
All Wear Surfaces	3 mm 1/8 in

    (3) Minimum flangeway depth for used frogs is 45 mm 1-3/4 inch. Minimum flangeway width is 48 mm 1-7/8 inch.

b. Provide new frog bolts, nuts, lock washers, and headlocks.

2.16.3.3 New or Replacement Guard Rails

Ensure new or replacement guard rails are a minimum of 4.6 m 15 ft in length and are new or used in good condition. Provide guard rails of any of the following designs: Tee rail in accordance with AREMA Eng Man, Plan No. 504, solid manganese steel in accordance with AREMA Eng Man, Plan No. 510, or an acceptable hook flange design. Ensure the guard face for used guard rails is smooth and not worn more than 3 mm 1/8 inch from its new condition. Equip guard rails bolted to the running rails with fillers. When fillers are installed or repaired, use new bolt assemblies. All bolts, nuts, and associated hardware must be new. Equip clamped guard rails with block wedges, filler wedges, and cotter keys. Provide new guard rail plates or use acceptable replacements. Install single-shoulder tie plates used with guard rails with the shoulder on the inside flush against the base of the guard rail.

2.16.3.4 Hook Plates

Hook plates must be new or acceptable used material and of the designs and lengths indicated on AREMA Eng Man, Plan Nos. 112 and 241.

2.16.3.5 Switch Stands

****

NOTE: The type and manufacturer of switch stand should be the same as presently used at the jobsite or serving railroad. Mixing positive-action and automatic-action switch stands on the same military base is not recommended. Examples of acceptable types of stands are Racor models 22 and 36D, or Bethlehem Steel models 51A and 53. Other specialty designs, like a rotary wheel switch stand, may be also required.

****

2.16.3.5.1 New or Replacement Switch Stands

Provide new or replacement switch stands conforming to AREMA Eng Man, Plan 251-64, which are new or fully reconditioned, low-stand type with model number [Bethlehem Steel model 51A][_____]. Provide [automatic-action][semi-automatic action (spring)] [positive-action (rigid)] switch stand with [adjustment from the top with shims through a moveable cover][spring connecting rods][adjustable connecting rods][_____].

2.16.3.5.2 Existing Switch Stands

Recondition existing switch stands, staffs and targets, where not designated for replacement, by cleaning to bare metal and then paint with one coat of metal primer.[Clean and re-lubricate the interior portion of the stands, including mechanisms.] Paint switch stand staff with two coats of black enamel paint. Similarly prepare and paint switch targets with two coats of red or white enamel paint to indicate switch position in accordance with normal railroad practice.

2.16.3.5.3 Switch Lamps

Equip each stand with one of the following switch lamps as indicated on the project plans:

2.16.3.5.3.1 Reflecting Type

Approved reflecting switch lamps fitted with standard commercial-type double red and white reflecting lenses but without day signal targets.

2.16.3.5.3.2 Reflecting Type with Daylight Disk

Approved reflecting switch lamps fitted with standard commercial-type double red and white reflecting lenses, and with day signal targets.

2.16.3.5.3.3 Illuminated Type

Approved illuminated lamps with primary battery, battery housing, and cable.

2.16.4 Track Crossings

Provide new track crossings fabricated in accordance with AREMA Eng Man, Plan No. [_____]. Rail weight and section is [_____]. Provide tie layout in accordance with AREMA Eng Man, Plan No. [_____].

2.16.5 Rail Braces

Provide either the fixed or adjustable type rail braces of standard manufacture.

2.17 GRADE CROSSINGS

Use recyclable materials in grade crossings conforming to EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.17.1 Crossing Material or Surface

****

NOTES: Coordinate this paragraph with the drawings showing the typical railroad crossing cross-section and details.

Where suitable local materials meeting state specifications for a granular highway base course material are available, those materials may be substituted for the ASTM D1241 material specified below. Ballast or subballast materials may also be used for semi-permanent aggregate crossings.

****

Within 30 days of the Notice to Proceed, submit the brand name of the premanufactured crossing material or crossing surface material proposed for use along with manufacturer's literature concerning the product; and for built-in-place crossings, the type of materials to be used along with manufacturer's literature. Submit detailed installation procedure for the premanufactured crossing material or crossing surface material proposed for use within 30 days of the notice to proceed. Ensure roadway width is as indicated in the contract drawings. Provide crossing material or surface complying with the following:

a. Construct a semi-permanent aggregate crossing of compacted crushed aggregate placed between the rails and as short approaches to the track. Provide aggregate consisting of a crushed gravel or crushed stone material conforming to the requirements of [ballast] [subballast] [ASTM D1241, Type I, Gradations A or B].

b. Construct a permanent aggregate crossing of compacted crushed aggregate placed in the track between bond timbers header as indicated. Provide crushed aggregate consisting of [ballast] [subballast] [a crushed aggregate material conforming to the requirements of ASTM D1241, Type I, Gradations A or B].

c. Provide [constructed-in-place] [prefabricated] full-depth timber crossings. Ensure timber road crossing materials are [oak] [acceptable hardwood]. Provide seasoning and treatment conforming to the requirements of AWPA U1 and paragraph WOOD TIES.

d. Use bituminous paving materials for full-depth asphaltic cement concrete (bituminous) crossing with bond timbers flangeway headers conforming to the applicable State of [_____] Highway Specification for a [_____] type mix design. Ensure bond timbers are [oak] [acceptable hardwood]. Provide seasoning and treatment conforming to AWPA U1 and paragraph WOOD TIES.

e. Provide concrete pavement materials for full-depth, cast-in-place concrete crossings conforming to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

f. Use premanufactured, precast concrete panels for grade crossings constructed of reinforced concrete having a minimum 28-day compressive strength of 34.5 MPa 5,000 psi. Ensure each panel is manufactured to meet HS20-44 loading in accordance with AASHTO HB-17, with 30 percent impact increment. Base loading on single axle loads of 14,500 kg 32,000 lbs. Use precast crossing panels that are the product of a company regularly engaged in the manufacture of such panels, and whose products have been successfully used in the commercial railroad industry for at least 2 years.

g. Provide full depth panels for premanufactured elastomeric crossing systems. Ensure elastomeric systems with or without steel composition grade crossing panels are the product of a company regularly engaged in the manufacture of such products, and whose products have been successfully used in the commercial railroad industry for at least 2 years.

2.17.2 Rail

****

NOTE: The use of 57 kg/m 115-lbs rail as the minimum through crossings and for 6 m 20 ft on either side of the crossing is recommended. The use of welded joints or long (24.4 m (78 feet) rail for the crossing area is also recommended to eliminate any joints in the crossing area. The use of 178 mm by 229 mm by 2.74 m 7 inches by 9 inches. by 9 feet long ties is recommended throughout the crossing area. Although 2.59 m 8-1/2 feet ties are acceptable, they are the minimum length that should be used in the crossing.

****

Provide rail within the road crossing and for at least 6 m 20 ft on either side of the crossing that is [_____] [115RE] as specified in paragraph Rail and Joint Bars.

2.17.3 Ties

Provide ties within the road crossing and for at least 6 m 20 ft on either side of the crossing consisting of hardwood or polymer composite and as specified in paragraphs Crossties and Switch Ties.

2.17.4 Track Materials

For premanufactured crossing surfaces or systems, provide tie plates, spikes or other rail fasteners, rail anchors, and other track materials conforming to the manufacturer's recommendations. Unless specified by the crossing manufacturer, provide track materials as specified in paragraph MISCELLANEOUS TRACK MATERIALS.

2.17.5 Threaded Fasteners and Screw Spikes

****

NOTE: Screw spikes having an ultimate tensile strength of 483 MPa 70,000 psi are commercially available.

****

Use threaded fasteners in grade crossings of the sizes and lengths specified by the grade crossing manufacturer or as indicated for built-in-place crossings. Use screw spikes with a minimum ultimate tensile strength of 414 MPa 60,000 psi and galvanized for corrosion protection.

2.17.6 Pipe for Subdrains

Pipe for subdrains must be [152] [203] [_____] mm [6] [8] [_____] inch diameter corrugated, perforated [polyethylene complying with ASTM F667/F667M] [bituminous coated galvanized corrugated steel].

2.17.7 Cable Conduit

Provide cable conduit under grade crossings consisting of 102 mm 4 inch diameter PVC pipe conforming to UL 651, and a minimum of Schedule 80.

2.18 MISCELLANEOUS TRACK MATERIALS

Submit manufacturer's data for all track materials to be furnished. Provide miscellaneous track materials as follows:

2.18.1 Spikes

2.18.1.1 Track Spikes

Provide new track spikes conforming to Chapter 5, Part 2 of AREMA Eng Man. Use track spikes size 152 by 16 mm 6 by 5/8 inch with 49.6 kg/m 100 lbs or heavier rail. Use track spikes 140 by 14 mm 5-1/2 by 9/16 inch with 44.6 kg/m 90 lb and under rail.

2.18.1.2 Bridge Spikes

[Use minimum 19 mm 3/4 in diameter washer head screw spikes that allow a minimum of 127 mm 5 inch penetration into the stringers to connect the bridge ties to the stringers on an open-deck bridge, in accordance with AREMA Eng Man, Chapter 7, Part 7.]

2.18.2 Bolts, Nuts, and Spring Washers

Use new track bolts, nuts, and spring washers throughout the project for both new and relay rail.[Use bolts in both steel and timber bridge connections.]

2.18.2.1 Bolts and Nuts

The various rail, joint bars, and rail drillings require various lengths and diameters of bolt assemblies. Determine the number of bolt assemblies of each size required. All bolt diameters must be the largest possible for a given rail drilling and joint bar punching. Provide track bolts and nuts conforming to Chapter 4, Part 2 of AREMA Eng Man. Ensure track bolts are long enough to leave at least two threads exposed after the nut is tightened.[Use ASTM A325M ASTM A325 or ASTM A490M ASTM A490 bolts for steel bridge connections. Use hot dip galvanized steel bolts, minimum 19 mm 3/4 in diameter with lengths as required for timber bridge connections.]

2.18.2.2 Spring Washers

Size spring washers and nuts to ensure that the spring washer develops its full reactive force and does not jam into the joint bar hole. Provide spring washers of the size to fit the bolt and nut used and conforming to Chapter 4, Part 2 and Section M12 of AREMA Eng Man.

2.18.3 Rail Anchors

****

NOTE: The number and position of rail anchors will be shown on the drawings and will be based on amount of traffic, character of traffic, and local conditions. When required, anchors will be placed in accordance with AREMA recommendations for "Light Density Lines" in Chapter 5 of AREMA Manual. This recommendation calls for 16 anchors per 11.9 meters 39-ft length of track, that is 8 anchors to resist movement in each direction. Where heavy traffic, steep grades or other factors result in rail creeping additional anchors may be specified.

****

Where special tools are required to install or remove anchors, furnish a minimum of one tool for each 5,000 anchors, or fraction thereof, not to exceed 5 tools per job.

2.18.3.1 New Installation

Provide [new] [repinched] rail anchors for new installations. Use sizes conforming to the various sizes of rail on the project and conforming to "Specifications for Rail Anchors" in Chapter 5, Part 7 of AREMA Eng Man. Anchors may be either drive-on or spring type.

2.18.3.2 Salvaged Rail Anchors

Rail anchors salvaged from the track being removed are the property of the Contractor and remove from the site. Do not reinstall used anchors unless they have been repinched.

2.18.3.3 Rail Clips and Fasteners

Provide single tight fit clips with fillers as necessary to fit rail section furnished. Clip or fastener design must anchor rail against longitudinal movement.

2.18.4 Insulated Joints

Provide insulated joints conforming to applicable portions of Chapter 4, Part 2 of AREMA Eng Man. Do not use conventional continuous insulated joints with fiber insulation. Unless otherwise directed by the Contracting Officer, use insulated joints for the following rail sections, rail drilling, and number of joints:

RAIL SECTION	DRILLING	NO. JOINTS
[_____]	[_____] - [_____]	[_____]

2.18.5 Bumping Posts, Cushion Heads and Wheelstops

Provide new bumping posts, cushion heads, and wheelstops of a standard design that has been in use by commercial railroad industry for at least 5 years. Use bumping posts, cushion heads, and wheelstops manufactured by a company regularly engaged in the manufacture of these products.

2.18.5.1 Bumping Posts

Provide bumping posts consisting of all-steel construction, that bolt firmly onto the rail, and of a type designed for general service. Provide bumping posts that have tension with 3800 mm^2 6 sq inch cross-sectional area and compression members with a moment of inertia no less than 15 X 10^6 mm^4 37 inch^4 of A36 steel. Bumping post must be capable of withstanding a yield load of 2450 kN 550,000 pounds.

2.18.5.2 Cushion Heads

Provide cushion heads consisting of all steel construction, that firmly bolt, attach, or clamp onto the bumper or end dock (platform or ramp). Cushion heads must resist 356 kN 80,000 lbs of compression.

2.18.5.3 Wheelstops

Provide wheelstops consisting of all-steel construction, that firmly bolt or clamp onto the rail, and of a type designed for general service.

2.18.6 Used Bumping Posts and Wheelstops

Do not furnish used bumping posts and wheelstops. Used bumping posts and wheelstops [must be salvaged from existing tracks which are removed or rebuilt under this Contract] [will be provided by the Government]. Use new fastening materials to install or reinstall used bumping posts or wheelstops. Furnish new fastening materials conforming to the applicable sections of this specification.

2.18.7 Inner Guard Rail

Inner guard rail must be Class IV or better used rails as indicated in Part 2, Chapter 4, "Inspection Classification of Second Hand Rail for Welding", of AREMA Eng Man. Rail must be 36 kg/m 80 lbs/yd or greater. Ensure all rails used at any one inner guard rail location are the same weight and section. Ensure joint bars match the rail provided and are in good condition.

2.18.8 Gage Rods

2.18.8.1 New Gage Rods

Provide new, double-clamp style gage rods manufactured in conformance with "Specifications for Special Trackwork" of AREMA Eng Man. Provide double clamp style gage rods that are threaded on both ends and equip with four malleable steel casting clamps to rigidly hold both sides of the base of both rails.

2.18.8.2 Used Gage Rods

Do not furnish used gage rods. Used gage rods [will be provided by the Government] [must be salvaged from existing track]. Clean and inspect salvaged gage rods prior to reinstallation. Scrap bent or broken gage rods.

2.18.9 Derails

****

NOTE: Derails may be either a hinged type, a sliding type, or a switch point derail. The contract drawings should indicate the required location, type, size, and direction. Sliding type derails are typically installed with a derail stand and operating mechanism for throwing the derail. A split switch derail is to be installed where absolute protection is required. If a switch point derail is to be installed, the project plans will show the layout of the switch point derail and this paragraph will be modified accordingly.

****

2.18.9.1 New Derails

Provide new derails of a standard design that has been in use by the commercial railroad industry for at least 5 years. Provide derails consisting of all-steel construction and designed to be permanently spiked to a crosstie. Provide either one-way or two-way derails as indicated. Provide either sliding type or hinged type derails as indicated. When the type of derail indicated requires a derail stand, connecting rod, and operating mechanism for proper operation, provide the derail and all necessary components as a unit. Provide locations, sizes, and directions of the derails as indicated on the contract drawings.

2.18.9.2 Used Derails

Do not furnish used derails. Used derails [will be provided by the Government] [must be salvaged from existing tracks that are removed or rebuilt under this Contract]. Use new track spikes and other fastening materials to install or reinstall the used derails. Furnish new fastening materials conforming to the applicable sections of this specification and AREMA Eng Man.

2.19 SALVAGED MATERIALS

2.19.1 Dunnage

Pallets, sills, and other material used for packaging and stacking salvaged track items must be clean, free of decay or other defect, and sufficiently sturdy for the service intended.

2.19.2 Marking Paint

Provide a good quality oil-based spray marking paint or a good quality oil-based paint marker.

2.19.3 Salvaging Rail

Salvage rail as directed; the Government will make available salvaged rail to the Contractor subject to the following:

a. Nondefective and reclaimable rails salvaged from existing tracks may be used to execute spot rail replacement work at other locations of the project, subject to review and approval of the materials by the Contracting Officer.

b. Reclaimable defective rails may be used to construct inner guard rails provided all defects can be cropped off. Make detailed inspection of such rails to ensure that rails which contain critical defects such as transverse defects, head-web separations, vertical split heads, pipe, split webs, etc., are not incorporated in the work. Inspect loose rails located along the right-of-way and use as directed.

2.19.4 Joint Bars

Nondefective joint bars salvaged from existing tracks may be used to execute spot replacement work at other locations of the project, subject to review and approval of the material by the Contracting Officer.

2.19.5 Tie Plates

Tie plates salvaged from existing tracks, which are not either broken, cracked, or severely corroded or worn, may be used to execute the work subject to review and approval of the material by the Contracting Officer.

2.20 RAIL BONDING AND GROUNDING

2.20.1 Rail Bonds

****

NOTES: Designer will select the length of web bonds based on the joint bar size; 600 mm 24 in. joint bars require 854 mm 34 in. bond wires, and 900 mm 36 in. joint bars require 1154 mm 46 in. bond wires.

Double bonding is required for crossing signals only (installation of both rail head and web bonds).

If only static electricity bonding/grounding

(without signals or lightning protection) is required, the size of cables may be reduced. If local experience indicates drive in tight connections performs satisfactorily, 12 mm drive in tight from American Steel drive socket terminal # 34100 type CPN or approved equal can be used.
****

Provide exothermic type ("Cadweld") bonds applied to the field side of the rail head[, or [1154] mm [46] inch bonds welded to the rail web]. The bond cables must be flexible bare copper stranded 1/0 AWG cables with preformed ends. Bond cables must be flexible bare copper stranded cables with preformed ends and must conform to applicable requirements of AREMA Eng Man Vol. 3.

2.20.2 Grounding Rods

Grounding rods must be [19 mm 3/4 in diameter copper clad steel rods] [25 mm 1 inch diameter zinc-coated steel rods]. The minimum length of ground rods must be 2.5 m 8 ft.

2.20.3 Ground Connection Cables

Make connections between the grounding system or ground rods and rails with a bare flexible copper stranded 2/0 AWG cable.

2.20.4 Electrical Connecting Hardware

Provide electrical connecting hardware consisting of bronze pressure bar type materials having no rotating parts coming in direct contact with conductors.

2.21 WELDING

2.21.1 Rail Welding Kits

Ensure kits for thermite type rail welds are approved by the Contracting Officer before use. Provide welding kits for all rail sections used and no differentiation will be made between Contractor-furnished and Government-furnished rail sections for measurement and payment purposes.

2.21.2 Electrodes

Provide AWS low-hydrogen, high tensile 140-16 (extrapolation) or 25-20 electrode, Grade 310-16 and 310-15 stainless steel rod welding electrodes. Provide electrodes of the smallest practical diameter worked at the lowest compatible current. Ensure coating on low-hydrogen type electrodes is thoroughly dry when the electrode is provided. Use electrodes taken from hermetically sealed packages within one hour of the time the package is opened. Dry electrodes not used within this one-hour period and electrodes taken from non-hermetically sealed packages for at least one hour between 371 and 427 degrees C 700 and 800 degrees F. Electrodes so dried may be stored at temperatures between 107 and 205 degrees C 225 and 400 degrees F until used, or, if not stored and not used within one hour after this drying is completed, re-dry before use. Do not use electrodes which have been wet.

PART 3 EXECUTION

3.1 REMOVAL, SALVAGE, AND DISPOSITION OF MATERIALS

****

NOTE: Delete paragraphs which are not applicable to the salvaged materials.

****

Do not dismantle tracks and segments of track until approved to do so by the Contracting Officer. Salvage the following materials for later use by the Government. Some of these items will be used in the repair of tracks as indicated.

3.1.1 Materials To Be Salvaged

****

NOTE: Provide list of materials to be salvaged. For example: "All 90RA Rail, All 90RA Joint Bars".

****

Materials to be salvaged for later use by the Government are:

a. [_____].

b. [_____].

Other materials are the property of the Contractor and remove from the project.

3.1.2 Methods and Procedures

The Contractor may use any methods to dismantle the track, provided proper measures are taken to ensure the safety of the laborers and the general public, and no damage is caused to track components to be salvaged or other tracks and structures which are indicated to remain. Do not cause damage to adjacent sidewalks or paved roadways during removal of existing tracks. Restore damage to these facilities caused by the Contractor at Contractor's expense.

3.1.3 Inventory of Track Materials

Keep a detailed inventory of excess and salvaged track materials stockpiled for the Government. Record detailed inventory in appropriate format and furnish to the Contracting Officer.

3.1.4 Inspection and Reconditioning of Used Track Materials

Clean and inspect salvaged track materials for defects to determine their suitability for further use.

3.1.4.1 Cleaning By Hand or Mechanical Means

Clean rail, joint bars, gage rods, tie plates, rail anchors, and other materials by hand or mechanical means to remove all adhering dirt and heavy rusting so that the bare steel can be examined.

3.1.4.2 Visual Examination of Rails

Visually examine rails for evidence of defects such as those illustrated on Form 402-A found in Chapter 4 Part 3 of AREMA Eng Man. Bring such defects to the attention of the Contracting Officer who will be the final judge as to the serviceability of the rail. Mark rails having bolt hole cracks or end batter under paragraph TRACK REPAIR that can be reconditioned for use by cropping and redrilling at the location of the defect with yellow paint. Reject rails with other defects or which cannot be reconditioned scrap and mark with bright red paint and stack separately.

3.1.4.3 Visual Examination of Joint Bars

Existing joint bars and compromise joint bars which are removed and no longer required at that location due to rail replacement or other work may be cleaned and reused at other locations, subject to review and approval of the Contracting Officer. Salvage or scrap joint bars and compromise joints that are not reused. Visually examine joint bars for defects and wear. Scrap joint bars with bolt hole or spike slot cracks. Scrap barr which do not fit tightly against the rail or bars in which the bolt holes are excessively corroded or worn. The Contracting Officer will be the final judge of the serviceability of joint bars. Mark scrapped bars with bright red paint and stack separately.

3.1.4.4 Visual Examination of Gage Rods

Visually examine gage rods for bends, cracks, or breaks. Bent, cracked, or broken gage rods are considered as scrap, marked with bright red paint and stacked separately.

3.1.4.5 Visual Examination of Tie Plates and Rail Anchors

Visually examine tie plates and rail anchors for cracks, breaks, excessive wear, and excessive corrosion. Track material with these defects are considered scrap, mark with bright red paint and stack separately.

3.1.4.6 Gage Rods

Remove and salvage gage rods which exist in tangent track and in curved track with a curvature of 10 degrees or less. Reuse salvaged gage rods that have been inspected and cleaned to the maximum extent possible.

3.1.4.7 Grade Crossing Materials

Salvage existing premanufactured grade crossing panels, rail and other track materials as indicated, or as designated by the Contracting Officer. All salvaged materials will remain the property of the Government, and reinstall as indicated or transport to the military installation storage yard. Remove grade crossing materials to be salvaged, clean as required for proper reinstallation, mark or label as necessary for proper reinstallation, and transport to the reinstallation location or to the storage yard.

3.1.5 Transport and Stack Excess and Salvaged Materials

3.1.5.1 Material Not Used In Track Repair

Stack excess and salvaged materials which are not used in track repair work at a site on the military installation designated by the Contracting

Officer.

3.1.5.2 Stacking of Rails

Stack rails on approved sills a minimum of 152 mm 6 inch above the ground. Stack rails with the heads up and with the ends even. Separate each layer by at least three 50 by 100 mm 2 by 4 inch wood strips evenly spaced along the length of the rail. Group rails by weight, section, drilling, condition, length, and amount of wear. Mark the weight, section, drilling, and length on one of the rails near the mid-height of the stack. Paint these markings neatly near one end of the rail.

3.1.5.3 Stacking of Joint Bars, Gage Rods, and Tie Plates

Sort joint bars, gage rods, and tie plates by section, punching and condition and stack on pallets. Steel band each pallet stack for forklift handling. The maximum weight on any pallet is 680 kg 1,500 lbs. Wire compromise joint bars together in pairs and stack on pallets, separate from other bars.

3.1.5.4 Containers

Sort rail anchors by type and size and place in kegs, steel drums, or other approved containers. Label containers with the rail weight and section.

3.1.5.5 Stacking of Special Trackwork Materials

Palletize and stack special trackwork materials as directed by the Contracting Officer. Mark the rail weight, rail section, and length on each switch point. Mark the weight, section, and frog number on the side of each frog casting. Place other salvaged switch materials in steel drums and label as to rail weight, section, length of points, and turnout size.

3.1.6 Material to be Scrapped

****

NOTE: Remove or edit above paragraphs and retain this paragraph when materials are to be scrapped.

****

[All material] [_____] must be scrapped and must become the property of the Contractor.

3.2 PLACEMENT OF BALLAST [AND SUBBALLAST]

Place ballast [and subballast] to the lines and grades indicated. The average thickness must be within 6 mm 0.25 inch of the thickness indicated. Subgrade must conform to the requirements of Section 31 00 00 EARTHWORK. Do not place ballast [and subballast] on soft, muddy, or frozen areas. Where the prepared subgrade (roadbed) is soft, muddy, rutted, exhibits severe depressions, or is otherwise damaged, do not place the ballast [and subballast] until the damaged subgrade has been repaired and the area has been approved by the Contracting Officer.

3.2.1 Subballast

****

NOTE: Remove these paragraphs when subballast is not required.

****

3.2.1.1 Subballast Placement

Place subballast in [two] uniform horizontal lifts of no more than 152 mm 6 inch for the full width of the cross-section to the total depth indicated. Shape each subballast layer to a section conforming to the subballast section shown on the drawings and thoroughly compact.

3.2.1.2 Subballast Compaction

Compact each subballast lift using approved compaction equipment. Use sufficient roller weights, vibration frequencies (where applicable), tire pressures (where applicable), and number of passes to obtain in-place densities across the full width of the subballast and throughout the entire depth of the layer of no less than 95 percent of the ASTM D1557 laboratory maximum dry density for the subballast material. Prior to placement of subsequent subballast layers, scarify the top of the previous layer to a depth of approximately 50 mm 2 inch to insure proper bond of the layers. Field measure density in accordance with ASTM D1556/D1556M(use base plate as shown in the drawing) [or ASTM D6938. Check and adjust the calibration curves, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D6938 result in a wet unit weight of soil and use ASTM D6938 to determine the moisture content of the soil. Also check the calibration curves furnished with the moisture gages along with density calibration checks as described in ASTM D6938. Make calibration checks of both the density and moisture gages by the prepared containers of material method, as described in paragraph Calibration, in ASTM D6938, on each different type of material to be tested at the beginning of a job and at intervals as directed.] Take one field density test for each 1000 square meters yards of each layer of material placed in each area.

3.2.2 Ballast

3.2.2.1 Ballast Placement

****

NOTE: Show detail of ballast section on the drawings.

****

Place Number 5 AREMA ballast in the tracks where indicated; use 50 mm 2 inch of Number 5 ballast near turnouts and for 10 m 30 feet each side of the switch stand to provide a smooth walking surface for railroad employees. All other areas require size AREMA Number [4] [4A] ballast.

3.2.2.2 Ballast Distribution

****

NOTE: For projects where large amounts of track are being ballasted, ballast distribution from railcars is beneficial. The provision of a Government locomotive and crew to move ballast cars for the Contractor may result in a lower unit cost for ballast distribution. If the installation has a locomotive available for use, insert the point of contact and telephone number for arranging use of the locomotive. Examples would be "... Rail

Movements Branch, Directorate of Logistics, extension 1234 at least 4 hours ..." If no locomotive is available indicate that Government locomotive is not available and the Contractor must provide equipment to unload ballast in paragraph LOCOMOTIVE.

****

Do not disturb ballast until the [subgrade] [subballast] has been approved by the Contracting Officer. No payment will be made for ballast which is distributed without the Contracting Officer's approval.

a. Distribute ballast distribution to the depth indicated, from either trucks or railroad cars. [If available, the Government will furnish a locomotive for unloading ballast along the track if a carload or more is used. Make arrangements for use of the locomotive by contacting [_____] at least [_____] hours in advance of the time the locomotive is needed.] [A government locomotive is not available for unloading ballast.]

b. Prevent forming of ruts that would impair proper roadway drainage when distributing ballast from trucks and off track equipment. Level any ruts formed greater than 25 mm 1 inch and grade to drain.

c. Unload ballast as close as possible to the point of use so that unnecessary handling is prevented. Pick up and redistribute excess ballast at the Contractor's expense. If additional ballast is required for dressing, add it at no increase in unit price.

d. Do not release ballast cars until they have been inspected. Ballast cars may be weighed by the Government before and after dumping the ballast at no cost to the Contractor.

3.2.2.3   Ballast Below Ties

For new construction, the last 100 mm 4 inches ballast below the tie, place the shoulder ballast and the ballast in the tie cribs subsequent to the rail and tie installation. For surfacing existing track, place the ballast subsequent to rail and tie replacements.

3.3   TRACK CONSTRUCTION AND OUT-OF-FACE RELAY

Ensure track construction not covered specifically herein is in accordance with AREMA recommendations and recommended practices.

3.3.1   Roadbed Preparation

****

NOTE: If the roadbed will require any major amount of preparation, such as compaction or provisions for drainage not covered by other sections of the specifications, this paragraph will be either revised or augmented to cover the work required, or Section 31 00 00 EARTHWORK will be added. If no roadbed preparation is required, delete this paragraph. If geotextiles are used, the "road crossing" tailoring option should be on to get the reference paragraph requirements for geotextiles.

****

Perform clearing and grubbing, grading, excavation, embankment preparation, and subgrade preparation in accordance with Section [_____]. Obtain approval of roadbed surface, grade, and drainage prior to any distribution of construction material. Where the subgrade or roadbed is damaged during distribution of materials, fill and compact ruts and depressions and ensure the roadbed surface is reapproved prior to track construction.

3.3.2 Geotextile for Track Construction

****

NOTE: Delete this paragraph if geotextile is not required.

****

Install geotextile between the subgrade and the ballast as shown. Perform installation in accordance with subparagraph Geotextile Installation under paragraph Highway Crossings.

3.3.3 Unloading the Materials

The use of picks in the handling of ties will not be permitted. Unload rails from cars with an approved derrick or crane and place with the head up without dropping and with sufficient support under the base. Distribute rails of proper length as necessary for road crossings, switches, joint spacing, and other special conditions.

3.3.4 Ties

****

NOTE: The center to center spacing will be inserted in the blank space in this paragraph in accordance with the following:

a. For main lines, access tracks, or other tracks where the movement may be classified as heavy or the desired speed is in excess of 32 km/hr 20 miles per hour, 480 to 560 mm 19.5 in. spacing will be used.

b. For body tracks in yards, sidings, running tracks, and access tracks, where the train speed is less than 32 km/hr 20 miles per hour and train movement is not classified as heavy, a 530 mm 21 in. spacing will be used.

****

Standard center-to-center spacing of crossties is [50][53] mm [19.5][21] inch. Space switch ties and bridge ties as indicated on the drawings. Lay ties perpendicular to the center line of the track with the grain up (heartwood side down) for wood ties. Use the best ties at the rail joints. Ensure the ends of ties on one side of the track are parallel to the rail and the center of the tie is on the approximate center line of the track. Align the ends on the inside of curves and continue on that side until reaching a curve in the opposite direction. On double tracks, align the ties on the outside ends. The top surface of ties must provide full bearing for the tie plates. Adzing of wood ties is restricted to that necessary to provide a sound true bearing for the tie plate. Adzing in excess of 5 mm 0.2 inch is not permitted. Where adzing is necessary, saturate the cut surface of the wood tie completely with creosote or other approved preservatives.

3.3.5 Tie Plates

****

NOTE: For track rehabilitation where the track does not currently have tie plates, plates should be installed on each new tie installed. As defective ties are replaced, tie plates are installed with the new ties and with time the entire track has plates.

****

Tracks must be fully tie-plated. Ensure tie plates are free of dirt and other foreign material when installed. Place tie plates so that the rails will have full bearing on the plate, and the plate will have full bearing on the tie. Set tie plates at right angles to the rail with the outside shoulder against the base of the rail, and centered on the tie. Install canted tie plates to cant the rail inward.

3.3.6 Rail

Ensure the base of the rail and the surface of the tie and tie plate are free of dirt and other foreign materials prior to laying rail.

3.3.6.1 Laying Rail

Lay rail without bumping or striking, to standard gage (1.435 m 4 ft 8-1/2 inch between points 16 mm 5/8 inch below the top of the rail) on tangents and on curves up to 12 degrees. For curves 12 degrees and greater, widen the gage 3.2 mm 1/8 in for each increment of 2 degrees to a maximum of 1.448 m 4 ft 9 inch, in accordance with TABLE V. Gage the track at every third tie as spikes are being driven.

TABLE V. TRACK GAGE FOR HIGH DEGREE OF CURVATURE

Degree of Curvature per 30.5 m 100-ft chord		
Equal to or Greater Than (Deg - Min)	But Less Than (Deg - Min)	Track Gage, m Ft. - In.
0 - 00	12 - 00	1.435 4 - 8-1/2
12 - 01	14 - 00	1.438 4 - 8-5/8
14 - 01	16 - 00	1.441 4 - 8-3/4
16 - 01	18 - 00	1.445 4 - 8-7/8
18 - 01	20 - 00	1.448 4 - 9

a. Lay jointed rails, one at a time, with space allowance for expansion being provided between rail ends in accordance with TABLE VI.

b. Gaps between rail ends in insulated joints must only be sufficient to permit insertion of standard end posts.

c. Use a standard rail thermometer to determine the rail temperature. Lay the thermometer close to the web on the side of the rail base which is shaded from the sun's rays in advance of the laying operation and leave there long enough to accurately record the temperature. The Contractor quality control representative must see that rail temperature is checked frequently and that proper rail expansion shims are used. Calibrate all thermometers against the Contracting Officer's rail thermometer which will have been accurately calibrated and will be considered as the standard.

d. Except through turnouts and at insulated joints, do not vary the staggering of the joints on one side no more than [460] [500] mm [18] [20] inch in either direction from the center of the opposite rail.

e. Do not use rails less than 10 m 33 ft in length in out-of-face rail relay. However, rails no less than 4 m 13 ft long may be used for final connections to existing rails to prevent joints from occurring at prohibited locations or to provide the specified joint stagger in curves.

f. Rail joints must not occur in or within 6 m 20 ft of a road crossing, alongside of or within 1.5 m 5 ft of the end of any switch or turnout guard rail, or the end of any open deck bridge.

3.3.6.2 Joints

Stagger joints in opposite rails one-half the rail length but no less than 3.5 m 12 ft apart, except closer joints may be required at turnouts and insulated joints. Do not install rail less than 4 m 13 ft in length in track. Ensure no joint is less than 2 m 6 ft from the ends of open-deck bridges, or less than 1 m 3 ft from switch points. Do not install joint within 6 m 20 ft of a road crossing, outer perimeter of any structure, or any location which restricts access to the joint. Where joints are required in these areas, weld the joints.

3.3.6.3 Expansion Allowance

Provide allowance for expansion at rail joints by using rail-expansion metal shims. Remove shims to within 12 rails of the laying. Provide shims of the thickness shown in TABLE VI. Determine the temperature of the rail by use of a thermometer placed on the rail base on the side away from the sun. Typical rail gap gages are as shown.

TABLE VI. SHIM THICKNESS

10.1 m 33-Ft. Rail 99 Joints per km160 Joints per Mile		11.9 m 39-Ft. Rail 84 Joints per km135 Joints per Mile		24.4 m 78-Ft. Rail 42 Joints per km68 Joints per Mile	
Rail Temperature (degrees C F)	Shim Thickness (mm) (in.)	Rail Temperature (degrees C F)	Shim Thickness (mm) (in.)	Rail Temperature (degrees C F)	Shim Thickness (mm) (in.)
Below -23 -10	85/16	Below -14 6	85/16	Below 2 35	85/16
-23 to -10 -10 to 14	61/4	-14 to -46 to 25	61/4	2 to 835 to 47	61/4
-9 to 115 to 34	53/16	-3 to 726 to 45	53/16	9 to 1648 to 60	53/16

TABLE VI. SHIM THICKNESS

10.1 m 33-Ft. Rail 99 Joints per km160 Joints per Mile		11.9 m 39-Ft. Rail 84 Joints per km135 Joints per Mile		24.4 m 78-Ft. Rail 42 Joints per km68 Joints per Mile	
Rail Temperature (degrees C F)	Shim Thickness (mm) (in.)	Rail Temperature (degrees C F)	Shim Thickness (mm) (in.)	Rail Temperature (degrees C F)	Shim Thickness (mm) (in.)
2 to 1535 to 59	31/8	8 to 1846 to 65	31/8	17 to 2361 to 73	31/8
Over 16 60	21/16	Over 19 66	21/16	Over 24 74	21/16

3.3.6.4 Cutting Rail

Use only rail saws or track chisels to cut rail. Drill new holes using a standard template. Do not burn holes in rail. Holes cut with a torch will not be accepted. When drilling of rail is necessary, remove all chips and burrs before applying joints.

3.3.6.5 Matching Rails

****

NOTE: Remove this paragraph when relay rail is not used.

****

Where relay rail is used, matching adjacent rails must not cause lipped or uneven joints. Weld any mismatched rail ends to provide proper match. Rail end mismatch must not exceed 3 mm 1/8 in on gage or tread portions of rail.

3.3.6.6 Rail Replacement

The following procedures apply to rail replacement work:

a. Spot rail replacement is defined as replacement of 30 m 100 ft or less of contiguous rails, usually with rails of the same section. Installation of relief rail in place of defective rail is considered spot rail replacement. Replacement of more than 30 m 100 ft of contiguous rails is considered to be out-of-face rail relay.

b. If spikes are withdrawn, plug the holes with treated tie plugs of proper size to fit the hole, prior to replacement of rail. If spikes are withdrawn and spikes are to be redriven in existing spike holes, plug the holes with treated tie plugs prior to redriving the spike. Do not install tie plugs in prebored holes unless spikes have been driven and withdrawn.

c. Spike all ties with new spikes in accordance with paragraph Spot Tie Replacement.

d. Ensure that rail ends at joints are not lipped or uneven. Ensure tread portion (vertical) or gage side (horizontal) rail end mismatch is no greater than 2 mm 1/16 inch. Correct rail end mismatch greater than 2 mm 1/16 inch by welding and grinding on the smaller rail. Grinding the larger rail is not permitted unless approved by the Contracting Officer. Make welded transitions at a rate of 1 to 80.

e. Rails removed from track will be designated by the Contracting Officer as relay (for use on project), reclaimer (to be salvaged and stockpiled), or scrap. Joint bars removed from track will be designated as relay, reclaimer, or scrap. Mark scrap materials as scrap using bright red paint, transport them off the military installation or to the military installation temporary scrapyard. Transport relay materials required to complete other repair work of this contract to the location of need. Classify and inventory materials and stack at the military installation storage site, all as indicated for salvage materials in paragraph Removal, Salvage, and Disposition of Materials.

f. Use metal rail expansion shims when laying rail. Do not use wood sticks or other material as shims. Provide a sufficient supply of each shim available to permit rail laying to progress without delay.

3.3.6.7 Out-of-Face Rail Relay

Replace existing rail with the designated new or used rail between designated limits in a continuous operation. It is expected that replacement of one rail of a given track will be completed prior to replacement of the opposite rail. Lay used rail [with previous gage side wear facing out, unless required to match existing wear patterns] [as directed by the Contracting Officer].

3.3.6.8 Spot Rail Replacement

Make spot rail replacements where necessary to replace existing defective rails or to compensate for rail joint gap adjustments.

3.3.6.8.1 Replacement Rail

Use replacement rail of equal length or longer than the rail it replaces. The minimum length of rail used is 4 m 13 ft.

3.3.6.8.2 Spot Rail Replacement Resulting in Joint Staggers

Unless otherwise approved by the Contracting Officer on a case by case basis, do not allow spot rail replacement to result in joint staggers less than 1.33 m 4 ft.

3.3.7 Joint Bars

****

NOTE: The location of compromise joints will be shown on the drawings. Where compromise joints are required, the portion of this paragraph in brackets will be retained. If compromise joints are not required, the portion of this paragraph in brackets will be deleted.

AREMA Manual recommends an initial bolt tension of between 89,000 and 133,000 N 20,000 and 30,000 lbs per bolt in order to overcome the surface roughness and provide proper seating for the joint bars.

After application of traffic, tension in the bolt is lost relatively rapidly and may lose from 22,000 to 44,000 N 5,000 to 10,000 lbs per bolt in the first month. Therefore, retightening of all track bolts after some period of time is necessary. Bolt tension recommended for subsequent tightening is within the range of 67,000 to 111,000 N 15,000 to 25,000 lbs per bolt. The torque required to develop the specified tension in a bolt is approximately as follows:

BOLT DIAMETER	**TORQUE***
(mm)(inch)	**(N m)(ft-lbs)**
193/4	**340250**
227/8	**408300**
251	**476350**
291-1/8	**544400**
***For well oiled bolts with clean threads.**	

****

Provide clean joint bars. Install rail joints so that bars are not cocked between the base and head of the rail. Properly seat bars in the rail and install the full number of correct-size bolts, nuts, and spring washers. Place bolts with nuts alternately on inside and outside of rail. Apply a corrosion resistant lubricant to the bolt threads prior to application of nuts. Tighten bolts to torque of approximately [_____] N-m ft-lbs, beginning at the center of the joint and working both ways to the ends of the joint. After the track has been in service [, but before acceptance of the work,] check all bolts and retighten to a torque of approximately [_____] N-mft-lbs. [Connect rail of different sections by properly fitting compromise joint bars. The mismatch for compromise joints for either tread surface or on the gage side must not exceed 3 mm 1/8 inch]. Replace defective joint bars designated on the contract drawings, discovered by the Contractor during track repair operations, or as identified by the Contracting Officer with acceptable joint bars.

3.3.8 Spiking

3.3.8.1 Spiking Procedures

Spike rail promptly after being laid. Start and drive spikes vertically and square with the rail. Pre-drill engineered polymer composite ties accordance with manufacturer's recommendations for size and depth. Drive spikes to allow approximately 3 to 5 mm 1/8 to 3/16 inch space between the underside of the spike and the top of the rail base. Do not overdrive spikes, or straighten while being driven. Do not install spikes through the slots in skirted-type, slotted joint bars (angle bars). Do not drive spikes against the ends of joint bars.

3.3.8.2 Number of Spikes

Use four rail-holding spikes on each tie on tangents and curves less than 4 degrees. Place spikes on the gage side of the running rail directly across from each other and place the spikes on the field side of the running rail directly across from each other. Offset spikes on the gage side longitudinally from the field spike and ensure all four spikes are rail-holding spikes next to the base of the rail. Hold this pattern consistent. On curves 4 degrees or greater, but no more than 36 degrees, use six spikes on each tie with the spikes located as follows: One rail-holding spike on the field side and two rail-holding spikes on the gage side for both rails. [Spike curves 36 degrees and greater with eight spikes per tie, located as follows: One rail-holding spike and one plate-holding spike on the field side and two rail-holding spikes on the gage side for both rails.] Use eight rail-holding spikes on each tie through road crossings.

3.3.9 Tie Plugs

If spikes are withdrawn from wood ties, swab the holes with creosote and plug with creosoted tie plugs of proper size to fit the hole. If spikes are withdrawn and spikes are to be reinserted in existing spike holes, swab the holes with creosote and plug with creosoted tie plugs prior to redriving the spike. Do not install tie plugs in prebored holes unless spikes have been driven and withdrawn.

3.3.10 Rail Anchor Placement

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NOTE: Coordinate this paragraph with paragraph Rail Anchors in PART 2.

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Locate rail anchors as indicated on the project plans. Where the use of rail anchors is indicated, apply a minimum of [_____] anchors per 11.9 m 39 ft of rail in the pattern indicated on the project drawings. Space the rail anchors approximately uniformly along the rail length. Install rail anchors to the gage side of the rail against the same tie face on opposite rails. Ensure rail anchors grip the base of the rail firmly and have full bearing against the face of the tie. Do not move rail anchors by driving them along the rail. Do not apply rail anchors to track on an open-deck bridge. Where anchors are used on track approaching an open deck bridge, box anchor every third tie for at least four rail lengths, off each end of the bridge. Anchor rail immediately after spiking and before rail has experienced a large temperature change.

3.3.11 Inner Guard Rails

Install guard rails on bridges and trestles as indicated. Ensure guard rails are approximately 280 mm 11 inch from the gage side of track rails and extend a minimum of 15 m 50 ft beyond the structure. Curve the ends inward and beveled. Fully bolt guard rails. Ensure guard rails are not higher than the running rail and no be more than 25 mm 1 inch lower than the running rail. Spike each guard rail with two spikes to each tie but do not tie-plate. Unfit track rail in short lengths may be used for guardrails.

3.3.12 Derails

Install derails properly where indicated. Do not allow derailed equipment to foul other tracks. Install in accordance with the manufacturer's instructions. Where no specific installation instructions are available for salvaged derails, reinstall in accordance with good track construction practice to ensure proper performance of their intended function.

3.3.13 Superelevation

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NOTE: Superelevation on military railroad track should not exceed 100 mm 4 inches. Superelevation for each curve will be shown on the drawings.

****

Superelevate curves as shown on the drawings unless otherwise directed by the Contracting Officer. Obtain superelevation by raising the outside rail of the curve. Maintain inside rail at grade. The maximum superelevation will be [_____] mm inch. Carry full superelevation throughout each curve, unless otherwise directed or shown on the drawings. Ensure superelevation runoff is at a uniform rate, and extends at least the full length of the spirals. The normal rate of superelevation runoff will be 13 mm per 9.4 m 1/2 inch per 31 ft; however, this may be increased to 25 mm in 9.4 m 1 inch in 31 ft with the prior approval of the Contracting Officer.

3.3.14 Preliminary Surfacing

The preliminary alignment and surfacing gangs must follow the unloading of the ballast. Complete rail renewal, tie renewal, bolt tightening, and ballast placement prior to commencement of surfacing and alignment work.

3.3.14.1 Lifts

a. Bring the track, after being aligned, to grade and surface in lifts not exceeding 100 mm 4 in each. After each lift, tamp the ballast. When using jacks, place them close enough together to prevent undue bending of rail or stress of rail and joint. Raise both rails at one time and as uniformly as possible, except where superelevation is required. Lift the track so that after a period of no less that 5 train operations (70 metric ton ton ballast car) after the last lift, it will be necessary to give the track a final lift of between 25 and 50 mm 1 and 2 inch to bring it to grade.

b. In areas where major track resurfacing is not required, perform a "skin lift" tamping operation to ensure that the ties are adequately tamped, the ballast section is adequately compacted and dressed, and to correct minor deficiencies in surface and alignment. The rise in skin lift areas is 25 mm 1 in or less and usually does not require that additional ballast be placed.

c. A 50 mm2 inch rise must provide an average 50 mm2 inch raise in the track being surfaced.

d. A 100 mm 4 in rise must provide an average 100 mm4 inch raise in the track being surfaced, and make in at least two lifts not to exceed 50 mm 2 inches per lift.

e. A 150 mm 6 inch raise must provide an average 150 mm 6 inch raise in the track being surfaced, and make in at least 2 lifts. The initial lift must not exceed 100 mm 4 inch with the final lift not to exceed 70 mm 2-1/2 inch.

3.3.14.2 Tamping

Perform raising and tamping of track with an automatic, vibratory, squeeze type power tamper with 16 tamping heads, capable of raising both rails simultaneously and maintaining cross-level. The equipment to be used for surfacing operations is subject to approval by the Contracting Officer. Every tie in the track must receive two or more full insertions of the tamping heads. Power-tamp ballast under both sides of ties from each end to a point [300 mm 12 inches inside each rail for 2.4 m 8-ft ties,] [380 mm 15 inches inside each rail for 2.6 m 8 feet-6 inch ties,] [and] [460 mm 18 inches inside each rail for 2.7 m 9 ft ties]. Fill the center with ballast, but tamping will not be permitted in the center of the tie between the above stated limits. Tamp both ends of the ties simultaneously and tamp inside and outside of the rail at the same time. Do not use tamping tools with more than 35 percent wear and work opposite each other on the same tie. Tamp ballast under switch ties and road crossing ties the entire length of each tie. Tamp all ties to provide solid bearing against the base of the rail after the track or turnout is raised to grade at final surfacing. Bring all down ties up to the base of rail and machine tamp. Ensure the resultant track surface and alignment is uniform and smooth. Tamping of track in snow or frozen ballast conditions will not be permitted.

3.3.14.3 Replacement of Ties

After tamping has been completed and the jacks removed, replace all ties pulled loose to their proper position, respike and retamp to provide full bearing against the rail.

3.3.14.4 Track Off The Ends of Open Deck Bridges

Track off the ends of open deck bridges must maintain the same grade as the track on the bridge for a minimum of 8 m 25 ft beyond the bridge abutment and then transition smoothly to meet established track grades.

3.3.14.5 Runoff of Track Raises

Do not allow the runoff at the end of a rise to exceed 13 mm in 9.4 m 0.5 inches in 31 ft of track unless otherwise approved by the Contracting Officer.

3.3.14.6 Horizontal Realignment

Establish horizontal realignment of curved track using manual or mechanical means as described in the AREMA Eng Man Chapter 5, Part 3 Section 3.2, "String Lining of Curves by the Chord Method".

3.3.15 Final Surfacing

After preliminary surfacing has been completed, check grade and line stakes and bring the track to grade and alignment.

3.3.15.1 Final Tamping

Bring track to grade and retamp the ballast in the manner described for preliminary surfacing, except decrease the tamping distance inside the rail from 300 to 250 mm for 2.4 m ties, 380 to 330 mm for 2.6 ties, and 460 to 410 mm for 2.7 12 to 10 inch for 8 ft. ties, 15 to 13 inch for 8 ft 6 inch ties, and 18 to 16 inch for 9 ft ties.

3.3.15.2 Final Alignment

Give the track a final aligning conforming to the established track centers.

3.3.15.3 Final Dressing

After the final alignment, dress the ballast to the section indicated. After final dressing, do not allow ballast to cover the tops of the ties. Leave the portion of the subgrade outside the ballast line ith a full, even surface and properly dress the shoulder of the subgrade to the indicated section to provide proper drainage away from the track.

3.3.15.4 Surplus Ballast

Distribute surplus ballast remaining after final surfacing and dressing of the ballast section or otherwise dispose of as directed by the Contracting Officer.

3.3.16 Cleanup

Upon completion of the work, [remove all rubbish, waste, and discarded materials generated by the work from the project area] [dispose of rubbish, waste, and discarded materials in an approved manner as directed by the Contracting Officer]. Leave areas where the Contractor has worked, including but not limited to, project areas, material storage sites, and borrow or disposal areas in a clean, well-graded, and well-drained condition.

3.3.16.1 Shoulder Removal and Reconstruction

Where track construction or rehabilitation operations result in deposition of materials along the track shoulders that would impede the free drainage of the geotextile and track structure, remove the material. Where [undercutting] [ploughing] operations leave fouled shoulder materials that impede free drainage of the geotextile and the track structure, remove the shoulder material, and reconstruct the ballast shoulders using the materials and dimensions as indicated. Areas where shoulder removal and reconstruction are required [are] [are not] indicated on the drawings.

3.3.16.2 Spoil Materials

Dispose spoil materials removed from the track [as indicated] [off site at the Contractor's expense]. Do not place spoil materials on the shoulders, in ditches, in drains, or in other areas where they would impede the flow of water away from the track.

3.3.17 Final Adjustments

Sixty calendar days after the track has been accepted and put into operation, perform, at no cost to the Government, necessary resurfacing adjustments to leave the track in alignment and on grade.

3.3.18 Tolerances for Finished Track

Completed track must meet the following tolerances. Repair track not meeting the tolerances specified below to meet these requirements, at no additional cost to the Government.

3.3.18.1 Gage

Track gage must be within plus 6 mm 1/4 inch or minus 3 mm 1/8 inch of standard gage.

3.3.18.2 Alignment

****

NOTE: The alignment and track surface tolerances for out-of-face surfacing of secondary track (less than 16 km/hour 10 MPH) may be doubled from the values given below if alignment is not critical. Horizontal alignment and profile drawings are recommended.

****

Measure alignment as the deviation of the mid-offset of a 18.9 m 62 ft line, with the ends of the line at points on the gage side of the line rail, 16 mm 5/8 inch below the top of the railhead. Either rail may be used as the line rail on tangent track; however, use the same rail for the entire length of the tangent. The outside rail in a curve is always the line rail. Alignment on tangents are not allowed to deviate from uniformity more than 13 mm 1/2 inch. Alignment on curves are not allowed to deviate from uniformity more than 10 mm 3/8 inch.

3.3.18.3 Track Surface

Track surface must meet the following requirements:

a. The runoff at the end of a raise must not exceed 13 mm 1/2 inch in any 9.4 m 31 ft of rail.

b. The deviation from design profile on either rail at the mid-ordinate of a 18.9 m 62 ft chord must not exceed 13 mm 1/2 in.

c. Deviation from design elevations on spirals must not exceed 13 mm 1/2 inch.

d. Deviation from zero cross level at any point on tangent or from designated superelevation on curves or spirals must not exceed 13 mm 1/2 in.

e. The difference in cross level between any two points less than 18.9 m 62 ft apart on tangents, and on curves between spirals must not exceed 13 mm 1/2 in.

3.3.18.4 Guard Face Gage

Guard face gage is the distance between the guard lines measured across the track at right angles to the gage line, and is measured at the point of frog on both sides of the turnout. The design value for guard face gage is 1340 mm 52-3/4 inch. Ensure guard face gage is within plus or minus 3 mm 1/8 inch of the design value.

3.3.18.5 Guard Check Gage

Guard check gage is the distance between the gage line of a frog and the guard line of its guard rail, or guarding face, measured across the track at right angles to the gage line. The design value for guard check gage is 1388 mm 54-5/8 inch. Ensure guard check gage is within plus or minus 3 mm 1/8 inch of the design value.

3.4 TURNOUTS AND TRACK CROSSINGS

Locate turnouts and crossovers as indicated on the drawings. Provide complete switch, frog and guardrail assemblies. Accurately bend rail. Changes in rail weight or section will not be permitted within the limits of the switch ties. Place headblocks at right angles to the main track and securely spike in place. Except where directed otherwise, install switch stands so that when the switch is set for the normal position, the connecting rod keeps the points closed with a pulling force. Adjust switches properly. Lubricate switch components and slide plates.

3.4.1 Turnout Reconstruction

****

NOTE: List the turnout identification numbers and/or other identifying information, such as location or milepost on the drawings. Indicate the appropriate work required on each turnout.

****

3.4.1.1 Install Salvaged Turnouts

Reconstruct turnouts using Government materials, except switch ties which are furnished and installed. This work includes transporting the turnout from the Government stockpile to the installation site and reconstruction of the turnout.

3.4.1.2 Salvage and Install Turnouts

Salvage (remove) and install turnouts. This work consists of removal of the turnout, transporting to the installation site all turnout materials except the switch ties, and reconstructing the turnout using new switch ties.

3.4.1.3 Turnout Removal and Salvaged or Scrapped

Salvage or scrap materials from turnouts that are removed from the track and that are not to be reinstalled as indicated on the drawings.

3.4.1.4 Trackbed

Prepare the trackbed by excavating and wasting existing ballast or subgrade materials and establishing a firm top of subgrade as indicated on the contract drawings.[Place subballast as indicated and compact.][Place geotextile to the limits indicated.]

3.4.1.5 Replacement Turnout

Construct the replacement turnout at the location indicated on the contract drawings. Locate replacement turnouts so that the point of frog remains at the same location as the original turnout point of frog. Use dimensions, details, and configuration of each turnout as indicated on AREMA Eng Man, Plans Nos. 910 and 911. Place switch ties as indicated on AREMA Eng Man, Plans Nos. 112 and 912, except substitute even meter foot increments in length of switch ties, at Contractor's option, for 150 mm 6 inch increments in length of switch ties. The end of a switch tie must not be within 355 mm 14 inch of a spike. Shift connecting tracks to their new alignments as shown on the contract drawings and connect all tracks to the replacement turnout. Place tracks within 30 mm 0.1 ft of design alignment prior to ballasting work.

3.4.1.6 Matching

****

NOTE: Allow at least 50 mm 2 in. of clearance between moving parts of the switch and the top of the ballast. One hundred mm Four inches is the minimum clearance in Northern climates, where snow and ice accumulation and heaving occur. Select the appropriate clearance for the project location.

****

Properly fit and match switch points/stock rails, rail joints, frog castings, and other parts of the turnout that must fit together. Match both rail ends at all rail joints throughout the turnout and at the joints at the frog matched on both the top (tread portion) and on the gage side of the rail. Rail end welding and grinding [are][are not] acceptable methods to achieve a good match.

3.4.1.7 Placing of Ballast

Place ballast as required and the bring turnout to proper grade in a minimum of three lifts. Do not exceed an initial lift of 100 mm 4 inch. Do not exceed a final lift of 50 mm 2 inch and bring all tracks into final alignment at that time. Ensure tamping, ballast dressing requirements, and alignment tolerances are as indicated in paragraph TRACK CONSTRUCTION AND OUT-OF-FACE RELAY. Ensure ballast level in cribs beneath the connecting rod, switch point rails, and switch rods are at least 100 mm 4 inch below any steel.

3.4.1.8 Existing Switch Stand

Install the existing switch stand, or a replacement stand if specified, and adjust the switch operating mechanisms so that the switch operates smoothly and without excessive force being required. Lubricate all switch plates and connection points in the switch rod with a switch lubricant, which does not allow sand or debris to adhere to the lubricant.

3.4.1.9 Rail Anchors

Box-anchor all switch ties to the extent possible. Anchor ties only when box-anchors can be applied to every rail on the tie.

3.4.2 Turnout Repair

****

NOTE: Designer will list the turnout identification numbers and/or other identifying information, such as location or milepost, along with the requirements in a schedule on the drawings.

****

Indicate turnouts which will remain in their existing location but require repairs in the "Schedule of Turnout Repairs" on the contract drawings and repaired as specified below.

3.4.2.1 Switch Ties

Remove and replace defective switch ties. Maintain existing nondefective switch ties in place. Install replacement switch ties at a uniform spacing, but no greater than 530 mm 21 inch center to center. The end of a switch tie must not be within 36 mm 14 inch of a spike. Do not interlace switch ties, where one tie penetrates the crib area of another tie.

3.4.2.2 Bolt Tightening

Tighten all bolts in all turnouts within the project area. Replace any bolt that cannot be tightened with a bolt assembly of the proper diameter and length.

3.4.2.3 Rebuild Switch Points and Protectors, Frogs, and Guard Rails

Reuild switchpoints, frogs, guard rails, or switch point protectors as specified in paragraph ELECTRIC ARC WELDING.

3.4.2.4 Regage Closure Rails

Regage track from heel of switch to the toe of frog. Perform regaging as specified in paragraph TRACK CONSTRUCTION AND OUT-OF-FACE RELAY.

3.5 HIGHWAY CROSSINGS

****

NOTE: Subdrains are recommended on all highway crossings. Drawings should show location of outfall pipe. Density requirements can be deleted if a separate specification section is provided for subgrade preparation.

****

Construct highway and other grade crossings within the project as indicated on the contract drawings.

3.5.1 Subgrade

[For new construction, blade the subgrade in the crossing area and for 6 m 20 ft beyond each end of the crossing to a level surface and compact to at least 90 percent CE55 maximum dry density for cohesive materials or 95 percent CE55 maximum dry density for cohesionless materials.][For track rehabilitation, excavate old contaminated ballast and subballast a minimum 300 mm 12 inch below the design elevation of the bottom of the tie, 300 mm 12 inch beyond the ends of the ties, and for at least 6 m 20 ft beyond each end of the crossing. Blade the subgrade to a level surface.] Clean drainage areas and slope away from the crossing in both directions along the track and the roadway. Install [surface ditches][subdrains] as indicated.

3.5.2 Geotextile Installation

****

NOTE: Coordinate these paragraphs with paragraph GEOTEXTILE. Delete these paragraphs if geotextile is not required.

The width of the geotextile should cover the entire width of the roadbed with no longitudinal seams or overlaps. Where mechanized geotextile laying equipment will be used to place the geotextile, the maximum diameter of the geotextile rolls should not exceed the capability of the equipment to be used on the project.

Prior to the placement of the cover material (ballast or subballast), the geotextile may be anchored in several ways, i.e., pins, small ballast piles, ballast bags, etc. If fixing of the geotextile is critical and adverse conditions exist, e.g., steep slopes or high winds, the specification can detail anchoring requirements, e.g., pin length and spacing. Care should be taken to prevent or quickly release any tension caused by anchoring and placement of the geotextile cover materials. Excessive tension can cause bridging of irregularities beneath the geotextile and increase the potential for puncture.

If there is reason to suspect movement which will reduce overlap, provision should be made in the specification to remove cover materials at selected areas in order to determine if required overlap is being maintained after cover placement.

****

Place geotextile between the subgrade and the ballast section in the crossing area and for 6 m 20 ft beyond each end of the crossing.

3.5.2.1 Preparation

Prepare surfaces on which geotextiles will be placed in accordance with the applicable portions of this specification, and ensure surfaces are free of irregularities such as sags, cavings, erosion, or vegetation. Correct any irregularities to ensure continuous, intimate contact of the geotextile with the whole surface. Remove any loose material or debris prior to geotextile placement.

3.5.2.2 Placement

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NOTE: Delete paragraph "b." if a protective sand layer is not specified.

****

a. When geotextile is to be installed in an existing track following removal of the ballast by undercutting or ploughing, take special care to remove as many of the large ballast particles that remain on the roadbed surface as possible.

b. Place a protective sand layer 50 mm 2 inch thick [or subballast] on top of the geotextile after it has been installed.

c. Carefully place the geotextile on the prepared surface with the long dimension parallel to the prepared surface. Place the geotextile free of wrinkles, folds, creases, and tension. Hold the geotextile in place by pins, small aggregate piles or ballast bags, until it is completely covered. Cover the geotextile immediately after placement in track. The maximum exposure time for the geotextile, from removal of the protective shipping cover to placement of the ballast/subballast cover materials which prevent exposure to sunlight, is 2 consecutive days.

d. The minimum overlap of geotextile splicing seams is 900 mm 36 inch. If several geotextile units are placed with the required overlap prior to the placement of the [ballast][subballast], check the overlap distance of each overlap as placement of [ballast][subballast] approaches the overlap. Ensure that the required overlap exists when the geotextile is covered.

e. The geotextile must remain free of any contamination such as mud, dust, sediment, debris, etc., that will impair its function. Remove contamination without damage to the geotextile or to the prepared surface at the Contractor's expense. If the geotextile is damaged, its function impaired by the cleaning efforts, or if it cannot be properly cleaned, repair the prepared surface, if necessary, and replace the damaged or impaired geotextile with geotextile meeting requirements of this specification. Do not operate equipment in direct contact with the geotextile. Direct surface drainage, as much as possible, away from the geotextile installation area to prevent accumulation of mud, debris, and sediment.

3.5.2.3 Placement of Cover Material

Place [ballast][subballast] cover material in contact with the geotextile ensuring intimate contact of the geotextile with the prepared surface and with the cover material. Perform placement without damage to the geotextile including tears, punctures, or abrasion.

3.5.2.4 Equipment Operations on the Cover Material

Place a minimum depth of 200 mm 8 inch of cover material over the geotextile before equipment is allowed to operate on the covered geotextile. Limit equipment operations on the covered geotextile to those necessary for track construction and equipment turning is not allowed on the covered geotextile.

3.5.2.5 Minimum Ballast Depth

The minimum depth of ballast between the bottom of the tie and the top of the geotextile is 300 mm 12 inch.

3.5.2.6 Tamping Operations

Tamp ballast materials by setting the tamping force and insertion depth to the minimum necessary to adequately tamp the track. Monitor the depth of tamping and limit the depth to prevent detrimental effects of the tamper feet on the geotextile.

3.5.2.7 Double Layers

Double layers of geotextile is not allowed, except for splicing overlaps at seams.

3.5.3 Ballast Placement and Surfacing

Place and tamp ballast as specified in paragraph TRACK CONSTRUCTION AND OUT-OF-FACE RELAY except that in crossings, compact the ballast between the ties thoroughly with a vibratory compactor, or other approved means, after each raise. Tamp the ballast for the entire length of the crossties for highway crossings. Perform final alignment and surfacing of the track prior to placement of the crossing surface. Perform final surfacing to bring the track to the final grade and alignment as indicated on the contract drawings. Where the crossing involves two or more tracks, the top of the rail for all tracks must form a plane with the adjacent roadway surface. The top of rail elevation must be 50 to 100 mm 2 to 4 inches above surrounding pavement elevation, with a smooth transition of pavement. Compact the ballast in the cribs and on the shoulders using a vibratory plate compactor or other approved means.

3.5.4 Ties

Use [hardwood][concrete][polymer composite] ties. Space a minimum of 500 mm 20 inches center to center. For premanufactured grade crossings, provide ties conforming to the manufacturer's recommendations for the type of grade crossing surface materials being used.

3.5.5 Tie Plates, Spikes, and Anchors

Fully tie plate all ties within the crossing and for 6 m 20 ft beyond each end of the crossing, and spike with 4 rail-holding spikes per tie plate. [Fully box anchor each tie within the crossing.] [Install rubber tie pads between the tie and tie plate on all ties within the crossing area and for 6 m 20 ft beyond each end of the crossing.]

3.5.6 Rail

Rail within the crossing area and for 6 m 20 ft beyond each end of the crossing must be, at a minimum, [57][_____] kg/m [115][_____] lbs/yd. [Protect] [Do not protect] rail from corrosion by application of an approved rust inhibitor. Bolted joints are not permitted in any Type 2, Type 3, Type 4, or Type 5 crossing or within 6 m 20 ft of either edge of the crossing surface. Bolted joints will be eliminated by either field welding the joints to form continuous rail throughout this area or by using 24.4 m 78 ft rail lengths.

3.5.7 Lining and Surfacing

Spike rail to line and mechanically tamp and surface the track to the grade and alignment of the existing track and roadway. Where the crossing involves two or more tracks, bring the top of rails for all tracks to the same plane.

3.5.8 Crossing Surface

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NOTE: Provide Typical Railroad Crossing cross section and details on the drawings.

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Ensure the surface of the highway is [in the same plane as][no greater than 6 mm 1/4 inch higher than] the top of the rails for a distance of 600 mm 2 ft outside of the rails for either single or multiple-track crossings. Make a smooth transition between the crossing surface and the adjoining pavement.

3.5.8.1 Type 1 Aggregate Crossings

Construct Type 1 crossings by placing the aggregate material between the rails and outside of the rails to form an approach ramp as indicated in the contract drawings.

3.5.8.2 Type 1A Aggregate with Timber Flangeway Guards Crossings

Install bond timber headers with the edge of the timber solid against the edges of the tie plates prior to placement of the aggregate. Fasten headers to the ties as indicated using the appropriate size and length fasteners. After installation of the bond timber, place the aggregate in the track and on the outside approaches and compact.

3.5.8.3 Type 2 Timber Plank Crossings

Install Type 2 crossings as shown or in accordance with the manufacturer's instructions for prefabricated timber crossing units. Allow the surface of the crossing timbers to form a smooth plane with the top of the rails and the adjacent roadway surface. Attach crossing timbers to the ties as indicated in the contract drawings using the appropriate size and length fasteners, unless otherwise specified by the manufacturer's instructions.

3.5.8.4 Type 3a Asphalt Crossings

Type 3a crossings are full-depth asphalt crossings as shown in the contract drawings. Place the asphalt in lifts not to exceed 50 mm 2 inch thick and compact with approved compaction equipment. General requirements for asphalt placement are specified in [_____] State Highway Specifications.

3.5.8.5 Type 3b Asphalt With Timber Flangeway Header Crossings

Type 3b crossings are full-depth asphalt crossings as shown in the contract drawings. Place the asphalt in lifts not to exceed 50 mm 2 inch thick and compact with approved compaction equipment. General requirements for asphalt placement are specified in [_____] State Highway Specifications. Install flangeway timbers prior to the placement of the asphalt pavement. Install timbers with the dappled edge of the timber solid against the ends of the tie plates. Fasten flangeway timbers to the ties as indicated in the contract drawings using the appropriate size and length fasteners.

3.5.8.6 Type 4a Cast-in-place Concrete Crossings

Construct Type 4 crossings as shown in the contract drawings using the materials specified herein. Provide concrete forming, reinforcement, and placement conforming to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5.8.7 Type 4b Prefabricated Concrete Panel Crossings

Install Type 4A crossings and crossing materials in accordance with the crossing manufacturer's instructions. Use tie spacings and track materials in the crossing in accordance with the installation instructions and manufacturer's recommendations.

3.5.8.8 Type 5 Full Depth Rubber Crossings

Install Type 5 crossings and crossing materials in accordance with the crossing manufacturer's printed instructions. Use tie spacings and track materials in the crossing in accordance with the installation instructions and manufacturer's recommendations.

3.5.9 Signs and Signals

The type and location of railroad-highway crossing warning signs and signals must conform to the requirements of MUTCD, Part VIII.

3.5.9.1 Location and Positioning of Signs

Locate and erect signs for both highway and railroad track installation as shown. Unless otherwise shown, erect signs so that sign face is vertical and at a deflection angle of 87 degrees from the center of the highway lane or track which the sign serves and facing the direction of travel. Where lanes or tracks are on curves, ensure sign faces are on a deflection angle of 87 degrees to the tangent to the curve. Erect signs so that specular reflection is minimized or eliminated. After installation is completed, the signs will be inspected during the day and at night by the Contracting Officer. If specular reflection is apparent on any sign, adjust its positioning to eliminate or minimize this condition. Make this adjustment and any subsequent adjustments at no additional cost to the Government.

3.5.9.2 Traffic Control

During installation of highway signs, provide for the safe and expeditious movement of traffic through the work area. Provide schedule of lane closures, work zone safety and traffic control, and related items.

3.5.10 Crossing Flangeways

Upon completion of the grade crossing installation, the flangeways through the crossing must be a minimum of 50 mm 2 inch deep and between 65 and 75 mm 2-1/2 and 3 inches wide. Ensure that adequate flangeways are provided prior to installation of the final crossing surface.

3.5.10.1 Flangeway Filler

Except for Type I crossings, fill all open crossing flangeways with [asphaltic concrete and compact as indicated on the drawings][preformed rubber filler].

3.5.10.2 Clean Grade Crossing Flangeways

Where grade crossing flangeways are obstructed (filled in), remove foreign material to provide a minimum 50 mm 2 inch depth and 65 mm 2-1/2 inch width flangeways on the gage side of the rails.

3.5.11 As-Built Drawings

Submit one set of reproducible originals of the final as-built drawings for each automatic crossing protection installation prior to final acceptance by the Contracting Officer. Use materials and methods to produce these drawings meeting the requirements of this specification that result in drawings which are easy to revise without damage to the drawing.

3.6 BONDING AND GROUNDING TRACK

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NOTE: Whenever rail facilities are required for unloading fuel, ammunition, other flammable or explosive materials, or if the track is located adjacent to electrical equipment, the rails and related track materials capable of conducting electrical current must be bonded, grounded and insulated from the remaining track. See UFC 4-860-01FA for details on which track must be bonded and grounded.

****

Bond and ground track as indicated. Where track is designated for bonding and grounding, ensure the rails are bonded electrically continuous and effectively grounded. Make connections by exothermite welds in accordance with the manufacturer's instructions.

3.6.1 Rail Joint Bond

Bond rail joints on both rails of designated track using an exothermic type bond. Apply bond to the field side of the rail [head] [web] unless otherwise approved by the Contracting Officer. Electrically insulate track to be bonded and grounded from the remaining track using one of the specified insulated joints.

3.6.2 Rail Cross-Bond and Ground

Install rail cross-bond and ground using an exothermic type bond. Apply the cross-bond to the [rail head][rail web]. [Install one cross-bond and ground at 30.5 m 100 ft intervals along the designated tracks.][Provide one cross-bond and ground for each section of bonded and grounded track.] Make connections between grounding system or ground rods and rails with bare stranded copper cable, install at least 300 mm 12 inch below the bottom of the ties. Drive ground rods vertically full-length. Locate the top of the ground rod at the toe of the ballast slope a minimum of 300 mm 12 inch below the top of the subgrade. Do not exceed a maximum resistance to ground from any grounded rail or structure of 25 ohms. Make any corrections needed to reduce the resistance to below 25 ohms at no cost to the Government.

3.6.3 Inspection of Rail Bond and Ground

Visually inspect loose, damaged, or missing rail bond wires, cross bond wires, ground connections, and ground rods. If there is a signal failure, bonding can be tested for current loss in the joints using a volt meter. Mark defective items for repair.

3.6.4 Rail Bonds At Signalized Grade Crossings

Bolted rail joints within the approach circuits to signalized highway grade crossings must be double-bonded using both a rail head bond and a web bond. Install rail head and web bonds in the locations indicated where the existing rail bonds are missing, broken, or otherwise ineffective.

3.6.5 Existing Bonds

Protect existing rail bonds[, cross-bonds][, ground connections, and grounding rods] from damage. Except for bonds attached to rails which are designated to be replaced in this contract, replace bonds which are damaged or destroyed by the Contractor's operation at no cost to the Government.

3.6.6 Removal of Defective Bonds

Remove rail head pin-type and welded-type bonds by shear cutting old cables immediately adjacent to the weld or pin. Remove rail web type pin bonds by knocking the old pin out with a drift. Do not use flames or torches to remove defective bonds.

3.7 INSTALLATION OF MISCELLANEOUS TRACK MATERIALS

3.7.1 Tie Plates

Furnish tie plates to the work sites as required. Deliver excess tie plates, remaining at the conclusion of the contract, to the military installation storage site and stack where directed by the Contracting Officer.

3.7.2 Insulated Joints

Install insulated joints where indicated and in accordance with the manufacturer's installation instructions.

3.7.3 Bumping Posts, Cushion Head, and Wheelstops

Bumping posts, cushion head, and wheelstops must be [removed,][installed,][or][reinstalled][_____]. Perform installation in accordance with the manufacturer's instructions. Where no specific installation instructions are available for salvaged bumping posts and wheelstops, reinstallation must be in accordance with good track construction practice to ensure proper performance.

3.7.4 Inner Guard Rails

Install inner guard rails as detailed in the contract drawings. Spike each rail to alternate crossties throughout the full length using two spikes per rail per tie; tie plates are not required. Install guard rails using acceptable joint bars of the proper size to fit the rails being joined. Bolt each joint with at least two bolts and one fully tightened bolt per rail.

3.7.5 Gage Rods

Install one gage in the crib immediately ahead of the switch point of all turnouts. Install two gage rods on the curved closure rail, one ahead of the joint, and one ahead of the toe of the frog in all turnouts.

3.7.6 Installation of Joint Bars

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NOTE: For low traffic volume tracks that are equipped with six hole angle bars, the bars may be installed by placing bolts in only the four center

holes. Modify paragraph as needed if six hole bars are used, and designate locations for four bolt use.
****

Install joint bars with their full number of bolt assemblies unless otherwise noted. Seat bars properly on the rail and tighten the bolts beginning at the center of the joint and working toward the ends of the bars, alternating between rails. Use bolts of the proper diameter and length for the rail and joint bars at the joint. The use of extra washers to shim out track bolt nuts is prohibited. Place bolts with nuts alternately on inside and outside of rail.

3.8 BRIDGE REPAIR

Submit shop drawings necessary for the construction and erection of the railroad bridge work. Provide shop drawings made from measurements taken at the site wherever possible or from established measurements, when actual measurements are not available. The Contractor is responsible for the accuracy of the established measurements, the information furnished to the subContractors for the preparation of their Shop Drawings, and the checking of all Shop Drawings. Drawings must bear the stamp of a Professional Engineer. Repair bridge as follows:

3.8.1 State and Local Government Permits

Obtain necessary permits from state and local governments for work over public roads. Prepare traffic maintenance and detour plans; submit them for approval to the appropriate authorities; erect and maintain signs, barricades, lighting, and other traffic control devices in accordance with MUTCD; pay for police details; and stage the work to provide for the continued safe public use of the roadways beneath the bridges.

3.8.2 Work Hours

The Contractor may be required by local or state authorities to work at night or on split shifts to avoid peak traffic hours at bridges [_____]. No additional compensation will be made for any costs associated with meeting such requirements.

3.8.3 Schedule of Bridge Repair Work

Schedule the work of this project to minimize the duration of interruptions to rail service. Schedule bridge repair work, so that to the maximum extent practical, bridges on the same line are taken out of service and repaired simultaneously.

3.8.4 Timber Pile Repair

A timber pile can be spliced or shimmed to repair areas of deterioration or to compensate for settlement of the pile. Any spliced pile must achieve a bearing adequate for its design loading. Do not splice more than 50 percent of the piles in a single bend. Do not splice or shim more than 25 percent of the piles in the entire substructure.

3.8.5 Timber Pile Replacement

Replace any pile when it does not achieve adequate bearing, the pile has greater than 50 percent deterioration, or replacement is more economical. [Drive replacement pile along side existing piles] [Construct a two pile support pier under the bridge cap to carry the load of the deteriorated pile].

3.8.6 Bridge Tie Replacement Open-Deck Bridges

Where spot replacement of bridge ties is required, remove the existing tie without permanently disturbing the track surface. Use new bridge ties of the proper wood species, structural grade, and size for the intended application. Shimming of bridge ties will not be permitted.

3.8.7 Rivet Replacement

Where replacement is required, replace rivets with high-strength bolts as specified in Section 05 12 00 STRUCTURAL STEEL.

3.9 ELECTRIC ARC WELDING

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NOTE: An electric flash butt mobile rail welder should be used on large projects.

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Perform welding to repair or rebuild frogs, switch point, guard rails, switch point protectors and rails (engine burns, battered ends, etc.) in accordance with AREMA Eng Man, Chapter 5, Part 5,Section 5.10 and AWS D1.1/D1.1M. Submit a detailed specification covering the step-by-step procedures to be employed in making the electric arc welds. Include a complete description of each of the following items as applicable and any other essential characteristics in the procedure specifications.

a. Type, size, and capacity of electric welding machine (250 amp minimum), grinder and other equipment. Also, type and size of material (welding rod or wire).

b. The method to be used to remove defective and excess metal prior to welding (arcair or grinding).

c. The method to be used to prevent warping.

d. The method used for preheating, including time and temperature.

e. The method of applying metal buildup and slag removal.

f. The method of securing original contour of items welded.

g. Quality control procedures to be followed.

h. Welding materials (rod or wire), name and manufacturer of materials (low carbon steel) for welding rail, rail frogs, guard rails, switch point protectors, and switch points without manganese inserts and materials (manganese alloy) for welding manganese frogs, RBM frogs, manganese switch point inserts and manganese railroad crossing inserts or castings.

3.9.1 Welding Supervision

Perform electric arc welding under the direct supervision of an experienced welding supervisor or foreman and by a certified welder.

3.9.2 Weather Conditions

Do not perform welding in rain, snow, or other inclement weather without adequate protection of the welding from the elements.

3.9.3 Welding Manganese Frogs and Crossings

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NOTE: Edit these paragraphs as needed to match the project requirements.
****

Tighten bolts, drive spikes down, and tamp ties under crossing and frogs for level surface, when welding manganese frogs and crossings. Grind out chips and cracks with grinding machine or gouge out with arcair gouging device even if crack goes through the entire casting. When gouging device is used, no finished grinding of cracks or chips is required. If cracks are gouged out to bottom of casting, reinforcement strap must be [placed underneath the hole.][welded to the bottom of the hole in casting with the wire feed machine, allowing the frog or crossing to be welded back to level surface using the skip method.]

3.9.3.1 Manganese Overheating

Ensure that manganese is not overheated in this process. If manganese shows signs of overheating, allow casting to air cool and then continue welding process. Repeat the process as many times as necessary to prevent manganese from overheating. [Use] [Do not use] flnge carbons to keep welding metal out of flangeways. Build welded surface slightly higher than normal surface of casting so when ground, it will have sufficient weld metal to grind to a level surface. Use a 600 mm 24 inch straightedge to check this work. Grind edges of flangeways and sides of points in a roll manner, using a frog and crossing flangeway gage as a guide.

3.9.3.2 Slotting

Slot manganese frogs and crossings with a 5 mm 3/16 inch slotting wheel. Also weld, grind, and slot connecting rail joints to frog in like manner. Repeat the grinding and slotting process approximately 6 weeks from the time the frog is put back in service and thereafter when overflow appears on points and flangeways.

3.9.4 Welding Switch Points

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NOTE: Field welding of switch points is not recommended. Qualifications of welder are very important for this type of work.
****

Overflow of stock rail must be ground off of ball of rail on both sides and switch point ground to where cracks and chips are ground out. Grind off all grease and rust of point as far back as point is to be welded. Adjust switch point tight against stock rail and check gage. If gage just ahead of switch point is tight, open it to where gage reads 6 mm 1/4 inch open. Do the following before starting to weld: 1) Open switch point and place rail flange carbon between switch point and stock rail. 2) Pull switch tight against carbon and hold with spike; another rail carbon can be placed just on top of reinforcement binding strap on point to use as guide for first welding pass; carbon can then be removed or left in place. 3) Grind switch point with surface grinder or utility grinder. 4) Apply graphite or oil to switch points and plates to prevent rusting and to make switch throw easier. 5) Check with proper authority to ensure ample time to complete welding, grinding and cooling before traffic is due. Switch point must be ground welded complete without chipping weld slag.

3.9.5 Welding Switch Point Protectors

3.9.5.1 In Track

Perform the following operations: 1) Check with proper authority to ensure ample time to complete welding, grinding and cooling before traffic is due. 2) Use a steel ruler to determine the amount of weld needed on manganese switch point protectors; measure the top of the protector any place where there is no wear. 3) Grind out the work hardened surface and any cracks or chips. 4) Weld the protector with the semi-automatic wire feed machine slightly wider than the width of a new switch point protector; run a string bead along the bottom of the wear surface on the protector guard; leaving flux on this bead continue with string bead until protector is built back to size without overheating the protector. If signs of overheating appear, use intermittent welding procedure. 5) Grind back the protector to the correct width. 6) Use roll method on top inside corner of protector.

3.9.5.2 Out of Track

Perform the following operations: 1) Use a steel tape to determine the amount of weld needed on manganese switch point protectors; measure the top of the protector any place where there is no wear. 2) Ground out the work hardened surface and any cracks or chips. 3) Weld the protector with the semi-automatic wire feed machine to just a little wider than the width of a new switch point protector; the protector can be laid on its side and three flat beads run on wear surface of the protector guard; ground back to the size of a new protector. 4) Use intermittent method and skip welding to keep protector from overheating. 5) Use the roll method on inside corner of running wear surface of guard.

3.9.6 Welding Engine Burns

Remove the damaged steel of the rail by grinding or arcair to get below the burn area into sound metal. Remove sufficient amount of metal to eliminate all shatter cracks.

3.9.6.1 Depth and Length Limitations

Do not repair engine burns requiring welds greater than 10 mm 3/8 inch in depth below the top of the rail head by welding and grinding. While grinding out the damaged metal, stop the operation when it is discovered that the necessary weld will go too deep into the rail head. Weld the ground out portion and apply joint bars at the weld location with the rail undrilled at the middle bolt holes, centering the joint bars under the engine burn. Notify the supervisor of maintenance immediately so that the rail can be removed from track. Dispose these failed rails in accordance with current instructions. Do not weld engine burns which would require a weld longer than 200 mm 8 inch.

3.9.6.2 Ambient Limitations

Avoid welding and grinding engine burns when the air temperature is below 0 degrees C 32 degrees F. When welding is necessary below 0 degrees C 32 degrees F, protect the heated area by covering with insulating material to retard cooling. Do not weld engine burns during rain or heavy snow.

3.9.6.3 Number of Welds

Determine the maximum number of burns in a 12 m 39 ft rail, or equivalent, that can be economically welded. Unless otherwise directed, when a rail has more than 8 burns needing repair, replace the rail.

3.9.6.4 Welding Procedure

Weld the burn with semi-automatic wire feed machine. Use the skip method in this process because no preheating or post heating is needed. If engine burns are found in groups close together, grind out ten to fifteen burns at a time, welding one pass at a time on each of the burns. Repeat the process until all of the burns are completed to a surface just higher than the normal ball of the rail. Then cool the burn until hand can be placed on it. Grind welds to a level surface with cup wheel attachment grinder.

3.9.7 Welding Rail Joints

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NOTE: Remove this paragraph when not required.

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Tighten bolts in the joint bars and pull the joint to a level surface. Check joint bars for wear and replace if they are badly worn. Use six hole bars if available. Place a straightedge across the joint to determine the amount of batter. Use straightedge with a minimum of 450 mm 18 inch in length. Do not weld a rail joint with less than 3 mm 0.012 inch of batter. If batter is 3 mm 0.012 inch or more, build up the rail joint. If rail cracks or chipped out places are present in rail ends, melt them out with acetylene torch, gouge out with arcair or grind out with grinder. If cracks or chips extend below ball, replace rail. Replace rail if horizontal crack in ball of rail extends more than 200 mm 8 inch. Preheat rail ends to approximately 93 degrees C 200 degrees F before welding. Starting 40 mm 1-1/2 inches from the end, build the rail back as follows: Weld a 25 mm 1 inch strip into bed; grind the rail ends to a level surface with surface grinder or cup wheel attachment; and cross slot rail joint with 5 mm 3/16 inch grinding stone to keep rail ends from overlapping and chipping out.

3.10 THERMITE WELDING PROCEDURES

Submit a detailed statement covering the step-by-step procedures to be employed in making the welds, including a complete description of each of the following items, as applicable, and any other essential characteristics included in the welding procedures:

a. The manufacturer's trade name for the welding process.

b. The method used for cutting and cleaning the rail ends. Flame cutting of rail ends will not be allowed.

c. The minimum and maximum spacing between rail ends.

d. The method used for maintaining the rails in alignment during welding.

e. The method used for preheating, including time and temperature.

f. The tapping procedure, including the minimum time required to cool the weld under the mold insulation.

g. The method used, including a description of special tools and equipment, for removing the upset metal and finishing the weld to the final contour.

h. Quality control procedures to be followed.

i. The contractual agreements with any subcontractor employed by the Contractor in doing the work.

Perform thermite welding procedures by a technician certified to meet ANSI/ASNT CP-189, level II or III qualifications and comply with the following paragraphs:

3.10.1 End Preparation

Rails to be welded must meet the requirements Section 2.2, "Specifications for Fabrication of Continuous Welded Rail" given in Chapter 4, Part 2 of AREMA Eng Man. Align the rail ends in accordance with paragraph GAP AND ALIGNMENT. Rail ends must show no steel defects, dents, or porosity before welding. Do not make bolt holes in, or permit to remain in, the ends of the rail to be welded. One handling hole may be made in each end of welded string. Cut off rail ends containing such holes during track construction. Rail which must be cut for any reason must be cut square and clean by means of approved rail saws or abrasive cutting wheels in accordance with Chapter 5 of AREMA Eng Man, Section 10.3, "Recommended Practice For Use of Abrasive Wheels".

3.10.1.1 Cleaning

Clean rails to be welded of grease, oil, dirt, loose scale, and moisture to a minimum of 150 mm 6 inch back from the rail ends, including the railhead surface. Clean using a wire brush, to completely remove dirt and loose oxide and by use of oxygen-acetylene torch to remove grease, oil and moisture. Use a power grinder with an abrasive wheel to remove scale rust, burrs, lipped metal and mill brands which would interfere with the fit of the mold, for 50 mm 2 inch on each side of the ends.

3.10.1.2 Gap and Alignment

The minimum and maximum spacing between rail ends must be as specified by the rail welding kit manufacturer and the approved welding procedures.

a. The ends of the rails to be welded must be properly gapped and aligned to produce a weld which conforms to the alignment tolerances below. Align rail on the head of the rail. Hold rail gap and alignment without change during the complete welding cycle.

b. Vertical alignment must provide for a flat running surface. Any difference of height of the rails must be in the base.

c. Align horizontally so that any difference in the width of heads of rails occurs on the field side. Horizontal offsets are not allowed to exceed 1 mm 0.04 in in the head and/or 3 mm 0.12 inch in the base.

3.10.2 Surface Misalignment Tolerance

Combined vertical offset and crown camber is not allowed to exceed 3 mm/m 0.04 inch/feet at 315 degrees C 600 degrees F or less. Combined vertical offset and dip camber is not allowed to exceed 1 mm/m 0.01 inch/feet at 315 degrees C 600 degrees F or less.

3.10.3 Gage Misalignment Tolerance

Combined horizontal offset and horizontal kink camber is not allowed to exceed 3 mm/m 0.04 inch/feet at 315 degrees C 600 degrees F or less.

3.10.4 Thermite Welding

Perform welding in accordance with Chapter 4, Part 2,Section 2.5 of AREMA Eng Man, articles "Thermite Welding - Rail Joints" and Section 2.2 "Specification for Fabrication of Continuous Welded Rail", except as modified by these specifications. Inspect all welds visually at the time of welding.

3.10.4.1 Thermite Weld Preheating

Preheat rail ends prior to welding to a sufficient temperature and for sufficient time as indicated in the approved welding procedures to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld.

3.10.4.2 Thermite Weld Cooling

Leave molds in place after tapping for sufficient time to permit complete solidification of the molten metal and proper slow cooling to prevent cracking and provide a complete weld with proper hardness and ductility.

3.10.5 Weld Finishing and Tolerances

Bring welded joints in the finished track to a true surface and alignment by means of a proper grinding or planing machine (shear). Perform finish grinding with an approved grinder operated by a skilled workman grinding evenly and leaving the joints in a smooth and satisfactory condition. Eliminate all cracks. Finish the completed weld by mechanically controlled grinding in conformance with the following requirements:

a. A finishing deviation of not more than plus or minus 1 mm 0.01 in of the parent section of the rail head surface will be allowed. Finish the gage side of the rail head to plus or minus 1 mm 0.01 in of the parent section.

b. Welds produced by welding kits which are specially designed to produce reinforced welds need not be ground in the finishing area except as necessary to remove fins, burrs, cracks, etc.

3.10.6 Weld Quality

Each completed weld must have full penetration and complete fusion and be entirely free of cracks or fissures. Welds must meet the acceptance criteria given in AWS D1.1/D1.1M.

3.10.7 Weld Numbering

Semi-permanently mark a sequential weld number on the rail immediately adjacent to the weld, using a quality lead paint marker at the time the weld is made. Number welds sequentially in the order in which they are made. The Contracting Officer will provide the initial weld number. Assign defective welds which are replaced a new sequential number by adding a letter to the defective weld number (e.g., defective weld 347 would be replaced by 347A).

3.11 TRACK REPAIR

3.11.1 Cutting and Drilling of Rail

Use only rail saws and abrasive cutting wheels for this operation. Other methods for cutting rail will not be acceptable. Cuts must be square and clean. When given the option of cutting existing rail or new rail being installed, cut the existing rail. When new holes are necessary, they must be drilled. Do not punch, slot, or burn holes with a torch. Ensure holes are sized and located as shown on the contract drawings. Peen or grind drilled bolt holes to remove sharp edges.

3.11.2 Rail Joints

In areas which do not require out-of-face rail replacement, tighten all track bolts. Defective track bolts, nuts and lock washers ("bolt assemblies"), and replace those that cannot be tightened. This work includes both spot replacement of assemblies at locations to be determined by the Contracting Officer ("Spot Bolt Assembly Replacement") and out-of-face replacement of all bolt assemblies within a rail joint ("Joint Repair").

3.11.2.1 Used Bolt Assemblies

Used bolt assemblies removed from rail joints are the Contractor's property and do not reincorporated in the work. Remove existing bolt assemblies designated to be replaced by methods which do not damage joint bars or rails.

3.11.2.2 Joint Repair

****

NOTE: List locations where out-of-face joint repairs are required on the drawings.

****

Replacement of defective joint bars and correction of rail-end mismatch, as designated or directed by the Contracting Officer, is defined as joint repair work. At designated joint repair locations, remove both joint bars from the rails and inspect the rail ends for damage or defects.

3.11.2.3 Cleaning of Finishing Area

Clean the finishing area of mill scale, rust, and dirt by wire brushing, compressed air, solvents, or a combination of these or other methods.

3.11.2.4 Rail Ends

The clean rail ends will be jointly examined by the Contractor and the Contacting Officer for the presence of any rail defects that would make the rail unsuitable for further use at the location. If a rail is determined to have an end defect, either crop or replace the rail.

3.11.2.5 Joint Gap

Where pull-aparts have occurred, whether currently gapped or not, or where the rail joint gap exceeds 19 mm 3/4 inch, adjust the joint gap to the rail joint gap specified in TABLE VI. Perform rail joint gap adjustment work in conjunction with spot rail replacement work and bolt renewal work.

3.11.3 Spiking

Verify the proper gage, as indicated in this section, immediately prior to spiking.

3.11.4 Spot Tie Replacement

Replace defective ties as marked in the field and as directed by the Contracting Officer.

3.11.4.1 Paint Markings and Tie Inspection

Paint markings may exist on the existing rails and crossties. Such markings do not necessarily indicate work within the scope of the contract. Participate in a walk-through tie inspection with the Contracting Officer prior to commencement of tie replacement work. The scope of the tie replacement work will be determined at that time and relevant paint markings made or touched up as required.

3.11.4.2 Additional Tie Work

In areas where existing ballast inhibits tie inspection, additional ties may be required beyond those marked. The scope of such additional tie work will be identified by the Contracting Officer as adjacent work progresses.

3.11.4.3 Old Spikes, Rail Anchors, tags and Tie Plates

Pull and scrap old spikes. Remove, sort, and salvage rail anchors. Remove and inspect tie plates and, classify as either relay or scrap. Mark scrap tie plates as scrap and do not reinstall in the track. Acceptable relay tie plates may be reused at that location or at other locations as required. Old stationing tags will be removed and replace on the new tie.

3.11.4.4 Humped Track

Where the track will not be surfaced, in order to prevent permanent distortion ("Humping") of the line and surface of the track when performing spot tie replacement, excavate the tie cribs and ends, remove the old ties, and install the new ties without jacking the rails. Resurface humped track at the Contractor's expense.

3.11.4.5 Minimal Humping

For spot or out-of-face tie replacement, where the track will be surfaced and aligned under this Contract, a minimal amount of humping will be allowed, provided the surfacing tolerances can be met.

3.11.4.6 Fouled or Muddy Ballast

Excavate and waste fouled or muddy ballast, as identified by the Contracting Officer, outside of the track area where it will not interfere with drainage of the track.

3.11.4.7 Insertion of New Ties

Insert new wood ties in track with the heartwood down, square to the line of the rails. Insert engineered polymer composite ties with the flat (tie plate) surface up, square to the line of the rails.

a. Insert ties so that the average tie spacing in any one rail length does not exceed 530 mm 21 in and so that the maximum spacing between any two ties does not exceed 610 mm 24 in and the maximum spacing is not less than 460 mm 18 in.

b. Crosstie position at joints must result in a "suspended joint" arrangement unless otherwise directed by the Contracting Officer.

3.11.4.8 Positioning of Tie Plates

Position tie plates on the tie so that the shoulder has full bearing against the base of the rail. Center the plate on the tie width, except position the plate up to 13 mm 1/2 in off-center if necessary to avoid spiking into an existing tie split. Ensure that all tie plates in a given stretch of track are either canted or flat. Do not mix canted and flat tie plates within a given stretch of track.

3.11.4.9 Re-spacing of existing ties

Re-spacing of ties is required to straighten slewed ties or to correct uneven tie spacing. Remove crib and shoulder ballast as required to facilitate sliding crossties to their final position or to insert new ties. Do not use spike mauls or sledges to slide ties. Install rail anchors and ballast immediately after ties are re-spaced.

3.11.4.10 Track Gage

Set track gage at the time of spiking.

3.11.4.10.1 Tangent Track

For track rehabilitation or spot rail replacement on tangent, regage the track if the existing gage is less than 1420 mm 56 in or is equal to or greater than 1460 mm 57-1/2 in. Regage these sections of track to conform with the gage of the adjacent track; ensure the gage after regaging is between 1430 and 1450 mm 56-1/4 and 57 in.

3.11.4.10.2 Curved Track

Gage curved track as shown in TABLE V.

3.11.5 Joint Respiking

Many joints in track will be found with nonstandard spiking patterns and other deficiencies. These include joints with no tie plates, plates which are positioned so that it is not possible to spike through the plate on both sides of the joint, spikes driven against the ends of skirted joint bars, and similar deficiencies. Respike such joints in accordance with the following.

3.11.5.1 Substitution of Tie Plates

When tie plates are available which will permit spiking through the tie plate at the edge of the joint bar skirts on both sides of the rail, substitute them for existing plates.

3.11.5.2 Respiked Joints

Plug existing spike holes in all respiked joints.

3.11.6 Regaging

Where the existing track gage is less than 1420 mm 56 in or is equal to or grater than 1460 mm 57-1/2 in, or as designated by the Contracting Officer, regage the track. Regage these sections of track to conform with the gage of the adjacent track; ensure the track gage after regaging is between 1430 and 1450 mm 56-1/4 and 57 in.

3.12 SAMPLING AND TESTING

Sampling and testing is the responsibility of the Contractor. Submit one certified copy of Test Reports for each test performed on the ballast [and subballast] within 2 working days of the test completion. Perform sampling and testing by an approved commercial testing laboratory, or by the Contractor, subject to approval. If the Contractor elects to establish testing facilities, base approval of such facilities on compliance with ASTM D3740. Work requiring testing will not be permitted until the Contractor's facilities have been inspected and approved. The first inspection of the facilities will be at the expense of the Government and any subsequent inspections required because of failure of the first inspection is at the expense of the Contractor. Such costs will be deducted from the total amount due the Contractor.

3.12.1 Ballast [and Subballast] Samples

Perform periodic sampling and testing of ballast [and subballast] material to ensure continued compliance with this specification. During construction, take one representative sample of the ballast [and subballast] material from each 1818 metric tons 2,000 tons of ballast [and subballast] delivered to determine the material gradation. For each 9090 metric tons 10,000 tons or a fraction thereof of ballast delivered, obtain an additional amount of material in order to perform the quality and soundness tests specified. Take samples for material gradation, quality, and soundness tests in conformance with ASTM D75/D75M. Reduce test samples from field samples in conformance with ASTM C702/C702M. Ensure sample sizes are sufficient to provide the minimum sample sizes required by the designated test procedures. If any individual sample fails to meet the gradation requirement, halt placement and take immediate corrective action to restore the specified gradation. If any individual sample fails to meet the specified quality and soundness requirements, halt placement and take immediate corrective action to restore the specified quality.

3.12.2 Ballast [and Subballast] Tests

3.12.2.1 Sieve Analyses

Make sieve analyses in conformance with ASTM C117 and ASTM C136/C136M. Sieves must conform to ASTM E11.

3.12.2.2 Bulk Specific Gravity and Absorption

Make bulk specific gravity and absorption tests in conformance with ASTM C127.

3.12.2.3 Percentage of Clay Lumps and Friable Particles

Determine the percentage of clay lumps and friable particles in conformance with ASTM C142/C142M.

3.12.2.4 Degradation Resistance

Determine resistance to degradation of materials in conformance with ASTM C131/C131M and ASTM C535. Test materials with gradations having 100 percent passing the 25 mm 1 in sieve in conformance with ASTM C131/C131M. Test materials having gradations with particles larger than 25 mm 1 in in conformance with ASTM C535.

3.12.2.5 Soundness Test

Make soundness tests in conformance with ASTM C88.

3.12.2.6 Percentage of Flat or Elongated Particles

Determine thepercentage of flat or elongated particles in conformance with ASTM D4791.

3.12.3 Tie Inspection

The Contractor is responsible for the quality of the treated ties. Permanently mark or brand each tie by the producer in accordance with AWPA M6. Inspect each treated wood tie in accordance with AWPA M2 for conformance with the specified AWPA standards. The 100 percent inspection must be performed by an independent inspection agency approved by the Contracting Officer. Make inspectione at the wood treatment site. The agency's report of inspection must accompany delivery of the ties. Core and check preservative treatment once per 1000 ties delivered to the construction site.

3.12.4 Examination of Geotextile

****

NOTE: The amount of geotextile being installed and the criticalness of the installation determine the size and scope of the geotextile testing and quality control/quality assurance program. Small jobs with minor importance may not warrant extensive preconstruction testing of the geotextile, and the manufacturer's Certificate of Compliance may be adequate for assuring that the physical properties are met. However, for large projects and critical installations, regardless of size, a complete

regimen of preconstruction and quality control testing should be specified.
****

[Sample the geotextile upon delivery to the project site. Use sampling procedures detailed in ASTM D4759and ASTM D4354 with the number of sample units selected from TABLE II of ASTM D4354. An independent testing laboratory must perform the index property tests specified in TABLE II on each of the sample units and determine conformance with the minimum requirements of TABLE II. Conformance must be determined in accordance with ASTM D4759.] [Test geotextile seams expected to perform a reinforcement function in accordance with ASTM D4595.] The Contracting Officer may examine any geotextiles for defects, damage, or nonconformance prior to installation. Any geotextile not meeting the minimum property requirements of paragraph GEOTEXTILE, or remove geotextile that is determined to be damaged or defective from the site and replace with additional geotextile meeting the requirements of this specification at no additional cost to the Government.

3.13 INSPECTION AND FIELD TESTING

Perform quality control inspection and field testing.

3.13.1 Track

Perform inspection to ensure that all the requirements of these specifications are met. Inspect bolted joints for loose bolts and for smooth transitions between rails of different sections. Check rail, tie plates, and ties to ensure that the rail is properly seated and has full bearing on the tie plate and tie. Upon completion of construction, take and record measurements of track gage, cross level, and alignment at least once every [30] [60] [_____] m [100] [200] [_____] feet of track centerline length. Provide a copy of these measurements to the Contracting Officer.

3.13.2 Welded Joints - Visual Inspection

Quality control inspection and field testing must be performed by a technician certified to meet ANSI/ASNT CP-189 level II or III qualifications with a minimum of one year experience in testing rail for defects. Inspect each welded joint in the presence of the Contracting Officer after removal of the mold and grinding of excess metal. Pay particular attention to surface cracking, slag inclusion, gas pockets, and lack of fusion. Correct or replace, at no extra cost to the Government, any weld found defective. The method of correction must be as approved by the Contracting Officer.

3.13.3 Electric Arc Welding Inspection

Inspect electric arc welds to determine that the item welded conforms to the desired contour and contains no visible cracks or voids.

3.13.4 Thermite Weld Joints Testing

Each thermite weld joint must be [ultrasonically tested] [dye tested] following the visual inspection. The method of inspection and acceptance must be in accordance with AWS D1.1/D1.1M. Correct or replace defective welds, at no additional cost to the Government. The method of correction must be as approved by the Contracting Officer. Ultrasonic testing [must] [will] be performed by the [Contractor] [Government] after the rail has been installed in track. The testing will determine whether or not each weld meets the criteria of paragraphs Gap and Alignment, Weld Finishing and Tolerances, and Weld Quality. Cut welds, made in the track which the Contracting Officer determines to be unacceptable, out of the rail and replace by a section of new rail and two new welds. Make saw cuts at least 150 mm 6 in from the centerline of the faulty weld. Replacement welds and replacement rails are the sole expense of the Contractor. Renumber replacement welds as indicated. Ultrasonically test replacement welds made in track.

3.13.5 Electric Arc Weld Testing

Inspect the welds visually and check the contours after completion and later test by the ultrasonic method. The [Government will] [Contractor must] have the welds tested by the ultrasonic method. The testing will determine whether or not each weld meets the quality criteria. Defective welds will be removed and the item rewelded at the Contractors expense.

3.13.6 Inspection of Geotextile

At the direction of the Contracting Officer, remove the cover material from the geotextile at 3 locations per km mile so that the geotextile may be inspected for damage. At each location, remove the cover material to expose a 1.2 by 1.2 m 4 by 4 feet section of the geotextile. If punctures, tears, improper installation, other impairment or damage are found within this section, excavate additional sections to determine the extent of the damage. Repair or replace damaged geotextile and recover with ballast/subballast at the Contractor's expense.

3.13.7 Testing Relay Rail

3.13.7.1 Testing for Wear

Check each relay rail for wear by the Contractor's quality control representative in the presence of the Contracting Officer after the material is delivered to the construction site. Monitor the installation of track for defects in rail and joint bars being installed. Do not install rail and joint bars that are found to be defective in track.

3.13.7.2 Testing for Defects

Upon completion of the track construction, have the rail tested by ultrasonic methods. Ultrasonic testing must be done by a Contractor normally engaged in this type of testing with a minimum of 5 years of experience. Submit results of the ultrasonic rail testing. Results must list defects and rail stationing. Schedule a rail testing machine and notify the Contracting Officer of the type of machine and schedule. Remove and replace Contractor furnished rails which are found to have any detectable defect at that time at no additional cost to the Government. Remove and replace Contractor furnished joint bars and compromise joint bars that are found to be cracked or broken at no additional cost to the Government. Submit Data package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

TABLE VII
RECORD OF ITEMS REPAIRED OR REBUILT BY THE ELECTRIC ARC WELDING METHOD AND GRINDING

[enter date]	[enter Installation name]			Turnout Number:	
[enter time (24hr)]	Air Temp (C*) and Weather Conditions:				
ITEM REBUILT	DESCRIPTION	WEIGHT	LENGTH	LH RH	REINFORCED
Switch Point					
Frog					
Railroad Crossing					
Guard Rails					
Switch Point Protector					
Rail (Ends)					
Rail-Engine Burns					
[_____]					
*NOTE: Temperature to the nearest 1/2 degree.					

INSTALLATION______________________________ WELD NUMBER ___________

FINAL INSTALLED
LOCATION _________________________ TRACK _______________________
STATION _________________________ RAIL Left Right (Circle)

AM
DATE ______________ TIME ______________ PM (Circle)

AIR TEMPERATURE ________ F*. WEATHER ____________________________
RAIL TEMPERATURE ________ F*. ____________________________

WELD KIT MANUFACTURER ____
RAIL GAP
NEAREST 1.6 MM 1/16 IN ________________
RAIL CUT REQUIRED? YES NO (Circle)
BACK RAIL
MANUFACTURER _______________________ USED RAIL? YES NO (Circle)
YEAR/MONTH ROLLED _________________ HEAT NUMBER _______________
____

AHEAD RAIL
MANUFACTURER _______________________ USED RAIL? YES NO (Circle)
YEAR/MONTH ROLLED _________________ HEAT NUMBER _______________
____

REMARKS____
____
____

ULTRASONIC TEST DATE & RESULTS ____________________________________

KIT MFG. REPRESENTATIVE
PRESENT _________ WELDING FOREMAN ________________________________
(Initial) (Signed)

CONTRACTING OFFICER'S
REPRESENTATIVE
PRESENT ___________ RECORDER ________________________________
(Initial) (Signed)

___________ RECORDER ________________________________
(Initial) (Signed)

FOR GOVERNMENT USE ONLY

ULTRASONIC TEST DATE AND RESULTS _________________________________

----

*NOTE: Determination will be made to the nearest 1/2 degree.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-34 11 19.00 20 (August 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-34 11 19.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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WELDING CRANE AND RAILROAD RAIL - THERMITE METHOD

08/18

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-34 11 19.00 20 (August 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-34 11 19.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 34 11 19.00 20

WELDING CRANE AND RAILROAD RAIL - THERMITE METHOD
08/18

****
NOTE: This guide specification covers the requirements for welding of crane rail and railroad rail by a thermite process.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

****
NOTE: Show the following information on the project drawings:

1. Location of welds.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM E10	(2023) Standard Test Method for Brinell Hardness of Metallic Materials
ASTM E110	(2014; R 2023) Standard Test Method for Rockwell and Brinell Hardness of Metallic Materials by Portable Hardness Testers

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-1699	(1992; Rev B) Nondestructive Evaluation of Butt Welds in Crane and Railroad Rails

1.2   SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welding Procedure

Cold Weather Welding Procedures

Wet Weather Welding Procedures

SD-06 Test Reports

Ultrasonic Tests

Hardness Tests

Weld Correction Method

SD-07 Certificates

Operator Qualification

SD-08 Manufacturer's Instructions

Thermite Kit

SD-11 Closeout Submittals

Joint Records

1.3 QUALITY ASSURANCE

****

NOTE: Thermite welding processes and kits have been developed by the following companies. There may be other processes available. This Guide Specification has been prepared with the processes of these manufacturers in mind. If another manufacturer's product is available in the vicinity of the activity

at which the work is to be performed, modify this Guide Specification as necessary.

1. Orgo-Thermit Inc., 3500 Colonial Drive North, Manchester, NJ 08759, Telephone: (732) 657-5781

2. Railtech Boutet, Inc., 25 Interstate Drive, P.O. Box 69, Napoleon, OH 43545, Telephone: (419) 592-5050

3. ESCO Equipment Service Co., 117 Garlisch Dr., Elk Grove Village, IL 60007, Telephone: (847) 758-9860
****

Use only qualified procedures and personnel. Procedures and personnel previously qualified in accordance with this specification are not required to be requalified, provided qualifications have not lapsed and qualification records are available.

1.3.1 Operator Qualification

Notify the Contracting Officer in writing one week prior to making qualification welds. Qualify operators by welding one acceptable rail joint in accordance with a qualified procedure. This qualification may be accomplished either prior to production welding or on the first joints to be welded at the work site. If welding operator qualification is conducted at the work site, perform no further welding until the qualification weldments have been accepted by visual inspection and ultrasonic tests. Obtain written approval of the acceptability of the welded joint from the Contracting Officer prior to continuing with welding. Welding operator's qualifications are effective from the test date and will remain in effect for a period of one year.

1.3.2 Acceptable Welds

Welds that meet the visual inspection and ultrasonic test requirements of MIL-STD-1699 are considered acceptable. Welds selected for testing for Brinell Hardness must meet the requirements of ASTM E10 and paragraph HARDNESS TESTS.

1.3.3 Procedure Qualification

1.3.3.1 Written Procedure

Prepare for the welding process to be used. The procedure must include any particulars of the process deemed pertinent to the successful completion of the welds.

1.3.3.2 Manufacturer's Procedure

No separate qualification is necessary for various rail weights, although in order to be qualified for a specific rail weight or cross section, the procedure must include fit-up requirements and other features unique to the rail weight or cross section of the rails to be welded.

1.3.3.3 Welding Procedure Qualification

a. Submit welding procedure qualification records acceptable to the

Contracting Officer as proof of previous qualification under this specification.

b. Welding procedure not previously qualified under this specification may be qualified by providing four consecutive acceptable welded rail joints. An acceptable weld is defined as a weld which has been visually inspected and ultrasonically tested and has been found acceptable in accordance with MIL-STD-1699 and ASTM E10. This qualification may be accomplished either by shop fabrication of the joints or on the first four joints welded at the work site. If procedure qualification is accomplished at the work site, perform no further welding until the qualification weldments have been accepted by visual inspection and ultrasonic tests. Obtain written approval of the acceptability of the four welded joints from the Contracting Officer prior to continuing with welding.

c. Ambient temperature: Welding procedures are considered qualified for use at an ambient temperature of 10 degrees C 50 degrees F and above regardless of ambient temperature during welding of qualification assemblies. Do not conduct welding below 10 degrees C 50 degrees F without a specifically qualified procedure. Procedures qualified for use at ambient temperatures less than 10 degrees C 50 degrees F must be qualified by welding test assemblies in accordance with the procedure qualification requirements of this specification at the desired minimum ambient temperature plus or minus one degree C 5 degrees F. Procedures thus qualified are considered acceptable for use at the minimum qualified ambient temperature and above. Submit cold weather welding procedures.

d. Wet weather welding: Perform welding only during dry weather. No welding will normally be permitted on wet, showery and inclement days. However, if means are provided to protect the work and work area, welding may be performed during other than dry weather, if approved by the Contracting Officer. Submit wet weather welding procedures.

e. Confined space welding: Welding in confined spaces must comply with AWS D1.1/D1.1M to assure adequate ventilation for personnel safety.

1.3.4 Required Data

Submit thermite kit manufacturer's instructions and recommendations covering rail end preheat treatment, thermite ignition, mold removal, and finishing.

1.3.5 Welding Procedure

Submit a report of the following information:

a. Thermite kit manufacturer's name and kit size or designation

b. Thermite kit batch numbers and manufacturing date

c. Welding procedure designation (name, number)

d. Size of rail section being joined and type of rail

e. Test assembly identification number

f. Results of nondestructive testing of qualifications assemblies

g. Date of qualification (test date)

1.3.6 Required Qualification Welds

Submit operator qualification welding results in accordance with paragraph OPERATOR QUALIFICATION. Submit procedure qualification welding results in accordance with paragraph WELDING PROCEDURE QUALIFICATIONS. Include results of ultrasonic test and hardness tests. Welders certification or procedure qualification may be substituted, pursuant to paragraph QUALITY ASSURANCE.

1.4 DELIVERY AND STORAGE

Deliver materials in the manufacturer's original unbroken packages or containers plainly labeled with the manufacturer's name and brand.

1.4.1 Receipt Inspection of All Thermite Weld Kits

Perform visual inspection of the weld kit package for freedom from damage and record the thermite weld mix batch number and manufacturing date. Do not use kits which have been manufactured more than 2 years before the date of use or show signs of having been wet.

1.4.2 Material Control

Store materials in the original package and keep dry at all times until used.

PART 2 PRODUCTS

2.1 MATERIALS

Provide in kit form including preformed mold, thermite powder, wicking cord, luting material, and all necessary materials and accessories needed to provide one welded rail joint per kit. Molds must be factory-made, moisture free, and of nonhygroscopic material.

PART 3 EXECUTION

3.1 SEQUENCE OF OPERATION

Perform work in strict accordance with the qualified procedure.

3.1.1 Rail Preparation

Cut rails which are battered, cracked or notched, or which contain bolt holes so that these irregularities are removed. Rail surface must be free of grease, dirt, loose oxide, and moisture on the face of and for approximately 125 mm 5 inches from the joint to be welded. Clean rail ends by grinding or wire brushing. Use a torch to remove grease, oil, or moisture in accordance with procedures in thermite manufacturer's instructions. Rail cutting, when necessary, must be by the saw-cut method. Remove all burrs, rolled-over edges, and loose oxide before applying the mold. No flame cutting of rails is permitted. If the space between the mold and the rail is unusually large on used or relayer rails, fill this gap with a piece of wicking cord before luting or packing.

3.1.2 Rail Alignment

Separate rail ends as recommended by the welding process manufacturer. Align rails as to both surface and gage, and raise the rails at the joint to compensate for the greater thermal contraction that occurs in the rail head during cooling relative to the web and base regions. Measure the amount of joint elevation with a 900 mm 36 inch long straightedge centered at the joint. The correct elevation is obtained when 2 mm 1/16 inch separates the top of the rail head and bottom surface of the straightedge at both ends.

3.1.3 Placing of Molds

Attach the molds to the rails, centered over the joint, and seal the molds to the rail with luting material according to the welding kit manufacturer's instructions. Handle the luting material, a mixture of clay and sand, so that none is introduced into the weld chamber. Align so that the centerline of the mold coincides with the centerline of the gap. Install the tapping plug or discs in the crucible and pour in the prescribed amount of thermite mixture.

3.1.4 Preheating Rail Ends

Preheat the rail ends in accordance with the manufacturer's instructions and recommendations.

3.1.5 Ignition of Thermite

Follow manufacturer's instructions and recommendations regarding the ignition of the thermite.

3.1.6 Mold Removal

Follow manufacturer's instructions regarding mold removal.

3.1.7 Finishing

Follow manufacturer's instructions and recommendations. No finishing is required on the web and base of rail. Perform final grinding when the weld and rail have cooled to ambient temperature. Do not use a cutting torch to remove excess weld metal.

3.1.8 Joint Records

Submit a record of the date and location of each weld made. The record must also include the rail type, size, thermite kit manufacturer's name, and thermite weld portion batch number. Also, provide a record of the nondestructive test date and acceptance date.

3.2 INSPECTION AND TESTING

3.2.1 Visual Inspection

Inspect each welded joint after removal of the mold and grinding or removal of excess metal. Pay particular attention to surface cracking, lack of fusion and other surface irregularities. Correct or replace all defective welds at no additional cost to the Government. Submit the weld correction method for approval by the Contracting Officer.

3.2.2 Nondestructive Inspection

Inspect each welded joint by ultrasonic tests using the method of inspection and acceptance as prescribed in MIL-STD-1699. Correct or replace all defective welds at no additional cost to the Government. The method of correction must be approved by the Contracting Officer. Inspect all repairs to defective welds using the method of inspection and acceptance as prescribed in MIL-STD-1699. Submit test reports showing compliance with MIL-STD-1699.

3.2.3 Hardness Tests

Perform Brinell hardness test in accordance with ASTM E10 and ASTM E110. The Brinell Hardness Number (BHN) of the weld and for the rail for a distance of 150 mm 6 inches on each side of the joint must be greater than 250. In the heat-affected zone (a distance not greater than 25 mm one inch to each side of the joint) the BHN may be up to 20 points lower except for the top of the rail, which must not be less than 250. Check hardness on at least 10 percent of all welds. Perform tests on randomly selected welds or as directed by the Contracting Officer. Submit test reports showing welds meet hardness requirements of this paragraph.

-- End of Section --

****
USACE / NAVFAC / AFCEC UFGS-34 60 13 (August 2024)

Preparing Activity: NAVFAC

Superseding
UFGS-11 11 37 (November 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 34 - TRANSPORTATION

SECTION 34 60 13

ELECTRIC VEHICLE CHARGING FACILITY (EVCF)

08/24

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-34 60 13 (August 2024)**

Preparing Activity: NAVFAC **Superseding**
UFGS-11 11 37 (November 2018)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 34 60 13

ELECTRIC VEHICLE CHARGING FACILITY (EVCF)
08/24

****
NOTE: This guide specification covers the requirements for charging facilities to support electric vehicles.

Coordinate with the Activity and provide specific requirements "to match existing systems" when necessary. If specifying proprietary products, insure that appropriate "Justification and Authorization (J & A)" documentation has been obtained by project manager and "proprietary language requirements" have been added to Division 1 as well as adding the following lines above the section number and title at the top of the first page of this section of the specifications:

****
This specification section contains proprietary products.
****

If there are any components (such as chargers, control systems, meters, housing, or current transformers) that will be Government Furnished Contractor Installed (GFCI), or Government Furnished Government Installed (GFGI), edit Division 1 and this specification section appropriately.

Service Tailoring Option
This specification also includes tailoring options for the Service (Air Force, Army, Navy) the specification is used for. Only ONE of the three tailoring options related to the Service should be used. You have currently included the following option(s):

ARMY
NAVY
AIR FORCE

If more than one item appears between the dashes above, you have included more than one Service's tailoring option and need to DESELECT all but one of them. If there is no text between the dashes above, you have not included any Service's tailoring options. Select ONE of the Service's tailoring options for inclusion.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C260/C260M	(2010a; R 2016) Standard Specification for

	Air-Entraining Admixtures for Concrete
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE C2	(2023) National Electrical Safety Code

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 15118	(2022) Road vehicles - Vehicle-to-Grid Communication Interface
ISO 15118-2	(2014; Reconfirmed 2020) Vehicle-to-Grid Communication Interface - Part 2: Network and Application
ISO 15118-3	(2015; Reconfirmed 2020) Vehicle-to-Grid Communication Interface - Part 3: Physical and Data Link Layer Requirements
ISO 15118-20	(2022) Vehicle-to-Grid Communication Interface - Part 20: 2nd Generation Network Layer and Application Layer Requirements

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1772	SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler
SAE J3068	(2022) SAE Electric Vehicle Power Transfer System Using a Three-Phase Capable Coupler

UL SOLUTIONS (UL)

UL 62	(2018) UL Standard for Safety Flexible Cords and Cables
UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 2202	(2022) UL Standard for Safety Electric Vehicle (EV) Charging System Equipment

UL 2231-1	(2012; Reprint Sept 2021; ANSI Approved 2021) Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits; Part 1: General Requirements
UL 2231-2	(2012; Reprint Dec 2020; ANSI Approved 2020) Standard for Personnel Protection Systems for Electrical Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems
UL 2251	(2017; Reprint Dec 2022; ANSI Approved 2022) Standard for Plugs, Receptacles and Couplers for Electric Vehicles
UL 2263	(2022) Electric Vehicle Cable
UL 2594	(2022) Electric Vehicle Supply Equipment

1.2 DEFINITIONS

1.2.1 Electric Vehicle Charging Facility

The DoD uses the term "Electric Vehicle Charging Facility" (EVCF) in place of the broader industry term "Electric Vehicle Supply Equipment" (EVSE) to differentiate between DoD equipment (EVSE) and DoD real property (EVCF). EVCF encompasses the conductors, including the ungrounded, grounded, and equipment grounding conductors and the electric vehicle connectors, attachment plugs, personnel protection system, and all other fittings, devices, power outlets, panel, or apparatus installed specifically for the purpose of transferring energy from the premises wiring to the electric vehicles (EVs). EVs include battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). There are three charging levels of EVCF:

a. Level 1 - Refers to a freestanding or wall mounted charging device with an input voltage ranging between 110-230 VAC, 1-phase, replenishing an electric vehicle (EV) battery at a rate of 4 to 6 miles of range per hour of charging time. Charging at Level 1 typically takes between 5-6 hours for a PHEV and 40-50 hours for a BEV depending on the size of the vehicle's battery.

b. Level 2 - Refers to a freestanding or wall mounted charging device capable of being networked, with an electrical output ranging between 2kW - 19.2kW, with an input voltage ranging between 208-240 VAC, 1-phase, and replenishing a EV battery at a rate from 18 - 28 miles per hour of charging time. Charging an EV at Level 2 typically takes between 1-2 hours for a PHEV and 2-10 hours for a BEV, depending on the size of the vehicle's battery.

c. Direct Current Fast Charger (DCFC) - Refers to a freestanding or wall mounted charging device capable of being networked that is designed to charge vehicles more quickly than Level 2, with an electrical output ranging between 25kW - 350kW, and an input voltage ranging between 208-600 VAC, 3-phase. DCFCs are designed to charge EV batteries up to 80 percent in 20 - 40 minutes and 100 percent in 60 - 90 minutes at an average rate of 50 - 100 miles of range per 15 minutes of charging time. DCFC is synonymous with Level 3.

1.2.2 Cable Management System

An apparatus designed to control and organize lengths of cable or cord.

1.2.3 Charger Power Converter

The device used to convert energy from the power grid to a high-frequency output for wireless power transfer.

1.2.4 Electric Vehicle Connector (Conductive Charge Coupler)

A device that, when electrically coupled (conductive or inductive) to an electric vehicle inlet, establishes an electrical connection to the electric vehicle for the purpose of power transfer and information exchange.

1.2.5 Electrical Vehicle Power Export Equipment (EVPE)

The equipment, including the outlet on the vehicle, that is used to provide electrical power at voltages greater than or equal to 30 Vac or 60 Vdc to loads external to the vehicle, using the vehicle as the source of supply.

1.2.6 Fixed In Place

Mounting means of equipment using fasteners that require a tool for removal.

1.2.7 Networked Management System

A networked management system that controls the amount of power dispensed by chargers to EVs to meet user’s charging needs while simultaneously responding to external power demand [and][or] pricing signals to provide load management, resilience, or other benefits to the electrical grid.

1.2.8 Output Cable To The Electric Vehicle

An assembly consisting of a length of flexible EV cable and an electric vehicle connector (supplying power to the electric vehicle).

1.2.9 Personnel Protection System (As Applied To EVSE)

A system of personnel protection devices and constructional features that when used together provide protection against electric shock of personnel.

1.2.10 Power-Supply Cord

An assembly consisting of an attachment plug and length of flexible cord connected to utilization equipment.

1.2.11 Listed

Equipment, materials, or services included in a list published by NRTL or an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

1.3 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving specialized power distribution equipment. Coordinate EVCF equipment with Government's cybersecurity requirements and interpretations.

****

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, Section 32 17 23.16 ROAD AND PARKING LOT PAVEMENT MARKINGS, Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS, and Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section with the additions and modifications specified herein.

1.4 SEISMIC REQUIREMENTS

****

NOTE: For use on Air Force and Army projects only. When directed to meet seismic requirements, edit Sections 13 48 73 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT to suit the project and include in the contract documents. Edit the following paragraph and include it in the project specification. When a Government designer is the Engineer of Record, provide seismic requirements on the drawings.

****

Provide seismic details[conforming to[Section 13 48 73 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT][and to] Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT][as indicated].

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

In addition, submit in accordance with paragraph COORDINATED SUBMITTAL REVIEWS herein.

****
NOTE: Bracketed submittal items correspond to bracketed paragraphs within the text. Use these submittal items when the bracketed paragraph is used.
****

SD-02 Shop Drawings

Installation Drawings; G, [_____]

[Wireless Survey; G, [_____]

] SD-03 Product Data

Output Cable to the Electric Vehicle; G, [_____]

Plug Connectors; G, [_____]

[Level 1 Plug-in EVCF; G, [_____]

][Level 2 Plug-in EVCF; G, [_____]

][DC Fast Charger EVCF; G, [_____]

] Charge Management System (CMS); G, [_____]

SD-07 Certificates

Certified Installers; G, [_____]

SD-08 Manufacturer's Instructions

Output Cable to the Electric Vehicle; G, [_____]

Plug Connectors; G, [_____]

[Level 1 Plug-in EVCF; G, [_____]

][Level 2 Plug-in EVCF; G, [_____]

][DC Fast Charger EVCF; G, [_____]

] Charge Management System (CMS); G, [_____]

SD-09 Manufacturer's Field Reports

Testing of Electric Vehicle Charging Facility; G, [_____]

SD-10 Operation and Maintenance Data

Electric Vehicle Charging Facility, Data Package 3

SD-11 Closeout Submittals

Warranty; G, [_____]

****

NOTE: Delete Record Documentation for Navy projects. Normally as-built documentation is a requirement of Division 01.

****

Record Documentation

[1.6 OPERATION AND MAINTENANCE MANUALS

Provide a list of manufacturer recommended maintenance items required for EVCF Operation.

1.6.1 Operation and Maintenance Manuals

****

NOTE: Provide number of copies based on Base needs.

****

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit [two][_____] manuals and electronic file at least 2 weeks prior to field training.

[1.6.2 Spare Parts

****

NOTE: Do not include for Navy projects.

****

Provide one spare cord and connector assembly for every [three][_____] stations installed.

]]1.7 QUALITY ASSURANCE

1.7.1 Installation Drawings

Drawings must include, but not be limited to the following:

a. Shop drawing must include installation details of EVCF equipment indicating location as proposed in design drawings, layout and arrangement of EVCF, dimensions, weights, clearances, support and mounting details, communications, conduits, meters, security systems, and all other accessories associated with the installation of the EVCF. Single-line diagrams must identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each equipment item for power, communications, and control wiring.[Include verification of wireless communications service via Wireless Survey at each location of EVCF.]

b. Shop drawings may include legible copies of manufacturer's product literature, with selected items and specifications highlighted thereon.

[1.7.2 Wireless Survey

Complete a wireless survey to verify if the wireless provider's signals meet or exceed the minimum manufacturer's recommended values.

]1.7.3 Certified Installers

Installers must be certified by EVSE manufacturer or the Electric Vehicle Infrastructure Training Program (EVITP).

Submit documentation certifying that pertinent personnel are qualified for EVSE installation. The documentation must include installation experience on a minimum of two projects of comparable size and scope of work.

1.7.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated. NECA NEIS 1 must be considered the minimum standard for workmanship.

1.7.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer and the component parts of the item must be the products of the same manufacturer. Additionally:

a. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been available on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

b. Products which are an upgraded model of equipment meeting the requirements above, are acceptable.

c. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation for not less than

6000 hours, exclusive of the manufacturer's factory or laboratory tests, is furnished.

1.7.5.1 Material and Equipment Manufacturing Date

Provide products manufactured within 2 years prior to date of delivery to site. As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices.

1.8 WARRANTY

****

NOTE: Include first bracketed option for CONUS, second bracketed option for OCONUS, or fill in the third bracket for special circumstances.

NOTE: Delete first paragraph on Navy Projects.

****

Provide equipment items supported by service organizations that are convenient to the equipment installation in order to render satisfactory service to the equipment within [24][48][_____] hours of notification during the warranty period of the contract.

Provide warranty for Materials and Workmanship of EVCF: Two [2][_____] years.

1.9 OPERATING CONDITIONS

****

NOTE: Select 50 degrees C 122 degrees F ambient temperature rating unless in areas subject to extreme temperatures (e.g., Middle East or desert environments). Use 0-95 percent relative humidity unless extreme condensation, such as in a jungle climate.

****

The equipment must be rated for continuous operation from no load to rated full load under the following conditions:

a. Ambient temperatures ranging from minus 30 to[50][55][60][65][_____] degrees C 22 to[122][131][140][149][_____] degrees F.

b. Relative humidity from [0 to 95][_____] percent noncondensing.

c. Ambient pressure from sea level to [1830][_____] meters [6000][_____] feet.

****

NOTE: Where the equipment operating conditions fall outside of the environmental conditions above, incorporate a method below to ensure the equipment can operate as intended.

****

[d. Provide a[sun shade,][environmentally controlled enclosure,][_____] to ensure the installed products meet the manufacturer's operating conditions.

]PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Provide products and materials not considered to be ELECTRIC VEHICLE CHARGING FACILITY and related accessories for power requirements as specified in[Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM,][and][Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION][and][Section 32 17 23.16 ROAD AND PARKING LOT PAVEMENT MARKINGS]. Equipment covered by the scope of this section must be listed.

2.2 ELECTRIC VEHICLE CHARGING FACILITY

2.2.1 Conductive Plug-in System Description

****

NOTE: Number and type of charging stations selection must be based on User's requirements after interviewing User to determine number and frequency of EVs to be charged. Each charger may have multiple ports to provide charge to multiple vehicles at once.

****

Electric Vehicle Charging Facility capable of charging [one] [multiple] vehicles at[Level 1][Level 2][Direct Current (DC) Fast Charger]. Equipment must have surge protection rated at [6000][_____] kV and [3000][_____]A.

[2.2.1.1 Level 1 EVCF

****

NOTE: Power levels for Electric Vehicle Charging Facility should be based on User's Projected Electric Vehicle usage. Verify power requirements for available chargers. Chargers range from 1.2-1.9 kW at 120VAC, 1-phase. Refer to NEC Article 625, 210 and 240 for sizing of conductors and overcurrent protection.

****

2.2.1.1.1 Level 1 Plug-in EVCF

UL 2251, UL 2231-1, UL 2231-2, UL 2594. Level 1, Input/Output VAC: [120][230][_____].[Input [_____] amps, output [_____] amps, [_____] kW.] Mounting: [wall-mounted][pedestal mounted][post mounted][overhead].

][2.2.1.2 Level 2 EVCF

****

NOTE: Power levels for Electric Vehicle Charging Facility should be based on User's Projected Electric Vehicle usage. Verify power requirements for available chargers. Chargers range from 2.0-19.2 kW at 208/240VAC, 1-phase. Refer to NEC Article 625, 210 and 240 for sizing of conductors and overcurrent protection.

****

2.2.1.2.1 Level 2 Plug-in EVCF

UL 2251, UL 2231-1, UL 2231-2, UL 2594. Level 2, Input/Output[208, 1-phase][208, 3-phase][230, 1-phase][400, 3-phase][480, 3-Phase] [_____].[Input [_____] amps, output [_____] amps, [_____] kW.] Mounting: [wall-mounted][pedestal mounted][post mounted][overhead].

][2.2.1.3 DC Fast Charger EVCF

****

NOTE: Power levels for Electric Vehicle Charging Facility should be based on User's Projected EV usage. Verify power requirements for available chargers. Chargers range from 25-350 kW at 480/600VAC, 3-phase. Refer to NEC Article 625, 210 and 240 for sizing of conductors and overcurrent protection.

****

2.2.1.3.1 DC Fast Charger EVCF

UL 2202, UL 2251, UL 2231-1, UL 2231-2. Input/Output VAC: [208, 3-phase][480, 3-phase][400, 3-phase][600, 3-phase] [_____].[Input [_____] amps, output [_____] amps, [_____] kW.] Mounting: [wall-mounted][pedestal mounted][overhead].

]2.2.1.4 Output Cable to the Electric Vehicle

[UL 62][or][and][UL 2263]. Cable must meet or exceed voltage and current ratings of charger.

****

NOTE: Provide length of cable for installation. Maximum cable length is 7.6 meters 25 feet unless equipped with a cable management system that is part of the listed EVCF (See NFPA 70, Article 625). Provide retractable cable management for each installation as standard practice.

****

a. [4.25 meters 14 feet][_____], minimum, UL rated [liquid cooled][_____] type charging cable with[integral retractable] cable management system.

2.2.1.5 Plug Connectors

UL 2251. Plug connector must meet or exceed voltage and current ratings or charger.

****

NOTE: Provide type of connector for installation. Coordinate the type of connector with geographical location, type of vehicle port, and charging output. North America accepts J1772, NACs, and J3068 for AC charging and CCS1, NACS, or Chademo for DC charging. EU accepts Mennekes, NACS for AC charging and CCS2, NACS for DC charging. Japan accepts J1772 for AC charging and Chademo, CCS1 for

DC charging.

****

a. CONUS - Connector Type: [SAE J1772,][CCS1,][NACS,][SAE J3068,][or][and][Chademo].

b. OCONUS - Connector Type: [SAE J1772,][CCS1,][CCS2,][Chademo,][or][and][Mennekes].

2.2.1.6 Connector Holster Dock

Provide connector holster dock to store charger plugs when not in use. Holster construction consist of high strength injection molded plastic with temperature ratings of minus 30 deg C to 50 deg C 22 deg F to 122 deg F. Provide holster to match EV plug.

2.3 EQUIPMENT ENCLOSURE

****

NOTE: For all outdoor applications at project locations with Environmental Severity Classification (ESC) factors of C4 and C5 and all indoor applications in a harsh environment, select NEMA 4X option below. In other outdoor locations, select NEMA 3R option. See UFC 1-200-01 for determination of ESC for project location. Designer to coordinate NEMA designation on drawings.

****

Provide corrosion resistant construction for outdoor use and continuous exposure to a marine environment and high humidity locations. Equipment enclosure must be NEMA Type[3R][3R Type 304 stainless steel][4X Type 304 stainless steel][4X fiberglass][4X plastic] [_____][as indicated].

2.4 CHARGE MANAGEMENT SYSTEM (CMS)

****

NOTE: NFPA 70 requires dedicated circuits for EVCF. However, an exception may be permitted to feed multiple EVSE from a single circuit when energy management systems in compliance with Section 750.30 of NFPA 70 is applied. Charge management systems provide operational and load management controls for network connected and non-network connected electric vehicle charging facilities locally from a programmable hardware controller or remotely via cloud based software.

Local control of electric vehicle charging stations is implemented by an external programmable hardware EVSE controller that is typically connected to specified number of chargers as well to a facility electric meter to primarily provide energy load management without a network connection. Where the external charge management system is not network connected, use non-network connected management system option. Where an external EVSE controller that may have options to connect to a network based

system, use network-connected charge management system option.

Electric vehicle charging facilities controlled remotely require a network connected charge management system. The cloud based charge management software uses a charging network to communicate over the internet with the charging stations and connected electric vehicles. Network connected CMS offer more advanced operation controls, energy load management, and scalability. Where cloud base charging management software is designed, use network-connected charge management system option.

****

****

NOTE: Where EVCF is designed in publicly accessible spaces for GOV and POV usage, a network connected charge management system must be selected.

****

****

NOTE: For non-network connected charge management system, provide EVCF behind a secure fence-line or some other means to limit access to only GOV vehicles. The chargers are plug-and-play, with no payment or access control features built-in.

****

[2.4.1 Non-Network Connected Charge Management System

[Provide a non-networked connected Charge Management System that will provide power to [_____] quantity of charging ports.][The system must not gather, store, report, or produce any data during the charger session.]

****

NOTE: When multiple charging ports are fed from a single circuit, an energy load management solution must be selected.

Static load management will equally distribute the available charging capacity between all charging ports. This is recommended in situations where vehicles have long dwell times as there will be a significant reduction in available power when there is high utilization of charging ports.

Programmable load management may provide a power ceiling limit during certain hours of the day, set charging schedule and limit the duration of charging sessions. This is recommended in areas of long term parking or when using interchangeable fleet vehicles.

****

[2.4.1.1 Energy Load Management

[a. Static Load Management

][b. Programmable Load Management

][c. [_____]

]]][2.4.2 Network Connected Charge Management System

****

NOTE: Include a version of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS edited specifically for electric vehicle charging facility control system where a network connected control management system is specified.

****

Provide a network connected charge management system that operates the electric vehicle charging system as described in the EVCF Control Strategies in the project plans. Submit Sequence of Operation for the Charge Management System describing the operation of the proposed charging of vehicles with any auxiliary devices as required for a complete and operable system. Sequence of Operation must provide the strategies identified in the EVCF Control Strategies. Provide a complete charge management system suitable for[access control][,][payment transaction and processing][,][energy load management][,][remote monitoring and reporting on station status][,][data collection, storing, and reporting of station usage][,][and][or][remote maintenance] through a[cloud-base management software][,][programmable controller] and other systems as indicated.

[Contractor must verify that the Charge Management System installed on any site is compatible with the base-wide Charge Management System with respect to the types of EVSE selected and the method used to program and operate the EVSE. Provide or coordinate with any software and programming tools necessary to set up the EVSE described by this specification. New software tools different from the programming methods currently used by base personnel will require an Authority to Operate (ATO) by Command Information Office at the Enterprise level.

][Contractor must verify that the Charge Management System installed on any site is compatible with the facility-wide or base-wide EVSE control.

][2.4.2.1 Charge Management System Vendor Requirements

****

NOTE: Select a bracketed option below if it is intended that the new Charge Management System be compatible with the existing system components.

****

****

NOTE: Keep this bracketed subpart ONLY for projects where the installation has obtained a J&A to downselect a particular vendor.

When keeping this subpart text:

1) Fill in the Charge Management System manufacturer and product line information. For example: "EVCF Co, Best System version 5".

2) Include the configuration setting requirements so

the equipment can be programmed in accordance with the existing Risk Management framework Authority to Operate. Obtain the equipment configuration settings from Public Works, the system owner, or local CIO office. Include these requirements as an attachment to this specification, as part of the contract drawings, or in some other manner and select the appropriate bracketed text indicating where the settings are provided.

****

The Charge Management System provided under this Section must be [_____]. Configure the equipment as indicated in[attached configuration setting requirements][the configuration settings drawings] [_____].

2.4.2.1.1 Proprietary Systems

For proprietary systems part of a J&A are exempted from open protocol requirements and a proprietary network and hardware communicating via proprietary protocol are permitted.[For these systems, a gateway or interface to connect the proprietary system to the open protocol network must be provided.]

]2.4.2.2 Network Connected Charge Management Communication Protocols

****

NOTE: Open Charge Point Protocol (OCPP) is used as the standard open-source communication protocol that governs the communication between chargers and the charging network that remotely manage the chargers. OCPP version 1.6J is being replaced with 2.0.1 which is expected to be implemented within industry by March 2024. Open Charge Point Interface (OCPI) is the open-source communication protocol that governs the communication among multiple charging networks, other communication networks, and software applications to provide information and services for users. ISO 15118 compliance is the standard vehicle to grid communication interface. Chargers should conform to ISO 15118-3 and provide hardware capable of implementing both ISO 15118-2 and ISO 15118-20.

ISO 15118-20 was released in 2022 and is the 2nd generation network layer and application requirement, which introduces higher security protocols than ISO 15118-2. Confirmation should be made for number of manufacturers who are meeting this standard prior to incorporating it. The ISO 15118-20 is not backwards compatible with ISO 15118-2. The advantage of ISO 15118-20 is stronger security protocols, including the digital certificates that are used to verify and authorize the sender, and external identification means (EIM) which includes secure payment methods (authorize EV charging session at a station).

****

****

NOTE: The EV-To-Charger Communication protocol is

satisfied when the appropriate connector type is selected.

****

a. Charger-to-Charger Network Communication: Open Charge Point Protocol (OCPP) version [1.6J][2.0.1] or higher.

[b. Charger Network-to-Charger Network Communication: Open Charge Point Interface (OCPI) version 2.2 or higher.

][c. ISO 15118 compliant, specifically ISO 15118-2, ISO 15118-3,[ISO 15118-20][and the ability to upgrade to ISO 15118-20] for[Level 2][and][DCFC].

]2.4.2.3 Charge Management System Network Connectivity

[a. WAN communication: [Cellular LTE: [3G][4G][5G][or][_____]] [Ethernet]

][b. LAN Communication: [Wi-Fi: [2.4 GHZ][and][or][5 GHZ]] [Ethernet]

][c. Provide back-up[cellular][or][Wi-Fi] network

]2.4.2.4 Charge Management System Software

****

NOTE: Select one of the next two paragraphs below for either local network-connected charge management or cloud-based management software.

Network connected charge management systems may be highly customizable with advanced options. Fleet managers can remotely control all charging stations and charging operations from a single dashboard in real-time. Charge management software can collect, store, and generate analytic-driven reports regarding charger performance, charging patterns, charging transaction, energy consumption, etc. Remote monitoring and maintenance of chargers help in early detection of any issues and offer resolutions that minimize charger downtime. Cloud-based charge management systems offer sophisticated energy load management that may dynamically distribute power based on the available capacity at the branch circuit, panel, or building service level and the demand request of each EV.

Cloud-based CMS software is the most robust option and may require tying into a base-wide EVCF charge management system.

****

****

NOTE: Where non-networked charging stations are used but the charge management system is network-connected, select local network-connected charge management option. The external controller may operate independently and without communication with EVCF. However, this will limit the options and

customization of the controls of the management system. Where network-connected chargers are used with a network-connected CMS or tying into a base-wide EVCF charge management system, select Cloud-based Charge Management Software.

****

[2.4.2.4.1 Cloud-based Charge Management Software

****

NOTE: Select all functions that may apply to the controls of the CMS as described in paragraph NETWORK CONNECTED CHARGE MANAGEMENT SYSTEM. If feature is not listed, input the feature. Where EVCF is design for public use, payment transaction and access control must be selected.

****

[a. Remote management of charging operations

][b. Transactional billing, payment, and processing

][c. [Dynamic]Energy load management

][d. Access Control Management

][e. Remote monitoring and maintenance

][f. Analytic-driven data collection, storing, and reporting operations

][g. [_____]

]][2.4.2.4.2 Local Network Connected Charge Management Software

****

NOTE: Select all functions that may apply to the controls of the CMS as described in paragraph NETWORK CONNECTED CHARGE MANAGEMENT SYSTEM. If feature is not listed, input the feature. Where EVCF is design for public use, payment transaction and access control must be selected.

****

[a. Transactional billing, payment, and processing

][b. [Programmable]Energy load management

][c. Access Control Management

][d. Analytic-driven data collection, storing, and reporting operations

][e. [_____]

]]][2.5 ACCESSORIES

****

NOTE: Provide accessories listed below as determined by user requirements and to provide a complete charge management system as described in

paragraph NON-NETWORK CONNECTED CHARGE MANAGEMENT SYSTEM or NETWORK CONNECTED CHARGE MANAGEMENT SYSTEM.
****

[a. Indicator lights to display charging status

][b. Daylight readable LCD/LED screen with auto brightness control, UV protection, and fingerprint resistant.

][c. Back-lit touch button interface keypad with audio feedback. LCD must display ready to charge, charging, charge complete, pause-waiting to charge, and fault.

][d. Capable of remote control and authorization including mobile phone application or toll free phone number.

][e. Access control via[magnetic strip,][RFID,][Near Field Communication (NFC) enabled reader,][contactless credit card reader,][and][barcode cards].

][f. Payment Card Industry (PCI) Compliant.

][g. Activation of EVCF upon identification utilizing[magnetic strip,][RFID,][and][or][barcode cards]

][h. Provide minimum four keycards/ barcodes/ RFID keys for each charger to activate the charger and its data network.

][i. Time-of-day pricing capability

][j. Nuisance tripping avoidance and auto-re-closure features

][k. Cold Load Pickup (Randomized auto restart following power outage).

][l. Real-time energy management controls.

][m. Fifteen minute energy management interval recording.

][n. EVCF must include automatic web-based tracking / metering and control connection via a cell phone service provider compatible with Electric Vehicle Management system. The web-based application must generate per vehicle kWh usage and charging times based on user input intervals. EVCF Electronic Data Interface must capture and be capable of push and pull file transfer of the parameters listed below. Web-based control capability must enable remote charger station administration and access control by the Government. Data must be User ID and Password protected.

(1) Kilowatt (kWh) data report must be compatible with Microsoft Excel.

(2) Must have option to limit usage to designated users with bar code/key card type system (locked or open access).

(3) Manufacturer control of EVCF is not allowed without prior written Government approval.

][2.6 CAST-IN-PLACE CONCRETE

****

NOTE: Coordinate the requirement for concrete pads

with user requirements.

****

****

NOTE: Use the first bracketed paragraph when project includes a concrete section in Division 3; otherwise, the second bracketed paragraph may be used. Coordinate requirements with Section 03 30 00 CAST-IN-PLACE CONCRETE.

****

[Concrete associated with electrical work for other than encasement of underground ducts must be 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. Concrete associated with electrical work for encasement of underground ducts must be 21 MPa 3,000 psi minimum 28-day compressive strength unless specified otherwise. All concrete must conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

] **

NOTE: If concrete requirements are detailed and no cast-in-place concrete section is to be included in the project specification, refer to Section 03 30 00 CAST-IN-PLACE CONCRETE, and select such portions as needed to provide complete requirements in addition to the requirements below.

****

[Must be composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture. Fine aggregate must be of hard, dense, durable, clean, and uncoated sand. The coarse aggregate must be reasonably well graded from 4.75 mm to 25 mm 3/16 inch to 1 inch. The fine and coarse aggregates must be free from injurious amounts of dirt, vegetable matter, soft fragments, or other deleterious substances. Water must be fresh, clean, and free from salts, alkali, organic matter, and other impurities. Concrete associated with electrical work for other than encasement of underground ducts must be 30 MPa 4000 psi minimum 28-day compressive strength unless specified otherwise. Concrete associated with electrical work for encasement of underground ducts must be 21 MPa 3,000 psi minimum 28-day compressive strength unless specified otherwise. Slump must not exceed 100 mm 4 inches. Retempering of concrete will not be permitted. Exposed, unformed concrete surfaces must be given a smooth, wood float finish. Concrete must be cured for a period of not less than 7 days, and concrete made with high early strength portland cement must be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer. Air entrain concrete exposed to weather using an air-entraining admixture conforming to ASTM C260/C260M. Air content must be between 4 and 6 percent.

]]2.7 MANUFACTURER'S NAMEPLATES

Each item of equipment must have a nameplate bearing, as a minimum, the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

[2.8 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings. Example would be chargers on emergency standby power.
****

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core.

[e. Provide red laminated plastic label with white center core where indicated.

] f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

g. Minimum size of nameplates: 25 by 65 mm 1 by 2.5 inches.

h. Lettering size and style: a minimum of 6.35 mm 0.25 inch high normal block style.

]2.9 PAVEMENT MARKINGS

****
NOTE: Verify base requirement and coordinate pavement markings. Coordinate with Section 32 17 23.16 ROAD AND PARKING LOT PAVEMENT MARKINGS.
****

Provide pavement markings for the vehicle charging parking spots to indicate the restrictions for electrical vehicle parking.

2.10 ELECTRIC VEHICLE CHARGING FACILITY (EVCF) SIGNAGE

****
NOTE: Coordinate signage requirements with base requirements and Manual on Uniform Traffic Control Devices (MUTCD). MUTCD Regulatory signs related to electric vehicle charging include the R7 series: 111, 111a, 112, 112a, 112b, 113, 113b, 114, 114a, and 114b.
****

Provide signage Electric Vehicle Charging Facility per the Manual on Uniform Traffic Control Devices (MUTCD) and Base standards.

2.11 WHEEL STOPS AND BOLLARDS

****
NOTE: Provide wheel stops or bollard where existing

curbing isn't present for protection of EVCF.
****

Provide wheel stops or bollards in Electrical Vehicle parking spaces to provide protection for Electric Vehicle Charging Facility.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to[IEEE C2,] NFPA 70, and to the requirements specified herein.

a. Provide chargers per manufacturer instructions and recommendations. EVCF must be programmed and configured by a certified installer.

[3.2 GROUNDING

****
NOTE: Use this paragraph when a new electrical service is being created for the EVCF system.
****

NFPA 70, ANSI/IEEE 142[and IEEE C2], except provide grounding systems with a resistance to solid earth ground not exceeding 5 ohms. Complete ground testing at proposed EVCF location with the solid earth.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

]3.3 WIRING AND CONDUIT

a. Install wiring and conduit as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM[and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION].

b. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

[3.4 FIELD APPLIED PAINTING

Where field applied painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

]3.5 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

[3.6 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

****

NOTE: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the equipment is located. Include construction requirements for concrete slab only if slab is not detailed in drawings.

****

3.6.1 Exterior Location

Mount pedestal units on concrete slab, unless otherwise indicated. The slab must be at least 200 mm 8 inches thick, reinforced with a 152 by 152 - MW19 by MW19 6 by 6 - W2.9 by W2.9 mesh placed uniformly 100 mm 4 inches from the top of the slab. Slab must be placed on a 150 mm 6 inch thick, well-compacted gravel base. Top of concrete slab must be flush where installed in pavement and walkways, and a minimum of approximately 100 mm 4 inches above the finished grade where installed in turf or other unpaved surfaces. Edges above grade must have 15 mm 1/2 inch chamfer. The slab must be of adequate size to project at least 200 mm 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter. Cut off and bush conduits 75 mm 3 inches above slab surface.

]3.7 OPERATION AND MAINTENANCE

3.7.1 Operation and Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of [2],[_____] hours for Level 1 or Level 2 and [4],[_____] hours for DC Fast Charge of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training Materials and schedule concurrently with the Operation and Maintenance Manuals and at least 30 days prior to conducting the training course.

3.8 RECORD DOCUMENTATION

****

NOTE: For use on Air Force and Army projects only.

****

Provide drawings indicating construction provided for this project. Provide electronic files and hard copies on 279 mm by 432 mm 11 inch by 17 inch paper.

3.9 FIELD QUALITY CONTROL

3.9.1 Testing of Electric Vehicle Charging Facility

Provide testing of Electric Vehicle Charging Facility with test equipment per current standards and manufacturers recommendations. Provide data submittal indicating time of charge and kW level used.

[3.9.2 Testing of Electric Vehicle Control Network

Provide testing of the Electric Vehicle Charging Facility proving EVSE is communicating with the Control system per manufacturer's recommendation. Provide data submittal indicating successful access and programming.

]3.9.3 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests. Submit reports, including acceptance criteria.

3.9.3.1 EVCF

a. Visual and mechanical inspection.

  (1) Compare equipment nameplate data with specifications and approved shop drawings.

  (2) Inspect physical and mechanical condition. Check for damage.

  (3) Inspect anchorage, alignment, and grounding.

  (4) Perform specific inspections and mechanical tests as recommended by manufacturer.

b. Electrical Tests

  (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

  (2) Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of 1,000 volts DC for 600 volt rated wiring and 500 volts DC for 300 volt rated wiring per NETA ATS to provide direct reading of resistance. All existing wiring to be reused must also be tested.

  (3) Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.

  (4) Perform control wiring performance test.

  (5) Verify voltage levels.

  (6) Check ground fault circuit interrupt.

  (7) Check pilot signal detection and verification.

  (8) Verify current limit for programmable load sharing and load capping.

  (9) Verify operation of alarms.

  (10) Verify EVCF Electronic Data Interface.

(11) If the EVCF system is connected to a distribution transformer:

  (a) Test the outgoing transformer voltage

  (b) Test the available capacity on the transformer

(12) Measure duty cycle to see max current available for charging all EVCFs.

Values of test must be within limits of manufacturer's recommendations.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-34 71 13.16 (February 2015)**

Change 1 - 05/17

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-34 71 13.16 (February 2015)**

Change 1 - 05/17

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 34 71 13.16

VEHICLE CRASH BARRIERS

02/15, CHG 1: 05/17

****

NOTE: This guide specification covers the requirements for roadside barriers.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 30	(2002; R 2010) Standard Specification for Zinc-Coated Steel Wire Rope and Fittings for Highway Guardrail
AASHTO M 180	(2012; R 2017) Standard Specification for Corrugated Sheet Steel Beams for Highway Guardrail
AASHTO MASH	(2016) Manual for Assessing Safety Hardware - Second Edition

ASTM INTERNATIONAL (ASTM)

ASTM A1	(2000; R 2018) Standard Specification for Carbon Steel Tee Rails
ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

ASTM A499	(2015, R 2020) Standard Specification for Steel Bars and Shapes, Carbon Rolled from "T" Rails
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A588/A588M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A1035/A1035M	(2024) Standard Specification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM D4956	(2013) Standard Specification for Retroreflective Sheeting for Traffic Control
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

NCHRP 350	(1993) Recommended Procedures for the

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

FHWA Acceptance Letter

SD-08 Manufacturer's Instructions

End Anchorage

Submit at least 14 days prior to installation.

Crash Cushion

Submit at least 14 days prior to installation.

PART 2 PRODUCTS

2.1 GUARDRAIL POSTS

Guardrail posts must be either wood or steel and of the dimensions indicated. Unless otherwise indicated, use only one type of post throughout the project.

2.1.1 Sawn Wood Posts and Offset Blocks

****

NOTE: Include reference to applicable State DOT specification for wood posts and offset blocks.

****

Except as otherwise specified herein, provide wood posts and offset blocks as specified in [_____]. Posts and offset blocks must be of stress grade and capable of resisting a working stress of 11 MPa 1600 psi on the extreme fibers when subjected to bending. Posts and blocks must be double end trimmed with the mounting bolt hole in each being drilled 2 mm 1/16 inch oversize and within 13 mm 1/2 inch of the specified location on either side of the post or block. All wood posts and offset blocks must be rough, free of wane, squarecut, and fully sawn to the dimensions indicated. Drill post bolt holes before preservative treatment is applied. Unless otherwise approved, use only one preservative on the project.

2.1.2 Steel Posts

Fabricate "H" beam sections from steel conforming to either ASTM A36/A36M, ASTM A588/A588M or ASTM A242/A242M and conforming to the size, weight and dimensions indicated. Use bolts must be of the diameters indicated. Bolts used with galvanized ASTM A36/A36M steel must conform to ASTM A307. ASTM F3125/F3125M, Type 3 bolts may be used with ASTM A588/A588M or ASTM A242/A242M steel without galvanizing. Galvanize bolts, posts, and all necessary hardware fabricated from ASTM A36/A36M steel in accordance with ASTM A123/A123M.

2.1.3 Polymer and Polymer Composite Offset Blocks

Pprovide polymer and polymer composite offset blocks certified by the Federal Highway Administration (FHWA) to meet the requirements of either NCHRP 350 or AASHTO MASH. Submit a copy of the FHWA Acceptance Letter.

2.2 W-BEAM GUARDRAIL

Provide galvanized steel beam guard rail elements and fittings of the indicated design and details. The finished steel beam elements must be Class A (base metal nominal thickness 2.67 mm 0.105 inch and conform to the requirements of AASHTO M 180. Galvanizing of steel beam elements must be Type 1 (zinc coated 550 grams per square meter 1.80 ounces per square foot, minimum single spot) and must conform to the requirements of AASHTO M 180.

2.3 "W' BEAM END SECTION

Provide "W" beam end sections of the same or greater thickness of metal and the same type as the beam to which it is attached.

2.4 GUARDRAIL HARDWARE

All fittings (bolts, nuts, washers, etc.) for guardrail must conform to the requirements of AASHTO M 180.

Bolt Use	Bolt Size and Configuration	
Rival Splices	16 mm 5/8 inch diameter	Button head type with oval shoulder conforming to alternative No. 1 or 2 configuration of AASHTO M 180
Fastening Rail to Steel or Timber Blocks	16 mm 5/8 inch diameter	Button head type with oval shoulder conforming to alternative No. 1 or 2 configuration of AASHTO M 180
Rail Splices	35 mm 1.25 inches long	
Fastening Rail to Steel Block	50 mm 2 inches long	Minimum thread length of 45 mm 1.5 inches
Fastening Rail to Timber Block and Post	460 mm 18 inches long	Minimum thread length of 100 mm 2.5 inches
Fastening Steel Block to Post	50 mm 1.5 inches long	16 mm 5/8 inch diameter hex head type

2.5 TERMINAL FOR W-BEAM GUARDRAIL

****

NOTE: Guardrail terminals must meet the crashworthiness criteria of NCHRP 350 or the Manual for Assessing Safety of Hardware (MASH). FHWA acceptance letters for various end treatments are available on the FHWA Safety Program webpage.

TL-1, TL-2 and TL-3 are conducted at speeds of 50 km/h, 70 km/h, and 100 km/h respectively. The tests conducted depend on whether the terminal is a gating or nongating device. A gating device is one designed to allow controlled penetration of the vehicle when impacted between the end and the beginning of the length of need of the device. A nongating device is designed to contain and redirect a vehicle when impacted downstream from the end of the device.

****

Provide a [flared] [Eccentric Loader Terminal (ELT)] [Modified Eccentric Loader Terminal (SRT)] [Flared Energy-Absorbing Terminal (FLEAT)] [Slotted Rail Terminal (SRT-350)] [tangent] [Extruder Terminal (ET-Plus)] [Sequential Kinking Terminal (SKT-350)] terminal for w-beam guardrail. Provide terminal certified by the Federal Highway Administration (FHWA) to meet the requirements for Test Level [2] [3] of NCHRP 350 or AASHTO MASH. Submit a copy of the FHWA Acceptance Letter.

2.6 CABLE BARRIER

****

NOTE: See the AASHTO "Roadside Design Guide" and

NCHRP Report 711 "Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems" for information on cable barrier systems.
****

2.6.1 Cable

Provide 19 mm 3/4 inch, Type I, Class A coating in accordance with AASHTO M 30.

2.6.2 Cable Splices, Ends, Fittings

Design cable splices and ends capable of developing the full breaking strength of the cable (110 kN) (25,000 lbs). Cable ends must be cast steel or malleable iron. Cable wedges must be malleable iron and not be galvanized. Conform cast steel fittings to ASTM A27/A27M, grade 485-250 70-36. Conform maleable iron fittings to ASTM A47/A47M. Galvanize cable splices, ends, and fittings in accordance with ASTM A123/A123M.

2.6.3 Compensating Device

Provide compensating devices with a spring rate of 78.8 newtons 450 lbs plus or minus 8.8 newtons 50 lbs per millimeter inch and a minimum total available travel of 150 mm 6 inches. Galvanize all parts in accordance with ASTM A153/A153M.

2.6.4 Hook Bolts

Provide hook bolts conforming to ASTM A307 Grade A with a tensile strength of 400 MPa 60 ksi and a yield strength of 240 MPa 36 ksi. Provide corrosion-resistant bolts manufactured from ASTM F3125/F3125M Type 3 material, with a tensile strength of 830 MPa 120 ksi and a yield strength of 660 MPA 92 ksi. Hook bolts must develop an ultimate pull open strength, applied in a direction normal to the longitudinal axis of the post, from 2 to 4.5 kN 500 to 1000 pounds. Use galvanized nuts conforming to ASTM A563M Class 5 ASTM A563 Grade A. Use corrosion-resistant nuts conforming to ASTM A563M Grade 8S3 ASTM A563 Grade C3. Finish galvanized bolts and nuts according to ASTM A153/A153M for Class C or ASTM B695 for Class 50. If galvanized, overlap the threads as specified in ASTM A563MASTM A563.

2.6.5 Steel Posts

****
NOTE: Cable guardrail designs typically include either structural steel I beam posts or flanged channel steel posts.
****

2.6.5.1 Structural Steel Posts

Provide structural steel posts and anchor plates conforming to ASTM A36/A36M. Galvanize in accordance with ASTM A123/A123M.

2.6.5.2 Flanged Channel Posts

Fabricate flanged channel posts from rerolled rail steel bars conforming to ASTM A499, Grade 415 60 except that the minimum yield strength must be 480 Mpa 70,000 psi. The post must meet the chemical properties of ASTM A1 for rails 44.56 kg/m 30 pounds per foot and heavier.

2.6.6 Anchor Assembly

****

NOTE: Cable is typically anchored to a concrete foundation with steel rods or hook or J bolts.

****

Provide steel cable anchor brackets conforming to ASTM A709/A709M Grade 250 36 or ASTM A36/A36M.[Provide anchor posts and anchor post plates conforming to ASTM A36/A36M.] Galvanize cable anchor brackets[, anchor posts, and anchor post plates] after fabrication in accordance with ASTM A123/A123M. Provide steel [rods] [hook or J bolts] conforming to ASTM A449 or ASTM A568/A568M and galvanize the top 150 mm 6 inches in accordance with ASTM A123/A123M. Provide hex nuts conforming to ASTM A563M ASTM A563.

2.6.7 Concrete

ASTM C94/C94M, using 19 mm 3/4 inch maximum aggregate, and having minimum compressive strength of 28 MPa 4000 psi at 28 days. Reinforcing steel must be deformed bars conforming to ASTM A615/A615M, ASTM A706/A706M, or ASTM A1035/A1035M grade 280 40.

2.7 CRASH CUSHION

Provide redirective, non-gating, bi-directional type crash cushion as indicated. Crash cushion must be certified by the Federal Highway Administration (FHWA) to meet the requirements for Test Level [2] [3] of NCHRP 350 or AASHTO MASH. Submit a copy of the FHWA Acceptance Letter.

2.8 RETROREFLECTIVE SHEETING

Provide retroreflective sheeting conforming to ASTM D4956, Type III, IV, V, VII, VIII, IX or XI. All retroreflective sheeting must have a precoated adhesive which will permanently adhere to the metal surface.

PART 3 EXECUTION

3.1 POSTS

Posts may be placed by driving or by setting in excavated holes. Post holes for guardrail posts must be round and at least 100 mm 4 inches larger, in diameter, than the greater dimensions (not the diagonal) of the posts, and must be backfilled around the posts with material removed or other suitable soil, placed in lifts not exceeding 100 mm 4 inches, each lift thoroughly tamped. When placed by driving, drive the posts plumb, to the depth and in the position indicated. Remove posts which are broomed, split or damaged in any other way and replace with a sound post. Carry on driving operations in such manner that nearby structures, shoulders, or pavements are not damaged. Cuts and abrasions in preservative-treated posts and blocks must have the newly exposed surfaces treated with at least three applications of the same type of preservative with which the material was originally treated. Each application must be reasonably dry before the succeeding coat is applied. At the time a timber post is installed, any seasoning check which extends the full length of the piece cannot exceed 6 mm 1/4 inch in width. Adjust posts used for vertical transition in length so that a minimum of 1550 mm 60 inches will be buried. Where guardrail cross buried structures and 1550 mm 60 inches of bury is not obtainable, install the guardrail post as deep as possible and with a 610 mm 24 inch diameter concrete encasement for the full depth of bury.

3.2 GUARDRAIL BEAM ELEMENTS

Place and fasten the beam elements, fittings, and other parts of the guardrail as indicated. Erect the elements to produce a smooth, even rail, closely conforming to a line and grade parallel to the pavement. Bolt the beam elements to each post, and make splices by lapping in the direction of traffic. Splice only at posts. Where the rail is on a curve, the beams at the splice must make contact throughout the area of the splice, forming a continuous beam before erection. On curves of 45 m 150 foot radius or less, install shop bent beam elements, bent to the radius indicated. Tighten all bolts in the finished rail.

3.3 GUARDRAIL DELINEATOR REFLECTOR TABS

****

NOTE: This paragraph is applicable for metal guardrail delineator tabs with retroreflective sheeting. Delete paragraph if other types of delineators are used.

****

Clean, degrease and etch the face of metal tabs using methods recommended by the retroreflective sheeting manufacturer. After cleaning and degreasing, apply retroreflective sheeting material to the metal tabs as recommended by the manufacturer. Perform shearing, cutting and punching prior to preparing the blanks for application of reflective material.

3.4 GUARDRAIL END ANCHORAGE

Install flared and non-flared end anchorages in accordance with the manufacturer's instructions. Submit a copy of the manufacturer's end anchorage installation instructions prior to installation.

3.5 THREE CABLE GUARDRAIL

3.5.1 Posts

Set all posts plumb and firm and spaced as indicated. Posts may be power driven or set by hand. Protect the top of steel posts by a suitable driving cap if power driven.

3.5.2 Cable Splices, Compensating Devices and Turnbuckle Cable End Assemblies

Stagger cable splices. Provide a minimum of 6 m 20 feet between any pair. Provide a minimum of 30 m 100 feet between cable splices on the same cable. For length of cable runs up to 305 m 1000 feet, use a compensating device on one end and a turnbuckle on the other end of each individual cable. For length of cable runs from 305 m 1000 feet to 610 m 2000 feet, use a compensating device on the ends of each individual cable. For length of cable runs over 610 m 2000 feet, start a new stretch by interlacing at the last parallel post.

3.5.3 Pretension of Cable

Install and tension the cable barrier as follows:

a. Properly seat the spring in the compensator device and permanently mark the unloaded spring position on the compensator rod.

b. Install spring end assemblies at one end of the barrier and secure to the anchor.

c. With cable strung through the hook bolts, introduce tension into the cable at the opposite end of the barrier to compress the installed springs approximately 90 mm 3.5 inches.

d. Clamp this tension in the cable while the end assemblies are installed at the second anchor.

e. Remove the slack between the clamp point and the second anchor by taking up the turnbuckle. If springs are also used at this end, compress them approximately 90 mm 3.5 inches.

****

NOTE: The cable barrier detail drawing should include a table indicating the required spring compression from the unloaded position for various temperatures.

****

f. After two weeks at this setting, reset the spring compression as indicated based on the temperature at the time of adjustment.

3.6 CRASH CUSHION

Assemble and install crash cushions as indicated and in accordance with the manufacturer's instructions. Submit a copy of crash cushion manufacturer's installation instructions.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-34 73 13 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-34 73 13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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AIRCRAFT TIEDOWNS

11/19

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****

USACE / NAVFAC / AFCEC **UFGS-34 73 13 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-34 73 13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 34 73 13

AIRCRAFT TIEDOWNS

11/19

****

NOTE: This guide specification covers requirements for aircraft tiedowns for Army and Air Force aircraft.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: It is recommended that this specification, and other contract requirements for mooring be coordinated with UFC 3-260-01, Airfield and Heliport Planning and Design.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C536	(1983; R 2018) Standard Test Method for Continuity of Coatings in Glassed Steel Equipment by Electrical Testing

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 81-123	(1981) Occupational Health Guideline for Chemical Hazards, (Vols. I, II, and III)

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item,

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

As-Built Drawings; G, [_____]

SD-06 Test Reports

Concrete; G, [_____]

SD-07 Certificates

Mooring Devices

Reinforcing Steel

1.3 AS-BUILT DRAWINGS

Submit as-built drawings that provide current factual information, including deviations from and amendments to the drawings and changes in the work, concealed and visible.

PART 2 PRODUCTS

2.1 MATERIALS

Do not use a combination of materials that forms an electrolytic couple, which accelerates corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such metals.

2.2 MOORING DEVICES

Cast mooring devices in ductile iron 80-55-06 in accordance with ASTM C536, unless otherwise indicated. Show the device in the contract drawings. Submit certificates of compliance on the devices stating that the mooring devices meet the specified requirements.

2.3 CONCRETE

****

NOTE: High-early-strength (Type III) cement is recommended. If Type III cement is not available, Types I and II cement are acceptable. However, Types I and II will increase the downtime before the mooring eye can be engaged. Allow the concrete to achieve a minimum compressive strength of 35 MPa 5000 psi before subjecting the tie-down to loading conditions. A 40 MPa 6000 psi concrete with Type III cement could be loaded in 48 to 72 hours. Conversely, a 40 MPa 6000 psi mix with Type I or II cement cannot be loaded for 12 to 14 days.

A 28-day 40 MPa 6000 psi compressive strength concrete is required for mooring point installation in drilled piers and in cored existing pavements. New rigid pavement 150 mm 6 inc or greater in thickness with a minimum 90-day flexural strength of 3.5 MPa 500 psi will be adequate for cast-in-place mooring point installation. Remove this paragraph if concrete is not required. If concrete is specified in another section, delete this paragraph.

****

Submit complete concrete mix design including all cement, aggregate, and concrete tests and compliance certificates. Use concrete in accordance with [Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS] [ASTM C94/C94M]. Use air entrained concrete havinga minimum compressive strength of 40 MPa 6000 psi. Use concrete with the following properties: nominal maximum aggregate size of 25 mm 1 in, air content of 6 percent, and a maximum slump of [100 mm 4 in for drilled piers] [and] [50 mm 2 in for all other applications].

2.4 REINFORCING STEEL

Use reinforcing steel in accordance with ASTM A615/A615M Grade 40 or 60 for #4 tie bars and Grade 60 for #6 vertical bars. Weld steel into cages in accordance with AWS D1.4/D1.4M and insert securely in the piers, in position and alignment, as shown in the drawings, prior to concrete placement. Submit certificates of compliance stating that the reinforcing steel meets the specified requirements.

PART 3 EXECUTION

3.1 MOORING POINTS IN NEW RIGID PAVEMENTS OR CONCRETE PADS

Install the mooring device within plus or minus 50 mm 2 in of the location shown on the contract drawings. Set the top of the mooring device within 6 mm 1/4 in of the plan pavement surface elevation, but not higher than the pavement surface. Install the mooring device prior to placement of the concrete pavement. Place concrete and reinforcement in accordance with Section [03 30 00 CAST-IN-PLACE CONCRETE][03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE]. Keep hand finishing of the concrete around the mooring devices to a minimum.

3.2 MOORING POINTS IN EXISTING RIGID PAVEMENTS

****

NOTE: Existing rigid pavement must be equal to or greater than 150 mm 6 in thick and in good condition, with very few cracked slabs. This is required to provide adequate mass to resist the horizontal component of the mooring point load.

****

Install the mooring points, unless otherwise indicated, in 305 plus or minus 13 mm 12 plus or minus 1/2 in diameter holes cored through the pavement. Drill the core holes within plus or minus 38 mm 1-1/2 in of the location shown in the contract drawings. Install the mooring device and attached grounding rod within plus or minus 13 mm 1/2 in of the center of the core hole. Install the top of the mooring device within 6 mm 1/4 in of the surrounding pavement surfaces, but not higher.

3.2.1 Coring Requirements

Core the holes using rotary, non-percussion drilling techniques. Check that the sides of the core hole are perpendicular to the pavement surface. Once the pavement is cored, excavate base course as shown in the drawings. Clean the sides of the core hole of latence and roughen by sand blasting. Place the concrete around the mooring device in two or more lifts. Place the first lift to within 125 plus or minus 6.5 mm 5 plus or minus 1/4 in of the pavement surface and consolidate by spud vibrators. Place the second lift and consolidate by internal vibration. Finish and texture the surface of the concrete to match the adjacent pavement surface and elevation. Uniformly apply curing compound meeting the requirements of ASTM C309 at a coverage of not more than 4.5 square m/L 200 square ft per gal.

3.2.2 Cleanup

Control all operations to minimize the amount of dust, dirt, debris and laitance in the work area. Clean all dirt, dust, debris, or laitance from coring or concreting operations, from the pavement surfaces prior to final acceptance.

3.3 MOORING POINTS INSTALLED IN DRILLED PIERS

Coordinate excavation of piers so that reinforcing steel and concrete placement is a continuous operation performed the same day that the excavation is completed. Do not leave excavations open overnight. Place concrete within 3 hours after approval of the completed pier excavation. Use pier drilling equipment having the minimum torque capacity and downward force capacity for the contract site conditions.

3.3.1 Government Inspection

The Contracting Officer will inspect each drilled pier excavation. Do not place concrete until the excavation has been approved. Make equipment used for drilled pier excavations available to the Contracting Officer for inspection and approval.

3.3.2 Installation Procedures

Excavate piers to the depths and dimensions shown in the drawings. Core drill piers through pavements. Clean bottoms of piers of loose or soft material and leveled. Dispose of excavated material in accordance with Section 31 00 00 EARTHWORK. Perform the following:

a. Adequately and securely protect the surrounding base courses, subgrade, and soil against cave-ins, displacement of the surrounding earth, and retention of ground water by means of temporary steel casings. Use casings with outside diameters not less than the indicated shaft sizes and a minimum thickness of 6 mm 1/4-in. Withdraw steel casings as the concrete is being placed, maintaining sufficient head of concrete within the casing to prevent extraneous material from falling in from the sides and mixing with the concrete. Allow casings to be jerked upward a maximum of 100 mm 4 in to break the bottom seal; but, thereafter, remove with a smooth, continuous motion.

b. Clean and oil the inside of steel casing before reuse.

c. Remove water that flows into the excavations and water from the excavation bottom prior to concrete placement. The maximum permissible depth of water is 50 mm 2 inch. In the event of a severe water condition that makes it impossible or impractical to dewater the excavation, place concrete using underwater tremie after water movement has stabilized.

d. Fill the entire shaft excavation with concrete of the approved mix design. Place concrete continuously as practical while preventing segregation of the wet mix and dislodging of soil within the sidewalls of the excavation. Place concrete by pumping or drop chutes in dry holes and by tremie or pumping in wet holes. Keep the discharge a minimum of 305 mm 1 ft below the fresh concrete surface during placement. Deposit concrete continuously as practical to prevent formation of cold joints within each pier. Immediately consolidate the freshly deposited concrete within the upper 1.5 m 5 ft using spud vibrators.

e. Correct any pier out-of-center or out-of-plumb beyond the specified tolerance for compliance; the Contractor will bear any cost of correction. Do not allow cross sections of shafts to be less than design dimensions as shown in the drawings. Install piers at the locations designated on the approved project plans within 50 mm 2 in of the design centerline locations.

f. Install the mooring device within plus or minus 25 mm 1 in of the center of the drilled pier. Measure that the top of the mooring device is within 6 mm 1/4 in of the top of the pier, but not higher.

g. Replace all piers found to be out-of-tolerance at no additional cost to the government.

h. Provide protection around top of the excavation to prevent debris from being dislodged into the excavation and concrete.

3.4 SAFETY

In addition to Safety Requirements contained in the Contract Clauses;

prevent employee respiratory, eye or skin contact with Portland cement. Provide and require employees to use and dispose or clean the following in accordance with the provisions of the National Institute for Occupational Safety and Health NIOSH 81-123:

a. Impervious clothing, boots, and gloves.

b. Splash-proof safety goggles and face shields.

c. Respiratory protection equipment.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-34 73 16 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-34 73 13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 34 - TRANSPORTATION

SECTION 34 73 16

AIRFIELD GROUNDING

11/19

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-34 73 16 (November 2019)**

Preparing Activity: USACE **Superseding**
UFGS-34 73 13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 34 73 16

AIRFIELD GROUNDING
11/19

****

NOTE: This guide specification covers requirements for airfield grounding points.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: Specify the items to provide ground points with a resistance of no more than 10,000 ohms to ground if the resistance of the surrounding soil or rock is less than 2 000 000 ohm-centimeters. In high resistivity soils of over 2 000 000 ohm-centimeters, allow 3 m 10 ft or sectional rods to be used to obtain the required resistivity to ground; however, where rock is encountered, additional rods, a counterpoise, or ground grid may be necessary. Allow resistance to ground for static electricity dissipation to be as much as 1 000 000 ohms. Static grounds are not designed for aircraft lightning protection or for equipment grounding.

It is recommended that this specification, and other

contract requirements for grounding points, be coordinated with UFC 3-260-01, Airfield and Heliport Planning and Design.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B371/B371M	(2008; R 2013) Standard Specification for Copper-Zinc-Silicon Alloy Rod

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 407	(2022; TIA 24-2) Standard for Aircraft Fuel Servicing

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

As-Built Drawings; G, [_____]

SD-06 Test Reports

Tests

SD-07 Certificates

Grounding Rods

Copper Conductors

Grounding Connectors

1.3 AS-BUILT DRAWINGS

Submit as-built drawngs that provide current factual information, including deviations from and amendments to the drawings and changes in the work, concealed and visible.

PART 2 PRODUCTS

2.1 METALS

Do not use a combination of materials that forms an electrolytic couple, which accelerates corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such metals.

2.2 GROUNDING RODS

Use grounding rods, unless otherwise indicated, in accordance with UL 467 and made of copper-clad steel, copper, galvanized steel, or copper-zinc-silicone alloy. Use rods not less than 19 mm 3/4 in in diameter and not less than 3 m 10 ft long. Use copper cladding in accordance with ASTM B371/B371M, Copper Alloy UNS No's. c 69400, c 69430, c 69440 or c 69450. Use copper cladding not less than 0.25 mm 0.010 in thick at any point and complying with adherence requirements and the banding requirements of UL 467. Submit certificates of compliance stating that the grounding rods meet the specified requirements. Provide rods with a closed eye or shepherd's hook bend having an inside diameter of not less than 38 mm 1-1/2 in. [Use pointed rods unless used for flexible pavement.] [For flexible pavement, use rods having 19 mm 3/4 in American standard rolled threads for attachment of a bottom anchor and equipped with a screw-type bottom having a wing diameter of not less than 127 mm 5 in.]

2.3 COPPER CONDUCTORS

Use copper conductors that bare number 4 AWG copper wire in accordance with ASTM B8. Submit certificates of compliance stating that the copper conductors meet the specified requirements.

2.4 GROUNDING CONNECTORS

Use grounding connectors that comply with UL 467 for the required application. Submit certificates of compliance stating that the grounding connectors meet the specified requirements.

PART 3 EXECUTION

Prior to installing grounding rods, obtain approved digging permits in accordance with Section 01 11 00 SUMMARY OF WORK.

****

NOTE: Remove types of grounding point installations not needed.

****

3.1 GROUNDING POINTS

Locate the grounding points as shown on the drawings to within plus or minus 50 mm 2 in.

3.1.1 Pavement Recess

Set the top of the grounding rod at or not more than 6 mm 1/4 in below the pavement surface grade. Provide a recess 75 mm 3 in wide, and not more than 150 mm 6 in long, with a smooth rounded edge in the pavement around the grounding point anchor eye to permit the entrance of lines into the eye and to allow for attachment of the grounding cable. Do not allow the depth of the recess to be deeper than the bottom of the opening of the grounding point eye.

3.1.2 Installation

3.1.2.1 Existing Rigid Pavement

Install grounding rods in holes cored through the rigid pavement using rotary, non-percussion drilling techniques. Check that the core holes have a minimum diameter of 150 mm 6 in. Check that the sides of the core hole are perpendicular to the pavement surface. Install the grounding rod by pushing or driving the rod through the pavement base courses and subgrade. Do not allow the installation technique chosen to damage the grounding rod or the pavement. Complete installation by placing concrete around the grounding rod in lifts not to exceed 150 mm 6 in in depth and consolidate each lift using spud vibrators.

3.1.2.2 New Rigid Pavement

Install the grounding rod by pushing or driving the rod through the pavement base courses and subgrade prior to concrete placement. Do not allow the installation technique chosen to damage the grounding rod. Keep hand finishing around the rod to a minimum.

3.1.2.3 Flexible Pavement

Install grounding rods in Portland cement concrete blockouts measuring 1.2 by 1.2 m 4 by 4 ft in plan dimensions. The thickness and reinforcing details are shown on the drawings. Install the grounding rod by pushing or driving the rod through the pavement base courses and subgrade prior to concrete placement. Do not allow the installation technique chosen to damage the grounding rod. Keep hand finishing around the rod to a minimum.

3.1.3 Interconnection

For grounding rods installed at fueling hydrant outlets, electrically interconnect with the fuel piping with not less than a number 4 AWG bare copper conductor.

3.2 TESTS

Submit an independent testing agency's certified reports of inspections and tests, including analysis and interpretation of test results. Properly identify each report. Describe test methods and standards used. Measure resistance to ground tests as specified in NFPA 407. Submit test results to the Contracting Officer. Report immediately to the Contracting Officer ground rods that have more than 10,000 ohms of resistance.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-34 75 13.13 (February 2022)**

Preparing Activity: USACE **Superseding**
UFGS-34 71 13.19 (February 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 34 - TRANSPORTATION

SECTION 34 75 13.13

CRASH RATED ACTIVE VEHICLE BARRIERS AND CONTROLS

02/22

PART 1 GENERAL

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-34 75 13.13 (February 2022)**

Preparing Activity: USACE

Superseding
UFGS-34 71 13.19 (February 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 34 75 13.13

CRASH RATED ACTIVE VEHICLE BARRIERS AND CONTROLS

02/22

****

NOTE: This guide specification covers the requirements for the design of a crash rated active vehicle barrier system where the crash rated active vehicle barriers can consist of a portable, semi-permanent, permanent, power-assisted or manually deployed crash rated active vehicle barriers, covers the active vehicle barrier control system, and non-crash rated actuated traffic arms. Designer should consult UFC 4-022-01 Entry Control Facilities Access Control Points at https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-4-022-01 and for Army projects consult the Access Control Point Standard and Standard Design Criteria. This specification supercedes previous versions of 34 71 13.19 Active Vehicle Barriers and replaces 34 41 26.00 10 Access Control Point Control System.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-1-300-02 when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a criteria change request at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs

****

PART 1 GENERAL

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NOTE: The design of an access control point/entry control facility (ACP/ECF) must be fully engineered to ensure compliance with the appropriate Army, Navy or Air Force Standards for ACPs/ECFs. Using these standards and criteria, the designer must prepare an ACP/ECF project specific design including the drawings as indicated herein. The project specific drawings along with this edited performance specification must be included in the procurement documents for the ACP/ECF crash rated active vehicle barrier (AVB) control system.

Drawings must identify the following: active and passive vehicle barrier locations, overspeed and wrong way detection zones, Closed Circuit Television (CCTV) camera coverage areas, Intrusion Detection Sensor and tamper switch locations, duress alarm locations, traffic signal and warning beacon locations, actuated traffic arm locations, and incidental construction. Provide active barrier control panels locations and layouts and sequence of operation.

Army Project: ACP Standard Design Drawings can be used in the development of the requirements herein. However, if changes to the control panels from the drawings are made, the designer is responsible for ensuring the changes are reflected.

****

This UFGS replaces UFGS 34 75 13.19. All references in other documents, standards, and criteria to 34 75 13.19 now apply to 34 75 13.13.

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO GDHS-7	(2018; Errata 2019) A Policy on Geometric Design of Highways and Streets
AASHTO LTS	(2013; Errata 2013) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
AASHTO RSDG-4	(2011; Errata 1 2012; Errata 2 2015) Roadside Design Guide

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM D4956	(2013) Standard Specification for Retroreflective Sheeting for Traffic Control
ASTM F2656/F2656M	(2023) Standard Test Method for Crash Testing of Vehicle Security Barriers

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60068-2-27	(2008; ED 4.0) Environmental Testing - Part 2-27: Tests - Test Ea and Guidance: Shock
IEC 60068-2-30	(2005; ED 3.0) Environmental Testing - Part 2-30: Tests - Test Db: Damp Heat, Cyclic (12 H + 12 H Cycle)
IEC 61000-4-5	(2017) Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test
IEC 61131-3	(2013) Programmable Controllers - Part 3: Programming Languages

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO ISO/IEC 17025	(2017) General Requirements for the Competence of Testing and Calibration Laboratories

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA MG 1	(2021) Motors and Generators
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TS-1	(1989; R 2020) Traffic Control Systems (not recommended for new designs)
NEMA TS-2	(2021) Traffic Controller Assemblies with NTCIP Requirements - Version 03.08

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J517	(2020) Hydraulic Hose

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8500.01	(2014; Change 1-2019) Cybersecurity
DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices
NCHRP 350	(1993) Recommended Procedures for the Safety Performance Evaluation of Highway Features

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

21 CFR 1040	Performance Standards for Light-Emitting Products
29 CFR 1910	Occupational Safety and Health Standards
47 CFR 15	Radio Frequency Devices

UL SOLUTIONS (UL)

UL 486A-486B	(2018; Reprint Jul 2023) UL Standard for Safety Wire Connectors
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 796	(2020; Reprint Oct 2023) UL Standard for Safety Printed Wiring Boards
UL 1059	(2024) UL Standard for Safety Terminal Blocks
UL 1076	(2018; Reprint Feb 2021) UL Standard for Safety Proprietary Burglar Alarm Units and Systems

1.2 ABBREVIATIONS AND DEFINITIONS

1.2.1 Abbreviations

a. ACP - Access Control Point
b. AIE - Automated Installation Entry
c. AVB - Active Vehicle Barrier
d. AVBCS - Active Vehicle Barrier Control System
e. BMS - Balanced Magnetic Switch
f. CCTV - Closed Circuit Television System
g. CPU - Central Processing Unit (Computer)
h. CSMS - Central Security Monitoring Station (e.g., Installation Police Station)
i. CVT - Contractor Verification Test
j. DTS - Data Transmission System
k. ECF - Entry Control Facility
l. EFO - Emergency Fast Operate (active barrier emergency fast close control)
m. FAT - Factory Acceptance Test
n. IDS - Intrusion Detection System
o. PLC - Programmable Logic Controller
p. PVT - Performance Verification Test
q. RSM - Remote Status Monitor
r. SDC - Standard Design/Criteria
s. SDDC - Surface Deployment and Distribution Command
t. SDDCTEA - Surface Deployment and Distribution Command Traffic Engineering Agency
u. TCU - Traffic Controller Unit
v. UPS - Uninterruptible Power Supply
w. VCC - Visitors Control Center
x. VPD - Vehicle Presence Detector

1.2.2 Definitions

Command & Control. Command & Control function refers to location the main guard will be located to oversee the activity at the ECF/ACP. This is typically the Gatehouse, but not in all cases.

Crash-rated active vehicle barrier. Crash-rated active vehicle barrier and active vehicle barrier in this specification refer to a vehicle barrier that has been tested to impede or stop a vehicle of a specific weight and speed. The barrier is operable either manually or through electrical controls.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overall System Drawings; G, [_____]

Point to Point Wiring Information; G, [_____]

TRAFFIC CONTROL PLANS; G, [_____]

crash rated active vehicle barrier system; G, [_____]

Installation; G, [_____]

Electrical Work; G, [_____]

Touchscreen; G, [_____]

SD-03 Product Data

[Major Components; G, [_____]

][Data Package; G, [_____]

] CRASH RESISTANCE: DEMONSTRATION OF COMPLIANCE; G, [_____]

Hydraulic Fluid manufacturer's data; G, [_____]

SD-05 Design Data

traffic signal support design calculations; G, [_____]

UPS Calculations; G, [_____]

Generic Design and Contract Revisions; G, [_____]

SD-06 Test Reports

Crash Test Reports; G, [_____]

Current Site Conditions; G, [_____]

KEY CONTROL PLAN; G, [_____]

Factory Acceptance Test; G, [_____]

Factory Acceptance Test Report; G, [_____]

Contractor Verification Test; G, [_____]

Contractor Verification Test Report; G, [_____]

Performance Verification Test (PVT); G, [_____]

Performance Verification Test Report; G, [_____]

Endurance Test; G, [_____]

Final Report; G, [_____]

SD-07 Certificates

COMPONENT CERTIFICATION; G, [_____]

Cybersecurity Equipment Certification; G, [_____]

Cybersecurity Installation Certification; G, [_____]

Installation Superintendent Qualifications; G, [_____]

Project Manager Qualifications; G, [_____]

TECHNICAL SPECIALISTS QUALIFICATIONS; G, [_____]

SD-08 Manufacturer's Instructions

Manufacturer Repair of Coatings Instructions; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

OPERATING AND MAINTENANCE INSTRUCTIONS; G, [_____]

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, Controls O&M Data Package and the requirements herein.

1.4 INSTALLATION PACKAGE

Submit Installation package [120][150] days after receipt of the Notice to Proceed. The installation package consists of the overall system drawings, major components and data package.

1.4.1 Overall System Drawings

Include the following in overall system drawing package:

a. Functional System Block Diagram, identifying all major equipment including interconnection between components specified herein and those furnished under other sections and communications protocols.

(1) Indicate control/signal and data communication paths and identify PLCs, control interface devices, and media to be used

(2) Describe characteristics of network and other data communication lines.

(3) Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

b. Block and Wiring Diagrams of each subsystem.

c. Drawing showing equipment layout in the Command & Control including the Master control panel, UPS, and other hardware intended to be located in the Command & Control.

d. Drawing showing equipment layout around the crash rated active vehicle barriers including the crash rated active vehicle barriers, active vehicle barrier control box(es), vehicle presence detectors, stop lines, traffic signals, warning beacons (wig-wag warning signals) (if applicable), and actuated traffic arms (if applicable).

e. A signing and pavement marking plan.

f. Drawing showing layout and dimensions of the each individual active vehicle barrier operating panels.

g. Touchscreen Audible Tones and Visual Indications if used. Include the following material for use at touchscreen video control panels:

(1) Audible indication, notification, and alarm tones.

(2) Visual materials for touchscreen video control panel display screens, complete with proposed shapes, colors, scale, and textual content. Provide the following: graphics, including maps; icons; dialog boxes; and help messages, prompts and instructions. Provide material in color.

h. Tamper switch locations for AVBCS related cabinets and operating panels.

i. Vehicle presence[, overspeed,] [and wrong-way] detector locations, set-points, and sensor detection patterns. Include descriptions of the security strategy for detecting potential threat vehicles, the coverage and operation of the sensors, and the human machine interfaces for overspeed and wrong way alarms.

j. Details of connections to power sources, including power supplies and grounding.

k. Preliminary point-to-point wiring database. Preliminary submittals is to provide sufficient detail to ensure the final database has all the appropriate information. Provide details such as the legend to be used for the different wiring types, alphanumeric numbering scheme, abbreviations to be used, and the layout of the database. Provide an example of a small section of the system showing the point-to-point wiring.

1.4.2 Point to Point Wiring Information

Final point-to-point wiring diagram of complete interconnected system including database listing of wire numbers, to and from designations, and wire characteristics. Provide the final database for the wiring. The database is to include details such as the legend to be used for the different wiring types, alphanumeric numbering scheme, abbreviations to be used, and where the wire starts and where it ends..

1.4.3 Major Components

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NOTE: Delete items not in the project.

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Submit the following for approval:

a. Active Vehicle Barrier Controls to include pushbuttons, indicating lights, switches and panels.

b. Programmable Logic Controller.

c. Traffic Signs: powered and unpowered.

d. Traffic signals and traffic signal supports.

e. Warning Beacons (wig-wags).

f. In-pavement lights.

g. Alarm display panels.

h. Sequence of Events Recorder.

i. Cable and wiring used for the data transmission.

j. Surge protection device.

k. Cabinets and other main components needed to make a complete system.

l. Tamper switches.

[m. Actuated traffic arms.
]
[n. Touch screens, if allowed.
]
[o. Equipment used for presence detection.
]
[p. Wrong-way detection.
]
[q. Overspeed detection.
]

1.4.4 Data Package

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NOTE: The acquisition of all technical data, data bases and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Department of Defense Acquisition Regulation Supplement (DOD FARS). Those regulations, as well as the Air Force, Navy, Army and Corps of Engineers implementations thereof, should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost. Specifically, the Rights in Technical Data and Computer Software Clause, DOD FAR 52.227-7013, and the Data Requirements Clause, DOD FAR 52.227-7031, as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS. In addition, the appropriate DD Form 1423 Contract Data Requirements List, will be filled out for each distinct deliverable data item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, will be used to explain and more fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to ensure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government.

Include with the request for proposals a completed DD Form 1423, Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified, both description and quantity being required.

****

1.4.4.1 Delivery

Deliver all items of computer software and technical data (including technical data which relates to computer software), which is specifically identified in this specification in accordance with the CONTRACT CLAUSES, SPECIAL CONTRACT REQUIREMENTS, and in accordance with the Contract Data Requirements List (CDRL), DD FORM 1423, which is attached to and thereby made a part of this contract. Identify all data delivered by reference to the particular specification paragraph against which it is furnished.

1.4.4.2 Technical Data and Software

Include the following in the data package:

a. Communications speeds and protocol descriptions.

b. Operator commands.

c. Alarm and system messages and printing formats.

d. Start-up and shut-down operations including system and database backup operations.

e. Expansion capability and method of implementation.

f. Sample copy of sequence of events report.

g. Color print of the graphical user interface (GUI) screens (when used) on 216 x 292 mm 8-1/2 by 11 inch paper.

h. System data entry requirements.

i. User enrollment.

j. System and application software descriptions.

k. Recovery and restart procedures.

l. Use of report generator and generation of reports.

1.4.4.3 Active Vehicle Barrier Controls

Describe operation of the different barrier control operating modes to include normal and emergency operation, barrier control switches, [actuated traffic arms,] [overspeed,] [wrong-way,] traffic signals, warning beacons, and vehicle presence detectors. Include description of security strategy for defeating a threat vehicle and the SDDC approved barrier safety scheme for protecting innocent vehicles from barrier operations.

1.5 TRAFFIC CONTROL PLANS

1.5.1 Traffic Control Plan for the maintenance of traffic during construction

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NOTE: Army Projects choose the bracketed option.

****

Provide a Traffic Control Plan for maintenance of traffic during construction[per Section 08C of EM 385-1-1].

1.5.2 Traffic Control Plan During Crash Rated Active Vehicle Barrier Maintenance

Describe plans for taking one or more active barriers out of service for maintenance or testing purposes, while other barriers at the ACP/ECF remain in service. As a minimum, include requirements for traffic signal indications, for bagging signal heads, and for temporary passive barriers and signage, e.g., Type 3 passive barriers, per MUTCD. Include both short term (less than an hour) and long term plans.

1.6 COMPONENT CERTIFICATION

Provide certifications from the manufacturers of the following equipment as part of the data package: crash rated active vehicle Barrier, [programmable logic controller (PLC),] [traffic arm,] warning signal, annunciator, sequence of events recorder, and all sensors including [overspeed,] [wrong-way,] [and]vehicle presence.

1.7 CYBERSECURITY EQUIPMENT CERTIFICATION

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NOTE: In some cases a dedicated cybersecurity

specification may be provided for the AVB control system. If so, designer is responsible for adding in the specification number and name into the paragraph. Coordinate equipment certification with Government's cybersecurity requirements and interpretations. Verify that the system includes remote control or remote access capability.

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Furnish a certification that control systems are designed and tested in accordance with Section 25 05 11 CYBERSECURITY OF FACILITY RELATED CONTROL SYSTEMS, and as required by individual Service Implementation Policy.

1.8 OPERATION AND MAINTENANCE MANUALS

Submit finalized manuals in electronic/digitial format within 30 days after completing the Endurance test. Update the draft copy used during site testing with any changes required prior to final delivery of the manuals. Identify each manual's contents on the cover. Include in each manual the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and the nearest service representative for each item of equipment. Provide each manual with a table of contents and tab sheets. Place tab sheets at the beginning of each chapter or section and at the beginning of each appendix. Include modifications made during installation, checkout, and acceptance in the final copies delivered after completion of the endurance test. Provide the number of copies of each manual to be delivered per DD FORM 1423.

1.8.1 Software Manual

In the software manual describe the functions of all software and include all other information necessary to enable proper loading, testing, and operation. As a minimum, include in the manual the following:

a. Definition of terms and functions.

b. Use of system and application software.

c. Procedures for system initialization, start-up and shutdown.

d. Alarm reports.

e. Reports generation.

f. Database format and date entry requirements.

g. Directory of all disk files.

h. Description of all communication protocols, including data formats, command characters, and a sample of each type of data transfer.

1.8.2 Hardware Manual

As a minimum, describe all equipment furnished in the hardware manual and include the following:

a. General description and specifications.

b. Installation and checkout procedures.

c. Equipment electrical schematics and layout drawings.

d. System schematics and layout drawings.

e. Alignment and calibration procedures.

f. Manufacturer's repair parts list indicating sources of supply.

1.8.3 Functional Design Manual

Identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions within the functional design manual. Include a description of hardware and software functions, interfaces, and requirements for all system operating modes.

1.8.4 Maintenance Manual

Include descriptions of maintenance for all equipment including inspection, periodic prevention maintenance (include specific time intervals for each recommended preventative maintenance tasks), fault diagnosis, and repair or replacement of defective components in the maintenance manual.

1.8.5 Application Software

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NOTE: Army projects. Choose the option USACE Protective Design Center.

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Provide a copy of the software installation package on optical disk that runs the control program. Provide on optical disk, separate from the operating system software, the complete program or image of the installed software, with all custom changes and configuration data specific for the installed system. At the end of project, after the endurance test is complete, provide complete sets of optical discs. [Provide one set of discs to the USACE Protective Design Center.Provide one to be turned over to the User.]

1.8.6 Final System Drawings

Maintain a separate set of drawings (including site, civil, electrical, mechanical, structural, and architectural plans, elevations, and details), elementary diagrams, wiring diagrams, and control diagrams of the system to be used for final system drawings. This set is to be accurately kept up-to-date with all changes and additions to the AVBCS and to be delivered to the Government with the final endurance test report. In addition to being complete and accurate, this set of drawings is to be kept neat and not be used for installation purposes. Furnish final drawings with the endurance test report on optical disk in [Microstation latest Version] [or] [AutoCAD latest version][_____] format.

1.9 CRASH RESISTANCE: DEMONSTRATION OF COMPLIANCE

****

NOTE: Prior to February 1, 2009 both DOS and DOD certified crash rated active vehicle barriers were based on test reports submitted by a manufacturer. Barriers tested prior to February 1, 2009 and subsequently certified by DOS are included in a

final published list for use by others. DOD will continue to certify and publish their own certified list. Both of these lists may be found by pointing your web browser to

DOD requires all crash-rated (anti-ram) active vehicle barriers utilized at access control points / entry control facilities be on the DOD Anti-Ram Vehicle Barrier list.

****

Submit the following as demonstration of compliance with the specified crash resistance requirements for each crash rated active vehicle barrier proposed for this project. Department of Defense requires all crash-rated active vehicle barriers to be on the DOD Anti-Ram Vehicle List. The DOD Anti-Ram Vehicle List in effect at the time of contract award is to be used.

1.9.1 DOD Letter of Certification

Submit a DOD Letter of Certification for crash-rated active vehicle barrier with a configuration identical to the as tested crash rated active vehicle barrier being provided. DOS Letter of Certification is allowed; however, the crash-rated active vehicle barrier must be on the DOD anti-ram vehicle barrier list.

1.9.2 Crash Test Report

****
NOTE: This paragraph is required for those barriers not on the DOD list.
****

Submit a crash test report for crash-rated active vehicle barrier with a configuration identical to the as tested crash rated active vehicle barrier being provided from a testing laboratory accredited by a nationally recognized testing agency in accordance with ISO ISO/IEC 17025. This report is only required for crash-rated active vehicle barriers that are not on the DOD list. The information is to be submitted with the barrier submittal and is to show an approved crash test per ASTM F2656/F2656M. This submittal takes up to 8 weeks to review and is not quarantee that the report will be approved.

****
NOTE: On Army projects, the Protective Design Center is required to review the submittal. See the following link:
****

1.9.3 Different Length

The only exception to the requirement that the tested crash rated active vehicle barrier be identical to the as tested crash rated active vehicle barrier being provided is the barrier's length. If a length other than that tested is required, the length of the required crash rated active vehicle barrier must represent an interperloation between the successfully tested lengths of crash rated active vehicle barriers that are identical in all other ways. The tested shorter crash rated active vehicle barrier and the tested longer crash rated active vehicle barrier must be identical in construction and testing conditions before the alternate length can be considered. If the length of the required barrier for this project is different than the length tested, provide Crash Test Reports for identical barriers at the maximum/minimum width conditions as required by ASTM F2656/F2656M section 8.2.5. In addition to the test report, provide a letter written by the manufacturer clearly stating that the alternate length crash rated active vehicle barrier is to be constructed in the same manner as the tested barriers. [The crash test reports are to be submitted to the Protective Design Center, Omaha US Army Corps of Engineers for review.]

1.9.4 Engineering Analysis

Engineering analysis is not an acceptable form of Demonstration of Compliance.

1.9.5 Retrofitted Barrier Systems

Manufacturer is to provide additional documentation that indicates DOD, DOS or ASTM required ratings have been maintained for any barriers that were originally configured and tested with hydraulic systems, but have been revised or retrofitted to be electric (electromechanical). Provide sufficient information to compare the hydraulic system with the electric system to ensure the change in actuation does not change the ability of the barrier to maintain its tested rating. Manufacturer is to provide a response on company letter head stating that the rating is still valid along with the supporting material.

Provide documentation from the manufacturer that ensures the motor and actuator is sized sufficiently for long term use given the weight of the barrier and the response time requirements. In addition, ensure the electrical components are adequate for the environment as covered elsewhere in this specification.

1.10 QUALITY CONTROL

****

NOTE: The prime contractor will have quality control managers and representatives as a part of their contract requirements. This additional level should only be considered on larger projects or on projects with unique control requirements. The main intention of this portion is to have one main person below the Prime contractor that is responsible for coordinating all the systems involved with the work in this specification. Edit or delete paragraphs as required for the project.

****

1.10.1 Project Manager Qualifications

Designate a Project Manager for all work under this specification. Project Manager is to provide technical and managerial leadership to all contractor personnel and subcontractors during the design, manufacturer, and installation phases of this specification. This person serves as the single point of contact for the General Contractor for all work required in this specification. The Project Manager must have a minimum of 5 years of experience in the design, manufacture, and installation of similar systems.

1.10.2 Installation Superintendent Qualifications

Designate an Installation Superintendent responsible for onsite installation team direction and leadership. First line supervision of tradesmen and subcontractors is provided by the Superintendent. The Superintendent is responsible for job planning and coordination between the work with trades, subcontractors, vendors, and site personnel. The Superintendent is responsible for scheduling materials, equipment, and labor to maintain the flow of work commensurate with the task schedule. The Superintendent administers and executes the provisions of the Accident Prevention Plan. The Superintendent must have a minimum of 5 years of experience in the installation, operation, and testing of similar systems. The Project Manager and the Installation Superintendent can be the same individual.

1.11 TECHNICAL SPECIALISTS QUALIFICATIONS

Provide the services of technical specialists for the crash rated active vehicle Barriers and the related control system. Submit names and qualifications for each of the technical specialists involved. The technical specialists are to have a minimum of 3 years of experience in the installation, operation, and testing of all components, software, and interconnecting wiring of their particular equipment/subsystem. The presence of each technical specialist is required during Factory Tests of the system, during installation in the field, and serves as the Contractor's Commissioning Specialist for their designated equipment/subsystem for the commissioning tests as specified.

1.12 KEY CONTROL PLAN

Key control plan for all Contractor provided enclosures requiring locks and all keyed control switches. Provide a key control plan that includes the following: 1) Procedures that will be used to log and positively control all keys during installation. 2) A listing of all keys and where they are used. 3) A listing of all persons allowed access to the keys.

1.13 DELIVERY, STORAGE, AND HANDLING

Protect components delivered to site and/or placed in storage from the weather, humidity (and humidity variation), temperature (and temperature variation), dirt and dust, or other contaminants. Store structural materials on sleepers or pallets and protect them from rust and objectionable materials such as dirt, grease, or oil. Handle all components to protect finish and coatings from scuffs, abrasions or other damage. Excessive damage to factory applied finishes and coatings is cause for rejection. Provide all other delivery, storage and handling protections as recommended by the manufacturer.

1.14 PROJECT/SITE CONDITIONS

****

NOTE: Edit with actual site conditions if more stringent then the default values.

****

1.14.1 Environmental Conditions

All materials, equipment and installation techniques must be appropriate for the prevalent environmental conditions at the installation location. Installation is to be in conformance with manufacturer's written environmental requirements. Submit Manufacturer's Environmental Requirements.

1.14.2 Exterior Conditions

House all components mounted in locations exposed to weather in corrosion-resistant enclosures with appropriate environmental protection. Improper housing design is not to cause a degradation in component performance.

Provide components (those installed outside or in an enclosure exposed outside) that meet the following ambient conditions:

a. Temperature: [-32 to 60][_____]degrees C[-25 to 140][_____]degrees F;

b. Pressure: Sea level to 4,573 m 15,000 feet above sea level;

c. Solar radiation: Six hours of solar radiation at dry bulb temperature of 60 degrees C 120 degrees F including 4 hours of solar radiation at 0.00112 watts per square mm 104 watts psf;

d. Sand and dust: Wind driven for up to [9.6][_____] km/hour [6][_____] mph;

e. Rain: 50 mm 2 inches per hour and 125 mm 5 inches per hour cyclic with wind plus one period of 300 mm 12 inches per hour;

f. Humidity: 5 to 95 percent;

g. Fungus: Warm, humid atmosphere conducive to the growth of heterotrophic plants;

h. Salt fog: Salt atmosphere with 5 percent salinity;

i. Snow: Snow loading of 234 kg/square m 48 pounds psf per hour; blowing snow of 22.5 kg/square m 4.6 psf per hour;

j. Ice accretion: Up to 13 mm 1/2 inch of radial ice;

k. Wind: Up to 80 km/h 50 mph with gusts to 106 km/h 66 mph, except that fence sensors are to detect intrusions up to 56 km/h 35 mph; and

l. Acoustical noise: Components are to suitable for use in high noise areas above 110 dB, such as flight lines, run up pads, and generator sites without adversely affecting their performance.

m. Elevation. [_____] m [_____] feet

1.14.3 Interior Conditions

Provide equipment, which is installed in environmentally protected interior areas, that meet the performance requirements specified for the following ambient conditions:

a. Temperature: 0 to 50 degrees C 32 to 120 degrees F. Components installed in unheated security protected areas must meet performance requirements for temperatures as low as -17 degrees Czero degrees F;

b. Pressure: Sea level to 4,573 m 15,000 feet above sea level;

c. Relative humidity: 5 to 95 percent;

d. Fungus: Provide system components located in fungus growth inductive environments with a treatment to provide fungus resistance. Treatments cannot include mercury, materials increase the flammability of the material or surface being treated or cause skin irritation or other injury to personnel handling it during fabrication, transportation, operation, or maintenance of the equipment, or during use of the finished items when used for the purpose intended; and

e. Acoustical noise: Provide components suitable for use in high noise areas above 100 dB, such as boiler rooms, power plants, and foundries without adversely affecting their performance.

****

NOTE: Barriers control systems that are not normally being used to meter traffic can delete the first sentence.

****

1.14.4 Traffic Flow

[Crash rated active vehicle Barriers are to be able to meet the cycle frequency of [_____] vehicles per [hour][day][week][month].]Typical vehicle speed over the barrier is expected to be [_____] kph[_____] mph."

1.14.5 Site Power Supply

Power supply at the site is [[____V] [_ phase] and is located] as shown on the drawings.

1.14.6 Current Site Conditions

Prepare and submit a report on "Current Site Conditions", within 75 days of Notice to Proceed, to the Government documenting site conditions that significantly differ from the design drawings and include any conditions on the design documents that would negatively affect performance of the system to be installed. Provide specification sheets, or written functional requirements to support the findings, and a cost estimate to correct those site changes or conditions. Do not perform any field work until the "Current Site Conditions" report is approved by the Government. Do not correct any deficiencies identified in the report without written permission from the Contracting Officer. Review of this package is to be by the designer of record and the local government construction manager.

1.14.7 Generic Design and Contract Revisions

Contract drawings show generic power circuits and voltage configurations for the crash rated active vehicle barriers, sump pumps, heaters, roadway heat tape, and associated. Contractor is responsible for revising the circuit breakers (size and configuration), backup power supplies, conductors and conduit for the specific crash rated active vehicle barrier system the contractor has chosen. Any changes required are the responsibility of the contractor at no cost to the government. Changes required need to be submitted under the paragraph CONTRACT MODIFICATIONS.

1.15 MAINTENANCE AND SERVICE

1.15.1 Description of Work

The adjustment and repair of the system includes all vehicle barriers and systems installed under this specification. Provide and perform all repair, calibration, and other work in accordance with the manufacturer's documentation and instruction. Responsibility is limited to Contractor installed equipment.

1.15.2 Service Personnel

Certify service personnel in the maintenance and repair of the specific type of equipment installed and qualified to accomplish work promptly and satisfactorily. Advice the Government in writing of the name of the designated service representative, and of any change in personnel.

1.15.3 Schedule of Work

Perform two minor inspections at 6 month intervals (or more often if required by the manufacturer), and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.

1.15.3.1 Minor Inspections

Include visual checks and operational tests of crash rated active vehicle barriers (cleaning pit if necessary), [actuated traffic arms,]traffic signals, console equipment, peripheral equipment, local processors, sensors, and electrical and mechanical controls as part of the minor inspections.

1.15.3.2 Major Inspections

Major inspections includes work described under paragraph Minor Inspections and the following work:

a. Clean interior and exterior surfaces of all system equipment and local processors, including monitors, keyboards, and console equipment.

b. Perform diagnostics on all equipment.

c. Check, walk test, and calibrate each sensor.

d. Run all system software diagnostics and correct all diagnosed problems.

e. Resolve any previous outstanding problems.

f. Purge and compress data bases.

g. Review network configuration.

1.15.3.3 Scheduled Work

Perform scheduled work during regular working hours, Monday through Friday, excluding federal holidays.

1.15.4 Operation

The applicable portion or portions from the performance verification test procedures are to be used after all scheduled maintenance and repair activities to verify proper component and system operation.

1.15.5 Records and Logs

Maintain records and logs of each performed task and organize cumulative records for each component and for the complete system chronologically resulting in a continuous log to be maintained for all devices. Provide a log that contains all initial settings. Ensure logs are kept and available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the system.

1.15.6 System Modifications

Make any recommendations for system modification in writing to the Government. Prior approval of the Government is required before any system modifications are made. Updating of the operation and maintenance manuals as well as any other documentation affected is required after any modification is made to the system.

1.15.7 Software

Provide a description of all software updates to the Government, who will then decide whether or not they are appropriate for implementation. After notification by the Government, implement the designated software updates and verify operation in the system. Accomplish updates in a timely manner, fully coordinated with system operators, and ensure all data is incorporated into the operation and maintenance manuals, and software documentation. Make a system image file prior to implementing any software update so the system can be restored to its original state if the update adversely affects system performance.

1.16 WARRANTY

****

NOTE: The standard warranty period is one year. If desired a two year period can be specified; however, there will need to be a separate line item for bidding and is paid with a separate funding source.

****

Provide all labor, equipment, and materials required to maintain the entire system in an operational state as specified, for a period of [one year][two years] after formal written acceptance of the system to include scheduled and nonscheduled adjustments. Contractor is responsible for ensuring the barriers are properly exercised and maintained per the manufacturer instructions until accepted by the Contracting Officer. If any corrections during the warranty period require a change to the program operating the AVB controls, then the contractor is responsible for ensuring a full commissioning effort is accomplished per the requirements herein. This programming change would be considered a latent defect, if the full commissioning failed to develop the issue.

1.16.1 Warranty Service

****

NOTE: In some cases the designer may determine a less rapid response time is acceptable when weighed

against the cost of the service. When editing consider the location of the project in relationship to available personnel.
****

The Government initiates service calls to the Contractor when the system is not functioning properly. Qualified personnel must be available to provide service to the complete system. Furnish the Government with a telephone number where the service supervisor can be reached at all times. Warranty service is to comply with 01 78 00 CLOSEOUT SUBMITTALS and the with the following codes:

a. First Priority Code 1. Perform onsite inspection to evaluate situation, and determine course of action within [24][_____] hours, initiate work within [24][_____] hours and work continuously to completion or relief.

b. Second Priority Code 2. Perform onsite inspection to evaluate situation, and determine course of action within [4][_____] days, initiate work within [48][_____] hours and work continuously to completion or relief.

c. Third Priority Code 3. All other work to be initiated within [7][_____] work days and work continuously to completion or relief.

d. The "Construction Warranty Service Priority List" is as follows:

Code 1-crash rated active vehicle barrier system (controls and barrier)
(1) Mechanical or electrical equipment failure that prevents the crash rated active vehicle barrier from opening or closing through the controls.
(2) Active vehicle barrier control system is unable to reset.
(3) Active vehicle barrier control system is unable to operate the crash rated active vehicle barriers properly.

Code 2-Active vehicle barrier system (controls and barrier)
(4) A single traffic signal is not operational.
(5) Problem associated with the vehicle presence detection system (typically safety loops).
(6) Problem associated with sequence event recorder.
(7) Crash rated active vehicle barrier opens and closes, but does not perform the operation in a smooth manner.
(8) Problem associated with wrong-way detection system.
(9) Problem associated with overspeed detection system.

Code 3-Active vehicle barrier system (controls and barrier)
(10) Warning beacon(s) is not operational.
(11) Active vehicle barrier warning light(s) or in-pavement light(s) are not operational.
(12) Any item associated with a control system malfunction (example indicating light or warning buzzer) that does not have a direct impact on operating the crash rated active vehicle barriers.

1.16.2 Service Call Requests

Record separately each service call request, as received. Provide a form that includes the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the material to be used, the time and date work started, and the time and date of completion. Deliver a record of the work performed within 5 days after work is accomplished.

PART 2 PRODUCTS

****

NOTE: The following sections address the most common types of crash rated active vehicle barriers. While the systems listed cover most installations there may be custom assemblies which will still build on the basic systems presented here. Designers specifying custom systems may select the most appropriate crash rating language and insert aesthetic and other requirements as appropriate.

****

2.1 SYSTEM DESCRIPTION

Furnish and install a complete and functional crash rated active vehicle barrier system for the ACP/ECF including crash rated active vehicle barriers, active vehicle barrier controls, traffic signals, traffic signal controls, traffic warning signals, traffic signs and pavement markings, [actuated traffic arms,][vehicle overspeed detectors,][wrong-way detectors,]vehicle presence detectors, tamper switches, alarm displays, sequence of events recorder, data transmission, and all interconnecting conduit and wiring. Crash rated active vehicle barrier types covered by this specification include [retractable bollards,] [retractable barriers,] [crash beams,] [active net barriers] [crash gates,] [portable barriers].

2.2 CRASH RATED ACTIVE VEHICLE BARRIER SAFETY SCHEME

****

NOTE: Select one or more of the following barrier safety schemes as appropriate. Include the appropriate Appendix, at the end of this specification. If not using one of the designed safety schemes, then revise paragraph as appropriate.

****

Install and program the [Hybrid Beacon][Full Containment][High Efficiency Presence Detection][Stop Control][2014 Conventional Signs & Signals][2015 HEPD][2014 Barrier-Up] safety scheme, as approved by the Surface Development and Distribution Command (SDDC) to ensure the safety of innocent motorists. See Appendix A [and the contract drawings]for the required features and operational sequences of this safety scheme.

2.3 CRASH RATED ACTIVE VEHICLE BARRIER FEATURES

2.3.1 Impact Conditions

****

NOTE: Performance levels are based on the following:

Crash Resistance is defined by a combination of the Impact Condition (size and velocity of the design vehicle) and the allowable Penetration Distance.

This UFGS addresses three crash rating standards:

ASTM F2656/F2656M, Standard Test Method for Vehicle Crash Testing of

Perimeter Barriers

US Department of State SD-STD-02.01, Revision A, Test Method for Vehicle Crash Test of Perimeter Barriers and Gates, 2003

US Department of State SD-STD-02.01, Specification for Vehicle Crash Test of Perimeter Barriers and Gates, 1985

Barriers tested prior to February 1, 2009 are to comply with to one of the two DOS standards;barriers tested after February 1, 2009 are to comply with ASTM F2656/F2656M.

ASTM Impact Condition:
ASTM F2656/F2656M Impact Conditions are listed in Table 1 of ASTM F2656/F2656M and are defined by a letter designation for the test vehicle (SC = Small Passenger Car (1,100 kg (2,340 lbs)); FS = Full Size Sedan (2,100 kg (4630 lbs); PU = Pickup Truck (2,300 kg (5,070 lbs)); M = Standard Test Truck (6,800 kg (15,000 lbs)); and H = Heavy Goods Vehicle(29,500 kg (65,000 lbs))) and the nominal velocity in miles per hour. The ASTM F2656/F2656M Impact Conditions are as follows:

Designation	Nominal Test Vehicle	Nominal Velocity
SC30	1,100 kg)(2,340 lbs)	30 mph (50 km/h)
SC40	1,100 kg)(2,340 lbs)	40 mph (65 km/h)
SC50	1,100 kg (2,340 lbs)	50 mph (80 km/h)
SC60	1,100 kg (2,340 lbs)	60 mph (100 km/h)
FS30	2,100 kg (4,630 lbs)	30 mph (50 km/h)
FS40	2,100 kg (4,630 lbs)	40 mph (65 km/h)
FS50	2,100 kg (4,630 lbs)	50 mph (80 km/h)
FS60	2,100 kg (4,630 lbs)	60 mph (100 km/h)
PU30	2,300 kg (5,070 lbs)	30 mph (50 km/h)
PU40	2,300 kg (5,070 lbs)	40 mph (65 km/h)
PU50	2,300 kg (5,070 lbs)	50 mph (80 km/h)
PU60	2,300 kg (5,070 lbs)	60 mph (100 km/h)
M30	6,800 kg (15,000 lbs)*	30 mph (50 km/h)
M40	6,800 kg (15,000 lbs)*	40 mph (65 km/h)
M50	6,800 kg (15,000 lbs)*	50 mph (80 km/h)
H30	29,500 kg (65,000 lbs)	30 mph (50 km/h)
H40	29,500 kg (65,000 lbs)	40 mph (65 km/h)
H50	29,500 kg (65,000 lbs)	50 mph (80 km/h)

* The Medium-duty Truck has the same inertial weight as the DOS test vehicle.

DOS Impact Conditions:
DOS Impact conditions are listed in Table 1 of DOS SD-STD-02.01, Revision A and in Section 5.0 DOS SD-STD-02.01. The impact conditions are as follows:

Designation	Test Vehicle	Nominal Velocity
K4	6,800 kg (15,000 lbs)*	30 mph (50km/h)
K8	6,800 kg (15,000 lbs)*	40 mph (65km/h)
K12	6,800 kg (15,000 lbs)*	50 mph (80 km/h)

* This is the same inertial weight as the ASTM F 2656 Medium-duty Truck;

K4 = M30, K8 = M40 and K12 = M50.

Designer to fill in the required ASTM F2656/F2656M Impact Condition and DOS rating (if applicable).

The crash rated active vehicle barriers are to withstand an impact corresponding to [ASTM F2656/F2656M, Impact Condition OF [M50][M40][M30][SC30][SC40][SC50][SC60][FS30][FS40][FS50][FS60][PU40][PU50][PU60][H30][H where the letter(s) correspond to the test vehicle and the last two digits correspond to the test velocity in mph][or][DOS [K12][K8][K4]].

2.3.2 Penetration Rating

****

NOTE: The Penetration Rating defines the permissible distance that the design vehicle may travel beyond the pre-impact inside edge of the barrier under the specified Impact Conditions.

The most current Penetration Rating system is from ASTM F2656/F2656M (Table 2). The penetration rating is based on the dynamic penetration of the test vehicle as shown in the following table.

Designation	**Dynamic Penetration Rating**
P1	**<= 1 m (3.3 feet)**
P2	**1.01 to 7 m (3.31 to 23 feet)**
P3	**7.01 to 30 m (23.1 to 98.4 feet)**

The DOS SD-STD-02.01 Revision A standard does not include a variable penetration rating system and passes only barriers that limit penetration of the front edge of the cargo bed to one meter beyond the pre-impact, inside edge of the barrier. This is roughly equivalent to an ASTM F2656/F2656M P1 rating.

Insert one of the "P" ratings from the above chart.

Energy absorbing barriers (net style) will allow a greater penetration the longer the barrier i.e. the more lanes it covers. Be sure to edit accordingly to account for the longer penetration distance.

****

[When subjected to the specified Impact Condition, vehicle barriers are to respond with Penetration Rating equal to or better than [P1][P2][P3]as defined in ASTM F2656/F2656M.]

****

NOTE: NOTE: A previous Penetration Rating system was presented in the 1985 DOS SD-STD-02.01. While this penetration rating system has not been used by DOS since 2003, it is still used by the DOD. Some of the early barrier systems were tested to this standard and the designer may therefore decide to include barriers with penetration ratings certified under 1985 DOS ST-STD-02.01 as an option in the specification. The 1985 DOS ST-STD-02.01 rating system should only be included in addition to the ASTM rating system.

Designation	**Dynamic**	**Meets ASTM**

	Penetration Rating	Designation Rating
L3.0	**<= 3 feet**	**P1**
L2.0	**<= 20feet**	**P2**
L1.0	**<= 50feet**	**P3**

The 1985 DOS SD-STD-02.01 also includes an L4.0 penetration rating for distances exceeding 50 feet, but barriers with this rating are not included on the DOD list of certified barriers. It is recommended that the following paragraph be included to reduce the potential for confusion with barriers tested prior to 2003. Insert the "L" rating which corresponds with the "P" rating included in the above paragraph. If appropriate, identify each barrier with its own rating.

****

[For DOD certified barriers, use the Penetration Rating of [L3.0][L2.0][L1.0] or better.]

2.3.3   Operators

[Provide manual crash rated active vehicle barriers.] [Provide [electric (electromechanical)] [or] [hydraulic][or] [pneumatic] crash rated active vehicle barriers.]

2.3.4   Vehicle Loads

All roadway components are to be capable of supporting a 14515 kg 32,000 pound axle load or a 7257.5 kg 16,000 pound wheel load.

2.3.5   Roadway Obstruction

When a barrier is in the "Access Allowed" position, no element in the drive path is to extend above the surrounding grade. Taper all changes in grade.

2.3.6   Dimension Requirements

****

NOTE: Include dimensional requirements for applicable crash rated active vehicle barriers. Minimum and maximum widths, heights and spacing should be specified to suit site conditions and the threat vehicle characteristics.

****

Provide crash rated active vehicle barrier dimensions with the same dimensions of the barrier tested in the Proof of Performance test(s) and as documented [in the Crash Test Report] [and described in the DOS or DOD] Certification Letter.

2.3.6.1   Portable Barrier Width

****

NOTE: Include the following bracketed statement if portable barriers are specified and the overall dimensions are to be limited.

****

Ensure overall system width, including all supporting structures and operating enclosures, is no more than [_____] mm[_____] inches.

2.3.7 Operation Speeds Excluding Crash Gates

****

NOTE: The normal time to transition from the "allow access" position to the "deny access" position should take into consideration operational and security plans and barrier configurations. Emergency Fast Operation (EFO) is the rapid deployment of the barrier to deny vehicle access.

Edit paragraph c below appropriately. Projects with hydraulic systems or pneumatic systems may not reverse. Also, those projects with final denial type barriers, as opposed to access control, typically do not need the barrier to be instantly reversible.

Paragraphs 'a', 'b', and 'c' are intended for all types of barriers but crash gates. Crash gates are a distance per time and not a flat time. Speeds for crash gates is covered in the paragraph on Crash Gates and are not suitable for an EFO operation. Crash beams that operate vertically, horizontally or slide typically do not have a speed association and are not suitable for EFO operation.

****

a. When in manual mode (normal mode), the time to transition to "deny access" is [3][8][_____] seconds or less and the time to "allow access" is [3][_____] seconds or less.

[b. Emergency Fast Operation (EFO) time is to be 2 seconds or less.

c. When the barrier is transitioning from the "deny access" position to the "allow access" position, the barrier is to be reversible when EFO is initiated.

]

2.3.8 Failure Modes of Operation

****

NOTE: Include the following bracketed paragraph if powered crash rated active vehicle barriers are specified.

It may also be necessary to manually control the barrier to change the position to either the 'access allowed' or 'access denied' position.

For hydraulic and pneumatic barriers, a system of check valves and accumulator pumps (compressor for pneumatic) may be used for maintaining or changing the position of the barrier. A catastrophic failure of the hydraulic or pneumatic lines, depending on the location in the system where it occurs, may cause the barrier to be in the 'access allowed' position.

****

Design the system to remain in the last commanded position in the event of [[hydraulic,][pneumatic,][electrical,][or mechanical]] failure.

[a. Design the system so that unauthorized personnel cannot manually manipulate the barrier into the "access allowed" position in the event of a power outage. Locks and tamperproof screws and bolts are examples of acceptable means to prevent unauthorized access.
]
[b. Design the system to allow authorized personnel to manually manipulate the barrier into the "access allowed" and "access denied" position in the event of a power outage or operator failure. Barriers are to be capable of being raised and lowered using a recessed handle on the top surface of the barrier or a manual hydraulic pump or other means when the hydraulics or electric motors are not operational. The operation is to require no more than 267 N 60 pounds of force to operate.
]
[c. Provide check valves on [hydraulic][pneumatic] systems if loss of hydraulic pressure can result in the barrier moving to the "access allowed" position.
]
[d. Design the system to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. [If a hydraulic system is used, provide pressure relief valves to prevent overpressure. Continuous running of the motor to stay in the raised position, excluding the use of manual pinning to do so is not allowed.] [If a pneumatic system is used, provide pressure relief valves to prevent overpressure. Continuous running of the compressor to stay in the raised position, excluding the use of manual pinning to do so is not allowed.]
]

2.3.9 Manual (Non-Powered) Barrier Operation

****

NOTE: If specifying a manual barrier, include the following paragraph.

****

Barriers are to be capable of being raised and lowered using a recessed handle, rope or other means. The force required to open/close needs to be less than 267 N 60 pounds of force. Provide a lockable mechanism to secure the barrier in both the full "access allowed" and "access denied" positions.

2.3.10 Crash Rated Active Vehicle Barrier Foundations

****

NOTE: Many of the Crash Rated Active Vehicle Barriers (gates, retractable barriers, crash beams) have variations which include a shallow foundation or are surface mounted, for areas with multiple underground utilities or that have high water tables. If there are specific foundation depth requirements, include this paragraph by selecting the bracketed statement that is applicable to the project. Barriers such as drum or bollards will have deeper foundations.

****

[Foundation systems are to be shallow with required depths no more than [600 mm][_____] [24 inches][_____].] [Provide surface mounted crash rated active vehicle barriers.]

2.3.11 Lane Coverage

****

NOTE: In some instances, single fixed-width barriers are installed to protect more than one lane of traffic or multiple barriers are installed to protect a single lane of traffic. The following paragraph should be included when specifying fixed-width barriers. Designer is to fill in the number of lanes and the number of barriers. Note: ASTM F2656/F2656M section 8.2.5) discusses the impacts of single barriers protecting more than one traffic lane. The ASTM document suggests demonstrating performance for this configuration by performing impact tests at 1/3 points for 3 lanes, ¼ points for 4 lanes, etc. This testing is not included in this specification due lack of feasibility to require that crash rated active vehicle barriers be identical to tested barriers, and also requiring testing based on actual lane configurations. There are too many potential permutations to require testing.

****

Provide and install a quantity of [_____] fixed-width barrier[s] to protect [_____] roadway lane[s].

2.3.12 SAFETY EQUIPMENT

Provide a safety bar with each retractable or raising crash beam barrier to secure the barrier in the open position during maintenance operations. Provide other equipment recommended for safety when working on the barrier.

2.4 CRASH RATED ACTIVE VEHICLE BARRIER(S)

****

NOTE: This section covers various types of crash rated active vehicle barriers. Delete those types of barriers not in the contract.

****

2.4.1 RETRACTABLE BARRIERS

****

NOTE: Retractable barriers consist of steel plates, rotating steel wedges or steel frames which rise to deny access and retract to allow access. Retractable barriers are generally installed with one barrier protecting a single traffic lane. When in the "access denied" position, retractable barriers provide limited pedestrian control. Retractable barriers are operated by hydraulic, pneumatic, electric, and manual means. Retractable barriers are available with standard depth, shallow depth, and surface mounted foundations.

****

In addition to meeting the design and performance requirements of this SECTION, retractable barrier systems are to conform to the following system-specific requirements.

[Barrier is to be electromechanical with no hydraulic fluid or pneumatics used.] [Barrier is allowed to be electromechanical or hydraulic.][Barrier is allowed to be electromechanical, hydraulic or pneumatics.]

2.4.1.1 Configuration

Retractable barriers are to be made of [steel plate][, rotating steel wedges][,or steel frames].

2.4.1.2 Buttresses

****

NOTE: retractable barriers can be configured with or without side buttresses. If space is limited, or for other reasons, it may be necessary to specify a configuration without buttresses. If so, include the following bracketed paragraph.

****

Do not provide above-grade buttresses with the retractable barriers.

2.4.1.3 Powered Retractable Barrier

****

NOTE: Based on peak hourly volumes, fill in number of cycles per hour that the barrier will be required to function (maximum 300 complete up/down cycles per hour). Barriers used in a final denial configuration (deployed upon a threat) do not need more than around 60 cycles per hour.

Most applications do not require the barrier to be reversible and some systems such as hydraulic may not be reversible. The standard safety schemes found in Appendix A do not require this feature. The reversible feature is provided on some barriers so that when a barrier is deploying and an event happens, such as a vehicle activates a safety loop, the barrier will stop and then open. Note that this time to stop and reverse to fully open will take time and may not prevent a vehicle impacting the crash rated active vehicle barrier.

****

Provide a retractable barrier that is capable of [_____] complete up/down cycles per hour. [Provide a retractable barrier where the motion of the barrier can be stopped and reversed prior to it becoming fully open or fully closed.]

2.4.2 ACTIVE NET BARRIERS

****

NOTE: Energy Absorbing crash rated active vehicle barriers are a type of crash rated active vehicle barrier system. Active vehicle barriers under this category normally have shallow mount foundations and secure more than one lane of traffic with a single barrier.

When specifying this type of barrier, be aware that there are only a few barriers that meet this category so in order to ensure competition one may

have to allow more than one type of actuator e.g. allow electric and hydraulic.

****

Provide active net barrier systems that meet the design and performance requirements of this SECTION. Provide active net barriers that consist of a [cable/net system][,] [cable/post system][,] [or] [rising gate systems]. Energy absorbing barrier systems are to have a minimum testing frequency of one week and not require any specialized equipment or trained personal to return to the "access allowed" position. Ensure system length does not exceed [_____] mm[_____] inches (perpendicular to roadway).

2.4.3 RETRACTABLE BOLLARDS

****

NOTE: Retractable bollard systems consist of steel cylinders which rise out of the ground to deny access and retract to "access allowed" position. Retractable bollards are generally installed in groups of 3 or more, as needed to protect the traffic lane, and are installed to rise and retract together. Retractable bollards do not provide pedestrian control. Retractable bollards come in hydraulic, pneumatic, electric and manual retractable configurations. There are no shallow or surface mounted bollard systems.

****

A bollard system is to consist of a minimum of 3 bollards spaced no more than 1220 mm 48 inches from centerline to centerline of bollards across a 3.0 m 10 foot roadway. Bollards in the lowered position are to be capable of supporting a 71 kN 16,000 pound wheel load each. Design in accordance with AASHTO GDHS-7 for this load.

2.4.3.1 Bollard Height

****

NOTE: The bollard height cannot be less than the as tested condition. Bollard heights vary in range for different manufacturers and associated barriers. The minimum bollard height specified must be sufficient to completely engage the frame rails of the threat vehicle.

****

Minimum height of bollards is not be less than the as tested condition[or [_____] m [_____] feet].

2.4.3.2 Bollard On Center Spacing

****

NOTE: The on center spacing of individual bollards ensures that the design-sized vehicle will not gain access between the bollard systems and when approaching perpendicular to the bollard system will impact at least one bollard. Spacing cannot exceed the spacing in the as tested condition, typical on center spacing ranges from [0.91 m][3 ft] to [1.5 m] [5 ft]. Consult criteria for spacing limitations.

****

Maximum on center spacing of bollards is not more than the as tested condition[or [0.9][ ] m [3 feet][__ feet]].

2.4.3.3   Number of Bollards

The minimum allowable number of bollards cannot be no less than the number [tested] [described in the [DOS][or] [DOD] Certification Letter].

2.4.3.4   Bollard Operations

****

NOTE: Indicate if bollards are to operate together or independently. Select appropriate requirements below. Most manufacturers have a set of three bollards for a lane that operate in unison.

****

[a. Provide a bollard system where each bollard is operated independently from the other bollards.

][b. Each bollard is to have its own controls.

][c. Bollards must operate in sets. Each set of bollards contains [_____] bollards. A set of bollards will be provided to protect [_____] [a single lane of traffic].

][d. Each set of bollards has its own controls and operate independently from each other set within the system.

]2.4.3.5   Decorative Covers

****

NOTE: Some manufacturers can provide retractable bollards with decorative covers. If required for project, include the following paragraph. The designer should consider possible conflict with marking requirements prior to specifying decorative covers. If cover profiles are not shown in the drawings, designer should provide descriptive information in the paragraph below.

****

Provide decorative covers as shown in the drawings. Provide decorative covers fabricated by the bollard manufacturer, and designed to function with the retractable bollard system without interfering with the operation of the system. Fabricate decorative covers of durable material appropriate for the project's location and environmental conditions. Submit a sample decorative cover for approval.

2.4.3.6   Powered Retractable Bollards

****

NOTE: Based on peak hourly volumes, fill in number of cycles per hour that the barrier will be required to function (maximum 300 complete up/down cycles per hour).

****

Provide a retractable bollard capable of [_____] complete up/down cycles per hour. Provide bollards capable of being raised or lowered within a 3 to 15-second range during normal use and within 2 seconds for emergency operations.

2.4.4 CRASH GATE

****

NOTE: Crash gates either slide across the traffic lane or swing from a hinge point on one or both sides of the traffic lane. The gate is supported by steel buttresses on either side of the opening. Crash gates are available with shallow or surface mounted foundations. Crash gates that are used for pedestrian and vehicle control need to have the taller dimension.

choose a speed that is suitable for the application. Some manufacturers do not have the high rate of speed indicated. Most manufacturers have a standard range that they can meet. Most can meet the two lower speeds indicated.

****

The crash gate consists of steel buttresses anchored into the ground and an above grade assembly consisting of a heavy steel structure or a combination of heavy steel and structural aluminum capable of being opened and closed. The height of the gate must be at least[0.762] [2.1] [_____] m [30][84] [_____] inches from the road surface to the top of the gate frame. The length closes and protects a minimum [3.0] [_____] m [120] [_____] inch clear opening. Provide an operator for the crash gate that opens and closed the gate at an operating speed of [9.1][13.7][18.3][36.6][_____] meters per minute[30][45][60][120][_____] feet per minute.

2.4.4.1 Configuration

Crash gates consist of [track sliding gate systems,] [cantilever sliding gate system,] [single leaf swing gate system].

[Sliding gates slide to the [left] [right] when facing the gate from the attack side.]

[Single leaf gate systems swing [inward in the direction of the secure side] [outward in the direction of the attack side] and swing to the [left] [right] when facing the gate from the attack side.]

2.4.4.2 Fence Fabric

****

NOTE: Crash gates may be installed with fence fabric so they are part of a fence system. If the crash gate is to be installed with fence fabric, the edit the following paragraphs. If fence fabric is not required, then delete the paragraphs.

****

a. Fence fabric can either be from the same manufacturer as the gate system or the attachments, coordinate dimensions, and fittings between the gate system and fence fabric manufacturer.

b. Fence Fabric consists of [vertical metal pickets] [chain link fence] [ballistic panels] [welded wire mesh] [wire fence] [_____].

c. Fence Fabric and gates must meet the requirements of Section[s] [32 31 13 CHAIN LINK FENCES AND GATES] [32 31 13.53 HIGH-SECURITY CHAIN LINK FENCES AND GATES] [32 31 26 WIRE FENCES AND GATES].

2.4.4.3 Powered Crash Gate

Control gate movement by [an electro-mechanical gate operator] [or] [a hydraulic gate operator] consisting of an operator unit with required control circuits and operator station. Provide a system that utilizes 24 vac (nominal)or, as an option 24 Vdc control and operating voltages. Provide a remote control master station that is capable of driving the gate at [[_____] m per second fpm] [[_____] degrees per second] for a swing gate. Unless otherwise indicated, motors are to have [drip-proof][totally enclosed] enclosures.

Design the system to prevent opening of the crash gate in the event of electrical or mechanical failure. Provide a disconnect system for the gate drive that allows manual operation of the barrier in the event of a power outage.

2.4.4.4 Manual Crash Gate

Provide a manual crash gate that is capable of being hinged from either side. Provide a hinge point on each buttress that contains a locking pin with padlock acceptance for securing the crash gate in the closed position.

2.4.5 CRASH BEAM

****

NOTE: A crash beam barrier consists of a beam across the traffic lane which is supported on either side of the roadway with concrete or steel buttresses. Generally, a crash beam is a vertical pivot, that operates by raising to allow access and lowering to deny access. The barrier pivots about a hinge point at one of the buttresses and is secured with a locking/pin mechanism on the other buttress. There are, however, several models on the market which allow and deny access with a vertically rising beam which remains parallel with the roadway surface (similar to a lift bridge), or swing horizontally. A crash beam can be hydraulically, electrically or manually actuated and is available in surface mounted configurations.

****

Provide a crash beam that consists of an above-grade assembly that, in the "DOWN" position, presents a visible obstacle to approaching vehicles. Provide a barrier with a minimum height of 750 mm 30 inches as measured from the roadway surface to the centerline of the crash beam. Provide a crash beam that is capable of blocking a minimum road width of [3.0][_____] m [120][_____] inches. Provide a crash beam end that contains a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position.

2.4.5.1 Vertical Rising/Lifting Crash Beam

****

NOTE: This barrier is able to have an EFO operating

mode and slower modes of operation. Typical maximum opening is around 7.3 meters/24 feet. Most of these tend to be hydraulically operated.

****

Provide a vertical rising (lifting) crash beam.

2.4.5.2 Vertical Pivot Crash Beam (Drop Arm)

****

NOTE: The barrier may or may not be suitable for EFO operation. It will depend on the specific model and the length of the beam arm. If the arm is normally in the open position, then take into account prevailing wind speed in the area. Most of these barriers tend to be hydraulic, electric (electro-mechanical), or non-powered.

****

Provide a vertical pivot crash beam.t

2.4.5.3 Horizontal Sliding Crash Beam

****

NOTE: This barrier is not suitable for EFO operation. Most of these barriers tend to be hydraulic or non-powered. This barrier is available, but not as common.

****

Provide a horizontal sliding crash beam.

2.4.5.4 Horizontal Swing Crash Beam (Barrier Arm)

****

NOTE: This barrier is not suitable for EFO operation. The longer the arm, the more time it will take to open and close. Most of these barriers tend to be hydraulic or non-powered.

****

2.4.5.5 Powered Crash Beam

Provide a [hydraulic power system] [or] [electro-mechanical system] for the crash beam that is capable of being raised or lowered within 8 to 15 second time range. Provide the crash beam with a disconnect system that allows manual operation of the barrier in the event of an electrical or mechanical failure

2.4.5.6 Manual (Non-Powered) Crash Beam

Counterbalance the crash beam so it can be manually raised and lowered with the aid of a counterbalanced end requiring approximately 267 N 60 pounds of force.

2.4.6 PORTABLE CRASH RATED RETRACTABLE BARRIER

****

NOTE: Portable crash rated active vehicle barriers are able to be transported by using equipment (trucks, forklifts, etc) and are able to be erected

in a relatively short amount of time. These systems will not be for permanent use and will therefore be surface mounted. They will also not have all of the wiring and control devices required for the permanent crash rated active vehicle barriers. These barriers can be portable retractable barriers, crash beams and crash gates. They can be manually actuated, powered but self contained, or powered via an external power supply.

****

Provide a portable crash rated retractable barrier that is transportable. When in the raised position, the total barrier height is to be no less than [750][_____] mm[30][_____] inches above the roadway surface and must be [_____] mm[_____] inches wide. Equip the barrier with entrance/exit ramps when the barrier extends more than 16 mm 5/8 inch above the roadway surface. Retractable barriers in the lowered position must be capable of supporting a 142 kN 32,000 pound axle load or a 71 kN 16,000 pound wheel load. Design for this load is to be accordance with AASHTO GDHS-7. Portable crash rated retractable barriers are to be anchored in accordance with the manufacturer instructions. This may include stakes or other means.

Portable barriers must be able to be moved via [integral wheels and tow package][or][and] [forklift] [_____].

2.4.6.1 Powered Portable Crash Rated Retractable Barrier

****

NOTE: Based on peak hourly volumes, fill in number of cycles per hour that the barrier will be required to function (maximum 300 complete up/down cycles per hour).

****

Provide a portable crash rated retractable barrier that is capable of [_____] complete up/down cycles per hour. Provide a retractable barrier that is capable of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, provide a barrier that is capable of being closed from the raised position to the lowered position in not more than 3 seconds. Equip portable power assisted retractable barriers with on and off ramps for smooth transition between surfaces when the barrier extends more than 16 mm 5/8 inch above the roadway surface. Anchor the barrier in accordance with the manufacturer instructions. Provide a barrier that is [electro-mechanical][or][hydraulic].

Provide a portable barrier that is of the [retractable barrier][or] [crash gate] type.

2.4.6.1.1 Failure Modes of Operation

Design the system to prevent lowering of the barrier in the event of hydraulic, electric, or mechanical failure. Include a manual pump for operation of hydraulic and/or mechanical barriers without power.

2.4.6.1.2 System

Design the system to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, equip it with a pressure relief valves to prevent overpressure.

2.4.6.1.3 Controls

****

NOTE: Portable system can be connected into larger control systems, but typically these are temporary or remote. Coordinate the choices below with the Control Panel Components and Construction. This paragraph is not required if using more than a control station that is part of the crash barrier.

If an umbilical cord set-up is required, then pick the desired length. Going over 6 meters/20 feet is not standard.

****

[Provide an open/close pushbutton station at the crash barrier location.] [Provide an open/close pushbutton station on a [3][6][_____] meter [10][20][_____] feet flexible cord.][Provide EFO Operation.]

2.4.6.2 Manual Crash Rated Retractable Portable Barriers

Provide a manual barrier capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 267 N 60 pounds of force. Provide a manual mechanism that contains a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position and is also capable of being locked in the "DOWN" position. Provide a retractable barrier to withstand a [_____] kg pound vehicle at impact speed of [_____] km/hour mph, with maximum barrier deflection or vehicle penetration of [_____] m feet.

2.4.7 PORTABLE PIVOTING OR SWINGING CRASH BEAM

Provide a portable crash beam with an above-grade assembly that, in the "DOWN" position, presents a visible obstacle to approaching vehicles. Provide a barrier with a minimum height of 750 mm 30 inches as measured from the roadway surface to the centerline of the crash beam. Provide a crash beam that is capable of blocking a minimum road width of [3.0] [_____] m [120][_____] inches. Provide the crash beam end with a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position.

2.4.7.1 Controls

****

NOTE: Portable system can be connected into larger control systems, but typically these are temporary or remote. Coordinate the choices below with the Control Panel Components and Construction. This paragraph is not required if using more than a control station that is part of the crash barrier.

If an umbilical cord set-up is required, then pick the desired length. Going over 6 meters/20 feet is not standard.

EFO operation is not used with this type of barrier.

****

[Provide an open/close pushbutton station at the crash barrier location.] [Provide an open/close pushbutton station on a [3][6][_____] meter [10][20][_____] feet flexible cord.]

2.4.7.2 Powered Portable Crash Beam

Provide a hydraulic power system for the portable crash beam that is capable of being raised or lowered within 8 to 15 second time range.

Provide a disconnect system for the portable crash beam to allow manual operation of the barrier in the event of an electrical or mechanical failure.

2.4.7.3 Manual Portable Crash Beam

Provide a crash beam that is manually operated by means of a counter balanced system requiring approximately 267 N 60 pounds of force.

2.5 POWER UNIT

2.5.1 HYDRAULIC POWER UNIT ENCLOSURE

****

NOTE: Based on manufacturer's system layout the hydraulic platform unit should be located above ground.The hydraulic oil viscosity must remain within its operating range, even after barrier non-use. If ambient temperature drops below -7 degrees C (20 degrees F) then hydraulic power unit needs to be equipped with proper hydraulic oil, hydraulic oil heater, insulated and heated hydraulic lines, and underground hydraulic oil lines in pipes. If ambient temperature exceeds 38 degrees C (100 degrees F) then the manufacture must supply efficient cooling and proper hydraulic oil for oil viscosity to remain within its operating range, even at constant heaviest use rate. If ambient temperature range requires the oil to be changed, the manufacturer must supply information on type of oil to be used and instructions for changing. Fill in the high and low air temperature of the area where the barrier will be installed.

Hydraulic operated barrier systems will contain synthetic biodegradable hydraulic fluid. Provide fluid that meets International Organization for Standardization (ISO) Grade 32 for cooler climates or ISO Grade 46 for temperate zones. Barriers for tropical or desert areas require a heavier grade, verify grade requirements with local suppliers. Based on barrier cycling and climate data, decide if a hydraulic fluid heater is required.

****

Provide the hydraulic power unit with synthetic biodegradable hydraulic fluid. Provide fluid ISO Grade that is appropriate for the temperature ranges listed in the Environmental Conditions Section of this specification. Submit recommended Hydraulic Fluid manufacturer's data for approval. Provide a hydraulic thermostatically controlled fluid heater so that the viscosity remains within its operating range if ambient temperatures below minus 7 degrees C 20 degrees F are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier are to consist of flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures are to exceed the maximum system relief pressure. [Where hydraulic lines are placed underground, provide a casing pipe consisting of PVC pipe and fittings in accordance PVC Type EPC-40 if concrete encased or EPC-80 if not concrete encased in accordance with NEMA TC 2 and UL 651] [Provide a HPU cabinet that is capable of containing leakage and slope hoses containing hydraulic hose pipes to drain to containment.]

a. Provide flexible hydraulic lines that are in accordance with SAE J517.

b. Provide rigid hydraulic lines that are seamless carbon steel pipe in accordance with ASTM A106/A106M.

Place the unit on a reinforced concrete pad or other approved pad material in a prefabricated weatherproof metal enclosure. Provide a containment area; i.e., depressed floor or catch pan, to ensure capture of the total amount of hydraulic fluid within the hydraulic power unit. Access door or doors are provided to meet the maintenance requirements of the unit. The physical location of the unit is on the protected side of the area.

Unless otherwise indicated, provide electric motors with [drip-proof] [totally enclosed] [totally enclosed fan cooled] enclosures. All couplings, motor shafts, gears, and other moving parts are to be fully guarded in accordance with 29 CFR 1910 Subpart O. Provide guards that are removable without disassembling the guarded unit. For multiple barriers operated from a single hydraulic unit it is highly recommended that the electric motor be 3-phase. This paragraph assumes motors are installed above grade.

2.5.2 ELECTRIC POWER UNIT ENCLOSURE

Provide a NEMA Type 3R enclosure as specified in NEMA 250 to enclose the electric power unit. Design the enclosure for easy removal of the power unit and other accessories without complete removal of the enclosure. Provide an access door with hinges and an inside and outside operable/lockable (exterior) door latch. Place and configure equipment within the enclosure so that all periodic maintenance can be performed through the access door without removal of the equipment. Equip the enclosure with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2.5.3 PNEUMATIC POWER UNIT ENCLOSURE

Provide a NEMA Type 3R enclosure as specified in NEMA 250 to enclose the power unit. Design the enclosure for easy removal of the compressor and other accessories without complete removal of the enclosure. Provide an access door with hinges and an inside and outside operable/lockable (exterior) door latch. Place and configure equipment within the enclosure so that all periodic maintenance can be performed through the access door without removal of the equipment. Equip the enclosure with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2.6 HEATER

Provide a waterproof barrier heater with a thermostat control and NEMA 4 junction box connection point for de-icing and snow melting. Provide a heater that ensures proper barrier operation is maintained down to an ambient temperature of minus 40 degrees C minus 40 degrees F. [Provide a [_____][250]-watt heater for each retractable bollard.]

[Provide heat tape in the drain pipe system that is controlled by the same thermostat for the barrier heater or by a separate thermostat.

]2.7 FINISH AND MARKINGS

Provide signs and markings that meet retroreflectivity requirements as contained in the MUTCD under Part 2 Signs sections on 'Retroreflectivity', 'Maintaining Minimum Retroreflectivity', and 'Shapes' plus ensure all state and local retroreflectivity requirements are satisfied. Paint surfaces in accordance with requirements of Section 09 90 00 PAINTS AND COATINGS.

Use red and white stripe marking on all crash rated active vehicle barriers [and actuated traffic arms] as required for a stop condition by AASHTO RSDG-4. Provide vertical striping and lights (unless otherwise noted in this SECTION) as per MUTCD Part 8B Signs and Markings, Section on 'Crossbuck Assemblies with YIELD or STOP Signs at Passive Grade Crossings'.

a. Provide bollards with full retroreflective markings. Provide bollards that alternate retroreflective colors red and white with the red starting on the side nearest the curb.

b. Paint wedge, frame, beam, and post type barriers with vertical red/white alternating retroreflective striping that is approximately 400 mm 16 inch wide and covers the entire exposed area of the barrier. Since barriers will vary in width, the striping can be adjusted wider or narrower to have it work so each stripe is the same width.

c. For Crash Gates markings will be provided by the installation of retroreflective markings on the both sides of the gate that are visible to the drivers. It will consist of alternating vertical retroreflective red and white stripes. Markings are to provide the same color scheme, retroreflective performance and durability as required in this SECTION.

Provide markings on both the front and back of the crash rated active vehicle barriers. Provide non-skid, durable markings that are part of the roadway (i.e. backside of plate barriers or the top of retractable bollards), and ensure retroreflectivity is maintained based on expected traffic flow (see paragraph PROJECT/SITE CONDITIONS of this SECTION) for a minimum of two years.

Markings on surfaces that are not part of the roadway must meet requirements of ASTM D4956, Type III or better and MUTCD.

Provide signing as shown in the drawings. A minimum sign sheeting of MUTCD Part 6F Temporary Traffic Control Device Zone Devices, Section on Channelizing Devices, Type III sign sheeting is to be used for regulatory and warning signs. Provide all sign posts with a breakaway design as set forth in AASHTO RSDG-4 or as required by the local/State Department of Transportation.

Provide a retroreflective white pavement marking envelope consisting of 305 mm 12 inches wide white stripes at 45 degree angle separated by a 610 mm 24 inches clear space at the crash rated active vehicle barriers. Provide an envelope that is full lane width and at least 2.4 meters 8 feet in length.

2.8 ACTIVE VEHICLE BARRIER CONTROL SYSTEM (AVBCS)

2.8.1 General Requirements

****

NOTE: Delete reference to remote control panel if it is not applicable.

****

The AVBCS provides alarm, status, and control information to the [Master Control Panel], [Remote Control Panel(s),] [Guard Booth Control(s) (panels and buttons),] [Search Area Control Panel(s),] [Search Building Control Panel,][Overwatch Position Control Panel,] [Pedestrian Control Panel,]and the Local Control Panel(s). A full layout showing the location of the controllers is required. A controller that is installed in a facility requires a complete layout of all equipment to be placed in the room/area to ensure all clearances are maintained. This layout is part of the shop drawings submittal. The control system contains all relays, timers, and other devices and an industrial programmable controller programmed as necessary for the barrier operation. The control panel allows direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and [sliding][swinging] gate limit switches. Provide logic to coordinate the barricade and the traffic lights.

2.8.2 System Integration

Provide the AVBCS as an integrated system, including all sub systems specified hereafter. AVBCS hardware and software integration is required to function as one integrated system. The Contractor is responsible for all integration and appetencies required for the system to behave as one system. Supply of separate sub systems without integration is not acceptable. The extent and nature of integration must be extensively documented and demonstrated in the Technical Data and Software Package. _ ***The system is configured with industrial programmable logic controllers.***

2.8.3 AVBCS Processor

The AVBCS processor consists of a combination of controllers located within the ACP/ECF that work with the various hand machine interface operating panels that are either hard control panels (discrete switches, buttons and indicating lights) or touchscreen control panel(s) or a combination of both touchscreen and hard control items.

a. A programmable logic controller (PLC) meeting the requirements listed herein. Provide the PLC or PLCs with the latest software version. This is the main overall controller for the AVBCS.

b. Overspeed controllers are to work in unison with the system to provide the appropriate alarms.

c. Wrong-way controllers are to work in unison with the system to provide the appropriate alarms.

****

NOTE: The EFO is required to be pushbutton or switch with a cover. Touchscreen is not allowed for this operation.

****

d. Human Machine Interface: [Hard-control] [Hard-control panel and touchscreen video-control] [Contractor allowed the option to provide either hard control or touchscreen control or a combination of the two systems; however, EFO is to be hard control] panel operator interface.

e. Vehicle Presence Detection: Controller that operate the vehicle presence detection system(s) are to work in unison with the overall system to provide the appropriate response.

f. Computer control. Controller(s) that are computers (not a PLC or traffic control unit) are not allowed.

****

NOTE: Delete if the red/yellow/green traffic signals associated with the crash rated active vehicle system are NOT located at an intersection.

****

[g. Traffic Control Unit. A traffic control unit is to be used when the crash rated active vehicle barrier traffic signals are co-located at an intersection. The traffic control unit is, as a minimum, control the intersection traffic signals and is to interface with the crash rated active vehicle barrier control system.

]2.8.4 PROGRAMMABLE LOGIC CONTROLLER (PLC)

2.8.4.1 PLC General Requirements

PLCs area digitally operating electronic apparatus that use a programmable memory for internal storage of instructions for implementing specific functions such as logic, sequencing, timing, counting, and arithmetic though digital or analog input/output modules. PLCs are capable of receiving discrete and analog inputs and, through programming, and are able to control discrete and analog output functions, perform data handling operations and communicate with external devices. Provide PLCs that meet the requirements of Class A computing devices, and are labeled as set forth in 47 CFR 15 and are able to withstand conducted susceptibility test as outlined in NEMA ICS 1, NEMA ICS 2, andIEEE C37.90.1. Provide PLCs that function properly at temperatures between 0 and 50 degrees C 32 and 122 degrees F at 5 to 95 percent relative humidity non-condensing and tolerate storage temperatures between minus 40 and plus 60 degrees C 40 and plus 140 degrees F at 5 to 95 percent relative humidity non-condensing. Provide an intelligent process controller that can perform both data acquisition and process control functions that has the ability to function independently; that is, perform its function without the need for commands from a separate computer.

2.8.4.2 Modular PLC

Provide PLCs that are based on a modular, field expandable design allowing the system to be tailored to the process control application. The system is expandable through the use of additional hardware and/or user software. As a minimum, provide the PLC with a mounting backplane, power supply module, central processing unit (CPU) module, communications module, and input/output (I/O) module. Group modules together in a mounting rack or cabinet. Ensure the mounting rack backplane provides the communications mechanism to fully integrate the individual modules located within the rack. Provide modules that plug directly into the backplane. The use of wire connectors between modules is not be allowed. Provide a rack or cabinet sized as needed to hold the equipment necessary while performing the required control functions. The system configuration allows for the removal and/or installation of modules under power.

2.8.4.2.1 Central Processing Unit (CPU) Module

The CPU module is a self contained, microprocessor based unit that provides time of day, scanning, application (ladder rung logic) program execution, storage of application programs, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self diagnostics.

a. Provide a processor with battery backed static RAM to hold application programs. Provide a battery that is serviceable without taking the processor module out of service. Provide a monitoring system that monitors the battery for a low voltage condition. Provide a low voltage status bit for use by the PLC program.

b. Provide the processor with illuminated indicators readable from the front of the processor module for diagnostics. Provide diagnostic status bits for use by the PLC program.

2.8.4.2.2 Communications Module

Provide a communications module that allows peer-to-peer communication with other PLCs and allows the PLC to communicate with the workstation. Provide a communication module that utilizes the manufacturer's standard communication architecture and protocol, Ethernet architecture and protocol or a combination of these. The communication module is to allow programming of the PLC to be done locally through the use of a laptop computer.

2.8.4.2.3 Power Supply Module

Provide one or more power supply modules as necessary to power other modules installed in the same cabinet. Provide power supply modules that plug directly into the backplane. Auxiliary power supplies may be used to supply power to remote cabinets or modules.

a. Provide power supply modules that use [AC] [or] [DC] power with a nominal voltage of [120 VAC] [or] [220 VAC] [24 VDC] [_____] plus or minus 5 percent. The power supply module is to monitor the incoming line voltage level and provide over current and over voltage protection. If the voltage level is detected as being out of range the power supply module continues to provide power for an adequate amount of time to allow for a safe and orderly shutdown. Power supply modules are capable of withstanding a power loss for a minimum of 20 milliseconds while still remaining in operation and providing adequate power to all connected modules.

b. Provide each power supply module with an on-off switch integral to the module. If the manufacturer's standard power supply module is not provided with an on-off switch, install a miniature toggle type switch near the PLC and clearly labeled the switch as to its function.

c. Provide power supply modules with an indicating light that is lit when the module is operating properly.

2.8.4.2.4 Input/Output (I/O) Modules

I/O Modules are self contained, microprocessor based units that provide an interface to field devices. Locate the I/O modules in the same mounting rack as the other PLC components. The unit is to plug directly into the backplane of the mounting rack. Each module is to contain visual indication to display the on-off status of individual inputs or outputs. All modules are to be mechanically keyed between the I/O module and the terminal strip to ensure the wiring and modules are correctly matched. Extensive diagnostic indicators are to be available on each module including information on the state of the I/O, along with specific module by module special features such as field wiring faults, blown fuses, and over/under voltage range information.

2.8.4.3 Program Storage/Memory Requirements

The CPU utilizes the manufacturer's standard non-volatile memory for the operating system. Provide the controller with electronically erasable, programmable, read only memory (EPROM) for storage of user programs and battery backed RAM for application memory. The EPROM is loaded through the controller keypad or through the use of a laptop computer. The CPU memory capacity is based on the system's control requirements. The memory capacity is sized such that, when the system is completely programmed and functional, no more than 50 percent of the memory allocated for these purposes is used.

2.8.4.4 Input/Output Characteristics

Each controller allows for analog input, analog output, discrete input and discrete output. The number and type of inputs and outputs for the system is as shown on the drawings or described herein and is to comply with the sequence of control. Include in the system capacity a minimum of 20 percent spare input and output points (no less than two points) for each point type provided. During normal operation, a malfunction in any input/output channel is to affect the operation of that channel only and must not affect the operation of the CPU or any other channel. Analog input circuits are available in +/-10V, +/-5V, 0-10V, 0-5V, or 4-20 mA. Discrete input circuits are available in 5 volt TTL, 10-30 VDC, 18-26 VDC, or 79-132 VAC. Provide all input circuits with a minimum optical isolation of 1500 VRMS and be filtered to guard against high voltage transients from the externally connected devices. Analog output circuits are to be available in +/-10V or 4-20 mA. Discrete output circuits are to be available in 5 volt TTL, 10-30 VDC, 18-26 VDC, or 79-132 VAC. Provide all output circuits with a minimum optical isolation of 1500 VRMS and filter to guard against high voltage transients from the externally connected devices. Provide a PLC that is able to communicate with a computer or other PLC's via fiber optic cable or copper cable. Provide a PLC processor that is able to process data from Remote Input/Output modules via fiber optic cable or copper cable. Ensure remote Input/Output modules do not require individual programming to function.

2.8.4.5 Wiring Connections

Provide wiring connections that are heavy duty, self lifting, pressure type screw terminals to provide easy wire insertion and secure connections. Provide terminals that accept two #14 AWG wires. Provide a hinged protective cover over the wiring connections. Provide write-on areas for identification of the external circuits on the cover.

2.8.4.6 On-Off Switch

Provide each controller with an integral on-off power switch. If the controller is not provided with a manufacturer's standard on-off switch, then install a miniature toggle type switch in the control panel near the controller and clearly labeled the switch as to its function.

2.8.4.7 Diagnostics

Provide each PLC with diagnostic routines implemented in firmware. The CPU is to continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and input/output. The diagnostic routines are to be regularly performed during normal system operation. Provide a portion of the scan time of the controller dedicated to performing these housekeeping functions. In addition, provide a more extensive diagnostic routine that is performed at power up and during normal system shutdown. The CPU is to log input/output and system faults in fault tables which are accessible for display. When a fault affects input/output or communications modules the CPU is to shut down only the hardware affected and continue operation by utilizing the healthy system components. Annunciate all faults at master control panel and at the PLC.

2.8.4.8 Accuracy

Provide controllers with an accuracy of plus or minus 0.25 percent of input span.

2.8.5 PLC SOFTWARE

Furnish all PLC software described in this specification as part of the complete control system.

2.8.5.1 Operating System

Provide each PLC with the manufacturer's standard operating system software package. Maintain a point database in its memory that includes all parameters, constraints and the latest value or status of all points connected to the PLC. Use the data in memory resident files for the execution of the PLC application programs. The operating system must support a full compliment of process control functions. It is possible to define these functions using a mix of function blocks, ladder logic diagrams, sequential function charts and text programming. Base programming methods and interactions on IEC 61131-3. A combination of the programming methods is to be possible within a single controller. The operating system allows loading of software locally. The operating system supports data entry and diagnostics using an operator interface panel attached directly to the PLC. Each PLC is be capable of operating in stand alone mode.

2.8.5.1.1 Startup

Provide the PLC with startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A PLC restart program based on detection of power failure at the PLC is to be included in the PLC software. The restart program includes start time delays between successive commands to prevent demand surges or overload trips.

2.8.5.1.2 Failure Mode

Upon failure for any reason, each PLC is to perform an orderly shutdown and force all PLC outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

2.8.5.2 Functions

Provide a controller operating system that is able to scan inputs, control outputs, and read and write to its internal memory in order to perform the required control as indicated in the sequence of control on the drawings. The controller periodically perform self diagnostics to verify that it is functioning properly.

2.8.5.2.1 Analog Monitoring

The system measures and transmits all analog values including calculated analog points.

2.8.5.2.2 Logic (Virtual)

Logic (virtual) points are software points entered in the point database which are not directly associated with a physical I/O function. Logic (virtual) points can be analog or digital points created by calculation from any combination of digital and analog points, or other data having all the properties of real points, including alarms, without the associated hardware. Logic (virtual) points are defined or calculated and entered into the database. The calculated analog point has point identification in the same format as any other analog point.

2.8.5.2.3 State Variables

If an analog point represents more than two (up to 8) specific states, each state is to be nameable.

2.8.5.2.4 Analog Totalization

Any analog point is to be operator assignable to the totalization program. Up to eight analog values are to be totalized within a selectable time period.

2.8.5.3 Alarm Processing

Provide each PLC with alarm processing software for analog input, digital input, and pulse accumulator alarms for all real and virtual points connected to that PLC.

2.8.6 AVB Control System Processing and Control Software

2.8.6.1 General

Specific functions to be implemented are defined in individual system control sequences and database tables shown on the drawings and herein. Provide software that provides the communication, programming and control capabilities necessary to support all specified points and functions, [plus a minimum expansion of [20][25][50][_____] percent of the current number of points] complete with their point database. Provide a controller that is online at all times and performs all required functions as specified. Provide software that consists of custom-developed code and/or one or more standard software modules. Where multiple modules are used, the modules need to be capable of sharing data and operating together seamlessly. Provide a system that supports multiple user operations with multiple tasks for each user and supports operation and management of all peripheral devices. Provide a system that allows on-line configuration modifications, while the system is operating. Provide software with complete user documentation online, including examples of how to operate the various modules within the software. Supply all documentation implemented software, including the custom-developed software codes to [the Contracting Officer][_____] after formal system acceptance. [[The Contracting Officer][______] has the right of use for the provided software for future enhancements and additions to the installed system.] Ensure the AVB control system does not contain proprietary code or passwords that limit work to be done exclusively by a manufacturer of the product. Provide open source code.

2.8.6.2 Resident Application Software

Provide resident applications programs developed in accordance with paragraph Graphical Object Oriented Programming to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the systems connected to the control system. All application programs are resident in the PLC and are to execute in the PLC, and coordinate with each other, to insure that no conflicts or contentions remain unresolved.

2.8.6.3 Display Information

Provide information necessary to support all requirements specified at the AVBCS display, including: guard control commands; alarm notification; status point changes; and report generation

2.8.6.4 Graphical Object Oriented Programming

Provide a system that includes a graphical object oriented programming function which is used to create all control sequences utilized in the control panels. The graphical object oriented programming function provides programming elements to be connected together to create a logic diagram. The diagram must be compliable to produce executable code for the control panel. Provide a graphical object oriented programming function that includes elements necessary to create logic diagrams that represent sequences of operation. Provide program elements that are able to be combined into a custom template which can then be used as a standard function.

2.8.6.5 Command Software

The Provide software for defining and selecting I/O, parameters, and all other functions associated with operation. The operator commands must be usable from keyboards with individual operator passwords as specified. Store the database in non-volatile RAM or other approved means. Static database must downloadable to backup devices.

2.8.6.6 Command Input and Errors

Provide command menus that utilize full words and acronyms selected to allow programmers/technicians to use the AVBCS without extensive training or data processing backgrounds. The AVBCS will issue a prompt to the programmer/technician. Insure the AVBCS supervise programmer/technician inputs to ensure they are correct for proper execution. Insure programmer/technician input assistance is provided whenever a command cannot be executed because of input errors.

2.8.6.7 Special Functions

The AVBCS supports the following special functions by using a mouse or touchscreen, in addition to all other commands specified:

a. The Help display will produce a display of all commands available to the operator. The help command, followed by a specific command, produces a context sensitive listing with a short explanation of the purpose, use, and system reaction to that command.

b. Print Report allows the operator to print reports.

2.8.6.8 Alarms

The software alarms is to notify a programmer/technician of the occurrence of an alarm condition. The AVBCS alarm history are to be stored, to be re callable by the programmer/technician using the report generator. Alarm messages take precedence over other functions. A minimum of the most recent 1000 alarms must be directly available at the AVBCS. Within the alarm response time digital alarms are subject to immediate reporting, within the alarm response time.

2.8.6.9 Report Generator

Provide software to generate and format standard and custom reports for displaying and storing on disk. Database values and parameters, values calculated using the real time static database or historical data base; with the reports subsequently stored on removable media to generate reports. Do not interrupt dynamic operation of the system to generate a report. Provide the report with the time and date when the report was printed.

2.8.6.10 Periodic Automatic Report

The system allows for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral. The system (through the Request Report Mode) allows for the operator to request, at any time, an immediate display of any report.

2.8.6.11 Historical Data Storage and Retrieval

Provide a historical data storage and retrieval function used to collect and store dynamic data. This function is in addition to other data storage requirements. The function must have the capability to collect and store alarm status changes, point values, events and operator commands, and system responses. Provide this function with the capability to retain historical data on non-volatile RAM for pre-specified time periods, up to forty-five days using last day roll over, for short-term analysis, and then output the data to the utility software for long-term retention. Insure the operator is able to selectively recall short-term data stored on non volatile RAM. Using the data retrieval and report generation program retrieval of the contents of any selected historical data file through utility programs is available. The output of the report generation program must be capable of being viewed on the screen, transferred to removable media, or stored.

2.8.6.12 System Access Control

Provide a minimum of 10 passwords that is usable with the control system software. The AVBCS maintains a log of programmers/technicians logged onto the system. Define each password as to the functions that the programmer/technician can perform. The software must support a user based security system. The security system allows for the creation of users with certain rights and/or privileges,When enabled. When user based security is enabled, an audit trail must be generated in the system which tags every programmer/technician logon with user identification (ID). Support the following functions within the security management application:

a. Define users.

b. Define groups which users may belong to.

c. Define user and/or group rights/privileges.

2.8.6.13 Convenience Outlet

****

NOTE: Coordinate with electrical drawings to provide power for control panel convenience outlet and other required accessories.

****

Provide a 120 volt ac, 15 amp, ground fault interruption (GFI) type duplex convenience outlet inside each cabinet that houses a PLC.

2.8.7 CONTROL PANEL(S)

****

NOTE: The first paragraph is to be used if using typical master, guard booth, overwatch style operating panels that are based on Appendix A with layouts shown on the drawings. The second paragraph is for non-standard applications for these control panels. choose the desired paragraph and delete the other.

The guide specification describes control panels here in generic terms of master control panel and types of remote operating panels.

****

[Provide a master control panel to interface between all barrier control circuits, remote EFO control panels,[remote EFO control buttons,][wrong-way][, overspeed], auxiliary equipment, and the crash rated active vehicle barrier power units. Provide remote control panel(s)/buttons [for each [guard booth,][search area,][Overwatch,][_____].] Provide remote local panel(s) at the barrier location to be used for maintenance purposes. Control circuits contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. Provide a control panel that allows direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and sliding or swinging gate limit switches. Ensure loop controllers do not allow an automatic barrier raise following power loss or restoration. Run all device interconnect lines to terminal strips. Descriptions are primarily for discrete controls making up a given control panel. None of the panels have to be listed under UL 508; however some components may have to meet certain requiremnet of the document as indicated elsewhere. If allowing or using touchscreen control instead, see paragraph "Touchscreen" for revised requirements. [Provide control panels as shown on the drawings and as described in Appendix A.][Provide control panels as shown on the drawings.][Provide control panels as described in Appendix A.][EFO function is not allowed to be accomplished with a touch screen.]]

[Provide a master control panel to interface between all barrier control circuits, remote EFO control panels,[remote EFO control buttons,] wrong-way[, overspeed], auxiliary equipment, and the crash rated active vehicle barrier power units. Provide remote control panel(s)/buttons [as shown.][for each[guard booth,][search area,][Overwatch,][_____].] Provide remote local panel(s) at the barrier location to be used for maintenance purposes. Control circuits contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. Provide a control panel that allows direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and sliding or swinging gate limit switches. Ensure loop controllers do not allow an automatic barrier raise following power loss or restoration. Run all device interconnect lines to terminal strips. Descriptions are primarily for discrete controls making up a given control panel. If allowing or using touchscreen control instead, see paragraph "Touchscreen" for revised requirements. [EFO function is not allowed to be accomplished with a touch screen.]]

[2.8.7.1 Master Control Panel

****

NOTE: If panel layout is shown on the drawings, then keep the first paragraph and delete all subparagraphs.

****

Provide a master control panel with all necessary displays and controls to allow the operator to view real-time alarms, discrete point status changes, to control crash rated active vehicle barriers and related equipment. Locate the master control panel[as shown on the drawings] in a manner to allow the operator to easily use the controls and monitor the displays while, at the same time, oversee entry and exit operations. Permanently label all control panel indicator lights, push buttons, and switches on the console.[Provide master control panel as shown on the drawings.][The master control panel includes the following:]

[a. Keyed Power On/Off switch with a red indicating light illuminating when power is on.

][b. Mode Selector Switch. Provide a selector switch for each barrier. The switch is to have ["EFO", "Test", "Local"] ["EFO", "Test"] [_____] modes. [Provide a keyed switch.] Provide amber indicating lights for each switch position with the corresponding name indicated.

][c. A pushbutton for "access allowed" and a pushbutton for "access denied" positions for each barrier and corresponding indicating light for each action. Illuminate a red indicating light for "access denied" and a green indicating light for "access allowed").

][d. A pictograph of the barrier in the "access allowed" position and "access denied" position next to the pushbutton.

][e. An EFO [pushbutton][switch][pushbutton or switch] with a cover that operates the barrier(s) in EFO mode.

][f. EFO Activated. Red indicating light.

][g. EFO Reset. [Lockable][Switch or pushbutton][Keyed switch].

][h. Lamp test button.

][i. An operating mode switch between EFO and manual modes for [each barrier][the inbound lanes and for the outbound lanes][as indicated].

][j. A toggle switch that arms or disarms each [remote panel with an EFO] [guard booth] control panel. Provide indicating light - red for arm and green for disarm.

][k. An audible alarm (buzzer) that has adjustable volume control. Volume control can be by another switch or built into the buzzer.

][l. Provide a pushbutton that is used to silence the audible alarm. Silence button when pushed just silences the present alarm. If a new alarm comes into the panel, the audible alarm will activate.

]][2.8.7.2 Remote EFO Control Panel - Primary

****

NOTE: The first paragraph is intended to be used for an overwatch position that does not have the master control panel. This overwatch is located at ACPs/ECFs. The second main paragraph is for other locations that may have different requirements. choose the appropriate option for the project. If panel layout is one drawings, then delete all the subparagraphs.

Within each paragraph, the choose the appropriate option.

****

[This panel is intended to be installed at each overwatch position. The panel operating panel is to be installed within a lockable cabinet when at a paved position; otherwise, place operating panel in the overwatch booth. [Provide as shown on the drawings.]

][[Provide Remote Control Panel(s) - Primary as shown on the drawings.][The Remote Control Panel(s) - Primary includes the following:]

][a. Provide a red indicating light for "access denied" and a green indicating light for "access allowed".

][b. Next to the pushbutton or position indicating lights, provide a pictograph of the barrier in the access allowed position and access denied position.

][c. An EFO [pushbutton][switch][pushbutton or switch] with a cover that operates the barrier(s) in EFO mode.

][d. EFO Activated. Red indicating light. Locate near the EFO.

][e. A lamp test button.

][f. An audible alarm (buzzer) that has adjustable volume control. Volume control can be by another switch or built into the buzzer.

][g. Provide a pushbutton that is used to silence the audible alarm. Silence button when pushed just silences the present alarm. If a new alarm comes into the panel, the audible alarm will activate.

][h. Provide a red indicating light that shows when the remote panel is Armed from the master control panel.

]][2.8.7.3 Remote EFO Control Panel - Secondary

****

NOTE: The first paragraph is to be used for guard booths and search areas that are at ACPs/ECFs. The second main paragraph is for other locations that may have different requirements. choose the appropriate option for the project. If panel layout is one drawings, then delete all the subparagraphs.

Within each paragraph, the choose the appropriate option.

****

[This panel is intended to be installed in each Guard Booth[, at the Pedestrian Booth,] and at each Search Area. [Provide as shown on the drawings.]

][[Provide Remote Control Panel(s) - secondary as shown on the drawings.][The Remote Control Panel(s) - secondary includes the following:]

][a. An EFO [pushbutton][switch][pushbutton or switch] with a cover that operates the barrier(s) in EFO mode.

][b. Provide a red indicating light that shows when the remote panel is Armed from the master control panel.

][c. EFO Activated. Red indicating light. Locate near the EFO.

][d. An audible alarm (buzzer) that has adjustable volume control. Volume control can be by another switch or built into the buzzer.

][e. An red visual indicating light for wrong-way.

][f. An red visual indicating light for overspeed.

]][2.8.7.4 Remote EFO Control Button

****

NOTE: Army Only. choose the first paragraph for Army projects.
The second main paragraph is for other locations that may have different requirements. choose the appropriate option for the project. If panel layout is one drawings, then delete all the subparagraphs.

Within each paragraph, choose the appropriate option.

****

[This EFO control button is intended to be installed at each Guard Booth. [Provide as shown on the drawings.]
]
[[Provide EFO control button as shown on the drawings.][The EFO control button includes the following:]
]
a. An EFO [pushbutton][switch][pushbutton or switch] with a cover that operates the barrier(s) in EFO mode.

b. Provide a red indicating light that shows when the remote EFO button is Armed from the master control panel.

c. EFO Activated. Red indicating light. Locate near the EFO.

][2.8.7.5 Remote - Local Control Panel

****

NOTE: Local Control Panel is a remote control panel that is to be located near the crash rated active vehicle barrier by the maintenance personnel. This panel in most applications does not have an EFO. Edit per the project requirements. If panel layout is one drawings, then delete all the subparagraphs.

NOTE: Include first bracketed choice that references Army projects with an Access Control Point and delete all other material.

****

This Remote Control Panel does not haven an EFO. The panel is to be located within a cabinet located near the crash-rated active vehicle barrier that is lockable. [Provide Local Remote Control Panel(s) as shown on the drawings.][The Local Remote Control Panel(s) includes the following:]

[a. A pushbutton for "access allowed" and a pushbutton for "access denied" positions for each barrier and corresponding indicating light for each action. Illuminate a red indicating light for "access denied" and a green indicating light for "access allowed").

][b. Next to the pushbutton, provide a pictograph of the barrier in the "access denied" position and "access allowed" position.

][c. Lamp test button.]

[d. Mode Selector Switch. Provide a selector switch on the panel for each [barrier][direction of travel]. The switch is to have ["EFO or Off", "Local"] modes. [Provide a keyed switch.] Provide with a red indicating light illuminating when in the [Local][On} position.
]
[e. Out of service switch. Provide a two-position switch that can be operated in any operating mode. Provide red indicating light for yes/enabled and a green indicating light for no/disabled.
]]
][2.8.7.6 Keys for Switches

[Provide keyed switches and keys as shown on the drawings and required in Appendix A.][Provide keyed switches and keys as shown on the drawings.][Provide keyed switches and keys as described in Appendix A.][The

Control Panel(s) include keyed switches with keys per the following:]

[a. Each master control panel switch operable by a unique key.

][b. Master control panel mode switch key removable in [all modes]["EFO", "Test", "Local"]["EFO", "Test"][_____]mode(s) only.

][c. Local panel mode selector switch with key removable in ([all modes]["Off", "Local"]["Off"][_____].

][d. Master control panel mode selector switch for a [specific barrier][direction of travel] is to match the corresponding Local Control Panel mode selector switch for the same barrier. The master control panel mode selector switch and the local control panel switch are keyed the same.

][e. Key removable only in [off][on][_____] position.]

]2.8.8 VOLTAGE

[The control circuit operates from a [120] [_____] volt [60][50] Hz supply.][Provide control circuits that have a voltage rating of [24] [12] [_____] [ac] [or] [dc] for all external control panels.][Contractor to choose the control voltage desired.]

2.8.9 SEQUENCE OF EVENTS RECORDER

All alarms and events listed in Appendix B must be collected by the AVBCS and stored with the following data: identification of the alarm/event, date and time to the nearest second of occurrence, date and time of acknowledgement (alarm points only), date and time of reset (alarm points only), and an alarm/event message. Events may have multiple messages to describe all possible states, e.g., AVB #1 in EFO mode, AVB #1 in Test mode, or AVB #1 in Local mode, EFO Guard booth 1 activated. Provide means and user-initiated procedure to export the stored alarms and events to a removable storage device for printing in a standard Windows application such as a spreadsheet. Receive and store all alarms and status changes in the AVBCS database with the appropriate time tags in no more than 100 milliseconds after the condition occurs (e.g., alarm/status point contact closure).

2.8.10 ALARM DISPLAY PANELS AT THE ID CHECK AREA AND SEARCH AREA(S)

Mount one or more Alarm Display Panels consisting of back-lit or LED [OVERSPEED and][WRONG WAY] messages outside of but near the guard booths at the ID Check Area. Mount so that the guards can see the message boards while looking toward the on-coming traffic. Include an adjustable audible alarm with the each alarm panel. Provide and locate a sufficient number of alarm panels to ensure any ACP/ECF guard either sitting in a guard booth or standing outside the guard booth can see and hear at least one panel. Provide an adjustable audible alarm that is loud enough to be heard over ambient traffic noise. Overspeed and wrong-way alarms clear automatically 3 seconds (adjustable) after the alarm condition ends with no action required by guard. Record overspeed and wrong-way alarms on the Alarm and Events Recorder.

2.8.11 Control Panel Components and Construction

2.8.11.1 Enclosures

Each control panel enclosure is to conform to the requirements of NEMA 250 for the types specified. Provide the manufacturer's standard finish color, unless otherwise indicated. Repair and refinish damaged using original type finish. Provide Type [1][4][12] enclosures for installation in equipment rooms; those for installation in clean, dry indoor occupied space may be Type 1; other locations are as otherwise specified or shown. [Provide Type 4 or as shown, enclosures for equipment installed outdoors.] [Provide Type 4X enclosures for installation in corrosive environment and construct of [stainless steel] [fiberglass] [polymer plastic]. Painted steel is not be allowed for use in a corrosive environment.] Provide enclosure with a single, continuously hinged exterior door with print pocket, 3-point latching mechanism and key lock and a single, continuously hinged interior door. Provide panels that are mounted on flat horizontal surface with a top that is tilted at 45 degrees or 60 degrees (unless a panel is wall mounted) to ensure easy viewing of the controls. Secure the control panel to the surface it is mounted.

2.8.11.2 Controllers

Provide controllers per paragraph programmable logic controller (PLC).

2.8.11.3 Standard Indicator Light

Provide indicator lights that comply with NEMA ICS 1, NEMA ICS 2, and UL 508. Provide lights that are heavy-duty, round are no smaller than 8 mm 0.315 inch and no larger than 22.5 mm 0.875 inch for alarm indicator, crash rated active vehicle barrier position indicator and EFO activation. Provide lights of the same size and type indicated for alarm indicator. Provide long-life LED type indicator lights that operate at 120 VAC or 24 VDC. Provide indicator light with a legend plate labeled as shown on the drawings. Provide the indicated lens color as shown on the drawings or specified herein. Provide panels with an overall "Push to Test" pushbutton or provide lights that are push to test (lamp) type. It is allowed to provide illuminated pushbuttons instead of a separate visual indicator.

2.8.11.4 Selector Switches

****

NOTE: Indicate on the drawings where key operated switches are required.

****

Selector switches must comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Provide selector switches that are heavy duty, round and mount in a 22.5 mm 0.875 inch mounting hole. Provide the number of positions as indicated on the drawings or specified herein. Provide switches as indicated on the drawings or specified herein. Provide switches that are rated for 600 volts, 10 amperes continuous. Provide selector switches with a legend plate labeled as shown on the drawings or specified herein. Where indicated or required, Provide dual auxiliary contacts for the automatic position where indicated or required, to provide position sensing at the workstation. Auxiliary contacts that are rated for 120 VAC, 1A as a minimum. Provide key operated switches where indicated on the drawings or specified herein. All keys are to be identical unless indicated on the drawings or specified herein to have different keying.

2.8.11.5 Push Buttons

Push buttons must comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Provide push buttons that are heavy duty, round and mount in a 22.5 mm 0.875 inch mounting hole. Provide the number and type of contacts as indicated on the drawings or required by the Sequence of Control. Provide push buttons that are rated for 600 volts, 10 amperes continuous. Provide push buttons with a legend plate labeled as shown on the drawings.

2.8.11.6 Relays

Relays must comply with IEEE C37.90 and derated for altitude above 1,500 meter 4921 feet. Provide relays that are as required by the Sequence of Control. Provide relay coils that are rated[120 VAC] [or] [24 VDC][that coordinates with the controls] and provide with matching mounting socket. Ensure power consumption is not greater than 3 watts.

2.8.11.7 Terminal Blocks

Terminal blocks must comply with NEMA ICS 4 and UL 1059. Provide terminal blocks for conductors exiting control panels that are two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Provide terminal blocks made of Bakelite or other suitable insulating material with full deep barriers between each pair of terminals. Provide a terminal identification strip that forms part of the terminal block and each terminal must be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

[2.8.11.8 Alarm Horns

****

NOTE: If using a SDDCTEA Safety Scheme found in Appendix A, some of the systems require an audible warning at the barrier and some it is just an option. Hybrid Beacon (Signs & Signals), HEPD, and Stop Control require a horn. Full Containment and 2014 Barrier-Up are not required to have a horn. The horn is to sound only for EFO operation. SDDCTEA requires horn to go on for 10 seconds.

****

Provide alarm horns where indicated on the drawings[or where required in Appendix A]. Provide horns that are vibrating type and comply with UL 508. Provide horns with a 100 dB at 3 meters 10 feet rating. Provide horns with a means to adjust the volume level. Exterior horns are to be weather proof by design or be mounted in a weather proof enclosure that does not reduce the effectiveness of the horn. Horn is to be set to go off for [10][4][6][_____] seconds after an EFO is activated.

]2.8.11.9 Alarm Buzzer

Provide warning alarm piezoelectric buzzer at the master control panel and other panels where indicated on the drawings and specified herein. Provide round buzzer that mounts mount in a 22.5 mm 0.875 inch mounting hole. Provide buzzers with a Maximum 100 dB at 1000 mm 39 inch. Provide buzzer with a means to adjust the volume level and with selectable alarm tones.

[2.8.11.10 Touchscreen

****

NOTE: The EFO pushbutton/switch function is not allowed to be done by touchscreen.

NOTE: Touchscreens are being used more and more for more complex control systems. If touchscreen are not allowed, then delete paragraph

NOTE: Touchscreens can show the ACP/ECF layout and equipment with the controls or just show the controls. The preferred choice is the layout. choose the appropriate option for this project. The symbology indicated can be revised for each project.

****

EFO function is to be done by a discrete pushbutton/switch and is not allowed to be done on the touchscreen. The power on/off is to consists of a keyed switch and is not allowed to be done with the touchscreen. The Contractor[has the option][is] to provide a touchscreen to perform the functions of the master control panel. [The master control panel graphical user interface is to show the layout of the ACP/ECF and have different screens that allow the user to go to specific areas to perform the operation.][The master control panel graphical user interface is to show pushbuttons and lights in graphical format.] The minimum size for the touchscreen is 15 inches380mm for the master control panel. Other panels are allowed to go down to 7 inches180mm. A sequence of operation is required to be finalized prior to equipment receiving final approval. The sequence of operation is to clearly describe symbology to be used, the operation to include description of use of pins/passwords, description of how the master control panel and local maintenance panel(s) will perform the lock out procedure, and a description with sketched layouts of the various screens that will be programmed. This sequence of operation is to be approved prior to submitting for approval any testing plan. Screen shots are to be submitted for review and approval as part of the panel layouts. Provide symbology as indicated:

a. Show the crash rated active vehicle barrier graphically.

b. Red circular symbol to "push" for closing. Green circular symbol to "push" to open.

c. Green rectangle with black lettering for changing between operating modes. When going between different operating modes, a different screen is to show. Items that do not function are not shown or can be grayed out on the screen if approved. If going between modes and the system is in the incorrect configuration, an alarm box stating "Incorrect Configuration" is to pop-up.

d. EFO Activation triggers a red square with the wording "Warning Emergency Fast Operate Activated".

e. EFO Reset will be a green square with the wording "Press to Reset EFO". This opens a screen with a keypad to enter the pin to reset the EFO.

f. Control systems that have different operating modes will have the modes on different screens or some means to clearly shown on the screen which mode the panel is currently operating.

g. Local mode, when using discrete components, uses a key to do a lock-out/tag-out type application to ensure the maintenance worker has full control. When using a touch screen, a keyed approach can still be used as well as a password approach. No matter the solution, it is imperative that it require an action done by the guard or maintenance worker at the master control panel and then at the Local control panel to achieve full control. A solution that has only a unique password at the Local control panel is not allowed.

h. The main screen is required, as a minimum, to show all the barriers position, the operating mode that each barrier is in, vehicle presence detection alarm for each barrier, EFO activation, ability to change screens icon, and all other alarms unless a general alarm is used instead where one can go to an alarm screen to see the individual alarms.

i. Subscreens are to have an icon (pushbutton) that states "Return to Main Screen".

j. AVB mode operation is to be by direciton of travel and not by individual AVBs.

k. Provide a separate screen for the arm/disarm of the remote EFOs.

l. Master control panel is to to have a means for the operator to tell which EFO was activated.

]2.8.11.11 Wiring

Wired, with multiconductor cable secured to underside of panel with straps at 1-inch25-mm maximum intervals and extra straps and cable sheath reinforcing sleeve where conductors break out for connections. Provide solderless, quick-disconnect, plug or sleeve connectors.

2.9 SEQUENCE OF OPERATION

****

NOTE: If Appendix A is used to define the operation or is shown on the drawings, then delete all the listed subparagraphs.

****

[Refer to Appendix A and the drawings for Sequence of Operation requirements.][Refer to Appendix A for Sequence of Operation requirements.][Sequence of Operation is as shown on the drawings.][The system operates in the following manner:]

[

a. [The master control panel arms or disarms the control functions at the [local][and][remote]control panels and controls the operational mode of all the barriers in the system. The master control panel also controls and monitors the position of each barrier.]

b. [When enabled by the Master Control Panel, the Local Control Panel[s] control[s] and monitor[s] the position of each barrier under the Local Panels control.]

c. [When enabled by the master control panel, the remote control panel[s] control[s] and monitor[s] the position of each barrier under the remote panel's control.]

d. Power On/Off switch. Provide a green light to indicate the "on" position. With the switch in the "off" position, all indicating lights and switches are off/disabled.

****

NOTE: Edit this for what is interned for this application. The selector switch(es) can be by barrier, by lane, or by direction of travel.

****

e. Selector Switch. Provide a selector switch for each barrier.[Provide a selector switch for each lane.][Provide a selector switch for each direction of travel.]Provide a switch that has ["EFO", "Test", "Local"] ["EFO", "Test"] [_____] modes. "EFO" mode locks out "Test" (manual) and "Local" operation for the barrier via "access allowed" /" and access denied" push buttons. "Test" mode locks out "EFO" and "Local" operation for the barrier. "Local" mode locks out the "Test" manual "access allowed"/ and "access denied" push buttons at the master control panel and the "EFO" mode for that barrier. [______]

f. EFO. When the EFO button is pushed, barriers that have their selector switch in EFO position deployed after a [4] [_____] second delay. Induction loops must also be clear for the barriers to deploy. [The delay timer allows the yellow light in the traffic signal to illuminate for 3 seconds and then illuminate the red light for [1] [_____] second[s] prior to allowing barrier(s) to deploy. When the EFO button is pushed, a red indicating light on the panel(s) illuminated to indicate EFO activation.][A horn located at the barriers is to sound for [4][6][_____] seconds as soon as the EFO button is pushed.]

g. EFO Reset. Use of a [pushbutton][or][keyed switch] is required to reset the logic after an EFO has occurred.

h. Active Vehicle Barriers with "Access Allowed" and "Access Denied" Pushbuttons. When the barrier is in the "access denied" position a red indicating light on a control panel will illuminate. When the barrier is in the "access allowed" position a green indicating light on the same panel illuminated. The green indicating light must not illuminate until the barrier is in the "access allowed" position.

i. Lamp Test Button. When pushed this button activated all indicating lamps to verify that all bulbs are functional.

j. Induction Loops at the barrier. Provide [one prior to and one after the barrier][as shown on the drawings][_____]. [In "EFO" mode, barrier activation is suppressed until the loops don't sense the presence of vehicles.][In other modes, if the loop is activated (i.e. a vehicle is on the loop) barrier operation is prevented. Once cleared, the barrier does not deploy.]]

2.10 AVB LIGHTING

Provide all crash rated active vehicle barriers with red warning flashing warning beacons mounted on the crash rated active vehicle barrier itself unless it is not practical as in the case of a net type. Provide LED type luminaires that have a lumen output sufficient to see easily at 61 m 200 feet. These luminaires are located on the face of the barrier that faces toward off-post (nonsecure side). Luminaires are to be on anytime the barrier is not fully open.

Provide the number and spacing of lights to meet the following requirements:

a. Bollard systems must include, as a minimum, one red led light per bollard.

b. Plate, drum or frame barrier systems equal to or greater than 1 m 3 feet in width will include, as a minimum, 3 red lights. One will be mounted within 305 mm 1 foot of each barrier edge and one will be mounted within 305 mm 1 foot of barrier centerline.

c. Plate, drum or frame barrier systems less than 1 m 3 feet in width will include, as a minimum, 1 red light. One light will be mounted within 305 mm 1 foot of the barrier centerline. Frame type barriers are allowed instead of the configuration described can have a light on each post/finger of the barrier If the frame type barrier does not have three or more lights visible, then in-pavement lights are required..

d. Crash beam barrier systems will include, as a minimum, 3 red lights. One will be mounted within 305 mm 1 foot of the each edge of the driving surface. One light will be mounted within 305 mm 1 foot of the roadway centerline.

e. Active Net type barriers are not required to have lighting mounted on the barrier. For Energy Absorbing Barriers, markings will be provided by the installation of retroreflective wrap on the netting/cables/posts which provide the same color scheme, retroreflective performance and durability as required in this SECTION. Provide retroreflective tape wrapped on the cables in alternating red and white pattern that is visible in both directions.

[2.11 IN-PAVEMENT LUMINAIRES

****

NOTE:In pavement lights are required when the barrier does not have lights in the main direction of travel toward the barrier and any path the threat vehicle can take toward the barrier. Also, active net (net/cable type) barriers are unable to have lights mounted on them. The use of the in-pavement lights do add some maintenance since they are installed in the ground/pavement. Normally uni-direction is sufficient, but for net type, it may be beneficial to have bi-directional.

****

In-pavement lumiaires are to be provided based on the following conditions:

a. AVB does not have any lights. Provide three in-pavement lights on each side of the AVB. If the AVB does not cross multiple lanes, then provide and wire so that the lights operate per direction of travel.

b. AVB has lights that face toward off-post/off-base i.e. lights face toward the threat. Provide three in-pavemet lights per lane on the secure side of the outbound AVB(s) only if there is a median between inbound and outbound lanes. If no median, then also provide lights for inbound AVBs (secure side) where these lights are operated with the inbound lane traffic signsls.

[Luminaire technical requirements are as shown on the drawings.
][Luminaire technical requirements are indicated below:]

[a. Provide [unidirectional] [bi-directional] in-pavement luminaires. Utilize red LEDs. Provide the in-pavement luminaire with a light beam spread of 60 degrees. Ensure the housing does not extend more than 6 mm 0.25 inches above the finished pavement. Provide a housing that can withstand a static load of 19958 kg 44,000 lbs without deformation.

][b. Provide a stainless steel luminaire housing when installed in areas with snow. Provide a unit that is rated for snow plow use.

][c. Luminaries are to flash on/off and operate [whenever the barrier is not fully open][when the traffic signal for the barrier is red][whenever an emergency fast operate button is activated].

]]2.12 WARNING BEACONS

The warning beacon or wig-wag must be [mounted within [_____] m[_____] ft of each barrier] [on each barrier] [as shown on the drawings] and is to include two alternately flashing signal sections. Provide each signal section with a standard traffic signal face with a flashing CIRCULAR YELLOW signal indication. Mount signal sections horizontally on the warning beacon. The visible diameter of each signal section is not to be less than 200 mm 8 inch. When illuminated, the beacon must be clearly visible, to all drivers it faces, for a distance of at least 1.6 km 1 mile under normal atmospheric conditions unless otherwise physically obstructed. Provide the yellow lens color to meet the requirements of MUTCD. Provide all flashing contacts with filters for suppression of radio interference. Provide beacons that flash at a rate of not less than 50 nor more than 60 times per minute. The illuminated period of each flash is 1/2 of the total cycle for each signal section. Provide a beacon this is programmable and in order to permit continuous non-flashing operation through a supervisory signal from the Traffic Controller Unit (CU). Provide day-light sensor and an automatic dimming system to reduce the brilliance of the beacon.

2.13 BLANK-OUT SIGNS

****

NOTE: Appendix A safety schemes for HEPD and Stop Control require the use of this type of signs. Hybrid Beacon indicates that this signage is optional.

****

Provide the blank-out sign with LEDs that have a lifetime of 80,000 hours or better. Automatic dimming is to adjust to ambient light levels. Flashing circuits are to be adjustable. Sign is to be NEMA 4 or 4X. Sign housing is to be constructed of extruded aluminum or stainless steel with gasket seals around the doors and lens. At full intensity, the sign is to be highly visible anywhere within a 15 degree cone centered about the optic axis. LED assemblies are removable and replaceable with simple hand tools. Provide a sign that is rated to operate in a temperature range of -37C to 74C -35F to 165F.

2.14 TRAFFIC SIGNALS/HYBRID BEACON TRAFFIC SIGNALS

****

NOTE: Designer must verify that vehicles using a

gate with a barrier will be able to see the barrier position or the traffic lights. Semi-trucks may require a painted stop line or a traffic arm versus a higher mounted traffic light to ensure the lights or barrier can be seen by all vehicles. Manual barriers are not required to have traffic signals.

****

Provide traffic signals with light emitting diode (LED) signal modules. The term "LED signal module" in this text refers to an array of LEDs and lens that are capable of providing a circular signal indication as specified herein and shown on the drawings. All LED signal modules are to conform to the Equipment Standards of the Institute of Transportation Engineers (ITE), chapter 2a. The arrangement and size of signal indications for each LED signal module are as shown on the drawings and are to conform with MUTCD. Provide visors on each signal. Provide [yellow] [or] [black] housing color.

****

NOTE: Red/yellow/green signals are required for HEPD, 2015-HEPD, full containment, 2014-barrier-up, and 2014-RYG-conventional signs & signals safety schemes. Delete if not required.

****

[Supply red/yellow/green 305 mm 12 inch traffic lights for each[entrance and exit lanes][as shown on the drawings or required by Appendix A] to alert motorists of the barrier position. Supply all necessary brackets to allow the lights to be properly mounted. Use the green light to indicate that the barrier is fully open.
]

****

NOTE: This signal is used only for hybrid beacon safety scheme and for 2014-HB-conventional signs & signals using hybrid beacon.

****

[Hybrid Beacon. A three light hybrid beacon signal head over each inbound and outbound active barrier and on each post or only, only in special cases, post mounted only. Post mounted only requires two posts with each having a traffic signal. Supply red/yellow 305 mm 12 inch traffic lights for each entrance and exit lanes to alert motorists of the barrier position. Signals are placed such that there are two red signals mounted side by side with a yellow signal centered below. Supply all necessary brackets to allow the lights to be properly mounted.
]

****

NOTE: This is required on Stop Control safety scheme.

****

[Supply red 305 mm 12 inch traffic lights for each[entrance and exit lanes][as shown on the drawings or required by Appendix A] to alert motorists of the barrier position. Supply all necessary brackets to allow the lights to be properly mounted.
]

2.15 TRAFFIC SIGNAL SUPPORTS

Submit all traffic signal support design calculations as well as shop drawings to the government for review and acceptance prior to installation. Ensure compliance with AASHTO LTS and applicable local and state standard specifications for the design and installation of all traffic control supports. Traffic signal supports consist of tubular members, mast arms, pole shaft, base plates, anchor bolts assemblies, foundations as well as associated connections and appurtenances. Evaluate loading to be consistent with local and state guidelines. Determine ice and wind loads based on the geographic location of the installation in accordance with AASHTO LTS guidelines. Evaluate group loading analysis to be consistent with local and state guidelines and section 1.2.6 of AASHTO LTS. Allowable stress must be consistent with local and state guideline and section 1.4 of AASHTO LTS. Provide fatigue calculations that are consistent with local and state guideline and section 1.9.6 of AASHTO LTS. It is the Contractor's responsibility to conduct soil borings for foundation design; otherwise, conservative soils assumptions are to be used in calculating foundation requirements. If local and state guidelines provide foundations designs for design conditions, these guidelines may be used provided all loading and design conditions fall within guideline parameters. Before forming and placing concrete, inspect and evaluate each foundation excavation for the actual soil conditions encountered. Do not proceed with the work until the excavation is inspected and evaluated. If necessary, revise the foundation design based on the soil conditions encountered. Before submitting the revised design for approval, obtain the signature and seal of a Professional Engineer registered in the State.

Provide poles with oval-shaped handhole having a minimum clear opening of 65 by 130 mm 2.5 by 5 inches. Secure handhole cover by stainless steel captive screws. Provide metal poles with an internal grounding connection accessible from the handhole near the bottom of each pole. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Provide steel poles having[hot-dipped galvanized in accordance with ASTM A123/A123M][iron-oxide primed][and a color that matches adjacent site lighting] factory finish. Do not install scratched, stained, chipped, or dented poles. [Provide traffic signal support with a luminaire mounted at the same height as the nearby area luminaires. The luminaire is to [match the area luminaires in the contract][be LED type].]

2.16 VEHICLE PRESENCE, WRONG-WAY, AND OVERSPEED DETECTORS

****

NOTE: Overspeed detection is recommended to be set at 4.5 m/sec 10 mph or more over the posted speed to limit nuisance alarms. In an area with a posted speed below 11.2 m/sec 25 mph use 11.2 m/sec 25 mph as the base. Settings closer to the actual posted speed can lead to nuisance alarms.

****

Provide sensors that are compatible with the barrier controller and that function as part of a complete barrier control system.

Sensors used to detect overspeed are to have an an alarm setpoint of ([____] m/sec [____] mph that covers a distance of ([____] m/sec [____] mph from the ID Check Area or as shows on the drawings.

2.16.1 Photoelectric Type

Provide photoelectric sensors that meet the requirements listed below. Photoelectric sensors are used for vehicle presence detection [and over-height detection] as shown on the drawings.

a. Photoelectric detectors consist of separate transmitter and receiver units. Detector design or arrangement requiring reflector is not acceptable.

b. Light beam: laser or infrared, modulated and synchronized between the transmitter-receiver pair to minimize cross talk with adjacent detectors or other light sources. Where laser is used, provide a light source that is rated laser Class II or lower as per 21 CFR 1040 10.

c. Provide shield cones for beam path to minimize and isolate interference from other light sources outside the detector aim cone and from other adjacent light sources.

d. Provide a photoelectric detector set, including the mounting post that is of robust design to withstand mechanical abuse such as plowed snow from roadway snow removal operations.

e. Provide surge protective devices (SPD) for the power and sensor wire terminations. Ground the SPD with minimum 10AW insulated ground wire of high strand-count to the closest ground termination point.

f. Provide matching cable connector as required

g. Provide a detector with a minimum range of 1.8 m 6 feet to no less than 19.5 m 65 feet.

h. Provide automatic detector tuning with temperature compensation.

i. Provide a detector with user selectable sensitivity settings.

j. Provide a detector with a response time of 15 milliseconds or less.

k. Provide detector with an output in a dry form C contact set, rated a minimum of 0.25 A at 24 Volts dc.

l. Provide detector enclosure with an enclosure rating NEMA 4X or better.

m. Provide a detector that is capable of operating in a humidity range of 0 to 95 percent and a temperature range of -40 to +77 degrees C -40 to +170 degrees F.

n. Provide a detector that is capable of operating from 120V/60Hz power, or be provided with appropriate power module/assembly and appurtenance, which are suitable for operation with 120V/60Hz.

2.16.2 Induction Loops

Induction loops may be used for vehicle presence detection, wrong-way detection, and point overspeed detection. Induction loops must be capable of detecting passenger vehicles, motorcycles, and high bed trucks. Tests for all three types of vehicles are to be conducted on each installed loop during the Performance Verification Test.[Provide a pair of inductive loops per barrier/lane whose outputs are used to prevent barriers raising[

and lowering] when a vehicle has activated the loop. These safety loops are to be in a quadrapole configuration.][Provide loops as required by Appendix A and as shown on the drawings.][Active vehicle barriers that cross multiple lanes are to have loops that are still sized for each lane.] Induction loops used for vehicle detection and not wrong-way or overspeed detection are to be quadrapole. Provide induction loops systemthat meet the following:

a. Tuning: automatic, with temperature compensation.

b. Loop input: to withstand minimum 2000V, both normal and common modes.

c. Loop Sensing frequency: minimum four user selectable frequencies to minimize cross talk with adjacent loops.

d. Sensitivity: user selectable, minimum 8 ranges, 20 to 2500 micro henries with a Q factor of minimum 5.

e. Diagnostic: provide diagnostics and related indication for short and open loop circuit.

f. Detector output: dry form C contact set, rated a minimum of 0.25 A at 24 Volts dc.

g. Operating humidity: 0 to 95 percent.

h. Operating temperature: -40 to 77 degrees C -40 to 170 degrees F.

i. Vibration: NEMA TS-2 -2.1.9 or better.

j. Shock: NEMA TS-2 -2.1.10 or better.

k. User selectable operation modes: presence, pulse on entrance, pulse on exit - factory set on presence mode.

****

NOTE: Choose the options desired. Fail-safe detector will output 'detect' when the loop circuit is failed. This means in an AVB safety scheme the control system will suppress the deployment of the barrier since the system indicates something is on the loop. Fail-secure will not indicate 'detection'. This means in an AVB safety scheme the control system will not prevent the AVB deployment under any circumstance. Default is to be Fail Safe unless requested in writing from the User.

****

l. User selectable operation: [Fail Safe.][Fail Secure.]

m. User selectable sensitivity boost feature, which boosts sensitivity after a presence detection and holds the increased sensitivity until the detection drops out, at which time sensor sensitivity returns to the original setting.

n. Power requirement: 120V/60Hz, or be provided with appropriate power module/assembly and appurtenance, which is suitable for operation with 120V/60Hz.

o. Loop Wire.

(1) Provide number of inductive loops as per manufacturer's recommendations based on loop size and distance between loop and loop amplifier.

(2) Ensure that the loop slots in which the loop wire is laid are free from debris, sharp objects, and are completely dry. Clean out slots with compressed air before installing loop wire.

(3) Install loop wire in layers. Install backer rods over top wire at a minimum of 300 mm 1 foot spacing to ensure uniform placement of wire in the slot. Fill the loop slots with sealant per recommendation of the loop wire manufacturer.

(4) Use 16AW stranded cable with cross-linked-polyethylene insulation installed in a PVC sleeve. Loop wire extending from the loop to the loop amplifier is to be twisted with a minimum twist pitch of 18 per m 6 per foot.

(5) Check conductor resistance to ground with "megger" of 500V or higher. Remove and replace the whole installation if ground resistance of less than 10 mega-Ohms is measured.

(6) Provide surge protective device for both loop-wire terminations at or near the loop detector module. Ground the SPD with minimum 10AW insulated ground wire of high strand-count to the closest ground termination point.

(7) Provide loops that are capable of detecting motorcycles, passenger vehicles, and high bed trucks with the same sensitivity setting.

(8) Provide two complete loops for wrong-way detection. Using a single loops to detect wrong-way is not acceptable.

2.16.3 Radar

****

NOTE: Select either Point or Continuous overspeed detection as required

****

Radar detection sensors may be used for vehicle overspeed and wrong-way detection.[Point overspeed Detection. Provide a detector unit that is capable of detecting the speed of one or more vehicles at a point in the ACP/ECF Approach Zone and closing an alarm contact if the vehicle speed is over a preset value.][Continuous overspeed Detection. The detector unit must be capable of continuously detecting the speed of vehicles within preset zones as they approach the ID Check Area of the ACP/ECF. The Sensor is to close an alarm contact when the speed of any vehicle anywhere within the zone is above a preset value. See drawings for required detection zones and detector speed settings. For radar sensors which sense speed at multiple discrete points in the direction of travel instead of continuously, the distance between discrete points is to be 5 m 15 feet or less.] Provide radar detection units that meet the following requirements:

a. Provide a detector unit with an operating temperature range of -40 to +77 degrees C -40 to +170 degrees F and a relative humidity range of 5 to 95 percent, non-condensing. Equip The detector unit with means for automatic temperature compensation as is necessary to overcome adverse effects of temperature and humidity swings in the specified range.

b. The detector unit must be resistant to vibration in accordance with NEMA TS-1, IEC 60068-2-30 (test Fc), or approved equivalent. The detector unit must be resistant to shock in accordance with NEMA TS-1, IEC 60068-2-27 (test Ea), or approved equivalent.

c. Provide a detector unit with a withstand voltage surge of minimum 1kV (rise time = 1.2 microsecond, hold = 50 microsecond) applied in differential mode to all lines, power and output, as defined by IEC 61000-4-5 standard.

d. Provide a detector unit that does not emit a noise at levels exceeding 55 dBa when measured at a distance of 1 meter 3 feet away from its surface.

e. Each detector unit is to transmit on a frequency band of 10.525 GHz +/-25 MHz or another approved spectral band. Provide a detector that complies with the limits for a Class A digital device pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority. Provide a detector unit that does not interfere with any known equipment. Ensure transmitter power does not exceed 10 mili-watts.

f. Provide a detector unit that can detect vehicle speed with 95 percent accuracy or greater independent of the vehicle's direction of travel through the detection zone.

g. Provide a detector unit with a field of view that covers an area defined by an oval shaped beam with a beam height and width of 15 degrees minimum and a range of3 to 70 m 10 to 200 feet minimum.

h. Provide a NEMA 3R enclosure or better for the detector unit. Do not exceed overall nominal envelop dimensions of 200 by 254 by 150 mm 8 by 10 by 6-inch.

i. Provide a detector unit with a power requirement of 120V/60Hz, or be provided with appropriate power module/assembly and appurtenance, which is suitable for operation with 120V/60Hz.

j. Provide the detector unit output upon detection of a vehicle speed over the adjustable preset value with a dry form C contact set, rated a minimum of 0.25 A at 24 Volts dc.

k. Provide a detector unit that has a blind zone of not more than 3 m 10 feet in front of the unit.

l. The detector unit may be applied in either Side-fired or Forward-looking configuration.

m. Detector units may be mounted on existing ACP/ECF structures or utility poles if suitable for this purpose. When existing structures and utility poles are not suitable, provide mounting trusses or poles for mounting detector units. Provide a support structure that deflect less than 13 mm 0.5 inch at exposure to 160 km/h 100 mph winds with a gust factor of 1.3 when a detector unit or units is mounted on it.

n. Set all detector unit parameters and adjust detectors to provide required zone coverage.

2.16.4 Video Detection

Video detectors may be used for vehicle presence, overspeed, and wrong-way detection. Detection is to be derived from video image signals received from a CCTV video camera. The video vehicle detector set includes the camera, hardware, software, and appurtenances required to perform the detection functions required on the drawings. The Video analytics system produced warning annunciation via alarm contacts when the required detection criteria are met. Refer to Section 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS) for requirement on the related video camera and video signal transmission system. Provide video detectors that meet the requirements listed below.

a. Provide a detector unit with an operating temperature range of -40 to +77 degrees C -40 to +170 degrees F and a relative humidity range of 5 to 95 percent, non-condensing.

b. Provide a detector that is resistant to vibration in accordance with NEMA TS-1, IEC 60068-2-30 (test Fc), or approved equivalent. Provide a detector unit that is resistant to shock in accordance with NEMA TS-1, IEC 60068-2-27 (test Ea), or approved equivalent.

c. Provide a detector unit when used for continuous speed detection that senses speed at multiple discrete points in the direction of travel. In order to adequately simulate continuous speed detection, the distance between discrete points is limited to no more than 5 m 15 feet.

d. The detector unit when used for speed detection must detect vehicle speed with a 95 percent accuracy or greater, independent of the vehicle's direction of travel through the detection zone. The detector unit when used for presence or wrong-way detection is to identify the required condition with a 95 percent accuracy or greater.

e. Provide a NEMA 3R enclosure or better for the detector unit.

f. Provide a detector unit with a power requirement of 120V/60Hz, or be provided with appropriate power module/assembly and appurtenance, which is suitable for operation with 120V/60Hz. Provide the detector unit output upon detection of a vehicle speed over the adjustable preset value with a dry form C contact set, rated a minimum of 0.25 A at 24 Volts dc.

g. The detector unit may be applied in either Side-fired or Forward-looking configuration.

h. Detector units may be mounted on existing ACP/ECF structures or utility poles if suitable for this purpose. [When existing structures and utility poles are not suitable, provide mounting trusses or poles for mounting detector units. Provide a support structure that deflect less than 13 mm 0.5 inch at exposure to 160 km/h 100 mph winds with a gust factor of 1.3 when a detector unit or units is mounted on it.]

i. Set all detector unit parameters and adjust detectors to provide required zone overages.

2.17 WRONG-WAY AND OVERSPEED WARNING ANNUNCIATOR

****

NOTE: The marquee panel may not be required if the

panel alarms are deemed sufficient.
****

Provide a warning annunciator (audible and visual) as indicated in the following:

(1) Provide a visual and audible annunciator that produces a sound whenever a [wrong way] [or overspeed] is detected by a vehicle entering from the exit. Provide the barrier control panels with an audible and visible indicating device as [indicated in Appendix A][indicated in Appendix A and on the drawings][indicated on the drawings.]

[(2) Provide a visual and audible annunciator that produces a sound whenever a [wrong way] [or overspeed] is detected by a vehicle entering from the exit. Provide a marquee style LED sign that shows "WRONG WAY" or "OVERSPEED" with an audible annunciator. Mount marquee on a column in the ID Check area that is visible to the guards when looking toward approaching traffic. Provide a means to adjust the volume on all the audible alarms. [Provide am audible annunciator that sounds until a silence reset button is pressed.][Provide an audible annunciator that sounds for [3][____] seconds and then clears itself.]

]2.18 NON-CRASH RATED ACTUATED TRAFFIC ARM ASSEMBLY

Provide actuated traffic arm capable of 300 duty cycles per hour as a minimum and capable of operating the arm through 90 degrees. Provide gate operators with single phase [[120][208][240][277][_____] volt]motors. Provide slab size and anchorage for gate operator in accordance with manufacturer requirements.

(1) Cover each traffic arm with 406 mm 16 inch wide reflectorized red and white sheeting. Provide the traffic arm with retroreflective markings, in accordance with MARKINGS, [LIGHTING] AND SIGNS paragraph of this SECTION.

(2) Furnish a spare traffic arm for each traffic arm.

(3) Construct gate operator cabinets of galvanized steel, or aluminum and paint per manufacturers approved standard color.

(4) Provide gates with a hand-crank, or other means, which will allow manual operation during power failures.

(5) Construct actuated traffic arms out of wood, steel, fiberglass, or aluminum, as specified by the manufacturer for the given lengths as shown on the drawings.

(6) Provide each gate operator with an obstruction detector that automatically reverses the gate motor when an obstruction is detected. Provide an obstruction detector that is one of the following: An induction loop buried in the road, a photocell electric eye mounted on the gate operator, or a safety strip mounted on the lower edge of the arm. The detector system automatically deactivates when the arm reaches the fully lowered position.

****

NOTE: This option is typically not required.

****

[(7) Provide a break sensor as part of the traffic arm assembly that detects when a vehicle makes contact with the traffic arm and breaks the arm. When the break sensor is activated provide an audible warning through the vehicle barrier control panel. Provide an audible warning that sounds until an audible warning silence reset button is pressed or for [3][_____] seconds.]

2.18.1 Traffic Arm at Other Areas

****

NOTE: Edit the traffic arm location based on design requirements. Traffic arms may be required for a SDDCTEA safety scheme. or may be located at the ID Check area and at Search Areas.

****

Provide non-crash rated actuated traffic arm (barrier gate arm) assembly with an opening and closing time of less than or equal to [2][3][5] seconds. Provide each entry lane with a vertical traffic arm gate. Each traffic arm is to be capable of being operated from a remote open-close push button station. The guard booth for that lane is to have the means to open and close. [Provide a means to open and close the Search Area traffic arms locally.][Provide a means to control each traffic arm from the Command and Control].[Provide actuated traffic arms with three LED flashing lights mounted on the arm.]

2.18.2 Traffic Arm at Active Vehicle Barrier

****

NOTE: HEPD and Full Containment safety schemes in Appendix A require a traffic arm near the active vehicle barrier. Hybrid Beacon safety scheme has the traffic arm optional.

It is optional to have flashing lights on the traffic arm. It is recommended when located at the barrier. However, if in-pavement lights are provided, it is not necessary.

****

Provide non-crash rated actuated traffic arm (barrier gate arm) assembly with an opening and closing time of less than or equal to 2 seconds. Provide a traffic arm, as a separate piece of equipment, with each non-portable crash rated active vehicle barrier as part of the barrier safety operating system. [This traffic arm automatically deploys (close) when the emergency up button is activated and open when the vehicle barrier is reset.][Provide actuated traffic arms with three (minimum)LED flashing lights mounted on the arm.]

2.19 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

****

NOTE: Edit the appropriate choice.

NOTE: Army projects require a minimum of 10 minutes for the batteries.

****

[A panelboard located at the barrier location is powered from main UPS located near or at the Command and Control. This panelboard can be used to power some of the equipment listed below instead of a stand alone units.][When the facility UPS provides power to equipment/systems listed, then separate stand alone UPS are not required.]Provide separate UPS units capable of carrying required loads for a minimum of [10][2][5][15][_____] minutes for those items not powered from a central UPS based on this list below. Submit UPS Calculations for all proposed UPS systems identifying all connected loads plus 25% spare capacity.

[a. Primary communications system.

][b. All sensors and controllers for [over speed,] [wrong-way,] [tamper,] etc.

][c. Active Vehicle Barrier Control system including all controls for crash rated active vehicle barriers, [traffic warning signals], [actuated traffic arms], and [warning signals]. This includes the crash rated active vehicle barrier, traffic signal lights, in-pavement lights, and wig-wags.

]

****

NOTE: For Army Projects the minimum is 1.5 cycles, but not more than 2 cycles.

****

[d. Active Vehicle Barrier activation systems for [1.5][2] complete operation cycle ("access allowed" position to "access denied" position or "access denied" position to "access allowed" position).

][e. Lighting. One luminaire for each ID Check Lane located near the ID guard position and one luminaire for each CCTV camera required at the Active Vehicle Barrier.

]2.20 SURGE PROTECTION

2.20.1 Power Line Surge Protection

Protect equipment connected to alternating current circuits protected from power line surges. Equipment protection must withstand surge test waveforms described in IEEE C62.41.1 and IEEE C62.41.2. Fuses are not to be used for surge protection.

2.20.2 Sensor Device Wiring and Communication Circuit Surge Protection

Protect inputs against surges induced on device wiring. Protect outputs against surges induced on control and device wiring installed outdoors and as shown. Protect communications equipment against surges induced on any communications circuit. Install surge protection circuits at each end on cables and conductors, except fiber optics, which serve as communications circuits between systems. Furnish protection at equipment, and additional metal-oxide varistor (MOV) protectors rated for the application on each wireline circuit is to be installed within 1 meter 3 feet of the building cable entrance. Fuses are not to be used for surge protection. Test the inputs and outputs in both normal mode and common mode.

a. If a 24VDC circuit, maximum continuous operation voltage is at least 33 VDC. Clamping voltage at 39 VDC. Maximum discharge current at 8/20 is 5000 amps.

2.21 INTRUSION DETECTION SYSTEM

****

NOTE: Edit Section 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS) to include appropriate project features of the Intrusion Detection System and the duress alarm system.

NOTE: In some cases the IDS/DURESS system equipment is future. Edit the paragraphs accordingly. Edit the appropriate specifications to ensure the conduit system is appropriate for the system.

****

Install and furnish the IDS and duress alarm system per the requirements of 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS).

[The IDS and duress alarm system for the contract consists of providing power and pathways for the signal wiring. A future contract will install the wiring and IDS equipment.][The IDS equipment is part of this contract as shown on the drawings.]

2.22 CCTV SYSTEM

Install and furnish the CCTV system per the requirements of 28 10 05 ELECTRONIC SECURITY SYSTEMS (ESS).

2.22.1 CCTV System

[The CCTV system for the contract consists of providing power and pathways for signal wiring. A future contract will install the wiring and CCTV.][The CCTV system equipment is part of this contract.]

2.22.2 AVBCS and ESS Interface

Provide the AVBCS with output contacts for use by the ESS (IDS and CCTV systems) as follows:

a. Pull up all camera views of the crash rated active vehicle barriers during any EFO activation. Provide a dry contact from the AVBCS to be used by the CCTV system.

b. Provide a dry contact from the AVBCS that indicates a tamper switch alarm. This contact is to be used by the IDS system.

c. Provide a spare dry contact from the AVBCS that indicates an EFO activation.

2.23 MATERIALS AND COMPONENTS

2.23.1 Materials and Equipment

Units of equipment that perform identical, specified functions are to be products of a single manufacturer. Provide all material and equipment that is new and currently in production.

2.23.2 Single Manufacturer Active Vehicle Barriers

Provide all parts, components, accessories fittings and fasteners by a single manufacturer as required by manufacturer's written requirements, installation instructions and written warranty, unless otherwise noted in this specification.

2.23.3 Field Enclosures

2.23.3.1 Interior Sensors

Provide sensors used in an interior environment with a housing that provides protection against dust, falling dirt, and dripping non-corrosive liquids.

2.23.3.2 Exterior Sensors

Provide sensors used in an exterior environment with a housing that provides protection against windblown dust, rain and splashing water, and hose directed water. Provide sensors that remain undamaged by the formation of ice on the enclosure.

2.23.3.3 Interior Electronics

Provide systems electronics used in an interior environment with enclosures which meet the requirements of NEMA 250, Type 12.

2.23.3.4 Exterior Electronics

Provide systems electronics used in an exterior environment with enclosures which meet the requirements of NEMA 250, Type 3R, 4, or 4X.

2.23.3.5 Corrosion Resistant

System electronics to be used in a corrosive environment as defined in NEMA 250 are to be housed in non-metallic non-corrosive enclosures which meet the requirements of NEMA 250, Type 4X.

2.23.4 Above Ground Components

All above ground metal components are to be [shop primed and site painted] [or] [hot dipped galvanized] [or] [powder coated] unless otherwise specified.

2.23.5 Below Ground Components

All below ground metal components are to be [shop primed and site painted] [or] [hot dipped galvanized] [or] [powder coated] unless otherwise specified.

2.23.6 Nameplates

2.23.6.1 Components

Provide a nameplate for major components of the system. Nameplates will not be required for devices smaller than 25 by 75 mm1 by 3 inch. Provide corrosion-resistant metal plates that have at least the following data legibly marked:

a. Manufacturer's name.

b. Manufacturer's address.

c. Type, Style or Model number.

d. Serial number.

e. Date of manufacture.

f. Catalog Number.

2.23.6.1.1 AVB Nameplate

Provide nameplate data that is permanently attached to each vehicle barrier. Provide corrosion-resistant metal plates that have at least the following data legibly marked:

a. Manufacturer's name.

b. Model number.

c. Serial number.

d. Date of manufacture.

e. Catalog Number.

2.23.7 Tamper Switches

Provide tamper switches on all equipment enclosures for the AVBCS to include all operating panels and provide on all manhole/handholes that contain spliced control wiring. Provide enclosures with doors larger than 24 inches with two tamper switches or more. Provide corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. The enclosure and the tamper switch must function together and not allow direct line of sight to any internal components before the switch activates. Tamper switches must be inaccessible until the switch is activated; have mounting hardware concealed so that the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; must be spring-loaded and held in the closed position by the door or cover; and be wired so that the circuit is broken when the door or cover is disturbed. The crash rated active vehicle barrier control system is to monitor the tamper switches and provide an audible/visual alarm to the Master control panel. The AVBCS is to provide a single dry contact output that indicates a tamper alarm. The alarms are to be zoned at the master control panel in the following manner:

(1) AVBCS operating control panels.

(2) AVBCS cabinets that contain control equipment such as PLCs that are not covered under Zone 1.

(3) Manholes/handholes that contain spliced control wiring associated with the AVBCS. If there are spliced wiring, then provide a visual alarm at the master control panel.

2.23.8 Locks and Key-Lock Switches

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NOTE: Either round key or conventional key type

locks are acceptable for use in the system. Selection should be based on hardware availability at the time of design and the requirements for matching locks currently in use at the site. If the locks do not have to be matched to locks in use, and the designer has no preference, all brackets may be removed.

****

2.23.8.1 Locks

Provide locks on system enclosures for maintenance purposes. Provide UL Listed locks, [round-key type with 3 dual, 1 mushroom, 3 plain pin tumblers][or][conventional key type lock having a combination of 5 cylinder pin and 5-point 3 position side bar]. Stamp keys "U.S. GOVT. DO NOT DUP". Arrange locks so that the key can only be withdrawn when in the locked position. Key locks alike and furnish only 2 keys for all of these locks. Control these keys in accordance with the key control plan as specified in paragraph Key Control Plan.

2.23.8.2 Key-Lock-Operated Switches

Provide UL listed Key-lock-operated switches as required to be installed on system components , [round-key type, with 3 dual, 1 mushroom, and 3 plain pin tumblers][or][conventional key type lock having a combination of 5 cylinder pin and 5-point 3 position side bar]. Stamp keys "U.S. GOVT. DO NOT DUP". Provide 2 or 3 position key -lock-operated switches , with the key removable in specified positions. Key all key-lock-operated switches differently and furnish only 2 keys for each key-lock-operated-switch. Keys must be removable in the positions described in these specifications or as shown on the drawings. Control keys in accordance with the key control plan as specified in paragraph Key Control Plan.

2.23.8.3 Construction Locks

Use a set of temporary locks during installation and construction. The final set of locks installed and delivered to the Government must not include any of the temporary locks.

2.23.9 System Components

Design system components for continuous operation. Provide electronic components that are solid state type, mounted on printed circuit boards conforming to UL 796. Printed circuit board connectors are to be plug-in, quick-disconnect type. Incorporate safety margins of not less than 25 percent with respect to dissipation ratings, maximum voltages, and current carrying capacity on power dissipating components. Provide control relays and similar switching devices that are solid state type or sealed electro-mechanical.

2.23.9.1 Modularity

Design equipment for increase of system capability by installation of modular components. Design system components to facilitate maintenance through replacement of modular subassemblies and parts.

2.23.9.2 Maintainability

Design components to be maintained using commercially available tools and equipment. Arrange and assemble components they are accessible to maintenance personnel. Insure there is no degradation in tamper protection, structural integrity, EMI/RFI attenuation, or line supervision after maintenance when it is performed in accordance with manufacturer's instructions.

2.23.9.3 Interchangeability

Construct the system with off-the-shelf components which are physically, electrically and functionally interchangeable with equivalent components as complete items. Replacement of equivalent components must not require modification of either the new component or of other components with which the replacement items are used. Do not provide custom designed or one-of-a-kind items without explicit approval from the Contracting Officer. Ensure interchangeable components or modules do not require trial and error matching in order to meet integrated system requirements, system accuracy, or restore complete system functionality.

2.23.9.4 Product Safety

Conform system components to applicable rules and requirements of NFPA 70. Install system components with instruction plates including warnings and cautions describing physical safety and any special or important procedures to be followed in operating and servicing system equipment.

2.24 LINE SUPERVISION

Supervise all signal and Data Transmission System (DTS) lines. Provide a system that supervises the signal lines by monitoring the circuit for changes or disturbances in the signal and for conditions as described in UL 1076 for line security equipment. The system is to initiate an alarm in response to a current change of [5][10] percent or greater. The system also initiates an alarm in response to opening, closing, shorting, or grounding of the signal and DTS lines.

2.25 ELECTRICAL WORK

Submit detail drawings containing complete wiring and schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Provide motors, manual or automatic motor control equipment [,except where installed in motor control centers] and protective or signal devices required for the operation specified herein in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide all field wiring for induction loop detectors, communication lines, and power circuits with surge protection. Provide any wiring required for the operation specified herein, but not shown on the electrical plans, or specified herein, under this section in accordance with Sections 26 20 00 INTERIOR DISTRIBUTION SYSTEM 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.26 WIRE AND CABLE

Provide all wire, cable, and conduit connecting all Contractor furnished and, where indicated on the drawings, Government furnished equipment. Provide wiring in accordance with NFPA 70. Provide wiring that is fiber optic or copper cable in accordance with the manufacturers' requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. [20][18][_____] AWG size conductors at a minimum. Ensure wire size is sufficient to prevent voltage drop problems. Circuits operating at

24 VDC must not operate at less than 21.6 volts. Circuits operating at any other voltage are to ensure the voltage drop does not exceed 5 percent of nominal voltage.

2.26.1 Above Ground Sensor Wiring

Provide sensor wiring that is 20 AWG minimum, twisted and shielded, 2, 3, 4, or 6 pairs to match hardware. Provide multi-conductor wire with an outer jacket of PVC.

2.26.2 Cable Construction

Provide all cable components to withstand the environment in which the cable is installed for a minimum of 20 years.

2.27 DATA TRANSMISSION SYSTEM (DTS)

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NOTE: Include Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM in the project specification for the appropriate Data Transmission required at the project site

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Provide DTS as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.28 CONCRETE

Provide concrete that conforms to Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.29 WELDING

Welding is to be in accordance with AWS D1.1/D1.1M.

2.30 ACCESSORIES

Supply all accessories as required for a complete and finished system. Provide, at a minimum, all accessories as required by manufacturer's instructions.

2.31 FABRICATION

Shop assembly the vehicle barrier systems to the greatest extent possible.

2.32 TEST, INSPECTIONS AND VERIFICATIONS

Provide manufacturer written verification that vehicle barrier systems provided under this contract are manufactured in the "as-tested" and/or "as-certified" configurations, based on the crash testing.

Submit a Verification of Performance certificate stating that the construction, materials, and methods used will meet performance standards described in this section for this project

[2.33 FACTORY ACCEPTANCE TEST

****

NOTE: Evaluate the need for a factory test. Take into account the size of the system, unusual site conditions, the complexity of the system, the

devices that comprise the system, expansion of an existing system as well as other pertinent information. If a factory test is deemed necessary, the factory test requirements below must be tailored to the control system to be tested. If a factory test is deemed unnecessary, delete it from the following paragraphs.

First paragraph, last choice is for Army projects only.

NOTE: Protective design center and COS-ACP is required on Army projects.
****

2.33.1 General

Provide personnel, equipment, instrumentation, and supplies necessary to perform a factory acceptance test of the complete crash rated active vehicle barrier control system. A factory acceptance test is to demonstrate that the proposed system and related equipment meet the control parameters within the contract documents. The test is to demonstrate how the systems operates if a PLC is damaged or if signals between systems are lost. The system must show that barriers cannot be deployed with anything but a red signal. The test is to demonstrate the required alarm annunciation, CCTV controls, and sequence of events recording. The test set-up must include the PLC(s), the master control panel, alarm panel, control switches, and at least one of each type of remote panel, tamper switches, and limit switches. The duress, overspeed, and wrong-way sensors; the crash rated active vehicle barrier open and close position switches; the VPDs; the traffic signals; and the warning beacons may all be simulated.[A member of the Protective Design Center and [of the Communities of Standardization for Access Control Points][Designer of Record] are to witness the factory acceptance test unless waived by the Government.]

Upon Test Plan approval by the Contracting Officer, assemble the test system and perform the factory acceptance test. The factory acceptance test is to demonstrate that the subsystems comply with the requirement specified herein. Conduct the factory acceptance test during regular daytime working hours on weekdays. The Contracting Officer reserves the right to witness all or a portion of the factory acceptance test.

2.33.2 Factory Acceptance Test Plan

Submit Test Plan for the factory acceptance test plan, a minimum of [45][30] days before the scheduled start of all factory acceptance tests. Factory test plan includes a schedule, test procedures, equipment catalog cuts, one line diagrams showing interconnections of all subsystem components, and diagrams showing control logic for the barriers, traffic signals, warning beacons, and alarm and status points. See paragraph "TEST PLANS" for list of information required to be tested.

2.33.3 Factory Acceptance Test Report

Submit the factory acceptance test report, which documents the results of the test, no more than 1 week after the successful completion of the factory acceptance test. The test report is to include the results of all test procedures showing all commands, stimuli, and responses to demonstrate compliance with the contract requirements in the test report. Include the certification from technical specialists from the crash rated active vehicle barrier, PLC, and the CCTV subsystems that their subsystem meets the contract requirements in the test report. The Contracting Officer will notify the Contractor within ten (10) days of receipt of the test report whether the test report is approved. If disapproved, the Contracting Officer will note the specific procedures that are disapproved; retest those procedures. Do not ship equipment to the field until the test report is approved by the Contracting Officer.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify that site conditions are in agreement with the contract drawings in accordance with paragraph "Current Site Conditions".

3.2 INSTALLATION

Perform installation in accordance with manufacturers instructions and in the presence of a representative of the manufacturer. Manufacturer's representative must be experienced in the installation, adjustment, and operation of the equipment provided. The representative is to be present during adjustment and testing of the equipment. Show on the drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation.

3.2.1 Oversight

The Contractor designated technical specialist for the crash rated active vehicle barrier control system (AVBCS) must oversee installation.

3.2.1.1 Observation and Inspection

Manufacturer's representative is to [observe and inspect] [inspect] crash rated active vehicle barrier systems installation. Manufacturer's representative must be experienced in the installation, adjustment, and operation of the equipment provided. Manufacturer's representative is to be present during adjustment and testing of the equipment.

3.2.1.2 Installer Training/Certification

Install crash rated active vehicle barriers by the manufacturer's trained or certified installers in accordance with manufacturer's written installation instructions.

3.2.2 Installation Schedule

Before beginning any site work, provide a schedule of all installation and testing activities. Arrange project activities in the proposed schedule in chronological order. Coordinate all installation and testing activities, specifically those requiring ACP/ECF outages, with the Contracting Officer. There must be a Contracting Officer approved schedule before any site work is performed.

3.2.3 Crash Rated Active Vehicle Barrier Installation

Include with the detail installation drawings a copy of the as tested installation drawing. Install crash rated and/or certified crash rated active vehicle barrier in an 'as-tested' condition. Additional site investigation and construction is required in order to accomplish this; except when a site specific crash test was performed where the exact site requirements were utilized in the crash test.

3.2.3.1 Vertical Alignment

Install all vertical elements plumb and in alignment with a tolerance of [6 mm] [1/4 inch][_____] or in accordance with manufacturer's installation instructions, whichever is more restrictive.

3.2.3.2 Horizontal Alignment

Install all horizontal elements in the alignment indicated on the approved shop drawings with a tolerance of [12 mm] [1/2 inch] in [2 m] [6 feet - 6 inches] or in accordance with manufacturer's installation instructions, whichever is more restrictive.

3.2.3.3 Field Welding

Field welding is unacceptable as it will cause significant damage to the galvanizing and powder coat protective finishes.

3.2.3.4 Field Cutting and Drilling

Avoid unnecessary cutting and drilling of pre-finished components. If necessary to cut or drill or otherwise modify product due to field conditions, repair factory finish in accordance with the manufacturer's written instructions.

3.2.4 Hydraulic Lines

Install the hydraulic unit no more than 7.6 m 25 feet from the barriers or no further than the distance provided in the manufacturer's instructions, whichever distance is more restrictive. Place buried hydraulic lines in polyvinyl chloride (PVC) sleeves. Keep sleeves clean of concrete, dirt, or foreign substances during construction. Use proper tools for field cuts requiring tapers. Thoroughly clean sleeves before they are laid. As each run is completed, draw a flexible testing mandrel approximately 305 mm12 inches long with a diameter less than the inside diameter of the sleeve through the sleeve. After which, draw a stiff bristle brush through until the sleeve is clear of particles of earth, sand and gravel; then immediately install plugs. Mark hoses for reference ("up", "down", "barrier #"). Coordinate project specific markings with the Contracting Officer.

3.2.5 Incidental Infrastructure

Provide all incidental construction as indicated. Design construct, and install incidental construction in accordance with local/state DOT requirements, AASHTO GDHS-7, AASHTO RSDG-4, NCHRP 350, and the MUTCD.

3.2.6 Concrete Placement

Provide concrete test reports per Section 03 30 00 CAST-IN-PLACE CONCRETE. After placement of the crash rated active vehicle barrier(s), replace the pavement sections to match the section and depth of the surrounding pavement unless a thicker pavement section is required for the tested condition of the crash rated active vehicle barrier. Warp pavement to match the elevations of existing pavement.

3.2.7   Reinforcing Steel Inspection

Inspect all by contractor's project manager manufacturer's representative and the Contracting Officer representative prior to concrete placement. Contractor is required to provide no less than [_____] days notice of concrete placement schedule to required inspection personnel. Coordinate with the requirements found in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3   CYBERSECURITY INSTALLATION CERTIFICATION

****

NOTE: Coordinate requirements with UFC 4-010-06 CYBERSECURITY OF FACILITY-RELATED CONTROL SYSTEMS at https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-4-010-06

****

Furnish a certification that control systems are designed and tested in accordance with DOD 8500.01, DOD 8510.01, 25 05 11 CYBERSECURITY OF FACILITY RELATED CONTROL SYSTEMS, and as required by individual Service Implementation Policy.

3.4   DRAINAGE

3.4.1   Pit Drainage

****

NOTE: Edit this paragraph for drainage requirements. If soil characteristic and/or climate dictates another solution, then this should be considered and edited into this paragraph. Provide self-priming sump pump with capacity and power requirements if one is required. Delete this paragraph if pit/vault type construction is not required.

Federal and/or state EPA regulations may require that an oil/water separator be installed in the pit drainage system to ensure capture of any hydraulic fluid that may leak out of the system. If pit/vault type construction is required provisions will be made for drainage and connection to storm drainage system, or if no storm drain exists, a self-priming submersible sump pump of adequate capacity will be specified.

Most the barrier manufacturer's have a 76 mm3 inches opening for drainage. This is the minimum acceptable size drain line. In some applications it is prudent to have larger drain line connect to the smaller opening since several barriers may connect to the same line.

****

Provide a drain connection [and oil/water separator] in each barrier that requires pit/vault type construction.[Provide hookups between the storm drains.] Provide a minimum drainage line of 76 mm3 inches.If there are multiple drain connections that can be made to the crash rated active vehicle barrier ensure the lines drain the low points as a minimum.[Where drain lines connect to a common header drain, provide a minimum header drainage line of [150][_____] mm[6][_____] inches.][If the drainage line(s) are allowed to daylight into the side of a ditch, then provide a cast iron grate over the opening that is embedded into a concrete foundation. Provide coarse rock around the opening for at least [900][_____] mm[36][_____] inches] and extend down the slope to prevent erosion.

[A self-priming submersible sump pump of adequate capacity is to be installed.][Provide the self-priming sump pump with the capacity to remove [_____] gallons liters per minute.] [Submit sump pump data sheets and calculations showing adequacy of the pump for its proposed use.]

3.4.2 Surface Drainage

****

NOTE: This has been a problem for barriers installed in pits/vaults. Areas that have high incident of rainfall over a short period of time can end up with water in the barrier for a period of time. Consider means to intercept and divert water flow around the crash rated active vehicle barrier.

****

Install crash rated active vehicle barrier per the test conditions for the crash rated active vehicle barrier. Ensure placement of the barrier provides positive drainage away from the barrier.

3.5 ELECTRICAL

****

NOTE: Choose the first option for Army projects. All other agencies use the second option.

****

Furnish and install all cables and conduits for all wiring interconnecting contractor furnished, and where indicated, Government furnished equipment. Install all wiring per Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. [Provide arc-flash labeling per 26 05 73 POWER SYSTEM STUDIES.][Ensure NFPA 70E requirements are met with proper labeling in accordance with the service requirements.]

3.5.1 Wiring

Use ring-style terminals for all control power wiring requiring compression terminals. Conform terminals and compression tools to UL 486A-486B. Use roundhead screws and lockwashers to provide vibration-resistant connections. Use screw connections or other locking means to prevent shock or vibration separation of the card from its chassis for connections between any printed circuit cards and the chassis. Ensure the electrical power supply breaker for the hydraulic power unit is capable of being locked in the power on and power off positions.

3.5.2 Grounding

Provide adequate grounding system for the following: Traffic signal supports, warning signal supports, AVBCS enclosure, crash rated active Vehicle Barrier frames, crash rated active vehicle barrier control enclosure, and supports for overspeed and wrong-way detectors. Test installed ground rods as specified in IEEE 142. Provide a #6 AWG ground wire from crash rated active vehicle barrier frame to the crash rated active vehicle barrier control enclosure.

3.5.3 Enclosure Penetrations

Penetrate enclosures through the bottom unless the system design requires penetrations from other directions. Seal penetrations of interior enclosures involving transitions of conduit from interior to exterior, and penetrations on exterior enclosures with rubber silicone sealant to preclude water entry. Terminate the conduit riser in a hot-dipped galvanized metal cable terminator. Fill the terminator with an approved sealant as recommended by the cable manufacturer and in a manner that does not damage the cable

3.5.4 Exterior Components

Those components installed outside are to be able to function within the environmental conditions indicated previously for the paragraph on Exterior Conditions.

****

NOTE: choose the appropriate IP rating. Both IP ratings protect from total dust ingress. IP66 protects against low pressure water jets from any direction). IP67 protects against temporary immersion up to 1 meter of water. IP68 protects against complete immersion in water for a long period of time. If barrier is installed in areas with high rate of rain per hour, then choose IP67 or IP68. IP68 is not available by all manufacturers, so ensure the type of barrier being considered has this option.

****

Provide motors, actuators, wiring, luminaires, and other components that are installed below grade that are rated to function in a wet environment. Components within the barrier below grade fall in this category. Manufacturers of the crash rated active vehicle barrier and other below grade components are to assume a water saturated environment for the components. The devices and components must be watertight per NFPA 70. Provide motors and actuators with a minimum rating of[IP66][IP67][IP68]per NEMA MG 1.

3.5.5 Other Requirements

Install the system in accordance with the standards for safety included in NFPA 70 and the appropriate installation instructions from the manufacturers of the equipment. Configure components within the system with appropriate service points to pinpoint system trouble in less than 30 minutes.

3.6 OPERATING AND MAINTENANCE INSTRUCTIONS

Submit written Operations and Maintenance Instructions.
As part of the Operations and Maintenance Instructions, provide:

a. Periodic inspection and testing recommendations for daily, weekly, monthly and yearly intervals.

[b. Electronic copy of the control system programming for each AVB control system. Provide a legend for the acronyms used in the program as well a description of each major logic element.
]

3.7 REPAIR

Repair damage to galvanized, coated, painted finishes in accordance with manufacturers written instructions. Submit Manufacturer Repair of Coatings Instructions. In the case where the manufacturer does not have written instructions, Submit recommended repair instructions (referencing published standards) for approval.

3.8 TEST PLANS

[Factory acceptance test plan is to cover items a through o and aa through hh or gg as appropriate as a minimum.] The contractor verification test plan and performance verification test plan are to include at least all the following:

a. Information on the AVB to include size and rating.

b. Listing of the controllers and description of each controller and the locations of the controllers.

c. PLC restart test (test each one PLC individually) by turning off the PLC for at least 1 minute then back on to verify proper reboot of the system.

d. Battery power test. 10 minutes on battery then do an EFO and lower barrier.

e. Power on/off test.

f. Test (manual) test for each barrier.

g. Local test for each barrier.

h. Test and Local mode loop (VPD) operation. Test each loop at least once with a motorcycle/utility vehicle, high bed vehicle, and passenger vehicle.

i. System alarms

j. Panel layout and labeling.

k. Matrix testing of the various combinations of modes that the AVBs can be found in.

l. Tests to verify loss of a PLC ensures safe operation of the system

m. Test traffic signal operation as well as wig-wag and in-ground light operation.

n. Verify loss of signal between controllers triggers a trouble alarm.

o. Other tests deemed necessary to ensure system operates safely.

p. Information on the layout of the barrier to include distance from ID

Check.

q. Information on signage to include wording and location

r. Verification of grounding as discussed herein.

s. Information on the cabinet ratings and NEC disconnect locations.

t. Test or verification on any heating system associated with the AVBs

u. Verification that the AVB drains properly (may be a sump pump etc. that needs testing).

v. General appearance of the system to include paint stripe configuration on the barriers, use of reflective tape, etc.

w. Verification of safety equipment necessary for performing maintenance.

x. Verification that all tamper switches send an appropriate alarm to the master control panel.

****

NOTE: The first bracketed choice are for systems that have an EFO. The second bracketed choice are for systems that do not use an EFO such as Full Containment (Platooning/Normally Deployed) safety scheme.

****

[y. EFO test for each EFO switch.

z. EFO loop (VPD) operation). Test each loop at least once with a motorcycle/small cart, SUV, and passenger vehicle.

aa. EFO loop activation when signal turns yellow

ab. EFO loop deactivation when signal turns yellow

ac. EFO Reset function works properly.

ad. Matrix testing of the various combination of loops for each safety mode: EFO, Test, Local. Note for Test and Local this does include both up (close) and down) open functions.

ae. Arm/Disarm (yes/no) selector switch operation for each remote EFO panel/station.

af. Other scenarios, not identified in the PVT plan, may be identified by commissioning team during the commissioning effort. In addition, timing of inductive loop activation within the parameters identified in the PVT may be varied by commissioning team. Unexpected AVB behavior is justification for failure whether or not the scenario is specifically identified in the PVT plan.

]

[ag. Auto mode test for normally closed

ah. Auto loop (VPD) operation). Test each loop at least once with a motorcycle/small cart, SUV, and passenger vehicle.

ai. Loop activation when signal turns yellow

aj. Loop deactivation when signal turns yellow

ak. Matrix testing of the various combination of loops for each safety mode: Auto, Test, Local. Note for Test and Local this does include both up (close) and down) open functions.

al. Arm/Disarm (yes/no) selector switch operation for each remote panel/station.

am. Other scenarios, not identified in the PVT plan, may be identified by commissioning team during the commissioning effort. In addition, timing of inductive loop activation within the parameters identified in the PVT may be varied by commissioning team. Unexpected AVB behavior is justification for failure whether or not the scenario is specifically identified in the PVT plan.

]

3.9 CONTRACTOR VERIFICATION TEST

Submit test plan for the Contractor Verification Test. Test plans are to include a a test schedule, a minimum of [30][45] days before the scheduled start of the Contractor Field Tests. See paragraph "TEST PLANS" for information required in a test plan. Calibrate and test all equipment, verify communications links between all subsystem components and between subsystems, place the integrated system in service, and test the integrated system using the approved test procedures for the contractor verification test. Submit the contractor verification test report no more than 1 week after the completion of each test. Deliver a report certifying that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. Include certifications from the Technical Specialists of the crash rated active vehicle barrier, PLC, and CCTV equipment/subsystems that the equipment/subsystems have been installed and tested and that they meet the requirements of the specifications in the report. If a change is made to the operating program during the contractor verification test for the crash rated active vehicle barrier system, then all completed testing up to that point must be done over in order to verify the change did not have a negative impact to the software operation.

3.10 FINAL SYSTEM ACCEPTANCE

3.10.1 General

Final system acceptance consists of successfully completing the Performance Verification Test and completion of the commissioning, the training of Installation security and maintenance personnel, and successfully completing an Endurance Test as described below.

3.10.2 Team Leader

Designate a team leader to be responsible for scheduling all tests, coordinating attendance of all required commissioning team members, conducting the tests, and preparing appropriate test reports and the final commissioning report.

3.10.3 Commissioning Team

****

NOTE: Army. Army projects are required to have the USACE Protective Design Center, Omaha Corps of

Engineers present.
****

The commissioning team consists of the commissioning team leader; the technical specialists from the crash rated active vehicle barrier supplier, and the programmer for the AVBCS;[a representative of the design of record;] [a representative of the USACE Protective Design Center;]a contracting officer's representative; and a representative from the Installation.

3.10.4 Training

3.10.4.1 General Requirements

****
NOTE: Coordinate the training requirements with the Installation and designate the number of persons to be trained.
****

Conduct training courses for designated personnel in the operation and maintenance of the AVBCS. Orient the training to the specific system being installed. Deliver training manuals for each trainee with 2 additional copies delivered for archiving at the project site. Include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson in the manuals. Furnish audio-visual equipment and other training materials and supplies. Where the Contractor presents portions of the course by audio-visual material, copies of the audio-visual material is to be delivered to the Government either as a part of the printed training manuals or on the same media as that used during the training sessions. A training day is defined as 8 hours of classroom instruction, including 60-minutes total of breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the operator training for the guards, assume that guards will have a high school education or equivalent and are familiar with ACPs/ECFs operations. For maintenance training, assume mechanical and electrical maintenance personnel typically employed at military installations. Obtain approval of the planned training schedule from the Government at least 30 days prior to the training. Do no provide training until the performance verification test has been successfully completed.

3.10.4.2 Guard's Training

Teach the guard training course at the project site for a period of up to eight hours after the performance verification test, but before commencing the endurance portion. Plan on a maximum of [12][_____] personnel attending the course. Include instruction on the specific hardware configuration of the installed system and specific instructions for operating the installed system in the course. Upon completion of this course, each student is to demonstrate the ability to perform the following when operating the AVBCS:

a. Operate the crash rated active vehicle barriers in[Test, Local and EFO/Auto][_____] modes.

b. Understand the differences between the normal and EFO/AUTO operation of the barriers.

c. Understand when to use Test, Local and EFO/AUTO modes for each barrier.

d. Understand all requirements for putting a barrier in either the Test or Local modes including required actions in the roadway ahead of the barrier and actions at the barrier.

e. Understand the crash rated active vehicle barrier safety scheme including operation of all vehicle presence detectors, traffic signals, signs, and warning signals.

f. Understand operation of the traffic signal including all signal indications for various operational modes and barrier positions.

g. Reconfigure barriers after an EFO/Auto activation/operation.

h. Monitor, acknowledge, and reset alarms.

[i. Understand the operation and coverage of all overspeed and wrong-way sensors.
]
[j. Monitor and control CCTV system
]
3.10.4.3 Maintenance Personnel Training

The Maintenance Personnel Training Course is to be taught at the project site for a period of up to eight hours after the Performance Verification testing. Plan on a maximum of [4][_____] personnel attending the course. Include the following in the course:

a. Instruction on each equipment and its configuration in the installed system.

b. Trouble shooting and diagnostic procedures.

c. Component repair and replacement procedures.

d. Emphasis on the importance of periodic testing and preventative maintenance. Provide a list of periodic preventative maintenance tasks for the crash rated active vehicle barriers and other critical equipment.

e. Calibration procedures.

f. Review of system drawings to identify device locations, communications, topology, and flow.

3.10.4.4 System Manager Training

Train System managers for a minimum of 4 hours in addition to the Guard and Maintenance Personnel described above. Provide system manager training training for trainers, such that, system managers will be able to train new guards and maintenance personnel in the future. Plan on a maximum of [4][_____] personnel attending this training. System manager training is to include the following:

a. Enrollment/deactivation process including the assignment of operator passwords.

b. Change database configuration.

c. Modify graphics, if provided.

d. Print reports, e.g., Sequence of Events reports.

e. Any other functions necessary to manage the system.

3.10.5 Performance Verification Test (PVT)

****
NOTE:
****

3.10.5.1 Test Plan

Submit a performance verification test plan. The test plan is to match the test plan used for the Contractor Verification Test plus any changes that came up during the testing. The test plan is to include the test procedures/plan, layouts of each of the operating panels and a site layout showing the location of the crash rated active vehicle barriers, traffic signals, warning beacons, actuated traffic arms, panels and all associated signs and signals. Submit to the contracting officer 30 days prior to the proposed start date of the performance verification test.

3.10.5.2 Test Equipment and Personnel

Provide the following for all PVT tests:

a. A minimum of 6 hand held radios/walkie-talkies with additional batteries.

b. Safety vests for all participants.

c. Two Stop watches.

d. Flash lights (if testing at night).

e. Multi-meter.

f. Metal of sufficient size and shape to activate vehicle presence detection (VPD) loops. Provide metal that is easily moveable and provide one piece of metal per loop. Metal roadway signs with a rope tied to one end works well.

g. SUV or High bed truck to test each VPD loop.

h. Sedan type car to test each VPD loop.

i. Motorcycle to test each VPD loop. If testing is during the fall/winter, then a small utility vehicle can be substituted.

j. Three copies of the PVT test plan.

k. Camera that can take video of the crash rated active vehicle barrier and traffic signal operation and then allows a person to go back and count frames to get actual "real time". This is more accurate than the stop watch.

l. Sufficient personnel during the matrix testing equivalent to the number of vehicle presence detection (VPD) loops plus three more. This number of personnel can include government representatives; however, it must be verified that they are willing and able to support the matrix testing. Testing that does not include matrix testing requires five personnel to include government personnel.

m. Contractor is to ensure that someone who can make corrections to the software is present.

3.10.5.3 Commissioning

Perform a performance verification test of the installed AVB Control System per approved test procedures and under the direction of the Contractor's Team Leader. The PVT is to demonstrate that the system complies with the requirements specified herein. Conduct the PVT, where possible, during regular daytime working hours on weekdays. At the completion of the PVT, appropriate Commissioning Team Members are to sign identifying what passed and any deficiencies left unresolved. If a change is made to the operating program during the performance verification test for the crash rated active vehicle barrier system, then all completed testing up to that point must be done over in order to verify the change did not have a negative impact to the software operation.

3.10.5.4 Test Report

Within ten (10) days of successful completion of the PVT, the Contractor's Team Leader submits a performance verification test report to the Contracting Officer documenting the results of the test. Include in the test report the results of all test procedures showing all commands, stimuli, and responses to demonstrate compliance with the contract requirements. The Contracting Officer will notify the Contractor, within ten (10) days of receipt of the test report, whether the Test Report is approved. If disapproved, the Contracting Officer will note the specific procedures that are disapproved; retest those procedures. Do not start the Endurance Test until the PVT test report is approved by the Contracting Officer.

[3.10.5.5 Opposite Season Test

****

NOTE: If the temperature at the site dips to below freezing for sustained duration in the winter time, specify an opposite season test.

****

Coordinate with the Commissioning Team to conduct an opposite season PVT. If the initial PVT test is performed in the winter, then the opposite season test is to be performed in the summer. If the initial PVT is done in the spring, summer, or fall, then the opposite season test it to be performed in the winter. All PVT tests and test reports submissions are required for the initial PVT are to be performed for the opposite season PVT.

]3.10.6 Endurance Test

****

NOTE: Army Only. This testing is only required by the Army.

****

3.10.6.1 General

The Contractor's Commissioning Team Leader must submit a test plan including a schedule, test description, list of personnel required to conduct the test, and a list of all data to collect and observances to be made in order to demonstrate system reliability and operability of the completed AVB control system. Conduct the endurance test in phases as specified. The Contractor is to notify the Contracting Officer, in writing, that training as specified has been completed and that the correction of all outstanding deficiencies has been satisfactorily completed prior to performing the endurance test. The Contracting Officer may terminate the testing at any time the system fails to perform as specified. Upon termination of testing by the Contracting Officer or by the Contractor, commence an assessment period as described for Phase II below. Minimum operation times indicated in the O&M manual will indicate the minimum specific intervals the system is to be exercised. Ensure the exercise intervals meet or exceed the O&M requirements. It is important to note that if the endurance testing uncovers a problem that requires a programming change then the PVT is required to be performed again. Intent of the Endurance test:

****

NOTE: Choose the safety scheme(s) used on the project and delete the ones not used. If not using one of the safety schemes, then will have to develop what is reasonable for the planned operation of the system.

The information provided is based on the SDDCTEA safety scheme layout and operation found in the SDDCTEA Pamphlet 55-15 Traffic and Safety Engineering for Better Entry Control Facilities 2019. There were some significant changes from the 2014 version on the sequence of operation. If you are working with existing systems where the AVBs are being replaced or control upgraded, then the SDDCTEA Pamphlet 55-15 2014 safety schemes are allowed with some interim guidance incorporated (indicated by 2015).

****

[Hybrid Beacon Safety Scheme. This system typically does not have the crash rated active vehicle barrier moving up/down on a regular basis. The system is to be tested both manually and by an EFO operation at least once every 24 hours or its equivalent as agreed upon by the Contracting Officer. Shift change times are a good time for this operation.
]
[High Efficiency Presence Detection Safety Scheme. Normal system operation can include having the AVB moving up/down on normal basis. A cycle needs to be performed at least twelve times per hour or its equivalent over the normal daylight hours the ACP/ECF operates. Contracting Officer can adjust how this testing is accomplished based on the anticipated operation of this ACP/ECF.
]
[Full Containment Safety Scheme. Normal system operation includes the fill/release of vehicles. A fill/release cycle needs to be performed ate least twelve times per hour or its equivalent over the normal daylight hours the ACP/ECF operates. Contracting Officer can adjust how this testing is accomplished based on the anticipated operation of

the ACP/ECF.
]

[Stop Control Safety Scheme. This system typically does not have the crash rated active vehicle barrier moving up/down on a regular basis. The system is to be tested both manually and by an EFO operation at least once every 12 hours or its equivalent as agreed upon by the Contracting Officer. Shift change times are a good time for this operation.
]

[General Barrier Operation. The system is to be tested manually at least once every[12][_____] hours or its equivalent as agreed upon by the Contracting Officer. Shift change times are a good time for this operation.
]

[2014-Hybrid Beacon Conventional Signs & Signals Safety Scheme. This is the 2014 safety scheme. This system typically does not have the crash rated active vehicle barrier moving up/down on a regular basis. The system is to be tested both manually and by an EFO operation at least once every 24 hours or its equivalent as agreed upon by the Contracting Officer. Shift change times are a good time for this operation.
]

[2014-Red/Yellow/Green Conventional Signs & Signals Safety Scheme. This is the 2014 safety scheme. This system typically does not have the crash rated active vehicle barrier moving up/down on a regular basis. The system is to be tested both manually and by an EFO operation at least once every 24 hours or its equivalent as agreed upon by the Contracting Officer. Shift change times are a good time for this operation.
]

[2015-High Efficiency Presence Detection Safety Scheme. Normal system operation can include having the AVB moving up/down on normal basis. A cycle needs to be performed at least twelve times per hour or its equivalent over the normal daylight hours the ACP/ECF operates. Contracting Officer can adjust how this testing is accomplished based on the anticipated operation of this ACP/ECF.
]

[2014-Barrier-Up Safety Scheme. Normal system operation includes the fill/release of vehicles. A fill/release cycle needs to be performed ate least twelve times per hour or its equivalent over the normal daylight hours the ACP/ECF operates. Contracting Officer can adjust how this testing is accomplished based on the anticipated operation of the ACP/ECF.
]

3.10.6.2 Phase I Testing

Conduct the test 24 hours per day for 14 consecutive calendar days, including holidays, and the system is to operate as specified. Make no repairs during this phase of testing unless authorized by the Contracting Officer in writing.

3.10.6.3 Phase II Assessment

After the conclusion of Phase I, identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Contracting Officer. Explain in detail the nature of each failure, corrective action taken, results of tests performed, and recommend the point at which testing should be resumed in the report. After delivering the written report, convene a test review meeting at the jobsite to present the results and recommendations to the Contracting Officer. As a part of this test review meeting, demonstrate that all failures have been corrected by performing appropriate portions of the performance verification test.

Based on the Contractor's report and the test review meeting, the Contracting Officer will determine the restart date, or may require that Phase I be repeated. If the original Phase I testing was completed without any failures the endurance test is deemed completed.

3.10.7 Final Report

Upon successful completion of the Endurance Test, the Contractor's Team Leader must prepare a Final Report documenting that the Contractor has successfully completed the PVT and Endurance Test and training. Include signatures of the Commissioning Team in the Commissioning Report.

[3.10.8 Post Commissioning PVT

****

NOTE: This is an optional test on the system. It is to be performed approximately 6 months after the system was commissioned. On large, more complex systems, this will add another level of assurance on the system. Most systems do not need this test. If an opposite season test is already required, then this option is not required.

****

Perform a performance verification test 6 months after the system was commissioned. All PVT tests and test reports required for the initial PVT are to be performed for the post commissioning PVT.

]

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NOTE: Appendix A contains several SDDCTEA approved safety schemes, of which the Designer must choose the appropriate one or ones for this project. SDDCTEA at times makes changes to the safety schemes that impact what is provided in Appendix A. Check the following website for a folder on Appendix A for an updates. The latest version of the Appendices and drawings for panel layouts are found at _ https://mrsi.erdc.mil/cos/nwo/acp

NOTE: Include a drawing showing the control switches and control logic for this safety scheme. Use drawings from the ACP Standard Design as a base.If the controls are modified from the standard Army COS-ACP drawings, then care must be taken to ensure compliance with the security and safety criteria.

****

3.10.9 APPENDICES

APPENDIX A - SDDCTEA Approved Safety Schemes

****

NOTE: The information provided is based on the SDDCTEA safety scheme layout and operation found in the SDDCTEA Pamphlet 55-15 Traffic and Safety Engineering for Better Entry Control Facilities 2019. There were some significant changes from the 2014 version on the sequence of operation. If you are working with existing systems where the AVBs are being replaced or control upgraded, then the SDDCTEA Pamphlet 55-15 2014 safety schemes are allowed with some interim guidance incorporated (indicated by 2015). See Appendixes A11-2014, A12-2015, A13-2014. If unsure contact the Army COS-ACPs or Protective Design Center for information on the operation of the safety schemes.

List of Appendix A safety schemes:

Appendix A1 - HYBRID BEACON Active Vehicle Barrier Safety Scheme - 7 Seconds

Appendix A2 - HYBRID BEACON Active Vehicle Barrier Safety Scheme - 9 Seconds

Appendix A3 - High Efficiency Presence Detection (HEPD) Active Vehicle Barrier Safety Scheme

Appendix A4 - FULL CONTAINMENT (Sally Port or Platooning) Active Vehicle Barrier Safety Scheme

Appendix A5 - Stop Control Safety Scheme Active Vehicle Barrier Safety Scheme

Appendix A10-HB-2014 - Conventional Signs and Signal Hybrid Beacon Active Vehicle Barrier Safety Scheme

Appendix A11-RYG-2014 - Conventional Signs and Signal Red/Yellow/Green Active Vehicle Barrier Safety Scheme

Appendix A12-2015 - High Efficiency Presence Detection (HEPD) Active Vehicle Barrier Safety Scheme

Appendix A13-2014 - BARRIER UP (Sally Port or Platooning) Active Vehicle Barrier Safety Scheme

Note that Stop Control is only in Appendix A4. The only difference between 2014 and 2019 was the safety loop size. The loop size was changed by interim guidance in 2015 to the size currently used in the 2019 version. No change to the operating panels or sequence of operation.

****

[Appendix A1 - HYBRID BEACON Crash Rated Active Vehicle Barrier Safety Scheme - 7 Seconds

****

NOTE: Delete if not used in project.

****

Hybrid Beacon Safety Scheme Features. Provide the following features for the Hybrid Beacon active vehicle barrier Safety Scheme:

****

NOTE: Paragraph 1 can be deleted in its entirety, if the layouts of equipment is shown on the drawings.

****

[1. General Layout Information

1.1 Active Vehicle Barriers in all inbound and outbound lanes. .

1.2 Hybrid Beacon. A three light hybrid beacon signal head over each inbound and outbound active barrier. Special location may require only posts i.e. no masts. Post mounted requires two posts with each having a traffic signal. Provide three head traffic signals with two Red signals adjacent horizontally and a Yellow centered below the two red beacons. Install the hybrid beacon signal at the centerline of the AVB. The beacons are to be Light Emitting Diode (LED) type. Mast arm will have a 'Barrier Signal' sign.

1.3 A 610 mm2 foot wide stop line placed 26.2M86 feet in front of the the active vehicle barrier and the traffic signal is 12.8 meters42 feet from the near edge of the stop line. Provide a 'Stop Here On Red' sign.

1.4 Double solid white lines between inbound lanes approaching the barriers to prohibit lane changes in front of the barriers.

1.5 Diagonal pavement striping. Provide white crosshatching pavement marking that covers the front and back VPDs.

1.6 Vehicle Presence Detectors (VPDs) located immediately before and immediately after each barrier. VPDs can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence. Induction loops must be diagonal quadrapole loop. A loop crossing multiple lanes is not allowed. The VPD before the AVB starts 610 mm2 feet from the AVB and is 23.16M76 ft long and . The VPD after the AVB starts 610 mm2 feet from the AVB and is 1830 mm6 ft by 1830 mm6 ft long.

1.7 Warning Sign and Warning Beacons (wig-wags) (2 Beacons with alternating flashing yellow lights) located 44.2 meters145 feet in front of the barriers. Beacon lamps will be LED.

****

NOTE: Army. First option choose for Army projects. All others, choose the second option.

****

1.8 One Master Control Panel, [one Guard Booth Control panel plus one Guard Booth EFO button each Guard Booth][one Guard Booth EFO panel], one Overwatch

Position Control Panel, one Search Area Control panel per separate search area, [Pedestrian panel,]and a Local Control Panel or panels at each barrier along with all control switches and indicating lights as shown on the Drawings. Locate the Master Control Panel in the Command and Control location for use by the ACP/ECF guards. Locate each Local Control Panel at or near its respective barrier power unit.

1.9 Red in-pavement lights. When required are to be located between the stop line and approach VPD.

1.10 Horn located at the crash-rated active vehicle barriers. Provide the horn with a means to adjust the volume.

1.11 Provide passive vehicle barrier between lanes as indicated.

1.12 LED blankout sign that indicates 'Do Not Enter' installed at the barrier. Two per direction of travel by placing one on each side of the roadway.
]

****

NOTE: choose the correct option.

****

2 BARRIER OPERATING CONTROL PANELS.

[Operating panel layouts are found in Army Standard Design drawing package.][Operating panel layouts are found in the contract drawings.]

3 TRAFFIC SIGNAL AND BARRIER CONTROLS.

3.1. Hybrid Beacon. EFO MODE OF OPERATION.

3.1.1 EFO Operation. Under normal operations, all barriers' mode selector switches on the Master Control Panel will be in the EFO position with the key removed and with that key being accessible only by the lead ACP/ECF guard. With the barrier's mode selector switch in the EFO position, EFO is enabled for that direction of travel, but the Open and Close switches for that barrier on the Master Control Panel and the Open and Close switches on that barrier's Local Control Panel are disabled.

3.1.2 In the EFO mode of operation with the barrier open, the Traffic Signal is Dark. Upon activation of an EFO command from any armed EFO, delay barrier emergency closure by 2 seconds. Activate the wig-wag (warning beacons) as soon as EFO is pushed. During the 2 seconds, the hybrid beacons signals change from dark (off) to Solid Yellow for 2 seconds and then to Alternating flashing Red (alternate on/off in a wig-wag fashion). Activate the in-pavement lights (flashing) when the traffic signal turns red and stay red as long as the traffic signal light is red. After 2 seconds from EFO activation, energize the barrier's emergency close circuit to close the barrier(s) in emergency fast mode (2 seconds or less) provided that the VPDs immediately in front of and behind the barrier are clear (entry and exit loops). If either or both VPDs detect a vehicle, then the barrier does not close; however, the the emergency close signal is latched only for those barriers that were in EFO mode at the time of activation. Once both VPDs are clear, the barriers (those in EFO mode) deploy (unless EFO Reset had been activated). The warning horn sounds for 10 seconds with the setting adjustable in the program. In addition to any indicating lights required for EFO activation, the system is to be programmed to show steady on red indicating light at all EFOs to indicate an EFO activation; however, the EFO that was activated is to have a flashing indicating light.

****

NOTE: Default is that EFO Reset turns off the wig-wags. This is a good visual to know that EFO Reset took place. If desired, they can stay on after EFO Reset.

****

3.2 Hybrid Beacon. EFO RESET. After an EFO activation, all EFO activated barriers cannot be operated until an EFO Reset is accomplished. The guards will close all inbound and outbound lanes. Guards will obtain the EFO Reset key and then activate the EFO Reset switch on the Master Control Panel to reset EFO. [This turns off the warning beacons (wig-wags) and removes the latch command for the EFO circuit.][This removes the latch command for the EFO circuit.] The person in charge can then place the Master Control Panel mode switches into Test (or go through the sequence to use the Local panel) and use the Open buttons to lower each barrier. Once all the barriers are Open for a given direction of travel and the corresponding mode switches are back in EFO mode, then the traffic signal for that direction of travel turns Dark and the in-pavement lights deactivate. This needs to be done for both directions of travel in order to have Dark traffic signals in all directions.

3.3 Hybrid Beacon. TEST MODE OF OPERATION.

3.3.1 Test Operation. An individual barrier can be test operated by installing the proper lane closure markings and barricades ahead of the active barrier and then placing the mode selector switch for that direction of travel into the Test position. With the mode selector switch in the Test position, the barrier's Open and Close switches on the Master Control Panel for that direction of travel are enabled, but the Open and Close switches on the Local Control Panel for that direction of travel are disabled. In addition all active EFO switches are disabled from operating any barrier for that direction of travel. Where a single barrier spans both inbound and outbound lanes, the test operation switch deactivates all EFO capability.

3.3.2 When a mode switch is placed in Test mode, the traffic signals for that direction of travel cycle to Alternating Flashing RED (the hybrid beacons signals change from dark (off) to Steady Yellow for 2 seconds and then to Alternate flashing Red (alternate on/off in a wig-wag fashion). The barriers for that direction of travel are allowed to operate without any time delay ONCE the signal is alternating flashing Red. The traffic signals for that direction of travel stay Red until all the conditions are met for RETURN TO EFO MODE. The in-pavement lights for that barrier activate when the traffic signal is red and stay red as long as the traffic signals are red. Note the warning beacons do not operate under Test or Local mode, but can be allowed to operate if requested and approved. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

3.4 HYBRID BEACON - LOCAL MODE OF OPERATION

3.4.1 Local Operation. Local mode is used when maintenance personnel need to perform maintenance on the barrier.

3.4.1.1 Maintenance personnel would obtain the mode selector switch key from the lead ACP/ECF guard and place the key into the Master Control Panel 3-position mode selector switch for the appropriate direction of travel.

3.4.1.2 The person then turns the selector switch to the Local position to enable Local mode and then removes the key.

3.4.1.3 With the mode selector switch on the Master Control Panel in the Local position, Open and Close switches on the Master Control Panel for the barriers for that direction of travel are disabled and all EFO switches are disabled for that direction of travel. If a single barrier spans multiple directions of travel all EFO capability will be deactivated.

3.4.1.4 The maintenance person would then insert the key into the appropriate Off-Local mode selector switch on the barrier's Local Control Panel and turn the key to the "Local" position. This action activates the Open and Close switches at the Local Control Panel for the barriers in that direction of travel.

3.4.1.5 Maintenance personnel would also have to block and mark the lane ahead of the barrier in accordance with standard lane closure procedures/standards and also lock and tag out certain equipment at the barrier per the barrier manufacturer's recommendations for the type of maintenance to be performed.

****

NOTE: Hybrid Beacon. First Paragraph applies to final denial barriers that are configured to have only one barrier per direction of travel. This can be a single lane per direction of travel or multiple lanes with one barrier covering all the lanes for that direction of travel.

Hybrid Beacon. Second paragraph applies to final denial barriers that are configured to have multiple barriers for a direction of travel.

****

[3.4.2 Hybrid Beacon. LOCAL MODE OF OPERATION (one barrier per direction of travel). When a mode switch is placed in Local mode, the traffic signals for that direction of travel cycle to Alternating Flashing RED (the hybrid beacons signals change from dark (off) to Steady Yellow for 2 seconds and then to Alternate flashing Red (alternate on/off in a wig-wag fashion). The barriers for that direction of travel are allowed to operate without any time delay ONCE the signal is alternating flashing Red and there is full Local control. The traffic signals for that direction of travel stay Red until all the conditions are met for RETURN TO EFO MODE. The in-pavement lights for that barrier activate when the traffic signal is red and stay red as long as the traffic signals are red. Note the warning beacons do not operate under Local, but can be allowed to operate if requested and approved. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

][3.4.2 Hybrid Beacon. LOCAL MODE OF OPERATION (more than one barrier per direction of travel). When a mode switch is placed in Local mode, the traffic signals DO NOT CHANGE STATE for that direction of travel The in-pavement lights for that barrier do not activate. The wig-wag beacons do not operate. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during Local mode operation.

]3.5 If the Master Control panel is in EFO mode and the Local Panel is in Local mode, that is a conflict. [Hybrid beacon is dark and EFO DOES NOT function.][Traffic signal is green and EFO DOES NOT function.]Local panel does not have any control. The mode indicating lights for Local and EFO are to alternate flashing and an audible alarm is to sound.

3.6 If the Master Control panel is in Test mode and the Local Panel is in Local mode, that is a conflict. [Hybrid beacon signal is Red after cycling and all corresponding Test mode functions are INACTIVE.][Traffic signal is Red after cycling and all corresponding Test mode functions are INACTIVE.] Local panel does not have any control. The mode indicating lights for Test and Local are to alternate flashing and an audible alarm is to sound.

****

NOTE: This is an optional switch function for locations that have only one lane per direction of travel or have one barrier across all the lanes. If there are multiple lanes per direction of travel with each lane having its own AVB and no lane separation, then provide this switch. Keep or delete as required by the project.

****

3.7 Out-of-Service switch. This function is provided for times when a barrier is damaged in a lane and needs to be taken out of service for an extended period of time. The out of service switch is to be located at the AVB location and is allowed to operate in EFO, Test and Local modes. This allows an AVB to be locked out in a lane, but the other lane can operate under EFO. The switch locks out all functions for the AVB when activated. The up and down lights for that AVB will alternate going on and off. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier, having guards present, etc). The Out-Of-Service switch has two positions: Yes and No [contractor is allowed to use Enable and Disable, but it must be clear].

3.7.1 No Position. All controls operate normally.

3.7.2 Yes Position. The Close/ Open position indicating lights for those barriers will alternate from one to the other approximately every 1 sec. This will happen at the Master Control Panel, Local Control Panel (if on) and at any other panel that has barrier position indicator lights.

3.7.2.1 If Local Panel is in Local Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the particular barrier(s) are locked out.

3.7.2.2 If system is in Test Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the particular barrier(s) are locked out.

3.7.2.2 If system is in EFO Mode, then traffic signal is dark. All controls to operate the particular barrier(s) are locked out.

3.8 Hybrid Beacon. RETURN TO EFO MODE. When the mode switch is placed in the EFO mode and all the barriers for that direction of travel are Open (not deployed), then the barrier's Traffic Signal change from Red to Dark. If a mode switch is placed in the EFO mode and any of the barriers for that direction of travel are Closed, then the barrier's Traffic Signal stays Red and an alarm is generated on the ACP/ECF TROUBLE window on the Gatehouse Control Panel. The in-pavement lights turn off when the traffic signal changes to Dark.

3.9 Vehicle Presence Detector consisting of safety loops on either side of a crash rated active vehicle barrier may require additional programming and hardware. If the loops are more than 3 meters10 feet apart, then add 0.5-1 sec additional time delay on the "back" loop. The alternative is to provide a latching logic between loops. In the latching logic, the master panel needs a release pushbutton for each barrier.

3.10 AUDIBLE ALARMS. Provide an audible alarm at the Master Control Panel, Overwatch Control Panel, [Pedestrian control panel,]main Guard Booth Control Panel and Search Area Control panel(s). The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.10.1 When an EFO is pushed an alarm will go off.

3.10.2 Overspeed and Wrong-way will each cause an alarm to go off for 3 seconds and then clear itself.

3.10.3 Duress activation.

3.10.4 AVB Trouble condition. Alarm happens where there is monitored problem detected that relates to the AVB. Red visual indicator for each electric power unit.

3.10.5 VPD Trouble condition. Alarm happens when there is something wrong with the loop controller or the loops monitored by that controller. Red visual indicator for each loop controller.

3.10.6 VPD Activation for over the set amount of time period (typically 15 seconds) Light goes on immediately for VPD activation, but audible alarm activates after 15 seconds.

3.10.7 Out of Service activation. When a barrier is initially placed in out-of-service, sound an audible alarm for 3 seconds. Open and Close indicator lights are to alternate on/off.

3.10.8 Master Panel in EFO mode and Local Panel is in Local Mode. EFO mode and Local mode indicator lights alternate being on.

3.10.9 Master Panel in Test mode and Local Panel is in Local Mode. Test mode and Local mode indicator lights alternate being on.

3.10.10 Return to EFO mode with an AVB or AVBs in the incorrect position (not fully open). EFO mode indicator light and open/down AVB position light(s) flash.

3.10.11 Communication Loss alarm. If a programmable logic controller loses communication with another programmable logic controller there will be an audible alarm. Red visual indicator.

3.10.12 Tamper switches - Control Panels. Tamper switches located inside each control panel cause an alarm when the cover is opened. Red visual indicator.

3.10.13 Tamper switches - Cabinets. Tamper switches located inside each cabinet cause an alarm when the cover is opened. Red visual indicator.

3.11 LED Blank-Out Sign. The sign is to conform to MUTCD or local Host Nation requirements.

3.12 AUDIBLE ALARMS. Provide an audible alarm at the Local Control Panel. The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops. The alarm does not operate if the panel is not in Local mode.

3.12.1. AVB Trouble condition.

3.13 AUXILIARY CONTACTS
Provide auxiliary contacts (dry) to be used by the Intrusion Detection System and the CCTV system as specified herein and indicated on the drawings.

3.14 WARNING BEACONS (wig-wags). Warning beacons are on anytime the barrier position receives a command to start the close process. The warning beacons do not go off until the traffic signal is Green.
]

[Appendix A2 - HYBRID BEACON Crash Rated Active Vehicle Barrier Safety Scheme - 9 Seconds

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NOTE: Delete if not used in project.

****

Hybrid Beacon Safety Scheme Features. Provide the following features for the Hybrid Beacon active vehicle barrier Safety Scheme:

****

NOTE: Paragraph 1 can be deleted in its entirety, if the layouts of equipment is shown on the drawings.

****

[1. General Layout Information

1.1 Active Vehicle Barriers in all inbound and outbound lanes. .

1.2 Hybrid Beacon. A three light hybrid beacon signal head over each inbound and outbound active barrier. Special location may require only posts i.e. no masts. Post mounted requires two posts with each having a traffic signal. Provide three head traffic signals with two Red signals adjacent horizontally and a Yellow centered below the two red beacons. Install the hybrid beacon signal at the centerline of the AVB. The beacons are to be Light Emitting Diode (LED) type. Mast arm will have a 'Barrier Signal' sign.

1.3 A 610 mm2 foot wide stop line placed 26.2M86 feet in front of the the active vehicle barrier and the traffic signal is 12.8 meters42 feet from the near edge of the stop line. Provide a 'Stop Here On Red' sign.

1.4 Double solid white lines between inbound lanes approaching the barriers to prohibit lane changes in front of the barriers.

1.5 Diagonal pavement striping. Provide white crosshatching pavement marking that covers the front and back VPDs.

1.6 Vehicle Presence Detectors (VPDs) located immediately before and immediately after each barrier. VPDs can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence. Induction loops must be diagonal quadrapole loop. A loop crossing multiple lanes is not allowed. The VPD before the AVB starts 610 mm2 feet from the AVB and is 23.16M76 ft long and . The VPD after the AVB starts 610 mm2 feet from the AVB and is 1830 mm6 ft by 1830 mm6 ft long.

1.7 Warning Sign and Warning Beacons (wig-wags) (2 Beacons with alternating flashing yellow lights) located 44.2 meters145 feet in front of the barriers. Beacon lamps will be LED.

****

NOTE: Army. First option choose for Army projects. All others, choose the second option.

****

1.8 One Master Control Panel, [one Guard Booth Control panel plus one Guard Booth EFO button each Guard Booth][one Guard Booth EFO panel], one Overwatch

Position Control Panel, one Search Area Control panel per separate search area, [Pedestrian panel,]and a Local Control Panel or panels at each barrier along with all control switches and indicating lights as shown on the Drawings. Locate the Master Control Panel in the Command and Control location for use by the ACP/ECF guards. Locate each Local Control Panel at or near its respective barrier power unit.

1.9 Red flashing in-pavement lights. When required are to be located between the stop line and approach VPD.

1.10 Horn located at the crash-rated active vehicle barriers. Provide the horn with a means to adjust the volume.

1.11 Provide passive vehicle barrier between lanes as indicated.

1.12 LED blankout sign that indicates 'Do Not Enter' installed at the barrier. Two per direction of travel by placing one on each side of the roadway.
]

****

NOTE: choose the correct option.

****

2 BARRIER OPERATING CONTROL PANELS.

[Operating panel layouts are found in Army Standard Design drawing package.][Operating panel layouts are found in the contract drawings.]

3 TRAFFIC SIGNAL AND BARRIER CONTROLS.

3.1. Hybrid Beacon. EFO MODE OF OPERATION.

3.1.1 EFO Operation. Under normal operations, all barriers' mode selector switches on the Master Control Panel will be in the EFO position with the key removed and with that key being accessible only by the lead ACP/ECF guard. With the barrier's mode selector switch in the EFO position, EFO is enabled for that direction of travel, but the Open and Close switches for that barrier on the Master Control Panel and the Open and Close switches on that barrier's Local Control Panel are disabled.

3.1.2 In the EFO mode of operation with the barrier open, the Traffic Signal is Dark. Upon activation of an EFO command from any armed EFO, delay barrier emergency closure by 4 seconds. Activate the wig-wag (warning beacons) as soon as EFO is pushed. During the 4 seconds, the hybrid beacons signals change from dark (off) to Solid Yellow for 3 seconds and then to Alternating flashing Red (alternate on/off in a wig-wag fashion). Activate the in-pavement lights (steady on) when the traffic signal turns red and stay red as long as the traffic signal light is red. After 4 seconds from EFO activation, energize the barrier's emergency close circuit to close the barrier(s) in emergency fast mode (2 seconds or less) provided that the VPDs immediately in front of and behind the barrier are clear (entry and exit loops). If either or both VPDs detect a vehicle, then the barrier does not close; however, the the emergency close signal is latched only for those barriers that were in EFO mode at the time of activation. Once both VPDs are clear, the barriers (those in EFO mode) deploy (unless EFO Reset had been activated). The warning horn sounds for 10 seconds with the setting adjustable in the program. In addition to any indicating lights required for EFO activation, the system is to be programmed to show steady on red indicating light at all EFOs to indicate an EFO activation; however, the EFO that was activated is to have a flashing indicating light.

****

NOTE: Default is that EFO Reset turns off the wig-wags. This is a good visual to know that EFO Reset took place. If desired, they can stay on after EFO Reset.

****

3.2 Hybrid Beacon. EFO RESET. After an EFO activation, all EFO activated barriers cannot be operated until an EFO Reset is accomplished. The guards will close all inbound and outbound lanes. Guards will obtain the EFO Reset key and then activate the EFO Reset switch on the Master Control Panel to reset EFO. [This turns off the warning beacons (wig-wags) and removes the latch command for the EFO circuit.][This removes the latch command for the EFO circuit.] The person in charge can then place the Master Control Panel mode switches into Test (or go through the sequence to use the Local panel) and use the Open buttons to lower each barrier. Once all the barriers are Open for a given direction of travel and the corresponding mode switches are back in EFO mode, then the traffic signal for that direction of travel turns Dark and the in-pavement lights deactivate. This needs to be done for both directions of travel in order to have Dark traffic signals in all directions.

3.3 Hybrid Beacon. TEST MODE OF OPERATION.

3.3.1 Test Operation. An individual barrier can be test operated by installing the proper lane closure markings and barricades ahead of the active barrier and then placing the mode selector switch for that direction of travel into the Test position. With the mode selector switch in the Test position, the barrier's Open and Close switches on the Master Control Panel for that direction of travel are enabled, but the Open and Close switches on the Local Control Panel for that direction of travel are disabled. In addition all active EFO switches are disabled from operating any barrier for that direction of travel. Where a single barrier spans both inbound and outbound lanes, the test operation switch deactivates all EFO capability.

3.3.2 When a mode switch is placed in Test mode, the traffic signals for that direction of travel cycle to Alternating Flashing RED (the hybrid beacons signals change from dark (off) to Steady Yellow for 2 seconds and then to Alternate flashing Red (alternate on/off in a wig-wag fashion)). The barriers for that direction of travel are allowed to operate without any time delay ONCE the signal is alternating flashing Red. The traffic signals for that direction of travel stay Red until all the conditions are met for RETURN TO EFO MODE. The in-pavement lights for that barrier activate when the traffic signal is red and stay red as long as the traffic signals are red. Note the warning beacons do not operate under Test or Local mode, but can be allowed to operate if requested and approved. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

3.4 HYBRID BEACON - LOCAL MODE OF OPERATION

3.4.1 Local Operation. Local mode is used when maintenance personnel need to perform maintenance on the barrier.

3.4.1.1 Maintenance personnel would obtain the mode selector switch key from the lead ACP/ECF guard and place the key into the Master Control Panel 3-position mode selector switch for the appropriate direction of travel.

3.4.1.2 The person then turns the selector switch to the Local position to enable Local mode and then removes the key.

3.4.1.3 With the mode selector switch on the Master Control Panel in the Local position, Open and Close switches on the Master Control Panel for the barriers for that direction of travel are disabled and all EFO switches are disabled for that direction of travel. If a single barrier spans multiple directions of travel all EFO capability will be deactivated.

3.4.1.4 The maintenance person would then insert the key into the appropriate Off-Local mode selector switch on the barrier's Local Control Panel and turn the key to the "Local" position. This action activates the Open and Close switches at the Local Control Panel for the barriers in that direction of travel.

3.4.1.5 Maintenance personnel would also have to block and mark the lane ahead of the barrier in accordance with standard lane closure procedures/standards and also lock and tag out certain equipment at the barrier per the barrier manufacturer's recommendations for the type of maintenance to be performed.

****

NOTE: Hybrid Beacon. First Paragraph applies to final denial barriers that are configured to have only one barrier per direction of travel. This can be a single lane per direction of travel or multiple lanes with one barrier covering all the lanes for that direction of travel.

Hybrid Beacon. Second paragraph applies to final denial barriers that are configured to have multiple barriers for a direction of travel.

****

[3.4.2 Hybrid Beacon. LOCAL MODE OF OPERATION (one barrier per direction of travel). When a mode switch is placed in Local mode, the traffic signals for that direction of travel cycle to Alternating Flashing RED (the hybrid beacons signals change from dark (off) to Steady Yellow for 2 seconds and then to Alternate flashing Red (alternate on/off in a wig-wag fashion). The barriers for that direction of travel are allowed to operate without any time delay ONCE the signal is alternating flashing Red and there is full Local control. The traffic signals for that direction of travel stay Red until all the conditions are met for RETURN TO EFO MODE. The in-pavement lights for that barrier activate when the traffic signal is red and stay red as long as the traffic signals are red. Note the warning beacons do not operate under Local, but can be allowed to operate if requested and approved. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

][3.4.2 Hybrid Beacon. LOCAL MODE OF OPERATION (more than one barrier per direction of travel). When a mode switch is placed in Local mode, the traffic signals DO NOT CHANGE STATE for that direction of travel The in-pavement lights for that barrier do not activate. The wig-wag beacons do not operate. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during Local mode operation.

]3.5 If the Master Control panel is in EFO mode and the Local Panel is in Local mode, that is a conflict. [Hybrid beacon is dark and EFO DOES NOT function.][Traffic signal is green and EFO DOES NOT function.]Local panel does not have any control. The mode indicating lights for Local and EFO are to alternate flashing and an audible alarm is to sound.

3.6 If the Master Control panel is in Test mode and the Local Panel is in Local mode, that is a conflict. [Hybrid beacon signal is Red after cycling and all corresponding Test mode functions are INACTIVE.][Traffic signal is Red after cycling and all corresponding Test mode functions are INACTIVE.] Local panel does not have any control. The mode indicating lights for Test and Local are to alternate flashing and an audible alarm is to sound.

****

NOTE: This is an optional switch function for locations that have only one lane per direction of travel or have one barrier across all the lanes. If there are multiple lanes per direction of travel with each lane having its own AVB and no lane separation, then provide this switch. Keep or delete as required by the project.

****

3.7 Out-of-Service switch. This function is provided for times when a barrier is damaged in a lane and needs to be taken out of service for an extended period of time. The out of service switch is to be located at the AVB location and is allowed to operate in EFO, Test and Local modes. This allows an AVB to be locked out in a lane, but the other lane can operate under EFO. The switch locks out all functions for the AVB when activated. The up and down lights for that AVB will alternate going on and off. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier, having guards present, etc). The Out-Of-Service switch has two positions: Yes and No [contractor is allowed to use Enable and Disable, but it must be clear].

3.7.1 No Position. All controls operate normally.

3.7.2 Yes Position. The Close/ Open position indicating lights for those barriers will alternate from one to the other approximately every 1 sec. This will happen at the Master Control Panel, Local Control Panel (if on) and at any other panel that has barrier position indicator lights.

3.7.2.1 If Local Panel is in Local Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the particular barrier(s) are locked out.

3.7.2.2 If system is in Test Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the particular barrier(s) are locked out.

3.7.2.2 If system is in EFO Mode, then traffic signal is dark. All controls to operate the particular barrier(s) are locked out.

3.8 Hybrid Beacon. RETURN TO EFO MODE. When the mode switch is placed in the EFO mode and all the barriers for that direction of travel are Open (not deployed), then the barrier's Traffic Signal change from Red to Dark. If a mode switch is placed in the EFO mode and any of the barriers for that direction of travel are Closed, then the barrier's Traffic Signal stays Red and an alarm is generated on the ACP/ECF TROUBLE window on the Gatehouse Control Panel. The in-pavement lights turn off when the traffic signal changes to Dark.

3.9 Vehicle Presence Detector consisting of safety loops on either side of a crash rated active vehicle barrier may require additional programming and hardware. If the loops are more than 3 meters10 feet (apart, then add 0.5-1 sec additional time delay on the "back" loop. The alternative is to provide a latching logic between loops. In the latching logic, the master panel needs a release pushbutton for each barrier.

3.10 AUDIBLE ALARMS. Provide an audible alarm at the Master Control Panel, Overwatch Control Panel, [Pedestrian control panel,]main Guard Booth Control Panel and Search Area Control panel(s). The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.10.1 When an EFO is pushed an alarm will go off.

3.10.2 Overspeed and Wrong-way will each cause an alarm to go off for 3 seconds and then clear itself.

3.10.3 Duress activation.

3.10.4 AVB Trouble condition. Alarm happens where there is monitored problem detected that relates to the AVB. Red visual indicator for each electric power unit.

3.10.5 VPD Trouble condition. Alarm happens when there is something wrong with the loop controller or the loops monitored by that controller. Red visual indicator for each loop controller.

3.10.6 VPD Activation for over the set amount of time period (typically 15 seconds) Light goes on immediately for VPD activation, but audible alarm activates after 15 seconds.

3.10.7 Out of Service activation. When a barrier is initially placed in out-of-service, sound an audible alarm for 3 seconds. Open and Close indicator lights are to alternate on/off.

3.10.8 Master Panel in EFO mode and Local Panel is in Local Mode. EFO mode and Local mode indicator lights alternate being on.

3.10.9 Master Panel in Test mode and Local Panel is in Local Mode. Test mode and Local mode indicator lights alternate being on.

3.10.10 Return to EFO mode with an AVB or AVBs in the incorrect position (not fully open). EFO mode indicator light and open/down AVB position light(s) flash.

3.10.11 Communication Loss alarm. If a programmable logic controller loses communication with another programmable logic controller there will be an audible alarm. Red visual indicator.

3.10.12 Tamper switches - Control Panels. Tamper switches located inside each control panel cause an alarm when the cover is opened. Red visual indicator.

3.10.13 Tamper switches - Cabinets. Tamper switches located inside each cabinet cause an alarm when the cover is opened. Red visual indicator.

3.11 LED Blank-Out Sign. The sign is to conform to MUTCD or local Host Nation requirements.

3.12 AUDIBLE ALARMS. Provide an audible alarm at the Local Control Panel. The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops. The alarm does not operate if the panel is not in Local mode.

3.12.1. AVB Trouble condition.

3.13 AUXILIARY CONTACTS
Provide auxiliary contacts (dry) to be used by the Intrusion Detection System and the CCTV system as specified herein and indicated on the drawings.

3.14 WARNING BEACONS (wig-wags). Warning beacons are on anytime the barrier position receives a command to start the close process. The warning beacons do not go off until the traffic signal is Green.
]

Appendix A3 - High Efficiency Presence Detection (HEPD) Active Vehicle Barrier Safety Scheme

HIGH EFFICIENCY PRESENCE DETECTION (HEPD) SAFETY SCHEME FEATURES. Provide the following features for the HEPD Safety Scheme:

****

NOTE: Paragraph 1 can be deleted in its entirety, if the layouts of equipment is shown on the drawings.

****

[1 General equipment layout information.

1.1 One Active Vehicle Barrier at the end of the Response Zone in each inbound and each outbound lane.

1.2 Vehicle presence detectors can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence. Induction loops must be diagonal quadrapole loop and sized per lane i.e. a loop crossing multiple lanes is not allowed. Provide an entry vehicle presence detector (VPD) that starts 1830 mm6 ft ahead of the stop line and goes across the stop line that is 1830 mm6 ft wide by 3 meters10 ft long. Provide threat side VPD that is between the stop line and AVB and starts 610 mm2 ft from the AVB that is 10.36 meters34 ft long and 1830 mm6 ft wide. There is a third VPD (secure VPD) is after the AVB and it is 1830 mm6 ft by 1830 mm6 ft and starts 610 mm2 ft the AVB. The secure loop is 610 mm2 ft from the AVB. All VPDs, if loops, are to be quadrapole.

1.3 A 610 mm2 foot wide stop line placed 13.72 meters45 feet in front of the the active vehicle barrier. Provide a 'Stop Here On Red' sign.

1.4 Traffic Signals and associated signage.

1.4.1 Locations with a single inbound lane and a single outbound lane are to be configured as follows. Provide a post on the driver side and passenger side of the lane. As a minimum the post is to have a three-head Traffic Signal and a LED blank-out sign and a sign that indicates which lane the signal is belongs. Provide a traffic signal that is Red-Yellow-Green top to bottom. The Traffic Signal is to be located at the centerline of the crash rated active vehicle barrier. Bottom of the signal must be 2.49 M8 ft above finished surface. The LED blank-out sign that states "DO NOT ENTER" and is to be mounted below the traffic signal.

1.5 Warning Sign and Warning Beacons (wig-wags) (2 Beacons with alternating flashing yellow lights) located typically between 39.6 meters130 ft and 45.7 meters150 ft in front of the AVB. Beacon lamps will be LED.

****

NOTE: Army. First option choose for Army projects. All others, choose the second option.

****

1.6 One Master Control Panel, [one Guard Booth Control panel plus one Guard Booth EFO button each Guard Booth][one Guard Booth EFO panel], one Overwatch Position Control Panel, one Search Area Control panel per separate search area, [Pedestrian panel,]and a Local Control Panel or panels at each barrier along with all control switches and indicating lights as shown on the Drawings. Locate the Master Control Panel in the Command and Control location for use by the ACP/ECF guards. Locate each Local Control Panel at or near its respective barrier power unit.

1.7 Red flashing in-pavement lights. Where required are to be located between the stop line VPD and the approach VPD.

1.8 Horn located at the crash-rated active vehicle barriers. Provide the horn with a means to adjust the volume.

1.9 Diagonal pavement striping. Provide white crosshatching pavement marking that covers the front and back VPDs. Do not stripe the stop line VPD.

1.10 LED blankout sign that indicates 'Do Not Enter' installed at the barrier. Two per direction of travel by placing one on each side of the roadway on the traffic signal post.

1.11 Passive barriers on raised islands between each lane. Passive barriers and islands extend at least the same distance as the stop line VPD on the secure side of the AVB. Passive barriers must be placed to ensure that a vehicle cannot do a reverse slip. A reverse slip is where a vehicle passes over the barrier after a vehicle passes (slips in behind going opposite direction). See Drawings.

1.12 Passive barrier on a raised median island between the inner most inbound and outbound lanes. The median is to extend at least 25 ft ahead of the stop line. Passive barriers as a minimum start at 3.66 meters12 ft from the the stop line and extend to 3.66 meters12 ft past the active vehicle barrier. Island has a passive barrier that is 1830 mm6 ft from the leading edge and 4 ft from the other edge.

1.11 Actuated Traffic Arm 609 mm2 feet beyond the back edge of the Stop Line

1.12 Actuated Traffic Arm for each inbound lane in the ID Check Area. ATAs are installed near the Guard Booths as shown on the Drawings. An ATA Control Panel with Open and Close control switches for the ATA are provided and mounted on the back wall of the Guard Booth below the back window. If the installation plans on getting Automatic Installation Entry, then just provide infrastructure for the future installation of the ATAs.
]

****

NOTE: Choose the appropriate option.

****

2 BARRIER OPERATING CONTROL PANELS.

[Operating panel layouts are found in Army Standard Design drawing package.][Operating panel layouts are found in the contract drawings.]

3 TRAFFIC SIGNAL AND BARRIER CONTROLS.

3.1 EFO MODE ACTIVATION. The following descriptions assume that the safety VPDs (those located adjacent to the AVB) are clear. A vehicle on the stop line VPD does not impact AVB movement under EFO. If the VPDs are not clear then the AVB deployment is delayed until all safety VPDs are clear. EFO Operation. Under normal operations, all lane mode selector switches on the Master Control Panel will be in the EFO position with the key removed and accessible only by the lead ACP/ECF guard. With the barrier's mode selector switch in the EFO position, EFO is enabled for that lane, but the Open and Close switches for that lane on the Master Control Panel and the Open and Close switches on that barrier's Local Control Panel is disabled. The normal position for the AVB is in the up position. In addition to any indicating lights required for EFO activation, the system is to be programmed to show steady on red indicating light at all EFOs to indicate an EFO activation; however, the EFO that was activated is to have a flashing indicating light.

3.1.1 EFO Mode of Operation with Active Vehicle Barrier (AVB) Up (Closed).

3.1.1.1 Initial State

a. AVB is UP (Closed)
b. VPDs do not have to be clear since the AVB is already in the closed position.
c. Traffic Arm is Down (Closed).
d. Traffic Signals for that lane are Red.
e. Warning beacons (wig-wags) and LED 'Do Not Enter' Blank-out signs area off.

3.1.1.2 EFO is Pushed.

a. Warning beacons (wig-wags) and LED Blank-out signs activate immediately.
b. Horn activates for 10 seconds.
c. AVB remains in the deployed position until EFO Reset is accomplished.

3.1.2 EFO Mode of Operation with Active Vehicle Barrier (AVB) Down (Open).

3.1.2.1 Initial State

a. AVB is Down (Open).
b. Traffic Arm is Down (Closed).
c. Traffic Signals for that lane are Red.
d. Warning beacons (wig-wags) and LED Blank-out signs area off.

3.1.2.2 EFO is Pushed.

a. Warning beacons (wig-wags) and LED Blank-out signs activate immediately.
b. Lane horn(s) is activated for 10 seconds.
c. AVB is deployed. AVB is fully Up (Closed) within 2 seconds (t=2). EFO is not to be interrupted by any position limit switch for the Actuated Traffic Arm.
d. AVB remains in the deployed position until EFO reset is accomplished.

3.1.3 EFO Mode of Operation while Active Vehicle Barrier (AVB) is Down (Open) While Processing Traffic.

3.1.3.1 Initial State

a. AVB is Down (Open).
b. Traffic Arm is Up (Open).
c. Traffic Signals for that lane are green i.e. in Normal Operation.
d. Warning beacons (wig-wags) and LED Blank-out signs area off.

3.1.3.2 EFO is Pushed.

a. Warning beacons (wig-wags) and LED Blank-out signs activate immediately.
b. Lane horn(s) is activated for 10 seconds.
c. Traffic Signal if Green will go to Yellow for 2 seconds (t=2).
d. Traffic Signal will go to Red (t=2).
e. Traffic Arm begins to go Down (Close) as soon as VPD 1a and 1b are clear. Traffic Arm is fully Down (Closed) after 2 seconds. EFO is not to be interrupted by any position limit switch for the Actuated Traffic Arm.
f. Once Traffic Arm is fully Down (Closed), then AVB is deployed. AVB is to be fully Up (Closed) within 2 seconds.
g. AVB remains in the deployed position until EFO reset is accomplished.

3.2 Normal Operations - EFO Mode

3.2.1.1 Initial State

a. AVB is Up (Closed).
b. Traffic Arm is Down (Closed).
c. Traffic Signals for that lane are Red.
d. Warning beacons (wig-wags) and LED Blank-out signs area Off.

3.2.1.2 Vehicle Stops is detected by stop line VPD.

a. Once vehicle detected, AVB is to start Down (Open) after a 1 second delay (t=1).

b. AVB is fully Down (Open) after 2 more seconds (t=3).

c. Once AVB is Down (Open), Traffic Arm is to start Up (Open).

b. Traffic Arm is fully Up (Open) after 2 more seconds (t=5).

c. Traffic signal changes to Green (t=5).

d. A timer is started once stop line VPD is cleared. The timer is set for 3 seconds.

(1). If stop line VPD is clear for the 3 seconds then the Traffic Signal is to change to Yellow (t=8).

(a). Traffic Signal is Yellow for 3 seconds (t=11). Once signal changes to Yellow, the system is to complete the following steps prior to processing other vehicles, even if a vehicle is detected by the stop line VPD.

(b). Traffic Signal changes to Red.

(c) Traffic Arm begins Down (Close).

(d) Traffic Arm is fully Down (Closed) after 2 seconds (t=13).

(e) Once Traffic Arm is fully Down (Closed), AVB is to start Up (Close).

(f) AVB is to be fully Up (Closed) within 2 seconds (t-15).

(2). If the stop line VPD detects a vehicle before 3 seconds elapse, then the Traffic Signal is to stay Green and the Traffic Arm stay Up (Open). The three second timer resets to each time the loop is cleared.

****

NOTE: Default is that EFO Reset turns off the wig-wags. This is a good visual to know that EFO Reset took place. If desired, they can stay on after EFO Reset.

****

3.3 EFO RESET. After an EFO activation, all EFO activated barriers cannot be operated until an EFO Reset is accomplished. The guards will close all inbound and outbound lanes. Guards will obtain the EFO Reset key and then activate the EFO Reset switch on the Master Control Panel to reset EFO. [This turns off the warning beacons (wig-wags) and removes the latch command for the EFO circuit.][This removes the latch command for the EFO circuit.] The person in charge can then place the Master Control Panel mode switches into Test (or go through the sequence to use the Local panel) and use the Open buttons to lower each barrier. Once all the barriers are Open for a given direction of travel and the corresponding mode switches are back in EFO mode, then the traffic signal for that direction of travel turns green and the in-pavement lights deactivate. This needs to be done for both directions of travel.

3.4 TEST MODE OF OPERATION.

3.4.1 When a barrier's mode switch is placed in Test mode the following is to happen. An individual barrier and traffic arm can be test operated by installing the proper lane closure markings and barricades ahead of the active barrier and then placing the mode selector switch for that direction AVB into the Test position. With the mode selector switch in the Test position, the barrier's and traffic arm's Open and Close switches on the Master Control Panel for that AVB is enabled, but the Open and Close switches on the Local Control Panel for that AVB are disabled. In addition all active EFO activations disabled from operating that barrier.

3.4.2 Test Mode Sequence of Operation

3.5.2.1 Initial State
a. Traffic Arm is Down (Closed).
b. Traffic Signals for that lane are Red. Note signals do not cycle through yellow before changing to red.
c. warning beacons (wig-wags) and LED Blank-out signs area off.
d. AVB can either be Up (Closed) or Down (Open).

3.4.2.2 Switch is placed in Test
a. The operator must ensure that the lane that the barrier is in is properly blocked and marked prior to placing the switch into Test or Local mode. This is to comply with MUTCD or Host Nation Criteria.
b. Switch must be in either Test or Local mode for 1 second.
c. Blocks EFO operation for that lane.
d. Horn sounds for 4 seconds or not at all .
e. LED blankout signs activate.
f. Warning beacons do not activate.

3.4.2.3 Initial State
a. AVB is Down (Open).
b. Traffic Arm is Up (Open).
c. Traffic Signals for that lane is Green.
d. warning beacons (wig-wags) and LED Blank-out signs area off.

3.4.2.4 Switch is placed in Test or Local Mode.
a. The operator must ensure that the lane that the barrier is in is properly blocked and marked prior to placing the switch into Test or Local Mode. This is to comply with MUTCD or Host Nation Criteria.
b. Blocks EFO operation for that lane.
c. Traffic Signal changes from green to yellow for 2 seconds then red.
d. Horn sounds for 4 seconds or not at all.
e. LED blankout signs activate.
f. Warning beacons do not activate.

3.5 LOCAL MODE OF OPERATION.

3.5.1 Local Operation. Local mode is used when maintenance personnel need to perform maintenance on the barrier.

3.5.1.1 Maintenance personnel would obtain the mode selector switch key from the lead ACP/ECF guard and place the key into the Master Control Panel 3-position mode selector switch for the appropriate AVB.

3.5.1.2 The person then turns the selector switch to the Local position and remove the key.

3.5.1.3 With the mode selector switch on the Master Control Panel in the Local position, Open and Close switches on the Master Control Panel for that barrier and actuated traffic arm is disabled and all EFO activations disabled for that AVB. Local mode operation is enabled.

3.5.1.4 The maintenance person would then insert the key into the appropriate Off-Local mode selector switch on the barrier's Local Control Panel and turn the key to the "Local" position. This action activates the Open and Close switches at the Local Control Panel for that barrier and actuated traffic arm.

3.5.1.5 Maintenance personnel would also have to block and mark the lane ahead of the barrier in accordance with standard lane closure procedures/standards and also lock and tag out certain equipment at the barrier per the barrier manufacturer's recommendations for the type of maintenance to be performed.

3.5.2 Local Mode Sequence of Operation.

3.5.2.1 Initial State
a. Traffic Arm is Down (Closed).
b. Traffic Signals for that lane are Red. Note signals do not cycle through yellow before changing to red.
c. warning beacons (wig-wags) and LED Blank-out signs area off.
d. AVB can either be Up (Closed) or Down (Open).

3.5.2.2 Switch is placed in Local Mode
a. The operator must ensure that the lane that the barrier is in is properly blocked and marked prior to placing the switch into Test or Local mode. This is to comply with MUTCD or Host Nation Criteria.
b. Switch must be in either Test or Local mode for 1 second.
c. Blocks EFO operation for that lane.
d. Horn does not sound.
e. LED blankout signs activate.
f. Warning beacons do not activate.

3.5.2.3 Initial State
a. AVB is Down (Open).
b. Traffic Arm is Up (Open).
c. Traffic Signals for that lane is Green.
d. warning beacons (wig-wags) and LED Blank-out signs area off.

3.5.2.4 Switch is placed in Local Mode.
a. The operator must ensure that the lane that the barrier is in is properly blocked and marked prior to placing the switch into Test or Local Mode. This is to comply with MUTCD or Host Nation Criteria.
b. Blocks EFO operation for that lane.
c. Traffic Signal changes from green to yellow for 2 seconds then red.
d. Horn does not sound.
e. LED blankout signs activate.
f. Warning beacons do not activate.

****

NOTE: This switch is optional. Verify with customer if desired.

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[3.6 Out-of-Service switch. Provide one per direction of travel. This function is provided for times when a barrier is damaged in a lane and needs to be taken out of service for an extended period of time. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier, having guards present, etc). The switch is located at the Local panel but can function at anytime. The Out-Of-Service switch has two positions: Yes and No or the wording Enable and Disable is allowed.

3.6.1 No Position. All controls operate normally.

3.6.2 Yes Position. The Close/ Open position indicating lights for those barriers will alternate from one to the other approximately every 1 sec. This will happen at the Master Control Panel, Local Control Panel (if on) and at any other panel that has barrier position indicator lights.

3.6.2.1 If Local Panel is in Local Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the barrier(s) are locked out.
3.6.2.2 If system is in Test Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the barrier(s) are locked out.

3.6.2.3 If system is in EFO Mode, then traffic signal is green. All controls to operate the barrier(s) are locked out.

]3.7 RETURN TO AN EFO MODE. The traffic arm is to be down, AVB is up, and the traffic signal is to be red. When the operator places the mode switch into EFO mode, the system is to wait 1 second and then check the position of the traffic arm and the AVB. If either the traffic arm or the AVB are not in the correct position or both are not in the correct position, then the EFO Mode indicating light is to flash and an audible alarm activates. The audible alarm is on for 1 second and then off for 2 seconds. The audible alarm continues in this manner until the equipment is either put in the correct position or the alarm silence is pushed.

3.8 VPDs.

3.8.1 Stop Line VPD. This vehicle presence detection device is used to notify the system when a vehicle is in position to be processed through the lane.

3.8.2. Safety VPDs. These vehicle presence detection devices are used to notify the system when a vehicle is traversing the AVB and it will suppress the AVB from going Up (Close) or Down (Open).
These VPDs must be clear before the AVB is allowed to deploy.

3.8.3. When a VPD is activated for 15 seconds or more, an audible/visual alarm indicating light activates for that lane.

3.8.4. Vehicle Presence Detector consisting of safety loops on either side of a crash rated active vehicle barrier may require additional programming and hardware. If the loops are more than 10 ft (3 meters) apart, then add 0.5-1 sec additional time delay on the "back" loop. The alternative is to provide a latching logic between loops. In the latching logic, the master panel needs a release pushbutton for each barrier.

3.9 Lane Horn. The horn activates under EFO. An adjustable timer is to be set at 10 seconds.

3.10 Actuated Traffic Arm. The Traffic Arm is to have an edge sensor or a torque motor sensor to stop it from continuing to close on a vehicle. When the sensor impacts an object it stops motion and reverses to the Up (Open) position. Loops or break beams are not allowed for this operation. The stop line VPD is to prevent the traffic arm from closing until the VPD is cleared.

3.11 AUDIBLE ALARMS. Provide an audible alarm at the Master Control Panel, Overwatch Control Panel, main Guard Booth Control Panel, Pedestrian Booth, and Search Area Control panel(s). The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.11.1. When an EFO is pushed an alarm will go off for 10 seconds unless silenced earlier.

3.11.2. Overspeed and Wrong-way will cause an alarm to go off for 3 seconds and then clear itself.

3.11.3. Duress activation.

3.11.4 AVB Trouble condition. Alarm happens where there is monitored problem detected that relates to the AVB. Red visual indicator for each electric power unit.

3.11.5 VPD Trouble condition. Alarm happens when there is something wrong with the loop controller or the loops monitored by that controller. Red visual indicator for each loop controller.

3.11.6 VPD Activation for over the set amount of time period (typically 15 seconds) Light goes on immediately for VPD activation, but audible alarm activates after 15 seconds.

3.11.7 Out of Service activation. When a barrier is initially placed in out-of-service, sound an audible alarm for 3 seconds. Open and Close indicator lights are to alternate on/off.

3.11.8 Master Panel in EFO mode and Local Panel is in Local Mode. EFO mode and Local mode indicator lights alternate being on.

3.11.9 Master Panel in Test mode and Local Panel is in Local Mode. Test mode and Local mode indicator lights alternate being on.

3.11.10 Return to EFO mode with an AVB or AVBs in the incorrect position (not fully open). EFO mode indicator light and open/down AVB position light(s) flash.

3.11.11 Communication Loss alarm. If a programmable logic controller loses communication with another programmable logic controller there will be an audible alarm. Red visual indicator.

3.11.12 Tamper switches - Control Panels. Tamper switches located inside each control panel cause an alarm when the cover is opened. Red visual indicator.

3.11.13 Tamper switches - Cabinets. Tamper switches located inside each cabinet cause an alarm when the cover is opened. Red visual indicator.

3.11.14 Traffic arm is neither in fully up or fully down for more than 10 seconds. Position indicator lights for that traffic arm alternate flashing.

3.12 LED Blank-Out Sign. The sign is to meet the following:

3.12.1 Symbol conforms to MUTCD or local Host Nation requirements.

3.13 AUDIBLE ALARMS. Provide an audible alarm at the Local Control Panel. The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.13.1. AVB Trouble condition.

3.14 AUXILIARY CONTACTS

Provide auxiliary contacts (dry) to be used by the Intrusion Detection System and the CCTV system as specified herein and indicated on the drawings.

Appendix A4 - FULL CONTAINMENT Active Vehicle Barrier Safety Scheme

FULL CONTAINMENT SAFETY SCHEME FEATURES. Provide the following features for the full containment Safety Scheme:

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NOTE: Paragraph 1 can be deleted in its entirety, if the layouts of equipment is shown on the drawings.

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[1 General equipment layout information.

1.1 One or more sets of Active Vehicle Barriers in the inbound and outbound lane or lanes. Each set of barriers consists of an initial and final barrier(s) separated by a selected distance to form an entrapment area, in which either the initial barrier(s) or final barrier(s) is always closed.

1.2 Passive barrier on a raised island separating the inbound entrapment area from the outbound entrapment area to prevent vehicle crossover.

1.3 Passive barriers along the ACP/ECF corridor to contain vehicles within the corridor.

1.4 One three-light Traffic Signal located on each side of each crash rated active vehicle barrier (or roadway if there is more than one barrier across the roadway) as shown on the Drawings. Provide three lights in each Traffic Signal with a light configuration of Red-Yellow-Green top to bottom.

1.5 A 610 mm2 foot wide stop line placed 4.3 meters14 feet in front of each barrier(s) as a driver normally approaches the barrier(s). Provide a 'Stop Here On Red' sign at the stop line on each side of the roadway.

1.6 Vehicle presence detectors located immediately before and immediately after each barrier. Presence detectors can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence. Induction loops must be diagonal quadrapole loop and sized per lane i.e. a loop crossing multiple lanes is not allowed.

1.7 Vehicle presence detector located at the stop line starts 1830 mm6 ft before the stop line then crosses the stop line and extends another 610 mm2 ft past the stop line. Threat loop located between the stop line and the AVB is 1830 mm6 ft by 1830 mm6 ft and is 610 mm2 ft from the AVB. The secure loop is 1220 mm4 ft by 1830 mm6 ft wide and is 610 mm2 ft from the AVB.Presence detectors can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence.

1.8 One Master Control Panel, one Guard Booth Control panel for each Guard Booth, and one Overwatch Panel along with all control switches and indicating lights as shown on the Drawings. The Master Control Panel is normally located in the Command and Control for use by the lead ACP/ECF guard.

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NOTE: Army. First option choose for Army projects. All others, choose the second option.

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1.9 One Master Control Panel, [one Guard Booth Control panel plus one Guard Booth EFO button each Guard Booth][one Guard Booth EFO panel], one Overwatch Position Control Panel, one Search Area Control panel per separate search area, [Pedestrian panel,]and a Local Control Panel or panels at each barrier along with all control switches and indicating lights as shown on the Drawings. Locate the Master Control Panel in the Command and Control location for use by the ACP/ECF guards. Locate each Local Control Panel at or near its respective barrier power unit.

1.10 Diagonal pavement striping. Provide white cross hatching pavement marking that covers the front and back VPDs. Do not stripe the stop line VPD.

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NOTE: Stop line traffic arm is optional. It is recommended to provide since it help provide another visual indicator.

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[1.11 Provide an Actuated Traffic Arm for each lane. Install ATAs 610 mm2 ft from the backside of the stop line.

][1.12 Provide an Actuated Traffic Arm (ATA) for each inbound lane in the ID Check Area. ATAs are to be installed near the Guard Booths as shown on the Drawings. Provide an ATA Control Panel with Open and Close control switches for the ATA and mount in the Guard Booth.
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NOTE: Choose the appropriate option.

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2 BARRIER OPERATING CONTROL PANELS.

[Operating panel layouts are found in Army Standard Design drawing package.][Operating panel layouts are found in the contract drawings.]

3 TRAFFIC SIGNAL AND BARRIER CONTROLS.

3.1 BARRIER LAYOUT AND DESIGNATIONS. Arrange each inbound and outbound lane to have two barriers per lane arranged in to entrap a vehicle or vehicles between them. Design the space between barriers to be long enough for the longest vehicle anticipated for the ACP/ECF. The space may be made longer to accommodate multiple vehicles in a platooning type arrangement. The initial barrier from the perspective of innocent motorists is designated 1, and the final barrier is designated 2 for inbound lanes. The initial barrier, again from the perspective of the innocent motorists leaving the installation, is designated 1, and the final barrier is designated 2 for outbound lanes.

3.2 AUTO MODE OF OPERATION.

3.2.1 Auto Operation. In the Auto mode of the Inbound Barriers' mode selector switch, the Close and Open switches on the Control Panel are deactivated for the inbound barriers and the Fill and Release switches on the Master Control panel are activated for the inbound barriers. Guard Booth Panels and Overwatch Panel are activated for the inbound barriers, but only if the arm/disarm switch for the given panel is in the armed position. The above requirements also apply to the control switches and control logic for the outbound barriers.

3.2.2 Initially with no vehicles present in the inbound lanes and the Inbound Barriers' Manual - Auto - Local mode selector switch in the Auto mode, Barrier 1 is open and Barrier 2 is closed. Incoming vehicles are checked at the ID Check point and if cleared are allowed to pass over Barrier 1 and proceed to the Stop Line for Barrier 2. The guard at either the Gatehouse or the Guard Booth then activates the Inbound Release switch. Upon activation of the Inbound Release switch, the Traffic Signal for Barrier 1 goes from Green to Yellow for three seconds and then to Red. After an additional second of Red, Barrier 1's close circuit is energized to close the barrier and traffic arm if present. After Barrier 1 is fully closed, Barrier 2's open circuit is energized to open Barrier 2. When Barrier 2 is fully open, its Traffic Signal changes from Red to Green to allow the vehicle or vehicles to proceed onto the Installation. If traffic arms are provided at the Stop Line, then the traffic arm associated with Barrier 1 will close first followed by closing Barrier 1. The traffic arm associated with Barrier 2 will have the barrier open first and then the traffic arm will open. In both cases, the traffic signal does not change to Green unless both the traffic arm and crash rated active vehicle barrier are fully open.

3.2.3 When the vehicle or vehicles between Barriers 1 and 2 have passed over Barrier 2, the guard activates the Inbound Fill switch. Upon activation of the Inbound Fill switch, the Traffic Signal for Barrier 2 changes from Green to Yellow for 3 seconds and then to Red. After an additional 1 second at Red, Barrier 2's close circuit is energized to close Barrier 2. After Barrier 2 is fully closed, the open circuit for Barrier 1 is energized to open Barrier 1. After Barrier 1 is fully open, its Traffic Signal changes from Red to Green. If there is a traffic arm associated with Barrier 2, the traffic arm closes once the signal is Red, then once fully closed, then Barrier 2 closes. If there is a traffic arm associated with Barrier 1, then Barrier 1 will open first, followed by the traffic arm. Once both are open then the signal changes to Green.

3.2.4 The same controls apply to Barriers 1 and 2 in the outbound lanes and control switches Outbound Release and Outbound Fill.

3.2.5 Supervise the close circuit for all barriers by the Vehicle Presence Detectors (VPD's) in front of and behind the barrier, such that if either VPD detects a vehicle, the barrier close circuit is suppressed. The open circuit is not impacted by a VPD being activated.

3.2.6 A green indicating light adjacent to each Fill switch illuminates when the lane barriers are moving to the Fill position from the barriers being in the Release position. The indicating light is only on while the barriers (and actuated traffic arms) are moving to the proper position. Once in the Fill position the indicating light goes off. Similarly, there is a green indicating light adjacent to each Release switch that lights when the lane barriers are moving to the Release position from the barriers being in the Fill position. The indicating light is only on while the barriers (and actuated traffic arms) are moving to the proper position. Once in the Release position the indicating light goes off.

3.2.7 Red indicating lights are provided to indicate when the barriers (and actuated traffic arms) are in the Fill or Release positions.

3.3 MANUAL MODE OF OPERATION.

3.3.1 In the Manual mode of the Inbound Barriers' mode selector switch, the

Close and Open switches on the Master Control Panel are activated for the inbound barriers, but the Fill and Release switches on the Master, Guard Booth Control Panels, and Overwatch Panel are deactivated for inbound barriers. The above requirements also apply to the control switches and control logic for the outbound barriers. The AVB and traffic arm in manual mode can be operated independently. Warning: In this mode it is possible to have the traffic arms and AVBs all in the option position.

3.3.1 When the Inbound Barriers Manual - Auto - Local mode switch is placed in the Manual mode, the inbound barriers can now be controlled by the individual barrier Open and Close switches on the Master Control Panel. Initiation of a Close command to an open barrier causes that barrier's Traffic Signal to change from Green to Yellow for 3 seconds and then to Red. After an additional one second of Red, the barrier's close circuit is energized through the VPD's immediately in front of and behind the barrier. If the VPD's are clear, the barrier closes. Initiation of an Open command to a closed barrier energizes the open circuit for the barrier and open the barrier. After the barrier is fully open and the mode switch is placed in Auto mode, then the Traffic Signal changes from Red to Green. In the Manual mode, both initial and final barriers in a given entrapment area can be opened. Situations requiring this configuration include passing a vehicle that is longer than the entrapment area. In such situations, guards must provide compensatory security measures to defeat a threat while both barriers are open. If there is a traffic arm associated with a barrier, the traffic arm is to close first and open last when compared to the barrier movement. Manual mode does not allow manual operation of the barrier and the traffic arm separately from each other.

3.3.2 The close circuit for all barriers is supervised by the Vehicle Presence Detectors (VPD's) in front of and behind the barrier, such that if either VPD detects a vehicle, the barrier close circuit is suppressed. The open circuit is not impacted by a VPD being activated.

3.4 LOCAL MODE OF OPERATION.

3.4.1 Local Operation. Local mode is used when maintenance personnel need to perform maintenance on the barrier.

3.4.1.1 Maintenance personnel would obtain the mode selector switch key from the lead ACP/ECF guard and place the key into the Master Control Panel 3-position mode selector switch for the appropriate direction of travel.

3.4.1.2 The person then turns the selector switch to the Local position and remove the key.

3.4.1.3 With the mode selector switch on the Master Control Panel in the Local position, Open and Close switches on the Master Control Panel for the barriers for that direction of travel are disabled and Auto mode is disabled disabled for that barrier set.

3.4.1.4 The maintenance person would then insert the key into the appropriate Off-Local mode selector switch on the barrier's Local Control Panel and turn the key to the "Local" position. This action enables the Open and Close switches at the Local Control Panel for the barriers in that direction of travel.

3.4.1.5 Maintenance personnel would also have to block and mark the lane ahead of the barrier in accordance with standard lane closure procedures/standards and also lock and tag out certain equipment at the barrier per the barrier manufacturer's recommendations for the type of maintenance to be performed.

3.4.2 When the Inbound Barriers Manual - Auto - Local mode switch is placed in the Local mode no change takes place with the traffic signals. This action just locks out the Auto and Manual mode functions. The key is then taken to the Local panel where the Local panel is placed into Local mode. The inbound barriers can now be controlled by the individual barrier Open and Close switches on the Local Control Panel. Initiation of a Close command to an open barrier causes that barrier's Traffic Signal to change from Green to Yellow for 3 seconds and then to Red. After an additional one second of Red, the barrier's close circuit is energized through the VPD's immediately in front of and behind the barrier. If the VPD's are clear, the barrier closes. Initiation of an Open command to a closed barrier energizes the open circuit for the barrier and open the barrier. After the barrier is fully open and the mode switch is placed in Auto mode, then the Traffic Signal changes from Red to Green. In the Local mode, both initial and final barriers in a given entrapment area can be opened. In such situations, guards must provide compensatory security measures to defeat a threat while both barriers are open. The traffic arm associated with a barrier is operated independent from the crash rated active vehicle barrier. Upon completion of maintenance, the traffic arm and corresponding barrier need to be in the same position e.g. either both open or both closed.

3.4.3 The close circuit for all barriers is supervised by the Vehicle Presence Detectors (VPD's) in front of and behind the barrier, such that if either VPD detects a vehicle, the barrier close circuit is suppressed. The open circuit is not impacted by a VPD being activated.

3.5 FINAL BARRIER: A VPD located at the barrier's STOP line detects a vehicle's presence in the entrapment area. If the final barrier is closed, then a signal is sent to the guard in the Gatehouse notifying him/her of the vehicle's presence. The signal causes a short audible noise to alert the guard and turns on a Red indicating light until the final barrier is open. If the barrier is open, then just the indicating light for the loop illuminates.

3.6 FILL OR RELEASE COMMAND WITH VPD.

3.6.1 Vehicle Presence Detector consisting of safety loops on either side of a crash rated active vehicle barrier may require additional programming and hardware. If the loops are more than 3 meters10 ft apart, then add 0.5-1 sec additional time delay on the "back" loop. The alternative is to provide a latching logic between loops. In the latching logic, the master panel needs a release pushbutton for each barrier.

3.6.2 When in Auto mode and a Fill or Release command is requested, then the system is to function as indicated.

3.6.2.1 When a VPD is activated on a barrier that is to close, then the action (Fill or Release) is suppressed. An audible alarm is to sound and the Fill or Release indicating light is to Flash. The original command is unlatched. Once the VPD(s) is cleared, then the guard must hit the reset button to clear the system and alarm. The Fill or Release command is to be reinitiated then. Once the traffic arm or barrier starts to close, a VPD activation is not to stop the cycle. The VPD must be activated prior to the command to stop the command.

3.6.2.2 A VPD activation on a barrier that is to open does not stop the action of opening (Fill or Release).

3.7 MANUAL OPEN OR CLOSE COMMAND WITH VPD.

3.7.1 Manual operation to Open a barrier or traffic arm is not impacted by a VPD activation associated with that barrier/traffic arm.

3.7.2 Manual operation to Close a barrier or traffic arm is suppressed by a VPD activation associated with that barrier/traffic arm. The VPD activation must take place prior to the Close command to suppress the action. The command is unlatched and must be reinitiated once the VPD(s) is cleared.

3.9 RETURN TO AUTO MODE.

3.8.1 When the mode switch is placed in the Auto mode and all the barriers for that direction of travel are in the appropriate configuration - one is Open (not deployed) and one is Closed (deployed), then the Auto mode indicating light illuminates and the corresponding Fill or Release light is to be illuminated.

3.8.2 If a mode switch is placed in the Auto mode and if both barriers for that direction of travel are either Open or Closed or if the traffic arm and barrier are in an incorrect position, then an alarm is to sound. The visual indicator is to be an alternating flashing of the Fill and Release indicator lights and the Auto indicating light is to turn off. The guard needs to go to manual mode and place the equipment in the correct configuration. Moving the mode switch from Auto to Manual (or local) mode turns off the alarm.

3.9 RESET. Reset button is only located at the Master Control Panel.

3.9.1 The reset button is used to reset after an Auto mode Fill or Release action is stopped by a VPD during a closing action. See RETURN to Auto Mode.

3.9.2 The reset button is also used to correct the unlikely situation that a barrier and traffic arm are prevented from completing a coordinated action. One possible is traffic arm closing on an object and then reversing back to the open position.

****

NOTE: This is an optional switch function for locations that have only one lane per direction of travel or have one barrier across all the lanes. If there are multiple lanes per direction of travel with each lane having its own AVB and no lane separation, then provide this switch. Keep or delete as required by the project.

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3.10 Out-of-Service switch. This function is provided for times when a barrier is damaged in a lane and needs to be taken out of service for an extended period of time. The out of service switch is to be located at the AVB location and is allowed to operate in EFO, Test and Local modes. This allows an AVB to be locked out in a lane, but the other lane can operate under EFO. The switch locks out all functions for the AVB when activated. The up and down lights for that AVB will alternate going on and off. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier, having guards present, etc). The Out-Of-Service switch has two positions: Yes and No or Enable and Disable is allowed for the wording..

3.11 AUDIBLE ALARMS. Provide an audible alarm at the Master Control Panel, Overwatch Control Panel, [Pedestrian control panel,] main Guard Booth Control Panel and Search Area Control panel(s). The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.11.1 Stop line VPD. When the stop line VPD is activated it activates a visual indicator and audible indicator when the barrier is in the Closed position. If the AVB is in the open position, only a visual indicator.

3.11.2. Overspeed and Wrong-way will cause an alarm to go off for 3 seconds and then clear itself.

3.11.3. Duress activation.

3.11.4 AVB Trouble condition. Alarm happens where there is monitored problem detected that relates to the AVB. Red visual indicator for each electric power unit.

3.11.5 VPD Trouble condition. Alarm happens when there is something wrong with the loop controller or the loops monitored by that controller. Red visual indicator for each loop controller.

3.11.6 VPD Activation for over the set amount of time period (typically 15 seconds) Light goes on immediately for VPD activation, but audible alarm activates after 15 seconds.

3.11.7 Out of Service activation. When a barrier is initially placed in out-of-service, sound an audible alarm for 3 seconds. Open and Close indicator lights are to alternate on/off.

3.11.8 Master Panel in Auto mode and Local Panel is in Local Mode. Auto mode and Local mode indicator lights alternate being on.

3.11.9 Master Panel in Manual/Test mode and Local Panel is in Local Mode. Manual/Test mode and Local mode indicator lights alternate being on.

3.11.10 Return to Auto mode with an AVB or AVBs in the incorrect position (not fully open). Auto mode indicator light and open/down AVB position light(s) flash.

3.11.11 Communication Loss alarm. If a programmable logic controller loses communication with another programmable logic controller there will be an audible alarm. Red visual indicator.

3.11.12 Tamper switches - Control Panels. Tamper switches located inside each control panel cause an alarm when the cover is opened. Red visual indicator.

3.11.13 Tamper switches - Cabinets. Tamper switches located inside each cabinet cause an alarm when the cover is opened. Red visual indicator.

3.12 AUDIBLE ALARMS. Provide an audible alarm at the Local Control Panel. The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.12.1. AVB Trouble condition.

3.13 AUXILIARY CONTACTS. Provide auxiliary contacts (dry) to be used by the Intrusion Detection System and the CCTV system as specified herein and indicated on the drawings.

Appendix A5 - Stop Control Safety Scheme Active Vehicle Barrier Safety Scheme

STOP CONTROL Provide the following features for the full containment Safety Scheme:

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NOTE: Paragraph 1 can be deleted in its entirety, if the layouts of equipment is shown on the drawings.

****

[1 General equipment layout information.

1.1 Active Vehicle Barriers in all inbound and outbound lanes.

1.2. Do Not Enter LED blankout signs are located at the midpoint of the AVB on each side of the lane.

1.3 A 610 mm2 foot wide stop line placed 4.3 meters14 feet in front of the the active vehicle barrier. A Stop sign is located at the front of the stop line.

1.4 Double solid white lines between inbound lanes approaching the barriers to prohibit lane changes in front of the barriers.

1.5 Double solid yellow lines between adjacent inbound and outbound lanes.

1.6 Vehicle Presence Detectors (VPDs) located immediately before and immediately after each barrier. VPDs can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence. Induction loops must be diagonal quadrapole loop and sized per lane i.e. a loop crossing multiple lanes is not allowed. The VPD before and after the AVB starts 610 mm2 ft from the AVB and is 1830 mm6 ft wide by 1830 mm6 ft long.

1.7 Warning Sign and Warning Beacons (wig-wags) (2 Beacons with alternating flashing yellow lights) located approximately 33.5 meters110 feet in front of the barriers. Beacon lamps will be LED.

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NOTE: Army. First option choose for Army projects. All others, choose the second option.

****

1.8 One Master Control Panel, [one Guard Booth Control panel plus one smaller panel for each Guard Booth][one Guard Booth EFO Control Button], one Overwatch Position Control Panel, one Search Area Control panel per separate search area, Pedestrian booth, and a Local Control Panel or panels at each barrier along with all control switches and indicating lights as shown on the Drawings. Locate the Master Control Panel in the Command and Control location for use by the ACP/ECF guards. Locate each Local Control Panel at or near its respective barrier power unit.

1.9 Diagonal pavement striping. Provide white crosshatching pavement marking that covers the front and back VPDs. Do not stripe the stop line VPD.

****
NOTE: In-pavement lights are optional. Edit per project requirements.
****

[1.10 Red flashing in-pavement lights on both sides of the barrier in each lane where there are inbound and outbound lanes adjacent to each other. If multiple lanes per direction of travel then the lights are only required where the AVB does not have lights facing normal traffic flow. Provide three lights per barrier on each side of the barrier. Locate approximately 610 mm2 ft in front of the stop line.

]1.11 Horn located at the crash-rated active vehicle barriers. Provide the horn with a means to adjust the volume.

1.12 Actuated Traffic Arm for each inbound lane in the ID Check Area. Install ATAs near the Guard Booths as shown on the Drawings. Provide an ATA Control Panel with Open and Close control switches for the ATA in the guard booth or as directed.
]
****
NOTE: choose the appropriate option.
****

2 BARRIER OPERATING CONTROL PANELS.

[Operating panel layouts are found in Army Standard Design drawing package.][Operating panel layouts are found in the contract drawings.]

3 TRAFFIC SIGNAL AND BARRIER CONTROLS.

3.1 EFO MODE. Under normal operations, all barriers' mode selector switches on the Master Control Panel will be in the EFO position with the key removed and with that key being accessible only by the lead ACP/ECF guard. With the barrier's mode selector switch in the EFO position, EFO is enabled for that direction of travel, but the Open and Close switches for that barrier on the Master Control Panel and the Open and Close switches on that barrier's Local Control Panel are disabled.

3.2 EFO OPERATION. In the EFO mode of operation with the barrier open, the LED Do Not Enter signs are off. Activation of an EFO command from any armed EFO deploys the AVB, activates the warning beacons, turns on the in-pavement lights (if present), red signal, and LED Do Not Enter signs as soon as EFO is pushed. The barrier(s) in emergency fast mode is to be fully deployed within 2 seconds provided that the VPDs immediately in front of and behind the barrier are clear. If either or both VPDs detect a vehicle, then the barrier does not close; however, the emergency close signal is latched only for those barriers that were in EFO mode at the time of activation. Once both VPDs are clear, the barriers (those in EFO mode) deploy (unless EFO Reset had been activated). Horn is to sound for 10 seconds. In addition to any indicating lights required for EFO activation, the system is to be programmed to show steady on red indicating light at all EFOs to indicate an EFO activation; however, the EFO that was activated is to have a flashing indicating light.

****
NOTE: Default is that EFO Reset turns off the wig-wags. This is a good visual to know that EFO Reset took place. If desired, they can stay on after EFO Reset.

****

3.3 EFO RESET. After an EFO activation, guards will close all inbound and outbound lanes. Guards will obtain the EFO Reset key and then activate the EFO Reset switch on the Master Control Panel to reset EFO. . [This turns off the warning beacons (wig-wags) and removes the latch command for the EFO circuit.][This removes the latch command for the EFO circuit.] The person in charge can then place the Master Control Panel mode switches into Test (or go through the sequence to use the Local panel) and use the Open buttons to lower each barrier. Once all the barriers are Open for a given direction of travel and the corresponding mode switches are back in EFO mode, then the warning beacons, red signal, and Do Not Enter signs for that direction of travel, and the in-pavement lights deactivate. This needs to be done for both directions of travel in order to have all signals off.

3.3 Test Operation.

3.3.1 An individual barrier can be test operated by installing the proper lane closure markings and barricades ahead of the active barrier and then placing the mode selector switch for that direction of travel into the Test position. With the mode selector switch in the Test position, the barrier's Open and Close switches on the Master Control Panel for that direction of travel are enabled, but the Open and Close switches on the Local Control Panel for that direction of travel are disabled. In addition all active EFO switches are disabled from operating any barrier for that direction of travel. Where a single barrier spans both inbound and outbound lanes, the test operation switch deactivates all EFO capability.

3.3.2 When a mode switch is placed in Test mode, the warning beacons, red signal, Do Not Enter signs, and in-pavement lights for that direction of travel activate. The barriers for that direction of travel are allowed to operate without any time delay. The traffic signals for that direction of travel stay on until all the conditions are met for RETURN TO EFO MODE. The AVB must be down and back in EFO mode to deactivate the signals. The warning beacons, in pavement lights, Do Not Enter signs, and red signal all deactivate. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

3.4 LOCAL MODE OF OPERATION

3.4.1 Local Operation. Local mode is used when maintenance personnel need to perform maintenance on the barrier.

3.4.1.1 Maintenance personnel would obtain the mode selector switch key from the lead ACP/ECF guard and place the key into the Master Control Panel 3-position mode selector switch for the appropriate direction of travel.

3.4.1.2 The person then turns the selector switch to the Local position to enable Local mode and then removes the key.

3.4.1.3 With the mode selector switch on the Master Control Panel in the Local position, Open and Close switches on the Master Control Panel for the barriers for that direction of travel are disabled and all EFO switches are disabled for that direction of travel. If a single barrier spans multiple directions of travel all EFO capability will be deactivated.

3.4.1.4 The maintenance person would then insert the key into the appropriate

Off-Local mode selector switch on the barrier's Local Control Panel and turn the key to the "Local" position. This action activates the Open and Close switches at the Local Control Panel for the barriers in that direction of travel.

3.4.1.5 Maintenance personnel would also have to block and mark the lane ahead of the barrier in accordance with standard lane closure procedures/standards and also lock and tag out certain equipment at the barrier per the barrier manufacturer's recommendations for the type of maintenance to be performed.

3.4.2 LOCAL MODE OF OPERATION (one barrier per direction of travel). When a mode switch is placed in Local mode, the traffic signals, in-pavement lights and LED blankout signs for that direction of travel activate. The barriers for that direction of travel are allowed to operate without any time delay. Everything stays activated for that direction of travel until all the conditions are met for RETURN TO EFO MODE. The in-pavement lights for that barrier activate when the traffic signal is red and stay red as long as the traffic signals are red. Note the warning beacons do not operate under Local, but can be allowed to operate if requested and approved. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

3.5 Vehicle Presence Detector consisting of safety loops on either side of a crash rated active vehicle barrier may require additional programming and hardware. If the loops are more than 3 meters10 ft apart, then add 0.5-1 sec additional time delay on the "back" loop. The alternative is to provide a latching logic between loops. In the latching logic, the master panel needs a release pushbutton for each barrier.

****

NOTE: This is an optional switch function for locations that have only one lane per direction of travel or have one barrier across all the lanes. If there are multiple lanes per direction of travel with each lane having its own AVB and the lanes are not separated by an island, then provide this switch. Keep or delete as required by the project.

****

3.6 Out-of-Service switch. This function is provided for times when a barrier is damaged in a lane and needs to be taken out of service for an extended period of time. The out of service switch is to be located at the AVB location and is allowed to operate in EFO, Test and Local modes. This allows an AVB to be locked out in a lane, but the other lane can operate under EFO. The switch locks out all functions for the AVB when activated. The up and down lights for that AVB will alternate going on and off. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier, having guards present, etc). The Out-Of-Service switch has two positions: Yes and No or use Enable and Disable.

3.6.1 No Position. All controls operate normally.

3.6.2 Yes Position. The Close/ Open position indicating lights for those barriers will alternate from one to the other approximately every 1 sec. This will happen at the Master Control Panel, Local Control Panel (if on) and at any other panel that has barrier position indicator lights. Controls for that AVB are all locked out.

3.7 RETURN TO EFO MODE. When the mode switch is placed in the EFO mode and all the barriers for that direction of travel are Open (not deployed), then the barrier's signs and warning beacons (wig-wags) deactivate. If a mode switch is placed in the EFO mode and any of the barriers for that direction of travel are Closed, then the barrier's signs stay on and an alarm is generated on the ACP/ECF TROUBLE window on the Gatehouse Control Panel.

3.8 AUDIBLE ALARMS. Provide an audible alarm at the Master Control Panel, Overwatch Control Panel, main Guard Booth Control Panel and Search Area Control panel(s). The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.8.1. When an EFO is pushed an alarm will go off for 3 seconds unless silenced earlier.

3.8.2. Overspeed and Wrong-way will cause an alarm to go off for 3 seconds and then clear itself.

3.8.3. Duress activation.

3.8.4 AVB Trouble condition. Alarm happens where there is monitored problem detected that relates to the AVB. Red visual indicator for each electric power unit.

3.8.5 VPD Trouble condition. Alarm happens when there is something wrong with the loop controller or the loops monitored by that controller. Red visual indicator for each loop controller.

3.8.6 VPD Activation for over the set amount of time period (typically 15 seconds) Light goes on immediately for VPD activation, but audible alarm activates after 15 seconds.

3.8.7 Out of Service activation. When a barrier is initially placed in out-of-service, sound an audible alarm for 3 seconds. Open and Close indicator lights are to alternate on/off.

3.8.8 Master Panel in EFO mode and Local Panel is in Local Mode. EFO mode and Local mode indicator lights alternate being on.

3.8.9 Master Panel in Test mode and Local Panel is in Local Mode. Test mode and Local mode indicator lights alternate being on.

3.8.10 Return to EFO mode with an AVB or AVBs in the incorrect position (not fully open). EFO mode indicator light and open/down AVB position light(s) flash.

3.8.11 Communication Loss alarm. If a programmable logic controller loses communication with another programmable logic controller there will be an audible alarm. Red visual indicator.

3.8.12 Tamper switches - Control Panels. Tamper switches located inside each control panel cause an alarm when the cover is opened. Red visual indicator.

3.8.13 Tamper switches - Cabinets.   Tamper switches located inside each cabinet cause an alarm when the cover is opened. Red visual indicator.

3.9 AUDIBLE ALARMS. Provide an audible alarm at the Local Control Panel. The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.9.1. AVB Trouble condition.

3.9 AUXILIARY CONTACTS Provide auxiliary contacts (dry) to be used by the Intrusion Detection System and the CCTV system as specified herein and indicated on the drawings.

[Appendix A10-HB-2014 - Conventional Signs and Signals Hybrid Beacon Active Vehicle Barrier Safety Scheme

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NOTE: This safety scheme is based on SDDCTEA 55-15, 2014. Do Not Use For New Construction. It is intended only for replacement of existing systems that cannot be fully upgraded to the latest corresponding safety scheme. This system allowed the use of Red/Yellow/Green traffic signals or the use of hybrid beacons, but hybrid beacon is now the preferred signal to use. Designer should try to incorporate as much of Appendix A1 as possible when doing the replacement project. Delete if not used in project.

****

Conventional Signs and Signal Safety Scheme Features. Provide the following features for the Conventional (Signs and Signals) Safety Scheme:

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NOTE: Paragraph 1 can be deleted in its entirety, if the layouts of equipment is shown on the drawings.

****

[1. General Layout Information

1.1 Active Vehicle Barriers in all inbound and outbound lanes. .

1.2a Hybrid Beacon. A three light hybrid beacon signal head over each inbound and outbound active barrier. Special location may require only posts i.e. no masts. Post mounted requires two posts with each having a traffic signal. Provide three head traffic signals with two Red signals adjacent horizontally and a Yellow centered below the two red beacons. Install the hybrid beacon signal at the centerline of the AVB. The beacons are to be Light Emitting Diode (LED) type. Mast arm will have a 'Barrier Signal' sign.

1.3 A 610 mm2 foot wide stop line placed 9M30 feet in front of the the active vehicle barrier and the traffic signal is 12 meters40 feet from the near edge of the stop line. Provide a 'Stop Here On Red' sign.

1.4 Double solid white lines between inbound lanes approaching the barriers to prohibit lane changes in front of the barriers.

1.5 Diagonal pavement striping. Provide white crosshatching pavement marking that covers the front and back VPDs.

1.6 Vehicle Presence Detectors (VPDs) located immediately before and immediately after each barrier. VPDs can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence. Induction loops must be diagonal quadrapole loop. A loop crossing multiple lanes is not allowed. The VPD before the AVB starts 610 mm2 feet from the AVB and is 1830 mm6 ft wide by 1830 mm6 ft long.

1.7 Warning Sign and Warning Beacons (wig-wags) (2 Beacons with alternating flashing yellow lights) located 44.2 meters145 feet in front of the barriers. Beacon lamps will be LED.

****

NOTE: Army. First guard booth panel option choose for Army projects. All others, choose the second guard booth option.

****

1.8 One Master Control Panel, [one Guard Booth Control panel plus one Guard Booth EFO button each Guard Booth][one Guard Booth EFO panel], one Overwatch Position Control Panel, one Search Area Control panel per separate search area, [Pedestrian panel,]and a Local Control Panel or panels at each barrier along with all control switches and indicating lights as shown on the Drawings. Locate the Master Control Panel in the Command and Control location for use by the ACP/ECF guards. Locate each Local Control Panel at or near its respective barrier power unit.

1.9 Red flashing in-pavement lights. When required are to be located between the stop line and approach VPD.

****

NOTE: Horn is optional.

****

[1.10 Horn located at the crash-rated active vehicle barriers. Provide the horn with a means to adjust the volume.
]

****

NOTE: LED Blankout sign is optional for Conventional Signs and Signals.

****

[1.11 LED blankout sign that indicates 'Do Not Enter' installed at the barrier. Two per direction of travel by placing one on each side of the roadway.
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NOTE: Choose the correct option. The operating panels used Appendix A1 and A11 are the same.

****

2 BARRIER OPERATING CONTROL PANELS.

[Operating panel layouts are found in Army Standard Design drawing package.][Operating panel layouts are found in the contract drawings.]

3 TRAFFIC SIGNAL AND BARRIER CONTROLS.

3.1. Hybrid Beacon. EFO MODE OF OPERATION.

3.1.1 EFO Operation. Under normal operations, all barriers' mode selector switches on the Master Control Panel will be in the EFO position with the key removed and with that key being accessible only by the lead ACP/ECF guard. With the barrier's mode selector switch in the EFO position, EFO is enabled for that direction of travel, but the Open and Close switches for that barrier on the Master Control Panel and the Open and Close switches on that barrier's Local Control Panel are disabled. In addition to any indicating lights required for EFO activation, the system is to be programmed to show steady on red indicating light at all EFOs to indicate an EFO activation;

however, the EFO that was activated is to have a flashing indicating light.

3.1.2 Hybrid Beacon. In the EFO mode of operation with the barrier open, the Traffic Signal is Dark. Upon activation of an EFO command from any armed EFO, delay barrier emergency closure by 4 seconds. Activate the wig-wag (warning beacons) as soon as EFO is pushed. During the 4 seconds, the hybrid beacons signals change from dark (off) to Solid Yellow for 3 seconds and then to Alternating flashing Red (alternate on/off in a wig-wag fashion). Activate the in-pavement lights (steady on) when the traffic signal turns red and stay red as long as the traffic signal light is red. After 4 seconds from EFO activation, energize the barrier's emergency close circuit to close the barrier(s) in emergency fast mode (2 seconds or less) provided that the VPDs immediately in front of and behind the barrier are clear (entry and exit loops). If either or both VPDs detect a vehicle, then the barrier does not close; however, the the emergency close signal is latched only for those barriers that were in EFO mode at the time of activation. Once both VPDs are clear, the barriers (those in EFO mode) deploy (unless EFO Reset had been activated). The warning horn sounds for 10 seconds with the setting adjustable in the program.

****

NOTE: Default is that EFO Reset turns off the wig-wags. This is a good visual to know that EFO Reset took place. If desired, they can stay on after EFO Reset.

****

3.2 Hybrid Beacon. EFO RESET. After an EFO activation, guards will close all inbound and outbound lanes. Guards will obtain the EFO Reset key and then activate the EFO Reset switch on the Master Control Panel to reset EFO. [This turns off the warning beacons (wig-wags) and removes the latch command for the EFO circuit.][This removes the latch command for the EFO circuit.] The person in charge can then place the Master Control Panel mode switches into Test (or go through the sequence to use the Local panel) and use the Open buttons to lower each barrier. Once all the barriers are Open for a given direction of travel and the corresponding mode switches are back in EFO mode, then the traffic signal for that direction of travel turns Dark and the in-pavement lights deactivate. This needs to be done for both directions of travel in order to have Dark traffic signals in all directions.

3.3 TEST MODE OF OPERATION.

3.3.1 Test Operation- General. An individual barrier can be test operated by installing the proper lane closure markings and barricades ahead of the active barrier and then placing the mode selector switch for that direction of travel into the Test position. With the mode selector switch in the Test position, the barrier's Open and Close switches on the Master Control Panel for that direction of travel are enabled, but the Open and Close switches on the Local Control Panel for that direction of travel are disabled. In addition all active EFO switches are disabled from operating any barrier for that direction of travel. Where a single barrier spans both inbound and outbound lanes, the test operation switch deactivates all EFO capability.

3.3.2 Hybrid Beacon. TEST MODE OF OPERATION. When a mode switch is placed in Test mode, the traffic signals for that direction of travel cycle to Alternating Flashing RED (the hybrid beacons signals change from dark (off) to Steady Yellow for 3 seconds and then to Alternate flashing Red (alternate on/off in a wig-wag fashion). The barriers for that direction of travel are allowed to operate without any time delay ONCE the signal is alternating flashing Red. The traffic signals for that direction of travel stay Red until all the conditions are met for RETURN TO EFO MODE. The in-pavement lights for that barrier activate when the traffic signal is red and stay red as long as the traffic signals are red. Note the warning beacons do not operate under Test or Local mode, but can be allowed to operate if requested and approved. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

3.4 LOCAL MODE OF OPERATION

3.4.1 Local Operation. Local mode is used when maintenance personnel need to perform maintenance on the barrier.

3.4.1.1 Maintenance personnel would obtain the mode selector switch key from the lead ACP/ECF guard and place the key into the Master Control Panel 3-position mode selector switch for the appropriate direction of travel.

3.4.1.2 The person then turns the selector switch to the Local position to enable Local mode and then removes the key.

3.4.1.3 With the mode selector switch on the Master Control Panel in the Local position, Open and Close switches on the Master Control Panel for the barriers for that direction of travel are disabled and all EFO switches are disabled for that direction of travel. If a single barrier spans multiple directions of travel all EFO capability will be deactivated.

3.4.1.4 The maintenance person would then insert the key into the appropriate Off-Local mode selector switch on the barrier's Local Control Panel and turn the key to the "Local" position. This action activates the Open and Close switches at the Local Control Panel for the barriers in that direction of travel.

3.4.1.5 Maintenance personnel would also have to block and mark the lane ahead of the barrier in accordance with standard lane closure procedures/standards and also lock and tag out certain equipment at the barrier per the barrier manufacturer's recommendations for the type of maintenance to be performed.

****

NOTE: Hybrid Beacon. First Paragraph applies to final denial barriers that are configured to have only one barrier per direction of travel. This can be a single lane per direction of travel or multiple lanes with one barrier covering all the lanes for that direction of travel.

Hybrid Beacon. Second paragraph applies to final denial barriers that are configured to have multiple barriers for a direction of travel.

****

[3.4.2 Hybrid Beacon. LOCAL MODE OF OPERATION (one barrier per direction of travel). When a mode switch is placed in Local mode, the traffic signals for that direction of travel cycle to Alternating Flashing RED (the hybrid beacons signals change from dark (off) to Steady Yellow for 2 seconds and then to Alternate flashing Red (alternate on/off in a wig-wag fashion). The barriers for that direction of travel are allowed to operate without any time delay ONCE the signal is alternating flashing Red and there is full Local control. The traffic signals for that direction of travel stay Red until all the conditions are met for RETURN TO EFO MODE. The in-pavement lights for that barrier activate when the traffic signal is red and stay red as long as the traffic signals are red. Note the warning beacons do not operate under Local, but can be allowed to operate if requested and approved. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

][3.4.2 Hybrid Beacon. LOCAL MODE OF OPERATION (more than one barrier per direction of travel). When a mode switch is placed in Local mode, the traffic signals DO NOT CHANGE STATE for that direction of travel The in-pavement lights for that barrier do not activate. The wig-wag beacons do not operate. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during Local mode operation.

]3.5 If the Master Control panel is in EFO mode and the Local Panel is in Local mode, that is a conflict. [Hybrid beacon is dark and EFO DOES NOT function.][Traffic signal is green and EFO DOES NOT function.]Local panel does not have any control. The mode indicating lights for Local and EFO are to alternate flashing and an audible alarm is to sound.

3.6 If the Master Control panel is in Test mode and the Local Panel is in Local mode, that is a conflict. [Hybrid beacon signal is Red after cycling and all corresponding Test mode functions are INACTIVE.][Traffic signal is Red after cycling and all corresponding Test mode functions are INACTIVE.] Local panel does not have any control. The mode indicating lights for Test and Local are to alternate flashing and an audible alarm is to sound.

****

NOTE: This is an optional switch function for locations that have only one lane per direction of travel or have one barrier across all the lanes. If there are multiple lanes per direction of travel with each lane having its own AVB and no lane separation, then provide this switch. Keep or delete as required by the project.

****

3.7 Out-of-Service switch. This function is provided for times when a barrier is damaged in a lane and needs to be taken out of service for an extended period of time. The out of service switch is to be located at the AVB location and is allowed to operate in EFO, Test and Local modes. This allows an AVB to be locked out in a lane, but the other lane can operate under EFO. The switch locks out all functions for the AVB when activated. The up and down lights for that AVB will alternate going on and off. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier, having guards present, etc). The Out-Of-Service switch has two positions: Yes and No [contractor is allowed to use Enable and Disable, but it must be clear].

3.7.1 No Position. All controls operate normally.

3.7.2 Yes Position. The Close/ Open position indicating lights for those barriers will alternate from one to the other approximately every 1 sec. This will happen at the Master Control Panel, Local Control Panel (if on) and at any other panel that has barrier position indicator lights.

3.7.2.1 If Local Panel is in Local Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the barrier(s) are locked out.

3.7.2.2 If system is in Test Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the barrier(s) are locked out.

3.7.2.2 If system is in EFO Mode, then traffic signal is dark. All controls to operate the barrier(s) are locked out.

3.8 Hybrid Beacon. RETURN TO EFO MODE. When the mode switch is placed in the EFO mode and all the barriers for that direction of travel are Open (not deployed), then the barrier's Traffic Signal change from Red to Dark if it was Red. If a mode switch is placed in the EFO mode and any of the barriers for that direction of travel are Closed, then the barrier's Traffic Signal stays Red (if it was red) and an alarm is generated on the ACP/ECF TROUBLE window on the Gatehouse Control Panel. The in-pavement lights turn off when the traffic signal changes to Dark.

3.9 Vehicle Presence Detector consisting of safety loops on either side of a crash rated active vehicle barrier may require additional programming and hardware. If the loops are more than 3 meters10 feet apart, then add 0.5-1 sec (0.5 sec default) additional time delay on the "back" loop. The alternative is to provide a latching logic between loops. In the latching logic, the master panel needs a release pushbutton for each barrier.

3.10 AUDIBLE ALARMS. Provide an audible alarm at the Master Control Panel, Overwatch Control Panel, [Pedestrian control panel,]main Guard Booth Control Panel and Search Area Control panel(s). The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.10.1 When an EFO is pushed an alarm will go off.

3.10.2 Overspeed and Wrong-way will each cause an alarm to go off for 3 seconds and then clear itself.

3.10.3 Duress activation.

3.10.4 AVB Trouble condition. Alarm happens where there is monitored problem detected that relates to the AVB. Red visual indicator for each electric power unit.

3.10.5 VPD Trouble condition. Alarm happens when there is something wrong with the loop controller or the loops monitored by that controller. Red visual indicator for each loop controller.

3.10.6 VPD Activation for over the set amount of time period (typically 15 seconds) Light goes on immediately for VPD activation, but audible alarm activates after 15 seconds.

3.10.7 Out of Service activation. When a barrier is initially placed in out-of-service, sound an audible alarm for 3 seconds. Open and Close indicator lights are to alternate on/off.

3.10.8 Master Panel in EFO mode and Local Panel is in Local Mode. EFO mode and Local mode indicator lights alternate being on.

3.10.9 Master Panel in Test mode and Local Panel is in Local Mode. Test mode and Local mode indicator lights alternate being on.

3.10.10 Return to EFO mode with an AVB or AVBs in the incorrect position (not fully open). EFO mode indicator light and open/down AVB position light(s) flash.

3.10.11 Communication Loss alarm. If a programmable logic controller loses communication with another programmable logic controller there will be an audible alarm. Red visual indicator.

3.10.12 Tamper switches - Control Panels. Tamper switches located inside each control panel cause an alarm when the cover is opened. Red visual indicator.

3.10.13 Tamper switches - Cabinets. Tamper switches located inside each cabinet cause an alarm when the cover is opened. Red visual indicator.

3.11 LED Blank-Out Sign (when used). The sign is to meet the following:

3.11.1 Symbol conforms to MUTCD or local Host Nation requirements.

3.12 AUDIBLE ALARMS. Operating panels with an audible alarm are to have a means to adjust the volume. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm from sounding if a new condition develops.

3.12.1. AVB Trouble condition.

3.13 AUXILIARY CONTACTS. Provide auxiliary contacts (dry) to be used by the Intrusion Detection System and the CCTV system as specified herein and indicated on the drawings.
]

Appendix A11-RYG-2014 - Conventional Signs and Signals Red/Yellow/Green Active Vehicle Barrier Safety Scheme

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NOTE: This safety scheme is based on SDDCTEA 55-15, 2014. Do Not Use For New Construction. It is intended only for replacement of existing systems that cannot be fully upgraded to the latest corresponding safety scheme. This system allowed the use of Red/Yellow/Green traffic signals or the use of hybrid beacons, but hybrid beacon is now the preferred signal to use. Designer should try to incorporate as much of Appendix A1 as possible when doing the replacement project. Delete if not used in project.

****

Conventional Signs and Signal Safety Scheme Features. Provide the following features for the Conventional (Signs and Signals) Safety Scheme:

****

NOTE: Paragraph 1 can be deleted in its entirety, if the layouts of equipment is shown on the drawings.

****

[1. General Layout Information

1.1 Active Vehicle Barriers in all inbound and outbound lanes. .

1.2b Red/Yellow/Green (RYG). A three light traffic signal with red/yellow/green signals over each inbound and outbound active barrier. Special location may require only posts i.e. no masts. Post mounted requires two posts with each having a traffic signal. Install the signal at the centerline of the AVB. The beacons are to be Light Emitting Diode (LED) type. Mast arm will have a 'Barrier Signal' sign.

1.3 A 610 mm2 foot wide stop line placed 9M30 feet in front of the the active vehicle barrier and the traffic signal is 12 meters40 feet from the near edge of the stop line. Provide a 'Stop Here On Red' sign.

1.4 Double solid white lines between inbound lanes approaching the barriers to prohibit lane changes in front of the barriers.

1.5 Diagonal pavement striping. Provide white crosshatching pavement marking that covers the front and back VPDs.

1.6 Vehicle Presence Detectors (VPDs) located immediately before and immediately after each barrier. VPDs can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence. Induction loops must be diagonal quadrapole loop. A loop crossing multiple lanes is not allowed. The VPD before the AVB starts 610 mm2 feet from the AVB and is 1830 mm6 ft wide by 1830 mm6 ft long.

1.7 Warning Sign and Warning Beacons (wig-wags) (2 Beacons with alternating flashing yellow lights) located 44.2 meters145 feet in front of the barriers. Beacon lamps will be LED.

****
NOTE: Army. First guard booth panel option choose for Army projects. All others, choose the second guard booth option.
****

1.8 One Master Control Panel, [one Guard Booth Control panel plus one Guard Booth EFO button each Guard Booth][one Guard Booth EFO panel], one Overwatch Position Control Panel, one Search Area Control panel per separate search area, [Pedestrian panel,]and a Local Control Panel or panels at each barrier along with all control switches and indicating lights as shown on the Drawings. Locate the Master Control Panel in the Command and Control location for use by the ACP/ECF guards. Locate each Local Control Panel at or near its respective barrier power unit.

1.9 Red flashing in-pavement lights. When required are to be located between the stop line and approach VPD.

****
NOTE: Horn is optional.
****

[1.10 Horn located at the crash-rated active vehicle barriers. Provide the horn with a means to adjust the volume.]
]

****
NOTE: Choose the correct option. The operating panels used Appendix A1 and A11 are the same.
****

2 BARRIER OPERATING CONTROL PANELS.

[Operating panel layouts are found in Army Standard Design drawing package.][Operating panel layouts are found in the contract drawings.]

3 TRAFFIC SIGNAL AND BARRIER CONTROLS.

3.1. Hybrid Beacon. EFO MODE OF OPERATION.

3.1.1 EFO Operation. Under normal operations, all barriers' mode selector switches on the Master Control Panel will be in the EFO position with the key removed and with that key being accessible only by the lead ACP/ECF guard. With the barrier's mode selector switch in the EFO position, EFO is enabled for that direction of travel, but the Open and Close switches for that barrier on the Master Control Panel and the Open and Close switches on that barrier's Local Control Panel are disabled.

3.1.2. Traffic Signal. EFO MODE OF OPERATION. In the EFO mode of operation with the barrier open, the Traffic Signal is Green. Upon activation of an EFO command from any armed EFO, delay barrier emergency closure by 4 seconds. Activate the wig-wag (warning beacons) as soon as EFO is pushed. During the 4 seconds, the Traffic Signals change from Green to Yellow for 3 seconds and then to Red. Activate the in-pavement lights (steady on) and stay red as long as the traffic signal light is red. After an additional one second at Red, energize the barrier's emergency close circuit to close the barrier(s) in emergency fast mode (2 seconds or less) provided that the VPDs immediately in front of and behind the barrier are clear. If either or both VPDs detect a vehicle, then the barrier does not close; however, the the emergency close signal is latched only for those barriers that were in EFO mode at the time of activation. Once both VPDs are clear, the barriers (those in EFO mode) deploy (unless EFO Reset had been activated). [The warning horn sounds for 4 seconds with the setting adjustable in the program.] In addition to any indicating lights required for EFO activation, the system is to be programmed to show steady on red indicating light at all EFOs to indicate an EFO activation; however, the EFO that was activated is to have a flashing indicating light.

****

NOTE: Default is that EFO Reset turns off the wig-wags. This is a good visual to know that EFO Reset took place. If desired, they can stay on after EFO Reset.

****

3.2 Traffic Signal. EFO RESET. After an EFO activation, guards will close all inbound and outbound lanes. Guards will obtain the EFO Reset key and then activate the EFO Reset switch on the Master Control Panel to reset EFO. [This turns off the warning beacons (wig-wags) and removes the latch command for the EFO circuit.][This removes the latch command for the EFO circuit.] The person in charge can then place the Master Control Panel mode switches into Test (or go through the sequence to use the Local panel) and use the Open buttons to lower each barrier. Once all the barriers are Open for a given direction of travel and the corresponding mode switches are back in EFO mode, then the traffic signal for that direction of travel turns Green and the in-pavement lights deactivate. This needs to be done for both directions of travel in order to have Green traffic signals in all directions.

3.3 TEST MODE OF OPERATION.

3.3.1 Test Operation- General. An individual barrier can be test operated by installing the proper lane closure markings and barricades ahead of the active barrier and then placing the mode selector switch for that direction of travel into the Test position. With the mode selector switch in the Test position, the barrier's Open and Close switches on the Master Control Panel for that direction of travel are enabled, but the Open and Close switches on the Local Control Panel for that direction of travel are disabled. In addition all active EFO switches are disabled from operating any barrier for that direction of travel. Where a single barrier spans both inbound and outbound lanes, the test operation switch deactivates all EFO capability.

3.3.2 Traffic Signal. TEST MODE OF OPERATION. When a mode switch is placed in Test mode, the traffic signals for that direction of travel cycle to RED (traffic signal changes from Green to Yellow for 3 seconds and then to Red). The barriers for that direction of travel are allowed to operate without any time delay ONCE the signal is Red. The traffic signals for that direction of travel stay Red until all the conditions are met for RETURN TO EFO MODE. The in-pavement lights for that barrier activate when the traffic signal is red and stay red as long as the traffic signals are red. Note the wig-wag beacons do not operate under Test mode, but can be allowed to operate if requested and approved. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during Test mode operation.

3.4 LOCAL MODE OF OPERATION

3.4.1 Local Operation. Local mode is used when maintenance personnel need to perform maintenance on the barrier.

3.4.1.1 Maintenance personnel would obtain the mode selector switch key from the lead ACP/ECF guard and place the key into the Master Control Panel 3-position mode selector switch for the appropriate direction of travel.

3.4.1.2 The person then turns the selector switch to the Local position to enable Local mode and then removes the key.

3.4.1.3 With the mode selector switch on the Master Control Panel in the Local position, Open and Close switches on the Master Control Panel for the barriers for that direction of travel are disabled and all EFO switches are disabled for that direction of travel. If a single barrier spans multiple directions of travel all EFO capability will be deactivated.

3.4.1.4 The maintenance person would then insert the key into the appropriate Off-Local mode selector switch on the barrier's Local Control Panel and turn the key to the "Local" position. This action activates the Open and Close switches at the Local Control Panel for the barriers in that direction of travel.

3.4.1.5 Maintenance personnel would also have to block and mark the lane ahead of the barrier in accordance with standard lane closure procedures/standards and also lock and tag out certain equipment at the barrier per the barrier manufacturer's recommendations for the type of maintenance to be performed.

****

NOTE: Traffic Signal. First Paragraph applies to final denial barriers that are configured to have only one barrier per direction of travel. This can be a single lane per direction of travel or multiple lanes with one barrier covering all the lanes per direction of travel.

Traffic Signal. Second paragraph applies to final denial barriers that are configured to have multiple barriers for a direction of travel.

****

[3.4.2 Traffic Signal. LOCAL MODE OF OPERATION (one barrier per direction of travel). When a mode switch is placed in either the Local mode, the traffic signals for that direction of travel cycle to RED (traffic signal changes from Green to Yellow for 3 seconds and then to Red). The barriers for that direction of travel are allowed to operate without any time delay ONCE the signal is Red. The traffic signals for that direction of travel stay Red until all the conditions are met for RETURN TO EFO MODE. The in-pavement lights for that barrier activate when the traffic signal is red and stay red as long as the traffic signals are red. Note the wig-wag beacons do not operate under Local mode, but can be allowed to operate if requested and approved. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

][3.4.2 Traffic Signal. LOCAL MODE OF OPERATION (more than one barrier per direction of travel). When a mode switch is placed in Local mode, the traffic signals for that direction of travel DO NOT CHANGE STATE i.e. stays green.

The barriers for that direction of travel are allowed to operate without any time delay. The in-pavement lights for that barrier do not activate. Note the wig-wag beacons do not operate. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier if a long term operation, having guards present, etc) during a Test or Local mode operation.

]3.5 If the Master Control panel is in EFO mode and the Local Panel is in Local mode, that is a conflict. Traffic signal is green and EFO DOES NOT function. Local panel does not have any control. The mode indicating lights for Local and EFO are to alternate flashing and an audible alarm is to sound.

3.6 If the Master Control panel is in Test mode and the Local Panel is in Local mode, that is a conflict. Traffic signal is Red after cycling and all corresponding Test mode functions are INACTIVE. Local panel does not have any control. The mode indicating lights for Test and Local are to alternate flashing and an audible alarm is to sound.

****

NOTE: This is an optional switch function for locations that have only one lane per direction of travel or have one barrier across all the lanes.

If there are multiple lanes per direction of travel with each lane having its own AVB and no lane separation, then provide this switch. Keep or delete as required by the project.

****

3.7 Out-of-Service switch. This function is provided for times when a barrier is damaged in a lane and needs to be taken out of service for an extended period of time. The out of service switch is to be located at the AVB location and is allowed to operate in EFO, Test and Local modes. This allows an AVB to be locked out in a lane, but the other lane can operate under EFO. The switch locks out all functions for the AVB when activated. The up and down lights for that AVB will alternate going on and off. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier, having guards present, etc). The Out-Of-Service switch has two positions: Yes and No [contractor is allowed to use Enable and Disable, but it must be clear].

3.7.1 No Position. All controls operate normally.

3.7.2 Yes Position. The Close/ Open position indicating lights for those barriers will alternate from one to the other approximately every 1 sec. This will happen at the Master Control Panel, Local Control Panel (if on) and at any other panel that has barrier position indicator lights.

3.7.2.1 If Local Panel is in Local Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the barrier(s) are locked out.

3.7.2.2 If system is in Test Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the barrier(s) are locked out.

3.7.2.2 If system is in EFO Mode, then traffic signal is dark. All controls to operate the barrier(s) are locked out.

3.8. Traffic Signal. RETURN TO EFO MODE. When the mode switch is placed in the EFO mode and all the barriers for that direction of travel are Open (not deployed), then the barrier's Traffic Signal change from Red to Green, if it was Red. If a mode switch is placed in the EFO mode and any of the barriers for that direction of travel are Closed, then the barrier's Traffic Signal stays Red (if it was red) and an alarm is generated on the ACP/ECF TROUBLE window on the Gatehouse Control Panel. The in-pavement lights turn off when the traffic signal changes to Green.

3.9 Vehicle Presence Detector consisting of safety loops on either side of a crash rated active vehicle barrier may require additional programming and hardware. If the loops are more than 3 meters10 feet apart, then add 0.5-1 sec (0.5 sec default) additional time delay on the "back" loop. The alternative is to provide a latching logic between loops. In the latching logic, the master panel needs a release pushbutton for each barrier.

3.10 AUDIBLE ALARMS. Provide an audible alarm at the Master Control Panel, Overwatch Control Panel, [Pedestrian control panel,]main Guard Booth Control Panel and Search Area Control panel(s). The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.10.1 When an EFO is pushed an alarm will go off.

3.10.2 Overspeed and Wrong-way will each cause an alarm to go off for 3 seconds and then clear itself.

3.10.3 Duress activation.

3.10.4 AVB Trouble condition. Alarm happens where there is monitored problem detected that relates to the AVB. Red visual indicator for each electric power unit.

3.10.5 VPD Trouble condition. Alarm happens when there is something wrong with the loop controller or the loops monitored by that controller. Red visual indicator for each loop controller.

3.10.6 VPD Activation for over the set amount of time period (typically 15 seconds) Light goes on immediately for VPD activation, but audible alarm activates after 15 seconds.

3.10.7 Out of Service activation. When a barrier is initially placed in out-of-service, sound an audible alarm for 3 seconds. Open and Close indicator lights are to alternate on/off.

3.10.8 Master Panel in EFO mode and Local Panel is in Local Mode. EFO mode and Local mode indicator lights alternate being on.

3.10.9 Master Panel in Test mode and Local Panel is in Local Mode. Test mode and Local mode indicator lights alternate being on.

3.10.10 Return to EFO mode with an AVB or AVBs in the incorrect position (not fully open). EFO mode indicator light and open/down AVB position light(s) flash.

3.10.11 Communication Loss alarm. If a programmable logic controller loses communication with another programmable logic controller there will be an audible alarm. Red visual indicator.

3.10.12 Tamper switches - Control Panels. Tamper switches located inside each control panel cause an alarm when the cover is opened. Red visual indicator.

3.10.13 Tamper switches - Cabinets. Tamper switches located inside each cabinet cause an alarm when the cover is opened. Red visual indicator.

3.11 LED Blank-Out Sign (when used). The sign is to meet the following:

3.11.1 Symbol conforms to MUTCD or local Host Nation requirements.

3.12 AUDIBLE ALARMS. Operating panels with an audible alarm are to have a means to adjust the volume. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm from sounding if a new condition develops.

3.12.1. AVB Trouble condition.

3.13 AUXILIARY CONTACTS

Provide auxiliary contacts (dry) to be used by the Intrusion Detection System and the CCTV system as specified herein and indicated on the drawings.

Appendix A12-2015 - High Efficiency Presence Detection (HEPD) Active Vehicle Barrier Safety Scheme

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NOTE: This safety scheme is based on SDDCTEA 55-15, 2014 with interim guidance for HEPD dated 2015. Do Not Use For New Construction. It is intended only for replacement of existing systems that cannot be fully upgraded to the latest corresponding safety scheme. Besides layout differences, the main difference for the controls are that this older system allowed a Normally Open operation and also used a dual phenomenology with loops and beam detectors. Designer should try to incorporate as much of Appendix A2 as possible when doing the replacement project. Delete if not used in project.

****

HIGH EFFICIENCY PRESENCE DETECTION (HEPD) SAFETY SCHEME FEATURES. Provide the following features for the HEPD Safety Scheme:

NOTE: Paragraph 1 can be deleted in its entirety, if the layouts of equipment is shown on the drawings.

****

[1 HIGH EFFICIENCY PRESENCE DETECTION (HEPD) SAFETY SCHEME FEATURES. Provide the following features for the HEPD Safety Scheme:

1.1 One Active Vehicle Barrier at the end of the Response Zone in each inbound and each outbound lane.

1.2 Dual phenomenology vehicle presence detectors (VPDs) located in front of and across the Stop Line (detectors 1a and 1b), between the Stop Line and the barrier (detectors 2a and 2b), and immediately after the barrier (detectors 3a and 3b). **Loops are 1a, 2a and 3a and the technology are to be diagonal quadrapole.** Presence detectors 1b, 2b and 3b can be IR Break Beams, video motion sensors, or other suitable technologies capable of sensing vehicle presence with a lag time of 0.5 seconds or less.

1.2.1 Stop Line Loop/Beam. Provide a vehicle presence detector (VPD) that starts 1830 mm6 ft ahead of the stop line and goes across the stop line that is 1830 mm6 ft wide by 7.3 meters24 ft long. Center the beam over the loop that is before the stop line.

1.2.2 Threat Loop/Beam. Provide entry VPD that is between the stop line and AVB and starts 610 mm2 ft from the AVB that is 6 meters20 ft long and 1830 mm6 ft wide. This second VPD starts 610 mm2 ft from the AVB. Center the beam over the loop.

1.2.3. Secure Loop/Beam. There is a third VPD is after the AVB and it is 1830 mm6 ft by 1830 mm6 ft and starts 610 mm2 ft the AVB. All VPDs, if loops, are to be quadrapole. Center the beam over the loop.

1.3 Passive barriers on raised islands between each lane. Passive barriers and islands extend at least 7.6 meters25 ft from just ahead of the Stop Line to at least 1520 mm5 ft beyond the trailing edge of the range of VPDs 3a and 3b for inbound and outbound lanes.   Passive barriers must be placed to ensure that a vehicle cannot do a reverse slip. A reverse slip is where a vehicle passes over the barrier after a vehicle passes (slips in behind going opposite direction). See Drawings.

1.4 Passive barrier on a raised median island between the inner most inbound and outbound lanes. Passive barriers and median extend at least 7.6 meters25 ft from just ahead of the Stop Line for the adjacent inbound lane and for the adjacent outbound lane. In some cases it may be valuable to move the outbound AVB closer to the ID check area and utilize barrier up (closed) operation. For this scenario, the raised median separating the inbound and outbound AVB's is of sufficient length to prevent wrong-way entry while a vehicle exits. This length is to be equal to, or exceeding, the distance traveled by the exiting vehicle at the posted speed limit until the barrier is securely closed. A passive barrier is to be extended between AVB's to prevent bypassing the system. See Drawings.

1.5 Traffic Signals and associated signage.

1.5.1 Locations with a single inbound lane and a single outbound lane are to be configured as follows. Provide a post on the driver side and passenger side of the lane. As a minimum the post is to have a three-head Traffic Signal and a LED blank-out sign. Provide a traffic signal that is Red-Yellow-Green top to bottom. The Traffic Signal is to be located at the front edge of the crash rated active vehicle barrier. Bottom of the signal must be 8 ft above finished surface. The LED blank-out sign that states "DO NOT ENTER" and is to be mounted below the traffic signal. See Drawings.

1.5.2 Locations with two or more lanes in the same direction are to have the following. Provide a post on the driver side and passenger side of the lane. As a minimum the post is to have a three-head Traffic Signal and a LED blank-out sign and a sign that indicates which lane the signal is belongs. Provide a traffic signal that is Red-Yellow-Green top to bottom. The Traffic Signal is to be located at the front edge of the crash rated active vehicle barrier. Bottom of the signal must be 8 ft above finished surface. The LED blank-out sign states "DO NOT ENTER" and is mounted below the traffic signal. The sign on the other post states "LEFT LANE SIGNAL" OR "RIGHT LANE SIGNAL" as appropriate. The outside lane has the LED blank-out sign on the passenger side post. The lane next to the median has the LED blank-out sign on the driver side post. See Drawings.

1.6 A 2 foot wide Stop Line placed 10 meters33 ft in front of the crash rated active vehicle barrier as a driver normally approaches the barrier. Provide a 'Stop Here On Red' sign.

1.7 Actuated Traffic Arm 610 mm2 ft beyond the back edge of the Stop Line

1.8 Warning Sign and Warning Beacons (wig-wags) (2 Beacons with alternating flashing yellow lights) located xxx feet in front of the barriers. "xxx" indicates the distance to the barrier, which is typically between 39.6 meters 130 ft and 45.7 meters150 ft. Beacon lamps will be LED.

1.9 Horn located at the crash-rated active vehicle barriers. Provide the horn with a means to adjust the volume.

****

NOTE: Army. First guard booth option chose for Army projects. All others, chose the second guard

booth option.

****

1.10 One Master Control Panel, [one Guard Booth Control panel plus one smaller panel for each Guard Booth][one Guard Booth EFO Control Button], one Overwatch Position Control Panel, one Search Area Control panel for each Search Area, and a Local Control Panel for each barrier along with all control switches and indicating lights as shown on the Drawings. The Master Control Panel will be located in the designated Command & Control which typically is in the Gatehouse for use by the ACP/ECF guards. Each Local Control Panel for an individual barrier is to be located locally at or near its respective barrier. If there are multiple barriers, the local control panels can be combined, if there is a clear visual line of site between the local control panel an all barriers.

1.11 Actuated Traffic Arm for each inbound lane in the ID Check Area. ATAs are installed near the Guard Booths as shown on the Drawings. An ATA Control Panel with Open and Close control switches for the ATA are provided and mounted on the back wall of the Guard Booth below the back window. If the installation plans on getting Automatic Installation Entry, then just provide infrastructure for the future installation of the ATAs.

1.12 Red flashing in-pavement lights. Where required are to be located between the stop line VPD and the approach VPD.

1.13 Diagonal pavement striping. Provide white crosshatching pavement marking that covers the front and back VPDs. Do not stripe the stop line VPD.

1.14 LED blankout sign that indicates 'Do Not Enter' installed at the barrier. Two per direction of travel by placing one on each side of the roadway on the traffic signal post.
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NOTE: Choose the correct option. The operating panels used Appendix A2 do not match the operating panels used for A12-2015. A12-2015 needs a four position mode switch and additional indicators for the beams.

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2 BARRIER OPERATING CONTROL PANELS.

[Operating panel layouts are found in Army Standard Design drawing package.][Operating panel layouts are found in the contract drawings.]

3 TRAFFIC SIGNAL AND BARRIER CONTROLS.

3.1 EFO MODE ACTIVATION. The following descriptions assume that the safety VPDs (those located adjacent to the AVB) are clear. A vehicle on the stop line VPD does not impact AVB movement under EFO. If the VPDs are not clear then the AVB deployment is delayed until all safety VPDs are clear. EFO Operation. Under normal operations, all lane mode selector switches on the Master Control Panel will be in the EFO position with the key removed and accessible only by the lead ACP/ECF guard. With the barrier's mode selector switch in the EFO position, EFO is enabled for that lane, but the Open and Close switches for that lane on the Master Control Panel and the Open and Close switches on that barrier's Local Control Panel is disabled. In addition to any indicating lights required for EFO activation, the system is to be programmed to show steady on red indicating light at all EFOs to indicate an EFO activation; however, the EFO that was activated is to have a flashing indicating light.

3.1.1 EFO Mode of Operation with Active Vehicle Barrier (AVB) Up (Closed).

3.1.1.1 Initial State
a. AVB is UP (Closed)
b. VPDs do not have to be clear since the AVB is already in the closed position.
c. Traffic Arm is Down (Closed).
d. Traffic Signals for that lane are Red.
e. Warning beacons (wig-wags) and LED 'Do Not Enter' Blank-out signs area off.

3.1.1.2 EFO is Pushed.
   a. Warning beacons (wig-wags) and LED Blank-out signs activate immediately.
   b. Horn activates for 10 seconds.
   c. AVB remains in the deployed position until EFO Reset is accomplished.

3.1.2 EFO Mode of Operation with Active Vehicle Barrier (AVB) Down (Open).

3.1.2.1 Initial State
a. AVB is Down (Open).
b. Traffic Arm is Down (Closed).
c. Traffic Signals for that lane are Red.
d. Warning beacons (wig-wags) and LED Blank-out signs area off.

3.1.2.2 EFO is Pushed.
a. Warning beacons (wig-wags) and LED Blank-out signs activate immediately.
b. Lane horn(s) is activated for 10 seconds.
c. AVB is deployed. AVB is fully Up (Closed) within 2 seconds (t=2). EFO is not to be interrupted by any position limit switch for the Actuated Traffic Arm.
d. AVB remains in the deployed position until EFO reset is accomplished.

3.1.3 EFO Mode of Operation while Active Vehicle Barrier (AVB) is Down (Open) While Processing Traffic.

3.1.3.1 Initial State
a. AVB is Down (Open).
b. Traffic Arm is Up (Open).
c. Traffic Signals for that lane are green i.e. in Normal Operation.
d. Warning beacons (wig-wags) and LED Blank-out signs area off.

3.1.3.2 EFO is Pushed.
a. Warning beacons (wig-wags) and LED Blank-out signs activate immediately.
b. Lane horn(s) is activated for 10 seconds.
c. Traffic Signal if Green will go to Yellow for 2 seconds (t=2).
d. Traffic Signal will go to Red (t=2).
e. Traffic Arm begins to go Down (Close) as soon as VPD 1a and 1b are clear. Traffic Arm is fully Down (Closed) after 2 seconds.   EFO is not to be interrupted by any position limit switch for the Actuated Traffic Arm.
f. Once Traffic Arm is fully Down (Closed), then AVB is deployed. AVB is to be fully Up (Closed) within 2 seconds.
g. AVB remains in the deployed position until EFO reset is accomplished.

3.2 Normal Operation - AVB UP EFO Mode

3.2.1.1 Initial State

a. AVB is Up (Closed).
b. Traffic Arm is Down (Closed).
c. Traffic Signals for that lane are Red.
d. Warning beacons (wig-wags) and LED Blank-out signs area Off.

3.2.1.2 Vehicle Stops is detected by stop line VPD.

a. Once vehicle detected, AVB is to start Down (Open) after a 1 second delay (t=1).

b. AVB is fully Down (Open) after 2 more seconds (t=3).

c. Once AVB is Down (Open), Traffic Arm is to start Up (Open).

b. Traffic Arm is fully Up (Open) after 2 more seconds (t=5).

c. Traffic signal changes to Green (t=5).

d. A timer is started once stop line VPD is cleared. The timer is set for 3 seconds.

(1). If stop line VPD is clear for the 3 seconds then the Traffic Signal is to change to Yellow (t=8).

(a). Traffic Signal is Yellow for 3 seconds (t=11). Once signal changes to Yellow, the system is to complete the following steps prior to processing other vehicles, even if a vehicle is detected by the stop line VPD.

(b). Traffic Signal changes to Red.

(c) Traffic Arm begins Down (Close).

(d) Traffic Arm is fully Down (Closed) after 2 seconds (t=13).

(e) Once Traffic Arm is fully Down (Closed), AVB is to start Up (Close).

(f) AVB is to be fully Up (Closed) within 2 seconds (t-15).

(2). If the stop line VPD detects a vehicle before 3 seconds elapse, then the Traffic Signal is to stay Green and the Traffic Arm stay Up (Open). The three second timer resets to each time the loop is cleared.

3.3 Normal Operation - EFO AVB Down (Open)

3.3.1.1 Initial State
a. AVB is Down (Open).
b. Traffic Arm is Down (Closed).
c. Traffic Signals for that lane are Red.
d. Wig-wags and LED Blank-out signs area off.

3.3.1.2 Vehicle Stops is detected by VPDs 1a and 1b.

a. Once vehicle detected, Traffic Arm starts Up (Open) after a 1 second delay (t=1).

b. Traffic Arm is fully Up (Open) after 2 more seconds (t=3).

c. Traffic signal changes to Green (t=3).

d. A timer is started once VPDs 1a and 1b are cleared. The timer is set for 3 seconds.

(1). If VPDs 1a and 1b stay clear for the 3 seconds then the Traffic Signal changes to Yellow (t=6).

(a). Traffic Signal is Yellow for 3 seconds (t=9). Once signal changes to Yellow, the system completes the following steps prior to processing other vehicles, even if a vehicle is detected by VPDs 1a and 1b.

(b). Traffic Signal changes to Red.

(c) Traffic Arm begins Down (Close).

(d) Traffic Arm is fully Down (Closed) after 2 seconds (t=11).

(2). If VPDs 1a and 1b detect a vehicle a vehicle before 3 seconds elapse, then the Traffic Signal stays Green and the Traffic Arm stay Up (Open). The three second timer resets to each time the loop is cleared.

****

NOTE: Default is that EFO Reset turns off the wig-wags. This is a good visual to know that EFO

Reset took place. If desired, they can stay on after EFO Reset.
****

3.4 EFO RESET. After an EFO activation, all EFO activated barriers cannot be operated until an EFO Reset is accomplished. The guards will close all inbound and outbound lanes. Guards will obtain the EFO Reset key and then activate the EFO Reset switch on the Master Control Panel to reset EFO. [This turns off the warning beacons (wig-wags) and removes the latch command for the EFO circuit.][This removes the latch command for the EFO circuit.] The person in charge can then place the Master Control Panel mode switches into Test (or go through the sequence to use the Local panel) and use the Open buttons to lower each barrier.

3.5 TEST MODE OF OPERATION.

3.5.1 When a barrier's mode switch is placed in Test mode the following is to happen. An individual barrier and traffic arm can be test operated by installing the proper lane closure markings and barricades ahead of the active barrier and then placing the mode selector switch for that direction AVB into the Test position. With the mode selector switch in the Test position, the barrier's and traffic arm's Open and Close switches on the Master Control Panel for that AVB is enabled, but the Open and Close switches on the Local Control Panel for that AVB are disabled. In addition all active EFO activations disabled from operating that barrier.

3.5.2 Test Mode Sequence of Operation

3.5.2.1 Initial State
a. Traffic Arm is Down (Closed).
b. Traffic Signals for that lane are Red. Note signals do not cycle through yellow before changing to red.
c. warning beacons (wig-wags) and LED Blank-out signs area off.
d. AVB can either be Up (Closed) or Down (Open).

3.5.2.2 Switch is placed in Test
a. The operator must ensure that the lane that the barrier is in is properly blocked and marked prior to placing the switch into Test or Local mode. This is to comply with MUTCD or Host Nation Criteria.
b. Switch must be in either Test or Local mode for 1 second.
c. Blocks EFO operation for that lane.
d. Horn sounds for 4 seconds or not at all .
e. LED blankout signs activate.
f. Warning beacons do not activate.

3.5.2.3 Initial State
a. AVB is Down (Open).
b. Traffic Arm is Up (Open).
c. Traffic Signals for that lane is Green.
d. warning beacons (wig-wags) and LED Blank-out signs area off.

3.5.2.4 Switch is placed in Test or Local Mode.
a. The operator must ensure that the lane that the barrier is in is properly blocked and marked prior to placing the switch into Test or Local Mode. This is to comply with MUTCD or Host Nation Criteria.
b. Blocks EFO operation for that lane.
c. Traffic Signal changes from green to yellow for 2 seconds then red.
d. Horn sounds for 4 seconds or not at all.
e. LED blankout signs activate.

f. Warning beacons do not activate.

3.6 LOCAL MODE OF OPERATION.

3.6.1 Local Operation. Local mode is used when maintenance personnel need to perform maintenance on the barrier.

3.6.1.1 Maintenance personnel would obtain the mode selector switch key from the lead ACP/ECF guard and place the key into the Master Control Panel 3-position mode selector switch for the appropriate AVB.

3.6.1.2 The person then turns the selector switch to the Local position and remove the key.

3.6.1.3 With the mode selector switch on the Master Control Panel in the Local position, Open and Close switches on the Master Control Panel for that barrier and actuated traffic arm is disabled and all EFO activations disabled for that AVB. Local mode operation is enabled.

3.6.1.4 The maintenance person would then insert the key into the appropriate Off-Local mode selector switch on the barrier's Local Control Panel and turn the key to the "Local" position. This action activates the Open and Close switches at the Local Control Panel for that barrier and actuated traffic arm.

3.6.1.5 Maintenance personnel would also have to block and mark the lane ahead of the barrier in accordance with standard lane closure procedures/standards and also lock and tag out certain equipment at the barrier per the barrier manufacturer's recommendations for the type of maintenance to be performed.

3.6.2 Local Mode Sequence of Operation.

3.6.2.1 Initial State
a. Traffic Arm is Down (Closed).
b. Traffic Signals for that lane are Red. Note signals do not cycle through yellow before changing to red.
c. warning beacons (wig-wags) and LED Blank-out signs area off.
d. AVB can either be Up (Closed) or Down (Open).

3.6.2.2 Switch is placed in Local Mode
a. The operator must ensure that the lane that the barrier is in is properly blocked and marked prior to placing the switch into Test or Local mode. This is to comply with MUTCD or Host Nation Criteria.
b. Switch must be in either Test or Local mode for 1 second.
c. Blocks EFO operation for that lane.
d. Horn does not sound.
e. LED blankout signs activate.
f. Warning beacons do not activate.

3.6.2.3 Initial State
a. AVB is Down (Open).
b. Traffic Arm is Up (Open).
c. Traffic Signals for that lane is Green.
d. warning beacons (wig-wags) and LED Blank-out signs area off.

3.6.2.4 Switch is placed in Local Mode.
a. The operator must ensure that the lane that the barrier is in is properly blocked and marked prior to placing the switch into Test or Local Mode. This

is to comply with MUTCD or Host Nation Criteria.
b. Blocks EFO operation for that lane.
c. Traffic Signal changes from green to yellow for 2 seconds then red.
d. Horn does not sound.
e. LED blankout signs activate.
f. Warning beacons do not activate.

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NOTE: This switch is optional. Verify with customer if desired.

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[3.7 Out-of-Service switch. Provide one per direction of travel. This function is provided for times when a barrier is damaged in a lane and needs to be taken out of service for an extended period of time. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier, having guards present, etc). The switch is located at the Local panel but can function at anytime. The Out-Of-Service switch has two positions: Yes and No or the wording Enable and Disable is allowed..

3.7.1 No Position. All controls operate normally.

3.7.2 Yes Position. The Close/ Open position indicating lights for those barriers will alternate from one to the other approximately every 1 sec. This will happen at the Master Control Panel, Local Control Panel (if on) and at any other panel that has barrier position indicator lights.

3.7.2.1 If Local Panel is in Local Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the barrier(s) are locked out.
3.7.2.2 If system is in Test Mode, then traffic signal is red and in-pavement lights are on. All controls to operate the barrier(s) are locked out.

3.7.2.3 If system is in EFO Mode, then traffic signal is green. All controls to operate the barrier(s) are locked out.

]3.8 RETURN TO AN EFO MODE. The traffic arm is to be down, AVB is up, and the traffic signal is to be red. When the operator places the mode switch into EFO mode, the system is to wait 1 second and then check the position of the traffic arm and the AVB. If either the traffic arm or the AVB are not in the correct position or both are not in the correct position, then the EFO Mode indicating light is to flash and an audible alarm activates. The audible alarm is on for 1 second and then off for 2 seconds. The audible alarm continues in this manner until the equipment is either put in the correct position or the alarm silence is pushed.

3.9 VPDs.

3.9.1 Stop Line VPD. This vehicle presence detection device is used to notify the system when a vehicle is in position to be processed through the lane.

3.9.2. Safety VPDs. These vehicle presence detection devices are used to notify the system when a vehicle is traversing the AVB and it will suppress the AVB from going Up (Close) or Down (Open).
These VPDs must be clear before the AVB is allowed to deploy.

3.9.3. When a VPD is activated for 15 seconds or more, an audible/visual alarm indicating light activates for that lane.

3.9.4. Vehicle Presence Detector consisting of safety loops on either side of a crash rated active vehicle barrier may require additional programming and hardware. If the loops are more than 10 ft (3 meters) apart, then add 0.5-1 sec additional time delay on the "back" loop. The alternative is to provide a latching logic between loops. In the latching logic, the master panel needs a release pushbutton for each barrier.

3.10 Lane Horn. The horn activates under EFO. An adjustable timer is to be set at 10 seconds.

3.11 Actuated Traffic Arm. The Traffic Arm is to have an edge sensor or a torque motor sensor to stop it from continuing to close on a vehicle. When the sensor impacts an object it stops motion and reverses to the Up (Open) position. Loops or break beams are not allowed for this operation. The stop line VPD is to prevent the traffic arm from closing until the VPD is cleared.

3.12 AUDIBLE ALARMS. Provide an audible alarm at the Master Control Panel, Overwatch Control Panel, main Guard Booth Control Panel, Pedestrian Booth, and Search Area Control panel(s). The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.12.1. When an EFO is pushed an alarm will go off for 10 seconds unless silenced earlier.

3.12.2. Overspeed and Wrong-way will cause an alarm to go off for 3 seconds and then clear itself.

3.12.3. Duress activation.

3.12.4 AVB Trouble condition. Alarm happens where there is monitored problem detected that relates to the AVB. Red visual indicator for each electric power unit.

3.12.5 VPD Trouble condition. Alarm happens when there is something wrong with the loop controller or the loops monitored by that controller. Red visual indicator for each loop controller.

3.12.6 VPD Activation for over the set amount of time period (typically 15 seconds) Light goes on immediately for VPD activation, but audible alarm activates after 15 seconds.

3.12.7 Out of Service activation. When a barrier is initially placed in out-of-service, sound an audible alarm for 3 seconds. Open and Close indicator lights are to alternate on/off.

3.12.8 Master Panel in EFO mode and Local Panel is in Local Mode. EFO mode and Local mode indicator lights alternate being on.

3.12.9 Master Panel in Test mode and Local Panel is in Local Mode. Test mode and Local mode indicator lights alternate being on.

3.12.10 Return to EFO mode with an AVB or AVBs in the incorrect position (not fully open). EFO mode indicator light and open/down AVB position light(s) flash.

3.12.11 Communication Loss alarm. If a programmable logic controller loses communication with another programmable logic controller there will be an audible alarm. Red visual indicator.

3.12.12 Tamper switches - Control Panels. Tamper switches located inside each control panel cause an alarm when the cover is opened. Red visual indicator.

3.12.13 Tamper switches - Cabinets. Tamper switches located inside each cabinet cause an alarm when the cover is opened. Red visual indicator.

3.13 LED Blank-Out Sign. The sign is to meet the following:

3.13.1 Symbol conforms to MUTCD or local Host Nation requirements.

3.14 AUDIBLE ALARMS. Provide an audible alarm at the Local Control Panel. The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.14.1. AVB Trouble condition.

3.15 AUXILIARY CONTACTS

Provide auxiliary contacts (dry) to be used by the Intrusion Detection System and the CCTV system as specified herein and indicated on the drawings.

Appendix A13-2014 - BARRIER-UP (Sally Port or Platooning) Active Vehicle Barrier Safety Scheme

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NOTE: This safety scheme is based on SDDCTEA 55-15, 2014. Do Not Use For New Construction. It is intended only for replacement of existing systems that cannot be fully upgraded to the latest corresponding safety scheme. This system did not require a traffic arm (optional only) nor a stop line loop. Designer should try to incorporate as much of Appendix A3 as possible when doing the replacement project. Delete if not used in project.

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BARRIER-UP (Sally Port or Platooning)SAFETY SCHEME FEATURES. Provide the following features for the full containment Safety Scheme:

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NOTE: Paragraph 1 can be deleted in its entirety, if the layouts of equipment is shown on the drawings.

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[1 General equipment layout information.

1.1 One or more sets of Active Vehicle Barriers in the inbound and outbound lane or lanes. Each set of barriers consists of an initial and final barrier(s) separated by a selected distance to form an entrapment area, in which either the initial barrier(s) or final barrier(s) is always closed.

1.2 Passive barrier on a raised island separating the inbound entrapment area from the outbound entrapment area to prevent vehicle crossover.

1.3 Passive barriers along the ACP/ECF corridor to contain vehicles within the corridor.

1.4 One three-light Traffic Signal located on each side of each crash rated active vehicle barrier (or roadway if there is more than one barrier across the roadway) as shown on the Drawings. Provide three lights in each Traffic Signal with a light configuration of Red-Yellow-Green top to bottom.

1.5 A 610 mm2 foot wide stop line placed 4.3 meters14 feet (AVB to nearest line edge) in front of each barrier(s) as a driver normally approaches the barrier(s). Provide a 'Stop Here On Red' sign at the stop line on each side of the roadway.

1.6 Vehicle presence detectors located immediately before and immediately after each barrier. Presence detectors can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence. Induction loops must be diagonal quadrapole loop and sized per lane i.e. a loop crossing multiple lanes is not allowed.

1.7 Threat loop located between the stop line and the AVB is 1830 mm6 ft by 1830 mm6 ft and is 610 mm2 ft from the AVB. The secure loop is 1220 mm4 ft by 1830 mm6 ft wide and is 610 mm2 ft from the AVB.Presence detectors can be induction loops, video motion sensors, or other suitable technologies capable of sensing vehicle presence.

1.7 One Master Control Panel, one Guard Booth Control panel for each Guard Booth, and one Overwatch Panel along with all control switches and indicating lights as shown on the Drawings. The Master Control Panel is normally located in the Command and Control for use by the lead ACP/ECF guard.

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NOTE: Army. First guard booth option choose for Army projects. All others, choose the second guard booth option.

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1.8 One Master Control Panel, [one Guard Booth Control panel plus one Guard Booth EFO button each Guard Booth][one Guard Booth EFO panel], one Overwatch Position Control Panel, one Search Area Control panel per separate search area, [Pedestrian panel,]and a Local Control Panel or panels at each barrier along with all control switches and indicating lights as shown on the Drawings. Locate the Master Control Panel in the Command and Control location for use by the ACP/ECF guards. Locate each Local Control Panel at or near its respective barrier power unit.

1.9 Diagonal pavement striping. Provide white cross hatching pavement marking that covers the front and back VPDs. Do not stripe the stop line VPD.

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NOTE: Stop line traffic arm is optional. It is recommended to provide since it help provide another visual indicator.

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[1.10 Provide an Actuated Traffic Arm for each lane. Install ATAs 610 mm2 ft from the backside of the stop line.

][1.11 Provide an Actuated Traffic Arm (ATA) for each inbound lane in the ID Check Area. ATAs are to be installed near the Guard Booths as shown on the Drawings. Provide an ATA Control Panel with Open and Close control switches for the ATA and mount in the Guard Booth.
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NOTE: Choose the appropriate option. Note that the only difference to the operating panel between A3 and A13-2014 is the stop line VPD indicator. A3 requires it.

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2 BARRIER OPERATING CONTROL PANELS.

[Operating panel layouts are found in Army Standard Design drawing package.][Operating panel layouts are found in the contract drawings.]

3 TRAFFIC SIGNAL AND BARRIER CONTROLS.

3.1 BARRIER LAYOUT AND DESIGNATIONS. Arrange each inbound and outbound lane to have two barriers per lane arranged in to entrap a vehicle or vehicles between them. Design the space between barriers to be long enough for the longest vehicle anticipated for the ACP/ECF. The space may be made longer to accommodate multiple vehicles in a platooning type arrangement. The initial barrier from the perspective of innocent motorists is designated 1, and the final barrier is designated 2 for inbound lanes. The initial barrier, again from the perspective of the innocent motorists leaving the installation, is designated 1, and the final barrier is designated 2 for outbound lanes.

3.2 AUTO MODE OF OPERATION.

3.2.1 Auto Operation. In the Auto mode of the Inbound Barriers' mode selector switch, the Close and Open switches on the Control Panel are deactivated for the inbound barriers and the Fill and Release switches on the Master Control panel are activated for the inbound barriers. Guard Booth Panels and Overwatch Panel are activated for the inbound barriers, but only if the arm/disarm switch for the given panel is in the armed position. The above requirements also apply to the control switches and control logic for the outbound barriers.

3.2.2 Initially with no vehicles present in the inbound lanes and the Inbound Barriers' Manual - Auto - Local mode selector switch in the Auto mode, Barrier 1 is open and Barrier 2 is closed. Incoming vehicles are checked at the ID Check point and if cleared are allowed to pass over Barrier 1 and proceed to the Stop Line for Barrier 2. The guard at either the Gatehouse or the Guard Booth then activates the Inbound Release switch. Upon activation of the Inbound Release switch, the Traffic Signal for Barrier 1 goes from Green to Yellow for three seconds and then to Red. After an additional second of Red, Barrier 1's close circuit is energized to close the barrier and traffic arm if present. After Barrier 1 is fully closed, Barrier 2's open circuit is energized to open Barrier 2. When Barrier 2 is fully open, its Traffic Signal changes from Red to Green to allow the vehicle or vehicles to proceed onto the Installation. If traffic arms are provided at the Stop Line, then the traffic arm associated with Barrier 1 will close first followed by closing Barrier 1. The traffic arm associated with Barrier 2 will have the barrier open first and then the traffic arm will open. In both cases, the traffic signal does not change to Green unless both the traffic arm and crash rated active vehicle barrier are fully open.

3.2.3 When the vehicle or vehicles between Barriers 1 and 2 have passed over Barrier 2, the guard activates the Inbound Fill switch. Upon activation of the Inbound Fill switch, the Traffic Signal for Barrier 2 changes from Green to Yellow for 3 seconds and then to Red. After an additional 1 second at Red, Barrier 2's close circuit is energized to close Barrier 2. After Barrier 2 is fully closed, the open circuit for Barrier 1 is energized to open Barrier 1. After Barrier 1 is fully open, its Traffic Signal changes from Red to Green. If there is a traffic arm associated with Barrier 2, the traffic arm closes once the signal is Red, then once fully closed, then Barrier 2 closes. If there is a traffic arm associated with Barrier 1, then Barrier 1 will open first, followed by the traffic arm. Once both are open then the signal changes to Green.

3.2.4 The same controls apply to Barriers 1 and 2 in the outbound lanes and control switches Outbound Release and Outbound Fill.

3.2.5 Supervise the close circuit for all barriers by the Vehicle Presence Detectors (VPD's) in front of and behind the barrier, such that if either VPD detects a vehicle, the barrier close circuit is suppressed. The open circuit is not impacted by a VPD being activated.

3.2.6 A green indicating light adjacent to each Fill switch illuminates when the lane barriers are moving to the Fill position from the barriers being in the Release position. The indicating light is only on while the barriers (and actuated traffic arms) are moving to the proper position. Once in the Fill position the indicating light goes off. Similarly, there is a green indicating light adjacent to each Release switch that lights when the lane barriers are moving to the Release position from the barriers being in the Fill position. The indicating light is only on while the barriers (and actuated traffic arms) are moving to the proper position. Once in the Release position the indicating light goes off.

3.2.7 Red indicating lights are provided to indicate when the barriers (and actuated traffic arms) are in the Fill or Release positions.

3.3 MANUAL MODE OF OPERATION.

3.3.1 In the Manual mode of the Inbound Barriers' mode selector switch, the Close and Open switches on the Master Control Panel are activated for the inbound barriers, but the Fill and Release switches on the Master, Guard Booth Control Panels, and Overwatch Panel are deactivated for inbound barriers. The above requirements also apply to the control switches and control logic for the outbound barriers. The AVB and traffic arm in manual mode can be operated independently. Warning: In this mode it is possible to have the traffic arms and AVBs all in the option position.

3.3.1 When the Inbound Barriers Manual - Auto - Local mode switch is placed in the Manual mode, the inbound barriers can now be controlled by the individual barrier Open and Close switches on the Master Control Panel. Initiation of a Close command to an open barrier causes that barrier's Traffic Signal to change from Green to Yellow for 3 seconds and then to Red. After an additional one second of Red, the barrier's close circuit is energized through the VPD's immediately in front of and behind the barrier. If the VPD's are clear, the barrier closes. Initiation of an Open command to a closed barrier energizes the open circuit for the barrier and open the barrier. After the barrier is fully open and the mode switch is placed in Auto mode, then the Traffic Signal changes from Red to Green. In the Manual mode, both initial and final barriers in a given entrapment area can be opened. Situations requiring this configuration include passing a vehicle that is longer than the entrapment area. In such situations, guards must provide compensatory security measures to defeat a threat while both barriers are open. If there is a traffic arm associated with a barrier, the traffic arm is to close first and open last when compared to the barrier movement. Manual mode does not allow manual operation of the barrier and the traffic arm separately from each other.

3.3.2 The close circuit for all barriers is supervised by the Vehicle Presence Detectors (VPD's) in front of and behind the barrier, such that if either VPD detects a vehicle, the barrier close circuit is suppressed. The open circuit is not impacted by a VPD being activated.

3.4 LOCAL MODE OF OPERATION.

3.4.1 Local Operation. Local mode is used when maintenance personnel need to perform maintenance on the barrier.

3.4.1.1 Maintenance personnel would obtain the mode selector switch key from the lead ACP/ECF guard and place the key into the Master Control Panel 3-position mode selector switch for the appropriate direction of travel.

3.4.1.2 The person then turns the selector switch to the Local position and remove the key.

3.4.1.3 With the mode selector switch on the Master Control Panel in the Local position, Open and Close switches on the Master Control Panel for the barriers for that direction of travel are disabled and Auto mode is disabled disabled for that barrier set.

3.4.1.4 The maintenance person would then insert the key into the appropriate Off-Local mode selector switch on the barrier's Local Control Panel and turn the key to the "Local" position. This action enables the Open and Close switches at the Local Control Panel for the barriers in that direction of travel.

3.4.1.5 Maintenance personnel would also have to block and mark the lane ahead of the barrier in accordance with standard lane closure procedures/standards and also lock and tag out certain equipment at the barrier per the barrier manufacturer's recommendations for the type of maintenance to be performed.

3.4.2 When the Inbound Barriers Manual - Auto - Local mode switch is placed in the Local mode no change takes place with the traffic signals. This action just locks out the Auto and Manual mode functions. The key is then taken to the Local panel where the Local panel is placed into Local mode. The inbound barriers can now be controlled by the individual barrier Open and Close switches on the Local Control Panel. Initiation of a Close command to an open barrier causes that barrier's Traffic Signal to change from Green to Yellow for 3 seconds and then to Red. After an additional one second of Red, the barrier's close circuit is energized through the VPD's immediately in front of and behind the barrier. If the VPD's are clear, the barrier closes. Initiation of an Open command to a closed barrier energizes the open circuit for the barrier and open the barrier. After the barrier is fully open and the mode switch is placed in Auto mode, then the Traffic Signal changes from Red to Green. In the Local mode, both initial and final barriers in a given entrapment area can be opened. In such situations, guards must provide compensatory security measures to defeat a threat while both barriers are open. The traffic arm associated with a barrier is operated independent from the crash rated active vehicle barrier. Upon completion of maintenance, the traffic arm and corresponding barrier need to be in the same position e.g. either both open or both closed.

3.4.3 The close circuit for all barriers is supervised by the Vehicle Presence Detectors (VPD's) in front of and behind the barrier, such that if either VPD detects a vehicle, the barrier close circuit is suppressed. The open circuit is not impacted by a VPD being activated.

3.5 FINAL BARRIER: A VPD located at the barrier's STOP line detects a vehicle's presence in the entrapment area. If the final barrier is closed, then a signal is sent to the guard in the Gatehouse notifying him/her of the vehicle's presence. The signal causes a short audible noise to alert the guard and turns on a Red indicating light until the final barrier is open. If the barrier is open, then just the indicating light for the loop illuminates.

3.6 FILL OR RELEASE COMMAND WITH VPD.

3.6.1 Vehicle Presence Detector consisting of safety loops on either side of a crash rated active vehicle barrier may require additional programming and hardware. If the loops are more than 3 meters10 ft apart, then add 0.5-1 sec additional time delay on the "back" loop. The alternative is to provide a latching logic between loops. In the latching logic, the master panel needs a release pushbutton for each barrier.

3.6.2 When in Auto mode and a Fill or Release command is requested, then the system is to function as indicated.

3.6.2.1 When a VPD is activated on a barrier that is to close, then the action (Fill or Release) is suppressed. An audible alarm is to sound and the Fill or Release indicating light is to Flash. The original command is unlatched. Once the VPD(s) is cleared, then the guard must hit the reset button to clear the system and alarm. The Fill or Release command is to be reinitiated then. Once the traffic arm or barrier starts to close, a VPD activation is not to stop the cycle. The VPD must be activated prior to the command to stop the command.

3.6.2.2 A VPD activation on a barrier that is to open does not stop the action of opening (Fill or Release).

3.7 MANUAL OPEN OR CLOSE COMMAND WITH VPD.

3.7.1 Manual operation to Open a barrier or traffic arm is not impacted by a VPD activation associated with that barrier/traffic arm.

3.7.2 Manual operation to Close a barrier or traffic arm is suppressed by a VPD activation associated with that barrier/traffic arm. The VPD activation must take place prior to the Close command to suppress the action. The command is unlatched and must be reinitiated once the VPD(s) is cleared.

3.8 RETURN TO AUTO MODE.

3.8.1 When the mode switch is placed in the Auto mode and all the barriers for that direction of travel are in the appropriate configuration - one is Open (not deployed) and one is Closed (deployed), then the Auto mode indicating light illuminates and the corresponding Fill or Release light is to be illuminated.

3.8.2 If a mode switch is placed in the Auto mode and if both barriers for that direction of travel are either Open or Closed or if the traffic arm and barrier are in an incorrect position, then an alarm is to sound. The visual indicator is to be an alternating flashing of the Fill and Release indicator lights and the Auto indicating light is to turn off. The guard needs to go to manual mode and place the equipment in the correct configuration. Moving the mode switch from Auto to Manual (or local) mode turns off the alarm.

3.9 RESET. Reset button is only located at the Master Control Panel.

3.9.1 The reset button is used to reset after an Auto mode Fill or Release action is stopped by a VPD during a closing action. See RETURN to Auto Mode.

3.9.2 The reset button is also used to correct the unlikely situation that a barrier and traffic arm are prevented from completing a coordinated action. One possible is traffic arm closing on an object and then reversing back to the open position.

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NOTE: This is an optional switch function for locations that have only one lane per direction of travel or have one barrier across all the lanes. If there are multiple lanes per direction of travel

with each lane having its own AVB and no lane separation, then provide this switch. Keep or delete as required by the project.

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3.10 Out-of-Service switch. This function is provided for times when a barrier is damaged in a lane and needs to be taken out of service for an extended period of time. The out of service switch is to be located at the AVB location and is allowed to operate in EFO, Test and Local modes. This allows an AVB to be locked out in a lane, but the other lane can operate under EFO. The switch locks out all functions for the AVB when activated. The up and down lights for that AVB will alternate going on and off. WARNING: Installation is responsible for proper lane closure procedures (closing off the lane, bagging the traffic signal over the barrier, having guards present, etc). The Out-Of-Service switch has two positions: Yes and No or Enable and Disable is allowed for the wording..

3.11 AUDIBLE ALARMS. Provide an audible alarm at the Master Control Panel, Overwatch Control Panel, [Pedestrian control panel,] main Guard Booth Control Panel and Search Area Control panel(s). The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.11.1. Overspeed and Wrong-way will cause an alarm to go off for 3 seconds and then clear itself.

3.11.2. Duress activation.

3.11.3 AVB Trouble condition. Alarm happens where there is monitored problem detected that relates to the AVB. Red visual indicator for each electric power unit.

3.11.4 VPD Trouble condition. Alarm happens when there is something wrong with the loop controller or the loops monitored by that controller. Red visual indicator for each loop controller.

3.11.5 VPD Activation for over the set amount of time period (typically 15 seconds) Light goes on immediately for VPD activation, but audible alarm activates after 15 seconds.

3.11.6 Out of Service activation. When a barrier is initially placed in out-of-service, sound an audible alarm for 3 seconds. Open and Close indicator lights are to alternate on/off.

3.11.7 Master Panel in EFO mode and Local Panel is in Local Mode. EFO mode and Local mode indicator lights alternate being on.

3.11.8 Master Panel in Test mode and Local Panel is in Local Mode. Test mode and Local mode indicator lights alternate being on.

3.11.9 Return to EFO mode with an AVB or AVBs in the incorrect position (not fully open). EFO mode indicator light and open/down AVB position light(s) flash.

3.11.10 Communication Loss alarm. If a programmable logic controller loses communication with another programmable logic controller there will be an audible alarm. Red visual indicator.

3.11.11 Tamper switches - Control Panels. Tamper switches located inside each control panel cause an alarm when the cover is opened. Red visual indicator.

3.11.12 Tamper switches - Cabinets. Tamper switches located inside each cabinet cause an alarm when the cover is opened. Red visual indicator.

3.11.13 If an actuated traffic arm is provided at the crash rated active vehicle barriers are equipped with a break arm alarm. Upon breakage of the traffic arm, an audible/visual alarm is to happen at the master control panel. The visual indicator consists of a the traffic arm position indicator light flashing.

3.11.14. Master Panel in Auto mode and Local Panel is in Local Mode. Auto mode and Local mode indicator lights alternate being on.

3.11.15. Master Panel in Manual/Test mode and Local Panel is in Local Mode. Manual/Test mode and Local mode indicator lights alternate being on.

3.11.16. Return to Auto mode with an AVB or AVBs are in the incorrect position (not fully open). Auto mode indicator light and open/down AVB position light(s) flash.

3.12 AUDIBLE ALARMS. Provide an audible alarm at the Local Control Panel. The volume must be adjustable either through a rheostat or other means. Provide a button that silences the audible alarm at each panel. This silence button does not affect the corresponding visual indicator. Silence button does not prevent an audible alarm if a new condition develops.

3.12.1. AVB Trouble condition.

3.13 AUXILIARY CONTACTS. Provide auxiliary contacts (dry) to be used by the Intrusion Detection System and the CCTV system as specified herein and indicated on the drawings.

APPENDIX B

Events and Alarms at ACP/ECF, CSMS, & Recorded

Event/Alarm Point	Alarm at Command & Control	Alarm at CSMS	Record on SER
On Generator Power (Note 8)	Yes	No	No
Generator Low Fuel (Note 8)	Yes	No	No
UPS Trouble Alarm (Note 9)	Yes	No	No
Hydrogen Gas Alarm (Note 10)	Yes	No	No
Barrier #N Inbound - EFO Mode (Note 4)	No	No	Yes
Barrier #N Inbound - TEST Mode	No	No	Yes
Barrier #N Inbound -LOCAL Mode	No	No	Yes
Barrier #N Inbound - AUTO Mode (Note 12)	No	No	Yes
Barrier #N Outbound - EFO Mode (Note 4)	No	No	Yes
Barrier #X Outbound - TEST Mode	No	No	Yes
Barrier #X Outbound - LOCAL Mode	No	No	Yes
Barrier #X Outbound - AUTO Mode (Note 12)	No	No	Yes
Barrier #N Inbound AVB - Manual Close Command	No	No	Yes
Barrier #N Inbound AVB - Manual Open Command	No	No	Yes
Barrier #N Inbound Traffic Arm - Manual Close Command (Note 3)	No	No	Yes
Barrier #N Inbound Traffic Arm - Manual Open Command (Note 3)	No	No	Yes
Barrier #X Outbound AVB - Manual Close Command	No	No	Yes
Barrier #X Outbound AVB - Manual Open Command	No	No	Yes
Barrier #X Outbound Traffic Arm - Manual Close Command (Note 3)	No	No	Yes
Barrier #X Outbound Traffic Arm - Manual Open Command (Note 3)	No	No	Yes
EFO Activation - Master Panel	Yes	No	Yes
EFO Activation - Pedestrian Booth	Yes	No	Yes
EFO Activation - Guard Booth #Y	Yes	No	Yes
EFO Activation - Search Area	Yes	No	Yes
EFO Activation - Overwatch	Yes	No	Yes
EFO Activation - Any Location (Note 11)	No	Yes	No

APPENDIX B

Events and Alarms at ACP/ECF, CSMS, & Recorded

Event/Alarm Point	Alarm at Command & Control	Alarm at CSMS	Record on SER
Barrier #N Inbound AVB Close Circuit Energized Barrier #X Outbound AVB Close Circuit Energized Barrier #N Inbound AVB - Trouble Alarm Barrier #X Outbound AVB - Trouble Alarm Barrier #N Inbound AVB - Safety Loop Trouble Barrier #X Outbound AVB - Safety Loop Trouble	No No Yes Yes Yes Yes	No No No No No No	Yes Yes Yes Yes No No
Barrier #N Inbound AVB - Loop 1 (stop line) Malfunction (Note 13) Barrier #N Inbound AVB - Safety Loop 2 (threat side) Malfunction Barrier #N Inbound AVB - Safety Loop 3 (secure side) Malfunction	No No No	No No No	Yes Yes Yes
Barrier #X Outbound AVB - Loop 1 (stop line) Malfunction (Note 13) Barrier #X Outbound AVB - Safety Loop 2 (threat side) Malfunction Barrier #X Outbound AVB - Safety Loop 3 (secure side) Malfunction	No No No	No No No	Yes Yes Yes
EFO Reset Barrier #N Inbound AVB - Loop 1 (stop line) Activation (Note 13) Barrier #N Inbound AVB - Safety Loop 2 (threat side) Activation Barrier #N Inbound AVB - Safety Loop 3 (secure side) Activation	No No No No	No No No No	Yes Yes Yes Yes
Barrier #X Outbound AVB - Loop 1 (stop line) Activation (Note 3) Barrier #X Outbound AVB - Safety Loop 2 (threat side) Activation Barrier #X Outbound AVB - Safety Loop 3 (secure side) Activation	No No No No No	No No No No No	Yes Yes Yes Yes Yes

APPENDIX B

Events and Alarms at ACP/ECF, CSMS, & Recorded

Event/Alarm Point	Alarm at Command & Control	Alarm at CSMS	Record on SER
Barrier #N Inbound AVB - Loop 1 (stop line) Deactivation (Note 13) Barrier #N Inbound AVB - Safety Loop 2 (threat side) Deactivation Barrier #N Inbound AVB - Safety Loop 3 (secure side) Deactivation	No No No	No No No No No	Yes Yes Yes Yes Yes
Barrier #X Outbound AVB - Loop 1 (stop line) Deactivation (Note 3) Barrier #X Outbound AVB - Safety Loop 2 (threat side) Deactivation Barrier #X Outbound AVB - Safety Loop 3 (secure side) Deactivation	No No No	No No No	Yes Yes Yes
Barrier #N Inbound AVB Close Limit Switch Activated Barrier #X Outbound AVB Close Limit Switch Activated Barrier #N Inbound AVB Open Limit Switch	No No No	No No No	Yes Yes Yes
Barrier #X Outbound AVB Open Limit Switch Activated Master Panel Power Off Local Panel Power Off EFO Not Armed - Guard Booth #Y EFO Not Armed - Overwatch	No No No No No	No No No No No	Yes Yes Yes Yes Yes
EFO Not Armed - Search Area Overspeed Activated (Alarm) Wrong-way Activated (Alarm) Inbound Traffic Signal Red On Inbound Traffic Signal Yellow On (Note 14)	No Yes Yes No No	No No No No No	Yes Yes Yes Yes Yes
Inbound Traffic Signal Green On (Note 15) Outbound Traffic Signal Red On Outbound Traffic Signal Yellow On (Note 14) Outbound Traffic Signal Green On (Note 15) Duress Activation - Any Location (Note 11) Duress Activation - Guard Booth #Y (Note 11)	No No No No Yes No	No No No No No No	Yes Yes Yes Yes No Yes

APPENDIX B

Events and Alarms at ACP/ECF, CSMS, & Recorded

Event/Alarm Point	Alarm at Command & Control	Alarm at CSMS	Record on SER
Duress Activation - Overwatch (Note 11)	No	Yes	No
Duress Activation - Command & Control (Note 11)	No	Yes	No
Duress Activation - Search Area (Note 11)	No	Yes	No
Duress Activation - Visitor Control Center (Note 11)	No	Yes	No
Intrusion Detection Activation - Guard Booth #Y (Note 11)	No	Yes	No
Intrusion Detection Activation - Overwatch (Note 11)	No	Yes	No
Intrusion Detection Activation - Command & Control (Note 11)	No	Yes	No
Intrusion Detection Activation - Search Area (Note 11)	No	Yes	No
Intrusion Detection Activation - Visitor Control Center (Note 11)	No	Yes	No
Intrusion Detection Activation - Any Location (Note 11)	Yes	No	No

NOTES:

1. CSMS - Central Security Monitoring Station
2. SER - Sequence of Events Recorder
3. Monitor on Hybrid Beacon, if used, HEPD, and Stop Control Safety Schemes
4. This command is for any safety scheme that has an EFO.
5. N = number of inbound crash rated active vehicle barriers.
6. X = number of outbound crash rated active vehicle barriers
7. Y = number of guard booths
8. Alarm can be by a Remote Generator Alarm/Status Panel.
9. Alarm can be by a Remote UPS Alarm/Status Panel.
10. Alarm can be separate from Master Control Panel.
11. Alarm is to be monitored by the Intrusion Detection System Panel. Alarm signal is sent by the IDS panel.
12. Only used on Full Containment (Platooning/Sally Port) Safety Scheme. Number is number of lanes.
13. HEPD and Full Containment.
14. Hybrid Beacon, HEPD and Full Containment.
15. HEPD and Full Containment.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 01 41.00 10 (August 2020)**
Change 3 - 05/23

Preparing Activity: USACE **Superseding**
UFGS-35 01 41.00 10 (November 2014)

UNIFIED FACILITIES GUIDE PECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

35 01 41.00 10

ELECTROMECHANICAL OPERATING MACHINERY FOR LOCKS AND DAMS

08/20, CHG 3: 05/23

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-35 01 41.00 10 (August 2020)**
Change 3 - 05/23

Preparing Activity: USACE **Superseding**
UFGS-35 01 41.00 10 (November 2014)

UNIFIED FACILITIES GUIDE PECIFICATIONS

References are in agreement with UMRL dated January 2025

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35 01 41.00 10

ELECTROMECHANICAL OPERATING MACHINERY FOR LOCKS AND DAMS

08/20, CHG 3: 05/23

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NOTE: This guide specification covers the requirements for mechanical power systems to operate gates, culvert valves, and other mechanisms at navigational locks and dams, flood control dams, and other civil works structures.

Adher to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification should be used in accordance with EM 1110-2-2610 MECHANICAL AND ELECTRICAL DESIGN FOR LOCK AND DAM OPERATING EQUIPMENT and EM 1110-2-3200 WIRE ROPE SELECTION CRITERIA FOR GATE OPERATING DEVICES. For hydraulic power systems, see UFGS 35 05 40.14 10 HYDRAULIC POWER SYSTEMS FOR CIVIL WORKS STRUCTURES and EM 1110-2-1424 LUBRICANTS AND HYDRAULIC FLUIDS FOR CIVIL WORKS PROJECTS. However, the designer should note that some components of hydraulic driven machinery systems may have applicable sections within this guide specification that should be used

for various configurations of linkages, pins, shafts, etc. For self-lubricated bearing systems, see UFGS 35 05 40.17 SELF-LUBRICATED BEARING MATERIALS, FABRICATION, HANDLING, AND ASSEMBLY.

Ensure products used in this section comply with Federal procurement preference under Section 9002 of the Farm Security and Rural Investment Act of 2002. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for requirements associated with EPA designated products.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. (AIA/NAS)

AIA/NAS NAS410	(2014; Rev 4) NAS Certification & Qualification of Nondestructive Test Personnel

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
AGMA 6013	(2006A; R2016) Standard for Industrial Enclosed Gear Drives
AGMA 9002	(2014C) Bores and Keyways for Flexible Couplings (Inch Series)

AGMA ISO 1328-1-B14	(2010A) Cylindrical Gears - ISO System of Flank Tolerance Classification - Part: Definitions and Allowable Values of Deviations Relevant to Flanks of Gear Teeth
ANSI/AGMA 2001	(2004D; R 2010) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
ANSI/AGMA 2003	(2010D) Rating the Pitting Resistance and Bending Strength of Generated Straight Bevel, ZEROL Bevel, and Spiral Bevel Gear Teeth
ANSI/AGMA 6001	(2008E; R 2014) Design and Selection of Components for Enclosed Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)
ANSI/AGMA 9005	(2016) Industrial Gear Lubrication

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel
ASNT SNT-TC-1A	(2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B17.1	(1967; R 2017) Keys and Keyseats
ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A29/A29M	(2023) Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A290/A290M	(2016; R 2021) Standard Specification for Carbon and Alloy Steel Forgings for Rings for Reduction Gears
ASTM A291/A291M	(2016) Standard Specification for Steel Forgings, Carbon and Alloy, for Pinions, Gears and Shafts for Reduction Gears
ASTM A322	(2024) Standard Specification Steel Bars, Alloy, Standard Grades
ASTM A380/A380M	(2017) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A388/A388M	(2016) Standard Practice for Ultrasonic Examination of Steel Forgings
ASTM A473	(2024a) Standard Specification for Stainless Steel Forgings
ASTM A487/A487M	(2024) Standard Specification for Steel Castings Suitable for Pressure Service
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A578/A578M	(2007; R 2012) Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A705/A705M	(2023) Standard Specification for Age-Hardening Stainless Steel Forgings
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM A744/A744M	(2020a) Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service
ASTM A829/A829M	(2014) Standard Specification for Alloy Structural Steel Plates
ASTM A1018/A1018M	(2023a) Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing,

	Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B148	(2024) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B271/B271M	(2023) Standard Specification for Copper-Base Alloy Centrifugal Castings
ASTM B505/B505M	(2023) Standard Specification for Copper Alloy Continuous Castings
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM D3233	(1993; R 2014) Standard Test Methods for Measurement of Extreme Pressure Properties of Fluid Lubricants (Falex Pin and Vee Block Methods)
ASTM D3951	(2018) Commercial Packaging
ASTM D4172	(1994; R 2016) Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)
ASTM E94/E94M	(2022) Standard Guide for Radiographic Examination Using Industrial Radiographic Film
ASTM E114	(2015) Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Contact Testing
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing
ASTM E1030/E1030M	(2015) Standard Test Method for Radiographic Examination of Metallic Castings
ASTM E1032	(2019) Standard Practice for Radiographic Examination of Weldments Using Industrial X-Ray Film
ASTM E1742/E1742M	(2018) Standard Practice for Radiographic Examination
ASTM E1955	(2004; R 2014) Standard Radiographic Examination for Soundness of Welds in Steel by Comparison to Graded ASTM E 390 Reference Radiographs

GERMAN INSTITUTE FOR STANDARDIZATION (DIN)

DIN 22252	(2012) Round Steel Link Chains for Use in Continuous Conveyors and Winning Equipment in Mining
DIN 22258-1	(2012) Chain Connectors - Part 1: Flat Type Connectors

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 281	(2007) Rolling Bearings -- Dynamic Load Ratings and Rating Life
ISO 10360-2	(2009) Geometrical Product Specifications (GPS) — Acceptance and Reverification Tests for Coordinate Measuring Machines (CMM) — Part 2: CMMs Used for Measuring Linear Dimensions

Japanese Standards Association (JSA)

JSA JIS B 1519	(2009; R 2013; R 2018) Rolling Bearings - Static Load Ratings

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-2610	(2013) Engineering and Design -- Mechanical and Electrical Design for Lock and Dam Operating Equipment

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-16173E	(1993; INT 1 2006; INT 2 2017) Corrosion Preventive Compound, Solvent Cutback, Cold-Application

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item,

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Purchase Agreements

Shop Test Information; G, [_____]

Shop Load Test Rig and Location; G, [_____]
Installation and Alignment Procedure; G, [_____]

Gate Support Method; G, [_____]

Measuring Tension Procedure; G, [_____]

Gate Position Settings on Limit Switches

Equipment Protection Plan; G, [_____]

Materials List; G, [_____]

Commissioning; G, [_____]

[Field Tensioning and] Operating Test Procedure; G, [_____]

Pre-Functional Checklist

Functional Checklist

SD-02 Shop Drawings

Detail Drawings; G, [_____]

Materials Orders

Shipping Bills

Reducer Shafts; G, [_____]

Shaft Bores

Keys And Keyways; G, [_____]

SD-03 Product Data

Manufacturer's Literature and Equipment Data; G, [_____]

Electric motors

SD-05 Design Data

Contractor Designed Gearing; G, [_____]

Gearbox Lubrication System; G, [_____]

Contractor Designed Sheaves; G, [_____]

Lubricating Oil for Speed Reducers

SD-06 Test Reports

[Sector] [Bull] [Spoked] [_____] Type Gears

Electric Motors

Final Operating Test; G, [_____]

Final [Field Tensioning and] Operating Test; G, [_____]

Round Link Chain Tensioning

Startup and Acceptance Test

Magnetic Particle Examination

Tooth Contact Patterns

Inspection Log

Shop Assembly and Tests

Final Alignment Test Report

SD-07 Certificates

Equipment Manufacturer's and Fabricator's Qualifications

Qualification of Welders and Welding Operators

Equipment Warranty

Erecting Engineer Installation and Operation

Nondestructive Examination Certification

Gear Certification

Drum Geometry for Synchronous Drums

Commissioning Document

SD-08 Manufacturer's Instructions

Cleaning of Corrosion-Resisting Steel; G, [_____]

SD-10 Operation and Maintenance Data

Operations and Maintenance (O&M) Manual; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer and Assembler

Manufacturing and assembly of the [miter gate] [dam gate] [and] [tainter] [valve], [_____] machinery units is to be performed by a Contractor and fabrication company that has been normally and regularly engaged in assembly, and manufacture of heavy machinery over the preceding [10] [_____] years. Changes to the dimensions shown on the drawings [and in the Bill of Materials] for the Gate and Valve Machinery (including structural supports) requires written approval from the Contracting Officer. Submit Equipment Manufacturer's and Fabricator's Qualifications showing evidence and years of experience for each of the equipment manufacturers and fabricators. Identify any certifications, standards, and/or professional organizations the manufacturers comply with or are members of.

1.3.2 Erecting Engineer Services

****

NOTE: This paragraph covers services of erecting engineers. The designer should incorporate the use of on-site erecting engineers from the equipment manufacturer when a particularly complex equipment is being installed as part of the project and/or on-site training for project personnel is desired.

****

Provide the services of one or more erecting engineers onsite during the installation and startup of each defined major piece of equipment and subassembly. The erecting engineer(s) are responsible to technically supervise and provide instruction for the equipment to be installed and operated. [The major pieces of equipment and subassemblies requiring engineering services is defined as follows:]

[a. [Miter Gate Machinery]]
[b. [Dam gate Machinery]]
[c. [Culvert Valve Machinery]]

Upon completion of the work and at a time designated, provide the services of one or more erecting engineers for training Government personnel in accordance with the requirements of paragraph FIELD TRAINING.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery Location

Upon completion of fabrication, testing, and at the Contracting Officers direction deliver specified equipment to [Street, City, State, Zip] Attn: [Receiving Persons Name or Division].

1.4.2 Critical Path Components/Systems

****

NOTE: Many custom and catalog selected items require long lead times that may affect the construction schedule. If this is the case, use the following paragraph.

****

Many of the components required for the electrical and mechanical equipment at a [Lock] [and] [Dam] have long delivery times. Perform a large percentage of the electrical and mechanical work only during critical times [([Lock] [and] [Dam] shutdown period may be required)]. To ensure that all work required during this time period is accomplished, present to the Contracting Officer, within [120] [_____] calendar days after receiving notice to proceed, written copies of finalized purchase agreements with component manufacturers (NOT SUPPLIERS) for the components and systems noted below.

COMPONENTS
Speed Reducers
Motors
High and Low Speed Couplings
Torque Limiting Couplings
Brakes and Control Units
Bearings
Open Gearing
Gear Arm
Strut Arm
Wire Rope Drums
Wire Rope
Pocket Wheels
Pocket Wheel Chain
Sprockets

COMPONENTS
Engineered Chain

Include a confirmed delivery date and point of contact at the particular manufacturer in the purchase agreements. Require the manufacturer to furnish a monthly report (submit to the Contracting Officer on the 10th of each month) of progress on the particular component/system and any delays in the previously specified delivery date. Include both written and photographic updates to track and monitor the current status of the equipment to be furnished in the progress reports. The reporting requirements specified herein are included in the requirements of Section 01 32 01.00 10 PROJECT SCHEDULE.

1.4.3 Delivery, Storage and Handling of Equipment

****

NOTE: This paragraph covers storage of equipment when delivered to the jobsite and storage of spares. Major pieces of equipment and subassemblies that require Government inspection prior to shipment should be identified by the designer.

****

Protect equipment and components from corrosion, deformation, and other types of damage. Store items in enclosed and secured areas free from contact with soil. Provide moisture proof weather protection for all equipment stored in outdoor locations. Transport, handle and store all equipment in accordance with the manufacturer's written instructions. Remove and replace damaged items with new items. [Do not prepare the major pieces of [lock] [and] [dam] operating equipment and subassemblies for shipment until they have been inspected and accepted for shipment at origin by the Contracting Officer, unless inspection has been waived in writing.] Ship each subassembly completely assembled. Submit the shipping bills with the delivery of finished pieces to the site. The major pieces of equipment and subassemblies for this contract are defined to include the following:

[a. [Miter Gate Machinery]]
[b. [Dam Gate Machinery]]
[c. [Culvert Valve Machinery]]

1.4.3.1 Packaging

Provide equipment and subassemblies with adequate protective pads, supports, and blocking. Securely restrain equipment and subassemblies to prevent distortion or damage to the painted surfaces in transit. Any loss or damage during shipment, including damage to the painted surfaces, is the responsibility of the Contractor. Replace or repair lost or damaged items without cost to the Government. Coat all parts with a rust preventative, wrap in heavy-duty plastic, and securely contain in wooden crates. Clearly mark each crate with its contents (including contract number and Corps mark number) on the outside, with a non-ferrous metal tag, engraved with the contents, and secured to the crate with non-ferrous screws. Provide a means for inspection of the crate's contents without destroying the crate. Pack all accessories and spare parts separately in containers plainly marked "ACCESSORIES ONLY," or "SPARE PARTS ONLY." Package each spare part or spare part assembly in a durable treated wooden crate with metallic, plastic or suitable outer shell for weathertight protection and with provisions for handling and long-term storage (60 months). Provide and deliver the component and assembly spare parts as delineated on the drawings. Place a separate packing list, listing the contents of each crate, in a moisture-proof envelope securely fastened to the outside of the crate. Standard commercial packaging in accordance with ASTM D3951 is acceptable except where a different method or standard of packaging is specified.

1.4.3.2 Shipping, Preservation, and Storage

Provide all packing, crating, e.g., necessary to ensure safe shipment of equipment. The crates become the property of the Government unless specifically waived. Fill or protect the equipment with the necessary fluids, coatings, and/or preservatives to maintain in a stable condition without corrosion, deterioration, or degradation for an extended period of storage of up to [12] [_____] months. Protect stored equipment from the weather, humidity, temperature variation, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 EQUIPMENT

****

NOTE: This guide specification covers operating machinery for lock gates, filling/emptying valves and dam gate operating equipment. It can be revised as needed to accommodate any type of gate or culvert valve.

****

2.1.1 Machinery

Furnish equipment under this specification consisting of [four] [_____] [[_____] type] gate operating machinery units [and [four] [[_____] type] filling/emptying valve operating machinery units; [two] [_____] upper gate and valve units and [two] [_____] lower gate and valve units [and spares]]. Furnish complete units including base supports, geared drives, brakes, motors, shafts, bearings, [wire rope,] [chain,] [pocket wheels,] [sprockets,] [engineered chain,] electrical equipment, controls, covers, guards, [portable] filtering unit and other necessary items to provide a complete and operable system.

2.1.2 Electrical Equipment

Conform electrical equipment, including limit switches, motor starters, conduit, conductors, controls, [slack cable safety devices,], to the requirements of [Section 35 20 20 ELECTRICAL EQUIPMENT FOR GATE HOIST][and][Section 40 60 00 PROCESS CONTROL].

2.1.3 Nameplate

Provide an engraved or raised [metallic] [_____] nameplate that is mechanically attached to each piece of equipment. Include the manufacturer's name, model designation, serial number, unit rating, application factor, reduction ratio's, and any other applicable information on the nameplate.

2.1.4 Equipment Submittal Data

Submit Equipment Data and Detail Drawings for [pocket wheels,] [sprockets,] [gears,] [shafts,] [bushings,] [hoisting chains,] [limit switches,] [supports,] and any other shop fabricated items, equipment dimensional drawings, assembly drawings, catalog cuts, and material data and shop drawings showing arrangement, construction details and ratings for factory built [miter gate] [tainter valve] [miter gate and tainter valve] machinery; test rig assembly details; proposed and final shop test procedures and data sheets; proposed and final field [cable tensioning and] operating test procedures and data sheets, for approval. Provide all details of fabrication and assembly to include shipping and long term storage instructions. Shop drawings lacking this information will be rejected. Approval of the material submitted in no way relieves the Contractor from the responsibility of complying with the requirements of the specifications as to the suitability and quality of materials and workmanship and the adequacy of capacity, operating speed and other essential characteristics of the [gate][valve][gate and valve] drives. Submit drawings, catalogs, and design data necessary to clearly show the details of any changes proposed in conformity with the requirements of this specification. Equipment, materials, and articles of construction installed or used without such approval will be at the risk of subsequent rejection.

Submit a materials list for fabricated items at the time as the detail drawings submittal.

Submit copies of all materials orders including purchase orders, mill orders, shop orders and work orders for materials prior to using the materials in the work.

Submit Manufacturer's Literature and Equipment Data for approval. Provide catalog cuts and material data for the proposed equipment that clearly indicates compliance with the requirements of these specifications and the drawings. Submit AGMA ratings for gear quality of all gears and gear reducers. Include the names of the manufacturers of all machinery and other equipment contemplated for incorporation into the work, performance capacities and other pertinent information about the equipment. As a minimum, include the following Manufacturer's Literature and Equipment Data:

2.1.4.1 Brakes

Manufacturer's Name	
Type	
Model Number	
Continuous Duty Torque Rating	
Torque Adjustment Range	
Supply Voltage	
Type of Conduit Box	[Standard] [Watertight]

Type of Lining	
Type of Bearing	
Type of External Brake Release Mechanism	
Brake Wheel Size	
Type of Bore	[Straight] [Tapered]
Bore Size	
Brake Wheel Material	
Brake Wheel Model Number	
Space Heater Manufacturer/Type/Size (KW)	
Space Heater Manufacturer/Type/Size (KW)	
Type of Enclosure	
Enclosure Model Number	
Torque Gauge Included	[Yes] [No]
Torque Scale Included	[Yes] [No]
Weight of Brake	
Weight of Enclosure	
Outline Dimensional Print of Brake	
Outline Dimensional Print of Enclosure	
Quantity Being Furnished	

2.1.4.2 Speed Reducers

Manufacturer's Name
Type
Model Number
Exact Ratio
Efficiency
Mechanical Rating - Durability - HP, Specify SAC
Mechanical Rating - Strength - HP, Specify SAT

Rating Calculations per applicable AGMA Standard
Life Factors CL, KL
Reliability Factors CF, KR
Type of Gearing and Heat-Treatment
Type of Bearings
Minimum L-10 Bearing Life
Method of Lubrication
Size and Number of Mounting Bolts
Weight and Air Volume of Unit without Oil
Weight and Air Volume of Unit with Oil
Outline Dimensional Print
Keys and Keyway Dimensions
Type of Breather
Quantity Being Furnished
AGMA and ISO Lubrication Oil/Viscosity rating
Type of Lubricant

2.1.4.3 Open [Spur] [Helical] [_____] Gears

Manufacturer's Name
[Spur][Helical] [_____] Gear P.D. and [Spur] [Helical] [_____] Gear D.P.
Number of Gear Teeth
Face Width of Gear
Gear Material
Gear Heat Treatment
BHN of Gear Teeth
Mating Pinion Gear P.D. and Mating
Number of Mating Pinion Gear Teeth
Face Width of Mating Pinion Gear
Type of Construction - Cast/Fabricated
Mating Pinion Gear Materials of
Mating Pinion Gear Heat Treatment
BHN of Mating Pinion Gear Teeth
Mechanical Rating of Gear Set - Durability - HP, Specify SAC

Mechanical Rating of Gear Set - Strength - HP, Specify SAT
Percentage of Material Yield Point Based on maximum Motor Full Load Torque
Life Factors CL, KL
Reliability Factors CF, KR
I Factor
J Factor
Number of Reduction Set
Outline Dimension Print
Weights of Gear and Pinion
Quantity Being Furnished
Rating Calculations per applicable AGMA Standard

2.1.4.4 Electric Motors

Manufacturer's Name
Type
Frame Number
Unique Serial Number
Certified Factory Motor Test Data, High Speed & Low Speed
Motor Performance Curves, High Speed & Low Speed
Enclosure Type
Input Voltage, Phases, Frequency
Full Load Amps, High Speed & Low Speed
Locked Rotor Amps, High Speed & Low Speed
Insulation Type
Temperature Rise
Drive Output Shaft Size/Tolerances
Space Heater Manufacturer/Type/Size (KW)
Input KW, Input Voltage
Conduit Box Size-Motor

Conduit Box Size-Heater
Drain Description (Manufacturer and Type)
Full Load Torque, High Speed & Low Speed
Upper Limit Torque, High Speed & Low Speed
Lower Limit Torque, High Speed & Low Speed
Locked Rotor Torque, High Speed & Low Speed
Percentage Slip, High Speed & Low Speed
Outline Dimensional Print
Weight of Motor
Quantity Being Furnished

2.1.4.5 Couplings (High and Low Speed Shafts)

Manufacturer's Name
Type
Model Number
Bore Sizes and Tolerances
Number of Keyways
Keyway Sizes and Tolerance
Recommended Shaft Size and Tolerance
Recommended Key Size and Tolerance
Recommended Key Material
Keyways Filleted - [Yes] [No]
Materials of Construction
Catalog Rating - Torque, kW/100 RPM HP/100 RPM
Service Factor Based on Catalog Rating
Angular Misalignment

Parallel Offset Misalignment
Axial Movement
Torque and HP/100 RPM Capacity of Low Speed Coupling with Anticipated Shaft Fits
Type of Lubrication
Assembly Procedure of Hub with Shaft
Weight
Outline Dimensions Print
Quantity Being Furnished

2.1.4.6 Torque Limiting Couplings

Manufacturer's Name
Type
Model Number
Bore Sizes and Tolerances
Number of Keyways
Keyway Sizes and Tolerance
Recommended Shaft Size and Tolerance
Recommended Key Size and Tolerance
Recommended Key Material
Keyways Filleted - [Yes] [No]
Materials of Construction
Catalog Rating - Slip Torque Range, Nm lb-in
Slip Torque Setting, lb-in
Service Factor Based on Catalog Rating
Angular Misalignment
Parallel Offset Misalignment
Axial Movement
Torque Capacity

Type of Lubrication
Weight
Outline Dimensions Print
Quantity Being Furnished

2.1.4.7 Pillow Block, Greaseless and Sleeve Bearing

Manufacturer's Name
Type
Model Number and Size
Bearing Housing Material
Sleeve Bearing Material/Grade
Coefficient of Friction
Composite Thickness (Greaseless
Percentage Water/Oil Swell (Greaseless Composites)
Coefficient of Thermal Expansion
Crush Strength (Greaseless Composites)
Bearing Bore Diameter
Bearing Bore [Fixed] [Floating]
Type of Bearing
Static Capacity of Bearing
Thrust Capacity of Bearing
Basic Dynamic Capacity of Bearing
Load Capacity of Bearing
L-10 Life of Bearing
Type of Seals
Type of Lubrication
Grease Grooves Included [Yes] [No]
Weight
Independent Laboratory Test Results (Greaseless Composites)
Outline Dimensional Print
Quantity Being Furnished

2.1.4.8 Wire Rope

Size
Classification, Type and Construction
Material
Lay
Delivery Length
Tensile Strength
Ductility
Pre-Forming Certification
Pre-Stretching Procedure/Certification
Sockets and End Termination
Speltering Material
Speltering Procedure/Certification
Type of Lubricant
Multi-Wire Rope Tensioning Procedure

2.1.4.9 Chain and Engineered Chain

Size
Material List
Hardness BHN
Proof Test Strength
NDE Test
Type of Lubricant
Outline Dimensional Print
Total Weight Being Furnished
Total Quantity Being Furnished

2.1.4.10 Pocket Wheels, Sprockets and Drums

Size
Material
Hardness BHN

Charpy V-Notch
Heat Treatment
NDE Test
Type of Lubricant
Outline Dimensional Print
Total Weight Being Furnished
Total Quantity Being Furnished

2.2 DESIGN CRITERIA

****

NOTE: Edit all or portions of this paragraph depending upon type of contract documents to be prepared. At a minimum the designer should provide the anticipated operating loads and required operating conditions to be satisfied for equipment manufacturers to best select and size equipment components to match the anticipated operating conditions. Review EM 1110-2-2610 Mechanical and Electrical Design for Lock and Dam Operating Equipment for specific guidance and design criteria related to the type of lock gate and filling/emptying valve configuration to be specified for the project. The designer should be aware that modifications and or deviations away from EM design criteria may require separate documentation, design analysis, and written USACE-HQ approval.

****

Provide equipment and machinery to meet the anticipated operating conditions as specified by the following design criteria.

COMPONENT DESIGN CRITERIA								
ITEM	MAXIMUM [LOAD (kN) (Kips)] or [TORQUE (Nm) (Ft-Lbs)]	OPERATING TEMP. RANGE Deg C Deg F	[MAXIMUM or MINIMUM] OPERATING SPEED (RPM) or (FPM)	OPERATING TRAVEL [CW][CCW] [Reversing]	CYCLES [Per Hr][Per Day]	[MAX] [MIN] TRAVEL TIME OPEN (Sec)	MAX][MIN TRAVEL TIME CLOSE (Sec)	[OTHER]

COMPONENT DESIGN CRITERIA								
ITEM	MAXIMUM [LOAD (kN) (Kips)] or [TORQUE (Nm) [Ft-Lbs]	OPERATING TEMP. RANGE Deg C Deg F	[MAXIMUM or MINIMUM] OPERATING SPEED (RPM) or (FPM)	OPERATING TRAVEL [CW][CCW] [Reversing]	CYCLES [Per Hr][Per Day]	[MAX] [MIN] TRAVEL TIME OPEN (Sec)	MAX][MIN TRAVEL TIME CLOSE (Sec)	[OTHER]

****

NOTE: Delete the following paragraph for Corps of Engineers designed projects and include only for non-Corps designed machinery where the AE, Contractor or Equipment Manufacturer are the responsible Designer of Record for calculating the equipment operating loads. The Corps should be made aware in the review of such designs any modifications and or deviations away from EM design criteria that may require separate documentation, design analysis, and written USACE-HQ approval.

****

[Design equipment in strict accordance with the requirements of EM 1110-2-2610 Mechanical and Electrical Design for Lock and Dam Operating Equipment unless otherwise specified within. Design equipment for the normal loads using factors of safety applicable to the type of service and the particular part with a minimum factor of safety of 5 based on the ultimate strength of the material. Include all anticipated loads in the design. Loads include, but are not limited to, the loads imposed by the dead weight, hydraulic forces, buoyancy forces, ice, and seal friction. In addition, design each part or component, including speed reducers[(excluding wire rope)], for a unit stress not in excess of 75 percent of the yield strength of the material under loads resulting from the locked rotor torque of the electric motor. Design components that might fail in buckling compression for a minimum factor of safety of 3.0, using the Euler or J.B. Johnson formulas. Apply the factor of safety to the maximum load on the member and the critical buckling load. Model the end fixity coefficient for pin-end conditions. [Consider both the normal loads and loads resulting from the locked rotor torque of the electric motor for miter gate machinery.] [Consider both the normal loads and loads resulting from the locked rotor torque of the motor as divided [70/30] [_____] between the two drums of a hoist for [tainter valve] [_______] machinery.] [Consider both the normal loads and loads resulting from the locked rotor torque of the electric motor for [gate][filling/emptying valve] operating equipment.] [For loads divided between the components of the operating equipment they should be considered for design purposes to have a [____/____] split in load distribution.] Allowances for shock and impact are not required unless specifically identified. Submit for approval all equipment modification design calculations.]

2.3 OPERATION SEQUENCES

2.3.1 [Lock Gate] [Hoisting Machinery] Operation

****

NOTE: Coordinate with electrical design engineers to develop the required sequence of operation and provide the requirements on the drawings. Specify the necessary control equipment and devices in UFGS Section 40 60 00 PROCESS CONTROL and Section 35 20 20 ELECTRICAL EQUIPMENT FOR GATE HOIST.

****

The equipment sequence of operation, interlocks and electrical controls are as indicated. [Conform equipment and hardware with the requirements of Section 35 20 20 ELECTRICAL EQUIPMENT FOR GATE HOIST and Section 40 60 00 PROCESS CONTROL.]

2.3.1.1 Sequence of Operation

****

NOTE: Include or edit the paragraphs below to describe the anticipated sequence of operation for the equipment specified.

****

2.3.1.1.1 [Lock] Gate Opening

a. Gearbox lubrication pump is energized and operates for [3] [_____] to [4] [_____] seconds prior to gearbox operation.

b. Motor and brake are energized (brake is released).

c. Motor starts and [runs in low speed mode] [ramps speed] for the first [5] [_____] percent of the [lock] gate travel.

d. Motor [shifts] [ramps] to high speed mode and runs at full speed mode until the [lock] gate is [95] [_____] percent open.

e. Motor [shifts] [ramps] to low speed and runs in low speed until the [lock] gate is fully open (last [5] [_____] percent of [lock] gate travel).

f. Gate position is device proven to be at end of travel.

g. Motor and brake are de-energized (brake is engaged).

2.3.1.1.2 [Lock] Gate Closing

The sequence for closing the gate is identical to that for opening, except the gate moves in the opposite direction to the closed position.

2.3.1.2 Design Considerations

Normal operations of the [lock][dam] [gates][valves] for the purpose of design consist of the [lock][dam] [gates][valves] operating through [3] [_____] complete cycles per hour with [2] [_____] starts and [2] [_____]

stops per cycle. A cycle is defined as moving the [lock][dam] [gate][valve] from the fully closed position to the fully opened position and back to the fully closed position.

2.4 SPEED REDUCERS

2.4.1 [Miter Gate Speed Reducers] [Gate Hoist Speed Reducer] [Tainter Valve Speed Reducer]

2.4.1.1 General

The speed reducer is a [single] [double] [triple] [quadruple] reduction, [right angle,] [parallel shaft,] [spiral bevel/helical gear] [helical gear] [right angle worm gear] type, entirely self contained in an oil tight, steel housing designed to maintain shafts and bearings in accurate alignment. Provide the gear ratio as indicated plus or minus [1.5] [_____] percent. [The [vertical] [horizontal] output shaft is to be [single] [double] extended and [be coupled to the pinion shaft] [have the pinion mounted on the output shaft]]. Provide a [vertical up] [horizontal] output shaft for position feedback with the gear reducer. Provide a shaft which is[19 mm 3/4 inches in diameter and extend to provide a [direct coupled][gear reduced coupling][non-contact coupling] to drive a [rotary cam limit switch][angular displacement transducer][non-contact transducer]]. [Reducers with dual output working shafts are to be designed to accommodate a split percentage torque distribution between the output shafts based upon the loads produced by the motor and in accordance with the design criteria specified in paragraph DESIGN CRITERIA.][Provide an input shaft that is [_____] mm inches in diameter.] Design, rate and manufacture the speed reducers in accordance with ANSI/AGMA 6113 AGMA 6013 with all components meeting the requirements of ANSI/AGMA 6001. Provide gearing whic is rated in accordance with ANSI/AGMA 2003 and ANSI/AGMA 2001. In all cases where these standards or this specification are in conflict with one another the more conservative design standard takes precedence.

2.4.1.2 Reducer Housing

****

NOTE: Gearboxes exposed to the environment should be fitted with filtering ports or a self-contained filter system so that the oil can be filtered to remove moisture. Coordinate with the gear box manufacturer on final material for housing.

****

Provide a reducer housing which is heavy duty cast steel or welded steel [gray cast iron and ductile cast iron]construction and have dowel pins at all parting seams for accurate gear and bearing alignment. Split the reducer housing to facilitate disassembly for maintenance and repair.[The reducer housing is to be of the dry well type design for the vertical down output shaft.][Design the dry well such that the speed reducer can be completely filled with oil while in storage and the oil can be drained out of the dry well when the speed reducer is to be put into service.] Design the base thickness and width with adequate rigidity and stiffness to not contribute additional stress on the mounting bolts. All surfaces are to be smooth and flat and easy to clean. Provide the upper and lower housings with large, rugged lifting lugs.[Provide a machined steel bracket for mounting the [rotary cam limit switch][angular displacement transducer][_____] and mount as indicated.] Provide all required oil drains, fill ports, breathers, heater ports, filtering ports, and inspection covers in the housing. Provide a main oil drain at the lowest point possible on the reducer housing. Fit the main oil drain with a 25 mm 1-inch stainless steel ball valve with a pressure-temperature rating of [13.8 MPa 2000 psig at 38 degrees C 100 degrees F]. Plug the valve on the open end.[Include a 25 mm 1-inch filter ports with 25 mm 1-inch stainless steel ball valve to be connected to the portable filtering unit where specified, otherwise cap the ends.] Also provide the lower bearings with drainable deepwell bearing end caps as indicated. Locate drain and fill plugs for speed reducers so as to be readily accessible on the completed units and provide with extension piping where required. Manifold and pipe the drains to a single point with a shutoff valve and threaded cap on the exterior of the housing so that it is easily accessible. The design of the reducer housing should minimize potential for water intrusion as the reducers will be continuously exposed to all weather conditions. This includes raising the upper bearing caps on top of the housing to prevent standing water from seeping into the enclosure. Internally raise lower bearings within the housing to prevent bearings from being the lowest point in the housings. Top side inspection covers are not acceptable. Provide side inspection access covers. All dimensions indicated are to remain as shown as a minimum for proper machinery alignment[, as well as interchangeability with other reducers within the [_____] District].

2.4.2 Gearing

****

NOTE: Coordinate with the gearbox manufacturer to determine the heat treatment and hardening method best suited to satisfy the operational conditions for the gearbox.

Several references from AGMA have been withdrawn in lieu of AGMA ISO 1328-1-B14. The most notable change is the Tolerance Class. Tolerance class has replaced Quality class e.g., Quality 11 is no longer accurate to say in a spec. AGMA 2015 gives accuracy grades with a scale of A2-A11 with A2 being the highest accuracy. AGMA 2000-A88 used a quality class on a scale of Q3-Q15, where Q15 would be the highest quality. Designers should be aware of the differences in scales and coordinate with the gear manufacturer regarding gear quality standards and scales.

****

Provide [spur] [helical] gearing made from high strength alloy steel that is hardened by [flame][induction][carburizing] with subsequent quenching and tempering to produce a [through][case] hardened gear. Grind the gears after gear cutting to achieve a minimum class [A] [_____] in accordance with AGMA ISO 1328-1-B14.[Integrally cut the [helical] pinions on the pinion shaft.][Make spiral bevel gears from high strength alloy steel with case hardened teeth, crown lapped for quality and smooth operation.]

2.4.3 Reducer Shafts

Make shafts from high-strength alloy steel in accordance with ASTM A668/A668M and of sufficient size and as indicated to insure rigid alignment. Provide keyways with fillet radii. Provide keys for all shafts. Design shafts in accordance with the requirements of ANSI/AGMA 6001. For keys and keyseats, see paragraph KEYS AND KEYSEATS.

2.4.4 Shaft Bearings

Provide shaft bearings which are high capacity antifriction roller bearings suitable for both radial and thrust loads that have a minimum L-10 bearing life of [75,000] [_____] hours based on the largest full load motor kW horsepower provided by the specified motor.

2.4.5 Gearbox Lubrication System

****

NOTE: A pressure or combination system generally is specified for right angle gearboxes that might have gearing above the oil line or a gearbox with slow moving gearing. If a splash type system is used, delete the requirement for the pump.

****

Provide a [splash] [pressure] [combination pressure/splash] type system using a [synthetic] [petroleum based] hydro-carbon lubricant conforming to the requirements of ANSI/AGMA 9005.[The pressure lubricating system consists of an electric motor driven lubricating gear pump and piping assembly which lubricates the upper bearings and gear meshes not submerged in oil. Provide a pump which is positive displacement [internal][external] gear type, cast iron construction. Equip the pump with an overpressure relief valve. [Internally][Externally] mount the pump on the gear box and provide with the proper seals to operate under the stated conditions. The gear reducer manufacturer is to design the lubrication system. Install external and internal piping as required to provide adequate lubrication to the gear meshes and bearings. Define, document and submit the pressure losses, total flow rate, and expected flow rate to each component and/or gear mesh. Mount a flow switch, pressure switch, and pressure gauge on the pump outlet.] Design the lubrication system to function properly at both nameplate speed ratings using the specified lubricating oil. All gears and lower bearings [with the exception of the lower bearing of the vertical (down) output shaft] are to be oil lubricated. All upper bearings are to be oil and/or grease lubricated. Provide all required oil slingers, dams, and passages.[House the lower vertical output shaft bearing in the dry well and grease lubricate.] Provide grease lines and lubrication fittings for all grease lubricated bearings and mounted on the reducer housing such that the bearings can be easily identified and lubricated from the side of the reducer housing. Equip the reducer with a sight gauge and dipstick in order to observe and measure the oil level. Also, fit the speed reducer with an oil sample valve arrangement. The valve is to be a 6 mm [1/4-inch] stainless steel ball valve with a pressure-temperature rating of 13.8 MPa [2000 psig at 38 degrees C 100 degrees F] and be fitted with a plug on the open end. Locate the oil sample port on the reducer housing such that an oil sample can be drawn (through the sample valve) from a point that is approximate 1/2 of the operating oil level in the reducer.

2.4.6 Seals

Provide spring loaded grease-purged dual lip seals for all shaft extensions. Design and size all seals to withstand the pressure head developed when the speed reducer is completely filled with oil (storage condition) without leaking.

2.4.7 Heater

****

NOTE: Use caution when specifying heaters for use. Give careful consideration to attempt to select a lubricant with the characteristics and viscosity range that is suitable for the anticipated operating conditions vs. randomly specifying heaters for use in the system. Damage and premature degradation of lubricants can result from high temperatures or excessive heating. Consult with the gearbox manufacturer to best access the lubrication requirements and need for auxiliary heating.

****

[Provide electric heating elements which have a maximum watt density of [1.5][_____] W/sq.cm [10][_____] W/sq.in. and have a supply voltage of [240][_____] Volt AC, [1][_____]phase.]

2.4.8 Breather

****

NOTE: Standard breather may be provided. However, to help prevent water contamination, a hygroscopic breather is recommended for gearboxes exposed to the environment.

****

Provide all reducers with a hygroscopic breather with threaded fittings for installation to prevent problems caused by moisture and particulate matter contamination in the reducer when it breathes in and out due to temperature fluctuations. Provide a breather rated to filter particles down to 3 µm microns in size which includes a hygroscopic agent indicator which changes color signifying when the unit requires replacement, i.e., when the desiccant is saturated with moisture. Air flow stoppage through the breather under freezing conditions is not allowed.

2.4.9 Lubrication

Provide lubricating oil for speed reducers which has good resistance to foaming under normal operating conditions and be noncorrosive to speed reducer components. Provide the oil in accordance with the gearbox manufacturer's requirements unless otherwise specified herein. Submit lubricant characteristics, physical properties and product data.[Provide lubricant in compliance with ANSI/AGMA 9005 and be [AGMA 5EP][______]]. Provide lubricant suitable for infrequent intermittent duty operation of the speed reducers with an ambient temperature range from minus 23 degrees C to plus 43 degrees C minus 10 degrees F to plus 110 degrees F. Lubricate couplings and bearings in accordance with the manufacturer's instructions.

2.4.10 Portable Filtering Unit

****

NOTE: Portable oil filtering unit may be desired if the gearbox unit will be exposed to the weather. Moisture can collect in the unit and become suspended in the oil. The liquid water that has separated can be drained off but the oil must be filtered to remove water still in solution. Heaters

can be provided to heat the oil. However, they are not energy efficient, can damage the oil, and may not completely prevent moisture intrusion. The designer may also elect to design a heated kidney loop filtration system which is integral to the gearbox for critical applications requiring continuous filtration during gearbox operation.
****

Provide [one][_____] portable filtering unit for use with the specified gear reducers.

a. The portable filtering unit is required to be [1.1][_____] kW [1.5][______] horsepower, 110-120 volt, [1,140][_____] RPM high efficiency, positive displacement, rotary internal gear type pump with a mechanical seal. Provide a pump capable of delivering [0.5][_____]L/s [8][_____] gallons per minute flow rate. Provide a pump which is self-priming and designed to handle liquids of 35 SSu to 1000 SSu viscosity, while able to develop 625 mm 25 inches of mercury vacuum at zero MPa psi. Equip the filtering unit with an ON/OFF switch, High/Low pressure switch, two interchangeable filter housings, one set of hose assemblies on a portable rolling cart frame.

b. Equip the one set of filter element with replaceable [5][_____] µm micron filter cartridges.[The portable filtering unit separates water from the oil by coalescing and gravity separation. The water sinks to the bottom and accumulates until it is periodically bled off. Design the coalescing chamber to handle dissimilar liquids with a specific gravity difference of 0.09 and greater, leaving the effluent with less than 10 ppm of the discontinuous phase. The coalescing element has an indefinite life, with replacement required only when it becomes plugged with solid particles.] Provide a multiple element filter with a non-channeling seal. A non-channeling seal has the flow of oil carrying the contaminants into the depths of the filter media with no flow restriction from surface loading. Each element removes water from wet oils. The multiple element filter consists of four or six sections in one housing that all work at the same time. Design the filters so that water and contaminants are absorbed in the filter element. The capacity of the filter element should be approximately 4 L1 gallon of water. A coalescing chamber is not necessary for the portable filtration system.

[c. Provide the portable filtering unit secured on a dolly or wheeled cart with all the necessary fittings, hoses, and pipe to connect the unit to the reducer using standard hand tools.]

2.5 BEARINGS

2.5.1 Pillow Block Bearing Assemblies

The pillow block bearing assemblies include the bearings, housings, seals and hardware. Housings are to be [one piece][split] type, with [stainless steel] [painted cast iron][painted cast steel][______] machined base housing with a [through drilled][tapped], [two bolt][four bolt] base.[Design split housings with dowels or steps to provide alignment accuracy.] Except as otherwise specified, shaft bearings are to be high capacity antifriction [spherical][tapered] self-aligning roller bearings suitable for both radial and thrust loads with pressure lubrication fittings. Use the manufacturer's ratings for loads and speeds in determining the bearing capacity. Comply with the bearing manufacturer's recommendations for service and installation factors. Provide bearings which are capable of withstanding the total resultant normal loads and axial loads as specified below.

Bearing Mark/ID No	Normal Load (Kg) (Lbs)	Axial Load (Kg) (Lbs)
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

Provide [floating][fixed] type bearing as indicated. Provide end caps on open ended shafts. All cap bolts are to be SAE Grade [8] [_____]. Provide locking rings, set screws, lock nuts, spacers, and the necessary sleeves to center and secure the bearings within the housing. Provide bearings which have a minimum L-10 bearing life of [75,000] [_____] hours as defined by ISO 281 or JSA JIS B 1519 based on the largest full load motor kW horsepower provided by the specified motor. Design the bearing and housing for [grease][oil] lubrication and equip with [labyrinth] [______] type shaft seals made of materials suitable for the working conditions and lubricant to be used to exclude foreign matter and retain lubrication without leakage under both static and dynamic operating conditions.

2.5.2 Sleeve Type Plain Pillow block Bearing Assemblies

[Provide [one piece][split] type bearing pillow block, [stainless steel][painted cast iron][painted cast steel][________] machined base housing with a [through drilled][tapped], [two bolt][four bolt] base. [Split housings are to have dowels or steps to provide alignment accuracy.]] Provide sleeve type plain bearings which have bronze alloy material suitable for the installation and conform to the requirements of ASTM B271/B271M or ASTM B584, Alloy [C93200][_____]. [Press-fit][Epoxy][_____] the sleeve type plain bearings into the bearing housing bore.[Use [retaining sets screws][locking pins][keys][machine screws] to secure the plain sleeve bearings.] Provide machined grease and oil grooves in the interior of the bearing unless otherwise shown. Break all edges of the grease grooves to provide a minimum [1.6][_____] mm [1/16][_____] inch fillet radius.

[2.5.3 Self-Lubricated Bearings

Conform self-lubricated and composite type bearings to the requirements of Section 35 05 40.17 SELF-LUBRICATED MATERIALS, FABRICATION, HANDLING, AND ASSEMBLY.

]2.6 SHAFTS

****

NOTE: For shafts to be designed by the Contractor the designer may select the following paragraph.

****

[Calculate and design shafts to satisfy the requirements of Corps of Engineers' guidance specified in EM 1110-2-2610. Design shafts at minimum to provide a factor of safety of 5 when maximum load condition stresses are compared to the ultimate strength of the material and the stresses produced by the maximum torque of the motor do not exceed 75 percent of the material yield strength. Equations used for design are to conform to the requirements of the ASME shafting code. Apply a combined shock-and-fatigue factor of 1.25. Limit the maximum shaft bending moment shaft deflection to 0.83 mm/m 0.01 in/ft of length at the maximum rated load. The torsional shaft deflection cannot exceed 0.26 deg/m 0.08 deg/ft of shaft length.]

2.7 SHAFT COUPLINGS

Provide [flexible disk] [elastomeric] [chain] [gear] [grid] [jaw] type of machined [steel] [stainless steel] construction capable of transmitting the applied design torques.

2.7.1 General

Provide couplings capable of the [vertical] [or] [horizontal] installation and design for [non-reversing][reversing] loads and a maximum [3000][_____]RPM operating speed. The couplings are to be capable of handling a maximum torque of [_____] Nm inch-pounds.[Design couplings to compensate for angular, parallel and axial misalignment. Provide couplings with a general service factor of [1.0][_____] applied to their selection and design based upon the anticipated application and expected service.] Provide couplings with sufficient capacity to develop the full strength of the shafting which they connect and are to be pressed and keyed thereon. All hub bores are to meet the dimensional and tolerance specifications in accordance with AGMA 9002 unless otherwise indicated. The key fit design is to be in accordance with paragraph entitled KEYS AND KEYSEATS. Submit the fabricated dimensions of the shaft bores. Equip couplings with lube plugs; enclose and seal with an elastomeric O-ring to retain the lubricant. Provide couplings which are oiltight under both static and dynamic operating conditions. Use SAE grade 8 bolts unless specifically used for shear applications by the manufacturer to achieve published shear strengths. Minimize misalignment for gear couplings by not exceeding the manufacturer's recommendations for installation limits pertaining to gap-hub separation, angular alignment, and parallel offset alignment measurements.

2.7.1.1 Flexible Disk Couplings

Use high strength stainless steel flexible disks to transmit torque and have no moving parts of backlash. Lubrication of the coupling is not required. Provide couplings of the [close coupled] [floating shaft] design. Dynamically balance the coupling in accordance with AGMA standards to achieve a AGMA [7] [_____] balance class.

2.7.1.2 Elastomeric Couplings

Provide [one-piece][two-piece][through bolt inserts] molded [EPDM][Neoprene][Urethane] sleeves to transmit torque with keyed metal flanges secured with set screws. The elastomeric coupling are to have a minimum service factor of [1.0][_____].

2.7.1.3 Chain Couplings

Provide hardened teeth sprocket hubs with a connecting ANSI Standard Double Width Roller Chain to transmit torque. Secure hubs to the shaft by means of keys/keyways. Furnish a sealed coupling cover of [die-cast aluminum] [stamped steel] material to retain lubricant. Provide rounded edge design covers with recessed and threaded lubricant plugs to fill and retain lubricant.

2.7.1.4 Gear Type Couplings

Flanged with exposed bolt, double engagement, made of forged steel. Provide ouplings which transmit torque by means of external gears on hubs engaging in internal gears on the coupling sleeves. Machine gears in accordance with AGMA 9002 and AGMA 908.

2.7.1.5 Grid Type Couplings

Keyed shaft hubs with slotted faces to connect each coupling half through an interlocking tapered high tensile metal alloy grid. The grid needs to be fully enclosed in a sealed [horizontally] [vertically] split cover to retain the lubricant. Provide rounded edge design covers with recessed and threaded lubricant plugs to fill and retain lubricant.

2.7.1.6 Jaw Type Couplings

Keyed shaft [stainless steel][sintered iron] hubs of the fail-safe spider design. Furnish set screws to secure the hubs. Make coupling insert material of [bronze][Buna-N][Urethane][_____] to transmit torque.

2.7.2 Torque Limiting Couplings

****

NOTE: Torque limiting couplings prevent motor over-torque which could result in damage to the equipment.

****

Install a [mechanical friction] [ball-detent] [_____] type torque limiting coupling limit applied torque of the electric motor for equipment protection. Design the torque limiting coupling to slip if the machinery torque exceeds [_____] N-m inch-pounds. The coupling is to continue to slip until the torque drops below this level. Provide a flexible type coupling design with bored and keyed steel hubs[and a steel grid which fits into the periphery of the coupling hubs].[Provide friction linings of the segmental type design and are easily replaced without removing connected equipment.][Hardened steel balls that are spring loaded in machined detents control the slip setting of the coupling.] Control the torque slip range by a spring type mechanism which can be adjusted by means of tightening or loosening bolts or adjustment nut. The torque slip is to have an adjustment range of plus or minus [20] [_____] percent of the specified load. Equip the spring mechanism with machined spacers of a specific length determined by the required slip setting. Preset the coupling slip setting at the factory. Equip the coupling with self lubricated bearings to permit free rotation when slipping. Provide elastomeric coupling seals that are both water and dust tight and have a fitting that allows grease lubrication. [Break in mechanical friction torque limiting couplings after assembly to the motor shafts. This consists of operating the couplings at a pre-determined number of revolutions at 100 percent slip and then re-setting the spring compression distance as described in the manufacturer's installation instructions.]

2.8 ELECTRIC MOTORS

****

NOTE: Coordinate with the respective electrical or

mechanical designers to ensure motors are not being specified elsewhere in the contract documents and that all motor requirements are satisfied.
****

Provide a motor with Horizontal shaft, squirrel cage induction, high slip, high torque, [dual horsepower rated], [two winding,] [two speed,] [460] [_____] volt, 3 phase, 60 Hertz type motor controlled by [across the line magnetic starter][Variable Frequency Drive] rated for continuous duty and conform to the applicable requirements of NEMA MG 1 and rated at a minimum of 8 percent and maximum of 13 percent slip for [both high and low speed] windings. The enclosure is to be totally enclosed, fan cooled, and weatherproof type. Provide the motors with a removable stainless steel drain. Remove the drain as specified by the motor manufacturer.[Motor installation is in an exterior location subjected to the weather elements.] Speed/torque characteristics are to be as described herein. Provide conduit box for incoming power with two [38] [_____] mm [1-1/2] [_____] inch diameter holes for installation of watertight fittings on the power cord. Provide conduit box for heater power with two [19] [_____] mm [3/4] [_____] inch diameter holes for installation of watertight fitting on the heater power cord. Locate conduit boxes on the side of the motor as indicated. Seal the motor shaft with a labyrinth type seal where the shaft penetrates the front and back of the motor.

2.8.1 Ratings

Rate tThe [gate][_____] motors at [/][_____] kW [20/6.25] [_____] horsepower at [745/230] [_____] RPM (high/low speed) based on [900/300] [_____] RPM synchronous speeds. The 100 percent full load speed values proposed for the new motor are not be less than [740] [_____] RPM and not more than [775] [_____] RPM for high speed and not less than [230] [_____] RPM and not more than [260] [_____] RPM for low speed at the specified horsepower values. Locked rotor torque are to be in a range from 200 to 300 percent of full load motor torque for high speed and from 250 to 300 percent of full load motor torque for low speed. [The motor has to havebreakdown torque.] It is preferred to optimize characteristics at full load conditions and allow locked rotor torque to be in the previously specified range if there are design trade-off's between full load torque and locked rotor torque values.

2.8.2 Construction

Motor frame size is to be a minimum of a NEMA [445TS] [_____] for the [gates][_____]. Temperature rise cannot be greater than [80] [_____] degrees C [176] [_____] degrees F. Provide an internal heater of the strip type as part of the motor. The heater is to have a minimum capacity of [90] [_____] W and have separate leads terminating in a separate conduit box. Heater power supply is to be 120 volt, 60 Hertz, single phase. Use Class F insulation throughout the motor. Impregnate motor windings with the insulating compound by the vacuum/pressure impregnating method. Repeat the procedure until all voids in the winding are completely filled with the insulating material. Provide antifriction type motor bearings incorporating a suitable method for lubrication. Bearing ratings are to meet or exceed a L-10 life of 30,000 hours at full radial load. Provide the motor with a visible nameplate indicating motor horsepower, voltage, phase, hertz, RPM, full load amps, frame size, manufacturer's name and model number, service factor, and serial number. Submit motor performance data at the time the motors are submitted. The data includes: percent efficiency, percent amperes, percent power factor, and percent slip plotted against 0 to maximum allowable motor overload above 100 percent for both high and low speed windings; and torque (N-m) (ft-lb.) and amperes plotted against 0-100 percent synchronous speed for both high and low speed windings.

2.8.3 Electric Motor Factory Tests

Factory test all motors to ensure that they are free from electrical and mechanical defects. Perform tests in compliance with IEEE 112 and NEMA MG 1. Document test results in accordance with the guidance indicated in IEEE 112 and NEMA MG 1. Testing includes the following. Additionally, perform all tests normally conducted by the manufacturer as part of its quality control program, but not specified herein.

2.8.3.1 No Load Test

For each winding (high and low speed); at no load and rated frequency and 100 percent rated voltage; record the current, voltage, frequency, kilowatt input, and RPM.

2.8.3.2 Locked Rotor Test

For each winding (high and low speed); with the motor blocked and at rated test frequency and 50 percent rated voltage; record the voltage, current, frequency, and kilowatt input. Repeat for 100 percent rated voltage.

2.8.3.3 High Potential Test

For each winding (high and low speed): Record voltage and duration.

2.8.3.4 Stator Winding Resistance Test

For each winding (high and low speed): Record resistance in ohms between the stator winding terminals. Record the temperature in degrees C.

2.9 BRAKES

****

NOTE: Brakes can be either AC or DC type. If electrohydraulic AC Thruster brakes are specified, delete paragraph RELEASE MAGNETS AND RECTIFIER below. If AC solenoid or DC magnet operated brakes are specified, delete paragraph ELECTROHYDRAULIC ACTUATOR.

****

Provide brakes that are self-adjusting, shoe type, spring set, [released by a sealed electrohydraulic AC thruster actuator] [with DC magnet operated release][with AC-rectified solenoid release] and are completely enclosed in a water-tight and dust-tight enclosing case arranged for floor mounting. The brake is to be [alternating current] [direct current] type rated for [120] [240] [460]-volts, [1] [3]-phase, 60 Hertz with an operating torque rating of [271] [_____] N-m [200] [_____] foot-pounds with a [250] [_____] mm [10] [_____] inch wheel bored for mounting on the brake shaft. Base the torque rating on open construction continuous duty. The brake is to be self-adjusting such that compensation for shoe wear is automatic. Provide a manually operated hand release, [external][internal] to the brake enclosure. The brake torque field setting cannot be less than [125] [150] [_____] percent of the full load torque of the motor when referred to the shaft on which the brake wheel is mounted.

2.9.1 Electrohydraulic Actuator

Consists of an electric motor that drives an impeller inside a fluid filled, heavy-duty, cast [aluminum][_____] housing. The rotation of the impeller is to develop hydraulic pressure to extend a cylinder which releases the brake by overcoming the main spring. Provide an adjustable valve to allow setting the brake timing. Completely enclose the actuator in the housing. Provide a fluid which is suitable for operation in temperatures to [minus] [plus] [4] [_____] degrees C [40] [_____] degrees F.

2.9.2 Release Magnets and Rectifier

Provide releasing magnets of the [AC][or][DC] shunt type and of standard stock design. Supply direct current by means of a self-contained rectifier unit of proper rating and suitable for operation on [120] [240] [460]-volt, [1] [3]-phase, 60-hertz, alternating current electrical power. The complete unit (brake and rectifier) has to be suitable for connection to the power circuit of the motor with which the brake is used so that the brake will set or release when the motor is de-energized or energized, respectively. The rating of the rectifier and the brake releasing magnet are to be in accordance with the brake rating requirements specified and be sufficient to release and hold the brake in the released position with 85 percent of rated voltage impressed on the incoming terminals of the rectifier. The brake is to operate satisfactorily at up to 110 percent of rated voltage. Provide a forcing contactor for operation of the DC operated magnet.

2.9.3 Enclosing Case

Provide a NEMA Type 4 enclosing case with watertight grease pressure lubricated shaft seals of a standard manufacturer. Hold the cover in place by heavy hinge bolts and wing nuts. Provide enclosing case for 115 volt AC space heaters. Space heaters total capacity is to be a minimum of [62] [_____] watts. Heaters are provided by the brake manufacturer. provide a bottom mounted drain and breather unit on the enclosure to allow condensate water to drain, but prevent outside water from entering the enclosure. Provide the enclosure with a shaft seal for each shaft penetration through the enclosure.

2.9.4 Mechanical Construction

Except for brake wheels, shoes, and electrical parts, no cast iron is allowed in brake construction. All pins, fittings and other miscellaneous small metal parts are to be of corrosion-resisting metal. Fit bearings with bronze or other approved bushings to prevent any binding of moving parts. Antifriction bearings of corrosion-resisting construction may be used. Provide means for lubrication for all bearings, unless bearings are of a self or pre-lubricated type. Provide and attach a nameplate of corrosion resisting material to a part of the brake which ordinarily will not be replaced. The nameplate is to indicate all necessary information required by this specification. Provide a manual release mechanism to allow removal of wheel or permit lining replacement without readjusting torque setting. Provide a mMagnet coil which is epoxy coated.

2.10 GUARDS AND COVERS

Provide safety guards or covers where necessary to protect the operators from accidental contact with moving parts. Provide openings in guards and covers as necessary to provide access to parts requiring lubrication or regular maintenance.

2.11 STRUCTURAL BASES AND SUPPORTS

For specific requirements for welded structural steel bases, frames, and supports see Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.12 OPEN [SPUR] [HELICAL] GEARS

****

NOTE: Coordinate with the gear manufacturer to determine the heat treatment and hardening method best suited to satisfy the operational conditions for the gears.

Several references from AGMA have been withdrawn in lieu of AGMA ISO 1328-1-B14. The most notable change is the Tolerance Class. Tolerance class has replaced Quality class e.g., Quality 11 is no longer accurate to say in a specification. AGMA 2015 gives accuracy grades with a scale of A2-A11 with A2 being the highest accuracy. AGMA 2000-A88 used a quality class on a scale of Q3-Q15, where Q15 would be the highest quality. Designers should be aware of the differences in scales and coordinate with the gear manufacturer regarding gear quality standards and scales.

****

2.12.1 Gearing

Make all [spur] [helical] gearing from high strength alloy steel that is hardened by [flame][induction][carburizing] with subsequent quenching and tempering to produce a [through][case] hardened gear. Grind the gears after gear cutting to achieve a minimum class [A] [_____] in accordance with AGMA ISO 1328-1-B14.[Integrally cut the [helical] pinions on the pinion shaft.][Make spiral bevel gears from high strength alloy steel with case hardened teeth, crown lapped for quality and smooth operation.] Make keys of [ASTM A108, UNS G10180 (ASTM A1018/A1018M),] [_______] keystock. Certified material test results for the drive pinion and drive pinion shaft are required.

Fabricate the overall dimensions and configurations of new [open] [spur] gears and mating shafts as indicated and manufacture to achieve a AGMA gear class of [A][_____] or better per AGMA ISO 1328-1-B14 and be supplied as match marked sets. Factory test all gears in accordance with the TESTING paragraphs of this specification. [Spur] [Helical] gear teeth are to be of the involute form. Cut pinion gears from solid steel and fabricate from [ASTM A148/A148M Grade 80-40 steel] [ASTM A291/A291M forged steel, Grade [7][_], Class [H][_]] [________]. The Brinell Hardness is to be a minimum 50 (BHN) greater than the Brinell Hardness of the mating gears. Harden the gear teeth as specified to measure at any point on the tooth face within [360] [_____] to [400] [_____] BHN after finishing. The ends of the pinion teeth need to be end relieved to prevent end loading. Crown the gear teeth as indicated.

2.12.1.1 Pinion "Drive" Gear

Pinion "drive" gear is to have a pitch diameter of [_____] mm inches. with a tooth provide of standard 20-degree full depth involute with a diametral pitch of [0.75] [_____]. Teeth width are to be [_____] mm inches. Accurately machine cut teeth to American Gear Manufacturer Association (AGMA) tolerance of No. 6 or better quality. Machine the inside rim of the gear as indicated and drill to match the mounted [shaft] [motor] [_____]. Verify machining dimensions to assure proper mounting. Manufacture gears from steel meeting the requirements as stated above. Scribe the pitch line, and two indexing lines offset 3 mm 1/8-inch to each side, on the top of the gear teeth of all mated gears to aid in installation alignment.

2.12.1.2 [Sector][Bull][Spoked][_____] Type Gears

Gears have through hardened teeth and are of fabricated or cast construction. Show the overall dimensions and configurations of the [sector][_____] gear be as indicated. Make the rim of the [sector][_____] gear of [ASTM A290/A290M forged steel, Grade [3][_], Class E[_]][_____]. The material of the spokes, hub and other parts of the [sector][_____] gear are determined based on design requirements. Conform cast hubs, spokes and arms to the requirements of [ASTM A148/A148M, Grade 90-60][_____]. Submit certified material test results for the gears and shafts. [Overhung gears on shafts and speed reducers are not be acceptable.]

2.12.2 Contractor Designed Gearing

****

NOTE: The designer should consider requiring a contractor with a manufacturing certification when specifying contractor designed gears. E.g. AGMA or ISO certifications.

****

Contractor designed gearing is to be engineered, designed, and manufactured by a gear manufacturer who has prior experience in designing and supplying the specified size gearing [and holds a quality certification of [_____]]. Submit the manufacturer's required calculations and shop drawings for the design and fabrication of the identified gearing prior to the start of shop fabrication. Design the [spur] [helical] gears in accordance with ANSI/AGMA 2001 with life factors CL and KL equal to unity and reliability factors CR and KR equal to 1.00 or greater. The reduction set number used in the design calculations cannot be greater than 3. The normal strength kW horsepower rating of the [spur] [helical] gears cannot exceed 1/2 of the peak strength kW horsepower rating as determined by ANSI/AGMA 2001. Durability rating of gears is to be as determined by ANSI/AGMA 2001 and based on a service factor of 1. The pinion is to have a generated tooth form as indicated.

2.13 PINTLE BUSHING

****

NOTE: The following paragraphs are included if the pintles are not specified with the lock gates. Choose the first paragraph if the pintle bushing is a greased bronze design. Choose the second paragraph if a self-lubricated pintle bushing is to be furnished and designed by the Government or a self-lubricating bearing manufacturer.

Self-lubricated pintle bushings must have performance criteria provided to allow the manufacturer to design and fabricate the pintle and bushing.
Additional paragraphs may be required for gate and shoe pintle components that are not included in this guide specification due to the wide variance in designs requirements. Recommendations for material selection of pintle bushing sockets, pintle shoes and pintle bases can be found in ERDC/CERL TR-02-7, Advanced Materials Selection Guide for Lock, Dam, and Hydroelectric Plant Components.

****

[Provide a grease lubricated alloy bronze pintle bushing to the dimensions and tolerances indicated. For the bushing material use either stainless steel conforming to [ASTM A564/A564M, Type 630, UNS S17400][_______] or aluminum bronze alloy and conform to the requirements of [ASTM B148][or][ASTM B271/B271M], [C95400][_______]. [Pattern cast and machine the bushing] [Machine the bushing from a solid piece of material] to acquire the shape and surface finishes indicated. [Provide a surface finish of[16][_____] µm micro-inches or better on the running bearing surface.] [Press fit][Mechanically secure] the bushing into the gate as indicated without distortion or altering the fit with the mating pintle ball.]

[Provide a greaseless self-lubricated pintle bushing [to the dimensions and tolerances indicated][designed by the self-lubricating bearing manufacturer to meet the requirements provided for bearing performance].[Conform the self-lubricated bearing composite material and bearing design to the requirements of Section 35 05 40.17 SELF-LUBRICATED BEARING MATERIALS, FABRICATION, HANDLING, AND ASSEMBLY.] Provide [one piece] [two piece] pintle bushings [and hinge ball bushings] from an approved manufacturer listed in 35 05 40.17 SELF-LUBRICATED BEARING MATERIALS, FABRICATION, HANDLING, AND ASSEMBLY. Bushing bearing surfaces for fabric reinforced polymers are to have a minimum thickness of 2 mm 1/12 inch (0.083 inch). Sprayed polymer coatings are to have a minimum thickness of 0.5 mm 2/100 inch (0.020 inch). The Bushing substrate material are to meet the requirements of ASTM B148, Alloy [C95400] [_____].]

[Provide a debris seal of the dimensions and materials as indicated with the pintle bushing. Mate the bushing bearing surface with the pintle ball through metrology methods and the use of a calibrated scanning probe coordinate measuring machine that meets the requirements of ISO 10360-2, [by [lapping] mating components], via [_____] to achieve the indicated tolerances and [compare] [test] with contact [measurements] [dye] [tape] [_____] to confirm uniform bearing contact. Test the contact area between the mating components, witnessed by the Government, to achieve a bearing contact area of [85][___] percent or better to be acceptable. Perform nondestructive examination testing of pintle bushings, balls and fabricated pintle components in accordance with the requirements of paragraph NONDESTRUCTIVE EXAMINATION.]

[The maximum static bearing pressure for the pintle bushing are not to exceed [17][_____] MPa [2500][_____] psi when a normal load of [_____] N pounds is applied at an angle of [_____] degrees from horizontal or [34][_____] MPa [5000][_____] psi during dynamic operation. Pintle bushings will operate submerged [and hinge] bushing will normally be dry but may be exposed to rain water.]

2.14 PINTLE BALL

Fabricate pintle ball(s) from steel castings conforming to [ASTM A487/A487M, Grade 13 Modified (Nickel 3.25-3.75)] [ASTM A743/A743M, Grade CF8, UNS J92600] [ASTM A744/A744M, Grade CF8, UNS J92600], ASTM A27/A27M, Grade 70-36, Class 2, [______] or age-hardened stainless steel forgings in accordance with [ASTM A473, Type 303, condition A, UNS S30300] [ASTM A705/A705M, UNS S17400, Type 630, minimum hardness 40 Rc] [______]. Machine pintle ball(s) to meet the dimensions, surface finish and tolerances as indicated. Any casting patterns developed become property of the Government and are to be packaged for long term storage with the pertinent part identification provided on the exterior packaging. [Free float][Press fit][Mechanically secure] the pintle ball into the pintle casting as indicated without distortion or altering the fit with the mating pintle bushing. Furnish removable lifting eyes with the pintle ball for lifting. Mate the pintle ball bearing surface with the pintle bushing through metrology methods and the use of a calibrated scanning probe coordinate measuring machine that meets the requirements of ISO 10360-2, [by [lapping] mating components], via [_____] to achieve the indicated tolerances and [compared] [tested] with contact [measurements] [dye] [tape] [_____] to confirm uniform bearing contact. Test the contact area between the mating components, witnessed by the Government, to achieve a bearing contact area of [85][___] percent or better to be acceptable. [The maximum static bearing pressure for the pintle ball is not to exceed [17][_____] MPa [2500][___] psi when a normal load of [_____] N pounds is applied at an angle of [_____] degrees from horizontal or [34][_____] MPa [5000][_____] psi during dynamic operation.]

2.15 PINTLE SHOE

Fabricate pintle shoes from steel castings conforming to [ASTM A27/A27M, Grade 70-36, (UNS J03501)] [_____]. Machine pintle shoes to meet the dimensions, surface finish and tolerances indicated. Any casting patterns developed become property of the Government and are to be packaged for long term storage with the pertinent part identification provided on the exterior packaging.

2.16 PINTLE BASE

Fabricate pintle bases from steel castings conforming to [ASTM A27/A27M, Grade 60-30, (UNS J03000)] [_____]. Machine pintle bases to meet the dimensions, surface finish and tolerances indicated. Any casting patterns developed become property of the Government and are to be packaged for long term storage with the pertinent part identification provided on the exterior packaging.

2.17 ENGINEERED CHAIN

****

NOTE: This and following five Articles can be retained and edited or deleted as needed depending on the gate hoist equipment specified.

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2.17.1 Corrosion-Resisting Steel Flats and Rounds

Conform corrosion-resisting steel flats and rounds [ASTM A564/A564M, [Type 630][_____], minimum charpy-V notch impact value of [20][_____] Nm [15 foot-pounds][_____] at -18 degrees C 0 degrees F; or [ASTM A564/A564M, Type

XM-25, Condition H1050], age-hardened heat treatment condition, hot-finished or cold-finished, Class C, minimum charpy-V notch impact value of [20][_____] Nm [15 foot-pounds][_____] at -18 degrees C 0 degrees F.][Furnish ASTM A564/A564M, Type 630 material to provide a minimum yield strength of 1000 MPa 145,000 psi, minimum Brinell Hardness of [331][_____] unless otherwise indicated.][Furnish ASTM A564/A564M, Type XM-25, H1050 material to provide a minimum yield strength of [930][_____] MPa [135,000] [_____] psi, minimum Brinell Hardness of [321][_____] unless otherwise indicated.]

2.17.2 Nickel-Aluminum Bronze Flats and Corrosion-Resisting Steel Rounds

Conform Nickel-Aluminum bronze flats to [ASTM B505/B505M, UNS C95500HT][_____] to provide a minimum yield strength of [427][_____] MPa [62,000][___] psi and rounds to [ASTM A564/A564M, Type 630][_____], minimum charpy-V notch impact value of [20][_____] Nm [15 foot-pounds][_____] at -18 degrees C 0 degrees F.

2.17.3 Pins

Fabricate normal and long pins from [ASTM A564/A564M, Type XM-25, Condition H1050][_____] stainless steel. Provide material which is certified by the steel manufacturer to provide a minimum yield strength of [930][_____] MPa [135,000] [_____] psi in accordance with ASTM A564/A564M. Heat treat at the mill that supplies the alloy in accordance with the relevant ASTM heat treatment instructions.

2.17.4 Retaining Rings

Provide retaining rings of [multiple-turn][_____] stainless construction. Provide retaining rings with offset permanently set into the design of the ring spiral to provide parallel flat sides that mate parallel against the groove wall. Provide retaining rings similar in design to [Smalley, model WST-400-S02 series][_____]. Provide a minimum of [667][_____] kN [150,000][_____] pounds thrust shear strength capacity with the retaining rings when installed in the recommended groove detail. Size the retaining rings to match the pin groove details as indicated unless otherwise approved.

2.17.5 Hardness

Hardness for material as indicated.

2.18 ROUND LINK CHAIN

2.18.1 Calibrated Hoisting Chain

Furnish [two][four][_____] lengths of calibrated hoisting chain , as indicated, for each [tainter][_____] gate hoist. Provide chain with [34 mm x 126 mm][[_____] mm x [_____] mm] [1.3 inches x 5 inches][[_____] inches x [_____] inches] [ASTM A322, UNS G8620, Grade 2 alloy steel] [_____] round link type manufactured to DIN 22252. Machine weld the links, and grind the welds to comply with the dimensions indicated. After welding, heat treat the chain to yield a minimum case hardness of [340][_____] BHN. Machine fit the chain to the tolerances set forth in DIN 22252. After heat treating, proof test each link of chain to [1080][_____] kN [242,800][_____] pounds. After proof testing, visually inspect the chain for permanent deformation cracks and deformed links. After proof testing and visual inspection, immersion coat the chain with a corrosion resisting coating of [TECTYL 846, Class I][MIL-PRF-16173E, Grade 4, Class I]. Tensile test a sample of finished chain to destruction to determine its breaking strength. The breaking strength can not be less than [1450][_____] kN [326,000][_____] pounds. [Make one 7.5 m 25-foot long test chain, of the above specification, available to the manufacturer of the pocket wheels specified in the paragraph FINISHED PRODUCT.]

2.18.2 Hoisting Chain/Gate Attachments

Provide each length of hoisting chain with accessory parts to connect the chain to the gate. Manufacture the accessory parts in accordance with requirements indicated.

2.18.3 Hoisting Chain Repair Links

Furnish repair links in conformance with the specification for connecting chain links as set forth in DIN 22258-1, for the hoisting chains, in the quantity listed. Forge the repair links from high-alloy steel and design to permit installation by mechanical means to replace a damaged link in any of the hoisting chains. Dimension the repair links to be compatible with the [pocket wheels] [hoisting drum] [_____]. Provide connector links which are capable of developing the full [1450][_____] kN [326,000][_____] pounds minimum breaking strength of the hoisting chain. Inspect each repair link by non-destructive methods during manufacture to ensure freedom from cracks and other flaws which would impair strength and durability. Finish coat the same as applied to the hoisting chain.

2.19 POCKET WHEEL [SPROCKET]

2.19.1 Ring Forging

Provide the pocket wheel or chain sprocket that is a ring forging of alloy steel conforming to [ASTM A290/A290M, Class K][_____],[or][ASTM A322] cast steel having the following mechanical properties:

Minimum Tensile Strength	[1172][_____] MPa[170,000][_____] psi
Minimum Yield Strength (0.2 percent offset)	[1000][_____] MPa[145,000][_____] psi
Brinell Hardness Range	[341 to 401][_____]
Charpy V-Notch at 20 to 27 degrees C 70 to 80 degrees F	[27][_____] Nm[20][_____] foot-pounds
Elongation	[Table 3 in ASTM A290/A290M][_____]
Reduction in Area	[Table 3 in ASTM A290/A290M][_____]

2.19.2 Machining and Heat Treatment

Rough machine the forging prior to heat treatment for mechanical properties. Rough machining prior to heat treatment may include definition of the chain pocket recesses, provided that the product form at that stage is not susceptible to cracking during heat treatment, and provided that specified dimensional accuracy requirements can be met thereafter by final machining or grinding.

2.19.3 Testing

Perform nondestructive examination of each pocket wheel in accordance with the requirements of paragraph NONDESTRUCTIVE EXAMINATION.

2.19.4 Finished Product

Finish-machine each pocket wheel [sprocket] within the dimensional tolerances indicated. Dimensionally verify the pocket wheel [sprocket] metrology methods and the use of a calibrated scanning probe coordinate measuring machine that meets the requirements of ISO 10360-2. The machine tools and the machining methods and procedures used by the manufacturer are such that the specified calibrated hoisting chain functions properly in engagement with each pocket wheel [sprocket]. Use a test length of calibrated chain, as specified in the paragraph CALIBRATED HOISTING CHAIN, to test-fit each pocket wheel after its final machining.

2.20 HOIST DRUMS

****

NOTE: If wire rope hoists are specified, use the following section for fabricated drums.

****

[For specific requirements comply with Section 05 50 15 CIVIL WORKS FABRICATIONS.]

[The hoist drum is to be a [centrifugally spun steel casting conforming to ASTM A148/A148M, GR90-60 spun cast steel][machined weldment of ASTM A829/A829M, Grade 4140 or 4340 material, condition [_____]][_____], as indicated. Each drum is to have full end diaphragms to transfer the supported load to the operating shaft. Stress relieve the entire drum after welding and before finish machining. Heat treat the drum spool face through [flame hardening][_____] to achieve a surface hardness of [375-400][_____] BHN after final machining. The hoist drums are to be of the through shaft type design and [keyed][welded][_____] to the drum shaft.[Fabricate multi drum assemblies to be synchronous right and left drum units.] Size the drum as indicated.[Weld the drum flange to the drum and fabricate of [ASTM A36/A36M steel][_____]. Fabricate the drum shaft from [ASTM A29/A29M, Grade 1045 cold finished steel][ASTM A473, UNS S4140 or S4340 material] with a minimum yield and tensile strength of 345 MPa and 483 MPa 50,000 psi and 70,000 psi, respectively][_____] MPa psi.]

2.21 GROOVED CHAIN DRUM (FOR ROUND LINK CHAIN)

2.21.1 General

Integrally weld the chain drum and shaft together by rib and diaphragm plates. The drum shell is to be cast steel, conforming to [ASTM A27/A27M, Grade 60-30, Class 1][_____]. Provide shafts fabricated from steel forgings conforming to [ASTM A668/A668M, Class D] [_____], with carbon content limited to 0.35 percent. Plates are to be ASTM A36/A36M material whith chain anchor block which is a steel forging conforming to ASTM A668/A668M, Class B, with carbon content of 0.35 percent maximum.

2.21.2 Machining and Welding

Machine the component parts for welding assembly as indicated. Conform all welding, including preheat and interpass temperature control, with

AWS D1.1/D1.1M. Stress relieve the weldment after completion of welding, and prior to final machining of the shaft to suit the bearings and machining the shell for mounting the [drum gear][_____].

2.21.3 Testing

Nondestructively examine grooved chain drums in accordance with the requirements in paragraph NONDESTRUCTIVE EXAMINATION. Conform all welding acceptance criteria with the requirements of AWS D1.1/D1.1M.

2.21.4 Finished Product

In the finished product the shaft is to be concentric with the drum shell and together with all other dimensions are to be within the tolerances indicated. The location of the chain anchor block with respect to the [drum gear][_____] machined shoulder, and the handing (R.H. or L.H.) of the chain groove in the drum shell is to be in accordance with the requirements indicated.

2.21.5 Dimension Test

Provide the first chain drum manufactured which is dimensionally match tested with the chain to verify the following:

a. Dimensionally verify the grooved chain drum through metrology methods and the use of a calibrated scanning probe coordinate measuring machine that meets the requirements of ISO 10360-2.

b. Clearance of U-bolt to the bottom of the chain groove when inserted into the chain anchor.

c. Clearance, if any, from first chain link to the chain anchor when first link is positioned so that its center bears on the drum.

d. Number of threads left over the nuts of the U-bolt when the first link is positioned as described in b. above.

e. Number of revolutions of the chain drum to take up [11.6 m] [38 feet-0 inch] [_____] of chain. Provide chain tension (approximately 9 kN 2000 lbs) during the wrapping and measurement to keep it wound tightly on the drum. Measure from W.P. beginning of groove as indicated.

f. Verify chain feeds smoothly onto drum.

g. Clearance between adjacent wraps of chain.

h. Clearance from the chain anchor to the adjacent wrap of chain.

i. Minimum shoulder distance from edge of groove to point where chain link bears on chain drum when chain is displaced to one side of the groove.

j. Clearance from chain welds on vertically oriented links to bottom of the chain drum groove measured approximately every [4][_____] m [13] [_____] feet of chain. Record a minimum of four measurements.

k. Maximum "off centeredness" of horizontally oriented links. (to nearest 6 mm 1/4 inch) the distance from the center of the link point where it bears on the drum. Link is to be at least 2 links into the wrap from where the chain leaves the drum.

2.22 WIRE ROPE AND END TERMINATIONS

Comply with Section 35 01 70.13 WIRE ROPE FOR GATE OPERATING DEVICES for the hoisting wire rope and end terminations.

2.23 SHEAVES

Provide sheaves of heavy duty [cast], [forged], [rolled][, or][welded] steel construction[that are a standard product design regularly offered by a sheave manufacturing company].[The selected sheave manufacturer is to have been regularly engaged in the production of wire rope sheaves and have a minimum of 5 years experience producing sheaves of similar size to those specified.] Provide sheave of a through shaft design and assemble with new bearings onto the shaft as indicated. Fit the interference fit between the sheave(s) and bearings in accordance with the bearing manufacturer's recommendations to prevent slipping between the components. Dimensions the sheaves and material for sheaves as indicated. Accurately machine sheave grooves for the wire rope diameter provided, smoothly finished, and free of surface defects. Flame harden the groove contact area to a minimum [50][_____] Rockwell C for a depth of [1.5][_____] mm [0.060] [_____] inch minimum with a minimum contact arc of 150 degrees. Design sheave(s) for a minimum radial design load of [2292][_____] kN [515.2][_____] KIPS. Provide sheaves with [roller] [bronze] bearings as indicated. [If casting is the fabrication method, produce casting pattern for the wire rope sheave that becomes the property of the Government upon completion of the contract. If heavy duty fabricated steel weldment is selected as the fabrication method, provide all engineering and design of the sheaves to satisfy the requirements specified herein and submit calculations and shop drawings.]

****

NOTE: For sheaves to be designed by the Contractor the designer may select the following paragraph.

****

[Conform Contractor designed sheaves to the requirements of EM 1110-2-2610 unless otherwise specified herein. Design the sheaves for the normal operating conditions with sufficient safety factors so that the maximum unit stresses do not exceed 75 percent of the yield points of the materials of construction based on the maximum hoisted load. Engineer, design, fabricate, and assemble the sheave units. Design the sheave assembly in accordance with the Crane Manufacturers Association of America (CMAA) standards and in accordance with ANSI standards and OSHA'S interpretation of their regulations for drums/sheaves for mill type cranes. Prepare and submit all required calculations and shop drawings for the design and fabrication of the hoisting sheave assembly to the Contracting Officer for approval prior to the start of shop fabrication.]

2.24 KEYS AND KEYSEATS

All shafts are to have standard keyways and keys in accordance with ASME B17.1, Class 2. Submit all fabricated dimensions of the keys and keyways.

2.25 PAINTING

****

NOTE: Consult with the manufacturer if considering

painting the interior of any enclosures such as gearboxes, cabinets, etc. to select the most appropriate paint coating system for the environment.
****

Paint all exposed ferrous surfaces in accordance with Section 09 90 00 PAINTS AND COATINGS[or as noted]. Paint equipment and components not otherwise specified by Section 09 90 00 PAINTS AND COATINGS with the manufacturer's standard coating system. Standards coatings are to be compatible with the lubrication and environmental conditions specified or recommended. Touch up all damaged painted surfaces after installation. Paint at a minimum uses zinc chromate primer, 2 coats of varnish, and gray enamel to result in a minimum dry film thickness of [0.062][_____] mm [2.5][_____] mils. Painting of nonferrous metals and corrosion resisting steel will not be required unless otherwise specified.

2.26 SHOP ASSEMBLY AND TESTS

****
NOTE: Shop tests are necessary to ensure proper assembly.
****

2.26.1 General

a. Each machinery unit consisting of the [motor,] [brake,] [reducer,] [wire rope drums], [wire rope,] [chain], [couplings,] [and bearings] is to be completely assembled [on its structural steel base (machinery base as indicated)] [with its respective mating component] in the shop and tested [without the [sector] [bull] gear and pinion assembly,] in the presence the Contracting Officer.[The [sector] [bull] gear, pinions, shaft, and bearings are to be completely assembled, shimmed, and aligned in the shop on the pinion support base.] Notify the Contracting Officer at least [10] [_____] calendar days before testing of each machinery unit. This notification includes information on how many units will be tested and the estimated time frame involved with each test.

b. The witnessing of a particular test may be waived by the Contracting Officer; however, the approved commissioning shop test procedures, notification, and documentation should still be performed as required by these specifications. Once informed that Government personnel will witness the test(s), notify the Contracting Officer that a particular test is scheduled as planned a minimum of 48 hours prior to the test(s). Perform all necessary preparations and preliminary testing prior to issuing the 48 hour notification.

c. Commence testing upon the arrival of Government personnel at the scheduled location and time. Design and furnish a test rig and facilities (within the continental United States) suitable for performing the tests. Submit details of the test rig and its location. Address in the submittal aspects including adequacy of rig strength, including, but not limited to, foundations; access to the test rig; availability of suitable power and cranes; how the work will be protected; how the test measurements will be made; and how test results can be verified. Clean all bearing surfaces and lubrication lines and lubricate reducer bearings, couplings, and gears before tests are begun. Fill all speed reducers with the specified lubricating oil; transfer of lubricating oil from one unit to another is not allowed. Electrically connect and operate the motors, brakes, and controls at rated voltage. Test and ship the [motor,] [speed reducer,] [and brake machinery] components to the job-site fully assembled on the structural steel base (machinery base as indicated).

d. [Match mark the [sector] [bull] gear and pinion assembly prior to shipment.]Machinery that is not tested or arrives on site without the machinery base installed will be rejected. Reimburse the Government for all travel, lodging and per diem costs incurred for any Government witness tests that fail to meet the contract specifications or performance requirements and result in the factory testing being terminated, postponed or rescheduled to correct the deficiencies.

2.26.2 Alignment

Conform alignment of interconnecting shafts to the installation requirements of the coupling and gear manufacturers in accordance with standard AGMA practices. Accurately align each machinery or structural unit by the use of stainless steel shims or other approved methods so that no binding in any moving parts or distortion of any member occurs before it is fastened in place. The alignment of all parts with respect to each other is to be true within the respective manufacturer's tolerances required. Set machines true to the elevations indicated.

2.26.3 Anti-Seize Lubricant

Assemble threaded portions of the assemblies using an anti-seize lubricant that prevents galling of parts and corrosion, allows for easy disassembly of parts, and reduces friction unless otherwise noted or specified. Select anti-seize lubricant that is a standard product designed for the intended use.

2.26.4 Acceptance

All readings taken from the equipment, components or assemblies are required to be within the specified limits. Failure of any part to meet these contract requirements is cause for rejection of the entire quantity until action is taken to correct defects and prevent recurrence and such actions have been approved by the Contracting Officer. Retesting is subject to the same random sampling and testing procedures as the original lots.

2.26.5 Gages

Make gages available to the Government at the fabrication site for use in checking critical dimensions. Gages are steel tape, vernier, micrometer, Gar S22 Surface Finish Comparator, etc.

PART 3 EXECUTION

3.1 STRUCTURAL FABRICATION

3.1.1 General

Fabricate components and assemblies in compliance with the requirements of Section 05 50 15, CIVIL WORKS FABRICATIONS unless otherwise specified herein. Where specification requirements are similarly covered in both sections the specification section, apply the more stringent requirements.

3.1.2 Material

Straighten material before being laid off or worked. If straightening is necessary, straighten by methods that do not impair or alter the metal. Sharp kinks, bends, or overcuts of material are cause for rejection of the material. Material with welds will not be accepted except where welding is specified, indicated, or otherwise approved. Flame cutting of material is not allowed. Shearing is to be accurately done and all portions of the work neatly finished. Ensure corners are square and true unless otherwise indicated.

3.1.3 Dimensional Tolerances for Structural Work

The overall dimensions of an assembled structural unit are to be within the tolerances indicated on the drawings or as specified for the item of work. Where tolerances are not specified in other sections of these specifications or shown, a variation of 0.8 mm 1/32 inch is permissible in the overall length of component members with both ends milled and component members without milled ends can not deviate from the dimensions shown by not more than 1.6 mm 1/16 inch for members 9 m 30 feet or less in length and by not more than 3 mm 1/8 inch for members over 9 m 30 feet in length.

3.2 MACHINE WORK

3.2.1 Finished Surfaces

a. Surface finishes indicated or specified herein, are to be in accordance with ASME B46.1. Determine compliance with specified surface by sense of feel and by visual inspection of the work compared to Roughness Comparison Specimens in accordance with the provisions of ASME B46.1. Values of roughness width and waviness height are not specified but have to be consistent with the general type of finish specified by roughness height. Flaws such as scratches, ridges, holes, peaks, cracks, or checks which will make the part unsuitable for the intended use are cause for rejection.

b. Where the finish is not indicated or specified, the type of finish is that which is most suitable for the particular surface and provides the class of fit required. Maximum surface roughness of any surface is 3.175 µm 250 micro-inch. Indicate surfaces to be machine finished by symbols which conform to ASME B46.1.

3.2.2 Unfinished Surfaces

In so far as practicable, lay out all work to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, chip and grind smooth or machine to secure proper alignment. Unfinished surfaces are to be true to the lines and dimensions indicated and have to be chipped or ground free of all projections and rough spots. Fill depressions or holes not affecting the strength or usefulness of the parts in a manner approved by the Contracting Officer.

3.2.3 Pin Holes

Bore pin holes true to gages, smooth, straight, and at right angles to the axis of the member. Perform the boring after the member is securely fastened in position.

3.3 FIELD QUALITY ASSURANCE

Perform all specified quality control inspections and tests. Implement and maintain an inspection log to include copies of all descriptive data for all specified inspections and tests. Make the inspection log available immediately to the Government's inspector upon request. Submit a complete copy of the inspection log to the Government at the end of specified inspections and tests. The Government reserves the right to witness any and all specified quality control (QC) procedures. Provide the Government with one-week advance notice of QC procedure scheduling to allow time for witness coordination. Fully test replacements for all rejected parts as specified herein for the original lots.

3.4 NONDESTRUCTIVE EXAMINATION

3.4.1 NDT Agency Requirements

Conduct NDT examinations [using a testing agency adequately equipped and competent to perform such services][or][using suitable equipment and qualified personnel]. [In either case, provide] [Provide] written approval of the examination procedures and perform the examination tests in the presence of the Contracting Officer. Persons performing the NDT examination are to be qualified for the specific procedure used in accordance with ASNT SNT-TC-1A. Submit nondestructive examination certification of qualified persons, procedures and equipment performing or used for nondestructive testing.

3.4.2 Nondestructive Testing (NDT) for Flaws

For all components to be furnished ultrasonically scan a quantity representing approximately 5 percent of the total supplied quantity for internal defects as specified. Select components, specified below, require (100 percent) of the quantities furnished to be NDT examined to satisfy the specific requirements herein. The minimum quantities and requirements for testing are shown in TABLE 2, below. Lots from which examined specimen parts are selected have to consist of at least 25 percent of the total quantity of each type part to be furnished. A lot is the completed components of a given type available at the inspection site. The Contracting Officer will select parts to be examined at random. Notify the Government one week prior to when the lots are available for specimen selection. Flawed specimens (excessive inclusion size, out-of-tolerance dimension or hardness, or excessive surface roughness) are subject to rejection.

3.4.3 Quality Assurance Measurements

Conduct inspections to supplement the Quality Control NDT in the presence of the Contracting Officer. This testing is to verify that dimensions, hardness and finish are within required tolerances. Perform this testing of the chain components at the fabrication site.

Quantities subject to this testing are specified in Table 2. Parts to be examined will be selected at random by the Contracting Officer. Lots from which inspected parts are selected consist of at least 25 percent of the total quantity of each type part to be furnished. A lot is the completed components of a given type available at the inspection site. Notify the Government one week prior to when the lots are available for specimen selection and inspection. More than one testing date may be required.

TABLE 2 QUALITY ASSURANCE TESTING		
ITEM	MEASURED AND RECORDED PARAMETERS	NUMBER OF SPECIMENS TESTED
[Long Pin 55/9-12] [Normal Pin#1 55/9-52]	[OD],[BHN],[FINISH],[UST] [OD],[BHN],[FINISH],[UST]	2 13
Spacer Sleeve 55/9-22	[ID],[OD],[BHN],[WIDTH],[FINISH]	15
Collar 55/9-82	[ID],[OD],[BHN],[WIDTH],[FINISH]	29
Sidebar 55/9-94	[ID],[PITCH],[WIDTH],[ID] [FINISH], [SIDE FINISH],[UST]	69
Spacer Washer 55/9-152	[ID],[WIDTH]	1
Link Plate 55/9-112	[ID],[WIDTH]	1

TABLE 2 Notes:

a. OD = Outside Diameter, ID = Inside Diameter, BHN = Brinell Hardness Number, FINISH = Surface Finish, UST = Ultrasonic Scan Test

b. Take two measurements per parameter per specimen.

c. Test specimen quantities shown are at least 5 percent of the total quantity furnished.

d. Measure inside diameters of both bores and take one measurement per bore. Measure pitch tolerance derived from sidebar inside diameter edge to edge measurements. Take two hardness readings per specimen. Take two width measurements per specimen.

e. Measure inside and outside diameter of each selected Bearing (three measurements per bore and three measurements per OD).

3.4.4 Pintle Component Nondestructive Testing Examination

All Pintle bushings, balls and fabricated pintle components are to have ANSI/ASNT CP-189, ASNT SNT-TC-1A, AIA/NAS NAS410 qualified personnel perform radiographic NDT testing in accordance with the guidelines, practices and applicable testing standards set forth in ASTM E94/E94M, ASTM E1742/E1742M, ASTM E1030/E1030M, and ASTM E1032. Also test the pintle components by magnetic particle NDT methods in accordance with supplementary requirement S3.1 of ASTM A290/A290M. Other NDT methods are subject to Government approval. Radiographic acceptance criteria for [welds][castings] satisfies the minimum severity level requirements for a Grade I condition as defined by ASTM E1955.

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NOTE: In some situations where castings are specified severity level requirements in accordance with reference radiographs as outlined by ASTM E390 may not be appropriate for defining acceptance criteria. In those situations the designer may consider the use of the following paragraph.

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[Any cracks found are unacceptable and reason for immediate rejection. Evaluate all relevant indications greater than 1.5 mm 1/16 inch in length present on radiographic films against the specified acceptance criteria. Where the length of each indication (li) within an area of interest and along a continuous straight line oriented in the direction of interest are measured. If the distance between two indications is smaller in length than the length of the smaller indication then both indications have to be added and treated as a single indication to include the distance of both indications as well as the distance between the indications. The total indication length is obtained as the sum of all indication lengths on a straight line within the area of interest. The maximum total indication length (lim) on any such single straight line is used to assess acceptance of the casting being evaluated.]

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NOTE: The designer should specify a feature length (Lf) and the maximum indication fraction limit acceptance level, where Level I F=0.1, Level II F=0.2, Level III F=0.3, Level IV F=0.4, Level V F=0.5.

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[This maximum total indication length (lim) is divided by the feature length (Lf), where (Lf) equals [_____] mm inches, to calculate the indication fraction F (F = lim / Lf). The value of indication fraction F has to be acceptable for values less than a [Level I F=0.1][_____].[Provide [7][_____] day advance notice of the NDT testing and perform all testing in the presence of the Contracting Officer.][If testing and certification is not performed in the presence of the Contracting Officer, the Government reserves the right to perform independent quality verification and the acceptable total indication length (lim) for the acceptable indication fraction Level will be increased by 1.5 mm 1/16 inch for the calculation to account for reproducibility in the evaluation.][The manufacturer is required to certify in writing that the inspection was performed in accordance with the requirements specified and found to meet or exceed the requirements of the specified inspection level.]]

3.4.5 Gear Nondestructive Testing Examination

Perform magnetic particle and liquid dye penetrant examination after fabrication of all gears. Conduct the testing in accordance with the requirements set forth in ASTM E709 and ASTM E165/E165M, respectively. Gears found to have unacceptable relevant indications are cause for rejection of the gear component.

3.4.5.1 Gear Teeth (Magnetic Particle or Dye Penetrant)

The gear teeth are defined as [all material] [beyond a radius of [_____] mm [_____] feet [_____] inches]. Only indications with major dimensions greater than 1.5 mm 1/16-inch are considered relevant. The following relevant indications are unacceptable:

a. Any linear indications greater than [4.8][_____] mm [3/16][_____]-inch (a linear indication is defined as having length three times its width)

b. Rounded indications with dimensions greater than [4.8][_____] mm [3/16][_____]-inch

c. Four or more relevant indications in a line separated by [1.5][_____] mm [1/16][_____]-inch or less, edge to edge

d. Ten or more relevant indications in any 3870 square mm 6 square inches of surface with the major dimension of this area not to exceed 150 mm 6 inches when taken in the most unfavorable orientation relative to the indications being evaluated

3.4.5.2 Gear Spokes and Hub (Dye Penetrant)

The gear spokes and hub are defined as all material inside a radius of [_____] mm inches. Only indications with major dimensions greater than [6] [_____] mm [1/4] [_____]-inch are considered relevant. The following relevant indications are unacceptable:

a. Any linear indications greater than [13] [_____] mm [1/2] [_____]-inch (a linear indication is defined as having length three times its width)

b. Rounded indications with dimensions greater than [6] [_____] mm [1/4] [_____]-inch

c. Four or more relevant indications in a line separated by [3] [_____] mm [1/8] [_____]-inch or less, edge to edge

d. Ten or more relevant indications in any 3870 square mm 6 square inches of surface with the major dimension of this area not to exceed 150 mm 6 inches when taken in the most unfavorable orientation relative to the indications being evaluated

3.4.6 Pocket Wheel Nondestructive Testing Examination

3.4.6.1 Ultrasonic Examination

Perform ultrasonic examination of all pocket wheels in accordance with supplementary requirement [S3.2 of ASTM A290/A290M] [_____], after preliminary machining of plain surfaces of the ring prior to heat treatment. In the straight-beam method of examination, use the back-reflection method of tuning in accordance with [ASTM A388/A388M][_____]. In addition to the reportable conditions of ASTM A388/A388M [_____], record indications exceeding the resultant back-reflection. Unless all injurious defects are to be completely removed by final machining, a forging is unacceptable when one or more reflections are present producing indications accompanied by a complete loss of back-reflection, not attributable to nor associated with the geometric configuration. For this purpose, a back-reflection of less than 5 percent of full screen height is considered complete loss of back-reflection. In the angle-beam method of examination, cut calibration notches into the inside diameter and outside diameter surfaces in accordance with ASTM A388/A388M [_____]. A forging that contains a discontinuity which results in an indication exceeding the amplitude of the reference line is subject to rejection. Report of the ultrasonic test in compliance with ASTM A388/A388M [_____]. Additional non-destructive examination or trepanning may be employed to resolve questions of interpretation of ultrasonic indications.

3.4.6.2 Magnetic Particle Examination

Provide test reports for non-destructive tests performed on the gears, pocket wheels, hoisting chains, repair links and all fabricated welded components.

Perform magnetic particle examination on all pocket wheels in accordance with supplementary requirement [S3.1 of ASTM A290/A290M] [_____], after heat treatment and after the chain pocket recesses are fully contoured, but not necessarily finally machined. Only indications with major dimensions greater than 1.5 mm 1/16-inch are considered relevant. The following relevant indications are unacceptable:

a. Any linear indications greater than [5] [_____] mm [3/16] [_____]-inch (a linear indication is defined as having length three times its width)

b. Rounded indications with dimensions greater than [5] [_____] mm [3/16] [_____]-inch

c. Four or more relevant indications in a line separated by [1.5] [_____] mm [1/16] [_____]-inch or less, edge to edge

d. Ten or more relevant indications in any 3870 square mm 6 square inches of surface with the major dimension of this area not to exceed 150 mm 6 inches when taken in the most unfavorable orientation relative to the indications being evaluated

3.4.7 Hoisting Drum Nondestructive Testing Examination

Perform nondestructive testing on all chain and wire rope hoisting drums. After stress relief, test the surfaces of all completed welds including adjacent heat-affected zones and face of drum grooves/sockets using a liquid dye penetrant method for the presence of flaws. Alternate methods of non-destructive testing which would be equal to or more effective than the liquid dye penetrant method may be used if approved by the Contracting Officer.

3.4.8 Engineered Chain Nondestructive Testing Examination

3.4.8.1 Sidebar Tests

Test sidebars in the machined and hardened state. Ultrasonically examine sidebars in accordance with ASTM A578/A578M and ASTM E114. Specimens with inclusion (defect) size greater than 5 mm 0.20 inch in any direction are unacceptable.

3.4.8.2 Pin Tests

Test pins in the machined and hardened state. Tested pins are to have ends finished to 3 µm 125 micro-inches or smoother to allow axial direction ultrasound scans. Ultrasonically examine pins in accordance with ASTM A578/A578M and ASTM E114. Specimens with inclusion (defect) size greater than 5 mm 0.20 inch in any direction are unacceptable.

3.5 GEAR CERTIFICATION

Prepare certified profile (involute) charts and certified tooth alignment (lead) charts for all gears fabricated to meet the American Gear Manufacturer's Association AGMA gear quality as specified for each gear to be fabricated. Satisfy a minimum contact ratio of 1.5 or higher. These charts are to be accurate to within +/-0.0125 mm 0.0005 inches and drawn directly by metrology methods and the use of a calibrated probe coordinate measuring machine that meets the requirements of ISO 10360-2. Submit these charts for both faces of all driven gear and drive pinion gear teeth arrangements. The tooth alignment charts need to span the entire face width of the tooth at the pitch line and indicate the tooth centerline. The profile charts are to indicate the theoretical involute line and span from base circle to tooth tip at the tooth centerline. Label scales on all charts. Charts are required to be traceable to the specific teeth from which they are measured.

3.6 CHAIN CERTIFICATION

The finished length of chains and assemblies cannot vary more than a [6][_____] mm [1/4][_____]-inch from the length of its respective mate. Measure length with the chains under a nominal load to eliminate slack between links. Chains are to be straight and aligned when under load without visible twists, kinks, bends or runout. Attach a taut string line at each end of the chain under nominal load to visually inspect for straightness. The string line cannot deviate away from the chain surface by more than [13][_____] mm [1/2][_____] inch at any point along the entire length of chain. Match and match mark chains in pairs with an indelible dye. In addition, match mark chain pins and link bars with metal stamped alpha-numeric characters.

3.7 HOISTING DRUM AND SHEAVE CERTIFICATION

All wire rope hoisting drums and sheaves need to have the grooves verified for size and contour with a groove gage (nominal size plus full oversize percentage) and meet the contact area and groove dimension limitations established within the Wire Rope Users Guide. Do not paint wire rope.

[Multi-drum assemblies that are connected to the same driven machinery is to have drum geometry for synchronous drums certified by metrology methods and the use of a calibrated probe coordinate measuring machine that meets the requirements of ISO 10360-2. Certify the dimensional data for each drum and submit the results.] [Multi-drum assemblies that are connected to the same driven machinery is to be shop tested and measured to demonstrate the ability to reeve equal lengths of wire rope on each commonly driven wire rope drum. The testing measurements need to be by direct measurement of wire rope length and wire rope tension when an interconnected tension load is applied to the wire ropes and drums. Continuously monitor the tension in each wire rope during the testing. Wind drums with sufficient length of pre-stretched wire rope to fill all drum grooves or a single layer of wire rope wound on grooveless drums. The drums are considered synchronous and equal when the tension in each wire rope does not deviate more than [5][_____] percent from the initial wire rope tension measured at the initiation of the testing.]

3.8 HOISTING MACHINERY AND DRUM SHOP LOAD TEST

The test procedure applies to all units and include raising and lowering a [_____] kg pound test load ([_____] kg pounds on each drum) vertically through a distance of [_____] mm feet. Suspend the load from the actual service hoisting wire ropes. The wire rope drums are to make [_____] revolutions to raise and the same to lower the load, done three times in succession at high and low speeds without significant interruption. Inspect the wire rope drums to ensure proper reeving of the wire rope. Demonstrate the brakes to hold the test load statically and upon receiving a stop travel command in each direction of travel. Any brake hand release specified is required to have its operation demonstrated by gradually allowing the suspended load to begin movement and catching the load upon release of the handle. Submit shop test information to include the proposed shop test procedures, test rig details, final shop test procedures, and test result data sheets.

3.9 POCKET WHEEL [SPROCKET] SHOP LOAD TEST

[a. Submit shop test information to include the proposed shop test procedures, test rig details, final shop test procedures, and test result data sheets. Conduct a load test for each complete [tainter][_______] gate assembly of [two][___] pocket wheels [sprockets], [four][_____] chains, gate connection assemblies, sprocket shaft gears, shafts, chain guards, and bearings, prior to installation of any hoist on the [service bridge][_____]. Prior to any load tests being performed, all submittals for materials and components will require approval by the Contracting Officer. Perform the assembly and load test. The load test will be witnessed by the Contracting Officer, unless otherwise waived. Provide [7][_____] working days notice before the testing. Design and furnish a test rig and facilities suitable for performing the assembly and testing. Submit Shop Load Test Rig and Location details of the Contractor designed test rig and its location for shop load test evaluation. The evaluation will address aspects including adequacy of rig strength including, but not limited to, foundations; access to the test rig; availability of suitable cranes; how the work will be protected, how the test measurements will be made, and how test results, including test load, can be verified.]

[b. [a][b]. The load test consists of raising and lowering a test load vertically through a distance of [3][_____] m [10][_____] feet [___] using the actual equipment furnished for this contract. The test rig is to, as a minimum, incorporate the use of the pocket wheel, shaft, chain, and gate connection assemblies. Alternate configurations of the test rig that simulates raising and lowering of the test load will be considered. Load one end of the chain and leave one end slack. Ensure that the chain extending from the test load passes over the top of the pocket wheel in the same direction as in the final installation. The total test load on [four][_____] chains is [965][_____] kN [217,000][_____] pounds. Connect the load to the actual hoisting chains of the hoist that will be installed in the field. During the test, the pocket wheels need to make [1.5][_____] revolutions to raise and the same to lower the test load, done [three][_____] times in succession without significant interruption. The chain has to enter, ride in, and exit the pocket wheel without binding or slipping.]

[c. [b][c]. Prior to any operation of the assembly, inspect for proper orientation and straight alignment. Prior to disassembly, match mark mating parts of the hoist in accordance with a system of numbering approved by the Contracting Officer.]

3.10 WELDING

Unless otherwise specified, conform welding to the provisions of AWS D1.1/D1.1M, Sections 1 through 8 and Section 10. Welders and welding operators are to pass the qualification tests as prescribed by AWS D1.1/D1.1M, Section 5 before being assigned to production work. Submit certifications showing qualification of welders and welding operators prior to commencing fabrication.

3.11 MISCELLANEOUS PROVISIONS

3.11.1 Cleaning of Corrosion-Resisting Steel

After fabrication, remove oil, paint, and other foreign substances from corrosion-resisting steel surfaces. Clean by vapor degreasing or by the use of cleaners of the alkaline, emulsion, or solvent type. After the surfaces have been cleaned, final rinse with clean water followed by a 24 hour period during which the surfaces are intermittently wet with clean water and then allowed to dry for the purpose of inspecting the clean surfaces. Visually inspect the surfaces for evidence of paint, oil, grease, welding slag, heat treatment scale, iron rust, or other forms of contamination. If evidence of foreign substance exists, clean the surface in accordance with the applicable provisions of ASTM A380/A380M. Submit the proposed method of treatment. After treatment visually reinspect the surfaces. Brushes used to remove foreign substances may only have stainless steel or nonmetallic bristles. Remove any contamination occurring subsequent to the initial cleaning by one or more of the methods indicated above.

3.11.2 Protection of Finished Work

Submit an equipment protection plan with detailed information on the method[s] proposed to protect the existing equipment from such operations as power washing, abrasive blast cleaning, welding, placement of concrete, and painting. Thoroughly clean machined surfaces of foreign matter. Protect all finished surfaces by suitable means. Unassembled pins and bolts are to be oiled and wrapped with moisture-resistant paper or protected by other approved means.

3.11.3 Lubrication

Lubricate all the components of the equipment requiring lubrication using only the lubricants [specified] [which have been provided by the Government]. Provide and lubricate the components and assemblies, in their entirety, after assembly with a [food grade][_____] lubricant which meets the following minimum characteristics:

ISO Grade	46
Four Ball Wear Test (ASTM D4172)	0.39 mm
Falex EP (ASTM D3233)	100 pounds force

3.12 FIELD ERECTION AND TESTS

3.12.1 General

Perform field erection and field tests. Install the machinery under supervision of the erecting engineer under the provisions of paragraph ERECTING ENGINEER. Submit the installation and alignment procedure and install in with the approved procedure. In the submittal provide detailed [manufacturer's] [Contractor developed] instructions concerning the installation and alignment procedures for the equipment to be furnished. Items include [gear reducers,] [bearings,] [shafts,] [brakes,] [motors,] [couplings,] [pocket wheels,] [sprockets,] [hoisting chains,] [_____] and [limit switches]. The procedure has to include consideration of all the other work that is obligated to be performed at the site [Lock] [and] [Dam]; and also the operating regime for the [Lock] [and][Dam] gates which the Government will enforce, as described and specified in the SPECIAL CLAUSES. Base the procedure on a proper sequence of construction that will complete the work with safety, efficiency, and in full accordance with these specifications. Submit for approval any Gate Support Method to be used. Include detailed information on the method proposed to support the [tainter] gate during the work delineated in this section. The support method, engineering computations, and support drawings have to be designed and certified by a licensed professional engineer.

3.12.2 General Test Procedure

Submit the commissioning, pre-functional and functional checklist test procedures, with a blank test results data sheet for each, prior to the commencement of any tests. Complete all Pre-Functional checklists prior to performing Functional operational tests. The testing is to comply with the requirements herein and as specified below. The test procedure will consist of operating the units with no load at high speed in both directions for [15][_____] minutes and at low speed in both directions for [10][_____] minutes.[VFD controlled equipment is to be ramped in speed from low to high and high to low for normal operation sequencing.] Inspect each piece of equipment for smooth operation and proper alignment and check all necessary clearances to ensure vibration, binding, or excessive heat does not occur in any moving part. During the test, provide readings of motor current, RPM, voltage, and bearing temperature. Stop the test immediately if there is any undue noise, vibration, or heat developed in any of the equipment. After correction of alignment and/or all other causes for the interruption of the test, reinspect the unit and resume testing when permitted by the Contracting Officer. Submit final operating test results for each unit.

3.12.3 Crane Availability

The Government's existing cranes will not be available for use in installation of the machinery.

3.12.4 Schedule

Schedule and coordinate operations with the Contracting Officer for the Government's installation and removal of the bulkheads for the [tainter] gates.

3.12.5 Wire Rope Tensioning

Submit the [Field Tensioning and] Operating Test Procedure, with a blank test results data sheet, prior to the commencement of any field tests.[Shim and level each [sector and pinion] support base prior to final grouting with attention given to maintaining the elevations indicated.] Submit details for the measuring tension procedure used to measure wire rope, [chain] tension during installation. Base the wire rope field tensioning procedure on the following steps. Upon connection of the wire rope to the [valves] gates, equalize the tension in the cables by the use of a hydraulic power pack or hydraulic ram to apply an equal horizontal force (perpendicular to the cable axis) on each cable and measuring the cable deflections at the point of force application. Apply the forces to the cables at a common elevation when the cables are under load. Make adjustments to the cables (to equalize cable tensions) at the [valve drum][adjustable cable connection][_____]. Equal tensioning will be considered achieved when the deflections of the [two][_____] cables are within 5 percent of each other. Measured deflections are to be greater than 63 mm 2-1/2 inches at the time they are considered equal. After final tensioning, the [cable end socket][adjustable connection] is required to be [welded][mechanically secured] to the drum as indicated. After the units have been installed [and the field tensioning tests are complete], operate each complete [gate] [and valve] unit [_____] cycles, as indicated, to demonstrate to the satisfaction of the Contracting Officer that the requirements of the specifications have been met and that the performance of the equipment is satisfactory for the purpose intended. During the test, provide readings of motor RPM, current, and voltage to the Contracting Officer as data to enable estimation of the motor kW horsepower developed. Submit final [field tensioning and] operating test results for each unit.

3.12.6 Round Link Chain Tensioning

Submit proposed operating test procedures, final field operating test procedures, data sheets, and the procedure for measuring the chain tensions. Install hoisting chains such to obtain equal tension in the chains when hoisting the gate. With proper precaution observed to restrain uncontrolled movement of the chains, the cross shaft couplings may be disengaged and rotated to perform gross chain tension adjustment. Use the gate connection and turnbuckle for final adjustment. The installation procedure will define the method to be used. Measure chain tensions using a linear dynamometer, strain gauges with instrumentation, or other approved direct load indicating device. Perform chain tensioning with the gate raised above the sill. Each chain assembly at each [pocket wheel] [sprocket] is to be tensioned within 5 percent of the mean tension for that [pocket wheel] [sprocket]. The total load supported by any [pocket wheel] [sprocket] cannot be less than [48] [_____] percent nor more than [52] [_____] percent of the total load on the two [pocket wheels] [sprockets] connected to the same gate. Repeat adjustments until the chain assemblies are within these specified limits.

3.12.7 Limit Switch and Position Indication Settings

Immediately prior to commencement of work on each gate, record the gate position settings. Submit the Gate Position Settings on Limit Switches. Refer to the [pre-recorded] limit switch and position indication requirements as specified [in paragraphs above] [Section 35 20 20 ELECTRICAL EQUIPMENT FOR GATE HOIST]. Following a thorough check of alignment, clearances, and readiness to operate, operate the machinery with due care to set the travel limits and confirm control or monitoring functions. The settings of the limit switch and control points need to conform to the indicated requirements.

3.12.8 Open Spur Gear Alignment

Install spur gears, shafts and bearings to meet the specified backlash and gear tooth contact area requirements. Measure the gear backlash in unloaded conditions with one of the mating gears secured and the other gear manually rotated to obtain the backlash measurements. Use dial indicators to collect backlash measurements. Align the gears to achieve a backlash of between 0.63 to 0.89 mm 0.025 and 0.035 inch. Check alignment of mating gear sets in both the unloaded and at rated load conditions. Check four teeth at 90 degree intervals on each gear set for each condition. The gears are considered aligned when there is a minimum of at least 75 percent tooth contact across the pinion or driven gear tooth face, whichever is larger, at rated load. The contact pattern is considered the area indicating a consistent length and depth of the tooth pattern (i.e. a rectangle). Edge loaded patterns or irregular and discontinuous patterns are not acceptable. Submit the calculations of the percentage of tooth contact patterns for each condition. Record unloaded contact patterns using a tooth marking grease or compound and transfer to contact tape. Overlay the contact tape with the lifted contact pattern onto paper with the entire gear tooth profile shown. Measure loaded condition contact patterns using machinist's layout lacquer similar to (DYKEM) or some other similar use "bluing" dye to verify alignment requirements are met. Submit a Final Alignment Test Report which includes the results of the backlash measurements and the tooth contact patterns with calculations of the tooth contact percentages. Clean the driven gear and pinion and coat with [a dry film][the specified] lubricant after alignment and prior to any operational testing of the equipment.[The dry film lubricant has to be heavy duty open gear and wire rope lubricant.] After performing successful initial no load gear alignment and prior to full load operational testing, secure the bearing supports with [tapered alignment pins] [fitted bolts] [bearing chocks] [shear blocks]. Verify band check final fastener torques before exposed metal surfaces are coated as required by the contract.

3.13 ERECTING ENGINEER

Furnish the services of one or more competent erecting engineers from the equipment manufacturer/fabricator to supervise and direct the erection and installation of this equipment.

a. The erecting engineer(s) are required to be present for all shop erection, inspections, tests, installation and operation of all equipment at the project site.

b. The erecting engineer has responsibility for the equipment meeting all the requirements of these specifications and fulfilling all the Contractor's guarantees.

c. The erecting engineer will verify the fit and alignment of mating components prior to erecting in the field and be present during final connection and all commissioning and field testing for contract compliance. The erecting engineer will keep records of all measurements taken during installation and testing.

d. Upon completion of the installation, commissioning and startup for each specified major equipment or subassemblies, each erecting engineer will submit an erecting engineer installation and operation certification approving the installation and operation of the equipment.

3.14 FIELD TRAINING

Provide field training conducted by the erecting engineer for operating staff after each system is functionally complete but prior to final acceptance. The training will be given for a period of not less than [8][_____] hours. The training will cover all pieces of equipment and include items contained in the operation and maintenance manuals. Do not conduct training until operation and maintenance manuals have been approved. Provide a one week advance notice of the scheduled training date to the Government. Digitally record all training conducted and provide two DVD copies of the training to the Government. The recording will be compatible with common DVD players in the United States.

3.15 STARTUP AND ACCEPTANCE TEST

Submit the pre-functional checklist for approval that includes checks, recordings, measurements and verifications to be performed prior to start up. Signature by all parties is required for acceptance. Following the completion of installation, checkout, adjustment, and setting the limit switches, controls, interlocks, perform a startup and acceptance test on each machinery unit. Perform the startup and acceptance test in accordance with the approved commissioning functional checklist, record and submit the results on test result forms of the procedure. Signature by all parties is required for acceptance. Include a demonstration of proper functioning of the limit switches, controls, interlocks in the acceptance test. For acceptance, the machinery unit(s) are to be successfully operated through a minimum of three complete cycles to satisfy the Contracting Officer that the requirements of the contract have been met and that the performance of the equipment is satisfactory for the purpose intended.

Upon successful completion of the field tests, the [miter gate] [and] [[tainter] valve] [_______] machinery, accessory items and equipment will be examined by the Contracting Officer, Erecting Engineer, Contractor, Project Personnel, and if found to comply with the contract it will be accepted by signature of all parties in a prepared commissioning document. Signatures and Acceptance will not occur until all found deficiencies have been corrected. submit copies of the signed commissioning document document to the Contracting Officer.

3.16 Equipment Warranty

Submit manufacturer's standard warranty or guarantee for equipment, e.g., speed reducers, or any other equipment. Identify any warranties that extend beyond a 1-year period.

3.17 OPERATIONS AND MAINTENANCE DATA

****

NOTE: Collective O&M Manuals are usually compiled from the individual O&M manuals for each piece of equipment. Incorporate UFGS 01 78 23 OPERATION AND MAINTENANCE DATA into the specifications when comprehensive and outlined data packages are to be furnished to the customer. Use the first bracketed paragraph if UFGS 01 78 23 OPERATION AND MAINTENANCE DATA is included in the specifications.

****

[For specifications on the furnishing, installation, operations and maintenance instructions, refer to Section 01 78 23 OPERATION AND MAINTENANCE DATA. Unless otherwise specified, all operation and maintenance manuals need to be comprehensive to the electro-mechanical operating system with independent sections for each unique piece of equipment. Operation and Maintenance manuals are to comply with the requirements of Data Package 3 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.]

Unless otherwise specified, all operation and maintenance manuals are to be comprehensive to the electro-mechanical operating system with independent sections for each unique piece of equipment. Include six copies of the following bound information.

a. Safety precautions
b. Operator prestart
c. Startup, shutdown, and post-shutdown procedures
d. Normal operations
e. Emergency operations
f. Environmental conditions
g. Lubrication data
h. Preventive maintenance plan and schedule
i. Cleaning recommendations
j. Troubleshooting guides and diagnostic techniques
k. Wiring diagrams and control diagrams
l. Maintenance and repair procedures
m. Removal and replacement instructions
n. Spare parts and supply list
o. Product submittal data
p. O&M submittal data
q. Parts identification
r. Warranty information
s. Testing equipment and special tool information
t. Testing and performance data
u. Contractor information

Submit six copies of the OPERATIONS AND MAINTENANCE (O&M) MANUAL [in accordance with paragraph OPERATIONS AND MAINTENANCE MANUALS and in compliance with Data Package 3 in Section 01 78 23 OPERATION AND MAINTENANCE DATA.]

-- End of Section --

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USACE / NAVFAC / AFCEC UFGS-35 01 70.13 (May 2021)

Preparing Activity: USACE Superseding
UFGS-35 01 70.13 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-35 01 70.13 (May 2021)**

Preparing Activity: USACE **Superseding**
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SECTION 35 01 70.13

WIRE ROPE FOR GATE OPERATING DEVICES

05/21

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NOTE: This guide specification covers the requirements for supplying and installing wire rope (new or replacement) needed by gate operating devices (i.e. spillway gates, Tainter gates, etc.)

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification is based on the assumption that a single Contractor will be responsible for supply and installation of the wire rope. Please refer to US Army Corps of Engineers Engineer Manual 1110-2-3200 Wire Rope Selection Criteria for Gate-Operating Devices (http://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals **)prior to editing this section. It is recommended that the designer talk with wire rope manufacturers to get their consensus that the proposed wire rope type can be manufactured and used successfully.**

If a specification is needed only for supply of wire rope, or for installation of wire rope, there are example specifications included in the appendices of US Army Corps of Engineers Engineer Manual 1110-2-3200 Wire Rope Selection Criteria for Gate-Operating Devices (link above). It is also assumed the wire rope is for replacement for a gate operating device. Paragraphs written in regard to removal of existing wire rope, and cleaning drums and sheaves would need to be deleted if the application is for a new installation.

Ensure products used in this section comply with Federal procurement preference under Section 9002 of the Farm Security and Rural Investment Act of 2002. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for requirements associated with EPA designated products.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A351/A351M	(2024) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General

	Purposes
ASTM E1571	(2011; R 2016; E 2016) Standard Practice for Electromagnetic Examination of Ferromagnetic Steel Wire Rope

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-S-550F	(2018; Notice 1) Sockets, Wire Rope
FS RR-W-410	(2022; Rev J) Wire Rope and Strand

WIRE ROPE TECHNICAL BOARD (WRTB)

WRTB	(2005) Wire Rope Users Manual

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Wire Rope Work Plan; G, [_____]

Wire Rope Safety Plan; G, [_____]

Contractor Qualifications; G, [_____]

Contractor Installation Qualifications; G, [_____]

Wire Rope Tensioning Plan; G, [_____]

Wire Rope Flux Leakage Test Plan; G, [_____]

SD-02 Shop Drawings

End Terminations; G, [_____]

SD-03 Product Data

Lubrication; G, [_____]

Pre-Stretching; G, [_____]

End Termination Attachment Method; G, [_____]

SD-06 Test Reports

Tension Testing; G, [_____]

Attaching and Proof Loading Terminations; G, [_____]

Wire Strength and Ductility; G, [_____]

Pre-Forming; G, [_____]

Stress Relief "(Wrapping Test)"; G, [_____]

Zinc Coating; G, [_____]

End Terminations; G, [_____]

Wire Rope Magnetic Flux Leakage Test Results (Pre-Installation); G, [_____]

Wire Rope Magnetic Flux Leakage Test Results (Post-Installation); G, [_____]

Spelter Socket Ndt Test Results; G, [_____]

SD-07 Certificates

Warranty

Type of Wire Rope; G, [_____]

Tension Testing Equipment; G, [_____]

Wire Rope Tension Equipment Calibration Certifications; G, [_____]

Tension Equipment Operator Qualifications; G, [_____]

SD-09 Manufacturer's Field Reports

Delivery Report

1.3 CONTRACTOR INSTALLATION QUALIFICATIONS

Submit the contractor installation qualifications for installation of the wire rope. The Contractors' installer must have performed work similar to that required in this contract on at least three separate occasions. The Contractors' installer must be on site at all times when wire rope is being delivered, stored, un-reeled, during testing, installation, and after installation testing.

1.4 SYSTEM DESCRIPTION

****

NOTE: The wire rope work plan submittal is only applicable if the contract work involves field installation. This is not needed for a supply contract.

If the wire rope work plan is needed, the designer should carefully consider all steps which are likely to accomplish the wire rope replacement. Add items below the wire rope work plan paragraph as needed.

****

1.4.1 Wire Rope Work Plan

Submit a work plan for Government approval indicating how the existing wire rope will be removed and how the new wire rope will be installed prior to field work proceeding. Describe specific details and practices considering the current condition of existing equipment. At a minimum include the following topics in the plan:

a. Schedule for delivery.
b. Removal plan for old wire rope.
c. Un-reeling and installation plans for new wire rope.
d. Plan for tensioning wire ropes.
e. Schedule for delivery.
f. Schedule for installation.
g. Lubrication method.
h. Field tensioning method.

1.4.2 Wire Rope Safety Plan

Submit a safety plan for approval indicating how work will conform to EM 385-1-1. Include details of how the wire rope will be handled and installed to minimize the risk to personnel. [Include the safety provisions of this section in the safety plan required by [Section [_____] SPECIAL CONTRACT REQUIREMENTS] [Section 01 35 26 GOVERNMENTAL SAFETY

REQUIREMENTS].]

1.4.3 Tools, Equipment and Expertise

****

NOTE: The last sentence may or may not be needed, or consider propane powered equipment.

****

The work may take place [over water] in areas with limited ventilation. [Only electric or air powered tools and equipment will be allowed within those areas (no internal combustion engines will be allowed inside of machinery spaces or indoors).]

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 General

[The work and storage areas are as indicated on the plans] [or as directed by the Contracting Officer]. Wind the wire ropes on spools in the same direction as they were bent during manufacturing. Cover the [coils] [spools] for protection from rain, snow, and/or road debris during shipping.

1.5.2 Inspection on Delivery

****

NOTE: Consider altering or deleting this paragraph to reduce cost if the wire rope can be inspected completely, while being installed.

****

Upon delivery to the work or storage area, inspect the wire [ropes] [ropes and sockets] in the presence of the Contracting Officer. Inspect the wire rope for dings, kinks or other damage.[Unreel the wire ropes from spool to spool to allow complete inspection of the wire ropes over their entire length. Perform the unreeling/reeling operation, and furnish extra spools or any other equipment required.] Upon completion of the inspection, furnish the Contracting Officer with a written delivery report of the results.

1.5.3 Storage

Store wire rope on site in a [covered] location stated on the plans. [After delivery, store spooled wire rope in well ventilated enclosures in the storage area and protect from the elements.]

1.6 ENVIRONMENT PRECAUTIONS

Submit lubricant catalog data for environmental applicability review.

1.7 WARRANTY

****

NOTE: Designer should contact wire rope manufacturers to determine the extent of manufacturer's warranties available. Warranties may vary with type of rope and application.

****

Submit signed copies of a [1][_____] year[s] warranty for all materials and services provided under this section.

PART 2 PRODUCTS

2.1 WIRE ROPE[AND SOCKETS]

Provide wire rope [and sockets] which are the standard product of a Contractor regularly engaged in the manufacture of wire rope, and that essentially duplicate products having been in satisfactory use for at least 5 years prior to [bid opening] [proposal evaluation]. Submit Contractor qualifications statement.

2.1.1 Quantity

Furnish [_____] wire ropes [with end terminations (sockets) [at both ends]]. Each wire rope must be [of the length indicated on Drawing No. [_____], and within the tolerance also indicated on that drawing.] [[_____] meters feet in length.] Wind the wire rope on reels in lengths such that [_____] sections, each with a length of [_____] meters feet available for use, as splicing will not be allowed.

2.1.2 Type of Wire Rope

****

NOTE: Base selections on EM 1110-2-3200, Fed Spec RR-W-410, and the Wire Rope Users Manual. Consider flattened strand in applications where wire rope wraps on a disk-layered drum.

****

Provide wire ropes as follows:

2.1.2.1 Strand Configuration

[6x19 Seale] [7x19 Seale] [6x26 Warrington Seale] [6X37 Warrington Seale] [_______]; [Flattened strand]

2.1.2.2 Lay

****

NOTE: The advantages of Lang lay wire rope are discussed in more detail in EM 1110-2-3200. In many Army Corp of Engineers applications existing regular lay wire rope would best be replaced by Lang lay wire rope.

****

[Right, Lang] [Left, Lang] [Right, regular] [Left, regular]

2.1.2.3 Diameter

[_____] mm inch, with a tolerance of minus and plus 5 percent

2.1.2.4 Finish

[Galvanized] [Plain]

[2.1.2.5 Minimum Breaking Strength

[_____] kN [pounds] [tons]

]2.1.2.6 Material

****

NOTE: Stainless steel wire rope tends to abrade on itself when wrapped on disk-layered drums. Some manufacturers are questioning the wisdom of making regular lay stainless steel wire rope with flattened strands, as the cold-working tends to be excessive and weaken the rope. Stress relieving to alleviate the cold working can be difficult and inconsistent with the stainless steels. Do not use stainless steel wire rope in saltwater applications because of susceptibility to crevice corrosion. If they are used, they must be inspected regularly and add O&M manual requirement for required duration of wire rope inspection.

Kevlar wire rope has specific needs which must be included if it's desired to be used. Kevlar rope is very susceptible to abrasion damage and must be protected with a jacket. See EM-1110-2-3200.

****

[Extra improved plow steel] [AISI 302 stainless] [AISI 304 stainless][Kevlar] [_____]

2.1.2.7 Core Type

****

NOTE: It is not recommended that fiber core be used for a gate lifting device.

****

Independent wire rope core.

2.1.2.8 Pre-Formed

****

NOTE: There is no reason not to preform.

****

[Yes] [No]

2.1.3 Pre-Stretching

****

NOTE: In the following paragraphs the manufacturer is tasked with some testing. This is intentional, as personnel who are familiar with the required procedures should perform these tasks.

Pre-stretching is highly recommended for installations with multi-rope drums, because initial stretch in the wire ropes tends to be uneven. Pre-stretching will likely result a more equal

tension between the ropes. It is also recommended for other wire rope so that final length after use will be closer to length at the time of installation.

****

Submit Pre-Stretching procedure. Pre-stretch the [wire rope] [wire ropes before attaching their end terminations] in accordance with ASTM A1023/A1023M. This is done by subjecting them to three cycles at 40 percent of its nominal strength. Hold the 40 percent loads for 5 minutes with 5 percent loads for 5 minutes between cycles. A method of dynamic pre-stretching may be proposed.

2.1.4 Wire Strength and Ductility

Perform testing in accordance with FS RR-W-410 to verify wire strength and ductility. Submit test results.

2.1.5 Pre-forming

Provide pre-formed wire rope, and perform testing in accordance with FS RR-W-410 to verify pre-forming. Submit test results.

2.1.6 Magnetic Flux Leakage Testing

****

NOTE: Magnetic flux leakage testing is an NDT method to examine wire rope for internal defects. It provides a baseline condition for new wire rope. If a District does not require the baseline condition for future wire rope inspection/maintenance, the NDT testing may be removed from the spec.

Contractors may prefer to perform this inspection during installation of the wire rope, as this is the easiest method to complete 100 percent testing. After the rope is installed, the full length of wire rope cannot be inspected without several setups.

Excerpt from EM 1110-2-3200 (2016) paragraph 8-3.m states: " NDT can be used to determine the internal condition of wire rope. However, there are conditions that cannot or may not be detected, such as breaks in small wires, closely-spaced broken wires, broken wire versus pit corrosion, and possibly other defects. The percentage of outer wires compared to the total cross sectional area of wire rope is 36 percent to 44 percent. Thus, NDT can provide valuable information on the condition of over 50 percent of the wire rope area. The end user should recognize that NDT is a valuable tool that nevertheless does have some limitations. It also does not require opening up the rope and damaging it in the process. The loss of metallic cross-sectional area and local faults, such as broken individual wires and strands can usually, but not always be detected."

****

Perform magnetic flux leakage testing for [25][50][100] percent of the wire rope to identify defects that are pre-existing in the ropes. Perform the testing prior to the rope being installed. Repeat the testing after the rope has been installed. Perform the testing in accordance with ASTM E1571. Personnel performing the testing must be qualified in accordance with the requirements of ASTM E1571.

Prepare and submit a Wire Rope Flux Leakage Test Plan that details the step-by-step procedure to inspect the ropes. Detail any differences in the testing procedure between the pre-installation testing and post-installed testing. Include in the plan the qualifications of the personnel who will be performing the testing, and the up-to-date calibration certificates of the test instruments.

Prepare and submit Wire Rope Magnetic Flux Leakage Test Results (Pre-Installation) and Wire Rope Magnetic Flux Leakage Test Results (Post-Installation) reports. Reports must contain the results from the Magnetic Flux Leakage Testing. Include the following in each report:

a. Identify which wire rope(s) the report covers. Reports must identify which end of the wire rope that the testing started from and all data must be identified by the corresponding rope.

b. Identify all local flaw (LF) and loss of metallic cross-sectional area (LMA) indications that are detected during testing. Document where the indications are located along the rope. For post-installation reports only; identify which LF and LMA indications are new from the pre-installation testing.

c. Verification from the Contractor that all LF or LMA indications are within acceptable values for that kind of defect.

2.1.7 Stress Relief "(Wrapping Test)"

Stress relieve the wire rope, and perform testing in accordance with FS RR-W-410 to verify stress relief. Submit test results.

2.1.8 Weld Distribution

Wire joints in any strand must not be closer than 450 mm 18 inches in any strand.

2.1.9 Galvanizing

****

NOTE: Wire rope woven from galvanized wires will have much better resistance to corrosion than un-galvanized wire rope woven from bare carbon steel. It will also have better resistance to corrosion than wire rope woven from drawn galvanized wire. However, it will also have a significantly lower strength. If full strength is required, then use wire rope woven from plain carbon steel or from drawn galvanized wire depending on how important corrosion resistance is. If full strength is not required, but high corrosion resistance is required, use wire ropes woven from galvanized wire and perform the zinc coat test to verify the zinc thickness. See FS RR-W-410 for information on the rate of zinc coating. Stainless steel or Kevlar

wire rope would not be galvanized, and this entire paragraph would be deleted.
****

[Weave the wire rope from drawn galvanized wire. That is, the wires galvanized prior to their last drawing operation. The wire rope must have the same accepted industry standards for nominal strength as it would, had it not been galvanized.] [Weave the wire ropes from galvanized wire. Apply zinc at a rate of [_____] grams per square meter ounces per square foot of wire surface. The Contractor must perform testing in accordance with FS RR-W-410 to verify the zinc coating has been applied at the required rate. Submit test report.] [Apply zinc coating by either the electrolytic plating process or by hot dipping in molten zinc. The weight of the zinc coating on each wire must be as specified in ASTM A1023/A1023M.]

2.1.10 Strand Pitch Length

Must not be less than 4-1/2 times the nominal rope diameter.

2.1.11 Core Strand Wires

The number of wires in the core strand must be equal to or greater than the number of wires in the other strands. Use the same material as the wires in the other strands, or use a material with a lower tensile strength.

2.1.12 End Terminations

****
NOTE: EM 1110-2-3200 discusses materials and coatings, and attachment methods for sockets. Note that the wire rope industry usually recommends replacing sockets when replacing wire rope. Sockets are usually selected from a catalog, however they can be custom fabricated. Spelter sockets are the Army Corp of Engineers standard for end terminations. Swaged sockets can be specified but are not suitable for Lang lay rope. Both types should develop 100 percent of the wire rope strength. Do not use molten zinc with stainless steel spelter sockets. Do not use molten zinc or epoxy resin spelter sockets with stainless steel wire rope in saltwater applications due to susceptibility to crevice corrosion. Swaged sockets can be used in saltwater applications.
****

Submit shop [fabrication] drawings, as specified. [The wire rope end terminations must be [an open] [a closed] spelter socket type with poured zinc or epoxy resin. Spelter sockets must be [forged] [cast alloy] [galvanized steel] [stainless steel] [swaged type of carbon steel suitable for cold forming] conforming to FS RR-S-550F.][Submit spelter socket NDT test results.] [Provide fabricated wire rope end terminations as indicated [on Drawing No. [_____]], and cast from [steel conforming to ASTM A148/A148M, Grade 105-85] [stainless steel conforming to ASTM A351/A351M CF8M] [_____]. Secure the wire rope in fabricated sockets with poured zinc or epoxy resin.]

2.1.13 Tension Testing

Submit rope tension test report. Perform a tension test to verify the wire rope meets the accepted industry standards for nominal strength. Test two rope samples to failure to be sure the expected performance level has been met. Perform the test using suitable tension testing equipment and by qualified personnel. Submit certification of rope tension testing device. Cut the rope samples to no less than 1 meter 3 feet of length. The test will not be considered valid if the failure occurs less than 50 mm 2 inches from either socket or holding mechanism and the test must be repeated. Relative speed between the machine heads must not exceed 25 mm 1 inch per minute.

[2.1.14 Attaching and Proof Loading Terminations

****

NOTE: EM1110-2-3200 suggests that pre-stretching the wire rope and proof loading the terminations might be accomplished simultaneously. However, for multi-rope drums the wire rope would need to be pre-stretched first to be sure they are closer to their final correct length before attaching the terminations. If the sockets must be attached in the field delete this paragraph.

****

The Contractor must attach the end terminations after pre-stretching the wire rope. [The end termination attachment method is indicated on the plans.] After their attachment, proof load the wire ropes at 40 percent of nominal strength of the rope. Measure the length of the wire ropes to the nearest 0.25 mm 0.01 inch at a load of [_____]. Submit proof load of terminations test report and measured rope lengths.

]2.2 LUBRICATION

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NOTE: All frequently used wire rope should be lubricated, however, if operation is infrequent, it may be best to specify that it not be lubricated. Explained in EM 1110-2-3200, some cases where the wire rope is rarely operated, the presence of a heavy lubricant may increase corrosion on wire ropes. Carbon steel wire ropes in saltwater applications should have a durable protective lubricant coating.

If the end user has their own lubrication product, they may provide the lubricant.

****

Submit literature for proposed factory and field lubricant. The field and factory lubricants must be compatible. [Lubricate the wire ropes at the time of manufacture. Apply the lubricant with equipment capable of forcing the lubricant between the rope wires, including the center strand.] [Do not lubricate the wire rope.] [Lubricant will be supplied by the Government.]

PART 3   EXECUTION

3.1   REMOVAL OF EXISTING WIRE ROPE

Existing removed wire rope becomes the Contractors' property after removal. Remove from the site following all federal, state, and local laws and regulations.

3.2   EXAMINATION

****

NOTE: Insert dates in this paragraph for supply contracts that primarily involve wire rope and do not have full front end sections.

For multi-section design bid build contracts site visit dates are typically included in the Contracting front end documents. Delete this paragraph and include the dates in the front end.

****

[It is recommended that bidders visit the site before submitting bids. A pre-bid site visit, between the dates of [_____] and [_____] can be arranged by contacting [_____] at telephone number [_____]. [See Section [_____] for site visit arrangements.]

]3.2.1   QA Inspections

Provide means for Government witness inspections at the Contractors' manufacturing facility. Up to two representatives of the Contracting Officer will be present to witness the various manufacturing processes for the wire rope. At a minimum, a site visit will be made by the Government to witness the tension test, and the wire rope will be inspected upon delivery. Inspection during removal of the existing wire rope and installation of the new wire rope will be ongoing. Provide means for remote or teleconference inspection upon request.

3.2.2   Verify Dimensions

After becoming familiar with the details of the work, verify dimensions in the field, and immediately advise the Contracting Officer of any discrepancies before performing any work.

3.3   ATTACHING SOCKETS

****

NOTE: Delete this paragraph if the sockets are to be attached at the wire rope factory.

****

Attach the end terminations to the wire rope [as indicated] [in accordance with Drawing No. [______]] and the recommendations of WRTB.

3.4   CLEAN DRUMS AND SHEAVES

Clean all drum and sheave grooves with a power wire brush, and inspect them for wear, abrasion, corrosion or other roughness and verify their dimensions are suitable for the new wire rope. Immediately advise the Contracting Officer of any problems.

3.5 LUBRICATION

Lubricate the wire ropes after they are installed, but before break-in/testing. Submit the proposed method in the work plan.

3.6 UN-REELING AND INSTALLING WIRE ROPE

****

NOTE: EM 1110-2-3200 suggests at least two and preferably three dead wraps on the rope on the drum.

****

Attach the wire rope(s) to spools or pulleys as shown on the plans. Wind the wire rope under adequate tension and guide the each end of the rope(s) to its proper location. Wind the wire rope in the same direction it was bent during its manufacture. Ensure that no twists or loops occur. Do not install wire rope damaged during installation by kinking, and remove from the site. Submit the proposed method of un-reeling and installing in the work plan.

3.7 FIELD TENSIONING [SINGLE LINE] [MULTI-LINE] HOISTS

3.7.1 Field Tensioning Plan

Submit a wire rope tensioning plan that includes:

1. Pre-Opening Tension Measurements and Adjustments
2. Initial Tension Measurements and Adjustments
3. Final Tension Measurements and Adjustments.

Adjust the wire rope tension of [single line][multi-line] hoists to ensure that they share load equally. Submit the proposed field tensioning method in the work plan. [For each multi-line hoist rope drum, final tension values for each rope must be no more than plus or minus 5 percent from the average of the individual rope tension values. For two multi-line hoists on a gate, the total wire rope load on each hoist is computed by summing the measured tension values for all wire ropes on a hoist.] The total wire rope load on each hoist must be within a range less than or equal to 0.5 percent of the average of the two total wire rope loads. Measure and adjust wire rope tensions while keeping the gate properly positioned and aligned[in the slot]. After "break-in/testing" test the ropes to determine if they share load equally, and if not, re-tension.

[3.7.2 Tensioning Instrumentation and Certificates

At every phase of the tensioning process, take tension measurements of the hoist wire rope using a tension meter. Submit Wire Rope Tension Equipment Calibration Certifications, which includes certifications for current calibration and tension measurement accuracy. Operators of the tension measuring equipment must be trained by the Contractor to use the equipment and have experience performing tension measurements using the equipment. Submit tension equipment operator qualifications detailing the training and experience of the operator of the tension equipment.

][3.7.3 Pre-Opening Tensioning Measurements

Pre-opening tensioning must achieve a tension value for each rope within a range that is equal to ten (10) percent of the average of the wire ropes initial tension values. For the [two (2)][_____] [hoists on a gate][_____], the total wire rope load on each [hoist][_____] must be computed by summing the measured tension values for all wire ropes on a [hoist][_____]. The total wire rope load on each [hoist][_____] must be within a range equal to five (5) percent of the average of the [two (2)][_____] total wire rope loads.

][3.7.4 Tensioning Procedure

Observe the [gate][_____] stopped [two (2)][_____] times prior to operating the equipment to check rope tension. Adjust rope tension during the pre-opening stops until all hoist ropes for the equipment have approximately equal tensions. The first pre-opening stop must occur when the wire ropes are supporting approximately 10 percent load. The second pre-opening stop must occur when the wire ropes are supporting approximately 75 percent equipment load.

][3.7.5 Initial Tensioning Measurements

For each [hoist][_____] rope drum, initial tensioning of the wire ropes must achieve a tension value for each rope within a range that is equal to five (5) percent of the average of the wire ropes initial tension values. For the [two (2)][_____] [hoists][_____], the total wire rope load on each [hoist][_____] must be computed by summing the measured tension values for all wire ropes on a [hoist][_____]. The total wire rope load on each [hoist][_____] must be within a range equal to 0.5 percent of the average of the two (2)[_____] total wire rope loads. Wire rope tensions must be measured and adjusted while keeping the [gate][_____] properly positioned and aligned in the [slot][_____].

]3.8 BREAK-IN/TESTING

After installation is complete, run the gate-operating device through [one] [two] [three] [four] [_____] complete cycles, fully open to fully closed.

3.9 ORDERLY WORK AREA/SITE CLEANUP

Maintain neat and orderly storage and work areas. The Contract will not be considered complete until all the tools, equipment and property have been removed from the site, and the storage and work areas have been restored. Remove all dirt, debris, litter etc. from project and dispose of in a proper manner.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 05 40.14 10 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-41 24 26 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 05 40.14 10

HYDRAULIC POWER SYSTEMS FOR CIVIL WORKS STRUCTURES

11/23

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-35 05 40.14 10 (November 2023)**

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****

SECTION 35 05 40.14 10

HYDRAULIC POWER SYSTEMS FOR CIVIL WORKS STRUCTURES

11/23

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NOTE: This guide specification covers the requirements for hydraulic power systems to operate gates and other mechanisms at civil works structures. This section was originally developed for USACE Civil Works projects, however the UFGS 41 24 26 has now been merged into this document.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information. Due to the size of the specification, tailoring features are also provided. Unselect each tailoring item with "cylinder" to provide a starting specification without a hydraulic cylinder as the operatoring element. Also, keep selected only one of the "cylinder" tailoring items to remove the other types of cylinder requirements and details.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

NOTE: For Civil Works, examine EM 1110-2-2610 "Mechanical and Electrical Design for Lock and Dam Operating Equipment" and EM 1110-2-3006 "Hydroelectric Power Plants Electrical and Mechanical Design" for additional guidance.

****

PART 1 GENERAL

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NOTE: Ensure products used in this section comply with Federal procurement preference under Section 9002 of the Farm Security and Rural Investment Act of 2002. Refer to Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for requirements associated with EPA designated products.

****

1.1 SUMMARY

The work covered by this section consists of detailed requirements for the [design,] fabrication, shop assembly, testing, delivery, and installation of the hydraulic power systems for operation of the [intake gates] [slide gates] [control gates] [Tainter gates] [miter gates] [butterfly valves][spherical valves] [hoisting equipment] [_____] as specified and as shown.

****

NOTE: Expand summary as necessary to provide context and details to the contractor. If not addressed elsewhere in specification package, include details about overall project location and the effects on the work to be provided in this section. Provide details about quantities and arrangements. If section is being used for multiple, varying applications provide details that differentiates the application of the requirements.

****

[1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED

****

NOTE: List in this article all property which will be furnished to the Contractor for installation. If a separate supply Contract by the Government is used to purchase, prior to the installation Contract, any of the materials and equipment that are detailed elsewhere in this specification, then list them under this article and delete the supply and feature requirements from the other articles of this specification.

Delete this paragraph if no GFE will be provided to the contractor for installation.

****

Pursuant to Contract Clause GOVERNMENT-FURNISHED PROPERTY (SHORT FORM), the Government will furnish to the Contractor the following property, if required, to be incorporated or installed in the work. Such property will be furnished at the project site for delivery acceptance. Install or incorporate all such property into the work. Verify the quantity and condition of such Government-furnished property when delivered, acknowledge receipt thereof in writing and in case of damage to or shortage of such property, report within 24 hours, in writing, such damage or shortage.

]1.3 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, move this paragraph and its subparagraphs from this section and insert in Section 01 20 00. If not then specify measurement and payment requirements for work subject to extreme variation in estimated quantity when unit price bidding is required.

****

1.3.1 Payment

Payment will be made for costs associated with the hydraulic power system(s) as specified.

1.3.2 Unit of Measure

Unit of measure: Job

1.4 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B17.1	(1967; R 2017) Keys and Keyseats
ASME B17.2	(1967; R 2017) Woodruff Keys and Keyseats

ASME B18.6.2	(2020) Square Head Set Screws and Slotted Headless Set Screws (Inch Series)
ASME B31.1	(2024) Power Piping
ASME B36.19M	(2022; Errata 2023) Welded and Seamless Wrought Stainless Steel Pipe
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.6/D1.6M	(2017) Structural Welding Code — Stainless Steel

ASSOCIATION FOR IRON AND STEEL TECHNOLOGY (AIST)

AIST PB-229	(2008) Stainless Steels: A Steel Products Manual

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel

	Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A266/A266M	(2024) Standard Specification for Carbon Steel Forgings for Pressure Vessel Components
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A354	(2017; E 2017; E 2018) Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A519/A519M	(2024) Standard Specification for Seamless Carbon and Alloy Steel Mechanical Tubing
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A576	(2023) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A659/A659M	(2012; R 2017) Standard Specification for Commercial Steel (CS), Sheet and Strip, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled
ASTM A705/A705M	(2023) Standard Specification for Age-Hardening Stainless Steel Forgings

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B177/B177M	(2011; R 2021) Standard Guide for Engineering Chromium Electroplating
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B254	(1992; R 2014) Standard Practice for Preparation of and Electroplating on Stainless Steel
ASTM B505/B505M	(2023) Standard Specification for Copper Alloy Continuous Castings
ASTM B546	(2019; R 2024) Standard Specification for Electric Fusion-Welded Ni-Cr-Co-Mo Alloy (UNS N06617), Ni-Fe-Cr-Si Alloys (UNS N08330 and UNS N08332),Ni-Cr-Fe-Al Alloy (UNS N06603), Ni-Cr-Fe Alloy (UNS N06025), and Ni-Cr-Fe-Si Alloy (UNS N06045) Pipe
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B650	(1995; R 2023) Standard Specification for Electrodeposited Engineering Chromium Coatings on Ferrous Substrates
ASTM C633	(2013; R 2017) Standard Test Method for Adhesion or Cohesion Strength of Thermal Spray Coatings
ASTM D2794	(1993; R 2019) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3951	(2018) Commercial Packaging
ASTM D5864	(2011) Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components
ASTM E1920	(2003; R 2014) Standard Guide for Metallographic Preparation of Thermal Sprayed Coatings
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile

	Strength
ASTM G48	(2011; R 2015) Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution
ASTM G85	(2011) Standard Practice for Modified Salt Spray (Fog) Testing

GERMAN INSTITUTE FOR STANDARDIZATION (DIN)

DIN 53504	(2017) Testing of Rubber - Determination of Tensile Strength at break, Tensile Strength at Yield, Elongation at Break and Stress values in a Tensile Test

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.70	(2020) Standard Terminal Markings and Connections for Distribution and Power Transformers

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 34-1	(2022) Rubber, Vulcanized or Thermoplastic -- Determination of Tear Strength -- Part 1: Trouser, Angle and Crescent Test Pieces
ISO 48-4	(2018) Rubber, Vulcanized or Thermoplastic -- Determination of Hardness -- Part 4: Indentation Hardness by Durometer Method (Shore Hardness) - First Edition
ISO 815-1	(2019) Rubber, Vulcanized or Thermoplastic -- Determination of Compression Set -- Part 1: At Ambient or Elevated Temperatures
ISO 1183-1	(2012) Plastics - Methods for Determining the Density of Non-Cellular Plastics - Part 1: Immersion Method, Liquid Pycnometer Method and Titration Method
ISO 1219-1	(2012; Amd 1 2016) Fluid Power Systems and Components Graphic Symbols and Circuit Diagrams - Part 1: Graphic Symbols for Conventional Use and Data-Processing Applications
ISO 1219-2	(2012) Fluid Power Systems and Components Graphic Symbols and Circuit Diagrams - Part 2: Circuit Diagrams
ISO 1817	(2015) Rubber, Vulcanized or Thermoplastic - Determination of the Effect of Liquids - Sixth Edition
ISO 3274	(1996, Corr 1998) Geometrical products Specifications (GPS) - Surface

	Texture:Profile method - Nominal Characteristics of Contact (Stylus) Instruments - Second Edition
ISO 4021	(1992) Hydraulic Fluid Power - Particulate Contamination Analysis - Extraction of Fluid Samples from Lines of an Operating System
ISO 4287	(1997, Amd 1 2009)Geometrical Product Specifications (GPS) - Surface Texture: Profile Method - Terms, Definitions and Surface Texture Parameters - First Edition
ISO 4288	(1996, Corr 1 1998)Geometrical Product Specifications (GPS) - Surface Texture: Profile Method - Rules and Procedures for the Assessment of Surface Texture - Second Edition
ISO 4406	(2021) Hydraulic Fluid Power - Fluids - Method for Coding the Level of Contamination by Solid Particles
ISO 4407	(2002) Hydraulic Fluid Power - Fluid Contamination - Determination of Particulate Contamination by the Counting Method Using an Optical Microscope
ISO 4413	(2010) Hydraulic Fluid Power — General Rules and Safety Requirements for Systems and Their Components
ISO 4516	(2002) Metallic and Other Inorganic Coatings - Vickers and Knoop Microhardness Tests
ISO 5598	(2020) Fluid Power Systems and Components - Vocabulary
ISO 5817	(2014) Welding - Fusion-Welded Joints in Steel, Nickel, Titanium And Their Alloys (Beam Welding Excluded) - Quality Levels For Imperfections - Third Edition
ISO 6507	(2018) Metallic Materials -- Vickers Hardness Test -- Part 1: Test Method - Fourth Edition
ISO 9001	(2015) Quality Management Systems-Requirements
ISO 9223	(2012) Corrosion of Metals and Alloys — Corrosivity of Atmospheres — Classification, Determination and Estimation - Second Edition
ISO 9227	(2017) Corrosion Tests in Artificial Atmospheres - Salt Spray Tests - Fourth

	Edition
ISO 9461	(1992) Hydraulic Fluid Power - Identification of Valve Ports, Subplates, Control Devices and Solenoids
ISO 10763	(2020) Hydraulic Fluid Power - Plain-end, Seamless and Welded Precision Steel Tubes - Dimensions and Nominal Working Pressures
ISO 11500	(2008) Hydraulic Fluid Power - Determination of the Particulate Contamination Level of a Liquid Sample by Automatic Particle Counting Using the Light-Extinction Principle - Second Addition
ISO 11727	(1999) Pneumatic Fluid Power - Identification of Ports and Control Mechanisms of Control Valves and Other Components
ISO 13565	(1996, Corr 1998) Geometrical Product Specifications (GPS) - Surface Texture: Profile Method; Surfaces Having Stratified Functional Properties - Part 1: Filtering and General Measurement Conditions
ISO 15614-1	(2017) Specification and Qualification of Welding Procedures for Metallic Materials - Welding Procedure test - Part 1: Arc and Gas Welding of Steels and Arc Welding of Nickel and Nickel Alloys - Second Edition; Corrected Version 10/2017
ISO 15614-7	(2016) Specification and Qualification of Welding Procedures for Metallic Materials - Welding Procedure Test - Part 7: Overlay Welding - Second Edition
ISO 16889	(2022) Hydraulic Fluid Power - Filters - Multi-Pass Method for Evaluating Filtration Performance of a Filter Element

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA RN 1	(2018) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NATIONAL FLUID POWER ASSOCIATION (NFLPA)

ANSI/NFLPA T3.16.2	(1997; Rev 1; Reapproved 2005) Hydraulic Fluid Power - Design for Nonintegral Industrial Reservoirs
NFLPA T2.13.1	(2007; 5th Ed) Recommended Practice – Hydraulic Fluid Power – Use Of Fire Resistant Fluids In Industrial Systems
NFLPA T3.5.1	(2002; R 2024) Hydraulic Fluid Power - Valves, Mounting Surfaces

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J514	(2012) Hydraulic Tube Fittings
SAE J517	(2020) Hydraulic Hose
SAE J518-1	(2013) Hydraulic Flanged Tube, Pipe, and Hose Connections, 4-Screw Flange Connection Part 1: 3.5 MPa to 35 MPa (Code 61)
SAE J1273	(2019) Recommended Practices for Hydraulic Hose Assemblies

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 560/6-82-002	(1982) Guidelines and Support Documents for Environmental Effects Testing

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations

1.5 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shop Testing Plan and Procedures; G, [_____]

Installation Procedures; G, [_____]

Piping Installation; G, [_____]

Field Pressure Testing Plan; G, [_____]

Field Functional Testing Plan; G, [_____]

Field Acceptance Testing Plan; G, [_____]

Existing Equipment Removal Plan and Procedures; G, [_____]

Installation Plan and Procedures; G, [_____]

SD-02 Shop Drawings

Drawings and Data; G, [_____]

SD-03 Product Data

Materials and Mechanical Equipment; G, [_____]

Standard Products; G, [_____]

Electrical Equipment; G, [_____]

Design and Performance Requirements; G, [_____]

Erecting Engineer Qualifications; G, [_____]

Cleaning and Flushing; G, [_____]

Seals, O-Rings, and Bearing Material; G, [_____]

[Rod Coating Data; G, [_____]

] Hydraulic Motor; G, [_____]

Spare Parts List; G, [_____]

Field Instructions; G, [_____]

SD-06 Test Reports

Shop Testing Report; G, [_____]

Field Pressure Testing Report; G, [_____]

Field Functional Testing Report; G, [_____]

Piston Rods (Standard Design); G, [_____]

Piston Rods (USACE Design); G, [_____]

Field Acceptance Testing Report; G, [_____]

Shop Oil Testing Reports; G, [_____]

Field Oil Testing Reports; G, [_____]

Oil Flushing Testing Report

Oil Cleanliness Report

SD-07 Certificates

Notification Of Shop Testing; G, [_____]

SD-10 Operation and Maintenance Data

Field Instructions; G, [_____]

Operation and Maintenance; G, [_____]

1.6 DRAWINGS AND DATA

1.6.1 Shop Drawings

Include fabrication, shop assembly, delivery, storage, and field installation drawings in the detailed shop drawings. Detail any component part of fabricated items omitted on the shop drawings. If departures from the Contract drawings are deemed necessary by the Contractor, submit details of such departures, including changes in related portions of the project and reasons, with the shop drawings. Provide fabrication and assembly drawings to 1:8 or 1-1/2 inch = 1 foot-0 inch or larger scale.[Contractor to update CADD/BIM files and mark-ups/as-builts along with tagging or inputing product data.]

1.6.2 Fabrication Drawings and Assembly Details

Provide fabrication drawings for all mechanical and structural parts and components, except those of standard design and manufacture. Include in fabrication drawings complete detailing, materials of construction, tolerances, machined surface finishes, connections, and weld details with annotation to differentiate shop welds from field welds. Provide detailed drawings of the manifolds including required drilled passages. Provide details and dimensions of the hydraulic cylinder and piston rod as applicable. Provide details of the cylinder rod measuring system as applicable [magneto resistive system] [magnetostrictive system] [_____]. Provide details of the proposed coating system for the cylinder rod to meet the required corrosivity category and provide data for any coating system.

1.6.3 Hydraulic Power Unit Drawings

Provide drawings for hydraulic power units showing general arrangement of components and outline dimensions of unit. Identify all components on the drawings and provide sufficient information to determine whether the components proposed conform to the specifications.

1.6.4 Manifold Drawings

Provide fabrication drawings for all manifolds showing general arrangements outline dimensions, and drilling dimensions. Identify all components on the drawings and provide sufficient information to determine whether the components proposed conform to the specifications. Identify all port configurations and connections.

1.6.5 Piping Drawings

Provide piping drawings showing the complete hydraulic system in schematic format identifying all items of equipment incorporated in the system. Include details of all pipe supports including those for manifolds and on the hydraulic power unit.

1.6.6 Electrical Drawings

Provide electrical drawings of all electrical equipment. On electrical drawings include complete schematic diagrams and connection diagrams. On connection diagrams show electrical connections (by lines) for each conductor between terminal points. Identify terminal points.

1.6.7 Shop Assembly Drawings

Provide shop assembly drawings with details for connecting the adjoining fabricated components in the shop to ensure satisfactory field installation.

1.6.8 Hydraulic Schematic

Provide a complete hydraulic schematic in accordance with ISO 1219-1 and ISO 1219-2. Include in the hydraulic schematic the following:

a. All piping, hoses and other component layouts symbolically indicating, using standard system symbols, all system piping, and other components, including their sizes, materials, heights, spacing, and locations.

b. Both new and refurbished components shown on the schematic with any interfaces to existing equipment noted.

c. All set points and size parameters for each component.

d. Component support types and locations, anchor points versus sliding supports, flex joints, and seismic supports.

e. Proposed pertinent installation details.

f. Indicate required capacities and system pressures.

g. Indicate direction of system flow and component motion.

h. Include a legend of symbols and bill of materials (BOM)in each drawing. BOM to include name of component, component drawing number or reference drawing, and part number.

i. When a hydraulic schematic is addressed by multiple drawings or sheets, whether divided between drawings or connected to sub-contractor supplier drawing(s), clearly outline on both the schematic and other drawing(s) or sheets the connection points, utilizing identical nomenclature.

1.6.9 Installation Drawings

Provide drawings detailing the installation of all provided components, equipment, and systems including the following:

a. Provide both plan and elevation views of all the installation.

b. Indicate materials, dimensions and sizes.

c. A legend of symbols and bill of materials (BOM)in each drawing.

d. Each BOM to include name of component, component drawing number or reference drawing, and part number.

e. Detailing of layout and anchorage of equipment and appurtenances, and equipment relationship to existing equipment and other parts of the work including clearances required for maintenance and operation.

f. Details of loadings and types of frames, brackets, stanchions and other supports, and pipe anchors for supported pipe and equipment.

g. Foundation drawings that include bolt setting information for equipment indicated or required to have concrete foundations.

h. Details of location and integration of any associated structure or other components.

i. A minimum of one section view to be submitted per area.

1.6.10 Product Data

Provide catalog cuts, manufacturer's descriptive and technical literature, and outline dimensions for all provided components, equipment, and systems including but not limited to all: pumps, [electric; hydraulic] motors, filters, heaters, thermostats, switches, transducers, breathers, valves, valve controls, hoses, fittings, piping, tubing, gauges, and other accessories. Include performance data and curves for pumps, [electric; hydraulic] motors and valves. Data is to indicate the name of the manufacturer, with type, construction, class, size and materials highlighted. Any non-applicable data to be clearly annotated as not applicable. Include for all the description of component location and any associated code numbers, design ratings including temperatures and pressures. Provide a complete summary of equipment, including equipment description, model number and quantity.

1.6.11 Delivery Drawings

Provide delivery [drawings][details][sketches]with descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damage. Material submitted is to comply and be coordinated with the requirements of paragraph "SHIPPING, HANDLING, DELIVERY, AND STORAGE".

1.6.12 Storage Drawings

Provide storage [drawings][details][sketches] with descriptions of the planned methods of storing components after leaving the manufacturing facility and before installation. Include details for supporting fabricated components to prevent distortion or other damage, adequately protect machined surfaces from corrosion and physical damage, and protect from the weather, humidity, temperature variation, dirt and dust, or other contaminants. Material submitted is to comply and be coordinated with the requirements of paragraph "SHIPPING, HANDLING, DELIVERY, AND STORAGE".

1.6.13 Field Installation Procedures

Provide field installation [drawings][sketches][manuals] with a detailed description of the field installation procedures. Include the location and method of support of installation and handling equipment, the provisions to be taken to protect concrete and other work during installation, the method of maintaining components in correct alignment, and the methods for installing other appurtenant items. Include dates and schedule of work. Submit methods and procedures to accelerate the sequence of work.

1.6.14 Design and Performance Requirements

Provide design computations for all items which are designed by the Contractor. [Include computerized simulations of the complete and proposed hydraulic system.]

1.6.15 Cleaning and Flushing Procedures and Results

Submit detailed procedure for the cleaning and flushing of hydraulic cylinders, piping, and power unit as outlined in paragraph "CLEANING AND FLUSHING," not less than 30 calendar days before start of operations. Provide test reports of the results of the flushing and of the oil used to fill the system.

1.6.16 Erecting Engineer Qualifications

Provide a resume for the on-site erecting engineer with details on experience and background in similar installations.

[1.7 WARRANTY

****

NOTE:

1) Warranty for supply or construction contracts is covered by FAR clauses and is typically set at 1 year. This paragraph should only be used if a warranty longer than 1 year is desired. Any modifications to the standard warranty clauses need to be coordinated with the Contracting Officer and/or Contract Specialist. Additional costs for a longer warranty should be considered against the benefits, probability of failure and consequences of equipment failure.

2) Consider adding minimum warranty claim response times based on the criticality of the system. For example, failures resulting in delays to navigation or the inoperability of systems integral to flood protection equipment should require faster response times.

****

Guarantee all equipment for a period of 2 years from the date of acceptance. [Date of acceptance is when installed system has passed Field Acceptance Testing, and all corrective work is completed.] Guarantee replacement parts for 2 years from date of replacement. Provide warranty against defective materials, design, and workmanship. In cases where the equipment manufacturer's advertised minimum guarantee is in excess of 2 years, it remains in force for its full period. Upon receipt of notice from the Government of failure of any of the parts during the warranty period, provide new replacement parts promptly at no additional cost to the Government.[Parts and labor including removal and reinstallation are required for warranty work.]

]1.8 QUALITY CONTROL

Establish and maintain quality control to assure compliance with Contract requirements and maintain records of quality control for all materials, fabricated parts, equipment, and construction operations. In addition, establish and maintain surveillance for quality control over sub-contractors, suppliers, or manufacturers. Include a minimum of two shop inspections during manufacture and assembly of the hydraulic cylinder[s] power units and manifolds. The quality control includes, but is not limited to, the following:

a. Materials and workmanship.

b. Manufacture and installation of the overall hydraulic system, subassemblies, and individual components such as manifolds, piping, hoses, pumps, hydraulic cylinders, and motors.

c. Cleaning and flushing.

d. Shop assembly and tests.

e. Field erection and tests.

f. Damage and defects.

Submit a copy of these records and tests, as well as the records of corrective action taken, to the Government.

PART 2 PRODUCTS

2.1 MATERIALS AND MECHANICAL EQUIPMENT

****

NOTE: The contents of the following paragraphs are dependent on design requirements which may necessitate revision or expansion to cover different conditions and standards.

****

2.1.1 General

Provide materials and mechanical equipment in accordance with the requirements as indicated or specified, and if not specified, furnish materials and mechanical equipment of the best commercial grade quality suited to the intended use and as approved. All electric motors, hydraulic motors, hydraulic pumps, hydraulic cylinders, valves and similar items and/or accessories, of the same type and size, to be the products of the same manufacturer, unless otherwise approved. Permanently display the manufacturer's name, address, and catalog number on an engraved or embossed non-corrosive metal nameplate securely attached to each major item of equipment with non-corrosive rivets or fasteners.

Submit data specifications [product manuals] and assembly drawings showing sizes, ratings, performance charts and curves, parts and material lists, overall dimensions, and mounting dimensions with the product data.

2.1.2 Standard Products

Where items are referred to hereinafter as "similar and equal to" a particular manufacturer's product, such references have been made merely as a convenient method of indicating the type of material or equipment required, with no intention of asserting superiority thereof. The standard product of any reputable manufacturer regularly engaged in the commercial production for at least 2 years prior to this solicitation of the type and quality of material or equipment referred to will not be excluded on the basis of minor differences, provided essential requirements of the specifications relative to materials, capacity, and performance are met.

Furnish performance capacities and other pertinent information concerning the manufacturer's "equal to" standard products intended for incorporation in the work. "Equal to" standard products installed or used without such approval are at the risk of subsequent rejection. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.3 General Nameplates

For each major item of equipment, unless stated otherwise in this section, permanently display on a securely attached plate the manufacturer's name, address, and catalog number. Securely attach a UL label or registration plate to all UL Electrical Appliance listed electrical equipment.

2.1.4 General Equipment Guards

Fully enclose or properly guard to preclude personnel contact all rotating parts such as gears, couplings, projecting setscrews, and keys, unless stated otherwise in this section.

2.2 DESIGN AND PERFORMANCE REQUIREMENTS

****

NOTE: Include this paragraph in the specifications when the Contractor is required to furnish the detailed design of the system.

List all items for which the Contractor must furnish design computations. If Contractor designed, also provide a reference to have the Contractor follow requirements in USACE EM 1110-2-2610 for hydraulic power systems.

****

The Contract drawings indicate the general arrangement of the hydraulic power system for operation of the [intake gates] [slide gates] [control gates] [Tainter gates] [miter gates] [butterfly valves] [hoisting equipment] [______], clearances necessitated by the structure or other equipment, maximum overall dimensions, and other pertinent features. Furnish the detailed design in accordance with ISO 4413, and the following design criteria. Identify design and dimensional changes necessary to satisfy the principal design parameters identified in the paragraph "Design Parameters" as variations in the submittals. Dimensions submitted that differ from those indicated and not otherwise constrained by the Design Parameters and physical limitations of installation are subject to approval. Also submit design computations for all extension of design items.

2.2.1 Design Parameters

****

NOTE: List all design parameters or criteria required by the Contractor to design the hydraulic power system. Possible design criteria to consider are:

a. Maximum system pressure.
b. Working system pressure.
c. Rated raising or retracting force.
d. Rated lowering or extending force.

e. Maximum raising or retracting time.
f. Maximum lowering or extending time.
g. Hoist stroke.
h. Critical or limiting dimensions.
i. Operating temperature range.
j. Duty cycles.
k. Accumulator performance characteristics.
l. Corrosivity category
m. Any other unusual features.
****

The principal design parameters for the hydraulic power system are as follows and were developed at the minimum operating temperature and utilizing the hydraulic fluid as specified:

2.2.2 Allowable Stresses

2.2.2.1 Structural Items

Design structural items associated with the hydraulic power system, such as support beams, to withstand the maximum force exerted by the [hydraulic operator] [hydraulic cylinder] plus any dead loads with a factor of safety of 2 based on the yield strength of the materials involved.

2.2.2.2 Hydraulic Cylinders

****
NOTE: Use telescopic hydraulic cylinders only for special retrofit applications where regular single or double acting cylinders cannot be used or where the physical constraints of the installation leave no other alternative. Utilize Euler formula or other analytical methods to determine buckling strength of cylinder rod. Designer will need to determine how the cylinder is fixed and connected to determine buckling strength.
****

Design all hydraulic cylinders to withstand a maximum operating pressure of 21[__] MPa 3000[___] psi with a factor of safety of 5 based on the ultimate strength of the material or 2.5 based on the yield strength of the material. Apply a factor of safety of 3 to the compression load when designing the hydraulic cylinders to resist buckling. End fixity coefficients for determining the effective buckling length for each hydraulic cylinder are [1.0] [____].

2.2.2.3 Stress Concentration Factors

Use stress concentration factors where applicable. Reduction of allowable stresses to compensate for repeated cycles of loading is not required.

2.2.3 Corrosivity Environment Category

Design hydraulic cylinders, cylinder rods and components to meet the corrosivity category [_____] in accordance with ISO 9223 to meet anticipated atmospheric environment the cylinders and piston rods will be operating within.

****

NOTE: Select a Corrosivity Category (C1-C5, or CX) to meet the measured corrosion rates of 1 year tests conducted in the actual intended environment for the hydraulic cylinder in accordance with ISO 9223 and ISO 9226 OR to meet the anticipated atmospheric environment in accordance with the Table 1 furnished below. The hydraulic cylinder manufacturer may already have test data which can be requested in a shop drawing submittal. It is important to work with the cylinder manufacturer on the selected corrosivity category. The corrosivity category impacts the selection of the piston rod and the type of rod coating and rod material. Submerged cylinders and piston rods should be selected for CX Extreme category. In environments with expected "CX category" classification, it is recommended that the atmospheric corrosivity classification be verified from one-year or three year corrosion loss analysis such as salt water droplet corrosion test to ensure correct classification if possible or from existing test data. Collection and analysis of water quality data in advance of the installation may also be beneficial for environments subject to immersion. When crossover between categories occurs the designer should select the category with the more severe environment. Additional factors that may influence the selected corrosivity category include salt spray, humidity, airborne pollutants, waterborne pollutants, anticipated cylinder rod retraction operation, frequency of immersion, frequency of movement, time spent extended, presence of sheltering, and inspection/maintenance accessibility.

****

Table 1: Description of Corrosivity Categories

Corrosivity Category	Typical Environments - Examples	
	INDOOR	OUTDOOR
C1 Very Low	Heated spaces with low relative humidity and insignificant pollution, e.g. offices, schools, museums.	Dry or cold zone, atmospheric environment with very low pollution and time of wetness, e.g. certain deserts, Central Arctic/Antarctica.

Corrosivity Category	Typical Environments - Examples	
	INDOOR	OUTDOOR
C2 Low	Unheated spaces with varying temperatures and relative humidity. Low frequency of condensation and low pollution, e.g. storage, sport halls.	Temperate zone, atmospheric environment with low pollution (SO2 < 5 micro grams/cubic meter), e.g. rural areas, small towns. Dry or cold zone, atmospheric environment with short time of wetness, e.g. deserts, subarctic areas.
C3 Medium	Spaces with moderate frequency of condensation and moderate pollution from production process, e.g. food-processing, laundries, breweries, dairies.	Temperate zone, atmospheric environment with medium pollution (SO2: 5 micro grams/cubic meter to 30 micro grams/cubic meter) or some effect of chlorides, e.g. urban areas, coastal areas with low deposition of chlorides. Subtropical and tropical zone, atmosphere with low
C4 High	Spaces with high frequency of condensation and high pollution from production process, e.g. industrial processing plants, swimming pools.	Spaces with high frequency of condensation and high pollution from production process, e.g. industrial processing plants, swimming pools Temperate zone, atmospheric environment with high pollution (SO2: 30 micro grams/cubic meter to 90 micro grams/cubic meter) or substantial effect of chlorides, e.g. polluted urban areas, industrial areas, coastal areas without spray of salt water or, exposure to strong effect of de-icing salts. Subtropical and tropical zone, atmosphere with medium pollution

Corrosivity Category	Typical Environments - Examples INDOOR	OUTDOOR
C5 Very High	Spaces with very high frequency of condensation and/or with high pollution from production process, e.g. mines, caverns for industrial purposes, unventilated sheds in subtropical and tropical zones.	Temperate and subtropical zone, atmospheric environment with very high pollution (SO2: 90 micro grams/cubic meter to 250 micro grams/cubic meter) and/or significant effect of chlorides, e.g. industrial areas, coastal areas, sheltered positions on coastline.
CX Extreme	Spaces with almost permanent condensation or extensive periods of exposure to extreme humidity effects and/or with high pollution from production process, e.g. unventilated sheds in humid tropical zones with penetration of outdoor pollution including airborne chlorides and corrosion-stimulating particulate matter. Submerged cylinders and piston rods.	Subtropical and tropical zone (very high time of wetness), atmospheric environment with very high SO2 pollution (higher than 250 micro grams/cubic meter) including accompanying and production factors and/or strong effect of chlorides, e.g. extreme industrial areas, coastal and offshore areas, occasional contact with salt spray. NOTE: Water Quality Sampling may be required in advance of the design project to collect sufficient data to assess pollution levels for determination of Corrosivity Category. Applications with frequent submergence for extended periods (> 24 hours).

2.2.4 Connections

2.2.4.1 Pinned Connections

Design pinned hydraulic cylinder connections for field assembly [as manufacture designed] [as shown].

2.2.4.2 Shop Connections

Design shop connections for assembly by means of welding or by bolting.

2.2.4.3 Welded Connections

****
NOTE: If the need exists for more stringent requirements for weldments, delete this first bracketed paragraph and use the second paragraph. The designer should also consider whether a U-Stamp per ASME BPVC SEC VIII code is necessary since custom produced hydraulic cylinders are generally exempt. Note specifically in paragraph below the exemption of the U-stamp requirement. All other requirements of the ASME BPVSC SEC VIII code should still be enforced.
****

[Design welded connections in accordance with AWS D1.1/D1.1M or AWS D1.6/D1.6M with the exception of provisions for repeated stress are not required.[Structural members must be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] Weld hydraulic cylinders in accordance with ASME BPVC SEC VIII D1, [ISO 15614-1]. Weld piping in accordance with ASME B31.1 with qualified procedures using qualified welders and welding operators. Qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. [U-stamp requirements per ASME BPVC are waived.] Notify the Contracting Officer within 24 hours in advance of tests and perform the tests at the work site if practicable. Apply the welder's or welding operator's assigned symbol near each weld made as a permanent record. Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.]

[Welding and nondestructive testing procedures for piping are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

2.2.4.4 Structural Bolted Connections

Make structural bolted connections carrying primary loads with ASTM F3125/F3125M, Grade [A325][A490] bolts [or ISO equivalent standards as approved].

2.3 HYDRAULIC CYLINDERS

2.3.1 Hydraulic Cylinders (Standard Design)

****
NOTE: Use this Alternate 1 when hydraulic cylinders of standard design and manufacture are required and available as standard catalogue items. These are typically tie rod type cylinders and will generally be available as standard catalogue items. Cylinder parts and components are generally standardized.
****

Provide [single end][double end] rod hydraulic cylinders that are a standard catalog item. Provide one of the hydraulic cylinder types listed in ISO 5598 as specified or indicated, of tie rod design, [square head standard construction]. Cylinders must meet the following requirements:

a. Select cylinders with the bore, stroke, rod diameter, and mounting style of the cylinder as indicated.

b. The manufacturer specified pressure rating of the cylinder must not be less than the maximum system pressure indicated.

c. Equip cylinders with dynamic seals are suitable for both frequent and infrequent operation and are capable of not less than [manufacturer defined and rated number of operations] [500,000 cycles of operation] in systems properly maintained.

[d. Equip the cylinders with the manufacturer's standard position measuring system.]

e. Equip cylinders with [SAE straight thread O-ring][SAE 4 bolt hydraulic flanges] [_____] piping ports.

f. [f. Provide the hydraulic cylinder with [adjustable] [nonadjustable] cushions on [the cap end only] [the rod end only] [both ends]. [Cushions to have free reverse flow check valves.]]

g. Provide evidence that each cylinder was hydrostatically tested by the manufacturer to [ASME BPVC SEC VIII D1 requirements] [200% of working load][150% working load] for the severest service rating.

2.3.1.1 Cylinder Tubes (Standard Design)

Cylinder tubes for standard design cylinders must meet the following requirements:

a. Machine the cylinder tube from [ASTM A519/A519M, Grade 1018][heavy wall seamless steel tubing] [or materials meeting ISO standard equivalent as approved]

b. Hone the bore to a [surface finish compatible with the seals being used so as to result in zero net leakage past the seals.] [to a 254 to 381 nanometers 10 to 15 microinch rms surface finish.]

2.3.1.2 Cylinder Heads and Caps (Standard Design)

Cylinder heads and caps for standard design cylinders must meet the following requirements:

a. Fabricate the cylinder head and cap from [ASTM A576, Grade 1018, steel bar stock][ASTM A516/A516M, Grade 60 plate][or materials meeting ISO equivalent standards as approved]

b. Provide a machine finish on all surfaces.

c. Equip the cylinder head with a rod seal and external dirt wiper, [ice scraper,] and a rod bushing piloted into the head to ensure concentricity. [Rod bushings must be removable without the use of special tools and without removing the tie rods or cylinder head.]

****

NOTE: An ice scraper is in addition to a standard wiper or scraper seal to clean rod and prevent debris from impacting the main rod seal(s). Recommend inclusion for any areas in which ice or

frost may form on the cylinder rod.
****

d. Attach the cylinder tube to the head and cap by tie rods [bolts] having a minimum yield strength of 690 MPa or 100,000 psi[or] [as indicated].

e. Removable attachments to have the cylinder tube end seals arranged to seal with pressure and be designed to prevent shearing and extrusion and to provide axial metal backup.

2.3.1.3 Pistons (Standard Design)

Pistons for standard design cylinders must meet the following requirements:

a. Fabricate the piston from [fine-grained cast iron][_____].

b. Precision fit the piston to the cylinder body bore.

c. Provide a suitable method for locking piston to the rod.

d. Equip pistons with [zero net leakage cup-type seals][bronze-filled polytetrafluoroethylene seals with phenolic wear rings][contractor furnished design].

e. The design must protect the piston rings from blow-out and over squeezing.

2.3.1.4 Piston Rods (Standard Design)

Piston rods for standard design cylinders must meet the following requirements:

a. Fabricate the rods from [medium carbon steel with a yield strength of 620 to 690 MPa 90,000 to 100,000 psi for rods 16 through 102 mm or 5/8 through 4 inches in diameter][620 to 760 MPa or 90,000 to 110,000 psi high tensile strength steel using ASTM A108, Type C 1045, for rods 16 to 64 mm or 5/8 to 2 1/2 inches in diameter, and ASTM A108, Type CR 4140, for rods 76 to 254 mm 3 to 10 inches in diameter][materials and coatings as recommended by the manufacturer to meet the specified design requirements for operation, strength, durability, corrosivity and operating environment].

b. [Provide the rod case hardened to 50-54 Rockwell C, polished to a 0.25 micrometer 10 microinch Ra surface finish or better, and nickel and hard-chrome plated to 75 micrometer or 0.003 inch minimum thickness.][Provide rod coating system per manufacturer standard design and standard surface finish to meet required corrosivity rating.]

2.3.2 Hydraulic Cylinders (Custom Design by Manufacturer)

****
NOTES: Use this Alternate 2 when the hydraulic cylinders are to be custom designed by the manufacturer specifically for this project in accordance with the design parameters.

Telescopic hydraulic cylinders may be used only for special retrofit applications where regular single or double acting cylinders cannot be used.

Unless the designer needs to make the choices because of unique criteria situations, the selection of materials and configurations should remain as Contractor's options. Mill type cylinders are preferable over tie rod cylinders and should be specified and utilized. Mill type cylinders generally are rated for the higher pressures than the other designs. The cylinder heads generally are mounted with bolts or cap screws.

****

Utilize mill type cylinders. Provide cylinder of [single][double] acting[, telescopic] type designed and manufactured [to be used under water and] to meet the criteria as stated in paragraph "Design Parameters."[Design cylinders and integrated appurtenances including position sensing systems to be submerged [and operate] under [_____] meters [_____] feet of water for up to [_____] days per year.][Telescopic cylinders may be either single or double wall as necessary to provide the best operating characteristics.] Provide cylinder measuring systems as approved. Material for the hydraulic cylinder to be a high strength carbon or alloy steel. Stress relief heat treat cylinder tubes which have been welded and [radiograph all welds including those on the end mounts][radiograph designated welds as indicated]. Material for the piston rod to be a high strength [carbon or alloy steel with chrome plating per ASTM B650][stainless steel with chrome plating per ASTM B177/B177M and ASTM B254][manufacturer standard thermal sprayed system with nickel chromium based alloy on stainless steel substrate][laser clad metal alloy on carbon steel or stainless steel substrates][_____].[Nickel plate the exterior of the extending rods and tubes on a telescopic cylinder.][The nickel plating to be a minimum of 75 micrometers or 0.003 inch thick and a [high][mid] phosphorous, electroless nickel process designed for corrosion protection.] Fabricate rings, bearings, packing, packing rings, retaining rings, seals, wiper-scrapers, and any other fabricated items from sufficiently qualified materials as recommended and approved to provide net zero leakage. Where a cylinder head is used as a positive-position stop, the stop head to incorporate an adjustable cushion, or an external deceleration control provided to minimize detrimental mechanical impact. [End mounts [for pinned connections] as indicated.] [Provide bronze bushings in accordance with ASTM B505/B505M, Alloy [C92200], in the pin holes.] [Fabricate connection pins from ASTM A564/A564M, Type 630, Condition H-1150, stainless steel.] [Mount the hydraulic cylinder as indicated.] Drill, tap, and surface ports to receive [SAE Code 61 flanges][_____] in the positions indicated or as otherwise approved. Locate the manifold and pipe supports, as indicated, to be an integral part of the machinery. Provide both ends of all the cylinders with convenient bleed ports. Tap each cylinder port to receive the 7/16-20-SAE bleed valves. Provide diagnostic connectors rated at least 31 MPa 4500 psi and consisting of a stainless steel body with internal ball check and spring, male SAE O-ring connection and protective cap as bleed valves. Integrated position indication systems mounted to the cylinders to be designed for minimal leakage [leakage free] and equipped with a pressureless leakage monitoring port collection system. [Cylinders to have ports on both sides and provisions for mounting piping in either left or right hand configuration so that the cylinders for both positions are interchangeable.]

2.3.3 Hydraulic Cylinders (USACE Custom Design)

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NOTE: Use this Alternate 3 when the hydraulic cylinders have been designed or by the Corps of Engineers or have specific and unique requirements and they are detailed on the contract drawings. Mill type cylinders to be utilized in accordance with EM 1110-2-2610. Mill type cylinders generally are rated for the higher pressures than the other designs. The cylinder heads generally are mounted with bolts or cap screws. Most main operating systems to be designed for this type of cylinder.

Position sensing systems are a critical feature and are either integral with the cylinder or external to the cylinder and sense either the cylinder or the gate or valve directly. An advantage of a position sensing system connected to the gate (not the cylinder) is the gate position is known if the actuator becomes disconnected or damaged. Systems integral with the cylinder can be provided by the manufacturer and require no external mechanisms or linkages.

Integral systems include the magneto resistive systems. Notches are etched or machined into the base material of the cylinder rod and a surface coating is applied over this. These systems, however, only work with carbon steel rods and non-magnetic coatings. Located in the rod seal gland housing is a sensor, which is positioned to receive signals from the etched or machined notch embedded below the polished surface. Signal pulses are counted and computed to provide an output positioning signal.

Magnetostrictive systems require drilling the cylinder rod from the piston end for a sensor rod. This system provides an absolute indication of position but is limited in stroke because of the length of the unsupported rod in the cylinder when extended.

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2.3.3.1 General Requirements (USACE Design)

Utilize mill type cylinders. The hydraulic cylinder to be of the [single][double] acting type designed and manufactured [to be used under water and] to meet the criteria stated in paragraph "Design Parameters."[Design cylinders and integrated appurtenances including position sensing systems to be submerged [and operate] under [_____] meters[_____] feet of water for up to [_____] days per year.][Cylinder design arrangement must allow for field serviceability of cylinders, where rod wiper/scraper seals and static o-rings can be serviced without specialty jig or offsite facility.]

2.3.3.2 Cylinders (USACE Design)

Cylinders for USACE Design hydraulic cylinders must meet the following requirements:

a. Make cylinders out of steel meeting one of the following options:

  (1) Option A: Rolled steel plate in accordance with ASTM A516/A516M, Grade 70 or equivalent material as approved, and welded flanges in accordance with ASTM A181/A181M, Class 70 or equivalent material as approved.

  (2) Option B: Provide centrifugal cast steel shell in accordance with ASTM A216/A216M, Grade WWC or equivalent material as approved, and welded flanges in accordance with ASTM A181/A181M, Class 70 or equivalent material as approved, or cast from ASTM A216/A216M, Grade WWC steel or equivalent material as approved.

  (3) Option C: The shell and flanges a solid trepanned forging in accordance with ASTM A266/A266M, Class 1 or equivalent material as approved.

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NOTE: Examine how long the cylinder is and how practical it is to produce it as one piece. Long cylinders, such as for gates and locks may require segments. Design may need to add provisions for welding of segments and the transition of dynamic seals over the assembly points.

****

b. The interior of the finished cylinder must honed to the dimensions, tolerances and surface finish shown.

c. The finished wall thickness must not be less than that shown.

d. Weld flanges to the cylinder parallel with each other and perpendicular to the cylinder center line.

e. Stress relief heat treat the cylinder after completion of all welding.

f. Fabricate cylinder to the tolerances as shown. The assembled cylinder to be of such straightness that the piston and rod move smoothly without any indication of binding or tight spots.

g. [Radiograph all welds including those on the end mounts.][Radiograph designated welds as indicated.]

2.3.3.3 Piston Rods (USACE Design)

****

NOTE: Choose one or more options depending on the unique requirements and life-cycle costs of the project. Carbon steel piston rods with chrome plating is noted but should be avoided if possible due to potential corrosion of the piston rod especially in high corrosivity environments. Welded overlay with carbon or stainless steel rods is the recommended approach.

The designer needs to reference and select the appropriate corrosivity category in Table 1 for the piston rod.

The designer should be aware that cylinder rod ends specified with carbon steel substrates have an increased likelihood of corrosion between the mating surfaces/threads of the cylinder rod and connected components. The cylinder rod ends are typically machined threads for adjustability and are not protected by the specified rod coating system. Standard o-ring type seal designs may not be enough to withstand environmental conditions. Designers should provide provisions in the design to seal, protect or coat mating surfaces to minimize the chance of seizing and corrosion for future maintenance and serviceability.

****

Piston rods for USACE Design hydraulic cylinders must meet the following requirements:

a. Rod and road coating system must be in accordance with one of the following options. All rod coatings must meet or exceed the minimum test criterion as stated in the following tables (Tables 2,3,4). [Submit Rod Coating Data that includes details on the coating materials, corrosivity testing, application method, and quality inspection methods and metrics.]:

[(1) Carbon steel rods with [chrome][nickel plus chrome] plating: Fabricate rods from carbon steel that meets the requirements of ASTM A108, Type C 1045 or Type CR 4140 or equivalent material as approved. Case hardened to 50-54 Rockwell C. The chrome plating thickness must be a minimum of 76 micrometers or 0.003 inch. Apply plating in accordance with ASTM B177/B177M or ASTM B650 [ASTM B546.]]

[(2) Stainless steel rods with chrome plating: Fabricate rods from stainless steel that meets the requirements ASTM A564/A564M or ASTM A705/A705M, Type 630 or Type XM-12 or equivalent material as approved. The chrome plating thickness must be a minimum of 76 micrometers or 0.003 inch. Apply plating in accordance with ASTM B177/B177M and ASTM B254.]

[(3) Carbon steel rods with welded overlay: Fabricate rods from carbon steel that meets the requirements of ASTM A108, Type C 1045 or Type CR 4140 or equivalent material as approved. The overlay material must be certified and formulated to consist of a metal alloy to meet corrosivity category and designed and applied by the cylinder manufacturer and submitted for approval. The minimum coating thickness must be [600] micrometers or [0.0236] inches[400 micrometers][300 micrometers].]

[(4) Carbon steel rods with high velocity oxygen fuel (HVOF) coating: Fabricate the rods from carbon steel that meets the requirements of ASTM A108, Type C 1045 or Type CR 4140 or equivalent material as approved. Case hardened to 50-54 Rockwell C. Apply thermal sprayed coatings with HVOF method and have the applied material composition certified and submitted for approval. HVOF application per ASTM E1920 and ASTM C633[manufacturer standard application process] and submitted for approval. Applied coating materials to consist of Nickel-Chromium based alloys as approved applied in multiple layers to achieve a total coating thickness greater or equal to [250] micrometers or [0.0089] inches for the first layer and not less than [440] micrometers or [0.0173] inches for two layers.]

[(5) Stainless steel rods with welded overlay: Fabricate rods from stainless steel that meets the requirements ASTM A564/A564M or ASTM A705/A705M, Type 630 or Type XM-12 or equivalent material as approved. The overlay material must be certified and formulated to consist of a metal alloy to meet corrosivity category and designed and applied by the cylinder manufacturer and submitted for approval. The minimum coating thickness must be [600] micrometers or [0.0236] inches[400 micrometers][300 micrometers].]

b. If rods are made from two or more pieces, joints must be made with full penetration welds. Perform radiograph testing on 100% of welds.

c. [The final rod surface to have a roughness height of not more than [0.20][___] micrometers[8][__] microinches Ra.]

d. Quantify the final rod surface roughness using the Rpk-Rk-Rvk in accordance with ISO 13565. Other parameters such as Ra, Rz or Rmax value can only be used indicative. Roughness to be determined by Cylinder manufacturer and Seal manufacturer for the intended cylinder operating environment as specified.

e. Submit certified test reports for both the rod material and performance requirements as specified.

****

NOTE: ASTM G48 testing is not a suitable test for porous coatings, e.g. hard chromium, thermal sprayed.

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Table 2: (Nickel) Chromium Piston Rod Coating Requirements

No.	Test	Criterion	Remarks
1.	Manufacturing Procedure Specification (MPS) for the application of technical coatings	Manufacturer to be ISO 9001 certified and or have produced coatings of the type and application specified for a minimum of 5 years with a written quality documentation procedure in place during that period.	Implementation and certification performed by the manufacturer. The MPS to address such items as personnel qualification for coating application, calibration of equipment and service maintenance records, material certificates with chemical composition, process parameter specification thresholds, dimensional control, inspection/ acceptance.

No.	Test	Criterion	Remarks
2.	Coating Thickness	As indicated or specified.	Conduct pre-and post-process diameter measurements. Additional tests may be performed of test samples produced at time of fabrication may be submitted.
3.	Hardness	900 - 1100 HV 0.1 Vickers in accordance with ISO 4516 and ISO 6507 [,670 - 730 Brinell]. Alternative testing and results in accordance with manufacturer's standard testing procedures may be submitted to the Government for	Hardness testing on final product prohibited.
4.	Adhesion strength	Per requirements of ASTM B254 or ASTM B650 as applicable or manufacturers equivalent test as approved.	Test in accordance with manufacturer's approved procedure if different than specified.
5.	Corrosion testing-Cr30	ISO 9227 or ASTM G85: Minimum 96h, Base material corrosion observed is prohibited.	Neutral Salt Spray Test
6.	Corrosion testing1-Ni/C 60/40	Test in accordance with manufacturer's standard test procedure as approved.	Salt Droplet Corrosion

No.	Test	Criterion	Remarks
7.	Surface finish	Rmr - mr (-1.5, 2.0) => 80% Ra: (>0.1 micrometers or 3.93 micro inches <0.4 micrometers or 15.75 microinches) All surface finish parameters in accordance with ISO 4287 and ISO 4288 Cracks, blisters, holes, or discoloration visible with naked eye are prohibited. Defects >0.2 micrometers or 7.87 microinches are prohibited.	Surface finish measurements to be obtained by contact stylus in accordance with ISO 3274. General visual inspection. Indications to be assessed visually at 30-40x magnification.
8.	Impact test	Perform impact testing in accordance with ASTM D2794, or a similar test in accordance with Manufacturer's standard testing procedures as approved. Radial cracking at or below 14 Joules is prohibited.	
9.	Dynamic bending (3-pt)	Perform Dynamic Bending (3-Pt) in accordance with Manufacturer's standard testing procedures. Submit test results.	

Table 3: Thermal Sprayed (HVOF) Coating Requirements

No.	Test	Criterion	Remarks
1.	Manufacturing Procedure Specification (MPS) for the application of technical coatings	Manufacturer to be ISO 9001 certified and or have produced coatings of the type and application specified for a minimum of 5 years with a written quality documentation procedure in place during that period.	Implementation and certification performed by the manufacturer. The MPS to address such items as Personnel Qualification for Coating application, Calibration of equipment and service maintenance records, Material Certificates with chemical composition, Process parameter specification thresholds, Dimensional control, Inspection/ Acceptance.
2.	Microscopic examination (cross section)	2-3% pores allowed. Cracking is prohibited.	Typically performed at 10-100x visual magnification.
3.	Chemical composition	NiCr based alloy.	To be documented by powder certificate provided as a submittal for approval.
4.	Coating thickness	As indicated or specified.	Conduct pre-and post-process diameter measurements. Additional tests may be performed of test samples produced at time of fabrication may be submitted.
5.	Hardness	550-700 HV 5 Vickers in accordance with ISO 6507-1 [,490 - 580 Brinell].	Hardness measurements on the finished product is prohibited.
6.	Adhesion strength	Strength to be per requirements of ASTM C633. Submit other procedures proposed by the manufacturer.	Test according to manufacturer's approved procedure if different than that specified.
7.	Corrosion testing [SDCT 10,000 hours] [SDCT 30,000	Perform Corrosion Testing according to Manufacturer's standard testing procedures. Submit test results or previous test results.	Salt droplet corrosion test as required. Submit for approval. A distinction between single and dual and multiple layers is necessary.

No.	Test	Criterion	Remarks
8 .	Surface finish	Rmr - mr (-1.5, 2.0) => 80% Ra: (>0.1 micrometers or 3.93 microinches <0.4 micrometers or 15.75 microinches) All surface finish parameters in accordance with ISO 4287 and ISO 4288. No cracks, blisters, holes, or discoloration visible with naked eye are allowed. No defects >0.2 micrometers or 7.87 microinches allowed. No defects through coating and into base material allowed.	Surface finish measurements to be obtained by contact stylus in accordance with ISO 3274. General visual inspection. Indications to be assessed visually at 30-40x magnification.
9.	Impact test	Perform impact testing in accordance with ASTM D2794, or a similar test in accordance with Manufacturer's standard testing procedures. Submit test results for approval. Radial cracking at or below 8 Joules is prohibited.	
10	Dynamic bending (3-pt)	Perform dynamic bending in accordance with manufacturer standard procedures. Cracking before 1000x @400MPa is prohibited.	

Table 4: Welded Overlay (Laser Cladding) Coating Requirements

No.	Test	Criterion	Remarks
1.	Welding Procedure Qualification (WPQR) for the application of technical coatings	Manufacturer to be ISO 9001 certified and or have produced coatings of the type and application specified for a minimum of 5 years with a written quality documentation procedure in place during that period. Welding to be performed in accordance with ISO 15614-7 or ASME BPVC SEC IX or both.	Implementation and certification performed by the manufacturer. The WPQR should address such items as Personnel Qualification for Coating application, Calibration of equipment and service maintenance records, Material Certificates with chemical composition, Process parameter specification thresholds, Dimensional control, Inspection/ Acceptance.
2.	Microscopic examination (cross section)	0.1% defects allowed in accordance with ISO 5817 Table 1	
3.	Chemical composition	Metal alloy	Powder certificate provided as a shop drawing submittal for approval.
4.	Coating thickness	As indicated by specification or drawings	Conduct pre-and post-process diameter measurements. Additional tests may be performed of test samples produced at time of fabrication may be submitted.
5.	Hardness	In accordance with ISO 15614-7 as recommended by manufacturer and approved. >300 HV 5 Vickers in accordance with ISO 6507-1 or 290 Brinell Hardness	Maximum hardness depends on substrate material. Care must be taken to keep the heat-affected zone (HAZ) soft enough to avoid brittleness and potential delamination with the substrate.
6.	Corrosion testing for low corrosivity categories [SDCT 4000 hours]	Perform Corrosion Testing in accordance with Manufacturer's standard testing procedures. Submit test results.	Electrochemical test or salt droplet corrosion test as required for low corrosivity category.

No.	Test	Criterion	Remarks
7.	Corrosion testing for high corrosivity categories C5 and CX by ASTM G48	ASTM G48-C/72h >60C	Utilize corrosion testing per manufacturer testing method or ASTM G48. No pitting at 60C.
8.	Surface finish	Rmr - mr (-1.5, 2.0) => 80%, Ra: (> 0.1 micrometer or 3.93 microinch < 0.4 micrometer or 15.75 microinch) All surface finish parameters in accordance with ISO 4287 and ISO 4288. No cracks, blisters, holes, or discoloration visible with naked eye are allowed. No defects >0.2 micrometer or 7.87 microinches allowed. No defects through coating and into base material allowed	
9.	Impact test	Perform impact testing in accordance with ASTM D2794, or a similar test in accordance with Manufacturer's standard testing procedures. Submit test results for approval. No cracking at 8 Joules minimum [15 Joules]	
10.	Dynamic bending (3-pt)	Perform Dynamic Bending (3-Pt) in accordance with Manufacturer's standard testing procedures. Submit test results. Achieve [400MPa] bending	

2.3.3.4 Pistons (USACE Design)

Provide pistons for USACE Design that are made from cast iron that meets the requirements of ASTM A536, Grade 80-55-06 or 10-50-05 or equivalent material as approved.

[2.3.3.5 Position Indication

Equip hydraulic cylinders with a position indication system of the [magnetoresisitive type] [magnetostrictive type] [_____].

]2.3.3.6 Seals, O-rings and Bearing Materials (USACE Design)

Provide seals, o-rings, and bearing materials for USACE design hydraulic cylinders in accordance with the following paragraphs.

Design and provide seals, O-rings, and bearing materials to be compatible with the specified hydraulic fluid. Each material in use with the hydraulic cylinder to be tested to verify the chemical resistance and hydraulic fluid compatibility. [Contractor to supply certificate from seal and hydraulic fluid manufacturer to sign off together to confirm compatibility.] Conduct testing in accordance with ISO 1817 to measure changes in hardness, tensile strength, and elongation to satisfy the requirements of [the cylinder and seal manufacturers][Table 5][Table 6]. Submit for Government approval seals, O-rings and bearing materials.

[Table 5: Allowable deviations in seal material properties after ISO 1817 testing.][

LHC specification. Test results described in the difference between before/after 1008 hours @ 80°C			
Hardness changes [Shore IRHD, A or D]	Volume changes [__]%	Changes tensile strength [__]%	Changes in elongation [__]%
-7 / +7	-0.5 / +10	-30 / +30	-25 / +30

]

Submit seals, O-rings, and bearing material properties in accordance with the minimum requirements as specified in Table 6 or manufacturers standard recommendation as approved.

****

NOTE: Designer should select properties from Table 6 as needed otherwise have the cylinder manufacturer submit for approval.

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[Table 6: Minimum Material Properties for Seal and Bearing Materials][

Density	[_____] g/cm3	ISO 1183-1
Hardness	[_____] Shore A/D	ISO 48-4

Density	[____] g/cm3	ISO 1183-1
Tensile strength	[____] MPa	DIN 53504
Elongation at break	[350____] %	DIN 53504
100% modulus	[____] MPa	DIN 53504
Compression set	[_30___] %	ISO 815-1
Tear Strength	[____] N/mm	ISO 34-1

]

2.3.3.6.1 Piston Wear Rings

Provide [composite] [cast iron] piston wear rings with a compressive and tensile strength of not less than 165 MPa or 24,000 psi, and an embeddability capability to prevent scoring of the cylinder.

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NOTE:

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Cast iron wear rings will not provide zero leakage. Use composite if piston seal is to be zero leakage.

2.3.3.6.2 O-Ring Seals

Use O-ring seals made from [Buna N][Viton] and designed for [_____] kPa psi service.

2.3.3.6.3 Rod Wiper/Scraper

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NOTE: Use option for metal scraper ring for environment subject to ice or other materials adhering to the rod.

****

Provide a [high-strength polyurethane scraper ring][spring reinforced brass scraper ring] which will withstand the impact and the abrasion of materials adhering to the piston rod and have a minimum tear resistance of 120 N/mm or 685.2 pounds per inch. Split and retain the scrapers with split, bolted retainer to facilitate replacement without removal of the rod end clevis.

2.3.3.6.4 Piston Rod Seals

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NOTE: Designer will need to examine the performance of the system for all conditions in order to determine the type of seals to detail. Either have zero leakage or specify allowable amount of internal bypass leakge. Allowing internal bypass leakage may

be allowed if the system does not need to hold position. However, all operations should be examined if allowing this to occur. Bypass leakage will allow pressure to equalize. This may require a back-up power system or larger accumulator capacity if an emergency operation capability is needed.

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Provide [zero leakage U-cup piston rod seals][low leakage V-ring, nonadjustable gland type piston rod seals], designed for [_____] kPa[_____] psi service.

2.3.3.6.5 Piston Seals

[Provide bronze-filled polytetrafluoroethylene (PTFE) zero-leakage C-shaped piston seals.][Provide low leakage V-ring, nonadjustable gland type piston seals, designed for [_____] kPa[_____] psi service.]

2.3.3.7 Rod Seal Gland and Locking Device Flange

Fabricate the rod seal gland and locking device flange from bronze in accordance with ASTM B505/B505M, Alloy No. C95400 or C93200. The ice scraper, attached to the gland, bronze-filled polytetrafluoroethylene in accordance with ASTM B584, Alloy No. C86300.

****

NOTE: The designer should work with the cylinder manufacturer to determine if a mechanical cylinder rod locking device can be provided for gate lifting applications. These are mechanical locking devices as opposed to valves in the hydraulic circuit for holding the load in place. These should be designed by the cylinder manufacturer and submitted for approval.

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[2.3.3.8 Hoist Locking Device

Fabricate the hoist locking device from stainless steel in accordance with ASTM A564/A564M or ASTM A705/A705M, Type 630 or XM-12, Condition H-1150.

]2.4 HYDRAULIC POWER UNIT (HPU)

2.4.1 HPU - General

Provide a self-contained hydraulic power unit. Design the packaged unit to operate the [output device][hydraulic cylinders] in accordance with the criteria stated in paragraph "Design Parameters." Design the power unit to meet the space limitations shown and configure essentially as indicated. The structure of the unit both internally and externally will be adequate for the unit to be free standing and capable of being lifted or moved without structural damage. Securely attach all components including piping, motors, pumps, and manifolds to the power unit in a manner to be free of damaging vibration during operation. [Design and provide each unit with forklift tubes and lifting eyes to facilitate lifting or moving the unit, including the reservoir when full of oil.]

****

NOTE: If due to install assess limitations the assembly may need to be modular. The HPU must be

designed to be modular by having flanged or fitting connection points. Split skids will need to have connection that allows either field sealing or other method for leak proof oil containment.

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[2.4.2 Oil Containment Skid

The entire HPU, including the reservoir, pumps, all piping, valves and routing must be within an oil containment skid, that is able to hold 1.5 times the total system volume without loss of fluid. Provide a normally closed manual ball valve for drainage of skid with threaded SAE fitting with O-ring . Design and provide the skid with forklift tubes and lifting eyes to facilitate lifting or moving the entire assembly, including the reservoir when full of oil.

]2.4.3 Pumps

****

NOTE: Only use the submerged pump option where space is restricted so that the pump cannot be mounted on the exterior of the reservoir with the pump suction flooded.

If the designer elects to select the particular type of pump to be used, consider the following factors: displacement, pressure rating, prime-mover speed, rated pump life, initial cost, mountings available, serviceability, porting connections, availability, compatibility, product history, efficiencies, and size and weight. Fixed displacement pumps are usually lower in cost, on a component basis. However, weigh the lower initial cost of the pump against the cost of the control components needed to make the system work. Variable displacement pumps, conversely, are generally higher in cost, but less control equipment may be needed to achieve the same result. The reduced control costs may more than offset the higher initial pump cost. As a general rule, gear pumps are usually least costly, vane pumps intermediate, and piston pumps most costly. However, on the basis of cost per watt (horsepower), there is no clear-cut rule. Evaluate each application individually.

****

Provide pumps in accordance with the following general requirements below and in the paragraphs that follow:

a. Pumps must be [submersible,] electric motor-driven, [variable] [fixed] displacement, [gear] [vane] [piston] type pump[s].

[b. Equip pumps with constant wattage horsepower control to regulate flow rate and pressure]

c. Pumps must be rated to [rated to deliver a nominal [_____] L/s at [_____] kPa [_____] gpm at [_____] psi] while operating with the specified oil in the specified temperature range at the design input speed.

d. The pumps must be rated for continuous operation at a discharge pressure equal to or greater than the system design pressure.

e. Maximum rotating speed must be no greater than 1800 rpm.

f. Equip the pumps with safety guards for all exposed rotation parts.

g. Mount the pumps [in] [on] [adjacent to] the reservoir in a manner similar to that indicated so that the pump suction is flooded. [The pump suction line is to be extend as far as practicable below the low fluid level but must clear the bottom of the tank by a distance equal to 1-1/2 times the nominal line size.] Pumps and motors must be accessible and removalle without disassembly of the structural framing, piping, or electrical other than the designated points of termination equipped with couplers, fittings, and factory termination juncture locations. Pumps must be accessible for vertical hoisting to perform maintenance and or replacement.

h. Pump ports to be [SAE with O-ring][NPT] [tapped NPTF] [tapped for straight pipe threads] [drilled and faced for flange connections] [socket weld]. Use of fitting adapters does not constitute compliance with these fitting requirements.

i. Operate the pumps on [_____] volts, 60 Hz, three phase power.

j. A permanent arrow located either on the pump body or on the motor indicating the proper rotation direction.

k. Unless specified otherwise, pump volumetric ratings, tests, type, application, and mounting provisions are to be in accordance with manufacturer's instructions and tested by approved methods for conformance with performance ratings.

2.4.3.1 Gear Pumps

Provide [fixed] [variable] [or] [_____] type gear pumps that meet the following requirements:

a. Make Covers and center section from [high strength aluminum alloy die castings] [steel] [cast iron].

b. Make thrust and wear plates from [heavy-duty bronze coated steel] [bronze] [or] [_____].

c. Use manufacturer's [standard] [or] [_____] shaft seals for rotary pumps.

d. Seals, wear plates and other wearing parts must be replaceable and suitable for the application, duty, and temperatures involved.

2.4.3.2 Vane Pumps

2.4.3.2.1 Fixed Displacement Vane Pumps

Fixed displacement vane pumps must meet the following requirements:

a. Pumps must be of the hydraulically balanced type.

b. Make pump and components from the following materials:

    (1) Housing - [high tensile strength ductile iron] [cast iron] [_____]

    (2) Vanes - [heat treated high-speed tool steel] [_____]

    (3) Shaft and rotor - [case hardened steel] [_____]

    (4) Cam ring - [high carbon chromium steel] [_____]

    (5) Seals - [Buna N] [nitrile rubber] [fluoroelastomer] [_____]

[c. Provide double vane pumps when indicated.]

[d. Shaft to ride in bearings at both ends.]

2.4.3.2.2 Variable Displacement Vane Pumps

Variable displacement vane pumps must meet the following requirements:

a. Incorporate means for varying the pump displacement from zero to the maximum rated quantity while the pump is operating against the system pressure indicated.

b. Make pump and components materials as specified above for fixed displacement vane pumps.

c. Arrange pumps for adjustment of discharge volume by [mechanical] [electrical] [hydraulic] [pneumatic] means.

d. Control the pump displacement by [integral automatic pressure compensation] [adjustment screw] control.

e. Provide the pump casing with a tapped outlet for connection of an external drain line.

2.4.3.3 Piston Pumps

Piston pumps must meet the following requirements:

a. Provide [cylinder block in-line] [axial fixed] [axial variable] [or] [_____] type piston pumps.

b. [In-line type must be capable of reversing flow direction and flow rate by means of external valve bank][Axial variable type must be capable of providing reversed flow with constant direction of input shaft rotation.][Axial variable type to be suitable for control of displacement [and direction of flow] by [manual] [mechanical] [hydraulic] [electric] [pneumatic] devices.]

c. [Provide manually adjustable maximum and minimum limits of displacement in each direction of flow.]

2.4.4 SHAFT COUPLINGS

Unless otherwise indicated, shaft couplings to have a strength equal to the full strength of the shafting which they connect and be pressed and keyed thereon. In determining the coupling capacity, the manufacturer's rating is to be divided by a service factor of [1.5] [_____].

2.4.4.1 Flexible Couplings

Unless otherwise indicated, flexible couplings to be of forged steel and must transmit torque by [a steel grid spring fitted into grooves in the periphery of the coupling's hubs] [external gear teeth on hubs engaging in internal gear teeth in the coupling sleeves] [or] [flexible annular discs bolted alternately to the end flanges and center member by body bound bolts]. [Flexible couplings of the [geared] [or] [grid] type to be fully enclosed and sealed to retain lubricant and are to be oil-tight under both static and operating conditions.]

2.4.4.2 Rigid Couplings

Unless otherwise indicated, rigid couplings to be cast or forged steel and be flanged or compression type with recessed bolts.

2.4.5 Filters

****

NOTE: Use duplex filters if continuous operation or system availability is necessary without shutting down the system for replacement of the filter element.

To ensure maximum reliability of the system and reduce repairs to or replacement of the system components, specify the filtration level for the system by the Beta ratio, the ratio of the number of particles in a certain size range upstream of the filter to the number of particles in that size range downstream of the filter. This will however increase initial costs and filter maintenance.

Filter media type and filtration level should be coordinated with the supplier of the hydraulic fluid to ensure that the fluid is compatible with the chosen filter and that the filter does not inadvertently remove additives.

****

2.4.5.1 Inline Filters

Locate the filter[s] in the return line to the reservoir [and in the pump discharge line] [in the indicated location]. [Filters and strainers are not to be located in the reservoir, where drainage of the reservoir is necessary to inspect or service the element.] Provide inline filters as detailed:

a. Provide the [spin-on type with a bypass and an indicator to show the condition of the filter element] [duplex type with a differential pressure device to indicate the need for filter element service][3-way valves to facilitate maintenance of duplex filters to avoid system shutdown].

b. Provide filter housing and cover of steel or cast iron construction.

c. Bolt the cover to the main housing.

d. Locate filters so that they can be changed without removal of hydraulic system components.

e. Shutoff valves to be easily accessible.

f. Equip the filter with a relief valve which protects the filter against excessive pressures.

g. Equip the filter unit with a gauge or gauges indicating the pressure loss or a cartridge replacement indicator.

h. Equip the filter unit with a pressure switch to signal excessive pressure loss across the filter.

i. Each filter to have a minimum capacity of [______] L/s [_____]gpm at a pressure drop not exceeding 69 kPa or 10 psi when filtering hydraulic fluid having a viscosity of 389 SSU at 38 degrees C or 100 degrees F.

j. The filter cartridges will not remove additives from the hydraulic fluid. The filter element to have a rating of [[_____] µm absolute] [5 µm absolute] [10 µm absolute unless a smaller mesh is recommended by the manufacturer of the component with the highest cleanliness requirement].

[k. The filter element to have a minimum silt control rating as approved and Beta rating of [200][1000][_____] at 400 kPa or 60 psi differential pressure in accordance with [ISO 16889].]

l. The filters are to be rated for use with hydraulic oil and the pressure drop not to exceed 40 kPa or 6 psi in the clean condition.

m. Pressure drop through each filter must not exceed the value indicated at the given maximum flow rate.

2.4.5.1.1 Pressure Rating

[The return filter to be pressure rated for 1400 kPa or 200 psi and a flow rate of [_____] L/s gpm.] [The discharge line filter to be pressure rated for [_____] kPa psi and a flow rate of [_____] L/s gpm.] [Determine the pressure and flow rating of the filters to be compatible with the design of the power units.]

2.4.5.1.2 Return Filters

[The return filter to be pressure rated for 1400 kPa or 200 psi and a flow rate of [_____] L/s gpm.] [The discharge line filter to be pressure rated for [_____] kPa psi and a flow rate of [_____] L/s gpm.] [Determine the pressure and flow rating of the filters to be compatible with the design of the power units.]

2.4.5.1.3 Pump Suction Line Filters

[Pump suction lines are to not have a filter or strainer.][Pump suction lines are to not have a filter or strainer unless a bypass circuit is provided to prevent starving of the pump and settings confirmed with pump supplier, and the filter or strainer element's status is clearly displayed and the element is accessible without system drainage.][Strainer material for the suction line to be [55-mesh nylon] [30-mesh brass] [or] [30-mesh stainless steel] material compatible with the reservoir material and the hydraulic fluid.] [The suction line must be equipped with a [100 by 100] [_____] mesh externally mounted strainer having a rated capacity not less than twice the pump discharge capacity.]

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NOTE: An off-line filter system should be included with the HPU in cases where there is: low flow or cycle of hydraulic system fluid that limits filtration of fluid by the inline filter; concerns of water accumulation; or desire for a consistently high cleanliness of system fluid, Low flow systems include closed loop systems for short stroke actuators.

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[2.4.5.2 Reservoir Offline Filtering System[with Heater]

Provide with the HPU a depth-type offline filter system[with a heater] to service the oil, and maintain clean and dry oil in the HPU reservoir. This filter system must be a true offline system, circulating the oil in the reservoir, even if the HPU is shut down. [The system will be operated in a controlled environment with an ambient temperature range of [] to [] degrees F.] The off-line filtering system must comply with the following features:

a. This system must be capable of removing solid impurities to achieve and maintain a Cleanliness Code of [15/13/10] [17/15/12] [ ] or better in accordance with ISO 4406

b. The system must be capable of removing all free and emulsified water from the oil.

c. The filters in these systems are to be capable to remove varnish, wear particles and other contaminants.

d. The filter elements are to be designed for absorbing water.

e. Consumables such as filter elements, along with parts such as electrical motors and gear pumps, must be readily available for replacement.

f. No by-pass valve is to be installed in or around the filter housing.

g. The filter system is to include a sealed drain tank that contains the fluid during filter changes and maintenance.

h. The pump is to be a gear-type pump.

i. A relief valve is required in the pump and is to be set to prevent damage to system components.

j. The gear type pump must be mounted or plumbed to the filter housing, allowing oil to flow through the filter media. Clean and dry oil is to be discharged from the base of the filter housing.

k. A dual maximum indicating, explosion-proof pressure gauge with minimum 2.0 inch Ø dial face is to be provided on the filter housing to display both the current pressure and record the maximum differential pressure reached [,by means of a black indicating needle and red recording needle with reset knob.]

l. A separate pressure switch is to be set not to exceed maximum operating pressure of filter element and must shut down the off-line filtering system [and indicate status by means of turning off the red light on the control panel that normally indicates the pump is running].

m. The filter system is to have an oil valve after the pump to enable sampling of the oil from the reservoir.

n. The filter housing cover is to be one section, having handles to allow for removal. The design pressure must be at least 150 percent of operating pressure and the design temperature a maximum of 176 degrees F.

o. A drain ball valve is to be mounted at the base of the filter housing with plumbing that directs drain oil into the reservoir. The routing is to be considered a return pipe.

p. Connecting ports for plumbing to reservoir are to be SAE o-ring or 37-degree JIC flare type fittings.

q. All metal surfaces, not stainless, are to be painted [with a manufacture's paint system to prevent surface corrosion] [per Section 09 97 02, PAINTING: HYDRAULIC STRUCTURES.]

r. This system must be designed to operate safely unattended.

[s. Control functions are to be included as part of the HPU's Integrated Controls and Instrument Panel.]

[t. A programmable timer that will allow a day and hour duration setting for operation of the heating system.]

s. [Filter system to be mounted on the HPU. Overall dimensions of the filter system to be contained within the overall dimensions of the HPU.] [Filter system to be mounted separate from HPU and have its own oil containment.]

[u. Filter system flow rate approximation of [_____][3] GPM.]

[v. The filter system is to have an attached oil heater.]

[w. The heater is to be capable of heating up the temperature of the oil through the filter system to 108 degrees F.]

[x. The oil heater elements are to be a low watt density type. The kW rating must range between 1.5 to 3.0 kW. Watt density of the heater is not to exceed 12 watt/square inch. The oil temperature must be manually adjustable and thermostatically controlled, but will be factory set at 104 degrees F.]

[y. The oil heater is to be equipped with a thermal fuse or shut-down to prevent overheating the oil in case the thermostat fails while on.]

[z. Shut-down status of the heating element is indicated by turning off the red light on the control panel that normally indicates the heater is on.]

][2.4.5.3 Depth Filters

Depth type filters are to be used as indicated. Pressure drop through each filter must not exceed the value indicated at the given maximum flow rate. Elements for depth type filters are to be [resin-coated] [paper] [synthetic fiber] [vinyl membrane] type. [Filter casings for installation in pressure lines are to have a working pressure rating in excess of the specified maximum pump discharge pressure.] [Filter casing for separate filtration circuits are to have a rated working pressure in excess of the maximum pressure of the filter circuit.] Filters are to be provided with [adjustable] [nonadjustable] [internal] [external] bypass. [An indicator is to be provided to show when the bypass has opened.] The cracking pressure of the bypass on pressure filters are to be as indicated. The cracking pressure of the bypass on filters installed on the suction side of pumps must be as required by the pump manufacturer.

]2.4.6 HPU Nameplate and Labeling

Provide nameplates for each gauge, port and device of the HPU, and submit for approval. Nameplates to clearly indicate the function of each device and, in the case of manually operated items, indicate the condition established for each position. Machine engrave [print] lettering on nameplates on [steel plate] [plastic laminate with white characters on a black background]. Mount instruction plates on a rigid backing and covered with clear, rigid plastic sheeting. Use metal wire to secure the nameplate when a panel or flat surface is not available.

2.5 OIL RESERVOIRS

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NOTE: Remove requirement for painting if reservoir is to be stainless steel. The design and sizing of the hydraulic reservoir is a critical feature. The designer should utilize EM 1110-2-2610 for sizing the reservoir or allow the manufacturer to determine the final size.

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Provide Oil Reservoirs addressing the following:

a. Size the oil reservoir [as indicated][to meet the space limitations indicated][in accordance with the manufacturer requirements as approved]. The capacity of each reservoir not to be less than [_____] liters [______] gallons [and include capacity for all accumulators discharged to 0 psig][plus 10%].

b. Fabricate the reservoir of [carbon steel][stainless steel][corrosion-resisting steel] with welded joints and conform to the requirements as shown. Fabricate the reservoirs in accordance with ISO 4413. [Unless otherwise indicated, nonintegral reservoirs must conform to the general requirements of ANSI/NFLPA T3.16.2.]

c. Provide a bolt-on mounting base alongside of the reservoir which supports the motor-driven hydraulic pumps, associated valves and accessories for design loads and speeds. The bottom of the reservoir to have a minimum clearance from the floor of not less than 0.3 m or 12 inches.

d. Shape the reservoir bottom in order to facilitate emptying and cleaning, including sloping to reservoir drain.

e. A foot valve or check suction lines to provide flooded inlets to the pumps.

f. Provide on each side of the reservoir with a cleanout opening of not less than 0.26 square meters or 400 square inches clearance with a bolted, removable, gasketed cover.

g. Provide each reservoir a its low point with a drain with shut-off valve [threaded for an SAE fitting with O-ring]; a magnetic trap; low oil float level switches; and other appurtenances as indicated and as specified herein.

h. Provide the reservoir with a [filter breather cap and] [fill port with a built-in strainer [that can be inspected and cleaned without need to drain the reservoir or access to the inside of the reservoir]][closed HPU system with expansion bladders]. Strainer material to be [55-mesh nylon] [30-mesh brass] [or] [30-mesh stainless steel] material compatible with the reservoir material and the hydraulic fluid. Provide a fluid level indicator at the filler port.

i. Provide a baffle between the intake and return lines to facilitate the separation of air and foreign matter from the hydraulic fluid. The connection between the two chambers of the reservoir to connect high enough from the bottom to form a settling chamber. Bring both the intake and return pipes down to a distance of 1-1/2 pipe diameters above the tank bottom.

j. [Clean interior surfaces of the reservoir down to bright metal and coated with an epoxy-based urethane finish or an approved alternate that is compatible with oil and water.]

k. Finish the welded joints of the reservoir smooth and free from irregularities. Do not grind welds to an extent that weakens the reservoir.

m. Until final installation of the hydraulic equipment, seal all openings with plastic closures.

n. Anchor the reservoirs to the concrete by suitable anchor bolts. Furnish all piping, fittings, hose, manifold blocks, fasteners and appurtenances required to connect equipment to the reservoir.

o. [After painting, insulate the exterior of the reservoir with a polystyrene, polyurethane, or [Foamglas] cellular glass type insulation. The insulation to be compatible with oil and not retain moisture. The insulation thickness to be 50 mm or 2 inches on all surfaces other than the top.]

p. [Provide retaining chain for all port caps.]

q. [Equip reservoir with extra return and drain line connections.]

r. [Provide a low-level alarm and pump cutoff device.]

s. Provide [a reservoir heater and switches][,magnetic separator][,low level float switches][,an air breather][,flexible reservoir breathers]and [, pressure relief and emergency venting] as outlined below.

2.5.1 Reservoir Heater

Provide the reservoir with one or more screw plug type immersion heaters with a watt density not to exceed 17 kW/square meter or 11 watts per square inch and a [built-in][remote] thermostat set to maintain the hydraulic oil at 5 degrees C or 40 degrees F. Fabricate the heater sheath and screw plug from stainless steel. Total heating output to be [[___] watts] at [_____] volts AC. Supply the heater with a watertight, stainless steel, NEMA 4X terminal housing as a minimum. Provide a weatherproof junction box with a single phase, [120][___] volt, control transformer for the thermostat and high temperature circuit. Install the heater in a location on the reservoir vessel to maintain complete submergence of the heating element during all operating level fluctuations within the reservoir.

2.5.1.1 Heater Switch

Provide a thermostat to sense the oil temperature in the tank and close its contacts when the temperature drops below [10] [_____] degrees C [50] [______] degrees F as indicated. Provide a bulb and capillary type thermostat and provided with a protective well which extends into the tank. The temperature adjustment range to be 10 degrees to 38 degrees C or 50 degrees to 100 degrees F with plus or minus 1 degree C or 2 degrees F differential switch. Fit the switch with an external calibrated adjustment knob. The thermostat to be rated for 15 amperes at 120 volts. Provide weatherproof junction box.

2.5.1.2 High Temperature Switch

Provide a thermostat to sense the oil temperature in the tank and close its contacts when the temperature exceeds [50][_____] degrees C [122][______] degrees F as indicated. The thermostat to be of the bulb and capillary type and provided with a protective well which extends into the tank. The temperature adjustment range to be 10 to 149 degrees C or 50 to 300 degrees F with plus or minus 1 degree C or plus or minus 2 degrees F differential switch. Fit the switch with an external calibrated adjustment knob. The thermostat to be rated for 15 amperes at 120 volts. Provide weatherproof junction box.

2.5.2 Magnetic Separators

Provide the manufacturer's standard magnetic separator in the reservoir. The magnetic separator consists of a high-strength permanent magnet arranged for rigid mounting with the poles of the magnet exposed to the fluid in the reservoir. The magnet is to be [combined in the construction of the fill strainer][mounted on a removable rod assembly installed through the top of the reservoir] [or] [incorporated in the bottom drain plug]. [The drain plug type installation to incorporate an automatic valve arranged to permit removal of the magnetic separator for inspection without loss of fluid from the reservoir.][The drain plug type installation to include provisions for automatic chip detection without removal of the plug.]

2.5.3 Low Level Float Switch[es]

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NOTE: All HPU reservoirs should have at least one low level float switch to prevent damage to the system and notification of issue with reservoir fluid level. A float switch should be used even when a digital oil reservoir level monitor is used in order to have a back-up to the level monitor.

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Provide each power unit with [one][two] float switch[es]. Provide [flanged][SAE threaded] switches and install inside a 125 mm or 5-inch nominal diameter pipe to eliminate surge effects. The [reed switches][analog measuring device with switching outputs] to have a narrow differential and be rated for [_____][0.5][2] amperes at [_____][120 volts AC][50 volts DC]. Set switches to close when oil level rises above or drops below those recommended by the manufacturer and observed during operational tests. [Provide switches with integral temperature probe and high temperature contacts.] Provide switch electronics with at least an IP[65][67] protection. Provide a NEMA 4X junction box for terminating leads.

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NOTE: If a flow meter is necessary, the designer should select an electronic flow meter or visual flow meter. The detailed design should be provided by the hydraulic power system manufacturer and fabricator.

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[][]2.5.4 Air Breather

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NOTE: Where space allows, flexible reservoir breathers are the preferred method of preventing or controlling the introduction of outside air into the reservoir. Delete either of two paragraphs which are not needed.

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Provide the reservoir with an air breather which removes dirt and moisture from the incoming air. The incoming air to first pass through a desiccant bed to remove the moisture, and then pass through a filter to eliminate the solid contaminants before entering the reservoir. Outgoing air to pass directly to the atmosphere through a check valve. The breather to also provide visual indication of the desiccant and filter condition.

2.5.5 Flexible Reservoir Breathers

Provide each hydraulic power unit with flexible reservoir breather units to eliminate the introduction of outside air into the reservoir during normal operation of the system and to accommodate expansion and contraction of the air inside the reservoir. The breather units to be of sufficient capacity to accommodate the differential volume of the reservoir. The flexible reservoir breathers to have a bladder compatible with the system hydraulic fluid. Equip the reservoir breathers with pressure vacuum breakers. The shell to be free standing and of rugged construction made of steel, fiberglass or other material as approved. Construct and mount the breather in a manner to facilitate bladder replacement. Provide piping to the breather with adequate pipe unions and screwed fittings to facilitate repair or replacement of the vent bladder. Install, securely attach and support the units as shown on the hydraulic power unit.

2.5.5.1 Pressure Relief and Emergency Venting

Provide a pressure relief system consisting of inline check valves and breathers in the breather piping, as indicated, to prevent collapse or "oil canning" of the tank. The check valve in-line with the breather to be removable to permit venting the reservoir during setup. Direct the air in the tank to the flexible breather during normal operations. The breathers to be of the threaded type with steel shell and nylon strainer and guard and rated for [127][_____] cubic meters per hour [75][_____] cubic foot per minute. The inline free flow check valves to be the threaded type with a 13.8 kPa or 2 psi cracking pressure.

2.5.6 Oil Level Gauge (Sight Glass)

Provide an [a continuous] oil level gauge with an indicating length of not less than 300 mm 12 inches on each unit and position to give a visual, clearly marked indication of the oil level in the tank including [the "low level", "add oil", "nor. min. level", and "max. level".][the maximum and minimum design operating levels and the fluid level when the system is idle.]. Mount oil level gauge in a readily visible location in proximity to the filler opening. After the system is operational and all tests complete, permanently mark the levels on the tank in a manner approved by the Contracting Officer. Gauge material to be compatible with hydraulic fluid and acceptable for use over full range of system fluid temperatures without staining or distortion. [Oil level gauge material to be shatter-proof.] [Oil gauge housing design to provide protection to the gauge glass.] [Gauge to be located so that it not susceptible casual damage.] [Manufacturer's standard recessed or protected oil level indicator.]

[2.5.7 Digital Oil Reservoir Level Monitor

In addition to the Oil Level Gauge (Sight Glass) and Low Level Float Switch[es] detailed above, provide the reservoir with a Digital Oil Reservoir Level Monitor. The electronic level indicator is to have [both] [a 1/4 inch or larger character height digital display][, and][electronic output for HPU Program Logic Controller (PLC)].

]2.6 ACCUMULATORS

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NOTE: Designer to be aware of the stored energy safety precautions necessary for systems with accumulators for isolation for maintenance and appropriate safety warnings/labeling.

****

Provide accumulators in accordance with all of the following general requirements below and in the paragraphs that follow:

a. Accumulators that are [piston] [bladder] type and [nitrogen] [gas pressure] [_____] charged.

b. Accumulator fluid capacity not less than indicated.

c. Accumulators designed for a rated working pressure not less than the maximum system pressure and have a safety factor of not less than four.

d. Fluid ports are to be [tapped for SAE fitting with O-ring] [tapped NPTF] [tapped for straight pipe threads] [drilled, tapped, and faced for flange connections] [drilled, tapped, and faced for SAE flange connections].

e. Provide the gas and accessories needed to recharge the accumulator with gas as indicated.

f. The accumulator must be equipped with a safety device to release excessive pressure before the burst pressure is reached.

g. Provide the indicated number of accumulators with the fluid capacity not less than [_____] [L] [gallons] [indicated].

h. [Provide a tee with a [_____]L gallon accumulator in the pressure line at each cylinder.]

i. Design the accumulators in accordance with ASME BPVC SEC VIII D1 for a rated working pressure of not less than [_____] kPa psi.

j. [Accumulators should be stamped and certified per ASME standards.]

k. Provide a ball type shutoff valve for each accumulator.

l. [Lever (Handle) of each shut-off valve to be located and oriented such that its position and access for direct use in the installed condition is not impeded by other components.]

m. [Each shut-off valve lever to be lockable with a locking tab eye sized for a common pad lock diameter.]

n. [Arrange accumulators so that pressures can be checked visually.]

2.6.1 Piston Type

Provide piston type accumulators addressing all of the following:

a. Cylinder to be [single] [double] wall type constructed from seamless steel tubing and wrought or forged steel end caps.

b. Piston to be [cast iron] [aluminum] [_____] and equipped with O-ring type seals with anti-extrusion backup guide rings.

c. Accumulators 152 mm 6 inches and larger designed and constructed in accordance with the requirements of ASME BPVC SEC VIII D1.

d. A high-pressure gas charging valve that is protected from damage by recessed type construction or by a protective cap.

e. Safety bleed holes in the shell and a gas valve or other means must be included to positively prevent disassembly of the accumulator until all gas and fluid pressures have been released.

2.6.2 Bladder Type

Provide bladder type accumulators addressing all of the following:

a. Bladder type suitable for charging with [nitrogen][the indicated gas].

b. Shells of one-piece alloy steel construction without welds, seams, or joints.

c. Fluid discharge port with a spring-loaded poppet valve arranged to close automatically upon discharge of all the fluid and prevent extrusion of the bladder.

d. An anti-extrusion ring when recommended by the manufacturer.

e. The design permits disassembly for repair without removing the accumulator from the system.

f. Arrange accumulators so that the bladders can be easily changed without the removal of other components.

g. The method of disassembly to include provisions to prevent disassembly until all gas and fluid have been bled.

h. A gas charging valve complete with protective cap and replaceable valve core.

2.7 PIPE, TUBE, HOSE, AND APPURTENANCES

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NOTE: Tubing is recommended for indoor and or protected environments where damage due to flooding, ice, debris, vibration or personnel traffic is not likely to occur. Use caution when specifying tubing applications in larger diameters as the available working pressures of the tubing may be lower than anticipated operating pressures of the hydraulic system.

Recommend providing an Engineering Consideration for In Field Personnel to have QA performed on the installation, assembly and testing of any threaded piping connections specified to ensure a leak free design.

Tube and tube fittings are readily commercially available in sizes up 1 inch nominal size. Tube fittings above 1 inch in size are less common and it is preferred to use pipe at sizes 1 inch and above.

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[Design piping, tubing, hose and appurtenances for a working pressure of [_____] kPa psi.][Provide piping, tubing, hose, fittings, and associated appurtenances rated for a working pressure no less than the rated working pressure of the connected hydraulic system or service.] Provide pipe, tube, and fittings in accordance with ASME B31.1 and subsequent addenda unless otherwise specified or indicated.

2.7.1 Piping

2.7.1.1 Pipe - General

[Provide piping when a 25 mm 1 inch or larger diameter is required.] Provide external cylinder piping as indicated.[Use pipe where indicated on the drawings]. Weld pipe as indicated.

2.7.1.2 Pipe

Provide piping in accordance with the following requirements:

[a. Seamless carbon steel piping conforming to ASTM A106/A106M, Grade B.]

[b. Seamless stainless steel piping in accordance with ASME B36.19M and ASTM A312/A312M, Grade TP304]

[[c. Schedule 80 piping.][c. Schedule 40 piping on hydraulic piping service with a rated pressure of 150 psi or less, and Schedule 80 piping in all other applications.]]

[d. Supplied carbon steel pipe in the pickled and oiled condition.]

2.7.1.3 Pipe Fittings

Provide pipe fittings in accordance with the following:

a. Unless specifically identified otherwise, use socket welding type pipe fittings in accordance with ASME B16.11.

b. Carbon steel used in fittings must meet the requirements of ASTM A234/A234M, Grade WPB.

c. Stainless steel used in fittings must meet the requirements of stainless steel in accordance with ASTM A182/A182M, Grade F304.

d. [Provide pressure class [_____] kg pounds][Where flanges are specified or otherwise allowed, provide flanges that meet the requirements of SAE J518-1, Code 61 for high pressure service or ASME B16.1 and ASTM A182/A182M for low pressure service.].

e. Flange material grade suitable for the pipe to which it is to be attached.

f. [Threaded fittings are prohibited] [Threaded fittings are only allowed where indicated on the contract drawings and must conform to the above requirements.]

2.7.1.4 Unions

Provide O-ring type unions, made of stainless steel with socket-welding ends. The Contractor may, as an option, substitute four bolt split flanges with [Buna N] [Viton] O-rings for the unions. [Flanged unions only allowed where indicated on the contract drawings.][Any allowed non-welded connections are to be located in areas that are visually and physically accessible without removal of other installed equipment.] The connections are not to be located over electrical equipment or walkway.

Bracket only in locations[as shown on drawings].

2.7.1.5 Expansion Fittings

Provide expansion fittings in accordance with the following:

a. Fittings must have a pressure rating that meets or exceeds the operating pressure for the line in which they are installed.

b. All wetted components must be compatible with the selected hydraulic fluid. All other portions must be made from stainless steel.

c. Fitting assembly must be replaceable without requiring the adjacent and connection piping to be disturbed or cut.

e. Fittings must allow expansion and movement in the axial and radial directions.

f. Provide expansion fittings [at each construction joint][as indicated on the drawings].

2.7.2 Tubing

2.7.2.1 Hydraulic Tubing

Only use tubing when less than 25 mm or 1 inch diameter is required. Provide hydraulic tubing in accordance with the following:S

a. Stainless steel tubing used for hydraulic circuits in accordance with [ASTM A269/A269M for Grade TP 304, Seamless][ISO 10763]

b. A minimum rating for system pressure or higher, and proof pressure rating of twice system pressure or higher, and burst pressure rating of [four][six] times system pressure or higher.

2.7.2.2 Tube Fittings

Provide fittings rated for the system pressure for which they will operate or higher. Fittings are not to twist the tubing during assembly or disassembly. Provide all tube fittings without special adaptors or custom-designed assemblies. Provide a leak-proof seal at the rated working pressure of the tubing or higher.

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NOTE: The first of these optional paragraphs are for most civil works facilities, especially those near waterways where fitting leakage risk is to be reduced as much as possible, and those involving system pressures of 3,000psi or more. The second of these optional paragraphs are if the procuring entity wishes to allow more flexibility to the providing entity. Flared fittings do have a higher likelihood of failure at higher pressures. Care must be taken to properly qualify flared and self-flared fittings to avoid pressure failure and cycling failure.

****

[Provide flareless type, [two-ferrule] compression-grip with SAE straight threads and [Buna N] [Viton] O-ring seals. Each fitting to hold the tubing with a chucking action and provide a firm flat grip on the tubing without penetration of the tubing wall. Each fitting connection to be capable of no less than 30 connect - disconnect - reconnect cycles without galling, leakage, or any other damage, and does not twist the tubing during assembly.. Provide Type 304 stainless steel fittings that conform to SAE J514.]

[Provide solderless steel fittings. Connections may be flared, flareless, self-flaring, or equivalent. When flared-type fittings are used, the tubing end of the connector body, nut, and sleeve when used, are to be 37 degrees from center (74 degrees included angle), and are to conform to SAE J514 for minimum performance requirements. Copies of test reports for all tubing fittings are to be submitted with detail d. Adapters for connecting tubing to threaded pipe ports are to be straight thread type with locknut, washer, and O-ring seal. Fittings that incorporate separate synthetic or metal-to-metal seals, or seals that seal with pressure are to have UNF straight-thread port connections. Fittings that incorporate synthetic, or metal-to-metal seals, or seals that seal with pressure may be used with pipe thread port connections.]

2.7.3 Hose

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NOTE: Carbon steel hose fittings can be evaluated by the designer for use depending on the application. Any applications that are submerged should utilize stainless steel fittings.

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2.7.3.1 Flexible Hose

Provide flexible hoses in accordance with the following:

a. All flexible hoses to have an inside diameter to match the line size to which it is to be connected.

b. The minimum working pressure of the hose to be rated by the manufacture not lower than the system operating pressure indicated [with a minimum factor of safety of 4 for burst pressure].

c. Provide hose in accordance with SAE J517, 100R12.

d. All components of each hose assembly are to be compatible with [system hydraulic fluid as indicated] [petroleum based hydraulic fluids].

e. [The hose used for general industrial use in hydraulic systems provided with petroleum base hydraulic fluids.]

f. Provide a synthetic rubber tube with four spiral wire reinforcements and [a synthetic rubber cover] [stainless steel cover].

g. Each end of the hose to have a straight split stainless steel flange fitting in accordance with SAE J518-1, Code [61][___].

h. Design fittings specifically for use with the hose selected and as recommended by the hose manufacturer.

i. Hose assembly, including length and fitting angle to allow for the hose's installation to adhere to the SAE J1273.

j. Hose to provide for uniform and neat routing such that are not-overlaying one another and are without kinks, sharp bends, binding, or rubbing [throughout the entire motion of the hydraulic actuator] without violating minimum bend radii.

k. Each hose assembly is to be [factory assembled] [assembled] using procedures and tools recommended by the manufacturer of the hose.

l. Fittings to be [stainless steel] [carbon steel] and of the [reusable] [permanently attached] type [unless otherwise indicated].

m. Connect the fittings to the hose assembly using the internal skive crimp method.

n. Fit the hose with a nylon sleeve to protect and prevent abrasion of the hose cover.

o. Use flexible hose in locations where [indicated and where]system pressure fluctuation is subject to occur, such as the hydraulic pump pressure, return and case lines, and system solenoid control valves.

2.7.4 Location of Connections

Piping, tubing, and hose connections must be designed and installed to permit quick removal and reassembly with hand tools. The connection locations are not to be over equipment that would be impacted if fluid was to leak from the connection.

2.7.5 Manifolds

Provide manifolds in accordance with the following:

a. Provide pre-drilled manifold blocks for connection of control valve assemblies [where indicated].

b. Construct each manifold block of [aluminum per ASTM B209][stainless steel per ASTM A240/A240M][ductile iron per ASTM A536][where indicated].

c. Machine ports and passages smooth and free of burrs and sharp edges.

d. Arrange manifold block interconnecting passages and valving so as to provide the system connections and functions as indicated.

e. Manifold block interconnecting passages and valving to be of ample proportions to minimize internal pressure losses.

f. Machine surfaces and recesses where valving and other components are installed to the specifications of the applicable valve or component manufacturer.

g. Make provisions for attaching the hydraulic piping to the manifolds by the use of flanges as specified in paragraph "Pipe Fittings", [with 4 bolt flange] and as indicated. Adapters are not to be used to make the manifold port comply with the fitting requirements.

h. The manifold to be in accordance with the valve manufacturers' recommendations to provide for installation of valves, flanges, and accessories.

i. Design the manifold for a minimum pressure rating of not less than [_____]kpa [_____] psi at 66 degrees C or 150 degrees F except as specified.

[j. Locate components on the manifold in positions as indicated.]

[k. All components as specified by their model numbers and mounted to the manifold in accordance with mounting details indicated and in the manufacturer's catalogs.]

[l. Supply manifolds with manifold enclosures rated for submergence to [_____] m [_____] feet.] [The manifolds and all attached valves, equipment, and electrical devices to be rated for submergence to [_____] m [_____] feet.]

[m. Provide test ports as shown on the schematics and fitted with diagnostic connectors with stainless steel quick coupling nipple and accessory stainless steel metal dust cap.]

n. Piping and hose layout is to not cause radial loading of manifold ports.

2.7.6 Valves

Provide valves with a minimum pressure rating of [_____] kPa psi unless stated otherwise. Valves must not have a published pressure ratings less than the maximum pressure ratings indicated for the circuit in which installed. Where possible, manifold mount valves. Manifold mounted valves to be either cartridge type or subplate mounted. Provide socket-welded piping connections on non-manifold mounted valves 25mm or 1-inch or larger. Provide valves less than 25 mm or 1 inch with SAE straight thread ends and [Buna N] [Viton] O-rings with tube fittings. Valves to be specifically designed and rated for hydraulic system applications. [Valves used in pneumatic lines, such as air-oil booster systems and gas-loaded accumulators, must be specifically designed and rated for use in pneumatic systems.] [Unless approved otherwise, all manual valve handles are to permit direct access for full use in the final installed location.]

2.7.6.1 Identification

All ports, pilot and solenoid actuators and solenoid leads are to have permanent identification as indicated by symbols conforming to ISO 9461 and ISO 11727.

[2.7.6.2 Valve Nameplates

[Provide brass or stainless steel nameplates for all valves and submit for approval. Nameplates to clearly indicate the function of each device and indicate the condition established for each. Machine engrave [print] lettering on nameplates on [steel plate] [plastic laminate with white characters on a black background. Secure to valve with stainless wire or chain.]]

]2.7.6.3 Shut-Off Valves

Provide in-line mounted, stainless steel, lever operated, ball type shut-off valves. Shut-off valves at piping manifolds of each [cylinder][hydraulic operator] at the upstream and downstream locations for the main supply and return lines to be [50] [_____] mm [2][_____]-inch line size, rated for a working pressure of [21][_____] MPa [3000][_____] psi, with socket-welded ends, double acting ball type. Shut-off valves for all other lines to be ball type, match the line size, and have a maximum allowable working pressure of [21] [_____] MPa [3000] [_____] psi. The valve ends to have socket-weld pipe connections and drilled to receive SAE Code [61][_____] flanges. Provide a removable operating lever for each valve. Valves to be specifically designed and rated for hydraulic system applications. Provide with stainless steel valve trim including handles. The valves to have replaceable seats and be repairable without disturbing the welded connections. [Valves must have a lever that is lockable with a locking tab eye sized for a common pad lock diameter.]

2.7.6.4 Needle Valves

Supply needle valves of stainless steel construction and designed for fine flow regulation. Use [Buna N] [Viton] stem sealing O-rings.

2.7.6.5 Manual Control Valves

2.7.6.5.1 Flow Control Valves

Flow control valves to be [subplate mounted for socket-welded piping] [line mounted] [manifold mounted cartridge valves] and of [stainless steel] [aluminum] [ductile iron] construction. The valves to be pressure-compensating, free flowing in one direction, and adjustable. The valves to be capable of being locked in position to prevent an unintentional adjustment. The flow rating to be [a minimum of [_____] L/s gpm] [determined by the Contractor in accordance with the design criteria stated in paragraph "Design Parameters"].["]

2.7.6.5.2 Manual Four-Way Directional Control Valves

The rotary shear seal type, open or closed center, and detent or spring centered as indicated. The valve to be three position, [subplate mounted with socket-welded piping connections][line mounted]of [stainless steel] [aluminum] [ductile iron] construction. The flow rating to be [a minimum of [_____] L/s gpm] [determined by the Contractor in accordance with the design criteria stated in paragraph "Design Parameters].["]

2.7.6.6 Solenoid Operated Control Valves

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NOTE: Solenoid operated control valves can be configured many ways. Two specific types are specified below as they are commonly used in USACE hydraulic systems. Designers should add additional valve types/configurations as needed.

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Solenoids to be rated for continuous operation without damage or malfunction. Control valves to be of [stainless steel] [aluminum] [ductile iron] construction. Solenoids to operate the valves within a 10 percent fluctuation range. Totally enclose all moving parts and windings of the solenoids to prevent entrance of dirt and moisture. Pilot fluid supply to be internally supplied and externally drained from the power circuit. Vent both end cap chambers as necessary to achieve spring centering. [Equip the valve with manual [push detent][lever] weather protected overrides.]

2.7.6.6.1 Pilot-Operated, Solenoid-Controlled Four-Way Directional Control Directional

Pilot-operated, solenoid-controlled four-way directional control valves to be [two][three] position and [open][closed] centered as indicated. Provide pilot operated valves with [a single] [two] solenoid[s], subplate mounted with [socket-welded piping] [tubing] connections. The valve's amplifier to be of the same manufacturer as the throttle valve. Provide a power supply for the valve and amplifier with an input of 120 volts AC. The flow rating to be [a minimum of [_____] L/s gpm] [determined by the Contractor in accordance with the design criteria stated in paragraph "Design Parameters].

2.7.6.6.2 Solenoid Operated Proportional Throttle Valve

Hydraulically control the rate of oil flow into the manifold by an electrohydraulic proportional throttle valve with electrical feedback setting. The throttle valve's amplifier to be of the same manufacturer as the throttle valve. Provide a power supply for the throttle valve and amplifier with an input of 120 volts AC. The flow rating to be [a minimum of [_____] L/s gpm] [determined by the Contractor in accordance with the design criteria stated in paragraph "Design Parameters].

2.7.6.7 Pressure Relief Valves

Provide adjustable pressure relief valves with a body designed for a set pressure of [_____] kPa psi. Relief pressure to be adjustable between [_____] kPa psi and [_____] kPa psi.[The valve to have the capacity to pass [_____] L/s gpm.][Determine the flow capacity in accordance with the design criteria stated in paragraph "Design Parameters].["] Provide balanced piston type relief valves. Valve bodies to be of close grain alloy cast iron, ," cast steel\, forged steel or stainless steel. Valve pistons to be hardened, alloy steel. Finish grind valve pistons to provide an interchangeable fit. Valve springs to be alloy steel or music wire. All relief valves to be field adjustable within the specified relief pressure adjustment range with a [key-lockable][_____] adjustment handle. Final factory settings as indicated, unless otherwise approved in writing by the Contracting Officer. [Provide manifold mounted type valves.]

2.7.6.8 Unloading Valves

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NOTE: Unloading valves provide free passage through a low pressure area when a signal is applied to a pilot connection. An unloading valve is normally located in the pump discharge line so that the pump can unload to the tank at a preset pressure. In a typical application, unloading valves may be arranged to accept a signal from an accumulator. At a predetermined pressure value, when the accumulator is charged to the preferred level, the pump unloads to the tank.

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Provide adjustable unloading valves designed for [_____] kPa psi service. Set the pressure as shown and determine the flow capacity so that the valve operates without cavitation.

2.7.6.9   Supply Spring Loaded Check Valves

Provide supply spring loaded check valves of stainless steel construction, the ball or poppet type with a body designed for high shock and [_____] kPa psi service.

2.7.6.10   Return Spring Loaded Check Valves

Construct the return spring loaded check valves of stainless steel, the ball or poppet type with a body designed for [_____] kPa psi service. Cracking pressure to be [_____] kPa psi.

2.7.6.11   Bleeder Valves

Provide 6 mm or 1/4 inch, stainless steel construction, wrench operated bleeder valves.

2.7.6.12   Pressure Snubbers

Provide stainless steel pressure snubbers for all pressure gauges and pressure switches to protect against shock and provide more stable instrument operation.

2.7.6.13   Counterbalance Valve

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NOTE: For hydraulic cylinders with attached flexible hoses, a counterbalance valve should be installed directly on the cylinder so that the lower hose is not subjected to a static load.

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Install in the oil line to the bottom side of the hoist piston as indicated to balance the load being held by the cylinder. The valve to be directly operated, internally drained, and adjustable for operating over a pressure range of [_____] to [_____] kPa psi. Design the valve for a system operating pressure of [_____] kPa psi. Provide the valve capacity rating of not less than [_____] L/s gpm. Permit unrestrained flow to the underside of the hoist piston and retain pressure in the hoist cylinder in the amount of the valve's pressure adjustment. [Each valve to be remote pilot operated with a check valve.] [Each valve to have an adjustable flow control valve in the pilot pressure line.] The counterbalance valve to be factory set in accordance with the settings as indicated.

[2.7.6.14   General Valve Requirements

Unless otherwise required, provided valves are to be in accordance with the following general requirements.

2.7.6.14.1   Valve Actuators

Valve actuators are to be [manual] [mechanical] [solenoid] [or] [pilot] as indicated. [Pilot actuators must be [barrier] [differential area] [differential pressure] [or] [solenoid controlled] as shown.]

2.7.6.14.2 Valve Mounting

Valve mounting provisions is to be [base] [in-line] [manifold] [or] [subplate] as indicated. Mounting surfaces, dimensional criteria, and general criteria of subplate mounted type valves for 20.7 MPa 3,000 psi maximum hydraulic service are to conform to NFLPA T3.5.1.

Valve Materials and Components

2.7.6.14.3 Valve Bodies

Valve bodies are to be [steel] [brass] [cast iron] [aluminum] [or] [_____] as indicated. Valve body bores which contain pistons, poppets or spools must be finished to 203 nanometers 8 microinch rms and are to be round and straight to within 1.3 micrometers 50 millionths of an inch.

2.7.6.14.4 Poppet Material

Poppet material is to be [soft seal (nitrile rubber)] [nylon] [solid metal] [or] [_____].

2.7.6.14.5 Seal Compound

Seal compound is to be [Buna N] [nitrile rubber] [or] [fluoroelastomer].

2.7.6.14.6 Spools

Spools are to be steel case hardened to 50 Rockwell C, minimum. Spool movement is to be by [manual actuation] [mechanical actuation] [hydraulic pilot] [air pilot] [or] [solenoid]. [Manual actuators are to be a [push button] [hand lever] [or] [foot pedal].] [Air pilot operated control valves must have bronze housings and stainless steel spools.]

2.7.6.14.7 Solenoids

Solenoids are to be [ac] [or] [dc] [wet armature] type and [pull-in] [or] [drop-out] style. Solenoids are to be [spring offset, single] [spring centered, double] [or] [detented, double] model. Solenoids must be moisture proof where indicated.

]2.7.7 Pipe and Tube Hangers and Supports

Locate all pipe support devices at intervals no greater than 2 m or 6 feet between centerlines of adjacent supports, except as modified as specified. Install support devices on both sides of a bend within four nominal pipe or tube diameters of the bend location. Furnish all supports, hangers, sleeves and brackets complete with compatible mounting hardware and appurtenances. Conventional pipe hangers and support in accordance with MSS SP-58 type as required. Provide stainless steel pipe supports and hangers. Provide special hangers and anchors as indicated. Construct tube supports of stainless steel hardware with polypropylene support halves. Provide each tube support with all mounting hardware required to connect with the appropriate anchorage system.

2.7.8 Sleeves and Wall Brackets

Fabricate sleeves and wall brackets of stainless steel as indicated.

2.7.9 Pipe Penetration Seals

Provide modular mechanical type pipe penetration seals, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and opening. Assemble links to form a continuous rubber belt around the pipe with a pressure plate under each bolthead and nut. Tightening of the bolts to cause the rubber sealing elements to expand and provide a watertight seal.

2.8 INSTRUMENTS AND APPURTENANCES

2.8.1 Pressure Gauges

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NOTE: Panel mounted pressure gauges and other sensors and or valves connected to the manifolds are recommended to avoid loose connections or items that can be bumped or disturbed. Avoid stem mountings.

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Provide in accordance with ASME B40.100. Gauges to be provided with [black enameled corrosion-resisting metal case] [phenolic case], [4-1/2 inch] [inch] dial, and a stainless steel Bourdon tube. The scale range of the gauge to be approximately [150 percent of the maximum pressure of the line in which installed] [twice the maximum pressure of the circuit in which installed]. Provide safety type gauges with solid fronts and blowout backs. Provide each gauge with a pressure snubber. [Mount gauge as indicated.] [Panel mount the pressure gauges and make them readable from the front of the power unit after opening the doors of the enclosure.] Provide bottom tap gauges and gauge lines in horizontal pressure lines. [All permanently installed gauges to have a shutoff valve arrangement to permit isolation of the gauge and snubber from the rest of the system.]

2.8.2 Pressure Transducers

Install pressure transducer as indicated to permit measurement and remote reading of the pressure in the system. Provide a transducer of the bonded strain gauge design with a pressure range of 0-21 MPa 0-3000 psi. The electrical output to be 4-20 mA with an accuracy of plus or minus 1 percent. The transducer to have a shielded electrical conductor cable of sufficient length to extend to the terminal strip in the junction box. Provide stainless steel housing construction with SAE hydraulic connections. Equip the pressure transducer with two adjustable setpoint switches that are integral to the unit to provide protection control. Alternatively, provide standard 4-20mA pressure transducers as approved.

2.8.3 Pressure Switches

Provide pressure switches in accordance with the following requirements:

[a. Provide a minimum pressure rating of [_____] kPa psi with set point operating as shown.][Pressure switches to have the operating pressure [settings] [and] [ranges] [and maximum allowable differentials] indicated.]

b. Enclose the switches in watertight, [galvanized] [stainless] steel, NEMA 4X housings.

c. Provide the switches with a normally open, normally closed contact having a minimum rating of 5 amps, 125/250 volts AC.

[d. Actuators to be of the [bellows] [piston] [Bourdon tube] [diaphragm] type [indicated] [required for the operating conditions].]

[e. Actuators to have a rated proof or withstand pressure of not less than 150 percent of the maximum possible pressures for the systems in which they are installed.]

[f. The maximum setting for switches with an adjustable range of operating pressures to be limited to 80 percent of the proof pressure ratings.]

[g. Actuators to be fabricated from materials which are compatible with the fluids employed.]

h. Switches to be the automatic reset type [except where manual reset type are indicated].

2.8.4 Thermometers

Provide thermometer(s)in accordance to the following requirements:

a. Mercury is not be used in provided thermometers.

b. Thermometer wells of the separable socket type for each thermometer with a direct type bulb.

c. A [manufacturer's standard]direct indicating thermometer to indicate fluid temperature in the reservoir.

[d. A bimetallic type thermometer [mounted directly on the reservoir] [and panel mounted as for the pressure gauges].]

[e. A remote reading, capillary tube-and-bulb type thermometer, panel mounted.]

f. [Minimum 75 mm or 3 inch diameter dial] [90 mm 3-1/2 inch diameter dial] with black markings on a white background, with scale range of minus 7 to plus 115 degrees C or 20 to 240 degrees F.

g. [Corrosion resistant] [[Cast iron] [Cast brass] with black enamel finish] case and stem, and stainless steel wetted components.

2.8.5 Flow Meter

2.8.5.1 Electronic Flow Meter

The flow meter to accurately measure the volumetric flow rate of fluids in the hydraulic system. The unit to be capable of directly measuring flow and constructed to be compatible with the hydraulic operating system. Convert the flow rate into a 4 to 20 mA signal. The mounting to be in-line with threaded connections and the unit capable of measuring flow rates up to [4.7][_____] L/s [75][_____] gpm with an accuracy of less than or equal to 2 percent of the measured value.

2.8.5.2 Visual Flow Meter

Provide an in-line flow meter with a spring loaded variable area annular orifice metering disk for measuring hydraulic fluid flow with a minimum pressure rating of 21 MPa or 3000 psi. Provide visual indication of the flow rate in the range of [0.32 to 3.2 L/s] [_____] [5 to 50 gpm] [_____]. The viewing window to be graduated to the flow range and of sealed glass construction.

2.8.6 Flow Switch

Provide thermal dispersion type flow detection switches with no moving parts and temperature sensors utilized to monitor flow or "no-flow" condition and be field adjustable with SPDT relays to detect flow in the range of [0-3.2][_____] L/s [0-50][____] gpm. Provide with powder coated steel or aluminum housing, splash-proof construction. Make the sensors of stainless steel construction. Operating temperature to be -29 to 177 degrees C or -20 to 350 degrees F and the operating pressure 0-28 MPa or 0-4,000 psig. Use either threaded or flanged connections. Electrical requirements are 120V, 60Hz, 4 watts. The relay output to be SPDT 3 amps resistive. Electronics associated with the sensor may be either integrally mounted of weather-proof construction or remotely located within NEMA 4 rated junction box at the [cylinder][hydraulic operator] manifold or located within the machinery rooms with extended cabling.

[2.8.7 Particle Count Monitors

Include particle count monitors.

]2.9 TIMERS

Provide electrically-activated [synchronous motor] [oil dashpot] [pneumatically] [electrically] [_____] -timed type timing devices with adjustable timing ranges as indicated. Where the adjustment range is not indicated, range is be adjustable from at least 50 to 150 percent of the delay setting indicated, specified, or required. Timers are to provide time delay on energizing and are to be of the automatic reset type unless otherwise indicated.

2.10 HYDRAULIC MOTORS

Provide hydraulic motors in accordance with all of the following general requirements below and in the paragraphs that follow.[Submit Hydraulic Motorproduct data meeting the salient features and requirements.]

a. Motors to be mounted [horizontally][vertically][as shown on drawings].

b. Fluid filtration to motor must be 10 micron or better and comply with manufacturers recommendations.

c. Equip the motors with safety guards for all exposed rotation parts.

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NOTE: If motor is to operate in a reverse capacity, then the displacement and speed in the reverse direction must also be specified in same manner as primary direction.

NOTE: If motor use is "non-standard", specifier should consider requiring a submittal from motor manufacturer certifying acceptable use of their

motor in the prescribed manner.
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d. The motor casing must be provided with a tapped outlet for connection of an external drain line.

e. The case drain leakage rate at rated system pressure must not exceed [_____] gpm.

f. Motor ports to be [SAE with O-ring][NPT] [tapped NPTF] [tapped for straight pipe threads] [drilled and faced for flange connections] [socket weld]. Use of fitting adapters does not constitute compliance with these fitting requirements.

[g. Unless specified otherwise, motor ratings, tests, type, application, and mounting provisions are to be in accordance with manufacturer's instructions and tested by approved methods for conformance with performance ratings.]

2.10.1 Vane Motor

[Fixed] [Variable] displacement vane motors to be [hydraulically balanced, and] [high speed, low torque (HSLT)][low speed, high torque (LSHT)][as shown] including all of the following:

a. Displacement of not less than [_____] cubic inches per revolution and rated for a system pressure of not less than [_____] psi.

b. The motors to be capable of producing an actual output torque not less than shown when operating at the indicated supply pressure.

c. The maximum rated speed must be not less than [_____] rpm.

d. Actual displacement not to exceed the value shown.

e. Transmit the motor torque to [_____] via a [_____] connection.

f. The shaft to be [straight keyed] [threaded] [or] [splined]. Shafts must be capable of rotation in either direction. [Displacement selector valve are to be provided.]

g. Motors to be rated for continuous operation at a system pressure equal to or greater than the pressure shown.

2.10.2 Piston Motor

Piston motors to be of [high speed, low torque (HSLT)][low speed, high torque (LSHT)][as shown], [axial in-line] [bent-axis][radial] type and designed as [fixed] [variable] displacement type including all of the following:

a. Displacement of not less than [_____] cubic inches per revolution and rated for a system pressure of not less than [_____] psi.

b. The maximum rated speed must be not less than [_____] rpm.

c. Variable displacement type to be capable of providing reversed rotation with constant direction of fluid flow.

d. Variable displacement type to be suitable for control of displacement and direction of rotation by [manual] [mechanical] [hydraulic] [electric] [pneumatic] devices.

e. Provide manually adjustable maximum and minimum limits of displacement.

f. Provide manually adjustable maximum limits of displacement in each direction of rotation.

g. Transmit the motor torque to [_____] via a [_____] connection.

h. The drive shaft to be supported by heavy-duty antifriction bearings.

****

NOTE: Intensifiers or boosters are not utilized often. They convert a low-pressure source into a localized high-pressure output. This may be needed when only a certain portion of a system needs the additional, higher pressure, and the increase overall of the system pressure to accommodate could result in: large heat generation due to a significant portion of the system flow having it pressure reduced; it is more cost effective or space effective to have a lower pressure system; retrofitting an existing system to address a local pressure/performance issue; or safety concerns with use of a high pressure system through-out.

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2.11 INTENSIFIERS (BOOSTERS)

Intensifiers Boosters are to be [oil-to-oil] [air-to-oil] type. Provide the driving cylinder bore size and operating fluid medium, the mounting style, and a manufacturer's series identification (or equal) to be as shown. [For cylinder-to-ram (piston) intensifiers, ram diameter to be as shown.] [For cylinder-to-cylinder units, output cylinder bore to be as indicated.] Inlet and outlet pressures and intensification ratio to be as indicated. Intensifier to be designed for use with petroleum base hydraulic fluid unless otherwise indicated. The manufacturer is to submit evidence that all dynamic seals are suitable for both frequent and infrequent operation and are capable of not less than 500,000 cycles of operation in systems properly maintained. The intensifier is to be capable of continuous operation under severe operating conditions at discharge pressures up to the indicated maximum circuit pressure.

2.12 HYDRAULIC FLUID

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NOTE: The designer should consult with the fluid supplier to ensure the hydraulic fluid is compatible with the filtration system used and that the filtration does not inadvertently remove portions of the additive package.

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2.12.1 Petroleum Based

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NOTE: Specify the hydraulic fluid by brand name only if it is necessary for the fluid to be compatible with the fluid in an existing hydraulic system or common fluid used at the facility that the new system will reside..

Mineral oil hydraulic fluids are the most common within USACE and will work for a majority of applications. They are refined with the addition of additives, which range from anti-wear (AW), rust and oxidation inhibitors (RO), anti-foaming, and viscosity index (VI) improvers. These fluids offer a lower cost alternative to synthetics and can be very comparable in performance when certain additive packages are included.

Viscosity should be determined by the pump type. ISO Grade 32 and 46 and 68 are the most common. Not having the correct viscosity for the application will dramatically reduce the average life of the pump and system, thereby directly reducing its reliability and production. When selecting the appropriate viscosity grade, look for the optimum viscosity required by the pump. This can be determined by collecting data from the pump original equipment manufacturer, actual operating temperature of the pump, and the lubricant properties referenced to the ISO grading system at 40 and 100 °C (104 and 212 °F).

NOTE: A minimum requirement of the Kinematic Viscosity at 40°C = 22 mm2/s (1 mm2/s = 1 cSt = 0.01 St). Lower values, for example 15 mm2/s at 40°C, can be allowed but special seals (similar to low friction seals) are advised. Chevron seals or U-cup seals at 15 mm2/s at 40°C can give friction problems and high wear. Of course, this is also depending on the viscosity index. The absolute minimum viscosity at maximum operation temperature should be no lower than 10 mm2/s.

The designer needs to carefully consider any applications of EA hydraulic fluid to insure proper system performance. Types of EA fluids generally considered to have acceptable properties in the variety of conditions found on civil works projects include synthetic esters and polyglycols (PAG's). Biobased fluids can also be considered, depending on the application, but the designer needs to carefully consider their performance. Some polyalphaolefins (PAOs) can also be considered EA fluids. Grade of filter to introduce hydraulic into the system through depends on the final target cleanliness of the system and the cleanliness requirements of individual components.

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Use the hydraulic fluid during shop testing, [to fill the cylinders before shipment,] flush the system after installation, and to fill the complete hydraulic system to be [[_____] Petroleum Corporation's [_____] hydraulic oil which has a high viscosity index, low pour point, and antifoam properties,] [an all-weather type hydraulic oil which has a high viscosity index, low pour point, rust and oxidation inhibitors, and antifoam properties]. The oil to have an ISO viscosity grade of [_____] and a pour point of minus [_____] degrees C degrees F. [Formulate the oil to separate quickly from water to prevent formation of emulsions.] [Provide hydraulic fluid certified by the manufacturer as fire resistant in accordance with NFLPA T2.13.1.] Filter fresh hydraulic fluid through a [10 µm] [5µm] [_____] µm filter before it is added to the system. [The cleanliness level of the hydraulic fluid is to be [15/13/10] [17/15/12] [ ] or better in accordance with ISO 4406.] Provide letters of assurance from the hose, pump, motor, cylinder, and valve manufacturers that the oil provided is satisfactory for use in their equipment in this application. Supply all oil and furnish two [210][_____] L [55][_____] gallon containers to the Government for a reserve supply.[Deliver the hydraulic fluid to the site in unopened containers with factory seals intact.] Clearly label containers in accordance with ASTM D3951.

2.12.2 Environmentally Acceptable

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NOTE: The designer should reference EM 1110-2-1424 for further discussion on EA hydraulic fluid. ISO 15380 identifies four categories of biodegradable hydraulic oil: These four categories of EA hydraulic fluids include:

*** Synthetic Esters (SE) - ISO Classification HEES**
*** Polyglycols (particularly Polyalkylene Glycols (PAG)) - ISO Classification HEPG**
*** Triglycerides (vegetable oils and biobased oils) - ISO Classification HETG**
*** Polyalphaolefins (PAO) and related hydrocarbon products - ISO Classification HEPR.**

USACE has also adopted a two-tiered approach for selecting EA fluids. Tier 1 is more stringent from an environmental perspective, but the selection of fluids may be less available. Tier 2 is less stringent environmentally and more fluids may be available to meet Tier 2 requirements. USACE would prefer a Tier 1 fluid if available and it meets the performance requirements of the system.

A Tier 1 USACE EAL is one that conforms to a strict interpretation of the United States Environmental Protection Agency (USEPA) definition and will either:
*** Be a product labeled by European Eco-label, and/or Ospar (other product labeling could be considered by an Environmental Officer), or**
*** Be a product classified as USEPA VGP document Appendix A compliant, or**
*** Have test data as specified in USEPA 800-R11-002 or in USEPA VGP document Appendix A. Test reports to indicate that it meets all requirements for bioaccumulation, toxicity, and biodegradability. Such data may be presented as test reports or reported on product specification sheets.**

A Tier 2 USACE EAL is a product that does not meet the criteria of a Tier 1 EAL, but:
*** It is labeled by one or more of the following: Blue Angel, Nordic Swan, or Swedish Standard and/or,**
*** It contains a manufacturer's statement that it meets one or more of the test criteria (bioaccumulation, toxicity, and biodegradability) in accordance with USEPA 800-R11-002 definition or USEPA VGP document Appendix A definition, with appropriate test data to confirm the other criteria, and/or**
*** Its base oil indicates that it meets one or more of the test criteria (see USEPA 800-R11-002, Section 4, Table 3 for biodegradability, Table 5 for toxicity, and Table 6 for bioaccumulation), with test data to support the other criteria.**
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NOTE: Current specification is not arranged to provide all requirements for a water-based hydraulic system or water-glycol system. Additional prescriptive requirements will need to be added to this specification section to reduce risk of component and system life impact with use of such power fluids.
****

Use nontoxic and biodegradable hydraulic fluid during shop testing, [to fill the cylinders before shipment,] flush the system after installation, and to fill the complete hydraulic system. Biodegradability is defined as 60 percent or more of the fluid carbon is converted to CO2 in 28 days, using test method in accordance with ASTM D5864. Nontoxicity is defined as concentrations greater than 1000 ppm of the fluid are necessary to kill 50 percent of the test organisms in 96 hours using test method EPA 560/6-82-002. Provide [synthetic ester] [poly glycol] type hydraulic fluid. The fluid to have a high viscosity index, low pour point, oxidation inhibitors, and antifoam properties. The oil to have an ISO viscosity grade of [_____], a viscosity index of [_____], and a pour point of minus [_____] degrees C degrees F. [Formulate the oil to separate quickly from water to prevent formation of emulsions.] [Provide hydraulic fluid certified by the manufacturer as fire resistant in accordance with NFLPA T2.13.1.] Introduce clean and fresh hydraulic fluid through a [10][5] [_____] µm filter before it is added to the system. [The cleanliness level of the hydraulic fluid is to be [15/13/10] [17/15/12] [ ] or better in accordance with ISO 4406.] Provide letters of assurance from the hose, pump, cylinder, and valve manufacturers that the oil provided is satisfactory for use in their equipment in this application.[Supply all oil plus furnish [two] [_____] [210] [_____] L [55][_____] gallon containers to the Government for a reserve supply.]

2.13   FASTENERS

2.13.1   Carbon Steel Bolts and Nuts

Provide in accordance with ASTM A354, Grade BC, with ASTM A194/A194M, Grade 2H nuts. Make structural bolted connections carrying primary loads with ASTM F3125/F3125M, Grade [325][490] bolts.

2.13.2 Stainless Steel Bolts and Nuts

Provide in accordance with ASTM A193/A193M, Grade B8, with ASTM A194/A194M, Grade 8 nuts.

2.13.3 Flat Washers

Provide in accordance with ASTM F844.

2.13.4 Setscrews

ASME B18.6.2unless otherwise indicated or specified. Setscrews not be used for transmitting torsion.

2.13.5 Methods of Securing Fasteners

[Indicated][All] fasteners not secured by mechanical devices, such as lock washers, cotter pins, safety wire, or locknuts, are to have the threaded portion of the fastener coated with sealing/locking compound, Grade E or Grade B, as applicable, before installation. Fasteners to be cleaned of all rust-inhibiting compounds and lubricants before applying the sealing/locking compound.

2.14 KEYS AND KEYWAYS

ASME B17.1 or ASME B17.2, unless otherwise specified or required.

2.15 FLUID COOLERS (HEAT EXCHANGERS)

Fluid coolers (Heat Exchangers) are to be [water-cooled] [or] [air-cooled] type and must have the cooling capacity indicated.

Most Hydraulic Power Systems do not require a cooling system. However, the location or duty cycles of some systems could present a condition in which fluid may need to be cooled. These requirements offer only a top-level detailing of what needs to be addressed by the system builder. If a cooling system is being designed by the government entity, it is recommended to generate a separate specification with all of the performance detail involved with a fully designed cooling system.

2.15.1 Air-Cooled

Air-cooled type are ti have a core of [oval-tube and plate-fin] [round-tube plate-fin] [or] [individual finned round tubes]. The cooler must be equipped with an electric motor-driven fan, selected to provide the air flow volume through the core to ensure that the cooling requirements are met. Operating sound level of fan and motor must not exceed 85 dBA.

2.15.2 Water-Cooled

Water-cooled type are to be [shell-and-tube] [plate type] construction. [Shell-and-tube type are to be arranged to handle water through the tubes and the hydraulic fluid through the shell.] [Shell-and-tube construction are to be arranged as [U-tube] [straight tube] [fixed tube bundle] [straight tube, removable bundle] type.]

2.16 ELECTRICAL EQUIPMENT

****

NOTE: The contents of the following paragraphs are

dependent on design requirements which may necessitate revision or expansion to cover different conditions and standards.
****

Provide electrical equipment for the hydraulic power systems as indicated and as specified. Other electrical materials and equipment required for the installation of the hydraulic power systems is specified in [Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.] [Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.] [Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.]. Furnish standard catalog item electrical equipment under regular manufacture with preexisting catalog ratings equal to or better than the requirements of the Contract drawings and specifications. Accompany request for approval of equipment other than as specified or as indicated by technical and descriptive data and specifications sufficient for the Contracting Officer to determine its adequacy. Unless otherwise specified or indicated, electrical materials and equipment to meet the standards, specifications, and tests referenced.

Submit data specifications and assembly drawings showing sizes, ratings, parts and material lists, overall dimensions, and mounting dimensions with the product data.

2.16.1 Conduit, Duct, and Accessories

[_____]Threads on the following equipment to be American Standard. No metric threads will be accepted.

2.16.1.1 [Plastic Coated] Rigid Metal Conduit

Hot-dip galvanize the conduit, including the threads, in accordance with ANSI C80.1 and UL 6. [The plastic coating to be factory applied by the same manufacturer who produces the hot-dip galvanized conduit. The plastic coating to have a minimum thickness of 1 mm or 0.040 inch for the full length of the pipe except for the threads and a tensile strength of 24.1 MPa or 3500 psi. Furnish a coupling loose with each length of the conduit. The bond between metal and plastic to be equal to or greater than the tensile strength of the plastic coating. The coated conduit in accordance with NEMA RN 1, Type A.]

2.16.1.2 Conduit Fittings

Provide galvanized, high test, gray iron castings. [The fittings to be plastic coated in the same manner as outlined above for the conduit.] Furnish gaskets for all covers.

2.16.1.3 Conduit and Cabinet Supports

Support conduit and cabinets as required by IEEE C57.12.70. The supports to be galvanized [and plastic coated in the same manner as outlined above for the conduit].

****
NOTE: The designer should consider the use of "Subsea" junction boxes, pin connectors and instrumentation components where flooding or submergence is likely to occur. All potential water ingress points of connection must be considered for possible failure risk of the operating system.

****

2.16.2   Cabinets and Boxes

Provide watertight, [galvanized] [stainless] steel, NEMA 4X housings sized as required. The cabinet and box hubs to be consistent with the NEMA 4X rating of the box. Mount cabinets and boxes such that the NEMA 4X rating is not compromised. Match threads on the hubs with the threads on the conduit [_____] and to be American Standard. Metric threads will not be accepted. The cabinets and boxes in accordance with UL 50.

2.16.3   Pump Motors

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NOTE: Where motor starters are provided in motor control centers, delete the reference to motor starters.

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Provide in accordance with NEMA MG 1, except as specified, and designed to withstand full voltage starting. Provide a totally enclosed frame, fan cooled construction for the pump. Provide a stainless steel drain-breather similar and equal to Crouse-Hinds type "ECD Universal" and locate so that any water present can be drained from inside the motor. [Encapsulate the motors windings.] [Provide motor starters complete with properly sized thermal overload protection and other appurtenances necessary for the motors specified.] Provide manual or automatic control and protective or signal devices required for the operation, and any control wiring required for controls and devices but not shown on the electrical drawings.

[Electric motor-driven equipment are to be provided complete with motors [motor starters] and controls. Where two-speed or variable-speed motors are indicated, solid-state variable speed controller may be provided to accomplish the speed function.]

2.16.3.1   Rating

The motors to operate on [_____] volts, 60 Hz, 3 phase power and sized to operate the pumps specified in paragraph "Pumps" [at the specified capacity without exceeding the nameplate rating of motor when operating at this voltage]. Design the motor to operate continuously without exceeding the temperature rise permitted by the applicable NEMA standards for the class of insulation and frame construction used.

2.16.3.2   Winding Insulation

Provide winding insulation of either class F or H [with special moisture, fungus, and oil-proof treatment]. Provide winding insulation of the type designed and constructed to withstand the severe moisture conditions and the wide range in ambient temperature to which the motors will be subjected.

2.16.3.3   Winding Heaters

Install heater[s] in the motor frame or end bells or wrapped around the winding end turns. The heater to automatically turn on when the motor is not running. The heater to be capable of withstanding the same temperature extremes as the motor. Provide heaters that when energized the temperature of the motor winding will be held approximately 10 degrees C or 18 degrees F above ambient. Design them for [_____] volts AC continuous operation. The heaters to withstand 10 percent overvoltage continuously. Terminals of the heaters, including the leads, to be watertight. Terminate the leads in the motor lead terminal box.

2.16.3.4 Terminal Leads

Extend the motor leads outside the frame, have insulation equivalent to that of the motor winding, and terminate in a two-piece, four-position, watertight, [galvanized] [stainless] steel, NEMA 4X, terminal box secured rigidly to the motor frame. Position and seal the leads where they pass through the frame with a water-resistant seal of a synthetic rubber material or else with a synthetic rubber gasket. Thread conduit entrances to the terminal box.

2.16.4 Control Components

****

NOTES: Where it is desired to control, coordinate, and program components of a hydraulic fluid power system to achieve synchronization of cylinders or components or to achieve a sequence of operations in several modes, tailor system requirements and specifications for the job.

a. The programmed controller is used in modern fluid power systems where a series of operations is to be performed in a sequential order on each cycle. It can be programmed to cause a number of hydraulic cylinders or motors to follow a sequential order of operations, extending and retracting, starting and stopping, during each cycle.

b. The controller can be programmable, consisting of a console plugged into a Central Processing Unit (CPU), or a specialized microcomputer system that can be custom programmed to control a wide variety of electronic and electrohydraulic systems and components, and has the capability to interface with other controls and transducers.

c. The designer should consider the use of "Subsea" rated components where there is a possible risk of flooding or submergence.

Other types of position measurement and control equipment may be used instead of the electronic limit switch and transducer combination indicated. Many other methods of position measurement are available including some which are entirely mechanical. Select the best type for the application.

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Components to be electronically and electro-hydraulically controlled as indicated.

2.16.4.1 Control Devices and Wiring

Provide manual or automatic control protective or signal devices required for the specified operation and all control wiring for these controls and devices whether indicated or not. Electrical control devices to have a minimum current and voltage ratings in accordance with NEMA ICS 2 contact rating designation A 300, as applicable, unless larger ratings are indicated or are required. Provide control devices with the number and arrangement of contacts required to perform the specified control functions. [Provide devices with or installed in NEMA 4X enclosures.] [Provide devices with or installed in [general purpose] [weatherproof] [NEMA Type 4 for [exterior] [interior] [hazardous] [nonhazardous] application] [corrosion-resistant] [NFPA 70 Class [_____] Division [_____], explosion-proof] enclosures as indicated.]

For Civil Works projects, all devices are to be installed in NEMA 4x enclosures unless there is clear justification for each instance to reduce the project level. It is found that due to environmental conditions, even units located inside of facility with be affected, and NEMA 4X has shown to be the solution.

2.16.4.2 Electronic Limit Switches

Limit switches to have activating mechanisms of the [roller arm] [push rod] [plunger] [fork] type [indicated] [required to detect the particular positions]. Except where manual reset type is specifically indicated, activating mechanisms and switch mountings are to be arranged so that over travel of the monitored member will not damage the activator and switch.

Provide solid-state, [thumbwheel] [dial], programmable limits with a count/revolution range of 0000 to 3599; four decades of limit programming; set point switch function selection; initial power supply that provides four AC power levels (plus 5 V, plus 15 V, plus 24 V) from standard 120 or 240 VAC sources; and outputs for read-outs on two [digital] [analog] displays (one remote digital read-out in the control room and one at the hydraulic power unit). The operating temperature range of the electronic limit switches to be [0] [minus 20] degrees C [32] [minus 4] degrees F to plus 65 degrees C or 150 degrees F. Locate and mount the limit switches as indicated.

2.16.4.3 Transducer (Electromagnetic Position Sensor)

Provide a single turn, heavy duty, and enclosed in a water-resistant NEMA 13 enclosure with an operating range of minus 20 degrees C or 4 degrees F to plus 85 degrees C or 185 degrees F.

2.16.4.4 Remote Read-Out [Digital] [Analog] Display

Provide a remote [digital] [analog] display which is to be connected to the BCD output from the limit switch.

2.16.4.5 Manual Switches

Manually operated switches, including push-button switches, selector switches, and key-operated switches, heavy-duty, oil-tight type in accordance with NEMA ICS 1. Switches to be the [momentary contact type with standard operators] [maintained contact type with [mushroom head] [illuminated button] [latching button]].

2.16.4.6 Relays

Relays used in control circuits are to be industrial magnetic control relays in accordance with NEMA ICS 2 contact rating designation A 300, except where other ratings are indicated. Apply relays in control circuits in such a manner that proper control function is obtained regardless of whether the contacts are overlapping or non-overlapping.

2.16.4.7 Indicating Lights

Indicating light assemblies to be the [oil tight], switchboard type, insulated for 120 volt AC service, with appropriate colored caps as indicated and integrally mounted resistors for 120 volt AC service. Make color caps of a material which will not be softened by the heat from the lamp, and the color as indicated. Lamps to be replaceable from the front of the panel. Furnish any special tools required for lamp replacement. The indicating light assemblies to be the same product line as compatible push buttons and switches.

2.16.5 Control Consoles and Valve and Gauge Panels

2.16.5.1 Control Console Construction

The control console to include a basic frame with metal panels fully custom fabricated or may consist of custom modules using standardized components where available to meet the dimensional and functional characteristics shown and specified. Unless otherwise indicated, construct the console of steel in accordance with NEMA ICS 6. Steel sheet in accordance with ASTM A659/A659M. Secure removable panels in place using captive, spring-loaded, self-locking spring nuts and hardened sheet metal screws. Use stainless steel screws and nuts. Secure access panels with spring-loaded, quarter-turn fasteners with studs held captive in the removable panel. Equip the console with adequate louvered panels to ventilate the interior and dissipate the heat generated within the console. Provide special equipment supports and guides as required to support the equipment and other components within the console. [Unless otherwise specified, finish the interior and exterior surfaces with one coat of primer and two coats of the manufacturer's standard baked-on white enamel finish.]

2.16.5.2 Valve and Gauge Panel Construction

Construct valve and gauge panels of stainless steel plate thick enough to provide rigid support for the valves and other components mounted thereon. Terminate all piping with bulkhead type connections in a position convenient for the connection of external lines.[Primer and finish to be the manufacturer's standard coating.]

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NOTE: For accumulators and other pressure vessels ASME stamps and certification are often necessary.

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2.16.5.3 Nameplates and Instruction Plates

Provide nameplates for each device on the control console, valve panels, and gauge panels and submit for approval. Nameplates to clearly indicate the function of each device and, in the case of manually operated controls, indicate the condition established for each position of the control.

Instruction plates to clearly indicate the proper procedures and sequences of operations to activate the system, to operate the system, and to secure the system after completion of operation. Machine engrave [print] lettering on nameplates on [brass plate] [plastic laminate with white characters on a black background]. Mount instruction plates on a rigid backing and covered with clear, rigid plastic sheeting. Mount instruction plates in a location easily visible to an operator stationed at the console or panel. Mounting provisions of plates to be permanent, and able to withstand the full range of operating environment without loss of retention of the plate in installed location.

2.16.5.4 Security Provisions

Construct and install control consoles to prevent unauthorized or accidental operation of the system.[The main power control switch mounted on the control console to be a key-operated type with provision for removal of the key only when the switch is in the "OFF" position.][Provide the control console with a hinged cover with a key-operated lock arranged to automatically lock the cover in the closed position.]

2.16.5.5 Weather Protection

Control consoles and valve and gauge panels exposed to the weather or subjected to water or dirt in the atmosphere to be NEMA Type 4 for exterior nonhazardous applications. Enclosures to have hinged and latched covers. Hinges to be the separable type to permit complete removal of the cover for maintenance. Construct hinges and latches of stainless steel.

2.17 SPECIAL TOOLS

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NOTE: The designer must identify and list all special tool requirements as needed for operation and maintenance of the operating system and any spare equipment requiring periodic cycling. Items to consider may include such items as; filtering carts, portable HPU, diagnostic pressure gauges, cylinder disassembly/tightening tools, spanner wrenches, oil monitoring/analysis or testing.

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Provide all special tools necessary for the proper operation, maintenance, assembly and disassembly of the machinery in a location and in a manner as directed. Special tools include those indicated and the following:

2.18 NONINTEGRAL EQUIPMENT BASES

Nonintegral equipment bases including brackets and mounts must be all-welded construction and are to be fabricated of ASTM A36/A36M steel.

After installation and final adjustment of all the system components on the equipment bases in the shop, each piece of equipment must be positively secured in place by dowels to ensure accurate location during installation in the field. Shear blocks may only be used where installation of dowels is completely impractical.

2.19 SHIMS

Approved for use shims are to be to the following:

a. Shims are to be provided in graduated thicknesses to permit adjustment in increments of 0.13 mm 0.005 inches from 0 to 6.4 mm 0 to 1/4 inch.

b. Shims for use between machinery components, subassemblies, or machinery bases and mounting brackets and unfinished surfaces of structural member are to provide adjustment in increments of 0.79 mm 1/32 inch from 6.4 mm 1/4 inch to 150 percent of the shim allowance indicated.

c. Tapered shims are to be provided as required to accurately align machinery components and bases which are mounted directly on unfinished structural steel surfaces.

d. Field measurements are to be taken to determine the exact amount of taper required to obtain proper alignment.

e. Material for all shims must be AIST PB-229, Types 304 or 316 unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

After visiting the site and becoming thoroughly familiar with all details of the work and working conditions, verify dimensions in the field, and then advise the Contracting Officer of any discrepancies prior to performing any work. The Contractor is specifically responsible for the coordination and proper relation of the contracted work to the structure and work of all trades.

3.2 SHOP FABRICATION

3.2.1 Painting

Shop prime and coat all exposed exterior surfaces of assemblies and equipment except stainless steel, synthetic rubber, and plastic, as specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES unless the equipment is given a standard factory finish as specified. Insofar as is practicable, apply the complete coating system to individual components and items before assembly to ensure complete coverage and maximum protection against corrosion. Paint shop assembled equipment prior to any storage or shipment. Do not paint aluminum, stainless steel, non-ferrous surfaces, or machined surfaces requiring field assembly, except as approved. Paint standard manufactured equipment, such as motors, pumps, hydraulic cylinders, valves, in accordance with the manufacturer's standard practice for high humidity service, subject to approval. Repair chips, scratches, and other damage to shop-applied painted surfaces in the field.

3.2.2 Prevention of Corrosion

Provide fasteners and nameplates of corrosion-resistant materials. Surfaces of products, such as [pumps,] [cylinders,] [fluid motors,] [and similar] components, of ferrous metal, where not otherwise specified, must be given a corrosion-protective coating at the factory. Manufacturers' standard coatings are acceptable where not otherwise specified, provided that coatings for interior use can withstand continuous exposure to salt spray for 120 hours and coatings for exterior use for 504 hours. The fog test must conform to ASTM B117. Immediately after completion of the test, coating must show no signs of wrinkling, cracking, or loss of adherence, and the specimen must show no signs of corrosion creepage beyond 3 mm l/8 inch on either side of the scratch mark made as specified. If coated samples have successfully withstood the salt spray test within the preceding 2 years, certificates will be acceptable in lieu of testing.

3.3 SHOP ASSEMBLY

3.3.1 General - Shop Assembly

Completely assemble all hydraulic cylinders and the hydraulic power unit in the shop. Upon satisfactory completion and verification of the shop assembly and testing, preliminary acceptance will be made by the Government and parts/components may be shipped to site.

3.3.2 Protection During Assembly

During cylinder and HPU assembly securely cover all openings to avoid the entrance of abrasives, dirt, metal chips, and other foreign materials into the hydraulic system through open ends of piping, tubing, and ports of the components.

3.3.3 Cleaning and Protection During Assembly

During assembly, ensure all components are free of abrasives, dirt, metal chips and other foreign materials. Clean components as needed to remove foreign materials. Securely cover openings to prevent recontamination.

3.3.4 Flushing

After completing assembly, flush each cylinder and HPU. Use the same hydraulic fluid for flushing as approved for the final filling. Filter oil using a [10 µm] filter. Perform flushing until the contamination level is [_____] in accordance with ISO 4406.[Submit Oil flushing testing report Submit Oil Flushing Testing Report][Submit oil cleanliness report].

[Take three 500 milliliter samples at approved locations in accordance with ISO 4021. Perform particle counting on each sample in accordance with ISO 11500 or ISO 4407 by an approved independent test laboratory. Water content of each sample to be below 200 ppm. Reclean if any sample does not comply with the permissible contamination limits, and reinspect. Submit shop oil testing reports.]

3.4 SHOP TESTING

3.4.1 General - Shop Testing

Perform the shop testing listed in the following paragraphs. Provide all personnel, tools, hydraulic fluid as a well as temporary piping, hoses, oil reservoirs, wiring, and other appurtenances and accessories as needed to complete testing. The designated Government Witness must be present for the entirety of each test unless previously waived in writing.

3.4.2 Notification of Shop Testing

Provide notification to the Government [45] days prior to the planned start of testing. Include in the notification an identification of what equipment is being tested.

[3.4.3 Hydraulic Cylinder Tests

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NOTE: This paragraph does not apply for cylinders of standard manufacture and design.

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Perform a shop test on each hydraulic cylinder. [Group the testing of cylinders with a minimum of [5] cylinders being tested as a group.] If at any point there is a cause for rejection or failed test, immediately stop the test, perform any required adjustments or repairs, and repeat the test from the beginning.

The shop test must consist of the following operations and tests:

a. Fill each cylinder with the hydraulic fluid specified in [this SECTION]. Fluid must be filtered through a [10 micron][8 micron] filter. Purge or bleed all air from filled cylinder.

b. Perform a hydrostatic test [per ASME BPVSC code standards] and the following requirements:

    (1) Perform the test for a minimum of [1][_____] hour[s].

    (2) Use a test pressure of [_____] kPapsi.

    (3) Perform the test in each direction.

[(4) With the rod and piston fully retracted, and the pressure applied to the lower side of the piston, observe the upper end for leakage past the piston.

][(5) With the telescopic cylinder fully retracted and under pressure, check the cylinder for leakage past the seals.

] (6) Observe for leakage past the steals. Any leakage past the seals is cause for rejection and a failed test.

c. Perform an operational test by extending and retracting the [cylinder rod and piston] [telescopic cylinder] through its full stroke. Support and orient the cylinder in a manner to avoid any damage to the cylinder or any of its parts. Provide a means of controlling the speed to the maximum allowable speed specified in this SECTION. Any operational problems or leakage to the outside of the cylinder is cause for rejection and a failed test. Perform [one] complete extension-retraction cycles.

d. At the conclusion of a successful test [drain][leave] oil in the cylinder and prepare for shipping in accordance with PARAGRAPH:

SHIPPING, HANDLING, DELIVERY, AND STORAGE.

]3.4.4 Hydraulic Power Unit Tests

Perform a shop test on the hydraulic power unit. Provide all temporary oil, piping, hoses, oil reservoirs, wiring, and other appurtenances and accessories as needed. During testing the temperature of oil during test not to be more than [21][_____] degrees C [70] [____] degrees F.

If at any time during any of the testing a deficiency is found or failure occurs, immediately stop the test, correct the issue, and restart that portion of the test from the start.

The shop test must consist of the following operations and tests:

a. Perform a hydrostatic test of all piping on the HPU. [Use the specified hydraulic fluid as the test fluid.] Use a test pressure of [21][_____] MPa [3000] [_____] psi for [30 minutes]. Check all joints for leakage. Any leakage found is cause for rejection and a failed test.

b. Perform a [hydrostatic][pneumatic] test of the storage tank. [Use the specified hydraulic fluid as the test fluid.] Use a test pressure of [21][_____] kPa [3][_____] psi for [30 minutes]. Check all joints and seals for leakage. Any leakage found is cause for rejection and a failed test.

c. Perform a functionality and controls test. During the test:

  (1) Verify the correct function of each [switch][, indicating light], [and][, outputs/alarms][, and [_____]].

  (2) Verify the correct function of each measurement instrument and device.

  (3) Verify the correct function and operation of each valve and valve operator.

  (4) [____]

d. Perform an operational test of the HPU consisting of the following:

  (1) Operate each pump individually for [15] minutes at the [specified operating pressure and flow rate][_____] MPa psi and [_____] L/s gpm. Measure pressure, flow rate, motor voltage, and motor amperage using calibrated instrumentation and data collection equipment. Collect a data at a minimum of [10 samples per second].

[(2) Operate all pumps simultaneously for [15] minutes at the specified operating pressure. Measure pressure, flow rate, motor voltage, and motor amperage using calibrated instrumentation and data collection equipment. Collect a data at a minimum of [10 samples per second].

] (3) Test the function of each unloader circuit. Record the pressure at which the unloading valve opens and closes. Record flow rate through the unloading circuit with calibrated instrumentation. Collect a data at a minimum of [10 samples per second].

(4) Test the function of each pressure relief valve. Record the pressure at which the pressure relief valve opens and closes. Perform the test 3 times.

[(5) Operate each pump as lead pump and test the lag functionality of the remaining pumps. Manually jumper, actuate, or otherwise trigger the required devices to initiate lag pumps starting.

]3.4.5 Draining of Fluid

Upon successful completion of flushing and testing operation, drain the flushing fluid from the equipment.

3.4.6 Shop Testing Plan and Procedures

Prepare and submit a shop testing plan and procedure prior to the start of testing. Shop testing activities are not allowed until the testing plan is approved. Submit the testing plan a minimum of [45][_____] days prior to the start of testing. Include the following elements, as a minimum, in the testing plan:

a. Address of testing location and contact information for the designated point of contact.

b. A step-by-step, repeatable procedure for each test to be performed, including but not limited the tests detailed above.

c. Diagrams or drawings of test setups showing orientation of equipment during testing and installation of instrumentation.

d. List of instrumentation that will be used to take measurements.

e. Sample data collection sheets, clearly identifying what is to be recorded, to what accuracy, and the planned outcome (such as value range, threshold, or condition).

3.4.7 Shop Testing Report

After completion of each test or group of tests, submit a test report. Include the following elements, as a minimum, in the testing plan:

a. Date(s) testing occurred.

b. Identification of which equipment was tested.

c. Completed data collection sheets.

d. Provide records of all adjustments and final settings for all hydraulic components in the system. This includes pump flow rates, operating times, relief settings[, counterbalance valve adjustments], operating pressures at both the hydraulic power units and [cylinder][hydraulic operator] manifolds, flow level adjustments[, filter differential switch settings], and other parameters.

e. Post-processed output from any data collection equipment.

f. Identification of a successful test. If any test stoppages or failures occurred, identify them and the measures taken to correct the deficiencies.

g. Current, non-expired calibration certificates for all instrumentation and measurement devices used during testing.

3.5 SHIPPING, HANDLING, DELIVERY, AND STORAGE

Protect all provided equipment from weather and damage during shipping, handling, delivery and storage.

3.5.1 Packaging

Do not prepare the hydraulic power systems for shipment until they have been inspected and accepted for shipment at origin by the Contracting Officer, unless inspection has been waived in writing. Ship each hydraulic power system or subassembly completely assembled as feasible. [Any separate delivery of components must be coordinated by the Contractor and noted in a submittal.] The subassemblies are defined as the following:

a. Hydraulic cylinders. Each hydraulic cylinder subassembly consists of the hydraulic cylinder, [trunnion,] [cardanic ring,] [pillow block bearings,] [bushings,] [cylinder support platform,] [manifold,] and [piping].

b. Hydraulic power units.

c. Piping assemblies.

d. Control consoles.

Provide all subassemblies and spare equipment and parts with adequate protective pads, supports, and blocking, and securely restrained to prevent distortion or damage to the painted surfaces in transit. Any loss or damage during shipment, including damage to the painted surfaces, will be the Contractor's responsibility; replace or repair without any cost to the Government. Pack all accessories and spare parts separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." Place a packing list, listing the contents of each container, in a moisture-proof envelope and securely fasten to the outside of the container. Standard commercial packaging in accordance with ASTM D3951 will be acceptable except where a different method or standard of packaging is specified.

3.5.2 Shipping, Preservation, and Storage

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NOTE: For very long cylinders, deflection of the rod during shipment may cause damage to the rod and/or bore of the cylinder. It is best to avoid the use of internal rod support blocks. One solution to this problem is to extend the rod a short distance, provide a bracket so that the rod cannot be retracted, and then pressurize the underside of the piston so that the rod is in tension. Also, shipping the cylinder filled with oil may help dampen the movement of the rod.

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Packing, crating, cradles, and other packing materials necessary to ensure safe shipment are the responsibility of the Contractor and become the property of the Government upon delivery of the equipment. The hydraulic cylinders to be [filled with the specified hydraulic fluid, and to account for expansion and contraction of the oil during shipping and storage by installation of a bladder type accumulator to the rod end bleed port.][drained and purged with nitrogen.] Then securely cap remaining ports with blank flanges to prevent the entrance of foreign matter. [Make provisions with external shipping devices to prevent damage to the cylinder and piston rod resulting from the rod flexing up and down in the cylinder during transport. Submit a proposal for controlling movement of the piston rod for approval.] [Provide internal rod supports to prevent the rod from deflecting and damaging the rod and cylinder bore during handling and shipping.] Adequately protect machined surfaces from corrosion and physical damage. Protect equipment delivered and placed in storage from the weather, humidity, temperature variation, dirt and dust, or other contaminants. [Furnish spare cylinders with a portable pump, hose and connections to stroke the cylinder in and out a short distance during storage to lubricate seals and prevent damage.] [The duration, procedures, and arrangement for storage over 30 days is to be formally approved by the designer and manufacturer.]

3.5.3 Manufacturer Preparation Before Shipment

3.5.3.1 Flushing Hydraulic Cylinders

Clean, flush, and fill hydraulic cylinders with specified oil, filtered through a [10 µm] [5µm] [_____] µm filter, taking precautions to exclude all air, before leaving the manufacturing facility. Clean and flush per Paragraph "Cleaning and Flushing." Submit oil for use in the system for approval. Make suitable provisions to allow for expansion and contraction of the hydraulic fluid. Accumulators connected to the cylinder ports are acceptable.

3.5.3.2 Flushing Hydraulic Power Unit

After cleaning and prior to shipment, flush each hydraulic power unit and manifold. Manifolds not to be installed until cleaned and flushed. Fill the hydraulic tank with hydraulic fluid as specified and actuate the oil filtration system with a [10 µm] element in the filter. Circulate the fluid and change filters as become clogged. After flushing of the fluid in the tank is complete, install a by-pass loop with filter on the pressure and tank lines of the unit and the run pumps alternately until the returning oil meets the requirement for system cleanliness.

3.5.4 TEMPORARY CORROSION PROTECTION

Unpainted metal surfaces are to be protected from corrosion during shipment, storage at the site, and during construction operations so that the surfaces are free of corrosion until application of final field finish. The temporary coating is to be completely removed and the surfaces properly prepared for final finishing as specified in Section 09 90 00 PAINTS AND COATINGS. Products, including pumps, reservoirs, cylinders, and similar assemblies, are not to be provided unpainted or with temporary coating, but to be [factory] finished as specified.

[3.6 ON-SITE DEMOLITION

Remove the existing hydraulic power systems equipment specified and as shown, including but not limited to [operators, HPU with reservoir, and all hydraulic tubing and hoses]. All equipment not specified to be salvaged is the property of the Contractor, removed from the Project site, and disposed of in a legal manner. Materials that cannot be removed daily may be temporarily stored on-site at an approved area. Salvaged materials are not to be sold on the project site.

[3.6.1 Existing Equipment Removal Plan and Procedures

Submit an Existing Equipment Removal Plan and Procedures detailing the sequence and procedures for all systems and components to be removed or affected by the removal. Procedure is to include but not be limited to a detailing of:

(1) Items to be removed.

(2) Temporary arrangement or storage of items.

(3) Special containment and disposal procedures.

(4) Protection procedures for open routing.

(5) Spill Prevention Measures.

(6) Lifting Plans

][3.6.2 Existing Hydraulic Oil Removal

The Contractor is responsible for the extraction, containment, transportation, and disposal of all the existing hydraulic fluid in the [operators, system routing, HPU components, HPU reservoir] involved with onsite demolition and equipment removal activities. Include the details in the submitted Existing Equipment Removal Plan and Procedures.

]]3.7 ON-SITE INSTALLATION

Submit an installation plan and procedures. Install the equipment specified and as shown to complete the hydraulic power systems for operation of the [intake gates][slide gates][control gates][Tainter gates][miter gates][butterfly valves][hoisting equipment][_____]. Install hydraulic components in accordance with the manufacturer's written instructions and under the direction of the erection engineer or manufacturer's representative. Install complete units or assemblies without disassembly. Installation in accordance with Section 05 50 14 STRUCTURAL METAL FABRICATIONS and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.7.1 Erection Engineer

Obtain the services of an experienced erection engineer who is regularly employed by the hydraulic cylinder/power unit manufacturer [with 3 years or more year of current experience] to supervise the installation, start-up, adjustment and operation, and testing of the equipment provided. The erection engineer to furnish a signed statement stating that the final installation and start-up of the hydraulic power system has been inspected, witnessed, and complies fully with the manufacturer's warranty requirements. Following completion of the work the erecting engineer to instruct the Contracting Officer in the operation and maintenance of the system. These field instructions to cover all items contained in the bound instructions. Do not conduct instruction until Operation and Maintenance Manuals are approved.

3.7.2 Mounting and Supports

Provide necessary supports for all appurtenances, pumps, motors, and other equipment or components as indicated. [Anchor floor-mounted equipment to concrete pads by anchor bolts or expansion anchors as shown.] [Floor-mounted equipment are to be anchored to concrete pads by dowels set in the concrete. Shear blocks may only be used where installation of dowels is completely impractical.] [Concrete for foundations are to be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.] [Shims are to be provided at locations required to permit proper adjustment, alignment, and position of system components and assemblies.] [Pumps and motors are to be carefully aligned with the mechanisms to be operated and are to be shimmed as necessary to eliminate angular and radial misalignment between the mating shafts.] Mounting subplates must be installed on rigid supporting surfaces in a manner that will preclude imposition of forces on the piping and tubing other than those created by fluid pressure alone. All valves and other fluid control devices must be mounted as indicated. Components are to be securely mounted to the supporting surface. Care is to be exercised that fastenings are not overtightened to the extent that component bodies are distorted or damaged. Pivot type mountings are to be carefully aligned to ensure free operation throughout the entire range of movement. Cylinders are to be carefully aligned so that no side loads are imposed on the piston rod at any point in the full stroke. Subassemblies must be mounted and braced independently of the connecting lines.

3.7.3 Markings, Nameplates, and Labels

Components must be marked to indicate pertinent operational requirements, warnings, and limitations such as maximum allowable operating pressure, temperature, velocity, range of adjustment, flow capacity, stroke, direction of flow, rotation or motion, safety precautions, and materials compatibility. The markings are to be by stamping or embossing on the component or on an attached plate or tag which must, barring mutilation, remain affixed and legible for the life of the component.

3.7.4 Filling and Bleeding the System

Supply a sufficient amount of hydraulic fluid, [of the type specified] [of the type specified and as recommended by the fluid manufacturer], to completely fill the system initially plus at least 10 percent additional reserve fluid. Also provide extra fluid to make up all losses resulting from venting operations, from servicing filtration equipment, from leakage and from all other causes before final acceptance. Deliver the hydraulic fluid to the site in unopened containers with factory seals intact.

With all hydraulic equipment installed and all cleaning and flushing complete filling of the system may begin. The cleanliness of the oil used to fill the system in accordance with the requirements for system cleanliness. Open the by-pass ball valves at the cylinders. Fill each hydraulic power unit and pump oil into the system through a [10 µm] [5µm] [_____] µm filter and keep adding oil as long as the level continues to drop. Cease pumping when the oil level no longer drops. Install by-pass piping and repeat the procedure to fill the drain/siphon line. Take care to expel as much air as possible from the piping and cylinders during the initial filling. Utilize bleeder valves and drains as much as possible to expel air from the system. Each power circuit pipe for the [Tainter valves] [and] [miter gate] to have this procedure performed to fill the respective piping. Actuate cylinders by shifting spool on the four-way valve back and forth and bleeding air from ports provided on cylinders. Continue procedure for all hydraulic power units until all cylinders have been bled. Ball valves in tank lines may be closed during bleeding to prevent introduction of air into tank lines. After all the [components] cylinders for the machinery have been filled and bled of air, fill the hydraulic power unit tanks with oil. The oil level with the [miter gate] open and all [Tainter valves] closed to be above the "low level" shut-off. The system, once filled, to be bled of air, operated, and periodically bled during the first week of operation to remove any air entrained in the system.

3.7.5 Used Hydraulic Oil

Contractor is responsible for the containment, transfer, removal, and disposal of all used hydraulic oil. Used hydraulic oil includes any oil in existing components being removed or refurbished, and any generated used oil from flushing, draining, or bleeding activities as identified in this section. Containment, transfer, removal, and disposal procedures for the used oil must be detailed in the applicable removal and installation procedures.

3.7.6 Power Piping and Hoses

The general arrangement of the hydraulic piping and hoses is as indicated. Any changes to the arrangement necessary to facilitate the installation and proper functioning of the system may be made subject to the approval of the Contracting Officer. Arrange the piping such as to close and open the [miter gates, and to raise and lower the Tainter valves,] when the valve spools are positioned as indicated. Drain lines are to be installed from the reservoir to each component requiring a drain connection.

3.7.6.1 Piping Installation

Install the system complete including all necessary valves, fittings, and pipe accessories. All joints to be tight and successfully pass the test as specified. Submit details of pipe supports and anchors not indicated. Adequately support all lines at intervals not greater than 3 m or 10 feet or as otherwise indicated. Install hangers and supports using machine bolts and masonry anchors caulked in drilled holes in the masonry or by using machine bolts and expansion shields. Power piping must not be used to support other equipment. Other equipment can use the same standoff or hanger mounting point as one to support the piping, but the pipe itself must not provide the support of the equipment's load. Spacers and guides can be used if no load is transferred. Ream and remove burrs from all cut ends of pipe. Remove metal particles from the reaming operations and thoroughly clean ends of pipe before proceeding with the work. Tightly plug all piping at all times except when work is being performed on a pipe. Clean the pipe sleeves, recesses and trenches of all debris and thoroughly wash with a high pressure stream of water before any piping is installed. Drilling, chipping, or grinding of concrete in close proximity of any piping being installed is not permitted. Repeat washing out of the sleeves, recesses and trenches from time to time as necessary. Store valves in a clean, dry place and protect against moisture. Do not install valves in the system prior to 4 months before the system is to be filled with hydraulic oil. Install pipes passing through masonry in pipe sleeves as indicated. Mitering of joints for elbows and notching of straight runs of pipe for tees is not permitted.

3.7.6.2 Piping Vents and Drains

Install plugged vent connections with high pressure globe or needle valves at all high points of piping. Provide plugged drain connections with valves in accessible locations at all low points of piping. Threads on valves and pipe plugs for vents and drains to be SAE Straight Thread with O-ring seals. Provide pipe plugs and other miscellaneous fittings required for the installation of the vents and drains of the same material as the pipe on which they are installed.

3.7.6.3 Mounting Support for Manifolds

Bolt the manifolds to a mounting base in such a manner that they can be removed by unbolting from flanges and mounting base and can be adapted for a left hand or right hand orientation of the cylinder mounted piping. Locate manifold and cylinder piping supports on the hydraulic power units or hydraulic cylinders as indicted and as recommended by the cylinder manufacturer to facilitate both left hand and right hand installations. All bolts and hardware used in the supports to be a minimum of 10 mm 3/8-inch. Provide all items in stainless steel [galvanized steel][painted steel].

3.7.6.4 Power Hose Installation

Install power hose with other power system components as above. Install hose such that it follows its natural lie, without being kinked or twisted. No hose is to be clamped. Hose guides and anti-chafe grommets many be used as long as they do not restrict any local expanding of the hose when pressurized. Hose installation is to adhere to the SAE J1273.

3.7.6.5 Support of Valves with Manual Operators

Valves that operate through a manual operator (such as a handwheel or handlever)connecting to hydraulic tubing must have a hanger or support on each side of the valve within 1 inch of the connection. Such valves include block, ball and needle valves. The hangers or supports must translate the load from the use of the manual operator away from the connection of the valve and tubing. Valves used with hydraulic piping larger than 2 inches in diameter may not require this additional support if the manual operator can be used without induction detrimental induction of forces into the assembly.

3.7.6.6 Support of Cartridge Components

Components, such as filters, that require the periodic removal and installation of housings and cartridges, must not be supported by hydraulic tubing. The component's manifold or housing must be directly supported so that the forces used to perform the periodic removal and installation of the housing or cartridge element is not translated into its connection with the hydraulic tubing or piping.

3.7.6.7 Identification of Piping, Hoses, and Valves

Identify all pipe, tubing, valves, fittings, as required, and hydraulic power equipment, located within the trenches, machine rooms, and machinery recesses. Use No. 20 gauge brass tags for tagging, with the proper identification symbol stamped into the metal. Use piping symbols as indicated and stamp with 19 mm or 3/4-inch high lettering. Attach tags to piping and valving by means of No. 12 gauge copper wire. Install pipe markers at intervals of no greater than 5 m or 15 feet, except as approved.

a. Provide a numerical identification tag on each valve, coded such that no other valve in a connected hydraulic power system has the same number. Provide each power circuit valve with an additional tag, which indicates the valve's function.

b. Provide manifold-mounted valves with port identification markings on a part of the valve body that remains in view after mounting.

c. Identify all other valves at the port location, on the connecting piping.

d. Identify manifold assemblies with a tag indicating the manifold's function and the identity of the machine operated.

e. Identify all ball, bleed, and globe valves with a "normally closed" or "normally open" legend.

f. Identify all gauge mounts and pressure transducer mounts with numerical tags, as well as any working or instruction tags required for safe operation.

g. Provide a warning tag and an instruction tag, or tags as required, at each return filter assembly to indicate the safe, approved procedures for cartridge replacement and by-pass operation.

3.8 CLEANING AND FLUSHING

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NOTES: The allowable limit of contamination in this paragraph is subject to the specific project design requirements which may necessitate revision or expansion to cover varying standards of acceptance. The amount and sizes of particles which any given component can tolerate is a function of the clearances between moving parts, the frequency and speed of operation, and the materials of construction. Tolerances range from low pressure gear pumps which may give satisfactory performance with dirt levels typically found in new fluid (ISO 4406) to servo control valves which require oil much cleaner (ISO 4406 16/14/11). General guidelines are as follows:

SYSTEM TYPE	**CODE LEVEL**
Low pressure - manual control	**20/18/15 or better**
Low to medium pressure - electrohydraulic controls	**19/17/14 or better**
Systems with servo or proportional control valves	**17/15/12**
High pressure-servo controlled	**16/14/11 or better**

Hydraulic fluid power equipment is rated according to maximum pressure. Generally low pressure is 0 to 4.1 MPa (0 to 600 psi), medium pressure to 20.7 MPa

(3000 psi), and high pressure to 34.5 MPa (5000 psi).

Results of microscopic automatic particle counter particle count in accordance with ISO 4406 Higher code levels indicate higher particle counts per millimeter.

ISO 4406 is an internationally recognized standard that expresses the level of particulate contamination of a lubricating fluid. This is the preferred standard for particle counting and should be used in testing lubricants. ISO 4406 is a cleanliness rating system that is based on a number of contamination particles in a 1-milliliter (ml) fluid sample. Once the number and size of the particles are determined, the points are plotted on a standardized chart of ISO range numbers to convert the particle counts into an ISO 4406 rating. The ISO 4406 rating provides three range numbers that are separated by a slash, such as 16/14/12. All three values for applicable range numbers can be determined through the use of the ISO 4406 standardized chart based on the actual number of particles counted within the 1-ml sample for each size category. The first number in the ISO 4406 standard represents the number of particles present measuring greater than 4 micron, the second represents particles greater than 6 micron and the third represents those greater than 14 micron. As the range number increases by one value, the number of particles in a sample of oil will double. On the range code, each number is double the range below.

For example, an oil with a code of 19/17/14 should contain twice as many particles in each size category as the code of 17/15/12. For critical components, particle counting and testing should be repeated to confirm the ISO rating.

Filter manufacturing firms can be the source of information regarding determination of contamination levels and analysis and have available portable kits for more general detection of contamination.
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During assembly, securely cover all openings to avoid the entrance of abrasives, dirt, metal chips, and other foreign materials into the hydraulic system through open ends of piping, tubing, and ports of the components. Use the same hydraulic fluid for flushing as approved for final filling. Include a detailed description of the equipment, materials, hydraulic fluid, temperatures, and duration of each phase of the flushing in the procedures. Clean the system of particles so that the cleanliness level is [15/13/10] [17/15/12] [_____] or better. in accordance with ISO 4406. Take three 500 milliliter samples at approved locations in accordance with ISO 4021. Perform particle counting on each sample in accordance with ISO 11500 or ISO 4407 by an approved independent test laboratory. Water content of each sample to be below 200 ppm. Reclean if any sample does not comply with the permissible contamination limits, and reinspect. When flushing is completed, [drain the system and then] fill system with the specified hydraulic fluid introduced through a [10 µm] [5µm] [_____] µm filter. Accessible interior portions of the system to also be subjected to visual and wipe tests and any evidence of contaminants exceeding allowable limits requires recleaning of the system.

3.8.1 Flushing Piping

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NOTE: Duration of flushing is very dependent on length of routing, the number of fittings, the number of valves, the number of hoses, the number of bypass loops, etc. The goal is to have the fluid circulate long enough to flush material, but also long enough so that there is not a false positive cleanliness reading due to inadequate time to loosen material.

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Flush all hydraulic piping before installation of the hydraulic power unit, cylinders, and manifolds. Install by-pass loops of piping in place of cylinders, manifolds and the power units. Circulate hydraulic fluid through each and every pipe unit [for a minimum of [15 minutes][30 minutes] and] until returning oil meets the requirement for system cleanliness. Sequence flushing so that all piping is flushed in both directions. The flow capacity of the flushing system to produce a minimum velocity of 4.6 meters per second or 15 feet per second in all piping. Provide means to verify the flow during the flushing operation.

3.8.2 Flushing Manifolds and Hoses

After cleaning and prior to installation, flush each valve manifold, pipe manifold, and hose by circulating hydraulic fluid through all ports until the returning fluid meets the requirement for system cleanliness.

3.9 FIELD TESTS AND INSPECTIONS

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NOTE: Each system will have functional and operational testing requirements that are specific to that system and installation. Add/remove paragraphs to address specific areas of the system being tested.

It is recommended that the designer develop pre-functional and functional checklists for the Contractor to perform all testing requirements and have all concerned parties, including the customer, present to witness and sign-off on the completion of the checklists.

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3.9.1 General Requirements - Field Testing

The following requirements apply to all testing activities:

a. Notify the Contracting Officer at least 14 calendar days before any field testing is to be conducted.

b. Conduct testing in the presence of the Contracting Officer unless waived in writing.

c. Conduct testing under the direction of the erection engineer or manufacturer's representative.

d. Constantly monitor details of all operations for signs of impending trouble or leakage and make corrections as necessary to prevent damage to the equipment.

e. Immediately correct any deficiency or maladjustment disclosed by the tests and repeat the test until satisfactory results are obtained. No subsequent tests will be permitted until all preceding tests have been completed satisfactorily.

f. No subsequent tests will be permitted until all preceding tests have been completed satisfactorily.

3.9.2 Field Pressure Testing

3.9.2.1 Pressure Testing Requirements

Perform a hydrostatic pressure test for all new installed[, rehabilitated] [and/or disturbed] piping and equipment. Pressure testing may be split up into distinct and separate portions as determined by the Contractor. Perform the pressure testing in accordance with the following requirements:

a. Use the hydraulic fluid specified in this SECTION as the test fluid.

b. Use a test pressure of [1.5 times the rated pressure of the system][____ psi].

c. Perform each test for a minimum of [1 hour] and additional time as needed to verify no leakage.

d. Inspect all joints, seals, packing, valves, and other areas that are possible leak points. Carefully examine welded, flanged, flared, and threaded connections and wipe for leakage, also inspect lines for evidence of deflection caused by inadequate anchorage.

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NOTE: Zero bypass leakage across piston seals is critical for load holding and confirming the health of the seal system.

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e. The criteria for a successful test is zero leaks, zero drop in pressure, and no deflection of piping or equipment.

f. Take means to protect other portions of the system not being tested from becoming inadvertently pressurized during testing.

3.9.2.2 Field Pressure Testing Plan

Prepare and submit a pressure testing plan a minimum of [45] days prior to the start of testing. The plan must be approved prior to the start of testing. Include the following elements, at a minimum, in the plan:

a. A step-by-step, repeatable procedure for performing the pressure testing. [Address how challenging to reach portions of the equipment will be accessed for inspection during the test.] [Address installation details of temporary instruments and measuring devices.]

b. List of equipment and instrumentation to be used during the test.

c. Spill protection, controls and counter measures plan to address plans and response to any leaking oil.

d. Sample data recording sheets.

3.9.2.3 Field Pressure Testing Report

For each pressure test performed, submit a test report. Include the following elements, at a minimum, in the report:

a. Date(s) testing took place.

b. Identification of the equipment or systems of equipment tested and covered by the test report.

c. Completed data recording sheets with the results from testing.

d. Short narrative or statement confirming successful completion of the test.

e. If issues were discovered during testing and any testing had to be repeated, provide a narrative describing the issues and the measures taken to correct the issues.

f. Current, non-expired calibration certificates for all instrumentation and measurement devices used during testing.

3.9.3 Field Functional Testing

3.9.3.1 HPU Functional Testing Requirements

Perform the following functional tests and inspections for the HPU:

a. Inspect the hydraulic reservoir to ensure that the fluid is at the proper level.

b. Start the hydraulic pumps from all control stations.

c. Pumps:

    (1) Inspect the pumps for proper operation and discharge pressure.

    (2) Verify proper operation of the pump controls [including lead-lag functions for all pumps.]

    (3) Read and record the discharge pressure and flow of [the][each] pump [with the pumps running individually and all possible combinations of multiple pumps running].

    (4) Monitor and record, using data collection equipment, the motor voltage and amperage during all motor operations.

d. Adjust the pressure relief [valve][valves] to limit the system pressure to the specified value. Record the set pressure and valve adjuster setting.

e. Adjust the unloading [valve][valves] to unload the pumps to the reservoir when the [accumulator has been charged] to the specified pressure or if the control valves are not actuated. Measure and record unloader settings, actuating pressure and flow rate during unloader operation.

[f. Inspect and adjust the accumulator precharge pressure to the specified value.]

3.9.3.2 Control Console Functional Testing Requirements

For [the][each] control console:

a. Verify the correct operation of each devices on the control console, including but not limited to: [manual shut-off valves][, manual control valves][, manual flow control valves][, solenoid operated valves][, check valves][, pressure gauges][, and ____].

b. Test all automated control systems and devices.

[c. Functional testing sequence specific to the system]

3.9.3.3 Field Functional Testing Plan

Prepare and submit a functional testing plan. Submit plan a minimum of [45 days] prior to the start of testing. Plan must be approved by the Government prior to the start of testing. Include the following elements in the plan at a minimum:

a. A step-by-step, repeatable procedure for performing the functional testing. The procedure must individually address testing of the controls and control consoles and the HPU.

b. List of equipment and instrumentation to be used during the test.

c. Spill protection, controls and counter measures plan to address plans and response to any leaking oil.

d. Sample data recording sheets.

3.9.3.4 Field Functional Testing Report

For each functional test performed, submit a test report. Include the following elements, at a minimum, in the report:

a. Date(s) testing took place.

b. Identification of the equipment or systems of equipment tested and covered by the test report.

c. Completed data recording sheets with the results from testing.

d. Short narrative or statement confirming successful completion of the test.

e. If issues were discovered during testing and any testing had to be repeated, provide a narrative describing the issues and the measures taken to correct the issues.

f. Current, non-expired calibration certificates for all instrumentation and measurement devices used during testing.

3.9.4 Acceptance Testing

3.9.4.1 General Requirements - Acceptance Testing

Upon completion of all pressure testing and functional testing, perform acceptance testing. Acceptance testing must prove that the complete system, as installed, meets all requirements of the contract. During acceptance testing perform the following:

a. Monitor and record the following during all acceptance testing. [Measurements must be recorded using continuous data logging equipment sampling at a minimum of 10 samples per second]:

   (1) Hydraulic fluid temperature at HPU discharge[, and ___]

   (2) Flow rate at each cylinder[at HPU discharge][, and ___]

   (3) Pressure in supply and return lines [, at HPU discharge][, and ___]

   (4) Speed, temperature, voltage, and amperage of each motor

   (5) Flow Control Valve Settings

   (6) [5) ____]

b. During each test operation, inspect the hydraulic lines and components for evidence of leakage.

c. Check flow control valves and adjust as required to conform to indicated operating time requirements.

d. Inspect and adjust sequence valves as required to obtain the indicated sequence of operation.

e. Adjust chokes in pilot circuits of pilot-operated valves to obtain smooth, shock-free operation.

f. Adjust relief valves and counterbalance valves to the proper pressures as indicated, unless otherwise directed by the Contracting Officer.

g. [Adjust proportional control valves for the proper flows to achieve desired cylinder operating speeds as directed by the Contracting Officer.]

h. Inspect response of components to operation of applicable controls to confirm that all connections have been made properly.

i. Observe components and for excessive vibration, alignment and operating clearances.

j. Record observations regarding such events as unusual sounds, malfunctions or difficulties encountered, and adjustments required.

3.9.4.2 Field Acceptance Testing Requirements

Perform the following acceptance tests. Operating tests to cover a period of not less than [4] [__] hours, and conduct all tests at such times as the Contracting Officer may direct. After installation and testing of the hydraulic system has been completed, install a complete set of new and unused filter cartridges.:

a. After final assembly and installation of the machinery, equipment and piping, and prior to [flooding the lock] [_____], operate each assembly of operating machinery individually as nearly as practicable under its normal operating conditions for a minimum of [5] [_____] open/close cycles to demonstrate that each assembly is in proper working order and free from defects of materials, workmanship or alignment.

b. Upon satisfactory completion of the individual tests, and before final acceptance of the work, conduct, in the presence of the Contracting Officer, over-all testing through a minimum of [10] [_____] additional [locking operations with the lock flooded] [operating cycles], to demonstrate that all machinery has been properly installed and that [lock] [____] operation can be effected without interruption.

3.9.4.3 Field Acceptance Testing Plan

Prepare and submit an acceptance testing plan. Submit plan a minimum of [45 days] prior to the start of testing. Plan must be approved by the Government prior to the start of testing. Include the following elements in the plan at a minimum:

a. A step-by-step, repeatable procedure for performing the acceptance testing.

b. List of equipment and instrumentation to be used during the test.

c. Spill protection, controls and counter measures plan to address plans and response to any leaking oil.

d. Sample data recording sheets.

e. A sign-off sheet must be included in the plan to include the Contractor, Sub-Contractor, Erecting Engineer, Government Construction, Government Engineering, and Government End User.

3.9.4.4 Field Acceptance Testing Report

For each functional test performed, submit a test report. Include the following elements, at a minimum, in the report:

a. Date(s) testing took place.

b. Identification of the equipment or systems of equipment tested and covered by the test report.

c. Completed data recording sheets with the results from testing.

d. Short narrative or statement confirming successful completion of the test.

e. If issues were discovered during testing and any testing had to be repeated, provide a narrative describing the issues and the measures taken to correct the issues.

f. Current, non-expired calibration certificates for all instrumentation and measurement devices used during testing.

g. A written statement that the hydraulic power system has been field tested and meets all operational requirements.

3.9.5 Final Oil Testing

After all field testing is complete, take three 500 milliliter samples at approved locations in accordance with ISO 4021. Perform particle counting on each sample in accordance with ISO 11500 or ISO 4407 by an approved independent test laboratory. Water content of each sample to be below 200 ppm. Reclean if any sample does not comply with the permissible contamination limits, and reinspect. Submit field oil testing reports.

3.10 CLEAN-UP

Keep the work areas clean during installation of the hydraulic system and appurtenances. Upon completion of the installation of the hydraulic system and appurtenances, remove debris and surplus materials resulting from the work. Check fluid levels and bring to the proper operating level immediately after satisfactory completion of all acceptance tests.

3.11 FIELD TOUCH-UP

Chips, scratches, and other damage to shop-applied painted surfaces to be repainted in the field [as specified in Section 09 90 00]. Finish field colors must match those of marred finishes.

3.12 SPARE PARTS LIST

After approval of the drawings and data, and not later than [_____] months prior to the date of beneficial occupancy submit the spare parts list detailing the data for each different item of material and equipment specified. Include a complete list of parts and supplies, including lubricants and fluids, current unit prices, sources of supply, and a list of the parts recommended by the manufacturer to be replaced after [1] [and] [3] [and] [5]year(s) of service.

3.13 FIELD INSTRUCTIONS PREPARATION

Submit proposed diagrams, instructions, and other sheets, before posting. Wiring and control diagrams showing the complete layout of the entire system including equipment piping, valves, and control sequence, framed under glass or in laminated plastic, to be posted where indicated for local operator and maintenance assistance. In addition, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system to be typed, framed as specified for the wiring and control diagrams, and posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

3.14 OPERATION AND MAINTENANCE

Submit Operation and Maintenance manuals as data packages in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Supplemental requirements are as described in this paragraph. Furnish [_____] complete sets of instructions containing the manufacturer's operation and maintenance instructions for each piece of equipment to the Contracting Officer. Permanently bind each set with a hard cover. Furnish one complete set prior to field testing and furnish the remaining sets before the contract is completed. Inscribe the following identification on the covers: "OPERATING AND MAINTENANCE INSTRUCTIONS," title of the project, location of the project, the name of the Contractor, and the contract number. Place a flysheet before instructions covering each subject. The instruction sheets size to be 210 by 297 mm 8 1/2 by 11 inches, with large sheets of drawings folded in. The instructions include, but are not limited to, the following:

a. A cross-section drawing of the hydraulic cylinder with parts list.

b. Detailed fabrication drawings for all custom fabricated components of the hydraulic cylinders.

c. [A] [Complete] system layout drawing[s] showing the piping, valves, and controls as installed.

d. [A] [Complete] system hydraulic schematic.

e. Manifold fabrication drawings with dimensions and locations of pre-drilled passages and cavities.

f. Electrical wiring and control diagrams as installed.

g. Operating and maintenance instructions.

h. Manufacturer's bulletins, catalog cuts, and descriptive data.

i. A written control sequence describing startup, operation, and shutdown. Uniquely identify the control sequence and list the individual components of the hydraulic system. Each component to have [the manufacturer's name, model number, service manual, parts list, and] a narrative description as to the function, purpose, and limits of adjustment (if any) and method of adjustment for that component.

j. Field cleaning procedures designed to clean the system to the requirements specified.

Provide the Operation and Maintenance (O&M) Manual with all information which may be needed or useful for operation, maintenance, repair, dismantling or assembling, and for identification of parts for ordering replacements. Include a detailing of possible breakdowns and repairs, and troubleshooting guides. The manual is subject to approval. Include the approved spare parts list.

3.15 TRAINING

[Training for the systems and components of this section in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.]

[Provide a field training course for designated operating staff members. Training to be provided for a total period of [_____] hours of normal working time and are to start after the system is functionally complete but prior to final acceptance tests. Field training to cover items contained in the Operation and Maintenance Manuals.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 05 40.17 (August 2020)**
Change 1 - 08/23

Preparing Activity: USACE **Superseding**
UFGS-35 05 40.17 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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Change 1 - 08/23

Preparing Activity: USACE **Superseding**
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SECTION 35 05 40.17

SELF-LUBRICATED MATERIALS, FABRICATION, HANDLING, AND ASSEMBLY

08/20 CHG 1: 08/23

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NOTE: This guide specification covers self-lubricated bearing materials for waterway and marine construction. These bearing materials are used for applications ranging from critical bearing applications to light duty and electro-galvanic isolating applications. This spec has been developed for USACE Civil Works projects.

In accordance with ER 10-1-53, the USACE Hydroelectric Design Center (HDC) in Portland OR is designated as the Mandatory Center of Expertise (MCX) for hydropower engineering and design. HDC's policy is to use self-lubricating materials in hydroturbine applications. For applications involving turbines, consult HDC (Phone: 503-808-4250).

Sections have also been included on self-lubricated bearings used for product lubricated vertical shaft pumps. Product lubricated pump bearings are used for applications that require minimizing or eliminating the exposure to petroleum lubricants to be in compliance with environmental, biological, or other applicable regulations.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for

this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: Use this guide specification in conjunction with EM 1110-2-1424 LUBRICANTS AND HYDRAULIC FLUIDS, EM 1110-2-2610 Mechanical and Electrical Design for Lock and Dam Operating Equipment, and EM 1110-2-3105 Mechanical and Electrical Design of Pumping Stations.

Users of this specification should understand that successful performance of self-lubricated materials relies on factors that are not covered under the scope of this specification. These factors include but are not limited to accurate estimation of applied loads, adequate alignment of self-lubricated parts including their housings and running surfaces, and adequate stiffness of housings and running surfaces to match the loading assumptions made.

Designers need to be aware that self-lubricated parts and materials have many differences in properties and behavior from traditional metallic supplied-lubricant bearings. Successful design of self-lubricated bearing systems relies on designers that understand these differences as well as acceptable design practices for self-lubricated materials. Designers unfamiliar with self-lubricated components, at a minimum, should have their designs and assumptions thoroughly checked by qualified individuals familiar with self-lubricated material systems.

It is common for minor design details, such as final tolerances and fits, to be left for the construction contractor to determine (in coordination with the self-lubricated material manufacturer). However, construction contractors typically are not qualified to perform the complete design for self-lubricated bearing systems. As discussed above successful design of self-lubricated bearing systems requires detailed knowledge of both the application and self-lubricated materials. Using construction contractors to perform the design of self-lubricated bearing systems is not recommended.

Designers are responsible to consult self-lubricated material manufacturers to verify that the products being used are appropriate for the application. Self-lubricated material manufacturers should also be consulted to verify the use of other appropriate design details such as bearing wall thicknesses, installation fits, mating materials, surface conditions, running clearance fits, edge chamfers.

Some self-lubricated components are susceptible to

damage caused by edge loading. The test procedure outlined in CERL Technical Report 99/104, Greaseless Bushings for Hydropower Applications tests the edge loading properties of materials with a tapered test sleeve. The slope of the tapered test sleeve is 0.229 degrees (0.004"/1.000"). Actual installations should be held to tighter alignment requirements than this procedure tests for. Define required alignment of self-lubricated components on the contract plans in accordance with an applicable code such as ASME Y14.5 - Dimensioning and Tolerancing.

Consider including self-lubricated material fabricator qualifications and self-lubricated material installation plans as evaluation criteria used to select a contractor.

Include in drawings a complete design indicating the character of the work to be performed and giving the dimensions, quantity, location, assembly details, and installation details of each self-lubricated component, housing, and associated running surface.

Information has been included in this specification for product lubricated pump bearings. This information has been included as many of the materials used to construct these bearings are the same as the materials covered in this specification for other lock and dam applications. This specification assumes the pump manufacturer will be responsible to select the appropriate product lubricated bearings. The information in this specification has been limited to the list of parameters that need to be specified to allow the pump manufacturer to select appropriate bearings. Product lubricated information in this specification should be copied to the applicable pump specification for use.

****

1.1 SUMMARY

This section specifies fabrication, handling, cleaning, and installation requirements for self-lubricated materials and their mating running surfaces.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of

the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B929	(2017) Standard Specification for Copper-Nickel-Tin Spinodal Alloy Rod and Bar
ASTM D149	(2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D695	(2010) Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D3846	(2008) Standard Test Method for In-Plane Shear Strength of Reinforced Plastics

U.S. ARMY CORPS OF ENGINEERS (USACE)

CERL TR 99/104	(1999) Greaseless Bushings for Hydropower Applications: Program, Testing, and Results

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Assembly and Installation Plan; G[,[____]]

SD-02 Shop Drawings

Shop Drawings; G

[Field Installation Drawings]; G[,[____]]

SD-03 Product Data

Self-Lubricated Material Product Data; G[,[____]]

[Seal Product Data; G[,[____]]]

SD-07 Certificates

[Manufacturer's Experience Record; G[,[___]]]

[Self-Lubricated Material Manufacturer's Warranty]; G[,[___]]

[FCB Material Certifications; G[,[___]]]

SD-09 Manufacturer's Field Reports

Post-Assembly QC Report

Acceptance Test Report

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G[,[___]]

[1.4 MANUFACTURER'S QUALIFICATIONS

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NOTE: This requirement doesn't add much value if only FCB materials are being specified because products are limited to a prequalifed list. If only FCB materials are being specified removing this section is recommended.

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Self-lubricated material manufacturer must have a minimum of 5 years experience in manufacturing self-lubricated materials. Submit a Manufacturer's Experience Record which details the number of years the manufacturer has been fabricating self-lubricated materials and a description of at least [five][three][one][_____] previous, separate, similar installations within the last 5 years.

]1.5 HANDLING

Handle self-lubricated components in a manner that does not damage or deform the self-lubricated material. Handle components that are the mating running surfaces of self-lubricated materials in a manner that does not damage or scratch the surface finish of the running surfaces. Do not allow self-lubricated components or their mating running surfaces to come into contact with chains, shackles, hooks, wire ropes, or other rigging that can damage them. Perform lifting, maneuvering, and securing of self-lubricated components and their mating running surfaces with fabric straps or other non-marring rigging. Replace self-lubricated components and components that are the mating running surfaces of self-lubricated components, at no cost to the Government, if they are scratched, nicked, chipped, marred, or otherwise damaged prior to the Government taking possession of the component.

1.6 SHIPPING AND TRANSPORT

Package self-lubricated components and components that are the mating running surfaces of self-lubricated components in a manner that protects them from damage during shipping and transport. Package self-lubricated components in crates or protective boxes with adequate padding prior to shipping or transport. If self-lubricated components are installed in a larger assembly that does not fit within a crate secure protective coverings over the self-lubricated components prior to shipping and transport.

1.7 SHOP DRAWINGS

Prepare and submit Shop Drawings for the self-lubricated components covered under this specification. Within the shop drawings show the complete fabrication dimensions and tolerances, installed dimensions and tolerances, component details, and material types of the self-lubricated components [and seals]. If the contract drawings only show a fit class or require the self-lubricated material manufacturer to determine the fit then detail the specific dimensions and tolerances of the fit in the shop drawings and indicate they are for Government approval. Show the same unit system on the shop drawings that was used in the contract drawings.

[1.8 FIELD INSTALLATION DRAWINGS

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NOTE: Removing this section if field installation drawings covering the self-lubricated components are required in a different specification section.

****

Prepare and submit Field Installation Drawings for the self-lubricated components covered under this specification. In the field installation drawings show the self-lubricated components in their installed configuration and show the post installation dimensions, tolerances, and alignment requirements.

][1.9 WARRANTY

****

NOTE: Consider adding minimum warranty claim response times based on the criticality of the system. For example, failures resulting in delays to navigation or the inoperability of systems integral to flood protection equipment should require faster response times. Also consider basing the warranty period on how much time it will take for a system to operate to an extent where you're confident the bearing is working properly.

****

Guarantee self-lubricated components for a period of [2] years from the date of acceptance. Guarantee replacement parts for [2] years from date of replacement. Provide warranty against defective materials, design, and workmanship. In cases where the equipment manufacturer's advertised minimum guarantee is in excess of 2 years, it remains in force for its full period. Upon receipt of notice from the Government of failure of a self-lubricated components during the warranty period, provide new replacement self-lubricated components [promptly][within 4 weeks][_____] at no additional cost to the Government. Submit the Self-Lubricated Material Manufacturer's Warranty.]

[1.10 SELF-LUBRICATED COMPONENTS

****

NOTE: This section can be used to identify the self-lubricated materials the Contractor must provide under this contract. Failure Critical Bearings (FCB) should be clearly identified especially where a mix of FCB and non-FCB applications are present. If self-lubricated materials are called out both in the specifications and contract drawings make sure to use verbatim language for the component names in each document.

****

Self-lubricated components covered under this specification are listed below or shown on the contract drawings. In addition, self-lubricated components that the Government has designated as a Failure Critical Bearing (FCB) are listed below or shown on the contract drawings. FCB requirements are outlined in sections below. Self-lubricated components that are not designated as FCB must meet the general self-lubricated material requirements detailed in section 2.1 below. Provide the following self-lubricated components:

TABLE 1:

Self-Lubricated Component Name	Quantity Required	Failure Critical Bearing (FCB)
[Component 1 name] [Example: Trunnion Bushing]	[____]	[Yes][No]
[Component 2 name] [Example: Thrust Washer]	[____]	[Yes][No]
[Component 3 name] [Example: Gate Connection Bushing]	[____]	[Yes][No]

]

PART 2 PRODUCTS

2.1 GENERAL SELF-LUBRICATED MATERIAL REQUIREMENTS

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NOTE: The operating temperature range requirement is based on what would likely be seen in a typical lock and dam application. This range is commonly achievable for self-lubricated materials.

A self-lubricated material's water absorption and thermal expansion behavior should be accounted for by following the material manufacturer's recommendations on interference and clearance fits. Use the water absorption requirement if there's a special need for your application to limit the expansion behavior of a material. If the manufacturers recommendations are being followed for fits the water absorption language can be removed.

Dielectric strength is an important property of self-lubricated materials as galvanic corrosion can jeopardize the performance of the bearing. Supplied lubricant metallic bearings rely on the lubricant to prevent galvanic corrosion. Designers should consider the sensitivity of their application to

galvanic corrosion and use the dielectric strength requirement below if prevention of galvanic corrosion in needed (a dielectric strength of 50V/mm should prevent galvanic corrosion for civil works applications). Remove the dielectric strength requirement if the self-lubricated material will have bronze surfaces in contact with the mating running surface of the bearing (such as a plugged bronze self-lubricated material).

Graphite is an electrically conductive material and can cause severe galvanic corrosion with other electrically conductive materials such as metals used for bearing running surfaces. However, If a self-lubricated material containing graphite meets the minimum dielectric strength requirement then it should prevent galvanic corrosion in a typical marine environment.

The requirement for self-lubrication to be continuous and without measurable gaps for the full self-lubricated surface in contact with the mating running surface may be needed for applications that regularly only have small ranges of movement. For these applications plugged bronze or other types of materials that don't meet this requirement may not be the best choice for successful performance. If the range of movement is large enough this requirement may not be relevant and can be removed.

The dynamic bearing pressure requirement in this section should be considered the absolute upper end of allowable bearing pressures during operation. Composite self-lubricated materials can be brittle and may fail due to edge loading at high bearing pressures. EM-1110-2-2610 ME EE design had guidance for allowable and recommended bearing pressures.

****

Submit Self-Lubricated Material Product Data showing the material[s] selected for use are in compliance with the requirements of this specification. Self-lubricated materials must:

a. Be approved by the material manufacturer for use in [submerged and marine environments][environments exposed to all weather conditions][____].

b. Have an operating temperature range of [-34] [_____] to [93] [_____] degrees C [-30] [_____] to [200] [_____] degrees F.

c. Be approved by the material manufacturer for a dynamic bearing pressure of69 MPa at least 10,000 psi.

[d. Have a water absorption of less than [0.1][0.2][0.3] percent increase in weight for long term immersion as tested in accordance with ASTM D570.
]

[e. Have a minimum dielectric strength of 50V/mm, as tested in accordance with ASTM D149, for surfaces of the self-lubricated materials that come into contact with bearing running surfaces .]

[f. Be continuous and without measurable gaps for the full self-lubricated material surface that contacts the mating running surface.]

2.1.1 Fabric or Fiber Reinforced Polymer Self-Lubricated Materials

In addition to the general self-lubricated material requirements in section 2.1 above fabric or fiber reinforced polymer self-lubricated materials must:

a. Be fabricated with isopthalic polyester, orthophthalic polyester, vinylester, or epoxy resin.

b. Have polyester reinforcement, or a combination of polyester and polytetrafluoroethylene (PTFE) sheet fabric or fiber strand.

c. Have a minimum compressive yield strength of 103 MPa 15,000 psi as tested in accordance with ASTM D695 with the load applied perpendicular to the fabric/fiber layers.

d. Have a minimum in-plane shear strength of 69 MPa 10,000 psi as tested in accordance with ASTM D3846.

2.1.2 Polymer Coating Self-Lubricated Materials

****

NOTE: Coating thickness and backer material selection vary with each application. Consult self-lubricated material manufacturers for appropriate selections for your application.

Over the last several years, several high profile failures have occured with polymer coated bearings. These bearings are highly susceptible to edge loading failures and highly sensitive to particulates like sand or grit, which has been a source of failure in several instances. These bearings can be a suitable selection for many applications, but they should be selected and specified very carefully. If used underwater, robust, watertight seals are recommended to keep contaminants out of the bearing.

****

In addition to the general self-lubricated material requirements in section 2.1 above polymer coated self-lubricated materials must:

a. Have a minimum of [0.38][0.51][0.64] mm [0.015][0.020][0.025] inches self-lubricated coating thickness after final machining.

b. Have a minimum compressive strength at failure of 241 MPa at least 20,000 psi as tested by the material manufacturer.

c. Have a coating backer material fabricated from [copper nickel alloy in accordance with ASTM B929, UNS C72900][copper alloy in accordance with ASTM B584] [stainless steel in accordance with ASTM A564/A564M, UNS S17400, Type 630, Condition [H1025] [H1075] [H1100]] [glass fiber reinforced composite].

d. Have an mechanical bond strength developed between the self-lubricated coating and backer material as the primary method of securing the self-lubricated coating. Mechanical fasteners, keys, or other keepers are not acceptable to retain the self-lubricated coating or transfer load between the coating and backer.

2.1.3 Extruded Homogeneous Polymer Self-Lubricated Materials

In addition to the general self-lubricated material requirements in section 2.1 above extruded homogeneous self-lubricated materials must:

b. Have a minimum compressive yield strength of 138 MPa 20,000 psi as tested in accordance with ASTM D695.

2.1.4 Plugged Bronze Self-Lubricated Materials

****

NOTE: Graphite plugged bronze self-lubricated materials can result in galvanic corrosion in a marine or submerged environment when used against a dissimilar metal such as a stainless steel. Make sure that galvanic corrosion behavior is considered in the design if using a plugged bronze material. PTFE plugged bronze does not have significant corrosion concerns.

The self-lubricated plugs used in plugged bronze materials are intermittently spaced and may not be ideal for applications with small ranges of movement. Discuss the required plug spacing with self-lubricated material manufacturers and require a plug spacing that accommodates the minimum range of movement for your application.

Optional requirements in section 2.1e (dielectric strength requirement) and 2.1f (requirement for self-lubricated material to be continuous and without measurable gaps for the full self-lubricated material surface)exclude the use of graphite plugged bronze materials. Remove these sections if using a plugged bronze material.

The specific alloy selected for the base material will depend on a variety of factors, such as corrosion resistance, wear, velocity, hardness requirements, machineability. Consult with manufacturers to determine the specific recommended alloys for your application.

****

In addition to the general self-lubricated material requirements in section 2.1 above plugged bronze self-lubricated materials must:

a. Have a base material fabricated from [a copper alloy in accordance with ASTM B584][an aluminum bronze in accordance with ASTM A148/A148M][_____].

b. Have self-lubricating plug recesses machined perpendicular to the bearing surface extending at least 0.25 inches deep.

c. Have a self-lubricating plug material appropriate for the application that provides the primary lubrication for the bearing.

d. Utilize a self-lubricating plug material that does not cause galvanic corrosion with the mating running surface material.

e. Have self-lubricating plugs arranged in a uniform overlapping pattern spaced no greater than 69 MPa[[10][15][20] deg][[0.5][0.75][1.0] inches] apart in the direction of bearing movement and extending no further than 0.25 inches from the edge of the bearing surface.

f. Have a minimum compressive yield strength of 103 MPa20,000 psi, as rated by the self-lubricated material manufacturer.

[2.2 FAILURE CRITICAL BEARINGS (FCB)

****

NOTE: This section designates additional performance, testing, and QC requirements for critical bearings. These requirements come with additional cost and should be used for applications where the critical nature of the application justifies the additional cost. Remove this section if it does not apply.

Definition of a failure critical bearing can be tailored as necessary for a specific project.

****

Failure critical bearings are bearing or bushing applications where failure could potentially result in damage to critical systems or, applications where repair or replacement of a failed bearing or bushing would result in a loss of service or operation of a critical system. The designation FCB means failure critical bearing. FCB's are determined by the Government and are identified on the Contract drawings or in the Contract specifications.

2.2.1 FCB Material Qualifications

****

NOTE: CERL TR 99/104 is available through the Defense Technical Information Center (dtic.mil).

****

The following is required for a material to be considered acceptable for FCB applications:

a. The material must have been tested by the procedure defined in CERL TR 99/104.

b. The material must receive a performance score of 350 or above for both wet and dry testing as evaluated by the USACE Hydro Electric Design Center (HDC) in Portland, Oregon, using the bearing rating system in CERL TR 99/104 Appendix F.

c. The material manufacturer must sign a release agreement allowing public distribution of the material's test results.

2.2.2 Approved FCB Materials

****

NOTE: For an updated list of material performance scores contact the USACE Hydroelectric Design Center (HDC) (Phone: 503-808-4250).

Over the last several years, several high profile failures have occured with polymer coated bearings. These bearings are highly susceptible to edge loading failures and highly sensitive to particulates like sand or grit, which has been a source of failure in several instances. These bearings can be a suitable selection for many applications, but they should be selected and specified very carefully. If used underwater, robust watertight seals are recommended to keep contaminants out of the bearing.

****

The following list of materials meet FCB requirements:

TABLE 2:

FCB Material Name	Manufacturer	General Material Construction
Triboglide 15M+	ACM Composite Bearings Americas	Fabric Reinforced Polymer
All True Hydro 2069-ATHB	All True Designs	Fabric Reinforced Polymer
CIP Hydro	Columbia Industrial Products	Fabric Reinforced Polymer
Devatex 522	Federal Mogul Corporation	Fiber Reinforced Polymer
Devatex 552	Federal Mogul Corporation	Fiber Reinforced Polymer
HPF	Glacier Garlock Bearings	Fabric Reinforced Polymer
HPM	Glacier Garlock Bearings	Fabric Reinforced Polymer
HPMB	Glacier Garlock Bearings	Fabric Reinforced Polymer
P302-PTFE (previous name: D-Glide FT)	GrayGo International (previous name: Drie-D Americas)	Fabric Reinforced Polymer
Karon V - bronze backed	Kamatics Corporation	Polymer Coating - Bronze Backed
Karon V - composite backed	Kamatics Corporation	Polymer Coating - Composite Backed
C417	Trelleborg Sealing Solutions (previous name: Orkot Engineering Plastics)	Fabric Reinforced Polymer

TXM-M	Trelleborg Sealing Solutions (previous name: Orkot Engineering Plastics)	Fabric Reinforced Polymer
Lubron HX	Lubron Bearing Systems	Polymer Coating - Bronze Backed

Submit FCB Material Certifications from the material manufacturer stating that the chemical formulations, manufacturing processes and overall structure of the materials supplied are identical to those of the bearings that meet the approved FCB materials above.

]2.3 VERIFICATION OF FABRICATION DETAILS

****

NOTE: The surface finish and hardness of the mating component of a self-lubricated material has a large effect on the successful operation of that self-lubricated material. Running surfaces typically need to be fabricated with a Rockwell hardness number between 30 and 40 on the Rockwell C scale (HRC 30 - HRC 40) in accordance with ASTM E18. Self-lubricated materials in applications with infrequent service typically require no rougher than a 0.8 µm 32 micro-inches surface finish. Surface finishes, typically no rougher than 0.4 µm 16 micro-inches are required for application that have frequent service. These requirements can often be overlooked by contractors and sub-contractors that are not familiar with self-lubricated materials.

The backing surface and running surface may come into contact if the self-lubricated coating fails. Stainless backing with a stainless running surface has caused severe galling on mulitple projects after the coating failed. Selecting a combination which results in bronze on stainless combination is preferable since that combination can work as a dry bearing. Many projects have also provided auxiliary grease grooves to allow supplemental lubrication if the self-lubricated material fails.

****

Verify that the fabrication and installation details shown meet the self-lubricated material manufacturer's recommendations. Specifically, verify that:

a. Surface finish and hardness requirements shown for self-lubricated material mating running surfaces are in compliance with the self-lubricated material manufacturer's recommendations.

b. Self-lubricated material clearance fits, interference fits, and tolerances shown comply with the self-lubricated material manufacturer's recommendations.

If these fabrication and installation details are outside of the self-lubricated material manufacturer's recommendations [notify the Government by submitting a Request for Information] [notify the Government by submitting a variance request on the shop drawings] [notify the Contracting Officer Representative].

2.4 Seals

****

NOTE: The use of physical seals for self-lubricated bushings/bearings is an important consideration for designers. Designers should remember that for a traditional greased bronze bearing the grease is not only lubricating but is also helping to seal the bearing. Self-lubricated materials provide their own lubrication but do not provide their own seal.

Adding a physical seal can help keep debris and contaminants out of the bearing which keeps friction low and minimizes the potential for abrasive wear.

In general, it's recommended that physical seals are used for critical bearings. However, other factors that should be considered when making this decision include the potential for debris or contaminants to enter the bushing/bearing, the bushing/bearing's natural tendency to evacuate debris or contaminants, and the abrasion resistance characteristics of the chosen material construction(s).

There are many acceptable materials and configurations that can be used for physical seals. The material choices presented here have been used in self-lubricated material bushing/bearing designs and are provided here as sample seal materials for consideration. Tailor this spec section to the types of seals selected for the design.

Elastomeric o-rings are commonly used for static joint seals. These are designed to be compressed with the assembly of the joint to provide positive contact to exclude debris, and other contaminants. Low friction polymer lip seals are commonly used for dynamic joint seals. PTFE is a very common selection because of its low friction, ability to run without grease or oil, and chemically resistive properties. A bent metal spring or compressed o-ring is typically used to energize the lip seal (provide positive contact) when the joint is assembled. These types of seals are typically readily available from seal manufacturers as they are commonly used on mechanical shafts and cylinders.

****

Submit Seal Product Data showing the seals selected for use are in compliance with the requirements of this specification.

2.4.1 Static Seals

Static seals must be synthetic ethylene propylene elastomeric o-rings meeting the following material requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Durometer Hardness (Shore Type A)	65 to 75	ASTM D2240
Tensile Strength	10 MPa 1450 psi (minimum)	ASTM D412
Elongation at Break	150 percent minimum	ASTM D412
200 percent Modulus	6 MPa 900 psi (minimum)	ASTM D412

2.4.2 Dynamic Seals

Dynamic seals must:

a. Be lip seals or face seals designed to exclude [rainwater][silt][heavy splash and mist][debris and contaminants] from the self-lubricated bearing.

b. Be suitable for use in a [submerged][high splash][outdoor]environment.

c. Be energized with springs fabricated from stainless steel or elastomeric o-rings to provide positive contact between the components being sealed.

d. Be molded or extruded from a polytetrafluoroethylene (PTFE) resin with appropriate fillers to achieve the performance requirements appropriate for the self-lubricated material seal application.

e. Be suitable for running without external lubrication.

[2.5 PRODUCT LUBRICATED PUMP BEARINGS

****

NOTE: If used, this section should be copied into an applicable pump specification. If pump bearings are not being used remove this section.

****

Submerged pump bearing must be [product lubricated][externally supplied water lubricated] and meet the following requirements:

a. Fabricated from an elastomeric material or polymer composite material and not require petroleum lubricants for operation.

b. Operate in [brackish][fresh] water that may contain [sand] [silt] [vegetative trash].

c. Does not require service or replacement for [50,000] [_____] operating hours.]

PART 3 EXECUTION

3.1 FABRICATION

Fabricate self-lubricated components and their mating running surfaces to the materials, dimensions, tolerances, and qualities shown. Fabricate self-lubricated components in accordance with the self-lubricated material manufacturer's recommendations.

3.2 TEST FITTING

Test the fit of self-lubricated components with their mating surfaces [in the presence of the Contracting Officer Representative] prior to transporting components on site.

3.3 INTERFERENCE FITTING OF SELF-LUBRICATED MATERIALS

3.3.1 Preparation of Interference Fit Surfaces

Prior to interference fitting:

a. Remove coatings such as paint, galvanizing, and anodizing from the interference fit surfaces of the bushing/bearing housing.

b. Clean the interference fit surfaces of the bushing/bearing and housing of oil, grease, cutting fluids, or other substances.

c. Prepare the interference fit surfaces of the bushing/bearing in accordance with the self-lubricated material manufacturer's recommendations.

3.3.2 Press-Fitting

Press fit self-lubricated components in accordance with the material manufacturer's recommendations. Do not use hammer blows or other impact type loading to press fit self-lubricated components. Use a method to press fit self-lubricated components that provides a smooth and constant force such as a hydraulic or other style of press. Protect components from damage during the press fitting process.

3.3.3 Shrink-Fitting

Perform shrink fitting by lowering the temperature of the inner component to a point where the outside diameter shrinks adequately to avoid interference with the outside part. Use a method to lower the temperature of self-lubricated materials that is approved by the self-lubricated material manufacturer and submitted with the Assembly and Installation Plan. Ensure shrink-fit components are fully seated and prevented from moving prior to allowing the parts to return to ambient temperature.

3.4 MECHANICAL FASTENING OF SELF-LUBRICATED COMPONENTS

Install self-lubricated components in accordance with the approved Assembly and Installation Plan. Use [300 series stainless steel fasteners] [_____] to install self-lubricated components unless otherwise noted. Install fasteners [with a thread locker and] to a torque value that does not damage or distort the self-lubricated materials. Determine the self-lubricated material manufacturer's maximum allowable amount of wear for the self-lubricated component. Install fasteners so that no part of the fastener extends beyond the fully worn running surface of the self-lubricated material.

3.5 BONDING INSTALLATION

****

NOTE: Installation of self-lubricated materials using bonding adhesives have had mixed results for previous installations. In general, bonded installations are much more challenging to perform successfully. Previous challenges have included difficulties with working with bonding adhesives, maintaining component alignment during bonding, and performing accelerated temperature curing of bonding adhesives without post-curing the self-lubricated materials. Overall, bonding installations require a high level of skill and craftsmanship to perform successfully and these qualifications are extremely difficult to specify in a contract. In addition, there's typically no advantage to a bonded installation over interference fitting or mechanical fastening. Therefore, bonded installations are not recommended.

****

Installing self-lubricated materials with a bonding adhesive is not permitted.

3.6 INSTALLATION PLAN

Submit an Assembly and Installation Plan showing the proposed method to assemble and install the self-lubricated components. Include pre-assembly fabrication dimensions, a description of the [interference fitting procedure][mechanical fastening procedure including installation torques], post-assembly dimensions, installation procedure,[seal installation procedure including any methods to temporarily support the seals during assembly,] method to measure and confirm the alignment requirements. Government approval of the plan does not relieve the requirement to provide a successful installation.

3.7 VERIFYING DIMENSIONS AFTER INSTALLATION

****

NOTE: The inner and outer diameter of self-lubricated bushings can change significantly after interference fitting. Consult the self-lubricated material manufacturer for pre-interference fit dimensions to achieve the desired post-interference fit dimensions. Manufacturer's can typically accurately predict the pre-interference fit dimensions required. However, sometimes post-interference fit machining is required to meet final dimensions.

Some self-lubricated materials are fabricated with a layer of premium grade material applied only at the

running surface of the part. This is a common practice and can be used to significantly reduce material costs. If this practice is used an adequate thickness of premium grade material needs to be provided to allow post-interference fit machining.

****

After [shop assembly] [field installation], measure self-lubricated components to verify contract required dimensions and alignment requirements are met. If assembly dimensions are not met, machine or hone the self-lubricated materials to achieve the required dimensions. Perform machining and honing of self-lubricated components in accordance with the self-lubricated material manufacturer's recommendations. Some self-lubricated materials are fabricated with a layer of premium grade material applied only at the running surface of the part. Provide enough premium grade material at running surfaces to allow for post-assembly machining. After completing the installation photograph the [bearing/bushing][self-lubricated component] showing the installed condition. Submit a Post-Assembly QC Report detailing the measured dimensions and alignment tolerances after assembly and showing compliance with the approved Assembly and Installation Plan. [Include color photographs of the [bearing/bushing][self-lubricated component] showing the installed condition.]

3.8 ASSEMBLY OF MATING COMPONENTS

3.8.1 Cleaning

Prior to final installation, clean self-lubricated materials and their running surfaces of oil, dirt, and debris using a method recommended by the self-lubricated material manufacturer.

[3.8.2 Seal Installation

****

NOTE: Delete this section if physical seals are not used.

****

Install seals in accordance with the approved Assembly and Installation Plan. [Temporary support of seals for assembly/installation may be performed with cyanoacrylate adhesive applied in small amounts at several locations equally spaced around seal grooves.]

]3.8.3 Final Installation

Do not force components together in a manner that causes binding of the running surfaces of the components. Do not use lubricants to assemble self-lubricated components unless otherwise specified.

[3.9 ACCEPTANCE TESTING

****

NOTE: Remove if acceptance testing is covered under a different spec section. Tailor the acceptance testing to your specific application. It's recommended that the designer develop a checklists for all testing or verifications need

to ensure the bearing system is functioning correctly. It's also recommended that acceptance testing is witnessed and signed off by all concerned parties such as the customer or stakeholders.

****

[Notify the Contracting Officer in writing at least [14] calendar days before performing acceptance testing. Perform acceptance testing in the presence of the Contracting Officer unless waived in writing.] Create an acceptance test report form to document the procedure to perform the test operation and monitoring required in this section. Verify the following requirements have been completed prior to starting acceptance testing:

[a. Self-lubricated component installation is complete and components of the bearing system have been fully assembled.]

[b. The self-lubricated component installed dimensions, tolerance, and alignments have been measured and found to comply with the installation requirements shown.]

[c. The Post-Assembly QC Report has been finalized and approved by the Government.]

[d. Fasteners and have been installed and torqued to their final values.]

3.9.1 Test Operation and Monitoring

****

NOTE: Use this section to describe the cycling that needs to be performed for the bearing system. Some general examples are provided but this section needs to be tailored to your specific application.

****

[In the presence of the Contracting Officer Representative][operate the [bearing system] through [5][10][_____] rotation cycles][operate the [bearing system] for [1 hour][2 hours][_____]][Perform test operation at [_____] load and [_____] speed]. During test operation monitor the [bearing system] for:

[a. Evidence of bending, warping, permanent deformation, cracking, or malfunction of components.]

[b. Abnormal noise, stick-slip movements, vibration, or overheating of the self-lubricated components.]

[c. Evidence of bearing movement or deformation.]

Stop test operation immediately if any of these deficiencies are observed. Investigate and correct deficiencies prior to proceeding with test operations. After completing test operation the [Contracting Officer Representative] will examine the [bearing system] and, if found to comply with the contract requirements, it will be accepted [by signature by all parties]. [Signatures and acceptance will not occur until deficiencies have been corrected.]

3.9.2 Test Report

Upon successful completion [and signoff] of the acceptance tests submit an Acceptance Test Report documenting the test operations performed, the monitoring checks performed, deficiencies discovered and their resolution, [and showing final signoff by all parties].

]3.10 OPERATION AND MAINTENANCE MANUALS

[In addition to the requirements of Section 01 78 00 CLOSEOUT SUBMITTALS,] [Provide][five][three][_____][printed and bound][PDF format] [legible] copies of the following information in the Operation and Maintenance Manuals. All information must be the most current and approved copy, reflecting any changes made during the construction process:

a. Shop Drawings.

[b. Field Installation Drawings.]

c. Self-Lubricated Material Product Data.

[d. Seal Product Data.]

[e. Self-Lubricated Material Manufacturer's Warranty.]

[f. FCB Material Certifications.]

g. Post-Assembly QC Report

h. Acceptance Test Report

[i. Photographs showing the installed self-lubricated components]

[j. Guidance for when self-lubricated components need to be replaced]

3.11 TRAINING

Provide field training conducted by the [self-lubricated material manufacturer] [erecting engineer] for operating staff after each system is functionally complete but prior to final acceptance. The training must be given for a period of not less than [four][_____] hours. Cover [operation], [inspection], and [maintenance] of [the self-lubricated bearing systems] include the items contained in the operation and maintenance manuals. Do not perform training until operation and maintenance manuals have been approved. Provide [four weeks] [_____] advance notice of the scheduled training. [Record video and audio of training conducted and provide two CD-ROM copies of the training. Provide MPEG-2 or MPEG-1 format to be compatible with common DVD players in the United States.]

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 20 14 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 14 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-35 20 14 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 14 (April 2008)

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****

SECTION 35 20 14

STOPLOGS

08/22

****

NOTE: This guide specification covers the requirements for fabricating, assembling, delivering, and installing stoplogs. This section was originally developed for USACE Civil Works projects.

Certain components of a Stoplog may be considered fracture critical. AWS D1.1 does not include provisions for fracture critical welding. The Designer should consider using guide specification SECTION 05 59 20 FABRICATION OF HYDRAULIC STEEL STRUCTURES for specifying fracture-critical welding utilizing a Fracture Control Plan. A Fracture Control Plan and the use of appropriate materials and welding is required by ER 1110-2-8157, "Responsibility for Hydraulic Steel Structures."

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

Select Alternate 1 (one pay item) or Alternate 2 (two pay items). Delete all paragraphs of Alternate not selected.

****

1.1.1 Furnishing and Installing Stop Logs

****

NOTE: Alternate 1.

****

1.1.1.1 Payment

Payment is made for costs associated with furnishing and installing stop logs and appurtenant items, which includes full compensation for the materials, fabrication, delivery, installation, and testing of stop logs and appurtenant items necessary for complete installation.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Furnishing Stop Logs

****

NOTE: Alternate 2.

****

1.1.2.1 Payment

Payment is made for costs associated with furnishing stop logs and appurtenant items, which includes full compensation for the materials, fabrication, and delivery of stop logs and appurtenant items necessary for complete installation.

1.1.2.2 Unit of Measure

Unit of Measure: lump sum.

1.1.3 Installing Stop Logs

****

NOTE: Alternate 2.

****

1.1.3.1 Payment

Payment is made for costs associated with the installation of stop logs and appurtenant items, which includes full compensation for the complete installation and testing of stop logs and appurtenant items.

1.1.3.2 Unit of Measure

Unit of measure: lump sum.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting

	for Low-Temperature Service
ASTM A529/A529M	(2019) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A588/A588M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B308/B308M	(2010; R 2020) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D413	(1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D572	(2004; R 2019) Rubber Deterioration by Heat and Oxygen
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, [_____]

Shop Assembly Drawings; G, [_____]

Delivery Drawings; G, [_____]

Field Installation Drawings; G, [_____]

Stress Relieving Plan; G, [_____]

Fracture Control Plan (FCP); G, [_____]

Handling Attachments And Pick Points; G, [_____]

SD-03 Product Data

Sequencing and Scheduling; G, [_____]

Materials

Identification System

SD-06 Test Reports

Tests, Inspections, and Verifications

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Welders and Welding Operators

Provide qualification of welders and welding operators conforming to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

1.5 DELIVERY, STORAGE, AND HANDLING

Perform delivery, handling, and storage of materials and fabricated items in accordance with the requirements specified [herein and] in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. [Unload material and equipment delivered to the site as approved by the Contracting Officer. Verify the condition and quantity of the items delivered and acknowledge receipt and condition thereof in writing to the Contracting Officer. If delivered items are damaged or a shortage is determined, notify the Contracting Officer of such in writing within 24 hours after delivery.]

1.5.1 Rubber Seals

Store rubber seals in a place which permits free circulation of air, maintains a temperature of 20 degrees C 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Keep rubber seals free of oils, grease, and other materials which would deteriorate the rubber. Do not distort rubber seals during handling.

1.5.2 Identification System

Submit an Identification System which shows the disposition of specific lots of approved materials and fabricated items in the work, before completion of the contract.

[1.6 SEQUENCING AND SCHEDULING

****

NOTE: The name of the appropriate railroad company or roadway agency should be inserted as indicated.

****

Before the work is commenced, submit the approved sequencing and scheduling plan which illustrates that work affecting [railroads] [roadways] has been coordinated with [_____]. Include schedules, lists of labor or materials to be provided to the affected [company] [agency], and any other aspects of the work that may impact on the operations of these entities. Clearly demonstrate how all [railroad tracks] [public or private roads, streets, or highways] will be kept open to traffic at all times during the construction period, except as otherwise specified or directed.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

Submit detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, conforming to the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.1.1.1 Fabrication Drawings

Show on the fabrication drawings complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.1.1.2 Shop Assembly Drawings

Show on the shop assembly drawings details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.1.1.3 Delivery Drawings

Show on the delivery drawings descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.1.1.4 Field Installation Drawings

Show on the field installation drawings a detailed description of the field installation procedures. Include in the description the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; plan for prestressing gate leaf diagonals, including descriptions of connections, riggings, anchorages, and measuring equipment; methods for installing quoin and miter blocks, including checking and maintaining alignments of the blocks during concreting and placement of [epoxy] [zinc] filler; [procedures and equipment used for heating and placing of the zinc filler;] and methods for installing other appurtenant items.

2.2 MATERIALS

Submit system of identification which shows the disposition of specific lots of approved materials and fabricated items in the work, before completion of the contract. Ensure materials orders, materials lists and materials shipping bills conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Submit approved samples prior to use of the represented materials or items in the work. Submit samples of standard and shop fabricated items that are both full size and complete as required for installation in the work. Approved samples may be installed in the work provided each sample is clearly identified and its location recorded.

2.2.1 Metals

****

NOTE: Consider the use of ASTM A709/A709M steel for fabrication of all steel components. A709 material is available in 36 ksi and 50 ksi and provides improved toughness and maximum yield to tensile ratios to ensure ductile performance.

****

Ensure structural steel, steel forgings, steel castings, stainless steel, bronze, aluminum bronze and other metal materials used for fabrication conform to the requirements shown and specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.2.1.1 Structural Steel

Conform to [ASTM A36/A36M][ASTM A572/A572M][ASTM A992/A992M][ASTM A709/A709M].

2.2.1.2 Structural Aluminum

Conform to [ASTM B221] [ASTM B308/B308M] [Alloy 6061, Temper T6].

2.2.2 Rubber Seals

Provide rubber seals that are [fluorocarbon (Teflon) clad rubber seals of the mold type only, and] compounded of natural rubber, synthetic polyisoprene, or a blend of both, and contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers.

2.2.2.1 Physical Characteristics

Ensure seals exhibit physical characteristics that meet the following requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	20.7 MPa3,000 psi (min.)	ASTM D412
Elongation at Break	500 percent (min.)	ASTM D412
300 percent Modulus	6.9 MPa1,000 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
*Water Absorption	5 percent by weight (max.)	ASTM D471
Compression Set	30 percent (max.)	ASTM D395, Method B
Tensile Strength (after aging 48 hrs)	80 percent tensile strength (min.)	ASTM D572

Perform the "Water Absorption" test using distilled water. Blot the washed specimen dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees for 22 plus or minus 1/4 hour. Remove the specimen and allow to air cool to room temperature, and weigh the specimen. Record the weight the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D471). Ensure the immersion temperature is 70 degrees C plus or minus

1 degree and the immersion duration is at least 166 hours.

[2.2.2.2 Fabrication of Rubber Seals

Provide rubber seals with a fluorocarbon film that is vulcanized and bonded to the sealing surface of the bulb. Ensure the film thickness is [0.762] [1.524] mm [0.030] [0.060] inch and is Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and has the following physical properties:

Tensile strength	13.8 MPa2,000 psi (min.)
Elongation	250 percent (min.)

Flush the outside surface of the bonded film with the surface of the rubber seal and ensure it is free of adhering or bonded rubber. Mold strips and corner seals in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, mask the fluorocarbon film during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

]2.3 MANUFACTURED UNITS

Ensure bolts, nuts, washers, screws and other manufactured units conform with the requirements shown and specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.3.1 Bolts, Nuts and Washers

Ensure high-strength bolts, nuts, and washers conform to ASTM F3125/F3125M, Grade A325, [hot-dip galvanized]. Ensure bolts, nuts, studs, stud bolts and bolting materials other than high-strength conform to ASTM A307, Grade A, [hot-dip galvanized] or ASTM A320/A320M, [Ferritic Steel, Grade [_____]] [Austenitic Steel, Grade [_____], Class [_____]]. Use bolts M16 1/2 inch and larger that have hexagon heads. Ensure the finished shank of bolts is long enough to provide full bearing. Use washer with bolts that conform to the requirements specified in the applicable specification for bolts.

2.3.2 Screws

Provide screws of the type indicated on the drawings.

2.4 FABRICATION

2.4.1 Structural Fabrication

Ensure all structural fabrications conform with the requirements shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop-fabricated of the materials specified and shown. Ensure dimensional tolerances comply with the specifications and as shown on the drawings. Splices are only allowed where shown or approved. Bore pin holes in components after welding, straightening, stress-relieving, and threading operations are completed. Brackets, eye bar sections, and other components requiring straightening are only to be straightened by methods which do not damage the material. Press-fit bronze bushings with supporting components. Provide bolt connections, lugs, clips, or other pick-up assembly devices for components as shown and required for proper assembly and installation. Make provisions for the installation of [cathodic protection system devices and other] appurtenances as required.

2.4.2 Welding

****

NOTE: List applicable welds requiring radiographic examination.

NOTE: Specification Section 05 50 14 STRUCTURAL METAL FABRICATIONS includes welds subjected to Ultrasonic Testing (UT), Dye Penetrant Testing (PT) and Magnetic Testing (MT). AWS D1.1 does not specify nondestructive testing of any completed weld. Designer must take this into account and specify any Nondestructive Testing (NDT) requirements as well as specifying which welds are to be subjected to nondestructive testing.

The designer is to consider whether any components included are likely to be fracture critical. Fracture critical components should be identified as requiring fabrication in accordance with a Fracture Control Plan.

****

Ensure welding conforms to the requirements of AWS D1.1/D1.1M, AWS D1.2/D1.2M, the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide welds of the types shown on the contract drawings and approved detail drawings. Radiographic examination is required on the major shop and field welds of the type and location indicated on the drawings and as follows: [_____]. Welds which have been designated to receive radiographic examination and are found to be inaccessible to a radiation source or film, or are otherwise so situated that radiographic examination is not feasible may be examined, with written approval, by dye penetrant, magnetic particle tests, or ultrasonic tests. All components are to be stress-relief heat treated after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances. Submit a Stress Relieving Plan for approval which follows the minimum requirements for thermal stress relief in accordance with AWS D1.1.[Stress-relief heat treat all components after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances.][Refer to Specification SECTION 05 50 14 STRUCTURAL METAL FABRICATIONS for nondestructive testing requirements.][Submit a Fracture Control Plan (FCP) for fracture critical components.]

2.4.3 Bolted Connections

Ensure bolted connections conforms to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.4 Machine Work

Ensure machine work conforms to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.5 Miscellaneous Provisions

Ensure miscellaneous provisions for fabrication conforms to the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.6 Fabrications

2.4.6.1 Stoplogs [and Posts]

****

NOTE: Fabricate stoplogs and posts of structural steel or aluminum. Where aluminum is specified, include the requirements for aluminum stoplogs and posts to be furnished by the Contractor, or aluminum materials and extrusion dies for fabricating stoplogs and posts to be furnished by the Government to the Contractor for fabricating aluminum stoplogs and posts if such is the practice in the Command.

****

Fabricate [stoplogs [and posts] of [structural steel conforming to [ASTM A36/A36M] [ASTM A242/A242M] [ASTM A529/A529M] [ASTM A572/A572M, Grade [42,] [50,] [60,] [or] [65]] [ASTM A588/A588M]] [extruded aluminum conforming to [ASTM B221,] [ASTM B308/B308M,] [Alloy 6061, Temper T6]].] [Galvanized steel items where indicated.] Fabricate [stoplogs [and posts] with the aluminum materials and extrusion dies provided to the Contractor by the Contracting Officer. Furnish all other materials and equipment as required for fabrication.]

2.4.6.2 Stoplog Guides [and Post Pockets]

Fabricate stoplog guides [and post pockets] of structural steel conforming to [ASTM A36/A36M] [ASTM A242/A242M] [ASTM A529/A529M] [ASTM A572/A572M, Grade [42,] [50,] [60,] [or] [65]] [ASTM A588/A588M].

2.4.6.3 Miscellaneous Embedded Metals

Ensure corner protection angles, frames, base plates, and other embedded metal items required for complete installation conform to the details shown.

2.4.6.4 Seal Assemblies

Provide seal assemblies consisting of rubber seals, stainless steel retainer and spacer bars, and fasteners. Provide rubber that continuous over the full length. Accurately fit and drill all seals for proper installation. Drill bolt holes in the rubber seals by using prepared templates or the retainer bars as templates. Fully mold splices in seals and develop a minimum tensile strength of 50 percent of the unspliced seal strength. Place splices only at shown locations. Shop vulcanize all splices. Locate vulcanized splices between molded corners and straight lengths as close to the corners as practicable. Place splices on a 45 degree bevel related to the "thickness" of the seal. Ensure all finished splice surfaces are smooth and free of irregularities. Field-splice stainless steel retainer bars only where shown and machine-finished after splicing.

2.4.6.5 Appurtenant Items

Sill assemblies, latches, bumpers fenders, seal plates and shapes, and other appurtenant items per the details specified and shown.

2.4.6.6 Shop Assembly

Shop assembly requirements for miter gates and appurtenant items are shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Completely shop assemble miter gates and appurtenant items, unless otherwise approved by the Contracting Officer, to assure satisfactory field installation. Fit and bolt adjoining components together to facilitate field connections. Carefully preserve the match-marking of unassembled items until the items are assembled. Cover mating surfaces and machined surfaces with a rust preventative until assembly. Shop-welded assembled components in their final positions as much as delivery and field installation conditions permit. Fit and drill rubber seals to match the seal retainers, match-marked, and removed for shipment. Perform shop assembly and disassembly work in the presence of the Contracting Officer unless otherwise approved by the Contracting Officer; however, the presence of the Contracting Officer does not relieve the Contractor of any responsibility under this contract.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit certified test reports for material tests with all materials delivered to the site.

2.5.1 General

Perform tests, Inspections, and Verifications for materials the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.5.2 Testing of Rubber Seals

Test the fluorocarbon film of rubber seals for adhesion bond in accordance with ASTM D413 using either the machine method or the deadweight method. Cut a 25 mm 1 inch long piece of seal from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. Ensure there is no separation between the fluorocarbon film and the rubber when subjected to the following loads:

THICKNESS OF FLUOROCARBON FILM	MACHINE METHOD AT 50 MM2 INCHES PER MINUTE	DEADWEIGHT METHOD
0.762 mm0.030 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width
1.524 mm0.060 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width

PART 3 EXECUTION

3.1 INSTALLATION

Installation per the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Assemble miter gates and appurtenant items for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Thoroughly clean and lubricate bearing surfaces requiring lubrication with an approved lubricant before assembly and installation. Ensure components to be field-welded are placed in correct alignment before welding is commenced. Design and submit handling attachments and pick points required to be added to any specified items herein prior to installation.

3.1.1 Embedded Metals

Accurately install sill assemblies, seal plates, frames, bases and other embedded metal items required for proper and complete installation to the alignment and grade required to ensure accurate fitting and matching of components. Primer coat all embedded metals with the required paint on all surfaces prior to installation in concrete forms. Install anchors for embedded metals as shown. Attach items requiring two concrete pours for installation to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour. Grind smooth welded field splices in sealing surfaces of embedded items.

3.1.2 Painting

Paint all exposed parts of gates and appurtenances except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in concrete, [cathodic protection system anodes,] and other specified surfaces as specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.1.3 Seal Assemblies

Install rubber seal assemblies after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Securely fasten rubber seals to metal retainers. Before operating the gate(s), apply a suitable lubricant to the rubber seal rubbing plates to protect the rubber.

3.2 FIELD QUALITY CONTROL

Non-Destructive testing of field welds is required to meet the same quality control requirements as shop-welded components.

3.3 SYSTEM START-UP

3.3.1 Trial Operation

After completion of the gate installation, conduct an examination of the gates in the presence of the Contracting Officer for final acceptance. First examine the gates to determine whether or not the workmanship conforms to the specification requirements. Operate the gates from the fully-opened to the fully-closed position a sufficient number of times to demonstrate to the Contracting Officer's satisfaction that all parts are functioning properly. The workmanship in the fabrication and installation of gates is the result in a condition where when the gates are in the closed position watertight barrier is formed across the opening. The contractor is required to make all repairs or replacements to correct defects, as determined by the Contracting Officer, at no cost to the Government. Repeat the trial operation after defects are corrected. Prior to final acceptance of the gates, provide temporary restraints to prevent unauthorized operation of the gates.

3.4 PROTECTION

Protect finished work per the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 20 15 (August 2018)**
Change 1 - 08/20

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-35 20 15 (August 2018)**
Change 1 - 08/20

Preparing Activity: USACE **New**

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References are in agreement with UMRL dated January 2025

****

SECTION 35 20 15

FRP COMPOSITES FOR LOW-HEAD WATER CONTROL STRUCTURES

08/18, CHG 1: 08/20

****

NOTE: This guide specification covers design-build gates and stop logs or boards made from fiber reinforced polymer (FRP) composite materials for use in low-head water control structures and weirs. Structures covered by this specification are to have a maximum static hydraulic head of 6.1 meters20 feet, accounting for overflow, a maximum height of 3.7 meters12 feet and a maximum width of 3.7 meters12 feet. This guide specification is not applicable if catastrophic failure of the water control structure would create a life safety risk as per ER 1110-2-1156. This specification covers the performance requirements for composite gates and stop logs or boards as well as appurtenant components such as seals, guide frames, anchors and fasteners.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

Units of work normally included should be FRP items which require specific fabrication to meet the desired project requirements.

****

PART 1 GENERAL

****
NOTE: The scope section may be edited by the User as needed. However, the maximum design head and maximum width must not be increased.
****

1.1 SCOPE

This guide specification covers low-head FRP water control structures, such as gates, valves or stoplogs, and any appurtenant features defined in the Contract Drawings that have a maximum static hydraulic head of 6.1 meters20 feet, accounting for overflow, a maximum height of 3.7 meters12 feet and a maximum width of 3.7 meters12 feet.

1.2 UNIT PRICES

Payment must constitute full compensation for furnishing all plant, labor, materials and equipment and performing all operations necessary for fabricating and installing the [Stoplogs] [Vertical Lift Gate] [_____] as specified.

1.2.1 Unit of Measure

Unit of measure: lump sum.

1.3 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN COMPOSITES MANUFACTURER'S ASSOCIATION (ACMA)

ACMA Code	(2011) Code of Standard Practice: Industry Guidelines for Fabrication and Installation of Pultruded FRP Structures

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C563	(2014) Fabricated Composite Slide Gates

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B308/B308M	(2010; R 2020) Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D572	(2004; R 2019) Rubber Deterioration by Heat and Oxygen
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1894	(2014) Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2563	(2008) Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D3917	(2015a) Standard Specification for Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Pultruded Shapes
ASTM D4020	(2011) Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials
ASTM D4329	(2013) Standard Practice for Fluorescent UV Exposure of Plastics
ASTM D4385	(2010) Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F436/F436M	(2024) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
ASTM G154	(2023) Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

1.4 DEFINITIONS

1.4.1 Design Head

The maximum differential head that will actually be applied to the gate (from AWWA C563).

1.4.2 Failure Critical Member

Any member for which failure would cause collapse, partial collapse or loss of functionality of the structure.

1.4.3 Fracture Critical Member

A steel member (or component thereof) that is in tension and whose failure would result in collapse or partial collapse of the structure

1.4.4 FRP Composites

A Fiber Reinforced Polymer (FRP) member composed of fibers and resin systems, including fillers and additives. These members are manufactured via pultrusion, filament winding, vacuum infusion, hand lay-up or other methods and may contain foam or wooden cores, metal frame members, other previously produced FRP composites or other materials. This includes structural shapes, sandwich panels, boards, or other members made of FRP.

1.4.5 Low-Head Water Control Structure

A gate, valve or stoplog structure with a maximum design head of 6.1 meters 20 feet, a maximum height of 3.7 meters12 feet, and a maximum width of 3.7 meters12 feet.

1.4.6 Stoplog

Horizontal members placed on top of each other fitting into a frame, groove or channel on each side channel in the water control structure.

1.4.7 Vertical Lift Gate

A gate that opens upward to allow water to flow under the gate. Vertical lift gates may also be referred to as sluice gates or slide gates.

1.4.8 Weir Dam

A dam to control water level by flowing water over the top of the structure; may include a control mechanism made of stoplogs or movable gates.

1.5 SEQUENCING AND SCHEDULING

Before the work is commenced, submit the approved sequencing and scheduling plan which illustrates that work affecting [railroads] [roadways] [utilities] [appurtenances][_____] has been coordinated with [_____]. The plan must include schedules, lists of labor or materials to be provided to the affected [company] [agency], and any other aspects of the work that may impact on the operations of these entities. The plan must clearly demonstrate how all [railroad tracks] [public or private roads, streets, or highways] [appurtenances] will be kept open to traffic at all times during the construction period, except as otherwise specified or directed or approved.

1.6 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Additional submittal requirements may be added by

the User as needed.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor, Manufacturer, and Engineer Qualifications; G, [_____]

Sequencing and Scheduling Plan; G, [_____]

Quality Control Plan

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

[Slide Gate][Stop Log] Technical Data Sheet; G, [_____]

Materials variances G, [_____]

SD-05 Design Data

Design Documentation; G, [_____]

SD-06 Test Reports

Test Reports; G, [_____]

Include test reports to verify all material properties used in design following ASTM or other specification bodies where possible.

SD-07 Certificates

Date and type of manufacture including constituent materials; G, [_____]

FRP Composites ; G, [_____]

Certification of State Product Approval; G, [_____]

Anchorage System; G, [_____]

SD-08 Manufacturer's Instructions

Shipping, Handling, Storage, Installation Procedures; G, [_____]

SD-09 Manufacturer's Field Reports

Certification of Installation; G, [_____]

Field Leakage Test; G, [_____]

SD-10 Operation and Maintenance Data

Care and Maintenance Instructions; G, [_____]

SD-11 Closeout Submittals

Warranty ; G, [_____]

Operation and Maintenance Manual; G, [_____]

Data Book; G, [_____]

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.7.1 Spare Parts

****

NOTE: Include a list of all spare parts required. This information should be provided on the contract drawings.

****

[_____]

1.8 QUALITY CONTROL

1.8.1 General

The Contractor is responsible for quality control and must establish and maintain an effective quality control system [in accordance with Contract Clauses 52.236-6 SUPERINTENDENCE BY THE CONTRACTOR and 52.236-5 MATERIAL AND WORKMANSHIP and with SECTION H, SPECIAL CONTRACT REQUIREMENTS]. The quality control system must consist of plans, procedures, and organization necessary to produce an end product which complies with the requirements of this contract. The system must cover all design, fabrication, painting, and delivery operations. The Contractor must submit a written Contractor quality control plan for approval.

1.8.2 Regulatory Requirements

****

NOTE: Include all regulatory information.

****

[_____]

1.8.3 Contractor, Manufacturer, and Engineer Qualifications

****

NOTE: If an engineer of record is close to the minimum or if the user has concerns about the nature and extent of the engineer's experience, the user may request a record of specific projects performed by the engineer in order to ensure the engineer possesses adequate qualifications to perform the proposed work.

****

Provide documentation from manufacturer having a minimum of [five][_____] years' experience in the manufacture of similar products and systems. Additionally, if requested, provide a record of at least [five][_____] previous, separate, similar successful installations in the last [five][_____] years. Submit Manufacturer's catalog data to include two copies of specifications, load tables, dimension diagrams, and anchor details for the following low-head water control structures and components.

Provide documentation from Engineer of Record having a minimum of [five] [_____] years' experience in the design of [five] [_____] similar products and systems and copy of current license. Additionally, if requested, provide a record of at least [five][_____] previous, separate, similar successful installations in the last [five][_____] years.

1.9 DELIVERY, STORAGE, AND HANDLING

1.9.1 General

Submit recommendations for shipping, handling, storage, installation procedures, and care and maintenance instructions. Deliver manufactured materials in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Ensure all related adhesives, resins and their catalysts and hardeners are crated or boxed separately, and noted as such to facilitate their movement to a dry indoor storage facility under controlled temperature and humidity.

1.9.2 Handling and Storage

Handle all materials to prevent abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store adhesives, resins and their catalysts in dry indoor storage facilities following MDS requirements.

1.10 PROJECT/SITE CONDITIONS

1.10.1 Design Parameters

****

NOTE: This information is to be provided by the user. The items suggested below are not necessarily all inclusive nor will all be necessary in all situations. User to edit this section as appropriate to include all relevant site conditions for the project and should be included with the scope of work or contract drawing documents.

****

****

NOTE: Provide information on the following items: type of water control structure; height and width of opening; design head (including operating head); bearing conditions (embedded metals condition and layout); type of actuator preferred to operate gate; type of frame (conventional, self-contained thrust reaction) and installation (surface mounted, in-channel wall mounted, embedded in wall, etc.); frequency of operation; debris and ice loads; corrosive, acidic or alkaline water conditions; operational limits (lifting, handling, etc.); and

other items listed in AWWA C563.
****

[_____]

1.11 WARRANTY

****
NOTE: Designated appurtenances of the gate assembly may be guaranteed for a minimum period of 1 year from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier, against defective materials and workmanship. Such guarantees will require the Contractor to furnish and install new replacement parts immediately upon receipt of notice from the Government of the failure of any part of the guaranteed items during the warranty period. These warranty requirements will be covered in the CONTRACT CLAUSES and this paragraph should be deleted from this section of the specifications.
****

Furnish manufacturer's no-dollar-limit warranty for the FRP composite low-head water control structure or components. The warranty period is to be no less than [1] [5][10][15][20] years from the date of acceptance of the work and be issued directly to the Government. The warranty must provide that, if within the warranty period, the composite low-head water control structure or components show evidence of deterioration resulting from defective materials and/or workmanship, correcting of any defects is the responsibility of the manufacturer. Repairs that become necessary because of defective materials and workmanship while the composite low-head water control structure or components are under warranty are to be performed within [32][_____] hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within [32][_____] hours of notification will constitute grounds for having emergency repairs performed by others and will not void the warranty.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****
NOTE: This section should be modified to account for the specific type of water control structure. The materials listed are suggestions showing most commonly used for such structures. Unsuitable materials for a particular application can be removed. Specify similar metals or provide dielectric insulators as necessary.
****

Provide [vertical lift gate] [stop logs] [_____] composed of fiber reinforced polymer composites [and embedded metal frame] in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified on the contract drawings and specifications.

Provide reinforcement in the form of glass or carbon fibers, mats, or fabrics to meet the design requirements and dimensions as specified. Select the reinforcement format for failure critical FRP components according to the mechanical requirements of the application and the geometry/shape of the part. Confirm selected reinforcements are compatible with selected resin matrix system to ensure proper adhesion/load transfer and long-term performance of the component in its intended physical-chemical environment of use. Ensure all surfaces of FRP composite items and fabrications are smooth, resin-rich, free of voids, and without dry spots, cracks, and un-reinforced areas as per quality requirements herein. Ensure all reinforcing fibers are completely covered during manufacturing with resin to a depth of 0.25 to 0.51 mm 0.01 to 0.02 inches to protect against their exposure to wear, water immersion, or weathering. Seal over fasteners that penetrate the FRP skin, end cuts, and penetrations in a way that prevents delamination and water ingress. Use mechanical fasteners or mechanical plus adhesive for built up FRP members connected in tension after manufacturing. Provide documentation showing core materials are resistant to decay and attack by fungus and bacteria.

Embedded frames made of [FRP] [galvanized steel] [T-[_____] stainless steel] [aluminum] may be used to provide added stiffness to meet the specified requirements, but must be submitted to the Contracting Officer or their approved representative for approval and have a minimum of 1/4 inch thick FRP on each side. [Metal frames made of [galvanized steel][T-[_____] stainless steel] [aluminum] must meet ASME/ASTM standards, be fully encapsulated in the FRP structure, and design submittals must account for the potential for the FRP to delaminate from the frame][Metal frames must be detailed to prevent galvanic corrosion if carbon is used in FRP]. Specification section [_____] must be referenced when embedded metals are used in conjunction with the composite structure. Provide anchored guide frames made of [carbon steel] [T-[_____] stainless steel] [FRP] [aluminum] [or approved material] that attach into the sidewalls of the water control structure. [Galvanize or epoxy coat carbon steel frames as per AWWA C563.] Provide anchors which match the frame material and provide dielectric insulators to secure the guide frame into the surrounding water control structure. As necessary, coat anchors to inhibit corrosion.

2.1.1 Design Requirements

****

NOTE: A factor of safety of 5 is suggested based on the typical response of FRP composites under sustained loads. This can be adjusted based on the site conditions of the structure and the associated risks. The design life is the same as HSS, but it should be noted that FRP composites do not have the performance data needed to calibrate design codes. Thus, the determination of the parameters that affect the design life would be based on the judgment of the designer of record.

****

The water control structure must be designed in accordance with this specification to achieve the objectives of constructability, safety, serviceability, with due regard to issues of inspectability, and economy. The structural system must be proportioned and detailed to ensure the development of significant and visible inelastic deformations at the strength and extreme event limit states before failure. Load-path redundant structures should be used unless there are compelling reasons to not do so.

Submit design documentation showing the water control structure is capable of meeting a factor of safety of [5] [_____] defined as the ratio of ultimate stress to the working or allowable stress using allowable stress design prior to commencement of work. Maximum sustained stress cannot exceed one-fifth of failure stress and account for creep and the effects of water adsorption. Design life should be assumed to be [100] [_____] years assuming routine inspection and maintenance. All design computations are to be stamped by a registered professional engineer who will be identified as the Engineer of Record. All design computations must also be initialed by an additional registered professional engineer who will be identified in the design documents as having provided design quality control. See paragraph 3.5.2 "Data Book" for additional requirements."

2.1.1.1 Mechanical Anchorage

Mechanical anchorage system to be designed to meet the load requirements as outlined in ASCE 7-16 and paragraph 1.10.1 Design Parameters. Anchorage calculations are stamped by a Registered Professional Engineer. Expansion anchors are not permitted.

2.1.2 Performance Requirements

****

NOTE: Delete columns as appropriate based on gate type. Leakage requirements should only be included for instances where leakage is considered a critical issue. Leakage tests can be performed in the shop or in the field, though testing may not be practical based on the size and head on the gate.

****

Submit documentation including [Slide Gate][Stop Log] Technical Data Sheet showing the full gate system is capable of meeting the following performance requirements prior to commencement of work.

Test	Vertical Lift Gates	Stoplogs
[Leakage (AWWA C563)]	[Less than 1.3 lpm/m 0.1 gpm/ft of seating perimeter]	[Less than 0.62 lpm/m 0.05 gpm/ft of seating perimeter]
Gate Deflection	Less than 1/720 of the gate width at maximum head water	Less than 1/360 of the gate width, max of 6.4 mm 1/4 inch at maximum head water
Yoke Deflection	Less than 1/360 of the gate width, max 6.4 mm 1/4 inch at maximum head water	[not applicable]

2.2 MANUFACTURED UNITS

Miscellaneous materials and standard articles must conform to the respective standards or specifications below when that type of material is furnished. Where material requirements are not specified, materials furnished must be suitable for the intended use and are subject to approval. Submit date and type of manufacture including constituent materials. Submit materials variances for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.1 Bolts, Nuts and Washers

Provide bolts, nuts, and washers of the material, grade, type, class, style and finish indicted or best suited for the intended use.

2.2.1.1 Bolts

Where the use of high strength bolts is required, the materials, workmanship, and installation must conform to the applicable provisions of ASTM F3125/F3125M and RCSC A348. Bolts for low-temperature applications must conform to ASTM A320/A320M. Bolts for non-high strength applications must conform to the applicable provisions of ASTM A307, Grade A.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.1.2 Nuts

All nuts to be used with high strength bolts must conform to ASTM A563 and ASME B18.2.2

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.1.3 Washers

All nuts must be equipped with washers. Washers to be used with high strength bolts must conform to ASTM F436/F436M. Plain washers must conform to ASME B18.22M or ASME B18.21.1, Type B as applicable. Lock washers must conform to ASME B18.21.1.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2 Anchorage

****

NOTE: For most jobs, ASTM F1554 248 MPa 36 ksi anchor bolts are used. If high tensile loads are anticipated, the designer should consider the use of 379 MPa 55 ksi or 724 MPa 105 ksi ASTM F1554 anchor bolts. If stainless steel is considered, the designer should select from material in ASTM A193/A193M.

****

2.2.2.1 Anchor Rods

ASTM F1554 [Stainless steel Gr 36 [55] [105], Class 1A [2A].

ASTM A193/A193M.]

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2.2 Anchor Nuts

ASTM A563, Grade A, hex style. [Stainless steel ASTM A193/A193M.]

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2.3 Anchor Washers

ASTM F844. [Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M.]

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2.4 Anchor Plate Washers

ASTM A36/A36M [Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M.]

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.2.2.5 [Sleeve Anchors][Adhesive Anchors]

Provide [_____] mm [_____] inch diameter [sleeve anchors][adhesive anchors]. Minimum concrete embedment must be [_____] mm [_____] in. Design values listed must be as tested according to ASTM E488/E488M.

a. Minimum [ultimate][allowable] pullout value: [_____] kN [_____] lb.

b. Minimum [ultimate][allowable] shear value: [_____] kN [_____] lb.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.3 EQUIPMENT

[Provide [manual] [powered] actuators to lift the gate as per AWWA C563]. [Provide lifting beams and storage racks for stop logs.]

2.4 MATERIALS

Miscellaneous materials and standard articles must conform to the respective standards or specifications below when that type of material is furnished. Where material requirements are not specified, materials furnished must be suitable for the intended use and are subject to approval. Submit materials variances for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.1 FRP Composites

****

NOTE: A wide range of strength properties for FRP composites are possible and depend on the fiber volume fraction, resin type, cross section, and manufacturing method. There is no need to specify a minimum design strength, as the manufacturer must design the low-head water control structure to meet the specified requirement. A manufacturer could use a weak material in bulk, or smaller quantities of a much stronger material. The key for the government is to ensure that the strength of the supplied FRP composite meets or exceeds the design values.

For reference, pultruded FRP composite structural shapes often have tensile, compressive and flexural strength design values at ultimate around 207 Mpa 30 ksi and tensile modulus around 17.2 Kpa 2.5 Msi in the lengthwise direction. Pultruded plates range from one half to two thirds of these values. FRP rods and bars are often two to three times stronger than structural shapes in tension and flexural. Properties of honeycomb members, sandwich panels and other shapes made via process other than pultrusion can vary significantly.

****

Submit documentation showing FRP composites meet the material properties used in the design as per the applicable [ASTM] [_____] test requirements. [Submit samples to permit verification testing for FRP composites made via hand-layup].

Submit documentation showing that FRP composites show no evidence of damage including breaks, cracks, blistering, delamination, exposure of fibers, or combination thereof, after being subjected to ASTM D4329 or ASTM G154 for a minimum of 720 hours.

Allowable visual defects of FRP Composite members must meet conditions as per ASTM D4385 for pultruded members, Level II of ASTM D2563 for laminates or a similar appropriate specification for other types of FRP composites. Dimensional tolerances for pultruded components must meet ASTM D3917.

2.4.2 Structural Steel

****

NOTE: If structural steel is not permitted to be used, omit this section.

****

Use non-fracture critical steel members conforming to ASTM A36/A36M or ASTM A992/A992M.

Use fracture critical steel members conforming to ASTM A709/A709M, Grade 50 (F) for temperature Zone 2 or ASTM A992/A992M, Grade 50 with a minimum average Charpy V-Notch (CVN) impact test value of 34 N-m 25 ft-lbs when tested at 4.4 degrees Celsius 40 degrees Fahrenheit.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.3 Stainless Steel

****

NOTE: If stainless steel is not permitted to be used, omit this section.

****

Use stainless steel bars and shapes conforming to ASTM A276/A276M, UNS [S20910,] [S30400,] [S40500,] [S31600,] [_____] Condition A, hot-finished or cold-finished, Class C; or ASTM A564/A564M, UNS [S17400,] [S45000,] Condition A, age-hardened heat treatment, hot-finished or cold-finished, Class C.

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.4 Aluminum

****

NOTE: If aluminum is not permitted to be used, omit this section.

****

Use aluminum bars and shapes conforming to [ASTM B209][ASTM B308/B308M][_____].

Submit variances of these suggested materials for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.5 Rubber Seals

****

NOTE: If fluorocarbon (Teflon) clad seals are not used, omit paragraphs FABRICATION OF RUBBER SEALS AND TESTING OF RUBBER SEALS.

****

Use [fluorocarbon (Teflon) clad rubber seals of the mold type only] [compounded of natural rubber, synthetic polyisoprene, or a blend of both, and must contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers]. Submit documentation showing the seals meet the following requirements prior to commencing work:

PHYSICAL TEST	TEST VALUE	TEST METHOD
Tensile Strength	17.2 MPa 2500 psi (min.)	ASTM D412
Elongation at Break	450 percent (min.)	ASTM D412
300 percent	6.2 MPa 900 psi (min.)	ASTM D412

PHYSICAL TEST	TEST VALUE	TEST METHOD
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
Water Absorption	5 percent by weight (max.)	ASTM D471
Compression Set	30 percent (max.)	ASTM D395
Tensile Strength (after aging 48 hrs)	80 percent of tensile strength (min.)	ASTM D572

The "Water Absorption" test must be performed with distilled water. The washed specimen must be blotted dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees 158 degrees F plus of minus 4 degrees F for 22 hours plus or minus 1/4 hour. The specimen must then be removed, allowed to cool to room temperature in air, and weighed. The weight must be recorded to the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D471). The immersion temperature must be 70 degrees C plus or minus 1 degree 158 degrees F plus of minus 2 degrees F and the duration of immersion is to be 166 hours.

Rubber seals must have a fluorocarbon film vulcanized and bonded to the sealing surface of the bulb. The film must be [0.726 mm] [1.524 mm] [0.030 inch] [0.060 inch] thick Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and must have the following physical properties:

Tensile strength	13.8 MPa 2,000 psi (min.)
Elongation	250 percent (min.)

The outside surface of the bonded film must be flush with the surface of the rubber seal and be free of adhering or bonded rubber. Strips and corner seals must be molded in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, the fluorocarbon film must be masked during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

Submit variances of these suggested materials and test methods for engineering review and subsequent approval by the Contracting Officer or their authorized representative.

2.4.6 Ultrahigh Molecular Weight Polyethylene (UHMWPE)

****

NOTE: If UHMWPE is not permitted to be used, omit this section.

****

If used, ultrahigh molecular weight polyethylene (UHMWPE) must conform to the following physical properties:

PROPERTY	TEST VALUE (+/- 10 percent)	TEST METHOD
Specific gravity	0.93 g/cm3 0.034 lbs/in3 (minimum)	ASTM D792
Tensile strength	27.6 Mpa 4,000 psi (minimum)	ASTM D638
Durometer	D68 (minimum)	ASTM D2240
Coefficient of friction	0.20 (maximum)	ASTM D1894

If the UHMWPE material is to be exposed to sunlight, the material must be stabilized for ultraviolet radiation via 2.5 percent carbon black or other equivalent stabilizer. The fabricated form must be from virgin resin. The virgin resin must be a homopolymer of ethylene and have an intrinsic viscosity (IV) between 22.0 and 28.0 dl/g per ASTM D4020.

2.5 FABRICATION

Follow the ACMA Code for pultruded FRP composites.

2.5.1 Drawings and Specifications

Submit detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, conforming to the specified requirements [_____] days prior to starting fabrication. The structure design is communicated to the Government through the required submittals designated in these specifications. All information necessary to fabricate the structure as intended in the design is depicted in these documents. Denote failure critical members on all drawings with the abbreviation FC. Denote fracture critical members on all drawings with the abbreviation FCM. The notation of FC and FCM on the drawings provides critical information to the Government for the structural response of the structure. Drawings must not be reproductions of the Government furnished contract drawings.

2.5.2 Fabrication Drawings

Fabrication drawings must show complete details of materials, dimensions, tolerances, connections.

2.5.3 Fabrication Tolerances

Measure dimensions by an approved measuring system. Submit the measuring system for approval with the work plan (i.e. calibrated steel tape of approximately the same temperature as the material being measured). The overall dimensions of an assembled structural unit must be within the tolerances indicated on the drawings or as specified for the item of work. Where tolerances are not specified in other section of these specifications or shown, a variation of 0.8 mm 1/32-inch is permissible in the overall length of component members with both ends milled and component members without milled ends must not deviate from the dimensions shown by not more than 1.6 mm 1/16-inch for members 3.7 meters 12 feet or less in length.

2.5.4 Delivery Drawings

Delivery drawings must provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit certified material test reports with all material delivered to the site. Tests, inspections, and verifications for materials and fabricated items must conform to the requirements specified.

2.6.1 General

Tests, inspections, and verifications for materials must conform to the specified requirements. Submit certified test reports for material tests, with all materials delivered to the site.

2.6.2 Inspection

****

NOTE: This paragraph must be edited to fit the project.

****

Inspect shop assembled components for accurate fit and compliance with dimensional tolerances. Sealing, guiding, and connecting surfaces must be inspected to determine if their planes are true, parallel, and in uniform contact with opposing surfaces.

2.6.3 Operation Tests Prior to Installation

****

NOTE: This paragraph is only applicable to slide gates.

****

[The operation of the shop-assembled gate assembly must be tested by opening and closing the gate several times by use of the operating machinery. The force used to operate the gate must be the minimum required to open and close the gate. Since the sill of the unembedded gate frame is not fully supported during the operation tests, special precaution must be taken to prevent the application of excessive force on the gate leaf and frame when the gate is closed. The operation of the lifting beam must be tested by engaging and disengaging the lifting beam several times. Adjustments must be made as required until operations are satisfactory as determined by the Contracting Officer or their approved representative.]

****

NOTE: The shop hydrostatic leakage test outlined below may not be practical due to the size or head requirements of the gate. This test should only be required if gate leakage is considered a critical issue.

****

[The gate assembly must be tested hydrostatically prior to installation by applying a hydrostatic pressure of [_____] Mpa [_____] psi, measured at the sill of the gate frame, to the upstream side of the gate leaf in the closed position. Under hydrostatic testing, the gate seals must prevent water leakage meeting paragraph 2.1.2.]

PART 3 EXECUTION

3.1 EXAMINATION

Gate will be inspected when delivered to site. When Government inspections result in product rejection, promptly segregate and remove rejected material from the premises. The Government may also charge an additional cost of inspection or testing when prior rejection makes re-inspection or retesting necessary.

3.2 PREPARATION

3.2.1 Protection

Protect the surrounding water control structure to prevent damage during the installation of the gate. Install temporary water control structures if replacing an existing gate to ensure water control is maintained.

3.3 INSTALLATION

Installation must conform to the requirements specified. Gate and appurtenant items must be assembled for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Bearing surfaces requiring lubrication must be thoroughly cleaned and lubricated with an approved lubricant before assembly and installation. Submit certification of installation. Submit Certification of State Product Approval.

3.4 FIELD QUALITY CONTROL

3.4.1 Tests

****

NOTE: The field leakage test outlined below may not be practical due to the size or head requirements of the gate. This test should only be required if gate leakage is a critical issue. Consideration should be given to the ability to apply head to the gate in the field.

****

[Conduct a field leakage test including [operating the gate][removing and replacing stoplogs] to ensure the as-built gate meets the requirements of paragraph 2.1.2.]

3.5 CLOSEOUT ACTIVITIES

3.5.1 Demonstration and Training

Demonstrate gate operation and provide training for [USACE] [owner] [_____] employees for a maximum [8] [_____] hours.

Provide an operation and maintenance manual to [USACE] [owner] [_____].

3.5.2 Data Book

Compile and maintain a "Data Book" throughout the duration of the contract. The "Data Book" consists of copies of all Requests for Information (RFI's) with Government responses, Material Orders, Mill

Certification Reports and Certification Letter's. Use tabs to separate each specific item identified above and a Table of Contents to identify which tab corresponds to which item. The in-progress "Data Book" must be available to the Government to review during shop inspections of the project.

When final revisions have been completed, prepare a "Certificate of Conformance" on their company letterhead certifying that: 1) all materials and workmanship included in the project were detailed, designed, manufactured, tested, inspected and documented as specified in the contract requirements; and 2) the requirements of applicable codes, standards, specifications and drawings have been complied with and that all required quality assurance documentation verify conformance to the contract documents have been submitted, signed by the Contractor's Quality Control System Manager and Engineer of Record.

Submit a draft copy of Final "Data Book" for review and approval within fifteen (15) calendar days following the completion of fabrication activities. Within thirty (30) calendar days of receipt of the Final "Data Book", the Government will return one copy annotated with any necessary corrections. Within fourteen (14) calendar days the Contractor must revise the "Data Book" accordingly at no extra cost and submit the Final Copy of the Final "Data Book" including the "Certificate of Conformance" to the Government. Approval and acceptance of the Final "Data Book" is required before final payment to the Contractor.

3.6 WARRANTY

****

NOTE: For USACE projects, delete the first two subparagraphs and utilize the tailored option.

****

3.6.1 Manufacturer's Warranty

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

3.6.2 Contractor's Warranty for Installation

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

3.6.3 Contractor's Five (5) Year No Penal Sum Warranty

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY FOR COMPOSITE LOW-HEAD WATER CONTROL STRUCTURE
STRUCTURE DESCRIPTION:
STRUCTURE NUMBER:
CORPS OF ENGINEERS CONTRACT NUMBER:
CONTRACTOR
CONTRACTOR:
ADDRESS:
POINT OF CONTACT:
TELEPHONE NUMBER:
OWNER
OWNER:
ADDRESS:
POINT OF CONTACT:
TELEPHONE NUMBER:
CONSTRUCTION AGENT
CONSTRUCTION AGENT:
ADDRESS:
POINT OF CONTACT:
TELEPHONE NUMBER:

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
COMPOSITE LOW-HEAD WATER CONTROL STRUCTURE
(continued)

The composite low head water control structure or component installed on the above named structure is warranted by [_____] for a period of [5][10][20] [_____] years against workmanship and material deficiencies, wind damage and structural failure within project specified design loads[, and leakage exceeding paragraph 2.1.2]. The composite low-head water control structure and components covered under this warranty includes, but is not limited to, the following:

Framing and structural members, opening mechanisms including motors, storage racks, accessories, trim, miscellaneous closure items, connectors, components, and fasteners, and other system components and assemblies installed to enable operation of the composite low-head water control structure; and items specified in other sections of these specifications that become part of the composite low-head water control structure.

All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads and water leaks must be repaired as approved by the contracting officer.

All material deficiencies, structural failure, and leakage associated with the composite low-head water control structure covered under this warranty must be repaired as approved by the contracting officer.

This warranty covers the entire cost of repair or replacement, including all material, labor, and related markups. The above referenced warranty commenced on the date of final acceptance on [_____] and will remain in effect for stated duration from this date.

Signed, dated, and notarized (by company president)

____

(Company President)   (Date)

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 20 16.33 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16.33 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 35 20 16.33

HYDRAULIC MITER GATES

08/22

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PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-35 20 16.33 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16.33 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 35 20 16.33

HYDRAULIC MITER GATES

08/22

****

NOTE: This guide specification covers the requirements for the fabrication, assembly, delivery, and installation of miter gates and appurtenant items as specified and shown. This section was originally developed for USACE Civil Works projects.

Certain components of a Miter Gate may be considered fracture critical. These components may include the gudgeon hood, gudgeon anchorage, diagonals, as well as others. AWS D1.1 does not include provisions for fracture critical welding. The Designer should consider using guide specification SECTION 05 59 20 FABRICATION OF HYDRAULIC STEEL STRUCTURES for specifying fracture-critical welding utilizing a Fracture Control Plan. A Fracture Control Plan and the use of appropriate materials and welding is required by ER 1110-2-8157, "Responsibility for Hydraulic Steel Structures."

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

Select Alternate 1 (one pay item) or Alternate 2 (two pay items). Delete all paragraphs of Alternate not selected.

****

1.1.1 Furnishing and Installing Miter Gates

****

NOTE: Alternate 1.

****

1.1.1.1 Payment

Payment is made for costs associated with furnishing and installing miter gates and appurtenant items, which includes full compensation for the materials, fabrication, delivery, installation, and testing of miter gates and appurtenant items including gate leaves, diagonals, strut connections, miter guides, miter latches, recess latch strikes, quoin and miter contact blocks, gudgeon top anchorages, pintle assemblies, [walkways,] [bridgeways,] gudgeon embedded anchorages, wall quoins, sill assemblies, seal assemblies, recess latches, bumpers, fenders, and all other items necessary for complete installation.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Furnishing Miter Gates

****

NOTE: Alternate 2.

****

1.1.2.1 Payment

Payment is made for costs associated with furnishing miter gates and appurtenant items, which includes full compensation for the materials, fabrication, and delivery of miter gates and appurtenant items including gate leaves, diagonals, strut connections, miter guides, miter latches, recess latch strikes, quoin and miter contact blocks, gudgeon top anchorages, pintle assemblies, [walkways,] [bridgeways,] gudgeon embedded anchorages, wall quoins, sill assemblies, seal assemblies, recess latches, bumpers, fenders, and other items necessary for complete installation.

1.1.2.2 Unit of Measure

Unit of Measure: lump sum.

1.1.3 Installing Miter Gates

****

NOTE: Alternate 2.

****

1.1.3.1 Payment

Payment is made for costs associated with the installation of miter gates and appurtenant items, which includes full compensation for the complete installation and testing of miter gates and appurtenant items.

1.1.3.2 Unit of Measure

Unit of measure: lump sum.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M6	(2024) Brands Used on Preservative Treated Materials

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM B6	(2023) Standard Specification for Zinc
ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D413	(1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate

ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D572	(2004; R 2019) Rubber Deterioration by Heat and Oxygen
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D3019	(2008) Lap Cement Used with Asphalt Roll Roofing Non Fibered, Asbestos Fibered, and Non Asbestos Fibered
ASTM D4020	(2011) Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 9.01	(1982; E 2004) Cold-Applied Asphalt Mastic Painting System with Extra-Thick Film

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Diagonals Prestressing Plan; G, [_____]

Gudgeon Embedded Anchorage; G, [_____]

Fabrication Drawings; G, [_____]

Shop Assembly Drawings; G, [_____]

Delivery Drawings; G, [_____]

Field Installation Drawings; G, [_____]

Stress Relieving Plan; G, [_____]

Fracture Control Plan (FCP); G, [_____]

Handling Attachments And Pick Points; G, [_____]

SD-03 Product Data

Materials

Gudgeon Embedded Anchorage

SD-04 Samples

Materials; G, [_____]

SD-06 Test Reports

Diagonals Prestressing Records

Tests, Inspections, and Verifications

SD-07 Certificates

Epoxy Filler

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Welders

Provide qualification of welders and welding operators conforming to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

1.5 DELIVERY, STORAGE, AND HANDLING

Perform delivery, handling, and storage of materials and fabricated items in accordance with the requirements specified [herein and] in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. [Unload material and equipment delivered to the site as approved by the Contracting Officer. Verify the condition and quantity of the items delivered and acknowledge receipt and condition thereof in writing to the Contracting Officer. If delivered items are damaged or a shortage is determined, notify the Contracting Officer of such in writing within 24 hours after delivery.]

1.5.1 Rubber Seals

Store rubber seals in a place which permits free circulation of air, maintains a temperature of 20 degrees C 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Keep rubber seals free of oils, grease, and other materials which would deteriorate the rubber. Do not distort rubber seals during handling.

[1.5.2 Epoxy Filler

Deliver epoxy filler from the manufacturer just prior to use in the work to insure receipt of recently manufactured material and store under cover, out of direct sunlight, at a temperature between 20 to 30 degrees C 65 to 85 degrees F.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

Submit detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, conforming to the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.1.1.1 Fabrication Drawings

Show on the fabrication drawings complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.1.1.2 Shop Assembly Drawings

Show on the shop assembly drawings details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.1.1.3 Delivery Drawings

Show on the delivery drawings descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.1.1.4 Field Installation Drawings

Show on the field installation drawings a detailed description of the field installation procedures. Include in the description the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; plan for prestressing gate leaf diagonals, including descriptions of connections, riggings, anchorages, and measuring equipment; methods for installing quoin and miter blocks, including checking and maintaining alignments of the blocks during concreting and placement of [epoxy] [zinc] filler; [procedures and equipment used for heating and placing of the zinc filler;] and methods for installing other appurtenant items.

2.2 MATERIALS

Submit system of identification which shows the disposition of specific lots of approved materials and fabricated items in the work, before completion of the contract. Ensure materials orders, materials lists and materials shipping bills conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Submit approved samples prior to use of the represented materials or items in the work. Submit samples of standard and shop fabricated items that are both full size and complete as required for installation in the work. Approved samples may be installed in the work provided each sample is clearly identified and its location recorded.

2.2.1 Metals

****

NOTE: Consider the use of ASTM A709/A709M steel for fabrication of all steel components. A709 material is available in 36 ksi and 50 ksi and provides improved toughness and maximum yield to tensile ratios to ensure ductile performance.

****

Ensure structural steel, steel forgings, steel castings, stainless steel, bronze, aluminum bronze and other metal materials used for fabrication conform to the requirements shown and specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.2.1.1 Structural Steel

Conform to [ASTM A36/A36M][ASTM A572/A572M][ASTM A992/A992M][ASTM A709/A709M].

2.2.1.2 Structural Steel Plates

Conform to [ASTM A36/A36M] [ASTM A572/A572M, Grade 50] [ASTM A709/A709M, Grade 50].

2.2.1.3 Steel Pipe

Conform to ASTM A53/A53M, Type S, Grade B, seamless, black, nominal size and weight class or outside diameter and nominal wall thickness as shown, [plain] [threaded] [threaded and coupled] ends.

2.2.1.4 Stainless Steel Bars and Shapes

Conform to ASTM A276/A276M, UNS [S 20910,] [S 30400,] [S 40500,] Condition A, hot-finished or cold-finished, Class C; or ASTM A564/A564M, UNS [S 17400,] [S 45000,] Condition A, age-hardened heat treatment, hot-finished or cold-finished, Class C.

2.2.1.5 Stainless Steel Plate, Sheet, and Strip

Conform toASTM A240/A240M, UNS [S 20910,] [S 30400,] [S 40500,]. Finish plates by hot-rolling, annealing or heat-treating, and blast-cleaning or pickling. Provide No. 1 sheet and strip finish.

2.2.2 Rubber Seals

Provide rubber seals that are [fluorocarbon (Teflon) clad rubber seals of the mold type only, and] compounded of natural rubber, synthetic polyisoprene, or a blend of both, and contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers.

2.2.2.1 Physical Characteristics

Ensure seals exhibit physical characteristics that meet the following requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	20.7 MPa3,000 psi (min.)	ASTM D412
Elongation at Break	500 percent (min.)	ASTM D412
300 percent Modulus	6.9 MPa1,000 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
*Water Absorption	5 percent by weight (max.)	ASTM D471
Compression Set	30 percent (max.)	ASTM D395, Method B
Tensile Strength (after aging 48 hrs)	80 percent tensile strength (min.)	ASTM D572

Perform the "Water Absorption" test using distilled water. Blot the washed specimen dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees for 22 plus or minus 1/4 hour. Remove the specimen and allow to air cool to room temperature, and weigh the specimen. Record the weight the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D471). Ensure the immersion temperature is 70 degrees C plus or minus 1 degree and the immersion duration is at least 166 hours.

[2.2.2.2 Fabrication of Rubber Seals

Provide rubber seals with a fluorocarbon film that is vulcanized and bonded to the sealing surface of the bulb. Ensure the film thickness is [0.762] [1.524] mm [0.030] [0.060] inch and is Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and has the following physical properties:

Tensile strength	13.8 MPa2,000 psi (min.)
Elongation	250 percent (min.)

Flush the outside surface of the bonded film with the surface of the rubber seal and ensure it is free of adhering or bonded rubber. Mold strips and corner seals in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, mask the fluorocarbon film during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

][2.2.3 Epoxy Filler

Use epoxy filler that is an approved epoxy resin formulation equal to "Loctite Nordback," a product of Hennkel Adhesives, or an approved equal, with a specific gravity of 1.90 to 1.95, minimum compressive strength after 72 hours at 20 degrees C 70 degrees F of 89.6 MPa 13,000 psi, and maximum shrinkage of 0.15 percent. Submit Manufacturer's certificate for epoxy filler stating that it meets or exceeds the specified physical properties; Deliver material to the site.

][2.2.4 Zinc Filler

2.2.4.1 Material

Comply with ASTM B6.

[2.2.4.2 Safety Provisions for Zinc Filler

The following special safety provisions are required for heating and placing zinc filler:

a. Ensure workers wear protective clothing including hard hats with fine wire mesh screen, goggles, leather sleeves, chaps, apron, and leather gloves.

b. Ensure workers wear air-line respirators certified by National Institute for Occupational Safety and Health (NIOSH) or Mine Safety and Health Administration (MSHA). In enclosed spaces, both local exhaust ventilation and air-line respirators are required. Provide local exhaust ventilation consisting of movable hoods placed close to the work to remove fumes at the source.

c. Pre-heat ladles, equipment, and material before being used so they are moisture-free.

d. Place heating devices and ladles on a level, firm foundation, and protected against traffic, accidental tipping, or similar hazard.

e. Do not carry hot zinc up or down ladders.

f. Use buckets or vessels handling and transporting hot zinc that are substantially constructed and fill them higher than 100 mm 4 inches from the top.

]][2.2.5 Bumpers and Fenders

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NOTE: Designer should consult ERDC-CERL TR-17-37 "Material Selection for Bumpers and Fenders for Lock Gates and Guidewalls" prior to specifying Bumpers and Fenders. The designer needs to evaluate the specifics each installation prior to selecting a material. Selection should be based on relative merit in terms of selection criteria such as first cost, frequency and duration of lock closures for repairs, ability to protect the gate, ability to survive impact(s), weather resistance, maintainability and aesthetics.

****

Provide rubber bumpers and fenders designed specifically for a marine environment.

2.2.5.1 HDPE Bumpers and Fenders

Provide High Density Polyethylene (HDPE) fenders that are [_____] in color, [with four (25cm1 in) diameter fiberglass bars embedded in the fender cross section]. Ensure provided fenders include an ultraviolet stabilizer. Provide fenders with actual dimensions of [_____] by [_____] (cmin).

2.2.5.2 Timber Bumpers and Fenders

Provide timber fenders and bumpers conforming to [Douglas Fir/Douglas Fir-Larch] [No. 2 southern yellow pine], structural grade, dressed surfacing, pressure treated with waterborne preservative. Cut, beveled, or bored fenders as required before pressure treatment. Ensure all waterborne preservative treatment used is in accordance with AWPA Standard to the requirements of Use Category [UC4C for Fresh Water Use] [UC5C for Salt Water Use], except that chromated zinc chlorides, pentachlorophenol-ammoniacal systems, and alkyl ammonium compounds are not allowed. Ensure the producer brands each piece of treated lumber or timber in accordance with AWPA M6. It is the Contractor's responsibility to ensure the quality of treated wood products complies with this specification.

2.2.5.3 UHMW-PE Bumpers and Fenders

Provide composite section fender pads fabricated from ultra-high molecular weight polyethylene (UHMW-PE) plastic on top of a rubber or synthetic rubber backing. Ensure the final cross section complies with the dimensional requirements shown on the drawings. Ensure the lengths of fenders and bolting patterns also comply with the contract drawings. Cut and bevel the ultra-high molecular weight polyethylene material to the cross-sectional dimensions shown on the drawings. Provide bumpers and fenders that are yellow in color. Ensure the UHMW-PE is manufactured with a maximum of 50 percent regenerated material; and with a molecular weight of 3,000,000 to 5,000,000, in accordance with ASTM D4020, compression molded, stress relieved, and including an ultraviolet manufactured by Solidur Plastics Company, 200 Industrial Drive, Rte. 66 North, Delmont, PA 15626, or "ULTRA FEND" as manufactured by Ultra-Poly, Inc., 2926 South Steel Street, Tacoma, WA 98409 Physical characteristics of the UHMW-PE are required to meet the following:

a. Static Coefficient of Friction to Steel (Dry) - less than 0.25
b. Specific Gravity - greater than 0.92 (ASTM D792)
c. Water Absorption - do not show water absorption under long term immersion (ASTM D570)
d. Izod Impact - fender must exhibit a non-breaking condition under Izod type impact test (ASTM D256)
e. Tensile Strength - minimum break tensile strength of 4,000 psi (ASTM D638)
f. Hardness - 65-70 Durometer (ASTM D2240)

Provide extruded rubber backing materials compounded of natural or synthetic polyisoprene or a blend of both and ensure it contains reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers.

PHYSICAL TEST	TEST VALUE	SPECIFICATION
Tensile Strength	3,000 psi (min.)	ASTM D412
Elongation at Break	450 percent (min.)	ASTM D412
300 Percent Modulus	900 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60-70	ASTM D2240
Water Absorption	5 percent by Weight (Max.)	ASTM D471
Compression Set	30 percent (Max.)	ASTM D395
Tensile Strength (after aging 48 hr.)	80 percent (Min.)	ASTM D572

* Perform the "Water Absorption" test with distilled water. Blot the washed specimen dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees for 22 plus or minus 1/4 hour. Remove the specimen, allow to cool to room temperature in air, and weigh the specimen. Record the weight to the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D471). Ensure the immersion temperature is 70 degrees C plus or minus 1 degree. Perform the immersion for 166 hours. Follow the method of attaching the rubber backing to the structure as indicated on the contract drawings.

]2.2.6 Asphalt Saturated Preformed Filler Strips

Comply with ASTM D1751.

2.2.7 Asphalt Cement

Comply with ASTM D3019.

2.2.8 Asphalt Mastic

Comply with SSPC PS 9.01.

2.3 MANUFACTURED UNITS

Ensure bolts, nuts, washers, screws and other manufactured units conform with the requirements shown and specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.3.1 Bolts, Nuts and Washers

Ensure high-strength bolts, nuts, and washers conform to ASTM F3125/F3125M, Grade A325, [hot-dip galvanized]. Ensure bolts, nuts, studs, stud bolts and bolting materials other than high-strength conform to ASTM A307, Grade A, [hot-dip galvanized] or ASTM A320/A320M, [Ferritic Steel, Grade [_____]] [Austenitic Steel, Grade [_____], Class [_____]]. Use bolts M16 1/2 inch and larger that have hexagon heads. Ensure the finished shank of bolts is long enough to provide full bearing. Use washer with bolts that conform to the requirements specified in the applicable specification for bolts.

2.3.2 Screws

Provide screws of the type indicated on the drawings.

2.4 FABRICATION

2.4.1 Structural Fabrication

Ensure all structural fabrications conform with the requirements shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop-fabricated of the materials specified and shown. Ensure dimensional tolerances comply with the specifications and as shown on the drawings. Splices are only allowed where shown or approved. Bore pin holes in components after welding, straightening, stress-relieving, and threading operations are completed. Brackets, eye bar sections, and other components requiring straightening are only to be straightened by methods which do not damage the material. Press-fit bronze bushings with supporting components. Provide bolt connections, lugs, clips, or other pick-up assembly devices for components as shown and required for proper assembly and installation. Make provisions for the installation of [cathodic protection system devices and other] appurtenances as required.

2.4.2 Welding

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NOTE: List applicable welds requiring radiographic examination.

NOTE: Specification Section 05 50 14 STRUCTURAL

METAL FABRICATIONS includes welds subjected to Ultrasonic Testing (UT), Dye Penetrant Testing (PT) and Magnetic Testing (MT). AWS D1.1 does not specify nondestructive testing of any completed weld. Designer must take this into account and specify any Nondestructive Testing (NDT) requirements as well as specifying which welds are to be subjected to nondestructive testing.

The designer is to consider whether any components included are likely to be fracture critical. Fracture critical components should be identified as requiring fabrication in accordance with a Fracture Control Plan.

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Ensure welding conforms to the requirements of AWS D1.1/D1.1M, AWS D1.2/D1.2M, the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide welds of the types shown on the contract drawings and approved detail drawings. Radiographic examination is required on the major shop and field welds of the type and location indicated on the drawings and as follows: [_____]. Welds which have been designated to receive radiographic examination and are found to be inaccessible to a radiation source or film, or are otherwise so situated that radiographic examination is not feasible may be examined, with written approval, by dye penetrant, magnetic particle tests, or ultrasonic tests. All components are to be stress-relief heat treated after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances. Submit a Stress Relieving Plan for approval which follows the minimum requirements for thermal stress relief in accordance with AWS D1.1.[Stress-relief heat treat all components after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances.][Refer to Specification SECTION 05 50 14 STRUCTURAL METAL FABRICATIONS for nondestructive testing requirements.][Submit a Fracture Control Plan (FCP) for fracture critical components.]

2.4.3 Bolted Connections

Ensure bolted connections conforms to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.4 Machine Work

Ensure machine work conforms to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.5 Miscellaneous Provisions

Ensure miscellaneous provisions for fabrication conforms to the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.6 Fabrications

2.4.6.1 Gate Leaf

Gate leaf is to be constructed from welded structural steel fabrication consisting of horizontal girders, [vertical beams,] [vertical girders,] intercostals, diaphragms, quoin post, gudgeon pin hood, operating strut connections, skin plate, and adjustable diagonals. Shop fabricate all gate leaves. The Contracting Officer's approval is required for any contractor proposed shop-fabrication of gate leaf in separate segments in order to facilitate handling and shipping. Show all such information on approved detail drawings. Such segments are required to permit easy field-assembly and be limited to as few as practicable to minimize the number of joints to be field-welded. Ensure the overall height of the gate leaf does not vary from the nominal dimension or differ from the mating gate leaf by more than 6 mm 1/4 inch. Ensure the surfaces of framing elements to which skin plates are to be welded do not vary from a true plane by more than 5 mm 3/16 inch. The outside surfaces of skin plates welded to framing members do not vary from a true plane by more than 5 mm. 3/16 inch. Locate splices in skin plates only where shown or approved. [In addition to welds specifically indicated on the drawings for nondestructive testing, conduct nondestructive testing on [_____] percent of the welds in the girders, gudgeon pin hood, verticals and skin plate of the gate leaf. The Contracting Officer will determine the location of these additional welds for testing.] Provide complete gate leaf with quoin and miter contact [blocks] [posts], miter guide assembly, pintle assembly, gudgeon anchorage, seal assembly, and other appurtenant components as required for complete installation, specified herein and shown.

2.4.6.2 Wall Quoin

Supply wall quoins fabricated from a welded structural steel frame with adjustable stainless steel base anchors and adjustable stainless steel quoin contact [block] [post].

2.4.6.3 Quoin and Miter Contact [Blocks] [Posts]

Supply quoin and miter contact [blocks] [posts] fabricated from stainless steel bars conforming to ASTM A276/A276M or ASTM A564/A564M. Make splices in contact [blocks] [posts] by an offset method so that there is no continuous joint across the [block] [post]. [Splices in gate leaf contact [block] [post] are only allowed to occur at the centerlines of horizontal girders.] Ensure splice locations match those of the opposing [block] [post]. Mill the contact faces of contact [blocks] [posts] at splices to assure watertight joints. Prove contact [blocks] [posts] with adjusting bolts as shown.

2.4.6.4 Pintle Assembly

Pintle assemblies consist of pintle socket, pintle, and pintle base as shown. Fabricate pintle socket from cast nickel alloys. Press fit pintle sockets with an aluminum bronze bushing with bearing surfaces finished truly hemispherical. Fabricate pintle from [cast alloy] [forged alloy] steel with bearing surfaces of corrosion-resisting steel. Provide pintle ball with a 0.4 micrometer 16 microinch finish and fit the ball into the bushing by scraping until uniform contact is attained over the entire bearing surface as determined by testing with carbon paper or other approved coloring. Match-mark the pintle ball with the bushing when fitted and so erected in the field. Fabricate the pintle base from cast steel. Drill and ream bolt holes for attaching pintle socket to gate leaf after the pintle socket is assembled with gate leaf. Connect pintle socket to the bottom of the lower girder web of the gate leaf with stainless steel bolts.

2.4.6.5 Gudgeon Anchorage

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NOTE: The engineer is required to specify and select all ASTM A668 materials greater than 4 inches in thickness based on their specific grades and classes of materials (A through L). Note that material of classes G and higher are quenched and tempered and therefore difficult to weld.

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Gudgeon anchorages are required to consist of gudgeon pin barrel, gudgeon anchorage links, gudgeon pin, and gudgeon embedded anchorage. Fabricate gudgeon pin barrel from welded [structural steel plates] [forged alloy steel plates conforming to ASTM A668/A668M] and fit them with a bronze bushing. Provide gudgeon anchorage links and gudgeon pins fabricated from forged alloy steel conforming to ASTM A668/A668M. Connect gudgeon anchorage links by a pin to the gudgeon embedded anchorage and provide a threaded section for adjustment of the gate leaf. Provide the threaded section with both right and left threads, a hexagonal sleeve nut with 13 mm 1/2 inch threads, and a jam nut with standard threads at each end of the sleeve nut. Fabricate the gudgeon embedded anchorage from a structural steel frame with end-restrained anchor bolts conforming to ASTM F3125/F3125M.

2.4.6.6 Seal Assemblies

Provide seal assemblies consisting of rubber seals, stainless steel retainer and spacer bars, and fasteners. Provide rubber that continuous over the full length. Accurately fit and drill all seals for proper installation. Drill bolt holes in the rubber seals by using prepared templates or the retainer bars as templates. Fully mold splices in seals and develop a minimum tensile strength of 50 percent of the unspliced seal strength. Place splices only at shown locations. Shop vulcanize all splices. Locate vulcanized splices between molded corners and straight lengths as close to the corners as practicable. Place splices on a 45 degree bevel related to the "thickness" of the seal. Ensure all finished splice surfaces are smooth and free of irregularities. Field-splice stainless steel retainer bars only where shown and machine-finished after splicing.

2.4.6.7 Appurtenant Items

Sill assemblies, latches, bumpers fenders, seal plates and shapes, and other appurtenant items per the details specified and shown.

2.4.7 Shop Assembly

Shop assembly requirements for miter gates and appurtenant items are shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Completely shop assemble miter gates and appurtenant items, unless otherwise approved by the Contracting Officer, to assure satisfactory field installation. Fit and bolt adjoining components together to facilitate field connections. Carefully preserve the match-marking of unassembled items until the items are assembled. Cover mating surfaces and machined surfaces with a rust preventative until assembly. Shop-welded assembled components in their final positions as much as delivery and field installation conditions permit. Fit and drill rubber seals to match the seal retainers, match-marked, and removed for shipment. Perform shop assembly and disassembly work in the presence of the Contracting Officer unless otherwise approved by the Contracting Officer; however, the presence of the Contracting Officer does not relieve the Contractor of any responsibility under this contract.

2.5 COMPONENTS

2.5.1 Cathodic Protection System

Conform to Section 26 42 19.00 10 CATHODIC PROTECTION SYSTEMS (IMPRESSED CURRENT) FOR LOCK MITER GATES.

2.5.2 Operating Machinery

Conform to Section 35 01 41.00 10 ELECTROMECHANICAL OPERATING MACHINERY FOR LOCKS AND DAMS.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit certified test reports for material tests with all materials delivered to the site.

2.6.1 General

Perform tests, Inspections, and Verifications for materials the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.6.2 Testing of Rubber Seals

Test the fluorocarbon film of rubber seals for adhesion bond in accordance with ASTM D413 using either the machine method or the deadweight method. Cut a 25 mm 1 inch long piece of seal from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. Ensure there is no separation between the fluorocarbon film and the rubber when subjected to the following loads:

THICKNESS OF FLUOROCARBON FILM	MACHINE METHOD AT 50 MM2 INCHES PER MINUTE	DEADWEIGHT METHOD
0.762 mm0.030 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width
1.524 mm0.060 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width

PART 3 EXECUTION

3.1 INSTALLATION

Installation per the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Assemble miter gates and appurtenant items for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Thoroughly clean and lubricate bearing surfaces requiring lubrication with an approved lubricant before assembly and installation. Ensure components to be field-welded are placed in correct alignment before welding is commenced. Design and submit handling attachments and pick points required to be added to any specified items herein prior to installation.

3.1.1 Embedded Metals

Accurately install sill assemblies, seal plates, frames, bases and other embedded metal items required for proper and complete installation to the alignment and grade required to ensure accurate fitting and matching of components. Primer coat all embedded metals with the required paint on all surfaces prior to installation in concrete forms. Install anchors for embedded metals as shown. Attach items requiring two concrete pours for installation to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour. Grind smooth welded field splices in sealing surfaces of embedded items.

3.1.2 Pintle Assembly

Embed base anchors for the pintle assembly in first-pour concrete. Attach the pintle assembly base plate to base anchors, adjusted to the exact elevation and center-to-center distance shown, leveled, blocked rigidly to prevent displacement, and embedded in second-pour concrete. Allow the concrete to set 72 hours and to reach a minimum compressive strength of [_____] MPa psi before loading is applied. [Fill the space in the floating pintle base not occupied by the pintle shoe completely with sponge rubber before the gate leaf is set in place.]

3.1.3 Gudgeon Embedded Anchorage

Submit gudgeon embedded anchorage prestressing plan for approval prior to initiating the anchorage operations. Submit gudgeon embedded anchorage prestressing records prior to completion of the contract. Cover the gudgeon embedded anchorage, except for anchor bolts and horizontal anchor arms, with asphalt saturated preformed strips applied with asphalt cement prior to being embedded in concrete. Coat anchor bolts with asphalt mastic. Align, level and block rigidly into place the gudgeon embedded anchorage to prevent displacement before concrete is placed. Place concrete in a manner not to damage the preformed strips. Prestress anchor bolts after the concrete has attained the specified strength in accordance with contract drawings and approved field installation drawings. Compile and submit a record of the gudgeon embedded anchorage prestressing operations immediately after completion of the prestressing operations.

3.1.4 Wall Quoin

Embed base anchors for the wall quoin in first-pour concrete. Attach the wall quoin to base anchors prior to setting the gate leaf in place. After the gate leaf is set in place, plumb and adjust the wall quoin in relation to the gate leaf quoin so as to provide for continuous contact between the sealing surfaces of the wall and gate leaf quoin contact [blocks] [posts] over the full height of the gate leaf. Make this adjustment almost entirely by moving the wall quoin so that the gap for the [epoxy] [zinc] filler behind the gate leaf quoin contact [block] [post] remains near the nominal dimension. After final adjustments have been made, the wall quoin firmly and place the second-pour concrete in the blockout.

3.1.5 Gate Leaf

Assemble gate leaf components not assembled in the shop in the field as required for installation. Coat the pintle ball with grease prior to setting the gate leaf in place. Tap pintle grease pipes into pintle bushing in correct register with bushing grease grooves. Flush grease pipes prior to connecting to bearings. Take all necessary precautions to avoid distortion of the gate leaf or any component parts. Exercise special care during installation to prevent any sag of the miter ends of the gate leaf due to compression of blocking or other causes. After the gate leaf has been set in place and the components of gudgeon anchorage are connected to the gate leaf, plumb the gate leaf and bring it into correct position by adjusting the sleeve nuts of the diagonals and the gudgeon anchorage links.

3.1.6 Diagonals

Attach gate leaf diagonals to the gate leaf after the leaf is set in place. Perform diagonals prestressing before the final adjustment of the quoin and miter contact [blocks] [post] are made. Prestress diagonals as specified, shown, and as approved on the Diagonals Prestressing Plan developed by the Contractor. Submit approved diagonal prestressing plan prior to initiating the prestressing operations. Submit diagonals prestressing records immediately after completion of the prestressing operations. Within the plan for prestressing the diagonals, describe the method of prestressing, including the materials, connections, rigging, anchorages, and stress measuring equipment. Compile a record of the prestressing operations consisting of the information indicated in the following table:

STRESS DATA TABLE					
Gate Leaf Location:				Date:	
	1	2	3	4	5
Diagonal	Strain Gage Initial	Readings Final	E (mm)(in.)	D (mm)(in.)	d (mm)(in.)
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

1. Collect initial strain gage readings after slack is removed.

2. Collect final strain gage readings after prestressing is complete.

3. E is the total elongation over the full length of the diagonal, computed from the strain gage readings.

4. D is the prestress deflection of the leaf as shown on the drawings.

5. d is the field deflection of the leaf measured after completion of the prestress operation; it is the deflection when final strain gage readings are taken.

3.1.7 Gate Leaf Quoin and Miter Contact [Blocks] [Posts]

After the wall quoin has been adjusted and concreted in place and final adjustments made to the gudgeon anchorage links, adjust the gate leaf quoin and miter contact [blocks] [posts] to provide continuous contact over the full height of the gate leaf in the mitered position. After the gate leaf diagonals are prestressed and final adjustments of gate leaf quoin and miter contact [blocks] [posts] have been made with the gate leaf in the mitered position, swing the gate leaf out of miter and [epoxy] [zinc] pour filler behind the quoin and miter contact [blocks] [posts]. Prior to pouring of the filler, ensure the surfaces to receive the filler are cleaned free of dirt, rust, and other foreign materials. Coat the adjusting and holding bolts with grease or other bond breaker to prevent adherence of the filler.

3.1.7.1 Placing [Epoxy] [Zinc] Filler

[Conduct a field test to determine the indentation hardness of the epoxy filler compound prior to placement. The field test procedures are as follows:

a. Cast a 50 mm 2 inch cube sample of mixed epoxy filler compound in a mold and cure at room temperature (20 to 25 degrees C 70 to 80 degrees F) for 24 plus or minus 8 hours.

b. Remove from mold and cut sample to expose interior surface.

c. Sand exposed interior surfaces to remove saw marks and provide a smooth surface.

d. Using a Type D Durometer conforming to ASTM D2240, measure the hardness across the exposed interior surface, taking a minimum of three readings on each half of the sample. Care must be taken during the durometer reading to insure the spring loaded pin used to penetrate the surface is not in a depressed surface caused by either residual saw marks or an exposed air bubble. The average reading should be at least 85, with no individual reading below 82. Durometer readings which fall below the required minimum values is grounds for the rejection of material.

Explicitly follow the manufacturer's instructions for placing the epoxy filler. Take special precautions to prevent leakage of the filler during placement. Ensure complete masses of all metals whose surface areas are to receive the epoxy filler have a temperature of 15 to 30 degrees C 60 to 90 degrees F. Keep the epoxy filler free from moisture or other foreign materials during mixing and placement and for at least 48 hours after placement.]

[Immediately preceding the pouring of the zinc filler, pre-heat the adjacent metal components to a temperature of 100 to 150 degrees C212 to 300 degrees F by an approved method which does not buckle the metal components. Pour the zinc filler at a temperature which insures that it completely fills all interstices. Maintain the pouring temperature of zinc filler between 430 and 480 degrees C 810 and 900 degrees F to minimize volatilization and oxidation of the zinc.]

3.1.7.2 Adjusting Contact [Blocks] [Posts]

After the [epoxy has set] [zinc has cooled], draw the quoin and miter contact [blocks] [posts] up against the filler by tightening the adjusting bolts. After the contact [blocks] [posts] are adjusted, swing the gate leaves into the mitered position without interference of the quoin contact [blocks] [posts] and ensure the gate leaf quoin contact [block] [post] makes tight contact with the wall quoin contact [block] [post].

3.1.8 Miter Guide

Install miter guide after the contact [blocks] [posts] have been properly set. Mount the guide bracket and roller bracket on gate leaves with leaves in the mitered position. Center the roller accurately in the saddle of the contact [blocks] [posts] and ensure it is in full contact with the [blocks] [posts]. Adjust the miter guide by adjusting the guide bracket and roller bracket so that the gap behind the contact [blocks] [posts] for the [epoxy] [zinc] filler is kept at the nominal dimension. Proper adjustment of the brackets results in either gate leaf to be mitered or opened without moving the other leaf. After final adjustments have been made, drill bolt holes in the brackets and gate leaves, bolt the brackets securely in place, and place [epoxy] [zinc] filler behind the contact [blocks] [posts].

3.1.9 Painting

Paint all exposed parts of gates and appurtenances except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in concrete, [cathodic protection system anodes,] and other specified surfaces as specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.1.10 Seal Assemblies

Install rubber seal assemblies after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Securely fasten rubber seals to metal retainers. Before operating the gate(s), apply a suitable lubricant to the rubber seal rubbing plates to protect the rubber.

3.2 FIELD QUALITY CONTROL

Non-Destructive testing of field welds is required to meet the same quality control requirements as shop-welded components.

3.3 SYSTEM START-UP

3.3.1 Trial Operation

After completion of the gate installation, conduct an examination of the gates in the presence of the Contracting Officer for final acceptance. First examine the gates to determine whether or not the workmanship conforms to the specification requirements. Operate the gates from the fully-opened to the fully-closed position a sufficient number of times to demonstrate to the Contracting Officer's satisfaction that all parts are functioning properly. The workmanship in the fabrication and installation of gates is the result in a condition where when the gates are in the closed position watertight barrier is formed across the opening. The contractor is required to make all repairs or replacements to correct defects, as determined by the Contracting Officer, at no cost to the Government. Repeat the trial operation after defects are corrected. Prior to final acceptance of the gates, provide temporary restraints to prevent unauthorized operation of the gates.

3.4 PROTECTION

Protect finished work per the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 20 16.39 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16 39 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 20 16.39

HYDRAULIC SECTOR GATES

08/22

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-35 20 16.39 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16 39 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 35 20 16.39

HYDRAULIC SECTOR GATES

08/22

****

NOTE: This guide specification covers the requirements for the fabrication, assembly, delivery, and installation of sector gates and appurtenant items. This section was originally developed for USACE Civil Works projects.

Certain components of a Sector Gate may be considered fracture critical. These components may include the gudgeon hood, gudgeon anchorage, diagonals, as well as others. AWS D1.1 does not include provisions for fracture critical welding. The Designer should consider using guide specification SECTION 05 59 20 FABRICATION OF HYDRAULIC STEEL STRUCTURES for specifying fracture-critical welding utilizing a Fracture Control Plan. A Fracture Control Plan and the use of appropriate materials and welding is required by ER 1110-2-8157, "Responsibility for Hydraulic Steel Structures."

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

Select Alternate 1 (one pay item) or Alternate 2 (two pay items). Delete all paragraphs of Alternate not selected.

****

1.1.1 Furnishing and Installing Sector Gates and Appurtenant Items

****

NOTE: Alternate 1.

****

1.1.1.1 Payment

Payment is to be made for costs associated with furnishing and installing sector gates and appurtenant items, which includes full compensation for the materials, fabrication, delivery, installation, and testing of sector gates and appurtenant items including gate leaves, pintle assemblies, hinge assemblies, seal assemblies, [walkways,] [bridgeways,] bumpers, fenders, and other items necessary for complete installation.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Furnishing Sector Gates and Appurtenant Items

****

NOTE: Alternate 2.

****

1.1.2.1 Payment

Payment is to be made for all costs associated with furnishing sector gates and appurtenant items, which includes full compensation for the materials, fabrication, and delivery of sector gates and appurtenant items including gate leaves, pintle assemblies, hinge assemblies, seal assemblies, [walkways,] [bridgeways,] bumpers, fenders, and other items necessary for complete installation.

1.1.2.2 Unit of Measure

Unit of Measure: lump sum.

1.1.3 Installing Sector Gates and Appurtenant Items

****

NOTE: Alternate 2.

****

1.1.3.1 Payment

Payment is to be made for costs associated with the installation of sector gates and appurtenant items, which includes full compensation for the complete installation and testing of sector gates and appurtenant items.

1.1.3.2 Unit of Measure

Unit of measure: lump sum.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M6	(2024) Brands Used on Preservative Treated Materials

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM B22/B22M	(2017) Standard Specification for Bronze Castings for Bridges and Turntables
ASTM B148	(2024) Standard Specification for Aluminum-Bronze Sand Castings
ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact

	Resistance of Plastics
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D413	(1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D572	(2004; R 2019) Rubber Deterioration by Heat and Oxygen
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D4020	(2011) Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 9.01	(1982; E 2004) Cold-Applied Asphalt Mastic Painting System with Extra-Thick Film

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, [_____]

Shop Assembly Drawings; G, [_____]

Delivery Drawings; G, [_____]

Field Installation Drawings; G, [_____]

Stress Relieving Plan; G, [_____]

Fracture Control Plan (FCP); G, [_____]

Handling Attachments and Pick Points; G, [_____]

SD-03 Product Data

Materials

Pintle Base Anchor Frame

Pintle Base

Hinge Assembly Embedded Anchorages

SD-04 Samples

Materials; G, [_____]

SD-06 Test Reports

Tests, Inspections, and Verifications

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Welders

Provide qualification of welders and welding operators conforming to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

1.5 DELIVERY, STORAGE, AND HANDLING

Perform delivery, handling, and storage of materials and fabricated items in accordance with the requirements specified [herein and] in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. [Unload material and equipment delivered to the site as approved by the Contracting Officer. Verify the condition and quantity of the items delivered and acknowledge receipt and condition thereof in writing to the Contracting Officer. If delivered items are damaged or a shortage is determined, notify the Contracting Officer of such in writing within 24 hours after delivery.]

1.5.1 Rubber Seals

Store rubber seals in a place which permits free circulation of air, maintains a temperature of 20 degrees C 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Keep rubber seals free of oils, grease, and other materials which would deteriorate the rubber. Do not distort rubber seals during handling.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

Submit detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, conforming to the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.1.1.1 Fabrication Drawings

Show on the fabrication drawings complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.1.1.2 Shop Assembly Drawings

Show on the shop assembly drawings details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.1.1.3 Delivery Drawings

Show on the delivery drawings descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.1.1.4 Field Installation Drawings

Provide field installation drawings showing a detailed description of the field installation procedures. Include in the description the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; plan for prestressing hinge bracket anchors, to include descriptions of connections, riggings, anchorages, and measuring equipment; methods for installing pintle and hinge assemblies, including checking and maintaining alignments during concreting; and methods for installing other appurtenant items.

2.2 MATERIALS

Submit system of identification which shows the disposition of specific lots of approved materials and fabricated items in the work, before completion of the contract; and materials orders, materials lists, and materials shipping bills in conformance with the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.2.1 Metals

****

NOTE: Consider the use of ASTM A709/A709M steel for fabrication of all steel components. A709 material is available in 36 and 50 ksi and provides improved toughness and maximum yield to tensile ratios to ensure ductile performance.

****

Ensure structural steel, steel forgings, steel castings, stainless steel, bronze, aluminum-bronze, and other metal materials used for fabrication conform to the requirements shown and specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.2.1.1 Structural Steel Shapes

[ASTM A36/A36M][ASTM A572/A572M][ASTM A709/A709M][ASTM A992/A992M].

2.2.1.2 Structural Steel Plates

[ASTM A36/A36M][or][ASTM A572/A572M, Grade 50][or][ASTM A709/A709M, Grade 50].

2.2.1.3 Steel Pipe

[ASTM A53/A53M, Type S, Grade B, seamless, black, normal size and weight class or outside diameter and nominal wall thickness as shown, [plain] [threaded] [threaded and coupled] ends.] [ASTM A501/A501M, seamless, outside diameter and nominal wall thickness as shown.]

2.2.1.4 Steel Castings

ASTM A27/A27M, Grade [_____], Class [_____]; or ASTM A148/A148M, Grade [_____].

2.2.1.5 Steel Forgings

ASTM A668/A668M, Class [_____], carbon content not exceeding 0.35 percent, and chemical composition which results in satisfactory weldability.

2.2.1.6 High-Strength Steel Bar

ASTM A722/A722M, Type [_____], and complying with all supplementary requirements.

2.2.1.7 Stainless Steel Bars and Shapes

ASTM A276/A276M, UNS [S 20910,] [S 30400,] [S 40500,] Condition A, hot-finished or cold-finished, Class C; or ASTM A564/A564M, UNS [S 17400,] [S 45000,] Condition A, age-hardened heat treatment, hot-finished or cold-finished, Class C.

2.2.1.8 Stainless Steel Plate, Sheet, and Strip

ASTM A240/A240M, UNS [S 20910,] [S 30400,] [S 40500,]. Finish plates by hot-rolling, annealing or heat-treating, and blast-cleaning or pickling. Provide sheet and strip with No. 1 finish.

2.2.1.9 Bronze Castings

ASTM B22/B22M, Copper Alloy UNS No. C91300.

2.2.1.10 Aluminum-Bronze Castings

ASTM A148/A148M, Copper Alloy UNS No. [_____].

2.2.2 Rubber Seals

Provide rubber seals that are [fluorocarbon (Teflon) clad rubber seals of the mold type only, and] compounded of natural rubber, synthetic polyisoprene, or a blend of both, and contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers.

2.2.2.1 Physical Characteristics

Ensure seals exhibit physical characteristics that meet the following requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	20.7 MPa3,000 psi (min.)	ASTM D412
Elongation at Break	500 percent (min.)	ASTM D412
300 percent Modulus	6.9 MPa1,000 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
*Water Absorption	5 percent by weight (max.)	ASTM D471

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Compression Set	30 percent (max.)	ASTM D395, Method B
Tensile Strength (after aging 48 hrs)	80 percent tensile strength (min.)	ASTM D572

Perform the "Water Absorption" test using distilled water. Blot the washed specimen dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees for 22 plus or minus 1/4 hour. Remove the specimen and allow to air cool to room temperature, and weigh the specimen. Record the weight the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D471). Ensure the immersion temperature is 70 degrees C plus or minus 1 degree and the immersion duration is at least 166 hours.

[2.2.2.2 Fabrication of Rubber Seals

Provide rubber seals with a fluorocarbon film that is vulcanized and bonded to the sealing surface of the bulb. Ensure the film thickness is [0.762] [1.524] mm [0.030] [0.060] inch and is Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and has the following physical properties:

Tensile strength	13.8 MPa2,000 psi (min.)
Elongation	250 percent (min.)

Flush the outside surface of the bonded film with the surface of the rubber seal and ensure it is free of adhering or bonded rubber. Mold strips and corner seals in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, mask the fluorocarbon film during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

]2.2.3 Bumpers and Fenders

****

NOTE: Designer should consult ERDC-CERL TR-17-37 "Material Selection for Bumpers and Fenders for Lock Gates and Guidewalls" prior to specifying Bumpers and Fenders. The designer needs to evaluate the specifics each installation prior to selecting a material. Selection should be based on relative merit in terms of selection criteria such as first cost, frequency and duration of lock closures for repairs, ability to protect the gate, ability to survive impact(s), weather resistance, maintainability and aesthetics.

****

Provide rubber bumpers and fenders designed specifically for a marine environment.

2.2.3.1 HDPE Bumpers and Fenders

Provide High Density Polyethylene (HDPE) fenders that are [_____] in color, [with four (25cm1 in) diameter fiberglass bars embedded in the fender cross section]. Ensure provided fenders include an ultraviolet stabilizer. Provide fenders with actual dimensions of [_____] by [_____] (cmin).

2.2.3.2 Timber Bumpers and Fenders

Provide timber fenders and bumpers conforming to [Douglas Fir/Douglas Fir-Larch] [No. 2 southern yellow pine], structural grade, dressed surfacing, pressure treated with waterborne preservative. Cut, beveled, or bored fenders as required before pressure treatment. Ensure all waterborne preservative treatment used is in accordance with AWPA Standard to the requirements of Use Category [UC4C for Fresh Water Use] [UC5C for Salt Water Use], except that chromated zinc chlorides, pentachlorophenol-ammoniacal systems, and alkyl ammonium compounds are not allowed. Ensure the producer brands each piece of treated lumber or timber in accordance with AWPA M6. It is the Contractor's responsibility to ensure the quality of treated wood products complies with this specification.

2.2.3.3 UHMW-PE Bumpers and Fenders

Provide composite section fender pads fabricated from ultra-high molecular weight polyethylene (UHMW-PE) plastic on top of a rubber or synthetic rubber backing. Ensure the final cross section complies with the dimensional requirements shown on the drawings. Ensure the lengths of fenders and bolting patterns also comply with the contract drawings. Cut and bevel the ultra-high molecular weight polyethylene material to the cross-sectional dimensions shown on the drawings. Provide bumpers and fenders that are yellow in color. Ensure the UHMW-PE is manufactured with a maximum of 50 percent regenerated material; and with a molecular weight of 3,000,000 to 5,000,000, in accordance with ASTM D4020, compression molded, stress relieved, and including an ultraviolet manufactured by Solidur Plastics Company, 200 Industrial Drive, Rte. 66 North, Delmont, PA 15626, or "ULTRA FEND" as manufactured by Ultra-Poly, Inc., 2926 South Steel Street, Tacoma, WA 98409 Physical characteristics of the UHMW-PE are required to meet the following:

a. Static Coefficient of Friction to Steel (Dry) - less than 0.25
b. Specific Gravity - greater than 0.92 (ASTM D792)
c. Water Absorption - do not show water absorption under long term immersion (ASTM D570)
d. Izod Impact - fender must exhibit a non-breaking condition under Izod type impact test (ASTM D256)
e. Tensile Strength - minimum break tensile strength of 4,000 psi (ASTM D638)
f. Hardness - 65-70 Durometer (ASTM D2240)

Provide extruded rubber backing materials compounded of natural or synthetic polyisoprene or a blend of both and ensure it contains reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers.

PHYSICAL TEST	TEST VALUE	SPECIFICATION
Tensile Strength	3,000 psi (min.)	ASTM D412

PHYSICAL TEST	TEST VALUE	SPECIFICATION
Elongation at Break	450 percent (min.)	ASTM D412
300 percent Modulus	900 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60-70	ASTM D2240
Water Absorption	5 percent by Weight (Max.)	ASTM D471
Compression Set	30 percent (Max.)	ASTM D395
Tensile Strength (after aging 48 hr.)	80 percent (Min.)	ASTM D572

* Perform the "Water Absorption" test with distilled water. Blot the washed specimen dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees for 22 plus or minus 1/4 hour. Remove the specimen, allow to cool to room temperature in air, and weigh the specimen. Record the weight to the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D471). Ensure the immersion temperature is 70 degrees C plus or minus 1 degree. Perform the immersion for 166 hours. Follow the method of attaching the rubber backing to the structure as indicated on the contract drawings.

2.2.4 Asphalt Mastic

SSPC PS 9.01.

2.3 MANUFACTURED UNITS

Ensure bolts, nuts, washers, screws and other manufactured units conform with the requirements shown and specified and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.3.1 Bolts, Nuts and Washers

Ensure high-strength bolts, nuts, and washers conform to ASTM F3125/F3125M, Grade A325, [hot-dip galvanized]. Ensure bolts, nuts, studs, stud bolts and bolting materials other than high-strength conform to ASTM A307, Grade A, [hot-dip galvanized] or ASTM A320/A320M, [Ferritic Steel, Grade [_____]] [Austenitic Steel, Grade [_____], Class [_____]]. Use bolts M16 1/2 inch and larger that have hexagon heads. Ensure the finished shank of bolts is long enough to provide full bearing. Use washer with bolts that conform to the requirements specified in the applicable specification for bolts.

2.3.2 Screws

Provide screws of the type indicated on the drawings.

2.4 FABRICATION

2.4.1 Structural Fabrication

Ensure structural fabrication conforms with the requirements shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop-fabricate the components of the materials specified and shown. Ensure dimensional tolerances are as specified and shown. Place splices only where shown or approved. Bore pin holes in components after welding, straightening, stress-relieving, and threading operations are completed. Straighten brackets, eye bar sections, and other components requiring straightening by methods which will not damage the material. Press-fit bronze bushings with supporting components. Provide bolt connections, lugs, clips, or other pick-up assembly devices for components as shown and required for proper assembly and installation. Make provisions for the installation of appurtenances as required.

Provide detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, conforming to the requirements specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.2 Welding

****

NOTE: List applicable welds requiring radiographic examination.

NOTE: Specification Section 05 50 14 STRUCTURAL METAL FABRICATIONS includes welds subjected to Ultrasonic Testing (UT), Dye Penetrant Testing (PT) and Magnetic Testing (MT). AWS D1.1 does not specify nondestructive testing of any completed weld. Designer must take this into account and specify any Nondestructive Testing (NDT) requirements as well as specifying which welds are to be subjected to nondestructive testing.

The designer is to consider whether any components included are likely to be fracture critical. Fracture critical components should be identified as requiring fabrication in accordance with a Fracture Control Plan.

****

Ensure welding conforms to the requirements of AWS D1.1/D1.1M, AWS D1.2/D1.2M, the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide welds of the types shown on the contract drawings and approved detail drawings. Radiographic examination is required on the major shop and field welds of the type and location indicated on the drawings and as follows: [_____]. Welds which have been designated to receive radiographic examination and are found to be inaccessible to a radiation source or film, or are otherwise so situated that radiographic examination is not feasible may be examined, with written approval, by dye penetrant, magnetic particle tests, or ultrasonic tests. All components are to be stress-relief heat treated after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances. Submit a Stress Relieving Plan for approval which follows the minimum requirements for thermal stress relief in accordance with AWS D1.1.[Stress-relief heat treat all components after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances.][Refer to Specification SECTION 05 50 14 STRUCTURAL METAL FABRICATIONS for nondestructive testing requirements.][Submit a Fracture Control Plan (FCP) for fracture critical components.]

2.4.3 Bolted Connections

Conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.4 Machine Work

Conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.5 Miscellaneous Provisions

Conform to the requirements specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.6 Fabrications

Submit approved samples, prior to use of the represented materials or items in the work. Provide full size, complete samples of standard and shop fabricated items as required for installation in the work. Approved samples may be installed in the work provided each sample is clearly identified and its location recorded. Ensure fabrications conform to the following requirements.

2.4.6.1 Gate Leaf

Fabricate the gate leaf of welded members except for bolted appurtenances. Include in the gate leaf construction a pintle socket, pipe column, and hinge pin housing integrally framed with horizontal and vertical trusses supporting vertical ribs faced with a continuous skin plate. Construct the pintle socket of cast steel conforming to ASTM A27/A27M. Press-fit pintle socket with bronze bushing conforming ASTM B22/B22M. Ensure all bearing surfaces of the bronze bushing have a truly hemispherical 0.4 micrometer 16 microinch finish. Fabricate the pipe column to conform to [ASTM A53/A53M] [ASTM A501/A501M]. Fabricate the hinge pin housing of [cast steel conforming to ASTM A27/A27M] [structural steel conforming to ASTM A36/A36M]. Fabricate trusses and vertical ribs of structural steel conforming to ASTM A36/A36M. Ensure skin plate conforms to [ASTM A36/A36M] [ASTM A572/A572M, Grade 50,]. Shop-fabricate the gate leaf. Obtain approval prior to shop-fabricating gate leaf in separate segments to facilitate handling and shipping. Show segmenting plan on approved detail drawings. Ensure such segments are constructed to permit easy field-assembly with as few sections as practicable to minimize the number of joints to be field-welded. Ensure the overall height of the gate leaf does not vary from the nominal dimension or differ from the mating gate leaf by more than 6 mm 1/4 inch. Ensure the surfaces of the vertical ribs to which skin plates are to be welded do not vary from a true plane by more than 5 mm 3/16 inch. Ensure the outside surfaces of skin plates welded to the vertical ribs do not vary from a true plane by more than 5 mm 3/16 inch. Locate splices in skin plates only where shown or approved. [In addition to welds specifically indicated on the drawings for nondestructive testing, include non-destructive testing for [_____] percent of the welds in the [hinge pin housing] [joints between trusses and pintle socket] [joints between trusses and hinge pin housing] [joints between vertical webs and skin plate] [and] skin plate. Obtain Contracting Officer's approval for the location of these additional welds for testing.] Provide the gate leaf complete with pintle assembly, hinge assembly, seal assembly, and other appurtenant components as required for complete installation as specified and shown.

2.4.6.2 Hinge Assembly

The hinge assembly consists of hinge bracket support anchor frame, hinge bracket support, hinge bracket, and hinge pin. Provide hinge bracket support anchor frame as a welded structural steel frame with high strength anchor bolts conforming to ASTM A722/A722M for prestressed anchorage of the hinge bracket support. Ensure hinge bracket support and hinge bracket are fabricated of [cast steel conforming to ASTM A27/A27M] [structural steel conforming to ASTM A36/A36M]. Fit the hinge pin barrel section of the hinge bracket with [a stainless steel collar conforming to ASTM A564/A564M and] [a bronze bushing conforming to ASTM B22/B22M] [an aluminum bronze bushing conforming to ASTM B148]. Fabricate the hinge pin of [forged steel conforming to ASTM A668/A668M] [stainless steel conforming to [ASTM A276/A276M] [ASTM A564/A564M]]. [In addition to welds specifically indicated on the drawings for nondestructive testing, perform nondestructive testing on [_____] percent of the welds in the hinge assembly components. Obtain the location of these additional welds for testing from the Contracting Officer.] [Stress-relieve the welded hinge assembly components by heat-treating after all welding is completed. Perform stress-relieving prior to machining.]

2.4.6.3 Pintle Assembly

The pintle assembly consists of pintle base anchor frame, pintle base, pintle socket seal retainer ring assembly, pintle, and pintle socket which are integral component of the gate leaf. Fabricate pintle base anchor frame as a welded structural steel frame [with high strength anchor bolts conforming to ASTM A722/A722M for prestressed anchorage of the pintle base]. Fabricate the pintle base of [cast steel conforming to ASTM A27/A27M] [structural steel conforming to ASTM A36/A36M]. Fabricate the pintle of [cast alloy steel] [forged alloy steel with bearing surfaces of corrosion-resisting steel deposited in weld passes to a thickness of not less than 3 mm 1/8 inch and machined the required shape]. Finish the pintle ball pintle with a 0.4 micrometer 16 microinch finish and that is fitted into the bushing of the pintle socket by scraping the bushing until uniform contact is attained over the entire bearing surface as determined by testing with carbon paper or other approved coloring. Match-mark the pintle ball with the bushing when fitted and so erected in the field.

2.4.6.4 Seal Assemblies

Provide seal assemblies consisting of rubber seals, stainless steel retainer and spacer bars, and fasteners. Ensure rubber seals are continuous over the full length. Fit and drill seals accurately fitted and drilled for proper installation. Drill bolt holes drilled in the rubber seals by using prepared templates or the retainer bars as templates. Fully mold splices in seals to develop a minimum tensile strength of 50 percent of the unspliced seal, and only at locations shown. Shop vulcanize all splices. Locate vulcanized splices between molded corners and straight lengths as close to the corners as practicable. Bevel splices on a 45 degree bevel related to the "thickness" of the seal. Finish the surfaces of splices smooth and free of irregularities. Field-splice stainless steel retainer bars only where shown and machine-finished them after splicing.

2.4.6.5 Appurtenant Items

Ensure seal plates, seal shapes, pintle socket seal retainer ring assembly, bumpers, fenders, [walkways,] [bridgeways,] and other appurtenant items conform to details specified and shown.

2.4.7 Shop Assembly

Ensure shop assembly requirements for sector gates and appurtenant items are as shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Completely shop assemble sector gates and appurtenant items, unless otherwise approved, to assure satisfactory field installation. Fit and bolt adjoining components together to facilitate field connections. Carefully preserve the match-marking of unassembled items until the items are assembled. Cover mating surfaces and machined surfaces with a rust preventive until assembly. Shop-weld assembled components in their final positions as much as delivery and field installation conditions will permit. Fit and drill rubber seals to match the seal retainers, match-marked, and removed for shipment. Perform shop assembly and disassembly in the presence of the Contracting Officer unless otherwise approved. Contractor's responsibilities under this contract are unaffected by the presence of the Contracting Officer.

2.5 COMPONENTS

2.5.1 Cathodic Protection System

conform the cathodic protection system to Section 26 42 19.00 10 CATHODIC PROTECTION SYSTEMS (IMPRESSED CURRENT)FOR LOCK MITER GATES.

2.5.2 Operating Machinery

Conform operating machinery to Section 35 01 41.00 10 ELECTROMECHANICAL OPERATING MACHINERY FOR LOCKS AND DAMS.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit certified test reports for material tests, with all materials delivered to the site.

2.6.1 General

Ensure tests, inspections, and verifications for materials conform to the requirements specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

[2.6.2 Testing of Rubber Seals

****

NOTE: If fluorocarbon (Teflon) clad seals are not used, delete this paragraph.

****

Test the fluorocarbon film of rubber seals for adhesion bond in accordance with ASTM D413 using either the machine method or the deadweight method. Cut a 25 mm 1 inch long piece of seal from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. Ensure there is no separation between the fluorocarbon film and the rubber when subjected to the following loads:

THICKNESS OF FLUOROCARBON FILM	MACHINE METHOD AT 50 MM2 INCHES PER MINUTE	DEADWEIGHT METHOD
1.524 mm0.030 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width
0.726 mm0.060 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width

]PART 3 EXECUTION

3.1 INSTALLATION

Installation per the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Assemble miter gates and appurtenant items for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Thoroughly clean and lubricate bearing surfaces requiring lubrication with an approved lubricant before assembly and installation. Ensure components to be field-welded are placed in correct alignment before welding is commenced. Design and submit Handling Attachments and Pick Points required to be added to any specified items herein prior to installation.

3.1.1 Embedded Metals

Accurately install sill assemblies, seal plates, frames, bases and other embedded metal items required for proper and complete installation to the alignment and grade required to ensure accurate fitting and matching of components. Primer coat all embedded metals with the required paint on all surfaces prior to installation in concrete forms. Install anchors for embedded metals as shown. Attach items requiring two concrete pours for installation to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour. Grind smooth welded field splices in sealing surfaces of embedded items.

3.1.2 Hinge Assembly Embedded Anchorages

Submit record of the prestressing of hinge bracket anchors immediately after completion of the prestressing operations. Accurately align, level, and rigidly block in place the hinge assembly embedded anchorages consisting of the hinge bracket support anchor frame and attached hinge bracket support anchor bolts in a manner to prevent displacement before concrete is placed. Coat hinge bracket support anchor bolts with asphalt mastic prior to the placement of first-pour concrete. Connect the hinge bracket support to anchor bolts and embed in second-pour concrete. Prestress anchor bolts as shown on contract drawings and approved field installation drawings after the concrete has attained the specified strength. Compile and submit a record of the prestressing operations to the Contracting Officer.

3.1.3 Pintle Base Anchor Frame and Pintle Base

****

NOTE: Design options provided in this paragraph consist of the pintle base bearing directly on an

anchor frame embedded in second-pour concrete and anchored with bolts embedded in first-pour concrete, the pintle base bearing directly on second-pour concrete and anchored with bolts attached to an anchor frame embedded in first-pour concrete, and the prestressing of pintle base anchor bolts when attached to an anchor frame embedded in first-pour concrete.
****

[Embed anchor bolts for the pintle base anchor frame in first-pour concrete. Submit record of the prestressing of the pintle base anchors immediately after the prestressing operations are completed. Attach the pintle base anchor frame to the anchor bolts, align, level, and block rigidly to prevent displacement, and embedded in second-pour concrete. Bolt pintle base to the pintle base anchor frame.] [Embed pintle base anchor frame in first-pour concrete. Attach pintle base to the pintle base anchor bolts extending from the embedded anchor frame, align, level, block rigidly to prevent displacement, and embed in second-pour concrete.] [Prestress pintle base anchor bolts as shown on contract drawings and approved field installation drawings. Compile and submit a record of the prestressing operations.] Allow concrete pours to set for 72 hours and ensure the specified strength has been attained before any loading is applied.

3.1.4 Pintle

Thoroughly clean the surfaces of the pintle base prior to installing the pintle. Set the pintle shaft in the pintle base and secure by lock-bolting.

3.1.5 Gate Leaf

Field-assemble gate leaf components not assembled in the shop as required for installation. Attach pintle socket seal retainer ring assembly to the pintle socket and coat the pintle ball with grease prior to setting the gate leaf in place. Tap pintle grease pipes into pintle bushing in correct register with bushing grease grooves. Flush grease pipes prior to connecting to bearings. Take all necessary precautions to avoid distortion of the gate leaf or any component parts. Exercise special care during installation to prevent any sag of the sector gate leaf due to compression of blocking or other causes.

3.1.6 Hinge Bracket and Hinge Pin

Attach the hinge bracket to the hinge bracket support after the gate leaf has been set in place. Insert the hinge pin to connect the hinge pin barrel of the hinge bracket to the hinge pin housing of the gate leaf. Adjust the hinge bracket so that the center of the hinge pin is in vertical alignment with the center of the pintle and each gate leaf swings without interference and any point on the moving gate leaf remain in a plane throughout the range of movement.

3.1.7 Painting

Paint exposed parts of gates and appurtenances, except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in concrete, [cathodic protection system anodes,] and other specified surfaces as specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.1.8 Seal Assemblies

Install rubber seal assemblies after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Fasten the rubber seals securely to metal retainers. Before operating the gates, apply a suitable lubricant to the rubber seal rubbing plates to protect the rubber.

3.2 FIELD QUALITY CONTROL

Non-Destructive Testing of field welds is required to meet the same quality control requirements as shop-welded components.

3.3 SYSTEM START-UP

3.3.1 Trial Operation

After completion of the gate installation, conduct an examination of the gates in the presence of the Contracting Officer for final acceptance. First examine the gates to determine whether or not the workmanship conforms to the specification requirements. Operate the gates from the fully-opened to the fully-closed position a sufficient number of times to demonstrate to the Contracting Officer's satisfaction that all parts are functioning properly. The workmanship in the fabrication and installation of gates is the result in a condition where when the gates are in the closed position watertight barrier is formed across the opening. The contractor is required to make all repairs or replacements to correct defects, as determined by the Contracting Officer, at no cost to the Government. Repeat the trial operation after defects are corrected. Prior to final acceptance of the gates, provide temporary restraints to prevent unauthorized operation of the gates.

3.4 PROTECTION

Protect finished work in conformance with the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 20 16.46 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16.46 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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HYDRAULIC TAINTER GATES AND ANCHORAGES

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USACE / NAVFAC / AFCEC **UFGS-35 20 16.46 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16.46 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 35 20 16.46

HYDRAULIC TAINTER GATES AND ANCHORAGES

08/22

****

NOTE: This guide specification covers the requirements for fabrication, assembly, delivery, and installation of Tainter gates, anchorage assemblies, and appurtenant items. This section was originally developed for USACE Civil Works projects.

Certain components of a Tainter Gate may be considered fracture critical. These components may include the gudgeon hood, gudgeon anchorage, diagonals, as well as others. AWS D1.1 does not include provisions for fracture critical welding. The Designer should consider using guide specification SECTION 05 59 20 FABRICATION OF HYDRAULIC STEEL STRUCTURES for specifying fracture-critical welding utilizing a Fracture Control Plan. A Fracture Control Plan and the use of appropriate materials and welding is required by ER 1110-2-8157, "Responsibility for Hydraulic Steel Structures."

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

Select Alternate 1 (one pay item) or Alternate 2 (two pay items). Delete all paragraphs of Alternate not selected.

****

1.1.1 Furnishing and Installing Tainter Gates, Appurtenant Items, and Tainter Gate Anchorage Assemblies

****

NOTE: Alternate 1.

****

1.1.1.1 Payment

Payment is made for costs associated with furnishing and installing Tainter Payment is to be made for costs associated with furnishing and installing Tainter gates, appurtenant items, and Tainter gate anchorage assemblies, which includes full compensation for materials, fabrication, shop assembly, delivery, and installation of Tainter gates, including gates, trunnions, trunnion yokes, trunnion pins; appurtenant items, including cable attachment brackets, seal assemblies, side seal plates, dogging brackets, sill beams, and stop beams; and Tainter gate anchorage assemblies, including Tainter gate trunnion girders and prestressing assemblies for anchoring trunnion girders to piers [and trunnion yokes to trunnion girders, and other items necessary for complete installation].

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Furnishing Tainter Gates, Appurtenant Items, and Tainter Gate Anchorage Assemblies

****

NOTE: Alternate 2.

****

1.1.2.1 Payment

Payment is made for costs associated with furnishing and installing Tainter Payment is to be made for costs associated with furnishing and installing Tainter gates, appurtenant items, and Tainter gate anchorage assemblies, which includes full compensation for materials, fabrication, shop assembly, delivery, and installation of Tainter gates, including gates, trunnions, trunnion yokes, trunnion pins; appurtenant items, including cable attachment brackets, seal assemblies, side seal plates, dogging brackets, sill beams, and stop beams; and Tainter gate anchorage assemblies, including Tainter gate trunnion girders and prestressing assemblies for anchoring trunnion girders to piers [and trunnion yokes to trunnion girders, and other items necessary for complete installation].

1.1.2.2 Unit of Measure

Unit of measure: lump sum.

1.1.3 Installing Tainter Gates, Appurtenant Items, and Tainter Gate Anchorage Assemblies

****

NOTE: Alternate 2.

****

1.1.3.1 Payment

Payment is made for costs associated with furnishing and installing Tainter Payment is to be made for costs associated with furnishing and installing Tainter gates, appurtenant items, and Tainter gate anchorage assemblies, which includes full compensation for materials, fabrication, shop assembly, delivery, and installation of Tainter gates, including gates, trunnions, trunnion yokes, trunnion pins; appurtenant items, including cable attachment brackets, seal assemblies, side seal plates, dogging brackets, sill beams, and stop beams; and Tainter gate anchorage assemblies, including Tainter gate trunnion girders and prestressing assemblies for anchoring trunnion girders to piers [and trunnion yokes to trunnion girders, and other items necessary for complete installation].

1.1.3.2 Unit of Measure

Unit of measure: lump sum.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes

ASTM B22/B22M	(2017) Standard Specification for Bronze Castings for Bridges and Turntables
ASTM B148	(2024) Standard Specification for Aluminum-Bronze Sand Castings
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C939/C939M	(2022) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C940	(2022) Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D413	(1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D572	(2004; R 2019) Rubber Deterioration by Heat and Oxygen
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, [_____]

Shop Assembly Drawings; G, [_____]

Delivery Drawings; G, [_____]

Field Installation Drawings; G, [_____]

Stress Relieving Plan; G, [_____]

Fracture Control Plan (FCP); G, [_____]

Handling Attachments and Pick Points; G, [_____]

SD-03 Product Data

Materials

Prestressing Assemblies

Grout Admixture

SD-04 Samples

Materials; G, [_____]

SD-06 Test Reports

Tests, Inspections, and Verifications

SD-07 Certificates

Anchorages and Couplers

Certification of Prestressing Technicians

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Welders

Provide qualification of welders and welding operators conforming to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

1.4.2 Certification of Prestressing Technicians

Submit certificates, for prestressing technicians who will use the proposed system in the work, 30 days prior to the start of prestressing operations certifying by name that the technicians are trained and skilled in the use of the proposed system.

1.5 DELIVERY, STORAGE, AND HANDLING

Perform delivery, handling, and storage of materials and fabricated items in accordance with the requirements specified [herein and] in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. [Unload material and equipment delivered to the site as approved by the Contracting Officer. Verify the condition and quantity of the items delivered and acknowledge receipt and condition thereof in writing to the Contracting Officer. If delivered items are damaged or a shortage is determined, notify the Contracting Officer of such in writing within 24 hours after delivery.]

1.5.1 Rubber Seals

Store rubber seals in a place which permits free circulation of air, maintains a temperature of 20 degrees C 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Keep rubber seals free of oils, grease, and other materials which would deteriorate the rubber. Do not distort rubber seals during handling.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

Submit detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, conforming to the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.1.1.1 Fabrication Drawings

Show on the fabrication drawings complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.1.1.2 Shop Assembly Drawings

Show on the shop assembly drawings details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.1.1.3 Delivery Drawings

Show on the delivery drawings descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.1.1.4 Field Installation Drawings

Show on the field installation drawings a detailed description of the field installation procedures. Include in the description the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; plan for prestressing gate leaf diagonals, including descriptions of connections, riggings, anchorages, and measuring equipment; methods for installing quoin and miter blocks, including checking and maintaining alignments of the blocks during concreting and placement of [epoxy] [zinc] filler; [procedures and equipment used for heating and placing of the zinc filler;] and methods for installing other appurtenant items.

2.2 MATERIALS

Submit a system of identification which shows the disposition of specific lots of approved materials and fabricated items in the work, before completion of the contract. Provide materials orders, materials lists, and materials shipping bills conforming with the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.2.1 Metals

****

NOTE: Consider the use of ASTM A709/A709M steel for fabrication of all steel components. A709 material is available in 36 and 50 ksi and provides improved toughness and maximum yield to tensile ratios to ensure ductile performance.

****

Provide structural steel, steel forgings, steel castings, stainless steel, bronze, aluminum-bronze, and other metal materials used for fabrication conforming with the requirements shown on the drawings and specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.2.1.1 Structural Steel Shapes

Conform to [ASTM A36/A36M][ASTM A572/A572M][ASTM A992/A992M][ASTM A709/A709M].

2.2.1.2 Structural Steel Plates

[ASTM A36/A36M][or][ASTM A572/A572M], Grade 50[ASTM A709, Grade 50].

2.2.1.3 Steel Pipe

[ASTM A53/A53M, Type S, Grade B, seamless, black, normal size and weight class or outside diameter and nominal wall thickness as shown on the drawings, [plain] [threaded] [threaded and coupled] ends.]

2.2.1.4 Steel Castings

ASTM A27/A27M, Grade [_____], Class [_____]; or ASTM A148/A148M, Grade [_____].

2.2.1.5 Steel Forgings

ASTM A668/A668M, Class [_____], carbon content not exceeding 0.35 per cent, and chemical composition which results in satisfactory weldability.

2.2.1.6 Stainless Steel Bars and Shapes

ASTM A276/A276M, UNS [S 20910,] [S 30400,] [S 40500,] Condition A, hot-finished or cold-finished, Class C; or ASTM A564/A564M, UNS [S 17400,] [S 45000,] Condition A, age-hardened heat treatment, hot-finished or cold-finished, Class C.

2.2.1.7 Stainless Steel Plate, Sheet, and Strip

ASTM A240/A240M, UNS [S 20910,] [S 30400,] [S 40500,]. Finish plates by hot-rolling, annealing or heat-treating, and blast-cleaning or pickling. Provide No. 1 grade sheet and strip finish.

2.2.1.8 Bronze Castings

ASTM B22/B22M, Copper Alloy UNS No. C91300.

2.2.1.9 Aluminum-Bronze Castings

ASTM B148, Copper Alloy UNS No. [_____].

2.2.1.10 Prestressing Steel Bar Tendons

ASTM A722/A722M, Type [_____], including Supplementary Requirements, except provide 180 degrees of bending for bend tests. Provide certified manufacturing records and test reports for tendons, identified with specific lots, and approved prior to use of tendons in the work. Include mixing casting, cooling, rolling, cold-stressing to 80 percent of the minimum ultimate strength, and stress-relieving for all manufacturing records. Include chemical analyses, mechanical properties testing and stress-strain curves, mechanical coupling demonstration, and product analyses of finished tendons representing each heat for all test reports.

2.2.1.11 Steel Bars for Concrete Reinforcement

Provide steel bars for concrete reinforcement other than steel bar prestressing tendons as specified in Section 03 23 00 STRESSED TENDON REINFORCING.

2.2.2 Anchorages and Couplers

Submit certificates for anchorages and couplers 30 days prior to the start of prestressing operations. Provide anchorages and couplers for prestressing tendons made of metal of proven corrosion resistance and compatibility with tendons and test by an approved method and certified to be capable of developing the minimum ultimate strength of tendons without excessive slip. Provide anchorages made of plate, bar, or other positive connecting type which allows complete placement and consolidation of concrete around and within its confines and exerts uniform bearing on the concrete. Provide couplers with housing or enclosures which are long enough to permit the necessary movements and fittings which allow complete grouting of all components.

2.2.3 Ducts

Provide ducts for encasing prestressing tendons of the type [shown on the drawings] [approved by the Contracting Officer]. Ensure ducts retain shape under the weight of concrete and prevent the entrance of cement paste from concrete.

2.2.4 Concrete

As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE [and Section 03 45 33 PRECAST[PRESTRESSED] STRUCTURAL CONCRETE].

2.2.5 Asphalt Mastic

Provide asphalt mastic in conformance with [_____].

2.2.6 Premolded Expansion Joint Sheets

As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.2.7 Gaskets for Seal Assemblies

Provide rubber gasket sheets for seal assemblies with nominal Shore A durometer value of [40][55][80] with dimensions as shown on the drawings.

2.2.8 Rubber Seals

Provide rubber seals that are [fluorocarbon (Teflon) clad rubber seals of the mold type only, and] compounded of natural rubber, synthetic polyisoprene, or a blend of both, and contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers.

2.2.8.1 Physical Characteristics

Ensure seals exhibit physical characteristics that meet the following requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	1.38 MPa2500 psi (min.)	ASTM D412
Elongation at Break	450 percent (min.)	ASTM D412

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
300 percent Modulus	6.21 MPa900 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
*Water Absorption	5 percent by weight (max.)	ASTM D471
Compression Set	30 percent (max.)	ASTM D395
Tensile Strength (after aging 48 hrs)	80 percent tensile strength (min.)	ASTM D572

Perform the "Water Absorption" test using distilled water. Blot the washed specimen dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees for 22 plus or minus 1/4 hour. Remove the specimen and allow to air cool to room temperature, and weigh the specimen. Record the weight the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D471). Ensure the immersion temperature is 70 degrees C plus or minus 1 degree and the immersion duration is at least 166 hours.

[2.2.8.2 Fabrication of Rubber Seals

Provide rubber seals with a fluorocarbon film that is vulcanized and bonded to the sealing surface of the bulb. Ensure the film thickness is [0.762] [1.524] mm [0.030] [0.060] inch and is Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and has the following physical properties:

Tensile strength	13.8 MPa2,000 psi (min.)
Elongation	250 percent (min.)

Flush the outside surface of the bonded film with the surface of the rubber seal and ensure it is free of adhering or bonded rubber. Mold strips and corner seals in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, mask the fluorocarbon film during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

]2.2.9 Grout

Provide grout made of a mixture of Portland cement specified in paragraph CEMENT FOR GROUT, shrinkage compensating admixture specified in paragraph GROUT ADMIXTURE, and potable water. Base final mix proportions on test results of sample mixtures. Minimize the water content of grout to achieve proper placement but never to exceed 0.50 by weight. Determine the fluidity of grout in accordance with ASTM C939/C939M. Limit efflux time of a grout sample immediately after mixing to less than 11 seconds. In all cases, the minimum value of the 7-day compressive strength of 50-mm 2-inch grout cubes molded, cured and tested in accordance with ASTM C109/C109M is 17.2 MPa 2500 psi.

2.2.9.1 Cement for Grout

ASTM C150/C150M, Type I or II.

2.2.10 Grout Admixture

Submit manufacturer's description of grout admixture, for approval, 30 days prior to the use of the material in the work. Provide grout admixture of the shrinkage compensating type which produces 2 percent maximum and 10 percent maximum unconfined expansion of the grout when tested in accordance with ASTM C940, and is free of chlorides, fluorides, or nitrates and dispensable in solid or liquid form. Submit complete manufacturer's description of the grout admixture for approval.

2.3 MANUFACTURED UNITS

Ensure bolts, nuts, washers, screws and other manufactured units conform with the requirements shown on the drawings and specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.3.1 Manufactured Units and Fabricated Items

Provide full-size samples of manufactured units and shop fabricated items complete as required for installation in the work. Approved samples may be installed in the work provided each sample is identified and its location recorded.

2.3.2 Bolts, Nuts and Washers

Provide high-strength bolts, nuts, and washers in conformance with ASTM F3125/F3125M, Grade A325, [hot-dip galvanized]. Provide bolts, nuts, studs, stud bolts and bolting materials other than high-strength items in conformance with ASTM A307, Grade A, [hot-dip galvanized] or ASTM F3125/F3125M, Ferritic Steel, Grade [_____] [Austenitic Steel, Grade [_____], Class [_____].] Provide bolts 13-mm 1/2-inch and larger with hexagon heads. Ensure the finished shank of bolts is long enough to provide full bearing. Provide washers for use with bolts in conformance with the requirements specified in the applicable specification for bolts.

2.3.3 Screws

Provide screws of the type indicated on the drawings.

2.4 FABRICATION

2.4.1 Structural Fabrication

Ensure all structural fabrications conform with the requirements shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop-fabricated of the materials specified and shown. Ensure dimensional tolerances comply with the specifications and as shown on the drawings. Splices are only allowed where shown or approved. Bore pin holes in components after welding, straightening, stress-relieving, and threading operations are completed. Brackets, eye bar sections, and other components requiring straightening are only to be straightened by methods which do not damage the material. Press-fit bronze bushings with supporting components. Provide bolt connections, lugs, clips, or other pick-up assembly devices for components as shown and required for proper assembly and installation. Make provisions for the installation of [cathodic protection system devices and other] appurtenances as required.

2.4.2 Welding

****

NOTE: List applicable welds requiring radiographic examination.

NOTE: Specification Section 05 50 14 STRUCTURAL METAL FABRICATIONS includes welds subjected to Ultrasonic Testing (UT), Dye Penetrant Testing (PT) and Magnetic Testing (MT). AWS D1.1 does not specify nondestructive testing of any completed weld. Designer must take this into account and specify any Nondestructive Testing (NDT) requirements as well as specifying which welds are to be subjected to nondestructive testing.

The designer is to consider whether any components included are likely to be fracture critical. Fracture critical components should be identified as requiring fabrication in accordance with a Fracture Control Plan.

****

Ensure welding conforms to the requirements of AWS D1.1/D1.1M, AWS D1.2/D1.2M, the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide welds of the types shown on the contract drawings and approved detail drawings. Radiographic examination is required on the major shop and field welds of the type and location indicated on the drawings and as follows: [_____]. Welds which have been designated to receive radiographic examination and are found to be inaccessible to a radiation source or film, or are otherwise so situated that radiographic examination is not feasible may be examined, with written approval, by dye penetrant, magnetic particle tests, or ultrasonic tests. All components are to be stress-relief heat treated after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances. Submit a Stress Relieving Plan for approval which follows the minimum requirements for thermal stress relief in accordance with AWS D1.1.[Stress-relief heat treat all components after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances.][Refer to Specification SECTION 05 50 14 STRUCTURAL METAL FABRICATIONS for nondestructive testing requirements.][Submit a Fracture Control Plan (FCP) for fracture critical components.]

2.4.3 Bolted Connections

Provide bolted connections in conformance with the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.4 Machine Work

Ensure machine work conforms to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.5 Miscellaneous Provisions

Ensure miscellaneous provisions for fabrication conform with the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.6 Fabrications

Submit samples for approval prior to use of the represented materials or items in the work. Submit samples of standard and shop fabricated items that are full size and complete as required for installation in the work. Approved samples may be installed in the work provided each sample is clearly identified and its location recorded.

2.4.6.1 Gates

Fabricate gates of welded fabrication except for bolted appurtenances as shown on the drawings. Provide structural steel framing members of structural steel conforming to ASTM A709/A709M, Grade 50. Provide skin plate conforming to [ASTM A709/A709M] [or] [ASTM A572/A572M], Grade 50. Shop-fabricate all gate. Obtain Contracting Officer approval for Contractor proposed shop-fabrication of gate leave in separate segments to facilitate handling and shipping as shown on approved detail drawings. Ensure segments permit easy field-assembly in as few sections as practicable to minimize the number of joints to be field-welded. Ensure the overall height of gates does not vary from the nominal dimension by more than 6 mm 1/4 inch. Ensure the surfaces of framing elements which support skin plates are in true alignment within 5 mm 3/16 inch so that skin plates will be in full bearing on all contact surfaces before being welded. Ensure the outside faces of skin plates after being welded to framing elements vary from the surface established on the drawings by no more than 5 mm 3/16 inch. Locate splices in skin plates only where shown on the drawings. Provide trunnions as an integral part of the gate framing and stress-relieve them by heat treatment after welding. Machine trunnion hubs and bushings after welding of the hubs is completed. Classify fit between trunnion hubs and bushings as shown on the drawings. Drill dowel holes and grease holes in bushings after installation in trunnion hubs. Provide gates with seal assemblies and other appurtenant items as shown on the drawings.

2.4.6.2 Trunnion Pins

Provide trunion pins fabricated from stainless steel, ASTM A564/A564M, UNS S17400 condition H1100 with an outside diameter surface finish roughness not to exceed 0.41 micrometers16 microinches, unless otherwise shown on the drawings.

2.4.6.3 Trunnion Yokes

Provide trunnion yokes complete with adjusting plates and bolts and thrust washers. Stress-relieve yokes by heat treatment and machine to the class to fit shown on drawings after fabrication welding is completed.

2.4.6.4 Prestressing Anchorage Assemblies

Submit prestressing records immediately after the work is completed. Furnish descriptions of the proposed method for installing the prestressing assemblies, for approval, 30 days prior to the start of prestressing operations. Prestressing assemblies consist of prestressing tendons, anchorages, ducts, grout and other appurtenances as required and shown on the drawings.

a. Provide prestressing tendons as specified in paragraph PRESTRESSING STEEL BAR TENDONS.

b. Provide anchorages as specified in paragraph ANCHORAGES AND COUPLERS.

c. Provide ducts as specified in paragraph DUCTS.

d. Provide grout as specified in paragraph GROUT.

2.4.6.5 Trunnion Girders

Provide trunnion girders constructed of [[cast-in-place] [precast] concrete girders with the 28-day compressive strength shown on the drawings and post-tensioned with prestressing anchorage assemblies. Cast the ducts of the anchorage assemblies in the girders in the positions and alignments shown on the drawings. Install prestressing assemblies as specified in paragraph PRESTRESSING ANCHORAGE ASSEMBLIES. Provide reinforcement steel, premolded expansion joint sheets, blockouts and other components of the girders as specified and indicated on the drawings] [structural steel as shown on the drawings].

2.4.6.6 Seal Assemblies

Seal assemblies consist of rubber seals, stainless steel retainer and spacer bars, and fasteners. Provide continuous rubber seals over the full length. Accurately fit and drill seals for proper installation. Drill bolt holes in the rubber seals by using prepared templates or the retainer bars as templates. Ensure all splices in seals are fully molded, and develop a minimum tensile strength of 50 percent of the unspliced seal, and occur only at locations shown on the drawings. Shop-vulcanize splices. Locate vulcanized splices between molded corners and straight lengths as close to the corners as practicable. Bevel splices on a 45 degree bevel related to the "thickness" of the seal. Ensure finished splice surfaces are smooth and free of irregularities. Field-splice stainless steel retainer bars only where shown on the drawings and machine-finish-retainer bars after splicing.

2.4.6.7 Appurtenant Items

Provide cable attachment brackets, dogging brackets, side seal plates, sill beams, stop beams and other appurtenant items in conformance with the requirements specified and shown on the drawings. Ensure all sealing surfaces of side seal plates and sill beams are flush, straight, and free from offsets, warps, twists or other distortions.

2.4.7 Shop Assembly

Comply with all shop assembly requirements for Tainter gates, anchorage assemblies and appurtenant items as shown on the drawings and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Assemble gates completely in the shop to assure satisfactory field installation. Fit and bolt adjoining components and appurtenant items together to facilitate field connections. Shop-weld assembled components in their final positions as much as delivery and field installation conditions permit. Fit and drill rubber seals to match the seal retainers on the gates, match-marked and removed for shipment. Allow a minimum adjustment of plus/minus 10 mm 3/8 inch in all drilled slots for attaching seals. Perform shop assembly and disassembly work in the presence of the

Contracting Officer unless otherwise waived in writing by the Contracting Officer. The presence of the Contracting Officer during assembly or disassembly in no way relieves the Contractor of any responsibility under this contract.

2.5 COMPONENTS

2.5.1 Cathodic Protection System

Provide cathodic protection system in conformance with Section [26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM] [26 42 19.00 10 CATHODIC PROTECTION SYSTEMS (IMPRESSED CURRENT) FOR LOCK MITER GATES].

2.5.2 Operating Machinery

Provide operating machinery in conformance with Section 35 01 41.00 10 ELECTROMECHANICAL OPERATING MACHINERY FOR LOCKS AND DAMS.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit certified test reports for material tests with all materials delivered to the site.

2.6.1 General

Tests, inspections, and verifications for materials are to be performed in conformance with the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.6.2 Testing of Rubber Seals

****

NOTE: If fluoro-carbon (Teflon) clad seals are not used, delete this paragraph.

****

Test the fluoro-carbon film of rubber seals for adhesion bond in accordance with ASTM D413 using either the machine method or the deadweight method. Cut a 25 mm 1 inch long piece of seal from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. Ensure there is no separation between the fluoro-carbon film and the rubber when subjected to the following loads:

THICKNESS OF FLUORO-CARBON FILM	MACHINE METHOD AT 50 mm2 INCHES PER MINUTE	DEADWEIGHT METHOD
0.762 mm0.030 in.	5.25 N per mm30 lbs per inch width	5.25 N per mm30 lbs per inch width
1.524 mm0.060 in.	5.25 N per mm30 lbs per inch width	5.25 N per mm30 lbs per inch width

PART 3 EXECUTION

3.1 INSTALLATION

Installation per the requirements specified herein and in Section 05 50 14

STRUCTURAL METAL FABRICATIONS. Assemble miter gates and appurtenant items for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Thoroughly clean and lubricate bearing surfaces requiring lubrication with an approved lubricant before assembly and installation. Ensure components to be field-welded are placed in correct alignment before welding is commenced. Design and submit handling attachments and pick points required to be added to any specified items herein prior to installation.

3.1.1 Embedded Metals

Accurately install sill assemblies, seal plates, frames, bases and other embedded metal items required for proper and complete installation to the alignment and grade required to ensure accurate fitting and matching of components. Primer coat all embedded metals with the required paint on all surfaces prior to installation in concrete forms. Install anchors for embedded metals as shown. Attach items requiring two concrete pours for installation to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour. Grind smooth welded field splices in sealing surfaces of embedded items.

3.1.2 Trunnion Girders

Anchor trunnion girders to concrete piers as specified and shown on the drawings. [Ensure the installation, post-tensioning and grouting of prestressing assemblies for anchoring trunnion girders conforms to the requirements specified in paragraph PRESTRESSING ASSEMBLIES.]

3.1.3 Trunnion Yokes

Install and adjust trunnion yokes in strict accordance with the procedure shown on the drawings. [Perform the final alignment of trunnion yokes after the prestressing tendons of the anchoring prestressing assemblies have been post-tensioned partially as specified in paragraph POST-TENSIONING.] Use special precautions to align the trunnion yokes so that the center lines of trunnion pins at the opposite ends of each gate are concentrically located on the established horizontal line. Ensure the eccentricity of the actual centerline of each trunnion pin with respect to the established horizontal line is no more than 0.8 mm 1/32 inch. Limit horizontal distance variance between trunnion yokes to no more than 3 mm 1/8 inch from the established dimension. [Place second-pour, high-strength concrete fills between the bases of trunnion yokes and trunnion girders [and place concrete non-shrink grout fills between the yokes of trunnion yokes and the abutting faces of concrete piers] after the successful completion of the trial operation specified in paragraph TRIAL OPERATIONS and the final alignment of trunnion yokes.] [Perform complete tensioning of the prestressing tendons after the concrete fills have attained the minimum [strengths] [strength]. Ensure the installation, post tensioning and grouting of prestressing assemblies for anchoring trunnion yokes to trunnion girders conforms to the requirements specified in paragraph PRESTRESSING ASSEMBLIES.]

3.1.4 Gates

****

NOTE: The water-tightness tests on the skinplates should be deleted when complete or spot radiographic or ultrasonic examination of the skinplates is required by the specifications.

****

Purge the trunnion lubrication system lines, fill with grease and connect to each trunnion assembly prior to installing gates. Clean the bearing surfaces of trunnion pins and bushings and coat with grease prior to installing the trunnion pins. Assemble gates in the field in strict conformity with shop match markings. Check controlling dimensions and alignments and correct as required before starting field welding. Weld in a manner such that distortion of gates is prevented. Remove erection bolts, lugs and ties after welding is completed. Fill holes and depressions with weld metal and remove surface projections by grinding. [Test skinplate welds for water-tightness after the gates are installed but prior to painting and mounting of seals by coating one face of the skinplate with soapsuds and applying air pressure with a hose using a minimum air pressure of 414 kPa 60 psi at the nozzle to the opposite face.] Seal disclosed leaks with light welds.

3.1.5 Prestressing Assemblies

Select and submit for approval the proposed method and equipment for installing prestressing anchorage assemblies, including riggings, tensioning jacks, gages, dynamometers and load cells or other devices for measuring stress loads. Selected method is required to provide for the accurate installation of all assemblies.

3.1.5.1 Ducts

Accurately place ducts, align and adequately support at close intervals to limit sag and deviation from established lines when tendons are inserted and concrete is placed. Install ducts with grout openings at both ends and grout vents as required. Ensure connections and other joints in ducts are watertight. Adequately protect openings to prevent the entry of water, concrete or debris. Ensure ducts have no blockages, dents or other defects which could cause increased friction between tendons and ducts or restrict grout flow.

3.1.5.2 Steel Bar Prestressing Tendons

Inspect steel bar prestressing tendons before placing in ducts to assure that they are not bent, nicked, scored or have damaged threaded ends. Do not place tendons in ducts until all welding has been completed on templates, supports or other items near or in contact with the tendons.

3.1.5.3 Anchorages

Set anchorages for steel bar prestressing tendons in a plan normal to the axis of the tendon so that uniform bearing on the concrete is assured and anchorages are positively connected to tendons. Extend ends of tendons beyond anchorages to accommodate testing. Remove end extensions after tests are completed and approved.

3.1.5.4 Post-Tensioning

Compile and submit complete records of the prestressing operation as required in paragraph GROUT RECORDS. Tension the steel bar prestressing tendons as specified and shown on the drawings. Tension tendons a minimum of [_____] days after the casting of concrete piers [and girders]. Do not begin tensioning until tests on concrete cylinders made and cured under the same conditions as the piers [and girders] indicate that the concrete has attained the required minimum strength. Conduct the tensioning operation in a manner so that the load being applied and the elongation of the tendon may be measured at all times. Ensure elongation measurements are accurate to 0.25 mm 0.01 inch. Ensure jack gage readings are accurate to the nearest 500 kPa 100 psi. If the stress in a tendon determined by gage pressure differ from the stress determined by elongation measurement in excess of 5 percent, determine the cause of the difference and corrected before proceeding with the tensioning operation. [Tension longitudinal tendons in concrete trunnion girders prior to the placement of the second-pour, high-strength concrete fills for the sections of piers adjacent to the face of trunnion girders.] [Tension the transverse tendons which anchor trunnion girders to piers after the second-pour concrete fills for the piers have attained the minimum required strength.] [Partially tension the transverse tendons which anchor trunnion yokes to trunnion girders prior to the trial operation of Tainter gates as specified below in paragraph TRIAL OPERATIONS and prior to the final adjustment of trunnion yokes as specified and shown on the drawings. Do not complete tensioning of these tendons until after the trunnion yokes have been adjusted and the second-pour, high-strength concrete fills between the base of trunnion yokes and the trunnion girders [and the concrete grout fills between the yokes of trunnion yokes and the piers] have attained the required minimum [strength] [strengths].] Protect exposed ends of prestressing components from damage during the tensioning operations; take the safety measures necessary to prevent accidents caused by failure of prestressing components.

3.1.5.5 Verification of Prestressing Forces

Tested the individual prestressing tendons selected by the Contracting Officer to verify the sustentation of prestress forces by being subjected to a force equal to the design force between 7 and 14 days after the complete tensioning of all tendons. A tendon which sustains the applied force without being unseated is considered to be satisfactory. Test no more than 10 percent of all tendons unless a tested tendon is unable to sustain the required test force. If a tested tendon is unable to sustain the required test force, retest all tendons and retension if required to the initial prestress. Retest retensioned tendons after 7 days at no additional cost to the Government.

3.1.5.6 Grouting

Grout prestressing assemblies immediately after complete tensioning of prestressing tendons and verification of prestressing forces. Provide grout in conformance with the requirements specified in paragraph GROUT. Provide grouting equipment capable of continuous mechanical mixing and placing of grout, measuring grout mix volume and measuring volume of grout placed within 2500 cubic mm 0.1 cubic foot. Provide a positive displacement type grout pump with the capacity to develop a pressure of 1.38 MPa 200 psi. Provide stand-by water flushing equipment for flushing out ducts partially grouted and stopped due to blockage or equipment breakdown. Flush ducts for prestressing tendons free of water, dirt or any other foreign substance and blow out with compressed air until no water comes through just prior to grouting. Pressure grout ducts at a minimum pressure of 690 kPa 100 psi immediately after post-tensioning has been completed. Continue grouting until all air within the duct has been displaced with grout. Continue the grouting of a system of prestressing tendons and ducts once started until that system has been completely grouted. Compile and track grout placement records.

3.1.6 Appurtenant Items

Attach side seal plates, sill beams, stop beams and other items to be embedded in second-pour concrete to anchors, align, level and rigidly block to prevent displacement during the placement of concrete. Align side seal plates in planes normal to the axis of rotation of the gates and check before embedding in concrete to ensure they do not vary more than 2.5 mm 3/32-inch from the established alignment in an arc length of 3.6 m 12 feet. Grind welded field splices in exposed metals smooth to assure proper sealing. Provide continuous metal supports for rubber seals that are free of waves, winds and distortions. Install rubber seals after the [skinplate water-tightness test and] gate painting operations have been completed. Adjust seals after installation so that they are slightly compressed in the closed, unwatered condition to prevent excessive depression and wear in the closed, watered condition. [Install the heating system for seals as shown on the drawings and specified in Section [_____] CREST-GATE-SEAL.]

3.1.7 Second-Pour, High-Strength Concrete [and Concrete Grout] Fills

****

NOTE: The zones and strengths of high-strength concrete and concrete grout should be shown on the drawings.

****

Execute the second-pour, high-strength concrete fills for the sections of piers adjacent to the face of trunnion girders [and the space between the base of trunnion yokes and trunnion girders] [and the concrete grout fills between the yokes of trunnion yokes and the piers] as shown on the drawings and as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.1.8 Painting

Paint exposed parts of gates and appurtenances, except machined surfaces, stainless steel surfaces, surfaces of anchorages embedded in concrete, [cathodic protection system anodes,] and other specified surfaces as specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.1.9 Seal Assemblies

Install rubber seal assemblies after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Fasten rubber seals securely to metal retainers. Before operating the gates, apply a suitable lubricant to the rubber seal rubbing plates to protect the rubber.

3.2 FIELD QUALITY CONTROL

Non-Destructive testing of field welds are required to meet the same quality control requirements of shop-welded components.

3.3 SYSTEM START-UP

3.3.1 Trial Operations

Perform gate trial operations after the complete installation of gates and appurtenant items. Perform trial operations and receive approval prior to placing the second-pour, high-strength concrete fills around embedded appurtenant items [and between trunnion yokes and trunnion girders and prior to the complete tensioning of the prestressing tendons anchoring the trunnion yokes]. Adjust hoist lifting cables and lubricate trunnion bushings through the permanent lubrication fittings with an approved, extreme-pressure lubricant before operating the gates. Adjust guide shoes, guide rollers, and bulb seals as necessary. Ensure gates move smoothly and without binding or lateral sway when raised and lowered through the complete range of travel. Correct defects disclosed from trial operations and repeat trial operations at no cost to the Government. Repeat trial operations after complete tensioning and grouting of all prestressing assemblies. Refer to Section 35 01 70.13 WIRE ROPE FOR GATE OPERATING DEVICES for wire rope tensioning procedures.

3.3.2 Acceptance Trial Operation

After completion of the gate installation, conduct an examination of the gates in the presence of the Contracting Officer for final acceptance. First examine the gates to determine whether or not the workmanship conforms to the specification requirements. Operate the gates from the fully-opened to the fully-closed position a sufficient number of times to demonstrate to the Contracting Officer's satisfaction that all parts are functioning properly. Adjust guide shoes, guide rollers, and bulb seals as necessary. The workmanship in the fabrication and installation of gates is the result in a condition where when the gates are in the closed position watertight barrier is formed across the opening. The contractor is required to make all repairs or replacements to correct defects, as determined by the Contracting Officer, at no cost to the Government. Repeat the trial operation after defects are corrected. Prior to final acceptance of the gates, provide temporary restraints to prevent unauthorized operation of the gates.

3.4 PROTECTION

Protect finished work in conformance with the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 20 16.53 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16.53 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 35 20 16.53

HYDRAULIC VERTICAL LIFT GATES

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PART 1 GENERAL

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USACE / NAVFAC / AFCEC **UFGS-35 20 16.53 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16.53 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 35 20 16.53

HYDRAULIC VERTICAL LIFT GATES
08/22

****

NOTE: This guide specification covers the requirements for the fabrication, assembly, delivery, and installation of vertical lift slide gate, vertical lift wheel gate, and vertical lift tractor gate and appurtenant items. This section was originally developed for USACE Civil Works projects.

Certain components of a Vertical Lift Gate may be considered fracture critical. These components may include the gudgeon hood, gudgeon anchorage, diagonals, as well as others. AWS D1.1 does not include provisions for fracture critical welding. The Designer should consider using guide specification SECTION 05 59 20 FABRICATION OF HYDRAULIC STEEL STRUCTURES for specifying fracture-critical welding utilizing a Fracture Control Plan. A Fracture Control Plan and the use of appropriate materials and welding is required by ER 1110-2-8157, "Responsibility for Hydraulic Steel Structures."

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (LUMP SUM PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

Select Alternate 1 (one pay item) or Alternate 2 (two pay items). Delete all paragraphs of Alternate not selected.

****

1.1.1 Furnish & Install Vertical Lift Side Gate & Appurtenances

****

NOTE: Alternate 1, Vertical Lift Slide Gate.

****

1.1.1.1 Payment

Payment is to be made for costs associated with furnishing and installing vertical lift slide gate and appurtenant items, which includes full compensation for the materials, fabrication, delivery, installation, and testing of vertical lift slide gate and appurtenant items including gate leaf, stem, stem guides, leaf nuts, leaf nut wrench, seal collars, frame, [bonnet,] [bonnet cover,] [pedestal,] [and] [base plate] for supporting operating machinery, [lock assembly,] [leaf springs,] [air vent liner,] and other appurtenances necessary for complete installation.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Furnish Vertical Lift Side Gate & Appurtenances

****

NOTE: Alternate 2, Vertical Lift Slide Gate.

****

1.1.2.1 Payment

Payment is to be made for costs associated with furnishing vertical lift slide gate and appurtenant items, which includes full compensation for the materials, fabrication, and delivery, of vertical lift slide gate and appurtenant items including gate leaf, stem, stem guides, leaf nuts, leaf nut wrench, seal collars, frame, [bonnet,] [bonnet cover,] [pedestal,] [and] [base plate] for supporting operating machinery, [lock assembly,] [leaf springs,] [air vent liner,] and other appurtenances necessary for complete installation.

1.1.2.2 Unit of Measure

Unit of Measure: lump sum.

1.1.3 Install Vertical Lift Side Gate & Appurtenances

****

NOTE: Alternate 2, Vertical Lift Slide Gate.

****

1.1.3.1 Payment

Payment is to be made for costs associated with installing vertical lift slide gate and appurtenant items, which includes full compensation for the complete installation and testing of vertical lift slide gate and appurtenant items.

1.1.3.2 Unit of Measure

Unit of measure: lump sum.

1.1.4 Furnish & Install Vertical Lift Wheel Gate & Appurtenances

****

NOTE: Alternate 1, Vertical Lift Wheel Gate.

****

1.1.4.1 Payment

Payment is to be made for costs associated with furnishing and installing vertical lift wheel gate and appurtenant items, which includes full compensation for the materials, fabrication, delivery, installation, and testing of vertical lift wheel gate and appurtenant items including gate leaf, frame, guides, [lifting sling,] [lifting beam assembly,] [dogging devices,] [conduit liner,] [air vent,] and other appurtenances necessary for complete installation.

1.1.4.2 Unit of Measure

Unit of measure: lump sum.

1.1.5 Furnish Vertical Lift Wheel Gate & Appurtenances

****

NOTE: Alternate 2, Vertical Lift Wheel Gate.

****

1.1.5.1 Payment

Payment is to be made for costs associated with furnishing vertical lift wheel gate and appurtenant items, which includes full compensation for the materials, fabrication, and delivery of vertical lift wheel gate and appurtenant items including gate leaf, frame, guides, [lifting sling,] [lifting beam assembly,] [dogging devices,] [conduit liner,] [air vent,] and other appurtenances necessary for complete installation.

1.1.5.2 Unit of Measure

Unit of Measure: lump sum.

1.1.6 Install Vertical Lift Wheel Gate & Appurtenances

****
NOTE: Alternate 2, Vertical Lift Wheel Gate.
****

1.1.6.1 Payment

Payment is to be made for costs associated with installing vertical lift wheel gate and appurtenant items, which includes full compensation for the complete installation and testing of vertical lift wheel gate and appurtenant items.

1.1.6.2 Unit of Measure

Unit of measure: lump sum.

1.1.7 Furnish & Install Vertical Lift Tractor Gate & Appurtenances

****
NOTE: Alternate 1, Vertical Lift Tractor Gate.
****

1.1.7.1 Payment

Payment is to be made for costs associated with furnishing and installing vertical lift tractor gate and appurtenant items, which includes full compensation for the materials, fabrication, delivery, installation, and testing of vertical lift tractor gate and appurtenant items including gate leaf, frame, guides, [lifting sling,] [lifting beam assembly,] [dogging devices,] [conduit liner,] [air vent,] and other appurtenances necessary for complete installation.

1.1.7.2 Unit of Measure

Unit of measure: lump sum.

1.1.8 Furnish Vertical Lift Tractor Gate & Appurtenances

****
NOTE: Alternate 2, Vertical Lift Tractor Gate.
****

1.1.8.1 Payment

Payment is to be made for costs associated with furnishing vertical lift tractor gate and appurtenant items, which includes full compensation for the materials, fabrication, and delivery of vertical lift tractor gate and appurtenant items including gate leaf, frame, guides, [lifting sling,] [lifting beam assembly,] [dogging devices,] [conduit liner,] [air vent,] and other appurtenances necessary for complete installation.

1.1.8.2 Unit of Measure

Unit of Measure: lump sum.

1.1.9 Install Vertical Lift Tractor Gate & Appurtenances

****

NOTE: Alternate 2, Vertical Lift Tractor Gate.
****

1.1.9.1 Payment

Payment is to be made for costs associated with installing vertical lift tractor gate and appurtenant items, which includes full compensation for the complete installation and testing of vertical lift tractor gate and appurtenant items.

1.1.9.2 Unit of Measure

Unit of measure: lump sum.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,

	Welded and Seamless
ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D413	(1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D572	(2004; R 2019) Rubber Deterioration by Heat and Oxygen
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch

Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-W-410	(2022; Rev J) Wire Rope and Strand

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, [_____]

Shop Assembly Drawings; G, [_____]

Delivery Drawings; G, [_____]

Field Installation Drawings; G, [_____]

Stress Relieving Plan; G, [_____]

Fracture Control Plan (FCP); G, [_____]

Handling Attachments And Pick Points; G, [_____]

SD-03 Product Data

Materials

SD-06 Test Reports

Tests, Inspections, and Verifications

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Welders and Welding Operators

Ensure all qualifications of welders and welding operators conforms to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

1.5 DELIVERY, STORAGE, AND HANDLING

Perform delivery, handling, and storage of materials and fabricated items in accordance with the requirements specified [herein and] in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. [Unload material and equipment delivered to the site as approved by the Contracting Officer. Verify the condition and quantity of the items delivered and acknowledge receipt and condition thereof in writing to the Contracting Officer. If delivered items are damaged or a shortage is determined, notify the Contracting Officer of such in writing within 24 hours after delivery.]

1.5.1 Rubber Seals

Store rubber seals in a place which permits free circulation of air, maintains a temperature of 20 degrees C 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Keep rubber seals free of oils, grease, and other materials which would deteriorate the rubber. Do not distort rubber seals during handling.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Detail Drawings

Submit detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, conforming to the requirements specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.1.1.1 Fabrication Drawings

Ensure fabrication drawings show complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.1.1.2 Shop Assembly Drawings

Ensure shop assembly drawings provide details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.1.1.3 Delivery Drawings

Ensure delivery drawings provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.1.1.4 Field Installation Drawings

****

NOTE: If zinc filler is not specified, delete requirements for procedures and equipment for it.

****

Ensure field installation drawings provide a detailed description of the field installation procedures. Include the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; plan for prestressing gate leaf diagonals, to include descriptions of connections, riggings, anchorages, and measuring equipment; methods for installing quoin and miter blocks, including checking and maintaining alignments of the blocks during concreting and placement of [epoxy] [zinc] filler; procedures and equipment used for heating and placing of the zinc filler; and methods for installing other appurtenant items.

2.2 MATERIALS

Submit system of identification which shows the disposition of specific lots of approved materials and fabricated items in the work, before completion of the contract. Ensure materials orders, materials lists and materials shipping bills conform to the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Submit approved samples prior to use of the represented materials or items in the work. Submit samples of standard and shop fabricated items that are both full size and complete as required for installation in the work. Approved samples may be installed in the work provided each sample is clearly identified and its location recorded.

2.2.1 Metals

****

NOTE: Consider the use of ASTM A709/A709M steel for fabrication of all steel components. A709 material is available in 36 and 50 ksi and provides improved toughness and maximum yield to tensile ratios to ensure ductile performance.

****

Ensure structural steel, steel forgings, steel castings, stainless steel, bronze, aluminum bronze and other metal materials used for fabrication conform to the requirements shown and specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.2.1.1 Structural Steel

Conform to [ASTM A36/A36M][ASTM A572/A572M][ASTM A992/A992M][ASTM A709/A709M].

2.2.1.2 Structural Steel Plates

Conform to [ASTM A36/A36M] [ASTM A572/A572M, Grade 50].

2.2.1.3 Steel Pipe

Conform to ASTM A53/A53M, Type S, Grade B, seamless, black, nominal size and weight class or outside diameter and nominal wall thickness as shown, [plain] [threaded] [threaded and coupled] ends.

2.2.1.4 Stainless Steel Bars and Shapes

Conform to ASTM A276/A276M, UNS [S 20910,] [S 30400,] [S 40500,] Condition A, hot-finished or cold-finished, Class C; or ASTM A564/A564M, UNS [S 17400,] [S 45000,] Condition A, age-hardened heat treatment, hot-finished or cold-finished, Class C.

2.2.1.5 Stainless Steel Plate, Sheet, and Strip

Conform to ASTM A240/A240M, UNS [S 20910,] [S 30400,] [S 40500,]. Finish plates by hot-rolling, annealing or heat-treating, and blast-cleaning or pickling. Provide No. 1 sheet and strip finish.

2.2.2 Rubber Seals

Provide rubber seals that are [fluorocarbon (Teflon) clad rubber seals of the mold type only, and] compounded of natural rubber, synthetic polyisoprene, or a blend of both, and contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers.

2.2.2.1 Physical Characteristics

Ensure seals exhibit physical characteristics that meet the following requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	20.7 MPa3,000 psi (min.)	ASTM D412
Elongation at Break	500 percent (min.)	ASTM D412
300 percent Modulus	6.9 MPa1,000 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
*Water Absorption	5 percent by weight (max.)	ASTM D471
Compression Set	30 percent (max.)	ASTM D395, Method B

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength (after aging 48 hrs)	80 percent tensile strength (min.)	ASTM D572

Perform the "Water Absorption" test using distilled water. Blot the washed specimen dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees for 22 plus or minus 1/4 hour. Remove the specimen and allow to air cool to room temperature, and weigh the specimen. Record the weight the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D471). Ensure the immersion temperature is 70 degrees C plus or minus 1 degree and the immersion duration is at least 166 hours.

[2.2.2.2 Fabrication of Rubber Seals

Provide rubber seals with a fluorocarbon film that is vulcanized and bonded to the sealing surface of the bulb. Ensure the film thickness is [0.762] [1.524] mm [0.030] [0.060] inch and is Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, and has the following physical properties:

Tensile strength	13.8 MPa2,000 psi (min.)
Elongation	250 percent (min.)

Flush the outside surface of the bonded film with the surface of the rubber seal and ensure it is free of adhering or bonded rubber. Mold strips and corner seals in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, mask the fluorocarbon film during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

]2.3 MANUFACTURED UNITS

Ensure that bolts, nuts, washers, screws and other manufactured units conform with the requirements as shown and as specified and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.3.1 Bolts, Nuts and Washers

Ensure high-strength bolts, nuts, and washers conform to ASTM F3125/F3125M, Grade A325, [hot-dip galvanized]. Ensure bolts, nuts, studs, stud bolts and bolting materials other than high-strength conform to ASTM A307, Grade A, [hot-dip galvanized] [_____] or ASTM A320/A320M, [Ferritic Steel, Grade [_____]] [Austenitic Steel, Grade [_____], Class [_____]]. Provide bolts 13 mm 1/2 inch and larger with hexagon heads. Ensure the finished shank of bolts is long enough to provide full bearing. Ensure washers for use with bolts conform to the requirements specified in the applicable specification for bolts.

2.3.2 Screws

Provide screws of the type indicated.

2.3.3 Sheaves

Provide sheaves of cast steel conforming to ASTM A27/A27M, sized for the wire rope used.

2.3.4 Wire Rope

Provide wire rope conforming to FS RR-W-410, Type [_____], Class [_____], Construction [_____], [wire size,] [strand seizing] as indicated.

2.3.5 Wheels

Provide wheels that are short hub or long hub, rigid type, heavy duty steel casters fabricated with steel castings conforming to ASTM A148/A148M. Provide wheels of the size and load capacity shown. Provide wheel with lubrication fittings, roller bearings, and removable axle or shaft. Machine-finish wheel treads as shown. Unless otherwise specified or shown, provide stainless steel shafts for wheels conforming to ASTM A276/A276M, UNS S 30400.

2.4 FABRICATION

2.4.1 Structural Fabrication

Ensure structural fabrication conforms to the requirements as shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide dimensional tolerances as specified and as shown. Splice only at locations where shown. Bore pin holes in components after welding, straightening, stress-relieving, and threading operations are completed. Brackets, eye bar sections, and other components requiring straightening are to be straightened by methods which will not damage the material. Press-fit bushings with supporting components. Provide bolt connections, lugs, clips, or other pick-up assembly devices for components as shown and required for proper assembly and installation. Make provisions for the installation of [cathodic protection system devices]and other appurtenances as required.

2.4.2 Welding

****

NOTE: List applicable welds requiring radiographic examination.

NOTE: Specification Section 05 50 14 STRUCTURAL METAL FABRICATIONS includes welds subjected to Ultrasonic Testing (UT), Dye Penetrant Testing (PT) and Magnetic Testing (MT). AWS D1.1 does not specify nondestructive testing of any completed weld. Designer must take this into account and specify any Nondestructive Testing (NDT) requirements as well as specifying which welds are to be subjected to nondestructive testing.

The designer is to consider whether any components included are likely to be fracture critical. Fracture critical components should be identified as requiring fabrication in accordance with a Fracture Control Plan.

****

Ensure welding conforms to the requirements of AWS D1.1/D1.1M, AWS D1.2/D1.2M, the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide welds of the types shown on the contract drawings and approved detail drawings. Radiographic examination is required on the major shop and field welds of the type and location indicated on the drawings and as follows: [_____]. Welds which have been designated to receive radiographic examination and are found to be inaccessible to a radiation source or film, or are otherwise so situated that radiographic examination is not feasible may be examined, with written approval, by dye penetrant, magnetic particle tests, or ultrasonic tests. All components are to be stress-relief heat treated after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances. Submit a Stress Relieving Plan for approval which follows the minimum requirements for thermal stress relief in accordance with AWS D1.1.[Stress-relief heat treat all components after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances.][Refer to Specification SECTION 05 50 14 STRUCTURAL METAL FABRICATIONS for nondestructive testing requirements.][Submit a Fracture Control Plan (FCP) for fracture critical components.]

2.4.3 Bolted Connections

Ensure bolted connections conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.4 Machine Work

Ensure machine work conforms to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.5 Miscellaneous Provisions

Ensure miscellaneous provisions for fabrication conform with the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.6 Operating Machinery

****

NOTE: Specify appropriate section for vertical lift gate operating machinery.

****

Conform operating machinery to Section [_____].

2.4.7 Slide Gate Leaf

Provide slide gate leaves constructed of single-component structural fabrication. Shop fabricate slide gates and provide complete with gate stem, stem guides, leaf nut, leaf nut spanner wrench, bar seals, seal collars, [lock assembly,] [leaf springs,] and other appurtenant items as required for installation. Ensure that surfaces of leaf framing elements to which skin plates are to be welded do not vary from a true plane by more than\ ^2 mm 1/16 inch to provide uniform bearing. Ensure the outside surfaces of skin plates welded to framing elements do not vary from a true plane by more than 2 mm 1/16 inch. Locate splices in skin plates only where shown. Ensure the overall width and height of the fabricated gate leaf does not vary from the respective dimensions shown by more than 2 mm 1/16 inch. Stress-relieve gate leaves prior to the attachment of bar seals. Machine surfaces where bar seals are attached accurately to provide uniform bearing for the full contact dimensions. Butt the top and side bar seals together firmly at the corners. Ensure the ends of side bar seals are flush with the bottom seating surface of the gate leaf. Perform final machining of bar seals after they are attached to the gate leaf. Machine the bottom seat of the gate leaf for a tight fit with the gate frame sill.

2.4.8 Slide Gate Frame and Bonnet

****

NOTE: Edit this paragraph to fit the project.

****

Shop fabricate the slide gate frame and bonnet. Ensure the guiding and seal surfaces of slide gate frame and bonnet are in a true vertical plane and are machined finished. Unmachined surfaces exposed to water flow are required to match at joints between component parts, and are not depart from true planes shown by more than 2 mm 1/16 inch and are to be free of offsets or irregularities greater than 2 mm 1/16 inch. Grind allowable offsets or irregularities less than 2 mm 1/16 inch to a bevel of not greater than one on twenty-four. Machine the bottom seat of the gate leaf for a tight fit with the gate frame sill. Ensure the gate frame and bonnet are stress relieved prior to the attachment of bar seals. Accurately machine surfaces where bar seals are attached to provide uniform bearing for the full contact dimensions. Butt top, side, and invert bar seals firmly together at the corners. Perform final machining of bar seals after they are attached to the gate frame and bonnet. Pour babbit in the gate frame sill and peen before machining the frame. When machining the gate frame sill, ensure the tool travel is parallel to the long dimension of the babbit.

2.4.9 Slide Gate Bonnet Cover, Pedestal and Base Plate

****

NOTE: Edit this paragraph to fit the project.

****

Accurately machine the flanges of the bonnet cover, pedestal and base plate for the supporting the operating machinery for the slide gate and drill to match mating flanges and provide the required true alignment. Coat unmachined oil-contacting surfaces of bonnet cover and pedestal with alkyd resin as specified for the unmachined oil-contacting surfaces of hydraulic cylinder heads. Base plate dimensions may be altered to fit the operating machinery furnished, provided the basic configuration, plate thickness, and number and sizes of fasteners are equal to that shown and the altered dimensions are approved.

2.4.10 Wheel Gate Leaf

****

NOTE: Delete first sentence if not applicable for the project.

****

Provide wheel gate leaves of single-component structural fabrication. Ensure wheel gate leaves are shop fabricated and are provided complete with lifting brackets, wheel assemblies, seal assemblies, [guide shoes,] [plates,] [dogging brackets,] and other appurtenant items as required for installation and proper operation. Check the design center of gravity of the gate leaf prior to fabrication and notify the Contracting Officer if an unreasonable amount of counter-weighting is required to attain the center of gravity as designed. Ensure surfaces of leaf framing elements to which skin plates are to be welded do not vary from a true plane by more than 2 mm 1/16 inch to provide uniform bearing. Ensure the outside surfaces of skin plates welded to framing elements do not vary from a true plane by more than 2 mm 1/16 inch. Locate splices in skin plates only where shown. Ensure the overall width and height of the fabricated gate leaf does not vary from the respective dimensions shown by more than 2 mm 1/16 inch. Stress relieve the gate leaves prior to the attachment of seal assemblies and other appurtenant items.

2.4.10.1 Wheel Gate Leaf Lifting Brackets

Coordinate the fabrication details of wheel gate leaf lifting brackets closely with the details of the [lifting sling] [lifting hoist] [engaging and disengaging mechanism of the lifting beam assembly] to assure proper operation.

2.4.10.2 Wheel Gate Leaf Wheel Assembly

Provide wheel assemblies from a manufacturer regularly engaged in the manufacture of such products. Provide each wheel assembly complete with wheel, shaft, roller bearing, lock washer, lock nut, bearing cover, seal housing, grease seal, seal retainer, shaft lock plate, lubrication fittings, fasteners, and other accessories as required for complete and proper installation. Provide wheel diameter and thickness shown without variation. Only change the dimensions and tolerances of other components as required for compatibility with the manufacturer's product.

2.4.10.3 Wheel Gate Leaf Seal Assembly

Provide seal assemblies consisting of rubber seals, stainless steel retainer and spacer bars, and fasteners. Provide rubber seals that are continuous over the full length. Accurately fit seals accurately fit and drill for proper installation. Drill bolt holes in the rubber seals by using prepared templates or the retainer bars as templates. Fully mold splices in seals to develop a minimum tensile strength of 50 percent of the unspliced seal, and place them only at locations shown. Vulcanizing of splices is only allowed to be done in the shop. Locate the vulcanized splices between molded corners and straight lengths as close to the corners as practicable. Place splices on a 45 degree bevel related to the "thickness" of the seal. Ensure the surfaces of finished splices are smooth and free of irregularities. Field splice stainless steel retainer bars only where shown and machine finish them after splicing.

2.4.11 Wheel Gate Frame and Guides

****

NOTE: Delete last sentence if not applicable to the project.

****

Ensure the exposed unmachined surfaces of wheel gate frame and guides match at joints between component parts, do not depart from true planes shown by more than 2 mm 1/16 inch, and are free of offsets or irregularities greater than 2 mm 1/16 inch. Grind allowable offsets or irregularities less than 2 mm 1/16 inch to a bevel of not greater than one on twenty-four. Accurately machine surfaces of frames and guides to receive seal bars and wheel track bars to provide uniform bearing for the full contact dimensions. Butt seal bars firmly together at corners. Machine bearing surfaces of wheel track bars and sealing surfaces of seal bars to the tolerances shown to provide uniform bearing and sealing at all points of contact. Perform the final machining of seal bars and wheel track bars after they are attached to the gate frame and guides. Locate the anchor bolt holes for gate frame and guides accurately using Government-furnished templates which provide the installation location of anchor bolts.

2.4.12 Wheel Gate Lifting Sling

Provide wheel gate lifting sling made of wire rope with thimble and socket fittings attached to the wire rope in a manner that develops the full strength of the wire rope.

2.4.13 Wheel Gate Lifting Beam Assembly

Fabricate the wheel gate lifting beam assembly as shown for automatic engaging and disengaging with the lifting brackets of the gate leaf. Stress relieve the lifting beam prior to final machining and attachment of the roller and counterweight assemblies.

2.4.14 Tractor Gate Leaf

****

NOTE: Delete first sentence if not applicable for the project.

****

Fabricate the tractor gate leaf as a single-component structure. Shop fabricate the tractor gate leaf and provide complete with roller train assemblies, lifting brackets, seal assemblies, guide [shoes,] [plates,] [dogging brackets,] [pier guides,] [pier ties,] and other appurtenant items as required for installation and proper operation. Check the design center of gravity of the gate leaf prior to fabrication and give notification if an unreasonable amount of counterweighting is required to attain the center of gravity as designed. Ensure the surfaces of leaf framing elements to which skin plates are to be welded do not vary from a true plane by more than 2 mm 1/16 inch to provide uniform bearing. Ensure the outside surfaces of skin plates welded to framing elements do not vary from a true plane by more than 2 mm1/16 inch. Locate splices in skin plates only where shown. Ensure the overall width and height of the fabricated gate leaf does not vary from the respective dimensions shown by more than 2 mm 1/16 inch. Stress relieve the gate leaf prior to the attachment of seal assemblies and other appurtenant items.

2.4.14.1 Tractor Gate Leaf Lifting Brackets

Coordinate the fabrication details of tractor gate leaf lifting brackets closely with the details of the [lifting sling] [lifting hoist] [engaging and disengaging mechanism of the lifting beam assembly] to assure proper operation.

2.4.14.2 Tractor Gate Leaf Roller Train Assemblies

Provide roller train assemblies consisting of roller guides, track plates, roller train, and roller train cover. Provide adjustable roller guides that are removable without dismantling the roller train. Provide turned bolts, jack screws, shims for mounting and adjusting roller guides, and cap screws for attaching track plates as shown. Attach track plates to the gate leaf so that the side faces of the track plates are parallel to a vertical plane within 2 mm 1/16 inch. Machine finish the track surfaces of track plates to a plane parallel to a common plane within 2 mm 1/16 inch after being attached to the gate leaf. Provide roller train complete with pins, link bars, retaining rings, and other appurtenances as shown and as required for proper installation and operation.

2.4.14.3 Tractor Gate Leaf Guide Shoes

Attach guide shoes to the gate leaf for drilling and reaming for bolting. Locate the guide shoes accurately on the gate leaf in a true vertical plane with each other in the upstream-downstream direction. Lines passing through face of guide shoes on each side of leaf are required to be parallel within 2 mm 1/16 inch.

2.4.14.4 Tractor Gate Leaf Seal Assemblies

Provide seal assemblies consisting of rubber seals, stainless steel retainer and spacer bars, and fasteners. Provide rubber seals continuous over the full length that are accurately fitted and drilled for proper installation. Drill bolt holes in the rubber seals by using prepared templates or the retainer bars as templates. Splices in seals are required be fully molded, developing a minimum tensile strength of 50 percent of the unspliced seal, and occurring only at locations shown. Shop vulcanizing all splices. Locate the vulcanized splices between molded corners and straight lengths as close to the corners as practicable. Place splices on a 45 degree bevel related to the "thickness" of the seal. Ensure the surfaces of finished splices are smooth and free of irregularities. Field splice stainless steel retainer bars only where shown and machine finish after splicing.

2.4.15 Tractor Gate Frame and Guides

****

NOTE: Delete last sentence if not applicable for the project.

****

Ensure exposed unmachined surfaces of tractor gate frame and guides match at joints between component parts, do not depart from true plane shown by more than 2 mm 1/16 inch, and are free of offsets or irregularities greater than 2 mm 1/16 in. Grind allowable offsets or irregularities less than 2 mm 1/16 inch to a bevel of not greater than one on twenty-four. Machine the surfaces of frames and guides to receive roller track plates and seal plates accurately to provide uniform bearing for the full contact dimensions. Butt seal plates firmly together at corners. Machine roller bearing surfaces of track plates and sealing surfaces of seal plates to the tolerances shown to provide uniform bearing and sealing at all points of contact. Perform final machining of track plates and seal plates after they are attached to the gate frame and guides. Locate the anchor bolt holes for gate frame and guides accurately using Government furnished templates which provide the installation location of anchor bolts.

2.4.16 Tractor Gate Lifting Sling

Provide tractor gate lifting sling made of wire rope with thimble and socket fittings attached to the wire rope in a manner that develops the full strength of the wire rope.

2.4.17 Tractor Gate Lifting Beam Assembly

Fabricate the tractor gate lifting beam assembly as shown for automatic engaging and disengaging with the lifting brackets of the gate leaf. Stress relieve the lifting beam prior to final machining and attachment of the roller and counterweight assemblies.

2.4.18 Appurtenant Items

Ensure the fabrication requirements for [air vents,] [air vent liner,] [conduit liner,] [dogging devices,] [pier tie anchors,] [gate leaf pier guides,] and other appurtenant items conform to the details shown.

2.4.19 Shop Assembly

Provide shop assembly requirements for gate, gate frame and appurtenant items as shown and as specified and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Assemble gate, frame, guides, and appurtenant items completely in the shop to assure satisfactory field installation. Carefully preserve the match-marking of unassembled components until the components are assembled. Provide adequate support during assembly to maintain components within 2 mm 1/16 inch of actual installation planes. Coat mating surfaces and machined surfaces with a rust preventive coating until assembled. Thinly coat other connecting surfaces which are not required to be disassembled for shipment with an approved rust preventive coating before being joined. Fit and bolt adjoining components together to facilitate field connections. Deliver shop assembled components assembled, if practically permitted by shipping and field installation conditions. Shop weld assembled components in their final positions as much as delivery and field installation conditions allow. Perform shop assembly and disassembly work in the presence of the Contracting Officer unless otherwise approved. The presence of the Contracting Officer in no way relieves the Contractor of any responsibility under this contract.

2.4.19.1 Gate Leaf

****

NOTE: This paragraph must be edited to fit the project.

****

Shop assemble the gate leaf in the [vertical position] [and] [horizontal position with the skin side of the gate leaf facing down]. Include in the shop assembly the attachment of all accessories to the gate leaf. Lift the [wheel gate leaf] [and] [tractor gate leaf] by the lifting brackets and inspect for balance about the center of gravity after being shop assembled. If the gate leaf is out of plumb by more than 6 mm 1/4 inch in the total length in a vertical plane in the upstream-downstream direction, or by more than 2 mm 1/16 inch in the total width in a vertical plane perpendicular to the vertical plane in the upstream-downstream direction, balance it by counterweighting or some other method as approved at the Contractor's expense.

2.4.19.2 Wheel Assemblies

Support the gate leaf in the horizontal position for adjusting wheel assemblies so that the wheels of the attached wheel assemblies are free to rotate to allow the proper adjustment. Adjust attached wheel assemblies so that the wheels remain perpendicular to the gate leaf and the contact surfaces of the wheels on each side of the gate leaf are in a single plane within 0.127 mm 0.005 inch when rotated 360 degrees. Make the final adjustment of wheel assemblies after the gate leaf is assembled with the gate frame and guides in the horizontal position. Tap the top of each wheel to insure that the weight of the wheel assembly has caused the shaft to bear firmly on the supporting framing of the gate leaf. Adjust wheel assemblies so that the tolerance on the distance between the plane through the downstream faces of the wheels and the plane through the downstream machined surfaces of the side bar supports for the seal assemblies does not exceed 1 mm1/32 inch. After wheel assemblies have been adjusted, lock them in position by drilling the lock plate, support plate, and shaft and installing cap screws as shown. Lubricate the wheel assemblies after being locked in position with a lubricant that is suitable for underwater operation, equal to the lubricant recommended by the manufacturer of the wheel roller bearings, and as approved. Apply additional lubricant at regular intervals until final acceptance of the work.

2.4.19.3 Roller Train Assemblies

Mount roller trains on the track plates with the gate leaf in the vertical position. Adjust roller guides so that the roller trains are in alignment and can traverse freely without binding and with a maximum sag of 19 mm 3/4 inch at the bottom. After the roller trains are mounted, maintain the gate leaf in a vertical position unless the roller trains are securely restrained from sagging.

2.4.19.4 Guide Shoes

Drill and ream guide shoes for bolting to the gate leaf while attached to the gate leaf. Locate the guide shoes accurately on the gate leaf in a true plane with each other in the upstream-downstream direction and parallel to the plane established by the downstream machined surfaces of the side bar supports for the seal assemblies. Provide shims as required.

2.4.19.5 Seal Assemblies

Attach seal assemblies to the gate leaf during shop assembly and remove for shipment. Fit the rubber seals of the assemblies accurately drill to match the seal retainers, match mark, and remove for shipment.

2.4.19.6 Lifting Beam Assembly

Shop assemble the lifting beam assembly in the sequence and manner shown. Check the balance of the completed assembly by lifting the assembly by the pick-up pin. If the lifting beam is out of true horizontal by more than 10 mm 3/8 inch, use counterweighting or some other method approved to balance the assembly at the Contractor's expense.

2.4.19.7 Dogging Devices

Shop assemble dogging devices completely. Drill pin holes in base plates and dogs with these components in assembly.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit certified test reports for material tests with all materials delivered to the site.

2.5.1 General

Perform tests, Inspections, and Verifications for materials the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.5.2 Testing of Rubber Seals

Test the fluorocarbon film of rubber seals for adhesion bond in accordance with ASTM D413 using either the machine method or the deadweight method. Cut a 25 mm 1 inch long piece of seal from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. Ensure there is no separation between the fluorocarbon film and the rubber when subjected to the following loads:

THICKNESS OF FLUOROCARBON FILM	MACHINE METHOD AT 50 MM2 INCHES PER MINUTE	DEADWEIGHT METHOD
0.762 mm0.030 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width
1.524 mm0.060 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width

PART 3 EXECUTION

3.1 INSTALLATION

Installation per the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Assemble miter gates and appurtenant items for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Thoroughly clean and lubricate bearing surfaces requiring lubrication with an approved lubricant before assembly and installation. Ensure components to be field-welded are placed in correct alignment before welding is commenced. Design and submit handling attachments and pick points required to be added to any specified items herein prior to installation.

3.1.1 Embedded Metals

Accurately install sill assemblies, seal plates, frames, bases and other embedded metal items required for proper and complete installation to the alignment and grade required to ensure accurate fitting and matching of components. Primer coat all embedded metals with the required paint on all surfaces prior to installation in concrete forms. Install anchors for embedded metals as shown. Attach items requiring two concrete pours for installation to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour. Grind smooth welded field splices in sealing surfaces of embedded items.

3.1.2 Gate Frame and Guides

****

NOTE: This paragraph must be edited to fit the project.

****

Connect gate frame and guides to embedded anchors, align, and rigidly block in place prior to the placement of second-pour concrete. Use the sealing surfaces of the slide gate frame seal bars as the reference plane for the installation alignment. Alignment by using two theoretical control planes described as control plane "A" and control plane "B". Control plane "A" is a vertical plane that is normal to the water passageway and is located at the sealing surface of the gate frame seal bars. Control plane "B" is a vertical plane that is parallel to the water passageway and is located at the centerline of the water passageway. Align the gate frame to within 0.381 mm 0.015 inch of control planes "A" and "B". Use a taut piano wire and an electric micrometer or some other approved method to measure the vertical alignment tolerances. Align the [wheel gate] [and] [roller gate] frame and guides such that planes through the bearing surfaces of track plates and the sealing surfaces of seal plates align to within 2 mm 1/16 inch of the alignment shown. Test gate frame and guides for proper alignment and clearances prior to being embedded in concrete by lowering and raising the gate leaf through the full operating range.

3.1.3 Gate Leaf

****

NOTE: Delete reference to rubber seals if not applicable for the project.

****

Assemble gate leaf completely, including the attachment of all components and accessories, prior to being placed in the gate frame. Take all necessary precautions to avoid distortion of the gate leaf and attached components during installation. Fasten rubber seals securely to metal retainers. Before operating the gate, apply a suitable lubricant to the rubber seal rubbing plates to protect the rubber.

3.1.4 Operating Machinery

****

NOTE: This paragraph must be edited to fit the project.

****

Position and align the operating machinery for the gate assembly and supporting components, including [bonnet,] [bonnet cover,] [pedestal,] [and] [base plate], to the installed location of the gate frame and guides and anchored in place. Project the location of the slide gate stem to the sill and scribe on the sill of the installed gate frame to serve as a reference point for the alignment of operating machinery and supporting components. Align operating machinery and components to within 0.762 mm 0.030 inch of the reference point. Bolt an alignment template, prior to being embedded in concrete, to the [bonnet,] [bonnet cover,] marked, and drilled to match the exact center point of the gate stem.

3.1.5 Concrete and Concrete Grout Placement

Perform the embedment of the gate frame and other components in concrete in an approved manner to fill all voids, secure anchorage, prevent seepage, and provide uniform finish surfaces. After embedment concrete has cured for at least 7 days, fill voids around embedded components by pumping concrete grout around the components. After the pumped grout has cured for at least 7 days, use hammer blows to the components to detect any remaining voids. Where remaining voids are located, drill 25 mm 1 inch diameter grout holes in the components and fill the voids pressure grouting through the grout holes. Plug the grout holes in the components by welding and grinding flush.

3.1.6 Painting

Paint exposed parts of the gate and appurtenance components, except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in concrete, and other specified surfaces, as specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.2 FIELD QUALITY CONTROL

Non-Destructive Testing of field welds are required to meet the same quality control requirements of shop-welded components.

3.3 SYSTEM START UP

3.3.1 Trial Operation

After the gate assembly has been installed, including operating machinery, the Contracting Officer will examine the complete system for final acceptance. Furnish all operation and test results to the Contracting Officer. The assembly will be examined first to determine whether or not the workmanship conforms to the specification requirements. Operate the gate throughout its full operating range a sufficient number of times to demonstrate proper operation. [Operate the gate from the remote control vault and the control panel in the control tower.] [Operation of hydraulic cylinders by use of compressed air will not be permitted.] Conduct the initial operation of the gate assembly in the dry. [With the gate leaf in the seated position and uniformly blocked so that the [wheels] [rollers] are in uniform contact with the track plates, check the rubber seals to ensure that they are uniformly compressed against the seal plates.] [Test the gate lock assembly by destructing one set of lock pins by inserting one set of pins in the lock position, permitting the weight of the gate leaf to rest on the pins, and using the hydraulic pressure system to break the pins by applying pressure to the top of the hydraulic cylinder. Adjust the pressure at the pressure reducing valve to its lowest setting and gradually increase it until the pins fail. Record the pressure reading at failure of the lock pins in the operation and test report. After completion of the test, replace the broken pins with new ones.] Conduct the second trial operation and testing of the gate assembly with the reservoir normal operating pool hydrostatic pressure. Ensure the workmanship in the fabrication and installation of the gate assembly causes the gate leaf to form a watertight barrier when lowered to the seated position. Make adjustments to the operation and control apparatus until all components function as required. Inspect the [lifting beam assembly,] [lifting sling,] [dogging devices,] and other appurtenances to assure proper operation. Make any and all required repairs or replacements to correct defects, as determined by the Contracting Officer, at no additional cost to the Government. Repeat the trial operation and testing after defects are corrected.

3.4 PROTECTION

Protect finished work in conformance with the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 20 16.54 (May 2021)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 35 20 16.54

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USACE / NAVFAC / AFCEC **UFGS-35 20 16.54 (May 2021)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 35 20 16.54

SLIDE GATES AND ACTUATORS

05/21

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NOTE: This guide specification covers the requirements for the fabrication, assembly, delivery, and installation of slide gates and actuators . This section was originally developed for USACE Civil Works projects.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 SCOPE

The work provided for herein consists of furnishing all plant, labor, materials and equipment and designing, manufacturing, factory testing, delivering, storing, installing and field testing [__#___] slide gates and actuators complete with all necessary accessories and appurtenances, all as shown on the contract drawings and specified herein. Cast-Iron slide gates must be constructed and assembled in accordance with AWWA C560. Fabricated Stainless-Steel slide gates must be constructed and assembled in accordance with AWWA C561. Electric actuators must meet the requirements of AWWA C542. Electrical work is specified in the applicable sections of Division 26 - ELECTRICAL.

1.2 GENERAL REQUIREMENTS

>The contract drawings indicate the requirements and general arrangement of the slide gates and actuators. The slide gates and assembly must fit into the allotted space and allow adequate acceptable clearances for installation, replacement, servicing, and maintenance. The following paragraphs may at times describe or refer to only one item, assembly or arrangement, but these requirements apply to all such items, assemblies or arrangements furnished and installed under these specifications.

1.3 MEASUREMENT AND PAYMENT

The slide gates will not be measured for payment. Payment will be made at the contract job price for "Slide Gates." Price and payment constitute full compensation for furnishing all plant, labor, material and equipment and designing, manufacturing, assembling, factory testing, preserving, delivering, storing, installing and field testing the gates, [including painting] and all appurtenant work, services and parts required.

1.4 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6010	(1997F) Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C542	(2016) Electric Motor Actuators for Valves and Slide Gates
AWWA C560	(2014) Cast-Iron Slide Gates
AWWA C561	(2012) Fabricated Stainless-Steel Slide Gates

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A351/A351M	(2024) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM B21/B21M	(2020) Standard Specification for Naval Brass Rod, Bar, and Shapes
ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B150/B150M	(2012; R 2017) Standard Specification for Aluminum Bronze Rod, Bar, and Shapes
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D4020	(2011) Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.5 DESIGN

The slide gates must be products of a manufacturer who has been regularly engaged during the past five years in the production of similar-sized gates for the design heads specified herein. Based on the heads specified, working stresses must not exceed the lower value of either one-half of the yield strength or one-fifth of the ultimate strength of the material. Design the gates accessories and appurtenances for installation as shown on the contract drawings.

1.6 ERECTING ENGINEER

Furnish the services of a competent erecting engineer to supervise and direct the installation and testing of the gates furnished under this section. Provide erecting engineer that is a full-time employee of, and designated as such by, the gate manufacturer, has at least five years of experience with the type of gate furnished under these specifications and will be subject to the approval of the Contracting Officer. The services of the engineer will be furnished at no extra cost to the Government. The installation and testing of the gates under the direction and supervision of the erecting engineer in no way relieves the Contractor of sole responsibility for the gates meeting all requirements of the specifications and fulfilling all the Contractor's guarantees.

1.7 WORKMANSHIP

All workmanship, whether in the factory or the field, must be performed in a skillful and professional manner by qualified mechanics under competent supervision and direction and in accordance with the best modern practice for the various trades involved and for the manufacture of high-grade machinery. All parts must have accurately machined mounting and bearing surfaces so that they can be assembled without fitting, chipping or remachining. All parts must conform to the design dimensions and be free of defects in either workmanship or material that will impair their service. All attaching bolt holes must be accurately drilled to the layout indicated on the shop drawings and dimensional outline drawings.

1.8 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item,

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G, [_____]

Dimensional Outline Drawings; G, [_____]

Furnish the Contracting Officer for his review and approval dimensional outline drawings, catalog data and other information and calculations for each size unit which will include at least the following:

(1) Name of actuator manufacturer.

(2) Model number and weight.

(3) Dimensional drawing.

(4) Descriptive bulletin, including a breakaway drawing illustrating all operating components, a parts list and materials of construction.

(5) Strength and durability HP ratings per AGMA 6010.

(6) The electric motor's HP rating, the starting, running, and locked rotor torques, full load and locked rotor amps.

(7) The maximum and operating stem opening and closing load.

(8) Equipment sizing calculations, including all related

factors and supporting literature.

(9) The maximum output of the motor operated actuator with the torque limiting switch inoperative.

(10) Calculations showing the required stem size and bracing required under condition (9) above for L/R < 200.

(11) Control wiring diagram.

SD-06 Test Reports

Quality Control Field Test Report; G, [_____]

Within three (3) days of a successful Quality Control Field Test, the Contractor must submit the Quality Control Field Test Report.

SD-10 Operation and Maintenance Data

Provide both electronic (PDF) and hard copies of Operation and Maintenance Manuals. All manuals and parts lists must be bound separately, be approximately 8-1/2 inches by 11 inches, printed on good quality paper and bound between flexible, durable covers. Drawings incorporated in the manual and/or parts lists may be reduced to page size provided they are clear and easily legible, or may be folded into the manual to page size. Photographs and/or catalog cuts of components may be included for identification. Submit the operation and maintenance manual and parts lists at the time of shipment of the gate actuators. Provide manuals for each type of slide gate and gate actuator.

Installation Manual; G, [_____]

Operation And Maintenance Manuals; G, [_____]

1.9 SUBMITTAL DESCRIPTIONS

The following subparagraphs describe in detail the submittals pertaining to the work specified in this section.

1.9.1 Shop Drawings

Submit complete shop drawings of the gate to the Contracting Officer for approval. Drawings of any items made specially or specifically for this project must be true shop drawings, but catalog cuts are sufficient for standard manufactured articles, and outline drawings of such equipment may be used in the assembly drawings. However, for those items for which true shop drawings are not required, sufficient descriptive data and/or other information, in addition to the catalog cuts, must be submitted to demonstrate compliance with the specifications. The embedded items and structural openings and clearances, which are dependent upon the gate design, must be included with the shop drawings.

1.9.2 Installation Manual

A minimum of 30 days prior to shipment of the slide gate and gate actuator, submit three (3) copies of the gate manufacturer's standard manual describing procedures to be followed by the field service representative in installing and adjusting the slide gates, gate actuators and appurtenances not furnished by the Government. The installation manual must be of such a nature that it may be comprehended by an engineer or mechanic without extensive experience in erecting slide gates of this type. The description must be a step by step explanation of operations required, and include, where applicable, such things as gate component alignment procedures, bolt torque values, limit switch setting adjustment, wedge block adjustment and similar details.

1.9.3 Operation and Maintenance Manuals

Submit five (5) hard copies of all operation and maintenance, lubrication, and repair manuals for all equipment not furnished by the Government. Submit also in electronic format (PDF). Furnish operation and maintenance manuals containing complete information in connection with the operation, lubrication, adjustment, routine and/or special maintenance, disassembly, repair and reassembly of the manual and electric motor driven gate actuators and appurtenances furnished under this section. Furnish copies of the manufacturer's spare parts lists and/or bulletins for the gate actuators and appurtenances. Clearly show all details and parts, and adequately describe all parts or have proper identification marks. Submit the operation and maintenance manual and parts lists at the time of shipment of the gate actuators.

1.10 QUALITY CONTROL

1.10.1 General

Establish and maintain quality control for slide gate operations to assure compliance with contract requirements and maintain records of quality control for all construction operations, including but not limited to the following:

(1) Machine work and electrical work.

(2) Shop painting.

(3) Galvanizing.

(4) Use of specified materials and equipment.

(5) Shop assembly and tests.

(6) Preparation for shipment and storage.

(7) Inspection at the worksite for damage to and defects in all material and equipment.

(8) Storage at the worksite.

(9) Field painting.

(10) Installation and tests.

(11) Operation and maintenance after installation.

1.10.2 Reporting

The original and four copies of these records of inspection and tests, as well as the corrective action taken, must be furnished to the Government daily. Format report as prescribed in Section 01 45 00 QUALITY CONTROL.

1.11 PREPARATION FOR SHIPMENT

Prior to shipment from the manufacturer's plant, prepare the gate for shipment as described herein. All large, bulky and/or heavy, greater than [50][_____] kilograms[100][_____] pounds, elements must be mounted on skids or pallets of ample size and strength to facilitate loading and unloading. Pack all small parts in sturdy wood or heavy corrugated paperboard boxes. Provide a packing list, indicating the contents of each such box and enclose in a moisture-proof envelope securely fastened to the outside of the box. The skid and/or pallet mounting and the boxing must be done in a manner which will prevent damage to the gate during loading, shipment, unloading, storage and any associated and/or subsequent handling. Provide Weatherproof covers during shipment to protect all items which the Contracting officer designates as requiring such protection. Any special slings, strong backs, skidding attachments or other devices used in loading the equipment at the manufacturers' and/or fabricators' plants must be furnished for unloading and handling at the destination and become the property of the Government.

1.12 PREPARATION FOR STORAGE

At the conclusion of all shop tests, the gate must be protectively processed for not less than 24-month storage either outdoors or indoors as the case may be, at the destination. Furnish for approval, a complete description of the processing method or methods intended to use, including complete instructions for maintaining the protection during the storage period. Surfaces of items or portions of items which are to be embedded in or rest on concrete, must be cleaned of all dirt, rust, and other foreign coatings, not including closely-adhering mill scale, and then coated with a rust preventative.

1.13 STORAGE

Upon delivery at the worksite, bulky parts of the gates, such as the frames, slides and wall thimbles, which have been coated with a complete paint system in the manufacturer's plant, may be stored outdoors provided these parts are stored on wood blocking not less than 8 inches above a base of washed gravel or crushed stone not less than 2 inches thick. All other parts of the gates such as the gate stem, fasteners, and actuators store in a weathertight building. A framework covered with a plastic film, or any other such expedient or makeshift arrangement, will not be acceptable. Inspect the storage site at least once per day. Submit a detailed description of the proposed storage facilities, and a plan for storage maintenance and inspection, before any storage actually begins.

1.14 SAFETY

The Contractor is responsible for selection of plant operating equipment to ensure safe installation of the equipment specified herein, at the worksite, based upon the local working conditions, including site-specific restrictions for utilities, access or environmental conditions. Provide all equipment, labor and power, required for ventilation at the worksite in order to ensure a safe working environment in accordance with EM 385-1-1, Safety and Health Requirements Manual, as well as any local, State, or National codes which apply to the work or work environment. The Contractor must test the air quality for toxicity, flammable gas and percentage of oxygen content prior to entering, and continuously during any work in an enclosed area. Use an air quality monitor from a recognized manufacturer to test the air quality.

1.15 WARRANTY

The Contractor must furnish to the Government, under separate cover, the manufacturer's standard commercial warranty for each size sluice gate and gate actuator, but not less than a minimum of 1 year warranty must be provided.

1.16 MAINTENANCE

After completion of the installation, continue to maintain and protect the gate and keep it ready for operation at any time until acceptance thereof. Provide electrical power in accordance with applicable Sections in Division 26 - ELECTRICAL for all operation and testing of the gates until final acceptance by the Government.

PART 2 PRODUCTS

2.1 MATERIALS

All materials must be free from defects and imperfections, of recent manufacture and unused, and of the classifications and grades specified herein unless otherwise approved by the Contracting Officer. Material not specifically described, as far as practicable, conform to the latest specifications of the American Society for Testing and Materials. All materials, supplies and articles not manufactured by the Contractor must be the products of recognized reputable manufacturers. Submit samples of materials for approval when so directed. Equipment, materials and articles installed or used without such approval are at risk of subsequent rejection.

2.1.1 Iron Castings

Material for iron castings must meet the applicable requirements of either ASTM A48/A48M for Class Nos. 30A, 30B or 30C or ASTM A126 for Class B.

2.1.2 Structural Steel

Structural steel used for shop fabricated items such as the gate actuator pedestals must meet the applicable requirements of ASTM A36/A36M. The contrctor may submit other gate material for approval.

2.1.3 Bronze

Bronze castings for such items as wedges, thrust nuts, lift nuts and couplings must meet the applicable requirements of ASTM B584 for Copper Alloy No. 865. Bronze extrusions for seat facings in the frame and slide must meet the applicable requirements of ASTM B21/B21M for Copper Alloy No. 464 or No. 482. Bronze for adjusting screws and lock nuts must meet the applicable requirements of ASTM B98/B98M for Copper Alloy No. 651 or No. 655. or ASTM B150/B150M for Copper Alloy No. 614, No. 623, or No. 630.

2.1.4 Stainless Steel

Stainless steel rods for stems must meet the applicable requirements of ASTM A276/A276M for Type 304 or 316. Stainless steel for fasteners must meet either the above-mentioned specification or the applicable requirements of ASTM F593 alloy group 1 Type 304. Stainless steel for slides and frames must meet the applicable requirements of ASTM A276/A276M for Type 304 or 316 or ASTM A240/A240M for Type 304L or 316L.

2.2 EQUIPMENT

The following equipment, together with all necessary accessories and appurtenances, must be installed. The following paragraphs may at times describe or refer to only one item, assembly, or arrangement, but these requirements apply to all such items, assemblies, or arrangements furnished under these specifications.

2.2.1 Gate

The [_____] gates for control structure [_____] must fit an opening [xx inches] wide X [xx inches] high, be designed for a maximum head of [xx feet] and an operating head of [x feet], and withstand an unseating head of [x feet]. Each gate must be cast-iron, fully bronze mounted, have side wedging devices for seating heads, and be the rising stem type. Each gate must be stainless steel, non self-contained, rising stem, standard bottom closure type. Cast-iron gates must meet the requirements of AWWA C560. Fabricated stainless steel gates must meet the requirements of AWWA C561.

[

No. Required	Opening Size	Location	Seating Head FT	Unseating Head FT	Type of Actuator	Type of Invert
1	in x in					

]

2.2.2 Frame

The frame must be the flat back type and of one piece, cast-iron construction. All contact surfaces of the frame must be machine-finished. The frame must have machined dovetail type grooves on its front face to accommodate the seat facings. The back face of the frame must be drilled and machined to bolt directly to the machined face of the thimble. Drill all bolt holes using templates to match the thimble. The frame must have integrally cast pads with machined surfaces and keyways to receive the side, wedging devices.

Construct the frame assembly of formed stainless steel plate with a minimum thickness of 1/4 inch. The frame must be of the flange back type design for mounting on a concrete wall with the use of embedded adhesive anchor bolts and grout pad. Size and spacing of anchor bolt holes must be suitable for the operating conditions of the gate. Anchor bolt hole spacing must not exceed [12 inches]. The frame must be of the [non self-contained] [self-contained] design. Design the frame sufficiently rigid to transfer hydrostatic loads to the gate anchorage. The frame must positively retain the polymer guide/seal strip and the neoprene loading pad on studs welded to it. Use non-loosening fasteners on the gate guide assembly.

2.2.3 Guides Guides and Seals

The guides must be of one-piece, cast-iron construction, conservatively designed to withstand the total thrust due to the water pressure and the wedging action. The guides must be machine-finished on all contact surfaces, and machine a groove the full length of the guide to provide sufficient clearance between the slide tongue and the guide groove to permit free movement and ensure proper engagement of the wedging devices. The guides must have machined areas on their front faces for at least one-half the vertical gate opening and be sufficiently long to retain and support at least one-half of the slide when the gate is in the full-open position. Attach the guides to the frame with steel and bronze fasteners and dowel to prevent relative motion between the guides and frame. Provide integrally cast pads with machined surfaces for attachment of the wedging devices.

The length of the guide must retain at least 2/3 of the slide height in the full open position. The guides must be conservatively designed to withstand the total thrust due to the water pressure. The guide seals must be specially milled or molded ASTM D4020 to positively retain the slide, form a tight seal, and restrict leakage. Seals must prevent metal to metal contact between the frame and slide. Sealing must be accomplished by pinching action of the polymer guide seal. Provide gate with a self-adjusting seal system to restrict leakage in accordance with the requirements of this specification. The guide seal assembly must be field adjustable and replaceable. The UHMW sealing system must maintain efficient sealing in any gate position.

2.2.4 Slide

The slide must be either square or rectangular and of one-piece, cast-iron construction with integrally-cast vertical and horizontal ribs and a reinforced section around the perimeter to provide for the seat facings. The slide must have machined areas on its seating face to accommodate the seat facings. Provide a tongue on each side of the slide, which extends its full length and machined on all sides to provide sufficient clearance between the tongue and the guide groove to permit free movement. Integrally cast pads must be provided and machine-finished to receive the wedges. A stem nut pocket must be cast integrally on the vertical centerline and above the horizontal center and be shaped to receive the stem nut.

The slide must be either square or rectangular and formed of welded stainless steel plate with integrally formed reinforcements at the top and bottom with welded interior reinforcements. The slide must have at least one vertical reinforcement on or adjacent to the vertical center line. All edges and corners must be rounded and polished for smooth operation within the guide seal assembly. Incorporate measures for attaching the stem to the gate with a clevis-type connection welded to the slide.

2.2.5 Wedging Devices

The gate must be provided with sufficient side wedging devices to limit leakage to 0.1 gallon per minute per foot of perimeter at the specified maximum seating heads. The wedging devices must be of solid cast bronze, machine-finished on all contact surfaces and keyed to the cast-iron pads to maintain adjustment. The wedging devices must be attached with either bronze or steel studs and bronze nuts, and the adjustable element be provided with a bronze adjusting screw with either a bronze lock nut or another approved locking device.

The gate must be provided with top wedging devices if recommended by the manufacturer to provide a practical degree of water-tightness. The wedging devices must be stainless steel castings and held onto the slide reinforcing member with two inline welded studs with backing plate. The wedging devices must be adjustable and provided with a positive means of locking. Wedging devices must be one piece and removable and replaceable without disassembly of other gate parts. Material for stainless steel castings must meet the requirements of ASTM A351/A351M-CF8M.

2.2.6 Seat Facings

Seat facings must be of extruded bronze. The facings must be of a special shape which, when impacted into place, will fill and be locked permanently into the dovetail-type grooves in the frame, and gate slide. Other methods of attachment will not be permitted. The width of the facing must be not less than 3/4-inch. After attachment, machine the facing to a plane surface and to at least a 63 micro-inch finish. The seal must be a specially molded shape designed to produce a wide sealing area on the machined stop bar bolted to the frame. The differential sealing pressure of the seal on the stop bar must be capable of being varied by adjustment of the side wedging devices. When the gate slide is in the fully closed position and wedged into position against the frame, the maximum clearance between the seating faces must not exceed 0.004 inch.

2.2.7 Wall Thimble

The wall thimble must be of one-piece, square front flange with a square opening made of cast-iron construction ASTM A126 or approved equal. The wall thimble must be of the "F" Type design unless the gate manufacturer requires an "E" type design based on the unseating heads present. Provide the thimbles with an integrally cast ring or water stop. The front flange face must be machine finished to a plane surface and provided with tapped holes, using a template to match the drilling of the frame. The vertical centerline must be clearly shown by permanent marks at the top and bottom of the machined surface and permanently mark the word "TOP" thereon. Provide the thimble with holes in the invert to permit satisfactory concrete placement. Provide a permanent gasket of uniform thickness between the front face of the thimble and the back face of the frame.

2.2.8 Stem, Couplings and Stem Guides

The stem must be of sufficient diameter to withstand, without buckling or permanent distortion, the stresses induced by closing the gate under locked torque conditions. Stem threads must be either machine-cut or cold rolled and of the double-lead ACME type. The stem and nut threads must have sufficient contact area so that the contact pressure will not exceed 5,000 psi when the maximum stem thrust is exerted. The stem thread surfaces in contact with the lift nut must have not rougher than a 63 micro-inch finish if machine cut and not rougher than a 32 micro-inch finish if roll-formed. The exterior corners of the threads, either during or after machining, must be given a slight radius of approximately 0.015-inch in order to prevent them from acting as cutting edges as the stem passes through the lift nut. The stem must be of corrosion-resisting steel. Fit the stem with a tapped hole in the top end for handling. Make the tapped hole of sufficient diameter and depth for the insertion of an eyebolt of sufficient strength to pick up the entire stem from a horizontal position. Provide the stem at its lower end with a bronze thrust nut which will fit into the pocket provided on the gate slide and which will positively prevent rotation of the stem. Stem guides must be of cast-iron, bronze bushed and mounted on cast iron brackets. Drill and slot stem guides to be adjustable in two directions and space at close enough intervals to support the stem adequately with an L/R ratio of not more than 200. The bronze bushing must be machine-bored 1/16-inch to 1/8-inch larger than the stem diameter. The stem guide, including the bronze bushing, must be the two-piece collar type which can be installed and removed with the stem in place. Attach stem guides with corrosion resistant steel anchor bolts.

2.2.9 Top and Bottom Seal

The top seal must be made of UHMW polyethylene attached to the top horizontal frame member. Provide seals with elastomer loading pads or continuous compression cords in order to ensure contact between the UHMW polyethylene and gate. Corners or intersections of seals and loading pads or compression cords be interlocked and sealed for a leak-proof joint. The bottom seal must be made of resilient neoprene attached to the bottom horizontal frame member and form a tight seal.

2.2.10 Anchor Bolts

New anchor bolts must be installed for the stem guides and actuator pedestal and fabricated slide gate frame if required. The anchor bolts must be adhesive anchors with stainless steel threaded rods provided with bronze nuts. The quantity, size, spacing, minimum pullout strength and required effective embedment depth of the anchors must be determined and provided by the manufacturer.

2.2.11 Fasteners

All fasteners must be of either silicon bronze or stainless steel. The quantity and size of fasteners per recommended by the gate manufacturer. Thread standards must meet the requirements of ASME B1.1

2.2.12 Stem Cover

Provide a stem cover for each slide gate actuator. The stem cover must be of galvanized steel pipe of sufficient diameter and length to permit full travel of the stem without obstruction or binding. The top of the cover is to be closed with a galvanized steel pipe cap. The pipe cap must have a drilled and tapped hole fitted with an eyebolt of sufficient strength for lifting the assembly from a horizontal position. The stem cover must have a grease fitting, which can be used for lubricating the stem, installed above the threads used for mounting the cover to the actuator. The cover is to be threaded into the top of the actuator to prevent rainwater entry. Prior to assembly, threaded portions of the stem cover, cap, and eyebolt are to be coated with pipe compound. After installation of the cover, clean exposed threads and degrease, then apply a heavy coat of an approved zinc-rich protective coating.

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NOTE: Designer select either paragraph MANUALLY OPERATED GATE ACTUATOR or paragraph ELECTRIC MOTOR DRIVEN GATE ACTUATOR based on project requirements.

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[2.3 MANUALLY OPERATED GATE ACTUATOR

Open and close each slide gate by means of a manual crank-operated actuator having either a single or double gear reduction depending upon the load and mounted as shown on the drawings. The actuator must have cast bronze lift nuts threaded to match and engage with the stem threads. Provide the lift nuts with ball thrust or tapered roller bearings both above and below the flanges on the lift nut to accommodate the opening and closing thrusts. The actuator housing must be cast iron. Provide adjustable stop collars for installation on the stem just above the lift nut and accessibly below the hoist. All gearing must be steel and have accurately machine-cut teeth. Positive mechanical seals to retain lubricant and exclude dirt and moisture are to be provided on the lift nut and pinion shafts where they extend through the housing. Provide lubrication fittings for lubrication of all gears and bearings. A removable cast-iron crank with a rotating brass grip and a maximum radius of 380 mm15 inches must be provided. Fit the actuator with a 2 inch square nut for operation with a portable electric drill. Design the actuator such that a maximum force of 178 N40 pounds at a 380 mm15 inch radius will unseat the slide from its wedging devices at maximum design head. After the slide is unseated from its wedges a maximum force of 111 N25 pounds at a 380 mm15 inch radius must operate the gate.

The actuator unit must include a cast-iron pedestal, drilled and machined to accommodate the gear and lift nut housing, arranged to be bolted to the operating platform, and designed to position the input shaft about 900 mm36 inches above the platform. An arrow or arrows, with the word "OPEN" adjacent thereto, must be either permanently attached to or cast on the housing to indicate the direction of rotation to open the gate. Affix a brass instruction plate to the gate actuator stating manufacture, lubrication cycle and type of lubricant to be used.

][2.4 ELECTRIC MOTOR DRIVEN GATE ACTUATOR

2.4.1 General

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NOTE: Designer - The process for calculating gate actuation forces are described in AWWA C560 and AWWA C561 and Engineering Manual EM 1110-2-3105. EM 1110-2-3105 provides detailed sketches showing how these forces are applied.

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Each slide gate must be opened and closed by means of an individual electric motor actuator unit driven by an electric motor and mounted on the operating platforms as shown on the contract drawings. The unit must consist of complete, compact, rugged assemblies specially designed and manufactured for the required service by a manufacturer regularly engaged for at least 5 years in the production of this type of device, and be delivered completely wired, assembled and ready for installation. All parts of the lift mechanism must be designed to move the gate slide at a rate of approximately 1 foot per minute under the specified operating head condition. The actuator must be designed in conformance with the latest edition of standard practices of AGMA 6010. Gate actuation forces must follow the requirements as shown in Appendix A of AWWA C560 and AWWA C561.

The gate actuator requirements must be computed using the following formula:

(a) $F_u = 62.4 \times H \times A \times f_u + (W_g + W_s)$

(b) $F_n = 62.4 \times H \times A \times f_n + (W_g + W_s)$

Fu = Minimum required unseating stem force, pounds

Fn = Minimum required stem force, pounds, after unseating

H = Operating head of water at gate disk centerline, feet

A = Area of gate opening, square feet

fu = 0.6 unseating friction factor

fn = 0.3 friction factor after unseating

Wg = Weight of gate disk, pounds

Ws = Weight of gate stem, pounds

2.4.2 Electric Gate Actuator Assembly

The electric motor for the gate actuator must have a continuous duty rating, be suitable for operation on a [240] [480] volt, 3 phase, 60 Hz circuit, have sufficient horsepower to operate the actuator unit through the full gate travel in both directions without exceeding the full load ampere rating, and conform to applicable requirements of NEMA MG 1. All bearings must be the anti friction type.

Actuator limit switches, torque switches and unit wiring must be provided in accordance with applicable section of Division 26 - ELECTRICAL. All components including the motor, reversing contactors and overload relays, pushbuttons, indicating lights, control transformer, reductions gearing, stem lift nuts, bearings and limit switches, must be enclosed in NEMA Type 4 enclosures and mounted on a cast iron pedestal with flanged base plate, complete with stainless steel anchor bolts and silicon bronze or stainless steel nuts. Design the pedestals to position the handwheel approximately 3 feet above the operating room floor on the standard slide gate installation.

a. Reduction gearing must consist of generated helical gears of heat-treated steel. Worms are to be of hardened alloy steel with threads ground and polished. The worm gear must be in one piece of high strength cast bronze. Run all reduction gearing in lubricant. All gears, the stem lift nuts and other working components must be carried on heavy duty ball or tapered roller bearings adequate for all torque and thrust loads imposed by operation of the gate at the specified maximum heads. Provide suitable seals at all points as required to retain the lubricant. Design the motor actuator to permit manual operation of the unit in event of power failure or as necessary during servicing.

b. Provide a handwheel, and an arrow with the word "OPEN" cast on the rim of the wheel, indicating the direction of opening. Effort required to operate the actuator manually with the gate in motion must not exceed 40 pounds at the wheel rim, and 80 pounds at the wheel rim to unseat the gate. The motor actuator must include a built in clutch mechanism so that the handwheel will not rotate during motor operation nor turn during manual operation. Locate a dial type indicator at the top of the motor actuator to show gate position during both hand and motor operation. The indicator must be graduated to show "FULL OPEN" when the bottom of the gate is at the fully open position. House the indicator in a watertight enclosure. Indicators which are of the 3-position type showing fully open, fully shut or in an intermediate position are not acceptable. The actuator must be able to watch the indicator from the same position one stands in to operate the controls.

c. The operating unit must include a built in, lost motion device which will permit the motor to attain full speed after which a hammer blow must be imparted to the hoisting mechanism to initiate gate motion in either the opening or closing direction of travel. Supply bronze lift nuts, made in two pieces with accurately machined splines or keys and threads. The two piece nut consists of an outer member, having a flange or flanges on the exterior and splines on the interior, which mates with an inner member having splines on the exterior and threads on the interior. The outer member must be mounted in the unit housing. Secure the inner member to the outer member by either a threaded retainer ring or another suitable arrangement.

d. After the gate has been either completely closed or securely supported in the partially open position, this inner member must be capable of being easily removed by disassembling its retaining arrangement and turning the handwheel. Each stem nut must be adequately designed, factory tested and inspected with the stem with which it will operate. Run each nut by hand throughout the length of the stem with which it will operate. Suitable marks must be used to identify the matched sets once they have been established in the shop. The internal thread must have the lower or non working face relieved 1/64 inch to ensure that the threads will bottom out before wedging can occur. Drill the lift nut or otherwise provide with adequate oil recesses and passages to ensure passage of lubricant to all interior threaded surfaces of the nut. The internal arrangement of the motor actuator units must be such that all moving parts run in lubricant, with adequate fittings and seals provided to retain the lubricant. Use lubricant per recommendations by the gate actuator manufacturer.

2.4.3 Limit Switches

The closing and opening travel of each gate must be protected against overload by torque-responsive mechanical switches, one for each direction of travel. Provide geared limit switches for stopping the gate at both the fully closed and the normal fully open positions. The torque switches must be operative during the entire travel of the gate to protect the stem and gate against possible damage in the event an obstruction is met. The torque switches must function without auxiliary relays or other devices and be field-adjustable to ensure (1) stopping the lowering operation of the gate should the stem load for any reason become compressive to a degree greater than the normal seating requirements, and (2) stopping the raising operation should a 100 percent overload develop. Provide position limit switches thar are adjustable and of the intermediate gear type, governed by rotation of the motor driving mechanism. Internal motor control wiring for 120 volt operation and motor power wiring for [240] [480] volt, 3 phase, 60 Hz operation must be provided complete to a suitable terminal block in the limit switch compartment, and clearly mark terminal blocks in a suitable manner to facilitate external control and power connections under another section of these specifications. All internal wiring must be not smaller than No. 12 stranded copper conductor with not less than 3/64-inch thick "NEOPRENE" or equal insulation and not less than a 1/64-inch thick "NEOPRENE" or equal jacket.

2.4.4 Gate Actuator Controls

2.4.4.1 Controls

Mount all controls on the side of limit switch compartment door with a hinged, padlockable, vandal resistant cover of at least 1/8 inch plate thickness and of NEMA Type 4 construction.

(a) Control Switch: One (1) selector switch with two positions, Open and Close.

(b) Selector Switch: One (1) heavy duty selector switch, five-position type with legend plate. Label the five positions LOCAL-STOP-OFF-STOP-REMOTE.

(c) Pilot Lights: Two (2) solid-state indicator LEDs for long life and ease of replacement with legend plates. Green for fully opened and red for the fully closed position.

(d) Legend Plates: Made of corrosion-resistant metal with permanent marking made by machine engraving or machine stamping; hand engraving, such as would be done with an engraving pencil, is not acceptable. Plates must be screwed or bolted in place.

2.4.4.2 Internal Control Features

In addition to the limit switches specified above, provide the following control features:

(a) A motor overload protective device in each phase.

(b) A terminal block with connectors for all external control signals. Route all leads from the actuator motor and limit switch assembly to terminal connections in the controller for external connections to other station control devices.

(c) A reversing controller which is both mechanically and electrically interlocked and provided with the necessary direct operated auxiliary contacts for required interlocking and control.

]PART 3 EXECUTION

3.1 PAINTING

Each cast-iron slide gate and actuator must be painted with a complete coating system in accordance with the manufacturer's standard practice, in which case it will be exempted entirely from the surface preparation and painting requirement specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES, provided the coating system is approved by the Contracting Officer, is of acceptable color and is touched up as necessary prior to shipment. Requests for such exemption must be accompanied by a description of the manufacturer's standard coating system, including the surface preparation, type of primer and finish coat or coats, dry film thickness and whether baked on or air dried. Fabricated stainless steel slide gates do not require painting.

3.2 LUBRICATION AND LUBRICANTS

Lubricate each actuator prior to any use or operation, either in the shop or in the field. Lubriacte each bearing through its associated lubrication fitting, and pack the gears with lubricant at assembly. After shop testing, and prior to shipment, relubricate the bearings. Prior to testing in the shop, and to initial operation in the field, the gate seat facings and wedging devices must be cleaned of all foreign material and lubricated thoroughly with a light grease. Just prior to field assembly, lubriacate the lift nut and stem threads. All lubricants must be as recommended by the gate and actuator manufacturer and be submitted by manufacturer's name and number as part of the shop drawings. Furnish an additional 20 poundsof each different actuator lubricant at no additional expense to the Government.

3.3 SHOP ASSEMBLY AND TESTS

After completion of initial machining, all gates must be completely assembled, in the vertical position, and the wedging devices adjusted to exclude a 0.004-inch thickness gage between the frame and slide seating surfaces. Perform any additional machining needed to achieve this condition, any discrepancies or deficiencies discovered as a result of this procedure must be corrected, and a retest conducted. Open and close the slide in the guides several times to ensure that it operates freely. Disassemble the gate to the extent necessary for shipment. The Contractor must notify the Contracting Officer sufficiently in advance (minimum 72 hours) so that a representative of the Contracting Officer may witness the assembly, testing and disassembly work, unless this requirement is waived in writing by the Contracting Officer. Any malfunctions or discrepancies disclosed as a result of these tests must be promptly remedied by the Contractor at no additional expense to the Government, and retests conducted.

3.4 FIELD INSTALLATION AND TESTS

3.4.1 Installation

Installation of the gates, actuators and appurtenances must be in accordance with the manufacturer's installation instructions and under the supervision and direction of the field service representative specified in paragraph "Erecting Engineer". Clean all elements of the gate of any protective coatings used thereon during shipment and storage, and remove all rust, dirt, grit and other foreign matter. The gate and actuator must then be "touch-up" painted. The actuator and each element of the gate must be carefully and accurately aligned so that after it is fastened in place there will be no binding or excessive pressure or wear in any moving part and no distortion of any member. Where the frame is attached to the structure by use of a wall thimble, apply mastic to the wall thimble contact surface per the manufacturers recommendation. Internally brace the wall thimble during concrete placement. Adjust each wedge assembly to ensure the specified minimum seal clearances without bending of wedge hooks or other damage to the wedges. Tighten fasteners uniformly and firmly, but take care to not overstress either the fastener or the member with which it is associated. Where specific torque values or ranges are cited in the installation instructions, an accurately calibrated torque-wrench, having the proper capacity range, is required. Stilson wrenches, cold chisels, or other tools likely to cause injury to the surface of any part, are not permitted for use in the work of assembly or tightening. Install all fasteners with an anaerobic locking compound. Cleaning prior to application of the locking compound per the manufacturer's recommendations. All shims must be of either bronze or corrosion-resisting steel. Where grouting is required, either an epoxy grout or a ready-to-use, non-shrinking grouting material conforming to the applicable requirements of ASTM C1107/C1107M, requiring only mixing with water at the worksite, must be used, and use of any grouting as recommended by the manufacturer. All blocking and wedges used for support during initial grouting are to be removed prior to final grouting.

3.4.2 Field Tests

3.4.2.1 Quality Control Tests

The gates and actuators must be operated and tested by and at the expense of the Contractor and under the supervision and direction of the Erecting Engineer to determine if they have been properly manufactured, assembled, and installed and if they meet the requirements of the specifications. No Government representatives will be present during these tests. After all position and torque limit switches have been set, raise and lower the gate slide not less than three times using the electric motor operated gate actuator. Measure and record the operating current each time the gate is raised. Also raise and lower the gate slide approximately 6 inches using the manual handwheel. After completion of these tests the gates are to be fully closed and an inspection made of each of the seals to verify proper clearance between the seals at all points as specified or per the manufactuerer's recommendation. Adjust gate wedges and seals as required to acheive neccessary clearance for a proper seal. The Contractor must prepare a Quality Control Field Test Report indicating the test date, personnel present, number of times the gate was operated, operating current measured and written verification from the gate manufacturer's Erecting Engineer that all gates have been properly installed and adjusted and tested successfully.

3.4.2.2 Quality Assurance Tests

The gates and actuators must be operated and tested by and at the expense of the Contractor, under the supervision and direction of the Erecting Engineer and in the presence of representatives of the Contracting Officer to determine if they have been properly manufactured, assembled, and installed and if they meet the requirements of the specifications. These tests will be conducted a minimum of ten (10) days after receipt of the Quality Control Field Test Report. Raise and lower the gate a minimum of three times using the electric motor operated gate actuator. The Contractor must measure and record the operating current and motor amperage each time the gate is raised and lowered. Recorded operating current and motor amperage must be within manufacturer specified tolerance. The gate slide must also be raised and lowered approximately 6 inches using the manual handwheel. After the raising and lowering of the gates is completed the gates are to be fully closed and an inspection made of each of the seals to ensure that there is less than 0.004 inch clearance between the seals at all points or per recommeded by the gate manufacturer if otherwise approved. If any gate indicates a seal clearance in excess, that gate will be adjusted as required the rechecked. Any malfunctions or discrepancies disclosed as a result of these tests must be promptly remedied by the Contractor at no additional expense to the Government, and retests conducted. [Contractor to develop a gate leakage test and submit for approval.]

3.5 MAINTENANCE

After completion of the installation, the Contractor must maintain and protect the gates and gate actuators and keep them ready for operation at any time until acceptance thereof.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 20 16.59 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16.59 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 20 16.59

HYDRAULIC CLOSURE GATES

08/22

PART 1 GENERAL

PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-35 20 16.59 (August 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 16.59 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 35 20 16.59

HYDRAULIC CLOSURE GATES
08/22

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NOTE: This guide specification covers the requirements for furnishing all plant, equipment, labor, and materials (except materials specified to be furnished by the government) for fabricating, assembling, delivering, and installing closure gates in accordance with these specifications and applicable drawings. This section was originally developed for USACE Civil Works projects.

Certain components of a Closure Gate may be considered fracture critical. These components may include the gudgeon hood, gudgeon anchorage, diagonals, as well as others. AWS D1.1 does not include provisions for fracture critical welding. The Designer should consider using guide specification SECTION 05 59 20 FABRICATION OF HYDRAULIC STEEL STRUCTURES for specifying fracture-critical welding utilizing a Fracture Control Plan. A Fracture Control Plan and the use of appropriate materials and welding is required by ER 1110-2-8157, "Responsibility for Hydraulic Steel Structures."

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

1.1 UNIT PRICES

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NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

Select Alternate 1 (one pay item) or Alternate 2 (two pay items). Delete all paragraphs of Alternate not selected.

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1.1.1 Furnishing and Installing Closure Gates

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NOTE: Alternate 1.

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1.1.1.1 Payment

Payment is made for costs associated with furnishing and installing closure gates and appurtenant items, which includes full compensation for the materials, fabrication, delivery, installation, and testing of closure gates and appurtenant items including gate leaves, diagonals, strut connections, miter guides, closure latches, recess latch strikes, quoin and closure blocks, gudgeon top anchorages, pintle assemblies, [walkways,] [bridgeways,] gudgeon embedded anchorages, wall quoins, sill assemblies, seal assemblies, recess latches, bumpers, fenders, and all other items necessary for complete installation.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Furnishing Closure Gates

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NOTE: Alternate 2.

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1.1.2.1 Payment

Payment is made for costs associated with furnishing closure gates and appurtenant items, which includes full compensation for the materials, fabrication, and delivery of closure gates and appurtenant items including gate leaves, diagonals, strut connections, closure guides, closure latches, recess latch strikes, quoin and closure contact blocks, gudgeon top anchorages, pintle assemblies, [walkways,] [bridgeways,] gudgeon embedded anchorages, wall quoins, sill assemblies, seal assemblies, recess latches, bumpers, fenders, and other items necessary for complete installation.

1.1.2.2 Unit of Measure

Unit of Measure: lump sum.

1.1.3 Installing Closure Gates

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NOTE: Alternate 2.

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1.1.3.1 Payment

Payment is made for costs associated with the installation of closure gates and appurtenant items, which includes full compensation for the complete installation and testing of closure miter gates and appurtenant items.

1.1.3.2 Unit of Measure

Unit of measure: lump sum.

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A1	(2000; R 2018) Standard Specification for Carbon Steel Tee Rails

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A148/A148M	(2024) Standard Specification for Steel Castings, High Strength, for Structural Purposes
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A320/A320M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A709/A709M	(2024) Standard Specification for Structural Steel for Bridges
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B6	(2023) Standard Specification for Zinc
ASTM B22/B22M	(2017) Standard Specification for Bronze

	Castings for Bridges and Turntables
ASTM B148	(2024) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B823	(2020; R 2024) Standard Specification for Materials for Nonferrous Powder Metallurgy (P/M)Structural Parts
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D413	(1998; R 2017) Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D572	(2004; R 2019) Rubber Deterioration by Heat and Oxygen
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1928	(Rev C; Notice 1; Notice 2; Notice 3; Notice 4) Padlock (Combination)
FS RR-C-271	(Rev H; Am 1) Chains and Attachments, Carbon And Alloy Steel
FS RR-W-410	(2022; Rev J) Wire Rope and Strand

[1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Sequencing and Scheduling

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NOTE: The name of the appropriate railroad company or roadway agency should be inserted as indicated.

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Submit a sequencing and scheduling plan, approved before the work is commenced, which illustrates that work affecting [railroads] [roadways] has been coordinated with [_____]. Include in the plan schedules, lists of labor or materials to be provided the affected [company] [agency], and any other aspects of the work that may impact on the operations of these entities as specified in Section SPECIAL CONDITIONS. Ensure the protection plan clearly demonstrate how all [railroad tracks] [public or private roads, streets, or highways] will be kept open to traffic at all times during the construction period, except as otherwise specified or directed. Refer to Section SPECIAL CONDITIONS for other requirements such as warning signs, flagmen, permits, and debris removal.

]1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, [_____]

Shop Assembly Drawings; G, [_____]

Delivery Drawings; G, [_____]

Field Installation Drawings; G, [_____]

Sequencing and Scheduling; G, [_____]

Anchorage of Overhead Support Beam; G, [_____]

Stress Relieving Plan; G, [_____]

Fracture Control Plan (FCP); G, [_____]

Handling Attachments And Pick Points; G, [_____]

Diagonals Prestressing Plan; G, [_____]

SD-03 Product Data

Materials

SD-04 Samples

Materials; G, [_____]

SD-06 Test Reports

Tests, Inspections, and Verifications

Diagonal Prestressing Record

SD-07 Certificates

Epoxy Filler

1.5 QUALITY ASSURANCE

1.5.1 Qualification of Welders

Welders and welding operators are required to conform to the qualification requirements included in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

1.6 DELIVERY, STORAGE, AND HANDLING

Perform delivery, handling, and storage of materials and fabricated items conforming to the requirements specified[herein and] in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.[Unload materials and equipment delivered to the site as approved by the Contracting Officer. Verify the condition and quantity of the items delivered and acknowledge receipt and condition thereof in writing. If delivered items are damaged or a shortage is determined, notify the Contracting Officer of such in writing within 24 hours after delivery.]

1.6.1 Rubber Seals

Store rubber seals in a place which permits free circulation of air, maintains a temperature of 20 degrees C 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Keep rubber seals free of oils, grease, and other materials which would deteriorate the rubber. Ensure rubber seals do not become distorted during handling.

[1.6.2 Epoxy Filler

Receive epoxy filler from the manufacturer just prior to use in the work to insure receipt of recently manufactured material and store the filler under cover, out of direct sunlight, at a temperature between 20 to 30 degrees C 65 to 85 degrees F.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

Submit detail drawings as specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS, of closure gates and appurtenant items, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings.

2.1.1.1 Fabrication Drawings

Within the fabrication drawings, show complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.1.1.2 Shop Assembly Drawings

Within the shop assembly drawings, provide details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.1.1.3 Delivery Drawings

Within the delivery drawings, provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.1.1.4 Field Installation Drawings

Within the field installation drawings, provide a detailed description of the field installation procedures. Include in the description the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; [plan for prestressing gate leaf diagonals, including descriptions of connections, riggings, anchorages, and measuring equipment;] [methods for installing quoin and miter blocks, including checking and maintaining alignments of the blocks during concreting and placement of [epoxy] [zinc] filler;] [procedures and equipment used for heating and placing of the zinc filler;] [method for installing hinge anchor plates, including checking and maintaining alignments of the plates during concreting and placement of epoxy filler;] and methods for installing other appurtenant items.

2.2 MATERIALS

Submit system of identification which shows the disposition of specific lots of approved materials and fabricated items in the work before completion of the contract. Furnish materials orders, materials lists and materials shipping bills conforming with the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.2.1 Metals

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NOTE: Consider the use of ASTM A709/A709M steel for fabrication of all steel components. A709 material is available in 36 and 50 ksi and provides improved toughness and maximum yield to tensile ratios to ensure ductile performance.

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All structural steel, steel forgings, steel castings, stainless steel, bronze, [aluminum alloy,] and other metal materials used for fabrication are required to conform to the requirements shown and specified herein and in Section 05 50 15 CIVIL WORKS FABRICATIONS.

2.2.1.1 Structural Steel

Structural steel shapes are required to conform to ASTM A36/A36M. Structural steel plates are required to conform to [ASTM A36/A36M] [ASTM A572/A572M, Grade 50][ASTM A709/A709M, Grade 50].

[2.2.1.2 Steel Pipe

Provide steel pipe conforming to ASTM A53/A53M, Type S, Grade B, seamless, black, nominal size and weight class or outside diameter and nominal wall thickness as shown, [plain] [threaded] [threaded and coupled] ends.

][2.2.1.3 Self-Lubricating Bearings

Ensure self-lubricating bearings conform to ASTM B823, Type II. Impregnate the bearings with a turbine grade lubricant containing oxidation and rust inhibitors and a polar anti-wear additive.

][2.2.1.4 Bronze Castings

Provide bronze castings conforming to ASTM B22/B22M, Copper Alloy UNS No. C91300 [and ASTM B148].

]2.2.1.5 Stainless Steel Bars and Shapes

Provide stainless steel bars and shapes conforming to ASTM A276/A276M, UNS [S 20910,] [S 30400,] [S 40500,] Condition A, hot-finished or cold-finished, Class C; or ASTM A564/A564M, UNS [S 17400,] [S 45000,] Condition A, age-hardened heat treatment, hot-finished or cold-finished, Class C.

2.2.1.6 Stainless Steel Plate, Sheet, and Strip

Provide stainless steel plate, sheet, and strip that conforms to ASTM A240/A240M, UNS [S 20910,] [S 30400,] [S 40500,] [S 41008]. Hot-roll, anneal or heat-treat, and blast-clean or pickle plate finish. Provide No. 1 sheet and strip finish.

[2.2.1.7 High-Strength Steel Bar

Provide high-strength steel bar conforming to ASTM A722/A722M, Type I or II, and all supplementary requirements.

]2.2.2 Rubber Seals

2.2.2.1 Physical Characteristics

Provide rubber seals [fluorocarbon (Teflon) clad rubber seals of the mold type only and] compounded of natural rubber, synthetic polyisoprene, or a blend of both, and containing reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers. the physical characteristics of the seals are listed below:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	17.2 MPa2500 psi (min.)	ASTM D412
Elongation at Break	450 percent (min.)	ASTM D412
300 percent Modules	6.2 MPa900 psi (min.)	ASTM D412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D2240
Water Absorption	5 percent by weight (max.)	ASTM D471
Compression Set	30 percent (max.)	ASTM D395
Tensile Strength (after aging 48 hrs.)	80 percent of tensile strength (min.)	ASTM D572

Perform the "Water Absorption" test with distilled water. Bolt the washed specimen dry with filter paper or other absorbent material and suspend by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees C for 22 plus or minus 1/4 hours. Remove the specimen, allow to cool to room temperature in air, and weigh it. Record the weight to the nearest 1 mg as M1 (M1 is defined in ASTM D471). Ensure the immersion temperature is 70 degrees C plus or minus 1 degree C and the duration of immersion is 166 hours.

[2.2.2.2 Fabrication of Rubber Seals

Provide rubber seals with a fluorocarbon film vulcanized and bonded to the sealing surface of the bulb. Ensure the film is [0.762] [1.524] mm [0.030] [0.060] inch thick Huntington Abrasion Resistant Fluorocarbon Film No. 4508, or equal, possessing the following minimum physical properties:

Tensile strength	13.8 MPa2,000 psi
Elongation	250 percent

Ensure the outside surface of the bonded film is flush with the surface of the rubber seal and is free of adhering or bonded rubber. Mold strips and corner seals in lengths suitable for obtaining the finish lengths shown and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, mask the fluorocarbon film during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

][2.2.3 Epoxy Filler

Use epoxy filler that is an approved epoxy resin formulation equal to "Loctite Nordback," a product of Hennkel Adhesives, or an approved equal, with a specific gravity of 1.90 to 1.95, minimum compressive strength after 72 hours at 20 degrees C 70 degrees F of 89.6 MPa 13,000 psi, and maximum shrinkage of 0.15 percent. Submit Manufacturer's certificate for epoxy filler stating that it meets or exceeds the specified physical properties; Deliver material to the site.

][2.2.4 Zinc Filler

Provide zinc filler that conform to ASTM B6.

2.2.4.1 Safety Provisions for Zinc Filler

The following special safety provisions are required for heating and placing zinc filler:

a. Workers are required to wear protective clothing including hard hats with fine wire mesh screen, goggles, leather sleeves, chaps, apron, and leather gloves.

b. Workers are required to wear air-line respirators certified by NIOSH or MSHA. In enclosed spaces, utilize both local exhaust ventilation and air-line respirators. The local exhaust ventilation system is required to include movable hoods placed close to the work to remove fumes at the source.

c. Pre-heat ladles, equipment, and material before use to ensure they are moisture-free.

d. Place heating devices and ladles on a level, firm foundation, and protect against traffic, accidental tipping, or similar hazard.

e. Do not carry hot zinc up or down ladders.

f. Ensure all buckets or vessels used for handling and transporting hot zinc are substantially constructed and not filled higher than100 mm 4 inches from the top.

]2.3 MANUFACTURED UNITS

Provide bolts, nuts, washers, screws and other manufactured units that conform with the requirements shown and specified herein and in Section 05 50 15CIVIL WORKS FABRICATIONS.

2.3.1 Bolts, Nuts and Washers

Provide high-strength bolts, nuts, and washers that conform to ASTM F3125/F3125M, Grade A325, [hot-dip galvanized] . Bolts, nuts, studs, stud bolts and bolting materials other than high-strength are required to conform to ASTM A307, Grade A, [hot-dip galvanized] or ASTM A320/A320M, [Ferritic Steel, Grade [_____]] [Austenitic Steel, Grade [_____], Class [_____].] Provide bolts 13 mm 1/2 inch and larger with hexagon heads. Ensure the finished shank of bolts is long enough to provide full bearing. Provide washers for use with bolts that conform to the requirements specified in the applicable specification for bolts.

2.3.2 Screws

Provide screws of the type indicated.

2.3.3 Shackles and Turnbuckles

Provide shackles and turnbuckles of forged steel conforming to ASTM A668/A668M, zinc coated. End-thread turnbuckles right and left hand and provide the size shown.

2.3.4 Screw Jacks

Provide screw jacks with a [_____] ton (metric) (2000 lb) rated capacity and ensure they conform to the details shown.

[2.3.5 Hoists

Provide hoists with a [_____] ton (metric) (2000 lb) capacity, with [_____] mfoot lift, link type chain and safety latch hook. Provide hoists of a light weight design, weighing not over [_____] kg lb and requiring not more than [_____] kg lb lever pull to lift the full-rated load.

]2.3.6 Winches

Winches are required to be [_____] ton (metric) (2000 lb) marine winches with [_____] mminch drum and adjustable handle. Equip each winch with [______] mm foot of [_____] mm inch diameter wire cable suitable for exterior exposure.

2.3.7 Sheaves

Provide cast steel sheaves conforming to ASTM A27/A27M, sized for the wire rope used.

[2.3.8 Rails

Provide rails conforms to ASTM A1, [No. 1] [No. 2], weighing [_____] kg/m. lb/yd. Provide rail stops as recommended by rail manufacturer for [_____] kg/m lb/yd rails and for the wheel diameters indicated.

]2.3.9 Wire Rope

Provide wire rope that conforms to FS RR-W-410, Type [_____], Class [_____], Construction [_____], [wire size,] [strand seizing] as shown.

[2.3.10 Wheels

Provide short hub or long hub wheels, rigid type, heavy duty steel casters fabricated from steel castings conforming to ASTM A148/A148M. Provide wheel of the size and load capacity shown complete with lubrication fittings, roller bearings and removable axle. Machine finish wheel treads to conform to the indicated rail. Unless otherwise specified or shown, wheel axles are required to be stainless steel bars conforming to ASTM A276/A276M, UNS S30400.

][2.3.11 Bridge Planks

Fabricate bridge planks of steel conforming to ASTM A1011/A1011M, Grade 33, with a minimum thickness and minimum section modulus as shown.

]2.3.12 Chains and Attachments

Provide chains and attachments conforming to FS RR-C-271, Type [_____], Grade [_____], Class [_____], Style [_____], Size [_____], Finish [_____].

2.3.13 Padlocks and Hasps

Provide padlocks conforming to CID A-A-1928, Type [I][II]. Key all padlocks alike and provide with two keys. Wrought steel hasps are to be provided and sized to accommodate padlocks.

[2.3.14 Elastomeric Bearing Pads

Provide elastomeric bearing pads conforming to the requirements of ASTM F3125/F3125M, and reinforced with steel plates.

]2.4 FABRICATION

2.4.1 Structural Fabrication

Structural fabrication is required to conform with the requirements shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Shop fabricate components from the materials specified and shown. Provide all dimensional tolerances as specified and shown. Splices are only allowed where shown. Bore pin holes in components after welding, straightening, stress-relieving, and threading operations are completed. Straighten brackets, eye bar sections, and other components requiring straightening by methods which will not damage the material. Press-fit bronze bushings with supporting components. Provide bolt connections, lugs, clips, or other pick-up assembly devices for components as shown and required for proper assembly and installation.

2.4.2 Welding

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NOTE: List applicable welds requiring radiographic examination.

NOTE: Specification Section 05 50 14 STRUCTURAL METAL FABRICATIONS includes welds subjected to Ultrasonic Testing (UT), Dye Penetrant Testing (PT) and Magnetic Testing (MT). AWS D1.1 does not specify nondestructive testing of any completed weld. Designer must take this into account and specify any Nondestructive Testing (NDT) requirements as well as specifying which welds are to be subjected to nondestructive testing.

The designer is to consider whether any components included are likely to be fracture critical. Fracture critical components should be identified as requiring fabrication in accordance with a Fracture Control Plan.

****

Ensure welding conforms to the requirements of AWS D1.1/D1.1M, AWS D1.2/D1.2M, the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Provide welds of the types shown on the contract drawings and approved detail drawings. Radiographic examination is required on the major shop and field welds of the type and location indicated on the drawings and as follows: [_____]. Welds which have been designated to receive radiographic examination and are found to be inaccessible to a radiation source or film, or are otherwise so situated that radiographic examination is not feasible may be examined, with written approval, by dye penetrant, magnetic particle tests, or ultrasonic tests. All components are to be stress-relief heat treated after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances. Submit a Stress Relieving Plan for approval which follows the minimum requirements for thermal stress relief in accordance with AWS D1.1.[Stress-relief heat treat all components after welding where shown. Perform stress-relieving of components prior to the attachment of miscellaneous appurtenances.][Refer to Specification SECTION 05 50 14 STRUCTURAL METAL FABRICATIONS for nondestructive testing requirements.][Submit a Fracture Control Plan (FCP) for fracture critical components.]

2.4.3 Bolted Connections

Ensure bolted connections conform to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.4 Machine Work

Ensure machine work conforms to the requirements specified in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.5 Miscellaneous Provisions

Ensure miscellaneous provisions for fabrication conform with the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

2.4.6 Fabrications

Submit samples approved prior to use of the represented materials or items in the work. Submitted samples of standard and shop fabricated items are required to be full size and complete as required for installation in the work. Approved samples may be installed in the work provided each sample is clearly identified and its location recorded. Fabrications are required to conform to the following requirements.

2.4.6.1 Gate Leaf

The gate leaf is required to be a welded structural steel fabrication provided complete with [quoin and miter contact [blocks] [posts],] [miter guide assembly] [elastomeric bearing pads,] [hinge assemblies,] [pintle assembly,] [wheel assemblies,] [trolley assembly,] [tie-down assembly], [gate hooks,] seal assemblies, and other appurtenant components as specified and shown. [Proposed shop-fabrication of gate leaf in separate segments to facilitate handling and shipping must be approved and performed as shown on approved detail drawings. Fabricate segments to permit easy field-assembly in as few segments as practicable to minimize the number of joints to be field-welded.] Ensure the overall height of gate leaf does not vary from the nominal dimension [or differ from mating gate leaf] by more than 6 mm. 1/4 inch. The surfaces of framing elements to which [skin plates] [bridge planks] are to be welded are not to vary from a true plane by more than 6 mm.1/4 inch. [Locate splices in [skin plates] [bridge planks] only where shown.] [In addition to welds specifically indicated for nondestructive testing, perform nondestructive testing on [_____] percent of the welds in the girders, verticals and [skin plate] [bridge planks] of the gate leaf. Locate these additional welds for testing as directed.]

[2.4.6.2 Wall Quoin

The wall quoin consists of a welded structural steel frame with adjustable base anchors and adjustable quoin contact [block] [post].

][2.4.6.3 Quoin and Miter Contact [Blocks] [Posts]

Quoins and miter contact [blocks] [posts] are to be made of stainless steel bars conforming to ASTM A276/A276M or ASTM A564/A564M. Make splices in the contact [block] [post] by an offset method so that there will not be a continuous joint across the [block] [post]. Mill contact faces of the contact [block] [post] at splices to assure watertight joints. [Locate splices in the gate leaf contact [block] [post] only at the centerlines of horizontal girders.] Provide contact [blocks] [posts] with adjusting bolts as shown.

][2.4.6.4 Hinge Assembly

The outer cylinder of the hinge assembly is to be made of steel pipe conforming to ASTM A53/A53M, Type S, Grade B. The cylinder bushing and thrust washer are to be made of bronze casting conforming to ASTM B22/B22M, Copper Alloy UNS No. C91300. Fabricate hinge pin [and bearing pedestal for the lower hinge assembly] of stainless steel conforming to ASTM A276/A276M, UNS S 21800. [Fabricate the pedestal base plate for the lower hinge assembly] of stainless steel conforming to ASTM A240/A240M, UNS S 30400. The hinge assembly gusset, stiffener, and anchor plates are to be made from structural steel conforming to ASTM A36/A36M. [In addition to welds specifically indicated for nondestructive testing, perform nondestructive testing on [_____] percent of the welds in the hinge assembly and the welds connecting the hinge assembly to the gate framing. Locate the additional welds for testing as directed.] After all welding is completed, stress-relieve the hinge assembly by heat-treating. Perform stress-relieving prior to machining.

][2.4.6.5 Pintle Assembly

The pintle assembly for miter gates consists of pintle socket, pintle, and pintle base as shown. Fabricate the pintle socket from cast nickel alloys and press-fit with an aluminum bronze bushing with bearing surfaces finished truly hemispherical. Fabricate the pintle of [cast alloy steel] [forged alloy steel] with bearing surfaces of corrosion-resisting steel. Finish the pintle ball to a 0.4 micrometer 16 microinch finish and fit into the bushing by scraping until uniform contact is attained over the entire bearing surface as determined by testing with carbon paper or other approved coloring. Match-mark the pintle ball with the bushing when fitted and so erected in the field. Fabricate the pintle base of cast steel. Drill and ream bolt holes for attaching pintle socket to gate leaf after the pintle socket is assembled with gate leaf.

][2.4.6.6 Trolley Gate Trolley Assembly

The trolley gate trolley assembly consists of trolley beam, two (2) four-wheeled, push type trolleys, and trolley hangers. Provide trolleys that are of steel fabrication, a manufacturer's standard product, rated for a minimum load of [_____] tons (metric) (2000 lb) and suitable for operation on the trolley beam of the type and size shown. Provide single-flanged trolley wheels with a diameter of [_____] mm inches and with machine-finished wheel treads to conform with the trolley beam. Mount trolley wheels on weather-protected roller bearings and a removable axle and provide with accessible lubrication fittings. Support trolley hangers by the wheel axle and provided with a cross pin with machined grooves and retaining rings spaced at intervals of [_____] mm inches to accommodate a [_____] mm inch thick suspension lug. Locate the centerline of the cross pin [_____] mm inches below the bottom of the trolley beam. For proper clearance, ensure the maximum horizontal dimension from the centerline of the trolley beam to the end of the cross pin does not exceed [_____] m. [_____] ft [_____] in. Provide trolleys designed for continuous outdoor service and painted with the manufacturers standard paint system for outdoor operation.

][2.4.6.7 Trolley Gate Overhead Support Beam

The trolley gate overhead support beam is required to conform to the details shown. The post-tensioned anchorage for support beam consists of ASTM A722/A722M, Type [_____] [_____] high-strength steel bars and prestressing system as specified in Section 03 23 00 STRESSED TENDON REINFORCING.

][2.4.6.8 Rolling Gate Wheel Assembly

Provide the rolling gate wheel assembly complete with cast steel wheels as specified herein and fittings, couplings and hoses for lubrication of wheels. Fittings are required to be 6 mm 1/4 inch threaded-pipe fitting. Couplings are required to be 6 mm 1/4 inch stainless steel half coupling. Provide 6 mm 1/4 inch inside diameter, double-braided stainless steel flexible hoses. Ensure all couplings and hoses provided have a pressure rating of 21 MPa. 3,000 psi.

][2.4.6.9 Rolling Gate Stabilizing Trolley Assembly

Fabricate the stabilizing support for trolley wheels from structural steel conforming to ASTM A36/A36M. Fabricate trolley wheels from steel rated for the minimum load shown. Provide single-flanged trolley wheels and ensure the wheel treads are machined-finished to conform with the guiding gate girder. Mount trolley wheels on weather-protected roller bearings and a removable axle and provide with lubrication fittings.

]2.4.6.10 Seal Assembly

the seal assembly consists of rubber seals, steel retainer and spacer bars, [retractable support,] and fasteners. Provide continuous rubber seals over the full length. Fit the seals accurately and drill for proper installation. Drill bolt holes in the rubber seals by using prepared templates or the retainer bars as templates. Splices in seals are required to be fully molded and develop a minimum tensile strength of 50 percent of the unspliced seal, and occur only at locations shown. Shop vulcanize splices. Locate the vulcanized splices between molded corners and straight lengths as close to the corners as practicable. Place splices on a 45 degree bevel related to the "thickness" of the seal. Ensure the surface of finished splices is smooth and free of irregularities. Field-splice steel retainer bars only where shown. Machine-finish steel retainer bars after splicing. [Provide the retractable support complete with hinge and operating winch.]

2.4.6.11 Miscellaneous Embedded Metals

Provide wall armor, shear anchors, protection and seal plates and shapes, and other miscellaneous embedded metals structural steel or corrosion-resisting steel conforming with the details specified herein and shown.

2.4.7 Shop Assembly

Shop assembly requirements for gates and appurtenant items are required to be provided as shown and specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Completely shop assemble gates and appurtenant items, unless otherwise approved, to assure satisfactory field installation. Fit and bolt together adjoining components to facilitate field connections. Carefully preserve the match-marking of unassembled items until the items are assembled. Cover mating surfaces and machined surfaces with a rust preventive until assembly. Shop-weld assembled components in their final positions as much as delivery and field installation conditions will permit. Fit and drill rubber seals to match the seal retainers, match-marked them, and remove for shipment. [Suspend the trolley gate in the shop to verify its center of gravity location. If the trolley gate is more than 3 mm 1/8 inch out-of-plumb in the suspended position, balance it by means as directed.] Perform shop assembly and disassembly work in the presence of the Contracting Officer unless waived in writing. The presence of the Contracting Officer does not relieve the Contractor of any responsibility under this contract.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit certified test reports for material tests with all materials delivered to the site.

2.5.1 General

Tests, inspections, and verifications for materials are required to conform to the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

[2.5.2 Testing of Rubber Seals

****

NOTE: If fluorocarbon (Teflon) clad seals are not used, delete this paragraph.

****

Test the fluorocarbon film of rubber seals for adhesion bond in accordance with ASTM D413 using either the machine method or the deadweight method. Cut 25 mm 1 inch long piece of seal from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. Ensure there is no separation between the fluorocarbon film and the rubber when subjected to the following loads:

THICKNESS OF FLUOROCARBON FILM	MACHINE METHOD AT 50 MM 2 INCHES PER MINUTE	DEADWEIGHT METHOD
0.762 mm0.030 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width
1.524 mm0.060 inch	13.6 kg per 25 mm30 pounds per inch width	13.6 kg per 25 mm30 pounds per inch width

]PART 3 EXECUTION

3.1 INSTALLATION

Installation per the requirements specified herein and in Section 05 50 14 STRUCTURAL METAL FABRICATIONS. Assemble miter gates and appurtenant items for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Thoroughly clean and lubricate bearing surfaces requiring lubrication with an approved lubricant before assembly and installation. Ensure components to be field-welded are placed in correct alignment before welding is commenced. Design and submit handling attachments and pick points required to be added to any specified items herein prior to installation.

3.1.1 Embedded Metals

Accurately install sill assemblies, seal plates, frames, bases and other embedded metal items required for proper and complete installation to the alignment and grade required to ensure accurate fitting and matching of components. Primer coat all embedded metals with the required paint on all surfaces prior to installation in concrete forms. Install anchors for embedded metals as shown. Attach items requiring two concrete pours for installation to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour. Grind smooth welded field splices in sealing surfaces of embedded items.

3.1.2 Lower Hinge Assembly

Embed the base anchors for the lower hinge assembly in the first pour concrete. Attach the base plate to base anchors, set to the final position, and place epoxy fill in the void behind the base plates and then allow fill to reach the strength as shown and the approved field installation drawings. After the gate leaf is set in place, adjust the hinge assembly to provide for continuous contact between the sealing surfaces over the full height and length of the gate leaf. Make allowances for the seals which are not attach until painting operations are completed. Place second pour concrete after final adjustments are completed.

3.1.3 Gate Leaf

Assemble gate leaf components not assembled in the shop in the field as required for installation. [[Coat lower hinge assembly bearings] [pintle ball] with grease prior to setting the gate leaf in place.] [Flush the grease pipes prior to connecting to bearing.] Take all necessary precautions to avoid distortion of the gate leaf or any component parts. Exercise special care during installation to prevent any sag of the ends of the gate leaf due to compression of blocking or other causes. After the gate leaf has been set in place and the top hinge assembly installed, plumb the gate leaf and bring into correct position.

3.1.4 Diagonals

Attach gate leaf diagonals to the gate leaf after the leaf is set in place. Perform diagonals prestressing before the final adjustment of the quoin and miter contact [blocks] [post] are made. Prestress diagonals as specified, shown, and as approved on the Diagonals Prestressing Plan developed by the Contractor. Submit approved diagonal prestressing plan prior to initiating the prestressing operations. Submit diagonal prestressing record immediately after completion of the prestressing operations. Within the plan for prestressing the diagonals, describe the method of prestressing, including the materials, connections, rigging, anchorages, and stress measuring equipment. Compile a record of the prestressing operations consisting of the information indicated in the following table:

STRESS DATA TABLE					
Gate Leaf Location:				Date:	
	1	2	3	4	5
Diagonal	Strain Gage Initial	Readings Final	E (mm)(in.)	D (mm)(in.)	d (mm)(in.)
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

1. Collect initial strain gage readings after slack is removed.

2. Collect final strain gage readings after prestressing is complete.

3. E is the total elongation over the full length of the diagonal, computed from the strain gage readings.

4. D is the prestress deflection of the leaf as shown on the drawings.

5. d is the field deflection of the leaf measured after completion of the prestress operation; it is the deflection when final strain gage readings are taken.

[3.1.5 Top Hinge Assembly

After the gate leaf has been set in place, install and adjust the top hinge assembly so that the center of the hinge pin is in vertical alignment with the center of the [pintle] [bottom hinge assembly pin]. When the top hinge pin is inserted, the gate leaf is required to swing horizontally throughout its range of movement. [Make any required final adjustments to the top hinge assembly after the gate leaf diagonals have been prestressed.] Make the second pour concrete after final adjustments are completed.

][3.1.6 Gate Leaf Quoin and Miter Contact [Blocks] [Posts]

After the wall quoin has been adjusted and concreted in place and final adjustments made to the top hinge assembly, adjust the gate leaf quoin and miter contact [blocks] [posts] to provide continuous contact over the full height of the gate leaf in the mitered position. After the gate leaf diagonals are prestressed and final adjustments of gate leaf quoin and miter contact [blocks] [posts] have been made with the gate leaf in the mitered position, swing the gate leaf out of miter and pour [epoxy] [zinc] filler behind the quoin and miter contact [blocks] [posts]. Prior to pouring of the filler, ensure the surfaces to receive the filler are free of dirt, rust, and other foreign materials. Coat the adjusting and holding bolts with grease or other bond breaker to prevent adherence of the filler.

3.1.6.1 Placing [Epoxy] [Zinc] Filler

[Epoxy Filler: Explicitly follow the manufacturer's instructions for placing the epoxy filler. Take special precautions to prevent leakage of the filler during placement. Ensure that the complete masses of the metals whose surface areas are to receive the epoxy filler have a temperature of15 to 30 degrees C. 60 to 90 degrees F. Keep the epoxy filler free from moisture or other foreign materials during mixing and placement and for at least 48 hours after placement. Conduct a field test to determine the indentation hardness of the epoxy filler compound prior to placement. The field test procedures are as follows:

a. Cast a 50 mm 2 inch cube sample of mixed epoxy filler compound in a mold and cure at room temperature 20 to 25 degrees C 70 to 80 degrees F for 24 plus or minus 8 hours.

b. Remove from mold and cut sample to expose interior surface.

c. Sand exposed interior surfaces to remove saw marks and provide a smooth surface.

d. Using a Type D Durometer conforming to ASTM D2240, measure the hardness across the exposed interior surface, taking a minimum of three readings on each half of the sample. Take necessary care during the durometer reading to insure the spring loaded pin used to penetrate the surface is not in a depressed surface caused by either residual saw marks or an exposed air bubble. The average reading should be at least 85, with no individual reading below 82. If the durometer readings fall below the required minimum values, the material will be rejected.

][Zinc Filler: Immediately preceding the pouring of the zinc filler, pre-heat the adjacent metal components to a temperature of 100 to 150 degrees C 212 to 300 degrees F by an approved method which does not buckle the metal components. Pour the zinc filler at a temperature which will insure that it will completely fill all interstices. Maintain pouring temperature of zinc filler between 430 and 480 degrees C 810 and 900 degrees F to minimize volatilization and oxidation of the zinc.]

[3.1.6.2 Adjusting Contact [Blocks] [Posts]

After the [epoxy has set] [zinc has cooled], draw the quoin and miter contact [blocks] [posts] against the filler by tightening the adjusting bolts. After the contact [blocks] [posts] are adjusted, swing the gate leaves into the mitered position without interference of the quoin contact [blocks] [posts] and ensure the gate leaf quoin contact [block] [post] makes tight contact with the wall quoin contact [block] [post].

]][3.1.7 Anchorage of Overhead Support Beam

Submit record of the post-tensioning operation for the trolley gate overhead beam anchors, immediately after the anchorage is completed, set in place and post-tensioned anchored as shown and as specified in Section

03 23 00 STRESSED TENDON REINFORCING.

][3.1.8 Rolling Gate Stabilizing Trolley Assemblies

Install rolling gate stabilizing trolley assemblies after the gate is set in place and properly adjusted. Place assemblies on the top girder of the gate leaf, attach to anchors embedded in the top of the supporting concrete wall, shim as required, and secure in place.

]3.1.9 Painting

Paint exposed parts of gates and appurtenances except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in concrete, and other specified surfaces as specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.1.10 Seal Assemblies

Install rubber seal assemblies after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Fasten rubber seals securely to metal retainers. Before operating the gate[s], apply a suitable lubricant to the rubber seal rubbing plates to protect the rubber.

3.2 SYSTEM STARTUP

3.2.1 Trial Operation

After completion of the gate installation, conduct an examination of the gates in the presence of the Contracting Officer for final acceptance. First examine the gates to determine whether or not the workmanship conforms to the specification requirements. Operate the gates from the fully-opened to the fully-closed position a sufficient number of times to demonstrate to the Contracting Officer's satisfaction that all parts are functioning properly. The workmanship in the fabrication and installation of gates is the result in a condition where when the gates are in the closed position watertight barrier is formed across the opening. The contractor is required to make all repairs or replacements to correct defects, as determined by the Contracting Officer, at no cost to the Government. Repeat the trial operation after defects are corrected. Prior to final acceptance of the gates, provide temporary restraints to prevent unauthorized operation of the gates.

3.3 FIELD QUALITY CONTROL

Non-Destructive testing of field welds are required to meet the same quality control requirements of shop-welded components.

3.4 PROTECTION

Protect of finished work in conformance with the requirements of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 20 20 (May 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 20 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 35 20 20

ELECTRICAL EQUIPMENT FOR GATE HOIST

05/22

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USACE / NAVFAC / AFCEC **UFGS-35 20 20 (May 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 20 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 35 20 20

ELECTRICAL EQUIPMENT FOR GATE HOIST
05/22

****
NOTE: This guide specification covers the technical requirements for hoist applications using a squirrel-type induction motor commonly used for control gates for outlet works; penstock gates, crest gates, spillway tainter gates, and other similar applications. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This specification is to be used as a section of a supply specification for the procurement of hoisting equipment, or, with only minor modification, it may be used as a section in a general contract specification.

The specification is general and covers all types and ratings of hoist applications used by the Corps of Engineers on Civil Works structures where a squirrel cage induction-type hoist motor is used.

The specification must be accompanied by a drawing or drawings showing the schematic wiring diagram of the control system for the particular application, along with a description of the scheme of operation and illustrations showing the several items of electrical equipment.

In adapting this specification to any project, the form and phraseology will be changed as necessary to properly specify the work contemplated. When technical deviations from this specification are considered necessary and the specification is not submitted to Headquarters, US Army Corps of Engineers (HQUSACE), for review, prior approval of (HQUSACE) will be obtained. Instructions for the preparation and submission of specifications for approval are included in ER 1110-2-1200.

The electrical equipment requirements contained herein are based upon experience and information gained from similar equipment now in service and are considered the most suitable for use on hydraulic structures.
****

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FB 1	(2014) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50553	(2015; Rev B; Notice 1) Fitting for Conduit, Metal, Rigid (Thick-Wall and Thin-Wall (EMT) Type)

UL SOLUTIONS (UL)

UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 546	(2008) UL Outline of Investigation for Conductor Termination Compounds

1.2 RELATED REQUIREMENTS

Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply.

1.3 SYSTEM DESCRIPTION

All equipment furnished under these specifications will be subjected to [severe moisture] [moderately moist] conditions, [that operate over a temperature range of [_____] to [_____] degrees C F,] and designed to render it resistant to corrosion. The general requirements to be followed are specified below; any additional special treatment or requirement considered necessary for any individual item is specified under the respective item.

1.3.1 Fastenings and Fittings

Where practicable, provide corrosion-resistant screws, bolts, nuts, pins, studs, springs, washers, and other miscellaneous fastenings and fittings or treat in an approved manner to render them resistant to corrosion.

1.3.2 Corrosion-Resisting Materials

Corrosion-resisting steel, copper, brass, bronze, copper-nickel, and nickel-copper alloys are acceptable corrosion-resisting materials. However, avoid contact between dissimilar metals as much as practicable, except where one of the dissimilar metals is steel or in the case of wiring and connections.

1.3.3 Corrosion-Resisting Treatments

Provide hot-dip galvanizing in accordance with ASTM A123/A123M or ASTM A153/A153M as applicable. Other corrosion-resisting treatments may be used if approved by the Contracting Officer.

1.3.4 Frames, Enclosing Cases, and Housings

Clean all surfaces of the enclosing cases or housings of controllers, brakes, limit switches, control stations, and other similar equipment, if other than plastic or stainless steel construction, of rust, grease, mill scale, and dirt and then treated with an approved iron and zinc phosphate solution followed by rinsing with a chromic acid solution, bonderizing, or equivalent process. Immediately after rinsing and drying, apply one coat of a zinc molybdate primer to the inside and outside surfaces and cure as required. For items of cast construction, the iron and zinc phosphate treatment may be omitted.

1.3.5 Finish Painting

****

NOTE: If severely moist conditions exist, a separate paint system should be specified using

Civil Works Guide Specification UFGS Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES, system 21, epoxy finish or equivalent. When such painting is specified, care must be taken to specify a paint that will adhere to and not be injurious to the protective painting provided under these specifications.
****

Apply a minimum of two coats of paint to all equipment in accordance with the manufacturer's standard process for the conditions specified.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Naming Convention; G, [_____]

SD-02 Shop Drawings

Controller; G, [_____]

Limit Switch; G, [_____]

Hoist Motor; G, [_____]

Control Station[s]; G, [_____]

Brake Enclosing Case

SD-03 Product Data

Hoist Motor; G, [_____]

Brake; G, [_____]

Programmable Limit Switch; G, [_____]

Overload Relays; G, [_____]

Controller; G, [_____]

Control Station[s]; G, [_____]

Wiring

Conductors

Terminal Leads

Terminal Blocks

Motor nameplates; G, [_____]

Equipment and Door Nameplates; G, [_____]

[Conductive Corrosion Inhibiting Compounds; G, [_____]]

Circuit Breakers; G, [_____]

SD-06 Test Reports

Factory Testing; G, [_____]

Acceptance Checks and Tests; G, [_____]

1.5 NAMING CONVENTION

Submit method of identifying conductors, terminal leads, and terminal blocks.

PART 2 PRODUCTS

2.1 HOIST MOTOR

****

NOTE: Coordinate with the respective electrical or

mechanical designers to ensure motors are not being specified elsewhere in the contract documents and that all motor requirements are satisfied.

****

Submit motor characteristics, curves or tabulated data (tested or calculated), indicating the speed, power factor, efficiency, current and kilowatt input, all plotted or tabulated against torque or percent of rated motor load.

a. Submit calculations to determine the required horsepower rating of each motor.

b. Submit detailed descriptive specifications of the motor, with necessary cuts, photographs, and drawings to clearly indicate the construction of the machine. Place special emphasis on describing and illustrating features of "Insulated Windings," "Winding Heaters," "Bearings and Lubrication," and "Terminal Leads."

2.1.1 Motor Type

****

NOTE: When a single-speed motor or two single-speed motors in lieu of a two-speed motor is acceptable for the application, the designer will specify NEMA MG 1 standard design letter. The torque requirements listed in paragraph MOTOR LIMITS must be met, and the designer will verify that the design specified is sufficient. Design "C" and "B" have a 5 percent or less slip limit and are used where load inertia is lower. Design "D" has a 5 percent or greater slip and must be used where inertia is high. Designs "B," "C," and "D" provide progressively higher torques and get progressively more expensive. Design "B" will generally apply to motors from 745 to 2240 W 1 to 3 hp, design "C" to motors between 2.24 to 11 kW 3 and 15 hp, and design "D" for motors larger than 11 kW 15 hp. This a general guide according to NEMA minimum standards and may vary with manufacturer's specific equipment.

Totally-enclosed motors can be used in outdoor locations but are not suitable for submersion. At reduced cost, dripproof encapsulated construction may be used in protected locations. Consult manufacturer's data for information on application of this type motor to specific environmental conditions.

****

Provide a motor of the horizontal-shaft, squirrel-cage induction type [two-speed, two-winding, constant torque] [NEMA design [B] [C] [D]], designed for [full-voltage starting][adjustable speed drive operation], [of water-proof, totally enclosed, fan-cooled or nonventilated frame construction],[dripproof, encapsulated frame construction]. The motor must conform to the applicable requirements of NEMA MG 1. Ensure the weep hole is at the lowest point of the motor for the intended installation.

2.1.2 Motor Rating

****

NOTE: For a two-speed motor, use single-voltage rating. Specify load conditions when Contractor designed. (Second Option) This specification covers three-phase motors which are suitable for most applications and must be used whenever possible. When utility three-phase power is unavailable and forces use of single-phase motors, this specification may be modified accordingly. Generally, single-phase motors used for this application should be below19 kW 25 horsepower. The torque limits should be carefully evaluated, and the testing requirements should be changed. Please consult Engineering Manual (EM) 1110-2-2610.

****

[The motor must be rated [_____] horsepower, [_____] rpm synchronous speed for the machinery design shown on the drawings or, if the design is changed as permitted by [_____], must have a horsepower rating as required by performance requirements specified to [_____].] [The motor must have a horsepower rating as required by the load conditions specified in [_____].] The motor must be rated for continuous full-load operation without exceeding the standard temperature rise for the class of insulation and frame construction used, and it must be wound for [_____] [230/460] [460] volts, three-phase, 60-Hz.

2.1.3 Motor Torque

****

NOTE: The torque values are those required by design guidance given in EM-1110-2-2610. The gate design must be coordinated with the requirements of this document to ensure that torque limits are met. Reducing the upper limit or raising the lower limit will result in significant cost increase and should be avoided where ever possible.

****

2.1.3.1 Motor Limits

The torque limits for each individual winding must be as follows:

a. Upper Limit: The upper limit of the torque between locked-rotor and breakdown must be not more than 280 percent of the rated full-load torque of the motor.

b. Lower Limit: The lower limit of the torque between locked-rotor and breakdown must be as high as possible consistent with good design but not less than 150 percent of the rated full-load torque of the motor.

c. When the characteristics of a motor or the winding of a motor results in a speed torque curve without a definite value of breakdown torque, the limitations on the minimum value of torque must apply between locked-rotor and 75 percent of synchronous speed.

[2.1.3.2 Single-Speed Motor Limits

****

NOTE: Permit the use of two single-speed motors in lieu of a single two-speed motor where space is not a concern, and a two-speed motor cannot meet the specifications requirements.

****

Two single-speed motors may be used in lieu of a two-speed motor, providing the synchronous speed of the high-speed motor is not more than 1,800 rpm's and the low-speed motor will conform to the 50 percent over-speed requirements of the high-speed motor.

]2.1.4 Frames and Shafts

****

NOTE: Shafts of stainless steel may be specified in lieu of manufacturer's standard treatment where extremely corrosive atmospheres exist. The use of stainless steel will change the motor design and increase the shaft diameter at a significant cost. Manufacturer's should be consulted before specifying stainless steel in a given application.

****

Size and dimensions of frames must conform to NEMA MG 1. Provide eye bolts on all motors. Provide each motor with a drain-breather which must be located to prevent accumulation of water inside the motor. Frames must have corrosion prevention in accordance with the requirements of paragraph CORROSION PREVENTION AND FINISH PAINTING. Exposed portions of shafts must be treated with manufacturer's standard primer and two coats of moisture proof varnish in accordance with the manufacturer's recommendation.

2.1.5 Windings and Insulation

****

NOTE: Select insulation class based on NEMA temperature requirements as follows:

CLASS	**LIMITING TEMPERATURE (in degrees Celsius)**
B	**130**
F	**155**
H	**180**

Selection of insulation class should be left to the Contractor when he is also responsible for motor design, but in no case should it be less than Class B. Class F is typical.

Designer will provide ambient temperature values where possible.

****

Insulation must be Class [B] [F] [H] [B or better as required for design conditions] with special moisture, [fungus], and oil proof treatment. Design and construct motors to withstand the environmental conditions specified. The following specifications describe the minimum requirements for acceptable insulation and are not intended to restrict or prohibit the use of materials or methods which will give equal or better performance. Temperature rise must be no greater than [80] [_____] degrees C [176] [_____] degrees F.

2.1.5.1 Insulated Windings

Unless otherwise approved, completely assemble insulated windings in the motor core before impregnating with the insulating compound. Insulating compound must be 100 percent solid. Use the vacuum impregnation method followed by baking to impregnate the windings with the insulating compound. Repeat the procedure as often as necessary to fill in and seal over the interstices of the winding, but in no case must the number of dips and bakes be less than two dips and bakes when the vacuum method of impregnation is used.

2.1.5.2 Magnet Wire

The magnet wire must have an insulation or combination of insulations with an insulation thickness not less than that required for the environment specified and the temperature rating as required by the hot-spot temperature of the motor.

2.1.6 Winding Heaters

****

NOTE: Delete this paragraph and the requirement for "Winding Heaters," if dripproof encapsulated motor is used. Additionally, the designer should consider elimination of winding heaters if possible in other situations, i.e. where the probability of condensation is low. In the past, heaters have been a maintenance problem and have been disconnected by project personnel.

****

A heater or heaters must be installed in the motor frame or end bells or wrapped around the winding end turns. Heaters must meet the requirements of paragraph HEATERS-GENERAL. Heaters installed around the winding end turns must consist of the required turns of heating cable wrapped around the end turns and secured in place before the motor windings are impregnated.

2.1.7 Bearings and Lubrication

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NOTE: The use of sealed bearings should be limited to special applications. Sealed bearings do not require as much maintenance but reduce the overall life of the motor.

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Provide the motors with antifriction bearings. The design of the housing and method of assembly must permit ready removal of the end brackets and prevent escape of lubricant and entrance of foreign materials. Bearings must be fitted with bronze or other approved bushings to prevent any binding of moving parts. Approved antifriction bearings of corrosion resisting construction may be used. Bearings [must be of an approved prelubricated type requiring no addition or change of lubrication for a period of at least 5 years] [must have fitted openings located on the top and bottom of the bearing housing. The openings must be readily accessible for applying and draining the lubricant]. Pressure lubrication fittings may be used provided the housings are properly vented to prevent damage to the seals. When the brake housing or other equipment is to be assembled adjacent to or bolted to the motor end bell, provide suitable filler and drain pipe extensions, with the ends properly fitted and easily accessible. For those applications where the brake wheel is mounted on a shaft extension on the front end of the motor, the bearing housing, or a suitable flange, must provide a suitable surface and connecting means to allow the fastening of the brake enclosure to the bearing housing (see paragraph BRAKE ENCLOSING CASE).

2.1.8 Terminal Leads

Terminals leads must extend outside the frame; must have insulation equivalent to that of the motor winding; must be terminated in a two-piece, watertight terminal box secured rigidly to the motor frame; and must be suitably identified. Position and seal leads where they pass through the frame with a water-resistant seal of a synthetic rubber material or a synthetic rubber gasket. Terminal box must have threaded conduit entrances on a minimum of four sides.

2.1.9 Machine Work

Machine work must be accurate, of high quality, and in conformity with approved standard practice. Threads must be in accordance with ASME B1.1. Thread fittings must be Class 2. Threads on all body-bound bolts must be chased a sufficient length so that when the nut is tightened there will be approximately one and one-half full threads under the nut. Provide all bolts and cap screws with lock washers.

2.1.10 Designation and Markings

Attach motor nameplates of a suitable corrosion-resisting material to the frame of each motor. Motor nameplates must indicate clearly the motor NEMA temperature and insulation class, continuous amperage rating, voltage rating, operating frequency, rated RPM, horsepower rating, nominal efficiency, NEMA locked rotor code letter and serial number. In addition, the nameplate must show a lead connection diagram. Identification or serial numbers must be die stamped on the frame.

2.1.11 Heaters

2.1.11.1 Heater Ratings

Heaters must be of such rating that, when energized, the temperature of the windings or enclosure will be held approximately 10C above ambient. They must be designed for 120 volts AC and for continuous operation under the conditions of installation. The rate of heat dissipation must be uniform throughout their effective length.

2.1.11.2 Insulation

Insulation for the heating cable (winding wrap around type) heaters must be suitable for a conductor temperature of 180C.

2.1.11.3 Heater Terminals

The terminals of the heater, including the leads, must be watertight. The leads must be terminated and sealed in a watertight terminal box located as selected by the motor manufacturer. The method of sealing must be as specified for the motor winding leads.

2.2 BRAKE

****

NOTE: Coordinate with the respective electrical or mechanical designers to ensure brakes are not being specified elsewhere in the contract documents and that all brake requirements are satisfied.

****

Submit detailed descriptive data covering the brake, with necessary cuts, photographs, and drawings to indicate clearly the construction of the brake and the materials used. Include releasing device specifications and characteristics, including input current minimum voltage required for brake release.

2.2.1 Brake Type

The brakes must be of the shoe type, spring set, type and must be completely enclosed in a watertight and dusttight enclosing case arranged for [floor mounting] [motor mounting].

2.2.2 Brake Rating

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NOTE: Delete paragraph b. if constant torque two-speed motor or a single-speed motor is specified.

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a. The brake must have a torque rating not less than 150 percent of the full load torque of the motor when referred to the shaft on which the brake wheel is mounted, efficiency of speed reducer not being considered. The torque rating must be based on open construction, [1-hour] [continuous] duty.

b. [The brake must have a torque rating of [_____] pound-feet as shown on the plans, or if the design is changed as permitted by [_____], the brake must have a torque rating not less than 150 percent of the full-load torque of the motor when referred to the shaft on which the brake wheel is mounted, efficiency of speed reducer not being considered.] [For a two-speed motor, computer the rating from the full-load torque of the low-speed winding of the motor.]

2.2.3 Adjustment

Provide means for varying torque required for holding. Additionally, the brake must have means of adjusting the position of the shoes to compensate for wear, unless the design is such that compensation for shoe wear is automatic.

2.2.4 Release

2.2.4.1 Releasing Magnets and Rectifier

****

NOTE: Coordinate voltage requirements with paragraph MOTOR RATING.

****

The releasing magnets must be of the DC or AC shunt type and of standard stock design, suitable for operation on [_____] [230] [460]-volt, 60-Hz, AC electrical power. Supply direct current by means of a self-contained rectifier unit of proper rating. The complete unit must be suitable for connection to the control circuit or the power circuit of the motor with which the brake is used so that the brake will set or release when the motor is deenergized or energized, respectively. The brake releasing magnet must be rated in accordance with the brake rating requirements of paragraph MOTOR RATING. The brake releasing magnet must be sufficient to release and hold the brake in the released position with 85 percent of rated voltage impressed on the incoming terminals. When a rectifier is required, mount it in the motor controller enclosing case unless otherwise noted.

2.2.4.2 Hand Release

Provide hand release. Hand release must be operable only when the enclosing case cover is removed and must be self-resetting.

2.2.5 Terminal Leads

Connecting leads from the releasing magnet must be extended outside the enclosing case and must terminated on a terminal block located in a watertight terminal box. The terminal box must be rigidly bolted or equally secured to and on the outside of the lower or fixed half of the enclosing case. The terminal box must provide for conduit entrances on four sides. All conduit entrances to the brake terminal box must be threaded. The leads inside the brake enclosing case must be suitably protected. Terminate enclosing case space heater leads in the same manner in separate terminal boxes.

2.2.6 Brake Enclosing Case

****

NOTE: Manufacturers do not generally weld enclosures. Welding required only where conditions require substantial construction and costs may be justified.

****

Submit dimensioned outline drawings showing specific relationships and clearances between equipment and their component parts. The outdoor NEMA Type 4-watertight enclosing case must be [welded type] [in accordance with the manufacturer's standard practice for the conditions indicated]. In order that the brake mechanism will be accessible from above, when the upper half or cover of the enclosing case is removed, the enclosing case must be constructed to give equal accessibility to all portions of the brake. Make the joint between the two halves with a synthetic rubber gasket, not less than 6 mm 1/4 inch in width, and held in place by embedding in a groove or by other equally effective means. For those applications where the brake wheel is mounted on a shaft extension on the front end of the motor, the enclosing case must be arranged to permit bolting to the bearing housing of the motor, the joint being made watertight with a gasket. For those applications where the brake wheel is mounted on a shaft of the operating machine or on a flange and shaft extension on the front end of the motor, suitable watertight seals must be provided on each part of the housing. The shaft seals must be arranged for pressure lubrication and must be adjustable for alignment relative to the shaft. An automatic drain breather, located in a protected location, must be provided in the lower part of the enclosing case. If the drain breather cannot be located in a protected location, the tapped hole must be plugged and the drain furnished separately for installation in the field. Provide enclosing case space heaters conforming to the applicable part of paragraph HEATERS-GENERAL. The enclosing case must be treated to render the steel resistant to corrosion as required by paragraph CORROSION PREVENTION AND FINISH PAINTING.

2.2.7 Mechanical Construction

Use no cast iron in brake construction, except for brake wheels, shoes, and electrical parts. All pins, fittings, and other miscellaneous small metal parts must be of approved corrosion-resisting metal or must be treated to render them corrosion-resistant as required by paragraph CORROSION PREVENTION AND FINISH PAINTING. Bearings must be fitted with bronze or other approved bushings to prevent any binding of moving parts. Approved antifriction bearings of corrosion-resisting construction may be used. Provide approved means for lubrication for all bearings, unless bearings are of an approved self- or prelubricated type. The machine work must conform to the requirements for the motor with which the brake is used.

2.2.8 Designation and Markings

Provide and attach a nameplate of suitable corrosion-resisting material to a part of the brake which ordinarily will not be renewed during its service life. The nameplate must conform to standard practice and clearly indicate the manufacturer's name, identification symbols, serial number, and salient design features such as type, frame, torque, rating, voltage, phase, and frequency. If adjustment is required, pertinent information for making the adjustments is necessary.

2.3 CONTROL SYSTEM

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NOTE: The scheme of control shown on the applicable plate at the end of this document should be retained where possible.

The Plates listed below, containing the related control sequences, are attached at the end of this spec.

PLATE NO.	**SUBJECT**
1.	**Crest Gate, Electrical Control System (With Approximately 300 mm 1.0 Foot Increments)**
2.	**Crest Gate, Electrical Control System (With Approximately 150 mm 0.5 Foot Increments)**

3. Crest Gate, Electrical Control System (With Remote Control and Approximately 300 mm 1.0 Foot Increments)

4. Crest Gate, Electrical Control System (With Remote Control and Approximately 150 mm 0.5 Foot Increments)

5. Outlet Control Gate, Electrical Control System (Single-Speed Motor)

6. Outlet Control Gate, Electrical Control System (Multispeed Motor)

7. Intake Gate, Electrical Control System.

In some instances, where control for a penstock intake gate hoist where the emergency lower control switch is to be located in the powerhouse, the length of the connecting circuit may be such that its mutual inductance may render the circuit susceptible to false operation. In such cases, it will be necessary to use direct current and interpose an additional control relay. The direct current can be provided from a rectifier located in the control cabinet or from a circuit on the power house control battery.

Use Section 40 60 00 or similar specification if PLC control is required.

****

The scheme of operation of the [outlet control gate] [tainter gate] [intake gate] hoist motor control system must be as described and indicated. The control system must include the controller, limit switch[es], control station[s], and such other items as may be required to accomplish the operating features specified. Each item must be [installed and] tested as specified and must be complete and ready for operation [, when installed under another contract,] in accordance with the scheme of operation.

2.4 CONTROLLER

****

NOTE: Separate mounting of the controller is usually the preferred practice. When mounting the controller on the hoist frame is desired, the Contractor will be required to submit a drawing showing the arrangement of the controller and other electrical equipment on the hoist frame. In this case, the electrical equipment should be wired in the shop complete and ready for operation upon bringing the power connection to the line side of the controller disconnect switch.

****

Submit a description of the operation scheme, if other than herein specified or shown on the drawings; a dimensioned outline drawings showing specific relationships and clearances between equipment and their component parts, detailed panel layouts, schematic wiring diagrams, and a panel wiring diagram dimensioned outline drawings showing specific relationships and clearances between equipment and their component parts. Submit detailed descriptive data covering all component parts of the controller.

2.4.1 Controller Type

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NOTE: Adjustable speed drives (ASD) are appropriate for gates hoisted on each side and requiring skew control. Full-voltage magnetic starters are appropriate when using a torque shaft across the gate or when using wound-rotor motors to form a virtual shaft for skew control.

****

The hoist motor controller must be[an adjustable speed drive (ASD) in accordance with Section 26 29 23 ADJUSTABLE SPEED DRIVES (ASD) SYSTEMS UNDER 600 VOLTS. The controller must be][of the full-voltage magnetic type] initiated by the push-button control station and controlled automatically by a limit switch or limit switches. Limit switch[es] must be driven by the hoist mechanism or other auxiliary operating devices as indicated or required to provide the sequence of operation specified or indicated on the plans.

2.4.2 Protection

The controller must provide [under-voltage protection,] inverse-time-limit overload protection, or other protection as indicated or specified. [In addition, the controller must provide protection from single-phase faults.] Accomplish the protection by suitable relays conforming to the requirements of paragraph RELAYS. Overload relays must provide protection during both the starting and running condition, and provide means to manually reset the relays without opening the enclosing case of the controller. All forward and reversing contactors must be electrically interlocked. Controller disconnecting circuit breaker[s] must be interlocked with the controller enclosing case access door to permit opening or closing the access door only when the disconnect is in the "OPEN" position.

2.4.3 Enclosure

****

NOTE: When controller is mounted in a dry room or gallery adjacent to the hoist equipment adjacent to the hoist equipment, a NEMA Type 12, industrial-use enclosure should be specified and the drawings and specifications revised accordingly. Hubs must be specified for all conduit entrances.

Wall mounting is generally the least costly alternative and should be used whenever practical.

Designer must coordinate padlock requirements with local physical security standards.

****

Enclosing cabinet must be of the NEMA Type [3R [stainless steel]] [4 watertight [stainless steel] and moisture-resisting] [12 industrial use] construction with interior dead-front panel meeting the requirements of NEMA ICS 6. Design the enclosing cabinet for [floor mounting] [mounting on the hoist frame] [wall mounting]. Provide suitable padlock eyes to allow locking the exterior door in the closed position. Provide padlocks, conforming to [_____], with each controller and chained to the enclosing case. The chain must be of a nonferrous material resistant to corrosion. Use only front-connected devices, and clearances must be in accordance with NEMA ICS 1 requirements. Provide threaded hubs for conduit entrance of the welded-in type as indicated on the drawings or as required to make the wiring connections. Provide an automatic breather-drain, not less than 3/8-inch size and located in a protected location and at the lowest point of the enclosure.

2.4.4 Circuit Breakers

Provide and assemble circuit breakers as shown on the drawings or specified in the housing of each controller.

2.4.4.1 Circuit Breakers - General

Each circuit breaker must be listed for UL 489. The circuit breakers must be manually operated and must be of the instantaneous trip type, unless otherwise specified or indicated on the drawings. Circuit breakers for cabinet heaters, lights, and receptacles must be of the inverse-time trip type. All poles of each breaker must operated simultaneously by means of a common handle and must be enclosed in a common molded plastic case. The contacts of multipole breakers must open simultaneously when the breaker is tripped manually or automatically. The operating handles must clearly indicate whether the breakers are in "ON," "OFF," or "TRIPPED" position. Each circuit breaker must be externally operated [and interlocked] as specified in paragraph PROTECTION. Provide approved means for padlocking the breaker[s] operating handle in the "OFF" position. Provide a padlock of the same type as specified in paragraph ENCLOSURE for each breaker[and chained the padlock to the enclosing case]. The circuit breakers must be products of only one manufacturer and must be interchangeable when of the same frame size.

2.4.4.2 Trip Units

Except as otherwise indicated on the drawings, provide the circuit breakers with combination thermal and instantaneous magnetic trip units unless otherwise indicated. The minimum frame sizes and the trip unit ratings must also be as required for the equipment controlled. Nonadjustable instantaneous magnetic trip unit must be set as approximately 10 times the continuous current ratings of the circuit breakers.

2.4.4.3 480-Volt AC Circuits

Circuit breakers for 480-volt AC circuits must be rated 600 volts AC and must have a minimum NEMA interrupting capacity of 14,000 symmetrical amperes at 600 volts AC.

2.4.4.4 120-Volt AC Circuits

Circuit breakers for 120-volt AC circuits must be rated not less than 120/240 or 240 volts AC and must have a minimum NEMA interrupting capacity of 10,000 symmetrical amperes.

2.4.4.5 125-Volt DC Circuits

Circuit breakers for 125-volt DC circuits must be two-pole rated 125/250 or 250 volts DC and must have a minimum NEMA interrupting capacity of [5,000] [10,000] amperes DC.

2.4.5 Assembly of Controller

Furnish all necessary circuit breakers, contactors, relays, resistors, interlocks, master switches, limit switches, or other devices required by the scheme of operation. The panel for mounting the relays and contactors must be sheet steel of sufficient thickness to provide rigid support for the equipment mounted thereon. Give the steel panel a corrosion resisting treatment in accordance with the requirements of paragraph CORROSION PREVENTION AND FINISH PAINTING.

2.4.5.1 Wiring

Submit data sufficient to demonstrate that the proposed wire and cable conform to these specifications. Insulated wire must conform to the requirements of paragraph CONDUCTORS. Securely hold all wiring in place and arrange in a neat and orderly manner in horizontal and vertical runs. Protect with grommets all wiring passing through steel gutters, unless the openings in the steel gutter are formed to protect the wiring from damage. [All controllers must be wired in like manner as to location of parts and phase sequence.] Neatly and legibly identify the wire and terminal numbers in an approved manner. Use terminal blocks for making all external connections.

2.4.5.2 Terminal Blocks

Terminal blocks for control wiring must be molded type with barriers, rated not less than 600 volts. Provide terminal blocks with covers. The terminals must be removable, screw type, or of the stud type with contact and locking nuts. The terminals must not be less than No. 10 AWG in size and must have sufficient length and space for connecting at least two indented terminals on No. 10 AWG conductors to each terminal. The terminal arrangement must approved by the Contracting Officer.

a. Provide not less than 10 percent, but in no case less than 2, spare terminals on each block. Terminal blocks for conductors larger than No. 10 AWG or with a capacity of more than 30 amperes must be adequate for the purpose intended, having length and space for at least two indented terminals of the size required on the conductors to be terminated.

b. For conductors rated more than 50 amperes, all screws must have hexagonal heads. For conductors rated 50 to 99 amperes, the minimum screw size must be 8 mm 5/16 inch. Conducting parts between connected terminals must have adequate contact surface and cross section to operate without overheating.

c. Provide white or other light-colored marking strips, fastened by screws to the molded sections at each block, for circuit designation. Each connected terminal of each block must have the circuit designation or wire number placed on the marking strip with permanent marking fluid. Furnish one reversible or one spare marking strip with each block.

2.4.6 Magnetic Contactors

2.4.6.1 Contactor Ratings

All heavy-duty magnetic contactors must be of the voltage rating indicated on the drawings or otherwise required. They must have a horsepower rating not less than the horsepower rating of the motor with which the controller is to be used, but the contactor used must not be smaller than NEMA, Size 1. The contactors must meet the requirements of NEMA ICS 2 and have continuous current ratings for the duty indicated. Contactors must be suitable for at least 200,000 complete operations under rated load without more than routine maintenance. They must operate successfully on 10 percent over-voltage and 15 percent under-voltage. The interrupting capacity must conform to NEMA standards. Provide mechanical interlocking between contactors as indicated or required and without any mechanical attachment between the interlocking mechanism and the moving parts of the contactor, unless otherwise approved by the Contracting Officer.

2.4.6.2 Arcing Protection

For each pole, the interruption arc and flame must be minimized by suitable arc chutes or other means so that no damage will be done to other portions of the device. The arc chutes, if provided, must be easily removable without removing or dismantling other parts.

2.4.6.3 Contactors

All current carrying surfaces must be of a silver alloy or of copper faced with a silver alloy and must be easily accessible and removable for replacement. Contactor must operate without chatter or perceptible noise while energized. Coils must be suitable for continuous operation on the voltage specified.

2.4.6.4 Construction

Provide each contactor with a minimum of three auxiliary contacts which may be easily changed from normally open to normally closed. Construct contactor to prevent corrosion in accordance with paragraph CORROSION PREVENTION AND FINISH PAINTING.

2.4.7 Relays

2.4.7.1 Control

****

NOTE: The numerical portion of the contact rating indicates the maximum operating voltage (e.g. 600 for 600 volts). The letter portion indicates the maximum operating current and AC or DC. Over-sizing the current rating will increase the life of the contacts. See NEMA ICS 5. Choose A600 for the highest-rated contacts on AC control circuits. Choose N600 for the highest-rated contacts on DC control circuits.

****

Control relay devices must meet applicable requirements of NEMA ICS 5 for Class [A600][N600] contacts. All contacts must be of a silver alloy or copper faced with a silver alloy.

2.4.7.2 Overload

Overload relays must meet the requirements of NEMA ICS 2 rated Class [20][_]. Relays must be the adjustable electronic type with normally closed control circuit contacts having a pilot and control circuit contact rating per paragraph CONTROL. Overload relays must have combination manual and automatic-type reset. They must have inverse-time tripping characteristics simulating the heating characteristics of the motor, must protect the motor against exceeding its specified temperature rise under any overload, stalled rotor, or single-phase condition, and must be self-protecting under all conditions, except short circuit. The relay must measure the current and electronically model the motor's thermal condition.

The means of adjusting the nominal rating must be sufficiently accurate to allow setting the relay at the full-load current value of the motor with which used. Reset mechanism must be trip free and arranged for manual reset in accordance with paragraph PROTECTION, unless automatic reset is indicated. Design the reset mechanism to permit changing from manual to automatic reset or vice versa without the use of special tools. Submit curves showing the overload relay tripping time versus current characteristics of the overload relays for the controller.

2.4.8 Control Transformer

The control transformer must be a standard, single-phase, 60-Hz, dry-type, [480][_]-120 volts, and with kVA rating sufficient to supply the control [and heater] circuits.

2.4.9 Control Voltage

****

NOTE: Control circuits and pilot devices operating under 50 volts are safer for operating and maintenance personnel per NFPA 70E.

****

Provide a switched-mode power supply for control circuits and pilot devices unless otherwise indicated for specific devices. Feed the power supply from the control transformer. Output voltage must be [24 volts DC][_].

2.4.10 Control Circuit Breakers

The control circuit breakers must conform to the requirements of paragraph CIRCUIT BREAKERS, except that an external operating mechanism is not required.

2.4.11 Indicating Lights

Indicating lights must be complete with LED lamps, full-voltage with internal power supplies, [push-to-test,]and lens or color caps. Lens and lamp must be removable from the front. They must be suitable for flush or semiflush mounting to the exterior cabinet door with [plastic][metallic] bevel and size [20 mm][30mm][_]. Exterior mounting of the indication lights must meet the requirement for the enclosure NEMA type. Use hinge wire for connections between the indicator lights and the terminal block.

2.4.12 [Plug Receptacle for Inching Pendant Control Switch

****
NOTE: Inching pendant control switch in paragraph INCHING STATION, and receptacle is not required on crest gates. Omit requirement for receptacle on controller enclosure and mount receptacle on wall of gate inspection room if inspection room is above maximum flood.
****

The receptacle body must be weather resistant with threaded cap and gasket complete with polarized female contact unit, four-wire, five-pole, grounded through shell and extra pole, and rated 30A, 460 volts.]

2.4.13 Equipment and Door Nameplates

Submit schedule of nameplates. Provide nameplates for the front of the cabinet door and for each item of equipment within the enclosure. Use anodized aluminum, stainless steel, or a laminated plastic sheet with black surface layer and a white bottom layer not less than 1/16 inch thick for the nameplate material. Identify equipment within the enclosure with nameplates or other suitable marking on the equipment unit base or on the panel.

2.4.14 Heater

[Where indicated,] [Each] control panel(s) must be provided with a thermostatically controlled electric heater capable of maintaining an enclosure temperature of [2] [_____] degrees C [35] [_____] degrees F when continuously exposed to an ambient temperature of [_____] degrees C degrees F.

2.4.15 Grounding

Make the ground connection for the controller enclosing cabinet by a threaded post fitting which extends through the enclosure wall and which is provided with fittings to connect No. 6 AWG stranded copper ground wire both inside and outside the enclosure. Inside the enclosure, the ground circuit must be extended with No. 6 AWG stranded copper wire from the connector to the panel.

2.5 CONTROL STATION[S]

****
NOTE: If possible, select contact ratings greater than the load to increase the lifespan of the contacts.
****

Control station[s] must be of the push-button type and must provide the number of indicating lights and individual switches of the type or types required by the scheme of operation. Enclosure must be NEMA 250 Type [3R] [4 watertight [stainless steel]] [12 industrial use] construction. All contacts must be of the double-break bridging type and must have a pilot and control circuit rating designation of [A600][N600][_] in accordance with NEMA ICS 5. Provide switch cases with threaded bosses for conduit or cable connection and provide ample wiring space for conductors of the size and insulation specified. Submit detailed descriptive data covering the control station[s] for approval before fabrication. Data must include schematic diagrams, wiring diagrams, layout drawings, and parts lists.

2.5.1 Primary Station

****

NOTE: Use padlocked stop switch on all hoists except intake gate hoists provided with remote lowering. Intake gate hoists may use either padlock or "substantial metal cover" alternate. If metal cover alternate is used, the emergency lower contact "ELS" in parallel with the stop switch contact should be deleted.

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NOTE: Use lamp colors in accordance with the "safety" scheme of NFPA 79-2015 Table 10.3.3.

COLOR	**PURPOSE**
Red	**Danger**
Yellow (Amber)	**Warning/Caution**
Green	**Safe**
Blue	**Mandatory action**
Clear, White, Gray, Black	**Unspecified**

****

Arange the primary station with the elements stacked vertically and with [_____]-inch conduit entrance from the bottom. The station must provide [a red indicating light and] [3] [4] operating rocker handle-type push buttons. Arrange the station starting at top with [a red light followed by] the "RAISE," ["CONDUIT OPEN,"] "LOWER," and "STOP" push buttons. The station switch elements must have nameplates with the above designations. [Provide the "STOP" switch with means of padlocking the switch in the stop or in the open position.] [Provide the station with a substantial removable or hinged metal cover which can be locked in the closed position to prevent operation of the switch elements.] The padlock must be chained to the enclosing case with a chain made of nonferrous material.

2.5.2 Inching Station

Arrange the inching station with the elements stacked vertically and with conduit entrance on the top for a cable clamp. The cable must be [_____] feet of five-conductor, No. 12 AWG portable cable with extra flexible conductors, heat and moisture resistant insulation, and outer Neoprene jacket. The station must have two rocker handle-type push buttons. The switch elements must be designated "INCH UP" and "INCH DOWN" from top to bottom, respectively.

2.6 PROGRAMMABLE LIMIT SWITCH

Submit dimensioned outline drawing of the limit switch. Show on the Drawings specific relationships and clearances between equipment and their component parts.

a. Submit all limit switch computations used to determine the selection of gear ratios and calibration for gate travel.

b. Submit complete descriptive data covering the limit switch with necessary cuts, photographs, and drawings to indicate clearly the construction, materials used in the parts, rating, accuracy of tripping and reset, method of adjustment, and safeguards.

2.6.1 Normal Operation

The limit switch must be the programmable type with digital display and must operate on [24 volts DC][120 volts AC]. It must contain all the contacts required for making and breaking all control and interlocking circuits necessary for the proper control and operation in the manner specified or required.

2.6.2 Construction

The limit switch must be of compact and rugged construction, totally enclosed in a NEMA Type 12 case, and housed within the controller enclosure. The digital display must be visible without opening the enclosure door. This viewing port in the door must have a replaceable gasketed piece of clear plastic mounted to maintain the NEMA rating of the enclosure. Provide the cover with cap screws or other approved means for readily breaking the cover free for removal unless the gasket is so designed that it will not stick. All parts must be of corrosion-resisting metal or treated in an approved manner to render it resistant to corrosion. The switch must permit final adjustment in the field. Provide tapped bosses for making all conduit connections to the switch. Provide a clamp-type connector bolted to the outside of the case for making ground connections.

2.6.3 Switches

Switches must be solid state with current rating as required. Assemble or combine switches into operating units as indicated on the plans. Provide them with suitable terminals for connecting the external conductors. Switches must provide one remote digital readout. Each terminal must be suitably marked or tagged with the wire number shown on the contract drawings. Design the tripping mechanism for fail-safe operation and resetting the contacts when moving in the reverse direction. The switch must have an operator lockout feature which permits programming only by authorized personnel.

2.6.4 Transducer

****

NOTE: Consider using a resolver if the point of measurement is exposed to significant heat, moisture, or vibration because resolvers do not contain optics or electronics. However, encoder feedback systems are simpler.

****

The position sensor must be heavy-duty [resolver][encoder] enclosed in a outdoor NEMA 4 watertight enclosure. Provide a cable [chain] connector for the enclosure which is suitable for No. 16 AWG shield twisted pair.

2.6.5   Accuracy of Trip and Reset

****

NOTE: For installations where water control requires gate travel of over 9 m 30 feet, measurement of gate travel may become nonlinear. This is due to stretching of the wire rope. The attachment point for measurement of travel should be as near the switch as possible and need not be at the top of the gate. The designer must investigate possible options, including use of chain and additional limit switches.

****

Design the switch elements and operating mechanism of the limit switch to provide uniform and accurate setting. The switch must accurately transmit position within + 75 mm/- 3 inches and must reset gate for drift exceeding 150 mm 6 inches.

[2.7   OVERTRAVEL LIMIT SWITCHES

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NOTE: The requirements for positively-driven and force-guided limit switches imply a safety style.

****

Provide dry-contact limit switches for overtravel protection. [The limit switches must be positively-driven with the mechanical force of the hoisting system must be transmitted directly to the contacts to force them open. The limit switches must be force-guided with the contacts mechanically linked to ensure the normally-open and normally-closed contacts are not simultaneously closed.] Hardwire the normally-closed contacts of the switches to the motor starting circuit. Include provisions to backout of overtraveled positions using momentary pushbuttons to defeat the limit switch protection.

]2.8   WIRE AND CONDUIT

2.8.1   Conductors

Conductors must be of annealed copper wire. Insulate copper conductors with cross-linked thermosetting polyethylene (XLPE) of type XHHW-2. Conductors mjst be Class B or Class C stranding, except for hinge wire which must be Class D or K stranding. Unless otherwise specified, all wire and cable for power and control must be single conductor. Insulation thickness must be that required for a rated circuit voltage of 0 to 600 volts. Apply a moisture resisting thermoplastic jacket over the insulated conductor. The method of accomplishment must be in accordance with the current practice of the industry. Wire for power and motor circuits must have a current carrying capacity corresponding to the ampere rating of the circuit's circuit breaker and not less than No. 12 AWG and the full-load current of the motor or the circuit. Wire for control circuits must not be smaller than No. 14 AWG.

2.8.2 Control Wire

All control wire entirely within an enclosure must be type SIS switchboard wire meeting the requirements of UL 44. All other control wire must be type XHHW-2 wire meeting the requirements of UL 44.

2.8.3 Conduit

Rigid steel conduit must conform to ANSI C80.1 and must be zinc-coated (galvanized) both inside and outside by the hot-dip method.

2.8.4 Fittings

Conduit fittings must conform to the requirements of NEMA FB 1 and CID A-A-50553.

[2.8.5 Conductive Corrosion Inhibiting Compounds

Provide conductive corrosion inhibiting compounds meeting the requirements of UL 546. Compounds must be compatible with aluminum and copper conductors, must inhibit oxidation at the conductor-to-connector interface, and must not damage the conductive or insulating materials.

Provide non-gritted conductive corrosion inhibiting compound that are non-petroleum based and non-toxic and contain no grit filler. Ensure non-gritted conductive corrosion inhibiting compound is specified by the manufacturer for application to the conductor-to-connector interface of mechanical connectors such as bolted joints, flat-to-flat contact surfaces, terminal and lug tongues, and grooves of bolted parallel connectors or clamps.

]2.8.6 Assembly

****

NOTE: For contracts where all conduit and wiring are furnished and installed by others, use paragraph 'a.'

For contracts where all conduit and wiring are on the hoist and are furnished and installed under this contract, use paragraph 'b.'

For contracts where the conduit and wiring on the hoist are furnished and installed under this contract and the connections to remotely located items are made under a subsequent contract, use paragraph 'c.'

****

Install the hoist motor, motor brake, controller, limit switch, and primary control station on the [hoist frame] [as shown on contract drawings].

[a. The conduit and wiring connections external to the items of electrical equipment previously mentioned will not be furnished or installed under this contract.]

[b. Furnish, install, completely connect, and make ready for operation the conduit and wiring connections external to these previously mentioned items of electrical equipment. The conduit, wiring, and connections for the incoming power will be made by others under a subsequent contract.]

[c. Furnish, install, completely connect, and make ready for opertation the conduit and wiring connections external to these previously mentioned items of electrical equipment which are installed on the hoist frame. The conduit and wiring connections to the remotely located control equipment and the incoming power connections will be made by others under a subsequent contract.]

d. Install all wiring in rigid hot-dip galvanized metal conduit with threaded-type fittings (Condulets) and zinc-coated watertight outlet and pull boxes. Securely mount and fasten the conduit to the hoist framework in a neat and professional manner. Change direction of a conduit run by means of threaded-type fittings (Condulets) or factory fabricated bends. Install the conduit to fit close to the hoist framework. Use conduit unions whenever it is necessary to join conduits that are to be turned right and left. No running threads will be permitted. Carefully ream ends of conduits. All threaded connections must be made up with electrically conductive colloidal copper rust-inhibiting compound or other suitable compound. Provide separate conduit systems for power and control circuits. Ground the entire conduit system and instal so that any moisture will be drained away from terminal boxes and equipment. All conduit connections to equipment enclosures must be of the watertight threaded type. Provide suitable "drain-breather" devices at all low points of the conduit system to prevent an accumulation of water. Terminate all conductors in an approved manner. Use indented terminals on No. 12 AWG and larger conductors and terminate on screw or stud terminals. Use toothed lock washers on all screw terminals, and use locking nuts or lock washers on all stud terminals.

2.9 FACTORY TESTING

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NOTE: If designer elects to do operational tests of the gate hoist equipment, in conjunction with testing of the hoist itself, the hoist specification number must be included.

****

Give a complete test of each item of equipment furnished, one of each rating and type and selected at random by the Contracting Officer. Give a routine test of the remaining items of equipment. All complete tests required herein will be witnessed by the Contracting Officer, unless waived in writing. Ship no equipment until it has been approved for shipment by the Contracting Officer. Notify the Contracting Officer sufficiently in advance of the date of the tests so that arrangements can be made for the Contracting Officer to be present at the tests. The test equipment and the test methods used must conform to the applicable requirements of ANSI, IEEE, and NEMA standards and will be subject to the approval of the Contracting Officer. Submit certified reports of all complete and routine tests, including complete test data. Certified copies of the results of a complete test for duplicate equipment will be accepted in lieu of the requirement of the complete test specified. Include analysis and interpretation of test results in reports, and properly identify the test systems and materials. Provide test reports for "complete tests" on the motor, brake, and controller. Certified copies of "Complete Tests" on duplicate equipment may be accepted with the approval of the Contracting

Officer. No substitute will be accepted for the routine test. The Contractor must bear the cost of performing all tests include the cost in the price bid. [Perform operational tests on the equipment in conjunction with the tests specified in [_____] for the assembled hoist.] [Perform operational tests on equipment after it is installed.] Performance curves indicating the results of the motor tests must be furnished as follows:

a. Excitation Tests. Volts or percent of rated voltage as abscissa vs. amperes and watts as ordinates.

b. Impedance Tests. Volts or percent of rated voltage as abscissa vs. amperes and watts as ordinates.

c. Performance Test. Torque or percent of rated horsepower output as abscissa vs. efficiency, power factor, amperes watts, and rpm or percent slip as ordinates.

d. Speed-Torque Test. Torque in foot-pounds as abscissa vs. speed in rpm or percent of synchronous speed as ordinates.

e. Temperature Test. Time in minutes as abscissa vs. temperature rise in degrees C as ordinate.

f. Insulation Resistance Test. Plot test result values on semilogarithmic graphs, the insulation resistance values as logarithmic ordinates, and the temperature values as uniform abscissa.

g. Include analysis and interpretation of test results in the routine test reports and properly identify the test systems and materials. No substitute will be accepted for the routine test. Provide test reports for "routine tests" on the motor, brake, controller, limit switch, [interrupter,] and wiring.

h. Submit description of "Interrupter" drive including copies of dimensioned outline drawing of the interrupter. Show on the Drawings specific relationships and clearances between equipment and their component parts.

2.9.1 Motor Tests

Perform all tests in accordance with the requirements of IEEE 112 for three-phase induction motors.

2.9.1.1 Complete Motor Tests

The complete tests must include the following:

a. Excitation test.

b. Impedance test.

c. Performance and speed-torque test (Prony brake or other approved method).

d. Temperature test.

e. Insulation resistance tests. Take measurements following temperature test with readings taken at approximately 10C intervals. Temperature must be determined by the resistance method.

f. Dielectric test.

g. Cold and hot resistance measurement.

h. Effectiveness of enclosure.

i. Motor winding heater test.

    (1) Successful operation.

    (2) Dielectric.

2.9.1.2 Routine Motor Tests

The routine tests must include the following:

a. Excitation test: (One point - no load, volts, amperes, and watts.)

b. Impedance test: (One point - half-voltage amperes and watts.)

c. General operation.

d. Insulation resistance - temperature test (one point).

e. Resistance measurements.

f. Dielectric.

g. Motor winding heater test.

    (1) Successful operation.

    (2) Dielectric.

[h. Interrupter.
]

2.9.2 Brake Tests

2.9.2.1 Complete Brake Tests

The complete tests must include the following:

a. Check operation of brake release at the specified rated brake torque for rated and 85 percent terminal voltage.

b. Heat run on release magnet at the specified rated brake torque and voltage.

c. Insulation resistance of release magnet including leads and terminal block.

d. Resistance measurements of release.

e. Dielectric test of release magnet including leads and terminal block.

f. Brake space heater test.

    (1) Successful operation.

    (2) Dielectric.

2.9.2.2 Routine Brake Tests

The routine tests of the brake must be the same as specified in paragraph COMPLETE BRAKE TESTS, except that the heat run tests must be omitted.

2.9.3 Controller Tests

2.9.3.1 Complete Controller Tests

The complete tests must include all tests listed in paragraph ROUTINE CONTROLLER TESTS, and the following:

a. Effect of voltage and frequency variation.

b. Temperature Test.

2.9.3.2 Routine Controller Tests

The routine tests must include the following:

a. Adjustment, fit, and material.

b. Successful operation.

c. Resistance.

d. Dielectric.

e. Insulation Resistance.

f. Enclosure space heater test.

    (1) Successful operation.

    (2) Dielectric.

2.9.4 Limit-Switch Tests

Test each limit switch in the manufacturer's shop by suitable means, simulating service conditions, to ascertain that it will transmit the correct information for the control sequence specified. In addition, the routine tests must include the following:

a. Adjustment, fit, and material.

b. Accuracy of trip and reset.

c. Successful operation.

2.9.5 Wiring Tests

Give all wiring outside an enclosure a dielectric test following installation by applying, for 1 minute, a voltage test of 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Apply voltage to each circuit and ground and between each conductor and all other conductors in the same conduit.

PART 3 EXECUTION

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NOTE: Designer should add a reference to this Section in Part 3 of Section 26 08 00 APPARATUS TESTING AND INSPECTION.

****

3.1 FIELD QUALITY CONTROL

Perform acceptance checks and tests in accordance with NETA ATS and Section 26 08 00 APPARATUS INSPECTION AND TESTING.

3.1.1 Circuit Breakers

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NOTE: See UFC 3-560-01 for requirements to perform acceptance testing of certain overcurrent protective devices in accordance with ANSI/NETA ATS. Field testing with actual settings will demonstrate proper trip timing and device operaton for arc flash protection.

****

Perform the following tests for [each main breaker and each breaker rated 225 amps or higher.][each three-phase, molded-case circuit breaker.]

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, and grounding.

4. Verify the unit is clean.

5. Operate the circuit breaker to insure smooth operation.

6. Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter.

7. Inspect operating mechanism, contacts, and arc chutes in unsealed units.

8. Perform adjustments for final protective device settings in accordance with the coordination study.

B. Electrical Tests

1. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer’s published data. In the absence of manufacturer’s published data, use 500 volts dc for 300-volt systems and 1000 volts for 600-volt systems and record the ambient temperature. Minimum insulation resistance must be 25 Megohms for 300-volt systems and 100 Megohms for 600-volt systems after correcting for temperature in accordance with NETA ATS Table

100.14.

2. Perform a contact/pole-resistance test.

3. Determine long-time pickup and delay by primary current injection.

4. Determine short-time pickup and delay by primary current injection.

5. Determine ground-fault pickup and time delay by primary current injection.

6. Determine instantaneous pickup by primary current injection.

7. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer’s published data.

8. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators.

9. Verify operation of charging mechanism.

Plate No. 1

CREST GATE
ELECTRICAL CONTROL SYSTEM
(With Approximately 1.0 Foot Increments)
DESCRIPTION OF CONTROL SYSTEM

1. SCHEME OF OPERATION

a. General. The control system for the gate must be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor must be controlled by:

(1) A push button station located on the gate hoist with momentary contacts designated "RAISE, "LOWER," and "STOP."

(2) A push button station located on the door of the controller cabinet with momentary contacts designated "BACKOUT FROM RAISE OVER TRAVEL" and "BACKOUT FROM LOWER OVER TRAVEL."

c. Operating Features

(1) Actuation of the "RAISE" and LOWER" contacts must provide seal-in operation.

(2) A limit switch geared or directly connected to the hoist machine, must control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(3) Actuation of the "STOP" contact during any operation must stop the hoist motor and set the brake.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed and the intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 1 foot and stop.

(2) When the gate is at or above the intermediate position, actuation of the "RAISE" contact will cause the gate to raise continuously to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and the intermediate position, actuation of the "LOWER" contact will cause the gate to lower continuously to the intermediate position and stop.

(2) When the gate is at or below the intermediate position and is above the closed position, each actuation of the "LOWER" contact will cause the gate to lower approximately 1 foot and stop.

c. Over Travel. If during normal operation, the gate motor should fail to stop when the gate reaches the raised or closed positions, the over travel limit switch contacts must stop the hoist motor after over travel by de-energizing the "main" or "line" contactor of the controller. To operate the gate after an over travel, the appropriate backout must be held closed to permit operation of the gate only in the direction away from the over travel position after operation of either the "RAISE" or "LOWER" contact on the primary control station.

Plate No. 2

CREST GATE
ELECTRICAL CONTROL SYSTEM
(With Approximately 0.5 Foot Increments)
DESCRIPTION OF CONTROL SYSTEM

1. SCHEME OF OPERATION

a. General. The control system for the gate must be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor must be controlled by:

(1) A push button station located on the gate hoist with momentary contacts designated "RAISE," "LOWER" and "STOP."

(2) A push button station located on the door of the controller cabinet with momentary contacts designated "BACKOUT FROM RAISE OVER TRAVEL" and "BACKOUT FROM LOWER OVER TRAVEL."

c. Operating Features

(1) Actuation of the "RAISE" and "LOWER" contacts must provide seal-in operation.

(2) A limit switch geared or directly connect to the hoist machine, must control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(3) Actuation of the "STOP" contact during any operation must stop the hoist motor and set the brake.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the first intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 0.5 foot and stop.

(2) When the gate is at or above the first intermediate position and is below the second intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 1 foot and stop.

(3) When the gate is at or above the second intermediate position, actuation of the "RAISE" contact will cause the gate to raise continuously to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and the second intermediate position, actuation of the "LOWER" contact will cause the gate to lower continuously to the second intermediate position and stop.

(2) When the gate is at or below the second intermediate position and above the first intermediate position, each actuation of the "LOWER" contact will cause the gate to lower approximately 1 foot and stop.

(3) When the gate is at or below the first intermediate position and is above the closed position, each actuation of the "LOWER" contact will cause the gate to lower approximately 0.5 foot and stop.

c. Over Travel. If during normal operation, the gate motor should fail to stop when the gate reaches the raised or closed positions, the over travel limit switch contacts must stop the hoist motor after over travel by de-energizing the "main" or "line" contactor of the controller. To operate gate after an over travel, the appropriate backout switch contact must be held closed to permit operation of the gate only in the direction away from the over travel position after operation of either the "RAISE" or "LOWER" contact on the primary control station.

Plate No. 3

CREST GATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM
(With Remote Control and Approximately 1.0 Foot Increments)

1. SCHEME OF OPERATION

a. General. The control system for the gate must be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor must be controlled by:

(1) A push button selector switch station located on the gate hoist with momentary push button contacts designated "RAISE", "LOWER", and "STOP" and selector switch contacts designated "LOCAL" and "REMOTE."

(2) A push button station located on the door of the controller cabinet with momentary contacts designated "BACKOUT FROM RAISE OVER TRAVEL" and "BACKOUT FROM LOWER OVER TRAVEL."

(3) A push button station, located on the spillway gate remote control board with momentary contacts designated "RAISE", "LOWER", and "STOP."

(4) A synchronous type indicator, located on the spillway gate remote control board to show the gate position.

c. Operating Features

(1) Actuation of the "RAISE" and "LOWER" contacts of the control station[s] must provide seal-in operation.

(2) The position of the "REMOTE-LOCAL" control switch will determine which station is operative.

(3) The remote control must utilize direct current interposing relays.

(4) A limit switch geared or directly connected to the hoist machine, must control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(5) Actuation of the "STOP" contact during any operation must stop the hoist motor and set the brake.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the intermediate position, each actuation of the "RAISE" contact will cause the gate to raise approximately 1 foot and stop.

(2) When the gate is at or above the intermediate position, actuation of the "RAISE" contact will cause the gate to raise continuously

to the raised position.

b. Lowering

  (1) When the gate is between the over travel raised position and the intermediate position, actuation of the "LOWER" contact will cause the gate to lower continuously to the intermediate position and stop.

  (2) When the gate is at or below the intermediate position and is above the closed position, each actuation of the "LOWER" contact will cause the gate to lower approximately 1 foot and stop.

c. Over Travel. If during normal operation, the gate motor should fail to stop when the gate reaches the raised or closed positions, the over travel limit switch contacts must stop the hoist motor after over travel by de-energizing the "main" or "line" contactor of the controller. To operate the gate after an over travel, the appropriate backout switch contact must be held closed to permit operation of the gate only in the direction away from the over travel position after operation of either the "RAISE" or "LOWER"contact on the primary control station.

Plate No. 4

CREST GATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM
(With Remote Control and Approximately 0.5 Foot Increments)

1. SCHEME OF OPERATION

a. General. The control system for the gate must be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor must be controlled by:

(1) A push button selector switch station located on the gate hoist with momentary push button contacts designated "RAISE", "LOWER", and "STOP" and selector switch contacts designated "LOCAL" and "REMOTE."

(2) A push button station located on the door of the controller cabinet with momentary contacts designated "BACKOUT FROM RAISE OVER TRAVEL" and "BACKOUT FROM LOWER OVER TRAVEL."

(3) A push button station, located on the spillway gate remote control board with momentary contacts designated "RAISE", "LOWER", and "STOP."

(4) A synchronous type indicator, located on the spillway gate remote control board to show the gate position.

c. Operating Features

(1) Actuation of the "RAISE" and "LOWER" contacts of the control station[s] must provide seal-in operation.

(2) The position of the "REMOTE-LOCAL" control switch will determine which station is operative.

(3) The remote control must utilize direct current interposing relays.

(4) A limit switch geared or directly connected to the hoist machine, must control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(5) Actuation of the "STOP" contact during any operation must stop the hoist motor and set the brake.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the first intermediate position, each actuation of the "RAISE " contact will cause the gate to raise approximately 0.5 foot and stop.

(2) When the gate is at or above the first intermediate position and is below the second intermediate position, each actuation of the

"RAISE" contact will cause the gate to raise approximately 1 foot and stop.

(3) When the gate is at or above the second intermediate position, actuation of the "RAISE" contact will cause the gate to raise continuously to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and the second intermediate position, actuation of the "LOWER" contact will cause the gate to lower continuously to the second intermediate position and stop.

(2) When the gate is at or below the second intermediate position and above the first intermediate position, each actuation of the "LOWER" contact will cause the gate to lower approximately 1 foot and stop.

(3) When the gate is at or below the first intermediate position and is above the closed position, each actuation of the "LOWER" contact will cause the gate to lower approximately 0.5 foot and stop.

c. Over Travel. If during normal operation, the gate motor should fail to stop when the gate reaches the raised or closed positions, the over travel limit switch contacts must stop the hoist motor after over travel by de-energizing the "main" or "line" contactor of the controller. To operate the gate after an over travel, the appropriate backout switch contact must be held closed to permit operation of the gate only in the direction away from the over travel position after operation of either the "RAISE" or "LOWER" contact on the primary control station.

Plate No. 5

OUTLET CONTROL DATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM
(Single-speed Motor)

1. SCHEME OF OPERATION

a. General. The control system for the gate must be as indicated by schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor must be controlled by:

(1) A push button station located on the gate hoist with contacts designated "RAISE," "CONDUIT OPEN," "LOWER," and "STOP."

(2) A push button station located on the gate hoist with momentary contacts designated "BACKOUT FROM LOWER OVER TRAVEL" and "BACKOUT FROM RAISE OVER TRAVEL."

(3) A pendant push button station with momentary contacts designated "INCH UP" and "INCH DOWN," provided with a portable cable of suitable length to permit operation from the inspection room. The cable must terminate in a polarized plug matching receptacle located on motor controller cabinet or other suitable place.

c. Operating Features

(1) Actuation of the "RAISE", "CONDUIT OPEN", and "LOWER" contacts of the push button station must provide seal-in operation.

(2) Actuation of the "INCH UP" and "INCH DOWN" contacts of the pedant push button station must not provide seal-in operation.

(3) Actuation of the "STOP" contact during any operation must stop the hoist motor and set the brake.

(4) A limit switch geared to directly connected to the hoist machine must control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the raised position, actuation of the "RAISE" contact will cause the gate to open continuously to the raised position.

(2) When the gate is between the closed position and the conduit open position, actuation of the "CONDUIT OPEN" contact will cause the gate to open continuously to the conduit open position.

b. Lowering. When the gate is between the over travel raised position and the closed position, actuation of the "LOWER" contact will cause the gate to lower continuously to the closed position.

c. Inching

(1) To raise the gate above the raised position the "INCH UP" contact must be held closed. The gate will be stopped at upper inch position by the limit switch.

(2) To lower the gate when it is above the raised position the "INCH DOWN" contact must be held closed. The gate will be stopped at the raised position by the limit switch.

d. Over Travel

(1) Over travel limit switches must stop the driving motor if it fails to stop at the raised or closed position on the gate.

(2) The "BACKOUT FROM LOWER OVER TRAVEL" or "BACKOUT FROM RAISE OVER TRAVEL" contact must be held closed to operate the gate from over travel closed and over travel raised, respectively.

Plate No. 6

OUTLET CONTROL GATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM
(Multispeed Motor)

1. SCHEME OF OPERATION

a. General. The control system for the gate must be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor must be controlled by:

(1) A push button station located on the gate hoist with momentary contacts designated "RAISE", "CONDUIT OPEN", "LOWER", and "STOP."

(2) A push button station located on the gate hoist with momentary contacts designated "BACKOUT FROM LOWER OVER TRAVEL" and "BACKOUT FROM RAISE OVER TRAVEL."

(3) A pendant push button station with momentary contacts designated "INCH UP" and "INCH DOWN", provided with a portable cable of suitable length to permit operation from the inspection room. The cable must terminate in a polarized plug matching receptacle located on motor controller cabinet or other suitable place.

c. Operating Features

(1) Actuation of the "RAISE", "CONDUIT OPEN", and "LOWER" contacts of the push button station must provide seal-in operation.

(2) Actuation of the "INCH UP" and "INCH DOWN" contacts of the pedant push button station must not provide seal-in operation.

(3) Actuation of the "STOP" contact during any operation must stop the hoist motor and set the brake.

(4) A limit switch geared to be directly connected to the hoist machine must control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

2. SEQUENCE OF OPERATION

a. Raising

(1) When the gate is between the closed position and the raised position, actuation of the "RAISE" contact will cause the gate to open continuously at low speed to the conduit open position.

(2) When the gate is between the closed position and the conduit open position, actuation of the "CONDUIT OPEN" contact will cause the gate to open continuously at low speed to the conduit open position where the limit switch must cause the gate to open continuously at high speed to the raised position. (3) When the gate is between the conduit open position and the raised position, actuation of the "RAISED" contact will cause the gate to open continuously at high speed to the raised position.

b. Lowering

(1) When the gate is between the over travel raised position and conduit open position, actuation of the "LOWER" contact will cause the gate to lower continuously at high speed to the conduit open position where the limit switch must cause the gate to close continuously at low speed to the closed position.

(2) When the gate is between the conduit open position and the closed position, actuation of the "LOWER" contact will cause the gate to lower continuously at low speed to the closed position.

c. Inching

(1) To raise the gate above the raised position the "INCH UP" contact must be held closed. The gate will be stopped at upper inch position by the limit switch.

(2) To lower the gate when it is above the raised position the "INCH DOWN" contact must be held closed.

(3) The gate will be stopped at the raised position by the limit switch.

d. Over Travel

(1) Over travel limit switches must stop the driving motor if it fails to stop at the raised or closed position or the gate.

(2) The "BACKOUT FROM LOWER OVER TRAVEL" or "BACKOUT FROM RAISE OVER TRAVEL" contact must be held closed to operate the gate from over travel closed and over travel raised, respectively.

Plate No. 7

INTAKE GATE
ELECTRICAL CONTROL SYSTEM
DESCRIPTION OF CONTROL SYSTEM

1. SCHEME OF OPERATION

a. General. The control system for the gate must be as indicated by the schematic control wiring diagram, and as specified below.

b. Control Points. The operation of the hoist motor must be controlled by:

(1) A push button station located on the gate hoist with momentary contacts designated "RAISE," "LOWER," and "STOP."

(2) A push button station located on the door of the controller with momentary contacts designated "BACKOUT FROM LOWER OVER TRAVEL" and "BACKOUT FROM RAISE OVER TRAVEL."

(3) A pendant push button station with momentary contacts designate "INCH UP" and "INCH DOWN," provided with a portable cable of suitable length to permit operation from the inspection room. The cable must terminate in a polarized plug matching receptacle located on motor controller cabinet or other suitable place.

c. Operating Features

(1) Actuation of the "RAISE" and "LOWER" contacts of the push button station must provide seal-in operation.

(2) Actuation of the "INCH UP" and "INCH DOWN" contacts of the pendant push button station must not provide seal-in operation.

(3) Actuation of the "CLOSE" contact of the emergency lower switch must provide seal-in operation.

(4) Actuation of the "STOP" contact during any operation must stop the hoist motor and set the brake.

(5) A "balanced-pressure switch" with normally closed contact.

(6) A limit switch geared or directly connected to the hoist machine must control the incremental and stopping operations initiated manually from the control station as described under sequence of operation.

(7) Gate position indicating lights as follows:

(8) a) A red light on push button station and with emergency lower switch indicating gate is in normal operating position.

(9) b) A green and blue light with emergency lower switch indicating gate is in closed and raised position, respectively.

(10) c) Am amber light with emergency lower switch indicating gate is closing.

2. SEQUENCE OF OPERATION

a. Raising. When the gate is between the closed position and the raised position, actuation of the "RAISE" contact will cause the gate to open continuously to the raised position. If there is a pressure difference between the two sides of the gate, the gate will stop at the cracked position. After pressure is balanced actuation of the "RAISE" contact will cause the gate to open to the raised position.

b. Lowering. When the gate is between the over travel raised position and the closed position, actuation of the "LOWER" contact will cause the gate to lower continuously to the closed position.

c. Normal Operating Position

(1) The gate is placed in the normal operating position by either the raising or lowering operation described above.

(2) The red light indicates the gate is in normal position.

(3) Actuation of the "STOP" contact of the push button station stops the gate.

d. Emergency Closing. When the gate is between the normal position and the closed position, actuation of the "CLOSE" contact of the emergency lower switch will cause the gate to lower continuously to the closed position.

e. Inching

(1) To raise the gate above the raised position the "INCH UP" contact must be held closed. Gate will be stopped at upper inch position by the limit switch.

(2) To lower the gate when it is above the raised position the "INCH DOWN" contacts must be held closed. Gate will be stopped at the raised position by the limit switch.

f. Over Travel

(1) over travel limit switches must stop the driving motor if it fails to stop at the raised or closed position of the gate.

(2) The "BACKOUT FROM LOWER OVER TRAVEL" or "BACKOUT FROM RAISE OVER TRAVEL" contact must be held closed to operate the gate from over travel closed and over travel raised, respectively.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 20 23 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 23 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

****

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****

USACE / NAVFAC / AFCEC **UFGS-35 20 23 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-35 20 23 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

****

SECTION 35 20 23

DREDGING
08/20

****

NOTE: This guide specification covers the requirements for dredging.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: The techniques of sounding, sweeping, or a combination thereof are applicable methods in the acceptance examination, depending upon specific requirements of the project. In general, for maintenance dredging or for new dredging on soft bottom, the acceptance examination by soundings will be acceptable; for new dredging on hard coral or rock bed, and also for dredging below existing channel bottom on hard coral or rock bed, sweepings are required. For new dredging on hard bed harbor channel and turning basin for capital ships (such as aircraft carriers), the combination of soundings and sweepings is required. If modification of navigation charts is required after completion of dredging work, the EFD must coordinate with Naval Facilities Engineering Systems Command Code 04A3 for the proper data transfer procedures to the Defense Mapping Agency. In the case of inland rivers all

navigation chart updates must be coordinated with Inland Electronic Navigation Chart (IENC) team of the Corps of Engineers.
****

PART 1 GENERAL

1.1 GENERAL INFORMATION

****
NOTE: Identify any known site specific information that would impact the contract work. Identification of known subsurface/submerged materials does not relieve the Contractor for doing their own investigations and should be noted in the contract.
****

This Section covers furnishing suitable dredging plant and performing all work required to remove the specified materials from within the prescribed work area limits as indicated, and placement of the dredge material within the prescribed material placement areas. The Contractor is responsible for making their own investigation of submerged, surface, and overhead structures in the work areas and other locations they find necessary to traverse. The exact location, depths, and heights of various structures including, but not limited to submarine cables, pipes, highlines, docks, piers, bulkheads, and bridges (as applicable), are not known and it will be necessary for the Contractor to ascertain interference problems and notify the respective owners in advance of dredging operations. The Contractor is responsible for making necessary arrangements with the respective owners of the structure(s) to assure satisfactory completion of dredging in the vicinity with a minimum interruption of service, and must perform their operations in such a manner as will avoid damage to these facilities.

1.2 DEFINITIONS

1.2.1 Maintenance Material

Maintenance material is defined as that comprising shoaling which has occurred since the channel areas were last dredged.

1.2.2 New Work Material

New work material is defined as previously undredged material.

1.2.3 Hard Material

Hard material is defined as material requiring [blasting or] [the use of] special equipment for economical removal, and includes boulders or fragments too large to be removed in one piece by the dredge.

1.3 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submerged Pipelines

Soundings or Sweepings; G, [_____]

Indicate pipeline location and installation details. Submit drawings of surveys during progress of work by soundings or sweepings.

SD-07 Certificates

Protection Plan

1.4 METHOD OF COMMUNICATION

****

NOTE: Where appropriate, also require communications between dredging crews, placement area, and the US Coast Guard or Port Services Department of the Naval installation. Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS should be referenced to ensure there is no redundancy or discrepancy.

****

Provide a system of communication between the dredge crew and the crew at the placement area. A portable two-way radio is acceptable.

1.5   OTHER DREDGING OPERATIONS

The Contractor should anticipate the possibility of concurrent dredging operations, adjacent to or nearby the dredge and placement areas in this contract. Delays should be anticipated in transiting to, and through, the placement sites during concurrent dredging and placement operations. As a standard safety precaution, observe all placement site specific restrictions pertaining to the limit of dredges operating within at any given time. Coordination with other dredge plant in the vicinity of the dredge and placement areas is required.

1.6   ENVIRONMENTAL COMPLIANCE AND PROTECTION

****

NOTE: USACE Division 01 specification concerning environmental compliance should be referenced to ensure there is no redundancy or discrepancy.

****

Comply with conditions and requirements of State or Federal permits. The Government will secure the permit for dredging and placement of material as indicated. Coordinate with [_____] for placement of excavated materials.

During the life of the contract, provide and maintain environmental protective measures. Also, environmental protective measures required to correct conditions, such as oil spills or debris, that occur during the dredging operations, must be provided. Comply with Federal, State, and local regulations pertaining to water, air, and noise pollution.

1.7   BASIS FOR BIDS

****

NOTE: USACE will reference Division 00 and Division 01 to ensure there is no redundancy or discrepancy. Where applicable, choose one of the following options. Choose the first option for lump sum bidding of dredging, in projects where exact quantities can be practically determined prior to the actual work. Choose the second option for unit price bidding of dredging. Specify unit price bid items for dredging for projects where exact quantities cannot be practically determined prior to the actual work.

****

[Base bids on the quantity of dredging indicated. Should the total quantity of dredging vary from that specified as the basis for bidding, the contract price will be adjusted in accordance with FAR 52.243-4 Changes. The dredging conditions specified and indicated describe conditions which are known. However, the Contractor is responsible for other conditions encountered which are not unusual when compared to the conditions recognized in the dredging business as usual in dredging activities such as those required under this contract.]

****

NOTE: For NAVFAC PAC projects, edit contract's prices schedule for inclusion in Bid Items.
****

For unit price bid, see Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

****
NOTE: For NAVFAC LANT projects, use the following for unit price bidding.
****

[Payment will be at the contract unit price per cubic meter cubic yard, multiplied by total cubic meters cubic yards of acceptable dredging. Base bids on total cubic meters cubic yards of dredging. Include a bid unit price per cubic meter cubic yard of dredging based on the quantity [as specified or indicated.] If the Contracting Officer requires an increase or a decrease in total volume of dredging, the contract price will be adjusted in accordance with the FAR 52.211-18 Variation in Estimated Quantity. Dredging conditions specified and indicated describe conditions which are known. However, the Contractor is responsible for other conditions encountered which are not unusual when compared to conditions recognized in the dredging business as usual in dredging activities such as those required under this contract.]

PART 2 PRODUCTS

2.1 CHARACTER OF MATERIAL

****
NOTE: Include silt, sand and mud if project is for maintenance dredging. Delete new material if area has been previously dredged to design depth. New material is material which has never been dredged. Provide the site specific material description if it is known. For USACE, review any site investigations specifications, as applicable, to ensure consistency as it relates to material characterization.
****

The material to be removed is [silt, sand, and mud] [new material] [maintenance material] [_____]. The in situ bulk density of the predominant material to be dredged is as follows:

a. Dredge Area 1 has an in situ bulk density of [_____] grams/liter, and consists of [_____] percent sand, [_____] percent gravel, and [_____] percent fines.

b. The Contractor is ultimately responsible for determination of the characteristics of materials to be dredged.

****
NOTE: When blasting will not be permitted, so state. When blasting is permitted, incorporate the project specification information relative to maximum amount of charge that will be permitted and detailed requirements applicable to the specific project.
****

Remove hard material as needed to achieve the required template. Use of blasting operations will be permitted. Reference Section 31 00 00 EARTHWORK for blasting requirements.

PART 3 EXECUTION

3.1 INSPECTION

****

NOTE: Choose one of the following options. Choose the first option for projects which incorporate Contractor Quality Control. Choose the second option for projects which do not incorporate Contractor Quality Control.

****

[Inspect the work, keep records of work performed, and ensure that gages, targets, ranges, and other markers are in place and usable for the intended purpose. Provide, at the request of the Contracting Officer, boats, boatmen, laborers, and materials necessary for inspecting, supervising, and surveying the work. When required, provide transportation for the Contracting Officer and inspectors to and from the placement area and between the dredging plant and adjacent points on shore.]

[The Government will keep a record of work performed and will require that gages, ranges, and other markers are usable for the intended purpose. Provide, at the request of the Contracting Officer, boats, boatmen, laborers, and materials necessary for inspecting, supervising, and surveying the work. When required, provide transportation for the Contracting Officer and inspectors to and from the placement area and between the dredging plant and adjacent points on shore.]

The dredge plant will be inspected by the Contracting Officer, or their representative, prior to beginning work to ensure total dredging plant is in safe working condition. Before any machinery or mechanized equipment is placed in service, it must be inspected and tested by the Contractor and certified to be in safe operating condition.

3.2 DREDGING

3.2.1 Order of Work

****

NOTE: Special scheduling requirements, restrictions, or other similar features bearing on the Contractor performing the work, should be specified in this paragraph or reference made to "Special Scheduling Requirements" paragraph in Section 01 14 00 WORK RESTRICTIONS.

****

The Contracting Officer will direct the Contractor on the order of work. The Government reserves the right to change the order of work at any time.

3.2.2 Interference with Navigation

****

NOTE: If known, include types of vessel and volume of traffic expected to be encountered. USACE review

Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS for Contractor requirements to ensure there is no redundancy or duplication.
****

Minimize interference with the use of channels and passages. The Contractor is responsible for shifting or moving of dredges or the interruption of dredging operations to accommodate the movement of vessels and floating equipment, if necessary. Adhere to Coast Guard Regulations for passing vessels.

3.2.3 Lights

Each night, between sunset and sunrise and during periods of restricted visibility, provide lights for floating plants, pipelines, ranges, and markers. Also, provide lights for buoys that could endanger or obstruct navigation. When night work is in progress, maintain lights from sunset to sunrise for the observation of dredging operations. Lighting must conform to United States Coast Guard requirements for visibility and color.

3.2.4 Navigation Warnings

Furnish and maintain navigation warning signs along the pipeline. Provide notice to increase public awareness of potential hazards presented by dredge plant equipment by stating the location, date of construction, equipment mooring, marshaling areas, using local newspapers, radios, television, waterway users associations, or other appropriate area specific communication networks. Ensure that an announcement is made through the same networks at the beginning of the dredging operation. Make periodic updates/status announcements at intervals of not more than a month throughout the contract life.

Display a sturdy and prominent warning sign at all public boat marinas within 10 miles of dredging operations or moored equipment. The Contractor is responsible for keeping this sign current with respect to the dredging operations or equipment.

3.2.5 Ranges, Gages, and Lines

Provide, set, and maintain ranges, buoys, and markers needed to define the work and to facilitate inspection. Establish and maintain gages in locations observable from each part of the work so that the depth may be determined. Suspend dredging when the gages or ranges cannot be seen or followed. The Contracting Officer will furnish, upon request by the Contractor, survey lines, points, and elevations necessary for the setting of ranges, gages, and buoys.

3.2.6 Dredge Plant and Equipment

****
NOTE: Include either (dredge type) or option for (clamshell) (hydraulic cutterhead) (trailing suction hopper) (other) after bracket.
****

a. A [_____] dredge will be used to perform all dredging work under this contract.

****

NOTE: Include (number) or (count).

****

b. [_____] dredge(s) may be in operation under this Contract at a time.

c. Maintain all dredge plant and associated equipment such as, but not limited to, scows, coamings, barges, and pipelines, to meet the requirements of the work. Promptly repair leaks or breaks along pipelines.

3.2.7 Layout of Work

****

NOTE: Include datum following bracket to identify purpose of bracket.

****

The Contractor will be provided layout charts for all dredging areas based on the schedule of work, the Contractor's hydrosurvey requests, and/or the results of Government hydrographic survey monitoring. The most current Government hydrosurvey information will be displayed on the dredging layout charts and provided to the Contractor. All depths are measured from [_____]. Other pertinent information to be included with each layout package will be: payment method, required and maximum dredging depths, coordinates for the material placement site, distance one-way from dredging location to placement site, specific placement site instructions, supplemental tide gauge information, horizontal control locations, and computed hydrosurvey quantities.

****

NOTE: For USACE, quantities for project dredging, overdepth dredging, and total in the blanks are included in the Bid Schedule and should be deleted from herein.

****

The total estimated quantity of material to be removed is computed as that material that is within the specified limits, including side slopes, but excluding unpaid overdepth. The quantities listed are estimates only. All estimated quantities are subject to FAR 52.211-18 Variation in Estimated Quantity.

3.2.7.1 Overdepth Dredging

To cover unavoidable inaccuracies of dredging processes, material actually removed to a depth of [_____] meters feet below the minimum required depth specified and within the dredging limits will be measured and paid for at full contract price.

The maximum amount of allowable unpaid overdepth dredging is [_____] meters feet below the specified maximum paid dredging depth.

3.2.7.2 Side Slopes

****

NOTE: Use the first bracketed item when the side slope overdredge allowance is specified; use second bracketed item when side slope overdredge allowance is not specified. For first bracketed item, insert

allowable depth for dredging of side slopes beyond the indicated or specified side slopes for which payment will be made.

Ensure project requirements consider slope natural angle of repose and potential for sloughing when selecting appropriate language herein. Dredge equipment used will impact the resultant amount of material required to be removed.
****

Side slopes in the dredge areas within this contract will be measured and paid based on a [_____] meter feet horizontal to [_____] meter feet vertical ratio. Dredging on side slopes must follow, as closely as practicable, the dredge area limits indicated on associated layout drawings.

[A [_____] meter feet allowance will be made for dredging beyond the indicated or specified side slopes, except as provided herein. Material removed from within the allowance area will be unpaid. The allowance will be determined by projecting a line upwards, paralleling the project design side slopes, from the intersection of the overdepth dredging limit (at a point located vertically below the limit of dredging at the top of slope). The amount of material excavated from side slopes will be determined by either cross-sections or computer, or both.

][No allowance will be made for dredging beyond the dredge area limits as indicated on the associated layout drawings. No dredging can occur outside of the dredge area and side slope limits.

]3.2.8   Obstructions and Debris

****
NOTE: Choose one of the following options. Choose the first option where no known obstructions exist and site is not near existing piers. Choose the second option where known obstructions exist or for dredging around existing piers.
****

[The Government has no knowledge of cables, pipes, or other artificial obstructions or of any wrecks, wreckage, or other material that would necessitate the use of explosives or the employment of additional equipment for economical removal. Contractors should however exercise due diligence in determining the existence of any obstructions within proposed work areas during bid preparation.

][The Government has knowledge of debris such as, but not limited to, metal bands, pallets, pieces of broken cable, rope, fire hose, and broken piles. The Contractor is responsible for the disposal of the removed debris. This disposal must occur outside the limits of government property, and done so in accordance with all federal, state, and municipal regulations.

The Government has no knowledge of existing wrecks, wreckage, or other material of such size or character as to require the use of explosives or special or additional plant for its economical removal.

]3.2.9 Dredging Requirements

****

NOTE: Include requirements for various dredge areas. The current text is a template for use.

****

Dredge Areas

1) Dredge Area 1

a) As determined by the results of a hydrographic survey monitoring, the Government will direct the Contractor to dredging areas within [_____]. Dredging depths at this area will be between plus or minus [_____] and plus or minus [_____] meters feet [datum] including paid overdepth, unless otherwise stated in the layout drawing.

b) Material placement will be [_____] site. See Section [01 20 00 PRICE AND PAYMENT PROCEDURES][_____] for more details.

2) Dredge Area 2

3.2.10 Quality Control

Establish and maintain quality control for operations to assure compliance with contractual requirements and maintain records of this quality control for dredging operations.

While performing all dredging work control the horizontal positioning of the dredge with electronic positioning.

3.2.11 Surveys during Progress of Work

Quality of dredging depth will be determined by soundings or sweepings taken behind the dredge as work progresses. The [Government will][Contractor will] take progress soundings or sweepings.

3.2.12 Skimming of Hoppers

Skimming of hoppers must be performed in compliance with environmental requirements and ABS/USCG load line marks.

3.2.13 Salvaged Material

Anchors, chains, firearms, and other articles of value, which are brought to the surface during dredging operations, must remain or become the property of the Government and will be placed on shore at a convenient location near the site of the work, as directed.

3.2.14 Safety of Structures

The prosecution of work must ensure the stability of piers, bulkheads, and other structures lying on or adjacent to the site of the work, insofar as structures may be jeopardized by dredging operations. Repair damage resulting from dredging operations is the responsibility of the Contractor, insofar as such damage may be caused by variation in locations or depth of dredging, or both, from that indicated or permitted under the contract. The Contractor is responsible for coordinating with the owner of the structure for any necessary repairs.

3.2.15 Protection Plan

Prior to blasting, submit a plan for protection of surrounding structures, equipment, and vessels in accordance with Section 31 00 00 EARTHWORK for blasting requirements.

3.3 PLACEMENT OPERATONS

3.3.1 Placement of Excavated Materials

****

NOTE: Delete inapplicable language for placement area; insert other placement area language as appropriate.

****

Provide for safe transportation and placement of dredged materials. Transport and placement of dredged material in the [_____][placement area][area designated for placement of dredged material].[The Contractor may, at his option, place dredge material at [_____] or provide placement at an government approved placement area.] The placement of dredged materials in unauthorized places is forbidden. Comply with rules and regulations of all, federal, state and local authorities.

3.3.2 Method of Placement

****

NOTE: Delete inapplicable method of placement and include only the language appropriate for the method of placement to be used. Details should be specified regarding exact location for discharge into the placement area, maximum allowable elevation of buildup, and any other limitations or special provisions for placement. It is not recommended to pay based on scow measurement.

****

Place all dredged material by [the hydraulic process][hopper dredge][self-dumping scow or barge].[Coordinate completion of load with the Government. Notify the Government when scows or barges are returned to the dredge area.][Pipeline for hydraulic dredging must discharge into the placement area.]

3.3.3 Placement in Indicated Site(s)

****

NOTE: Include any special requirements for the construction and maintenance of fill area bulkheads and weirs. Delete when fill areas are not shown on the contract drawings. Require bulkheads and weir submittals for Contracting Officer review.

****

In placing excavated material for fill, uniformly grade and allow for shrinkage. Provide and maintain necessary bulkheads, dikes, ditches, weirs, spillways, and other construction necessary to confine and retain the fill in the dredge fill area.

3.3.4 Charges for Material Placement

****

NOTE: Insert "Department of the Army" in the first blank where placement area is under jurisdiction of the Corps of Engineers. Insert name of placement area in second blank. Delete entire paragraph when not applicable.

****

The [Government][Contractor] is responsible for payment of charges imposed by the [_____] for placement of material in the [_____] placement area.

3.3.5 Operation of Sluiceways

****

NOTE: Insert Corps of Engineers or other controlling agency in the blank provided. Delete when not applicable to the project.

****

Sluiceways on the placement area levees will be operated and maintained by the [_____]. The Government will relieve the Contractor of operations thereof.

3.3.6 Misplaced Dredged Material

Any dredged materials deposited at locations other than in areas designated or approved by the Contracting Officer will be considered misplaced material and will not be paid for until the Contractor, at his own expense, removes and deposits such misplaced material where directed. This required removal and redeposit of the misplaced material and any necessary placement site restoration work is not the basis for a time extension or additional compensation under this contract.

3.3.7 Submerged Pipelines

If a leak occurs in the discharge pipeline, immediately discontinue using the line until leaks are repaired. Following a leak, the Contractor should conduct, or request the Government to conduct, a hydrosurvey to ensure that any dredged material discharged through the leak did not accumulate or cause mounding. If accumulation did occur, the Contractor must coordinate with the Government to remove the accumulated material, if deemed necessary. The Contractor is responsible for any resulting costs of repair and restoration.

3.4 MEASUREMENT

****

NOTE: FOR US Army Corps of Engineers Projects, the measurement is discussed in Division 01 Measurement and Payment and should not be included in the specification herein.

****

The [Government will be][Contractor is] responsible for taking soundings before and after dredging.

Final quantities will be subject to deductions or correction of deductions previously made because of excessive overdepth, dredging outside or authorized areas, or placement of material in an unauthorized manner.

3.4.1 Method of Measurement

****

NOTE: The method of survey must be defined by the Government. Details for the method of measurement, calculations, and time frame for measurements to be made must all be defined herein.

****

Quantity of material removed that will be paid for will be measured by cubic meter cubic yard [in place][by means of volume difference from soundings taken before and after dredging][by means of topographic surveys of fill sites taken before and after dredging][_____]. The drawings represent existing conditions based on current available information, but will be verified and corrected, if necessary, by soundings taken before dredging in each locality. Areas sounded within [_____] of completion of work. The Contractor has the option of being present when such soundings are made.

3.4.2 Monthly Estimates

****

NOTE: The progress payments requirements for US Army Corps of Engineers Contracts are typically included in Division 01 Measurement and Payment, as well as the front end clauses, and if so, must be deleted from herein.

****

Monthly estimates of work completed will be based on the result of soundings taken during the progress of the work[or, at the option of the Contracting Officer, on 85 percent of the scow or barge measurement]. Deductions will be made for dredging and placement not in accordance with the specifications.

3.5 FINAL EXAMINATION AND ACCEPTANCE

****

NOTE: The techniques of sounding, sweeping, or a combination thereof are applicable methods in the acceptance examination, depending upon specific requirements of the project. In general, for maintenance dredging or for new dredging on soft bottom, the acceptance examination by soundings will be acceptable; for new dredging on hard coral or rock bed, and also for dredging below existing channel bottom on hard coral or rock bed, sweepings are required. For new dredging on hard bed harbor channel and turning basin for capital ships (such as aircraft carriers), the combination of soundings and sweepings is required. If modification of navigation charts is required after completion of dredging work, the EFD must coordinate with Naval Facilities Engineering Systems Command Code 04A3 for the proper data transfer procedures to the Defense Mapping Agency. In the case of inland rivers all

navigation chart updates must be coordinated with Inland Electronic Navigation Chart (IENC) team of the Corps of Engineers.

For USACE, do not use if removal requirements are included in other specification sections.
****

As soon as practicable after the completion of areas, which in the opinion of the Contracting Officer, will not be affected by further dredging operations, each area will be examined by the Government by sounding or sweeping, or both. Remove shoals and lumps as required by methods approved by the Government. However, if the bottom is soft and the shoal areas form no material obstruction to navigation, removal may be waived at the discretion of the Government. The Contractor will be notified when soundings or sweepings are to be made and will be permitted to accompany the sounding or sweeping party and to inspect the data and methods used in preparing the final quantity for payment. When areas are found to be in a satisfactory condition, the work therein will be accepted as complete.

Re-dredging at the Contract price, within the limit of available funds, may be completed with the consent of both the Government and the Contractor when infill or shoaling beyond the Contractor's control occurs in any area previously accepted.

3.6 PLANT REMOVAL

Upon completion of the work, remove all dredging plant, including ranges, buoys, piles, and other markers or obstructions within [_____] days.

-- End of Section --

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USACE / NAVFAC / AFCEC   UFGS-35 20 23.13 (February 2022)

Preparing Activity: USACE   New

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SECTION 35 20 23.13

NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM - SCOW [MONITORING][AND][ULLAGE] PROFILE

02/22

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NOTE: This guide specification covers the requirements for the National Dredging Quality Management Program for the scow monitoring[and] ullage profile.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

When to Choose a Specific Profile Tailoring Option. Use the following information to determine which profile to choose:

Monitoring Profile - The Monitoring Profile includes scow position, heading, hull status, draft sensors, and displacement tables to give a relative indication of when most of the material has left the scow (or the length of time the material takes to dump). Increases in draft can show digging locations and changes in loading can show leakage in gross relative terms.

Ullage Profile - The Ullage Profile contains all the instrumentation from the previous profile, adding ullage sensors and ullage volume tables. This profile may be used when dredging a material like mud, which will (for the most part) seek its own level, and ullage can be accurately measured to get an idea of bin volume.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 DESCRIPTION

The work under this contract requires use of the National Dredging Quality Management Program (DQM)to monitor the dredge's status at all times during the contract and to manage data history. For the purpose of these specifications, a scow is defined as any non-self-propelled vessel used to transport dredged material. This includes, but is not limited to, split-hull scows, pocket scows, hopper barges, and deck barges.

This performance-based specification section identifies the minimum required output and the precision and instrumentation requirements. The requirements may be satisfied using equipment and technical procedures selected by the Contractor.

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

National Dredging Quality Management Program Certification,
[_____] District; G, [_____]

1.3 PAYMENT

Separate payment for installation, operation, and maintenance of the DQM-certified system as specified herein for the duration of the dredging operations is not allowed; all costs in connection therewith are considered a subsidiary obligation of the Contractor and are covered under the contract unit price for dredging in the bidding schedule.

1.4 NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM CERTIFICATION

1.4.1 Certification

The Contractor is required to have a current certification from DQM for the scow instrumentation system to be used under this contract. Criteria for certification is based on the most recent specification posted on the DQM website https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/ Verify compliance with these criteria by onsite quality assurance (QA) checks conducted by the DQM Support Center Data Acquisition and Analysis Team and by periodic review of the transmitted data. If a system is installed specifically for this contract, in order to ensure that it is capable of transmitting quality data to the DQM database, the QA checks should take place either prior to the start of the contract or, with prior approval of the local USACE District, as soon as practical after dredging commences. DQM Certification is valid for one year from the date of certification and is contingent upon the system's ability to meet the performance requirements as outlined in paragraph PERFORMANCE REQUIREMENTS. If issues with data quality are not corrected within 48 hours, the system certification will be revoked and additional QA checks by the Data Acquisition and Analysis Team may be necessary. Annual DQM Certification must be based on the following:

A series of QA checks as outlined on the DQM website https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Managem

Verification of data acquisition and transfer as described in paragraph PERFORMANCE REQUIREMENTS

Review of the Dredge Plant Instrumentation Plan (DPIP) as described in paragraph DREDGE PLANT INSTRUMENTATION PLAN (DPIP)

1.4.2 Quality Assurance (QA)

The Dredging Contractor must have personnel who are familiar with the system instrumentation and who have the ability to recalibrate the sensors on site during the QA process. The Dredging Contractor must coordinate pickup times and locations and provide transportation to and from any platform with a DQM system to team personnel in a timely manner. The

Dredging Contractor must also have on site for the QA checks a tug capable of towing the scow. As a general rule, DQM Data Acquisition and Analysis Team personnel will come with personal protective equipment (PPE) consisting of hardhats, steel toe boots, and life jackets. If additional safety equipment is needed, such as eye protection, safety harnesses, work gloves, or personal location beacons, provide these items to the team while on site. Submit a test data package to the DQM database from the system on each scow and have it accepted by the DQM Support Center prior to scow compliance checks. Also submit data collected during the QA Checks from the scow monitoring system to the DQM database and the Data Acquisition and Analysis Team personnel while on site. It is the Dredging Contractor's obligation to inform the QA team if the location designated for the QA checks has any site-specific safety concerns prior to their arrival on site.

The owner or operator of the scow must contact DQM at https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/ on an annual basis, or at least three weeks prior to the proposed beginning of dredging, to schedule QA checks. This notification is meant to make the Data Acquisition and Analysis Team aware of a target date and the contract on which the plant will be used. At least one week prior to the target date, the Dredging Contractor must contact the Data Acquisition and Analysis Team and verbally coordinate a specific date and location. The Contractor must then follow up this conversation with a written email confirmation. The owner/operator must coordinate the QA checks with all local authorities including, but not limited to, the local USACE Contracting Officer's Representative (COR).

1.4.3 Recertification

Recertification is required for any yard work which produces modification to displacement (for example, a change in scow lines, or repositioning or repainting hull marks), modification to bin volume (change in bin dimensions or addition or subtraction of structure), or changes in sensor type or location; report these changes in the sensor log section of the DPIP. A system does not have to be transmitting data between jobs; however, in order to retain certification during this period, the system sensors or hardware should not be disconnected or removed from the scow. If the system is powered down, retain calibration coefficients.

1.5 DREDGE PLANT INSTRUMENTATION PLAN (DPIP)

The Contractor must have a digital copy of the DPIP on file with the DQM Support Center. While working on site, the Contractor must also maintain on the dredge a copy of the DPIP which is easily accessible to Government personnel at all times. This document must describe the sensors used, configuration of the system, how sensor data will be collected, how quality control on the data will be performed, and how sensors/data reporting equipment will be calibrated and repaired if they fail. A description of computed scow-specific data and how the sensor data will be transmitted to the DQM database must also be included. The Contractor must submit to the DQM Support Center any addendum or modifications made to the plan, subsequent to its original submission, prior to start of work.

A complete list of the required DPIP contents is provided on the DQM website https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/ Submit to the DQM Support Center any addendum or modifications made to the plan, subsequent to its original submission, prior to the start of work. Any changes to the computation methods must be approved by the DQM Support

Center prior to their implementation.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 REQUIREMENTS FOR REPORTED DATA

Provide, operate, and maintain all hardware and software to meet these specifications. The Contractor is responsible for replacement, repair, and calibration of sensors and other necessary data acquisition equipment needed to supply the required data. Complete repairs within 48 hours of any sensor failure. Notify the Contracting Officer's Representative (COR) upon completion of a repair, replacement, installation, modification, or calibration. The COR may request recalibration of sensors or other hardware components at any time during the contract as deemed necessary.

Keep a log of sensor repair, replacement, installation, modification, and calibration in the onsite copy of the DPIP. The log must contain a three-year history of sensor maintenance, including the time of sensor failures (and subsequent repairs), the time and results of sensor calibrations, the time of sensor replacements, and the time that backup sensor systems were initiated to provide the required data. It must also contain the name of the person responsible for the sensor work. Install sensors that are capable of collecting parameters within specified accuracies and resolutions indicated in the following subparagraphs.

With the exception of position and any value calculated, reported sensor values should represent a weighted average with the highest and lowest values not included in the calculated average for the given interval. The averaging routine used should be consistent across all event triggers. This information should be documented in the DPIP sections that say "Calculations done external to the instrumentation." These data-reporting requirements cover the collection of electronic data on a scow through the entire dredging cycle. Disposal events can consist of both open-water disposal and offloading. Open-water disposal is the placement of material via bottom doors or split hull. Offloading is the placement of material via either hydraulic or mechanical means.

3.1.1 Scow Name

Assign a unique name for each scow that will remain constant from one dredging operation to the next.

3.1.2 Contract Number

The USACE-assigned contract number for the project will be reported.

3.1.3 Load Number

A DQM load number must document the end of a disposal event for a given scow.

3.1.4 Horizontal Positioning

Record horizontal positioning as the geographic coordinates of the vessel as indicated by the location of the Global Positioning System (GPS) antenna. Obtain all locations using a positioning system operating with a minimum accuracy level of 1 to 3 meters 3 to 10 feet horizontal Circular Error Probable (CEP). Report positions as Latitude/Longitude WGS 84 in decimal degrees. West Longitude and South Latitude values are reported as negative.

3.1.5 Date and Time

Report the date and time to the nearest second and referenced to Universal Time Coordinated (UTC) based on a 24-hour format: yyyy-mm-dd hh:mm:ss.

3.1.6 Hull Status

Hull status is meant to reflect a condition when material could be removed or released from the scow. For this contract, hull status must register closed prior to leaving the disposal area.

3.1.6.1 Open-Water Disposal

Indicate an open split hull or open bottom door of a scow by reporting an "OPEN" value. Indicate a closed split hull or closed bottom door of a scow by reporting a "CLOSED" value. An open status must be indicated as the bin starts to open, and a closed status must be indicated only once the bin is fully closed. For pocket scows, the open/closed status must correspond to the compartment which is first to open and last to close.

3.1.7 Offloading

Offloading occurs when the scow is being unloaded, either by hydraulic or mechanical means. When offloading is occurring, a value of "true" must be reported; otherwise, a "false" value must be reported. The only permissible values are "true" and "false".

3.1.8 Course

Provide scow course-over-ground (COG) using industry-standard equipment. Provide scow course-over-ground (to the nearest whole degree) with values from 000 (true north) to 359 degrees referenced to a clockwise positive direction convention.

3.1.9 Speed

Provide scow speed-over-ground in knots using industry-standard equipment with a minimum accuracy of 1.0 knot and resolution to the nearest 0.1 knot.

3.1.10 Heading

Provide scow heading using industry-standard equipment. The scow heading must be accurate to within 5 degrees and reported to the nearest whole degree with values from 000 (true north) to 359 degrees referenced to a clockwise positive direction convention.

3.1.11 Draft

Report all draft measurements in feet, tenths, and hundredths with an accuracy of plus or minus 0.1 foot relative to observed physical draft readings. Report the measurements at a resolution of two decimal places (hundredths of a foot). The reported forward draft value must be equal to the sum of the visual forward port and starboard draft mark readings divided by two. The reported aft draft value must be equal to the sum of the visual aft port and starboard draft mark readings divided by two. Forward draft, aft draft, and average draft will be reported. Place sensors at an optimum location on the scow to be reflective of observed physical draft mark readings at any trim or list. Minimum accuracies are conditional to relatively calm water. The reported sensor value is an average of at least ten samples per event, with at least one maximum value and one minimum value removed, and the minimum eight remaining values averaged. When the average draft is calculated for the purpose of determining displacement, maintain significant digits for average draft such that if forward draft were 0.15 and aft draft were 0.1, then the average draft would be 0.125.

3.1.12 Displacement

Report scow displacement in long tons, based on the most accurate method available for the scow. The minimum standard of accuracy for displacement is interpolation from the displacement table, based on the average draft. For this contract the density of water used to calculate displacement is [_____]* kg/cubic meter lbs/cubic foot and is used for an additional interpolation between the fresh and salt water tables.

*The water density used is project-/location-specific. Enter the appropriate water density in the blank:

Fresh Water: 1000 kg/m3 (1 g/cm3)62.43 lbs/cubic foot
Salt Water: 1027-1030 kg/m3 (1.027-1.03 g/cm3)64.11 - 64.30 lbs/cubic foot

3.1.13 Bin Ullage Sounding

Report all ullage soundings in meters feet, tenths, and hundredths with an accuracy of plus or minus 0.1 foot with respect to the combing and be representative of the forward and aft extents of the hopper as close to the centerline as is possible. Report the measurements at a resolution of two decimal places (hundredths of a foot). If sensors must be offset from the centerline of the bin, they should be offset to opposite sides of the vessel. Forward ullage, aft ullage, and average ullage soundings will be reported. The reported sensor value is an average of at least ten samples per event, with at least one maximum value and one minimum value removed, and the minimum eight remaining values averaged. When the average ullage is calculated for the purpose of determining the hopper volume, maintain significant digits for the average ullage such that if the forward ullage were 0.15 and aft ullage were 0.1, then the average ullage would be 0.125. Special arrangements for pocket scows may be made in consultation with the DQM Support Center.

3.1.14 Bin Volume

Report scow bin volume in cubic meters yards based on the most accurate method available for the scow. The minimum standard of accuracy for bin volume is interpolation from the bin volume table based on the average ullage soundings.

3.2 NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM SYSTEM REQUIREMENTS

The Contractor's DQM system must be capable of collecting, displaying, and transmitting information to the DQM database. The parameters which must be reported to the DQM database include trip number, date and time, hull status, offloading status, scow course, scow speed, scow heading, draft, displacement, ullage, and bin volume. Provide an easily accessible, permanent visual display on the scow to show in real time the parameters collected by the system in the same units as the data submitted to the DQM database. In the event a reported parameter is calculated based on multiple sensors, the sensor values as used in the equation must be able to be viewed in addition to the required parameter. If a hardware problem occurs, or if a part of the system is physically damaged, the Contractor is be responsible for repairing it within 48 hours of determination of the condition.

3.2.1 Telemetry

The Contractor may select any commercial satellite, cellular phone, or other data communications systems available, as long as it is capable of transmitting real-time data as well as enough additional bandwidth to clear historically queued data when a connection is reobtained. If connectivity is lost, que and transmit unsent data upon restoration of connectivity. Delays in pushing real-time data to the DQM database should not exceed four hours. Exceptions to these requirements may be granted by the DQM Center on a case-by-case basis with consideration for contract-specific requirements, site-specific conditions, and extreme weather events.

The data transmission process from the scow to the DQM database must be automated. The data may be sent from the scow directly to the DQM database or to a shore-based system. Data transmitted to the DQM database should be raw data; use repeatable automated software or programming routine to process any shoreside data. Include a description of this process in the DPIP.

3.2.2 Data Reporting Frequency

Log disposal activities with high temporal and spatial resolution. Log data as a series of events. Each set of measurements (time, position, etc.) will be considered an event. Collect any required information in paragraph REQUIREMENTS FOR REPORTED DATA, that is not an averaged variable (that is, draft and ullage) within 1 second of the reported time. Measure data with sufficient frequency by the scow system to resolve the events to the accuracy specified in the following table. Any averaged variable must be collected and computed within this sampling interval. Reporting intervals must be consistent and not change for the data collected on a given scow. This interval should be documented by the Contractor in the DPIP.

Event Type	**Event Trigger Descriptions**	**Event Time Resolution**	**Event Position Resolution**
Loading	**No change in position with hull status closed** An elapsed time of 1 hour since the last event. NONCLOSURE In the event a scow has completed an open water disposal and transited back to a holding station without closing the hull, the sampling must be changed to once per hour.	1 minute	N/A

Event Type	**Event Trigger Descriptions**	**Event Time Resolution**	**Event Position Resolution**
Sailing	**Change in position with hull status closed** Time from the last sample equals 1 minute.	1 second	plus or minus 3 m 10 ft
Offloading	**Offloading material, hull status reported as open** A position must be recorded within 1 minute arrival at the offload location and within one secnd of the material starting to be removed from scow. The time from the last sample equals 1 minute. STANDBY OFFLOADING In the even a scow is not being actively offloaded at the offload location for a time equal to one hour, the sampling interval must be equal to once an hour.	1 second 1 minute	plus or minus 3 m 10 ft
Open Water Disposal	**Hull status open** A data point must be recorded within 1 second of the hull status going from closed to open and again within 1 second of the hull status going from open to closed. Between these events, report the data at equal interval from 6 to 12 seconds. This interval must always remain consistent for the dredge plant.	1 second	plus or minus 3 m 10 ft

Example: The scow is stationary for 1 hour and 15 minutes, and then it sails to the disposal area. You should have a "Loading/Stationary" event at time 0, time 1 hour, and time 1 hour and 15 minutes. Then, for "Sailing," within 1 second of an elapsed time of 1 minute from the 1 hour and 15 minutes event, another event occurs.

3.2.3   Data Transmission to the Web Service

Use a Simple Object Access Protocol (SOAP) web service to report sensor data to the DQM database. Transmit data as it is collected in real time and pushed to the DQM web service. If the web service is not available or returns an error message, store the data in a queue and transmit upon re-establishment of the connection, starting with the oldest data in the queue and continuing until real-time transmission is restored. Delays in pushing real-time data to the DQM database should not exceed four hours. Exceptions to these requirements may be granted by the DQM Support Center on a case-by-case basis with consideration for contract-specific requirements, site-specific conditions, and extreme weather events.

Contact dqm-support@usace.army.mil to obtain the web service URL and the appropriate key credentials and communication protocol.

The data transmission method call takes two arguments: a string containing the plant identifier assigned by the DQM Support Center and a second string containing the XML-formatted sensor data. The method returns the string "OK" if the data is received. If the data is not received, either the web service or the client application throws an error.

3.2.4   XML-Formatted Sensor Data String

Pass each scow event as a string on one continuous line of data. The example below is broken up by variable for ease of reading:

```
<?xml version="1.0"?>
<SCOW_DREDGING_DATA version="2.5">
   <SCOW_NAME>AU1994</SCOW_NAME>
   <PLANT_IDENTIFIER>1999</PLANT_IDENTIFIER>
   <CONTRACT>W123BA-09-D-0087_RL01</CONTRACT>
   <TRIP_NUMBER>34</TRIP_NUMBER>
   <X_POSITION>-81.670632</X_POSITION>
   <Y_POSITION>41.528987</Y_POSITION>
   <DATE_TIME>2010-08-14 10:50:15</DATE_TIME>
   <SCOW_SPEED>0.0</SCOW_SPEED>
   <SCOW_COURSE>0.0</SCOW_COURSE>
   <HULL_STATUS>OPEN</HULL_STATUS>
   <OFFLOADING>FALSE</OFFLOADING>
   <SCOW_HEADING></SCOW_HEADING>
   <SCOW_FWD_DRAFT></SCOW_FWD_DRAFT>
   <SCOW_AFT_DRAFT></SCOW_AFT_DRAFT>
   <SCOW_AVG_DRAFT></SCOW_AVG_DRAFT>
   <ULLAGE_FWD></ULLAGE_FWD>
   <ULLAGE_AFT></ULLAGE_AFT>
   <ULLAGE_AVG></ULLAGE_AVG>
   <SCOW_BIN_VOLUME></SCOW_BIN_VOLUME>
   <SCOW_DISPLACEMENT></SCOW_DISPLACEMENT>
   <ADDITIONAL_DATA>Some more scow info, if needed</ADDITIONAL_DATA>
</SCOW_DREDGING_DATA>
```

Format DATE_TIME values as YYYY-MM-DD HH:MM:SS, as shown above. If, for any reason, a field has no value, the enclosing XML tags should be sent with nothing between them (for example, <DRAFT_AFT></DRAFT_AFT>). The web service cannot handle a "null" value or any other indicators of no value collected.

3.2.5   Contractor Data Backup

Maintain an archive of all data sent to the DQM database during the dredging contract. The Contracting Officer's Representative (COR) may require, at no increase in the contract price, that the Contractor provide a copy of these data covering specified time periods. Provide the data in the HTML format which would have been transmitted to the DQM database. Submit data via storage medium acceptable to the COR.

At the end of the dredging contact, contact the DQM Support Center prior to discarding the data. The DQM Support Center will verify that all data has been received and appropriately archived before giving the Contractor discard permission. Record in a separate section at the end of the scow's onsite copy of the DPIP the following information:

Person who made the call
Date of the call
DQM representative who gave permission to discard

3.3 PERFORMANCE REQUIREMENTS

The Contractor's DQM system must be fully operational at the start of dredging operations and fully certified prior to moving dredge material on the contract (see paragraph NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM CERTIFICATION). To meet contract requirements for operability, in addition to certification, the Contractor's system must provide a data string with values for all parameters while operating, as described within the specifications. Additionally, all hardware must be compliant with DPIP requirements (see paragraph DREDGE PLANT INSTRUMENTATION PLAN (DPIP)). Quality data strings are considered to be those providing values for all parameters reported when operating according to the specification. Make repairs necessary to restore data return compliance within 48 hours. Failure by the Contractor to report the required data within the specified time window for scow measurements (see paragraph DATA REPORTING FREQUENCY, and paragraph DATA TRANSMISSION TO THE WEB SERVICE) and failure to receive DQM certification prior to dredging will result in withholding of up to 10 percent of the contract progress payment.

3.4 LIST OF ITEMS TO BE PROVIDED BY THE CONTRACTOR

DPIP - https://dqm.usace.army.mil
    https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Man
    Paragraph DREDGE PLANT INSTRUMENTATION PLAN (DPIP)

DQM SYSTEM
    Sensor instrumentation - Paragraph REQUIREMENTS FOR REPORTED DATA

SCOW DATA
    Event documentation - Paragraph DATA REPORTING FREQUENCY
    Data reports - Paragraph DATA TRANSMISSION TO THE WEB SERVICE

QA EQUIPMENT ON THE DREDGE
    Clear and accurate draft marks
    Ullage tape

-- End of Section --

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SECTION 35 20 23.23

NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM - HOPPER DREDGE
02/22

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NOTE: This guide specification covers the requirements for the National Dredging Quality Management Program for hopper dredging.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 DESCRIPTION

The work under this contract requires use of the National Dredging Quality Management Program (DQM)to monitor the dredge's status at all times during the contract and to manage data history.

This performance-based specification section identifies the minimum required output and the precision and instrumentation requirements. The requirements may be satisfied using equipment and technical procedures selected by the Contractor.

1.2 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

National Dredging Quality Management Program Certification,
[_____] District; G, [_____]

1.3 PAYMENT

Separate payment for installation, operation, and maintenance of the DQM-certified system as specified herein for the duration of the dredging operations is not allowed; all costs in connection therewith are considered a subsidiary obligation of the Contractor and are covered under the contract unit price for dredging in the bidding schedule.

1.4 NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM CERTIFICATION

1.4.1 Certification

The Contractor is required to have a current certification from DQM for the hopper dredge instrumentation system to be used under this contract. Criteria for certification is based on the most recent specification posted

on the DQM website:
https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/
Verify compliance with these criteria by annual onsite quality assurance (QA) checks conducted by the DQM Support Center Data Acquisition and Analysis Team and by periodic review of the transmitted data. DQM Certification is valid for one year from the date of the annual QA checks. Certification is contingent upon the system's ability to continuously meet the performance requirements as outlined in paragraph PERFORMANCE REQUIREMENTS. If issues with data quality are not corrected within 48 hours, the system certification will be revoked and additional QA checks by the Data Acquisition and Analysis Team may be necessary.

Annual DQM Certification must be based on the following:

a. A series of quality assurance checks as outlined on the DQM website: https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Managem

b. Verification of data acquisition and transfer as described in paragraph Performance Requirements.

c. Review of the Dredge Plant Instrumentation Plan (DPIP) as described in paragraph DREDGE PLANT INSTRUMENTATION PLAN (DPIP).

1.4.2 Recertification

The owner or operator of the dredge must contact DQM at
https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/
on an annual basis, or at least three weeks prior to certification expiration, to schedule QA checks for renewal. This notification is meant to make the Data Acquisition and Analysis Team aware of a target date for the annual QA checks for the dredge. At least one week prior to the target date, the Contractor must contact the Data Acquisition and Analysis Team and verbally coordinate a specific date and location. The Contractor must then follow up this conversation with a written email confirmation. The owner/operator must coordinate the QA checks with all local authorities, including but not limited to, the local USACE Contracting Officer's Representative (COR).

Recertification is required for any yard work which produces modification to displacement (change in dredge lines, or repositioning or repainting hull marks), modification to bin volume (change in bin dimensions, or addition or subtraction of structure), or changes in sensor type or location; report these changes in the sensor log section of the DPIP. A system does not have to be transmitting data between jobs; however, in order to retain its certification during this period, the system sensors or hardware should not be disconnected or removed from the dredge. If the system is powered down, retain calibration coefficients.

1.5 DREDGE PLANT INSTRUMENTATION PLAN (DPIP)

The Contractor must have a digital copy of the DPIP on file with the DQM Support Center. While working on site, the Contractor must also maintain on the dredge a copy of the DPIP which is easily accessible to Government personnel at all times. This document must describe the sensors used, configuration of the system, how sensor data will be collected, how quality control on the data will be performed, and how sensors/data reporting equipment will be calibrated and repaired if they fail. A description of the computed dredge-specific data and how the sensor data will be transmitted to the DQM database will also be included. A complete list of the required DPIP contents is provided on the DQM website https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/

Submit to the DQM Support Center any addendum or modifications made to the plan, subsequent to its original submission, prior to the start of work. Any changes to the computation methods must be approved by the DQM Support Center prior to their implementation.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 REQUIREMENTS FOR REPORTED DATA

Provide, operate, and maintain all hardware and software to meet these specifications. The Contractor is responsible for replacement, repair, and calibration of sensors and other necessary data acquisition equipment needed to supply the required data. Complete repairs within 48 hours of any sensor failure. Notify the COR upon completion of a repair, replacement, installation, modification, or calibration. The COR may request recalibration of sensors or other hardware components at any time during the contract as deemed necessary.

Keep a log of sensor repair, replacement, installation, modification, and calibration in the dredge's onboard copy of the DPIP. The log must contain a three-year history of sensor maintenance, including the time of the sensor failures (and subsequent repairs), the time and results of sensor calibrations, the time of sensor replacements, and the time that backup sensor systems were initiated to provide required data. It must also contain the name of the person responsible for the sensor work. Install sensors that are capable of collecting parameters within specified accuracies and resolutions indicated in the following subparagraphs. Reported sensor values for ullage, draft, and draghead depth should represent a weighted average with the highest and lowest values not included in the calculated average for the given interval. This information should be documented in the DPIP sections that say "Calculations done external to the instrumentation."

3.1.1 Date and Time

Report the date and time to the nearest second and referenced to UTC time based on a 24-hour format: mm/dd/yyyy hh:mm:ss. The reported time must be the time reported by the GPS in the NMEA string.

3.1.2 Load Number

A load number must document the end of a disposal event. Load numbering will begin at number 1 at the start of the contract and will be incremented by 1 at the completion of each disposal event or emptying of the hopper. Whenever possible, calculate the load number off of the sensors aboard the dredge, which must be a mathematically repeatable routine. Make efforts to include logic that avoids false load number increments. Do not allow the routine to miss any disposal event. If manual incrementing of the load number is in place, pay extra attention to this value in the quality control process.

3.1.3 Horizontal Positioning

Obtain all locations using a positioning system operating with a minimum accuracy level of 1 to 3 meters 3 to 10 feet horizontal Circular Error Probable (CEP). Report positions as Latitude/Longitude WGS 84 in decimal degrees. West Longitude and South Latitude values are reported as negative.

3.1.3.1 Vessel Horizontal Positioning

Record vessel horizontal positioning as geographic coordinates of the vessel as indicated by the location of the GPS antenna.

3.1.3.2 Draghead Horizontal Positioning

Record draghead horizontal positioning as geographic coordinates of the heel on the centerline of the draghead(s). Describe any offset calculations from the GPS antenna in the DPIP.

3.1.4 Hull Status

Monitor open/closed status of the hopper dredge, corresponding to the split/non-split condition of a split-hull hopper dredge. For dredges with hopper doors, the status of a single door that is the first opened during normal disposal operations may be monitored. An "open" value indicates that the hopper door is open or, in the case of split-hull dredges, that the hull is split. A "closed" value indicates that the hopper doors are closed or, in the case of split-hull dredges, that the hull is not split.

For this contract, hull status must register closed prior to leaving the disposal area.

3.1.5 Dredge Course

Provide dredge course-over-ground (COG) using industry-standard equipment. Provide dredge course-over-ground to the nearest whole degree with values from 000 (true north) to 359 degrees referenced to a clockwise positive direction convention.

3.1.6 Dredge Speed

Provide dredge speed-over-ground in knots using industry-standard equipment with a minimum accuracy of 1 knot and resolution to the nearest 0.1 knot.

3.1.7 Dredge Heading

Provide dredge heading using industry-standard equipment. The dredge heading must be accurate to within 5 degrees and reported to the nearest whole degree with values from 000 (true north) to 359 degrees referenced to a clockwise positive direction convention.

3.1.8 Tide

Obtain tide data using appropriate equipment to give the water level with an accuracy of plus or minus 0.03 meter 0.1 foot and a resolution of 0.003 meter 0.01 foot. Enter tide values above project datum described in the dredging specification with a positive sign and those below with a negative sign.

3.1.9 Draft

Report all draft measurements in meters feet, tenths, and hundredths with an accuracy of plus or minus 0.03 meter 0.1 foot relative to observed physical draft readings. Report the measurements at a resolution of two decimal places (hundredths of a meter foot). The reported forward draft value is equal to the sum of the visual forward port and starboard draft mark readings divided by two. The reported aft draft value is equal to the sum of the visual aft port and starboard draft mark readings divided by two. Forward draft, aft draft, and average draft will be reported. Place sensors at an optimum location on the vessel to be reflective of observed physical draft mark readings at any trim or list. Minimum accuracies are conditional to relatively calm water. The sensor value reported must be an average of at least ten samples per event, with at least one maximum value and one minimum value removed, and the minimum eight remaining values averaged. When the average draft is calculated for the purpose of determining displacement, maintain significant digits for average draft such that if forward draft was 0.15 and aft draft was 0.1, the average draft would be 0.125.

3.1.10 Hopper Ullage Sounding

Report all reported ullage soundings in meters feet, tenths, and hundredths with an accuracy of plus or minus 0.03 meter 0.1 foot with respect to the combing and be representative of the forward and aft extents of the hopper as close to the centerline as is possible. Report the measurements at a resolution of two decimal places (hundredths of a foot). Report forward ullage and aft ullage soundings. Mount sensors to avoid discharge flume turbulence, foam, and any structure that could produce sidelobe errors. If sensors must be offset from the centerline of the hopper, they should be offset to opposite sides of the vessel. If more than one fore or one aft sensor are used, place the sensors near the corners of the hopper, and report the average value of the fore sensors and the average value of the aft sensors. The sensor value reported must be an average of at least ten samples per event, with at least one maximum value and one minimum value removed, and the minimum eight remaining values averaged. When the average ullage is calculated for the purpose of determining hopper volume, maintain significant digits for average ullage such that if forward ullage was 0.15 and aft ullage was 0.1, then the average ullage would be 0.125.

3.1.11 Hopper Volume

Report hopper volume in cubic meters yards, based on the most accurate method available for the dredge. The minimum standard of accuracy for hopper volume is interpolation from the certified hopper volume table, based on the average fore and aft ullage soundings.

3.1.12 Displacement

Report dredge displacement in long tons, based on the most accurate method available for the dredge. The minimum standard of accuracy for displacement is interpolation from the displacement table, based on the average draft. For this contract the density of water used to calculate displacement is [_____][*] kg/cubic meter lbs/cubic foot, and it will be used for an additional interpolation between the fresh and salt water tables.

[*] The water density used is project-/location-specific. Enter the appropriate water density in the blank:

Fresh Water: 1000 kg/m3 (1 g/cm3)62.43 lbs/cubic foot
Salt Water: 1027-1030 kg/m3 (1.027-1.03 g/cm3)64.11 - 64.30 lbs/cubic foot

3.1.13 Empty Displacement

Report empty displacement in long tons, which is the lightship value of the dredge, or the weight of the dredge with no material in the hopper, adjusted for fuel and water consumption.

3.1.14 Draghead Depths

Report draghead depths with an accuracy of plus or minus 0.15 meter 0.5 foot and a resolution to the nearest 0.03 0.1 foot as measured from the surface of the water with no tidal adjustments. Minimum accuracies are conditional to relatively calm water. The sensor value reported must be an average of at least ten samples per event, with at least one maximum value and one minimum value removed, and the minimum eight remaining values averaged.

3.1.15 Slurry Densities

Use a density metering device, calibrated according to the manufacturer's specifications, to record the slurry density of each dragarm to the nearest 0.001 g/cc with an accuracy of plus or minus 0.01 g/cc. If the manufacturer does not specify a frequency of recalibration, conduct calibration prior to commencement of work.

3.1.16 Slurry Velocities

Use a flow metering device, calibrated according to the manufacturer's specifications, to record the slurry velocity of each dragarm to the nearest 0.003 mps 0.01 fps with an accuracy of plus or minus 0.15 mps 0.5 fps. If the manufacturer does not specify a frequency of recalibration, conduct calibration prior to commencement of work. Measure the slurry velocity in the same pipeline inside diameter as that used for the slurry density measurement.

3.1.17 Pump RPM

Measure the RPM of any pump being used to move material with the highest level of accuracy that is standard on the vessel operational displays, either at the bridge, at the drag tender's controls, or in the engine room. Dredges with multiple pumps per side must report RPM for the pump that best describes the dredging process (typically the outboard pump).

3.1.18 Sea Suction Valve for Dragarm

If sea suction can be taken to bypass suction through the draghead, the sea suction location and valve status will be reported. The status of the valve will change from "closed" to "open" when the valve starts to open and will register "closed" when the valve is fully closed. When applicable, the state of the latch will be reported as "true" or "false." Report the sea suction location in a standard non-changing name string of no more than 20 characters. These field values will always occur in the XML string as a set. The DQM system can accommodate only up to four unique sea suction locations. Suggested options for the naming convention can be found in the example dataset in paragraph DATA FORMAT.

3.1.19 Pumpout

When the hopper dredge is being pumped out, report a "true" value; when it is not, report a "false" value. The only permissible values are "true" and "false."

3.2 NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM SYSTEM REQUIREMENTS

The Contractor's DQM system must be capable of collecting, displaying, and transmitting information to the DQM database. Record the applicable parameters from paragraph REQUIREMENTS FOR REPORTED DATA as events locally and continually transmitted to the DQM database anytime an Internet connection is available. Equip the Dredge with a DQM computer system, consisting of a computer, monitor, keyboard, mouse, data modem, UPS, and network hub. Provide a standalone computer system, exclusive to the DQM monitoring system, and with USACE DQM software installed on it. If a hardware problem occurs, or if a part of the system is physically damaged, the Contractor is responsible for repairing it within 48 hours of determination of the condition.

3.2.1 Computer Requirements

Provide a dedicated onboard computer for use by the DQM system. This computer must run USACE software and receive data from the Contractor's data-reporting interface. This computer must meet or exceed the following performance specifications:

CPU:	Intel or AMD processor with a (non-overclocked) clock speed of at least 1.6 gigahertz (GHz)
Hard drive:	250 gigabytes (GB); internal
RAM:	4 gigabytes (GB)
Ethernet adapter:	Internal network card with an RJ-45 connector
Ports:	1 free serial port with standard 9-pin connectors; 1 free USB port
Other hardware:	Keyboard, mouse, monitor

Install a fully licensed copy of Windows 10 Professional Operating System or higher on the computer specified above. Also install any necessary manufacturer-provided drivers for the installed hardware. Locate and orient the computer to allow data entry and data viewing, as well as to provide access to data ports for the connection of external hardware.

3.2.2 Software

The DQM computer's primary function is to transmit data to the DQM shoreside database. Do not install software which conflicts with this function on this computer. The DQM computer must have the USACE-provided Dredging Quality Management Onboard Software (DQMOBS) installed on it by DQM personnel along with USACE-selected software for remote support and management.

3.2.3 UPS

Supply an Uninterruptible Power Supply (UPS) for the computer and networking equipment. The UPS must provide backup power at 1 kVA for a minimum of ten minutes. The UPS must interface with the DQM computer to communicate UPS status. Ensure that sufficient power outlets are available to run all specified equipment.

3.2.4 Internet Access

Maintain an Internet connection capable of transmitting real-time data to the DQM server and supporting remote access, as well as enough additional bandwidth to clear historically queued data when a connection is re-obtained. If connectivity is lost, que and transmit unsent data upon restoration of connectivity. Delays in pushing real-time data to the DQM database should not exceed four hours. Exceptions to these requirements may be granted by the DQM Support Center on a case-by-case basis with consideration for contract-specific requirements, site-specific conditions, and extreme weather events.

Acquire and install all necessary hardware and software to make the Internet connection available for data transmission to the DQM web service. Configure the hardware and software to allow the DQM Support Center remote access to this computer. Coordination between the dredging company's IT and the DQM Support Center may be required in order to configure remote access though any security, firewall, router, and telemetry systems. Telemetry systems must be capable of meeting these minimum reporting requirements in all operating conditions.

3.2.5 Data Routing Requirements

Onboard sensors must continually monitor dredge conditions, operations and efficiency and route this information into the shipboard dredge-specific system (DSS) computer to assist in guiding dredge operations. Portions of this Contractor-collected information must be routed to the DQM computer on a real-time basis. Use an RS-232 9600- or 19200-baud serial interface to send standard sensor data to the DQM computer. Configure the serial interface as 8 bits, no parity, and no flow control.

3.2.6 Data Reporting Frequency

Log data as a series of events. Each event will consist of a dataset containing dredge information in accordance with paragraph REQUIREMENTS FOR REPORTED DATA. Each set of measurements (time, position, etc.) will be considered an event. Collect any required information in paragraph REQUIREMENTS FOR REPORTED DATA that is not an averaged variable (draft and ullage) within 1 second of the reported time. Send a data string for an event to the DQM computer every 6 to 12 seconds. This interval must remain constant throughout the contract; do not transmit data strings more than once per every 5 seconds. Collect and compute any averaged variable within this sampling interval.

3.2.7 Data Format

Report data as an extensible Markup Language (W3C standard XML 1.0) document as indicated below. Line breaks and spaces are added for readability, but the carriage return, line feed character combination is added only to delineate records (HOPPER_DREDGING_DATA tag) for actual data transmission.

```
{?xml version="1.0"?}
{HOPPER_DREDGING_DATA version = "2.0"}
    <PLANT_IDENTIFIER>integer string</PLANT_IDENTIFIER>
```

```
     {DREDGE_NAME} string32 {/DREDGE_NAME}
        {HOPPER_DATA_RECORD}
            {DATE_TIME} time date string {/DATE_TIME}
            {CONTRACT_NUMBER} string32 {/CONTRACT_NUMBER}
            {LOAD_NUMBER} integer string {/LOAD_NUMBER}
            {VESSEL_X coord_type="LL"} floating point string {/VESSEL_X}
            {VESSEL_Y coord_type="LL"} floating point string {/VESSEL_Y}
        {PORT_DRAG_X coord_type="LL"} floating point string
{/PORT_DRAG_X}
        {PORT_DRAG_Y coord_type="LL"} floating point string
{/PORT_DRAG_Y}
        {STBD_DRAG_X coord_type="LL"} floating point string
{/STBD_DRAG_X}
            {STBD_DRAG_Y coord_type="LL"} floating point string
{/STBD_DRAG_Y}
            {HULL_STATUS} OPEN/CLOSED string {/HULL_STATUS}
            {VESSEL_COURSE} floating point string {VESSEL_COURSE}
            {VESSEL_SPEED} floating point string {/VESSEL_SPEED}
            {VESSEL_HEADING} floating point string {/VESSEL_HEADING}
            {TIDE} floating point string {/TIDE}
            {DRAFT_FORE} floating point string {/DRAFT_FORE}
            {DRAFT_AFT} floating point string {/DRAFT_AFT}
            {ULLAGE_FORE} floating point string {/ULLAGE_FORE}
            {ULLAGE_AFT} floating point string {/ULLAGE_AFT}
            {HOPPER_VOLUME} floating point string {/HOPPER_VOLUME}
            {DISPLACEMENT} floating point string {/DISPLACEMENT}
           {EMPTY_DISPLACEMENT} floating point string
{/EMPTY_DISPLACEMENT}
            {DRAGHEAD_DEPTH_PORT} floating point string
{/DRAGHEAD_DEPTH_PORT}
            {DRAGHEAD_DEPTH_STBD} floating point string
{/DRAGHEAD_DEPTH_STBD}
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            {PORT_VELOCITY} floating point string {/PORT_VELOCITY}
            {STBD_VELOCITY} floating point string {/STBD_VELOCITY}
            {PUMP_RPM_PORT} floating point string {/PUMP_RPM_PORT}
            {PUMP_RPM_STBD} floating point string {/PUMP_RPM_STBD}
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            {VALVE_1_STATUS} open/closed {/VALVE_1_STATUS}
            {VALVE_1_LATCHED} true/false {/VALVE_1_LATCHED}
            {VALVE_2_LOCATION} string32 {/VALVE_2_LOCATION}
            {VALVE_2_STATUS} open/closed {/VALVE_2_STATUS}
            {VALVE_2_LATCHED} true/false {/VALVE_2_LATCHED}
            {VALVE_3_LOCATION} string32 {/VALVE_3_LOCATION}
            {VALVE_3_STATUS} open/closed {/VALVE_3_STATUS}
            {VALVE_3_LATCHED} true/false {/VALVE_3_LATCHED}
            {VALVE_4_LOCATION} string32 {/VALVE_4_LOCATION}
            {VALVE_4_STATUS} open/closed {/VALVE_4_STATUS}
            {VALVE_4_LATCHED} true/false {/VALVE_4_LATCHED}
            {PUMP_OUT_ON} true/false/unknown string {/PUMP_OUT_ON}
            {/HOPPER_DATA_RECORD}

          {/HOPPER_DREDGING_DATA}
           Carriage Return - ASCII value 13
           Line Feed - ASCII value 10
```

Example

```
{?xml version="1.0"?}
{HOPPER_DREDGING_DATA version = "2.0"}
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     {HOPPER_DATA_RECORD}
            {DATE_TIME}04/11/2002 13:12:05{/DATE_TIME}
            {CONTRACT_NUMBER}GDSNWP-11-G-0001{/CONTRACT_NUMBER}
            {LOAD_NUMBER}102{/LOAD_NUMBER}
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            {TIDE}-0.1{/TIDE}
            {DRAFT_FORE}10.05{/DRAFT_FORE}
            {DRAFT_AFT}15.13{/DRAFT_AFT}
            {ULLAGE_FORE}10.11{/ULLAGE_FORE}
            {ULLAGE_AFT}10.22{/ULLAGE_AFT}
            {HOPPER_VOLUME}2555.2{/HOPPER_VOLUME}
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            {EMPTY_DISPLACEMENT}2345.0{/EMPTY_DISPLACEMENT}
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            {PUMP_RPM_STBD}54{/PUMP_RPM_STBD}
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            {VALVE_1_LATCHED}true{/VALVE_1_LATCHED}
            {VALVE_2_LOCATION}Port Dragarm{/VALVE_2_LOCATION}
            {VALVE_2_STATUS}closed{/VALVE_2_STATUS}
            {VALVE_2_LATCHED}false{/VALVE_2_LATCHED}
            {VALVE_3_LOCATION}Port Sea Chest{/VALVE_3_LOCATION}
            {VALVE_3_STATUS}closed{/VALVE_3_STATUS}
            {VALVE_3_LATCHED}false{/VALVE_3_LATCHED}
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            {VALVE_4_STATUS}open{/VALVE_4_STATUS}
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      {/HOPPER_DATA_RECORD}
{/HOPPER_DREDGING_DATA}
{cr}
{lf}
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 <HOPPER_DREDGING_DATA version = "2.0">
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{DREDGE_NAME}Essayons{/DREDGE_NAME}
     {HOPPER_DATA_RECORD}
            {DATE_TIME}04/11/2002 13:12:10{/DATE_TIME}
            {CONTRACT_NUMBER}GDSNWP-11-G-0001{/CONTRACT_NUMBER}
            {LOAD_NUMBER}102{/LOAD_NUMBER}
```

```
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                {PORT_DRAG_Y coord_type="LL"}10.12336{/PORT_DRAG_Y}
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                {DRAFT_AFT}15.15{/DRAFT_AFT}
                {ULLAGE_FORE}10.15{/ULLAGE_FORE}
                {ULLAGE_AFT}10.20{/ULLAGE_AFT}
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                {EMPTY_DISPLACEMENT}2345.0{/EMPTY_DISPLACEMENT}
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                {PUMP_RPM_PORT}55{/PUMP_RPM_PORT}
                {PUMP_RPM_STBD}54{/PUMP_RPM_STBD}
                {VALVE_1_LOCATION}Starboard Dragarm{VALVE_1_LOCATION}
                {VALVE_1_STATUS}open{/VALVE_1_STATUS}
                {VALVE_1_LATCHED}true{/VALVE_1_LATCHED}
                {VALVE_2_LOCATION}Port Dragarm{/VALVE_2_LOCATION}
                {VALVE_2_STATUS}closed{/VALVE_2_STATUS}
                {VALVE_2_LATCHED}false{/VALVE_2_LATCHED}
                {VALVE_3_LOCATION}Port Sea Chest{/VALVE_3_LOCATION}
                {VALVE_3_STATUS}closed{/VALVE_3_STATUS}
                {VALVE_3_LATCHED}false{/VALVE_3_LATCHED}
                {VALVE_4_LOCATION}Starboard Sea Chest{/VALVE_4_LOCATION}
                {VALVE_4_STATUS}open {/VALVE_4_STATUS}
                {VALVE_4_LATCHED} false{/VALVE_4_LATCHED}
                {PUMP_OUT_ON}false{/PUMP_OUT_ON}
                {/HOPPER_DATA_RECORD}
    {/HOPPER_DREDGING_DATA}
    {cr}
    {lf}
```

3.2.8 Data Reporting

The system must transmit correctly formatted event data XML strings to the DQM database continuously from mobilization until the last USACE post-dredging survey has been accepted. If the Internet connection (paragraph INTERNET ACCESS) is non-operable, perform manual backups from the dredge computer of the XML data string which would have been transmitted to the DQM computer over the serial connection for each day the device is inoperable and submit to the DQM Support Center within 48 hours. This submission does not replace the requirement of correcting the issue affecting the automatic transmission of data. In the event of data transfer, transmission, or hardware failure, maintain a manually recorded disposal log consisting of a series of events. These events are start of dredging, end of dredging, pre-disposal, and post-disposal. Include time stamp (GMT), position (Latitude and Longitude WGS84), draft, ullage, volume, and displacement for each event. Submit disposal logs on a daily basis to the COR during the time when the system is not operational.

3.2.9 Contractor Data Backup

Maintain an archive of all data sent to the DQM computer during the dredging contract. The COR may require, at no increase in the contract price, that the Contractor provide a copy of these data covering specified time periods. Provide the data, transmitted to the DQM computer, in the XML format with no line breaks between the parameters and each record string on a separate line. The naming convention for the files is {dredgename}_{StartYYYYMMddhhmmss}_{EndYYYYMMddhhmmss}.txt. Submit data via storage medium acceptable to the COR.

At the end of the dredging contract, contact the DQM Support Center prior to discarding the data. The DQM Support Center will verify that all data has been received and appropriately archived before giving the Contractor discard permission. Record the following information in a separate section at the end of the dredge's onboard copy of the DPIP:

Person who made the call
Date of the call
DQM representative who gave permission to discard

3.3 PERFORMANCE REQUIREMENTS

The Contractor's DQM system must be fully operational at the start of dredging operations and fully certified prior to moving dredge material on the contract (see paragraph NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM CERTIFICATION). To meet contract requirements for operability, in addition to certification, the Contractor's system must provide a data string with all values for all parameters while operating, as described in the specifications. Additionally, all hardware must be compliant with hardware requirements (paragraph COMPUTER REQUIREMENTS). Quality data strings are considered to be those providing values for all parameters reported when operating according to the specification. Make repairs necessary to restore data return compliance within 48 hours. Failure by the Contractor to report the required data within the specified time window for dredge measurements (see paragraph DATA REPORTING FREQUENCY and paragraph DATA REPORTING) will result in withholding of up to 10 percent of the contract progress payment per FAR 52.232-5 Payments under Fixed-Price Construction Contracts.

3.4 LIST OF ITEMS TO BE PROVIDED BY THE CONTRACTOR

DPIP
    https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Man

DQM System
    Sensor instrumentation: paragraph REQUIREMENTS FOR REPORTED DATA
    DQM computer: paragraph NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM SYSTEM REQUIREMENTS

Dredge Data
    Event documentation: paragraph DATA REPORTING
    Dredge data backups: paragraph CONTRACTOR DATA BACKUP

QA Equipment on the Dredge
    Dragarm depth chain

Ullage tape
Refractometer
Water sampling device

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 20 23.33 (February 2022)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

****

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02/22

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USACE / NAVFAC / AFCEC **UFGS-35 20 23.33 (February 2022)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

****

SECTION 35 20 23.33

NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM - PIPELINE HYDRAULIC DREDGE

02/22

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NOTE: This guide specification covers the requirements for the National Dredging Quality Management Program for pipeline hydraulic dredging.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 DESCRIPTION

The work under this contract requires use of the National Dredging Quality Management Program (DQM)to monitor the dredge's status at all times during the contract and to manage data history.

This performance-based specification section identifies the minimum required output and the precision and instrumentation requirements. The requirements may be satisfied using equipment and technical procedures selected by the Contractor.

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

National Dredging Quality Management Program Certification, [_____] District; G, [_____]

1.3 PAYMENT

Separate payment for installation, operation, and maintenance of the DQM-certified system as specified herein for the duration of the dredging operations is not allowed; all costs in connection therewith are considered a subsidiary obligation of the Contractor and are covered under the contract unit price for dredging in the bidding schedule.

1.4 NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM CERTIFICATION

The Contractor is required to have a current certification from the DQM Program for the cutter/suction head hydraulic dredge instrumentation system to be used under this contract. Standard Operating Procedures (SOP) and criteria for certification are presented on the DQM website at https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/

1.5 DREDGE PLANT INSTRUMENTATION PLAN (DPIP)

The Contractor must have a digital copy of the Dredge Plant Instrumentation Plan (DPIP) on file with the DQM Support Center. While working on site, the Contractor must also maintain on the dredge a copy of the DPIP, which is easily accessible to Government personnel at all times. This document must accurately describe the sensors used, the configuration of the system, how sensor data will be collected, how quality control on the data will be performed, and how the sensors/data-reporting equipment will be calibrated and repaired if it fails. A description of the computed dredge-specific data and how the sensor data will be transmitted to the DQM database will also be included. Prior to the start of work, the Contractor must submit to the DQM Support Center any addendum or modifications made to the plan subsequent to its original submission. Requirements and a template for the DPIP are available on the DQM website at https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 REQUIREMENTS FOR REPORTED DATA

Provide, operate, and maintain all hardware and software to meet these specifications. The Contractor is also responsible for the replacement, repair, and calibration of the sensors and other necessary data acquisition equipment needed to supply the required data. Document and complete the procedure to complete a repair as soon as practical. If repair is not possible within two business days of any sensor failure, submit a plan and timeline to complete the repair. Upon completion of a repair, replacement, installation, modification, or calibration, notify the Contracting Officer's Representative (COR). The COR may request recalibration of the sensors or other hardware components at any time during the contract as deemed necessary.

Keep a log of sensor repair, replacement, installation, modification, and calibration in the dredge's onboard copy of the DPIP. The log must contain a three-year history of sensor maintenance, including the time of the sensor failures (and subsequent repairs), the time and results of sensor calibrations, the time of sensor replacements, and the time that backup sensor systems were initiated to provide the required data. It must also contain the name of the person responsible for the sensor work. Install sensors that are capable of collecting parameters within the specified accuracies and resolutions indicated in the following subparagraphs and transmit these parameters to the DQM database. Transmit all data in JSON message bundles. Each bundle can contain multiple message types. Transmit sensor data as work event messages, and transmit data which relates to the operational state of the dredge or its sensors as state event messages. (See paragraph PARAMETER TRANSMISSION TO THE WEB SERVICE.)

3.1.1 Message Bundle Data

Every message bundle must contain descriptive data that relates the message to a given dredge plant and date/time. Identify the start of a message bundle by the tag "DQM_data".

3.1.1.1 Messages

Messages contain operational data that populates the DQM database for a dredge plant. A message must consist of an event type and its associated data (as defined in paragraph DREDGE EVENTS - WORK EVENT and paragraph DREDGE EVENTS - STATE EVENT), a date/time stamp indicating when the event occurred or started, and a comment providing clarification or metadata about the situation. There are multiple event types, but they all fall into one of two categories - work events and state events.

3.1.1.1.1 Message Time

In a work event message, message time is the date and time that the data is collected from the sensors; in a state event message, message time is the date and time that the state event begins. Report and reference the message time to the nearest second and to Coordinated Universal Time (UTC) time based on a 24-hour format (*YYYY-MM-DD HH:MM:SS*). In order to ensure accuracy and reliability, synchronize the time stamp to UTC format from an accurate, unchangeable source (for example, a GPS National Marine Electronics Association [NMEA] datastring). Identify message time by the tag "msg_time".

3.1.1.1.2 Comment

Comments concerning the work event or state event messages being transmitted provide descriptive information that relates to the data. An example of a comment for work event data is information about a sensor issue; an example of a comment for state event data is a description of operations. Identify a comment by the introductory tag "comment", and the comment must not consist of more than 250 characters.ext

3.1.1.2 Dredge Events - Work Event

There are two types of dredge event messages - work event messages and state event messages. Work event messages contain data that are instantaneously collected or calculated from sensors and are logged as a series of events. Work events are triggered by a time interval change (as described in paragraph WORK EVENT MESSAGES). Initiate all work event messages by the header tag "work_event".

3.1.1.2.1 Vertical Correction

Obtain the variation of the water level from the vertical datum for the river stage or tidal gage described in the state events using appropriate equipment to give the water level with an accuracy of plus or minus 0.1 ft. Enter vertical correction values above project datum described in the dredging specification with a positive sign and those below with a negative sign. The tag for vertical correction is "vert_correction".

3.1.1.2.2 Cutter/Suction Head Location and Movement

Monitor the X, Y, and Z components of the cutter/suction head location. Additional calculations made from the observed values determine the rates of movement to track the progress of the dredge.

3.1.1.2.2.1 Cutter/Suction Head Horizontal Position

Obtain the forwardmost point of the cutter/suction head using a positioning system operating with a minimum accuracy level of 3-10 feet horizontal

Circular Error Probable (CEP). Report it as Latitude/Longitude WGS 84 in decimal degrees with West Longitude and South Latitude values reported as negative. Identify position values by the tags "ch_latitude" and "ch_longitude".

3.1.1.2.2.2 Cutter/Suction Invert Depth

Cutter/suction invert depth is the depth of the invert of the suction mouth relative to the surface of the water. Instrumentation must be capable of reporting to an accuracy of plus or minus 0.5 foot and a resolution to the nearest 0.1 foot with no tidal adjustments. Minimum accuracies are conditional to relatively calm water. Use the tag "ch_depth" to identify the cutter/suction head depth.

3.1.1.2.2.3 Cutter/Suction Head Heading

The cutter/suction head heading is the angle of the centerline of the cutter/suction head and dredge ladder measured relative to true north. Provide all headings using industry-standard equipment. The heading must be accurate to within 5 degrees and reported to the nearest whole degree with values from 000 (true north) to 359 degrees referenced to a clockwise positive direction convention. Use the tag "ch_heading" to identify the cutter/suction head heading.

3.1.1.2.3 Dredge Activity

Monitor dredge activity using a combination of the following parameters.

3.1.1.2.3.1 Slurry Velocity

Slurry velocity is not a mandatory field for the Small Business profile; however, if the dredge is outfitted with a velocity meter, then it is expected that velocity data will be included within the DQM string and will meet the standard DQM requirements outlined below.

Use a flow-metering device, calibrated according to the manufacturer's specifications, to record the slurry velocity to the nearest 0.01 fps with an accuracy of plus 0.5 fps. If the manufacturer does not specify a frequency of recalibration, conduct calibration prior to the commencement of work. Measure the slurry velocity for the same pipeline inside diameter as that used for the slurry density measurement. Associate the tag "slurry_velocity" with this value.

3.1.1.2.3.2 Slurry Density

Slurry density is not a mandatory field for the Small Business profile; however, if the dredge is outfitted with a density meter, then it is expected that density data will be included within the DQM string and will meet the standard DQM requirements outlined below.

Use a density-metering device, calibrated according to the manufacturer's specifications, to record the slurry density to the nearest 0.01 g/cc. It is understood that the accuracy of this sensor can vary based on several factors, including the type of material, the magnitude of the cut, and the length of time since calibration. If the manufacturer does not specify a frequency of recalibration, conduct calibration prior to the commencement of work. Continuous monitoring of this sensor ensures that drift and other factors inherent in the dredging process can be accounted for in monitoring dredge activity. Associate the tag "slurry_density" with this value.

3.1.1.2.3.3 Pump RPM

The pump rpm is the number of revolutions per minute measured for the slurry pump shaft. Measure the shaft revolution rate (rev/min) with the highest level of accuracy that is standard on the vessel's operational displays either at the bridge or in the engine room. Identify this value by the tag "rpm".

3.1.1.2.3.4 Pump Vacuum

Measure the vacuum pressure of the dredge pump(s) (inches of mercury) as near to the eye as practicable in the pump's suction pipe with the highest level of accuracy that is standard on the vessel's operational displays either at the leverman's controls or in the engine room. Identify vacuum pressure by the tag "vacuum".

3.1.1.2.3.5 Pump Outlet Pressure

Measure the pump outlet pressure in the discharge line on the pump side of the flap valve in terms of pounds per square inch (psi) on a gauge. Identify pump outlet pressure by the tag "outlet_psi".

3.1.1.2.4 Outfall Information (Open Water/Spill Barge Disposal)

Monitor the X and Y position of the terminal end of the outfall pipe continuously and report the position as part of the work event string.

3.1.1.2.4.1 Discharge Horizontal Position

Obtain the horizontal position of the outfall end of the discharge pipe using a positioning system operating with a minimum accuracy level of 3-10 feet horizontal Circular Error Probable (CEP). Report it as Latitude/Longitude WGS 84 in decimal degrees with West Longitude and South Latitude values being reported as negative. Identify position values by the tags "outfall_latitude" and "outfall_longitude".

3.1.1.3 Dredge Events - State Event

There are two types of dredge event messages - work event messages and state event messages. State event messages provide information about the current state of the dredge equipment or operations. They are created and sent only when a state changes. Since state events often cannot be collected in real time, state events are tagged with a date time stamp (referenced to Coordinated Universal Time [UTC]) that indicates when the state change happened relative to the work event message tag. This data is considered to be "true" until another state event tag of the same type is received. Indicate each type of state event message by a specific header tag as enumerated in the following subparagraphs. State events can be transmitted along with work event message bundles directly by the contractor using the indicated format, or they can be entered on the "State" tab in the DQM-provided software. However, they should be sent only if the state value changes.

3.1.1.3.1 Message Time

The state event time is the date and time that the event starts. Enter the leverman's time to the nearest second as local time and automatically convert to and report in UTC based on a 24-hour format (YYYY-MM-DD

HH:MM:SS). Identify message time by the tag "msg_time".

3.1.1.3.2 Contract Event

Report information concerning the contract under which dredging is being performed at the start and completion of each contract using the header tag "contract_event".

3.1.1.3.2.1 Contract Number

Report the USACE-assigned contract number for the project using the tag "contract_number".

3.1.1.3.2.2 Contract Start and End

Report the start and end of a contract using the tag "event_type" with the appropriate value of "start" or "end".

3.1.1.3.3 Tide Station/River Stage Gage Event

Group together properties associated with the vertical correction (see paragraph VERTICAL CORRECTION) for the tide station/river stage gage under the header tag "station_event". This information must be sent at the start of the contract and each time the dredge has moved enough to change the station being used.

3.1.1.3.3.1 Station Name

The station name is a concise name defining the tide station/river stage gage begin referred to. It must be introduced by the tag "station_name", and it must not consist of a descriptor of more than 25 characters.

3.1.1.3.4 Length of Pipe Event

Report the leverman's estimate of the length of pipe downflow from the dredge pump, measured to the nearest whole foot, under the header tag "pipe_length_event". This information must be sent at the start of the contract and at the completion of each 24-hour period ending at midnight local time.

3.1.1.3.4.1 Floating Pipe

Report the total length of floating pipe with the tag "length_floating".

3.1.1.3.4.2 Submerged Pipe

Report the total length of floating pipe with the tag "length_submerged".

3.1.1.3.4.3 Shore Pipe

Report the total length of shore pipe with the tag "length_land".

3.1.1.3.5 Booster Pump

Include information concerning the booster pumps being used under the header tag "booster_pump_event". A message must be sent to indicate any change in the status of the booster pumps being used.

3.1.1.3.5.1 Number of Booster Pumps

Upon the addition or removal of a booster pump, report the total number of booster pumps being used with the tag "booster_total".

3.1.1.3.6 Dredge Advance

Measure the dredge advance, the total forward progress of the dredge relative to the centerline of the cut, to the nearest whole foot and cumulatively calculate over a 24-hour period from midnight to midnight local time. Identify it by the tag "advance_daily". Report in Greenwich Mean Time (GMT)the msg_time associated with this tag as the first timestamp of the following 24-hour period (based on the local time) rather than as midnight of the day for which the value was calculated.

3.1.1.3.7 Outfall Information

Monitor and send the X and Y position of the terminal end of the outfall pipe at the start of the contract and thereafter according to the following table. Discharge Heading and Pipe Elevation may be omitted if the dredge is not discharging into an upland disposal site. For beach nourishment, the horizontal X and Y position of the outfall must be sent at the start of the contract and at the completion of each 24-hour period ending at midnight local time.

Discharge Location	Horizontal Position	Discharge Pipe Elevation	Discharge Outfall Heading
Open Water	Continuous Work Event	N/A	N/A
Scow	Upon Change	N/A	N/A
Beach	Every 24 Hours	N/A	N/A
Upland	Upon Change	Upon Change	Upon Change

3.1.1.3.7.1 Discharge Location

Report information on where the slurry is being discharged with the tag "outfall_location". Acceptable values include "upland", "open water", "beach", and "scow".

3.1.1.3.7.2 Discharge Horizontal Position

Obtain the horizontal position of the outfall end of the discharge pipe using a positioning system operating with a minimum accuracy level of 3-10 feet horizontal Circular Error Probable (CEP). Report it as Latitude/Longitude WGS 84 in decimal degrees with West Longitude and South Latitude values being reported as negative. Identify position values by the tags "outfall_latitude" and "outfall_longitude".

3.1.1.3.7.3 Discharge Outfall Heading

The discharge outfall heading is the angle relative to true north measured from the centerline of the pipe in the direction of discharge. Provide all headings using industry-standard equipment. They must be accurate to within 5 degrees and report to the nearest whole degree with values from 000 (true north) to 359 degrees referenced to a clockwise positive direction convention. Identify the discharge heading by the tag "outfall_heading".

3.1.1.3.7.4 Discharge Pipe Elevation

The discharge pipe elevation is the height of the outfall measured in feet and tenths of a foot relative to the project datum. The required accuracy is contingent upon contract requirements. Use the tag "outfall_elevation" to identify this elevation.

3.1.1.3.8 Non-effective Work Event

Report delays and dredge downtime at the conclusion of the event. Submit the reason for the non-effective work time under the header tag "non_eff_event" within 24 hours of the event.

3.1.1.3.8.1 Non-effective Work Interval

Report the start and end times for the non-effective work event using the tags "msg_start_time" and "msg_end_time".

3.1.1.3.8.2 Dredge Function Code

Transmit the dredge operator indication of production delays, as listed on Form 4267, at the end of the non-effective interval. Identify dredge function event messages by the tag "function_code" consisting of one of the following standardized entries to indicate the operation:

AGV	Assisting Grounded Vessels
CCH	Change Cutterhead
CCSH	Clear Cutter Suction
CLPJ	Change Location Bar
COLL	Collision
CPPL	Clear Pump Pipeline
CPR	Change Impeller
DR	Dike Repair
FBD	Fire Boat Drills
HPL	Handling Pipe Line
HSL	Handling Swing Line
HSP	Handling Shore Pipe
LDNE	Loss Due to Natural Elements
LDPV	Loss Due to Passing Vessel
LNL	Transfer to New Location
MISC	Miscellaneous
MOB	Mobilization & Demobilization
MSC	Miscellaneous/Non-pay
OC	Out of Commission
OR	Operating Repairs
P	Preparation
PREP	Preparation & Making Up Tow
RPL	Repair Pipeline
SB	Sounding & Buoying
SBT	Stand-By Time as Directed
SH	Sundays-Holidays
TFS	Taking on Fuel & Supplies
TOW	Time on Tow
WAP	Waiting Attendant Plant

3.1.1.3.8.3 Additional Comments

Use the "comment" tag to provide additional explanation for the noted delays or downtimes. For example, when the code "LDPV" (Loss Due to Passing Vessel) is indicated, list the name of the vessel and the number of tows with the "comment" tag.

3.2 NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM SYSTEM REQUIREMENTS

The Contractor's DQM system must be capable of collecting and transmitting information to the DQM system. Record the applicable parameters from paragraph REQUIREMENTS FOR REPORTED DATA as local events and transmit continuously to the DQM database anytime an Internet connection is available. To accomplish this transmission, there are two options. The first option is to equip the vessel with a DQM computer system consisting of a computer, monitor, keyboard, mouse, data modem, Universal Power Supply (UPS), and network hub. Provide a standalone computer system, exclusive to the DQM monitoring system, with USACE DQM software installed on it. If a hardware problem occurs, or if a part of the system is physically damaged, the Contractor is responsible for repairing it within two business days of the determination of the condition or submitting a plan and timeline for repair if the repair will take more than two business days.

The second option is to send data directly to DQM's web endpoint as outlined in paragraph DIRECT DATA TRANSMISSION.

3.2.1 Computer Requirements

Provide a dedicated onboard computer for use by the Dredging Quality Management system. This computer must run the USACE DQM software and receive data from the Contractor's data-reporting interface. This computer must meet or exceed the following performance specifications:

CPU:	Intel or AMD processor with a (non-overclocked) clock speed of at least 1.6 gigahertz (GHz)
Hard drive:	250 gigabytes (GB); internal
RAM:	4 gigabytes (GB)
Ethernet adapter:	Internal network card with an RJ-45 connector
Ports:	1 free serial port with standard 9-pin connectors; 1 free USB port
Other hardware:	Keyboard, mouse, monitor

Install a fully licensed copy of Windows 10 Professional Operating System or newer on the computer specified above. Also install any necessary manufacturer-provided drivers for the installed hardware.

Locate and orient this computer to allow data entry and data viewing as well as to provide access to data ports for connection of external hardware.

3.2.2 Software

The DQM computer's primary function is to transmit data to the DQM shoreside database. Do not install software which conflicts with this function on this computer. The DQM computer must have the USACE-provided Dredging Quality Management Onboard Software (DQMOBS) installed on it by

DQM personnel.

3.2.3 UPS

Supply an Uninterruptible Power Supply (UPS) for the computer and networking equipment. It must interface with the DQM computer to communicate UPS status, and it must provide backup power at 1 kVA for a minimum of 10 minutes. Ensure that sufficient power outlets are available to run all specified equipment.

3.2.4 Direct Data Transmissions

Option 2: Direct Data Transmissions to the DQM Web Service - Use the web service to report sensor data to the DQM database. Data must be transmitted as it is collected in real time and pushed to the DQM web service. If the web service is not available or returns an error message, the data must be stored in a queue and transmitted upon re-establishment of the connection, starting with the oldest data in the queue and continuing until real-time transmission is restored.

Contact https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Management/ to obtain the web service URL and the appropriate key credentials and communication protocol. If this option is chosen, a display of the raw data being transmitted to DQM must be easily accessible and visible onboard the dredge

3.2.5 Internet Access

Maintain an Internet connection capable of transmitting real-time data to the DQM server as well as enough additional bandwidth to clear historically queued data when a connection is re-established. If connectivity is lost, que and transmit unsent data upon restoration of connectivity. Delays in pushing real-time data to the DQM database should not exceed four hours. Exceptions to these requirements may be granted by the DQM Support Center on a case-by-case basis with consideration for contract-specific requirements, site-specific conditions, and extreme weather events.

Acquire and install all necessary hardware and software to make the Internet connection available for data transmission to the DQM web service. Configure the hardware and software to allow the DQM Support Center remote access to this computer, and the telemetry system must be capable of meeting these minimum reporting requirements in all operating conditions.

In areas with poor cellular service and at the local District's discretion, it may be required to manually download the data on a daily basis using the protocol for retrieving and submitting backup files provided by the DQM Support Center. This method of data transmission should be used only if Internet connectivity is unavailable at the dredging site, and it should be considered a temporary measure.

3.2.6 Data Routing Requirements

Onboard sensors continually monitor dredge conditions, operations, and efficiency and route this information to the shipboard dredge-specific system (DSS) computer to assist in guiding dredge operations. Portions of this Contractor-collected information, as described in this specification, must be routed to the DQM computer on a real-time basis utilizing one of the two options outlined in this section. Use an RS-232 serial interface with a baud rate of 9600 or 19200 bps to send standard sensor data to the DQM computer. Configure the serial interface as 8 bits, no parity, and no flow control.

Digitally log and transmit information regarding changes in the state of the dredge as close to the time of the occurrence as possible. These events can either be included in a separate message bundle going to the DQM onboard computer, or they can be entered on the "State" tab in the DQM Pipeline Software, or entered online in the DQM State Data Tool.

3.3 DREDGE MONITORING DATA

3.3.1 General

Onboard sensors continuously collect dredging data in support of the dredge Contractor's operations. Portions of this Contractor-collected information, as described in this specification, and store and transmit calculations based on them to the DQM database on a near real-time basis. Additionally, digitally log and transmit information regarding the state of the dredge.

3.3.2 Data Measurement Frequency

The frequency of data transmission is dependent on the type of message being sent. Work Event messages contain data that are instantaneously collected or calculated from sensors and are logged as a series of events. State event messages are activated by a change in the dredge state.

3.3.2.1 Work Event Messages

Log data as a series of events. Each event must consist of a dataset containing dredge information (as defined in paragraph REQUIREMENTS FOR REPORTED DATA). Consider each set of measurements (for example, time and position) an event with a 6-12 second interval between work events. This interval must remain consistent across event types for the dredge plant.

Record a standard data string within one second of an event trigger with the time stamp and all parameters reflecting when the event happened.

3.3.2.2 State Event Messages

Consider a set of descriptive information (event name, time, description, comment) a state event. Record these events within 24 hours of a change in state with the time stamp reflecting when the event happened.

3.3.3 Parameter Transmission to the Web Service

****

NOTE: Do not alter the code below (text, parenthesis, and brackets). The brackets and parenthesis structure in the code below are necessary for the code to be implemented correctly. When utilizing the bracket verification report, ignore the error associated with these brackets.

****

Format the data as JSON (JavaScript Object Notation, as defined at http://www.json.org) strings of arbitrary length. These JSON strings represent a hierarchical data structure consisting of a message bundle which may contain 0-3 automatic data messages and any number of manual data messages.

A tag/parameter is reported only when it contains a value. Do not include "Null" value strings in a message bundle.

```
    ****************************
    Message bundle
    ****************************

    {
      "DQM_Data": {
          "plant_identifier": <integer value 0000-9999>,
          " transmission_time": <24-hour UTC time YYYY-MM-DD HH:MM:SS>,
        "messages": [
          {
            "work_event": {
            "msg_time":             <24-hour UTC time YYYY-MM-DD HH:MM:SS>,
              "vert_correction":   <floating point 100th decimal place>,
              "ch_latitude":       <decimal to 6 decimal places>,
              "ch_longitude":      <decimal to 6 decimal places>,
              "ch_depth":          <floating point 100th decimal place>,
              "ch_heading":        <integer value 000-359>,
              "slurry_velocity":   <floating point 100th decimal place>,
              "slurry_density":    <floating point 100th decimal place>,
              "pump_rpm":          <integer>,
              "vacuum":            <floating point 100th decimal place>,
              "outlet_psi":        <floating point 100th decimal place>,
              "comment":           <string>},
            }
          },
          {
            "contract_event": {
              "msg_time":          <24-hour UTC time YYYY-MM-DD HH:MM:SS>,
              "contract_number":   <string>,
              "event_type":        <string - "start" or "end">,
              "comment":           <string>
            }
          },
          {
            "station_event": {
              "msg_time":          <24-hour UTC time YYYY-MM-DD HH:MM:SS>,
              "station_name":      <string>,
              "comment":           <string>
            }
          },
          {
            "pipe_length_event": {
              "msg_time":          <24-hour UTC time YYYY-MM-DD HH:MM:SS>,
              "length_floating":   <integer>,
              "length_submerged":  <integer>,
              "length_land":       <integer>,
              "comment":           <string>
            }
          },
          {
            "booster_pump_event": {
              "msg_time":          <24-hour UTC time YYYY-MM-DDHH:MM:SS>,
```

```
          "booster_total":     <integer>,
          "comment":           <string>
        }
      },
      {
        "advance_Event": {
          "msg_time":          <24-hour UTC time YYYY-MM-DD HH:MM:SS>,
          "advance_daily":     <integer>,
          "comment":           <string>
        }
      },
      {
        "outfall_position": {
          "msg_time":          <24-hour UTC time YYYY-MM-DD HH:MM:SS>,
          "outfall_location":  <string-"upland", "beach", "scow", "open
water">
          "outfall_latitude":  <decimal to 6 decimal places>,
          "outfall_longitude": <decimal to 6 decimal places>,
          "outfall_heading":   <integer value 000-359>,
          "outfall_elevation": <floating point 10th decimal place>,
          "comment":           <string>
        }
      },
      {
        "non_eff_event": {
          "msg_start_time":    <24-hour UTC time YYYY-MM-DD HH:MM:SS>,
          "msg_end_time":      <24-hour UTC time YYYY-MM-DD HH:MM:SS>,
          "function_code":     <string - 1 to 4 characters>,
          "comment":           <string>

        }
      }
    ]
  }
}
```

3.3.4 Contractor Data Backup

Maintain an archive of all data sent to the DQM computer during the dredging contract. The COR may require, at no increase in the contract price, that the Contractor provide a copy of these data covering specified time periods. Provide the data in the same JSON format as would have been transmitted to the DQM computer. There must be no line breaks between the parameters, and each record string must be on separate line. The naming convention for the files must be <*dredgename*>_<*StartYYYYMMddhhmmss*>_<*EndYYYYMMddhhmmss*>.txt.
Data submission must be via a storage medium acceptable to the COR.

At the end of the dredging contact, call the National DQM Support Center prior to discarding the data. The DQM Support Center will verify that all data has been received and appropriately archived before giving the Contractor discard permission. Record the following information in a separate section at the end of the dredge's onboard copy of the DPIP:

Person who called the National DQM Support Center
Date of the call
DQM representative who gave permission to discard the data

3.4 PERFORMANCE REQUIREMENTS

The Contractor's National Dredging Quality Management Program's data transmission must be fully operational at the start of dredging operations. To meet contract requirements for operability, the Contractor's system must provide an accurate data string return and be compliant with hardware requirements. Data string return is defined as the number of quality records within an event or state tag sent by the contractor's system to the DQM database. Quality data strings are considered to be those providing accurate values for all parameters reported when operating according to the specification. Make repairs necessary to restore data return compliance within two business days, or submit a plan and timeline for repair if the repair will take more than two business days. Failure by the Contractor to report quality data within the specified time window for dredge measurements as stated in the specifications (see paragraph INTERNET ACCESS, paragraph DATA MEASUREMENT FREQUENCY, and paragraph PARAMETER TRANSMISSION TO THE WEB SERVICE, will result in withholding of up to 10 percent of the contract progress payment.

3.5 LIST OF ITEMS TO BE PROVIDED BY THE CONTRACTOR

DPIP
https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/Dredging-Quality-Man

DQM System
Paragraph 3.2 NATIONAL DREDGING QUALITY MANAGEMENT PROGRAM SYSTEM REQUIREMENTS, including all subparagraphs

Dredge Data
Paragraph DREDGING MONITORING DATA

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-35 31 19.20 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-35 31 19.20 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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****

USACE / NAVFAC / AFCEC **UFGS-35 31 19.20 (November 2023)**

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****

SECTION 35 31 19.20

ARTICULATING CONCRETE BLOCK REVETMENTS

11/23

****

NOTE: This guide specification covers the requirements for commercially available concrete block products for revetments.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: PART 2 PRODUCTS is based on commercial items, and does not address field casting of blocks or manufacturing of non standard blocks.

This guide specifications assumes the ACB is Government designed for issues such as hydraulic stability and geotextile filters. Maximum flexibility is desirable for Contractor product selection, installation sequence, construction equipment, and block orientation.

Notes before paragraphs are provided to present assumptions in preparation of the guide specification, make suggestions for conditions that

warrant project revisions, and provide background technical information or references for further information. They should be reviewed prior to revising wording for use in project specifications.

The drawings should show appropriate details for toe key-in, anchor trenches, revetment termination, transition to riprap, anchors, geotextiles, horizontal and vertical joint thickness between ACB, joint/placement pattern of ACB's.

****

1.1 MEASUREMENT AND PAYMENT

Measurement of ACB revetment for payment will be made on the basis of the face area. The pay lines of ACB revetment will be neat lines taken off the approved shop drawings; and will include embedded blocks and anchor trenches. Work includes incidental grading and preparatory work, furnishing and installing the geotextile and ACB, filling the voids, securing cable fasteners, installing soil anchors, and seeding (where specified). Engineering services and product testing are incidental, if required. Placing cast-in-place concrete joints and cutting blocks are incidental, if required. Payment will be made at the respective unit price per square meter foot listed on the Bidding Schedule. Payment will be full compensation for all material, labor and equipment to complete the work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications

ASTM INTERNATIONAL (ASTM)

ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C138/C138M	(2024a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C140/C140M	(2024) Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C1262/C1262M	(2024) Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units
ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M	(2017) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533/D4533M	(2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2020) Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4833/D4833M	(2007; R 2020) Standard Test Method forIndex Puncture Resistance of Geomembranes and Related Products
ASTM D4873/D4873M	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA RD-89-199	(1989) Hydraulic Stability of Articulated Concrete Block Revetment Systems During Overtopping Flow

1.3 DEFINITIONS

1.3.1 Articulating Concrete Block (ACB) Revetment System

A matrix of interconnected concrete block units for erosion protection. Units are connected by geometric interlock and/or cables, geotextiles, or geogrids, and typically include a geotextile underlayment for subsoil retention.

1.3.2 Blocks

Articulating concrete block revetment units will be referred to as blocks.

1.3.3 Interlocking Blocks

For each pair of abutting blocks provide interlocking keys that limit lateral expansion. Provide key and keyhole with an interference fit such that the joint movement has a minimum aperture at closure, and a maximum aperture when pulled apart. The joint freeplay must allow articulation of each individual block.

1.3.4 Freeplay

Freeplay is the maximum lateral joint movement for interlocking blocks (difference between maximum and minimum aperture).

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy or Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Block Installation; G, [_____]

Geotextile Installation; G, [_____]

SD-03 Product Data

Articulating Concrete Block; G, [_____]

Geotextile; G, [_____]

Anchors; G, [_____]

SD-04 Samples

Articulating Concrete Block

SD-06 Test Reports

Flume Test

1.5 DELIVERY, STORAGE, AND HANDLING

Check products upon delivery to assure that the proper material has been received and is undamaged. For geosynthetics, follow the guidelines presented in ASTM D4873/D4873M.

1.5.1 Blocks

Provide blocks which are sound and free of defects that would interfere with proper placement or that would impair the strength or longevity of the installation. Discard blocks with the following defects:

a. Broken appendages.
b. Chips larger than 50 mm 2 inches in any dimension.
c. Cracks wider than 0.5 mm 0.02 inches and longer than 33 percent of the nominal height.
d. Exposed skin reinforcement or rebar.
e. Displaying evidence of the Alkali-Silica Reaction (ASR) such as map cracking.
f. Discard/remove blocks exhibitting efflorescence over 25 percent of the surface if directed by the Contracting Officer.

Minor cracks, incidental to the usual method of manufacture, or chipping that results from customary methods of handling in shipping, delivery and placement will not be deemed grounds for rejection. Store blocks in a suitable location away from mud, paint, wet cement, and other contamination or disturbance.

1.5.2 Geotextiles

1.5.2.1 Labeling

Label each roll with the manufacturer's name, product identification, roll dimensions, lot number, and date manufactured.

1.5.2.2 Handling

Handle and unload geosynthetic rolls by hand, or with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Do not drag geosynthetic rolls, lift by one end, lift by cables or chains, or drop to the ground.

1.5.2.3 Storage

Protect geotextiles from cement, paint, excessive mud, chemicals, sparks and flames, temperatures in excess of 70 degrees C 160 degrees F, and any other environmental condition that may degrade the physical properties. If stored outdoors, elevate the rolls from the ground surface and protected with an opaque waterproof cover. Deliver geotextiles to the site in a dry and undamaged condition.

1.6 SCHEDULING

To limit ultraviolet light exposure of the geotextile, place the blocks within 7 days after placing the geotextile, and the void filler within 14 days after placing the geotextile.

PART 2 PRODUCTS

2.1 ARTICULATING CONCRETE BLOCK

****

NOTE: Hand placed (interlocking) ACB typically provides a neater, more pleasing appearance in parks and public areas. Cabled ACB can have superior hydraulic stability to interlocking products, it is more difficult to remove (such as by vandalism), and it has improved constructability when placed in water.

The table of ACB requirements is comprehensive, and many of the properties are interrelated. Including all listed properties will be specification overkill for most projects. Renumber notes where properties are deleted.

The critical shear stress is preferred by the industry over critical velocity because the critical shear is relatively constant for a product. Critical velocity varies depending on flow characteristics (such as depth and turbulence); so that the critical velocity in the flume test is not comparable to the required critical velocity in the field.

The surface void area ratio, DCF, and curvature radius can be used to specify products best suited to placement on curved surfaces, and turf establishment. Some blocks are available with open cells or solid cores. Most products marketed specifically for ACB revetments are within reasonable limits for general use.

Modifying the requirements for a performance

specification may be considered for small low hazard projects or negotiated contracts, and may be preferred by some manufacturers. However, performance requirements for firm fixed price (low bid) contracts is not recommended for ACB's because of the price level jumps between product sizes, and because there is no control in how bidders incorporate risk for a low frequency design event.

Interface friction for soil/fabric and fabric/blocks should be considered by the designer. Because typical design values for soil/fabric are available in geosynthetic design guides, and because the Contractor generally has no control over the soil, the soil/fabric interface friction angle is not addressed in the specification (although for certain critical applications, this may need to be added to verify design assumptions). Interface friction for fabric/blocks is addressed in the specification because it is affected by geotextile and block combinations, it can affect installation, and because the interface friction for fabric/block is highly variable dependent on manufacturing characteristics of both products.

****

Submit descriptive technical data on the blocks, cables, cable fittings, soil anchors, and geotextile. Include all material properties specified under paragraph PRODUCTS. Submit catalog cuts, technical data sheets, or test data showing that the products meet the specifications. Also include a copy of any standard manufacturer's warranties for the products. See below under "geotextile" for more requirements. Meet the following criteria:

TABLE 1. ACB Requirements		
Criteria	Required Value	Test Method
Matrix Assembly: [Interlocking Blocks] [Cabled System]		
Thickness, minimum	[100 mm][4 inches]	N/A
Net Weight/Area, minimum	1.4 kN/m230 psf	Note a.
Critical Shear Stress, minimum	[170 N/m2][3.5 psf]	FHWA RD-89-199
Critical Velocity, minimum	5 m/sec15 ft/sec	FHWA RD-89-199
Curvature Radius, maximum	1 m3 feet	Note b.
Surface Void Area Ratio	25 - 40 percent	Note c.
Drainage Correction Factor (DCF)	20 - 35 percent	Note d.
Block/Geotextile Interface Friction Angle	[35 degrees, minimum]	Note e.

TABLE 1. ACB Requirements

Criteria	Required Value	Test Method
a. Determine the weight of the mattress per unit area with the nominal joint spacing, in a non-submerged condition.		
b. The curvature radius must be indicative of the ability of the assembled mattress to conform to one dimensional subgrade curves without binding, such as for anchor trenches and swales. The curvature radius must be demonstrated, if requested by the Contracting Officer.		
c. The surface void area ratio must be determined at the visible (with filled voids) surface of the blocks, with the joints spaced in a neutral position (50 percent), and express as a percentage of the gross mat area. The void area must include area between the blocks and open cells within the block.		
d. The drainage correction factor must the minimum void area ratio (usually taken at the base of the blocks), with the joints spaced in a neutral position (50 percent freeplay in each direction), and must be expressed as a percentage of the gross mat area.		
e. The concrete surface must be sufficiently rough to prevent sliding of the blocks on the geotextile. The interface friction must be matched with the selected block and geotextile combination, and must be included with the ACB and Geotextile Data submittal. Demonstrate the block/geotextile interface friction angle, if requested by the Contracting Officer.		

2.1.1 Hydraulic Stability

****

NOTE: The velocity and shear stress conditions derived from this test are critical state conditions, and do not represent allowable design values. The surface tolerances for block placement are generally better in the test than field conditions.

FHWA RD-89-199 is a research document, not a standard test method. ASTM committee D18.25.04 has a draft standard based on a flume test, similar to FHWA RD-89-199. The flume test is very expensive: testing expenses can be on the order of $30,000.

FHWA RD-89-199 included a 20 mm 3/4 inch Enkamat fabric below the blocks for the purpose of installing instrumentation to research block behavior. The Enkamat provided a very effective drainage layer that is not integral to the test method. A drainage layer provides a very significant improvement in the ACB stability in the flume test. Regardless of the flume test

conditions, the designer should consider including a granular drainage layer in areas with high turbulence flow.

****

2.1.1.1 Flume Test

Submit a report of testing for the ACB in conformance with FHWA RD-89-199. Usage of a drainage layer as prescribed in FHWA RD-89-199 is not required. Clearly state if the critical shear stress associated with the stability threshold of the ACB system was derived from laboratory testing that included a sub-block drainage layer as a component of the tested system. Test the ACB product in a flume chamber satisfying the requirements of FHWA RD-89-199. If the product was tested with a drainage layer, the installed product must incorporate a similar drainage layer with adequate filtration design for the site soils. Base the flume test on conservative assumptions for field placement of the blocks (such as block orientation, and joint spacing within construction tolerances). Indicate the critical shear stress (and critical velocity) in the test report. Submit the Flume Test results at the same time as the ACB and Geotextile Data.

2.1.1.2 Extrapolation of Hydraulic Stability

****

NOTE: Preliminary research has indicated that extrapolation is conservative when extrapolating to thicker blocks, and unconservative when extrapolating to thinner blocks.

The paragraph has no description for similiar footprint, interlocking mechanism, and industry standards. Recommend that additional requirments be for those description be inserted based on actual field conditions.

****

Extrapolation of critical shear stress for untested blocks within a similar family of ACB are subject to limitations. Use extrapolation only for blocks having a similar footprint area and interlock mechanism, but with variable thickness or net weight/area. Accept extrapolation only if the following conditions are met:

a. The extrapolation is in strict accordance with hydraulic similitude methods commonly accepted by the industry, and includes quantitative treatment for a block overturning failure mode.

b. The tested block is the smaller product size in both thickness and net weight/area, and extrapolation does not extend the critical velocity more than 3 meters per second 10 feet per second from the tested product size.

2.1.2 Matrix Assembly - Interlocking Blocks

Interlocking blocks are assumed to function without the use of cables or similar restraints. Place void filler to inhibit lateral movement and block pullout, cover the geotextile, and increase hydraulic stability.

2.1.3 Matrix Assembly - Cabled Systems

Interconnect cable tied concrete block by flexible cables running through the blocks. Penetrate each block by a cable that allows articulation of the blocks, but restrains removal of individual blocks. Place void filler to inhibit lateral movement, cover the geotextile, and increase hydraulic stability.[ ][Fabricate articulating concrete block, cables, and fittings into transportable mattresses at the manufacturer's plant.]

2.1.4 Structural requirements

****

NOTE: Freeze-thaw Testing - The specifier should edit this paragraph based on the project's location. The default values correspond to the default values in ASTM C1372, Segmental Concrete Retaining Wall Units. The freeze thaw requirements for retaining wall blocks are referenced since they are similar products, ACB blocks can be produced by similar manufacturing methods, and retaining walls have been the subject of more freeze thaw durability research. The number of seasonal freeze thaw cycles for typical ACB's is likely less than for retaining walls. Chloride from deicing salts or sea water increases saturation of the concrete, and thus has a very pronounced affect on freeze thaw degradation.New procedures has been developed and should be investigated and specify to measure the rate of freeze thaw degradation from chloride. The amount of degradation that is unacceptable should be stated.

****

Provide wet cast articulating concrete block using concrete as specified herein, or dry-cast by a vibratory block forming machine. Manufacture the blocks to the following requirements:

2.1.4.1 Compressive Strength

Provide a minimum compressive strength of 28 MPa 4000 psi for an average of 3 units, and 24 MPa 3500 psi for an individual unit. Determine compressive strength by ASTM C42/C42M for wet cast blocks, or by ASTM C140/C140M for dry cast blocks.

2.1.4.2 Water Absorption for Dry Cast Units

Provide a maximum water absorption for dry cast units of 145 kg/m^3 9 pcf for an average of 3 units, and 195 kg/m^3 12 pcf for an individual unit. Determine water absorption by ASTM C140/C140M.

[2.1.4.3 Saturated Surface-Dry Density

Provide a minimum saturated surface-dry density of [140] [_____] for average of 3 units, and [140] [_____] for an individual unit.

][2.1.4.4 Air Entraining

Air entrain wet cast concrete to contain between 4 and 7 percent total air determined in accordance with ASTM C138/C138M.

][2.1.4.5 Freeze-Thaw Durability

For freeze-thaw durability tested in accordance with ASTM C1262/C1262M, specimens must comply with either of the following: (1) the weight loss of each of 5 specimens after 100 cycles must not exceed 1 percent; or (2) the weight loss of each of 5 specimens after 150 cycles must not exceed 1.5 percent.

]2.2 GEOTEXTILE

****

NOTE: The AASHTO M 288 table provides survivability requirements. Class 1 is recommended for harsh or severe installation conditions where there is a potential for vehicular traffic, or where irregular sections may require removal and replacement of mattresses to achieve proper alignment. Class 2 is allowed where no vehicle traffic will occur on the installation, and where mattress placement is in regular, even reaches. Reference Protection of Work paragraph in Part 3.

Some manufactures require minimum geotextile properties for warranty coverage. Most manufacturers have recommended geotextiles, but these should be verified for compatibility with the subgrade soils.

Filters should not impede seepage. Clogging resistance is critical for uplift stability. Site specific design should be performed if any of the following problematic soil conditions are encountered: highly erodible soils such as non-cohesive silts, gap graded soils, or laminated sand/silt.

Some references for geotextile design include:
1. Koerner, "Designing with Geosynthetics", Prentice Hall.
2. FHWA, "Geosynthetic Design and Construction Guidelines."
3. Geosynthetics '95, "Geotextile Permeability Criteria for Revetments", pp. 217-230.

Geosynthetic Selection - The Federal Acquisition Regulations require full and open competition. Usually justification is not necessary if 3 products meet the specifications. In combining various material requirements, it is easy to specify a geosynthetic product that does not exist. Design utilizing geosynthetics should include a listing with the calculations that verify the specified products are commercially available. The Geotechnical Fabrics Report magazine publishes an annual specifiers guide that is ideal for this purpose.

****

Submit two samples of the proposed block at the same time as the ACB and Geotextile Data submittal. Provide samples that are typical of the size, texture, color, and finish. If the Contracting Officer is familiar with the product, this submittal may be waived. Geotextile used as filters below the ACB must be a [woven] [non-woven] fabric. The geotextile must meet the material properties specified in AASHTO M 288 for Class [2] strength property requirements and for permanent erosion control. Base filter requirements in AASHTO M 288 on in-situ soil with [less than 15 percent] [15 percent to 50 percent] [greater than 50 percent] passing the 0.075 mm sieve opening.Geotextile used as a filter below the ACB must be a [woven] [non-woven] fabric, meeting the requirements specified in Table 2. The property values (except for AOS) represent minimum average roll values (MARV) in the weakest principal direction.

TABLE 2. GEOTEXTILE PHYSICAL PROPERTIES

PROPERTY	TEST REQUIREMENT	TEST METHOD
Grab Tensile, N lbs.	[700 160 nonwoven]	ASTM D4632/D4632M
	[1100 250 woven]	
Tear Strength, N lbs.	[250 55 nonwoven]	ASTM D4533/D4533M
	[400 90 woven]	
Puncture Strength, N lbs.	[250 55 nonwoven]	ASTM D4833/D4833M
	[400 90 woven]	
Permittivity, 1/sec	[0.5]	ASTM D4491/D4491M
Apparent Opening Size, µm U.S. Sieve	[150 - 212][70 - 100]	ASTM D4751
Ultraviolet Stability	[50 percent]	ASTM D4355/D4355M

2.3 CABLE

2.3.1 Installation Requirements for Cable

Use cable for preassembled mattresses that is sufficiently sized and fastened for the size/weight of the assembled mattresses such that the assembled mattresses can be placed in compliance with OSHA standards. The manufacturer is responsible for determining the minimum cable strength compatible with the mattress size for safe handling. Base cable strength on a minimum factor of safety of 5, and include appropriate reduction factors for mechanically crimped cable, and other fasteners. If applicable, include the use of a spreader bar for placing the mattresses in loading conditions.

2.3.2 Fasteners Other than Cable

Any systems which rely on geotextiles (or other fabric integral with the mattress) to maintain block-to-block interconnection must meet the applicable portions of this specification for cables. Geosynthetics strength must include appropriate factors of safety, with particular attention given to the grab points.

2.3.3 Design Requirements for Cable

****

NOTE: The designer may need to research survivability of cables in the environment where the ACB will be placed. The installation requirements for cable strength usually govern, unless anchors are used.

****

Use ropes manufactured from polyester, stainless steel wire, or galvanized steel wire for ACB's that rely on cables to maintain block to block interconnection. Provide cable with a minimum breaking strength of [_____] pounds. Construct polyester rope of high tenacity, large elastic modulus, continuous filament polyester fibers; and consisting of a core construction comprised of parallel fibers contained within an outer jacket or cover.

2.3.4 Anchors

****

NOTE: Anchors require a cabled system. Anchors should be used with caution. Control of mattress uplift may only be successful for short term, low frequency, overload. ACB mattresses that are locally uplifted, with or without anchors, may show significant subgrade distortion, which could be a precursor to failure. Anchors spaced throughout the revetment also require special details to maintain integrity of the geotextile filter.

Because anchors are not required for typical installations, this paragraph may commonly be deleted. Where anchors are used for specialized applications, add requirements for anchor materials, minimum property requirements, and design characteristics.

Drawings must detail location and spacing of anchors.

****

Submit calculations for the anchor pullout capacity. Tabulated manufacturer's data is acceptable, provided the embedment soils are proven applicable to the project site. Select anchors with an ultimate vertical pullout resistance for the project site soil conditions of at least [_____] pounds. Provide anchors that are capable of being attached directly to the ACB mat in a manner which will achieve little or no slack in the cable system or gaps in the ACB mattress. Attach anchors to the mat in such a manner that they will not be affected by tampering or vandalism. Anchors must have the capability of being load-tested to the specified pull-out capacity.

2.4 VOID FILLER

2.4.1 Aggregate

****

NOTE: Aggregate is used below the normal water

level, or where turf can not be established. Department of Transportation specifications for road base aggregate have been used, such as ASTM D1241, Gradation B.
****

Provide aggregate for filling the voids in the block meeting the requirements of [_____].

2.4.2 Topsoil and Seed

Provide topsoil for filling the voids in the block and seed for turf establishment meeting the requirements of Section 32 92 19 SEEDING.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

Place the ACB revetment on undisturbed native soils, or acceptably placed and compacted fill. Do not place the ACB on surfaces that contain mud, frost, organic soils, embankment that has not met compaction requirements, or where the Contracting Officer determines that unsatisfactory material remains in or under the subgrade.

3.1.1 Clearing

Completely remove all vegetation as specified in Section [31 00 00 EARTHWORK] [31 11 00 CLEARING AND GRUBBING]. Completely remove root balls and stump. Remove remaining roots from trees and brush to a depth of 0.3 meters 1 foot below the subgrade surface. Rake and remove loose roots and twigs, turf clods, stones larger than 13 mm 1/2 inch diameter, and other debris from the final surface. Correct rills and gullies from erosion.

3.1.2 Bank Grading

Finish grading to a smooth surface, typical of that obtainable with a dozer and blade. A rough surface typically obtained with a backhoe or dragline will not be acceptable. When ACB placement in water is shown on the drawings, the slope stability and grading requirements must be determined by a qualified geotecnical engineer.[When natural shorelines require grading in preparation for ACB installation, observe the bank stratification and document in daily Contractor Quality Control reports. Use grading practices that avoid spreading fine grained soils over more pervious soils, particularly near the toe of slopes. If inadequate material is available to comply with this requirement, notify the Contracting Officer.].

3.1.3 Compaction and Subgrade Finishing

[Compact fill soils to the specified density in Section 31 00 00 EARTHWORK.] Compact incidental grading (where embankment is not otherwise specified) by heavy equipment or by tamping with a bucket to a density characteristic of the surrounding soils. Compact the final surfaces accessible by compaction equipment with a smooth drum roller or vibratory plate tamper until there is no further evidence of consolidation. Where slopes limit operation of compaction equipment, the final surface conditions must be determined by a qualified geotechnical engineer. Correct localized loose or soft zones.

3.1.4 Grade Tolerances

Provide grading tolerance within 50 mm 2 inches from the prescribed elevations, with no abrupt variations that would cause unacceptable projections of individual blocks.

3.1.5 Subgrade Surface Tolerances

Maintain the subgrade in a smooth condition between installation of the geotextile and the blocks. Rake windrows, stones, clods of cohesive soil, and irregularities smooth. Correct ruts, rills and gullies resulting from traffic, precipitation runoff, groundwater seepage, prior to installation of blocks.

3.2 GEOTEXTILE INSTALLATION

3.2.1 General

See "block installation" paragraph for drawing requirements. Lay the geotextile flat and smooth so that it is in direct contact with the subgrade. Provide geotextile that is free of tension, folds, and wrinkles. Minimize the number of seams and overlaps by selective orientation of geotextile panels, within the limitations of maintaining a consistent pattern. Place geotextile in accordance with the requirements of paragraph GEOTEXTILE. Place immediately prior to block installation, if necessary to limit damage to the geotextile from equipment or repeated pedestrian traffic and limit disturbance of the subgrade from precipitation or runoff.

3.2.2 Geotextile Seams

****

NOTE: Sewn, welded or glued seams are desirable for shoreline protection (or where flow reversal occurs). Substitute the following for sewn seams:

Seams must be continuously sewn at the locations shown on the drawings. The minimum distance from the geotextile edge to the stitch line nearest to that edge must be 75 mm 3 inches. Seam strength must meet the minimum requirements specified in AASHTO M288 for a class 2 geotextile. Take quality assurance samples at the request of the Contracting Officer. Tie off the thread at the end of each seam run to prevent unraveling. Seams must be on the top side of the geotextile to allow inspection. Sew skipped stitches or discontinuities with an extra line of stitching with a minimum of 450 mm 18 inches of overlap.

Pins/staples may not be desirable where filtration is critical.

****

Overlap seams a minimum of 450 mm 18 inches or according to manufacturers recommendations, whichever is the most stringent requirement. Provide shingled seams on slopes and butt end seams so that runoff and channel flow passes over the fabric. Secure geotextile panels before block placement by adequate sandbags, spare blocks, or pins/staples.

3.3 BLOCK INSTALLATION

Place all blocks in accordance with the manufacturer's recommendations and the Contractor's approved shop drawings. Submit drawings showing details of the ACB and Geotextile Installation, including the block layout patterns in relation to the feature alignment, anticipated locations of cast-in-place concrete joints, mattress junction details, soil anchors, and proposed installation methods for void filling materials.

3.3.1 Placement of Pre-Assembled Mattresses

****

NOTE: The spreader bar may be deleted where tolerances are a minor concern. The spreader bar may have associated cost when placing one end of the mattress in water, due to work in disconnecting the rigging on the wet end.

****

[Place pre-assembled ACB mattresses with mattresses attached to a spreader bar to aid in lifting, aligning and placing the mattresses.]Place mattresses directly into position, with a maximum space or gap between mattresses of 75 mm 3 inches in excess of the nominal joint spacing of blocks within the mattress. Lift and reset mattresses out of alignment. Do not push or pull mattresses laterally after they are in contact with the geotextile. Do not accept overlapping of mats and blocks that project vertically more than 25 mm 1 inch beyond the adjacent blocks are not permitted. [As adjacent mats are placed, secure them to each other by fastening the protruding horizontal and vertical cable connections and end cable loops together along each side of the mats.]

3.3.2 Hand Placement of Interlocking Blocks

Space hand placed blocks to maximize the ACB ability to articulate. Use adequate alignment control, such as string lines, to keep the block pattern in alignment and the joint spacing consistent and uniform. Initially, no more than two working block rows must progress simultaneously in the direction of placement. Additional working rows may be added after experience shows that true lines are maintained. Choose a convenient location as the starting position for ACB placement for control of the block pattern alignment. Sumbit the starting position for placement of the ACB to the Contracting Officer for approval.

3.3.2.1 Target Joint Spacing

Install interlocking blocks with a uniform aperture in the interlocking connections. Neutrally space the target joint spacing with equal free-play for the joint to open and close.

3.3.2.2 Correction of Joint Spacing

If the block pattern becomes skewed to an extent that blocks bind, joints close, or blocks stickup, then remove and replace the placed ACB that is determined to be out of tolerance. Where the nonconformance of the joint spacing is due to project features, such as warped slopes or anchor trenches, then field locate cast-in-place concrete joints in concurrence with the Contracting Officer.

3.3.2.3 Maintenance of Joint Spacing

If the block pattern becomes skewed to an extent that the joint freeplay is not acceptable to the Contracting Officer, then field locate cast-in-place concrete joints as directed by the Contracting Officer.

3.3.2.4 Block Layout Pattern Dependent on Project Features

If the block pattern is shown to be maintained parallel and perpendicular to selected project features, such as the crest/toe of levee/channel slopes, then implement field location of cast-in-place concrete joints as needed, and as directed by the Contracting Officer.

3.3.3 Tolerances

3.3.3.1 Vertical Tolerance

Maximum acceptable block projections (vertical offset from adjacent blocks) for "installation in the dry" must not exceed 0.5 inches for interlocking blocks, 25 mm 1.0 inch for cabled systems. Typical block projections must be less than half the maximum projections.

3.3.3.2 Horizontal Tolerance

Less than half the maximum projections.

3.4 ANCHORS

Carefully position anchors for attachment to the ACB. Align rigid shafts with the ACB cables. Flexible anchors (cables, ropes, and tie offs) must be linear between the ACB fastener and the restraining device before tensioning. Seal gaps and penetrations in the geotextile to allow for penetration of the anchor [in accordance with the drawing details].

3.5 CONCRETE JOINTS

3.5.1 General Requirements

Minimize use of cast in place concrete joints to the extent practicable. All concrete joints not shown on the shop drawings must be reviewed and approved by the Contracting Officer prior to field placement. Joints that require concrete include:

a. Joints between cable tied mattresses where the joint is 75 mm 3 inches wider than the nominal joint.

a. Joints where block interlock is discontinuous.

b. Abutments where the ACB meets headwalls, pipe penetrations, or sidewalks.

c. Any areas where there are partial blocks (to avoid small blocks with reduced hydraulic stability).

Field placed concrete must have a specified strength that is 1000 psi greater than the specified strength of the ACB concrete miture. The durability properties as the be proportioned for similar strength and durability properties of the ACB concrete must meet applicable portions of Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS

CAST-IN-PLACE CONCRETE]. Complete all cable ties and anchoring prior to placing concrete.

3.5.2 Abutments

The ACB must abut pipe outlets, retaining walls, flood walls, head walls, sidewalks, and other abutments in a neat appearance. Unless a specific detail is indicated on the drawings, fill voids with partial blocks and fill the gap with cast-in-place concrete. Place the concrete flush with the surface of the blocks, and float finish. Strike control joints both vertically and horizontally in locations where gap fills exceed the width or height of a single ACB. Fill control joints with a polyurethane base sealant to be approved by the Contracting Officer prior to usage.

3.6 VOID FILLER AND SEEDING

****

NOTE: Topsoil will consolidate in the voids. Overfilling above the top of block is common to increase the topsoil fill level, but may increase sedimentation during turf establishment.

Broadcast seeding of ACB is difficult because it is difficult to rake the seed in. Hydroseeding of ACB is difficult because of channelization of runoff and susceptibility of the void filler to desiccation. In areas where establishment of quality turf is important, it has been successful to blend a rich mixture of seed (about 10 times the normal application rate, or about 0.5 to 1 kg/cubic m 1 to 2 pounds per cubic yard into the topsoil prior to placing. Hanging geogrids and retaining wall geogrids, now exist to facilitate vegetation, which may be useful in establishing vegetation. Watering during establishment is more critical than typical turf due to the heat absorption of the concrete blocks and capillary break of the geotextile.

****

Fill the voids of the articulating concrete block mats with topsoil, except fill voids below the normal water level with aggregate void filler. Complete all cable ties and anchoring prior to filling voids. Complete seeding and maintenance in accordance with Section 32 92 19 SEEDING.

3.7 PROTECTION OF WORK

Protect work against damage from subsequent operations. Remove and replace displaced or broken blocks to conform to all requirements of this section. Do not incorporate damaged material. Do not allow equipment on the ACB that could crack, cause abrasion, or otherwise damage the blocks. Do not operate vehicles directly on geotextile, except that rubber tired vehicles may operate directly on short reaches of geotextile that meets or exceeds AASHTO M 288 survivability requirements for Class 1 geotextile, if there is no rutting, if the vehicle access is necessary to accomplish the work, and if the Contracting Officer observes the operation and approves. Do not operate vehicles on the ACB until (during or after) placement of void filler. Restrict vehicle traffic on the ACB to light weight rubber tired vehicles, and where intermittent access is necessary to accomplish the work. Do not establish routine haul routes on the ACB. These allowances do not waive the Contractor's obligation to maintain the installation until acceptance, and verify that vehicle access does not crack, or in any way damage, the ACB.

3.8 QUALITY CONTROL TESTING

****

NOTE: The manufacturer should have completed similar testing for it's own QC. The following testing is suggested as an acceptance check on a schedule typical for QA. The suggested frequency is on the order of 0.5 percent of construction cost.

****

Perform the following testing independent of the manufacturing process, by an agency other than the manufacturer. Sample and test the ACB blocks for compressive strength, water absorption and unit weight. The sample frequency must be 3 specimens for each 2500 m^2 3000 SY. Test methods are consistent with those specified in PART 2 PRODUCTS.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-35 31 19.40 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-35 31 19 (November 2023)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 31 19.40

STONE REVETMENTS

11/24

ATTACHMENTS:

sources listed at the end of this section

GRADATION TEST DATA SHEET

gradation curve

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-35 31 19.40 (November 2024)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 35 31 19.40

STONE REVETMENTS

11/24

****

NOTE: This guide specification covers the requirements for stone protection, including foundation preparation, bedding layers and filters, for the slopes and bottom of channels, ditches, structures, lock approaches, etc.; constructing trenchfill revetment, bank paving, and outlet drains; stone revetment, stonefill dikes, stoneroots, and junctions; constructing stone capouts and revetment reinforcing along the river; revetment repairs; shoreline/coastal protection. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Field adjustments may be made at the direction of the Contracting Officer's Representative (COR/ACO) to the location of stone placement that do not alter the design intent or pay quantities. Such field adjustments should be documented as to the justification, location, and documentation of the adjustments should be included in the permanent Contract Documentation and As-Built drawings. The Contracting Officer and Designer of Record should be notified as soon as practicable.

Comments, suggestions and recommended changes for this guide specification are welcome and should be

submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: The EMs and ETLs referenced in this guide specification can be found on the Internet at http://www.usace.army.mil.inet/usace-docs.

To clarify the difference between Stone Protection, Channel Protection, and Shoreline Protection, the following definitions are provided. Stone Protection is defined as a system which includes a layer of bedding material or layers of filter material beneath a layer or layers of riprap. Stone protection is placed around structures in slack water or within a dewatered site. Stone protection may also be used to protect channel banks when it is placed in the dry or in slack water. Riprap is defined as a material having a gradation band similar to those specified in EM 1110-2-1601, Chapter 3. Channel Protection is stone placed in a current as revetment, dikes, or slope paving without the use of a separate layer of bedding or filter material. In this type of environment, bedding sand or geotextiles and materials with gradation bands with a top size of 150 mm 6 inches will not stay where placed. Shoreline Protection is defined as a system of bedding or filter materials and stone used to protect coastlines of lakes and oceans and for harbor protection.

Grouted riprap should only be used when the quantity of larger stone on a project is very small and in a noncritical area. Also, grouted riprap should be considered only when minor settlement is expected in the foundation, potential of undermining is very low, and the density of the fill material is at a minimum of 95 percent Standard Proctor. Additional information provided in ETL 1110-2-334.

EM 1110-2-2302, Construction with Large Stone, presents criteria and gives guidance for selection, evaluation, and use of large-stone materials in construction. This document also references other EM's that have additional related guidance for the protection design. One additional reference not listed is EM 1110-2-1614, Design of Coastal Revetments, Seawalls, and Bulkheads. However, the quality criteria specified in this document was based upon a limited review of criteria being used by Corps. Quality criteria that is specified by a District should be that which has been selected to be used on its projects or criteria specified by a Division to be used by the District to meet the durability requirements for the project being constructed.

"Riprap Quality Criteria in Standard Specification and Engineering and Guidance", Rock for Erosion Control, ASTM STP 1177; and TR-GL-81-8, Evaluation of Quality and Performance of Stone as Riprap or Armor", both support the need to perform freeze-thaw testing by COE CRD-C 144 instead of ASTM procedures. Also, both indicate that soundness tests and L.A. Abrasion tests are of limited use when evaluating Riprap and Armor Stone.

NOTE: The designation of types of materials (sand, filter, stone, riprap, bedding, etc. should be consistent with the nomenclature of the project and entities involved - and defined within PART 1 and/or PART 2 of the Specification. Such designations as "Type 1, Type A, must be well-defined and consistently used in order to avoid confusion and to limit the apparent numbers of different materials required by the Contract. The designations between the definitions in the Technical Specification, the Drawings and the Bid Schedule MUST BE CONSISTENT.
****

1.1 UNIT PRICES

****
NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
****

1.1.1 [Bedding][and][Filter] Layer(s)

1.1.1.1 Payment

Payment for gravel, crushed stone, and sand placed for bedding and/or filter material will be made at the applicable contract unit prices for [Sand "[_____]",][and][Gravel "[_____]",][and][Filter Stone,] [Bedding Stone]. Price(s) and payment(s) include all costs of furnishing, hauling, placing and maintaining the bedding and/or filter material until placement of the riprap cover is completed and accepted. Geotextiles used as filters will be paid for in accordance with provisions of Section 01 20 00 PRICE AND PAYMENT PROCEDURES. Preparation of the base will not be paid for separately and all costs incidental thereto will be included in contract prices for other items for which payment will be made. No payment will be made for excess thickness of bedding and/or filter material, nor for material required to replace subgrade material lost by rainwash, wind erosion, overexcavation or otherwise.

1.1.1.2 Measurement

****
NOTE: Alternative 1.
****

[[Gravel,][crushed stone,][and sand] placed for bedding and/or filter layers will be measured for payment by the ton (metric) ton. Quantities will be computed to the nearest whole ton. Gravel, crushed stone, and sand will be measured for payment, in the presence of the Contracting Officer, by weighing on approved, accurately calibrated scales furnished by and at the expense of the Contractor.[The scales must be capable of printing a weight ticket including time, date, truck number, and weight.] Weight certificates furnished by a public weighmaster will be acceptable.] Submit Weigh Scale Certification and Certified Weight Scale Tickets, by a copy of the certification from the regulation agency, attesting to the scale's accuracy and a copy of each certified weight scale ticket after [_____] working day(s) after weighing.

****

NOTE: Alternate 2.

****

[[Gravel,][crushed stone,][and sand] placed for bedding and/or filter layers will be measured for payment as the volume determined by multiplying the area[, as measured in the field,] of the surface on which the gravel, crushed stone, or sand is placed, by the thickness measured perpendicular to the surface of the gravel, crushed stone, or sand as dimensioned on the contract drawings.] Geotextiles used as filters will be measured in accordance with provisions of Section 01 20 00 PRICE AND PAYMENT PROCEDURES. Preparation of the base will not be measured for payment.

1.1.1.3 Unit of Measure

Unit of measure: [ton (metric)][cubic meter][ton][cubic yard].

1.1.2 [Riprap] [[Manufactured] Derrick Stone] [Capstone] [Graded Stone] [Stone] [Bedding/Mattress Stone] [Splash/Fill Stone] [Armor/Cover Stone] [Core/Underlayer/Scour Stone]

[Due to the variable nature of broken concrete or construction debris, it is prohibited for stone channel, shoreline, or coastal protection.][_____]

1.1.2.1 Payment

****

NOTE: Select the first optional paragraph for Alternate 1; select the second optional paragraph for Alternate 2a; select the last optional paragraph for Alternate 2b.

****

[Payment for [riprap] [and] [stone] satisfactorily placed will be made at the applicable contract unit price for [M[_____] R[_____] Riprap,] [Grouted M[_____] R[_____] Riprap,] [[Manufactured] Derrick Stone,] [and] [Capstone,] [Stone,] [Bedding/Mattress Stone,] [Splash/Fill Stone,] [Armor/Cover Stone,] [Core/Underlayer/Scour Stone]. Price(s) and payment(s) constitute full compensation for furnishing, hauling, handling, placing, and maintaining the [riprap][stone] until final acceptance by the Government. [No separate payment will be made for the stockpiling of [riprap] [and] [stone], and include all cost in connection with stockpiling in the Contract Unit Price for [riprap] [and] [stone].]]

[Payment for [riprap] [and] [stone] satisfactorily placed will be made at the applicable contract unit price for [M[_____] R[_____] Riprap,] [Grouted M[_____] R[_____] Riprap,] [[Manufactured] Derrick Stone,] [Capstone,]

[Stone,] [Bedding/Mattress Stone,] [Splash/Fill Stone,] [Armor/Cover Stone,] [Core/Underlayer/Scour Stone]. Price(s) and payment(s) constitute full compensation for furnishing all plant, labor, materials and equipment and constructing the stone protection in the work as specified. [No separate payment will be made for the stockpiling of [riprap] [and] [stone], and include all cost in connection with stockpiling in the contract unit price for [riprap] [and] [stone].]]

Payment for stone satisfactorily placed in constructing the [trenchfill revetment,] [stonefill dikes,] [stonefill revetments and junctions,] [excluding trenchfill revetments, wrap-around,] [dike capouts,] [reinforcements,] [bank paving,] and [outlet drains] will be made at the contract unit price for Graded Stone ["A"] ["B"] [and/or] ["C"], [57][_____]-kg [125][_____]-pound stone. Price(s) and payment(s) constitute full compensation for furnishing all plant, labor, stone, and performing all work necessary in placing the stone in constructing the trenchfill revetment, bank paving, and drainage structures as specified herein or shown on the drawings. Full payment for stone will not be permitted until trenchfill bank paving has been completed in a satisfactory manner. Twenty (20) percent of the payment for stone will be retained until bank paving has been completed in a satisfactory manner.

1.1.2.2 Measurement

****
NOTE: Alternative 1.
****

[[Riprap][Stone] will be measured for payment by the ton (metric) ton. Quantities will be computed to the nearest whole ton.] [[Riprap][Stone] will be measured for payment, in the presence of the Contracting Officer, by weighing on approved, accurately calibrated scales furnished by and at the expense of the Contractor.][The scales must be capable of printing a weight ticket including time, date, truck number, and weight.][Weight certificates furnished by a public weighmaster will be acceptable.]

****
NOTE: Alternative 2.
****

[[Riprap][and][Stone] will be measured for payment by the ton (metric) ton as determined by [barge][vessel] displacement, [certified railroad weights,] where direct placement into structure(s) is practicable, or by weighing by the truckload on approved scales meeting the requirements of paragraph TRUCKLOAD.]

a. Truckload. Weigh each truck load to the nearest 0.10 ton (metric) 0.1 ton and the final quantity rounded to the nearest whole ton. Weigh [Riprap] [and] [Stone] for payment by weighing on approved scales before being placed in the work. Provide scales of sufficient length to permit simultaneous weighing of all axle loads and with an accuracy within 0.2 percent throughout the range of the scales. Ensure the scale's accuracy conforms to the applicable requirements of NIST HB 44 and is certified [by an acceptable scales company representative] [by an inspector of the State Inspection Bureau charged with scales inspection within the state in which the project is located] prior to weighing any [riprap] [and] [stone].[Locate the scales at the site of work.][Ensure the scales are capable of printing a weight ticket including time, date, truck number, and weight.][If commercial scales are readily available in close proximity (within [_____][16] km [_____][10] miles) of site of work, they are to be used with the approval of the Contracting Officer and documentation certifying that the scales meet the requirements of the specification are to be provided.][Furnish the scales and weigh the [riprap] [and] [stone] in the presence of the Contracting Officer,[who will read and record the weights thereof][who will certify the correctness thereof]].[The Contracting Officer may elect to accept certified [railroad weights or] weight certificates furnished by a public weighmaster in lieu of scale weights at the jobsite.][Quarry weights will not be accepted.] Scales will be checked and certified before hauling [riprap] [and] [stone] [and after each [50 000][_____] tons (metric) [50,000][_____] tons increment of [riprap][and][stone] weighed under this contract].

b. [Barge][or Vessel] Load

(1) If delivered by [barge][or vessel], [riprap][and][stone] will be measured for payment by the Contracting Officer by weight determined by [barge][vessel] displacement. Furnish the Contracting Officer a [barge][vessel] displacement table not less than 10 work days prior to unloading the [riprap][and][stone] from any [barge][vessel]. Submit each table showing the name and/or number of the [barge][vessel] owner, the name of the fabricator, and the certification and date of certification of the person or firm preparing the table. Furnish with the [barge][vessel] displacement tables a drawing or sketch of each [barge][vessel], dimensioned in sufficient detail to permit checking of the tables. Show, as a minimum, the length, width, depth of the [barge][vessel], and dimensions of the rake or rakes. A person or firm customarily performing this function other than the Contractor must certify the accuracy of each such table. Submit each table containing, in parallel columns, the freeboard of the [barge][vessel] in meters feet and tenths from zero to the full depth of the [barge][vessel] and the corresponding gross displacement to the nearest ton. Mark each [barge][vessel] suitably with [two][three] displacement gaging locations on each side near each end of the [barge][vessel][and two amidships on opposite sides]. Mark each gaging location by a line perpendicular to the edge of the [barge][vessel], 100 mm 4 inches wide and 300 mm 1 foot long, on both the deck and side of the [barge][vessel][and two amid ship on opposite sides]. Provide [barges][vessels] with rakes that have the displacement gaging lines placed at each corner of the box section between the rakes. If a [barge][vessel] has a box end or ends, place the gaging locations approximately 1200 mm 4 feet from the box end(s). The freeboard will be measured at the [four][six] gaging locations and the displacement determined by the use of "STANDARD [BARGE][VESSEL] TABLES" from the average of these measurements. The displacement will be determined before and after being unloaded and the difference between these values is the quantity delivered. Submit the Gaging Table Data, stone hauling vessel, gaging tables[and a copy of the data and calculations used for the preparation of the tables]. [Load [barges][vessels] so that the readings taken at the gaging locations do not vary more than 450 mm 1.5 feet port to starboard fore and aft and do not vary more than 150 mm 0.5 feet port to starboard. If such is not the case, trim the carrier by shifting the stone until this limit is reached, before the measurement will be accepted.][Determine the draft from the average of all six readings weighting the readings

of the middle gage at double those of the end gages. (G_1 + G_2 + 2xG_3 + 2xG_4 + G_5 + G_6) divided by 8 = average draft.][Ensure all carriers used in transporting stone are free of leaks such as would render accurate gauging difficult. Provide facilities for inspecting the hold of each carrier to determine whether leakage is occurring. Provide each carrier with adequate pumping facilities, and if water is found to be accumulating in the hold, pump the carrier dry before each gaging, both before and after unloading.] [Lightening by pumping or by transfer of crew or supplies will not be permitted while stone is being transferred.] [Leave rejected [riprap][stone] [_____] and unacceptable material aboard the [barge][vessel] until after the final readings are taken.]

(2) [If [barge][vessel] tables are furnished for fresh water and if it is believed that [barge][vessel] displacement measurements made within the contract limits of the work are being taken in water that has salinity, the Contractor has the option of obtaining water samples and determining densities or unit weights of these samples. Take these water samples in accordance with ASTM D3370 (Practice A - Grab Samples) at depths of 1200 and 2400 mm 4 and 8 feet in the area where measurements are made. Perform water sampling when the [barges][vessels] are measured for quantities, both when fully loaded and when empty. Take water samples, as witnessed by the Contracting Officer, with the use of "Polypro" 2000 ml water sampler, or equal. Determine densities as specified in ASTM D1429 (Method D-Hydrometer Method). Perform testing for the Contractor by a [certified] [validated] testing laboratory, and ensure test results are certified by the laboratory. After review and approval of the test results by the Contracting Officer, the average of the densities obtained at 1200 and 2400 mm 4 and 8 feet will be used as the suitable salt water conversion factor. In all calculations, the unit weight of 1000 kN/m^3 62.4 pounds per cubic foot will be used for fresh water.]

c. Stockpiled [Riprap][Stone] [_____]. If the Contractor elects to stockpile [riprap][stone] [_____] [on the worksite] [or] [offsite], weigh the [riprap][stone] [_____] immediately before placement by [either][the] method described above. [[Riprap][Stone] [_____] placed in temporary storage on the worksite as specified in paragraph WORKSITE STOCKPILE will not be required to be re-weighed prior to placement.] [If the [barge][vessel] displacement method is elected, a minimum of [one-third the total maximum displacement of the [barge][vessel]] [_____][500] tons (metric) [_____][500] tons of [Riprap][Stone] [_____] is required on each [barge][vessel].]

(1) Determination of Excess Stone. All stone outside the limits and tolerances of the cross sections of the structure, except variations so minor as not to be measurable, will be deducted from the quantity of new stone for which payment is to be made. Weight of excess stone will be determined from the cross sections obtained by the method provided for in paragraph FINAL SURVEYS, on the basis that the cubic meters feet of volume (including voids) for each type of stone, as listed in the Table in paragraph FACTORS USED FOR CONVERTING IN PLACE VOLUME TO WEIGHT, is equal to one ton (metric) or 1000 kg one ton or 2,000 pounds for the bulk specific gravity and percentage of voids shown. If the bulk specific gravity of the stone furnished or the percentage of voids is other than as listed below, recompute the cubic meters feet of

volume equaling 1000 kg 2,000 pounds as described in paragraph REVISIONS OF BIDDING SCHEDULE QUANTITIES. Should any excess stone be disclosed above the tolerance line as defined in paragraph CONSTRUCTION TOLERANCES, its volume will be computed by the average end area method, based upon the cross section in the following manner. The average end area of excess stone above the tolerance line for two (2) successive cross sections, multiplied by the distance between the cross sections will be accepted as the volume. [The Contractor will not be required to remove such excess stone and deductions for the weights thereof will be made from contract payments for new stone.]In addition to the above, deduct stone, which has been delivered to the site and has been lost or wasted or otherwise not properly incorporated into the final required work, from the quantity for which payment is to be made.

(2) Final Surveys. Perform survey work and measurements required for determination of excess volume computations for stone materials in the presence of the Contracting Officer. Notify the Contracting Officer not less than 3 days in advance of each survey.[In the event of unavailability of the Contracting Officer, perform the survey and certify to the Contracting Officer that it complies with the specifications.] Take cross section surveys perpendicular to the axis of the structures. Take elevations and soundings on lines [8][_____] m [25][_____] feet apart measuring along the structure reference line, with the readings at 1.5-meter 5-foot intervals and at breaks in the grade along the line. Other survey intervals and readings may be used if deemed appropriate or advisable by the Government's on-site representative. Additional cross sections, elevations, and soundings may be taken if determined necessary by the Government's on-site representative. Determination of quantities will be made by the Government's on-site representative and having once been made, will not reopen, except on evidence of collusion, fraud or obvious error. Prior to performing any work under this Section, coordinate all operations with the Government's on-site representative so that excess volume surveys will be made at the appropriate time. The surveys made under paragraph CHECK SURVEYS may be used when deemed appropriate by the Government's on-site representative, as part of the surveys required herein. Base stone quantity computations entirely upon weights of new stone as determined from carrier displacement or certified scale weight tickets. [Existing stone placed in lieu of new stone from off-site sources is excluded from measurement and payment.]

1.1.2.3 Unit of Measure

Unit of measure: [ton (metric)][cubic meter] [ton][cubic yard].

1.1.3 Concrete Grout for Grouted Stone Protection

1.1.3.1 Payment

Payment will be made for cost associated with concrete grout for grouted stone protection, which includes full compensation for furnishing all plant, labor, material, equipment and other items necessary and incidental to the completion of the work.

1.1.3.2 Measurement

Concrete grout for grouted stone protection will be measured for payment based upon the volume determined from the calculated batch volume and the number of mixed batches delivered to the site and acceptably placed in the work.

1.1.3.3 Unit of Measure

Unit of Measure: cubic meter cubic yard.

1.1.4 Bedding Sand

1.1.4.1 Payment

Payment for bedding sand will be made at the contract unit price for "Bedding Sand" and constitute full compensation for material and placement of bedding sand in constructing drainage structures as specified herein.

1.1.4.2 Measurement

Measure bedding sand for payment by the ton (metric) ton of sand satisfactorily in-place in accordance with the requirements for stone measurement in paragraph STONE.

1.1.4.3 Unit of Measure

Unit of measure: ton (metric) ton.

1.1.5 Revetment Repairs

1.1.5.1 Earthwork, Small Repairs

When less than 8000 cubic meters 10,000 cubic yards of earthwork is specified, consider the earthwork as Earthwork, Small Repairs.

a. Payment will be made for costs associated with grading and excavation, which includes furnishing all equipment, labor and materials, and performing all clearing, except range clearing, drift removal and disposal of debris; grading and excavation; disposal of material from grading, whether or not used for fill; dressing; and all other operations incidental thereto.

b. Earthwork, Small Repairs will be measured for payment based upon on-site surveys, taken under the direction of the Government Representative, of the required grading or excavation areas prior to commencement and on-site surveys taken after completion of the work. All quantities removed will be determined from these surveys computed to the nearest cubic meter yard.

c. Unit of measure: cubic meter yard.

1.1.5.2 Earthwork, Large Repairs

When 8000 cubic meters 10,000 cubic yards or more of earthwork is specified, consider the earthwork as Earthwork, Large Repairs.

a. Payment will be made for costs associated with grading and excavation, which includes furnishing all equipment, labor and materials, and performing all clearing, except range clearing, drift removal and disposal of debris; grading and excavation; disposal of material from grading, whether or not used for fill; dressing; and all other operations incidental thereto.

b. Earthwork, Large Repairs will be measured for payment based upon on-site surveys, taken under the direction of the Government Representative, of the required grading or excavation areas prior to commencement and after completion of the work. All quantities removed will be determined from these surveys computed to the nearest cubic meter yard.

c. Unit of measure: cubic meter yard.

1.1.5.3 Breaking Out Pavement

a. Payment will be made for costs associated with breaking out asphalt and/or concrete pavement, which includes furnishing all material, equipment and labor for breaking out pavement, breaking concrete or asphalt into the required sizes, and using the broken pavement as fill where required, disposing of any excess material, and performing all work incidental thereto. Broken concrete or asphalt is prohibited as part of the designed structure. No payment will be made for breakout in those areas where only restoration or dressing of subgrade is necessary.

b. Breaking Out Pavement will be measured for payment based upon the number of square meters feet broken out, computed to the nearest 1/10 square meter 1/100 square foot.

c. Unit of measure: square meter feet.

1.1.5.4 Bedding Stone

a. Payment will be made for costs associated with Bedding Stone satisfactorily placed, which includes furnishing all material, equipment, and labor; placing the stone, including overbank paving and stone fills; dressing of subgrade; and performing other work incidental thereto, except that stone used in overbank paving, overbank stone spur, or stone landward of an obstruction will be paid for under pay item "Stone Placement Premium".

b. Bedding Stone will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.5.5 [[57][_____]-kg [125][_____]-Pound Stone] [[_____] Riprap]

a. [Payment will be made for costs associated with [57][_____]-kg [125][_____]-Pound Stone] [[_____] Riprap] satisfactorily placed, which includes furnishing all material, equipment, and labor; placing the stone, including overbank paving and stone fills; dressing of subgrade; and performing other work incidental thereto, except that stone used in overbank paving, overbank stone spur, or stone landward of an obstruction will be paid for under pay item "Stone Placement Premium".

b. [[57][_____]-kg [125] [_____]-Pound stone] [[_____] Riprap] will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.5.6 [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Small Repairs

a. Payment will be made for costs associated with [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Small Repairs, satisfactorily placed, which includes furnishing all material, equipment, and labor; placing the stone, including overbank paving and stone fills; dressing of subgrade; and performing other work incidental thereto, except that stone used in overbank paving, overbank stone spur, or stone landward of an obstruction will be paid for under pay item "Stone Placement Premium".

b. [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Small Repairs, will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.5.7 [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Large Repairs

a. Payment will be made for costs associated with [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Large Repairs, satisfactorily placed, which includes furnishing all material, equipment, and labor; placing the stone, including overbank paving and stone fills; dressing of subgrade; and performing other work incidental thereto, except that stone used in overbank paving, overbank stone spur, or stone landward of an obstruction will be paid for under pay item "Stone Placement Premium".

b. [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Large Repairs, will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.5.8 Stone Placement Premium

a. A premium payment will be made for costs associated with [Crushed Stone][[57][_____]-kg [125][_____]-Pound] [Riprap][Stone][Graded Stone A, Small Repairs][Graded Stone A, Large Repairs] satisfactorily placed in overbank paving, overbank stone spur, or stone landward of an obstruction satisfactorily constructed or repaired, which includes furnishing all material, equipment, and labor; preparing the subgrade; hauling or rehandling stone; shaping spurs to the lines and grades specified; and performing other work incidental thereto.

b. Stone Placement Premium will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.6 Reworking and Utilizing Existing Stone Materials

1.1.6.1 Payment

Payment for reworking existing stone materials and utilizing existing stone in lieu of required materials from off-site sources will be paid for separately from construction utilizing materials obtained from off-site sources. [Specifications pertaining to construction with existing onsite materials are included in Section 31 00 00 EARTHWORK for Site Preparation.]

1.1.6.2 Measurement

Reworking and Utilizing Existing Stone Materials will be measured for payment based upon [_____][[cubic][square] meters [cubic yards][square feet] of surface area of existing protection].

1.1.6.3 Unit of Measure

Unit of measure: [ton (metric)][square meter] [ton][square foot].

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 305R	(2020) Guide to Hot Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates

ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C476	(2023) Standard Specification for Grout for Masonry
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C685/C685M	(2024) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling

	Aggregates
ASTM D1429	(2013) Specific Gravity of Water and Brine
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3370	(2018) Standard Practices for Sampling Water from Flowing Process Streams
ASTM D3740	(2019) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4992	(2014; E 2015) Evaluation of Rock to be Used for Erosion Control
ASTM D5312/D5312M	(2012; R 2013) Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions
ASTM D5313/D5313M	(2012; R 2013) Evaluation of Durability of Rock for Erosion Control Under Wetting and Drying Conditions
ASTM D5519	(2015) Particle Size Analysis of Natural and Man-Made Riprap Materials

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 144	(1992) Standard Test Method for Resistance of Rock to Freezing and Thawing
COE CRD-C 148	(1969) Method of Testing Stone for Expansive Breakdown on Soaking in Ethylene Glycol
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
EM 1110-2-1601	(1991; 1994 Change 1) Engineering and Design -- Hydraulic Design of Flood Control Channels
EM 1110-2-1906	(1970; 1986 Change 2) Engineering and Design -- Laboratory Soils Testing

1.3 DEFINITIONS

1.3.1 Bank Stabilization

This paragraph explains certain terminology which is common to construction of bank stabilization work on the [_____] and which may not be self explanatory in the subsequent applicable provisions of the technical specifications and on the drawings.

1.3.1.1 Revetments

The term "revetment" applies to various types of stabilization structures that are constructed along the river approximately parallel to the current. The revetments are constructed of stone or piling.

1.3.1.2 Dikes

The term "dike" applies to the types of stabilization structures that are constructed along the river at an angle to the current. The dikes are constructed of stone or piling.

1.3.2 Standard Drawings

Details of various types of structures in general use on the [_____] are shown on standard drawings forming a part of these specifications.

1.3.3 Stone Protection

Stone Protection is defined as a system which includes a layer of bedding material or layers of filter material beneath a layer or layers of riprap. Stone protection is placed around structures in slack water or within a dewatered site. Stone protection may also be used to protect channel banks when it is placed in the dry or in slack water.

1.3.4 Riprap

Riprap is defined as a material having a gradation band similar to those specified in EM 1110-2-1601, Chapter 3, uniform graded material. Riprap is normally produced by mechanical methods, with a jaw crusher and grizzly after the stone has been mined by blasting in a quarry. Riprap gradations have a maximum top size of 3.5 tons.

1.3.5 Graded Stone

Graded Stone is defined as material with gradations that are produced by the mining technique and minimal additional processing other than the use of a skeleton bucket or a bar grizzly. The gradation band have more fines than riprap and have gradations with top size up to 3.5 tons and could be classified as being well graded.

1.3.6 Channel Protection

Channel protection is stone placed in a current as revetment, dikes, or slope paving without the use of a separate layer of bedding or filter material. In this type of environment, bedding sand or geotextiles and materials with gradation bands with a top size of 150 mm (6 inches) will not stay where placed.

1.3.7 Shoreline Protection

Shoreline Protection is defined as a system of bedding or filter materials and stone used to protect coastlines of lakes and oceans and for harbor protection.

1.4 SYSTEM DESCRIPTION

1.4.1 Factors Used for Converting In-Place Volume to Weights

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NOTE: Insert values from the design report in the following table.

****

The following factors were used in converting the in-place volume to the quantities shown in the BIDDING SCHEDULE.

BULK STONE MATERIAL	SPECIFIC GRAVITY (SSD)	PERCENT VOIDS	CUBIC METERSFEET OF VOLUME PER METRIC TON INCLUDING COMPENSATION VOIDS (For Excess Quantity Calculations)
Mattress	[_____]	[_____]	[_____]
Bedding	[_____]	[_____]	[_____]
Core	[_____]	[_____]	[_____]
Underlayer	[_____]	[_____]	[_____]
Cover	[_____]	[_____]	[_____]
Armor	[_____]	[_____]	[_____]
Riprap	[_____]	[_____]	[_____]
Scour	[_____]	[_____]	[_____]
Fill	[_____]	[_____]	[_____]

1.4.1.1 Revision of Bidding Schedule Quantities

The estimated quantities of stone listed in the BIDDING SCHEDULE were computed on the basis of stone having a percentage of voids and a bulk specific gravity (saturated surface dry (SSD) basis) as shown in the above table based on water having a unit weight of 1000 kg per cubic meter 62.4 pounds per cubic foot. When the bulk specific gravity (SSD) of the stone to be used in the work is other than that shown in the above table, the estimated quantities will be revised by multiplying them by the fraction which results when the bulk specific gravity (SSD) of the stone furnished is divided by the value shown in the above table for each respective stone gradation. Revision for the percentage of voids will likewise be made. The Contracting Officer will issue a modification to the contract in accordance with FAR 52.243-4 Changes, to adjust the estimated quantities in the BIDDING SCHEDULE. The revised quantities will then be the quantities from which the allowable fifteen percent (15 percent) variation in estimated quantity, for payment purposes, will be determined as defined in FAR 52.211-18 Variation in Estimated Quantity.

1.4.1.2 Re-revision of Estimated Quantities

If during the progress of the work it is determined that the delivered stone actually placed has a percentage of voids or a bulk specific gravity range different from that on which the BIDDING SCHEDULE is based, the BIDDING SCHEDULE will be further revised in accordance with paragraph REVISION OF BIDDING SCHEDULE QUANTITIES.

1.4.2 Bulk Specific Gravity of Stone and Redesign

If the Contractor, after award of the contract, requests approval of stone from a source(s) which has a range of bulk specific gravity (SSD), whose limits are lower or higher than the specified design range of [2.5 to 2.9] [_____] as specified in paragraph MATERIAL QUALITY, consideration will be given to revising the project design through modification of the design range under the following conditions:

a. The modification of the specified design range will result in a savings to the Government. Such savings are not subject to FAR 48 Value Engineering.

b. Only one (1) such proposal for modification will be allowed. In addition, do not extend the required completion time more than [thirty (30] [_____] calendar days as a result of redesign for any reason, including acts of the Government.

c. The modified design range of bulk specific gravity (SSD) to be used must not have a lower limit of less than [2.30] [_____] nor higher than [3.50] [_____].

d. The stone sections of the required structure are to be redesigned by the Government. Such redesign will be based upon the Contractor's proposed modifications to the specified design range of bulk specific gravity (SSD) and will include any required revisions to allowable tolerances. Only one such redesign will be made. A charge of [$5,000] [$_____] will be assessed the Contractor whether the redesign is used or not.

    (1) The above redesign will be made upon written request from the Contractor. State the proposed modified design range of bulk specific gravity (SSD). With the request, submit records of laboratory tests performed on the proposed stone source(s) indicating the range of bulk specific gravity (SSD) of the stone source(s). Ensure the laboratory tests are performed by a Government validated commercial laboratory.

    (2) The Government is allowed a period of [twenty-one (21)] [_____] calendar days after receipt of the request to make the redesign. The redesign will be made based upon the lower limit of the proposed modified design range of bulk specific gravity (SSD) furnished.

    (3) Upon completion, redesign will be furnished to the Contractor, including revised estimated quantities for the BIDDING SCHEDULE, based upon the average bulk specific gravity (SSD) of the proposed

modified design.

(4) Upon receipt of the redesign, make a formal proposal to modify the allowable range and to perform the work in accordance with the redesign, within fifteen (15) calendar days after receipt of the Government's redesign; if the Contractor proposes to utilize stone having a specific gravity outside of the specific design range, and as a result thereof, the Government provides the Contractor with a redesign. Include a statement of the direct savings to the Government and a tabulation in the form of a revised BIDDING SCHEDULE showing unchanged unit prices for the revised quantities.

e. Submit any proposal to modify the specified design range within fifteen (15) calendar days after receipt of the Government's redesign and include a statement as to the savings which will result from the modification. If a formal proposal is not submitted within the time limit, perform the work in accordance with the specified design, in which case use of stone having a bulk specific gravity (SSD) less than the specified design range is not allowed.

f. The statement of savings must be in the form of a proposed revised BIDDING SCHEDULE showing unchanged unit prices for the revised quantities.

g. If the Contractor elects to perform the work in accordance with the redesign, the estimated quantities to be shown in the BIDDING SCHEDULE will be the quantities derived from the Government's redesign. See the above paragraph REVISION OF BIDDING SCHEDULE QUANTITIES.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Riprap; G, [_____]

Filter Material; G, [_____]

Bedding Material; G, [_____]

Ready-Mixed Concrete Grout

Conveying and Placing

Admixtures

Curing Materials

Batching and Mixing Equipment

Gaging Table Data

[Manufactured]Derrick Stone; G, [_____]

Concrete Grout Mixture Proportions; G, [_____]

Bulk Specific Gravity of Stone and Redesign; G, [_____]

SD-04 Samples

Stone; G, [_____]

SD-06 Test Reports

Gradation Test

Evaluation Testing of Stone

Bedding Material

Bulk Specific Gravity

SD-07 Certificates

Stone

Bedding Material

Filter Material

Laboratory; G, [_____]

Weigh Scale Certification

Certified Weight Scale Tickets

1.6 QUALITY ASSURANCE

1.6.1 Stone

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NOTE: For contracts having a short duration or awarded for emergency repair, there will be insufficient time to allow a Contractor to propose an unlisted source and have it evaluated; therefore, the bracketed sentences in paragraph STONE, subparagraphs SOURCES and EVALUATION TESTING, should be deleted.

****

Submit suitable stone samples prior to delivery of any such material to the worksite if stone is not from one of the stone sources listed at the end of this section.

1.6.1.1 General

All stone must be durable material as approved by the Contracting Officer. [Selected stone from the required excavation may be used if it satisfies all requirements as to quality and dimensions.] In case an unlisted source is to be used, show that an adequate quantity of material is available and provide quality test data.[Unlisted sources necessitate an evaluation by the Contracting Officer to determine their acceptability based upon a combination of laboratory test results, prior use in projects of a similar size and scope, and a site inspection by a Government geologist.] Provide stone of a suitable quality to ensure permanence in the structure and in the climate in which it is to be used. Ensure stone is free from cracks, blast fractures, bedding, seams and other defects or discontinuities that would tend to increase its deterioration from natural causes.[Inspect for discontinuities, cracks, fractures, seams and defects by visual examination. If, by visual examination, it is determined that [10][20] percent or more of the stone produced contains significant hairline cracks, then reject all stone produced by the means and measures which caused the fractures.] A hairline crack that is defined as being detrimental must have a minimum width of 0.1 mm 4 mil and continuous for one-third the dimension of at least two sides of the stone. [Provide stone that is clean and reasonably free from soil, quarry fines, and contains no refuse.] [Provide stone that is clean and adequately free from all foreign matter. Remove any foreign material adhering to or combined with the stone as a result of stockpiling prior to placement.]

1.6.1.2 Sources

****

NOTE: A special test that could be used to evaluate the abrasion resistance of the riprap is COE CRD-C 63, Abrasion-Erosion Resistance of Concrete. Assume that an Abrasion-Erosion Loss, percent by Mass of

approximately 4 is equal to an L.A. Abrasion of 20 percent for a chert aggregate, and 8 is equal to an L.A. Abrasion of 20 percent for limestone.

The number of work days specified in this paragraph are based on the assumption that to tentatively approve the use of a source under a single contract requires data for unit weight, absorption, and petrographic analysis of the stone. A minimum of 80 work days would be required to have available data from the freeze and thawing test. Arrangements need to be made with the testing laboratory when notice is given to evaluate source not after samples are collected.

On the form attached at the end of this section, the Specifier must insert a listing of POTENTIALLY acceptable sources, giving at the minimum quarry locations, addresses, and telephone numbers applicable for the contract or a more detailed list as presented in EM 1110-2-2302, Figure 4-2.

****

[Stone approval is based on lab testing, in-service performance of stone in this or other projects from this source, quarry inspection and a demonstration stockpile on site at the quarry. Provide Lab testing results obtained not more than 5 years prior to date of Contract Award to ensure the data are representative and that the quarry has not moved into a section of substantially different material. Each source approval request is evaluated on a case by case basis. Evaluation requires submission of up-to-date lab testing results with every source approval. Approval testing will be at the contractor or quarry's expense. Test results will be accepted from a [certified] [validated]independent laboratory in lieu of testing at the government's laboratory at the discretion of the Contracting Officer.]

If approved, furnish stone from any of the sources listed at the end of this section or from any other source designated by the Contractor and accepted by the Contracting Officer, subject to the conditions herein stated.[Non-listed sources are prohibited.][If the Contractor proposes to furnish stone from a source not currently listed at the end of this section, the Government will conduct a quarry investigation and evaluate the quality test data provided by the Contractor to determine whether acceptable quantity and quality stone can be produced from the proposed source.] Satisfactory service records on other similar work may be considered by the Contracting Officer in the investigation. In order for stone to be acceptable on the basis of service records, stone of a similar quantity and size must have been placed in a similar thickness and exposed to weathering under similar conditions as are anticipated for this contract, and must have satisfactorily withstood such weathering for a minimum of [5][20] years. If no such records are available, the Government may choose to have tests conducted [at the Contractor's expense] [at the Government's expense] to assure the acceptability of the stone.[In addition to an acceptable 5 year service record, the Contracting Officer has the option to have representative samples taken and tested.]

[a. List of Sources. On the basis of information and data available to the Contracting Officer, stone meeting the quality requirements of these specifications has been produced from the sources listed at the end of this section.]

[

a. List of Sources]

[(1) Category I Sources: Category I sources have been inspected and evaluated within the last five years by the Government and have produced stone materials of acceptable quality from satisfactory geological formations. The Category I sources have previously demonstrated effective quality control programs at the source and the test results of the materials furnished have been verified that some material are of satisfactory quality. In a like manner, the source would be capable of providing the quality[, quantity,][and] [gradation] of required stone materials. Further evaluation and testing of the source will not be required unless the preparation of the required demonstration stockpile reveals an adverse condition not previously taken into account.]

****

NOTE: Lists may be provided either categorized indicating the level of confidence in a source's ability to meet the criteria of a specification based on how recent the previous usage, testing or inspections have been, by designating Category 1 and Category 2, or the list may simply provide sources with which there is some familiarity and that have a prior record. For emergency or expedited Contracts, or in the interests of common understanding between the agency, suppliers and contractors, or for reasons of cost or material availability, it may be useful to utilize State Highway Department gradations of materials. This should be done with caution as there is potentially great difference in quality requirements for highway department materials and Erosion Protection stone. When using highway department gradations it must be emphasized that the designation is FOR GRADATION ONLY, and that QUALITY/STONE CHARACTERISTICS properties MUST STILL BE MET, REGARDLESS OF STATE HIGHWAY DEPARTMENT CERTIFICATION.

****

[(2) Category II Sources: Category II sources either have not been inspected and evaluated within the past five years or have had a deficiency in the past which may or may not affect its qualifications to provide stone materials for this project. Deficiencies may include, but are not limited to: ineffective quality control program; unsatisfactory production techniques; unacceptable quality of material in the geological formation being quarried; insufficient quantities of required materials; or unsatisfactory durability of stone materials previously furnished. These factors of this kind do not disqualify the source for this project. A current inspection and evaluation of the source by the [Government][Contractor] would be necessary [to determine whether acceptable stone can be produced from the proposed source][before allowing the source to proceed with preparation of demonstration stockpiles].[Disapproval of a proposed Category II source based on the inspection and evaluation would necessitate having the Contractor name a replacement source from the Category I list.]]

[b. Selection of Source. Designate in writing only one source or one combination of sources from which he proposes to furnish stone. [If the Contractor proposes to furnish stone from a source not listed at the end of this section, he may designate only a single unlisted source for stone and notify the Contracting Officer at least [60] [30] workdays before the stone leaves the quarry.] It is the Contractor's responsibility to determine that the stone source or combination of sources selected is capable of providing the [quality,] quantities and gradation needed and at the rate needed to maintain the scheduled progress of the work.[Provide samples for acceptance testing in accordance with paragraph EVALUATION TESTING below. If a source for stone so designated by the Contractor is not accepted for use by the Contracting Officer, the Contractor may not propose other sources but must furnish the stone from a source listed[in Category I] at the end of this section with no additional payment.]]

[c. Acceptance of Materials.[Acceptance of a source of stone is not to be construed as acceptance of all material from that source. The right is reserved to reject materials from certain localized areas, zones, strata, or channels, when such materials are unsuitable for stone as determined by the Contracting Officer. The Contracting Officer also reserves the right to reject individual units of produced specified materials in stockpiles at the quarry, all transfer points, and at the project construction site when such materials are determined to be unsuitable. During the course of the work, the stone may be tested by the Government, if the Contracting Officer determines that testing is necessary. If such tests are determined necessary, the testing will be done in [the Government's testing laboratory][or][commercial laboratory selected by the Government]. Materials produced from a listed or unlisted source must meet all the requirements herein. The cost of testing will be at the Government's expense.][During the contract period, both prior to and after materials are delivered to the job site, visual inspections and measurements of the stone materials may be performed by the Contracting Officer. If the Contracting Officer, during the inspections, finds that the stone quality, gradation or weights of stone being furnished are not as specified or are questionable, re-sampling and re-testing is required. Sampling of the delivered stone for testing and the manner in which the testing is to be performed must be as directed by the Contracting Officer. Perform this additional sampling and testing at the Contractor's expense when test results indicate that the materials do not meet specified requirements. When test results indicate that materials meet specified requirements, an equitable adjustment in the contract price will be made for the sampling and testing. Remove or dispose of any rejected material as specified and at the Contractor's expense.]]

1.6.1.3 Evaluation Testing of Stone

****

NOTE: Alternate 1 - Use this paragraph if testing is to be performed by the Government at the Material Testing Center at CEWES or at a Government selected commercial laboratory that has been validated to being able to perform the required tests; delete paragraph EVALUATION TESTING OF STONE (Alternate 2) in PART 2 PRODUCTS.

For contracts having a short duration or are awarded

for emergency repair, there will be insufficient time to allow a Contractor to propose and unlisted source and have it evaluated; therefore, delete the bracketed sentences in paragraph STONE above; and subparagraphs SOURCES, above, and this paragraph, EVALUATION TESTING OF STONE, should be deleted.

Table 6-1 of EM 1110-2-2302 gives a broad generalization of desired quality criteria for stone. However, the quality criteria specified in this document was based upon a limited review of criteria being used by Corps. Each District or Division should specify the desired quality of stone necessary to meet performance criteria. It is recommended that at a minimum the stone should be evaluated using petrographic analysis, specific gravity, unit weight, freezing and thawing, and resistance of rock to wetting and drying. The freezing and thawing testing should be performed in accordance with COE CRD-C 144 or ASTM D5312/D5312M on the largest sawn sections of stone, between [_____] mm^2 (144-2304 square inches), so that bedding planes or any potential planes of weakness can be evaluated. These size samples require stone samples that range between 70 kg and 3400 kg 150 pounds and 7400 pounds. If ASTM D5313/D5313M are required, the test specimen must be of the same size range as specified above. LRD has testing and evaluation procedures for shoreline protection that require larger samples for evaluation of material being used on their projects due to the severity of their environment and the larger sizes of stone used for shoreline protection. These procedures should be investigated if the standard procedures specified are not giving you adequate durability for stone placed on past projects.

A special test that could be used to evaluate the abrasion resistance of stone is COE CRD-C 63, Abrasion-Erosion Resistance of Concrete.

The number of work days specified in this paragraph are based on the assumption that to tentatively approve the use of a source under a single contract requires data for unit weight, absorption, and petrographic analysis of the stone. A minimum of 80 work days would be required to have available data from the freeze and thawing test. Arrangements need to be made with the testing laboratory when notice is given to evaluate source not after samples are collected.

The size of a sample has been reduced to three pieces of stone weighing 70 kg 150 pounds minimum each for stone gradations with a nominal top size less than 1400 kg 3000 pounds. The number of pieces has been reduced by the COR being a geologist or materials engineer and present during the sample collection. Also, the pieces need to be washed to

make sure they are similar and only three pieces are required by the Laboratory for evaluation of sample. Larger size stones may be required for evaluating stone used for shoreline protection.

Delete this submittal if evaluation testing of stone will be performed by the Government at a Government Laboratory.

****

****

NOTE: The Drop Test should not be used to determine stone durability as it is entirely qualitative, and may produce fine fractures that are not immediately discernible. Further, it may damage stone that may very well be later incorporated into the work, if not discarded following the "test."

****

Submit a copy of the laboratory inspection report along with actions taken to correct deficiencies and a copy of the test reports, prior to delivery of such material to the worksite; since quality test on the stone in accordance with PART 2 paragraph EVALUATION TESTING OF STONE is the responsibility of the Contractor. The tests to which the stone may be subjected will include petrographic analysis, specific gravity, unit weight, absorption, wetting and drying, freezing and thawing and such other tests as may be considered necessary to demonstrate that the stone is of a satisfactory quality which is at least equivalent to stone from the sources listed at the end of this section.

a. [Unit Weight][Bulk Specific Gravity, saturated surface dry (SSD)] and Absorption. Stone must [weigh more than [_____][2500] kN/m^3 [_____][155] pounds per cubic foot][have a bulk specific gravity, saturated surface dry, (SSD), greater than [_____][2.48]]. Provide stone with an absorption less than [2][_____] percent unless other tests and service records show that the stone is satisfactory. The method of test for [unit weight][bulk specific gravity (SSD)] and absorption will be ASTM C127.

b. Samples. Take samples of stone from a source not listed at the end of this section by a representative of the quarry under the supervision of the Contracting Officer for testing and acceptance prior to delivery of any stone from this source to the site of the work. Samples consist of at least three pieces of stone, roughly cubical in shape and weighing no less than [70][_____] kg [150][_____] pounds each from each unit that will be used in the production of the required stone. If the source is an undeveloped quarry[, or if the operation has been dormant for more than one year such that fresh samples are not available,] expose fresh rock for 6 m 20 feet horizontally and for the full height of the face proposed for production, prior to the field evaluation.[The Contracting Officer may also require documentation of subsurface exploration of an undeveloped quarry in order to determine whether or not sufficient reserves are available.] Ship samples at the Contractor's expense to [Waterways Experimental Station, Structures Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180, Attn: [_____]], and notify [Mr.][Ms.] [_____], [_____] Branch, [_____] District to arrange for testing at least [40][60][_____] workdays before the stone leaves the quarry.

c. Tests. The tests will be conducted in accordance with applicable Corps of Engineers methods of tests given in the Handbook for Concrete and Cement or ASTM methods of tests.[The cost of testing one new source will be borne by the Government.]

[1.6.1.4 Random Sampling

The stone produced by each source will be sampled by the Government for Quality Assurance testing on the basis of a minimum once each year[or once during the production of each [_____][25 000][50 000] tons (metric) tons of stone produced each year for the Government]. The samples will be evaluated based upon petrographic analysis, specific gravity, [unit weight,][bulk specific gravity (SSD),] [_____], and absorption.

]1.6.2 Concrete Grout for Stone Protection

****

NOTE: If the Designer elects to specify grouting requirements for the project under another section, special care should be taken to delete all grouting requirements specified in this section and appropriate references added identifying the section specifying the grouting requirements.

****

1.6.2.1 General

The Government reserves the right to sample and test the aggregates and grout to determine compliance with the specifications. Provide facilities and labor as may be necessary to assist the government in procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D75/D75M. Grout will be sampled in accordance with ASTM C172/C172M. The slump and air content will be determined when cylinders are molded in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively. Compression test specimens will be made, cured and transported in accordance with ASTM C31/C31M. Compression test specimens will be tested in accordance with ASTM C39/C39M. Samples for strength tests will be taken not less than once each shift in which grout is produced. A minimum of three specimens will be made from each sample, two will be tested at 28 days (90 days if pozzolan is used) for acceptance and one will be tested at 7 days for information.

1.6.2.2 Concrete Grout Mixture Proportions

Concrete grout mixture proportions is the responsibility of the Contractor.[Submit the mixture proportions that will produce grout of the qualities required, ten days prior to placement.][Submit grout mixture proportions for grouting manufactured derrick stone.] Submit mixture proportions for review [_____] [10] days prior to being used under this contract. Include mixture proportions of the dry weights of cementitious material(s); the specific gravities, absorptions, and saturated surface-dry weights of the fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per cubic meters cubic yards of grout. Also, submit applicable test reports, such as air content, compressive strength, and unit weight of the grout, to verify the proportions selected will produce grout of the quality specified. Do not change the approved grout mixture proportions without approval by the Contracting Officer. The air content must be between 4.5 and 7.5

percent. The specified compressive strength f'c is [1.4][1.8][_____] kg/mm^2 [2000][2500][_____] pounds per square inch at 28 days (90 days if pozzolan is used). The maximum water cement ratio is [_____][0.70]. The slump of the grout mix is 150 mm 6 inches plus or minus 25 mm 1 inch. For maximum coarse aggregate size see paragraph AGGREGATES FOR CONCRETE GROUT.

1.6.2.3 Evaluation and Acceptance of Grout

The acceptance test results will be the average of the strengths of the two specimens tested at 28 days (90 days if pozzolan is used). The strength of the concrete grout will be considered satisfactory so long as the average of three consecutive acceptance test results equal or exceed the specified compressive strength f'c and no individual acceptance test result falls below the specified strength f'c by more than [350] g/mm^2 500 pounds per square inch.

1.7 REGULATORY REQUIREMENTS

****

NOTE: Insert the appropriate State Highway Department specifications as applicable.

****

The regulatory requirements listed below form a part of this specification to the extent referenced. The regulatory requirements are referred to in the text by basic designation only.

[_____] STATE HIGHWAY AND TRANSPORTATION DEPARTMENT ([_____])

[_____] [(____)] Standard Specifications for Highway Construction

1.8 CONSTRUCTION TOLERANCES

****

NOTE: For tolerances in general, 1/2 of the D-50 stone dimension of gradation range is allowed above the neatline and 1/4 of the same dimension is allowed below the neatline for stone gradation with a maximum size of 300 kg 650 pounds. For large stone the tolerance may be reversed. It is critical to make sure that layer thicknesses are physically possible for the stone materials specified - you cannot require two layers of stone in space too small for even one individual stone. Check both the Specifications and the Drawings to verify that the slopes and grades are constructable with the sizes of materials specified.

****

The finished surface and stone layer thickness is not allowed to deviate from the lines and grades shown by more than the tolerances listed below. Tolerances are measured perpendicular to the indicated neatlines. Ensure extreme limits of the tolerances given are not continuous in any direction for more than [_____] [five] times the nominal stone dimension nor for an area greater than [9.3][18.6][93] m^2 [100][200][1000] square feet of the structure surface.

NEATLINE TOLERANCES		
MATERIAL	ABOVE NEATLINE (mm) (inches)	BELOW NEATLINE (mm) (inches)
Foundation	[_____]	[_____]
Mattress	[_____]	[_____]
Bedding	[_____]	[_____]
Core	[_____]	[_____]
Underlayer	[_____]	[_____]
Cover	[_____]	[_____]
Armor	[_____]	[_____]
Riprap	[_____]	[_____]
Scour	[_____]	[_____]
Fill	[_____]	[_____]

The intention is that the work is built generally to the required elevations, slope and grade and that the outer surfaces are even and present a neat appearance. Remove or rearrange placed material not meeting these limits as directed by the Contracting Officer. Payment will not be made for excess material which the Contracting Officer allows to remain in place.

PART 2 PRODUCTS

2.1 BEDDING MATERIAL

****

NOTE: This paragraph presents gradation bands of materials that were developed based upon seepage criteria presented in EM 1110-2-1913. Each bedding material system should be designed to be used with a specific range of riprap gradations, foundation conditions, and channel conditions.

****

2.1.1 General

Submit the source for materials used in riprap[,] [and] [filter][,] [and] [bedding]. Provide bedding material consisting of [a washed] [gravel or] crushed stone. Submit test reports attesting that the [bedding material] [,] [and] [filter material] meet specified requirements.

2.1.2 Material

****

NOTE: Delete gradation limits that are not required.

****

Ensure bedding material is composed of tough, durable particles, adequately free from thin, flat and elongated pieces, and contains no organic matter nor soft, friable particles in quantities considered objectionable by the Contracting Officer. Provide aggregates meeting the quality requirements of ASTM C33/C33M[or paragraph REGULATORY REQUIREMENTS]. Use gradation conforming to the following requirements:

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
BEDDING STONE NO. 1 - GRAVEL OR CRUSHED STONE	
100 mm4 in.	[_____]
75 mm3 in.	[_____]
50 mm2 in.	[_____]
25 mm1 in.	[_____]
12.5 mm1/2 in.	[_____]
4.75 mmNo. 4	[_____]

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
BEDDING STONE NO. 2 - CRUSHED STONE	
150 mm6 in.	[_____]
100 mm4 in.	[_____]
75 mm3 in.	[_____]
25 mm1 in.	[_____]
12.5 mm1/2 in.	[_____]
2.36 mmNo. 8	[_____]

Provide bedding material well-graded between the limits shown. Perform at least one test on each [_____] 1000 tons [to be delivered to the project site][placed] for each specified gradation in accordance with ASTM C136/C136M.[Remove a representative sample weighting no less than 45 kg 100 pounds from the bedding layer placed at locations directed by the Contracting Officer.] Ensure all points on individual grading curves obtained from representative samples of bedding material lie between the boundary limits as defined by smooth curves drawn through the tabulated gradation limits plotted on ENG FORM 2087 or similar form. The individual gradation curves within these limits are not allowed to exhibit abrupt changes in slope denoting either gap grading or scalping of certain sizes or other irregularities which would be detrimental to the proper functioning of the bedding layers.

2.2 FILTER MATERIAL

****

NOTE: This paragraph presents gradation bands of materials that were developed based upon seepage criteria presented in EM 1110-2-1913. Each filter material system should be designed to be used with a specific range of riprap gradations, foundation conditions, and channel conditions.

The Specifier should use Alternative 1 if there is a concrete section in the specifications and if the gradations therein are satisfactory for filter materials. If there is no concrete section, or if the gradations therein are unsatisfactory for filter materials, the Specifier should use Alternative 2.

NOTE: Alternative 1.

****

Submit certificates of compliance attesting that the materials meet specification requirements.[Provide filter material consisting of [washed][sand and gravel][and crushed stone] [filter stone and geotextile]. Provide [sand and gravel][and crushed stone] for filter materials which meets the applicable requirements of Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, paragraph MATERIALS, subparagraph AGGREGATES.][Provide geotextiles as specified in Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK.]

****

NOTE: Alternative 2.

****

[Provide filter material consisting of [Sand "[_____]",] [Gravel "[_____]",] [Filter Stone] [Filter Stone and Geotextile]. Ensure the [filter material] [filter stone] is composed of tough, durable particles, adequately free from thin, flat and elongated pieces, and contains no organic matter nor soft, friable particles in quantities considered objectionable by the Contracting Officer. Provide aggregate meeting the quality requirements of ASTM C33/C33M[or paragraph REGULATORY REQUIREMENTS]. Ensure grading conforms to the following requirements:

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
SAND "[_____]"	
9.50 mm3/8 in.	[_____]
4.75 mmNo. 4	[_____]
2.36 mmNo. 8	[_____]
1.18 mmNo. 16	[_____]
600 µmNo. 30	[_____]
300 µmNo. 50	[_____]

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
SAND "[_____]"	
150 µmNo. 100	[_____]

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
GRAVEL "[_____]"	
37.5 mm1-1/2 in.	[_____]
19.0 mm3/4 in.	[_____]
9.5 mm3/8 in.	[_____]
4.75 mmNo. 4	[_____]
2.36 mmNo. 8	[_____]
1.18 mmNo. 16	[_____]

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
FILTER STONE	
150 mm6 in.	[_____]
100 mm4 in.	[_____]
75 mm3 in.	[_____]
37.5 mm1-1/2 in.	[_____]
25 mm1 in.	[_____]
12.5 mm1/2 in.	[_____]

Provide [filter materials] [filter stone] that are well-graded between the limits shown.[Naturally-produced gravel is not considered crushed stone.] Perform at least one test on each 1000 tons [to be delivered to the project site][placed for each specified gradation in accordance with ASTM C136/C136M].[Remove a representative sample weighing no less than 45 kg 100 pounds from the filter layer placed at locations directed by the Contracting Officer.] All points on individual grading curves obtained from representative samples of [filter material] [filter stone] must lie between the boundary limits as defined by smooth curves drawn through the tabulated gradation limits plotted on ENG FORM 2087 or similar form. The individual gradation curves within these limits are not allowed to exhibit abrupt changes in slope denoting either gap grading or scalping of certain sizes or other irregularities which would be detrimental to the proper functioning of the filter. Provide geotextile in accordance with Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK.]

2.3 [BEDDING]SAND[FILL][CUSHION LAYER]

****

NOTE: Sand fill is used to bring areas which are below grade in paragraph BASE PREPARATION to within allowable minus tolerance instead of using filter or bedding materials.

****

[Provide a clean, free draining sand in accordance with classification SP in ASTM D2487, except that no more than 5 percent by weight of the material smaller than a No. 4 sieve, must pass a No. 200 sieve. If sand meeting this criteria is available on site it may be used.][Sand must meet [paragraph REGULATORY REQUIREMENTS][ASTM C33/C33M] gradation requirements for fine aggregate.]

2.4 STONE

2.4.1 General

2.4.1.1 Evaluation Testing of Stone

****

NOTE: Alternate 2 - Use this paragraph if testing is to be performed by the Contractor at a Commercial Laboratory; delete paragraph EVALUATION TESTING OF STONE (Alternate 1) in PART 1 GENERAL.

For contracts having a short duration or are awarded for emergency repair, there will be insufficient time to allow a Contractor to propose an unlisted source and have it evaluated; therefore, delete the bracketed sentences in paragraph STONE above, and subparagraphs SOURCES, above, and this paragraph EVALUATION TESTING OF STONE, should be deleted.

Table 6-1 of EM 1110-2-2302 gives a broad generalization of desired quality criteria for stone. However, the quality specified in this document was based on a limited review of criteria being used by the Corps. Each District or Division should specify the desired quality of stone necessary to meet performance criteria. It is recommended that at a minimum the stone should be evaluated using petrographic analysis, specific gravity, unit weight, absorption, freezing and thawing, and resistance of rock to wetting and drying. The freezing and thawing testing should be performed in accordance with COE CRD-C 144 or ASTM D5312/D5312M on the largest sawn sections of stone, between 0.09-1.49 m^2 144-2304 square inches so that bedding planes or any potential planes of weakness can be evaluated. These size samples require stone samples that range between 70 kg and 3400 kg 150 pounds and 7400 pounds. If ASTM D5313/D5313M is required, the test specimen must be of the same size range as specified above. Some organizations have testing and evaluation procedures for shoreline

protection that require larger samples for evaluation of material being used on their projects due to the severity of their environment and the larger sizes of stone used for shoreline protection. These procedures should be investigated if the standard procedures specified are not giving adequate durability information for stone placed on past projects.

A special test that could be used to evaluate the abrasion resistance of the stone is COE CRD-C 63, Abrasion-Erosion Resistance of Concrete.

The number of work days specified in this paragraph is based on the assumption that to tentatively approve the use of a source under a single contract requires data for unit weight, absorption, and petrographic analysis of the stone. A minimum of 80 work days would be required to have available data from the freeze and thawing test. Arrangements need to be made with the testing laboratory when notice is given to evaluate source not after samples are collected.

The size of a sample has been reduced to three pieces of stone weighing 70 kg 150 pounds minimum each for stone gradations with a nominal size less than 1400 kg 3000 pounds. The number of pieces has been reduced by the COR being a geologist or materials engineer and present during the sample collection. Also, the pieces need to be washed to make sure they are similar and only three pieces are required by the laboratory for evaluation of sample. Larger size stones may be required for evaluating stone used for shoreline protection.

****

For stone from an unlisted source, have evaluation tests performed on stone samples collected from the proposed source. Perform quarry investigation by a registered geologist or registered engineer. The tests include petrographic examination (ASTM C295/C295M), [bulk specific gravity (SSD),][unit weight,] absorption (ASTM C127), resistance of stone to freezing and thawing ([COE CRD-C 144][ASTM D5312/D5312M]), resistance to wetting and drying (ASTM D5313/D5313M). The laboratory to perform the required testing must be validated based on relevant paragraphs of ASTM D3740, and no work requiring testing is permitted until the laboratory has been inspected and validated unless approved prior to testing by the Contracting Officer. A copy of the documents, provided by the Materials Testing Center (MTC) at CEWES[or other governmental agency], that validates that the laboratory can perform the required tests. List the individual tests for which the validation covers along with the date of the inspection. The first inspection of the facilities is at the expense of the Government and any subsequent inspections required because of failure or deficiencies identified by the first inspection are at the expense of the Contractor.

a. Bulk Specific Gravity Range. All stone must have a minimum bulk specific gravity, saturated surface dry (SSD), of [_____][2.50][and a maximum bulk specific gravity of not more than [_____] [2.90]] based upon water having a unit weight of 9.8 kN/m^3 62.4 pounds per cubic foot. The method of test for bulk specific gravity (SSD) is ASTM C127.[Reference is made to paragraph FACTORS USED FOR CONVERTING IN-PLACE VOLUME TO WEIGHT for instructions for converting in-place volume to bid quantities and for instructions on adjusting bid schedule quantities for variations in bulk specific gravity and percentage of voids.]

b. Unit Weight and Absorption. Stone must [weigh more than [24][_____] kN/m^3 [155][_____] pounds per cubic foot][have a bulk specific gravity, saturated surface dry, greater than [2.48][_____][2.60]]. Provide stone with an absorption less than [1][2][_____] percent unless other tests and service records show that the stone is satisfactory. The method of test for unit weight and absorption is ASTM C127.

c. Petrographic Examination. Evaluate stone in accordance with ASTM C295/C295M which includes information required by ASTM D4992, paragraph 10. Use COE CRD-C 148 to perform Ethylene glycol tests required on rocks potentially containing smectite as specified in ASTM D4992 and on samples identified to contain swelling clays.

d. Resistance to Freezing and Thawing. Use stone with a maximum loss of [_____][5][10] percent after the number of cycles specified in ASTM D5312/D5312M, Figure 1, when determining the durability of stone when subjected to freezing and thawing in accordance with [COE CRD-C 144][ASTM D5312/D5312M], except the surface area of one side of the sample must be between [0.09][_____] and [1.49][_____] m^2 [144][_____] and [2304][_____] square inches.

[

e. Resistance of Rock to Wetting and Drying. Use stone with a maximum loss of [1][_____] percent when determining the durability of stone when subject to wetting and drying in accordance with ASTM D5313/D5313M, except the surface area of one side of the sample must be between [0.09][_____] and [1.49][_____] mm^2 [144][_____] and [2304][_____] square inches.]

f. Samples. Take samples of stone from a source not listed at the end of this section by a representative of the quarry or source under the supervision of the Contracting Officer for testing and acceptance prior to delivery of any stone from this source to the site of the work. Include in the information provided with the samples the location within the quarry or source from which the sample was taken along with a field examination of the quarry or source. Include the information outline in ASTM D4992, paragraph 7, in the field examination. Samples consist of at least three pieces of stone, roughly cubical in shape and weighing no less than [70][_____] kg [150][_____] pounds each from each unit that is used in the production of the required stone. If the source is an undeveloped quarry, or if the operation has been dormant for more than one year such that fresh samples are not available, expose fresh rock for 6 m 20 feet horizontally and for the full height of the face proposed for production, prior to the field evaluation.[The Contracting Officer may also require documentation of subsurface exploration of an undeveloped quarry in order to determine whether or not sufficient reserves are available.] Ship samples at the Contractor's expense to a laboratory validated by the government to perform the required tests.

g. Tests. Conduct the tests in accordance with applicable ASTM and Corps of Engineers methods of tests, given in the Handbook for Concrete and

Cement, in a laboratory validated by the government. The cost of testing are borne by the Contractor.

2.4.1.2 Quarry Operations

Conduct quarry operations in a manner to produce stone conforming to the requirements specified. This may involve selective quarrying, handling, processing, blending, and loading as necessary, [as specified in Section 01 45 00 QUALITY CONTROL]. Controlled blasting and handling of rock to produce rock of the size ranges and quality specified. Techniques such as the use of proper hole diameter, hole depth, hole angle, burden and spacing distances, types and distribution of explosives. delay intervals and sequence, removal of muck piles between each shot, and special handling techniques are required as necessary to produce the specified materials. Specifically design all aspects of blasting operations so that the end product is not damaged from the blasting technique and that the stone is suitable for the intended purpose.

a. Curing Stone

Conduct curing operations on freshly quarried stone to allow it to release stored energy and moisture. This will allow the stone to exhibit initial and subsequent post blasting stress relief and reveal any significant fractures during the energy release and drying-out phase. Stockpile stones of sizes which are individually picked temporarily at the quarry site a minimum of [_____] calendar days before being shipped to the project site, unless this requirement is waived by the Contracting Officer. Such waiver will be granted only if the stone has characteristics that make curing unnecessary.

b. Stone Quarrying Exclusion Period

****

NOTE: Exclude the possibility of waiving the quarrying period restrictions unless the District Geologist authorizes inclusion of the language in the specification for the project.

****

Stone quarried between the [_____][15th of September and the 15th of April] will not be approved for use in the project.[If the stone is not affected by freeze-thaw cycles, and the durability history of the stone demonstrates that quarrying during the exclusion period has not adverse effect on the durability of the stone and the Contracting Officer approves the use of stone quarried during the exclusion period, the stone quarrying period exclusion may be waived by the Contracting Officer.] Stone quarried before the the exclusion period at a time which will not permit sufficient curing time before being subjected to freezing conditions, and which is subject to fracturing as a result of freeze-thaw cycles, will not be approved for use.

c. Temporary Storage at Quarry

Prolonged storage of stone materials prior to shipment from the quarry and prior to permanent placement in the required work are subject to approval of the Contracting Officer.[Underwater storage of stone materials is prohibited.]

2.4.1.3 Gradation Test

****

NOTE: As a rule of thumb the sample size should be between 20 to 100 times the weight of the maximum size stone within a specified gradation (see ASTM D5519, Note 2). Recommend using either the calculated minimum sample size or the following size samples for the ranges specified.

15 metric ton sample required for riprap with a top size up to 225 kg 500 pounds. 25 metric ton sample required for riprap or stone with top size between 225 kg 500 pounds and 1000 kg 2200 pounds and 50 metric ton sample required for riprap or stone with top size larger than 1000 kg 2200 pounds up to 3400 kg 7500 pounds.

For sources which have riprap or stone as a standard production item: One gradation test minimum, at the quarry, required for each 50 000 metric tons of riprap or stone with a top size of 460 kg 1,000 pounds or larger, or one test required for each 25,000 metric tons of smaller riprap or stone.

To allow the Contractor to perform a gradation test without the Contracting Officer present, the quantity of riprap or stone required for the project must be less than 10,000 metric tons.

Use consistent terminology - if the CLIN in the Bid Schedule refers to Jetty Stone or Armor Stone, use terms exclusively in the text of the Specifications that apply to each - and cross check that the terms are used correctly in the Drawings.

****

Perform a gradation test or tests on the riprap, stone, or [_____] at the quarry in accordance with paragraph STANDARD TEST METHOD FOR GRADATION OF RIPRAP, GRADED STONE, AND [_____]. Take the sample in the presence of the Contracting Officer. Notify the Contracting Officer not less than 3 days in advance of each test. Submit the gradation tests using the GRADATION TEST DATA SHEET enclosed at end of this section for riprap or stone. [In the event of unavailability of the Contracting Office, perform the tests and certify to the Contracting Officer that the riprap, stone, or [_____] shipped complies with the specifications.] Perform at least [one] [_____] gradation test(s) per [50,000] [_____] tons(metric)tons of each size of riprap, stone, or [_____] placed, but do not perform less than one test. Report gradation tests using the forms, GRADATION TEST DATA SHEET and ENG FORM 4794-RM 4794-R, attached at end of this section or approved alternative.[Designate on the test form that portion in tons (metric) tons of the lot tested which is applicable to this contract. Correct any deviation from the reported tonnage and record on a revised GRADATION TEST DATA SHEET.][Provide sample consisting of no less than [15] [25] [50] [_____] tons(metric) tons of [_____] riprap, stone, or [_____], and collect in a random manner which will provide a sample which accurately reflects the actual gradation arriving at the jobsite.][Provide sample consisting of between 30 to 35 pieces of armor stone and jetty stone. A minimum of two tests are required for acceptance of armor stone and jetty stone. Mark the weight of the individual pieces of armor stone and jetty stone, representing the minimum, maximum and 50 percent greater than sizes for the specified armor stone and jetty stone gradation, on each stone [and place at the quarry to provide visual comparison during production at the quarry]and place in a location adjacent to the work site in order to provide a basis for visual comparison during placement of the armor stone and jetty units. Use these stones in the last placement if needed.] Failure of the test on the initial sample and on an additional sample will be considered cause for rejection of the quarry and/or quarry process, and set aside all riprap, stone , or [_____] represented by the failed tests and do not incorporate into the work. Any additional tests required because of the failure of an initial test sample will not be considered as one of the other required tests. If collected by the truckload, each truckload must be representative of the gradation requirements. [The Contracting Officer may direct additional testing of the riprap, stone or [_____] at the project site if the riprap, stone, or [_____] appears, by visual inspection, to be out of gradation.] [Perform additional tests on in-place materials at the locations directed, or on random loads selected by the Contracting Officer.][In-place test areas must be no less than 3.6 by 3.6 m 12 by 12 feet [_____] and include the full thickness of the placed riprap, stone, or [_____] layer, without disturbing or including the underlying material and meet the minimum sample size specified above]. Refill and rework each pit or void excavated for an in-place test sample to provide a surface void of signs of disturbance.[Perform [one][additional] in-place gradation on each [3800 cubic meters][7500 tons (metric] [5,000 cubic yards][7,500 tons] or portion thereof placed.][If the gradation test fails, additional gradation tests will be required at the Contractor's expense to delineate the limits of unacceptable stone. Do not count additional gradation tests as part of the minimum number of gradation tests required. Rework and replace the unacceptable stone as necessary to correct the deficiency within the specified gradation or remove the stone from the project site as determined by the Contracting Officer.] The Contracting Officer may direct this testing under FAR 52.246-12 Inspection of Construction. Provide all necessary screens, scales and other equipment, and operating personnel, to grade the sample. Certification and test results represent riprap, stone, or [_____] shipped from the quarry. Certification and tests results must be received by the Contracting Officer at the jobsite before the riprap, stone. or [_____] is used in the work.

2.4.1.4 Proportional Dimension Limitations

[The maximum aspect ratio (greatest dimension:least dimension) of any piece of stone for size ranges [which are not graded with a screen or grizzly,] must be not greater than 3:1 when measured across mutually perpendicular axis. Allow no more than 25 percent of the stones within a gradation range to have an aspect ratio greater than 2.5:1.][A maximum of [5][10][15] percent flat and elongated pieces by weight will be acceptable. A flat and elongated piece of riprap is defined as having a ratio of width to thickness or length to width greater than 3:1. Use ASTM D4791 as a guide to perform the test.]

2.4.1.5 [Riprap][Stone][_____] Stockpile

Storage of [riprap][stone][_____] at the worksite is not to be confused with off-site stockpiling of riprap, stone, or [_____]. If the Contractor elects to provide off-site stockpiling areas, notify the Contracting Officer of all such areas.[The Contractor's stockpile must be a maximum of 3.6 m 12 feet high and formed by a series of layers of truckload dumps, where the rock essentially remains where it is placed. Start subsequent layers 3 m 10 feet from the edge of the previous layer so that the rock will not roll down the edges of the previous layers.] The first layer must be a maximum of 1.8 m 6 feet high. After being stockpiled, do not put any riprap, stone, or [_____] which has become contaminated with soil or refuse into the work unless the contaminating material has been removed from the riprap, stone, or [_____] prior to placement.

a. Worksite Stockpile. [Place riprap, stone, or [_____] delivered to the work sites, which requires temporary storage[landward of top of slope,] in a container suitable for storing the riprap, stone, or [_____] without waste[, or a sand-clay-gravel or crushed stone pad may be constructed for the storage area and removed upon completion of the work. If the sand-clay-gravel or crushed stone pad method is used, use pad with a minimum thickness of at least 150 mm 6 inches.] The container[or sand-clay-gravel or crushed stone pad method] is subject to approval by the Contracting Officer prior to delivery of the riprap, stone, or [_____]. Upon completion of the work, clean the storage areas of all storage residues and return to their original condition.][Temporary storage of riprap, stone, or [_____] at the worksite will be allowed, provided the stockpile toe of the riprap, stone, or [______] be no closer than [18][30] m [60][100] linear feet from the closest edge of the [excavation's][stream's] top slope, and the amount must not exceed 200 t 200 T[unless otherwise approved].]

b. Off-site Stockpile. In areas where riprap, stone, or [_____] is stockpiled for placement, remove excess or residual rock prior to completion of work. Remove all rock and spalls greater than 75 mm 3 inches in diameter. Where rocks may have become buried due to soft ground or operation of the equipment, [dispose of rock as directed] [put rock in a disposal area][buried in acceptable soil]. After the excess or residual rock has been removed, grade, dress, and fill the storage area to return the ground surface as near as practical to the condition that existed prior to construction unless otherwise approved by the Contracting officer.

2.4.2 Riprap

****

NOTE: At the end of this section, the Specifier must attach copies (Plates) of ENG FORM 4794-RM RIPRAP GRADATION CURVES for M40, M65, M90, M180, or M300 (ENG FORM 4794-R RIPRAP GRADATION CURVES FOR R90, R140, R200, R400, or R650), etc., as applicable for this contract.

The riprap gradations presented were developed in Lower Mississippi Valley Division in 1981 and were standardized to limit the number of gradation bands that a producer would have to produce. These gradation bands were developed from gradation bands presented in EM 1110-2-1601, Chapter 3. All bands were modified slightly after meetings with producers in AR, MO, and IL to reduce production costs. These five of thirteen gradation bands are provided as examples.

Riprap gradations may be designated by state highway department standard specifications in areas where

quarries are more familiar with producing these products, provided the gradations meet the project needs. Care must be taken in accepting sources of state highway department gradations of riprap to verify the STONE QUALITY CRITERIA other than merely gradation also meet the project needs, as state highway departments may not design to the same long-term performance durations.

Riprap is typically specified by the weight of the maximum D100 size of the riprap gradation.

****

Use only quarried stone. Provide well graded stone conforming to [the table(s) below and to Plate(s) [_____], [_____], [_____] and [_____] attached at the end of this section][the gradation requirements for [_____], [_____], and [_____] as specified in [paragraph REGULATORY REQUIREMENTS][_____]].

TABLE [_____] - FOR RIPRAP "M40""R90"

PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KGLB.
100	40 - 2090 - 40
50	20 - 1040 - 20
15	10 - 320 - 5

TABLE [_____] - FOR RIPRAP "M90""R200"

PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KGLB.
100	90 - 35200 - 80
50	40 - 2080 - 40
15	20 - 540 - 10

TABLE [_____] - FOR RIPRAP "M300""R650"

PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KGLB.
100	300 - 120650 - 260
50	130 - 60280 - 130
15	60 - 20130 - 40

TABLE [_____] - FOR RIPRAP "M450""R1000"	
PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KGLB.
100	450 - 1801000 - 400
50	200 - 90430 - 200
15	95 - 30210 - 60

TABLE [_____] - FOR RIPRAP "M3400"	
PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KG
100	3400 - 1350
50	1400 - 680
15	680 - 225

2.4.3 [Riprap][Stone] Paving

Use stone for [riprap][stone] paving in pieces approximately rectangular in cross section, each piece having its greatest dimension no more than three times its least dimension and with one dimension not varying more than 50 mm 2 inches from the thickness of the paving as shown.

2.4.4 [Manufactured]Derrick Stone

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NOTE: Specifier should insert weight limits, a weight tabulation to define the desired range of sizes (similar to a riprap gradation), or a range of sizes.

****

[Manufactured derrick][Derrick] stone must be unreinforced concrete shapes weighing not less than 2300 kN/m^3 145 pounds per cubic foot. Provide concrete as specified in Section [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [03 70 00 MASS CONCRETE].[Submit the design of the shapes of the manufactured derrick stone prior to commencing their manufacture. Form [either handling][handling] holes in the shapes[or embed handling hardware in the shapes] at the time they are manufactured.] Derrick stone must consist of [pieces weighing [_____] kg plus or minus [_____] kg pounds plus or minus [_____] pounds] [pieces as tabulated below:] [rectangular pieces [_____] m feet long by [_____] m feet wide by [_____] m feet thick.] [pieces with dimensions as tabulated below:]

[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

[Ensure stone is [roughly] graded as to size between the several limits.][

Provide stone in pieces generally rectangular in cross section, each piece having its greatest dimension no more than three times its least dimension.]

2.4.4.1 Grout for Manufactured Derrick Stone

Use materials required to make the grout as specified in Section [03 70 00 MASS CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE]. Mix grout in the proportions of one part cement to [_____] parts sand, [and] sufficient water to produce a workable mixture[, and that amount of admixture which will entrain sufficient air to produce durable grout. Submit grout mixture proportions in accordance with paragraph SUBMITTALS.]

2.4.4.2 Epoxy Materials

Epoxy material must meet the requirements of ASTM C881/C881M, [Type IV, when mixed with packaged sand to form a mortar] [Type VII, for a sealer.]

2.4.5 [Capstone][and][Derrick Stone]

[Capstone][and][Derrick stone] must consist of [pieces weighing [_____] kg plus or minus [_____] kg pounds plus or minus [_____] pounds] [pieces as tabulated below:] [rectangular pieces [_____] m feet long by [_____] m feet wide by [_____] m feet thick.] [pieces with dimensions as tabulated below:]

[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

[Provide stone that is [roughly] graded as to size between the several limits.][Provide stone in pieces generally rectangular in cross section, each piece having its greatest dimension no more than three times its least dimension.]

2.4.6 Graded Stone "A"

Graded Stone "A" must conform to the following table:

GRADED STONE "A"	
STONE WEIGHT (kg)(Pounds)	CUMULATIVE PERCENT (Finer by Weight)
23005000	100
11502500	70-100
230500	40-65
45100	20-45
25	0-15
0.51	0-5

A plot of the gradation curve is attached at the end of this section.

2.4.7 Graded Stone "B"

[_____].

2.4.8 Graded Stone "C"

[_____].

2.4.9 57-kg 125-Pound Stone

Except as indicated by the following tolerances, 57-kg 125-pound riprap stone must be in pieces weighing no less than 2.7 kg 6 pounds each nor more than 57 kg 125 pounds each,and no dimension must be over 500 mm 20 inches. Grade each shipment as follows:

WEIGHT OF PIECES (KG)(LBS)	PERCENT OF TOTAL WEIGHT
34 to 5775 to 125	10 Maximum
11 to 3425 to 75	40 to 60
3 to 116 to 25	20 to 40
0 to 30 to 6	0 to 15
Note: Not more than 5 percent passing a 25 mm1-inch sieve.	

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NOTE: For any of the following four paragraphs, when the size of the largest stone within a gradation is 115 kg 250 pounds or less, specify gradation by dimension (mm (inches) instead of by weight.

****

2.4.10 [Bedding/Mattress] Stone

Furnish stones that weigh between [_____] kg pounds and [_____] kg pounds each, free of fines and well graded within the following limits:

STONE WEIGHT IN KG LBS	PERCENT LIGHTER BY WEIGHT OF TOTAL MIXTURE
[_____]	[_____]
[_____]	[_____]

2.4.11 [Core/Underlayer/Scour] Stone

Furnish stones that weigh between [_____] kg pounds and [_____] kg pounds each, free of fines and well graded within the following limits:

STONE WEIGHT IN KG LBS	PERCENT LIGHTER BY WEIGHT OF TOTAL MIXTURE
[_____]	[_____]
[_____]	[_____]

2.4.12 [Armor/Cover] Stone

****

NOTE: The design of armor/cover stone should be based upon criteria presented in EM 1110-2-2904. Quality Control and gradations for especially large armor stone may be more stringent than riprap. Armor stone quarries are less common because the geology, strata or rock mass necessary to produce large intact and durable pieces free from weak discontinuities is less common.

****

Furnish stones that weigh between [_____] kg pounds and [_____] kg pounds each, free of fines. Ensure seventy-five percent (75 percent) of the stones weigh greater than [_____] kg pounds each.

2.4.13 Splash/Fill Stone

Furnish stones for splash/fill stone behind the steel sheet pile wall that are well graded from [_____]mm inch to [_____] mm inches, free of fines and contain no more than five percent (5 percent) stones larger than [_____] mm inches in any dimension.

2.5 CONCRETE GROUT

****

NOTE: If concrete grouting is not required for the project, delete this paragraph and its subparagraphs in their entirety.

Requirements are written to match an abridged version of Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE or applicable Grout specs. Do not use grouted riprap in areas where frost heave or ice in the sub-base can be expected to cause uplift failure and on the river-side slopes of levees. A system designed for pressure relief and drainage should be provided beneath the area to be grouted along with edge and toe design to prevent undercutting and lateral movement of water beneath the grouted riprap.

****

2.5.1 Cementitious Materials

Submit manufacturer's certificate of compliance, or mill test reports, stating that the materials meet the requirements of the furnished specification.

2.5.1.1 Portland Cement

ASTM C150/C150M, Type [I,] [IA,] [II,] [IIA], low alkali.

2.5.1.2 Pozzolan

ASTM C618, Class C or F, including requirements of Tables 1A and 2A. Pozzolan in amount not to exceed 25 percent, based on absolute volume, may be substituted for an equivalent amount of portland cement in the grout mixture proportions.

2.5.2 Aggregates for Concrete Grout

****

NOTE: Insert the appropriate State Highway Department gradation requirements if applicable.

****

Use fine aggregates for grout meeting the quality and gradation requirements of either ASTM C33/C33M or paragraph REGULATORY REQUIREMENTS. Use coarse aggregates meeting the quality and gradation requirements of ASTM C33/C33M, Class designation 4M, Size No. 67, 7 or 8[or paragraph REGULATORY REQUIREMENTS], Class designation [_____], Size No. [_____].

2.5.3 Admixtures

Submit manufacturers' literature for the concrete admixtures and curing materials. Use admixtures, when required or approved, that comply with the following:

a. Air-Entraining Admixture: ASTM C260/C260M.

b. Water-Reducing or Retarding Admixture: ASTM C494/C494M, Type A, B, or D.

2.5.4 Curing Materials

Provide curing materials as follows:

a. Impervious Sheet Materials: ASTM C171, type optional, except polyethylene film, if used, must be opaque white.

b. Membrane-Forming Curing Compound: ASTM C309, Type 1-D or 2, Class [A] [B].

2.5.5 Water

Use fresh, clean, potable water for mixing and curing. Ensure water is free from injurious amounts of oil, acid, salt, alkali, except that nonpotable water may be used if it meets the requirements of COE CRD-C 400.

2.5.6 [Equipment]

Batching and mixing equipment will be accepted on the basis of manufacturer's data which demonstrates compliance with the applicable specifications.

PART 3 EXECUTION

3.1 DEMONSTRATION SECTION

Prior to placement of stone, construct a section of [stone][channel] protection consisting of [toe stone][riprap][grouted stone][_____] to demonstrate his proposed operations for production placement. Demonstrate procedures and capability of grading, placing [toe] stone and bank protection[, and placing grout, and curing of the grouted stone] within the tolerances specified. The demonstration section must be[30][_____] m [100][_____] feet in length and must conform to all applicable specifications.

3.1.1 Methods and Equipment

Demonstrate means, methods and equipment employed for placement of [toe stone][riprap][grouted stone][_____] conform to the requirements specified. Accurately tabulate quantities of all materials placed within the section and provide immediately to the Contracting Officer for comparison with computed quantities.

3.1.2 Demonstration Section Evaluation

Do not proceed with placing [stone][channel] protection prior to the approval of the demonstration section. Within a period of 7 days after completion of the section, the Contracting Officer will determine the adequacy of the section to function as part of the permanent construction. The Contractor will be notified as to the acceptability of the section and may be directed to modify methods of construction[, mix design,] and remove the section if necessary.

3.1.3 Removal of Demonstration Section

If removal of the demonstration section is required, conduct it in such a manner as to maintain the integrity of the underlying subgrade. Dispose of unused demonstration section materials at an offsite location.

3.2 BASE PREPARATION

****

NOTE: Sand fill is specified for the filling of low areas below the waterline around structures in slack water and giving the Contractor the option of using bedding or filter materials. However, if fill material is required where the designer assumes there will be flowing water, the designer will have to determine the minimum size of materials that will stay in place until the stone protection can be completed. This may require the fill material to be specified as bedding/filter material or riprap.

Tolerances plus 50 to 75 mm 2 to 3 inches (Above water placement).

Tolerances plus 300 mm 1 foot and minus 600 mm 2 feet (Below water placement).

****

Grade and/or dress areas on which [geotextile and riprap are] [filter layers and riprap are] [bedding material and riprap are] to be placed to conform to cross sections shown on the contract drawings within an allowable tolerance of plus 50 mm 2 inches and minus 100 mm 4 inches from the theoretical [slope] lines and grades. The prepared base must be approved by the Contracting Officer. Where such areas are below the allowable minus tolerance limit, restore to grade by fill [with earth similar to the adjacent material] [with sand fill] and then compact to a density equal to the adjacent in place material. [Subaqueous areas on which [bedding material and riprap] [filter materials and riprap] are to be placed must be geotechnically stable as determined by a qualified geotechnical engineer. Grade and/or restore subaqueous material to conform to cross sections shown on the contract drawings within an allowable tolerance of plus 300 mm 1 foot and minus 600 mm 2 feet from the specified [slope] line and grades. Where such areas are below the allowable minus tolerance limit, fill with sand or other suitable fill as determined by the existing bottom conditions. As an alternative, these areas may be filled with [bedding material] [filter material] if approved by the Contracting Officer. No payment will be made for any material thus required.] Immediately prior to placing the [geotextile] [bedding layers] [filter layers], the prepared base will be inspected by the Contracting Officer and do not place material thereon until that area has been approved.

3.3 PLACEMENT OF BEDDING LAYERS

3.3.1 General

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NOTE: The following construction tolerances will be used for bedding layer placement. Tolerances will vary based upon District experience and project conditions.

Plus or minus 50 mm 2 inches

Plus 100 mm 4 inches or minus 50 mm 2 inches

Plus 150 mm 6 inches or minus 50 mm 2 inches (below water) should be possible if water depths are less than 3 m 9 feet. Placement tolerances at greater depths should be deleted and replaced with tons/square as specified for under water placement of stone.

****

Place a bedding layer, consisting of a [_____] -mm -inch layer of [gravel or] crushed stone, on the prepared base as described below, in accordance with the details shown on the contract drawings, and within the limits shown on the contract drawings or staked in the field. A tolerance of plus 50 mm 2 inches and minus 25 mm 1 inch from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the bedding, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet.

3.3.2 Placement of Bedding Material on Prepared Base

Spread bedding material uniformly on the prepared base to the [slope] lines and grades as indicated on the contract drawings and in such manner as to avoid damage to the prepared base. Placing of [gravel or] crushed stone by methods which tend to segregate the particle sizes within the bedding layer [or cause mixing of the separate layers] is prohibited. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Replace or repair any damage to the surface of the prepared base that occurs during placement. Compaction of material placed on the prepared base will not be required, but finish [the material surface] [each layer] to present an adequately even surface, free from mounds or windrows.

3.4 PLACEMENT OF FILTER LAYERS

3.4.1 General

****

NOTE: The following construction tolerances will be used for filter layer placement. Tolerances will vary based upon District experience and project conditions.

Plus or minus 50 mm 2 inches

Plus 100 mm 4 inches or minus 50 mm 2 inches

Plus 150 mm 6 inches or minus 50 mm 2 inches (below water) should be possible if water depths are less than 3 m 10 feet. Placement tolerances at greater depths should be deleted and replaced with tons/square as specified for under water placement of stone.

****

****

NOTE: Alternative 1.

****

Place [filter layers, composed of geotextile [and a [_____] -mm -inch layer of filter stone][and a [_____] -mm -inch layer of sand (cushion layer)] on the prepared base as described below, in accordance with the details shown on the contract drawings, and within the limits either shown on the contract drawings or stake in the field.] [A tolerance of plus 50 mm 2 inches and minus [25][50] mm [1 inch][2 inches] from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the filter layers, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet.]

****

NOTE: Alternative 2.

****

Place [filter layers composed of a [_____] -mm -inch lower layer of [Sand "[_____]"], [a [_____] -mm -inch middle layer of Gravel "[_____]"], and a [_____] -mm -inch upper layer of [Gravel "[_____]"] [Filter Stone] on the prepared base as described below, in accordance with the details on the contract drawings, and within the limits shown on the contract drawings or stake in the field.] [A tolerance of plus [_____] mm inch(es) and minus [_____] mm inch(es) from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the filter layers, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet].

[3.4.2 Geotextile

****
NOTE: Delete this paragraph if Alternate 2 is used.
****

Install geotextile as specified in Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK.

][3.4.3 Placement of [Filter Material] [Sand Cushion Layer] on Geotextile

****
NOTE: Delete this paragraph if Alternate 2 is used.
****

Uniformly spread [crushed stone][filter material] on the geotextile to the [slope] lines and grades as indicated on the contract drawings and in such manner as to avoid damage to the geotextile. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Placing of [crushed stone][filter stone][sand cushion layer] by methods which tend to segregate the particle sizes within the filter layer is prohibited. Repair or replace any damage to the surface of the geotextile during placement of [crushed stone][filter stone][sand cushion layer] before proceeding with the work. Compaction of material placed on the geotextile will not be required, but finish to present an adequately even surface, free from mounds or windrows.

]3.4.4 Placement of Filter Material on Prepared Base

Uniformly spread filter material on the prepared base to the [slope] lines and grades as indicated on the contract drawings and in such manner as to avoid damage to the prepared base. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Placing of [sand,] [gravel,] and [crushed stone] by methods which tend to segregate the particle sizes within the filter layers or cause mixing of the separate layers is prohibited. Repair or replace any damage to the surface of the prepared base during placement of the material before proceeding with the work. Compaction of material placed on the prepared base will not be required, but finish each layer to present an adequately even surface, free from mounds or windrows.

3.5 PLACEMENT OF RIPRAP

****
NOTE: At the end of this section, the Specifier must attach copies (Plates) of ENG FORM 4794-RM RIPRAP GRADATION CURVES for M40, M_____ (ENG FORM 4794-R RIPRAP GRADATION CURVES for R90, R_____), etc.
****

3.5.1 General

****
NOTE: The Specifier will not specify riprap by layer thickness. Specify riprap by the weight of the maximum D100 size of the riprap gradation.

****

Place riprap on the [filter] [and] [bedding] layers specified in paragraph(s) [BEDDING MATERIAL] [and] [FILTER MATERIAL] within the limits shown on the contract drawings.

3.5.2 Placement

****

NOTE: Select appropriate Alternative.

****

[Use under water placement rates when the top of the layer to be placed is covered by more than 900 mm 3 feet of water.]

[3.5.2.1 Above Water

****

NOTE: Alternative 1.

For placement of riprap above water on a bedding layer or filter layer(s).

For tolerances in general, 1/2 of the average stone dimension of gradation range is allowed above the neatline and 1/4 of the same dimension is allowed below the neatline.

Use bottom hinged tailgates on dump trucks used in placing the riprap if larger than M180 R400 riprap is specified.

****

Place riprap in a manner which will produce a well-graded mass of rock with the minimum practicable percentage of voids, and construct, within the specified tolerances, to the lines and grades shown on the contract drawings or stake in the field. A tolerance of plus [_____] mm inch(es) and minus [_____] mm inch(es) from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the riprap, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet. The average tolerance above or below the neat lines for the entire job must have no more than 50 percent of the tolerances specified above. [Place riprap by means of truck, crane operated skip-pan (box), dragline bucket, clamshell, rock-bucket, hydraulic excavator, trackhoe, or other approved equipment. [The use of tractor loaders or other equipment commonly referred to as front end loaders is prohibited. [Pneumatic tired front end loaders may be used provided that in the opinion of the Contracting Officer no degradation of the rock occurs.]]] Place riprap to its full course thickness in one operation and in such manner as to avoid displacing the [bedding] [filter] material. Distribute large stones well and grade the entire mass of stones in their final position to conform to the gradation specified in paragraph RIPRAP. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Provide finished riprap that is free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers will not be permitted. Placing riprap by dumping it into chutes, or by similar methods likely to cause segregation of the various sizes, is prohibited. Placing riprap by dumping it at the top of the slope and pushing it down the slope is prohibited. Do not operate equipment directly on the completed stone protection system. Produce the desired distribution of the various sizes of stones throughout the mass by selective loading of the material at the quarry or other source; by controlled dumping of successive loads during final placing; or by other methods of placement which will produce the specified results. Each truckload must be representative of the gradation requirements. [Equip all dump trucks used in placing the riprap with bottom hinged tailgates. Arrange the gate releasing mechanism so that it may be operated only from, at, or near the front of the truck.] Rearrange individual stones to the extent necessary to obtain a well-graded distribution of stone sizes as specified above.[However, manipulating stone by means of dozers or other blade equipment is prohibited.][Unless otherwise authorized by the Contracting Officer, place riprap in conjunction with the construction of the embankment and with only sufficient lag in construction of the stone protection as may be necessary to prevent mixing of embankment and stone protection materials.][Maintain the stone protection until accepted by the Contracting Officer; replace any material displaced prior to acceptance due to the Contractor's negligence with no additional payment and to the lines and grades shown on the contract drawings.]

****

NOTE: Alternative 2.

For placement of riprap on geotextile or geotextile and filter stone.

Tolerance +100 mm and -50 mm +4 inches and -2 inches for riprap with a top size up to 230 kg 500 pounds riprap and a tolerance of +150 mm and -150 mm +6 inches and -6 inches for large riprap.

Add bottom hinged tailgates to dump trucks used in placing the riprap if larger than M180 R400 riprap is specified.

Drop heights of 900 mm 3 feet specified in this paragraph are based on the geotextile having a minimum puncture strength of 0.51 kN 115 pounds and a minimum tensile strength of 1.07 kN (240 pounds) and the riprap has a top size larger than 90 kg 200 pounds. For riprap with a top size larger than 90 kg 200 pounds and less than 225 kg 500 pounds, the drop height is reduced to 600 mm 2 feet without a layer of filter stone or a sand cushion layer is required.

****

[Place riprap to produce a well graded mass of rock with the minimum practicable percentage of voids, and construct within the specified tolerances to the lines and grades indicated. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material to ensure a relatively homogenous mass. A tolerance of plus [_____] mm inch(es) or minus [_____] mm inch(es) from the slope lines and grades indicted will be allowed in the finished surface of the riprap, except ensure that either extreme of such tolerance is not continuous over an area greater than 18 m^2 200 square feet. The average deviation from the neat line of the entire job must not be more than 50 percent of the tolerance specified above. Do not drop stone through air from a height greater than 900 mm 3 feet and do not drop stones heavier than 230 kg 500 pounds from a height greater than 600 mm 2 feet. [The drop height greater than 300 mm 1 foot for riprap with a top size of 225 kg 500 pounds is prohibited, except, if approved by the Contracting Officer, it may be, increased by placing a cushioning layer of sand [or [_____]] on top of the geotextile before placing the riprap, or other methods deemed necessary if demonstrated in the field to not damage the geotextile.] Distribute the larger stones and roughly grade the entire mass of stones in their final position to conform to the gradation specified in paragraph RIPRAP, subparagraph GENERAL. Provide finished riprap that is free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers will not be permitted. Placing riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. Placing riprap by dumping it at the top of the slope and pushing it down the slope is prohibited. Do not operate equipment directly on the completed stone protection system. Obtain the desired distribution of the various sizes of stones throughout the mass by selective loading of the material at the quarry or other source, by controlled dumping of successive loads during final placing, or by other methods of placement which will produce the specified results. Equip all dump trucks used in placing the riprap with bottom hinged tailgates. Arrange the gate releasing mechanism so that it may be operated only from, at, or near the front of the truck. Rearrange stones to the extent necessary to obtain a well-graded distribution of stone sizes as specified above. Maintain the stone protection until accepted by the Contracting Officer; replace any material displaced by any cause, with no additional payment, to the lines and grades indicated.]

][3.5.2.2 Under Water

****

NOTE: The equation presented in this paragraph (Alternative 3) was developed to simplify the relationship between required riprap layer thickness and underwater placement rate in slack water. This equation assumes that riprap weighs approximately 1.8 tons metric per cubic meter 1.5 tons per cubic yard and that the underwater placement rate is based upon a required layer thickness 1.5 times the layer thickness required to be constructed in the dry. The quantities are based on a placement to be performed in two passes with the second pass being perpendicular to the first. This equation is provided as an example and should be modified to meet project design criteria.

$$T_{mm} = \frac{(1.36t)(1.5)}{(25M^2)(304\text{ mm})} = R_M$$

T_{mm} = Required theoretical thickness if placed in the dry. (Layer thickness given in mm.)

R_M = Required placement rate in Tons/sq m/pass

180 kg placement rate is 10 T/sq m/pass (assume required thickness in the dry is 750 mm for high turbulent flow criteria).

90 kg placement rate is 5 T/sq m/pass (assume required thickness in the dry is 400 mm for low turbulent flow criteria).

$$T(0.347) = \frac{(1.5\ T/yd^3)(100\ ft^2)(1.5)}{(27\ ft^3/yd^3)(12\ in./ft)(2)} = R$$

T = Required theoretical thickness if placed in the dry. (Layer thickness given in inches.)

R = Required placement rate in Tons/sq/pass. Where a square is referring to 100 square feet.

400 pound placement rate is 10 T/sq/pass (assume required thickness in the dry is 30 inches for high turbulent flow criteria).

200 pound placement rate is 5 T/sq/pass (assume required thickness in the dry is 16 inches for low turbulent flow criteria).

Alternative 3:

The depth of water over the geotextile is based on the puncture strength of the geotextile being a minimum of 0.61 kN 140 pounds and the impact energy of 1.74 kN 400 pounds top size riprap being placed without a layer of filter stone or sand cushion layer.

****

When riprap [, with a maximum size of 180 kg 400 pounds,] is placed under water onto geotextile it may be dropped from the water surface if the water depth over the geotextile is greater than 1.5 m 5 feet. Place riprap in the wet evenly at a rate of [_____] tons per square (9.3 m^2) tons per square (100 square feet) per pass for M[_____] R[_____] riprap and [_____] tons per square (9.3 m^2) tons per square (100 square feet) per pass for M[_____] R[_____] riprap. Prior to starting work, submit the proposed method of placing riprap under water. Riprap to be placed in the wet must be done during periods of low water levels during the months of June through November. Place riprap in two passes, with the second pass perpendicular to the first pass. The total quantity of M[_____] R[_____] riprap placed in two passes must be [_____] tons per square and the total quantity of M[_____] R[_____] riprap placed in two passes must be [_____] tons per square.

][3.6 PLACEMENT OF GROUTED RIPRAP

3.6.1 General

Place riprap on the [filter] [and] [bedding] material specified in paragraph(s) [FILTER MATERIAL] [and] [BEDDING MATERIAL] within the limits shown. [Install pressure relief holes every 3 m 10 feet and formed by 75-mm 3-inch diameter pipe. Install the end(s) of the pipe into the [bedding][filter] layer so that it will not become clogged with grout. Use perforated or slotted cap end(s) of the pipe buried in the [bedding][filter] layer. Exercise necessary care to prevent grout from entering the weep holes.]

3.6.2 Placement

****

NOTE: Placement of grouted riprap must be placed in the dry on filter layers or bedding layer.

Tolerances of +150 mm +6 inches for riprap up to 300 kg 650 pounds and a tolerance of +300 mm +12 inches for large riprap.

Add bottom hinged tailgates to dump trucks used in placing the riprap if larger than 180-kg 400-pound riprap is specified.

****

[Place riprap in a manner which will produce a well-graded mass of rock with the minimum practicable percentage of voids, and construct, within the specified tolerance, to the lines and grades either shown on the contract drawings or staked in the field. A tolerance of not less than plus [_____] mm inch(es) from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the riprap except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet. The average deviation from the lines on the drawing for the entire job must have no more than 50 percent of the tolerances specified above. Place riprap to its full course thickness in one operation and in such manner as to avoid displacing the [filter] [bedding] material. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Distribute large stones well and grade the entire mass of stones in their final position to conform to the gradation specified in paragraph RIPRAP. Ensure the finished riprap is free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers is prohibited. Placing riprap by dumping it into chutes, or by similar methods likely to cause segregation of the various sizes, is prohibited. Placing riprap by dumping it at the top of the slope and pushing it down the slope is prohibited. Do not operate equipment directly on the completed stone protection system. Obtain the desired distribution of the various sizes of stones throughout the mass by selective loading of the material at the quarry or other source; by controlled dumping of successive loads during final placing; or by other methods of placement which will produce the specified results. Each truckload is representative of the gradation requirements. [Equip all dump trucks used in placing the riprap with bottom hinged tailgates. Arrange the gate releasing mechanism so that it may be operated only from, at, or near the front of the truck.] Rearrange individual stones to the extent necessary to obtain a well-graded distribution of stone sizes as specified above. [Unless otherwise authorized by the Contracting Officer, place riprap in conjunction with the construction of the embankment and with only sufficient lag in construction of the stone protection as may be necessary to prevent mixing of embankment and stone protection materials.] Maintain the stone protection until accepted by the Government; replace any material displaced prior to acceptance due to the Contractor's negligence at no additional cost, and to the lines and grades shown on the contract drawings.]

3.6.3 Grouting of Riprap

Place grout as specified in paragraph PRODUCING, CONVEYING AND PLACING OF GROUT.

][3.7 PLACEMENT OF RIPRAP PAVING STONE

3.7.1 General

Place riprap paving on the [filter][and][bedding] material specified in paragraph(s) [FILTER MATERIAL][and][BEDDING MATERIAL] within the limits shown.

3.7.2 Placement

Place riprap paving stone carefully, by hand or machine, resulting in a compact paving to the lines and grades either shown on the drawings or staked in the field. Place the stone in a single layer with the dimensions of the stones corresponding to the thickness of the paving laid normal to the plane of the slope. Select adjacent stones for size and shape and lay in such close contact as to produce a reasonable minimum of voids. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Place the stones in roughly coursed array with courses running horizontally and breaking joints with the preceding course as far as practicable. Double-decking of the flat stones to obtain the required depth of paving is prohibited. Fill spaces between the stones in the face of the paving with tightly driven spalls and tamp the paving if necessary to produce a compact mass and an adequately even surface. A tolerance of plus or minus [_____] mm inch(es) from the slope lines and grades shown will be allowed in the finished surface of the riprap paving, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet.

][3.8 PLACEMENT OF HAND-PLACED RIPRAP

3.8.1 General

Place hand-placed riprap on the [filter][and][bedding] material specified in paragraph(s) [FILTER MATERIAL][and][BEDDING MATERIAL] within the limits shown. Stone must conform to the requirements of [paragraph RIPRAP][Part 2 of this Setion]. Except for spalls for wedging, stone must be roughly rectangular in shape of which the least dimension must be no less than one-third the length.

3.8.2 Placement

Carefully place riprap by hand in such a manner that adjacent stones are in close contact and, in general, have their greatest dimensions across the slope. Place "through stones" well-distributed throughout the mass and the sum of their cross sections, parallel to the slope being protected, and covering not less than than two-thirds of such area. As used in this specification a "through stone" is defined as a stone with dimension normal to the surface being riprapped is not less than the full depth of the riprap. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material on the slope immediately adjacent to previously placed material in such a manner to ensure a relatively homogenous mass. The riprap along the lower edge of an area must consist of the largest stones set in a trench so as to form a band. Except for spalls used to fill voids between larger stone, do not use stone in the exposed face of the riprap which will extend less than one-half the thickness of the riprap. Fill spaces between the larger stones with spalls and smaller stones of the largest feasible size to form a compact mass. Do not place spalls and small stone in nests in lieu of larger size stone. A tolerance of plus or minus [_____] mm inch(es) from the slope lines and grades shown will be allowed in the finished surface of the riprap paving, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet.

][3.9 PLACEMENT OF GROUTED HAND-PLACED RIPRAP

3.9.1 General

Place hand-placed riprap on the [filter][and][bedding] material specified in paragraph(s) [FILTER MATERIAL][and][BEDDING MATERIAL] within the limits shown. Stone must conform to the requirements of paragraph RIPRAP. Except for spalls for wedging, stone must be roughly rectangular in shape of which the least dimension must be no less than one-third the length.

3.9.2 Placement

Carefully place the riprap paving to form a layer [_____] mm inch(es) in thickness. Place the riprap in conformance with the general requirements of paragraph PLACEMENT OF HAND-PLACED RIPRAP, except lay the stone with open joints to facilitate grouting and do not fill the smaller spaces between stones in the face of the paving with spalls but leave open to receive grout readily. [Install pressure relief holes every 3 m 10 feet and form by 75-mm 3-inch diameter pipe. Install the end(s) of the pipe into the [bedding][filter] layer so that it will not become clogged with grout. Use slotted or perforated caps on the end(s) of the pipe, which is buried in the [bedding][filter] layer.. Exercise necessary care to prevent grout from entering the weep holes.]

3.9.3 Grouting of Hand-Placed Riprap

Place grout as specified in paragraph PRODUCING, CONVEYING AND PLACING OF GROUT.

][3.10 PLACEMENT OF GROUTED RIPRAP PAVING

3.10.1 General

Place riprap paving on the [filter][and][bedding] material specified in paragraph [FILTER MATERIAL][and][BEDDING MATERIAL] within the limits shown. Stone must conform to the requirements of paragraph PLACEMENT OF RIPRAP PAVING STONE.

3.10.2 Placement

Carefully place riprap paving to form a layer [_____] mm inch(es) in thickness. Place riprap in conformance with the general requirements of paragraph PLACEMENT OF RIPRAP PAVING STONE except place the stone with open joints to facilitate grouting.Do not fill the smaller spaces between stones. Filling joints with spalls is prohibited in this case. Leave open space to receive grout readily. [Install pressure relief holes every

3 m 10 feet and form by 75-mm 3-inch diameter pipe. Install the end(s) of the pipe into the [bedding][filter] layer so that it will not become clogged with grout. Cap the end(s) of the pipe which is buried in the [bedding][filter] layer and perforate with holes or slots. Take care to prevent grout from entering the weep holes.]

3.10.3 Grouting of Riprap Paving

Place grout as specified in paragraph PRODUCING, CONVEYING AND PLACING OF GROUT.

][3.11 PLACEMENT OF [DERRICK STONE] [AND] [CAPSTONE]

****

NOTE: The tolerance for the riprap layer may have to be tightened in paragraph PLACEMENT OF RIPRAP to meet tolerance required for this layer.

****

3.11.1 General

Place [derrick stone] [and] [capstone] carefully with equipment suitable for handling the stone of the size(s) specified on a [_____] mm inch(es) thick layer of [M40] [M____] [R90] [R____] riprap specified in paragraph PLACEMENT OF RIPRAP.

[3.11.2 Placement

Place the various sizes of [derrick stone] [and] [capstone] in such a manner as to produce a compact, uniform, well-graded mass [within the limits shown on the contract drawings.] [to the lines and grades indicated on the contract drawings and staked in the field.] Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Select adjacent stone with reasonable care as to size and shape and place in close contact, the smaller stones filling the spaces between the larger ones so as to leave a reasonable minimum of voids. Distribute "through stones" well throughout the mass, and ensure the sum of their cross sections parallel to the surface being protected is no less than 70 percent of such area. As used herein, a "through stone" is defined as a stone whose dimension normal to the surface being protected is not less than the full depth of the protection. A tolerance of no less than plus [_____] mm inch(es) from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the stone except ensure the extreme of deviation from lines and grades is not continuous over an area greater than 18 m^2 200 square feet. The average deviation from lines and grades of the entire job must have no more than 50 percent of the tolerances specified above. Maintain the stone until accepted by the Government; replace to the lines and grades shown on the contract drawings any material displaced prior to acceptance at no additional cost to the Government.

]]3.12 GROUTING OF STONE PROTECTION

Place grout as specified in paragraph PRODUCING, CONVEYING AND PLACING OF GROUT.

3.12.1 Producing, Conveying and Placing of Grout

3.12.1.1 Producing Grout

Use batching and mixing equipment with provide sufficient capacity to prevent cold joints. Stockpile materials and utilize batching methods that prevent segregation or contamination of aggregates and insure accurate proportioning of the ingredients of the mixture. Follow applicable portions of ASTM C476 requiring clean a potable water. Mixing in additional water in excess of the amount required by the job mix to the grout mixture during mixing, hauling, or after arrival at the delivery point[, except as required and approved] is prohibited.

a. Ready-Mixed Concrete Grout must conform to ASTM C94/C94M except as otherwise specified.

b. Volumetric Batching and Continuous Mixing must conform to ASTM C685/C685M.

c. Onsite Batching and Mixing. The Contractor has the option of using an onsite batching and mixing facility. The facility must provide sufficient capacity to prevent cold joints and be able to batch the cement and aggregate by weight, and the water and admixtures by weight or volume. The method of measuring materials, the batching operation, and the mixer must be approved in accordance with paragraph SUBMITTALS. On-site plant must conform to the requirements of either ASTM C94/C94M or ASTM C685/C685M.

3.12.1.2 Preparation for Placing

[Take adequate precautions to prevent grout from penetrating the upper filter layer.]Flush the rock with water to remove the fines from the rock prior to placing the grout. Keep tstone moist just ahead of the actual placing, but keep free of flowing or standing water during the grout operation. Remove any snow and ice. Ensure all equipment needed to place, protect, and cure the grout is at the placement site and in good operating condition. The entire preparation must be accepted by the Contracting Office prior to placing the grout.

3.12.1.3 Conveying and Placing

Grout placement will not be permitted when weather conditions prevent proper placement, except upon approval. Submit the methods and equipment for transporting, handling, depositing, and consolidating the grout prior to first grout placement. Do not place the grout mixture until the stone protection has been inspected and approved. Ensure grout is in place within 15 minutes after discharge from the mixer. Do not drop grout more than 1.5 m 5 feet vertically unless suitable equipment is used to prevent segregation.

a. Conveying

When the grout is mixed [and] [or] transported by a truck mixer, deliver the grout to the site of the work and complete discharge within 1-1/2 hours after introduction of the cement to the aggregate and water. When the air temperature is 29 degrees C 85 degrees F or greater) or under conditions contributing to quick stiffening of the grout, the time between the introduction of the cement and discharge of the grout must not exceed 45 minutes. The Contracting Officer may allow a longer time, provided the setting time of the grout is increased a corresponding amount by the addition of an approved set-retarding admixture. Deposit grout as close as possible to its final position by methods that will prevent segregation of the aggregates or loss of mortar.

b. Placing

Keep the riprap moist just ahead of the actual grout placement, but free of standing or flowing water when placing grout. Grout placed on inverts or other nearly level areas may be placed in one course. On slopes, place the grout in two (2) courses in successive lateral strips approximately 3 m 10 feet in width starting at the toe of the slope and progressing to the top. Deliver the grout to the place of final deposit and discharge directly on the surface of the riprap, using a splash plate of metal or wood to prevent displacement of the rock directly under the discharge. Direct the flow of grout with brooms, spades or baffles to prevent it from flowing excessively along the same path and to assure that all intermittent spaces are filled. Perform sufficient barring to loosen tight pockets of riprap and otherwise aid the penetration of grout so that all voids are filled and the grout fully penetrates the riprap [as specified][from the base of the riprap layer to at least two-thirds of the thickness of the stone layer]. Ensure all brooming on slopes is uphill and after the grout has stiffened, rebroom the entire surface to eliminate runs, to fill voids caused by sloughing, and to remove grout from the top surface and pockets or depressions of the upper stones.

3.12.1.4 Cold-Weather Requirements

Do not place grout when the ambient temperature is below 2 degrees C 35 degrees F, nor if the ambient temperature is below 5 degrees C 40 degrees F and falling. Provide suitable covering and other means, as approved, for maintaining the grout at a temperature of at least 10 degrees C 50 degrees F for no less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. When freezing conditions prevail, riprap to be grouted must be covered and heated to a range of 5 to 16 degrees C 40 to 60 degrees F for at least 24 hours prior to placing the grout. Mixing salt, chemicals, or other foreign materials with the grout to prevent freezing is prohibited. Remove and replace any grout damaged by freezing at the expense of the Contractor.

3.12.1.5 Hot Weather Requirements

When the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, is expected to exceed 100 g/m^2 0.2 pounds per square foot per hour, provide windbreaks, shading, fog spraying, or wet covering with a light-colored material in advance of placement, and deploy protective measures as quickly as finishing operations will allow.

3.12.2 Curing and Protection of Grouted Stone Protection

Beginning immediately after placement and continuing for at least 7 days, cure all grout and protect from premature drying, extremes in temperature, rapid temperature change, freezing, mechanical damage, and exposure to rain or flowing water. Make all materials and equipment needed for adequate curing and protection available and at the site of the placement prior to the start of grout placement. After completion of any strip or panel, no workman or other load is permitted on the grouted surface for a period of twenty-four (24) hours. Keep exposed surfaces continuously moist for the entire curing period, or until curing compound is applied. Preserve moisture for grout surfaces by one of the following methods:

a. Continuous sprinkling and ponding.

b. Application of absorptive mats or fabrics kept continuously wet.

c. Application of sand kept continuously wet.

d. Application of impervious sheet material conforming to ASTM C171.

e. Application of membrane-forming curing compound conforming to ASTM C309. Spray the compound on the moist surface as soon as free water has disappeared, but do not apply to any surface until finishing of that surface is completed. Apply at a uniform rate of not less than 300 ml/m2 (1 gallon per 150 square feet) of surface and form a continuous adherent membrane over entire surface to be cured. Curing compound on surfaces requiring bond to subsequently placed grout is prohibited. If the membrane is damaged during the curing period, reapply compound to damaged area at the rate of application specified above.

3.13 TRENCHFILL REVETMENT, BANK PAVING, AND OUTLET DRAINS

3.13.1 Trenchfill Revetment

Stone for the trenchfill must be Graded Stone ["A"] ["B"] ["C"] [[_____]-kg] [[_____]-Pound] Stone and must be back-dumped from the dump trucks, placed by skip, clamshell, or other approved method directly in the trench excavated at the toe of the graded revetment slope. Do not place stone more than 300 m 1,000 feet in advance of the completed trenchfill section, including upper bank paving, unless otherwise permitted by the Contracting Officer. Construct the trenchfill to the elevations and cross sections shown on the drawings. A tolerance of [150][_____] mm [6][_____] inches above or below the lines and grades of final excavation will be permitted provided the area of the finished section is not less than the area of the theoretical section. Complete placement of the trenchfill prior to placement of the bank paving. Bulldozing of stone from the upper bank into the excavated trench is prohibited.

3.13.2 Bank Paving

Stone bank paving must be Graded Stone "C" [[57][_____]-kg [125][_____]-pound stone] [_____] -kg -Pound riprap. Excess stone placed directly in the trench at the toe of the graded revetment slope may be dragged up the slope a maximum of 3 m 10 feet vertically above the [Average Lower Water Plane (ALWP)] [Lowe Water Datum (LWD)]. The remainder of the upper bank paving stone may be placed in continuous stockpiles at 3 m 10 feet intervals above the [ALWP][LWD] by means of back-dumping from dump trucks or by skip, clamshell, or other approved method, and dragged up the slope a maximum of 3 m 10 feet vertically. The remainder of the upper bank paving stone may also be back-dumped from dump trucks; placed by skip, clamshell, or other approved method; and spread by bulldozing except that pushing stone down the slope will not be permitted and maximum allowed drop heights are not to be exceeded. Place the stone in such a manner to achieve a minimum of segregation of sizes in the in-place upper bank paving stone, with uniform gradation from the bottom of the slope to the top elevation of the stone as indicated on the drawings. Prior to placing the stone, bring graded slopes to final grade and dress to conform to the limits specified in Section 31 00 00 EARTHWORK and to the lines and grades in the contract drawings. A tolerance of 75 mm 3 inches above and below the specified bank paving thickness will be allowed provided the area of the finished section is not less than the area of the theoretical section. To prevent overtopping of the paved portion of the slope by rising river stages, place bank paving in strips parallel to the water's edge when directed by the Contracting Officer. Repair any damage to the graded bank or paving occasioned by such overtopping of the paving because of failure to keep paving operations above the water surface.

3.13.3 Outlet Drains

Where required, construct standard outlet drains or special drainage ditches. A tolerance of 150 mm 6 inches above or below the lines and grades will be permitted provided the area of the finished section is not less than the area of the theoretical section. Place Graded Stone "C" [[_____] -kg -Pound stone] [[_____] -kg -pound riprap] for all outlet drain paving to provide a minimum of segregation of sizes in the in-place materials. Place a layer of 150-mm 6-inch thick bedding stone under the Graded Stone "C" [[_____] -kg -pound stone] [[_____] -kg -pound riprap] in the manner and at the locations shown on the drawings. A thickness tolerance of plus 25 mm 1 inch for the 150-mm 6-inch thick bedding material will be allowed. Where the outlet drains must be constructed in silts or silty sands, place a 150-mm 6-inch layer of bedding sand beneath the bedding stone. The bedding sand must meet the quality and gradation requirements as specified in paragraph BEDDING MATERIALS.

3.13.4 Toe Trench Revetment

Construct toe trench revetment, when so ordered on the construction schedule, at locations where the existing bank or riverbed at the structure azimuth line is 3 m 10 feet or less below [Average Low Water Plane (ALWP)] [_____]. The Toe Trench Revetment must consist of stone placed along the toe of the bank excavated as specified in [Section 31 00 00 EARTHWORK] [_____] and on the graded slope of the upper bank as applicable. Provide two types of Toe Trench Revetment as shown on the contract drawings for the following conditions:

a. Type "A" - For conditions where the top of the graded slope is 2700 mm 9 feet or more above [Average Low Water Plane (ALWP)] [LWD] [_____].

b. Type "B" - For conditions where the top of the graded slope is less than 2700 mm 9 feet above [Average Low Water Plane (ALWP)][LWD] [_____].

3.13.4.1 Trench Fill

Place a fill consisting of stone along the excavated toe of the bank to the elevation and cross section designated on the contract drawings for both types of toe trench revetment. Ensure fill consists of no less than 27 tons 9 tons nor more than 41 tons 14 tons of stone per meter linear foot of fill, unless otherwise specified on the construction schedule. A dozer to move stone from the upper bank into the trench is prohibited.

3.13.4.2 Upper Slope Fill

For Type "A" revetment, place a fill consisting of stone on the graded slope to a minimum depth normal to the slope of 250 mm 10 inches at the top of the slope and increasing uniformly to a minimum depth of 375 mm 15 inches where it abuts the trench fill. Arrange the upper slope fill uniformly with the larger stone at the bottom of the slope and the small stone at the top and do not exceed 0.7 t/m^2 7 T per 100 square foot of upper slope fill. Rearrange the upper slope fill stone as necessary to conform to these specifications. The use of a dozer in placing the upper slope fill is prohibited.

3.13.4.3 Crown Fill

For Type "B" revetment, place a fill consisting of stone, abutting the trench fill, to the elevation and crown width specified on the construction schedule and drawings. The crown fill must have a riverward side slope of 1V on 3H, a landward side slope of 1V on 2H, and a minimum thickness of 375 mm 15 inches as shown on the contract drawings.

3.13.4.4 Juncture With Other Types of Revetment

Where toe trench revetment joins an existing structure and the alignment and riverward slopes of the stone fills in the structures are not the same, construct a transition by gradually adjusting the alignment and slope of the toe trench revetment over a distance of approximately 30 m 100 feet so that it conforms to the alignment and slope of the existing stone fill at the junction of the structures. Construct the transition in a workmanlike manner and as directed by the Contracting Officer.

3.13.4.5 Intermittent Repair of the Trench Fill and Upper Slope Area of Revetment

Intermittent repair consists of stone placed along the trench fill and/or upper slope area of the revetment to the elevation and cross section designated on the drawings for trench fill or upper slope, and is ordered on the construction schedule. When specified by the Contracting Officer, adjustment in the line and grade may be authorized to accomplish necessary repairs to conform to alignment and grade of undamaged sections. Do not perform trench fill repair when the river stage exceeds [Average Low Water Plane (ALWP)] [LWD] [_____] and do not perform upper slope repair when the river stage exceeds 1.5 m 5 feet above [ALWP] [LWD][_____], unless otherwise directed by the Contracting Officer.

3.13.5 Stone Fill Revetment

Construct stone fill revetment, when so ordered on the construction schedule, that consists of a stone fill placed as specified in [Section 31 00 00 EARTHWORK] [_____]. If required to obtain proper placement of material, the Contractor has the option of using either mooring piles, anchors, spud barges, or other suitable methods approved by the Contracting Office to obtain the proper configuration and alignment while placing stone.

3.13.5.1 Stone Fill

Place a fill consisting of stone along the structure azimuth line to a cross-section as shown on the contract drawings and to such elevation and crown width as specified on the construction schedule. The [riverward][lakeward][inboard] slope must be [1V on 1.5H][ ] and must intersect the structure azimuth line 900 mm 3 feet below [ALWP][LWD] [_____] unless otherwise specified; minor irregularities must be approved by the Contracting Officer. Place the stone in lifts of such height and length as the Contracting Officer considers necessary to prevent or reduce scour ahead of the fill.

3.13.5.2 Juncture With Other Types of Revetment

Where stone fill revetment joins and existing structure and the alignment and riverward slope of the stone fills in the structures are not the same, construct a transition by gradually adjusting alignment and slope of the stone fill revetment over a slope of the existing stone fill at the junction of the structures. Construct the transition in a workmanlike manner and as directed by the Contracting Officer.

3.14 STONE REVETMENT, STONEFILL DIKES, STONEROOTS, AND JUNCTIONS

3.14.1 Excavation and Grading

Where required for bank protection, excavate and grade the existing ground at the proposed structures to provide a foundation for the complete placement of stone. Perform excavation and grading in accordance with Section 31 00 00 EARTHWORK.

3.14.2 Construction Method

Construct the stonefill revetment and dikes of [Graded Stone ["A"] ["B"] ["C"]] to the lines, grades, and sections shown or as noted on the drawings. Commence construction of the stonefill revetments and stonefill dikes at the upstream end and continue progressively to the downstream end. The initial work consists of a stone blanket approximately 600 mm 2 feet thick and extending over the full width and length of the revetment or dike. If stone is placed by land based equipment, this stone blanket is not unless directed by the Contracting Officer. Place the remaining stone required to complete the underwater portion of the revetment or dike from the shoreward to the [riverward] [lakeward] end of the revetment or dike in approximately uniform layers not exceeding 1.5 m 5 feet in thickness and extending over the full width and length of the revetment or dike. The portion of the revetment or dike above the water may be placed in one lift.

3.14.3 Placement

Place stone in the revetment and dikes by skip or clamshell, cast off barges by hand or machine, or by other methods approved by the Contracting Officer. Distribute the larger stone well throughout the mass, and ensure the finished revetment or dike is free from pockets of small stone and clusters of larger stone. A tolerance of plus or minus 300 mm 1 foot will be allowed on the prescribed crown elevation and width. Determine the side slopes by the natural angle of repose of the stone, varying from 1V on 1.25H to 1V on 2H.

3.14.4 Stoneroots

Place stoneroots consisting of [Graded Stone ["A"] ["B"] ["C"] [_____] -kg -pound stone][[_____] -kg -pound riprap] in the excavated trench as specified in paragraph PLACEMENT and as shown on the drawings.

3.14.5 Junctions

Construct junctions consisting of [Graded Stone ["A"] ["B"] ["C"] [_____] -kg -pound stone][[_____] -kg -pound riprap]. The 60 m 200 feet trenchfill revetment wraparound portion of the junction must consist of Graded Stone "B".

3.15 CAPOUT AND REINFORCEMENT

The work covered by this section consists of furnishing all plant, labor and stone, and performing all work necessary in placing the stone for the revetments and dikes capouts, and reinforcement, complete, all as specified herein and shown on the drawings. Ensure stone is Graded Stone "B".

3.15.1 Debris Removal

Remove debris from the structures to allow for the placement of the stone in the capout and reinforcement to the extent directed by the Contracting Officer. There will be no measurement nor payment for the debris removal and all costs will be considered incidental to the contract. Dispose of debris [landward of the existing structures] [_____] so as not to interfere with placement of capouts and reinforcement.

3.15.2 Construction Method

Construct capouts and reinforcement of Graded Stone "B" at the lines, grades and sections shown or as noted on the drawings. Commence construction at the upstream end of each structure or portion thereof and continue progressively to the downstream end. Place stone required to complete the underwater portion of the capouts and reinforcement from the upstream to the downstream end of the revetments and landward end to the riverward end of the dikes in approximately uniform layers not exceeding [1.5][_____] m [5]feet[_____] in thickness and extending over the full width and length of the revetment. The portion of the revetments or dikes above the water may be placed in one lift. Where reinforcement is required to be placed below water , place the stone from barges or by other approved methods to provide a close compact paving with a required thickness of [600][_____] mm [2][_____] feet. Ensure that the stone placement methods for placement of stone between Structural Azimuth Line (SAL) stations [_____] to [_____] will not result in damages to the "sensitive historic site." Prior to the start of work submit,for approval, the proposed method or methods for placing stone underwater.

3.15.3 Placement

Place stone in the capouts and reinforcement by skip, clamshell, cast off barges by hand or machine, or by other methods approved by the Contracting Officer. Distribute the larger stone well throughout the mass and ensure the finish revetment is free from pockets of small stone and clusters of larger stone. A tolerance of plus or minus [150][_____] mm [6][_____] inches will be allowed for reinforcement and a tolerance of plus or minus [300][_____] mm [1][_____] foot will be allowed for capouts on the prescribed crown elevation and width provided the area of the finished section is not less than the area of the theoretical section. Ensure the allowable tolerances from the prescribed theoretical cross section are not continuous for more than [60][_____] m [200][_____] linear foot of revetment and/or dike. When completed, abrupt changes in the revetment and/or dike crown widths and elevations are not permitted.[The side slopes may be determined by the natural angle of repose of the stone, varying from 1V on 1.25H to 1V on 2H.]

3.16 STONE DIKE

3.16.1 Dike Stone Placement

Construct diked to the elevations, cross sections, and minimum thicknesses and within the limits shown on the contract drawings. Determine side slopes by the angle of repose of the stone, approximately 1V on 1.25H. Construct dikes of Graded Stone "A" as specified in paragraph GRADED STONE "A". Place stone in the dikes in such a manner as to produce a well-graded mass of stone with the minimum practicable percentage of voids. A tolerance of 300 mm 1 foot will be allowed in the specified elevation, and 300 mm 1 foot under and 600 mm 2 feet over in the specified crown width provided these variations are gradual over a minimum distance of 30 m 100 feet measured along the dikes centerlines. The stone may be placed by either backhoe or dragline equipped with rock bucket; by [either bulldozer or]front-end loader or bulldozer, except when placing the base blanket subaqueously; and by trucks and other methods, if approved by the Contracting Officer. Add additional stone if either soundings or sections indicate such to be necessary to attain required lines and grades. Arrange large stones throughout the mass distributed and finished sodikes are free from pockets of small stones and clusters of large stones. Bulldozing stone into excavated trenches is prohibited. Subaqueous placement of stone is prohibited at river stage limitations specified in [Section [_____]] [_____], paragraph [RIVER STAGE LIMITATIONS], without prior approval, in writing, by the Contracting Officer or at any river stage when site and current conditions prevail which, in the opinion of the Contracting Officer, make construction operations either impractical or uneconomical.

3.16.2 Placement Control

Furnish, operate, maintain necessary equipment, and furnish all necessary material and supplies while maintaining control of the placement of stone in the dikes. At all times when stone placement from floating plant is underway, the means by which the Contractor positions the plant, equipment, and stone supply barges must function accurately and consistently. The plant and equipment must have a dragline or backhoe capable of being mobile on the spud barge and the flexibility to perform stone placement by the drag-off method. Do not use the kick-off method for stone placement unless approved by the Contracting Officer. Whatever the method employed, it must readily permit the Contractor and the Government inspector to determine the exact position of the stone-placing operation. Do not not place anchors for the purpose of holding floating plant in place over existing or partially completed dikes.

3.16.2.1 Alignment Control

The method of alignment control must be either a manned transit or laser or colored or polarized light beams, or any other method demonstrated to be practicable and sufficiently precise and reliable as approved by the Contracting Officer.

3.16.2.2 Distance Control

The method of distance control for floating plant engaged in the subaqueous placement of stone must be either wire distance wheel or another equally accurate measuring device as approved by the Contracting Officer.

3.16.2.3 Depth Finder

Provide an electronic recording depth finder, approved by the Contracting Officer, in writing, during the construction of the dikes. Provide depth finder with a recording scroll no less than 150 mm 6 inches wide with a scale of not more than 3 m of depth to 25 mm 10 feet of depth to the inch. Ensure the depth finder is capable of obtaining accurate profiles and cross-sections during construction of the dikes and use it to monitor anticipated and actual scour and as an aid in the control of stone placement. Furnish and maintain an adequate stock of recording paper for the depth finder.

3.16.2.4 Nonpermitted Devices

The use of buoys and piles of stone placed above the water surface as placement control devices will not be permitted. The use of bank targets for alignment control will not be permitted for work distances of more than 120 m 400 feet without prior approval, in writing, by the Contracting Officer.

3.16.2.5 Skiff or Boat

Furnish an aluminum skiff or boat with a minimum length of 5.5 m 18 feet and equipped with a 38 kW 50 hp outboard motor.

3.16.3 Longitudinal Stone Dike Placement

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NOTE: For use with stone under 180 kg 400 pounds top size.

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Place stone in the longitudinal peaked stone dikes, stone tiebacks and transverse stone dikes by skip, grapple, hand, or other approved method, in such a manner as to produce a well graded mass or stone with the minimum practicable percentage of voids. Do not drop stone from a height greater than 900 mm 3 feet. A variation of 300 mm 1 foot above or 150 mm 6 inches below the specified deviation and 150 mm 6 inches under or 300 mm 1 foot over the specified crown width will be allowed provided these variations are gradual over a minimum distance of 3 m 10 feet measured along the dike's centerline. Bulldozing stone into excavated trenches will not be permitted. Store stone delivered on-site as specified in paragraph STONE.

3.17 CORRECTIVE EARTHWORK

3.17.1 Grading

Grading consists of the sloping of bluff banks damaged by failures in the bank paving and the preparation of the subgrade for placement of new paving; reshaping of damaged drains and constructing new drains; reshaping of overbank areas; and any incidental work as may be required in the prosecution of the work. Most of the grading will be in areas where mechanical equipment can be used, but some hand grading will be required. Use material resulting from grading operations, including broken pavement, if any, for making fills where required, including the restoration of deficient slopes. Perform all grading and filling to the lines and grades as staked in the field or as specified. Roots, trees, brush, roots, trash and organic materials are prohibited for use in fills. Restored subgrade must be free from roots, brush or other debris; and placed in layers not to exceed 300 mm (1 foot) in thickness. Thoroughly compact each layer to a density at least equal to that of the adjacent undisturbed earth. If environmentally approved, [spread excess clean fill material on the slope adjacent to the area of repair] [excess clean fill may be disposed of].

3.17.2   Excavation in Failure Areas

Perform excavation in failures where protrusion of stone above adjacent surface is objectionable. Where specified, excavate subgrades 250 to 300 mm 10 to 12 inches below the surface of the adjacent paving. Large areas may not require excavating throughout, but excavation to the depths specified above will be required only for a distance of 1.5 m 5 feet inside the perimeter of the failure. Most of the excavation can be accomplished by mechanical means, but some hand work around the edges will be required. Perform all excavation to the lines and grades as staked in the field or as specified. Use material resulting from the operation for making fills where required as specified in paragraph GRADING. Excess material may be wasted or spread on the adjacent slopes.

3.18   BREAKING OUT PAVEMENT

The work consists of the breaking out of concrete or asphalt pavement in damaged or undermined areas of pavement. The concrete pavement is approximately [100][_____] mm [4][_____] inches in thickness, and the asphalt pavement is approximately [125][_____] mm [5][_____] inches in thickness. The area of pavement to be broken out will be marked by the Contracting Officer prior to the start of work. Any additional areas to be broken out adjacent thereto will be marked as required as the work progresses. Repair or replace any pavement outside the limits marked to be broken out that is damaged by the Contractor's operations at no additional cost to the Government. The breaking out may be done by any approved method which will accomplish the results desired and will not damage paving outside the limits marked.[Blasting is prohibited.]

3.18.1   Concrete Breakout

Break up damaged or undetermined monolithic, articulated or slab concrete into pieces not exceeding 450 mm 18 inches in any dimension. Leave the pieces on the subgrade where broken. In areas where grading may be required, break out the concrete to the extent necessary to permit grading the bank to slopes suitable for paving and the broken concrete used in making fills adjacent to the breakout. Using broken concrete for riprap or armor stone is prohibited.

3.18.2   Asphalt Breakout

Generally, asphalt breakout will be limited to areas requiring grading of the bank to slopes suitable for paving. Use the broken asphalt to the extent possible in making fills adjacent to the breakout. When broken asphalt is used in making fills, the pieces must not exceed 450 mm 18 inches in any dimension. Spread out the broken asphalt that is not used for fill sufficiently to avoid abrupt humps on the adjacent paving. In areas where asphalt is damaged and grading of bank is not required, stone may be placed on top of the broken or damaged asphalt to the extent necessary to cover the damaged area.

3.18.3   Removal of Drift and Clearing

Remove accumulations of drift from the areas to be repaired. Clearing will not generally be necessary; however, cut off any trees, stumps or brush in the areas where repair work is prescribed flush with the ground or to an elevation 300 mm 1 foot below the top of the fill, and remove from the area. Dispose of debris as specified in [Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL][and][Section 31 11 00 CLEARING AND

GRUBBING].

3.18.4 Preparation of Subgrade

In areas where grading or excavation is required, dress the subgrade to a uniform surface suitable for paving. In other areas where crushed stone or [riprap][stone] is specified, dress the subgrade as necessary to provide an even surface for paving or to provide for a suitable tie to the existing paving.

3.19 STONE WORK

Use bedding stone, [_____] -kg -pound [Riprap][Stone][, and/or] [Graded Stone ["A"]["B"] ["C"]] to repair failure areas in existing paving or to protect the upstream, downstream, and landward areas adjacent to an existing paved bank; for constructing or repairing drains; for making stone fills, both above and below the water surface; and for constructing overbank spurs. Place stone on the bank or overbank area by crane or dragline equipped with skip, grapple, clamshell, or rock bucket; by front-end loader[or bulldozer]; or by trucks or other methods approved by the Contracting Officer. Unless otherwise approved by the Contracting Officer, the maximum capacity of dragline buckets used to place [Riprap][Stone] paving on the bank will be limited to 2.3 cubic meters 3 cubic yards.

3.19.1 Placement

It is contemplated that the quantities required will be in increments of a barge load of approximately [_____] [1000] tons (metric) [_____] [1,000] tons for placement at a single revetment. When less than [_____] [10 000] tons (metric) [_____] [10,000] tons of [Graded Stone ["A"]["B"]["C"]] [_____] is specified at a single revetment, consider the stone "Graded Stone "A", Small Repairs" for payment purposes. When [_____][10 000] tons (metric) [_____] [10,000] tons or more of Graded Stone "A" is specified at a single revetment, consider the stone "Graded Stone ["A"]["B"]["C"] [_____], Large Repairs" for payment purposes.

3.19.1.1 Bedding Material

Bedding stone may be required for use under [Riprap][Stone] paving or to fill scoured areas or depressions in the subgrade, or as a blanket in the construction or repair of drains. Bedding stone is normally placed [100][_____] mm [4][_____] inches in thickness above the water surface, [150][_____] mm [6][_____] inches in drains and in the amount of 1.8 t per square (9.3 m^2) [two][_____] T per square (100 square feet) when placed below the water surface. Place materials above the water must be to the lines and grade specified or as staked in the field; below the water surface, in the amount specified or as directed at the time of placing.

3.19.1.2 [Riprap][Stone] Paving

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NOTE: For determining the placement rate for under water placement, see notes at paragraph PLACEMENT OF RIPRAP, subparagraph [UNDER WATER].

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Place [riprap][stone] of the specified maximum size on the dry slope or overbank areas and rearrange by hand as necessary to provide complete coverage of the specified area with an average thickness of [250][_____] mm for [57][_____]-kg [10][_____] inches for [125][_____]-pound [riprap][stone]. A tolerance of 50 mm 2 inches above or below the average thickness will be allowed. Openings between stones exposing more than 2600 mm^2 4 square inches of the graded slope will not be allowed. Spalls and quarry chips may be used as a base but not as a filler. Place stone for underwater portions of the work uniformly distributed at the rate of [_____][7.3] tons per square [_____][8] tons per square unless another rate is shown or specified. [Riprap][Stone] may be required for use in constructing stone fills and making other repairs to revetments. [It is contemplated that the quantities of [_____] -kg -pound [riprap][stone] required will be in increments of a barge load of approximately 1000 tons for placement at one or more nearby locations.]

3.19.1.3 Overbank Paving

[Riprap][Stone] paving may be required to repair scour damage behind top bank. Overbank paving will generally consist of a blanket of stone 250 mm 10 inches thick and up to 15 m 50 feet wide placed behind the top bank or landward of the existing paving. Place overbank paving in accordance with paragraph [Riprap][Stone] PAVING above or as specified.

3.19.1.4 Stone Fills

Stone fills may be required to be constructed of [_____] -kg -pound [riprap][stone] or Graded Stone ["A"] ["B"] ["C"] as specified. Place stone fills specified above the water surface to the lines and grades specified or as staked in the field. Where specified below the water surface, the material may be placed by any method elected by the Contractor, subject to approval by the Contracting Officer.

3.19.1.5 Overbank Stone Spurs

In the repair or prevention of overbank scour, [riprap][stone] is required to construct or repair spurs landward of the top of bank at some locations. Provide spurs consisting of stone fill with variable crown widths and side slopes, usually tying into the revetment paving and extending landward at varying angles with the top of bank. Extensions of existing overbank spurs may also be required. The height of stone spurs will usually be from 900 to 1800 mm 3 to 6 feet, with maximum heights depending upon the depth of overbank scour. Generally, work will not extend beyond 90 m 300 feet landward of the top of the bank, but conditions at some locations may require construction beyond this limit. The location, alignment, and dimensions of the overbank spurs are as shown or as directed. [Riprap][Stone] that can be placed entirely by the floating plant will not be considered Overbank Stone Spur.

3.19.1.6 Stone Landward of an Obstruction

Occasionally in the repair of a revetment, stone must be placed on the revetment slope behind or landward of a structure which prevents placement of stone by a barge-mounted dragline or at a revetment location which, in the opinion of the Contracting Officer, is inaccessible by floating plant for other reasons. These repairs may be accomplished by hauling or other means approved by the Contracting Officer.

3.20   SLOPE DRESSING AND [Riprap][Stone] PAVING

3.20.1   Slope Dressing

The work consist of furnishing all plant, labor and materials and performing all work in strict accordance with these specifications, schedules and drawings for construction of [Riprap][Stone] paving on the [river banks] [banks of the [_____] River between [_____] and [_____]]. Perform work at several localities which will be selected after the award of the contract and will be designated in the jobsite specifications and "Before Construction" drawings to be issued pursuant to paragraph [_____],[Section 01 35 13 SPECIAL PROJECT PROCEDURES][,_____]. Perform the work regardless of the number of localities involved. Work may not be required under these specifications at all localities at which mattress sinking operations will be performed; however, work may be required at locations where articulated concrete mattress is not required. The work to be performed normally includes the final preparation of the slopes and procuring and placing the [Riprap][Stone] on the graded bank. At some locations, underwater and/or overbank paving may be required. Such locations will be specified in the jobsite specifications or indicated on the "Before Construction" drawings. The Government reserves the right to accomplish all or any portion of the work at any location by other means.

3.20.1.1   General

The bank will be graded, including finish grading, by others. However, preparatory to placing the paving, dress the slope to eliminate any irregularities, including irregularities in the bedding material placed by others, due to rain or wave wash or operations of the Contractor's equipment. Fill irregularities in the ungraveled slope with layers of earth no greater than 300 mm 1 foot in uncompacted thickness and firmly compact into place. If directed by the Contracting Officer, fill irregularities in graveled areas with stone, and payment will be made at the applicable contract unit price for "[Riprap][Stone] Paving" for stone so placed. Acquire earth fill material from adjacent areas within the limits of the right-of-way. Redress and/or clean out any landside drainage ditch damaged by the operations.

[3.20.1.2   Regrading

Any regrading necessitated by slides in the bank occurring before or during construction of the bank paving will be done by others and will in no way be the responsibility of the Contractor except that evidence of such slides should be reported promptly to the Contracting Officer. Do not place paving on such a disturbed area until the slide has been graded out or otherwise corrected.

]3.20.1.3   Repairs

Repair, with no additional payment, any damage to the graded bank or strip paving caused by failure to place paving at the rate required by paragraph [_____] of [Section 01 35 13 SPECIAL PROJECT PRODCEDURES][_____]. If strip paving is ordered by the Contracting Officer due to reasons beyond the control of the Contractor and the graded bank or strip paving is damaged by rain wash or overtopping, make the repairs as ordered by the Contracting Officer and an adjustment in the contract price and time of performance as appropriate for that portion of the work will be made in accordance with the Contract Clause, CHANGES.

3.20.2 [Riprap][Stone] Paving

3.20.2.1 General

[Riprap][Stone] upper bank paving consists of a course of stone with an average thickness of 250 mm 10 inches, measured normal to the slope, except where other thickness is specified or indicated on the drawings. Cover the surface of the bank between the limits of work as shown on the site plans or surface of the bank between the limits of work as shown on the site plans or as determined by the Quality Assurance Representative in the field. The landward limit of [riprap][stone] paving may include an overbank strip not exceeding a distance of 15 m 50 feet landward of the top of the bank. The bank to be paved will have been graded by others to a slope that will vary from approximately 1V on 3H to 1V on 5H and any overbank area to be paved will have been dressed by others to a surface suitable for paving. In general, the width of the paving will vary between approximately 15 m 50 feet and 60 m 200 feet slope measurement.

3.20.2.2 Strip Paving

When directed by the Contracting Officer, pave the bank in strips parallel to the water's edge. It is anticipated that strip paving will be required whenever there is more than 600 m 2,000 linear feet of unpaved bank available to the Contractor for paving or whenever rising river stages threaten overtopping of the inshore limit of mattress within that area. In areas where an articulated concrete mattress has been placed, provide strip paving consisting of placing [riprap][stone] paving in a strip along and parallel to the inshore edge of mattress. Unless otherwise authorized or directed, the strip paving must be 9 m 30 feet wide except it must include complete paving of drains within the area. At locations requiring only stone paving, place the underwater paving along with a strip 9 m 30 feet wide above and parallel to the water's edge and include paving of drains. Once strip paving operations are directed, continue this method of paving as long as required by the Contracting Officer, and conduct at such locations and in such order of precedence as required in order to protect the interest of the Government. If strip paving operations and moving, as required by the Contracting Officer to be performed the most essential work, prevent the Contractor from maintaining the required production rate, an equitable adjustment in contract time will be allowed upon written request and justification. Additional towing required to move between jobs as prioritized by the Contracting Officer and to return to unfinished jobs to complete them will be paid for as provided in [Section 01 35 13 SPECIAL PROJECT PROCEDURES][_____], paragraph [PAYMENT FOR EXCESS TOWING][_____].

3.20.2.3 Underwater Paving

Where specified in the Plans and Specificationsor indicated on the "Before Construction" drawings, place underwater [riprap][stone] paving on subaqueous areas not covered by articulated concrete mattress. Distribute the underwater [riprap][stone] paving uniformly over the area to be paved in the amount of 7.3 tons per square (9.3 m^2) 8 tons per square (100 square feet) or such other amount as indicated in the Specifications.

3.20.2.4 Placement

Place the stone on the graded slopes by crane or dragline equipped with skip, grapple,clamshell, or rock bucket or by other method approved by the Contracting Officer and rearranged by use of a trackhoe or by hand as necessary to provide complete coverage of the banks to the specified average thickness. If the entire upper bank cannot be paved from floating plant and stone is windrowed on the upper slope, spread the windrowed stone to the prescribed thickness by pulling the stone up the slope with a trackhoe or by other approved methods. Pulling stone downslope is prohibited. A tolerance of 50 mm 2 inches above and below the specified average thickness will be allowed. Openings between stones exposing more than 2600 mm^2 4 square inches of the graded slope or gravel blanket will not be permitted. In underwater placement, distribute the stone uniformly in the amount specified. Control placement of [riprap][stone] underwater to the extent necessary to provide coverage as indicated on the "Before Construction" drawings and/or to assure a connection between articulated concrete mattress and [riprap][stone] paving placed above water.

3.20.2.5 Connections

Construct connections between [riprap][stone] upper bank paving and concrete mattress or paving as detailed on the drawings. Remove any stone placed or spilled onto the concrete mattress and place by hand into the paving and mattress connection area. Ensure the thickness of stone in the connection is no less than 450 mm 18 inches at a point 1200 mm 4 feet from the concrete mattress or paving, and taper to an average thickness of 250 mm 10 inches at the edge of the mattress and at a point 1800 mm 6 feet from the mattress or paving, unless other thickness is specified. At the connection between [riprap][stone] paving and existing asphalt paving, increase the thickness of the [riprap][stone] paving to 250 mm 18 inches in a strip approximately 1200 mm 4 feet in width along the connection of the [riprap][stone] and existing asphalt paving.

3.20.2.6 Bedding Material

Bedding material approximately [100] [_____] mm [4] [_____] inches thick will have been placed by others at most locations from approximately the [_____] contour to the [_____] contour. Exercise reasonable care in placing [riprap][stone] so that the bedding material will not be damaged.

3.20.2.7 Exposed Flanks

When the bank paving ends with a flank or flanks not connected with existing work, the Contracting Officer may direct that the last 18 m 60 linear feet be paved with [riprap][stone] averaging 500 mm 20 inches in thickness from a point 1200 mm 4 feet landward of the articulated concrete mattress to the landward limit of the paving.

3.20.2.8 Ditch Outlets

Pave the bottom and side slopes of drainage ditches for a distance of 3 to 8 m 10 to 25 feet landward of the top bank as specified in [the Supplementary Specifications] [_____][or in the jobsite specifications].

3.21 DIKE REPAIRS

The work requires grading and paving areas of damaged dike bankheads, placing stone fill in areas of dikes where damage has occurred, and performing other stone repairs necessary to maintain integrity of the dike field. Except as provided below, work will be required only on portions of dike fields which are accessible by floating plant. Jobsite work orders will be issued for each dike field where work is required, setting forth the details and limits of work. It is anticipated that at some locations where dike field repairs are specified, the site may be inaccessible to floating plant, and hauling of stone may be necessary to restore the integrity of the dike field or to extend a dike landward. In such cases, [except for work at [_____],]the Contractor will be given the option of performing work at the applicable contract unit prices or omitting the work. However, should the Contractor agree to do the work, the entire work specified at that location must be satisfactorily completed. The Contractor will be furnished a jobsite work order with details as necessary to perform the work. After a review of the jobsite work order and an inspection of the site, notify the Contracting Officer, in writing, whether the work will be performed at the contract unit price or omitted from the job. It is anticipated that the length of a landward dike extension will not exceed [150][_____] m [500][_____] feet. Grading and dressing of the bank and excavation may be required. The type of stone required may be [57][_____] kg [125][_____] pounds [Riprap][Stone], or Graded Stone ["A"]["B"]["C"]. The placing of any of the above types of stone may include placing fill in a dike, bank paving and the filling of key trench. Where the Contractor agrees to perform stone dike repair work, which is inaccessible by floating plant and must be hauled, additional compensation for the tonnage hauled will be made at the applicable contract unit price for "Stone Placement Premium".

3.21.1   Tolerances

The following tolerances will be allowed in the specified repairs, provided the extremes do not occur adjacent to each other.

a. Surface Elevations

(1) [Upstream [_____] m feet of dike crown - zero to minus 300 mm 1 foot][_____].

[(2) [Downstream 2700 mm 9 feet of crown and apron -plus or minus 150 mm 6 inches][_____].]

b. Crown line (each side) -150 mm 6 inches inside to 300 mm 1 foot outside.

c. Slopes - plus or minus 300 mm 1 foot.

3.21.2   Earthwork

3.21.2.1   Grading

Grade or fill the bank with material available from grading to the slopes indicated in the Plans and Specifications and as staked in the field. Slopes must be no steeper than 1V on 3H except that steeper slopes may be authorized in making connection with existing paving. The grade of the slope must conform to the prescribed grade within the limits of plus or minus 300 mm 1 foot. When less than 7600 m^3 10,000 cubic yards is specified in the for a single dike field, consider the grading "Earthwork, Small Repairs" for payment purposes. When 7600 m^3 10,000 cubic yards or more of grading is specified in the Plans and Specifications for a single dike field, consider the grading "Earthwork, Large Repairs" for payment purposes.

3.21.2.2   Key Trench

A key trench may be required along the downstream limit of the [Riprap][Stone] paving or at other locations on the bankhead. Unless otherwise specified or directed, the key trench must extend from top of bank to waters edge, have a bottom width of 3 m 10 feet and side slopes of 1V on 1H. The bottom grade must be 1.5 m 5 feet below the prescribed grade of [riprap][stone] paving.

3.21.2.3 Disposal of Material

Dispose of material from grading in excess of that used as fill by depositing riverward of the top of bank upstream or downstream from the limits of the repair work.

3.21.2.4 Stone Work

a. Provide stone quality and size as specified.

b. Where [riprap][stone] is required in dike repairs, the size is [57][_____]-kg [125][_____]-pound [riprap][stone].

(1) [Riprap][Stone] Paving - Unless otherwise specified, provide [riprap][stone] paving consisting of a course of graded stone with an average thickness of 300 mm 12 inches measured normal to the slope. Where paving is placed under water, the amounts required are 7.3 tons 8 tons per square unless otherwise shown in the Contract Drawings or as directed by the Contract Office. Placing of stone must follow grading and excavation as soon as practicable. Preparatory to placing the [riprap][stone] paving, dress the slope to eliminate any irregularities due to wave or rain wash, or operation of the Contractor's equipment. Place the stone by crane or dragline equipped with skip, clamshell, or rock bucket; by frontend loader or bulldozer; or by trucks or other methods approved by the Contracting Officer and rearrange by hand as necessary to provide complete coverage of the bank to the specified average thickness. A tolerance of 20 percent above or below the specified average thickness will be allowed. Openings between stones exposing more than 2600 mm^2 4 square inches of the graded slope will not be permitted. In underwater areas, place the stone uniformlydistribute in the amount specified.

(2) Stone-Filled Key Trench - Fill the excavated key trench to the elevation of adjacent [riprap][stone] with stone of the specified size to provide a thickness of 1.5 m 5 feet with a tolerance of 300 mm 1 foot. Bulldozing stone into the excavated trenches is prohibited.

(3) [Riprap][Stone] Fill - Restore eroded areas of stone dikes and fill minor gaps with [riprap][stone] of the specified size. Place the stone fill to the elevations and sections of adjacent portions of the dike or in accordance with theContract Drawings or as directed by the Contracting Officer. Construct underwater portion of the repairs in uniform horizontal layers of about 1.5 m 5 feet thickness. Construct each lift across the entire length of the dike repairs. Generally a 1800 mm 6 feet crown width with slopes of angle of repose (approximately 1V on $1^{1/4}$ H) will be required. A tolerance of plus or minus 300 mm 1 foot will be allowed in the specified elevation and crown width. Place the stone by a crane or dragline equipped with a skip, grapple, clamshell, or rock bucket; by frontend loader or bulldozer; or by trucks or other equipment approved by the Contracting Officer. Placing of stone along the dike when river stages are above the top of dike without prior approval of the Contracting Officer or at any river stages

when site and current conditions prevail which, in the opinion of the Contracting Officer, make operations impracticable or uneconomical is prohibited.

3.21.2.5 Placement Control

Control placement of stone in the dikes, and furnish, operate, and maintain the necessary equipment, and all necessary material and supplies. At all times, when stone placement from floating plant is underway, the means by which the plant, equipment, and stone supply barges are positioned must function accurately and consistently. Whatever the method employed, it must permit the Contractor and the Government Quality Assurance Representative to readily determine the exact position of the stone-placing operation. Prior approval of the contracting Officer will be required in each instance before placing any stone subaqueously without the aid of any equipment listed below.

a. The method of alignment control may consist of piles or pile clumps. Other acceptable methods of alignment control include the use of a manned transit, laser, colored or polarized light beams, or other method demonstrable to be practicable and sufficiently precise and reliable.

b. Acceptable methods of distance control for floating plant engaged in subaqueous placement of stone may consist of piles or pile clumps at intervals of 90 to 120 m 300 to 400 feet. Supplement piles or pile clumps, if used, by a wire distance wheel or other equally accurate measuring device for use in conjunction with the piles. Other acceptable methods include the use of electronic distance surveying instruments or other method demonstrable to be practicable and sufficiently precise and reliable.

c. Provide suitable recording electronic depth finder at each location of work under this contract. Provide a depth finder with a recording scroll no less than 100 mm 4 inches wide with a scale of no more than 3 m of depth to 25 mm 10 feet of depth to the inch. Ensure the depth finder is capable of obtaining accurate soundings and use as an aid in the control of subaqueous stone placement. Ensure that the depth finder is in proper working order at all times and furnish and maintain an adequate stock of recording paper for the depth finder. Submit to the Contracting Officer, for approval, the manufacturer's name, model number, and/or model name of the electronic depth finder proposed for use prior to the unit being place in service.

d. The use of buoys as placement control devices will not be permitted. The use of bank targets for alignment control will not be permitted for working distance of more than 1200 mm 400 feet without prior approval of the Contracting Officer.

3.22 PLACEMENT OF SHORELINE PROTECTION

3.22.1 Debris

Remove any timbers, unsatisfactory material and debris within the reaches for construction except as otherwise directed by the Contracting Officer, and upon removal is the property of the Contractor. Properly dispose of all materials in accordance with the requirements of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, including any applicable local requirements.

3.22.2 Limitations of Placement Procedures

Stone construction in advance of completed permanent protection except as specified herein is performed at the Contractor's risk. Keep the Contracting Officer informed as to any and all situations that may result in a possible interruption of work.

3.22.2.1 Interruptions

If the Government can anticipate that the stone construction will be interrupted for more than [_____] [four (4)] continuous days, including weekends and holidays, the Contractor may be required to complete the placement of [_____] and [_____] stone on both sides of the breakwater and provide protection of the exposed ends prior to the start of the interruption. The above-required protection for the exposed ends of the breakwater must consist of the same type of stone protection required on the lake side of the breakwater. Remove all material used for protecting the exposed ends of the breakwater after the need therefore has ended and incorporate appropriately into the required permanent construction. All materials which are removed and placed in the permanent construction, in accordance with the provisions of this section, will be measured and paid for only once. When temporary protection of exposed ends of construction in progress is ordered or directed by the Contracting Officer, an equitable adjustment will be made for the work of temporarily placing and removing the stone materials. The Government has no obligation to order that exposed ends be protected. If the Government takes no action to have exposed ends protected, then the provisions of the paragraph MATERIAL PLACEMENT IN ADVANCE apply.

3.22.2.2 Material Placement in Advance

Do not construct the breakwater more than [_____] m feet in advance of completed placement of the [_____] and [_____] stone. If at the completion of a day's placement operations the unprotected portion (maximum [_____] m feet) is surveyed to determine the shape and grade of the materials placed, the Government will assume the responsibility for the cost to replace it (maximum [_____] m feet) if it is displaced or lost due to a storm during the nonwork period but not exceeding a continuous [_____] [four] day nonwork period. In the event an unprotected section of any length unsurveyed is left during a nonwork period or is left unprotected for a period longer than four continuous days and is damaged or causes damage to a completed section, replace or reshape the damaged portion(s) as approved by the Contracting Officer with no additional payment.

[3.22.3 Core/Mattress/Bedding Stone

Place stone to the lines, grades and thickness shown on the Contract Drawings. Use placement method such that any soft and organic materials on the lake floor will be displaced outward towards the extreme outside toes of the required sections of the structure and in the direction of the construction. Start stone placement at the centerline of the stone structure and extend outward to the toes of the structure in a fashion whereby the line of stone advancement takes an inverted "U" shape.[Placement by self-unloading lake carriers [will be allowed] is prohibited.] Place with reasonably systematic care that segregation of particle sizes will not occur.[If the materials are placed by clam shell, dragline, or other similar equipment, do not drop the stone from a height exceeding [_____][600] mm [_____][two] feet above the existing lake bottom or previously placed material.][Placement with bottom dump scows [is prohibited][will be allowed].] Ensure the finished surface of the stone is adequately smooth and free of mounds or windrows.[Ensure the finished work is free of clusters or small stones and cluster of larger stones.]

][3.22.4 Armor/Cover/Riprap Stone

Place stone in the locations and at the thickness shown without deviating from the lines and grade shown, including allowance for tolerances. Perform final shaping of the slope concurrently with the initial placement of the stone. Randomly select stones and set in contact with each other so that the interstices between adjacent stones are as small as the character of the stone will permit. Place the face of stone having the largest area against the surface of the underlying material. Begin placement at the bottom of the slope. Place the heaviest stones as toe stones. Place stones in a manner to avoid displacing underlying materials or placing undue impact force on underlying material that would cause the breaking of stones. Unless otherwise specified, do not drop stone from a height greater than [_____][600] mm [_____][two] feet. Use equipment in placing the stone suitable for handling materials of the sizes required including the ability to place the stone over its final position before release and if necessary pick up and reposition the stone. Do not use dragline buckets and skips in placement. Moving stone by drifting or manipulating down the slope is prohibited. The finished work must be a well distributed mass, free of pockets of either smaller or larger stone, having a minimum of voids and with the maximum of interlocking of stones. It should be anticipated that rehandling of individual stones after initial placement will be required to achieve the above requirements. Do not drop stones required to be placed over or adjacent to drains and subsurface pipes, but gently lower and place in their final position by material handling equipment.

][3.22.5 Underlayer Stone

Place stone, to a full zone thickness, in one operation in a manner to avoid displacing the underlying material or placing undue impact force on underlying materials and supporting subsoils. Place underlayer stone in a manner to produce a resultant graded mass of stone with minimum voids. Rearranging of individual stones may be required to achieve this result. Placement by any method which is likely to cause segregation of the various sizes is prohibited. Lower unsegregated stone in a bucket or container and place in a systematic manner directly on the underlying material. Begin placement at the bottom of the slope and proceed upward. Casting or dropping of stone over [_____][600] mm [_____] [2] feet or moving by drifting and manipulating down the slope is prohibited. Construct final finish of the slope as the material is placed.

][3.22.6 Scour/Riprap Stone

Place stone, to a full zone thickness, in one operation in a manner to avoid displacing the underlying material or placing undue impact force on underlying materials and supporting subsoils. Place the stone in a manner to produce a resultant graded mass of stone with minimum voids. Rearranging of individual stones may be required to achieve this result. Placement by any method which is likely to cause segregation of the various sizes will not be permitted. Lower unsegregated stone in a bucket or container and place in a systematic manner directly on the underlying material. Begin placement at the bottom of the slope and proceed upward. Casting or dropping of stone over [_____][300] mm [_____][one] foot or moving by drifting or manipulating down the slope is prohibited. Construct final finish of slope as the material is placed.

][3.22.7 Fill Stone

Do not place fill stone within steel sheet pile walls until tie-rods, wales, and connections are installed, tightened, and inspected; and the structure is aligned within the required tolerances. Uniformly place the fill materials in maximum [_____][900]-mm [_____][3]-foot lifts and in such a manner that there will be no undue later settlement of the materials and that the structure will not be subjected to undue strains, deformations, or other damage. Responsibility for damage to the structure due to filling operations rests with the Contractor. Distribute and consolidate the stone by use of a vibratory hammer or similar vibrating hammer or similar vibrating equipment affixed to a steel beam inserted into the fill at intervals no greater than [_____][1.5] m [_____][5] feet. Continue vibratory operations until there is no visual continuation of settlement. Other distribution or consolidation methods may be used when approved by the Contracting Officer. Compact stone above water to [_____][90 percent] of maximum density obtained at optimum moisture content as determined by the Contractor in accordance with [EM 1110-2-1906][_____]. Perform at least [_____][one] compaction test for each [_____] metric ton ton of material placed.

][3.22.8 Splash Stone

Place stone to the lines and grades shown and in a manner that will avoid tearing the underlying geotextile.

]3.22.9 Fitted Cap Stone

Place fitted cap stone upon the geotextile covering the fill stone within the limits of the steel sheet pile structure to the lines and grades shown. Use stones of assorted sizes and place to tightly fit against each other in the space bounded by the perimeter [_____][concrete sidewalk]. Use individual stones of the maximum size which will fill a given space between larger stones to minimize the need for chinking. Ensure the flattest face of each stone is the top surface of the placed stone. Following placement of the cap stones, fill the remaining spaces between individual stones with pieces of the next smaller stone obtained from the required[underlayer] stone gradation materials being supplied for this contract. Fill the spaces between cap stones with selected stones of the maximum size which will fit in each remaining space. At the elevation of the upper horizontal surface of the cap stones, place the stones used for chinking with their elongated dimension in a vertical direction and force into place in the spaces between cap stone spaces such that they become firmly wedged in place.

3.22.10 Slides

In the event of the sliding or failure of any part of the structure during its construction, or after its completion, but prior to its acceptance, [upon written order of the Contracting Officer,] cut out and remove the slide from the structure and then rebuild that portion of the structure with new materials or reuse the displaced materials for rebuilding if deemed appropriate. The Contracting Officer will determine the nature and cause of the slide. In case the slide is caused through fault of the Contractor, perform the foregoing operations without cost to the Government.

3.23 TESTS AND INSPECTIONS

3.23.1 Concrete Grout

3.23.1.1 General

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NOTE: Select the first bracketed option if ACI International references are cited in the project specification; select and verify the correctness of the second bracketed option if ACI International references are not cited in the project specifications.

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Ensure individuals who sample and test grout as required by this section have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to ACI minimum guidelines for certification of Concrete Transportation Construction Inspector or ACI Concrete Construction Inspector Level II, obtainable from [the address and telephone number for ACI INTERNATIONAL in Section 01 42 00 SOURCES FOR REFERENCE PUBLICATIONS] [ACI INTERNATIONAL, P.O. Box 9094, Farmington Hills, MI 48333-9094, Ph: 248-848-3700, Fax: 248-848-3701, Internet: http://www.aci-int.inter.net].

3.23.1.2 Preparations for Placing

Inspect riprap in sufficient time, prior to each grout placement, in order to certify that it is ready to receive the grout.

3.23.1.3 Air Content

Check air content at least [once][twice] during each shift during which grout is placed. Obtain samples in accordance with ASTM C172/C172M and test in accordance with ASTM C231/C231M. Whenever a test result is outside the specification limits, do not deliver the grout to the area to be grouted and adjust future air-entrainment admixture proportions.

3.23.1.4 Slump

Check slump [once][twice] during each shift during which concrete grout is produced. Obtain samples in accordance with ASTM C172/C172M and test in accordance with ASTM C143/C143M.

3.23.1.5 Placing

The placing foreman must verify that adequate equipment, supplies and workmen are available before permitting placement to begin on a shift.

3.23.2 Pre-Production

3.23.2.1 Bulk Specific Gravity

Submit, at least [120] [_____] calendar days in advance of shipment of stone to the work site, a copy of bulk specific gravity test results for each gradation range of stone proposed to be furnished. Furnish the information prior to preparation of pre-production demonstration stockpiles. Quantity determinations are contingent upon the range of bulk specific gravity (saturated surface dry (SSD) basis) of stone to be supplied. Therefore, during the process of selecting a source or sources of stone for the project, make an investigation to determine the lowest and highest bulk specific gravity (SSD) of stone available at the source or sources proposed to be utilized for each gradation range of stone. Perform tests at a Government [approved][validated] testing laboratory in accordance with [_____]. Submit testing results in accordance with paragraph SUBMITTALS. Test results which display an extraordinarily wide range of values may necessitate additional testing to determine whether the source contains strata or units with stones of an acceptable range of bulk specific gravity. For Category I sources which have been acceptably tested not more than two years earlier, and the material is of an acceptable quality and bulk specific gravity, the Contracting Officer may waive the requirement for bulk specific gravity testing.

3.23.2.2 Material Quality

Before selecting a source for preparation of a demonstration stockpile, be reasonably certain that the source is capable of meeting the quality and source requirements specified in paragraphs SOURCES and EVALUATION TESTING OF STONE, including their respective subparagraphs.

3.23.2.3 Borderline Material Quality

If the COR's evaluation of a demonstration stockpile results in not being able to determine by visual examination whether the material is acceptable or unacceptable, the COR will select at least one but not more than three representative stones from the demonstration stockpile to be prepared for shipment to the Government's laboratory for testing in accordance with paragraph EVALUATION TESTING OF STONE. Where specified sizes are in excess of 900 kg 2,000 pounds, cut or break a representative piece, weighing approximately 900 kg 2,000 pounds each, off of the selected stones. For specified stone sizes of less than 900 kg 2,000 pounds but more than 230 kg 500 pounds, individual samples must be the size of the largest stone specified for the size range. Samples of stone groupings with a maximum size less than 230 kg 500 pounds must contain at least two (2) stones representative of the higher limit of the stone weights specified. In addition, the sample is representative of the gradation specified and the minimum weight of the total sample must be greater than 230 kg 500 pounds. Repeat sampling and testing procedures for each strata or distinct rock type being quarried. Ship the samples to the laboratory as specified in paragraph EVALUATION TESTING OF STONE. If the laboratory testing reveals the materials are unacceptable, submit a replacement source for approval and proceed with the demonstration stockpile procedures anew.

3.23.2.4 Demonstration Stockpile at Source

Following submittal of the Contractor's Quality Control (CQC) Plan and selection of a source, but prior to the Government's approval of a source and the CQC Plan, make arrangements to provide a pre-production demonstration stockpile for each of the stone size ranges for the project. Assemble the stockpiles at the source of the stone and shape in windrow fashion. Place stones with a size range greater than [_____] [2.7] tons [_____] [3] tons in a single layer with [_____] [300] mm [_____] [1] foot or more of clear space around each stone. Do not stack stones in smaller sizes under [_____] [2.7] tons [_____] [3] tons in weight higher than [_____] [1200] mm [_____] [4] feet. The stones placed in the demonstration stockpiles are representative of the overall quality of materials in the source and must not consist of the best specimens unless it is reasonable to determine that the source will provide the required amount of stone of the applicable size range with a degree of quality no less than that existent in the demonstration stockpile. Prepare separate examples of unacceptable stones so labeled demonstrating characteristics that are outside of acceptability for the project, to be used as guidance by personnel. The quantity of stone required in each demonstration stockpile is dependent upon the gradation size range to be produced for the project. The following parameters apply:

SIZE OF INDIVIDUAL STONES WITHIN A RANGE	DEMONSTRATION STOCKPILE QUANTITY BASED ON PROJECT QUANTITY FOR SIZE RANGE
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

Ensure stones placed in the stockpile have been preselected by the Contractor's Quality Control Plan (QCP) inspector or supervisor and acceptable stones over 230 kg 500 pounds in size have been marked with spray paint on three mutually perpendicular sides with a coded mark to denote acceptability for a certain size range. Assemble a stockpile of representative reject stones marked with a red "X" at the [site][source] as examples of unacceptable materials or shapes.

3.23.2.5 Evaluation of Demonstration Stockpile at Source

Notify the Contracting Officer when stockpiles are ready for evaluation. The Contractor's approved Quality Control Plan (QCP) supervisor and all QCP inspectors must accompany the Contracting Officer's Representative (COR) during the Government's evaluation of the demonstration stockpiles and source. Arrange to have individual stones turned as necessary to accommodate the COR's evaluation. The COR will mark rejected stones with a red "X" and remove such stones to the reject stockpile or to a crusher if one is available. If more than [_____][3 percent] unacceptable stones are found within a stockpile, the entire stockpile will be rejected by the Government and a replacement stockpile will be created for re-evaluation. If the replacement stockpile is rejected, revise and resubmit the Quality Control Plan (QCP) and create another replacement demonstration stockpile for evaluation. If the third demonstration stockpile for a particular size range at a single source is found unacceptable, the source will be disapproved for such size rang and submit a new source for approval. In addition, submit the name and qualifications for a person to replace the QCP supervisor. The Contractor may choose a replacement source at the time a first or second demonstration stockpile is found unacceptable. The replacement of demonstration stockpiles or stone sources is at no additional cost to the Government and with no change in the time of completion.

3.23.2.6 Approval of Demonstration Stockpile at Source

At the time the COR finds the contents of a demonstration stockpile to be acceptable, either through visual examination or through laboratory testing, the Contractor will be notified in writing that the source, the QCP plan and QCP staff are approved, whereupon the Contractor may proceed with production of materials for the project provided they are consistent with demonstration stockpiles.

3.23.2.7 Duration of Demonstration Stockpile at Source

Other than for being shipped as the final quantities of materials to be placed in the work, each demonstration stockpile must remain unchanged at the source until all other required material of the size range represented by the stockpile has been shipped from the source.

3.23.3 Placement Control

3.23.3.1 Quality Control Measures

Establish and maintain quality control for all work performed at the job site under this section to assure compliance with contract requirements. Maintain records of the quality control tests, inspections and corrective actions. Cover all construction operations including, but not limited to, the placement of all materials to the slope and grade lines shown and in accordance with this section.

3.23.3.2 Check Surveys

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NOTE: EM 1110-2-1003 should be referred to for spacing requirements for a Hydrographic Survey.

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Surveys made by the Contractor are required on each material placed for determining that the materials are acceptably placed in the work. Make checks as the work progresses to verify lines, grades and thicknesses established for completed work. Perform at least one check survey as specified below for each [_____][25] foot section as shown as practicable after completion. Following placement of each type of material, the cross section of each step of the work must be approved by the Contracting Officer before proceeding with the next step of the work. Approval of cross sections based upon check surveys does not constitute final acceptance of the work. Perform cross sections on lines [_____][8] m [_____][25] feet apart, measure along the structure reference line, with readings at [_____][1.5] m [_____][5] foot intervals and at beaks along the lines. However, other cross section spacing and reading intervals may be used if determined appropriate by the Contracting Officer. Take additional elevations and soundings as the Contracting Officer may deem necessary. Conduct surveys in the presence of an authorized representative of the Contracting Officer, unless this requirement is waived by the Contracting Officer.

a. Above Water: Determine the elevation of stone above the water surface by the use of a leveling instrument and a rod having a base 300 mm 12 inches in diameter. If approved by the Contracting Officer other means may also be used.

b. Below Water: For portions of the work that are under water, perform sounding surveys either by means of a sounding pole or a sounding basket weighing about 4 kg 8 1/2 pounds, each of which has a base measuring 300 mm 12 inches in diameter.

c. Gage Board: Check the gage prior to any survey. Install a gage board at the project site.

d. Electronic Depth Recorder Method: When using an electronic depth recorder, use the following procedures.

   (1) Calibrate and adjust the depth recorder for the gage, with check bar, at least [_____][six] times within a normal eight hour work day.

   (2) Normal calibration times is at the beginning of the work day, mid-morning, close of morning's work, start of afternoon's work, mid-afternoon, and the end of the day.

   (3) Perform further calibrations whenever there is any malfunction within the depth recorder or transducer which might affect the soundings, a major gage change, or change in water temperature due to industrial discharge or other causes.

   (4) Set the check bar at approximately the deepest sounding in the area to be sounded.

   (5) Calibrate the depth recorder to read at low water datum.

   (6) When checking the calibration at mid-morning, end of morning, mid-afternoon and end of work, use the same setting used for the previous calibration.

   (7) If the calibration check does not agree with the previous calibration, calibrate the depth recorder to the proper setting.

   (8) Do not change the setting of the depth recorder between calibrations.

e. Electronic Depth Recorder: The survey depth recorder used must be a standard model acceptable to the Contracting Officer using a sounding chart that can be read directly to the nearest 300 mm foot and estimated to the nearest 30 mm tenth (0.1) of a foot. Ensure accuracy is better than 1/2 of 1 percent.

f. Tagline Method of Horizontal Location Along Station: If a tagline is used with a depth recorder, mark the soundings with a fix every [_____][1.5] m [______][5] feet.

g. Predetermined Transit Angle Method or Ranges Method: The interval between predetermined angles or ranges along a sounding line must not exceed [_____][60] m [_____][200] feet along the entire length of the sounding line. Do not allow predetermined angle to form an intersection with the sounding line of less than 45 degrees.

h. Speed of the Sounding Boat: When sounding, ensure the speed of the sounding boat is as constant as possible, preferably between 55 and 67 m per minute 180 and 220 feet per minute.

i. Checking Gage: Check the gage prior to each calibration and record on the sounding chart or in the field notes.

3.23.4 Bedding Layers, Filter Layers, and Sand Fill

3.23.4.1 General

Perform gradation tests to assure compliance with contract requirements and maintain detailed records. Sample bedding material, filter materials and/or sand fill in accordance with ASTM D75/D75M and test in accordance with ASTM C136/C136M. Perform the tests before and after surveys of each layer of stone protection material placed.

3.23.4.2 Reporting

Reporting must be in accordance with paragraph GRADATION TEST.

[3.23.5 Trenchfill Revetment, Bank Paving, and Outlet Drains

Establish and maintain quality control for stone placement operations to assure compliance with contract specifications and maintain records of his quality control for all construction operations including, but not limited to, the following:

a. Check grades of trenchfill and bank paving for compliance with design sections.

b. Record tonnage of stone placed in each station of trenchfill revetment and check quantity for compliance with design sections.

c. Check for uniform thickness of paving stone and specified elevation of top paving on graded slopes.

d. Check for even distribution of spalls used in paving.

[

e. Insure that outlet drains conform with design sections.]

][3.23.6 Stonefill Revetment and Stonefill Dikes

Check grade, slope, and placement of stone for compliance with design sections and specifications.

][3.23.7 Stone Dike

Establish and maintain quality control for all stone dike operations to assure compliance with contract requirements and maintain detailed records of this quality control for all construction operations, including, but not limited to, the following:

a. Placement and alignment of stone in the dike.

[

b. Periodic fathometer surveys as directed by the Contracting Officer.]

[

c. Record of the tonnage of stone placed in each station.]

][3.23.8 Revetment Repairs

Inspect the revetment repairs for compliance with the contract requirements and record the inspection of all operations including, but not limited to, the following:

a. Bank grading, excavating or reshaping damaged drains through the paving, placing graded material into areas, and disposing of waste material.

b. Breaking out pavement within specified limits.

c. Disposition of cleared material, drift, and other debris.

d. Preparation of subgrade for paving.

]3.23.9 [Stone][Riprap] Paving

Establish and maintain quality control for slope dressing and riprap paving to assure compliance with contract requirements, and maintain records of his quality control for all construction operations, including but not limited to the following:

a. Dressing the slope to eliminate any irregularities, including irregularities in the gravel blanket placed by others, due to rain or wave wash or operations of the Contractor's equipment.

b. Grading and dressing necessary to secure a suitable connection with the riprap paving in place.

c. Underwater paving to assure proper connection with concrete mattress and complete coverage.

d. Above-water connection between riprap paving and concrete mattress.

e. Connection between riprap paving and asphalt paving.

f. Placement of riprap on gravel blanket, upper bank slope, and if applicable, overbank areas for thickness and proper coverage.

g. Placement of riprap in ditch outlets.

3.23.10 Dike Repairs

Inspect all dike stone repair operations for compliance with contract requirements and record the inspection of all operations including, but not limited to the following:

a. Grading of slopes to design grade within tolerance.

b. Disposition of material from grading and excavation.

c. Dressing of slope before placement of paving.

d. Placement of slope and underwater paving.

e. Grade and section of stone fill.

Furnish to the Contracting officer a copy of these records an tests, as well as records of corrective action taken.

[3.23.11 Gradation Tests for Stone

[3.23.11.1 Gradation Test Method for Riprap

Perform gradation tests in accordance with ASTM D5519, Test Method A [_____].

][3.23.11.2 Standard Test Method for Gradation of Quarry Run Stone or Stone Paving

****

NOTES: Alternative 2. The gradation test method was developed to provide guidance to field personnel and Contractors so that the procedures would be uniform. This test procedure is provided as an example.

This test method should not be used in contract specifications that cover stone, upper bank and stone, overbank, and quarry run stone.

****

a. Select a representative sample (Note No. 1), weigh and dump on hard stand.

b. Select specific sizes (see example) on which to run "individual weight larger than" test. (See Note No. 2). Procedure is similar to the standard aggregate gradation test for "individual weight retained".

c. Determine the largest size stone in the sample. (100 percent size)

d. Separate by "size larger than" the selected weights, starting with the larger sizes. Use reference stones, with identified weights, for visual comparison in separating the obviously "larger than" stones. Stones that appear close to the specific weight must be individually weighed to determine size grouping. Weigh each size group, either individually or cumulatively.

e. Paragraph d above will result in "individual weight retained" figures. Calculate individual percent retained (heavier than), cumulative percent retained, and cumulative percent passing (lighter than).

NOTE NO. 1: Sample Selection: The most important part of the test and the least precise is the selection of a representative sample. No "standard" can be devised; larger quarry run stone is best sampled at the shot or stockpile by given direction to the loader; small graded stone is best sampled by random selection from the transporting vehicles. If possible, all parties should take part in the sample selection and agree before the sample is run that the sample is representative.

NOTE NO. 2: Selection of Size for Separation: For these types of stone gradations the separation points need to be selected as the smallest size stone at each break in the gradation specified.

EXAMPLE GRADATION SPECIFICATIONS	
INDIVIDUAL PERCENT RETAINED	STONE WEIGHT IN KGLBS
10 Max.	34 - 5775 - 125
40-60	11 - 3425 - 75

EXAMPLE GRADATION SPECIFICATIONS

INDIVIDUAL PERCENT RETAINED	STONE WEIGHT IN KGLBS
20-40	3 - 116 - 25
15 Max.	0 - 30 - 6

EXAMPLE WORKSHEET

STONE SIZE KGLBS	INDIVIDUAL WT. RETAINED	INDIVIDUAL PERCENT RETAINED	SPECIFICATIONS
Greater than 57125	0	0	0
34 - 5775 - 125	1180 2600	8	10 Max.
11 - 3475 - 125	735016,200	50	40-60
3 - 116 - 25	454010,000	32	20-40
0 - 30 - 6	1450 3200	10	15 Max.
TOTAL	14,520 kg32,000 pounds		

NOTE: Largest stone 68 kg150 pounds

]3.23.11.3 Standard Test Method for Gradation of Riprap, Graded Stone, and [______]

****

NOTE: Alternative 2. The STANDARD TEST METHOD FOR GRADATION OF RIPRAP AND GRADED STONE gradation test method was developed to provide guidance to field personnel and Contractors so that the procedures would be uniform. This test procedure is provided as an example.

This test method should be presented in contract specifications that require riprap or graded stone. This test method should not be used in contract specifications that only cover stone, upper bank and stone, overbank.

****

a. Select a representative sample (Note No. 1), weigh and dump on hard stand.

b. Select specific sizes (see example) on which to run "individual weight larger than" test. (See Note No. 2). Procedure is similar to the standard aggregate gradation test for "individual weight retained".

c. Determine the largest size stone in the sample. (100 percent size)

d. Separate by "size larger than" the selected weights, starting with the larger sizes. Use reference stones, with identified weights, for visual comparison in separating the obviously "larger than" stones. Stones that appear close to the specific weight must be individually weighed to determine size grouping. Weigh each size group, either individually or cumulatively.

e. Paragraph d above will result in "individual weight retained" figures. Calculate individual percent retained (heavier than), cumulative percent retained, and cumulative percent passing (lighter than). Plot percent passing, along with the specification curve on ENG Form 4794-RM 4794-R.

(1) NOTE NO. 1: Sample Selection: The most important part of the test and the least precise is the selection of a representative sample. No "standard" can be devised; larger quarry run stone is best sampled at the shot or stockpile by given direction to the loader; small graded stone is best sampled by random selection from the transporting vehicles. If possible, all parties should take part in the sample selection and agree before the sample is run that the sample is representative.

(2) NOTE NO. 2: Selection of Size for Separation: It is quite possible and accurate to run a gradation using any convenient sizes for the separation, without reference to the specifications. After the test is plotted on a curve, then the gradation limits may be plotted. Overlapping gradations with this method are no problem. However, it is usually more convenient to select points from the gradation limits, such as the minimum 50 percent size, the minimum 15 percent size, and one or two others, as separation points.For these types of stone gradations the separation points need to be selected as the smallest size stone at each break in the gradation specified.

FOR

EXAMPLE

ONLY

EXAMPLE GRADATION SPECIFICATIONS	
PERCENT LIGHTER BY WEIGHT	STONE WEIGHT IN KGLBS
100	180 - 75400 - 160
50	75 - 35160 - 80
15	35 - 1580-30

EXAMPLE WORKSHEET

STONE SIZE KGLBS	INDIVIDUAL WT. RETAINED	INDIVIDUAL PERCENT RETAINED	CUMULATIVE RETAINED	PERCENT PASSING
180400	0	0	0	100
75160	43549600	30	30	70
3580	508011,200	35	65	35
1530	36298000	25	90	10
<15<30	14513200	10	100	-
TOTAL	14,514 kg 32,000 pounds			

NOTE: Largest stone 114 kg251 pounds

GRADATION TEST DATA SHEET

Quarry ______________________________ Type of Stone Tested

Date of Test _________________________ Testing Rate _________________________

TEST REPRESENTS		
Contract No.	District	Tons
	TOTAL	

GRADATION					
			Cumulative		
Stone Size	Weight	Individual %	Percent	Percent	Specification
Total Weight					
Max Size					

Remarks:

I certify that the above stone sample is representative of the total tonnage covered by this test report.

Contractor Representative ____

Government Representative ____

<table>
<tr><th colspan="3">STONE SOURCES</th></tr>
<tr><th>LATITUDE/LONGITUDE</th><th>QUARRY LOCATION, ADDRESS, & TELEPHONE</th><th>MAIN OFFICE ADDRESS & TELEPHONE NUMBER</th></tr>
<tr><td colspan="3">[STATE]</td></tr>
<tr><td rowspan="4"></td><td></td><td></td></tr>
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<tr><td colspan="3">[STATE]</td></tr>
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] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 41 00 (November 2018)**
Change 1 - 02/20

Preparing Activity: USACE **Superseding**
UFGS-35 41 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

35 41 00

LEVEE CONSTRUCTION

11/18, CHG 1: 02/20

PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-35 41 00 (November 2018)**

Change 1 - 02/20

Preparing Activity: USACE **Superseding**

UFGS-35 41 00 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

35 41 00

LEVEE CONSTRUCTION

11/18, CHG 1: 02/20

****

NOTE: This guide specification covers the requirements for levee construction. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections.**

This guide specification includes paragraphs for construction activity that may have their own UFGS Guide Specifications. These include Section 31 00 00 EARTHWORK, Section 31 66 10 ROCK FOUNDATION PREPARATION and Section 31 11 00 CLEARING AND GRUBBING among others. If those Guide Specifications are to be referenced, remove the appropriate paragraphs from this section or those as is appropriate.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification includes the installation of settlement gages for the

determination of increases in quantities of embankment materials resulting from settlement of the embankment foundation during construction and for payment to the Contractor for such increases in quantities. These provisions should be included in a project specification when it is determined that settlement in the range of 5 percent or more of the planned embankment height is anticipated over a considerable portion of the embankment foundation area. They will also be used when gages are needed for engineering control purposes, required in critical locations or called for if adverse contractual relationships are expected. When settlement gages are to be used the following information will be indicated on the plans:

1. The location of the gages as well as the stations at which zero settlement will be assumed.

2. The detail construction of the foundation settlement gages to be used. Any applicable type of gage may be selected.

The requirements for rock as prescribed herein are intended to be used on embankments involving rock fill sections. Where rock for slope protection is specified, Section 35 31 19.40 STONE REVETMENTS should be used.

Approval of testing laboratory is addressed in ER 1110-1-8100, dated 31 Dec 1997, Laboratory Investigations and Testing.

****

1.1 [LUMP SUM] [UNIT] PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title ([LUMP SUM] [UNIT] PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 as appropriate.

****

1.1.1 Clearing, Grubbing, and Stripping

****

NOTE: If Section 31 66 10 ROCK FOUNDATION PREPARATION or Section 31 11 00 CLEARING AND GRUBBING is included in the project specifications, this paragraph title Clearing, Grubbing, and Stripping should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 31 66 10 or Section 31 11 00 as appropriate.

****

1.1.1.1 Payment

Payment will be made for clearing, grubbing and stripping at the contract [lump sum] [unit price] for clearing, grubbing and stripping. This price will constitute full compensation for all equipment, labor, materials and incidentals necessary to complete the work specified herein. Payment for refilling of holes resulting from grubbing will be included in the contract [lump sum] [unit price] for clearing, grubbing and stripping. No separate or direct payment will be made for stockpiling and disposition of stripped materials. All costs in connection therewith will be considered as a subsidiary obligation of the Contractor. If regrowth of vegetation or trees occurs after clearing and grubbing and before placement of embankment, and the Contractor is required to clear and grub again prior to embankment construction, no payment will be made for this additional clearing and grubbing.

1.1.1.2 Measurement

****

Note: If clearing, grubbing, and stripping is to be paid for with a unit price bid item include the method of measurement. Delete this paragraph if payment is by lump sum.

****

Clearing, grubbing, stripping, stockpiling and the disposition of the materials from these operations will [not] be measured for payment.[Refilling of grubbing holes will not be measured for payment.]

1.1.1.3 Unit of Measure

Unit of measure: [lump sum] [unit price].

1.1.2 Demolition and Removal of Existing Structures

1.1.2.1 Payment

Payment will be made for demolition or removal of existing drainage structures, pavements, foundations, superstructure, walls, fences, or any other manmade object at the contract [lump sum] [unit price] for demolition and removal of existing structures. This price will constitute full compensation for all equipment, labor, materials and incidentals necessary to complete the work specified herein. Payment for refilling of holes resulting from removal of structures will be included in the contract [lump sum] [unit price] for demolition and removal of existing structures. No separate or direct payment will be made for stockpiling and disposition of removed materials. All costs in connection therewith will be considered as a subsidiary obligation of the Contractor.

1.1.2.2 Measurement

****

NOTE: If removal or demolition of existing drainage structures is to be paid for with a unit price bid item include the method of measurement. Delete this paragraph if payment is by lump sum.

****

Plugging or removal of existing structures required from these operations will [not] be measured for payment.

1.1.2.3 Unit of Measure

Unit of measure: [lump sum] [unit price].

1.1.3 Excavation

****

NOTE: If Section 31 00 00 EARTHWORK is used, this item should be deleted.

If excavation will not be measured or paid for separately, select the following paragraph and delete subparagraphs PAYMENT, MEASUREMENT, and UNIT OF MEASURE. Delete the following paragraph if excavation is to be measured and paid for separately. If significant quantities of rock excavation is anticipated measurement and payment for rock excavation should be addressed separately. A definition of rock excavation should also be included.

****

No separate measurement or payment will be made for Excavation. All costs in connection with excavation will be considered a subsidiary obligation of the Contractor.

1.1.3.1 Payment

Payment will be made for Excavation at the contract unit price which includes full compensation for all equipment, labor, materials, and incidentals necessary to complete the work specified.[No separate payment will be made for stockpiling.]

1.1.3.2 Measurement

Excavation will be measured for payment by use of the average end area method. The basis of measurement will be a survey of the area prior to the excavation[and clearing and grubbing] and a second survey of the same area after the completion of the excavation. For areas where lines and grades are shown on the drawings, measurement will be limited to those lines and grades. Slides caused by fault of the Contractor, over excavation, and excavation performed for will not be measured for payment.

1.1.3.3 Unit of Measure

Unit of measure: cubic meters yards.

1.1.4 Fill Material

****

NOTE: There are restrictions in guidance for the use of Hydraulic fill in levee construction. Designer should refer to EM 1110-2-1913 for guidance.

****

1.1.4.1 Payment For Embankment Fill

Payment will be made for material placed as required in embankments, backfills and ramps, and including additional material placed by reason of foundation settlement and by reason of soft material in the foundation being forced outward from the section during construction, for [Embankment Material Type [_____],] [Semicompacted Fill] [Uncompacted Fill] [Hydraulic Fill]. Payment will constitute full compensation for furnishing all plant, labor, equipment and material, [except earth material,]and performing all operations necessary for foundation preparation and placing and compacting the material [, materials testing,] [and moisture control]. [This payment is in addition to any payment for excavating and transporting of the material as required in paragraph EXCAVATION.]

1.1.4.2 Measurement of Fill Material

****

NOTE: The last sentence of the following paragraph (in brackets) should be deleted if surveys are taken "after" clearing and grubbing operations. The last sentence should be included if surveys are taken "prior" to clearing and grubbing operations.

****

Submit a copy of the records of each compliance survey the next work day following the survey.

1.1.4.2.1 Fill Materials Specified for Embankment

Fill materials specified for embankment will be measured for payment by the cubic meter yard, and quantities will be determined by the average end area method. The basis for measurement will be cross sections of the areas to be filled taken [prior to] [after] clearing, grubbing, and stripping operations and the [theoretical cross sections] [actual cross sections] of the embankments constructed within the specified tolerance[plus additional fill placed as the result of displacement or settlement of foundation material as calculated below].[Cross sections will be performed at significant breaks in grade except that the maximum distance between cross sections will not exceed [_____] meters feet.] Embankments not constructed to design grade and section including allowable tolerance as indicated on the Contractor's compliance survey will not be accepted.[Volumes occupied by drainage structures will not be included in measurement of embankment for payment.] [Material removed as a result of the clearing, grubbing, and stripping operations will not be included in measurement of embankment for payment.]

1.1.4.2.2 Fill Due to Soft Material in the Foundation

The basis for measurement of fill placed by reason of soft material in the foundation being forced outward from the section will be a survey of the area taken prior to fill placement and a second survey of the same area after completion of fill placement. The cross sections will extend [_____] meters feet beyond the toes of the fills.[A cross section will be taken at each settlement measurement location.]

1.1.4.2.3 Levee Settlement

****

NOTE: The designer can choose to measure settlement

using settlement gages.
****

Measurement of additional fill material placed in each settlement measurement range, shown on the drawings by reason of foundation settlement, will be based on measurements [taken on the respective settlement gage] at the respective settlement measurement locations as specified and will be determined as follows:

a. The settlement measured at each settlement measurement location will be considered to apply to the foundation area throughout the length of the settlement ranges shown on the drawings.

b. The foundation settlement under the embankment at each transverse cross section within a settlement range will be considered to vary uniformly between break points in the cross section.

c. At each breakpoint, the settlement allowance will be based upon the proportion that the specified fill height at the break point bears to the specified fill height at the settlement measurement locations, in accordance with the following formula.

d.

S = h X sm/hm, where	
S	settlement to be computed at a break point
h	specified gross fill height at S
sm	measured or adjusted vertical change at settlement measurement location
hm	specified gross fill height at settlement measurement location

e. Symbols used in the formula and the break points are [shown on a typical settlement cross section on the drawing] [included in these specifications].

1.1.4.2.4 Forfeiture of Payment for Settlement of Foundation

Failure to utilize settlement gages in strict accordance with the specifications and drawings will result in total forfeiture of any payment which will otherwise be due the Contractor for settlement of the foundation. Payment for settlement of the foundation will be totally forfeited for the reach attributable to the each settlement measurement location in each case for the following reasons: embankment over a settlement measurement location is constructed to a height in excess of the specified construction lines plus the tolerance permitted; settlement plates have been set and cannot be found after completion of the embankment; failure to take the settlement measurement within [_____] hours after the final cross sections have been taken over the completed embankment.

1.1.4.3 Unit of Measure

Unit of measure: cubic meters yards.

1.1.5 Mortar and Concrete for Foundation Preparation

****

NOTE: If Section 31 66 10 ROCK FOUNDATION PREPARATION, specifically paragraphs DENTAL CONCRETE or DENTAL MORTAR is a part of the project specifications, this section should be deleted.

****

1.1.5.1 Payment

Payment will be made for costs associated with mortar and concrete used in foundation and abutment preparation, which includes full compensation for furnishing all labor, equipment, material, and incidentals, and performing all operations necessary for placement of concrete and mortar for foundation and abutment preparation.

1.1.5.2 Measurement

Mortar and concrete used in filling spaces beneath rock overhangs and around protrusions will be measured for payment as the actual volumes of such mortar and concrete in cubic meters yards as determined by field surveys made before and after placement of the mortar and concrete.[No measurement will be made for the mortar used in filling the open joints and cracks in the rock surface.][Measurement of mortar or concrete used in filling the open joints and cracks in the rock surface will be made by the square meter yard based on the horizontal projection of the area obtained from a survey performed before application.][Measurement of mortar or concrete used in filling the open joints and cracks in the rock surface will be the bags of cement used.]

1.1.5.3 Unit of Measure

Unit of measure: cubic meters yards.

[1.1.6 Settlement Gages

No separate payment will be made for furnishing, installing, and maintaining settlement gages during embankment construction as specified herein, if used, including measurements required to be made by the Contractor, and will be at the expense of the Contractor. No separate payment will be made for compaction of fill around and over the settlement gages or for interference with the Contractor's operations resulting from the settlement gage installations.

]1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 43	(2005; R 2018) Standard Specification for Sizes of Aggregate for Road and Bridge Construction

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM D422	(1963; R 2007; E 2014; E 2014) Particle-Size Analysis of Soils
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2937	(2017; E 2017; E 2018) Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
ASTM D4253	(2016; E 2019) Standard Test Methods for

	Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	(2016) Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D5195	(2014) Density of Soil and Rock In-Place at Depths Below the Surface by Nuclear Methods
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.3 DEFINITIONS

****

NOTE: Add applicable definitions.

****

1.3.1 Clearing

Clearing consists of the removal and satisfactory disposal of all [above ground and below ground]trees, downed timber, snags, slash, brush, garbage, trash, debris, fencing, and other items occurring in the designated areas to be cleared.

1.3.2 Grubbing

Grubbing consists of the removal and satisfactory disposal of stumps, roots larger than [_____] mm inches in diameter, and matted roots from the designated grubbing areas. Grubbing also includes filling of holes from the grubbing operation.

1.3.3 Stripping

Stripping consists of the removal and satisfactory disposal of crops, weeds, grass, and other vegetative materials to the ground surface[and topsoil to a depth of [_____] mm inches].

1.3.4 Satisfactory Materials

****

NOTE: Use of CH material should be avoided if

possible. As a minimum, constraints should be set governing their use.
****

Satisfactory materials consists of materials classified in accordance with ASTM D2487 as CL,[CH,] CL-ML, ML, SC, SP, SW, [_____] free from: roots and other organic matter; contamination from hazardous, toxic or radiological substances; trash, debris; and frozen materials. Not all satisfactory materials can be used in levee. Only the satisfactory materials stated above, meeting the additional or modified requirements of paragraph TYPES OF FILL MATERIALS, can be used for levee construction.

1.3.5 Unsatisfactory Materials

Do not use unsatisfactory materials in any levee or other required fill. Unsatisfactory materials includes all other materials that are not defined above as satisfactory materials. Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include, man-made fills (unless excavated, sorted/separated/stockpiled, and tested); trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material.

1.3.6 Embankment

The term "embankment" as used in these specifications is defined as the earth [and rock]fill portions of the levee structure or other fills related to the levee structure, including [cut-off trench] and includes all types of earth fill [and filter materials]for the levee [and cut-off trench,] and all other fills within the limits of the levee as shown on the project drawings. [Stone and other rock materials used for slope protection are described in paragraph [_____]].

1.3.7 Backfill

Backfill as used in this section is defined as that fill material which cannot be placed around or adjacent to a structure until the structure is completed or until a specified time interval has elapsed after completion.

1.3.8 Excavation

Excavation consists of removal of material to the lines and grades shown on the drawings, or as otherwise directed or approved by the Contracting Officer and as described in paragraph [_____] EXCAVATION in PART 3 EXECUTION.

1.3.8.1 Over-excavation

Excavation performed beyond lines and grades shown on the plans that is made at the convenience of contractor. No separate payment will be made for over-excavation or for additional embankment materials needed to backfill the over-excavation.

1.3.8.2 Additional Excavation

Excavation performed beyond lines and grades shown on the plans that is performed at the direction of the Government, and to be paid at unit prices for excavation and backfill, or as negotiated.

1.3.9 Classification of Soils

Materials used to construct the embankments and for backfills will be classified in accordance with ASTM D2487 (Unified Soil Classification System). Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

1.3.10 Degree of Compaction

1.3.10.1 Cohesive Material

****

Note: If a higher compactive effort than is attainable by ASTM D698 is desired, ASTM D1557 may be utilized and references to ASTM D698, relative to compactive effort, should be changed to ASTM D1557.

****

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in [ASTM D698] [ASTM D1557], abbreviated hereinafter as percent laboratory maximum density.

1.3.10.2 Cohesionless Material

****

Note: Factors such as (but not limited to) site specific materials, availability of testing equipment and local practice may make it more practical to utilize methods other than ASTM D4253 and ASTM D4254 to control the degree of compaction of cohesionless material. If other methods are utilized the appropriate sections of the specifications should be modified to reflect method selected. The other methods used include comparison of in-place density to either the maximum Proctor density or the maximum density obtained by ASTM D4253 (if vibratory table is available).

****

Degree of compaction is expressed as a percentage of the relative density in accordance with ASTM D4253 and ASTM D4254.

1.4 SYSTEM DESCRIPTION

****

NOTE: This section should describe all appropriate activities to be performed to accomplish the completed projects as planned, including any special work items that must be conducted.

****

The work covered by this section consists of furnishing all equipment, labor, materials, and incidentals, and performing all operations necessary for the clearing, grubbing, and stripping of the areas specified herein or indicated on the drawings, and for the removal and disposal of cleared, grubbed, and stripped materials,[removal or plugging of existing drainage structures,] and refilling of holes resulting from grubbing; excavation of borrow areas [and existing levees,] and for all other required excavations or excavations incidental to the construction of levees[, channels] [, ditches] [, structures] [, and ponding areas] as specified and shown; foundation preparation and the construction of levee embankments, including new levee, enlargement of existing levee, backfill of inspection trenches, cutoff trenches, berms, road crossings, backfill at drainage structures, and other incidental earthwork as may be necessary to complete the levee as specified herein and as shown on the drawings. All work under this section will comply with the requirements of EM 385-1-1.

1.4.1 Embankment and Backfill Materials

****

NOTE: All available sources of materials for embankment and backfill should be designated.

****

At least [30] [_____] days prior to delivery of any Contractor-furnished material to the site of the work, submit soil classification test results, moisture-density curves, gradation curves, and laboratory results of the required tests of the proposed material. Materials for embankment and backfill construction will be obtained from [the borrow sources] [sources provided by the Contractor] [required excavation]. Materials obtained from required excavation which meet or which can be processed to meet the requirements for each embankment material, or any other material required for this project, as specified herein, may be utilized [in the appropriate zone of] [in] the embankment or as backfill. Submit to the Contracting Officer the source or sources intended to provide materials for embankment construction. If a source is selected other than a commercial quarry or other commercial entity from which earth or rock material will be directly purchased and where the Contractor or his subcontractor will perform the borrow excavation, a written statement will be provided to the Contracting Officer indicating permission to utilize the area. It is the Contractor's responsibility to obtain Federal, State, and local permits which may be required for excavation and reclamation of the borrow area. A copy of the plan and procedures to be utilized for reclamation will be furnished to the Contracting Officer as required in Section [_____], paragraph [_____]. The Contracting Officer will require material samples from any proposed borrow source to be submitted as indicated in paragraph FIELD QUALITY CONTROL.

1.4.2 Haul Roads

****

NOTE: Haul roads are highly project specific. Contractor should be given as much latitude as feasible to determine his traffic patterns. Haul roads must be safe, not interfere with public traffic, environmentally friendly and generally must be restored to preconstruction conditions.

****

Locate and construct haul roads [as indicated and] [as] [approved by the Contracting Officer] [within the project boundaries shown on the drawings].[Prior to the commencement of construction submit for approval a site plan detailing the location of all haul roads within the project limits.] [Locate haul road[s] between the borrow site[s] and the levee embankment within the limits [shown on the drawings] [approved by the Contracting Officer].] [Mark the limits of the borrow haul road in the field using construction fencing or similar methods approved by the

Contracting Officer. Areas on each side of the borrow haul road corridor must not be disturbed.] Construct haul roads to maintain the intended traffic, be free draining, and remain in good condition throughout the contract period.[Any haul road which crosses any creek or drainage channel must be constructed, and maintained so as to not flood either upstream areas by restricting stream flows or flood downstream areas by the release of any stored water in the event that the crossing fails for any cause.] Remove haul roads constructed during the contract duration after work is completed and the impacted area restored to its preconstruction conditions.[Plow and/or scarify or otherwise loosen all access and haul roads other than existing roads to a minimum of [_____] mm inches deep and leave the surface in a smooth condition.] All haul roads within the right-of-way that will remain as public thoroughfares after construction must be cleaned daily and maintained in the preconstruction condition. Consider all costs associated with these haul roads as a subsidiary obligation of the Contractor.

1.4.3 Ramps and Crossings

Construct ramps and crossings at the locations shown on the drawings by placement of a fill as specified in paragraph [_____]. Construct ramps and crossings by adding material to the levee crown and slopes. Provide ramps that have a [_____] meter foot crown width, a grade not to exceed [_____] percent, and 1V on [_____]H side slopes.

1.4.4 Runways

****

NOTE: Runways are temporary haul roads over a levee.

****

Where material is hauled over an existing levee for construction, the Contractor, at no extra cost, will be permitted to construct temporary runways over the levee by the addition of material to the levee cross section. For the construction of runways, if the Contractor so desires, the existing levee may be cut, [but not to exceed a depth of [_____] meters feet below the crown] [not to exceed [_____] meters feet below the project flowline] [or 100-year level] [not to excavate below elevation [_____] or one half the height of the levee, whichever is less], and provided that the cut is made with side slopes not steeper than 1V on 1H, and with a minimum width of haul road of [_____] [7.6] m [_____] [25] feet for one-way traffic, and [_____] [18.3] m [_____] [60] feet for two-way traffic. Cutting into the existing levee at intervals of less than [_____] [152] m [_____] [500] linear feet for the [_____] [7.6]-m [_____] [25]-foot bottom widths or less than [_____] [304] m [_____] [1,000] linear feet for the [_____] [18.3]-m [_____] [60]-foot bottom widths will not be allowed, and no more than [_____] runways will be open at one time. Stockpile, as directed by the Contracting Officer, sufficient suitable levee embankment material to construct emergency closure of the cuts.

1.4.5 Closure of Runways

Where runways have been cut through the levee, the Contracting Officer reserves the right to order their closure at no additional cost to the Government at any time that such runways may endanger the security of the levee. Just prior to restoration of the runway, the bottom of any cut made in the levee must be broken to a depth of [_____] [300] mm [_____] [6] inches and the side slopes thoroughly scarified. The restoration must be made with suitable embankment material, placed and compacted as provided in paragraph [_____]. Remove material used in the construction of the approach ramps of the runways and use for fill, if satisfactory. If not used for fill, dispose the material by placing it in abandoned portions of the borrow areas or by any other method specified in paragraph disposal of material.[No section of the levee will be degraded or weakened to provide runways nor will existing runways remain open during the nonwork season described in [GENERAL CONTRACT REQUIREMENTS], [paragraph] [Clause] EXCLUSION OF PERIODS IN COMPUTING COMPLETION SCHEDULES, unless otherwise approved in writing by the Contracting Officer.]

1.4.6 Stockpiling

****

NOTE: Cost of stockpiling embankment fill material should be included in the price for placing fill in the levee embankment.

****

Any on-site stockpiling of embankment materials will be in accordance with paragraph [_____] Stockpiles.[No payment will be made for such stockpiling nor for the reloading and hauling of these materials to their final position.]

1.4.7 Slides and Foundation Failures

When sliding occurs in any part of the embankment and backfills prescribed in this section after they have been placed, but prior to final acceptance of all work under the contract, either cut out and remove the slide from the embankment and then rebuild that portion of the embankment, or construct a stability berm of such dimensions, and place in such manner as prescribed by the Contracting Officer. When the slide is caused through the fault of the Contractor, the repair will be made at no cost to the Government.

1.4.8 Drainage Requirements

****

NOTE: Modify the following paragraph for specific job conditions such as fill placed in/under water.

****

Submit written evidence consisting of an authenticated copy of the [conveyance] [easement] under which the Contractor acquired the property rights and access thereto, prepared and executed in accordance with applicable State and local requirements. Do not block or restrict the flow in a natural drain, existing culvert, ditch or channel at any time without obtaining prior written approval from the Contracting Officer. This approval will not relieve the Contractor from responsibility for any damage caused by the operation. Monitor the [river] [canal] [stream] flow and provide sufficient free discharge areas so that conditions are not worsened upstream or downstream by possible floods during construction. Surface water will be directed away from excavations and construction sites so as to prevent erosion and undermining of foundations. Diversion ditches, dikes, and grading will be provided and maintained as necessary during construction. Protect excavated slopes and backfill surfaces to prevent erosion and sloughing. Perform excavation so that the site and the area immediately surrounding the site and affecting operations at the site will be continually and effectively drained. If private property is to be used for drainage, submit written evidence that the right has been obtained from the property owner for drainage on his property.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Plan Of Operations; G, [_____]

Submit complete and detailed descriptions of proposed earthwork plan. This plan must include, but not be limited to, the Contractor's proposed sequence of construction for all earthwork including backfill and embankment items; methods and types of equipment to be utilized for all earthwork operations, including transporting, placing and compacting; quantity, type and final disposition of stockpiled materials; location and drainage of proposed stockpiles; proposed disposition of all excavated materials, including items which are anticipated to be disposed of off-site. Submit the earthwork plan to the Government not less than 30 days prior to initiating any earthwork operation.

Embankment And Backfill Materials; G, [_____]

At least 30 days prior to delivery of any Contractor-furnished material to the site of the work, submit soil classification test results, moisture-density curves, gradation curves, and laboratory results of the required tests of the proposed material.

Excavation; G, [_____]

Submit complete and detailed descriptions of proposed excavation plan. Obtain approval of the detailed plan from the Contracting Officer prior to starting the work. If necessary, modify the plan as required to meet field conditions, and the modifications must be approved prior to use. This plan must include:

a. Proposed methods for preventing interference with, or damage to, existing underground or overhead utility lines, trees designated to remain and other man-made facilities or natural features designated to remain within or adjacent to the construction rights-of-way.

b. Provision for coordinating the work with other Contractors working in the construction rights-of-way or on facilities crossing or adjacent to this work.

c. The proposed methods for controlling surface and ground water in the borrow areas and required excavations.

d. Stockpiling plan for embankment material before it is transported to the project site showing locations, stockpile heights, slopes, limits, and drainage around the stockpile areas.

e. A complete listing of equipment used for excavation and to transport the excavated material.

f. The proposed sequence of work for excavating the borrow areas with plan and cross sectional views showing starting and final work locations and clearing, grubbing and stripping limits.

g. The proposals for conserving arable land and for making optimum use of available borrow, including the Contractor's proposed methods for grading the bottom of the borrow areas after completing use of the borrow areas.

h. The proposed haul road and haulage patterns, and plan for implementing dust control measures.

i. Proposed disposition of all excavated materials, including items which are anticipated to be disposed of off-site.

SD-02 Shop Drawings

Drainage Requirements

SD-03 Product Data

Shoring, Sheeting, and Bracing; G, [_____]

Borrow Areas; G, [_____]

Filter Sand; G, [_____]

Nuclear Density; G, [_____]

SD-06 Test Reports

Measurement of Fill Material; G, [_____]

Submit a copy of the records of each compliance survey the next work day following the survey.

1.6 PROJECT SITE CONDITIONS

****

NOTE: The following paragraphs are commonly included with Division 02, EXISTING CONDITIONS. If those sections are to be used, the following paragraphs should be deleted.

****

1.6.1 Protection of Man-Made Facilities and Natural Features

Trees within the clearing area will be felled in such a manner as to avoid damage to trees left standing and trees outside the clearing area, existing buildings, man-made facilities and natural features, with due regard to the safety of employees and others, and in compliance with EM 385-1-1. Excavation will follow the same requirements specified above for felling trees and will be in compliance with EM 385-1-1. Existing utility lines that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation and that are to be retained will be protected from damage during excavation. When utility lines that are to be removed are encountered within the area of operations, notify the applicable utility companies in sufficient time for measures to be taken to prevent interruption of the services.

1.6.2 Historical, Archeological, and Cultural Resources

Historical, archeological, and cultural resources within the Contractor's work limits [are known to exist] [may exist]. If, during construction activities, the Contractor observes items that may have historical or archeological value, such observations will be reported immediately to the Contracting Officer so that appropriate authorities may be notified and a determination made as to their significance and what, if any, special disposition of the finds should be made. Cease all activities that may result in the destruction of these resources and prevent the workers from trespassing on or otherwise damaging such resources.

1.6.3 Subsurface Data

Subsurface soil boring logs are [shown on the drawings] [included in these specifications] [found in the Project Geotechnical Report]. Subsurface investigation reports and samples of materials obtained from subsurface investigations may be examined at the [_____] District Office. These data represent subsurface information at the boring locations; however, variations may exist in the subsurface between boring locations. The Contractor is ultimately responsible for subsurface interpretation across the entire project site. Groundwater levels indicated on the soil boring logs were levels found at the time of exploration. The groundwater table can vary significantly depending on time of year, variation from normal precipitation, and river stage or tide level. Contractor is ultimately responsible for subsurface interpretation across the entire project site.

1.7 MERCHANTABLE TIMBER

****

NOTE: The following paragraphs are commonly included with Division 02, EXISTING CONDITIONS. If those sections are to be used, the following paragraphs should be deleted.

****

Merchantable timber remaining within the areas to be cleared on or after the date of award of this contract may be disposed of as the Contractor sees fit, as long as such merchantable timber is either removed from the rights-of-way or is satisfactorily disposed of in accordance with the paragraph DISPOSITION OF CLEARED, GRUBBED, AND STRIPPED MATERIAL DISPOSITION OF EXCAVATED MATERIAL and the Contractor complies with all applicable State and local regulations and laws.

1.8 SEQUENCING

1.8.1 Clearing and Grubbing

****

NOTE: If the specification for this project includes Section 31 11 00, CLEARING and GRUBBING, the following paragraph should be deleted.

****

Complete all clearing and grubbing work at least [100] [_____] meters [300][_____] feet in advance of embankment construction.[In locations where work on drainage structures is performed prior to embankment construction, complete all clearing and grubbing for the structure at least [_____] meters feet on each side of the structure, measured along the levee centerline and [_____] meters feet perpendicular to the structure.] If regrowth of vegetation or trees occurs after clearing and grubbing and before placement of embankment, the Contractor will be required to clear and grub again prior to embankment construction.

1.8.2 Stripping

After inspection and acceptance of cleared and grubbed areas, stripping may proceed. All stripping work must be completed not more than [_____] meters feet in advance of embankment construction.

PART 2 PRODUCTS

****

NOTE: After "PART 2 PRODUCTS" above, insert the following "(NOT APPLICABLE)", if there are no subparagraphs in PART 2. PART 2 material requirements should be added for contracts in which the Contractor is required to supply materials.

****

2.1 HAUL ROAD MATERIALS

[_____].

2.2 TYPES OF FILL MATERIALS

****

NOTE 1: The types of fill materials used for levee construction usually depend on the availability of materials from required construction excavation and the nearby borrow sources. The material types listed below as satisfactory materials are often used in levee construction.

2: Separate paragraphs, such as those below, should be included for EACH material type that is to be placed under a contract. The plans should clearly show, with labels, the location of the fill types. Embankment fills should include, but not be limited to, the levee, berms, inspection trench, cutoff trenches and any other specified fill or backfill. This allows the Designer and Specifications Engineer to use multiple fill types within the same contract and clearly indicate locations of each type. The types of satisfactory materials should be edited for each type of fill. The bid schedule should include a line for each type of fill. Where multiple fills are placed in layers or zoning, the measurement, payment and tolerance paragraphs should be edited to specify the interfaces of the multiple fill types.

Omit the following soil types which are not applicable to the specific project.

****

2.2.1 [Select Fill

Obtain select fill embankment material from [the borrow site provided by the Government] [sources provided by the Contractor] [required excavation]. Provide select fill material consisting of satisfactory materials classified in accordance with ASTM D2487 as [_____].]

2.2.2 [Impervious Fill

****

NOTES: Caution should be exercised regarding the use of high plasticity clay and silt (CH, MH) soils with Plasticity Indices greater than about 40 (30 in dry climates and 50 in humid climates). Spreading and compacting CH or MH materials can also present constructability problems due to difficulty maintaining proper moisture content. These soils are susceptible to shrinkage and cracking upon drying. Seasonal cycles of swelling and shrinkage can also result in loss of shear strength, which may ultimately result in slope instability. Chemical treatment, such as lime, has been used to reduce the PI and potential for cracking.

Compact Impervious Fill material using self-propelled or towed sheeps-foot rollers.

****

Provide material consisting of satisfactory impervious material classified as lean clay (CL),[fat clay (CH),] low plasticity silt (ML),[high plasticity silt (MH),] [sand containing more than 30 percent of clay (CL),] and borderline clay and silt (CL-ML) in accordance with ASTM D2487.]

2.2.3 [Pervious Fill

****

NOTE: The designer should define the types of material which are acceptable as Pervious Fill.

****

Provide material consisting of satisfactory pervious material classified as well graded sand (SW), poorly graded sand (SP)), poorly graded gravel (GP) or well graded gravel (GW) in accordance with ASTM D2487.]

2.2.4 [Random Fill

Provide random fill consisting of any satisfactory materials[other than those classified in ASTM D2487 as [_____]] [and any silt or sand with a uniformity coefficient (Cu) less than 6].[Random fill may consist of select fill, impervious fill, and pervious fill, or a combination of them.]]

2.2.5 Random Rock

****

NOTE: Random rock is sometimes used in levee construction to build up an underwater levee toe foundation or to buttress a slope in a constricted area. Due to its high permeability, random rock or pervious fill should not be used alone as levee fill material. The designer should select the types of acceptable rock material and the maximum allowable percent fines.

****

Provide random rock consisting primarily of [_____] (shale, siltstone, sandstone, granite or limestone) obtained from a source provided by the Contractor. Provide random rock that is free of silt, clay, or other earth material in quantities greater than [_____] [5] percent by weight, and containing no debris or organic material. Random rock must be reasonably well-graded and the largest stones must have a maximum dimension not exceeding [_____] [450] mm [_____] [18] inches. Control rock production at the source such that not more than 20 percent of the material has a maximum dimension between adjacent earth fill choke off with a layer of finer random rock material. Random rock placed within 1 meter 3 feet of any structure must have a maximum size of 125 mm 5 inches.

[2.2.6 Coarse Drainage Gravel

****

NOTE: It is important to use appropriate filter criteria in the design of the drainage features. Selection of the gradation for the coarse and fine drainage materials should be developed with

consideration of filter compatibility with native soils and the materials to be obtained for use.

****

Obtain coarse gravel material for the [rectangular and trapezoidal] toe drains [landside seepage berms] [road stone] from a source [provided by the Contractor]. Provide coarse drainage gravel that is non-calcareous, composed of tough durable particles, and does not contain any organic material or soft, friable particles in quantities. Blast furnace slag will not be permitted. The gravel material in-place must meet the quality requirements of [AASHTO M 43, Size No. 57][ASTM C33/C33M No. 57].

][2.2.7 Fine Drainage Gravel

****

NOTE: Identify source of materials. It is important to use appropriate filter criteria in the design of the drainage features. Selection of the gradation for the coarse and fine drainage materials should be developed with consideration of filter compatibility with native soils and the materials to be obtained for use.

****

Obtain fine drainage gravel material for the [rectangular and trapezoidal] [toe drains] [landside seepage berms] [road stone] from a source [provided by the Contractor]. Provide fine drainage gravel material that is non-calcareous, composed of tough durable particles, and does not contain organic material. The fine drainage gravel in-place must meet the requirements of [AASHTO M 43, Size No. 8][ASTM C33/C33M].

][2.2.8 Filter Sand

****

NOTE: It is important to use appropriate filter criteria in the design of the drainage features. Selection of the gradation for the coarse and fine drainage materials should be developed with consideration of filter compatibility with native soils and the materials to be obtained for use.

****

At least [30] [_____] days prior to delivery of any Contractor-furnished material to the worksite, submit soil classification test results and a gradation curve for each of the proposed filter materials to be used. Fine aggregate for the filter sand in-place must meet the quality requirements of ASTM C33/C33M grading for fine aggregate with additional limits on the allowable percentage passing the No. 200 sieve as specified below.

SIEVE SIZE U.S. STANDARD SQUARE MESH	PERCENTAGE BY WEIGHT PASSING INDIVIDUAL SIEVE
9.5 mm3/8-inch	100
4.75 mmNo. 4	95-100

SIEVE SIZE U.S. STANDARD SQUARE MESH	PERCENTAGE BY WEIGHT PASSING INDIVIDUAL SIEVE
1.18 mmNo. 16	50-85
150 µmNo. 100	2-10
75 µmNo. 200	0-5

Additionally, the filter sand must not contain any organic matter or soft friable particles.

]2.2.9 Bedding

Bedding material, placed as a backing layer must consist of satisfactory pervious fill material satisfying the material requirements presented in [Section 31 36 00 GABIONS] and [Section 35 31 19.40 STONE REVETMENTS].

2.2.10 Topsoil

Provide topsoil consisting of organic soil and place on the levee slopes as shown on the contract drawings and as specified in Section [32 92 23 SODDING] [_____].

[2.2.11 Semicompacted Fill

****

NOTE: The designer should list the material types that are acceptable for semicompacted fill, which can be defined in terms of previously defined fill types or basic material types.

****

Provide material for semicompacted fill consisting of satisfactory materials classified in accordance with ASTM D2487 as [_____].

][2.2.12 Uncompacted Fill

****

NOTE: The designer should list the material types that are acceptable for uncompacted fill, which can be defined in terms of previously defined fill types or basic material types.

****

Provide material for uncompacted fill consisting of satisfactory materials classified in accordance with ASTM D2487 as [_____].

][2.2.13 Hydraulic Fill for Berms and Depressed Areas

****

NOTE: Caution should be used when specifying hydraulic fill. Hydraulic fill is to be used only in stability berms, pit fills, and seepage berms. Hydraulic fill will normally not be used in construction for levee embankment. In addition to requiring a large levee footprint, the levee

embankment constructed by hydraulic fill is susceptible to soil liquefaction, and excessive seepage. Hydraulic fill also erodes quickly in a situation where a levee is overtopped or where an impervious covering is penetrated. See the appropriate Engineering Manuals for further guidance.

Tie this back to Section 01 45 00 QUALITY CONTROL requirement for inspection and validation of CQC laboratories by the government.

****

Place fill shown on the drawings as hydraulic fill by hydraulic methods in accordance with the plan of operations approved by the Contracting Officer. Thirty (30) days prior to commencement of haul road construction or placing embankment and backfill, whichever is earlier, submit for approval a Plan of Operations for accomplishing all embankment and backfill construction and for the location and construction of haul roads. This plan must include, but not be limited to, the proposed sequence of construction for embankment and backfill items, and methods and types of equipment to be utilized for all embankment and backfill operations, including transporting, placing, and compaction. This plan must also include the names and addresses of the [commercial testing labs] [engineering firms] which will perform the soil testing and inspection and describe how all required soils testing will be performed. The dredged material must have, as placed, not less than [_____] percent by weight passing U.S. Standard Sieve No. [_____] and not less than [_____] percent by weight passing a U.S. Standard Sieve No. [_____].

][2.3 MANUFACTURED PRODUCTS

****

NOTE: Add applicable requirements.

****

[_____].

][2.4 GROUTS AND DENTAL CONCRETE

Provide grouts and dental concrete as specified in concrete Section [_____] CONCRETE, except that the slump must be [_____] mm inches for dental concrete.

][2.5 STABILIZERS

****

NOTE: Add applicable requirements.

****

[_____].

][2.6 INSTRUMENTATION

[2.6.1 Piezometers and Observation Wells

Install piezometers and observation wells as shown.

][2.6.2 Settlement Markers and Survey Monuments

Install survey monuments and settlement markers as shown.

][2.6.3 Settlement Gages

Provide settlement gages as shown.

]]PART 3 EXECUTION

3.1 CONSTRUCTION

3.1.1 Lines and Grades

Construct embankment and backfill to the lines, grades, and cross sections indicated on the drawings, unless otherwise directed by the Contracting Officer. The Government reserves the right to increase or decrease the foundation widths and embankment slopes or to make such other changes in the embankment or backfill sections as may be deemed necessary to produce a safe structure. Changes in quantities resulting from such revisions will not constitute justification for change in contract unit prices, except as provided for in FAR 52.211-18 Variation in Estimated Quantities Clause. Increases in height of section, made to compensate for settlement or consolidation of the embankment material subsequent to the completion of the embankment, will not exceed [_____] percent of the height above the foundation at the levee centerline indicated. Provide end slopes and side slopes of partial fill sections no steeper than [one vertical on [_____] horizontal] [, unless otherwise shown on the drawings].

3.1.2 Conduct of the Work

Maintain and protect the embankment and backfill in a satisfactory condition at all times until final completion and acceptance of all work under the Contract.[If, in the opinion of the Contracting Officer, the hauling equipment causes horizontal shear planes or slicken sides, rutting, quaking, heaving, cracking, or excessive deformation of the embankment or backfill, limit the type, load, or travel speed of the hauling equipment on the embankment or backfill.] The Contractor may be required to remove, at no additional payment, any embankment material placed outside of prescribed slope lines. Replace approved embankment or backfill material which is lost in transit or rendered unsuitable after being placed in the embankment or backfill and before final acceptance of the work in a satisfactory manner and no additional payment will be made therefore.

Excavate and remove from the embankment or backfill any material which is unsatisfactory, dispose of such material, and refill the excavated area as directed, all at no cost to the Government.

3.2 CLEARING

Accomplish clearing within the [limits][construction limits shown on the drawings] of existing ground to receive embankment [and structures], together with strips [1.5] [_____] meters [5] [_____] feet wide, beyond and contiguous thereto, existing levees to be degraded, ponding areas, ditches, structures, traverses, channels, riprap, revetment, borrow areas and ramps. Clear trees, downed timber, snags, slash, brush, garbage, trash, debris, fencing and other items [[_____] mm inches above] [flush with] the existing ground surface. Protect trees and vegetation designated to be left standing or to remain from damage from construction operations. Limit clearing of borrow areas to the minimum area required for construction operations.

3.3 GRUBBING

Accomplish grubbing within the [limits][construction limits shown on the drawings] of existing ground to receive embankment [and structures], together with strips [1.5] [_____] meters [5] [_____] feet wide, beyond and contiguous thereto, existing levees to be degraded, ponding areas, ditches, structures, traverses, channels, riprap, revetment, borrow areas and ramps. Accomplish grubbing to a depth of at least [1] [_____] m [3] [_____] feet below the existing ground surface. Fill holes caused by grubbing operations and removal of pipes and drains, excluding holes in borrow areas, channels and ditches [above required grade], with satisfactory material as specified in paragraph [_____]. Place material in [_____] mm inch layers to the elevation of the adjacent ground surface and each layer compacted to a density at least equal to that of the adjoining undisturbed material.

3.4 STRIPPING

The entire area within the [limits][construction limits shown on the drawings] of existing ground to receive embankment and structures, together with strips [1.5] [_____] meters [5] [_____] feet wide, beyond and contiguous thereto, existing levees to be degraded, ponding areas, and ditches [shown on the drawing must be stripped to remove crops, weeds, grass, and other vegetative materials to the ground surface [and topsoil to a depth of [_____] mm inches]].

3.5 DISPOSITION OF CLEARED, GRUBBED, AND STRIPPED MATERIAL

****

NOTE: Delete undesirable options for Disposition of Cleared, Grubbed, and Stripped Materials.

****

Except as otherwise specified or indicated on the drawings, dispose all materials resulting from clearing and grubbing operations at the Contractor's option, by windrowing or stockpiling within construction limits, burying within construction limits, burning, chipping, removal from the site, or a combination thereof. Do not bury or place any material resulting from clearing and grubbing operations within the levee foundation or any structural foundation. Make a reasonable effort to channel merchantable material into the commercial market and to make beneficial use of the materials resulting from clearing and grubbing. [Temporarily stockpile the topsoil material resulting from the stripping operations within the rights-of-way.]

3.5.1 Windrows

Place cleared, grubbed and stripped material [as shown on the drawings] in a neat windrow or in piles with tree limbs trimmed sufficiently to make the windrow as small as practicable. Do not extend cleared, grubbed or stripped material beyond the construction limits.

3.5.2 Burning

Subject to applicable Federal, State and local burning restrictions, the Contractor may burn material within the contract rights-of-way. Conduct burning operations to prevent damage to adjacent man-made facilities and natural features. The Contractor is responsible for any damage to life and property resulting from fires that are started by the Contractor's employees or as a result of the Contractor's operations. Furnish, at the site of burning operations, adequate fire fighting equipment to properly equip personnel for fighting fires. Guard fires at all times and provide constant surveillance until they have been extinguished. Remove all unburned material (material not reduced to ash) from the site or dispose of by [_____].

3.5.3 Burying

Subject to applicable Federal, State and local burying restrictions, the Contractor may bury the cleared and grubbed material in the area(s) as shown on the drawings or in [_____]. Do not bury material within [_____] meters feet of any standing timber. Cover all buried material with a minimum of [_____] mm inches of earth.

3.5.4 Chipping

All cut timber, down timber, dead timber, branches, and brush may be chipped. Haul the chips to stockpiles indicated on the drawings or to other locations approved by the Contracting Officer or remove from site of work. Deposit chips in these areas in piles or windrows [above] [below] elevation [_____] NGVD.

3.5.5 Removal from Site of Work

The Contractor may elect to remove all or part of the cleared and grubbed materials from the site of the work[in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS]. The Contractor may opt either to retain any such materials of value or dispose of them by sale or otherwise. The Government is not responsible for the protection and safekeeping of any materials retained by the Contractor. [Materials resulting from the clearing and grubbing operations must be removed from the site [weekly] [monthly].][Remove such materials from the site of the work before the date of completion of the work.]

3.6 REMOVAL OR PLUGGING OF ABANDONED PIPE AND CONDUITS

****

NOTE: The terms and conditions in any permits and environmental commitments obtained by the Government must be made a part of the contract. The designer must include technical requirements necessary to comply with these terms and commitments.

****

Remove abandoned pipes and conduits to the limits shown on the drawings or abandon in place by grouting or filling with concrete as shown on the plans a minimum distance of [_____] meters feet from [_____]. Prior to plugging, clean the interior of the pipe to be plugged and place the concrete in such a manner as to insure a dense, well bonded plug.

3.7 SHORING, SHEETING, AND BRACING

****

NOTE: Add applicable minimum requirements for the shoring, sheeting and bracing plan based upon site

specific conditions.
****

Submit a detailed shoring, sheeting and bracing plan [_____] days prior to the beginning of any excavation so supported. The plan for shoring, sheeting and bracing will be prepared and certified by licensed professional engineer, registered in [_____]. All shoring must be designed so that it is effective to the bottom of the excavation, and must be based upon calculation of pressures exerted by the earthen materials to be retained, including the condition and nature of those materials as well as any surcharge loads imparted to the excavation by slopes, equipment, traffic, or stored materials. Include in the plan drawings and design computations of the proposed shoring, sheeting, and bracing, and documentation, showing details of the coordination and approval of shoring, sheeting, and bracing by the applicable parties. Obtain approval of the detailed plan from the Contracting Officer prior to starting the work. If necessary, modify the plan as required to meet field conditions, and the modifications must be approved prior to use. Install shoring, sheeting, and bracing where required for the protection of existing natural features and man-made facilities, for the safety of workers and the public, in compliance with EM 385-1-1, and to insure the integrity of the embankment. Design, furnish and install sheet piling, cribbing, bulkheads, bracing, shores or whatever means that may be necessary to support earthen material carrying structures and other improvements, and maintain such piling, cribbing, bulkheads, bracing, shores in position until they are no longer needed. Do not use shoring, sheeting and bracing in lieu of the required excavation slopes. Design and properly install shoring, sheeting, and bracing to withstand anticipated loads. Remove all shoring, sheeting and bracing as embankment and backfill operations progress so that the backfill is placed directly against the undisturbed excavation face. Shoring deemed necessary by the Contracting Officer must remain in place during the backfill operations. Remove shoring in such a manner as not to disturb or damage the completed work or any adjacent property. If any problems are encountered during excavation, stop excavation operation and notify the Contracting Officer.

3.8 DEWATERING AND DIVERSION

Accomplish surface and groundwater control in coordination with the required excavation and embankment construction. Surface and/or groundwater control may necessitate the use of temporary diversion ditches, cofferdams and/or dewatering by the use of pumping. Methods for care of surface water and for controlling the surface and groundwater levels will be subject to approval of the Contracting Officer. Borrow pits must be drained and kept dry during excavation, as excavation will not be permitted in water nor will excavated material be scraped, dragged or otherwise moved through water. Drain borrow areas by ditching, sump pumping, or other approved methods. Drain borrow areas excavated under this contract and flooded from rains or high river stages and allow to dry as quickly as practicable after the high river stage has passed.

Minimize surface runoff from entering the work areas. Complete the necessary ditching or earthwork shaping at the end of each workday or as necessary to prevent surface runoff from entering the work area. Drain excess precipitation that collects in the work areas and allow to dry as quickly as practicable before work resumes.

3.9 EXCAVATION

Excavation will consist of removal of material in preparing the foundations to the lines and grades shown on the drawings, removal of material from ditches and channels to the lines and grades shown on the drawings, removal of objectionable materials and obtaining required fill materials from the borrow areas.[Blasting will [not] be permitted.] Over excavation will be backfilled to grade with satisfactory material and compacted to a density of at least that of the surrounding material. Backfill and compact excavation beyond the lines shown on the plans in accordance with adjacent materials as directed.

[3.9.1 Inspection Trench

Excavate an inspection trench and maintain free of standing water to the dimensions and locations shown on the drawings or as indicated by the Contracting Officer. Excavate the trench at least [_____] meters feet in advance of but not more than [_____] meters feet in advance of construction. When the inspection trench excavation is complete, notify the Contracting Officer's representative in order to examine the foundation stratigraphy in the side walls and bottom of the inspection trench.

]3.9.2 Structures

Provide excavations for structures conforming to the dimensions and elevations indicated for each structure and footing, except as specified hereinafter, and include trenching for utility and foundation drainage systems to a point [_____] meters feet beyond each structure and all work incidental thereto[except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces]. Excavation must extend a sufficient distance from walls and footings to allow for placing and removal of forms. Replace satisfactory material removed below the depths indicated without specific direction of the Contracting Officer at no additional cost to the Government and fill in accordance with paragraph OVER EXCAVATION above.[Backfill over excavation below required invert elevations or bottoms of footings with concrete at no additional cost to the Government. Do not construct footings on unsatisfactory material as determined by the Contracting Officer.] [Remove and replace excessively wet and/or soft material in subgrades resulting from water ponding in footing excavations with [lean concrete] [satisfactory material compacted to the density of the surrounding undisturbed material]].

3.9.3 Channels

Excavate channels at the locations and to the lines and grades shown on the drawings and in accordance with paragraph TOLERANCES.

3.9.4 Ditches

Excavate drainage ditches at the locations and to the lines and grades shown on the drawings and in accordance with paragraph TOLERANCES.

3.9.5 Slopes and Surcharges

Temporary excavation slopes for any channel, structure excavation, or other required excavation must not be steeper than the specified finished slope or the specified construction slope. Any field deviations from this provision must be approved by the Contracting Officer. Temporary slopes must be benched such that the average slope is not steeper than the specified slope. In addition, do not surcharge temporary, permanent, or construction slope with excavated or stockpiled material or with heavy construction equipment which would have the same effect as the surcharge material. Maintain the toe of stockpiled material a minimum distance back from the top of the finished excavation equal to the depth of the excavation. Determine the maximum height of such stockpile without causing instability of the excavation slope and provide justification for such in the Excavation Plan submittal.

3.9.6 Borrow Areas

Submit a written statement to the Government not later than [_____] days after receipt of Notice to Proceed indicating the Contractor's intention to use the specified Government-furnished borrow area(s), Contractor-furnished borrow area(s), dredged borrow areas, or a combination of these borrow areas.

3.9.6.1 Government-Furnished

Excavate borrow areas to the extent necessary to obtain satisfactory material within the lines and grades as shown on the drawings. When the material necessary for the construction of the embankment and berms cannot be obtained from adjacent borrow areas, obtain it from other Government-furnished borrow areas. [The permissible depth(s) in the borrow areas are indicated on the drawings.] Backfill any excavation below the depths and slopes specified herein or shown on the drawings, at the Contractor's expense, to the specified permissible excavation line, with satisfactory [material(s)] [cohesive material] [or] [other material] as specified by the Contracting Officer to a density of at least that of the surrounding material. Drain borrow areas and keep dry during excavation. In so far as is practicable, do not remove unsatisfactory materials in borrow areas unless otherwise directed by the Contracting Officer.

3.9.6.2 Contractor-Furnished

Proposed borrow areas will be subject to approval by the Contracting Officer. Any borrow sources proposed, accepted and approved by the Contracting Officer must meet all applicable Federal, State and local requirements including written evidence to the Contracting Officer that the Contractor has obtained property rights and access to the material therein. [Proposed sources located within [_____] meters feet landward and [_____] meters feet riverward of the levee between Stations [_____] and [_____] will not be permitted.] No payment will be made for Contractor-furnished borrow areas.

3.9.6.3 Dredged

Dredging operations may be conducted to obtain material for the pervious zones or the random zones subject to the requirements and the conditions specified herein. Dredging operations may be conducted at approved locations in the present stream bed of [_____] or as shown on the drawings. Dredging operations will not be permitted within [_____] meters feet of the levee centerline and no material will be obtained within [_____] meters feet of any revetment, stabilized channel line, bridge pier and/or abutment.

3.9.7 Cut-Off Trenches

Excavate and maintain cutoff trench free of standing water to the dimensions and locations shown on the drawings. Excavate the trench at least [_____] meters feet in advance of but not more than [_____] meters feet of construction.

3.9.8 Existing Levees and Spoil Banks

Remove existing levees and spoil banks as shown on the drawings. In areas where the existing levee is located within the random or berm zone of the levee, incorporate it into the embankment. Remove portions of existing embankments which lie within the impervious zone of the levee. Utilize existing levees located within the rights-of-way landward of the levee and berms to be constructed, as borrow material, but only after equal protection has been provided by construction of the new levee. When excavated for borrow material, remove the existing levee to the adjacent ground surface in a uniform manner, and shape to maintain drainage in accordance with the adjacent natural drainage pattern. [When lower levels of flood protection would be caused by levee construction provide the Contracting Officer a plan to maintain existing levels of protection during the construction period.]

3.9.9 Toe Drains

Excavate toe drains to the dimensions and the locations indicated on the drawings.

3.9.10 Utilities

Shape excavations for pipe beds to fit the contour of the pipe over a width of not less than 0.6 of the pipe diameter, or as shown on the drawings.

3.9.11 Rock

Clean rock and other hard foundation materials of loose debris and cut to a firm surface, either level, stepped, or serrated, as shown on the drawings. Remove loose disintegrated rock and thin strata. Rock excavation will not be measured for payment.[Rock excavation will not be paid for as a separate bid item.]

3.9.12 Riprap and Bedding

Perform excavations for riprap and bedding at the locations and to the lines and grades shown.

3.10 TOLERANCES

Allow a tolerance of [_____] mm inches above or below the prescribed grade in the excavation for channels, ditches, inspection trenches, cutoff trenches, excavations for riprap and bedding, and mandatory borrow areas. Allow a tolerance of [_____] mm inches below the prescribed grade in the excavation for all other borrow areas.

Construct all embankments and backfills to the grades, lines, and cross-sections shown on the drawings. At all points a tolerance of [100] [_____] mm [4] [_____] inches above or below the prescribed grade will be permitted in the final dressing, provided that any excess material is so distributed that the crown of the levee drains and that there are no abrupt humps or depressions in any surfaces. For topsoil, a tolerance of [_____] mm inches above the thickness as shown on the drawings will be permitted.

3.11 SLIDES

In case sliding or slope failure occurs in any part of the excavations prescribed in this section after they have been excavated, but prior to final acceptance of all work under the contract, repair the slide or slope failure as directed by the Contracting Officer. In case the slide or slope failure is caused through the fault or negligence of the Contractor, repair at no cost to the Government.

3.12 TRAVERSES

Leave traverses unexcavated between borrow areas at the locations [and to the cross sections] shown on the drawings. [Provide traverses with minimum top widths of [_____] meters feet with side slopes no steeper than 1 on 3 or as shown on the drawings.]

3.13 STOCKPILES

Provisions of paragraph SLOPES AND SURCHARGES are applicable to all stockpiled materials. Upon completion of construction operations, remove and dispose of all remaining stockpiled material by the disposal methods specified in paragraph DISPOSITION OF EXCAVATED MATERIALS.

3.14 SURFACE DRAINAGE OF COMPLETED AREAS

Grade the areas shown on the drawings designated as "GRADE FOR SURFACE DRAINAGE", the borrow areas, and the finished embankment areas to the lines and grades shown on the drawings. Provide surface that is free from sharp ridges, gullies, potholes, sinkholes, and any other surface irregularities. A tolerance of [_____] mm inches above or below the prescribed grade will be allowed provided that the surface drains in the direction as indicated on the drawings.

3.15 MAINTENANCE OF WORK

3.15.1 Debris Removal

Maintain all ditch and channel excavations free from leaves, brush, sticks, trash, and other debris until final acceptance of all work under the contract at no additional cost to the Government.

3.15.2 Sediment Removal

Prior to final acceptance of all work under this contract, remove sediments from ditch or channel excavations to restore design grade and section at no additional cost to the Government.

3.16 DISPOSITION OF EXCAVATED MATERIALS

3.16.1 Satisfactory Materials

Incorporate satisfactory excavated material in the appropriate zones of the embankment. Provide satisfactory material consisting of material as defined in paragraph DEFINITIONS, subparagraph SATISFACTORY MATERIALS. When direct placement is not practicable, satisfactory material from the excavation [may] [must] be stockpiled for subsequent use in parts of the work for which it is specified herein and/or as indicated on the drawings. Dispose satisfactory materials in excess of the quantity necessary to construct backfills and embankments as specified for unsatisfactory materials.

3.16.2 Unsatisfactory Materials

Unsatisfactory materials will be as defined in paragraph DEFINITIONS, subparagraph UNSATISFACTORY MATERIALS. Permanently dispose unsatisfactory materials from the excavations prescribed in this section by [removal from the site to a Contractor-furnished disposal area] [placing in the disposal area shown on the drawings] [placing in abandoned portions of the borrow areas]. [Shape the material so that its surface is free from abrupt changes in grade and slope to drain.] [No additional payment will be made for [Contractor-furnished disposal areas] [placing in abandoned portions of the borrow areas].] [Shape the material so that its surface is free from abrupt changes in grade and slope to drain.] [No additional payment will be made for Contractor-furnished disposal areas.]

3.17 PREPARATION OF FOUNDATION, PARTIAL FILL SURFACES AND ABUTMENTS

****

NOTE: If Section 31 66 10 ROCK FOUNDATION PREPARATION is to be used, the following sections may be deleted or modified as appropriate.

****

3.17.1 Earth

****

NOTE: Modify and or add to this paragraph to be compatible with the embankment construction procedures. If uncompacted or semicompacted fill is being utilized major modifications may be required.

****

After excavation (as described in paragraph EXCAVATION) or stripping (as described in paragraph CLEARING, GRUBBING AND STRIPPING) of the embankment foundation [and excavation of the [cut-off trench][inspection trench]] to the extent indicated or otherwise required, break down the sides of stump holes, test pits, and other similar cavities or depressions to flatten out the slopes, and scarify the sides of the cut or hole to provide bond between the foundation material and the fill. [Scarify the slopes and bottom of the cut-off trench as directed.] Perform all scarifying and breaking of ground surface parallel to the centerline of the levee. Unless otherwise directed, fill each depression with the same material type that is to be placed immediately above the foundation. place the fill in layers, moistened, and compacted in accordance with the applicable provisions of paragraphs PLACEMENT, MOISTURE CONTROL, and COMPACTION for the specific material type. Compact materials which cannot be compacted by roller equipment because of inadequate clearances with power tampers in accordance with the paragraph COMPACTION for the specific material type.

After filling of depressions [and cut-off trench] and immediately prior to placement of compacted fill in any section of the embankment, thoroughly loosen the foundation of such section by scarifying, plowing, discing or harrowing to a minimum depth of [_____][150] mm[_____][6] inches, and adjust the moisture content to the amount specified in paragraph MOISTURE CONTROL for the appropriate type of material. [After removal of roots or other debris turned up in the process of loosening, compact the entire surface of the embankment foundation area by [_____] complete coverages of the compaction equipment as specified for the appropriate type of fill.] Immediately prior to placement of compacted fill on or against the surfaces of any partial fill section, remove all soft or loose material, all material containing cracks or gullies, and all material that does not conform with the specified zoning of the embankment. Loosen the remaining surface of the partial fill by scarifying, plowing, discing or harrowing to a minimum depth of [_____] [150] mm [_____] [6] inches, and adjust the moisture content as specified in paragraph MOISTURE CONTROL for the appropriate type of material. Compact the surface of the partial fill section upon which fill is to be placed as specified for the appropriate type of fill. No separate payment will be made for loosening and rolling the foundation area, the abutment area, or the surfaces of partial fill sections, but the entire cost thereof will be included in the applicable contract price for fill.

3.17.2 Rock Foundation

Excavate all rock surfaces upon which or against which embankment materials are to be placed (as described in paragraph EXCAVATION) or strip (as described in paragraph CLEARING, GRUBBING AND STRIPPING).

Prior to the placement of embankment material upon or against a rock surface, fill all open joints and cracks in that surface with mortar to the depths cleaned. Fill those portions of such rock surfaces where, in the opinion of the Contracting Officer, the compaction of the embankment materials cannot be accomplished satisfactorily with power tampers or other specified compaction equipment, with mortar or concrete as directed to the extent necessary to permit satisfactory use of the compaction equipment. Do not leave a thin coat of mortar on smooth, intact rock surfaces[as shown on Drawing No. _____ Foundation Preparation and Treatment]. Remove large rock overhangs and protrusions and lay back rock surfaces to a slope no steeper than 4V on 1H by the use of pre-splitting or line drilling techniques in such a manner as to minimize damage to the underlying rock, or fill the spaces beneath overhangs and around protrusions with tamped concrete so that satisfactory compaction of embankment materials can be accomplished. Rock surfaces must not be more than 0.67 m 2 feet in height, and provide benches of sufficient width as necessary so that the average slope of any rock face is not steeper than [_____]V on [_____]H. Mortar and concrete, including forming as necessary, must conform with the applicable provisions of Section [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [_____].

3.17.3 [Benching

Benching into existing levee embankment and abutments is required in order to place and compact the material in horizontal layers. The vertical face cut into the existing embankment or abutment resulting from the benching operation must be a minimum of [_____] mm inches in height but can not exceed [_____] mm inches in height.]

3.17.4 [Preloading

****

NOTE: Insert applicable language for preloading as required. Identify the extent of the area over which preloading will be required by designating the stationing along the centerline of the levee.

Indicate the length of time the preload will be left in place or define the settlement conditions which must occur before construction in the preloaded area can proceed. Address whether or not the preload embankment will become part of the permanent levee.

****

Preloading of the levee foundation will be required between Station [_____] and Station [_____]. The preload embankment will be constructed to the cross section shown on the drawings for the applicable location. No additional construction is permitted after completion of the construction of the preload embankment in the preloaded areas [for [_____] days] [until the required settlement has occurred]].

3.17.5 [Settlement of Foundation

****

NOTE: Modify the following as necessary for determining foundation settlement, which may be achieved by installing settlement gages.

****

The Contractor [must] [may elect to] furnish and install settlement gages, at the settlement measurement locations shown on the plans, for determination of settlement of the foundation during construction within the settlement measurement ranges shown on the drawings. [Locate each settlement measurement location on the prepared foundation at a point directly under the crown of the planned levee section prior to placing of fill material. Level gage beds by removing the minimum amount of earth necessary to produce an even foundation and in such manner that the density of gage beds will remain at the same density as the undisturbed adjacent ground. Leveling of gage beds by the addition of fill will not be permitted. Maintain gages and extend, if necessary, during the construction. The type and arrangement of the gages are as shown on the drawings. Make such measurements and determine such elevations on the gages prior to the placing of fill material and again within 72 hours [or longer] after final cross sections have been taken over the completed embankment at the locations of the gages.] [Perform a cross section at the settlement measurement location prior to the placing of fill material to establish the elevation of the foundation/embankment interface.] Settlement measurements will be [verified] [subject to verification] by the Contracting Officer.]

3.18 TEST FILL STRIPS

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NOTE: Test strips are needed when the volume of the project is large, the compaction requirement will be obtained by specifying the type of compaction equipment and the number of passes on each lift (i.e. a method or procedure specification is being utilized) and there is not sufficient information on the compaction characteristics of the proposed fill materials and equipment to be used for the project. On projects where the levees are small (no greater than 5 meters 15 feet high) and on levee raising projects where fill placement zones are narrow (3.3 meters (10 feet), some of the larger compaction equipment specified herein (such as 50-ton rubber

tired roller and some tamping rollers) are not appropriate. Consistently Contractors propose using smaller equipment with shorter tamping feet. Test fills, therefore, may also be an appropriate means of evaluating performance and setting placement and compaction criteria to assure satisfactory result.
****

3.18.1 [General

Before beginning embankment construction, construct test strip(s) for [_____] fill materials to demonstrate that the equipment and compaction procedure will achieve the moisture density relationship as specified. The test strips may be incorporated as part of the final embankment, if the fills meet the requirements of the specifications. Construct the test strips using materials from the borrow sources which have been approved by the Contracting Officer. Perform a test strip for each of the following type of fill materials [_____]. Each test strip must be of sufficient size to allow compaction equipment to achieve normal operating speed over a [_____] [17] meter [_____] [50] foot length. The test strip must be a minimum of two (2) times wider than the compaction equipment. Construct each test strip with a minimum of 4 lifts. Prior to the construction of the test strips, proof roll the foundation (subgrade) as specified in paragraph [_____] and install [a][an] 200 mm 8 inch thick subbase layer. Provide a subbase layer consisting of the same material to be used in the test strip and spread and compact to the same requirements. Construct the test strips in accordance with the applicable provisions of paragraphs PLACEMENT, MOISTURE CONTROL, and COMPACTION for the specific material type. Place and spread the fill material in layers in accordance with the applicable provisions of paragraphs PLACEMENT AND SPREADING for the specific material type. Compact each layer of the fill with a minimum of four (4) complete coverages using the specified compaction equipment, and as many additional coverages as may be required to achieve the specified density. Even if the results from the test strips show that the required densities can be obtained with less than four coverages by the compaction equipment, compaction of the impervious and random fills with a minimum of (4) complete coverages is still required. If the use of the proposed compaction equipment causes shearing of the fill, laminations in the fill, or results in inadequate compaction, the Contracting Officer may direct that such roller be removed from the fill and that another appropriate tamping roller be used.]

3.18.2 Testing and Reporting Requirements for Test Strips

Prior to construction of the test strips, perform [_____] laboratory compaction test[s] for each type of material used in test strips. Perform compaction tests in accordance with the requirements specified in paragraph MATERIALS TESTING. Submit test results to the Contracting Officer before construction of the test strips. After placement and spreading of the fill in the test strip, but prior to compaction, obtain five samples from each lift for moisture content determination in accordance with ASTM D2216. Use nuclear density testing equipment in accordance with ASTM D6938. In addition, the following condition applies:

a. Prior to using the nuclear density testing equipment on the site, submit to the Contracting Officer a certification that the operator has completed a training course approved by the nuclear density testing equipment manufacturer[, the most recent data sheet from the manufacturer's calibration, and a copy of the most recent statistical check of the standard count precision.

b. Provide nuclear density testing equipment capable of extending a probe a minimum of 150 mm 6 inches down into a hole.]

After compaction of the fill, perform a minimum of [_____] [5] in-place nuclear density and moisture content tests (in accordance with ASTM D6938) and one (1) sand cone density test (in accordance with ASTM D1556/D1556M) on each lift. Obtain one sample from each test strip for classification testing as specified in paragraph MATERIALS TESTING. All testing and sampling locations will be determined by the Contracting Officer. The Contractor's QC personnel will monitor and document construction and testing of the test strips. Documentation must include weather conditions, soil type, spreading and compaction equipment type, lift thickness, number of coverages, moisture content, dry density, and a plan showing approximate location of sampling and testing. Provide documentation of the test strip construction procedures and results of all testing to the Contracting Officer. Do not commence full scale embankment construction until the equipment and placement methods are approved by the Contracting Officer.

3.19 PLACEMENT AND SPREADING

3.19.1 General

[Prior to beginning embankment placement on the levee foundation, notify the Government that the foundation is ready to receive fill.] [Do not place fill on any part of the embankment foundation until such areas have been inspected and given final approval in writing by the Contracting Officer.]

3.19.1.1 Gradation and Distribution

The gradation and distribution of materials throughout each zone of the levee must be such that the embankment will be free from lenses, pockets, streaks, and layers of material differing substantially in texture or gradation from surrounding material of the same class. If lenses, pockets, or layers of materials differing substantially in texture or gradation from surrounding material occur in the spread material, mix the layer by harrowing or any other approved method to blend the materials. During the placing and spreading process, maintain at all times a force of workers adequate to remove all roots, debris, and oversize stone from all embankment materials. Remove all stones and rock fragments larger than [2/3 of the placement lift thickness measured by the greatest dimension] [75 mm 3 inches in any dimension] [at the source prior to hauling to] [from] the fill. Do not place fill upon a frozen surface, nor incorporate snow, ice, or frozen earth in the embankment.

3.19.1.2 Foundations and Partial Embankment Fills

Keep the foundations and all partial embankment receiving fills thoroughly drained. Placing operations will be such as to avoid mixing of materials from adjacent sections as much as practicable.

3.19.1.3 Equipment Traffic

Route equipment traffic on any embankment zone to distribute the compactive effort as much as practicable. Ruts formed in the surface of any layer of spread material will be filled before that material is compacted. If, in the opinion of the Contracting officer, the compacted surface of any layer of material is too smooth to bond properly with the succeeding layer, loosen the surface by scarifying or other approved methods before material from the succeeding layer is placed.

3.19.2 Placement on Surfaces Containing Frozen Materials

Do not place embankment on a foundation which contains frozen material, [or which has been subjected to freeze-thaw action]. This prohibition encompasses all foundation types, including the natural ground, all prepared subgrades (whether in an excavation or on an embankment, and all layers of previously placed and compacted earth fill which become the foundations for successive layers of earth fill. Remove all material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to nights, holidays, weekends, or winter shutdowns of earthwork operations, to a depth that is acceptable to the Contracting Officer and replace with new material. Alternatively, thaw, dry, rework and recompact the material to the specified criteria before placing additional material. The Contracting Officer will determine when placement of fill must cease due to cold weather. The Contracting Officer may elect to use average daily air temperatures, and/or physical observation of the soils for the determination. Levee embankment material must not contain frozen clumps of soil, snow or ice.

3.19.3 Placement of Embankment and Backfill Against Rock

Clean all rock surfaces upon which or against which embankment materials are to be placed in accordance with paragraph PREPARATION OF FOUNDATION, PARTIAL FILL SURFACES AND ABUTMENTS, subparagraph ROCK. In restricted areas where material can not be placed in large lifts with normal spreading and compaction equipment, spread material in lifts not exceeding [_____] mm inches and compact with mechanical hand tampers, vibrating plates, or other approved methods and equipment.

3.19.4 Placement of Embankment and Backfill Against Structures

Do not place embankment or backfill on or against concrete less than [14][7] days after placement or 70 percent of the design strength, without prior approval of the Contracting Officer. Do not use crawler-type tractors, vibratory equipment and other similar compaction equipment within [_____] [1] meter [_____] [4] feet of any completed or partially completed structure. Accomplish compaction within [_____] [1] meter [_____] [4] feet of completed or partially completed structures by the use of mechanical hand tampers, vibrating plates, or other approved methods and equipment. Ensure that compaction operations do not damage any existing utilities. Any damage caused by the Contractor's operation must be repaired at the Contractor's expense.

3.19.5 Select Fill

****

NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected and the following should be substituted into the appropriate paragraphs below. [Place or spread the materials for [_____] fill in layers, the first layer not more than [_____] mm inches in thickness and the succeeding layers not

more than [_____] mm inches in thickness prior to compaction.]

****

Place and spread select fill material in layers not more than 200 mm 8 inches in uncompacted thickness, except that within [_____] [1] m [_____] [4] feet of [______] structures, reduce the uncompacted layer thickness to [150] [_____] mm [6] [_____] inches. [Layers should be started full out to the slope stakes and must be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [Place or spread the materials for [_____] fill in layers, the first layer not more than [_____] mm inches in thickness and the succeeding layers not more than [_____] mm inches in thickness prior to compaction.]

3.19.6 Coarse Drainage Gravel and Filter Sand

Place and spread coarse drainage gravel and filter sand in layers not more than [_____] [300] mm [_____] [12] inches in uncompacted thickness, except that within [_____] [1] m [_____] [4] feet of the [_____] structures, reduce the uncompacted layer thickness to [_____] [150] mm [_____] [6] inches. Control the method of placement of all gravel and sand material to minimize segregation of particle sizes and contamination with other embankment materials.

3.19.7 Impervious Fill

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NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected.

****

Place and spread the impervious fill material in layers not more than [_____] [200] mm [_____] [8] inches in uncompacted thickness, except that within [_____] [1] m [_____] [4] feet of [______] structures, reduce the uncompacted layer thickness to [_____] [100] mm [_____] [4] inches. [Layers should be started full out to the slope stakes and must be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [Place or spread the materials for [_____] fill in layers, the first layer not more than [_____] mm inches in thickness and the succeeding layers not more than [_____] mm inches in thickness prior to compaction.]

3.19.8 Pervious Fill

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NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected.

****

Place and spread the pervious fill material in layers not more than [_____] [200] mm [_____] [8] inches in uncompacted thickness, except that within [_____] [1] m [_____] [4] feet of [______] structures, reduce the uncompacted layer thickness to [_____] [150] mm [_____] [6] inches.

[Layers should be started full out to the slope stakes and must be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [Place or spread the materials for [_____] fill in layers, the first layer not more than [_____] mm inches in thickness and the succeeding layers not more than [_____] mm inches in thickness prior to compaction.]

3.19.9 Random Fill

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NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected.

****

Place and spread random fill material in layers not more than [_____] [200] mm [_____] [8] inches in uncompacted thickness, except that within [_____] [1] m [_____] [4] feet of [_____]structures, reduce the uncompacted layer thickness to [_____] [150] mm [_____] [6] inches. [Layers should be started full out to the slope stakes and must be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [Place or spread the materials for [_____] fill in layers, the first layer not more than [_____] mm inches in thickness and the succeeding layers not more than [_____] mm inches in thickness prior to compaction.]

[3.19.10 Random Rock

Place random rock within the limits indicated on the drawings in such a manner as to produce a reasonably well graded mass of stone with a minimum percentage of voids. Place random rock in layers that will will produce a compacted [_____] [600] mm [_____] [24] inch thick layer as shown on the drawings.[Provide sufficient dewatering of the foundation beneath the random rock zone to allow the random rock material to be placed and compacted as specified herein to produce a firm, dense surface upon which to place select earth fill.] Grade the outside slope of the random rock zone to produce a reasonably even surface, within a tolerance of plus or minus [_____] [300] mm [_____] [12] inches measured [vertical] [normal] to the slope from the lines indicated on the drawings, upon which slope protection layers can be placed.

][3.19.11 Fine Drainage Gravel Placed Around Structures

Place fine drainage gravel placed for drainage around [_____] structures in horizontal layers not exceeding [_____] mm inches in loose lift thickness, or within [_____] [1] m [_____] [4] feet when hand operated compactors are used. After placing, uniformly spread, moisten or aerate each layer as necessary to obtain the specified moisture content, thoroughly mix and compact as specified. Do not backfill until construction below finish grade has been approved, forms removed, and the excavation cleaned of trash and debris. Use power driven hand operated compactors along the closure structure for compaction within [_____] [0.7] m [_____] [2] feet of concrete structures. Do not place backfill against concrete prior to 7 days after placement. As far as practicable, bring backfill up evenly on each side of the structure and slope to drain away from the structure.

][3.19.12 Semicompacted Fill

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NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected.

****

The location and extent of the semicompacted fill are as shown on the drawings. Do not place semicompacted fill in water. Place and spread semicompacted fill material in layers not more than [_____] [300] mm [_____] [12] inches in uncompacted thickness, [except that within [_____] [1] m [_____] [4] feet of [_____] structures, reduce the uncompacted layer thickness to [_____] [150] mm [_____] [6] inches].[Layers must be started full out to the slope stakes and must be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [Place or spread the materials for [_____] fill in layers, the first layer not more than [_____] mm inches in thickness and the succeeding layers not more than [_____] mm inches in thickness prior to compaction.]

][3.19.13 Uncompacted Fill

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NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the second bracketed sentence should be selected.

****

Place uncompacted fill in approximately horizontal layers not exceeding [_____] mm inches in thickness. Uniformly spread, distribute, and manipulate the layers during placement such that individual loads of material deposited on the fill will not remain intact, and large, open voids in the fill will be eliminated. Do not place lifts in a manner which causes shrinkage cracks and open voids from developing in previously placed lifts.[Start layers full out to the slope stakes and must be carried in lifts approximately horizontal and parallel to the centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [Place or spread the materials for [_____] fill in layers, the first layer not more than [_____] mm inches in thickness and the succeeding layers not more than [_____] mm inches in thickness prior to compaction.][Compaction other than that obtained by the controlled movement of the hauling and spreading equipment over the area will not be required.][Where material must be placed in water, dump therein until it reaches an elevation [_____] mm foot above the water surface, or until a stable fill surface is obtained before layer construction will be required. The material deposited under water must be placed in such a manner to ensure that any soft material will be forced progressively outward from the section and not be trapped within the base of the embankment.][Do not place material containing more than [_____] [15] percent fines passing the No. 200 sieve below the water surface.]

]3.19.14 Hydraulic Fill

3.19.14.1 Discharge Pipe

At all times when the dredge discharge pipe is being washed out or when the discharge consists of a high percentage of water with only a minimum amount of solid material being pumped, close all control plates at the bottom openings along the spill-pipe sections of the discharge pipe lines immediately and remain in a closed position until the pumping operation produces a minimum of [10] [_____] percent solid materials in the discharge.

3.19.14.2 Discharge Pipe Outlets

During placement operations of the fill, provide free outlets to conduct discharge water away from the embankment at intervals of not more than [610] [_____] m [2,000] [_____] feet, for 300-mm 12-inch dredges or smaller; [915] [_____] m [3,000] [_____] feet, for 325 to 400 mm 13- to 16-inch dredges; and [1219] [_____] m [4,000] [_____] feet, for dredges over 400 mm 16 inches. The size of dredges are determined by the minimum inside diameter of the discharge pipe. No obstruction to free flow will be permitted in these outlets or at any point in the fill area, between the end of the discharge pipe and the outlet. Construct a retaining dike, transverse to the fill area center line, immediately beyond each outlet and do not breach until the end of the discharge pipe has approached the retaining dike to within 76 m 250 feet, in the case of 300 mm 12-inch dredges or smaller; 114 m 375 feet, in case of 325 to 400 mm 13- to 16-inch dredges; or 152 m 500 feet, in the case of dredges over 400 mm 16 inches.

3.19.14.3 Control of Materials in Hydraulic Construction

In general, distribute the materials in the fill in a way to produce a section of relatively uniform permeability. In order to maintain uniform permeability of the fill, do not place strata and large pockets of gravel, not containing sufficient fines. Whenever they occur promptly blend with finer materials. Take necessary precautions to prevent damage from discharge water or other causes.

3.19.14.4 Rehandling Hydraulic Material

Rehandling of hydraulic material to bring the fill area to required grade and cross section must conform to paragraph [_____]. If, in the opinion of the Contracting Officer, the rehandled material is too dry to permit its placement by compacted fill method, then the soil placement must conform to paragraph [_____].

3.20 MOISTURE CONTROL

3.20.1 General

The materials in each layer of the fill must contain the amount of moisture, within the limits specified below or as directed by the Contracting Officer, necessary to obtain the required compaction. Rework material that is not within the specified moisture content limits after compaction to obtain the specified moisture content, regardless of density.

3.20.1.1 Insufficient Moisture for Suitable Bond

If the top or contact surfaces of a partial fill section become too dry to permit suitable bond between these surfaces and the additional fill to be placed thereon, loosen the dried materials by scarifying or discing to such depths as may be directed by the Contracting Officer, dampen the loosened material to an acceptable moisture content, and compact this layer in accordance with the applicable requirements of paragraph COMPACTION.

3.20.1.2 Excessive Moisture for Suitable Bond

If the top or contact surfaces of a partial fill section become too wet to permit suitable bond between these surfaces and the additional fill to be placed thereon, scarify and dry the wet material, assisted by discing or harrowing, if necessary, to such depths as may be directed by the Contracting Officer. Dry the material to an acceptable moisture content, and compact in accordance with the applicable requirements of paragraph COMPACTION.

3.20.1.3 Drying Wet Material

Material that is too wet must [be spread on the embankment and permitted to dry,] [be dried in the borrow area prior to bringing to the levee embankment] be assisted by discing or harrowing, if necessary, until the moisture content is reduced to an amount within the specified limits.

3.20.1.4 Increasing Moisture in Dry Material

The moisture content of material that is too dry, [will be adjusted on the levee embankment] [will be adjusted in the borrow area prior to bringing to the levee embankment]. Add water to the fill material and by harrowing, or other approved methods, work the moisture into the material until a uniform distribution of moisture within the specified limits is obtained. Control the amount of water applied on a layer of fill on the levee embankment so that free water will not appear on the surface during or subsequent to rolling. Should too much water be added to any part of the embankment, delay the rolling on that section of the embankment until the moisture content of the materials is reduced to an amount within the specified limits. If it is impracticable to obtain the specified moisture content by wetting or drying the material on the fill, the Contractor may be required to pre-wet or dry back the material at the source of excavation or in the borrow area.

3.20.2 Select Fill

The moisture content after compaction must be within the limits of [_____] percentage points above optimum to [_____] percentage point below optimum moisture content as determined by ASTM D698.

3.20.3 Impervious Fill

The moisture content after compaction must be within the limits of [2] [_____] percentage points above optimum to [2] [_____] percentage point below optimum moisture content as determined by ASTM D698.

3.20.4 Pervious Fill

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NOTE: Saturation of the pervious fill may not be appropriate if the fill is placed in a zone or area (trenches, etc.) which can not readily drain.

****

Place, work and compact each layer of material in a saturated condition.

3.20.5 Random Fill

****

NOTE: The moisture control of random earth must be conformed to the requirements of the material type it most closely approximates in behavior.

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[The moisture content after compaction must be within the limits of [_____] percentage points above optimum to [_____] percentage point below optimum moisture content as determined by ASTM D698.] [The moisture content must be that which will facilitate obtaining the specified compaction.]

3.20.6 Coarse Drainage Gravel and Filter Sand

Control the moisture content such that hauling, spreading, and compacting equipment can operate with normal procedure without excessive rutting of the fill. If the material is too wet or too dry to facilitate proper compaction, wet or dry the coarse drainage gravel or filter sand as required by the procedures specified in paragraph [_____].

3.20.7 Fine Drainage Gravel

Place, work, and compact fine drainage gravel in a saturated condition. The moisture content after compaction must be as uniform as practicable throughout any one layer of fine drainage gravel.

3.20.8 Semicompacted Fill

[Place semicompacted fill within plus or minus [_____] percent of optimum moisture content.] [Semicompacted fill will be placed at their in situ moisture content.] [Control the moisture content of semicompacted fill such that hauling, spreading, and compacting equipment can operate with normal procedure without excessive rutting of the fill.] [The moisture content must be that which will facilitate obtaining the specified compaction.]

3.20.9 Uncompacted Fill

Uncompacted fill will be placed at their in situ water content.[Control the moisture content such that hauling, spreading, and compacting equipment can operate with normal procedure without excessive rutting of the fill.]

3.20.10 Hydraulic Fill

No moisture control is required for Hydraulic Fill.

3.21 COMPACTION

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NOTE: The designer should edit the following paragraphs to account for the use of either an end product specification (i.e., the Contractor is required to obtain a specified degree of compaction) or a method specification (i.e., when the Contractor is required to compact the embankment by a specified number of coverages of a specified/approved roller and is not responsible for the obtained degree of compaction). If the method specification is used and the required degree of compaction is not achieved within the specified number of passes using the specified compaction equipment, the Contractor

should be paid for additional rolling for compaction under a separate bid item as specified in paragraph ADDITIONAL ROLLING FOR COMPACTION.

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3.21.1 Compaction Equipment

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NOTE: If an end-product (production) specification is to be used, the following paragraphs may not be necessary at the judgment of the designer and specification writer.

With reference to the use of compaction equipment in this paragraph, the following precautions should be noted:

1. Specifications should be written to ensure that the type of compaction equipment will be used is best suited to obtain the desired compaction of the material being used. When the size of the contract can justify the costs a requirement should be included in the specifications for the performance evaluation of each type of compaction equipment conforming with the specifications and intended for use by the Contractor at an early stage of embankment construction. This equipment evaluation should be accomplished through analysis of test fill areas that are carefully constructed under representative working conditions with materials and moisture contents as specified. Test fill areas may either be separate or part of the permanent work, and for clarity to prospective bidders, payment under a separate item is recommended to equitably cover costs of required variations in equipment coverages, possible changes in equipment loading or foot sizes, as well as intensified field soils testing. The following paragraphs are provided to serve as examples of the information that should be included within the specifications.

2. For tamping rollers that are either towed or self-propelled, with drums capable of being ballasted with fluid, the provision for a pressure relief valve and safety head is optional, and should be included at the discretion of the designer based on local experience and practice. Over-pressurization of fluid ballasted compaction drums to the level of a safety hazard has been rare, but has occurred on several occasions at locations of high elevation and temperature.

3. In compacting materials consisting of shales, sandstones, weathered rock and similar random materials, consideration should be given to specifying sheepfoot-type tamping equipment that has been modified by replacing the standard feet with "chisel" point tamper feet generally referred to as "shale breakers". The end areas of these modified

tamper feet range from 650 to 1000 square mm 1 to 1-1/2 square inches and tend to break up weathered rock to prevent the bridging effect sometimes created by large rock particles.

4. For compaction of sand and gravel fills or filter and drainage layers, equipment characteristics for both a large and small vibratory roller have been provided for optional selection by the designer, depending upon location, selected lift thickness, gradation, grain shape, and durability properties of the materials. The smaller roller, which utilizes an upper limit of 40 kN/m 9000 lbs. per foot of drum length applied force, should be specified for materials which exhibit degradation under compaction. Other options, based on construction experience may also be exercised. For example, it has been found that improved trafficability can often be achieved when compacting clean, fine grained, uniform sands by specifying a drum driven self-propelled vibratory roller.

****

Compaction equipment must conform to the following requirements and be used as prescribed in subsequent paragraphs.

3.21.1.1 Tamping Rollers

[3.21.1.1.1 Towed

Provide tamping rollers consisting of a heavy duty double drum unit, with a drum diameter not less than 1.5 m 60 inches, and an individual drum length of not less than 1.5 m 60 inches. Provide drums that are capable of being ballasted with water or a combination of sand and water. Each drum must have staggered feet uniformly spaced over the cylindrical surface to provide approximately three tamping feet for each 0.19 square meter 2 square feet of drum surface. Provide tamping feet that are 175 to 225 mm 7 to 9 inches in clear projection from the cylindrical surface of the roller and have a face area of not less than 3226 square mm 5 square inches nor more than 4516 square mm 7 square inches. The roller must be equipped with cleaning fingers, designed and attached to prevent the accumulation of material between the tamping feet. Maintain these cleaning fingers at their full length throughout the periods of use of the roller. The weight of the roller must be a minimum of 5200 kg/m 3500 psf of linear drum length weighted, and no more than 2975 kg/m 2000 psf of drum length empty. Yoke the two drums comprising one roller unit such that they will oscillate when traversing uneven surfaces. The design and operation of the tamping roller will be subject to the approval of the Contracting Officer who has the right at any time during the prosecution of the work to direct such repairs to the tamping feet, minor alterations in the roller and variations in the weight as may be found necessary to secure optimum compaction of the earth fill materials. The Contractor may be required to add ballast to the roller to the maximum capacity specified by the manufacturer of the roller. Draw the roller by a crawler-type or a rubber-tired tractor at a speed not to exceed 5.6 km 3.5 miles per hour. Discontinue the use of the rubber-tired tractor if the tires leave ruts that prevent uniform compaction by the tamping roller. If tamping rollers are used in tandem, not more than two rollers in tandem will be permitted and in such case, one trip of the tandem rollers over any surface will be considered as two passes. When tamping rollers are used in tandem, the tamper foot spacing must be offset so that the circumferential rows on the rear drums are in line with the mid-point of the circumferential rows on the forward drums.

]3.21.1.1.2 Self-Propelled

[Conditioned upon satisfactory performance, self-propelled tamping rollers may be used in lieu of tractor-drawn tamping rollers. Self-propelled rollers exceeding the empty weight requirement may be used provided that by the substitution of tamping feet, having a face area not exceeding [_____] [9030 square mm 14 square inches], the nominal foot pressure on the tamping feet of the self-propelled roller can be adjusted to approximate the nominal foot pressure of the towed roller for the particular working condition required for the towed rollers. The tamping feet must be 175 to 225 mm 7 to 9 inches in clear projection from the cylindrical surface of the roller. For self-propelled rollers, in which steering is accomplished through use of rubber-tired wheels, the tire pressure must not exceed [_____] [276 kPa 40 psi]. [Operate self-propelled rollers at a speed not to exceed 5.6 km 3.5 miles per hour.] [Self-propelled tamping rollers may be used in lieu of tractor drawn tamping rollers provided the foot pressure on the tamping feet of the self-propelled roller are approximately the same as the foot pressure on the towed roller.] For self-propelled rollers steered with rubber-tired wheels, the tire pressure must not exceed [_____] [276 kPa 40 psi]. Operate self-propelled rollers at speeds not exceeding 5.6 km 3.5 miles per hour. The Contracting Officer has the authority to limit or eliminate the use of self-propelled rollers if they are found to cause shearing or laminations of the compacted fill.]

3.21.1.2 Vibratory Rollers

Equip vibratory rollers for compacting rock fills, pervious sand and gravel fills, or filter and transition drainage layers with a smooth steel compaction drum and operate at a frequency of vibration during compaction operations between 1100 and 1500 vpm. Vibratory rollers may be either towed or self-propelled with an unsprung drum weight that is a minimum of 60 percent of the rollers' static weight. Towed rollers must have at least 90 percent of their weight transmitted to the ground through the compaction drum when the roller is standing in a level position hitched to the towing vehicle. Rollers for compacting rockfill, [sand and gravel fills, or filter and drainage layers] must have a minimum static weight of 90 kN 20,000 pounds, a minimum dynamic force of 180 kN 40,000 pounds when operating at 1400 vpm, and an applied force not less than 130 kN/m 9,000 pounds per foot of compaction drum length.[Rollers for compacting sand and gravel fills or filter and drainage layers must have a minimum static weight of 36 kN 8,000 pounds, a minimum dynamic force of 71 kN 16,000 pounds when operating at 1400 vpm, and an applied force not less than 22 kN 5,000 pounds nor greater than 130 kN/m 9,000 pounds per foot of compaction drum length.] The level of amplitude and vibration frequency during compaction will be maintained uniform throughout the embankment zone within which it is operating. Operate rollers at speeds not to exceed 2.4 km/h 1.5 mph. The equipment manufacturer must furnish sufficient data, drawings, and computation for verification of the above specifications, and the character and efficiency of this equipment will be subject to approval.

3.21.1.3 Rubber-tired Rollers

Provide rubber-tired rollers that have a minimum of four wheels equipped with pneumatic tires. The tires must be of such size and ply as to be capable of being operated at tire pressures between 550 and 690 kPa 80 and

100 psi at an 11,340 kg 25,000 pound wheel load. The roller wheels must be located abreast and designed so that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels must be such that the distance between the nearest edges of adjacent tires will not be greater than 50 percent of the rated tire width of a single tire at the operating pressure for an 11,340 kg 25,000 pound wheel load. The roller must have a body suitable for ballast loading such that the load per wheel may be varied, as directed by the Contracting Officer, from 8,165 to 11,340 kg 18,000 to 25,000 pounds. Tow the roller at a speed not to exceed 8 km 5 miles per hour. The character and efficiency of this equipment will be subject to the approval of the Contracting Officer.

3.21.1.4 Hand Operated Compactors

Perform compaction of material, in areas where it is impracticable to use a roller or tractor compaction, using approved hand operated power compactors.

3.21.1.4.1 Power Tampers

Power tampers must be hand operated equipment capable of compacting material in confined areas. Provide compactors that are either an internal combustion or pneumatic activated tamper. Tampers must have sufficient weight and striking power to produce the specified compaction. The character and efficiency of this equipment will be subject to the approval of the Contracting Officer.

3.21.1.4.2 Vibratory Plate Compactor

Vibratory compactors operated by hand in confined areas must utilize the oscillating cam principal and must deliver an impact of not less than 9 kN 2000 lbf at a rate of approximately 2000 impulses per minute. The character and efficiency of this equipment will be subject to the approval of the Contracting Officer.

3.21.1.5 Crawler-type Tractors

Crawler-type tractors used for spreading or compaction must have a minimum weight of [_____] [9,070] kg [_____] [20,000] pounds, exert a minimum unit tread pressure of [_____] [41.4] kPa [_____] [6] psi, and operate at a maximum speed of [_____] [5.6] km [_____] [3.5] miles per hour.

3.21.1.6 Sprinkling Equipment

Provide sprinkling equipment consisting of tank trucks, pressure distributors or other equipment designed to apply water uniformly and in controlled quantities to variable width of surface.

3.21.1.7 Miscellaneous Equipment

Provide scarifiers, disks, spring-tooth or spike-tooth harrows, spreaders, and other equipment that is suitable for use in embankment construction and approved by the Contracting Officer. Equipment used for blending fill material must be capable of penetrating the full loose lift thickness of the specific material type.

3.21.2 Compaction of Select Fill

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NOTE: Experience indicates that by the time the

surface lift has been laid down, sufficient compactive effort has occurred due to hauling and spreading equipment such that one, two, or even three passes of a heavy disk plow is not sufficient for penetrating the full depth of lift. A harrow equipped with closely spaced spikes (teeth) has been found to effectively penetrate the semi-compacted surface lift in one pass, but this type of device has minimal ability to blend and mix the fill material. It was found that a suitably designed spiked-tooth harrow working in combination with a heavy disk plow can reliably produce the desired result. This note applies to all types of fill placement for which moisture and blending are required.

****

After a layer of material has been dumped and spread, harrow it to break up and blend the fill materials to obtain uniform moisture distribution. Perform harrowing with a heavy disk plow, or other approved harrow, to the full depth of the layer. When the moisture content and the condition of the layer are satisfactory, compact the lift [to a minimum of [95] [_____] percent of the maximum dry density as determined by the Contractor in accordance with ASTM D698] [with not less than [six] [_____] complete coverages of an approved tamping roller or [four] [_____] complete coverages of an approved 45 metric ton 50-ton rubber-tired roller traversing in a direction parallel to the axis of the levee]. In areas which are not accessible by roller, place the fill in layers not more than 100 mm 4 inches in uncompacted depth and compact with an approved hand operated compactor to a density equal to that obtained in other areas which are accessible to rollers. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Operate compaction equipment such that the strip being traversed by the roller overlaps the rolled adjacent strip by not less than [_____] [1] m [_____] [3] feet.

3.21.3 Compaction of Random Fill

****

NOTE: Random fill must be compacted in accordance with the requirements of the material type it most closely approximates in behavior.

****

After a layer of material has been dumped and spread, harrow it to break up and blend the fill materials to obtain uniform moisture distribution. Perform harrowing with a heavy disk plow, or other approved harrow, to the full depth of the layer.[If one pass of the harrow does not accomplish the breaking up and blending of the materials, additional passes of the harrow are required, but in no case will more than [_____] [three] passes of the harrow on any one layer be required for this purpose.] When the moisture content and the condition of the layer are satisfactory, compact the lift [to a minimum of [95] [_____] percent of the maximum dry density as determined by the Contractor in accordance with ASTM D698] [with not less than [six] [_____] complete coverages of an approved tamping roller or [four] [_____] complete coverages of an approved 45 metric ton 50-ton rubber-tired roller traversing in a direction parallel to the axis of the levee]. In areas which are not accessible by roller, place the fill in layers not more than 100 mm 4 inches in uncompacted depth and compact with an approved hand operated compactor to a density equal to that obtained in other areas which are accessible to rollers. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Operate compaction equipment such that the strip being traversed by the roller overlaps the rolled adjacent strip by not less than [_____] [1] m [_____] [3] feet.

3.21.4 Compaction of Impervious Fill

After a layer of material has been dumped and spread, harrow it to break up and blend the fill materials to obtain uniform moisture distribution. Perform harrowing with a heavy disk plow, or other approved harrow, to the full depth of the layer.[If one pass of the harrow does not accomplish the breaking up and blending of the materials, additional passes of the harrow are required, but in no case will more than [_____][three] passes of the harrow on any one layer be required for this purpose.] When the moisture content and the condition of the layer are satisfactory, compact the lift [with not less than [six][_____] complete coverages of an approved tamping roller traversing in a direction parallel to the axis of the levee]. In areas which are not accessible by roller, place the fill in layers not more than 4 inches in uncompacted depth and compact with an approved hand operated compactor to a density equal to that obtained in other areas which are accessible to rollers. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Operate compaction equipment such that the strip being traversed by the roller overlaps the rolled adjacent strip by not less than [_____] [1] meter [_____] [3] feet.

3.21.5 Compaction of Pervious Fill

After a layer of material has been dumped and spread, harrow it as required to break up and blend the fill materials to obtain uniform moisture distribution. Perform harrowing with a heavy disk plow, or other approved harrow, to the full depth of the layer.[If one pass of the harrow does not accomplish the breaking up and blending of the materials, additional passes of the harrow are required, but in no case will more than [_____] [three] passes of the harrow on any one layer be required for this purpose.] When the moisture content and the condition of the layer are satisfactory, compact the lift to a [minimum [80] [_____] percent relative density in accordance with ASTM D4253 and ASTM D4254] [with not less than [six] [_____] complete coverages of an approved vibratory roller]. In areas which are not accessible by roller, place the fill in layers not more than 100 mm 4 inches in uncompacted depth and compact with an approved hand operated compactor to a density equal to that obtained in other areas which are accessible to rollers. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Operate compaction equipment such that the strip being traversed by the roller overlaps the rolled adjacent strip by not less than [_____] [1] m [_____] [3] feet.

[3.21.6 Compaction of Random Rock

After the random rock has been placed and spread to the thickness specified herein, and oversized rock has been removed or broken down, compact by not less than [_____] [3-6] complete coverages of the specified [crawler tractor] [vibratory roller]. [Each coverage of the tractor must consist of sufficient trips to provide complete coverage of the area by the treads of the tractor. The tractor coverages specified are in addition to spreading operations.] [Operate the vibratory roller such that the strip being traversed by the roller overlaps the rolled adjacent strip by not less than [_____] [1] m [_____] [3] feet.]

][3.21.7 Compaction of Semicompacted Fill

After a layer of material has been dumped and spread, harrow it as required to break up and blend the fill materials to obtain uniform moisture distribution. Perform harrowing with a heavy disk plow, or other approved harrow, to the full depth of the layer. When the moisture content and the condition of the layer are satisfactory, compact the new layer of fill by the controlled movement of the hauling equipment over the area of the fill. Equipment will be routed so as to prevent excessive rutting of the fill surface. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously.

]3.21.8 Compaction of Uncompacted Fill

No compaction other than that obtained by the controlled movement of the hauling equipment over the area of the fill is required. Route equipment to prevent excessive rutting of the fill surface.

[3.21.9 Compaction of Hydraulic Fill

Hydraulic fill will be compacted as uncompacted fill. If the rehandled hydraulic fill is too dry to permit its placement by uncompacted full method, then compact the fill material using the method specified in paragraph [_____] [COMPACTION OF SEMICOMPACTED FILL].

][3.21.10 Compaction of Random Fill Within the MSE Walls

Place and compact random earth fill within the limits of the Mechanically Stabilized Earth (MSE) walls in accordance with [the vendor's requirements, subject to the approval of the Contracting Officer] [requirements specified in Section [_____]].

]3.21.11 Compaction of Coarse Drainage Gravel and Filter Sand

Place coarse drainage gravel placed in the drains in maximum [_____] [300] mm [_____] [12] inch loose lifts and compact by not less than four (4) complete coverages with a [static] [vibratory] roller. Compact each lift of gravel within confined spaces which is not accessible to rollers by at least [_____] [3] complete coverages with a vibratory plate compactor [and as many additional coverages as necessary to achieve the same density obtained with full-size compaction equipment]. Compact filter sand placed along the existing rock fill in accordance with the requirements for the adjacent select earth fill material.

3.21.12 Compaction of Fine Drainage Gravel

Place fine drainage gravel placed in the drains in maximum [_____] [300] mm [_____] [12] inch loose lifts and compact by not less than four (4) complete coverages with a [static] [vibratory] roller. Compact each lift of gravel within confined spaces which is not accessible to rollers by at least three [_____] [3] complete coverages with a vibratory plate compactor [and as many additional coverages as necessary to achieve the same density obtained with full-size compaction equipment].

3.21.13 Compaction Adjacent to Structures and Utilities

Do not operate heavy equipment for spreading and compacting fill within [_____] [1] m [_____] [4] feet of structures or utilities, except as otherwise specified herein. Compact material within [_____] [1] m [_____] [4] feet using appropriate hand operated compactors specified herein.

[3.21.14 Additional Rolling for Compaction

****

NOTE: Use the following paragraph only when a method specification is utilized. A bid item for "Additional Rolling for Compaction" should be included in the bid form so that payment can be made. Measurement and payment information should also be added to paragraph [UNIT][LUMP SUM] PRICES or Section 01 20 00 PRICE AND PAYMENT PROCEDURES as applicable.

****

If the Contracting Officer determines that the desired compaction of any portion of the embankment is not achieved by the number of coverages specified, additional complete coverages will be made over the surface area as directed by the Contracting Officer. Payment for additional rolling directed by the Contracting officer will be made in accordance with Bid Item No. [_____] ADDITIONAL ROLLING FOR COMPACTION; however, no payment will be made for additional rolling not specifically directed by the Contracting Officer.

][3.21.15 Topsoil

Place topsoil on the embankment surfaces as shown on the contract drawings and as specified in SECTION [32 92 23 SODDING] [_____].

]3.22 FIELD QUALITY CONTROL

****

NOTE: FAR 46.312 Construction Contracts establishes a requirement for Contractor Quality Control (CQC) in construction contracts and ER 1180-1-6 requires that a CQC section based on Section 01 45 00 QUALITY CONTROL be included in contracts of $1,000,000 or more. Use of Section 01 45 00 for contracts of less than $1,000,000 is discretionary. This part of the specifications must be consistent with the CQC section.

Use caution when applying nuclear gages for in-place density measurement of cohesive and cohesionless soils. Soils consisting of mica, halloysite, some other chemical composition, or oversize rocks and large voids would affect the measurement accuracy of wet density. The chemical composition and "non-free" water of the sample may also dramatically (sometimes over 10 percent) affect the measurement of moisture content (see the paragraph entitled

"Interferences" in ASTM D2922 and D3017. Also see paragraph 5-10.d.(2).(b). entitled "Nuclear Method" in EM 1110-2-1911). When water content can not be accurately measured using nuclear method, a computer controlled microwave oven system for water content measurement combined with nuclear method for wet density has been successfully used by some districts. Sand Cone or similar field density tests should be performed periodically at the same location as Nuclear Tests to assure nuclear testing is providing accurate information.

****

3.22.1 Clearing, Grubbing, and Stripping

Establish and maintain quality control for clearing, grubbing, and stripping operations to assure compliance with contract requirements, and maintain records of the quality control for all construction operations including but not limited to the items indicated below. Furnish these records, as well as the records of corrective actions taken, to the Government in accordance with Section 01 45 00 QUALITY CONTROL.

3.22.1.1 Clearing

Station to station limits, transverse clearing limits from applicable centerline; percentage of area complete; types of materials cleared.

3.22.1.2 Grubbing

Station to station limits, transverse grubbing limits from applicable centerline; percentage of area complete; type of material; filling of grubbed holes.

3.22.1.3 Stripping

Station to station limits, transverse stripping limits from applicable centerline; percentage of area complete; type of material; depth of stripping.

3.22.2 Excavation

Establish and maintain quality control for excavation operations to assure compliance with contract requirements, and maintain records of the Contractor's quality control for all construction operations including but not limited to the following:

a. Equipment; type, size, suitability for the work,

b. Lines, grades and tolerances,

c. Segregation/Disposition of materials,

d. Disposal and/or stockpiling of materials,

e. Unsatisfactory materials,

f. Conditions that may induce seepage or weaken the foundation or embankment,

g. Stability of excavations,

h. Quantity surveys.

Furnish records of inspections and tests, as well as the records of corrective actions taken, to the Government in accordance with Section 01 45 00 QUALITY CONTROL.

3.22.3 Embankment

3.22.3.1 General

As a part of the Contractor Quality Control (CQC) system required by SECTION 01 45 00 QUALITY CONTROL, establish and maintain field quality control for foundation preparation, embankment and backfill operations to assure compliance with contract requirements and maintain detailed records of field quality control for all operations including but not limited to the following:

3.22.3.1.1 Earthwork Equipment

Type, size, number of units and suitability for construction of the prescribed work.

3.22.3.1.2 Foundation Preparation

Methods of preparing the foundations in advance of embankment and backfill construction and methods for providing drainage of the foundation and partially completed fills.

3.22.3.1.3 Construction

Layout, maintaining existing drainage, moisture control, thickness of layers, spreading and compacting.

3.22.3.1.4 Grade and Cross Section

Crown width, crown slope, side slopes, and grades.

3.22.3.1.5 Roads and Ramps

Location of temporary roads to fields or buildings, location and placement of fills for ramps in accordance with specified dimensions and grades.

3.22.3.1.6 Grade Tolerances

Check fills to determine if placement conforms to prescribed grade and cross section.

3.22.3.1.7 Slides

Location and limits; methods and equipment used where remedial work has been directed.

3.22.3.1.8 Quantity Surveys

Accuracy and timeliness.

3.22.3.2   Materials Testing

****
NOTE: Types of tests and frequency of testing should be detailed below. Types of tests and frequency of testing will be dependent upon the types of materials utilized, configuration of foundation and embankment, placement and compaction procedures required, moisture control requirements etc. Testing requirements are material type specific rather than embankment fill type specific. It is desirable to present the testing frequency and type in tabular form.
****

Perform sufficient testing to insure that the fill is being constructed as specified. Consider the testing program specified below the minimum acceptable frequency of testing. This does not relieve the Contractor from the responsibility of performing additional testing, if required to ensure compliance with these specifications.

[3.22.3.2.1   Soil Classification Tests

Perform soil classification tests in accordance with ASTM D2487. Perform one initial classification test for each different classification of material to be utilized as embankment fill or backfill. As prescribed in ASTM D2487, perform grain size analyses in accordance with ASTM D422 and Atterberg limits in accordance with ASTM D4318 on each different classification. Submit additional tests for every [[_____] cubic m][20,000 cubic yards] of embankment or backfill material. Perform soil classification tests on foundation material as required to determine the acceptability of the in-situ soils. Additional tests will be required if noticeable changes in the material occur.

][3.22.3.2.2   Cohesive Material Testing

****
NOTE: Edit the following to comply with the method selected to determine the optimum properties (i.e., density and moisture content, LL, PL, PI).
****

3.22.3.2.2.1   Moisture Density Relationships

Determine the moisture-density relations for each different classification of cohesive material utilized in accordance with [_____] [ASTM D698], [Method A] [Method B] [Method C].[Prior to placing any fill material containing cohesive material, perform a minimum of [_____] five-point [_____] compaction test on representative samples of the material to be used as fill.] During fill placement perform a minimum of one additional moisture-density test for every [[_____] cubic m][20,000 cubic yard] placed. Additional tests will be required each time a new material is encountered.[The moisture-density curves will be compiled to form a family of curves which will be utilized to estimate optimum properties (maximum dry density and optimum moisture content) to be used with field density test.]

3.22.3.2.2.2 Water (Moisture) Content Tests

Perform determination of water content in accordance with ASTM D2216.[ASTM D4643 may be used when rapid moisture content results are needed. Confirm all rapid results obtained by ASTM D4643 by a test on a duplicate sample performed in accordance with ASTM D2216. In the event of disagreement between the results, ASTM D2216 will govern.] One water content test will be performed for each [_____] cubic m cubic yards of material placed [or each lift of material whichever is less].[These test will be in addition to the water content tests performed in conjunction with in-place density tests.] Retest backfill and fills not meeting the required specifications for water content after corrective measures have been applied.

3.22.3.2.2.3 In-place Density Testing for Cohesive Materials

****

NOTES: The designer should pick the method or methods of In-place density which are acceptable. If uncompacted fill is specified density control may not be required.

Use caution when applying nuclear gages for in-place density measurement of cohesive and cohesionless soils. Soils consisting of certain chemical composition, or oversize rocks and large voids would affect the measurement accuracy of wet density. When water content can not be accurately measured using nuclear method, a microwave oven system for water content measurement may be used.

****

Determine the in-place density of the cohesive materials in accordance with [ASTM D1556/D1556M] [, ASTM D2167] [, ASTM D6938] [, ASTM D2937] [, or] [ASTM D5195]. Perform at least one (1) in-place density test on [[each lift of material][shift][day] or] every [_____] cubic m cubic yards of completed fill whichever is more frequent with the horizontal locations randomly staggered in the fill.[At each field density test location, obtain soil samples and perform one [one-point] [two-point] compaction test, one moisture content, [one grain size analysis,] [and one Atterberg limits test,] [if applicable,] on the sample.] [The results of the [one-point] [two-point] compaction test and the moisture content test will be utilized to obtain the optimum properties to compare to the results of the in-place density test.] [For use with the family of curves to determine the optimum properties of the material, perform a [one-point] [two-point] compaction test in conjunction with each in-place density. Use a portion of the soil from the in-place field density test and soil obtained immediately adjacent to the field density test location for a [one-point] [two-point] compaction test. The minus 19 mm 3/4-inch portion of the soil must be subjected to [_____] compactive effort using a 150 mm 6-inch compaction mold in accordance with the procedures presented in ASTM D [_____] [ASTM D698] [ASTM D1557]]. Retest fill not meeting the required specifications for in-place density after additional compaction has been completed.[When nuclear method is used for in-place density testing according to ASTM D6938, include a sand cone correlation test in accordance with ASTM D1556/D1556M for the first test and every fifth test thereafter for each material type. Perform the sand cone test adjacent to the location of the nuclear test, including a nominal 150 mm 6 inch diameter sand cone, and including a minimum wet soil weight of 2.7 kg 6 pounds extracted from the hole. Do not use nuclear density testing equipment during rain. Submit the density correlations with test results. For each transmittal including density test data, include a summary of all density correlations for the job neatly prepared on a summary sheet including at a minimum:

a. Test Identification Number.
b. Test location.
    (1) Station.
    (2) Coordinates.
c. Elevation of Lift.
d. Lift number (if appropriate).
e. Photo number (if appropriate).
f. Meter serial number and operators initials.
g. Standard count for each test.
h. Material type.
i. Probe depth.
j. Moisture content by each test method and the deviation.
k. Wet density by each test method and the deviation.
l. Pass/Fail.
m. Retest.
n. Comments.]

][3.22.3.2.3 Cohesionless Material Testing

3.22.3.2.3.1 Compaction Tests

Run not less than one relative density test for every [3,000] [_____] cubic m 3,900 [_____] cubic yards of cohesionless fill in accordance with ASTM D4253 and ASTM D4254.

3.22.3.2.3.2 In-Place Density Tests

Determine the in-place density of the cohesionless materials in accordance with [ASTM D1556/D1556M] [, ASTM D2167] [, ASTM D6938] [, ASTM D2937] [, or] [ASTM D5195]. Run not less than one (1) field in-place density test on [each lift of material or] every [_____] cubic m cubic yards of completed embankment fill or backfill whichever is less. Randomly stagger horizontal locations in the fill.[When nuclear method is used for in-place density testing according to ASTM D6938, include a sand cone correlation test in accordance with ASTM D1556/D1556M for the first test and every tenth test thereafter for each material type. Perform the sand cone test adjacent to the location of the nuclear test, including a nominal 150 mm 6 inch diameter sand cone, and including a minimum wet soil weight of 2.7 kg 6 pounds extracted from the hole. Submit the density correlations with test results. For each transmittal including density test data, include a summary of all density correlations for the job neatly prepared on a summary sheet including at a minimum:

a. Test Identification Number.
b. Test location.
    (1) Station.
    (2) Coordinates.
c. Elevation of lift.
d. Lift number (if appropriate).
e. Photo number (if appropriate).
f. Meter serial number and operators initials.
g. Standard count for each test.
h. Material type.
i. Probe depth.

j. Moisture content by each test method and the deviation.
k. Wet density by each test method and the deviation.]

[3.22.3.2.3.3 Water (Moisture) Content Tests

Perform determination of water content in accordance with ASTM D2216.[ASTM D4643 may be used when rapid moisture content results are needed. Confirm all rapid results obtained by ASTM D4643 by a test on a duplicate sample performed in accordance with ASTM D2216. In the event of disagreement between the results, ASTM D2216 will govern.] One water content test will be performed for each [_____] cubic m cubic yards of material placed[or each lift of material whichever is less].[These test will be in addition to the water content tests performed in conjunction with in-place density tests.] Retest backfill and fills not meeting the required specifications for water content after corrective measures have been applied.

]][3.22.3.2.4 Additional Testing

The Contracting Officer may request additional tests if there is reason to doubt the adequacy of the compaction, or special compaction procedures are being used, or materials change or if the Contracting Officer determines that the Contractor's testing is inadequate or the Contractor is concentrating backfill and fill operations in a relatively small area.

]3.22.3.3 Materials

Suitability of materials for use in embankment and backfill.

3.22.3.4 Fill Placement

Layout, maintaining existing drainage, moisture control, thickness of layers, removal of oversized material, spreading and compaction for embankment and backfill.

3.22.3.5 Grade and Cross Section

Surveys to verify that the dimensions, slopes, lines and grades conform to those shown on the drawings.[Surveys to monitor settlement gages to measure foundation settlement.]

3.22.3.6 Testing by the Government

During the life of this contract, the Government [or its Contractors] will perform quality assurance tests. The performance of such tests may temporarily delay the Contractor and must not be the basis for additional compensation and/or time. Make available to the government [or its Contractors] the equipment to perform these test.

3.22.3.7 Reporting

On a daily basis, furnish the inspection records and all material testing results, [the quantity of fill placed,] as well as the records of corrective action taken, in accordance with Section 01 45 00 QUALITY CONTROL.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 42 34 (August 2020)**

Preparing Activity: USACE **Superseding**
UFGS-35 42 34 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 35 42 34

REINFORCED SOIL SLOPE

08/20

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USACE / NAVFAC / AFCEC **UFGS-35 42 34 (August 2020)**

Preparing Activity: USACE **Superseding**
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References are in agreement with UMRL dated January 2025
****

SECTION 35 42 34

REINFORCED SOIL SLOPE
08/20

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NOTE: This guide specification covers the requirements for steepened soil slopes using geosynthetic soil reinforcement. It does not include soil reinforcements such as segmented type retaining walls, metal reinforcing strips, soil nails, and combi walls. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This guide specification does not address requirements for dewatering, shoring, or earthwork below foundation level. Geometric requirements such as slope height, crest, toe, length, and construction limits should be shown on the drawings.

Notes before paragraphs are provided to present assumptions in preparation of the guide specification, make suggestions for conditions that warrant revisions, and provide background technical

information or references for further information. They should be consulted prior to revising wording for project specifications.
****

1.1 MEASUREMENT AND PAYMENT

1.1.1 Excavation

The unit of measurement for excavation is the cubic meter (CM) yard (CY), computed by the average end area method from cross sections taken before and after the excavation operations. The volume to be paid for will be the material measured in its original position and removed from the excavation areas when the material is acceptably utilized or disposed of as herein specified. The excavation is unclassified and includes material of all types. The measurement will not include material excavated without authorization. Payment will be made at the respective unit price listed on the bidding schedule. Payment will be full compensation for furnishing all material, labor, equipment, supplies and incidentals to complete the work. Shoring is incidental to excavation.

1.1.2 Fill

Material of all types not otherwise paid for is included under the unit price for fill. The unit of measurement for fill is the cubic meter (CM) yard (CY) computed by the average end area method from cross sections taken of the final slope and after the excavation operations. The volume to be paid for will be the material measured in its final position and placed within the designated areas when the material is acceptably placed and compacted as herein specified. Payment will be made at the respective unit price listed on the bidding schedule. Payment will be full compensation for furnishing all material, labor, equipment, supplies and incidentals to complete the work.

1.1.3 Soil Slope Reinforcement

The unit of measurement for reinforcement is the square meter (SM) yard (SY). The pay lines of the reinforcement will be neat lines taken off the approved shop drawings. Overlaps for splicing (if allowed) and for the Contractors convenience will not be measured for payment. Overlaps in curved sections will be measured assuming the slope is linear. Payment will be made at the respective unit price listed on the bidding schedule. Payment will be full compensation for furnishing all material, labor, equipment, supplies and incidentals to complete the work.

1.1.4 Soil Slope Drainage System

The drainage system, including associated pipe, geotextile, and aggregate will not be measured for payment and will be paid for on a job basis (JB), complete. Payment will be full compensation for furnishing all material, labor, equipment, supplies and incidentals to complete the work.

1.1.5 Soil Slope Facing and Seeding

Facing and seeding of the soil slope will be measured by the square meter (SM) yard (SY) of exposed face, measured in the plane of the slope face. The pay lines will be neat lines taken off the approved shop drawings. The work includes [seed, mulch, turf reinforcement mat, erosion control blankets, erosion control netting, and staples]. Payment will be made at the respective unit price listed on the bidding schedule, and will be full compensation for furnishing all material, labor, equipment, supplies and incidentals to complete the work.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 252	(2009; R 2017) Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications

ASTM INTERNATIONAL (ASTM)

ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D448	(2012; R 2017) Standard Classification for Sizes of Aggregate for Road and Bridge Construction
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1238	(2013) Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	(2018) Standard Test Method for Density of

	Plastics by the Density-Gradient Technique
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491/D4491M	(2017) Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4595	(2017) Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2020) Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4873/D4873M	(2017) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D4884/D4884M	(2014a) Strength of Sewn or Thermally Bonded Seams of Geotextiles
ASTM D5035	(2011) Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D5199	(2012) Measuring Nominal Thickness of Geosynthetics
ASTM D5261	(2010; R 2018) Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
ASTM D5321/D5321M	(2020) Standard Test Method for

	Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
ASTM D6637	(2011) Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
ASTM D6706	(2001; R 2013) Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GG6	(1996) Grip Types for Use in Wide Width Testing of Geotextiles and Geogrids

NATIONAL CONCRETE MASONRY ASSOCIATION (NCMA)

NCMA TR127B	(2010) Design Manual for Segmental Retaining Walls

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R 1998) Federal Seed Act

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA NHI-00-043	(2000) Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines (ISDDC)
FHWA NHI-10-024	(2009) Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume I
FHWA NHI-10-025	(2009) Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume II

1.3 DEFINITIONS

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NOTE: Subparagraph "Reinforcement" - This guide specification only applies to geosynthetic (extensible) reinforcement. There are differences in design and construction applicable to steel soil (inextensible) reinforcement.

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1.3.1 Drainage Aggregate

Granular soil or aggregate which is placed in or around drains.

1.3.2 Fill

Soil or aggregate placed in, behind, or below the embankment or slope will be referred to as fill.

1.3.3 Reinforced Fill

Soil which is placed and compacted within the neat line volume of reinforcement as outlined on the plans.

1.3.4 Retained Fill

Soil which is placed and compacted behind the reinforced fill.

1.3.5 Reinforcement

Reinforcement consisting of a geogrid or a geotextile product manufactured for use as reinforcing. Reinforcement does not include steel products.

1.3.6 Long Term Design Strength

The long term design strength (LTDS) is:

$$LTDS = T_{ult} / (RF_D * RF_{ID} * RF_{CR})$$

where:

T_{ult} is the ultimate tensile reinforcement strength
RF_D is the reduction factor for chemical and biological durability
RF_{ID} is the reduction factor for installation damage
RF_{CR} is the reduction factor for creep

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Drawings; G, [_____].

Shoring; G, [_____]

SD-03 Product Data

Geotextile Reinforcement

Geogrid Reinforcement

Reinforcement Testing

Geotextile Filter

Calculations; G, [_____].

SD-04 Samples

Reinforcement

SD-06 Test Reports

Field Testing Results

SD-07 Certificates

Certificates of Compliance

1.5 QUALITY ASSURANCE

1.5.1 Manufacturer Representative

Provide a qualified and experienced representative from the reinforcement manufacturer available on an as-needed basis during the construction. Visit the site for consultation [at least once during construction] [as requested by the Contracting Officer].

1.5.2 Detailed Drawings

Submit the fabrication and installation drawings indicating fabrication and erection details for the slope, including sequencing and construction procedures. If approved by the Contracting Officer, shop drawings may consist of marked up contract drawings showing exact dimensions for the reinforcement supplied, and other minor revisions. The design and layout of the internal reinforcement are subject to the following:

a. Incorporate all features indicated in the contract documents in the final design and construction.

b. Run each reinforcement level as continuous as practical throughout the profile. If a geotextile filter is present, lay out the reinforcement so that interference with the geotextile is minimized.

c. Identify any reinforcement not placed with the machine direction as the design reinforcement direction on the shop drawings.

1.5.3 Classification of Soil Materials

Perform classification of soil materials in accordance with ASTM D2488. The Contracting Officer reserves the right to revise the Contractor classifications. In the case of disagreement, the Contracting Officer's classification will govern unless the soils are classified in accordance with ASTM D2487. All testing completed by the Contractor in conjunction with soil material classification is considered incidental to the contract work.

1.6 DELIVERY, STORAGE, AND HANDLING

Check products upon delivery to assure that the proper material has been received and is undamaged. Protect the materials from damage and exposure following the guidelines presented in ASTM D4873/D4873M.

1.6.1 Labeling

Label each roll with the manufacturer's name, product identification, roll dimensions, lot number, and date manufactured.

1.6.2 Handling

Handle and unload geosynthetic rolls by hand, or with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Do not drag, lift by one end, lift by cables or chains, or drop geosynthetic rolls to the ground.

1.6.3 Storage

Protect geosynthetics from cement, paint, excessive mud, chemicals, sparks and flames, temperatures in excess of 70 degrees C 160 degrees F, and any other environmental condition that can degrade the physical properties. If stored outdoors, elevate the rolls from the ground surface. Protect geosynthetics, except for extruded grids, with an opaque waterproof cover. Deliver geosynthetics to the site in a dry and undamaged condition. Do not expose geotextiles to direct sunlight for more than 7 days.

PART 2 PRODUCTS

2.1 REINFORCEMENT

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NOTE: Polyester is susceptible to hydrolysis in alkaline conditions. A high molecular weight and low carboxyl end group number limit the hydrolysis. Normally, a mill certificate or certification of these properties is adequate. The molecular weight of polyester geosynthetics is determined from GSI GRI GG6, "Determination of the Number Average Molecular Weight of Polyethylene Terephthalate (PET) yarns Based on a Relative Viscosity Value", and ASTM D4603, "Determining Inherent Viscosity of Poly(Ethylene Terephthalate) (PET) by Glass Capillary Viscometer." The carboxyl end group number is determined from GSI GRI GG7, "Carboxyl End Group Content of Polyethylene Terephthalate (PET) Yarns."

Survivability - The AASHTO M 288 requirements are minimum requirements and will not normally control in the product selection. The AASHTO reference can be avoided by listing the grab, tear, burst, and puncture strengths. These properties are listed in AASHTO M 288. The puncture strength (ASTM D4833/D4833M), the trapezoidal tear strength (ASTM D4533/D4533M/D4533M) and the mullen burst strength (ASTM D3786) are recognized as important geotextile properties. For the intended application, the commonly specified values for puncture, burst and tear seldom control the product selection.

Geosynthetic Selection - The Federal Acquisition Regulations require full and open competition. Usually justification is not necessary if 3 products meet the specifications. In combining various material requirements, it is easy to specify a geosynthetic product that does not exist. Design utilizing geosynthetics should include a listing with the calculations that verify the specified products are commercially available. The Geosynthetics Fabrics Report magazine publishes an annual specifiers guide that is ideal for this purpose.

The geogrid sample is intended to be for visual demonstration prior to product delivery. Quality assurance testing, if performed, should be obtained from material actually delivered to the job. If testing is to be performed for pre qualification, the minimum sample size should be 1 m 36 inches in length and the full roll width. Although 1 square meter yard will provide enough material for testing, the full roll width should be sampled since it provides a better selection of specimen locations, it clearly shows the machine and cross directions, and the difference in waste and shipping costs is

negligible.
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Submit Certificates of Compliance for the materials; and calculations of the long term design strength for the reinforcement in accordance with the NCMA TR127B or FHWA NHI-00-043. Submit an affidavit certifying that the reinforcement and seams meets the project specifications. Provide the certificates and affidavits a minimum of 30 days prior to delivery of materials. Have the affidavit signed by an official authorized to certify on behalf of the manufacturer and include a mill certificate that verifies physical properties were tested during manufacturing and lists the manufacturer's quality control testing. [If the affidavit is dated after award of the contract and/or is not specific to the project, attach a statement certifying that the affidavit addressed to the wholesale company is representative of the material supplied.] Include a statement confirming that all purchased resin used to produce reinforcement is virgin resin. Include the tensile strength tested in accordance with either ASTM D4595 or ASTM D6637 in the mill certificate. Base the ultimate strength or index strength on the minimum average roll value tensile strength of the product using the wide width strength test in ASTM D4595 or the single rib test in ASTM D6637. Itemize each reduction factor and include backup data to justify each reduction factor in the calculations. Demonstrate splice efficiency from testing, if used. Submit and label samples of each type of reinforcement with a minimum size of 200 by 250 mm 8 by 10 inches. Include at least 2 apertures in each direction for the geogrid.

2.1.1 Geogrid Reinforcement

Provide geogrid, which is a geosynthetic manufactured for reinforcement applications. The geogrid must be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil, aggregate, or other fill materials. The geogrid structure must be dimensionally stable and able to retain its geometry under manufacture, transport and installation. Manufacture the geogrid with 100 percent virgin resin consisting of polyethylene, polypropylene, or polyester, and with a maximum of 5 percent in-plant regrind material. Polyester resin must have a minimum molecular weight of 25,000 and a carboxyl end group number less than 30. Stabilize polyethylene and polypropylene with long term antioxidants.

2.1.2 Geotextile Reinforcement

Submit descriptive technical data on the reinforcement and geotextile filter materials. Include all material properties specified under paragraph PRODUCTS. Geotextile must be a pervious sheet of polymeric material consisting of long-chain synthetic polymers composed of at least 95 percent by weight polyethylene, polypropylene, or polyesters. Manufacture the geotextile with 100 percent virgin resin, and with a maximum of 5 percent in-plant regrind material. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages. Polyester resin must have a minimum molecular weight of 20,000 and a carboxyl end group number less than 50. Stabilize polyethylene and polypropylene with long term antioxidants. For survivability during installation, and in addition to installation damage used in calculating the long term design strength, the geotextile must meet the minimum requirements in AASHTO M 288 Class 1, and have a minimum mass per unit area of 270 g/m^2 8 oz/sy.

2.1.3 Reinforcement Properties

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NOTE: Permittivity - Reinforcement geotextiles should not puddle or impede infiltration or seepage. AASHTO M 288 provides some default guidance.

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2.1.3.1 Primary Reinforcement Properties

Meet the property requirements listed in Table 1 for reinforcement shown on the contract drawings. Reinforcement strength requirements represent minimum average roll values in the machine direction.

TABLE 1

PROPERTY	REQUIREMENT	TEST DESIGNATION
Long Term Design Strength	[_____] kN/m lb/inch	NCMA TR127B, Method A
Permittivity	[0.5][_____] per second	ASTM D4491/D4491M
UV Resistance	70 percent after 500 hours	ASTM D4355/D4355M
Coefficient of Interaction for Pullout	[.85][_____]	ASTM D6706
Coefficient for Direct Shear	[_____]	ASTM D5321/D5321M

2.1.3.2 Secondary Reinforcement Properties

Meet the property requirements listed in Table 2 for reinforcement shown on the contract drawings. Reinforcement strength requirements represent minimum average roll values in the machine direction.

TABLE 2

PROPERTY	REQUIREMENT	TEST DESIGNATION
Long Term Design Strength	[_____] kN/m lb/inch	NCMA TR127B, Method A
Permittivity	[0.5][_____] per second	ASTM D4491/D4491M
UV Resistance	70 percent after 500 hours	ASTM D4355/D4355M
Seam Strength	[90 percent][_____]	ASTM D4884/D4884M
Coefficient of Interaction for Pullout	[.85][_____]	ASTM D6706

TABLE 2

PROPERTY	REQUIREMENT	TEST DESIGNATION
Coefficient for Direct Shear	[______]	ASTM D5321/D5321M

2.1.3.3 Long Term Design Strength

Base the long term design strength on reduction factors for installation damage and durability that are applicable to the fill that will be used. Minimum reduction factors for durability include: 1.1 for polyethylene and polypropylene geosynthetics, 1.15 for coated polyester geogrids, and 1.6 for polyester geotextiles. Minimum reduction factors for creep include: 2.5 for polyester, 4 for polupropylene, and 2.6 for high density polyethylene.

Ranges for damage reduction factors in accordance with FHWA NHI-10-024 are listed in Table 3.

TABLE 3

GEOSYNTHETIC	Type 1 Backfill Max. Size 10 cm 4 in. D50 about 3 cm	Type 2 Backfill Max. Size 1.9 cm 3/4 in. D50 about No. 30
HDPE uniaxial geogrid	1.20 - 1.45	1.10 - 1.20
PP biaxial geogrid	1.20 - 1.45	1.10 - 1.20
PVC coated PET geogrid	1.30 - 1.85	1.10 - 1.30
Acrylic coated PET geogrid	1.30 - 2.05	1.20 - 1.40
Woven geotextiles (PP&PET)[a]	1.40 - 2.20	1.10 - 1.40
Non woven geotextiles (PP&PET)[a]	1.40 - 2.50	1.10 - 1.40
Slit film woven PP geotextile[a]	1.60 - 3.00	1.10 - 2.00
[a] Minimum weight 270 g/m2 8.0 oz/yd2.		

2.1.4 Reinforcement Splices

Provide reinforcement splices consisting of a standard method or device recommended and approved by the manufacturer of the reinforcing. Splices less than 90 percent efficient (width wide tensile strength of splice to mean average roll value tensile strength of reinforcing) are not acceptable. Demonstrate and submit the splice efficiency. Splicing may consist of overlaps, fusion wedge welding, sewing, or bodkin connections. Splicing methods that are dependent on installer experience and skill level, such as hot air and torch-applied open flame, are not acceptable. Perform sewing by 2 lines of stitching with a Federal 401 double thread lock stitch with a thread of the same polymer type and UV protection as the geotextile. [Perform overlaps as indicated on the drawings.][Overlaps must be a minimum of[300][600] mm[12][24] inches for linear runs along the slope face where the primary design strength axes of adjacent reinforcement panels are parallel.] The overlap is to be protected from folding and/or bunching during installation of fill..

2.1.5 Seams

Test seams in accordance with method ASTM D4884/D4884M.

2.2 GEOTEXTILE FILTER

Meet the requirements specified in Table 4. The property values (except for AOS) represent minimum average roll values (MARV) in the weakest principal direction. For survivability during installation, meet the minimum requirements in AASHTO M 288 Class 2, and have a minimum mass per unit area of 270 g/m^2 8 oz/sy.

TABLE 4. GEOTEXTILE PHYSICAL PROPERTIES

PROPERTY	TEST REQUIREMENT	TEST METHOD
Grab Tensile	[700 N160 lbs. nonwoven] [1100 N250 lbs. woven]	ASTM D4632/D4632M
Apparent Opening Size	150 - 212 um70 - 100 U.S. Sieve	ASTM D4751
UV Resistance	80 percent after 500 hours	ASTM D4355/D4355M
Permittivity, sec^{-1}	0.5	ASTM D4491/D4491M

2.3 TURF REINFORCEMENT MAT

Turf Reinforcement Mat (TRM) must consist of nondegradable monofilaments and meet the requirements specified in Table 5. The property values (except for AOS) represent minimum average roll values (MARV) in the weakest principal direction.

TABLE 5. TRM PHYSICAL PROPERTIES

PROPERTY	TEST REQUIREMENT	TEST METHOD
Tensile Strength	[_____] kN/mlbs/ft	ASTM D5035
UV Resistance	80 percent after 500 hours	ASTM D4355/D4355M
Thickness	8 mm300 mils	ASTM D5199

2.4 EROSION CONTROL BLANKET

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NOTE: In 1999, there are 4 proposed ASTM standards for ECB's: (1) Measuring Mass per Unit Area of Erosion Control Blankets, (2) Determination of Erosion Control Blanket (ECB) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion, (3) Determination of Erosion Control Blanket (ECB) Performance in Protecting Hillslopes from Rainfall-Induced Erosion, and (4) Tensile Properties Breaking Force and Elongation of Erosion Control Blankets.

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Erosion control blanket (ECB) must consist of biodegradable open weave blankets used for establishing vegetation and have a minimum mass per unit area of [_____] g/m^2 oz/SY, determined in accordance with ASTM D5261.

2.5 SOILS AND AGGREGATES

Classify all material placed as fill by ASTM D2487 as GW, GP, GC, GM, SP, SM, SC, CL, ML, or SW and be free of ice; snow; frozen earth; trash; debris; sod; roots; organic matter; contamination from hazardous, toxic or radiological substances; or stones larger than 75 mm 3 inches in any dimension. Obtain each material entirely from one borrow source, unless the Contracting Officer determines that quality control is adequate and the alternate source produces material that is similar in gradation, texture, and interaction with the reinforcement. All materials must be of a character and quality satisfactory for the purpose intended.

a. Reinforced Fill. Soil placed in the reinforced fill zone must consist of [soils with less than 50 percent passing the 75 µm No. 200 sieve, maximum particle size of 1.9 cm 3/4-inch, and Plasticity Index less than or equal to 20] [alternate properties of available fill soils consistent with soil strengths and reinforcement damage assessment utilized in design]. The reinforced fill soils must have a minimum drained friction angle of 28 [_____] degrees.

b. Retained Fill. Soil in the retained fill zone [consists of existing in-situ soils][meets the material classification and requirements listed above].

c. [c. Drainage Aggregate. Meet the requirements of ASTM D448, size No.7].

2.6 DRAINAGE PIPE

Corrugated polyethylene pipe meeting requirements of AASHTO M 252.

2.7 SEED

Provide state-certified seed of the latest season's crop in original sealed packages bearing the producer's guaranteed analysis for mixture percentage, purity, germination, weed seed content, and inert material. Provide labels that are in conformance with AMS Seed Act and applicable state seed laws. Proportion the seed mix by weight as follows: [_____].

PART 3 EXECUTION

3.1 SHORING

Construct shoring in accordance with the safety requirements of EM 385-1-1. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations[at least 30 days prior to installation]. Also include sequencing and methods of shoring installation and removal that will facilitate verification that the methods will not leave voids, seepage paths, or other deficiencies. The Contractor is responsible for design and maintenance of all shoring to be installed. Do not negatively impact existing and proposed work during installation. Unless otherwise authorized, remove all sheeting and bracing when backfill is completed. Do not negatively impact completed work during removal.

3.2 EARTHWORK

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NOTE: Notification of the Contracting Officer - It is beyond the scope of a specification to provide remedies to all possible problems. If the specification indicates the Contracting Officer must be notified, it is assumed qualified assistance will be utilized to assess the situation when necessary.

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Bear the reinforced fill zone on undisturbed native soils, or acceptably placed and compacted fill. In the event that it is necessary to remove material or place fill below the excavation lines shown on the drawings, or not otherwise provided for in the contract, notify the Contracting Officer prior to work and an adjustment in the contract price will be considered in accordance with the contract. It is at the Contractor's expense if additional work not authorized by the Contracting Officer is performed.

3.2.1 Excavation

Excavate to contours, elevation, and dimensions indicated. Reuse excavated materials that meet the specified requirements for the material type required at the intended location. Keep excavations free from water. Excavate soil disturbed or weakened by Contractor's operations, soils softened or made unsuitable for subsequent construction due to exposure to weather. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. [_____][Remove as directed] unsatisfactory material encountered below the grades shown.[Refill with [backfill and fill material][satisfactory material][select material][porous fill] and compact to [95][_____] percent of [ASTM D698][ASTM D1557] maximum density.][Unless specified otherwise, refill excavations cut below indicated depth with [backfill and fill material][satisfactory material][select material][porous fill] and compact to [95][_____] percent of [ASTM D698][ASTM D1557] maximum density.] Replace satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer, with satisfactory materials to the indicated excavation grade; except as specified for spread footings. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated will be done under the direction of the Contracting Officer. Perform excavation and fill in a manner and sequence that will provide proper drainage at all times. The Contractor is responsible for disposal of surplus material, waste material, and material that does not meet specifications, including any soil which is disturbed by the work operations or softened due to exposure to the elements and water.

3.2.2 Stockpiles

Stockpile material for backfilling in a neat and orderly manner at a sufficient distance from the banks of the excavation to avoid overloading and to prevent slides or caving. Keep stockpiles of all material to be incorporated into the work in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal the ground surface at stockpile locations. Stockpile topsoil separately from suitable backfill material. Protect stockpiles of aggregates and granular soils from contamination which can destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes frozen, saturated, intermixed with other materials, or otherwise out of specification or unsatisfactory for the use intended, remove such material and replace with new material from approved sources at no additional cost to the Government.

3.3 SUBGRADE PREPARATION

Remove unsatisfactory material in surfaces to receive fill or in excavated areas and replace with satisfactory materials as directed by the Contracting Officer. Scarify the surface to a depth of 150 mm 6 inches before the fill is placed. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 150 mm 6 inches), pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 300 mm 12 inches and compact as specified for the adjacent fill. Do not place material on surfaces that are muddy, frozen, or contain frost. Accomplish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material or aerate as necessary [to plus or minus [_____] percent of optimum moisture][to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used]. Minimum subgrade density is as specified herein. Smooth the surface to be free of windrows, sheepsfoot impressions, and rocks. Do not place reinforcement directly on native soil unless the upper 0.3 meter 1 foot of soil meets specification of fill materials.

3.4 PROOF ROLLING

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NOTE: Specify proof rolling when the quality of the existing subgrade is questionable. Proof rolling can be used to verify that no unsatisfactory material is present (no bid quantity required, location shown or specified) or to locate suspected unsatisfactory material (indicate a bid quantity to be removed).

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Perform proof rolling on an exposed subgrade free of surface water at near optimum, or at the moisture content that was used to achieve the required compaction.[If proof-rolling is performed after installation of pipe underdrains, do not use the proof-roller within 0.5 m 1-1/2 feet of the underdrains.] Perform proof-rolling with a 22,680 kg 25 ton pneumatic-tired tandem axle roller with at least three wheels on each axle, a minimum tire pressure of 5.2 kg per square centimeter 75 pounds per square inch, and a minimum rolling width of 1.9 m 75 inches. Operate proof-rolling equipment at a speed between 2.4 to 4.8 km per hour 1.5 to 3 miles per hour. Notify the Contracting Officer a minimum of 3 days prior to proof rolling. Carry out proof-rolling in two directions at right angles to each other with no more than 60 cm 24 inches between tire tracks of adjacent passes. Operate the proof-roller in a pattern that readily allows for the recording of deformation data and complete coverage of the subgrade.

Take the following actions based on the results of the proof-rolling activity in accordance with FHWA NHI-10-025:

1. Rutting less than 6 mm 1/4 inch – The grade is acceptable.

2. Rutting greater than 6 mm 1/4 inch and less than 38 mm 1-1/2 inches – Scarify and re-compact the grade.

3. Rutting greater than 38 mm 1-1/2 inches – Remove and reconstruct the compacted area.

4. Pumping (deformation that rebounds, or materials that are squeezed out of a wheel’s path) greater than 25 mm 1 inch – Remediate the area as directed by the Engineer.

3.5 REINFORCEMENT INSTALLATION

a. Place reinforcement at the elevations and to the extent shown on the construction drawings and the approved shop drawing submittal. Orient the reinforcement with the design strength axis perpendicular to the slope face. Place reinforcement strips as indicated on the drawings to provide 100 percent coverage of the reinforced area. Keep reinforcement from being exposed to direct sunlight after installation. [This can be accomplished by requiring coverage with reinforced fill material during the same work shift.]

b. Install the reinforcement in tension. Pull the reinforcement taut and anchor with pins, staples, or stakes prior to placing the overlying lift of fill. Maintain uniform tension along the length of the slope and consistent between layers.

c. Where the slope bends, place a veneer of fill to a nominal thickness of 75 mm 3 inches to separate overlapping reinforcement. [Overlap a minimum of 150 mm 6 inches along the edges perpendicular to the slope for wrapped face structures.][With grid reinforcement, clip or tie the edges together.][When reinforcements are not required for face support, no overlap is required and edges should be butted.]

d. Splicing. Splicing is not allowed unless identified on the shop drawings. Limit splicing to only one splice per reinforcing strip and do not include a splice with two consecutive reinforcing. Place splices randomly without a pattern. Discard individual reinforcing lengths less than 3 meters 10 feet. Place seams facing upward for inspection purposes.

3.6 FILL PLACEMENT

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NOTE: Subparagraph "b." below - Studies have documented rubber tired heavy equipment traveling on geogrids with minimal or no damage. However, it is regarded as poor practice and usually unnecessary. Problematic conditions include coarse crushed gravel and coated geogrids. The intent of the specification is to minimize equipment on the geogrid so that it occurs only when necessary.
****

a. Place reinforced fill from the slope face back toward the fill area to ensure that the reinforcement remains taut. Place, spread, and compact fill in such manner that minimizes the development of wrinkles in or movement of the reinforcement.

b. A minimum fill thickness of 150 mm 6 inches is required prior to operation of vehicles over the reinforcement. Avoid sudden braking and sharp turning. Do not turn tracked equipment within the reinforced fill zone to prevent tracks from displacing the fill and damaging the reinforcement. Do not operate construction equipment directly upon the reinforcement as part of the planned construction sequence. Rubber tired equipment can operate directly on the reinforcement if the travel is infrequent, equipment travels slow, turning is minimized, and no damage or displacement to the reinforcement is observed.

c. At the end of each day, slope the last lift of fill away from chimney drains in a manner that will allow drainage and direct runoff away from aggregate.

3.7 COMPACTION

Do not place fill on surfaces that contain mud, frost, organic soils, fill soils that have not met compaction requirements, or where the Contracting Officer determines that unsatisfactory material remains in or under the fill. Spread fill and compact in lifts[not exceeding the height of the face wrapping].

3.7.1 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D698 or ASTM D1557. The maximum density is hereafter abbreviated as the "Standard Proctor" or "Modified Proctor"value.

3.7.2 Moisture Control

****
NOTE: Moisture content limits for compaction should be included in these paragraphs when necessary for obtaining strength and stability in embankments and fill, for controlling movement of expansive soils and when, in the opinion of the project geotechnical engineer, moisture control is required for the soils being used. Specify an acceptable variation from the optimum moisture if justified from experience with similar soils or where demonstrated from

moisture-density tests for the borrow material during planning.

****

Maintain control of moisture in the fill to provide acceptable compaction. In the stockpile, excavation or borrow areas, a minimum of two tests per day per type of material or source of materials being placed is required during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and test approved moisture content in accordance with ASTM D2216. Include moisture content test results in daily report. Disking and plowing will not be allowed in the reinforced fill zone. Adjust moisture content of cohesive soils at the borrow source before placement. Only conduct adding water directly to the reinforced fill zone under conditions where the soil has sufficient porosity and capillarity to provide uniform moisture throughout the fill during compaction. Ensure that moisture content is within plus or minus [2][_____] percentage points of optimum moisture content as determined in ASTM D698 or ASTM D1557.

3.7.3 Compaction

Compact reinforced and retained fill to 95[_____] percent of the Standard Proctor as determined in ASTM D698.

3.8 SOIL TESTING

3.8.1 General

All testing expenses is the Contractor's responsibility. Prior to sampling and testing the work, inspect testing laboratories and approve in accordance with Section 01 45 00 QUALITY CONTROL. The Contracting Officer reserves the right to direct the location and select the material for samples to be tested and to direct where and when moisture-density tests are to be performed.

3.8.2 Transmittal

Inform the Contracting Officer of test results daily for direction on corrective action required. Provide draft copies of field testing results to the Contracting Officer on a frequent and regular basis, as directed. Submit testing data specific to the reinforcement to be supplied:

a. Establish the coefficient for direct shear of the reinforcement on a soil similar in gradation and texture to the material that will be used for fill in the reinforced zone in accordance with ASTM D5321/D5321M.

b. Establish the coefficient of interaction for pull-out resistance of the reinforcement in a soil similar in gradation and texture to the material that will be used for fill in the reinforced zone in accordance with ASTM D6706.

3.8.3 Corrective Action

Tests of materials which do not meet the contract requirements (failed test) will not be counted as part of the required testing. If testing indicates material does not meet the contract requirements, do not place the material represented by the failed test in the contract work or recompact or remove. Determine the quantity of material represented by the failed test by the Contracting Officer up to the quantity represented by the testing frequency. The Contractor may increase testing frequency in the vicinity of a failed test in order to reduce removal requirements, as approved by the Contracting Officer. Such increases in testing frequency are at the Contractor's expense and at no additional cost to the Government.

3.8.4 Testing Schedule

a. Moisture-Density Relations (ASTM D698or ASTM D1557)

One test for each material variation[, not less than [_____] tests total].

b. In-Place Densities (ASTM D1556/D1556M or ASTM D6938)

****

NOTE: Density test frequency can vary from one test per 10 square meter 100 square feet for small areas up to one test per 900 square meter 10,000 square feet. The following table will also help establish test frequency for various situations:

Borrow	**Any**	**One test per lift per 400 cubic m placed.**

Material Type	**Location of Material**	**Test Frequency**
Undisturbed native soil	**Structures**	**Two random tests in native soil building footings and two tests on subgrade within building line.**
Fills and backfills	**Structures (adjacent to)**	**One test per structure per 2,000 sq. ft taken 12 inches below finished grade.**
Subgrades	**Site (except airfields)**	**One test per lift per 2,500 sq. ft**
Embankments or borrow	**Any**	**One test per lift per 500 cubic yds placed.**
Native soil subgrade other than structures and parking	**Any**	**One test or one test per 10,000 sq. ft whichever is greater.**
Borrow	**Any**	**One test per lift per 500 cubic yds placed.**

****

Test each lift at randomly selected locations every [200] [_____] square meters [2000][_____] square feet of existing grade in fills for structures and concrete slabs, and every [250] [_____] square meters [2500][_____] square feet for other fill areas and every [200] [_____] square meters [2000][_____] square feet of subgrade in cut. Test density in accordance with ASTM D1556/D1556M, or ASTM D6938. When ASTM D6938 density tests are used, verify density test results by performing an ASTM D1556/D1556M density test at a location already ASTM D6938 tested as specified herein. Perform an ASTM D1556/D1556M density test at the start of the job, and for every ten ASTM D6938 density tests thereafter. Include density test results in daily report.

c. Sieve Analysis, (ASTM C136/C136M)

Drainage Aggregate, 1 test for each source.

3.9 REINFORCEMENT TESTING

****

NOTE: Primary reasons for testing geosynthetics include verification of quality control by the manufacturer, detecting degradation during shipping and storage, and verifying the correct product is supplied. Verification of quality control by the manufacturer and detecting degradation during shipping and storage is not economically justified for small jobs. Unlike reinforcing steel for concrete, geosynthetics are difficult to identify in the field, and even experienced personnel can sometimes mistake the product identity of unlabeled material. Testing after delivery to verify the correct product was supplied may be advisable for critical structures. The strength is usually the most critical property to verify an acceptable product is furnished.

****

It is the Contractor's responsibility for all testing expenses. Perform testing by a commercial testing laboratory selected by the Contractor and approved by the Contracting Officer or performed by the Contractor if approved by the Contracting Officer. The Contracting Officer reserves the right to direct the location and select the material for samples.

TABLE 6. REINFORCEMENT TESTING

PROPERTY	TEST DESIGNATION	FREQUENCY
Wide Width Strip Tensile Strength (Geotextiles)	ASTM D4595	[_____]
Single Rib Tensile Strength (Geogrids)	ASTM D6637	[_____]
Specific Gravity (HDPE only)	ASTM D1505	[_____]

TABLE 6. REINFORCEMENT TESTING		
PROPERTY	TEST DESIGNATION	FREQUENCY
Melt Flow Index (PP & HDPE)	ASTM D1238	[_____]

Modify ASTM D4595 for geogrids considering recommendations in GSI GRI GG6; and express the tensile strength on a unit length basis by substituting n*a for Ws, where:

Ws = specimen width, (mm inches)
n = number of ribs in the sample (must be a whole number)
a = nominal rib spacing for the product tested, (mm inches)

3.10 DRAINAGE PIPE

Place drain pipe as indicated on the drawings. Lay drain lines to true grades and alignment with a continuous fall in the direction of flow. Keep the interior of the pipe clean from soil and debris; and temporarily cap open ends as necessary.

3.11 EROSION CONTROL

Install erosion control in accordance with the manufacturer's recommendations. Clear the ground surface of vegetation, cobbles, rubbish, or debris prior to placement.

3.12 SEEDING

Apply seed at the rate of 18 square m/kg 10 square yards per pound of seed. Evenly distribute the seed by hand or using broadcast seeders. Cover seed to a nominal 13 mm 1/2 inch depth by rakes.

3.13 CONSTRUCTION TOLERANCES

a. Horizontal: Ensure the slope crest and toe are within 150 mm 6 inches of the plan location.

b. Vertical: Ensure the slope crest elevations are within 90 mm 0.3 feet above to 90 mm 0.3 feet below the prescribed elevations shown on the drawings.

3.14 PROTECTION OF WORK

Protect work against damage from subsequent operations.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 45 01 (February 2021)**
Change 3 - 08/23

Preparing Activity: USACE **Superseding**
UFGS-35 45 01 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 45 01

VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE

02/21, CHG 3: 08/23

ATTACHMENTS:

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-35 45 01 (February 2021)**

Change 3 - 08/23

Preparing Activity: USACE **Superseding**

UFGS-35 45 01 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 35 45 01

VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE

02/21, CHG 3: 08/23

****

NOTE: This guide specification covers the requirements for vertical axial-and mixed-flow impeller-type pumps, having a pump discharge diameter up to and including 2100 mm 84 inches, for flood control and hurricane protection projects. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

TO DOWNLOAD UFGS GRAPHICS
Go to
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms

****

PART 1 GENERAL

****

NOTE: Figure 1, System Loss Curve (May be provided by the Designer). The Specifier should insert Figure 2 and Figure 3 at the end of this section as applicable to the design. (See paragraphs BEARING HEAT SENSORS, TEST SETUP, and VALUE OF NPSHR.)

This specification is written to obtain reliable, long-lasting pumps that are suited for the purpose intended at the most economical price. It requires the use of grease-, water- or oil-lubricated bearings and packing glands, and permits the manufacturer to use his standard castings for the suction bell and the bowls.

Alternate specifications for the "FACTORY TEST" have been provided in this specification. Alternate 1 gives the manufacturer the option of testing either the prototype pump or a homologous model of the pump. This alternative should be used for all pumps having a diameter up to and including 1200 mm 48 inches. Alternate 2, which requires a homologous model of the pump be tested for performance and NPSHR characteristics, should be used for pumps having a diameter greater than 1200 mm 48 inches. Alternate 2 can also be used for pumps smaller than 1200 mm 48 inches in diameter if the expected annual operating time is greater than 500 hours per year or for the special case when there is no published NPSHR curve available.

If this guide specification is used for a supply contract, the flexible mechanical couplings and harness bolts should be obtained under the construction contract, except when the pump manufacturer is required to furnish the discharge piping.

With a construction contract, it is the prime Contractor's responsibility to have equipment delivered when ready for installation. Inevitably, delays occur. Some storage will most likely be required. These requirements may be modified as required, but in no case should they be deleted when the storage of equipment is contemplated.

With a supply contract, the delivery of the equipment being furnished should be arranged to coincide with the date of installation, when possible. This will obviate the need for long-term storage of the equipment in Government-furnished space.

This specification has been prepared on the basis that it will be used in construction contracts. If this guide specification is to be used for supply contracts, paragraphs to be included in Part IV - TECHNICAL PROVISIONS should be arranged to follow the format listed below. Section 5 should be deleted when a reduction gear is not to be furnished, and the word "DELETED" should be substituted in lieu thereof. Section 1 should include appropriate provisions of Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES, Section 05 50 14 STRUCTURAL METAL FABRICATIONS and Section 05 50 15 CIVIL WORKS FABRICATIONS.

Section 1 Materials and Fabrication
Section 2 Vertical Pumps
Section 3 Factory Test
Section 4 Electric Motor or Diesel Engine
Section 5 Reduction Gear
Section 6 Services of Erecting Engineer

****

1.1 PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below be inserted into Section 01 20 00.

****

1.1.1 Vertical Pumps, Axial-Flow and Mixed-Flow Impeller-Type

1.1.1.1 Payment

Payment will be made for costs associated with [furnishing][furnishing and installing][installing] the vertical pumps, axial-flow and mixed-flow impeller-type, as specified.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Contractor's Erection Engineer(s)

1.1.2.1 Payment

Payment will be made for costs associated with the services of the Contractor's erection engineer(s) for the period of time that erecting engineers are in service of the Government within the Continental United States, including time required by them to travel. No payment will be made for days the erecting engineers are absent from the jobsite, except for non-work days, National Legal Holidays, and authorized travel time. No additional or overtime payment will be made to the Contractor when the erecting engineers are required to work in excess of 8 hours per calendar day or 40 hours per week. If delays occur during periods of assembly, erection, or testing, wherein services of erecting engineers are not required, the Contracting Officer may direct the engineers to return to their home station, in which case they will not be paid for time they are not at the site of work, except for travel time; or direct engineers to remain at the site of work, in which case they will be paid as provided by contract.

1.1.2.2 Measurement

Services of the Contractor's erection engineer(s) will be measured for payment based upon contract unit price per calendar day for the number of calendar days that their services are required, including Sundays and National Legal Holidays. Time for travel will be measured for payment by the most direct commercial airline or rail route from their home station or port of entry, or from their duty station when travel time from the duty station is less than that required from home station or port of entry, to site of erection and return. When travel time from the duty station is greater than that required from home station or port of entry, only time from home station or port of entry will be allowed. Travel time will be allowed only from time of the first available transportation after release for return to home station or port of entry.

1.1.2.3 Unit of Measure

Unit of measure: per calendar day.

1.1.3 Transportation Expenses of Contactor's Erecting Engineer(s)

1.1.3.1 Payment

Payment will be made for costs associated with the travel and transportation expenses of the Contractor's erecting engineer(s). No payment will be made for daily commuting expenses or subsistence or other personal expenses while in route or at the jobsite. Also, no payment will be made for fare and transportation expenses outside of continental limits of the United States. Payment may be made for travel by privately owned conveyance if used in lieu of travel by common carrier.

1.1.3.2 Measurement

Travel and other necessary transportation expenses of the Contractor's erecting engineer(s) will be measured for payment based upon the travel fare by scheduled airline using less than first class accommodations, when available, or railroad and sleeping car fare when air travel accommodations are not available. Payment for travel by privately owned conveyance is made at the applicable mileage rate of [_____] cents per km mile, provided that such payment do not exceed the constructive cost of air coach accommodations, including consideration of the cost to the Government for the rate per calendar day bid for the services of the erecting engineer and regardless of whether space would have been available. When air accommodations are not available, the mileage reimbursement will be limited to the constructive cost of first class rail, when the elapsed time of rail travel is more than 4 hours; coach class when the elapsed time of rail travel is 4 hours or less; or when neither air nor rail accommodations are provided, the mileage reimbursement will be limited to the constructive cost of bus transportation.

1.1.3.3 Unit of Measure

per km mile.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of

the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 686	(2009) Recommended Practice for Machinery Installation and Installation Design

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B17.1	(1967; R 2017) Keys and Keyseats
ASME B31.1	(2024) Power Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C207	(2023) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C208	(2022) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA M11	(2017; Errata 2018, Addendum 2019) Steel Pipe: A Guide for Design and Installation

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A217/A217M	(2022) Standard Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A285/A285M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A351/A351M	(2024) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A352/A352M	(2021) Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service

ASTM A576	(2023) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A609/A609M	(2012; R 2023) Standard Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B148	(2024) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing
ASTM F1476	(2007; R 2024) Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

HYDRAULIC INSTITUTE (HI)

HI 9.1-9.5	(2021) Pumps General Guidelines for Materials, Sound Testing, and Decontamination - B117
HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 9.8	(2014) Rotodynamic Pumps for Pump Intake Design - A123
HI ANSI/HI 14.6	(2011) Rotodynamic Pumps for Hydraulic Performance Acceptance Tests - A136

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing

	Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances
ISO 10816-3	(2017, AMD 1) Mechanical Vibration - Evaluation of Machine Vibration by Measurements on Non-rotating Parts - Part 3: Industrial Machines with Nominal Power above 15 kW and Nominal Speeds Between 120 r/min and 15 000 r/min when Measured in situ AMENDMENT 1 - Second Edition
ISO 20816-3	(2022) Mechanical Vibration - Measurement and Evaluation of Machine Vibration - Part 3: Industrial Machinery with a Power Rating Above 15 kW and Operating Speeds Between 120 r/min and 30 000 r/min

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA RP2.1	(1978) Manometer Tables

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-3105	(2020) Engineering and Design -- Mechanical and Electrical Design of Pump Stations

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 800-R-11-002	(2011) Environmentally Acceptable Lubricants

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor Selected Manufacturers; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Humidity-Controlled Storage

Materials; G, [_____]

Spare Parts

Shipping Bills

Pump Curves; G, [_____]

Preliminary Pump Curves; G, [_____]

Installation and Erection Instructions Manual

Field Tests

Impeller Weight

In Water Bearing Lubrication; G, [_____]

Grout; G, [_____]

SD-04 Samples

Materials; G, [_____]

SD-05 Design Data

Dynamic Analysis; G, [_____]

Stress-Relieving Procedure; G, [_____]

FSI Connection; G, [_____]

Centralized Pressure Lubrication System; G, [_____]

Piping; G, [_____]

Baseplates and the Anchoring Bolts

Computations Of Total Head And Losses; G, [_____]

SD-06 Test Reports

Witness Test

Factory Test

Balancing Procedure; G, [_____]

Results Of Impeller Balancing

Field Test Results

SD-07 Certificates

Qualified Welders

Examination Procedure And Qualification Of The Examiner; G, [_____]

Qualifications Of Erecting Engineer; G, [_____]

SD-09 Manufacturer's Field Reports

Record Of Measurements Taken During Erection; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions Manual; G, [_____]

1.4 QUALITY ASSURANCE

Provide one or more competent erecting engineers who is knowledgeable about the installation of vertical pumps and associated drive machinery. Erecting engineers provided by this section must include those from the Contractor's suppliers. This Contractor's erecting engineers are responsible for providing complete and correct direction during initial starting and subsequent operation of equipment until field tests are completed. The Contractor's erecting engineer must initiate instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment. The erecting engineer(s) must keep a record of measurements taken during erection, and submit one copy to the Contracting Officer on request or on completion of installation of the assembly or part. The erecting engineer must instruct the Contracting Officer in operation and maintenance features of work. Submit qualifications of erecting engineer for approval.

1.4.1 Detail Drawings

****

NOTE: Select appropriate alternate paragraph "d". The first paragraph choice may be used for pump with discharge diameters up to and including 1350 mm 54 inch. The second paragraph choice should be used for pumps with discharge diameters above 1350 mm 54 inch.

****

Submit drawings of sufficient size to be easily read, within [90] [_____] days of notice of award of contract. Submit information in the English language. Provide with English (IP) dimensions[, or metric with English conversion].[Submit drawings requiring changes as a result of model test within 45 days after approval of model test.] Drawings must consist of complete designs of the pump, pump installation instructions, performance charts, brochures, and other information required to illustrate that the entire pumping system (including the pump, [engine] [motor] [and speed reducer] has been coordinated and will function as a unit.

a. Outline drawings of the pump showing pertinent dimensions and weight of each component of the pump. Prepare drawings to scale.

b. Drawing showing details and dimensions of pump mounting design or layout including any embedded items[and the FSI].

c. Cross-sectional drawings of the pump showing each component. Show major or complicated sections of the pump in detail. Indicate on each drawing an itemized list of components showing type, grade, and class of material used and make and model number of standard component used.

[d. Detail and assembly drawings required for manufacturing showing dimensions, tolerances, and clearances of shafts, [sleeve journals], bearings, including dimensions of grooving, couplings, and packing gland, and diameter and tip clearance of propeller.]

[e. Detail and assembly drawings of entire pump. Include all dimensions required to manufacture pump.]

f. Drawings covering erection and installation, that are intended to be furnished to the erecting engineer.

g. Drawings of the pump; base plate showing its dimensions.

1.4.2 Welding

Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING. For all other welding, procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the Contracting Officer 24 hours in advance of qualification tests. Perform the qualification tests at the work site if practical. The welder or welding operator must apply their assigned symbol near each weld made as a permanent record.

The names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, and standards tested to.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 General

Outfit major pump components with lifting lugs or eye bolts to facilitate handling. Design and arrange lugs or bolts to allow safe handling of pump components singly or collectively as required during shipping, installation, and maintenance. Submit copies of certified shipping bills to the Contracting Officer or memorandums of all shipments of finished pieces or members to designated site, giving designation mark and weight of each piece, number of pieces, total weight, and if shipped by rail in carload lots, car initial and number.

1.5.2 Processing for Storage

Prepare pumps [and spare parts] for storage indoors. Indoor storage consists of a permanent building that has a leak-proof roof, full walls to contain stored equipment, and a concrete floor or temporary trailers. A temporary structure may also be built at the job site for equipment storage that will contain features of the permanent building above except that provision for ventilation must be provided and floor may be crushed rock. Provide a vapor barrier below the crushed rock. Use cribbing below equipment stored on crushed rock so that equipment does not come in contact with crushed rock. Provide a plastic barrier between equipment and wood cribbing. Submit a list of equipment and materials requiring humidity-controlled storage to the Contracting Officer no later than 30 days prior to shipment of pumping units. Store long term (greater than 6 months) in accordance with Contractor selected pump specifications.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Datum

****

NOTE: Datum Selection
NAVD 1988 Datum is required for new projects. NGVD is only appropriate if this contract is for, or relates to, an existing project where National Geodetic Vertical Datum (NGVD) was used originally.

****

Elevations shown or referred to in this contract, are above [plus] or below [minus] [mean sea level] North American Vertical Datum of 1988 (NAVD) [_____].

[Elevations shown or referred to in this contract, are above [plus] or below [minus] [mean sea level] National Geodetic Vertical Datum (NGVD) [_____].]

1.6.2 [Static][Pool-To-Pool][Bowl] Head

****
NOTES: Select appropriate alternate paragraph.

Static head (1st alternate) is generally used for pumping stations having discharges over the protection, free discharge or a discharge chamber type pumping station. If this alternate is selected, the Specifier should attach FIGURE 1, SYSTEM LOSS CURVE to the end of this section.

Pool-to-pool heads (2nd alternate) are usually specified when the discharge and suction systems are complex and total head is found by model test or determined by the Contractor.

Bowl Head (3rd alternate).
****

[Static head is the difference, in meters feet, between water surface elevation in the [sump bay] [sump] [immediately inside trash rack] and [top of discharge pipe at highest elevation] [water surface elevation of [river] [lake] [discharge chamber] [centerline of discharge flap gate in discharge chamber] [_____]]. Total head includes static head, friction losses outside of equipment being furnished, plus velocity head loss. [A curve showing friction losses plus velocity head for pumped capacities is included at the end of this section.]]

[Pool-to-pool head is the difference in meters feet between the water surface elevation in the [sump bay] [sump] and water surface elevation in [discharge chamber] [discharge channel] [river] [_____]. Submit computations of total head and losses. Total head includes losses from the water surface on the suction side of the pump to discharge water surface.]

[Bowl head is the difference in meters feet between the water surface elevation in the [sump bay] [sump] [immediately inside of trash rack] and the elevation of the diffuser exit plus head of water occurring at the diffuser exit. The Contractor must determine total head. Total head includes losses beyond the pump diffuser plus velocity head loss.]

1.7 MAINTENANCE

1.7.1 Special Tools

****
NOTE: Add applicable sections for drive units used.
****

Include one set of special tools required to completely assemble, disassemble, or maintain the pumps. Special tools refer to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items. If required, provide a device for temporarily supporting the pump shaft and impeller during assembly, disassembly, and reassembly of the [motor] [gear reducer] when the thrust bearing is not in place.

Provide lifting devices required for use in conjunction with [the overhead] [a truck] crane. [Provide a portable steel cabinet large enough to accommodate all special tools included under this paragraph and as required by Section(s) [26 29 01.00 10 ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE] [26 29 02.00 10 ELECTRIC MOTORS, 3-PHASE VERTICAL SYNCHRONOUS TYPE], [41 65 10.00 10 [DIESEL][NATURAL GAS] FUELED ENGINE PUMP DRIVES] and [35 45 03.00 10 SPEED REDUCERS FOR STORM WATER PUMPS]. Mount the cabinet on four rubber-tired casters. Provide drawers to accommodate tools. Fit front of cabinet with doors hinged to swing horizontally. Furnish doors with necessary stops, catches, and hasps for completely securing the cabinet with a padlock. Furnish the padlock complete with three keys. Pack special tools in wooden boxes if the size and weight do not permit storage in the tool cabinet. Provide slings if the box and tools are heavier than 34 kg 75 pounds.]

[1.7.2 Extra Materials

****

NOTE: Spare parts should be required if estimated station operating hours are greater than 500 hours per year. Spare parts should also be considered for pumps located in remote locations and for pumps with unusual design. Spare parts for pumping stations having more than three pumps of identical construction should be considered, since acquisition of these spares will be more economical when purchased with the pumping units. Decisions on requiring spare parts can also be based on including spare parts for stations in remote areas or having unusually designed pumps where parts could take considerable time to obtain. When spare parts are included as part of the original supply contract, their cost would probably be half of their cost if obtained after original construction. When spare parts are included as part of the original purchase of the pumping units, their cost could be less than one half of the cost when obtained at a later date.

Select appropriate alternate paragraphs for subparagraphs "d" and "f", below.

****

Provide the following spare parts:

a. One complete replacement set of bearings, bearing shells, journal sleeves, shaft coupling, if applicable, and seals for each size pump.

b. One complete replacement set of wearing parts for the packing gland for each size pump, and sufficient packing for all pumps.

c. Fifty percent of each size and length of bolt, nut, and washer used on each size pump assembly.

d. [One lube pump, complete with motor and timer control, for the centralized lubrication system.] [One complete manually operated centralized lubrication system.] [One oil storage container including drip device and solenoid oil valve.]

e. One complete main pump shaft, including keys and thrust collars.

f. [One complete pump impeller for each size pump.] [One complete main pump impeller bowl assembly for each size pump, consisting of the impeller bowl, diffuser bowl, suction bell if so equipped, impeller shaft with sleeves, bearings, impeller, and all fasteners required to make a complete assembly.] All spare parts must be duplicates of the original parts furnished and be interchangeable therewith. Pack spare parts in crates as specified in paragraphs under DELIVERY, STORAGE, AND HANDLING. Provide slings if the crates and parts are heavier than 34 kg 75 pounds.

g. Provide copies of complete parts list showing all parts, spare parts, and bulletins for each size pump. Clearly show all details and parts, and adequately describe parts or have proper identification marks.

][1.8 WARRANTY

****

NOTE: Consider including an extended warranty for the pumping equipment if there is a likelihood that the pumping equipment will be operated very little during the first years due to a lack of water, ongoing interconnected projects, or permitting issues.

****

Provide a warranty for all equipment included under this section against defective workmanship, materials, design, and performance for a period of [_____] years from the date the equipment is accepted. If the equipment or part does not conform to these warranties, and the Government notifies the Contractor within a reasonable time after its discovery, the Contractor must promptly correct such nonconformity by repair or replacement. Coordinate the down time and repair for the equipment with the Contracting Officer. The Contractor is liable during the warranty period for the direct cost of removal of the equipment from the installed location, transportation for repair, and reinstallation on site. The expense of removing adjacent apparatus, installing spare equipment, costs of supplying temporary service, is not included in this warranty provision.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Design and provide [_____] [identical] vertical [axial-flow] [or] [mixed-flow], single [or two-]stage impeller-type pumps, as indicated. The pumping systems include pumps, [diesel engine pump drives], [electric motor pump drives], [and reduction gears].

2.1.1 Design Requirements

****

NOTE: Delete the reference to the pump operating in the dry if the pump is product- water lubricated. Select appropriate alternate paragraph for subparagraph "d". A discharge line is used for all applications, except for stations that have the discharge system integral with the wall of the pumping station.

****

a. Pumps are for the purpose of pumping [_____] from [_____] into [_____]. Water pumped will not exceed [_____] degrees C F, will be relatively turbid, and may contain sand, silt, and vegetative trash capable of passing through the trash rack. Trash racks will have [_____] mm inch clear openings. [Design pumps to operate in the dry.]

b. Drive the pumps with the [vertical] [horizontal] [induction] [synchronous] [motors described in Section [26 29 01.00 10 ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE] [26 29 02.00 10 ELECTRIC MOTORS, 3-PHASE VERTICAL SYNCHRONOUS TYPE]] [horizontal crankshaft diesel engines described in Section [41 65 10.00 10 [DIESEL][NATURAL GAS] FUELED ENGINE PUMP DRIVES],] [through right angle, vertical shaft, reducers described in Section [35 45 03.00 10 SPEED REDUCERS FOR STORM WATER PUMPS]] as indicated.

c. Design pumps so that no major modifications, alterations, or additions will be required to the pumping station or suction bays to accommodate them. Design pumps so that pump parts will fit within the limiting horizontal and vertical dimensions shown and that installation and maintenance can be accomplished by the [interior; overhead traveling crane,] [truck crane using hatch in roof.] Pumps, [or pump parts assembled at pumping station] must be capable of being lowered through floor openings shown with a minimum of 25 mm 1 inch clearance around each side.

[d. Each pump must discharge into discharge system shown. System loss curve, which includes friction losses from pump discharge elbow to [end of discharge line], [beginning of down [riverward] leg of discharge line], including bend losses, exit loss, and velocity head, is included as Figure 1 at end of this section to permit determination of total head. Determine losses within the pump.]

[e. Each pump discharge system downstream of pump [discharge elbow] [diffuser] must be compatible with Contractor selected pumps. It must be of type shown and fit within limiting dimensions and elevations shown. Determine all losses for discharge system and submit for approval.]

[f. Each pump must discharge into discharge chamber shown. System loss curve(s) furnished includes all losses beyond the discharge elbow. Determine losses within the pump.]

[g. Accomplish priming of siphon [with] [without] assistance of vacuum equipment.]

[h. Design the pump and column to be installed and removed using the [_____] kg ton overhead crane indicated. Design the pump and column section lengths with the indicated crane lift as a limiting factor.]

[i. Design documents must be signed and sealed by a professional engineer.]

2.1.2 Capacities

****

NOTE: Select appropriate alternate paragraphs. Capacities are those determined from earlier design studies for the station. If hydrology/hydraulic studies indicate that gross over-capacity may cause a problem, as in certain discharge chambers, a

maximum capacity should be specified. If a siphon discharge system is to be used, there should be a minimum of two design points listed; one for the priming condition and one for the design operating condition.
****

Each pump must:

[a. The guarantee point for the pump is [[_____] L/s gal/min] with a differential head pressure of [_____] m feet with water surface in sump at Elevation [_____] m feet.]

[b. Be capable of constant-speed operation from a total head corresponding to a [pool-to-pool][static][bowl] head of [_____] m feet down to total head corresponding to a [pool-to-pool][static][bowl] head of [_____] m feet[with water surface in the sump at Elevation [_____]].]

[2.1.2.1 Primed Condition

Each pump must discharge more than [[____] m3/scfs [_____] L/sgal/min] against a total head corresponding to a [pool-to-pool][static][bowl] head of [_____] m feet. This rated condition is based on an intake canal elevation of [_____] m feet and a discharge pool elevation of [_____] mfeet. These pumps must be capable of constant speed operation from a pool-to-pool head of [_____] m feet down to and including a pool-to-pool head of [_____] m feet with water surface in the intake sump ranging from elevation [_____] m feet to elevation [_____] m feet. Once the system is primed, the water level in the discharge impoundment can range from elevation [_____] m feet to elevation [_____] m feet.

][2.1.2.2 Start-Up Condition

Upon startup, each pump must discharge sufficient water for the pumps to become primed and siphon recovery to begin. Since the head conditions will be higher prior to the pump discharge pipe becoming filled, the pump may be operated at a higher speed for a short period of time. The pump flow must be sufficient to result in a flow velocity in the discharge pipe of no less than 2 m per second 7 feet per second. The pump speeds may be changed during the pump priming period, but after priming is accomplished, the pumps must operate as constant-speed pumps. Siphon breaker valves will be used to help prime the pumps.

]2.1.3 Pump Curves

Indicate on the pump curves for the submitted pumps that the pumps are capable of operating over the entire total head corresponding to the [full pool-to-pool] [static head range]. [Also provide pump curves for the startup condition for pumps that are operated at a different speed during startup.]

Submit preliminary pump curves with the initial pump submittal. Indicate the pump's expected total head, static heads, brake horsepower, and efficiency, as ordinates. Plot against the pump discharge as the abscissa. The curves must indicate that the pump meets all specified conditions of capacity, head, brake horsepower, and efficiency.

2.2 MATERIALS

****

NOTE: The Designer should discuss materials and design details for specific site application with pump manufacturers; and the Designer should edit Sections 05 50 14, 05 50 15, and 08 31 00 as appropriate.

The use of corrosion resistant materials for pump fabrication such as composite impellers or components may be appropriate on a case by case basis. If a designer believes conventional pump materials are not suitable or reliable. The Designer should specifically consult pump fabricators while developing contract documents when considering the use of composite material. Some standards which govern structural composite materials are ASTM D638, ASTM D790, ASTM D695, ASTM D2344, ASTM D3846, ASTM D3433, ASTM D696, ASTM D2583, ASTM D785 and ASTM D570.

****

If not specified, materials and fabrication must conform to the requirements of Section [08 31 00 ACCESS DOORS AND PANELS] [05 50 14 STRUCTURAL METAL FABRICATIONS] and Section 05 50 15 CIVIL WORKS FABRICATIONS. Material selection not specified is guided by HI 9.1-9.5 for corrosion, erosion, and abrasion resistance. Submit copies of purchase orders, deviations from the specified materials, mill orders, shop orders for materials, and work orders, including orders placed or extended by each supplier. Furnish a list designating materials to be used for each item at time of submittal of drawings. Within 60 days of notice of award submit names of Contractor selected manufacturers of machinery and other equipment contemplated to be incorporated in the work, together with performance capacities and other relevant information pertaining to the equipment. Submit samples of materials as directed. Equipment, materials, and articles installed or used without the approval of the Contracting Officer are at risk of subsequent rejection.

a. Identify each pump by means of a separate nameplate permanently affixed in a conspicuous location. The plate must bear the manufacturer's name, model designation, serial number if applicable, and other pertinent information e.g. horsepower, speed, capacity, type, direction of rotation. Make the plate of corrosion-resisting metal with raised or depressed lettering and a contrasting background.

b. Equip each pump with suitably located instruction plates, including any warnings and cautions, describing any special and important procedures to be followed in starting, operating, and servicing the equipment. Make the plates of corrosion-resisting metal with raised or depressed lettering and contrasting background.

c. Provide safety guards and/or covers wherever necessary to protect the operators from accidental contact with moving parts. Make guards and covers of sheet steel, expanded metal, or another acceptable material and removable for disassembly of the pump.

2.3 METALWORK FABRICATION

2.3.1 Designated Materials

Designated materials must conform to the following specifications, grades, and classifications.

MATERIALS	SPECIFICATION	GRADE, CLASS
Aluminum-Bronze	ASTM B148	Alloy No. C95500 Castings
Cast Iron	ASTM A48/A48M	Class Nos. 150A 150B, and 150C; 30A, 30B, and 30C
Cast Steel	ASTM A27/A27M	Grade 65-35, annealed
Cast Stainless Steel	ASTM A743/A743M	CF8
Coal Tar Protective Coatings	AWWA C203	
Cold-Rolled Steel Bars	ASTM A108	min, Wt. Strm 450 MPa 65,000 psi
Copper Alloy Castings	ASTM B584	Alloy No. C93700
Corrosion-Resistant Alloy Casting	ASTM A217/A217M	Grade CA15
	ASTM A352/A352M	CA6NM
	ASTM A351/A351M	CF8M
Dimensions for Steel Water Piping Fittings	AWWA C208	
Hot-Rolled Stainless	ASTM A576	Graded G10200 and C11410
Ring Flanges	AWWA C207	Class B
Rubber Products in Automotive Applications	ASTM D2000	
Seamless and Welded Austenitic Stainless Steel Pipe	ASTM A312/A312M	
Stainless Bars and Shapes	ASTM A276/A276M	Grades S30400 and S41000
Steel Forging	ASTM A668/A668M	Class F
Cast Stainless Steel	ASTM A743/A743M	CF8
Steel Pipe 150 mm 6 inch and	AWWA C200	
Steel Plates, Pressure Vessel	ASTM A516/A516M	Grade 55
Steel Plates, Pressure Vessel	ASTM A242/A242M	
Steel Plate, Structural Quality	ASTM A285/A285M	Grade B
Structural Steel	ASTM A36/A36M	

MATERIALS	SPECIFICATION	GRADE, CLASS
Surface Texture (Surface Roughness, Waviness, and Lay)	ASME B46.1	

2.3.2 Bolted Connections

2.3.2.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers must conform to requirements of paragraphs under METALWORK FABRICATION, and paragraphs under VERTICAL PUMPS for types required. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

2.3.2.2 Materials Not Specifically Described

Materials not specifically described must conform to latest ASTM specification or to other listed commercial specifications covering class or kinds of materials to be used.

2.3.3 Metalwork

2.3.3.1 Flame Cutting of Material

Flame cutting of material other than steel is subject to approval of the Contracting Officer. Shear accurately, and neatly finish all portions of work. Steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a smooth surface free from cracks and notches is secured. Prepare surfaces and edges to be welded in accordance with AWS D1.1/D1.1M. Do not chip or grind except where specified and as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Visible or exposed hand-guided cuts must be chipped, ground, or machined to metal free of voids, discontinuities, and foreign materials.

2.3.3.2 Alignment of Wetted Surfaces

Exercise care to assure that correct alignment of wetted surfaces being joined by a flanged joint is being obtained. [Where plates of the water passage change thickness, transition on the outer surface, leaving inner surface properly aligned.] When welding has been completed and welds have been cleaned, but prior to stress relieving, carefully check joining of plates in the presence of the Contracting Officer for misalignment of adjoining parts. Localized misalignment between inside or wetted surfaces of an adjoining flange-connected section of pump or formed suction intake cannot exceed the amount shown in Column 4 of Table 1 for the respective radius or normal distance from the theoretical flow centerline. Correct misalignments greater than the allowable amount by grinding away offending metal, providing the maximum depth to which metal is to be removed does not exceed amount shown in Column 5 of Table 1. Do not remove metal until assuring the Contracting Officer that no excessive stresses will occur in the remaining material and that excessive local vibration will not result from removal of the material. Where required correction is greater than the amount in Column 5 of Table 1, reject pipe for use. Proposed procedure for all corrective work, other than minor grinding, must be approved by the Contracting Officer prior to start of corrective work. Finish corrective work by grinding corrected surface to a smooth taper. Length of the taper along each flow line element must be 10 times the depth of the offset error at the flow line. Wetted surface irregularities that might have existed in an approved model cannot be reason for accepting comparable surface irregularities in the prototype pump.

TABLE 1

(1)	(2)	(3)	(4)	(5)
Pipe Diameter (mm) (inches)	Pipe Radius or Distance (mm) (inches)	Pipe Thickness (mm) (inches)	Maximum Offset (mm) (inches)	Grind-Not More Than (mm) (inches)
60024	30012	103/8	1.61/16	2.43/32
75030	37515	103/8	1.61/16	2.43/32
90036	45018	103/8	2.43/32	2.43/32
105042	52521	131/2	2.43/32	3.21/8
120048	60024	131/2	3.21/8	3.21/8
135054	67527	131/2	3.21/8	3.21/8
150060	75030	193/4	4.05/32	4.05/32
180072	90036	251	4.05/32	4.05/32
210084	105042	291-1/8	4.83/16	6.41/4

2.3.3.3 Stress-Relieving Procedure

After all fabrication welding is completed, and prior to any machining, stress-relieve the bell and the impeller (if it is fabricated) by heat treatment. Submit proposed stress-relieving procedure.

2.3.4 Examination of Castings

Clean and carefully examine all castings for surface defects. Examine all discovered defects by nondestructive means. Examination personnel must be qualified/certified in accordance with applicable ASTM requirements. Submit the examination procedure and qualification of the examiner. Conduct examination tests in the presence of the Contracting Officer. Choose the examination procedure best suited for the application.

2.3.4.1 Examination Procedures

2.3.4.1.1 Ultrasonic

Conform inspection to the applicable provisions of ASTM A609/A609M.

2.3.4.1.2 Magnetic Particle

Conform inspection to the applicable provisions of ASTM E709.

2.3.4.1.3 Liquid Penetrant

Conform inspection to the applicable provisions of ASTM E165/E165M.

2.3.4.2 Acceptance and Repair Criteria

Acceptance and repair criteria must be in accordance with Section [08 31 00 ACCESS DOORS AND PANELS] [05 50 14 STRUCTURAL METAL FABRICATIONS].

2.4 VERTICAL PUMPS

2.4.1 Speed

****

NOTE: Select appropriate alternate paragraph. Alternate 1 is used when cavitation testing is part of the contract. Alternate 2 is used when the pump will not be tested to determine the cavitation characteristics and the designer has determined the maximum speed to be specified based on the NPSHA. The following criteria should be used by the designer in determining the maximum rotative speed:

$$N_{ss} = \frac{(SS) \times (NPSHA)^{3/4}}{Q^{1/2}}$$

where:

N_{ss} = pump rotative speed, in revolutions per minute
SS = suction-specific speed
Q = flow, in gallons per minute
NPSHA = net positive suction head available

Maximum value of SS to be used in the formula:

SS = 8,500

A more conservative value of suction specific speed may be used when operating for extended periods of time above or below the optimum efficiency point.

****

[Rotative speed of pump must be no greater than [_____] r/min rpm. Verify that rotative speed of pump at which the NPSH is produced is no less than required, as determined by cavitation tests specified in paragraph FACTORY TEST (Alternate 2).][

Rotative speed of pump must be no greater than [_____] r/min rpm.]

2.4.2 Reverse [Rotation] [Flow]

****

NOTE: Select appropriate alternate paragraph: Reverse Rotation (1st alternate) and Reverse Flow (Alternate 2). 1st alternate (bracketed paragraph) is used when the pumping unit does not have a non-reverse device. 2nd alternate (bracketed paragraph) is used when the pumping unit is equipped

with a non-reverse device.

****

[Each pump must withstand, with no damage, full rotative speed caused by subjecting the pump to reverse flow. The head used to determine this reverse rotative speed is calculated from specified highest discharge side water elevation and lowest pump intake side water elevation.[Each pump and its connected electric motor must be capable of full reverse rotative speed when acting as a turbine by reverse water flow. Use the highest head specified in paragraph [STATIC][POOL-TO-POOL][BOWL] HEAD to determine the reverse speed.][Provide a non-reverse device for drive systems containing reduction gears or engines with .]][

The pump(s) must withstand, with no damage, the full force exerted on it, with the impeller subjected to reverse flow and the upper end locked in place by a backstop. Calculate the head to determine the force developed by this reverse flow from the specified highest discharge side water elevation and lowest pump intake side water elevation. Reverse rotative speed must be [0.0][_____] with instantaneous activation of the backstop.]

2.4.3 Efficiency

****

NOTES: Select appropriate alternate paragraph.

All pump specifications should require some minimum efficiency at the primary or normal operating design point. This minimum efficiency should be based on the pump selections made during pump station layout and design.

Alternate 1 is used when pool-to-pool head is specified in paragraph PROJECT/SITE CONDITIONS, and the pump manufacturer is required to model the discharge system (Alternate 2). Alternate 2 is a measure of pump efficiency as defined in HI ANSI/HI 14.6. The stated efficiency is based on the pump selection made during station layout and design.

****

[Pool-to-pool efficiency at head-capacity condition(s) specified in paragraph CAPACITIES must not be less than [_____] percent when calculated as follows:

$$\text{Efficiency} = \frac{Q \times H}{366 \times BKW} \times 100$$

Where: Q = Discharge, cubic meter/hour
H = Pool-to-pool total head, meters
BKW = Pump brake kilowatt

$$\text{Efficiency} = \frac{Q \times H}{3960 \times BHP} \times 100$$

Where: Q = Discharge, gallons per minute
H = Total head, feet
BHP = Pump brake horsepower

]

[Pump efficiency, as defined in HI ANSI/HI 14.6, must include losses from the suction bell to the discharge elbow outlet and must not be less than [_____] percent at the head-capacity condition(s) specified in paragraph CAPACITIES.]

2.4.4 Suction Bell

****

NOTE: The recommended minimum thickness of steel pipe to be specified is:

DISCHARGE DIAMETER mminch	**MINIMUM THICKNESS mm inch**
Up to and including 750 30	**103/8**
Above 750 30 and up to and including 1200 48	**131/2**
Above 1200 48 and up to and including 2100 84	**165/8**

More detailed procedure for computing minimum pipe thickness can be found in AWWA M11 Steel Pipe or ASME B31.3 Process Piping. If a formed suction inlet (FSI) is specified, this paragraph should be deleted.

****

Make each suction bell of [either cast iron, cast steel, or welded steel plate,] [stainless steel plate]. Provide a flanged connection for mating with the impeller bowl with a rabbet fit or four equally spaced dowels installed in the vertical position for initial alignment purposes and to maintain concentric alignment of the pump. [Steel plate, if used,][Stainless steel plate] must have thickness of not less than [_____] mm inch. Each suction bell must be [made in one piece][split vertically with bolted flanges joining the two pieces together. Maintain alignment by use of dowels]. Support each suction bell entirely by the pump casing. Supports from sump floor will not be acceptable, [except those that are part of a formed suction intake].[Support umbrellas, if used, by the suction bowl. Construct the umbrella in two pieces if a single piece umbrella could not be removed using the pump opening in the operating floor. Provide bolted flanges on each half of the umbrella and provide for and easily removable bolted connection to the suction bowl. Provide sufficient lifting lugs on the umbrella to aid in handling.]

2.4.5 Impeller Bowl

****

NOTE: The recommended minimum thickness of steel plate to be specified is:

DISCHARGE DIAMETER mminch	**MINIMUM THICKNESS mminch**
Up to and including 750 30	**131/2**

DISCHARGE DIAMETER mminch	**MINIMUM THICKNESS mminch**
Above 750 30 and up to and including 1200 48	**165/8**
Above 1200 48 and up to and including 2100 84	**193/4**

****

Make each impeller bowl of [either cast iron, cast steel, welded steel plate or a combination of cast steel and steel plate] [stainless steel plate][cast stainless steel]. [Steel plate, if used,][Stainless steel plate] must have thickness of not less than [_____] mm inch after machining is completed. Heat-treat and stress-relieve welds before final machining. Provide flanges for mating with the [suction bell][formed suction intake] and the impeller bowl or two-piece construction of the impeller. Provide flanged connections with the suction bell and the diffuser or split construction with a rabbet fit or four equally spaced dowels installed in the vertical position for initial alignment purposes and to maintain concentric alignment of the pump. Machine finish the impeller-swept area in the impeller bowl to at least 3.2 µm 125 microinch rms and concentric with the impeller axis. For mixed-flow impellers, the angle in the impeller bowl must equal the outside angle of the impeller blade tips. Tolerance for concentricity of the impeller with the impeller axis is not greater than 20 percent of the operating clearance between the impeller and the impeller bowl.

2.4.6 Diffuser Bowl

****

NOTE: Use the same thickness for the steel plate as specified in paragraph IMPELLER BOWL.

****

Make each diffuser bowl of [cast iron, cast steel, welded steel plate, or a combination of cast steel and steel plate][stainless steel plate][cast stainless steel]. [Steel plate, if used,][Stainless steel plate] must have a thickness of not less than [______] mm inch after machining is completed. The diffuser must contain support for the upper impeller shaft bearing and have vanes to guide the pumped flow. Equip the diffuser bowl with a bypass drain, if required, to outside of the pump from the diffuser cavity located between the enclosing tube connection and the impeller. Furnish throttle bushing located in the cavity immediately above the impeller. Design bypass drain and throttle bushing to reduce water pressure on the lower seal. Impeller back-wear rings can also be used to reduce water pressure on the lower seal.

2.4.7 Pump Column and Discharge Elbow

2.4.7.1 Column and Discharge Elbow

****

NOTE: Use the same thickness for the steel plate as specified in paragraph IMPELLER BOWL, above. For most pumps, space should be provided for using a long radius type elbow. Unless the elbow is made of cast materials, the elbow will be the mitered type. The roundness tolerance should be specified when the

flexible coupling is not part of the contract. Turning vanes must be used in pumps having an access door to inspect/remove trash.

The following tolerance should be used for specifying the tolerance for the plain end of the elbow.

NOMINAL PIPE SIZE mminch	**TOLERANCE ON ACTUAL O.D. mminch**
Less than or equal to 400 16	**Plus/minus 1.5 0.06**
Above 400 16 and up to and including 600 24	**Plus/minus 2.0 0.08**
Above 600 24 and up to and including 1050 42	**Plus/minus 2.5 0.10**
Greater than 1050 42	**Plus 3.0 0.12/Minus 1.5 0.06**

****

Make each column and discharge elbow of [either cast iron, cast steel, or welded steel plate] [stainless steel plate]. [Steel plate, if used,][Stainless steel plate] must have a thickness of not less than [_____] mm inch after machining is completed. Provide elbow of [short radius type][long radius type][mitered type].[Do not use turning vanes.][Space turning vanes, if used, at least twice the space of clear space of the trash rack.] If turning vanes made of welded steel plate are used, provide an access door in the discharge elbow to allow personnel to inspect turning vanes and remove trash if necessary. Design column and discharge elbow to withstand internal pressures and external loadings associated with various conditions of pump operation. Provide flanges for mating individual segments together and for mating the pump column to the diffuser bowl. Flanges must have rabbeted fits or four equally spaced dowels installed in flanges for initial alignment purposes and to maintain concentric alignment. Terminate the elbow in a plain-end circular section. Diameter tolerance of plain end is [_____] mm inch. Provide diameter of discharge end of elbow as indicated and allow standard diameter flexible couplings to be used. Use adjustable thrust rods and thrust lugs to transfer the load by bridging the coupling between the pump discharge elbow and discharge piping. Determine the size and number of thrust rods needed for the expected loading. Use a minimum of four thrust rods. Maintain complete access to the discharge piping until the discharge pipe installation is complete, inspected, and approved.

2.4.7.2 Column and Discharge Elbow Support

****

NOTE: Select appropriate alternate paragraph. Pump Column and Discharge Elbow (1st alternate) is used for conventional pumps supported from the base-plate. Design Pump Unit (2nd alternate) is used for large stations having pumps over 1800 mm 72 inches in discharge diameter and supported from different floors.

****

[Design pump column and discharge elbow for suspension from a baseplate assembly specified in paragraph BASEPLATE AND SUPPORTS and located at operating floor level.]

[Design each pumping unit for installation as indicated. Install the baseplate for supporting the [electric motor] [gear reducer] at elevation of operating floor, EL [_____]. Support the pump casing at intermediate floor, EL [_____]. Provide the [support system] [support system consisting of columns extending from baseplate to intermediate floor]. The support system must transfer the entire load on the baseplate to the intermediate floor. Design the support system to maintain proper alignment of the pumping unit and propeller blade setting. Include the support system in the dynamic analysis.]

2.4.7.3 Pumps Discharge Diameter

****

NOTE: A manhole is used if the pump has a shaft enclosing cover that can be removed without disassembly of the pump.

****

Pumps having a discharge diameter greater than 1500 mm 60 inches must contain a manhole. Provide a structural steel bracket with a platform of raised-pattern floor plate similar to the one(s) indicated as a support for maintenance personnel for access to the pump through a manhole. Provide a manhole 600 by 750 mm 24 by 30 inches, or largest practicable size with a gasketed cover, in the column above the diffuser bowl. Provide jack bolts in the cover together with eye bolts to facilitate removal.

[2.4.7.4 Formed Suction Intake

****

NOTE: Select appropriate alternate paragraph.

Alternate 1 should be used when a rectangular sump is designed using criteria established by U.S. Army Engineer Research and Development Center (ERDC).

The use of a Formed Suction Intake (FSI) (Type 10), Alternate 2, is determined during the design phase of the station/pump. The Government will furnish all dimensions and be responsible for the design. The FSI was developed by ERDC and is now included in HI ANSI/HI 9.8.

The sump floor elevations should be determined in the design of the pumps/station. The impeller datum elevation should allow the necessary submergence as determined by the computations in EM 1110-2-3105, and verified with pump manufacturers' data.

The Designer should contact at least 3 pump manufacturers early in the project design phase to verify the Designer's pump size estimate. Normally the eye of the impeller is located at minimum sump elevation, and the geometry of the FSI determines sump floor elevation. The early verification is

important for the pump house structural design FSI hydraulics are very sensitive to change, and the pump diameter determines the dimensions of the FSI.

In designs where the FSI is not constructed of concrete, it is recommended that all materials indicated, or combination of these materials, should be specified. A hatch in the operating floor is generally provided in each pump bay to permit the placement of the FSI sections into the sump. If the station design/size does not have space for a hatch, then the opening for the pump is used for placement and removal of the FSI or is designed so that it can be removed using the sump gates and trash rack. The minimum thickness of fabricated material for the FSI should be:

EXIT DIAMETER OF FSI mminch	THICKNESS mminch
Up to and including 450 18	103/8
Above 450 18 and up to and including 900 36	131/2
Above 900 36 and up to and including 1350 54	165/8
Above 1350 54 and up to and including 2100 84	193/4

When a FSI is used, paragraphs SUCTION BELL and IMPELLER BOWL should be changed to coordinate with the FSI requirements.

The thickness of the rubber gasket must be as follows:

FSI EXIT DIAMETER mminch	THICKNESS mminch
Up to and including 1200 48	131/2
Above 1200 48 and up to and including 2100 84	193/4

****

[Sump has been designed using information obtained by sump model testing. Changes to sump layout will not be permitted.]

[Formed Suction Intake (FSI):

a. Provide the FSI water passage with the pump, sized to fit within the limiting elevations and dimensions indicated. Do not locate bearing below the impeller when an FSI is used.

b. Dimensions of the intake elbow and conical transition section of the FSI are relative to the diameter at the top of the cone, as defined on the drawings. The diameter at top of the cone and related dimensions are determined to accommodate the size of pump, providing limiting values for discharge and submergence are not exceeded, the floor of the FSI remains at elevation [_____], and impeller datum is set no higher than elevation [_____]. The rectangular transition section of the FSI upstream of the elbow can be modified in length to match the width of the individual pump bay or sump intake. Any modification must be limited to surfaces and dimensions indicated, and must be approved.

c. Construct each FSI of [fabricated steel,][cast iron,][cast steel,][or a combination of these materials embedded in concrete][formed concrete as indicated]. Stiffeners used must be on the outside of the FSI to allow smooth flows in the FSI. Size subassemblies of the FSI, unless constructed of formed concrete, to permit placement and removal through [a hatch in operating floor] [the pump opening in the operating floor] [through the sump gate and trash rack]. Bolts used to connect flanges must be stainless steel with bronze nuts. Minimum thickness of fabricated material must be [10][13][16][19] mm [3/8][1/2][5/8][3/4] inch for fabricated portions. Provide grout holes in floor of the FSI to permit full grouting. [FSIs formed in concrete must meet the surface requirements specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and conform to the construction tolerances given in TABLE 1.][FSIs constructed of iron or steel must conform to the construction tolerances given in Section 05 50 14 STRUCTURAL METAL FABRICATIONS.]

TABLE 1 TOLERANCES FOR FORMED SURFACES			
1.	Variations from the plumb		
	a. In the lines and surfaces of columns, piers, walls and in arises	In any 3 m 10 feet of length	6 mm 1/4 inch
		Maximum for entire length	25 mm 1 inch
2.	Variation from the level or from the grades indicated:		
	a. In slabs, ceilings, and in arises, measured before removal of supporting shores	In any 3 m 10 feet of length	6 mm 1/4 inch
		In any bay or in any 9 m 20 feet of length	10 mm 3/8 inch
		Maximum for entire length	20 mm 3/4 inch
	b. In exposed slab, floors and other conspicuous lines	In any bay or in any 9 m 20 feet of length	6 mm 1/4 inch
		Maximum for entire length	13 mm 1/2 inch

TABLE 1
TOLERANCES FOR FORMED SURFACES

3.	a. Variation of the linear building lines from established position in plan	In any 9 m 20 feet	13 mm 1/2 inch
		Maximum	25 mm 1 inch
	b. Variation of cornered		6 mm 1/4 inch
4.	Variation of distance between walls partitions.	6 mm 1/4 inch per 3 m 10 feet of distance, but not more than 13 mm 1/2 inch in any one bay, and not more than 25 mm 1 inch total variation	
5.	Variation in the sizes and locations of pump throats, floor openings, and wall openings	Minus	6 mm 1/4 inch
		Plus	13 mm 1/2 inch
6.	Variation in cross-sectional dimensions of pump throat and in the thickness of slabs and walls	Minus	6 mm 1/4 inch
		Plus	13 mm 1/2 inch
7.	Footings:		
	a. Variation of dimensions in plan	Minus when formed	13 mm 1/2 inch
		Plus when formed	50 mm 2 inches
		or plus 75 mm 3 inches when placed against unformed excavations	
	b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than 50 mm 2 inches	
	c. Reduction in thickness of specified	Minus	5 percent
8.	Variation in steps:		
	a. In a flight of stairs	Riser	3 mm 1/8 inch
		Tread	6 mm 1/4 inch
	b. In consecutive steps	Riser	2 mm 1/16 inch
		Tread	3 mm 1/8 inch

d. FSI connection to pump impeller bowl flange must be designed by the Contractors selected pump supplier and be rigid or flexible as indicated by results of the dynamic analysis required in paragraph DYNAMIC ANALYSIS. Submit design and drawings indicating materials of construction and method of assembly of the FSI for approval.]

]2.4.7.5 Flanges

****

NOTE: The recommended minimum flange thickness to be specified is:

INSIDE DIAMETER OF JOINT mminch	**THICKNESS mminch**
Up to and including 600 24	**321-1/4**
Above 600 24 and up to and including 1050 42	**381-1/2**
Above 1050 42 and up to and including 2100 84	**502**

See AWWA C207 for additional flange thickness details.

****

Machine flanges and drill bolt holes concentric with pump shaft vertical centerline, having a tolerance of plus or minus one fourth of the clearance between the bolt and bolt hole. When fabricated from steel plate, flanges must not be less than [25][32][38][50] mm [1][1-1/4][1-1/2][2] inch thick after machining. Flange thickness after machining cannot vary more than 10 percent of greatest flange thickness. Provide external stiffeners, if needed. Construct fabricated flanges, as a minimum, to the dimensions of AWWA C207, Class B. Design flanges on major components of pump casing (suction bell, impeller bowl, diffuser bowl, and column and elbow piping) such that blind holes necessitating use of cap screws or stud bolts are not used. Design flanges for connection to column pipe by at least two continuous fillet welds. Connect the inside diameter of the flange to pump column with one weld, and connect the outside diameter of the pump column to the flange with the other weld. Final design of welds rests with the manufacturer, and specified welds are the minimum requirement. Parallel machine, when provided on each end of the same component, and mount parallel to a plane that is normal to pump shaft centerline. Flanges on each end of the same component must have parallel tolerance of 0.051 mm 0.002 inch. Finish machine mating surface on flange to 3.2 µm 125 microinch finish or better. Provide flanges with a minimum of three jacking bolts to aid in disassembly of the pump.

2.4.7.6 Flanged Joints

Design flanged joints to be air-and water-tight, without the use of preformed gaskets, against positive and negative operating pressures that will be experienced, except that permanent gasketing compound will be permitted. Provide mating flanges, unless of the male-female rabbet type, with not less than four tapered dowels equally spaced around each flange. If rabbeted fit is not used, then provide the method used to determine concentricity of connected pieces.

2.4.7.7 Nuts and Bolts

Use 300 series stainless steel for bolts used in assembling the pump and its supporting members, including anchor bolts and dowels. Use only bronze nuts and hexagonal bolts and nuts. Also use 300 series stainless steel washers.

2.4.7.8 Galvanic Protection

****

NOTE: Select appropriate alternate paragraph.

Alternate 1 should be used for pumps having discharge diameters of 500 mm 20 inches or less.

Alternate 2 should be used for pumps having a discharge diameter greater than 500 mm 20 inches. This may also be used for pumps with sidecharge diameters of 500 mm 20 inches or less when manufacturers' information indicates that this method will be the least expensive. The total weight of anodes to be used for each pump is:

DISCHARGE DIAMETER mm inch	MINIMUM NUMBER OF ANODES USED	TOTAL WEIGHT OF ANODES USED kg lbs
From 500 20 up to and including 900 36	2	1840
Above 900 36 up to and including 1200 48	4	3680
Above 1200 48 up to and including 2100 84	7	68150

****

[When dissimilar metals are used, electrically isolate dissimilar parts. Verify isolation by checking joint with an ohmmeter.] [When dissimilar metals are used, use zinc anodes. Provide machined mounting pads and install anodes on carbon steel or cast iron parts. Fasten anodes to bare material on the pump so that continuity is obtained between the anode and the pump. Verify continuity by checking the joint with an ohmmeter. Locate anodes on the exterior of the pump below normal sump level. Total weight of anodes used per pump must be [18][36][68] kg [40][80][150] pounds. Electrically bond pump joints at the joints.]

2.4.7.9 Harnessed Coupling

****

NOTE: This alternative is used when the flexible coupling is to be furnished by the pump Contractor. The applicable connection should be stated.

****

Provide a flexible mechanical coupling or split-sleeve type coupling that either conforms to ASTM F1476, Type II, Class 3, stainless steel or ASTM F1476, Type 1, to connect the pump discharge elbow to the [transition section] [wall thimble] [discharge piping]. Install a minimum of four harness bolts (sized by the pump manufacturer) at each coupling.

2.4.7.10 Wall Thimble

****

NOTE: This alternative is used when the discharge piping includes the piece that will be embedded in the wall of the station. The size of vent to be used is determined from information in EM 1110-2-3105.

****

Provide each wall thimble with one plain end to accommodate the flexible mechanical coupling and one flanged end to mate with the [flap gate] [multiple shutter gate] [discharge piping]. The plain end must match the pump discharge elbow in thickness and diameter and drill the flanged end to match, and be capable of supporting without distortion, the [flap gate] [multiple shutter gate]. Provide the seal ring on the wall thimble located so that it is centered in the wall when embedded. In addition, provide a [_____] mm inch flanged vent nozzle equipped with an ASME B16.5 Standard 125 pound flange and locate where indicated. Fabricate the wall thimble from steel plates.

2.4.7.11 Discharge Piping

****

NOTE: Include applicable discharge pipe description.

****

[Provide discharge piping consisting of a transition section and a wall thimble. Provide a transition section with one plain end and one flanged end, and have a change in cross section from round to [square] [rectangular]. On the plain end, match the pump discharge elbow in thickness and diameter. Arrange the wall thimble for embedment and with the flanges on each end. Mate one end with the flange on the transition section and mate the other end with the flap gate. Fabricate the discharge flange with a minimum dimension of AWWA C207, Class D, and drill to match. The discharge flange must be capable of supporting without distortion, the multiple shutter gate. Provide a seal ring on the wall thimble and locate it so that it is centered in the wall when embedded. In addition, provide a [_____] mm inch flanged vent nozzle equipped with an ASME B16.5 Standard 125 pound flange and locate where indicated. Fabricate the discharge piping from steel plate.]

[Install the discharge piping as indicated. Match the plain end of each discharge pipe with the pump discharge elbow in thickness and diameter and be able to allow a flexible mechanical coupling to connect it to the pump discharge elbow. [Terminate the discharge piping in a flanged end to mate with a flap gate. Drill the flanged end to match, and be capable of supporting the flap gate without distortion.] [Terminate the discharge piping in an open end.] Provide the discharge pipe with pipe supports or cradles as recommended by the pump manufacturer. Locate the supports between the flexible coupling and the wall, as indicated. Provide suitably-sized thrust restraints at each flexible coupling as indicated. The supports must provide support for the weight of the pipe, the water that will pass through the pipe, and any dynamic forces that may develop due to water flowing through the pipe. Furnish a minimum [_____] mm inch flanged vent nozzle equipped with an ASME B16.5 standard 125 pound flange and locate where indicated. The discharge pipe must be non-galvanized piping of welded or seamless pipe or welded steel plate. Use steel pipe conforming to AWWA C200 with dimensional requirements as given in

ASME B36.10M. Provide fittings in compliance with AWWA C208.]

[2.4.7.12 Flap Gate

Design the flap gate for pump discharge service with flange-frame with a resilient seat of neoprene or BUNA-N to prevent closing shock. Make the size of the flap gate the same as the discharge pipe size. [Use cast iron for the body of the valve and the flap in compliance with ASTM A126. Use high-tensile bronze ASTM B584- CA 865 for the hinge arms. Design the hinge pins in double shear and of silicon bronze, ASTM B98/B98M- CA 655.] [Fabricate the flap gate entirely of stainless steel. Use only stainless steel hardware.] Provide lubrication fittings on the hinge arms. Extend the grease lines to a convenient location for lubricating. Provide an anti-locking bar to prevent excessive rotation about the lower hinge pin. Provide a stainless steel leaf spring with rubber pad to safely limit the travel of the flap gate during pumping.

]2.4.8 Impeller

****

NOTE: Cast steel and aluminum bronze are normally used when pumps are less than 2100 mm 84 inch. Fabricated steel impellers are used with pumps having discharge diameters 2100 mm 84 inch or greater. Cast stainless steel is used for pumps where the difference between pump NPSHA and NPSHR is small (less than 600 mm 2 feet) or, when severe corrosion is expected.

****

Make the impeller of [cast steel,] [cast stainless steel,] [aluminum bronze] or [fabricated of welded steel plate].

2.4.8.1 Removal and Prior To Finishing

After removal from mold, and prior to finishing of surface imperfections, the Contracting officer will inspect castings. Fill and grind minor surface imperfections as necessary to preserve correct contour and outline of impeller and to restore surface imperfections to the same degree of finish as surrounding surfaces. Correct surface pits, depressions, projections, or overlaps showing greater than 2 mm 1/16 inch variation from the general contour for that section. Method and procedure for accomplishing repair must be as required in Section [08 31 00 ACCESS DOORS AND PANELS] [05 50 14 STRUCTURAL METAL FABRICATIONS]. Castings that exhibit surface imperfections (as defined above) covering an area of more than 10 percent of blade surface will be rejected.

2.4.8.2 Balance

****

NOTE: The maximum operating speed is used for driver/pumps which operate at different speeds. The rated operating speed is used with a single speed driver. The g-mm oz-inch used in this paragraph are determined from ISO 1940-1 for grade G6.3. Impellers for pumps having a discharge diameter greater than 600 mm 24 inch must have the impeller weighted. The amount of allowable unbalance or the level of balance in the acceptable standards must be

chosen and included in this guide specification. This includes choosing acceptable standard(s). A suggested standard is balance quality grade G6.3 in accordance with ISO 1940-1.
****

Balance each impeller by the two-plane balancing technique. Balance each impeller at [maximum] [rated] operating speed. Check the balance at 110 percent of balance speed, and make needed corrections. Amount of allowable unbalance is in accordance with grade G6.3 of ISO 1940-1. Securely fasten weights needed to obtain the required level of balance to the inside cavity of the impeller hub. In no case can portions of the impeller be removed or weights be added to the outside of the hub, vanes, or water passages. Submit balancing procedure at least four weeks prior to the date of balancing. Weigh each finished impeller and weight stamped on the bottom of the hub with weight accurate to 0.5 percent of the total weight of the impeller. Weighing and balancing will be witnessed by the Contracting Officer. Submit all impeller weights and the results of impeller balancing.

2.4.9 Shafting

2.4.9.1 Shaft

****
NOTE: Stainless steel shafting should be used when the potential for corrosion is high such as a pump used in a station where the pump/station sump is not capable of being dewatered. The shaft lengths are limited in length by the headroom available. Shaft sections are usually less than 3000 mm 10 feet in length. Vertical adjustment of the shaft should be performed above the operating floor. The motor and gear reducer are normally specified to be hollow shaft type to allow the pump shaft to pass concentrically through the reducer and motor allowing finite impeller elevation adjustments.
****

Each impeller shaft must be stainless steel and intermediate shaft(s) must be [cold-rolled carbon steel] [same material as the impeller shaft]. Design shafting so that [shaft sections do not exceed [_____] mm feet in length and that] any necessary vertical adjustment of the impeller can be made [from the operating room floor] without interfering with shaft alignment. Also provide for removal of the impeller from below without disassembly of the pump above the impeller bowl. If the pump is multi-staged, design to permit the lower bowls and impeller to be easily removed for in-place inspections of upper propeller and bowl. Design shafts for two different design cases. The first uses a factor of safety of 5 based on ultimate tensile strength of the shaft material and rated wattage horsepower of the [motor] [engine]. The second uses 75 percent of the yield strength of the shaft material and [the locked rotor torque of the motor] [maximum wattage horsepower of the engine].

2.4.9.2 Couplings

****
NOTE: Rigid flange couplings should be specified only for pumps having discharge diameters greater than 1800 mm 72 inch. The rigid flange coupling may

be specified as an option for all pumps less than 1800 mm 72 inch. Sleeve type couplings should be used for pumps having discharge diameters from 600 mm 24 inch to 2100 mm 84 inch. Threaded shaft couplings can be used for pumps with discharge diameters less than 600 mm 24 inch.

****

Couple the pump and [motor] [gear reducer] shafts[and pump shaft sections] together using rigid flanged coupling capable of transmitting the forces and torques involved. Bolt coupling halves together and maintain concentric with each other, by means of a rabbet fit, to within 500 µm 0.002 inch. Retain a shaft coupling nut, if used, by fitted bolts, and comply with all tolerances specified for the coupling. Finish machine the flange and bore in one setup to insure that the flange of the coupling is true to the bore. Each flange must be perpendicular to the bore, and parallel to the opposite end and mating flanges to within 500 µm 0.002 inch. Each flange must be concentric to the centerline of the shaft to within 0.50 mm 0.002 inch. [Join together pump shaft sections with [sleeve-type couplings capable of taking rotation in either direction. Threads, except on fasteners, cannot be employed in construction of sleeve-type couplings] [threaded couplings in which the threaded shaft ends are threaded into the coupling].] Construct couplings, including keys and fasteners, of stainless steel materials. All keys and keyseats (keyways) must meet the requirements of ASME B17.1. The finished shaft assembly must be concentric about the shaft centerline to within 100 µm 0.004 inch. Shop assemble couplings and the pump shaft, and inspect for compliance with contract requirements. After inspection, matchmark parts, including fitted bolts, to their mating pieces.

2.4.9.3 Journals

****

NOTE: Select the appropriate alternate paragraph. The first alternate is used when plain steel shafting is used for the intermediate shafting. The second alternate is used when all the shafting is stainless steel. If self-lubricated bearings are used ensure to specify those in 35 05 40.17.

****

[Provide replaceable stainless steel one-piece journal sleeves at each guide bearing, packing gland and seal locations. [For self-lubricated bearings see 35 05 40.17 SELF-LUBRICATED MATERIALS, FABRICATION, HANDLING, AND ASSEMBLY]. Finish sleeves at all bearings and packing gland locations to at least 32 rms and finish sleeves at seal locations to 16 rms. Securely fasten sleeves to the shaft to prevent movement. Make keys and fasteners, if used, from corrosion resisting steel; fastening by adhesive or welding is not acceptable. All keys and keyseats (keyways) must meet the requirements of ASME B17.1. The surface hardness of the sleeves at the bearing and packing gland locations must be as recommended by the pump manufacturer.

][Finish the shaft journal at all guide bearing and packing gland locations to at least 32 rms and finish the shaft at seal journal locations to 16 rms. The option exists to install replaceable stainless steel one-piece sleeves at each bearing, packing gland, and seal locations with the finishes stated above. Securely fasten sleeves to the shaft to prevent movement. Make keys and fasteners, if used, from corrosion resisting steel; fastening by adhesive or welding is not acceptable. All keys and keyseats (keyways) must meet the requirements of ASME B17.1. The surface hardness at the seal locations must be as recommended by the seal manufacturer.

]2.4.9.4 Circumferential Line

****

NOTE: The circumferential line with pointer should be used for pumps having 1200 mm 48 inch and greater discharge diameters. The following information will be used for determining whether the pump driver is specified as using a hollow or solid shaft.

Pump drivers with rating less than 745 kW 1000 horsepower are equipped with hollow shafts permitting vertical shaft adjustment from the top of the driver.

Pumps drivers over 745 kW 1000 horsepower are equipped with hollow shafts whenever possible but as a minimum the pump will have a means of vertical adjustment above the operating floor.

****

Inscribe or etch a circumferential line on the shaft above the stuffing box and mount an adjustable pointer opposite this line in order to indicate a change in vertical position of shaft and to permit realignment after [motor] [gear reducer] removal.

2.4.10 Shaft Enclosure

****

NOTE: Shaft enclosure tubes are tensioned for pumps with discharge diameters less than 1350 mm 54 inch. Rigid enclosing tubes are used on pumps having discharge diameters 1350 mm 54 inch and greater. External supports or bracing located in the pump water passage are used for pumps with tensioned enclosing tube of 6000 mm 20 ft in length or greater. Self-supported enclosing tubes 4500 mm 15 feet length or greater should have external supports. The enclosing tube is split when pump size is 1800 mm 72 inch or larger. Select appropriate bracketed statements based on the type of pump lubrication being called for.

****

Provide a shaft enclosure to cover the intermediate shaft and coupling. It [must be placed in tension or]must be rigid enough to be self-supporting. [Do not use external supports or bracing located in the pump water passage for support of the enclosing tube unless necessary to support intermediate bearings or indicated to be necessary or advantageous by the dynamic analysis required in paragraph DYNAMIC ANALYSIS. Consider the effect of external supports, including rubber inserts, in the dynamic analysis required in paragraphs under TEST, INSPECTIONS, AND VERIFICATIONS.] Design each enclosure [to be watertight and] for easy assembly and disassembly in the field.[Split each enclosure longitudinally to permit easy removal without removing or disassembling the pump shaft.] [Perforate each enclosure tube sufficiently to allow a free flow of pump discharge water (i.e., product water) to lubricate the shaft bearings.] Construct enclosing tubes, constructed with screw type joints and using tension in the tube to hold alignment, to prohibit the tension tube from unscrewing when the packing gland adjustments are made. [Provide a shaft enclosure for grease-lubricated pumps with a drain having a shut-off valve located outside of the pump to permit draining the enclosure between operation periods. Locate the drain at the bottom of the shaft enclosure.] [On oil-lubricated pumps, fit the enclosing tube below the lowest bearing and above the oil seals with an oil/water drain line to the outside of the pump. The drain line must have a check valve outside of the pump to preclude the entrance of sump water.]

2.4.11 Guide Bearings and Seals

****

NOTE: The Clean Water Act requires all in water bearings to meet the standard EAL criteria (Vessel General Permit (VGP), or EPA 800-R-11-002). Confirm submitted EAL product data conforms to EM 1110-2-1424. Grease lubrication can be used with all size pumps. Oil lubrication may be used in pumps having discharge diameters of 900 mm 36 inch or smaller. Select appropriate bracketed statements based on the type of pump lubrication being called for. The first water-lubricated bearing alternative is for product lubricated bearings. The second water-lubricated alternative if for externally-provided water.

****

2.4.11.1 Guide Bearings

All in water bearing lubrication must conform EPA 800-R-11-002 for environmental acceptability. Submit in water bearing lubrication product data to show bearings meet environmental, performance, and comparability requirements for the application.

[Provide each pump with sleeve-type bearings designed for [grease] [oil] lubrication. Each bearing must have a bronze lining in contact with shaft journal and must be replaceable type. Arrange the bearing liner for maximum distribution of [grease] [oil] for lubrication of journal surface. Bearings must have a surface finish of 0.80 µm 32 microinches rms or better to match the journal finish. Since pumped water may contain some fine sand and silt in suspension, give special attention to the design and selection of bearing parts, especially seal rings, to preclude entrance of foreign material between the bearing and journal due to differential water pressure.

][Provide elastomeric polymer alloy bearings, sealed in the shaft enclosure. Support the bearings in threaded bronze sleeves acting as an enclosing tube. Ensure the bearings are submerged in water when the pump is in operation. Accomplish lubrication by pump discharge water (product water) free-flowing through perforations in the shaft enclosure tube.

][Provide each pump with bearings that are grooved and continuous. Machine the bearings to marine clearances for strained canal water lubrication and of sufficient length and diameter to keep bearing pressure to the allowable design. Select bearing thicknesses and marine clearances to allow for material swell from water submergence. Shaft bearings may be located as the design dictates with the following exceptions. Provide no fewer than three bearings in the pump with a maximum bearing spacing of 1.5 m 5 feet. Locate bearings at the top of the diffuser section, above the impeller, and near the baseplate. Bearings in the right angle gear, other than the thrust bearing, are not acceptable for use as pump shaft support. Support the line shaft bearing by the diffuser inner cone fabricated assembly. Secure tubing for bearing lubrication water to and routed on the outside of the casing for each bearing. The tubing must be continuously welded to a diffuser vane or bearing support to cross from the outside of the casing to the bearing mounting assembly.

Bearings must be easily removable for servicing in the field.]

2.4.11.2 [Oil][Grease] Lubrication Shaft Seals

****

NOTE: Select appropriate alternate paragraph. The designer must select the appropriate seal material which is compatible with the selected oil lubrication.

****

[Pumps designed for oil lubrication must have a shaft seal system located below the upper pump shaft bearing. The seal system consists of a seal containing two lip elements. The element facing the bearing must have a stainless steel garter spring back-up and be constructed of [tetrafluoroethylene][fluoropolymer elastomer][Buna N]. The secondary element faces the impeller and is constructed of tetrafluoroethylene. Use a bullet-shaped assembly tool or other special tool over the end of the shaft or grooves in the shaft to preclude damage to the lip element during assembly. Assembly tools used are considered a special tool and must be furnished to the Government as part of special tools specified in paragraph SPECIAL TOOLS. Pumps having two stages must have seals to protect the extra bearings required by two stages of construction.

][Pumps designed for grease lubrication must have a shaft seal consisting of lip seals. The seal system consists of a lip-type seal located on each end of the bearing. Each seal must contain a lip element having a stainless steel garter spring back-up and be constructed of [tetrafluoroethylene][fluoropolymer elastomer][Buna N]. Face the lip element out, away from the bearing to keep water from intruding into the bearing chamber. The lowest bearing must have an additional grease seat with the lip facing away from the bearing. Use a bullet-shaped assembly tool or other special tools over the end of the shaft and shaft grooves to preclude damage to the lip element during assembly. The assembly tool used is considered a special tool and must be furnished to the Government as part of special tools specified in paragraph SPECIAL TOOLS.

][2.4.11.3 Product Lubricated Pump Bearings

Submerged pump bearing must be [product lubricated][externally supplied water lubricated] and meet the following requirements:

a. Fabricated from an elastomeric material or polymer composite material and not require petroleum lubricants for operation.

b. Operate in [brackish][fresh] water that may contain [sand] [silt] [vegetative trash].

c. Does not require service or replacement for [50,000] [_____] operating hours.

]2.4.12 Bearing Heat Sensors

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NOTE: Bearing heat sensors may be used in pumps having a discharge diameter larger than 600 mm 24 inches. Pumps with large discharge diameters should be furnished with heat sensors for the impeller bearings only, when the estimated annual operation is less than 100 hours per pump. Pumps with greater operating hours per year may be equipped with bearing heat sensors for all bearings in the pump. Schedule 80 guard pipes must be used when the unsupported length is 450 mm 18 inches or less. Schedule 120 should be used for greater unsupported lengths.

****

Fit [the impeller shaft bearings] [each bearing] with temperature-sensing elements, inserted in the bearings to within 3 mm 1/8 inch of shaft. Provide these temperature-sensing elements with temperature readouts mounted [on the [engine] [motor] instrument board] [at a central location as shown]. Provide a visual and audible alarm system to warn of bearing overheating. Provide temperature indicator with dual outputs that have setpoints that are separately adjustable. Support leads and protect them from water and mechanical damage. Terminate the leads outside of the pump casing in a waterproof connection head and cap until final connections are made in the field. The connection head must be rated watertight to 175 kPa 25 psi. Lead protection consists of pipes fastened to the pump with brackets using bolts and nuts to permit their removal, and constructed with enough unions to be completely disassembled. Leads passing through the pump water passage in the pump must either be contained in a guide vane or be protected by [Schedule 80] [Schedule 120] pipe. Make protection pipe removable if connected to the shaft-enclosing tube. Install bearing heat sensors as [shown in Figure 2 at end of the section] [indicated]. Run leads and wiring to a junction box located on the baseplate. Provide a terminal strip in the junction box for connection of wiring to temperature readouts.

2.4.13 Thrust Bearing

Provide a thrust bearing in the [speed reduction gear][motor] to carry total thrust load[as specified in [_____]].

2.4.14 Packing Gland

Provide [grease-] [water-]lubricated packing gland split longitudinally to facilitate removal or renewal. Arrange it to permit inspection, repair, removal, or replacement of packing without entering pump from below operating room floor. Provide eye bolts and tapped holes in each half of the split gland if halves weigh over 14 kg 30 pounds each.

[2.4.15 Siphon Breaker Valve

Provide a siphon breaker valve assembly for each of the vertical axial-flow pumps. Provide [mechanical, self-actuating] [electrically-operated] valves. Install each assembly at the top (summit) of the discharge pipe and must vent air from the discharge pipe when the pump is started. The assembly must also permit air to enter the discharge pipe through the siphon breaker valve to prevent reverse siphoning of water when the pump is stopped. Size the valves based on the pumping conditions (e.g. flow, head, discharge pipe diameter) of the specific system. If a mechanically-actuated valve is chosen, size the valve to allow air to relieve at a maximum of 90 m per second 300 feet per second. Provide a means to operate the valve manually to stop back-siphoning through the pump in case the normal operator of the siphon breaker valve fails.

]2.5 LUBRICATION SYSTEM

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NOTE: Select appropriate alternate paragraph. Oil lubrication may be used for pumps with discharge diameters up to and including 900 mm 36 inch. Grease lubrication may be used for all size pumps. The centralized pressure lubrication system will be used when grease lubrication is selected. Select the water-lubricated bearings bracketed information if this type of lubrication is being used. The Clean Water Act requires all in water bearings to meet the standard EAL criteria (Vessel General Permit (VGP), or EPA 800-R-11-002). Confirm submitted EAL product data conforms to EM 1110-2-1424.

****

All in water bearing lubrication must conform EPA 800-R-11-002 for environmental acceptability. Submit in water bearing lubrication product data to show bearings meet environmental, performance, and comparability requirements for the application.

[Oil lubrication of shaft bearings consists of introducing oil at the top line shaft bearing and allowing oil to run down the shaft for the lubrication of the lower bearings. Oil lubrication consists of an oil reservoir mounted on the pump baseplate or pump driver at such height to permit gravity flow of oil to the highest lubrication point of the pump shaft. Construct the reservoir of transparent material to permit observation of the quantity of oil in the reservoir. The oil reservoir must have a minimum capacity of 1 L 1 quart. The reservoir must have a solenoid valve to permit oil flow whenever the pump driver is in operation. The flow rate from the oil reservoir must be adjustable from five drips per minute to constant flow. The reservoir valve must permit manual flow of oil when the pump driver is not operating for prelubrication of the shaft bearing. Construct the oil line from the oil reservoir to the pump line shaft of stainless steel tubing and support at sufficient locations to preclude vibration of tubing when the pump is operating. If the pump has a bearing located below the impeller, this bearing must be grease-lubricated. Provide a grease line with a grease fitting from this bearing to a location on top of the baseplate. Provide a grease reservoir with this bearing configuration for containing extra grease. Lubricate shaft packing by grease. Run the grease lines to a location outside of the driver pedestal and provide with a fitting for manual lubrication.

][Support grease lines to each bearing and protect them from water and mechanical damage. Grease line protection consists of channels fastened to the pump with brackets, using bolts and nuts to permit removal. Grease lines passing through the pump water passage must either be contained in a guide vane or be protected by Schedule [80] [120] pipe. This protection pipe must be removable if connected to the shaft-enclosing tube. Prefill grease lines before connection to bearings. Terminate grease lines above baseplate for connection to the lubricating grease pump.

][Provide lubrication for the bearings from the water being pumped (i.e., product water) by means of perforations in the shaft enclosure. Design the perforations such that the shaft tube is constantly filled with water during pump operation, thereby continually covering the contact surfaces of the bearings. If upper bearings will not receive sufficient pumped water for lubrication, use another means to provide sufficient water to these bearings using either product water or water from the intake canal. Provide a means to indicate visually that the upper bearing(s) and packing gland are obtaining sufficient lubrication water.

2.5.1 Supplemental Lubrication Water

If it is determined that the pumped product water cannot be lifted sufficiently to lubricate the upper bearing(s), it is the Contractor's responsibility to design and provide a complete water lubrication system. Provide a separate water lubrication system for each pump. The water cannot come from the potable/well water system. This water lubrication system must include a means for providing sufficient lubrication water to the upper bearing(s). The supplemental lubrication water system must include an alarm and shutdown in case of low-flow or no-flow to the upper bearing(s), along with electrical input to the [engine] [motor] control panel and SCADA/PLC systems as needed. Provide any necessary filtering, flow switches, time delays, to ensure that the upper bearings are satisfactorily lubricated. Coordinate any additional electrical power and controls requirements with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and other electrical sections. The supplemental lubrication water system must be fully maintainable. If the supplemental lubrication water system is needed, provide shop drawings, operations and maintenance data, and as-built drawings as required.

][2.5.2 Centralized Pressure Lubrication System

[2.5.2.1 General

Provide each pump with its own individual electric motor-driven centralized pressure lubrication system, designed to deliver the proper predetermined or metered quantity of lubricant to each individual bearing and stuffing box. Positively indicate proper or improper functioning of any individual metering device. Mount the pressure pump, individual metering devices, and any required auxiliary operating accessories on the baseplate. Furnish the system complete and ready for operation, including sufficient lubricant to fill each pressure pump lubricant reservoir. Submit the complete centralized pressure lubrication system for review and approval. Provide the lubricant recommended for the selected pumps, subject to approval of Contracting Officer.

][2.5.2.2 Pumping Unit

Provide an electric motor-driven central pumping unit as a complete assembly, consisting of a positive displacement type pump, flow-directing valve (if required), lubricant reservoir, suitable pressure gage to indicate pump discharge pressure, operation counter, pressure protective device, and other auxiliary accessories as required to give a complete and workable unit conforming to the requirements specified. The pump must be of multiple individual piston, positive displacement type utilizing hardened steel pistons, closely fitted to the cylinder bores to eliminate the need for packing. Spring-actuated check valves is not be required for its operation. The pump must deliver not less than 100 mL 6 cubic inches of lubricant per minute against a pressure of not less than 13.8 MPa 2000 psi measured at the most remote bearing connection. The lubricant reservoir must be of a suitable metallic construction, with a capacity of not less than 11 kg 24 pounds of lubricant, and provided with a means that will ensure positive priming of the pump at all times (such as an atmospheric or spring-loaded follower plate), an indicator to show quantity of lubricant in the reservoir, and a screened fill connection to permit filling the reservoir by a transfer pump without exposing the lubricant to the atmosphere. Provide the pump unit with a fully automatic control system, capable of suitable or proper scheduling by an adjustable synchronous motor-driven timing device, and other required auxiliaries necessary to give a complete and workable system. Provide the controller with a "Hand-Off-Automatic" selector master switch to permit selection between push button manual and automatic time clock operation, and to deenergize the system. Supply electric power at 115 volts single phase, 60 cycles. Use the time clock setting recommended for the selected pumps.

][2.5.2.3 Metering Valves

Provide a metering or measuring valve for each bearing and stuffing box. It must be fully hydraulic in its operation, requiring no internal springs or check valves. Size the valve based on requirements of the selected pumps.

][2.5.2.4 Piping

The system piping must be stainless steel tubing (ASTM A269/A269M, Type 410 or equal) using flared or compression-type connectors. Adequately protect and rigidly support the piping located below the operating room floor in a manner approved by the Contracting Officer. Provide each individual grease line with a "Tee" fitting, located immediately below the respective metering valve and accessible from the operating room. Provide the piping with a standard 6 mm 1/4 inch grease fitting so that each individual line may be fully charged without using the lubricating system pump. The size, strength of pipe, and type and strength of fittings must be as recommended and guaranteed by the Contractor for the selected pumps, but in no case can the bursting pressure of the pipe or tubing used be less than three times the maximum working pressure. Provide a check valve located between the discharge outlet of the measuring valve and the "Tee" fitting specified above in each bearing lubricating line that is exposed to water pressure to prevent entrance of water into the respective measuring valves.

]]2.5.3 Lubrication System Accessories

2.5.3.1 Grease Gun

Provide a hand operated, heavy duty lever grease gun for charging lubrication lines and for emergency lubrication. Provide grease as recommended for the Contractor's selected pumps.

[2.5.3.2 Service Facilities

Provide a service facility consisting of a portable hand operated transfer pump, a hand-towed dolly, and a 55 kg 120 pound drum of lubricant, all assembled and ready for operation. The pump must be self-contained and designed for mounting on the grease drum to protect the contents from the entrance of foreign matter. The pump must deliver not less than 0.45 kg one pound in not more than eight strokes of the pump handle under normal temperature conditions. Provide the necessary hose and quick disconnect coupling for a complete system. The hand-towed dolly must have a rigid platform with four anti-friction bearing mounted wheels, a towing handle, and a provision for securing the lubricant barrel. Use the type of lubricant recommended for the Contractor's selected pumps.

]2.6 PAINTING

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NOTE: The painting paragraph refers to Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES. Edit UFGS Section 09 97 02 to require the use of System No. 21-A-Z Formula 151 for ferrous parts of the pump located above the finish floor. For the interior and exterior surfaces of the pump located below the baseplate, except for stainless steel or galvanized, the required paint system should be System No. 6-A-Z. Contact the CERL Paint Lab for all painting questions.

****

Perform painting in accordance with Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

2.7 FACTORY ASSEMBLY

The pump must be assembled at the Contractor's selected manufacturer's plant[in a vertical position] to assure proper fitting and alignment of all parts. Tolerances cannot exceed those specified or shown on the the manufacturing drawings. Check rotating elements for binding. The suction bell, impeller housing, diffuser, and the discharge elbow must be properly match marked and have their centerlines clearly marked on the outside of all flanges to facilitate erection and alignment in the field. Notify the Contracting Officer sufficiently in advance to permit a representative of the Contracting Officer to inspect and witness the pump assembly. Matchmark all parts disassembled for shipment.

2.8 BASEPLATE AND SUPPORTS

****

NOTE: If Alternate 2 or 3 of paragraph [CRITICAL SPEEDS] [DYNAMIC ANALYSIS] is part of the contract, the results of the dynamic analysis are included as a load.

Seismic design criteria are provided in UFC 3-301-01 SEISMIC DESIGN FOR BUILDINGS.

****

Design and proportion the [soleplate and] baseplate to support the entire pump assembly, the [reduction gear] [motor] and the loads (including the results of the dynamic analysis) to which it may be subjected during operation.[Support and anchor is as indicated.] Furnish lifting lugs or eye bolts, special slings, strongbacks, or other devices necessary to handle the pump during loading, unloading, erection, installation, and subsequent disassembly and assembly. [Provide a sole plate [as indicated] under the baseplate. Install, level and grout the sole plate in accordance with API RP 686, Chapter 5 - Mounting Plate Grouting.] Provide [leveling nuts][jacking bolts] for leveling the baseplate assembly. Provide an anchor bolt layout to aid in placement of anchor bolts.[Back off all leveling jacking bolts after grouting so that they do not support any of the load.] The pedestal supporting the [motor][right-angle reduction gear] must contain a 25 mm 1-inch lip to contain water leakage from the shaft packing. [Provide a sole plate [as indicated] under the baseplate.][Seismic requirements must be in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS.] Provide the calculations used in the design of the baseplates and the anchoring bolts to ensure that the proper forces (e.g. shear, torsion, bending) have been considered. Submit product data for grout used as pump supports. The baseplates must be structural steel plate of adequate thickness to support the weight of the pump and right angle hear or motor (as applicable) plus the maximum hydraulic thrust of the pump. Provide plates of the length, width, and thickness as determined by the Contractor.

2.9 TESTS, INSPECTIONS, AND VERIFICATIONS

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NOTE: Testing, inspections, and verifications should take place with the pump(s) installed on the baseplate(s). Typically after successful testing is complete, pumps can remain on baseplates for shipment to the Government.

****

2.9.1 Pump Testing

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NOTE: When specifying well established pumps which are mass produced and exist in catalogs, the designer may chose to simply require pumps be tested in accordance with HI 14.6 "Rotodynamic Pumps for Hydraulic Performance Acceptance Tests". Table D.1 in HI 14.6 provides recommendations for which tests are appropriate for given conditions. For pumps which are highly custom, irregular, or unconventional the following alternate paragraphs may be included.

****

Test specified pumps in accordance with HI ANSI/HI 14.6. For all pumps include [Performance][hydrostatic][NPSH][and mechanical] testing as described in HI ANSI/HI 14.6.

[2.9.2 [Critical Speeds][Dynamic Analysis]

****

NOTE: For the case of custom, irregular, or unconventional pumps, select appropriate alternate paragraph.

Alternate 1, Critical Speeds is used when the estimated operating hours for the pumping station is less than 50 hours per year.

Alternate 2, Dynamic Analysis is used when operating hours are greater than 50 hours per year and the pump is driven by an electric motor. The motor described is a vertical shaft type without a speed reducer. If the decision is made to use a horizontal shaft motor, then Alternate 2 needs to be revised to include the speed reducer in the analysis as described in Alternate 3. Select the first and second bracketed paragraphs for Alternate 2.

Alternate 3, Dynamic Analysis, is used when operating hours are greater than 50 hours per year and the pump is driven by a diesel engine/gear reduction unit or when an FSI is used. Select the first bracketed paragraph and the TORSIONAL ANALYSIS and LATERAL FREQUENCY ANALYSIS paragraphs.

The designer should specify performance testing of the assembled pump in the factory to check that the requirements of the specification have been met.

The Performance Test is a required test, whereas the Cavitation, Hydrostatic, Submersible Motor Integrity, and Vibration tests are optional. The designer should be familiar with ANSI/HI 14.6 to determine which tests are needed to balance technical adequacy and cost.

The Cavitation test, or NPSHR test, is costly due to the complexity. The designer should include cavitation testing whenever the cavitation characteristics of the proposed pump have not been determined (by test) by any one of the prospective suppliers. Testing should be conducted on a full-scale (prototype) pump. It should also establish the structural and operating integrity of the complete pumping unit. The prototype pump would be the first pump built. This test may not be necessary if there is sufficient inlet head pressure and the pump has a stated NPSHR that would be acceptable with a suitable margin (see ANSI/HI 9.6.1). The pump could be tested at the minimum design head pressure to verify that the guaranteed head and power at the specific rate of flow instead of performing the NPSHR test. HI ANSI/HI 14.6 provides guidance for testing in Appendix D.

****

[The assembled pumping unit, consisting of the [motor] [,] [engine] [,] [speed reducer] and pump must be free from critical speeds or harmful torsional vibrations at all speeds encountered within the operating range.]

[Before the pump and motor, furnished under Section(s) [26 29 01.00 10 ELECTRIC MOTORS, 3-PHASE VERTICAL INDUCTION TYPE] [26 29 02.00 10 ELECTRIC MOTORS, 3-PHASE VERTICAL SYNCHRONOUS TYPE], [41 65 10.00 10 [DIESEL][NATURAL GAS] FUELED ENGINE PUMP DRIVES] and [35 45 03.00 10 SPEED REDUCERS FOR STORM WATER PUMPS] are released for manufacture, the pump/motor structure must be analyzed by the Contractor for harmful natural frequencies in the lateral and torsional directions. A natural frequency that occurs within 25 percent above or below normal operating speed is unacceptable. Construct a dynamic analysis model using a commercially available program such as Ansys, Cosmos/M, or equivalent, which utilize finite element methods. Incorporate effects of column pipes, cover pipes, shafts, bearings, mass concentrations, and other such features as necessary to accurately model the pump structure. Analyze the structure in the run (wet) condition and consider the effect of water mass in the column and damping effect of water in the sump (vertical units only) at highest and lowest sump water levels. Incorporate Reed critical frequency and mass elastic diagram information for the Contractor's selected motors. If the Contractor cannot demonstrate to the satisfaction of the Contracting Officer (based on impact tests of similar units) that the Reed critical frequency value is accurate, the Contractor must conduct a dynamic analysis using finite element methods as described to determine motor Reed critical frequency for use with the Contractor selected pumps. Submit the complete detailed dynamic analysis report including the following information:

a. Computer program used.

b. Schematic diagram of the model depicting nodes and elements.

c. Input data consisting of node coordinates, element types, material properties, element characteristics, element connectivities, and specified displacements.

d. Motor mass elastic and Reed critical information (or dynamic analysis, if required).

e. Analysis results, including significant natural frequencies.

f. Interpretation of results.

Impact the test motor provided before shipment to determine actual Reed critical frequency of motor. Include results of impact tests included in motor test data to be submitted. The Contractor must address any discrepancy between calculated and actual motor Reed critical frequency values to determine whether design changes are required to prevent harmful natural frequencies in the pump/motor structure. Incorporate any design changes which are required to correct these discrepancies.]

[2.9.2.1 Torsional Analysis

Before the pump, gear drive, and engine are released for manufacture, the Contractor must analyze the system for harmful torsional natural frequencies using mass elastic information for the selected pump(s) and gear drive(s). A natural frequency that occurs within 25 percent above or below [normal operating speed][any of the operating speeds required for pump operating conditions] is considered to be unacceptable.

][2.9.2.2 Lateral Frequency Analysis

Before each pump, engine, and gear drive provided under Section(s) [41 65 10.00 10 [DIESEL][NATURAL GAS] FUELED ENGINE PUMP DRIVES][,] [35 45 03.00 10 SPEED REDUCERS FOR STORM WATER PUMPS], respectively, are released for manufacturing, the pump/gear drive structure must be analyzed by the Contractor for harmful natural frequencies in the lateral directions. A natural frequency that occurs within 25 percent above or below [normal operating speed] [any operating speeds required for pump operating conditions] is considered to be harmful. Construct the dynamic analysis model using a commercially available program such as Ansys, Cosmos/M, or equivalent that utilizes finite element methods. Incorporate effects of column pipes, cover pipes, shafts, bearings, mass concentrations, and other such features in the model as necessary to accurately model the pump structure. Analyze the structure in the run (wet) condition and consider the effect of water mass in the column and the damping effect of water in the sump at the highest and lowest sump water levels. The model must incorporate Reed critical frequency and mass elastic diagram information provided by the contractor. If the Contractor cannot demonstrate to the satisfaction of the Contracting Officer (based on impact tests of similar units) that the Reed critical frequency value is accurate, a dynamic analysis using finite element methods as described herein must be conducted by the Contractor to determine gear drive Reed critical frequency for use by pump manufacturer. Submit the complete dynamic analysis report including the following information:

a. Computer program used.

b. Schematic diagram of the model depicting nodes and elements.

c. Input data consisting of node coordinates, element types, material properties, element characteristics, element connectivities, and specified displacements.

d. Gear mass elastic and Reed critical information(or dynamic analysis, if required).

e. Analysis results including all significant natural frequencies.

f. Interpretation of results.

Impact-test the gear drive before shipment to determine the actual Reed critical frequency of the drive. Submit results of impact tests. The Contractor must address any discrepancy between calculated and actual gear drive Reed critical frequency values as to whether or not design changes are required to prevent harmful natural frequencies in the pump/gear drive structure. If any design changes are required, incorporate at no cost to the Government.

]][2.9.3 Lubricating System Tests

****

NOTE: Delete these paragraphs if water-lubricated pumps are called for.

****

Test the complete lubricating system for each pumping unit, as deemed necessary by the Contracting Officer, to determine that the system meets the operational requirements specified. Test at least one valve of each size furnished with the lubrication line removed from its bearing and fitted with a pressure relief valve and pressure gage. Adjust the pressure relief valve to discharge it at the operating pressure specified and operate the system through one or more cycles as required to obtain an accurate measurement of the quantity of lubricant delivered. This must be within plus or minus 20 percent of the theoretical delivery of the respective valve. Replace, reinstall, and retest any component parts that are damaged as the result of these tests or that fail to meet the requirements of the specification.

]2.9.4 Factory Test

****
NOTE: Test each different size pump for performance.

Alternate specifications for the "Factory Test" have been provided in this specification. Alternate 1 gives the manufacturer the option of testing either the prototype pump (first pump produced) or a homologous model of the pump. This alternative should be used for all pumps having a diameter up to and including 1200 mm 48 inch. Alternate 2, which requires a homologous model of the pump be tested for performance and NPSHR characteristics, should be used for pumps having a diameter greater than 1200 mm 48 inch. Alternate 2 can also be used for pumps smaller than 1200 mm 48 inch in diameter if the expected annual operating time is greater than 500 hours per year or for the special case when there is no published NPSHR curve available.

The designer should specify performance testing of the assembled pump in the factory to check that the requirements of the specification have been met.

The Performance Test is a required test, whereas the Cavitation, Hydrostatic, Submersible Motor Integrity, and Vibration tests are optional. The designer should be familiar with ANSI/HI 14.6 to determine which tests are needed to balance technical adequacy and cost.

The Cavitation test, or NPSHR test, is costly due to the complexity. The designer should include cavitation testing whenever the cavitation characteristics of the proposed pump have not been determined (by test) by any one of the prospective suppliers. Testing should be conducted on a full-scale (prototype) pump. It should also establish the structural and operating integrity of the complete pumping unit. The prototype pump would be the first pump built. This test may not be necessary if there is sufficient inlet head pressure and the pump has a stated NPSHR that would be acceptable with a suitable margin (see ANSI/HI 9.6.1). The pump could be tested at the minimum design head pressure to verify that the guaranteed head and power at the specific rate of flow instead of performing the NPSHR test. HI ANSI/HI 14.6 provides guidance for testing in Appendix D.
****

2.9.4.1 General

****
NOTE: Select the appropriate alternate paragraph.

In the second alternate, the inclusion of the discharge water passage is based on the complexity of the passage and should be decided in earlier design documents.

****

Allow government access for witness testing upon request. [Provide means for remote witness test upon Government request.]

[Performance of [the] [each size] pump to be furnished will be accepted on the basis of the factory test. Conduct this test using either a scale model of [pump or first pump produced for this contract.] [each size of pump or one of each size of pump produced for this contract.] [Perform cavitation testing in accordance with HI ANSI/HI 14.6][NPSH testing is not required].

][Determine the performance and cavitation limits of the proposed pump [and the shape of the discharge water passage] by a series of tests made on a scale model of the pump[and discharge water passage]. Complete the model test within [180] [240] days after the date of notice to proceed.

][2.9.4.2 Test Setup

****

NOTE: Select the appropriate alternate paragraph. First paragraph, Alternate 1; second paragraph, Alternate 2.

If an FSI is used that does not use the dimensions/ratios as furnished by the Government, a complete pump should be tested.

****

[Alternate 1) [A model pump, if used, must be homologous to the proposed prototype pump, installed with the shaft in the vertical position, and have an impeller inlet diameter of not less than 275 mm 11 inches. Complete the model test within [150] [180] days after date of notice of award. Include a model of the[[sump] [including sump closure gate] [and discharge water passage]] [[Contractor's standard sump] [and discharge water passage]].[Install a model of the formed suction intake (FSI) specified on the model pump that is tested.]

[Prototype Pump(s) - Set prototype (first pump built) pump(s), if selected, with the shaft in the vertical position. A factory test elbow may be used in lieu of the prototype elbow for testing purposes, providing test results are adjusted to reflect the difference in losses. Complete tests prior to assembling any pump except the [one] [ones] to be tested. (Install the FSI specified on the prototype pump that is tested.)]]]

[Alternate 2) [The model pump must be homologous to the proposed prototype pump, and mounted with the shaft in the vertical position.[Equip the sump where the pump suction occurs with windows strategically located for viewing those areas where separation is likely to occur. Windows may be rings of transparent material approximately 100 to 125 mm 4 to 5 inches wide securely anchored between flanges.] The impeller inlet diameter and the datum for this test specification must be as indicated on Figure 3 at the end of this section. The inlet diameter must be not less than 275 mm 11 inches.[If a formed suction intake (FSI) is specified for the pump, include the complete FSI, including the [gate][bulkhead] slot, in the model test.] The FSI used in the model test must be geometrically the same as that used for the proposed pump.]]

****

NOTE: Delete paragraph below. if Alternate 2, above, is selected.

****

][2.9.4.3 Instrumentation and Procedures

In the test report describe each instrument to be used in the tests in detail, giving all data applicable, such as manufacturer's name, type, model number, certified accuracy, coefficient, ratios, specific gravity of manometer fluid to be used, and smallest scale division. Provide calibration data on each of the instruments used. When necessary for clarity, include a sketch of the instrument or instrument arrangement. Include fully detailed narrative description of each proposed method of instrumentation, procedures to be used, and a sample set of computations. State the lowest equivalent static head that is obtainable with the testing when operating along the head-capacity curve of the proposed pump. Perform test procedures, except as specified, in accordance with applicable provisions of HI ANSI/HI 14.6.

2.9.4.3.1 Head Measurements

Make head measurements using either a direct reading water column, mercury-air, mercury-water, a Meriam fluid manometer, or a pressure transducer. Measure vacuums with either a mercury-air manometer, a mercury-water manometer, or a pressure transducer. Dampen fluctuations sufficiently to permit column gages or a differential pressure transducer to be read to either closest 2 mm 0.01 foot of water or Meriam fluid or 2 mm 0.1 inch of mercury. Use manometers as indicated by ISA RP2.1. When pressure transducers are used, check their accuracy with a manometer.

2.9.4.3.2 Capacity

Determine capacity by a calibrated venturi flowmeter or long-radius ASME flow nozzle. Do not use orifice plates. Connect the venturi or nozzle taps to the column gages equipped with dampening devices that permits differential head to be determined to either the closest 2 mm 0.01 foot of water or Meriam fluid or 2 mm 0.1 inch of mercury. Magnetic flowmeters and flowmeters utilizing ultrasonic flow measurements will be acceptable if calibration of flowmeter has been completed within the last 6 months.

2.9.4.3.3 Rotational Speed of Pump

Measure the rotational speed of the pump in accordance with "Method of Rotary Speed Movement" in HI ANSI/HI 14.6, except that revolution counters cannot be used. Non-contacting hand-held electronic tachometers are acceptable. The device used must permit the speed to be determined to 1 rpm.

2.9.4.3.4 Power Input

Measure power input to the pump in accordance with "Power Measurements" in HI ANSI/HI 14.6. Use a method to permit pump brake wattage horsepower to be determined to the closest 0.5 kW 0.5 horsepower.

2.9.4.3.5 Cavitation Tests

****

NOTE: Alternate 2.

****

Use instruments suited for cavitation testing. However, do not use instruments that yield results less accurate than those obtained with the performance test. {may not be applicable in some situations, for instance very high head.}

2.9.4.3.6 Mechanical Tests

****

NOTE: This mechanical test is highly involved and should only be used in specific circumstances of newly designed or custom pumps.

****

Take vibration measurements of the assembled pumping units per HI ANSI/HI 14.6.

][2.9.4.4 Pump Test

****

NOTE: Tolerance Bands
The designer may use AISI/HI 14.6 to specify different testing tolerance bands based on size and application of specified pumps.

****

Demonstrate that the proposed pump complies with the specified performance. The pump must be capable of operation without instability over the entire range of heads specified in paragraph CAPACITIES. Tolerances must be in accordance with HI requirements. Instability is defined, for this specification, as when one or more of the following conditions occur:

a. the pump has two or more flow rates at the same total head;

b. The head-capacity curve has a dip (region on curve where change in flow rate produces an abnormally low head);

c. When any point in the usable range of head-capacity curve cannot be repeated within 3 percent.

Rerun the test if this occurs. Compliance with specifications will be determined from curves required by paragraph TEST RESULTS. Test procedures, except as specified, must be in accordance with applicable provisions of HI ANSI/HI 14.6. The acceptance grade is 1U as described in HI ANSI/HI 14.6. [Pumps are acceptable is they achieve the guarantee point requirements stated in paragraph CAPACITIES.] Use water at approximately the same temperature for all tests run and record the temperature during test runs.

][2.9.4.5 Motor, Cables, and Controller Test

Test the pump motor per NETA ATS. For induction motors use NETA ATS 7.15.1. For Synchronous motors use NETA ATS 7.15.2.

][2.9.4.6 Test Procedure

****

NOTE: The suction water elevation is that level indicated in paragraph CAPACITIES.

****

2.9.4.6.1 Performance of The Pump

Determine the performance of the pump by a series of test points sufficient in number to develop a constant-speed curve over the range of total heads corresponding to the [static] [pool-to-pool] [bowl] heads in paragraph CAPACITIES. The performance/test range must include additional testing at total heads 600 mm 2 feet higher than the total head determined in paragraph CAPACITIES. The lowest total head for testing must be, as a minimum, the total head determined from paragraph CAPACITIES. If the test setup permits testing at lower total heads, extend the range of total heads 600 mm 2 feet lower. Testing must be inclusive for [each] [the] speed(s) involved with the sump at elevation[s] [_____] [and [_____] NGVD feet]. Conduct tests using prototype [total] [pool-to-pool] heads. Head differentials between adjacent test points cannot exceed 900 mm 3 feet, but in no case may fewer than 10 points be plotted in the pumping range. If the plot of the data indicates a possibility of instability or dip in the head-versus-capacity curve, a sufficient number of additional points on either side of instability must be made to clearly define the head-capacity characteristics. When a scale model of the pump is tested, consider the efficiency of the prototype pump to be the efficiency of the model. No other computation or adjustment of model efficiency to prototype conditions will be permitted.

2.9.4.6.2 Sump Elevations

Conduct tests at two different sump elevations (approximately a 1500 mm 5 foot differential) to determine the effect of test sump geometry on the performance of the pump. Should the test results indicate that the performance is not the same in all respects for both sump conditions, take whatever corrective action is necessary to produce congruent results.[One of the two sump elevations used may be at the specified elevation.] [Use the sump elevations specified in paragraph CAPACITIES.] The test results with this sump elevation must meet all specified conditions of capacity, head, and brake kW horsepower. {Submit} curves indicating test results.

2.9.4.6.3 Tests Results

Plot results of tests to show total head, [[static] [pool-to-pool] [bowl] heads], brake kW horsepower and efficiency as ordinates; all plotted against pump discharge as the abscissa. Plot curves showing prototype performance to a scale that will permit reading head directly to [60] [150] mm [0.2] [0.5] foot, capacity to [190] [380] [760] [1900] L/min [50] [100] [200] [500] gpm, [0.14] [0.28] [1.4] m^3/s [5] [10] [50] cfs, efficiency to 1 percent, and power input to [3.7] [7.5] [18.6] [37.2] kW [5] [10] [25] [50] horsepower.

2.9.4.6.4 Demonstration

Demonstrate to the Contracting Officer that the blade templates fit the tested pump. Perform the demonstration immediately after testing is completed. Retain all templates for the tested pump, and provide them to the Government upon request of the Contracting Officer, to permit the Government to verify geometric similarity with the Contractor's pump. In addition to providing templates, submit dimensioned drawings of the impeller that contain all dimensions needed to manufacture it. Stamp the tested impeller with identification marks. Provide necessary facilities and instruments needed to permit the Government to verify that pump[s] [is] [are] in complete geometric similarity with the tested pump.

][2.9.4.7 Cavitation Tests

****

NOTE: Alternate 2.

****

2.9.4.7.1 Model Test

The model test must include the determination of net positive suction head required (NPSHR) at five or more points on [the constant speed curve][each constant speed curve when more than one speed is involved]. Determine NPSHR, as a minimum, for five or more capacities corresponding to prototype capacities over the total range of specified operating conditions. If the pump has a capacity greater than that specified for the lowest and/or highest operating condition, then use these over-capacity conditions. Equally space the other test capacity points between the highest and lowest capacities.

2.9.4.7.2 NPSHR

Determine NPSHR on a constant-capacity, constant-speed basis, using arrangement Figure F.3 or F.4 as described under paragraph NET POSITIVE SUCTION HEAD REQUIRED TEST in HI ANSI/HI 14.6. Vary suction conditions to produce cavitation. NPSHR must be the maximum value at which any one or all of the plotted curves, head, kW horsepower, and efficiency depart from the constant values (point of tangency). Obtain a sufficient number of points to accurately locate the departure point.

2.9.4.7.3 Value of NPSHR

****

NOTE: The amount head margin used to determine adequacy of NPSHR is determined during the design of the pumping station as indicated in Engineering Manual EM 1110-2-3105.

****

The value of NPSHR must be [300] [600] [900] mm [1] [2] [3] feet less than the corresponding available net positive suction head available (NPSHA). Determine NPSHA using the temperature of the water in the model at the time the tests are run and the datum shown on Figure 3 at the end of this section. Use the water elevations specified in paragraph CAPACITIES to determine the NPSHA for the pumps.

2.9.4.7.4 Plotting Test Results

Plot the test results to the scales determined by the Contracting Officer at the time of the test. Draw curves showing [static] [pool-to-pool] [total] head, brake kW horsepower, and [pool-to-pool] efficiency as ordinates and NPSH as the abscissa. In addition, draw curves showing NPSHR versus capacity with NPSH as the ordinate and capacity as the abscissa.

Show NPSHA points on the curves.

2.9.4.7.5 Curves

Should it be considered necessary by the Contractor to take into account measurement inaccuracies when drawing the curve needed to determine NPSHR in accordance with paragraph NPSHR, use the following method. No other method is acceptable. Determine the inaccuracy for each parameter, and submit the calculations to the Contracting Officer for approval. Using the calculated inaccuracy as the radius and the test point as the center, draw a circle for each test point. Draw two curves, one a maximum and the other a minimum, and pass through or touch each circle. The maximum curve must touch the top and the minimum curve must touch the bottom of as many circles as is practicable while maintaining smooth curves. Should the plot indicate that a test point is obviously erroneous, it may be ignored by mutual consent or the test may be rerun. Halfway between the maximum and minimum curves, draw another curve (the mean). The point at which the mean curve departs from the constant values (point of tangency) is considered to be the NPSHR of the pump for the capacity at which the test was run.

][2.9.5 Intake Tests

****

NOTE: Delete this paragraph if a model test of the intake to the pumping system(s) is not required.

****

Provide complete performance model testing of the pump intake systems. Use the model testing to confirm the configuration of the intake systems, including the proposed intake conduit, hydraulic losses to the pump, the position of the pump in the intake bay, and to confirm the selection of the pump. The Contracting Officer will witness the final tests confirming the geometry for the intake conduit. Notify the Contracting Officer with not less than 14 days written notice of the time and location for the final tests.

2.9.5.1 Qualifications

Perform the modeling work in a hydraulic laboratory located within the United States where this type of work has been performed for a period of at least ten years. The individual in responsible charge of the modeling work must be a registered professional engineer in the U.S. state where the model testing will be performed with at least ten years' experience in pump and intake modeling work for similar projects. The engineer must seal and sign all reports and data documents generated as a part of the test work prior to submitting them.

2.9.5.2 Intake Model Setup and Objectives

The model intake setup must be of the intake system, custom designed for this installation and suitable for operation at atmospheric pressure for observation of the intake basin performance. The intake model must be suitable for use with a model pump. Use clean and clear water for the test to allow proper observation. The temperature of the water during any test cannot exceed 30 degrees C 85 degrees F.[For the FSI, provide a setup to determine flow patterns in the suction basin approaching the intake, along with losses to the pump. Provide further tests to identify flow patterns in the intake itself and approach patterns at the entrance to the pump.]

In the intake model, include all items in the intake path, including, but not limited to: models of the trash rack, stoplog slots, access ladders, and the stilling wells in the intake bays.

2.9.5.3 Intake Model Tests

The objective of the modeling work is to define the performance of the proposed pumping unit and to confirm the geometry to be used for the pump intake. The model must have a model-to-prototype Froude number ratio of 1, based upon the pump impeller diameter. Arrange the model in the same relative orientation as the prototype structure and include the bay configuration and screening system. Perform all testing with the same model.[

Intake Tests: For the formed suction intake geometry shown on the drawings, use the model setup to determine flow characteristics in the suction basin intake bay and at the entrance to the FSI at all specified operating conditions. In addition, use the model to determine the effect of the intake system on pump operating characteristics. Use a siphon generated by a separate pump to examine flow characteristics in the intake bay using Froude relationships to model intake operation in the first set of tests. Use second test to develop information on the effect of the intake on pump operation. Use these values to forecast the performance of the pump-intake conduit combination.]

[Alternate Intake Geometry: If an intake geometry differing from that indicated is proposed, or other modifications such as baffling, test the proposed intake and/or modifications to demonstrate its suitability for use in the project and compliance with Appendix I in EM 1110-2-3105. For that reason, design the laboratory setup specifically to monitor free and sub-surface vortices, swirl and pre-rotation approaching the pump impeller, flow separation at hydraulic surfaces in the intake conduit and at the hydraulic surfaces approaching the pump impeller, and axial velocity distribution at the entrance to the impeller.]

a. The intake conduit and pump inlet must contain several clear windows and similar appurtenances and adequate lighting at all critical areas to allow visual determination of the presence of vortices, turbulence, and other defects. Make provisions to insert dye at intervals in the intake conduit and at the entrance to the impeller during operation of the test. Reynolds and Weber numbers for all model runs must be greater than 30,000 and 120, respectively. The Contractor must develop scale factors for velocity, flow, and time for use in evaluation of model results. Scale factors are subject to review by the Contracting Officer. In addition to model runs at all specified operating conditions, conduct no fewer than five runs at 1.5 times Froude-scaled flows after final geometrics for the intake conduit and intake bays have been established, keeping the submergences at the geometrically scaled values. Track and document circulation contributing to development of vortices.

b. Determine vortex formation in the model every 15 seconds extending over a period of 10 minutes. Classify vortices in accordance with the strength classification system in HI ANSI/HI 9.8 for both surface and subsurface vortices, using dye wand injection to assist in classification. The Contractor must provide both photographic and video documentation of vortex formation. Direct particular attention to subsurface vortex formation at the intake conduit entrance and on intake conduit surfaces leading to the impeller entrance.

c. Provide a swirl meter or other satisfactory device to determine liquid rotation (swirl) at the entrance to the impeller. Obtain swirl readings at intervals of 20 seconds for a period of not less than 10 minutes after the model has achieved steady-state operation at any specified operating condition. Swirl angle is defined by the relationship:

(1) swirl angle = (1/(tan))(pi*d*n)÷ u

Where:
u = average axial velocity at the swirl meter.
d = diameter of the conduit at the swirl meter.
n = revolutions/second at the swirl meter.

d. Headloss Measurements: Measure headloss from the upstream model boundary to just upstream of the pump inlet for each documentation test and include a minimum of the following conditions:

Pump No.	Avg On/Off El. (m) (feet)	Individual Pump Q (cubic m per second) (fps)	Total Pump Q (cubic m per second) (fps)

****

NOTE: Provide an expected order of pump operations and expected intake elevations at start-up for each pump.

****

e. Also record the head loss from just upstream of the FSI to the throat of one model pump for a minimum of 10 flow rates after the model Euler number is determined to be constant and at least one point (near the middle of the data) must be within 2 percent of the scaled rated flow of the pump. Measure head loss with a differential manometer or differential stilling basin. Install a minimum of four pressure taps around the pump throat measurement point and joined to form an average pressure reading. Calculate a dimensionless head loss coefficient for the formed inlet that includes the entrance loss into the formed inlet.

f. Determine the velocity profile in the channel cross section approaching the intake and performing the velocity traverses on perpendicular axes at the intake throat, just upstream from the impeller. Velocity measurement instruments must be capable of an accuracy of plus or minus 2 percent.

g. Use the following as criteria for acceptance of the proposed design:

(1) Free surface and sub-surface vortices entering the pump intake must be less severe than Type 1, as defined in HI ANSI/HI 9.8, unless dye core vortices appear for less than 10 percent of the time or only for pump operating conditions that are expected to be infrequent, such as the listed maximum or minimum operating conditions.

(2) Swirl angles, both maximum and average, indicated by swirl meter readings, must be less than 5 degrees. Swirl angles as great as 7 degrees will be accepted if occurring less than 10 percent of the

time or for operating conditions that are expected to be infrequent, such as the listed maximum or minimum operating conditions.

(3) Velocities at points of equal radii at the throat of the intake conduit must be within 10 percent of each other.

(4) Determine NPSHR on the basis of a one percent reduction of efficiency.

(5) Time-varying velocity fluctuation (turbulence) levels as defined by a standard deviation over average velocity at a point within the pump throat must be less than 10 percent.

h. Unless otherwise specified, conform accuracy of all measurements to the levels established in HI ANSI/HI 14.6.

2.9.5.4 Recommendations from the Model Test

If the results of the intake model testing indicate that any features of the design are deficient, report this to the Contracting Officer in writing immediately. If the intake modeler has recommendation for improving the flows in the pumps, provide them in the Intake Model Test Report. Flag these as important information that requires the Contracting Officer's immediate attention. Note all recommendations considered major changes. provide any minor recommended changes to the intake as variations in the shop drawings.

]2.10 PUMP DRAINAGE

Provide drain holes for all parts of the pump to eliminate trapped water. These drain provisions must be self-draining without any requirement to enter the sump.

2.11 WITNESS TEST

****

NOTE: The time to review test data should be 2 weeks. Longer times may be used when the District has staffing difficulties or special arrangements are required to have data reviewed by others. The shortest period is preferred since this may permit the pump tested to remain in place during the review period. If the pump/test instruments are not moved, then the possibility of changes to the test results for the witness test are less likely to occur. The cost of the tests would be less also.

****

When the Contractor is satisfied that the tested pump performs in accordance with the requirements of the specifications and the guaranteed values, notify the Contracting Officer that the witness tests are ready to be run and provide copies of the curves required in paragraph PUMP TESTING [and paragraphs under CAVITATION TESTS] along with a set of sample calculations with constants and conversion factors. Also, provide instrument calibration data in this report. [Two] [Three] [Four] weeks will be required to review this data before the Contracting Officer will be available to visit the Contractor's laboratory for witnessing the test. Should the results of the witness test reveal that the tested pump does not perform in accordance with the requirements of the specification and the guaranteed values, make such changes as are required to make it acceptable before again notifying the Contracting Officer that the witness tests are ready to be run. Immediately upon completion of each witness test, submit copies of all data taken during the test to the Contracting Officer witnessing the test. Furnish computations of test results and plotted preliminary curves to the witness.

2.12 CERTIFIED TEST REPORT

****

NOTE: The certified test report is appropriate when testing required under the contract was of the general requirements outlined in HI 14.6 and pumps are of a common conventional type.

****

Submit Contractor's pump manufacturer certified completed test report stating the specified pumps meet HI ANSI/HI 14.6 after testing is complete.

[2.13 TEST REPORT

****

NOTE: This section is not necessary if Contractor's pump fabricator is required to provide a certified test report.

Require this more detailed report when more custom and specific testing was outlined in the specifications.

If used, delete item "o" if water passage is not included in the contract.

****

Submit, in accordance with HI ANSI/HI 14.6, and within 30 days of receipt of approval of the witness test, to Government [3] [4] [7] [hard bound] [digital] copies of a report covering completely the test setup and performance[and cavitation] tests. Include, as a minimum, the following in each test report:

a. Provide a statement of the purpose of the test, the name of the project, contract number, and design conditions. Also provide where guaranteed values differ from specified values.

b. A resume of preliminary studies, if such studies were made.

c. A description of the test pump and motor, including serial numbers, if available. Information required under "b" may be included here.

d. A description of the test procedure used, including dates, test personnel, any retest events, and witness test data.

e. A list of all test instruments with model numbers and serial numbers.

f. Sample computations (complete).

g. A discussion of test results.

h. Conclusions.

i. Photographic evidence in the form of either multiple color photographs of test equipment, test setup, and representative test segments, and a digital recording on optical disc, at least 30 minutes in length, covering the same information as photographs. Label all photographic evidence with the Contract number, location, date/time, and test activity. Voice annotate the digital recording with the same information.

j. Copies of instrument calibration.

k. Copies of all recorded test data.

l. Curves required by paragraph TESTS RESULTS.

m. Curves showing the performance of the test pump.

n. Drawings of the test setup showing all pertinent dimensions and elevations and a detailed dimensioned cross section of the pump.

[o. Drawings including cross sections of water passages that must be incorporated in the construction contract.

] p. The name and credentials of the Contractor's Erecting Engineer(s) who was(were) responsible for the pump testing.

]PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: Designers should be come familiar with API RP 686 so details can be specified appropriatly.

****

Install the [soleplate and] baseplate in accordance with API RP 686. Provide [leveling nuts][jacking bolts] for leveling the baseplate assembly. Provide an anchor bolt layout to aid in placement of anchor bolts.[Back off all leveling jacking bolts after grouting so that they do not support any of the load.] The pedestal supporting the [motor][right-angle reduction gear] must contain a 25 mm 1-inch lip to contain water leakage from the shaft packing. Provide a threaded drain to the sump.

3.1.1 Equipment

a. Install the equipment specified under this section and related drive machinery specified under other sections of this specification in accordance with the approved Installation and Erection Instructions Manual; no later than time of pump delivery, submit a typed or printed, and bound, [digital] manual describing procedures to be followed by the erecting engineer in erecting, assembling, installing, and dry-and wet-testing the pump. To the extent necessary or desirable, coordinate and consolidate description of the pump with similar descriptions specified for the [gear reducer and diesel engine] [motor] [gear reducer].

(1) The description must be a complete, orderly, step-by-step explanation of operations required, and also include such things as alignment procedures, bolt torque values, permissible blade/bowl clearances; permissible bowl out-of-roundness; permissible shaft misalignment; recommended instrument setups; recommended gages and instruments; bearing clearances; and similar details.

(2) Complement and supplement the description with drawings, sketches, photos, and similar materials to whatever extent necessary or desirable, resulting in a description that may be comprehended by an engineer or mechanic without extensive experience in erecting or installing pumps of this type.

b. The Contractor's erection engineer(s), familiar with the equipment to be installed, must supervise the handling, installation, start-up and testing of the equipment as required by paragraph QUALITY ASSURANCE.

c. Submit [digital] copies of Operation and Maintenance Instructions Manual containing complete information on operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, reassembly, and trouble diagnostics for the pump and auxiliary units. [Print the operation and maintenance manual and both parts lists on good quality ANSI size A 216 by 280 mm 8-1/2 by 11-inch paper, bound separately between flexible, durable covers.] [Provide the operation and maintenance manual and both parts lists on optical disc, formatted to print on ANSI size A 216 by 280 mm 8-1/2 by 11-inch paper.] Drawings incorporated in manual or parts lists, may be reduced to page size provided they are clear and legible[, or may be folded into the manual to page size]. Photographs or catalog cuts of components may be included for identification. [Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.]

3.1.2 Pipes and Joints

Install pipes and joints in accordance with AWWA M11.

3.2 FIELD TESTS

****

NOTE: Select appropriate bracketed statement. Different projects will have different site conditions to perform these field tests. It's likely that many projects will be accepted outside of flood conditions with very little water available for a long term test run. Edit these testing requirements carefully and account for the anticipated field conditions.

****

After the pumping unit is installed and prior to start-up, completely clean the sump area of any accumulated construction debris. Once final cleaning of the sump area is completed, the area will be area reviewed by a representative of the Government. Correct any damage to the pumping units or related equipment during initial start-up due to foreign objects left in the sump areas.

Prior to proceeding with construction of the [test setup but not later than [60] [90] days after date of notice to proceed, submit a description of the test setup and test procedure proposed. Include dimensioned drawings and cross-sectional views of the setup and pump, respectively, with location of instruments and points of their connection shown.] [model, but not later than 90 days after the date of notice to proceed, submit a description of the proposed model and test procedure. Include dimensioned drawings and cross-sectional views of the model pump showing with the location of all instruments and the point of their connection to the model.]

3.2.1 Dry Tests

****

NOTE: Specify an operating field test duration which is reasonable. This could be as little as 15-30 minutes, or as much as a few hours. All three tests below give you confidence that your pump will operate as designed in its installed location. Whenever possible a combination of both field tests should be performed, even if it it limited.

• Factory Test (shop or model)
PRO - captures the actual design points while pumping
CON - pump not captured in final installed location (in situ per ISO), but rather on a pump stand that is perfectly level and rigidly supported

• Field Dry Test
PRO - isolates the pump assembly in the installed location (in situ)
CON - could face limited test time due to cooling issues with the lack of pump medium (bearings, keel coolers, etc.) thus have higher bearing temps; no hydrodynamic load

• Field Wet Test
PRO - hydrodynamic load present; pump medium available for cooling
CON - not likely pumping at design points, so possible to have some cavitation; could have less test time due to limited water in the intake canal.

Dry tests cannot be conducted on pumps that are lubricated with product water.

****

Test each pumping unit, consisting of a pump [and motor] [and gear reducer] [right-angle gear reducer, and diesel engine] in the dry to determine whether it has been properly erected and connected. [Conduct such test when, and as, directed by Contracting Officer.] [After each pumping unit has been completely assembled, including all rotating elements and the lubrication system, operate at the full rated speed for [15 minutes][30 minutes][a period of 1 hour][three 15 minute periods][a period of 2 hours], to assure proper alignment and satisfactory operation.] Submit field test results.

[a. Take vibration measurements in accordance with HI 9.6.4. Vibration limits cannot exceed those recommended by HI Figure 9.6.4.2.5.1b. If it is not possible to operate the pump at its best efficiency point, vibration limits may be adjusted in accordance with the requirements of the stated standard.

][b. Operate each pumping unit at full-rated speed until the temperature rate of rise has stabilized for all bearings. Consider the bearings' temperature stabilized when the rate of rise does not exceed 0.5 degree Celsius in five minutes 1 degree Fahrenheit in five minutes [[_____] degree(s) [_____] in [_____] minutes].

][c. Repeat the dry test run if it is necessary to interrupt the test before all bearing temperatures have become stable. [If after a run of reasonable duration][If after a test run of [_____] hours] the temperature rate of rise for any bearing has not stabilized, terminate the test until the cause of overheating is determined and corrections are made. Then repeat the dry test run. Should tests reveal that there is a design deficiency or a manufacturing error in the pumping unit components, promptly correct the problem.

][d. Perform testing in accordance with ISO 20816-3]

3.2.2 Wet Tests

****

NOTE: The longest period should be used if water for testing will be available. The estimated water available and the number of pumps requiring tests should be considered when specifying length of tests. Sound testing, if required would only establish a base line for future reference. Consult HI 9.1-9.9.

****

Test each pump unit under load, at or near normal operating conditions, for at least [_____] hours or as directed by the Contracting Officer; the test will be witnessed by the Government. Provide all supplies and equipment required to conduct the test. During the test observe, measure and record the operation of the pumps during the test for[sound,] vibration and bearing temperatures in accordance with [HI 9.6.4][ISO 10816-3]. Submit field test results. Without additional costs to the Government, make all changes and correct any errors. The Contracting Officer may waive or postpone the test if sufficient water is not available.

SYSTEM LOSS CURVE

(DESIGNER TO PROVIDE THIS

FIGURE WHEN CONTRACT

IS PREPARED)

FIGURE 1

BEARING RTD INSTALLATION

FIGURE 2

AXIAL FLOW PUMP
AND
MIXED FLOW PUMP

FIGURE 3

NOTE: Figures 2 and 3 exist as a PDF file located at

http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-ta
for download.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 45 02.00 10 (May 2021)**
Change 1 - 08/23

Preparing Activity: USACE **Superseding**
UFGS-35 45 02.00 10 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 35 45 02.00 10

SUBMERSIBLE PUMP, AXIAL-FLOW AND MIXED-FLOW TYPE

05/21, CHG 1: 08/23

****

NOTE: This guide specification covers the requirement for submersible axial-flow and mixed-flow pumps for a turbid water pumping station. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification is for use in construction contracts. It may be used in supply contracts, but should be changed as appropriate. Differences between the technical paragraphs written for Contractor-supplied pumps versus Corps supply specification should be minimal.

This pump specification will be used with the design criteria in EM 1110-2-3105, "Mechanical and Electrical Design of Pumping Stations", and the references listed in those publications. To the extent possible the Hydraulic Institute (HI)

Standards have been referenced as the primary reference standard, and the minimum for manufacturers' compliance, for the manufacture, material, design, test, and performance specifications. The vibration analysis often required of pumps is eliminated and a vibration limit specified.

Hydraulic Institute (HI) Standards have been referenced as the primary reference standard, and the minimum for manufacturers' compliance, for the manufacture, material, design, test, and performance specifications. The vibration analysis often required of pumps is eliminated and a vibration limit specified.

Pertinent HI standards are:

HI/ANSI 9.1-9.5	**General Design**
HI/ANSI 9.6.4	**Vibration Analysis**
HI/ANSI 11.6	**Testing**
HI/ANSI 14.1-14.2	**Nomenclature and Definitions**
HI/ANSI 14.3	**Design and Application**

The pumps are of the pre-engineered (catalog) type, used at flood control and storm water projects. Over specifying can prove costly and even double the cost of an otherwise inexpensive pump. In general, the two most important attributes to a successful specification will be to obtain a qualified, experienced manufacturer and to properly specify the pumping conditions so that the correct pump is obtained.

Model testing is not included as an alternative for these pumps. Manufacturers assemble and performance test the pumps at the factory. The pumps are shipped assembled.

Witness tests and factory visits have been limited to one visit during the performance test and a pump inspection at the time of the test.

****

1.1 SUMMARY

****

NOTES: Insert the name of the Pumping Station.

The other elements of the pumping unit designed for this project should be stated; e.g., electric submersible motor, reduction gear (if needed), and controls.

Coordinate the bar spacing in the trash rack with the structural designer and with pump manufacturers.

The planetary gear reduction unit, on rare occasion, may be required in the larger volume propeller pumps

such that a smaller, high-speed motor can be used. The design of the gear is an integral part of the design of the pumping unit.

Axial and mixed flow pumps are well suited for higher flow and lower head applications. Centrifugal pumps should be considered for higher pressure applications or where larger passing of solids is needed.

****

Design, furnish, and install [_____] identical pumping units for the [_____] Pumping Station shown. Water pumped will be less than [_____] degrees C F, will be relatively turbid, and may contain sand, silt, and trash capable of passing the trashrack [having 41 mm 1-5/8 inch clear openings].

1.2   LUMP SUM PRICE

a. Payment will be made for costs associated with [furnishing] [furnishing and installing] [installing] the submersible pump, axial-flow or mixed-flow type, as specified.

b. Unit of measure: lump sum.

1.3   REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B4.1	(1967; R 1994; R 2004; R 2009; R 2020) Preferred Limits and Fits for Cylindrical Parts
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.1	(2024) Power Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C207	(2023) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C208	(2022) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA E102	(2017) Submersible Vertical Turbine Pumps

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A242/A242M	(2024) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A297/A297M	(2021a) Standard Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A576	(2023) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A582/A582M	(2022) Standard Specification for Free-Machining Stainless Steel Bars
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM A890/A890M	(2018) Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application
ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B148	(2024) Standard Specification for Aluminum-Bronze Sand Castings

ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM F1476	(2007; R 2024) Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

HYDRAULIC INSTITUTE (HI)

HI 9.1-9.5	(2021) Pumps General Guidelines for Materials, Sound Testing, and Decontamination - B117
HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 9.8	(2014) Rotodynamic Pumps for Pump Intake Design - A123
HI ANSI/HI 11.6	(2016) Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests
HI ANSI/HI 14.1-14.2	(2019) Rotodynamic Pumps for Nomenclature and Definitions
HI ANSI/HI 14.3	(2019) Rotodynamic Pumps for Design and Application

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances
ISO 20816-1	(2016) Mechanical Vibration - Measurement and Evaluation of Machine Vibration - Part 1: General Guidelines

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or

	Less for the Distribution of Electrical Energy
NEMA WC 72	(1999; R 2020) Continuity of Coating Testing for Electrical Conductors

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-3105	(2020) Engineering and Design -- Mechanical and Electrical Design of Pump Stations

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Pump Supplier Qualifications; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Equipment; G, [_____]

Spare Parts

Installation Instruction Manual; G, [_____]

Impeller Balancing

Factory Tests

Pump Field Tests; G, [_____]

General Design Requirements; G, [_____]

Paint

Environmentally Acceptable Lubricant; G[, [_____]]

Materials; G, [_____]

SD-05 Design Data

Computations; G, [_____]

SD-06 Test Reports

Factory Test Report

Intake Model Tests

Field Test Report

Contractor's Installation and Start-Up Engineer

Installation Report

Intake Model Test Report; G, [_____]

SD-07 Certificates

Qualified Welders

Contractor's Modeling Engineer Qualifications; G, [_____]

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Contractor's Pump Supplier Qualifications

****

NOTE: Submersible pumps are designed as a single machine even though specifications may not always recognize that unity. Clearly state that a single manufacturer is to design and supply all parts of the pump unit including pump, motor, discharge tube, reduction gear, and cables. That manufacturer should also have demonstrated capability in sump design for pumps of the larger size.

****

The Contractor's pump manufacturer has overall responsibility to supply the pumping unit (submersible pump/motor, [reducing gear (if needed)], discharge tube, [discharge elbow,] cables, and related [instrumentation and accessories]) that meet the requirements of this specification. Supply a list of similar installations which have been operating for at least 2 years.

1.5.2 Contractor's Installation and Start-up Engineer

Furnish a competent installation engineer (including those from Contractor's suppliers) who is knowledgeable and experienced with the installation and start-up procedures for submersible pumps and the associated equipment specified to act on behalf of the Contractor. Submit the installation and start-up engineer's qualifications. The Contractor's installation engineer is responsible for providing complete and correct direction during installation, initial starting, and subsequent operation of equipment until field tests are completed. The Contractor's installation engineer initiates instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment. Submit an installation report including a record of measurements taken during erection and furnish one copy to the Contracting Officer upon request or upon the completion of the installation of assembly or part. The erecting engineer conducts training on the operation and maintenance features of the pump units.

1.5.3 Detail Drawings

Submit drawings within [90] [_____] days of Notice of Award for review and approval. Dimension in the metric (SI) with English conversion inch-pound-second system. Furnish the following:

a. Outline drawings of the pump showing dimensions and weight of the pump/motor.

b. Drawings showing details and dimensions of pump mounting design and layout including any embedded items and lifting connections.

c. Cross-sectional drawings of each different size of pump, showing each component, and major or complicated sections of the pump in detail. On each drawing indicate an itemized list of components showing type, grade, class of material used, and make and model of the standard component used. Include detail and assembly drawings of entire pumping unit assembly.

d. Provide drawings covering the installation which are intended for the Contractor's installation engineer.

e. Indicate efficiency,kW bhp, and NPSHR with the capacity-head curve.

f. Motor characteristic curves or tabulated data (test or calculated) to indicate the speed, power factor, efficiency, current, and kilowatt input, all plotted or tabulated against percent load as abscissas.

1.5.4 Welding

Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING. For all other welding, qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the Contracting Officer 24 hours in advance of qualification tests. Perform the qualification tests at the work site if practical. The welder or welding operator must apply their assigned symbol near each weld made as a permanent record.

Submit the names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to.

1.6 DELIVERY, STORAGE, AND HANDLING

Inspect each pump for damage or other distress when received at the project site. Store each pump and associated equipment indoors as recommended by the pump manufacturer, protected from construction or weather hazards at the project site. Provide adequate short-term storage for each pump and equipment in a covered, dry, and ventilated location prior to installation. Follow the manufacturer's instructions for extended storage. Supply proper equipment for handling the pump and consider the equipment as special tools if not completely standard. Follow the manufacturer's recommendations for handling of the pump.

1.7 EXTRA MATERIALS

****

NOTE: The spare parts noted herein are from other Corps documents. For any specific project, it would be appropriate to discuss an adequate spare parts and spare pump list during the designer's plant visitations or discussions with the end user as suggested by EM 1110-2-3105.

****

a. Furnish the following spare parts:

(1) One complete set of bearings and seals for each size pump.
(2) Replacement wearing rings and O-rings for each size pump.
[(3) One impeller for each size pump.]

b. Furnish one set of all special tools required to completely assemble, disassemble, or maintain the pumps. Special tools refers to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items. Furnish lifting devices required for use in conjunction with the [overhead] [truck] crane. Provide the tools in a toolbox or toolboxes.

c. Submit copies of parts list showing all parts, spare parts, and bulletins for each pump. Clearly show all details, parts, and adequately describe parts or have proper identification marks. Provide the parts lists [on good quality 216 by 279 mm 8-1/2 by 11 inch paper][on optic disk with default letter print size of, 8-1/2 by 11 inch], bound separately from the Operation and Maintenance manual[with a flexible, durable cover]. Drawings incorporated in the parts lists may be reduced to page size provided they are clear and legible[, or they may be folded to page size and inserted into the bound lists]. Photographs or catalog cuts of components may be included for identification.

d. Provide [one][two][three][four] spare pumps as required.

1.8 WARRANTY

****

Consider including an extended or hourly based warranty for the pumping equipment if there is a likelihood that the pumping equipment will be operated very little during the first years due to a lack of water, ongoing interconnected projects, or permitting issues.

****

Provide a warranty for the submersible pumps and all equipment furnished under this section against defective workmanship, materials, design, and performance for a period of [_____] years from the date the equipment is accepted. If the equipment or any part thereof does not conform to these warranties, and the Government notifies the Contractor within a reasonable time after its discovery, the Contractor must promptly correct such nonconformity by repair or replacement. Coordinate the down time for the equipment with the Government, and keep to a minimum duration that is mutually agreed to by the Contractor and the Government. The Contractor is liable during the warranty period for the direct cost of removal of the equipment from the installed location, transportation to the Contractor's factory or service shop for repair and return, and reinstallation on site. The Contractor must be given the opportunity to perform the removal and reinstallation and to select the means of transportation. The expense of work required to perform warranty repair e.g., removing adjacent equipment, installing spare equipment, supplying temporary service is not included in this warranty provision.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

****

NOTE: The designer should include in this section those factors of the project design that relate to the specification of the pump. These are factors that will be data inputs to the manufacturer, and are examined during the pump selection procedure. The specifications as written are for water of normal chemistry and abrasive quality. The Contractor must be informed in the specification of

any unusual project conditions.
****

2.1.1 Pumping Unit Description

****
NOTE: Provide a pumping plant design that will accommodate the available pumps and their structural and hydraulic requirements. Pumps are designed to be contained in a discharge tube and able to be lifted from the discharge tube for maintenance and repair.
****

Each pumping unit includes a pump/motor, discharge tube, [discharge elbow], air vent, [lifting chain], cable, and controls. Each pump must be of the vertical, axial, or mixed-flow submersible type for [storm water,] [flood control,] [attached to the same shaft with a submersible electric motor] [direct coupled through a reducing gear to a submersible motor]. Use an electrically operated pump/motor installed in a discharge tube. Except as otherwise stated or noted, the terms pump and pump/motor both refer to a pump/motor integral unit.

2.1.2 Spare Pumps

Provide a total of [_____] spare pumps. Spare pumps must be identical to the other pumps provided under this contract. For the spare pumps only, access covers and the guide rail systems are not required. Tag and label spare pumps as spares.

2.1.3 Service Availability

The pumps furnished must be supported by a service organization. Service and parts must be available within [500] miles of the [_____] area. Provide this information in a shop drawing.

2.1.4 Pump Station Start-up Services

The installation and start-up engineer must be present at the installation for each location. Provide for two days on-site for each location. In addition, provide for two days for pump/motor start-up at each location.

2.1.5 Name Plates

Secure a name plate to each major item of equipment to include the manufacturer's name, address, type/style, model, serial number, and catalog number. Provide nameplates made of corrosion resisting metal with raised or depressed lettering on a contrasting colored background.

2.1.6 Instruction Plates

As necessary, equip each item of equipment with suitably installed instruction plates including warnings and cautions describing special and important procedures to be followed during starting, operating, and servicing the equipment. Provide plates made of corrosion resisting metal with raised or depressed lettering on a contrasting colored background.

[2.1.7 Factory Test Location

Factory testing facility must be in the continental United States. Submit the proposed testing facility as a shop drawing.

]2.1.8 General Design Requirements

a. Provide the pump meeting head, capacity, speed, efficiency, range of operation, cavitation, and vibration requirements as specified.[Reduction gears or adjustable impeller blades may be utilized to meet the specification performance requirements.]

b. Design the pump for runaway speed as calculated for the system shown and specified. Calculate the reverse speed assuming a power failure and the discharge valves fail to close.

c. The pump must, as a minimum, meet the applicable design, materials, and manufacturing requirements of HI 9.1-9.5, HI ANSI/HI 14.1-14.2, HI ANSI/HI 14.3, AWWA E102 and these specifications.

d. The pumping unit design and performance must have been demonstrated by previous successful operation of pumps of the required type and of equal design complexity by the Contractor.

e. Operate the pump in a discharge tube that fits within the dimensions shown, and so that installation and maintenance can be carried out by an [overhead bridge] [jib] [mobile] crane. The weight of the pump/motor integral unit must not exceed [_____] kg lb.

f. Design the pump for the calculated hydraulic pressure including a water hammer to which the pump parts are exposed.

g. The pump must have a continuously rising head characteristic with decreasing capacity over the required range of operation specified. The pump must not have an unstable operating characteristic over the required range of operation.

h. The pump must meet all requirements for net positive suction head required (NPSHR) and operate without surging.

i. Use associated pumping equipment including, but not limited to, electrical controls, instrumentation, [and pump control center] that is suitable for [indoor] [outdoor] operation.

[j. Include water hammer calculations.]

[2.1.9 Design of Discharge System

****

NOTE: A number of installation designs are possible depending on the project site conditions. The designer normally designs the discharge system but, has the option to allow the Contractor to design as much of the discharge system as desired. The calculations must be in accordance with EM 1110-2-3105, with the hydraulic definitions as stated in the HI standards. If used it is the designer's responsibility to develop FIGURE 1.

****

a. [Discharge the pumping unit into the discharge system indicated. The system loss curve is included as FIGURE 1 at the end of this section to permit determination of total head. Determine losses within the pumping unit.] [The pump discharge system downstream of the pumping unit must be designed by the pump manufacturer; of the type indicated and fitting within limiting dimensions and elevations indicated. Determine all losses for the discharge system and submit the design head loss computations. Provide sufficient hydraulic computations to substantiate pump selection and demonstrate that the selected pump will meet the project design and operating requirements as specified. Determine losses within the pumping unit.] [Discharge the pumping unit into the discharge chamber indicated. The system loss curve(s) furnished includes all losses beyond the pumping unit. Determine losseswithin the pumping unit.]

[b. Accomplish priming of the siphon without the assistance of vacuum equipment.]

]2.1.10 Operating Conditions

a. The pump must be capable of operating in the dry (for the purpose of maintenance and operating checks) for short periods of time as stated in the manufacturer's operating instruction.

b. The pump manufacturer establishes and states in the operating manual the procedures for starting and stopping the pumps, including setting of valves or any sequential operations.

2.1.11 Performance Requirements

a. The maximum level of vibration of the assembled pumping unit cannot be greater than the value of the lower limit of the good range of vibration severity per ISO 20816-1. Take measurements at pump operating speed during the Factory Test and the field start-up test.

b. The pump must be capable of operating without instability over the required range of head.

2.1.12 Capacities

****

NOTES: The Corps' policy and procedures for plant design and pump selection are explained in detail in EM 1110-2-3105. Using the data from hydrology and hydraulic studies, the designer will establish the performance requirements of the pumps. Using the manufacturers' catalogs that tabulate the characteristics of their pre-engineered units, select a pump. The designer should then locate other pumps with the described characteristic and establish contact with manufacturers.

Any pump selected results from careful analysis of the relationships of speed, net positive suction head (NPSH) (cavitation), head-capacity, range of plant operation, sump design requirement, and to a lesser extent, efficiency. During the selection process the manufacturer's input to the design is

obtained and integrated into the selection.

The specification will then state specific values to be attained so that a pump with the desired performance can be obtained. It is necessary to state the requirements so that more than one manufacturer can respond. All manufacturers must meet the previous experience and manufacturing standards requirements.

Compliance with the performance requirements will be established using procedures stated in the HI Standards and at the time when the pump is assembled and tested at the factory. Efficiency, heads, and other hydraulic values for purpose of specification should conform to HI definitions, even though Corps manuals are used for the purpose of design criteria.

Each pump installation will be uniquely different and may require a slightly different head-capacity specification to establish that the correct pump will be obtained. During the pump selection procedure, the designer will establish certain capacities that must be met over a range of heads. The designer may state more than one operating point on the performance curve or utilize different points on the curve such as rated head, design head best efficiency point (BEP), maximum head, and minimum head. The heads defined are as stated in EM 1110-2-3105 and applicable HI standards.

ANSI/HI 11.6 provides various acceptance grades for testing tolerances. In accordance with the standard, pumps smaller than 10 hp would have a greater tolerance band as defined in the standard, unless otherwise specified.

ANSI/HI 11.6 allows the option of either verifying the minimum pump efficiency, or verifying the maximum power input, but not both. The efficiency and power requirements would be for the guarantee point only unless otherwise stated. Also, the efficiency and power requirement would need to be defined if the units were a combined pump and motor unit, or just the pump. HI ANSI/HI 14.6 provides guidance for testing in Appendix D.

The selection of pumps for flood and storm water projects will not usually depend on the economics of efficiency. However, a low efficiency can usually be correlated with poor pump hydraulics resulting in a shortened pump life. Therefore, an efficiency relating to the values from the manufacturer's catalog curves should be specified.

****

a. The guarantee point is [_____] L/s gpm with a differential pressure of [_____] m ft. [The minimum pump and motor unit efficiency is [_____] m percent.] [The maximum power pump unit input power is [_____]kW hp.]

The tolerance band is HI ANSI/HI 11.6 class [1B][1E][1U][2B][2U][3B].

b. The pumps must continuously pump water without signs of distress, including cavitation, with a Net Positive Suction Head Available (NPSHA) of [_____] m ft.

2.1.13 Efficiency

****

NOTES: In the last bracketed option, specify the point at which the efficiency percentage should be reached.

****

The pump must have an efficiency of not less than [_____] percent at [_____].

2.1.14 Equipment

Submit, within 60 days of Notice of Award, a list of equipment as specified, catalog data, performance capacities, and other relevant information for the machinery and other equipment contemplated to be incorporated into the work.

2.2 METALWORK FABRICATION

****

NOTE: Refer to HI 9.1 and ANSI/AWWA E102 for design assistance with material selection.

****

Submit a list designating materials to be used for each pump part. If deviation from specified materials is desired, submit complete specifications for the proposed deviating materials after award of the contract.

[Provide materials and fabrication conforming to the requirements specified herein and to Section 08 31 00 ACCESS DOORS AND PANELS and Section 05 50 15 CIVIL WORKS FABRICATIONS and to additional specified requirements.] Classifications and grade of material incorporated in the work must be in accordance with designated specifications. Submit deviations from the specified materials in accordance with paragraph SUBMITTALS.

The materials of construction must comply with the following:

TABLE 1 - MATERIALS OF CONSTRUCTION

PART	MATERIAL
[Discharge Elbow] [Discharge Pipe]	[Cast iron] [cast steel] [chromium-nickel cast stainless steel] [duplex stainless steel] [super duplex stainless steel]
Surface Plate	[quality steel]

TABLE 1 - MATERIALS OF CONSTRUCTION	
PART	MATERIAL
Pipe Column	[Cast iron] [cast steel] [chromium-nickel cast stainless steel] [duplex stainless steel] [super duplex stainless steel]
Intermediate Bowl	[Cast iron] [cast steel] [chromium-nickel cast stainless steel] [duplex stainless steel] [super duplex stainless steel]
Impeller	[Cast iron] [aluminum bronze] [chromium-nickel cast stainless steel] [duplex stainless steel] [super duplex stainless steel]
Shaft	[Cold-rolled carbon steel] [stainless steel]
Wearing Ring	[aluminum bronze] [Manufacturer's standard]
O-rings	Nitrile rubber
Mechanical seal	Tungsten carbide

2.2.1 Designated Materials

Designated materials must conform to the following specifications, grades, and classifications.

MATERIALS	SPECIFICATION	GRADE, CLASS
Aluminum-Bronze	ASTM B148	Alloy No. C95500 Castings
Cast Iron	ASTM A48/A48M	Class 35B
Cast Steel	ASTM A216/A216M	WCB
Chromium-nickel Cast Stainless Steel	ASTM A743/A743M	CF-8, CF-8M or CN-7M
Coal Tar Protective Coatings	AWWA C203	
Cold-Rolled Steel Bars	ASTM A108	min, Wt. Strm 450 MPa 65,000 psi
Copper Alloy Castings	ASTM B584	Alloy No. C93700
Corrosion-Resistant Alloy Casting	ASTM A297/A297M	Grade CA-15, CAGNN and CF-8M

MATERIALS	SPECIFICATION	GRADE, CLASS
Dimensions for Steel Water Piping Fittings	AWWA C208	
Duplex Stainless Steel	ASTM A890/A890M	Grade 1B or 3A
Hot-Rolled Stainless	ASTM A576	Graded G10200, G10450, and G11410
Ring Flanges	AWWA C207	Class B
Rubber Products in Automotive Applications	ASTM D2000	
Seamless and Welded Austenitic Stainless Steel Pipe	ASTM A312/A312M	
Stainless Bars and Shapes	ASTM A276/A276M or ASTM A582/A582M	Grades S30400 and S41000
Steel Forging	ASTM A668/A668M	Class F
Steel Pipe 150 mm 6 inch and Larger	AWWA C200	
Steel Plates, Pressure Vessel	ASTM A516/A516M	Grade 55
Steel Plate	ASTM A242/A242M	
Stainless Steel Plate	ASTM A240/A240M	UNS S30400
Super Duplex Stainless Steel	ASTM A890/A890M	Grade 5A
Quality Steel	ASTM A36/A36M	
Surface Texture	ASME B46.1	

2.2.2 Bolted Connections

2.2.2.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers must conform to requirements herein specified and paragraphs SUBMERSIBLE PUMP, DISCHARGE TUBE [AND DISCHARGE ELBOW], and subparagraph, NUTS AND BOLTS for types required. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

2.2.2.2 Materials Not Specifically Described

Conform materials not specifically described to the latest ASTM specification or to other listed commercial specifications covering class or kinds of materials to be used.

2.2.2.3 Regular Bolt Holes

Holes for regular bolts must be drilled or sub-drilled and reamed in the shop. Holes must be accurately located, smooth, perpendicular to the member, and cylindrical.

2.2.2.4 Fitted Bolt Holes

Match ream or drill holes for fitted bolts in the shop. Holes must be smooth, perpendicular to the member, and cylindrical. Remove burrs resulting from reaming . The threads must be entirely outside of the holes. The body diameter of the bolt must have tolerances as recommended by ASME B4.1 for the class of fit required. Fitted bolts must be fitted in reamed holes by selective assembly to provide an LN 2 fit.

2.2.2.5 High Strength Bolt Holes

Holes for high strength bolts must be accurately spaced, perpendicular to the member, and cylindrical. If the thickness of the material is greater than the diameter of the bolt, the holes must be either drilled full size or must be sub-drilled and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting done during assembly must not distort the metal or enlarge the holes. For slight mismatching, reaming to a larger diameter for the next standard size bolt will be allowed.

2.2.3 Flame Cutting of Material

Flame cutting of material, other than steel, is subject to Contracting Officer approval. Accurately perform shearing, and neatly finish all portions of work. Steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a smooth surface free from cracks and notches is secured. Prepare surfaces and edges to be welded in accordance with Section 3 of AWS D1.1/D1.1M. Chipping and grinding are not permitted except where specified and as necessary to remove slag and sharp edges of technically guided or hand-guided cuts not exposed to view. Chip, grind, or machine visible or exposed hand-guided cuts to metal free of voids, discontinuities, and foreign materials.

2.2.4 Alignment of Wetted Surfaces

Exercise care to ensure that the correct alignment of wetted surfaces being joined by a flanged joint is being obtained. Where plates of the water passage change thickness, provide a transition on the outer surface, leaving the inner surface properly aligned. When welding has been completed and welds have been cleaned, but prior to stress relieving, carefully check joining of plates in the presence of a Government inspector for misalignment of adjoining parts.

2.2.5 Metallic Zinc Coatings

Apply zinc coatings in a manner, thickness, and quality conforming to ASTM A123/A123M. Where the zinc coating is destroyed by cutting, welding, or other causes, re-galvanize the affected areas to the thickness and quality required for the original zinc coating.

2.3 SUBMERSIBLE PUMP

2.3.1 Design and Manufacture

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NOTE: Under paragraph PUMP SUPPLIER QUALIFICATIONS the Contractor is required to submit names of

previous installations where the selected manufacturer has documented the operating performance for pumps of this design. While the general venturi configuration of the pumps built by different suppliers is similar, the details (e.g., number of bearings, wearing ring design, cast versus fabrication, impeller design, and materials) can be different. Based on design details available, there seems to be little justification to prefer one manufacturer's design over another. The pump portion of the specification is a low tech design compared with the motor and housing internal design, 70 to 80 percent of the cost may be contained in the motor. The emphasis on the pump portion should be on rugged, reliable, long-lasting components that are trouble-free.

****

The submersible pump may be either of cast or fabricated construction. The level of manufacture must be consistent with the standards referenced in the specifications. The Government reserves the right to observe and witness the manufacturing of the pumps and to inspect the pumps for compliance with contract requirements during factory assembly.

2.3.2 Speed

****

NOTE: HI 2000 bases the maximum operating pump speed calculations on a value of suction-specific speed of 8500. EM 1110-2-3105, Appendix B uses 8000. When calculating the maximum specified pump speed use the more conservative value of suction-specific speed for application where pumps will operate continuously or for extended periods of time above or below point of optimum efficiency.

****

2.3.2.1 Pump Speed

Rotative speed of the pump cannot be greater than [_____] rpm.

2.3.2.2 Runaway Speed

Design the pump to sustain full runaway speed without damage at maximum head difference across the pump. Based on the system design as indicated, the manufacturer must compute the maximum reverse runaway speed, and design the pump and motor to sustain that reverse rotation without damage.

2.3.3 Pump Construction

2.3.3.1 General

The major pump components must be of materials as described in Table 1. [Design the entire support assembly in accordance with UFC 3-301-01 [and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS].] All exposed nuts and bolts must be stainless steel. Machine and fit all mating surfaces where watertight sealing is required with nitrile rubber O-rings. The fitting must be such that the sealing is accomplished by metal-metal contact between machined surfaces which results in controlled compression of the O-rings. Sealing compounds, grease, or secondary devices are not acceptable.

2.3.3.2 Pump Lifting Handle And Lifting Lugs

Design the lifting handle to bear the entire weight of the pumping unit at a factor of safety of 5. Provide lifting lugs where the weight of the separate part requires a lug.

2.3.3.3 Pump and Motor Bearing Arrangement

The pump and motor bearings must be the standard design of the manufacturer for the pump supplied under this specification. The type and number must be of proven design as used in previous operating units supplied by the manufacturer. Provide bearings of the grease lubricated and sealed type; having a minimum B-10 bearing life of 50,000 hr. Each bearing must be of the correct design to resist the radial and thrust loads applied. Provide enough bearings to ensure the pump rotating elements are supported so that the possibility of excessive vibration is eliminated. Conform ball and roller bearings life and load ratings to ABMA 9 and ABMA 11.

2.3.3.4 Mechanical Seals

Provide a mechanical rotating shaft seal system between the impeller and motor to ensure the motor housing is sealed properly. The mechanical seals must be in tandem, lapped and face type seals running in lubricant reservoirs for cooling and lubrication. The mechanical seals must contain both stationary and rotating tungsten carbide face rings unless otherwise specified. In order to avoid failure from sticking, clogging, and misalignment from elements contained in the mixed media. Only the seal faces of the outer seal assembly and its retaining clips can be exposed to the mixed media. Contain all other components in the lubricant housing. All seal faces must be solid material capable of being relapped. The seals must not require maintenance or adjustment, but be easy to inspect and replace. Shaft seals without positively driven rotating members are not considered acceptable or equal.

2.3.3.5 Lubricant Housing

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NOTE: The designer will need to consider the use of Environmentally Acceptable Lubricant (EAL) based on current local requirements. EAL installation is specified in EM 1110-2-1424. EAL may affect the seal material for compatibility.

****

Provide an oil housing with oil, as recommended by the Contractor's pump manufacturer, to lubricate the shaft sealing system and to dissipate the heat generated by the motor and bearings. [Oil must be environmentally acceptable lubricant (EAL). EAL must meet the requirements of EPA 800-R-11-002 or VGP (Vessel General Permit). The oil must have performance characteristics that are suitable for this application, meets the compatibility requirements for the system components, and is technically acceptable by the pump manufacturer. Submit the physical and performance properties as well as the certification that the oil meets the above requirements.]

2.3.3.6 Impeller

The impeller design and manufacture must be standard to the Contractor's proposed pumps. The impeller surface must be smooth, without holes and fabrication offsets. The attachments to shaft must be with keys or other fasteners that are made of stainless steel, and of sturdy construction designed to not loosen, but be easily removed for maintenance. The impeller construction may be cast or fabricated. At the time of assembly the impeller clearances must be those shown on assembly drawings and may be checked in the field or at the factory at the Contracting Officer's option. Balance the impeller at the design operating speed. The standard balance quality grade is G6.3 in accordance with ISO 1940-1. Balance in accordance with the procedure in HI 9.6.4, except that a two-plane balance is required. Submit the results of impeller balancing.

2.3.3.7 Shaft

The shaft must be [one piece integral with the motor] [two piece with gear reduction] of high-strength cold-rolled carbon steel or stainless steel with a factor of safety of five measured against the ultimate strength. Design the shaft for all torque conditions during normal operation and for runaway speed during reverse flow.

2.3.3.8 Bowl Assembly

****

NOTE: This portion of the pump is composed of the venturi section and consists of the suction bell, pump bowl, and discharge bowl. The entire unit acts as a venturi to hydraulically guide and stabilize the flow as it passes through the pump. Heads and stresses are low, and its major design consideration is for rugged, reliable, and long-lived materials.

****

The bowl assembly may be cast or fabricated. The hydraulic design must be the design shown in the submitted general drawings. The general manufacture quality relating to flange design, drilling, bolts, alignments, must be in accordance with industry standard practice.

[2.3.3.9 Column Check Valve

Provide a spring loaded column check valve within 20 feet above the bowl section.

][2.3.3.10 Flow Shroud

Provide a flow shroud to direct flow to pump over motor surface for motor cooling.

][2.3.3.11 Strainer

Provide a strainer to prevent large objects from entering the pump. The maximum opening of the strainer must not be more than 75 percent of the maximum opening of the water passage through the bowl or impeller.

]2.3.4 Motor

The motor must be submersible and conform to the requirements of NEMA MG 1.

Size the motor to avoid overload when operating at any point along the characteristic curve of the pump. Provide 3-phase, 60-Hz, [_____] V, squirrel cage induction type motors, NEMA Design B Type. Insulate the stator windings and stator leads with a moisture-resistant Class F insulation with temperature resistance of 155 degrees C 311 degrees F. Use a service factor of 1.0. The temperature rise above ambient for continuous full load rated conditions and for the class of insulation used cannot exceed the values in NEMA MG 1. The motor must be rated for continuous duty when submerged and also be capable of operation in the dry for short periods of time for testing and maintenance purposes.

2.3.4.1 Torque

Starting torque must be sufficient to start the pump, but in no case less than 60 percent of full-load torque. Break-down torque cannot be less than 150 percent of full-load torque.

2.3.4.2 Support

Provide thrust bearing support of sufficient strength and rigidity to support the weight of the entire rotating element of the motor, pump impeller and shaft, and the hydraulic thrust.

2.3.5 Cable

a. Specifically design power and instrumentation cable for use with a submersible pump application and conform to the requirements of NEMA WC 70 and NEMA WC 72. Use submersible cable suitable for continuous immersion in water at the maximum depth encountered. Cable must have an ampacity of not less than 125 percent of the motor full load current. [The cable length must be [_____] m ft].

b. Power and instrumentation cables must enter the motor through a sealing system that prevents water entry into the unit and provides strain relief. The cable entry may be comprised of rubber bushings, flanked by stainless steel washers, having a close tolerance fit against the cable outside diameter and the entry inside diameter for sealing by compression of the bushing, or the entry may be sealed by other gland compression methods.

2.3.6 Pump Control and Monitoring

Provide a self-contained pump control and monitoring system. Provide pump controls and control panels in accordance with [Section [_____]] [_____]. Provide independent local indication of the alarm and separate contacts for the remote indication of each alarm and local reset. Sensors must alarm and shut down the pump at an abnormal operating condition. provide separate red alarm indicator lamps and green pump running lamps and label in the enclosure specified in [Section [_____]] [_____]. Provide the following sensors:

[2.3.6.1 Thermal Sensor

A thermal sensor in the gear reduction unit (if used) to monitor oil temperature.

]2.3.6.2 Temperature Sensor

Temperature sensors in the stator windings to protect the motor against overheating.

Temperature sensors to monitor the main and support bearings.

2.3.6.3 Float Switch Sensor

Float-switch sensor positioned between the bearings and the stator-end coils to detect if liquid penetrates the stator housing.

2.3.6.4 Detectors

A junction box leakage detector and a water-in-oil detector.

2.3.7 Air Vent

Provide an air vent and a combination air and vacuum valve type. The valve must be a minimum 862 kPa 125 lb class and sized for the design flow rate. Provide an isolation valve at the valve's inlet. Materials of construction must be cast iron for the valve body; stainless steel for the internal linkage, float, and float stem; and Buna-N for the needle and seat. The valve must provide a dual function to release air during pump start-up and to permit air to re-enter to break the vacuum during pump shutdown.

2.4 DISCHARGE TUBE [AND DISCHARGE ELBOW]

2.4.1 General

a. Design, manufacture, and install the discharge tube [and discharge elbow]. For purposes of performance and this specification it is treated as part of the pumping unit. Provide the discharge tube of such size to accommodate the dimensions of the pump supplied in accordance with its specific requirements. Furnish the discharge tube with lifting points to aid in the handling and installation of the tube. Permanently install it in the pump sump as indicated.

b. Design so the pumps are automatically and firmly connected to the discharge tube when lowered into place and in accordance with the pump manufacturer's instructions. Provide a locking device that prohibits rotational movement of the pump within the tube.

c. The pumps must be easily removable for inspection or service without need to enter the pump sump. The pumps must not require any bolts, nuts, or fasteners for connection to the discharge housing. Provide stiffening, guides, or other features at the pump support to ensure concentric positioning of the pump in the discharge tube. provide means such that an effective seal is obtained between the pump and discharge tube. Power cable penetrations must be watertight.

[d. Install a sole plate as indicated. Design the entire support assembly to the requirements of UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS.]

2.4.2 Flanged Joints

Design flanged joints to be airtight and watertight, without the use of preformed gaskets, except that the use of a gasketing compound will be permitted. Mating flanges must be male/female rabbet type or doweled with not less than four tapered dowels equally spaced around the flange.

Machine flanges and drill bolt holes concentric with the centerline, having a tolerance of plus or minus 1/4 of the clearance between the bolt and the bolt hole. When fabricated from steel plate, flanges must not be less than 40 mm 1-1/2 inch thick after machining. Flange machining must not vary more than 10 percent of the greatest flange thickness. Construct fabricated flanges, as a minimum, to the dimensions of AWWA C207, Class B. Connect flanges to the column tube [and discharge elbow] with two continuous fillet welds, one at the inside diameter of flange-to-pump-tube and the other at the outside diameter of pump-tube-to-flange. Machine mating flanges parallel to a tolerance of 0.05 mm 0.002 inch. Finish the machine mating flange surface to 125 microns or better.

2.4.3 Nuts and Bolts

Use hexagonal type nuts and bolts; with bolts, including assembly, anchor, harness, and dowels of 300 stainless steel. Provide bronze nuts and 300 series stainless steel washers.

[2.4.4 Bolted Lid

Provide a watertight lid, hinged and bolted to the top of the discharge tube.

][2.4.5 Harnessed Coupling

Provide a flexible mechanical coupling or split-sleeve type coupling that either conforms to ASTM F1476, Type II, Class 3, or ASTM F1476, Type 1, to connect the pump discharge elbow to the [transition section] [wall thimble] [discharge piping]. Finish the middle ring without pipe stop to facilitate the installation and removal of the coupling. Install a minimum of four harness bolts at each coupling.

]2.4.6 Wall Thimble

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NOTE: This alternative is used when the discharge piping includes the piece that will be embedded in the wall of the station. The size of vent to be used is determined from information in EM 1110-2-3105.

****

Each wall thimble must have one plain end to accommodate the flexible mechanical coupling and one flanged end to mate with the [flap gate] [multiple shutter gate] [discharge piping]. Match the plain end with the pump discharge elbow in thickness and diameter and drill the flanged end to match, and be capable of supporting without distortion, the [flap gate] [multiple shutter gate]. Provide the seal ring on the wall thimble located so that it is centered in the wall when embedded. In addition, furnish a [_____] mm inch flanged vent nozzle equipped with an ASME B16.5 standard 125 pound flange and locate where indicated. Fabricate the wall thimble from steel plates.

2.4.7 Discharge Piping

****

NOTE: Include applicable discharge pipe description.

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[Provide discharge piping consisting of a transition section and a wall thimble. Transition section must have one plain end and one flanged end, and provide a change in cross section from round to [square] [rectangular]. The plain end must match the pump discharge elbow in thickness and diameter. Arrange the wall thimble for embedment and with the flanges on each end. One end mates with the flange on the transition section and the other end mates with flap gate. Fabricate the discharge flange with a minimum dimension of AWWA C207, Class D, and drill to match. The discharge flange must be capable of supporting, without distortion, the multiple shutter gate. Provide a seal ring on the wall thimble and locate it so that it is centered in the wall when embedded. In addition, furnish a [_____] mm inch flanged vent nozzle equipped with an ASME B16.5 standard 125 pound flange and locate it where shown. Fabricate discharge piping from steel plate.]

[Install the discharge piping as indicated. Match the plain end of each discharge pipe to the pump discharge elbow in thickness and diameter, and configured to allow a flexible mechanical coupling to connect it to the pump discharge elbow. [Terminate the discharge piping in a flanged end to mate with a flap gate. Drill the flanged end to match, and configure to be capable of supporting the flap gate without distortion.] [Terminate the discharge piping in an open end.] The discharge pipe must have pipe supports or cradles as recommended for the Contractor's selected pumps. Locate the supports between the flexible coupling and the wall, as indicated. Provide suitably-sized thrust restraints at each flexible coupling as indicated. The supports must provide support for the weight of the pipe, the water that will pass through the pipe, and any dynamic forces that may develop due to water flowing through the pipe. Furnish a minimum [_____] mm inch flanged vent nozzle equipped with an ASME B16.5 standard 125 pound flange and locate as indicated. The discharge pipe must be non-galvanized piping of welded or seamless pipe or welded steel plate. The steel pipe must conform to AWWA C200 with dimensional requirements as given in ASME B36.10M. Fittings must comply with AWWA C208.]

2.4.8 Flap Gate

Design the flap gate for pump discharge service with flange-frame with a resilient seat of neoprene or nitrile butadiene rubber to prevent closing shock. Size the flap gate to be the same as the discharge pipe size. [The body of the valve and the flap must be cast iron ASTM A126. The hinge arms must be high-tensile bronze ASTM B584- CA 865. Design the hinge pins in double shear and of silicon bronze, ASTM B98/B98M- CA 655.] [Fabricate the flap gate entirely of stainless steel. Use only stainless steel hardware.] Provide lubrication fittings on the hinge arms. Extend the grease lines to a convenient location for lubricating. provide an anti-locking bar to prevent excessive rotation about the lower hinge pin. provide a stainless steel leaf spring with rubber pad to safely limit the travel of the flap gate during pumping.

2.4.9 Dissimilar Metals

When dissimilar metals are used in intimate contact, apply suitable protection against galvanic corrosion. Protect the anodic member by proper electrical insulation of the joint.

2.5 INTAKE DESIGN

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NOTE: Information on intake design is available in

EM 1110-2-3105, Hydraulic Institute standards, manufacturers' catalogs, and model tests from the U.S. Army Engineer Research and Development Center (ERDC). The designer should be aware of net positive suction head available (NPSHA) and NPSHR from pump performance curves and the plant design operation. If the approach inlet conditions to the pumping station are unique or unusual, the designer should consider having the contractor perform a model intake test, or the contractor may consult ERDC about the need for a model test or to learn about results from previous testing.

Detailed design information about using a formed suction intake is available in EM 1110-2-3105.
****

2.5.1 General

The intake sump design will be provided by the Government. Supply a pump that will meet the performance requirements without undue modifications to the sump as indicated on the drawings. Any such modifications are at no cost to the Government and must receive prior approval.

[2.5.2 Formed Suction Intake (FSI)

Provide an FSI for each pump to the dimensional requirements and arrangement shown on the drawings. Connect the FSI to the inlet of the discharge tube. Use flanged joint as specified in paragraph FLANGED JOINTS as the method of connection. Assume the FSI has a K value of 0.15 for head loss calculations. Construct the FSI of [fabricated steel], [cast iron], [a combination of fabricated steel and cast iron]. Any stiffeners used must be on the outside of the FSI to allow smooth flow within. Use stainless steel bolts with bronze nuts. The minimum thickness of fabricated material must be [10 mm 3/8 inch] [12 mm 1/2 inch] [16 mm 5/8 inch] [19 mm 3/4 inch]. Provide grout holes in the floor [and sides] of the FSI to permit grouting during installation.

][2.6 INTAKE TESTING

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NOTE: Delete this paragraph if a model test of the intake to the pumping system(s) is not required.

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Provide complete performance model testing of the pump intake systems. Use the model testing to confirm the configuration of the intake systems, including the proposed intake conduit, hydraulic losses to the pump, the position of the pump in the intake bay, and to confirm the selection of the pump. The Contracting Officer will witness the final tests confirming the geometry for the intake conduit. Notify the Contracting Officer with at least 14 days notice of the time and location for the final tests.

[2.6.1 Contractor's Modeling Engineer Qualifications

Perform the modeling work in a hydraulic laboratory located within the United States where this type of work has been performed for a period of at least ten years. The individual in responsible charge of the modeling work must be a registered professional engineer in any U.S. state with at least ten years of experience in pump and intake modeling work for similar projects. The engineer must seal and sign all reports and data documents generated as a part of the test work prior to submitting them.

][2.6.2 Intake Model Setup and Objectives

The model intake setup must be of the intake system, custom designed for this installation and suitable for operation at atmospheric pressure for observation of the intake basin performance. The intake model must be suitable for use with a model pump. Use clean and clear water for the test to allow proper observation. The temperature of the water during any test cannot exceed 30 degrees C 85 degrees F.[For the FSI, provide a setup to determine flow patterns in the suction basin approaching the intake, along with losses to the pump. Provide further tests to identify flow patterns in the intake itself and approach patterns at the entrance to the pump.] In the intake model, include all items in the intake path, including, but not limited to: models of the trash rack, stoplog slots, access ladders, and the stilling wells in the intake bays.

][2.6.3 Intake Model Tests

The objective of the modeling work is to define the performance of the proposed pumping unit and to confirm the geometry to be used for the pump intake. The model must have a model-to-prototype Froude number ratio of 1, based upon the pump impeller diameter. Arrange the model in the same relative orientation as the prototype structure and include the bay configuration and screening system. Perform all testing with the same model.

[Intake Tests: For the formed suction intake geometry shown on the drawings, use the model setup to determine flow characteristics in the suction basin intake bay and at the entrance to the FSI at all specified operating conditions. In addition, use the model to determine the effect of the intake system on pump operating characteristics. Use a siphon generated by a separate pump to examine flow characteristics in the intake bay using Froude relationships to model intake operation in the first set of tests. Use second test to develop information on the effect of the intake on pump operation. Use these values to forecast the performance of the pump-intake conduit combination.

][Alternate Intake Geometry: If an intake geometry differing from that indicated is proposed, or other modifications such as baffling, test the proposed intake and/or modifications to demonstrate its suitability for use in the project and compliance with Appendix I in EM 1110-2-3105. For that reason, design the laboratory setup specifically to monitor free and sub-surface vortices, swirl and pre-rotation approaching the pump impeller, flow separation at hydraulic surfaces in the intake conduit and at the hydraulic surfaces approaching the pump impeller, and axial velocity distribution at the entrance to the impeller.

] a. The intake conduit and pump inlet must contain several clear windows and similar appurtenances and adequate lighting at all critical areas to allow visual determination of the presence of vortices, turbulence, and other defects. Make provisions to insert dye at intervals in the intake conduit and at the entrance to the impeller during operation of the test. Reynolds and Weber numbers for all model runs must be greater than 30,000 and 120, respectively. The manufacturer must develop scale factors for velocity, flow, and time for use in evaluation of model results. Scale factors are subject to review by the Contracting Officer. In addition to model runs at all specified operating conditions, conduct no fewer than five runs at 1.5 times Froude-scaled flows after final geometrics for the intake conduit and intake bays have been established, keeping the submergences at the geometrically scaled values. Track and document circulation contributing to development of vortices.

b. Determine vortex formation in the model every 15 seconds extending over a period of 10 minutes. Classify vortices in accordance with the strength classification system in HI ANSI/HI 9.8 for both surface and subsurface vortices, using dye wand injection to assist in classification. Provide both photographic and video documentation of vortex formation. Direct particular attention to subsurface vortex formation at the intake conduit entrance and on intake conduit surfaces leading to the impeller entrance.

c. Provide a swirl meter or other satisfactory device to determine liquid rotation (swirl) at the entrance to the impeller. Obtain swirl readings at intervals of 20 seconds for a period of not less than 10 minutes after the model has achieved steady-state operation at any specified operating condition. Swirl angle is defined by the relationship:

(1) swirl angle = (1/(tan))(pi*d*n)÷ u

Where:
u = average axial velocity at the swirl meter.
d = diameter of the conduit at the swirl meter.
n = revolutions/second at the swirl meter.

d. Headloss Measurements: Measure headloss from the upstream model boundary to just upstream of the pump inlet for each documentation test and include a minimum of the following conditions:

Pump No.	Avg On/Off El. (m) (feet)	Individual Pump Q (cubic m per second) (fps)	Total Pump Q (cubic m per second) (fps)

****

NOTE: Provide an expected order of pump operations and expected intake elevations at start-up for each pump.

****

e. Also record the head loss from just upstream of the FSI to the throat of one model pump for a minimum of 10 flow rates after the model Euler number is determined to be constant and at least one point (near the middle of the data) must be within 2 percent of the scaled rated flow of the pump. Measure head loss with a differential manometer or differential stilling basin. Install a minimum of four pressure taps around the pump throat measurement point and joined to form an average pressure reading. Calculate a dimensionless head loss coefficient for the formed inlet that includes the entrance loss into the formed inlet.

f. Determine the velocity profile in the channel cross section approaching the intake and performing the velocity traverses on perpendicular axes at the intake throat, just upstream from the impeller. Velocity measurement instruments must be capable of an accuracy of plus or minus 2 percent.

g. Use the following as criteria for acceptance of the proposed design:

(1) Free surface and sub-surface vortices entering the pump intake must be less severe than Type 1, as defined in HI ANSI/HI 9.8, unless dye core vortices appear for less than 10 percent of the time or only for pump operating conditions that are expected to be infrequent, such as the listed maximum or minimum operating conditions.

(2) Swirl angles, both maximum and average, indicated by swirl meter readings, must be less than 5 degrees. Swirl angles as great as 7 degrees will be accepted if occurring less than 10 percent of the time or for operating conditions that are expected to be infrequent, such as the listed maximum or minimum operating conditions.

(3) Velocities at points of equal radii at the throat of the intake conduit must be within 10 percent of each other.

(4) Determine NPSHR on the basis of a one percent reduction of efficiency.

(5) Time-varying velocity fluctuation (turbulence) levels as defined by a standard deviation over average velocity at a point within the pump throat must be less than 10 percent.

h. Unless otherwise specified, conform accuracy of all measurements to the levels established in HI ANSI/HI 11.6.

]2.6.4 Recommendations from the Model Test

Submit an intake model test report. If the results of the intake model testing indicate that any features of the design are deficient, report this to the Contracting Officer in writing immediately. If the intake modeler has recommendation for improving the flows in the pumps, provide them in the Intake Model Test Report. Flag these as important information that requires the Contracting Officer's immediate attention. Note all recommendations considered major changes. provide any minor recommended changes to the intake as variations in the shop drawings.

]2.7 MOTOR TESTING

Field test the motors per NETA ATSNETA ATS. For induction motors test per part 7.15.1. For synchronous motors test per part 7.15.2.

2.8 SHOP ASSEMBLY

Assemble the discharge tube [and discharge elbow] to ensure the proper fitting and alignment of all parts. Prior to disassembly, match-mark all parts to facilitate the correct assembly in the field.

2.9 FACTORY TESTS

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NOTE: The designer should specify performance

testing of the assembled pump in the factory to check that the requirements of the specification have been met.
****

Perform the following factory tests in accordance with HI ANSI/HI 11.6. [Testing is nonwitnessed factory testing. The pump manufacturer is responsible for maintaining all test results, however reporting of these test results is not required.][Testing is certified nonwitnessed factory testing. The pump manufacturer is responsible for maintaining all test results, however reporting of these test results is not required.][Testing is certified nonwitnessed factory testing. The pump manufacturer must provide certification and data to indicate that the testing meets the testing standard.][Testing must be witnessed by a Government Representative. When satisfied that the pump performs in accordance with the specified requirements, notify the Contracting Officer, [two weeks] in advance, that the witness tests are ready to be run and furnish two copies of curves required in paragraph TEST RESULTS. If the tests reveal that the pump does not perform in accordance with the specifications, make necessary changes before again notifying the Contracting officer that witness tests are ready to be run. Provide copies of all data taken during the witness testing and plotted preliminary curves to the Contracting Officer with the factory test report.]

2.9.1 Performance Test

Compliance with specifications will be determined from curves required by paragraph TEST RESULTS. Test procedures, except as herein specified, must be in accordance with applicable provisions of HI ANSI/HI 11.6. Use water for testing at approximately the same temperature (68 degrees F) for all tests run and record it during test runs.

2.9.1.1 Performance of the Pump

Determine performance of the pump by a minimnum of 5 test points sufficient to develop a constant speed curve over the range of total heads corresponding to the requirements of paragraph CAPACITIES. Testing must be inclusive for the speed involved.

2.9.1.2 Test Results

Plot test results to show the total head, static heads, bkW bhp, and efficiency as ordinates. Plot the results against pump discharge in L/s gpm as the abscissa. Plot curves showing pump performance to a scale that will permit reading the head directly to 0.15 m 0.5 ft, capacity to 30 L/s 500 gpm, efficiency to 1 percent, and power input to 20 bkW 25 bhp. Establish that the performance requirements of these specifications under this contract have been fulfilled at the best efficiency point, preferred operating region, and the acceptable operating region of the pump on the plotted curves developed during the factory performance testing. Perform the performance test with the pump and motor assembled as an operating unit to simulate field installation unless otherwise approved in writing by the Contracting Officer. Conduct the test in accordance with accepted practices at full speed; and, unless otherwise specified, conform to HI ANSI/HI 11.6 procedure and instruments.

[2.9.2 Cavitation Test

Use the testing procedures provided in HI ANSI/HI 11.6 to determine the net positive suction head required (NPSHR) by the pump. Select the test arrangement and procedure, from the choices provided in HI ANSI/HI 11.6, that best suits the test facility. NPSHR must be determined for five or more capacities over the total range of the specified operating conditions. Plot the test results and define NPSHR as the point where a 3 percent drop in performance occurs. The value of NPSHR must be 1 m 3.3 ft less than the corresponding net positive suction head available (NPSHA). Use the temperature of the water at the time the tests are run in determining the NPSHR. Use the water elevations specified in paragraph CAPACITIES to determine the NPSHA for pumps.

][2.9.3 Hydrostatic Test

Perform a hydrostatic test of the pump to verify the absence of leakage from the pressure containing walls and the joints of the pump assembly in is accordance with HI ANSI/HI 11.6. The hydrostatic test pressure is based on the differential pressure of the pump as specified in paragraph CAPACITIES. [Submit the certification that the Hydrostatic Test meets the requirements of HI ANSI/HI 11.6 with no visible signs of leakage.] [Submit a full report of the Hydrostatic Test in accordance with HI ANSI/HI 11.6.]

][2.9.4 Vibration Test

Perform a vibration test to verify that the tested pump does not exceed a guaranteed vibration velocity level as specified in HI ANSI/HI 11.6. Submit the certification that the Vibration Test meets the requirements of HI ANSI/HI 11.6 and summarize findings in a report.

][2.9.5 Submersible Motor Integrity Test

Perform a submersible motor integrity test to verify the sealing and electrical integrity of a submersible motor in accordance with HI ANSI/HI 11.6. Submit the certification that the Submersible Motor Integrity Test meets the requirements of HI ANSI/HI 11.6.

]2.9.6 Factory Test Report

Submit, within 30 days of receipt of approval of the witnessed factory test,[bound] [digital] copies of a report covering test setup and performance tests. Include the specified information in the factory test report that meets the guidance identified in HI ANSI/HI 11.6.

2.10 PAINT

Paint the pump/motor in accordance with the Contractor's pump manufacturer's standard coating system. External unmachined and non-mating machined surfaces (except for stainless steel) must be thoroughly cleaned and painted with a hydrocarbon-resistant, anti-corrosive (lead and chromate free) primer and topcoat. Painting external surfaces of nonferrous parts and components is not required but is permissible to avoid excessive masking. Identification plates must not be painted or oversprayed. Submit paint catalog data. Paint the discharge tube [and discharge elbow] and appurtenances in accordance with Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.[Provide the manufacturers standard coating which is rated for use in brackish conditions.]

[2.11 CORROSION PROTECTION

Provide mounted zinc anodes on the pump casing to prevent against corrosion for pumps which will operate in brackish conditions. Size zinc anodes with enough material to last for at least 3 years of normal operation.[Verify with potential tests the effictiveness of the mounted zincs.]

]PART 3 EXECUTION

3.1 INSTALLATION

Perform correct installation and assembly of the pumping unit in accordance with the drawings and with the installation instruction manual. Submit, no later than 30 days prior to time of pump delivery, three copies of a typed and bound manual describing procedures to be followed by the installation engineer in assembling, installing, and dry- and/or wet-testing the pump. Coordinate and consolidate the description of the pump with similar descriptions for other specified pump parts. The description must be of such a nature that it may be comprehended by an engineer or mechanic without extensive experience in erecting or installing pumps of this type. The description must be a step-by-step explanation of operations required, and include, where applicable, such things as alignment procedures, bolt torque values, recommended instrument setups, recommended gauges and instruments, and similar details. Furnish all bolts, shims, tools, and other devices necessary for installing the pumping units. The manufacturer's representative(s) familiar with the equipment being installed must supervise the handling, installation, start-up, and testing of the equipment as required in the paragraph Contractor's Installation And Start-Up ENGINEER.

3.2 CLEANUP PRIOR TO START

After the pumping unit is installed and prior to start-up, completely clean the sump area of any accumulated construction debris. This final cleaning of the sump area will be witnessed by a representative of the Government. Correct any damage to the pumping units or related equipment during initial start-up due to foreign objects left in the sump areas.

3.3 PUMP FIELD TESTS

****

NOTES: Compliance with specification performance has been made a part of the factory tests; therefore, field tests are for the purpose of baseline measurements. Pump integrity, vibration, , and inspection of manufacturing quality are witnessed at the factory.

Perform field testing to ensure proper alignment and installation, start-up and shutdown procedures, checking out controls, and establishing baseline measurements. Two field test methods are available, dry or wet testing, depending on availability of water. Wet testing is preferred, but dry testing may be all that is possible when the pumps are prepared for initial start-up.

If a wet test cannot be conducted at the time of initial start-up because of a lack of water, it should be conducted at a later time, if possible, and does not unduly extend the contract period.

****

Submit a field test plan prior to field testing. Field testing must be conducted by an experienced field test engineer and will be witnessed by the Contracting Officer. Before initially energizing the pump/motors, ensure that all pumping plant control, monitoring, and protective circuits have been successfully tested. This thorough electrical checkout procedure must follow a detailed step-by-step approved test plan. Also check the motor and other pumping unit elements undergoing tests at this time. Field test the plan prior to field testing.

[3.3.1 Dry Test

Test each pumping unit in the dry in accordance with the pump's instructions to determine whether it has been properly installed. Operate the pump at full rated speed. If tests reveal a design or installation deficiency or a manufacturing error in pumping unit components, promptly correct the problem.

]3.3.2 Wet Test

Test each unit under load for a period of at least [_____] hours or as directed by the Contracting Officer. Conduct the tests to be witnessed by the Government. During the tests, observe, measure, and record the operation of the pumping units [noise (in accordance with HI 9.1-9.5),] motor-bearing temperatures, voltage, and current for each pump. Measured parameters must be within the pump's published limits. make vibration measurements at the top of the discharge tube [and flange of the discharge elbow] for each pump. Vibration limits must not exceed those recommended by HI 9.6.4.

3.3.3 Field Test Report

Submit the field test report that summarizes results of the testing.

3.3.4 Operation and Maintenance Manual

Prepare and submit the field test report and a manual of Operating and Maintenance Instructions for the completed system. Submit the instructions containing complete information on operation, lubrication, adjustment, routine and special maintenance disassembly, repair, reassembly, and trouble diagnostics of pump and auxiliary equipment. [Print the operation and maintenance manual and both parts lists on good quality ANSI size A 216 by 280 mm 8-1/2 by 11-inch paper, bound separately between flexible, durable covers.] [Provide the operation and maintenance manual and both parts lists on optical disc, formatted to print on ANSI size A 216 by 280 mm 8-1/2 by 11-inch paper.]Drawings incorporated in manual or parts lists, may be reduced to page size provided they are clear and legible[, or may be folded into the manual to page size]. Photographs or catalog cuts of components may be included for identification.

3.3.5 Pump Removal and Installation

Install and remove each maintenance pump unit a minimum of three times to demonstrate proper pump alignment and installation. Verify that the pump can be removed and installed without sticking or binding. [Verify proper sealing at the discharge elbow.]

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 45 03.00 10 (May 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 45 03.00 10 (February 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 45 03.00 10

SPEED REDUCERS FOR STORM WATER PUMPS

05/22

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-35 45 03.00 10 (May 2022)**

Preparing Activity: USACE **Superseding**
UFGS-35 45 03.00 10 (February 2016)

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****

SECTION 35 45 03.00 10

SPEED REDUCERS FOR STORM WATER PUMPS
05/22

****
NOTES: This guide specification covers the requirements for speed reducers used with vertical impeller pumps.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This guide specification, as written, is for use in construction contracts for the building of pumping stations. If it is to be used in supply contracts, it should be changed as appropriate.

The pump, motor, base, electrical power, engine, and clutch (if used) are all related components but are not included in this specification.

The epicyclic reducer is reliable and especially well suited to high power applications. It should not normally be deleted as an option if the prime mover has a vertical shaft.

****

1.1 UNIT PRICES

****
NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
****

1.1.1 Speed Reducers for Storm Water Pumps

Make payments for costs associated with [furnishing] [furnishing and installing] [installing] the speed reducers for storm water pumps as specified.

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6013	(2006A; R2016) Standard for Industrial Enclosed Gear Drives

AGMA 6123	(2016C) Design Manual for Enclosed Epicyclic Gear Drives
ANSI/AGMA 6025	(1998D; R 2010) Sound for Enclosed Helical, Herringbone and Spiral Bevel Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)
ANSI/AGMA 9000	(2011D) Flexible Couplings - Potential Unbalance Classification
ANSI/AGMA 9005	(2016) Industrial Gear Lubrication

AMERICAN PETROLEUM INSTITUTE (API)

API RP 686	(2009) Recommended Practice for Machinery Installation and Installation Design

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2024) Power Piping

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 4406	(2021) Hydraulic Fluid Power - Fluids - Method for Coding the Level of Contamination by Solid Particles
ISO 16889	(2022) Hydraulic Fluid Power - Filters - Multi-Pass Method for Evaluating Filtration Performance of a Filter Element
ISO 20816-3	(2022) Mechanical Vibration - Measurement and Evaluation of Machine Vibration - Part 3: Industrial Machinery with a Power Rating Above 15 kW and Operating Speeds Between 120 r/min and 30 000 r/min

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 800-R-11-002	(2011) Environmentally Acceptable Lubricants

1.3 SYSTEM DESCRIPTION

1.3.1 General Product Requirements

****

This section is intended to be used along with Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE. The designer is responsible for determining whether a speed reducer is required or whether a direct drive vertical induction motor can be used to drive the pump. Guidance for making this decision is EM 1110-2-3105, MECHANICAL AND ELECTRICAL DESIGN OF PUMPING STATIONS. An additional section for the prime mover, an electric motor or diesel engine, is also normally added. The intention is for these components to be purchased and installed by the Construction Contractor. Purchase of the three components in a single contract allows the supplier to obtain the most optimum combination of components thus reducing costs while not sacrificing reliability. This also makes it feasible for the Contractor to perform dynamic analysis as described in Section 35 45 01 and be solely responsible for acquiring the necessary data to perform such analysis. The dynamic analysis is important to ensure the pump, reducer, and motor or engine combination is free of detrimental vibration. If the reducer and prime mover are purchased separately, the designer is responsible to provide additional plans and specifications covering reducer instrumentation. Provisions for a pump, reducer, and Provisions for a pump, reducer, and prime mover base plate are described in Section 35 45 01. Pump and reducer alignment is described in Section 35 45 01. The "Buy American Act" which will be included in the non-technical portion of the contract will preclude the use of nondomestic reducers and appurtenances.

****

Provide speed reducers which are designed and manufactured by an organization that is regularly engaged in the manufacture of speed reducers of the type utilized for these installations which conform to the requirements of ANSI/AGMA 6113AGMA 6013 or AGMA 6123. Submit complete computations, design loads, and catalog data. Display the certified Contractor's manufacturer's ANSI/AGMA insignia as evidence of conformance to these standards on the reducers nameplate. Cite the Contractor's selected manufacturer's name, model designation, serial number, unit rating, application factor, reduction ratio, and other applicable information on the nameplate. Provide a [single reduction spiral bevel] [spiral bevel primary, helical secondary stage] [single reduction parallel shaft] [double reduction parallel shaft] [epicyclic] gear type equipped with thrust bearings to make the speed reducer suitable for use with a vertical impeller pump. Equip the reducer with a thrust bearing where upthrust is possible during pump startup or shutdown. Provide a backstop to prevent reverse rotation of the pump.

1.3.2 Design Conditions

1.3.2.1 Operating Conditions

****

NOTES: The speed reducer, pump, and prime mover are intended to be purchased together; responsibility for establishing operating loads should be placed on the Contractor. If the speed reducer is purchased separately, the designer must determine the operating loads from pump and prime mover data.

For motor stall torque, 350 percent of rated load should be used for induction motors. For diesel engines, the maximum torque should equal the slip torque of the overload protection device. An air actuated clutch should be used as overload protection.

****

Include the following operating conditions as a minimum: maximum input power, motor or engine speed, speed reducer ratio, maximum pump reverse overspeed, low-speed shaft downward thrust including weight[, low-speed shaft momentary upward thrust during startup or shutdown], high-speed shaft direction of rotation, low-speed shaft direction of rotation, overhung load, motor stall torque, or maximum engine overload torque transmitted through the clutch, reverse torque load on the backstop.

1.3.2.2 Runaway

****

NOTE: Delete this paragraph for engine-driven units. If emergency closure might not be achieved within 30 minutes, this time period must be increased.

****

Design the speed reducer to withstand backstop failure and maximum pump reverse runaway speed for a period of [30] [_____] minutes.

1.3.3 Arrangement

****

NOTE: In making choices as to the reducer arrangement, the designer must coordinate with the pump (Section 35 45 01) and prime mover specifications. These contain statements on shaft configuration. The hollow output shaft arrangement is preferred for ease of installation. If the reducer is purchased separately from the pump and prime mover, the designer is responsible for determining input and output shaft details and ensuring the reducer will be compatible. For reducers driven by a diesel engine, an air actuated clutch is recommended. The clutch should be part of the diesel engine specification.

****

[Provide a true hollow low-speed shaft where the pump shaft passes concentrically through the reducer shaft allowing finite impeller elevation adjustment.] [Provide a speed reducer output shaft connected to the pump using a rigid coupling.] [Connect speed reducer input shaft to the motor shaft by a flexible coupling.] [Connect the speed reducer input shaft to the engine with two universal joints and an intermediate shaft.] [Connect the speed reducer input shaft to the engine with a flexible coupling.] Ensure compatibility and fit of the reducer high-speed and low-speed shafts with that of the pump and prime mover. Provide a speed reducer mounting which is designed to permit removal of the reducer and reinstallation without requiring realignment of the reducer and shafting. Before assembly, dynamically balance each gear and shaft assembly.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Speed Reducers; G, [_____]

Lubrication System; G, [_____]

Instrumentation; G, [_____]; G, [_____]

SD-03 Product Data

System Description; G, [_____]

Bearings; G, [_____]

Gears; G, [_____]

Shafts; G, [_____]

[Couplings] [Universal Joints]; G, [_____]

Backstop; G, [_____]

Housing; G, [_____]

Lubrication System; G, [_____]

Instrumentation; G, [_____]

Speed Reducers; G, [_____]

Lubricating Oil; G, [_____]

SD-06 Test Reports

Shop Testing

Field Testing

SD-10 Operation and Maintenance Data

Operations and Maintenance (O&M) Manual; G, [_____]

1.5 DELIVERY, STORAGE, AND HANDLING

Protect material and equipment from weather, humidity, temperature variation, dirt, dust, and other contaminants during delivery and storage.

1.6 EXTRA MATERIALS

****

NOTE: The designer is responsible for providing a list of spare parts requirements. This should be based on consideration of whether the purchase of a complete spare reducer is justified and the consequences of downtime of one or more units. Spare parts might otherwise include spare gears, bearings, seals, lubrication system parts, instrumentation components, or heat exchanger. The designer should consult with the end user of the system to determine spare parts requirements.

****

Submit the following: [_____]

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

****

NOTE: Application factors of 1.25 (electric motor) and 1.50 (diesel engine) are the values recommended by EM 1110-2-3105 MECHANICAL AND ELECTRICAL DESIGN OF PUMPING STATIONS. These are suitable for most applications. Where reducer operating conditions are considered severe, the application factors of 1.75 (electric motor) and 2.0 (diesel engine) may be used to increase reliability.

ISO 20816-3 was added in the event any vibration testing may be required by the designer.

****

Provide new materials and equipment which are the standard products of the Contractor's manufacturers who are regularly engaged in the production of gear reducers for vertical pump drives and that essentially duplicate products which have been in prior satisfactory use for at least 2 years prior to bid opening. Submit detail drawings consisting of a complete list of equipment and materials, including descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions. Show on the drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of work including clearances for maintenance and operation. Rate the reducer assembly in accordance with ANSI/AGMA 6113AGMA 6013 or AGMA 6123 as applicable. Provide reducers which are equal to or exceed the maximum input power times an application factor[of [1.25][1.75] for reducers driven by electric motors][[1.5][2.0] for reducers driven by diesel engines.][For vibration testing conform to ISO 20816-3.]

2.2 BEARINGS

****

NOTE: The selection of thrust bearing type should be left to the reducer manufacturer. The selection of bearing type is based upon thrust load. For very high thrust loads, a hydrodynamic fluid film thrust bearing may be needed. If the designer has specific experience which relates to which bearing type is best for the application, one of the options for thrust bearing type may be omitted.

****

2.2.1 Thrust Bearings

Provide thrust bearings which are either hydrodynamic fluid film type or antifriction type. Antifriction thrust type bearings can be either tapered roller or spherical roller type. Size the thrust bearing for the pump thrust plus the weight of the impeller and shaft. Size the bearings to be able to sustain continuous operational load as well as startup and shutdown loads. For hydrodynamic fluid film thrust bearings use pivoted segmental shoes with the babbitted face surfaced as recommended by the bearing manufacturer to maintain an optimum oil film.

2.2.2 Radial Bearings

Use antifriction type radial bearings for spiral bevel and parallel shaft reducers. Use either hydrodynamic fluid film type or antifriction type radial bearings for epicyclic reducers.

2.2.3 Hydrodynamic Fluid Film Bearings

Design the bearings to have a minimum oil film thickness of 12.5 µm 0.0005 inch under the most severe operating conditions. The bearing loads can not exceed 2400 kPa 350 psi for the maximum load. Where hydrodynamic fluid film thrust bearings are used, make suitable hydrostatic lift provisions if required to prevent bearing damage during startup. Provided thrust bearings with either spring loaded or embedded instrumentation to monitor operating temperatures.

2.2.4 Antifriction Bearings

Use antifriction bearings which are rated for an L-10 life of 100,000 hours at the operating load of the reducer. Conform to ABMA 9 for ball bearing load ratings. Conform to ABMA 11 for roller bearing load ratings.

2.3 GEARS

****

NOTE: Designer must delete inapplicable statements which pertain to the gear types not used.

****

[Provide double helical designs for Epicyclic gearing.] [Provide helical designs for parallel shaft gearing.][Provide spiral bevel designs for right angle gearing.] Gas nitride or carburize, then harden and ground spiral bevel, helical, and double helical gears. For epicyclic gearing the annulus ring may be cut by gear shaper. Crown the pinion or gear of each helical set to eliminate end loading. For helical gears, use standard normal diametral pitches. In addition to rating the gears according to ANSI/AGMA 6113AGMA 6013 or AGMA 6123 as applicable, ensure gear stresses do not exceed 80 percent of yield strength for any overload, motor stall, or engine overload condition. Use 350 percent of motor rated torque for motor stall condition minimum.

2.4 SHAFTS

Provide heat treated alloy steel for gear shafts. Ensure input shaft sizes and configurations are compatible with the motor or engine and clutch. Ensure output shaft sizes and configurations are compatible with the pump. Welded shafts are not acceptable.

2.5 [COUPLINGS] [UNIVERSAL JOINTS]

****

NOTE: The designer must delete inapplicable statements. Couplings are to be used with electric motor prime movers. Universal joints are to be used with diesel engine prime movers. In some cases, flexible couplings may be used with diesel engines.

****

Connect the speed reducer to the motor (engine) by [flexible coupling] [universal joints]. Specify a service factor of 2 based on maximum rated load for [couplings] [universal joints]. Do not exceed 80 percent of yield strength at maximum overload conditions. [Provide couplings which transmit torque by means of a steel grid spring fitted into groves in the periphery of the coupling hubs or by means of external gears on hubs engaging in internal gears on the coupling sleeves or by hubs engaged with flexible self-lubricating members. Couplings with sleeves held in place by snap rings are not acceptable.] [Provide universal joints which have forged steel yokes and spiders and sealed needle roller bearings. Install universal joints in pairs. Conform the angles between each shaft and the intermediate shaft as required. Set the driving pins on the yokes attached to the intermediate shaft parallel to each other.] [Enclose and seal couplings to exclude contaminants and retain the lubricant under both static and operating conditions.] [Provide ANSI/AGMA 9000 class 7 or better flexible couplings with grease unless self-lubricated.]

2.6 BACKSTOPS

****

NOTE: Mounting of the backstop with the inner member and rollers stationary will decrease wear and heat generation and consequently increase the life of the backstop. The outward radial load on the rollers is decreased in this mounting situation. This mounting method can be obtained without undue cost but is not the standard mounting method for these backstops. The designer may opt for the standard method (inner member and rollers rotating) but is advised that better life has been obtained with the inner member stationary. For smaller wattage horsepower units (375 kW (500 hp and below), the drop-pin type backstop is a satisfactory alternative and may be added to the specification. Spragtype backstops perform adequately in many installations but have been more prone to problems such as wear and excessive heat generation than the other types and are not listed as an option here. If a diesel engine is used, the idle speed and duration should be listed for proper consideration during backstop sizing.

****

Provide a backstop on the output shaft to prevent reverse rotation of the pump. For double reduction reducers, the backstop may be mounted on the output or intermediate shaft. Size the backstop for the resulting torque at the reducer during maximum reverse flow at pump and apply a service factor of 2.0 to the equipment's published rating. In addition provide a backstop which is suitable for continuous operation at engine idle speed of [800] [_____] rpm that's of a type with cylindrical rollers on inclined cam planes or drop-pin type. Arrange the backstop with the outer race moving and the inner race fixed. The backstop temperature cannot exceed 160 degrees F under all operating conditions with an ambient temperature up to 40 degrees C 100 degrees F. Provide a circulating oil lubrication system with sufficient flow to provide the required cooling. The lubrication system may be part of the gear reducer lubrication system.

2.7 HOUSING

2.7.1 General

Provide a housing made from cast or fabricated steel. Stress relieve prior to machining, and reinforce to carry all applied loads and to maintain gear alignment. Provide a sole plate under the reducer. Level and grout the sole plate in accordance with API RP 686. Use jacking bolts for leveling before grouting, and back off jacking bolts after leveling to transfer the load to the grout pad. Provide an anchor bolt layout to aid in placement of the anchor bolts. Machine the housing bottom. Paint the interior of the reducer with an oil compatible coating. Paint the exterior with the Contractor's standard coating system. Provide an oil fill connection and a drain connection with a magnetic plug. Provide lifting lugs for lifting the entire reducer assembly and any subassembly or component which cannot be lifted using web slings.

2.7.2 Seals

Use a drywell design seal for vertical down output shafts. Use a lip seal on the input shaft to prevent leakage of oil and exclude dirt and utilize hardened steel wear sleeves.

2.7.3 Inspection Covers

Provide inspection holes with cover plates located above the maximum oil level to permit viewing of gear teeth allowing evaluation of the contact patterns of each gear mesh and to allow inspection of internal features of the lubrication system.

2.8 LUBRICATION SYSTEM

****

NOTE: Consult with EM 1110-2-1424 when designing an Enviromentally Acceptable Lubricant (EAL) system.

****

2.8.1 General

Provide an oil lubrication system that will provide continuous lubrication to the gears, bearings, and oil lubricated-type backstop consisting of an oil circulating pump, [oil-to-water][air] heat exchanger, piping, filters, and controls for each reducer driven directly from the speed reducer shaft. The maximum oil sump temperature at rated speed allowable is 160 degrees F at an ambient temperature of 40 degrees C 100 degrees F. If a hydrodynamic thrust bearing is used, its lubrication system may be part of the gear reducer lubrication system, or a separate lubrication system may be provided.

2.8.2 Lubricating Oil

Provide mineral oil or Polyalphaolefine (PAO) synthetic hydrocarbon lubricating oil as recommended in ANSI/AGMA 6113AGMA 6013 or AGMA 6123 for an ambient temperature range of [minus 10 to plus 50 degrees C 15 to 125 degrees F][_____] for use in the gear reducer(s) and backstop(s). Provide viscosity rating and necessary lubricant additives as recommended by the Contractor's fabricator. [Provide environmentally acceptable lubricant in accordance with EPA 800-R-11-002 which is compatible with the lubrication system.] Submit catalog data for the proposed lubricant.

Provide a manufacturer of oil which has a minimum of 15 years of experience in the processing and manufacture of similar oil. Provide gear oil which is the standard product of the manufacturer and from a standard product line.

Provide gear oil which meets all requirements of ANSI/AGMA 9005 which can operate at both extreme high temperatures and low temperatures. Use gear oil which provides rust and corrosion protection for the gear sets and bearings. Submit lubrication manufacturer data which clearly indicates the lubrication meets the general performance requirements.

a. Thermal and oxidative stability under high temperatures
b. Operation under extreme low temperatures
c. Operation under high temperature
d. Extreme pressure and extreme wear properties to protect the gears and bearings
e. Operation under boundary lubrication to protect gear sets
f. High viscosity index
g. Sludge protection
h. Resistance to water and moisture
i. Hydrolytic stability and water separability data
j. Resistance to foaming

Provide oil with a cleanliness rating that conforms to ISO 4406 and meets the following three digit rating code: 17/15/13. Acceptable water content is below 300 ppm. Provide at least 3 random samples and corresponding test data of gear oil from each delivery to show it conforms to the cleanliness rating and water concentration requirements.

2.8.3 Oil Pumps

Provide positive displacement type oil pumps equip with a relief valve which discharges to the sump which is reversible so it continues to function during a runaway condition.

2.8.4 Prelubrication Pump

****

NOTE: An electric motor-driven prelubrication pump is recommended where hydrodynamic thrust bearings will be used to ensure an optimum oil film is developed prior to startup. Many applications with hydrodynamic thrust bearings do not use electric motor-driven pumps. The designer has the option of omitting the requirement for an electric motor-driven pump.

****

Provide a prelubrication pump which is positive displacement. [Provide a hand-operated type where antifriction thrust bearings are used.][Provide a positive displacement electric motor-driven pump where hydrodynamic thrust bearings are used]. Provide an electric motor-driven pump capable of delivering sufficient pressure to lift the thrust bearing runner from the shoes. Provide the means to operate in manual and automatic modes. Automatic mode consists of automatically supplying oil prior to reducer startup, operating at least 30 seconds after reducer startup, then automatically shutting down. Manual mode, consists of the prelubrication pump being started and stopped from a local push button station.

[Available power for the pump and controls will be 480 V, 3 Ph, 60 Hz and 120 V, 1 Ph, 60 Hz.] Supply oil from the lubrication system prior to reducer startup. Utilize zero-leakage check valves to isolate it from the lubrication system during operation of the reducer. Valve operation is not permitted to execute the prelubrication cycle or to return to normal operation.

2.8.5 Oil and Breather Filters

Provide two oil filters on the pump outlet side, one for removing particles and the other for water removal. Provide a particle filter with a Beta rating of B6 greater than 200 at 400 kPa 60 psi differential tested in accordance with ISO 16889. [The reducer manufacturer may propose an alternate Beta rating by submitting proof that B6 greater than 75 is unsuitable for the lubricant to be used.] Incorporate an oil-filled differential pressure gauge to indicate the pressure drop across the filter. Equip the filter with an internal magnetic element. Provide a water removal filter which can maintain a water content in the oil to no greater than 200 ppm. Size all filter assemblies so the pressure drop across the clean filter is no greater than 30 kPa 4 psi. Size the particle filter to avoid bypass at a startup oil temperature of 25 degrees C 80 degrees F. Provide a filter bypass setting of 300 to 400 kPa 45 to 60 psi. The minimum element collapse rating 1050 kPais 150 psi. Provide a breather filter with a Beta rating of B6 greater than 75 and a desiccant chamber to remove water.

2.8.6 Heat Exchanger

****

NOTES: When using an oil-to-air heat exchanger, use the second bracketed paragraph.

The designer must consider the water source. Where possible, potable water is the first choice. When flows are excessive, other sources must be used. Depending on the turbidity of the water, different methods will be needed to clean the water such as a cyclonic separator. If the water through the heat exchanger tubes is turbid, velocities should be kept above 2 m/s 7 fps to prevent clogging. Where the water is brackish or otherwise highly corrosive, 70-30 tube material should be used. Plate heat exchangers should be left as an option as they are generally easier to maintain. Where suitable cooling water is unavailable or may cause maintenance problems, an oil-to-air heat exchanger should be used.

****

[Provide a heat exchanger which is either a water-cooled shell and tube type, water-cooled plate type, or internal water-cooled coils within the reducer sump. Compose heat exchanger tubes of [90-10 Copper Nickel Alloy][70-30 Copper Nickel Alloy] with a minimum tube thickness of 1.519 mm 0.0598 inch (16 gauge) which adequate for the specified pressure rating. Provide heat exchanger plates type 316 corrosion resistant steel. Circulate water through the tubes or plates. Provide a design which will allow tubes or plates to be cleaned. Maximum temperature of cooling water provided is [25 degrees C 80 degrees F][_____], at a pressure of [550 kPa 80 psi][_____], at a maximum flow rate of [0.6 L/s 10 gpm][_____]. Strain the cooling water to a maximum [3 mm 1/8 inch][_____] particle size. The maximum pressure drop through the clean heat exchanger allowable is [55 kPa (gage) 8 psig][_____]. Design the heat exchanger for a working pressure of [550 kPa (gage) 80 psig][_____]. Pressure test the heat exchanger to 150 percent of the design pressure for a period of 4 hours and monitor the heat exchanger for leakage during the test. Any leakage will be cause for rejection.]

[Provide an oil-to-air type heat exchanger with size based upon a maximum ambient temperature of 40 degrees C 100 degrees F. composed of copper or copper alloy tubes. Design the heat exchanger to withstand a test pressure of 150 percent of the design pressure held for a period of 4 hours and monitor the heat exchanger for leakage during the test. Leakage is cause for rejection. Include a fan, motor, and controls in the oil-to-air heat exchanger system for maintaining the specified oil temperature.]

2.8.7 Cooling Water Control Valve

****

NOTE: Delete if an oil-to-air heat exchanger is used.

****

Provide a thermo-mechanical control valve to adjust the flow rate of water through the heat exchanger to maintain a minimum oil temperature of 50 degrees C 120 degrees F in the housing sump.

2.8.8 Piping and Tubing

Use seamless steel tubing oil lines up to 50 mm 2 inches o.d. with 37 degree flare or flareless fittings. Use steel pipe with welded fittings where pipe sizes of 50 mm 2 inches and over are required. Use copper or copper alloy with brazed or 95-5 soldered joints for water pipes. Ensure all piping, tubing, and fittings conform to ASME B31.1. Use vibration isolating tubing and piping supports. Keep oil tubing or ports within the gear case where feasible. Keep dissimilar metals electrically isolated to prevent corrosion.

2.8.9 Oil Heater

****

NOTE: In regions where the temperature during flood season is rarely below 10 degrees C 50 degrees F, consideration may be given to omission of the oil heater. However, omission of the oil heater is generally not recommended because it results in poor oil circulation at startup and it is impractical to size the filter to avoid a bypass condition at temperatures below 20 to 25 degrees C 70 to 80 degrees F. Accumulated contaminants can be passed at unacceptable concentrations during a bypass condition. The oil heater should be used since it will help ensure adequate oil flow during unit startup. Caking of the oil on the heater is prevented by using a low watt density heater, 9300 watts per square meter 6 watts per square inch.

****

Install a thermostatically operated oil heater to maintain the oil at a temperature of 25 degrees C 80 degrees F. Size the heater based on a minimum ambient temperature of [minus 10 degrees C 15 degrees F] [_____]. Equip the heater with the ability to be shut off if the unit is to be out of service for an extended period. The heaters watt density can not be greater than 9300 W/square m 6 W/inch squared.

2.9 INSTRUMENTATION

****

NOTE: Provided that the prime mover and reducer are purchased and installed under a single contract, the Contractor must deliver the instrumentation as a complete working package. If the reducer is purchased separately, the designer is responsible for taking care of additional plans and specifications for the instrumentation. On noncritical applications, consideration may be given by the designer to delete the high temperature switch, flow switch, and vibration switch. The designer would then delete all electrical requirements for instrumentation.

****

Provide instrumentation for the reducer supplied and installed as a complete working package. Conform electrical work to NFPA 70. Provide NEMA 250, Type 4 electrical enclosures. Provide an electrical termination cabinet. [Available power is 120 V, 1 ph.] Provide the following devices within the speed reducer at a minimum:

a. High oil temperature switch in unit sump.

    (1) Alarm at 80 degrees C 180 degrees F.

    (2) Shut down prime mover at 95 degrees C 200 degrees F.

    (3) Lower settings may be used if recommended by the Contractor's manufacturer.

b. Oil pressure gauge.

    (1) After oil pump.

    (2) Electric motor-driven prelubrication pump (if used).

    (3) Gauges which are oil or glycerin filled and with snubbers and isolation valves.

c. Thermometer. Mercury is not allowed.

    (1) Sump

    (2) Oil line after heat exchanger

    (3) Backstop

d. Oil Level Sight Gauge, with built in reflector.

e. Resistance Temperature Detector (RTD), Hydrodynamic Thrust Bearing, if used.

(1) Alarm at 80 degrees C 180 degrees F.

(2) Shut down prime mover at 95 degrees C 200 degrees F.

(3) Lower settings may be used if recommended by the reducer and bearing manufacturers.

f. Oil Flow Switch.

(1) Alarm at 80 percent of design flow.

(2) Shut down prime mover at 60 percent of design flow.

g. Vibration Switch - Alarm at 13 mm/s 0.5 inch/sec or at baseline level recommended by the reducer manufacturer.

PART 3 EXECUTION

3.1 TESTS, INSPECTIONS, AND VERIFICATIONS

3.1.1 Shop Testing

Submit a shop test report fully documenting the test. In addition to or as part of the Contractor's normal shop testing procedure, test the reducer at rated speed with no load to check for potential problems prior to field testing. Check gear contact patterns, sound level, lubrication and cooling, and all other operational characteristics. [90 dBA is the maximum sound pressure level of the speed reducer and prime mover allowed in the shop test measured at a distance of 1 m 3 feet from the equipment.] Measure sound in accordance with ANSI/AGMA 6025. Provide any preventative measures to control background noise. Notify the Contracting Officer 2 weeks prior to performing the shop test.

[3.1.1.1 Critical Speeds

****

NOTE: Dynamic analysis of the pump, reducer, and engine or motor assembly will be performed by the pump manufacturer as described in Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE. If the reducer is purchased separately from the pump, this paragraph should be deleted and responsibility for dynamic analysis, if done, is that of the designer.

****

Perform dynamic analysis of the pump, reducer, and motor (engine) assembly. Make any design modifications to the reducer which are necessary to avoid resonances in the system. A torsional or lateral natural frequency within 25 percent of normal operating speed of any shaft or gear mesh frequency is unacceptable.

]3.1.2 Installation

****

NOTE: If the reducer is not furnished installed, this paragraph must be modified or eliminated.

****

Install the speed reducer under the supervision of the reducer Contractor's representative and ensure all features and systems are operational. Provide all necessary lifting devices, attachments, and special tools required for maintenance. Submit an OPERATIONS AND MAINTENANCE (O&M) MANUAL which provides detailed startup and operating procedures, lubrication instructions, installation and alignment procedures, routine maintenance requirements and procedures, complete detailed procedures for disassembly and assembly of the reducer, parts list for all parts detailed, assembly drawings of the reducer showing all parts, suppliers for all parts, settings and adjustment for protective devices, and a list of all tools, handling devices, and spare parts furnished.

3.1.3 Field Testing

Field test the speed reducer at rated speed and load to demonstrate that reducer operation, lubrication, cooling, and instrumentation meet contract requirements. Ensure the duration of the test is long enough to reveal verifiable gear contact patterns. Inspected gear contact patters and provide to the Contracting Officer. Ensure gear contact patterns are at least 70 percent of face width. Ensure spiral bevel gears have a central toe contact pattern with contact of 50 percent of face width at full load. Photograph and include as part of the field test report the observed gear contact patterns. Document all data collected for load and speed measurement, lubrication, oil temperature and flow, ambient temperature, cooling water temperature and flow, gear contact patterns, and any other data required to show compliance with specifications. Should there be insufficient water available to perform the test, the Contracting Officer may delay the test [for up to [9][___] months]or waive the test.

3.2 OPERATIONS AND MAINTENANCE DATA

[For specifications on the furnishing, installation, operations and maintenance instructions, refer to Section 01 78 23 OPERATION AND MAINTENANCE DATA. Unless otherwise specified, all operation and maintenance manuals are to be comprehensive to the gear reducer system with independent sections for each unique piece of equipment. Operation and Maintenance manuals are to comply with the requirements of Data Package 3 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

] a. Safety precautions
b. Operator prestart
c. Startup, shutdown, and post-shutdown procedures
d. Normal operations
e. Emergency operations
f. Environmental conditions
g. Lubrication data
h. Preventive maintenance plan and schedule
i. Cleaning recommendations
j. Troubleshooting guides and diagnostic techniques
k. Wiring diagrams and control diagrams
l. Maintenance and repair procedures
m. Removal and replacement instructions
n. Spare parts and supply list
o. Product submittal data
p. O&M submittal data
q. Parts identification
r. Warranty information
s. Testing equipment and special tool information

t. Testing and performance data
u. Contractor information

Submit six copies of the OPERATIONS AND MAINTENANCE (O&M) MANUAL [in accordance with paragraph OPERATIONS AND MAINTENANCE MANUALS and] in compliance with Data Package 3 in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-35 45 04.00 10 (November 2020)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SUBMERSIBLE PUMP, CENTRIFUGAL TYPE

11/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-35 45 04.00 10 (November 2020)**

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SECTION 35 45 04.00 10

SUBMERSIBLE PUMP, CENTRIFUGAL TYPE

11/20

****

NOTE: This guide specification covers the requirements for submersible centrifugal pumps for a turbid water pumping station. Note that the guide specification for submersible axial flow and mixed flow pumps is provided in Section 35 45 02.00 10 SUBMERSIBLE PUMP, AXIAL-FLOW AND MIXED-FLOW TYPE.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide specification is for use in construction contracts. It may be used in supply contracts, but should be changed as appropriate. Differences between the technical paragraphs written for Contractor-supplied pumps versus Corps supply specification should be minimal.

This pump specification will be used with the design criteria in EM 1110-2-3105, "Mechanical and Electrical Design of Pumping Stations", and the references listed in those publications. To the

extent possible the Hydraulic Institute (HI) Standards have been referenced as the primary reference standards, and the minimum for manufacturers' compliance, for the manufacture, material, design, test, and performance specifications:

HI/ANSI 9.1-9.5	**General Design**
HI/ANSI 9.6.4	**Vibration Analysis**
HI/ANSI 11.6	**Testing**
HI/ANSI 14.1-14.2	**Nomenclature and Definitions**
HI/ANSI 14.3	**Design and Application**

The vibration analysis often required of pumps is eliminated and a vibration limit specified.

The pumps are of the pre-engineered (catalog) type, used at flood control and storm water projects. Over specifying can prove costly and even double the cost of an otherwise inexpensive pump. In general, the two most important attributes to a successful specification will be to obtain a qualified, experienced manufacturer and to properly specify the pumping conditions so that the correct pump is obtained.

Model testing is not included as an alternative for these pumps. Manufacturers assemble and performance test the pumps at the factory. The pumps are shipped assembled.

Witness tests and factory visits have been limited to one visit during the performance test and a pump inspection at the time of the test.

****

1.1 SUMMARY

****

NOTES: Centrifugal pumps have greater solid passing capability and are well suited for higher pressure applications. However if this is not a concern then axial flow or mixed flow pumps should be considered.

This specification is for flood risk management pumping stations or similar applications. Specifications for centrifugal solids handling sanitary sewerage pumps are available at Section 22 13 29 SANITARY SEWERAGE PUMPS.

****

Design, furnish, and install [_____] identical pump/motors. Water pumped will not exceed [_____] degrees C F, will be relatively turbid, and may contain sand, silt, and trash and fibrous materials with spherical solids up to [three] inches in diameter.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B4.1	(1967; R 1994; R 2004; R 2009; R 2020) Preferred Limits and Fits for Cylindrical Parts
ASME B31.1	(2024) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A108	(2024) Standard Specification for Steel

	Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A285/A285M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A564/A564M	(2019) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A576	(2023) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications

HYDRAULIC INSTITUTE (HI)

HI ANSI/HI 9.1-9.5	(2021) Pumps General Guidelines for Materials, Sound Testing, and Decontamination - B117
HI ANSI/HI 9.6.4	(2022) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 11.6	(2016) Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests
HI ANSI/HI 14.1-14.2	(2019) Rotodynamic Pumps for Nomenclature and Definitions

HI ANSI/HI 14.3	(2019) Rotodynamic Pumps for Design and Application

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 72	(1999; R 2020) Continuity of Coating Testing for Electrical Conductors

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pump Supplier Qualifications; G, [_____]

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Materials; G, [_____]

Installation Instruction Manual; G, [_____]

Impeller Balancing; G, [_____]

Factory Tests; G, [_____]

Pump Field Tests; G, [_____]

Spare Parts; G, [_____]

Special Tools; G, [_____]

SD-06 Test Reports

Factory Test Report; G, [_____]

Field Test Report; G, [_____]

Installation and Start-Up Engineer; G, [_____]

SD-07 Certificates

Qualified Welders; G, [_____]

Warranty; G , [_____]

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G[, [_____]]

1.4 QUALITY CONTROL

1.4.1 Pump Supplier Qualifications

The pump manufacturer has overall responsibility to supply the pumping unit (submersible pump/motor, discharge elbow, and cables) that meet the requirements of this specification. Thus, during start-up, installation, and performance evaluation, the pump manufacturer is the sole responsible party. The pump manufacturer must supply a list of installations at which pumps of his manufacture, and ones similar to those specified, have been operating for at least two years. The components and materials of the pumping unit may occur at different facilities, and be the product of other manufacturers.

1.4.2 Installation and Start-up Engineer

Furnish a competent installation engineer (including those from Contractor's suppliers) who is knowledgeable and experienced with the installation and start-up procedures for submersible centrifugal pumps and the associated equipment specified. Submit the installation and start-up engineer's qualifications. When so requested, the installation engineer is responsible for providing complete and correct direction during installation, initial starting, and subsequent operation of equipment until field tests are completed. The installation engineer initiates instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment.

1.4.3 Detail Drawings

Submit drawings of sufficient size to be easily read, within [90] days of Notice of Award. Submit information in the English language. Dimension in the metric (SI) with English conversion inch-pound-second system. Furnish the following:

a. Outline drawings of the pump showing dimensions and weight of the pump/motor.

b. Drawings showing details and dimensions of pump mounting design and layout including any embedded items and lifting connections.

c. Cross-sectional drawings of each different size of pump, showing each component, and major or complicated sections of the pump in detail. On each drawing indicate an itemized list of components showing type, grade, class of material used, and make and model of the standard component used. Include detail and assembly drawings of entire pumping unit assembly.

d. Provide drawings covering the installation that is intended for the installation engineer.

e. Indicate efficiency,kW bhp, and NPSHR with the capacity-head curve.

f. Motor characteristic curves or tabulated data (test or calculated) to indicate the speed, power factor, efficiency, current, and kilowatt input, all plotted or tabulated against percent load as abscissas.

g. Submit shop drawings for each size access cover supplied. Include all dimensional data necessary for installation. Include installation details for access cover shop drawings.

1.4.4 Welding

Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING. For all other welding, qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the Contracting Officer

24 hours in advance of qualification tests. Perform the qualification tests at the work site if practical. The welder or welding operator must apply their assigned symbol near each weld made as a permanent record. Submit the names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to.

1.4.5 Operating and Maintenance Instructions

Prior to delivery of any pumps, submit manuals containing complete information in connection with the operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, and re-assembly of the pumps and accessories. Submit a total of [five] copies for each pump size and type. Include a listing of special tools required for working on the pumps. Include comprehensive as built drawings, photographs, factory test results, and sketches of the pumps. Include complete diagnostic information on the pumps and all approved shop drawing submittals on the pumps. Include in the Operation and Maintenance Instructions all approved shop drawings on the access covers, interface modules, and sump pumps.

a. Parts list: provide a complete parts list for the pumps including furnished spare parts and special tools. Clearly show all details and parts. Provide identification markings and sources for all parts.

b. Provide manuals with hard cover post type binders or 3-ring binders and printed on 8-1/2 inch by 11 inch high quality paper with indexed, tabbed section dividers. Provide large sheets that are neatly folded and installed with post hole reinforcements such that sheets can unfold without need to open binder posts. Drawings, sketches, and parts lists incorporated in the manual may be reduced to page size provided such reductions are clear and easily legible, otherwise they may be folded into the manual.

1.5 DELIVERY, STORAGE, AND HANDLING

Inspect each pump for damage or other distress when received at the project site. Store each pump and associated equipment indoors as recommended by the pump manufacturer, protected from construction or weather hazards at the project site. Provide adequate short-term storage for each pump and equipment in a covered, dry, and ventilated location prior to installation. Follow the manufacturer's instructions for extended storage. Supply proper equipment for handling the pump and consider the equipment as special tools if not completely standard. Follow the manufacturer's recommendations for handling of the pump.

1.6 EXTRA MATERIALS

****

NOTE: The spare parts noted herein are from other Corps documents. For any specific project, it would be appropriate to discuss an adequate spare parts list during the designer's plant visitations or discussions with the end user as suggested by EM 1110-2-3105.

****

a. Furnish the following spare parts:

    (1) One complete set of bearings and seals for each size pump.

(2) Replacement wearing rings and O-rings for each size pump.
[(3) One impeller for each size pump.]

b. Furnish one set of all special tools required to completely assemble, disassemble, or maintain the pumps. Special tools refers to oversized or specially dimensioned tools, special attachments or fixtures, or any similar items. Furnish lifting devices required for use in conjunction with the [overhead] [truck] crane. Provide the tools in a toolbox or toolboxes.

1.7 WARRANTY

Provide a manufacturer's warranty for the submersible centrifugal pumps and all equipment furnished under this section against defective workmanship, materials, design, and performance for a period of [_____] years from the date the equipment is accepted. If the equipment or any part thereof does not conform to these warranties, and the Government so notifies the manufacturer within a reasonable time after its discovery, the manufacturer must thereupon promptly correct such nonconformity by repair or replacement. Coordinate the down time for the equipment with the Government, and keep to a minimum duration that is mutually agreed to by the manufacturer and the Government. The manufacturer is liable during the warranty period for the direct cost of removal of the equipment from the installed location, transportation to the manufacturer's factory or service shop for repair and return, and reinstallation on site. The manufacturer must be given the opportunity to perform the removal and reinstallation and to select the means of transportation. For instance, the expense of removing adjacent apparatus, installing spare equipment, costs of supplying temporary service, is not included in this warranty provision.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Spare Pumps

Provide a total of [_____] spare pumps. Spare pumps must be identical to the other pumps provided under this contract. For the spare pumps only, access covers and the guide rail systems are not required. Tag and label spare pumps as spares.

2.1.2 Service Availability

The pumps furnished must be supported by a service organization. Service and parts must be available within [500] miles of the [_____] area. Provide this information in a shop drawing.

2.1.3 Pump Station Start-up Services

The installation and start-up engineer must be present at the installation for each location. Provide for two days on-site for each location. In addition, provide for two days for pump/motor start-up at each location.

2.1.4 Name Plates

Secure a name plate to each major item of equipment to include the manufacturer's name, address, type/style, model, serial number, and catalog number. Provide nameplates made of corrosion resisting metal with raised or depressed lettering on a contrasting colored background.

2.1.5 Instruction Plates

As necessary, equip each item of equipment with suitably installed instruction plates including warnings and cautions describing special and important procedures to be followed during starting, operating, and servicing the equipment. Provide plates made of corrosion resisting metal with raised or depressed lettering on a contrasting colored background.

2.1.6 Factory Test Location

Factory testing facility must be in the continental United States. Submit the proposed testing facility as a shop drawing.

2.2 SYSTEM REQUIREMENTS

2.2.1 Pumping Unit Description

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NOTE: Pumps are designed to be lifted from the sump for maintenance and repair.

****

Each pumping unit includes a pump/motor, discharge elbow, guide rail system, and cable. Each pump must be of the centrifugal submersible type for [storm water,] [flood control,] attached to the same shaft with a submersible electric motor. Except as otherwise stated or noted, the terms pump and pump/motor both refer to an assembled pump motor unit complete with discharge elbow, guide rail system, and cable.

2.2.2 Design Requirements

a. The pump must, as a minimum, meet the applicable design, materials, and manufacturing requirements of HI ANSI/HI 9.1-9.5, HI ANSI/HI 14.1-14.2, HI ANSI/HI 14.3, and these specifications.

b. Operate the pump so that installation and maintenance can be carried out by an [overhead bridge] [jib] [mobile] crane. The weight of the pump/motor integral unit must not exceed [_____] kg lb.

2.2.3 Operating Conditions

a. The pump must be capable of operating in the dry (for the purpose of maintenance and operating checks) for short periods of time as stated in the manufacturer's operating instruction.

b. The pump manufacturer establishes and states in the operating manual the procedures for starting and stopping the pumps, including setting of valves or any sequential operations.

2.2.4 Capacities

****

NOTES: The Corps' policy and procedures for plant design and pump selection are explained in detail in EM 1110-2-3105. Using the data from hydrology and hydraulic studies, the designer will establish the performance requirements of the pumps. Using the manufacturers' catalogs that tabulate the

characteristics of their pre-engineered units, select a pump. The designer should then locate other pumps with the described characteristic and establish contact with manufacturers.

Any pump selected results from careful analysis of the relationships of speed, net positive suction head (NPSH) (cavitation), head-capacity, range of plant operation, sump design requirement, and to a lesser extent, efficiency. During the selection process the manufacturer's input to the design is obtained and integrated into the selection.

The specification will then state specific values to be attained so that a pump with the desired performance can be obtained. It is necessary to state the requirements so that more than one manufacturer can respond. All manufacturers must meet the previous experience and manufacturing standards requirements.

Compliance with the performance requirements will be established using procedures stated in the HI Standards and at the time when the pump is assembled and tested at the factory. Efficiency, heads, and other hydraulic values for purpose of specification should conform to HI definitions, even though Corps manuals are used for the purpose of design criteria.

Centrifugal submersible pumps can range in size from approximately 500 gpm to over 25,000 gpm. Horsepower can range from under 10 hp to over 200 hp. The designer should be aware that for the larger size pumps over 200 hp and 25,000 gpm the weight of the pump and motor combination can be significant. The designer should compare against vertical mixed flow pumps for these size pumps.

Each pump installation will be uniquely different and may require a slightly different head-capacity specification to establish that the correct pump will be obtained. During the pump selection procedure, the designer will establish certain capacities that must be met over a range of heads. The designer may state more than one operating point on the performance curve or utilize different points on the curve such as rated head, design head best efficiency point (BEP), maximum head, and minimum head. The heads defined are as stated in EM 1110-2-3105 and applicable HI standards.

ANSI/HI 11.6 provides various acceptance grades for testing tolerances. Class 2B would be acceptable for most pumping stations that have pumps greater than 10 hp and less than 124 hp. Larger pumps could use class 1B. In accordance with the standard, pumps smaller than 10 hp would have a greater tolerance band as defined in the standard, unless otherwise specified.

ANSI/HI 11.6 allows the option of either verifying the minimum pump efficiency, or verifying the maximum power input, but not both. The efficiency and power requirements would be for the guarantee point only unless otherwise stated. Also, the efficiency and power requirement would need to be defined if the units were a combined pump and motor unit, or just the pump. HI ANSI/HI 14.6 provides guidance for testing in Appendix D.

The selection of pumps for flood and storm water projects will not usually depend on the economics of efficiency. However, a low efficiency can usually be correlated with poor pump hydraulics resulting in a shortened pump life. Therefore, an efficiency relating to the values from the manufacturer's catalog curves should be specified.

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a. The guarantee point is [_____] L/s gpm with a differential pressure of [_____] m ft. [The minimum pump and motor unit efficiency is [_____] m percent.] [The maximum power pump unit input power is [_____] m hp.] The tolerance band is HI ANSI/HI 11.6 class [1B][1E][1U][2B][2U][3B].

[b. The pumps must continuously pump water without signs of distress, including cavitation, with a Net Positive Suction Head Available (NPSHA) of [_____] m ft.]

2.3 MATERIALS

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NOTE: The designer usually establishes communication with pump manufacturers concerning materials and design details appropriate for a specific site. Consideration needs to be given to the end user's input. The designer should utilize appropriate HI Standards. Additionally, AWWA Standards 101-88 (withdrawn) and E102-17 (Vertical Pumps) have useful guidance.

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Submit the generic material for all parts and material specifications including class and grade for all major components (casing, impeller, discharge elbow, shaft, and wear rings) of the pump assembly. Include the latest ASTM specification or to other listed commercial specifications covering class or kinds or materials to be used. Materials must be consistent with the guidelines of HI ANSI/HI 9.1-9.5 and HI ANSI/HI 14.3. Designated items must conform to the following

ITEMS	REQUIREMENTS
Cast Iron	ASTM A48/A48M, Class No. 30A, 30B and 30C
Cast Steel	ASTM A27/A27M, Grade 65 35, annealed
Copper Alloy Castings	ASTM B584, Alloy No. C93700 or C86300
Structural Steel	ASTM A36/A36M
Cold Rolled Steel Bars	ASTM A108, Minimum Working Strength 65,000 psi

ITEMS	REQUIREMENTS
Hot Rolled Steel Bars	ASTM A576, Grades: G10200, G10450, G11410
Hot Rolled Stainless	ASTM A564/A564M, Grade 517400
Bars and Shapes:	
Steel Plates, Structural	ASTM A285/A285M, Grade B
Steel Plates, Pressure	ASTM A516/A516M, Grade 55
Steel Forgings	ASTM A668/A668M, Class F

2.4 SUBMERSIBLE PUMP

2.4.1 Design and Manufacture

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NOTE: Under paragraph PUMP SUPPLIER QUALIFICATIONS the Contractor is required to submit names of previous installations where the selected manufacturer has documented the operating performance for pumps of this design. While the general venturi configuration of the pumps built by different suppliers is similar, the details (e.g., number of bearings, wearing ring design, cast versus fabrication, impeller design, and materials) can be different. Based on design details available, there seems to be little justification to prefer one manufacturer's design over another. The pump portion of the specification is a low tech design compared with the motor and housing internal design, 70 to 80 percent of the cost may be contained in the motor. The emphasis on the pump portion should be on rugged, reliable, long-lasting components that are trouble-free.

The design elements described in this section are taken from drawings, manuals, catalogs, and brochures requested from two manufacturers, one domestic and one foreign. Both have over 30 years of experience and thousands of operating pumps worldwide. A primary concern in the specification was to avoid making it restrictive and yet to ensure that only qualified manufacturers would respond.

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The submersible pump may be either of cast or fabricated construction. The level of manufacture skill must be consistent with the standards referenced in the specifications. All work performed in the manufacturing of the pumps must be in a skillful and professional manner in accordance with the best modern shop practice and manufacturing of finished products similar in nature to those specified herein. The Government reserves the right to observe and witness the manufacturing of the pumps and to inspect the pumps for compliance with contract requirements during factory assembly.

2.4.2 Speed

2.4.2.1 Pump Speed

Rotative speed of the pump cannot be greater than [_____] rpm.

2.4.2.2 Runaway Speed

Design the pump to sustain full runaway speed without damage at maximum head difference across the pump. Based on the system design as indicated, the manufacturer must compute the maximum reverse runaway speed, and design the pump and motor to sustain that reverse rotation without damage.

2.4.3 Pump Construction

2.4.3.1 General

All the exposed nuts and bolts must be stainless steel. Machine and fit all mating surfaces where watertight sealing is required with nitrile rubber O-rings. The fitting must be such that the sealing is accomplished by metal-metal contact between machined surfaces which results in controlled compression of the O-rings. Sealing compounds, grease, or secondary devices are not acceptable.

2.4.3.2 Casing

The casing may be of cast or fabricated manufacture. The hydraulic design must be the manufacturer's standard design as used in previous operating installations. The general manufacture quality relating to flange design, drilling, bolts, alignments, must be in accordance with industry standard practice.

2.4.3.3 Discharge Elbow

The maintenance pump discharge elbow must be furnished by the pump supplier. The elbow must be matched marked to its respective pump and shipped and crated with the pump. Manufacture the discharge elbow of either cast iron or cast steel. Include a flange for automatically mating with the pump discharge bowl when the pump is lowered into place. Elbow must be a long radius type. Include a cast iron or cast steel shoe for anchoring to the sump floor. The seal between the pump volute and discharge shoe must remain tight and intact under any pump thrust. Pump thrust must not be induced on the guide rails. Provide installation instructions for setting the discharge elbow.

2.4.3.4 Trash Stand

The trash stand must be furnished by the pump supplier. The trash stand must be bolted to the bottom of the pump at the inlet. The trash stand mustsupport the pump/motor assembly and keep the pump positioned above the bottom of the sump.

2.4.3.5 Shaft

The shaft must be one piece integral with the motor of [stainless steel] [high-strength cold-rolled carbon steel]. Design the shaft for all torque conditions during normal operation and for runaway speed during reverse flow.

2.4.3.6 Impeller

The impeller design and manufacture must be the manufacturer's standard. The impeller surface must be smooth, without holes and fabrication offsets. The attachments to shaft must be with keys or other fasteners that are made of stainless steel, and of sturdy construction designed to not loosen, but be easily removed for maintenance. The impeller construction may be cast or fabricated. The impellers must be capable of handling solids found in storm water such as trash and fibrous materials. Impellers must be capable of passing [three] inch solids. At the time of assembly the impeller clearances must be those shown on assembly drawings and may be checked in the field or at the factory at the Contracting Officer's option. Balance the impeller at the design operating speed. The standard balance quality grade is G6.3 in accordance with ISO 1940-1. Balance in accordance with the procedure in HI ANSI/HI 9.6.4, except that a two-plane balance is required. Submit the results of impeller balancing.

2.4.3.7 Wear Ring

A wear ring system must be installed to provide efficient sealing between the volute and impeller. The wear ring must consist of a stationary ring made of bronze insert press fitted into the volute inlet, and a rotating stainless steel ASTM A276/A276M, Type 316 ring force fitted into the impeller runner.

2.4.3.8 Nuts and Bolts

Provide bolts used in assembling each pump and its supporting members of corrosion resisting steel and hexagonal type. Stainless steel cap screws conforming to ASTM A276/A276M, Type 316, and used with silicon bronze nuts or stainless steel nuts will be permitted as will silicon bronze cap screws with tapped casting holes.

2.4.3.9 Pump Lifting Handle And Lifting Lugs

Design the lifting handle to bear the entire weight of the pumping unit at a conservative factor of safety. Provide lifting lugs where the weight of the separate part requires a lug.

2.4.3.10 Pump and Motor Bearing Arrangement

The pump and motor bearings must be the standard design of the manufacturer for the pump supplied under this specification. The type and number must be of proven design as used in previous operating units supplied by the manufacturer. Provide bearings of the grease lubricated and sealed type; having a minimum L-10 bearing life of 50,000 hr. Each bearing must be of the correct design to resist the radial and thrust loads applied. Provide enough bearings to ensure the pump rotating elements are supported so that the possibility of excessive vibration is eliminated. Conform ball and roller bearings life and load ratings to ABMA 9 and ABMA 11.

2.4.3.11 Mechanical Seals

Provide a mechanical rotating shaft seal system between the impeller and motor to ensure the motor housing is sealed properly. The mechanical seals must be in tandem, lapped and face type seals running in lubricant reservoirs for cooling and lubrication. The mechanical seals must contain both stationary and rotating tungsten carbide face rings unless otherwise specified. In order to avoid seal failure from sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips can be exposed to the mixed media. Contain all other components in the lubricant housing. All seal faces must be solid material capable of being relapped. The seals must require neither maintenance nor adjustment, but be easy to check and replace. Shaft seals without positively driven rotating members are not considered acceptable or equal.

2.4.3.12 Lubricant Housing

Provide an oil housing with oil, as recommended by the pump manufacturer, to lubricate the shaft sealing system and to dissipate the heat generated by the motor and bearings.

2.4.3.13 Guide Rail System

Furnish each maintenance pump with a stainless steel guide rail system for lifting the pump in and out of the wetwell and connecting to the discharge elbow. The guide rail system must be either a single or double rail system. Guide bars (pipe) must be Type 304 stainless steel. The upper guide bar brackets and intermediate guide bar brackets must be furnished by the pump manufacturer. Match Mark the guide bar brackets to their respective pump. Ship the brackets with the pumps. Brackets must be Type 304 stainless steel. Provide a stainless steel lifting chain of adequate length for removing and installing the pump unit.

2.4.3.14 Cooling System

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NOTE: An air cooled system could be considered depending on the application.

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Each pump unit must have an adequately designed cooling system, consisting of a water jacket which encircles the stator housing. Provide a water jacketwith a separate circulation of the pumped liquid. Cooling media channels and ports must be non-clogging by virtue of their dimensions. All cooling paths or ports must be internal to the pump and motor water jacket to preclude clogging or physical abuse. Design the cooling system to allow for continuous pump operation at rated capacity with the external water level at the minimum pump submergence level.

2.4.4 Motor

The motor must be submersible and conform to the requirements of NEMA MG 1. Size the motor to avoid overload when operating at any point along the characteristic curve of the pump. Provide 3-phase, 60-Hz, [480][_____]V, squirrel cage induction type motors, NEMA Design B Type. Insulate the stator windings and stator leads with a moisture-resistant Class F insulation with temperature resistance of 155 degrees C 311 degrees F. The motor must have a service factor of [1.15]. The temperature rise above ambient for continuous full load rated conditions and for the class of insulation used cannot exceed the values in NEMA MG 1. The motor must be rated for continuous duty when submerged and also be capable of operation in the dry for short periods of time for testing and maintenance purposes. Starting torque must be sufficient to start the pump, but in no case less than 60 percent of full-load torque. Break-down torque cannot be less than 150 percent of full-load torque.

2.4.5 Cable

a. Specifically design power and instrumentation cable for use with a submersible pump application and conform to the requirements of NEMA WC 70 and NEMA WC 72. Use submersible cable suitable for continuous immersion in water at the maximum depth encountered. Cable must have an ampacity of not less than 125 percent of the motor full load current. The cable length must be determined by the pump manufacturer for the installation shown but cannot be less than [_____] m ft.

b. Power and instrumentation cables must enter the motor through a sealing system that prevents water entry into the unit and provides strain relief. The cable entry may be comprised of rubber bushings, flanked by stainless steel washers, having a close tolerance fit against the cable outside diameter and the entry inside diameter for sealing by compression of the bushing, or the entry may be sealed by other gland compression methods.

2.4.6 Alarms

Provide the following alarm features for all the pump/motors.

a. Over temperature alarm: The motor over temperature alarm circuit must be actuated by three thermal sensors embedded in the stator windings of the pump motor (one switch in each stator phase). The pump motor must stop on over temperature and not restart until the over temperature alarm is manually reset and the motor temperature has cooled to the appropriate temperature.

b. Overload alarm: The motor overload circuit on the pump motor must stop the motor upon overload and not restart until the overload condition is corrected and manually reset.

c. Lower seal failure alarm: Provide a leakage sensor in the oil chamber. The sensor must activate an alarm when water concentration exceeds 30 percent.

d. Stator Leakage Sensor: Sensor must activate an alarm and stop the motor when any water is detected.

2.4.7 Pump Interface Modules

The pump supplier must furnish any electrical interface modules necessary for the pump sensors to communicate with the motor control center and control system. Interface modules must be adaptable to any type of standard control system. Match mark interface modules to each pump.

2.4.8 Painting

Paint the pump/motor in accordance with the pump manufacturer's standard coating system. External unmachined and non-mating machined surfaces (except for stainless steel) must be thoroughly cleaned and painted with a hydrocarbon-resistant, anti-corrosive (lead and chromate free) primer and topcoat. Painting external surfaces of nonferrous parts and components is not required but is permissible to avoid excessive masking. Identification plates must not be painted or oversprayed.

2.5 PUMP ACCESS HATCHES (COVERS)

The pump supplier must furnish the access hatches required for each pump. Match mark the access covers to their respective pump. Ship and crate the access covers with the pump. Hatch sizes must be adequate to install or remove pumps in a single action without tipping or tilting the pumps. Covers must be minimum 1/4" thick, extruded 6061 aluminum construction, and designed for incorporating the guide rail system for each pump. Cover must be double leaf design and rated for 300 pounds per square foot and have diamond tread surfacing. Hatches must be complete including framing, flush locking mechanism, handles, and hardware. Frame must be extruded aluminum, minimum 1/4" thick, with concrete anchors as part of the extrusion. All hardware must be stainless steel. Covers must have stainless steel hinges and open to 90 degrees and lock automatically in the open position. Covers must close flush with the frame, resting on a 1/2" wide lip around the entire perimeter of the frame. Attach a stainless steel safety chain to both cover leafs. The chain must help prevent a person from falling into the wetwell when the hatch covers are open. Provide installation manuals for the access covers as noted.

2.6 FABRICATION AND MACHINING

2.6.1 Machine Work

All tolerances, allowances, and gauges for metal fits between plain, non-threaded cylindrical parts must conform to ASME B4.1 for the class of fit required.

2.6.2 Castings

Each casting must have a mark number cast or stamped upon it. In addition, each casting weighing more than 500 pounds must have the heat number cast or stamped upon it. Warped or otherwise distorted castings that are oversize to an extent that could interfere with proper fit with other parts of the machinery or structure will be rejected. Cracked castings of non-weldable materials (i.e., cast iron) will be rejected. Repairs to castings must not be made without prior approval.

2.6.3 Casting Repair

Remove all unsound material or defects from castings by chipping, machining, air arc gouging, or grinding; and repair by welding. Conform welding repairs to the welding procedures that have been submitted and approved for the type material involved. Accomplish stress relief annealing, where required, prior to final machining.

2.6.4 Bolted Connections

Conform bolts, nuts, and washers to the applicable requirements of ASTM A193/A193M and ASTM A194/A194M for the types required.

2.6.5 Regular Bolt Holes

Holes for regular bolts must be drilled or sub-drilled and reamed in the shop. Holes must be accurately located, smooth, perpendicular to the member, and cylindrical.

2.6.6 Fitted Bolt Holes

Match ream or drill holes for fitted bolts in the shop. Holes must be smooth, perpendicular to the member, and cylindrical. Remove burrs resulting from reaming . The threads must be entirely outside of the holes. The body diameter of the bolt must have tolerances as recommended by ASME B4.1 for the class of fit required. Fitted bolts must be fitted in reamed holes by selective assembly to provide an LN 2 fit.

2.6.7 High Strength Bolt Holes

Holes for high strength bolts must be accurately spaced, perpendicular to the member, and cylindrical. If the thickness of the material is greater than the diameter of the bolt, the holes must be either drilled full size or must be sub-drilled and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting done during assembly must not distort the metal or enlarge the holes. For slight mismatching, reaming to a larger diameter for the next standard size bolt will be allowed.

2.6.8 Metallic Coating

Apply zinc coatings sin a manner, thickness, and quality conforming to ASTM A123/A123M. Where the zinc coating is destroyed by cutting, welding, or other causes, re-galvanize the affected areas to the thickness and quality required for the original zinc coating

2.7 FACTORY TESTS

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NOTE: The designer should specify performance testing of the assembled pump in the factory to check that the requirements of the specification have been met.

The Performance Test is a required test, whereas the Cavitation, Hydrostatic, Submersible Motor Integrity, and Vibration tests are optional. The designer should be familiar with ANSI/HI 11.6 to determine which tests are needed to balance technical adequacy and cost.

The Cavitation test, or NPSHR test, is costly due to the complexity. The designer should include cavitation testing whenever the cavitation characteristics of the proposed pump have not been determined (by test) by any one of the prospective suppliers. Testing should be conducted on a full-scale (prototype) pump. It should also establish the structural and operating integrity of the complete pumping unit. The prototype pump would be the first pump built. This test may not be necessary if there is sufficient inlet head pressure and the pump has a stated NPSHR that would be acceptable with a suitable margin (see ANSI/HI 9.6.1). The pump could be tested at the minimum design head pressure to verify that the guaranteed head and power at the specific rate of flow instead of performing the NPSHR test. HI ANSI/HI 14.6 provides guidance for testing in Appendix D.

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Perform the following factory tests in accordance with HI ANSI/HI 11.6. [Testing is nonwitnessed factory testing. The pump manufacturer is responsible for maintaining all test results, however reporting of these test results is not required.][Testing is certified nonwitnessed factory testing. The pump manufacturer must provide certification and data to indicate that the testing meets the testing standard.][Testing must be witnessed by a Government Representative. When satisfied that the pump performs in accordance with the specified requirements, notify the Contracting Officer, [two weeks] in advance, that the witness tests are ready to be run and furnish two copies of curves required in paragraph TEST RESULTS. If the tests reveal that the pump does not perform in accordance with the specifications, make necessary changes before again notifying the Contracting officer that witness tests are ready to be run. Provide copies of all data taken during the witness testing and plotted preliminary curves to the Contracting Officer with the factory test report.]

2.7.1 Performance Test

Compliance with specifications will be determined from curves required by paragraph TEST RESULTS. Test procedures, except as herein specified, must be in accordance with HI ANSI/HI 11.6. Use clean water for testing at approximately the same temperature (68 F) for all test runs and record it during test runs.

2.7.1.1 Performance of the Pump

Determine performance of each pump by a minimum of 5 test points to develop a constant speed curve over the range of total heads corresponding to the requirements of paragraph CAPACITIES. Testing must be inclusive for the speed involved. Perform tests using the heads and suction water elevation specified in paragraph CAPACITIES. Test results with this sump elevation must meet all specified conditions of capacity, head, and bkW bhp.

2.7.1.2 Test Results

Submit the factory test report for performance testing in accordance with HI ANSI/HI 11.6. Plot test results to show the total head, static heads,bkW bhp, and efficiency as ordinates. Plot the results against pump discharge in L/s gpm as the abscissa. Plot curves showing pump performance to a scale that will permit reading the head directly to 0.15 m [0.5] ft, capacity to 30 L/s [500] gpm, efficiency to [1] percent, and power input to 20 bkW [25 bhp]. Establish that the performance requirements of these specifications and the warranties under this contract have been fulfilled. Perform the performance test with the pump and motor assembled as an operating unit to simulate field installation unless otherwise approved in writing by the Contracting Officer. Conduct the test in accordance with accepted practices at full speed; and, unless otherwise specified, conform to HI ANSI/HI 11.6 procedure and instruments.

[2.7.2 Cavitation Test

Use the testing procedures provided in HI ANSI/HI 11.6 to determine the net positive suction head required (NPSHR) by the pump. Select the test arrangement and procedure, from the choices provided in HI ANSI/HI 11.6, that best suits the test facility. NPSHR must, as a minimum, be determined for five or more capacities over the total range of the specified operating conditions. Plot the test results and define NPSHR as the point where a three percent drop in performance occurs. The value of NPSHR must be 0.6 m [3.3] ft less than the corresponding NPSHA. Use the temperature of the water at the time the tests are run in determining the NPSHR. Refer to the paragraph CAPACITIES for the NPSHA.

][2.7.3 Hydrostatic Test

Perform a hydrostatic test of the pump to verify the absence of leakage from the pressure containing walls and the joints of the pump assembly is in accordance with HI ANSI/HI 11.6. The hydrostatic test pressure is based on the differential pressure of the pump as specified in paragraph CAPACITIES. [Submit the certification that the Hydrostatic Test meets the requirements of HI ANSI/HI 11.6 with no visible signs of leakage.] [Submit a full report of the Hydrostatic Test in accordance with HI ANSI/HI 11.6.]

][2.7.4 Submersible Motor Integrity Test

Perform a submersible motor integrity test to verify the sealing and electrical integrity of a submersible motor in accordance with HI ANSI/HI 11.6. Submit the certification that the Submersible Motor Integrity Test meets the requirements of HI ANSI/HI 11.6.

][2.7.5 Vibration Test

Perform a vibration test to verify that the tested pump does not exceed a guaranteed vibration velocity level as specified in HI ANSI/HI 11.6. Submit the certification that the Vibration Test meets the requirements of HI ANSI/HI 11.6 and summarize findings in a report.

]PART 3 EXECUTION

3.1 INSTALLATION

Perform correct installation and assembly of the pumping unit in accordance with the drawings and with the manufacturer's installation instruction manual. Submit, no later than 30 days prior to time of pump delivery, three copies of a typed and bound manual describing procedures to be followed by the installation engineer in assembling, installing, and dry- or wet-testing or both of the pump. Coordinate and consolidate the description of the pump with similar descriptions for other specified pump parts. The description must be of such a nature that it may be comprehended by an engineer or mechanic without extensive experience in erecting or installing pumps of this type. The description must be a step-by-step explanation of operations required, and include, where applicable, such things as alignment procedures, bolt torque values, recommended instrument setups, recommended gauges and instruments, and similar details. Furnish all bolts, shims, tools, and other devices necessary for installing the pumping units. The manufacturer's representative(s) familiar with the equipment being installed must supervise the handling, installation, start-up, and testing of the equipment as required in the paragraph INSTALLATION AND START-UP ENGINEER.

3.2 CLEANUP PRIOR TO START

After the pumping unit is installed and prior to start-up, completely clean the sump area of any accumulated construction debris. This final cleaning of the sump area will be witnessed by a representative of the Government. Correct any damage to the pumping units or related equipment during initial start-up due to foreign objects left in the sump areas.

3.3 PUMP FIELD TESTS

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NOTES: Compliance with specification performance has been made a part of the factory tests; therefore, field tests are for the purpose of baseline measurements. Pump integrity, vibration, , and inspection of manufacturing quality are witnessed at the factory.

Perform field testing to ensure proper alignment and installation, start-up and shutdown procedures, checking out controls, and establishing baseline measurements. Two field test methods are available, dry or wet testing, depending on availability of water. Wet testing is preferred, but dry testing may be all that is possible when the pumps are prepared for initial start-up.

If a wet test cannot be conducted at the time of initial start-up because of a lack of water, it should be conducted at a later time, if possible, and does not unduly extend the contract period.

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Submit a field test plan prior to field testing. Field testing must be conducted by an experienced field test engineer and will be witnessed by the Contracting Officer. Before initially energizing the pump/motors, ensure that all pumping plant control, monitoring, and protective circuits have been successfully tested. This thorough electrical checkout procedure must follow a detailed step-by-step approved test plan. Also check the motor and other pumping unit elements undergoing tests at this time. Field test the plan prior to field testing. Submit the Field Test Report that summarizes the results of the testing.

[3.3.1 Dry Test

Test each pumping unit in the dry in accordance with the pump manufacturer's instructions to determine whether it has been properly installed. Conduct such test when, and as, directed by Contracting Officer. Operate the pump at full rated speed. If tests reveal a design or installation deficiency or a manufacturing error in pumping unit components, promptly correct the problem.

]3.3.2 Wet Test

Test each unit under load for a period of at least [_____] hours or as directed by the Contracting Officer. Conduct the tests to be witnessed by the Government. During the tests, observe, measure, and record the operation of the pumping units, motor-bearing temperatures, voltage, and current for each pump. Measured parameters must be within the pump manufacturer's published limits.

3.3.3 Pump Removal and Installation

Install and remove each maintenance pump unit a minimum of three times to demonstrate proper pump alignment and installation. Verify that the pump can be removed and installed without sticking or binding. Verify proper sealing at the discharge elbow.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 51 13.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-03420N (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 35 51 13.00 20

CONCRETE FLOATING PIER FOR SMALL CRAFT

04/06

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-35 51 13.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-03420N (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 35 51 13.00 20

CONCRETE FLOATING PIER FOR SMALL CRAFT

04/06

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NOTE: This guide specification covers the requirements for precast non-prestressed concrete floating piers and associated hardware and accessories.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 309R	(2005) Guide for Consolidation of Concrete
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C2	(2003) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA C18	(2003) Standard For Pressure Treated Material in Marine Construction
AWPA C28	(2003) Standard for Preservative Treatment of Structural Glued Laminated Members and Lamination Before Gluing of Southern Pine, Coastal Douglas Fir, Hemfir and Western Hemlock by Pressure Processes

AWPA C33	(2003) Standard for Preservative Treatment of Structural Composite Lumber by Pressure Processes
AWPA P5	(2015) Standard for Waterborne Preservatives

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland

	Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C272/C272M	(2018; R 2024) Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions
ASTM C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D1894	(2014) Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D4020	(2011) Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials

ASTM D5456	(2017) Standard Specification for Evaluation of Structural Composite Lumber Products
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM G109	(2023) Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments E(2000)

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN/CENELEC)

CENELEC EN 60529	(1991; A1 2000; A2 2013) Degrees of Protection Provided By Enclosures (IP Code)
EN 60309-1	(1999; A1 2007; A2 2012) Plugs, Socket-Outlets and Couplers for Industrial Purposes Part 1: General Requirements
EN 60309-2	(1999; A1 2004; A11 2007; A2 2012) Plugs, Socket-Outlets and Couplers for Industrial Purposes Part 2: Dimensional Interchangeability Requirements for Pin and Contact-Tube Accessories

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(2021) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 5th Edition
PCI MNL-120	(2021) PCI Design Handbook - Precast and Prestressed Concrete, 8th Edition

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-QQ-A-200/8	(1997; R 2012) Aluminum Alloy 6061, Bar, Rod, Shapes, Tube, and Wire, Extruded

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-I-24768/14	(1992; Notice 1 2020) Insulation, Plastic, Laminated, Thermosetting, Cotton-Fabric-Base, Phenolic-Resin (FBG)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-55619	(Rev C; Notice 1; Notice 2; Notice 3) Casters, Industrial, Heavy Duty

UL SOLUTIONS (UL)

UL 98	(2016; Reprint Jan 2022) UL Standard for Safety Enclosed and Dead-Front Switches
UL 231	(2016; Reprint Oct 2022) UL Standard for Safety Power Outlets
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1686	(2023; Reprint Nov 2024) Standard for Pin and Sleeve Configurations

1.2 MODIFICATIONS TO REFERENCES

In the ACI publications, the advisory provisions shall be considered to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears; reference to the "Building Official," the "Structural Engineer" and the "Architect/Engineer" shall be interpreted to mean the Contracting Officer.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings of Precast Floats; G, [_____]

Gangways

[Receptacle Stations; G, [_____]

] SD-03 Product Data

Anchorage and lifting inserts and devices

[Receptacle Stations; G, [_____]

] Guide Pile Caps

SD-05 Design Data

Precast Concrete Floats Design Calculations; G, [_____]

Gangway Design

Concrete Mix Design

SD-06 Test Reports

Contractor-Furnished Mix Design

Submit copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Obtain approval before concrete placement.

SD-07 Certificates

Fabrication

Rubbing Surface

[Paint Coating System

] Submit quality control procedures established in accordance with PCI MNL-116 by the precast manufacturer.

1.4 PRECAST FLOATS

The work includes the provision of precast, non-prestressed concrete floating pier modules herein referred to as precast floats, and all other items relating to the precast floating pier system. Precast floats shall be the product of a manufacturer specializing in the production of precast concrete floats with a minimum of 10 years experience in the manufacture of precast concrete floating piers.

1.5 QUALITY CONTROL

1.5.1 Precast Concrete Float Design

ACI 318M, ACI 318 and the PCI MNL-120. Design precast floats (including connections) for the design load conditions and spans indicated, and for additional loads imposed by the work of other trades. Design precast floats for handling without cracking in accordance with the PCI MNL-120.

1.5.1.1 Pier Loading

Float and anchorage systems shall be designed for the following load conditions as a minimum. Load cases shall be combined based upon their probability of simultaneous occurrence, and in accordance with applicable codes and standards. Wind and current exposure areas shall be based on average vessel profile and draft, respectively. To account for sheltering effects, 15 percent of the full load shall be applied to all vessels sheltered by the vessels exposed to full load. Calculations shall be performed for wind and current loads both parallel and perpendicular to the pier.

****

NOTE: Designer should consult with a manufacturer of precast concrete floats to determine maximum allowable loadings for a given float size. The use of values exceeding the recommended default maximums should be confirmed with a reputable manufacturer prior to inclusion.

Environmental loadings (wind, wave, current & tide surge) will be site specific.

Default values for berthing and mooring loads are recommended maximum values, based on limitations of the precast modules. Berthing load is vessel and pier configuration specific. Mooring load is maximum, based on anchorage strength of (default) cleat size (confirm with manufacturer). The designer should input berthing and mooring loads based on the actual vessels berthed.

****

a. Dead load, including all work of other trades (utilities, etc.)

b. Live load: [_____] [3.83] kPa [80 PSF]

c. Wind pressure: As indicated on drawings
Acting on the projected area of the pier and moored vessels, assuming full occupancy. For vessel area, assume an average height of [_____] m feet above the waterline.

d. Minimum current pressure: [_____] kPa [PSF][FPS velocity]
Acting on the projected area of the pier and moored vessels, assuming normal occupancy.

e. Berthing load: [_____] [136] N/m [100] PLF horizontal

f. Mooring load: [_____] [1.78] kN [400] lb.
Line pull acting in any direction at a 45 degree angle from the horizontal.

g. Vertical wave load: As determined from a [_____] [0.9] m [3] ft. wave height

h. Lateral wave load:As determined from a [_____] [0.9] m [3] ft. wave height

i. Lateral pile loads at maximum surge level: For surge level indicated on drawings

1.5.1.2 Performance

a. Precast float modules shall be sized so that a single module (excluding walers) is used to attain the indicated pier width. The use of more than one module connected side by side to attain pier width is unacceptable.

b. Freeboard under dead load only shall not be less than [_____] 610mm 24 in. nor exceed [_____] 762mm 30 in. Precast floats shall be designed to float level under dead load only. Maximum out of level tolerance for transverse and longitudinal slope is [_____] 25mm per 3m 1 in. per 10 ft. Freeboard under dead and live load shall not be less than [_____] 203mm 8 in.

c. Special precast floats must be designed to support the additional concentrated loads as imposed by gangways, transformers, or other equipment. Modules with special loadings shall have the same freeboard as standard modules without special loading, so that there will be no residual stresses or tilting when modules are interconnected.

d. Flotation units shall be located within the structure so as to be capable of supporting a [_____] 136 kg 300 lb moving point load in any area on a module without causing excessive rolling or tilting of the pier. The pier shall be capable of supporting a [_____] 181 kg 400 lb point load at 305mm 1 ft from the offshore end of the pier and loose no more than 101mm 4 in of freeboard; and supporting a [_____] 136 kg 300 lb point load applied to the corner of the offshore end of the pier and loose no more than 51mm 2 in of freeboard differential per 914mm 3 ft of pier width between the offshore corners.

[e. Precast floats shall have PVC sleeves and pull boxes embedded as required for electrical and communications systems. Pull boxes shall have a nominal 25mm 1 in concrete bottom with a light brushed, slip resistant finish. All bolts and inserts for pull box lids shall be 316 stainless steel. Pull box lids shall be flush with the deck surface and rated for the pier deck loading. Sleeves shall remain above water surface under dead load conditions and shall be designed to facilitate installation, removal, and servicing of utilities. Pull boxes and access openings shall be sized and located as indicated on the drawings.

]1.5.2   Gangway Design

Provide gangways of prefabricated aluminum for floating pier access, including connections at the bulkhead and bearing on the floating pier. Gangway shall be designed in accordance with "Specifications for Aluminum Structures", AA, latest edition, using allowable stresses for bridges.

1.5.2.1   Gangway Loading

Gangways shall be subject to the same load conditions identified in the paragraph titled "Pier Loading", except for berthing, mooring, current, wave, and pile loading conditions. Additionally, the gangway bulkhead end connections shall be designed to withstand a lateral force equal to 20 percent of the total dead load and 50 percent of the live load acting simultaneously with the dead and live loads. Handrails shall be designed for the following independent load cases: 1) a continuous horizontal load of 27.1 N/m 20 PLF applied along the full length of the top rail, and 2) a horizontal point load of 113.4 kg 250 lbs acting at any point along the top rail.

1.5.2.2   Performance

a. Gangways shall have a minimum clear walkway width of [_____] 1.07m 3.5 ft, and an overall outside width not to exceed [_____] 1.37m 4.5 ft. Length of gangways shall be as indicated on the drawings. Gangways shall have continuous handrails that are a minimum of 1.07m 3.5 ft above the walking surface, but not to exceed 1.14m 3.75 ft.

b. Walking surface shall be skid resistant.

c. Gangway pier end connections shall allow unrestricted vertical movement through tidal variation. Gangway bearing on floating piers shall be fitted with UHMW polyurethane rollers of adequate bearing area. Gangways shall be fitted with hinged apron plates to assure a safe uniform transition between gangway and deck surfaces. Apron plates will be designed so as to not damage or mar the floating pier surface.

d. Maximum midspan deflection under live load shall not exceed L/240.

e. Contact between aluminum and dissimilar metals or concrete shall be avoided, except for the use of compatible stainless steel pins. Where potential for galvanic corrosion exists, the aluminum shall be isolated from direct contact with other metals or concrete by use of suitable non-conducting insulators or bushings.

1.5.3   PCI Quality Certifications

****

NOTE: For normal routine projects, use the first paragraph. For complex or large precast/prestressed projects, use the second paragraph. Note that use of the second paragraph may limit competition. Verify the availability of certified PCI precasters in the bidding area.

****

PCI MNL-116. At the precast manufacturer's option, in lieu of core samples, ACI 318M and ACI 318, full scale load tests may be performed. Perform on randomly selected precast floats, as directed by the Contracting Officer.

[1.5.3.1 Product Quality Control

PCI MNL-116 for PCI enrolled plants. Where precast floats are manufactured by specialists in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

]1.6 DELIVERY AND STORAGE

Lift and support precast floats at the lifting and supporting points indicated on the shop drawings. Store precast floats off the ground. Separate stacked precast floats by battens across the full width of each bearing point. Protect from weather, marring, damage, and overload.

1.7 FACTORY INSPECTION

At the option of the Contracting Officer, precast floats shall be inspected by the QC Representative prior to being transported to the job site. The Contractor shall give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.8 QUALITY ASSURANCE

1.8.1 Drawing Information

Submit drawings indicating complete information for the fabrication, handling, and erection of the precast floats and gangways. Drawings shall not be reproductions of contract drawings. Design drawings of precast floats and gangways (including connections) shall be prepared and sealed by a registered professional engineer, and submitted for approval prior to fabrication. The drawings shall indicate, as a minimum, the following information:

a. Floating pier system layout

b. Marking of floats for assembly

c. Connections between floats, and connections between floats and other construction

d. Location and anchorage of mooring fittings

e. Waler size and splice pattern

f. Guide pile size, length, location and connection to pier

g. Reinforcing details

h. Material properties of all materials used

i. Lifting and assembly inserts and embedded items

j. Dimensions and surface finishes of each float

k. Erection sequence and handling requirements

l. All loads used in design (such as live, dead, wind, current, berthing, handling, and erection)

m. Bracing/shoring required

n. Gangways

[o. Utility routing and connections for work of other trades

] 1.8.2 Design Calculations

Submit calculations reflecting design conforming to requirements of paragraph entitled "Precast Concrete Float Design" and "Gangway Design". Design calculations of precast floats and gangways (including connections) shall be prepared and sealed by a registered professional engineer, and submitted for approval prior to fabrication. In addition to member sizing calculations, submit calculations for the pier system which include:

a. Anchorage attachment points to insure reactions shall be appropriately and rationally distributed throughout the system

b. Overall system loads under full occupancy, with consideration for shielding factors, and deflection of the system and its effects on anchor loading

c. Anchorage system capacity for individual and overall load considerations

d. Guide pile size, length, cross section, and minimum embedment

1.8.3 Concrete Mix Design

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Include a complete list of materials including type; brand; source and amount of cement, pozzolan, and admixtures; and applicable reference specifications.

[1.8.4 Paint Coating System

Submit IEEE C57.12.29 coating system performance requirements test on "test specimens" of the same material used in fabrication of the receptacle stations.

]PART 2 PRODUCTS

2.1 CONTRACTOR-FURNISHED MIX DESIGN

****

NOTE: Normal precast design is based on concrete having a compressive strength of 35 MPa 5000 psi at 28 days. Some precast manufacturers like to speed up production by using Type III (high early strength) concrete.

****

****

NOTE: Delete air entraining requirements when the

project is located in a nonfreezing climate.
****

ACI 211.2, using weight method. The minimum compressive strength of concrete at 28 days shall be [_____] [35] MPa [5000] psi with a unit weight of 1800 kg/m^3 115 pcf dry. Mix shall contain a corrosion inhibitor[and air-entraining admixtures at the mixer to produce between 5 to 7 percent air by volume]. The use of foaming agents is prohibited.

2.2 PRECAST FLOAT MATERIALS

2.2.1 Cement

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NOTE: For normal precasting (not requiring sulfate resistance), use the first bracketed item. If sulfate resistance is required, use the second bracketed item.
****

ASTM C150/C150M, Type [I][II]; or ASTM C595/C595M Type IP(MS) or IS(MS) blended cement, except as modified herein. The blended cement shall consist of a mixture of ASTM C150/C150M cement and one of the following materials: ASTM C618pozzolan or fly ash, or ASTM C989/C989M ground iron blast furnace slag. The pozzolan/fly ash content shall not be less than 20 percent nor exceed 40 percent by total mass of cementitious material. The content of ground granulated blast-furnace slag shall not exceed 50 percent of the mass of cement. The minimum amount of portland cement is 50 percent of the total mass of cementitious material. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

2.2.1.1 Fly Ash and Pozzolan

ASTM C618, Type N, F, or C, except that the maximum allowable loss on ignition shall be 6 percent for Type N and F.

2.2.1.2 Ground Iron Blast-Furnace Slag

ASTM C989/C989M, Grade 100 or 120.

2.2.2 Water

Water shall be fresh, clean, and potable.

2.2.3 Aggregates

2.2.3.1 Aggregates Selection

****
NOTE: Select gradation(s) based on job requirements and constraints. The maximum aggregate size shall not exceed three-quarters the minimum cover over reinforcing. Aggregate grading sizes with their general grading ranges are as follows: Size 57 (25 mm one inch to No. 4 sieve), Size 67 (20 mm 3/ 4 inch to No. 4 sieve), and Size 7 (12 mm 1/2 inch to No. 4 sieve).
****

ASTM C330/C330M, Size 8 (3/8 inch), except as modified herein. Obtain aggregates for exposed concrete surfaces from one source. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalies in the cement.

2.2.4 Grout

2.2.4.1 Nonshrink Grout

ASTM C1107/C1107M.

2.2.4.2 Cementitious Grout

****

NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.

****

Shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method.[Provide air entrainment for grout exposed to the weather.]

2.2.5 Admixtures

[2.2.5.1 Air-Entraining

****

NOTE: Delete air entraining requirements when the project is located in a nonfreezing climate.

****

ASTM C260/C260M.

]2.2.5.2 Accelerating

ASTM C494/C494M, Type C or E.

2.2.5.3 Water Reducing

ASTM C494/C494M, Type A, E, or F.

2.2.5.4 Corrosion Inhibitor

Calcium nitrite, ASTM G109. Add at the rate of 22.25 l per cubic meter 4.5 gallons per cubic yard.

2.2.6 Reinforcement

All reinforcement shall be hot-dipped galvanized, ASTM A123/A123M or ASTM A153/A153M.

2.2.6.1 Reinforcing Bars

****

NOTE: Specify ASTM A706/A706M reinforcing where welding or bending of reinforcement bars is important.

****

ASTM A615/A615M[ASTM A706/A706M], Grade 420 [40] [60].

2.2.6.2   Welded Wire Fabric

ASTM A1064/A1064M. Provide flat sheets of welded wire fabric, rolled fabric is not acceptable. Maximum fabric grid is 50mm x 50mm 2 in. x 2 in..

2.2.7   Metal Accessories

Provide ASTM A123/A123M or ASTM A153/A153M, hot-dipped galvanized.

2.2.7.1   Inserts

ASTM A47/A47M, Grade 22010 32510 or 35018, or ASTM A27/A27M Grade 415-205 U-60-30.

2.2.7.2   Structural Steel

ASTM A36/A36M.

2.2.7.3   Bolts

ASTM A307 and ASTM A36/A36M. Waler rods shall be continuous laterally through the pier, with a minimum diameter of 19 mm 3/4 inch. All continuous waler rods shall be placed within PVC sleeves cast into the precast float modules.

2.2.7.4   Nuts

ASTM A563M ASTM A563.

2.2.7.5   Washers

ASTM F844 washers for ASTM A307 bolts.

2.2.7.6   Cleats

Provide [_____] 457 mm 18 in boat cleats spaced at approximately [_____] 6100 mm 20 ft.

2.2.8   Foam Core

Closed cell, expanded polystyrene (EPS), ASTM C578. Foam core laminations shall be glued with a low solvent glue. Core shall not be made from more than four laminated sections. Horizontal laminations in the upper 254mm 10 in are not permitted. Core shall be strapped to prevent de-lamination during transportation and handling. Core shall not contain more than 10 percent reground EPS foam material. Reground foam pieces shall not exceed 10mm 3/8 in diameter.

Unit Weight: 12 - 48 kg/m^3 0.70 - 3.00 pcf

Water absorption (ASTM C272/C272M): 3 percent (by volume)

Dimensional tolerance: plus or minus 3mm 1/8 in

2.3 FABRICATION

PCI MNL-116 unless specified otherwise.

2.3.1 Precast Floats

Precast floats shall be cast monolithically, cold joints of any type are not acceptable. Modules shall have a minimum deck and wall thickness of 51mm 2 in. Precast float decks shall be constructed to drain freely and there shall be no floodable enclosed spaces.

2.3.2 Forms

Brace forms to prevent deformation. Forms shall produce a smooth, dense surface. Chamfer exposed edges of floats 13 mm 1/2 inch, unless otherwise indicated. Form tolerance shall not exceed 3mm 1/8 in dimensions indicated on shop drawings. When measured diagonally, floats more than 13mm 1/2 in out of square shall be rejected.

2.3.3 Reinforcement Placement

ACI 318M and ACI 318 for placement and splicing. Reinforcement may be preassembled before placement in forms.

2.3.4 Concrete

2.3.4.1 Concrete Mixing

ASTM C94/C94M. Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

2.3.4.2 Concrete Placing

ACI 304R, ACI 305R for hot weather concreting , ACI 306.1for cold weather concreting, and ACI 309R, unless otherwise specified. Concrete shall be vibrated internally and/or externally to assure a smooth, dense finish.

2.3.4.3 Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing. Provide curing procedures to keep the temperature of the concrete between 10 and 90 degrees C 50 and 190 degrees F. When accelerated curing is used, apply heat at controlled rate and uniformly along the casting beds. Monitor temperatures at various points in a product line in different casts. Cure for a minimum of seven days prior to transporting, launching and assembly.

2.3.5 Surface Finish

Precast floats containing hairline cracks which are visible and are less than 0.5 mm 0.02 inches in width, may be accepted, except that cracks larger than 0.1 mm 0.005 inches in width for surfaces exposed to the weather shall be repaired. Precast floats which contain cracks greater than 0.5 mm 0.02 inches in width shall be approved by the Contracting Officer, prior to being repaired. Any precast float that is structurally impaired or contains honeycombed section deep enough to expose reinforcing shall be rejected.

2.3.5.1 Unformed Surfaces

Provide a steel troweled and broomed finish for pier deck surface. Slip resistant broomed deck finish shall be transverse to pier orientation. All deck edges shall have a 10mm 3/8 in tooled radius with a minimum 38mm 1 1/2 in wide, smooth, hard steel finished face.

2.3.5.2 Formed Surfaces

****

NOTE: PCI MNL-116 different grades of formed surface finishes:

Commercial Grade: Concrete produced in forms that produce a rough finish. Fins are removed and large surface blemishes filled. Sharp edges that will be visible in the finished structure are ground down.

Standard Grade: Same finish as commercial grade, except the forms do not produce a texture on the concrete. Surface can be painted, but will have surface voids.

Finish Grade B: Same as standard grade, except all surface blemishes should be filled or finished to provide a smooth surface or uniform appearance if painted.

Finish Grade A: Same as Finish Grade B, except that the components of the completed structure, where exposed, shall be reasonably color matched. This finish is difficult to obtain.

****

PCI MNL-116 (Appendix A - Commentary), Chapter 3, for grades of surface finishes. Provide a standard grade surface finish for both exposed and unexposed areas.

2.3.6 Float Identification

All precast floats are to be clearly identified on one side and one end, between the bottom of the waler and the waterline. Identification shall include name of manufacturer, date of manufacture, specific float type, and job number.

2.4 TIMBER AND WOOD PRODUCTS

All walers shall be fabricated from parallel strand lumber (PSL) engineered structural beams. PSL structural beams shall be in accordance with ASTM D5456 All other structural lumber shall be No. 1 Southern Yellow Pine.

2.4.1 Preservative Treatment

Treat wood to be used in contact with salt water or salt water splash in accordance with AWPA C2 (Material Subject to Marine Borer Exposure) with waterborne preservative AWPA P5, (ACA - Ammoniacal Copper Arsenate, ACZA - Ammoniacal Copper Zinc Arsenate, CCA - Chromated Copper Arsenate) to 0.6 pcf retention. For wood continuously immersed, treat in accordance with

AWPA C1 and AWPA C18 as applicable, to 2.5 pcf retention. For glue laminated engineered structural beams treat in accordance with AWPA C28 and AWPA C33 as applicable

2.5 RUBBING SURFACE - ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE (UHMWPE)

Materials including additives shall be traceable by original lot number. Materials used shall be FDA approved or otherwise harmless to marine life. Fabricated form shall be from virgin resin.

2.5.1 Resin

ASTM D4020. Virgin resin shall be homopolymer of ethylene and have an intrinsic viscosity (IV) between 22.0 and 28.0 dl/g. No reprocessed resin shall be used. Resin shall be oil and moisture free (0.2 percent weight maximum).

2.5.2 Composition and Fabricated Form

Resin shall comprise a minimum 95.0 percent by weight concentration in the formulation. The finished form shall maintain ultraviolet stability for a minimum of 25 years and be free of saltwater or petroleum product leachable materials. No unfused areas or light patches greater than 300 micrometers No. 50 sieve shall be in the final fabricated form. Form shall be 38mm 1 1/2 in thick, depth equal to design depth of waler, and length as required but not less than 3m 10 ft. Exterior edges shall be rounded to 19mm 3/4 in radius. Color shall be black. The fabricated form shall have the following properties:

Density (ASTM D792)	0.92-0.94 g/cc 57.5-58.7 lb/cu.ft
Tensile Strength (ASTM D638)	
Ultimate, minimum	31.7 MPa 4600 psi
Ultimate Elongation, minimum	250 percent
Impact Strength (ASTM D256)	
Test Method A, Izod	Non-break for all five determinations in sample
Hardness (ASTM D2240), minimum	Shore D 65
Coefficient of Friction (ASTM D1894)	
Kinetic, maximum	0.13
Static, maximum	0.20
Water Absorption (ASTM D570)	Nil

Abrasion Index (relative to steel = 100), maximum	10

2.6 GUIDE PILES

Guide piles shall be prestressed concrete piles; fabricated and installed in accordance with section 31 62 13.20 PRECAST/PRESTRESSED CONCRETE PILES. Pile size, length, cross section and embedment shall be determined by pier manufacturer's design.[Recommended pile butt elevation is[_____] [1.5] m [5.0] ft above [extreme] high water.] Pile quantity and location shall be as indicated on the drawings. Relocation of pile layout and additional piles required by the manufacturer's design to resist the indicated design loads, shall be subject to approval by the government.

2.6.1 Guide Pile Caps

Provide heavy UV-resistant, low density polyethylene piling caps with an estimated life in excess of 10 years. Caps shall be cone or pyramid shaped and attached to the piling top with stainless fasteners.

2.7 GANGWAYS

2.7.1 Aluminum

Aluminum alloy shall be 6061-T6. Extruded in accordance with the applicable requirements of SAE AMS-QQ-A-200/8.

2.7.2 Stainless Steel

Type 316 L.

2.7.3 Castings

F-214 Cast aluminum. Castings shall be true to pattern, structurally sound and free from blow holes or other defects.

2.7.4 Insulators

MIL-I-24768/14. Bushings or separation sheets shall be a minimum of 1.5mm 1/16 in thickness.

2.7.5 Rollers

CID A-A-55619, UHMW polyurethane, with UV inhibitors added. Color shall be black.

[2.8 Receptacle Stations

Receptacle stations shall include enclosure, mechanical interlocks, and related wiring and devices as indicated.

2.8.1 Enclosure

Enclosure shall be NEMA ICS 6, type 3R, fabricated of 12 gauge stainless steel. Paint ASTM D1535 light gray No. 61. Paint coating system shall comply with IEEE C57.12.29.

2.8.2 Mechanical Interlocks

UL 231, UL 1686, UL 98. Mechanical interlock devices shall incorporate a fused disconnect safety switch and IEC receptacle in a non-metallic, watertight, enclosure. The interlock mechanism shall prevent making and breaking of power under load. Enclosure shall be rated NEMA 4X and also rated IP67 in accordance with CENELEC EN 60529. Include matching plug for each mechanical interlock provided. Plugs and receptacles shall be classified to EN 60309-1 and EN 60309-2.

2.8.3 Circuit Breakers

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated.

2.8.4 Ground-Fault Circuit Interrupter Receptacles

****

NOTE: For NAVFAC LANT projects, use GFI terminology in lieu of GFCI. NAVFACENGCOM has established these GFCI/GFI safety standards at a higher level of protection than NFPA 70's minimum requirements as a result of a GAO report and DOD concern about health and safety.

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UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFI devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads. Provide in nonmetallic box with gasketed, weatherproof, nonmetallic cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations with plug in use."

]PART 3 EXECUTION

3.1 SURFACE REPAIR

Prior to erection, and again after installation, precast floats shall be checked for damage, such as cracking, spalling, and honeycombing. As directed by the Contracting Officer, precast floats that do not meet the surface finish requirements specified in Part 2 in paragraph entitled "Surface Finish" shall be repaired, or removed and replaced with new precast floats.

3.2 LAUNCH AND ASSEMBLY

Precast floats shall be launched after the concrete has attained the specified compressive strength, unless otherwise approved by the precast manufacturer. Assemble in accordance with the approved shop drawings. PCI MNL-116 and PCI MNL-120 (Chapter 8), for tolerances. Brace precast floats, unless design calculations submitted with the shop drawings indicate bracing is not required. Follow the manufacturer's recommendations for maximum construction loads.

3.3 ANCHORAGE

Provide anchorage for fastening work in place. Conceal fasteners where practicable. Make threaded connections up tight and nick threads to prevent loosening.

3.4 WELDING

AWS D1.4/D1.4M for welding connections and reinforcing splices. Protect the concrete and other reinforcing from heat during welding. Weld continuously along the entire area of contact. Grind smooth visible welds in the finished installation. Welding of epoxy-coated reinforcing is not allowed.

3.5 OPENINGS

Holes or cuts requiring reinforcing to be cut, which are not indicated on the approved shop drawing, shall only be made with the approval of the Contracting Officer and the precast manufacturer. Drill holes less than 300 mm 12 inches in diameter with a diamond tipped core drill.

3.6 GALVANIZING REPAIR

Repair damage to galvanized coatings using ASTM A780/A780M zinc rich paint for galvanized surfaces damaged by handling, transporting, cutting, welding, bolting, or acid washing. Do not heat surfaces to which repair paint has been applied.

3.7 GROUTING

Clean and fill indicated areas, solidly with nonshrink grout or cementitious grout. Provide reinforcing where indicated. Remove excess grout before hardening.

3.8 SEALANTS

Provide as indicated and as specified in Section 07 92 00 JOINT SEALANTS.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 59 13.13 (August 2009)**

Preparing Activity: NAVFAC **Superseding**
UFGS-35 59 13.13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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USACE / NAVFAC / AFCEC **UFGS-35 59 13.13 (August 2009)**

Preparing Activity: NAVFAC **Superseding**
UFGS-35 59 13.13 (April 2006)

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References are in agreement with UMRL dated January 2025

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SECTION 35 59 13.13

PRESTRESSED CONCRETE FENDER PILING

08/09

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NOTE: This guide specification covers the requirements for prestressed concrete fender piling.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.

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NOTE: Refer to NFESC TM 53-89-03, "Prestressed Concrete Fender Piling User Data Package" for details of these fender piles. The following information shall be shown on the drawings:

1. Locations and design loads of piles.

2. Size, shape, and length of piles.

3. Locations, sizes, and number of prestressing steel strands. Unit stresses for prestressing

strands or wire.

4. Details of reinforcement and tendons.

5. Soil data, where required.

6. Embedment depth.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2021) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 212.3R	(2016) Chemical Admixtures for Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary

ACI MNL-66	(2020) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A501/A501M	(2021) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates

ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311/C311M	(2024) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1202	(2022; E 2022) Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates

	(Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1894	(2014) Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D4020	(2011) Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(2021) Manual for Quality Control for Plants and Production of Structural Precast Concrete Products, 5th Edition

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Piles

Driving helmets, capblocks, and pile cushions

SD-05 Design Data

Concrete mix design

Submit a concrete mix design before concrete is placed, for each type of concrete used for the piles.

SD-06 Test Reports

Aggregates

Fly ash and Pozzolan

Ground Slag

Silica fume

Concrete

Submit concrete cylinder compressive strength test results.

SD-07 Certificates

Precasting manufacturer's quality control procedures

Suitability of pile driving equipment

[Curing of piles

][Silica fume manufacturer's representative

] Prestressing steel

Portland cement

Concrete mix design

Reinforcing steel

[Rubbing surface

] Bolts, nuts, and washers

1.3 REQUIREMENTS

1.3.1 Piling Lengths and Quantity

Provide prestressed pretensioned concrete piles. Base bids upon the number, size, and length of piles as indicated. Adjustments in the contract price will not be made for cutting off piles or for broken, damaged, or rejected piles.

1.3.2 Piles

Prepare in accordance with ACI MNL-66. Indicate placement of reinforcement including tendons. Indicate location of special embedded or attached lifting devices, employment of pick-up points, support points other than pick-up points, and any other methods of pick-up. [Provide certification of a professional engineer registered in any jurisdiction in the U.S. or its territories, that layout and details of reinforcement and tendons conform with that shown on the structural design drawings.]

1.3.3 Driving Helmets, Capblocks, and Pile Cushions

Show details of driving helmets, capblocks, and pile cushions. Submit 2 weeks prior to [test] pile installation.

1.4 QUALITY ASSURANCE

1.4.1 Quality Control Procedures

Submit [_____] copies of precasting manufacturer's quality control procedures established in accordance with PCI MNL-116.

[1.4.1.1 Curing of Piles

Submit proposed materials and methods.

]1.4.2 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative will be present at plant to ensure proper mix, including high range water reducer (HRWR), and batching methods.

1.4.3 Aggregates

Prior to pile fabrication, submit certified test reports for the following tests specified in ASTM C33/C33M:

a. Grading

b. Amount of material finer than 75 micrometers No. 200 sieve

c. Organic impurities

d. Soundness

e. Clay lumps and friable particles

f. Coal and lignite

g. Weight of slag

h. Abrasion of coarse aggregate

i. Fineness modulus

j. Reactive aggregates

k. Freezing and thawing

1.4.4 Fly Ash and Pozzolan

Furnish fly ash and pozzolan test results performed within 6 months of submittal date. Sampling and testing shall be in accordance with ASTM C311/C311M.

1.4.5 Silica Fume

Furnish silica fume test results performed within 6 months of submittal date. Sampling and testing shall be in accordance with ASTM C311/C311M.

1.4.6 Portland Cement

Certification identifying cement; brand name, type, mill location, quantity to be used, size of lot represented by quality control sample, lot number, and destination of shipment.

1.4.7 Concrete Mix Design

Certify, using a Government-approved independent commercial testing laboratory, that proportioning of mix is in accordance with ACI 211.1 or ACI 318M for specified strength and is based on aggregate data which has been determined by laboratory tests during last 12 months.

1.5 DELIVERY, STORAGE, AND HANDLING

Piles shall be stored, handled, and transported in accordance with PCI MNL-116 except as follows. Methods used for handling and storage of piles shall be such that the piles are not subjected to excessive bending stress, cracking, spalling, or other damage.

1.5.1 Damaged Piles

The Contractor shall inspect each pile for sweep and structural damage such as cracking and spalling before transporting them to the project site and immediately prior to placement in the driving leads. Any unusual cracks (cracks other than crazing, surface drying, shrinkage cracks and end cracks) shall be brought to the attention of the Contracting Officer. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, shall be rejected and removed from the project site, or may be repaired, if approved, at no cost to the Government.

1.5.1.1 Repairable Cracks

Piles with cracks equal to or greater than 0.15 mm 0.006 inches but less than 1.5 mm 0.06 inches shall be rejected or repaired. As an alternate to pile rejection, the Contractor may submit a proposal to repair deficient piles, which shall be restored prior to driving to provide its required design capacity, perform its intended function in the structure, and take into consideration long term durability in corrosive environment.

1.5.1.2 Non-Repairable Cracks

Piles with cracks equal to or greater than 1.5 mm 0.06 inches shall be rejected.

1.5.2 Pile Sweep

Sweep shall be limited to 3 mm per 3 M 1/8 inch per 10 feet over the length of the pile. Piles having excessive sweep shall be rejected.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall be portland cement, [blended cement] or portland cement in combination with natural pozzolan or fly ash [or ground granulated blast furnace slag] and conforms to appropriate specifications listed below.

2.1.1.1 Cement

****

NOTE: Insert type of cement required. Generally, Types II, or I/II, is preferred. Type I, or Type III with 8 percent maximum C3A and "low alkali" may be used. Do not use Type III in conjunction with silica fume. In very special cases, Type V, "low alkali," which has limited availability, may be used.

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NOTE: Cement type and quantity of cement required in mix design is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling:

(a) CHLORIDE PROTECTION:

Normal Use. In fresh water or air environment, specify Type I or Type II cement. Type III may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent and it is low alkali.

Marine Use. In soil or water environments, subject to chlorides above 1,000 ppm, within about 300 m 1000 feet of the ocean or tidal water, specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement, a minimum cementitious materials content of 335 kilograms per cubic meter 564 pounds per cubic yard and a maximum water to cementitious materials ratio of 0.40.

Seawater Exposure. In direct contact with ocean water, specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement, a minimum cementitious materials content of 390 kilograms per cubic meter 658 pounds per cubic yard and a maximum water to cementitious materials ratio of 0.40.

(b) SULFATE RESISTANCE:A minimum cementitious materials content of 335 kilograms per cubic meter 564 pounds per cubic yard is recommended.

Normal Use. In soils with negligible amount of sulfate, specify Type I or Type II cement. Type III cement may be permitted provided tricalcium aluminate (C3A) content is limited to 8 percent and it is low alkali.

Moderate Sulfate Exposure. In exposures with moderate sulfate content (between 0.10 and 0.20 percent in soil and less than 1500 ppm in water), specify Type II or Type III (with a maximum tricalcium aluminate (C3A) content of 8 percent and low alkali) cement and a maximum water to cementitious materials ratio of 0.40. Do not use Class C fly ash, blast furnace slag, or silica fume for cement replacement.

Severe Sulfate Exposure. In exposures with high sulfate content (exceeds 0.20 percent in soil or 1500 ppm in water), specify Type V or Type II (with a maximum tricalcium aluminate content of 5 percent) cement, and a maximum water to cementitious materials ratio of 0.40. Do not use Class C fly ash, blast furnace slag, or silica fume for cement replacement.

Alkali-Silica Reactivity. When alkali-silica reactivity is a concern, it is recommended to limit the maximum alkali content of cement to 0.40 or 0.50, when it is locally available, otherwise use

0.60.

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ASTM C150/C150M, [Type I, II, or III[_____] with a maximum alkali content of [0.40] 0.60 percent][; or][ASTM C595/C595M, Type [IP(MS) or IS(MS)][_____]] blended cement except as modified herein. The blended cement shall consist of a mixture of ASTM C150/C150M cement (with alkali content not exceeding[0.40] 0.60 percent) and one of the following materials: ASTM C618 pozzolan or fly ash, or ASTM C989/C989M ground iron blast-furnace slag, or ASTM C1240 silica fume. If no satisfactory test results are available (made within the past six months) to prove that the cement alkali content is less than 0.40 percent, then cement with a maximum of 0.60 percent alkali shall be used. Cement certificates shall include test results in accordance with ASTM C150/C150M, including equivalent alkalies indicated in the optional chemical requirements. [Use cement with a tricalcium aluminate (C3A) content of less than [8][5] percent.] Type III cement shall not be used in conjunction with silica fume.

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NOTE: Fly ash, pozzolan, and ground iron blast-furnace slag increase durability. They may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Use Fly ash/pozzolan (loss on ignition not exceeding 3 percent) for frost areas to reduce carbon interference with air entraining admixture. Straight replacement with fly ash or natural pozzolan beyond 15 percent may decrease the concrete's strength gain rate. The following options can help mitigate this slower gain rate: (1) a lower water/cement ratio may be used, (2) partial cement replacement can be completed, e. g., 1 sack of cement can be replaced by 1.5 sacks of fly ash, as long as the final replacement ratio meets the requirements, and (3) very fine fly ashes or pozzolans (e. g. with average particle sizes below 5 microns) can be used.

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2.1.1.2 Fly Ash and Pozzolan

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NOTE: Loss on ignition greater than 3 percent may result in significant variations in air content. The air entrainment admixture content may need to be varied often to maintain the same level of entrained air.

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ASTM C618, Class N, or F except that the maximum total alkalies shall be 3 [6] percent. If the aggregates are reactive the maximum calcium oxide content shall be 13.0 percent. Class C shall not be used.

2.1.1.3 Ground Iron Blast-Furnace Slag

ASTM C989/C989M, Grade 120.

2.1.1.4 Silica Fume

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NOTE: Use silica fume concrete for marine structures where low permiability and enhanced durability are necessary. The silica fume and HRWR additive should be from the same manufacturer. The Contractor and batch plant may need help from the manufacturer. Select weight percentage based on performance required. If used, a replacement of 7 percent is recommended.

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NOTE: Use for high durability and low permeability. The initial cost of the concrete will increase, and supervision at the batch plant, finishing, and curing is necessary. A HRWR must be used with silica fume. The slump can be increased 50 to 125 mm 2 to 5 inches without reducing strength. Finishing may be more difficult. Proper curing is essential because there is a tendency for plastic shrinkage cracking.

****

ASTM C1240, provide silica fume that is a by-product of silicon or ferrosilicon production. Provide percent by weight of the total cementitious materials as indicated in table below.

2.1.1.5 Supplemental Cementitious Materials (SCM) Content

The concrete mix shall contain one of the four SCMs listed below, or a linear combination thereof.

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT		
SCM	Minimum Content	Maximum Content
Class N Pozzolan or Class F Fly Ash with with SiO2 plus Al2O3 plus Fe2O3 greater than 70 percent	25 percent	35 percent
Class N Pozzolan or Class F Fly Ash with with SiO2 plus Al2O3 plus Fe2O3 greater than 80 percent	20 percent	35 percent
Class N Pozzolan or Class F Fly Ash with with SiO2 plus Al2O3 plus Fe2O3 greater than 90 percent	15 percent	35 percent
GGBF Slag	30 percent	50 percent
Silica Fume	5 percent	10 percent

2.1.2 Water

Water shall be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete or steel.

2.1.3 Aggregates

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NOTE: For piles in areas where reactive aggregates are likely to be supplied, provide for additional tests and certification to ensure that reactive aggregates will not be used. While not wholly conclusive, petrographic examination (ASTM C295/C295M), chemical test (ASTM C289/C289M), and mortar bar method (ASTM C227) are valuable indicators. While more reliable, the concrete prism test (ASTM C1293) takes 1 to 2 years to complete and is not practical. The accelerated mortar bar method (ASTM C1260) is similarly reliable and takes only 16 days to yield results. In areas where reactive aggregates can not be avoided, specify use of low alkali cement, and/or cements modified to mitigate alkali-silica reactivity. Service records of concrete made with these materials along with tests should be used in evaluating these materials.

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NOTE: Include modification to ASTM C33/C33M when reactive aggregates could be encountered. More modifications may be required. Additional tests and certifications may be required in the submittal paragraphs.

****

ASTM C33/C33M[, except as modified herein. Provide aggregate free from any substance which may be deleteriously reactive with alkalies in cement in an amount sufficient to cause excessive expansion of concrete]. Do not mix, store in same stockpile, or use fine aggregates from different sources of supply in same concrete mix or same structure without approval. The fineness modulus of fine aggregate shall be not less than 2.40 or greater than 3.0. For piles that will be exposed to freezing and thawing, fine and coarse aggregate subjected to five cycles of the sodium sulfate soundness test shall show a loss not greater than 10 percent. If the selected aggregates fail the soundness test, the Contractor may use the aggregate source, provided concrete specimens made with the aggregates to be used for the piles shall have a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666/C666M. Prior to pile fabrication, submit certified test reports for the following tests specified in ASTM C33/C33M[,in addition, [twice] [_____] during each shift when the concrete plant is operating, the gradation of each size of aggregate shall be tested in accordance with ASTM C136/C136M]:

a. Grading

b. Amount of material finer than 75 micrometers No. 200 sieve

c. Organic impurities

d. Soundness

e. Clay lumps and friable particles

f. Coal and lignite

g. Weight of slag

h. Abrasion of coarse aggregate

i. Fineness modulus

j. Reactive aggregates

k. Freezing and thawing

2.1.3.1 Alkali-Silica Reactivity (ASR)

Fine and coarse aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate activity.

The fine and coarse aggregates shall be evaluated separately, using ASTM C1260. Test results of the individual aggregates shall have a measured expansion equal to or less than 0.08 percent at 16 days after casting. Should the test data indicate an expansion of greater than 0.08 percent, the aggregates(s) shall be rejected or additional testing, using ASTM C1567 shall be performed as follows: utilize the Contractor's proposed low alkali portland cement [blended cement] and SCM in combination with the proposed aggregate for the test portioning. The SCM quantity shall be determined that will meet all the requirements of these specifications and that will lower the ASTM C1567 expansion to equal or less than 0.08 percent at 16 days after casting.

If the above option does not lower the expansion to less than 0.08 percent at 16 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.1.4 Admixtures

****

NOTE: For guidance in use of either water-reducing admixtures, set retarding admixtures, or combination of admixtures, refer to ACI 543R, "Recommendations for Design, Manufacture, and Installation of Concrete Piles."

****

Chemical admixtures shall conform to ASTM C494/C494M, [Type A] [Type B]. [Air-entraining admixture shall conform to ASTM C260/C260M.] Do not use admixtures containing chlorides.

2.1.5 Prestressing Steel

Use seven-wire stress-relieved or low-relaxation strand conforming to

ASTM A416/A416M, Grade 270 psi. Use prestressing steel free of grease, oil, wax, paint, soil, dirt, and loose rust. Do not use prestressing strands or wire having kinks, bends, or other defects.

2.1.6 Reinforcing Steel

****

NOTE: Minimum cover for reinforcing steel in concrete structures is dependent upon the environment, soil conditions, need for corrosion protection, and location of piling. For normal exposure minimum cover is 50 mm 2 inches. For piles exposed to marine conditions (chloride content above 1000 ppm) in or within about 300 m 1000 feet of the ocean or tidal water, use 75 mm 3 inches minimum cover, including chamfered corners. For additional detailed guidance, see following publications: ACI 543R, "Recommendations for Design, Manufacture and Installation of Concrete Piles" (ACI Manual, Part 3); State of California, Department of Public Works, Design Specifications, Volume l, Bridge Planning and Design Manual, Chapter 6. Piles to be used in a marine environment may receive a protective coating, particularly if the piles are steam cured. The protective coating should be applied to that portion of pile which remains aboveground or water line. Show areas to be protected on drawings.

****

****

NOTE: Insert grade of reinforcement. Specify ASTM A706/A706M reinforcing where welding or bending of reinforcement bars is important. In addition, ASTM A934/A934M may be specified for epoxy coating of reinforcing where extra reinforcement protection is required.

****

[ASTM A615/A615M, Grade [300][420] [40][60];] [ASTM A706/A706M, Grade [420] [60];][ASTM A996/A996M, Grade [420] [60]]. Weld reinforcing steel in accordance with AWS D1.4/D1.4M.

2.1.7 Ties and Spirals

****

NOTE: If project has been designed for epoxy rebar, add ASTM A934/A934M, "Epoxy-Coated Prefabricated Steel Reinforcing Bars" in this paragraph and in the paragraph entitled "References."

****

Steel, ASTM A1064/A1064M for spirals and ASTM A615/A615M[ASTM A706/A706M]for ties.

2.1.8 Pipe Sleeves

Use ASTM A53/A53M, Grade B, or ASTM A501/A501M galvanized pipe. Sleeves shall be galvanized in accordance with ASTM A153/A153M with chromate wash.

Do not place galvanized pipe in contact with any prestressing or reinforcing steel.

2.1.9 Bolts, Nuts, and Washers

2.1.9.1 Bolts

ASTM A307, Grade A.

2.1.9.2 Nuts

ASTM A563M ASTM A563, Grade A, hex style.

2.1.9.3 Washers

ASTM F844.

2.1.10 Ultrahigh Molecular Weight Polyethylene (UHMWPE) Rubbing Surface

2.1.10.1 General

a. Materials including additives shall be traceable by original lot number.

b. Materials used shall be FDA approved or otherwise harmless to marine life.

c. Fabricated form shall be virgin resin.

2.1.10.2 Resin

a. ASTM D4020. Virgin resin shall be homopolymer of ethylene and have an intrinsic viscosity (IV) between 22.0 and 28.0 dl/g.

b. No reprocessed resin shall be used.

c. Resin shall be oil and moisture free (0.2 percent weight maximum).

2.1.10.3 Composition and Fabricated Form

a. Resin shall comprise a minimum 95.0 percent by weight concentration in the formulation.

b. The finished form shall maintain ultraviolet stability for a minimum of 25 years and be free of saltwater or petroleum product leachable materials.

c. No unfused areas or light patches greater than 300 micrometers No. 50 sieve shall be in the final fabricated form.

d. The fabricated form shall have the following properties:

Density (ASTM D792)	0.92-0.94 g/cc 57.5-58.7 lb/cu.ft
Tensile Strength (ASTM D638)	
Ultimate, minimum	31.7 MPa 4600 psi

Ultimate Elongation, minimum	250 percent
Impact Strength (ASTM D256)	
Test Method A, Izod	Non-break for all five determinations in sample
Hardness (ASTM D2240), minimum	Shore D 65
Coefficient of Friction (ASTM D1894)	
Kinetic, maximum	0.13
Static, maximum	0.20
Water Absorption (ASTM D570)	Nil
Abrasion Index (relative to steel = 100), maximum	10

e. Color shall be black.

2.2 CONCRETE

2.2.1 Contractor-Furnished Concrete Mix Design

****

NOTE: Insert the specified compressive strength, f'c. Consider reducing average overstrength factor to produce a more economical concrete mix design, since these piles are not critical structural elements. ACI 318M may be modified for a specified compressive strength, f'c, over 35 MPa 5000 psi to permit a required average compressive strength, f'cr, of f'c plus 4.8 MPa 700 psi. Concrete may be proportioned in accordance with ACI 214R for the probability of 1 test in 10 falling below the specified compressive strength, f'c, if the mix design reflects actual concrete plant standard deviations and the resulting production concrete conforms to specified requirements. Do not use lightweight or fiber-reinforced concrete.

****

Concrete shall have a minimum specified compressive strength, f'c, of [_____] psi at 28 days. The minimum cementitious materials content shall be 354 kg per cubic meter 600 pounds per cubic yard of concrete. The design shall be prepared in accordance with ACI 211.1 or ACI 318M. The mix design shall be based on current materials previously evaluated by the concrete producer whose established methods of statistical quality control is in conformance with ACI 318M. In the absence of such data, the Contractor shall sample and test the aggregates for the design of concrete.

2.2.2 Concrete Mix Design Proportioning

a. Water and cement ratio shall be equal to or less than 0.40. If fly ash is used, the water and cement ratio shall be calculated as the weight of water divided by the weight of cement plus 60 percent of the weight of fly ash. If silica fume is used, the water and cement ratio shall be calculated as the weight of water divided by the weight of cement plus the weight of silica fume.

b. Maximum aggregate size shall not exceed 19 mm 3/4 inch.

****

NOTE: Air-entrainment may be considered optional only in regions that do not experience freezing temperatures.

****

c. Air-entrainment shall be 4.5 to 7.5 percent. Determine air void structure in accordance with ACI 212.3R. Spacing factor shall be less than 2.5 mm 0.01 inch, the specific surface area shall be greater than 0.39 square meter per 0.000016 cubic meter 600 square inches per cubic inch of air void volume, and the number of air voids per mm inch of traverse shall be significantly greater than the numerical value of the percentage of air in the concrete.

2.2.3 Trial Mixtures

Trial mixtures having proportions and consistencies of the proposed mix design shall be made to document the Contractor's ability to produce workable concrete which does not segregate or show excessive slump loss characteristics.

2.3 FABRICATION OF PRETENSIONED PILES

Piles shall be pretensioned concrete piles. Workmanship shall conform to standard commercial practice in prestressing plants.

2.3.1 Formwork

Provide forms of metal, braced and stiffened against deformation, accurately constructed, watertight, and supported on unyielding casting beds. Forms shall permit movement of pile without damage during release of the prestressing force. Make piles to dimensional tolerances in accordance with PCI MNL-116 and as follows:

a. Length: 10 mm per 3 meters 3/8 inch per 10 feet.

b. Cross section: plus 13 mm to minus 6 mm plus 1/2 inch to minus 1/4 inch.

c. Deviation from straight lines: not more than 3 mm per 3 meters 1/8 inch per 10 feet of length.

d. Pile head: plus or minus 6 mm per 0.30 meter 1/4 inch per foot of head dimension from true right angle plane. Surface irregularities: plus or minus 3 mm 1/8 inch.

e. Location of reinforcing steel

    (1) Main reinforcement: 3 to 6 mm 1/8 to 1/4 inch from position designated on drawings.

    (2) Spacing of spiral: plus or minus 13 mm 1/2 inch from position designated on drawings.

f. Location of pipe sleeves from true position: plus or minus 10 mm 3/8 inch.

2.3.2 Pretensioning

Measure tension to which steel is to be pretensioned by jack pressure read on a calibrated gage and verify by elongation of steel. Use gage calibrated within last 6 months by a laboratory approved by Contracting Officer. Provide means for measuring elongation of steel to nearest 3 mm 1/8 inch. When difference between results of measurement and gage reading is more than 5 percent, determine cause of discrepancy and correct. Give tensioning steel a uniform prestress prior to being brought to design prestress. Induce same initial prestress in each unit when several units of prestressing steel in a pile are stretched simultaneously.

2.3.3 Casting

2.3.3.1 Conveying

Clean conveying equipment thoroughly before each run. Convey concrete from mixer to forms as rapidly as practicable by methods which will not cause segregation or loss of ingredients. Deposit concrete as nearly as practicable to its final position. During placing, make any free vertical drop of the concrete less than one meter 3 feet. Remove concrete which has segregated in conveying or placing.

2.3.3.2 Placing and Casting

****

NOTE: Select chamfer required. Consult with local producers. Where project requires a large quantity of piling, a specific value may be specified, otherwise, use a minimum or a range of values.

****

Perform concrete casting within 3 days after pretensioning steel; however, do not deposit concrete in forms until placement of reinforcement and anchorages have been inspected and approved by pile manufacturer's quality control representative. Produce each pile of dense concrete straight with smooth surfaces with reinforcement retained in its proper position during fabrication. Use vibrator with heads smaller than the minimum distance between steel for pretensioning. Make surface of pile ends perpendicular to axis of pile. Chamfer, [a minimum of 19 mm 3/4 inch,] [[_____] mm inch,] [between 19 and 31 mm 3/4 and 1 1/4 inch,] ends of piles and corners of square piles.

2.3.4 Curing of Piles

Cure piles using moist or accelerated curing.

2.3.4.1 Moist Curing

a. Impervious sheeting: ASTM C171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

b. Pervious sheeting: AASHTO M 182.

c. Liquid membrane-forming compound: ASTM C309, white pigmented, Type 2, Class B.

2.3.4.2 Accelerated Curing

After placement of concrete, moist cure for a period of 4 hours. Follow by accelerated curing until concrete has reached specified release strength. Enclose casting bed for accelerated curing with a suitable enclosure. During application of steam or heat, increase the air temperature at a rate not to exceed 22 degrees C 40 degrees F per hour. Cure at a maximum temperature of 65 degrees C 150 degrees F until concrete has reached specified release strength. Reduce temperature at a rate not to exceed 11 degrees C 20 degrees F per hour until a temperature of 11 degrees C 20 degrees F above ambient air temperature is reached. After accelerated curing, moist cure using either water or membrane curing until a total accelerated and moist curing time of 72 hours is achieved.

2.3.5 Detensioning

****

NOTE: Specify "release strength." Release strength of 30 MPa 4000 psi (design strength of 35 MPa 5000 psi) or 0.8 of the 28 day design strength is desirable; however, some regions use 0.7 of the design strength (25 MPa 3500 psi for design strength of 35 MPa 5000 psi). A minimum release strength of 0.6 of the design strength is required. Check with local pile manufacturers.

****

Perform releasing of prestressed steel in pretensioned piles in such an order that eccentricity of prestress will be minimized. Gradually release tension in strands from anchorage. Detension after approval by pile manufacturer's quality control representative. Perform transfer of prestressing force when concrete has reached a minimum compressive strength of [_____] MPa psi.

2.3.6 Marking

Mark pile to identify in-place impact face. Marking shall be clearly visible during driving.

2.4 PRODUCT QUALITY CONTROL

Where piling is manufactured in a plant with an established quality control program as attested to by a current certification in the PCI Certification Program for Quality Control, perform product quality control procedures in accordance with PCI MNL-116. Where piling is manufactured by specialists or in plants not currently enrolled in the PCI Certification Program for Quality Control, set up a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an independent commercial testing laboratory approved by the Contracting Officer in accordance with the following.

2.4.1 Aggregate Tests

Take samples of fine and coarse aggregate at the concrete batch plant and test. Perform mechanical analysis (one test for each aggregate size) in accordance with ASTM C136/C136M including determination of the specific gravity. Tabulate the results of the tests in accordance with ASTM C33/C33M.

2.4.2 Strength Tests

Sample concrete in accordance with ASTM C172/C172M at the time the concrete is deposited for each production line. Compression tests shall conform to methods of ASTM C39/C39M and ASTM C31/C31M. Perform slump tests in accordance with ASTM C143/C143M. Mold at least six cylinders per day or for every 15 cubic meter 20 cubic yards of concrete placed, whichever is greater. Test two cylinders of the set at 7 days of 14 days, or at a time for establishing transfer of prestressing force (release strength) and removal of pile from forms. Perform strength tests 28 days after molding using the remaining cylinders of the set. Cure the cylinders in the same manner as the piles and place at the point where the poorest curing conditions are offered. This is the coolest point in the bed for steam curing. Cylinders to be tested at 28 days shall be moist cured.

2.4.3 Changes in Proportions

If, after evaluation of strength test results, the compressive strength is less than the specified compressive strength, make adjustments in the proportions and water content and changes in the temperature, moisture, and curing procedures as necessary to secure the specified strength. Submit changes to the Contracting Officer in writing.

2.4.4 Compressive Strength Test Results

Evaluate compression test results at 28 days in accordance with ACI 214R using a coefficient of variation of 10 percent. Evaluate the strength of concrete by averaging the test results (two specimens) of each set (four specimens) of standard cylinders tested at 28 days. Not more than 10 percent of the individual specimens tested shall have an average compressive strength less than specified average compressive strength.

2.4.5 Chloride Ion Concentration

Sampling and determination of water soluble chloride ion content in accordance with ASTM C1218/C1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed 0.06 percent by weight of cement.

2.4.6 Chloride Ion Penetration

To ensure the durability of concrete in marine environment, concrete shall be proportioned to have the chloride ion penetration test in accordance with ASTM C1202, and be below 3000 coulombs for concrete specimens tested at 56 days.

PART 3 EXECUTION

3.1 PILE DRIVING

3.1.1 Driving Piles

Piles shall not be driven until 100 percent of design strength has been attained and until at least 14 days after detensioning. Drive piles to the indicated tip elevation and to the minimum embedment depth shown on the drawings. Pile driving shall be conducted as one continuous operation. The pile shall be driven until the resistance criterion is met. During the initial driving and until the pile tip has penetrated beyond layers of very soft soil or below the bottom of prejetted or preformed holes, use a reduced rated driving energy of the hammer of not more than 20,235 Joules 15,000 foot-pounds per blow or as otherwise directed by the Contracting Officer, to prevent high tension-wave driving stresses which could damage the pile. Resistance criterion shall be 20 blows for 0.3 m one foot or less. The Contracting Officer may modify the criteria based upon the actual hammer being used and its rated energy and its compatibility as verified by a pile test program. If a pile fails to reach the indicated butt elevation or minimum embedment, the Contractor shall notify the Contracting Officer and perform corrective measures as directed. Provide hearing protection when noise levels exceed 140 dB.

3.1.2 Pile Driving Leads and Templates

Piles shall be driven with the hammer positioned in a fixed or swinging lead. "Free hammer" will not be permitted. Swinging lead shall be used only in conjunction with a template system to spot the piles.

3.1.3 Installation of Piles

Take care to avoid damage to piles during handling, when placing the pile in leads, and during pile-driving operations. Inspect piles when delivered, when in leads immediately before driving, and after installation. Notify the Contracting Officer of any unusual cracks and perform corrective measures as directed. Laterally support piles during driving, but allow rotation in leads. Take special care to maintain the pile orientation during driving. Square the top of the pile to the longitudinal axis of the pile. Maintain axial alignment of pile hammer with that of pile.

3.1.4 Tolerances in Driving

Drive piles with a variation of not more than one percent from vertical for plumb piles. Maintain and check axial alignment of pile and leads at start of pile driving and when the pile top is approximately 1.5 m 5 feet above the indicated elevation. Make intermediate checks of pile alignment if there is evidence of pile drifting. If subsurface conditions cause pile drifting beyond the allowable axial alignment tolerance, notify the Contracting Officer and perform corrective measures as directed. Place butts within 50 mm 2 inches of the location indicated. Manipulation of pile within specified tolerances is permitted, but do not manipulate piles more than one percent of their exposed length above the mudline. Check piles for heave. Redrive, to the indicated elevation, piles found to be heaved.

3.1.5 Jetting of Piles

****

NOTE: Jetting should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Adjacent to existing structures.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Water jets will[not] be permitted.[Jetting [may] [shall] be used to assist driving piles through strata that cannot be penetrated practicably by use of the hammer alone. [Driving shall be restricted to a static weight while water is being injected to prevent inducing tensile stresses in the piles which damage the concrete.] After the penetration of the strata requiring jetting has been accomplished, jetting shall be discontinued and hammer driving shall be resumed.][Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration.][Adequate measures shall be taken for collecting and disposing of runoff water.][Jetting method and equipment shall be approved by the Contracting Officer prior to commencing jetting operation.] Before starting final driving, firmly seat piles in place by application of a number of reduced energy hammer blows.[Measures, including use of a silt curtain, shall be employed to contain turbid water created by jetting piles.]

3.1.6 Pre-drilling of Piles

****

NOTE: Predrilling should generally not be permitted for piles:

1. Dependent on side friction in fine-grained low permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.

2. Subject to uplift or lateral forces.

3. Located in cohesionless soils.

4. In closely spaced clusters unless the load capacity is confirmed by test.

****

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven[will[not] be permitted][shall be provided]. [The diameter of the hole should not exceed two-thirds the width of the pile.][Predrill only to a depth of [_____] meters feet below cut-off elevation prior to setting piles.][Discontinue drilling when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration.]

3.1.7 Splices

Splicing of piles is not permitted.

3.1.8 Buildup

Buildups are not permitted.

3.1.9 Pile Cutoffs

Cut off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods approved by the Contracting Officer. The use of explosives for cutting is not permitted.

3.1.10 Patching

a. Embedded Lifting Loops. Provide a 25 mm one inch minimum conical depression around embedded lifting loops. Cut off lifting loops at bottom of depression and patch depression with epoxy mortar.

b. Pile Butt. Apply 25 mm one inch thick layer of epoxy mortar cover over exposed prestressing strand on pile butt after driving.

3.2 EQUIPMENT

3.2.1 Pile Hammers

Furnish a hammer having a capacity at least equal to the hammer manufacturer's recommendation for the total weight of pile and character of subsurface material to be encountered. Obtain the required driving energy of the hammer, except for diesel hammers, by use of a heavy ram and a short stroke with low-impact velocity. The pile hammer shall be capable of operating at a reduced energy level (1/2 to 2/3 of rated energy level) during seating of the piles in preformed holes and when driving through soft or loose materials. The driving energy of the hammer, at final driving, shall be not less than 40.650 Joules 30,000 foot-pounds. At final driving, operate the pile hammer in accordance with the manufacturer's recommendation. At final driving, operate diesel-powered hammers at the rate recommended by the manufacturer for hard driving. Maintain sufficient pressure at the steam hammer so that (1) for double-acting hammer, the number of blows per minute during and at the completion of driving of a pile is equal approximately to that at which the hammer is rated; (2) for single-acting hammer, there is a full upward stroke of the ram; and (3) for differential-type hammer, there is a slight rise of the hammer base during each downward stroke.

3.2.2 Driving Helmets, Capblocks, and Pile Cushions

3.2.2.1 Driving Helmets or Caps and Pile Cushions

****

NOTE: Insert minimum and maximum thicknesses for pile cushion. An absolute minimum would be 75 mm 3 inches and the actual required thickness would depend upon pile length, hammer energy, design load, required final penetration resistance, and character of subsurface material to be encountered. Generally thicker blocks are required for longer piles, larger hammers, and harder driving. A wave equation analysis is useful in determining required thicknesses for pile cushion. Minimum thickness is to protect head of pile. Pile cushion should also have a maximum thickness to ensure effective driving. Select when pile cushion is to be replaced. It is generally recommended that a new pile cushion be used at the start of driving of each pile.

****

Use a steel driving helmet or cap, including a pile cushion between top of pile and driving helmet or cap, to prevent impact damage to pile. The driving helmet or cap-and-pile cushion combination shall be capable of protecting the head of the pile, minimize energy absorption and dissipation, and transmit hammer energy uniformly over the top of the pile. The driving helmet or cap shall fit sufficiently loose around the top of the pile so that the pile may be free to rotate without binding within the driving helmet. The Contractor shall demonstrate to the satisfaction of the Contracting Officer that the equipment to be used on the project performs the above function. The pile cushion shall be of laminated construction using softwood boards with the grain parallel to the end of the pile. The thickness of the pile cushion shall be 300 mm 12 inches minimum. The cushion shall not be changed near the end of driving. Replace the pile cushion when it has become compressed beyond two-thirds of its original thickness, charred, or burned, or has become spongy or deteriorated in any manner. Use new cushions for initial driving of each pile. During redriving or restriking of piles, a used cushion assembly shall be used. The Contractor shall submit to the Contracting Officer at least 2 weeks before the start of pile driving operations detailed drawings of the driving helmet and pile cushion to be used.

3.2.2.2 Hammer Cushion or Capblock

****

NOTE: Select either wood or aluminum/micarta capblock. Delete inappropriate sentences. An aluminum/micarta capblock is recommended because of its consistent elastic properties and long life. If final pile penetration resistance is based on a wave equation analysis, the type capblock used should be the same as that used in the analysis.

****

Use a hammer cushion or capblock between driving helmet or cap and hammer ram consisting of [a solid hardwood block with grain parallel to the pile axis and enclosed in a close-fitting steel housing] [aluminum and micarta (or equal) discs stacked alternately in a steel housing]. Use steel plates at top and bottom of capblock. [Replace wood capblock when it becomes highly compressed, charred or burned, or becomes spongy or deteriorated in any manner.] [Replace aluminum or micarta discs that have become damaged, split, or deteriorated in any manner.] [Do not replace wood capblock during final driving of any pile.] Do not use small wood blocks, wood chips, rope, or other materials that permit excessive loss of hammer energy.

3.3 FIELD QUALITY CONTROL

3.3.1 Pile Records

For each pile, keep a record of the number of blows required for each 0.30 m 0.985 feet of penetration and the number of blows for the last 150 mm 6 inch penetration or fraction thereof. Include in the record the beginning and ending times of each operation during driving of pile, type and size of the hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of the hammer cushion (capblock) and pile cushion used. Record re-tap data and any unusual occurrence during driving of the pile. Include in the record performance characteristics of jet pump, unassisted penetration of pile, jet-assisted penetration of pile, and tip elevation before driving and at end of driving. Notify Contracting Officer 10 days prior to driving of piles. Submit complete and accurate records of installed piles to Contracting Officer within 15 calendar days after completion of the pile driving. Make pile-driving records available to the Contracting Officer at the job site within 24 hours of each day's pile driving. A preprinted form for recording pile driving data, the Pile Driving Log, is included at the end of this section.

PILE DRIVING LOG

CONTRACT NO.________________________ CONTRACT NAME_______________________
CONTRACTOR_____________________________ TYPE OF PILE_____________________
PILE LOCATION_____________ PILE SIZE: BUTT/TIP: ________ LENGTH_________
GROUND ELEVATION_________________________ CUT OFF ELEVATION______________
PILE TIP ELEVATION_________________ VERTICAL (_____) BATTER 1 ON (_____)
SPLICES ELEVATION____________________ COMPANY____________________________

HAMMER: MAKE & MODEL_________________ WT. RAM______________________
STROKE______________________ RAM RATED ENERGY___________________________
DESCRIPTION & DIMENSIONS OF DRIVING CAP_________________________________
CUSHION MATERIALS & THICKNESS____

INSPECTOR____

"DEPTH" COLUMN OF PILE DRIVING RECORD REFERENCED TO:
_____________________ CUT-OFF ELEVATION
_____________________ FINISH FLOOR ELEVATION

TIME: START DRIVING_______ FINISH DRIVING________ DRIVING TIME_________
INTERRUPTIONS (TIME, TIP ELEV. & REASON)_______________________________
JET PRESSURE & ELEVATIONS____

____

DRIVING RESISTANCE

DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS
0	_____	5.4	_____	10.8	_____
0.3	_____	5.7	_____	11.1	_____
0.6	_____	6.0	_____	11.4	_____
0.9	_____	6.3	_____	11.7	_____
1.2	_____	6.6	_____	12.0	_____
1.5	_____	6.9	_____	12.3	_____
1.8	_____	7.2	_____	12.6	_____
2.1	_____	7.5	_____	12.9	_____
2.4	_____	7.8	_____	13.2	_____
2.7	_____	8.1	_____	13.5	_____
3.0	_____	8.4	_____	13.8	_____
3.3	_____	8.7	_____	14.1	_____
3.6	_____	9.0	_____	14.4	_____
3.9	_____	9.3	_____	14.7	_____
4.2	_____	9.6	_____	15.0	_____
4.5	_____	9.9	_____	15.3	_____
4.8	_____	10.2	_____	15.6	_____
5.1	_____	10.5	_____	15.9	_____

SHEET 1 OF 2

PILE DRIVING LOG

16.2	______	23.1	______	29.7	______
16.5	______	23.4	______	30.0	______
16.8	______	23.7	______	30.3	______
17.1	______	24.0	______	30.6	______
17.4	______	24.3	______	30.9	______
17.7	______	24.6	______	31.2	______
18.0	______	24.9	______	31.5	______
18.3	______	25.2	______	31.8	______
18.6	______	25.5	______	32.1	______
18.9	______	25.8	______	32.4	______
19.2	______	26.1	______	32.7	______
19.5	______	26.4	______	33.0	______
19.8	______	26.7	______	33.3	______
20.1	______	27.0	______	33.6	______
20.4	______	27.3	______	33.9	______
20.7	______	27.6	______	34.2	______
21.0	______	27.9	______	34.5	______
21.3	______	28.2	______	34.8	______
21.6	______	28.5	______	35.1	______
21.9	______	28.8	______	35.4	______
22.2	______	29.1	______	35.7	______
22.5	______	29.4	______	36.0	______
22.8	______				

____

Driving resistance in blows per 25 mm for last 0.30 m of penetration:

DEPTH________ DEPTH________

25mm___ 50mm___100mm___125mm___150mm___175mm___200mm___225mm___ 250mm___

275mm___300mm___

ELEV._______ ELEV.________

REMARKS____

____

CUT OFF ELEVATION: FROM DRAWING ________________

TIP ELEVATION = GROUND ELEVATION - DRIVEN DEPTH = ________________

DRIVEN LENGTH = CUT OFF ELEVATION - TIP ELEVATION = ________________

CUT OFF LENGTH = PILE LENGTH - DRIVEN LENGTH = ________________

SHEET 2 OF 2

PILE DRIVING LOG

CONTRACT NO.________________________ CONTRACT NAME_______________________
CONTRACTOR_____________________________ TYPE OF PILE_____________________
PILE LOCATION_____________ PILE SIZE: BUTT/TIP: ________ LENGTH_________
GROUND ELEVATION_________________________ CUT OFF ELEVATION______________
PILE TIP ELEVATION_________________ VERTICAL (_____) BATTER 1 ON (_____)
SPLICES ELEVATION____________________ COMPANY____________________________

HAMMER: MAKE & MODEL_________________ WT. RAM______________________
STROKE______________________ RAM RATED ENERGY_____________________________
DESCRIPTION & DIMENSIONS OF DRIVING CAP_____________________________________
CUSHION MATERIALS & THICKNESS____

INSPECTOR____

"DEPTH" COLUMN OF PILE DRIVING RECORD REFERENCED TO:
_____________________ CUT-OFF ELEVATION
_____________________ FINISH FLOOR ELEVATION

TIME: START DRIVING_______ FINISH DRIVING________ DRIVING TIME_________
INTERRUPTIONS (TIME, TIP ELEV. & REASON)__________________________________
JET PRESSURE & ELEVATIONS____

____

DRIVING RESISTANCE

DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS
0	______	18	______	36	______
1	______	19	______	37	______
2	______	20	______	38	______
3	______	21	______	39	______
4	______	22	______	40	______
5	______	23	______	41	______
6	______	24	______	42	______
7	______	25	______	43	______
8	______	26	______	44	______
9	______	27	______	45	______
10	______	28	______	46	______
11	______	29	______	47	______
12	______	30	______	48	______
13	______	31	______	49	______
14	______	32	______	50	______
15	______	33	______	51	______
16	______	34	______	52	______
17	______	35	______	53	______

SHEET 1 OF 2

PILE DRIVING LOG

54	______	77	______	99	______
55	______	78	______	100	______
56	______	79	______	101	______
57	______	80	______	102	______
58	______	81	______	103	______
59	______	82	______	104	______
60	______	83	______	105	______
61	______	84	______	106	______
62	______	85	______	107	______
63	______	86	______	108	______
64	______	87	______	109	______
65	______	88	______	110	______
66	______	89	______	111	______
67	______	90	______	112	______
68	______	91	______	113	______
69	______	92	______	114	______
70	______	93	______	115	______
71	______	94	______	116	______
72	______	95	______	117	______
73	______	96	______	118	______
74	______	97	______	119	______
75	______	98	______	120	______
76	______				

DRIVING RESISTANCE IN BLOWS PER INCH FOR LAST FOOT OF PENETRATION:

DEPTH________ DEPTH________

1"___2"___3"___4"___5"___6"___7"___8"___9"___10"___11"___12"___

ELEV.________ ELEV.________

REMARKS____

____

CUT OFF ELEVATION: FROM DRAWING ________________

TIP ELEVATION = GROUND ELEVATION - DRIVEN DEPTH = ________________

DRIVEN LENGTH = CUT OFF ELEVATION - TIP ELEVATION = ________________

CUT OFF LENGTH = PILE LENGTH - DRIVEN LENGTH = ________________

SHEET 2 OF 2

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 59 13.14 20 (February 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-35 59 13.14 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-35 59 13.14 20 (February 2018)**

Preparing Activity: NAVFAC **Superseding**
UFGS-35 59 13.14 20 (February 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 35 59 13.14 20

POLYMERIC PILES

02/18

****

NOTE: This guide specification covers the requirements for polymeric marine fender piling. The specification is tailored for lateral load-bearing (fender) piling, bracketed items will require editing for axial load-bearing and lateral load-bearing piles. The intended use of bearing piles is for low-capacity (40 ton or less) "short" piles. Further testing will be required before these products can be used to replace concrete or steel marine bearing piles for primary piling on a berthing pier but may have applications at Magnetic Silencing Facilities.

Load combinations for polymeric piling are in accordance with UFC 4-152-01.

Axial load-bearing piles may require a site specific geotechnical report, pile drivability studies, and dynamic or static load tests; this type of testing may not be required for typical "secondary" fender pile system placed in soft marine soils.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings or included in the project specification.

****

****

NOTE: For lateral load-bearing fender piles, show the following information on the drawings:

1. Locations and types of the fender piles. If more than one type of fender pile (primary, secondary, corner) is used, indicate the location of each pile type.

2. Design loads (design vessel(s), berthing angle, berthing velocity).

3. Size, shape, and length of piles.

4. Connection details.

5. Length of polymeric pile protection. (Ensure that the camels, separators or watercraft bear on the protective layer throughout the entire tidal range.)

6. Soil data, where available.

7. Embedment depth. (The piles are typically designed as pinned/pinned, therefore ensure that the bottom of the piles have lateral restraint but not moment fixity.)

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D883	(2020a) Standard Terminology Relating to Plastics
ASTM D1143/D1143M	(2007; R 2013) Piles Under Static Axial Compressive Load
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2310	(2006; R 2012) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3689	(2007; E 2013; R 2013) Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM D3966/D3966M	(2007; R 2013; E 2013) Standard Test Methods for Deep Foundations Under Lateral Load
ASTM D4060	(2019) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4329	(2013) Standard Practice for Fluorescent UV Exposure of Plastics
ASTM D4945	(2017) Standard Test Method for High-Strain Dynamic Testing of Deep Foundations
ASTM D6109	(2013) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber and Related Products
ASTM D7258	(2017) Standard Specification for

Polymeric Piles

ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 DEFINITIONS

See ASTM D883 for standard terminology related to plastics.

Axial load-bearing pile – A vertical or battered member driven into the ground to help support a load of any structure bearing upon it. Axial load-bearing piles are commonly divided into two kinds; point-bearing (end-bearing) and friction. A point-bearing pile derives a significant proportion of capacity at its tip and much less from contact with soil along the pile shaft. A friction pile derives its support principally from the soil along the pile shaft through the development of shearing resistance between the soil and the pile.

CFRP - Carbon Fiber Reinforced Polymers - Composite materials which consist of a polymer resin matrix, and carbon fiber reinforcement.

Extrusion - A manufacturing process where molten polymer is forced through a die of a desired shape to encapsulate fiberglass reinforced plastic or steel bars which run continuously throughout the length of the product without joints.

FRP - Fiber reinforced polymer. A polymer matrix, either thermoset or thermoplastic, reinforced with a fiber or other material with a sufficient aspect ratio (length to thickness) to provide a discernable reinforcing function in one or more directions.

GFRP - Glass fiber reinforced plastic. A composite made from fiberglass reinforcement in a plastic (polymer) matrix.

Lateral load-bearing pile – a vertical or battered member driven into the ground to resist lateral loads imposed upon it or a structure. A common application for a lateral load-bearing pile is to absorb lateral forces at points of impact and dissipate them horizontally into a structure and/or soil stratum. A fender pile is an example of a lateral load-bearing pile.

Polymer - Any of numerous natural and synthetic compounds of usually high molecular weight consisting of up to millions of repeated linked units, each a relatively light and simple molecule.

Polymeric Pile - Piling products characterized by the use of polymers, whereby (1) the pile strength or stiffness requires the inclusion of the polymer or (2) a minimum of 50 percent of the weight or volume is derived from the polymer. Polymeric piles may be reinforced by composite design for increased stiffness or strength.

Pultrusion - A continuous process for manufacturing composites that have a cross sectional shape. The process consists of pulling a fiber reinforcing material through a resin impregnation bath and through a shaping die, where the resin is subsequently cured.

Resin - Any of numerous physically similar polymerized synthetics or chemically modified natural resins. Two main types of polymers used for resins include thermoset and thermoplastic materials.

Thermoset Plastics (thermosets) - Refer to a range of polymer materials that once cured do not flow or melt when heated. Thermoset materials are transformed through the addition of energy into a stronger substance. Thermoset materials are usually liquid or malleable prior to curing and designed to be molded into their final form; or used as adhesive. Thermoset polymer resins can be transformed into plastics or rubbers by cross-linking. A thermoset material cannot be melted and re-molded after it is cured. Thermoset materials are generally stronger than thermoplastic materials. They are also better suited to high temperature applications. They are not easily recyclable like thermoplastics, which can be melted and re-molded. Examples of thermoset plastics include: natural rubber, Bakelite, Urea-Formaldehyde, Melamine, Polyester Resin, and Epoxy Resin.

Thermoplastics - Most thermoplastics are high molecular weight polymer chains, mostly joined through weak dispersion forces and more rarely dipole-dipole interactions. Thermoplastic polymers are usually contrasted with thermosetting polymers, which cannot go through melt/freeze cycles. Many thermoplastic materials are addition polymers (chain growth polymers), such as polyethylene and polypropylene.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification

and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Polymeric piles; G, [_____]

SD-03 Product Data

Polymeric Piles; G, [_____]

Pile Driving Equipment; G, [_____]

Driving Helmet; G, [_____]

Pile Caps; G, [_____]

Pile Driving Tips; G, [_____]

Driving Pads; G, [_____]

Pile Tops; G, [_____]

HDPE Sleeve; G, [_____]

Manufacturer's Warranty; G, [_____]

Contractor's Warranty; G, [_____]

SD-05 Design Data

Polymeric Piles; G, [_____]

Allowable Bending Moment

Allowable Stresses

Concrete Mix Design; G, [_____]

[Wave Equation Analysis; G, [_____]

][Order List; G, [_____]

] SD-06 Test Reports

Material Test Reports; G, [_____]

[Performance Test Data; G, [_____]

] Allowable Stresses

Delivery Inspection List

[Pile Driving Analyzer; G, [_____]

][Dynamic Testing of Piles; G, [_____]

] SD-07 Certificates

Driving Hammer; G, [_____]

Polymeric Piles; G, [_____]

SD-11 Closeout Submittals

Pile Records

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect each pile for surface damage, cracks, blemishes, scaring and straightness upon delivery. Record the condition of each pile and submit the delivery inspection list to the Contracting Officer. Do not incorporate materials damaged in transport from plant to site. Handle the piles with ropes or nylon slings without dropping, breaking, bruising or penetrating outer surface with tools. Do not use cant dogs, peaveys, hooks or pikepoles. Protect piles from damage. Store piles above the ground on blocking which is shaped or padded and prevent scaring or sagging of the piles. Cover and arrange storage racks to permit air circulation.

1.5 BASIS OF BIDS

1.5.1 Polymeric Piles

Base bids on the type, number, diameter, and length of piles as indicated. Should the total number of piles vary from that specified as the basis for bidding, the Contract price will be adjusted in accordance with Contract Clause entitled "Changes". Adjustment in Contract price will not be made for cutting off piles, for any portion of a pile remaining above the cutoff elevation, or for broken, damaged or rejected piles.

PART 2 PRODUCTS

2.1 PILE CLASSIFICATION

1. Type I - Polymeric only

****

NOTE: Solid and tubular polymeric section are included.

****

2. Type II - Polymeric with reinforcement in the form of chopped, milled or continuous fiber or mineral

****

NOTE: The most common Type II piles are recycled HDPE reinforced with chopped glass fibers and composite plastic lumber.

****

3. Type III - Polymeric with reinforcement in the form of metallic bars, or cages, or shapes

****

NOTE: The most common Type III piles are plastic piles with steel reinforcing or a steel pipe core.

****

4. Type IV - Polymeric with reinforcement in the form of non-metallic bars or cages

****

NOTE: The most common Type IV piles are plastic piles with a fiberglass reinforcing cage.

****

5. Type V - Polymeric composite tube with a concrete core

****

NOTE: The most common Type V piles are fiberglass tubes with concrete fill placed prior to driving.

****

6. Type VI - Any other polymeric piling meeting the requirements of this specification and not otherwise described above, such as hollow polymeric composite tubes driven without a concrete core.

****

NOTE: The Type VI pile section provides for new types of polymeric pilings. Examples of "new" piling types with respect to ASTM D7258, include polymeric composite tube installed (driven) without a concrete core.

****

2.2 POLYMERIC PILES

Provide polymeric piles manufactured as specified. Include dimensions, material specifications, and method of manufacturing. Provide all polymeric piles of a particular type manufactured by a single manufacturer. Permanently tag each pile with the pile's serial number, date of fabrication and manufacturer's name. Place the stamp or tag two to four feet from the top of the pile and ensure it is visible after installation. Splices will not be permitted, unless approved by the Contracting Officer. Provide pile driving tips, when required, per manufacturer's recommendations.

2.3 PERFORMANCE REQUIREMENTS

****

NOTE to Designer: Polymeric piles are not recommended for the replacement of single fender piles when the polymeric pile stiffness is different than that of the pile being replaced. When this occurs, the more flexible pile will not carry its share of the berthing load. As an example, polymeric piles will usually be more flexible than

timber piles, in which case the timber piles adjacent to the polymeric piles will take increased loads, which may cause the piles to fail. Therefore, single or limited replacement of the timber piles are not recommended. Transverse misalignment of the piles can also cause individual piles to fail, and precautions to minimize this occurrence should be taken.

Comparison values for a typical timber pile

Typical ASD Design Properties for treated Southern Yellow Pine (SYP) marine pile per ASTM D25:

Allowable Axial compression:	**1250 psi**
Allowable Bending Strength	**1950 psi**
Allowable Shear Perpendicular to Grain	**160 psi**
Allowable Compression Perp. to grain	**440 psi**
Modulus of Elasticity	**1,500,000 psi**
Modulus of Rupture(MOR)	**7,300 psi**
90 percent MOR (accidental berthing)	**6,570 psi**
"Operational" Bending Strength	**3,900 psi**

For a 12 in. butt 50 ft long SYP pile with a 7 in. tip treated for marine use (Bending moments taken at mid height).

Allowable Axial Capacity "short"	**24 ton (48 kip)**
Mid Height Diameter	**9.5 in.**
Mid Height Section Modulus	**84.2 in.^3**
Mid Height Moment of Inertia	**400.0 in.^4**
Stiffness = 'E' x 'I'	**600,000.0 kip-in^2**
Allowable Moment Capacity (FS = 3.73)	**13.7 kip-ft**
Operational Moment Capacity (FS = 1.87)	**27.3 kip-ft**
Accidental Moment Capacity (FS = 1.11)	**46.1 kip-ft**

See UFC 4-152-01 Section 5-4.4.3(a) for allowable timber stresses on fender piles for normal/operational and accidental berthing. FS = Factor of Safety based on rupture strength = 7.3 ksi x 84.2 in^3/12 = 51.2 kip-ft. Axial capacity does not consider Euler buckling (Short Column).

For pultruded members the minimum factor of safety is 2.5 for flexure and 3.0 for compression, shear, and connections.

****

Determine the cross-sectional dimensions of piles on the basis of the ability to perform satisfactorily under the physical loading and environmental conditions imposed and to effectively perform the energy absorption properties desired. Submit[the Performance Test Data] to substantiate the performance. The performance requirements listed are allowable (service level) values. For berthing/flexure the minimum factor of safety is [2.0][2.5] for normal/operational loads. For compression and shear, the minimum factor of safety is [2.5][3.0].

2.4   PERFORMANCE CHARACTERISTICS

****

NOTE: The designer must fill in the required performance characteristics for each pile, for a particular application. Provide a separate table for each pile type and application.
****

Provide the following performance characteristics for each pile:

PERFORMANCE CHARACTERISTICS			
Description	Value	Units	Test Method
Structural Outer Dimension/Diameter	[______]	mm in.	N/A, +/- 10 percent
Allowable Moment Capacity	[______]	kNm kip-ft	ASTM D7258
Allowable Axial Capacity - Short Column	[______]	kg kip	ASTM D7258
Flexural Rigidity (EI)	[______]	kg-mm^2 lb-in^2	ASTM D6109, +/- 10 percent
Allowable Shear Capacity	[______]	kg kip	ASTM D7258

2.4.1 Allowable Moment Capacity

Submit the allowable bending moment for the particular pile selected based on the ASTM testing procedures indicated.

2.4.2 Allowable Axial Capacity

****
NOTE: Allowable axial capacity is the structural capacity of the piling. See UFC 3-220-01 for geotechnical capacity. A load test may be appropriate for critical load bearing applications to allow the use of the lowest geotechnical factor of safety.
****

Submit the allowable axial capacity based on the ASTM testing procedures indicated. Unless noted otherwise the allowable axial capacity must be based on a short member without considering slenderness effects.

2.4.3 Flexural Rigidity (EI)

****
NOTE: Maximum deflection and operational level deflections are based on the Flexural Rigidity of the member. Consider service level deflections under all operational load combinations in UFC 4-152-01. Pay special attention to environmental loads which may cycle the product into a state of fatigue. For bearing piles consider deflection limits stated in UFC 1-200-01.

****

Flexural rigidity "EI" is defined as the product of Modulus of Elasticity "E" times Moment of Inertia "I". "EI" is related to the slope of a moment-deflection curve in accordance with ASTM D6109. Determine the values for "EI" from the peak load at failure.

2.4.4 Allowable Shear Capacity

Submit the allowable shear capacity based on the ASTM testing procedures indicated.

2.4.5 Allowable Stresses

Submit the following: allowable flexural stress, allowable shear stress, allowable bearing stress perpendicular to the member, allowable bearing stress parallel to the member, allowable tensile stress, and allowable compressive stress. See paragraph PERFORMANCE REQUIREMENTS for minimum factor of safety.[Use allowable tensile and compressive stresses for Wave Equation Analysis.]

2.5 SIZE TOLERANCES

Unless specified otherwise refer to the tolerances listed in ASTM D7258.

2.6 MATERIALS

2.6.1 Physical Properties

****

NOTE: The designer must select the appropriate pile types and fill in the required physical properties for each pile. Properties which do not apply to a particular pile type may be deleted or indicated as n/a.

****

Submit Material Test Reports, as applicable, for each type of material. See below for the required:

1. Water Absorption, ASTM D570, < 3 percent at 24 hours.

2. Brittleness, ASTM D746, no break.

3. Hardness, ASTM D2240 Shore D, [60].

4. Ultraviolet, ASTM D4329, [2 percent] change in Shore D Durometer Hardness after 500 hours of exposure.

5. Flame Spread Rating, ASTM E84, <200.

2.6.2 Type III and IV Polymeric Piles

2.6.2.1 Placement of Reinforcing

In accordance with ASTM D7258, place longitudinal reinforcement within 5 percent of the specified radial location as measured from centroid of the cross-section of the pile. Longitudinal reinforcement will not twist more than 5 degrees over any 6.1 m 20 foot section of the pile. The minimum cover is 25 mm 1 inch.

2.6.3 Type V Polymeric Piles

2.6.3.1 Polymeric Composite Tube

Manufacture polymeric composite pile comprising of material which provides the tube strength. Manufacture the tube in accordance with ASTM D2996 and ASTM D2310.

2.6.3.2 Outer Surface

Furnish an outer surface comprising of a suitable, high impact, marine grade coating that provides a protective barrier as well as wear and impact resistance. It must provide an ultraviolet and chemical resistant barrier of at least 0.75 mm 0.03 inch thickness and be of a black opaque color.

2.6.3.3 Inner Surface

Provide an inner surface of a pure polymeric liner layer of at least 0.64 mm 0.025 inch thickness for alkalinity resistance. Roughen or wrinkle the inner surface to provide adhesion of the inner shell to the concrete fill.

2.6.3.4 Concrete Fill

Fill the composite tube completely with concrete in accordance with the manufacturer's written instructions. Furnish concrete with a minimum 28-day compressive strength of 41.4 MPa 5,000 psi. Submit a concrete mix design certifying that the proportioning of the mix is in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE for specified strength and is based upon aggregate data which has been determined by laboratory tests during the last twelve months.

2.6.3.5 HDPE Sleeve

Provide HDPE sleeve per paragraph POLYMERIC PILE PROTECTION.

2.6.3.6 Type VI Hollow Polymeric Piles

2.6.3.6.1 Hollow Polymeric Composite Tube

Furnish hollow polymeric composite tube satisfying the requirements of ASTM D7258.

2.6.3.6.2 Concrete Fill

****

NOTE: For lateral-load bearing (fender) piles, at a minimum place a concrete "plug" a distance D above and a distance of 2*D below the upper support to prevent crushing/local buckling of the hollow tube at the point of impact (D = outside diameter of the pile).

****

Fill the composite tube with concrete [to [_____] m [_____] ft below the pile top][from the pile top to the mudline] after driving. Provide concrete with a minimum 28-day compressive strength of 34.5 MPa 5,000 psi. Submit a concrete mix design certifying that the proportioning of the mix is in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE for specified strength and is based upon aggregate data which has been determined by laboratory tests during the last twelve months.

2.6.3.6.3 HDPE Sleeve

Provide HDPE sleeve per paragraph POLYMERIC PILE PROTECTION.

2.7 PILE FINISHING

2.7.1 Polymeric Pile Protection

Furnish the polymeric piles such that the rubbing surface of the piles has an abrasion resistance less than 0.5g per ASTM D4060. If the materials are reactive to seawater, protect the pile by encasing in an HDPE sleeve or abrasion resistant polymer, with a minimum thickness of 13 mm 1/2 inch.[Extend the protective encasement, as a minimum, from 0.6 m 2 feet below the mean lower low water (MLLW) to 0.3 m 1 feet below the pile support, unless indicated otherwise.]

****

NOTE: The length of protection may need to be increased for barges or other flat sided vessels and for systems supporting deep draft separators. The contact surface for barges may be near the deck level if there is a rail, or if the piles are sloped the contact area may be near the bottom of the hull. The contact areas must consider the upper and lower rub strips for deep draft separators.

****

2.7.1.1 HDPE Sleeve

Provide ASTM D3350, 2 - 3 percent carbon black UV stabilized HDPE sleeve. Attach as indicated or per Manufacturer's recommendation to protect the lateral load-bearing pile. Provide length as indicated in paragraph POLYMERIC PILE PROTECTION. Furnish sleeve with minimum wall thickness of 13 mm 1/2 inch, and hardness of 62 (Shore D) per ASTM D2240.

2.7.2 Surface Condition

Ensure that the pile surface exhibiting roughness or corrugations due to manufacturing processes, do not have depressions or projections greater than 12 mm 1/2 inch and less than 5,800 mm^2 9 in^2 in surface area. The surface of the pile is required to be free of any cracks or splits, in any orientation.

2.7.3 Pile Cover

Furnish the polymeric piles with approved pile tops, concrete fill sloped to drain, or encapsulated in polymeric material.

2.7.3.1 Pile Tops

Furnish the polymeric top with a thickness of approximately 6 mm 0.25 inches and color to match the pile. Secure the top in place with 6 mm diameter by 38 mm 1/4 inch diameter by 1 1/2 inch long Type 316 stainless steel screws spaced a maximum of 100 mm 4 inches on center. Center the screws in the ribbon band of the top. Use appropriate screw types for the matrix material and place in pilot holes.

2.8 SOURCE QUALITY CONTROL

2.8.1 Plant Inspection

The Contracting Officer reserves the right to perform plant inspection of the polymeric pile manufacturing process. Provide the Contracting Officer a minimum two weeks advance notice, indicating the date manufacturing is to start and tests that will be conducted. Allow the Contracting Officer unlimited access to the plant and inspection privileges for each facet of the manufacturing process.

2.8.2 Curing

2.8.2.1 Type I, II, III, IV and VI Polymeric Piles

Cure piles at the plant as recommended by the manufacturers prior to shipment to the site.

2.8.2.2 Type V Polymeric Piles

Fill Type V piles with concrete prior to driving. Support the pile to prevent sag during concrete placement and curing. Cure a minimum of one week prior to placement of the concrete fill. Move piles to curing table within 20 minutes of wet concrete placement. Do not handle or transport piles for seven days or until concrete has reached 85 percent of the 28 day compressive strength. Drive concrete filled piles after full strength has been obtained or after 28 days of curing.

2.9 DRIVABILITY

Furnish piles capable of being driven by contractors vibratory, air, steam, diesel or hydraulic hammers without damage to the pile anywhere along its length, with the exception of a sacrificial 0.6 m 2 ft at pile head.

2.10 MANUFACTURER'S WARRANTY

Warranty all polymeric piles to be free from defects in materials and workmanship for a period of ten years. The Contracting Officer has the right to require complete replacement of any pile with material or workmanship defects. All construction costs related to the repair or replacement of the defective piles are at Manufacturer's expense. This warranty need not cover repairs required as a result of normal wear and tear, misuse, mishandling, extreme weather, failure to perform routine maintenance, non-recommended or improperly executed alterations by anyone other than the Manufacturer, tampering, loading of the pile beyond its rated capacity, improper installation, or other use inconsistent with Manufacturer's specifications.

2.11 CONTRACTOR'S WARRANTY

Warranty all polymeric piles to be free from defects in materials caused by mishandling prior to installation and improper installation for a period of 5 years. The Contracting Officer has the right to require complete replacement of any pile deemed by the Contracting Officer to have defects due to mishandling or improper installation. All construction costs related to the repair or replacement of the defective piles are at the Contractor's expense.

PART 3 EXECUTION

3.1 PILE DRIVING EQUIPMENT

Select the proposed pile driving equipment, including hammers and other required items, and submit complete descriptions of the proposed equipment. Provide driving helmet, pile caps, pile driving tips and driving pads as recommended by the pile Manufacturer for the polymeric piles.[Final approval of the proposed equipment is subject to the satisfactory completion and approval of pile tests.] Changes in the selected pile driving equipment will not be allowed after the equipment has been approved except as[specified and] directed. No additional contract time will be allowed for Contractor proposed changes in the equipment.

3.1.1 Pile Driving Hammers

Provide impact[or vibratory] type pile driving hammers.

3.1.1.1 Impact Hammers

Use an air, steam, diesel or hydraulic powered hammer, of an approved type. The capacity of the driving hammer is required to meet or exceed the hammer manufacturer's recommendation for the total weight of pile and character of subsurface material to be encountered. In accordance with paragraph SUBMITTALS, submit the following information for each impact hammer proposed:

a. Make and model.

b. Ram weight.

c. Anvil weight.

d. Rated stroke.

e. Rated energy range.

f. Rated speed.

g. Steam or air pressure, hammer, and boiler[and][or] compressor.

[h. Rated bounce chamber pressure curves or charts, including pressure correction chart for type and length of hose used with pressure gage.

] i. Pile driving cap, make, and weight.

j. Cushion block dimensions and material type.

k. Power pack description.

[3.1.1.2 Vibratory Hammers

[The use of vibratory hammers is dependent upon satisfactory driving and load testing of piles.][Final approval of the proposed hammer and other driving equipment is subject to the satisfactory completion and approval of the pile tests.][The size or capacity of hammers must be as recommended by the hammer manufacturer for the total pile mass weight and the character of the soil formation to be penetrated.]Provide a rigid connection between the hammer and the pile. In accordance with paragraph SUBMITTALS, submit the following information for each vibratory hammer proposed:

a. Make and model.

b. Eccentric moment.

c. Dynamic force.

d. Steady state frequency or frequency range.

e. Vibrating weight.

f. Amplitude.

g. Maximum pull capacity.

h. Non-vibrating weight.

i. Power pack description.

]3.1.2 Pile Driving Leads

Support and guide hammers with[suspended leads,] fixed extended leads or fixed underhung leads.[Operate vibratory hammers free hanging without leads.][For driving battered piles, support and guide impact hammers with three-axis, fixed-extended leads capable of 1 H and 2-1/2 V fore and aft batter and 1 H on 6 V side batter, with 30 degree rotation each side of an axis running along the center line of rotation of the crane through the center line of the leads.][For driving battered piles, support and guide vibratory hammers with fixed extended leads or templates.][Provide two intermediate supports for the pile in the leads to reduce the unbraced length of the pile during driving.]

3.1.3 Pile Extractors

Use vibratory pile extractors for pile extraction.

[3.1.4 Jetting Equipment

Provide jetting equipment with at least removable or fixed jet of the water or combination air-water type. Design water jet so that the discharge volume and pressure are sufficient to freely erode the material immediately under and adjacent to piles without resulting in pile drift. Submit jetting equipment including plant description, volume of water and pressure, and size and length of hoses and pipes in accordance with paragraph SUBMITTALS.

][3.2 PRELIMINARY WORK

[3.2.1 Wave Equation Analysis of Pile Drivability

****

NOTE: This section may be applicable for axial load-bearing piles only.

****

a. Prior to driving any pile, submit a pile Wave Equation Analysis, performed by the Contractor's Geotechnical Consultant, for each size pile and distinct subsurface profile condition. Take the following into account for the analysis: the proposed hammer assembly, pile cap block and cushion characteristics, the pile properties and estimated lengths and the soil properties anticipated to be encountered throughout the installed pile length based on static capacity analysis with consideration of driving gain/loss factors. Only one specific model of pile hammer may be used for each pile type and capacity.

b. Demonstrate with the Wave Equation Analysis that the piles will not be damaged during driving and the driving stresses will be maintained within the limits stated in paragraph ALLOWABLE STRESSES. Indicate the blow count necessary to achieve the required ultimate static pile capacities.

c. Upon completion of the dynamic and static testing programs outlined in this specification section, perform a refined Wave Equation Analysis taking into consideration the evaluated capacities, gain/loss factors and recommended production pile lengths. Develop production pile driving criteria based on the results of the refined Wave Equation Evaluations.

d. Furnish pile driving equipment approved by the Contractor's Geotechnical Consultant. Complete the attached pile and driving equipment data form, including hammer information, in full as part of the submittal of the results of the Wave Equation Analyses.

e. The cost of performing the Wave Equation Analyses must be paid for by the Contractor. Include the cost in the base bid.

][3.2.2 Order List

Submit an itemized list for piles to the Contracting Officer for approval prior to placing the order with the supplier. Indicate the pile lengths required at each location as shown on the plans and the corresponding ordered length of each pile on the list.[Complete load testing and refined wave equation analysis prior to submission of an order list.]

]]3.3 INSTALLATION

3.3.1 On Site Storage

Continually support all stored piles in a manner which minimizes creep, saddling and sag.

3.3.2 Preexcavation

3.3.2.1 Jetting of Piles

****

NOTE: Jetting should generally not be permitted for piles:

1. When capacity is dependent on side friction in fine-grained, low-permeability soils high clay or silt content) where considerable time is required for soil to reconsolidate around the piles.

2. Subject to uplift.

3. Adjacent to existing structures.

4. In closely spaced clusters unless the load capacity is confirmed by test and unless all jetting is done before final driving of any pile in the cluster.

****

Jetting of piles is not permitted without the approval of the Contracting Officer.

3.3.2.2 Spudding of Piles

Spudding of piles is not permitted without the approval of the Contracting Officer. If spudding is allowed, limit it to an elevation 1.5 meters 5 feet above the specified pile tip elevation.

3.3.2.3 Predrilling of Piles

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NOTE: If predrilling is permitted by the Geotechnical Engineer of Record, it is recommended to use an auger smaller than the diameter of the pile.

****

Predrilling of piles is not permitted without the approval of the Contracting Officer. If predrilling is allowed, limit it to an elevation 1.5 meter 5 feet above the specified pile tip elevation.

3.3.3 Driving Piles

Notify Contracting Officer 10 days prior to driving of[test] piles[and load test]. Drive piles to[indicated][or below calculated] tip elevation[to reach a driving resistance established by the wave equation analyses (WEAP) in accordance with the schedule which the will prepare from the test-pile driving data]. During initial driving and until pile tip has penetrated beyond layers of very soft soil [or below bottom of predrilled or prejetted holes], use a reduced driving energy of the hammer as required to prevent pile damage. Refusal criteria must be established by the Contracting Officer. If a pile fails to reach the indicated[or calculated] tip elevation,[or if a pile reaches[calculated] tip elevation without reaching required driving resistance,] notify Contracting Officer, provide pile record and perform corrective measures as directed. Provide hearing protection in accordance with EM 385-1-1. Piles may be driven without pile guides or leads providing a hammer guide frame is used to keep the pile and hammer in alignment.

3.3.3.1 Protection of Piles

Square the heads and tips of piles to the driving axis. Laterally support piles during driving, but do not unduly restrain piles from rotation in the leads. The use of swinging or hanging leads is at the Contractor's risk. Repair any damage incurred by such use at the Contractor's expense.

3.3.3.2 Tolerances in Driving

Drive piles in the locations indicated. Place each pile, at its contact with the design mudline or mudline elevation indicated in the construction documents, no further than 40 mm per meter 0.5 inch per foot of free pile length (length in meters feet above the average soil contact line at each pile)in a direction parallel to the pier face and 10 mm per meter 0.125 inch per foot of the free pile length in a direction perpendicular to the pier face. Remove and replace with new piles those damaged, mislocated, driven below the design cutoff, or driven out of alignment.

3.3.4 Buoyant Piles

After driving buoyant piles, provide temporary framing or weights to prevent the pile from floating up out of the ground. Keep the temporary framing or weights in place until the pile is secured in place. If there is sufficient friction provided by the soil to prevent the pile from floating, the Contractor may, at his own risk, waive the temporary framing or weight requirement.

3.3.5 Pile Cutoff

Provide each polymeric pile a minimum of 0.6 meter 2 feet longer than the specified length to allow the top to be cut off if it is damaged during driving. Cut off piles with a smooth level cut using pneumatic tools, sawing, or other suitable methods per the polymeric pile Manufacturer's recommendations. Use of explosives for cutting is not permitted. Cut off pile heads level and sound. Cut off piles at no additional cost to the Government.

3.3.6 Fastening

Fasten the polymeric piles as indicated.

[3.4 PILE TESTS

****

NOTE: Pile tests may be applicable for axial load-bearing piles.

This specification allows for two types of pile tests: pile driving tests and pile load tests. Pile driving tests are used to determine the blow count required to drive a pile to a given penetration or to refusal on a hard layer. Pile driving tests may be performed with a pile driving analyzer attached to piles to record the information listed below. Pile load tests are used to determine pile capacity. The combination of pile driving tests and pile load tests gives information on pile capacity versus refusal blow count. Pile driving analyzer data may be used in some instances in place of pile load tests to reduce the number of load tests required for a project.

****

[3.4.1 Dynamic Testing of Piles

[Provide][Employ]a specialty engineering firm to perform dynamic testing of piles[and job piles] to determine velocity of stress wave propagation, acceleration, monitor hammer and drive system performance, assess pile installation stresses and integrity[, and to evaluate pile capacity]. Furnish personnel experienced in performing wave equation analysis, dynamic testing, the use of the Pile Driving Analyzer and its related equipment, and interpretation of results to install and operate the testing equipment and to interpret its results. Furnish equipment to obtain dynamic measurements, record, reduce and display its data and meet the requirement of ASTM D4945. The equipment must have been calibrated within 12 months thereafter throughout the contract duration. Supply all power requirements for operating the equipment. Submit Pile Driving Analyzer data within one [day][week] after each test is completed.

3.4.1.1 Test Piles

Perform dynamic testing on [_____] test piles as indicated. Test piles are at least [3 m10 ft] longer than minimum indicated job pile length. Perform testing during the full length of pile driving.[Restrike piles installed as part of pile driving test after a minimum waiting period of [_____] days.][Warm up the hammer prior to restriking.][Restrike the pile for 50 blows or until the pile penetrates an additional 75 mm 3 inches, whichever occurs first. In the event the pile movement is less than one-quarter inch during restrike, the restrike may be terminated after 20 blows.]

3.4.1.2 Job Piles

Perform dynamic pile testing on [_____] job piles during the full length of initial driving[and during restrike driving]. Tested piles must be as [indicated] [selected by the Contracting Officer over the duration of installation]. The Contracting Officer will direct testing of additional piles if the hammer or driving system is modified or replaced.

3.4.1.3 Reports

Prepare and submit a summary report of dynamic test results for test piles. Submit reports of the dynamic testing of piles within[seven days][two weeks] after dynamic testing is completed. Discuss in the report pile capacity obtained from dynamic testing, velocity of stress wave propagation, acceleration, evaluation of hammer and driving system performance, driving stress levels, and pile integrity. Perform[a CAPWAPC, or similar, analysis of the dynamic test data on data obtained from the end of initial driving and the beginning of restrike for [_____] test piles as directed. Use the analysis to predict pile capacity, establish resistance distribution, and predict quake and damping factors.] Include refined wave equation analyses incorporating the results of dynamic testing and analysis.[For job piles, prepare and submit a field summary report. Include energy transferred to the pile, calculated driving stresses, pile integrity and estimated pile capacity at the time of testing in the field summary report.] Include in the report for the test piles[and the monthly report for job piles] the pile driving record as an attachment and also address the items listed in ASTM D4945, paragraph titled "Dynamic Testing."

][3.4.2 Pile Load Tests

****

NOTE: Each ASTM pile load test specification listed offers a number of options as to how the test is performed. Specify the required load testing option and any modifications to include other desired requirements.

Insert the number of test piles to be load tested. The safe design capacity of a test pile to be determined based on the failure criteria indicated.

****

Perform load tests at locations shown, or as directed. Provide testing and measuring equipment, perform loading, and provide observation facilities for personnel to inspect, record, and analyze settlement/movement and deflection of piles under test loads. Do not mobilize load test equipment until directed by the Contracting Officer. Perform pile load tests under the supervision of a registered professional engineer provided by the Contractor and experienced in conducting pile load tests. Loading frames and equipment for pile load tests must be ready to be placed in operation as soon as a load test pile has been driven. Provide loading equipment of sufficient capacity to apply the maximum load specified in a safe manner. Start loading of each test pile when directed.

The Contractor is responsible for the application of loads. Accurately determine and control the magnitude of applied loads using a calibrated load cell and readout device. The design working load, as confirmed by the results of load tests, will be determined by the Contracting Officer. Load test piles indicated or directed to be driven in permanent locations may be incorporated into the work if, after satisfactory completion of load test, they are approved for inclusion in the work. Any pile load test not accomplished in accordance with this specification will be rejected. A new pile load test must be conducted for each rejected pile load test. The Contractor must compile a report for each pile load test including, as a minimum, all applicable information required by the specified test.

[3.4.2.1 Compressive Load Test

Perform [_____] pile compressive load tests in accordance with ASTM D1143/D1143M [, as modified]. Apply a compressive load of [_____] kN ton to each compressive load test pile.

][3.4.2.2 Tensile Load Test

Perform [_____] pile tensile load tests in accordance with ASTM D3689[, as modified]. Apply a tensile load of [_____] kN tons to each tensile load test pile.

][3.4.2.3 Lateral Load Test

Perform [_____] pile lateral load tests in accordance with ASTM D3966/D3966M [, as modified]. Perform lateral load tests consisting of jacking two piles apart with a hydraulic jack, with one pile serving as the reaction pile for the other. Apply a lateral load of [_____] kN tons to each pair of lateral load test piles. Take required movement readings and record for each pile.

]3.4.2.4 Safe Design Capacity

Load test piles to twice the anticipated working load unless failure occurs first. The safe design capacity of a load test as determined from the results of load tests is the lesser of the two values computed according to the following:

a. One-half the load that causes a net settlement after rebound of not more than 0.029 mm per kN 0.01 inch per ton of total test load.

b. One-half the load that causes a gross settlement of not more than 25 mm 1 inch provided the load settlement curve shows no sign of failure.

]]3.5 FIELD TREATMENT

3.5.1 Polymeric Work

Field treat cuts, bevels, notches, refacing and abrasions made in the field in accordance with the Manufacturer's recommendations.

3.6 FIELD QUALITY CONTROL

3.6.1 Inspections

Inspect piles when delivered and when in the leads immediately before driving. Secure piles in their proper alignment.

When Government inspections result in product rejection, promptly segregate and remove rejected material from the premises. The Government may also charge the Contractor an additional cost of inspection or testing when prior rejection makes reinspection or retesting necessary.

3.6.1.1 Straightness

ASTM D7258. Reject piles not meeting with the straightness criteria.

3.6.1.2 Cracks and Defects

Inspect each pile for cracks and defects prior to driving. After the piles are installed and all connections to the structure are completed, inspect each pile again for cracks and defects. Notify the Contracting Officer of any cracking or other defects observed and await direction. The Contracting Officer may reject any piles with defects. The Contractor is responsible for all costs incurred to replace the rejected piles.

3.6.2 Pile Driving Inspection

Perform special inspection of the pile installation. Employ approved Special Inspectors as required in the paragraph QC SPECIALIST DUTIES AND QUALIFICATIONS in Section 01 45 00 QUALITY CONTROL.

3.6.3 Pile Records

For each pile, keep a legible record of the number of blows required for each 0.30 m foot of penetration[and the number of blows for the last 150 mm 6 inch penetration or fraction thereof]. Include in the record the beginning and ending times of each operation during driving of pile, type and size of the hammer used, rate of operation, stroke or equivalent stroke for diesel hammer, type of driving helmet, and type and dimension of the hammer cushion (capblock) and pile cushion used. Record re-tap data and any unusual occurrence during driving of the pile. Include in the record performance characteristics of jet pump, unassisted penetration of pile, jet-assisted penetration of pile, and tip elevation before driving and at end of driving. Notify Contracting Officer 10 days prior to driving of piles. Submit complete and accurate records of installed piles to Contracting Officer within 15 calendar days after completion of the pile driving. Make pile-driving records available to the Contracting Officer at the job site within 24 hours of each day's pile driving. A preprinted form for recording pile driving data, the Pile Driving Log, is included at the end of this section.

PILE DRIVING LOG

CONTRACT NO.________________________ CONTRACT NAME_______________________
CONTRACTOR_____________________________ TYPE OF PILE_____________________
PILE LOCATION_____________ PILE SIZE: BUTT/TIP: ________ LENGTH_________
GROUND ELEVATION_________________________ CUT OFF ELEVATION______________
PILE TIP ELEVATION________________ VERTICAL (_____) BATTER 1 ON (_____)
SPLICES ELEVATION____________________ COMPANY____________________________

HAMMER: MAKE & MODEL_________________ WT. RAM______________________
STROKE______________________ RAM RATED ENERGY__________________________
DESCRIPTION & DIMENSIONS OF DRIVING CAP_________________________________
CUSHION MATERIALS & THICKNESS____

INSPECTOR____

"DEPTH" COLUMN OF PILE DRIVING RECORD REFERENCED TO MUDLINE ELEVATION

TIME: START DRIVING_______ FINISH DRIVING________ DRIVING TIME_________
INTERRUPTIONS (TIME, TIP ELEV. & REASON)_________________________________
JET PRESSURE & ELEVATIONS____

DRIVING RESISTANCE

DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS	DEPTH M	NO. OF BLOWS
0	_____	3.0	_____	7.0	_____	10.0	_____
0.3	_____	3.3	_____	7.3	_____	10.3	_____
0.6	_____	3.6	_____	7.6	_____	10.6	_____
0.9	_____	3.9	_____	7.9	_____	10.9	_____
1.2	_____	4.2	_____	8.2	_____	11.2	_____
1.5	_____	4.5	_____	8.5	_____	11.5	_____
1.8	_____	4.8	_____	8.8	_____	11.8	_____
2.1	_____	5.1	_____	9.1	_____	12.1	_____
2.4	_____	5.4	_____	9.4	_____	12.4	_____
2.7	_____	5.7	_____	9.7	_____	12.7	_____

REMARKS____
____
____
____

PILE TOP ELEVATION: FROM DRAWING ______________

TIP ELEVATION = GROUND ELEVATION - DRIVEN DEPTH = ______________

DRIVEN LENGTH = PILE TOP ELEVATION - TIP ELEVATION = ______________

CUT OFF LENGTH = PILE LENGTH - DRIVEN LENGTH = ______________

PILE DRIVING LOG

CONTRACT NO.________________________ CONTRACT NAME_______________________
CONTRACTOR_____________________________ TYPE OF PILE_____________________
PILE LOCATION_____________ PILE SIZE: BUTT/TIP: ________ LENGTH_________
GROUND ELEVATION_________________________ PILE TOP ELEVATION______________
PILE TIP ELEVATION_________________ COMPANY______________________________

HAMMER: MAKE & MODEL_________________ WT. RAM______________________
STROKE______________________ RAM RATED ENERGY____________________________
DESCRIPTION & DIMENSIONS OF DRIVING CAP__________________________________
CUSHION MATERIALS & THICKNESS____

INSPECTOR____

"DEPTH" COLUMN OF PILE DRIVING RECORD REFERENCED TO MUDLINE ELEVATION

TIME: START DRIVING_______ FINISH DRIVING________ DRIVING TIME_________
INTERRUPTIONS (TIME, TIP ELEV. & REASON)__________________________________
JET PRESSURE & ELEVATIONS____

DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS	DEPTH FT.	NO. OF BLOWS
0	______	16	______	32	______	48	______
1	______	17	______	33	______	49	______
2	______	18	______	34	______	50	______
3	______	19	______	35	______	51	______
4	______	20	______	36	______	52	______
5	______	21	______	37	______	53	______
6	______	22	______	38	______	54	______
7	______	23	______	39	______	55	______
8	______	24	______	40	______	56	______
9	______	25	______	41	______	57	______
10	______	26	______	42	______	58	______
11	______	27	______	43	______	59	______
12	______	28	______	44	______	60	______
13	______	29	______	45	______	61	______
14	______	30	______	46	______	62	______
15	______	31	______	47	______	63	______

REMARKS____
____
____
____

PILE TOP ELEVATION: FROM DRAWING ________________

TIP ELEVATION = GROUND ELEVATION - DRIVEN DEPTH = ________________

DRIVEN LENGTH = PILE TOP ELEVATION - TIP ELEVATION = ________________

PILE DRIVING LOG

CUT OFF LENGTH = PILE LENGTH - DRIVEN LENGTH = ________________

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 59 13.16 (November 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-35 59 13.16 (May 2011)
UFGS-35 59 13.19 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 59 13.16

EXTRUDED AND MOLDED MARINE FENDERS

11/21

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-35 59 13.16 (November 2021)**

Preparing Activity: NAVFAC **Superseding**
UFGS-35 59 13.16 (May 2011)
UFGS-35 59 13.19 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 35 59 13.16

EXTRUDED AND MOLDED MARINE FENDERS
11/21

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NOTE: This guide specification covers the requirements for extruded and molded marine fenders.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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****

NOTE: Fender type should be selected based on the following considerations:

1. Performance, including energy, berthing angle, reaction, and hull pressure.

2. Geometry, including stand-off, dock configuration, vessel configuration, and tidal variation.

3. Configuration and construction, including corrosion resistance, netted vs not netted, magnetic permeability, buoyancy and portability.

The following information shall be shown on the project drawings:

1. Location, size,and mounting elevation (if applicable) of each fender type.

2. Connection details to the waterfront structure. Include connection sizes, material type, embedment, plate sizes and hole sizes and locations, as applicable.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A479/A479M	(2024) Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D573	(2004; R 2019) Standard Test Method for Rubber - Deterioration in an Air Oven
ASTM D575	(1991; R 2012) Rubber Properties in Compression
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D1171	(2018) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking Outdoors (Triangular Specimens)
ASTM D1894	(2014) Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	(2022) Standard Specification for

	Stainless Steel Nuts
ASTM F648	(2021) Standard Specification for Ultra-High-Molecular-Weight Polyethylene Powder and Fabricated Form for Surgical Implants
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F2192	(2005; R 2022) Standard Test Method for Determining and Reporting the Berthing Energy and Reaction of Marine Feeders

INTERNATIONAL NAVIGATION ASSOCIATION (PIANC)

PIANC 2002	(2002) Guidelines for the Design of Fender Systems: 2002

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-907	(2020; Rev H) Antiseize Thread Compound, High Temperature

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-C-271	(Rev H; Am 1) Chains and Attachments, Carbon And Alloy Steel

1.2 SYSTEM DESCRIPTION

1.2.1 Extruded Fenders

****

NOTE: Extruded fender systems typically absorb a minimum amount of energy. Therefore, they are typically used at the wale elevation of fender pile systems. They have also been used as festoon fenders, rub strips and as an energy absorbing element in a separator.

****

Extruded fenders are elements typically manufactured in a long length by an extrusion process. After manufacture, the elements are cut to length. These fender elements are typically used as fenders for small craft, rub strips on marine structures,and energy absorbing elements at the wale. Examples of extruded fender shapes are 'Side Mounted Hollow Bore', 'Cylindrical', 'D', 'Square', 'W' and 'Wing'.

1.2.2 Molded Fenders

****

NOTE: Molded fenders are typically mounted to the vertical face of a marine structure. These systems are used to berth ships of similar size and hull curvature. Therefore, they are usually found in commercial ports.

****

Molded fenders are elements manufactured by the molded process. They typically have embedded metal plates cast into the molds. The fender elements are typically used as fenders for medium to large, flat sided vessels. The elements can be used as stand-alone fenders, combined with multiple fenders and a face panel, and energy absorbing elements at the wale. They include the shear fenders which absorb energy by deflecting parallel to the attachment plane. Examples of molded fender shapes are 'Leg Type', 'Arch Type', 'Cell Type', and 'Cone Type'.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panels; G, [_____]

SD-03 Product Data

Stainless Steel Hardware; G, [_____]

Galvanized Steel Hardware; G, [_____]

Restraint Chains; G, [_____]

Facing; G, [_____]

Extruded Fender; G, [_____]

Molded Fender; G, [_____]

SD-05 Design Data

****

NOTE: Performance requirements: the rated energy of the fender shall be no less than the calculated berthing energy and the rated fender reaction shall not exceed the allowable load on the structure supporting it.

The maximum reaction divided by the corresponding contact area, shall be less than or equal to the maximum specified hull pressure for fender panels.

Structural components shall be sized in accordance with the latest edition of AISC allowable stress design, including effects for internal spacing of stiffeners. Panel loads shall be based on the greater of:

1. Horizontal line contact applied at any elevation over the flat height of the panel.

2. Simultaneous horizontal line contacts at top and bottom edge of the front face of the panel.

Design factor for attachment points, restraints and nets shall be based on 1.5 times the dynamic shear. The end attachment load shall not exceed 80 percent of yield. Restraints shall be sized such that the load applied to the weakest component does not exceed 50 percent of its breaking strength.

A weak link, preferably a shackle, swivel or other readily replaceable, cost effective component shall be designed to fail first. Concrete embedments shall have a break out capacity of at least 1.5 times the characteristic load of the weakest link.

Mechanical hardware, such as fasteners shall be sized with a design working load that does not exceed 60 percent of the lower of the yield or breaking load.

****

Rubber Fenders; G, [_____]

Energy-Deflection Curve; G, [_____]

Load-Deflection Curve; G, [_____]

SD-06 Test Reports

Minimum Tensile Strength

Shore Hardness (Durometer)

Modulus at 200 Percent Elongation

Maximum Compression Set

Tear Resistance

Minimum Elongation

Ozone Resistance; G, [_____]

Low Temperature Impact Resistance; G, [_____]

Water Absorption; G, [_____]

Heat Resistance; G, [_____]

Compression Deflection Resistance

Fender Compression Test

SD-07 Certificates

Galvanized Steel Hardware Certificates; G, [_____]

Stainless Steel Hardware Certificates; G, [_____]

SD-08 Manufacturer's Instructions

Installation Instructions

SD-10 Operation and Maintenance Data

Fender Manual

1.4 DELIVERY, HANDLING AND STORAGE

Fenders must be undamaged when delivered. Handle and store fenders so as to prevent damage, such as bending or abrading end fittings, cutting of rubber, or damage to coating of hardware. Protect fenders from exposure to damaging liquids, oils, greases and extended exposure to sunlight.

1.4.1 Rejection

Fenders that are delivered to the site in a damaged condition or that are not in conformance with this specification are subject to rejection. Replace any rejected materials with suitable materials, at no additional cost to the Government.

1.4.2 Fender Marking

Unless unsuitable for specified fender or otherwise specified, identify all fenders in readable characters at least 25 mm 1 in high, either directly or on corrosion- and sunlight resistant permanently attached tags. The markings must include the following:

a. Full or abbreviated manufacturer name,

b. fender size model or part number designation,

c. fender serial number, and

d. other information as the purchase specification or contract requires.

1.4.3 Fender Instructions and Manual

Provide installation instructions and a fender manual describing maintenance requirements for each fender type.

1.4.4 Handling Coated Material

Store, handle and place coated material in a manner that will minimize damage to the coating and will not reduce its effective protective value. Repair damaged surfaces as directed and per the Manufacturer's recommendations. Handle coated work which is flexible in a manner that will prevent flexing sufficient to crack coating, especially when temperature is below 4 degrees C 40 degrees F. Do not place coated surfaces on strips or skids until coating has hardened thoroughly. Wide fabric slings used for lifting, and strips, slings, blocks, skids, cradles, and other supports must provide ample bearing areas. In transporting, fasten and protect coated materials in a manner that will prevent movement and preclude chafing and rubbing, and when unloading, do not dump or drop. Place coated material in position carefully on suitably prepared beds and with a minimum of handling.

1.5 QUALITY ASSURANCE

1.5.1 Extruded Fenders, Molded Fenders

Fender elements must be manufactured of rubber, homogeneous and free from any defects, impurities, pores or cracks. Where internal plates are used, the rubber must be bonded to integral steel mounting plates. The plates must be fully encased in rubber to a minimum thickness of 2 mm 1/16 inch.

1.5.2 Elastomer Skin

The elastomer skin of the fender must be free from cracks, burrs, warpage, checks, chipped or blistered surfaces, and must have a smooth surface.

1.5.3 Steel Fabrication

The steel used in fabrication must be free from kinks, sharp bends, and other conditions which would be detrimental to the finished product. Manufacturing processes must not reduce the strength of the steel to a value less than intended by the design. Manufacturing processes must be done neatly and accurately. Make bends by controlled means to insure uniformity of size and shape.

1.5.4 Welding

AWS D1.1/D1.1M. Provide sufficient size and shape welds to develop the full strength of the parts connected by the welds. Welds must transmit stress without permanent deformation or failure when the parts connected by the weld are subjected to proof and service loadings.

PART 2 PRODUCTS

2.1 EXTRUDED AND MOLDED FENDERS

2.1.1 Configuration

Provide dimensions, material specifications, and method of manufacture for each type of fender.

2.1.1.1 Extruded Fender

Fenders must be extruded and continuous in the length indicated. The fenders must be black in color. The fenders must have a truncated "A" cross section shape and be attached to the structure at the base, the widest dimension, of the arch. The connecting hardware must be fully exposed. No encased hardware or molded fenders are allowed. The fender and hardware must be designed and factory tested to the loads per linear meter foot of fender specified in paragraph PERFORMANCE. Fender anchor bolts and method of anchorage must be of the size and spacing required by the manufacturer's design and testing; however, the size and spacing of anchor bolts indicated must be construed to be the minimum required, unless exceeded by the requirements of the fender manufacturer's design.

2.1.1.2 Molded Fender

Fenders must be molded and continuous in the length indicated up to the maximum mold size available. Molded sections must not be mechanically bonded. The fenders must be black in color. Each fender must be molded of rubber, homogeneous and free from any defects, impurities, pores or cracks, and bonded to integral, steel mounting plates. The mounting plates must be fully encased in rubber with a minimum thickness of 2 mm 1/16 inch. The fender and hardware must be designed for and be factory tested to the loads specified. Fender anchor bolts and method of anchorage must be of the size and spacing dimensions required by the manufacturer's design and testing; however, the size and spacing of anchor bolts indicated must be construed to be the minimum required, unless exceeded by the requirements of the fender manufacturer's design.

2.1.2 Elastomer

The elastomer must be the ethylene propylene dimonomer (EPDM) or a blend of NR/SBR, as specified in ASTM D2000, with the following line callout:

****

NOTE: Coordinate values with calculated design requirements. The 3BA 720 compound is the typical compound. The 3BA 620 compound has approximately 70 percent of the energy capacity and a reduced reaction. Other compounds may be available.

****

a. 3BA 720 A_{14} B_{13} C_{12} EA_{14} $F1_{7}$

[b. 3BA 620 A_{14} B_{13} C_{12} EA_{14} $F1_{7}$

] The elastomer must have the following properties:

****

NOTE: Coordinate values with calculated design requirements.

****

ELASTOMER PROPERTY REQUIREMENTS	
Minimum Tensile Strength (ASTM D412)	[14][_____] MPa [2000][_____] psi
Shore Hardness (Durometer) (ASTM D412)	[70 plus 5][_____]
Modulus at 200 Percent Elongation (ASTM D412)	[6.2][_____] MPa [900][_____] psi
Maximum Compression Set (ASTM D395 Method B, Maximum Percent 22 Hr. at 70 degrees C 158 degrees F)	[25][_____] Percent
Tear Resistance (ASTM D624; DIE B Min.26.8 kg/cm 150 lb/in)	53.6 kg/cm 300 lb/in
Minimum Elongation (ASTM D412)	[500][_____] Percent
Ozone Resistance (ASTM D1171 Exposure Method B; 70h Bent Loop at 38 degrees C 100 degrees F; 50 pphm)	[80][_____] H plus
Low Temperature Impact Resistance (ASTM D746 Procedure B; Non-Brittle at minus 55 degrees C minus 67 degrees F)	[0][_____] degrees C [minus 40][_____] degrees F
Water Absorption (ASTM D471 Method B; 70h at 100 degrees C 212 degrees F; Volume Change plus 5 Percent	[10.0][_____] Percent
Heat Resistance (ASTM D573; 70h at 100 degrees C 212 degrees F Ch Tensile, Elong. minus 25 Percent, Hardness plus 10	Shall exceed requirements
Compression Deflection Resistance (ASTM D575 Method B; 3 S Dwell at 23 degrees C 73 degrees F	Shall exceed requirements

2.1.3 Performance Requirements

****

NOTE: This performance criteria should be tailored for extruded and molded shapes. Coordinate values with calculated design requirements.

****

Submit rated performance data (RPD) and published performance curves per ASTM F2192 or PIANC 2002 for the rubber fenders.

Each of the rubber fenders must have the following performance characteristics:

SIZE	ENERGY ABSORPTION	REACTION FORCE
	at rated deflection	at predicted energy attainment
[_____] m x [_____] m [_____] ft x [_____] ft	[_____] kN-m [_____] ft-kips	[_____] kN x [_____] [_____] kips

When vertically compressed by a plate extending the full length and width of a 1 meter 3.28 feet section of the fender, the fender must absorb [_____] [_____] newton-meters [_____] foot-pounds of energy with a corresponding load of not more than [_____] [_____] N [_____] [_____] pounds.

2.1.4 Test Reports

Perform tests on the specified fender within 5 years of submittal of the reports for approval. Test reports must be accompanied by notarized certificates from the manufacturer certifying that the tested material is of the same type, size, quality, manufacture and make as that proposed to be supplied. Perform the following tests:

a. Minimum Tensile Strength

b. Shore Hardness (Durometer)

c. Modulus at 200 Percent Elongation

d. Maximum Compression Set

e. Tear Resistance

f. Minimum Elongation

g. Ozone Resistance

h. Low Temperature Impact Resistance

i. Water Absorption

j. Heat Resistance

k. Compression Deflection Resistance

l. Fender Compression Test

****

NOTE: Coordinate values with calculated design

requirements.

****

Compress fender along its longitudinal axis between two parallel flat plate surfaces to its rated deflection. Record load and the corresponding deflection at 6 mm 1/4 inch increments and plot as a graph of load versus deflection. The Load-Deflection curve must then be integrated to generate an Energy-Deflection curve for the fender.

2.1.5 Break-In Deflection

Break-in deflection is required for buckling type fenders with reaction ratings of 100 tonnes or more, or if the energy-absorbing material has a reaction decrease of more than 10 percent between its original deflection and and its fifth deflection. Break-in deflection must be to at least the manufacturer's rated deflection. The number of break-in cycles must be sufficient to assure each elements first on-dock reaction will not exceed it fully broken-in reaction by more than 10 percent.

2.1.6 Fender Hardware

Provide manufacturer's product data for all fender hardware, including bolts, anchor bolts, inserts, nuts, washers, chains, turnbuckles, dimensions, material specifications, working loads and ultimate loads, as applicable. For anchor bolts and inserts, include methods and materials for installation.

2.1.6.1 Stainless Steel Hardware

Submit stainless steel hardware certificates of compliance certifying that materials meet the requirements specified herein.

****

NOTE: It is recommended that all concrete inserts be of stainless steel materials.

****

2.1.6.1.1 Plates and Angles

ASTM A479/A479M, Type 316L stainless steel for plates, angles, and miscellaneous hardware required to attach the fenders to the structure.

2.1.6.1.2 Bolts, Nuts, and Washers

ASTM F593 or ASTM F594, Group 2 (316 alloy) stainless steel for nuts and bolts. ASTM F844 for washers, except fabricate washers of 316 alloy stainless steel.

2.1.6.1.3 Antiseize Compound

MIL-PRF-907.

2.1.6.2 Galvanized Steel Hardware

****

NOTE: Galvanized steel hardware may be used at locations where the hardware can be easily replaced.

****

All hardware must be hot-dip galvanized in accordance with ASTM A123/A123M, ASTM A153/A153M or ASTM B695, as applicable.

Submit galvanized steel hardware certificates of compliance certifying that materials meet the requirements specified herein. In addition, when the coating is shop applied, submit certificates of conformance or compliance certifying that surface preparation, coverage, and thickness meet the requirements specified.

2.1.6.2.1 Plates

ASTM A36/A36M.

2.1.6.2.2 Bolts, Nuts and Washers

Bolts must be ASTM A307. Nuts must be ASTM A563, grade A heavy hex. Washers must be ASTM F844 of carbon steel.

2.1.6.2.3 Restraint Chains and Shackles

Chain and shackles must meet the requirements of FS RR-C-271. The chain assembly must have a design safety factor of 3:1 based on minimum breaking strength.

2.1.7 Panels

Panel design must be of closed box construction for optimum strength and corrosion resistance. Material thickness must be 10 mm 3/8 inch minimum when one side is exposed and 12 mm 1/2 inch minimum when both sides are exposed. Submit shop drawings indicating the dimensions of the panels.

2.1.7.1 Facing

Provide UHMWPE (ultra high molecular weight polyethylene) facing per ASTM F648 on the panels that is ultraviolet stabilized with 2.5 percent carbon black or equivalent, minimum 12 mm 1/2 inch wear thickness and 12 mm 1/2 inch clamping thickness, with a 0.20 maximum coefficient of friction per ASTM D1894. The UHMWPE must exhibit no failure when tested per ASTM D256, Method B. Configure the facing connections to account for the thermal properties of the polyethylene.

PART 3 EXECUTION

3.1 EXTRUDED FENDERS AND MOLDED FENDERS

Tighten the bolts per the manufacturers requirements.

3.2 WELDING

Perform welding in accordance with AWS D1.1/D1.1M.

3.3 CONNECTIONS

3.3.1 Antiseize Compound

Coat threads of bolts prior to applying washers and nuts. Recoat bolt thread projection beyond nut after tightening.

-- End of Section --

****

USACE / NAVFAC / AFCEC UFGS-35 59 13.17 (November 2021)

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 35 59 13.17

FOAM-FILLED MARINE FENDERS

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****

USACE / NAVFAC / AFCEC   **UFGS-35 59 13.17 (November 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 35 59 13.17

FOAM-FILLED MARINE FENDERS

11/21

****

NOTE: This guide specification covers the requirements for foam-filled marine fenders.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Fender type should be selected based on the following considerations:

1. Performance, including energy, berthing angle, reaction, and hull pressure.

2. Geometry, including stand-off, dock configuration, vessel configuration, and tidal variation.

3. Configuration and construction, including corrosion resistance, netted vs not netted, magnetic permeability, buoyancy and portability.

The following information shall be shown on the project drawings:

1. Location, size,and mounting elevation (if applicable) of each fender type.

2. Connection details to the waterfront structure. Include connection sizes, material type, embedment, plate sizes and hole sizes and locations, as applicable.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BUREAU OF SHIPPING (ABS)

ABS 2	(2019) Rules for Building and Classing Steel Vessels

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM D412	(2016; R 2021) Standard Test Methods for

	Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D470	(2013) Crosslinked Insulations and Jackets for Wire and Cable
ASTM D1052	(2009; R 2019) Measuring Rubber Deterioration-Cut Growth Using Ross Flexing Apparatus
ASTM D1630	(2006; R 2012) Rubber Property - Abrasion Resistance (Footware Abrader)
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D3575	(2020) Standard Test Methods for Flexible Cellular Materials Made from Olefin Polymers
ASTM F2192	(2005; R 2022) Standard Test Method for Determining and Reporting the Berthing Energy and Reaction of Marine Feeders

INTERNATIONAL NAVIGATION ASSOCIATION (PIANC)

PIANC 2002	(2002) Guidelines for the Design of Fender Systems: 2002

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-C-271	(Rev H; Am 1) Chains and Attachments, Carbon And Alloy Steel

1.2 SYSTEM DESCRIPTION

1.2.1 Foam-Filled Fenders

****

NOTE: Foam-filled fenders are typically used at berths that support ships of various sizes and with a variety of hull curvatures. Due to the wide variety of ship types that berth at Naval facilities, the foam-filled fenders are typically the fender of choice.

****

Foam-Filled fenders are fenders typically manufactured by wrapping closed cell foam with a nylon reinforcement embedded in a polyurethane coating. The fenders typically used for fendering have an internal chain, though fenders having an external chain/tire netting have also been used. The fenders are typically used for berthing of medium to large vessels; vessels with considerable hull curvature; and at berths that support various ship types and sizes. The fenders can be used as stand-alone fenders, fendering between ships, or between a ship and a berthing structure.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Foam-Filled Fenders; G, [_____]

SD-05 Design Data

****

NOTE: Performance requirements: the rated energy of the fender shall be no less than the calculated berthing energy and the rated fender reaction shall not exceed the allowable load on the structure supporting it.

The maximum reaction divided by the corresponding contact area, shall be less than or equal to the

maximum specified hull pressure for fender panels.

Deflected standoff at specified energy must be greater than or equal to minimum specified standoff. The undeflected standoff, including nets if any, shall not be greater than any specified undeflected standoff.

Fender design load shall be less than the rated reaction of the fender. Static shear force shall use the minimum static coefficient of friction. Dynamic shear force for foam-filled, pneumatic and hydro-pneumatic shall be the rated reaction times the difference between the coefficient of friction between the structure and fender and the coefficient between the fender and vessel times a factor of safety of 1.5. Dynamic shear force for rubber fenders for slicing surfaces shall be twice the maximum published dynamic coefficient of friction. For UHMW against steel, use 0.20 or the maximum published for the coefficient of friction.

The ultimate elastomeric elongation shall be at least three times the maximum elongation anticipated at maximum design conditions. The bond strength of the elastomer to its substrate shall be greater than the elastomer's tensile strength at the ultimate elongation.

Structural components shall be sized with a design load that does not exceed 80 percent of yield. Panel loads shall be based on the greater of:

1. Horizontal line contact applied at any elevation over the flat height of the panel.

2. Simultaneous horizontal line contacts at top and bottom edge of the front face of the panel.

Design factor for attachment points, restraints and nets shall be based on 1.5 times the dynamic shear. The end attachment load shall not exceed 80 percent of yield. Restraints shall be sized such that the load applied to the weakest component does not exceed 50 percent of its breaking strength.

A weak link, preferably a shackle, swivel or other readily replaceable, cost effective component shall be designed to fail first. Concrete embedments shall have a break out capacity of at least 1.5 times the characteristic load of the weakest link.

Mechanical hardware, such as fasteners shall be sized with a design working load that does not exceed 60 percent of the lower of the yield or breaking load.

Foam-filled fenders should have at least 50 percent of the contact dimension in bearing on the

supporting structure, or as recommended by the manufacturer. The contact surface for all floating fenders when not under load, should have low abrasion characteristics. Typically UHMWPE or plastic is used to face concrete or composite elements in the wear area.
****

Foam-Filled Marine Fenders; G, [_____]

SD-06 Test Reports

Fender Cyclic-Compression Test; G, [_____]

Fender Sustained-Load Test; G, [_____]

Fender Pull-Through Test; G, [_____]

Skin Thickness Core Test; G, [_____]

Foam Core Density Test

SD-08 Manufacturer's Instructions

Installation Instructions

SD-10 Operation and Maintenance Data

Fender Manual

SD-11 Closeout Submittals

Foam-Filled Fenders - Warranty; G

1.4 DELIVERY, HANDLING AND STORAGE

Fenders must be undamaged when delivered and must be handled and stored so as to prevent damage, such as bending or abrading end fittings, cutting of rubber, or damage to coating of hardware. Protect fenders from exposure to damaging liquids, oils, greases and extended exposure to sunlight.

1.4.1 Rejection

Fenders that are delivered to the site in a damaged condition or that are not in conformance with this specification are subject to rejection. Remove and replace any rejected materials with suitable materials, at no additional cost to the Government.

1.4.2 Fender Marking

Unless otherwise specified, all fenders must be identified in readable characters at least 25 mm 1 inch high, either directly or on corrosion- and sunlight resistant permanently attached tags. The markings must include the following:

a. full or abbreviated manufacturer name,

b. fender size model or part number designation,

c. fender serial number,

d. other information as the purchase specification or contract requires.

1.4.3 Fender Instructions and Manual

Provide installation instructions and a fender manual describing maintenance requirements for each fender type.

1.4.4 Handling Coated Material

Store, handle, and place coated material in a manner that will minimize damage to the coating and will not reduce its effective protective value. Repair damaged surfaces as directed and per the Manufacturer's recommendations. Handle coated work which is flexible in a manner that will prevent flexing sufficient to crack coating, especially when temperature is below 4 degrees C 40 degrees F. Do not place coated surfaces on strips or skids until coating has hardened thoroughly. Wide fabric slings used for lifting, and strips, slings, blocks, skids, cradles, and other supports must provide ample bearing areas. In transporting, fasten and protect coated materials in a manner that will prevent movement and preclude chafing and rubbing, and when unloading, do not dump or drop. Place coated material in position carefully on suitably prepared beds and with a minimum of handling.

1.5 QUALITY ASSURANCE

1.5.1 Elastomer Skin

The elastomer skin of the fender must be free from cracks, burrs, warpage, checks, chipped or blistered surfaces, and have a smooth surface.

1.5.2 Foam Core

The foam core must be homogeneous and of one piece fabricated construction and not be in chip or granular form. The foam core must not contain scraps, strips, or sheets of foam either rolled or stuffed into the required shape unless pieces are bonded together in layers of uniform patterns to form a homogeneous, one piece core. Foam widths less than 48 inches are not acceptable. Homogeneous foam rings of adequate thickness to insure performance of the fender are acceptable if a minimum 5-year performance of similar fenders is provided.

1.5.3 Steel Fabrication

The steel used in fabrication must be free from kinks, sharp bends, and other conditions which would be detrimental to the finished product. Manufacturing processes must not reduce the strength of the steel to a value less than intended by the design. Manufacturing processes must be done neatly and accurately. Make bends by controlled means to insure uniformity of size and shape.

1.5.4 Welding

AWS D1.1/D1.1M. Provide welds of sufficient size and shape to develop the full strength of the parts connected by the welds. Welds must transmit stress without permanent deformation or failure when the parts connected by the weld are subjected to proof and service loadings.

1.6 FOAM-FILLED FENDERS - WARRANTY

****

NOTE: The warranty requirements in this guide specification have been approved by a Level I Contracting Officer in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS).

NFAS can be found at the following link:
https://www.navfac.navy.mil/

The paragraphs in this guide specification may be used without further approval.

****

Furnish the manufacturer's warranty. Issue the warranty directly to the Government. It must not be limited in dollar value. The warranty period must not be less than 1 year from the date of Government acceptance of the work.

PART 2 PRODUCTS

2.1 FOAM-FILLED FENDERS

Prior to fabrication, submit copies of the manufacturer's catalog data including reaction, energy and percent compression curves, dimensions material specifications, and method of manufacture.

2.1.1 Configuration

Fenders must have cylindrical mid-bodies with conical or hemispherical shaped ends terminating in an end fitting on the cylinder's centerline at each end. The diameter of the mid-body must be 60 inches minimum, and the length of the mid-body must be 73 inches minimum. If conical ends are provided, they must have an angle of 60 to 75 degrees, when measured from the central axis of the fender. The fittings at either end must be connected through the center of the fender by a chain, must terminate in a clevis fitting sized for the indicated shackle and must swivel to allow the end fitting to rotate freely on the axis of the fender. Design end fitting as small as possible to transmit the ultimate load of the shackle to the fender. Size the end fitting so as not to contact loading surfaces when the fender is compressed to 30 percent of its original diameter (70 percent compression). Each end fitting must not be a continuous member; however, each independent end fitting must be of sufficient length to span all of 3 feet in the center of the fender. Permanently affix the end fitting to the fender core with urethane elastomer prior to applying the skin. Fill interior of the fender with energy absorbing closed-cell foam as specified. The use of chipped or particulate foam is not acceptable.

Dimensional tolerance: plus or minus 4 percent for diameter and length.

2.1.2 Foam Core

The energy absorbing foam core must be a closed-cell cross-linked polyethylene foam with the following properties:

a. Density, ASTM D1667, [52 to 104] [[_____] to [_____]] kg/m^3 [3.3 to 6.5] [[_____] to [_____]] lbs/ft^3

b. Tensile strength, ASTM D3575 or ASTM D412, [550] [_____] kPa [80] [_____] psi minimum

c. Elongation (ultimate), ASTM D3575 or ASTM D412, [40 percent] [_____] to [_____] minimum

d. Water absorption percent volume after 24 hour exposure, ASTM D1667, [5.0 percent] [_____] maximum

e. Continuous service temperature, [minus 54 to 49 degrees C] [minus 65 to 120 degrees F] [_____] to [_____]

f. 25 percent compressive set, ASTM D1667, [8 percent] [_____] maximum *

g. 50 percent compressive set, ASTM D3575, [12 percent] [_____] maximum *

* Option: Compressive Set of foam core material must be based on either the 25 percent or the 50 percent requirement listed.

2.1.3 Fender Skin

The outer fender skin must be minimum [32] [_____] mm [1.25] [_____] inches thick and constructed of elastomer as specified. Produce the fender skin with a singular homogeneous material. Multiple material types or layers are not permitted. Reinforcing is mandatory. Reinforcement utilizing a fabric is prohibited. Filament reinforcing is required. [Twelve][_____] separate filament reinforcing wraps must be applied as specified under Filament Wrap. Evenly distribute the filament wraps in the inner 80 percent to 90 percent of the coating thickness. The outer 10 percent to 20 percent of elastomer must have no filament reinforcing. Apply the elastomer and filaments in a continuous manner to assure adhesion between the various layers. Design and size the connection of the skin to the end fittings to transmit twice the safe tensile capacity of the chain into the fender skin.

Dimensional Tolerance: -10 percent

2.1.3.1 Elastomer

The elastomer used in the fender skin must be non-marking solvent free 100 percent PTMEG (polytetramethyleneether glycol) polyether urethane elastomer, ultraviolet stabilized with 2.5 percent carbon black or equivalent, with the following unreinforced properties:

a. Shore A. hardness, ASTM D2240, [80 to 95] [_____] to [_____].

b. Tensile strength, ASTM D412, [19.3] [_____] MPa [2800] [_____] psi minimum.

c. Elongation (ultimate), ASTM D412, [300 percent] [_____] minimum.

d. Tear strength, ASTM D470, [1.25] [_____] kg per mm [70] [_____] lbs/inch minimum.

e. Flex life (Ross), ASTM D1052, [200,000] [_____] cycles minimum.

f. Abrasion resistance (NBS), ASTM D1630, [100] [_____] minimum.

2.1.3.2 Filament Wrap

Construct each filament reinforcing wrap of continuous filaments applied in a helical pattern, at a helix angle of 0.79 to 1.05 rad 45 to 60 degrees to the longitudinal axis of the buoy. A wrap must consist of two such filament helixes of equal but opposing helix angles. The spacing between the filaments in the same helix must be no more than 3 mm 1/8 inch, measured in a direction parallel to the longitudinal axis of the fender. Each wrap must extend along the entire longitudinal axis of the fender and also encase the fender end fittings and secure them to the fender body. The reinforcing filaments must be nylon tire cord of 0.00028 kg per m 2540 denier weight with the following properties:

a. Breaking strength, [235] [_____] N [53] [_____] pounds

b. Elongation (ultimate), [18] [_____] percent

2.1.3.3 Color

Fender skin color must be black throughout the entire thickness. Galvanized hardware must be unpainted.

2.1.3.4 Repairability

The fender casing must be repairable in the event of tears or punctures in the elastomer skin. The repaired area must have not less than 90 percent of the properties as specified in paragraph ELASTOMER. Required repair materials must be readily available from the fender manufacturer.

2.1.4 Internal Hardware

The internal chain connecting the two end fittings and the two end fittings must be galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M as appropriate. The chain and end clevis fitting must have a minimum ultimate tensile capacity of [640,000] [_____] N [144,000] [_____] pounds. The internal chain and end clevis fitting must have a minimum ultimate tensile capacity of [578,000] [_____] N [130,000] [_____] pounds. Shackles must be [45] [_____] mm [1 3/4] [_____] inches and have a minimum ultimate tensile capacity of [289,000] [_____] N [65,000] [_____] pounds.

2.1.5 Performance Requirements

Each foam-filled fender must have the following performance characteristics:

SIZE	ENERGY ABSORPTION	REACTION FORCE
	at 60 percent compression	at predicted energy attainment
[_____]mm x [_____]mm [_____]ft x [_____]ft	[_____] kN-m [_____] ft-kips	[_____]kN x [_____] [_____] kips

Design the resilient, foam filled marine fenders so that when compressed across its diameter by two parallel flat plates extending the full length and width of the fender, the fender absorbs [221,500] [_____] foot-pounds of energy plus 15 percent when [60] [_____] percent compressed (i.e. to a dimension of [40] [_____] percent of its original diameter) with a corresponding load of not more than [712,000] [_____] N [160,000] [_____]

pounds plus 15 percent. Also design the fender to withstand a sustained reaction force of 667,200 [_____] N [150,000] [_____] pounds for a duration of not less than 24 hours each occurrence for at least 200 occurrences during its 10-year predicted life.

Submit the foam-filled marine fenders rated performance data (RPD) and published performance curves per ASTM F2192 or PIANC 2002.

2.1.6 Test Reports

Perform tests on the specified fender within 5 years of submittal of the reports for approval. Test reports must be accompanied by notarized certificates from the manufacturer certifying that the tested material is of the same type, size, quality, manufacture and make as that proposed to be supplied. Perform the following tests:

2.1.6.1 Fender Cyclic-Compression Test

Compress the fender along its diameter between two parallel flat plate surfaces to a compressed dimension of 40 percent of its original diameter. Repeat the compression and release cyclic loadings for a minimum of 10 full cycles of compression. Permanent deformation, cracking, or tearing of the fender skin, fender core, or end fittings must constitute failure of this test.

2.1.6.2 Fender Sustained-Load Test

Apply a [667,000] [_____] N [150,000] [_____] pound compressive load and hold this load for 24 hours. Record load and deflection each hour. Immediately after release of the load, measure rebound of the fender. Continue to record fender rebound for 24 hours. Failure of the fender or foam core to rebound to 90 percent of its original diameter after 24 hours must constitute failure of this test. If the foam core is not bonded to the skin of the fender, devise and execute a means for measuring rebound of the foam core and for measuring the void between the foam core and the skin. The maximum rate of compression per minute must be 20 percent of the total reaction force at 60 percent compression. The full compression cycle, not including rebound, must take a minimum of 5 minutes.

2.1.6.3 Fender Pull-Through Test

Devise and perform a test which will measure the resistance of the end fittings and internal chain to pull through the longitudinal axis of the fender. Failure of the chain, end fittings, or skin to resist at least [178,000] [_____] N [40,000] [_____] pounds of pull-through tension must constitute failure of this test. After loading, evidence of permanent deformation, cracking, or tearing of the fender or end fittings must also constitute failure of this test.

2.1.6.4 Skin Thickness Core Test

****

NOTE: The suggested number of fenders that should be tested is as follows:

Fenders Procured	**Number to Test**
1 - 3	**1**
4 - 8	**2**
9 - 20	**3**
21 and above	**4**

****

[After fabrication of all of the fenders and prior to fender shipment to the construction site, perform a minimum of [3] [_____] skin thickness tests per fender for each of [1] [2] [3] [4] fenders to be selected at random by the Contracting Officer.]Test locations on the fenders will be selected by the Contracting Officer. Verify testing by an ABS inspector prior to fender shipment. Each test must consist of taking a 6 mm 1/4 inch diameter (minimum) to 13 mm 1/2 inch diameter (maximum) core from the fender skin which can be removed from the skin and examined for thickness of elastomer and placement of reinforcing (when reinforcing is required). Take skin thickness measurements from the core sample and record measurements noting placement of reinforcing. Where the skin thickness measurement is less than the specified minimum, or the minimum required by the design (whichever is greater) by more than 10 percent, reject the fender. In addition, if the average of skin thickness tests for one fender is not equal to or greater than the specified minimum, or the minimum required by the design (whichever is greater), reject the fender. If tested fender is rejected, at the option of the Contracting Officer, the conduct thickness tests for additional fenders. Replace rejected fenders with fenders meeting the provisions of this specification. Test replacement fenders for skin thickness as specified herein. Skin thickness tests will be witnessed by the Contracting Officer. Notify the Contracting Officer 10 working days prior to conducting skin thickness tests. After skin thickness testing, patch core holes with elastomer of the same composition and thickness as the specified elastomer skin. Nylon reinforcing is not required in core hole patches.

2.1.6.5 Foam Core Density Test

During the skin thickness testing the fender must be cored to the center of the fender (up to the internal chain). A hole saw long enough to reach the center of the fender must be used to extract the foam sample. The fender manufacturer must provide the ABS inspector with the appropriate hole saw to perform the test. Test the foam sample at one-foot incremental depths to determine the conformance to the density requirements of this specification. Reject fenders with nonconforming foam.

After skin thickness and foam core testing, patch core holes with foam of the same density (provided by the fender manufacturer with the delivery of the fenders) and elastomer of the same composition and thickness as the specified elastomer skin. Nylon reinforcing is not required in core hole patches.

Testing must be verified by an ABS inspector prior to fender shipment.

2.1.7 Connecting Hardware

The connecting chain, swivel and shackles must be galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M, as appropriate. The hardware must be as follows:

Item	Type
Chain	ABS 2, Grade 2, Stud Link or Open Link
Shackle	FS RR-C-271, Type IVA, Class 3, Grade A
Swivel	FS RR-C-271, Type VII, Class 2

All connecting bolts and pins must be of mild steel, matching the properties of the shackle bow. For Class 3 shackles, secure the bolt or pins in place with stainless steel (Type 316) cotter pins or locking pins.

PART 3 EXECUTION

3.1 FOAM-FILLED FENDERS

Install fenders as indicated on the drawings and in accordance with the manufacturer's specifications and shop drawings. Tighten bolts an additional 1/3 turn of the nut, from the snug tight condition, and secured with cotter pins.

3.2 WELDING

Perform welding in accordance with AWS D1.1/D1.1M.

3.3 CONNECTIONS

3.3.1 Antiseize Compound

Coat threads of bolts prior to applying washers and nuts. Recoat bolt thread projection beyond nut after tightening.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-35 59 13.18 (November 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 35 59 13.18

PNEUMATIC AND HYDRO-PNEUMATIC MARINE FENDERS

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USACE / NAVFAC / AFCEC **UFGS-35 59 13.18 (November 2021)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 35 59 13.18

PNEUMATIC AND HYDRO-PNEUMATIC MARINE FENDERS

11/21

****

NOTE: This guide specification covers the requirements for pneumatic and hydro-pneumatic marine fenders.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

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NOTE: Fender type should be selected based on the following considerations:

1. Performance, including energy, berthing angle, reaction, and hull pressure.

2. Geometry, including stand-off, dock configuration, vessel configuration, and tidal variation.

3. Configuration and construction, including corrosion resistance, netted vs not netted, magnetic permeability, buoyancy and portability.

The following information shall be shown on the project drawings:

1. Location, size,and mounting elevation (if applicable) of each fender type.

2. Connection details to the waterfront structure. Include connection sizes, material type, embedment, plate sizes and hole sizes and locations, as applicable.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BUREAU OF SHIPPING (ABS)

ABS 2	(2019) Rules for Building and Classing Steel Vessels

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 34-1	(2022) Rubber, Vulcanized or Thermoplastic -- Determination of Tear Strength -- Part 1: Trouser, Angle and Crescent Test Pieces
ISO 37	(2024) Rubber, Vulcanized or Thermoplastic -- Determination of Tensile Stress-Strain Properties
ISO 815-1	(2019) Rubber, Vulcanized or Thermoplastic -- Determination of Compression Set -- Part 1: At Ambient or Elevated Temperatures
ISO 1431-1	(2012) Rubber, Vulcanized or Thermoplastic - Resistance to ozone cracking - Part 1: Static and dynamic strain testing
ISO 7619-1	(2010) Rubber, Vulcanized or Thermoplastic - Determination of indentation hardness - Part 1: Durometer method (Shore hardness)
ISO 17357-1	(2014) Ships and Marine Technology - Floating Pneumatic Rubber Fenders - Part 1: High Pressure

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-C-271	(Rev H; Am 1) Chains and Attachments, Carbon And Alloy Steel

1.2 SYSTEM DESCRIPTION

1.2.1 Pneumatic and Hydro-pneumatic Fenders

****

NOTE: Pneumatic fenders are inflated with air and float on the surface of the water to serve as a protective buffer for ships. Hydro-pneumatic fenders are similar, but contain water in addition to the pressurized air, with a counterweight at one end so the fender is partially submerged and are specifically designed for the berthing of submarines.

****

Pneumatic and hydro-pneumatic fenders are constructed of an inner rubber layer, reinforcing cord layers and an outer rubber layer that form a synthetic-cord-rubber sheet, which forms a cylindrical air-bag with hemispherical heads at each end,which can be inflated with air. These fenders can be used as stand-alone fenders, fendering between ships, or between a ship and a berthing structure. In hydro-pneumatic fenders, the upper hemispherical head has a top plate that allows internal placement of water and air into the bag, and the lower hemispherical head has a bottom plate that provides a connection location for the counterweight. The air-bag typically has a long cylindrical shape and is counter-weighted to float vertically. Hydro-pneumatic fenders are typically used as fenders for submarines, acting as buffers between submarines and berthing structures and as separators between submarines. Hydro-pneumatic fenders can be used in combination with foam-filled fenders or pneumatic fenders to support both ships and submarines at the same berth, if designed appropriately.

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Pneumatic Fenders Manufacturer's Data; G, [_____]

Hydro-Pneumatic Fenders Manufacturer's Data; G, [_____]

SD-05 Design Data

****

NOTE: Performance requirements: the rated energy of the fender shall be no less than the calculated berthing energy and the rated fender reaction shall not exceed the allowable load on the structure supporting it.

The maximum reaction divided by the corresponding contact area, shall be less than or equal to the maximum specified hull pressure for fender panels.

Deflected standoff at specified energy must be greater than or equal to minimum specified standoff. The undeflected standoff, including nets if any, shall not be greater than any specified undeflected standoff.

Fender design load shall be less than the rated reaction of the fender. Static shear force shall use the minimum static coefficient of friction. Dynamic shear force for pneumatic and hydro-pneumatic shall be the rated reaction times the difference between the coefficient of friction between the structure and fender and the coefficient between the fender and vessel times a factor of safety of 1.5. Dynamic shear force for rubber fenders for slicing surfaces shall be twice the maximum published dynamic coefficient of friction. For UHMW against steel, use 0.20 or the maximum published for the coefficient of friction.

The ultimate elastomeric elongation shall be at least three times the maximum elongation anticipated at maximum design conditions. The bond strength of the elastomer to its substrate shall be greater than the elastomer's tensile strength at the ultimate elongation.

Structural components shall be sized with a design load that does not exceed 80 percent of yield. Panel loads shall be based on the greater of:

1. Horizontal line contact applied at any elevation over the flat height of the panel.

2. Simultaneous horizontal line contacts at top and bottom edge of the front face of the panel.

Design factor for attachment points, restraints and nets shall be based on 1.5 times the dynamic shear. The end attachment load shall not exceed 80 percent of yield. Restraints shall be sized such that the load applied to the weakest component does not

exceed 50 percent of its breaking strength.

A weak link, preferably a shackle, swivel or other readily replaceable, cost effective component shall be designed to fail first. Concrete embedments shall have a break out capacity of at least 1.5 times the characteristic load of the weakest link.

Mechanical hardware, such as fasteners shall be sized with a design working load that does not exceed 60 percent of the lower of the yield or breaking load.

Pneumatic and hydro-pneumatic fenders should have at least 50 percent of the contact dimension in bearing on the supporting structure, or as recommended by the manufacturer. The contact surface for all floating fenders when not under load, should have low abrasion characteristics. Typically UHMWPE or plastic is used to face concrete or composite elements in the wear area.

****

Pneumatic Fenders Performance Characteristics; G, [_____]

Hydro-Pneumatic Fenders Performance Characteristics; G, [_____]

Pneumatic Fenders Design Data; G, [_____]

Hydro-Pneumatic Fenders Design Data; G, [_____]

SD-06 Test Reports

Prototype Fender Performance Confirmation; G, [_____]

****

NOTE: Prototype fender performance confirmation includes the following tests: (1) performance; (2) angular compression; (3) durability; (4) compression recovery; and (5) puncture resistance.

****

Dimensional Inspection; G, [_____]

Air-leakage Test; G, [_____]

Hydrostatic-pressure Test; G, [_____]

Pressure Relief Valve Test

Design Proof; G, [_____]

Rubber Material Test; G, [_____]

Submit copies of reports of tests specified herein. Also, submit reports for tests specified in referenced documents which are applicable to the particular material furnished for use.

SD-07 Certificates

Hydro-Pneumatic Certificates; G, [_____]

Pneumatic Certificates; G, [_____]

SD-08 Manufacturer's Instructions

Installation Instructions

SD-10 Operation and Maintenance Data

Fender Manual

SD-11 Closeout Submittals

Pneumatic and Hydro-Pneumatic Fenders - Warranty; G

1.4 DELIVERY, HANDLING AND STORAGE

Deliver fenders undamaged. Handle and store fenders as to prevent damage, such as bending or abrading end fittings, cutting of rubber, or damage to coating of hardware. Protect folded fender corners from forklift and/or maintenance while tires that could possibly damage the outer rubber and reinforced layers of the fender. Protect fenders from exposure to damaging liquids, oils, greases and extended exposure to sunlight.

1.4.1 Rejection

Fenders that are delivered to the site in a damaged condition or that are not in conformance with this specification are subject to rejection. Replace any rejected materials with suitable materials, at no additional cost to the Government.

1.4.2 Fender Marking

Unless otherwise specified, identify all fenders in readable characters at least 25 mm 1 inch high, either directly or on corrosion- and sunlight resistant permanently attached tags. For fenders 2500 mm 8 feet in diameter, the letter heights must be a minimum of 100 mm 4 in. The markings must include the following:

a. International Standard number and applicable year, i.e. ISO 17357-1:2014.

b. size (Diameter and Length),

c. initial internal pressure,

d. date of manufacture or its abbreviation,

e. full or abbreviated name of manufacturer

f. individual serial number,

g. type of reinforcement layer,

h. other information as the purchase specification or contact requires.

1.4.3 Fender Instructions and Manual

Provide installation instructions and a fender manual describing maintenance requirements for each fender type.

1.4.4 Handling Coated Material

Store, handle, and place coated material in a manner that will minimize damage to the coating and will not reduce its effective protective value. Repair damaged surfaces as directed and per the Manufacturer's recommendations. Handle coated work which is flexible in a manner that will prevent flexing sufficient to crack coating, especially when temperature is below 4 degrees C 40 degrees F. Do not place coated surfaces on strips or skids until coating has hardened thoroughly. Wide fabric slings used for lifting, and strips, slings, blocks, skids, cradles, and other supports must provide ample bearing areas. In transporting, fasten and protect coated materials in a manner that will prevent movement and preclude chafing and rubbing, and when unloading, do not dump or drop. Place coated material in position carefully on suitably prepared beds and with a minimum of handling.

1.5 QUALITY ASSURANCE

1.5.1 Certificates

Submit pneumatic certificates of compliance and hydro-pneumatic certificates of compliance certifying that materials meet the requirements specified herein.

1.5.2 Elastomer Skin

The elastomer skin of the fender must be free from cracks, burrs, warpage, checks, chipped or blistered surfaces, and must have a smooth surface.

1.5.3 Steel Fabrication

The steel used in fabrication must be free from kinks, sharp bends, and other conditions which would be detrimental to the finished product. Manufacturing processes must not reduce the strength of the steel to a value less than intended by the design. Manufacturing processes must be done neatly and accurately. Make bends by controlled means to insure uniformity of size and shape.

1.5.4 Welding

AWS D1.1/D1.1M. Provide welds of sufficient size and shape to develop the full strength of the parts connected by the welds. Welds must transmit stress without permanent deformation or failure when the parts connected by the weld are subjected to proof and service loadings.

1.6 PNEUMATIC AND HYDRO-PNEUMATIC FENDERS - WARRANTY

****

NOTE: The warranty requirements in this guide specification have been approved by a Level I Contracting Officer in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS).

NFAS can be found at the following link:
https://www.navfac.navy.mil/

The paragraphs in this guide specification may be used without further approval.
****

Furnish the manufacturer's warranty. Issue the warranty directly to the Government. It must not be limited in dollar value. The warranty period must be not less than 1 year from the date of Government acceptance of the work.

PART 2 PRODUCTS

2.1 PNEUMATIC AND HYDRO-PNEUMATIC FENDERS

2.1.1 Manufacturer's Data

2.1.1.1 Pneumatic Fenders Manufacturer's Data

Prior to fabrication, submit copies of the manufacturer's catalog data, performance curves per ISO 17357-1, dimensions, material specifications, and method of manufacture.

2.1.1.2 Hydro-Pneumatic Fenders Manufacturer's Data

Prior to fabrication, submit copies of the manufacturer's catalog data, performance curves per ISO 17357-1, dimensions, material specifications, and method of manufacture.

2.1.2 Design Data

2.1.2.1 Pneumatic Fenders Design Data

Submit rated performance data (RPD) and published performance curves per ISO 17357-1.

2.1.2.2 Hydro-Pneumatic Fenders Design Data

Submit rated performance data (RPD) and published performance curves per ISO 17357-1.

2.1.3 Configuration

Manufacture fenders in accordance with ISO 17357-1. Fenders must have cylindrical mid-bodies with hemispherical shaped ends terminating in an end fitting on the cylinder's centerline at each end. Size the flange opening fittings (not to exceed 12 percent of fender diameter) so as not to contact loading surfaces when the fender is compressed to 20 percent of its original diameter (80 percent compression). Incorporate a safety valve for Pneumatic and Hydro-Pneumatic fenders 2500 mm 8 feet diameter or larger and pressure monitoring system in their manufacture.

2.1.4 Dimensions

Diameter and length as indicated on the drawings.

2.1.5 Fender Skin

The fender skin must have a minimum strength in accordance with ISO 17357-1. When designing the skin thickness, consider skin strength and the stress induced by the internal operating and berthing pressure, and the abrasion and impact loads caused by handling and berthing operations. Ensure an adequate margin of safety is incorporated for the fender's intended use. Design the connection of the skin to the end fittings to resist the specified minimum endurable pressure at 60 percent compression in ISO 17357-1 for the respective operating pressure. For hydro-pneumatic fenders, the Minimum Endurable Pressure value in Table 5 of ISO 17357-1 (Pneumatic 80 fender pressure requirements) must be used.

2.1.5.1 Elastomer

Provide rubber material test proving the elastomer meets the requirements of ISO 17357-1, material test of rubber.

****

NOTE: After aging refers to air oven aging at 70 degrees C 158 degrees F plus/minus 1 degree C 33.8 degrees F, 96 hours.

****

Per ISO 17357-1, the elastomer used in the outer skin must be rubber, with the following unreinforced properties:

a. Durometer Hardness, Shore A	
(ASTM D2240 or ISO 7619-1)	
Before Aging	[50 to 70] [_____]
After Aging	Not to exceed the original property by more than 8

b. Minimum Tensile strength	
(ASTM D412 or ISO 37)	
Before Aging	[18] [_____] MPa [2600] [_____] psi
After Aging	Not less than 80 percent of original property

c. Minimum Elongation (ultimate)	
(ASTM D412 or ISO 37)	
Before Aging	[400 percent] [_____]
After Aging	Not less than 80 percent of original property

d. Minimum Tear strength	[400] [_____] N per cm [228] [_____] lbs/inch

(ASTM D624 or ISO 34-1)	

e. Compression set	30 percent(70 degrees C 158 degrees F plus/minus 1 degree C 33.8 degrees F, 22 hours) or less
(ISO 815-1)	

f. Static ozone aging test (ISO 1431-1)	No cracks after elongation by 20 percent and exposure to 50 pphm (parts of ozone per hundred million of air by volume) at 40 degrees C 104 degrees F for 96 hours

The elastomer used in the inner skin must be rubber, with the following unreinforced properties:

a. Durometer Hardness, Shore A	
(ASTM D2240 or ISO 7619-1)	
Before Aging	[40 to 60] [_____]
After Aging	Not to exceed the original property by more than 8

b. Minimum Tensile strength	
(ASTM D412 or ISO 37)	
Before Aging	[10] [_____] MPa [1450] [_____] psi
After Aging	Not less than 80 percent of original property

c. Minimum Elongation (ultimate)	
(ASTM D412 or ISO 37)	
Before Aging	[400 percent] [_____]
After Aging	Not less than 80 percent of original property

2.1.5.2 Color

Fender skin color must be black throughout the entire thickness. Galvanized hardware must be unpainted.

2.1.5.3 Repairability

The fender casing must be repairable in the event of tears or punctures in the elastomer skin. The repaired area must have not less than 90 percent of the properties as specified in paragraph ELASTOMER. Required repair materials must be readily available. Each fender must include a detailed repair procedure from the manufacturer that outlines a step by step process for mending tears, punctures or severe abrasions to fender casings.

2.1.6 Test Reports

Perform tests on the specified fender within 5 years of submittal of the reports for approval. Test reports must be accompanied by notarized certificates from the manufacturer certifying that the tested material is of the same type, size, quality, manufacture and make as that proposed to be supplied. Perform the following tests:

2.1.6.1 Performance Requirements

The performance of each fender must be meet the requirements of ISO 17357-1. Confirm the performance of the fender with a prototype fender performance confirmation per ISO 17357-1. The tests must include a parallel performance, angular compression, durability, compression-recovery, and puncture-resistance test.

2.1.6.1.1 Design Proof

Design proof must document minimum endurable pressure based on at least 30 test samples that cover entire range of compression from 0 percent to 60 percent plus or minus 5 percent deflection.

2.1.6.1.2 Pneumatic Fenders Performance Characteristics

****

NOTE: Refer to ISO 17357-1 for guaranteed energy absorption and reaction force values for nominal size of fender under consideration.

****

Provide the performance characteristics of each pneumatic fender ensuring they meet the following:

SIZE	GUARANTEED ENERGY ABSORPTION (GEA)	REACTION FORCE (R)
	at 60 +/- 5 percent deflection	at GEA deflection (+/- 10 percent)
[_____]mm x [_____]mm [_____]ft x [_____]ft	[_____] kN-m [_____] ft-kips	[_____] kN [_____] kips

2.1.6.1.3 Hydro-pneumatic Fenders Performance Characteristics

****

NOTE: The performance of the hydro-pneumatic fenders vary according to the size, water/air ratio and internal pressure. The Manufacturer should be consulted in the selection of the desired performance characteristics.

****

****

NOTE: Refer to ISO 17357-1 for guaranteed energy absorption and reaction force values for nominal size of fender under consideration.

****

Provide the performance characteristics of each hydro-pneumatic fender ensuring they meet the following:

SIZE	GUARANTEED ENERGY ABSORPTION (GEA)	REACTION FORCE (R)
	at 60 +/- 5 percent deflection	at GEA deflection (+/- 10 percent)
[_____]mm x [_____]mm [_____]ft x [_____]ft	[_____] kN-m [_____] ft-kips	[_____] kN [_____] kips

2.1.6.2 Dimensional Inspection

Perform and submit the dimensional inspection results proving the dimensions of all fenders meet the requirements of ISO 17357-1.

****

NOTE: The dimensional tolerances per ISO 17357-1 are as follows:
- length: plus 10 percent, minus 5 percent
- diameter: plus 10 percent, minus 5 percent

The diameter shall be obtained from the average of at least two different measurements taken at the middle of the cylindrical section of the fender.

The diameters of bead ring or other steel material around the flange opening shall be inspected, and the results shall be less than 0.20 fender diameters.

****

2.1.6.3 Air-leakage Test

Perform and submit the results of the air leakage test per ISO 17357-1. The test must confirm that there is no air leakage when the initial pressure is held for more than 30 minutes.

2.1.6.4 Hydrostatic-pressure Test

Perform and submit the Hydrostatic-pressure test results per ISO 17357-1. Perform the test for 10 minutes at the hydrostatic pressure shown as "Testing pressure at 0 percent deflection" in Tables 4 and 5 in ISO 17357-1. There must be no leakage of water and no defects during the test.

****

NOTE: The frequency of the test shall be one per 20 fenders of each size and pressure. If the customer so requests, one per order of each size and pressure if the quantity is less than 20.

Circumferential and longitudinal lengths shall be measured at 10 kPa pressure and at the test pressure shown in Table 4 or Table 5 in ISO 17357-1. The temporary elongation shall be as follows:

a) maximum circumferential temporary elongation:10

percent;
b) maximum longitudinal temporary elongation:10 percent.

The increase in diameter and length shall be obtained by measuring the distance of two points marked circumferentially and longitudinally, at 10 kPa 1.45 psi pressure, on the middle of the fender's body.

The distance between the two points shall be larger than one-fifth of the fender's diameter.

****

2.1.6.5 Pressure Relief Valve Test

Mount the pressure relief valve to a test chamber for a pressure relief test. After mounting, the chamber internal pressure must be slowly increased until the specified relief pressure is attained. Set the pressure relief valve to relieve pressure according to the manufacturers recommendations. If the pressure relief valve opens at a higher or lower pressure than allowed, it must be adjusted as required and tested again until within the specified limits. Maintain a written test procedure and records pertaining to this test.

2.1.7 Connecting Hardware

Galvanize the connecting chain, swivel, and shackles in accordance with ASTM A123/A123M or ASTM A153/A153M, as appropriate. The hardware must be as follows:

Item	Type
Chain	ABS 2, Grade 2, Stud Link or Open Link
Shackle	FS RR-C-271, Type IVA, Class 3, Grade A
Swivel	FS RR-C-271, Type VII, Class 2

All connecting bolts and pins must be of mild steel, matching the properties of the shackle bow. For Class 3 shackles, secure the bolt or pins in place with stainless steel (Type 316) cotter pins or locking pins.

2.1.7.1 Hydro-pneumatic Guy Chain

Provide guy chains for attachment from the upper fender end fitting assembly to the pier. Cover the portion of the chain extending from the fender itself with protective rubber sleeves to a point beyond which the fender will be contacted for fender body protection.

2.1.7.2 Hydro-pneumatic Hanging Chain

Provide hanging chains for attachment from the counterweight to the pier.

2.1.7.3 Hydro-pneumatic Lower End Fitting Assembly

Fabricate the lower end fitting from steel and provide connecting points for the connecting chain and the hanging chain.

2.1.7.4 Hydro-pneumatic Upper End Fitting Assembly

Fabricate the upper end fitting from steel and design to house all necessary valves and fitting necessary to charge and discharge the fender body with air and water necessary for proper installation and operation of the deployed fender. Include the air charging assembly, the water charging assembly, the pressure safety relief valve assembly and lifting eyes adequately sized for guy chain attachment. Attach all valves and related hardware to the inner assembly plate. Include an outer assembly blind flange plate to provide protection during handling and operations. The pressure relief valve must be bronze, adjustable to ensure maintenance of the proper setting, and capable of adequate flow (volume of air released per second) to maintain a safe internal pressure. Make certain a changeable rubber gasket is installed between the top flange and plate to prohibit moisture from collecting inside the upper end fitting assembly that could possibly corrode valve handles and cause debris that could foul the pressure relief valve assembly.

2.1.7.5 Hydro-pneumatic Counterweight

Provide a steel counterweight for attachment to the fender's lower flange assembly by two shackles. Include an upper eye for shackle attachment of the hanging chain and coat with a marine coating system. The counterweight must be sized in accordance with the Manufacturer's recommendation.

PART 3 EXECUTION

3.1 PNEUMATIC AND HYDRO-PNEUMATIC FENDERS

Install the fendering system in accordance with the manufacturer's specifications and shop drawings. Tighten bolts an additional 1/3 turn of the nut, from the snug tight condition, and secured with cotter pins or screw lock.

3.2 WELDING

Perform welding in accordance with AWS D1.1/D1.1M.

3.3 CONNECTIONS

3.3.1 Antiseize Compound

Coat threads of bolts prior to applying washers and nuts. Recoat bolt thread projection beyond nut after tightening.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-35 73 13 (November 2018)**

Preparing Activity: USACE **Superseding**
UFGS-35 73 13 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

SECTION 35 73 13

EMBANKMENT FOR EARTH AND ROCKFILL DAMS

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PART 1 GENERAL

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-35 73 13 (November 2018)**

Preparing Activity: USACE **Superseding**
UFGS-35 73 13 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 35 73 13

EMBANKMENT FOR EARTH AND ROCKFILL DAMS

11/18

****

NOTES: This guide specification covers the requirements for preparing the embankment and blanket foundations and placing and compacting all permanent fills and backfills for earth and rock fill dams. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

This guide specification has removed paragraphs for related construction activities that have their own UFGS Guide Specifications. These include Section 31 00 00 EARTHWORK, Section 31 66 10 ROCK FOUNDATION PREPARATION and Section 31 11 00 CLEARING AND GRUBBING among others. Those Guide Specifications should be included and referenced as is appropriate..

REMOVE INFORMATION AND REQUIREMENTS NOT REQUIRED IN RESPECTIVE PROJECT, WHETHER OR NOT BRACKETS ARE PRESENT.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This guide specification provides for furnishing all plant, labor, and equipment, and performing all operations in connection with the

placement of embankment materials for earthen or rockfill dams.

The requirements for rock as prescribed herein are intended to be used on embankments involving rock fill sections. Where rock for slope protection is specified, Section 35 31 19.40 STONE REVETMENTS should be used.

****

This specification provides for furnishing all materials, labor, and equipment, and performing all operations in connection with the placement of embankment materials for construction of the [earthen][rockfill] dam.

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00 as appropriate.

****

1.1.1 Compacted Fill, [Impervious][Pervious][Random]

****

NOTE: Include separate paragraphs for each type of compacted fill material that will be required for the construction of the dam, and select the appropriate bracketed description for each.

****

1.1.1.1 Payment

Payment will be made for costs associated with placement of compacted [impervious] [pervious] [random] fill embankment; spreading, harrowing, moisture control, compacting, removing objectionable materials; and all other incidental work required for the construction, protection, and maintenance of the dam embankment. [This payment is separate to any payment for excavating and transporting of material as specified in Section 31 00 00 EARTHWORK.] Payment for preparation of foundations to receive compacted [impervious] [pervious] [random] fill will be made in accordance with Section 31 66 10 ROCK FOUNDATION PREPARATION.

1.1.1.2 Measurement of Fill Material

Compacted [impervious][pervious][random] fill will be measured for payment in place based upon the established limit lines and the payment lines shown on the plans or as otherwise established. Limit lines will be established by the volume between the foundation lines as determined on the basis of a survey made from excavation [including the cut-off trench] and[accomplishment of foundation preparation (except scarifying)] and the lines, grades and slopes of the accepted embankment.

1.1.1.3 Unit of Measure

Unit of measure: cubic meter yard.

1.1.2 Backfill, [Impervious][Pervious][Random]

****

NOTE: Include separate paragraphs for each type of backfill material that will be required for the construction of the dam, and select the appropriate bracketed description for each.

****

1.1.2.1 Payment

Payment will be made for costs associated with preparation of contacting surfaces, including the spreading, compacting, moisture control, and all other operations incidental to the placement of [impervious] [pervious] [random] backfill. [This payment is in addition to any payment for excavating and transporting of the material as specified in Section 31 00 00 EARTHWORK.] Payment for preparation of rock foundations to receive [impervious] [pervious] [random] backfill will be done in accordance with Section 31 66 10 ROCK FOUNDATION PREPARATION.

1.1.2.2 Measurement

Backfill, [impervious][pervious][random], will be measured for payment in place based upon the established limit lines and the payment lines indicated on the cross sections shown on the plans or as otherwise established. Limit lines will be established by the volume between the foundation lines as determined on the basis of a survey made from excavation [and accomplishment of foundation preparation (except scarifying)]and the lines, grades and slopes of the accepted embankment.

1.1.2.3 Unit of Measure

Unit of measure: cubic meter yard.

1.1.3 Filter [Sand][Gravel][Rock]

****

NOTE: If several classes of material are to be used to include transition zones or a multi-stage filter, a separate pay item should be included for each class.

****

1.1.3.1 Payment

Payment will be made for costs associated with obtaining filter [sand] [gravel] [rock], [transportation to the site (whether from required excavation, borrow, or commercial source),] mixing the materials to the required gradation, spreading, moisture control, compacting, removing objectionable materials, and all other incidental work required for the construction, protection, and maintenance of the filter. This payment is in addition to any payment for excavation (from required excavation or borrow) of the material as specified in Section 31 00 00 EARTHWORK.

1.1.3.2 Measurement

Filter [sand][gravel][rock] will be measured for payment in place based upon the established limit lines and the payment lines indicated on the cross sections shown on the plans or as otherwise established. Limit lines will be established by the volume between the foundation lines as determined on the basis of a survey made from excavation and [accomplishment of foundation preparation (except scarifying)] and the lines, grades and slopes of the accepted embankment.

1.1.3.3 Unit of Measure

Unit of measure: cubic meter yard.

1.1.4 Rock Fill

****

NOTE: If several classes of rock fill material are used, a separate pay item should be included for each class of material.

****

1.1.4.1 Payment

Payment will be made for costs associated with rock fill, including all operations with excavation, quarrying, stockpiling, hauling, placing, moisture conditioning, removing objectionable material, and all other operations incidental to the placement of the rock fill.

1.1.4.2 Measurement

Rock fill will be measured for payment in place based upon the established limit lines and the payment lines indicated on the cross sections shown on the plans or as otherwise established. Limit lines will be established by the volume between the foundation lines as determined on the basis of a survey made from excavation [and accomplishment of foundation preparation (except scarifying)]and the lines, grades and slopes of the accepted embankment.

1.1.4.3 Unit of Measure

Unit of measure: cubic meter yard.

[1.1.5 Additional Rolling for Compaction

****

NOTE: If an end result (production) specification is used for compaction in section COMPACTION, delete this item.

****

1.1.5.1 Payment

Payment will be made for costs associated with additional rolling for compaction.

1.1.5.2 Measurement

****

NOTE: Delete the bracketed reference to Section 35 73 13 if this paragraph is not moved to Section 01 20 00.

****

Additional rolling for compaction will be measured for payment on the basis of the number of roller hours the compaction equipment is operated in accomplishing the compaction specified in [Section 35 73 13 EMBANKMENT FOR EARTH DAMS,]paragraph COMPACTION.

1.1.5.3 Unit of Measure

Unit of measure: hour.

]1.1.6 Instrumentation [Piezometer][Settlement Gage][Survey Marker]

****

NOTE: The installation of instrumentation is not strictly speaking an activity of construction of an embankment dam. This activity should be placed within its own specification division as an item of SPECIAL CONSTRUCTION. There is presently no UFGS guide specification for this item. The specification writer should consider the use of a section for SPECIAL CONSTRUCTION, and if so, delete the following paragraphs.

Include paragraphs for all types of instruments as may be utilized.

****

1.1.6.1 Payment

Payment will be made for costs associated with furnishing, installing, [monitoring] and maintaining the [piezometers] [settlement gages] [survey markers] during construction as specified[in Section 35 73 13 EMBANKMENT FOR EARTH DAMS] during construction, including measurements required to be made by the Contractor.

1.1.6.2 Measurement

[Piezometers] [Settlement gages] [Survey markers] to be installed will be measured for payment on the basis of the number specified[in Section 35 73 13 EMBANKMENT FOR EARTH DAMS].

1.1.6.3 Unit of Measure

Unit of measure: each.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D422	(1963; R 2007; E 2014; E 2014) Particle-Size Analysis of Soils
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2216	(2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D2937	(2017; E 2017; E 2018) Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
ASTM D4253	(2016; E 2019) Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	(2016) Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4643	(2017) Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D5195	(2014) Density of Soil and Rock In-Place at Depths Below the Surface by Nuclear Methods
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 DEFINITIONS

****

NOTE: Add applicable definitions as appropriate for the project.

****

1.3.1 Embankment

Embankment, as used in these specifications, is defined as the earth [and rock]fill portions of the dam structure and includes all types of earth [and rock]fill and filter materials for the dam [and cut-off trench,]and all other specified or directed earth and rock fills within the limits of the dam[, excepting those stone and filter materials used for slope protection in accordance with Section 35 31 19.40 STONE REVETMENTS].

1.3.2 Compacted Fill

Compacted fill includes all fill, except backfill and rock fill, deposited in layers and compacted by rolling or tamping. The types of compacted earth fill are:

a. Impervious fill for the [cut-off trench][, horizontal and inclined impervious blankets,][and]impervious section of the embankment;

b. Random fill where indicated on the plans;

c. Pervious fill forming the upstream and downstream sections of the embankment or where indicated on the plans, and

d. Filter drainage layers forming the horizontal [and/or vertical or inclined] pervious drainage blankets.

1.3.3 Uncompacted Fill

All fill, deposited in layers but not compacted except by the controlled movement of hauling and spreading equipment.

1.3.4 Backfill

Backfill, as used in these specifications, is defined as that excavation refill which cannot be placed around or adjacent to a structure until the structure is completed and reached a specified concrete strength, requires special compaction efforts, and is defined by limits indicated on the plans and specifications.

1.3.5 Filter Materials

Filter materials are defined as material used as drainage or transition zones between various types of fill and backfill (impervious, pervious, random, and rock fill).

1.3.6 Rock Fill

Those portions of the embankment where rock is used as embankment fill.

1.3.7 Unsatisfactory Materials

****

NOTE: Unsatisfactory material will be defined in accordance with ASTM D2487. This paragraph should be edited as appropriate to delete inapplicable materials.

****

[Materials which do not comply with the requirements for satisfactory materials are unsatisfactory.] [Materials unsatisfactory for use as fill and backfill are those earth and earth mixtures that classify by ASTM D2487 as [CH], [MH], OL, OH, and PT. In addition all topsoil, organics, roots and other organic matter, biodegradable materials, debris, trash, rubble and contaminated soil is unsatisfactory for use as embankment, backfill or engineered fills. Unsatisfactory materials or processes are not in compliance with these specifications.] Notify the Contracting Officer when encountering any contaminated materials.

1.3.8 Unsatisfactory vs Satisfactory

The use of the terms satisfactory and unsatisfactory in this section is in reference to the Contract requirements. Satisfactory materials or processes are in full compliance with these specifications and unsatisfactory materials or processes are not in compliance with these specifications.

1.4 SYSTEM DESCRIPTION

1.4.1 Haul Roads

****

NOTES: Where roads are to be used by other

Contractors, the limits of responsibility should be stated in the specifications.

With reference to the coverage in this paragraph, it has been found advantageous to establish a project traffic pattern for jobs of considerable scope and to indicate on the plans acceptable haul road locations and to specify maximum grades and minimum road widths which are considered suitable. Where project operations are varied and the use of haul roads by other Contractors is required, the specifications should so indicate. Detailed requirements for haul roads should be based upon the anticipated length of time the roads will be in use, traffic load and probable types of hauling equipment applicable to the specific project. This paragraph should be modified as necessary to clarify the requirements of the particular project.

****

Haul roads must be [located as indicated and][located and] constructed as approved. Design haul roads to maintain the intended traffic, to be free draining and maintain good condition throughout the contract period, unless otherwise directed. Remove haul roads within the area of contact between the embankment and its foundation and abutments and treat the area as specified in paragraph PREPARATION OF FOUNDATION, PARTIAL FILL SURFACE, AND ABUTMENTS.

Submit a Plan of Operations for approval thirty days prior to commencement of haul road construction or placing embankment and backfill, whichever is earlier, for accomplishing all embankment and backfill construction and for the location and construction of haul roads.

1.4.2 Stockpiling from [Approved Borrow Sources][Required Excavations]

When the excavation from [approved borrow sources][or required excavations] progresses at a faster rate than placement in the fill is being accomplished, stockpile excavated material at approved locations adjacent to the work until its use is authorized. No payment will be made for such stockpiling nor for the reloading and hauling of this material to its final position in the embankment.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Plan of Operations; G, DO

30 days prior to commencement of haul road construction or placing embankment and backfill, whichever is earlier, submit for approval a Plan of Operations for accomplishing all embankment and backfill construction and for the location and construction of haul roads. This plan must include, but not be limited to, the proposed sequence of construction for embankment and backfill items, and methods and types of equipment to be utilized for all embankment and backfill operations, including transporting, placing, and compaction. Also include the names and addresses of the commercial testing labs which will perform the soil testing and inspection and describe how all required soils testing will be performed in this plan.

Embankment and Backfill Materials; G, DO

At least 30 days prior to delivery of any Contractor-furnished material to the site of the work, submit soil classification test results, moisture-density curves, gradation curves, and laboratory results of the required tests of the proposed material.

SD-06 Test Reports

Foundation Inspection; G, DO

Provide a foundation inspection report, certified by a registered Professional Geotechnical Engineer or Geologist, documenting the inspection. The report must include, at a minimum, a description of each geologic stratum encountered along the slopes and excavation bottom, laboratory testing results if any tests were performed, and other pertinent information. The report's main body must be a color copy submitted to the Government within four calendar days of completion of the inspection by the Contractor's geologist. Include figures, tables and photographs as necessary.

Measurement of Fill Material; G, RO

Submit a copy of the records of each compliance survey the next work day following the survey.

Testing; G, RO

Within 24 hours of conclusion of physical tests, three copies of test results, including calibration curves and results of calibration tests.

SD-07 Certificates

Testing; G, RO

Qualifications of the [USACE validated] [validate] commercial testing laboratory or the Contractor's validated testing facilities.

Nuclear Density; G, RO

Use nuclear density testing equipment in accordance with ASTM D6938. In addition, the following conditions are applicable:

a. Prior to using the nuclear density testing equipment on the site, submit to the Contracting Officer a certification that the operator has completed a training course approved by the nuclear density testing equipment manufacturer, the most recent data sheet from the manufacturer's calibration, and a copy of the most recent statistical check of the standard count precision.

b. Provide nuclear density testing equipment capable of extending a probe a minimum of 12 inches down into a hole.

c. Field density reports must include the laboratory density reports applicable to the field data presented.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: This paragraph may be modified to specify soils for various types of fill in accordance with the Unified Soil Classification System. When this is done, the optional sentence should be selected.

****

[Classification of soils will be in accordance with ASTM D2487.]

2.1.1 General

The origin of any fill material in no way determines where it may be used in the embankment. Obtain materials for embankment fills from required excavations, from the borrow areas indicated, or from off-site commercial sources as required. The intention is to use the most suitable materials obtainable from these sources. Material to be wasted will be specifically designated at the time the material is excavated. Materials containing brush, roots, sod, organics or other perishable materials will not be considered suitable. The suitability of the materials are subject to approval and their disposition in the embankment will be as directed. Excavate in the borrow areas in the location determined by the Contracting Officer, whenever such control is necessary to obtain the type of material required for the embankment. Use borrow pits in accordance with Section 31 00 00 EARTHWORK paragraph SELECTION OF BORROW MATERIAL and paragraph OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS. Mixing of materials during the excavating process at the borrow area may be required.

****

NOTE: The designer may choose to limit the definition of impervious with restriction on liquid limit, plasticity index, or fines content. If so, those restrictions should be added to paragraph 2.1.2.

****

2.1.2 Impervious Fill

Provide material for compacted impervious fill consisting of [GC SC ML CL MH CH clays, silty clays, or clayey silts] classified as cohesive materials in accordance with ASTM D4318, ASTM C136/C136M and ASTM D1140 obtained from the designated borrow areas [or required excavation] [or off-site commercial sources].

2.1.3 Random Fill

Provide material for compacted random fill consisting of any or all types of satisfactory material which are suitable for use in the dam embankment.

2.1.4 Pervious Fill

Material for compacted pervious fill must be clean, free draining sand or sand and gravel obtained from natural deposits [within borrow areas and from designated excavations][or][from sources designated]. Provide particles of material that are free from any objectionable coating and not more than [_____] percent of the material, by weight, and passing a 0.075 mm No. 200 sieve.

2.1.5 Uncompacted Fill

Except as otherwise [indicated or]required, material for uncompacted fill may consist of any or all types of material available from required excavations and designated borrow areas with the exception of material that is considered unsatisfactory as defined in Unsatisfactory Materials.

2.1.6 Backfill

Provide backfill consisting of material of a type and quality conforming to that specified for the contiguous embankment fill material, unless otherwise directed.

2.1.7 Filter Drainage Layers

Filter materials must meet the quality requirements of ASTM C33/C33M concrete aggregate except as stated herein. Filter materials must consist of sand, gravel, or crushed stone composed of tough, durable, angular particles; must be free from thin, flat and elongated pieces, and must contain no organic matter or soft, friable particles. The material must be washed with clean water such that the final product has no visible soil, soil slurry, or objectionable coatings.

Gradation of the material must be determined in accordance with ASTM D2487, ASTM D422, ASTM D1140, and ASTM D4318. All points on individual grading curves obtained from representative samples of filter material must lie between the boundary limits as defined by smooth curves drawn through the tabulated grading limits plotted on a mechanical analysis diagram. The individual grading curves within these limits must not exhibit abrupt changes in slope denoting skip grading, scalping of certain sizes or other irregularities which would be detrimental to the proper functioning of the filter; and will be well-graded between the limits specified below:.

SIEVE SIZE	PERCENT BY WEIGHT PASSING
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

2.1.8 Rock Fill

2.1.8.1 Rock

Stone classed as "rock" must be sound; well graded and free draining.[The presence of rock meeting the requirements of slope protection, Section 35 31 19.40 STONE REVETMENTS, will not be objectionable.] Obtain rock from required excavation[and from already existing stockpiles][and from designated quarries]. Shales, mudstone and other rock and excavated material unsuitable for use as rock fill, will be wasted in designated spoil areas.

PART 3 EXECUTION

3.1 CONSTRUCTION

3.1.1 Lines and Grades

****

NOTE: If settlement of the foundation is expected during construction, install settlement gages as detailed in 3.9.2 and 1.1.11.

****

Construct the embankment to the lines, grades and cross sections indicated, unless otherwise directed. The Government reserves the right to increase or decrease the foundation widths or the embankment slopes or make such other changes in the embankment sections as may be deemed necessary to produce a safe structure. Increases in height of section, made to compensate for shrinkage or consolidation of the embankment material or foundation during construction of the embankment, will not exceed five percent of the height above the foundation indicated without the approval of the Contracting Officer. The end slopes and side slopes of partial fill sections must not be steeper than[one vertical on [_____] horizontal][those shown].

3.1.2 Conduct on the Work

Maintain and protect the embankment in a satisfactory condition at all times until final completion and acceptance of all work under the contract. At all times protect pervious fills, filters, and drainage layers from erosion, runoff, and contamination from different soils or other materials. These materials must be uncontaminated for minimum dimensions shown on the plans. Minimize equipment travel on these zones to prevent segregation, contamination, and breakdown of materials.

If in the opinion of the Contracting Officer the hauling equipment causes horizontal shears or slickensides, rutting, quaking, heaving, cracking or excessive deformation of the embankment, limit the type, load or travel speed of the hauling equipment on the embankment. Replace any embankment material rendered unsuitable after being placed in the embankment and before final acceptance of the work in a satisfactory manner and no additional payment will be made therefor. Excavate and remove from the embankment any material which the Contracting Officer considers objectionable, dispose of such material, and refill the excavated area as directed, all at no cost to the Government. Do not place unsatisfactory materials in the embankment. The Contractor may be required to remove, without additional payment, any embankment material placed outside of prescribed slope lines.

3.2 PREPARATION OF FOUNDATION, PARTIAL FILL SURFACES AND ABUTMENTS

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NOTE: General preparation of the foundation for dam construction should be addressed in Section 31 66 10 ROCK FOUNDATION PREPARATION. The following paragraphs may be deleted or modified as appropriate to provide explicit direction to preparation of surfaces for placement of embankment fill.

****

3.2.1 Earth

After excavation or stripping of the embankment foundation[and excavation of the cut-off trench] to the extent indicated or otherwise required, break down the sides of stump holes, test pits, and other similar cavities or depressions where so directed to flatten out the slopes, and scarify the sides of the cut or hole to provide bond between the foundation material and the fill.[Scarify the slopes and bottom of the cut-off trench as directed.] Unless otherwise directed, fill each depression with either pervious, random, or impervious[, or rockfill] material dependent upon the type of material which is to be placed immediately above the foundation. Place the fill in layers; moisten and compact in accordance with the applicable provisions of paragraphs PLACEMENT, MOISTURE CONTROL, and COMPACTION. Spread materials which cannot be compacted by roller equipment because of inadequate clearances in [_____]-mm-inch layers and compact with power tampers to an extent equal to that of the contiguous embankment fill material. After filling of depressions[and cut-off trench] and immediately prior to placement of compacted fill in any section of the embankment, loosen the foundation of such section thoroughly by scarifying, plowing, discing or harrowing to a minimum depth of [_____] mm [_____] inches, and adjust the moisture content to the amount specified in paragraph MOISTURE CONTROL for the appropriate type of material, except in areas where this requirement is waived by the Contracting Officer. After removal of roots or other debris turned up in the process of loosening, compact the entire surface of the embankment foundation area [by [_____] complete coverages of the compaction equipment as specified for the appropriate type of fill in accordance with paragraph COMPACTION.] [compacted to a density of [_____] percent in accordance with paragraph COMPACTION.][Proof roll foundation areas in accordance with Section 31 00 00 EARTHWORK paragraph PROOF ROLLING.]

Prior to placement of compacted fill on or against the surfaces of any partial fill section, remove all soft or loose material, all material containing cracks or gullies, and all material that does not conform with the specified zoning of the embankment. Loosen the remaining surface of the partial fill by scarifying, plowing, discing or harrowing to a minimum depth of 150 mm 6 inches, and adjust the moisture content as specified in paragraph MOISTURE CONTROL for the appropriate type of material. Compact the surface of the partial fill section upon which fill is to be placed as specified in paragraph COMPACTION for the appropriate type of fill. No separate payment will be made for loosening and rolling the foundation area, the abutment area, or the surfaces of partial fill sections, but include the entire cost in the applicable contract price for fill.

3.2.2 Rock

Claen all rock surfaces upon which or against which embankment materials are to be placed in accordance with the applicable provisions of Section 31 00 00 EARTHWORK and Section 31 66 10 ROCK FOUNDATION PREPARATION.[Prior to the placement of embankment material upon or against a rock surface, fill all open joints and cracks in that surface with mortar to the depths cleaned. Fill those portions of such rock surfaces where, in the opinion of the Contracting Officer, the compaction of the embankment materials cannot be accomplished satisfactorily with power tampers or other specified compaction equipment with mortar or concrete as directed to the extent necessary to permit satisfactory use of the compaction equipment. Do no leave a thin coat of mortar on smooth, intact rock surfaces. Remove large rock overhangs and protrusions by pre-splitting or line drilling techniques in such a manner as to minimize damage to the underlying rock, or the spaces beneath overhangs and fill around protrusions with consolidated concrete so that satisfactory compaction of embankment materials can be accomplished. Provide vertical surfaces that are no more than [_____] meters [_____] feet in height, and provide benches of sufficient width as necessary so that the average slope of any rock face is not steeper than [_____] vertical on [_____] horizontal. Provide mortar and concrete, including forming as necessary, conforming with the applicable provisions of Section [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE][03 30 00 CAST-IN-PLACE CONCRETE][_____].]

[3.2.3 Foundation Inspection and Mapping Procedures

Foundation means any area of the excavation to receive concrete, backfill, or embankment, including the entire excavation bottom and side slopes.

Inspections to determine the adequacy of the foundations will be performed by the Contracting Officer in all foundation areas between completion of the surface preparation and placement of Embankment Fill, Filter Material, Mud Mat, or concrete. The Contractor will cooperate to the extent necessary to assist in the inspection. This will include having equipment and personnel available to assist excavating, compacting, proof rolling, cleaning, etc. The Contractor must coordinate his schedule for foundation preparation and final cleanup with the Contracting Officer to ensure that the cleanup and inspection proceed in an orderly manner.

][3.2.4 Foundation Condition Evaluation

[Government will perform foundation condition inspection of the completed foundation after final cleanup, dental treatment (if required) and mapping/documentation are complete. Notify the Contracting Officer at least seven days before foundation cleanup will be completed and ready for inspection by the Government. Maintain the foundation in a cleaned condition for a period of at least [_____] [days] [hours] for Government foundation inspection. The [____] [days][hours] for Government evaluation starts after the Contracting Officer receives notification from the Contractor that the foundation is completed and ready for mapping and inspection. Government will evaluate excavation surfaces to receive backfill or structures. As used in this Section, evaluation means inspection, testing, mapping, exploratory test pits, interpretation, and decision making. Government will perform inspection of excavated foundation subgrade and cut slopes at each site to obtain a geologic record.

][Proof roll the earth foundation by a fully loaded dump truck or approved roller to detect and eliminate soft spots in the foundation.

][During inspection, following cleanup for geologic mapping, if the Contracting Officer determines that additional excavation is required to improve foundation conditions, perform additional excavation as directed. Clean the areas of additional excavation. The Government will map and inspect the surfaces of additional excavation.

]][3.2.5 Excavation and Foundation Mapping

Foundation mapping will be performed by Government personnel throughout excavation, foundation cleanup, and foundation acceptance inspection. Permit and facilitate safe access to the excavation by Government personnel for geologic mapping, sampling, inspection, and testing of surfaces exposed during construction.

a. Keep traffic and equipment away from test areas during testing to ensure personnel safety and to prevent ground vibrations;

b. Keep traffic and equipment away from personnel performing mapping to ensure personnel safety;

c. Provide support, such as excavating equipment, to permit proper inspection.

Foundation mapping will require excavated surfaces to be closely inspected and documented. The Government will require surfaces to be cleaned by the Contractor to facilitate mapping. Cleaning will require cutting of fresh surface on the excavation bottom and on excavated slopes, and excavation of test pits on excavated slopes and excavation bottom. The Contractor must provide Government personnel access to the excavation bottom for a period of [_____] [days] [hours] after final cleanup and foundation preparation, and before dental treatment. During excavation and foundation mapping, remove any temporary ramps covering side slopes such that the excavation side slopes can be documented and mapped by the Government. The Contractor must provide equipment to perform test pits as deemed necessary by the Government geologist and engineers performing the excavation mapping.

][3.2.6 Equipment for Foundation Excavation and Mapping

The Contractor must have on site and make available to Government personnel performing mapping and inspection the following equipment with equipment operators to aid in performing excavations for test pits, sampling, inspection and cutting fresh surfaces for inspection and mapping:

a. Excavating equipment - Backhoe with smooth edge bucket and bulldozer.

b. Proof roller - Fully loaded dump truck.

c. Hand tools - Shovels, bars, picks, wedges, and brooms.

d. Water jet - A water jet consists of a high flow nozzle with a supply hose connected to a suitable source of water. Provide a system capable of delivering up to 24 gpm. The flow rate must be controllable at the nozzle.

]3.3 PLACEMENT

3.3.1 General

Do not place fill on any part of the embankment foundation until such areas have been inspected and approved by the Contracting Officer in writing. The gradation and distribution of materials throughout the compacted earth fill section of the dam must be such that the embankment will be free from lenses, pockets, streaks, and layers of material differing substantially in texture or gradation from surrounding material of the same classification. Dump successive loads of material at locations on the fill as directed or approved. Do not place fill upon a frozen surface, nor incorporate snow, ice, or frozen earth in the embankment. Fill will not be placed on or against any dry surface, but against a surface that is moist or damp.

3.3.2 Frozen Material

Do not place embankment on frozen material, or on material which has been subjected to freeze-thaw action. This prohibition encompasses natural ground, all prepared subgrades, whether in an excavation or on an embankment, and all layers of previously placed and compacted earth fill upon which successive layers of embankment fill will be placed. Remove all material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to, nights, holidays, weekends, or winter shutdowns or earthwork operations, to a depth that is acceptable to the Contracting Officer and replace with new material. Alternatively, the material must be thawed, dried, reworked, and recompacted to the specified criteria before additional material is placed. The Contracting Officer will determine when placement of fill must cease due to cold weather. Embankment material containing frozen clumps of soil, snow, or ice is not acceptable.

3.3.3 Rate of Placement

****

NOTE: If construction of the embankment involves a closure section, the following considerations should be taken into account and specified by the designer,

if required.

Placement of rock fill in the closure section may be delayed until completion of the compacted fill to elevation [_____] meters feet m.s.l. The rate of placement of materials in the embankment closure section will be such that this section will be completed to elevation [_____] meters feet m.s.l. within a period of [_____] calendar days from the authorized date of diversion, but in no event will the rate of placement in this section be faster than required to construct the embankment to elevation [_____] meters feet m.s.l. within [_____] days from the beginning of fill operations. Subsequent to completion of the embankment closure section to elevation [_____] meters feet m.s.l. and prior to the beginning of topping operations a period of [_____] calendar days will elapse, unless this provision is waived in writing by the Contracting Officer at the time of construction.

Rate of placement of clay fill materials should be governed by the potential for development of high pore pressures in the fill that could lead to instability of the embankment slopes. Appropriate paragraphs should be included to identify elevations where placement may need to cease until pore pressures have dissipated sufficiently to prevent slides or failure of the embankment.

****

Unless otherwise directed, maintain the embankment at approximately the same level regardless of the number of types of materials being placed,[except place rock fills and the adjoining filter blankets with sufficient lag to prevent mixture of embankment and filter blanket and/or rock materials].

3.3.4 Impervious Fill

Place impervious fill in the impervious section of the embankment as shown on the plans[, cut-off trench,][and impervious blanket].

3.3.5 Random Fill

Place random fill in the random sections of the embankment as shown on the plans.

Except as specified below, limits of random sections shown indicate the maximum extent of random material. In general, place the finer grained random material toward the impervious section or blanket and place the coarser-grained random material toward the outer edge of the random section so that a transition in permeability is effected from the impervious section to the [pervious section][outer portions of the embankment].

3.3.6 Pervious Fill

Place pervious fill in the pervious sections of the embankment as shown on the plans.

3.3.7 Filter Drainage Layers

****

NOTE: Where there are vertical or inclined filters and horizontal filters, a different tolerance may be indicated for each.

****

Place [sand filters][, gravel filters,][and][sand and gravel filters] in the embankment in the manner described and to the lines and grades indicated. Tolerance of plus or minus [_____] mm inches will be allowed.

3.3.8 Rockfill

Construct the [upstream][,][and][downstream][and rock drain] sections of the embankment of quarry run sizes of durable rock dumped and bulldozed into place in not greater than [_____] mm foot lifts to the lines and grades shown, or as staked in the field, and in such manner as to produce a reasonably well graded mass with no objectionable pockets of small stones or clusters of larger stones. A tolerance of plus 300 mm 12 inches and minus 150 mm 6 inches from the slope lines and grades shown will be allowed in the finished surfaces of the rock fills, except that the extreme minus tolerance must not be continuous over an area greater than 20 square meters 200 square feet. Break all bridging in rock fills as well as all slabs and slabby rock. Stone having a length to thickness ratio greater than 3:1 are considered flat, elongated, or flat and elongated and will be rejected. Special care must be exercised in placing rock fill in all areas within 1 m 3 feet of structures to avoid damage to such structures.

3.3.9 Spreading

After dumping, spread the materials by bulldozers or other approved means in approximately horizontal layers over the entire fill areas. Unless otherwise directed, the thickness of these layers before compaction with tamping type rollers must not be more than [_____] mm inches for impervious materials, nor more than [_____] mm inches for other embankment materials, except backfill which must be spread in accordance with paragraph BACKFILL. Unless otherwise directed, the thickness of layers before compaction with rubber-tired rollers must not be more than [_____] mm inches for impervious materials, nor more than [_____] mm inches for other embankment materials except backfill. Spread pervious fill and filters in layers not more than [_____] mm inches in thickness. As soon as practicable after commencement of construction of any section of the embankment, raise or crown the [central portion thereof][area adjacent to the inclined or vertical filter drain] with grades not to exceed [_____] percent so that the surface of the fill will drain freely and maintain throughout construction. Filter material placement should lead the placement of adjacent material to avoid contamination of the filter material. If the compacted surface of any layer of material, exclusive of filter material[and rock fill], is determined to be too smooth to bond properly with the succeeding layers, loosen it by harrowing, or by any other approved method, before the succeeding layer is placed. At all times during the dumping and spreading processes, maintain a force of men adequate to remove all roots and debris from all embankment materials and all stones of greater than [_____] mm inches in maximum dimension from impervious materials and greater than [_____] mm inches in maximum dimension from pervious materials, except filters. Remove stone, roots, and debris from the embankment and dispose of in an approved manner.

Maintain the entire surface of any section of the embankment under construction in such condition that construction equipment can travel on any part of any one section. Remove ruts in the surface of any layer by scarifying before placing and compacting additional material.

3.4 MOISTURE CONTROL

Provide materials in each layer of the fill containing the amount of moisture, within the limits, specified below or as directed, necessary to obtain the specified compaction. Rework material that is not within the specified limits after compaction regardless of density.

3.4.1 Impervious Sections

****

NOTE: It is preferable to moisture condition the impervious fill material either at the excavation site, borrow site, or another area that is not on the embankment itself.

****

The moisture content after compaction must be uniform throughout any one layer of impervious materials placed. The moisture content after compaction as determined by ASTM D2216 must be within the limits of [_____] percentage points above optimum and [_____] percentage points below optimum moisture content.

Process material such that the moisture content is within [_____] percent of the specified range prior to placing the material on the embankment. This may require material processing either at the borrow/excavation site or other location near the embankment. Harrowing, or other approved methods may be required ensure a uniform distribution of moisture.

Accurately control the amount of water applied on a layer of fill such that free water does not appear on the surface during spreading and rolling. Should too much water be added to any part of the embankment, so that the material is too wet to obtain the specified compaction, the rolling on that section of the embankment will be delayed until the moisture content of the material is reduced to an amount within the specified limits. Material that is too wet may be worked by discing or harrowing, if necessary, until the moisture content is reduced to an amount within the specified limits. Wet material may also be blended with drier material to produce a product that meets the moisture requirements of this specification.

If, in the opinion of the Contracting Officer, the top or contact surfaces of the partial fill section become too dry to permit suitable bond with the succeeding lift, the Contractor will be required to moisture condition the materials on the fill. The Contractor will loosen the dried materials by scarifying or discing to such depths as may be directed by the COR, dampen the loosened material to an acceptable moisture content, and compact this layer in accordance with the applicable requirements of paragraph COMPACTION, subparagraph IMPERVIOUS FILL.

3.4.2 Random Sections

****

NOTE: The designer should determine if specified control of the moisture content of the random portions of the embankment is important. In many

cases, the density is the only consideration and the random sections may be specified to achieve a certain density regardless of moisture content.

****

The upper and lower limits of moisture content, and the moisture control procedures for random materials must be [the same as that specified for impervious material, or pervious material, dependent upon which of these types it most nearly resembles][such that the specified density can be achieved].

3.4.3 Pervious Section

Wet pervious material by sprinkling after spreading on the embankment and [maintain the moisture content of each layer at the optimum for compaction] [keep each layer in an approximately saturated condition] during rolling. Prewetting of pervious material at the sources of excavation or borrow will not be required. Sprinkle with hoses connected to header pipes along the faces of the embankment, by water trucks with pressure spray bars, or by any other approved method. All connections in the water supply system, including the hose connections to the header pipes, must be watertight. Do not direct jets at the embankment with such force that the finer materials will be washed out. Provide capacities of pumps and sizes of header pipes sufficient to supply the required amount of water at all times.

3.4.4 Filter Drainage Layers

Moisture control of graded gravel filter and bedding layers will not be required and sluicing will not be permitted. Moisture control of filters containing a predominate amount of sand particles will be as required to achieve the density specified in paragraph COMPACTION.

3.4.5 Rock Fill

[No moisture control will be necessary on rock fills.][The moisture content of the rock fill must be reasonably uniform throughout each layer of material placed prior to and during compaction. Add water in an amount equal to [15][_____] percent of the volume of the fill to the material on the embankment prior to compaction by uniform spraying from a water truck. The required water amount may be modified based on results of a test fill, as approved by the Contracting Officer.]

3.5 COMPACTION

3.5.1 Equipment

****

NOTES: In determining the use of a method specification versus an end-result (production) specification, the following should be considered:

a. The use of a method specification involving restrictions on material type, lift thickness, moisture content, and a specified number of passes with approved compaction equipment, a test fill should be required at the start of embankment work, to include foundation preparation. This will allow for the evaluation of the results achieved for particular efforts prior to the beginning of

production work.

b. If the designer chooses an end-result (production) specification which would specify material type, lift thickness, moisture content, and in-place density, the requirements of COMPACTION EQUIPMENT and ADDITIONAL ROLLING FOR COMPACTION may be either removed or tailored to fit the project requirements.

With reference to the use of compaction equipment in this paragraph, the following precautions should be noted:

a.The following paragraphs are provided as examples of the information that should be provided within the specifications to describe the selection of equipment to perform construction. Specifications should be written to ensure that the type of compaction equipment will be used which, in the judgment of the designer and Contracting Officer, is best suited to obtain the desired compaction of the material being utilized. Consideration must be given to soil type, lift thickness and placement location. A requirement should be included in the specifications for the performance evaluation of each type of compaction equipment conforming with the specifications and intended for use by the Contractor at an early stage of embankment construction. This equipment evaluation should be accomplished through analysis of test fill areas that are carefully constructed under representative working conditions with materials and moisture contents as specified. Test fill areas may either be separate or part of the permanent work, and for clarity to prospective bidders, payment under a separate item is recommended to equitably cover costs of required variations in equipment coverages, possible changes in equipment loading or foot sizes, as well as intensified field soils testing.

b. For tamping rollers that are either towed or self-propelled, with drums capable of being ballasted with fluid, the provision for a pressure relief valve and safety head should be included. Over-pressurization of fluid ballasted compaction drums to the level of a safety hazard has been rare, but has occurred on several occasions at locations of high elevation and temperature.

c. In compacting materials consisting of shales, sandstones, weathered rock and similar random materials, consideration should be given to specifying sheepfoot-type tamping equipment that has been modified by replacing the standard feet with "chisel" point tamper feet generally referred to as "shale breakers". The end areas of these modified tamper feet tend to break up weathered rock to prevent the bridling effect sometimes created by

large rock particles.

d. For compaction of sand and gravel fills or filter and drainage layers, equipment characteristics for both a large and small vibratory roller have been provided for optional selection by the designer, depending upon location, selected lift thickness, gradation, grain shape, and durability properties of the materials. The smaller roller should be specified for materials which exhibit degradation under compaction. Other options, based on construction experience may also be exercised. For example, it has been found that improved trafficability can often be achieved when compacting clean, fine grained, uniform sands by specifying a drum driven self-propelled vibratory roller.

****

Provide compaction equipment conforming to the following requirements and use as prescribed in subsequent paragraphs.

3.5.1.1 Tamping Rollers

3.5.1.1.1 Towed

****

NOTE: Towed rollers are generally obsolete and seldom used in modern construction. The specification writer should delete this section unless there is an expectation that towed roller will be used.

****

Provide tamping rollers consisting of two or more non-vibratory roller drums mounted side-by-side in a suitable frame and towed by either a crawler-type or rubber tired tractor having sufficient power to pull the roller satisfactorily when the drums are fully ballasted. Each drum must be free to pivot about an axis parallel to the direction of travel. Control rollers operating in tandem sets in a manner such that the prints produced by the tamping feet of the tandem units are staggered. Each drum of a roller must have an outside diameter of not less than [_____] m [_____] feet and must be not less than [_____] m [_____] feet in length. The space between two adjacent drums, when on a level surface, must not be less than [_____] m [_____] feet nor more than [_____] m [_____] feet. [Equip each drum ballasted with fluid with at least one pressure-relief valve and with at least one safety head. The safety head must be equal to union-type safety heads equipped with rupture discs suitable for rupturing pressures between 350 and 500 kPa50 and 75 psi. The pressure relief valve is a manually operated valve and must be opened periodically. Instruct personnel responsible for opening pressure-relief valves periodically to ascertain that valve openings are free from plugging to assure that any pressure developed in roller drums is released at each inspection.] Provide at least one tamping foot for each [_____] square mm[_____] square feet of drum surface. The length of each tamping foot from the outside surface of the drum must be not more than [_____] mm [_____] inches and must be maintained at not less than [_____] mm [_____] inches. The bearing surface of each tamping foot must be flat with a surface area not less than [_____] mm [_____] inches nor more than [_____] mm [_____] inches. During the operation of rolling, the spaces between the tamping feet must be maintained clear of materials which would impair the effectiveness of the tamping rollers. The weight of a roller when fully loaded must be not less than [_____] N/m[_____] pounds per foot of drum length, and the weight of a roller empty must be not more than [_____] N/m[_____] pounds per foot of drum length. The bearing surface, tamping foot size, the drum loading, and the operation of the rollers must be as required to obtain the desired compaction. If more than one roller is used on any one layer of fill, all rollers so used must be of the same type and essentially of the same dimensions. Draw rollers by crawler-type or rubber-tired tractors at a speed not to exceed [_____] km/h[_____] mph. Discontinue the use of rubber-tired towing equipment if the tires leave ruts that prevent uniform compaction by the tamping roller, and the substitution of crawler-type towing equipment may be directed.

3.5.1.1.2 Self-propelled

The use of self-propelled non-vibratory tamping rollers conforming with the following specification will be permitted, and their design and operation will be subject to approval, and subject to the right, at any time during the prosecution of the work, to direct such modifications to the tamping feet or variations in roller drum weight where applicable, as may be found necessary to secure optimum compaction of the earth fill materials. If use of self-propelled tamping rollers causes shearing of the fill, laminations in the fill, or results in inadequate compaction, the Contracting Officer may direct that such rollers be removed from the fill and that appropriate towed tamping rollers be used. Two-or three-drum side-by-side units that are either in drive position or drawn by separate power equipment must have a clearance between adjacent drums not less than [_____] mm[_____] inches nor more than [_____] mm[_____] inches. Two-drum or four-drum equipment separated by cab and differential and arranged in tandem must have its static weight equally distributed to all compaction drums and must have the tandem drums positioned such that the prints of the tamping feet produced by the tandem drums are staggered. The surface on which the tamping feet are mounted must have a minimum outside diameter of [_____] mm[_____] feet and at least one tamping foot for each [_____] square mm[_____] square feet of drum surface. The distance between the centers of any two adjacent tamping feet must be not less than [_____] mm[_____] inches. The length of each tamping foot from the outside mounting surface of the drum must be not more than [_____] mm[_____] inches and must be maintained at not less than [_____] mm [_____] inches. The bearing surface of each tamping foot must be flat and have a surface area not less than [_____] square mm[_____] square inches nor more than [_____] square mm[_____] square inches. Cupped recesses within the bearing surface of each tamping foot will be permitted but must not exceed [_____] mm[_____] inches in depth. During rolling operations, keep the spaces between the tamping feet clear of materials which would impair the effectiveness of the tamping roller. The weight of all roller drums during compaction of fill materials must be maintained uniform and with the weight per foot of drum length not less than [_____] N [_____] pounds. [For self-propelled rollers with drums capable of being ballasted with fluid, equip each drum with at least one pressure-relief valve and with at least one safety head. The safety head must be equal to union type safety heads equipped with rupture discs suitable for rupturing pressures between 350 and 500 kPa50 and 75 psi. The pressure relief valve is a manually operated valve and must be opened periodically. Instruct personnel responsible for opening pressure-relief valves periodically to ascertain that valve openings are free from plugging to assure that any pressure developed in roller drums is released at each inspection.] For self-propelled rollers in which steering is accomplished through the use of rubber-tired wheels, the tire pressure must not exceed [_____] kPa[_____]

psi. Discontinue use of the compactor if the tires leave ruts that prevent uniform compaction by the tamping roller and the substitution of appropriate towed tamping rollers may be directed. When a self-propelled roller is provided with a dozer blade, do not count coverages made with the blade in operation as compaction coverages. Operate self-propelled rollers at a speed not to exceed [_____] km/h[_____] mph.

3.5.1.2 Vibratory Rollers

Equip vibratory rollers for compacting rock fills, pervious sand and gravel fills, or filter and transition drainage layers with a smooth steel compaction drum and operate at a frequency of vibration during compaction operations between 1100 and 1500 vibrations per minute (vpm). Provide vibratory rollers that are either towed or self-propelled and that have an unsprung drum weight that is a minimum of 60 percent of the rollers' static weight. Provide towed rollers that have at least 90 percent of their weight transmitted to the ground through the compaction drum when the roller is standing in a level position hitched to the towing vehicle. Rollers for compacting rock fill, [sand and gravel fills, or filter and drainage layers] must have a minimum static weight of [_____] kN [_____] pounds, a minimum dynamic force of [_____] kN [_____] pounds when operating at 1400 vpm, and an applied force not less than [_____] kN/m [_____] pounds per foot of compaction drum length. [Rollers for compacting sand and gravel fills or filter and drainage layers must have a minimum static weight of [_____] kN [_____] pounds, a minimum dynamic force of [_____] kN [_____] pounds when operating at 1400 vpm, and an applied force not less than [_____] kN [_____] pounds nor greater than [_____] kN/m [_____] pounds per foot of compaction drum length.] The level of amplitude and vibration frequency during compaction will be maintained uniform throughout the embankment zone within which it is operating. Operate rollers at speeds not to exceed [_____] km/h [_____] mph.

3.5.1.3 Rubber-tired Rollers

Provide rubber-tired rollers that have a minimum of four wheels equipped with pneumatic tires. The tires must be of such size and ply to maintain tire pressures between [_____] and [_____] kPa [_____] and [_____] psi for a [_____] kN [_____] pound wheel load during rolling operations. Locate the roller wheels abreast and design so that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels will be such that the distance between the nearest edges of adjacent tires will be greater than 50 percent of the tire width of a single tire at the operating pressure for a [_____] kN [_____] pound wheel load. Provide the roller with a body suitable for ballast loading such that the load per wheel may be varied, from [_____] to [_____] kN [_____] to [_____] pounds. Tow roller at speeds not to exceed [_____] km/h [_____] mph. The character and efficiency of this equipment will be subject to approval.

3.5.1.4 Power Tampers

Perform compaction of material, in areas where it is impracticable to use a roller or tractor, as provided in paragraph EARTHWORK, by the use of approved power tampers.

3.5.2 Impervious Fill

After a layer of impervious fill material has been dumped and spread, harrow it if required, to break up and blend the fill materials, to remove laminations, ruts or smooth surfaces to enhance bonding between layers.

Perform harrowing to the full depth of the layer.

When the moisture content and the condition of the layer is satisfactory, compact the lift [to at least [_____] percent of maximum dry density as determined by ASTM D698, prior to placement of the next layer. Determination of in-place density must be in accordance with ASTM D1556/D1556M and ASTM D6938.][by [not less than][[_____] complete coverages of the tampering roller][[_____] complete coverages of the rubber-tired roller].][Provide complete coverage consisting of the coverage of the entire lift to be compacted with the roller specified.][A complete coverage must consist of the application of compactive effort to the entire lift to be compacted with a single roller drum having the characteristics as specified in paragraph SELF-PROPELLED. The use of four-drum self-propelled equipment that is laterally separated by operator's cab and differential may be used; however, two complete coverages of the lift to be compacted will be achieved by a subsequent offset trip of the roller for coverage of the previously uncompacted central portion of the roller path.] Place portions of the fill which are not accessible to the roller [_____] mm inch layers loose measurement and compacted with power tampers to a degree equal to that obtained on the other portions of the compacted fill by rolling as specified in accordance with paragraph BACKFILL. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously.

3.5.3 Pervious Fill

After each layer of pervious material has been dumped and spread, and the moisture content is in accordance with the provisions of paragraph PERVIOUS SECTION, compact the entire surface of the layer [to an average of [_____] percent minimum relative density][by not less than [_____] complete coverages of [the rubber-tired roller][the vibratory roller]].

[3.5.4 Additional Rolling for Compaction

If, in the opinion of the Contracting Officer, the desired compaction of any portion of the embankment is not achieved by the minimum number of coverages specified, make additional complete coverages over the surface area of such designated portion until the desired compaction has been obtained.

]3.5.5 Filter and Transition Drainage Layers

****

NOTE: The following paragraph for Transition Layers does not include bedding for riprap slope protection, which should be provided under Section 35 31 19.40 STONE REVETMENTS.

****

Accomplish compaction of filter soil using the compaction equipment described in subparagraph VIBRATORY ROLLERS of paragraph COMPACTION above. The roller must make a minimum of two (2) passes, acting in vibratory mode, across the initial lift of filter material. Upon completion of these first 2 passes, check the density of the filter material. Make additional passes of the vibratory roller until a relative density between [_____] and [_____] percent is attained based on the maximum dry density obtained in accordance with ASTM D4253 and minimum dry density as determined by

ASTM D4254. The number of passes required to achieve a relative density of [_____] percent must be the minimum required number of passes on subsequent lifts of filter material. Compaction equipment must be clean and free from other fill types or debris and must not result in contamination of the filter material. Slightly sope adjacent lifts of other fill types to drain away from the filter material. Remove and replace any contaminated filter material at no additional cost. Placement methods must not result in segregation of the filter material (such as but not limited to placement via conveyor of chute).

3.5.6 Rock Fill

After the rock fill has been dumped and spread to the thickness specified, compact the entire surface of the layer by not less than [_____] complete coverages of the vibratory roller specified in paragraph VIBRATORY ROLLERS. Provide a complete coverage consisting of the entire coverage of the area with one trip of the equipment specified. Each trip of the roller must overlap the adjacent trip not less than [_____] mm feet.

3.6 BACKFILL

3.6.1 General

Do not place embankment fill, filter soil or backfill against a concrete structure until the top of the structure has been completely placed, and has reached 80 percent of its design strength. Bring fill up in lifts evenly on both sides of structure and headwall structures with no more than [_____] m[_____] feet difference in elevation on opposing sides of the structure.

Subsequent to the concrete structure attaining 80 percent of design strength, backfill operations may be initiated but no rolling or hauling equipment will be permitted to pass over the structure, or within [_____] mm [_____] feet of any part of the structure. During this period, backfill may be placed against the sides of the structure and to a minimum thickness of [_____] mm [_____] feet over the top of the structure, if compaction is accomplished by power tampers as specified in paragraph POWER TAMPERS. Before passage of hauling and rolling equipment over the top of the conduit or other structure will be permitted, the depth of fill over the concrete must be sufficient to permit such passage without inducing harmful stresses or vibrations in the structure.

3.6.2 Placement

Place backfill in [_____] mm inch layers and thoroughly compact. Unless otherwise directed, the placing and compacting of all backfill material and the control of its moisture content must conform to the applicable provisions of paragraphs PLACEMENT, MOISTURE CONTROL, and COMPACTION. Keep fill in back of wing walls at approximately the same elevations as that of the backfill, gravel blankets, riprap, or derrick stone on the opposite side of the wall until placement has reached the maximum elevation of the materials to be placed on the toe of the wall. Keep drainage openings through walls open at all times.

3.7 FIELD QUALITY CONTROL

****

NOTE: FAR Part 46.312 establishes a requirement for Contractor Quality Control (CQC) in construction

contracts and ER 1180-1-6 requires that a CQC section based on Section 01 45 00 QUALITY CONTROL be included in contracts of $1,000,000 or more. Use of Section 01 45 00 for contracts of less than $1,000,000 is discretionary. This part of the specifications must be consistent with the CQC section.

Use caution when applying nuclear gages for in-place density measurement of cohesive and cohesionless soils. Soils consisting of mica, halloysite, some other chemical composition, or oversize rocks and large voids would affect the measurement accuracy of wet density. Sand Cone or similar field density tests should be performed periodically at the same location as Nuclear Tests to assure nuclear testing is providing accurate information.

Specifier may desire the use of a tabular format for frequency of testing of materials.
****

Establish and maintain field quality control for embankment and backfill operations to assure compliance with contract requirements and maintain detailed records of field quality control for all operations including but not limited to the following:

3.7.1 Materials Testing

****
NOTE: Types of tests and frequency of testing should be detailed below. Types of tests and frequency of testing will be dependent upon the types of materials utilized, configuration of foundation and embankment, placement and compaction procedures required, moisture control requirements etc. Testing requirements are material type specific rather than embankment fill type specific. It is desirable to present the testing frequency and type in tabular form.
****

Perform sufficient testing to ensure that the fill is being constructed as specified. The testing program specified below will be considered the minimum acceptable frequency of testing. This does not relieve the Contractor from the responsibility of performing additional testing, if required to ensure compliance with these specifications.

[3.7.1.1 Soil Classification Tests

Soil classification tests will be performed in accordance with ASTM D2487. One initial classification test will be required for each different classification of material to be utilized as embankment fill or backfill. As prescribed in ASTM D2487, grain size analyses in accordance with ASTM D422 and Atterberg limits in accordance with ASTM D4318 will be performed on each different classification. Submit additional tests for every [_____] cubic mcubic yards of embankment or backfill material. Soil classification tests will be performed on foundation material as required to determine the acceptability of the in-situ soils. Additional tests will be required if noticeable changes in the material occur.

]3.7.1.2 Cohesive Material Testing

****

NOTE: Edit the following to comply with the method selected to determine the optimum properties (i.e., density and moisture content, LL, PL, PI).

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3.7.1.3 Moisture Density Relationships

The moisture-density relations for each different classification of cohesive material utilized will be determined in accordance with [_____] [ASTM D698], [Method A] [Method B] [Method C].[Prior to placing any fill material containing cohesive material, a minimum of [_____] five-point [_____] compaction test will be performed on representative samples of the material to be used as fill.] During fill placement a minimum of one additional moisture-density test will be performed for every [_____] cubic m cubic yard placed. Additional tests will be required each time a new material is encountered.[The moisture-density curves will be compiled to form a family of curves which will be utilized to estimate optimum properties (maximum dry density and optimum moisture content) to be used with field density test.]

3.7.1.4 Water (Moisture) Content Tests

Determination of water content will be performed in accordance with ASTM D2216.[ASTM D4643 may be used when rapid moisture content results are needed. All rapid results obtained by ASTM D4643 will be confirmed by a test on a duplicate sample performed in accordance with ASTM D2216. In the event of disagreement between the results, ASTM D2216 will govern.] One water content test will be performed for each [_____] cubic mcubic yards of material placed [or each lift of material whichever is less].[These tests will be in addition to the water content tests performed in conjunction with in-place density tests.] Backfill and fills not meeting the required specifications for water content will be retested after corrective measures have been applied.

3.7.1.5 In-place Density Testing for Cohesive Materials

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NOTE: The designer should pick the method or methods of In-place density which are acceptable. If uncompacted fill is specified density control may not be required.

Use caution when applying nuclear gages for in-place density measurement of cohesive and cohesionless soils. Soils consisting of certain chemical composition, or oversize rocks and large voids would affect the measurement accuracy of wet density.

****

The in-place density of the cohesive materials will be determined in accordance with [ASTM D1556/D1556M] [, ASTM D2167] [, ASTM D6938] [, ASTM D2937] [, or] [ASTM D5195]. At least one (1) in-place density test will be performed on [each lift of material or] every [_____] cubic mcubic yards of completed fill whichever is more frequent with the horizontal locations randomly staggered in the fill.[At each field density test location, soil samples will be obtained and one [one-point] [two-point] compaction test, one moisture content, [one grain size analysis,] [and one Atterberg limits test,] [if applicable,] will be performed on the sample.][The results of the [one-point] [two-point] compaction test and the moisture content test will be utilized to obtain the optimum properties to compare to the results of the in-place density test.][For use with the family of curves to determine the optimum properties of the material a [one-point] [two-point] compaction tests will be performed in conjunction with each in-place density. A portion of the soil from the in-place field density test and soil obtained immediately adjacent to the field density test location will be used for a [one-point] [two-point] compaction test. The minus 19 mm 3/4-inch portion of the soil will be subjected to [_____] compactive effort using a [150 mm][6-inch][_____] compaction mold in accordance with the procedures presented in ASTM D[_____] [ASTM D698] [ASTM D1557]]. Fill not meeting the required specifications for in-place density will be retested after additional compaction has been completed.[When nuclear method is used for in-place density testing according to ASTM D6938, the first test and every tenth test thereafter for each material type will include a sand cone correlation test in accordance with ASTM D1556/D1556M. The sand cone test will be performed adjacent to the location of the nuclear test, will include a nominal 150 mm6 inch diameter sand cone, and will include a minimum wet soil weight of 2.7 kg 6 pounds extracted from the hole. Nuclear density testing equipment will not be used during rain. The density correlations will be submitted with test results. Each transmittal including density test data will include a summary of all density correlations for the job neatly prepared on a summary sheet including at a minimum:

a. Test Identification Number.
b. Test location.
    (1) Station.
    (2) Coordinates.
c. Elevation of Lift.
d. Lift number (if appropriate).
e. Photo number (if appropriate).
f. Meter serial number and operators initials.
g. Standard count for each test.
h. Material type.
i. Probe depth.
j. Moisture content by each test method and the deviation.
k. Wet density by each test method and the deviation.
l. Pass/Fail.
m. Retest.
n. Comments.]

[3.7.1.6 Cohesionless Material Testing

3.7.1.6.1 Compaction Tests

Run not less than one relative density test for every [3,000] [_____] cubic m[3,900] [_____] cubic yards of cohesionless fill in accordance with ASTM D4253 and ASTM D4254.

[3.7.1.6.2 In-place Density Tests

The in-place density of the cohesionless materials will be determined in accordance with [ASTM D1556/D1556M] [, ASTM D2167] [, ASTM D6938] [, ASTM D2937] [, or] [ASTM D5195]. Run not less than one (1) field in-place density test on [each lift of material or] every [shift][day] [_____] cubic m cubic yards of completed embankment fill or backfill whichever is less. Horizontal locations will be randomly staggered in the fill. When nuclear method is used for in-place density testing according to ASTM D6938, the first test and every tenth test thereafter for each material type will include a sand cone correlation test in accordance with ASTM D1556/D1556M. The sand cone test will be performed adjacent to the location of the nuclear test, and will include a nominal 150 mm6 inch diameter sand cone, and will include a minimum wet soil weight of 2.7 kg6 pounds extracted from the hole. The density correlations will be submitted with test results. Each transmittal including density test data will include a summary of all density correlations for the job neatly prepared on a summary sheet including at a minimum:

a. Test Identification Number.
b. Test location.
    (1) Station.
    (2) Coordinates.
c. Elevation of Lift.
d. Lift number (if appropriate).
e. Photo number (if appropriate).
f. Meter serial number and operators initials.
g. Standard count for each test.
h. Material type.
i. Probe depth.
j. Moisture content by each test method and the deviation.
k. Wet density by each test method and the deviation.

][3.7.1.6.3 Water (Moisture) Content Tests

Determination of water content will be performed in accordance with ASTM D2216.[ASTM D4643 may be used when rapid moisture content results are needed. All rapid results obtained by ASTM D4643 will be confirmed by a test on a duplicate sample performed in accordance with ASTM D2216. In the event of disagreement between the results, ASTM D2216 will govern.] One water content test will be performed for each [_____] cubic mcubic yards of material placed[or each lift of material whichever is less].[These tests will be in addition to the water content tests performed in conjunction with in-place density tests.] Backfill and fills not meeting the required specifications for water content will be retested after corrective measures have been applied.

][3.7.1.6.4 Additional Testing

The Contracting Officer may request additional tests if there is reason to doubt the adequacy of the compaction, or special compaction procedures are being used, or materials change, or if the Contracting Officer determines that the Contractor's testing is inadequate, or the Contractor is concentrating backfill and fill operations in a relatively small area.

]]3.7.1.7 Materials

Suitability of embankment and backfill materials.

3.7.1.8 Fill Placement

Layout, maintaining existing drainage, moisture control, thickness of layers, removal of oversized material, spreading and compaction for embankment and backfill.

3.7.1.9 Grade and Cross Section

Surveys to verify that the dimensions, slopes, lines and grades conform to those shown on the drawings.[Surveys to monitor settlement gages to measure foundation settlement.] [Surveys to locate core boring locations and elevations to determine foundation settlement.]

3.7.1.10 Testing by the Government

During the life of this contract, the Government [or its Contractors] will perform quality assurance tests. Make available to the Government [or its Contractors] the equipment to perform these test.

3.7.1.11 Reporting

On a daily basis, furnish the inspection records and all material testing results, [the quantity of fill placed,] as well as the records of corrective action taken, in accordance with Section 01 45 00 QUALITY CONTROL.

3.8 SLIDES

In the event of slides, in any part of the embankment prior to final acceptance of the work, remove material from the slide area, as directed, and rebuild such portion of the embankment. In case it is determined that the slide was caused through the fault of the Contractor, perform the removal and disposal of material and the rebuilding of the embankment without cost to the Government; otherwise this work will be paid for at the applicable contract unit prices for borrow excavation and compacted fill or backfill.

3.9 PIEZOMETERS, SETTLEMENT GAGES AND SURFACE REFERENCE MARKS

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NOTE: The installation of instrumentation is not strictly speaking an activity of construction of an embankment dam. This activity should be placed within its own specification division as an item of SPECIAL CONSTRUCTION. There is presently no UFGS guide specification for this item. The specification writer should consider the use of a section for SPECIAL CONSTRUCTION, and if so, delete the following paragraphs.

Include paragraphs for all types of instruments to be utilized.

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[3.9.1 Government Installed Piezometers

A number of piezometers will be installed on the embankment foundations by the Government with its own forces. Connections and extensions of riser pipes must be made by the Contractor with materials furnished by the Contractor. Determine the elevation of the top of the riser pipe immediately before and immediately after each extension is added to the pipe. Keep the top of such pipes at least 600 mm 2 feet above the embankment surface. During construction, place a mound of fill around the riser pipes and compact to the same density and moisture content as the surrounding fill material. Conduct the required operations in such a manner that the devices will not be damaged. Place suitable markers and guard posts around the gages for protection. No separate payment will be made for such protection or for special measures required in connection with the installation of these devices; include all costs in the contract prices bid for related items of work.

][3.9.2 Location and Installation of Settlement Gages

Furnish and install settlement gages for determining foundation and embankment settlement during construction. Provide type, arrangement and location of gages as shown. The areas in which adjustment in quantities will be made as a result of foundation settlement are as indicated on the plans. Place the base plate on a level surface of well compacted foundation material. Determine the elevations of the base plates before placing fill material and again within 48 hours after completion of the embankment. Determine the elevation of the stem immediately before and immediately after each extension is added. These elevations will be verified by the Contracting Officer. Carefully install the stem plumb. Extend the stem in increments as the embankment rises with the top of the stem at a minimum of 600 mm 2 feet above the surface of the embankment. Conduct these operations in such a manner that the gages will not be damaged. Place suitable guard posts around the gages for protection. Compact fill around the stem to the same density and moisture content as the surrounding material. Restore or replace any settlement gage damaged or destroyed due to fault or negligence at no additional cost to the Government. No additional payment will be made for compaction of fill around and over the settlement gages or for interference with the Contractor's operations resulting from the settlement gage installations.

][3.9.3 Surface Reference Marks

Furnish and install surface reference marks as shown. Furnish the horizontal and vertical location of each reference mark with respect to established bench marks at the time of installation, and every [_____] calendar days thereafter until completion of the contract. Conduct these operations in such a manner that the reference marks will not be disturbed or damaged. Replace or repair any reference mark disturbed or damaged due to negligence on the Contractor's part and furnish the correct horizontal and vertical locations the Contractor's expense.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-40 05 13 (October 2007)**
Change 2 - 02/20

Preparing Activity: USACE **Superseding**
UFGS-40 05 13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 40 05 13

PIPELINES, LIQUID PROCESS PIPING

10/07, CHG 2: 02/20

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NOTE: This guide specification covers the requirements for above and below grade liquid process piping located both inside and outside of treatment plants.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Show the following information on the project drawings:

a. Location of pipelines indicating pipe designation, diameter and valves.

b. Pipe schedule relating pipe designation and service.

c. Valve schedule indicating valve designation and service.

d. Piping details.

****

1.1 UNIT PRICES

****

NOTE: This paragraph does not apply to invitation for bid (IFB) contracts. If it is determined that a lump sum contract may be more advisable, this paragraph will be deleted. If a unit price contract is to be used, the bid items for the unit price contract will be defined for each unit to be furnished and installed.

****

Measurement and payment will be based on completed work performed in accordance with the drawings, specifications and the contract payment schedules. No payment will be made under this section for excavation, trenching, or backfilling. Payment for such work will be made under Section 31 00 00 EARTHWORK.

1.1.1 Measurement

Determine the length of pipelines, for which payment will be made, by measuring along the centerlines of the various piping systems and sizes as furnished and installed. Measure pipe from the center of fitting to center of fitting and from center of main header to end of pipe. Make no deduction for the space occupied by valves or fittings.

1.1.2 Payment

Payment will be made at the price per linear meter foot listed in the bid form for the various types and sizes of piping, and will be full compensation for all pipes, joints, fittings and specialties, complete in place. Payment for valves and other appurtenances will be made at the respective contract unit price for each item complete in place. Payment will include the furnishing of all testing, plant, labor, and material and incidentals necessary to complete the work, as specified and as shown in contract documents.

1.1.2.1 Connections to Existing Piping

Connections to existing piping systems where new fittings in the existing line are required will be paid for according to the contract prices for such connection. The price will be considered as full compensation for material and labor required for the removal and replacement of the existing pipe as necessary.

1.1.2.2 Connections to Existing Equipment

Connections to existing equipment where new fittings for the existing equipment are required will be paid for according to the contract prices for such connection. The price will be considered as full compensation for material and labor required for the installation of new fittings or the removal and replacement of existing fittings, as necessary.

1.2 REFERENCES

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NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ANSI H35.2M	(2024) Dimensional Tolerances for Aluminum Mill Products

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B1.20.7	(1991; R 2013) Standard for Hose Coupling Screw Threads (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and

	Threaded
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.20	(2023) Metallic Gaskets for Pipe Flanges
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.42	(2021) Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.1	(2024) Power Piping
ASME B31.3	(2022; Errata 2023) Process Piping
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe
ASME B36.19M	(2022; Errata 2023) Welded and Seamless Wrought Stainless Steel Pipe
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2021) Performance Requirements for Atmospheric Type Vacuum Breakers
ASSE 1012	(2023) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent
ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies

ASSE 1015	(2021) Performance Requirements for Double Check Backflow Prevention Assemblies
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

ANSI/AWWA C541	(2016; R 2021) Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
ANSI/AWWA C542	(2016; R 2021) Electric Motor Actuators for Valves and Slide Gates
AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C150/A21.50	(2021; R 2023) Thickness Design of Ductile-Iron Pipe
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C207	(2023) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2023) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C509	(2023) Resilient-Seated Gate Valves for Water Supply Service
AWWA C510	(2017; R 2021) Double Check Valve Backflow Prevention Assembly
AWWA C511	(2017; R 2021) Reduced-Pressure Principle Backflow Prevention Assembly

AWWA C550	(2024) Protective Interior Coatings for Valves and Hydrants
AWWA C606	(2022) Grooved and Shouldered Joints
AWWA C651	(2023) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS A5.3/A5.3M	(2023) Specification for Aluminum and Aluminum-Alloy Electrodes for Shielded Metal Arc Welding
AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS A5.10/A5.10M	(2023) Welding Consumables - Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys - Classification
AWS A5.11/A5.11M	(2018) Specification for Nickel and Nickel-Alloy Welding Electrodes for Shielded Metal Arc Welding
AWS A5.14/A5.14M	(2024) Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A268/A268M	(2024) Standard Specification for Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A334/A334M	(2004a; R 2021) Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A351/A351M	(2024) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A352/A352M	(2021) Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A395/A395M	(1999; R 2022) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A423/A423M	(2019) Standard Specification for Seamless and Electric-Welded Low-Alloy Steel Tubes
ASTM A436	(2024) Standard Specification for Austenitic Gray Iron Castings
ASTM A479/A479M	(2024) Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
ASTM A513/A513M	(2024) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A576	(2023) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A587	(2022) Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry
ASTM A632	(2004; R 2014) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service
ASTM A727/A727M	(2014; R2019) Standard Specification for Carbon Steel Forgings for Piping Components with Inherent Notch Toughness
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip

	Galvanized Coatings
ASTM A789/A789M	(2024) Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
ASTM A813/A813M	(2024) Standard Specification for Single- or Double-Welded Austenitic Stainless Steel Pipe
ASTM A814/A814M	(2015; R 2019) Standard Specification for Cold-Worked Welded Austenitic Stainless Steel Pipe
ASTM A815/A815M	(2024a) Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings
ASTM A858/A858M	(2024) Standard Specification for Heat-Treated Carbon Steel Fittings for Low-Temperature and Corrosive Service
ASTM A865/A865M	(2023) Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B124/B124M	(2020) Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B150/B150M	(2012; R 2017) Standard Specification for Aluminum Bronze Rod, Bar, and Shapes
ASTM B161	(2005; R 2014) Standard Specification for

	Nickel Seamless Pipe and Tube
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B165	(2019) Standard Specification for Nickel-Copper Alloy (UNS N04400)* Seamless Pipe and Tube
ASTM B167	(2023) Standard Specification for Nickel-Chromium-Aluminum Alloys, Nickel-Chromium-Iron Alloys, Nickel-Chromium-Cobalt-Molybdenum Alloy, Nickel-Iron-Chromium-Tungsten Alloy, and Nickel-Chromium-Molybdenum-Copper Alloy Seamless Pipe and Tube
ASTM B210/B210M	(2019a) Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B211/B211M	(2023) Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
ASTM B241/B241M	(2022) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B247	(2020) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM B247M	(2020) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings (Metric)
ASTM B302	(2017) Standard Specification for Threadless Copper Pipe, Standard Sizes
ASTM B345/B345M	(2011) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube for Gas and Oil Transmission and Distribution Piping Systems
ASTM B361	(2016; R 2024) Standard Specification for Factory-Made Wrought Aluminum and Aluminum-Alloy Welding Fittings
ASTM B366/B366M	(2023) Standard Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings
ASTM B517	(2019) Standard Specification for Welded Nickel-Chromium-Iron-Alloy (UNS N06600, UNS N06603, UNS N06025, and UNS N06045) Pipe

ASTM B546	(2019; R 2024) Standard Specification for Electric Fusion-Welded Ni-Cr-Co-Mo Alloy (UNS N06617), Ni-Fe-Cr-Si Alloys (UNS N08330 and UNS N08332),Ni-Cr-Fe-Al Alloy (UNS N06603), Ni-Cr-Fe Alloy (UNS N06025), and Ni-Cr-Fe-Si Alloy (UNS N06045) Pipe
ASTM B564	(2022) Standard Specification for Nickel Alloy Forgings
ASTM B574	(2023) Standard Specification for Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Molybdenum-Chromium, Low-Carbon Nickel-Molybdenum-Chromium-Tantalum, Low-Carbon Nickel- Chromium-Molybdenum-Copper, and Low-Carbon Nickel-Chromium-Molybdenum-Tungsten Alloy Rod
ASTM B619/B619M	(2019; R 2023) Standard Specification for Welded Nickel and Nickel-Cobalt Alloy Pipe
ASTM B622	(2023) Standard Specification for Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube
ASTM B725	(2022) Standard Specification for Welded Nickel and Nickel Copper Alloy Pipe
ASTM B775/B775M	(2022) Standard Specification for General Requirements for Nickel and Nickel Alloy Welded Pipe
ASTM B813	(2024) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B829	(2024) Standard Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C600	(1985; R 2010) Thermal Shock Test on Glass Pipe
ASTM D1418	(2010; R 2016) Standard Practice for Rubber and Rubber Lattices - Nomenclature
ASTM D1527	(1999; R 2005) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2235	(2004; R 2016) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D2239	(2012) Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2310	(2006; R 2012) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	(2023) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2609	(2015) Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2683	(2020) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D2737	(2012a) Polyethylene (PE) Plastic Tubing
ASTM D2774	(2021a) Standard Practice for Underground Installation of Thermoplastic Pressure Piping

ASTM D2855	(2020) Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
ASTM D2992	(2012) Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
ASTM D3035	(2022) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3222	(2018a) Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3307	(2016) Standard Specification for Perfluoroalkoxy (PFA)-Fluorocarbon Resin Molding and Extrusion Materials
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3754	(2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
ASTM D3839	(2014; R 2019) Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3892	(2015) Standard Practice for Packaging/Packing of Plastics
ASTM D3965	(2016) Standard Classification System and Basis for Specifications for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings
ASTM D4024	(2015) Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM D4101	(2017) Standard Classification System and

	Basis for Specification for Polypropylene Injection and Extrusion Materials
ASTM D4161	(2014; R 2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D5421	(2015) Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM D5685	(2019) Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings
ASTM E438	(1992; R 2024) Standard Specification for Glasses in Laboratory Apparatus
ASTM E814	(2024) Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM F336	(2002; R 2023) Standard Practice for Design and Construction of Nonmetallic Enveloped Gaskets for Corrosive Service
ASTM F402	(2018) Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	(2024) Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	(2023) Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	(2024) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441/F441M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F442/F442M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	(2022) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

ASTM F656	(2021) Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F714	(2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F876	(2024b) Standard Specification for Crosslinked Polyethylene (PEX) Tubing
ASTM F1055	(2016; R 2022a) Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX)Pipe and Tubing
ASTM F1056	(2018; R 2022) Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
ASTM F1199	(2021) Standard Specification for Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)
ASTM F1200	(2021a) Standard Specification for Fabricated (Welded) Pipe Line Strainers (Above 150 psig and 150 degrees F (1Mpa and 65 degrees C))
ASTM F1290	(2019) Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F1545	(2015a; R 2021) Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings and Flanges

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA TRD	(2016) Thrust Restraint Design for Ductile Iron Pipe

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 228-1	(2000) Pipe Threads Where Pressure-Tight Joints Are Not Made on The Threads - Part 1: Dimensions, Tolerances and Designation

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-43	(2019) Wrought Stainless Steel

	Butt-Welding Fittings
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NACE INTERNATIONAL (NACE)

NACE SP0185	(2024) Extruded Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 704	(2022) Standard System for the Identification of the Hazards of Materials for Emergency Response

PLASTICS PIPE INSTITUTE (PPI)

PPI Handbook	(2008) PPI Handbook Of PE Pipe

RUBBER MANUFACTURERS ASSOCIATION (RMA)

RMA IP-2	(2009) Hose Handbook; 8th Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's

Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Materials and Equipment

Cable System

SD-03 Product Data

Qualifications

Welders

Waste Water Disposal

Manufacturer's Field Services

Delivery, Storage and Handling

Materials and Equipment

Installation

Pipe Schedule

Valve Schedule

Operator Schedule

SD-06 Test Reports

Double Containment Piping System

Pipe Leakage Tests

Hydrostatic Tests

Pneumatic Tests

Double Containment Piping Leak Detection System

Valve Testing

Disinfection

SD-07 Certificates

Fiberglass Reinforced Plastic (FRP) Piping System

Plastic Piping System

Plastic Pipe Installation

SD-10 Operation and Maintenance Data

Piping and Appurtenances; G, [_____]

1.4 QUALIFICATIONS

1.4.1 Experience

Submit a statement certifying that the Contractor has the specified experience. Ensure Contractor has successfully completed at least [three] [_____] projects of the same scope and size or larger within the last [six] [_____] years. Demonstrate specific experience in regard to the system installation to be performed.

1.4.2 Double Containment Piping System Manufacturer

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NOTE: Delete the following paragraph when it is not required.

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The double containment piping system manufacturer will have at least [ten] [_____] years of installation experience with leak detection/location sensor cable technology.

1.4.3 Welders

Submit the names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc. Weld pressure piping systems in accordance with qualifying procedures using performance qualified welders and operators. Use procedures and welders in accordance with Section 40 05 13.96 WELDING PROCESS PIPING. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials delivered and placed in storage must be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged must be replaced at the Contractor's expense. During installation, piping must be capped to keep out dirt and other foreign matter. A Safety Data Sheet in conformance with 29 CFR 1910 Section 1200(g) must accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling must be in accordance with ASTM F402. Storage facilities must be classified and marked in accordance with NFPA 704. Materials must be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings must be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe must be packed, packaged and marked in accordance with ASTM D3892.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Environmental Requirements

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NOTE: HTRW sites are typically well studied and investigated. Site conditions found during these previous investigations (e.g., soil resistivity testing for corrosion control design) must be incorporated into the design. The next paragraph must be edited carefully to address existing site conditions.

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Buried piping at the site may be subject to corrosion from the surrounding soil. Conduct testing and measurements in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Ensure piping system design, supply and installation addresses the external corrosion conditions so indicated.

1.6.2 Existing Conditions

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NOTE: Connection locations and wet/dry connections must be clearly indicated to avoid confusion and claims.

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Verify existing piping and penetrations. Prior to ordering materials, expose all existing pipes which are to be connected to new pipelines. Verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes, and inspect size and location of structure penetrations to verify adequacy of wall sleeves, and other openings before installing connecting pipes.

1.7 SEQUENCING AND SCHEDULING

For slab, floor, wall, and roof penetrations, keep on site pertinent wall pipes and sleeves before they are required for placement in concrete forms. Verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

1.8 MAINTENANCE

1.8.1 Service

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NOTE: Selectively require manufacturer's service. Automatic valves in critical or hazardous systems require service assistance. Coordinate these services with specification sections that address instrumentation and control.

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Provide services for [automatic valve] [double containment leak detection monitoring system] [double containment leak sensor cable] [_____] systems by a manufacturer's representative who is experienced in the installation, adjustment and operation of the equipment specified. Inspect the installation, and supervise the adjustment and testing of the equipment.

1.8.2 Extra Materials

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NOTE: Include items needed for future maintenance and repair, items that might be difficult to obtain because of color or pattern match, or spare parts to ensure operation of critical systems.

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Submit the manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation. Concurrent with delivery and installation of the specified piping systems and appurtenances, furnish spare parts for each different item of material and equipment specified that is recommended by the manufacturer to be replaced any time up to [3 years] [_____] of service. For each type and size of valve, provide the following extra materials: lubricator, lubricant (with appropriate temperature rating), lubricator/isolating valve; [galvanized operating wrench, [1.2] [____]m [4.1] [_____] feet long, for T-handled operators;] [galvanized operating key for cross handled valves;] [_____]. Extra materials include [2] [_____] of the following spare parts for each type and size of valve: gaskets; [O-ring seals;] [diaphragms (molded);] all elastomer parts; stem packing; [seat rings [and seat ring pulling tool];] [_____].

PART 2 PRODUCTS

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NOTE: All materials of construction specified will be retained except under conditions where they would not be suitable (see UFC 3-240-01); upon specific instructions of HQUSACE; as stipulated in specific project directives.; and as described within notes throughout the specification. A study of the process conditions will be made to determine the suitability of the materials. Where a material would be altogether unsuitable, every mention of the unsuitable material and referenced publications that

pertain only to the unsuitable material will be deleted. If a material would be suitable in a part of the system and unsuitable in other parts, the locations where the material may and may not be used will be stated in the contract specifications and shown on the contract drawings.

Soil conditions that may affect the corrosion rate of buried ferrous piping should be evaluated. The evaluation and corrosion control design will be performed in accordance with the directions provided in UFC 3-570-02A.
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2.1 SYSTEM REQUIREMENTS

This specification covers the requirements for above and below grade liquid process pipe, pipe supports, fittings, equipment and accessories located both inside and outside of treatment plants.

2.1.1 Design Requirements

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NOTE: Determine the design wind speed from ASCE 7-16 and/or UFC 3-301-01 STRUCTURAL ENGINEERING, although a minimum of 161 km/h (100 miles per hour) will be used. Similarly, use 1.2 kPa 25 psf snow load for most heavy snow climates. In some cases, local climates and topography will dictate that a larger value is required. This may be determined from ANSI A58.1, local codes or by research and analysis data of the effect of local climate and topography. Snow load requirements can be deleted for locations where the maximum snow is insignificant. Provide seismic requirements and show on the drawings. Delete the bracketed phrase if seismic details are not included. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.
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Select and design support systems in accordance with MSS SP-58 within the specified spans and component requirements. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout facility. The structural design, selection, fabrication and erection of piping support system components must satisfy the seismic requirements in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS [as indicated], accounting for a [_____] MPa psf soil bearing capacity, a maximum wind speed of [_____] km/h mph, a ground snow load of [_____] kPa psf, a maximum ambient air temperature of [_____] degrees Cdegrees F and a minimum ambient air temperature of [_____] degrees C degrees F.

2.1.2 Performance Requirements

The pressure ratings and materials specified represent minimum acceptable standards for piping systems. Provide piping systems suitable for the services specified and intended. Coordinate each piping system to function as a unit. Provide flanges, valves, fittings and appurtenances with a pressure rating no less than that required for the system in which they are installed.

2.1.2.1 Buried Piping Systems

Provide piping systems suitable for design conditions, considering the piping both with and without internal pressure. Give consideration to all operating and service conditions both internal and external to the piping systems. Ensure buried ferrous piping has cathodic protection in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

2.1.2.2 Above Grade Piping Systems

Provide piping systems suitable for design conditions, considering the piping both with and without internal pressure, and installation factors such as insulation, support spans, and ambient temperatures. Give consideration to all operating and service conditions both internal and external to the piping systems.

2.2 MATERIALS AND EQUIPMENT

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NOTE: Verify that the pipe schedule is included in the contract drawings.

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Submit manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings; thermal characteristics (coefficient of expansion and thermal conductivity); and chemical resistance to each chemical and chemical mixture in the liquid stream. Provide piping materials and appurtenances as specified and as shown on the drawings, and suitable for the service intended. Ensure piping materials, appurtenances, and equipment supplied as part of this contract are of equal material and ratings as the connecting pipe, new and unused except for testing equipment. Ensure components that serve the same function and are the same size are identical products of the same manufacturer. Provide general materials to be used for the piping systems in accordance with TABLE I and indicate by service in the [Pipe Schedule] [contract drawings] [_____]. Submit a list of piping systems, pressure ratings and source of supply for each piping system broken out by material, size and application as indicated on the contract drawings. A list of any special tools necessary for each piping system and appurtenances furnished for adjustment, operation, maintenance and disassembly of the system. Provide pipe fittings compatible with the applicable pipe materials.

2.2.1 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least [2] [_____] years prior to bid opening. Submit the following: Equipment shop drawings and support system detail drawings showing piping systems and appurtenances, such as mechanical joints, valves, local indicators and hangers, including a complete list of equipment and materials. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. As-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices; if the contract drawings contained P&IDs, revise the P&IDs found in the contract drawings to reflect the constructed process system, as directed by the Contracting Officer. Use nominal sizes for standardized products. Provide pipe, valves, fittings and appurtenances supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.2 Identification and Tagging

Each piece of pipe must bear the ASTM designation and all other markings required for that designation. Mark valves in accordance with MSS SP-25 and securely attach an identification tag using [No. 12 AWG copper wire] [stainless steel wire] [chrome-plated beaded chain] [plastic straps designed for that purpose]. Identification tags must be [35 mm 1.375 inch] [[_____] mm inches] minimum diameter, made of [brass] [engraved laminated plastic] [engraved anodized aluminum] [stamped stainless steel] [_____]. [Use black indentations for reading clarity.] Display service, valve identification number shown on the [Operator Schedule] [Valve Schedule] in the contract drawings, the manufacturer's name, and the valve model number.

2.3 DUCTILE IRON PIPING SYSTEM

2.3.1 Ductile Iron Pipe

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NOTE: Standard thicknesses of ductile iron pipe are governed by AWWA C150/A21.50 or AWWA C151/A21.51, except for integral flanged piping. The thickness of integral flanged pipe is regulated in AWWA C115/A21.15. If restrained joint pipe is used, thickness must conform to AWWA C151/A21.51.

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Provide ductile iron pipe for pressure service with a design and wall thickness conforming to [AWWA C150/A21.50] [AWWA C151/A21.51] [AWWA C115/A21.15]. Provide ductile iron pipewith a [[standard] [double thickness] cement lining conforming to AWWA C104/A21.4] [standard asphaltic lining] [_____].

2.3.2 Ductile Iron Joints

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NOTE: Flanged connections should not be used for buried service. Use joints for pipe and fittings installed underground (buried).

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Provide joints with a working pressure rating for liquids equal to the pressure rating of the connected pipe. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.3.2.1 Mechanical Joints

Provide mechanical joints conforming to AWWA C110/A21.10 and

AWWA C111/A21.11. [Furnish gaskets, glands, bolts and nuts in sufficient quantity for the complete assembly of each mechanical joint. Provide [ductile] [or] [gray] iron glands with an [asphaltic] [_____] coating. Provide gaskets consisting of [vulcanized synthetic rubber, reclaimed rubber is not acceptable] [_____].] [For grooved shoulder piping, use self-centering gasketed couplings designed to mechanically engage piping and lock in a positive watertight couple.] [Compose housing of [malleable iron, ASTM A47/A47M] [or] [ductile iron, ASTM A536] and use gaskets of molded synthetic rubber, [halogenated isobutylene isoprene] [nitrile] [_____]. Bolts and nuts must be [heat treated carbon steel, ASTM A183, minimum tensile 760 MPa 110,000 psi] [_____].] [Mechanical joints must have bolt holes oriented [straddling the vertical centerline of the valves and fittings] [_____].]

2.3.2.2 Push-on Joints

Provide push-on type joints conforming to AWWA C111/A21.11. Supply each push-on joint complete with gasket and lubricant. Ensure gaskets are compatible with joint design and are comprised of [vulcanized synthetic rubber, reclaimed rubber is not acceptable] [_____]. Provide lubricant that is specifically formulated for use with push-on joints, non-toxic, odorless, tasteless and does not support bacteria growth.

2.3.2.3 Restrained Joints

Provide restrained joints conforming to the requirements of AWWA C111/A21.11, and designed for a working pressure equal to connected pipe rating. When using ductile iron pipe with restrained joints, supply field cuts with a lock ring complete with retainer, retainer lock and roll-pin, as required by manufacturer's recommendations, procedures and/or installation instructions.

2.3.2.4 Flanged Joints

Provide flanged joints conforming to AWWA C110/A21.10. Provide gaskets, bolts and nuts with flanged joints in sufficient quantity for the complete assembly of each joint. Gaskets must be [vulcanized synthetic rubber, reclaimed rubber is not acceptable] [_____].

2.3.3 Ductile Iron Fittings

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NOTE: Fittings for ductile-iron or gray-iron piping involving 1.03 MPa 150 psi and 1.72 MPa 250 psi service are specified in AWWA C110/A21.10; for 2.41 MPa 350 psi service use AWWA 153. Typically, either gray or ductile iron fittings are acceptable. Specify the exact material if service conditions warrant.

Take special precaution with mating flanges specified in this paragraph; that is, mating flanges conforming to AWWA C110/A21.10 with flanges that are specified elsewhere using ASME B16.1 or B16.5 standards.

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Fittings must be gray iron ASTM A48/A48M or ductile iron [AWWA C110/A21.10] [AWWA C153/A21.53]. Up to [300] [_____] mm [12] [_____] inches inclusive, the fittings must be [1.7] [_____]MPa [250] [_____] psig rated. Gray iron fittings must be cement mortar lined [standard] [double] thickness. Provide flanges and flanged fittings conforming to [AWWA C110/A21.10] [ASME B16.1] and rated for [1.03 MPa 150 psig] [1.72 MPa 250 psig] [[_____] MPa psig] service. Provide [ductile iron] [or] [gray iron] [_____] materials. For tie-in to existing flanges, field check existing flanges for nonstandard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolts and nuts must be [carbon steel conforming to ASTM A307, Grade [B] [_____]] [_____]. Provide bolts with washers of the same material as the bolts. Gaskets must be [rubber] [ring] [_____] [full face], maximum [3.2] [_____] mm [0.125] [_____] inch thick.

2.3.4 Corrosion Control

Ductile iron piping must be [coated with the manufacturer's standard asphaltic coating, approximately [0.025 mm 1 mil] [[_____] mm mil] thick, applied to the outside of pipe and fittings] [hot-dipped galvanized in accordance with ASTM A153/A153M] [_____]. Coat and wrap buried pipe, and provide with cathodic protection in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

2.4 CARBON STEEL PIPING SYSTEM

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NOTE: Consult the referenced standards for the proper carbon steel use and fittings. For example, ASTM A53/A53M carbon steel piping is a good general piping material and ASTM A106/A106M carbon steel is for high temperature applications. In addition, some of the types and grades may not be suitable for certain joining methods or cold bending; etc. Steel pipe meeting API Spec 5L is specified only with 50 mm 2 inch and smaller pipe that is subject to a low pressure application and the use of taper-threaded couplings.

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2.4.1 Carbon Steel Pipe

2.4.1.1 General Service

Provide carbon steel pipe meeting the requirements of [ASTM A53/A53M [seamless] [butt welded] [electric-resistance welded], Grade [A] [B]] [API Spec 5L, Schedule [40] [80] [_____]] and [in accordance with Pipe Schedule] [, hot-dipped galvanized]. Provide Schedule [80] [_____] buried carbon steel piping and fittings.

2.4.1.2 High Temperature Service

Seamless carbon steel pipe for high temperature service must [conform to ASTM A106/A106M Grade [A] [B] [C], [hot-finished] [cold-drawn], Schedule [40] [80] [_____]] [be in accordance with Pipe Schedule] with dimensions conforming to ASME B36.10M.

2.4.1.3 Chemical Process Service

Provide electric-resistance welded low-carbon steel pipe conforming to ASTM A587 with a nominal wall thickness [of [_____] mm inch] [in accordance with Pipe Schedule].

2.4.2 Carbon Steel Tubing

Provide tubing meeting the requirements of [ASTM A334/A334M, [seamless] [welded], Grade [1] [_____] carbon steel] [ASTM A423/A423M, [seamless] [electric-resistance-welded], Grade [1] [2] low-alloy carbon steel] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.4.3 Carbon Steel Joints

Join carbon steel piping by [straight-threaded couplings] [taper-threaded couplings] [welding fittings] [flanges] [mechanical joints for grooved ends meeting the requirements of AWWA C606]. Join tubing using [compression] [_____] fittings. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.4.4 Carbon Steel Fittings

[Fittings must be [cast malleable iron] [carbon steel] [heat-treated low-carbon steel] [_____].] [Where cast fittings are not available, fabricate segmental welded steel fittings, ASTM A53/A53M, Grade B, meeting the requirements of manufacturer's recommended wall thicknesses.]

2.4.4.1 Threaded Fittings

Threaded fittings must be Class [150] [300] [_____], [malleable iron, ASTM A47/A47M, conforming to ASME B16.3, black, banded] [forged carbon steel ASTM A105/A105M, conforming to ASME B16.11] [low carbon steel, ASTM A858/A858M, conforming to ASME B16.11] [_____], and threaded in accordance with ASME B1.20.2MASME B1.20.1. Threaded, rigid couplings must be [welded] [seamless], [black] [Type I (hot-dipped galvanized)] [Type II (electrogalvanized)] carbon steel in accordance with [ASTM A865/A865M] [_____] and threaded in accordance with ASME B1.20.2MASME B1.20.1. [Use polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.4.4.2 Welding Fittings

Provide [butt-welding] [or] [socket-welding] welding fittings. Provide welding fittings consisting of forged [steel, ASTM A105/A105M Class [150] [300] [_____]] [low-carbon steel, ASTM A858/A858M [seamless] [or] [welded]] [_____] conforming to [ASME B16.9] [, or] [ASME B16.11].

2.4.4.3 Flanged Fittings

Ensure the internal diameter bores of flanges and flanged fittings are the same as that of the associated pipe. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Flanges and flanged fittings must be [forged steel, [ASTM A105/A105M] [ASTM A727/A727M] [_____]] [_____], faced and drilled to ASME B16.5 Class [150] [300] [_____] with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. [Drill cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, in conformance with [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Provide bolting consisting of [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, use [ASTM A193/A193M Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 that are a maximum [3.2] [_____] mm [0.125] [_____] inch thick [chloroprene rubber, durometer hardness No.80,] [_____] 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.4.4.4 Compression Fittings for Tubing

Provide compression fittings consisting of [carbon steel [ASTM A108] [ASTM A576]] [_____] nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.4.5 Carbon Steel Coatings

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NOTE: Carbon steel piping system components will be coated with corrosion resistant materials suitable for exposure to the environmental and process conditions of the site. For potential exposures to pressures less than 70 kPa 10 psi, temperatures less than 100 degrees C 212 degrees F and mild chemicals, prepare the surfaces in accordance with SSPC SP 6/NACE No.3.

For potential exposures to pressures and temperatures greater than those previously mentioned, and mild chemicals, intermediate options may be appropriate. For severe chemical exposures, the thermoplastic resin system should be used.

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Coat carbon steel piping components with corrosion resistant materials. Ensure coatings and finishes are 100 percent holiday free.

2.4.5.1 Silicone Coating

Prepare carbon steel piping surfaces in accordance with SSPC SP 6/NACE No.3. Provide surfaces with an alkyd primer of [0.0625] [_____] mm [2.5] [_____] mils dry film thickness followed by two alkyd modified silicone final coats.

2.4.5.2 Zinc Coating

Galvanizing must be hot-dip applied and meet the requirements of ASTM A153/A153M; electroplated zinc or cadmium plating is unacceptable. Stainless steel components may be substituted where galvanizing is specified.

2.4.5.3 Thermoplastic Resin Coating System

[Carbon steel piping surfaces must have a minimum of [4] [_____] coats of phenolic type coatings applied at a minimum dry film thickness of [0.040] [_____] mm [1.6] [_____] mils per coat. Bake each coat at [149] [_____] degrees C [300] [_____] degrees F for [10] [_____] minutes. Cure the full coating system in an oven at [190] [_____] degrees C [375] [_____] degrees F for [30] [_____] minutes.] [Coat carbon steel piping system components with an adhesively mounted polyethylene coating system. Ensure the continuously extruded polyethylene and adhesive coating system materials conform to NACE SP0185 Type A.]

2.4.6 Carbon Steel Cathodic Protection

Buried ferrous piping must have cathodic protection.

2.5 LINED STEEL PIPING SYSTEM

2.5.1 Outer Pipe Shell

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NOTE: For the outer shell, carbon steel is most common; stainless steel will considerably limit suppliers. Flanged joining, Class 150 or 300, is commonly used. Most thermoplastic liners allow some vapors to permeate and become trapped between the liner and the shell. Therefore, venting via weep holes in the outer shell or venting flange collars (note that a single manufacturer has a patent on venting collars) are required to avoid gas accumulation. These are not required for nonpermeable liners such as PVDC. The use of thermoplastics with aggressive chemicals may result in a lower maximum operating temperature than that rated for an unlined pipe composed of the same material.

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The outer shell of the lined piping system must be [carbon steel meeting the requirements of [ASTM A53/A53M [electric-resistance welded] [_____], Grade [B] [_____]] [_____], Schedule [40] [80] [in accordance with Pipe Schedule]] [TP304 stainless steel, [ASTM A312/A312M [seamless] [welded]] [_____], Schedule [10S] [40S] [80S] [5S] [in accordance with Pipe Schedule]] [_____]. Equip outer pipe with [3] [_____] mm [0.125] [_____] inch vent holes spaced axially at [_____] mm inches on center or locking and venting collars at each flange. If insulated, equip the vents of the lined piping system with the manufacturer's standard vent extensions to avoid blocking. [Coat carbon steel piping components externally with corrosion resistant materials. Ensure coatings and finishes are 100 percent holiday free.]

2.5.2 Lined Steel Joints

Join lined piping by [[cast steel] [forged steel] flanges] [_____].

2.5.3 Lined Steel Fittings

Fittings must be [cast gray iron, [ASTM A126 Grade B] [_____], conforming to ASME B16.1] [cast ductile iron, [ASTM A395/A395M] [_____], conforming to ASME B16.42] [cast carbon steel, [ASTM A216/A216M Grade WCB] [_____], conforming to ASME B16.5] [cast, fabricated or forged carbon steel, [ASTM A587] [ASTM A106/A106M Grade B] [ASTM A53/A53M] [ASTM A105/A105M]] [stainless steel, [ASTM A312/A312M Grade 304L] [ASTM A276/A276M] [_____], conforming to ASME B16.5] [_____].

2.5.4 Lined Steel Flanged Fittings

Ensure the internal diameter bores of flanges and flanged fittings are the same as that of the associated pipe. [Cast steel, [ASTM A216/A216M Grade [WCB] [_____]] [_____],] [Forged steel, [ASTM A105/A105M] [_____],] [Stainless steel, [ASTM A312/A312M Grade 304L] [_____],] flanges and flanged fittings must be faced and drilled to ASME B16.5 Class [150] [300] [_____]. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must be [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, use [ASTM A193/A193M Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [______]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5 and nonmetallic conforming to ASME B16.21.

2.5.5 Lined Steel Spacers

For making connections between lined piping systems and other types of pipe or equipment, use spacers. Ensure spacers are composed of the same material as the liner with a bore identical to the internal diameter of the associated lined pipe. Unless otherwise specified for the liner systems, use a gasket between the spacer and the unlined piping system or equipment that conforms to the gaskets required for the unlined piping system or equipment nozzle. Spacers must be [standard ring] [standard full face] [lined steel ring] [as indicated on the contract drawings] [_____] for flanged connections. Provide spacers that are a minimum of [13] [_____] mm [1/2] [_____] inch thick for piping 200 mm 8 inches and smaller in diameter, and a minimum of [15] [_____] mm [5/8] [_____] inch thick for piping larger than 200 mm 8 inches in diameter. [Use] [Do not use] a tapered face spacer for piping directional changes less than [5] [_____] degrees, and do not use for piping directional changes larger than [5] [_____] degrees.

2.5.6 Glass Liner

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NOTE: A pressure rating of 2 MPa 300 psi is available for the lining and piping system if Class 300 split flanges are used as joints.

****

Lock the liner to the shell. The liner must consist of [1.6] [_____] mm [1/16] [_____] inch of [chemical resistant, low-expansion, Type-I borosilicate glass, Glass A] [porcelain enamel] [_____] conforming to ASTM E438 rated to operate between -29 and plus 66 degrees C -20 and plus 450 degrees F at a nominal working pressure of [1.03] [_____] MPa [150] [_____] psig and full vacuum. [Test thermal shock resistance in accordance with ASTM C600.] [Use polytetrafluoroethylene (PTFE)] [_____] enveloped gaskets that conform to ASTM F336.

2.5.7 Perfluoroalkoxyl (PFA) Liner

****

NOTE: Liner thicknesses range from 1.5 to 3.8 mm 60 to 150 mil, depending on the size of the pipe. Nominal pipe diameters 25 mm 1 inch through 80 mm 3

inches are rated for full vacuum up to 230 degrees C 450 degrees F; 100 mm 4 inches diameter pipe is rated for full vacuum to 150 degrees C 300 degrees F; 150 mm 6 inches diameter pipe is rated for full vacuum at 120 degrees C 250 degrees F; and 200 mm 8 inches diameter pipe is rated for full vacuum at 65 degrees C 150 degrees F. Larger pipe diameters are available.

****

Lock the liner to the shell. The liner must consist of PFA, ASTM D3307 Type II, conforming to ASTM F1545, and rated to operate between -29 and plus 260 degrees C -20 and plus 500 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. Provide liner for fittings with a minimum wall thickness and minimum uniform face thickness of [_____] mmmil. The part of the liner that extends onto a gasket face must have a uniform thickness of no less than 80 percent of the pipe liner wall thickness.

2.5.8 Polypropylene (PP) Liner

****

NOTE: Liner thicknesses range from 3.8 to 8.6 mm 150 to 340 mil), depending on size of pipe. Nominal pipe diameters 25 mm 1 inch through 300 mm 12 inch are rated for full vacuum up to 107 degrees C 225 degrees F, if the liner is of swaged construction. For interference fit type liners, pipe diameters 25 mm 1 inch through 200 mm 8 inch are rated for full vacuum to 107 degrees C 225 degrees F; 250 mm 10 inch and 300 mm 12 inch diameter pipe is rated for full vacuum to 38 degrees C 100 degrees F.

****

Lock the liner to the shell. The liner must consist of PP, ASTM D4101, must conform to ASTM F1545, and rated to operate between -18 and plus 107 degrees C 0 and 225 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. Provide liner for fittings with a minimum wall thickness and minimum uniform face thickness of [_____] mm mil. The part of the liner that extends onto a gasket face must have a uniform thickness of no less than 80 percent of the pipe liner wall thickness.

2.5.9 Polytetrafluoroethylene (PTFE) Liner

****

NOTE: Liner thicknesses range from 1.5 to 3.8 mm 60 to 150 mil, depending on pipe dimensions. Nominal pipe diameters 25 mm 1 inch through 300 mm 12 inch are rated for full vacuum up to 107 degrees C 225 degrees F, if the liner is of swaged construction. For interference fit type liners, pipe diameters 25 mm 1 inch through 100 mm 4 inch are rated for full vacuum to 230 degrees C 450 degrees F; 150 mm 6 inch and 200 mm 8 inch diameter pipe is rated for full vacuum at 180 degrees C 350 degrees F. For swaged fit type liners, pipe diameters 25 mm 1 inch through

200 mm 8 inch are rated for full vacuum to 230 degrees C 450 degrees F. For slip fit type liners, pipe diameters 25 mm 1 inch through 100 mm 4 inch are rated for full vacuum to 230 degrees C 450 degrees F.

****

Lock the liner to the shell. The liner must consist of PTFE, must conform to [_____], and rated to operate between -29 and plus 260 degrees C -20 and plus 500 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. The part of the liner that extends onto a gasket face must have a minimum uniform face thickness of [_____] mm mil.

2.5.10 Polyvinylidene Fluoride (PVDF) Liner

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NOTE: Liner thicknesses range from 3.81 to 5.33 mm 150 to 218 mil depending on the pipe dimensions. Proper liner thickness assures a non-permeable lining. Nominal pipe diameters 25 mm 1 inch through 200 mm 8 inch are rated for full vacuum up to 135 degrees C 275 degrees F, if the liner is of swaged or interference fit construction. For loose fit type liners, nominal pipe diameters 25 mm 1 inch through 100 mm 4 inch are rated for full vacuum to 135 degrees C 275 degrees F, and 150 mm 6 inch and 200 mm 8 inch diameter pipe is rated for 64.2 kPa 19 inch of mercury of vacuum to 135 degrees C 275 degrees F.

****

Lock the liner to the shell. The liner must consist of PVDF, ASTM D3222, and must be rated to operate between -18 and plus 135 degrees C 0 and 275 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. Provide liner for fittings with a minimum wall thickness and minimum uniform face thickness of [_____] mm mil. The part of the liner that extends onto a gasket face must have a uniform thickness of no less than 80 percent of the pipe liner wall thickness.

2.5.11 Rubber Liner

****

NOTE: Liner thicknesses range from 3.2 mm 0.125 inch to 12.7 mm 0.5 inch. Rubber lined pipe is not rated for vacuum service. Use a standard gasket for hard rubber lining. For soft rubber use a coating or sheet of polyethylene or similar material consistent with the application as a gasket. Operating temperature ranges are as follows:

natural rubber	**-54 to plus 82 degrees C -65 to plus 180 degrees F**

chloroprene	**-54 to plus 107 degrees C -65 to plus 225 degrees F**
isobutylene isoprene	**-54 to plus 149 degrees C -65 to plus 300 degrees F**
nitrile	**-54 to plus 107 degrees C -65 to plus 225 degrees F**
EPDM	**-54 to plus 149 degrees C -65 to plus 300 degrees F**
chlorosulfonated polyethylene	**-54 to plus 121 degrees C -65 to plus 250 degrees F**

****

Lock the liner to the shell. The liner must consist of [_____] mm inch of elastomeric material, ASTM D1418 Class [_____], with a hardness of [_____]. Terminate lining inside of the bolt holes. Fill remaining space from the liner to the flange edge with a [_____] mm inch [polytetrafluoroethylene (PTFE)] [polyvinylidene fluoride (PVDF)] [polypropylene (PP)] [_____] spacer. Provide flange gaskets that are [a maximum [3] [_____] mm [1/8] [_____] inches thick [polyethylene (PE)] [_____] [sheet] [or] [coating]] [[_____] gasket].

2.5.12 Polyvinylidene Chloride (PVDC) Liner

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NOTE: No vents are needed in the outer pipe for PVDC. Liner thicknesses range from 3.8 to 5.5 mm 150 to 218 mil depending on the pipe dimensions.
****

Lock the liner to the shell. The liner must consist of PVDC conforming to ASTM F1545 and rated to operate between -18 and plus 79 degrees C 0 and 175 degrees F. Ensure the lined piping system is rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. Provide pipe liner with a minimum wall thickness of [_____] mm mil. Provide fittings liner with a minimum wall thickness and minimum uniform face thickness of [_____] mm mil. The part of the liner that extends onto a gasket face must have a uniform thickness of no less than 80 percent of the pipe liner wall thickness.

2.5.13 Lined Steel Cathodic Protection

Buried ferrous piping must have cathodic protection.

2.6 STAINLESS STEEL PIPING SYSTEM

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NOTE: The following paragraphs specify general liquid service use of stainless steel piping. To specify the material, review the application. For example, of the austenitic steels, TP316 or TP316L have better resistance to pitting corrosion than

TP304 or TP304L where brines, sulphur-bearing waters or halogen salts, such as chlorides, are present.

The option for crimped couplings and fittings requires a low pressure application - less than 1.03 MPa 150 psig, service where the stainless steel piping materials (TP304, TP304L, TP316 and TP316L) are compatible to the fluid and thin wall (schedule 5S) pipe or tubing. A limited number of manufacturers are available so include other joint/fitting option(s).

****

2.6.1 Austenitic Piping

2.6.1.1 Stainless Steel Pipe

Stainless steel pipe intended for general corrosive service must meet the requirements of [ASTM A312/A312M, [seamless] [welded]] [ASTM A813/A813M for fit-up and alignment quality, Class [SW] [DW]] [ASTM A814/A814M for flanged and cold-bending quality, Class [SW] [DW]] [_____], Grade [TP304] [TP304L] [TP316] [TP316L] [_____], Schedule [10S] [40S] [80S] [5S] [in accordance with Pipe Schedule] [_____] with dimensions conforming to ASME B36.19M.

2.6.1.2 Stainless Steel Tubing

Provide stainless steel tubing meeting the requirements of [[ASTM A269/A269M] [ASTM A632], [seamless] [welded], Grade [TP304] [TP304L] [TP316] [TP316L] [_____]] [ASTM A789/A789M, [seamless] [welded], Grade [S32760] [_____]] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.6.1.3 Stainless Steel Joints

Join stainless steel piping by [threaded couplings] [welded fittings] [flanges] [crimping couplings]. Join tubing using [crimping couplings] [compression] [_____] fittings. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.6.1.4 Stainless Steel Threaded Fittings

Provide threaded fittings consisting of [austenitic stainless steel, [ASTM A182/A182M Grade [TP304] [TP304L] [TP316] [TP316L] [_____], conforming to [ASME B16.11] [_____], and threaded in accordance with ASME B1.20.2M ASME B1.20.1.]] Use [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.6.1.5 Stainless Steel Welding Fittings

Provide [butt-welding] [or] [socket-welding] welding fittings. Provide welding fittings consisting of forged austenitic stainless steel, [ASTM A403/A403M Grade [TP304] [TP304L] [TP316] [TP316L] [_____], [butt-welding fittings, Class [CR], conforming to ASME B16.9] [socket-welding fittings, Class [WP-S] [WP-W] [WP-WX] [WP-WU], conforming to ASME B16.11].] [_____].

2.6.1.6 Stainless Steel Flanged Fittings

Provide internal diameter bores of flanges and flanged fittings that are the same as that of the associated pipe. Ensure flanges are [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Provide flanges and flanged fittings consisting of [forged austenitic stainless steel, ASTM A182/A182M Grade [TP304] [TP304L] [TP316] [TP316L] [_____]] [_____], Class [150] [300] [_____], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. [Drill cast austenitic stainless steel backing flanges, ASTM A351/A351M Grade [_____], Van Stone type, to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must be [alloy-steel ASTM A193/A193M Grade [B8] [B8C] [_____] hex head bolts and ASTM A194/A194M Grade [8] [8C] [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, use [ASTM A193/A193M Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 and that are a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.6.1.7 Stainless Steel Crimping Fittings

Crimping fittings must be cold drawn, [TP304] [TP304L] [TP316] [TP316L] austenitic stainless steel. O-ring seals must be [butadiene acrylonitrile] [ethylene propylene diene monomer (EPDM)] [fluoro-elastomeric] [_____].

2.6.1.8 Compression Fittings for Tubing

Provide compression fittings consisting of [ASTM A479/A479M] [_____] stainless steel, Grade TP316, nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.6.1.9 Stainless Steel Cathodic Protection

Buried ferrous piping must have cathodic protection.

2.6.2 Ferritic and Martensitic Piping

2.6.2.1 Pipe

Provide stainless steel pipe meeting the requirements of [ASTM A268/A268M, [seamless] [welded], Grade [S44627] [S43035TP430] [_____], Schedule [5S] [10S] [40S] [80S] [in accordance with Pipe Schedule]] [_____] with dimensions conforming to ASME B36.19M.

2.6.2.2 Tubing

Provide stainless steel tubing meeting the requirements of [ASTM A268/A268M, [seamless] [welded], Grade [TP410] [_____]] [ASTM A789/A789M, [seamless] [welded], Grade [S31500] [_____]] [ASTM A268/A268M, welded, unannealed Grade [S44627] [_____]] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.6.2.3 Joints

Join stainless steel piping by [threaded couplings] [welding fittings] [flanges]. Join tubing using [compression] [_____] fittings. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.6.2.4 Threaded Fittings

Provide threaded fittings consisting of [stainless steel, ASTM A182/A182M Grade [TP430] [6a Class 1] [_____], conforming to [ASME B16.11] [_____], and threaded in accordance with ASME B1.20.2MASME B1.20.1.] [Use polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.6.2.5 Welding Fittings

Provide [butt-welding] [or] [socket-welding] welding fittings. Provide welding fittings consisting of forged stainless steel, [ASTM A815/A815M Grade [TP430] [TP410] [_____], [butt-welding fittings, Class CR, conforming to ASME B16.9] [socket-welding fittings, Class [WP-S] [WP-W] [WP-WX], conforming to ASME B16.11].] [_____].

2.6.2.6 Flanged Fittings

Provide internal diameter bores of flanges and flanged fittings that are the same as that of the associated pipe. Ensure flanges are [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Provide flanges and flanged fittings consistig of [forged stainless steel, ASTM A182/A182M Grade [TP430] [6a Class 1] [_____]] [_____], Class [150] [300] [_____], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. [Drill cast stainless steel backing flanges, ASTM A352/A352M Grade [_____], Van Stone type, to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must be [alloy-steel ASTM A193/A193M Grade [L7] [L7A] [_____] hex head bolts and ASTM A194/A194M Grade [7] [7A] [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, use [ASTM A193/A193M Grade Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 and a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.6.2.7 Compression Fittings for Tubing

Provide compression fittings consisting of [ASTM A479/A479M] [_____] stainless steel, Grade TP316, nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.6.2.8 Cathodic Protection

Buried ferrous piping must have cathodic protection.

2.7 NICKEL AND NICKEL ALLOYS PIPING SYSTEMS

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NOTE: The preferred method for joining nickel and nickel alloy pipe is welding due to cost of flanges. In all cases, only Schedules 40S and 80S can be threaded due to wall thickness. Flanges should be used when attaching nickel pipe to pumps, process vessels, and other equipment that requires removal periodically. Generally, for temperatures up to 115 degrees C 240 degrees F, and normal pressures encountered, the chloroprene gasket specified is appropriate for most "dilute" process liquids, water and sludge services. However, other liquids may require other, more suitable gasket materials.

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2.7.1 Nickel

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NOTE: Alloy N02200 and alloy N02201 are the 2 basic compositions of nickel pipe. Alloy N02200 is limited to a maximum operating temperature of 315 degrees C 600 degrees F.

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2.7.1.1 Nickel Pipe

[Alloy N02200] [Alloy N02201] nickel pipe must be [seamless conforming to ASTM B161 and ASTM B829] [welded conforming to ASTM B725 and ASTM B775/B775M], and dimensioned Schedule [5S,] [10S,] [40S,] [80S] [in accordance with the Pipe Schedule in the contract drawings].

2.7.1.2 Nickel Joints

Joining must use [welded] [or] [threaded] [_____] methods, except that connections to equipment or spool pieces that may be periodically removed must be [flanged] [_____]. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.7.1.3 Nickel Fittings

Fittings including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43 must be [butt] [or] [socket] welding and meet the requirements of ASTM B366/B366M. Provide fittings for alloy N02200 that are [corrosion resistant, Grade CRN] [Class [150] [_____], Grade WPN] and for alloy N02201, provide fittings that are [corrosion resistant, Grade CRNL] [Class [150] [_____], Grade WPNL].

2.7.1.3.1 Welding Fittings

Conduct welding in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

2.7.1.3.2 Threaded Fittings

Provide threads in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308]

[_____] for lubricant/sealant.

2.7.1.3.3 Flanged Fittings

Provide flanges and flanged fittings consisting of [ASTM B564 forged nickel alloy [N02200] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system] [_____], Class [150] [300] [600], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. Ensure flanges are [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Use cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____]. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [nickel-copper alloy, ASTM B164 alloy [N04400] [_____] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Nonmetallic gaskets must conform to ASME B16.21 and be a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.7.2 Nickel-Molybdenum-Chromium (NMC) Alloy

2.7.2.1 NMC Pipe

[Alloy N06022] [Alloy N06455] [Alloy N10276] [Hastelloy] [_____] NMC alloy pipe must be [seamless conforming to ASTM B622 and ASTM B829] [welded conforming to ASTM B619/B619M and ASTM B775/B775M], and dimensioned Schedule [5S,] [10S,] [40S,] [80S] [in accordance with the Pipe Schedule].

2.7.2.2 NMC Tubing

Provide seamless tubing conforming to ASTM B622 NMC alloy [N06022] [N06455] [Hastelloy] [_____] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.7.2.3 NMC Joints

Use [welded] [or] [threaded] [_____] joining methods, except use [flanged] [_____] connections to equipment or spool pieces that may be periodically removed. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.7.2.4 NMC Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43, must be [butt] [or] [socket] welding and meet the requirements of ASTM B366/B366M. Provide fittings for alloy N06022 that are [corrosion resistant, Grade CRHC22] [Class [150] [_____], Grade

WPHC22]; for alloy N06455, provide fittings that are [corrosion resistant, Grade CRHC4] [Class [150] [_____], Grade WPHC4]; and for alloy N10276, provide fittings that are [corrosion resistant, Grade CRHC276] [Class [150] [_____], Grade WPHC276] [_____].

2.7.2.4.1 Welding Fittings

Conduct welding in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

2.7.2.4.2 Threaded Fittings

Provide threads in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.7.2.4.3 Flanged Fittings

Provide flanges and flanged fittings consisting of [ASTM B564 forged NMC alloy [N06022] [N10276] [Hastelloy] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system, Class [150] [300] [600] and drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face]] [_____]. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Use cast steel backing flanges, [ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1 Class [150]] [_____]]. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [low carbon NMC alloy, ASTM B574 alloy [N06022] [_____] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 and a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.7.2.5 NMC Compression Fittings for Tubing

Compression fittings must be of ASTM B574 [low carbon NMC alloy] [Hastelloy], nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.7.3 Nickel-Copper Alloy

2.7.3.1 Nickel-Copper Pipe

Alloy [N04400] [_____] nickel-copper alloy pipe must be [seamless conforming to ASTM B165, [annealed] [stress-relieved] condition, and ASTM B829] [welded conforming to ASTM B725 and ASTM B775/B775M], and dimensioned Schedule [5S,] [10S,] [40S,] [80S] [in accordance with the Pipe Schedule].

2.7.3.2 Nickel-Copper Tubing

Provide seamless tubing conforming to ASTM B165 nickel-copper alloy N04400, [annealed] [stress-relieved] condition, with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.7.3.3 Nickel-Copper Joints

Use [welded] [or] [threaded] [_____] joining methods, except use [flanged] [_____] connections to equipment or spool pieces that may be periodically removed. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.7.3.4 Nickel-Copper Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43, must be [butt] [or] [socket] welding and meet the requirements of ASTM B366/B366M. Fittings for alloy [N04400] [_____] must be [corrosion resistant, Grade CRNC] [Class [150] [_____], Grade WPNC] [_____].

2.7.3.4.1 Welding Fittings

Conduct welding in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

2.7.3.4.2 Threaded Fittings

Provide threads in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.7.3.4.3 Flanged Fittings

Flanges and flanged fittings must be [ASTM B564 forged nickel-copper alloy [N04400] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system] [_____], Class [150] [300] [600], and drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. [Use cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [nickel-copper alloy, ASTM B164 alloy [N04400] [_____] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 that are a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and constructed of [_____].]

2.7.3.5 Nickel-Copper Compression Fittings for Tubing

Compression fittings must be of ASTM B164 nickel-copper alloy [N04400] [N04405] nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Threads must be straight, conforming to [ISO 228-1] [ASME B1.1].

2.7.4 Nickel-Chromium-Iron (NCI) Alloy

2.7.4.1 NCI Pipe

Alloy [N06600] [N06025] [N06045] [_____] NCI alloy pipe must be [seamless conforming to ASTM B167 and ASTM B829] [welded conforming to ASTM B517 and ASTM B775/B775M] [electric fusion-welded conforming to ASTM B546, and dimensioned Schedule [5S,] [10S,] [40S,] [80S]] [in accordance with the Pipe Schedule in the contract drawings].

2.7.4.2 NCI Joints

Use [welded] [or] [threaded] [_____] joining methods, except use [flanged] [_____] connections to equipment or spool pieces that may be periodically removed. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.7.4.3 NCI Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43, must be [butt] [or] [socket] welding and meet the requirements of ASTM B366/B366M. Fittings for alloy N06600 must be [corrosion resistant, Grade CRNCl] [Class [150] [_____], Grade WPNCl]; for alloy N06025, fittings must be [corrosion resistant, Grade CRV602] [Class [150] [_____], Grade WPV602]; and for alloy N06045, fittings must be [corrosion resistant, Grade CRV45TM] [Class [150] [_____], Grade WPV45TM] [_____].

2.7.4.3.1 Welding Fittings

Conduct welding in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

2.7.4.3.2 Threaded Fittings

Provide threads in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.7.4.3.3 Flanged Fittings

Provide flanges and flanged fittings consisting of [ASTM B564 forged NCI alloy [N06600] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system] [_____], Class [150] [300] [600], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. [Use cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [NCI alloy, ASTM B164 alloy [N06600] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Provide bolts with washers of the same material as the bolts. Provide gaskets meeting the requirements of ASME B16.5. [Provide nonmetallic gaskets conforming to ASME B16.21 that are a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.] [Provide metallic ring joint gaskets conforming to ASME B16.20 and be constructed of [_____].]

2.8 ALUMINUM PIPING SYSTEM

****

NOTE: Alloys 1060, 3003, 5052, 6061 and 6063 are the most common compositions of aluminum pipe. Alloy 6063 is most widely used due to economical cost, good corrosion resistance and mechanical properties.

The preferred method for joining aluminum pipe to handle corrosives is welding. Be aware that welding reduces tensile strength. Threading is not recommended for aluminum piping systems that handle corrosives. Flanges are usually limited to connecting aluminum pipe to pumps, process vessels, etc.

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2.8.1 Aluminum Pipe

Aluminum and aluminum alloy pipe must be seamless alloy [6063] [6061] [5052] [3003] [1060], Temper [TL] [_____], Schedule [5S] [10S] [40S] [80S] [in accordance with the Pipe Schedule], with AA ANSI H35.2M standard dimensions, and conforming to [ASTM B241/B241M with [ASME B1.20.2M ASME B1.20.1 threaded] [standard] ends] [ASTM B345/B345M with [ASME B1.20.2M ASME B1.20.1ASME B1.20.2M threaded] [grooved] [beveled] [standard] [_____] ends].

2.8.2 Aluminum Tubing

Tubing must be drawn seamless and conform to ASTM B210/B210M alloy [6061, temper T6,] [_____] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.8.3 Aluminum Joints

Use [welded] [mechanical coupling] [or] [threaded] [_____] joining methods, except use [flanged] [_____] connections to equipment or spool pieces that may be periodically removed. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.8.4 Aluminum Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, must be [butt][or][socket] welding and meet the requirements of ASTM B361. Provide Grade [WP1060] [WP3003] [WP Alclad 3003] [WP6061] [or] [WP6063] fittings.

2.8.4.1 Aluminum Welding Fittings

Welding fittings must be [butt-welding] [or] [socket-welding] and factory made, wrought alloy [WP6063] [_____] in accordance with ASTM B361. [Provide butt-welding fittings conforming to ASME B16.9.] [Provide socket-welding fittings conforming to ASME B16.11.] Conduct welding in accordance with AWS A5.3/A5.3M and AWS A5.10/A5.10M.

2.8.4.2 Aluminum Threaded Fittings

Provide threaded fittings consisting of forged aluminum alloy [3003] [6061] [_____], Temper [_____], in accordance with ASTM B247M ASTM B247 and conforming to ASME B16.11. Provide threads in accordance with ASME B1.20.2M ASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D3308] [_____] for lubricant/sealant.

2.8.4.3 Aluminum Flanged Fittings

Design flanges and flanged fittings in accordance with ASME B31.3. Flanges must be forged aluminum alloy [3003] [6061] [_____] Temper [_____], conforming to ASTM B247M ASTM B247, Class [150] [300] [600] [_____], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges must be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting must consist of [aluminum bolting material, conforming to ASTM B211/B211M and ASME B16.5, dimensioned to ASME B18.2.1 and ASME B18.2.2 and with ASME B1.1 coarse threads] [_____]. Provide bolts with washers of the same material as the bolts. [Gaskets listed in ASME B16.5, Annex E, Fig. E1, Group 1a may be used with any flange rating class and bolting.] [Use nonmetallic enveloped gaskets for corrosive service conforming to ASTM F336.]

2.8.4.4 Aluminum Compression Fittings for Tubing

Provide compression fittings consisting of ASTM B211/B211M aluminum alloy [2014], temper [T4] [T6], nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Provide straight threads conforming to [ISO 228-1] [ASME B1.1].

2.8.5 Aluminum Piping Supports

****

NOTE: Galvanic corrosion must be prevented from occurring on piping support systems. Conventional steel hangers should not be used. Galvanized steel is acceptable only as long as the galvanizing is intact; therefore, a galvanized system should not be used where expansion/contraction or other piping movement is likely.

****

Support piping system using [aluminum] [[galvanized] [alloy] [_____] steel units, integrally padded with [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____],] [_____] piping supports conforming to MSS SP-58. Do not use conventional steel and galvanized pipe hangers for aluminum piping systems.

2.9 COPPER PIPING SYSTEM

****

NOTE: This paragraph covers copper pipe that may be used for corrosive services, and tubing used for noncorrosive water; refrigerant, and sample lines, etc. Copper is rapidly corroded by oxidizing acids such as chromic and nitric acids. The most common copper alloy is alloy 122 (C12200); however, other alloys may also be suitable for use. These include C10200, C10300, C10800 and C12000.

Thin walled piping systems (ASTM B302) can only be assembled using brazed joint pipe fittings. However, for high pressure and Class 'M' fluid services soldered or brazed joints and fittings are not permitted pursuant to ASME B31.3.

****

2.9.1 Copper Pipe

Seamless [C12200] [_____] copper alloy pipe, must be a [[O61 (annealed] [H55 (light-drawn)] [or] [H80 (hard-drawn)] Temper with [regular] [extra strong] standard dimensions conforming to ASTM B42] [H (drawn) Temper with standard dimensions conforming to ASTM B302].

2.9.2 Copper Tubing

Provide seamless copper alloy tubing conforming to [ASTM B88M ASTM B88 alloy C12200, Type [K] [L] [or] [M], with a [O60 (annealed)] [H (drawn)] temper] [ASTM B75/B75M alloy [C12200] [_____] with a [O60 (soft-annealed)] [_____] temper]. Specifications for applications include: [refrigerant tubing - Type L, hard drawn] [P-trap priming connection - Type L, soft Temper] [sample lines - Type L, hard drawn] [_____].

2.9.3 Copper Joints

Join pipe using [threaded] [soldered] [or] [brazed] fittings and [flanged] [_____] connections to equipment. Join tubing using [solder] [flared] [or] [press] [compression] fittings. Provide dielectric fittings or isolation joints between all dissimilar metals.

2.9.4 Copper Fittings

Provide component castings of flanges and fittings consisting of copper alloy [C92200, Temper [_____] conforming to ASTM B61] [C83600 (also known as alloy 85-5-5-5), Temper [_____] in accordance with ASTM B62]. Provide solder joint fittings conforming to ASME B16.22 and ASME B16.18. Provide fittings for flared copper tube conforming to ASME B16.26. Provide cast bronze threaded fittings conforming to ASME B16.15 and are threaded in accordance with ASME B1.20.2MASME B1.20.1. Ensure flanges and flanged fittings are faced and drilled Class [150] [300] [_____] in accordance with ASME B16.26. Provide copper and bronze press fittings conforming to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements must be of EPDM and factory installed or an alternative supplied by fitting manufacturer. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Tubing compression fittings must be [forged brass alloy C37700, conforming to ASTM B124/B124M] [_____], nuts, ferrules and bodies rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.9.4.1 Bolting For Copper Piping

Provide bolting materials that meet the requirements of ASME B31.1 and consist of [ASTM B98/B98M alloy [C65100] [C66100]] [ASTM B150/B150M alloy [C63000] [C64200]] [ASTM B164 alloy [N04400] [N04405]] [_____] materials. Provide bolts with washers of the same material as the bolts.

2.9.4.2 Gaskets For Copper Piping

[Gaskets listed in ASME B16.5, Annex E, Group [1a] [1b] may be used with any flange rating class and bolting.] [Provide nonmetallic, full faced gaskets used with low strength or non-ferrous bolting with a seating pressure less than 11.0 MPa 1,600 psi.] Ensure gasket dimensions conform to [ASME B16.21] [ASME B16.20].

2.9.5 Solder For Copper Piping

****

NOTE: Solder compositions can be selected from Table 5 contained in ASTM B32. Common solder types are Sb5 and SN95. Selection should be made based on suitability to the application considering temperature and corrosivity.

****

Use solder [and flux] conforming to ASTM B32 [and AWS A5.8/A5.8M]. The solder alloy must [be [_____]] [contain less than 0.2 percent lead]. [Ensure the flux type is [R] [RMA] [RA] [OA] [OS] [IS] and conforms to ASTM B813.]

2.9.6 Copper Piping Supports

****

NOTE: Galvanic corrosion must be prevented from occurring to piping support systems; conventional and galvanized steel hangers should not be used.

****

Support piping system using [copper] [brass] [padded steel] [_____] piping supports that conform to MSS SP-58. Do not use conventional steel and galvanized pipe hangers for copper piping systems. Ensure all valves, instruments and other equipment attached to the piping system are individually supported.

2.10 PLASTIC PIPING SYSTEM

****

NOTE: Plastic Piping Systems - Many of the thermoplastic piping systems are available in both a nominal pipe schedule dimension or in a standard dimension rating (SDR). Schedule based piping has the same dimensions, outer diameter and wall

thickness, as steel pipe but the pressure rating decreases with increasing pipe diameter. For SDR pipe, the pressure rating is kept uniform for all nominal pipe sizes of a given material and SDR value by increasing wall thickness. Refer to ASTM D2241 and ASTM D1785 for PVC SDR piping.

Backing flanges for plastic piping systems can be stainless steel, ductile iron, steel (galvanized and plain), or aluminum, depending on the application. Change the flange subparagraphs accordingly. Similarly, change the gasket material selections as required by the liquid application.

Use PVC for selected chemical services, where pipelines may be subjected to exterior corrosion, and liquid processes of 60 degrees C 140 degrees F or below.

Schedule 40 pipe should not be threaded at all. Schedule 80 pipe should not be threaded in sizes larger than 100 mm 4 inch. Schedule 80 threaded joints larger than 50 mm 2 inch must be back-welded to achieve fully rated maximum operating pressures.

****

Submit documentation certifying that the manufacturer of each thermoplastic piping system is listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.

2.10.1 PVC Pipe

PVC, ASTM D1784, minimum cell classification [12545-C] [_____], pipe must be [Schedule [40] [80] [_____] conforming to ASTM D1785] [manufactured to an SDR rating in accordance with ASTM D2241, so that the pressure rating of the pipe is consistent for all pipe sizes. Provide SDR [_____] pipe with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F] [_____].

2.10.2 PVC Tubing

Provide flexible and clear tubing with nominal size and wall thickness [in accordance with Pipe Schedule] [_____] [and reinforcement].

2.10.3 PVC Joints

Join piping system by [socket-weld] [flanged] [or] [mechanical] connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Ensure connections at those points are threaded and back-welded. Tubing connections must use compression fittings.

2.10.4 PVC Fittings

****

NOTE: Specify ASTM D2464 for Schedule 80 threaded type; ASTM D2466 for Schedule 40 socket type; ASTM D2467 for Schedule 80 socket type.

****

Ensure the schedule rating for the fittings is not less than that for the associated pipe. Fittings must be ASTM D1784, minimum cell classification [_____], PVC conforming to the requirements of [ASTM D2464, threaded in accordance with ASME B1.20.2MASME B1.20.1] [ASTM D2466, socket type] [ASTM D2467, socket type]. [[No] [_____] thread lubricant is required.]

2.10.4.1 Push-on Joints

Seal push-on type joints with [ethylene propylene rubber (EPR)] [_____] gaskets in accordance with ASTM F477.

2.10.4.2 Flanged Fittings

Provide flanges and flanged fittings that are Class [125] [_____], [one piece, molded hub type, flat faced, and conform to [ASME B16.1] [ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Provide flanges complete with one-piece, molded PVC stub ends]. Ensure flanged connections have the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3] [_____] mm [1/8] [_____] inch thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, use a flat ring gasket and provide a filler gasket between outer diameter of the raised face and the flange outer diameter to protect the PVC flange from bolting moment.

2.10.4.3 Tubing Fittings

Provide compression type fittings comprised of [forged brass alloy C37700, conforming to [ASTM B124/B124M] [_____], nuts, ferrules and bodies] [[acetal] [polypropylene] [polyvinylidene fluoride (PVDF)] [_____] nuts and bodies, with elastomeric O-ring seals] [[polypropylene] [_____] bodies, barb and holding nut] [_____], rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.10.5 PVC Solvent Cement

Join socket connections with PVC solvent cement conforming to ASTM D2564. Ensure manufacture and viscosity is as recommended by the pipe and fitting manufacturer to assure compatibility. [Prepare joints with primers conforming to ASTM F656 prior to cementing and assembly.]

2.11 CHLORINATED POLYVINYL CHLORIDE (CPVC)

****

NOTE: Use CPVC for chemical or corrosive services that are between 60 degrees C 140 degrees F and 99 degrees C 210 degrees F.

Like PVC, CPVC Schedule 40 pipe should not be threaded at all. Schedule 80 pipe should not be threaded in sizes larger than 100 mm 4 inch. Schedule 80 threaded joints larger than 50 mm 2 inch must be back-welded to achieve fully rated maximum operating pressures.

****

2.11.1 CPVC Pipe

CPVC, ASTM D1784, minimum cell classification [23447] [_____], pipe must be [Schedule [40] [80] conforming to ASTM F441/F441M] [manufactured to an SDR rating in accordance with ASTM F442/F442M, so that the pressure rating of the pipe is consistent for all pipe sizes. Provide SDR [_____] pipe with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F] [_____].

2.11.2 CPVC Joints

Join piping system by [socket-weld] [flanged] [or] [mechanical] connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Ensure connections at those points are threaded and back-welded.

2.11.3 CPVC Fittings

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NOTE: Specify ASTM F437 for Schedule 80 threaded type; ASTM F438 for Schedule 40 socket type; ASTM F439 for Schedule 80 socket type.

****

Ensure the schedule rating for the fittings is not less than that for the associated pipe. Fittings must be ASTM D1784, cell classification [23447] [_____], CPVC conforming to the requirements of [ASTM F437, threaded in accordance with ASME B1.20.2MASME B1.20.1] [ASTM F438, socket type] [ASTM F439, socket type]. [[No] [_____] thread lubricant is required.]

2.11.3.1 Push-on Joints

Seal push-on type joints with [ethylene propylene rubber (EPR)] [_____] gaskets in accordance with ASTM F477.

2.11.3.2 Flanged Fittings

Provide flanges and flanged fittings that are Class [125] [_____], [one piece, molded hub type, flat faced, and conforming to [ASME B16.1] [ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Provide flanges complete with one-piece, molded CPVC stub ends]. Ensure flanged connections have the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3.2 mm 0.125 inch] [[_____] mm inch] thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, use a flat ring gasket and provide a filler gasket between outer diameter of the raised face and the flange outer diameter to protect the CPVC flange from the bolting moment.

2.11.4 Solvent Cement

Join socket connections with PVC solvent cement conforming to ASTM F493. Ensure manufacture and viscosity is as recommended by the pipe and fitting manufacturer to assure compatibility.

2.12 POLYVINYLIDENE FLUORIDE (PVDF)

****

NOTE: PVDF pipe is chemically resistant to most acids, bases and organics, and can transport liquid halogen solutions of chlorine or bromine. PVDF should not be used with strong alkalis, fuming acids, polar solvents, amines, ketones or esters. PVDF does not degrade in sunlight; therefore, PVDF does not require UV stabilizers or antioxidants. Use on liquids above 49 degrees C 120 degrees F require continuous support. Care must be used in using PVDF piping under suction.

****

2.12.1 PVDF Pipe

[High Purity] PVDF, conforming to ASTM D3222, pipe must be [Schedule [40] [80]] [manufactured to a SDR rating so that the pressure rating of the pipe is consistent for all pipe sizes. The pipe must be SDR with a pressure rating of [1.03 MPa 150 psig at 23 degrees C 73.4 degrees F] [1.6 MPa 232 psig at 23 degrees C 73.4 degrees F]] [_____].

2.12.2 PVDF Tubing

Provide flexible tubing with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.12.3 PVDF Joints

****

NOTE: Fusion welding is the preferred method for joining PVDF pipe. Threading can only be accomplished on Schedule 80 pipe.

****

Join PVDF pipe by [thermal butt-fusion] [socket heat fusion] [or] [socket electric-resistance fusion], except where connecting to valves and equipment that may require future disassembly, provide [threaded] [or] [flanged] joints. Tubing connections must use compression fittings.

2.12.4 PVDF Fittings

Provide molded PVDF fittings. Provide fittings with the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. Provide flanges and flanged fittings that are Class [125] [_____], [one piece, molded hub type, flat faced, and conforming to [ASME B16.1] [ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Provide flanges complete with one-piece, molded PVDF stub ends]. Ensure flanged connections have the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3] [_____] mm [1/8] [_____] inch thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, use a flat ring gasket and provide a filler gasket between outer diameter of the raised face and the flange outer diameter to protect the PVDF flange from bolting moment. Provide compression type tubing fittings comprised of [forged brass alloy C37700, conforming to ASTM B124/B124M [_____], nuts, ferrules and bodies] [[acetal] [polypropylene] [polyvinylidene fluoride (PVDF)] [_____] nuts and bodies, with elastomeric O-ring seals] [[polypropylene] [_____] bodies, barb and holding nut] [_____], rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.13 ACRYLONITRILE-BUTADIENE-STYRENE (ABS) Piping

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NOTE: ABS piping is resistant to many chemicals, however, for mixed waste systems chemical analyses and corrosion testing may be necessary to properly select the piping system. The recommended maximum temperature for continuous liquid applications is 82 degrees C 180 degrees F.

Verify acceptance and installation of ABS piping systems with local code enforcement authorities having jurisdiction.

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2.13.1 ABS Pipe

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NOTE: While ASTM D1527 has been withdrawn by ASTM without replacement, the standard remains a valid reference.

****

ABS, ASTM D3965, minimum cell classification [42222][_____], pipe must be Schedule [40][80] conforming to ASTM D1527, so that the pressure rating of the pipe is consistent for all pipe sizes. Provide SDR [_____] pipe with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F. Where ABS pipe is subjected to severe temperature fluctuations, provisions for expansion and contraction must be provided. Accomplish this with the use of expansion joints and offset piping arrangements.

2.13.2 ABS Joints

Join pipe by solvent cementing, except where connecting to valves and equipment that may require future disassembly, then provide [flanged] [_____] joints.

2.13.3 ABS Fittings

Provide molded ABS fittings. Ensure fittings have the same or higher pressure rating as the pipe when installed in accordance with the specifications. Provide flanges and flanged fittings that are Class [125][_____], [one piece, molded hub type, flat faced, and conform to [ASME B16.1][ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1][ASME B16.5] drilling. Provide flanges complete with one-piece, molded ABS stub ends]. Ensure flanged connections have the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8][B8M][_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Bolts Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3.2 mm 0.125 inch] [[_____] mm inch] thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, aupplya flat ring gasket and provide a filler gasket between outer diameter of the raised face and the flange outer diameter to protect the ABS flange from bolting moment.

2.13.4 ABS Solvent Cement

Join socket connections with ABS solvent cement conforming to ASTM D2235. Use viscosity as recommended by the pipe and fitting manufacturer to assure compatibility.

2.14 POLYETHYLENE (PE)

****

NOTE: The requirements listed below are for normal pressure applications, and where operating temperatures will not exceed 38 degrees C 100 degrees F. For more difficult installations and/or higher temperatures, the ASTM D3350 cell classification should be carefully chosen. In addition, use the cell classification to specify UV stabilizers and color additives.

****

2.14.1 PE Pipe

Ensure pipe is extruded from PE, ASTM D3350 with a minimum cell classification of [324433-C] [_____]. The PE pipe must be [Schedule [40] [80]] [[manufactured to an SDR rating in accordance with ASTM D3035 for piping systems less than 100 mm 4 inch in diameter, or in accordance with ASTM F714 for piping systems with a diameter equal to or greater than 100 mm 4 inch] [manufactured to an SDR rating in accordance with ASTM D2239 for use with insert fittings], so that the pressure rating of the pipe is consistent for all pipe sizes. Provide SDR [_____] pipe with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F] [Schedule 40 conforming to ASTM D2239 for use with insert fittings] [_____].

2.14.2 PE Tubing

Tubing must be flexible [low-density PE conforming to ASTM D3350, minimum cell classification [_____], and dimensioned in accordance with ASTM D2737] [crosslinked PE conforming to ASTM D3350, minimum cell classification [35400] [_____], and dimensioned in accordance with ASTM F876] with nominal size [in accordance with Pipe Schedule] [_____].

2.14.3 PE Joints

Join PE pipe by [thermal butt-fusion] [socket heat fusion] [and/or] [socket electrofusion], except where connecting to valves and equipment that may require future disassembly, use [threaded [polystyrene] [_____] fittings] [or] [flanged] joints.

2.14.4 PE Fittings

Provide PE fittings with the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. Provide molded PE fittings. Provide butt-fusion fittings conforming to

ASTM D3261. Provide socket-fusion fittings conforming to ASTM D2683 with tools meeting the requirements of ASTM F1056. Provide insert fittings conforming to ASTM D2609.

2.14.4.1 Couplings

Join couplings and saddle joints by electrofusion in accordance with ASTM F1055.

2.14.4.2 Flanged Fittings

Provide flanges and flanged fittings that are [Class [125] [_____]], [ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Provide flanges complete with one-piece, molded PE stub ends. Ensure flanged connections have the same pressure rating as the pipe or greater. Bolting must be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Provide bolts with washers of the same material as the bolts. Gaskets must be full-faced, maximum [3] [_____] mm [1/8] [_____] inch thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21.

2.14.4.3 Tubing Fittings

Provide compression type fittings comprised of [forged brass alloy C37700, conforming to ASTM B124/B124M [_____], nuts, ferrules and bodies] [[acetal] [polypropylene] [polyvinylidene fluoride (PVDF)] [_____] nuts and bodies, with elastomeric O-ring seals] [[polypropylene] [_____] bodies, barb and holding nut] [_____], rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.15 RUBBER/ELASTOMER PIPING SYSTEM

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NOTE: Rubber/elastomer piping systems are generally useful in applications requiring unusual flexing, resilience and abrasion service.

****

2.15.1 Elastomeric Hose

Provide elastomeric hose consisting of an elastomeric tube, [reinforced] [not reinforced], and [with] [without] an external cover. Provide hose conforming to RMA IP-2 Class [212-A] [_____], rated for [1.03 MPa 150 psig] [[_____] MPa psig] with a minimum burst pressure of [4] [_____] times the rated working pressure. Provide hose with a nominal diameter [of [_____] mm inch] [as indicated in the Pipe Schedule in the contract drawings] with tolerances conforming to RMA IP-2. Use a minimum bend radius of [6] [_____] times the hose internal diameter.

2.15.1.1 Elastomeric Tube

Provide hose tube composed of [fluoro-elastomer] [isobutylene isoprene] [butadiene acrylonitrile] [chloroprene] [natural polyisoprene] [_____], [ASTM D2000 Grade [_____], Type [_____], Class [_____] base requirements] [_____] materials.

2.15.1.2 Tube Reinforcement

[Strengthen the tube with [[one] [_____] wire-braid] [two spiral wire and one wire-braid] [two rayon-braid] [one textile-braid and one wire-braid] [synthetic-fiber] [[four] [six] -ply, [light] [heavy] spiral-wire] [_____] reinforcement.] [Do not reinforce the tube.]

2.15.1.3 Hose Cover

[Protect the hose with a [synthetic rubber] [thin, nonskive] [textile-braid] [thermoplastic] [_____] cover.] [The hose must not have a cover.]

2.15.2 Hose Joints

[Hose must be continuous, without joints] [Hose must be supplied cut to length with integral end connections] [Join hose using [swaged] [crimped] [insert] [internally expanded - full flow] [_____] fittings]. [_____].

2.15.3 Fittings For Elastomeric System

Ensure all fittings are supplied by the same manufacturer. Join fittings to the hose assembly as specified. Ensure fittings are [supplied in accordance with the Pipe Schedule in the contract drawings and] constructed of [aluminum] [TP304 stainless steel] [TP316 stainless steel] [_____]. Accomplish interconnections through integral couplers configured as [ASME B1.20.7 threaded] [quick connect interlocking] [compression ring] [_____] couplings.

2.16 FIBERGLASS REINFORCED PLASTIC (FRP) PIPING SYSTEM

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NOTE: Consult a reputable manufacturer to determine the FRP type for given application and temperature. Temperature is ambient if unlisted.

****

Submit the name and qualifications of the manufacturer's representative and written certification from the manufacturer stating that the representative is technically qualified to supply and install FRP piping systems. Provide all FRP pipe, fittings, and flanges for each system complete by one manufacturer and with a design internal pressure rating [in accordance with the Pipe Schedule in the contract drawings] [of 0.69 MPa 100 psig] [of [_____] MPa psig], as specified in ASTM D2310 and ASTM D2992.

2.16.1 FRP Pipe

Provide FRP pressure pipe conforming to ASTM D3754 Type [1] [2] [3] [4], liner designation [_____], surface layer grade [_____], pressure Class [_____], pipe stiffness [_____]. Provide size [in accordance with the Pipe Schedule in the contract drawings] [[_____] mm inches] [_____]. Ensure the inside diameter of the pipe is consistent with the inside diameter of the fittings.

2.16.2 FRP Joints

Join the pipe using [axially unrestrained bell and spigot gasket joints, conforming to ASTM D4161, with elastomeric gaskets meeting the requirements of ASTM F477] [butt-joints with laminated overlays in accordance with

ASTM D3754] [bell and spigot joints with laminated overlays in accordance with ASTM D3754] [adhesive bonded bell and spigot joints in accordance with ASTM D3754] [flanged] [_____].

2.16.3 FRP Fittings

Provide fittings, other than flanges, conforming to [ASTM D5685] [_____]. Provide filament wound fittings of the same thickness specified for adjoining pipe or duct. Provide other fitting types of the minimum pipe wall thickness required for the specified pressure class. Provide contact molded flanges and flanged fittings conforming to ASTM D5421 Type [A] [B], Grade [_____], Class [I] [II], pressure rating [_____]. All other flange types must conform to ASTM D4024 Type [_____], Grade [_____], Class [_____], pressure rating [_____]. Flanges mating with flanges on thermoplastic-lined steel pipe must be ductile iron castings, ASTM A395/A395M or cast steel, ASTM A216/A216M Grade WCB, Van Stone type, conforming to [ASME B16.1] [ASME B16.5] Class [150] [_____].

2.16.3.1 FRP Bolting

With flat ring gaskets, the bolting must be stainless steel, ASTM A193/A193M Grade [B8] [B8M] [_____], hex head bolts and, ASTM A194/A194M Grade [8] [8M] [_____], hex head nuts. Provide bolts with washers of the same material as the bolts.

2.16.3.2 FRP Gaskets

Gaskets must be full-faced, maximum [3.2 mm 0.125 inch] [[_____] mm inch] thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____]. When the mating flange has a raised face, use a flat ring gasket and provide a filler gasket between the outer diameter of the raised face and the flange outer diameter in order to protect the FRP flange from the bolting moment. When mating a FRP flange, Van Stone type, to a thermoplastic-lined steel pipe, use a [polytetrafluoroethylene (PTFE)] [_____] enveloped, flat ring type gasket in accordance with ASTM F336.

2.17 DOUBLE CONTAINMENT PIPING SYSTEM

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NOTE: Due to the difficulty of proper installation of double containment pipe, double containment piping should only be specified when it is absolutely required. Refer to the Handbook of Double Containment Piping Systems, Christopher G. Ziu, McGraw-Hill, NY, 1995, for the design and selection of a double containment piping system. According to Ziu, page 71, many pre-engineered double containment piping systems have only been conceptualized and not engineered.

****

Submit manufacturer's engineering end load calculations for anchors in double containment piping systems. Provide double containment piping systems conforming to the requirements of ASME B31.3.

2.17.1 Primary (Carrier) Pipe

The primary, or carrier, pipe of the double containment piping system must be [[PVC][CPVC][PVDF][PE][_____], [Schedule [40] [80] [_____]] [SDR [_____]]][TP304 stainless steel, Schedule [10] [40] [_____]][[FRP], pressure class [_____]] [_____], as specified elsewhere in this Section. Ensure the primary piping is rated at a working pressure of at least [_____] MPa psig at a maximum operating temperature of [_____] degrees C degrees F. Provide piping that is free of flanges and other joints that are not compatible with the secondary piping installation. Equip piping with expansion loops, offsets, or direction changes as necessary to counter thermal expansion and contraction, which must be coordinated with the secondary piping.

2.17.2 Secondary (Containment) Pipe

The secondary, or containment, pipe of the double containment piping system must be [[PVC][CPVC][PVDF][PE][_____], [Schedule [40] [80] [_____]] [SDR [_____]]][carbon steel, Schedule [40] [80] [_____]] [TP304 stainless steel, Schedule [10] [40] [_____]] [_____], as specified elsewhere in this Section. Provide secondary piping that is resistant to weathering, impacts, and ambient temperature variations, and rated at a working pressure of at least [_____] MPa psig at a maximum operating temperature of [_____] degrees C degrees F. Equip piping with expansion joints, expansion loops, offsets, or direction changes as necessary to counter thermal expansion and contraction. Coordinate equipment for addressing thermal movement with the primary piping. Ensure secondary piping is drainable and dryable [, and capable of being tested using air pressure]. The secondary piping system must be [compartmentalized] [continuous] and equipped with drains at all low points and vents at all high points. Equip pressurized secondary piping systems with pressure relief devices. Provide drains, vents and pressure relief devices as specified elsewhere in this Section. Design piping to allow pulling of the leak detection cable into the containment pipe both during and after piping installation. Minimum annular clearance must be [19] [_____] mm [0.75] [_____] inch. Locate containment pull ports a maximum of [150] [_____] m [492] [_____] feet apart for straight runs and reduced by [45] [_____] m [148] [_____] feet for every 90 degree change in direction.

2.17.3 Cathodic Protection For Double Containment System

Buried ferrous piping must have cathodic protection.

2.17.4 Connections and Fittings For Double Containment System

All fittings must be factory manufactured of material compatible with the process fluids and associated piping. [All secondary contained fittings must be of unitized construction with the carrier and containment integrally anchored together to prevent the movement of the carrier relative to the containment within the fitting.] Provide anchors of sufficient thickness to withstand the maximum possible end loads that will be generated by the carrier pipe during the life of the system. [Elbows must be anchored on both ends.] [Tees must be anchored on both the run and the branch.]

2.17.4.1 Fitting Pressure Rating

Ensure pressure rating of connections and fittings is greater than or equal to the design pressure of the system with a minimum safety factor of [five] [_____].

2.17.4.2 End Seals

Provide dnd seals and other subassemblies which are designed and factory prefabricated to prevent the ingress of moisture into the system. Design subassemblies to allow for complete draining of the secondary containment.

2.17.5 Leak Detection

Provide a [cable detection] [sensing probe] [visual detection] leak detection system. [Equip the leak detection system with an electronic monitoring and control unit.]

2.17.5.1 Leak Detection Monitoring Unit

Provide a microprocessor based monitoring unit. The monitoring unit must indicate when any liquid leaks into the secondary containment piping by sounding an alarm, actuating output relays, displaying a message that a leak has been detected and the location of that leak. Ensure the unit is capable of monitoring [sensor cables] [probe sensors] [and] [switch sensors]. The monitoring unit power requirements must be [120] [240] [_____] VAC, [60] [_____] Hz, [single] [_____] phase. Equip monitoring units with [an RS-232 communication port] [and] [one common and one SPDT output relay per cable, rated for 250 VAC, 10 amp]. [Furnish a complete cable-type leak detection and location system consisting of a microprocessor based monitoring unit, sensor cable, probes, system layout map and auxiliary equipment required to provide continuous monitoring of the sensing strings for leaks, shorts, breaks and probe activation. If any of these conditions should occur at any point along the cable, sound an alarm, clearly identify type of condition and clearly display the location. Monitor the interstitial space of double contained piping.]

2.17.5.1.1 Enclosure

Enclose monitoring unit in a NEMA 250 Type [12] [_____] enclosure. [The unit must be Underwriters Laboratory (UL) listed and Factory Mutual approved to provide connections for intrinsically safe sensor circuits for use in Class [1] [_____], Division [I] [_____], Groups [C and D] [_____] hazardous locations.] Ability to locate a leak must not depend on battery backed up functions. In the event of power failure, ensure system conditions and parameters are stored in nonvolatile memory allowing the unit to automatically resume monitoring, without resetting, upon restoration of power. Provide an on-off switch in the panel for servicing. [Furnish a NEMA 250 Type 4X outer enclosure with a viewing window for mounting outdoors] [Furnish a NEMA 250 Type 7 explosion proof outer enclosure] [_____].

2.17.5.1.2 Relay Outputs

Provide relays for remote indication of an alarm condition. The relays must provide indication that no alarm conditions exist, an alarm condition exists but has not yet been acknowledged, and an alarm condition exists and has been acknowledged. [Ensure communications are available via RS-232 and ASCII communication protocols to allow central point monitoring and control via a remote computer.]

2.17.5.1.3 Storage Memory

Record significant events in permanent memory. Store a minimum of [_____] events. When the memory becomes full, delete the recorded events from memory in sequential order beginning with the oldest event. Include the time and date that the event occurred for each recorded event. [Ensure archives are retrievable through RS-232 and ASCII communication protocols.]

2.17.5.1.4 Status Indication

The system must continuously provide positive indication that it is monitoring the sensing string and the status of the sensing string.

2.17.5.1.5 Security

The system must have assignable password security.[Ensure the system has multilevel security passwords for access to operating functions with recording of all password entries to nonvolatile memory.] Do not allow the system to permit unauthorized modifications to the sensing string without causing an alarm condition.

2.17.5.2 Cable System

Submit an as-built location map for the cable leak detection system in double containment piping systems indicating the as installed system configuration and sensing string layout. Provide marks in meters feet along the length of the cable as references to locate leaks. [Ensure sensor cable, connectors, [probes] and jumpers are supplied by the manufacturer of the monitoring unit.]The cable sensing principle must provide for continuous monitoring while short lengths of the cable are in contact with liquids, without altering the system's sensitivity and/or accuracy. The cable system must be a [conductance][or][impedance] type system.

2.17.5.2.1 Requirements

Locate the point of origin of the first liquid leak within [0.1] [_____] percent of the sensor string length. Identify the type of alarm as well as the location. Ensure system is able to monitor (detect and locate) with up to [30 m 98.4 feet] [[_____] m feet] of wetted cable without significant inaccuracy in location. Ensure system is capable of monitoring up to [600 m 1,970 feet] [[_____] m feet] of cable per sensor string from a single monitoring unit. [The system must be capable of monitoring (detecting and locating) for multiple leaks or additional liquid on the sensor cable.]

2.17.5.2.2 Detection Capabilities

[The system must be capable of detecting all liquids, including, but not limited to aqueous, hydrocarbon, and conductive and nonconductive liquids.] [Furnish two cables to detect and differentiate between hydrocarbons/solvents and aqueous liquids.] [Only hydrocarbons are to be detected.] [Only acids are to be detected.] Provide system with field adjustable sensitivity to increase or decrease the amount of wetted cable needed to cause an alarm from several mm to m inches to feet. Ensure system is capable of identifying the location of breaks and shorts on the cable. When either of these faults occur, an alarm must sound and a display visible on the front of the monitoring unit must clearly indicate the type of fault and display the location of the fault.

2.17.5.2.3 Materials

Provide sensor cables suitable for use with the monitoring unit. Provide sensor cables of coaxial construction consisting of an insulated [copper]

[_____] center conductor, a suitable spacer material, and an outer braid. Provide center conductors that are no less than [twenty AWG] [_____] for mechanical strength. Cables must be capable of field installation of connectors by trained technicians. Ensure cable is available in bulk spools. All cables must be field repairable by trained technicians.

2.17.5.3 Sensing Probes

Sensing probes for the leak detection system must be [pH probes] [conductivity probes] [liquid level switches] [specific ion probes] [or] [pressure transducers].

2.17.5.4 Visual Leak Detection System

Equip all low points of the secondary piping system with sample valves meeting the requirements specified in paragraph [SAMPLE PORTS] [_____] of this Section.

2.17.6 Supports

Design and supply supports for the conveyance and containment piping to prevent distortion of the pipes and strain on joints and fittings. Design supports by the double containment piping system manufacturer. No field fabricated supports will be allowed. Design and fabricate the system taking into account pressure and temperature requirements when placing the pipe supports. [Double supports are required throughout the system to minimize stresses due to point loading.] [Support clips are not allowed.]

2.18 ISOLATION JOINTS AND COUPLINGS

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NOTE: Isolation joints and couplings require gaskets for isolating and/or sealing. The gaskets are typically shaped to meet each particular manufacturer's coupling requirements and may not be interchangeable. Refer to manufacturers' catalogs for material compatibility and selection.

****

2.18.1 Dielectric Fittings

Provide dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves. Provide dielectric fittings, suitable for the required working pressure, temperature and corrosive application, to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.18.2 Isolation Joints

Provide isolation joints between nonthreaded ferrous and nonferrous metallic pipe fittings and valves. Provide isolation joints consisting of an isolation gasket of the dielectric type, isolation washers and isolation sleeves for flange bolts. Provide full faced isolation gaskets with an outside diameter equal to the flange outside diameter. Bolt isolation sleeves must be full length. Units must be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.18.3 Metallic Piping Couplings

Provide thrust ties where shown on the contract drawings and where required to restrain the force developed by [1.5] [_____] times the maximum allowable operating pressures specified. For metallic pipe other than ductile iron, attach thrust ties with fabricated lugs. For ductile iron pipe, attach thrust ties with socket clamps against a grooved joint coupling or flange. For exposed installations, use zinc-plated nuts and bolts. However, high-strength, low-alloy steel, in accordance with AWWA C111/A21.11, may be substituted for use on cast iron and ductile iron couplings. For buried and submerged installations, provide [TP304] [_____] stainless steel bolts and nuts. Use steel middle rings and followers that are [fusion bonded epoxy-lined and coated in accordance with Section 09 90 00 PAINTS AND COATINGS and] pressure tested beyond yield point.

2.18.3.1 Sleeve-Type Couplings

Use sleeve-type couplings for joining plain end pipe sections in a flexible manner with a diameter to properly fit the pipe. A coupling consists of one [steel] [ductile iron] middle ring, two [steel] [ductile iron] followers, two elastomeric [wedge] [_____] section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. For pipe sizes between 13 through 40 mm 0.5 through 1.5 inch, ensure the followers are [ductile iron] [malleable iron], and the middle ring is in accordance with [ASTM A513/A513M] [ASTM A395/A395M] with AWWA C111/A21.11 bolting, [light pattern coupling]. For pipe sizes 50 mm 2 inch and larger, ensure the followers are [ASTM A395/A395M] [_____], and the middle ring is [ASTM A513/A513M] [ASTM A395/A395M] [_____] with AWWA C111/A21.11 bolting, [light pattern coupling]. Gaskets must be [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____]. [Split sleeve-type couplings may be used in aboveground installations under special situations and when approved in advance by the Contracting Officer.]

2.18.3.2 Transition Couplings

Transitional couplings may be used to connect two pipes of the same material that have small differences in outside diameter. Size a fully assembled transitional coupling to properly fit pipe diameters. The coupling must consist of one [steel] [ductile iron] [_____] middle ring, two [steel] [ductile iron] [malleable iron] [_____] followers, two elastomeric [wedge] [_____] section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. The coupling must use [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____], [wedge] [insulated] gaskets. Size the coupling to match the associated piping.

2.18.3.3 Flanged Coupling Adapters

Provide flanged coupling adapters consisting of fully assembled units manufactured to meet [ASTM A126 Class [B] [_____], cast iron]. The flanges must mate with [ASME B16.1] [ASME B16.5] [AWWA C207] Class [_____] flanges of the same nominal size. [Apply a factory applied corrosion resistant coating.] The coupling must use [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____], [wedge] [insulated] gaskets. Where pipe movement out of the adaptor may occur, provide proper anchorage of the pipe [and furnish couplings with lock pins]. Size the coupling to match the associated piping.

2.18.4 Couplings for Nonmetallic Piping

2.18.4.1 Bellows Coupling

Provide a bellows coupling with a minimum of two [polytetrafluoroethylene (PTFE)] [_____] convolutions unless otherwise shown, with [[ductile iron] [_____] flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [125] [150] [300] [_____]], [_____] end connections, and metal reinforcing bands. The maximum allowable working pressure is [960 kPa 140 psig] [_____] at [49] [_____] degrees C [120] [_____] degrees F. Limit bolting to restrain the force developed by [1.5] [_____] times the specified maximum allowable operating pressure. Size the coupling to match the associated piping.

2.18.4.2 Compression Coupling

A compression coupling consists of one [steel] [_____] middle section, two [steel] [_____] mechanical nuts, two elastomeric gaskets and two machined steel lock rings. The coupling must use [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____], [wedge] [insulated] gaskets. The maximum allowable working pressure is [1.03 MPa 150 psig] [_____] at [49] [_____] degrees C [120] [_____] degrees F. Size the coupling to match the associated piping.

2.19 VALVE BOXES[, SERVICE BOXES][, VALVE MANHOLES][AND VALVE PITS]

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NOTE: Construction of valve manholes is to be avoided where feasible because of problems with dewatering/drainage and frostproofing. Use manually operated gate and butterfly valves suitable for direct burial and fitted with valve boxes in lieu of valves in manholes whenever possible. Review project-specific valve box requirements. Select and modify as required or refer to Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

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The box length must adapt [to the length required for the depth of the line] [to the depth of cover required over the pipe at the valve location] without full extension. Boxes must be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Provide boxes with housings of sufficient size to completely cover the valve or service stop and complete with covers.

2.19.1 Valve Boxes

Provide cast-iron valve boxes with minimum metal thickness of 5 mm 3/16 inch and of the extension type with slide-type adjustment and flared base. Provide concrete boxes that are the standard product of a manufacturer of precast concrete equipment.

2.19.2 Service Boxes

Provide extension service boxes with either screw or slide-type adjustment.

2.19.3 Valve [Manholes] [or Pits]

Construct valve [manholes] [or pits] for automatic valves and meters installed below grade in accordance with Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

2.20 VALVES

****

NOTE: This paragraph will be coordinated with Section 33 61 13.19 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES. Material selection based on piping materials and liquid characteristics is also provided. For critical or hazardous applications, insert specific material requirements, grades and alloys, and standards rather than a general material name.

Valves are grouped together by type. If a valve is required for your application that is not listed, insert the valve specification and notify the Contracting Officer. Check manufacturer's catalogs to make sure valves selected are current. Operator options vary by both manufacturer and valve size.

****

2.20.1 General Requirements For Valves

Valves include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation. Ensure valves are suitable for the intended service. Renewable parts are not to be of a lower quality than those specified. [Provide valves that are the same size as adjoining pipe]. Ensure valve ends are compatible with adjacent piping system. Size an operator to operate the associated valve for the full range of pressures and velocities. Valves will open by turning [counterclockwise] [_____]. Provide factory mounted operators, actuators, and accessories.

2.20.2 Valve Schedule

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NOTE: Verify that the schedules are included in the contract drawings. Delete this subparagraph if the valve schedule is not used.

****

Submit a list of valve materials, pressure ratings, valve operator's materials, air supply pressure, electrical service, location, source of supply, and reference identification as indicated in the contract drawings. Provide a list of any special tools necessary for each valve type and appurtenances furnished for adjustment, operation, maintenance and disassembly. Requirements relative to this paragraph are shown on the [Valve Schedule] [and Operator Schedule] located [in the contract drawings] [_____].

2.20.3 Factory Finishing

[Provide valves with an epoxy [lining and] coating in accordance with

AWWA C550 unless otherwise specified. Ensure the epoxy is either a two-part liquid material or a heat-activated (fusion) material except that only a heat-activated material applies if a valve coating is specified as "fusion" or "fusion bonded" epoxy. Provide epoxy [lining and] coating with a minimum [0.180 mm 7.0 mils] [[_____] mm mils] dry film thickness except where it is limited by valve operating tolerances.] Finish exposed valves in accordance with Section 09 90 00 PAINTS AND COATINGS. [Paint safety isolation valves and lockout valves with handles, handwheels, or chain wheels "safety yellow."]

2.20.4 Check Valves

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NOTE: "Check valves" are generally service oriented. Specific types of check valves should be specified for the specific applications; for example, the ball check valve is capable of passing solids. Rated operating pressures vary based on body and seat materials, size and other parameters such as wafer class. Consult manufacturer's information to select the appropriate rating for the application.

Piping plane and valve orientation may affect check valve performance. Certain types of check valves will only operate under specific conditions; for example, lift check valves can only operate in horizontal lines, and swing check valves can operate in either horizontal or vertical (flow up) positions.

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2.20.4.1 Swing Check Valves

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NOTE: The requirements on subpart c. below are based on general water service and AWWA ratings.

****

Provide swing check valves conforming to the following:

a. Provide swing check valves, 50 mm 2 inches and smaller, with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, in accordance with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.18 solder joint] [_____] ends. Provide valves with a swing type, replaceable [butadiene acrylonitrile] [polytetrafluoroethylene (PTFE)] [_____] disc. Ensure valves are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service.

b. Provide swing check valves, 65 mm 2.5 inches through 300 mm 12 inch, with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, in accordance with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [_____] ends. Provide valves with a bronze-mounted swing type, [bronze] [ductile iron] [cast iron] [_____] disc, [solid bronze] [ductile iron] [_____] hinges, and stainless steel hinge shaft [with outside lever and [weight] [spring]]. Ensure valves are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service.

c. Provide swing check valves, 50 mm 2 inch through 900 mm 36 inch, conforming to AWWA C508, and have [ASME B16.1 Class [_____] flanged], [welding], [mechanical joint] [grooved] [_____] end connections. Provide valves with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, [bronze] [_____] -mounted disc, solid [bronze] [ductile iron] [_____] hinges, and a stainless steel hinge shaft. Provide valves 50 mm 2 inch through 300 mm 12 inch rated for [1.2 MPa 175 psig] [[_____] MPa psig] service and valves 350 through 900 mm 14 through 36 inch rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Fit valves with an [adjustable outside lever and spring] [adjustable outside lever and weight]. An increasing-pattern body valve may be used where increased outlet piping size is shown.

2.20.4.2 Thermoplastic Check Valve

Provide thermoplastic check valves, 8 mm 0.25 inch through 400 mm 16 inch, of a [Y-check] [ball-check] design, manufactured of [polyvinyl chloride (PVC)] [chlorinated polyvinyl chloride (CPVC)] [polypropylene (PP)] [polyvinylidene fluoride (PVDF)] [_____] with [flanged] [socket] [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] end connections. Use valves that are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service. Provide valves with [fluoro-elastomeric O-ring] [_____] seals and seats. [Fit discs with a polyvinyl chloride (PVC) coil guide.] [Caps must be of hex design.]

2.20.4.3 Double Disc Swing Check Valve

Double disc swing check valves, 50 mm 2 inch through 1300 mm 52 inch, must be wafer style, spring loaded swing check valve, with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, a [aluminum-bronze] [ductile iron] [stainless steel] [bronze] [carbon steel] [_____] disc, resilient seats, stainless steel hinge pin, and a stainless steel stop pin spring. Ensure valves 50 mm 2 inch through 300 mm 12 inch are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F and valves 350 mm 14 inch through 1300 mm 52 inch are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

2.20.4.4 Slanting Disc Check Valve

Slanting disc check valves, 50 mm 2 inch through 1500 mm 60 inch, must be of a slanting or tilting disc design, with off-center pivot. Provide valve bodies consisting of [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____], and of a [two-piece] [wafer-style] design. Seats must be [bronze] [stainless steel] [_____] set on a [55] [_____] -degree angle. Discs must be [bronze] [ductile iron] [cast iron] [stainless steel] with pivot pin and bushing constructed of [TP304 stainless steel] [aluminum bronze] [_____], [butadiene acrylonitrile] [_____] disc seal, [TP316 stainless steel] [Monel] [_____] spring, [bottom mounted buffer cylinder for cushion closing] [and] [valve disc position indicator]. Use valves that are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service [and have [ASME B16.5] [ASME B16.1] Class [_____] flanged end connections].

2.20.4.5 Silent Check Valve

Provide silent check valves conforming to the following:

a. Silent check valves, 50 through 250 mm 2 through 10 inch, must be wafer style, center guided valve with a [cast iron] [cast steel] [bronze] [TP316 stainless steel] [_____] body, [bronze] [stainless steel] [_____] trim, [butadiene acrylonitrile] [_____] seat, and [bronze] [stainless steel] [_____] springs. Ensure valves are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

b. Silent check valves, 65 through 1050 mm 2.5 through 42 inch, must be globe style, center guided valve with [ASME B16.1] [ASME B16.5] Class [125] [250] [_____] flanged end connections, a [cast iron] [ductile iron] [cast steel] [bronze] [TP316 stainless steel] [_____] body, [bronze] [stainless steel] [_____] trim, [butadiene acrylonitrile] [_____] seat, and [bronze] [stainless steel] [_____] spring. Ensure valves are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service.

2.20.4.6 Ball Check Valve

Provide ball check valves, 25 mm 1 inch and larger, in accordance with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] ends, and [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [polyvinyl chloride (PVC)] [_____] bodies with a cleanout and [floating] [sinking] type [hollow steel] [phenolic] [butadiene acrylonitrile covered metal] ball. [Flanges must be ASME B16.1 Class [125] [_____].] Ensure valves are rated for [690 kPa 100 psig] [[_____] MPa psig] service and are suitable for vertical or horizontal flow.

2.20.5 Ball Valves

****

NOTE: Top or bottom entry bronze ball valves are not readily available. An end entry valve requires additional unions or ability to spring pipe clear in order to service valve. Flanged and wafer style valves can be readily removed.

****

2.20.5.1 General Purpose Ball Valves

Provide general purpose ball valves conforming to the following:

a. Ball valves, 50 mm 2 inch and smaller, must be end entry type with [bronze] [brass] [_____] bodies and [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] [soldered] [_____], [full bore] [regular] ports. Provide valves with [polytetrafluoroethylene (PTFE)] [_____] seats and packing, [chrome plated] [brass] [stainless steel] [_____] balls and [hand lever] [tee-handle] [hand wheel] [pneumatically actuated] [electrically actuated] [_____] operators. Ensure valves are rated for [2.76 MPa 400 psig] [[_____] MPa psig] service at 66 degrees C 150 degrees F and conform to ASME B16.34 Class [_____]. [Install a union adjacent to the valves to provide access to the seat.]

b. Ball valves, 65 mm 2.5 inch and larger, must be end entry type with [bronze] [cast iron] [_____] bodies and [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.18 solder joint] [_____] ends. Provide valves with [polytetrafluoroethylene (PTFE)] [_____] packing and seats, a [chrome plated] [brass] [stainless steel] [_____] ball, [regular] [full bore] ports, and [hand lever] [tee-handle] [hand wheel] [pneumatically actuated] [electrically actuated] [_____] operators. Ensure valves are rated for [2.76 MPa 400 psig] [[_____] MPa psig] service at 66 degrees C 150 degrees F and conform to ASME B16.34 Class [_____].

c. Provide ball valves, 50 to 300 mm 2 to 12 inch, conforming to ASME B16.34 Class [_____], and with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, stainless steel ball and stem, polytetrafluoroethylene (PTFE) packing and gasket, and [flanged] [welding] [_____] ends, full port. Ensure valves are rated for [1.38 MPa 200 psig] [[_____] MPa psig] service, and have [hand lever] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.5.2 Multiple Piece Body Ball Valves

Provide multiple piece body ball valves, 40 to 150 mm 1.5 to 6 inch, with [three] [_____] piece bodies constructed of [stainless steel ASTM A276/A276M Grade [TP316] [_____]] [cast steel ASTM A351/A351M Grade [CF8M] [_____]] [ASTM A216/A216M] [_____] stainless steel. Valves must have a [TP316] [_____] stainless steel ball, and [ASME B16.11 threaded] [ASME B16.5 flanged] [_____] end connections. Ensure valves are rated for [6.89 MPa 1000 psig] [_____] service and conform to ASME B16.34 Class [_____]. Provide valves with [reinforced polytetrafluoroethylene (PTFE)] [_____] seats and stem packing, that are [full] [standard] bore, andequipped with [handwheel] [hand lever] [tee-handle] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.5.3 Thermoplastic Ball Valve

Provide thermoplastic ball valves, 150 mm 6 inch and smaller, rated for [1.03 MPa 150 psig] [1.55 MPa 225 psig] [[_____] MPa psig] service at 49 degrees C 120 degrees F, and have ASTM D1784, minimum cell classification [_____], [polyvinyl chloride (PVC)] [chlorinated polyvinyl chloride (CPVC)] [ASTM D3222 polyvinylidene fluoride (PVDF)] [_____] bodies, balls, and stems. Provide valves of end entry, double union design, with [solvent-weld socket] [threaded, in accordance with ASME B1.20.2M ASME B1.20.1,] [flanged] [butt] [_____] ends connections, a [ethylene propylene diene monomer (EPDM)] [fluoro-elastomer] [_____] seat, and [fluoro-elastomer] [polytetrafluoroethylene (PTFE)] [ethylene propylene diene monomer (EPDM)] [_____] O-ring stem seals. Provide valves with [hand lever] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.6 Gate Valves

2.20.6.1 General Service Gate Valves

****

NOTE: The requirements on subpart b. below are based on general water service and AWWA ratings.

****

Provide general service gate valvesconforming to the following:

a. Provide gate valves, 50 mm 2 inch and smaller, with [bronze] [_____] bodies and stems, [screwed] [union] [bolted] [yoke] bronze [_____] bonnets, single [solid] [split] wedge bronze discs, and [rising] [non-rising] stems. Provide valves rated for [1.2 MPa 175 psig] [[_____] MPa psig] service and conforming to ASME B16.34 Class [_____]. End connections must be [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.11 threaded] [_____]. Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

b. Provide gate valves, 65 mm 2.5 inch and larger, with [Ni-resistant] [3 percent nickel-iron] [cast-iron] [_____] bodies with [iron] [bronze] [Ni-resistant stainless steel] [_____] trim. Provide valves meeting the requirements of [AWWA C500] [AWWA C509] and have Class [125] [250] [_____] [flanged] [welding] [threaded, in accordance with ASME B1.20.2M ASME B1.20.1,] [mechanical joint] [push-on] [_____] end connections. Provide a [clamp] [OS&Y Bolted] [NRS Bolted] type bonnet. Discs must be [wedge] [double] type of [iron] [bronze] [ductile iron] [bronze faced iron] [rubber coated ductile iron] [_____] construction, and have [nonrising] [rising] stems [with backseats]. Include a by-pass of the same materials as the gate valve for each gate valve, 400 mm 16 inch and larger. Provide bypass meeting the requirements of AWWA C500. Use valves rated for [1.4 MPa 200 psig] [[_____] MPa psig] service. Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.6.2 Thermoplastic Gate Valve

Provide thermoplastic gate valves, 13 mm1/2 inch and larger, with [ASTM D1784 polyvinyl chloride (PVC), minimum cell classification [_____],] [ASTM D1784 chlorinated polyvinyl chloride (CPVC), minimum cell classification [_____],] [_____] bodies, [bolted] [_____] bonnets, single [styrene butadiene rubber] [polypropylene] [_____] wedge discs, [non-rising] [rising] stems, and [flanged] [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] [_____] end connections. Provide valves rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Equip valves with [handwheel] [_____] [pneumatically actuated] [electrically actuated] operators.

2.20.7 Globe Valves

2.20.7.1 General Requirements For Globe Valves

Provide globe valves, 80 mm 3 inch and smaller, that are [angle pattern] [globe style] valve with [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] bodies, with [bronze] [brass] [stainless steel] [_____] trim, and [bronze] [brass] [_____] bonnets. Provide valves conforming to ASME B16.34 Class [_____], and with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.18 solder joint] [_____] end connections. Include [union] [threaded] [OS&Y] bonnets, inside screws, rising stems, [plug] [needle] [conventional] discs constructed of [polytetrafluoroethylene (PTFE)] [butadiene acrylonitrile] [bronze] [stainless steel] [_____], and [bronze] [brass] [stainless steel] [_____] rings. Ensure valves are rated for [1.4 MPa 200 psig] [[_____] MPa psig] service. Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.7.2 Needle Valve

Needle valves, 25 mm 1 inch and smaller, must be of a [straight] [angle] [cross] pattern and must have [brass] [TP316 stainless steel] [_____] bodies and trim. Provide valves [conforming to ASME B16.34 Class [_____] with ASME B16.11 [male] [female] threaded, in accordance with ASME B1.20.2M ASME B1.20.1,] [have tubing compression fittings, that match associated tubing fittings,] [_____] end connections. Ensure valves include [threaded] [integral] [union] [_____] bonnets, [TP316 stainless steel]

[_____] stems, [plug] [soft tip] [non-rotating ball] [_____] stem tips constructed of [polytetrafluoroethylene (PTFE)] [butadiene acrylonitrile] [bronze] [stainless steel] [_____], [fluoro-elastomer] [polytetrafluoroethylene (PTFE)] [ethylene propylene diene monomer (EPDM)] [_____] packing [and O-ring stem seals]. Ensure valves are rated for [2.07 MPa 300 psig] [[_____] MPa psig] service. Equip valves with [toggle-handle] [handwheel] [tee-handle] [pneumatically actuated] [_____] operators.

2.20.7.3 Hose Valve

Hose valves, 20 through 80 mm 0.75 through 3 inch, must be [globe style] [angle pattern] hose valves with [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] bodies, [bronze] [stainless steel] [_____] trim, inside screws, rising stems, and [polytetrafluoroethylene (PTFE)] [rubber] [_____] disc. The outlet ports must be [cast brass] [_____] in accordance with [ASME B1.20.2MASME B1.20.1 pipe threads, male by male, nipple adapter with hexagonal wrench feature [and brass cap with chain]] [_____]. Provide valves rated for [860 kPa 125 psig] [[_____] MPa psig] service.

2.20.8 Plug Valves

2.20.8.1 Eccentric Valve

Provide nonlubricated type eccentric valves, 80 mm 3 inch and smaller, rated for [1.2 MPa 175 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Valves must have drip-tight shutoff with pressure from either direction, and [cast iron] [bronze] [Ni-resistant] [acid resistant bronze] [aluminum] [carbon steel] [stainless steel] [nickel] [_____] bodies, in accordance with [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.11 threaded] [AWWA C606 grooved] [_____] end connections, [all metal, matching body] [rubber lined] [_____] plugs with [round] [rectangular] ports, [stainless steel] [nickel] [_____] seats, self-lubricating [stainless steel] [Monel] [nickel] [_____] stem bearings, and [butadiene acrylonitrile] [polytetrafluoroethylene (PTFE)] [filled polytetrafluoroethylene (PTFE)] [fluoro-elastomer filled polytetrafluoroethylene (PTFE)] [_____] [U-cup] [_____] seals. [Provide valves conforming to ASME B16.34 Class [_____].] Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.8.2 Lined Eccentric Valve

Provide nonlubricated type eccentric valves, 80 through 1350 mm 3 through 54 inch, rated for [1.2 MPa 175 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Provide valves with drip-tight shutoff with pressure from either direction, and [cast iron] [bronze] [Ni-resistant] [aluminum] [carbon steel] [stainless steel] [nickel] [_____] bodies in accordance with [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.11 threaded] [AWWA C606 grooved] [AWWA C111/A21.11 mechanical joint] [_____] end connections. Provide cast iron plugs with [round] [or] [rectangular] ports of no less than [80] [_____] percent of the connecting pipe area [and coated with] [butadiene acrylonitrile] [chloroprene] [fluoro-elastomer] [hard natural rubber] [_____]. Provide valves with [stainless steel] [nickel] [_____] seats, self-lubricating [stainless steel] [reinforced polytetrafluoroethylene (PTFE)] [_____] stem bearings, and [multiple [V-rings] [U-cups] [O-rings] stem seals] [[nitrile rubber] grit seals on the stems]. [Equip valves with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.] [Provide valves 150 mm 6 inch and smaller with a wrench lever manual operator and valves 200 mm 8 inch and larger with a totally enclosed, geared, manual operator with handwheel, 2-inch nut, or chain wheel.] [Ensure valves conform to ASME B16.34 Class [_____].]

2.20.9 Butterfly Valves

****

NOTE: Refer to AWWA C504 and manufacturers' data for valve selection and torque calculation data. Only valves with high velocities, heavy grit loads, or severe throttling service should be specified with a seat in the body.

****

2.20.9.1 Standard Service Butterfly Valve

Provide butterfly valves, 50 mm 2 inch and larger, with [ASTM A126 cast iron] [ductile iron] [carbon steel] [stainless steel] [_____] bodies, [[wafer] [lugged] styled] [with [ASME B16.5 flanged] [ASME B16.1 flanged] [AWWA C111/A21.11 mechanical joint] [_____] end connections]. Provide valves conforming to [AWWA C504 Class [125] [150] [_____]] [ASME B16.34 Class [_____]]. Discs must be contoured [ASTM A436 Type 1 Ni-resist cast iron with maximum lead content of 0.003 percent] [ASTM A536 Grade 65-45-12 ductile iron] [stainless steel] [polyvinylidene fluoride (PVDF) coated ductile iron] [bronze] [_____]. Provide [carbon steel] [stainless steel] [_____] valve shafts with self-lubricating, corrosion-resistant sleeve type bearings. Provide valve seats, constructed of [chloroprene] [_____], for [600 mm 24 inch] [_____] and smaller valves and attach to either the valve body or the disc. Provide valve seats for valves larger than [750 mm 30 inch] [[_____] mm inch] which are field replaceable in accordance with AWWA C504. Provide valves with [manual, locking hand lever] [hand wheel] [crank] [chain wheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.20.9.2 Thermoplastic Butterfly Valves

Provide thermoplastic butterfly valves, 40 mm 1.5 inch and larger, with [wafer] [lugged] style bodies constructed of [polyvinyl chloride (PVC)] [polyvinylidene fluoride (PVDF)] [polypropylene (PP)] [polyvinylidene fluoride (PVDF) coated ductile iron] [_____]. Provide valves with [polyvinyl chloride (PVC)] [polyvinylidene fluoride (PVDF)] [polypropylene (PP)] [polytetrafluoroethylene (PTFE)] [_____] discs, [ethylene propylene diene monomer (EPDM)] [fluoro-elastomeric] [butadiene acrylonitrile] [natural rubber] [ethylene propylene diene monomer (EPDM) backed] [_____] seats, [ethylene propylene diene monomer (EPDM)] [polytetrafluoroethylene (PTFE)] [same material as seats] [_____] seals, and [lever] [gear] [_____] [pneumatically actuated] [electrically actuated] operators. Ensure valves are rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

2.20.10 Pinch Valves

****

NOTE: Pinch valves are commercially available in sizes ranging from 50 mm 2 inch to 1500 mm 60 inch. Consider using an enclosed bevel gear operator for valves 150 mm 6 inch and larger and above 500 kPa

72.6 psig. The pinch valve included is illustrative, consult manufacturers' catalogs for other styles, pressure ratings, and operators.
****

Provide pinch valves with [aluminum] [stainless steel] [carbon steel] [ductile iron] [cast iron] [_____] bodies, in accordance with [ASME B16.1] [ASME B16.5 Class [125] [150] [_____]] flanged end connections, [natural rubber] [chloroprene] [chlorobutyl] [butadiene acrylonitrile] [fluoro-elastomeric] [ethylene propylene diene monomer (EPDM)] [_____] seats, [full port] [double wall] [reduced port] [cone] [variable orifice] sleeves, and [manual] [pneumatically actuated] [electrically actuated] [upper] [and] [lower] pinch bars.

2.20.11 Diaphragm Valves

****
NOTE: Diaphragm valves are commercially available in sizes ranging from 15 mm 0.5 inch to 250 mm 10 inch depending upon the materials of construction. Contact manufacturers to confirm availability based upon size and material.
****

2.20.11.1 Standard Service Diaphragm Valve

Provide diaphragm valves, 13 mm 1/2 inch and larger, with [aluminum] [stainless steel] [carbon steel] [ductile iron] [cast iron] [_____] bodies, [ASME B16.1] [ASME B16.5 Class [125] [150] [_____]] [flanged] [_____] end connections and [natural rubber] [chloroprene] [chlorobutyl] [butadiene acrylonitrile] [fluoro-elastomeric] [ethylene propylene diene monomer (EPDM)] [_____] seals, and are [manually] [pneumatically] [_____] actuated. Provide position indicators to indicate diaphragm position. Valves must be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

2.20.11.2 Thermoplastic Diaphragm Valve

Provide thermoplastic diaphragm valves, 13 mm 1/2 inch and larger, with [polyvinyl chloride (PVC)] [polypropylene (PP)] [polyvinylidene fluoride (PVDF)] [_____] bodies, [ASME B16.1] [ASME B16.5 Class [125] [150] [_____]] [flanged] [union socket] [butt-fusion] [_____] end connections and [ethylene propylene diene monomer (EPDM)] [polytetrafluoroethylene (PTFE)] [_____] seals, and that are [manually] [pneumatically] [_____] actuated. [Pneumatically operated valves must be [fail-closed] [fail-open] [double acting].] Provide position indicators to indicate diaphragm position. Valves must be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 20 degrees C 68 degrees F.

2.20.12 Self-Contained Automatic Valves

2.20.12.1 Pressure-Reducing Valve

****
NOTE: Verify that the valve schedule is included in the contract drawings.
****

Pressure-reducing valves, 13 mm 1/2 inch and larger, must be [direct] [hydraulically] operated, diaphragm actuated, [pilot] [spring] controlled [angle] [globe] valves with [cast iron] [ductile iron] [steel] [aluminum] [stainless steel] [bronze] [_____] bodies. End connections must be [ASME B16.1] [ASME B16.5 Class [150] [_____] flanged] [ASME B16.11 [threaded] [socket-welded]]. Provide [stainless steel] [_____] trim and stem. Valves must be normally [open] [closed] to maintain a constant downstream pressure regardless of fluctuations in flow or upstream pressure [, and prevents backflow,] [and have externally mounted strainers with cocks]. Use valves sizes and ratings as [shown in the Valve Schedule on the contract drawings.] [as follows.] PCV [_____] mm inch, maximum flow of [_____] cubic m/s gpm with inlet pressure of [_____] MPa psig. Outlet pressure set at [_____] MPa psig.

2.20.12.2 Pump Control Valve

Provide pump control valve which is [hydraulically operated, diaphragm actuated, pilot controlled globe valve with [cast iron] [ductile iron] [cast steel] [_____] bodies, [ASME B16.1] [ASME B16.5] Class [_____] flanged end connections, [bronze] [stainless steel] [_____] trim, stainless steel stems, and externally mounted strainers with cocks] [_____]. Design valves to eliminate pipeline surge caused by pump startup and shutdown, and include automatic check features.

2.20.13 Operators

2.20.13.1 Operator Schedule

****

NOTE: Verify that the operator schedule is included in the contract drawings. Delete this subparagraph if an operator schedule is not used.

****

Requirements relative to this paragraph are shown on the Operator Schedule located [in the contract drawings] [_____].

2.20.13.2 Manual Operator

The force in a manual operator is not allowed to exceed [175 N 39.3 pound] [[_____] N pound] under any operating condition, including initial breakaway. Equip the operator with gear reduction when force exceeds [175 N 39.3 pound] [[_____] N pound]. Provide a self-locking type manual operator or equip with a self-locking device. Supply a position indicator on quarter-turn valves. Provide worm and gear operators consisting of a one-piece design with worm-gears of gear bronze material. Worm must be hardened alloy steel with the thread ground and polished. Provide traveling nut type operators with threader steel reach rods with an internally threaded bronze or ductile iron nut.

2.20.13.2.1 Exposed Operators

Provide exposed operators with galvanized and painted handwheels. Lever operators are allowed on quarter-turn valves [200 mm 8 inch] [[_____] mm inch] and smaller. Supply cranks on gear type operators. If located off of the operator floor, provide chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level. Ensure valve handles are capable of padlocking, and provide wheels that are lockable with a chain and padlock.

2.20.13.2.2 Underground Operators

Buried service operators on valves larger than [65 mm 2.5 inch] [[_____] mm inch] must have a [50 mm 2 inch] [[_____] mm inch] operating nut. Buried operators on valves [50 mm 2 inch] [[_____] mm inch] and smaller must have a cross handle for operation by a forked key. Enclose the moving parts of valve and operator in housing to prevent contact with the soil. Design buried service operators for quarter-turn valves to withstand an input torque of [^610 N-m (450 foot-pound) 450 foot-pound] [[_____] N-m foot-pound] of input torque at the fully open or fully closed positions, and grease pack and gasket to withstand a submersion in water to [70 kPa 10.2 psig] [[_____] MPa psig]. Provide buried valves with extension stems, bonnets, and valve boxes.

2.20.13.3 Pneumatic Operator

****

NOTE: Associated transducers must pneumatically provide the same pressure range as used by the actuator. Do not use piston actuators at less than 275 kPa 40 psig supply pressure. Include a safety vented isolation valve in the operator paragraph for use on air sets.

****

Provide pneumatic operators complete with actuators, air sets, exhaust mufflers, speed controls, pilot solenoids, safety vented isolation valves, and accessories. Ensure pneumatic operators are suitable for full operation range of valve at air supply pressure indicated. Use actuators to return the valve to the closed position upon loss of signal unless otherwise indicated. [Use springs to return valve to this failed position.] Furnish pneumatic operators with features noted on the [Operator Schedule] [Valve Schedule] in the contract drawings. [Provide limit switches on all actuators.]

2.20.13.3.1 Cylinder Actuators

Provide cylinder actuators conforming to ANSI/AWWA C541 and ANSI/AWWA C542, and operate with an air supply pressure of [550 kPa 80 psig] [[_____] MPa psig]. Totally enclose the nonswivel type with travel stops and position indicator, and factory lubricate and seal, requiring no additional lubrication. The double acting type must be nonmetallic for operation on nonlubricated air and must have a [manual] [handwheel] override independent of the cylinder. Locate the manual override [_____].

2.20.13.3.2 Diaphragm Actuators

Provide diaphragm actuators with a spring return with a [steel or aluminum] [_____] diaphragm case and spring barrel, steel spring and actuator stem, and [fabric-reinforced chloroprene] [_____] diaphragm. Use actuators on quarter-turn valves which include a totally enclosed valve actuating mechanism with adjustable travel stops and valve position indicator with manual override if indicated. The actuating mechanism must factory lubricated and sealed. Size and configure diaphragm actuators for the service indicated and an air supply pressure of [240 kPa 35 psig] [[_____] MPa psig].

2.20.13.3.3 Air Sets

Include a pressure regulator with internal relief, filter, outlet pressure gauge, and adjustable reduced pressure range as required by the valve actuator. The air set must have an aluminum body and handwheel, safety vented lockout isolation valve, and gauge range [1.33 to 2] [_____] times maximum operating pressure.

2.20.13.3.4 Limit Switches

Provide single-pole, double-throw (SPDT) type limit switches, rated 10 amps at 120 volts ac, housed in a NEMA 250 Type [4] [_____] enclosure, and adjustable for open and closed valve positions.

2.20.13.3.5 Positioners

The positioners for modulating actuators must be pneumatic force balance instruments to control valve positions as a function of the input signals. The positioners must accomplish positive positioning of valve by a mechanical feedback connection from the valve actuating mechanism. Provide position feedback through a characterized linear cam to allow adjustment of valve positioning and input signal. Provide positioner suitable for either a double acting or spring return actuator. Provide positioner with zero and span adjustment and field reversible for direct or reverse action. Include gauges for supply and output pressure and for input signal pressure. Operate modulating valve positioners on a [21 to 103 kPa 3 to 15 psig pneumatic] [or] [[4 to 20 mA] [1 to 5 v dc] electric] input signal unless otherwise indicated. [A positioner for dc input signal with transducers must convert the electrical signal to the appropriate pneumatic signal. Ensure transducer is [integral with the positioner] [or] [a separate component]. If separate, factory mount the transducer on the pneumatic operator. Line electric power is not required for transducer operation.] Corrosion-resistant enclosures for positioners and transducers must be splash- and moisture-proof with gasketed covers.

2.20.13.3.6 Solenoid Valve

Use a solenoid valve to pilot the control actuator in the appropriate configuration for the type of actuator being controlled. Provide a pilot operated diaphragm type solenoid valve consisting of a [brass] [_____] body and resilient seat and operate with minimum operating pressure differential no greater than [70 kPa 10.2 psi] [[_____] kPa psi] and maximum operating pressure differential no less than [1.03 MPa 150 psi] [[_____] MPa psi]. Provide corrosion-resistant internal parts. Provide solenoid valve with Class F molded coils for operation on 120 volts, 60-Hz, ac, unless otherwise indicated. Provide solenoid enclosure conforming to NEMA 250 Type [4] [_____]. Solenoids on double acting cylinders for open-close and throttling valves must be four-way with dual coils. Solenoids on spring return cylinders for open-close and throttling valves must be three-way, spring return. Furnish an air exhaust muffler in the exhaust port of all actuator pilot solenoid valves.

2.20.13.4 Electric Operator

Provide electric operators complete with actuators, speed controls and accessories. Operate actuators on [120 VAC, 60 Hz] [_____] with a [75] [_____] percent duty cycle and equip with an AC thermal overload protector with automatic rest, reversing (bi-directional) operation for use with quarter-turn valves, or rotating equipment to full rotation. Gearing must be a two-stage planetary, permanently lubricated self-locking gear train with self-lubricating bearings; connections via male output staff. Use start-up torque of [163 N-m 120 foot-pound] [[_____] N-m foot-pound]. Use stall torque of [203 N-m 150 foot-pound] [[_____] N-m foot-pound]. Mount [two] [_____] travel stop limit switches with cams, internal, independent, adjustable, and actuated by cams, on the drive shaft. Provide a side mounted hand turn wheel for a manual override. Ensure actuators have a NEMA 250 Type [4] [_____] enclosure with a corrosion resistant, baked epoxy finish as standard. Operate actuator in a temperature range of -40 to plus 65 degrees C -40 to plus 150 degrees F. Actuators must fail in last position unless otherwise indicated. Furnish electric operators with features noted on the [Operator Schedule] [Valve Schedule] in the contract drawings. [Provide limit switches on all actuators.]

2.20.13.4.1 Limit Switches

Limit switches must be single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac, housed in a NEMA 250 Type [4] [_____] enclosure, and adjustable for open and closed valve positions.

2.20.13.4.2 Positioners

Provide positioners for modulating actuators to control valve positions as a function of the input signals. Operate positioner on [120 VAC, 60 Hz.] [_____] voltage. The mode of operation must be [direct acting] [reverse acting]. Operate modulating valve positioners on a [4 to 20 mA] [1 to 5 v DC] [_____] input signal unless otherwise indicated. Provide splash-and moisture-proof corrosion-resistant enclosures with gasketed covers for positioners.

2.20.14 Valve Accessories

2.20.14.1 Extension Bonnet for Valve Operator

Provide all extension bonnets as necessary, complete with stem and accessories applicable to the specific valve and operator.

2.20.14.2 Floor Stand and Extension Stem

Provide the nonrising, indicating type floor stand and extension stem, complete with stem, coupling, handwheel, stem guide brackets, and yoke attachment. Space stem guide such that stem L/R ratio does not exceed [200] [_____]. Supply anchors as required.

2.20.14.3 Floor Box and Stem

Provide the plain type floor box and stem for support of nonrising type stem; complete with stem, operating nut, and stem guide brackets. Space stem guide such that stem L/R ratio does not exceed [200] [_____]. Supply anchors as required.

2.20.14.4 Chain Wheel and Guide

Provide the handwheel direct-mount type chain wheel and guide, complete with galvanized or cadmium-plated chain.

2.21 DRAINS

Valved drains may not be shown on the detailed drawings for individual pipelines; their absence will not relieve the Contractor of the responsibility for providing and installing them as indicated in the piping and instrumentation diagrams to complete the piping system for the use intended.

2.21.1 Locations

[Locate drains as indicated on the contract drawings] [Drain all pipeline low points] [_____].

2.21.2 Sizes

For pipelines 65 mm 2.5 inch and larger, provide [20 mm 0.75 inch] [[_____] mm inch] drains equipped with [gate valves] [globe valves] [ball valves] [_____]. For pipelines [50 mm 2 inch] [[_____] mm inch] and smaller, provide [13 mm 1/2 inch] [[_____] mm inch] drains equipped with [gate valves] [globe valves] [ball valves] [_____].

2.22 SAMPLE PORTS

****

NOTE: Sample port materials of construction typically match the piping system.

For highly critical situations where the materials being sampled are very hazardous or where valves may tend to clog or leak, the first sampling valve option is used to specify a sampling valve. Otherwise, the second option is used to specify the sampling configuration.

****

[Sample ports, shown on the flow diagrams and piping and instrument diagrams of the contract drawings, may not be shown on the detailed drawings of the individual pipelines; their absence does not relieve the Contractor of the responsibility for providing them.] [Provide sample ports as indicated in the piping and instrument diagrams to complete the piping systems for the use intended.] Locate sample ports in easily accessible locations, and avoid potential stagnant points and/or areas where material could collect. [Provide a plug-type sampling valve with a stainless steel piston that extends beyond the inner surface of the pipe when closed at [all the sampling ports] [the sampling ports indicated]. Seal piston by two compressible replaceable [polytetrafluoroethylene (PTFE)] [_____] rings, one above the discharge port, the other below the discharge port. Provide valve body consisting of stainless steel Class [150] [_____] with a [male ASME B1.20.2MASME B1.20.1 pipe threads] [_____] inlet connection and [female ASME B1.20.2MASME B1.20.1 pipe threads] [_____] outlet connection] [Provide sampling ports comprised of pipe fittings, pipe, and [ball] [gate] [_____] valves which comply with material, temperature, and pressure requirements of the associated piping system as specified elsewhere in this Section.] [Provide a double block and bleed configuration] [_____].

2.23 MISCELLANEOUS PIPING COMPONENTS

2.23.1 Air Release and Vacuum Breakers

****

NOTE: For air and vacuum, vacuum, air release and

combination valves, check trim materials for compatibility with service. In addition, discharge points should be designed to be safe for both the environment and personnel.

****

Locate air release vents, and vent such that a hazardous atmosphere will not be created upon operation.

2.23.1.1 Locations

[Locate air release and vacuum breakers as indicated on the contract drawings.] [Ensure all pipeline high points have air release vents [and vacuum breakers].] [_____]. [Provide vacuum breakers on all tanks and process equipment.]

2.23.1.2 Vacuum Breakers

Provide vacuum breakers [50] [_____] mm [2] [_____] inch and smaller of an angle type with all [bronze] [cast iron] [semi-steel] [_____] bodies and bonnets, and [install at least [152] [_____] mm [6] [_____] inch above the flood line of associated equipment] [and] [conforming to ASSE 1001 for pipe applied units].

2.23.1.3 Air and Vacuum Valve Suitable for Corrosive Service

Provide air and vacuum valve conforming to [ASSE 1001] [ASSE 1020] [_____], and automatically exhaust air during the filling of a system while allowing air to re-enter during draining or when vacuum occurs. Ensure valve is rated for [1.03] [_____] MPa [150] [_____] psig working pressure and built with [a special short body] [a standard elongated body]. Provide valve consisting of a [cast iron] [ductile iron] [semi-steel] [_____] body and cover, with [stainless steel] [_____] float and trim. Provide end connections as follows: for 13 through 80 mm 1/2 through 3 inch ASME B1.20.2MASME B1.20.1 pipe threaded inlet and outlet, for 100 mm 4 inch and larger [ASME B16.5] [ASME B16.1] Class [_____] flanged inlet with outlet. Fit air and vacuum valve with blowoff valve, quick disconnect couplings, and a minimum [2] [_____] m [6.6] [_____] feet of hose in order to permit back flushing after installation without dismantling the valve.

2.23.1.4 Air Release Valve Suitable for Corrosive Service

Use [Factory Mutual listed] [ASSE approved] [_____] air release valve to automatically exhaust entrained air that accumulates in a system. Ensure valve is rated for [1.03] [_____] MPa [150] [_____] psig working pressure and built with [a special short body] [a standard elongated body]. Provide valve consisting of a [cast iron] [ductile iron] [semi-steel] [_____] body and cover, with [stainless steel] [_____] float and trim. Ensure valve end connections are [ASME B1.20.2MASME B1.20.1 pipe threaded] [[ASME B16.5] [ASME B16.1] Class [_____] flanged] [_____]. Fit air and vacuum valve with blowoff valve, quick disconnect couplings, and a minimum 2 m 6.6 feet of hose in order to permit back flushing after installation without dismantling the valve.

2.23.1.5 Combination Air Valve Suitable for Corrosive Service

The valve combines the operating functions of both an air and vacuum valve and an air release valve. The air and vacuum portion must automatically exhaust air during filling of a piping system and allow air to re-enter during draining or when a vacuum occurs. Air release portion must automatically exhaust entrained air that accumulates in the piping system. Provide valve consisting of a [single body unit] [or] [an individual air and vacuum valve and an air relief valve mounted on a common header]. Ensure valve is rated for [1.03] [_____] MPa [150] [_____] psig working pressure and built with [a special short body] [a standard elongated body]. Provide valve with a [cast iron] [ductile iron] [semi-steel] [_____] body and cover, with [stainless steel] [_____] float and trim. Ensure valve end connections are [ASME B1.20.2MASME B1.20.1 pipe threaded] [[ASME B16.5] [ASME B16.1] Class [_____] flanged] [_____]. [The air and vacuum valve to be fitted with a blowoff valve, quick disconnect couplings, and a minimum [2] [_____] m [6.6] [_____] feet of hose in order to permit back flushing after installation without dismantling the valve.]

2.23.2 Backflow Preventer

****

NOTE: Under process conditions, backflow prevention can be handled with either a double check valve assembly or a backflow preventer specifically manufactured for that purpose. The backflow preventer should be used if pressure loss is a concern. However, if the backflow prevention device is to be installed on a potable water line at a treatment plant and the potential for contamination of the potable water line exists, a backflow preventer specifically manufactured for that purpose must be used.

The reduced pressure backflow preventer can be used on continuous duty systems only. The other backflow preventer can be used on either continuous or intermediate services.

****

The backflow preventer must be identical in size to pipe. Do not allow total head loss through the complete backflow assembly to exceed [70] [_____] kPa [10.1] [_____] psi at rated flow.

2.23.2.1 Double Check Valve Assembly

Provide backflow preventer consisting of two [check valves] [independently operating, spring loaded, "Y" check valves] rated for [1.25] [_____] MPa [175] [_____]psig service at 60 degrees C 140 degrees F, with [one isolation gate valve] [one isolation ball valve], [one differential relief valve], [and testing cocks]. Use port size of [25] [_____] mm [1] [_____] inch and ASME B1.20.2MASME B1.20.1 threaded, [female] [male]. Ensure check valve assembly is rated for [1.03] [_____] MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F. Provide assembly meeting the requirements of [ASSE 1015] [AWWA C510].

2.23.2.2 Reduced Pressure Backflow Preventer

Provide assembly body consisting of two independent [bronze] [epoxy coated cast iron] [_____] body check valves rated at [1.2][_____] MPa [150] [_____] psig at 60 degrees C 140 degrees F, with an intermediate relief valve, and [isolation gate valve,] [full-ported [ball valves] [gate valves] [_____]] as testing cocks. [Ensure all internal parts are serviceable in-line.] Use port sizes of [25] [_____] mm [1] [_____] inch and

ASME B1.20.2MASME B1.20.1 threaded, [female] [_____]. Ensure reduced pressure backflow prevention assembly is rated for [1.03] [_____]MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F. Provide assembly body in accordance with [AWWA C511] [ASSE 1013].

2.23.2.3 Backflow Preventer with Intermediate Vent

Provide assembly body consisting of two independent [bronze] [epoxy coated cast iron] [_____] body check valves rated at [1.2] [_____] MPa [175] [_____] psig at 60 degrees C 140 degrees F, with an intermediate atmospheric vent, and [isolation gate valve,] [full-ported [ball valves] [gate valves] [_____]] as testing cocks. Use port sizes of [25] [_____] mm [1] [_____] inch and ASME B1.20.2MASME B1.20.1 threaded, [female] [_____]. Ensure backflow prevention assembly is rated for [1.03] [_____] MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F. Provide assembly body in accordance with [AWWA C511] [ASSE 1012].

2.23.3 Strainers

Provide [simplex] [duplex] strainers with a [Y-pattern] [_____] body. Use port sizes of [25] [_____] mm [1] [_____] inch and ASME B1.20.2MASME B1.20.1 threaded, [female] [male]. Ensure strainers are rated for [1.03] [_____] MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F and conform to [ASTM F1199] [ASTM F1200]. Provide body consisting of [cast bronze] [cast iron] [welded steel] [_____] with a [screwed bronze] [bolted iron] [_____] cap. The screen must be heavy-gauge [stainless steel] [Monel] [_____], [30] [_____] mesh [and equipped with a ASME B1.20.2M ASME B1.20.1 pipe threaded blowoff hole].

2.23.4 Indicating Devices

****

NOTE: This subparagraph will be coordinated with requirements for remote or control instrumentation. The devices specified by this section may be in addition to the control instrumentation.

****

2.23.4.1 Pressure and Vacuum Gauges

Pressure and vacuum gauges must be [stem] [flush] [semi-flush] [panel] [_____] mounted, with [phenolic] [aluminum] [glass filled nylon] [glass filled polypropylene (PP)] [stainless steel] [brass] [acrylonitrile-butadiene-styrene (ABS)] [_____] cases [equipped with safety pressure blowout backs] and [dry] [[glycerine] [_____] -filled] [_____] dials. The gauge sensors must be [diaphragm] [C-Type Bourdon tube] [helical Bourdon tube] [bellows] [_____] actuated and constructed of [phosphor bronze] [stainless steel] [Monel] [silicone rubber] [Inconel] [beryllium-copper] [_____]. Equip gauges with [brass] [Monel] [TP316L stainless steel] [alloy steel] [_____] threaded [8] [_____] mm [0.25] [_____] inch [male] [female] connections. The dials of the gauges must be [114] [152] [_____]mm [4.5] [6] [_____]inch in diameter with scale readings in [MPa and mm of mercury psig and inches of mercury] [_____] ranging from zero to approximately twice the anticipated process operating or equipment pressure. Provide a slotted adjustable pointer with accuracy to conform to [ASME B40.100, Grade A] [_____]. [Provide a lever handled gauge cock and filter type snubber.][Install snubber between the pipeline and the gauge.] [Isolate the gauges from the process fluids using remote corrosion resistant diaphragm seals. Construct the housing of the corrosion resistant seals of [stainless steel] [Monel] [tantalum] [titanium] [polytetrafluoroethylene (PTFE)] [polypropylene (PP)] [polyvinyl chloride (PVC)] [Inconel] [Hastelloy] [_____]. Compose seals of [stainless steel] [Monel] [Hastelloy] [nickel] [polytetrafluoroethylene (PTFE)] [_____].]

2.23.4.2 Thermometers

Provide bi-metal actuated thermometers, with [127] [_____] mm [5] [_____] inch dished anti-parallax dials that have [external] [_____] calibration adjustment and [stainless steel] [_____] cases. Do not use mercury in thermometers. Use thermometers with [stainless steel] [_____] stems, [adjustable angle] [back-connection] [left side-connection] [or] [right side-connection] type for the correct viewing angle. Include union connections with associated thermowells. Scale must be [-5 to plus 50 degrees C 25 to 125 degrees F] [[_____] to [_____] degrees C degrees F] with accuracy within one scale division.

2.23.4.3 Thermowells

Provide [TP316 stainless steel] [brass] [steel] [_____] thermowells with a diameter of [25] [_____] mm [1] [_____] inch. Use length as shown on the contract drawings and coordinate with the associated temperature element. Construct process connections of [stainless steel] [_____] with [flanges, faced and drilled to ASME B16.5 Class [150] [300] [_____]] [fixed hex nipples [male ASME B1.20.2MASME B1.20.1 threaded] [female ASME B1.20.2M ASME B1.20.1 threaded sockets]] [_____]. Use thermowells, equipped with terminal connection heads rated NEMA 250 Type [4X] [4] [7] [_____], with thermocouples or RTDs.

2.23.5 Static Mixer

Design static mixer to disperse the design flow, [_____] cubic m/s gpm of added chemicals in a process flow stream with flows ranging from [_____] to [_____] cubic m/s gpm. The minimum allowable pressure drop is [_____] kPa feet of water column. The maximum allowable pressure drop for the static mixer is [_____] kPa feet of water column in accordance with the requirements of the process stream pumping system. Size diameter of the mixer housing identical to the process piping. Use length in accordance with the number of mixing elements required. Provide [TP316 stainless steel] [_____] housing materials, providing chemical resistance to both the chemical additives and process stream. [Ensure coatings on coated components are factory spark-tested to verify that the coating is free from pinholes.] Ensure end configurations are [plain ends] [ends prepared for welding] [ASME B1.20.2MASME B1.20.1 threaded ends] [[forged steel, [ASTM A105/A105M] [ASTM A727/A727M]] [_____], flanged faced and drilled to [ASME B16.5] [ASME B16.1] Class [150] [300] [_____]] [_____] and compatible with the piping system. Provide injection ports of the same materials as the mixer housing in the number, dimensions, and positions shown on drawings, and with [female ASME B1.20.2MASME B1.20.1 threaded] [flanged] [_____] connections compatible with the chemical feed piping system. Supply each housing with a name plate which at a minimum provides the manufacturer's name and address, part model number, and direction of flow. Construct mixing elements of [TP316 stainless steel] [_____] providing resistance to both the chemical additives and process stream. Install elements consecutively, with the number required designed to provide mixing with a homogeneity of the final mix of less than or equal to [0.05] [_____] by the end of the static mixer.

2.23.6 Expansion Joints

****

NOTE: Thermal expansion of the piping systems must be taken into account. One of the most common methods to accommodate thermal expansion, the incorporation of expansion loops into the piping system, should be carefully investigated when corrosive materials are handled due to the potential of inducing stress corrosion. Alternatives are expansion joints and flexible connections or sections. Calculate maximum expansion compensation based on maximum pipeline temperature and pressure.

****

Provide all structural work and equipment required to control expansion and contraction of piping. Verify that the anchors, guides, and expansion joints provided, adequately protect the piping systems.

2.23.6.1 Expansion Joint for Metallic Pipe

The expansion joint must be a [single slip] [double slip] [ball] [bellows] [elastomer sleeve] [_____] type with [stainless steel] [_____] wetted materials of construction. Size expansion joint to match the associated piping. The maximum allowable working pressure is [1.03] [_____] MPa [150] [_____] psig at [48.9] [_____] degrees C [120] [_____] degrees F. Size expansion joint for a maximum axial [compressing] [expanding] deflection of [_____] mm inches [, a lateral movement of [_____] mm inch,] [and] [an angular rotation of [15] [_____] degrees.] End connections must be [as specified for the associated pipe joints] [[ASME B16.5] [ASME B16.1] Class [_____] flanged] [ASME B16.11 [threaded] [welding]]. Provide required accessories for a complete assembly including: [swivel joints,] [limit stops,] [internal guides,] [anti-torque device,] [internal flow liners,] [control rods,] [control cables,] [_____].

2.23.6.2 Expansion Joint for Nonmetallic Piping

Provide a bellows expansion joint with a minimum of [_____] convolutions to accommodate an axial deflection of [_____] mm inch, [a lateral movement of [_____] mm inch,] [and] [an angular rotation of [_____] degrees,] with [[ductile iron] [_____] flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [125] [150] [300] [_____],] [_____] end connections, and metal reinforcing bands. The maximum allowable working pressure is [960] [_____] kPa [140] [_____] psig at [49] [_____] degrees C [120] [_____] degrees F. Limit bolting to restrain the force developed by [1.5] [_____] times the specified maximum allowable operating pressure. Size expansion joint to match the associated piping.

2.23.7 Pressure Relief Devices

****

NOTE: Pressure relief devices must discharge to a safe location that does not endanger either operators or the environment. Discharge piping and the supports for the discharge piping must be carefully designed to prevent failure during a pressure relief event. Select all materials based upon the application; refer to manufacturers' catalogs.

****

Provide pressure relief devices conforming to the requirements of ASME B31.3.

2.23.7.1 Pressure-Relief Valve

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NOTE: Verify that the valve schedule is included in the contract drawings.

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Provide pressure-relief valves conforming to the following:

a. Pressure-relief valves, 50 mm 2 inch and smaller, must be a direct diaphragm, spring controlled type with [cast iron] [_____] bodies and spring cases. Trim must be [bronze] [stainless steel] [_____] and seats, [nitrile] [_____]. Diaphragms must be elastomeric, [chloroprene] [nylon reinforced butadiene acrylonitrile rubber] [or] [_____]. Ensure miscellaneous parts such as the valve stems, nuts, and springs are [stainless steel] [_____]. Ensure end connections are [flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [150] [300] [______]] [ASME B16.11 [threaded] [welding]] [_____]. The valves must open when the upstream pressure reaches a maximum set point. Sizes and ratings [as shown in the Valve Schedule in the contract drawings.] [as follows: PSV- [_____] [_____] mm inch, maximum flow of [_____] cubic m/s gpm with inlet pressure of [_____] MPa psig. Outlet pressure set at [_____] MPa psig].

b. Pressure relief valves, 65 mm 2.5 inch and larger, must be hydraulically operated, diaphragm actuated, pilot controlled [globe] [angle] valves with externally mounted strainers and test cocks. Provide bodies consisting of [cast iron] [ductile iron] [forged steel] [_____] and trim consisting of [bronze] [stainless steel] [_____]. Stem must be [stainless steel] [_____]. Ensure end connections are [flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [150] [300] [_____]] [ASME B16.11 [threaded] [welding]] [_____]. The valves must open when the upstream pressure reaches a maximum set point. Sizes and ratings [as shown in the Valve Schedule in the contract drawings.] [as follows: PSV- [_____] [_____] mm inch, maximum flow of [_____] cubic m/s gpm with inlet pressure of [_____] MPa psig. Outlet pressure set at [_____] MPa psig].

2.23.7.2 Rupture Discs

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NOTE: Verify that the rupture discs are sized and rated in the contract drawings.

****

Provide [tension loaded] [compression loaded] type rupture discs [as indicated in contract drawings]. Provide discs consisting of [copper] [aluminum] [stainless steel] [dual element with a seal composed of [metal] [plastic] [_____] conforming to piping system] with a maximum operating ratio of [70] [85] [90] [_____] percent. [Provide vacuum support, if required, by the manufacturer.] [Knife blades are not necessary for initiating rupture.] The discs must rupture when the upstream pressure reaches a set maximum. Sizes and ratings [as shown in the contract drawings.] [as follows: PSE- [_____] [_____] mm inch, diameter. Rupture pressure is [_____] MPa psig].

2.24 PIPE SUPPORTS AND PENETRATIONS

****
NOTE: Pipe-support is a major design consideration of any process piping system; carefully design and edit the following paragraphs.
****

Provide auxiliary steel where the support of piping systems and equipment is required between building structural elements. Provide light gauge and structural steel shapes conforming to the requirements of ASTM A36/A36M. The Contractor has the option to use pre-engineered support systems of electrogalvanized steel products. However, a mixture of support system manufacturers products is not permitted. Where auxiliary steel is indicated as stainless steel, provide [TP304] [_____] stainless steel conforming to [ASTM A167, No. 1 Finish] [_____].

2.24.1 Pipe Supports

Provide pipe supports conforming to the requirements of MSS SP-58. Where pipe supports contact bare piping or in-line devices, provide supports of compatible material so that neither has a deteriorating action on the other.

2.24.1.1 Beam Clamps

For upper attachments on structural steel, provide beam clamps of [ASTM A36/A36M carbon steel] [or] [ASTM A181/A181M forged steel] [_____] and MSS SP-58 Types [19 through 23, 25 or 27 through 30] [_____]. Holes drilled in structural steel for hanger support rods will not be permitted. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place. Base clamp size selection only on the support of the required load.

2.24.1.2 Riser Clamps

Support vertical runs of piping at each floor, or closer where required, with [ASTM A36/A36M carbon steel] [_____] clamps bolted around pipes and attach to the building construction. [Provide copper plated clamps for copper tubing support.] [Use two bolt-type clamps designed for installation under insulation on insulated pipe runs.]

2.24.1.3 Brackets

Where piping is run adjacent to walls or steel columns, provide welded [ASTM A36/A36M steel] [_____] brackets, pre-punched with a minimum of two fastener holes.

2.24.1.4 Offset Pipe Clamp

Where pipes are indicated as offset from wall surfaces, supply a double-leg design two-piece pipe clamp.

2.24.1.5 Racks

Fabricate multiple pipe racks or trapeze hangers from [ASTM A36/A36M steel] [_____], and design to suit the conditions at the points of installation. Keep pipes in their relative positions to each other by the use of clamps or clips. Pipelines subject to thermal expansion must be free to slide or roll.

2.24.1.6 Hangers

Fabricate hangers of [malleable iron, ASTM A47/A47M] [or] [ASTM A36/A36M carbon steel] [_____]. Ensure all hangers are of a uniform type and material for a given pipe run and application. Use coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe. Ensure hangers for pipe sizes 65 mm 2.5 inch or larger incorporate a means of vertical adjustment after erection while supporting the load. For piping systems with operating temperatures from 50 to 230 degrees C 122 to 446 degrees F, use the following: [MSS SP-58 Type [1] [or] [3 through 12] [_____] hangers with overhead support and appropriate saddle of MSS SP-58 Type [40] [_____] for insulated pipe;] [MSS SP-58 Types [41] [or] [43 through 46] [_____] hangers or supports with roller support and appropriate saddle of MSS SP-58 Type [39] [_____] on insulated pipe;] [MSS SP-58 Types [35 through 38] for sliding support]. For piping systems with liquid temperatures up to 50 degrees C 122 degrees F, use the following: MSS SP-58 [Types 1,3 through 12,] [Types 24 and 26 with overhead support,] [or] [Types 35 through 38 with support from below].

2.24.1.7 Hanger Rods

Provide carbon steel hanger rods conforming to ASTM A576. The diameter of the rods for piping system support must conform to [the contract drawings] [ASME B31.1].

2.24.2 Pipe Guides

2.24.2.1 Intermediate Guides

For piping [150 mm 6 inch] [[_____] mm inch] and smaller, provide a pipe clamp with an oversize pipe sleeve for a minimum [4 mm 0.16 inch] [[_____] mm inch] clearance. For piping [200 mm 8 inch] [[_____] mm inch] and larger, use U-bolts with double nuts that are manufactured for the purpose to provide a minimum [7 mm 0.28 inch] [[_____] mm inch] clearance around pipe. The stock sizes for the U-bolts are as follows: for a [200 mm 8 inch] [[_____] mm inch] pipe use a [16 mm 0.625 inch] [[_____] mm inch] U-bolt; for a [250 mm 10 inch] [[_____] mm inch] pipe, use a [19 mm 3/4 inch] [[_____] mm inch] U-bolt; for a [300 mm 12 inch] [[_____] mm inch] to [400 mm 16 inch] [[_____] mm inch] pipe, use a [24 mm 0.875 inch] [[_____] mm inch] U-bolt; and for [450 mm 18 inch] [[_____] mm inch] to [750 mm 30 inch] [[_____] mm inch] pipes use [25 mm 1 inch] [[_____] mm inch] U-bolts.

2.24.2.2 Alignment Guides

For piping, [200 mm 8 inch] [[_____] mm inch] and smaller, ensure alignment guides are [galvanized steel] [_____], [spider] [or] [sleeve] [_____] type. For piping, [250 mm 10 inch] [[_____] mm inch] and larger, ensure alignment guides are [galvanized steel] [_____], [roller] [_____] type guides.

2.24.3 Flashing Sleeves

[Install[galvanized steel] [_____] flashing sleeves wherever piping passes through concrete roof structures.] [Where piping penetrates roofs, provide [2 kg 4 lb.] [[_____] kg lb.] [lead] [_____] flashing.] Extend flashing [200 mm 8 inches] [[_____] mm inches] from the pipe in all directions, extend up the pipe, and fit with double-threaded flashing for pipes [75 mm

3 inches] [[_____] mm inches] and smaller. Turn down flashing inside the pipe for [100 mm 4 inch] [[_____] mm inch] and larger pipes.

2.24.4 Wall Penetrations

2.24.4.1 Above Grade Wall Penetrations

Provide piping which passes through fire-rated or smoke-rated walls, floors, or ceilings with insulated and encased pipe sleeves. Seal penetrations through an existing fire or fire barrier wall with a fire stop system that has an "F" rating no less than the required fire resistance rating of the penetrated wall. The fire stopping sealant for metal piping systems must be [[a water based] [vibration resistant, polysiloxane (also known as silicone) based,] nonslumping, premixed sealant with intumescent properties] [_____], that is rated for [3] [_____] hours pursuant to ASTM E814 and UL requirements. The fire stopping sealant for plastic and insulated piping systems must be a [polysiloxane (also known as silicone) based, nonslumping, premixed sealant with intumescent properties] [acrylic based, nonslumping, premixed sealant with intumescent properties] [_____], that is vibration and moisture resistant, and is rated for [3] [_____] hours pursuant to ASTM E814 and UL requirements with metal collars. Fit vented plastic pipe penetrations with galvanized steel collars that have intumescent inlays.

2.24.4.2 Below Grade Wall Penetrations

****

NOTE: For critical systems, use the interlocking rubber link system. In other instances, a nonslumping water-resistant elastomeric based sealant with intumescent properties may be used.

****

Provide below-grade wall penetrations with [hydrostatic seals designed to seal opening between pipe or conduit and a through-structure opening. The seals must be modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening] [polysiloxane (also known as silicone) based, nonslumping, vibration and water resistant sealant with intumescent properties] [_____].

2.24.4.3 Galvanizing

Galvanizing must be [hot-dip applied and meet the requirements of ASTM A153/A153M] [or] [zinc or cadmium plating]. Stainless steel components may be substituted where galvanizing is specified.

2.25 MISCELLANEOUS MATERIALS

****

NOTE: In cold climates, exposed pipe, valves, and equipment should be insulated and potentially heat traced to prevent freezing. Method of heat trace will be dictated by hazard classification and site conditions.

****

2.25.1 Pipe Insulation Material

Provide insulation for pipes, valves, instrumentation and controls, and other equipment [in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS] [consisting of 25 mm one inch ASTM C552 cellular glass and integral moisture barriers][_____].

2.25.2 Heat Trace

****

NOTE: Delete subparagraphs a. b. and c. below if steam heat trace is used.

****

Heat trace must be [steam] [electrical] with materials selected for compatibility with transported liquids and ambient environment. The heat trace must be capable of maintaining the liquid process design temperature at [27] [_____] degrees C [80] [_____] degrees F maximum when subjected to an exterior temperature of [-29] [_____] degrees C [-20] [_____] degrees F.[Provide steam piping in accordance with Section 23 58 00.00 10 CENTRAL STEAM HEATING AND UTILITIES SYSTEMS.][Ensure electrical work is in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and UL listed, and includes all terminations, junction boxes, and automatic controls.] Perform work in conformance to hazard classifications indicated on the drawings[, and implement in accordance with NFPA 70, Section 427].

a. Provide UL listed parallel conduction type heat tape, with adjustable thermostat for outdoor aboveground winterized piping. Ensure tape is not affected by direct sunlight, ambient temperature, operating temperature, rain, or salt laden atmosphere. Provide flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation must prevent overheating and burnouts even where the cable overlaps itself.

b. Provide end seals for ends of circuits. Wire at the ends of circuits are not to be tied together.

c. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at [1.1] [_____] degrees C [34] [_____] degrees F minimum during winter outdoor design temperature as indicated, but not less than the following: 80 mm 3 inch pipe and smaller with 25 mm one inch thick insulation, 4 watts/0.3 m 4 watts/feet; and 100 mm 4 inch pipe and larger 38 mm 1.5 inch thick insulation, 8 watts/0.3 m 8 watts/feet of pipe.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 PREPARATION

3.2.1 Protection

Close pipe and equipment openings with caps or plugs during installation. Protect equipment from dirt, water, and chemical or mechanical damage.

3.2.2 System Preparation

3.2.2.1 Pipe and Fittings

Inspect pipe and fittings before exposed piping is installed or buried piping is lowered into the trench. Clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.

3.2.2.2 Damaged Coatings

Repair damaged coating areas in the field with material equal to the original coating, except promptly remove damaged glass-lined pipe from the site. Do not install damaged piping materials. Field repair damaged and uncoated areas of galvanized piping conforming to ASTM A780/A780M.

3.2.2.3 Field Fabrication

Notify the Contracting Officer at least [2] [_____] weeks prior to the field fabrication of pipe or fittings and at least [3] [_____] days prior to the start of any surface preparation or coating application work. Perform field welding in accordance with Section 40 05 13.96 WELDING PROCESS PIPING. Provide welding electrodes in accordance with [Table 3.1 of AWS D1.1/D1.1M] [_____] as required for the applicable base metals and welding process. Fabricate fittings in accordance with the manufacturer's instructions.

3.3 EXPOSED PIPING INSTALLATION

Run exposed piping as straight as practical along the alignment shown on the contract drawings and with a minimum of joints. Install piping and appurtenances in conformance with reviewed shop drawings, manufacturer's instructions and ASME B31.3. Install piping without springing or forcing the pipe.

3.3.1 Anchors and Fasteners

Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.

3.3.1.1 Drilled-In Expansion Anchors and Fasteners

****

NOTE: This subparagraph addresses anchors and fasteners that are used with concrete or masonry applications. The first option is used for masonry brick and precast concrete hollow-core block anchoring/fastening systems and the second is suitable for cast-in-place concrete and solid precast concrete structural elements.

****

[Design anchors to accept both machine bolts and/or threaded rods. Such anchors must consist of an expansion shield and expander nut contained inside the shield. Fabricate and design the expander nut to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches, and bears against the shield bottom. Provide shield body consisting of four legs,taper the inside of each toward shield bottom (or nut end). Elongate the end of one leg and turn across shield bottom. Rib the outer surface of shield body for grip-action. The expander nut must be of square design with sides tapered inward from bottom to top. The anchor materials of construction must be [zinc plated steel] [TP304 stainless steel] [_____] of [300 MPa 43,541 psi] [[_____] MPa psi] minimum tensile strength. Provide fasteners consisting of machine bolts for use with above anchors; provide nuts and washers conforming to ASTM A194/A194M. Ensure the anchor length, diameter, and embedment depth meet the manufacturer's requirements for the maximum allowable working load of the application.] [Provide anchor/fastener assembly which is UL listed with a one-piece stud (bolt) that has integral expansion wedges, nuts and washers. [Construct stud of [TP304] [_____] stainless steel, and nut and washer of [TP304] [_____] stainless steel.] Ensure the anchor length, diameter, and embedment depth meet the manufacturer's requirements for the maximum allowable working load of the application.]

3.3.1.2 Drilled-In Adhesive Anchors

[Do not use drilled-in adhesive anchors for overhead applications.] Compose anchors of an anchor rod assembly and an anchor rod adhesive cartridge. Provide anchor rod assembly composed of a chamfered and threaded stud rod of [zinc plated ASTM A36/A36M steel] [TP304 stainless steel] [_____] with a nut and washer of [ASTM A194/A194M alloy-steel] [TP316 stainless steel] [_____]. Use anchor length, diameter, and embedment depth meeting the manufacturer's requirements for the maximum allowable working load of the application. Ensure the adhesive cartridge is a sealed capsule containing premeasured amounts of resin, quartz sand aggregate, and a hardener contained in a separate vial within the capsule. Activate the capsule ingredients by the insertion procedure of the anchor rod assembly.

3.3.2 Piping Expansion and Contraction Provisions

Install piping to allow for thermal expansion and contraction resulting from the difference between installation and operating temperatures. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial must have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI Handbook. Install anchors as shown in the contract drawings to withstand expansion thrust loads and to direct and control thermal expansion. Install an intermediate pipe guide for every pipe at each metal channel framing support not carrying an anchor or alignment guide. Where pipe expansion joints are required, install pipe alignment guides adjacent to the expansion device and within [four] [_____] pipe diameters. Install expansion devices in accordance with the manufacturer's instructions [and at the locations shown in the contract drawings].

3.3.3 Piping Flexibility Provisions

Provide thrust protection as required. Install flexible couplings and expansion joints at connections to equipment, and where shown on the contract drawings. Provide additional pipe anchors and flexible couplings, beyond those shown on the contract drawings, to facilitate piping installation, in accordance with reviewed shop drawings.

3.3.4 Couplings, Adapters and Service Saddles

Thoroughly clean pipes of oil, scale, rust, and dirt in order to provide a clean seat for gaskets. Wipe gaskets clean prior to installation. Lubricate flexible couplings and flanged coupling adapter gaskets with [soapy water] [or] [the manufacturer's standard lubricant] before installation on the pipe ends. Install couplings, service saddles, and anchor studs in accordance with manufacturer's instructions. Tighten bolts progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Use torque-limiting wrenches to tighten bolts.

3.3.5 Piping Equipment/Component Installation

Install piping components and indicators in accordance with manufacturer's instructions. Provide required upstream and downstream clearances, isolation valves, and miscellaneous devices for an operable installation. [Make straight runs of piping upstream and downstream of flow measuring devices as shown in the contract drawings.] [Use upstream and downstream lengths of undisturbed piping in accordance with flow indicator manufacturer's recommendations.]

3.3.5.1 Backflow Preventers

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NOTE: Discharge to an open drain with an air gap is required on potable water lines.
****

Install backflow preventers with nameplate and test cocks accessible from front of unit, and with a minimum clearance of [310 mm 12.2 inches] [[_____] mm inches] between the port and grade. Install assemblies in accordance with local codes [and discharge to an open drain with an air gap]; vertical installation [must be avoided] [is prohibited].

3.3.5.2 Local Indicators

Install all direct-reading indicator devices, thermometers, and pressure gauges so that they can be easily read from floor level, and are readily accessible for maintenance and service. Coat all temperature sensing bulbs with a [silver base heat transfer grease] [_____] prior to insertion into the thermowell. Install pressure gauges and thermometers where indicated in the contract drawings. [Field calibrate all indicators at time of installation to ensure measuring and reading accuracy.] Install differential pressure gauges [across all process equipment] [across the process equipment indicated in the contract drawings], in accordance with the manufacturer's recommendations, and arranged for easy observation.

3.3.6 Pipe Flanges

****
NOTE: Specify the requirement for bolting to straddle the vertical centerline of the pipe for the installation of orientation sensitive devices such

as some types of flow meters.
****

Pipe flanges must be set level, plumb, and aligned. Install flanged fittings true and perpendicular to the axis of the pipe. Ensure bolt holes are concentric to the centerline of the pipe [and straddle the vertical centerline of the pipe].

3.3.7 Valve Locations

Locate valves in accordance with the contract drawings where actuators are shown. Where actuators are not shown, locate and orient valves to permit easy access to the valve operator, and to avoid interferences.

3.3.8 Pipe Tap Connections

Taps to pipe barrels are unacceptable. Make taps to ductile iron piping only with a service saddle or at a tapping boss of a fitting, valve body, or equipment casting. Make taps to steel piping only with a welded threadolet connection.

3.3.9 Plastic Pipe Installation

Submit a statement signed by the [reinforced thermosetting resin pipe] [and] [plastic pipe] manufacturer's representative certifying that the Contractor's personnel are capable of properly installing the piping system on the project. Cut, make up, and install all plastic pipe in accordance with the pipe manufacturer's recommendations.

a. Perform heat joining in accordance with ASTM D2657. Perform electrofusion joining in accordance with ASTM F1290. Do not thread Schedule 40 pipe. Use Schedule 80 threaded nipples where necessary to connect to threaded valves or fittings. Use strap wrenches for tightening threaded plastic joints, and do not over tighten these fittings.

b. Do not lay pipe when the temperature is below [4.5 degrees C 40.1 degrees F] [[_____] degrees C degrees F], nor above [32 degrees C 90 degrees F] [[_____] degrees C degrees F] when exposed to direct sunlight. Ensure any plastic pipe installed above grade and outdoors is ultraviolet (UV) protected or UV resistant.

c. Shield pipe ends that are to be joined from direct sunlight prior to and during the laying operation. Provide adequate ventilation when working with pipe joint solvent cement and handle solvent cements, primers and cleaners in accordance with ASTM F402.

d. Provide and install supports and hangers [in accordance with the manufacturer's recommendations] [as specified and indicated] [_____]. Where plastic pipe is subjected to severe temperature fluctuations, provisions for expansion and contraction must be provided. Accomplish this with the use of expansion joints and offset piping arrangements. Hydrostatically test all lines [at the maximum operating pressures] [at the pressures listed in the Pipe Schedule shown on the contract drawings].

e. Submit [6] [_____] copies each of operation and maintenance manuals in indexed booklet form. Detail in the Operation Manuals the step-by-step procedures required for specialized startup, operation and shutdown of piping systems, and include the manufacturer's name, model number, parts list and brief description of piping equipment such as valves and other appurtenances and their basic operating features. List in the Maintenance Manuals routine maintenance procedures and troubleshooting guides for the equipment, and include piping layout and valve locations.

3.3.9.1 PVC Piping

Construct solvent-cemented joints in accordance with ASTM D2855.

3.3.9.2 FRP Piping

Cut, fabricate, and install pipe, duct, and fittings in strict accordance with the pipe manufacturer's written recommendations and as shown on the contract drawings. Ensure all FRP pipe and fittings have interior surfaces which are highly polished, with no exposed fibers. Cure field joints as recommended by the manufacturer. [Where it is absolutely necessary to make a field weld on pipe specified to be field flanged only, make the weld only under direct supervision of the pipe manufacturer's field representative, who is experienced in FRP pipe lay-up techniques.]

3.3.10 Double Containment Piping Installation

Factory trained field representatives of the piping supplier must provide technical field support during critical periods of piping [and leak detection system installation including final check out of the leak detection/location system, and end user training].

3.3.11 Insulation

Install insulation on piping as indicated [on the Pipe Schedule] [in the contract drawings in accordance with the provisions of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.]

3.4 BURIED PIPE PLACEMENT

[Install thermoplastic piping systems underground in accordance with ASTM D2774.] [Install thermosetting resin and reinforced plastic mortar piping systems underground in accordance with ASTM D3839.]

3.4.1 Excavation and Backfilling

Perform earthwork as specified in Section 31 00 00 EARTHWORK. Accomplish backfilling after inspection by the Contracting Officer. Exercise care when lowering pipe into the trench to prevent damage or twisting of the pipe.

3.4.2 Fittings

Make press connections in accordance with manufacturer's installation instructions using tools approved by the manufacturer. Insert tubing fully into the fitting and then mark at the shoulder of the fitting. Check fitting alignment against the mark on the tubing to ensure the tubing is fully inserted before the joint is pressed. At valves and connections, dig out the trench bottom with sufficient length, width, and depth to ensure clearance between the undisturbed trench bottom and the valves and such connections.

3.4.3 Thrust Restraint

Thrust restraint devices are generally not shown in the contract drawings; their absence will not relieve Contractor of the responsibility for providing them as required to provide complete systems for the use intended. Provide thrust blocks and ties where required, whether or not shown on the contract drawings. At a minimum, provide thrust restraint at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.

3.4.3.1 Thrust Blocks

Thrust blocking must be concrete of a mix not leaner than [1] [_____] cement, [2.5] [_____] sand and [5] [_____] gravel, and have a compressive strength of not less than [14 MPa 2000 psi] [[_____] MPa psi] after [28] [_____] days. Place blocking between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, pour the base and thrust bearing sides of the thrust blocks against undisturbed earth. The sides of thrust blocks not subject to thrusts may be poured against forms. Provide area of bearing as shown or directed. Place blocking so that fitting joints are accessible for repair. Use steel rods and clamps, protected by galvanizing or a coating of bituminous paint, to anchor vertical down bends into gravity thrust blocks.

3.4.3.2 Restrained Joints

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NOTE: When the restrained pipe length is specified, this paragraph will be modified in accordance with the design requirement. Use UFC 3-230-01 for guidance.

****

[The restrained pipe length is [_____] m feet]. [For ductile iron pipe, design restrained joints in accordance with DIPRA TRD.]

3.4.4 Marking Tape

Provide and install pipe marking tape in accordance with the requirements of Section 31 00 00 EARTHWORK.

3.4.5 Plastic Pipe Installation

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NOTE: Thrust blocking should be used only where slip joints are used. Otherwise, piping will be designed to withstand compression or expansion forces imposed by trench conditions.

****

Cut, fabricate, and install plastic pipe in strict conformance with the pipe manufacturer's recommendations. Provide offset loops from the trench centerline as recommended by the manufacturer for the maximum temperature variation between the pipe temperature at the time of solvent welding and operating temperature. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial must have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI Handbook. Support flexible plastic pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between the plastic pipe at the flanged joint and the rigid structures is possible. [Do not use thrust blocking for flexible plastic piping. Design and install piping to withstand the compression and expansion forces imposed by the trench conditions.] [Construct concrete thrust blocks where shown in the contract drawings] [_____].

3.5 CONNECTING DISSIMILAR PIPE

Install flexible transition couplings, dielectric fittings and isolation joints in accordance with the manufacturer's instructions.

3.6 EXTERNAL CORROSION PROTECTION

Protect all pipe and piping accessories from corrosion and adverse environmental conditions.

3.6.1 Underground Metallic Piping

Protect buried metallic piping from corrosion using [protective coatings] [and] [cathodic protection]. Provide cathodic protection for metallic underground piping systems as specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Where dissimilar metals are joined underground, use gas-tight isolation joints. [Provide insulating joint material where shown to control galvanic or electrical action.]

3.6.2 Above Grade Metallic Piping

Do not paint nonferrous and stainless steel piping except for aluminum alloy piping. Where dissimilar metals are joined, use isolation joints.

3.6.2.1 Ferrous Piping

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed. Clean surfaces that contain loose rust, mill scale or other foreign substances mechanically by [power wire brushing] [commercial sand blasting conforming to SSPC SP 6/NACE No.3] and prime with a [ferrous metal primer] [vinyl type wash coat] [_____]. Finish primed surfaces with two coats of exterior [oil] [vinyl] [_____] paint in accordance with Section 09 90 00 PAINTS AND COATINGS. Provide cathodic protection as shown in the contract drawings for above ground ferrous piping systems as specified in [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM].

3.6.2.2 Aluminum Alloy Piping

Paint surfaces of aluminum alloy pipe and fittings to protect against corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by water, detergents or chemicals. Solvent clean surfaces must be solvent and treat with a [vinyl type wash coat] [_____]. Apply a first coat of aluminum paint and a second coat of [alkyd gloss enamel] [silicone alkyd copolymer enamel] [_____] in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.7 DOUBLE CONTAINMENT PIPING LEAK DETECTION SYSTEM

a. Install the system in accordance with the manufacturer's recommended installation procedures. Follow all local, state and federal codes and requirements. Install system by properly trained personnel. Provide a location map with the system by the Contractor indicating the "as built" system configuration and sensing string layout. Provide markings along the cable length as references to locate leaks. Base markings upon calibration points. Take and record calibration points along the sensing string in accordance with the manufacturer's recommended procedures. Provide cable not in containment piping with cable tags every [15 m 49.2 feet] [[_____] m feet].

b. Perform tests to demonstrate the ability of the system to detect and locate breaks, shorts and probes on the sensor string. Perform leak testing pursuant to the following procedure in order to verify operation and the ability to work with condensation pools or other static moisture. The double containment piping system leak detection field test procedures are as follows:

    (1) Wet the sensor cable near the start of the sensor string and acknowledge the detection/location alarm and remap the system.

    (2) Wet the sensor cable near the end of the sensor string with the first location still wetted and acknowledge the detection/location alarm and remap the system.

    (3) Wet the sensor cable in three additional locations between the first and second leak locations with each detection/location alarm being acknowledged and with all prior leak locations still wetted.

    (4) Prepare and submit a report verifying each leak location and detection accuracy. Furnish a hard copy report of the test results.

3.8 FLEXIBLE JOINTS AT CONCRETE STRUCTURES

Provide flexible joints at the face of all structures, whether or not shown on the contract drawings. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded pipe joints are not. Joints may be flush with the structure face or may be located up to [1] [_____] pipe diameter away from face [, but not further than [450 mm 17.7 inches] [[_____] mm inches] away from face]. [For pipelines larger than [450 mm 18 inch] [[_____] mm inch] in diameter the first joint must be within [1] [_____] pipe diameter.]

3.9 CLOSURES

Install closure pieces as necessary to end pipe runs and conforming to ASME B16.9 or ASME B16.11. Elastomer sleeves bonded to pipe ends are not acceptable. Provide pressure piping with closures of [butt-welded caps] [blind flanges] [threaded plugs] [plain end pieces, with thickness matching the nominal wall thickness of the associated pipe, mounted on double flexible couplings], unless otherwise shown on contract drawings or approved by the Contracting Officer. Ensure pipes with restrained joints have pipe closures installed with thrust tie-rod assemblies [as shown in contract drawings].

3.10 PENETRATIONS

Steel pipe sleeves must be hot-dipped galvanized after fabrication for above grade applications in nonsubmerged areas. For below grade, or in submerged and damp environments, line and coat steel pipe sleeves as specified in Section 09 90 00 PAINTS AND COATINGS. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations. Coatings must be as specified in Section 09 90 00 PAINTS AND COATINGS. Support wall pipes securely by form work to prevent contact with reinforcing steel and tie-wires. Ensure joints are [caulked with rubber sealant] [or] [sealed with a wall penetration seal]. For existing concrete walls, rotary drilled holes may be provided in lieu of sleeves.

3.11 VALVE INSTALLATION

Install flanged valve bolt holes so as to straddle the vertical centerline of pipe. Clean flanged faces prior to inserting the gasket and bolts, and then tighten the nuts progressively and uniformly. Clean threads of threaded ends by wire brushing or swabbing prior to installation.

3.11.1 Valve Orientation

Install operating stem of a manual valve in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations [1.37 m 4.5 feet] [[_____] m feet] or less above finished floor, unless otherwise shown on contract drawings. Install operating stem of a manual valve in a horizontal position in horizontal runs of pipe having centerline elevations between [1.37 m 4.5 feet] [[_____] m feet] and [2.05 m 6.75 feet] [[_____] m feet] above finish floor, unless otherwise shown on contract drawings. Install automatic valves in accordance with [the manufacturer's instructions] [and] [approved drawings].

3.11.1.1 Butterfly Valves

Orientation of butterfly valves must take into account changes in pipe direction. Orient valve shafts so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of the disc.

3.11.1.2 Plug Valves

If a plug valve seat position is not shown in the contract drawings, locate the seat position as follows: for horizontal flow, the flow must produce an "unseating" pressure, and the plug must open into the top half of valve; and for vertical flow, install the seat in the highest portion of the valve.

3.11.2 Line Size Ball Valves

Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding [magnetic flowmeters] [_____], for isolation during maintenance.

3.11.3 Isolation Valve

Install safety isolation valves on compressed air supplies. Locate valve to provide accessibility for control and maintenance. If necessary, install access doors in finished walls and plaster ceilings for valve access.

3.11.4 Operator Extension Stems

Where the depth of the valve is such that its centerline is more than [925 mm 3 feet] [[_____] mm feet] below grade, furnish an operator extension stem with a [50 mm 2 inch] [[_____] mm inch] operating nut to bring the operating nut to a point [150 mm 5.9 inches] [[_____] mm inches] below the surface of the ground and/or box cover. Locate operating nut in a floor box.

3.11.5 Torque Tube

Where the operator for quarter-turn valve is located on a floor stand, furnish an extension stem torque tube, properly sized for the maximum torque capacity of the valve.

3.11.6 Chain Wheel and Guide

Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves located over [2.05 m 6.73 feet] [[_____] m feet] above finished floor elevation. Where chains hang in normally traveled areas, use appropriate ["L" type] [_____] tie-back anchors.

3.12 AIR RELEASE, DRAINS AND SAMPLE PORTS

Provide sample ports where indicated on the contract drawings. Install specified vents at piping high points for entrapped air release and install drains in the low points of pipelines regardless of whether shown on contract drawings.

3.13 PIPING SUPPORT SYSTEMS INSTALLATION

The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout plant.

3.13.1 General Support Requirements

Provide pipe support systems meeting the requirements of MSS SP-58. Install Contractor-designed and selected support systems in accordance with MSS SP-58, and as specified herein. Support piping connections to equipment by pipe supports and not off the equipment. Support large or heavy valves, fittings, and/or equipment independently of associated piping. Do not support pipes off other pipes. Provide supports at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the contract drawings. Do not install pipe supports and hangers in equipment access areas or bridge crane runs. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing. At each channel type support, provide every pipe with an intermediate pipe guide, except where pipe anchors are required. Existing support systems may be used to support additional new piping only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads. Provide pedestal type pipe supports under base flanges adjacent to rotating equipment and where required to isolate vibration. Brace piping [65 mm 2.5 inch] [[_____] mm inch] in diameter and larger for seismic forces. Install lateral supports for seismic loads at all changes in direction.

3.13.2 Support of Insulated Piping

Install oversized supports to fit the insulation inserts. Provide supports with galvanized or stainless steel protection shields and oversized rollers.

3.13.3 Dielectric Barriers

Install dielectric barriers between supports and copper or stainless steel piping, and between stainless steel supports and non-stainless steel ferrous piping.

3.13.4 Support Spacing

****

NOTE: Calculate spans and rod sizes pursuant to MSS SP-58. Coordinate with manufacturers data and/or other standards for guidance in determining maximum support spans. Duplicate the following subparagraphs as required.

****

3.13.4.1 Acceptable Limits for Metallic Piping

[Stainless steel] [_____] [Schedule [10S] [_____]] with a wall thickness of [_____] mm inch, diameter [_____] mm inch, must have a maximum span of [_____] mm inch and a minimum rod size for single rod hangers of [_____] mm inch.

3.13.4.2 Acceptable Limits for Thermoplastic Piping

[PVC] [_____], [Schedule [40] [_____]] [SDR [21] [_____]], diameter [_____] mm inch, must have a maximum span of [_____] mm inch and a minimum rod size for single rod hangers of [_____] mm inch.

3.13.4.3 Acceptable Limits for Rubber/Elastomer Piping

[Chloroprene] [_____], internal diameter [_____] mm inch, must have a maximum span of [_____] mm inch and a minimum rod size for single rod hangers of [_____] mm inch.

3.13.5 Support Methods

Provide piping support as specified and as shown in the contract drawings. Support single horizontal suspended piping by [adjustable swivel-ring,] [split-ring,] [or] [clevis] [_____] hangers. Support multiple horizontal suspended piping by [trapeze hangers with channel type supports] [_____]. Provide horizontal pedestal mounted piping with [saddle] [_____] type supports. Provide horizontal wall mounted piping with [wall brackets] [_____]. Support vertical piping by [wall brackets,] [base elbows,] [or] [riser clamps on floor penetrations] [_____].

3.13.6 Supports and Hangers for Stainless Steel Piping

Provide all hanger-pipe contact surfaces with a dielectric barrier consisting of [chloroprene rubber] [_____] wrapping [or plastic coated hangers]. The load rating of universal concrete inserts is not allowed to be less than that of the hanger rods they support.

3.14 PIPE IDENTIFICATION, PAINTING AND COLOR CODING

****

NOTE: Color coding for piping identification as required by the using agency will be developed and inserted in the Color Code Schedule (Table I) in Section 09 90 00 PAINTS AND COATINGS. For Air Force installations, piping will be color coded in accordance with Attachment 4 of Air Force Regulation 88-15.

****

Ensure color, coating, and lettering requirements for exposed piping are in accordance with Section 09 90 00 PAINTS AND COATINGS. [Except where piping is required to be completely painted in its code color, piping or its insulation covering may be banded either with plastic adhesive tapes or painted stripes around pipe designating piping contents [in accordance with following options and requirements].] [Provide a single individual band, of plastic adhesive tape or paint, designating pipe contents with sufficient length to permit the stenciling of pipe contents in letters.] [Provide identification at branch connections, inlets and outlets of equipment, every [6 m 19.7 feet] [[_____] m feet] of straight run, upstream of valves, and within [1 m 3.3 feet] [[_____] m feet] of entrance to or exit from wall curtains, or other similar type barrier.]

3.15 FIELD QUALITY CONTROL

****

NOTE: The general pipe testing requirements are basically taken from ASME B31.3 for Chemical and Petroleum Refinery Piping. Test pressure for hydrostatic pressure and leakage tests will be the working pressure multiplied by 1.33. For a working pressure of 1.03 MPa 150 psig, the test pressure will be 1.38 MPa 200 psig. For other working pressures the test pressure will be adjusted accordingly.

Pneumatic testing should be avoided if possible. Specify pneumatic testing on systems where residual moisture in the lines could be a problem (such as with anhydrous liquid chlorine and hydraulic fluid), and where the use of another nontoxic liquid is not feasible. ASME B31.3 methods should be used.

****

3.15.1 Hydrostatic Tests

Where any section of a pipeline is provided with concrete thrust blocking for fitting, do not make the hydrostatic tests until at least [5] [_____] days after the installation of the concrete thrust blocking, unless otherwise approved by the Contracting Officer.

3.15.1.1 Buried Piping

After the pipe is laid, the joints completed and the trench partially backfilled leaving the joints exposed for examination, subject the newly laid piping or any valved section of piping, unless otherwise specified, for [1] [_____] hour to a hydrostatic test pressure [of [_____] MPa psig] [as listed in the Pipe Schedule in the contract drawings]. Open and close each valve several times during the test. Carefully examine exposed pipe, joints, fittings, and valves during the partially open trench test. Replace joints showing visible leakage as necessary. Remove defective pipe, joints, fittings, and valves found during the pressure test and replace with new material, and repeat the test until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions are encountered: (1) wet or unstable soil conditions in the trench; (2) compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions; or (3) maintaining the trench in an open condition would delay completion of the Contract. The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the hydrostatic tests. Place backfill placed prior to the tests in accordance with the requirements of Section 31 00 00 EARTHWORK.

3.15.1.2 Exposed Piping

Conduct hydrostatic testing in accordance with ASME B31.3. Test piping systems under normal service conditions (as indicated in the Pipe Schedule in the contract drawings) to demonstrate compliance. Test pressure less than [1.5] [_____] times the design pressure is prohibited. Use [water] [_____] as the hydrostatic test fluid. Provide clean test water of such quality to prevent corrosion of the piping system materials. Open air release vents at all high points of the piping system in order to purge air pockets while the piping system is filling.

3.15.1.2.1 Rigid Piping

For rigid piping hydrostatic testing, calculate the maximum test pressure according to ASME B31.3, but do not exceed the yield strength of the piping system. The maximum velocity during filling is [[0.075 m/s 0.25 fps] [[_____] m/s fps] applied over full area of pipe] [in accordance with the manufacturer's instructions]. [Venting during filling may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.] Test all parts of the piping system. Maintain hydrostatic test pressure continuously for [30] [_____] minutes minimum and for such additional time as necessary to conduct examinations for leakage. Examine all joints and connections for leakage. Ensure piping system, exclusive of possible localized instances at pump or valve packing, shows no visual evidence of leaking. Correct visible leakage and retest. Unless otherwise directed by the Contracting Officer, leave the piping system full of water after leaks are repaired.

3.15.1.2.2 [Non-Rigid, Non-Metallic Piping] [and] [Metallic Piping with a Non-Metallic Liner]

For [non-rigid, non-metallic piping] [and] [metallic piping with a non-metallic liner] hydrostatic testing, calculate the maximum test pressure according to ASME B31.3, but do not exceed [1.5] [_____] times the maximum pressure rating of the lowest rated component in the piping system. The maximum velocity during filling is [[0.075 m/s 0.25 fps] [[_____] m/s fps] applied over full area of pipe] [in accordance with the manufacturer's instructions]. Pressurize the system initially to [50] [_____] percent of the normal service conditions and inspect. Repair any leaks . Then pressurize the system to the test pressure. Add small amounts of [water] [_____] as required on a hourly basis for a maximum of [3] [_____] hours in order to maintain the test pressure. After [4] [_____] hours, lower the test pressure by [70 kPa 10.2 psi] [[_____] kPa psi]. If the hydrostatic pressure remains steady for [1] [_____] hour, then no leakage is indicated. Inspect for leaks, repair and retest if necessary. Allow piping system to relax for [8] [_____] hours before retesting.

3.15.1.3   Double Containment Primary Piping

Test the primary piping of a double containment piping system in accordance with Subparagraph [Buried Piping] [Exposed Piping] of this paragraph. Pneumatically pressure test secondary containment piping of a double containment piping system in accordance with Subparagraph Double Containment Secondary Piping. Pressure test at the maximum test pressure of [5 psi] [_____] or manufacturer's recommended maximum, [_____] times the maximum pressure rating of the lowest rated component in the piping system. The maximum velocity during filling is [[0.075 m/s 0.25 fps] [[_____] m/s fps] applied over full area of pipe] [in accordance with the manufacturer's instructions]. Pressurize the system initially to [50] [_____] percent of the normal service conditions and inspect. Repair any leaks. Then pressurize the system to the test pressure. Add small amounts of [water] [_____] as required on a hourly basis for a maximum of [3] [_____] hours in order to maintain the test pressure. After [4] [_____] hours, lower the test pressure by [70 kPa 10.2 psi] [[_____] kPa psi]. If the hydrostatic pressure remains steady for [1] [_____] hour, then no leakage is indicated. Inspect for leaks, repair and retest if necessary. Allow piping system to relax for [8] [_____] hours before retesting.

3.15.1.4   Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a delay, underground piping jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Conduct tests for above ground pressure piping after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

3.15.2   Pneumatic Tests

****

NOTE: Do not use pneumatic tests for primary piping of double containment piping systems.

****

Prepare for and conduct pneumatic testing in accordance with the requirements of ASME B31.3. Care must be taken to minimize the chance of a brittle fracture or failure during a pneumatic leak test. Use only non-toxic, nonflammable, inert gases or air.

3.15.2.1   Pressure Relief Device

During pneumatic testing, provide a pressure relief device for each piping section being tested. The device must have a set pressure no higher than the test pressure plus the lesser of [10] [_____] percent of the test pressure or [350 kPa 50.8 psi] [[_____] kPa psi].

3.15.2.2 Pneumatic Testing Procedures

The test fluid must be [air] [_____] and the test pressure must be [110] [_____] percent of the design pressure. Increase test pressure incrementally until the gage pressure reaches the lesser of [50] [_____] percent of the test pressure or [170 kPa 25 psig] [[_____] kPa psig]. Examine piping joints for leakage. If no leakage is occurring, continue to increase the pressure incrementally, while maintaining each incremental increase long enough to equalize pipe strains, until the test pressure is reached. Then reduce the test pressure to the design pressure and maintain for [10] [_____] minutes without additional energy expenditure. If the pneumatic pressure remains steady, then no leakage is indicated. Inspect for and repair leaks, and retest if necessary.

3.15.2.3 Double Containment Secondary Piping

Hydrostatically test the primary piping of a double containment piping system in accordance with Subparagraph [Buried Piping] [Exposed Piping]. Pneumatically pressure test secondary containment piping of a double containment piping system at the maximum test pressure of [5 psi] [_____] or manufacturer's recommended maximum. The test fluid must be [air] [_____]. [Testing procedures must be in accordance with manufacturer's recommendations.] [Increase the test pressure incrementally until the gage pressure reaches [50] [_____] percent of the test pressure. Examine piping joints for leakage. If no leakage is occurring, continue to increase the pressure incrementally, while maintaining each incremental increase long enough to equalize pipe strains, until the test pressure is reached. Then reduce the test pressure to the design pressure and maintain for [10] [_____] minutes without additional energy expenditure. If the pneumatic pressure remains steady, then no leakage is indicated.] Inspect for and repair leaks, and retest if necessary.

3.15.3 Pipe Leakage Tests

Unless approved by the Contracting Officer, conduct leakage testing after the pressure tests have been satisfactorily completed. The duration of each leakage test is at least [2] [_____] hours, and during the test, subject the piping to no less than [1.38 MPa 200 psig] [[_____] MPa psig] pressure. Leakage is defined as the quantity of the test liquid, [water] [_____], that is supplied to the piping system, or any valved or approved section thereof, in order to maintain pressure within [34.5 kPa 5 psi] [[_____] kPa psi] of the specified leakage test pressure after the piping has been filled with the test liquid and all air is expelled. No piping installation will be accepted if leakage exceeds [the values listed in the Pipe Schedule in the contract drawings] [or, if applicable,] [the allowable leakage determined by the following formula:

L = Cf x N x D x P0.5		
Cf	conversion factor	10.786 0.0001351
L	allowable leakage	mm3 per hour gallons per hour
N	number of joints in the length of piping tested	
D	nominal pipe diameter	mm inches

L = Cf x N x D x P0.5		
P	average test pressure during the test	MPa psig

]

Should any test disclose leakage greater than that allowed, locate the leaks and repair until the leakage is within the specified allowance, without additional cost.

3.15.4 Testing New to Existing Connections

Test new piping connected to existing pipe, existing equipment, existing treatment systems, or tanks and treatment systems furnished under other Sections. Isolate the new piping with pipe caps, spectacle blinds, or blind flanges. Test the joint between new piping and existing piping by methods that do not place the entire existing system under the test load. Proceed. then, with the testing of new piping systems as specified herein.

3.15.5 Valve Testing

Submit copies of all field test reports within [24] [_____] hours of the completion of the test. Valves may either be tested while testing pipelines, or as a separate step. Demonstrate that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications. Count and record the number of turns required to open and close each valve, and account for any discrepancies with manufacturer's data. Examine air and vacuum relief valves as the associated pipe is being filled to verify venting and seating is fully functional. Set, verify, and record set pressures for all relief and regulating valves. Test self-contained automatic valves at both maximum and minimum operating ranges, and reset upon completion of test to the design value. [Test automatic valves that are not self-contained in conjunction with control system testing.]

3.16 FINAL CLEANING

3.16.1 Interim Cleaning

Prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. Examine the piping to assure removal of these and other foreign objects prior to assembly and installation.

3.16.2 Flushing

Following assembly and testing, and prior to final acceptance, flush piping systems with [water] [_____] to remove accumulated construction debris and other foreign matter. Flush piping until all foreign matter is removed from the pipeline. Provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity is [0.76 m/s 2.5 fps] [[_____] m/s fps]. For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, clean the pipeline in-place from the inside by brushing and sweeping, then flushing the pipeline at a lower velocity. Install cone strainers in the flushing connections of attached equipment and leave in place until cleaning is completed. Remove accumulated debris through drains, or by removing spools or valves.

3.16.3 Disinfection

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NOTE: Selectively require the Contractor to perform disinfection work for liquid process piping. This should be limited only to processes where bacteriological interferences could damage process equipment.

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Disinfect the [pipelines so noted in the Pipe Schedule in the contract drawings] [following pipelines: [_____]] [_____]. Before acceptance of piping system operation, disinfect each section of completed pipeline [in accordance with AWWA C651] [as specified herein]. After pressure tests have been made, thoroughly flush the piping section to be disinfected with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material must be [liquid chlorine] [calcium hypochlorite] [or] [sodium hypochlorite] [_____]. Ensure the chlorinating material provides a dosage of no less than [50] [_____] ppm and introduce into the piping in an approved manner. [Chlorinate PVC pipe lines using only the above specified chlorinating material in solution.] Do not introduce the agent into the line in a dry solid state. Retain the treated water in the pipe long enough to destroy all non-spore-forming bacteria. Except where a shorter period is approved, the retention time is at least 24 hours and produce no less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. Open and close all valves on the lines being disinfected several times during the contact period. Then flush the line with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, open and close each outlet on the line several times. From several points in the pipeline section, [the Contracting Officer will take samples of water in sterilized containers for bacterial examination] [Contractor personnel, approved by the Contracting Officer, must take samples in sterilized containers and have a bacterial examination performed by a commercial laboratory in accordance with state approved methods. The commercial laboratory must be certified by the state's approving authority for examination of potable water.] Repeat the disinfection until the piping system passes the bacterial examination for [2] [_____] consecutive days. The piping system will not be accepted until satisfactory bacteriological results have been obtained.

3.17 WASTE WATER DISPOSAL

Submit the method proposed for disposal of waste water from hydrostatic tests and disinfection, and all required permits, prior to performing hydrostatic tests. Dispose of water used for testing, cleaning, flushing and/or disinfection in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. Provide the method proposed for disposal of waste water to the Contracting Officer for approval prior to performing any testing, cleaning, flushing and disinfection activities.

3.18 TABLES

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NOTE: The intention of the Table is to give the designer a structure to specify the most suitable piping system materials for a project. The designer

will edit or delete this table to fit the project. Verify that each pipeline designation is identified for the Contractor and the Contracting Officer on the drawings. Consult EM 1110-1-4008 Liquid Process Piping to determine acceptable materials for each application. Allow the Contractor selection of the most economical of the acceptable systems. Table may be shown on the drawings and deleted from this section of the specifications.

As indicated in paragraph 2.16, Double Containment pipe is supplied in different materials of construction. Selection of which depends upon the fluids being handled and other conditions of installation; i.e., underground, above ground, and temperature.

****

TABLE I

PIPE AND FITTING MATERIALS FOR COMMON PIPING SYSTEMS

Item No.	Pipe Material	SERVICE															
		A	B1	B2	C	D1	D2	E1	E2	E3	E4	E5	E6	E7	F	G	H
2.2	DI	x	x	x	x												
2.3	CS	x	x	x	x	x	x			x		x		x		x	
2.4	Lined Steel	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
2.5	SS	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
2.6	Nickel/Nickel Alloys	x	x		x	x	x		x	x	x	x				x	x
2.7	Aluminum	x	x		x	x	x		x	x		x	x		x	x	x
2.8	Copper	x	x	x	x	x	x			x				x	x	x	x
2.9	PVC	x	x					x	x	x	x		x		x	x	
2.10	CPVC	x	x					x	x	x	x		x	x	x	x	
2.11	PVDF	x	x			x		x	x	x	x	x	x		x	x	x
2.12	ABS	x	x					x	x	x							
2.13	PE	x	x				x	x	x	x	x		x		x	x	x
2.14	Rubber/Elastomer	x	x		x				x	x							
2.15	FRP	x	x				x	x	x	x	x	x	x				
2.16	Double Containment	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x

TABLE I
PIPE AND FITTING MATERIALS FOR COMMON PIPING SYSTEMS

Item No.	Pipe Material	SERVICE															
		A	B1	B2	C	D1	D2	E1	E2	E3	E4	E5	E6	E7	F	G	H
LEGEND:																	
A	Underground																
B1	Aboveground: with ambient temperature exposure -25 to plus 45 degrees C -13 to plus 113 degrees F and ultraviolet light exposure																
B2	Aboveground: with heat trace and insulated jacket																
C	Temperature, Greater than 80 degrees C 176 degrees F																
D1	Solvents: non-polar																
D2	Solvents: polar																
E1	Chemical: [strong,][_____] percent [sulfuric][hydrochloric][____] acid																
E2	Chemical: [weak,][_____] percent [sulfuric][hydrochloric][____] acid																
E3	Chemical: [weak,][_____] percent base																
E4	Chemical: [strong,][_____] percent base																
E5	Chemical: [chlorine][_____]																
E6	Chemical: [oxidizing agents][_____]																
E7	Chemical: [sulfate][_____]																
F	POLs																
G	NAPLs																
H	DNAPLs																

3.19 MANUFACTURER'S FIELD SERVICES

Submit a signed statement certifying that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance. Obtain manufacturer's technical assistance for Contractor training, installation inspection, start up, and owner operating and maintenance training. Follow manufacturer's instructions for installation.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-40 05 13.96 (May 2010)**

Preparing Activity: USACE **Superseding**
UFGS-43 02 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 40 05 13.96

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05/10

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-- End of Section Table of Contents --

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SECTION 40 05 13.96

WELDING PROCESS PIPING
05/10

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NOTE: This guide specification covers the requirements for welding of piping and piping system components used for fluids and gases under pressure, including hydraulic systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing
ASNT SNT-TC-1A Q&A Bk A	(2010) Supplement to Recommended Practice No. SNT-TC-1A (Q&A Book): Radiographic Testing Method
ASNT SNT-TC-1A Q&A Bk B	(2007) Supplement to Recommended Practice SNT-TC-1A (Q&A Book): Magnetic Particle Method
ASNT SNT-TC-1A Q&A Bk C	(2011; Text Correction 2011) Supplement to Recommended Practice No. SNT-TC-1A (Q&A Book): Ultrasonic Testing Method
ASNT SNT-TC-1A Q&A Bk D	(2011; Text Correction 2011) Supplement to Recommended Practice No. SNT-TC-1A (Q&A Book): Liquid Penetrant Testing Method

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2024) Power Piping
ASME B31.3	(2022; Errata 2023) Process Piping
ASME B31.4	(2022) Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquid
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B31.8	(2022; Supplement 2022) Gas Transmission and Distribution Piping Systems
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing

	Qualifications
ASME BPVC SEC V	(2017) BPVC Section V-Nondestructive Examination

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0M/A3.0	(2025) Standard Welding Terms and Definitions
AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

1.2 DEFINITIONS AND SYMBOLS

Definitions are in accordance with AWS A3.0M/A3.0. Symbols are in accordance with AWS A2.4.

1.3 PERFORMANCE REQUIREMENTS

****

NOTE: If quality control is to be the responsibility of the Government, delete this paragraph.

The paragraphs will be edited and bracketed portions inserted if necessary to ensure proper implementation of the CONTRACTOR QUALITY CONTROL PROGRAM. The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible; i.e., primarily the Contractor or the Government.

In many cases a project may not require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing, and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, NDE symbols, or other means. The referenced applicable publications will be used for guidance in determining inspection and testing requirements.

The specifications or drawings must clearly indicate which joints require 100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the drawings must indicate the location, number of joints, and minimum

increment length of weld that will be NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods must be subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for NDE should be deleted from these paragraphs and from paragraph Inspection and NDE Personnel.

****

Quality of all joint preparation, welding, and examination is the Contractor's responsibility for. Clearly identify and record all materials used in the welding operations. The inspection and testing defined in this specification are minimum requirements. Additional inspection and testing is the responsibility of the Contractor when it is deemed necessary to achieve the quality required.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pressure Piping; G, [_____]

SD-03 Product Data

Welding Operations

SD-07 Certificates

Qualifications

1.5 QUALIFICATIONS

Welding procedures, welders, and welding operators previously qualified by test may be accepted for the work without requalification, provided that all of the following conditions are fulfilled:

a. Copies of the welding procedures, the procedure qualification test records, and the welder and welding operator performance qualification test records are submitted and approved in accordance with paragraph SUBMITTALS.

b. Testing was performed by an approved testing laboratory or technical consultant or by the Contractor's approved quality assurance organization.

c. The welding procedures, welders, and welding operators were qualified in accordance with ASME BPVC SEC IX, or AWS B2.1/B2.1M, AR-2 level; and base materials, filler materials, electrodes, equipment, and processes conformed to the applicable requirements of this specification.

d. The requirements of paragraph "Renewal of Qualification" below are met and records showing name of employer and period of employment using the process for which qualified are submitted as evidence of conformance.

1.5.1 Welding Procedures Qualification

Record in detail and qualify the Welding Procedure Specifications for every proposed welding procedure. Qualification for each welding procedure must conform to the requirements of [ASME B31.1,] [ASME B31.3,] [ASME B31.4,] [ASME B31.5,] [ASME B31.8,] and to this specification. Specify end preparation for butt welds including cleaning, alignment, and root openings. Provide preheat, interpass temperature control, and postheat treatment of welds as required by approved welding procedures, unless otherwise indicated or specified. Describe the type of backing rings or consumable inserts, if used, and if they are to be removed, describe the removal process. Submit copies of the welding procedure specifications and procedure qualification test results for each type of welding required in accordance with paragraph SUBMITTALS. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds. Identify welding procedures individually and reference on the detail drawings or key to the contract drawings.

1.5.2 Welder and Welding Operator Performance

Provide qualified welder and welding operator assigned to work in accordance with [ASME B31.1,] [ASME B31.3,] [ASME B31.4,] [ASME B31.5,] [

ASME B31.8].

1.5.2.1 Certification

Before assigning welders or welding operators to the work, provide the Contracting Officer with their names together with certification that each individual is performance-qualified as specified. State the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.5.2.2 Identification

Identify each particular weld with the personal number, letter, or symbol assigned to each welder or welding operator. To identify welds, submit written records indicating the location of welds made by each welder or welding operator, and each welder or welding operator must apply the personal mark adjacent to the welds using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Contracting Officer that do not deform the metal. For seam welds, place identification marks adjacent to the welds at 1 m 3 foot intervals. Identification by die stamps or electric etchers will not be allowed.

1.5.2.3 Renewal of Qualification

Requalification of a welder or welding operator is required under any of the following conditions:

a. When a welder or welding operator has not used the specific welding process for a period of 3 months; the period may be extended to 6 months if the welder or welding operator has been employed on some other welding process.

b. When a welder or welding operator has not welded with any process during a period of 3 months, all the personal qualifications are considered expired, including any extended by virtue of a., above.

c. There is specific reason to question the person's ability to make welds that will meet the requirements of the specifications.

d. The welder or welding operator was qualified by an employer, other than those firms performing work under this contract, and a qualification test has not been taken within the preceding 12 months.

e. Renewal of qualification for a specific welding process under conditions a., b., and d., above, needs to be made on only a single test joint or pipe of any thickness, position, or material to reestablish the welder's or welding operator's qualification for any thickness, position, or material covered under previous qualification.

1.5.3 Inspection and NDE Personnel

****

NOTE: If quality control is to be the responsibility of the Government, delete these paragraphs.

Coordinate with paragraph Performance.

****

All inspection and NDE personnel must be qualified in accordance with the following requirements.

1.5.3.1 Inspector Certification

Welding inspectors must be qualified in accordance with AWS QC1.

1.5.3.2 NDE Personnel

Furnish certified NDE personnel, and establish a written procedure for the control and administration of NDE personnel training, examination, and certification. Base the procedures on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A, [ASNT SNT-TC-1A Q&A Bk A] [ASNT SNT-TC-1A Q&A Bk B] [ASNT SNT-TC-1A Q&A Bk C] [and] [ASNT SNT-TC-1A Q&A Bk D].

1.6 REGULATORY REQUIREMENTS

****

NOTE: The drawings should be checked to ensure that any supplementary information required has been shown and that there is no conflict between the drawings and the specifications.

Project drawings must indicate, or text of project specifications must specify, the welding procedures, and size, length, type, and location of the welds, as necessary.

****

This section covers the welding of pressure piping systems. Submit detail drawings showing location, length, and type of welds; and indicating postweld heat treatment and NDE as required. Deviations from applicable codes, approved procedures, and approved detail drawings will not be permitted without prior written approval. Materials or components with welds made offsite will not be accepted if the welding does not conform to the requirements of this specification, unless otherwise specified. Develop procedures for welding all metals included in the work. Do not start welding until welding procedures, welders, and welding operators have been qualified. Perform qualification testing by an approved testing laboratory, or by the Contractor if approved by the Contracting Officer. Notify the Contracting Officer at least 24 hours in advance of the time and place of the tests. When practicable, perform the qualification tests at or near the worksite. Maintain current records of the test results obtained in the welding procedure, welding operator, welder performance qualifications, and nondestructive examination (NDE) procedures readily available at the site for examination by the Contracting Officer. Qualify the procedures for making transition welds between different materials or between plates or pipes of different wall thicknesses. [ASME B31.1,] [ASME B31.3,] [ASME B31.4,] [ASME B31.5,] [ASME B31.8] requirements for branch connections may be used in lieu of detailed designs. Unless otherwise specified, the choice of welding process is the responsibility of the Contractor. Safety precautions must conform to AWS Z49.1.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver all filler metals, electrodes, fluxes, and other welding materials to the site in manufacturers' original packages and stored in a dry space until used. Properly label and design packages to give maximum protection from moisture and to insure safe handling.

1.7.1 Material Control

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NOTE: If additional requirements are necessary regarding limits on out-of-oven exposure time, refer to AWS D1.1/D1.1M.

****

Store materials in a controlled access and clean, dry area that is weathertight and maintained at a temperature recommended by the manufacturer. The materials must not be in contact with the floor and store on wooden pallets or cribbing.

1.7.1.1 Damaged Containers

Store low-hydrogen steel electrodes in their sealed shipping container. If the seal is damaged during shipment or storage, and the damage is not immediately detected, rebake the covered electrodes in that container in accordance with the manufacturer's instructions prior to issuance or discard. If a container is damaged in storage and the damage is witnessed, immediately place the electrodes from that container in a storage oven. Provide storage oven temperature as recommended by the manufacturer or the welding material specification.

1.7.1.2 Partial Issues

When a container of covered electrodes is opened and only a portion of the content is issued, place the remaining portion, within 1/2 hour, in a storage oven.

1.7.2 Damaged Materials

Discard damaged materials. Discard covered electrodes which are oil or water-soaked, dirty, or on which the flux has separated from the wire.

PART 2 PRODUCTS

2.1 MATERIALS

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NOTE: Normally, selection of the electrodes is done by the Contractor. In special cases, if the selection of the proper electrode is critical to the design, the designer may specify the electrodes to be used. In special cases it also may be necessary to specify the welding process.

****

Provide welding materials which comply with ASME BPVC SEC II-C. Provide welding equipment, electrodes, welding wire, and fluxes capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

Perform welding in accordance with qualified procedures using qualified welders and welding operators. Submit detailed procedures which define methods of compliance to contract drawings and specifications. Inspection and material procurement records. System and material testing and certification records. Written records and drawings indicating location of welds made by each welder or welding operator.

Do not perform welding when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Contracting Officer will determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural members must conform to Section 05 05 23.16 STRUCTURAL WELDING.

3.1.1 Base Metal Preparation

Do not use oxy-fuel cutting on austenitic stainless steel or nonferrous materials.

3.1.2 Weld Joint Fit-Up

Fit, align, and retain parts that are to be joined by welding in position during the welding operation by the use of bars, jacks, clamps, or other mechanical fixtures. Do not used welded temporary attachments except when it is impractical to use mechanical fixtures. When temporary attachments are used, they must be the same material as the base metal. Completely remove by grinding or thermal cutting after the welding operation is completed. If thermal cutting is used, cut the attachment no less than 6 mm 1/4 inch from the member and remove the balance by grinding. After the temporary attachment has been removed, visually examine the area.

3.1.3 Preheat and Interpass Temperatures

Provide preheat temperatures meeting the requirements specified by [ASME B31.1,] [ASME B31.3,] [ASME B31.4,] [ASME B31.5,] [ASME B31.8]. However, preheat below 10 degrees C 50 degrees F for ferritic steel or austenitic stainless steel, or 0 degrees C 32 degrees F for nonferrous alloys is not acceptable. Do not exceed maximum interpass temperatures of 149 degrees C 300 degrees F for austenitic stainless steels, nickel alloys, and copper alloys; and 260 degrees C 500 degrees F for carbon steels. Use preheat techniques to ensure that the full thickness of the weld joint preparation and/or adjacent base material, at least 75 mm 3 inches in all directions, is at the specified temperature. Preheating by induction or resistance methods is preferred. When flame heating is used, employ only a neutral flame. Do not use oxy-fuel heating on austenitic stainless steel or nickel-alloy materials; however, air-fuel heating is acceptable if controlled to insure that the surface temperature does not exceed 66 degrees C 150 degrees F. Check interpass temperatures on the surface of the component within 25 mm 1 inch of the weld groove and at the starting location of the next weld pass, and for a distance of about 150 mm 6 inches ahead of the weld, but not on the area to be welded.

3.1.4 Production Welding Instructions

a. Do not perform welding when the ambient temperature is lower than minus 18 degrees C 0 degree F.

b. Welding is not permitted on surfaces that are wet or covered with ice, when snow or rain is falling on the surfaces to be welded, or during periods of high winds, unless the welders and the work are properly protected.

c. Provide welding grade gases for purging and shielding with a dew point of minus 40 degrees C minus 40 degrees F or lower.

d. Back purges are required for austenitic stainless steels and nonferrous alloys welded from one side and set up such that the flow of gas from the inlet to the outlet orifice passes across the area to be welded. The oxygen content of the gas exiting from the purge vent must be less than 2 percent prior to welding.

e. Maintain the purge on groove welds for at least three layers or 5 mm 3/16 inch.

f. Furnish removable purge dam materials made of expandable or flexible plugs, such as plexiglass, plywood (which must be dry when used), etc. Provide wood dams of kiln-dried quality. Provide nonremovable purge dams and purge dam adhesives made of water soluble materials. Purge dams made of polyvinyl alcohol are not permitted.

g. Do not perform any welding process which requires the use of external gas shielding in a draft or wind unless the weld area is protected by a shelter. This shelter must be of material and shape appropriate to reduce wind velocity in the vicinity of the weld to a maximum of 8 km/hour 5 mph (440 fpm).

h. Welding of low-alloy and hardenable high-alloy steels may be interrupted provided a minimum of at least 10 mm 3/8 inch thickness of weld deposit or 25 percent of the weld groove is filled, whichever is greater, and the preheat temperature is maintained during the time that welding is interrupted. If the temperature falls below the minimum preheat temperature before all welding has been completed on a joint, or, where required, before post weld heat treatment, perform a liquid penetrant or magnetic particle examination to insure sound deposited metal before reheating. Welding of other materials may be interrupted without restriction provided a visual inspection is performed before welding is resumed.

i. Taper the ends of tack welds to be incorporated in the final welds by grinding or welding technique. Remove tack welds that are cracked or defective and retack the groove prior to welding. Remove temporary tack welds, ground the surface smooth, and visually inspect. For low-alloy and hardenable high-alloy steels, the area must be magnetic particle examination inspected.

j. When joining ferritic steel pressure piping components to austenitic stainless steel pressure piping components and postweld heat treatment is required, the following requirements apply:

    (1) Butter the weld-end preps of ferritic steel components, which are to be welded to austenitic stainless steel, with one of the following weld filler metals conforming to the specified requirements: ASME BPVC SEC II-C, SFA 5.14, Classification ERNiCr-3; or ASME BPVC SEC II-C, SFA 5.11, Classification ENiCrFe-2.

(2) Butter the ferritic steel weld-end prep, apply a postweld heat treatment as required by [ASME B31.1,] [ASME B31.3,] [ASME B31.4,] [ASME B31.5,] [ASME B31.8] and then machine with the applicable weld-end preparation. After machining, the buttered layer must be a minimum of 6 mm 1/4 inch thick.

(3) Complete pressure piping transition joints using ERNiCr-3 or ENiCrFe-2 weld filler metals. Do not perform further postweld heat treatment.

k. When joining ferritic steel pressure piping components to austenitic stainless steel pressure piping components and postweld heat treatment is not required, prepare and weld the joint using either ERNiCr-3 or ENiCrFe-2 filler metals. For service temperatures of 93 degrees C 200 degrees F or less, stainless filler metal 309 ASME BPVC SEC II-C, SFA 5.4 or 5.9 is permissible in lieu of the nickel-based alloys.

l. Grinding of completed welds is to be performed only to the extent required for NDE, including any inservice examination, and to provide weld reinforcement within the requirements of [ASME B31.1,] [ASME B31.3,] [ASME B31.4,] [ASME B31.5,] [ASME B31.8]. If the surface of the weld requires grinding, avoid reducing the weld or base material below the minimum required thickness. Provide minimum weld external reinforcement flush between external surfaces.

3.1.5 Postweld Heat Treatment

a. Perform postweld heat treatment in accordance with [ASME B31.1,] [ASME B31.3,] [ASME B31.4,] [ASME B31.5,] [ASME B31.8]. Measure temperatures for local postweld heat treatment continuously by thermocouples in contact with the weldment.

b. Perform postweld heat treatment of low-alloy steels, when required, immediately upon completion of welding and prior to the temperature of the weld falling below the preheat temperature. However, postweld heat treatment may be postponed after the completion of the weld, if, immediately after the weld is completed, it is maintained at a minimum temperature of 149 degrees C 300 degrees F or the preheat temperature, whichever is greater, for 2 hours per 25 mm inch of weld thickness.

c. For low-alloy steels, use cooling rates that avoid temper embrittlement.

3.2 EXAMINATIONS, INSPECTIONS, AND TESTS

****

NOTE: Coordinate with paragraph Performance.

Information based on the table must be developed and included in each project specification. The table must clearly define the systems to be inspected and the type of NDE required. The information presented in TABLE I is based on ASME B31.1. Specific project requirements may necessitate revision or expansion. In no case must the degree of testing and type of NDE be less than that required by the standard applicable to the work.

****

Visual and NDE must be performed [by the Government] [by the Contractor] to detect surface and internal discontinuities in completed welds. [Employ the services of a qualified commercial inspection or testing laboratory or technical consultant approved by the Contracting Officer.] Visually inspect all tack welds, weld passes, and completed welds. In addition, perform [magnetic particle] [liquid penetrant] examination on root passes. [Radiographic] [Liquid penetrant] [Magnetic particle] [or] [Ultrasonic] examination is required as indicated in TABLE I. When inspection and testing indicates defects in a weld joint, repair the weld by a qualified welder in accordance with paragraph CORRECTIONS AND REPAIRS.

TABLE I. MANDATORY MINIMUM NONDESTRUCTIVE EXAMINATIONS

Type Weld	Piping Service Conditions and Nondestructive Test		
	Temperatures over 400 degrees C 750 degrees F and at all pressures	Temperatures between 177 degrees C 350 degrees F and 400 degrees C 750 degrees F inclusive and at pressures above 7100 kPa 1025 psig	All others
Butt Welds (Girth and Longitudinal)	RT for NPS over 50 mm 2 inches MT or PT for NPS 50 mm 2 inches and less	RT for over 50 mm 2 inches NPS with thickness over 20 mm 3/4 inch. Visual for all sizes with thickness 20 mm 3/4 inch or less.	Visual for all sizes and thicknesses
Welded Branch Conncetions (Size indicated is branch size) (See Note 7)	RT for NPS over 100 mm 4 inches MT or PT for NPS 100 mm 4 inches and less	RT for over 100 mm 4 inches NPS with thickness over 20 mm 3/4 inch. Visual for all sizes with thickness 20 mm 3/4 inch or less.	Visual for all sizes and thicknesses
Fillet, Socket Attachment and Seal Welds	PT or MT for all sizes and thicknesses	Visual for all sizes and thicknesses	Visual for all sizes and thicknesses

NOTES TO TABLE I

(1) All welds must be given a visual examination in addition to type of specific nondestructive examination specified.

(2) NPS - nominal pipe size.

(3) RT - Radiographic examination; MT - magnetic particle examination; PT - liquid penetrant examination.

TABLE I. MANDATORY MINIMUM NONDESTRUCTIVE EXAMINATIONS	
Type Weld	Piping Service Conditions and Nondestructive Test
(4) RT of branch welds must be performed before any nonintegral reinforcing material is applied.	
(5) The thickness of butt welds is defined as the thicker of the two abutting ends after end preparation.	
(6) Temperatures and pressures shown are design.	
(7) In lieu of radiography of welded branch connections when required above, liquid penetrant or magnetic particle examination is acceptable and, when used, must be performed at the lesser of one half of the weld thickness or each 13 mm 1/2 inch of weld thickness and all accessible final weld surfaces.	
(8) For nondestructive examination of the pressure retaining component, refer to the standards listed in applicable code or the manufacturing specifications.	
(9) Fillet welds not exceeding 6 mm 1/4 inch throat thickness which are used for the permanent attachment of nonpressure retaining parts are exempt from the PT or MT requirements of the above table.	

3.2.1 Random NDE Testing

****

NOTE: Coordinate with paragraph Performance.

This paragraph will be deleted when the Contractor is not required to perform random inspection. Edit to delete any listed NDE method which is inapplicable. Insert a number from 1 to 99 for percent of welds to be random inspected; 10 percent is recommended for most projects.

****

When random [radiographic] [liquid penetrant] [magnetic particle] [or] [ultrasonic] examination is required, test a minimum of [_____] percent of the total length or number of piping welds. Randomly select welds for inspection, but include an examination of welds made by each welding operator or welder in the selection. If the random testing reveals that any welds fail to meet minimum quality requirements, inspect an additional [_____] percent of the welds in that same group. If all of the additional welds inspected meet the quality requirements, accept the entire group of welds represented and repair the defective welds. If any of the additional welds inspected also fail to meet the quality requirements, reject that entire group of welds. Remove and reweld the rejected welds, or 100 percent inspect the rejected welds and remove and reweld all defective weld areas.

3.2.2 Visual Inspection

Visually inspect weld joints as follows:

3.2.2.1 Before Welding

For compliance with requirements for joint preparation, placement of backing rings or consumable inserts, alignment and fit-up, and cleanliness.

3.2.2.2 During Welding

For cracks and conformance to the qualified welding procedure.

3.2.2.3 After Welding

For cracks, contour and finish, bead reinforcement, undercutting, overlap, and size of fillet welds.

3.2.3 NDE Testing

****

NOTE: Delete any NDE method not required. If magnetic particle inspection is required, specify whether wet or dry particle method is appropriate.

****

Perform NDE in accordance with written procedures. Procedures for [radiographic] [liquid penetrant] [magnetic particle] [or] [ultrasonic] tests and methods must conform to ASME BPVC SEC V. Demonstrate the approved procedure to the satisfaction of the Contracting Officer. In addition to the information required in ASME BPVC SEC V, include the timing of the NDE in relation to the welding operations and safety precautions.

3.2.4 Inspection and Tests by the Government

The Government will perform inspection and supplemental nondestructive or destructive tests as deemed necessary. The cost of supplemental NDE will be borne by the Government. Correct and repair defects and reexamine weld repairs at no additional cost to the Government. Inspection and tests will be performed as required for visual inspection and NDE, except that destructive tests may be required also. When destructive tests are ordered by the Contracting Officer and performed by the Contractor, and the specimens or other supplemental examinations indicate that the materials and workmanship do not conform to the contract requirements, the cost of the tests, corrections, and repairs are borne by the Contractor. When the specimens or other supplemental examinations of destructive tests indicate that materials or workmanship do conform to the specification requirements, the cost of the tests and repairs will be borne by the Government. When destructive tests are made, repairs must be made by qualified welders or welding operators using welding procedures which will develop the full strength of the members cut. Welding is subject to inspection and tests in the mill, shop, and field. When materials or workmanship do not conform to the specification requirements, the work may be rejected at any time before final acceptance of the system containing the weldment.

3.3 ACCEPTANCE STANDARDS

****

NOTE: These acceptance standards were taken from ASME B31.1 and are suitable for most jobs. Evaluations of indications, as given in ASME B31.1, are applicable to these standards. Specific project design requirements may necessitate revision or expansion to cover different items of work and varying standards of acceptance. In no case must the acceptance criteria be less conservative than the criteria specified by the standard applicable to

the work. The 5 mm 3/16 inch dimension specified in sub item c is based on TABLE 127.4.2 of ASME B31.1 for temperatures less than 177 degrees C 350 degrees F and thicknesses less than 25 mm 1 inch. If actual conditions exceed these limits, this requirement must be expanded or revised as required.

****

3.3.1 Visual

The following indications are unacceptable:

a. Cracks.

b. Undercut on surface which is greater than 1 mm 1/32 inch deep.

c. Weld reinforcement greater than 5 mm 3/16 inch.

d. Lack of fusion on surface.

e. Incomplete penetration (applies only when inside surface is readily accessible).

f. Convexity of fillet weld surface greater than 10 percent of longest leg plus 0.76 mm 0.03 inch.

g. Concavity in groove welds.

h. Concavity in fillet welds greater than 2 mm 1/16 inch.

i. Fillet weld size less than indicated or greater than 1.25 times the minimum indicated fillet leg length.

3.3.2 Magnetic Particle Examination

The following relevant indications are unacceptable:

a. Any cracks and linear indications.

b. Rounded indications with dimensions greater than 5 mm 3/16 inch.

c. Four or more rounded indications in a line separated by 2 mm 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 3870 square mm 6 square inches of surface with the major dimension of this area not to exceed 150 mm 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

3.3.3 Liquid Penetrant Examination

Indications with major dimensions greater than 2 mm 1/16 of an inch are considered relevant. The following relevant indications are unacceptable:

a. Any cracks or linear indications.

b. Rounded indications with dimensions greater than 5 mm 3/16 inch.

c. Four or more rounded indications in a line separated by 2 mm 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 3870 square mm 6 square inches of surface with the major dimension of this area not to exceed 150 mm 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

3.3.4 Radiography

Welds that are shown by radiography to have any of the following discontinuities are unacceptable:

a. Porosity in excess of that shown as acceptable in ASME BPVC SEC I, Appendix A-250.

b. Any type of crack or zone of incomplete fusion or penetration.

c. Any other elongated indication which has a length greater than:

    (1) 6 mm 1/4 inch for "t" up to 19 mm 3/4 inch inclusive. Where "t", here and below, pertains to the thickness of the weld being examined; if a weld joins two members having different thickness at the weld, "t" is the thinner of these two thicknesses.

    (2) 1/3 "t" for "t" from 19 mm 3/4 inch to 57 mm 2-1/4 inch, inclusive.

    (3) 19 mm 3/4 inch for "t" over 57 mm 2-1/4 inch.

d. Any group of indications in line that have an aggregate length greater than "t" in a length of "12t", except where the distance between the successive indications exceeds 6L where L is the longest indication in the group.

3.3.5 Ultrasonic Examination

Where discontinuities are interpreted to be cracks, lack of fusion, and incomplete penetration, they are unacceptable regardless of length. Linear-type discontinuities are unacceptable if the amplitude exceeds the reference level and discontinuities have lengths which exceed the following:

a. 6 mm 1/4 inch for "t" up to 19 mm 3/4 inch. Where "t", here and below, is the thickness of the weld being examined; if the weld joins two members having different thicknesses at the weld, "t" is the thinner of these two thicknesses.

b. 8 mm 1/3 inch for "t" from 19 to 57 mm 3/4 to 2-1/4 inch.

c. 19 mm 3/4 inch for "t" over 57 mm 2-1/4 inch.

3.4 CORRECTIONS AND REPAIRS

Remove and repair defects as specified in [ASME B31.1,] [ASME B31.3,] [ASME B31.4,] [ASME B31.5,] [ASME B31.8] unless otherwise specified. Repair disqualifying defects discovered between weld passes before additional weld material is deposited. Wherever a defect is removed, and repair by welding is not required, blend the affected area into the surrounding surface eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, examine the area by the same test method which first revealed the defect to ensure that the defect has been eliminated. After rewelding, reexamine the repaired area by the same test method originally used for that area. Regard any indication of a defect as a defect unless reevaluation by NDE or by surface conditioning shows that no disqualifying defects are present. The use of any foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-40 17 26.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15216N (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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WELDING PRESSURE PIPING

04/06

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USACE / NAVFAC / AFCEC **UFGS-40 17 26.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15216N (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 40 17 26.00 20

WELDING PRESSURE PIPING

04/06

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NOTE: This guide specification covers the requirements for welding of piping and piping system components which will contain fluids under pressure including hydraulic systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Piping materials, components, and supports are specified in other sections of the project specifications.

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NOTE: The following information must be shown on the project drawings:

1. Tensile strength, elongation, shear strength, size, length, type, and location of the welds, as necessary.

2. The project drawings should be checked to ensure that any supplementary information required by the

paragraphs has been shown and that there is no conflict between the drawings and the specifications. See also Note in DEFINITIONS. The project drawings must indicate, or text of the project specifications must specify, the tensile strength, elongation, shear strength, size, length, type, and location of the welds, as necessary.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Std 1104	(2013; Errata 1-3 2014; Addendum 1 2014; Errata 4 2015; Addendum 2 2016) Welding of Pipeline and Related Facilities

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2024) Power Piping
ASME B31.3	(2022; Errata 2023) Process Piping
ASME B31.4	(2022) Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquid

ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B31.9	(2020) Building Services Piping
ASME BPVC SEC I	(2017) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-C	(2017) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC V	(2017) BPVC Section V-Nondestructive Examination

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0M/A3.0	(2025) Standard Welding Terms and Definitions
AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction

1.2 RELATED REQUIREMENTS

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NOTE: The project drawings should be checked to ensure that any supplementary information required by the paragraphs has been shown and that there is no conflict between the drawings and the specifications.

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Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section with the additions and modifications specified herein.

1.3 DEFINITIONS

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NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph REFERENCES, may be used.

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AWS A3.0M/A3.0 [and applicable ANSI piping documents].

1.4 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Welding Pressure Piping

SD-07 Certificates

Welding Procedures Qualification

Nondestructive Examination (NDE) Procedures

NDE personnel Certification Procedures

Inspector Certification

Submit inspector certification and NDE personnel certification for record.

SD-11 Closeout Submittals

Weld Identifications

1.5 QUALITY ASSURANCE

1.5.1 Welding Pressure Piping

Show location, length, and type of welds, and indicate postweld heat treatment and nondestructive testing as required.

1.5.2 Procedures

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NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph REFERENCES, may be used.

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Develop and qualify procedures for welding metals included in the work. Do not start welding until welding procedures, welders, and welding operators have been qualified. Perform qualification testing by an approved testing laboratory, or by the Contractor if approved by the Contracting Officer in accordance with the qualified procedures. Notify the Contracting Officer at least 24 hours in advance of the time and place of the tests. When practicable, perform the qualification tests at or near the work site. Maintain current records of the test results obtained in welding procedure, welding operator/welder performance qualifications, and nondestructive examination (NDE) procedures. These records must be readily available at the site for examination by the Contracting Officer.Qualify the procedures for making transition welds between different materials or between plates or pipes of different wall thicknesses. [ANSI Piping] [_____] requirements for branch connections may be used in lieu of detailed designs. Unless otherwise specified, the choice of welding process must be the responsibility of the Contractor.

1.5.2.1 Previous Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for the work without requalification provided that the following conditions are fulfilled:

a. Copies of welding procedures, procedure qualification test records, and welder and welding operator performance qualification test records are submitted and approved in accordance with the paragraph SUBMITTALS.

b. Testing was performed by an approved testing laboratory or technical consultant or by the Contractor's approved quality control organization.

c. The welding procedures, welders, and welding operators were qualified in accordance with ASME BPVC SEC IX or AWS B2.1/B2.1M, AR-2 level; and base materials, filler materials, electrodes, equipment, and processes conformed to the applicable requirements of this specification.

d. The requirements of paragraph WELDER AND WELDING OPERATOR PERFORMANCE QUALIFICATION for renewal of qualification were met, and records showing name of employer and period of employment using the process for which qualified are submitted as evidence of conformance.

1.5.2.2 Performance

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NOTE: The paragraphs will be edited and inserted if necessary to ensure proper implementation of the "CONTRACTOR QUALITY CONTROL PROGRAM." The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible, i.e., primarily the Contractor or the Government. If quality control is to be the responsibility of the Government, delete paragraphs PERFORMANCE and QUALIFICATION OF INSPECTION AND (NDE) PERSONNEL through NDE PERSONNEL CERTIFICATION PROCEDURES and renumber paragraphs as necessary. Rarely will a project require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, nondestructive test symbols, or other means. The specifications or project drawings must clearly indicate which joints require 100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the project drawings must indicate the location, number of joints, and minimum increment length of weld that will be subject to NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods must be subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for nondestructive examinations should be deleted from these paragraphs and from paragraph QUALIFICATION OF INSPECTION AND (NDE) PERSONNEL.

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The Contractor must be responsible for the quality of joint preparation, welding, and examination. Clearly identify and record materials used in the welding operations. The examination and testing defined in this specification are minimum requirements. Provide additional examination and testing as necessary to achieve the quality required.

1.5.3 Welding Procedures Qualification

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NOTE: The project drawings must indicate, or text of the project specifications must specify, the tensile strength, elongation, shear strength, size, length, type, and location of the welds, as necessary.
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NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph REFERENCES, may be used.
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Qualification of the welding procedures for each group of materials to be welded is required as indicated in ASME BPVC SEC IX. Record in detail and qualify the "Welding Procedure Specifications" for every welding procedure proposed. Qualification for each welding procedure must conform to the requirements of ANSI Standards and to this specification. The welding procedures must specify end preparation for welds, including cleaning, alignments, and root openings. Preheat, interpass temperature control, and postheat treatment of welds must be as required by ANSI Piping documents, unless otherwise indicated or specified. Describe the type of backing rings or consumable inserts, if used, and, if they are to be removed, the removal process. Welding procedure qualifications must be identified individually and referenced on the shop drawings or suitably keyed to the contract drawings.

1.5.4 Welder and Welding Operator Performance Qualification

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NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph REFERENCES, may be used.
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Qualify each welder and welding operator assigned to work covered by this specification by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires from the same specification, classification, or group number that will be encountered on his assignment. Welders or welding operators who make acceptable procedure qualification tests will be considered performance-qualified for the welding procedure used. Determine performance qualification in accordance with [ASME BPVC SEC IX, [ANSI Piping Standards]] [_____] and as specified.

1.5.5 Renewal of Qualification

Requalification of a welder or welding operator must be required under one or any combination of the following conditions:

a. When a welder or welding operator has not used the specific welding process for a period of 3 months. The period may be extended to 6 months if the welder has been employed on another welding process.

b. There is specific reason to question the welder's ability to make welds that will meet the requirements of the specifications.

c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract and a qualification test has not been taken within the preceding 12 months. Renewal of qualification under this condition need be made on only a single test joint or pipe of any thickness, position, or material to reestablish qualification for any thickness, position, or material for which the welder or welding operator had qualified previously.

1.5.6 Qualification of Inspection and (NDE) Personnel

Qualification of Inspection and Nondestructive Examination (NDE) Personnel: Qualify inspection and nondestructive examination personnel in accordance with the following requirements:

1.5.6.1 Inspector Certification

Qualify welding inspectors in accordance with AWS QC1.

1.5.6.2 NDE Personnel Certification Procedures

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NOTE: The paragraphs will be edited and inserted if necessary to ensure proper implementation of the "CONTRACTOR QUALITY CONTROL PROGRAM." The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible, i.e., primarily the Contractor or the Government. If quality control is to be the responsibility of the Government, delete paragraphs PERFORMANCE and QUALIFICATION OF INSPECTION AND (NDE) PERSONNEL through NDE PERSONNEL CERTIFICATION PROCEDURES and renumber paragraphs as necessary. Rarely will a project require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, nondestructive test symbols, or other means. The referenced applicable publications and Army Technical Manual, "Welding Design, Procedures and Inspection," TM-5-805-7, will be used for guidance in determining inspection and testing requirements. The specifications or project drawings must clearly indicate which joints require 100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the project drawings must indicate the location, number of joints, and minimum increment length of weld that will be subject to NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods must be subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for nondestructive examinations should be deleted from

these paragraphs and from paragraph QUALIFICATION OF INSPECTION AND (NDE) PERSONNEL.

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Certify NDE personnel and establish a written procedure for the control and administration of NDE personnel training, examination, and certification. Base procedures on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A, [Supplement A-Radiographic] [Supplement B-Magnetic particle] [Supplement C-Ultrasonic] [and] [Supplement D-Liquid Penetrant].

1.5.6.3 Welding Procedures and Qualifications

a. Specifications and Test Results: Submit copies of the welding procedure specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

b. Certification: Before assigning welders or welding operators to the work, submit their names, together with certification that each individual is performance qualified as specified. Do not start welding work prior to procedure qualification. The certification must state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.5.7 Symbols

Conform to AWS A2.4.

1.5.7.1 Weld Identifications

Submit a list of the welders' names and symbol for each welder. To identify welds, submit written records indicating the location of welds made by each welder or welding operator.

1.5.8 Safety

Conform to AWS Z49.1, 29 CFR 1910-SUBPART Q, "Welding, Cutting, and Brazing," 29 CFR 1926-SUBPART J, "Welding and Cutting."

1.6 ENVIRONMENTAL

Do not perform welding when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Contracting Officer will determine when weather or working conditions are unsuitable for welding.

1.7 DELIVERY AND STORAGE

Deliver filler metals, electrodes, fluxes and other welding materials to the site in manufacturers' original packages and store in a dry space until used. Label and design packages properly to give maximum protection from moisture and to assure safe handling.

PART 2 PRODUCTS

2.1 WELDING MATERIALS

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NOTE: Normally, selection of the electrodes is done by the Contractor as part of his qualified welding procedure. In special cases, if the selection of the proper electrode is critical to the design, the designer may specify the electrodes to be used. In special cases it also may be necessary to specify the welding process.

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Comply with ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes must be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

PART 3 EXECUTION

3.1 WELDING

Do not deviate from applicable codes, approved procedures and approved shop drawings without prior written approval from the Contracting Officer. Materials or components with welds made off the site will not be accepted if the welding does not conform to the requirements of this specification unless otherwise specified. Assign each welder or welding operator an identifying number, letter, or symbol that must be used to identify his welds. Each welder or welding operator must apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, place identification marks adjacent to the welds at one meter 3 foot intervals. Confine identification by die stamps or electric etchers to the weld reinforcing crown, preferably in the finished crater.

3.2 WELDING OPERATORS

Perform welding in accordance with qualified procedures using qualified welders and welding operators.

3.3 SUPPORTS

Welding of hangers, supports, and plates to structural members must conform to AWS D1.1/D1.1M.

3.4 EXAMINATIONS AND TESTS

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NOTE: The paragraphs will be edited and inserted if necessary to ensure proper implementation of the "CONTRACTOR QUALITY CONTROL PROGRAM." The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible, i.e., primarily the Contractor or the Government. If quality control is to be the responsibility of the Government, delete paragraphs PERFORMANCE and QUALIFICATION OF INSPECTION AND

(NDE) PERSONNEL through NDE PERSONNEL CERTIFICATION PROCEDURES and renumber paragraphs as necessary. Rarely will a project require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, nondestructive test symbols, or other means. The referenced applicable publications and Army Technical Manual, "Welding Design, Procedures and Inspection," TM-5-805-7, will be used for guidance in determining inspection and testing requirements. The specifications or project drawings must clearly indicate which joints require 100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the project drawings must indicate the location, number of joints, and minimum increment length of weld that will be subject to NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods must be subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for nondestructive examinations should be deleted from these paragraphs and from paragraph QUALIFICATION OF INSPECTION AND (NDE) PERSONNEL."

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NOTE: Information based on the two tables must be developed and included in each project specification. Tables must clearly define the systems to be inspected and the type of NDE required. Specify 100 percent NDE when required by UFC 3-460-01, "Design: Petroleum Fuel Facilities" and 49 CFR 195, as covered by paragraph "Piping Subject to 100 percent NDE."

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Visual and nondestructive examinations must be performed [by the Government] [by the Contractor] to detect surface and internal discontinuities in completed welds. [Employ the services of a qualified commercial inspection or testing laboratory or technical consultant approved by the Contracting Officer.] Visually examine welds [Radiographic,] [Liquid penetrant,] [Magnetic particle,] [or] [Ultrasonic] examination must be required as indicated in Tables [IV] [and] [V] attached to this section [or in accordance with other sections where detailed requirements are specified]. Random NDE testing applies to ASME B31.3 and ASME B31.4 piping unless specified otherwise. When examination and testing indicates defects in a weld joint, a qualified welder must repair the weld in accordance with the paragraph CORRECTIONS AND REPAIRS of this section.

3.4.1 Random NDE Testing

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NOTE: The paragraphs will be edited and inserted if necessary to ensure proper implementation of the

"CONTRACTOR QUALITY CONTROL PROGRAM." The specification writer or design engineer must indicate how much quality control of welding is needed for each project and who is to be responsible, i.e., primarily the Contractor or the Government. If quality control is to be the responsibility of the Government, delete paragraphs QUALIFICATION OF INSPECTION AND (NDE) PERSONNEL through NDE PERSONNEL CERTIFICATION PROCEDURES and renumber paragraphs as necessary. Rarely will a project require 100 percent testing of welds by NDE methods. The designer must determine the required methods and the extent of inspection and testing and must indicate the extent in this or other sections of the project specifications or on the project drawings by notes, nondestructive test symbols, or other means. The referenced applicable publications and Army Technical Manual, "Welding Design, Procedures and Inspection," TM-5-805-7, will be used for guidance in determining inspection and testing requirements. The specifications or project drawings must clearly indicate which joints require 100 percent NDE inspection, which joints require random NDE inspection, and which NDE methods are to be employed for each joint. For random inspection, the project drawings must indicate the location, number of joints, and minimum increment length of weld that will be subject to NDE inspection without predisclosing the exact spots to be examined. Joints not indicated to be tested by NDE methods must be subject to visual inspection only. In cases where the nature of the welding is such as to require visual inspection only, the requirements for nondestructive examinations should be deleted from these paragraphs and from paragraph QUALIFICATION OF INSPECTION AND (NDE) PERSONNEL.

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NOTE: This paragraph will be deleted when the Contractor is not required to perform random inspection. Edit to delete any listed nondestructive test method which is inapplicable. Insert a number from 1 to 99 for percent of welds to be randomly inspected; 10 percent is recommended for most projects.

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When [radiographic,] [liquid penetrant,] [magnetic particle,] [or] [ultrasonic] examination is required, test a minimum of [10] [_____] percent of the total length or number of piping welds. Randomly select the welds examined, but include an examination of welds made by each welding operator or welder. If random testing reveals that a weld fails to meet minimum quality requirements, examine an additional [10] [_____] percent of the welds in that same group. If the additional welds examined meet the quality requirements, the entire group of welds represented must be accepted and the defective welds must be repaired. If any of the additional welds examined also fail to meet the quality requirements, that entire group of welds must be rejected. Remove and reweld rejected welds or examine rejected welds 100 percent and remove and reweld defects.

3.4.2 Visual Examination

Visually examine welds as follows:

a. Before welding -- for compliance with requirements for joint preparation, placement of backing rings or consumable inserts, alignment and fit-up, and cleanliness.

b. During welding -- for conformance to the qualified welding procedure.

c. After welding -- for cracks, contour and finish, bead reinforcement, undercutting, overlap, and size of fillet welds.

3.4.3 Nondestructive Examination

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NOTE: Delete any nondestructive test method not required. If magnetic particle inspection is required, specify whether wet or dry particle method is appropriate.

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NDE must be in accordance with written procedures. Procedures for [radiographic,] [liquid penetrant,] [magnetic particle,] [or] [ultrasonic] tests and methods must conform to ASME BPVC SEC V. The approved procedure must be demonstrated to the satisfaction of the Contracting Officer's QA personnel. In addition to the information required in ASME BPVC SEC V, the written procedures must include:

a. Timing of the nondestructive examination in relation to the welding operations.

b. Safety precautions.

3.4.4 Examinations and Tests by the Government

Examinations and tests will conform to paragraphs "Visual Examination" and "Nondestructive Examination" of this section, except that destructive tests may be required also. When destructive tests are made, qualified welders or welding operators must make repairs using welding procedures which will develop the full strength of the members cut. Welding must be subject to examination and tests in the mill, shop, and field.

3.4.5 Piping Subject to 100 Percent NDE

ASME B31.4 [and ASME B31.3] Piping Subject to 100 Percent NDE: 100 percent of each day's girth welds installed in the following locations must be nondestructively examined 100 percent by radiographic, magnetic particle, or liquid penetrant examination unless impracticable, in which case at least 90 percent must be examined. Nondestructive examination must be impracticable for each girth weld not examined.

a. At onshore locations where a loss of hazardous liquid (petroleum, petroleum products, or anhydrous ammonia) could reasonably be expected to pollute stream, river, lake, reservoir, or other body of water, and any offshore area;

b. Within railroad or public road rights-of-way;

c. At overhead road crossings and within tunnels;

d. Within the limits of any incorporated subdivision of a State government; and

e. Within populated areas, including, but not limited to, residential subdivisions, shopping centers, schools, designated commercial areas, industrial facilities, public institutions, and places of public assembly.

3.5 ACCEPTANCE STANDARDS

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NOTE: These acceptance standards are taken from ASME B31.1 and are suitable for most jobs. Evaluations of indications as given in ASME B31.1 are applicable to these standards. Visual acceptance standards are given for some other piping codes. It should be noted that specific project design requirements may necessitate revision or expansion to cover different items of work and varying standards of acceptance.

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3.5.1 Visual

The following indications are unacceptable:

a. Cracks--external surface.

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NOTE: In the text below, if only ASME B31.3 is applicable, delete all text in brackets. For ASME B31.3 under normal service conditions, use 25 percent with text in brackets and omit last sentence in brackets. For ASME B31.4 use 12.5 percent, and add the material in brackets pertaining to B31.4. Consider use of ASME B31.1 acceptance standard for codes other than B31.3 and B31.4.

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b. Undercut on surface which is greater than 1.00 mm 1/32 inchdeep [or [25 percent for ASME B31.3] [and] [12.5 percent for ASME B31.4 and ASME B31.9] of the wall thickness, whichever is less,] provided that the remaining wall thickness is not less than the minimum design thickness. [For ASME B31.4 and in accordance with API Std 1104, undercuts over 0.40 mm through 0.80 mm 1/64 inch through 1/32 inch or over 6 to 12.5 percent of the pipe wall thickness, whichever is smaller, must not exceed 51 mm 2 inches in a continuous weld length of 305 mm 12 inches or 1/6 the length of the weld, whichever is smaller; and undercuts 0.40 mm 1/64 inch or 6 percent of the wall thickness, whichever is smaller, are acceptable regardless of length.]

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NOTE: Include Tables I, II, or III below as applicable to project.

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c. Weld reinforcement:

(1) ASME B31.1, conform to Table I.

TABLE I REINFORCEMENT OF GIRTH AND LONGITUDINAL BUTT WELDS			
	Maximum Thickness of Reinforcement for Design Temperature		
Thickness of Base Metal, millimeters (mm)	Greater than 400 degrees C	175 degrees C - 400 degrees C	Less than 175 degrees C
	mm	mm	mm
Up to 3.00, incl.	2.00	2.50	5.00
Over 3.00 to 5.00, incl.	2.00	3.00	5.00
Over 5.00 to 13.00, incl.	2.00	4.00	5.00
Over 13.00 to 25.00, incl.	2.50	5.00	5.00
Over 25.00 to 50.00, incl.	3.00	6.00	6.00
Over 50.00	4.00	The greater of 6 mm or 1/8 times the width of the weld in mm.	
NOTES:			
1. For double welded butt joints, this limitation on reinforcement given above must apply separately to both inside and outside surfaces of the joint.			
2. For single welded butt joints, the reinforcement limits given above must apply to the outside surface of the joint only.			
3. The thickness of weld reinforcement must be based on the thickness of the thinner of the materials being joined.			
4. The weld reinforcement thicknesses must be determined from the higher of the abutting surfaces involved.			
5. Weld reinforcement may be removed if so desired.			

TABLE I REINFORCEMENT OF GIRTH AND LONGITUDINAL BUTT WELDS			
	Maximum Thickness of Reinforcement for Design Temperature		
Thickness of Base Metal, inches	Greater than 750 degrees F	350 degrees F - 750 degrees F	Less than 350 degrees C
	inch	inch	inch
Up to 1/8, incl.	1/16	3/32	3/16
Over 1/8 to 3/16, incl.	1/16	1/8	3/16
Over 3/16 to 1/2, incl.	1/16	5/32	3/16
Over 1/2 to 1, incl.	3/32	3/16	3/16
Over 1 to 2, incl.	1/8	1/4	1/4
Over 2	5/32	The greater of 1/4 inch or 1/8 times the width of the weld in inches.	
NOTES:			
1. For double welded butt joints, this limitation on reinforcement given above must apply separately to both inside and outside surfaces of the joint.			
2. For single welded butt joints, the reinforcement limits given above must apply to the outside surface of the joint only.			
3. The thickness of weld reinforcement must be based on the thickness of the thinner of the materials being joined.			
4. The weld reinforcement thicknesses must be determined from the higher of the abutting surfaces involved.			
5. Weld reinforcement may be removed if so desired.			

(2) ASME B31.3, conform to Table II.

TABLE II	
Wall Thickness, mm	Height, mm
Less than or equal to 6.40	Less than or equal to 1.60

TABLE II	
Wall Thickness, mm	Height, mm
Greater than 6.40, is less than or equal to 12.70	Less than or equal to 3.20
Greater than 12.70, is less than or equal to 25.40	Less than or equal to 4.00
Greater than 25.40	Less than or equal to 4.80
NOTES:	
1. Wall thickness is the nominal wall thickness of the thinner of components joined by butt weld.	
2. Height: For "Normal Service" and "Severe Cyclic" conditions, use the listed value. For "Category D Fluid Service," use twice the listed value. Measure from surfaces of adjacent components. The lesser of the two measurements, in any plane through the weld, must not exceed the applicable value at right. Weld metal must merge smoothly into component surfaces.	

TABLE II	
Wall Thickness, inches	Height, inches
Less than or equal to 1/4	Less than or equal to 1/16
Greater than 1/4, is less than or equal to 1/2	Less than or equal to 1/8
Greater than 1/2, is less than or equal to 1	Less than or equal to 5/32
Greater than 1	Less than or equal to 3/16
NOTES:	
1. Wall thickness is the nominal wall thickness of the thinner of components joined by butt weld.	
2. Height: For "Normal Service" and "Severe Cyclic" conditions, use the listed value. For "Category D Fluid Service," use twice the listed value. Measure from surfaces of adjacent components. The lesser of the two measurements, in any plane through the weld, must not exceed the applicable value at right. Weld metal must merge smoothly into component surfaces.	

(3) ASME B31.4, conform to Table I for under 175 degrees C 350 degrees F.

(4) ASME B31.5, conform to Table III.

TABLE III	
Pipe Wall Thickness, mm	Reinforcement Thickness, mm
6.40 and under	1.60
Over 6.40 through 12.70	2.40
Over 12.70, through 25.40	3.20
Over 25.40	4.80

TABLE III	
Pipe Wall Thickness, inches	Reinforcement Thickness, inches
1/4 and under	1/16
Over 1/4 through 1/2	3/32
Over 1/2, through 1	1/8
Over 1	3/16

(5) ASME B31.9: Thickness of weld reinforcement must not exceed 4.80 mm 3/16 inch.

d. Lack of fusion on surface.

e. Incomplete penetration (applies only when inside surface is readily accessible).

f. Convexity of fillet weld surface greater than 10 percent of longest leg plus 1.0 mm 0.03 inch.

g. Concavity in groove welds.

h. Concavity in fillet welds greater than 2.0 mm 1/16 inch.

i. Fillet weld size less than indicated or greater than 1 1/4 times the minimum specified fillet leg length.

3.5.2 Magnetic Particle Examination

The following relevant indications are unacceptable:

a. Any cracks and linear indications.

b. Rounded indications with dimensions greater than 5.0 mm 3/16 inch.

c. Four or more rounded indications in a line separated by 2.0 mm 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 3870 square mm 6 square inches of surface, with the major dimension of this area not to exceed 150 mm 6 inches, with the area taken in the most unfavorable location relative to the indications being evaluated.

3.5.3 Liquid Penetrant Examination

Indications whose major dimensions are greater than 2.0 mm 1/16 inch must be considered relevant. The following relevant indications are unacceptable:

a. Any cracks or linear indications.

b. Rounded indications with dimensions greater than 5.0 mm 3/16 inch.

c. Four or more rounded indications in a line separated by 2.0 mm 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 3870 square mm 6 square inches of surface, with the major dimension of this area not to exceed 150 mm 6 inches, with the area taken in the most unfavorable location relative to the indications being evaluated.

3.5.4 Radiography

Welds that are shown by radiography to have any of the following discontinuities are unacceptable:

a. Any type of crack or zone of incomplete fusion or penetration.

b. Any other elongated indication which has a length greater than:

  (1) 6.0 mm 1/4 inch for t up to 19.0 mm 3/4 inch, inclusive;

  (2) 1/3 t for t from 19.0 mm 3/4 inch to 57.00 mm 2 1/4 inches, inclusive;

  (3) 19.00 mm 3/4 inch for t over 57.00 mm 2 1/4 inches where t is the thickness of the thinner portion of the weld.

("t" pertains to the thickness of the weld being examined. If a weld joins two members having different thickness at the weld, "t" is the thinner of these two thicknesses.)

c. Any group of indications in line that have an aggregate length greater than t in a length of 12t, except where the distance between the successive indications exceeds 6L where L is the longest indication in the group.

d. Porosity in excess of that shown acceptable in Appendix A-250, Acceptance Standard for Radiographically Determined Rounded Indications in Welds, ASME BPVC SEC I.

3.5.5 Ultrasonic Examination

Permitted for ASME B31.3 and ASME B31.4 piping only. Linear type discontinuities are unacceptable if the amplitude exceeds the reference level and discontinuities have lengths which exceed the following:

a. 6.0 mm 1/4 inch for t up to 19.0 mm 3/4 inch

b. 1/3 t for t from 19.0 mm 3/4 inch to 57.0 mm 2 1/4 inches

c. 19.0 mm 3/4 inch for t over 57.0 mm 2 1/4 inches

("t" is the thickness of the weld being examined. If the weld joins two members having different thickness at the weld, "t" is the thinner of these two thicknesses. Discontinuities are interpreted to be cracks, lack of fusion, and incomplete penetration are unacceptable regardless of length.)

3.6 CORRECTIONS AND REPAIRS

****

NOTE: Insert the applicable ANSI piping codes. ANSI B31.2, "Fuel Gas Piping," and ASME B31.8, "Gas Transmission and Distribution Piping Systems," not listed under paragraph REFERENCES, may be used.

****

Remove defects and replace welds as specified in [ANSI Piping Standards] [_____], unless otherwise specified. Repair defects discovered between weld passes before additional weld material is deposited. Wherever a defect is removed, and repair by welding is not required, the affected area must be blended into the surrounding surface eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, reexamine the area by the same test methods which first revealed the defect to ensure that the defect has been eliminated. After rewelding, reexamine the repaired area by the same test methods originally used for that area. For repairs to base material, the minimum examination must be the same as required for butt welds. Indication of a defect must be regarded as a defect unless reevaluation by NDE or by surface conditioning shows that no unacceptable indications are present. The use of foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

****

NOTE: Regarding Table IV, information based on the table must be developed and included in each project specification. Tables must clearly define the systems to be inspected and the type of NDE required. Specify 100 percent NDE when required by UFC 3-460-01, "Design: Petroleum Fuel Facilities" and 49 CFR 195, as covered by paragraph "Piping Subject to 100 Percent NDE." Where appears, select 100 percent or random but not both.

****

TABLE IV - EXAMINATIONS AND TESTS FOR VARIOUS MATERIALS AND SERVICES				
Examinations or Tests Required				
Material or Application	Visual	Radiographic	[Magnetic Particle] [or] [Liquid Penetrant]	Ultrasonic
High-alloy austenitic or nickel steels or nickel alloys for cryogenic service and vacuum service				
a. Tack welds	Yes	No	No No	
b. Root passes	Yes	No	Yes No	
c. Intermediate passes	Yes	No	No No	
d. Completed weld	Yes	100 percent for DN over 32 mm 60 percent for DN 32mm and less 100 percent for NPS over 1-1/4 inches 60 percent for NAPA PS 1-1/4 inches and less	Yes(PT only); 50 mm 1/2 inch and over	Yes for wall thickness
High-alloy austenitic or nickel steels or nickel alloys for other than cryogenic or vacuum service				
a. Tack welds	Yes	No	No No	

TABLE IV - EXAMINATIONS AND TESTS FOR VARIOUS MATERIALS AND SERVICES

Examinations or Tests Required

Material or Application	Visual	Radiographic	[Magnetic Particle] [or] [Liquid Penetrant]	Ultrasonic
b. Root passes	Yes	No	[No][Yes]	No
c. Intermediate passes	Yes	No	No No	
d. Completed weld	Yes	[100 percent] [Random]	Yes (PT only)	[No] [Yes]
Stainless steel to carbon steel				
a. Completed weld	Yes	[No] [Yes] [Random]	Yes (PT only)	No
Carbon steel piping systems				
a. Tack welds	Yes	No	No	No
b. Root passes	Yes	No	[No] [Yes MT]	No
c. Intermediate passes	Yes	No	No	No
d. Completed weld	Yes	[100 percent] [Random]	[No] [Yes MT]	No

****
NOTE: Regarding Table V, information based on the table must be developed and included in each project specification. Tables must clearly define the systems to be inspected and the type of NDE required. Specify 100 percent NDE when required by UFC 3-460-01, "Design: Petroleum Fuel Facilities" and 49 CFR 195, as covered by paragraph "Piping Subject to 100 Percent NDE."
****

TABLE V - MANDATORY MINIMUM NONDESTRUCTIVE EXAMINATIONS FOR ASME B31.1 PIPING

	Temperatures over 400 degrees C and at all pressures.	Temperatures between 175 degrees C and 400 degrees C inclusive and at all pressures over 7100 kPa gage	All others
Buttwelds (Girth and Longitudinal)	RT for DN over 50 mm MT or PT for DN 50 mm and less.	RT for over 50 mm DN with thickness over 19 mm. Visual for all sizes with thickness 19 mm or less.	Visual for all sizes and thicknesses.
Welded Branch Connections (Size indicated is Branch Size)	RT for DN over 50 mm MT or PT for DN 50 mm and less.	RT for branch over 100 mm DN and thickness of branch over 19 mm. Visual for all sizes with branch thickness 19 mm or less.	Visual for all sizes and thicknesses.
Fillet, Socket Welds	PT or MT for all sizes and thicknesses.	Visual for all sizes and thicknesses.	Visual for all sizes and thicknesses.
NOTES:			
1. Thickness refers to pressure boundary wall thickness (such as pipe wall, fitting wall, or nozzle wall thickness).			
2. All welds must be given a visual examination in addition to type of specific nondestructive examination specified.			

TABLE V - MANDATORY MINIMUM NONDESTRUCTIVE EXAMINATIONS FOR ASME B31.1 PIPING

	Temperatures over 400 degrees C and at all pressures.	Temperatures between 175 degrees C and 400 degrees C inclusive and at all pressures over 7100 kPa gage	All others
3. NPS-Nominal Pipe Size.			
4. RT-Radiographic examination; MT-magnetic particle examination; PT-liquid penetrant examination.			
5. RT of branch welds must be performed before any nonintegral reinforcing material is applied.			
6. The thickness of buttwelds is defined as the thicker of the two abutting ends after end preparation.			
7. Temperatures and pressures shown are design.			
8. In lieu of radiography of welded branch connections when required above, liquid penetrant or magnetic particle examination is acceptable and, when used, must be performed at the lesser of one-half of the weld thickness or each 50 mm of weld thickness and all accessible final weld surfaces.			
9. For nondestructive examination of the pressure retaining component, refer to the standards listed in applicable code or the manufacturing specifications.			

TABLE V - MANDATORY MINIMUM NONDESTRUCTIVE EXAMINATIONS FOR ASME B31.1 PIPING

	Temperatures over 750 degrees F and at all pressures.	Temperatures between 350 degrees F and 750 degrees F inclusive and at all pressures over 1052 psig gage	All others
Buttwelds (Girth and Longitudinal)	RT for NPS over 2 inches MT or PT for NPS 2 inches and less.	RT for over 2 inch NPS with thickness over 3/4 inch. Visual for all sizes with thickness 3/4 inch or less.	Visual for all sizes and thicknesses.
Welded Branch Connections (Size indicated is Branch Size)	RT for NPS over 2 inch MT or PT for NPS 2 inch and less.	RT for branch over 4 inch NPS and thickness of branch over 3/4 inch. Visual for all sizes with branch thickness 3/4 inch or less.	Visual for all sizes and thicknesses.
Fillet, Socket Welds	PT or MT for all sizes and thicknesses.	Visual for all sizes and thicknesses.	Visual for all sizes and thicknesses.

NOTES:

1. Thickness refers to pressure boundary wall thickness (such as pipe wall, fitting wall, or nozzle wall thickness).

2. All welds must be given a visual examination in addition to type of specific nondestructive examination specified.

3. NPS-Nominal Pipe Size.

4. RT-Radiographic examination; MT-magnetic particle examination; PT-liquid penetrant examination.

5. RT of branch welds must be performed before any nonintegral reinforcing material is applied.

<table>
<tr><td colspan="4">TABLE V - MANDATORY MINIMUM NONDESTRUCTIVE EXAMINATIONS FOR ASME B31.1 PIPING</td></tr>
<tr><td></td><td>Temperatures over 750 degrees F and at all pressures.</td><td>Temperatures between 350 degrees F and 750 degrees F inclusive and at all pressures over 1052 psig gage</td><td>All others</td></tr>
<tr><td colspan="4">6. The thickness of buttwelds is defined as the thicker of the two abutting ends after end preparation.</td></tr>
<tr><td colspan="4">7. Temperatures and pressures shown are design.</td></tr>
<tr><td colspan="4">8. In lieu of radiography of welded branch connections when required above, liquid penetrant or magnetic particle examination is acceptable and, when used, must be performed at the lesser of one-half of the weld thickness or each 1/2 inch of weld thickness and all accessible final weld surfaces.</td></tr>
<tr><td colspan="4">9. For nondestructive examination of the pressure retaining component, refer to the standards listed in applicable code or the manufacturing specifications.</td></tr>
</table>

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-40 60 00 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-40 95 00 (November 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 40 - PROCESS INTERCONNECTIONS

SECTION 40 60 00

PROCESS CONTROL

05/20

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-40 60 00 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-40 95 00 (November 2019)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 40 60 00

PROCESS CONTROL
05/20

****

NOTE: This guide specification covers the requirements for process instrumentation and control systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Use Section 43 21 29 FLOW MEASURING EQUIPMENT [POTABLE WATER] [SEWAGE TREATMENT PLANT] for simple liquid flow applications.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering
ANSI INCITS 154	(1988; R 2004) Office Machines and Supplies - Alphanumeric Machines - Keyboard Arrangement

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.8	(2022; Supplement 2022) Gas Transmission and Distribution Piping Systems
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2022) Grooved and Shouldered Joints

ASTM INTERNATIONAL (ASTM)

ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1238	(2013) Melt Flow Rates of Thermoplastics

	by Extrusion Plastometer
ASTM D1693	(2015) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D2000	(2018; R 2024) Standard Classification System for Rubber Products in Automotive Applications

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE C37.90.1	(2023; ERTA) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60584-1	(2013) Thermocouples - Part 1: EMF Specifications and Tolerances
IEC 61131-3	(2013) Programmable Controllers - Part 3: Programming Languages

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 7.0.01	(1996) Quality Standard for Instrument Air
ISA 92.00.01	(2010; R 2015) Performance Requirements for Toxic Gas Detectors
ISA 101.01	(2015) Human Machine Interfaces for Process Automation Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V

NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 79	(2015) Electrical Standard for Industrial Machinery

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250	(1991) Calibration Services Users Guide

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60	Standards of Performance for New Stationary Sources
47 CFR 15	Radio Frequency Devices

UL SOLUTIONS (UL)

UL 94	(2023; Reprint Jan 2024) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	(2018; Reprint Jul 2022) UL Standard for Safety Industrial Control Panels
UL 1059	(2024) UL Standard for Safety Terminal Blocks

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Contractor Design Drawings; G, [_____]

Draft As-Built Drawings; G, [_____]

SD-03 Product Data

****

NOTE: Delete the requirement for compressed air station on systems that do not utilize pneumatic devices.

****

Control Drawings

Sensors and Meters

Performance Verification Test (PVT)

Factory Test Procedure

Compressed Air Stations

SD-06 Test Reports

Factory Test Report

Testing, Adjusting and Commissioning

Performance Verification Test(PVT)

Endurance Test

Turbine Flowmeter

SD-07 Certificates

Control and Sensor Wiring

Ground Rods

Wiring

Installation

SD-10 Operation and Maintenance Data

Training Manual; G, [_____]

Control System; G, [_____]

SD-11 Closeout Submittals

Final As-Built Drawings; G

1.3 SITE ENVIRONMENTAL CONDITIONS

The expected site environmental conditions are a minimum of [_____] degrees C [_____] degrees F and a maximum of [_____] degrees C [_____] degrees F.

1.4 SEQUENCING

****

NOTE: Provide Table I provides bracketed text in which the following site number of days between items may be specified. In many cases this information will be specified elsewhere. When project schedule is specified elsewhere remove bracketed text and Table I will provide sequencing but not specific intervals. If time intervals are to be specified here keep the bracketed text and enter the number of days in the space provided.

****

TABLE I: PROJECT SEQUENCING specifies the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column).

1.5.1 Sequencing for Submittals

The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within [14] [_____] days of notification that the submittal has been rejected. Upon re-submittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

1.5.2 Sequencing for Activities

The sequencing specified for activities indicates the earliest the activity may begin.

1.5.3 Abbreviations

In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Add site specific requirements. Supplement this specification with drawings which include a piping and instrumentation diagram (P&ID) and a comprehensive control diagram showing devices, a sequence of operations, and a points schedule.

****

The process control system must be used to monitor and control the operation of process equipment as specified and in accordance with the sequence of operation and control schematics shown on the drawings. The process control system must provide for operator interaction, overall process control system supervision, and process equipment control and monitoring. The system must adhere to Section 25 05 11 CYBERSECUIRITY OF FACILITY-RELATED CONTROL SYSTEMS. Provide hardware configured and sized to support expansion as specified and shown on the drawings.

The process control system must be comlete including sensors, field preamplifiers, signal conditioners, offest and span adjustments, amplifiers, transducers, transmitters, control devices, engineering units conversions and algorithms for the applications; and must maintain the specified end-to-end process control loop accuracy from the sensor to display and final control element. Connecting conductors must be suitable for installed controls. Enclosers must be rated for NEMA [1] [4] [_____].

2.1.1 Operation

****

NOTE: Show the number of control panels to be provided on the drawings. Provide setpoint ranges, alarm settings and other parameters not addressed in the sequence of control in a points schedule on the drawings.

****

The process control system provided under this specification must operate using a combination of sequential function charts, function block diagrams, structured text, instruction, and ladder logic type as defined in IEC 61131-3 and supervisory control to provide the required sequences of operation. Input data to the controller must be obtained by using instruments and controls interfaced to mechanical, electrical, utility systems and other systems as shown and specified. All required setpoints, settings, alarm limits, and sequences of operation must be as identified [in the database/ settings tables] [and] [or] [sequences of operation indicated].

2.1.2 Points

****

NOTE: Provide an input/output (I/O) summary table on the drawings. List all inputs to and outputs from the process control system. Identify each point type, analog, binary, pulse accumulator; input, output, control, monitoring, etc. Identify alarms, trends, software and failure mode setting associated with each point in the table. Label each point so that it can be easily referenced to the process control system schematic drawings or process and instrumentation drawings.

****

Provide inputs to and outputs from the process control system in accordance with the Input/Output (I/O) Summary Table indicated. Each connected analog output (AO), analog input (AI), binary output (BO), binary input (BI), pulse accumulator (PA) input and other input or output device connected to the control system must represent a "point" where referred to in this specification.

2.1.3 Building Telecommunications Cabling (BTC)

****

NOTE: Include in the project specification any of the following UFGS for the appropriate BTC: Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM, Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

****

Provide data transmission systems for communication [between PLCs] [and] [between PLCs and the central station] [and] [server] as specified in [Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM][Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP)] and as indicated.

2.1.4 System Reliabilty

The system must be designed for maximum reliability, safety and integrity while maintaining an availability of [99.99%] or better.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Product Certifications

****

NOTE: Note: FCC part 15 does not apply to many of the computing devices used for industrial applications. Title 47 Part 15 provides for exqamption of unintentional radiators considered "digital devices used exclusively as an electronic control" or power system utilized by a public utility or in and industrial plant.

****

Computing devices, as defined in FCC Part 15, supplied as part of the process control system must be certified to comply with the requirements of Class B computing devices.

2.2.2 Standard Products

Materials and equipment must be standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products. Units of the same type of equipment must be products of a single manufacturer. Items of the same type and purpose must be identical and supplied by the same manufacturer, unless replaced by a new version approved by the Government.

2.2.3 Nameplates

Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Laminated plastic nameplates must be provided for equipment devices and panels furnished. Each nameplate must identify the device, such as pump "P-1" or valve "VLV-402". Labels must be coordinated with the schedules and the process and instrumentation drawings. Laminated plastic must be 3 mm 1/8 inch thick, white with black center core. Nameplates must be a minimum of 25 by 75 mm 1 by 3 inches with minimum 6 mm 1/4 inch high engraved block lettering. Nameplates for devices smaller than 25 by 75 mm 1 by 3 inches must be attached by a nonferrous metal chain. All other nameplates must be attached to the device.

2.3 GENERAL REQUIREMENTS

****

Show hazardous area classification on the drawings.

****

Equipment located outdoors, not provided with climate controlled enclosure, must be capable of operating in the ambient temperature range. Electrical equipment will conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Equipment and wiring must be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

2.4 SENSORS

****

NOTE: Provide a schedule on the drawings that includes all required instrumentation. Provide device information such as: Alpha-Numeric designator, the operating range (pressure, temperature, flow) of construction material, media to be monitored or controlled, control signal, valve type (2-way, 3-way, normally open, normally closed, etc.). Include automatic control valves and manually operated control valves.

It may be appropriate to defer the enclosure requirements to the electrical section or to provide different enclosures for different areas: indoor, outdoor, areas with hazard classification indicated on the drawings, etc. Within an area, the requirements should be consistent.

****

2.4.1 Transmitter

****

NOTE: Show all panels on the drawings. Distance between transmitter and sensor is critical. Specifying the digital communication of sensors opens up the possibility of proprietary sensors.

****

Unless indicated otherwise, each sensor must be provided with a transmitter, selected to match the sensor. Except where specifically indicated otherwise on the drawings, the transmitter must be provided with a [four] [_____] digit or analog visual display of the measured parameter and with a [4 to 20 mAdc] [binary] [0-10 vdc] [_____] output signal proportional to the level of the measured parameter. Accuracy must be plus or minus [0.5] [1] [2] [5] [_____] percent of full scale reading with output error not exceeding plus or minus [0.25] [0.5] [_____] percent of [the calibrated measurement] [full scale]. Transmitter must be located where indicated, mounted integrally with the sensor, pipe mounted, wall mounted or installed in the control panel. The distance between the sensor and transmitter must not exceed the manufacturer's recommendation. Field preamplifiers and signal conditioners must be included when necessary to maintain the accuracy from sensor to the programmable logic controller or recorder.

2.4.2 Off-Gas or Vapor Service

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NOTE: If there are substantial temperature or pressure changes across a blower or unit process, it may be cost effective to specify differing requirements upstream and downstream of the process.

****

Sensors and meters in [off-gas] [or] [vapor] service must be rated for continuous duty service at fluid approach velocities from 2.5 to 25 m/s 500 to 5000 fpm with correspondingly higher constriction velocities over a fluid temperature range from minus [18] [25] [_____] degrees C to [40] [50] [66] [_____] degrees C minus [0] [15] [_____] degrees F to [105] [120] [150] [_____] degrees F at pressures from minus [50] [_____] kPa gage up to [100] [700] [_____] kPa gage minus [7.2] [_____] psi gage up to [15] [100] [_____] psi gage.

2.4.3 Liquid Service

****

NOTE: If there are substantial temperature or pressure changes across a pump or unit process, it may be cost effective to specify differing requirements upstream and downstream of the process.

****

Sensors and meters in liquid service must be rated for continuous duty service at fluid approach velocities from [0.1] [0.75] [_____] m/s to [2] [3] [_____] m/s [0.327] [2.5] [_____] ft/s to [7] [10] [_____] ft/s with correspondingly higher constriction velocities over a fluid temperature range from [0] [-50] [_____] degrees C to [40] [50] [250] [_____] degrees C [32] [-58] [_____] degrees F to [105] [120] [482] [_____] degrees F at pressures up to [70] [350] [700] [1000] [_____] kPa [10] [50] [100]

[150][_____] psi gage.

2.4.4 Flow Rate Sensors and Meters

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NOTE: Most flow meters need straight unobstructed piping of 10 pipe diameters upstream and 5 pipe diameters downstream. Verify that the location will allow installation meeting the criteria or that the accuracy of type of flow meter selected is not affected by the location. Design includes attendant elements such as mounting devices, differential pressure transmitter and interpretive ancillary components in this and other sections and on the drawings to complete the system.

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Liquid flow indication must be provided in [L/s] [gpm]. [Off-gas] [or] [Vapor] flow indication must be provided in [cubic m/second] [cubic feet per minute]. Pressure taps must incorporate appropriate snubbers. Unless indicated otherwise, the flow transmitter must produce a signal that is proportional to the volumetric flow rate, compensated for fluid temperature, and must have an accuracy of plus or minus [1] [3] [_____] percent of [full flow] [the actual flow]. Flow transmitter must be located within [5 m] [15 feet] of the flow element. The flow transmitter must include a [digital] [_____] readout of the volumetric flow rate to [3] [_____] significant figures. [The controller must be provided with a minimum of three alarm lights. The first alarm light must indicate when the lower (warning) detection level has been exceeded. The second alarm light must indicate when the upper (alarm) detection level has been exceeded. The third alarm light must indicate a controller malfunction, including loss of power or loss of sensor input.] [The controller must be provided with a minimum of three sets of dry contacts rated in accordance with NEMA ICS 1. The first set of contacts must close when the lower (warning) detection level has been exceeded. The second set of contacts must close when the upper (alarm) detection level has been exceeded. The third set of contacts must close when a controller malfunction has occurred, including loss of power or loss of sensor input.] The alarm levels must be individually adjustable. The controller must be provided with an audible warning horn that sounds when the upper detection level has been exceeded, and a warning horn silence button. The controller must provide a [4-20 mAdc] [_____] output signal to the programmable logic controller, proportional to the measured parameter. The controller must be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost. Flow rate must be controlled to within plus or minus [5] [_____] percent of the design flow.

2.4.4.1 Flow Nozzle

Flow nozzle must be made of austenitic stainless steel. The inlet nozzle form must be elliptical and the nozzle throat must be the quadrant of an ellipse. The thickness of the nozzle wall and flange must be such that the accuracy will not be degraded by distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline. The outside diameter of the nozzle flange or the design of the flange facing must be such that the nozzle throat is centered accurately in the pipe.

2.4.4.2 Flow Switch

Flow switch must have a repetitive accuracy of plus or minus [10] [_____] percent of actual flow setting. Switch actuation must be adjustable over the operating flow range. Flow switch for use in [water] [contaminated groundwater] [sewage] [air] [vapor] [gas] [hot gas] [corrosive vapor] [_____] system must be rated for use and constructed of suitable materials for installation in the environment encountered. The flow switch must have non flexible [paddle] [shuttle/piston] [thermal] [pezio] with Form C snap action contacts, rated in accordance with NEMA ICS 1.

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NOTE: Magnetic flowmeters are to be used only for conductive fluids.

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2.4.4.3 Magnetic Flowmeter

Magnetic flowmeter must be [non-intrusive,] DC pulse type and must measure fluid flow through the use of a self generated magnetic field. The meter must have automatic zeroing circuitry. The magnetic flow element must be encapsulated in [type 300 stainless steel] [or] [anodized aluminum]. Flowmeter must be capable of measuring up to a maximum flow velocity of [3] [_____] m/s [10] [_____] fps. The metering tube must be constructed of [316 stainless steel] [anodized aluminum] [_____]. The meter must be rated for a process temperature range of [32 to 212 F] [0 to 100C] and [0 to 149F] [-18 to 65C] ambient. The maximum pressure drop across the meter and appurtenances must be 34 kPa 5 psi at the maximum flow rate.

2.4.4.4 Natural Gas or Propane Flow Meter

Flowmeter for natural gas or propane flows, corrected to standard conditions, of up to 19.7 L/sec 2500 SCFH must be of the positive displacement diaphragm or bellows type and for flows above 0.02 cu. m/sec 2500 cfh, must be of the axial flow turbine type. Meters must be designed specifically for natural gas or propane supply metering and rated for the pressure, temperature and flow rates of the installation. Permanent meters must be suitable for operation in conjunction with an energy monitoring and process control system. Meter body must be constructed of [316 stainless steel] [_____]. Meter must have a minimum turndown ratio of [10] [_____] to [1] [_____] with an accuracy of plus or minus [1] [_____] percent of actual flow rate. The meter index must include a direct reading mechanical totalizing register and electrical impulse dry contact output for remote monitoring. The electrical impulse dry contact output must provide not less than 1 pulse per 2.8 cubic meters 100 cubic feet of gas and must require no field adjustment or calibration. The highest electrical impulse rate available from the manufacturer, not exceeding [15] [_____] pulses per second, for the installed application must be provided.

2.4.4.5 Orifice Plate

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NOTE: Show the operating ranges and ratings on the drawings for operating pressures and flow. Differential pressure output ranges for flow conditions are to be coordinated. Accuracy of computed flow will be improved with inclusion of temperature and pressure of upstream conditions.

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Orifice plate must be made of [304] [316] series stainless steel sheet. The outlet side of the bore must be beveled at a 45 degree angle. The thickness of the cylindrical face of the orifice must [not exceed one-fiftieth of the pipe inside diameter or one-eighth of the orifice bore, whichever is smaller] [be 3.3 mm 0.125 inch nominal]. The orifice plate must be flat within 0.10 mm 20 mils. The orifice surface roughness must not exceed 0.5 micron 0.02 mils. Orifice plates must be concentric plates with a square and sharp upstream edge of the orifice. Orifice bore must be designed to match the operating parameters stated in the drawings. Plate must be permanently identified with line size, flange rating, orifice bore diameter, plate thickness and material. The accuracy must be plus or minus [1] [_____] percent of full flow.

2.4.4.6 Paddle Type Flowmeter

Sensor accuracy must be plus or minus [1] [_____] percent of rate of flow, minimum operating flow velocity must be [0.3] [_____] m/s [1.0] [_____] fps. Sensor repeatability and linearity must be plus or minus [1] [_____] percent. Sensor must be non-magnetic, with forward curved impeller blades designed for water containing debris. Wetted materials must be made from non-corrosive materials and must not contaminate water. The sensor must be provided with isolation valves. The transmitter housing must be a NEMA 250 Type 4 enclosure. The sensor must be rated for installation in pipes of 76 mm to 1 m 3 to 40 inch diameters.

2.4.4.7 Pitot Tube Air Flow Measurement Array (AFMA)

Each Pitot Tube AFMA must contain an array of velocity sensing elements. The velocity sensing elements must be of the multiple pitot tube type with averaging manifolds. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published installation instructions of the AFMA manufacturer.

a. Pitot Tube AFMAs for use in airflows over 3.0 m/s 600 fpm must have an accuracy of plus or minus [5] percent over a range of 2.5 to 12.5 m/s 500 to 2500 fpm.

b. Pitot Tube AFMAs for use in airflows under 3.0 m/s 600 fpm must have an accuracy of plus or minus [5] percent over a range of 0.6 to 12.5 m/s 125 to 2500 fpm.

2.4.4.8 Annular Pitot Tube

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NOTE: Annular pitot tubes should not be used where the flow is pulsating or where pipe vibration is allowed. Pulse flow is characteristic of positive displacement pumps and blowers.

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Sensor must have an accuracy of plus or minus [2] [_____] percent of full flow and a repeatability of plus or minus [0.5] [_____] percent of measured value. Annular pitot tube must be averaging type differential pressure sensors with no less than four total head pressure ports with an averaging manifold and at least one static port made of austenitic stainless steel. The total head pressure ports must extend diametrically across the entire pipe.

2.4.4.9 Electronic AFMA

Each electronic AFMA must consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published application data of the AFMA manufacturer. Electronic AFMAs must have an accuracy of plus or minus [5] percent over a range of [.6] [_____] m/s to [25][50] m/s [120] [_____] fpm to [5,000] [10,000] fpm and the output must be temperature compensated over a range of 0 to 100 degrees C 32 to 212 degrees F.

2.4.4.10 Positive Displacement Flowmeter

Output accuracy must be plus or minus [2] percent of the flow range. The flow meter must be a direct reading, gerotor, nutating disc or vane type displacement device rated for liquid service. A counter must be mounted on top of the meter, and must consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer must have a six digit register to indicate the volume passed through the meter in L gallons. A sweep-hand dial will indicate down to 5 L 1 gallon. The pulse transmitter must have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter must have a bronze body with threaded or flanged connections as required for the application. The maximum pressure drop at full flow must be 35 kPa 5 psi gage.

2.4.4.11 Turbine Meters

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NOTE: Verify that the location will allow installation with the minimum straight unobstructed piping of 10 pipe diameters upstream and 5 pipe diameters downstream.

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Turbine meters wetted metal components must be [nickel plated brass][series 300 stainless steel] [series 316 stainless steel][bronze] with an accuracy of plus or minus [1] [_____] percent from [30] [_____] percent to 100 percent of actual flow.

2.4.4.12 Turbine Flowmeter

****

NOTE: Verify that the location will allow installation with the minimum straight unobstructed piping of 10 pipe diameters upstream and 5 pipe diameters downstream. Placement downstream of the blower or pump is preferable for head loss considerations.

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Design of the flowmeter probe assembly must incorporate integral flow, temperature, and pressure monitoring. The meter flow sensing element must be [single][double] turbine and operate over the temperature range with a pressure loss limited to [1] [_____] percent of operating pressure at maximum flow rate. The internal temperature transmitter must monitor the full temperature range of the fluid. The integral pressure transmitter must monitor the pressure range with end limits of [0] [_____] MPa [0]

[_____] psi to [2] MPa [300] psi gage. The flowmeter electronics must be scaled and rescaled in the field when application data changes. The flowmeter must be designed for installation in pipe sizes of 75 mm 3 inches and larger to accommodate maximum probe insertion depths up to 1.1 m 44 inches. The retractor assembly must have a rotor depth gage having graduations of 2.5 mm 0.1 inches to determine exact position of turbine rotor in the pipe. The meter retractor assembly and the turbine rotor assembly must be constructed of [Series 300 stainless steel] [_____] with [polytetrafluoroethylene (PTFE)] [_____] seals. The meter retractor assembly must be designed to protect the turbine rotor during insertion into the pipeline. Retraction of the turbine rotor must be accomplished by using a hand wheel and must enable insertion and removal of the meter without system shutdown. The retractor assembly must include an isolation valve providing a means of removal of the meter from service to allow for field maintenance and field replacement of the rotor assembly or parts. The turbine rotor must have an over range operating capacity of 150 percent of maximum flow for up to 5 seconds. The rotor must be calibrated at the factory in an actual flow of similar fluid over the flow range performed on test equipment with accuracy traceable to the National Institute of Standards and Technology (NIST). A copy of the calibration test data, including all of the physical parameters under which the calibration tests were performed, must be submitted with each turbine rotor. Calibration test data must be analyzed to determine the rotor's arithmetic average "K" factor, the best line fit and the plus or minus deviation from these figures. Turbine flowmeter accuracy must be plus or minus 1 percent of reading for a minimum turndown ratio of 1:1 through a maximum turndown ratio of 50:1. Repeatability must be plus or minus 0.25 percent of reading. Accuracy of the transmitter must be plus or minus 0.25 percent over the calibrated span. The turbine rotor response time from minimum to maximum flow must be less than 10 milliseconds. The flowmeter must include one of the following: dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs.

2.4.4.13 Ultrasonic Flowmeter

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NOTE: Doppler meters rely on reflectors in the flowing liquid. To obtain reliable measurements attention must be given to the lower limits for concentrations and sizes of solids or bubbles. The flow must also be rapid enough to keep these materials in suspension. One manufacturer gives values of 1.8 m/s 6 ft/s for solids and 0.75 m/s 2.5 ft/s for small bubbles. To perform within their stated specifications, some Doppler meters require a minimum Reynolds number of 4,000.

Transit-time meters rely on an ultrasonic signal's completely traversing the pipe, so the path must be relatively free of solids and air or gas bubbles. To perform within stated specifications, one type of transit-time meter requires a minimum Reynolds number of 10,000.

****

Ultrasonic flowmeter must utilize high frequency [Doppler shift] [transit-time] transducer. Flowmeter must be capable of measuring flow up to a maximum flow rate of [5] [_____] m/s [15] [ ] fps. Provide Ultrasonic Flow Meters complete with matched transducers, self aligning installation hardware and transducer cables. Ultrasonic transducers must be optimized for the specific pipe and process conditions for the application. The flow meter accuracy must plus or minus 1 percent of rate from 0.3 to 12 meters/sec 0 to 40 ft/sec. The flowmeter must include one of the following: dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc output.

2.4.4.14 Variable Area Flow Indicator

Indicator must have an accuracy of plus or minus [5] [ ] percent of full scale. The body must be clear acrylic plastic with [brass] [stainless steel] end fittings. The float must be [glass] [or] [stainless steel]. The metering tube must be tapered and must be provided with a direct reading flow scale engraved on the meter body.

2.4.4.15 Venturi Tube

Venturi tube must be made of cast iron or cast steel and must have an accuracy of plus or minus [1] percent of full flow. The throat section must be lined with austenitic stainless steel. Thermal expansion characteristics of the lining must be the same as that of the throat casting material. The surface of the throat lining must be machined to a plus or minus 1.2 micron 50 mils finish, including the short curvature leading from the converging entrance section into the throat. The metering tube must be rated for continuous duty service at minimum pressure of [700] [_____] kPa [100] [_____] psi gage.

2.4.4.16 Vortex Shedding Flowmeter

The accuracy must be within plus or minus [0.8] [_____] percent of the actual volumetric flow. Steam meters must contain density compensation by direct measurement of temperature. Mass flow inferred from specified steam pressure are not acceptable. The flow meter body must be made of austenitic stainless steel and include a weather tight NEMA 4X electronics enclosure. Flowmeter must be rated for continuous duty service at minimum pressure of [700] [_____] kPa [100] [_____] psi gage. The vortex shedding flowmeter body must not require removal from the piping in order to replace the shedding sensor.

2.4.5 Level Instrumentation

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NOTE: Indicate the location and the NFPA hazard classification on the drawings. Hazard classification of sumps and tank interiors frequently differ from the general area hazard classification. Include a schedule of level sensing elements with operating range requirements. Tabulation of devices is to be included on the drawings. Component identifiers are to be coordinated with the drawings. Use the Instrument Society of America (ISA) suggested alphanumeric system for development of discrete device numbering.

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Pressure taps must incorporate appropriate snubbers. Relays and housing must be intrinsically safe or explosion proof as required by the NFPA hazard rating for compatibility with the contents of the tank or sump. [The controller must be provided with a minimum of three alarm lights. The first alarm light must indicate when the lower (warning) detection level has been exceeded. The second alarm light must indicate when the upper (alarm) detection level has been exceeded. The third alarm light must indicate a controller malfunction, including loss of power or loss of sensor input.][The controller must be provided with a minimum of three sets of dry contacts rated in accordance with NEMA ICS 1. The first set of contacts must close when the lower (warning) detection level has been exceeded. The second set of contacts must close when the upper (alarm) detection level has been exceeded. The third set of contacts must close when a controller malfunction has occurred, including loss of power or loss of sensor input.] The alarm levels must be individually adjustable. The controller must be provided with an audible warning horn that sounds when the upper detection level has been exceeded, and a warning horn silence button. The controller must provide a [4-20 mAdc] [_____] output signal to the programmable logic controller, proportional to the measured parameter. The controller must be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost.

2.4.5.1 Bubble Type Level Sensor

Bubble type liquid level sensor must be of the hydrostatic balance type, operating from compressed air. Each gauging system must contain the following: an air set including [compressor] [or] [connection to plant air], compressed air pressure regulating valve, air filter and moisture trap; a sight feed bubbler with built-in adjusting needle valve; a tank entry gland with air supply and equalized pilot signal connections; a [13 mm 1/2 inch] [standard weight 316 stainless steel] [schedule 80 carbon steel] dip tube; a direct reading circular gauge 300 mm 12 inch in diameter calibrated for the connected tank and tank liquid; connections to the circular gauge and to the pressure transducer for zero setting and calibration check; a connecting bubbler supply and equalized pilot signal [copper] [aluminum] [stainless] tubing with minimum field made joints; and a pressure transmitter mounted at the top of the dip tube, selected to correspond to the range required to gauge the connected tank. Instrument air lines must be trace heated if there is a frost risk with an air flowrate of [28 L/H][1.0SCFH].

2.4.5.2 Capacitance Type Level Sensor

Liquid level sensor must produce a signal that is proportional to the measured level. Sensor must be capacitance type. Sensor must [work with conductive material] [work with non-conductive material] [be proximity or non-contact type]. The transmitter must have non-interacting zero and span adjustments, and must have an accuracy of plus or minus [0.1] [_____] percent of calibrated span. Assemblies must include wall bracket or mounting plate, austenitic stainless steel rods, stainless steel bolts and corrosion resistant housing.

2.4.5.3 Conductivity Switch

The switch must detect the presence of a fluid by measuring the electrical resistance between a sensor and a ground electrode. Electrodes must be constructed of [316 stainless steel] [Hastelloy] [titanium]. Electrodes must be fully clad using [polyolefin] [polytetrafluoroethylene (PTFE)]. The conductivity switch must be capable of [1] [2] [3] [4] separate level set points. The switch must [be provided with] [use the container as] a ground electrode. Electrode lengths must be as necessary, based on the application and to meet the requirements of the control sequence. A relay switching point must be provided for each sensor. Contacts must be rated for a maximum of 240 VAC, 5 A. Switch must have a maximum response time of 2 seconds. Assembly must be [flange mounted] [NPT thread (male)] [including surface mounting bracket] and suitable for the indicated environment.

2.4.5.4 Displacement Type Level Switch

Liquid level switch must be displacement type, having a minimum of two tandem floats with each float independently activating a set of Form C contacts at two different level settings. Each switch must have an adjustable differential band. The mounting connections must be threaded, flanged or surface mounted to suit the application. All surfaces in contact with the tank contents must be austenitic stainless steel. The switch enclosure must be explosion proof for use in a hazardous environment, complete with a sealed water tight junction box, terminal block, and mounting plate. Each set of contacts must be snap action, dry contact type with one normally open and one normally closed, contact rated in accordance with NEMA ICS 1. The switch must be actuated by a magnetically equipped stainless steel displacer. Repetitive accuracy must be plus or minus 6 mm 1/4 inch of actual displacer setting.

2.4.5.5 Mercury Float Switch

Float switch assemblies for use in liquid systems must consist of wall bracket or mounting plate, galvanized steel rods, stainless steel bolts, explosion proof and corrosion resistant housing, and intrinsically safe relays. Each switch must consist of two normally open mercury switches, encapsulated in epoxy resin. The float casing must be polypropylene. The switch cable must be oil resistant neoprene or PVC cable with 4 No. 18 gauge stranded copper conductors, rated for 600 Volt application.

2.4.5.6 Reed Switch

Switch must consist of a transmitter tube with a reed strip located inside. The tube length must [be of sufficient length to permit adjustment of switch actuation within process parameters] [extend the full height of the tank]. A float containing a permanent magnet must fit over the transmitter tube and must move up and down with the liquid level. The transmitter tube and sliding float assembly must be as required for the application as shown on the drawings. Wetted parts must be [_____], [316 stainless steel,] [PVC,] [polypropylene,] or [polytetrafluoroethylene (PTFE)] suitable for the installed service indicated. Assembly must be [flange mounted] [NPT thread (male)] [include surface mounting bracket]. Maximum switching power must be [15 Watts], maximum switching current [1 amp], maximum carrying current [200Vdc], breakdown voltage [300Vdc], and initial contact resistance [0.10 ohms]. Maximum operating time must be [0.50 msec].

2.4.5.7 Non-Contact Ultrasonic Level Sensor

The sensor must be microprocessor based and must provide continuous, non-contact level measurement of liquids and solids utilizing microwave pulsed time of flight measurement method. [Sensor must have pushbutton calibration and LCD display.] The sensor must operate in a frequency band approved for industrial use. The sensor must be capable of measuring in a range of 0 to [7] [1] [_____] m 0 to [20] [3] [_____] feet with an accuracy of plus or minus [.25] [_____] percent of full scale and repeatability [± 0.125" 3mm]. The sensor must be capable of distinguishing between real echoes, reflections and background noise. The sensor must automatically compensate for temperature changes. The sensor must be capable of operating in a temperature range from minus [25] [_____] degrees C to [40] [50] [_____] degrees C minus [15] [_____] degrees F to [105] [120] [_____] degrees F. Assembly must be [flange mounted] [NPT thread (male)] [include surface mounting bracket] of sufficient size to eliminate echoing and suitable for the installed environment indicated. Mounting assembly must be suitable for service without requiring entry or drainage of the [vessel] [sump] where level is being measured.

2.4.5.8 Leak Detection

Double walled containment system leak detectors must use electrodes mounted in the interstices of double walled containment systems with a minimum time delay of [0.5] [_____] seconds. Leak detectors for open systems must be mounted at slab or floor level with either a minimum time delay of [0.5] [_____] seconds or a minimum built-in-vertical adjustment of [3] [_____] mm [1/8] [_____] inch to prevent activation due to high humidity. Detector must have a contact rating of 1.0 amps resistive or 200 mA inductive at 28 VDC. Leak detector panel must indicate the location and detector causing the alarmed state. The indicator must be manual reset type. A framed, non-fading half-size as-built location map in laminated plastic must be provided for the cable leak detection system in double containment piping systems indicating the as installed system configuration; sensing string layout must be furnished. Marks in meters feet along the length of pipeline interstitial cable must be provided as references to locate leaks.

2.4.6 Pressure Instrumentation

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NOTE: Indicate on the drawings where visual indication of the measured pressure is required. Include a schedule of pressure sensing elements with operating range requirements. Include a tabulation of devices drawings. Component identifiers are to be coordinated with the drawings using the Instrument Society of America (ISA) suggested alphanumeric system for development of discrete device numbering.

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Pressure taps must incorporate appropriate snubbers.

2.4.6.1 Pressure Controller

The controller must be provided with a minimum of three [alarm lights. The first alarm light must indicate when the lower (warning) detection level has been exceeded. The second alarm light must indicate when the upper (alarm) detection level has been exceeded. The third alarm light must indicate a controller malfunction, including loss of power or loss of sensor input] [sets of dry contacts rated in accordance with NEMA ICS 1. The first set of contacts must close when the lower (warning) detection level has been exceeded. The second set of contacts must close when the upper (alarm) detection level has been exceeded. The third set of contacts must close when a controller malfunction has occurred, including loss of power or loss of sensor input]. The alarm levels must be individually adjustable. The controller must be provided with an audible warning horn that sounds when the upper detection level has been exceeded, and a warning horn silence button. The controller must provide a [4-20 mAdc] [_____]

output signal to the programmable logic controller, proportional to the measured parameter. The controller must be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost. Pressures must be controlled to within plus or minus [5] [_____] percent of design pressures.

2.4.6.2 Pressure Sensor and Transducer

The sensing element must be either [capsule] [diaphragm] [bellows] [Bourdon tube] [solid state] type. The pressure transducer must withstand up to 150 percent of rated pressure, with an accuracy of plus or minus [1.0] [_____] percent of full scale selected to put the design range of the measured pressure in the middle third of the transducer's range. Pressure must be measured in [kPa psi] gage with a range, plus or minus [10] [_____] percent of design range and must be furnished with [display] [display and printout] to the nearest [1.0] [_____] kPa [0.145] [_____] psi. The transmitter output error must not exceed [0.1] [_____] percent of calibrated span.

2.4.6.3 Pressure Switch

Sensors must be [diaphragm] [Bourdon tube] [solid state] and must be constructed of [brass] [316 stainless steel] [_____]. Pressure switch must have a repetitive accuracy of plus or minus [5.0] [_____] percent of the operating range and must withstand up to [150] [_____] percent of rated pressure.

Switch actuation set point must be adjustable over the operating pressure range with a differential adjustment span of [20] [_____] to [40] [_____] percent of the range of the switch. The switch must have Form C snap-action contacts rated in accordance with NEMA ICS 1.

2.4.6.4 Differential Pressure

The sensor/transmitter assembly accuracy must be plus or minus [1] [_____] percent of full scale. The over pressure rating must be a minimum of [150] [_____] percent of the operating pressure. Transmitter must be suitable for installation with the low pressure connection removed.

2.4.6.5 Differential Pressure Switch

Provide differential pressure switches with a user-adjustable setpoint that are sized for the application such that the setpoint is between 25 percent and 75 percent of the full range. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The switch must have two sets of contacts and each contact must have a rating greater than it's connected load. Contacts must open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as indicated. Each switch must have taps for sensing lines for connection of pressure fittings designed to sense fluid pressure. [For measuring air, gas or vapor stream differential pressure, these fittings must be of the angled-tip type with tips pointing into the air stream.] The adjustable differential range must be a maximum of [0.037] [0.125] [_____] kPa [0.15] [0.5] [_____] inches water at the low end to a minimum of [0.087] [1.49] [_____] kPa [0.35] [6.0] [_____] inches water at the high end. Two Form C contacts rated in accordance with NEMA ICS 1 must be provided.

2.4.6.6 Pneumatic to Electric (PE) Switch

Provide each switch with an adjustable set point range of [20] [_____] to [137] [_____] kPa [3.0] [_____] to [20] [_____] psi gage and an adjustable differential from [13] [_____] to [41] [_____] kPa [2.0] [_____] to [6.0] [_____] psi. Contacts must be Form C rated in accordance with NEMA ICS 1.

2.4.7 Temperature Instrumentation

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NOTE: Component identifiers are to be coordinated with the drawings using the Instrument Society of America (ISA) suggested alphanumeric system for development of discrete devise numbering.

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Temperature sensors may be provided without transmitters. Where transmitters are used, the range must be the smallest available from the manufacturer and suitable for the application such that the range encompasses the expected range of temperatures to be measured. The end to end accuracy includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the end user interface (graphic presentation) including transmitters if used.

2.4.7.1 Temperature Controller

The controller must be provided with a minimum of [three] alarm lights. [The first alarm light must indicate when the lower (warning) detection level has been exceeded. The second alarm light must indicate when the upper (alarm) detection level has been exceeded. The third alarm light must indicate a controller malfunction, including loss of power or loss of sensor input]. Also [3] sets of dry contacts rated in accordance with NEMA ICS 1. [The first set of contacts must close when the lower (warning) detection level has been exceeded. The second set of contacts must close when the upper (alarm) detection level has been exceeded. The third set of contacts must close when a controller malfunction has occurred, including loss of power or loss of sensor input]. The alarm levels must be individually adjustable. The controller must be provided with an audible warning horn that sounds when the upper detection level has been exceeded, and a warning horn silence button. The controller must provide a [4-20 mAdc] [_____] output signal to the programmable logic controller, proportional to the measured parameter. The controller must be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost.

2.4.7.2 Fluid Temperature Range

****

NOTE: Include a schedule of temperature sensing elements with operating range requirements. The following includes sample tables to assist in defining the exposure and service requirements. Alternatively, tabulation of devices may be included on the drawings. Include a table on the drawings with the following headings:

ID No.	Description	Minimum, C	Maximum, C	Type

****

All devices must be suitable for process temperatures, which define the exposure of the element, and are described in the table on the drawings. Mercury must not be used in thermometers.

2.4.7.2.1   Type A Bimetal Thermometer

Direct reading, hermetically sealed, suitable for external adjustment. Accurate within 1 percent of full range. Stainless steel construction. Complete with thermowell. Thermometers must have either 230 mm 9 inch long scales or 90 mm 3.5 inch diameter dials, with insertion, immersion, or averaging elements.

2.4.7.2.2   Type B Remote Reading Gas/Vapor Thermometer

Direct reading, [stainless steel] [aluminum] [phenolic] case designed for panel mounting, complete with armor cable, bulb and ancillary components for complete system.   Motionless design, resistant to shock and vibration and free from error created by elevation.   Provided with gas operated molecular sieve. Accurate within 1 percent over full range.

2.4.7.2.3   Type C Resistance Temperature Detector (RTD)

RTD must be [platinum] [copper] [_____], with an accuracy of plus or minus [0.1] [_____] percent at 0 degrees C 32 degrees F. RTD must be encapsulated in [epoxy,] [stainless steel Series 300,] [anodized aluminum,] [copper].

2.4.7.3   Continuous Averaging RTD

****

NOTE: Indicate on the drawings where averaging temperature probes are required.

****

Continuous averaging RTD must have an accuracy of plus or minus [0.5] [2] [_____] degrees C [0.9] [3.6] [_____] degrees F at the reference temperature, and must be of sufficient length to ensure that the resistance represents an average over the cross-section in which it is installed. The sensor must have a bendable copper sheath.

2.4.7.4   Infrared Temperature Sensor

Infrared temperature sensor must be encapsulated in series 300 stainless steel or anodized aluminum.   Sensor must have an accuracy of plus or minus 1 percent of temperature measured or 1.4 degrees C 2.5 degrees F, whichever is less.

2.4.7.5   Temperature Switch

****

NOTE: Include a table on the drawings with the following headings:

ID No.	**Description**	**Minimum, C**	**Maximum, C**

****

All devices must be suitable for process temperatures, which define the exposure of the element, and as described in the table shown on the drawings. Temperature switch must have a repetitive accuracy of plus or minus [1] [_____] percent of the operating ranges shown. Switch actuation must be adjustable over the operating temperature range. The switch must have Form C snap action contacts, rated in accordance with NEMA ICS 1.

2.4.7.6 Thermocouple

****

NOTE: Thermocouples should not be used for measuring temperatures below 260 degrees C 500 degrees F.

****

Thermocouple must be factory assembled with Series 300 stainless steel sheathing. Wiring insulation must be magnesium oxide. Minimum insulation resistance wire to wire or wire to sheath must be 1.5 megohm at 500 V dc. Thermocouple must be [Type E,] [Type K,] [Type J,] [or] [Type R]. Thermocouple error must not exceed that specified in IEC 60584-1. All wire/cable from thermocouple to transmitter must be of the type necessary to match the thermocouple used. Transmitter selected must match the type of thermocouple provided. The transmitter must include automatic cold junction reference compensation with span and offset adjustments, and upscale open thermocouple detection.

2.4.7.7 Thermowell

Thermowell must be monel, brass, or copper for use in water lines; wrought iron for measuring flue gases; and austenitic stainless steel for other applications. Calibrated thermowells must be provided with threaded plug and chain, 50 mm 2 inch lagging neck and inside diameter insertion neck as required for the application. The thermowell must include a connection box, sized to accommodate the temperature sensing devise.

2.4.8 Process Analytical Instrumentation

****

NOTE: Add requirements for additional site specific measurements, including span and accuracy for any application not included in this specification.

****

Probes must be easily removable without interrupting service. Sampling pumps must be included where necessary or applicable to the sensing device. For sensors integral to the electronic controller the sample may be drawn directly into the sensor or may be drawn through a sample tube. For sensors remotely located the sample may be drawn through a sample tube. Outdoor sample tubes must be heat traced. Sensor and controller construction must be suitable for operation in the monitored medium. Systems requiring automated zero and calibration gas or reagents must be provided with [_____] days supply of calibration gas or reagent. The controller must be provided with a minimum of three [alarm lights. The first alarm light must indicate when the lower (warning) detection level has been exceeded. The second alarm light hall indicate when the upper (alarm) detection level has been exceeded. The third alarm light must indicate a controller malfunction, including loss of power or loss of sensor input] [sets of dry contacts rated in accordance with NEMA ICS 1. The first set of contacts must close when the lower (warning) detection level has been exceeded. The second set of contacts must close when the upper (alarm) detection level has been exceeded. The third set of contacts must close when a controller malfunction has occurred, including loss of power or loss of sensor input]. The alarm levels must be individually adjustable. The controller must be provided with an audible warning horn that sounds when the upper detection level has been exceeded, and a warning horn silence button. The controller must provide a [4-20 mAdc] [_____] output signal to the programmable logic controller, proportional to the measured parameter. The controller must be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost.

2.4.8.1 Ammonia Gas

The sensor must be capable of monitoring ammonia in the range of [0] [_____] to [100] [_____] mg/L with an accuracy of plus or minus [1] [_____] percent of full scale reading. The sensor response time must be [90] [_____] percent in a maximum of [20] [_____] seconds.

2.4.8.2 Calorimeter (Heat Capacity/Fuel Value)

Calorimeter must be a self-contained device capable of measuring the heat capacity of a sample. The colorimeter must measure the heat released from the sample by igniting the sample reading use of multiple temperature sensors. The sensor must be capable of detecting methane in the range of [0] [_____] to [100] [_____] ppmv with an accuracy of plus or minus [1] [_____] percent of full scale reading.

2.4.8.3 Carbon Dioxide

Continuous emissions monitoring systems (CEMS) for measuring CO2 must be provided with installed back-up devices. The CEMS must comply with 40 CFR 60, Appendix B, Performance Specification 2 and the QA/QC requirements of 40 CFR 60, Appendix F. Calculation of emission rates must be in conformance with 40 CFR 60, Appendix A, Reference Method 19. Provide photometric type CO2 sensors with integral transducers and linear output. Carbon dioxide (CO2) sensors must measure CO2 concentrations between [0 to 2000] parts per million (ppm) using non-dispersive infrared (NDIR) technology with an accuracy of plus or minus [50 ppm] and a maximum response time of 1 minute. The sensor must be rated for operation at ambient air temperatures within the range of 0 to 50 degrees C 32 to 122 degrees F and relative humidity within the range of 20 to 95 percent (non-condensing). The sensor must not exceed a maximum drift of 2 percent by volume a year. The sensor chamber must be manufactured with a non-corrosive material that does not affect carbon dioxide sample concentration. Sensors must be designed to protect the sensing element from dust accumulation and mechanical damage. The sensor must have a calibration interval no less than 5 years.

2.4.8.4 Carbon Monoxide - CO

Continuous emissions monitoring systems (CEMS) for measuring CO must be provided with installed back-up devices. The CEMS must comply with 40 CFR 60, Appendix B, Performance Specification 4 and the QA/QC requirements of 40 CFR 60, Appendix F. Calculation of emission rates must be in conformance with 40 CFR 60, Appendix A, Reference Method 19. Carbon monoxide analyzer must consist of an infrared light source in a weather proof steel enclosure for duct or stack mounting. An optical detector/analyzer in a similar enclosure, suitable for duct or stack mounting must be provided. Both assemblies must include internal blower systems to keep optical windows free of dust and ash at all times. The third component of the analyzer must be the electronics cabinet. Automatic flue gas temperature compensation and manual/automatic zeroing devices must be provided. Unit must read parts per million (ppm) of carbon monoxide in the range of [0] [ ] to [100][ ] ppm and the response time must be less than 3 seconds to 90 percent value. Unit measurement range must not exceed specified range by more that 50 percent. Repeatability must be plus or minus 1 percent of full scale with an accuracy of plus or minus 1 percent of full scale.

2.4.8.5 Chlorine Gas

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NOTE: Follow Chlorine Institute Recommendations.

****

All parts of the chlorine measurement system, including the sensors, transmitters, controllers and peripheral devices, that may come in contact with chlorine or a chlorine-filled environment must be constructed of materials suitable for this application. The chlorine sensor must provide continuous monitoring of the chlorine concentration. The detector must measure concentrations of chlorine in air with a range of [0 to 10 ppm] [with a repeatability of plus or minus [1] percent of full scale] and an accuracy of plus or minus 2 percent of full scale. The Chlorine Detector transmitter must be housed in a non-corrosive NEMA 250 Type 4X enclosure. Detector must include a local panel with adjustable alarm trip level, local audio and visual alarm with silence function. The sensor response time must be [90] [_____] percent in a maximum of [30] [_____] seconds.

2.4.8.6 Chlorine in Liquid

****

NOTE: Follow Chlorine Institute recommendations.

****

All parts of the chlorine measurement system, including the sensors, transmitters, controllers and peripheral devices, that may come in contact with chlorine or a chlorine-filled environment must be constructed of materials suitable for this application. Residual chlorine sensor must continuously monitor the chlorine residual. The sensor must be capable of detecting chlorine in the range of [0] [_____] to [1] [5] [10] [20] [_____] mg/L with an accuracy of plus or minus [1] [_____] percent of full scale reading. The sensor response time must be [90] [_____] percent in a maximum of [60] [_____] seconds.

2.4.8.7 Combustible Gas

Combustible gas sensor must be provided with a means to collect representative continuous samples and measure for the presence of explosive vapors. Measuring range must be from [0] [_____] percent of the lower explosive limit (LEL) to 100 [_____] percent of the [lower explosive limit (LEL)] [upper explosive limit (UEL)]. Response time must be less than [10] [_____] seconds to indicate [50] [_____] percent LEL when exposed to [100]

[_____] percent LEL. Drift must be less than [3] [_____] percent per year. The sensor must have a minimum operational life of [1] [_____] year. The system must be provided with [_____] days of zero and calibration gas.

2.4.8.8 Calorimetric Analyzer

****

NOTE: Limit the range to improve the sensitivity. Substitute the appropriate analyzer name and range in the first sentence. The remainder of the paragraph applies to any of the following:

Phenolphthalein Alkalinity Analyzer	**0 to [50] [100] mg/L**
Total Alkalinity Analyzer	**0 to [50] [100] [500] mg/L**
Free Chlorine Analyzer	**0 to [0.5] [1.0] [2.0] [5.0] mg/L**
Total Chlorine Analyzer	**0 to [0.5] [1.0] [2.0] mg/L**
Hexavalent Chromium Analyzer	**0 to [0.2] [1.0] mg/L**
Copper Analyzer	**0 to [5.0] [10.0] mg/L**
Hardness Analyzer	**0 to [0.5] [1.0] [2.0] [5.0] [10] [20] [50] [100] mg/L**
Silica Analyzer	**0 to [25] [50] mg/L**

****

[Hardness] [_____] analyzer must be suitable for range of [0] [_____] to [_____] mg/L as [Calcium Carbonate (CaCO3) equivalent] [_____]. Calorimetric analyzer must be an on-line continuous reading process instrument using a colorimeter that compensates for moderate changes in the light source, the sample cell condition, sample turbidity and background color. Analyzer must include sampling pumps, reagent storage and dispenser as well as colorimeter and colorimeter cell. System must be self-cleaning. Analyzer must require no more than weekly instrument standardization. Repeatability and reproducibility must be plus or minus [10] percent of the alarm trip value on 1 and 2 mg/L range and plus or minus 4 percent of alarm trip value on the remaining ranges. Reagent requirements must be no greater than 1 L each of indicator and buffer every two months for continuous operation.

2.4.8.9 Flame Ionization Detector (FID)

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NOTE: A version with non-methane (NMOC) measurement capability is available when regulations require it.

****

A continuous flame ionization detector (FID) must be installed on a pumped sampling line to measure the total hydrocarbon (THC) content. The analyzer must have been configured at the factory for either H2, H2/He, or H2 and nitrogen fuel and calibrated for propane or methane equivalence. Total accuracy (includes calibration gas, response factor, and sample mix accuracies) must be not less than [_____] [4 ppmv] [± 3 percent of full scale] as methane. Repeatability must be [± 1%] maximum. Range and span must be continuously variable. Zero stability must be [± 1% in 30 days], span stability must be [±5% in 1 year]. Linearity must be within 1% of full scale. Outputs must include one 4-20mA and [6] relays for [warning, danger, fault, horn, calibration-in-progress, and service needed]. Detector response time must be [1.2 seconds] or less.

2.4.8.10 Hydrogen Sulfide Gas

****

NOTE: OSHA has established a permissible exposure limit (PEL) of 10 ppm. 10-20 ppm is the borderline concentration for eye irritation. 20 ppm is the acceptable ceiling concentration established by OSHA. 50 ppm is the acceptable maximum peak above the ceiling concentration for an 8 hour shift, with a maximum duration of 10 minutes.

****

The hydrogen sulfide sensor must be rated for continuous monitoring of the hydrogen sulfide level in the range from [0] [_____] to [20] [50] [100] [_____] ppmv with an accuracy of plus or minus [1] [_____] percent of full scale reading. The sensor response time must be a maximum of [30] [_____] seconds with full scale gas applied according to ISA 92.00.01. Repeatability must be ± 2ppm or 10% of the applied gas, whichever is greater. The sensor must have a calibration, calibration check, and setup modes.

2.4.8.11 Oxides of Nitrogen (NOx) Gas

Continuous emissions monitoring systems (CEMS) for measuring NOx must be provided with installed back-up devices. The CEMS must comply with 40 CFR 60, Appendix B, Performance Specification 3 and the QA/QC requirements of 40 CFR 60, Appendix F. Calculation of emission rates must be in conformance with 40 CFR 60, Appendix A, Reference Method 19. Monitor must be designed to verify compliance with standards for NOx normalized to a 3 percent oxygen basis and must have a range of from [0] [_____] to [100] [_____] ppmv. Sensor must be accurate to plus or minus [5] [_____] ppmv. Sensor must be complete with automatic zero and span calibration using a timed calibration gas system, and must require no periodic calibration.

2.4.8.12 Oxygen Gas

Continuous emissions monitoring systems (CEMS) for measuring O2 must be provided with installed back-up devices. The CEMS must comply with 40 CFR 60, Appendix B, Performance Specification 2 and the QA/QC requirements of 40 CFR 60, Appendix F. Calculation of emission rates must be in conformance with 40 CFR 60, Appendix A, Reference Method 19. Oxygen in air must be monitored by an oxygen sensor and electronic controller. The oxygen sensor must be rated for continuous monitoring of the oxygen level in air in the range of [0] [_____] to [20] [25] [30] [_____] percent with an accuracy of plus or minus [1] [_____] percent of full scale reading at constant temperature and pressure and plus or minus [5] percent of full scale reading over operating temperature range. The sensor response time must be [90] [_____] percent in a maximum of [5] [_____] seconds. The controller must have automatic zeroing and must require no normal maintenance or periodic recalibration.

2.4.8.13 Oxygen Dissolved

The dissolved oxygen sensor must provide continuous measure of dissolved oxygen. Wetted materials must be [stainless steel,] [PVC] or glass. Sensor must be rated for continuous use to a depth of [15] [_____] m [50] [_____] feet and must be automatically temperature compensating over the temperature range. Sensor must be capable of measuring dissolved oxygen level of from [0] [_____] to [15] [_____] ppmv. The sensor must have an accuracy of plus or minus [1] [_____] percent of full scale reading, repeatability of [±0.05] and response time of [25 sec to 63%] of final reading at 25°C 77F.

2.4.8.14 Oxygen Reduction Potential (ORP)

The sensor must be [submersible] [flow-through] type. Sensor must have a redox potential range of plus or minus [500] [_____] mV and must have an accuracy of plus or minus [1] percent of sensor span. The sensor must automatically compensate for temperature over the temperature range. The sensor body must be [PVC, CPVC, Liquid Crystal Polymer (LCP) or epoxy] and suitable for installation in the environment.

2.4.8.15 Ozone (O3) Gas

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NOTE: The standard instrument provides the range 0-1,000 ppmv (parts per million by volume) an alternate display of ozone concentration is in millipascals.

****

Ozone in air must be monitored by an ozone gas sensor and electronic controller. The sensor must be capable of detecting ozone in the range of [0] [_____] to [1,000] [_____] ppmv with an accuracy of plus or minus [1] [_____] percent of the full scale reading. The sensor response time must be [90] [_____] percent in a maximum of [60] [_____] seconds.

2.4.8.16 Ozone (O3) in Water

The dissolved ozone sensor must provide continuous measurement of dissolved ozone level from [0] [_____] to [5] [_____] mg/L. The sensor must automatically compensate for temperature over the temperature range. The sensor must have an accuracy of plus or minus [1] [_____] percent of the full scale reading. [System must include variable area flow meter and needle valve to regulate rate of sample flow through sensor unit.] [Sensor must be suitable for direct submersion.]

2.4.8.17 pH Monitoring

****

NOTE: Limit the range to improve the sensitivity.

****

The sensor must be [submersible] [or] [flow-through] type. [Sensor must be a differential type]. Sensor must have a range of [1] [4] [5] [5.5] [_____]. pH units to [8.5] [9] [11] [14] [_____]. pH units and must have an accuracy of plus or minus [0.1] [0.01] [_____]. pH unit. The sensor must automatically compensate for temperature over the temperature range. The sensor body must be PVC, CPVC or epoxy.

2.4.8.18 VOC Detector

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NOTE: Show sampling points on the drawings.
****

Detector must be either photoionization or Gas Sensitive Semiconductor type. Contaminant and background concentrations are [as follows:] [_____]. Detector must be provided with a means to collect representative continuous samples and measure for the presence of volatile organic compounds (VOCs). Sampling points are as indicated on the drawings. The system must be provided with automated zero and calibration gas system as well as a [4-20ma] [relay controller] output.

2.4.8.19 Total Dissolved Solids (TDS)

The TDS sensor must measure the specific conductance using a conductivity sensor, displaying the total dissolved solids value in [milligrams per liter (mg/L) of dissolved NaCl equivalent] [microohms (microSiemens) per centimeter (uS/cm)] and transmitting an analog signal for remote processing. System must be industrial grade, [contacting][torodial] and suitable for measurement of conductivity in a solution [by insertion of the sensing element into the pipeline, using a hot tap assembly] [including a variable area flow meter and needle valve to regulate rate of sample flow through sensor unit]. Sensor assembly must be suitable for periodic removal for adjustment and cleaning without requiring shut down of the process. Sensor must be suitable for range of [0] [_____] to [10,000] [_____] [milligrams per liter (mg/L) of dissolved NaCl equivalent] [microohms per centimeter (uS/cm)]. Range must be field verified for the application and adjusted as required. Sensing element must be constructed of [316 stainless steel] [_____] and glass, including temperature element, and be capable of continuous operation. Sensing element must be unaffected by color in the fluid, pressure, and rate of flow. Sensor must have automatic temperature compensation and must require no normal maintenance or periodic recalibration.

2.4.8.20 Water Turbidity

System must be complete and include indicating meter, sensing element and a transmitter. System must be industrial grade and suitable for measurement of turbidity by [insertion of the sensing element into the pipeline, using a hot tap assembly] [direct submersion of the sensing element into the vessel or flow channel]. Sensor assembly must be suitable for periodic removal for adjustment and cleaning without requiring shutdown of the process. Sensor must be suitable for range from [0] [_____] to [2] [20] [200] Nephelometric turbidity units (NTU). The accuracy must be plus or minus [2] [_____] percent of full scale reading. Range must be field verified for the application and adjusted as required. Sensing element must be constructed of [316 stainless steel] [_____] and glass. Sensing element must be unaffected by color in the fluid, pressure, temperature and rate of flow. Sensor must have automatic zeroing and must require no normal maintenance or periodic recalibration. Sensor must have [active and] passive anti-fouling mechanisms.

2.4.9 Electrical Instrumentation

Electrical power measurements with a range for the specific application, plus or minus [1.0] [_____] percent of range (display and print to nearest kWh and kW). Electrical measurements with a range for the specific application plus or minus [1.0] [_____] percent of range (display and print to nearest [0.1] [_____] for volts and amperes, and to the nearest [0.01]

2.4.9.1 Hour Meter

Hour meter must provide a totalized readout of the number of hours of operation for the equipment monitored. Meter must provide readout with a minimum of [5] [6] [7] digits including [1] [_____] decimal places. The display must be non-resettable. The meter must be driven by a [24] [120] [240] VAC synchronous motor.

2.4.9.2 Watt-Hour Meter

Watt-hour meters must be in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC.

2.4.10 Limit Switch

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NOTE: See NEMA ICS 5 Part 9 for application guidelines. To increase the number of operations during the life of the contact, select contacts with make and break values much higher than those applied

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Limit switch must be [rotary/lever] [induction/proximity] type, contacts must be heavy duty and rated A600 or N600. Enclosure must be metal. The actuating head must vary based upon the application.

2.4.11 Absolute Rotary Encoder

The absolute rotary encoder must retain the count upon loss of power without use of battery or alternate power source. The encoder must increase the count when turning in the direction which causes [the gate to raise] [_____] and must decrease the count in the opposite direction. The encoder must be capable of counting at least [4,096] data points per revolution and [counting [4096] revolutions.][tracking the full range of operation.] The output signal must be [synchronous serial interface (SSI)][Common Industrial Protocol (CIP)] [_____]. Draw wire string encoder type of absolute rotary enconder must not be used in outdoor settings.

2.4.12 Linear Displacement Position Sensor

The linear displacement position sensor must be a magnetostrictive position sensor capable of 0.02% accuracy or better along the entire hydraulic cylinder stroke length. The sensor mmust measure the full stroke of the hydraulic cylinder. The sensor must be capable of 4-20mA analog output with an update cycle of at most 10ms. The sensor module and rod must meet IP 67 standards. The sensor must mount to the hydraulic cylinder by threaded flange and be constructed to integrate with the hydraulic cylinder.

2.4.13 Emergency Stop

Emergency stop pushbutton must have red mushroom actuator and yellow background. Actuator must be self-latching and manually reset. Provide contacts that are NEMA ICS A600 and directly opened. Pushbutton must meet NFPA 79 SECTION 10.7.

2.5 COMPRESSED AIR STATIONS

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NOTE: If the process control system does not utilize pneumatic devices, the air compressor and accessories should be deleted.

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Submit instrumentation compressed-air station schematic diagram showing equipment utilized, including compressor with motor output and voltage; starter; isolators; manual bypasses; tubing sizes; drain piping and drain traps; reducing valves; air-dryer; and data on manufacturer's names and model numbers, mounting, access, and clearance requirements. Include in the air-compressor and air-dryer data calculations of the air consumption of pneumatic control valves and of other process control system devices to be connected to the compressed-air station; the number of starts per hour, the running time for the unit selected; and the compressed air-supply dewpoint temperature at 552 kPa 80 psig.

2.5.1 Air Compressor Assembly

The air compressor must be a high-pressure compressing unit with electric motor. The compressor must be equipped with a motor with totally enclosed belt guard, an operating-pressure switch, safety relief valves, gauges, intake filter and intake silencer and combination type magnetic starter with under voltage protection and thermal overload protection for each phase, and must be supported by a steel base mounted on an air storage tank. The air compressor must provide the compressed air required for control operation while operating not more than one-third of the time. The tank must be of sufficient volume so that no more than six compressor starts per hour are required with the starting pressure switch differential set at 140 kPa 20 psi gage. The air storage tank must be fabricated for a working pressure of not less than 1380 kPa 200 psi gage and constructed and certified in accordance with ASME BPVC SEC VIII D1. The tank must be provided with an automatic condensate drain trap with manual override feature. [A second (duplex arrangement) compressor of capacity equal to the primary compressor must be provided, with interlocked control to provide automatic changeover upon malfunction or failure of either compressor. A manual selector switch must be provided to index the lead compressor including the automatic changeover.]

2.5.2 Compressed Air Station Specialties

2.5.2.1 Refrigerated Dryer, Filters and Pressure Regulator

A refrigerated dryer must be provided in the air outlet line of the air storage tank. The dryer must be of the size required for the full delivery capacity of the compressor. The air must be dried at a pressure of not less than 483 kPa 70 psi gage to a temperature not greater than 2 degrees C 35 degrees F. The dryer must be provided with an automatic condensate drain trap with manual override feature. The refrigerant used in the dryer must be one of the fluorocarbon gases. A 5 micron prefilter and coalescing-type oil removal filter with shut-off valves must be provided in the dryer discharge. Each filter bowl must be rated for 1034 kPa 150 psi gage maximum working pressure. A pressure regulator with high side and low side pressure gauges and a safety valve must be provided downstream of the filter. Pressure regulators of the relieving type must not be used.

2.5.2.2 Coalescing Filter

A coalescing prefilter, together with an automatic drain valve, must be provided for removal of liquids. The flow through the prefilter must be from inside to outside and reduce an entrained quantity of 50 ppmv oil to 0.0013 ppmv effluent liquid oil and water and remove all particulates greater than 0.6 micron absolute. The prefilter housing (bowl) must be fitted with a drain port to eliminate collected liquids and provide sufficient sump volume to prevent liquid re-entrainment, and an automatic drain valve with adjustable cycle and drain times. Prefilter pressure drop must be less than 21 kPa 3 psi saturated. A particulate after filter, outside to inside flow, designed to remove desiccant fines must be provided. The after filter cartridge must have a particulate removal rating of 0.5 micron absolute. Both prefilter and after filter housings must allow for service of elements without removing the entire assembly from the system. Filter life must be stated and guaranteed by the vendor.

2.5.2.3 Flexible Pipe Connections

The flexible pipe connectors must be designed for 1034 kPa 150 psi gage and 121 degrees C 250 degrees F service and must be constructed of rubber, polytetrafluoroethylene (PTFE) resin or braided corrosion-resistant steel, bronze, monel or galvanized steel. The connectors must be suitable for the service intended and may have threaded or soldered ends. The length of the connectors must be as recommended by the manufacturer for the service intended.

2.5.2.4 Vibration Isolation Units

The vibration isolation units must be standard products with published loading ratings and must be single rubber-in-shear, double rubber-in-shear or spring type.

2.5.2.5 Compressed Air Piping

Control air delivered to the system must conform to ISA 7.0.01. Air lines for pneumatic controls must be seamless copper tubing or nonmetallic tubing. Nonmetallic tubing must be compounded from polyethylene. Air lines concealed in walls must be hard-drawn copper tubing or nonmetallic tubing in rigid conduit. Terminal single lines must be hard-drawn copper tubing except when the run is less than 300 mm 12 inches in length, flexible polyethylene may be used. Nonmetallic tubing will not be used for applications where the tubing could be subjected to a temperature exceeding 55 degrees C 130 degrees F. Fittings for nonmetallic tubing must be for instrument service and may be brass or acetyl resin of the compression or barbed push-on type. Tubing must be as follows:

a. Copper tubing must conform to ASTM B88M ASTM B88 and must have sweat fittings and valves.Exposed tubing must be hard drawn in exposed areas and hard-drawn or annealed in concealed areas. Only tool made bends must be used. Fittings for copper tubing must be brass or copper solder joint type except at connections to the apparatus, where fittings must be brass compression type. Grooved mechanical joints and fittings must be designed for not less than 862 kPa 125 psig service and must be the product of the same manufacturer. Grooved fittings and mechanical coupling housing must be ductile conforming to ASTM A536. Gaskets for use in grooved joints must be molded synthetic polymer of pressure responsive design and must conform to ASTM D2000 for circulating medium up to 110 degrees C 230 degrees F. Grooved joints must conform to AWWA C606. Tubing must be rack mounted where multiple tubes run in parallel. Multiple tubes may be bundled when concealed.

b. Tubing must be flame resistant, multiple polyethylene tubing in an extruded PVC protective sheath, or unsheathed polyethylene tubing in rigid metal, intermediate metal, or electrical metallic tubing conduit for areas where tubing is exposed. Tubing must have barbed fittings and valves, and must conform to the following: Burst pressure must be 3.8 MPa 550 psi gage at 24 degrees C 75 degrees F to 1.2 MPa 175 psi gage at 66 degrees C 150 degrees F, minimum. Stress crack resistance in accordance with ASTM D1693 must be 200 hours, minimum. Tensile strength in accordance with ASTM D638 must be 14 MPa 2000 psi, minimum. Average density in accordance with ASTM D792 must be 920 kg/m3. Average flow rate in accordance with ASTM D1238 must be 0.30 decigram per minute.

c. Plastic tubing must have the burning characteristics of linear low density polyethylene tubing, must be self extinguishing when tested in accordance with ASTM D635, must have UL 94 V-2 flammability classification, and must withstand stress cracking when tested in accordance with ASTM D1693. Polyethylene tubing must not be used for smoke removal systems.

2.5.3 Barrier Jacket

Provide plastic tubing bundles mylar barrier and flame retardant polyethylene jacket. Each tube must be numbered.

2.6 PROGRAMMABLE LOGIC CONTROLLER (PLC)

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NOTE: Typically, either modular or loop type PLCs will be used throughout the process control system. The designer must determine which is best suited for the application and delete the paragraph pertaining to the type that will not be used. If it is determined that the use of both types is necessary, the drawings will indicate where each type will be used and both types will be included in the edited specification.

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2.6.1 PLC General Requirements

PLCs must be micro-processor based, capable of receiving binary and analog inputs and, through programming, must be able to control binary and analog output functions, perform data handling operations and communicate with external devices. PLCs must meet the requirements of Class A computing devices, and must be labeled as set forth in 47 CFR 15 and must be able to withstand conducted susceptibility test as outlined in NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, [and] [or] IEEE C37.90.1. PLCs must function properly at temperatures between 0 and 50 degrees C 32 and 122 degrees F at 5 to 95 percent relative humidity non-condensing and must tolerate storage temperatures between minus 40 and plus 60 degrees C 40 and plus 140 degrees F at 5 to 95 percent relative humidity non-condensing.

2.6.2 Modular PLC

PLCs must be based on a modular, field expandable design allowing the system to be tailored to the process control application. The system must be expandable through the use of additional hardware and/or user software. As a minimum, the PLC must include a mounting backplane, power supply module, central processing unit (CPU) module, communications module, and input/output (I/O) module. The modules must be grouped together in a mounting rack or cabinet. The mounting rack backplane must provide the communications mechanism to fully integrate the individual modules located within the rack. Modules other than I/O modules must plug directly into the backplane. The use of wire connectors between modules will not be allowed except for expansion of the system to include multiple backplanes. The rack size must be as needed to hold the equipment necessary while performing the required control functions. [The system configuration must allow for the removal and/or installation of modules under power.]

2.6.2.1 Central Processing Unit (CPU) Module

The CPU module must be a self contained, microprocessor based unit that provides time of day, scanning, application program execution, storage of application programs, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self diagnostics. The scan time must be [250 milliseconds] or better including spare I/O channels.

2.6.2.2 Communications Module

The communications module must allow peer-to-peer communication with other PLCs and must allow the PLC to communicate with the central station, or workstation. The communication module must utilize the manufacturer's standard communication architecture and protocol, ethernet architecture and protocol or a combination of these. The communication module must allow programming of the PLC to be done locally through the use of a laptop computer[or from the central station or remote workstation].

2.6.2.3 Power Supply Module

One or more power supply modules must be provided as necessary to power other modules installed in the same cabinet. Power supply modules must plug directly into the backplane. Auxiliary power supplies may be used to supply power to remote cabinets or modules.

a. Power supply modules must use [AC] [DC] power with a nominal voltage of [120 VAC] [220 VAC] [24 VDC] [48 VDC] [125VDC] plus or minus 5 percent. The power supply module must monitor the incoming line voltage level and must provide over current and over voltage protection. If the voltage level is detected as being out of range the power supply module must continue to provide power for an adequate amount of time to allow for a safe and orderly shutdown. Power supply modules must be capable of withstanding a power loss for a minimum of 20 milliseconds while still remaining in operation and providing adequate power to all connected modules.

b. Each power supply module must be provided with an on-off switch integral to the module. If the manufacturer's standard power supply module is not provided with an on-off switch, a miniature toggle type switch must be installed near the PLC and must be clearly labeled as to its function..

c. Provide power supply modules with an indicating light which must be lit when the module is operating properly.

2.6.2.4 Input/Output (I/O) Modules

Modules must be self contained, microprocessor based units that provide an interface to field devices.[The modules must be located in the same cabinet as the other PLC components.] Each module must contain visual indication to display the on-off status of individual inputs or outputs. Each I/O must be protected against reversal of polarity of the signal. Analog inputs and analog outputs must have 'open, short and out of range circuit' detection. It must be configurable per channel.

2.6.3 Loop PLC

PLCs must be single or multiple loop controllers depending on the process control system requirements. Controllers must be self contained and must include a central processing unit (CPU), program memory, power supply, input/output capability, [network communications capability] and display/keyboard. The controller must have a scaleable process variable for each loop. Controller must have proportional, integral and derivative (PID) control logic. Analog outputs must be configured as direct acting or reverse acting. The controller must have keyboard, display, auto/manual selection for control of each loop output, remote setpoint, adjustment/local setpoint adjustment selection with adjustable high-end and low-end limits, ratio and bias adjustment on remote setpoint input, [operator-initiated self-tune/manual-tune selection] [and anti-reset wind-up feature]. Controller must power analog output loops to 20 mAdc when connected to a load of 600 ohms.

2.6.3.1 Central Processing Unit (CPU)

The central processing unit must be microprocessor based and must provide time of day, scanning, application program (ladder rung logic) execution, storage of application programs, storage of numerical values related to the applications process and logic, I/O bus traffic control, peripheral and external device communications and self diagnostics.

2.6.3.2 Power Requirements

Each controller must be powered by [AC] [DC] power with a nominal voltage of [120 VAC] [220 VAC] [24 VDC] [48 VDC] [125VDC]. Power consumption must not exceed 25 watts. Controller must provide electrical noise isolation between the AC power line and the process variable inputs, remote setpoint inputs and output signals of not less than 100 dB at 60 Hertz common mode rejection ration and not less than 60 dB at 60 hertz normal-mode rejection ration.

2.6.3.3 On-Off Switch

Each controller must be provided with an integral on-off switch. If the controller is not provided with a manufacturers standard on-off switch, a miniature toggle type switch must be installed near the controller and must be clearly labeled as to its function.

2.6.3.4 Parameter Input and Display

Enter and display control parameters directly, in the correct engineering units, through a series of keystrokes on a front panel display with decimal point and polarity indication. Provide display [in metric English units] [in metric or English units as selected by the operator].

[2.6.3.5 Self Tuning

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NOTE: If the process control system does not utilizeAnalog control, or if self tuning is not needed delete this bracketed section as it limits the number of vendors.

****

Provide controllers with self-tuning operation which applies to proportional, integral and derivative modes of control and modify the mode constants as required. Self-tuning must only be in operation when selected from the front panel.

]2.6.3.6 Manual Tuning

Controllers must be provided with manual tuning operation which must apply to proportional, integral and derivative modes of control, by means of individually adjustable mode constants. These adjustments must be set for the appropriate value if a particular control mode action is required or to zero if that particular mode is not desired. The proportional mode constant must be adjustable from 0 to 200 percent of the input signal range. The integral mode constant must be adjustable from 0 to 20 repeats per minute. The derivative mode constant must be adjustable from 0 to [5] [____] minutes.

2.6.4 Program Storage/Memory Requirements

The CPU must utilize the manufacturer's standard non-volatile memory for the operating system. The controller must have electronically [readable and writeable non volatile memory (EPROM, EEPROM, or Flash PROM)] [battery backup volatile memory. Must be possible to change battery with power on] for storage of user programs. The user programs must be loaded through the controller keypad, central station or through the use of a laptop computer. The CPU memory capacity must be based on the system's control requirements. The memory capacity must be sized such that, when the system is completely programmed and functional, no more than 50 percent of the memory allocated for these purposes is used.

2.6.5 Input/Output Characteristics

Each controller must allow for analog input, analog output, binary input and binary output. The number and type of inputs and outputs for the system must be as shown on the drawings and must comply with the sequence of control. The system capacity must include a minimum of 20 percent spare input and output points (no less than two points) for each point type provided. During normal operation, a malfunction in any input/output channel must affect the operation of that channel only and must not affect the operation of the CPU or any other channel. All input circuits must have a minimum optical isolation of 1500 VRMS and must be filtered to guard against high voltage transients from the externally connected devices. All output circuits must have a minimum optical isolation of 1500 VRMS and must be filtered to guard against high voltage transients from the externally connected devices.

2.6.5.1 Analong Inputs

Analog input circuits must be available in [+/-10V] [+/-5V] [0-10V] [0-5V]

[4-20 mA].

2.6.5.2 Binary Inputs

Binary input circuits must be available in [5 volt TTL] [10-30 VDC] [18-26 VDC] [79-132VDC] [79-132 VAC].

2.6.5.3 Analog Outputs

Analog output circuits must be available in [+/-10V] [4-20 mA].

2.6.5.4 Binary Outputs

Binary output circuits must be available in [5 volt TTL] [10-30 VDC] [18-26 VDC] [79-132 VAC].

2.6.5.5 Pulse Inputs

Pulse inputs must be able to detect a pulse of [x milliseconds] or less.

2.6.6 Wiring Connections

Wiring connections must be heavy duty, self lifting, pressure type screw terminals to provide easy wire insertion and secure connections. The terminals must accept two #14 AWG wires. A hinged protective cover must be provided over the wiring connections. The cover must have write-on areas for identification of the external circuits.

2.6.7 On-Off Switch

Each controller must be provided with an integral on-off power switch. If the controller is not provided with a manufacturer's standard on-off switch, a miniature toggle type switch must be installed in the control panel near the controller and must be clearly labeled as to its function.

2.6.8 Diagnostics

Each PLC must have diagnostic routines implemented in firmware. The CPU must continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and input/output. The diagnostic routines must be regularly performed during normal system operation. A portion of the scan time of the controller must be dedicated to performing these housekeeping functions. In addition, a more extensive diagnostic routine must be performed at power up and during normal system shutdown. The CPU must log input/output and system faults in fault tables which must be accessible for display. When a fault affects input/output or communications modules the CPU must shut down only the hardware affected and continue operation by utilizing the healthy system components. All faults must be annunciated at [the PLC] [and] [the central station]. Diagnostic software must be useable in conjunction with the portable tester. The following diagnostics must be performed:

a. Analong Inputs: Sensor out of range, open or shorted loop, analog-to-digital converter check

b. Analog Outputs: Open or shorted loop

c. Configuration: Check compatibility and availability of selected I/O hardware and software

d. Memory: Checksum, parity check End-to End CPU memory

2.6.9 Accuracy

Provide controllers with an accuracy of plus or minus [0.25] percent of input span.

[2.6.10 Primary/Secondary PLC

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NOTE: Determine if the system is critical enough to require a Primary/Secondary PLC arrangement. This is a significant cost addition and makes the system more complex.

****

The Primary/Secondary PLCs must have redundancy built into the process control system by having two systems (power supply and CPU) either of which is capable of controlling the system. Data must be transferred from the primary processor to the secondary processor each logic cycle. [The I/O scan must be transferred from the PLC currently in charge to the other at the end of each logic execution and the logic must be executed.] [The data must be transferred via asynchronous transfer where the primary processor haws two separate microprocessors embedded in its circuitry and at the end of logic execution all data must be passed to the second microprocessor and the second microprocessor must handle all transfer tasks while the first executes the next program scan.] The Primary must perform the execution of the outputs unless a fault is detected in which case execution of the outputs is performed by the Secondary. Switchover must be automatic and indication of the switchover must be displayed on the Central Operator Workstation.

]2.7 PLC SOFTWARE

Furnish all PLC software described in this specification as part of the complete control system.

2.7.1 Operating System

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NOTE: If loading of control logic is allowed from the central station this presents a security risk.

****

Each PLC must be provided with the manufacturer's standard operating system software package. The PLC must maintain a point database in its memory that includes all parameters, constraints and the latest value or status of all points connected to the PLC. Execution of the PLC application programs must use the data in memory resident files. The operating system must support a full compliment of process control functions. It must be possible to define these functions using a mix of ladder logic diagrams, function blocks, sequential function charts and text programming. Programming methods and interactions must be based on IEC 61131-3. A combination of the programming methods must be possible within a single controller. The operating system must allow loading of control logic locally [or from the central station in which case it must require a password to do so] and data files from the portable tester. It must also support data entry and diagnostics using an operator interface panel attached directly to the PLC. Each PLC must be capable of operating in stand alone mode.

2.7.1.1 Startup

The PLC must have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A PLC restart program based on detection of power failure at the PLC must be included in the PLC software. The restart program must include start time delays between successive commands to prevent demand surges or overload trips.

2.7.1.2 Failure Mode

Upon failure for any reason, each PLC must perform an orderly shutdown. Systems which are not Primary/Secondary must force all PLC outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device. Primary/Secondary systems must transfer I/O scan and control to the PLC not currently failed.

2.7.2 Functions

The controller operating system must be able to scan inputs, control outputs, and read and write to its internal memory in order to perform the required control as indicated in the sequence of control on the drawings. The controller must periodically perform self diagnostics to verify that it is functioning properly. [If the system is set up as a Primary/Secondary system the system must attempt to switch to the other PLC upon sensing a fault in the currently controlling PLC.]

2.7.2.1 Analog Monitoring

Measure and transmit all analog values including calculated analog points.

2.7.2.2 Logic (Virtual)

Logic (virtual) points must be software points entered in the point database which are not directly associated with a physical I/O function. Logic (virtual) points must be analog or binary points created by calculation from any combination of binary and analog points, or other data having all the properties of real points, including alarms, without the associated hardware. Logic (virtual) points must be defined or calculated and entered into the database. The calculated analog point must have point identification in the same format as any other analog point.

2.7.2.3 State Variables

If an analog point represents more than two (up to 8) specific states, each state must be nameable. For example, a level sensor must be displayed at its measured engineering units plus a state variable with named states usable in programs or for display such as low alarm/low/normal/high/high alarm.

2.7.2.4 Analog Totalization

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NOTE: If the analog totalization is to be performed at the central station and is not to be

done at the PLC, this requirement will be deleted.

****

Any analog point must be operator assignable to the totalization program. Up to eight analog values must be totalized within a selectable time period.

2.7.3 Alarm Processing

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NOTE: If the alarm processing function is to be performed at the central station and is not to be done at the PLC, this requirement will be deleted.

****

Each PLC must have alarm processing software for AI, DI, and PA alarms for all real and virtual points connected to that PLC.

2.7.3.1 Binary Alarms

Binary alarms are those abnormal conditions indicated by BIs as specified and shown. The system must automatically suppress analog alarm reporting associated with a binary point when that point is turned off.

2.7.3.2 Analog Alarms

Analog alarms are those conditions higher or lower than a defined value, as measured by an AI. Analog readings must be compared to predefined high and low limits, and alarmed each time a value enters or returns from a limit condition. Unique high and low limits must be assigned to each analog point in the system. In control point adjustment (CPA) applications, key the limit to a finite deviation traveling with the setpoint. The system must automatically suppress analog alarm reporting associated with an analog point when that analog point is turned off.

2.7.3.3 Pulse Accumulator (PA) Alarms

Pulse accumulator alarms are those conditions calculated from totalized values of accumulator inputs or PA input rates that are outside defined limits as specified and shown. PA totalized values must be compared to predefined limits and alarmed each time a value enters a limit condition. Unique limits must be assigned to each PA point in the system.

2.7.4 Constraints

2.7.4.1 Equipment Constraints Definitions

Each control point in the database must have PLC resident constraints defined and entered by the Contractor, including as applicable: maximum starts (cycles) per hour; minimum off time; minimum on time; high limit (value in engineering units); and low limit (value in engineering units).

2.7.4.2 Constraints Checks

All control devices connected to the system must have the PLC constraints checked and passed before each command is issued. Each command point must have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value must be assigned to each AI. Each individual point must be capable of being selectively disabled by the operator from the central station.

2.7.5 Control Sequences and Control Loops

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NOTE: Sequences to be implemented will be developed by the designer to meet site requirements. The designer will define allowable process control loop accuracies as a part of the sequences. Control sequences and database tables will be shown on the drawings.
****

Specific functions to be implemented are defined in individual system control sequences and database tables shown on the drawings, and must include, as applicable, the following functions: PI control must provide proportional control and proportional plus integral control; two position control must provide control for a two state device by comparing a set point against a process variable and an established dead band; floating point control must exercise control when an error signal exceeds a selected dead band, and must maintain control until the error is within the dead band limits; signal selection must allow the selection of the highest or lowest analog value from a group of analog values as the basis of control and must include the ability to cascade analog values so that large numbers of inputs can be reduced to one or two outputs; signal averaging must allow the mathematical calculation of the average analog value from a group of analog values as the basis of control and must include the ability to "weight" the individual analog values so that the function output can be biased as necessary to achieve proper control; reset function must develop an AO based on up to two AIs and one operator specified reset schedule.

2.7.6 Command Priorities

A scheme of priority levels must be provided to prevent interaction of a command of low priority with a command of higher priority. Override commands entered by the operator must have higher priority than those emanating from applications programs.

2.7.7 Resident Application Software

****
NOTE: The data base and settings tables will be incorporated into the contract package. Specify only those applications programs to be implemented at time of acceptance. Do not specify a program unless sensors and controls required to implement it are included in the design package.
****

Provide resident applications programs developed in accordance with paragraph GRAPHICAL PROGRAMMING to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the process systems connected to the process control system. All application programs must be resident in the PLC and must execute in the PLC, and must coordinate with each other, to ensure that no conflicts or contentions remain unresolved.

2.7.7.1 Program Inputs and Outputs

Use program inputs listed for each application program to calculate the required program outputs. Where specific program inputs are not available, a "default" value or virtual point appropriate for the equipment being controlled and the proposed sequence of operation must be provided to replace the missing input, thus allowing the application program to operate.

2.7.7.2 Failure Mode

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NOTE: Assure that the appropriate failure modes are identified on the drawings.

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In the event of a PLC failure, the controlled equipment must continue to function in the failure mode shown on the drawings. Systems that are Primary/Secondary must transfer control to the non-failed system.

2.8 CONTROL PANELS

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NOTE: For locations or equipment that will be powered by an uninterruptible power supply (UPS) during a commercial power outage, the control panel must be included on the UPS.

Include in the design package requirements for sufficient ventilation, heating or air conditioning to ensure that the control panel internal temperature and humidity will be maintained within the PLCs operational parameters when exposed to the temperature and humidity indicated in paragraph SITE ENVIRONMENTAL CONDITIONS. Include allowance for any solar gain. If the requirements for ventilation, heating and air conditioning are not necessary, they will be deleted.

****

2.8.1 Components

2.8.1.1 Enclosures

The enclosure for each control panel must conform to the requirements of NEMA 250 for the types specified. Finish color must be the manufacturer's standard, unless otherwise indicated. Enclosures for installation in mechanical equipment rooms must be Type [1] [4] [12]; those for installation in clean, dry indoor occupied space may be Type 1; other locations must be as otherwise specified or shown. Enclosures for equipment installed outdoors must be Type 4 or as shown. Enclosures for installation in a corrosive environment must be Type 4X and must be constructed of [stainless steel] [fiberglass] [polymer plastic]. Painted steel must not be allowed for use in a corrosive environment. Enclosure must be provided with a single, continuously hinged exterior door with print pocket, 3-point latching mechanism and key lock and a single, continuously hinged interior door.

2.8.1.2 Controllers

Provide controllers in accordance with paragraph Programmable Logic Controller (PLC).

2.8.1.3 Standard Indicator Light

Indicator lights showing on, off, stand-by, automatic, manual depending on the application must comply with NEMA ICS 1, NEMA ICS 2 and UL 508A. Lights must be heavy duty, round and must mount in a 22.5 mm 0.875 inch mounting hole. Indicator lights must be LED type and must operate at 120 VAC or 24 VDC. Long life bulbs must be used. Indicator light must be provided with a legend plate labeled as shown on the drawings. Lens color must be as indicated on the drawings. Lights must be push to test (lamp) type.

2.8.1.4 Selector Switches

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NOTE: Indicate on the drawings where key operated switches are required.

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Selector switches must comply with NEMA ICS 1, NEMA ICS 2 and UL 508A. Selector switches must be heavy duty, round and must mount in a 22.5 mm 0.875 inch mounting hole. The number of positions must be as indicated on the drawings. Switches must be [illuminated] [non-illuminated] [as indicted of the drawings]. Switches must be rated for 600 volts, 10 amperes continuous. Selector switches must be provided with a legend plate labeled as shown on the drawings. Where indicated or required, dual auxiliary contacts must be provided for the automatic position to provide position sensing at the central station or workstation. Auxiliary contacts must be rated for 120 VAC, 1A as a minimum. Where indicated on the drawings, switches must be key operated. All keys must be identical.

2.8.1.5 Push Buttons

Push buttons must comply with NEMA ICS 1, NEMA ICS 2 and UL 508A. Push buttons must be heavy duty, round and must mount in a 22.5 mm 0.875 inch mounting hole. The number and type of contacts must be as indicated on the drawings or required by the Sequence of Control. Push buttons must be rated for 600 volts, 10 amperes continuous. Push buttons must be provided with a legend plate labeled as shown on the drawings.

2.8.1.6 Relays

Relays must comply with NEMA ICS 5 and derated for altitude above 1,500 m. Relays must be [single-pole, single-throw (SPST)] [single-pole, double-throw (SPDT)] [double-pole, single throw (DPST)] [double-pole, double-throw (DPDT)] [as required by the Sequence of Control]. Relay coil must be [120 VAC] [24 VDC] and must be provided with matching mounting socket. Power consumption must not be greater than 3 watts. Coils must have a minimum current rating of [___] amps and minimum voltage rating of [___] volts. Contacts must have a minimum current rating of [ ] amps and minimum voltage rating of [___] volts.

2.8.1.7 Terminal Blocks

Terminal blocks must comply with NEMA ICS 4 and UL 1059. Terminal blocks for conductors exiting control panels must be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks must be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip must form part of the terminal block and each terminal must be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.8.1.8 Alarm Horns

Alarm horns must be provided where indicated on the drawings. Horns must be vibrating type and must comply with UL 508A. Horns must provide 100 dB at 10 feet. Exterior mounted horns must be weather proof by design or must be mounted in a weather proof enclosure that does not reduce the effectiveness of the horn.

2.8.2 Panel Assembly

Control panels must be factory assembled and shipped to the jobsite as a single unit. Panels must be fabricated as indicated and devices must be mounted as shown or required. Each panel must be fabricated as a bottom-entry connection point for process control system electrical power, [process control system main air source,] process control system wiring, [control air pneumatic tubing,] [communications system wiring to [other control panels] [operators workstation]].

2.8.3 Electrical Requirements

Each panel must be powered by a dedicated [120 volts ac] [208 volts ac] [125VDC] circuit, with a fuse, [10 amp] [____] [sized as recommended by the equipment manufacturer], and a disconnect switch located inside the panel. Wiring must terminate inside the panel on terminal blocks. Electrical work must be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as shown on the drawings.

2.8.4 Power Line Conditioner

Each control panel must be provided with a power line conditioner to provide both voltage regulation and noise rejection. The power line conditioner must be of the ferro-resonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The power line conditioner must be sized for 125 percent of the actual connected kva load. Characteristics of the power line conditioner must be as follows:

2.8.4.1 85 Percent Load

At 85 percent load, the output voltage must not deviate by more than plus or minus 1 percent of nominal voltage when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal voltage.

2.8.4.2 Load Changes

During load changes of zero to full load, the output voltage must not deviate by more than plus or minus 3 percent of nominal voltage. Full correction of load switching disturbances must be accomplished within 5 cycles, and 95 percent correction must be accomplished within 2 cycles of the onset of the disturbance.

2.8.5 Grounding

Control panel enclosures must be equipped with a solid copper ground bus or equivalent. The ground bus must be securely anchored to the enclosure so as to effectively ground the entire structure. Clamp-type terminals sized large enough to carry the maximum expected current must be provided on the ground bus for grounding cables. Where a definite circuit ground is required, a single wire not less than #10 AWG must run independently to the panel ground bus and must be fastened to the ground bus with a bolted terminal lug. Cases of instruments, relays and other devices must be effectively grounded through the enclosures steel structure unless otherwise indicated. Insulated wiring having a continuous rated current of not less than the circuit fuse rating must be used for grounding. Grounding terminals of power receptacles must be solidly grounded to the panel enclosure.

2.8.6 Convenience Outlet

****

NOTE: Coordinate with electrical drawings to provide power for control panel convenience outlet and other required accessories.

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A 120 volt ac, 20 amp, ground fault interruption (GFI) type duplex convenience outlet must be provided inside the panel. The outlet circuit must be separate from the panel power circuit.

2.8.7 Panel Interior Light

[Where indicated,] [Each] control panel[s] must be provided with a [60 watt incandescent] [40 watt fluorescent] [15 watt LED] light. The light must be operated by a manual on-off switch mounted on the interior door of the enclosure. The light must be powered by the same circuit as the convenience outlet.

2.8.8 Ventilation System

[Where indicated,] [Each] control panel[s] must be provided with two single phase, 120 volt ac ventilation fans. Each fan must supply a minimum of 50 L/s 100 cfm of ventilation air through the enclosure. Each fan must be provided with a line voltage thermostat. Thermostat setpoints must be adjustable in a range of 21 to 60 degrees C 70 to 140 degrees F as a minimum. Each supply and exhaust grille must contain a filter that is easily removed for cleaning or replacement.

2.8.9 Heating System

[Where indicated,] [Each] control panel(s) must be provided with a thermostatically controlled electric heater capable of maintaining an enclosure temperature of [2] [_____] degrees C [35] [_____] degrees F when continuously exposed to an ambient temperature of [_____] degrees C degrees F.

2.8.10 Air Conditioning System

[Where indicated,] [Each] control panel[s] must be provided with a mechanical refrigeration air conditioning system. The system must be capable of maintaining a temperature of [38] [_____] degrees C [100]

[_____] degrees F inside the enclosure with all equipment in the panel operating and while continuously exposed to [full sunlight and] an ambient air temperature of [_____] degrees C degrees F. The compressor and condenser must be located outside the control panel enclosure. Provisions must be made to remove condensate from the control panel and to protect all devices within the enclosure from condensate.

2.9 COMPUTER HARDWARE

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NOTE: The designer must edit the following paragraph to require only the computer equipment that is necessary based on the requirements and complexity of the process control system. Must Verify that the location for the equipment will be provided with climate controls to provide a suitable environment for the equipment.

****

For computer hardware furnished under this specification provide standard products of a single manufacturer which advertises service in all 48 contiguous states, and provide only model currently in production. Except for PCI-E cards installed into expansion slots provided in a desktop or server computer in order to meet the requirements of this specification, do not modify computer hardware from the manufacturer configuration.

[2.9.1 Server Hardware

****

NOTE: Coordinate with the project site to determine if the server(s) will be contractor supplied or Government Furnished. If contractor supplied, coordinate with the Project Site's NEC (IT group) and include the sites 'standard' server redundancy requirements. Note that computer technology changes quickly and these requirements should be edited to reflect current products. Default requirements (current as of 2012) have been provided in brackets.

****

Computer Server Hardware (server) [will be furnished by the Government] [must be a desktop or server computer meeting the following minimum requirements:]

2.9.1.1 Processor

[____][Quad-core processor designed for server applications. Processor speed must be at least 50 percent of the speed of the fastest Intel server processor commercially available].

2.9.1.2 Random Access Memory (RAM)

[____][300 percent of the recommended requirements of the software to be installed on the server[and no less than 24GB].]

2.9.1.3 Communications Ports

[____][Four USB 3 3.0 3.1 ports.]

2.9.1.4 Hard Drives

2.9.1.4.1 Internal Hard Drives

[____][Solid State Hard drives with SATA-3 Controller providing at least [2TB][____] usable disk space. Hard drives must use RAID (Redundant Array of Inexpensive Disks) at levels 1 or 5 (RAID-1 or RAID-5).]

2.9.1.5 Optical Drive

[____][Blue-Ray burner drive.]

2.9.1.6 Video Output

[____][32-bit color at a minimum resolution of 1920 by 1080 at a minimum refresh rate of 70 Hz and a DVI or display port output.]

2.9.1.7 Network Interface

[[____][[Two] integrated 1000Base-T Ethernet with RJ45 connector.]]

2.9.1.8 Monitor

[____][Widescreen flat panel LCD monitor sized as indicated but no less than 24 inch nominal with a minimum resolution of 1920 by 1080 pixels and a minimum refresh rate of 70Hz.]

2.9.1.9 Keyboard

[____][101 key wired USB keyboard having a minimum 64 character standard ASCII character set based on ANSI INCITS 154.]

2.9.1.10 Mouse

[____][2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.]

2.9.1.11 Power Supplies

[____][Hot-swappable redundant power supplies.]
]

2.9.2 Workstation Hardware (Desktop and Laptop)

****

NOTE: Coordinate with the project site to determine if the workstation(s) will be contractor supplied or Government Furnished, or a mix where some workstations are Gov't furnished and others are contractor supplied:

"Replace Brackets" instructions

1) Government furnished only : Keep first bracketed text and remove the [as indicated].

2) Contractor supplied only: Keep the second bracketed text.

3) Combination of Government furnished and Contractor supplied: Keep all bracketed text. When keeping bracketed text (Contractor supplied or combination of Government and Contactor supplied) note that computer technology changes quickly and these requirements should be edited to reflect current products. Default requirements (current as of 2012) have been provided in brackets.
****

[The Government will provide the] [Provide a standard desktop computer or a laptop meeting the following minimum requirements for the] Computer Workstation Hardware (workstation) [as indicated].

2.9.2.1   Processor

2.9.2.1.1   Desktop

Quad-core processor designed for desktop applications. Processor speed must be at least 75 percent of the speed of the fastest Intel desktop processor commercially available.

2.9.2.1.2   Laptop

Quad-core processor designed for laptop applications. Processor speed must be at least 50 percent of the speed of the fastest Intel laptop processor commercially available.

2.9.2.2   Random Access Memory (RAM)

[____][300 percent of the recommended requirements of the software to be installed on the server[and no less than 16GB].]

2.9.2.3   Communications Ports

2.9.2.3.1   Desktop

[____][Six USB ports.]

2.9.2.3.2   Laptop

[____][Two USB ports, plus a PCMCIA card slot or an additional USB port, plus an integral RS-232 serial port or an additional USB port and a USB to RS-232 serial adapter.]

2.9.2.4   Hard Drive and Controller

2.9.2.4.1   Desktop

[____][[1.5TB][____] or larger with a SATA-3 controller.]

2.9.2.4.2   Laptop

[____][[250GB][____] or larger solid state drive.]

2.9.2.5   Optical Drive

[____][Blue-Ray drive]

2.9.2.6 Video Output

2.9.2.6.1 Desktop

[____][32-bit color with dual monitor support minimum resolutions of 3840 by 2160 at minimum refresh rates of 70 Hz and dual DVI or display port outputs.]

2.9.2.6.2 Laptop

[____][32-bit color with a minimum resolution of 3840 by 2160 at minimum refresh rates of 70 Hz and VGA or HDMI output.]

2.9.2.7 Network Interface

2.9.2.7.1 Desktop

[____][Integrated 1000Base-T Ethernet with RJ45 connector.]

2.9.2.7.2 Laptop

[____][Integrated 1000Base-T Ethernet with RJ45 connector.]

2.9.2.8 Monitor

2.9.2.8.1 Desktop

[____][Dual widescreen flat panel LCD monitors sized as indicated but no less than 600 mm 24 inch nominal with minimum resolutions of 3840 by 2160 pixels and a minimum refresh rate of 70Hz.]

2.9.2.8.2 Laptop

[____][LCD Screen sized as indicated but no less than 325 mm 13 inch nominal with a maximum supported resolution of no less than 3840 by 2160 pixels.]

2.9.2.9 Keyboard

2.9.2.9.1 Desktop

[____][101 key wired USB keyboard having a minimum 64 character standard ASCII character set based on ANSI INCITS 154]

2.9.2.9.2 Laptop

[____][Standard laptop keyboard.]

2.9.2.10 Mouse

2.9.2.10.1 Desktop

[____][2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.]

2.9.2.10.2 Laptop

[____][Integrated touch-pad plus a 2-button wired USB optical scroll mouse with a minimum resolution of 400 dots per inch.]

2.9.2.11 Printers

Provide [local or network] printers as indicated. Provide local printers which have a USB interface. Provide network printers which have a 100Base-T or faster interface with an RJ45 connection.

2.9.2.11.1 Alarm Printer

Provide alarm printers which use sprocket-fed fanfold paper with adjustable sprockets for paper width up to 280 mm 11 inches. Alarm printers must have programmable control of top-of-form. [Provide floor stands with paper racks for alarm printers.]

2.9.2.11.2 Laser Printer

Provide laser printers as indicated meeting the following minimum requirements:

Resolution 600 by 600 dots per inch
Printing Time 10 pages per minute
Data Buffer Size 16 Megabytes
Media Type Paper and transparency film
Media Size ANSI A(216 by 279 mm 8.5 by 11 inches) or 11 by 17 inches
[Color] and other sizes as indicated
Paper Cassette 250 sheet capacity

2.9.3 Uninterruptible Power Supply (UPS)

A self contained UPS suitable for installation and operation at the Server and Workstation must be provided. The unit[s] must be sized to provide a minimum of 10 minutes of operation of the central station [and operator's workstation] computer. The UPS must incorporate surge suppression, noise filtering (normal and common mode) short circuit protection and voltage regulation (brownout and overvoltage protection). UPS must be complete with all necessary power supplies, transformers, batteries, and accessories and must include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power. The UPS must comply with the Federal Communications Commission Standard 15J part A for radio noise emissions.

2.9.4 Communication and Programming Device

A hand-held communication [and programming]device must be provided. The communication [and programming]device must connect to the PLC directly for readout of variables, override, control, servicing, troubleshooting and adjustment of control parameters. The device must be provided with all necessary cables, connectors and adapters to allow connection to the PLC. The device must communicate in English language for inquiry, reporting [and programming] purposes.

2.10 TOUCHSCREEN HMI

Human Machine Interface (HMI) display screens must be supplied to provide an interface to the PLC. The touch screens must be compatible with the specific PLC being furnished. Locate touch screens in the cabinets as shown in the Contract Drawings. The touch screens must provide maintenance information and indication of the systems. The touch screens must be [15"] [ ] panel mount with a minimum resolution of 1024x768. Provide operator interface as shown on the Contract Drawings or approved equal.

2.10.1 TOUCHSCREEN HMI Display Layout

Develop HMI control and supervision display layouts complying with the minimum requirements of the Control Narrative in the Contract Drawings. Submit for approval prior to implementation.

2.11 MONITORING AND CONTROL SOFTWARE

****

NOTE: The designer should edit this paragraph, as needed, to require only the central station software that is necessary based on the requirements and complexity of the process control system. Where no information is available on future expansion, require a minimum expansion capability of 50 percent. Where specific expansion requirement information is available, it must be used to determine the expansion capability requirements.

****

Provide a single software package which implements the Scheduling, Alarming, Trending, Graphical System Display, and System Display Editor functionality. Other specified M&C functionality may be implemented in the same software package or in additional software packages. The monitoring and control software must provide the communication, programming and control capabilities necessary to support all specified points and functions, plus a minimum expansion of [50] [____] percent of the current number of points, complete with their point database. The monitoring and control station must be online at all times and must perform all required functions as specified. Where multiple modules are used the modules must be capable of sharing data and operating together seamlessly. [Software must be a client-server software package with a graphical user interface (GUI) using web-browser based clients.]The system must support multiple user operation with multiple tasks for each user and must support operation and management of all peripheral devices.

2.11.1 M&C Software Update Licensing

****

NOTE: The installation may procure its own software update licensing or contract and thus need less than 5 years. Alternatively the installation may require longer than five years (although this will likely increase the costs significantly). Coordinate with the installation to determine if they have any specific requirement; if they don't then keep the 5 year requirement.

****

In addition to all other licensing requirements, provide M&C Software licensing which includes licensing of the following software updates for a period [of no less than 5 years][____]:

a. Security and bug-fix patches issued by the M&C Software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common

Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

2.11.2 Graphical Operations

2.11.2.1 Graphical User Interface

****
NOTE: Standalone or web based are designer options.
****

The central station must be provided with a mouse driven, graphical user interface.

2.11.2.2 Display Information

The central station must display information necessary to support all requirements specified, including: operator commands; alarm notification; reports; system graphics as specified and as shown, incorporating dynamic data; and curve plotting.

2.11.2.3 System Graphics Implementation

System graphics displays must be hierarchical displays which integrate dynamic data into the display. System graphics must reflect actual system configuration. Each system schematic must be included as a separate display. Different colors, textures, and use of inverted video must be used for various components and dynamic data. The displays must include standard and/or custom symbols. A library of callable display symbols containing symbols for all necessary equipment and control devices must be furnished. Symbols must conform to ISA 101.01 where applicable. Data associated with a display must be updated within 5 seconds of the binary status change or the analog change in excess of the analog change differential. Any dynamic data which is not current, due to PLC communications failure, PLC failure, or point out of service, must be highlighted or flagged.

2.11.2.4 Display Editor

The display editor must enable the user to create, modify, save and delete displays and symbols. Within the display there must by dynamic fields with the function of linking the dynamic fields with the database and must be executed automatically as the last step of the database generation and modification procedure.

2.11.2.5 Graphical Programming

The system must include a graphical programming function which must be used to create all control sequences utilized in the control panels. This function must reside in the central station to create, modify, and test software for control panel resident programs. The graphical programming function must provide programming elements to be connected together to create a logic diagram. The diagram must be compiliable to produce executable code for the control panel. The graphical programming function must include elements necessary to create logic diagrams that represent sequences of operation. Program elements must be able to be combined into a custom template which can then be used as a standard function. Program checkout and debug facilities must include display of dynamic and/or simulated system variables and points on the programming screens. The user must be able to fix or force values of variables to enable program checkout during debugging. The programming must allow for the use of the portable tester for loading files directly into the control panel, uploading of existing control panel programming and database information and downloading of control panel programming and database information.

2.11.2.6 System Menus and Displays

The user must be able to call up the following displays by dedicated function key, pull down menu or by icon and must be able to page forward and backward on linked multiple page displays. The system menu and index displays must also contain icons which can be used to call up subsequent displays.

a. System Menu (list of all graphics and menus).

b. Index (list of all PLCs).

c. Alarm Summary (list of all uncleared alarms).

d. Abnormal Summary (list of all devices not in normal state; keeps track of alarm conditions which have been cleared).

e. Data Communications Summary (listing of availability for each communication channel, by statistically processing the number of transmission errors, outages, and other abnormal conditions for each channel).

2.11.2.7 Hard-Copy Screen Request

The central station must be able to obtain a hard copy of the monitor display being viewed. This must be an exact "snapshot" of the data and device symbols shown on the selected monitor.

2.11.3 Command Software

The software must provide for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands must be usable from central station computer and workstation keyboards with individual operator passwords as specified.

2.11.3.1 Command Input

Command menus must utilize full words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The system must prompt the operator.

2.11.3.2 Command Input Errors

The system must supervise operator inputs to ensure they are correct for proper execution. Provide operator input assistance whenever a command cannot be executed because of operator input errors.

2.11.3.3 Special Functions

The system must support the following special functions by using a mouse, in addition to all other commands specified:

2.11.3.3.1 Help

Produce a display of all commands available to the operator. The help command, followed by a specific command, must produce context sensitive listing with a short explanation of the purpose, use, and system reaction to that command.

2.11.3.3.2 Start/Enable

Manually start equipment and enable monitoring and control of points.

2.11.3.3.3 Stop/Disable

Manually stop equipment and disable monitoring and control components.

2.11.3.3.4 Display Diagram

Display diagrams of specific utility systems or other systems.

2.11.3.3.5 Diagram Development

Facilitate development of diagrams of specific utility systems or other systems.

2.11.3.3.6 Auto/Override

Override automatic operation of a point or return a point to automatic operation.

2.11.3.3.7 Print Report

Allow the operator to print reports.

2.11.3.3.8 Confirm Action

Allow the operator to confirm that the desired command sequence has been correctly entered and is to be executed.

2.11.3.3.9 Cancel Action

Perform the opposite function of the confirm action, at any time prior to executing confirm action.

2.11.3.3.10 Memo Pad

Allow the operator to create, store and retrieve pop-up notes.

2.11.3.4 Operator's Commands

The operator's commands must provide the means for entry of control and monitoring commands, and for retrieval of information. The operator's commands must perform such tasks as requesting a display of any binary, analog, or accumulator point, or any group of related points, startup and shutdown selected systems or devices, modifying

2.11.3.5 Level of Addressing

****

NOTE: When specifying level of addressing for

identification, delete Area or Facility where not required.
****

Provide four levels of addressing for identification as follows:

2.11.3.5.1 Point

The individual sensor or control device within a unit.

2.11.3.5.2 Unit

The unit that a point is associated with, such as a blower.

2.11.3.5.3 Sub-System

The sub-system that a point is located in or near.

2.11.3.5.4 System

The system that a sub-system is located in or near.

2.11.3.6 System Access Control

A minimum of [_____] passwords must be usable with the process control system software. The system must maintain an ASCII disk file logging all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications for each password. Each password must be definable as to the functions that the operator can perform.

2.11.4 Alarms

Provide M&C Software meeting the following minimum requirements for alarms:

a. The M&C software must be capable of generating alarms by comparing the value of any point from any connected system to user-configurable limits and must notify an operator of the occurrence of an alarm condition. The process control system alarm history must be stored and must be recallable by the operator using the report generator. Alarm messages must take precedence over other functions. A minimum of the most recent [25] [_____] system alarms must be directly available at the central station computer. Operator acknowledgment of one alarm must not be considered as acknowledgment of any other alarm nor must it inhibit reporting of subsequent alarms. Alarm data to be displayed and stored must include: identification of the alarm; date and time to the nearest second of occurrence; device or sensor type; limit exceeded (if analog); engineering units; current value or status; alarm class; and alarm messages.

b. The M&C software must support at least two alarm priority levels: critical and informational. Critical alarms must remain in alarm until acknowledged by an operator and the alarm condition no longer exists; informational alarms must remain in alarm until the alarm condition no longer exists or until the alarm is acknowledged.

c. The creation, modification, and handling (routing) of alarms must be fully accessible and fully adjustable from the graphical user interface.

d. Alarm Data. Alarm data to be displayed and stored must include:

e. 1) Identification of alarm including building, system (or sub-system), and device name.

   2) Date and time to the nearest second of occurrence.

   3) Alarm type:

   4) Unreliable: Indicates that the source device has failed due to the sensing device or alarm parameter being out-of-range or bad data.

   5) High Alarm.

   6) Low Alarm.

   7) Current value or status of the alarm point, including engineering units

   8) Alarm limits, including engineering units.

   9) Alarm priority.

   10) Alarm Message: A unique message with a field of at least 60 characters. Assignment of messages to an alarm must be an operator editable function.

   11) Acknowledgement status of the alarm including the time, date and user of acknowledgement.

2.11.4.1 Binary Alarms

Binary alarms must be subject to immediate reporting, within the alarm response time, at the central station.

2.11.4.2 Analog Alarms

These alarms must be subject to immediate reporting, within the alarm response time, at the central station. The control panel analog readings must be compared to predefined high and low limits, and alarmed to the central station each time a value enters or returns from a limit condition. The program must automatically change the high or low limits, or both, of any analog point, based on time scheduled operations as specified, allowing for a time interval before the new alarm limit becomes effective. For those applications where setpoint adjustments are made, the alarm limit must be keyed to a finite deviation traveling with the setpoint.

2.11.4.3 Alarm Messages

A unique message with a field of 60 characters must be provided for each alarm. Assignment of messages to a point must be an operator editable function. Secondary messages must be assignable by the operator for printing to provide further information, such as telephone lists or maintenance functions, and must be editable by the operator.

2.11.4.4 Alarm Classes

Classes of alarms, which will be identified for each item, include class 1 and class 2 alarm conditions. Class 1 (Critical) must include display, print, and audible alarm at occurrence and at return-to-normal. Acknowledgment of class 1 alarms by the operator must be required at occurrence and at return-to-normal. Class 2 (Informational) must include display, print, and audible alarm at occurrence and at return-to-normal. No acknowledgment of class 2 alarms is required unless otherwise shown.

2.11.5 Pop-up Note Function

A pop-up note function must be included with the workstation, providing the operator a capability of noting any data which may be associated with alarms or with any other event. A note created by an operator must be automatically called up when any other workstation calls up the associated point, alarm, or alarm summary. The pop-up note function must also support free form entry of data which can be used by any workstation operators as general reminders or instructions.

2.11.6 Real Time Clock Synchronization

****

NOTE: If real time clock synchronization is not required, this paragraph will be deleted.

****

The system must synchronize each central station computer, real time clock, within one second and at least once per day automatically, without operator intervention and without requiring system shutdown. The central station computer must automatically initiate a call once per day to the NIST clock to obtain the correct time and date and update the real time clock. The central station computer must generate a report showing the time difference.

2.11.7 System Reaction

Under system normal heavy load, no more than [10] [_____] seconds must lapse from the time a binary status alarm or analog alarm occurs at a PLC until the change is displayed at the central station [and operator's workstation]. The total system response time from initiation of a control action command to display of the resulting status change must not exceed [20] [_____] seconds under system normal heavy load conditions, assuming a zero response time for operation of the PLC's control device. The alarm printer must continue to print out all occurrences, including time of occurrence, to the nearest second. All system normal heavy load conditions must be introduced to the system via AIs and DIs.

2.11.7.1 Occurrence

System normal heavy load conditions are defined as the occurrence throughout the system of a total of three status changes, three binary alarms, three analog high or low limit alarms, and three analog quantity changes within the high and low limits during a single 1-second interval. This number of similar occurrences must repeat on a continuous basis during successive 1-second intervals for a period of 2 minutes.

2.11.7.2 Location

System normal heavy load conditions, as specified, must have 50 percent of the changes and alarms, including no less than one of each type, occurring at a single PLC with the remaining changes and alarms distributed among the remaining PLCs.

2.11.8 Report Generator

Software must be provided to generate and format standard and custom reports for displaying, printing, and storing on disk. Reports must use database values and parameters, values calculated using the real time static database or historical data base; with the reports subsequently stored on hard disk or zip drive. Dynamic operation of the system must not be interrupted to generate a report. The report must contain the time and date when the sample was taken, and the time and date when the report was printed. The software must allow for automatic and manual generation of reports. For automatic reports an operator must be able to specify the time the initial report is to be generated, the time interval between reports, end of period, and the output format for the report. Manual report generation must allow for the operator to request at any time the output of any report.

2.11.8.1 Periodic Automatic Report

The system must allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.

2.11.8.2 Request Report Mode

The system must allow for the operator to request, at any time, an immediate printout of any report.

2.11.9 Data Interchange

Software must be provided to format and store on a government approved removable hard drive the data, trends, profiles, reports and logs as specified in a defined, standard format such as ASCII text or DIF for export and further processing by other software and/or computer systems.

2.11.10 Control Panel and DTS Circuit Alarms

The system must supervise each control panel, I/O function and DTS circuit for alarm reporting, including: control panel not responding; control panel responding (return to normal); control panel to central station DTS circuit high error rate; control panel to control panel DTS circuit high error rate; control panel/central station real time clock error more than 15 seconds (adjustable); control panel intrusion alarm; control panel offline; control panel online (return to normal); control panel failure (self-diagnostics); point not responding to command; and point change of state without command.

2.11.11 Central Station Database

The central station database must be stored on disk and in memory. The static database must be downloadable as required to control panels in the system.

2.11.11.1 Database Definition Process

Software must be provided to define and modify each point in the database using operator commands. The definition must include all physical parameters and constraints associated with each point. Each database item must be callable for display or printing, including EEPROM, ROM and RAM resident data. Each point must be defined and entered into central station database.

2.11.11.2 Dynamic Database

The dynamic database includes those variables which change with time or conditions including all DIs, AIs, PAs, and virtual (logic) points.

2.11.11.3 Dynamic Database Update

Update the dynamic database from the field, allowing the operator to select update times from 0.1 seconds to 2.0 seconds.

2.11.11.4 Static Database

The static database includes those fixed parameters and constraints from all PLCs which define the characteristics of the system and I/O functions such as alarm limits, start/stop times, point names, PLC channel addresses, and sensor spans.

2.11.11.5 Central Station Static Database Update

A copy of each control panels static database must be updated automatically once per day, each time an authorized change is submitted or upon demand from the central station database.

2.11.11.6 Workstation Access to Dynamic Data

Any workstation with proper access password and connected to the central station via the BTS must have access to the central station's dynamic data. Display of data must commence within 5 seconds.

2.11.12 Historical Data Storage and Retrieval

A historical data storage and retrieval function must be provided at the central station to collect and store dynamic data. This function must be in addition to other data storage requirements. The function must have the capability to collect and store alarm status changes, point values, events and operator commands, and system responses. The storage function must also have the capability to collect and store multiple sets of analog data at pre-specified sampling rates. This function must have the capability to retain historical data on hard disk for pre-specified time periods, up to forty five days using last day roll over, for short-term analysis, and then output the data to a solid state drive in a SQL database for long-term retention. The operator must also be able to selectively recall short-term data stored on hard disk. Retrieval and printing of the contents of any selected historical data file must be available using the data retrieval and report generation program. The output of the report generation program must be capable of being viewed on the screen, printed in a report, or stored.

2.11.13 Trending

Provide M&C software capable of creating, modifying, uploading and archiving Point properties and performing real-time display of point properties with a minimum trending rate of 100 points per second.

a. The M&C Software must include a graphical display for trend configuration, creation and deletion accessible through the graphical user interface. Each trend must be user-configurable for:

b. (1) Point to trend.

    (2) Sampling interval: adjustable between 1 second and 1 hour.

    (3) Start and Stop Time of Trend: Start and stop times determined by one or more of the following methods:

        (a) Start time and stop time

        (b) Start time and duration

        (c) Start time and number of samples

c. The M&C software must be capable of displaying and printing a graphical representation of each trend, and of multiple trended points on the same graph. The software must be capable of saving trend logs to a file. If the file format is not plain ASCII text in a Comma-Separated-Value (CSV) format, provide a means to export or convert the file to plain ASCII text in a CSV format.

2.11.14 Analog Monitoring

The system must measure, transmit, and display analog values, including calculated analog points. Differential measurements must be displayed as positive or negative values with respect to their reference points shown. An analog change in value is defined as a change exceeding a preset differential value as specified. Each analog change in value must be operator selectable and settable to provide for a minimum reporting change in value of one-half the specified end-to-end accuracy of the measured variable. Displays and reports must express analog values in proper engineering units with sign. Provide [128] [____] different sets of engineering unit conversions. Each engineering conversion unit must include range, span, and conversion equation.

2.11.15 Analog Totalization

Any analog or calculated point must be operator assignable to the totalization program. The analog totalization time period must be defined uniquely for each point. At the end of the period, totals must be stored on disk for future reference. Totalization must then restart from zero for the next time period. The program must keep track of the peak and total value measured during the current period and for the previous period. The operator must be able to initiate a summary of totalization information on a point, unit, sub-system or system. The operator must be able to set or reset each totalized value individually. The operator must be able to define, modify, or delete the time period online.

2.11.16 LAN Software

A network operating system must be supplied as part of the LAN software. The network operating system must support network device access to the central station. The system must provide workstation access to the central station as a virtual terminal. The network must provide network access to shared peripherals. The LAN software must provide for transparent communication with any node on the system. The LAN software must support the following:

2.11.16.1 Access Control

Access control to the central station computer and workstations. Operators must be able to perform all specified functions, given the proper passwords, including database definition/modification, graphic creation/modification, and trending.

2.11.16.2 Other Functions and Configurations

2.11.17 Virus Protection Software

****
NOTE: Coordinate with the project site to determineif the Virus Protection Software will be contractor supplied or Government Furnished.
****

[Provide Virus Protection Software consisting of the project site's standard virus protection software complete with a virus definition update subscription] [Virus Protection Software will be furnished by the Government].

2.11.18 Disk Imaging (Backup) Software

****
NOTE: Coordinate with the project site to determineif the Disk Imaging (Backup) Software will be contractor supplied or Government Furnished.
****

[Provide Disk imaging (backup) software capable of performing a bare-metal restore (imaging and restoring to a new blank hard drive such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software).] [Provide Disk imaging (backup) software consisting of the project site's standard disk imaging software.] [Disk imaging (backup) software will be furnished by the Government.]

2.12 DATA COMMUNICATION REQUIREMENTS

****
NOTE: The designer will edit the following paragraph as needed to require only the data communications requirements that are necessary based on the requirements and complexity of the control system. A communications system layout or block diagram must be provided on the drawings to clearly show the communications system configuration requirements.
****

Process control system data communications must support the specified functions and process control system configuration shown on the drawings.

2.12.1 Central Station/Workstation

Each workstation must be able to communicate with the central station as a virtual terminal. The workstation must be able to initiate uploads or downloads of programs and resident data, including parameters of connected systems PLCs and devices, constraints and programs in the central station.

2.12.2 Central Station/PLC

The central station must be able to initiate an upload or download of PLC data programs.

2.12.3 Communication

****

NOTE: Indicate on the communications system layout diagram, on the drawings, where modem communication is required. Coordinate this with the central station/workstation computer requirements.

****

Communication with other computer systems must be accomplished using an Ethernet communications port. The central station or workstation must be able to initiate upload or download of data files.

2.12.4 Error Detection and Retransmission

Error detection and retransmission must comply with current Ethernet standards.

2.13 FACTORY TEST

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NOTE: Evaluate the need for factory tests. Take into account the size of the system, the complexity of the system, the devices that comprise the system as well as other pertinent information. If a factory test is deemed necessary, the factory test requirements below must be tailored to the process control system to be tested. If any factory test is deemed unnecessary, delete it from the following paragraphs.

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The process control system must be tested at the factory prior to shipment. Written notification of planned testing must be given to the Government at least 21 days prior to testing, and in no case must notice be given until after the Contractor has received written Government approval of the test procedures.

2.13.1 Factory Test Setup

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NOTE: Items not applicable to the factory test should be deleted.

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Assemble and integrate the factory test setup as specified to prove that performance of the system satisfies all requirements of this project, including system communications requirements in accordance with the approved test procedures. The factory test must take place during regular daytime working hours on weekdays. Equipment used must be the same equipment that is to be delivered to the site. The factory test setup must include the following:

Factory Test	
central station equipment	one each of the components
workstation	one of each type
control panel	not less than two control panels: at least one of each type used in the system plus at least one per
test set	one of each type
portable tester	one of each type
communications circuits	one of each type and speed to be utilized in the proposed system including bridges, modems, encoder/decoders, transceivers and repeaters
surge protection equipment	for power, communications, I/O functions and networks
I/O functions	sufficient to demonstrate the I/O capability and system normal operation
software	software required for proper operation of the proposed system including application programs and sequences of operation

2.13.2 Factory Test Procedure

Test procedures must define the tests required to ensure that the system meets technical, operational, and performance requirements. The test procedures must define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required. Provide for testing all process control system capabilities and functions specified and shown. Cover actual equipment and sequences to be used for the specified project and include detailed instructions for test setup, execution, and evaluation of test results. The test reports must document results of the tests. Surge testing need not be conducted acceptable documented proof can be provided that such testing has been satisfactorily demonstrated to the Government with identical surge protection applied. The procedures must include the following:

	Test Procedure
equipment	block diagram
hardware and software	descriptions
commands	operator commands

	Test Procedure
I/O functions	test database points with failure modes
passwords	required for each operator access level
each type of digital and analog point in the test	description
test equipment	list
surge protection	circuit diagrams
inputs required (I/O point values and status) and corresponding expected results of each set of input	for each application program
default values	for the application program inputs not implemented or provided for in the contract documents for the application programs to be tested

2.13.3 Factory Test Report

Submit original copies of data produced during the factory test, including results of each demonstration procedure within 7 days after completion of each test. Arrange the report so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

PART 3 EXECUTION

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NOTE: Determine the applicability and need for a Factory Test and remove the Factory Test requirements if a Factory Test is not needed.

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3.1 FACTORY TEST

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NOTE: Include the reference to section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM TESTING if appropriate. Otherwise indicate another basis for the Factory Test Procedures.

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Perform factory testing of the System as specified. The Contractor is responsible for providing personnel, equipment, instrumentation, and supplies necessary to perform required testing. Provide written notification of planned testing to the Government at least 21 days prior to testing, and do not give this notice until after receiving written Government approval of the specific Factory Test Procedures. Provide Factory Test Procedures which define the tests required to ensure that the system meets technical, operational, and performance specifications. Within the Procedures define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required. Provide procedures which test all capabilities and functions specified and indicated. Perform the Factory Test using equipment and software of the same manufacturer, model and revision as will be used for the specified project. Include detailed instructions for test setup, execution, and evaluation of test results in the Procedures. Upon completion of the test, prepare a Factory Test Report, documenting the results of the Test, and submit it as specified. This report must be approved before any equipment is shipped.

Perform the Factory Test and provide Factory Test Submittals as shown in TABLE II. FACTORY TEST SEQUENCING.

TABLE II FACTORY TEST SEQUENCING

ITEM #	DESCRIPTION	SEQUENCING (START of ACTIVITY or DEADLINE FOR SUBMITTAL)
1	Submit Factory Test Procedure	[[_____] days after notice to Proceed] [_____]
2	Perform Factory Test	After Approval of #1
3	Submit Factory Test Report	[____] days After Completion of #2

3.2 EQUIPMENT INSTALLATION REQUIREMENTS

3.2.1 Installation

Install system components and appurtenances in accordance with the manufacturer's instructions and provide necessary interconnections, services, and adjustments required for a complete and operable system. Adjust or replace devices not conforming to the required accuracies. Replace factory sealed devices, rather than adjusting. Installation, adjustment, and operation of the equipment specified must be supervised by a manufacturer's representative experienced in the installing, adjusting, and testing of the equipment.

a. Install instrumentation and communication equipment and cable grounding as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

b. Install wiring in exposed areas, including low voltage wiring, in [metallic raceways] [EMT conduit] [rigid conduit] as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Wiring in air plenum areas installed without conduit must be plenum-rated in accordance with NFPA 70.

c. Submit detail drawings containing complete piping, wiring, schematic, flow diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Piping and Instrumentation (P&ID) drawings (prepared using industry recognized device symbols, clearly defined and describing piping designations to define the service and materials of individual pipe segments and instrument tags employing Instrument Society of America suggested identifiers). Include in the Drawings, as appropriate: product specific catalog cuts; a drawing index; a list of symbols; a series of drawings for each process control system using abbreviations, symbols, nomenclature and identifiers as shown; valve schedules; compressed instrument air station schematics and ASME air storage tank certificates for each type and make of compressed instrument air station.

3.2.1.1 Isolation, Penetrations and Clearance from Equipment

Dielectric isolation must be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exteriors must be made watertight. Holes in concrete, brick, steel and wood walls must be drilled or core drilled with proper equipment; conduits installed through openings must be sealed with materials which are compatible with existing materials. Openings must be sealed with materials which meet the requirements of NFPA 70 and Section 07 84 00 FIRESTOPPING. Installation must provide clearance for control-system maintenance. Process control system installation must not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.1.2 Device Mounting

Devices must be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed in piping must be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Any deviations must be documented and submitted to the Government for approval prior to mounting. Damaged insulation must be replaced or repaired after devices are installed to match existing work. Damaged galvanized surfaces must be repaired by touching up with zinc paint.

3.2.1.3 Pneumatic Tubing

Tubing must be concealed in finished areas. Tubing may be run exposed in unfinished areas, such as mechanical equipment rooms. For tubing to be enclosed in concrete, rigid metal or intermediate metal conduit must be provided. Tubing must be installed parallel or perpendicular to building walls throughout. Maximum spacing between tubing supports must be 1.5 m 5 feet. Each tubing system must be tested pneumatically at 1.5 times the working pressure for 24 hours, with a maximum pressure drop of [0.15] [____] kPa [1.0] [____] psig with compressed air supply turned off. Joint leaks must be corrected by remaking the joint. Caulking of joints will not be permitted. Tubing and two insulated copper phone wires for installation checkout may be run in the same conduit. Tubing and electrical power conductors must not be run in the same conduit; however, control circuit conductors may be run in the same conduit as polyethylene tubing.

3.2.1.4 Grooved Mechanical Joints

Grooves must be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools must be the products of the same manufacturer. Pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded.

3.2.2 Sequences of Operation

Study the operation and sequence of local equipment controls, as a part of the conditions report, and note any deviations from the described sequences of operation on the contract drawings. Perform necessary adjustments to make the equipment operate in an optimum manner and must fully document changes made.

3.3 INSTALLATION OF EQUIPMENT

Install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational control system.

3.3.1 Control Panels

Control panels must be located as indicated on the drawings. Devices located in the control panels must be as shown on the drawings or as needed to provide the indicated control sequences.

3.3.2 Flow Measuring Device

Fluid flow instruments must be installed in accordance with manufacturer's recommendations, unless otherwise indicated in the specification. The minimum straight unobstructed piping for the flowmeter installation must be 10.0 pipe diameters upstream and 5.0 pipe diameters downstream. Meters for gases and vapors must be installed in vertical piping, and meters for liquids must be installed in horizontal piping, unless otherwise recommended by the manufacturer or indicated in the specifications.

3.3.2.1 Flow Nozzle

Flow nozzles flanges must be installed so that the pressure taps are in a horizontal plane with the centerline of the pipe. Flow nozzles must be installed for ease of accessibility for periodic maintenance. Differential pressure sensors must be installed as close to the flow nozzle as possible.

3.3.2.2 Flow Switch

Flow switches must be installed in such a manner as to minimize disturbance of the flow of fluid while maintaining reliable operation of the switch.

3.3.2.3 Magnetic Flowmeter

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NOTE: Locating magnetic flowmeters near large electric motors or transformers should be avoided.

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Meter must be installed in vertical piping so that the flow tube remains full of the process fluid under all operating conditions. A minimum of ten pipe diameters straight run upstream of the flowmeter and five pipe diameters straight run downstream of the flowmeter must be provided. The flowmeter and piping system must be grounded to earth ground.

3.3.2.4 Natural Gas or Propane Flowmeter

Install meters in accordance with ASME B31.8. Permanent gas meters must be installed with provisions for isolation and removal for calibration and maintenance, and must be suitable for operation in conjunction with an energy monitoring and control system.

3.3.2.5 Orifice Plates

Orifice plates must be installed for ease of accessibility for periodic maintenance. Differential pressure sensors must be as close to the orifice plates as possible. Orifice plates for liquid measurement must be located in horizontal pipe runs with the orifice plate flanges installed so that the pressure taps are in the horizontal plane with the centerline of the pipe. For liquid, the differential pressure transmitter must be installed below the orifice taps. For gas measurement, the orifice plate flanges must be installed so that the pressure taps are 45 degrees or more above the horizontal plane with the centerline of the pipe. For gas measurement the required differential pressure transmitter must be physically installed above the orifice taps.

3.3.2.6 Paddle Flowmeter

Meter must be installed using manufacturer's published procedures. Installers must be trained for such installations in the pipes encountered. Provide certificates demonstrating installer's qualifications.

3.3.2.7 Annular Pitot Tubes

Annular pitot tubes must be installed so that the total head pressure ports are set-in-line with the pipe axis upstream and the static port facing downstream. The total head pressure ports must extend diametrically across the entire pipe. Annular pitot tubes must not be used where the flow is pulsating or where pipe vibration is allowed.

3.3.2.8 Positive Displacement Flow Meters

Flow meters must be installed horizontally, and aligned correctly in the direction of flow.

3.3.2.9 Turbine Meters

Turbine meters must be installed so that the sensor is located in the center of the fluid flow pipe on the main axis. Turbine meters must be installed without interruption to service. Install a welded flanged riser of appropriate pipe line rating, with a full opening valve bolted to it. Sensor must be located in accordance with the manufacturer's instructions for the specified flow rates and installation conditions. Reduced diameter pipe sections must be provided as necessary to achieve required flow velocities. Meters must be installed using the hot-tap method with tools recommended by the manufacturer. The minimum straight unobstructed piping for the flow meter installation must be 10 pipe diameters upstream and 5 pipe diameters downstream. The meter must be installed in a horizontal section unless manufacturer specifically allows otherwise.

3.3.2.10 Ultrasonic Flowmeter

Meter must be installed using manufacturer's published procedures for installation. Installers must be trained for such installations in the pipes encountered. Provide certificates demonstrating installer's qualifications.

3.3.2.11 Variable Area Flowmeter

Meters must be installed in a vertical piping section with full flow through the meter.

3.3.2.12 Venturi Flowmeter

The flowmeter must be installed with its top above the pipeline in horizontal pipe run installations. The direction of flow must be upward in vertical pipe run installations. The flowmeter must be aligned to the direction of the flow and must be rigidly mounted and vibration free. The minimum straight unobstructed piping for the flow meter installation must be 10 pipe diameters upstream and 5 pipe diameters downstream.

3.3.2.13 Vortex Shedding Flowmeters

The flowmeter must be installed with its top above the pipeline in horizontal pipe run installations. The direction of flow must be upward in vertical pipe run installations. The flowmeter must be aligned to the direction of the flow and must be rigidly mounted and vibration free. The minimum straight unobstructed piping for the flow meter installation must be 10 pipe diameters upstream and 5 pipe diameters downstream.

3.3.3 Level Instruments

3.3.3.1 Liquid Level Sensor (Bubble Type)

The air pressure regulating valve, air filter, moisture trap, air flow adjustment valve, level gauge, air isolation valve and pressure transducer must be mounted on a panel where indicated on the drawings. The level gauge must be labeled to identify the tank being measured. The isolation valve must be located in the air supply line upstream of the moisture trap, air filter and pressure regulator. The air inlet line to the dip tube and the dip tube must be mounted to a flange at the top of the tank. The dip tube must extend to the bottom of the tank, leaving the manufacturer's recommended clearance between the dip tube and tank bottom. The dip tube material must be compatible with the tank contents. The pressure regulating valve must be adjusted to the outlet pressure recommended by the manufacturer. Where exposed, the air supply line to the tank and from the tank to the level gauge and pressure transducer must be protected from damage.

3.3.3.2 Capacitance Liquid Level Sensors

The sensing probes must be located close to, and parallel with, the tank or sump wall.

3.3.3.3 Conductivity Level Switch

Level switches must be installed vertically and in accordance with the manufacturer's instructions. Switches must be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket must be provided for connection to the inside tank wall, maintaining the minimum recommended distance from the tank fill opening.

3.3.3.4 Displacement Type Liquid Level Switch

Level switches must be installed in accordance with the manufacturer's instructions. Switches must be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket must be provided for connection to the inside tank wall.

3.3.3.5 Mercury Float Switches

Switches must be mounted in accordance with manufacturer's published instructions. Procedures must be those used for equipment in hazardous locations.

3.3.3.6 Ultrasonic Level Sensor

Sensor must be installed vertically in the top of the tank and in accordance with the manufacturer's instructions. Switches must be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket must be provided for connection to the inside tank wall. Sensor must be positioned to maximize the return echo signal and minimize vessel obstructions in the sensors line of sight. The minimum recommended distance from the tank fill opening and from the side of the tank must be maintained.

3.3.4 Pressure Instruments

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NOTE: Do not use differential pressure switches on liquid pumps. Gage pressure switches are better suited for liquid application. Indicate by appropriate icon on the drawings where the switches are to be located and which type is to be used.

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Pressure sensors and pressure transducers must be verified by calibration. All pressure taps must incorporate appropriate snubbers. Pressure sensors and pressure switches must have valves for isolation, venting, and taps for calibration. Pressure switches and pressure transducers installed on liquid or steam lines must have drains. Pressure transducers, differential pressure sensors and differential pressure switches must have nulling valves. Pressure switches must be adjusted to the proper setpoint and must be verified by calibration. Switch contact ratings and duty must be selected for the application.

3.3.5 Temperature Instrument Installation

3.3.5.1 RTD

[When the RTD is installed in pipe or is susceptible to corrosion or vibration, the] [Each] RTD must be installed in a thermowell. Thermowells must be filled with conductive heat transfer fluid prior to installation of the RTD in the thermowell. RTDs used for space temperature sensing must include a housing suitable for wall mounting. RTDs used for outside air sensing must have an instrument shelter or sun shield as shown to minimize solar effects, and must be mounted to minimize building effects. RTD assemblies must be readily accessible and installed to allow easy replacement.

3.3.5.2 Temperature Switches

Temperature switches must be installed as specified for RTDs. Temperature switches must be adjusted to the proper setpoint and must be verified by calibration. Switch contact ratings and duty must be selected for the application.

3.3.5.3 Thermometers and Temperature Sensing Elements

Thermometers and temperature sensing elements installed in liquid systems must be installed in thermowells.

3.3.5.4 Thermocouples

Each thermocouple must be installed in a protective tube or in a thermowell. Thermocouples must be insulated from ambient temperature effects. Thermocouple wires must not be installed in the same conduits as power wiring. Thermocouples must not be used for measuring temperatures below 260 degrees C 500 degrees F. Type E thermocouples may be used when the atmosphere is chemically reducing environment. Type K thermocouples may be used when the atmosphere is a chemically oxidizing environment.

3.3.6 Process Analytical Instrumentation

3.3.6.1 Ammonia Monitor

The controller must be located as shown on the drawings. The ammonia sensor must be mounted as recommended by the manufacturer. The location of the sensor must be representative of the area to be monitored and must allow access to the sensor for periodic calibration. The sensor must be located in a dry area or must be protected from moisture without restricting the flow of ammonia gas to the sensor.

3.3.6.2 Carbon Dioxide Measurement

The controller must be located in the control panel or other location as shown on the drawings. Where a sample tube is used, the size and maximum length of sample tubing must be as recommended by the manufacturer. Sample tubing must be not crimped or kinked.

3.3.6.3 Carbon Monoxide Measurement

Carbon monoxide controller and sensor must be located as shown on the drawings or as recommended by the manufacturer. The location must be representative of the area to be monitored. Installation must be in accordance with the manufacturer's instructions.

3.3.6.4 Chlorine in Air

The controller must be located in the control panel or other location as shown on the drawings. Where a sample tube is used, the size and maximum length must be a recommended by the manufacturer. The sample tube must not be crimped or kinked. The location of the [controller] [sample tube inlet] must be near the bottom of the area to be monitored.

3.3.6.5 Chlorine in Water

The controller must be located in the control panel or other location as shown on the drawings. The chlorine sensor must be immersed in the fluid being monitored using an assembly that will allow removal of the sensor from the water. The sensors must be located in an area of continuous flow.

3.3.6.6 Combustible Gas Sensor

The sensor and transmitter must be located as shown or the drawings or as recommended by the manufacturer. The location of the sensor must be representative of the area to be monitored and must allow access to the sensor for periodic replacement.

3.3.6.7 Hydrogen Sulfide

The controller must be located as shown on the drawings or as recommended by the manufacturer. Where a sample tube is used, the tube size and maximum length must be a recommended by the manufacturer. The sample tube must not be crimped or kinked. The location of the [controller] [sample tube inlet] must be representative of the area to be monitored.

3.3.6.8 NOx Monitor

The controller must be mounted in the control panel or as otherwise shown. Sensor must be located in the flue as shown and in accordance with the manufacturer's recommendation. Installation must prevent all leakage of flue gases at the sensor.

3.3.6.9 Oxygen and Ozone in Air Monitor

The controller must be mounted in the control panel or as otherwise shown on the drawings. The oxygen sensor must be located in accordance with the manufacturer's recommendations and as shown on the drawings. High and low alarm settings must be set as required by the sequence of control. Settings must be verified through the use of a manufacturer's standard calibration kit.

3.3.6.10 Dissolved Oxygen

The dissolved oxygen sensor must be immersed in the fluid to be monitored using manufacturer's mounting assembly. The sensor must be located in an area of continuous fluid flow. [The transmitter must be located remote from the sensor.] The transmitter and wiring connections must be in a weathertight enclosure. [The transmitter must be mounted to allow the digital readout to be easily viewed.]

3.3.6.11 PH and ORP Sensor

Pipe mounted flow sensor must be located in a threaded tee or fitting to allow removal from the pipe. Submersible sensor must be completely immersed in the fluid being monitored using an ensemble that will allow for removal of the sensor from the fluid for replacement. The sensor must be located in an area of continuous flow. The transmitter must be located [at the sensor] [remote from the sensor]. [The transmitter must be mounted to allow the digital readout to be easily viewed].

3.3.6.12 Total Dissolved Solids

The sensor must be [pipe] [tank] [submersible] type as indicated on the drawings. [Pipe mounted sensor must be mounted in a threaded tee or fitting to allow removal of the sensor.] [Tank mounted sensor must be mounted in a threaded fitting to allow removal of the sensor.] [Submersible sensor must be mounted in an assembly that will allow removal of the sensor from the fluid for replacement.] The transmitter must be located [at the sensor] [remote from the sensor]. The transmitter and wiring connections must be located in a weathertight enclosure.

3.3.7 Instrument Shelters

Instrument shelters must be installed in the location shown with the bottom 1.2 meter 4.0 feet above the supporting surface using legs and secured rigidly to minimize vibrations from winds. Instrument shelters must be oriented with door facing North. Instruments located in shelters must be mounted in the 3-dimensional center of the open space of the shelter.

3.3.8 Electric Power Devices

3.3.8.1 Potential and Current Transformers

Install potential and current transformers in enclosures unless otherwise shown. Current transformer leads must be shorted when they are not connected to the measurement circuits.

3.3.8.2 Hour Meters

Meters must be located in the control panel or as otherwise shown. Power to the meter must be connected to the motor starter auxiliary contacts for pumps, blowers and other motor driven devices. For devices without motor starters, the meter must be connected in parallel with the load. Where the meter voltage differs from the metered devices voltage, transformer must be provided as necessary.

3.3.8.3 Watt-hour Meters

Install watt-hour meters and transducers in enclosures unless otherwise shown.

3.3.8.4 Transducers

Transducers must be wired in accordance with the manufacturer's instructions, and installed in enclosures.

3.3.8.5 Current Sensing Relays and Current Transducers for Motors

When used to sense meter/fan/pump status, current sensing relays must be used for applications under 4 kW 5 hp. Applications over 4 kW 5 hp must use a current transducer.

3.3.9 Output Devices

Output devices (transducers, relays, contactors, or other devices) which are not an integral part of the control panel, must be mounted in an enclosure mounted adjacent to the control panel, unless otherwise shown. Where H-O-A and/or override switches on the drawings or required by the control sequence, the switches must be installed so that the process control system controls the function through the automatic position and other controls work through the hand position.

3.3.10 Enclosures

All enclosure penetrations must be from the bottom of the enclosure, and must be sealed to preclude entry of water using a silicone rubber sealant.

3.3.11 Transformers

Transformers for control voltages below 120 VAC must be fed from the nearest power panel or motor control center, using circuits provided for the purpose. Provide a disconnect switch on the primary side and a fuse on the secondary side. Transformers must be enclosed in a steel cabinet with conduit connections.

3.4 WIRE, CABLE AND CONNECTING HARDWARE

3.4.1 LAN Cables and Connecting Hardware

LAN cables and connecting hardware must be installed in accordance with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM and Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).

3.4.2 Metering and Sensor Wiring

Metering and sensor wiring must be installed in accordance with the requirements of ANSI C12.1, NFPA 70, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.4.2.1 Power Line Surge Protection

Control panels must be protected from power line surges. Protection must meet the requirements of IEEE C62.41.1 and IEEE C62.41.2. Fuses must not be used for surge protection.

3.4.2.2 Sensor and Control Wiring Surge Protection

Digital and analog inputs must be protected against surges induced on control and sensor wiring. Protect binary and analog outputs against surges induced on control and sensor wiring installed outdoors and as shown. Fuses must not be used for surge protection. Test the inputs and outputs in both the normal and common mode using the following two waveforms: The first waveform must be 10 microseconds by 1000 microseconds with a peak voltage of 1500 volts and a peak current of 60 amperes. The second waveform must be 8 microseconds by 20 microseconds with a peak voltage of 1000 volts and a peak current of 500 amperes. Submit certified test results for surge protection.

3.5 SOFTWARE INSTALLATION

Load software required for an operational process control system, including databases (for points specified and shown), operational parameters, and system, command, and application programs. Adjust, tune, debug, and commission all software and parameters for controlled systems to assure proper operation in accordance with the sequences of operation and database tables.

3.6 CONTROL DRAWINGS

3.6.1 Control

Control drawings, [framed, non-fading half-size in laminated plastic] [reproducible, with corresponding CADD files] [____], must be provided for equipment furnished and for interfaces to equipment at each respective equipment location. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system manually must be prepared in typed form, [framed as specified for the instrumentation and control diagrams] [reproducible, with corresponding word processor files] [____] and posted beside the diagrams. Diagrams and instructions must be submitted prior to posting. The framed instructions must be posted before acceptance testing of the system.

3.6.2 Contractor Design Drawings

Contractor Design Drawings as a single complete package: [_____] hard copies and [_____] copies in electronic form. As a minimum they must include wiring, logic, and layout. Submit hardcopy drawings on [ISO A1 841 by 594 mm 34 by 22 inches][or][A3 420 by 297 mm 17 by 11 inches] sheets, and electronic drawings in PDF and in [AutoCAD][Microstation][Bentley BIM V8][Autodesk Revit 2013] format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule. Contractor Design Drawings must be approved prior to any fabrication.

3.6.2.1 Draft As-Built

Draft As-Built Drawings as a single complete package: [_____] hard copies and [_____] copies in electronic form. Submit hardcopy drawings on [ISO A1 841 by 594 mm 34 by 22 inches][or][A3 420 by 297 mm 17 by 11 inches] sheets, and electronic drawings in PDF and in [AutoCAD][Microstation][Bentley BIM V8][Autodesk Revit 2013] format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

3.6.2.2 Final As-Built

Final As-Built Drawings as a single complete package: [_____] hard copies and [_____] copies in electronic form. Submit hardcopy drawings on [ISO A1 841 by 594 mm 34 by 22 inches][or][A3 420 by 297 mm 17 by 11 inches] sheets, and electronic drawings in PDF and in [AutoCAD][Microstation][Bentley BIM V8][Autodesk Revit 2013] format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

3.6.3 Points Schedule

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NOTE: Template Points Schedules in electronic format for use with this section are available in online at: http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf

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Provide a Points Schedule in tabular form for each system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.

a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing with updated information in addition to the indicated fields.

b. When Point Schedules are included in the contract package, items requiring contractor verification or input have been shown in angle brackets ("<" and ">"), such as <___> for a required entry or <value> for a value requiring confirmation. Complete all items in brackets as well as any blank cells. Do not modify values which are not in brackets without approval. Points Schedule Columns must include:

3.6.3.1 Point Name

The abbreviated name for the point using the indicated naming convention.

3.6.3.2 Description

A brief functional description of the point such as "Supply Air Temperature".

3.6.3.3 DDC Hardware Identifier

The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.

3.6.3.4 Settings

The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.

3.6.3.5 Range

The range of values, including units, associated with the point, including but not limited to setpoint adjustment range, a sensor measurement range, or the status of a safety.

3.6.3.6 Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entires in this column:

a. AI: The value comes from a hardware (physical) Analog Input

b. AO: The value is output as a hardware (physical) Analog Output

c. BI: The value comes from a hardware (physical) Binary Input

d. BO: The value is output as a hardware (physical) Binary Output

e. PULSE: The value comes from a hardware (physical) Pulse Accumulator Input

f. NET-IN: The value is provided from the network (generally from another
device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.

g. NET-OUT: The value is provided to another controller over the network.

Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

3.6.3.7 Network Data Exchange Information

(Gets Data From, Sends Data To) Provide the DDC Hardware Identifier of other DDC Hardware the point is shared with.

3.6.3.8 Override Information

For each point requiring an Override, indicate if the Object for the point is Commandable.

3.6.3.9 Trend Object Information

For each point requiring a trend, indicate if the trend is Local or Remote. For remote trends provide the DDC Hardware Identifier for the device performing the trend.

3.6.3.10 Alarm Information

Indicate the Alarm Generation Type.

3.7 FIELD TESTING AND ADJUSTING EQUIPMENT

Provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Government will witness the PVT, and written permission must be obtained from the Government before proceeding with the testing. Original copies of data produced, including results of each test procedure, during PVT must be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test. The test procedures must cover actual equipment and functions specified for the project.

3.7.1 Testing, Adjusting and Commissioning

****

NOTE: Delete reference to a factory test if no factory test is to be required.

****

After successful completion of the factory test as specified, the Contractor will be authorized to proceed with the installation of the system equipment, hardware, and software. Once the installation has been completed, tested, adjusted, and commissioned each control loop and system in accordance with NIST SP 250 and must verify proper operation of each item in the sequences of operation, including hardware and software. Calibrate field equipment, including control devices, adjust control parameters and logic (virtual) points including control loop setpoints, gain constants, constraints, and verify data communications before the system is placed online. Test installed ground rods as specified in IEEE 142 and submit certification stating that the test was performed in accordance with IEEE 142. Calibrate each instrumentation device connected to the process control system control network by making a comparison between the reading at the device and the display at the workstation, using a standard at least twice as accurate as the device to be calibrated. Check each control point within the process control system control network by making a comparison between the control command at the central station and field-controlled device. Deliver trend logs/graphs of all points showing to the Government that stable control has been achieved. Points on common systems must be trended simultaneously. One log must be provided showing concurrent samples taken once a minute for a total of [4] [___] hours. One log must be provided showing concurrent samples taken once every 30 minutes, for a total of [24] [___] hours. Verify operation of systems in the specified failure modes upon Process control system network failure or loss of power, and verify that systems return to process control system control automatically upon a resumption of process control system network operation or return of power. Deliver a report describing results of functional tests, diagnostics, calibrations and commissioning procedures including written certification to the Government that the installed complete system has been calibrated, tested, adjusted and commissioned and is ready to begin the PVT. The report must also include a copy of the approved PVT procedure.

3.7.2 Performance Verification Test (PVT)

Submit test procedures for the PVT. The test procedure must describe all tests to be performed and other pertinent information such as specialized test equipment required and the length of the PVT. The test procedures must explain, in detail, step-by-step actions and the expected results, to demonstrate compliance with all the requirements of the drawings and this specification. The test procedure must be site specific and based on the inputs and outputs, required calculated points and the sequence of control. Refer to the actions and expected results to demonstrate that the process control system performs in accordance with the sequence of control. Include a list of the equipment to be used during the testing plus manufacturer's name, model number, equipment function, the date of the latest calibration and the results of the latest calibration.

Demonstrate that the completed Process control system complies with the contract requirements. All physical and functional requirements of the project including communication requirements must be demonstrated and shown. Demonstrate that each system operates as required in the sequence of operation. The PVT as specified must not be started until after receipt of written permission by the Government, based on the written report including certification of successful completion of testing, adjusting and commissioning as specified, and upon successful completion of training as specified. Upon successful completion of the PVT, furnish test reports and other documentation.

3.7.3 Endurance Test

Use the endurance test to demonstrate the overall system reliability of the completed system. The endurance test must be conducted in phases. The endurance test must not be started until the Government notifies the Contractor in writing that the PVT is satisfactorily completed, training as specified has been completed, outstanding deficiencies have been satisfactorily corrected, and that the Contractor has permission to start the endurance test. Provide an operator to man the system [8 hours per day during daytime operations, including weekends and holidays,] [during Phase I endurance testing, in addition to any Government personnel that may be made available.] The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, commence an assessment period as described for Phase II. Upon successful completion of the endurance test, deliver test reports and other documentation, as specified, to the

Government prior to acceptance of the system.

3.7.3.1 Phase I (Testing)

****

NOTE: The designer will determine the required Phase I testing period. The testing period should be based on the system size and complexity.

****

The test must be conducted 24 hours per day, 7 days per week, for [_____] consecutive calendar days, including holidays, and the system must operate as specified. Make no repairs during this phase of testing unless authorized by the Government in writing.

3.7.3.2 Phase II (Assessment)

After the conclusion of Phase I, identify failures, determine causes of failures, repair failures, and deliver a written report to the Government. The report must explain in detail the nature of each failure, corrective action taken, results of tests performed, and must recommend the point at which testing should be resumed. After delivering the written report, convene a test review meeting at the job site to present the results and recommendations to the Government. The meeting must not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, demonstrate that failures have been corrected by performing appropriate portions of the performance verification test. [The Government reserves the right to cancel the test review meeting if no failures or deficiencies occur during the Phase I testing. If the Government chooses to do so, the Contractor will be notified in writing.] Based on the Contractor's report and the test review meeting, the Government will determine if retesting is necessary and the restart point. The Government reserves the right to require that the Phase I test be totally or partially rerun. Do not commence any required retesting until after receipt of written notification by the Government. After the conclusion of any retesting which the Government may require, the Phase II assessment must be repeated as if Phase I had just been completed.

3.7.3.3 Exclusions

The Contractor will not be held responsible for failures resulting from the following: Outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the process control system performed as specified. Failure of a Government furnished communications link, provided that the PLC automatically and correctly operates in the stand-alone mode as specified, and that the failure was not due to Contractor furnished equipment, installation, or software. Failure of existing Government owned equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

3.8 FIELD TRAINING

****

NOTE: The number of hours required to instruct a Government representative in operation and maintenance of the system will depend on the complexity of the system specified. Designer is to

establish the number of hours of each type (preliminary, additional maintenance, specialized, flow meter, and specialized sensor) of training based on equipment manufacturer recommendations, system complexity and consultation with the installation..

****

Field training oriented to the specific system must be provided for designated personnel. Furnish a copy of the training manual for each trainee plus [two] [_____] additional copies. Manuals must include an agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Furnish audiovisual equipment and other training supplies and materials. Copies of the audiovisuals must be delivered with the printed training manuals. The Government reserves the right to videotape training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. Submit the training manual and schedule to receive approval from the Government at least 30 days before the training.

3.8.1 Preliminary Operator Training

Prior to the start of field testing, preliminary operator training must be taught at the project site for [___] consecutive training [days] [hours]. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course must include: general system architecture; functional operation of the system, including workstations; operator commands; application programs, control sequences, and control loops; database entry and modification; reports generation; alarm reporting; diagnostics; and historical files.

3.8.2 Additional Operator Training

Following the field testing, additional classroom training for operators must be taught for [___] consecutive training days; individual instruction sessions of [4] [___] -hour periods in the morning (or afternoon) of the same weekday for [___] consecutive weeks and an additional [___] day classroom session for answering operator questions. Individual instruction must consist of "hands-on" training under the constant monitoring of the instructor. Classroom training must include instruction on the specific hardware configuration of the installed process control system and specific instructions for operating the installed system. Schedule activities during this period so that the specified amount of time on the equipment will be available for each student. The final session will address specific topics that the students need to discuss and to answer questions concerning the operation of the system. Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed process control system. Each student should be able to start the system, operate the system, recover the system after a failure and describe the specific hardware architecture and operation of the system and be fully proficient in all system operations. Report the skill level of each student at the end of this course.

3.8.3 Maintenance Training

****
NOTE: Edit training requirements to the systems.
****

Following the [endurance test] [_____] a minimum period of [one] [_____] training [days][hours] must be provided by a factory representative or a qualified Contractor trainer for [five] [_____] designated personnel on maintenance of the equipment. The training must include: physical layout of each piece of hardware, calibration procedures, preventive maintenance procedures, schedules, troubleshooting, diagnostic procedures and repair instructions.

3.8.4 Specialized Training

****
NOTE: Coordinate with specifications for the unit processes, adding or deleting parts.
****

Following the maintenance training, a minimum period of [five] [_____], total training day(s) mustbe provided by a factory representative or a qualified Contractor trainer for [ten] [_____] people on the input devices.

3.8.4.1 Flow Meter Training

Each type of flow meter, to include calibration, maintenance and testing of flow elements and transducers.

3.8.4.2 Specialized Sensor Training

Provide training on each type of specialized sensor such as [chlorine,] [turbidity,] [pH,] [NOx,] [_____] to include calibration, maintenance and testing of sensing elements and transducers for [five] people.

3.9 OPERATION AND MAINTENANCE DATA REQUIREMENTS

Outline the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions layout, wiring and control diagrams of the system as installed, the manufacturer's name, model number, service manual, parts list and a brief description of all equipment and their basic operating features. List routine maintenance procedures, possible breakdowns and repairs and troubleshooting guides.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-41 22 13.14 (November 2019)**
Change 1 - 02/21

Preparing Activity: NAVFAC **Superseding**
UFGS-41 22 13.14 (April 2008)
UFGS-41 22 13.13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-41 22 13.14 (November 2019)**
Change 1 - 02/21

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 41 22 13.14

BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING

11/19, CHG 1: 02/21

****

NOTE: This guide specification covers the requirements for top running overhead electric traveling (OET) cranes with top running bridges and trolleys, Crane Manufacturers Association of America (CMAA) 70 service class A, B, C, D, E, and F and with capacities less than 27 metric ton 30 ton 27,000 kg 60,000 pounds, suitable for indoor or outdoor use in general purpose service, ordnance handling service, or hazardous area environments.

This guide specification incorporates the design criteria and requirements identified in NAVCRANECEN INSTRUCTION 11450.2A (December 2018).

This guide specification includes tailoring options for NAVFAC, pounds (per NAVFAC P-307), and tons. The NAVFAC tailoring option also includes requirements specific to the Navy and Marine Corps. Crane procurements for the Navy and Marine Corps must select the NAVFAC tailoring option.

Crane tailoring options are included for the Air Force, outdoor, ordnance/explosives handling, or hazardous (explosive) environments. Only one unique specialized application tailoring option should be selected at a time, however multiple can be used with additional specific project editing in the resulting sections. "General Purpose Service" is the default crane condition and that tailoring option should be selected if the crane is not to be used in any specialized applications. When "Maximum Anti-Spark" protection is required, the "Minimum Anti-Spark" tailoring option MUST ALSO be selected as the maximum requirements are in addition to the minimum requirements.

Selection or deselection of a tailoring option (select view-tailoring options) will include or

exclude that option in the section. Specific project editing is still required for the resulting section.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

Use this guide specification to specify cranes that are procured as part of a building construction contract for such applications as machine shops, warehouses, and other areas, including those that do require specialized weight handling equipment.

Explanations of CMAA service classifications A through E are covered in the notes portion of the "Classification" sub-section of "OET Design Criteria". The minimum allowable classification for Ordnance/Explosive Handling is CMAA service class D. Navy Crane Center minimum requirement is CMAA service class C.

Forward all procurement of OET systems at Naval Shore based activities with rated capacities of 9000 kg 20,000 pounds or greater or for use in specialized applications (e.g. ordnance handling, molten metal handling, special purpose service as defined in NAVSEA Publication 0989-030-7000, hazardous/explosive area environments, or precision handling operations requiring complex or synchronized lifting capacity) to: Naval Facilities Engineering Systems Command, Navy Crane Center, Building 491, Norfolk Naval Shipyard, Portsmouth, Va., 23709-5000. (See NAVCRANECEN INSTRUCTION 11450.1C of 11 JULY 2019).

****

****

NOTE: This specification covers cranes with top-running bridge and trolley, multiple-girder, with CMAA 70 service class of A through E.

Control types and systems may be specified as follows:

1. Remote, Cab, or Pendant Crane Controls or a combination of the three can be provided.

2. Alternating current (AC) control systems must be specified. The vast majority of new cranes are AC powered and AC controlled.

Terminology: - refer to DEFINITIONS in this specification.

a. Top-running bridge is a bridge which travels on the top surface of rails of a fixed runway structure.

b. Top-running Trolley is a trolley which travels on the top surfaces of rails of the bridge girder(s).

c. Ordnance/Explosives Handling – Cranes handling palletized or unpackaged ammunition, missiles, torpedoes, and other types of ordnance. Minimum requirement of CMAA service class D.

d. Hazardous (Explosive) Environments – Cranes operating in hazardous environments as defined by the cognizant activity safety office shall be equipped with electrical safety features that meet NEC Article 500. The activity safety office must identify the specific Class, Division, and Group, as well as the envelope that the hazard exists, to allow proper design. Materials for mechanical components must be chosen to minimize the potential for sparking, typically bronze, stainless steel, or aluminum. Hazardous environments are split into two groups: minimum anti-spark protection and maximum anti-spark protection.

d.1. Minimum Anti-Spark Protection applies when only the load block enters the hazardous area.

d.2. Maximum Anti-Spark Protection applies when the hazardous area envelops the entire crane.

****

****

NOTE: The RFP must provide the relevant dimensions and load data for the crane. See "Crane Inquiry Data Sheet" in CMAA 70 section 6.1 or see "Crane Information Form for Over Head Electric Traveling Cranes(s)" pages 6 and 7 at the following Navy Crane Center link:

https://www.navfac.navy.mil/navfac_worldwide/specialty_centers/ncc/about_us/resources/downloads.html

****

****

NOTE: Show the following information on the project drawings:

1. Complete details of plan, elevations and sections of crane, including building clearances.

2. Maximum span of runway girder.

3. Runway rail size.

4. Runway girder size.

5. Channel cap size.

6. Size and location of crane stops.

7. Electrical junction box location (including mounting height).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
ANSI/AGMA 2001	(2004D; R 2010) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
ANSI/AGMA 2015-1	(2001A; R 2014) Accuracy Classification System - Tangential Measurements for

	Cylindrical Gears
ANSI/AGMA 6013	(2006A; R 2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B30.2	(2022) Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
ASME B30.10	(2019) Hooks
ASME HST-4	(2021) Performance Standard for Overhead Electric Wire Rope Hoists
ASME NOG-1	(2020) Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z359	(2013) Fall Protection Code

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D14.1/D14.1M	(2019) Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

ASTM INTERNATIONAL (ASTM)

ASTM A275/A275M	(2023) Standard Practice for Magnetic Particle Examination of Steel Forgings
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A931	(2008; R 2013) Standard Test Method for Tension Testing of Wire Ropes and Strand

ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM E125	(1963; R 2023) Photographs for Magnetic Particle Indications on Ferrous Castings
ASTM E543	(2021) Standard Specification for Agencies Performing Non-Destructive Testing
ASTM E1417/E1417M	(2016) Standard Practice for Liquid Penetrant Testing
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA ICS 8	(2011) Crane and Hoist Controllers
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. AIR FORCE (USAF)

AFMAN 91-118	(2010) Safety Design and Evaluation Criteria for Nuclear Weapon Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.179	Overhead and Gantry Cranes
29 CFR 1910.306	Specific Purpose Equipment and Installations

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1004-1	(2012; Reprint Nov 2020) UL Standard for Safety Rotating Electrical Machines - General Requirements
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 DEFINITIONS

a. Bridge Crane: That part of an overhead crane system consisting of girder(s), end trucks, end ties, walkway, and drive mechanism which carries the trolley(s) and travels along the runway rails parallel to the runway.

b. Crane Runway: The track system along which the crane operates horizontally, including track hangar rods, track connection devices, and runway structural supports.

c. Dead Loads: The loads on a structure which remain in a fixed position relative to the structure.

d. Girder: The principal horizontal beam of the crane bridge. It is supported by the crane end trucks.

e. Lifted Load: The load consisting of the rated load and the weight of lifting devices attached to the crane such as the load block, bucket, or other supplemental devices.

f. Pendant: A control for a hoist and a crane. The pendant hangs from the hoist or the crane by a cable at a height that is easy for the operator to reach.

g. Rated Load: The maximum working load suspended under the load hook.

h. Standard Commercial Cataloged Product: A product which is currently being sold, or previously has been sold, in substantial quantities to the general public, industry or Government in the course of normal business operations. Models, samples, prototypes or experimental units do not meet this definition. The term "cataloged" as specified in this section is defined as "appearing" on the manufacturer's published product data sheets. These data sheets must have been published or copyrighted prior to the issue date of this solicitation and have a document identification number or bulletin number.

i. Top Running Crane: An electric overhead traveling crane that runs on rails on top of support girders.

j. Trolley Load: Weight of the trolley and its associated equipment carried by the trolley wheels.

k. Operating Environments:

    (1) General Purpose Service: This applies to most cranes and are, in large measure, the manufacturers' standard designs. Cranes should be classified as General Purpose Service if they are operating in routine environments.

    (2) Ordnance/Explosives Handling: Cranes handling palletized or unpackaged ammunition, missiles, torpedoes, and other types of ordnance. Minimum requirement of CMAA service class D.

    (3) Hazardous (Explosive) Environments: Cranes operating in hazardous environments as defined by the cognizant activity safety office must be equipped with electrical safety features that meet NEC Article 500. The activity safety office will identify the specific Class, Division, and Group, as well as the envelope that the hazard exists, to allow proper design and must list these in this section. Choose materials for mechanical components to minimize the potential for sparking, typically bronze, stainless steel, or aluminum. Hazardous environments are split into two groups: minimum anti-spark protection and maximum anti-spark protection.

        (a) Minimum Anti-Spark Protection is used when only the load block enters the explosive area.

        (b) Maximum Anti-Spark Protection is used when the hazardous area envelops the entire crane.

1.3 SYSTEM DESCRIPTION

****

NOTE: Remove the following sentence if the runway rail is not to be installed as a part of the crane procurement. If rail is to be installed, ensure Section 05 12 00 STRUCTURAL STEEL is included in the Request for Proposal (RFP).

****

[The requirements for the crane runway system and rail supporting structures are specified in Section 05 12 00 STRUCTURAL STEEL, and must conform to AISC 360.

]1.3.1 Crane Design Criteria

****

NOTE: Clearly show the area of hook coverage, runway dimensions, rail size, hook vertical travel, clear hook height, and lifting capacity on drawings.

****

Cranes will operate in the given spaces and match the runway dimensions and rails indicated. Hook coverage, hook vertical travel, clear hook height, lifting capacity, and load test weight must not be less than that indicated.

1.3.1.1 General

****

NOTE: Add number of cranes, building name, and crane rated load capacity in kilograms pounds.

****

Include the following: Number of cranes [_____], located in building identified as [_____], with the capacity expressed in [_____] metric tons tons kilograms pounds, for each overhead electric traveling (OET) crane. Also clearly locate and identify each multiple girder hoist and system components.

1.3.1.2 Classification

****

NOTE: For NAVFAC, specify CMAA service class C or higher. For Ordnance/Explosives Handling specify CMAA service class D or higher.

****

****

NOTE: Refer to NFPA 70 for environmental requirements. Make a selection from the following CMAA 70 service classifications:

Class A (Standby or Infrequent Service): This service covers cranes which may be used in installations such as powerhouses, public utilities, turbine rooms, motor rooms and transformer stations where precise handling of equipment at slow speeds with long, idle periods between lifts are required. Capacity loads may be handled for initial installation of equipment and for infrequent maintenance.

Class B (Light Service): This service covers cranes which may be used in repair shops, light assembly operations, service buildings, and light warehousing where service requirements are light and the speed is slow. Loads may vary from no load to occasional

full rated loads with 2 to 5 lifts per hour, averaging 3 m 10 feet per lift.

Class C (Moderate Service): This service covers cranes which may be used in machine shops of paper mill machine rooms, where service requirements are moderate. In this type of service, the crane will handle loads which average 50 percent of the rated capacity with 5 to 10 lifts per hour, averaging 4.5 m 15 feet, not over 50 percent of the lift at rated capacity.

Class D (Heavy-Duty): This service covers cranes which may be used in heavy machine shop, foundries, fabricating plants, steel warehouses, container yards, lumber mills, and standard duty bucket and magnet operations where heavy-duty production is required. In this type of service, loads approaching 50 percent of the rated capacity will be handled constantly during the working period. High speeds are desirable for this type of service with 10 to 20 lifts per hour averaging 4.5 m 15 feet, not over 65 percent of the lifts at rated capacity. This service is the minimum requirement for Ordnance/Explosive Handling.

Class E (Severe Service): This type of service requires a crane capable of handling loads approaching rated capacity throughout its life. Applications may include magnet, bucket, magnet/bucket combination cranes for scrap yards, cement mills, lumber mills, fertilizer plants, and container handling with 20 or more lifts per hour at or near the rated capacity.

Class F (Continuous Severe Service): This type of service requires a crane capable of handling loads approaching rated capacity continuously under severe service conditions throughout its life. Applications may include custom designed specialty cranes essential to performing the critical work tasks affecting the total production facility. These cranes must provide the highest reliability with special attention to ease of maintenance features.

****

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NOTE: Operating Environments

General Purpose Service: This applies to most cranes and are, in large measure, the manufacturers' standard designs. Cranes should be classified as General Purpose Service if they are operating in routine environments. Cranes operating in non-routine environments or unique, dedicated service should meet the requirements of one of the below Specialized Applications:

Ordnance/Explosives Handling: Cranes handling palletized or unpackaged ammunition, missiles, torpedoes, and other types of ordnance. Minimum requirement of CMAA service class D.

Hazardous (Explosive) Environments: Cranes operating in hazardous environments as defined by the cognizant activity safety office must be equipped with electrical safety features that meet NEC Article 500. The activity safety office must identify the specific Class, Division, and Group, as well as the envelope that the hazard exists, to allow proper design and must list these in this section. Materials for mechanical components must be chosen to minimize the potential for sparking, typically bronze, stainless steel, or aluminum. Hazardous environments are split into two groups: minimum anti-spark protection and maximum anti-spark protection.

a. Minimum Anti-Spark Protection is used when only the load block enters the explosive area.

b. Maximum Anti-Spark Protection is used when the hazardous area envelops the entire crane.

****

Provide top running overhead electric traveling (OET) multiple girder crane[s] conforming to CMAA 70 service class [A] [B] [C] [D] [E] [F] for operation in an [indoor] [outdoor] environment, [general purpose] [ordnance handling] [hazardous area] service, meeting the requirements of ASME B30.2, with an ambient temperature range of [_____] to [_____] degrees Celsius Fahrenheit. This crane must operate in an NEC Class [_____], Division [_____], Group [_____] hazardous area. Hazardous protection is required for the [full height of the crane][18 inches above ground level][_____]. The crane span must be [_____] meters feet with a vertical lift of [_____] meters feet and as specified herein.

The crane must be [pendant controlled] [radio controlled] [cab controlled] and operate in the spaces and within the loading conditions indicated.[The pendant controller must be mounted on a separate festooned cable system from the trolley power supply.] The crane must operate on [_____]-volts AC, [60] [50] [_____] Hz, [single] [three] phase power source. Maximum crane wheel loads (without impact) due to dead, trolley, and lifted loads, with the trolley in any position, must not cause a more severe loading condition in the runway support structure than that produced by the design wheel loads and spacing indicated.

1.3.1.3 Rated Capacity and Speeds

****

NOTE: Specify the rated speed under full load for the main hoist, auxiliary hoist (if specified), bridge, and trolley.

1. Hoist: Select hoist speed which conforms to the recommendations of CMAA 70 or ASME tables, based on capacity.

2. Trolley: Trolley travel speed must conform to the recommendations of CMAA 70, based on capacity.

3. Bridge: Bridge travel speed must conform to the suggested speeds per minute for floor controlled cranes as stipulated in CMAA 70.
****

Provide crane with rated capacity of [_____] metric tons tons kilograms pounds.[Provide auxiliary hoist with [_____] metric tons tons kilograms pounds capacity.] Lower load block or assembly of hook, swivel bearing sheaves, pins, and frame suspended by the hoisting ropes are not considered part of the rated capacity.

Rated (maximum) speeds plus or minus 10 percent (in meters/second) (feet/min) for the main hoist, [auxiliary hoist,] bridge, and trolley at the rated load are specified in the table below. The minimum speed must not exceed the values listed.[Values in the table are for a fully loaded crane. Using overspeed, the hoist function must be capable of [_____] when not loaded.]

Rated Speeds meters/second feet/min		
Description	Minimum	Maximum
Main Hoist	[_____]	[_____]
[Auxiliary Hoist]	[_____]	[_____]
Trolley	[_____]	[_____]
Bridge	[_____]	[_____]

1.4 VERIFICATION OF DIMENSIONS

The Contractor is responsible for the coordination and proper relation of their work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Electric Traveling Crane; G, [_____]

Complete Schematic Wiring Diagram; G, [_____]

Control System and Network Drawings; G, [_____]

SD-03 Product Data

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NOTE: Each catalog cut must be marked-up to fully identify the model or size/rating of the item and supplemental pages with data or information to demonstrate specification compliance.

****

Gear Reducers; G, [_____]

Hoist Brakes; G, [_____]

Travel Brakes; G, [_____]

Couplings; G, [_____]

Load Blocks and Hooks; G, [_____]

Wheels; G, [_____]

Hoists; G, [_____]

Sheaves; G, [_____]

[Commercial Hoist and Trolley Units; G, [_____]

] End Trucks; G, [_____]

Bridge Rails; G, [_____]

End Stops; G, [_____]

Bumpers; G, [_____]

[Operator's Cab; G, [_____]

] Variable Frequency Drives; G, [_____]

Motors; G, [_____]

Runway Conductor System; G, [_____]

Bridge Conductor System; G, [_____]

Limit Switches; G, [_____]

[Radio Control System; G, [_____]

][Pendant Pushbutton Station; G, [_____]

][Pendant Conductor System; G, [_____]

][Cab Control Station; G, [_____]

] Controls; G, [_____]

[Control Parameter Settings; G, [_____]

] Runway Conductor System; G, [_____]

Bridge Conductor System; G, [_____]

Capacity Overload Protective Device; G, [_____]

[Load Indicating Device; G, [_____]

] Painting System; G, [_____]

Control System and Network; G, [_____]

SD-05 Design Data

Load and Sizing Calculations; G, [_____]

SD-06 Test Reports

[Hook Proof Test; G, [_____]

][Hook Non-destructive Test (NDT); G, [_____]

] Post-erection Inspection; G, [_____]

Operational Tests; G, [_____]

Hook Tram Measurement; G, [_____]

Load Tests; G, [_____]

SD-07 Certificates

Wire Ropes; G, [_____]

Crane Runway System; G, [_____]

Hazardous Material; G, [_____]

Loss of Power Test; G, [_____]

Coupling Alignment Verification Record; G, [_____]

Overload Test; G, [_____]

Brake Adjustment Record; G, [_____]

Compliance with Listed Standards; G, [_____]

Contractor Hazardous Environment; G, [_____]

Public Domain Software; G, [_____]

Software and Services; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

SD-11 Closeout Submittals

Disabled Ports, Connectors, and Interfaces; G, [_____]

Network-Capable Control Devices; G, [_____]

Control System Access Control; G, [_____]

Control System Account Management; G, [_____]

Patch Management and Updates; G, [_____]

Malware Detection and Protection; G, [_____]

Wireless Technology Provisions; G, [_____]

Control System Inventory; G, [_____]

Evaluation Status of Hardware and Software; G, [_____]

1.6 QUALITY ASSURANCE

1.6.1 Manufacturer Qualification

Overhead Electric Traveling Crane must be designed and manufactured by a company with a minimum of 10 years of specialized experience in designing and manufacturing the type of overhead crane required to meet requirements of the Contract Documents. Crane design must be accomplished by, or directly supervised by, a registered professional engineer (PE). PE licensing must be by a board or agency authorized to license and register professional engineers. The PE may be a Contractor's regular employee or a consultant. The PE's review and attestation of specification compliance and professional responsibility must be signified by his or her PE original seal and dated signature on the final drawings. The professional engineers must only undertake and perform work under this contract in the branch(s) of engineering in which they are licensed.

1.6.2 Pre-Delivery Inspections

Contractor is responsible for performance of quality control inspections, testing, and documentation. Submit all crane test data recorded on appropriate test record forms suitable for retention for the life of the crane.

1.6.2.1 Inspection of Steel Castings

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NOTE: Navy Crane Center does not require magnetic-particle testing of steel castings. Magnetic testing for USACE projects should be coordinated with the Contracting Officer.

****

Visually inspect [and test]load-carrying steel castings[using the magnetic-particle inspection method][using ultrasonic testing].[Reference allowable degree of discontinuities to ASTM E125, and relationship to service loads and stresses, critical configuration, location and type.] All load bearing components, couplings, shafts, and gears, in the hoist drive train must be rolled or forged steel, except brake drums which may be ductile iron. Methods of repairing the discontinuities is subject to review by the Contracting Officer.

1.6.2.2 Inspection of Hook Assembly

Inspect hook[by a magnetic-particle type inspection] [and X-rayed] [and tested ultrasonically] prior to delivery. Furnish documentation of hook inspection to Contracting Officer prior to field operational testing. As part of the acceptance standard, linear indications[greater than 1/16 inch] are not allowed. Welding repairs of hook are not permitted. A hook showing linear indications, damage or deformation is not acceptable and must be replaced immediately.

[1.6.2.2.1 Hook Non-Destructive Test (NDT)

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NOTE: Delete this paragraph if selected agency does not require magnetic particle testing.

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NOTE: For NAVFAC, substitute tailored paragraph.

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Magnetic-particle inspect the hook over the entire area in accordance with ASTM A275/A275M. Acceptance standard is no defects. A defect is defined as a linear indication that is greater than [3 mm 1/8 inch][1.5 mm 1/16 inch] long. For hooks of non-magnetic material, NDT will be liquid penetrant (PT) method in accordance with ASTM E1417/E1417M. For PT testing of hooks containing stainless steels, titanium, or nickel based alloys, total halogens and Sulphur used in the NDT process must be controlled as specified in T9074-AS-GIB-010/271.

Inspect each hook and shank over the entire surface area by magnetic particle inspection.

a. Procedure: Conduct magnetic particle inspection in accordance with ASTM A275/A275M with the following restrictions: Do not use DC yokes (including switchable AC/DC yokes used in the DC mode) or permanent magnet yokes. Do not use automatic powder blowers or any other form of forced air other than from a hand-held bulb for the application or removal of dry magnetic particles. Remove arc strikes. Equipment ammeters must have an accuracy of plus or minus 5 percent of full scale (equipment ammeter accuracy other than that stated is acceptable provided the MT procedure states that a magnetic field indicator is used to establish and verify adequate field strength for all aspects of the inspection.)

b. Acceptance Criteria: Defects found on the hook will result in rejection of defective items for use on furnished hoist. For this inspection, a defect is defined as a linear indication for which the largest dimension is greater than 1.5 mm 1/16 inch.

c. Test Report: Submit a test report of the magnetic particle inspection of each hook provided the Contracting Officer for approval prior to final acceptance of hoist installation. Certify test reports by the testing organization. The performing organization must provide a written statement of certification to ASTM E543, current within one year of the date the NDT was performed. The NDT procedures including technique sheets specific to the types, shapes, and size of the parts being examined must adequately describe the orientation of the hooks within the magnetizing equipment. The performing organization must have the NDT procedures and its technique sheet used for testing of the hook reviewed and approved by an independent Level III examiner. Submit the (Level III examiner) approved procedures, technique sheet, and certification to the Contracting Officer with the test report.

][1.6.2.3 Hook Proof Test

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NOTE: Hook proof tests are required for custom designed or non-ferrous (bronze or stainless steel) hooks. Bronze/stainless steel hooks are generally associated with minimum hazardous area requirements.

****

Proof test the load hook per ASME B30.10. Perform the proof test prior to Hook NDT.

]1.6.3 Certificates

All certifications must be dated and bear the original signature (above the printed name) of the authorized representative of the Contractor or the manufacturer of the items or equipment being certified. Each certification will clearly identify the crane, the drives, components, and location (as applicable) to which it applies:

a. Submit a Wire Ropes Certification with the wire rope manufacturer's certification that the rope meets the published breaking strength or the actual breaking strength of a sample taken from the reel and tested. Certification is to be traceable to the hoist, crane, and reel.

b. Submit a Crane Runway System Certificate stating that the new crane will operate properly on the runway; if the crane(s) cannot operate without restriction, the Contractor must indicate crane limitations.

c. Submit a Hazardous Material Certificate that the crane does not contain hazardous material including asbestos, lead, cadmium, chromium, PCBs, or elemental mercury. Products required for the designing and manufacturing of cranes must not contain the prohibited materials.

d. Submit a Loss of Power Test Certificate stating that a test may be performed in which power is removed from the crane while the hoist, bridge, and trolley are in operation.

e. Submit a Certificate of the Coupling Alignment Verification Record.

f. Submit an Overload Test Certificate stating that the crane can be periodically load tested to 125 percent (plus 0 minus 5 percent) of rated load.

g. Submit an Overload Test Certificate stating that the crane can be periodically load tested to 125 percent (plus [0] [_____] minus [5] [_____] percent) of rated load.

h. Submit a Certificate of the Brake Adjustment Record. Provide a brake adjustment record and installation/maintenance manuals for each brake on the crane. Each brake measurement must have a tolerance traceable to the associated brake manual or documentation provided by the brake manufacturer, location of measurements, and the actual brake setting. Changes made to settings of the brake, at any time, will void the record.

i. Submit a Certificate of Compliance with Listed Standards

j. Provide a Contractor Hazardous Environment Certificate stating that the new crane and all associated components excluding the hoist are designed for operation in the hazardous environment specified in the Classification section.

k. The Contractor must provide a Public Domain Software Certificate declaring that public domain software (e.g., freeware, shareware) is not used in the system.

l. The Contractor must provide a certificate stating that all Software and Services that are not required for operation and/or maintenance of the product have been removed. The software/services to be removed are identified in paragraph SOFTWARE AND SERVICES.

1.6.4 Drawings: Overhead Electric Traveling Crane

a. Submit drawings showing the general arrangement of all components in plan, elevation, and end views. Show all major features of the crane including: hook approaches on all four sides, clearances and principal dimensions, assemblies of hoist, trolley and bridge drives, motor nameplate data, overcurrent protective device ratings, and electrical schematic drawings. Include weights and centers of gravity of major components. Provide maximum wheel loads (without impact) and spacing imparted to the crane runway system track beams. Indicate the crane speeds along the runway, the trolley speeds along the bridge girder, and the hoist lifting speeds; all speeds indicated are speeds with hoist loaded with rated crane capacity load.

b. Submit shop drawings of all fabricated components. Shop drawing quality must be equivalent to the contract drawings accompanying this solicitation. Drawings must be reviewed, signed, and sealed by a registered professional engineer.

c. Provide integral schedule of crane components on each drawing. The schedule must provide a cross reference between manufacturer data and shop drawings. Components listed on the schedule of crane components must include total quantity, description, original manufacturer, and part number. Distributing agents will not be acceptable in lieu of the original manufacturer.

d. Provide control system and network drawings. Network diagram must show equipment locations, names, models, and IP addresses on network communications schematic for all Programmable Logic Controllers (PLCs), Remote Terminal Unit (RTU), Supervisory Controller, and Other Network-Capable Devices. In addition, the drawings must consist of all software block, flow, and ladder diagrams.

1.6.5 Design Data: Load and Sizing Calculations

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NOTE: Design data for Load and Sizing Calculations, and welding procedures, may not be available for commercially procured hoists and trolleys.

****

Submit complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Submit calculations reviewed, signed, and sealed by a registered professional engineer verifying the load cases, sizing of the bridge girders, end trucks, travel drives, brake selections, and overcurrent protection for motors, controllers, and branch circuits. Provide a list of all codes and standards, design assumptions, equations, specified efficiencies, limits, factors of safety, component ratings, and sources of values used. Include free body diagrams or sketches of each load case.[Include seismic analysis of crane.]

1.6.6 Welding Qualifications and Procedures

Welding must be in accordance with qualified procedures using AWS D14.1/D14.1M as modified. Written welding procedures must specify the Contractor's standard dimensional tolerances for deviation from camber and sweep and not exceed those specified in AWS D14.1/D14.1M and CMAA 70. Welders and welding operators must be qualified in accordance with AWS D1.1/D1.1M or AWS D14.1/D14.1M.

1.7 CRANE SAFETY

****

NOTE: Add ASME HST-4 if commercial hoist/trolley unit will be used.

****

Comply with the mandatory and advisory safety requirements of ASME B30.10, ASME B30.2[, ASME HST-4], CMAA 70, 29 CFR 1910.147, 29 CFR 1910.179, 29 CFR 1910.306, and all applicable provisions of 29 CFR 1910 and NFPA 70. Where personal fall arrest anchorages are provided, design anchorages in accordance with ASSP Z359.

[1.7.1 Nuclear Safety Analysis

****

NOTE: Certification is required for cranes handling nuclear materials. Results from the Safety Analysis will be utilized by the Using Agency as a basis for bridge crane certification. Delete this paragraph if the crane is not required to handle nuclear

materials.

This section is not applicable to NAVFAC projects. The Navy Crane Center must be involved with the procurement and overhaul of all NAVY cranes that handle Nuclear material as identified in the forward notes section of this specification.

****

Nuclear certification, testing, and rules of construction must be in accordance with 29 CFR 1910.147 and ASME NOG-1. Air Force Nuclear certified hoists must meet requirements of AFMAN 91-118. Submit analysis and test reports to Contracting Officer for approval.

]PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Provide materials and equipment which are standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment. Material will be free from defects and imperfections that might affect the serviceability and appearance of the finished product. All material must be new and unused.

2.1.2 Nameplates

Secure nameplates to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Provide two bridge identification plates, one for each side of the bridge. Provide noncorrosive metal identification plates with letters which are easily read from the floor, showing a separate number such as BC-1, BC-2, for each bridge crane.

2.1.3 Capacity Marking

Mark the rated capacity in metric ton ton kilograms pounds units on each side of the crane on the bridge girders. Capacity marks must be large enough to be clearly visible from the floor. The markings must be positioned to be visible at the operator's position after the crane has been installed.[Provide additional markings in operator's cab.]

2.1.4 Safety Warnings

Affix labels in a readable position to each lift block or control station in accordance with ASME B30.2. Submit safety warnings, diagrams and other instructions suitably framed and protected for display as indicated by the Contracting Officer as follows:

Design and locate the word "WARNING" or other legend to bring the label to the attention of the operator. Provide durable type warning labels and display the following information concerning safe-operating procedures: Cautionary language against lifting more than the rated load; operating the hoist when the hook is not centered under the hoist; operating hoist with twisted, kinked or damaged rope; operating damaged or malfunctioning hoist; operating a rope hoist with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label.

2.2 STRUCTURAL REQUIREMENTS

Structural requirements must be in accordance with CMAA 70, Section 3. Structural steel materials must conform to the standards permitted in CMAA 70 and AISC 360.

2.2.1 Structural Connections

High-strength bolted structural connections must be designed and installed in accordance with RCSC A348. Bolts must be of ASTM F3125/F3125M Grade A325/A325M or Grade A490/A490M material. Galvanized bolts are not acceptable.

Welded connections must be performed in accordance with AWS D14.1/D14.1M. Allowable stress values must comply with CMAA 70.

2.2.2 Bridge Girder or Girders

****

NOTE: Suggest specifying welded structural steel box girders for CMAA 70 Class C, D, or E with a capacity greater than 18 metric tons 20 tons 16330 kg 36,000 pounds or a span greater than 12 m 40 feet.

****

Provide [welded structural steel box section] [wide flange beam, standard I-Beam, or section fabricated from rolled plates and shapes] bridge girders. If the ends of bridge girders are notched to fit over the end trucks, the notches must be reinforced with vertical diaphragms and horizontal stiffeners.

2.2.3 Bridge Rails

Provide bridge rails, crane girders and other sections that are straight and true. Make all rail joints flush and true without misalignment of running tread and design to minimize vibration. The gap between adjacent rail ends and the vertical misalignment of running treads must not exceed 0.794 mm 1/32 inch. Solid stock (e.g. square bar, roundstock) is not permitted as bridge rail. Center bridge rail on top flange or position bridge rail over girder web for torsion box girders. Fasten rail to girder with welded clips. Position rail clips in pairs and at not more than 914 mm 36 inches on center. Bolt bridge rail joints using standard joint bars. Stagger and position rail joints directly over girder diaphragms. Provide a positive stop at bridge rail ends to prevent creep.

2.2.4 End Ties and Bridge Girder End Connections

****

NOTE: Specify end ties for cranes with more than 4 wheels. Specify welded structural steel box sections for CMAA 70 Class C, D, or E with a capacity greater than 18 metric tons 20 tons 18000 kg 40,000 pounds or a span greater than 12 m 40 feet.

****

If equalizing end trucks are used, provide rigid end ties between girders to form a frame that is rigid about the vertical and horizontal axes. If compensating end trucks are used, provide end ties which are rigid about the vertical axis but relatively flexible about the horizontal axis to permit partial rocking motion for wheel load compensation. Provide full depth diaphragms at girder connections and jacking points. Provide horizontal gusset plates at the elevation of top and bottom end tie flanges for connection to girder ends. Make end connections with high-strength bolts in accordance with the Structural Connections section of this specification. Use tapered alignment pins to maintain original shop alignment between bridge girders and end ties/trucks.

2.2.5 End Trucks

Provide [rotating] [fixed axle] type end trucks fabricated from structural steel plate to provide a rigid box section structure. Center wheels between the webs of the box section. Configure bridge and trolley trucks with a feature that limits load movement to 25.4 mm 1 inch in the event of wheel or shaft failure. Provide jacking pads for removal of wheel assemblies. Wheel axle bearing seats must be designed such that wheel and axle bearing assembly can be removed with not more than 76 mm 3 inches of jacking.

[2.2.6 Trolley Frame

Provide trolley frame as a one-piece structural steel weldment. Provide pads for the use of jacks or wedges when changing truck wheels. Make all trolley yokes and load bars of drop forged, cast or rolled steel.[Equip trolley with permanent lifting attachments.]

]2.2.7 End Stops and Bumpers

Fit bridge girders with structural steel end stops. Locate stops to permit maximum trolley travel. Fit bridge end trucks and trolley frames with shock-absorbing bumpers capable of decelerating and stopping the bridge and trolley within the limits stated by 29 CFR 1910 and CMAA 70. Bumpers must fully engage end stops. Mount bumpers so that there is no direct shear on mounting bolts (if any) upon impact. Bumpers must provide adequate clearance between the crane and surrounding structure when compressed to preclude damaging equipment. Ensure bridge and trolley bumper retention in accordance with ASME B30.2. When more than one crane is located and operated on the same runway, bumpers must be provided on their adjacent ends or on one end of one crane. Fit the other end of the end-truck with a structural steel stop to engage the bumpers of the adjacent crane. Ensure bridge bumpers are properly aligned with runway end stops. Metal to metal contact at the bumper to end stop connection is not permitted.

[2.2.8 Footwalks

****

NOTE: A footwalk is recommended unless: the crane can be safely serviced by another means or where lack of clearance would prohibit one.

****

Set the location and construction of footwalks conforming to ASME B30.2 and 29 CFR 1910. A structural platform is required on the drive girder side of the crane. The length of the drive side footwalk must be [adequate to provide access to the trolley and provide sufficient room for mounting control cabinets] [along the entire length of the bridge]. Provide checkered steel flooring for platform.[To give access to the opposite side of the trolley, bridge conductors, or other equipment, mount a footwalk [twice the length of the trolley] [the full length of the girder] on the opposite side of the crane. Provide a cross-over footwalk over an end tie between the two girder footwalks.] Mate the drive side footwalk with the crane access platform. Footwalks must be free of exposed hazardous moving parts and electrical components that may injure personnel and not require the use of safety harnesses or other extraordinary means.

][2.2.9 Operator's Cab

****

NOTE: Applicable if a cab is specified, otherwise delete paragraph. Specify enclosed cab for outdoor use. Open cab may be used indoors. Enclosed cabs can be provided with a heating and air conditioning unit according to environmental conditions. Specify the location of cab and the direction the operator should face.

****

[2.2.9.1 Design

Design and construct operator's cab in accordance with CMAA 70 and ASME B30.2. Locate cab access to facilitate entry and exit by crane operator. Provide space for a carbon-dioxide, dry chemical, or equivalent hand fire extinguisher. In addition to the operator's seat, the cab must have a seat for a back-up operator.

][2.2.9.2 Cab Construction

Provide [fixed cab mounted on bridge] [trolley mounted cab] of the [open] [enclosed] type for [indoor] [outdoor] use, and designed to provide a clear view of the operating floor and hook for the operator.[Provide cab with a suitable [heating] [heating and air conditioning] unit]. Locate cab on the [_____] of the [bridge] [trolley] with the operator facing [_____].[Provide [sliding] [fixed] windows of laminated safety type glass.]

]]2.2.10 Additional Provisions for Outside Service

****

NOTE: This paragraph is applicable for outdoor cranes only.

****

Seal weld structural members on outdoor cranes. Provide crane bridges with parking brakes which will sufficiently hold the crane against a wind pressure of 2404 Pa 5 psf for in-service conditions. Provide crane bridges with manually-operated pin locks at each rail, designed to securely anchor the crane against a wind pressure of 1.44 kPa 30 psf for out-of-service conditions. Design members to prevent the collection of water on crane.

[2.2.11 Seismic Forces

****

NOTE: Seismic forces must be considered in the design of the cranes with a component importance factor of greater than 1.0 and in facilities with a Seismic Design Category of D, E, or F per ASCE 7-16 or ASME NOG-1. Seismic input (e.g. design spectrum)

must be specified for ASME NOG-1 analysis to be performed.

****

Perform a seismic analysis as a part of the design of the crane in accordance with ASCE 7-16 or ASME NOG-1. The seismic analysis must be included in the CMAA 70 extraordinary load case (Case 3). For project locations beyond the scope of ASCE 7-16, a widely accepted design standard may be used for seismic analysis.

]2.3 MECHANICAL REQUIREMENTS

****

NOTE: For ordnance handling further material restrictions exist.

****

a. Provide steel shafts, gears, keys, and couplings. Cast iron and aluminum used to support components of the hoist power transmission train must be ductile. Gray cast iron load bearing parts are prohibited.

b. All bearings, except those subject only to small rocker motion, must be anti-friction type. All connections subject only to small rocking motion are to be fitted with bushings or thrust washers in the pivot pin bore, as applicable. Bronze bushings must have provisions for grease lubrication.

c. All mechanical components must be accurately aligned and positively secured to maintain the alignment. Parts must not be forced into position to obtain apparent alignment.

2.3.1 Hoists

****

NOTE: For ordnance handling CMAA class D is required and, if used, packaged hoists must be HST-4 Duty Class H4 or better.

For ordnance handling custom hoist shafts must have a fatigue design factor of 1.5.

****

Provide hoist conforming to ASME B30.2 and CMAA 70 service class [A] [B] [C] [D] [E] [F] or better, double reeved, except as modified and supplemented in this section.[Standard commercial hoist and trolley units (packaged hoists), if used, must meet ASME HST-4 Duty Class [H1] [H2] [H3] [H4] or better.] For custom hoist shafts, the fatigue design factor must be a minimum of 1.5.

2.3.2 Drives

2.3.2.1 Bridge Drives

****

NOTE: If the span is less than 12 m 40 feet and the application is CMAA Class "A" or "B", then A-1 drive may be included as an option. Outdoor drive wheel requirement is optional since paragraph ADDITIONAL

PROVISIONS FOR OUTSIDE SERVICE also requires additional parking brakes for outdoor cranes.

****

Provide [either A-1 or] [A-4] bridge drive arrangement as specified in CMAA 70 consisting of a single electric motor mechanically connected through gear reduction and drive shafts to the drive wheels or separate drive motors at each end of bridge. Outdoor cranes must have half of the total wheels driven.

Acceleration and deceleration must meet the requirements specified in this section. Gears must conform to applicable AGMA standards. Provide oil tight fully enclosed gear reducers with pressure or splash type lubrication. Bridge travel limit switches are optional.

2.3.2.2 Trolley Drives

Provide complete trolley drive arrangement with a minimum of two wheels driven by an integral electric motor. Drive mechanism must run in totally enclosed oil bath. Limit switches are optional for drive mechanism. Acceleration and deceleration controls must meet requirements specified in this section.

2.3.3 Load Blocks and Hooks

****

NOTE: The following paragraphs contain tailoring for NAVFAC. For text tailored to Minimum Anti-Spark requirements, remove conflicting requirements (i.e. load block cannot simultaneously be steel and anti-sparking or steel hook meeting ASTM A668 cannot also be non-sparking).

For Ordnance Handling: The insulated link(s) are required unless the following conditions are met:
1. There is no threat of a lightning strike during operations;
2. There is no chance for contact with overhead power lines;
3. RF emissions control is in effect regardless of the HERO classification of the ordnance being held.

****

The load block must be constructed of steel non-sparking materials and designed to prevent steel-to-steel contact of moving parts. The block must be fully enclosed, concealing the sheaves and wire ropes, except for wire rope slots and drain holes. The block must be clearly marked with the capacity in kilograms pounds on both sides. The load block sheaves must be constructed of non-sparking materials.[An insulated link must be provided on each hook block per the requirements of NAVSEA OP-5.] Standard commercial blocks may be used at their published ratings when their published design factors are 5.0 or greater.

Provide an unpainted single barbed forged steel hook complying with ASTM A668/A668M. Provide an unpainted single barbed hook of non-sparking material with a minimum material longitudinal elongation of 16 percent in 2 inches. Bronze clad hooks are prohibited. Hook dimensions must be as shown on the drawings. Fit hook with a safety latch designed to preclude inadvertent displacement of slings from the hook saddle. The hook and hook nut must be removable without unreeving of the hoist. Provide hook nut with a removable type set screw or other similar fastener, installed in a plane parallel to the longitudinal axis of the hook shank. Do not weld hook nut. Uniquely mark the hook in a permanent fashion that is traceable to the NDT certification. The hook nut must be of non-sparking materials. Hook must be free to rotate through 360 degrees when supporting the test load up to 125 percent of the rated capacity. Provide only hooks which are designed and commercially rated in accordance with CMAA and conforming to ASME B30.10 and CMAA 70. Upper hooks of hook suspended hoists must be of non-sparking materials.

2.3.4 Wire Ropes

****

NOTE: For NAVFAC, add tailored paragraph section.

For minimum anti-spark protection, add tailored paragraph section.

****

a. Wire ropes must conform to ASTM A1023/A1023M and be tested as required by ASTM A931. The wire rope must be in a double reeved configuration and equalized with a sheave. Provide wire rope with a minimum design factor of [5 to 1] [_____ to 1] based on the load experienced at rated capacity and minimum breaking strength of the wire rope.

b. Provide hoisting ropes with improved plow steel, extra improved plow steel, or extra-extra improved plow steel, regular lay, bright, and uncoated with an independent wire rope, wire strand, or otherwise, steel core. Hot-dipped galvanized wire rope is not permitted.

c. Provide stainless steel construction hoist ropes.

d. Maximum hoisting rope fleet angles must be 4 degrees for drums and 4.75 degrees for sheaves. Hoisting rope end connections, other than drum connections, must be speltered sockets with forged steel terminals or swaged fittings installed in a fashion that provides 100 percent of the breaking strength of the wire rope. Provide proof of Wire Rope breaking strength. Wedge sockets or aluminum swages are not permitted on wire rope end connections.

2.3.5 Sheaves

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NOTE: Select 16 rope diameters for CMAA service class A or B, 18 rope diameters for class C, 20 rope diameters for class D, 24 rope diameters for class E, or 30 rope diameters for class F.

****

****

NOTE: For NAVFAC, add additional requirements in the tailored paragraph section.

****

Provide steel sheaves. Minimum pitch diameters must be [16] [18] [20] [24] times the rope diameter for running sheaves, and no less than 12 times the rope diameter for equalizer sheaves. Sheave surfaces which contact wire rope are not to be painted.

The sheaves must be heat treated to a minimum hardness of 320 Brinell Hardness Number (BHN) in the wire rope contact area, have a groove depth not less than 1.5 times the hoisting rope diameter, with a throat angle of 30 to 40 degrees.

2.3.6 Hoist Drum

****
NOTE: Select 16 rope diameters for CMAA service class A or B, 18 rope diameters for class C, 20 rope diameters for class D, 24 rope diameters for class E, or 30 rope diameters for class F.
****

Provide drum made of steel. Design the drum such that all hoisting rope is wound in a single layer and so that not less than two dead wraps of hoisting rope remain on each anchorage when the hook is in its extreme low position. Drum grooving must be machined right and left hand beginning at the ends and grooving toward the center of the drum. Minimum drum groove depth must be 0.375 times the rope diameter. Minimum drum groove pitch must be either 1.14 times the rope diameter or the rope diameter plus 3 mm 1/8 inch, whichever is smaller. Minimum drum pitch diameter must be [16] [18] [20] [24] times the rope diameter. Do not paint, coat, or galvanize the surface of the drum which comes in contact with wire rope.

For wire rope drums installed directly onto the output shaft of the hoist speed reducer without an intermediate flexible coupling, the drum to shaft connection must be a barrel coupling.

2.3.7 Gearing

Provide gearing of the enclosed gear reducers type. Provide steel spur, helical, or herringbone type gears and pinions only. Gearing must conform to ANSI/AGMA 2001 and AGMA 908. Internal and external gear dimensional tolerances must conform to the applicable AGMA standard for tooth geometry and tolerances. Open-type gearing is not acceptable, except for final drives.

2.3.7.1 Gear Reducers

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**NOTE: For CMAA service class D, enclosed gearing must be selected for "Mill Duty" service.
For NAVFAC, CMAA service class C enclosed gearing must be selected for "Industrial Duty".**
****

Gear reducers must be [integral components of standard hoists or hoist/trolley units of manufacturers regularly engaged in the design and manufacture of hoists or hoist/trolley units for Class A, B, or C cranes][or][standard items of manufacturers regularly engaged in the design and manufacture of gear reducers for Class D and E cranes]. Gear reducers must be designed, manufactured, and rated in accordance with ANSI/AGMA 6113 (ANSI/AGMA 6013) (for trolley drives only), as applicable. Except for final reduction, the gear reduction units must be fully enclosed in oil-tight housing.[Enclosed gearing must be selected for ["Industrial Duty"] ["Mill Duty"].] Gearing must be designed to AGMA standards and operate in an oil bath. Operation must be smooth and quiet.

2.3.7.2 Open Gearing

Provide all gears and pinions with adequate strength and durability for the crane service class and manufactured to ANSI/AGMA 2015-1 Accuracy Grade A8 or better. Open gears must be enclosed with safety guards provided with openings with covers for inspection and access for grease lubrication.

2.3.8 Wheels

****

NOTE: For maximum anti-spark protection, add the tailored words. Remove any conflicting items (i.e. wheels cannot be non-sparking and steel). Remove the 320 BHN sentence since the wheels will not be steel.

****

Provide double flanged, straight tread trolley and bridge travel wheels of rolled-to-shape or roll-forged steel. Provide double flanged, straight tread trolley and bridge travel wheels of non-sparking materials with sufficient diameter and hardness to meet allowable wheel loads. The rim, flanges, and wheel tread must be hardened to not less than 320 Brinell Hardness Number (BHN). Wheel sizing and flange-to-rail head clearances must be in accordance with CMAA 70 recommendations.

2.3.9 Bridge and Trolley Travel Brakes

Provide bridge and trolley drives with electro-mechanical brakes or non-freecoasting mechanical drive capable of stopping the motion of the bridge or trolley within a distance in feet equal to 10 percent of the full load speed in feet per minute when traveling at full speed with a full load. The brakes must have a minimum torque rating per CMAA 70 according to the applicable environment, but not sized larger than 150 percent of the motor torque. Brakes must have an externally accessible means to manually release the brake. The brakes must be equipped with a manual self-return to ON brake release and designed to permit inspection and adjustment without disassembly of the brake.

2.3.10 Hoist Brakes

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NOTE: Each hoist must have, at a minimum, two brakes. Two electro-mechanical brakes are recommended.

Consider the Controls section under ELECTRICAL REQUIREMENTS. If a variable frequency drive (VFD) is selected for use, the brake configuration must reflect the type of VFD selected (open loop vs closed loop).

If closed loop controls are selected, brake configuration must be two electro-mechanical/thruster type brakes.

If open loop controls are selected, brake configuration must be one electro-mechanical/thruster type brake and one

mechanical load brake.

If not using a VFD, and electromatic controls are selected, the brake configuration can be the manufacturer's option as long as there are a minimum of two holding brakes provided.

Cranes with two electro-mechanical/thruster holding brakes must have a time delay between the setting of the primary and secondary brakes.

Service brakes which slow down and stop the load must be adjustable down to 50 percent of their torque rating. Holding brakes which hold the load after the variable frequency drive (VFD) slows down and stops the brake are not required to be adjustable.

Additional tailoring options are provided for NAVFAC cranes.

****

a. Equip hoist with a minimum of two holding brakes, each with a minimum torque rating of 125 percent of the rated load hoisting torque.[Provide a brake configuration with [one electro-mechanical or thruster brake and one mechanical load brake that stops and holds 125 percent of the hoist's rated load and does not require the load to be raised before being lowered.] [two electro-mechanical or thruster brakes.]][A mechanical load brake may be utilized in lieu of one of the hoist holding brakes provided it stops and holds 125 percent of the hoist's rated load and does not require the load to be raised before being lowered].

[b. For cranes with two electro-mechanical or thruster brakes, designate each brake as primary or secondary with the primary brake being the brake mounted closer to the motor. Provide the primary brake with a non-time delayed setting and secondary brake with an adjustable setting time delay, set between one to three seconds after the primary brake in any stopping condition. Do not use an uninterruptible power supply (UPS) to create the secondary brake time delay.

] c. Electro-mechanical or thruster brake [must be adjustable to 50 percent of its rated capacity, and]must have an externally accessible means of manual release. On drives where the brakes are utilized as holding brakes only, torque adjustment is not required. The brakes must be equipped with a manual self-return to ON brake release and designed to permit inspection and adjustment without disassembly of the brake.

2.3.11 Couplings

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NOTE: This section is tailored to NAVFAC.

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Chain and continuous sleeve type couplings must not be used. Spline couplings are acceptable as installed on c, d, or p-face assemblies. Conventional couplings must not be loaded in the radial direction. Brake wheel or brake disc couplings (if used) must be compatible with the required coupling type. Flexible couplings must not be relied upon to compensate for inaccurate alignment. Ends of coupled shafts must be aligned within the recommended installation criteria of the coupling manufacturer.

[2.3.12 Drip Pans

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NOTE: Drip pans may be added for general purpose service or any other type of crane specialized service, if there is an additional requirement to prevent lubrication from falling to the floor or lifted load. Modify the section as needed to specific the desired drip pans.

****

a. The crane must be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment or components, which cannot be made leak-proof, must be fitted with unpainted corrosion resistant steel drip pans or must have the foundations seal welded to create a dam. Drip pans that utilize liquid sealant to prevent leakage of lubricants are not permitted.

b. The drip pans must be sized to hold the entire gear case fluid capacity, installed under all drive machinery, designed to permit easy removal of collected lubricant. A trolley floor designed to contain any lubricant drips may be used as fluid containment for any equipment that is mounted on it.

c. Provide drip pans fitted around the shank of the hook and extending outward to encompass all possible points of lubrication drips from the load block or wire rope. The drip pans must be easily removable without disassembly of the hook or load block and cannot interfere with the crane structure during testing of the upper limits.

]2.4 ELECTRICAL REQUIREMENTS

2.4.1 Motors

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NOTE: Inverter duty motors are required for open loop variable frequency drives (VFD). Vector duty motors are required for closed loop variable frequency drives (VFD).

Select two speed motors for bridge and trolley drives if magnetic controls are specified in paragraph CONTROLS; select single speed motors if electronic controls are specified in paragraph CONTROLS.

****

Motors must meet all applicable requirements of NEMA MG 1 and UL 1004-1. All motors must have a minimum of a 60 minute duty rating and be Totally Enclosed Non Ventilated (TENV), Totally Enclosed Fan Cooled (TEFC), or Totally Enclosed Blower Cooled (TEBC).[Provide inverter duty motors for Open Loop Variable Frequency Drives (VFD).][Provide vector duty motors for Closed Loop VFDs.][Provide [two] [single] speed AC squirrel cage induction type motors for the bridge and trolley drives.][Provide two speed, AC squirrel cage induction type motor for the hoist.] Provide motors with a minimum of Class F insulation. Provide motor overload protection utilizing a thermal sensitive device embedded in its windings. Provide motors painted to manufacturer's standard for "wash-down" service. Motors located outdoors must be furnished with anti-condensation heaters that remain energized when the mainline contactor is deenergized.

2.4.2 Controls

****

NOTE: Use the first three paragraphs to select electronic variable frequency drive controls for either the hoist, bridge or trolley. With VFD controls the hoist can be configured as open loop or closed loop (flux vector). Open loop is more cost effective and requires a mechanical load brake while closed loop control offers better load control and requires hoist motors with encoders for position feedback. Ensure the Hoist Brakes section of this specification reflect the type of controls chosen. Use the fourth, fifth, and sixth paragraphs to select one or two speed control for the hoist, bridge, or trolley. Selections can be made using a combination of electronic controls and one or two speed motor controls for the various functions.

When the two-speed bridge and trolley motor is specified, the slow speed will be 1/3 to 1/4 of rated travel speed. Reduced voltage starting, acceleration, and deceleration, serve to reduce the acceleration rate that is normal for squirrel-cage motors. Squirrel-cage motors with two-speed magnetic controls provide satisfactory results with slow bridge and trolley speeds, and should be specified when short travel distances are involved and where fine positioning is not required.

For faster bridge and trolley speeds or finer positioning requirements, specify electronic controls.

Various VFD manufacturers offer an option to overspeed the hoist to a value over 60Hz (usually 120Hz). This allows the operator to position the hoist at faster speeds when it is not loaded. When selecting this feature list the maximum no load speed in section "Rated Capacity and Speeds".

****

[a. Provide static reversing, variable frequency drives (VFD) for the [bridge,] [trolley] [and] [hoist] electric controls.[Provide static reversing, VFD, speed regulated, closed loop, flux vector electric controls for the hoist[s]. For feedback, provide hoist motors with encoders. The hoist controller must enable the drive motor to develop full torque continuously at zero speed. The hoist secondary brake must be controlled separate from the primary and connected to different output (within the drive) from the primary brake.] VFD controllers must meet NEMA ICS 8, Part 8 and at a minimum, provide under-voltage protection, electronic instantaneous over current protection, DC bus over voltage protection, and be able to withstand output line to line shorts without component failure. Select bridge and trolley drives such that the continuous rating of the controller is not less than the calculated motor full load current based on CMAA 70 5.2.9.1.1.1 and NEC Table 430.250. Select hoist drives such that the continuous rating of the controller is not less than 130 percent of the calculated motor full load current based on CMAA 70 5.2.9.1.1.1 and NEC Table 430.250. All hoist drives must have a motor over-torque limit to lock out the hoist and prevent gross overload of the associated hoist. Provide dynamic braking for each electric drive that is sized per VFD manufacturer's requirements. Submit VFD Control Parameter Settings.

b. Provide speed control which is infinitely variable for each function, controlled via [radio control system][and][pendant pushbutton station][and][cab control station].[Provide controls designed such that the maximum speed of each function will be limited to 25 percent of rated speed when a slow speed switch is actuated on the controller[s]. Energize a yellow/amber light/indicator while in slow speed mode.]

[c. The hoist control system may utilize overspeed up to 120hz, unloaded only, if the drivetrain equipment has all been balanced and is rated for the resulting speed.

] d. The [hoist][,] [trolley][,] and [bridge] brakes must set after the associated controller decelerates the drive motor to a controlled stop. The hoist, trolley, and bridge controllers must be sized to provide sufficient starting torque to initiate motion of that crane drive mechanism from standstill with 0 to 125 percent of rated load on the hook. The hoist controller must prove torque before release of the brakes and enable the drive motor to develop full torque continuously at zero speed. Motors must operate smoothly at all speeds without torque pulsations, and must only be energized within the frequency range of 50-60 Hz at rated speed.

][e. Provide [one][two]-speed magnetic controls for the [bridge drive][,] [trolley drive][,][and][hoist] drive. Controllers must meet the requirements of NEMA ICS 8. Ensure that an energized drive motor initially rotates only in the direction selected by the operator by activating the corresponding direction; i.e., is not overhauled. For AC squirrel cage motor controllers, the requirements of NEMA ICS 2, Part 2, for general-purpose controllers, must be met.

[f. Provide the bridge and trolley motor control systems with a drift point between OFF and the first speed control point in each direction.

]]g. The use of definite purpose contactors is prohibited. If IEC contactors are used, the application cannot exceed the contactor manufacturer's AC3 ratings for the contactor at a minimum.

h. On hoist function roll-up must be less than 1/8 inch measured at the hook block and roll-back must not occur over the entire load range.

i. Use of Uninterruptable Power Supplies (UPS) is prohibited. Feed control circuits from a single phase, air cooled, double wound transformer with a grounded metal screen between the primary and secondary windings of the transformer.

j. Provide a main line contactor. Energization of the main line contactor must be controlled by the POWER-OFF/POWER-ON switch/pushbutton on all controllers. Upon actuation of the POWER-OFF pushbutton; power to all drive motors, brakes, and controls must be removed. The mainline contactor must not be able to be energize while the POWER-OFF pushbutton is actuated. The POWER-OFF pushbutton circuitry must be independent of all controls or any other electronic devices.

2.4.3 Protection

Protection must not be less than that required by NEMA ICS 8, CMAA 70, NFPA 70,UL 1004-1, UL 1449, UL 489, UL 50, UL 943, 29 CFR 1910.147, 29 CFR 1910.179, 29 CFR 1910.306 and all applicable provisions of 29 CFR 1910. Provide enclosed type circuit breaker readily accessible to the crane operator for crane disconnect. Provide an On/Off button that removes power from the motors, brakes and control circuit on all operator control stations[and][or] [radio controllers]. Provide for lockout/tagout of all hazardous energy sources.

2.4.4 Resistors

Provide resistors with natural convection cooling sized as recommended by the VFD OEM and fabricated of corrosion resistant metal; the use of "wire wound" type resistors is prohibited for segments of 8 ohms or less. Mount resistors in substantial, ventilated enclosures constructed entirely of non-combustible materials. When mounted outdoors provide stainless steel resistor enclosures. Provide resistors with terminals fitted in the coolest position in the enclosure.

[2.4.5 Transients and Harmonics Protection

****

NOTE: The following items are required only for VFD Controls.

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a. Provide contactors and relays with appropriate Metal Oxide Varistors (MOV) or resistor-capacitor (R-C) surge absorbers installed across the respective coil.

b. Provide transient protection for electronic drive controllers that is either internal to the drive or via an MOV connected line-to-ground close to the line terminals of the drive.

c. Provide line reactors rated for continuous duty operation based upon the motor nameplate amperes. With motors of 50 horsepower or greater, harmonics protection must be provided by an isolations transformer or as recommended by the VFD OEM. For a drive motor branch circuit that exceeds 150 feet in length, a reactor must also be connected in series with the controller load (output) terminals to provide standing wave protection or as otherwise recommended by the VFD or motor OEM.

]2.4.6 Limit Switches

a. Limit switches must be rated for the NEC Hazardous Classifications specified in the Classification section of this specification.

b. Provide primary upper and lower geared limit switches. Geared limits must allow reversing direction to back out of the limit without resetting. The lower limit switch must be set such that there are a minimum of two wraps of rope on the hoist drum.

c. Provide a backup mechanical hook block activated upper limit switch wired independent of the directional controllers and the primary upper limit switch that removes power from the hoist motor, hoist brake and hoist controls conforming to NEMA ICS 5. The backup limit must require hoist resetting prior to operation of the hoist in any direction.

[d. Travel limit switches must be provided for the [bridge][and][trolley] motion to slow the crane to [25 percent] [_____] of its rated speed [[10] [_____] feet before the bridge end stops][and][[5] [_____] feet from the trolley end stops]. Limit switches must be mounted rigidly in a manner so as to protect the switch from misalignment or damage. The target/trip arm must be large enough to provide interception given a misalignment were to occur.

]2.4.7 Operator Controls

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NOTE: Available operator controls are operator's cab, pendant, and radio control. Cranes can also be set-up to be controlled by two separate systems. For cranes with one set of controls use paragraph 1. For cranes with two sets of controls use paragraph 2. In such a case some type of interlock must exist to prevent control from both systems simultaneously.

The pendant can be suspended from the trolley or an independent festooned messenger track system. The festooned system allows the operator to have maximum separation from the load. When this is a requirement include PENDANT CONDUCTOR SYSTEM section of this specification.

When specifying a radio control system, the following requirements must be considered and if needed added to the specification. None are hard requirements of NAVCRANECENINST 11450.2:
1. What type of batteries? Rechargeable?
2. Are spare batteries needed? How many?
3. Are spare remote control units required? How many?
4. Is a battery charger required?
5. Type of transmitter unit.
6. Is a belt/harness required for the remote control?

When specifying a cab operated crane, the following requirements must be considered and if needed added to the specification. None are hard requirements of NAVCRANECENINST 11450.2:
1. Where would the user like the operator controls/indicators to be located (master switches, push buttons, key switches, lights)? See paragraphs LEFT-HAND OPERATOR CONTROL PANEL and RIGHT-HAND OPERATOR CONTROL PANEL under CAB CONTROL STATION.
2. Specific details on controllers can be listed.

****

[a. Provide crane equipped with a [pendant pushbutton station] [cab control station] [radio control system].

][b. Provide crane equipped with both a [pendant pushbutton station] [cab control station] [radio control system] (see paragraph PENDANT PUSHBUTTON STATION) and a [pendant pushbutton station] [cab control station] [radio control system] (see paragraph RADIO CONTROL SYSTEM). Provide a selector switch to allow the use of only one of the two available control stations [in the operator's cab] [on the pendant controller].

] c. If VFD controls are not provided, provide directional contactors with both mechanical and electrical interlocks.

d. Operator controls must be rated for the NEC Hazardous Classifications specified in the Classification section of this specification.

[2.4.7.1 Pendant Pushbutton Station

****

NOTE: Pendants can be suspended from either the trolley or an independent conductor system that is independent of the trolley (recommended). If cost is a concern and maximum separation of the operator from the load is not a requirement, suspending the pendant from the trolley is the best option. Otherwise specify a pendant conductor system by including paragraph PENDANT CONDUCTOR SYSTEM and suspending the pendant from "an independent festooned messenger track system."

****

The cranes must be controlled from a pendant pushbutton station suspended from [the trolley] [an independent festooned messenger track system, operating the length of the bridge]. Provide multiconductor flexible cords for pendant pushbutton stations with No. 16 AWG minimum conductors. Provide a method of strain relief to protect the electrical conductors from damage. Locate the pendant pushbutton station [1200 mm 4 feet] [_____] above the finished floor. Pushbutton pendant station must have its elements legibly marked and arranged vertically, in order, in accordance with CMAA 70.[Provide [one speed] [two speed] [3-step infinitely variable] [2-step infinitely variable] pendant pushbuttons for control of the [hoist] [bridge][and][trolley].] Provide pendant pushbuttons for control that spring return to the OFF position. Voltage in the pendant pushbutton station must not exceed 150 Volts AC or 300 Volts DC.[Provide a maintained two-position selector switch for slow speed selection.] The pendant must be rated for the NEC Hazardous Classifications specified in the Crane Design Criteria "Classification" Section.

[2.4.7.1.1 Pendant Conductor System

Provide a festoon type pendant conductor system. The festoon cables must be flat cables suspended from carriers riding on an I-beam or C-track. The pendant controller must be capable of traveling the entire length of the bridge and move independently of the trolley. Festoon loops must not extend below the high hook position.

]][2.4.7.2 Radio Control System

Provide each system with a [belly box] [handheld] [_____] type portable transmitter unit [and an identical back-up transmitter unit].[Provide each transmitter with an adjustable belt or harness to support it when worn by the operator]. Only one transmitter at a time can control the crane and there must be no interference from one crane's controller affecting operation of the other cranes in the building. Each transmitter must include: individual [infinitely variable spring return joystick motion control levers] [push button controls] for each hoist, trolley, and bridge; a maintained contact, keyed switch, marked ON-OFF, for portable transmitter unit power; indication of Battery Power, and indication of Transmitting Status; a red emergency STOP mushroom pushbutton; [and]a floodlight on/off pushbutton[and a maintained slow speed selector switch]. The transmitters and all controls must each be clearly and permanently labeled with functionality and direction. Directions for controllers must be in accordance with CMAA 70 recommendations. The remote radio control system must be designed to meet the requirements of NEMA ICS 8, Part 9 and ECMA 15. Each radio remote control lever must be in the OFF position before the associated crane function can begin. The system frequency must be within the unlicensed FCC Part 15 range. Each control unit must maintain a continuous status signal to the associated receiver during operation. There must be no significant loss in systems efficiency and function at the end of eight hours of continuous battery use. Provide a contact monitoring board with the crane radio system receiver.

][2.4.7.3 Cab Control Station

All crane motions/functions must be able to be controlled from an integral operator's control chair.[Provide three master switches integrated into the chair, two on the left side and one on the right side.][All master switches must be of the single axis type operating in the forward/reverse direction.][Provide all master switches with infinitely variable speed control to the particular function.] Directional contacts must be utilized to ensure proper motions are executed. Provide all master switches with a detent neutral position. All master switch operating handles must be in the OFF position before any initial crane function can begin. Provide all master switches with dead man controls. All controllers must be clearly and permanently labeled for proper function and direction. Provide pushbuttons that are guarded to prevent accidental activation, except for the STOP/POWER OFF pushbutton.[Directions for controller movement must be in the general direction of movement of load and in accordance with CMAA 70 recommendations. The two left side master switches must control the bridge function (outermost stick) and the trolley function (innermost stick). The right master switch must control the Main hoist.]

[2.4.7.3.1 Left-Hand Operator Control Panel

Identified as follows:

NAMEPLATE: Description – Function.

a. POWER ON: Blue momentary pushbutton – Energizes the mainline contactor as long as all joysticks are in the OFF position.

b. POWER OFF: Push-pull type, red mushroom head pushbutton – Emergency Stop / De-energizes the mainline contactor.

][2.4.7.3.2 Right-Hand Operator Control Panel

Identified as follows:

NAMEPLATE (SECOND LINE OF NAMEPLATE): Description – Function.

a. SPEED RANGE (MICRO - NORMAL): Two-position selector switch – Toggles between the micro and normal drive operations.

b. HORN: Black momentary pushbutton – Sounds the warning horn mounted outside of the operator's cab.

c. FLOODLIGHTS: Two-position selector switch – Toggles the floodlights On/Off.

]]2.4.8 Electrification Systems

****

NOTE: Various methods may be used to transfer power from the runway to the crane (Runway Conductor System) and then again to the trolley (Bridge Conductor system). Typically, the Runway Conductor System is a set of conductor bars on the runway and collector shoes on the crane. Bridge Conductor system is typically a set of festoon cables.

Site conditions and environment might require the design to deviate from the norm. Hazardous locations will need to be designed with either a cable reel or festoon system.

****

2.4.8.1 Runway Conductor System

[a. Provide a rigid runway Conductor Bar System for the runway conductor system, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. Provide electrification system with three power conductors and an equipment grounding conductor. UV resistant. Steel (non-stainless) conductor bars are prohibited. The crane must be grounded through the runway electrification system. The grounded conductors must be a minimum of 70 square millimeters. Provide runway conductors sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. If there is any way the hook block or wire rope can swing into the runway electrification, provide a guard installed to prevent contact.

b. Provide two Collector Shoes (tandem design) for each conductor; each collector shoe must be rated for not less than the overcurrent protective device for the runway conductor system, so as to provide redundancy.

][c. Provide a Festoon System for the runway conductor system utilizing cables suspended from carriers riding on an I-beam or C-track for the crane, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. Provide electrification system with three power conductors and an equipment grounding conductor. Conductors must be fabricated from copper. The crane is required to be grounded through this conductor system. The grounded conductors must be a minimum of 2/0 AWG. Provide conductors sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. Festooned cable loops must not extend low enough to come into contact with any obstructions.

][d. Provide a Cable Reel System for the runway conductor system, including all necessary cables and hardware to connect the cable reel to the floor level fused disconnect switch. The cable reel must have three power conductors and an equipment grounding conductor. The crane is required to be grounded through this conductor system. Conductors must be fabricated from copper, and sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. The grounded conductors must be a minimum of 2/0 AWG.

][e. Provide a totally enclosed flexible cable tray electrification system (cable chain) for the runway conductor system, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. The cable chain must have three power conductors and an equipment grounding conductor. The conductors must be selected so as to be of the longest length without splices. Conductors must be fabricated from copper, and sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. The crane is required to be grounded through this conductor system. The grounded conductors must be a minimum of 2/0 AWG.

]2.4.8.2 Bridge Conductor System

[a. Provide Festoon System for the bridge conductor system utilizing cables suspended from carriers riding on an I-beam or C-track. Conductors must be fabricated from copper. A minimum of 20 percent of the festoon control circuit conductors for each electrification system must be spares at the time of crane acceptance. The trolley is required to be grounded through this conductor system. The grounded conductors must be a minimum of 2/0 AWG. Festooned cable loops must not extend low enough to come into contact with any obstructions.

][b. Provide a Cable Reel System for the bridge conductor system. The cable reel must have three power conductors, an equipment grounding conductor, and all necessary control cables. A minimum of 20 percent of the festoon control circuit conductors for each electrification system must be spares at the time of crane acceptance. The trolley must be grounded through the cable reel connection and all conductors must be of copper construction. The grounded conductors must be a minimum of 2/0 AWG.

][c. Provide a totally enclosed flexible cable tray electrification system (cable chain) for the bridge conductor system. The cable chain must have three power conductors, an equipment grounding conductor, and all necessary control cables. The conductors must be selected so as to be of the longest length without splices and must be copper. A minimum of 20 percent of the control circuit conductors in the flexible cable tray system must be spares at the time of crane acceptance. The trolley is required to be grounded through this conductor system. The grounded conductors must be a minimum of 2/0 AWG.

]2.4.9 Capacity Overload Protective Device [and Load Indicating Device]

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NOTE: Overload protection on a crane is required and is provided by two types of systems: Capacity

Overload Protection and Over-Torque Limit.

The Over-Torque Limit only applies to cranes with VFD controls. It is a parameter setting in the drive and is typically set at 150 percent. Cranes with magnetic controls do not have this feature. Delete third paragraph if VFD controls are not specified.

Capacity Overload Protection is usually adjustable. If adjustable, it needs to be set at less than the crane's minimum test load. This protection can take the form of one of the following devices:
1. Clutch – Not adjustable and is common on package hoists.
2. Load Limit Switch – Installed on the wire rope and measures deflection. Does not require a break in the wire rope and is simply clamped onto the wire. Typically used on smaller hoists that have magnetic controls.
3. VFD Drive Overload Protection – Similar to the Over-Torque Limit, but is set at a lower setting. Adjusted via parameters within the drive.
4. Separate Load Indicating Device – This involves the installation of a load cell and a digital readout that displays weight. The load cell is usually bolted onto the end of the wire rope or is installed as a pin in one of the sheaves.

****

a. Provide a capacity overload protective device for all hoist systems [using VFD drive capacity overload protection (separate from torque limiting feature of the VFD)] [using the load indicating device (LID) described in the next paragraph]. Set hoist capacity overload protection at [_____]. Hoist capacity overload protection must be adjustable between 80 and 150 percent of hoist capacity. Provide a keyed override or other means to disable the hoist capacity overload protection when performing a load test.[If a non-adjustable slip clutch is utilized, the OEM factory setting is acceptable and must be identified.]

[b. Provide an LID for the [main][and][auxiliary] hoist[s].[Provide [a display] [displays] installed on the underside of the bridge of each crane to provide load information from the load indicating system, to be displayed in kilograms pounds, for [both] the [main][and][auxiliary] hoist[s].][Provide [a display] [displays] installed in the cab of each crane to provide alarm circuits and continual load readout information from the load indicating system, to be displayed in kilograms pounds, for [both] the [main][and][auxiliary] hoist[s].] The display[s] must be large enough so that the operator can read the load value[s] [from the ground level] [while seated in the operator's cab]. The load indicating system capacity is to be compatible with the maximum test load for each hoist. The accuracy of the load indicating system is to be such that the indicated load is not less than 100 percent of the actual load, and not more than 110 percent of the actual load. The load indicating system must be configured with a set point for an overload limit. Provide Tare (zero) functionality at each operator's station for [the] [each] load indicating system. Any load bearing components used in the LID system must be steel, have a minimum design factor of 5 to 1 based on ultimate tensile strength and a hardness not to exceed HRC 40. Precipitation hardened stainless steel load bearing elements must be aged hardened at a minimum temperature of 1025 degrees F.

][c. Initially, set the torque limiting capability of the VFD (that is separate from the capacity overload protective device) to 150 percent of the motor torque (amperage) necessary to hoist 100 percent load. It may be adjusted up only to avoid nuisance trips and adjusted down if possible while still avoiding nuisance trips.

]2.4.10 Enclosures

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NOTE: Select classification of control panels, controls, and brakes based on the environmental conditions in which the crane will be installed:
1. Choose one of the following for an indoor installation: 1, 2, or 12.
2. Choose one of the following for an outdoor installation: 3, 4X, or 8.
3. Choose on of the following for a Class I Hazardous installation: 7 (indoor) or 8 (indoor/outdoor).
4. Choose one of the following for a Class II Hazardous installation: 9 (indoor).

Other enclosure types exist that might be a better alternative for a particular installation. If necessary, refer to NEMA 250.

****

a. Provide enclosures for control panels, controls, and brakes in accordance with NEMA 250 and NEMA ICS 6, Classification Type [1 indoor, general purpose] [12 indoor without knockouts, general purpose] [2 indoor, drip-proof] [3 outdoor, dust-tight, rain-tight, sleet-resistant] [4X outdoor] [7 indoor Class I hazardous] [9 indoor Class II hazardous] [8 indoor/outdoor Class I hazardous][_____]. Provide enclosures with listed drains to prevent accumulation of water within the enclosure. There must not be any condensation inside the control panels. If anti-condensation heaters are provided, these heaters must remain energized when the main line contactor is deenergized.

b. Provide a non-resettable hour meter, connected across the main line contactor, readable from the exterior of the main control panel, to indicate the elapsed number of hours the crane is energized.

c. Gaskets of enclosures and fixtures, and joints and contact surfaces of hazardous/explosive enclosures must be kept free of any paint to prevent damage during removal and reinstallation of gaskets of enclosures.

[2.4.11 Warning Devices

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NOTE: A warning horn or light is required for all radio controlled cranes and recommended for all others.

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[Provide a warning horn that is operable from a push button at the [pendant pushbutton] [radio control] station.][Provide a warning [strobe] [rotating beacon] that is illuminated at all times during movement of the hoist, trolley, or bridge function.]

][2.4.12 Floodlights[and Walkway Illumination]

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NOTE: Outdoor cranes require exterior footwalks, ladders, and stairs to be illuminated to 5 foot-candles.

****

Provide evenly spaced floodlights along the bridge. Select floodlights to provide an illumination level of 40 foot-candles at three feet above the finished floor. All lights must be vibration resistant and designed to prevent any material from falling from the fixture. Switch the floodlights from the [pendant pushbutton] [radio controlled] station.

[[Exterior] footwalks, ladders and stairs must be illuminated to 5 foot-candles.

]][2.4.13 Indicator Lights

Provide Indicator Lights mounted in an enclosure on the bottom of the bridge with lights sized and positioned to be visible from the ground. The lights must be the dual-lamp type. Provide a white light to indicate that power is available on the load side of the crane disconnect and a blue light to indicate that the main contactor is energized. Light voltage must be 115 VAC. Provide nameplates that are legible from ground level. The nameplates must read, in their respective order, "POWER AVAILABLE" and "CRANE ENERGIZED". The POWER AVAILABLE light must be supplied by a separate, fused transformer for its energization.

]2.4.14 Wind Speed Indicating System

Provide a wind speed indicating device. The transmitter must be mounted on the highest unobstructed location.

[2.4.15 Electrical Outlets

Provide a minimum of [one] [_____] 120 VAC duplex outlet[s] on the crane, mounted [on] [in] the [outside of the control panel(s)] [trolley] [cab] [_____]. The circuit(s) supplying receptacles must incorporate ground-fault circuit-interrupter protection for personnel and be protected by a circuit breaker with a minimum rating of [15] [20] amps.

]2.4.16 Cyber Security of Control Systems

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NOTE: Cyber Security of Control Systems requirements are tailored to NAVFAC.

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NOTE: SECNAVINST 5400.15 designates NAVFAC as the functional technical authority for WHE. NAVFAC is

designated as Functional Security Control Assessor (FSCA) and the Functional Authorizing Official (FAO) for Ashore Control Systems in their domain; therefore, this includes WHE control systems. WHE control system owners are responsible for the Information System Security Engineer (ISSE) functions and producing artifacts (documentation) for review by the FSCA and FAO.

All new and electrically overhauled cranes must implement the following cybersecurity requirements as applicable to the control system architecture (i.e., networked drives, non-networked drives, and any wireless applications) so that supporting artifacts and considerations are available for the implementation of the RMF process.

****

a. Provide the following for PLC, RTU, Supervisory Controller, or other network-capable (whether networked or not upon delivery) control devices as applicable:

  (1) Hardware list (Hardware list must include the following for each device):
    (a) Manufacturer
    (b) Model
    (c) Location
    (d) Key technical ratings (e.g. memory)
    (e) Serial number
    (f) MAC addresses
    (g) IP addresses

  (2) Software List (Software list must include the following for each device):
    (a) Manufacturer
    (b) Version/subversion
    (c) Location/device
    (d) Used network ports/protocols/services

  (3) List and discussion of all security features of Contractor hardware and software.

b. For every PLC, RTU, Supervisory Controller, or other network-capable control devices (whether networked or not upon delivery), deliver the following on CD/DVD:

  (1) Original firmware
  (2) Original firmware hash
  (3) SOP for application of firmware updates/patches
  (4) POC or website for firmware updates/patches
  (5) Count of interfaces and types
  (6) Protocols in use, per interface
  (7) Configuration file
  (8) SOP for configuration

2.4.16.1 Control System and Network

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NOTE: Select options a. & b. if a standalone laptop

is required.
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[a. Provide a rugged laptop type workstation (computer) complete with all compatible software (including software licenses), redundant physical back-up copies on CD/DVD of the installed software, and all necessary cables and special connectors to allow crane software to be troubleshot, checked and upgraded, and for the data recorder to be accessed and information retrieved. Equip the workstation with a CD/DVD drive and the associated CD/DVD burning software. The workstation must also be equipped with USB ports (2.0 and 3.0), an Ethernet port, and a serial port. Delivering the software on a USB (flash drive) device is prohibited.

b. The laptops must be designed for an industrial environment and must be shock resistant and weatherproof as a minimum. Provide the laptop with a built-in CD/DVD reader with the capability to burn CDs and DVDs including associated software to burn CDs and DVDs.

] c. The Contractor must provide all equipment, including software and hardware, necessary for testing, installation, and communicating/troubleshooting all systems provided with the crane (e.g. engine/generator, control system, LID, etc.). The Contractor must provide all crane specific operational software files (e.g. ladder logic, functional block programming, etc.) for their associated systems (e.g. control systems, LID, engine generator, etc.).

d. A single common networked design must not be used for the control systems. A network for an individual function may be used as long as a failure of the network does not affect any other function/network except as defined for specific safety interlocks (e.g. LMI system). A common crane network may be used in a monitoring mode for recording faults and trending and is encouraged. Failure of the monitoring system must not affect crane functions.

e. All provided hardware and software must be currently marketed products, not currently scheduled for end of life or obsolescence, to ensure system sustainability.

f. Ensure there is no remote access capability enabled as remote access capabilities are prohibited. Physically disable or remove all modem/network devices not required for operational purposes.

2.4.16.2 Software and Services

a. Remove all Software and Services not required for operation and/or maintenance of the product. If removal is not technically feasible, then disable software not required for the operation and/or maintenance of the product. Configure the product to allow the ability to re-enable ports and/or services if they are disabled by software. The removal of software or services may not impede the primary function of the product. If software that is not required cannot be removed or disabled, document a specific explanation and provide risk mitigating recommendations and/or specific technical justification. The software/service to be removed and/or disabled includes, but is not limited to:

(1) Cameras

(2) Games

(3) Device drivers for product components not procured/delivered

(4) Messaging services (e.g., email, instant messenger, peer-to-peer file sharing)

(5) Source code

(6) Software compilers in user workstations and servers

(7) Software compilers for programming languages that are not used in the control system

(8) Unused networking and communications protocols

(9) Unused administrative utilities, diagnostics, network management, and system management functions

(10) Backups of files, databases, and programs used only during system development

(11) All unused data and configuration files

(12) Remove and/or disable, through software, physical disconnection, or engineered barriers, all services and/or ports in the procured product not required for normal operation, emergency operations, or troubleshooting. This includes communication ports and physical input/output ports (e.g., USB docking ports, video ports, and serial ports).

b. Provide documentation showing all disabled ports, connectors, and interfaces for all network-capable devices. In addition, the documentation must provide summary documentation of the procured product's security features and security-focused instructions on product maintenance, support, and reconfiguration of default settings.

c. For the evaluation status of hardware and software, the Contractor must provide information on Common Criteria or National Information Assurance Partnership (NIAP) or Federal Information Processing Standards (FIPS) evaluation status of hardware and software.

2.4.16.3 Access Control

a. The Contractor must configure each component of the procured product to operate using the principle of least privilege. This includes operating system permissions, file access, user accounts, application-to-application communications, and energy delivery system services.

b. Provide user accounts with configurable access and permissions associated with one or more organizationally defined user role(s), where roles are used.

c. Provide a system administration mechanism for changing user(s') role (e.g., group) associations.

d. The Contractor must document control system access control options by defining access and security permissions, user accounts, and applications with associated roles.

e. Provide recommended methods for the Acquirer to prevent unauthorized changes to the Basic Input/Output System (BIOS) and other firmware. If it is not technically feasible to protect the BIOS to reduce the risk of unauthorized changes, the Contractor must document this case and provide mitigation recommendations.

2.4.16.4 Control System Account Management

The Contractor must document all accounts (including, but not limited to, generic and/or default) that need to be active for proper operation of the procured product.

Remove or disable any accounts that are not needed for normal or maintenance operations, emergency, or troubleshooting of the energy delivery system.

2.4.16.5 Session Management

The Contractor may not allow multiple concurrent logins using the same authentication credentials, allow applications to retain login information between sessions, provide any auto-fill functionality during login, or allow anonymous logins.

Provide account-based and group-based configurable session-based logout and timeout settings (e.g., alarms and human-machine interfaces).

2.4.16.6 Authentication/Password Policy and Management

Provide a configurable account password management system that allows for, but is not limited to, the following:

a. Changes to passwords (including default passwords)

b. Selection of password length

c. Frequency of change

d. Setting of required password complexity

e. Number of login attempts prior to lockout

f. Inactive session logout

g. Screen lock by application

h. Comparison to a library of forbidden strings

i. Derivative use of the user name

j. Denial of repeated or recycled use of the same password

The Contractor must time stamp log files.

2.4.16.7 Logging and Auditing

Provide logging capabilities that cover the following events, at a minimum (as appropriate to their function):

a. Information requests and server responses

b. Successful and unsuccessful authentication and access attempts

c. Account changes

d. Privileged use

e. Application start-up and shutdown

f. Application failures

g. Major application configuration changes

2.4.16.8 Heartbeat Signals

The Contractor must identify heartbeat signals or protocols and recommend which should be included in network monitoring. At a minimum, a last gasp report from a dying component or equivalent must be included in network monitoring.

The Supplier must provide packet definitions of the heartbeat signals and examples of the heartbeat traffic if the signals are included in network monitoring.

2.4.16.9 Patch Management and Updates

The Contractor must verify that procured products (including third-party hardware, software, firmware, and services) have appropriate updates and patches installed prior to delivery.

Provide documentation of the patch management program and update process (including third-party hardware, software, and firmware). This documentation must include resources and technical capabilities to sustain this program and process. Provide the Contractor's method or a recommendation for how the integrity of the patch is validated by the Acquirer as well as the Supplier's approach and capability to remediate newly reported zero-day vulnerabilities.

2.4.16.10 Malware Detection and Protection

a. The Contractor is required to implement at least one of the following:

   (1) Provide a host-based malware detection capability that quarantines (instead of automatically deleting) suspected infected files. Provide an updating scheme for malware signatures. The Contractor must test and confirm compatibility of malware detection application patches and upgrades.

   (2) If the Contractor is not providing the host-based malware detection capability, the Contractor must suggest malware detection products to be used and provide guidance on malware detection and configuration settings that will work with Contractor products.

b. The Contractor must validate that cybersecurity services running on the procured product (e.g., virus checking and malware detection) do not conflict with other such services running on the procured product.

c. For malware detection and protection, the Contractor must provide, or specify how to implement, the capability to automatically scan any removable media that is introduced to the product being acquired.

2.4.16.11 Physical Security

Provide lockable or locking enclosures or rooms for energy delivery systems and system components (e.g., servers, clients, and networking hardware) and for the systems used to manage and control physical access (e.g., servers, lock controllers, and alarm control panels). Provide a method for tamper detection on lockable or locking enclosures. If a physical security and monitoring system is used, tamper detection must be compatible. The Contractor must ensure that physical security features do not hamper the crane system operations. Provide the tools and instructions for making changes to locks, locking codes, keycards, and any other keyed entrances.

2.4.16.12 Wireless Technology

For wireless technology provisions, the Contractor must document:

a. Specific protocols and other detailed information required for wireless devices to communicate with the control network, including other wireless equipment that can communicate with the Contractor-supplied devices.

b. Use, capabilities, and limits for the wireless devices.

c. Power and frequency requirements of the wireless devices (e.g., microwave devices meet the frequency requirements of Generic Requirements [GR]-63 Network Equipment Building System [NEBS] and GR-1089).

d. Range of the wireless devices and verify that the range of communications is minimized to both meet the needs of the Acquirer's proposed deployment and reduce the possibility of signal interception from outside the designated security perimeter.

e. Wireless technology and associated devices compliance with standard operational and security requirements specified in applicable wireless standard(s) or specification(s) (e.g., applicable IEEE standards, such as 802.11).

f. Configuration control options that enable varying of the security level of the devices.

2.4.16.13 Control System Inventory

Provide the complete control system inventory. The Control System Inventory must include the following attributes, in tabular format, as applicable:

General Information	Location Information	Hardware Details	Operating System and Platform	Network Information (Actual Function, not potential function)
Unique ID	Facility Name	Device Type	Embedded OS (Yes/No)	MAC Address(es)
Barcode or Identifier	NFAID	Device Sub-Type	OS Contractor	IP Address(es)
Region	Commodity	Device Function	Operating System (O/S)	Upstream Device
Installation	Floor	Manufacturer	O/S Version	Protocols In Use
Special Area (Option DNA1)	Room	Product Line	Platform Contractor	Host Name
	Location	Model No.	Platform Product Line	
	System Type	Serial No.	Platform	
	Functional System or Equipment Control	Remote Connectivity: (Wired / Wireless / None)	Platform Version	
		Network Type Used: (Serial / Ethernet / Both / None)		

2.5 PAINTING SYSTEM

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NOTE: Three-coat zinc primer/epoxy/polyurethane system is provided for mild to severe atmospheric, indoor and outdoor cranes. For cranes in abnormal environments including exposure to chemicals or in immersion service, a system designed for that environment should be used. Other systems may suffice for milder environments.

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a. Remove all grease, oil, and surface debris by solvent wiping or detergent/water scrubbing, prior to blast cleaning. Prepare surfaces to be coated by abrasive blasting to SSPC SP 6/NACE No.3, Commercial Blast Cleaning, or in accordance with the coating manufacturer's requirements, whichever is more stringent.

b. Use a painting system appropriate for the conditions provided in the Crane Design Criteria section. Paint exposed portions of the crane using a [three] [_____]-coat system as follows: [zinc-rich primer consisting of a minimum of 85 percent zinc by weight in the dry film, an anticorrosive epoxy intermediate coat, and an aliphatic polyurethane top coat] [_____]. All paint products must be supplied by a single manufacturer and free of chromates, lead, and mercury. Apply each coat in accordance with manufacturer's instructions and requirements. Ensure each coat is smooth, even, and free of runs, sags, orange peel, and other defects. Desired color of finish coat is [brilliant yellow] [_____]. Submit product data for painting system.

c. Coat faying surfaces of bolted connections per RCSC A348, but do not apply finish paint.

d. Paint the load block [brilliant yellow] [_____] with black diagonal striping. Paint, coatings, or galvanizing on the following items or areas is not acceptable: hoist wire ropes, hooks, hook nuts, running bearing surfaces (including sheaves and wheel treads), grease fittings, or other items not normally painted.

e. Factory paint electrical and mechanical equipment in accordance with the manufacturer's best standard practice (for the specified environment), except that electrical equipment doors, which expose current-carrying electrical conductors when opened, must be orange.

2.6 IDENTIFICATION PLATES

Furnish and install identification plates. Provide non-corrosive metal identification plates with clearly legible permanent lettering giving the manufacturer's name, model number, serial number, capacity in both kilogram and pound units printed in different colors, and other essential information or identification.

2.6.1 Markings on Crane, Trolley, and Hook

To avoid operation of the crane in the wrong direction, affix the appropriate directions (NORTH, SOUTH, EAST, and WEST) with arrows on the bottom of the girder where they can be easily seen by the operator and from the loading point. Provide labels on the controls with corresponding directional (NORTH, SOUTH, EAST, and WEST) markings. Markings must agree with the markings on controller. Do not indicate directional arrows on controller.

Mark the hook rated capacity in kilograms pounds on both sides of the hoist load block.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, and before performing any work, verify all dimensions in the field. The Contractor is responsible for the coordination and proper relation of the contracted work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

[3.2 SHOP ASSEMBLY AND TESTS

Shop assemble major components as completely as possible, except for reeving of drums and sheaves. Functionally test the crane system at the construction facility prior to shipment. The Government reserves the right to inspect the crane for compliance with this specification and to witness the functionality tests. Notify the Contracting Officer [14] [_____] days prior to starting testing operations.

]3.3 ERECTION AND INSTALLATION

Perform the entire crane erection in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative.

3.3.1 Mechanical Alignment

Align motors, couplings, brakes, gear boxes and drive components in accordance with manufacturer's instructions. Complete the Coupling Alignment Verification Record.

3.3.2 Electrical Adjustments

Adjust control system in accordance with manufacturer's instructions. Store a copy of all Control Parameter Settings (PLC, VFD). Provide the final alignment data on the Complete Schematic Wiring Diagram, including but not limited to, timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents. Provide the test conditions such as ambient temperature, motor load, date performed and person performing the alignment as part of the Operational Tests report.

3.3.3 Field Welding

Perform welding indoors, where possible. Surface of parts to be welded must be free from rust, scale, paint, grease or other foreign matter. Minimum preheat and interpass temperatures must conform to the requirements of AWS D14.1/D14.1M. Perform welding of girders and beams conforming to AWS D14.1/D14.1M.

3.3.4 Field Painting

Perform painting indoors, where possible. Field painting (including touch-up) must conform to the requirements of the coating manufacturer and as specified in PAINTING SYSTEM.

3.4 FIELD QUALITY CONTROL

3.4.1 Post-Erection Inspection

[After erection, the Contractor[, the Activity Crane Inspector/Test Director,] and the Contracting Officer must jointly inspect the crane bridge and hoist systems and components to determine compliance with specifications and approved submittals. Notify the Contracting Officer [_____] days before the inspection.]Provide a report of the inspection indicating the crane is considered ready for operational tests.

3.4.2 Operational Tests

****

NOTE: Determine if Government furnished certified test weights are available at the site. If not they must be provided by the Contractor.

****

Check the clearance envelope of the entire crane prior to picking or traversing any load to ensure there are no obstructions. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the crane is operational.[The Contractor must furnish test weights, operating personnel, instruments, and other apparatus necessary to conduct field tests on each crane. Solid weights must be measured using calibrated equipment traceable to National Institute of Standards and Technology (NIST) with a minimum accuracy of plus or minus two percent.]

3.4.2.1 No-Load Test

Raise and lower each hook through the full range of normal travel at rated speed for three complete cycles. Raise and lower each hook, testing other speeds of the crane. Verify proper operation of hoist limit switches. Operate the bridge and trolley in each direction the full distance between end stops. Operate through the entire speed range and verify proper brake operation. Verify correct operation of all indication and ancillary devices.

3.4.3 Test Data

Record test data on appropriate test record forms suitable for retention for the life of the crane. Record operating and startup current measurements for hoist, trolley, and bridge motors using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) must be justified or appropriate adjustments performed. In addition, note, investigate, and correct any high temperatures or abnormal operation of any equipment or machinery. Record hoist, trolley, and bridge speeds during each test cycle.

3.4.4 Hook Tram Measurement

Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 0.4 mm 1/64 inch). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening from the base measurement is cause for rejection.

3.4.5 Load Tests

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NOTE: The following paragraph contains NAVY Tailoring. The NAVY requires a load test of 125 percent (plus 0 minus 5) of the rated load.

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Perform the following tests for each hoist, as specified below.

Test loads used in this section are defined as the following:

Wire rope run-in load: 25 – 50 percent of rated load.

Rated load test: [100 percent (plus 0 minus 10)] [100 percent (plus [_____] minus [_____])] of rated load.

Overload test: [125 percent (plus 0 minus 5)] [125 percent (plus [0] [_____] minus [5] [_____])] of rated load.

3.4.5.1 Wire Rope Run-In

The primary purpose of this procedure is to exercise the newly installed wire rope.

Place the load on the hook. Start at ground level and hoist up to one foot below upper limit at slow speed. Hoist down to lower limit at slow speed. Repeat hoisting and lowering of the load for approximately 10 hoisting cycles, increasing the speed for each cycle. During this test, the capacity overload lockout should not activate.

3.4.5.2 Rated Load Test

3.4.5.2.1 Hoist

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately 300 mm one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees to check bearing operation with no binding. Observe lowering that may occur which indicates a weakness in the structure or malfunction of hoisting components or brakes. Verify that maximum beam and girder deflections do not exceed CMAA 70 design limits.

b. For hoists with primary and secondary holding brakes, raise the test load and release the secondary holding brake while testing the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage secondary holding brake and release the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage the primary holding brake. Recheck proper operation of time delay and ensure smooth positive stopping.

c. Hoist Mechanical Load Brake (if present): Raise test load approximately 1500 mm 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

d. Raise and lower test load through the full lift range and visually observe smooth control and acceleration between points. Completely stop the machinery at least once in each direction to ensure proper brake operation.

e. Hoist Loss of Power Test: Raise the test load to approximately 2400 mm 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.2.2 Trolley

Operate the trolley (if space is available) the full distance of the bridge rails in each direction with a test load on the hook. Check proper functioning through the range of speeds. Verify proper brake action.

3.4.5.2.3 Bridge

With a test load on the hook, operate the bridge for the full length of the runway (if space is available) in one direction with the trolley at the far end of the bridge, and in the opposite direction with the trolley at the opposite end of the bridge. Use extreme caution. Check proper functioning through the range of speeds. Check for any binding of the bridge end trucks and verify proper brake action. Record deficiencies. Secure from testing if deficiencies are found.

3.4.5.2.4 Trolley Loss of Power Test

With a test load of 100 percent of rated load, raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of trolley travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the trolley stops and that the brake sets properly. Measure the distance required for the trolley to stop.

3.4.5.2.5 Bridge Loss of Power Test

With a test load of 100 percent of rated load, raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of bridge travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the bridge stops and that the brake sets properly. Measure the distance required for the bridge to stop.

3.4.5.3 Overload Test

3.4.5.3.1 Hoist

Disconnect or adjust the overload limit device to allow the hoist to lift the test load. Verify proper operation of the overload limit device after it is reconnected.

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately 300 mm one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees to check bearing operation with no binding. Observe lowering that may occur which indicates a weakness in the structure or malfunction of hoisting components or brakes.

   For hoists with primary and secondary holding brakes, raise the test load and release the secondary holding brake while testing the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage secondary holding brake and release the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage the primary holding brake. Recheck proper operation of time delay and ensure smooth positive stopping.

b. Raise and lower test load and visually observe smooth control. Stop the load during raising and lowering to verify that the brakes holds the load.

c. Hoist Load Brake (if present): Raise test load approximately 1500 mm 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

d. Hoist Loss of Power Test: Raise the test load to approximately 2400 mm 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.3.2 Trolley

Operate the trolley the full distance of the bridge rails in each direction with a test load on the hook (one cycle) through the range of speeds. Verify proper brake action.

3.4.5.3.3 Bridge

With a test load on the hook, operate the bridge for the full length of the runway in one direction with the trolley at the extreme end of the bridge, and in the opposite direction with the trolley at the opposite extreme end of the bridge (one cycle). Check proper functioning through the range of speeds. Check for any binding of the bridge end trucks and verify proper brake action. Record deficiencies. Secure from testing if deficiencies are found.

3.5 MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

Furnish a qualified experienced manufacturer's field service representative to supervise the crane installation, assist in the performance of the on-site testing, and instruct personnel in the operational and maintenance features of the equipment.

3.6 OPERATION AND MAINTENANCE MANUALS

Provide [two] [_____] hard copies of operation and [two] [_____] hard copies of maintenance manuals for the equipment furnished along with an electronic copy (PDF) of each on a Compact Disc. Provide one complete set prior to performance testing and final copies upon acceptance. Provide operation manuals that detail the step-by-step procedures required for system startup, operation and shutdown. Include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. List in the maintenance manuals routine maintenance procedures, including weekly, monthly, semi-annual, and annual required maintenance items, possible breakdowns and repairs, and troubleshooting guides. Also include as-built drawings, piping and equipment layout, design calculations, Control Parameter Settings and printouts of any software, and simplified wiring and control diagrams of the system as installed. Secure approval of operation and maintenance manuals prior to the field training course.

[3.7 FIELD TRAINING

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NOTE: Training is recommended, but not required.

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Conduct a training course for [_____] operating and maintenance staff[and provide a copy of the training material to each participant]. Provide a training period consisting of a total of [_____] hours of normal working time and starting after the system is functionally completed but prior to final acceptance. Cover all pertinent points involved in operating, starting, stopping, and servicing the equipment, including all major elements of the Operation and Maintenance Manuals. Demonstrate in course instructions all routine maintenance operations such as lubrication, general inspection, and [_____].

][3.8 FINAL ACCEPTANCE

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NOTE: Use this paragraph as written for projects where the crane is the principal construction element, or represents a very significant portion of the Contract cost. However, if the crane is part of a new facility or renovation, delete the acceptance paragraph from this section. Warranty period and operating and maintenance processes must coincide with the actual beneficial occupancy of the entire facility.

****

Final acceptance of crane system will not be given until Contractor has successfully completed all testing operations, corrected all material and equipment defects, made all proper operation adjustments, and removed paint or overspray on wire rope, hook, and electrical collector bars.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-41 22 13.15 (November 2022)**
Change 1 - 02/23

Preparing Activity: NAVFAC **Superseding**
UFGS-41 22 13.15 (February 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-41 22 13.15 (November 2022)**
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SECTION 41 22 13.15

BRIDGE CRANES, OVERHEAD ELECTRIC, UNDER RUNNING TROLLEY

11/22, CHG 1: 02/23

****

NOTE: This guide specification covers requirements for top running and under running single girder electric traveling (OET) cranes with under running trolleys and hoists, Crane Manufacturers Association of America (CMAA) 74 Class A, B, C and D suitable for indoor or outdoor use in general purpose service, ordnance handling service, or hazardous area environments Crane capacities less than 23 metric ton 25 ton 23,000 kg 50,000 pounds. For NAVY, crane capacities in this specification should be limited to 9,100 kg 20,000 pounds for administrative purposes.

Single girder under running crane configuration is not recommended for spans greater than 12 meters 40 feet or capacities greater than 9,100 kg 20,000 pounds. Utilize multiple single girder spans or see Section 41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING for top running double girder configurations more appropriate at longer spans and higher capacities. Contact Navy Crane Center for more information (Naval Facilities Engineering Systems Command, Navy Crane Center, Building 491, Norfolk Naval Shipyard, Portsmouth, Va., 23709-5000)

This guide specification incorporates the design criteria and requirements identified in NAVCRANECEN INSTRUCTION 11450.2A (December 2018).

This guide specification includes tailoring options for NAVFAC, pounds (per NAVFAC P-307), and tons. The NAVFAC tailoring option also includes requirements specific to the Navy and Marine Corps. Crane procurements for the Navy and Marine Corps must select the NAVFAC tailoring option.

Crane tailoring options are included for the Air Force, outdoor, ordnance/explosives handling, or hazardous (explosive) environments. Only one unique

specialized application tailoring option should be selected at a time, however multiple can be used with additional specific project editing in the resulting sections. "General Purpose Service" is the default crane condition unless an alternate specialized tailoring option is selected. When "Maximum Anti-Spark" protection is required, the "Minimum Anti-Spark" tailoring option MUST ALSO be selected as the maximum requirements are in addition to the minimum requirements.

Selection or deselection of a tailoring option (select view-tailoring options) will include or exclude that option in the section. Specific project editing is still required for the resulting section.

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NOTE: Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: Use this guide specification to specify cranes that are procured as part of a building construction contract for such applications as machine shops, warehouses, and other areas that do require specialized weight handling equipment.

Explanations of CMAA service classifications A through D are covered in the "Notes" portion of paragraph CRANE DESIGN CRITERIA, sub-paragraph CLASSIFICATION. The minimum allowable classification for Ordnance/Explosive Handling is CMAA service class D. Navy Crane Center minimum requirement is CMAA service class C.

Forward all procurement of OET systems at Naval Shore based activities with rated capacities of 9000 kg 20,000 pounds or greater or for use in specialized applications (e.g., ordnance handling, molten metal handling, special purpose service as defined in NAVSEA Publication 0989-030-7000, hazardous/explosive area environments, or precision

handling operations requiring complex or synchronized lifting capacity) to: Naval Facilities Engineering Systems Command, Navy Crane Center, Building 491, Norfolk Naval Shipyard, Portsmouth, Va., 23709-5000. (See NAVCRANECEN INSTRUCTION 11450.1C of 11 JULY 2019).
****

****
NOTE: This specification covers cranes with top running or under running bridge and under running trolley and hoist, single girder, with CMAA 74 service class of A through D.

Control types and systems may be specified as follows:

1. Remote or Pendant Crane Controls or a combination of the two can be provided.

2. Alternating current (AC) control systems must be specified. The vast majority of new cranes are AC powered and AC controlled.
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NOTE: The RFP must provide the relevant dimensions and load data for the crane. See "Crane Inquiry Data Sheet" in CMAA 74 section 6.1 or see "Crane Information Form for Under running Cranes(s)" pages 5 and 6 at the following Navy Crane Center link:

https://ncc.navfac.navy.mil/Popular-Links/DOWNLOADS/

Projects that are routed through Navy Crane Center should be accompanied by a completed Crane Information Form (CIF) per the above link.
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NOTE: Show the following information, as a minimum, on the project drawings:

1. Complete details of plan, elevations, and sections of crane.

2. Runway track system (if installed), including span and size of girder, runway rail size, channel cap size, size and location of crane stops, and building clearances.

3. Electrical junction box location (including mounting height).
****

PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
ANSI/AGMA 2001	(2004D; R 2010) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
ANSI/AGMA 2015-1	(2001A; R 2014) Accuracy Classification System - Tangential Measurements for Cylindrical Gears
ANSI/AGMA 6013	(2006A; R 2016) Standard for Industrial Enclosed Gear Drives

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B30.10	(2019) Hooks
ASME B30.16	(2022) Overhead Underhung and Stationary Hoists
ASME B30.17	(2020) Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoists)
ASME B30.30	(2019) Ropes
ASME HST-1	(2023) Performance Standard for Electric Chain Hoists
ASME HST-4	(2021) Performance Standard for Overhead Electric Wire Rope Hoists
ASME NUM-1	(2023) Rules for Construction of Cranes, Monorails, and Hoists (With Bridge or Trolley or Hoist of the Underhung Type)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D14.1/D14.1M	(2019) Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

ASTM INTERNATIONAL (ASTM)

ASTM A275/A275M	(2023) Standard Practice for Magnetic Particle Examination of Steel Forgings
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM E543	(2021) Standard Specification for Agencies Performing Non-Destructive Testing
ASTM E1417/E1417M	(2016) Standard Practice for Liquid Penetrant Testing
ASTM F436/F436M	(2024) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F2973	(2021) Standard Specification for Insulating Lifting Links for Load Lifting Equipment Working Near Energized Power Lines
ASTM F3125/F3125M	(2019) Standard Specification for High

Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

BRITISH STANDARDS INSTITUTION (BSI)

BS ISO 4309	(2017) Cranes - Wire Ropes - Care and Maintenance, Inspection and Discard

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes
CMAA 74	(2020) Specifications for Single Girder Cranes

ELECTRIFICATION AND CONTROLS MANUFACTURERS ASSOCIATION (ECMA)

ECMA 15	(2018) Cable-less Controls for Electric Overhead Traveling Cranes

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC ISO 15408	(2022) Information Technology-Security Techniques-Evaluation Criteria for IT Security

MATERIAL HANDLING INDUSTRY OF AMERICA (MHI)

MHI MH27.1	(2016) Specifications for Underhung Cranes and Monorail Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NEMA ICS 8	(2011) Crane and Hoist Controllers
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J429	(2014) Mechanical and Material Requirements for Externally Threaded Fasteners
SAE J995	(2017) Mechanical and Material Requirements for Steel Nuts

U.S. AIR FORCE (USAF)

AFMAN 91-118	(2010) Safety Design and Evaluation Criteria for Nuclear Weapon Systems

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-W-410	(2022; Rev J) Wire Rope and Strand

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.179	Overhead and Gantry Cranes
29 CFR 1910.306	Specific Purpose Equipment and Installations

U.S. NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSEA T9074-AS-GIB-010/271	(2014; Revision 1) Requirements for Nondestructive Testing Methods

UL SOLUTIONS (UL)

UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters

UL 1004-1	(2012; Reprint Nov 2020) UL Standard for Safety Rotating Electrical Machines - General Requirements

1.2 DEFINITIONS

a. Crane Bridge: That part of an overhead crane system consisting of a girder, end trucks, walkway, and drive mechanism which carries the trolley(s) and travels along the runway rails parallel to the runway.

b. Crane Runway: The track system along which the crane operates horizontally, including track hangar rods, track connection devices, and runway structural supports.

c. Dead Loads: The weight of all effective parts of the bridge structure, the machinery parts, and the fixed equipment supported by the structure.

d. Crane Bridge Girder: The principal horizontal beam of the crane bridge structure. It is supported by the crane end trucks. Typically for single girder cranes the trolley mounted hoist is suspended from the girder below the crane. For double girder cranes, the trolley is typically run on top of the bridge girder and the hoist is mounted on top of the trolley.

e. Insulated Link: A component normally installed between the hook and the lifting wire rope or lower load block, or below the hook to prevent the flow of electrical energy. Insulated links are primarily used when there is the possibility radio frequency energy collecting on the weight handling equipment structure. Insulated links are used extensively in the handling of ordnance.

f. Lifted Load: The load consisting of the rated load and the weight of lifting devices attached to the crane such as the load block, bucket, or other supplemental devices.

g. Original Equipment Manufacturer (OEM): the Company that produced the part or original equipment.

h. Packaged Hoist: A commercially designed and mass produced hoist characterized by the motor, gearing, brake(s), and drum contained in a single package often connected by the use of c, d, or p-face flanges.

i. Patented Track: A generic term referring to track built in accordance with MHI MH27.1 utilizing a composite track section incorporating a proprietary bottom flange shape. For this crane system, it is provided for the crane bridge girder and also the crane runway track, if under running.

j. Pendant: A control for a hoist and a crane. The pendant hangs from the hoist or the crane by a cable at a height that is easy for the operator to reach.

k. Rated Load: The maximum working load suspended under the load hook.

l. Standard Commercial Cataloged Product: A product which is currently being sold, or previously has been sold, in substantial quantities to the general public, industry or Government in the course of normal business operations. Models, samples, prototypes or experimental units do not meet this definition. The term "cataloged" as specified in this section is defined as "appearing on the manufacturer's published product data sheets. These data sheets must have been published or copyrighted prior to the issue date of this solicitation and have a document identification number or bulletin number.

m. Top Running Crane: An overhead electric traveling crane that is supported by end trucks which run on top of supporting rails.

n. Trolley Load: The weight of the trolley and its associated equipment carried by the trolley wheels.

o. Under running (Underhung) Crane: An electric overhead traveling crane that is supported by crane end trucks suspended below the crane runway. The load is supported by hanging from the lower flange of a beam or patented track.

1.3 SYSTEM DESCRIPTION

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NOTE: Remove the following sentence if the runway rail is not to be installed as a part of the crane procurement. If rail is to be installed, ensure Section 05 12 00 STRUCTURAL STEEL is included in the Request for Proposal (RFP).

Top running runway beam and runway crane rail are typically provided by the facility. Under running runway rail is typically provided by the crane contractor. See also CRANE BRIDGE GIRDER.

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[The requirements for the structures supporting the crane runway are specified in Section 05 12 00 STRUCTURAL STEEL, and must conform to AISC 360.

]1.3.1 Crane Design Criteria

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NOTE: Cranes installed outside the United States are still required to meet the features and characteristics specified.

When necessary, the design may be able to use the host nation's consensus standards in lieu of US standards. An equivalency study may be requested from the contractor to justify use of the international standard.

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NOTE: Clearly show the area of hook coverage, runway dimensions, rail size, hook vertical travel, clear hook height, and lifting capacity on drawings.

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Cranes will operate in the given spaces and match the runway dimensions and rails indicated. Hook coverage, hook lift, clearances, lifting capacity, and load test weight must not be less than that indicated. Provide loaded hook coverage to the maximum extent possible.

1.3.1.1 General

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NOTE: For NAVY, crane capacity should be limited to 9,100 kg 20,000 pounds, since Navy Crane Center is required to be contacted for cranes with higher capacities.

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NOTE: Add number of cranes, building name, bay, and crane rated load capacity in metric tons tons.

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NOTE: For NAVFAC projects, capacity markings MUST be expressed in pounds unless the crane is located in Europe or Asia.

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Include the following: Number of cranes [_____], located in building identified as [_____], [bay [_____],] with the capacity expressed in [_____] metric tons tons, for each crane. Also clearly locate and identify each hoist and system components.

1.3.1.2 Classification

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NOTE: The need for single or double girder design is influenced by the capacity, span, and runway type.

For under running bridge girders (with runway suspended from the facility ceiling):

1. **Recommend a single bridge girder for total spans less than 12 meters 40 feet.**
    a. **If the total span is more than 12 meters 40 feet recommend two or more bridge girder spans of equal length.**

2. **For total spans more than 12 meters 40 feet or capacity more than 9,100 kg 20,000 pounds, an alternative option is two separate bridge girders for use with an underhung trolley/hoist.**
    a. **Double girder designs are unique for this type of application and are not covered under this specification.**

For top running bridge girders:

Recommend a single bridge girder for total spans less than 12 meters 40 feet for use with an underhung trolley/hoist. Multiple bridge girder spans is not an option for top running girders.
    a. **For total spans more than 12 meters 40 feet or capacity more than 9,100 kg 20,000 pounds, recommend two separate bridge girders for use with a top running trolley/hoist. For this configuration, see Section 41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING.**

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NOTE: For NAVFAC, specify CMAA service class C or higher. For Ordnance/Explosives Handling, specify CMAA service class D.

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NOTE: Make a selection from the following CMAA 74 service classifications:

Class A (Standby or Infrequent Service): This service covers cranes which may be used in installations such as powerhouses, public utilities, turbine rooms, motor rooms and transformer stations where precise handling of equipment at slow speeds with long, idle periods between lifts are required. Capacity loads may be handled for initial installation of equipment and for infrequent maintenance.

Class B (Light Service): This service covers cranes which may be used in repair shops, light assembly operations, service buildings, and light warehousing, where service requirements are light and the speed is slow. Loads may vary from no load to occasional full rated loads with 2 to 5 lifts per hour, averaging 3 m 10 feet per lift.

Class C (Moderate Service): This service covers cranes which may be used in moderate service requirements such as machine shops of paper mill machine rooms. In this type of service, the crane will handle loads which average 50 percent of the rated capacity with 5 to 10 lifts per hour, averaging 4.5 m 15 feet, not over 50 percent of the lift at rated capacity.

Class D (Heavy-Duty): This service covers cranes which may be used in heavy machine shop, foundries, fabricating plants, steel warehouses, container yards, or lumber mills and standard duty bucket and magnet operations where heavy-duty production is required. In this type of service, loads approaching 50 percent of the rated capacity will be handled constantly during the working period. High speeds are desirable for this type of service with 10 to 20 lifts per hour averaging 4.5 m 15 feet, not over 65 percent of the lifts at rated capacity. This service is the minimum requirement for Ordnance/Explosive Handling.

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NOTE: Operating Environments

(1) General Purpose Service: This applies to most cranes and are, in large measure, the manufacturers' standard designs. Cranes should be classified as

General Purpose Service if they are operating in routine environments.

(2) Ordnance/Explosives Handling: Cranes handling palletized or unpackaged ammunition, missiles, torpedoes, and other types of ordnance. Minimum requirement of CMAA service class D.

(3) Hazardous (Explosive) Environments: Locations where fire or explosion hazards may exist due to flammable gases, flammable liquid–produced vapors, combustible liquid–produced vapors, combustible dusts, or ignitable fibers/flyings. Cranes operating in hazardous environments as defined by the cognizant activity safety office must be equipped with electrical safety features that meet NFPA 70 Article 500. The activity safety office must identify the specific Class, Division, and Group, as well as the envelope that the hazard exists, to allow proper design and must list these in this section. Materials for mechanical components must be chosen to minimize the potential for sparking, typically bronze, stainless steel, or aluminum. Hazardous environments are split into two groups: minimum anti-spark protection and maximum anti-spark protection.

(a) Minimum Anti-Spark Protection is used when only the load block and pendant enter the explosive area. Anti-spark protection is required for the pendant controller, hook, hook block, and wire rope.

(b) Maximum Anti-Spark Protection is used when the hazardous area envelops the entire crane. In addition to the minimum anti-spark protections, the entire crane and runway components must also be protected against sparking.

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NOTE: Hazardous Area Environments

Refer to NFPA 70 National Electric Code (NEC), Article 500 for hazardous area environment requirements and classifications. The determination(s) for hazardous area are made by the facility or project. Some, but not all, of the options are:
Class I, Division 1 or 2, and Group A, B, C, or D.
Class II, Division 1 or 2, and Group E, F, or G.
Class III, Division 1 or 2.

Class I: a location where explosive gases, vapors, or liquids are present.
Class II: a location where explosive or combustible dust is present.
Class III: a location where combustible fibers or flyings are present.
Division I: a location where the hazardous material

is present continuously, long term, or frequently.
Division II: a location where the hazardous material is not likely to be present or is present only in the short term.
Groups A, B, C, and D: a location where the hazardous material is a specific gas, liquid, or vapor.
Groups E, F, and G: a location where the hazardous material is specific dust, fiber, or flyings.

The height of the hazardous area directly affects crane requirements. For areas that encompass the floor and immediate area above the floor, the minimum anti-spark provisions for crane components entering the hazardous area are sufficient (anti-spark measures for the hook, load block, wire rope, and pendant). Minimum anti-spark protection is far more common than maximum anti-spark protection.

For hazardous areas that cover the entire crane envelope (i.e., bridge and trolley), the "maximum hazardous" tailoring option must be selected. This tailoring option adds anti-spark measures for the entire crane, such as electrical enclosures and wheels.
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NOTE: The bracketed option for separate runways is necessary if ensuring more than one crane is not installed on the same runway for contracts with multiple cranes in the same building, bay, or location.
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Provide [under running] [top running] single girder electric bridge crane(s), with under running trolley mounted hoist, conforming to MHI MH27.1, CMAA 70, and CMAA 74 service class [C] [D] [A] [B], as applicable. The crane(s) must be designed for operation in an [indoor] [outdoor] environment, [general purpose] [ordnance handling] [hazardous area] service, meeting the requirements of ASME B30.16 and ASME B30.17, with an ambient temperature range of [_____] to [_____] degrees Celsius Fahrenheit. The crane(s) must operate in an NFPA 70 Class [I] [II] [_____], Division [2] [1] [_____], Group [D] [_____] hazardous area. Hazardous protection is required from the finished floor level up to [1.5 meters 5 feet above ground level] [0.5 meters 1.5 feet above ground level] [full height of the crane] [[_____] meters feet above ground level]. The total crane span must be [_____] meters feet with a minimum vertical hook lift of [_____] meters feet and as specified herein. Provide runways for multiple span cranes equally spaced apart.[Provide separate runways for each crane.]

The crane must be [pendant controlled] [radio controlled] and operate in the spaces and within the loading conditions indicated. Provide a crane, including hooks and hoisting rope or load chain, that is able to clear permanent obstructions in all operating configurations.[The pendant controller must be mounted on a separate festooned cable system from the trolley power supply.] The crane must operate on [_____]-volts AC, [60 Hz] [_____], [three] [single] phase power source. Maximum loading on the facility (without impact) due to dead loads, trolley loads, and lifted loads, with the trolley in any position, must not exceed the allowable wheel loading and wheel spacing of the facility (or not exceed maximum hanger loading for under running cranes).

1.3.1.3 Rated Speeds

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NOTE: Slow full-load operating speeds invariably provide improved load control and increased productivity.

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NOTE: Specify the maximum rated speed under full load for the main hoist, bridge, and trolley.

1. Hoist speeds must conform to the recommendations of CMAA 74 or ASME tables. Trolley travel speed must conform to the recommendations of CMAA 74. A table of suggested hoisting and travel speeds can be found at the end of section 6 in CMAA 74.

2. Bridge travel speed must not exceed the maximum speed that the floor walking, crane pendent control operator can comfortably negotiate in a work area, approximately 750 mm/s 150 ft/min, and as recommended in CMAA 74.

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NOTE: Recommend "Medium" rated speeds, where appropriate. Another consideration for operating speeds is the distance travelled per minute (e.g., 20 ft hook lift height corresponds to hook lift speed of 20 fpm). Consider limiting bridge or trolley travel speeds when operation occurs over shorter distances (e.g., for a 50 ft runway, a bridge travel speed of 50 fpm may be more appropriate than the 115 fpm "medium" speed).

Most projects will have a minimum and maximum speed entered. The speeds can be the same whether using two speed motors with magnetic controls or variable frequency drive controls.

Single speed motors will be selected if electronic controls are specified in paragraph CONTROLS. For 1-speed motors, only enter a maximum operating speed.

Two speed motors will be selected if magnetic controls are specified in paragraph CONTROLS. For 2-speed motors, recommend selecting a minimum speed that is 1/4 to 1/3 the maximum speed. Common maximum speed selections:
Wire Rope Hoists IAW ASME HST-4 (fpm): 15, 20, 30, 40
Chain Hoists IAW ASME HST-1 (fpm): 8, 15, 30
Trolley (fpm): 30, 50, 75, 100, 125
Bridge (fpm): 50, 75, 100, 150, 175

Cranes using variable frequency drive controls are more flexible regarding speed selection than magnetic contactor controls.

****

Provide the crane with rated (maximum) speeds within plus or minus 10 percent (in meters/second feet/min) for the main hoist, bridge, and trolley at the rated load as specified in the table below. The minimum speed must not exceed the values listed.

Rated Speeds meters/second feet/min		
Description	Minimum	Maximum
Main Hoist	[_____]	[_____]
Trolley	[_____]	[_____]
Bridge	[_____]	[_____]

The hook lift capacity and speed must be the manufacturer's standard within the limits specified.

[1.3.1.4 Foreign Design Standards and Practices

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NOTE: This subpart is tailored to NAVFAC. This subpart will NOT typically be included and is to only be used when cranes are procured for international locations (outside of the United States), which could use contractors that design and build equipment for localities under different laws and standards.

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a. Foreign design standards and engineering practices are acceptable, provided they are accompanied by satisfactory explanation and are shown to meet corresponding U.S. standards and practices, as approved by Navy Crane Center. Design calculations and drawings that use foreign language and nomenclature must be provided with corresponding English equivalents. Metric units may be used for both calculations and shop drawings, but they must include conversions to English units. In the case of calculations, only the initial inputs and final results need to be so converted. Professional training and accreditation of foreign engineers may vary in some aspects from those in the U.S., but they are satisfactory if comparable for the design work in which they engage. Mechanical properties and quality standards of common construction materials of foreign sources supplied in accordance with recognized standards that resemble those of ASTM and other U.S. standards are acceptable, as approved by Navy Crane Center. Typically, foreign welding procedures, materials, standards, and welder qualifications are comparable to those of AWS and are therefore acceptable. Provide all necessary certifications and other data for review and approval prior to start of work. Special attention must be given to ensure the weld sizes are being specified and measured uniformly. Unique constructions and metric sizes not complying with FS RR-W-410, the Wire Rope Users

Manual, or ASTM A1023/A1023M, may be used on Navy cranes, subject to Navy Crane Center review and approval of the specific applications. In selecting metric wire ropes for installation on new cranes with sheave and hoist drum grooves configured for a specific US wire rope size, the metric diameter must be within the limits of the wire ropes for which the sheave and drum are grooved. When the wire rope is installed on an older crane with sheave and hoist drum grooves configured for a specific U.S. produced wire rope size, the sheave and hoist drum grooving must be considered to ensure a satisfactory match with the wire rope. The capacities or ratings of components produced in foreign countries in compliance with foreign standards, and their installation requirements, must be converted to the English engineering units and verified for specification compliance.

b. Some components from foreign sources are prohibited due to practical considerations - either susceptibility to counterfeiting or maintenance and timely support. Specific examples are:

   (1) High-Strength Structural Bolts and Nuts. The use of structural bolts from foreign manufacturers is allowed provided the bolts meet Research Council on Structural Connections (RCSC) Specification for Structural Joints Using High-Strength Bolts (RCSC A348).

   (2) Electronic controls of foreign manufacturers are prohibited unless technical support is available in the U.S.

]1.4 VERIFICATION OF DIMENSIONS

The Contractor is responsible for the coordination and proper relation of their work to the building structure and to the work of all trades. Coordinate with the crane support structure design, where applicable, to provide the desired crane operating envelope (i.e., hook envelope and hook height). Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

1.5 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Electric Crane System; G, [_____]

Complete Schematic Wiring Diagram; G, [_____]

Control System and Network Drawings; G, [_____]

SD-03 Product Data

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NOTE: Each catalog cut must be marked-up to fully identify the model or size/rating of the item and supplemental pages with data or information to demonstrate specification compliance.

****

Hoist Brakes; G, [_____]

Travel Brakes; G, [_____]

Load Block and Hook; G, [_____]

Hoist and Trolley Units; G, [_____]

[Hoisting Rope; G, [_____]

][Hoisting Chain; G, [_____]

][Insulated Lifting Link; G, [_____]

] Travel Reducer; G, [_____]

Wheels; G, [_____]

Bridge End Trucks; G, [_____]

Crane Bridge Girder; G, [_____]

End Stops; G, [_____]

Bumpers; G, [_____]

[Crane Runway System; G, [_____]

] Motors; G, [_____]

Enclosures; G, [_____]

Circuit Breakers; G, [_____]

Disconnect Switch; G, [_____]

Contactors and Relays; G, [_____]

Fuses; G, [_____]

[Variable Frequency Drives; G, [_____]

] Limit Switches; G, [_____]

Resistors; G, [_____]

[Radio Control System; G, [_____]

][Pendant Push-Button Station; G, [_____]
]
[Pendant Conductor System; G, [_____]

] Crane Controllers; G, [_____]

[Control Parameter Settings; G, [_____]

][Pilot Devices; G, [_____]

][Warning Devices; G, [_____]

][Floodlights; G, [_____]

] Runway Conductor System; G, [_____]

Bridge Conductor System; G, [_____]

Overload Protection; G, [_____]

Painting System; G, [_____]

Control System and Network; G, [_____]

SD-05 Design Data

Load and Sizing Calculations; G, [_____]

SD-06 Test Reports

[Hook Proof Test; G, [_____]

][Hook Non-Destructive Test (NDT); G, [_____]

][Insulated Link Non-Destructive Test (NDT); G, [_____]

] Post-Erection Inspection; G, [_____]

Operational Tests; G, [_____]

Hook Tram Measurement; G, [_____]

Load Tests; G, [_____]

SD-07 Certificates

[Wire Rope; G, [_____]

] **

NOTE: A solid non-sparking wire rope (e.g., stainless steel) is the preference for hazardous areas.

Include the requirement for end user notification if the crane operates in a Division 2 hazardous area (per CLASSIFICATION) and drawn galvanized wire rope is allowed per HOISTING ROPE.

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[Drawn Galvanized Wire Rope End User Notification; G, [_____]

][Load Chain; G, [_____]

][Insulated Link Mechanical Proof Test; G, [_____]

][Insulated Link Electrical Proof Test; G, [_____]

] Crane Runway; G, [_____]

Hazardous Material; G, [_____]

Loss of Power Test; G, [_____]

Overload Test; G, [_____]

Brake Adjustment Record; G, [_____]

Contractor Hazardous Environment; G, [_____]

Public Domain Software; G, [_____]

Software and Services; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 3; G, [_____]

SD-11 Closeout Submittals

Network-Capable Control Devices; G, [_____]

Disabled Ports, Connectors, and Interfaces; G, [_____]

Evaluation Status of Hardware and Software; G, [_____]

Control System Access Control; G, [_____]

Control System Account Management; G, [_____]

Patch Management and Updates; G, [_____]

Malware Detection and Protection; G, [_____]

Wireless Technology Provisions; G, [_____]

Control System Inventory; G, [_____]

1.6 QUALITY ASSURANCE

1.6.1 Manufacturer Qualification

Overhead Electric Crane System, including sub-system components manufactured by vendors, must be designed by, or directly supervised by, a registered professional engineer (PE). PE licensing must be by a board or agency authorized to license and register professional engineers. The PE may be a Contractor's regular employee or a consultant. The PE's review and attestation of specification compliance and professional responsibility must be signified by their PE original seal and dated signature on the final drawings. The professional engineers must only undertake and perform work under this contract in the branch(s) of engineering in which they are licensed.

1.6.2 Pre-Delivery Inspections

Contractor is responsible for performance of quality control inspections, testing, and documentation.

[1.6.2.1 Hook Proof Test

****

NOTE: Hook proof tests are required by the NAVY for custom designed or non-ferrous (bronze or stainless steel) hooks. Bronze/stainless steel hooks are generally associated with minimum hazardous area requirements. Hook material selected in LOAD BLOCK AND HOOK.

Outside of hazardous area anti-spark protection, this section will likely not be required for the NAVY. The hooks are required to be standard commercial components (i.e., not custom designed and manufactured).

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Proof test custom designed or non-ferrous load hooks per ASME B30.10. Perform the proof test prior to Hook NDT.

]1.6.2.2 Inspection of Hook Assembly

****

NOTE: For NAVY, carbon steel hooks require magnetic-particle type inspections and non-ferrous hooks (typically anti-spark hooks for hazardous areas) require liquid penetrant type inspection.

NAVY acceptance criterion is no linear indications greater than 1.5 mm 1/16 inch. General recommendation is that linear indications greater than 1.5 mm 1/16 inch not be allowed.

Use of X-ray and ultrasonic inspection is not required for NAVY cranes.

****

Inspect hook [by a magnetic particle type inspection] [by liquid penetrant type inspection] [and X-rayed] [and tested ultrasonically] prior to delivery. Furnish documentation of hook inspection to Contracting Officer prior to field operational testing.

Acceptance standard is no defects. A defect is defined as a linear indication for which the largest dimension is greater than [1.5 mm 1/16 inch] [3 mm 1/8 inch] [_____] long. Welding repairs of hooks are not permitted. A hook showing linear indications, damage, or deformation is not acceptable.

[1.6.2.2.1 Hook Non-Destructive Test (NDT)

****

NOTE: This section is required for NAVY cranes.

Remove this section if the selecting agency does not require hook non-destructive testing or the necessary non-destructive testing is not IAW NAVY requirements.

For NAVFAC, add tailored paragraphs with additional requirements.

****

For hooks of ferromagnetic materials, magnetic-particle inspect the hook over the entire area in accordance with NAVSEA T9074-AS-GIB-010/271 or ASTM A275/A275M. For hooks of non-magnetic material, NDT must be liquid penetrant (PT) method in accordance with ASTM E1417/E1417M or NAVSEA T9074-AS-GIB-010/271. For PT testing of hooks containing stainless steels, titanium, or nickel based alloys, total halogens and Sulphur used in the NDT process must be controlled as specified in NAVSEA T9074-AS-GIB-010/271.

Inspect each hook and shank over the entire surface area. If NDT cannot be performed on surfaces inside small holes (e.g., hook/nut captivation roll pin holes), visually inspect those surfaces to the maximum extent practical.

a. Procedure for magnetic particle inspection: Conduct magnetic particle inspection in accordance with NAVSEA T9074-AS-GIB-010/271. ASTM A275/A275M may be used with the following restrictions: Do not use DC yokes (including switchable AC/DC yokes used in the DC mode) or permanent magnet yokes. Do not use automatic powder blowers or any other form of forced air other than from a hand-held bulb for the application or removal of dry magnetic particles. Remove arc strikes. Equipment ammeters must have an accuracy of plus or minus 5 percent of full scale (equipment ammeter accuracy other than that stated is acceptable provided the MT procedure states that a magnetic field indicator is used to establish and verify adequate field strength for all aspects of the inspection.)

b. Acceptance Criteria: Defects found on the hook will result in rejection of defective items for use on furnished hoist.

c. Test Report: Submit a test report of the inspection of each hook to the Contracting Officer for approval prior to final acceptance of hoist installation. Certify test reports by the testing organization. The performing organization must provide a written statement of certification to ASTM E543, current within one year of the date the NDT was performed. The NDT procedures including technique sheets specific to the types, shapes, and size of the parts being examined must adequately describe the orientation of the hooks within the magnetizing equipment, as applicable. The performing organization must have the NDT procedures and its technique sheet used for testing of the hook reviewed and approved by an independent Level III examiner. Submit the (Level III examiner) approved procedures, technique sheets, and certification to the Contracting Officer with the test report.

][1.6.2.3 Insulated Link Non-Destructive Test (NDT)

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NOTE: Insulated link non-destructive test is required when an integral insulated lifting link is installed as selected in the LOAD BLOCK AND HOOK section. The insulating link is typically associated with OUTDOOR ordnance handling cranes. Insulated links integrated with the load block is uncommon, even for ordnance handling cranes.

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Disassemble the link and connecting stud(s) in conjunction with disassembly of the hook and nut. Perform a visual inspection of the metal link ends for thread damage, wear, and corrosion. Apply a temporary sealing tape over the threaded holes to prevent moisture entry into the link while the link is disassembled. Perform a magnetic particle inspection of the stud in accordance with ASTM A275/A275M or NAVSEA T9074-AS-GIB-010/271. Acceptance criterion is no linear indications greater than 1.5 mm 1/16 inch.

Test Report: Submit a test report of the inspection to the Contracting Officer for approval prior to final acceptance of hoist installation. Certify test reports by the testing organization. The performing organization must provide a written statement of certification to ASTM E543, current within one year of the date the NDT was performed. The NDT procedures including technique sheets specific to the types, shapes, and size of the parts being examined must adequately describe the orientation of the hooks within the magnetizing equipment, as applicable. The performing organization must have the NDT procedures and its technique sheet used for testing of the hook reviewed and approved by an independent Level III examiner. Submit the (Level III examiner) approved procedures, technique sheets, and certification to the Contracting Officer with the test report.

]1.6.3 Drawings: Overhead Electric Crane System

a. Submit drawings showing the general arrangement of all components in plan, elevation, and end views to demonstrate proper interface with the facility and relation to other cranes on the same rail system, if applicable. Show all major features of the crane including: hook approaches on all four sides, clearances and principal dimensions, hoist, trolley and bridge drives, motor nameplate data, overcurrent protective device ratings, and electrical schematic drawings. Include weights and centers of gravity of major components (e.g., bridge girder(s), trolley/hoist). Indicate on the drawings the wind speed above which the crane must be placed in the stowed position.

b. Submit shop drawings of all fabricated components. Shop drawing quality must be equivalent to the contract drawings accompanying this solicitation. Drawings must be reviewed, signed and sealed by a licensed professional engineer.

c. Provide Bill of Materials for crane components on each drawing. The schedule must provide a cross reference between manufacturer data and shop drawings. Components listed on the schedule of crane components must include total quantity, description, original manufacturer, and part number. Distributing agents will not be acceptable in lieu of the original manufacturer.

d. Provide control system and network drawings. Network diagram must show equipment locations, names, models, and IP addresses on network communications schematic for all Programmable Logic Controllers (PLCs), Remote Terminal Unit (RTU), Supervisory Controller, and Other Network-Capable Devices. In addition, the drawings must consist of all software block, flow, and ladder diagrams.

1.6.4 Design Data: Load and Sizing Calculations

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NOTE: Design data for Load and Sizing Calculations, and welding procedures, may not be available for commercially procured hoists and trolleys. Coordinate seismic analysis requirement with paragraph SEISMIC FORCES.

****

Submit complete list of equipment and materials, including manufacturer's descriptive data, technical literature, and performance charts and curves. Submit calculations reviewed, signed, and sealed by a registered professional engineer verifying the load cases, sizing of the bridge girder(s), end trucks, travel drives, motors, overcurrent protection, and conduit. Provide a list of all codes and standards, design assumptions, equations, specified efficiencies, limits, factors of safety, component ratings, and sources of values used. Include free body diagrams or sketches of each load case. Ensure the crane is designed for the operating wind load case in accordance with CMAA 74 or MHI MH27.1, as appropriate. Determine the wind forces that will cause the outdoor crane to move in a parked condition with the brakes provided.[Include seismic analysis of crane.]

1.6.5 Certificates

All certifications must be dated and bear the original signature (above the printed name) of the authorized representative of the Contractor or the manufacturer of the items or equipment being certified. Submit certifications that clearly identify the crane, the drives, components, and location (as applicable) to which it applies:

[a. Wire Rope Certification with either the wire rope manufacturer's certification that the rope meets the published breaking force, or certification of the actual breaking force of a sample taken from the reel and tested. Show the published breaking force on the wire rope certificate; the actual wire rope breaking force must meet or exceed the published value. Certification must be traceable to the hoist, crane, and reel.

****

NOTE: A solid non-sparking wire rope (e.g., stainless steel) is the preference for hazardous areas.

Include the requirement for end user notification if the crane operates in a Division 2 hazardous area (per CLASSIFICATION) and drawn galvanized wire rope is allowed per HOISTING ROPE.

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[(1) Drawn Galvanized Wire Rope End User Notification from the crane, hoist, or wire rope OEM notifying the end user that the crane is operated in a Division 2 hazardous area as defined by NFPA 70, which is a location where the hazardous material is not likely to be present or is present only in the short term. The wire rope is made of drawn galvanized steel, meaning it is manufactured from sparking materials but provided with a spark resistant outer layer. The outer layer or individual wire strands could become compromised if the wire rope is used in an improper manner or inadequately maintained, which would affect the integrity of the spark-resistant protection. In this scenario, immediate replacement is recommended. The wire rope will need to be evaluated and potentially replaced with a compliant configuration if the hazardous area Division is changed.

]]a. Load Chain Certification from either the load chain manufacturer or the hoist manufacturer that the chain samples taken and tested meet the chain manufacturer's designed minimum breaking force, and the load chain has been proof tested with a load at least equivalent to one and a half times the hoist rated load divided by the number of chain parts supporting the load. Certification must be traceable to the crane and hoist.

] **

NOTE: Insulated link mechanical and electrical proof test certifications are required when an integral insulated lifting link is installed as selected in the LOAD BLOCK AND HOOK section. The insulating link is typically associated with OUTDOOR ordnance handling cranes. Insulated links integrated with the load block are uncommon, even for ordnance handling cranes. Commands typically prefer to use insulated links in below the hook lifting devices (e.g., rigging gear).

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[b. Insulated Link Mechanical Proof Test Certification from the insulating lifting link OEM showing that the insulated link was mechanically proof tested in accordance with ASTM F2973.

c. Insulated Link Electrical Proof Test Certification from the insulating lifting link OEM showing that the insulated link was electrically proof tested in accordance with ASTM F2973.

] d. Crane Runway Certificate stating that the new crane will operate properly on the runway. For runways provided by Contractor, include statement certifying runway has been aligned in accordance with CMAA 74 or MHI MH27.1, as applicable.

e. Hazardous Material Certificate that the crane does not contain hazardous material including asbestos, lead, cadmium, chromium, PCBs, or elemental mercury. Products required for the designing and manufacturing of cranes must not contain the prohibited materials.

f. Loss of Power Test Certificate stating that a test may be performed in which power is removed during operation without any detrimental effects to the crane.

****

NOTE: For NAVFAC, the Overload Test Certificate must state that the cranes can be periodically load tested to 125 percent (plus 0 minus 5 percent). Remove the conflicting Overload Test Certificate which allows for testing at different tolerances.

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g. Overload Test Certificate stating that the crane can be periodically load tested to 125 percent (plus 0 minus 5 percent) of rated load. Overload Test Certificate stating that the crane can be periodically load tested to 125 percent (plus [0] [_____] minus [5] [_____] percent) of rated load.

h. Certificate of the Brake Adjustment Record. Provide a brake adjustment record and installation/maintenance manuals for each brake on the crane. Each brake measurement must have a tolerance traceable to the associated brake manual or documentation provided by the brake manufacturer, location of measurements, and the actual brake setting. Changes made to settings of the brake, at any time, will void the record.

i. Contractor Hazardous Environment Certificate stating that the new crane and all associated components including the hoist are designed for operation in the hazardous environment specified in the paragraph CLASSIFICATION.

j. Public Domain Software Certificate declaring that public domain software (e.g., freeware, shareware) is not used in the system.

k. Certificate stating that all Software and Services that are not required for operation and/or maintenance of the product have been removed. The software/services to be removed are identified in paragraph SOFTWARE AND SERVICES.

1.6.6 Welding Qualifications and Procedure

Welding must be in accordance with qualified procedures using AWS D14.1/D14.1M as modified. Written welding procedures must specify the Contractor's standard dimensional tolerances for deviation from camber and sweep and not exceed those specified in AWS D14.1/D14.1M, MHI MH27.1 and CMAA 74. Welders and welding operators must be qualified in accordance with AWS D1.1/D1.1M or AWS D14.1/D14.1M.

1.7 CRANE SAFETY

Comply with the mandatory and advisory safety requirements of ASME B30.10, ASME B30.16, ASME B30.17, ASME HST-4 or ASME HST-1, 29 CFR 1910.147, 29 CFR 1910.179, 29 CFR 1910.306, and all applicable provisions of 29 CFR 1910 and NFPA 70.

[1.7.1 Nuclear Safety Analysis

****

NOTE: Certification is required for cranes handling nuclear materials. Results from the Safety Analysis will be utilized by the Using Agency as a basis for bridge crane certification. Delete this paragraph if the crane is not required to handle nuclear materials.

This paragraph is not applicable to NAVFAC projects. The Navy Crane Center must be involved with the procurement and overhaul of all NAVY cranes that handle Nuclear material as identified in the forward notes section of this specification.

****

Nuclear certification, testing, and rules of construction must be in accordance with 29 CFR 1910.147 and ASME NUM-1. Air Force Nuclear certified hoists must meet requirements of AFMAN 91-118. Submit analysis and test reports to Contracting Officer for approval.

]PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Provide materials and equipment which are standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment. Material will be free from defects and imperfections that might affect the serviceability and appearance of the finished product. All material must be new and unused.

2.1.2 Nameplates

Secure nameplates to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Provide two bridge identification plates, one for each side of the bridge. Provide noncorrosive metal identification plates with letters which are easily read from the floor, showing a separate number such as BC-1, BC-2, for each bridge crane.

2.1.3 Capacity Marking

****

NOTE: NAVFAC requires markings to be indicated in pound units. The kilogram marking option is provided for cranes installed in a foreign country.

****

Mark the rated capacity in pound units [with kilogram units printed in a different color] on each side of the crane on the bridge girder. Capacity marks must be large enough to be clearly visible from the floor. Individual hoist units must have their rated capacity clearly marked on their lower block, and additionally labeled on the hoist body.

2.1.4 Safety Warnings

Affix labels in a readable position to each lift block or control station in accordance with ASME B30.16 and ASME B30.17. Submit safety warnings, diagrams and other instructions suitably framed and protected for display as indicated by the Contracting Officer as follows:

Design and locate the word "WARNING" or other legend to bring the label to the attention of the operator. Provide durable type warning labels and display the following information concerning safe-operating procedures: Cautionary language against lifting more than the rated load; operating the hoist when the hook is not centered under the hoist; operating hoist with twisted, kinked or damaged rope; operating damaged or malfunctioning hoist; operating a rope hoist with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label.

2.2 STRUCTURAL REQUIREMENTS

Structural requirements must be in accordance with CMAA 74 and MHI MH27.1, as applicable. Structural steel materials must conform to the standards permitted in CMAA 74, MHI MH27.1, and AISC 360. Skewing and other applicable lateral loads must be considered in the design.

2.2.1 Structural Connections

High-strength bolted structural connections must be designed and installed in accordance with RCSC A348. Bolts must be of ASTM F3125/F3125M Grade A325/A325M or Grade A490/A490M material. Galvanized bolts are not acceptable.

Welded connections for the crane must be performed in accordance with AWS D14.1/D14.1M. Welded connections to the building must be performed in accordance with AWS D1.1/D1.1M. Allowable stress values must comply with CMAA 74 or MHI MH27.1, as applicable.

2.2.2 Crane Bridge Girder

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NOTE: Ordnance handling cranes must run on patented track. Tailor requirement to ordnance handling. Remove conflicting or redundant track options.

****

a. Provide crane bridge girder(s) of [rolled steel shape conforming to CMAA 74] [or] [patented track conforming to MHI MH27.1]. For ordnance handling cranes, provide crane bridge girders of patented track. Intermittent ("skip") welds on bridge girder elements (e.g., web and flange interfaces) are prohibited. If the girder is notched to fit over the end trucks, reinforce the girder ends with vertical and horizontal stiffeners. Splices in the unsupported length of the girder are prohibited.

b. For patented track girder(s), submit manufacturer's standard published tables that verify the crane bridge girder is sized in compliance with all specification requirements. When standard published tables are not available, provide calculations for the strength design and deflection of the bridge. Patented track girder must be of welded steel construction and fabricated by a manufacturer regularly engaged in the production of this type of beam.

c. Keep splices in the bridge girder(s) to a minimum and splices in high stress locations must be avoided. Make splices with complete joint penetration welds. Field (on-site) welded splices are prohibited.

2.2.3 Bridge End Trucks

****

NOTE: For cranes in hazardous areas which encompass the entire crane envelope, the drop lugs pose a sparking risk if it is metal-to-metal. Use the maximum anti-spark tailoring option to minimize this sparking risk.

****

Provide bridge end trucks conforming to ASME B30.17 and CMAA 74 or MHI MH27.1, as applicable. Configure end trucks with a feature that limits end truck movement to 25.4 mm one inch in the event of wheel or shaft failure. Provide drop (safety) stops with contact surfaces of non-sparking materials.

2.2.4 End Stops

Fit the crane bridge girder(s) with structural steel end stops. Locate stops to permit maximum trolley travel. Design end stops in accordance with MHI MH27.1 and ASME B30.17. Provide a system in which the travel wheels do not contact the end stops. End stops must be designed to absorb the maximum kinetic energy and impact force developed by the bumper contact. Provide end stops compatible with trolley bumpers and designed to bolt to the crane bridge girder.

2.2.5 Bumpers

****

NOTE: The following paragraph contains tailoring for MAXHAZ for cranes located in hazardous areas which encompass the entire crane envelope; the bumper to end stop connection poses a sparking risk if it is metal-to-metal. Use the maximum anti-spark tailoring option to minimize this sparking risk.

****

Fit bridge end trucks and trolley frames with shock-absorbing bumpers capable of decelerating and stopping the bridge and trolley within the limits stated by ASME B30.17. Ensure bumpers conform to ASME B30.17. Bumpers must fully engage end stops. Mount bumpers so that there is no direct shear on mounting bolts (if any) upon impact. Bumpers must provide adequate clearance between the crane and surrounding structure when compressed to preclude damaging equipment (clearance requirements are defined in MHI MH27.1 or CMAA 74, as applicable, and ASME B30.17). When more than one crane is located and operated on the same runway, bumpers must be provided on their adjacent ends or on one end of one crane. Fit the other end of the end-truck with a structural steel stop to engage the bumpers of the adjacent crane. Ensure bridge bumpers are properly aligned with runway end stops. Metal to metal contact at the bumper to end stop connection is not permitted.

[2.2.6 Crane Runway System

****

NOTE: For under running cranes, the runway and its support structure is usually supplied by the crane contractor. Use Crane Runway System only if crane contractor is to provide a new runway.

In general, the top running runway rail is outside the scope of this specification as it is typically provided by the facility. The crane must be designed to operate on a rail that meets CMAA 70 alignment criteria.

****

****

NOTE: For top running cranes, bridge end stops are typically provided by the facility and not the crane contractor. The crane contractor does supply end stops for under running cranes, since they typically supply the runway and its support structure.

****

a. Provide the complete runway track suspension system that is required to hang the crane runway track at its indicated location from the structural supports indicated on the drawings. Provide runway and support structure for under running crane of rolled steel shapes conforming to CMAA 74 or patented track girders conforming to MHI MH27.1.

b. For rolled steel shapes, locate splices under structural support members.

c. For patented track girders, perform splices as necessary in accordance with the manufacturer's recommendations and requirements. Align ends of lower T-section to minimize the horizontal gap on the running surface to not greater than 1.5 mm 1/16 inch and not greater than a vertical difference of 0.75 mm 1/32 inch for the wheel running surface alignment for a smooth crossing by the wheels. Splice assemblies must be from the same manufacturer as the patented track and located under structural support members. When runways are suspended, bracing preventing damaging lateral or longitudinal movement is required. Loads transmitted to the building through the suspension must have the review and approval of the building engineer of record (EOR) prior to installation. Submit manufacturer's standard published tables that verify the crane runway track is sized in compliance with all specification requirements. When standard published tables are not available, provide calculations for the strength design and deflection of the beams.

d. Runway support structure must be designed, fabricated, and installed such that runway rails meet the alignment tolerances of CMAA 74 or MHI MH27.1, as applicable. Provide means to allow for vertical adjustment of the runway track both before and after the system has been put in operation so that track can be erected and maintained level. Brace runway to restrain the track against damaging lateral and longitudinal movements. Where the runway track is suspended from hanger rods, provide means preventing the hanger rod nuts from backing off the rods. Allowable stress in hanger rods is 20 percent of the minimum specified ultimate strength of the material used.

e. For under running crane runways, design, fabricate, and install new runway end stops in accordance with ASME B30.17 and CMAA 74 or MHI MH27.1, as applicable. End stops must be designed to absorb the maximum kinetic energy and impact force developed by the bumper contact. Provide end stops compatible with end truck bumpers, designed to bolt to the runway support girders, and maximize bridge travel.

][2.2.7 Seismic Forces

****

NOTE: Seismic forces for under running cranes with under running trolley where the trolley is free to swing on the girder (i.e., single girder) are typically considered negligible. If not considered negligible, include the analysis section below. Seismic forces must be considered in the design of the cranes with a component importance factor of greater than 1.0 and in facilities with a Seismic Design Category of D, E, or F per ASCE 7.

Coordinate selection with paragraph DESIGN DATA: LOAD AND SIZING CALCULATIONS

****

Perform a seismic analysis as a part of the design of the crane in accordance with ASCE 7-16. The seismic analysis must be included in the CMAA 74 or MHI MH27.1 extraordinary load case (Case 3), as applicable.

For project locations beyond the scope of ASCE 7-16, a widely accepted design standard may be used for seismic analysis.

][2.2.8 Additional Provisions for Outside Service

****

NOTE: This paragraph is applicable for outdoor cranes only. See also TRAVEL DRIVES and TRAVEL BRAKES.

****

Seal weld structural members on outdoor cranes. Design members to prevent the collection of water on the crane. Provide a means to secure the crane against a wind pressure of 1.44 kPa 30 psf in accordance with ASME B30.17.

]2.3 MECHANICAL REQUIREMENTS

****

NOTE: For ordnance handling, further material restrictions exist.

****

a. Provide steel shafts, gears, and keys, with the exception of worm gears which may be bronze. No three or more bearing shaft configurations are allowed.

b. Cast iron and aluminum used to support components of the hoist power transmission train must be ductile. For the purposes of this specification, "ductile" is defined as having a minimum elongation of 5 percent in 2.00 inches. Gray cast iron load bearing parts are prohibited. Provide hoist speed reducer housings that are steel or ductile/malleable cast iron and hoist electric motor housings that are steel or ductile/malleable cast iron or cast aluminum.

c. Provide steel or ductile/malleable cast iron brake housings of motor mounted disc brakes, brake lining backing plates, shoes and shoe holders. Provide spring-set brake shoe or pad linings of a non-asbestos material.

d. All mechanical components must be accurately aligned and positively secured to maintain the alignment. Parts must not be forced into position to obtain apparent alignment.

e. Provide minimum bearing life in accordance with ASME hoist performance standards and MHI MH27.1 or CMAA 74, as applicable.

f. All "should" statements in CMAA 74, MHI MH27.1, and ASME B30 are considered to be "must" statements.

2.3.1 Threaded Fasteners

Fasten mechanical connections that are not part of a commercial packaged assembly with SAE J429 Grade 5 fasteners, ASTM F436/F436M washers, and SAE J995 Grade 5 nuts. Lubricate all mechanical fasteners unless otherwise specified by the original component manufacturer.

2.3.2 Hoist

****

NOTE: Generally, hoist duty class roughly aligns with CMAA class. An H3 hoist service duty class would typically be specified for a CMAA 74 service class C crane; H4 for service class D. See paragraph CRANE DESIGN CRITERIA, sub-paragraph CLASSIFICATION to identify the CMAA service duty class specified for this crane.

Selecting either electric chain hoists (ASME HST-1) and wire rope hoists (ASME HST-4) is not straight forward or consistent across all scenarios. Generally recommend electric chain hoists for lower lift heights (less than 6 meters 20 feet or lower capacities 4500 kilograms 10,000 pounds. Electric chain hoists only have the possibility of hoist duty

classes H2, H3, or H4.

For ordnance handling, CMAA class D is required and packaged hoists must be Duty Class H4 or better; generally recommend the use of chain hoists (ASME HST-1), if practical.

****

Provide hoist conforming to ASME B30.16, except as modified and supplemented in this section. Packaged hoist and trolley units (packaged hoists) must be [electric chain hoist conforming to ASME HST-1] [double reeved electric wire rope hoist conforming to ASME HST-4] Duty Class [H3] [H4] [H1] [H2]or better and be rated for the operating environment.

Configure trolley such that the trolley frame contacts the trolley stops and prevents the trolley from dropping more than one inch in the event of an axle or wheel failure. Provide drop (safety) stops with contact surfaces of non-sparking materials. Metal to metal contact at the bumper to end stop connection is not permitted.

2.3.2.1 Hoist Brakes

****

NOTE: Each hoist must have, at a minimum, two brakes. For packaged hoists, the most common brake configuration is one electro-mechanical spring set brake and one mechanical load brake (or self-locking worm gear).

Consider the CONTROLS paragraph under ELECTRICAL REQUIREMENTS.

If a variable frequency drive (VFD) is selected for use, the brake configuration must reflect the type of VFD selected (open loop). If open loop controls are selected, brake configuration must be one electro-mechanical brake and one mechanical load brake (or self-locking worm gear).

If not using a VFD, and electromatic controls are selected, the brake configuration must still be one electro-mechanical brake and one mechanical load brake (or self-locking worm gear).

Additional tailoring options are provided for NAVFAC cranes.

****

a. Equip the hoist with two holding brakes, each with a minimum torque rating of 125 percent of the rated load hoisting torque. Provide a brake configuration with one electro-mechanical spring set brake and one mechanical load brake, or self-locking worm gear, that stops and holds 125 percent of the hoist's rated load and does not require the load to be raised before being lowered.

b. Electro-mechanical brakes must have an externally accessible means of manual release. Provide manual-adjusting brakes designed to permit inspection and adjustment without disassembly of the brake. The brakes must be equipped with a manual self-return to ON brake release;

maintained brake releases must reset when power is applied. Double face-mounted brakes are not permitted.

2.3.2.2 Load Block and Hook

****

NOTE: Some text tailored to NAVFAC.

For text tailored to Minimum Anti-Spark requirements, remove conflicting requirements (i.e., load block cannot simultaneously be steel and anti-sparking or steel hook meeting ASTM A668 cannot also be non-sparking).

****

****

NOTE: Where space permits, the NAVY prefers forged carbon steel hooks due to NDT periodicity requirements, however that option is not mandated.

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NOTE: In list item 'a.', select the load block option for sheaves and wire ropes for wire rope hoists and or chain hoists select the load block option for load chains.

List item 'c.', requirements for an integrated insulated link, is tailored to ordnance handling as that is the most likely scenario in which this component will be added to protect the load against the flow of electrical energy.

****

****

NOTE: For Ordnance Handling, the crane may need to be outfitted with an insulated link. If possible, the more flexible (and cheaper) option is to use an insulated link with the rigging gear (per NAVFAC P-307) when needed for specific lifts. However, an integrated insulated link may be necessary in the load block. Insulated links integrated with the load block are not common. For ordnance handling cranes, integral insulated links are more likely for OUTDOOR applications.

Insulated links must be provided to prevent the flow of electricity from radio frequency (RF) energy from traveling through the wire ropes and metal hook to the item being lifted in accordance with NAVSEA OP 5 Volume 1, Section 10-6.1, unless the following conditions are met:
1. There is no threat of a lightning strike during operations;
2. RF emissions control is in effect regardless of the HERO classifications of the ordnance being handled.

****

a. Provide a load block constructed of steel. Provide a load block constructed of non-sparking materials. Covering the exposed surfaces of the load block with bronze, stainless steel, or aluminum covers attached with similar fasteners is acceptable. The load block must be designed to prevent metal-to-metal contact of moving parts.[The block must be fully enclosed, concealing the sheaves and wire ropes, except for wire rope slots and drain holes. The design must preclude the wire rope from being cut, pinched, crushed, or chafed in case of two-blocking.][The design must preclude the load chain from being cut, pinched, crushed, or chafed in case of two-blocking. Provide sprockets constructed of non-sparking metals in the load block.] Standard commercial blocks may be used at their published ratings when their published design factors are 5.0 or greater.

b. Provide an unpainted and unplated forged [carbon] steel single barbed hook with a minimum material longitudinal elongation of 16 percent in 2 inches. Provide an unpainted and unplated single barbed hook of non-sparking material. Bronze clad hooks are prohibited. Hooks must conform to the requirements of ASME B30.10. The hook must be a standard commercial product with a published design factor of 5.0 or greater. Fit hook with a safety latch designed to preclude inadvertent displacement of slings from the hook saddle. The hook and hook nut must be removable without unreeving of the hoist. Provide hook nut secured to the hook with a commercial standard removable and reusable means. Do not weld hook nut. When provided, provide shank and nut threads with a Class 1 or 2 fit, per ASME B1.1. Uniquely mark the hook in a permanent fashion that is traceable to the NDT certification. The nut must be marked to match the hook. The hook nut must be of non-sparking materials. Hook must be free to rotate through 360 degrees when supporting the test load up to 125 percent of the rated capacity. Upper hooks of hook suspended hoists must be of non-sparking materials.

[c. Provide an insulated lifting link that is integrated with the load block and hook to prevent the flow of electrical energy to the lifted load.

(1) The insulated link must conform with ASTM F2973 and be designed with a minimum safety factor of five times the rated hook load.

(2) Each insulated link must be legibly and permanently marked with its safe working load in pounds.

(3) Provide each insulated link with a unique, legible, and permanent identification mark traceable back to its base tram measurement and nondestructive test (NDT).

(4) Establish tram points across the dielectric structure of the link. Tram reading must be recorded before and after the insulated link proof test. The link will be rejected if the difference in measurement exceeds the base tram measurement by more than one percent. Provide copy of insulated link proof test and NDT.

(5) Cover exposed metal portions of the insulated link with a non-sparking material, such as neoprene or polyurethane.

]2.3.2.3 [Hoisting Rope] [Hoisting Chain]

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NOTE: Items a and b apply to wire rope and are for wire rope hoists only. In the hoist section, the appropriate packaged hoist must be chosen (ASME HST-4). If a wire rope hoist is chosen, item c (hoisting chain) must be removed from the specification. There is a tailored paragraph b option for wire rope in minimum hazardous areas; if selected, the standard item b wording must be removed.

Item c is optional and only applies to chain hoists. In the hoist section, the appropriate packaged hoist must be chosen (ASME HST-1). If a chain hoist is chosen, paragraphs a and b must be removed from the specification.

****

****

NOTE: For minimum anti-spark protection, add tailored paragraph section for stainless steel wire rope or chain. If stainless steel wire rope is required, remove entire conflicting paragraph requiring improved, extra improved, or extra-extra improved plow steel.

****

****

NOTE: A solid non-sparking wire rope (e.g., stainless steel) is the preference for hazardous areas.

There are some packaged hoist and capacity combinations (e.g., 5 ton capacity) in which the published stainless steel wire rope breaking strength for the given rope diameter cannot meet the prescribed design factors per ASME B30.16. In those instances an alternative wire rope material is necessary. Drawn galvanized wire rope is acceptable in Division 2 hazardous areas provided the crane, hoist, or wire rope OEM provide a notification to the end user with the wire rope certification / submittal. This notification will identify that the wire rope is made of drawn galvanized steel, meaning it is manufactured from sparking materials but provided with a spark resistant outer layer. The outer layer or individual wire strands could become compromised if the wire rope is used in an improper manner or inadequately maintained, which would affect the integrity of the spark-resistant protection.

****

[a. Wire rope must comply with ASME B30.30 and FS RR-W-410, ASTM A1023/A1023M, or BS ISO 4309 and have a rope classification appropriate for the usage. Wire ropes must be handled and seized in accordance with ASME B30.30. The wire rope must be in a double reeved configuration equalized with a sheave. Select wire rope minimum design factor in accordance with ASME B30.16. Provide proof of Wire Rope breaking force.

b. Provide hoist wire ropes with improved, extra-improved, or extra-extra-improved plow steel (or appropriate ISO grades), pre-formed, regular lay, bright, and uncoated, with an independent wire rope, wire strand, or otherwise, steel core. Hot-dipped galvanized wire rope is not permitted.

c. Wire rope must be spark resistant. Provide stainless steel hoist ropes with an independent wire rope, wire strand, or otherwise, steel core.[Drawn galvanized wire rope is acceptable in Division 2 hazardous areas when provided with a drawn galvanized wire rope end user notification.]

][d. Provide a welded link load chain suitable for powered hoist service with no less than a 5.0 to 1 design factor based on the minimum breaking force of the chain. Provide stainless steel load chain. The chain must be pitched and sized to pass over load sprockets without binding. Provide an equalizing method when the load is supported by more than one part of load chain. Provide the chain with a chain stop or dead end connection to prevent the load chain from running out of the hoist at its fully extended position. Provide chain hoists with 3 m 10 foot lift or more with a load chain bucket.

][2.3.2.4 Drum

****

NOTE: The DRUM and SHEAVE paragraphs apply to wire rope hoists (ASME HST-4). Remove DRUM and SHEAVE paragraphs for chain hoists (ASME HST-1).

****

Provide grooved drum made of steel. Design drum in accordance with ASME B30.16. All hoisting rope is to be wound in a single layer and provided with no less than two dead wraps of hoisting rope remaining at each anchorage when the hook is in its extreme low position.

2.3.2.5 Sheaves

****

NOTE: The DRUM and SHEAVE paragraphs apply to wire rope hoists (ASME HST-4). Remove DRUM and SHEAVE paragraphs for chain hoists (ASME HST-1).

****

****

NOTE: Tailoring option for minimum hazardous to provide sheaves of non-sparking metals in the load block. Steel sheaves in the upper nest may still be provided.

****

Provide steel sheaves. Provide sheaves constructed of non-sparking metals in the load block. Size sheaves in accordance with ASME B30.16 for the minimum pitch diameters of running and equalizer sheaves.

]2.3.3 Travel Drives

****

NOTE: Outdoor tailoring option for cranes to have half of the total wheels driven in order to provide adequate holding capability against non-operating wind loads without providing additional wind tie-downs. See also paragraph TRAVEL BRAKES

****

Provide under running travel assemblies with a minimum of one driven wheel on each side of the web and at least one quarter of all wheels driven.

The travel drive arrangement must consist of motor(s) driving through self-contained gear reduction units located at each driven wheel assembly. Gear reducers must be fully enclosed in an oil-tight housing and provided with a convenient means of lubricant level indication and draining. Open-type gearing is not acceptable, except for final drives. Outdoor cranes must have half of the total wheels driven.

2.3.3.1 Trolley Drives

****

NOTE: Trolley limit switches are an optional safety device.

Trolley travel limit switches are used to prevent the crane trolley from contacting the travel end stops at high speed should the crane operator mistakenly forget to slow down. If selected, ensure the appropriate options are chosen in the ELECTRICAL REQUIREMENTS, Limit Switches section.

****

Provide a motor-driven trolley arrangement. Acceleration and deceleration must meet the requirements specified in CMAA 70.[Provide trolley travel limit switches].

2.3.3.2 Bridge Drives

****

NOTE: Bridge limit switches are an optional safety device.

Bridge travel limit switches are used to prevent the crane bridge from contacting the travel end stops at high speed should the crane operator mistakenly forget to slow down. If selected, ensure the appropriate options are chosen in the ELECTRICAL REQUIREMENTS, Limit Switches section.

****

Provide a motor-driven bridge arrangement. Acceleration and deceleration must meet the requirements specified in CMAA 74.[Provide bridge travel limit switches].

2.3.3.2.1 Bridge Travel Gearing

Gearing must conform to ANSI/AGMA 2001 and AGMA 908, with internal and external gear dimensional tolerances conforming to the applicable AGMA standard for tooth geometry and tolerances.

2.3.3.2.1.1 Bridge Travel Reducer

Gear reducers must be standard commercial products designed, manufactured, and rated in accordance with ANSI/AGMA 6013. Provide cranes with a CMAA service class "C" or higher with the corresponding "Industrial Duty" service factors. The speed reducer input (high speed) gear set must use helical (including double helical and herringbone), spiral bevel, or worm gear tooth forms. Provide torque arms that are not of the threaded rod type. Operation must be smooth and quiet.

2.3.3.2.1.2 Bridge Open Gearing

Provide all gears and pinions with adequate strength and durability for the crane service class and manufactured to ANSI/AGMA 2015-1 Accuracy Grade A8 or better. Wherever feasible, open gears must be enclosed with safety guards provided with openings with covers for inspection and access for grease lubrication.

2.3.4 Travel Brakes

****

NOTE: NAVFAC tailoring option for additional travel brake requirements.

Outdoor tailoring option for parking brake requirements. Parking brakes are one of the methods that can technically be used to secure outdoor cranes against high winds, however the requirements of TRAVEL DRIVES pushes the crane manufacturer in this direction. Another option chosen by the crane manufacturer could be rail clamps/anchors.

****

Provide travel drives with an end-mounted electro-mechanical spring set brake conforming to the requirements of CMAA 74 or non-freecoasting mechanical drive capable of stopping the motion of the travel function within a distance in meters feet equal to 10 percent of the full load speed in meters feet per minute when traveling at full speed with a full load. Parking brakes used to secure outdoor bridge cranes in accordance with ASME B30.17 must be sized to secure against a wind pressure of 1.44 kPa 30 psf.

Spring set brakes must be provided with an externally accessible means to manually release the brake. Provide manual-adjusting brakes designed to permit inspection and adjustment without disassembly of the brake. The brakes must be equipped with a manual self-return to ON brake release; maintained brake releases must reset when power is applied. Double face-mounted brakes are not permitted.

2.3.4.1 Trolley Brake

****

NOTE: NAVFAC tailoring option to require electro-mechanical brakes be end-mounted.

****

Provide brakes for underrunning trolleys/carriers sized in accordance with ASME B30.17, but not sized larger than 150 percent of the drive motor rated torque.

2.3.4.2 Bridge Brake

****

NOTE: NAVFAC tailoring option to require electro-mechanical brakes be end-mounted.

****

Provide brakes with a minimum torque rating per CMAA 74 according to the applicable environment, but not sized larger than 150 percent of the drive motor rated torque.

2.3.5 Wheels

****

NOTE: Wheels are typically steel for top running and steel or ductile cast iron for under running.

a. For ordnance handling, underhung wheels must be forged steel.

b. For hazardous areas requirement maximum anti-spark protection, wheels must be made of non-sparking material (e.g., bronze or stainless steel). Remove any conflicting items (i.e., wheels cannot be non-sparking and steel).

c. EXCEPTION: For ordnance handling cranes that also happen to require maximum anti-spark protection, the anti-spark protection is the controlling factor and wheels must be made of non-sparking material (e.g., bronze or stainless steel).

****

a. Top running wheels are to be straight tread, double flanged, and sized in accordance with CMAA 74 recommendations for wheel sizing and flange to rail head clearances. Wheel material must be forged steel. Provide wheels made from non-sparking material. Bronze wheels must have a minimum tread hardness of 225 BHN. Hollow stamped and gray cast iron wheels may not be used; the use of plate steel is prohibited. Provide steel wheels with a minimum tread hardness of 320 BHN.

b. Provide under running wheel sizing and flange-to-rail head clearances in accordance with MHI MH27.1 and CMAA 74 recommendations, as applicable. The wheels must be compatible with their respective runway profile. Wheel material is to be cast or forged steel, or ductile or malleable cast iron. Wheels are to be made of forged steel. Provide wheels of non-sparking material. Bronze wheels must have sufficient size and hardness to withstand the intended loading and use. Hollow stamped and gray cast iron wheels may not be used; the use of plate steel is prohibited. Minimum tread hardness for underhung wheels (non-bronze) that run on patented track is 375 BHN. Minimum tread hardness for wheels (non-bronze) running on structural shapes is 320 BHN.

[2.3.6 Drip Pans

****

NOTE: Drip pans may also be added for GPS or any other type of crane service if there is an additional requirement to prevent lubrication from falling to the floor or lifted load. Any portion of this section may be used to support the request of the Activity. Not recommended for outdoor service.

List items a. and b. are generic drip pan requirements for inclusion beneath gearboxes. List item c is less likely to be needed.

****

a. The crane must be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment or components, which cannot be made leak-proof, must be fitted with unpainted corrosion resistant steel drip pans or must have the foundations seal welded to create a dam. Drip pans that utilize liquid sealant to prevent leakage of lubricants are not permitted.

b. The drip pans must be sized to hold the entire gear case fluid capacity, installed under all drive machinery, designed to permit easy removal of collected lubricant. A trolley floor designed to contain any lubricant drips may be used as fluid containment for any equipment that is mounted on it.

c. Provide drip pans fitted around the shank of the hook and extending outward to encompass all possible points of lubrication drips from the load block. The drip pans must be easily removable without disassembly of the hook or load block and cannot interfere with the crane structure during testing of the upper limits.

]2.4 ELECTRICAL REQUIREMENTS

****

NOTE: List item d., the voltage selected (e.g., 480) must match that provided for the crane in CLASSIFICATION.

****

a. The design, selection, rating, and installation of the electrical portions of the crane and its accessories must conform to the requirements of NEMA ICS 3,NEMA ICS 8, the applicable ASME HST standard, and NFPA 70, and other requirements specified herein.

b. All electrical components must be industrial grade, commercially available and comply with established national or internationally recognized approving organizations such as Underwriters Laboratories (UL) and Canadian Standards Association (CSA). All electrical components installed or operated in hazardous areas including but not limited to enclosures, junction boxes, disconnects, pendant controller, and electrification must be designed and rated for the NFPA 70 Hazardous Classifications specified in the paragraph CLASSIFICATION.

c. All electrical components must be located so they are easily accessible for inspection and maintenance without removing other parts, doors, or door center posts. Electrical equipment and panel wiring must be installed in a neat and workmanlike manner in accordance with Electrical Construction Standard NECA NEIS 1. Each motion of the crane must be provided with a separate control system or drive. The loss of any one function must not prevent the operation of other unaffected functions. Two independent relays, contactors, drive inputs, or other equivalent components/logic must be utilized for each function to provide directional control such that the failure of a single relay/contactor/component cannot result in motion in an unintended direction.

d. Disconnecting means for cranes must be in accordance with NFPA 70 Article 610.32. A permanent placard must be installed on the face of the main line disconnect that states "WARNING – THIS DOES NOT ISOLATE POWER TO LIGHTING, RECEPTACLES, AND ANCILLARY EQUIPMENT". Additionally, a lighting (ancillary equipment) disconnect must be provided, with lockout feature, as the isolation means for the lighting transformer and lighting circuit breaker panel, which must power the crane's ancillary equipment. It must feed [_____] VAC to the primary side of the transformer directly from the runway conductors via tapping the line side of the main power disconnect. Provide individual disconnects, with lockout feature, capable of being locked in the open position for bridge lights and receptacles.

e. Unless otherwise specified, interconnecting wiring must be of copper stranded construction complying with Table 310.104(A) of NFPA 70. Interconnecting wiring containing asbestos in the insulation or outer covering are prohibited. Aluminum conductors must not be used. Aluminum connectors are allowed if they are rated for use with copper conductors (marked "AL/CU"). All conductors connected to or routed above resistors must have insulation shown in NFPA 70 Table 610.14(a) for 125 degrees C 257 degrees F. For packaged hoists and hoist/trolleys, provide wiring sizes in accordance with NFPA 70 Table 610.14(a). Motor branch circuit conductors not part of a packaged hoist and hoist/trolley must be sized as to have an ampacity not less than 150 percent of the motor full load current rating and to be no smaller than 12 AWG. Conductors must be selected and de-rated based on maximum ambient temperature. Continuous loads such as utility, heating, lighting, and air conditioning must be multiplied by 2.25 to determine ampacity in order to permit application of NFPA 70 610.14 (A) for crane supply conductors. Wire-nuts are not permitted on splices. However, connections for lighting ballasts may be made using wire-nuts (if applicable).

f. Excluding conduit directly connected to dynamic breaking resistors, raceways must maintain a 12-inch clearance between the raceway and dynamic braking resistors. A separate grounding wire, sized in accordance with Section 250.122 of NFPA 70, must be routed with all ungrounded conductors. Only one equipment grounding conductor must be run in each conduit and be the largest size required for any circuit routed in that conduit. All wiring must be numbered or tagged at all connection points. Power conductors which are shielded such that their wire size cannot be easily determined must be labeled as to the conductor size. All unused conduit openings must be plugged.

g. When fiber optic cable is utilized, inspections and performance checks must be accomplished upon completion of on-site installation to ensure cable cleanliness and proper signal integrity. Testing and verification must be conducted by a knowledgeable fiber optics technician using specialized, calibrated equipment. Cables must be tested for signal loss/attenuation. The fiber optic system must also be tested using an Optical Time Domain Reflectometer (OTDR). Final attenuation and OTDR readings from each fiber optic cable run, including spares, must be documented as a baseline for future reference. All spare fiber optic cables must have protective covers over their ends to maintain cleanliness while not in use. When fiber optic cable is utilized the drive OEM's recommendations for encoders and optical to digital converters must be followed. All system components utilized for this purpose must have known compatibility prior to integration.

h. Power cables and low voltage signal cables may not be mixed in the same conduit.

i. The crane manufacturer must furnish and install all electrical equipment on the crane conforming to NEMA ICS 6, including motors, conforming to NEMA MG 1, electrically released brakes, switches, crane controllers, panels, operating station, wiring system, cables, and crane electrification.

2.4.1 Motors

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NOTE: Inverter duty motors are required for open loop variable frequency drives (VFD).

Select two speed motors for bridge and trolley drives if magnetic controls are specified in paragraph CONTROLS; select single speed motors if electronic controls are specified in paragraph CONTROLS.

U.S. Navy allows only 60-minute duty rating motors. 30-minute duty rating motors require Navy Crane Center approval. For non-Navy applications, the motor duty rating may be selected to match what is required by the class of HST-1 or HST-4 hoist (such as H1, H2, H3) specified.

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Motors must meet all applicable requirements of NEMA MG 1 and UL 1004-1. Use CMAA 70 calculations for motor horsepower in selecting bridge, trolley, and hoist drive motors. All motors must have a minimum of a [60] [30] [_____] minute duty rating and be Totally Enclosed Non Ventilated (TENV), Totally Enclosed Fan Cooled (TEFC), or Totally Enclosed Blower Cooled (TEBC).[Provide [two] [single] speed AC squirrel cage induction type motors for the bridge and trolley drives.] [Provide two speed, AC squirrel cage induction type motor for the hoist.][Provide inverter duty motors for Open Loop Variable Frequency Drives (VFD).] Provide motors with a minimum of Class F insulation. Provide motor overload protection utilizing a thermal sensitive device embedded in its windings. Provide motors painted to manufacturer's standard for "wash-down" service. Motors located outdoors must be furnished with anti-condensation heaters that remain energized when the mainline contactor is deenergized.

2.4.2 Controls

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NOTE: If one or two speed point controls are

required, recommend magnetic controls. If three or more speed points or infinitely variable speed adjustment is needed, Variable Frequency Drive (VFD) controls are required.

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NOTE: Use the first two paragraphs to select one or two speed control for the hoist, bridge, or trolley. Selections can be made using a combination of electronic controls and one or two speed motor controls for the various functions. Use the third, fourth, and fifth paragraphs to select electronic variable frequency drive controls for either the hoist, bridge or trolley. With VFD controls the hoist must be configured as open loop. Open loop is more cost effective and requires a mechanical load brake (or self-locking worm gear). Ensure the Hoist Brakes section of this specification reflect the type of controls chosen.

When the two-speed bridge and trolley motor is specified, the slow speed will be 1/3 to 1/4 of rated travel speed. Reduced voltage starting, acceleration, and deceleration, serve to reduce the acceleration rate that is normal for squirrel-cage motors. Squirrel-cage motors with two-speed magnetic controls provide satisfactory results with slow bridge and trolley speeds, and should be specified when short travel distances are involved and where fine positioning is not required.

For faster bridge and trolley speeds or finer positioning requirements, specify electronic controls.

Various VFD manufacturers offer an option to overspeed the hoist to a value over 60Hz (usually 120Hz). This allows the operator to position the hoist at faster speeds when it is not loaded. When selecting this feature list the maximum no load speed in paragraph RATED CAPACITY AND SPEEDS.

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NOTE: The final paragraph for hoist brake bypass keyswitch is optional for hoists with one electro-mechanical spring set brake and one mechanical load brake. Choose this option if the Activity wants the functionality; the intent for this keyswitch is to allow for easier load testing of all hoist brakes while the crane is installed by bypassing the primary electro-mechanical brake for independent testing of the mechanical load brake.

****

[a. Provide [one] [two]-speed magnetic controls for the [bridge drive][,] [trolley drive][,] [and] [hoist] drive. Controllers must meet the requirements of NEMA ICS 8. Ensure that an energized drive motor initially rotates only in the direction selected by the operator by activating the corresponding direction; i.e., is not overhauled. For AC squirrel cage motor controllers, the requirements of NEMA ICS 2, Part 2, for general-purpose controllers, must be met.

[b. Provide the bridge and trolley motor control systems with a drift point between OFF and the first speed control point in each direction.

]]c. Provide static reversing, variable frequency drives (VFD) for the [bridge,] [trolley] [and] [hoist] electric controls.[Provide static reversing, VFD, speed regulated, closed loop, flux vector electric controls for the hoist[s]. For feedback, provide hoist motors with encoders. The hoist controller must enable the drive motor to develop full torque continuously at zero speed. The hoist secondary brake must be controlled separate from the primary and connected to different output (within the drive) from the primary brake.] VFD controllers must meet NEMA ICS 8, Part 8 and at a minimum, provide under-voltage protection, electronic instantaneous over current protection, DC bus over voltage protection, and be able to withstand output line to line shorts without component failure. Select bridge and trolley drives such that the continuous rating of the controller is not less than the calculated motor full load current based on CMAA 70 paragraph 5.2.9.1.1.1 and NFPA 70 Table 430.250. Select hoist drives such that the continuous rating of the controller is not less than 125 percent of the calculated motor full load current based on CMAA 70 paragraph 5.2.9.1.1.1 and NFPA 70 Table 430.250. All hoist drives must have a motor over-torque limit to lock out the hoist and prevent gross overload of the associated hoist. Provide dynamic braking for each electric drive that is sized per VFD manufacturer's requirements. Submit VFD Control Parameter Settings.

d. Provide speed control which is infinitely variable for each function, controlled via [radio control system] [and] [pendant pushbutton station].[Provide controls designed such that the maximum speed of each function will be limited to 25 percent of rated speed when a slow speed switch is actuated on the controller[s].[Energize a yellow/amber light/indicator while in slow speed mode.]]

e. The [hoist][,] [trolley][,] and [bridge] brakes must set after the associated controller decelerates the drive motor to a controlled stop. The hoist, trolley, and bridge, controllers must be sized to provide sufficient starting torque to initiate motion of that crane drive mechanism from standstill with 0 to 125 percent of rated load on the hook. The hoist controller must prove torque before release of the brakes and enable the drive motor to develop full torque continuously at zero speed. Motors must operate smoothly at all speeds without torque pulsations and must only be energized within the frequency range of 50-60 Hz at rated speed.[The hoist control system may utilize overspeed up to 120hz, unloaded only, if the drivetrain equipment has all been balanced and is rated for the resulting speed.]

] f. The use of definite purpose contactors is prohibited. If IEC contactors are used, the application cannot exceed the contactor manufacturer's AC3 ratings for the contactor at a minimum.

g. On hoist function roll-up must be less than 1/8 inch measured at the hook block and roll-back must not occur over the entire load range.

h. Use of Uninterruptible Power Supplies (UPS) is prohibited. Feed control circuits from a single phase, air cooled, double wound transformer with a grounded metal screen between the primary and secondary windings of the transformer.

i. Provide a main line contactor. Energization of the main line contactor must be controlled by the POWER-OFF/POWER-ON switch/pushbutton on all controllers. Upon actuation of the POWER-OFF pushbutton; power to all drive motors, brakes, and controls must be removed. The mainline contactor must not be able to be energize while the POWER-OFF pushbutton is actuated. The POWER-OFF pushbutton circuitry must be independent of all controls or any other electronic devices.

[j. Provide a spring returned brake bypass keyswitch for each hoist. The switch allows for actuation of the electro-mechanical brake for independent testing of the mechanical load brake. The normal position allows both brakes to work in their normal operating configuration. Label the keyswitch positions as "NORMAL" and "LOAD BRAKE TEST".

]2.4.3 Protection

Protection must not be less than that required by NEMA ICS 3, NEMA ICS 8, CMAA 74, NFPA 70, UL 1004-1, UL 943, 29 CFR 1910.147, 29 CFR 1910.179, 29 CFR 1910.306 and all applicable provisions of 29 CFR 1910. All protection must be by circuit breakers or fuses. Provide a disconnect switch or enclosed type circuit breaker readily accessible to the crane operator for the crane disconnect. Motor branch circuits must be individually protected by inverse time circuit breakers capable of being locked in the open position. The means for locking must remain in place with or without the lock installed. Motor full load current from NFPA 70 Article 430, Part XIV (Tables) must be used to calculate the circuit breaker size.

Provide disconnecting means on the crane in accordance with NFPA 70 Article 610.32. Provide for lockout/tagout of all hazardous energy sources. Provide product data for all circuit breakers and fuses.

2.4.3.1 Conductors

a. The crane contractor is responsible for ensuring that all conductors from the load side of the existing floor level disconnect to the motor branch circuits have adequate overcurrent protection complying with one of the following:

   (1) Not be greater than the largest rating or setting of any branch circuit protective device plus the sum of the nameplate rating of all other loads per NFPA 70 Article 610.41(A).

   (2) Not be greater than the ampacity of all feeder conductors after all ampacity correction factors have been applied.

b. Conductors for brake coils must be protected by fuses or other protective devices. The device must be chosen to protect the brake circuit conductors from ground faults or short circuits.

2.4.4 Resistors

Provide resistors with natural convection cooling sized as recommended by the VFD OEM and fabricated of corrosion resistant metal; the use of "wire wound" type resistors is prohibited for segments of 8 ohms or less. Mount resistors in substantial, ventilated enclosures constructed entirely of non-combustible materials. When mounted outdoors provide stainless steel resistor enclosures. Provide resistors with terminals fitted in the coolest position in the enclosure.

[2.4.5 Transients and Harmonics Protection

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NOTE: The following items are required only for VFD Controls.

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a. Provide contactors and relays with appropriate Metal Oxide Varistors (MOV) or resistor-capacitor (R-C) surge absorbers installed across the respective coil.

b. Provide transient protection for electronic drive controllers that is either internal to the drive or via an MOV connected line-to-ground close to the line terminals of the drive.

c. Provide line reactors rated for continuous duty operation based upon the motor nameplate amperes. With motors of 50 horsepower or greater, harmonics protection must be provided by an isolations transformer or as recommended by the VFD OEM. For a drive motor branch circuit that exceeds 150 feet in length, a reactor must also be connected in series with the controller load (output) terminals to provide standing wave protection or as otherwise recommended by the VFD or motor OEM.

]2.4.6 Limit Switches

a. Provide primary upper and lower geared limit switches. Geared limits must allow reversing direction to back out of the limit without resetting. The lower limit switch must be set such that there are a minimum of two wraps of rope on the hoist drum.

b. Provide a backup mechanical hook block activated upper limit switch wired independent of the directional controllers and the primary upper limit switch that removes power from the hoist motor, hoist brake and hoist controls conforming to NEMA ICS 5. The backup limit must require hoist resetting prior to operation of the hoist in any direction.

c. For chain hoists, the upper hoist limit switch must be wired to remove all power from the hoist drive motor and brake(s) independent of the microprocessor drive. A two-position spring-returned bypass switch must be provided that allows for resetting of the final limit switch prior to resuming operation. During resetting of the final limit, the hoist must operate in the lowering direction only.

[d. Travel limit switches must be provided for the [bridge][and][trolley] motion to slow the crane to [25 percent] [_____] of its rated speed [[10] [_____] feet before the bridge end stops][and][[5] [_____] feet from the trolley end stops]. Limit switches must be mounted rigidly in a manner so as to protect the switch from misalignment or damage. The target/trip arm must be large enough to provide interception given a misalignment were to occur.

] e. Limit switches must be rated for the NFPA 70 Hazardous Classifications specified in the CLASSIFICATION paragraph of this specification.

2.4.7 Operator Controls

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NOTE: Available operator controls are pendant, and radio control. Cranes can also be set-up to be controlled by two separate systems. For cranes with one set of controls use paragraph 1. For cranes with two sets of controls use paragraph 2. In such a case some type of interlock must exist to prevent control from both systems simultaneously.

The pendant can be suspended from the trolley or an independent festooned messenger track system. The festooned system allows the operator to have maximum separation from the load. When this is a requirement include section Pendant Conductor System section of this specification.

When specifying a radio control system, the following requirements must be considered and if needed added to the specification. None are hard requirements of NAVCRANECENINST 11450.2:
1. What type of batteries? Rechargeable?
2. Are spare batteries needed? How many?
3. Are spare remote control units required? How many?
4. Is a battery charger required?
5. Type of transmitter unit.
6. Is a belt/harness required for the remote control?

****

[a. Provide crane equipped with a[pendant pushbutton station][radio control system].

][b. Provide crane equipped with both a pendant pushbutton station and a radio control system. Provide a selector switch to allow the use of only one of the two available control stations on the pendant controller.

] c. If VFD controls are not provided, provide directional contactors with both mechanical and electrical interlocks.

d. "Operator controls must be rated NEMA Type 7 for Class I, or NEMA Type 9 for Class II according to the NFPA 70 Hazardous Classifications specified in the CLASSIFICATION paragraph of this specification."

[2.4.7.1 Pendant Pushbutton Station

The cranes must be controlled from a pendant pushbutton station suspended from [the trolley] [an independent festooned messenger track system, operating the length of the bridge]. Provide multiconductor flexible cords for pendant pushbutton stations with No. 16 AWG minimum conductors. Provide a method of strain relief to protect the electrical conductors from damage. Locate the pendant pushbutton station [1200 mm 4 feet] [_____] above the finished floor. Pushbutton pendant station must have its elements legibly marked and arranged vertically, in order, in accordance with CMAA 74.[Provide [one speed] [two speed] [3-step infinitely variable] [2-step infinitely variable] pendant pushbuttons for control of the [hoist][,] [trolley][,] [and] [bridge].] Provide pendant pushbuttons for control that spring return to the OFF position. Voltage in the pendant pushbutton station must not exceed 150 Volts AC or 300 Volts DC.[Provide a maintained two-position selector switch for slow speed selection.] The pendant must be rated for the NFPA 70 Hazardous Classifications specified in the CRANE DESIGN CRITERIA, sub- paragraph CLASSIFICATION. Provide the pendant pushbutton station with a NEMA Type 7 for Class I, hazardous environments and NEMA Type 9 for Class II, hazardous environments, as classified by NFPA 70.

[2.4.7.1.1 Pendant Conductor System

Provide a festoon type pendant conductor system. The festoon cables must be flat cables suspended from carriers riding on an I-beam or C-track. The pendant controller must be capable of traveling the entire length of the bridge and move independently of the trolley. Festoon loops must not extend below the high hook position.

][2.4.7.1.2 Radio Control System

Provide each system with a [belly box] [handheld] [______] type portable transmitter unit [and an identical back-up transmitter unit].[Provide each transmitter with an adjustable belt or harness to support it when worn by the operator]. Only one transmitter at a time can control the crane and there must be no interference from one crane's controller affecting operation of the other cranes in the building. Each transmitter must include: individual [infinitely variable spring return joystick motion control levers] [push button controls] for each hoist, trolley, and bridge; a maintained contact, keyed switch, marked ON-OFF, for portable transmitter unit power; indication of Battery Power, and indication of Transmitting Status; a red emergency STOP mushroom pushbutton;[and]a floodlight on/off pushbutton[and a maintained slow speed selector switch]. The transmitters and all controls must each be clearly and permanently labeled with functionality and direction. Directions for controllers must be in accordance with CMAA 74 recommendations. The remote radio control system must be designed to meet the requirements of NEMA ICS 8, Part 9 and ECMA 15. Each radio remote control lever must be in the OFF position before the associated crane function can begin. The system frequency must be within the unlicensed FCC Part 15 range. Each control unit must maintain a continuous status signal to the associated receiver during operation. There must be no significant loss in systems efficiency and function at the end of eight hours of continuous battery use. Provide a contact monitoring board with the crane radio system receiver.

The Contractor must submit the frequency allocation application to the National Telecommunications and Information Administration (NTIA) via EL-CID version 6.1 software found on NTIA.gov. Provide the temporary authorization, and the final approved application when available. The technical section of the application must be completed by the manufacturer of the radio control equipment being furnished under this contract. Verify frequency availability at this activity prior to design approval.

]]2.4.8 Electrification Systems

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NOTE: Various methods may be used to transfer power from the runway to the crane (Runway Conductor System) and then again to the trolley (Bridge Conductor system). Typically, the Runway Conductor

System is a set of conductor bars on the runway and collector shoes on the crane. The Bridge Conductor system is typically a set of festoon cables.

Site conditions and environment might require the design to deviate from the norm. Hazardous locations will need to be designed with either a cable reel or festoon system.

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2.4.8.1 Runway Conductor System

[a. Provide a rigid runway Conductor Bar System for the runway conductor system, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. Provide electrification system with three power conductors and an equipment grounding conductor. UV resistant. Steel (non-stainless) conductor bars are prohibited. The crane must be grounded through the runway electrification system. The grounded conductors must be a minimum of 70 square millimeters. Provide runway conductors sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. If there is any way the hook block or wire rope can swing into the runway electrification, provide a guard installed to prevent contact.

b. Provide two Collector Shoes (tandem design) for each conductor; each collector shoe must be rated for not less than the runway conductor sizing, so as to provide redundancy.

][c. Provide a Festoon System for the runway conductor system utilizing cables suspended from carriers riding on an I-beam or C-track for the crane, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. Provide electrification system with three power conductors and an equipment grounding conductor. Conductors must be fabricated from copper. The crane is required to be grounded through this conductor system. The grounded conductors must be a minimum of 2/0 AWG. Provide conductors sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. Festooned cable loops must not extend low enough to come into contact with any obstructions.

][d. Provide a Cable Reel System for the runway conductor system, including all necessary cables and hardware to connect the cable reel to the floor level fused disconnect switch. The cable reel must have three power conductors and an equipment grounding conductor. The crane is required to be grounded through this conductor system. Conductors must be fabricated from copper, and sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. The grounded conductors must be a minimum of 2/0 AWG.

][e. Provide a totally enclosed flexible cable tray electrification system (cable chain) for the runway conductor system, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. The cable chain must have three power conductors and an equipment grounding conductor. The conductors must be selected so as to be of the longest length without splices. Conductors must be fabricated from copper, and sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. The crane is required to be grounded through this conductor system. The grounded conductors must be a minimum of 2/0 AWG.

]2.4.8.2 Bridge Conductor System

[a. Provide Festoon System for the bridge conductor system utilizing cables suspended from carriers riding on an I-beam or C-track. Conductors must be fabricated from copper. A minimum of 20 percent of the festoon control circuit conductors for each electrification system must be spares at the time of crane acceptance. The trolley is required to be grounded through this conductor system. The grounded conductors must be a minimum of 2/0 AWG. Festooned cable loops must not extend low enough to come into contact with any obstructions.

][b. Provide a Cable Reel System for the bridge conductor system. The cable reel must have an equipment grounding conductor, and all necessary control cables. A minimum of 20 percent of the festoon control circuit conductors for each electrification system must be spares at the time of crane acceptance. The trolley must be grounded through the cable reel connection and all conductors must be of copper construction. The grounded conductors must be a minimum of 2/0 AWG.

][c. Provide a totally enclosed flexible cable tray electrification system (cable chain) for the bridge conductor system. The cable chain must have three power conductors, an equipment grounding conductor, and all necessary control cables. The conductors must be selected so as to be of the longest length without splices and must be copper. A minimum of 20 percent of the control circuit conductors in the flexible cable tray system must be spares at the time of crane acceptance. The trolley is required to be grounded through this conductor system. The grounded conductors must be a minimum of 2/0 AWG.

]2.4.9 Overload Protection

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NOTE: Overload protection on a crane is required and is provided by two types of systems: Capacity Overload Protection and Over-Torque Limit.

The Over-Torque Limit only applies to cranes with VFD controls. It is a parameter setting in the drive and is typically set at 150 percent of rated motor torque. Cranes with magnetic controls do not have this feature. Delete third paragraph if VFD controls are not specified.

Capacity Overload Protection is usually adjustable. If adjustable, it needs to be set at less than the crane's minimum test load; recommend setting at 100 percent of rated capacity or less. This protection can take the form of one of the following devices:

1. Clutch – Not adjustable and is common on package hoists.
2. Load Limit Switch – Installed on the wire rope and measures deflection. Does not require a break in the wire rope and is simply clamped onto the wire. Typically used on smaller hoists that have magnetic controls. Can also be installed as part of the equalizer sheave.
3. VFD Drive Overload Protection – Similar to the

Over-Torque Limit, but is set at a lower setting. Adjusted via parameters within the drive.

****

a. Provide a capacity overload protective device for all hoist systems[using VFD drive capacity overload protection (separate from torque limiting feature of the VFD)]. Set hoist capacity overload protection at [100] [_____] percent of rated capacity. Hoist capacity overload protection must be adjustable between 80 and 150 percent of hoist capacity. Provide a keyed override or other means to disable the hoist capacity overload protection when performing a load test. If a slip clutch is used as the overload limiting device, it must comply with all ASME B30.16 requirements. Provide adjustable slip clutches set at or less than the cranes maximum test load. If the slip clutch is non-adjustable, the OEM factory setting is acceptable and must be identified with the Product Data sheets and O&M manual.

[b. Initially, set the torque limiting capability of the VFD (that is separate from the capacity overload protective device) to 150 percent of the motor torque (amperage) necessary to hoist 100 percent load. It may be adjusted up only to avoid nuisance trips and adjusted down if possible while still avoiding nuisance trips.

]2.4.10 Enclosures

****

NOTE: Select classification of control panels, controls, and brakes based on the environmental conditions in which the crane will be installed:
1. Choose one of the following for an indoor installation: 1, 2, or 12.
2. Choose one of the following for an outdoor installation: 3, 4X, or 8.
3. Choose one of the following for a Class I Hazardous installation: 7 (indoor)or 8(indoor/outdoor).
4. Choose one of the following for a Class II Hazardous installation: 9 (indoor).

Other enclosure types exist that might be a better alternative for a particular installation. If necessary, refer to NEMA 250.

****

a. Provide enclosures for control panels, controls, and brakes in accordance with NEMA 250 and NEMA ICS 6, Classification Type [1 indoor, general purpose] [12 indoor without knockouts, general purpose] [2 indoor, drip-proof] [3 outdoor, dust-tight, rain-tight, sleet-resistant] [4X outdoor] [7 indoor Class I hazardous] [9 indoor Class II hazardous] [8 indoor/outdoor Class I hazardous] [_____]. Provide enclosures with listed drains to prevent accumulation of water within the enclosure. There must not be any condensation inside the control panels. If anti-condensation heaters are provided, these heaters must remain energized when the main line contactor is deenergized.

[b. Provide a non-resettable hour meter, connected across the main line contactor, readable from the exterior of the main control panel, to indicate the elapsed number of hours the crane is energized.

] c. Gaskets of enclosures and fixtures, and joints and contact surfaces of hazardous/explosive enclosures must be kept free of any paint to prevent damage during removal and reinstallation of gaskets of enclosures.

2.4.11 Warning Devices

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NOTE: A warning horn or light is required for all radio controlled cranes and recommended for all others.

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[Provide a warning horn that is operable from a push button at the [pendant pushbutton] [radio control] station.] [Provide a warning [strobe light] [rotating beacon] that is illuminated at all times during movement of the hoist, trolley, or bridge function[, but may be deactivated on the operator control station].]

[2.4.12 Floodlights

Provide evenly spaced floodlights along the bridge. Select floodlights to provide an illumination level of 40 foot-candles at three feet above the finished floor. All lights must be vibration resistant and designed to prevent any material from falling from the fixture. Switch the floodlights from the [pendant pushbutton] [radio controlled] station.

][2.4.13 Pilot Devices

Provide Indicator Lights mounted in an enclosure on the bottom of the bridge with lights sized and positioned to be visible from the ground. The lights must be the dual-lamp type. Provide a white light to indicate that power is available to the crane and a blue light to indicate that the main contactor is energized. Light voltage must be 115 VAC. Provide nameplates that are legible from ground level. The nameplates must read, in their respective order, "POWER AVAILABLE" and "CRANE ENERGIZED". The POWER AVAILABLE light must be supplied by a separate, fused transformer for its energization.

]2.4.14 Wind Speed Indicating System

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NOTE: This section is tailored to outdoor requirements, as wind speed indicating devices are required on outdoor cranes.

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Provide a wind speed indicating device in accordance with ASME B30.17, which provides a visible and audible alarm to the crane operator at a predetermined wind speed. The transmitter must be mounted on the highest unobstructed location.

[2.4.15 Electrical Outlets

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NOTE: Electrical outlets are typically provided on trolleys for maintenance purposes on double girder cranes with top running custom built-up hoists

(which typically have walkways). The addition of electrical outlets may not be a standard manufacturer option on packaged hoists and is not recommended for single girder cranes or underhung packaged hoists.
****

Provide a minimum of [one] [_____] 120 VAC duplex outlet[s] on the crane, mounted [on] [in] the [outside of the control panel(s)] [trolley] [cab] [_____]. The circuit(s) supplying receptacles must incorporate ground-fault circuit-interrupter protection for personnel and be protected by a circuit breaker with a minimum rating of [15] [20] amps.

]2.4.16 Cyber Security of Control Systems

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NOTE: Cyber Security of Control Systems requirements are tailored to NAVFAC. This subpart must be included for NAVFAC, it is not replaced by Division 25 Cybersecurity Section.
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NOTE: SECNAVINST 5400.15 designates NAVFAC as the functional technical authority for WHE. NAVFAC is designated as Functional Security Control Assessor (FSCA) and the Functional Authorizing Official (FAO) for Ashore Control Systems in their domain; therefore, this includes WHE control systems. WHE control system owners are responsible for the Information System Security Engineer (ISSE) functions and producing artifacts (documentation) for review by the FSCA and FAO.

All new and electrically overhauled cranes must implement the following cybersecurity requirements as applicable to the control system architecture (i.e., networked drives, non-networked drives, and any wireless applications) so that supporting artifacts and considerations are available for the implementation of the RMF process.
****

a. Provide the following for PLC, RTU, Supervisory Controller, or other network-capable (whether networked or not upon delivery) control devices as applicable:

    (1) Hardware list (Hardware list must include the following for each device):

        (a) Manufacturer

        (b) Model

        (c) Location

        (d) Key technical ratings (e.g., memory)

        (e) Serial number

(f) MAC addresses

(g) IP addresses

(2) Software List (Software list must include the following for each device):

(a) Manufacturer

(b) Version/subversion

(c) Location/device

(d) Used network ports/protocols/services

(3) List and discussion of all security features of Contractor hardware and software.

b. For every PLC, RTU, Supervisory Controller, or other network-capable control devices (whether networked or not upon delivery), deliver the following on CD/DVD:

(1) Original firmware

(2) Original firmware hash

(3) SOP for application of firmware updates/patches

(4) POC or website for firmware updates/patches

(5) Count of interfaces and types

(6) Protocols in use, per interface

(7) Configuration file

(8) SOP for configuration

2.4.16.1 Control System and Network

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NOTE: Select options a. & b. if a standalone laptop is required. Recommend including one laptop if the activity regularly performs all crane maintenance.

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[a. Provide one rugged laptop type workstation (computer) complete with all compatible software (including software licenses), redundant physical back-up copies on CD/DVD of the installed software, and all necessary cables and special connectors to allow crane software to be troubleshot, checked and upgraded, and for the data recorder to be accessed and information retrieved. Equip the workstation with a CD/DVD drive and the associated CD/DVD burning software. The workstation must also be equipped with USB ports (2.0 and 3.0), an Ethernet port, and a serial port. Delivering the software on a USB (flash drive) device is prohibited.

b. The laptop must be designed for an industrial environment and must be shock resistant and weatherproof as a minimum. Provide the laptop with a built-in CD/DVD reader with the capability to burn CDs and DVDs including associated software to burn CDs and DVDs.

] c. The Contractor must provide all equipment, including software and hardware, necessary for testing, installation, and communicating/troubleshooting all systems provided with the crane (e.g., engine/generator, control system, LID, etc.). The Contractor must provide all crane specific operational software files (e.g., ladder logic, functional block programming, etc.) for their associated systems (e.g., control systems, LID, engine generator, etc.).

d. A single common networked design must not be used for the control systems. A network for an individual function may be used as long as a failure of the network does not affect any other function/network except as defined for specific safety interlocks (e.g., LMI system). A common crane network may be used in a monitoring mode for recording faults and trending and is encouraged. Failure of the monitoring system must not affect crane functions.

e. All provided hardware and software must be currently marketed products, not currently scheduled for end of life or obsolescence, to ensure system sustainability.

f. The control system engineering workstation hardware and operating system must be in conformance to the Common Criteria for IT Security Evaluation (IEC ISO 15408, visit https://www.niap-ccevs.org for more information).

g. Ensure there is no remote access capability enabled as remote access capabilities are prohibited. Physically disable or remove all modem/network devices not required for operational purposes.

2.4.16.2 Software and Services

a. Remove all Software and Services not required for operation and/or maintenance of the product. If removal is not technically feasible, then disable software not required for the operation and/or maintenance of the product. Configure the product to allow the ability to re-enable ports and/or services if they are disabled by software. The removal of software or services may not impede the primary function of the product. If software that is not required cannot be removed or disabled, document a specific explanation and provide risk mitigating recommendations and/or specific technical justification. The software/service to be removed and/or disabled includes, but is not limited to:

(1) Cameras

(2) Games

(3) Device drivers for product components not procured/delivered

(4) Messaging services (e.g., email, instant messenger, peer-to-peer file sharing)

(5) Source code

(6) Software compilers in user workstations and servers

(7) Software compilers for programming languages that are not used in the control system

(8) Unused networking and communications protocols

(9) Unused administrative utilities, diagnostics, network management, and system management functions

(10) Backups of files, databases, and programs used only during system development

(11) All unused data and configuration files

(12) Remove and/or disable, through software, physical disconnection, or engineered barriers, all services and/or ports in the procured product not required for normal operation, emergency operations, or troubleshooting. This includes communication ports and physical input/output ports (e.g., USB docking ports, video ports, and serial ports).

b. Provide documentation showing all disabled ports, connectors, and interfaces for all network-capable devices. In addition, provide summary documentation of the procured product's security features and security-focused instructions on product maintenance, support, and reconfiguration of default settings.

c. For the evaluation status of hardware and software, the Contractor must provide information on Common Criteria (IEC ISO 15408) or National Information Assurance Partnership (NIAP) or Federal Information Processing Standards (FIPS) evaluation status of hardware and software.

2.4.16.3 Access Control

a. The Contractor must configure each component of the procured product to operate using the principle of least privilege. This includes operating system permissions, file access, user accounts, application-to-application communications, and energy delivery system services.

b. Provide user accounts with configurable access and permissions associated with one or more organizationally defined user role(s), where roles are used.

c. Provide a system administration mechanism for changing user(s') role (e.g., group) associations.

d. The Contractor must document control system access control options by defining access and security permissions, user accounts, and applications with associated roles.

e. Provide recommended methods for the Acquirer to prevent unauthorized changes to the Basic Input/Output System (BIOS) and other firmware. If it is not technically feasible to protect the BIOS to reduce the risk of unauthorized changes, the Contractor must document this case and provide mitigation recommendations.

2.4.16.4 Control System Account Management

The Contractor must document all accounts (including, but not limited to, generic and/or default) that need to be active for proper operation of the procured product.

Remove or disable any accounts that are not needed for normal or maintenance operations, emergency, or troubleshooting of the energy delivery system.

2.4.16.5 Session Management

The Contractor may not allow multiple concurrent logins using the same authentication credentials, allow applications to retain login information between sessions, provide any auto-fill functionality during login, or allow anonymous logins.

Provide account-based and group-based configurable session-based logout and timeout settings (e.g., alarms and human-machine interfaces).

2.4.16.6 Authentication/Password Policy and Management

Provide a configurable account password management system that allows for, but is not limited to, the following:

a. Changes to passwords (including default passwords)

b. Selection of password length

c. Frequency of change

d. Setting of required password complexity

e. Number of login attempts prior to lockout

f. Inactive session logout

g. Screen lock by application

h. Comparison to a library of forbidden strings

i. Derivative use of the user name

j. Denial of repeated or recycled use of the same password

The Contractor must time stamp log files.

2.4.16.7 Logging and Auditing

Provide logging capabilities that cover the following events, at a minimum (as appropriate to their function):

a. Information requests and server responses

b. Successful and unsuccessful authentication and access attempts

c. Account changes

d. Privileged use

e. Application start-up and shutdown

f. Application failures

g. Major application configuration changes

2.4.16.8 Heartbeat Signals

The Contractor must identify heartbeat signals or protocols and recommend which should be included in network monitoring. At a minimum, include a last gasp report from a dying component or equivalent.

The Supplier must provide packet definitions of the heartbeat signals and examples of the heartbeat traffic if the signals are included in network monitoring.

2.4.16.9 Patch Management and Updates

The Contractor must verify that procured products (including third-party hardware, software, firmware, and services) have appropriate updates and patches installed prior to delivery.

Provide documentation of the patch management program and update process (including third-party hardware, software, and firmware). This documentation must include resources and technical capabilities to sustain this program and process. Provide the Contractor's method or a recommendation for how the integrity of the patch is validated by the Acquirer as well as the Supplier's approach and capability to remediate newly reported zero-day vulnerabilities.

2.4.16.10 Malware Detection and Protection

a. The Contractor is required to implement at least one of the following:

    (1) Provide a host-based malware detection capability that quarantines (instead of automatically deleting) suspected infected files. Provide an updating scheme for malware signatures. The Contractor must test and confirm compatibility of malware detection application patches and upgrades.

    (2) If the Contractor is not providing the host-based malware detection capability, the Contractor must suggest malware detection products to be used and provide guidance on malware detection and configuration settings that will work with Contractor products.

b. The Contractor must validate that cybersecurity services running on the procured product (e.g., virus checking and malware detection) do not conflict with other such services running on the procured product.

c. For malware detection and protection, the Contractor must provide, or specify how to implement, the capability to automatically scan any removable media that is introduced to the product being acquired.

2.4.16.11 Physical Security

Provide lockable or locking enclosures or rooms for energy delivery systems and system components (e.g., servers, clients, and networking hardware) and for the systems used to manage and control physical access (e.g., servers, lock controllers, and alarm control panels). Provide a method for tamper detection on lockable or locking enclosures. If a physical security and monitoring system is used, tamper detection must be compatible. The Contractor must ensure that physical security features do not hamper the crane system operations. Provide the tools and instructions for making changes to locks, locking codes, keycards, and any other keyed entrances.

2.4.16.12 Wireless Technology

For wireless technology provisions, the Contractor must document:

a. Specific protocols and other detailed information required for wireless devices to communicate with the control network, including other wireless equipment that can communicate with the Contractor-supplied devices.

b. Use, capabilities, and limits for the wireless devices.

c. Power and frequency requirements of the wireless devices (e.g., microwave devices meet the frequency requirements of Generic Requirements [GR]-63 Network Equipment Building System [NEBS] and GR-1089).

d. Range of the wireless devices and verify that the range of communications is minimized to both meet the needs of the Acquirer's proposed deployment and reduce the possibility of signal interception from outside the designated security perimeter.

e. Wireless technology and associated devices compliance with standard operational and security requirements specified in applicable wireless standard(s) or specification(s) (e.g., applicable IEEE standards, such as 802.11).

f. Configuration control options that enable varying of the security level of the devices.

2.4.16.13 Control System Inventory

Provide the complete control system inventory. The Control System Inventory must include the following attributes, in tabular format, as applicable:

General Information	Location Information	Hardware Details	Operating System and Platform	Network Information (Actual Function, not potential function)
Unique ID	Facility Name	Device Type	Embedded OS (Yes/No)	MAC Address(es)
Barcode or Identifier	NFAID	Device Sub-Type	OS Contractor	IP Address(es)
Region	Commodity	Device Function	Operating System (O/S)	Upstream Device

Installation	Floor	Manufacturer	O/S Version	Protocols In Use
Special Area (Option DNA1)	Room	Product Line	Platform Contractor	Host Name
	Location	Model No.	Platform Product Line	
	System Type	Serial No.	Platform	
	Functional System or Equipment Control	Remote Connectivity: (Wired / Wireless / None)	Platform Version	
		Network Type Used: (Serial / Ethernet / Both / None)		

2.5 PAINTING SYSTEM

****

NOTE: Three-coat zinc primer/epoxy/polyurethane system is provided for mild to severe atmospheric, indoor and outdoor cranes. For cranes in abnormal environments including exposure to chemicals or in immersion service, a system designed for that environment should be used. Other systems may suffice for milder environments.

****

a. Remove all grease, oil, and surface debris by solvent wiping or detergent/water scrubbing, prior to blast cleaning. Prepare surfaces to be coated by abrasive blasting to SSPC SP 6/NACE No.3, Commercial Blast Cleaning, or in accordance with the coating manufacturer's requirements, whichever is more stringent.

b. Use a painting system appropriate for the conditions provided in the Crane Design Criteria section of this specification. Paint exposed portions of the crane [and crane runway system] using a [three] [_____]-coat system as follows: [zinc-rich primer consisting of a minimum of 77 percent zinc by weight in the dry film, an anticorrosive epoxy intermediate coat, and an aliphatic polyurethane top coat] [_____]. All paint products must be supplied by a single manufacturer and free of chromates, lead, and mercury. Apply each coat in accordance with manufacturer's instructions and requirements. Ensure each coat is smooth, even, and free of runs, sags, orange peel, and other defects. Desired color of finish coat is [brilliant yellow] [_____]. Submit product data for painting system.

c. Coat faying surfaces of bolted connections per RCSC A348, but do not apply finish paint.

d. Paint the load block [brilliant yellow] [_____] with black diagonal striping.

e. Paint, coatings, or galvanizing on the following items or areas is not acceptable: hoist wire rope or load chain, hooks, hook nuts, sheave and drum grooves, sprockets, wheel treads, lubrication fittings, nameplates, flange mounting faces, corrosion resistant steel, bronze, or other items not normally painted.

f. Factory paint electrical and mechanical equipment in accordance with the manufacturer's best standard practice for the specified environment.

2.6 IDENTIFICATION PLATES

****

NOTE: NAVFAC P-307 requires the capacity be displayed in pound units. The kilogram marking option is provided for cranes installed in a foreign country.

****

Furnish and install identification plates. Provide non-corrosive metal identification plates with clearly legible permanent lettering giving the manufacturer's name, model number, serial number, capacity in pound units, [with kilogram units printed in a different color,] and other essential information or identification.

2.6.1 Markings on Crane, Trolley, and Hook

****

NOTE: NAVFAC P-307 requires the capacity be displayed in pound units. The kilogram marking option is provided for cranes installed in a foreign country.

****

To avoid operation of the crane in the wrong direction, affix the appropriate directions (NORTH, SOUTH, EAST, and WEST) with arrows on both sides of the bridge and both sides of trolley, as applicable. Markings must be visible by the operator and from the loading point. Labels on the controls must have corresponding directional (NORTH, SOUTH, EAST, and WEST) markings. Markings must agree with the markings on controller. Do not indicate directional arrows on controller.

Mark the hook rated capacity in pound units[, with kilogram units printed in a different color,] on both sides of the hoist load block.

2.7 ELECTRICAL ASSEMBLY

Installation of all electrical wiring, conduit, and components must be performed in accordance with the requirements of NFPA 70. As a minimum, items a. through g. below must be followed:

a. All electrical connections must be installed in accordance with NFPA 70 Articles 110.14 or 430.9, as applicable, or as recommended by the device manufacturer.

b. Crimped terminal lugs, if used, must be properly sized for the wire and installed using the device(s) – e.g., crimping tool and indenter – recommended by the terminal lug manufacturer.

c. All spare conductors must be identified as spare conductors, and must have their ends insulated to preclude accidental contact with energized equipment.

d. Bonding straps and equipment grounding conductors must be connected to engineered ground points, have all paint removed from their termination points, or have tooth lockwashers (star lockwashers) installed, to insure proper grounding of the equipment.

e. Rigid Polyvinyl Chloride conduit may be used to protect festoon cable from physical damage when the cable is run along the footwalk of the crane, provided that only sections of conduit are used.

f. Festoon cable must be installed with suitable strain relief and protected from physical damage in accordance with NFPA 70 Article 610.11(E)(1). This includes damage from chafing against the crane structure and any other type of damage that may be incurred.

g. Fiber optic cable must be installed in accordance with the manufacturer's installation guidelines. However, at a minimum the following guidelines must be adhered to: no sharp bends (bend radii must be greater than 1 inch or as prescribed by the manufacturer), avoid tight loops, no zip ties, and no stretching of cable.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, and before performing any work, verify all dimensions in the field. The Contractor is responsible for the coordination and proper relation of the contracted work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

[3.2 SHOP ASSEMBLY AND TESTS

****

NOTE: Shop inspection and testing at the manufacturing facility is typically recommended for specialized applications (e.g., ordnance handling, molten metal handling, special purpose service, hazardous/explosive area environments, precision handling operations requiring complex or synchronized lifting capacity, or custom designs). This section may not be necessary for standard commercial packaged hoists.

****

Shop assemble major components as completely as possible. Reeving of drums and sheaves is not advisable for shop testing, however it is acceptable for packaged hoists. Functionally test the crane system at the construction facility prior to shipment. The Government reserves the right to inspect the crane for compliance with this specification and to witness the functionality tests. Notify the Contracting Officer [14] [_____] days prior to starting testing operations.

]3.3 ERECTION AND INSTALLATION

Perform the entire crane system erection in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative.

3.3.1 Mechanical Alignment

Align motors, couplings, brakes, gear boxes, and drive components in accordance with manufacturer's instructions.

3.3.2 Electrical Adjustments

Adjust control system in accordance with manufacturer's instructions. Store a copy of all Control Parameter Settings (PLC, VFD). Provide the final settings and configurations data on the Complete Schematic Wiring Diagram, including but not limited to, timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents. Provide the test conditions such as ambient temperature, motor load, date performed and person performing the adjustments as part of the Operational Tests report.

3.3.3 Field Welding

Perform welding indoors, where possible. Surface of parts to be welded must be free from rust, scale, paint, grease, and other foreign matter. Minimum preheat and interpass temperatures must conform to the requirements of AWS D14.1/D14.1M.

3.3.4 Field Painting

Perform painting indoors, where possible. Field painting (including touch-up) must conform to the requirements of the coating manufacturer and as specified in paragraph PAINTING SYSTEM.

3.4 FIELD QUALITY CONTROL

3.4.1 Post-Erection Inspection

After erection, the Contractor[, the Activity Crane Inspector/Test Director,] and the Contracting Officer must jointly inspect the crane bridge and hoist systems and components to verify compliance with specifications and approved submittals. Notify the Contracting Officer [14] [_____] days before the inspection. Provide for approval a report of the inspection indicating the crane is considered ready for operational tests.

Document the results of this inspection and submit the post-erection inspection report to the Contracting Officer for approval.

3.4.2 Operational Tests

****

NOTE: Determine if Government furnished certified test weights are available at the site (recommended). If not, they must be provided by the Contractor. These weights are for acceptance testing and will not be permanently retained by the Government.

****

Check the clearance envelope of the entire crane prior to picking or traversing any load to ensure there are no obstructions. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the crane is operational.[The Contractor must furnish test weights, operating personnel, instruments, and other apparatus necessary to conduct field tests on each crane. Solid weights must be measured using calibrated equipment traceable to National Institute of Standards and Technology (NIST) with a minimum accuracy of plus or minus two percent.]

3.4.2.1 No-Load Test

Raise and lower each hook through the full range of normal travel at rated speed for three complete cycles. Raise and lower each hook, testing other speeds of the crane. Verify proper operation of hoist limit switches. Operate the bridge and trolley in each direction the full distance between end stops and bring bumpers into contact with the end stops. Operate through the entire speed range and verify proper brake operation. Verify correct operation of all indication and ancillary devices.

3.4.3 Test Data

Submit all crane test data recorded on appropriate test record forms suitable for retention for the life of the crane. Record operating and startup current measurements for hoist, trolley, and bridge motors using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) must be justified or appropriate adjustments performed. In addition, note, investigate, and correct any high temperatures or abnormal operation of any equipment or machinery. Record hoist, trolley, and bridge speeds during each test cycle.

3.4.4 Hook Tram Measurement

Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 0.4 mm 1/64 inch). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening from the base measurement is cause for rejection.

3.4.5 Load Tests

****

NOTE: For NAVFAC, require a rated load test of 100 percent (plus 0 / minus 10) and an overload test of 125 percent (plus 0 / minus 5) of the rated load.

Wire rope run-in is applicable to wire rope hoists.

****

a. Perform the following tests, as specified below.

b. Test loads used in this section are defined as the following:

Wire rope run-in load (when applicable): 25 - 50 percent of rated load.

Rated load test: 100 percent (plus [0] [_____] minus [10] [_____]) of rated load.

Overload test: 125 percent (plus [0] [_____] minus [5] [_____]) of rated load.

c. Testing of cranes must be done with the use of test weights. The use of dynamometers in lieu of lifting test weights is not permitted. Each test weight for crane tests must be marked with a unique identification number and the weight in pounds. The weight marked must be the actual weight taken from the scale or other measuring device. Solid weights must be measured using calibrated equipment traceable to the National Institute of Standards and Technology (NIST), with a minimum accuracy of plus or minus two percent (i.e., indicated weight must be within plus or minus two percent of actual weight). A list of test weights, with identification numbers and weights, must be retained. The list must include the type and serial number (or other identifier) of the weighing device(s) used to weigh the test weights. Where a lifting attachment supports multiple test weights (e.g., stacked weights or multiple weights suspended from a padeye), the total capacity must be marked on the attachment. All rigging gear must meet OSHA and ASME requirements.

[3.4.5.1 Wire Rope Run-In

****

NOTE: This section is not applicable for hoists with load chain.

****

The primary purpose of this procedure is to exercise the newly installed wire rope.

Place the load on the hook. Start at ground level and hoist up to one foot below upper limit at slow speed. Hoist down to lower limit at slow speed. Repeat hoisting and lowering of the load for approximately 10 hoisting cycles, increasing the speed for each cycle. During this test, the capacity overload lockout should not activate.

]3.4.5.2 Rated Load Test

3.4.5.2.1 Hoist

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately 300 mm one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees clockwise and counterclockwise to check bearing operation with no binding. Observe for lowering of the load, which may indicate a malfunction of hoisting components or brakes. Verify that maximum beam and girder deflections do not exceed CMAA 74 and MHI MH27.1 design limits, as applicable.

b. Dynamic Load Test: Raise and lower test load through the full lift range and visually observe smooth control and acceleration between points. Completely stop the machinery at least once in each direction to ensure proper brake operation.

c. Hoist Mechanical Load Brake (or Self-locking Worm Gear): Raise test load approximately 1500 mm 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again, with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

d. Hoist Loss of Power Test: Raise the test load to approximately 2400 mm 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.2.2 Trolley

Operate the trolley (if space is available) the full distance of the bridge rails in each direction with a test load on the hook. Check proper functioning through the range of speeds. Verify proper brake action and stopping distance.

3.4.5.2.3 Bridge

With a test load on the hook, operate the bridge for the full length of the runway (if space is available) in one direction with the trolley at the far end of the bridge, and in the opposite direction with the trolley at the opposite end of the bridge. Use extreme caution. Check proper functioning through the range of speeds. Check for any binding of the bridge end trucks. Verify proper brake action and stopping distance. Record deficiencies. Secure from testing if deficiencies are found.

3.4.5.2.4 Trolley Loss of Power Test

Raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of trolley travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the trolley stops and that the brake sets properly. Measure the distance required for the trolley to stop.

3.4.5.2.5 Bridge Loss of Power Test

Raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of bridge travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the bridge stops and that the brake sets properly. Measure the distance required for the bridge to stop.

3.4.5.3 Overload Test

3.4.5.3.1 Hoist

Disconnect or adjust the overload limit device to allow the hoist to lift the test load. Verify proper operation of the overload limit device after it is reconnected.

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately 300 mm one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees clockwise and counterclockwise to check bearing operation with no binding. Observe for lowering of the load, which may indicate a malfunction of hoisting components or brakes.

b. Dynamic Load Test: Raise and lower test load and visually observe smooth control. Stop the load during raising and lowering to verify that the brakes holds the load.

c. Hoist Mechanical Load Brake (or Self-locking Worm Gear): Raise test load approximately 1500 mm 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again, with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

d. Hoist Loss of Power Test: Raise the test load to approximately 2400 mm 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.3.2 Trolley

Operate the trolley the full distance of the bridge rails in each direction with a test load on the hook (one cycle) through the range of speeds. Verify proper brake action.

3.4.5.3.3 Bridge

With a test load on the hook, operate the bridge for the full length of the runway in one direction with the trolley at the extreme end of the bridge, and in the opposite direction with the trolley at the opposite extreme end of the bridge (one cycle). Check proper functioning through the range of speeds. Check for any binding of the bridge end trucks and verify proper brake action. Record deficiencies. Secure from testing if deficiencies are found.

3.5 MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

Furnish a qualified experienced manufacturer's field service representative to supervise the crane installation, assist in the performance of the on-site testing, and instruct personnel in the operational and maintenance features of the equipment.

3.6 OPERATION AND MAINTENANCE MANUALS

Provide [two] [_____] hard copies of operation and [two] [_____] hard copies of maintenance manuals for the equipment furnished along with an electronic copy (PDF) of each on a Compact Disc. Provide one complete set prior to performance testing and final copies upon acceptance. Provide operation manuals that detail the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. List in the maintenance manuals routine maintenance procedures, including weekly, monthly, semi-annual, and annual required maintenance items, possible breakdowns and repairs, and troubleshooting guides. Also include as-built drawings, piping and equipment layout, design calculations, Control Parameter Settings and printouts of any software, and simplified wiring and control diagrams of the system as installed. Secure approval of operation and maintenance manuals prior to the field training course (as applicable).

[3.7 FIELD TRAINING

****

NOTE: Training is recommended, but not required.

Additional items that could be included in the blank: general review of the entire capabilities, limitations, and safety features of the crane.

An optional variable frequency drive (VFD) training is available, should the crane be provided with VFD's and the command feel the additional training is beneficial.

****

Conduct a training course for [eight] [_____] operating and maintenance staff[and provide a copy of the training material to each participant]. Provide a training period consisting of a total of [four] [eight] [_____] hours of normal working time and starting after the system is functionally completed but prior to final acceptance. Cover all pertinent points involved in operating, starting, stopping, and servicing the equipment, including all major elements of the Operation and Maintenance Manuals. Demonstrate in course instructions all routine maintenance operations such as lubrication, general inspection, and basic troubleshooting[, and [_____]].

[Provide a minimum [four] [_____] hour training session on the Variable Frequency Drives (VFDs) discussing maintenance, troubleshooting of fault codes, theory of operation, and adjustment of crane parameters. This training session will be for an audience of approximately [eight] [_____] people.

]][3.8 FINAL ACCEPTANCE

****

NOTE: Use this paragraph as written for projects where the crane is the principal construction element, or represents a very significant portion of the Contract cost. However, if the crane is part of a new facility or renovation, delete the acceptance paragraph from this section. Warranty period and operating and maintenance processes must coincide with the actual beneficial occupancy of the entire facility.

****

Final acceptance of crane system will not be given until Contractor has successfully completed all testing operations, corrected all material and equipment defects, made all proper operation adjustments, and removed paint or overspray on wire rope, hook, and electrical collector bars.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-41 22 13.16 (April 2008)**
Change 1 - 02/20

Preparing Activity: NAVFAC **Superseding**
UFGS-41 22 15.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 41 22 13.16

GANTRY CRANES

04/08, CHG 1: 02/20

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NOTE: This guide specification covers the requirements for overhead electric traveling (OET) gantry cranes with capacities in excess of 9 tons 10 tons 9072 kg 20,000 pounds capacity but less than 27 metric tons 30 tons 27,000 kg 60,000 pounds, suitable for [indoor][or outdoor] use in [hazardous][or non-hazardous] environments.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

Forward all procurement of crane systems at Naval Shore based activities with rated capacities of 9072 kg 20,000 pounds or greater, or for use in specialized applications to: Naval Facilities Engineering Systems Command, Navy Crane Center, Building 491, Norfolk Naval Shipyard, Portsmouth, Va., 23709-5000. (See NAVFAC Instruction 11450.1a of 22 January, 1997)

****

PART 1 GENERAL

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Use SECTION 41 22 13.14 BRIDGE CRANES, OVERHEAD

ELECTRIC, TOP RUNNING for top running cranes with top running bridges and trolleys with capacities less than 27 metric ton 30 ton 27,000 kg 60,000 pounds, CMAA 70 Class A, B, C, D, E, or F, suitable for indoor or outdoor use in general purpose service, ordnance handling service, or hazardous area environments.

Use SECTION 41 22 13.15 BRIDGE CRANES, OVERHEAD ELECTRIC, UNDER RUNNING for top running and under running single girder cranes with under running trolleys and hoists, with capacities less than 27 metric ton 30 ton 27,000 kg 60,000 pounds, CMAA 74 Class A, B, C, or D, suitable for indoor or outdoor use in general purpose service, ordnance handling service, or hazardous area environments.

Use SECTION 41 22 23.19 MONORAIL HOISTS (manual, electric, or air-powered).

Types of crane covered, (more than 9.07 tons 10 tons 9072 kg 20000 pounds, but less than 27 tons 30 tons 27215 kg 60000 pounds, including:

Top-running gantry and trolley, single or multiple-girder, with CMAA 70 or CMAA 74 service class of A through E. Control types and systems may be specified as follows:

1. Remote, Cab, or Pendant Crane Controls or a combination of the three can be provided.

2. Alternating current or direct current control systems can be specified.

Crane Terminology: - refer to DEFINITIONS in this specification.

a. Tracks for gantry crane travel may be at the same (gantry) or different (semi-gantry) levels, depending on the leg design and intended purpose. Trolley travel and leg position defines the type of gantry.

b. Top-running Trolley is a trolley which travels on the top surfaces of rails of the gantry girder(s).

c. Types of Gantry Cranes may include; Deck-Leg Gantry, Through-Leg Gantry, Semi-Gantry Deck-Leg, Semi-Gantry Through Leg, Outdoor Storage or Hauling Gantry, and Polar Gantry.

Show the following information, as a minimum, on the project drawings:

1. Complete details of plan, elevations, and sections of Gantry Crane system including data.

2. Maximum span of runway girder.

3. Gantry Runway rail size.

[4. Runway girder size (for semi-gantry applications).]

5. Channel cap size.

6. Size and location of gantry crane stops.

7. Electrical junction box location (including mounting height).

****

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2011	(2014B) Cylindrical Wormgearing Tolerance and Inspection Methods
AGMA ISO 10064-6	(2010A) Code of Inspection Practice - Part 6: Bevel Gear Measurement Methods
AGMA ISO 17485	(2008A; Supplement 2008) Bevel Gears - ISO System of Accuracy (Including Supplement - Tolerance Tables 2008)
ANSI/AGMA 2001	(2004D; R 2010) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
ANSI/AGMA 2015-1	(2001A; R 2014) Accuracy Classification System - Tangential Measurements for

	Cylindrical Gears
ANSI/AGMA 6013	(2006A; R 2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B30.2	(2022) Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
ASME B30.10	(2019) Hooks
ASME B30.11	(2010) Monorails and Underhung Cranes - Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings
ASME B30.16	(2022) Overhead Underhung and Stationary Hoists
ASME B30.17	(2020) Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoists)
ASME HST-1	(2023) Performance Standard for Electric Chain Hoists
ASME HST-4	(2021) Performance Standard for Overhead Electric Wire Rope Hoists
ASME NOG-1	(2020) Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)
ASME NUM-1	(2023) Rules for Construction of Cranes, Monorails, and Hoists (With Bridge or Trolley or Hoist of the Underhung Type)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

AWS D14.1/D14.1M	(2019) Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

ASTM INTERNATIONAL (ASTM)

ASTM A159	(1983; R 2024) Standard Specification for Automotive Gray Iron Castings
ASTM A275/A275M	(2023) Standard Practice for Magnetic Particle Examination of Steel Forgings
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A490M	(2014a) Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A931	(2008; R 2013) Standard Test Method for Tension Testing of Wire Ropes and Strand
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM B438	(2021) Standard Specification for Bronze-Base Powder Metallurgy (PM) Bearings (Oil Impregnated)
ASTM B439	(2021) Standard Specification for Iron-Base Powder Metallurgy (PM) Bearings (Oil-Impregnated)
ASTM B633	(2023) Standard Specification for

	Electrodeposited Coatings of Zinc on Iron and Steel
ASTM E125	(1963; R 2023) Photographs for Magnetic Particle Indications on Ferrous Castings
ASTM E543	(2021) Standard Specification for Agencies Performing Non-Destructive Testing
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)
ASTM F959/F959M	(2017a; R 2023) Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes
CMAA 74	(2020) Specifications for Single Girder Cranes

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA ICS 8	(2011) Crane and Hoist Controllers
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.179	Overhead and Gantry Cranes
29 CFR 1910.306	Specific Purpose Equipment and Installations

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1004-1	(2012; Reprint Nov 2020) UL Standard for Safety Rotating Electrical Machines - General Requirements
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 DEFINITIONS

a. Crane Bridge: That part of an overhead crane system consisting of girder(s), end trucks, end ties, walkway, and drive mechanism which carries the trolley(s) and travels along the runway rails perpendicular to the gantry runway.

b. Crane Runway: The track system along which the crane operates horizontally, including track, track hangar rods, track connection devices, and runway structural supports.

c. Dead Loads: The loads on a structure which remain in a fixed position relative to the structure.

d. Girder: The principal horizontal beam of the crane gantry. It is supported by the crane end legs. Normally the crane trolley is mounted on top of the girder, and the hoist is suspended from the trolley to below the crane girder; however,the trolley and cab may also be suspended from the girder.

e. Live Load: A load which moves relative to the structure under consideration.

f. Pendant: A control for a hoist and/or a crane. The pendant hangs from the hoist or the crane by a cord at a height that is easy for the operator to reach.

g. Rated Load: For the purpose of this specification the rated load is defined as the maximum working load suspended under the load hook.

h. Standard Commercial Cataloged Product: A product which is currently being sold, or previously has been sold, in substantial quantities to the general public, industry or Government in the course of normal business operations. Models, samples, prototypes or experimental units do not meet this definition. The term "cataloged" as specified in this section is defined as "appearing on the manufacturer's published product data sheets. These data sheets must have been published or copyrighted prior to the issue date of this solicitation and have a document identification number or bulletin number.

i. Top Running Crane: An electric overhead traveling (OET) crane that runs on rails on top of support beams (bridge girders); or OET with equal or unequal legs supporting a girder, trolley, hoist (and cab)which travels horizontally on legs. The load is supported by the entire cross-section of the beam in bridge cranes. The load is carried by the cross-section of the beam supported by movable legs for a gantry crane, distributing the load to the legs, wheels, and gantry track.

j. Trolley Mounted Hoist: A combined unit consisting of a wheeled trolley that provides horizontal motion along the gantry girder, and a hoist suspended from the trolley, that provides lifting and lowering of a freely suspended load.

k. Under running (Underhung) Crane: An electric overhead traveling crane that is supported by crane end trucks suspended below the crane runway. The load is supported by hanging from the lower flange of a beam.

1.3 SYSTEM DESCRIPTION

The requirements for the crane runway and rail supporting structures are specified in Section 05 12 00 STRUCTURAL STEEL.

[1.3.1 Load and Sizing Calculations

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NOTE: Design data for Load and Sizing Calculations, and welding procedures, may not be available for commercially procured hoists and trolleys.

****

Submit complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Submit calculations verifying the sizing of the gantry girder, end trucks and travel drives.[Include seismic analysis of gantry girder and end trucks.]

]1.3.2 OET Design Criteria

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NOTE: Clearly show the area of hook coverage, runway dimensions, rail size, hook vertical travel, clear hook height and lifting capacity on drawings.

****

Cranes will operate in the given spaces and match the runway dimensions and rails indicated. Hook coverage, hook vertical travel, clear hook height, lifting capacity, and load test weight must not be less than that indicated.

1.3.2.1 General

****

NOTE: Add number of cranes, building name, crane span and rated load capacity expressed in tons pounds. The last sentence may be deleted if only one hoist system is in project.

****

Include the following: Number of cranes [_____], located in building identified as [_____], the required span, and the rated capacity expressed in [_____] metric tons tons kilograms pounds, for each OET. Also clearly locate and identify each multiple girder hoist and system components.

1.3.2.2 Classification

****

NOTE: CMAA 70 covers top running bridge and gantry electric overhead traveling cranes with a duty rating of A, B, C, D, E and F. CMAA 74 covers top running and under running single girder electric traveling cranes utilizing an under running trolley with a duty rating of A ,B, C and D. Make a selection from the following CMAA 70 and CMAA 74 service classifications.

Class A (Standby or Infrequent Service): This service covers cranes which may be used in installations such as powerhouses, public utilities, turbine rooms, motor rooms and transformer stations where precise handling of equipment at slow speeds with long, idle periods between lifts are required. Capacity loads may be handled for initial installation of equipment and for infrequent maintenance.

Class B (Light Service): This service covers cranes which may be used in repair shops, light assembly operations, service buildings, light warehousing, etc., where service requirements are light and the speed is slow. Loads may vary from no load to occasional full rated loads with 2 to 5 lifts per hour, averaging 3 m 10 feet per lift.

Class C (Moderate Service): This service covers cranes which may be used in machine shops of paper mill machine rooms, etc., where service requirements are moderate. In this type of service the crane will handle loads which average 50 percent of the rated capacity with 5 to 10 lifts per hour, averaging 4.5 m 15 feet, not over 50 percent of the lift at rated capacity.

Class D (Heavy-Duty): This service covers cranes which may be used in heavy machine shop, foundries, fabricating plants, steel warehouses, container

yards, lumber mills, etc., and standard duty bucket and magnet operations where heavy-duty production is required. In this type of service, loads approaching 50 percent of the rated capacity will be handled constantly during the working period. High speeds are desirable for this type of service with 10 to 20 lifts per hour averaging 4.5 m 15 feet, not over 65 percent of the lifts at rated capacity.

Class E (Severe Service): This type of service requires a crane capable of handling loads approaching rated capacity throughout its life. Applications may include magnet, bucket, magnet/bucket combination cranes for scrap yards, cement mills, lumber mills, fertilizer plants, container handling, etc., with 20 or more lifts per hour at or near the rated capacity.

Class F (Continuous Severe Service): This type of service requires a crane capable of handling loads approaching rated capacity continuously under severe service conditions throughout its life. Applications may include custom designed specialty cranes essential to performing the critical work tasks affecting the total production facility. These cranes must provide the highest reliability with special attention to ease of maintenance features.

****

Provide crane designed and constructed to[CMAA 70 Class [_____], [_____] service][CMAA 74 [Duty Class A][Duty Class B] [Duty Class C] service] requirements for operation in[indoor][outdoor][hazardous][non-hazardous] environment with[multiple girder hoist system][electric chain hoist conforming to ASME HST-1][electric wire rope hoist conforming to ASME HST-4].

1.3.2.3 Rated Capacity and Speeds

NOTE: Auxiliary [monorail hoist][multiple girder hoist] may be specified. VFAC drive should be specified if precise handling and position are required. VFAC drives are normally capable of driving the crane at 5 mm/s 1 fpm or less. Delete reference to VFAC-drive and auxiliary hoist if not applicable.

Delete micro-drive and columns from the table if not applicable.

****

Provide crane conforming to[CMAA 70][CMAA 74] with rated capacity of [_____] metric tons tons kg pounds.[Provide auxiliary hoist with [_____] metric tons tons kg pounds capacity.] Lower load block or assembly of hook, swivel bearing sheaves, pins and frame suspended by the hoisting ropes are not considered part of the rated capacity. Rated speeds (in meters/second fpm) for the hoist,[hoist micro-drive, gantry micro-drive, trolley micro-drive,] gantry and trolley at the rated load are as follows:

Rated Speeds [meters per second] [feet per minute]			
Description	Minimum	Maximum	[Micro-drive]
Main Hoist	[_____]	[_____]	[[_____].]
[Auxiliary Hoist]	[_____]	[_____]	[[_____].]
Trolley	[_____]	[_____]	[[_____].]
Gantry	[_____]	[_____]	[[_____].]

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Electric Traveling (OET) Crane(s); G, [_____]

Crane Runway System; G, [_____]

Complete Schematic Wiring Diagram; G, [_____]

Description of operation.

SD-03 Product Data

OET Design Criteria; G, [_____]

Overhead Electric Traveling (OET) Crane(s); G, [_____]

Load and Sizing Calculations; G, [_____]

Festoon System; G, [_____]

Runway Electrification System; G, [_____]

Variable Frequency Drives; G, [_____]

Bumpers; G, [_____]

End Stops; G, [_____]

[Spare Parts; G, [_____]

] Framed Instructions; G, [_____]

SD-06 Test Reports

Acceptance Testing; G, [_____]

SD-07 Certificates

Overload Test Certificate

No Hazardous Material; G, [_____]

Loss of Power Test; G, [_____]

Crane Runway System; G, [_____]

Certificate of Compliance; G, [_____]

Including listed Standards.

Wire Ropes; G, [_____]

Including Manufacturer's Certificate of Breaking Strength.

Hook NDT Reports; G, [_____]

NDT Vendor Certification; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

1.5 QUALITY ASSURANCE

1.5.1 Manufacturer Qualification

Overhead Electric Traveling (OET) Crane(s) must be designed and manufactured by a company with a minimum of 10 years of specialized experience in designing and manufacturing the type of overhead crane required to meet requirements of the Contract Documents.

1.5.2 Pre-Delivery Inspections

Contractor is responsible for performance of quality control inspections, testing and documentation of steel castings, hook assembly and nuclear safety as follows. Submit all crane test data recorded on appropriate test record forms suitable for retention for the life of the crane. Visually inspect and test load-carrying steel castings ASTM A668/A668M using the magnetic-particle inspection method per ASTM A275/A275M. Reference allowable degree of discontinuities to ASTM E125, and relationship to service loads and stresses, critical configuration, location and type. Methods of repairing the discontinuities is subject to review by the Contracting Officer.

1.5.3 Certificates

Submit an Overload Test Certificate stating that the crane can be periodically load tested to 125 percent (plus 5 to minus 0) 131.25 percent of rated load. Also submit the following certificates:

a. stating that No Hazardous Material, including, but not limited to asbestos, cadmium, chromium, lead, elemental mercury, or PCB'c, is contained within system or components.

b. stating that the system is safe to perform a Loss of Power Test

c. stating that the Crane Runway System conforms to the requirements as specified herein and as specified in Section 05 12 00 STRUCTURAL STEEL.

d. Certificate of Compliance with Listed Standards

e. Provide manufacturer's Wire Ropes Breaking Strength certification that each rope meets the published breaking strength, or actual breaking strengths, of samples taken from reels and tested. Certifications must be traceable to the crane and to the hoist to which the wire rope is installed. Wire rope must conform to ASTM A1023/A1023M. and ASTM A931.

f. Hook NDT Reports

1.5.4 NDT Vendor Certification

Provide certification that the NDT vendor meets the requirements of ASTM E543. Provide the NDT report to the Government which is traceable to the unique ID number on the hook and nut.

a. Submit for review the NDT vendor's procedures, including technique sheets specific to the types, shapes, and sizes of the parts being examined (e.g., shank hook, eye hook, duplex hook, eye bar, nut).

b. For the magnetic particle method, adequately describe the procedures for the orientation of the hooks, nuts, or pins with the magnetizing equipment. Procedures must bear the approval of an independent Level III examiner.

c. Prior to performing any operational testing of the cranes, inspect the hook and hook nut by the magnetic particle method (MT) over their entire surface area[in accordance with NAVSEA Technical Publication T9074-AS-GIB-010/271]. ASTM A275/A275M may be used with the following restrictions:

  (1) . Do not use DC yokes (including switchable AC/DC yokes used in the DC mode) and permanent magnet yokes;

  (2) . Do not use automatic powder blowers or any other form of forced air other than from a hand-held bulb for the application or removal of dry magnetic particles;

  (3) . Remove all arc strikes;

  (4) . Equipment ammeters must have an accuracy of plus or minus 5 percent of full scale (equipment ammeter accuracy other than that stated is acceptable provided the MT procedure states that a magnetic field indicator is used to establish and verify adequate field strength for all aspects of the inspection).

  (5) . If NDT cannot be performed on surfaces inside holes, visually inspect those surfaces to the maximum extent practical. Acceptance criterion is "no linear indications greater than 1/16 inch".

1.5.5 Overhead Electric Traveling (OET) Crane(s)

a. Submit shop drawings detailing all OET Design Criteria, showing the general arrangement of all components in plan, elevation, and end views; hook approaches on all four sides, clearances and principal dimensions, assemblies of hoist, trolley and gantry drives, and complete schematic wiring diagram with description of operation, and Runway Electrification System. Include weights of components and maximum gantry wheel loads and spacing.

b. Provide shop drawings whose quality is equivalent to the contract drawings accompanying this solicitation.

c. Provide integral schedule of crane components on each drawing. Provide maximum wheel loads (without impact) and spacing imparted to the crane runway system track beams. Indicate the crane speeds along the runway, the trolley speeds along the gantry girder, and the hoist lifting speeds; all speeds indicated are speeds with hoist loaded with rated crane capacity load.

[1.5.6 Welding Qualifications and Procedures

Perform welding in accordance with qualified procedures using AWS D14.1/D14.1M as modified. Written welding procedures must specify the Contractor's standard dimensional tolerances for deviation from camber and sweep not exceeding those specified in AWS D14.1/D14.1M. Welders and welding operators must be qualified in accordance with AWS D1.1/D1.1M or AWS D14.1/D14.1M. Allowable stress values must comply with CMAA 70.

]1.5.7 Safety Requirements

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NOTE: Certification is required for cranes handling nuclear materials. Results from the Safety Analysis will be utilized by the Using Agency as a basis for gantry crane certification. Delete this paragraph if the crane is not required to handle nuclear materials.

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Comply with the mandatory and advisory safety requirements of ASME B30.10, ASME B30.11,ASME B30.16, ASME B30.17, ASME B30.2, ASME HST-1, ASME HST-4, NFPA 70, 29 CFR 1910, 29 CFR 1910.179, and 29 CFR 1910.306. Nuclear certification, testing, and rules of construction must be in accordance with 29 CFR 1910.147, and [ASME NOG-1 top running type cranes][ASME NUM-1 for underhung type cranes]. Submit analysis and test reports to Contracting Officer for approval.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect all delivered and stored equipment from the weather, humidity, temperature variations, dirt and dust, and other contaminants.

[1.7 EXTRA MATERIALS

****

NOTE: The extent to which spare parts are stocked is an economic judgment determined by the user. The impact of downtime expense must be weighed versus the prompt availability and amount of cost allocated to spare parts. Power plant cranes, and similar use cranes receive severe service during the plant construction period, and normal wearing parts should be maintained at the project site.

****

Submit spare parts data for each different item of material and equipment specified and/or as recommended by the manufacturer, after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include in data a complete list of parts and supplies, with current unit prices and source of supply. Furnish and deliver one set of manufacturer's recommended spare parts to the site. Suitably package the spare parts for long-term protection and storage. Legibly label the packaging to identify the spare parts. Also include a list of the furnished spare parts in the Maintenance manual.

]PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Provide materials and equipment which are standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment.

2.1.2 Nameplates

Secure nameplates to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Provide two gantry identification plates , one for each side of gantry. Provide noncorrosive metal identification plates with letters which are easily read from the floor, showing a separate number such as BC-1, BC-2, for each gantry crane.

2.1.3 Prohibited Use of Asbestos Products

Materials and products required for designing and manufacturing cranes must not contain asbestos.

2.1.4 Capacity Plates

Two capacity plates indicating the crane capacity in metric tons and tons tons kilograms pounds are required, one secured to each side of gantry. Fabricate each capacity plate with a steel backing plate and exterior quality/fade-resistant stick-on labels with letters large enough to be easily read from the floor. Place capacity plates in a location visible to pendant operator's position after the crane has been installed.

2.1.5 Safety Warnings

Affix labels in a readable position to each lift block or control pendant in accordance with ASME B30.16, ASME B30.2 and ASME B30.17. Submit safety warnings, diagrams and other framed instructions suitably framed and protected for display as indicated by the Contracting Officer as follows:

a. Design and locate the word "WARNING" or other legend to bring the label to the attention of the operator. Provide durable type warning labels and display the following information concerning safe-operating procedures:

b. Cautionary language against lifting more than the rated load; operating the hoist when the hook is not centered under the hoist; operating hoist with twisted, kinked or damaged rope; operating damaged or malfunctioning hoist; operating a rope hoist with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label.

c. To avoid operation of the crane in the wrong direction, affix the appropriate directions, with arrows, NORTH, SOUTH, EAST and WEST on the bottom of the girder where they can be easily seen by the operator. Labels on the controls must have corresponding direction (NORTH, SOUTH, etc.). Markings must agree with the markings on control pendant. Do not indicate directional arrows on control pendant.

2.2 STRUCTURAL MATERIALS

2.2.1 Bolts, Nuts and Washers

Utilize corresponding lockwashers with high-strength bolted connections ASTM F436M ASTM F436, nuts ASTM A563M ASTM A563, etc., conforming to requirements of AISC 325. Bolts, nuts and washers ASTM F959/F959M must conform to ASTM A325M ASTM A325 bolts or ASTM A307. Galvanized bolts are not acceptable. Do not use ASTM A490M ASTM A490 bolts.

2.2.2 Gantry Girder or Girders

****

NOTE: Specify welded structural steel box sections for multiple girder cranes Class C, D, or E with a capacity greater than 18 metric tons 20 tons 16330 kg 36,000 pounds or a span greater than 12 m (40 feet).

****

Provide[welded structural steel box section][wide flange beam, standard I-Beam, reinforced beam or section fabricated from rolled plates and shapes] gantry girders.

2.2.3 Gantry Rails or Bars

****

NOTE: Remove this paragraph for underhung cranes and cranes having a capacity less than 18 metric tons 20 tons 16330 kg 36,000 pounds (many crane manufacturers do not need or want rails or bars).

****

Trolley runway rails, crane girders and other sections must be straight and true. When loaded with motor driven cranes the deflection of rails must not exceed 1/888 of the span. Calculate the deflection with the worst case of two loaded gantry cranes located adjacent each other. Make all rail joints flush and true without misalignment of running tread and design to minimize vibration. The gap between adjacent rail ends and the vertical misalignment of running treads must not exceed 1.588 mm 0.0625 inch. Level the gantry rail to a plus-or-minus 3 mm 1/8 inch at all rail support joints.[Fasten upper gantry rail to[top cover plate][wide flange] or centered on flange or offset near web plate for welded box sections, complete with welded clips.] Bolt gantry rail joints using standard joint bars. Stagger rail joints. Provide a positive stop at gantry rail ends to prevent creep.

2.2.4 End Ties and Gantry Girder End Connections

****

NOTE: Specify end ties for cranes with more than four wheels. Specify welded structural steel box sections for multiple-girder cranes Class C, D, or E with a capacity greater than 18 metric tons 20 tons 16330 kg 36,000 pounds or a span greater than 12 m 40 feet.

****

Use welded steel box sections for end ties. Provide full depth diaphragms at girder connections and jacking points. Provide horizontal gusset plates at the elevation of top and bottom end tie flanges for connection to girder ends. Make end connections with high-strength bolts per AISC 325. Use body-bound bolts fitted in drilled and reamed holes to maintain the crane square.

2.2.5 Gantry End Trucks

Provide[rotating][fixed axle] type end trucks fabricated of structural tubes or from structural steel to provide a rigid box section structure. Provide jacking pads for removal of wheel assemblies.

[2.2.6 Trolley Frame

****

NOTE: Trolley frame is applicable only to multiple girder cranes.

****

Provide trolley frame consisting of two structural steel side frames or trucks welded together with one or more structural steel load girts to form a one-piece unit. Provide pads for the use of jacks or wedges when changing truck wheels.

]2.2.7 End Stops and Bumpers

****

NOTE: Rubber bumpers dry out with time. Hydraulic type bumpers are more expensive. Using the words shock-absorbing allows the manufacturer to choose. Rubber like materials are not acceptable as an option.

****

Fit crane runways and gantry girders with structural steel end stops. Fit gantry end trucks and trolley frames with shock-absorbing, [spring][or][hydraulic] type bumpers capable of decelerating and stopping the gantry and/or trolley within the limits stated by OSHA and MHI CMAA. Provide trolley end stops of sufficient strength to withstand the impact of a fully loaded trolley moving at 50 percent of maximum rated travel speed. When two gantry cranes are on the same runway, fit one crane with shock-absorbing bumpers on each face of each end-truck, and the other crane must have shock-absorbing bumpers as per above on one face only of each end-truck which is the opposite face of the adjacent crane. Fit the other face of the end-truck with a structural steel stop to engage the bumpers of the adjacent crane. Provide gantry bumper stops as specified in Section 05 12 00 STRUCTURAL STEEL. Locate stops to permit maximum gantry and trolley travel.

[2.2.8 Footwalks

****

NOTE: Delete the following paragraph if footwalks are not required. Provide footwalk fall protection with guard rails or static line with safety belts.

****

The location and construction of footwalks must conform to ASME B30.2. A full-length structural platform is required on the driver's side of the gantry. Provide[checkered steel][non-slip] flooring for platform, double member handrail and a suitable toe-guard, with 760 mm 30 inch clearance in front of control equipment. Minimum 380 mm 15 inch clearance is required in front of gantry machinery.[To give access to the opposite side of the trolley, gantry conductors, or other equipment, mount a footwalk a minimum of twice the length of the trolley on the opposite side of the crane. Provide a cross-over footwalk over an end tie between the two girder footwalks.] Mate the drive side footwalk with the crane access platform. Make the length of the drive side footwalk[adequate to provide access to the trolley and provide sufficient room for mounting control cabinets][along the entire length of the gantry]. Provide safety handrails for footwalks.

]2.2.9 Runway Rails

Provide runway rail size as specified in Section 05 12 00 STRUCTURAL STEEL.

[2.2.10 Operator's Cab

****

NOTE: Applicable if a cab is specified, otherwise delete paragraph. Specify enclosed cab for outdoor use. Open cab may be used indoors. Enclosed cabs can be provided with a heating and/or air conditioning unit according to environmental conditions. Specify the location of cab and the direction the operator should face.

****

[2.2.10.1 Design

Design and construct operator's cab in accordance with[CMAA 70][CMAA 74][and ASME B30.2]. Locate cab access to facilitate entry and exit by crane operator. Provide space near cab entrance for storage of a carbon-dioxide, dry chemical, or equivalent hand fire extinguisher.

][2.2.10.2 Cab Construction

Provide a[standing][seated] type[fixed cab mounted on gantry][trolley mounted cab] of the[enclosed][open] type for[outdoor][indoor] use, and designed to provide a clear view of the operating floor and hook for operator.[Provide cab with a suitable[heating][heating and air conditioning] unit]. Locate cab on the [_____] of the[gantry][trolley] with the operator facing [_____].

]][2.2.11 Additional Provisions for Outside Service

****

NOTE: This paragraph is applicable for outdoor cranes only.

****

Seal weld structural members on outdoor cranes. Provide crane gantries with parking brakes which will sufficiently hold the crane against a wind pressure of 244 Pa 5 psf for in-service conditions. Provide crane gantries with manually-operated pin locks at each rail, designed to securely anchor the crane against a wind pressure of 1.5 kPa 30 psf for out-of-service conditions.

]2.3 MECHANICAL EQUIPMENT

2.3.1 Variable Frequency Drives

2.3.1.1 Gantry Drives

****

NOTE: If the span is less than 12 m 40 feet and the application is CMAA Class "A" or "B", then A-1 drive may be included as an option. A-1 and A-4 drives are only referenced in CMAA 70, and if selected, delete the reference to CMAA 74.

****

Provide Variable Frequency AC (VFAC) [either the A-1 or][A-4] gantry drive arrangement as specified in[CMAA 70][CMAA 74], consisting of a single electric motor mechanically connected through gear reduction and drive shafts to the drive wheels or separate drive motors at each end of gantry. Perform acceleration and deceleration meeting the requirements specified in this section. Gears must conform to applicable AGMA standards. Provide gear reducers that are oil tight and fully enclosed with pressure or splash type lubrication. Gantry-travel limit-switches are optional.

2.3.1.2 Trolley Drives

Provide complete trolley drive arrangement with a minimum of two wheels driven by an integral electric motor. Drive mechanism must run in totally enclosed oil bath. Limit switches are optional for drive mechanism. Provide acceleration and deceleration controls meeting the requirements specified in this section.

[2.3.1.3 Micro-Drives

****

NOTE: Current industry standards use Variable Frequency Alternating Current Drives (VFAC) in lieu of micro-drive motors. The following paragraph is included in this section for instances where the micro-drive motors will not be replaced with newer VFAC drives. If micro-drives are not to be used, delete this paragraph.

Include those motions where a micro-drive is required. If micro-drive is not specified, delete these paragraphs. Micro-drives are generally required when slow speeds are required for an extended amount of time. If precision movement is required for limited time for final positioning of loads, use adjustable frequency or dc variable voltage crane controls instead of micro-drives.

****

Provide the following crane motions with a separate micro-drive: [main hoist,] [auxiliary hoist,] [trolley drive][and][gantry drive]. The micro-drives are used to precisely position loads. Provide each micro-drive with an electric motor, gear reducer, magnetic coupling clutch and necessary controls. Connect the output shaft of the reducer to an extension of the primary drive high-speed shafting with a magnetic coupling clutch. Coupling must normally be disengaged and become engaged only if the micro-drive is required. Provide electrical clutch components, required for proper operation, conforming to the requirements specified in paragraph ELECTRICAL COMPONENTS. Provide magnetic coupling type clutches which engage and disengage the micro-drives from the high speed shafts of the main drive arrangement. The clutch must be engaged by electromagnet and released by springs. Provide clutch ratings not less than 150 percent of the micro-motor rated torque as amplified by the intervening gearing. Provide clutch enclosures to facilitate easy access for wear inspection of the friction elements and visual examination of the clutch assemblies.

]2.3.2 Gearing

Provide enclosed gear reducers type gearing. Gears and pinions must be spur, helical, or herringbone type only, and be forged, cast or rolled steel. Open-type gearing is not acceptable, except for final drives. Provide gears and pinions with adequate strength and durability for the crane service class and manufactured to ANSI/AGMA 2001 Quality Class 6 or better precision per [AGMA ISO 10064-6] [AGMA ISO 17485] [AGMA 2011] [ANSI/AGMA 2015-1].

2.3.2.1 Gear Reducers

Provide gear reducers which are [standard items of manufacturers regularly engaged in the design and manufacture of gear reducers for Class D and E cranes][or][integral components of standard hoists or hoist/trolley units of manufacturers regularly engaged in the design and manufacture of hoists or hoist/trolley units for Class A, B or C cranes]. Provide gear reducers designed, manufactured and rated in accordance with ANSI/AGMA 6113 ANSI/AGMA 6013 (for trolley drives only), as applicable. Except for final reduction, provide the gear reduction units with fully enclosed in oil-tight housing. Design gearing to AGMA standards and to operate in an oil bath. Operation must be smooth and quiet.

2.3.2.2 Open Gearing

Provide gears and pinions possessing adequate strength and durability for the crane service class and manufactured to ANSI/AGMA 2001 quality class 6 or better precision per [AGMA ISO 10064-6] [AGMA ISO 17485] [AGMA 2011] [ANSI/AGMA 2015-1]. Enclose open gears with safety guard removable covers over openings for inspection and access for grease lubrication.

2.3.3 Hoist Brakes

a. General: In addition to the requirements of CMAA 70, provide shoe, disc, or conical type brakes with thermal capacity suitable for class and service specified in this section. Shoe, disc, and conical brakes must be spring-set and electrically-released by a continuously rated direct acting magnet. Provide brakes which are self-aligning and easily adjusted for torque setting and lining wear. Use brake lining material which is asbestos free. Provide cast iron brake wheels conforming to ASTM A159 or the manufacturer's standard high-strength ductile cast-iron brake wheels, provided that the material exhibits wear characteristics in the form of powdered wear particles and is resistant to heat-checking. Provide disc brakes totally enclosed and having multiple discs with stationary releasing magnets. Brake torque must be easily adjustable over a 2:1 torque range.

b. Gantry Brakes:[Provide gantry braking system with a spring-applied and electrically-released single shoe, disc, or conical brake for each gantry drive motor.] Braking system which automatically sets when controls are released or power is interrupted. Make provisions to facilitate easy brake adjustment. Provide brakes with a torque rating of at least 50 percent of gantry drive motor rated torque.

2.3.4 Wheels

****

NOTE: Include the second sentence for CMAA 70 class D and E, cranes; otherwise delete. Include the

requirement for trolley wheels only for multiple girder cranes.
****

Furnish wheels manufactured of rolled or forged steel.[Wheel treads and flanges must be rim toughened to between 320 and 370 Brinell hardness number.] Provide double-flanged [gantry][gantry and trolley]wheels. Trolley and gantry wheels must have straight treads. Equip wheels with self-aligning double-row spherical roller-bearings of capacity as recommended by bearing manufacturer for design load of trolley or gantry.

2.3.5 Bearings

****
NOTE: Equalizer sheaves compensate for unequal length, stretch of the hoisting, and swinging of the load block.
****

All bearings, except those subject to a small rocker motion, must be anti-friction type. Provide a means for lubrication for bearings not considered lifetime lubricated by the manufacturer. Equip equalizer sheaves with sintered oil-impregnated type bushings in accordance with ASTM B438 or ASTM B439.

[2.3.6 Anti-Drip Provisions

Design cranes to preclude leakage of lubricants onto the lifted loads, floor, or external grounds. Fit all equipment and components which cannot be made leak-proof with suitable drip pans. Provide drip pans manufactured of steel and designed to permit removal of collected lubricant.

]2.4 ELECTRICAL COMPONENTS

[2.4.1 Explosion Proof Requirements

****
NOTE: Delete this paragraph if explosion proofing is not part of design criteria. Define hazardous classification and evaluate Contractor's proposal for electrical equipment. Show location of the hazardous areas.
****

Provide equipment and wiring in locations indicated conforming to NFPA 70 for Class [I] [II] [III], Division [1] [2] hazardous locations. Provide equipment suitable for[Group [_____]][operating temperature of [_____] degrees C degrees F]. Provide wiring and equipment in locations indicated of the classes, groups, divisions, and suitable for the operating temperature as specified.

]2.4.2 Control Systems

Provide a separate controller for each motor; however, use a duplex controller two motor gantry drives. Provide overload protection in conformance with the requirements of NEMA ICS 2 and mechanically and electrically interlock contactors that are used for starting, stopping, and reversing.

2.4.2.1 Travel Motion Control System

Provide AC inverter duty, totally enclosed non-ventilated (TENV), squirrel cage induction type bridge and trolley drive motors.

2.4.2.2 Drive Control System

Provide static reversing, adjustable frequency controllers conforming to[NEMA ICS 3][,][NEMA ICS 8] for the [hoist][trolley][and bridge]infinitely variable electric drives. Provide dynamic braking. Provide two step infinitely variable speed control for the bridge and trolley functions, controlled via pendant pushbuttons. The trolley, and bridge brakes must set after associated controller decelerates motor to a controlled stop. Size the bridge and trolley controllers to provide sufficient starting torque to initiate motion of that crane drive mechanism from standstill with 0 to 131.25 percent of rated load on the hook and not produce any hook rollback. Drive motors must run smoothly, without torque pulsations at the lowest speed, and be energized at a frequency not exceeding 60 HZ.

2.4.3 Power Sources

2.4.3.1 System Supply Voltage

Design cranes to be operated from a [_____] volt,[three-phase, 60 Hz, alternating current][direct current] system power source. Design energy isolating devices for such machine or equipment to accept a lockout device in accordance with NFPA 70.

2.4.3.2 Transformers

****

NOTE: This paragraph is applicable to ac power supplies only.

****

Provide dry type transformers and carry full load continuously at rated voltage and frequency without exceeding an average temperature rise of 115 degrees C above an ambient temperature of 40 degrees C. Provide transformer with totally enclosed case finished with manufacturer's standard coating system. Fully encapsulate transformers, except for those specifically designed for use as an isolation transformer for static power conversion units.

2.4.4 Motors

****

NOTE: Motor heaters are desirable for outdoor cranes, unheated warehouse service cranes, or any other condensing high-humidity application, but specify heaters only if an integral component of the hoist and motor manufacturer. Select a motor from the following types and coordinate with the desired control type.

Select industrial motors for CMAA 70, Class A, B, C and D cranes, as follows:

a. For critical load handling, self-excited

alternator with electrical load brakes or emergency dynamic braking is preferred.

b. Select crane type motors for ac motors.

c. Select 800 Series dc mill type motors or dc industrial motors for dc motors.

d. If crane and/or industrial type motors are specified, select NEMA MG 1.

Select mill motors for CMAA 70, Class E cranes, as follows:

a. If 800 Series dc mill type motors are specified, select AISLE Std No. 1.

b. Select dc motor type (squirrel cage, wound rotor) for the appropriate control system.

c. Select dc series wound motors for dc constant potential control.

d. Select dc shunt wound for dc variable voltage control.

e. Select ac motor (squirrel cage, wound rotor) for the appropriate control system.

****

2.4.4.1 General Requirements for Motors

a. Provide motors designed specifically for crane and hoist duty. Provide drain holes at low points near each end; inspection and service covers with gaskets; and hardware which is corrosion-resistant. Provide motors conforming to the requirements of NFPA 70[,] [NEMA MG 1]and UL 1004-1.

[b. Motor heaters must energize when mainline contactor is de-energized, and water heaters de-energize when mainline contactor is de-energized. Provide motors 15 kW 20 HP and larger with a suitable heater to prevent condensation during long periods of inactivity. Provide motor heater which is an integral component of the hoist and motor manufacturer.

] c. Provide one embedded thermal sensitive device in hoist motor windings. Device and associated circuitry must serve as an alarm activating an amber signal or pilot light visible to control stations when motor temperatures become excessive. Establish set point below the Class B insulation temperature limit. Thermal-sensitive device and associated circuits must be self-restoring (automatic reset). Two-speed, two-winding motors with a solid-state control are not allowed for creep-speed use.

2.4.4.2 Gantry and Trolley Drive Motors

Provide [ac crane type] [dc industrial type] [800 Series dc mill type] [[single-speed; single-winding] [two-speed; two-winding]] [NEMA design B squirrel cage ac type rated] [wound rotor ac induction type] [ac type designed for ac adjustable frequency operation] [dc series wound type] [dc shunt-wound type] gantry and trolley drive motors.

2.4.4.3 Motor Enclosures

****

NOTE: Applicable to 1 or 2 speed ac magnetic control of ac squirrel cage motor. If it is not desirable to have the motor immediately reverse direction, include sentence on plugging to allow the motor to stop prior to reversing direction. If excessive load swing cannot be tolerated during the start of the gantry or trolley, include sentence on reduced voltage starting.

a. Select drip-proof enclosure for indoor usage, except in a hazardous atmosphere.

b. Select totally enclosed nonventilated enclosure for outdoor use and indoor use in a hazardous atmosphere.

c. Select totally enclosed fan cooled enclosure for motors operating at rated speed for long periods.

d. Select forced ventilated enclosure for Class E service.

****

Provide motor enclosures which are [totally enclosed, non-ventilated (TENV)] [totally enclosed, fan cooled (TECH)] [totally enclosed, air-over frame (TAO)] [drip-proof] [drip-proof forced ventilation] conforming to NEMA 250.

2.4.4.4 Motor Insulation and Time Rating

****

NOTE: For gantry and trolley motors, select Class F or H insulation based on rated temperature rise of 105 (Class F)/125 (Class H) degrees C by resistance above a 40 degree C ambient for CMAA Class A, B, C cranes and CMAA 74 cranes with ac or dc magnetic control and electrical control braking.

For gantry and trolley motors, select Class F insulation for Duty Class H1, H2, and H3 hoists and CMAA 70 Class A, B, C cranes and CMAA 74 cranes with ac or dc magnetic control.

For all motors, select Class F or H insulation with a rated temperature rise of 105 (Class F)/125 (Class H) degrees C by resistance above a 40 degree C ambient for CMAA 70 Class A, B, C and CMAA 74 cranes with ac or dc static controls.

For all motors, select Class F or H insulation based on a rated temperature rise of 105 (Class F)/125 (Class H) degrees C by resistance above a 40 degree C ambient for CMAA 70 Class D and E cranes.

Delete frame size selection if not needed for the project.
****

Provide motors with [Class F] [Class H] rated insulation based on an [105] [125] degree C motor temperature rise above 40 degrees C ambient, with frame size selection based on continuous ratings.

[2.4.4.5 Micro-Motors

Micro-motors for gantry [and trolley] drives must be [direct current industrial type, shunt wound motors] [industrial type, single-speed; single-winding; ac squirrel cage motor] and conform to the requirements of NEMA MG 1. Provide totally enclosed micro-motor , fan cooled (TEFC), with Class F or H insulation. Motor voltage rating must comply with system supply voltage rating specified.

]2.4.5 Electric Hydraulic Brakes

[2.4.5.1 Travel Brakes

****
NOTE: Delete this paragraph if hydraulic braking system is not required.

If electric brakes are used, provide a drift point so the brakes will release after the motor is de-energized, thereby allowing the motion to coast and reduce swing of the load. A drift point can also allow the trolley to center itself over the load before actually starting to lift.

For pendant control cranes and cab controlled cranes where hydraulic braking is not desired, select spring-applied electrically-released brakes.

For cab operated cranes, specify electric-hydraulic brakes for gantry or trolley brakes except in the case of constant speed/speed regulated (at a particular controller setting) type controls.

Limit electric-hydraulic brakes to ac magnetic or secondary saturable reactor and dc magnetic controls for ac wound rotor motors and dc series/compound wound motors respectively. Limit electric-hydraulic brakes to gantry brakes on gantry mounted cabs and trolley brakes for trolley mounted cabs.

Do not specify electric-hydraulic brakes for the following:

a. Single and multi-speed magnetic control of squirrel cage motors.

b. Alternating current adjustable frequency control of squirrel cage motors.

c. Direct current variable voltage control of shunt wound ac motors.

****

Provide electric-hydraulic [gantry][trolley] brakes which are dc shunt magnet type equipped with hydraulic actuators manually-operated with a foot-operated master control unit in the operator's cab, and electrically released with the operation of the mainline contactor POWER-OFF pushbutton or power failure. Provide remote control bleeders operable by pushbutton and foot pedal except for power-assisted brake systems. Remote control bleeders must be complete with pushbutton clearly labeled and located in operator's cab where the operator can easily depress the pushbutton and pump the brake simultaneously. In lieu of the combination electric-hydraulic brakes, separate hydraulic and electric brakes may be provided. Design hydraulic brake system to ensure equal pressure at each brake cylinder.

][2.4.5.2 Hoist Brake Time Delay

****

NOTE: Delete this paragraph if one brake is specified.

****

Provide one of the hoist holding brakes with a time-delay setting (from 1 to 3 seconds). Initiate the time-delay upon releasing the control pushbutton or returning the master switch to OFF. Operation of mainline POWER-OFF pushbutton or power failure must result in each hoist brake's setting without any time-delay.

]2.4.5.3 Automatic Stop System

Provide fail-safe spring set electrically-controlled brakes when power is interrupted. Release brakes with a mainline contactor POWER-OFF pushbutton or a master switch for the associated drive. Brakes must automatically stop when there is a power failure. Design electric system to be mechanically released. Provide enclosures for electrical-controlled brake components conforming to NEMA ICS 6 Type [_____]. Provide direct current shunt magnetic shoe brakes with an electrical forcing circuit for rapid release of brake. Circuit each shunt coil brake for both conductors to open simultaneously when the brake is de-energized.

2.4.6 Controls

2.4.6.1 Control Panels

****

NOTE: Control panel heaters are desirable for outdoor cranes, unheated warehouse service cranes or any other condensing high-humidity application.

Alternating current or dc static crane control for outdoor cranes need thermostatically-controlled panel heaters for outdoor panels or any other application which is colder than 0 degrees C. Alternating current or dc static crane control may need both thermostatic control and mainline contactor control.

****

Fabricate control panels of solid sheet steel designed and constructed to conform to requirements of NEMA ICS 6 Type [_____]. [Provide thermostatically-controlled heaters to keep control enclosure temperatures at or above 0 degrees C in each static crane control panel.][Control panel heaters must be energized when mainline contactor is de-energized, and be de-energized when mainline contactor is energized to prevent anti-condensation.]Hinge and equip control panel doors with gaskets and fitted with key-lock handle design, complete with a single key to open all locks. Provide a non-resettable hour meter, connected across the main line contactor, readable from the exterior of the main control panel, to indicate the elapsed number of hours the crane is energized.

2.4.6.2 Drift Point

****

NOTE: Provide gantry and trolley directions normally oriented to main compass headings.

Select method of festoon suspension. For multiple girder cranes select underneath footwalk and for single girder cranes select auxiliary girder. If a hoist thermal sensor is specified, include requirement for yellow pilot light. If a micro-drive is specified, include the sentence, "A 2-position [_____]."

Pendant handles are required only if pendant is in an explosion area. Monorail cranes do not require an independent track for pendants.

****

Provide trolley and gantry main control systems with a drift point between OFF and first speed control point in each direction or have a separate pushbutton.

[2.4.6.3 Micro-Drive Motor and Clutch Control

Design micro-drive system such that when micro-drive is selected at control station, all main motors are disconnected, and all micro-drive clutches energized. Operation of micro-drive motors must be from crane control station. Provide micro-motor control systems with single-speed in each direction by means of an electrically-operated, full-magnetic, [reduced][full] voltage type starter. Do not apply power to any micro-motor unless all clutches are fully engaged. If a clutch disengages during operation of micro-motors, the mainline contactors must open and all brakes must set. Prevent application of power to any main motor with any clutch engaged. Provide a transfer switch at crane control station to allow transfer from either mode of operation to the other only when all brakes have been set for not less than 5 seconds. Provide a single CLUTCH-ENGAGED green pilot light [at the pendant station][in the cab] when all clutches are energized; also provide individual CLUTCH ENGAGED pilot lights on drive control panels.

][2.4.7 Cab Control Station

****

NOTE: Delete this and the following four paragraphs if a cab is not required.

****

2.4.7.1 General

****

NOTE: Provide gantry and trolley directions normally oriented to main compass headings. If stepped speeds and/or drift point are specified, include the applicable requirements in this paragraph. Delete auxiliary hoist switch if not necessary for the project.

****

Accomplish crane control by a [gantry-mounted][trolley-mounted] cab control. Provide spring-return to "OFF" for master switch operating handles, with [distinct drift point detents,][distinct speed-point intents,] and OFF position latching. Provide NEMA Type 1 master switch enclosures. Provide POWER-OFF pushbutton with a red mushroom head and a green or black POWER-ON pushbutton. Provide the following cab master switches:

a. Main Hoist - up/down.

[b. Aux Hoist - up/down.

] c. Gantry - [_____] [_____].

d. Trolley - [_____] [_____].

e. POWER-OFF.

f. POWER-ON.

2.4.7.2 Cab Indications

****

NOTE: If hoist thermal sensor is specified, include requirement for red light. Voltmeter applicable to dc control systems only. If rail clamps are specified, include sentence regarding rail clamp operation and indication. If flood lighting is specified, include requirement for toggle switch.

****

Provide red pilot lights to indicate excessive hoist motor temperature. Provide a white pilot light to indicate that power is available on load side of crane disconnect switch. Provide a blue pilot light to indicate that the main contactor is energized.[Supply a minus 300 to plus 300 Dc voltmeter to monitor the main rectifier output voltage, and provide a selector switch to select the voltage to be monitored.][Provide a red pilot light to indicate the rail clamps are set.][Provide a single-toggle switch to operate crane floodlights.][Provide a single green pilot to indicate all micro-drive clutches are engaged.]

[2.4.7.3 Cab Controls

****

NOTE: Delete this paragraph if combination controls (cab and pendant or cab and radio control) are not used. If it is desirable to raise the pendant out of the way, include the last sentence. Otherwise,

delete.

****

Provide cab with a 2-position key-operated switch to allow transfer of control from cab to [pendant][radio control] station and a red pilot light mounted in cab to indicate that the control has been transferred to other station. Selection of one operating station must lock out the controls of other stations.[Also provide a 2-position switch to raise and lower the pendant station.]

][2.4.7.4 Cab Heating & Ventilating [& Air-Conditioning]

****

NOTE: If heating or air conditioning of the cab is required, edit this paragraph to specify design requirements; otherwise delete this paragraph. Refer to UFC 3-400-02, "Design: Engineering Weather Data" ambient temperatures for cab heating and air conditioning.

****

Provide thermally-insulated cab with [air-conditioner][and electric heater]. Provide a filter unit to pressurize the cab with filtered outside air. Provide air filter which is a standard commercial type capable of removing airborne dust and located where it can be readily cleaned or changed. Provide adjustable thermostat to control [air conditioner][with][heater]. The unit must meet the Energy Efficient requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP. Keep the cab interior at 18 degrees C 65 degrees F in winter with [_____] degrees C F ambient temperature and [_____] degrees C F in summer with [_____] degrees C F dry bulb and [_____] degrees C F wet-bulb ambient temperatures. Provide corrosion-resistant material or protection against corrosion for all other hardware and components. Mount motor compressor assembly on vibration isolators.

]][2.4.8 Pendant Control Station

****

NOTE: Delete the following paragraphs if pendant control is not specified. If the crane is higher than 18 m 60 feet above the operating floor and the span is greater than 15 m 50 feet, consider including a pendant drive for ease of movement of the pendant if it is not towed by the trolley; otherwise delete this paragraph. Pendant drive speed should be the same as the trolley.

****

[2.4.8.1 General

Provide NEMA Type [1] [3R] [7] [9] [12] pendant control station. Hold physical size of pendant to a minimum. Provide a separate cable of corrosion-resistant chain consisting of minimum 6.4 mm 1/8 inch wire. Attach pendant station to [underside of crane gantry footwalk][an auxiliary girder] and hang vertically with bottom of pendant at 1 m 40 inches above floor. Do not support weight of pendant by control cable.

]2.4.8.2 Operating Pushbuttons

****

NOTE: Provide gantry and trolley directions normally oriented to main compass headings. Select method of festoon suspension: For multiple girder cranes select underneath footwalk and for single-girder cranes select auxiliary girder. If a hoist thermal sensor is specified, include requirement for yellow pilot light.

****

Provide heavy-duty, dust-and-oil-tight type operating pushbuttons with distinctly-felt operating positions which meet requirements of NEMA ICS 2. Pendant control buttons must be momentary pushbuttons. Provide recessed type pushbuttons (except the POWER-OFF button) to avoid accidental operation. Make diameter of buttons a size which will make operation possible with a thumb while holding the pendant with same hand. Provide nameplates adjacent to each pushbutton. Provide barriers on pendant between various pushbutton functions, except on elements mounted in junction box. In a multi-speed application, provide dual-position pushbuttons that have a definite click-detent position for each speed. Design and manufacture pushbuttons not to hang up in control case. Include with the pendant a separate set of pushbuttons for each motion and for POWER-ON POWER-OFF. Provide the following pushbuttons:

POWER-OFF.

POWER-ON.

Hoist-up.

Hoist-down.

[Gantry]-[_____].

[Gantry]-[_____].

Trolley-[_____].

Trolley-[_____].

2.4.8.3 Light Indicators

****

NOTE: Coordinate requirement for pilot lights and selector switches. Delete micro-drive if not applicable.

****

Provide pilot lights meeting heavy-duty requirements of NEMA ICS 5. Provide one red pilot light to indicate excessive hoist motor temperature on pendant station. Provide a blue pilot light to indicate that the main contactor is energized, and a white pilot light to indicate that power is available on the load side of crane disconnect switch. Provide a bright red mushroom head for the POWER-OFF pushbutton. Provide a 2-position selector switch to select between normal and micro-drive.[Provide a single green pilot light to indicate all [micro-drive]clutches are engaged.]

[2.4.8.4 Pendant Drive Control

****

NOTE: If the crane is higher than 18 meters 60 feet above the operating floor and the span is greater than 15 meters 50 feet, consider including a pendant drive for ease of movement of the pendant if it is not towed by the trolley; otherwise delete this paragraph. Pendant drive speed should be the same as the trolley.

****

Provide a 3-position momentary contact spring-return to OFF toggle switch to control the motorized trolley for pendant.

][2.4.8.5 Transfer of Control Stations

Provide pendant with a green pilot light to indicate that control has been transferred to pendant station from cab with key lock-out.

]][2.4.9 Radio Remote Control, Infrared Remote Control

****

NOTE: Include this and the following paragraph if radio remote control or infrared remote control is desired; otherwise delete.

****

2.4.9.1 General

Equip crane with a complete digital radio remote-control system to permit full control of crane from a portable wireless transmitter. Provide a system which is the use-proven product of a manufacturer regularly engaged in design and manufacture of crane radio remote-control systems. Provide a "fail-safe" designed system so that the failure of any component or loss of signal will cause all crane motors to stop. The system must permit complete, independent and simultaneous operation of all crane functions.[Set system frequency in the 72MHz-76MHz band.][Frequencies must conform to FCC Part 15.] Include transfer relays in receiver if crane is also cab or pendant controlled.

2.4.9.2 Transmitter

****

NOTE: Provide gantry and trolley directions normally oriented to main compass headings.

****

Provide portable transmitter complete with an adjustable belt or harness. Crane motion switches must spring-return to OFF. Provide transmitter with two spare batteries and battery charger to permit continuous operation. Provide a key-lock with the key removable in the OFF position only to control transmitter operation. Provide a blue signal light mounted on crane visible from floor to indicate the main contactor is energized. Make POWER-OFF toggle-switch bright red. Provide the transmitter with the following controls:

Hoist-up/down.

Gantry-[_____].

Trolley-[_____].

POWER-ON.

POWER-OFF.

]2.4.10 Protection

2.4.10.1 Main Line Disconnect

Provide a main line disconnect consisting of a combination circuit breaker (50,000 AIC) and non-reversing starter, starter without overloads (mainline contactor) in NEMA Type [_____] enclosure. Control circuit of mainline disconnect must cause all crane motions to stop upon mainline undervoltage, overload, control circuit fuse failure, or operation of POWER OFF pushbutton. Equip mainline disconnect with energy isolating devices designed to accept lockout devices.

2.4.10.2 Isolation Transformer

****

NOTE: Specify an isolation transformer and surge protection to protect electronics from external faults. Recommended for dc static control systems. Applicable to ac power supplied systems only.

****

Provide an SCR drive type isolation transformer specifically designed for cranes, with a continuous rating which will exceed that required of the sum of rated full-load full-speed KVA of hoist plus 50 percent of rated full-load full-speed KVA of trolley and gantry motors plus the rated KVA of controls. Multiply the total KVA by 1.05 (efficiency factor). Connect the isolation transformer to the load side of mainline disconnect of the transformer. Supply crane dc static control electric power distributed on the crane through this isolation transformer.

2.4.10.3 Surge Protection

Provide surge suppressors meeting the requirements of UL 1449. Provide three metal oxide varistors on the line side of each SCR drive isolation transformer to provide transient over-voltage protection.

2.4.10.4 Circuit Breakers

Provide circuit breakers meeting the requirements of UL 489.

2.4.10.5 Overloads

****

NOTE: Select applicable overload protection based on control circuit type.

****

[Provide alternating current circuit overload relays of the ambient compensated, automatic reset, inverse time type located in all phases individual motor circuits. Arrange overload relays to de-energize the associated motor on an overload condition.] [Provide an automatically reset inverse time-trip running overload relay for each dc motor circuit. Provide an automatically reset instantaneous trip overload relay in each dc motor circuit or for a pair of series-connected motors. Arrange overload relays to de-energize the associated motor on an overload condition.] [Alternating current adjustable frequency-control motor overload-protection must be electronic and protected by inverse time and current versus output frequency which will allow less current for a given amount of running time when frequency (speed) is lower than rated.] [Provide electronic direct current variable voltage control motor overload-protection.]

2.4.11 Limit-Switches

****

NOTE: Delete reference to micro-drive control system if not applicable.

****

Provide heavy-duty quick-break double-pole double-throw type gear limit switches conforming to NEMA ICS 2. The geared limit-switch interruption of a motion in one direction must not prevent the opposite motion. Geared limit-switches must reset automatically. Provide NEMA Type [1] [4] limit switch housings. Provide limit-switches to interrupt power to the primary [and micro-drive]control systems. Provide a geared limit switch to limit upward travel at an upper limit and a geared limit switch to limit downward travel at a lower limit. Provide also a block activated mechanical limit switch that removes power from the brake, motor and control drive simultaneously.

2.4.11.1 Gantry and Trolley Travel Limit-Switches

Provide runway (track-type) limit-switches for crane gantry and trolley motions to stop the gantry and trolley motions, respectively. Install limit-switch actuators on building and trolley frame to actuate the limit-switches and stop the crane gantry or trolley prior to contacting the trolley frame bumpers. Locate trip mechanism for trolley motion on crane runway to trip the switch before the bumper contacts the stop. Locate trip mechanism for gantry motion on crane runway to trip switch before bumper contacts the stop. When the switch is tripped, permit the switch opposite travel in the direction of stop and to automatically reset.

[2.4.11.2 Rail Clamp Limit-Switches

****

NOTE: Include paragraph for outdoor cranes; otherwise delete. Delete reference to micro-drive when not applicable.

****

When rail clamps are set, furnish each rail clamp with a limit-switch designed to interrupt the primary [and micro-drive]control circuits to gantry drive. Provide a red pilot light at control station to indicate the rail clamps are set.

]2.4.12 Wiring

Perform wiring complying with Article 610 of NFPA 70. Number or tag wires at connection points. Make all splices in boxes or panels on terminals boards or standoff insulators. Base motor loop, branch circuit and brake conductor selection on NFPA 70 for 90 degrees C 194 degrees F conductor rating on indoor cranes, and for 75 degrees C 164 degrees F conductor rating on outdoor cranes. Provide Type SRML conductors in the vicinity of resistors and conductors connected to resistors.

2.4.13 Electrification

2.4.13.1 Main Power Electrification

Main power electrification system must provide power to crane starter/disconnect circuit breaker.

2.4.13.2 Crane Runway Conductors

****

NOTE: Select covered conductor bar system for:

a. Indoor non-hazardous service
b. Outdoor non-corrosive environment

Select festoon system for:

a. Indoor - hazardous service
b. Outdoor - corrosive (marine) environment

****

[Provide covered conductor bar type crane runway conductor system designed and manufactured to meet UL requirements. Provide rigid or flexible self-closing type protective cover designed to cover all live conductors and shaped to prevent accidental contact with conductors. Provide heavy-duty sliding shoe type collectors compatible with the electrification system. Provide two tandem designed collector heads for each conductor rail to provide redundancy.] [Provide festooned type crane runway conductor system consisting of a support rail, cables, junction boxes, cable cars and accessories. Hardware must be corrosion-resistant or protected against corrosion. Festoon storage area must not restrict the crane travel at the ends of runway.]

2.4.13.3 Gantry Span Conductors

Provide[festooned type consisting of a support rail, electrical cables, junction boxes, cable cars and accessories][rigid conductor/collector type located within enclosure] gantry span conductor system. Do not allow cable loops to drop below the hook high position. Furnish corrosion resistant, outdoor crane gantry festoon, system hardware.

[2.4.13.4 Pendant Festoon System

****

NOTE: The pendant festoon system is an option to the Designer.

****

Provide pendant festoon system consisting of a support rail, cables, junction boxes, cable cars and accessories. Do not allow cable loops to drop below the hook high position. Provide pendant control car with NEMA Type [1] [3R] [12] junction box. Pendant festoon must be[towed by trolley][independent of trolley motion]. Furnish corrosion resistant, outdoor crane, pendant festoon system hardware.

][2.4.13.5 Pendant Drive System

Provide pendant festoon system with a motor-drive system capable of driving the pendant control car at [_____] m/s fpm. Control of pendant motor drive must be from the pendant.

][2.4.13.6 Pendant Retraction System

****

NOTE: Select method of pendant retraction if specified; otherwise delete paragraph.

****

[Provide pendant control car with an electric-powered cable reel so that the pendant station will retract fully.][Provide a wire-rope hoist to hoist the pendant station. Pendant and pendant drop-cable must be retractable to approximately 1/3 of drop cable length.]Control retraction system from cab.

]2.4.14 Special Requirements

2.4.14.1 Warning Horn

****

NOTE: Delete last sentence if not applicable to project.

****

Provide a solid-state electronic warning horn on the crane. Accompany any gantry or trolley motion by a continuous series of alternating tones.[The warning horn must not sound when the crane is in the micro-drive mode.]

2.4.14.2 Accessory Power

****

NOTE: If lighting, motor or control cabinet heaters or receptacles are specified, include the following paragraph if 460 volt ac is the power source. Select the components requiring power.

****

Use three-phase 208Y/120 volt ac power supplied via a circuit breaker and isolation transformer from the line side of the main line disconnect for [lighting,] [heaters,] [and accessory circuits] on the crane. Provide the circuit breaker with a NEMA Type [1] [3R] [12] enclosure. The enclosure must have provisions to lock the breaker in the OFF position. Provide each circuit breaker pole with individual thermal and magnetic trip elements and the enclosure cover with a button for mechanically tripping the circuit breaker. Supply three-phase 480 volt delta primary and 208Y/120 volt wye secondary general lighting transformer from the accessory circuit breaker and feed a 208Y/120 volt UL listed circuit breaker panelboard and a heater circuit breaker/combination starter. Provide a panelboard to supply branch circuits for utilization of various accessories such as [receptacles,] [lighting,] [panel internal lighting,] [motor heaters and control enclosure which meets NEMA requirements]. Transformer and panelboard must have the same NEMA classification as the circuit breaker.

2.4.14.3 Receptacles

****
NOTE: Specify receptacles for multiple girder cranes. Specify ground fault protection for outside cranes. Delete requirement for receptacle in cab when not applicable.
****

Provide single-phase, 120-volt 15-amp, grounded, duplex type receptacles complete with metal weather-proof enclosure with self-closing weatherproof receptacle cover. Provide a receptacle on the trolley at each end of the front gantry walkway in the vicinity of gantry travel drive motors and in the cab. Provide several receptacles in the vicinity of the control equipment equally spaced every 3 m 10 feet. Breakers used to protect circuits supplying the receptacles for outside cranes must incorporate ground fault current interruption feature and meet the requirements of UL 943.

2.4.14.4 Lighting

****
NOTE: Specify lighting for outdoor cranes or in dimly lighted areas.
****

Provide control panels with a 120-volt lamp fixture with an unbreakable lens and switch. Provide floodlights to illuminate the work area under the crane and drum area on crane, controlled from crane control station. Provide metal halide industrial floodlight luminaries. Totally enclose each floodlight, vapor-tight design, gasketed and provided with a heat-resistant and impact-resistant glass lens. Space and attach floodlights to underside of crane to provide uniform lighting.

[2.4.14.5 Anti-Condensation Heaters

****
NOTE: Motor heaters recommended for outdoor cranes, unheated warehouse service cranes or any other condensing high-humidity application; if not desired delete this paragraph. Thermostatically-controlled heaters is a designer option.
****

Equip motor and control panels with anti-condensation heaters. Provide thermostatically-controlled heaters in each static-control panel to keep control enclosure temperatures at or above 0 degrees C. Provide NEMA Type [1] [3R] [12] enclosure for circuit breaker combination magnetic starter. Equip magnetic starter with manually-reset overload relays and interlock with the mainline disconnect so that anti-condensation heaters are de-energized when the mainline contactor is energized and the magnetic starter is energized when the mainline contactor is de-energized.

][2.4.14.6 Wind Indication and Alarm

****
NOTE: Specify location of wind alarm station for outdoor cranes, normally mounted near center of the gantry. Provide location of cutout. Delete

paragraph if not applicable.
****

Provide a wind-indicating device with an adjustable alarm trip point. Provide alarm trip with time-delay for wind gusts. Adjustable trip must actuate an oscillating blue light and bell mounted near [_____]. Provide ability to cut off bell alarm from the[pendant station][cab].

][2.4.14.7 Electrically-Driven Oil Pump Alarm

****
NOTE: Delete this paragraph for equipment which does not contain an oil pump.
****

Provide electrically -driven lubricating pump complete with an audible alarm and red light for indication of pump malfunction. Make location of alarm the factory standard location.

]2.4.15 Load-Limit System

****
NOTE: Specify load sensing if loads approaching the capacity of the crane are to be lifted routinely.
****

Provide a load-limit visual/audible system for the main hoist to inform the operator that the preset load has been exceeded. Provide a load-limit system consisting of a load-cell, load-sensing electronics, overload indicator lights, overload alarm bell and alarm cut-out switch. Mount load cell to receive the load from equalizing sheave pin or upper block sheave pin. The alarm setpoint must be adjustable.

2.4.15.1 Load-Sensing Electronics

Provide NEMA Type [1] [3R] [12] enclosures for load sensing electronics. Alarm setpoint must be adjustable.

2.4.15.2 Alarm and Indicator Light

Provide an overload alarm light to indicate a load greater than the preset maximum. Indicate overload alarm with a red light and clearly labeled "OVERLOAD". Also provide a bell to indicate when an overload condition exists. Make provisions to turn off the bell from[pendant station][cab] [_____].

2.4.16 Fungus Resistance

****
NOTE: Specify fungus resistance for cranes in marine or humid environments.
****

Coat electrical connections such as terminal connections, circuit connections, components and circuit elements with fungus-resistant varnish. Do not treat components and elements which are inherently inert to fungi or hermetically sealed. Do not treat elements whose operation will be adversely affected with the application of varnish.

2.5 ELECTROMAGNETIC INTERFERENCE SUPPRESSION

****

NOTE: Specify EMI suppression if electro-magnetic interference from the crane may be a problem to sensitive electronics in the work area.

****

2.5.1 Shielded Cable

Provide shielded type pendant and festooned cables of braided tinned-copper. Ground each cable shielding with a single connection to equipment grounding conductor.

2.5.2 EMI/RFI Shielded Boxes

2.5.2.1 General

Boxes designed to house electronic and electrical control equipment, instruments, metering equipment, etc., in installations where electromagnetic compatibility and/or system security is required must protect interior components from stray radio frequency (RF) fields and contain RF signals produced by interior components.

2.5.2.2 Construction

Design Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) shielded boxes to meet UL 50 Type 12 and Type 13. Construct the shielded boxes of [1.519] [1.897] mm [16] [14] gauge steel with seams continuously welded and ground smooth, without holes and knockouts. Cover gasket must be a combination of woven plated steel mesh and oil-resistant gasket which will provide an EMI/RFI seal as well as an oil-tight, dust-tight and water-tight seal between cover and body. Attach gasket to cover with oil-resistant adhesive. Provide stainless steel cover clamps and screws which are quick and easy to operate on three sides of hinged cover for positive clamping.

2.5.2.3 Attenuation

Design EMI/RFI shielded boxes to provide maximum shielding of electric and magnetic components of radiated RF energy. Provide RF filters to suppress conducted radio frequency in cables and conductors. Provide shielded boxes with attenuation greater than 60 db at 14.5 KHz to greater than 100 db at 1 MHz for magnetic fields and greater than 100 db from 14.5 KHz to 430 MHz for electric fields.

2.5.2.4 Finish

Provide zinc-plated EMI/RFI shielded boxes in accordance with ASTM B633 SC3/Type II to provide corrosion-resistant conductive surfaces for gasket contact area and conduit entries. Match the finish coat with the crane finish.

[2.5.3 Hoist Drum Grounding

****

NOTE: A grounding drum is required for non-sparking environment only (general nuclear or explosive).

****

Provide a copper ring/collector assembly to ground each drum. Provide electrically-bonded ring to drum. Collector must be stationary and connected to equipment grounding conductor system with a No. 8 AWG copper wire.

]PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, and before performing any work, verify all dimensions in the field and submit a letter describing the results of this verification including discrepancies to the Contracting Officer and crane manufacturer. The Contractor is responsible for the coordination and proper relation of the contracted work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

3.2 ERECTION

Perform the entire crane erection in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative. Provide a written certificate from crane manufacturer indicating the crane is erected in accordance with manufacturer's recommendations before testing the completed installation.

3.2.1 Shop Assembly

Shop assemble major crane components as completely as possible. Match mark disassembled parts and tag electrical connections after complete no-load shop testing. Protect all parts and equipment at site from weather, damage, abuse and loss of identification. Erection procedures must ensure that the crane is erected without initial stresses, forced or improvised fits, misalignments, nicks of high-strength structural steel components, stress-raising welds and rough burrs. Clean and repaint damaged surfaces after crane is erected. Provide all necessary grease and oil of approved quality and grade for the initial servicing and field test.

3.2.2 Mechanical Alignment

Align motors, couplings, brakes, gear boxes and drive components when reinstalled in accordance with manufacturer's instructions.

3.2.3 Electrical Alignment

Align control system in accordance with manufacturer's instructions. Store a copy of the final alignment data in control panel door, including but not limited to, timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents and test conditions such as ambient temperature, motor load, date performed and person performing the alignment.

3.2.4 Welding

Qualify or pre-qualify welders, welding operations and welding procedures in accordance with AWS D14.1/D14.1M. Perform welding indoors. Surface of parts to be welded must be free from rust, scale, paint, grease or other foreign matter. Minimum preheat and interpass temperatures must conform to the requirements of AWS D14.1/D14.1M. Perform welding in accordance with written procedures which specify the Contractor's standard dimensional tolerances for deviation from camber and sweep. Such tolerances must not exceed those specified in accordance with AWS D14.1/D14.1M. Allowable stress ranges must be in accordance with CMAA 70. Perform welding of girders and beams conforming to AWS D14.1/D14.1M.

3.2.5 Field Painting

****
NOTE: The last sentence will only be required if the gantry crane is in an explosion proof area.
****

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the facility, must conform to SSPC SP 6/NACE No.3 and as specified in Section 09 90 00 PAINTS AND COATINGS. Paint gantry crane including gantry, trolley, hoist and all attached items in accordance with the manufacturer's standard practice. Paint the complete crane of one color. Paint gantry rail, supports and bracing in accordance with Section 09 90 00 PAINTS AND COATINGS. **Do not paint** items such as surfaces in contact with the rail wheels, wheel tread, hooks, wire rope, surfaces on the electrical collector bars in contact with the collector shoes and nameplates.[Coordinate the requirements of explosion proof cables with cable manufacturer.]

3.3 ACCEPTANCE TESTING

3.3.1 General

****
NOTE: This paragraph applies to new construction only. Specify the test weights required. The weights normally required are the rated load, 125 percent of the rated load and 10 percent of the rated load (for the grounding and the acceleration/deceleration test).
****

Provide all personnel necessary to conduct the required testing, including but not limited to, crane operators, riggers, rigging gear and test weights. Perform testing in the presence of Contracting Officer or his designated representative. Notify the Contracting Officer [_____] days prior to testing operations. Operate all equipment and make all necessary corrections and adjustments prior to the testing operations witnessed by Contracting Officer. A representative of the Contractor responsible for procuring and installing hoist equipment must be present to direct the field testing. Use compact test loads and permit a minimum of 50 percent of vertical lift. Test loads must be minus 0 percent to plus 5 percent of the required weight, and be verified prior to testing. Test weights required are [_____], [_____] and [_____] kg [_____], [_____] and [_____] pounds. Do not perform operational testing until after building interior has been painted. Furnish [three] [_____] copies of all test reports to Contracting Officer.

3.3.1.1 Test Sequence

Test crane in accordance with applicable paragraphs of this procedure in the sequence provided. Verify clearance envelope is clear to ensure there are no interferences.

3.3.1.2 Test Data

Record operating and startup current measurements for coils, hoist, trolley, and gantry motors using the appropriate instrumentation. Record speed measurements as required by facility evaluation tests (normally at 100 percent load). Compare recorded values with design specifications or manufacturer's recommended values. Abnormal differences must be justified in the remarks and appropriate adjustments performed. Note any high temperatures or abnormal operation of any equipment or machinery, investigate and correct. Record hoist, trolley and gantry speeds during each test cycle.

3.3.1.3 Equipment Monitoring

Monitor improper operation or poor condition of safety devices, electrical components, mechanical equipment and structural assemblies during the load test. Report defects observed to be critical during the testing period immediately to the Contracting Officer and suspend the testing operations until the defects are corrected. During each load test and immediately following each load test, make the following inspections:

a. Inspect for evidence of bending, warping, permanent deformation, cracking or malfunction of structural components.

b. Inspect for evidence of slippage in wire rope sockets and fittings.

c. Check for overheating in brake operation; check for proper stopping. Test all safety devices including emergency stop switches and POWER-OFF pushbuttons and inspect separately to verify proper operation of the brakes. When provided, inspect all safety accessories including warning horn, lighting, gauges, warning lights and accuracy of wind indicating device and alarm.

d. Check for abnormal noise or vibration and overheating in machinery drive components.

e. Check wire rope sheaves and drum spooling for proper reeving and operation, freedom of movement, abnormal noise or vibration.

f. Check electrical drive components for proper operation, freedom from chatter, noise, overheating, and lockout/tag-out devices for energy isolation.

g. Inspect gears for abnormal wear patterns, damage, or inadequate lubrication.

h. Verify that locations of crane capacity plates are visible from pendant operator's position.

[3.3.2 Trolley Travel

****

NOTE: Delete references to micro-drive when not applicable.

****

Operate trolley the full distance of gantry rails exercising all primary drive [and micro-drive]speed controls in each direction. Verify brake operation in each direction. In slow speed [or micro-drive,]trolley bumpers must contact trolley stops located on the gantry girders. In slow speed, test the proper operation (interrupt power, automatic reset) of the trolley limit-switches at both limits of trolley motion.

]3.3.3 Gantry Travel

****

NOTE: Delete references to micro-drive when not applicable.

****

Operate gantry in each direction the full distance of runway exercising all primary drive [and micro-drive]speed controls. Verify brake operation in each direction.[In slow speed the proper operation (interrupt power, automatic reset) of the gantry, test limit-switches at both limits of gantry motion.] In slow speed [or micro-drive]the crane gantry bumpers must contact the runway rail stops.

3.3.4 Gantry Crane Tests

3.3.4.1 Dynamic Load Tests

a. Trolley Dynamic Load Test: While operating the trolley the full distance of gantry rails in each direction with test load on the hook (one cycle), test proper functioning of all primary drive and micro-drive speed control points and proper brake action.

b. Gantry Dynamic Load Test: With test load on hook, operate gantry for the full length of runway in both directions with trolley at each extreme end of gantry. Verify proper functioning of all primary drive and micro-drive speed control points and brake action. Binding of the gantry end trucks indicates a malfunction requiring adjustment.

3.3.4.2 Trolley and Gantry Loss of Power Test

A test load of 100 to 105 percent of rated load must be raised clear of any obstructions on operating floor. Starting at a safe distance from walls or other obstructions, select a slow speed using the trolley and gantry primary drive. While maintaining a safe distance to obstructions, disconnect the main power source and verify brakes have set and that the equipment stops within the distance recommended by manufacturer.

3.3.5 Overload Tests

After the operational tests, test gantry crane system and all functions of gantry crane at 125 percent of rated load. With the trolley in the center of the bridge span, raise the test load approximately 1 foot and hold the load for 10 minutes. Verify the load does not move. Verify the girder deflection is within specifications.

3.3.6 Acceleration and Deceleration Tests

Test the acceleration and deceleration of gantry and trolley with approximately 10 percent of rated load at lowest possible location of hook. Operate gantry and trolley to run up to high speed and then stop without jarring or swinging the load.

3.3.7 Grounding Test

Test hoist to determine that the hoist, including hook and pendant, are grounded to building during all phases of hoist operation. Test the grounding of gantry and trolley with approximately 10 percent of rated load on hook. Test grounding between hoist hook and the structure's grounding system.

3.3.8 Adjustments and Repairs

Perform adjustments and repairs under the direction of the Contracting Officer at no additional cost to the Government, until satisfactory conditions are maintained, and contract compliance is affected. After adjustments are made to assure correct functioning of the components, repeat pertinent testing.

3.4 SCHEMATIC DIAGRAMS

Store schematic diagrams for equipment where indicated on drawings.

3.5 MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

Furnish a qualified experienced manufacturer's field service representative to supervise the crane installation, assist in the performance of the on site testing, and instruct personnel in the operational and maintenance features of the equipment.

3.6 OPERATION AND MAINTENANCE MANUALS

Provide [six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Detail in the operation manuals the step-by-step procedures required for system startup, operation and shutdown. Include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Also include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Secure approval of operation and maintenance manuals prior to the field training course.

3.7 FIELD TRAINING

Conduct a training course for the operating staff. Provide a training period consisting of a total of [_____] hours of normal working time and starting after the system is functionally completed but prior to final acceptance. Cover all pertinent points involved in operating, starting, stopping, and servicing the equipment, including all major elements of the Operation and Maintenance Manuals. Demonstrate in course instructions all routine maintenance operations such as lubrication, general inspection, and [_____]. Give Contracting Officer at least 2 weeks advance notice of field training.

3.8 FINAL ACCEPTANCE

****

NOTE: Use this paragraph as written for projects where the crane is the principal construction element, or represents a very significant portion of

the Contract cost. However, if the crane is part of a new facility or renovation, delete the acceptance paragraph from this section. Warranty period and operating and maintenance processes must coincide with the actual beneficial occupancy of the entire facility.
****

Final acceptance of crane system will not be given until Contractor has successfully completed all testing operations, corrected all material and equipment defects, made all proper operation adjustments, and removed paint or overspray on wire rope, hook and electrical collector bars.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-41 22 13.33 (May 2010)**

Preparing Activity: NAVFAC **Superseding**
UFGS-41 22 13.33 (April 2008)
UFGS-41 22 23.23 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 41 22 13.33

PORTAL CRANE TRACK INSTALLATION

05/10

****

NOTE: This guide specification covers the requirements for procurement, installation and testing of portal crane trackage.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Use this specification in conjunction with the following NAVFAC Standard Drawings that form part of MIL-DTL-82020 and MIL-DTL-29229 and following Definitive Drawings and UFC 4-860-02N, "Design: Trackage ." These are available in inch-pound units only.

NAVFAC NO./TITLE

1404353 "Definitive Drawing - Fabricated Portal Crane Track Switch Throw Linkage"

1404354 "Definitive Drawing - Portal Crane Track Switch Power Mechanism"

1404355 "Definitive Drawing - Portal Crane Track Turntable Frog Power Mechanism"

Crane track material, especially fittings, frequently require long lead time to become available to the Contractor. Ensure that the lead time required for material specified in this guide specification is considered when project construction time is established.

****

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NOTE: TO DOWNLOAD UFGS GRAPHICS

Go to http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms

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NOTE: Show the following information on the project drawings:

1. Existing material to be reused, if required

2. Crane rail system type

3. Crane wheel type

4. Rail curvature geometry

5. Switch throw mechanism

6. Utility line connections for power operated switch throw mechanism

7. Drainage for track fittings and switch throw mechanism housings

8. Rail alignment and gage

9. Rail joint connection types

10. Welding method at each welded joint

11. Sketch No. 41 22 13.33-1 and Sketch No. 41 22 13.33-2

Scheduling restraints which impact on the Contractor's time or cost to perform the work, station operations affected by the Contractor's work, and station operations which may affect the performance of the Contractor's work should be addressed in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS. The following is a sample paragraph which may be used in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, paragraph "Special Scheduling Requirements."

INTERFACE WITH TRACK OPERATIONS: Schedule work to

minimize interference to crane, (train,) and vehicular traffic operations. Crane and/or train operations will be scheduled to minimize interruptions to Contractor's work. However, critical materials must be transported as necessary. When it is required to transport critical material over trackage where Contractor is working, or to utilize portal cranes in work areas, Government will notify Contractor at least 5 calendar days, or as required, in advance so that he may schedule his work accordingly. If necessary, work scheduling for the entire project will be discussed during the pre-construction conference and present a proposed work schedule not later than 5 calendar days (or as required) after the pre-construction conference.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2023) Manual for Railway Engineering
AREMA Track Plans	(2008) Portfolio of Trackwork Plans

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1	(2000; R 2018) Standard Specification for Carbon Steel Tee Rails
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A49	(2012; R 2019) Standard Specification for Heat Treated Carbon Steel Joint Bars, Microalloyed Joint Bars and Forged Carbon Steel Compromise Joint Bars
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A128/A128M	(1993; R 2017) Standard Specification for Steel Castings, Austenitic Manganese
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM C109/C109M	(2023) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C144	(2024) Standard Specification for Aggregate for Masonry Mortar
ASTM C157/C157M	(2024; E 2024) Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM D1763	(2000; R 2013) Epoxy Resins

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-29229	(Rev B, Notice 1) Switches and Frogs, Track, Fabricated, for Portal Cranes
MIL-DTL-82020	(1997; Rev C; Notice 1; CANC Notice 2) Switches and Frogs, Track, Cast Manganese Steel, for Portal Cranes
MIL-STD-1699	(1992; Rev B) Nondestructive Evaluation of Butt Welds in Crane and Railroad Rails

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Crane track fittings; G, [_____]]

[Switch throw mechanisms and housings; G, [_____]]

[Drainage lines connections; G, [_____]]

[Weldable, adjustable rail clips; G, [_____]]

[Impact pads; G, [_____]]

SD-03 Product Data

Rail materials; G, [_____]

joint bars and methods of installation; G, [_____]

Rail clips; G, [_____]

Anchor bolts; G, [_____]

Grout; G, [_____]

Drainage lines; materials, pipe, and fittings; G, [_____]

SD-06 Test Reports

Test for grout; G, [_____]

Visual inspection; G, [_____]

Ultrasonic inspection of welded rail joints; G, [_____]

Load test; G; G, [_____]

Throw mechanism operational test; G, [_____]

Retesting; G, [_____]

SD-07 Certificates

Standard railway fittings; G, [_____]

Base plates; G, [_____]

Grout; G, [_____]

Aggregate materials; G, [_____]

Welding method; G, [_____]

Welder qualification; G, [_____]

1.3 QUALITY ASSURANCE

1.3.1 Welder, Welding Method, and Welder Qualification

a. Manual Shielded-Arc Welding Method: AWS D1.1/D1.1M, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests.

b. Thermite Welding Method: Welder qualification requirements for thermite welding method are defined in Section 34 11 19.00 20 WELDING CRANE AND RAILROAD RAIL - THERMITE METHOD.

1.3.2 Certifications Required

Submit certifications for standard railway fittings as outlined in AREA Manual and for base plates, grout, and aggregate materials used in crane track support in accordance with requirements specified herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver assembled items, and other materials to the job site in an undamaged condition. Handle and store materials to protect against damage before and after delivery. [Prevent distortion of double-tongue switches in transit and storage.]

1.5 EXISTING CONDITIONS

****

NOTE: An additional description of existing conditions may be included in this paragraph. If there is doubt as to foundation location, provide for confirmation by the Contractor. A description of any special conditions, such as any required salvage or reuse of existing crane track components or fittings, may be included in this paragraph.

****

****

NOTE: When existing crane rail trackage is to be removed, use Section 34 11 00 RAILROAD TRACK AND ACCESSORIES, subparts 1.2 38 through 1.2.46 as applicable, or the EFD regional guide specification for removal work. Provide specific requirements for removal of crane rail trackage material. When existing materials are to be reused, list materials here and indicate quantities on project drawings. The designer must determine the appropriateness of reusing existing materials. When it is determined that existing materials to be reused require reconditioning, identify the materials and include reconditioning requirements at the end of Part 2.

This "NOTE" applies to Parts 2 and 3.

****

Confirm existing rail, rail fittings, foundations, and utility locations by means of a field survey. Do not prepare drawings before the completion of field survey and measurements.

Submit details for [casting] [and] [fabrication] of fittings. Include complete dimensioning, alignment data, shop instructions, and a material list indicating description and quantity of components and fasteners for each fitting. Submit drawings for each individual fitting which is adequate to determine the conformance of fittings with project drawings and as provided for herein. Show details of drainage connections from fittings and housings to drain pipes.

Do not manufacture materials until drawings have been approved.

PART 2 PRODUCTS

2.1 RAIL MATERIALS

Provide new track material [except for existing material approved for reuse. Perform removal work as specified in Section 34 11 00 RAILROAD TRACK AND ACCESSORIES. The following material is existing and may be reused: [_____]].

2.1.1 Crane Rail

2.1.1.1 Rail Section Weight and Hardness

****

NOTE: Requirements for minimum length of closure rail sections do not apply to stub rail sections provided as part of fabricated crane rail fittings.

****

****

NOTE: All references in this section to rail section specify per yard (135-CR) crane rail. The 135-CR section is the most common for new and replacement portal crane track. In some work, rail sections other than 135-CR may be required for crane use. These include heavier rail section or, for connection to older existing installations, use of 60 kilogram 132 pound or other railroad rail may be specified. Make changes where rail sections are required that are different than the 135-CR.

This also applies to subparts 2.1.4 through 2.1.6, and 2.2.1.

****

AREMA Eng Man and ASTM A1. Rails must be [664] [_____] kg per meter [135] [_____] pounds per yard in weight and be control-cooled, [fully heat-treated,] [321 to 388] [250 minimum] Brinell hardness carbon steel referred to herein as [135-CR] [_____]. Crane rail hardness must not exceed crane wheel Brinell hardness of [388] [_____]. Provide standard 12 m 39 foot rail lengths except for closure rails. Provide closure rails in one or two sections as long as practical, but in no case less than 4 m 13 feet long.

2.1.1.2 Metallurgical Composition

Provide steel crane rail with chemical composition within the following limits:

a. Carbon, percent 0.67 to 0.82

b. Manganese, percent 0.60 to 1.00

c. Phosphorus, percent 0.04 maximum

d. Silicon, percent 0.10 to 0.23

e. Sulfur, percent 0.04 maximum

2.1.2 Joint Bars

ASTM A49 and AREMA Eng Man, Chapter 4. Provide heat-treated carbon steel six-hole joint bars sized to fit the rail section.

2.1.3 Track Bolts, Nuts, and Washers

AREMA Eng Man, Chapter 4. Provide track bolts not less than 23 mm one inch in diameter.

2.1.4 Rail Clips

****

NOTE: Rail clips should be used on curves for lateral support. If rail clips are not used provide some form of lateral restraint.

****

Provide single clips and holders designed for tight fit and sized to match [135-CR] [_____] crane rail section.

2.1.5 [Weldable, Adjustable Rail Clips

****

NOTE: Rail clips should be used on curves for lateral support. If rail clips are not used provide some form of lateral restraint.

****

****

NOTE: Use weldable, adjustable rail clips if the rail will not be permanently anchored in the pavement. Adjustable rail clips are normally used on overhead electric traveling cranes.

****

Provide weldable, adjustable rail clips sized for [135-CR] [_____] crane rail section. Provide rail clips made by a manufacturer currently manufacturing crane rail clips. Rail clips must be forged steel which can be welded directly to structural steel. Rail clip bolts must conform to ASTM A325M ASTM A325. Provide rail clips designed for a side thrust of [_____] kg [_____] pounds. Provide rail clips designed to allow rail removal without the removal of the welded portion of the rail clip.

]2.1.6 [Impact Pads

****

NOTE: Use impact pads where there will be a large number of crane movements or where vibration could cause excessive wear on the crane or rail.

****

Provide impact pads sized for [135-CR] [_____] crane rail section. Provide pads which are impervious to water, oil, fuels, grease and ultraviolet rays. Provide pads with vulcanized reinforcing and encapsulated in synthetic rubber. The required properties are:

a. Shore hardness: [75 to 85] [_____] to [_____] degrees

b. Thickness (minimum): [6] [_____] mm [1/4] [_____] inch

c. Ultimate tensile strength (minimum): [17] [_____] MPa [2500] [_____] pounds per square inch

d. Reduction in load per square mm inch (minimum): [30] [_____] percent

e. Temperature range: Minus 7 to 100 degrees C 20 to 212 degrees F

f. Wheel Load: [_____] kg [_____] pounds

g. Crane rail bending stress (maximum): 75 percent of allowable bending

The pads must meet the required properties for a minimum of 1,000,000 wheel passes at the maximum permissible wheel load.

]2.1.7 Electrodes

****

NOTE: Welded rail joints are preferred for crane rail except at connections between rail and rail fittings such as switches and frogs where bolted joints are recommended. Indicate on the drawings each joint type (bolted and/or welded). Accomplish welded connections between carbon steel rail and rail fittings fabricated from carbon steel, using either of the methods identified in paragraph "Welded Crane Rail Joints." Determine the welding method(s) to be used and show on project drawings location of each welding method. Welded connections between carbon steel rail and cast manganese steel are not recommended. However, if the activity requires a dissimilar metal welded connection such as this, the cast manganese stub rail end section must be prepared for welding in accordance with Sketch NFGS-14606-1. Use the manual shielded arc welding method in accordance with paragraph "Manual Shielded-arc Welding Method" and electrodes in accordance with paragraph "Electrodes" . Thermite method is not acceptable for welding dissimilar metal.

****

Provide AWS low-hydrogen, high-tensile E 14018 or E 14016 electrodes. Utilize electrodes of the smallest practical diameter worked at the lowest compatible current. Coating on low-hydrogen type electrodes must be thoroughly dry when the electrode is used. Use electrodes taken from hermetically sealed packages within one hour of the time the package is opened. Dry electrodes not used within this one hour period and electrodes taken from nonhermetically sealed packages for at least one hour between 370 and 430 degrees C 700 and 800 degrees F before use. Store dried electrodes at temperatures between 110 and 200 degrees C 225 and 400 degrees F until used, or if not stored and not used within one hour after this drying is completed,re-dry before use. [Do not use electrodes which have been wet.] [Hard surfacing rod used on top 3 mm 1/8 inch of railheads must be alloy with the following composition:

a. Carbon, percent 0.4 to 0.6

b. Manganese, percent 4.0

c. Chromium, percent 18.0 to 21.0

d. Nickel, percent 9.0 to 10.5

e. Molybdium, percent 1.2

f. Iron, base

Heat railhead to a minimum temperature of 260 degrees C 500 degrees F for a distance of 200 mm 8 inches on each side of the joint before welding overlay.]

2.2 CRANE TRACK FITTINGS

****

NOTE: Two types of crane rail fittings are available:

1. Manganese Steel Castings: Most existing crane track fittings are of this type, which has a superior ability to withstand wear. These castings are, however, costly when custom-manufactured, and require long lead time to order.

2. Fabricated (Build-up) Fittings: Fabricated crane track switches and frogs are alternatives to the conventional cast fittings. They consist of stock rails and a number of steel plates bolted and/or welded together into the required configuration. Due to the use of standard components, many machine shops are capable of producing fabricated fittings, thus reducing cost and lead time. Fabricated fittings are, however, heavier and less wear-resistant than cast fittings.

Military standards as listed in this guide specification are available for both types of fittings and paragraphs are provided for both types. Delete paragraphs referring to inapplicable types of fittings. For further information on use of cast and fabricated fittings contact:

Commander
Atlantic Division
Naval Facilities Engineering Systems Command
Code 15C2
Bldg. N-26, Room 234
Norfolk, VA 23511-6287

****

Provide configuration and geometry of fittings as indicated and as specified herein. Substitutions will not be accepted. Fittings include [switches] [and] [frogs] for use with crane wheels indicated.

2.2.1 Four-Rail Portal Crane Track Systems

****

NOTE: There are two types of portal crane trackage systems in use in the Naval Shore Establishment:

1. Four-Rail System: This system consists of two standard gage (railroad) tracks. The cranes for this system are equipped with single-flanged wheels. Switches and frogs are of the standard railroad type except for some small frog angles, where turntable frogs may be required. For details of two- and four-rail system applications, see UFC 4-860-02N. This guide specification may be used for either two-rail or four-rail crane track systems by deletion of inapplicable paragraphs describing the use of specific types of switches and frogs. For four-rail systems, additional references based on Section 34 11 00 RAILROAD TRACK AND ACCESSORIES for Standard Gage Railroad Track may be used.

2. Two-Rail System: The cranes for this system are equipped with double-flanged wheels. Special double-tongue switchpoints and ramp-type frogs are required for this system. Turntable frogs may also be required for small frog angles.

****

Crane track switches and frogs for use with single-flanged wheels must conform to applicable requirements of the AREMA Eng Man and AREMA Track Plans, with the following limitations:

a. Provide fittings for use with [135-CR] [_____] crane rail section.

b. [b. Provide turntable frogs.]

2.2.2 Two-Rail Portal Crane Track Systems

Crane track switches and frogs for use with double-flanged wheels must be special fittings meeting the following requirements:

2.2.2.1 Cast Manganese Steel Double-Tongue Switch Points

****

NOTE: If deviation from the military specification is necessary, include the phrase, "except as specified in paragraph entitled "_____." Either specify the deviations in the appropriate paragraph or list together in a new paragraph.This NOTE applies to subparts 2.2.2.1 through 2.2.2.6

****

MIL-DTL-82020 [, except as specified in paragraph [_____],] for use with double-flanged wheels. Provide manganese steel castings conforming to ASTM A128/A128M. [Provide double-tongue switch points with rail curvature geometry indicated. Variations will not be accepted.] [Confirm switch point dimensions by preparation of full-size patterns before molds for castings are made.] [Provide switch points for use in a single crane track turnout in matched pairs.]

2.2.2.2 Cast Manganese Steel Rigid Ramp-Type Frogs

MIL-DTL-82020 [, except as specified in paragraph [_____],] for use with double-flanged crane [and railroad] wheels. Provide manganese steel castings conforming to ASTM A128/A128M. [Provide rigid frogs with frog angle and rail curvature geometry indicated. Variations will not be accepted.] [Cast half-crossings at the intersection of a crane rail and a standard gage railroad track as an integral one- or two-piece unit.]

2.2.2.3 Cast Manganese Steel Turntable Frogs

MIL-DTL-82020 [, except as specified in paragraph [_____],] for use with double-flanged crane [and railroad] wheels. Provide manganese steel castings conforming to ASTM A128/A128M. [Provide turntable frogs with frog angle and rail curvature geometry indicated. Variations will not be accepted.]

2.2.2.4 Fabricated Double-Tongue Switch Points

MIL-DTL-29229 [, except as specified in paragraph [_____],] for use with double-flanged wheels. [Provide double-tongue switch points with rail curvature geometry indicated. Variations will not be accepted.] [Confirm switch point dimensions by preparation of full-size patterns before fabrication is commenced.] [Provide switch points for use in a single crane track turnout in matched pairs.]

2.2.2.5 Fabricated Rigid Ramp-Type Frogs

MIL-DTL-29229 [, except as specified in paragraph [_____],] for use with double-flanged crane [and railroad] wheels. [Provide rigid frogs with frog angle and rail curvature geometry indicated. Variations will not be accepted.]

2.2.2.6 Fabricated Turntable Frogs

MIL-DTL-29229 [, except as specified in paragraph [_____],] for use with double-flanged crane [and railroad] wheels. [Provide turntable frogs with frog angle and rail curvature geometry indicated. Variations will not be accepted.]

2.2.2.7 Manually-Operated Switch Throw Mechanisms and Housings

****

NOTE: Manually-operated switch throw mechanisms and housings are commercially available items preferably supplied and pre-tested by the switch manufacturer whenever possible. NAVFAC Definitive Drawing No. 1404353, "Portal Crane Track Switch Throw Linkage," contains definitive details for a manually operated throw mechanism but may not be similar to commercially available units. If paragraph entitled "Power-Operated Switch Throw Mechanism" is used, then paragraph entitled "Manually-Operated Switch Throw Mechanisms and Housings" must be used.

The power throw mechanism utilizes a hydraulic linear actuator of a manufacturer's standard design employing an electric or air-driven motor pump. NAVFAC Definitive Drawing No. 1404354 "Portal Crane Track Switch Power Mechanism" and 1404355 "Portal Crane Track Turntable Frog Power Mechanism" contain definitive details for the layout of a power-operated switch throw mechanism but may not be similar to commercially available designs. The minimum performance characteristics for the NAVFAC Definitive Design power throw mechanisms are as follows:

Turntable Frog:

Stroke: 300 mm 12 inches

Speed: 20 mm/s 3/4 inches per second

Force: 5 kN 1200 pounds working: 70 kN 16,000 pounds maximum

Switch Points:

Stroke: 250 mm 10 inches

Speed: 20 mm/s 3/4 inches per second

Force: 13 kN 3000 pounds working: 187 kN 42,000 pounds maximum

Satisfactory commercially available power throw mechanisms for certain site specific crane rail switches have recently been installed at:

Puget Sound, Naval Shipyard, Bremerton, Washington

The Public Works Departments at that activity may be able to provide additional information pertaining to these units. If paragraph "Power-Operated Switch Throw Mechanism," is used, then paragraph "Manually-Operated Switch Throw Mechanisms and Housings," must be used.
****

a. Provide switch points in a single crane track turnout (including turnouts containing shared railroad tracks) to operate simultaneously by a single throw mechanism.

b. Provide each switch with a manually operated throw mechanism. [Provide switch throw as indicated.] [Provide switch throw designed and fabricated by the manufacturer of the switch point.] Base the design on a [bell crank] [lever] operator principle so that the switch can be readily and easily operated by one person without causing damage to the linkage or component parts.

c. Provide throw mechanism to automatically lock into place at the end of the throw in both operating positions.

d. Provide throw handles which indicate the position of the switch, easily accessible, and visible to the crane operator

e. [Provide visible indicators capable of being seen by the crane operator to indicate position of switch.]

f. Provide throw mechanism of a heavy-duty type for specific use with double-flange wheel crane rail fittings.

g. Provide linkage oriented 90 degrees to the switch tongue.

h. All component parts must be readily accessible to allow for inspection, cleaning, maintenance and easy removal and replacement of parts.

i. Provide turn buckles of the open type to permit inspection to ensure engagement of ends of threaded rods.

j. Provide rods and throw linkage components adequately sized and laterally supported to prevent bending and buckling during operation.

k. Provide box housing frames bolted to base plates and equipped with heavy-duty cover plates designed to fit neatly over the housing frame.

l. [When an unequal throw is required for crane track switch points, achieve throw using mechanical bar linkage and not by use of lost motion spring action.]

m. [Lost motion utilizing a spring system action may be employed to facilitate the operation of a railroad switch used in conjunction with the throw of a crane rail switch.]

2.2.2.8 [Power-Operated Switch Throw Mechanism

****

NOTE: If deviation from the military specification is necessary, include the phrase, "except as specified in paragraph entitled "_____." Either specify the deviations in the appropriate paragraph or list together in a new paragraph.

Manually-operated switch throw mechanisms and housings are commercially available items and should be supplied and pre-tested by the switch manufacturer whenever possible. NAVFAC Definitive Drawing No. 1404353, "Portal Crane Track Switch Throw Linkage," contains definitive details for a manually operated throw mechanism but may not be similar to commercially available units. If paragraph entitled "Power-Operated Switch Throw Mechanism" is used, then paragraph entitled "Manually-Operated Switch Throw Mechanisms and Housings" must be used.

****

Provide power-operated switch throw mechanism with all the features specified for the manually operated switch, except remove the throw handle mechanism (and retain at the site for backup operation) and allow the switch operation to be accomplished with the aid of a hydraulic linear actuator driven by [compressed air] [electric] power. Provide utility line connections to the power unit as indicated. Minimum performance characteristics for [turntable frog] [switch point] are as follows:

a. Stroke: [_____] mm [_____] inches

b. Speed: [_____] mm/s [_____] inches per second

c. Force: [_____] N working [_____] pounds

d. [d. [_____] N [_____] pounds maximum]

]2.3 DRAINAGE LINES FOR FITTINGS

Provide storm water drains for [turntable frogs,] [double-tongue switch points,] [_____] and [throw mechanism housings] to prevent ponding of water therein. Provide 100 mm 4 inch diameter steel drainage pipe lines conforming to ASTM A53/A53M to drain the fittings and housings as indicated. Slope pipes not less than 2 percent.

2.4 FOUNDATION MATERIALS

2.4.1 Base Plates

ASTM A36/A36M or ASTM A283/A283M. [Provide continuously welded plates, except where existing crane rail base covers the joint between the plates.] [Stagger rail joints and base plate joints.] Shape plates to conform to the configuration of rail curvature and to each special fitting. Minimum width of plates under rails must be 300 mm 12 inches. Minimum length of plates must be 1200 mm 4 feet and maximum length 3000 mm 10 feet. Minimum edge distance for holes as indicated. Provide [28] [_____] mm [1 1/8] [_____] inch diameter anchor bolt holes, field or shop fabricated. Provide grouting holes 50 mm 2 inches in diameter in plates wider than 900 mm 3 feet. Center grout holes, spaced approximately 600 mm 2 feet apart, and locate so as not to interfere with the proper function of the plate.

2.4.2 Anchor Bolts

ASTM A183, square head [25] [_____] mm 1 [_____] inchdiameter steel. Provide each bolt with two finished hexagon nuts and one spring washer. Provide bolt threads conforming to ASME B18.2.1, and nuts and threads to ASME B18.2.2. [For bolts fastened to existing grade beams determine lengths in the field after the elevation of the concrete support beams has been determined and the finished profile grade from the drawings has been taken into consideration.] [Minimum length of anchor bolt is [_____] mm [_____] inches.]

2.4.3 Nonmetallic Nonshrink Grout

Provide grout under base plates as indicated. Provide high early strength, nonshrink, nonmetallic grout, with components passing the No. 4 sieve and proportioned so as to provide a 3-day compressive strength of not less than [28] [45] MPa [4,000] [6,500] psi as determined by ASTM C109/C109M, an expansion-to-original length ratio of 0.018 to 0.020 as determined by ASTM C157/C157M. As an option, commercial premixed grout may be used if it meets the strength, workability, nonshrink, and nonmetallic requirements herein specified. When the depth of grouting exceeds 25 mm one inch, the addition of crushed stone, 6 to 10 mm 1/4 inch to 3/8 inch maximum size, to the grout mixture will be allowed. The ratio of grout to crushed stone by weight must be maximum 2:1 or as specified in the manufacturer's instructions. After installation, cure the nonshrink grout a minimum of 3 days in accordance with the curing requirements as recommended by the manufacturer.

2.4.4 Epoxy Grout

ASTM D1763, two component, Grade 1. Provide epoxy grout for cored anchor bolt holes in existing concrete grade beams. Aggregates for epoxy grout must conform to ASTM C144.

2.4.5 Portland Cement Concrete

Provide concrete for flangeways, [grade beams] and [encasements] conforming to Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.5 STANDARD GAGE RAILROAD TRACK

****

NOTE: Use Section 34 11 00 RAILROAD TRACK AND ACCESSORIES and AREMA Eng Man and PTWP for standard gage railroad track intersecting with crane tracks. Provide specification for guardrails as required opposite rigid frogs for use by standard gage wheels. Where guardrail flangeway is for use by crane wheels, provide adequate flangeway width or flare. For a railroad in dual gage with crane track, add references as required for half ties or rail on grade beam foundation.

****

In accordance with Section 34 11 00 RAILROAD TRACK AND ACCESSORIES.

2.6 OIL FOR TRACK FIXTURES

Meet the following requirements:

a. Flash point, minimum: 57 degrees C 135 degrees F.

b. Asphalt, 100 penetration, minimum 45 percent viscosity, saybolt Universal: 54 degrees C 130 degrees F, 240 to 350 seconds

PART 3 EXECUTION

3.1 WORKMANSHIP

Handle fittings, rails, and accessories to avoid kinking or other damage. Maintain tracks in proper grade, alignment, curvature, and gage.

3.2 INSTALLATION OF CRANE TRACK AND FITTINGS

3.2.1 Crane Rails

Install crane rails to the alignment indicated. Install rails atop continuous steel base plates with anchor bolts and rail clips. Do not bend rail in the field, but preform rail to the required radii in a plant prior to installation. [Assemble the entire curved layout with all pieces match-marked.] Completely lay out and mark in the field and have approved by the Contracting Officer before any portion of crane rail alignment is installed. Tolerances are as follows:

a. Horizontal alignment: Place rails within plus or minus 6 mm 1/4 inch of the designed rail centerline alignment indicated.

b. Crane track gage: Provide track gage between railheads within plus or minus 12 mm 1/2 inch of the design gage indicated. Crane rail gage is measured from centerline of rail to centerline of rail.

c. Vertical alignment: Place top of rails within plus or minus 3 mm 1/8 inch of the designed rail elevation indicated.

d. Cross-level elevation: Elevation differences between rails must not exceed 3 mm 1/8 inch.

****
NOTE: Regarding the text below, use Section 34 11 00 RAILROAD TRACK AND ACCESSORIES and AREMA Eng Man and PTWP for standard gage railroad track intersecting with crane tracks. Provide specification for guardrails as required opposite rigid frogs for use by standard gage wheels. Where guardrail flangeway is for use by crane wheels, provide adequate flangeway width or flare. For a railroad in dual gage with crane track, add references as required for half ties or rail on grade beam foundation.
****

e. Where the crane rail also serves as one rail of a standard gage railroad track, gage the railroad rail from the crane rail based on standard gage requirements in accordance with Section 34 11 00 RAILROAD TRACK AND ACCESSORIES.

3.2.2 Welded Crane Rail Joints

****
NOTE: Welded rail joints are preferred for crane rail except at connections between rail and rail fittings such as switches and frogs where bolted joints are recommended. The project drawings must indicate each joint type (bolted and/or welded). Welded connections between carbon steel rail and rail fittings fabricated from carbon steel, if desired, may be accomplished using either of the methods identified in paragraph "Welded Crane Rail Joints." Determine the welding method(s) to be used and show location of each welding method on project drawings. Welded connections between carbon steel rail and cast manganese steel are not recommended. However, if the activity requires a dissimilar metal welded connection such as this, the cast manganese stub rail end section must be prepared for welding in accordance with Sketch 14606-1. Use the manual shielded arc welding method in accordance with paragraph "Manual Shielded-arc Welding Method" and electrodes in accordance with paragraph "Electrodes". Thermite method is not acceptable for welding dissimilar metal.
****

Weld crane rail joints [, except those joints at fittings]. The welding together of rails which have been bored for bolted joints is not permitted. Clean rails of foreign substances prior to welding. [Welded compromise joints must be by the thermite method.] Align and weld rail in accordance with the recommendations and specifications of the manufacturer and supplier of the particular welding process used. Do not weld when the rail temperature is lower than that recommended for the welding method used. Use the following method[s].

3.2.2.1 Thermite Method

In accordance with Section 34 11 19.00 20 WELDING CRANE AND RAILROAD RAIL - THERMITE METHOD.

3.2.2.2 Manual Shielded-Arc Welding Method

AWS D1.1/D1.1M and the following:

****

NOTE: Regarding the text below, when manual shielded-arc welding method is specified, prepare rail ends in accordance with Sketch No. NFGS-41 22 13.33-1. Show sketch information on the project drawings.

****

a. Prepare rail end as indicated and as specified herein. Bevel ends of the rails at approximately 35 degrees full bevel on the head, 35 degrees double bevel on the web, and 35 degrees full bevel on the upper side of the base. Retain a narrow "nose" of approximately 2 mm 1/16 inch of original rail-end face across the base and up the web, following beveling operation, to permit proper alignment of rail ends. When beveling with a torch, first preheat each rail end to 260 degrees C 500 degrees F. After torch cutting, grind off scale and oxides. Grind level faces only after preheating. Use proper grinding wheel and speed to avoid grinding "burns" or formation of "hard spots" from localized overheating.

b. Align the beveled rail ends, allowing approximately 3 mm 1/8-inch root clearance, and place a copper shim under the joint opening. Clamp the rails during the welding with up to 6 mm 1/4 inch vertical camber (ends high) in 1200 mm 4 feet, centered over the joint to compensate for contracting distortion.

c. Preheat the joint area to approximately 260 degrees C 500 degrees F for a distance of 150 to 200 mm 6 to 8 incheson each side of the joint using a suitable heat source, such as an oxy-acetylene or propane torch.

d. Initiate arc welding of the joint immediately after preheating in the following sequence: base, web, and head. Weld alternately on both sides of base and web. Do not entrap foreign material, such as slag, in the weld. Grind, chip, or arc-air the root of the initial weld to sound metal before welding is started from the second side. Maintain a 260 degrees C 500 degree F to moderately higher interpass temperature. Proceed with welding until the joint is completed and sufficient metal has been deposited to permit grinding to finish contour in the head area. Provide slight reinforcement of the web and top of the base areas.

e. Postheat the joint area to approximately 370 degrees C 700 degrees F immediately after the welding operation, using the same technique for preheating. After postheating, protect the weld area against rain and snow and cool as slowly as possible by covering with an insulating blanket.

f. Grind the excess deposited weld metal from sides and top of rail head using heavy-duty grinder. Heat area of the weld to at least 290 degrees C 550 degrees F before and during grinding. Grind the area smooth, finishing to within plus or minus 0.5 mm 0.020 inch of original contour. Use proper grinding wheel, speed, and rate of metal removal to avoid grinding "burns" or formation of "hard spots" from localized overheating. Prevent grinding cracks.

g. Measure temperatures specified by temperature pencils.

3.2.2.3 Electrical Flash-Butt Method

Welding process must conform to applicable provisions of Chapter 4 of AREMA Eng Man.

3.2.3 Bolted Rail Joints

****

NOTE: Welded rail joints are preferred for crane rail except at connections between rail and rail fittings such as switches and frogs where bolted joints are recommended. Indicate on project drawings each joint type (bolted and/or welded). Welded connections between carbon steel rail and rail fittings fabricated from carbon steel, if desired, may be accomplished using either of the methods identified in paragraph "Welded Crane Rail Joints." Determine the welding method(s) to be used and show location of each welding method on drawings. Welded connections between carbon steel rail and cast manganese steel are not recommended. However, if the activity requires a dissimilar metal welded connection such as this, prepare the cast manganese stub rail end section for welding in accordance with Sketch 14606-1. Use the manual shielded arc welding method in accordance with paragraph "Manual Shielded-Arc Welding Method" and electrodes in accordance with paragraph "Electrodes". Thermite method is not acceptable for welding dissimilar metal.

****

[Provide bolted joints at rail connectors.] [Provide bolted rail joints to connect crane rail to crane rail fittings.] Bolted joints will be permitted for connection of crane rail fittings to intersecting railroad rail not for use by cranes. Chamfer rail head at joints in accordance with AREMA Eng Man.

3.2.3.1 Joint Bars

Install joint bars with the full number of bolts, nuts and washers. After track has been tested as provided for herein and before flangeway concrete is poured, check and tighten bolts. The openings between railheads must not deviate more than 3 mm 1/8 inch from the opening recommended for a given temperature. Vertical or horizontal mismatch at joints must not exceed 2 mm 1/16 inch. Joints must conform to applicable AREMA Eng Man. Tighten joint bar bolts to a tension no less than the proof load given in ASTM A183. Perform tightening with a properly calibrated wrench[or by turn of the nut method].

3.2.3.2 Compromise Joints

Provide bolted [and welded] compromise joints for connection of adjoining rails or fittings of differing cross sections. Make joints by means of either cast or fabricated compromise bars or welded transition rails. Provide step chairs, as required, at joints of rails of differing height. Provide compromise joints with proper allowance for rail wear. The offset of compromise joints or of either surface or gage alignment must not exceed

3 mm 1/8 inch. Rails at compromise joints of rails for double-flanged wheels must have the centerlines of the rails in alignment and provide a smooth surface along the top of rails. Grind edges of the wider of the two rail heads smooth over a minimum transition length of 450 mm 18 inches. Heat area to be ground to at least 290 degrees C 550 degrees F before and during grinding. Clad welding is not permitted to achieve transitions for compromise joints. [Align compromise joints of rails for single-flange wheels only along top and gage side of rails.] [Use thermite method to weld compromise joints.]

3.2.4 Anchor Bolts

Provide pairs of anchor bolts for connection of rail clips and crane rails to base plate and supporting grade beam. At crane track fittings, provide separate groups of anchor bolts for connection of fittings to base plate and to supporting grade beam. [Install anchor bolts with epoxy grout specified herein into 50 mm 2 inch diameter holes drilled into existing concrete rail support beams.] [Cast anchor bolts into new concrete grade beams.] Tighten anchor bolt nuts to snug tight using the effort of an ordinary man with a 6'-0" spud wrench. Perform tightening with properly calibrated wrenches [or by turn of nut method]. Make longitudinal spacing as indicated.

3.2.5 Base Plates

****

NOTE: Install base plates in accordance with Sketch No. NFGS-41 22 13.33-2. The sketch is based on 61 kilogram 135 pound crane rail and should be modified as required to reflect actual size of crane rail to be installed. Show sketch information on the project drawings.

****

Install as indicated and as specified herein. Install 25 mm 1 inch thick base plates to support rail, switches, frogs, and throw mechanism housings. Shape base plates, as necessary, under [switches] [and] [frogs]. Furnish plates with anchor bolt holes located and drilled in field or shop fabricated; use as template for setting anchor bolts. Do not enlarge bolt holes in the field. Do not torch, cut holes. Provide finished plate free of bows, bends, and lips, and cleaned of grease and oil. After installation of rail, vertically align base plates to within plus or minus 3 mm 1/8 inch of the profile grade elevation indicated by adjustment of base leveling nut and washer underneath plates. After installation, check to ensure proper grade and alignment of the base plates and install temporary hold-down nuts before grouting with nonshrink grout. After grout has hardened, and with rail clips, crane rail, and fittings in place, tighten anchor bolt nuts to snug tight using the effort of an ordinary man with a 6'-0" spud wrench.

3.2.6 Crane Track Fittings

3.2.6.1 Crane Switches

Install fittings and throw mechanisms atop steel base plates and align vertically by means of leveling nuts as indicated. Connect switch points to adjacent rails by means of [bolted] [welded] joints. [Secure the nuts of bolted joints in place with a cotter pin through the bolt.] Install throw mechanisms complete in housings as indicated. Mechanisms must operate smoothly and reliably and hold the switchpoints in position securely, against motion of crane wheels.

3.2.6.2 Rigid Frogs

Install crane track rigid frogs atop steel base plates and align vertically be means of leveling nuts as indicated. Connect to adjacent crane rails [and railroad rails] by means of [bolted] [welded] joints.

3.2.6.3 Turntable Frogs

Install frog [and throw mechanism] atop steel base plates and align vertically by means of leveling nuts as indicated. Connect fittings to adjacent rails by means of [bolted] [welded] joints. Install throw arm complete in housings as indicated. Mechanism must operate smoothly and reliably, and hold the turntable in position securely, against motion of crane wheels.

3.2.7 Standard Gage Railroad Tracks

Install in accordance with Section 34 11 00 RAILROAD TRACK AND ACCESSORIES.

3.2.8 Oiling Track Fixtures

Swab [track bolts,] [switch points,] [throw mechanisms,] and [joint bars] with oil specified.

3.2.9 Concrete

Install concrete for flangeways [, grade beams] and [encasements] in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3 CLEANUP

Upon completion of the work, clear job site of equipment, surplus material, and debris. [Dispose of such material [off Government property] [at the site indicated].] [Disposal is as required in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.]

3.4 FIELD QUALITY CONTROL

3.4.1 Test for Grout

Verify nonmetallic, nonshrink grout strength during placement of grout at daily intervals by molding and testing standard cubes of samples taken at the job site. Take three test cubes each day for grout placed that day. Mold and cure test specimens in accordance with ASTM C109/C109M. Furnish necessary labor, materials, and facilities for molding the samples and for handling and storing the cubes at the site of the work. Transport cubes to the laboratory not sooner than 24 hours after molding. Test specimens for compressive strength in accordance with ASTM C109/C109M. Grout strength test evaluation is the average of the strengths of specimens tested at 3 days.

3.4.2 Visual Inspection

Inspect rail fittings thoroughly. Inspect for defects that might hinder satisfactory operation. [Inspect bolted joints for loose bolts and smooth transitions between rails of different sections.] Inspect each welded joint thoroughly after removal of the mold and grinding of excess metal. Correct or replace welds containing surface cracking, slag inclusion, gas pockets, and lack of fusion. Method of correction must be approved by the Contracting Officer.

3.4.3 Ultrasonic Inspection of Welded Rail Joints

[The Government will inspect each weld ultrasonically following the visual inspection.] Perform ultrasonic inspection and testing of each weld in accordance with MIL-STD-1699. Correct or replace defective welds. Clean rails at testing locations as directed by Contracting Officer. The method of correction must be approved by Contracting Officer.

3.4.4 Load Test

Load test of trackage will be performed by the Government prior to work on concrete flangeways, encasements, and pavement. The load test is to be performed after completion of track work, but before rails are covered by concrete flangeways and encasements. The load test for crane trackage consists of a portal crane supporting a load designated by the Contracting Officer traversing new track work. The crane must operate without difficulty, without binding of crane wheel flanges, or without visible rail deflection. Vertical movement of the ends of crane [switches] [and] [turntable frogs] must not exceed 3 mm 1/8 inch during the passage of any crane. Correct or replace defective welded rail joints, rail, and fittings. Correct the causes of excess deflections, and retighten anchor bolts loosened under crane wheel loading.

3.4.5 Throw Mechanism Operational Test

Test throw mechanisms for effectiveness, security, integrity, and reliability in accordance with the operational requirements of the mechanical and electrical sections of the specifications.

3.4.6 Retesting

Retest corrected and replaced items.

3.4.7 Record Drawing Survey

****

NOTE: A Record Drawing survey may be required where alignment of crane rails, gage reduction, or orientation of fittings is expected to be critical or problematic. The survey may be performed by Contractor, Government, or independent surveyor.

****

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NOTE: Include bracketed (last) sentence if Contractor is to perform record drawing survey.

****

At completion of crane track replacement work, and before start of work on concrete flangeways, encasements, and paving, [perform] a record drawing survey of crane track alignment [will be performed by Contracting Officer. Notify Contracting Officer [_____] calendar days in advance of the availability of the crane trackage for conducting the survey. Execution of the survey will require [_____] days for completion]. Deviation of record drawing horizontal crane rail alignment in excess of tolerances specified herein will constitute grounds for rejection of the work. Surveys, in addition to the initial survey made necessary by nonconforming work, are at Contractor's expense. [Provide two sets of full-size contract drawings marked-up to show record drawing conditions. The requirements for these surveys are in addition to the requirements of Division 1 for quality control.]

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-41 22 13.55 (February 2022)**
Change 3 - 02/23

Preparing Activity: NAVFAC **Superseding**
UFGS-41 22 13.55 (November 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 41 22 13.55

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02/22, CHG 3: 02/23

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USACE / NAVFAC / AFCEC **UFGS-41 22 13.55 (February 2022)**
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References are in agreement with UMRL dated January 2025
****

SECTION 41 22 13.55

BRIDGE CRANES, UNDER RUNNING, AIRCRAFT HANGAR
02/22, CHG 3: 02/23

****

NOTE: This guide specification addresses requirements for under running bridge cranes that are procured as part of a building construction contract for Aircraft Maintenance Hangars. As a result of the installation location, all cranes will meet hazardous area requirements.

This guide specification covers requirements for under running single girder electric traveling (OET) cranes with under running trolleys and hoists, Crane Manufacturers Association of America (CMAA) 74 Class C and D and with capacities up to 9.1 metric ton 10 ton 9,100 kg 20,000 pounds, suitable for indoor use in hazardous area environments.

This guide specification incorporates the design criteria and requirements identified in NAVCRANECEN INSTRUCTION 11450.2A (December 2018). Also included are hangar crane requirements identified in UFC 4-211-01 Change 2, 2020. This guide specification does not cover requirements for custom built-up hoists, which would be an abnormal requirement for an aircraft hangar crane. Contact NAVY CRANE CENTER for assistance with this hoist type.

Consider the use of multiple bridge spans for total crane span lengths greater than 12 meters 40 feet or capacities greater than 9,100 kg 20,000 pounds. See Section 41 22 23.19 MONORAIL HOISTS for any aircraft hangar monorail hoists.

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NOTE: Forward all procurement of OET systems at Naval Shore based activities with rated capacities of 9000 kg 20,000 pounds or greater or for use in specialized applications (e.g., ordnance handling, molten metal handling, special purpose service as defined in NAVSEA Publication 0989-030-7000,

hazardous/explosive area environments, or precision handling operations requiring complex or synchronized lifting capacity) to: Naval Facilities Engineering Systems Command, Navy Crane Center, Building 491, Norfolk Naval Shipyard, Portsmouth, Va., 23709-5000. (See NAVCRANECEN INSTRUCTION 11450.1C of 11 July 2019).

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****

NOTE: This guide specification includes tailoring options for NAVFAC, pounds (per NAVFAC P-307), and tons. The NAVFAC tailoring option also includes requirements specific to the Navy and Marine Corps. Crane procurements for the Navy and Marine Corps must select the NAVFAC tailoring option.

Crane tailoring options are included for the Army, Air Force, Navy, and maximum hazardous (explosive) environments. The default crane configuration includes additional minimum anti-spark, hazardous area requirements. Maximum anti-spark protection includes requirements that are in addition to the minimum anti-spark requirements.

Selection or deselection of a tailoring option (select view-tailoring options) will include or exclude that option in the section. Specific project editing is still required for the resulting section.

****

****

NOTE: Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This specification covers cranes with under running bridge and under running trolley and hoist, single girder, with CMAA 74 service class C or D, with provisions for operation in hazardous areas.

Explanations of CMAA service classifications C and D are covered in the "Notes" portion of paragraph

CRANE DESIGN CRITERIA, sub-paragraph CLASSIFICATION. The minimum allowable classification for hangar cranes is CMAA service class C.

Explanations of hazardous areas are covered in the DEFINITIONS paragraph as well as the "Notes" portion of paragraph CRANE DESIGN CRITERIA, sub-paragraph CLASSIFICATION. All hangar cranes must meet minimum anti-spark protection.

Control types and systems may be specified as follows:

1. Remote or Pendant Crane Controls or a combination of the two can be provided.

2. Alternating current (AC) control systems must be specified. The vast majority of new cranes are AC powered and AC controlled.

****

****

NOTE: The RFP must provide the relevant dimensions and load data for the crane. See "Crane Inquiry Data Sheet" in CMAA 74 section 6.1 or see "Crane Information Form for Underrunning Cranes(s)" pages 5 and 6 at the following Navy Crane Center link:

https://ncc.navfac.navy.mil/Popular-Links/DOWNLOADS/

Projects that are routed through Navy Crane Center should be accompanied by a completed Crane Information Form (CIF) per the above link.

****

****

NOTE: Show the following information, as a minimum, on the project drawings:

1. Complete details of plan, elevations, and sections of crane.

2. Runway track system (if installed), including span and size of girder(s), runway rail size, channel cap size, size and location of crane stops, and building clearances.

3. Electrical junction box location (including mounting height).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
ANSI/AGMA 2001	(2004D; R 2010) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
ANSI/AGMA 2015-1	(2001A; R 2014) Accuracy Classification System - Tangential Measurements for Cylindrical Gears
ANSI/AGMA 6013	(2006A; R 2016) Standard for Industrial Enclosed Gear Drives

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B30.10	(2019) Hooks
ASME B30.16	(2022) Overhead Underhung and Stationary

	Hoists
ASME B30.17	(2020) Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoists)
ASME B30.30	(2019) Ropes
ASME HST-4	(2021) Performance Standard for Overhead Electric Wire Rope Hoists

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D14.1/D14.1M	(2019) Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

ASTM INTERNATIONAL (ASTM)

ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM E543	(2021) Standard Specification for Agencies Performing Non-Destructive Testing
ASTM E1417/E1417M	(2016) Standard Practice for Liquid Penetrant Testing
ASTM F436/F436M	(2024) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

BRITISH STANDARDS INSTITUTION (BSI)

BS ISO 4309	(2017) Cranes - Wire Ropes - Care and Maintenance, Inspection and Discard

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes
CMAA 74	(2020) Specifications for Single Girder Cranes

ELECTRIFICATION AND CONTROLS MANUFACTURERS ASSOCIATION (ECMA)

ECMA 15	(2018) Cable-less Controls for Electric Overhead Traveling Cranes

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC ISO 15408	(2022) Information Technology-Security Techniques-Evaluation Criteria for IT Security

MATERIAL HANDLING INDUSTRY OF AMERICA (MHI)

MHI MH27.1	(2016) Specifications for Underhung Cranes and Monorail Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA ICS 8	(2011) Crane and Hoist Controllers
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J429	(2014) Mechanical and Material Requirements for Externally Threaded Fasteners

SAE J995	(2017) Mechanical and Material Requirements for Steel Nuts

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-W-410	(2022; Rev J) Wire Rope and Strand

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.179	Overhead and Gantry Cranes
29 CFR 1910.306	Specific Purpose Equipment and Installations

U.S. NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSEA T9074-AS-GIB-010/271	(2014; Revision 1) Requirements for Nondestructive Testing Methods

UL SOLUTIONS (UL)

UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1004-1	(2012; Reprint Nov 2020) UL Standard for Safety Rotating Electrical Machines - General Requirements

1.2 DEFINITIONS

a. Crane Bridge: That part of an overhead crane system consisting of a girder, end trucks, walkway, and drive mechanism which carries the trolley(s) and travels along the runway rails parallel to the runway.

b. Crane Runway: The track system along which the crane operates horizontally, including track hangar rods, track connection devices, and runway structural supports.

c. Dead Loads: The weight of all effective parts of the bridge structure, the machinery parts, and the fixed equipment supported by the structure.

d. Crane Bridge Girder: The principal horizontal beam of the crane bridge structure. It is supported by the crane end trucks. Typically, for single girder cranes the trolley mounted hoist is suspended from the girder below the crane.

e. Lifted Load: The load consisting of the rated load and the weight of lifting devices attached to the crane such as the load block, bucket, or other supplemental devices.

f. Original Equipment Manufacturer (OEM): the Company that produced the part or original equipment.

g. Packaged Hoist: A commercially designed and mass produced hoist characterized by the motor, gearing, brake(s), and drum contained in a single package often connected by the use of c, d, or p-face flanges.

h. Patented Track: A generic term referring to track built in accordance with MHI MH27.1 utilizing a composite track section incorporating a proprietary bottom flange shape. For this crane system, it is provided for the crane bridge girder and also the crane runway track, if under running.

i. Pendant: A control for a hoist and a crane. The pendant hangs from the hoist or the crane by a cable at a height that is easy for the operator to reach.

j. Rated Load: The maximum working load suspended under the load hook.

k. Standard Commercial Cataloged Product: A product which is currently being sold, or previously has been sold, in substantial quantities to the general public, industry or Government in the course of normal business operations. Models, samples, prototypes or experimental units do not meet this definition. The term "cataloged" as specified in this section is defined as "appearing on the manufacturer's published product data sheets." These data sheets must have been published or copyrighted prior to the issue date of this solicitation and have a document identification number or bulletin number.

l. Trolley Load: The weight of the trolley and its associated equipment carried by the trolley wheels.

m. Under running (Underhung) Crane: An electric overhead traveling crane that is supported by crane end trucks suspended below the crane runway. The load is supported by hanging from the lower flange of a beam or patented track.

1.3 SYSTEM DESCRIPTION

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NOTE: Remove the following sentence if the runway rail is not to be installed as a part of the crane procurement. If rail is to be installed, ensure Section 05 12 00 STRUCTURAL STEEL is included in the Request for Proposal (RFP).

****

[The requirements for the structures supporting the crane runway are specified in Section 05 12 00 STRUCTURAL STEEL, and must conform to AISC 360.

]1.3.1 Crane Design Criteria

****

NOTE: Cranes installed outside the United States are still required to meet the features and characteristics specified.

When necessary, the design may be able to use the host nation's consensus standards in lieu of US standards. An equivalency study may be requested from the contractor to justify use of the international standard.

****

****
NOTE: Clearly show the area of hook coverage, runway dimensions, rail size, hook vertical travel, clear hook height, and lifting capacity on drawings.
****

Cranes will operate in the given spaces and match the runway dimensions and rails indicated. Hook coverage, hook lift, clearances, lifting capacity, and load test weight must not be less than that indicated. Provide loaded hook coverage to the maximum extent possible in the Aircraft Maintenance Bay.

1.3.1.1 General

****
NOTE: Add number of cranes, hangar name, hangar bay location, and crane rated load capacity in metric tons tons.
****

****
NOTE: For NAVFAC projects, capacity markings MUST be expressed in pounds unless the crane is located in Europe or Asia.
****

Include the following: Number of cranes [_____], located in Hangar identified as [_____], [bay [_____],] with the capacity expressed in [_____] metric tons tons, for each crane. Also clearly locate and identify each hoist and system components.

1.3.1.2 Classification

****
NOTE: Make a selection from the following CMAA 74 service classifications:

Class C (Moderate Service): This service covers cranes which may be used in moderate service requirements such as machine shops of paper mill machine rooms. In this type of service, the crane will handle loads which average 50 percent of the rated capacity with 5 to 10 lifts per hour, averaging 4.5 m 15 feet, not over 50 percent of the lift at rated capacity.

Class D (Heavy-Duty): This service covers cranes which may be used in heavy machine shop, foundries, fabricating plants, steel warehouses, container yards, or lumber mills and standard duty bucket and magnet operations where heavy-duty production is required. In this type of service, loads approaching 50 percent of the rated capacity will be handled constantly during the working period. High speeds are desirable for this type of service with 10 to 20 lifts per hour averaging 4.5 m 15 feet, not over 65 percent of the lifts at rated capacity. This service is the minimum requirement for

Ordnance/Explosive Handling.

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****

NOTE: Hazardous Area Crane Operating Environments

The design engineer will have to determine if the hazardous area envelops just the load block and pendant or the entire crane bridge girder and runway. The hazardous area encompassing just the load block and pendant is standard for this specification. If the hazardous area does encompass the entire crane and runway, then the tailoring option for maximum hazardous area protections is required.

Hazardous (Explosive) Environments: Locations where fire or explosion hazards may exist due to flammable gases, flammable liquid-produced vapors, combustible liquid-produced vapors, combustible dusts, or ignitable fibers/flyings. Cranes operating in hazardous environments as defined by the cognizant activity safety office must be equipped with electrical safety features that meet NFPA 70 Article 500. The activity safety office must identify the specific Class and Division, as well as the envelope that the hazard exists, to allow proper design and must list these in this section. Materials for mechanical components must be chosen to minimize the potential for sparking, typically bronze, stainless steel, or aluminum. Hazardous environments are split into two groups: minimum anti-spark protection and maximum anti-spark protection.

(1) Minimum Anti-Spark Protection is used when only the load block enters the explosive area. Anti-spark protection is required for the pendant controller, hook, hook block, and wire rope.

(2) Maximum Anti-Spark Protection is used when the hazardous area envelops the entire crane. In addition to the minimum anti-spark protections, the entire crane and runway components must also be protected against sparking.

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NOTE: Refer to NFPA 70 National Electric Code (NEC) for environmental requirements.

Section 500.5 covers classifications of hazardous locations: Classes I, II, and III, along with Divisions 1 and 2. It is unlikely that Classes II or III will be required for Aircraft Hangars.

Section 500.6 covers material groups A, B, C, D, E, F and G.

Section 513 covers specific requirements for

Aircraft Hangars.
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****
NOTE: NFPA 70, Section 513 Aircraft Hangars. See also NEC Handbook, Section 513.3, Exhibit 513.1 for visual representation of these requirements.

Pits or Depression: In accordance with NFPA 70, Section 513.3, any pit or depression below the level of the hangar floor must be classified as a Class I, Division 1 or Zone 1 location that extends up to said floor level. Items that may be installed or operated in these areas such as wiring, radio controller, and pendant controller must comply with the requirements of Section 513 of NFPA 70.

Aircraft Maintenance and Storage Hangars: In accordance with NFPA 70, Section 513.3, the hangar is classified as Class 1, Division 2 up to 18 inches above the floor and within 5 feet horizontally from engines and fuel tanks up to 5 feet above the engine or fuel tank enclosure. Items that may be installed or operated in these areas such as wiring, radio controller, and pendant controller must comply with the requirements of Section 513 of NFPA 70.

Aircraft Painting Hangars: In accordance with NFPA 70, Section 513.3, the hangar is classified as Class 1, Division 2 up to 18 inches above the floor and Class I, Division 1 or Class I, Zone 1 within 3 m 10 ft horizontally from aircraft surfaces from the floor to 3 m 10 ft above the aircraft. The area horizontally from aircraft surfaces between 3.0 m and 9.0 m 10 ft and 30 ft from the floor to 9.0 m 30 ft above the aircraft surface must be classified as Class I, Division 2 or Class I, Zone 2. Electrical and mechanical items that are installed or operated in these areas must comply with the requirements of Section 513 of NFPA 70.
****

****
NOTE: Ensure the correct hazardous area is specified (class, division, and group) for the actual hangar bay.

The first of the options provided is the more likely option for a standard aircraft hangar crane: NEC Class I, Division 2 hazardous area. Another potential option for aircraft hangars: NEC Class 1, Division 1 hazardous area.

Group requirements are dependent on Class and combustible gases/vapors in the hangar. For Class I locations, Groups A, B, C, and D are possible. Group D is typical due to fumes from jet fuel.

The blanks are provided should a slight variance

exist in the hangar bay hazardous classification.

The height of the hazardous area directly affects crane requirements. For areas that encompass the floor and immediate area around the aircraft, the default anti-spark provisions for crane components entering the hazardous area are sufficient (anti-spark measures for the hook, load block, wire rope, and pendant). For hazardous areas that cover the entire crane envelope (i.e., bridge and trolley), the "maximum hazardous" tailoring option must be selected. This tailoring option adds anti-spark measures for the entire crane, such as electrical enclosures and wheels.

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NOTE: Minimize the lowest overall crane depth for the configuration.

The minimum hook clearance height requirements, (measured from the finished floor elevation to the saddle of the hook at full elevation are referenced in each specific Service's Chapter of UFC 4-211-01.

Cranes may have wire connected controls (pendants) or wireless controls. Coordinate the selection of wire connected controls and wireless controls with the users. When wireless controls are provided, coordinate the frequency of wireless controls with the local frequency manager.

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NOTE: The bracketed option for separate runways is necessary if ensuring more than one crane is not installed on the same runway for contracts with multiple cranes in the same building, bay, or location.

****

Provide under running, single girder electric bridge crane(s), with under running trolley mounted hoist, conforming to MHI MH27.1, CMAA 70, and CMAA 74 service class [C] [D], as applicable. The crane(s) must be designed for operation in an indoor environment, hazardous area service, meeting the requirements of ASME B30.16 and ASME B30.17, with an ambient temperature range of [_____] to [_____] degrees Celsius Fahrenheit. The crane(s) must operate in an NFPA 70 Class [I] [_____], Division [2] [1] [_____], Group [D] [_____] hazardous area. Hazardous protection is required from the finished floor level up to [1.5 meters 5 feet above wing upper surface and engine enclosures] [3 meters 10 feet above the aircraft] [9 meters 30 feet above the aircraft surface] [[_____] meters feet]. The total crane span must be [_____] meters feet with a minimum vertical hook lift of [_____] meters feet and as specified herein. Provide runways for multiple span cranes equally spaced apart.[Provide separate runways for each crane.]

The crane must be [pendant controlled] [radio controlled] and operate in the spaces and within the loading conditions indicated. Provide a crane, including hooks and hoisting ropes, that in all operating configurations is able to clear the vertical lift fabric door maintenance catwalk or other obstructions.[The pendant controller must be mounted on a separate festooned cable system from the trolley power supply.] The crane must operate on [_____]-volts AC, [60 Hz] [_____], [three] [single] phase power source. Maximum loading on the facility (without impact) due to dead loads, trolley loads, and lifted loads, with the trolley in any position, must not exceed the allowable wheel loading and wheel spacing of the facility (or not exceed maximum hanger loading for under running cranes).

1.3.1.3 Rated Speeds

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NOTE: Slow full-load operating speeds invariably provide improved load control and increased productivity.

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NOTE: Specify the maximum rated speed under full load for the main hoist, bridge, and trolley.

1. Hoist speeds must conform to the recommendations of CMAA 74 or ASME tables. Trolley travel speed must conform to the recommendations of CMAA 74. A table of suggested hoisting and travel speeds can be found at the end of section 6 in CMAA 74.

2. Bridge travel speed must not exceed the maximum speed that the floor walking, crane pendent control operator can comfortably negotiate in a work area, approximately 750 mm/s 150 ft/min, and as recommended in CMAA 74.

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NOTE: Recommend "Medium" rated speeds, where appropriate. Another consideration for operating speeds is the distance travelled per minute (e.g., 20 ft hook lift height corresponds to hook lift speed of 20 fpm). Consider limiting bridge or trolley travel speeds when operation occurs over shorter distances (e.g., for a 50 ft runway, a bridge travel speed of 50 fpm may be more appropriate than the 115 fpm "medium" speed).

Common maximum speed selections:
Wire Rope Hoists IAW ASME HST-4 (fpm): 15, 20, 30, 40
Trolley (fpm): 30, 50, 75, 100, 125
Bridge (fpm): 50, 75, 100, 150, 175

A common minimum speed selection is 1/10th of maximum speed. Cranes using variable frequency drive controls are more flexible regarding speed selection.

****

Provide the crane with rated (maximum) speeds within plus or minus 10 percent (in meters/second feet/min) for the main hoist, bridge, and trolley at the rated load as specified in the table below. The minimum speed must not exceed the values listed.

Rated Speeds meters/second feet/minute		
Description	Minimum	Maximum
Main Hoist	[_____]	[_____]
Trolley	[_____]	[_____]
Bridge	[_____]	[_____]

The hook lift capacity and speed must be the manufacturer's standard within the limits specified.

[1.3.1.4 Foreign Design Standards and Practices

****

NOTE: This subpart is tailored to NAVFAC. This subpart will NOT typically be included and is to only be used when cranes are procured for international locations (outside of the United States), which could use contractors that design and build equipment for localities under different laws and standards.

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a. Foreign design standards and engineering practices are acceptable, provided they are accompanied by satisfactory explanation and are shown to meet corresponding U.S. standards and practices, as approved by Navy Crane Center. Design calculations and drawings that use foreign language and nomenclature must be provided with corresponding English equivalents. Metric units may be used for both calculations and shop drawings, but they must include conversions to English units. In the case of calculations, only the initial inputs and final results need to be so converted. Professional training and accreditation of foreign engineers may vary in some aspects from those in the U.S., but they are satisfactory if comparable for the design work in which they engage. Mechanical properties and quality standards of common construction materials of foreign sources supplied in accordance with recognized standards that resemble those of ASTM and other U.S. standards are acceptable, as approved by Navy Crane Center. Typically, foreign welding procedures, materials, standards, and welder qualifications are comparable to those of AWS and are therefore acceptable. Provide all necessary certifications and other data for review and approval prior to start of work. Special attention must be given to ensure the weld sizes are being specified and measured uniformly. Unique constructions and metric sizes not complying with FS RR-W-410, the Wire Rope Users Manual, or ASTM A1023/A1023M, may be used on Navy cranes, subject to Navy Crane Center review and approval of the specific applications. In selecting metric wire ropes for installation on new cranes with sheave and hoist drum grooves configured for a specific US wire rope size, the metric diameter must be within the limits of the wire ropes for which the sheave and drum are grooved. When the wire rope is installed on an older crane with sheave and hoist drum grooves configured for a specific U.S. produced wire rope size, the sheave and hoist drum grooving must be considered to ensure a satisfactory match with the wire rope. The capacities or ratings of components produced in foreign countries in compliance with foreign standards, and their installation requirements, must be converted to the English engineering units and verified for specification compliance.

b. Some components from foreign sources are prohibited due to practical considerations – either susceptibility to counterfeiting or maintenance and timely support. Specific examples are:

(1) High-Strength Structural Bolts and Nuts. The use of structural bolts from foreign manufacturers is allowed provided the bolts meet Research Council on Structural Connections (RCSC) Specification for Structural Joints Using High-Strength Bolts (RCSC A348).

(2) Electronic controls of foreign manufacturers are prohibited unless technical support is available in the U.S.

]1.4 VERIFICATION OF DIMENSIONS

The Contractor is responsible for the coordination and proper relation of their work to the building structure and to the work of all trades. Coordinate with the crane support structure design, where applicable, to provide the desired crane operating envelope (i.e., hook envelope and hook height). Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Electric Crane System; G, [_____]

Complete Schematic Wiring Diagram; G, [_____]

Control System and Network Drawings; G, [_____]

SD-03 Product Data

****
NOTE: Each catalog cut must be marked-up to fully identify the model or size/rating of the item and supplemental pages with data or information to demonstrate specification compliance.
****

Hoist Brakes; G, [_____]

Travel Brakes; G, [_____]

Load Block and Hook; G, [_____]

Hoist and Trolley Units; G, [_____]

Hoisting Rope; G, [_____]

Travel Reducer; G, [_____]

Wheels; G, [_____]

Bridge End Trucks; G, [_____]

Crane Bridge Girder; G, [_____]

End Stops; G, [_____]

Bumpers; G, [_____]

[Crane Runway System; G, [_____]

] Motors; G, [_____]

Enclosures; G, [_____]

Circuit Breakers; G, [_____]

Disconnect Switch; G, [_____]

Contactors and Relays; G, [_____]

Fuses; G, [_____]

Variable Frequency Drives; G, [_____]

Limit Switches; G, [_____]

Resistors; G, [_____]

[Radio Control System; G, [_____]

][Pendant Push-Button Station; G, [_____]

][Pendant Conductor System; G, [_____]

] Crane Controllers; G, [_____]

[Control Parameter Settings; G, [_____]

][Pilot Devices; G, [_____]

][Warning Devices; G, [_____]

][Floodlights; G, [_____]

] Runway Conductor System; G, [_____]

Bridge Conductor System; G, [_____]

Overload Protection; G, [_____]

Painting System; G, [_____]

Control System and Network; G, [_____]

SD-05 Design Data

Load and Sizing Calculations; G, [_____]

SD-06 Test Reports

[Hook Proof Test; G, [_____]

][Hook Non-Destructive Test (NDT); G, [_____]

] Post-Erection Inspection; G, [_____]

Operational Tests; G, [_____]

Hook Tram Measurement; G, [_____]

Load Tests; G, [_____]

SD-07 Certificates

Wire Rope; G, [_____]

****

NOTE: A solid non-sparking wire rope (e.g., stainless steel) is the preference for hazardous areas.

Include the requirement for end user notification if the crane operates in a Division 2 hazardous area (per CLASSIFICATION) and drawn galvanized wire rope is allowed per HOISTING ROPE.

****

[Drawn Galvanized Wire Rope End User Notification; G, [_____]

] Crane Runway; G, [_____]

Hazardous Material; G, [_____]

Loss of Power Test; G, [_____]

Overload Test; G, [_____]

Brake Adjustment Record; G, [_____]

Contractor Hazardous Environment; G, [_____]

Public Domain Software; G, [_____]

Software and Services; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 3; G, [_____]

SD-11 Closeout Submittals

Network-Capable Control Devices; G, [_____]

Disabled Ports, Connectors, and Interfaces; G, [_____]

Evaluation Status of Hardware and Software; G, [_____]

Control System Access Control; G, [_____]

Control System Account Management; G, [_____]

Patch Management and Updates; G, [_____]

Malware Detection and Protection; G, [_____]

Wireless Technology Provisions; G, [_____]

Control System Inventory; G, [_____]

1.6 QUALITY ASSURANCE

1.6.1 Manufacturer Qualification

Overhead Electric Crane System, including sub-system components manufactured by vendors, must be designed by, or directly supervised by, a registered professional engineer (PE). PE licensing must be by a board or agency authorized to license and register professional engineers. The PE may be a Contractor's regular employee or a consultant. The PE's review and attestation of specification compliance and professional responsibility must be signified by their PE original seal and dated signature on the final drawings. The professional engineers must only undertake and perform work under this contract in the branch(s) of engineering in which they are licensed.

1.6.2 Pre-Delivery Inspections

Contractor is responsible for performance of quality control inspections, testing, and documentation.

[1.6.2.1 Hook Proof Test

****

NOTE: Hook proof tests are required by the NAVY for custom designed or non-ferrous (bronze or stainless steel) hooks. Bronze/stainless steel hooks are generally associated with the minimum hazardous area requirements, which applies to all cranes specified by this document.

****

Proof test custom designed or non-ferrous load hooks per ASME B30.10. Perform the proof test prior to Hook NDT.

]1.6.2.2 Inspection of Hook Assembly

****

NOTE: For NAVY, crane hooks require liquid penetrant type inspections for non-ferrous hooks with acceptance criterion being no linear indications greater than 1.5 mm 1/16 inch. General recommendation is that linear indications greater than 1.5 mm 1/16 inch not be allowed. Use of X-ray and ultrasonic inspection is not required for NAVY cranes.

****

Inspect hook [by liquid penetrant type inspection] [and X-rayed] [and tested ultrasonically] prior to delivery. Furnish documentation of hook inspection to Contracting Officer prior to field operational testing.

Acceptance standard is no defects. A defect is defined as a linear indication for which the largest dimension is greater than [1.5 mm 1/16 inch] [3 mm 1/8 inch] [_____] long. Welding repairs of hooks are not permitted. A hook showing linear indications, damage, or deformation is not acceptable.

[1.6.2.2.1 Hook Non-Destructive Test (NDT)

****

NOTE: This section is required for NAVY cranes.

Remove this section if the selecting agency does not require hook non-destructive testing or the necessary non-destructive testing is not IAW NAVY requirement.

NOTE: For NAVFAC, add tailored paragraphs with additional requirements.

****

For hooks of non-magnetic material, NDT must be liquid penetrant (PT) method in accordance with ASTM E1417/E1417M or NAVSEA T9074-AS-GIB-010/271. For PT testing of hooks containing stainless steels, titanium, or nickel based alloys, total halogens and Sulphur used in the NDT process must be controlled as specified in NAVSEA T9074-AS-GIB-010/271.

Inspect each hook and shank over the entire surface area. If NDT cannot be performed on surfaces inside small holes (e.g., hook/nut captivation roll pin holes), visually inspect those surfaces to the maximum extent practical.

a. Acceptance Criteria: Defects found on the hook will result in rejection of defective items for use on furnished hoist.

b. Test Report: Submit a test report of the inspection of each hook provided the Contracting Officer for approval prior to final acceptance of hoist installation. Certify test reports by the testing organization. The performing organization must provide a written statement of certification to ASTM E543, current within one year of the date the NDT was performed. The performing organization must have the NDT procedures and its technique sheet used for testing of the hook reviewed and approved by an independent Level III examiner. Submit the (Level III examiner) approved procedures, technique sheets, and certification to the Contracting Officer with the test report.

]1.6.3 Drawings: Overhead Electric Crane System

a. Submit drawings showing the general arrangement of all components in plan, elevation, and end views to demonstrate proper interface with the facility and relation to other cranes on the same rail system, if applicable. Show all major features of the crane including: hook approaches on all four sides, clearances and principal dimensions, hoist, trolley and bridge drives, motor nameplate data, overcurrent protective device ratings, and electrical schematic drawings. Include weights and centers of gravity of major components (e.g., bridge girder, trolley/hoist).

b. Submit shop drawings of all fabricated components. Shop drawing quality must be equivalent to the contract drawings accompanying this solicitation. Drawings must be reviewed, signed, and sealed by a licensed professional engineer.

c. Provide Bill of Material for crane components on each drawing. The schedule must provide a cross reference between manufacturer data and shop drawings. Components listed on the schedule of crane components must include total quantity, description, original manufacturer, and part number. Distributing agents will not be acceptable in lieu of the original manufacturer.

d. Provide control system and network drawings. Network diagram must show equipment locations, names, models, and IP addresses on network communications schematic for all Programmable Logic Controllers (PLCs), Remote Terminal Unit (RTU), Supervisory Controller, and Other Network-Capable Devices. In addition, the drawings must consist of all software block, flow, and ladder diagrams.

1.6.4 Design Data: Load and Sizing Calculations

****

NOTE: Design data for Load and Sizing Calculations, and welding procedures, may not be available for commercially procured hoists and trolleys. Coordinate seismic analysis requirement with specification section SEISMIC FORCES.

****

Submit complete list of equipment and materials, including manufacturer's descriptive data, technical literature, and performance charts and curves. Submit calculations reviewed, signed, and sealed by a registered professional engineer verifying the load cases, sizing of the bridge girder, end trucks, travel drives, motors, overcurrent protection, and conduit. Provide a list of all codes and standards, design assumptions, equations, specified efficiencies, limits, factors of safety, component ratings, and sources of values used. Include free body diagrams or sketches of each load case.[Include seismic analysis of crane.]

1.6.5 Certificates

All certifications must be dated and bear the original signature (above the printed name) of the authorized representative of the Contractor or the manufacturer of the items or equipment being certified. Submit certifications that clearly identify the crane, the drives, components, and location (as applicable) to which it applies:

a. Wire Rope Certification with either the wire rope manufacturer's certification that the rope meets the published breaking force, or the actual breaking force of a sample taken from the reel and tested. Show the published breaking force on the wire rope certificate; the actual wire rope breaking force must meet or exceed the published value. Certification must be traceable to the hoist, crane, and reel.

****

NOTE: A solid non-sparking wire rope (e.g., stainless steel) is the preference for hazardous areas.

Include the requirement for end user notification if the crane operates in a Division 2 hazardous area (per CLASSIFICATION) and drawn galvanized wire rope is allowed per HOISTING ROPE.

****

[(1) Drawn Galvanized Wire Rope End User Notification from the crane, hoist, or wire rope OEM notifying the end user that the crane is operated in a Division 2 hazardous area as defined by NFPA 70, which is a location where the hazardous material is not likely to be present or is present only in the short term. The wire rope is made of drawn galvanized steel, meaning it is manufactured from sparking materials but provided with a spark resistant outer layer. The outer layer or individual wire strands could become compromised if the wire rope is used in an improper manner or inadequately maintained, which would affect the integrity of the spark-resistant protection. In this scenario, immediate replacement is recommended. The wire rope will need to be evaluated and potentially replaced with a compliant configuration if the hazardous area Division is changed.

] b. Crane Runway Certificate stating that the new crane will operate properly on the runway. For runways provided by Contractor, include statement certifying runway has been aligned in accordance with MHI MH27.1.

c. Hazardous Material Certificate that the crane does not contain hazardous material including asbestos, lead, cadmium, chromium, PCBs, or elemental mercury. Products required for the designing and manufacturing of cranes must not contain the prohibited materials.

d. Loss of Power Test Certificate stating that a test may be performed in which power is removed during operation without any detrimental effects to the crane.

****

NOTE: For NAVFAC, the Overload Test Certificate must state that the cranes can be periodically load tested to 125 percent (plus 0 minus 5 percent). Remove the conflicting Overload Test Certificate which allows for testing at different tolerances.

****

e. Overload Test Certificate stating that the crane can be periodically load tested to 125 percent (plus 0 minus 5 percent) of rated load. Overload Test Certificate stating that the crane can be periodically load tested to 125 percent (plus [0] [_____] minus [5] [_____] percent) of rated load.

f. Certificate of the Brake Adjustment Record. Provide a brake adjustment record and installation/maintenance manuals for each brake on the crane. Each brake measurement must have a tolerance traceable to the associated brake manual or documentation provided by the brake manufacturer, location of measurements, and the actual brake setting. Changes made to settings of the brake, at any time, will void the record.

g. Contractor Hazardous Environment Certificate stating that the new crane and all associated components including the hoist are designed for operation in the hazardous environment specified in the Classification section.

h. Public Domain Software Certificate declaring that public domain software (e.g., freeware, shareware) is not used in the system.

i. Certificate stating that all Software and Services that are not required for operation and/or maintenance of the product have been removed. The software/services to be removed are identified in

SOFTWARE AND SERVICES.

1.6.6 Welding Qualifications and Procedure

Welding must be in accordance with qualified procedures using AWS D14.1/D14.1M as modified. Written welding procedures must specify the Contractor's standard dimensional tolerances for deviation from camber and sweep and not exceed those specified in AWS D14.1/D14.1M and MHI MH27.1. Welders and welding operators must be qualified in accordance with AWS D1.1/D1.1M or AWS D14.1/D14.1M.

1.7 CRANE SAFETY

Comply with the mandatory and advisory safety requirements of ASME B30.10, ASME B30.16, ASME B30.17, ASME HST-4, 29 CFR 1910.147, 29 CFR 1910.179, 29 CFR 1910.306, and all applicable provisions of 29 CFR 1910 and NFPA 70.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Provide materials and equipment which are standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment. Material will be free from defects and imperfections that might affect the serviceability and appearance of the finished product. All material must be new and unused.

2.1.2 Nameplates

Secure nameplates to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Provide two bridge identification plates, one for each side of the bridge. Provide noncorrosive metal identification plates with letters which are easily read from the floor, showing a separate number such as BC-1, BC-2, for each bridge crane.

2.1.3 Capacity Marking

****

NOTE: NAVFAC requires markings to be indicated in pound units. The kilogram marking option is provided for cranes installed in a foreign country.

****

Mark the rated capacity in pound units [with kilogram units printed in a different color] on each side of the crane on the bridge girder. Capacity marks must be large enough to be clearly visible from the floor. Individual hoist units must have their rated capacity clearly marked on their lower block, and additionally labeled on the hoist body.

2.1.4 Safety Warnings

Affix labels in a readable position to each lift block or control station in accordance with ASME B30.16 and ASME B30.17. Submit safety warnings, diagrams and other instructions suitably framed and protected for display as indicated by the Contracting Officer as follows:

Design and locate the word "WARNING" or other legend to bring the label to the attention of the operator. Provide durable type warning labels and display the following information concerning safe-operating procedures: Cautionary language against lifting more than the rated load; operating the hoist when the hook is not centered under the hoist; operating hoist with twisted, kinked or damaged rope; operating damaged or malfunctioning hoist; operating a rope hoist with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label.

2.2 STRUCTURAL REQUIREMENTS

Structural requirements must be in accordance with MHI MH27.1. Structural steel materials must conform to the standards permitted in MHI MH27.1 and AISC 360. Skewing and other applicable lateral loads must be considered in the design.

2.2.1 Structural Connections

High-strength bolted structural connections must be designed and installed in accordance with RCSC A348. Bolts must be of ASTM F3125/F3125M Grade A325/A325M or Grade A490/A490M material. Galvanized bolts are not acceptable.

Welded connections for the crane must be performed in accordance with AWS D14.1/D14.1M. Welded connections to the building must be performed in accordance with AWS D1.1/D1.1M. Allowable stress values must comply with MHI MH27.1.

2.2.2 Crane Bridge Girder

a. Provide a crane bridge girder of patented track conforming to MHI MH27.1. Intermittent ("skip") welds on bridge girder elements (e.g., web and flange interfaces) are prohibited. If the girder is notched to fit over the end trucks, reinforce the girder ends with vertical and horizontal stiffeners. Splices in the unsupported length of the girder are prohibited.

b. Submit manufacturer's standard published tables that verify the crane bridge girder is sized in compliance with all specification requirements. When standard published tables are not available, provide calculations for the strength design and deflection of the bridge. Patented track girder must be of welded steel construction and fabricated by a manufacturer regularly engaged in the production of this type of beam.

c. Keep splices in the bridge girders to a minimum and splices in high stress locations must be avoided. Make splices with complete joint penetration welds. Field (on-site) welded splices are prohibited.

2.2.3 Bridge End Trucks

****

NOTE: For cranes in hazardous areas which encompass the entire crane envelope, the drop lugs pose a sparking risk if it is metal-to-metal. Use the maximum anti-spark tailoring option to minimize this sparking risk.

****

Provide bridge end trucks conforming to ASME B30.17 and MHI MH27.1. Configure end trucks with a feature that limits end truck movement to 25.4 mm one inch in the event of wheel or shaft failure. Provide drop (safety) stops with contact surfaces of non-sparking materials.

2.2.4 End Stops

Fit the crane bridge girder(s) with structural steel end stops. Locate stops to permit maximum trolley travel. Design end stops in accordance with MHI MH27.1 and ASME B30.17. Provide a system in which the travel wheels do not contact the end stops. End stops must be designed to absorb the maximum kinetic energy and impact force developed by the bumper contact. Provide end stops compatible with trolley bumpers and designed to bolt to the crane bridge girder.

2.2.5 Bumpers

****

NOTE: The following paragraph contains tailoring for MAXHAZ for cranes located in hazardous areas which encompass the entire crane envelope; the bumper to end stop connection poses a sparking risk if it is metal-to-metal. Use the maximum anti-spark tailoring option to minimize this sparking risk.

****

Fit bridge end trucks and trolley frames with shock-absorbing bumpers capable of decelerating and stopping the bridge and trolley within the limits stated by ASME B30.17. Ensure bumpers conform to ASME B30.17. Bumpers must fully engage end stops. Mount bumpers so that there is no direct shear on mounting bolts (if any) upon impact. Bumpers must provide adequate clearance between the crane and surrounding structure when compressed to preclude damaging equipment (clearance requirements are defined in MHI MH27.1 or CMAA 74, as applicable, and ASME B30.17). When more than one crane is located and operated on the same runway, bumpers must be provided on their adjacent ends or on one end of one crane. Fit the other end of the end-truck with a structural steel stop to engage the bumpers of the adjacent crane. Ensure bridge bumpers are properly aligned with runway end stops. Metal to metal contact at the bumper to end stop connection is not permitted.

[2.2.6 Crane Runway System

****

NOTE: For underrunning cranes, the runway and its support structure is usually supplied by the crane contractor. Use Crane Runway System only if crane contractor is to provide a new runway.

****

a. Provide the complete runway track suspension system that is required to hang the crane runway track at its indicated location from the structural supports indicated on the drawings. Provide runway and support structure for underrunning crane of patented track girders conforming to MHI MH27.1.

b. Splice assemblies must be from the same manufacturer as the patented track and located under structural support members. Submit manufacturer's standard published tables that verify the crane runway track is sized in compliance with all specification requirements. When standard published tables are not available, provide calculations for the strength design and deflection of the beams.

c. Runway support structure must be designed, fabricated, and installed such that runway rails meet the alignment tolerances of MHI MH27.1. Provide means to allow for vertical adjustment of the runway track both before and after the system has been put in operation so that track can be erected and maintained level. Brace runway to restrain the track against damaging lateral and longitudinal movements. Where the runway track is suspended from hanger rods, provide means preventing the hanger rod nuts from backing off the rods. Allowable stress in hanger rods is 20 percent of the minimum specified ultimate strength of the material used.

d. The lower T-section ends of the runway must be aligned to minimize the horizontal gap on the running surface to not greater than 1.5 mm 1/16 inch and not greater than a vertical difference of 0.75 mm 1/32 inch for the wheel running surface alignment for a smooth crossing by the wheels. Provide splices located directly under structural support members. When runways are suspended, bracing preventing damaging lateral or longitudinal movement is required. Loads transmitted to the building through the suspension must have the review and approval of the building engineer of record (EOR) prior to installation.

e. Design, fabricate, and install new runway end stops in accordance with MHI MH27.1 and ASME B30.17. End stops must be designed to absorb the maximum kinetic energy and impact force developed by the bumper contact. Provide end stops compatible with end truck bumpers, designed to bolt to the runway support girders, and maximize bridge travel.

][2.2.7 Seismic Forces

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NOTE: Seismic forces for underrunning cranes are typically considered negligible. If not considered negligible, include the analysis section below. Seismic forces must be considered in the design of the cranes with a component importance factor of greater than 1.0 and in facilities with a Seismic Design Category of D, E, or F per ASCE 7. Coordinate requirement with specification section DESIGN DATA: LOAD AND SIZING CALCULATIONS.

****

Perform a seismic analysis as a part of the design of the crane in accordance with ASCE 7-16. The seismic analysis must be included in the MHI MH27.1 extraordinary load case (Case 3).

For project locations beyond the scope of ASCE 7-16, a widely accepted design standard may be used for seismic analysis.

]2.3 MECHANICAL REQUIREMENTS

a. Provide steel shafts, gears, and keys, with the exception of worm gears which may be bronze. No three or more bearing shaft configurations are allowed.

b. Cast iron and aluminum used to support components of the hoist power transmission train must be ductile. For the purposes of this specification, "ductile" is defined as having a minimum elongation of 5 percent in 2.00 inches.

c. Provide steel or ductile/malleable cast iron brake housings of motor mounted disc brakes, brake lining backing plates, shoes and shoe holders. Provide spring-set brake shoe or pad linings of a non-asbestos material.

d. All mechanical components must be accurately aligned and positively secured to maintain the alignment. Parts must not be forced into position to obtain apparent alignment.

e. Provide minimum bearing life in accordance with ASME hoist performance standards and MHI MH27.1.

f. All "should" statements in CMAA 74, MHI MH27.1, and ASME B30 are considered to be "shall" statements.

2.3.1 Threaded Fasteners

Fasten mechanical connections that are not part of a commercial packaged assembly with SAE J429 Grade 5 fasteners, ASTM F436/F436M washers, and SAE J995 Grade 5 nuts. Lubricate all mechanical fasteners unless otherwise specified by the original component manufacturer.

2.3.2 Hoist

****

NOTE: Generally, hoist duty class roughly aligns with CMAA class. An H3 hoist service duty class would typically be specified for a CMAA 74 service class C crane; H4 for service class D. See the Crane Design Criteria – Classification section to identify the CMAA service duty class specified for this crane.

****

Provide hoist conforming to ASME B30.16 except as modified and supplemented in this section. Packaged hoist and trolley units (packaged hoists) must be double reeved electric wire rope hoist conforming to ASME HST-4 Duty Class [H3] [H4] or better and be rated for the operating environment.

Configure trolley such that the trolley frame contacts the trolley stops and prevents the trolley from dropping more than one inch in the event of an axle or wheel failure. Provide drop (safety) stops with contact surfaces of non-sparking materials. Metal to metal contact at the bumper to end stop connection is not permitted.

2.3.2.1 Hoist Brakes

****

NOTE: Each hoist must have, at a minimum, two brakes. For packaged hoists, the most common brake configuration is one electro-mechanical spring set brake and one mechanical load brake (or self-locking worm gear).

Consider the CONTROLS paragraph under ELECTRICAL REQUIREMENTS.

If a variable frequency drive (VFD) is selected for use, the brake configuration must reflect the type of VFD selected (open loop). If open loop controls are selected, brake configuration must be one electro-mechanical brake and one mechanical load brake (or self-locking worm gear).

NAVFAC tailoring option is for brakes utilized as holding brakes only.

****

a. Equip the hoist with two holding brakes, each with a minimum torque rating of 125 percent of the rated load hoisting torque. Provide a brake configuration with one electro-mechanical spring set brake and one mechanical load brake, or self-locking worm gear, that stops and holds 125 percent of the hoist's rated load and does not require the load to be raised before being lowered.

b. Electro-mechanical brakes must have an externally accessible means of manual release. Provide manual-adjusting brakes designed to permit inspection and adjustment without disassembly of the brake. The brakes must be equipped with a manual self-return to ON brake release; maintained brake releases must reset when power is applied. Double face-mounted brakes are not permitted.

2.3.2.2 Load Block and Hook

****

NOTE: NAVFAC tailoring options for uniquely marked hook and nut and commercial blocks.

Tailoring option for maximum anti-spark protection (upper hooks must be non-sparking).

****

a. Provide a load block constructed of non-sparking materials. Covering the exposed surfaces of the load block with bronze, stainless steel, or aluminum covers attached with similar fasteners is acceptable. The load block must be designed to prevent metal-to-metal contact of moving parts. The block must be fully enclosed, concealing the sheaves and wire ropes, except for wire rope slots and drain holes. The design must preclude the wire rope from being cut, pinched, crushed, or chafed in case of two-blocking. Standard commercial blocks may be used at their published ratings when their published design factors are 5.0 or greater.

b. Provide an unpainted and unplated single barbed hook of non-sparking material. Bronze clad hooks are prohibited. Hooks must conform to the requirements of ASME B30.10. The hook must be a standard commercial product with a published design factor of 5.0 or greater. Fit hook with a safety latch designed to preclude inadvertent displacement of slings from the hook saddle. The hook and hook nut must be removable without unreeving of the hoist. Provide a hook nut secured to the hook with a commercial standard removable and reusable means. Do not weld hook nut. When provided, provide shank and nut threads with a Class 1 or 2 fit, per ASME B1.1. Uniquely mark the hook in a permanent fashion that is traceable to the NDT certification. The nut must be marked to match the hook. The hook nut must be of non-sparking materials. Hook must be free to rotate through 360 degrees when supporting the test load up to 125 percent of the rated capacity. Upper hooks of hook suspended hoists must be of non-sparking materials.

2.3.2.3 Hoisting Rope

****

NOTE: A solid non-sparking wire rope (e.g., stainless steel) is the preference for hazardous areas.

There are some packaged hoist and capacity combinations (e.g., 5 ton capacity) in which the published stainless steel wire rope breaking strength for the given rope diameter cannot meet the prescribed design factors per ASME B30.16. In those instances an alternative wire rope material is necessary. Drawn galvanized wire rope is acceptable in Division 2 hazardous areas provided the crane, hoist, or wire rope OEM provide a notification to the end user with the wire rope certification / submittal. This notification will identify that the wire rope is made of drawn galvanized steel, meaning it is manufactured from sparking materials but provided with a spark resistant outer layer. The outer layer or individual wire strands could become compromised if the wire rope is used in an improper manner or inadequately maintained, which would affect the integrity of the spark-resistant protection.

****

a. Wire rope must comply with ASME B30.30 and FS RR-W-410, ASTM A1023/A1023M, or BS ISO 4309 and have a rope classification appropriate for the usage. Wire ropes must be handled and seized in accordance with ASME B30.30. The wire rope must be in a double reeved configuration equalized with a sheave. Select wire rope minimum design factor in accordance with ASME B30.16. Provide proof of Wire Rope breaking force.

b. Wire rope must be spark resistant.Provide stainless steel hoist ropes with an independent wire rope, wire strand, or otherwise, steel core.[Drawn galvanized wire rope is acceptable in Division 2 hazardous areas when provided with a drawn galvanized wire rope end user notification.]

2.3.2.4 Drum

Provide grooved drum made of steel. Design drum in accordance with ASME B30.16. All hoisting rope is to be wound in a single layer and provided with no less than two dead wraps of hoisting rope remaining at each anchorage when the hook is in its extreme low position.

2.3.2.5 Sheaves

Provide sheaves constructed of non-sparking metals in the load block. Provide sheaves constructed of steel for the equalizer and in the upper sheave nest. Size sheaves in accordance with ASME B30.16 for the minimum pitch diameters of running and equalizer sheaves.

2.3.3 Travel Drives

Provide travel assemblies with a minimum of one driven wheel on each side of the web and at least one quarter of all wheels driven. The travel drive arrangement must consist of motor(s) driving through self-contained gear reduction units located at each driven wheel assembly. Gear reducers must be fully enclosed in an oil-tight housing and provided with a convenient means of lubricant level indication and draining. Open-type gearing is not acceptable, except for final drives.

2.3.3.1 Trolley Drives

****

NOTE: Trolley limit switches are an optional safety device.

Trolley travel limit switches are used to prevent the crane trolley from contacting the travel end stops at high speed should the crane operator mistakenly forget to slow down. If selected, ensure the appropriate options are chosen in the ELECTRICAL REQUIREMENTS, Limit Switches section.

****

Provide a motor-driven trolley arrangement. Acceleration and deceleration must meet the requirements specified in CMAA 70.[Provide trolley travel limit switches.]

2.3.3.2 Bridge Drives

****

NOTE: Bridge limit switches are an optional safety device.

Bridge travel limit switches are used to prevent the crane bridge trucks from contacting the travel end stops at high speed should the crane operator mistakenly forget to slow down. If selected, ensure the appropriate options are chosen in the ELECTRICAL REQUIREMENTS, Limit Switches section.

****

Provide a motor-driven bridge arrangement. Acceleration and deceleration must meet the requirements specified in CMAA 74.[Provide bridge travel limit switches.]

2.3.3.2.1 Bridge Travel Gearing

Gearing must conform to ANSI/AGMA 2001 and AGMA 908, with internal and external gear dimensional tolerances conforming to the applicable AGMA standard for tooth geometry and tolerances.

2.3.3.2.1.1 Bridge Travel Reducer

Gear reducers must be standard commercial products designed, manufactured, and rated in accordance with ANSI/AGMA 6013. Provide cranes with a CMAA service class "C" or higher with the corresponding "Industrial Duty" service factors. The speed reducer input (high speed) gear set must use helical (including double helical and herringbone), spiral bevel, or worm gear tooth forms. Provide torque arms that are not of the threaded rod type. Operation must be smooth and quiet.

2.3.3.2.1.2 Bridge Open Gearing

Provide all gears and pinions with adequate strength and durability for the crane service class and manufactured to ANSI/AGMA 2015-1 Accuracy Grade A8 or better. Wherever feasible, open gears must be enclosed with safety guards provided with openings with covers for inspection and access for grease lubrication.

2.3.4 Travel Brakes

****

NOTE: NAVFAC tailoring option for additional travel brake requirements.

****

Provide travel drives with an end-mounted electro-mechanical spring set brake conforming to the requirements of CMAA 74 or non-freecoasting mechanical drive capable of stopping the motion of the travel function within a distance in meters feet equal to 10 percent of the full load speed in meters feet per minute when traveling at full speed with a full load.

Spring set brakes must be provided with an externally accessible means to manually release the brake. Provide manual-adjusting brakes designed to permit inspection and adjustment without disassembly of the brake. The brakes must be equipped with a manual self-return to ON brake release; maintained brake releases must reset when power is applied. Double face-mounted brakes are not permitted.

2.3.4.1 Trolley Brake

****

NOTE: NAVFAC tailoring option to require electro-mechanical brakes be end-mounted.

****

Provide brakes for underrunning trolleys/carriers sized in accordance with ASME B30.17, but not sized larger than 150 percent of the drive motor rated torque.

2.3.4.2 Bridge Brake

****

NOTE: NAVFAC tailoring option to require electro-mechanical brakes be end-mounted.

****

Provide brakes with a minimum torque rating per CMAA 74 according to the applicable environment, but not sized larger than 150 percent of the drive motor rated torque.

2.3.5 Wheels

****

NOTE: The following paragraph contains tailoring regarding the use of non-sparking wheels with maximum anti-spark protection. Remove any conflicting items (i.e., wheels cannot be non-sparking and steel or ductile cast iron).

****

Provide under running wheel sizing and flange-to-rail head clearances in accordance with MHI MH27.1 recommendations. The wheels must be compatible with their respective runway profile. Wheel material is to be cast or forged steel, or ductile or malleable cast iron. Provide wheels of non-sparking material. Bronze wheels must have sufficient size and hardness to withstand the intended loading and use. Hollow stamped and gray cast iron wheels may not be used; the use of plate steel is prohibited. Minimum tread hardness for underhung wheels (non-bronze) that run on patented track is 375 BHN.

[2.3.6 Drip Pans

****

NOTE: Drip pans may also be added for any type of crane service if there is an additional requirement to prevent lubrication from falling to the floor or lifted load. Any portion of this section may be used to support the request of the Activity. Not recommended for outdoor service.

List items a. and b. are generic drip pan requirements for inclusion beneath gearboxes. Paragraph c is less likely to be needed.

****

a. The crane must be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment or components, which cannot be made leak-proof, must be fitted with unpainted corrosion resistant steel drip pans or must have the foundations seal welded to create a dam. Drip pans that utilize liquid sealant to prevent leakage of lubricants are not permitted.

b. The drip pans must be sized to hold the entire gear case fluid capacity, installed under all drive machinery, designed to permit easy removal of collected lubricant. A trolley floor designed to contain any lubricant drips may be used as fluid containment for any equipment that is mounted on it.

c. Provide drip pans fitted around the shank of the hook and extending outward to encompass all possible points of lubrication drips from the load block or wire rope. The drip pans must be easily removable without disassembly of the hook or load block and cannot interfere with the crane structure during testing of the upper limits.

]2.4 ELECTRICAL REQUIREMENTS

a. The design, selection, rating, and installation of the electrical portions of the crane and its accessories must conform to the requirements of NEMA ICS 3, NEMA ICS 8, the applicable ASME HST standard, and NFPA 70, and other requirements specified herein.

b. All electrical components must be industrial grade, commercially available and comply with established national or internationally recognized approving organizations such as Underwriters Laboratories (UL) and Canadian Standards Association (CSA). All electrical components installed or operated in hazardous areas including but not limited to enclosures, junction boxes, disconnects, pendant controller, and electrification must be designed and rated for the NFPA 70 Hazardous Classifications specified in Classification section.

c. All electrical components must be located so they are easily accessible for inspection and maintenance without removing other parts, doors, or door center posts. Install electrical equipment and panel wiring in a neat and workmanlike manner in accordance with Electrical Construction Standard NECA NEIS 1. Each motion of the crane must be provided with a separate and independent variable frequency drive unit. The loss of any one function must not prevent the operation of other unaffected functions. Two independent relays, contactors, drive inputs, or other equivalent components/logic must be utilized for each function to provide directional control such that the failure of a single relay/contactor/component cannot result in motion in an unintended direction.

d. Disconnecting means for cranes must be in accordance with NFPA 70 Article 610.32. A permanent placard must be installed on the face of the main line disconnect that states "WARNING – THIS DOES NOT ISOLATE POWER TO LIGHTING, RECEPTACLES, AND ANCILLARY EQUIPMENT". Additionally, a lighting (ancillary equipment) disconnect must be provided, with lockout feature, as the isolation means for the lighting transformer and lighting circuit breaker panel, which must power the crane's ancillary equipment. It must feed 480 VAC to the primary side of the transformer directly from the runway conductors via tapping the line side of the main power disconnect. Provide individual disconnects, with lockout feature, capable of being locked in the open position for bridge lights and receptacles.

e. Unless otherwise specified, interconnecting wiring must be of copper stranded construction complying with Table 310.104(A) of NFPA 70. Interconnecting wiring containing asbestos in the insulation or outer covering are prohibited. Aluminum conductors must not be used. Aluminum connectors are allowed if they are rated for use with copper conductors (marked "AL/CU"). All conductors connected to or routed above resistors must have insulation shown in NFPA 70 Table 610.14(a) for 125 degrees C 257 degrees F. For packaged hoists and hoist/trolleys, provide wiring sizes in accordance with NFPA 70 Table 610.14(a). Motor branch circuit conductors not part of a packaged hoist and hoist/trolley must be sized as to have an ampacity not less than 150 percent of the motor full load current rating and to be no smaller than 12 AWG. Conductors must be selected and de-rated based on maximum ambient temperature. Continuous loads such as utility, heating, lighting, and air conditioning must be multiplied by 2.25 to determine ampacity in order to permit application of NFPA 70 610.14 (A) for crane supply conductors. Wire-nuts are not permitted on splices. However, connections for lighting ballasts may be made using wire-nuts (if applicable).

f. Excluding conduit directly connected to dynamic breaking resistors, raceways must maintain a 12-inch clearance between the raceway and dynamic braking resistors. A separate grounding wire, sized in accordance with Section 250.122 of NFPA 70, must be routed with all ungrounded conductors. Only one equipment grounding conductor must be run in each conduit and be the largest size required for any circuit routed in that conduit. All wiring must be numbered or tagged at all connection points. Power conductors which are shielded such that their wire size cannot be easily determined must be labeled as to the conductor size. All unused conduit openings must be plugged.

g. When fiber optic cable is utilized, inspections and performance checks must be accomplished upon completion of on-site installation to ensure cable cleanliness and proper signal integrity. Testing and verification must be conducted by a knowledgeable fiber optics technician using specialized, calibrated equipment. Cables must be tested for signal loss/attenuation. The fiber optic system must also be tested using an Optical Time Domain Reflectometer (OTDR). Final attenuation and OTDR readings from each fiber optic cable run, including spares, must be documented as a baseline for future reference. All spare fiber optic cables must have protective covers over their ends to maintain cleanliness while not in use. When fiber optic cable is utilized the drive OEM's recommendations for encoders and optical to digital converters must be followed. All system components utilized for this purpose must have known compatibility prior to integration.

h. Power cables and low voltage signal cables may not be mixed in the same conduit.

i. The crane manufacturer must furnish and install all electrical equipment on the crane conforming to NEMA ICS 6, including motors, conforming to NEMA MG 1, electrically released brakes, switches, crane controllers, panels, operating station, wiring system, cables, and crane electrification.

2.4.1 Motors

****

NOTE: Inverter duty motors are required for open loop variable frequency drives (VFD).

U.S. Navy allows only 60-minute duty rating motors. 30-minute duty rating motors require Navy Crane Center approval. For non-Navy applications, the motor duty rating may be selected to match what is required by the class of HST-4 hoist (such as H1, H2, H3) specified.

****

Motors must meet all applicable requirements of NEMA MG 1 and UL 1004-1. CMAA 70 calculations for motor horsepower shall be used in selecting bridge, trolley, and hoist drive motors. All motors must have a minimum of a [60] [30] [_____] minute duty rating and be Totally Enclosed Non Ventilated (TENV), Totally Enclosed Fan Cooled (TEFC), or Totally Enclosed Blower Cooled (TEBC).[Provide inverter duty motors for Open Loop Variable Frequency Drives (VFD).][Provide AC squirrel cage induction type motors for the bridge, trolley, and hoist drives.] Provide motors with a minimum of Class F insulation. Provide motor overload protection utilizing a thermal sensitive device embedded in its windings.

2.4.2 Controls

****

NOTE: Use the first three paragraphs to select electronic variable frequency drive controls for either the hoist, bridge or trolley. With VFD controls, the hoist must be configured as open loop. Open loop is more cost effective and requires a mechanical load brake (or self-locking worm gear). Ensure the Hoist Brakes section of this specification reflect the type of controls chosen. Use the fourth, fifth, and sixth paragraphs to select one or two speed control for the hoist, bridge, or trolley. Selections can be made using a combination of electronic controls and one or two speed motor controls for the various functions.

When the two-speed bridge and trolley motor is specified, the slow speed will be 1/3 to 1/4 of rated travel speed. Reduced voltage starting, acceleration, and deceleration, serve to reduce the acceleration rate that is normal for squirrel-cage motors. Squirrel-cage motors with two-speed magnetic controls provide satisfactory results with slow bridge and trolley speeds, and should be specified when short travel distances are involved and where fine positioning is not required.

For faster bridge and trolley speeds or finer positioning requirements, specify electronic controls.

Various VFD manufacturers offer an option to overspeed the hoist to a value over 60Hz (usually 120Hz). This allows the operator to position the hoist at faster speeds when it is not loaded. When selecting this feature list the maximum no load speed in paragraph RATED CAPACITY AND SPEEDS.

****

a. Provide static reversing, variable frequency drives (VFD) for the [bridge,] [trolley] [and] [hoist] electric controls. VFD controllers must meet NEMA ICS 8, Part 8 and at a minimum, provide under-voltage protection, electronic instantaneous over current protection, DC bus over voltage protection, and be able to withstand output line to line shorts without component failure. Select bridge and trolley drives such that the continuous rating of the controller is not less than the calculated motor full load current based on CMAA 70 paragraph 5.2.9.1.1.1 and NFPA 70 Table 430.250. Select hoist drives such that the continuous rating of the controller is not less than 125 percent of the calculated motor full load current based on CMAA 70 paragraph 5.2.9.1.1.1 and NFPA 70 Table 430.250. All hoist drives must have a motor over-torque limit to lock out the hoist and prevent gross overload of the associated hoist. Provide dynamic braking for each electric drive that is sized per VFD manufacturer's requirements. Submit VFD Control Parameter Settings.

b. Provide speed control which is infinitely variable for each function, controlled via [radio control system] [and] [pendant pushbutton station].[Provide controls designed such that the maximum speed of each function will be limited to 25 percent of rated speed when a slow speed switch is actuated on the controller[s].[Energize a yellow/amber light/indicator while in slow speed mode.]]

c. The [hoist][,] [trolley][,] [and] [bridge] brakes must set after the associated controller decelerates the drive motor to a controlled stop. The hoist, trolley, and bridge, controllers must be sized to provide sufficient starting torque to initiate motion of that crane drive mechanism from standstill with 0 to 125 percent of rated load on the hook. The hoist controller must prove torque before release of the brakes and enable the drive motor to develop full torque continuously at zero speed. Motors must operate smoothly at all speeds without torque pulsations and must only be energized within the frequency range of 50-60 Hz at rated speed.[The hoist control system may utilize overspeed up to 120hz, unloaded only, if the drivetrain equipment has all been balanced and is rated for the resulting speed.]

d. The use of definite purpose contactors is prohibited. If IEC contactors are used, the application cannot exceed the contactor manufacturer's AC3 ratings for the contactor at a minimum.

e. On hoist function roll-up must be less than 3 mm 1/8 inch measured at the hook block and roll-back must not occur over the entire load range.

f. Use of Uninterruptible Power Supplies (UPS) is prohibited. Feed control circuits from a single phase, air cooled, double wound transformer with a grounded metal screen between the primary and secondary windings of the transformer.

g. Provide a main line contactor. Energization of the main line contactor must be controlled by the POWER-OFF/POWER-ON switch/pushbutton on all controllers. Upon actuation of the POWER-OFF pushbutton; power to all drive motors, brakes, and controls must be removed. The mainline contactor must not be able to be energize while the POWER-OFF pushbutton is actuated. The POWER-OFF pushbutton circuitry must be independent of all controls or any other electronic devices.

2.4.3 Protection

Protection must not be less than that required by NEMA ICS 3, NEMA ICS 8, CMAA 74, NFPA 70, UL 1004-1, UL 943, 29 CFR 1910.147, 29 CFR 1910.179, 29 CFR 1910.306 and all applicable provisions of 29 CFR 1910. All protection must be by circuit breakers or fuses. Provide a disconnect switch or enclosed type circuit breaker readily accessible to the crane operator for the crane disconnect. Motor branch circuits must be individually protected by inverse time circuit breakers capable of being locked in the open position. The means for locking must remain in place with or without the lock installed. Motor full load current from NFPA 70 Article 430, Part XIV (Tables) must be used to calculate the circuit breaker size.

Provide disconnecting means on the crane in accordance with NFPA 70 Article 610.32. Provide for lockout/tagout of all hazardous energy sources. Provide product data for all circuit breakers and fuses.

2.4.3.1 Conductors

a. The crane contractor is responsible for ensuring that all conductors from the load side of the existing floor level disconnect to the motor branch circuits have adequate overcurrent protection complying with one of the following:

(1) Not be greater than the largest rating or setting of any branch circuit protective device plus the sum of the nameplate rating of all other loads per NFPA 70 Article 610.41(A).

(2) Not be greater than the ampacity of all feeder conductors after all ampacity correction factors have been applied.

b. Conductors for brake coils must be protected by fuses or other protective devices. The device must be chosen to protect the brake circuit conductors from ground faults or short circuits.

2.4.4 Resistors

Provide resistors with natural convection cooling sized as recommended by the VFD OEM and fabricated of corrosion resistant metal; the use of "wire wound" type resistors is prohibited for segments of 8 ohms or less. Mount resistors in substantial, ventilated enclosures constructed entirely of non-combustible materials. Provide resistors with terminals fitted in the coolest position in the enclosure.

[2.4.5 Transients and Harmonics Protection

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NOTE: The following items are required only for VFD Controls.

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Provide contactors and relays with appropriate Metal Oxide Varistors (MOV) or resistor-capacitor (R-C) surge absorbers installed across the respective coil.

Provide transient protection for electronic drive controllers that is either internal to the drive or via an MOV connected line-to-ground close to the line terminals of the drive.

Provide line reactors rated for continuous duty operation based upon the motor nameplate amperes. With motors of 50 horsepower or greater, harmonics protection must be provided by an isolations transformer or as recommended by the VFD OEM. For a drive motor branch circuit that exceeds 150 feet in length, a reactor must also be connected in series with the controller load (output) terminals to provide standing wave protection or as otherwise recommended by the VFD or motor OEM.

]2.4.6 Limit Switches

a. Provide primary upper and lower geared limit switches. Geared limits must allow reversing direction to back out of the limit without resetting. The lower limit switch must be set such that there are a minimum of two wraps of rope on the hoist drum.

b. Provide a backup mechanical hook block activated upper limit switch wired independent of the directional controllers and the primary upper limit switch that removes power from the hoist motor, hoist brake and hoist controls conforming to NEMA ICS 5. The backup limit must require hoist resetting prior to operation of the hoist in any direction.

[c. Travel limit switches must be provided for the [bridge] [and] [trolley] motion to slow the crane to [25 percent] [_____] of its rated speed

[[10] [_____] feet before the bridge end stops] [and] [[5] [_____] feet from the trolley end stops]. Limit switches must be mounted rigidly in a manner so as to protect the switch from misalignment or damage. The target/trip arm must be large enough to provide interception given a misalignment were to occur.

] d. Limit switches must be rated for the NFPA 70 Hazardous Classifications specified in the Classification section of this specification.

2.4.7 Operator Controls

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NOTE: Available operator controls are pendant, and radio control. Cranes can also be set-up to be controlled by two separate systems. For cranes with one set of controls use paragraph 1. For cranes with two sets of controls use paragraph 2. In such a case some type of interlock must exist to prevent control from both systems simultaneously.

The pendant can be suspended from the trolley or an independent festooned messenger track system. The festooned system allows the operator to have maximum separation from the load. When this is a requirement include section Pendant Conductor System section of this specification.

When specifying a radio control system, the following requirements must be considered and if needed added to the specification. None are hard requirements of NAVCRANECENINST 11450.2:

1. What type of batteries? Rechargeable?
2. Are spare batteries needed? How many?
3. Are spare remote control units required? How many?
4. Is a battery charger required?
5. Type of transmitter unit.
6. Is a belt/harness required for the remote control?

****

[Provide crane equipped with a [pendant pushbutton station] [radio control system].

][Provide crane equipped with both a pendant pushbutton station and a radio control system. Provide a selector switch to allow the use of only one of the two available control stations on the pendant controller.

] If VFD controls are not provided, provide directional contactors with both mechanical and electrical interlocks.

Operator controls must be rated NEMA Type 7 for Class I, or NEMA Type 9 for Class II according to the NFPA 70 Hazardous Classifications specified in the CLASSIFICATION section of this specification.

[2.4.7.1 Pendant Pushbutton Station

The cranes must be controlled from a pendant pushbutton station suspended from [the trolley] [an independent festooned messenger track system, operating the length of the bridge]. Provide multiconductor flexible cords for pendant pushbutton stations with #16 AWG minimum conductors. Provide a method of strain relief to protect the electrical conductors from damage. Locate the pendant pushbutton station [1200 mm 4 feet] [_____] above the finished floor. Pushbutton pendant station must have its elements legibly marked and arranged vertically, in order, in accordance with CMAA 74.[Provide [one speed] [two speed] [3-step infinitely variable] [2-step infinitely variable] pendant pushbuttons for control of the [hoist][,] [trolley][,] [and] [bridge].] Provide pendant pushbuttons for control that spring return to the OFF position. Voltage in the pendant pushbutton station must not exceed 150 Volts AC or 300 Volts DC.[Provide a maintained two-position selector switch for slow speed selection.] The pendant must be rated for the NFPA 70 Hazardous Classifications specified in the Crane Design Criteria "Classification" Section. Provide the pendant pushbutton station with a NEMA Type 7 for Class I, hazardous environments and NEMA Type 9 for Class II, hazardous environments, as classified by NFPA 70.

[2.4.7.1.1 Pendant Conductor System

Provide a festoon type pendant conductor system. The festoon cables must be flat cables suspended from carriers riding on an I-beam or C-track. The pendant controller must be capable of traveling the entire length of the bridge and move independently of the trolley. Festoon loops must not extend below the high hook position.

][2.4.7.1.2 Radio Control System

Provide each system with a [belly box] [handheld] [_____] type portable transmitter unit[and an identical back-up transmitter unit].[Provide each transmitter with an adjustable belt or harness to support it when worn by the operator.] Only one transmitter at a time can control the crane and there must be no interference from one crane's controller affecting operation of the other cranes in the building. Each transmitter must include: individual [infinitely variable spring return joystick motion control levers] [push button controls] for each hoist, trolley, and bridge; a maintained contact, keyed switch, marked ON-OFF, for portable transmitter unit power; indication of Battery Power, and indication of Transmitting Status; a red emergency STOP mushroom pushbutton;[and]a floodlight on/off pushbutton[and a maintained slow speed selector switch]. The transmitters and all controls must each be clearly and permanently labeled with functionality and direction. Directions for controllers must be in accordance with CMAA 74 recommendations. The remote radio control system must be designed to meet the requirements of NEMA ICS 8, Part 9 and ECMA 15. Each radio remote control lever must be in the OFF position before the associated crane function can begin. The system frequency must be within the unlicensed FCC Part 15 range. Each control unit must maintain a continuous status signal to the associated receiver during operation. There must be no significant loss in systems efficiency and function at the end of eight hours of continuous battery use. The technical section of Form DD 1494 frequency allocation application (found on the NAVFAC/NCC website), addressing the Contractor's equipment, must be completed by the manufacturer of the radio control equipment being furnished under this contract.[For unlicensed radio control systems, Form DD 1494 must be submitted to the activity's frequency coordinator for information.][For licensed radio control systems, Form DD1494 must be submitted to the local frequency coordinator to initiate equipment approval for use in the geographical location.] The Contractor must receive approval from the

Government for the frequency to be used (licensed or unlicensed) for the radio remote system prior to design approval. Forms may be submitted via the Equipment Location Certification Information Database (EL CID) on-line system in lieu of submitting Form DD 1494.

]]2.4.8 Electrification Systems

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NOTE: Various methods may be used to transfer power from the runway to the crane (Runway Conductor System) and then again to the trolley (Bridge Conductor system). Typically, the Runway Conductor System is a set of conductor bars on the runway and collector shoes on the crane. The Bridge Conductor system is typically a set of festoon cables.

Site conditions and environment might require the design to deviate from the norm. Hazardous locations will need to be designed with either a cable reel or festoon system.

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2.4.8.1 Runway Conductor System

[Provide a rigid runway Conductor Bar System for the runway conductor system, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. Provide electrification system with three power conductors and an equipment grounding conductor. The crane must be grounded through the runway electrification system. Provide runway conductors sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. If there is any way the hook block or wire rope can swing into the runway electrification, provide a guard installed to prevent contact.

Provide two Collector Shoes (tandem design) for each conductor; each collector shoe must be rated for not less than the runway conductor sizing, so as to provide redundancy.

][Provide a Festoon System for the runway conductor system utilizing cables suspended from carriers riding on an I-beam or C-track for the crane, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. Provide electrification system with three power conductors and an equipment grounding conductor. Conductors must be fabricated from copper. The crane is required to be grounded through this conductor system. Provide conductors sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. Festooned cable loops must not extend low enough to come into contact with any obstructions.

][Provide a Cable Reel System for the runway conductor system, including all necessary cables and hardware to connect the cable reel to the floor level fused disconnect switch. The cable reel must have three power conductors and an equipment grounding conductor. The crane is required to be grounded through this conductor system. Conductors must be fabricated from copper, and sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads.

][Provide a totally enclosed flexible cable tray electrification system (cable chain) for the runway conductor system, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. The cable chain must have three power conductors and an equipment grounding conductor. The conductors must be selected so as to be of the longest length without splices. Conductors must be fabricated from copper, and sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. The crane is required to be grounded through this conductor system.

]2.4.8.2 Bridge Conductor System

[Provide Festoon System for the bridge conductor system utilizing cables suspended from carriers riding on an I-beam or C-track. Conductors must be fabricated from copper. A minimum of 20 percent of the festoon control circuit conductors for each electrification system must be spares at the time of crane acceptance. The trolley is required to be grounded through this conductor system. Festooned cable loops must not extend low enough to come into contact with any obstructions.

][Provide a Cable Reel System for the bridge conductor system. The cable reel must have an equipment grounding conductor, and all necessary control cables. A minimum of 20 percent of the festoon control circuit conductors for each electrification system must be spares at the time of crane acceptance. The trolley must be grounded through the cable reel connection and all conductors must be of copper construction.

][Provide a totally enclosed flexible cable tray electrification system (cable chain) for the bridge conductor system. The cable chain must have three power conductors, an equipment grounding conductor, and all necessary control cables. The conductors must be selected so as to be of the longest length without splices and must be copper. A minimum of 20 percent of the control circuit conductors in the flexible cable tray system must be spares at the time of crane acceptance. The trolley is required to be grounded through this conductor system.

]2.4.9 Overload Protection

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NOTE: Overload protection on a crane is required and is provided by two types of systems: Capacity Overload Protection and Over-Torque Limit.

The Over-Torque Limit only applies to cranes with VFD controls. It is a parameter setting in the drive and is typically set at 150 percent of rated motor torque.

Capacity Overload Protection is usually adjustable. If adjustable, it needs to be set at less than the crane's minimum test load; recommend setting at 100 percent of rated capacity or less. This protection can take the form of one of the following devices:

1. Clutch – Not adjustable and is common on packaged hoists.
2. Load Limit Switch – Installed on the wire rope and measures deflection. Does not require a break in the wire rope and is simply clamped onto the wire. Typically used on smaller hoists that have magnetic controls. Can also be installed as part of

the equalizer sheave.
3. VFD Drive Overload Protection – Similar to the Over-Torque Limit, but is set at a lower setting. Adjusted via parameters within the drive.

****

a. Provide a capacity overload protective device for all hoist systems using VFD drive capacity overload protection (separate from torque limiting feature of the VFD). Set hoist capacity overload protection at [100] [_____] percent of rated capacity. Hoist capacity overload protection must be adjustable between 80 and 150 percent of hoist capacity. Provide a keyed override or other means to disable the hoist capacity overload protection when performing a load test.

[b. Initially, set the torque limiting capability of the VFD (that is separate from the capacity overload protective device) to 150 percent of the motor torque (amperage) necessary to hoist 100 percent load. It may be adjusted up only to avoid nuisance trips and adjusted down if possible while still avoiding nuisance trips.

]2.4.10 Enclosures

****

NOTE: Select classification of control panels, controls, and brakes based on the environmental conditions in which the crane will be installed:

1. Choose one of the following for an indoor installation: 1, 2, or 12.
2. Choose one of the following for an outdoor installation: 3, 4X, or 8.
3. Choose one of the following for a Class I Hazardous installation: 7 (indoor) or 8 (indoor/outdoor).
4. Choose one of the following for a Class II Hazardous installation: 9 (indoor).

Other enclosure types exist that might be a better alternative for a particular installation. If necessary, refer to NEMA 250.

****

a. Provide enclosures for control panels, controls, and brakes in accordance with NEMA 250 and NEMA ICS 6, Classification Type [1 indoor, general purpose] [12 indoor without knockouts, general purpose] [2 indoor, drip-proof] [3 outdoor, dust-tight, rain-tight, sleet-resistant] [4X outdoor] [_____] [7 indoor Class I hazardous] [9 indoor Class II hazardous] [8 indoor/outdoor Class I hazardous], or all controls must be intrinsically safe as defined by NFPA 70 Article 504.

[b. Provide a non-resettable hour meter, connected across the main line contactor, readable from the exterior of the main control panel, to indicate the elapsed number of hours the crane is energized.

] c. Gaskets of enclosures and fixtures, and joints and contact surfaces of hazardous/explosive enclosures must be kept free of any paint to prevent damage during removal and reinstallation of gaskets of enclosures.

2.4.11 Warning Devices

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NOTE: A warning horn or light is required for all radio controlled cranes and recommended for all others.
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[Provide a warning horn that is operable from a push button at the [pendant pushbutton] [radio control] station.] [Provide a warning [strobe light] [rotating beacon] that is illuminated at all times during movement of the hoist, trolley, or bridge function[, but may be deactivated on the operator control station].]

[2.4.12 Floodlights

Provide evenly spaced floodlights along the bridge. Select floodlights to provide an illumination level of 40 foot-candles at three feet above the finished floor. All lights must be vibration resistant and designed to prevent any material from falling from the fixture. Switch the floodlights from the [pendant pushbutton] [radio controlled] station.

][2.4.13 Pilot Devices

Provide Indicator Lights mounted in an enclosure on the bottom of the bridge with lights sized and positioned to be visible from the ground. The lights must be the dual-lamp type. Provide a white light to indicate that power is available to the crane and a blue light to indicate that the main contactor is energized. Light voltage must be 115 VAC. Provide nameplates that are legible from ground level. The nameplates must read, in their respective order, "POWER AVAILABLE" and "CRANE ENERGIZED". The POWER AVAILABLE light must be supplied by a separate, fused transformer for its energization.

][2.4.14 Electrical Outlets

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NOTE: Electrical outlets are typically provided on trolleys for maintenance purposes on double girder cranes with top running custom built-up hoists (which typically have walkways). The addition of electrical outlets may not be a standard manufacturer option on packaged hoists and is not recommended for single girder cranes or underhung packaged hoists.
****

Provide a minimum of [one] [_____] 120 VAC duplex outlet[s] on the crane, mounted [on] [in] the [outside of the control panel(s)] [trolley] [cab] [_____]. The circuit(s) supplying receptacles must incorporate ground-fault circuit-interrupter protection for personnel and be protected by a circuit breaker with a minimum rating of [15] [20] amps.

]2.4.15 Cyber Security of Control Systems

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NOTE: Cyber Security of Control Systems requirements are tailored for NAVFAC. This subpart must be included for NAVFAC, it is not replaced by

Division 25 Cybersecurity Section.
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NOTE: SECNAVINST 5400.15 designates NAVFAC as the functional technical authority for WHE. NAVFAC is designated as Functional Security Control Assessor (FSCA) and the Functional Authorizing Official (FAO) for Ashore Control Systems in their domain; therefore, this includes WHE control systems. WHE control system owners are responsible for the Information System Security Engineer (ISSE) functions and producing artifacts (documentation) for review by the FSCA and FAO.

All new and electrically overhauled cranes must implement the following cybersecurity requirements as applicable to the control system architecture (i.e., networked drives, non-networked drives, and any wireless applications) so that supporting artifacts and considerations are available for the implementation of the RMF process.
****

a. Provide the following for PLC, RTU, Supervisory Controller, or other network-capable (whether networked or not upon delivery) control devices as applicable:

  (1) Hardware list (Hardware list must include the following for each device):

    (a) Manufacturer

    (b) Model

    (c) Location

    (d) Key technical ratings (e.g., memory)

    (e) Serial number

    (f) MAC addresses

    (g) IP addresses

  (2) Software List (Software list must include the following for each device):

    (a) Manufacturer

    (b) Version/subversion

    (c) Location/device

    (d) Used network ports/protocols/services

  (3) List and discussion of all security features of Contractor hardware and software.

b. For every PLC, RTU, Supervisory Controller, or other network-capable control devices (whether networked or not upon delivery), deliver the following on CD/DVD:

(1) Original firmware

(2) Original firmware hash

(3) SOP for application of firmware updates/patches

(4) POC or website for firmware updates/patches

(5) Count of interfaces and types

(6) Protocols in use, per interface

(7) Configuration file

(8) SOP for configuration

2.4.15.1 Control System and Network

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NOTE: Select options a. and b. if a standalone laptop is required. Recommend including one laptop if the activity regularly performs all crane maintenance.

****

[a. Provide one rugged laptop type workstation (computer) complete with all compatible software (including software licenses), redundant physical back-up copies on CD/DVD of the installed software, and all necessary cables and special connectors to allow crane software to be troubleshot, checked and upgraded, and for the data recorder to be accessed and information retrieved. Equip the workstation with a CD/DVD drive and the associated CD/DVD burning software. The workstation must also be equipped with USB ports (2.0 and 3.0), an Ethernet port, and a serial port. Delivering the software on a USB (flash drive) device is prohibited.

b. The laptop must be designed for an industrial environment and must be shock resistant and weatherproof as a minimum. Provide the laptop with a built-in CD/DVD reader with the capability to burn CDs and DVDs including associated software to burn CDs and DVDs.

] c. The Contractor must provide all equipment, including software and hardware, necessary for testing, installation, and communicating/troubleshooting all systems provided with the crane (e.g., engine/generator, control system, LID, etc.). The Contractor must provide all crane specific operational software files (e.g., ladder logic, functional block programming, etc.) for their associated systems (e.g., control systems, LID, engine generator, etc.).

d. A single common networked design must not be used for the control systems. A network for an individual function may be used as long as a failure of the network does not affect any other function/network except as defined for specific safety interlocks (e.g., LMI system). A common crane network may be used in a monitoring mode for recording faults and trending and is encouraged. Failure of the monitoring system must not affect crane functions.

e. All provided hardware and software must be currently marketed products, not currently scheduled for end of life or obsolescence, to ensure system sustainability.

f. The control system engineering workstation hardware and operating system must be in conformance to the Common Criteria for IT Security Evaluation (IEC ISO 15408, visit https://www.niap-ccevs.org for more information).

g. Ensure there is no remote access capability enabled as remote access capabilities are prohibited. Physically disable or remove all modem/network devices not required for operational purposes.

2.4.15.2 Software and Services

a. Remove all Software and Services not required for operation and/or maintenance of the product. If removal is not technically feasible, then disable software not required for the operation and/or maintenance of the product. Configure the product to allow the ability to re-enable ports and/or services if they are disabled by software. The removal of software or services may not impede the primary function of the product. If software that is not required cannot be removed or disabled, document a specific explanation, and provide risk mitigating recommendations and/or specific technical justification. The software/service to be removed and/or disabled includes, but is not limited to:

(1) Cameras

(2) Games

(3) Device drivers for product components not procured/delivered

(4) Messaging services (e.g., email, instant messenger, peer-to-peer file sharing)

(5) Source code

(6) Software compilers in user workstations and servers

(7) Software compilers for programming languages that are not used in the control system

(8) Unused networking and communications protocols

(9) Unused administrative utilities, diagnostics, network management, and system management functions

(10) Backups of files, databases, and programs used only during system development

(11) All unused data and configuration files

(12) Remove and/or disable, through software, physical disconnection, or engineered barriers, all services and/or ports in the procured product not required for normal operation, emergency operations, or troubleshooting. This includes communication ports and physical

input/output ports (e.g., USB docking ports, video ports, and serial ports).

b. Provide documentation showing all disabled ports, connectors, and interfaces for all network-capable devices. In addition, provide summary documentation of the procured product's security features and security-focused instructions on product maintenance, support, and reconfiguration of default settings.

c. For the evaluation status of hardware and software, the Contractor must provide information on Common Criteria (IEC ISO 15408) or National Information Assurance Partnership (NIAP) or Federal Information Processing Standards (FIPS) evaluation status of hardware and software.

2.4.15.3 Access Control

a. The Contractor must configure each component of the procured product to operate using the principle of least privilege. This includes operating system permissions, file access, user accounts, application-to-application communications, and energy delivery system services.

b. Provide user accounts with configurable access and permissions associated with one or more organizationally defined user role(s), where roles are used.

c. Provide a system administration mechanism for changing user(s') role (e.g., group) associations.

d. The Contractor must document control system access control options by defining access and security permissions, user accounts, and applications with associated roles.

e. Provide recommended methods for the Acquirer to prevent unauthorized changes to the Basic Input/Output System (BIOS) and other firmware. If it is not technically feasible to protect the BIOS to reduce the risk of unauthorized changes, the Contractor must document this case and provide mitigation recommendations.

2.4.15.4 Control System Account Management

The Contractor must document all accounts (including, but not limited to, generic and/or default) that need to be active for proper operation of the procured product.

Remove or disable any accounts that are not needed for normal or maintenance operations, emergency, or troubleshooting of the energy delivery system.

2.4.15.5 Session Management

The Contractor may not allow multiple concurrent logins using the same authentication credentials, allow applications to retain login information between sessions, provide any auto-fill functionality during login, or allow anonymous logins.

Provide account-based and group-based configurable session-based logout and timeout settings (e.g., alarms and human-machine interfaces).

2.4.15.6 Authentication/Password Policy and Management

Provide a configurable account password management system that allows for, but is not limited to, the following:

a. Changes to passwords (including default passwords)

b. Selection of password length

c. Frequency of change

d. Setting of required password complexity

e. Number of login attempts prior to lockout

f. Inactive session logout

g. Screen lock by application

h. Comparison to a library of forbidden strings

i. Derivative use of the user name

j. Denial of repeated or recycled use of the same password

The Contractor must time stamp log files.

2.4.15.7 Logging and Auditing

Provide logging capabilities that cover the following events, at a minimum (as appropriate to their function):

a. Information requests and server responses

b. Successful and unsuccessful authentication and access attempts

c. Account changes

d. Privileged use

e. Application start-up and shutdown

f. Application failures

g. Major application configuration changes

2.4.15.8 Heartbeat Signals

The Contractor must identify heartbeat signals or protocols and recommend which should be included in network monitoring. At a minimum, include a last gasp report from a dying component or equivalent.

The Supplier must provide packet definitions of the heartbeat signals and examples of the heartbeat traffic if the signals are included in network monitoring.

2.4.15.9 Patch Management and Updates

The Contractor must verify that procured products (including third-party hardware, software, firmware, and services) have appropriate updates and patches installed prior to delivery.

Provide documentation of the patch management program and update process (including third-party hardware, software, and firmware). This documentation must include resources and technical capabilities to sustain this program and process. Provide the Contractor's method or a recommendation for how the integrity of the patch is validated by the Acquirer as well as the Supplier's approach and capability to remediate newly reported zero-day vulnerabilities.

2.4.15.10 Malware Detection and Protection

a. The Contractor is required to implement at least one of the following:

  (1) Provide a host-based malware detection capability that quarantines (instead of automatically deleting) suspected infected files. Provide an updating scheme for malware signatures. The Contractor must test and confirm compatibility of malware detection application patches and upgrades.

  (2) If the Contractor is not providing the host-based malware detection capability, the Contractor must suggest malware detection products to be used and provide guidance on malware detection and configuration settings that will work with Contractor products.

b. The Contractor must validate that cybersecurity services running on the procured product (e.g., virus checking and malware detection) do not conflict with other such services running on the procured product.

c. For malware detection and protection, the Contractor must provide, or specify how to implement, the capability to automatically scan any removable media that is introduced to the product being acquired.

2.4.15.11 Physical Security

Provide lockable or locking enclosures or rooms for energy delivery systems and system components (e.g., servers, clients, and networking hardware) and for the systems used to manage and control physical access (e.g., servers, lock controllers, and alarm control panels). Provide a method for tamper detection on lockable or locking enclosures. If a physical security and monitoring system is used, tamper detection must be compatible. The Contractor must ensure that physical security features do not hamper the crane system operations. Provide the tools and instructions for making changes to locks, locking codes, keycards, and any other keyed entrances.

2.4.15.12 Wireless Technology

For wireless technology provisions, the Contractor must document:

a. Specific protocols and other detailed information required for wireless devices to communicate with the control network, including other wireless equipment that can communicate with the Contractor-supplied devices.

b. Use, capabilities, and limits for the wireless devices.

c. Power and frequency requirements of the wireless devices (e.g., microwave devices meet the frequency requirements of Generic Requirements [GR]-63 Network Equipment Building System [NEBS] and GR-1089).

d. Range of the wireless devices and verify that the range of communications is minimized to both meet the needs of the Acquirer's proposed deployment and reduce the possibility of signal interception from outside the designated security perimeter.

e. Wireless technology and associated devices compliance with standard operational and security requirements specified in applicable wireless standard(s) or specification(s) (e.g., applicable IEEE standards, such as 802.11).

f. Configuration control options that enable varying of the security level of the devices.

2.4.15.13 Control System Inventory

Provide the complete control system inventory. The Control System Inventory must include the following attributes, in tabular format, as applicable:

General Information	Location Information	Hardware Details	Operating System and Platform	Network Information (Actual Function, not potential function)
Unique ID	Facility Name	Device Type	Embedded OS (Yes/No)	MAC Address(es)
Barcode or Identifier	NFAID	Device Sub-Type	OS Contractor	IP Address(es)
Region	Commodity	Device Function	Operating System (O/S)	Upstream Device
Installation	Floor	Manufacturer	O/S Version	Protocols In Use
Special Area (Option DNA1)	Room	Product Line	Platform Contractor	Host Name
	Location	Model #	Platform Product Line	
	System Type	Serial #	Platform	
	Functional System or Equipment Control	Remote Connectivity: (Wired / Wireless / None)	Platform Version	
		Network Type Used: (Serial / Ethernet / Both / None)		

2.5 PAINTING SYSTEM

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NOTE: Three-coat zinc primer/epoxy/polyurethane system is provided for mild to severe atmospheric, indoor and outdoor cranes. For cranes in abnormal environments including exposure to chemicals or in immersion service, a system designed for that environment should be used. Other systems may suffice for milder environments.

****

a. Remove all grease, oil, and surface debris by solvent wiping or detergent/water scrubbing, prior to blast cleaning. Prepare surfaces to be coated by abrasive blasting to SSPC SP 6/NACE No.3, Commercial Blast Cleaning, or in accordance with the coating manufacturer's requirements, whichever is more stringent.

b. Use a painting system appropriate for the conditions provided in the Crane Design Criteria section of this specification. Paint exposed portions of the crane [and crane runway system] using a [three] [_____]-coat system as follows: [zinc-rich primer consisting of a minimum of 77 percent zinc by weight in the dry film, an anticorrosive epoxy intermediate coat, and an aliphatic polyurethane top coat] [_____]. All paint products must be supplied by a single manufacturer and free of chromates, lead, and mercury. Apply each coat in accordance with manufacturer's instructions and requirements. Ensure each coat is smooth, even, and free of runs, sags, orange peel, and other defects.[Desired color of finish coat is [brilliant yellow] [_____].] Submit product data for painting system.

c. Coat faying surfaces of bolted connections per RCSC A348, but do not apply finish paint.

d. Paint, coatings, or galvanizing on the following items or areas is not acceptable: hoist wire ropes, hooks, hook nuts, sheave and drum grooves, wheel treads, lubrication fittings, nameplates, flange mounting faces, corrosion resistant steel, bronze, or other items not normally painted.

e. Factory paint electrical and mechanical equipment in accordance with the manufacturer's best standard practice for the specified environment.

2.6 IDENTIFICATION PLATES

****

NOTE: NAVFAC P-307 requires the capacity be displayed in pound units. The kilogram marking option is provided for cranes installed in a foreign country.

****

Furnish and install identification plates. Provide non-corrosive metal identification plates with clearly legible permanent lettering giving the manufacturer's name, model number, serial number, capacity in pound units, [with kilogram units printed in a different color,] and other essential information or identification.

2.6.1 Markings on Crane, Trolley, and Hook

****

NOTE: NAVFAC P-307 requires the capacity be displayed in pound units. The kilogram marking option is provided for cranes installed in a foreign country.

****

To avoid operation of the crane in the wrong direction, affix the appropriate directions (NORTH, SOUTH, EAST, and WEST) with arrows on both sides of the bridge and both sides of trolley, as applicable. Markings must be visible by the operator and from the loading point. Labels on the controls must have corresponding directional (NORTH, SOUTH, EAST, and WEST) markings. Markings must agree with the markings on controller. Do not indicate directional arrows on controller.

Mark the hook rated capacity in pound units[, with kilogram units printed in a different color,] on both sides of the hoist load block.

2.7 ELECTRICAL ASSEMBLY

Installation of all electrical wiring, conduit, and components must be performed in accordance with the requirements of NFPA 70. As a minimum, items a. through g. below must be followed:

a. All electrical connections must be installed in accordance with NFPA 70 Articles 110.14 or 430.9, as applicable, or as recommended by the device manufacturer.

b. Crimped terminal lugs, if used, must be properly sized for the wire and installed using the device(s) – e.g., crimping tool and indenter – recommended by the terminal lug manufacturer.

c. All spare conductors must be identified as spare conductors, and must have their ends insulated to preclude accidental contact with energized equipment.

d. Bonding straps and equipment grounding conductors must be connected to engineered ground points, have all paint removed from their termination points, or have tooth lockwashers (star lockwashers) installed, to insure proper grounding of the equipment.

e. Rigid Polyvinyl Chloride conduit may be used to protect festoon cable from physical damage when the cable is run along the footwalk of the crane, provided that only sections of conduit are used.

f. Festoon cable must be installed with suitable strain relief and protected from physical damage in accordance with NFPA 70 Article 610.11(E)(1). This includes damage from chafing against the crane structure and any other type of damage that may be incurred.

g. Fiber optic cable must be installed in accordance with the manufacturer's installation guidelines. However, at a minimum the following guidelines must be adhered to: no sharp bends (bend radii must be greater than 1 inch or as prescribed by the manufacturer), avoid tight loops, no zip ties, and no stretching of cable.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, and before performing any work, verify all dimensions in the field. The Contractor is responsible for the coordination and proper relation of the contracted work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

[3.2 SHOP ASSEMBLY AND TESTS

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NOTE: Shop inspection and testing at the manufacturing facility is typically recommended for specialized applications (e.g., ordnance handling, molten metal handling, special purpose service, hazardous/explosive area environments, precision handling operations requiring complex or synchronized lifting capacity, or custom designs). This section may not be necessary for standard commercial packaged hoists.

****

Shop assemble major components as completely as possible. Reeving of drums and sheaves is not advisable for shop testing, however it is acceptable for packaged hoists. Functionally test the crane system at the construction facility prior to shipment. The Government reserves the right to inspect the crane for compliance with this specification and to witness the functionality tests. Notify the Contracting Officer [14] [_____] days prior to starting testing operations.

]3.3 ERECTION AND INSTALLATION

Perform the entire crane system erection in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative.

3.3.1 Mechanical Alignment

Align motors, couplings, brakes, gear boxes, and drive components in accordance with manufacturer's instructions.

3.3.2 Electrical Adjustments

Adjust control system in accordance with manufacturer's instructions. Store a copy of all Control Parameter Settings (PLC, VFD). Provide the final settings and configurations data on the Complete Schematic Wiring Diagram, including but not limited to, timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents. Provide the test conditions such as ambient temperature, motor load, date performed and person performing the adjustments as part of the Operational Tests report.

3.3.3 Field Welding

Perform welding indoors, where possible. Surface of parts to be welded must be free from rust, scale, paint, grease, and other foreign matter. Minimum preheat and interpass temperatures must conform to the requirements of AWS D14.1/D14.1M.

3.3.4 Field Painting

Perform painting indoors, where possible. Field painting (including touch-up) must conform to the requirements of the coating manufacturer and as specified in paragraph PAINTING SYSTEM.

3.4 FIELD QUALITY CONTROL

3.4.1 Post-Erection Inspection

After erection, the Contractor[, the Activity Crane Inspector/Test Director,] and the Contracting Officer must jointly inspect the crane bridge and hoist systems and components to verify compliance with specifications and approved submittals. Notify the Contracting Officer [14] [_____] days before the inspection. Provide for approval a report of the inspection indicating the crane is considered ready for operational tests.

Document the results of this inspection and submit the post-erection inspection report to the Contracting Officer for approval.

3.4.2 Operational Tests

****

NOTE: Determine if Government furnished certified test weights are available at the site (recommended). If not, they must be provided by the Contractor. These weights are for acceptance testing and will not be permanently retained by the Government.

****

Check the clearance envelope of the entire crane prior to picking or traversing any load to ensure there are no obstructions. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the crane is operational.[The Contractor must furnish test weights, operating personnel, instruments, and other apparatus necessary to conduct field tests on each crane. Solid weights must be measured using calibrated equipment traceable to National Institute of Standards and Technology (NIST) with a minimum accuracy of plus or minus two percent.]

3.4.2.1 No-Load Test

Raise and lower each hook through the full range of normal travel at rated speed for three complete cycles. Raise and lower each hook, testing other speeds of the crane. Verify proper operation of hoist limit switches. Operate the bridge and trolley in each direction the full distance between end stops and bring bumpers into contact with the end stops. Operate through the entire speed range and verify proper brake operation. Verify correct operation of all indication and ancillary devices.

3.4.3 Test Data

Submit all crane test data recorded on appropriate test record forms suitable for retention for the life of the crane. Record operating and startup current measurements for hoist, trolley, and bridge motors using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) must be justified or appropriate adjustments performed. In addition, note, investigate, and correct any high temperatures or abnormal operation of any equipment or machinery. Record hoist, trolley, and bridge speeds during each test cycle.

3.4.4 Hook Tram Measurement

Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 0.4 mm 1/64 inch). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening from the base measurement is cause for rejection.

3.4.5 Load Tests

****

NOTE: For NAVFAC, require a rated load test of 100 percent (plus 0 / minus 10) and an overload test of 125 percent (plus 0 / minus 5) of the rated load.

****

a. Perform the following tests, as specified below.

b. Test loads used in this section are defined as the following:

Wire rope run-in load: 25 - 50 percent of rated load.

Rated load test: 100 percent (plus [0] [_____] minus [10] [_____]) of rated load.

Overload test: 125 percent (plus [0] [_____] minus [5] [_____]) of rated load.

c. Testing of cranes must be done with the use of test weights. The use of dynamometers in lieu of lifting test weights is not permitted. Each test weight for crane tests must be marked with a unique identification number and the weight in pounds. The weight marked must be the actual weight taken from the scale or other measuring device. Solid weights must be measured using calibrated equipment traceable to the National Institute of Standards and Technology (NIST), with a minimum accuracy of plus or minus 2 percent (i.e., indicated weight must be within plus or minus 2 percent of actual weight). A list of test weights, with identification numbers and weights, must be retained. The list must include the type and serial number (or other identifier) of the weighing device(s) used to weigh the test weights. Where a lifting attachment supports multiple test weights (e.g., stacked weights or multiple weights suspended from a padeye), the total capacity must be marked on the attachment. All rigging gear must meet OSHA and ASME requirements.

3.4.5.1 Wire Rope Run-In

The primary purpose of this procedure is to exercise the newly installed wire rope.

Place the load on the hook. Start at ground level and hoist up to one foot below upper limit at slow speed. Hoist down to lower limit at slow speed. Repeat hoisting and lowering of the load for approximately 10 hoisting cycles, increasing the speed for each cycle. During this test, the capacity overload lockout should not activate.

3.4.5.2 Rated Load Test

3.4.5.2.1 Hoist

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately 300 mm one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees clockwise and counterclockwise to check bearing operation with no binding. Observe for lowering of the load, which may indicate a malfunction of hoisting components or brakes. Verify that maximum beam and bridge girder deflections do not exceed MHI MH27.1 design limits.

b. Dynamic Load Test: Raise and lower test load through the full lift range and visually observe smooth control and acceleration between points. Completely stop the machinery at least once in each direction to ensure proper brake operation.

c. Hoist Mechanical Load Brake (or Self-locking Worm Gear): Raise test load approximately 1500 mm 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again, with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

d. Hoist Loss of Power Test: Raise the test load to approximately 2400 mm 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.2.2 Trolley

Operate the trolley (if space is available) the full distance of the bridge rails in each direction with a test load on the hook. Check proper functioning through the range of speeds. Verify proper brake action and stopping distance.

3.4.5.2.3 Bridge

With a test load on the hook, operate the bridge for the full length of the runway (if space is available) in one direction with the trolley at the far end of the bridge, and in the opposite direction with the trolley at the opposite end of the bridge. Use extreme caution. Check proper functioning through the range of speeds. Check for any binding of the bridge end trucks. Verify proper brake action and stopping distance. Record deficiencies. Secure from testing if deficiencies are found.

3.4.5.2.4 Trolley Loss of Power Test

Raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of trolley travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the trolley stops and that the brake sets properly. Measure the distance required for the trolley to stop.

3.4.5.2.5 Bridge Loss of Power Test

Raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of bridge travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the bridge stops and that the brake sets properly. Measure the distance required for the bridge to stop.

3.4.5.3 Overload Test

3.4.5.3.1 Hoist

Disconnect or adjust the overload limit device to allow the hoist to lift the test load. Verify proper operation of the overload limit device after it is reconnected.

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately 300 mm one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees clockwise and counterclockwise to check bearing operation with no binding. Observe for lowering of the load, which may indicate a malfunction of hoisting components or brakes.

b. Dynamic Load Test: Raise and lower test load and visually observe smooth control. Stop the load during raising and lowering to verify that the brakes holds the load.

c. Hoist Mechanical Load Brake (or Self-locking Worm Gear): Raise test load approximately 1500 mm 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again, with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

d. Hoist Loss of Power Test: Raise the test load to approximately 2400 mm 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.3.2 Trolley

Operate the trolley the full distance of the bridge rails in each direction with a test load on the hook (one cycle) through the range of speeds. Verify proper brake action.

3.4.5.3.3 Bridge

With a test load on the hook, operate the bridge for the full length of the runway in one direction with the trolley at the extreme end of the bridge, and in the opposite direction with the trolley at the opposite extreme end of the bridge (one cycle). Check proper functioning through the range of speeds. Check for any binding of the bridge end trucks and verify proper brake action. Record deficiencies. Secure from testing if deficiencies are found.

3.5 MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

Furnish a qualified experienced manufacturer's field service representative to supervise the crane installation, assist in the performance of the on-site testing, and instruct personnel in the operational and maintenance features of the equipment.

3.6 OPERATION AND MAINTENANCE MANUALS

Provide [two] [_____] hard copies of operation and [two] [_____] hard copies of maintenance manuals for the equipment furnished along with an electronic copy (PDF) of each on a Compact Disc. Provide one complete set prior to performance testing and final copies upon acceptance. Provide operation manuals that detail the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. List in the maintenance manuals routine maintenance procedures, including weekly, monthly, semi-annual, and annual required maintenance items, possible breakdowns and repairs, and troubleshooting guides. Also include as-built drawings, piping and equipment layout, design calculations, Control Parameter Settings and printouts of any software, and simplified wiring and control diagrams of the system as installed. Secure approval of operation and maintenance manuals prior to the field training course (as applicable).

[3.7 FIELD TRAINING

****

NOTE: Training is recommended, but not required.

Additional items that could be included in the blank: general review of the entire capabilities, limitations, and safety features of the crane.

An optional variable frequency drive (VFD) training is available, should the command feel the additional training is beneficial.

****

Conduct a training course for [eight] [_____] operating and maintenance staff[and provide a copy of the training material to each participant]. Provide a training period consisting of a total of [four] [eight] [_____] hours of normal working time and starting after the system is functionally completed but prior to final acceptance. Cover all pertinent points involved in operating, starting, stopping, and servicing the equipment, including all major elements of the Operation and Maintenance Manuals. Demonstrate in course instructions all routine maintenance operations such as lubrication, general inspection, and basic troubleshooting[, and [_____]].

[Provide a minimum [four] [_____] hour training session on the Variable Frequency Drives (VFDs) discussing maintenance, troubleshooting of fault codes, theory of operation, and adjustment of crane parameters. This training session will be for an audience of approximately [eight] [_____] people.

]][3.8 FINAL ACCEPTANCE

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NOTE: Use this paragraph as written for projects where the crane is the principal construction element, or represents a very significant portion of the Contract cost. However, if the crane is part of a new facility or renovation, delete the acceptance paragraph from this section. Warranty period and operating and maintenance processes must coincide with the actual beneficial occupancy of the entire facility.

****

Final acceptance of crane system will not be given until Contractor has successfully completed all testing operations, corrected all material and equipment defects, made all proper operation adjustments, and removed paint or overspray on wire rope, hook, and electrical collector bars.

] -- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-41 22 23.19 (May 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-41 22 23.19 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-41 22 23.19 (May 2020)**

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SECTION 41 22 23.19

MONORAIL HOISTS

05/20

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NOTE: This guide specification covers the requirements for monorail hoists with manual, electric, or air powered lifting chains or wire rope; with or without manual, electric or air powered trolleys and other accessories; suitable for indoor or outdoor use in general purpose service, ordnance handling service, or hazardous area environments.

This guide specification incorporates the design criteria and requirements identified in NAVCRANECEN INSTRUCTION 11450.2A (December 2018).

This guide specification includes tailoring options for NAVFAC, pounds (per NAVFAC P-307), and tons. The NAVFAC tailoring option also includes requirements specific to the Navy and Marine Corps. Crane procurements for the Navy and Marine Corps must select the NAVFAC tailoring option.

Crane tailoring options are included for the Air Force, outdoor, ordnance/explosives handling, or hazardous (explosive) environments. Only one unique specialized application tailoring option should be selected at a time, however multiple can be used with additional specific project editing in the resulting sections. "General Purpose Service" is the default crane condition unless an alternate specialized tailoring option is selected. When "Maximum Anti-Spark" protection is required, the "Minimum Anti-Spark" tailoring option MUST ALSO be selected as the maximum requirements are in addition to the minimum requirements.

Selection or deselection of a tailoring option (select view-tailoring options) will include or exclude that option in the section. Specific project editing is still required for the resulting section.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present. Of particular note, if procurement is to go on an existing monorail system, all references to installing and testing a new monorail and associated equipment such as end stops must be removed.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: Use this guide specification to specify cranes that are procured as part of a building construction contract for such applications as machine shops, warehouses, and other areas that do require specialized weight handling equipment.

Forward all procurement of OET systems at Naval Shore based activities with rated capacities of 9000 kg 20,000 pounds or greater or for use in specialized applications (e.g. ordnance handling, molten metal handling, special purpose service as defined in NAVSEA Publication 0989-030-7000, hazardous/explosive area environments, or precision handling operations requiring complex or synchronized lifting capacity) to: Naval Facilities Engineering Systems Command, Navy Crane Center, Building 491, Norfolk Naval Shipyard, Portsmouth, Va., 23709-5000. (See NAVFAC Instruction 11450.1B of 28 March 2014).

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NOTE: Control types and systems may be specified as follows:

1. Remote or Pendant Crane Controls or a combination of the two can be provided.

2. Alternating current (AC) control systems must be specified. The vast majority of new cranes are AC powered and AC controlled.

Terminology: - refer to DEFINITIONS in this specification.

a. Ordnance/Explosives Handling – Cranes handling palletized or unpackaged ammunition, missiles, torpedoes, and other types of ordnance. Hoists are required to must meet ASME HST-1 and ASME HST-4 duty class H4 (electric chain or wire rope hoists), ASME HST-5 and HST-6 duty class A4 (air chain and wire rope hoists), or the requirements of ASME HST-2 and ASME HST-3 (manual chain and manual lever hoists). Hoists are also required to have two brakes.

b. Hazardous (Explosive) Environments – Cranes operating in hazardous environments as defined by the cognizant activity safety office must be equipped with electrical safety features that meet NEC Article 500. The activity safety office must identify the specific Class, Division, and Group, as well as the envelope that the hazard exists, to allow proper design. Materials for mechanical components must be chosen to minimize the potential for sparking, typically bronze, stainless steel, or aluminum. Hazardous environments are split into two groups: minimum anti-spark protection and maximum anti-spark protection.

c(1) Minimum Anti-Spark Protection applies when only the load block enters the hazardous area.

c(2) Maximum Anti-Spark Protection applies when the hazardous area envelops the entire crane.

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NOTE: The RFP must provide the relevant dimensions and load data for the crane. See "Crane Inquiry Data Sheet" in CMAA 74 section 6.1 or see "Crane Information Form for Underrunning Cranes(s)" pages 5 and 6 at the following Navy Crane Center link:

https://www.navfac.navy.mil/navfac_worldwide/specialty_centers/ncc/about_us/re

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NOTE: Indicate on the plan drawings a schematic line for the location of the centerline of monorail track beam, including curves and switches. Only indicate the dimensions that are critical to locating points such as the end of the travel range of the hoist operating hook at each end of the track beam. Indicate any critical clearance requirements for the area adjacent the monorail track beam.

Indicate on the elevation drawings a generic elevation for the monorail beam. Only indicate the dimensions that are critical to locating points such as the ends of the vertical travel range of the hoist operating hook. Indicate any clearance requirements for the area above the monorail track

beam.

When there is one hoist on one monorail system, the capacity rating of the monorail track beam and beam hangers must be equal to the hoist capacity. When there is more than one hoist on the monorail track beam, design and construct the monorail track beam and beam hangers for the most stressful positioning of the hoists on the track beam.

Indicate on the plan drawings the electrical junction box location (including mounting height).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B30.10	(2019) Hooks
ASME B30.16	(2022) Overhead Underhung and Stationary Hoists
ASME B30.17	(2020) Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoists)

ASME HST-1	(2023) Performance Standard for Electric Chain Hoists
ASME HST-2	(2023) Performance Standard for Hand Chain Manually Operated Chain Hoists
ASME HST-3	(2022) Performance Standard for Lever Hoists
ASME HST-4	(2021) Performance Standard for Overhead Electric Wire Rope Hoists
ASME HST-5	(2014) Performance Standard for Air Chain Hoists
ASME HST-6	(2020) Performance Standard for Air Wire Rope Hoists
ASME NUM-1	(2023) Rules for Construction of Cranes, Monorails, and Hoists (With Bridge or Trolley or Hoist of the Underhung Type)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D14.1/D14.1M	(2019) Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

ASTM INTERNATIONAL (ASTM)

ASTM A275/A275M	(2023) Standard Practice for Magnetic Particle Examination of Steel Forgings
ASTM E125	(1963; R 2023) Photographs for Magnetic Particle Indications on Ferrous Castings
ASTM E543	(2021) Standard Specification for Agencies Performing Non-Destructive Testing
ASTM E1417/E1417M	(2016) Standard Practice for Liquid Penetrant Testing
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 74	(2020) Specifications for Single Girder Cranes

ELECTRIFICATION AND CONTROLS MANUFACTURERS ASSOCIATION (ECMA)

ECMA 15	(2018) Cable-less Controls for Electric Overhead Traveling Cranes

MATERIAL HANDLING INDUSTRY OF AMERICA (MHI)

MHI MH27.1	(2016) Specifications for Underhung Cranes and Monorail Systems
MHI MH27.2	(2009) Specifications for Enclosed Track Underhung Cranes and Monorail Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ESPG	(2009-2010) Electrical Standards and Product Guide (ESPG)
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA ICS 8	(2011) Crane and Hoist Controllers
NEMA MG 1	(2021) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. AIR FORCE (USAF)

AFMAN 91-118	(2010) Safety Design and Evaluation Criteria for Nuclear Weapon Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.306	Specific Purpose Equipment and Installations

U.S. NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSEA T9074-AS-GIB-010/271	(2014; Revision 1) Requirements for Nondestructive Testing Methods

UL SOLUTIONS (UL)

UL 1004-1	(2012; Reprint Nov 2020) UL Standard for Safety Rotating Electrical Machines - General Requirements

1.2 DEFINITIONS

a. Monorail Track: The track system along which the crane operates horizontally, including track hangar rods, track connection devices, and runway structural supports.

b. Lifted Load: The load consisting of the rated load and the weight of lifting devices attached to the crane such as the load block, bucket, or other supplemental devices.

c. Pendant: A control for a hoist or a crane. The pendant hangs from the hoist by a cable at a height that is easy for the operator to reach.

d. Patented Track: A generic term referring to track built in accordance with MHI MH27.1 utilizing a composite track section incorporating a proprietary bottom flange shape.

e. Enclosed Track: A generic term referring track built in accordance with MHI MH27.2 whose related equipment operates on the internal lower operating or running flange of such track.

f. Rated Load: The maximum working load suspended under the load hook.

g. Standard Commercial Cataloged Product: A product, which is currently being sold, or previously has been sold, in substantial quantities to the general public, industry or Government in the course of normal business operations. Models, samples, prototypes or experimental units do not meet this definition. The term "cataloged" as specified in this section is defined as "appearing on the manufacturer's published product data sheets. These data sheets must have been published or copyrighted prior to the issue date of this solicitation and have a document identification number or bulletin number.

h. Operating Environments:

  (1) h(1) General Purpose Service: This applies to most cranes and are, in large measure, the manufacturers' standard designs. Cranes should be classified as General Purpose Service if they are

operating in routine environments.

(2) h(2) Ordnance/Explosives Handling: Cranes handling palletized or unpackaged ammunition, missiles, torpedoes, and other types of ordnance. Hoists are required to must meet ASME HST-1 and ASME HST-4 duty class H4 (electric chain or wire rope hoists), ASME HST-5 and ASME HST-6 duty class A4 (air chain and wire rope hoists), or the requirements of ASME HST-2 and ASME HST-3 (manual chain and manual lever hoists). Hoists are also required to have two brakes.

(3) h(3) Hazardous (Explosive) Environments: Cranes operating in hazardous environments as defined by the cognizant activity safety office must be equipped with electrical safety features that meet NFPA 70 Article 500. The activity safety office must identify the specific Class, Division, and Group, as well as the envelope that the hazard exists, to allow proper design and must list these in this section. Materials for mechanical components must be chosen to minimize the potential for sparking, typically bronze, stainless steel, or aluminum. Hazardous environments are split into two groups: minimum anti-spark protection and maximum anti-spark protection.

(a) Minimum Anti-Spark Protection is used when only the load block enters the explosive area.

(b) Maximum Anti-Spark Protection is used when the hazardous area envelops the entire crane.

1.3 SYSTEM DESCRIPTION

****

NOTE: Remove the following sentence if the track rail is not to be installed as a part of the crane procurement. If rail is to be installed, ensure Section 05 12 00 STRUCTURAL STEEL is included in the Request for Proposal (RFP).

****

[The requirements for the supporting structures of the monorail track and rail are specified in Section 05 12 00 STRUCTURAL STEEL, and must conform to AISC 360.

]1.3.1 Crane Design Criteria

****

NOTE: Clearly show the area of hook coverage, track dimensions, rail size, hook vertical travel, clear hook height, and lifting capacity on drawings.

****

Cranes will operate in the given spaces and match the track dimensions and rails indicated. Hook coverage, hook vertical travel, clear hook height, lifting capacity, and load test weight must not be less than that indicated.

1.3.1.1 General

****

NOTE: Add number of hoists, building name, and

hoist rated load capacity in kilograms pounds.
****

Include the following: Number of hoists [_____], located in building identified as [_____], with the capacity expressed in [_____] metric tons tons kilograms pounds, for each hoist. Also clearly locate and identify each hoist and system components.

1.3.1.2 Classification

****
NOTE: For NAVFAC, specify ASME HST-1 and ASME HST-4 duty class H3 (electric) or ASME HST-5 and ASME HST-6 duty class A4 (air hoist) or higher.
****

****
NOTE: Refer to NFPA 70 for environmental requirements.
****

****
NOTE: Operating Environments

General Purpose Service: This applies to most cranes and are, in large measure, the manufacturers' standard designs. Cranes should be classified as General Purpose Service if they are operating in routine environments. Cranes operating in non-routine environments or unique, dedicated service should meet the requirements of one of the below Specialized Applications:

Ordnance/Explosives Handling: Cranes handling palletized or unpackaged ammunition, missiles, torpedoes, and other types of ordnance. Specify duty class as described in the paragraph DEFINITIONS for ordnance.

Hazardous (Explosive) Environments: Cranes operating in hazardous environments as defined by the cognizant activity safety office must be equipped with electrical safety features that meet NEC Article 500. The activity safety office must identify the specific Class, Division, and Group, as well as the envelope that the hazard exists, to allow proper design and must list these in this section. Materials for mechanical components must be chosen to minimize the potential for sparking, typically bronze, stainless steel, or aluminum. Hazardous environments are split into two groups: minimum anti-spark protection and maximum anti-spark protection.

a. Minimum Anti-Spark Protection is used when only the load block enters the explosive area.

b. Maximum Anti-Spark Protection is used when the hazardous area envelops the entire crane.

****

Provide a monorail system with [manual hoist][electric powered hoist][air-powered hoist] and [plain type (hand operated)][hand chain operated][electric powered]trolley for operation in an [indoor] [outdoor] environment, [general purpose] [ordnance handling] [hazardous area] service, with an ambient temperature range of [_____] to [_____] degrees Celsius Fahrenheit. This hoist must operate in an NFPA 70 Class [_____], Division [_____], Group [_____] hazardous area. Hazardous protection is required for the [full height of the crane] [18 inches above ground level] [_____]. Monorail, hoist, trolley, equipment, materials, installation, examination, inspection, and workmanship must conform to the applicable requirements of NFPA 70, ASME B30.17, ASME B30.16,[ASME HST-1,][ASME HST-2,][ASME HST-3,][ASME HST-4,][ASME HST-5,][ASME HST-6,] MHI MH27.1[and MHI MH27.2], as modified and supplemented by this specification.

The hoist must be [pendant controlled] [radio controlled] and operate in the spaces and within the loading conditions indicated. The hoist must operate on [_____psi tool air] [[_____]-volts AC, 60 Hz [_____], [single] [three] phase] power source. Maximum trolley wheel loads (without impact) due to dead, trolley, and lifted loads, with the trolley in any position, must not cause a more severe loading condition in the track support structure than that produced by the design wheel loads and spacing indicated.

1.3.1.3   Rated Capacity and Speeds

****

NOTE: Plain type (hand operated) trolleys are recommended where trolley motion is infrequent or the distance is short, providing good load spotting ability and use for hoists of 3 metric ton 3 tons capacity and under. Plain type trolleys are not recommended for hoists of 3 metric ton 3 tons capacity and greater, or for tracks higher than 6 m 20 feet above the floor level. Motor operated trolleys are recommended where the operating frequency, travel distance, rated load, or beam elevation makes other types of trolleys impractical.

Unless otherwise specified, the nominal rated maximum speed of the hoists and trolley will be the manufacturer's standard within the limits of Table 2 of ASME HST-1, HST-4, HST-5, HST-6, AS APPLICABLE. For higher tonnage ratings, consult with the manufacturer(s).

****

Provide hoist with a rated capacity of [_____] metric tons tons kg pounds. The hook lift capacity and speed must be the manufacturer's standard within the limits specified. The hoist and trolley must meet the minimum design requirements specified in [ASME HST-1, Duty Class [H3][H4]][ASME HST-2][ASME HST-3][ASME HST-4, Duty Class [H3][H4][H5]][ASME HST-5, Duty Class [A4][A5]][ASME HST-6, Duty Class [A4][A5]].

1.4   VERIFICATION OF DIMENSIONS

The Contractor is responsible for the coordination and proper relation of their work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the monorail system and notify the Contracting Officer of any discrepancy before finalizing the crane order.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Monorail Crane System; G, [_____]

Complete Schematic Wiring Diagram; G, [_____]

SD-03 Product Data

Hoist Brakes; G, [_____]

[Trolley Brakes; G, [_____]

] Load Block and Hook; G, [_____]

Hoist; G, [_____]

Trolley; G, [_____]

[End Stops; G, [_____]

][Bumpers; G, [_____]

][Monorail Track System; G, [_____]

][Motors; G, [_____]

][Variable Frequency Drives; G, [_____]

][Limit Switches; G, [_____]

][Air Hoist Limit Switches

][Radio Control System; G, [_____]

][Pendant Push-Button Station; G, [_____]

][Controls; G, [_____]

][Control Parameter Settings; G, [_____]

][Runway Conductor System; G, [_____]

][Overload Protection; G, [_____]

][[Air][Manual] Hoist Capacity Overload Protection; G, [_____]

][Load Indicating Device; G, [_____]Painting System; G, [_____]

] SD-05 Design Data

Load and Sizing Calculations; G, [_____]

SD-06 Test Reports

[Hook Proof Test; G, [_____]

][Hook Non-Destructive Test (NDT); G, [_____]

] Post-Erection Inspection; G, [_____]

Operational Tests; G, [_____]

Hook Tram Measurement; G, [_____]

Load Tests; G, [_____]

SD-07 Certificates

[Wire Rope; G, [_____]

][Load Chain; G, [_____]

][Monorail Track System Survey; G, [_____]

] Hazardous Material; G, [_____]

[Loss of Power Test; G, [_____]

] Brake Adjustment Record; G, [_____]

Compliance with all Listed Standards; G, [_____]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, [_____]

1.6 QUALITY ASSURANCE

1.6.1 Manufacturer Qualification

Monorail System, including sub-system components manufactured by vendors, must be designed and manufactured by a company with a minimum of 10 years of specialized experience in designing and manufacturing the type of overhead crane required to meet requirements of the Contract Documents.

1.6.2 Pre-Delivery Inspections

Contractor is responsible for performance of quality control inspections, testing, and documentation. Submit all crane test data recorded on appropriate test record forms suitable for retention for the life of the crane.

[1.6.2.1 Inspection of Steel Castings

****

NOTE: Navy Crane Center does not require magnetic-particle testing of steel castings. Magnetic testing for USACE projects should be coordinated with the Contracting Officer.

****

Visually inspect [and test]load-carrying steel castings[using the magnetic-particle inspection method][using ultrasonic testing].[Reference allowable degree of discontinuities to ASTM E125, and relationship to service loads and stresses, critical configuration, location and type.] All load bearing components, shafts, and gears, in the hoist drive train must be rolled or forged steel, except brake drums which may be ductile iron. Methods of repairing the discontinuities is subject to review by the Contracting Officer.

][1.6.2.2 Inspection of Hook Assembly

Inspect hook[by a magnetic-particle type inspection][and X-rayed][and tested ultrasonically] prior to delivery. Furnish documentation of hook inspection to Contracting Officer prior to field operational testing. As part of the acceptance standard, linear indications[greater than 1.5 mm 1/16 inch] are not allowed. Welding repairs of hook are not permitted. A hook showing linear indications, damage or deformation is not acceptable.

1.6.2.2.1 Hook Non-Destructive Test (NDT)

****
NOTE: Delete this paragraph if selected agency does not require magnetic particle testing.
****

****
NOTE: For NAVFAC, substitute tailored paragraph.
****

Magnetic-particle inspect the hook over the entire area in accordance with ASTM A275/A275M or NAVSEA T9074-AS-GIB-010/271. Acceptance standard is no defects. A defect is defined as a linear indication that is greater than [3 mm 1/8 inch][1.5 mm 1/16 inch] long. For hooks of non-magnetic material, NDT must be liquid penetrant (PT) method in accordance with ASTM E1417/E1417M. For PT testing of hooks containing stainless steels, titanium, or nickel based alloys, total halogens and Sulphur used in the NDT process must be controlled as specified in NAVSEA T9074-AS-GIB-010/271.

Inspect each hook and shank over the entire surface area by magnetic particle inspection.

a. Procedure: Conduct magnetic particle inspection in accordance with ASTM A275/A275M with the following restrictions: Do not use DC yokes (including switchable AC/DC yokes used in the DC mode) or permanent magnet yokes. Do not use automatic powder blowers or any other form of forced air other than from a hand-held bulb for the application or removal of dry magnetic particles. Remove arc strikes. Equipment ammeters must have an accuracy of plus or minus 5 percent of full scale (equipment ammeter accuracy other than that stated is acceptable provided the MT procedure states that a magnetic field indicator is used to establish and verify adequate field strength for all aspects of the inspection.)

b. Acceptance Criteria: Defects found on the hook will result in rejection of defective items for use on furnished hoist. For this inspection, a defect is defined as a linear indication for which the largest dimension is greater than 1.5 mm 1/16 inch.

c. Test Report: Submit a test report of the magnetic particle inspection of each hook provided the Contracting Officer for approval prior to final acceptance of hoist installation. Certify test reports by the testing organization. The performing organization must provide a written statement of certification to ASTM E543, current within one year of the date the NDT was performed. The NDT procedures including technique sheets specific to the types, shapes, and size of the parts being examined must adequately describe the orientation of the hooks within the magnetizing equipment. The performing organization must have the NDT procedures and its technique sheet used for testing of the hook reviewed and approved by an independent Level III examiner. Submit the (Level III examiner) approved procedures, technique sheets, and certification to the Contracting Officer with the test report.

][1.6.2.3 Hook Proof Test

****
NOTE: Hook proof tests are required for custom designed or non-ferrous (bronze or stainless steel)

hooks. Bronze/stainless steel hooks are generally associated with minimum hazardous area requirements.
****

Proof test the load hook per ASME B30.10. Perform the proof test prior to Hook NDT.

]1.6.3 Drawings

1.6.3.1 Monorail Crane System

a. Submit drawings showing the general arrangement of all components in plan, elevation, and end views. Show all major features of the crane including: [assemblies of hoist [and trolley] drive[s],]hook envelope, and the general arrangement of the track beam system with switches and curves, details of all structural connections, clearances and principal dimensions. Include weights and centers of gravity of major components.

b. Submit shop drawings of all fabricated components. Shop drawing quality must be equivalent to the contract drawings accompanying this solicitation. Drawings must be reviewed, signed, and sealed by a licensed professional engineer.

c. Provide integral schedule of crane components on each drawing. The schedule must provide a cross reference between manufacturer data and shop drawings. Components listed on the schedule of crane components must include total quantity, description, original manufacturer, and part number. Distributing agents will not be acceptable in lieu of the original manufacturer.

[1.6.3.2 Complete Schematic Wiring Diagram

Provide electrical schematic drawings with motor nameplate data[, VFD drive nameplate data] and overcurrent protective device ratings

]1.6.4 Design Data: Load and Sizing Calculations

****
NOTE: Design data for Load and Sizing Calculations, and welding procedures, may not be available for commercially procured hoists and trolleys.
****

Submit complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Provide a list of all codes and standards, design assumptions, equations, specified efficiencies, limits, factors of safety, component ratings, and sources of values used. Include free body diagrams or sketches of each load case.[Include seismic analysis of crane.]

1.6.5 Certificates

All certifications must be dated and must bear the original signature (above the printed name) of the authorized representative of the Contractor or the manufacturer of the items or equipment being certified. Each certification must clearly identify the crane, the drives, components, and location (as applicable) to which it applies:

[a. Submit a Wire Rope Certification for each hoist with the wire rope manufacturer's certification that the rope meets the published breaking strength or the actual breaking strength of a sample taken from the reel and tested. Certification must be traceable to the hoist, and reel.

][b. Submit a Load Chain Certification clearly indicating load chain breaking strength for each hoist, and clearly identified for traceability. Submit factory certification of load chain rated capacity.

][c. Submit a Monorail Track System Survey certifying monorails have been aligned in accordance with CMAA 74, MHI MH27.1, or MHI MH27.2 as applicable. If monorail(s) are existing and if the crane(s) cannot operate without restriction, the Contractor must indicate crane limitations.

] d. Submit a Hazardous Material Certificate that the crane does not contain hazardous material including asbestos, lead, cadmium, chromium, PCBs, or elemental mercury. Products required for the designing and manufacturing of cranes must not contain the prohibited materials.

[e. Submit a Loss of Power Test Certificate stating that a test may be performed in which power is removed from the crane while the hoist and trolley are in operation.

] f. Submit a Certificate of the Brake Adjustment Record. Provide a brake adjustment record and installation/maintenance manuals for each brake on the crane. Each brake measurement must have a tolerance traceable to the associated brake manual or documentation provided by the brake manufacturer, location of measurements, and the actual brake setting. Changes made to settings of the brake, at any time, will void the record.

g. Submit a certificate stating that the hoist, hook, and trolley system design and fabrication is in compliance with all listed standards.

1.6.6 Welding Qualifications and Procedure

Welding must be in accordance with qualified procedures using AWS D14.1/D14.1M as modified. Written welding procedures must specify the Contractor's standard dimensional tolerances for deviation from camber and sweep and not exceed those specified in AWS D14.1/D14.1M, MHI MH27.1, MHI MH27.2 and CMAA 74 as applicable. Welders and welding operators must be qualified in accordance with AWS D1.1/D1.1M or AWS D14.1/D14.1M.

1.7 CRANE SAFETY

Comply with the mandatory and advisory safety requirements of ASME B30.10, ASME B30.16, ASME B30.17, [ASME HST-1] [ASME HST-2] [ASME HST-3] [ASME HST-4] [ASME HST-5] [ASME HST-6], 29 CFR 1910.147, 29 CFR 1910.306, and all applicable provisions of 29 CFR 1910 and NFPA 70.

[1.7.1 Nuclear Safety Analysis

****

NOTE: Certification is required for cranes handling nuclear materials. Results from the Safety Analysis will be utilized by the Using Agency as a basis for

crane certification. Delete this paragraph if the crane is not required to handle nuclear materials.

This section is not applicable to NAVFAC projects. The Navy Crane Center must be involved with the procurement and overhaul of all NAVY cranes that handle Nuclear material as identified in the forward notes section of this specification.
****

Nuclear certification, testing, and rules of construction must be in accordance with 29 CFR 1910.147 and ASME NUM-1. Air Force Nuclear certified hoists must meet requirements of AFMAN 91-118. Submit analysis and test reports to Contracting Officer for approval.

]PART 2   PRODUCTS

2.1   MATERIALS

2.1.1   General

Provide materials and equipment which are standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment. Material will be free from defects and imperfections that might affect the serviceability and appearance of the finished product. All material must be new and unused.

2.1.2   Nameplates

Secure nameplates to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Provide two monorail identification plates, one for each side of the track beam. Provide noncorrosive metal identification plates with letters which are easily read from the floor, showing a separate number such as M-1, M-2, for each monorail hoist.

2.1.3   Capacity Marking

Mark the rated capacity in metric tons tons kg pounds units on each side of the monorail track beam. Capacity marks must be large enough to be clearly visible from the floor. Individual hoist units must have their rated capacity clearly marked on their bottom block, and additionally labeled on the hoist body. Rated capacity must include all accessories below the hook, such as load bars, magnets, grabs, and other weight handling equipment as part of the load to be handled.

2.1.4   Safety Warnings

Affix labels in a readable position to each lift block or control station in accordance with ASME B30.16 and ASME B30.17.

2.2   STRUCTURAL REQUIREMENTS

Structural steel materials must conform to the standards permitted in CMAA 74, MHI MH27.1, MHI MH27.2 and AISC 360 as applicable.

2.2.1 Structural Connections

High-strength bolted structural connections must be designed and installed in accordance with RCSC A348. Bolts must be of ASTM F3125/F3125M Grade A325/A325M or Grade A490/A490M material. Galvanized bolts are not acceptable.

Welded connections for the crane must be performed in accordance with AWS D14.1/D14.1M. Welded connections to the building must be performed in accordance with AWS D1.1/D1.1M.

2.2.2 Monorail Track System

****

NOTE: For Monorail Hoists, track and its support structure is usually supplied by crane contractor. Use Monorail Track System only if crane contractor is to provide a new track.

Monorail tracks may be of three types. "Patented track" as defined in the definitions section and built IAW MHI MH27.1, "enclosed track" built IAW MHI MH27.2 and "rolled steel shapes" which is defined in CMAA 74. The activity may decide the track type to be used or allow the provider to decide, except ordinance handling cranes require patented track.

****

Provide the complete track suspension system that is required to hang the monorail track at its indicated location from the structural supports indicated on the drawings. Provide monorail and support structure for underrunning monorail of rolled steel shapes conforming to CMAA 74, patented track beams conforming to MHI MH27.1, or enclosed track beams conforming to MHI MH27.2.

For rolled steel shapes, locate splices under structural support members.

For patented track beams, perform splices as necessary in accordance with the manufacturer's recommendations and requirements. Align ends of lower T-section to minimize the horizontal gap on the running surface to not greater than 1.59 mm 1/16 inch and not greater than a vertical difference of 0.79 mm 1/16 inch for the wheel running surface alignment for a smooth crossing by the wheels. Splice assemblies must be from the same manufacturer as the patented track and located under structural support members. Submit manufacturer's standard published tables that verify the monorail track is sized in compliance with all specification requirements. When standard published tables are not available, provide calculations for the strength design and deflection of the beams.

Monorail support structure must be designed, fabricated, and installed such that monorail meet the alignment tolerances of CMAA 74, MHI MH27.1 or MHI MH27.2, as applicable. Provide means to allow for vertical adjustment of the track both before and after the system has been put in operation so that track can be erected and maintained level. Brace track to restrain against damaging lateral and longitudinal movements. Where the track is suspended from hanger rods, provide means preventing the hanger rod nuts from backing off the rods. Allowable stress in hanger rods is 20 percent of the minimum specified ultimate strength of the material used.

2.2.3 End Stops

Fit monorail track system with end stops at all open end locations. Locate stops to contact the trolley bumper and permit maximum trolley travel. Metal to metal contact at the bumper to end stop connection is not permitted.

2.2.4 Additional Provisions for Outside Service

****

NOTE: This paragraph is applicable for outdoor cranes only.

****

Provide hoist trolley with parking brakes which will sufficiently hold the crane against a wind pressure of 240 Pa 5 psf for in-service conditions. Provide hoist trolley with manually-operated pin locks at each rail, designed to securely anchor the crane against a wind pressure of 1.44 kPa 30 psf for out-of-service conditions. Design members to prevent the collection of water on crane.

2.3 MECHANICAL REQUIREMENTS

****

NOTE: For ordnance handling, further material restrictions exist.

****

Cast iron and aluminum used to support components of the hoist power transmission train must be ductile. Gray cast iron load bearing parts are prohibited.

2.3.1 Hoist

****

NOTE: Electric chain hoists (ASME HST-1) only have the possibility of hoist duty classes H2, H3, or H4.

For ordnance handling, packaged hoists must be HST-4 Duty Class H4 or better.

For ordnance handling, custom hoist shafts must have a fatigue design factor of 1.5.

****

[2.3.2 [Manual Hoist][Electric Chain Hoist][Air Chain Hoist]

Provide [manually][lever][Air] operated chain hoist conforming to ASME B30.16, and [ASME HST-2] [ASME HST-3] [ASME HST-5].[Electric chain hoist must conform to ASME HST-1, NEMA ICS 8, NEMA MG 2, and NEMA ESPG] except as modified herein.

2.3.2.1 Hoisting Chain

a. Provide a welded link load chain.

b. Provide a chain stop or dead end connection to prevent the load chain from running out of the hoist at its fully extended position.

c. Provide chain hoists with 3 m (10 foot) lift or more with a load chain bucket.

][2.3.3 [Electric][Air]Wire Rope Hoist

Provide [Electric Wire Rope Hoist conforming to ASME HST-4][Air Powered Wire Rope Hoist conforming to ASME HST-6] except as modified herein.

2.3.3.1 Hoisting Ropes

****

NOTE: Paragraph b is shown as optional only because there is a tailored paragraph b option for minimum hazardous area. One of the two options must be chosen and included in the specification.

****

****

NOTE: For minimum anti-spark protection, add tailored paragraph section.

****

Provide the following:

a. Rope lengths sufficient to maintain a minimum of two full wraps of rope at the dead end(s) of the drum, with the block in its lowest indicated position. The wire rope must be in a double reeved configuration with the equalizing method perpendicular to the running sheaves.

b. Provide hoisting ropes with improved plow steel, extra improved plow steel, or extra-extra improved plow steel, regular lay, bright, and uncoated with an independent wire rope, wire strand, or otherwise, steel core. Hot-dipped galvanized wire rope is not permitted. Provide stainless steel hoist ropes.

2.3.3.2 Sheaves

Provide steel sheaves. Provide sheaves constructed of non-sparking materials.

2.3.3.3 Drum

Provide drum made of steel. Design the drum such that all hoisting rope is wound in a single layer and so that not less than two dead wraps of hoisting rope remain on each anchorage when the hook is in its extreme low position.

]2.3.4 Trolley

Provide a [manual][geared manual][air motor powered][electric motor powered] trolley drive designed to operate from [[_____] track beam section][the track beam section furnished under this contract]. Configure trolley such that the trolley frame contacts the track end stops or bumper of an adjacent trolley and prevents the trolley from dropping more than one inch in the event of an axle or wheel failure (drop lugs). Drop lug contact surfaces must be of non-sparking materials.

2.3.4.1 Trolley Wheels

****

NOTE: For maximum anti-spark protection, add the tailored words. Remove any conflicting items (i.e. wheels cannot be non-sparking and steel).

****

Wheel material is to be steel or ductile cast iron. Hollow stamped steel and gray cast iron wheels are prohibited. Wheels are to be made of forged steel. Provide wheels of non-sparking material. The minimum tread hardness for bronze wheels is 225 BHN.

[2.3.4.2 Bumpers

For powered trolleys, fit the trolley frames with shock-absorbing bumpers. Ensure bumpers and end stops conform to ASME B30.17. Mount bumpers so that there is no direct shear on mounting bolts (if any) upon impact. Bumpers must provide adequate clearance between the hoist and surrounding structure when compressed to preclude damaging equipment. When more than one hoist is located and operated on the same track, bumpers must be provided on their adjacent ends or on one end of one hoist such that the trolley frame of the adjacent hoist comes in contact with the bumper.

][2.3.4.3 Trolley Brakes

****

NOTE: Only powered trolleys that don't have a non-coasting drive need a brake.

****

Provide trolley with either a non-coasting (i.e. worm) drive or with an end-mounted [air] [electro-mechanical] brake that is spring applied, [air] [electrically] released. The brakes must be equipped with a manual self-return to ON brake release and designed to permit inspection and adjustment without disassembly of the brake.

]2.3.5 Hoist Brakes

****

NOTE: NAVFAC requires each hoist to have, at a minimum, two brakes, with the exception of manual hoists and non-ordnance handling pneumatic hoists which may have only one, which is typically a mechanical load brake.

****

2.3.5.1 Hoist Mechanical Load Brake

Provide a mechanical load brake that is capable of stopping and holding [125][100]125 percent of the hoist's rated load and does not require the load to be raised before being lowered.

[2.3.5.2 Hoist Secondary Brake

Provide a spring set electro-mechanical brake that stops and holds [125][100]125 percent of the hoist's rated load. Equip spring set brake with a manual release mechanism that automatically resets when power is applied to the brake. If the hoist has more than one brake, each brake must independently stop and hold [125][100]125 percent of rated capacity.

][2.3.5.3 Air Hoist Brake

Equip [air] hoists with a braking means that prevents the lowering of the load in the event of a loss of air supply, can stop and hold [125][100]125 percent of the hoist's rated load, and does not require the load to be raised before being lowered.

2.3.5.4 Air Hoist Secondary Brake

Ordnance handling air hoists are to be equipped with a second holding brake with a minimum torque rating of [125][100]125 percent of the rated load hoisting torque.

]2.3.6 Load Block and Hook

****

NOTE: Some text tailored to NAVFAC. For text tailored to Minimum Anti-Spark requirements, remove conflicting requirements (i.e. load block cannot simultaneously be steel.

For Ordnance Handling: The insulated link(s) are required unless the following conditions are met:
c. There is no threat of a lightning strike during operations;
d. There is no chance for contact with overhead power lines;
e. RF emissions control is in effect regardless of the HERO classification of the ordnance being held.

****

****

NOTE: Include sentences for custom design load block with trunnion if requested by using activity.

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The load block must be constructed of steel non-sparking materials and designed to prevent metal-to-metal contact of moving parts. and designed to prevent metal-to-metal contact of moving parts. [The design must preclude the wire rope from being cut, pinched, crushed, or chafed in case of two-blocking.]The block must be clearly marked with the capacity in kilograms pounds on both sides. An insulated link must be provided on each hook block per the requirements of NAVSEA OP-5. Standard commercial blocks may be used at their published ratings when their published design factors are 5.0 or greater.

Provide an unpainted single barbed forged steel hook which complies with ASME B30.10. Provide an unpainted single barbed hook of non-sparking material with a minimum material longitudinal elongation of 16 percent in 2 inches. Bronze clad hooks are prohibited. Fit hook with a safety latch designed to preclude inadvertent displacement of slings from the hook saddle. The hook and hook nut must be removable [without unreeving of the hoist or]disassembly of the block. Provide an easily removable and reusable means to positively secure the hook nut to the hook shank. Do not weld hook nut. Uniquely mark the hook in a permanent fashion that is traceable to the NDT certification. The nut must be marked to match the hook. The hook nut must be of non-sparking materials. Hook must be free to rotate through 360 degrees when supporting the test load up to [125][100] 125 percent of the rated capacity. Upper hooks of hook suspended hoists must be of non-sparking materials.

2.3.7 Wind Speed Indicating Device

Provide a wind speed indicating device in accordance with the requirements of ASME B30.17.

[2.3.8 [Air][Manual] Hoist Capacity Overload Protection

Capacity overload protection which prevents further hoisting of a load set at or less than the crane's minimum test load. If a non-adjustable slip clutch is utilized, the OEM factory setting is acceptable and must be identified. If the device is adjustable, it must be adjusted to prevent hoisting in excess of the test load.

][2.3.9 Air Hoist Limit Switches

Provide a Hoist limit switch to limit hook over-travel in both the raising and lowering direction.[The lower limit switch must be set such that there are no less than a minimum of two wraps of hoist on the hoist drum upon limit switch actuation.][For chain hoists, chain stops and an overload clutch that meets the requirements of ASME B30.16 are acceptable as upper and lower limit switches.]

2.3.10 Air Hoist Air Supply

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NOTE: If the provided shop air is not lubricated chose the option to provide air lubricator.

****

The air supply hose must not hang below the high hook position.[Provide an air lubricator.]

][2.4 ELECTRICAL REQUIREMENTS

The design, selection, rating, and installation of the electrical portions of the crane and its accessories must conform to the requirements of NEMA ICS 8, the applicable ASME HST standard, and NFPA 70, and other requirements specified herein.

The crane manufacturer must furnish and install all electrical equipment on the crane conforming to NEMA ICS 6, including motors, conforming to NEMA MG 1, electrically released brakes, switches, crane controllers, panels, operating station, wiring system, cables, and crane electrification.

2.4.1 Motors

****

NOTE: Select two speed motors for trolley drives if magnetic controls are specified in paragraph CONTROLS; select single speed motors if electronic controls are specified in paragraph CONTROLS.

U.S. Navy allows only 60-minute duty rating motors. 30-minute duty rating motors require Navy Crane Center approval. For non-Navy applications, the

motor duty rating may be selected to match what is required by the class of HST-4 hoist (such as H1, H2, H3) specified.

****

Motors must meet all applicable requirements of NEMA MG 1 and UL 1004-1. All motors must have a minimum of a 60 [30] [60] [_____] minute duty rating and be Totally Enclosed Non Ventilated (TENV), Totally Enclosed Fan Cooled (TEFC), or Totally Enclosed Blower Cooled (TEBC). Provide inverter duty motors if Variable Frequency Drives (VFD) are used. Provide motors with a minimum of Class F insulation. Provide motor overload protection utilizing a thermal sensitive device embedded in its windings. Provide motors painted to manufacturer's standard for "wash-down" service. Motors located outdoors must be furnished with anti-condensation heaters that remain energized when the mainline contactor is deenergized.

2.4.2 Controls

****

NOTE: Use the first three paragraphs to select electronic variable frequency drive controls for either the hoist or trolley.

Use the fourth paragraph to select one or two speed control for the hoist or trolley which the manufacturer may accomplish with magnetic controls or a simple VFD. Selections can be made using a combination of electronic controls and one or two speed motor controls split between the hoist and trolley.

When the two-speed trolley motor is specified, the slow speed will be 1/3 to 1/4 of rated travel speed. Reduced voltage starting, acceleration, and deceleration, serve to reduce the acceleration rate that is normal for squirrel-cage motors. Squirrel-cage motors with two-speed magnetic controls provide satisfactory results with slow trolley speeds and should be specified when short travel distances are involved and where fine positioning is not required.

For faster trolley speeds or finer positioning requirements, specify electronic controls.

Various VFD manufacturers offer an option to overspeed the hoist to a value over 60Hz (usually 120Hz). This allows the operator to position the hoist at faster speeds when it is not loaded. When selecting this feature list the maximum no load speed in section "Rated Capacity and Speeds".

NAVY requires hoist drives with a controller continuous rating of 125 percent of the motor full load current. Tailor to NAVFAC. All other groups may use 100 percent.

****

[Provide static reversing, variable frequency drives (VFD) for the [trolley][and][hoist] electric controls. VFD controllers must meet NEMA ICS 8, Part 8 and at a minimum, provide under-voltage protection, electronic instantaneous over current protection, DC bus over voltage protection, and be able to withstand output line to line shorts without component failure. Select trolley drive such that the continuous rating of the controller is not less than the motor full load current. Select hoist drives such that the continuous rating of the controller is not less than 125 100 percent of the motor full load current. All hoist drives must have a motor over-torque limit to lock out the hoist and prevent gross overload of the associated hoist. Provide dynamic braking for each electric drive that is sized per VFD manufacturer's requirements. Submit VFD Control Parameter Settings.

Provide speed control, which is infinitely variable for each function, controlled via [radio control system][and][pendant pushbutton station]. [Provide controls designed such that the maximum speed of each function will be limited to 25 percent of rated speed when a slow speed switch is actuated on the controller[s].][Energize a yellow/amber light/indicator while in slow speed mode.]

The [hoist][and][trolley] brakes must set after the associated controller decelerates the drive motor to a controlled stop. The hoist and trolley controllers must be sized to provide sufficient starting torque to initiate motion of that crane drive mechanism from standstill with 0 to 125 100 percent of rated load on the hook. The hoist controller must prove torque before release of the brakes and enable the drive motor to develop full torque continuously at zero speed. Motors must operate smoothly at all speeds without torque pulsations, and must only be energized within the frequency range of 50-60 Hz at rated speed.[The hoist control system may utilize overspeed up to 120hz, unloaded only, if the drivetrain equipment has all been balanced and is rated for the resulting speed.]

][Provide [one][two]-speed controls for the [trolley drive][and][hoist] drive. Controllers must meet the requirements of NEMA ICS 8. Ensure that an energized drive motor initially rotates only in the direction selected by the operator by activating the corresponding direction; i.e., is not overhauled. For AC squirrel cage motor controllers, the requirements of NEMA ICS 2, Part 2, for general-purpose controllers, must be met.

[Provide the trolley motor control systems with a drift point between OFF and the first speed control point in each direction.

] The use of definite purpose contactors is prohibited. If IEC contactors are used, the application cannot exceed the contactor manufacturer's AC3 ratings for the contactor at a minimum.

]

[On wire rope hoist, roll-up must be less than 1/8-inch measured at the hook block and roll-back must not occur over the entire load range.

] Use of Uninterruptible Power Supplies (UPS) is prohibited. Feed control circuits from a single phase, air cooled, double wound transformer with a grounded metal screen between the primary and secondary windings of the transformer.

Provide a main line contactor. Energization of the main line contactor must be controlled by the POWER-OFF/POWER-ON switch/pushbutton on all controllers. Upon actuation of the POWER-OFF pushbutton; power to all drive motors, brakes, and controls must be removed. The mainline contactor must not be able to be energize while the POWER-OFF pushbutton is actuated.

The POWER-OFF pushbutton circuitry must be independent of all controls or any other electronic devices.

2.4.3 Protection

Protection must not be less than that required by NEMA ICS 8, CMAA 74, NFPA 70, UL 1004-1, 29 CFR 1910.147, 29 CFR 1910.306 and all applicable provisions of 29 CFR 1910. Provide enclosed type circuit breaker readily accessible to the crane operator for crane disconnect. Provide an On/Off button that removes power from the motors, brakes and control circuit on all [operator control stations][and][radio controllers]. Provide for lockout/tagout of all hazardous energy sources.

2.4.4 Resistors

Provide resistors with natural convection cooling sized as recommended by the VFD OEM and fabricated of corrosion resistant metal; the use of "wire wound" type resistors is prohibited for segments of 8 ohms or less. Mount resistors in substantial, ventilated enclosures constructed entirely of non-combustible materials. When mounted outdoors provide stainless steel resistor enclosures. Provide resistors with terminals fitted in the coolest position in the enclosure.

[2.4.5 Transients and Harmonics Protection

****

NOTE: The following items are required only for cranes with VFD or radio controls.

****

Provide contactors and relays with appropriate Metal Oxide Varistors (MOV) or resistor-capacitor (R-C) surge absorbers installed across the respective coil.

Provide transient protection for electronic drive controllers that is either internal to the drive or via an MOV connected line-to-ground close to the line terminals of the drive.

[Provide line reactors rated for continuous duty operation based upon the motor nameplate amperes. With motors of 50 horsepower or greater, harmonics protection must be provided by an isolations transformer or as recommended by the VFD OEM. For a drive motor branch circuit that exceeds 150 feet in length, a reactor must also be connected in series with the controller load (output) terminals to provide standing wave protection or as otherwise recommended by the VFD or motor OEM.

]]2.4.6 Limit Switches

Limit switches must be rated for the NFPA 70 Hazardous Classifications specified in the Classification section of this specification.

Provide primary upper and lower geared limit switches. Geared limits must allow reversing direction to back out of the limit without resetting. [The lower limit switch must be set such that there are a minimum of two wraps of rope on the hoist drum.]Provide a backup mechanical hook block activated upper limit switch wired independent of the directional controllers and the primary upper limit switch that removes power from the hoist motor, hoist brake and hoist controls conforming to NEMA ICS 5. The backup limit must require hoist resetting prior to operation of the hoist in any direction. For chain hoists, chain stops and an overload clutch that meets the requirements of ASME B30.16 are acceptable as upper and lower limit switches.

[Travel limit switches must be provided for the trolley motion to slow the crane to [25 percent] [_____] of its rated speed [[5] [_____] feet before the monorail end stops]. Limit switches must be mounted rigidly in a manner so as to protect the switch from misalignment or damage. The target/trip arm must be large enough to provide interception given a misalignment were to occur.

]2.4.7 Operator Controls

****

NOTE: Available operator controls are pendant and radio control. Cranes can also be set-up to be controlled by two separate systems. For cranes with one set of controls use paragraph 1. For cranes with two sets of controls use paragraph 2. In such a case some type of interlock must exist to prevent control from both systems simultaneously.

When specifying a radio control system, the following requirements must be considered and if needed added to the specification. None are hard requirements of NAVCRANECENINST 11450.2A:

1. What type of batteries? Rechargeable?
2. Are spare batteries needed? How many?
3. Are spare remote control units required? How many?
4. Is a battery charger required?
5. Type of transmitter unit.
6. Is a belt/harness required for the remote control?

****

[Provide crane equipped with a [pendant pushbutton station] [radio control system].

][Provide crane equipped with both a pendant pushbutton station and a radio control system. Provide a selector switch to allow the use of only one of the two available control stations on the pendant controller.

] If VFD controls are not provided, provide directional contactors with both mechanical and electrical interlocks.

Operator controls must be rated for the NEC Hazardous Classifications specified in the Classification section of this specification.

[2.4.7.1 Pendant Pushbutton Station

The cranes must be controlled from a pendant pushbutton station suspended from the trolley. Provide multiconductor flexible cords for pendant pushbutton stations with #16 AWG minimum conductors. Provide a method of strain relief to protect the electrical conductors from damage. Locate the pendant pushbutton station [1200 mm] [4 feet] [_____] above the finished floor. Pushbutton pendant station must have its elements legibly marked and arranged vertically, in order, in accordance with CMAA 74.[Provide [one speed] [two speed] [3-step infinitely variable] [2-step infinitely variable] pendant pushbuttons for control of the [hoist][and][trolley].] Provide pendant pushbuttons for control that spring return to the OFF position. Voltage in the pendant pushbutton station must not exceed 150 Volts AC or 300 Volts DC.[Provide a maintained two-position selector switch for slow speed selection.] The pendant must be rated for the NEC Hazardous Classifications specified in the Crane Design Criteria "Classification" Section.

][2.4.7.2 Radio Control System

Provide each system with a [belly box] [handheld] [_____] type portable transmitter unit[and an identical back-up transmitter unit].[Provide each transmitter with an adjustable belt or harness to support it when worn by the operator]. Only one transmitter at a time can control the crane and there must be no interference from one crane's controller affecting operation of the other cranes in the building. Each transmitter must include: individual [infinitely variable spring return joystick motion control levers] [push button controls] for each hoist and trolley; a maintained contact, keyed switch, marked ON-OFF, for portable transmitter unit power; indication of Battery Power, and indication of Transmitting Status; a red emergency STOP mushroom pushbutton;[and] a floodlight on/off pushbutton[and a maintained slow speed selector switch]. The transmitters and all controls must each be clearly and permanently labeled with functionality and direction. Directions for controllers must be in accordance with CMAA 74 recommendations. The remote radio control system must be designed to meet the requirements of NEMA ICS 8, Part 9 and ECMA 15. Each radio remote control lever must be in the OFF position before the associated crane function can begin. The system frequency must be within the unlicensed FCC Part 15 range. Each control unit must maintain a continuous status signal to the associated receiver during operation. There must be no significant loss in systems efficiency and function at the end of eight hours of continuous battery use. Provide a contact monitoring board with the crane radio system receiver.

][2.4.8 Runway Conductor System

Provide a rigid runway Conductor Bar System for the runway conductor system, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. Provide electrification system with three power conductors and an equipment grounding conductor. UV resistant. Steel (non-stainless) conductor bars are prohibited. The crane must be grounded through the runway electrification system. The grounded conductors must be a minimum of 70 square millimeters. Provide runway conductors sized for simultaneous motions of the hoist, trolley mechanisms, and any ancillary loads. If there is any way the hook block or [load chain] [wire rope] can swing into the runway electrification, provide a guard installed to prevent contact.

Provide two Collector Shoes (tandem design) for each conductor; each collector shoe must be rated for not less than the runway conductor sizing, so as to provide redundancy.

]2.4.9 Overload Protection [and Load Indicating Device]

****

NOTE: Overload protection on a crane is required and is provided by two types of systems: Capacity Overload Protection and Over-Torque Limit.

The Over-Torque Limit only applies to cranes with VFD controls. It is a parameter setting in the drive and is typically set at 150 percent. Manual hoists, air hoists, and electric hoists with magnetic controls do not have this feature. Delete third paragraph if VFD controls are not specified.

Capacity Overload Protection is usually adjustable. If adjustable, it needs to be set at less than the crane's minimum test load. This protection can take the form of one of the following devices:
1. Clutch – Not adjustable and is common on package hoists.
2. Load Limit Switch – Installed on the wire rope and measures deflection. Does not require a break in the wire rope and is simply clamped onto the wire. Typically used on smaller hoists that have magnetic controls. Can also be installed as part of the equalizer sheave.
3. VFD Drive Overload Protection – Similar to the Over-Torque Limit but is set at a lower setting. Adjusted via parameters within the drive.
4. Separate Load Indicating Device – This involves the installation of a load cell and a digital readout that displays weight. The load cell is usually bolted onto the end of the wire rope or is installed as a pin in one of the sheaves.

****

Provide capacity overload protection for all hoist systems [separate from torque limiting feature of the VFD] [using the load indicating device (LID) described in the next paragraph]. Set hoist capacity overload protection at [_____]. Hoist capacity overload protection must be adjustable between 80 and 150 percent of hoist capacity. Provide a keyed override or other means to disable the hoist capacity overload protection when performing a load test. If a non-adjustable slip clutch is utilized, the OEM factory setting is acceptable and must be identified.

[Provide an LID for the hoist[s]. Provide [a display][displays] installed on the underside of [each] hoist to provide load information from the load indicating system, to be displayed in kilograms pounds. The display[s] must be large enough so that the operator can read the load value[s] from the ground level. The load indicating system capacity is to be compatible with the maximum test load for each hoist. The accuracy of the load indicating system is to be such that the indicated load is not less than 100 percent of the actual load, and not more than 110 percent of the actual load. The load indicating system must be configured with a set point for an overload limit. Provide Tare (zero) functionality at the operator's station for [the] [each] load indicating system. Any load bearing components used in the LID system must be steel, have a minimum design factor of 5 to 1 based on ultimate tensile strength and a hardness not to exceed HRC 40. Precipitation hardened stainless steel load bearing elements must be aged hardened at a minimum temperature of 1025 degrees F.

][Initially, set the torque limiting capability of the VFD (that is separate from the capacity overload protective device) to 150 percent of the motor torque (amperage) necessary to hoist 100 percent load. It may be adjusted up only to avoid nuisance trips and adjusted down if possible while still avoiding nuisance trips.

]2.4.10 Enclosures

****

NOTE: Select classification of control panels, controls, and brakes based on the environmental conditions in which the crane will be installed:
1. Choose one of the following for an indoor installation: 1, 2, or 12.
2. Choose one of the following for an outdoor installation: 3, 4X, or 8.
3. Choose one of the following for a Class I Hazardous installation: 7 (indoor)or 8(indoor/outdoor).
4. Choose one of the following for a Class II Hazardous installation: 9 (indoor).
Other enclosure types exist that might be a better alternative for a particular installation. If necessary, refer to NEMA 250.

****

Provide enclosures for control panels, controls, and brakes in accordance with NEMA 250 and NEMA ICS 6, Classification Type [1 indoor, general purpose] [12 indoor without knockouts, general purpose] [2 indoor, drip-proof] [3 outdoor, dust-tight, rain-tight, sleet-resistant] [4X outdoor] [7 indoor Class I hazardous][9 indoor Class II hazardous] [8 indoor/outdoor Class I hazardous] [_____]. Provide enclosures with listed drains to prevent accumulation of water within the enclosure. There must not be any condensation inside the control panels. If anti-condensation heaters are provided, these heaters must remain energized when the main line contactor is deenergized.

[Provide a non-resettable hour meter, connected across the main line contactor, readable from the exterior of the main control panel, to indicate the elapsed number of hours the crane is energized.

] Gaskets of enclosures and fixtures, and joints and contact surfaces of hazardous/explosive enclosures must be kept free of any paint to prevent damage during removal and reinstallation of gaskets of enclosures.

[2.4.11 Warning Devices

****

NOTE: A warning horn or light is required for all radio controlled cranes.

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[Provide a warning horn that is operable from a push button at the [pendant pushbutton] [radio control] station.][Provide a warning [strobe] [rotating beacon] that is illuminated at all times during movement of the hoist or trolley function.]

][2.4.12 Indicator Lights

Provide Indicator Lights mounted in an enclosure on the bottom of the trolley with lights sized and positioned to be visible from the ground. The lights must be the dual-lamp type. Provide a white light to indicate that power is available to the crane and a blue light to indicate that the main contactor is energized. Light voltage must be 115 VAC. Provide nameplates that are legible from ground level. The nameplates must read, in their respective order, "POWER AVAILABLE" and "CRANE ENERGIZED". The POWER AVAILABLE light must be supplied by a separate, fused transformer for its energization.

]2.4.13 Wind Speed Indicating System

Provide a wind speed indicating device. The transmitter must be mounted on the highest unobstructed location.

][2.5 PAINTING SYSTEM

****

NOTE: Three-coat zinc primer/epoxy/polyurethane system is provided for mild to severe atmospheric, indoor and outdoor cranes. For cranes in abnormal environments including exposure to chemicals or in immersion service, a system designed for that environment should be used. Other systems may suffice for milder environments.

****

Remove all grease, oil, and surface debris by solvent wiping or detergent/water scrubbing, prior to blast cleaning. Prepare surfaces to be coated by abrasive blasting to SSPC SP 6/NACE No.3, Commercial Blast Cleaning, or in accordance with the coating manufacturer's requirements, whichever is more stringent.

Use a painting system appropriate for the conditions provided in the Crane Design Criteria section. Paint exposed portions of the crane [and crane track system] using a [three] [_____]-coat system as follows: [zinc-rich primer consisting of a minimum of 77 percent zinc by weight in the dry film, an anticorrosive epoxy intermediate coat, and an aliphatic polyurethane top coat] [_____]. All paint products must be supplied by a single manufacturer and free of chromates, lead, and mercury. Apply each coat in accordance with manufacturer's instructions and requirements. Ensure each coat is smooth, even, and free of runs, sags, orange peel, and other defects. Desired color of finish coat is [brilliant yellow] [_____]. Submit product data for painting system.

Coat faying surfaces of bolted connections per RCSC A348, but do not apply finish paint.

Paint the load block [brilliant yellow] [_____] with black diagonal striping. Paint, coatings, or galvanizing on the following items or areas is not acceptable: hoist [load chain] [wire ropes], hooks, hook nuts, running bearing surfaces (including[sheaves and] wheel treads), grease fittings, or other items not normally painted.

Factory paint electrical and mechanical equipment including hoist, trolley, and track in accordance with the manufacturer's best standard practice (for the specified environment).

]2.6 IDENTIFICATION PLATES

Furnish and install identification plates. Provide non-corrosive metal identification plates with clearly legible permanent lettering giving the manufacturer's name, model number, serial number, capacity in both kilogram and pound units printed in different colors, and other essential information or identification.

2.6.1 Markings on Crane, Trolley, and Hook

****
NOTE: NAVFAC requires markings to be indicated in pounds.
****

To avoid operation of the crane in the wrong direction, affix the appropriate directions (NORTH, SOUTH, EAST, and WEST) with arrows on both sides of the trolley, as applicable. Markings must be visible by the operator and from the loading point. Labels on the controls must have corresponding directional (NORTH, SOUTH, EAST, and WEST) markings. Markings must agree with the markings on controller. Do not indicate directional arrows on controller.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, and before performing any work, verify all dimensions in the field. The Contractor is responsible for the coordination and proper relation of the contracted work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

[3.2 SHOP ASSEMBLY AND TESTS

Shop assemble major components as completely as possible. Functionally test the crane system at the construction facility prior to shipment. The Government reserves the right to inspect the crane for compliance with this specification and to witness the functionality tests. Notify the Contracting Officer [14] [_____] days prior to starting testing operations.

]3.3 ERECTION AND INSTALLATION

Perform the entire monorail system erection in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative.

[3.3.1 Electrical Adjustments

Adjust control system in accordance with manufacturer's instructions.[Store a copy of all Control Parameter Settings (PLC, VFD, and other microprocessor-controlled equipment).] Provide the final settings and configurations on the Complete Schematic Wiring Diagram, including but not limited to, timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents. Provide the test conditions such as ambient temperature, motor load, date performed and person performing the configuration as part of the Operational Tests report.

]3.3.2 Field Welding

Perform welding indoors, where possible. Surface of parts to be welded must be free from rust, scale, paint, grease, and other foreign matter.

Minimum preheat and interpass temperatures must conform to the requirements of AWS D14.1/D14.1M.

3.3.3 Field Painting

Perform painting indoors, where possible. Field painting (including touch-up) must conform to the requirements of the coating manufacturer and as specified in the paragraph PAINTING SYSTEM.

3.4 FIELD QUALITY CONTROL

3.4.1 Post-Erection Inspection

After erection, the Contractor[, the Activity Crane Inspector/Test Director,] and the Contracting Officer must jointly inspect the crane monorail track and hoist systems and components to verify compliance with specifications and approved submittals. Notify the Contracting Officer [_____] days before the inspection. Provide a report of the inspection indicating the crane is considered ready for operational tests.

Document the results of this inspection and submit the post-erection inspection report to the Contracting Officer for approval.

3.4.2 Operational Tests

****

NOTE: Determine if Government furnished certified test weights are available at the site. If not, they must be provided by the Contractor.

****

Check the clearance envelope of the entire crane prior to picking or traversing any load to ensure there are no obstructions. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the crane is operational.[The Contractor must furnish test weights, operating personnel, instruments, and other apparatus necessary to conduct field tests on each crane. Solid weights must be measured using calibrated equipment traceable to National Institute of Standards and Technology (NIST) with a minimum accuracy of plus or minus two percent.]

3.4.2.1 No-Load Test

Raise and lower each hook through the full range of normal travel at rated speed for three complete cycles. Raise and lower each hook, testing other speeds of the crane. Verify proper operation of hoist limit switches. Operate the trolley in each direction the full distance between end stops. Operate through the entire speed range and verify proper brake operation. Verify correct operation of all indication and ancillary devices.

3.4.3 Test Data

Record test data on appropriate test record forms suitable for retention for the life of the crane. Record operating and startup current measurements for hoist and trolley motors using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) must be justified or appropriate adjustments performed. In addition, note, investigate, and correct any high temperatures or abnormal operation of any equipment or machinery. Record hoist and trolley speeds during each test cycle.

3.4.4 Hook Tram Measurement

Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 0.4 mm 1/64 inch). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening from the base measurement is cause for rejection.

3.4.5 Load Tests

****

NOTE: NAVFAC Tailoring - the NAVY requires a load test of 125 percent (plus 0 minus 5) of the rated load.

****

Perform the following tests as specified below.

Test loads used in this section are defined as the following:

Rated load test: [100 percent (plus 0 minus 10)] [100 percent (plus [_____] minus [_____])] of rated load.

Overload test: [125 percent (plus 0 minus 5)] [125 percent (plus [0] [_____] minus [5] [_____])] of rated load.

3.4.5.1 Rated Load Test

3.4.5.1.1 Hoist

a. Static Load Test: With the trolley centered between hangar supports, raise the test load approximately 300 mm one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees to check bearing operation with no binding. Observe lowering that may occur which indicates a weakness in the structure or malfunction of hoisting components or brakes. Measure and verify deflection for the longest monorail beam section do not exceed MHI MH27.1/MHI MH27.2 and L/600 for rolled steel shapes design limits, as applicable.

b. Hoist Mechanical Load Brake: Raise test load approximately 1500 mm (5 feet). With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again, with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

c. For hoists with primary and secondary holding brakes, raise the test load and release the secondary holding brake while testing the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage secondary holding brake and release the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage the primary holding brake. Recheck proper operation of time delay and ensure smooth positive stopping.

d. Raise and lower test load through the full lift range. Stop the machinery at least once in each direction to ensure proper brake operation.

[e. Hoist Loss of Power Test: Raise the test load to approximately 2400 mm 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

]3.4.5.1.2 Trolley

Operate the trolley the full distance of the monorail system including all curves and switches in each direction with rated load on the hook. Check proper functioning through the range of speeds. Completely stop the machinery at least once in each direction during each cycle to ensure proper brake action.

[3.4.5.1.3 Trolley Loss of Power Test

With rated load, raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of trolley travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the trolley stops and that the brake sets properly.

]3.4.5.2 Overload Test

3.4.5.2.1 Hoist

Disconnect or adjust the overload limit device to allow the hoist to lift the test load. Verify proper operation of the overload limit device after it is reconnected.

a. Static Load Test: With the trolley centered between vertical supports, raise the test load approximately 300 mm one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees to check bearing operation with no binding. Observe lowering that may occur which indicates a weakness in the structure or malfunction of hoisting components or brakes.

b. For hoists with primary and secondary holding brakes, raise the test load and release the secondary holding brake while testing the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage secondary holding brake and release the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage the primary holding brake. Recheck proper operation of time delay and ensure smooth positive stopping.

c. Raise and lower test load and visually observe smooth control. Stop the load during raising and lowering to verify that the brakes holds the load.

d. Hoist Mechanical Load Brake: Raise test load approximately 1500 mm 5 feet. [With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake.]The load brake must hold the test load. [Again, with the holding brake in the released position.]Start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

[e. Hoist Loss of Power Test: Raise the test load to approximately 2400 mm 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

]3.4.5.2.2 Trolley

Operate the trolley the full distance of the monorail rail system including all curves and switches in each direction with a test load on the hook (one cycle) through the range of speeds. Verify proper brake action.

3.5 MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

Furnish a qualified experienced manufacturer's field service representative to supervise the crane installation, assist in the performance of the on-site testing, and instruct personnel in the operational and maintenance features of the equipment.

3.6 OPERATION AND MAINTENANCE MANUALS

Provide [two] [_____] hard copies of operation and [two] [_____] hard copies of maintenance manuals for the equipment furnished along with an electronic copy (PDF) of each on a Compact Disc. Provide one complete set prior to performance testing and final copies upon acceptance. Provide operation manuals that detail the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. List in the maintenance manuals routine maintenance procedures, including weekly, monthly, semi-annual, and annual required maintenance items, possible breakdowns and repairs, and troubleshooting guides. Also include as-built drawings, piping and equipment layout, design calculations, Control Parameter Settings and printouts of any software, and simplified wiring and control diagrams of the system as installed. Secure approval of operation and maintenance manuals prior to the field training course.

[3.7 FIELD TRAINING

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NOTE: Training is recommended, but not required.

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Conduct a training course for [_____] operating and maintenance staff[and provide a copy of the training material to each participant]. Provide a training period consisting of a total of [_____] hours of normal working time and starting after the system is functionally completed but prior to final acceptance. Cover all pertinent points involved in operating, starting, stopping, and servicing the equipment, including all major elements of the Operation and Maintenance Manuals. Demonstrate in course instructions all routine maintenance operations such as lubrication, general inspection, and [_____].

][3.8 FINAL ACCEPTANCE

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NOTE: Use this paragraph as written for projects where the crane is the principal construction element or represents a very significant portion of the Contract cost. However, if the crane is part of a new facility or renovation, delete the acceptance paragraph from this section. Warranty period and operating and maintenance processes must coincide with the actual beneficial occupancy of the entire facility.

****

Final acceptance of crane system will not be given until Contractor has successfully completed all testing operations, corrected all material and equipment defects, made all proper operation adjustments, and removed paint or overspray on [wire rope] [load chain], hook, and electrical collector bars.

] -- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-41 36 30.00 10 (January 2008)**

Preparing Activity: USACE **Superseding**
UFGS-41 36 30.00 10 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-41 36 30.00 10 (January 2008)**

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SECTION 41 36 30.00 10

ULTRASONIC INSPECTION OF PLATES

01/08

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NOTE: This guide specification covers the requirements for ultrasonic inspection of rolled steel plates.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

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NOTE: This guide specification covers the ultrasonic inspection of rolled plates both in air and by immersion techniques for laminar types of flaws, for lack of bonding between plate and cladding, and for lack of fusion between the welded overlay and the base metal. Where ultrasonic inspection of weldments is to be required, use Section 05 05 23.13 10 ULTRASONIC INSPECTION OF WELDMENTS. If the work will involve both ultrasonic inspection of plates and of weldments, this section and Section 05 05 23.13 10 ULTRASONIC INSPECTION OF WELDMENTS may be used as separate sections of the contract specifications, or may be combined into a single section to be titled ULTRASONIC INSPECTION.

If combined, repetitions will be deleted, and the entire specification will be edited for appropriate paragraphs and definitions, reference specimens, acceptance/rejection standards, and other associated data.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing
ASNT SNT-TC-1A Q&A Bk C	(2011; Text Correction 2011) Supplement to Recommended Practice No. SNT-TC-1A (Q&A Book): Ultrasonic Testing Method

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing

1.2 DEFINITIONS

1.2.1 A Scan

Method of data presentation on a cathode ray tube using rectangular coordinates in which a horizontal base line indicates elapsed time when reading from left to right. A vertical deflection in the base line indicates reflect signal amplitude.

1.2.2 Acoustically Similar Material

Material the same as that to be inspected; or another material proven to have acoustical velocity within plus or minus 3 percent and an attenuation within plus or minus 0.001 dB/mm 0.25 dB/inch of the inspected material for the inspection frequency and wave mode, using the same mode as that to be used for inspection.

1.2.3 Amplitude

When referring to an indication in A scan presentation, amplitude is the vertical height of the indication measured from peak-to-peak for radio frequency indications and trace-to-peak for video indications.

1.2.4 Attenuation

Dissipation or loss of energy as ultrasonic vibrations travel through the material. Attenuation is caused almost entirely by scattering of the ultrasonic vibrations generated by the search unit.

1.2.5 Attenuation-Correction Controls

Circuitry to provide a continuous increased amplification with respect to time. This circuitry compensates for the reduction in sensitivity with depth as a result of sound beam divergence and its attenuation in material.

1.2.6 Back Reflection or End Reflection

Reflection from the opposite side, end, or boundary of the material into which the ultrasonic energy was introduced.

1.2.7 Calibrated Gain Control (Attenuator)

Circuitry with which gain can be increased or reduced finite amounts by switching electrical signal attenuation into the circuit.

1.2.8 Calibration

Process of comparing an instrument or device with a standard to determine accuracy or produce a scale.

1.2.9 Cathode Ray Tube (CRT)

Electron tube in which a controlled beam of electrons from the cathode is used to produce an image on a fluorescent screen at the end of the tube.

1.2.10 Couplant

Any material, usually a liquid or semiliquid, used between the search unit and the inspection surface to exclude air and convey the ultrasonic vibrations between the search unit and the material being inspected.

1.2.11 Damping Control

Control that varies the duration of transducer ringing.

1.2.12 Decibel (dB)

Units for the logarithmic expression of the ratio of power levels. Power levels can be functions of voltage, current, or impedance. Decibel units have no values of their own and are only significant when a reference is stated, as 10 dB above one reference level or 6 dB below another reference level.

1.2.13 Delay Control

Means of delaying the pattern obtained on the cathode ray tube.

1.2.14 Discontinuity

Anything within a material that will cause a detectable interruption in an ultrasonic beam.

1.2.15 Distance-Amplitude Correction Curve

Curve showing the relationship between signal amplitude and equal-sized reflecting surfaces at various distances from the transducer. Reference standards are used to obtain such curves.

1.2.16 Dynamic Range

Ratio of maximum to minimum size of reflective areas that can be adequately distinguished on the cathode ray tube at a constant gain setting.

1.2.17 Effective Depth of Penetration

Maximum depth at which the sensitivity is satisfactory for the quality of test desired.

1.2.18 Examination

Within the context of this specification, the word "examination" is equivalent to the word "inspection."

1.2.19 Gain Control

Circuitry designed into the ultrasonic system to vary reflection amplitude. This control is usually calibrated in decibels. It is also called the sensitivity control.

1.2.20 Gross

Background displacement of the trace on the cathode ray tube from the established baseline due to the gain setting, the characteristics of the test equipment, or the material under examination.

1.2.21 Hertz

One complete set of recurrent values of a periodic quality comprises a cycle. In other words, any one set of periodic variations starting at one condition and returning once to the same condition is a cycle. A hertz is a unit of frequency equal to one cycle per second.

1.2.22 Immersion Techniques

Test methods in which the part to be tested and the search units are immersed in water or other suitable liquid couplant. A mechanical device is used to firmly hold and direct the wave angle of the search unit. The search unit does not contact the item being inspected.

1.2.23 Indication

Visual presentation on the cathode ray screen resulting from a sound beam reflection from a boundary surface or discontinuity.

1.2.24 Initial Pulse Indication

Usually called the "initial pulse". A signal on the CRT screen marking the instant at which a voltage impulse is applied to the transmitting crystal. Its rising edge is frequently invisible due to the time lag in the probe shoe and the consequent necessity to ensure coincidence between the time base zero and the instant at which the transmitter pulse actually enters the material under test.

1.2.25 Linearity

Property of an instrument revealed by a linear change in reflected signal or displacement. The vertical linearity is determined by plotting by change in ratios of signal amplitude from two adjacent reflections from an area of known size. The horizontal linearity is determined by plotting the distance the signal is displaced along the sweep against the change in material thickness or by noting the spacing of multiple back reflections.

1.2.26 Longitudinal or Compressional Waves

Simple compression refraction waves in which particle motion within a material is linear and in the direction of wave propagation. Also called straight beams, or compressional or normal waves.

1.2.27 Longitudinal Wave Inspection

Ultrasonic technique, normally using straight beam methods, in which longitudinal waves are the dominant form.

1.2.28 Mid-Screen Reflection

Reflection whose amplitude is equal to one-half the usable screen height on the CRT.

1.2.29 Megahertz (MHz)

One million hertz per second frequency.

1.2.30 NDT Level I

An NDT Level I individual should be qualified to properly perform specific calibrations, specific NDT, and specific evaluations for acceptance or rejection determinations according to written instructions, and to record results.

1.2.31 NDT Level II

An NDT Level II individual should be qualified to set up and calibrate equipment and to interpret and evaluate results with respect to applicable codes, standards, and specifications.

1.2.32 NDT Level III

An NDT Level III individual should be capable of establishing techniques and procedures; interpreting codes, standards, specifications, and procedures; and designating the particular NDT methods, techniques, and procedures to be used.

1.2.33 Node

Distance a shear wave travels in a straight line from the inspection surface before being reflected by the opposite surface.

1.2.34 Pulse Repetition Rate

Number of spaced pulses of sound per second sent into the material being inspected.

1.2.35 Range Control

Means of expanding the pattern obtained on the CRT so any portion of the total distance being tested can be presented.

1.2.36 Reference Reflector

Standard reflector 1.52 mm 0.060 inch diameter reference hole in the IIW reference block. Other approved blocks may have a different diameter reflector.

1.2.37 Reflector

Boundary, consisting of an opposite side, crack, or separation, or a distinct change in material such as slag or porosity that reflects the ultrasonic energy the same as a mirror reflects light.

1.2.38 Refracted Waves

Waves that have undergone change of velocity and direction by passing from one material to another material with different acoustical properties. Refraction will occur wherever the angle of the incident wave to the interface is other than perpendicular.

1.2.39 Rejectable Discontinuity (Defect)

Reflector large enough to produce a signal (decibel rating) that exceeds the reject/repair line.

1.2.40 Resolution

Ability to clearly distinguish signals obtained from two reflective surfaces with a minimum separation distance. Near-surface resolution is the ability to clearly distinguish a signal from a reflector at a minimum distance under the contact or near surface without interference from the initial pulse signal. Far-surface resolution is the ability to clearly distinguish signals from reflectors displaced at minimum distance from the far or back surface when the sound beam is normal to that back surface.

1.2.41   Ringing

Excitation of the transducer crystal due to a short pulse of high-voltage electricity.

1.2.42   Scanning

Process of moving the search unit or units along a test surface to obtain complete inspection of the entire volume of a material being inspected.

1.2.43   Search Unit

Device containing a piezoelectric material used for introducing vibrations into a material to be inspected or for receiving the vibrations reflected from the material. The active element of the search unit is defined as the effective transmitting area. Search units are also called transducers or probes. They may be single or dual and contain one or two piezoelectric elements, respectively, for transmission and reception. The single search unit is sometimes enclosed in a transducer wheel or search unit wheel. The search unit may be manually handled and placed in direct contact with the material to be inspected or may be held in a fixture for immersion technique.

1.2.44   Sensitivity

Measure of the ultrasonic equipment's ability to detect discontinuities. Quantitatively, it is the level of amplification of the receiver circuit in the ultrasonic instrument necessary to produce the required indication on the scope from the reference hole in the reference block. Also see "standard reference level".

1.2.45   Shear Waves

Waves in which the particles within the material vibrate perpendicularly to the direction in which the wave travels or propagates. Also called transverse waves.

1.2.46   Shear Wave Inspection

Inspection technique using shear waves in a material. The search unit is placed at an angle to the contact surface of the material so the resultant refracted sound is a shear wave at an angle to the normal.

1.2.47   Standard Reference Level

Mid-screen height reflection when beaming at the 1.52 mm 0.060 inch hole in the primary reference block or the reference hole in the secondary standard.

1.2.48   Surface Waves

Waves that propagate along the surface of the material and penetrate it to only about 1/2 wavelength. Also known as Rayleigh waves.

1.2.49 Test Frequency

Operating frequency in hertz per second of the search unit during period of activation. Frequency is usually expressed in megacycles per second or megahertz. The latter term has been adopted for international use and is preferred.

1.2.50 Video Form

Type of signal presentation on a CRT in which only the upper or position half of the signal appears.

1.3 SYSTEM DESCRIPTION

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NOTE: The designer will indicate the extent of inspection required, where the inspection will be made, and the number of plates to be inspected. The number will depend on the service to which the plates will be subjected. For example, inspect all plates intended for pressure vessels and dynamically loaded structures such as rail and highway bridges, cranes, and missile service towers. In the case of plates for statically loaded structures such as buildings and storage tanks, inspection must be on the basis of heats in which the sample size must be in accordance with the governing specifications or standards for tensile tests. However, the plates intended for ultrasonic inspection will not be the same as those from which the tensile specimens were taken. For economy, plates should be inspected at the mill following final processing and before shipment. However, in some instances, this may not be expedient. Where critical, the designer will specify in detail the occasion for inspection in the construction process.

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This section includes procedures, methods, standards, and descriptions of equipment which are used for [mill] [shop] [field] inspection of rolled plate, including clad materials which are 13 mm 1/2 inch or thicker, through which interpretable ultrasonic penetration is possible. Inspect plate [individually.] [by lots. Use a sample size of two plates per lot. A lot is defined as being all plates in a 50 mm 2 inch thickness interval rolled from the same heat. Include in the thickness determination any overlay, pressure cladding, or weld deposit.] Perform ultrasonic inspection to detect the following defects:

a. [Internal laminar discontinuities.]

b. [Lack of bond between roll or explosive bonded sheet.]

c. [Lack of fusion between welded overlays and base plate.]

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit

the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Procedures and Methods

Personnel Qualification and Certification

Equipment Qualification Requirements

SD-06 Test Reports

Reports and Results

1.5 QUALITY ASSURANCE

1.5.1 Personnel Qualification and Certification

Personnel must be qualified to perform ultrasonic inspection, as defined in ASNT SNT-TC-1A. Personnel must be certified under ASNT SNT-TC-1A and ASNT SNT-TC-1A Q&A Bk C within a period of 1 year before the date of this contract. Other qualification or certification may be accepted at the Contracting Officer's discretion. Personnel with only an operator or inspector trainee certification will not be considered qualified to pass judgment on the acceptability of inspected items, but may work under the direct supervision of a qualified ultrasonic inspector. Qualified ultrasonic inspectors must be able to pass judgement on the acceptability of the item in accordance with paragraph ACCEPTANCE/REJECTION LIMITS.

1.5.2 Examinations

If the Contracting Officer doubts an individual's ability as an operator, inspector, or supervisor, recertify the individual in accordance with ASNT SNT-TC-1A. The Contracting Officer may participate in administering the examination and in evaluating the results.

1.6 REFERENCE STANDARDS

Use reference standards to calibrate the inspection equipment, test its operating condition, and record the sensitivity or response of the equipment during the inspection in accordance with paragraph EQUIPMENT QUALIFICATION REQUIREMENTS. Use standards that comprise a standard reference block and working standards as described next.

1.6.1 Standard Reference Block

Provide the standard reference block or primary standard consisting of the International Institute of Welding (IIW) reference block in AWS D1.1/D1.1M, Section: Inspection, subsection, Reference Standards. Also use the standard reference block in any reinspection on the same basis as the original inspection, even though the reinspection is to be performed by other ultrasonic instruments and accessories.

1.6.2 Working Standards

Recognized working standards detailed with the IIW block in AWS D1.1/D1.1M, such as the Sensitivity Calibration Block, may be used. Details of their use must be included in the procedure description submitted for approval. Use blocks of the same acoustical material as the plates to be inspected, that are suited for the applicable tests specified in paragraph EQUIPMENT QUALIFICATION REQUIREMENTS, and use as follows except where the IIW block is specifically required:

a. To assure adequate penetration of the base material.

b. To provide a secondary field standard.

c. To calibrate the equipment and to establish the standard reference level.

1.6.3 Resolution Test Block

Furnish a resolution test block in accordance with the details shown in AWS D1.1/D1.1M, Section: Inspection, subsection Reference Standards.

1.7 EQUIPMENT QUALIFICATION REQUIREMENTS

Evaluate the ultrasonic instrument and accessories on their arrival at the jobsite just before the start of the inspection, using the Contractor's furnished primary standard; meet or exceed the requirements below. Do not use equipment that does not meet these requirements.

Submit the procedure specifications, the procedure qualification test records and the personnel qualification test records.

1.7.1 Requalification

Requalify equipment after normal use at intervals not to exceed 40 hours. In addition, requalify equipment immediately after maintenance or repair or when the Contracting Officer considers its operation questionable.

1.7.2 Longitudinal Wave System

1.7.2.1 Horizontal Linearity

Space the first three multiple reflections obtained through the thickness of the primary or secondary standard equally within plus or minus 5 percent when spread over 90 percent of the sweep length.

1.7.2.2 Vertical Amplitude Linearity

Two adjacent reflections of different amplitudes obtained through the thickness of the primary or secondary standard must vary in the same proportion as the amplitude of the first reflection is increased in discrete 2-dB increments between 20 and 80 percent of full screen height. For each gain setting, the amplitude of each reflection must vary by the same factor within plus or minus 5 percent.

1.7.2.3 Near-Surface Resolution

Excessive ringing that appears on the cathode ray tube (CRT) just to the right of the sound entry point must not exceed a 13 mm 1/2 inch equivalent distance in steel with the search unit placed on the 100 mm 4 inch edge of the IIW block and positioned for maximum amplitude reflection from the 1.52 mm 0.060 inch hole. Set the reference reflector to mid-screen and increase the gain 20 dB. In either case, excessive ringing must not appear on the CRT to the right of the sound entry point in excess of a 13 mm 1/2 inch equivalent distance in steel. Use the reference hole located at least 13 mm 1/2 inch from one edge of the AWS D1.1/D1.1M, Type SC secondary standards similarly. Acceptability must be on the same basis as in the primary standard.

1.7.2.4 Far-Surface Resolution

Delineate the three resolution holes in the resolution block appropriate for the angle of the transducer to be used in the inspection.

1.7.2.5 Signal-to-Noise Ratio

With the search unit located as in the near-surface resolution tests, set the gain to obtain an 80-percent full screen height first reflection from the respective reference reflector. A reference reflection-to-noise less than 10 to 1 is not acceptable.

1.7.2.6 Penetration

Obtain at least three multiple back reflections through plates up to 75 mm 3 inches thick and at least one for plates greater than 75 mm 3 inches thick. In either case, the initial or back reflection only must fall within mid-screen range with a gain input no greater than 50 percent of the instrument capacity.

1.7.3 Immersion Testing

For immersion techniques, the back reflection from the interface between the couplant and the plate surface is called the "first interface signal". All measurements are to be referenced to this signal. Provide equipment that meets all requirements of paragraph EQUIPMENT SENSITIVITY CALIBRATION.

1.8 EQUIPMENT SENSITIVITY CALIBRATION

Perform sensitivity calibration immediately after a change of operators and at least every 30 minutes thereafter as testing proceeds. Recalibration is also required after any power interruption, including a change of source, when the equipment is suspected of being in error, or after relocation on the jobsite. The 30-minute and relocation calibrations may coincide. Before calibration is attempted, allow the instrument to warm up.

1.8.1 Calibration of Longitudinal Wave System

Adjust the instrument range and delay controls to display signals from the far surface of the plate to be inspected. Adjust the gain to produce a first back reflection 50 percent of full-scale. Establish the reject/repair line at 40 percent of full-scale or 2 dB below mid-screen height. Determine the relationship between the 50-percent reflection and the first back reflection from the 1.52 mm 0.060 inch reference hole in the primary standard in the following way: without further adjustment of the instrument gain after the initial sensitivity setting, couple the transducer to the primary standard and positioned for a maximum first back reflection from the 1.52 mm 0.060 inch reference hole. Adjust the instrument gain to bring the maximum reflection to mid-screen height and record this instrument gain setting. Also record a similar relationship, correlated with the respective plate identifications, for each subsequent plate inspected. Compensate for adjustment for loss of signal due to distance as specified below. However, for plates less than 25 mm 1 inch thick, no adjustment for loss of signal is required.

1.8.2 Calibration of Secondary Standard

After adjusting the first reflection from the reference hole in the secondary standard to a 50-percent full-scale response for a shear or longitudinal wave inspection, obtain a maximized reflection from the 1.52 mm 0.060 inch reference hole in the primary standard without changing the gain setting. Readjust this gain setting to obtain a 50-percent full-scale reflection. Record the readjusted setting to provide a basis for recalibration when the secondary standard is unavailable.

1.8.3 Equipment With a Calibrated Gain Control

When a calibrated gain control attenuator is used, position the transducer for maximum reflection from the reference hole in the secondary standard representing approximately 1/2 the longest inspection distance. Adjust this reflection to mid-scale by varying the gain control accordingly. Measure the difference in decibels between this amplitude and the signals obtained from the first, second, and longest distance reflections obtainable on the secondary standard. Record and plot the differences on a curve to determine the necessary correction to the amplitude at the various inspection distances. A level 80 percent of the primary level, obtained from the corrected signal heights, is equal to the reject/repair line.

1.8.4 Equipment With Electronic Distance Compensation Circuitry

If the distance in amplitude between the first reflection and the reflection obtained from the maximum inspection distance is 1 dB or less, the instrument may be used as is. If not, use the procedure used for equipment with a calibrated decibel control to determine the necessary correction for the reflections obtained at the various inspection distances.

1.8.5 Longitudinal Wave Distance-Amplitude Corrective Curve

Construct and draw a longitudinal wave distance-amplitude correction curve on the face of the CRT when longitudinal waves are to be used in the inspection and when material thickness exceeds 50 mm 2 inches if the test equipment design permits. Use the reference hole in the secondary standard. Adjust the instrument sensitivity to 50 percent full-scale of the maximized response from the reference hole at 1/2 maximum inspection distance. Construct the reject/repair line at 80 percent of the established distance-amplitude curve. Take the reflection amplitudes to define this curve from the faces of the secondary sensitivity standard which are 25 mm 1 inch, 50 mm 2 inches, 1/2 maximum inspection distance, and the longest distance obtainable from the secondary standard, respectively, from the reference hole. When a correction curve cannot be drawn on the face of the CRT, apply an approved distance-amplitude correction method.

1.8.6 Longitudinal Wave Inspection Using Immersion Techniques

Use the reference hole in a secondary standard for each different inspection distance. Establish reject/repair limits by immersing both the search unit and secondary standard in the liquid bath in which the inspection is to be conducted. Use the following procedure:

a. Direct the longitudinal waves from the search unit toward the face of the secondary standard closest to the reference hole.

b. Position the search unit for maximum response. Adjust the amplitude of reflection to 50 percent full-scale. Mark the top of that indication on the CRT with a wax pencil or by other means. This establishes the standard reference level. Calculate and mark a point at 80 percent of the standard reference level. This locates the reject/repair point. Repeat the above procedure for each different surface-to-hole distance to establish reject/repair lines.

c. With the gain at the same setting and primary standard and search unit in the bath, obtain a maximized reflection from the 1.52 mm 0.060 inch reference hole in the primary standard. Readjust the gain setting to obtain a 50-percent full-scale reflection. Record the readjusted setting to provide a basis for recalibration when the secondary standard is unavailable.

1.8.7 Angle Wave System

The sensitivity level must be a minimum of a mid-screen height, 50-percent back reflection, with the transducer placed at the first node position from a plate edge. No other calibration tests are required unless repair of discontinuity excavation is accomplished by welding. In that case, when inspection of the weld repair is required, accomplish qualification and calibration of the shear wave equipment in accordance with Section 05 05 23.13 10 ULTRASONIC INSPECTION OF WELDMENTS.

PART 2 PRODUCTS

2.1 ULTRASONIC EQUIPMENT

Provide ultrasonic test instrument conforming to the requirements listed in AWS D1.1/D1.1M, Section: Inspection, subsection, Ultrasonic Equipment, except any requirement relating to weld inspection and the following additional requirements:

2.1.1 Pulses

Provide an ultrasonic test instrument able to generate, receive, and present pulses in any frequency in the 1- to 10-megahertz (MHz) range.

2.1.2 Horizontal Linearity Test

Test the horizontal linearity of the ultrasonic instrument in accordance with the requirements for horizontal linearity of paragraph EQUIPMENT QUALIFICATION REQUIREMENTS, in addition to the AWS D1.1/D1.1M requirement.

2.1.3 Resolution Tests

In addition to the resolution test specified in AWS D1.1/D1.1M for ultrasonic equipment, conduct both near- and far-surface resolution tests in accordance with the procedures specified for those characteristics in paragraph EQUIPMENT QUALIFICATION REQUIREMENTS.

2.2 PROCEDURES AND METHODS

Use the pulse echo contact method with an A scan presentation for the ultrasonic inspection of plate except when immersion techniques may be approved for use in some applications. Submit for approval the procedures to be used for personnel and equipment qualification, equipment calibration, and inspection at least 30 days before their intended use. Approval will in no way affect the Contractor's obligation to employ qualified personnel, equipment, and procedures, and to perform the inspection as specified. Include the following in the procedure description:

a. Type of couplant.

b. Search unit characteristics including shape, nominal frequency, diameter, type, and transducer angle if other than straight.

c. Method and type of wave.

d. Equipment and accessories including manufacturer, model number, date of manufacture, last date of calibration, and the manufacturer's electrical, physical, and performance specifications.

e. Decibel (dB) compensation system for distance-amplitude correction.

2.3 TEST FREQUENCY

Provide test frequency for ferrous materials as specified in AWS D1.1/D1.1M, Section: Inspection, subsection, Ultrasonic Equipment. For other materials that are difficult to penetrate, any frequency within the operating range of the equipment may be used. Demonstrate the effective depth of penetration and sound beam divergency to the Contracting Officer.

2.4 WAVE TYPES

Use types of waves and conditions as follows:

2.4.1 Longitudinal Waves

Use longitudinal waves to locate, identify, and evaluate defects in the various plate materials to be inspected.

2.4.2 Shear Waves

Shear waves may be used as a supplementary means of inspection to locate questionable areas.

2.5 CHANGES IN PROCEDURE

Should application of an approved procedure not provide for good resolution or adequate ultrasonic penetration as specified in paragraph EQUIPMENT QUALIFICATION REQUIREMENTS, make and approve changes in procedure or equipment such as frequency, pulse repetition rate, angle of search unit, couplant, or oscilloscope. Demonstrate adequacy of the new procedure to the Contracting Officer. During these tests, if any of the test system's characteristics fall below the levels listed in paragraph EQUIPMENT QUALIFICATION REQUIREMENTS, the Government reserves the right to require a change in procedure or equipment.

PART 3 EXECUTION

3.1 PREPARATION OF MATERIALS FOR INSPECTION

Provide inspection surface that is clean and free of loose scale, dirt, rust, grease, oil (other than couplant), and paint. Grind smooth any roughness on the inspection surface that could interfere with transmission of the ultrasound into the material enough to obtain a back or end reflection in excess of 40 percent full-scale. Inspect plates after final heat treatment or processing. Restore plate identification removed by grinding or other means after inspection.

3.2 INSPECTION PROCEDURE

****

NOTE: The designer will specify limits closer than those cited if the application is judged critical.

Delete inapplicable words, sentences, and paragraphs when the item mentioned is not to be furnished under this contract; for example, if clad plate is not furnished, delete all reference to clad plate.

****

Make inspection for [laminar types of flaws and] lack of fusion between welded overlay [or explosion bonded sheet] [and the base metal] as detailed below with the search unit coupled to the base plate. Use the correct frequency as defined in paragraph TEST FREQUENCY. Perform final evaluation for acceptance or rejection with the equipment properly calibrated and the gain control set at the reference level. Use the reject/repair line to evaluate the quality of each item inspected. If a periodic calibration check shows that the equipment is not operating properly or that the sensitivity of the system has decreased more than 20 percent or 2 dB from the established sensitivity level, reexamine all items that have been inspected since the previous calibration. When adequate penetration, as specified in paragraph EQUIPMENT QUALIFICATION REQUIREMENTS, cannot be obtained by the proposed longitudinal wave method, modify the procedure in accordance with paragraph CHANGES IN PROCEDURE.

3.2.1 Couplants

****

NOTE: The designer may limit the choice of couplants if some couplants are considered injurious to the item to be inspected.

****

The choice of couplant, such as oil or water, is optional, except as follows:

a. Use the same couplant as that used for equipment qualification and calibration.

b. Do not use couplants that may cause corrosion of the reference standards or the material being tested.

c. Do not use oil for plate to be installed in systems that will handle liquid oxygen.

d. Provide couplants that have the proper viscosity to overcome surface roughness or irregularities.

3.2.2 Detection of Laminar Types of Flaws

a. Mark off plates in grid lines with a maximum spacing of 12 inches between lines, test along each grid line and also along a path within one thickness (T) of the plate from each plate edge.

b. Maintain back or end reflection from the far surface of the plate in excess of 40-percent of full-scale screen height during the entire inspection to assure adequate ultrasonic penetration.

c. When a complete loss of back or end reflection occurs along any grid line, inspect the entire area of the square adjacent to that point. Continue complete testing of all additional adjacent squares until the extent of the defective area is defined.

3.2.3 Detection of Lack of Bonding: Base Plate and Cladding

a. Inspect the clad area for any lack of bonding between the cladding and the base metal. Mark off the clad area in grid lines with a maximum spacing of 150 mm 6 inches between lines, test along each grid line and also along a path within T of each edge.

b. Perform inspection from the base metal side, provided the interface between the base plate and overlay can be resolved.

3.2.4 Detection of Lack of Fusion: Welded Overlay and Base Plate

a. Inspect the fusion-welded area for any lack of fusion between the overlay and the base plate. Mark off the fusion-welded area in grid lines with a maximum spacing of 150 mm 6 inches between lines, test along each grid line and also along a path within T of each edge.

b. Perform inspection from the base metal side, provided the interface between the base plate and overlay can be resolved.

3.2.5 Immersion Techniques for Longitudinal Wave Inspection

This procedure may be used at the Contractor's option unless otherwise specified. Inspect plates for laminar type of flaws, lack of bonding between base plate and cladding, or lack of fusion between welded overlay and the base metal, as appropriate. In addition, make provision for immersing the plate and mounting the transducer in a fixture so that its motion along the required grid patterns can be controlled accurately.

3.3 ACCEPTANCE/REJECTION LIMITS

Evaluate discontinuities only when the ultrasonic equipment is properly calibrated. If discontinuities are detected, direct the sound beam to maximize the signal amplitude. To determine the length of a discontinuity, move the search unit parallel to the discontinuity axis in both directions from the position of maximum signal amplitude. One-half the amplitude (or a 6-dB increase in sensitivity) from a point at which the discontinuity signal drops rapidly to the baseline is defined as the extremity of the discontinuity. For discontinuities whose signal amplitudes exceed full screen height, consider 50-percent full-screen half peak amplitude of the signal. At this point, mark the scanning surface at the position indicated by the center of the transducer. Repeat this procedure to determine the other extremity. The length of the discontinuity is defined as the distance between these two marks. Determine and report the maximum signal amplitude, length, depth, and position within the inspection zone for discontinuities yielding a signal amplitude equal to or exceeding the reject/repair line. The minimum recordable length of discontinuity is 13 mm 1/2 inch.

3.3.1 Investigation of Questionable Indications

Bring any indications considered doubtful to the attention of the Contracting Officer, and repair the plate or investigate further as directed. Investigate indications detected within 10 mm 3/8 inch or less of accessible surfaces further by liquid penetrant as provided in ASTM E165/E165M, or by magnetic particle methods in accordance with ASTM E709, as applicable, to determine if they penetrate the surface. Failure to locate the flaws by one of these methods requires further investigation by the other. For nonmagnetic materials, only dye penetrant inspection is required. Further investigate questionable defects by modifications of the inspection procedure in accordance with paragraph CHANGES IN PROCEDURE.

3.3.2 Inspection of Repairs

Reexamine repairs by the same procedure that originally detected the faults, and meet the standards of acceptance for the original plate. More than two repairs to the same area are to be accepted at the discretion of the Contracting Officer.

3.3.3 Acceptance Standards

****

NOTE: The extent and diameters of defective areas depend on the class of service intended for the plates undergoing inspection. The designer will indicate the applicable class or classes and the intended service in the blank space provided for this purpose. For example: "All plate materials intended for dynamically loaded structures must conform to Class I requirements; those designed for foundations must conform to Class III requirements". Where only one class of service is required, inapplicable matter in parentheses will be deleted.

The tolerable extent of lack of bond depends on the service requirement of the plates and the severity of forming operations which might increase the size of the discontinuities judged acceptable. Reinspection of areas for lack of bond or fusion must be specified if the designer believes the original "safe" areas will extend after cold forming.

****

Plates will be unacceptable if they contain any of the defective areas detailed below:

a. Evaluate laminar types of flaws on the basis of their proximity to the plate surfaces. For evaluation, apply the zonal locations defined below in terms of base plate thickness, T. The T/4 criteria apply when the flaw is situated within T/4 distance of their nonoverlaid or base plate surfaces. The T/2 criteria apply to flaws located in the cross sectional area between T/4 layers of either overlaid or base plate surface. The T/4 criteria applies if the flaw extends from one zone to the other. Any single or two or more defects resulting in a reflection that exceeds the reject/repair line simultaneously with a continuous loss of back reflection from the far surface is cause for rejection, provided the extent of the single or multiple defects cannot be contained within a circle whose diameter is subject to the limits listed in TABLE II. Plate materials intended for [_____] must conform to class [_____] requirements whereas those intended for [_____] must conform to class [_____]. [Other plate materials must conform to class [_____] requirements.]

b. Lack of bond criteria applies to areas at which the cladding is overlaid on the base plate by a pressure or forging process. Lack of bond type flaws include:

(1) Any area that results in an interface back reflection exceeding the reject/repair line and that cannot be contained within a circle of 150 mm 6 inch diameter.

(2) Two or more smaller areas, each of which results in interface back reflection exceeding the reject/repair line, and which cannot be contained within a circle of 150 mm 6 inch diameter unless separated by a distance equal to the maximum dimension of the larger detective area.

(3) Any area that results in an interface back reflection exceeding the reject/repair line and that is closer than 50 mm 2 inches or less to any point at which penetrations are to be made through the cladded thicknesses.

c. Lack of fusion criteria applies to areas at which cladding is overlaid on the base plate by a fusion welding process. Lack of fusion type flaws include:

(1) Any area that results in an interface back reflection exceeding the reject/repair line and that cannot be contained within a circle of 150 mm 6 inch diameter.

(2) Two or more smaller areas, each of which results in an interface back reflection exceeding the reject/repair line, and which cannot be contained within a circle of 150 mm 6 inch diameter unless separated by a dimension equal to, or greater than the larger defect.

(3) Any in-line inclusions in the overlay, 25 mm 1 inch long or equal to 1/2 the plate thickness, whichever is greater.

(4) Any area that results in an interface back reflection exceeding the reject/repair line that is closer than 50 mm 2 inches or less to any point at which penetrations are to be made through the cladded thickness.

3.4 REPAIRS AND REPLACEMENT

****

NOTE: The designer will indicate or specify, directly or by reference to a suitable publication, the limiting dimensions for repairable defects. Where no applicable specifications exist, repairs will be limited to those areas at which their depth extends within 3/8 the plate thickness of the surface.

****

Replace plates containing defects in excess of the limit specified on a one-for-one basis or, at the Contractor's option, may be repaired if such defects are within the limits shown in TABLE I. [When plates are inspected on a lot basis, individually inspect each plate in the lot if more than one plate in the representative sample is found defective.] Reexamine repairs by the same procedure originally used to detect the faults, and the repairs must conform to the standards listed in paragraph ACCEPTANCE/REJECTION LIMITS.

TABLE I. PERCENTAGE OF PLATE AREA ALLOWED FOR REPAIRS

Plate Class	Area Allowed for Repairs
I	1.0 pct
II	1.5 pct
III	2.0 pct

3.5 REPORTS AND RESULTS

Submit reports containing the following information to the Contracting Officer:

a. Identification of each production plate by heat number and plate number, plate thickness, and the initial and final decibel settings needed for correlation of the plate back reflection with the standard reference block reflection as specified in paragraph EQUIPMENT SENSITIVITY CALIBRATION. Permanently record heat number and plate number on each production plate.

b. Place of plate inspection.

c. Identification and description of the standard reference block.

d. Details of methods, types of waves used, search unit, frequencies, inspection equipment identification, and calibration data with enough detail to permit duplication of the inspection later.

e. Locations, dimensions, area (if any) of unacceptable defects and their repairs. These may be noted on a sketch or marked-up drawing.

f. A record of repaired areas as well as the results of the repaired area reinspection.

TABLE II. SINGLE AND MULTIPLE AREA REJECTION LIMITS FOR LAMINAR TYPE FLAWS

Class	Criterion	No. of Defects	Diameter of Enclosing Circle	Minimum Spacing Between Defects
I	T/4	Single	75 mm3 in. or 1/2 plate thickness, whichever is greater	
		Multiple	Same as single	Equal to or greater than the maximum dimension of the larger defect
	T/2	Single	90 mm3.5 in. or 5/8 plate thickness, whichever is greater	
		Multiple	Same as single	Equal to or greater than 7/8 maximum dimension of the larger defect

TABLE II. SINGLE AND MULTIPLE AREA REJECTION LIMITS FOR LAMINAR TYPE FLAWS

Class	Criterion	No. of Defects	Diameter of Enclosing Circle	Minimum Spacing Between Defects
II	T/4	Single	90 mm3.5 in. or 5/8 plate thickness, whichever is greater	
		Multiple	Same as single	Equal to or greater than 3/4 maximum dimension of the larger defect
	T/2	Single	95 mm3.75 in. or 3/4 plate thickness, whichever is greater	
		Multiple	Same as single	Equal to or greater than 5/8 maximum dimension of the larger defect
III	T/4	Single	100 mm4 in. or 7/8 plate thickness, whichever is greater	
		Multiple	Same as single	Equal to or greater than 1/2 maximum dimension of
	T/2	Single	110 mm4.25 in. or plate thickness, whichever is greater	
		Multiple	Same as single	Equal to or greater than 3/8 maximum dimension of larger defect

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-41 65 10.00 10 (May 2009)**

Preparing Activity: USACE **Superseding**
UFGS-41 65 10.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 41 - MATERIAL PROCESSING AND HANDLING EQUIPMENT

SECTION 41 65 10.00 10

[DIESEL][NATURAL GAS] FUELED ENGINE PUMP DRIVES

05/09

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-41 65 10.00 10 (May 2009)**

Preparing Activity: USACE **Superseding**
UFGS-41 65 10.00 10 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 41 65 10.00 10

[DIESEL][NATURAL GAS] FUELED ENGINE PUMP DRIVES

05/09

****

NOTE: This guide specification covers the requirement for diesel or natural gas fueled engines used as prime movers for vertical pumps at civil works flood control pumping stations. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This guide is intended to be used in the preparation of project specifications along with Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE, and Section 35 45 03.00 10 SPEED REDUCERS FOR STORM WATER PUMPS. The Designer should edit the title of this section to reflect appropriate project requirements.

The designer is responsible for making a prime mover selection from either an electric motor, a diesel engine, or a natural gas engine. The guidance for

making proper selection is contained in EM 1110-2-3105, "Mechanical and Electrical Design of Pumping Stations".

The specification is written for a construction contract. Under a construction contract, these components can be purchased and installed by a Construction Contractor. A single contract allows the Contractor to obtain the most optimum combination and be responsible for the total performance of the unit, including shaft alignment. This also makes it feasible for the Contractor to perform a dynamic analysis of the pump, speed reducer, and prime mover system, as described in Section 35 45 01, and makes the Contractor solely responsible for acquiring the necessary data to perform such analysis.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(2024) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM B395/B395M	(2018) Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM D975	(2020) Standard Specification for Diesel Fuel Oils

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and

	Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 37	(2024) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE ARP892	(1965; R 1994) DC Starter-Generator, Engine
SAE J537	(2016) Storage Batteries
SAE J1995	(2014) Engine Power Test Code - Spark Ignition and Compression Ignition - Gross Power Rating

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 1236	(2015; Reprint Feb 2021) UL Standard for Safety Battery Chargers for Charging Engine-Starter Batteries

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up

to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout and Shop Drawings; G, [_____]

Installation; G, [_____]

SD-03 Product Data

Equipment and Performance; G, [_____]

Cooling System; G, [_____]

****

NOTE: Delete requirement for dynamic analysis of engine, pump, and speed reducer system, if this analysis will be performed by others.

****

Dynamic Analysis of Engine, Pump, and Governor; G, [_____]

Project/Site Conditions

Onsite Training; G, [_____]

Manufacturer's Published Instructions

Field Engineer; G, [_____]

DieselNatural Gas Fueled Engine Pump Drive; G, [_____]

Welder Qualifications

Installation; G, [_____]

SD-06 Test Reports

Engine

A fully documented shop test report.

The field test report, documenting all data for lubrication oil temperature and flow, cooling [water] [air] temperature and flow, and compliance with specified performance criteria tested during the field tests.

SD-07 Certificates

Pressure Vessels

Regulatory Requirements

SD-11 Closeout Submittals

As-Built Drawings; G, [_____]

Operation and Maintenance Manual; G, [_____]

1.3 WELDER QUALIFICATIONS

Perform welding in accordance with qualifying procedures using performance qualified welders and welding operators. Qualify procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1.[Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.][Welding and nondestructive testing procedures for pressure piping are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

Notify the Contracting Officer 24 hr in advance of tests, and perform the tests at the work site, if practical. The welder or welding operator must apply the assigned symbol near each weld made as a permanent personal record. Submit a letter listing the welder-qualifying procedures for each welder, complete with all supporting data such as test procedures used, what was tested to, and a list of the names of all welders and their identification symbols.

1.4 REGULATORY REQUIREMENTS

1.4.1 General

Conform design, fabrication, and installation of the equipment to the [specified] [applicable national, state, and local] codes. Submit documentation for conformance according to paragraph SUBMITTALS.

1.4.2 Layout and Shop Drawings

Submit layout and shop drawings including the following:

a. Base-mounted equipment, complete with base and all attachments including anchor bolt template and recommended clearances for maintenance and operation.

b. Complete starting system.

c. Complete fuel system.

d. Complete cooling system.

e. Complete intake and exhaust systems.

f. Layout of relays, breakers, switches, and instrumentation provided and applicable single line and wiring diagrams with a written description of the sequence of operation.

g. Lubrication system complete including piping, pump(s), strainers, filters, [heat exchangers for lube oil and turbocharger cooling], [electric heater], controls, and wiring.

h. Location, type, and description of vibration isolation devices for all applications.

i. The safety system, together with a detailed description of its operation. Include wiring schematics, safety devices with a listing of their normal ranges, alarm and shutdown valves (to include operation parameters such as pressures, temperatures, voltages, currents, and speeds).

j. Layout of the engine control panel and alarm panel.

k. Mounting and support for each panel and major piece of electrical equipment.

l. Engine lifting points and rigging instructions.

m. Alignment information for the engine, [gear box] and [pump] specifying sequences, tolerances, and temperature change effects.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect material and equipment from weather, humidity, temperature variation, dirt, dust, and other contaminants during delivery and storage. Lift, move, and store the engine in accordance with manufacturer's requirements.

1.6 PROJECT/SITE CONDITIONS

****

NOTE: The designer should specify the ambient conditions where the engine drive will be installed. Maximum and minimum air temperature is determined by location. For indoor installation, use indoor design maximum and minimum temperatures. For outdoor installations use the 99-percentile selection from ASHRAE Guide application tables for the installation location.

****

Maximum Air Temperature	[_____] degrees C F
Minimum Air Temperature	[_____] degrees C F

Raw Water Temperature	Max. [_____] degrees C F
	Min. [_____] degrees C F
Installation Elevation	[_____] m ft above sea level

Submit the record of the survey of the existing installation site conditions and verification of site work details.

1.7 MAINTENANCE

1.7.1 Extra Materials

****

NOTE: Spare parts to be furnished under this contract should be specified here. The designer is responsible for determining and providing a list of spare parts requirements. The following is a partial list:

****

Furnish the following minimum spare parts when applicable to the type of engine proposed.

UNITS	DESCRIPTION
[_____]	Complete engine cylinder head(s) and valve set, etc. (if applicable)
[_____]	Complete valve set(s) for one cylinder with springs, cages, etc
[_____]	Cylinder liner(s) with all necessary water seal rings
[_____]	Complete piston(s) with rings and connecting rod assemblies
[_____]	Wrist pins with retaining rings and wrist pine bearing shells
[_____]	Complete set(s) of piston rings for one engine
[_____]	Complete set(s) of main bearing shell of each size and type for the crankshaft of each engine rating supplied
[_____]	Crankpin bearing shell for each crankshaft of each engine rating supplied
[_____]	Complete fuel injector nozzle assembly and fuel injector pump assembly
[_____]	Air start motor (if applicable)
[_____]	Air start check valve (if applicable)
[_____]	Complete gaskets set for one engine
[_____]	Refills, with storage box, for all lubricating oil filters for each engine
[_____]	Refills, with storage box, for all fuel oil filters for each engine

UNITS	DESCRIPTION
[_____]	Spare lubricating oil circulating pump assembly
[_____]	Jacket water pump
[_____]	Pre-lube oil pump and motor assembly (if applicable)
[_____]	Pressure transducer(s)

1.7.2 Special Tools

Provide one complete set of special tools required for maintenance. Special tools are those that only the manufacturer provides for special purposes or to reach otherwise inaccessible parts. Supply tools complete with a suitable tool box.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 General Requirements

Provide and install complete and totally functional, [the] [each] engine with all necessary ancillary equipment including, but not limited to, air filtration, starting system, instrumentation, lubrication, fuel system, cooling system, and engine exhaust system. [The] [Each] engine rating must be in accordance with SAE J1995. Provide DieselNatural Gas Fueled Engine Pump Drive composed of complete units with all components, accessories, and system interconnections coordinated, so that the complete assembly has the capabilities required, for proper operation with the pump specified under Section 35 45 01 VERTICAL PUMPS, AXIAL-FLOW AND MIXED-FLOW IMPELLER-TYPE and the speed reducer specified in Section 35 45 03.00 10 SPEED REDUCERS FOR STORM WATER PUMPS.

Submit written documentation that the products being supplied are appropriate for this engine pump drive, including past performance of the drive on certain types of service, i.e., marine generators, pump drives, locomotives, metal shredders, etc., with a minimum operation of 2,000 hr per year of service with a minimum of 2 years of qualifying service. The certification of the unit's speed, horsepower, and duty rating that forms the basis of the qualifying experience is required for acceptance and must be within 30 percent of [this drive's rating] [these drives' ratings].

2.1.2 Performance Requirements

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NOTE: The designer should specify the service requirements for the pump drive: Continuous, Standby, or Emergency. The designer should furnish pump manufacturer's data including pump curves and plans unless this specification is used in

conjunction with pump specification Section 35 45 01 as a package. The selection of the engine speed should follow the guidance given in EM 1110-2-3105. Rated capacity should be based on the pump manufacturer's recommendation.

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Service Requirements	**[Continuous][Standby][Emergency]**
Rated Capacity	110 percent maximum kW (hp)required from the pump curves at specified speed plus power required by the accessories
Overload Capacity	110 percent rated capacity for 2 hours in 24 consecutive hours
Maximum Speed	[_____][900][1,200][1,800] RPM
[Characteristics of the pump load for the engine drive are described in the pump curves and pump plans included in [_____].]	
Site Ambient Conditions: The site characteristics are as described in paragraph PROJECT/SITE CONDITIONS.	

2.1.3 Arrangement

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NOTES: The engine shaft can be connected to the gear box by either a flexible coupling or universal joint assembly. In cases where the engine is large or the operating floor space is limited, a flexible coupling would be more appropriate. Manufacturer's recommendations should be solicited for arrangement alternatives. The designer should determine the configuration of the day tank, main fuel storage tank, and engine injection ports. If the main storage fuel tank is the lowest point in the engine fuel system, then a pump will be required to deliver fuel oil to the day tank.

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Each engine, as shown and specified, is to be used as the prime mover for the vertical pump.[Connect the engine shaft to the reducer input shaft with two universal joints and an intermediate shaft.][Connect the engine shaft to the reducer input shaft with a flexible coupling.] Coordinate among the manufacturers of the dieselnatural gas fueled engine, gear reducer, and the pump manufacturer to ensure the compatibility of these components including, but not limited to, the proper fit of engine and reducer shafts, the interaction of major components, and control of safety and alarm signals. Supply fuel for each engine by an individual day tank located near the engine and in accordance with NFPA 37. Fuel oil will be [supplied by gravity] [pumped] to day tank from outside storage tanks. Supply natural gas to the fuel solenoid shutoff valve to be supplied on the engine. Use a cooling system to maintain engine and lubricating oil temperatures at the temperatures recommended by the manufacturer. Furnish a starting system along with necessary accessories for engine start-up. Provide each engine with a completely independent lubrication [and pre-lubrication] system with an engine-driven primary pump.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials and equipment, comprising the engine drive system, which are the standard products of manufacturers regularly engaged in the production of dieselnatural gas fueled engine pump drives and that essentially duplicate products which have been used satisfactorily for at least two years prior to bid opening. An offer proposing an experimental engine, one having a lesser or greater number of cylinders than the offerers' standard production engines, or one without a demonstrated satisfactory service record as a full dieselnatural gas fueled engine operating not less than 1,200 hr a year at not less than 75 percent rated load, will be rejected. All products must be new.

2.2.2 Equipment and Performance

Submit equipment and performance data certifying that the engine and cooling system function properly in the ambient temperature specified and provides the following design and performance data:

a. The maximum allowable inlet temperature of the [coolant fluid] [coolant air].

b. The minimum allowable inlet temperature of the [coolant fluid] [coolant air].

c. The maximum allowable temperature rise in the [coolant fluid through the engine] [cooling air across the engine].

d. The magnitude of monitored values defining alarm or action set points, and the tolerance (plus and/or minus) at which the protective device activates the alarm or action.

e. The minimum allowable inlet fuel temperaturefuel supply pressure.

f. The maximum impact/dynamic load that will be transferred from the engine to the structure.

Manufacturer's standard catalog data including a description and depiction of each engine and all ancillary equipment in sufficient detail to demonstrate complete specification compliance. If standard catalog data does not contain sufficient detail to verify compliance, then submit supplementary support documentation to verify compliance. Submit all data on the engine manufacturer's letterhead and signed by a representative or official of the manufacturer authorized to make technical representations of his company's products.

2.2.3 Nameplates

Provide each major component with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment. As a minimum, provide nameplates for the following items:

a. Engines
b. Pumps and pump motors
c. Radiators

d. Heaters
e. Exhaust mufflers
f. Heat exchangers
g. Day tanks

2.2.4 Personnel Safety Devices

Insulate, fully enclose, guard, or fit with other types of safety devices all exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel. Install the safety devices so that proper operation of the equipment is not impaired.

2.3 MATERIALS

2.3.1 Filter Elements

Provide fuel-oil, lubricating-oil, and combustion-air filter elements which are the manufacturer's standard type and able to filter out particles down to a 25 to 40 micron size, unless otherwise noted.

2.3.2 Pipe (150 psi System and Under)

Provide pipe for sleeves, fuel/lube-oil, compressed air, coolant, exhaust, and miscellaneous uses in compliance with ASTM A53/A53M, or ASTM A106/A106M steel pipe. Pipe smaller than 50 mm 2 inch must be Schedule 80. Pipe 50 mm 2 inch and larger must be Schedule 40.

a. Flanges and flanged fittings: ASTM A181/A181M, Class 150, or ASME B16.5.

b. Pipe welding fittings: ASTM A234/A234M, Grade WPB or WPC, Class 150 or ASME B16.11, 1360.7 kg 3,000 lbs.

c. Threaded fittings: ASME B16.3, Class 150.

d. Valves: MSS SP-80, Class 150.

e. Gaskets: manufacturer's standard.

2.3.3 Temperature Gauges for Oil or Water Service

Manufacturer's standard flush-mounted, 100 mm 4 inch minimum diameter dial size with standard operating point at 50 percent of the full gauge range. Provide gauge construction and materials that are appropriate for the intended service.

2.3.4 Pipe Hangers

MSS SP-58

2.3.5 Pressure Gauges

Manufacturer's standard flush mounted, 100 mm 4 inch minimum dial diameter with standard operating point at 50 percent of the full gauge range. Ensure gauge construction and materials are appropriate for the intended service.

2.4 DIESELNATURAL GAS FUELED ENGINE

****

NOTES: Specify the fuel type if different than No. 2 diesel. The rating of the equipment should be in accordance with SAE standards. If the facility is located below 457 m 1,500 ft in elevation above sea level and the intake air temperature is under 38 degrees C 100 degrees F, then de-rating is not required.

Naturally aspirated engines are available to about 1,500 kW continuous. Turbocharged engines are generally available from 50 to 350 kW continuous. Turbocharged-aftercooled engines are generally available from 200 kW to over 4,000 kW continuous. Engine suppliers should be contacted for recommendations regarding the appropriate engine based on the application.

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a. The engine must be a full diesel, 2 or 4 cycle, compression-ignition type, for stationary applications and operate on No. 2-D diesel fuel conforming to ASTM D975. The engine must be naturally aspirated, turbocharged, or turbocharged-aftercooled.

a. The engine must be a natural gas fueled, 2 or 4 cycle, spark ignition type, for stationary applications and operate on standard pipeline natural gas. The engine must be naturally aspirated or turbocharged-aftercooled.

b. Provide engine rating as specified in paragraph PERFORMANCE REQUIREMENTS. The engine must be of the vertical in-line, vee, or opposed-piston type, with a solid cast block or individually cast cylinders. Provide opposed-piston engines with no less than four cylinders. Provide current models of a type in regular production complete with all devices specified or normally furnished with the engine.

2.4.1 Fuel Consumption

Do not exceed the following maximum limits based on the conditions listed below:

SIZE RANGE NET kW	PERCENT OF RATED FULL LOAD	FUEL USAGE kg/kWhLbs/bhp-hr
100 - 299	75 - 100	0.2720.447
300 - 999	75 - 100	0.2610.429
1,000 - 2,500	75 - 100	0.2430.400

Conditions:

a. 45 MJ/kg 19,350 BTU/pound heat value for fuel.

b. Sea level operation.

c. Intake air temperature not over 32 degrees C 90 degrees F.

d. Intake air barometer pressure not less than 95.7 kPa 28.25 inch of mercury.

SIZE RANGE NET kW	PERCENT OF RATED FULL LOAD	FUEL USAGE kJ/kWhbtu/bhp-hr
100 - 299	75 - 100	12,3408,700
300 - 999	75 - 100	11,3258,000
1,000 - 2,500	75 - 100	11,3258,000

Conditions:

a. Based on 118 octane natural gas with a heat value of 33,500 kJ/m3 900 btu/ft3.

b. Sea level operation.

c. 25 degrees C 77 degrees F ambient air temperature at 30 percent relative humidity.

d. 100 kPa 29.53 inch of mercury barometer pressure.

2.4.2 Crankcase Pressure Relief Valve

****

NOTES: Engines larger than 20 kW 27 hp must utilize a pressure relief valve on the crankcase to relieve primary crankcase explosions. The crankcase pressure relief valve vents quickly and then reseats to prevent return of air and to protect against secondary explosions. The plans should show the crankcase pressure relief valve vent piping on indoor engine installations.

****

Provide a pressure relief valve in the crankcase. Vent the crankcase in accordance with the manufacturer's recommendations, except do not use the engine exhaust as the venting system. Pipe crankcase breathers, if provided on engines installed in either a building or enclosure, to vent to the outside. If the engine is located outside, fit the crankcase breather with a goose-neck to prevent rain entry.

Provide a pressure relief valve in the crankcase. Vent the crankcase in accordance with the manufacturer's recommendations. Crankcase breathers using the venturi effect of the exhaust system will be allowed only when designed, installed, and provided directly from the engine manufacturer. Otherwise, vent the crankcase to the outside and fit with a goose neck to prevent rain entry.

2.5 FUEL SYSTEM

The fuel system for each engine must conform to requirements of NFPA 30 and NFPA 37. Include the following items.

2.5.1 Fuel Pump

Provide each engine with an engine-driven, positive displacement engine fuel pump. Provide pump with the capacity to transfer fuel from the day tank at a rate in excess of maximum fuel consumption stated in paragraph FUEL CONSUMPTION, as well as supplying adequate pressure for the fuel injectors.

Provide each engine with a fuel solenoid shutoff wired to a shutdown system and a fuel pressure regulator supplied by the engine manufacturer to control the fuel over air mixture to the engine. The fuel supply pressure available at the site is [_____] kPainch H20. The engine fuel system design must be adequate to power to 110 percent load at the site fuel supply pressure as stated above.

2.5.2 Filter

Supply a minimum of one duplex filter with a trans-flow change-over valve for each engine. Provide filter with inlet and outlet connections plainly marked. Provide an indicating differential pressure gauge across the filter. Locate the filter on the inlet side of the fuel pump. Ensure the filter is capable of filtering out particles down to 25 micron size.

Provide each engine with a fuel filter located upstream of the fuel solenoid shutoff to filter 100 percent of the incoming gas. Provide filter with inlet and outlet connections plainly marked. Provide an indicating differential pressure gauge across the filter. Ensure the filter is capable of filtering out particles down to 5 micron size.

2.5.3 Strainer

Provide a full flow strainer of the replaceable cartridge type between the engine and the fuel tank, upstream of the duplex filter. Provide an indicating differential pressure gauge for upstream and downstream of the strainer. Ensure the strainer cartridge is capable of filtering out particles down to 125 micron size.

2.5.4 Fuel Gas Compressor

Where the basic engine fuel system design requires fuel pressures above that available at the site, a fuel gas compressor is required. Select and certify this fuel gas compressor by the engine manufacturer to comply with both these specifications and the requirements of the engine throughout its load range and up to 110 percent load. Package the fuel gas compressor on the same skid as the engine with a fully plumbed fuel system providing one point for fuel connection and junction boxes as required for electrical connections.

2.5.5 Safety Bypass Valve

Provide a safety bypass valve next to the pump isolation valve to prevent the buildup of excessive pressures if the discharge line or fuel pump filters become clogged. This bypass must protect the fuel piping from over-pressurizing and will relieve it at [_____] kPa psi. The bypass valve relief line must return the fuel to the engine day tank.

2.5.6 Day Tank

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NOTE: See NFPA 37 and NFPA 30 for day tank restrictions on allowable day tank sizes. The day tank should be located in close proximity to the engine to avoid exceeding the total suction head capabilities of the engine-driven fuel pump (paragraph FUEL PUMP). Nominal suction head capabilities of typical engine-driven fuel pumps are in the range of 2.75 to 3.65 m 9 to 12 ft.

Delete this paragraph in its entirety if natural gas fueled engines are specified.

****

Provide each engine with a day tank located next to the engine. Fit each day tank with a fuel supply line, fuel return line, local fuel fill port, direct reading liquid level indicator, vent, fill limit float switch assembly for automatic control of the fuel oil transfer pump (if provided), alarm level sensing device, and a drain line. Provide a fuel return line cooler, if recommended by the engine manufacturer. Provide each day tank with [a [_____] L gal capacity] [capacity sufficient to supply the engine without interruption for 2 hr] [capacity sufficient to supply the engine for [_____] hr continuously at 100 percent rated load without being refilled].

2.5.6.1 Drain Line

Equip each day tank drain line with a shutoff valve and arrange to allow drainage into 220 L 55 gal drums.

2.5.6.2 Local Fuel Fill

Provide each local fill port with a [screw-on cap][hinged, fill cap]. Provide an air vent with brass screen so that the day tank does not develop a vacuum leading to the collapse of the day tank as the system empties.

2.5.6.3 Fuel Level Limit Devices

a. Provide each day tank with a fill level float switch assembly device to:

    (1) Initiate refueling of the day tank at the low level mark, (e.g., 30 percent volume remaining).

    (2) Stop refueling of the day tank at the high level mark, (e.g., 90 percent volume).

b. Provide each day tank with a separate level-sensing device to activate alarms at day tank overfill and day tank empty. Day tank empty must indicate at 20 percent volume remaining. Day tank overfill must indicate at 95 percent volume. See paragraph ALARM PANEL for further function requirements.

2.5.6.4 Redundant Fuel Shutoff

To stop fuel flow to the day tank, provide an automatic shutoff valve on the fill line of the day tank and provide an automatic safety device to stop the pump supplying fuel to the day tank. Activate the valve and the safety device at the overfill level as defined in paragraph SAFETY SYSTEM, and respond before any fuel is forced out of the fuel overflow line.

2.5.6.5 Arrangement

Position and arrange the day tank so that fuel level in the day tank at the day tank empty level is above the suction port of the engine-driven fuel pump. Position and arrange the day tank overflow connection so that the highest possible fuel level in the day tank is below the fuel injectors. The fuel supply line from the day tank to the engine connections must be welded steel pipe. Provide a water drain at the low point of the day tank.

2.5.7 Fuel Supply System

Provide diesel fuel supply from the main diesel fuel storage to the day tank as specified in Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Provide natural gas fuel supply system as specified in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES and Section 23 11 20 FACILITY GAS PIPING.

2.5.8 Main Fuel Storage Tank

****

NOTE: The location of this tank is important for day tank draining and day tank fuel supply. The appropriate type and location should be determined by costs and operational requirements and should follow local, state, and Federal Environmental Protection Agency regulations, Section 33 56 10 and NFPA-30.

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The main fuel storage tank is specified in [Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS][_____].

2.6 LUBRICATION

****

NOTE: Delete the adjustable requirement for pressure regulation on the pressurized lube oil system for engines smaller than 1,000 kW 1,350 hp.

****

Provide each engine with a separate lube-oil system conforming to NFPA 30 and NFPA 37. Pressurize each system by engine-driven pumps.[Adjust and regulate the system pressure as recommended by the engine manufacturer.] Furnish a sump tank as required. The lube-oil pump must draw oil from the oil pan or sump tank through a mesh intake strainer and force it through a lubricating oil cooler and a single or duplex full-flow strainer into the engine. Protect the pump by a relief valve to bypass the oil into sump. Bypass a portion of the oil from the sump through a lubricating oil filter and back into the engine oil pan or sump. Regulate the lubricating oil temperature by means of an automatic temperature regulator which will control the amount of bypass oil around the cooler. Make the system readily accessible for service such as draining or refilling. Permit the addition of oil and have oil-level indication with the set operating.

2.6.1 Pump Filters

Provide one full-flow, duplex, 80 micron filter for each pump. Ensure the filter is readily accessible and capable of being changed without disconnecting the piping or disturbing other components. Provide filter with inlet and outlet connections plainly marked. Provide an indicating differential pressure gauge across the filter.

2.6.2 Lube-Oil Sensors

Equip each engine with lube-oil temperature and pressure sensors. Use temperature sensors to provide signals for pre-high and high lube-oil indication and alarms. Locate pressure sensors downstream of the filters and provide signals for pre-low and low lube-oil indication and alarms.

2.6.3 Lubricating Oil Strainer

Furnish a full-flow, oil strainer in-line, ahead of the engine. The strainer must be as recommended by the engine manufacturer. Provide a bottom drain plug to allow easy removal of the sludge.

[2.6.4 Pre-Lubrication Oil Pump

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NOTE: Normally, engine size greater than 350 kW 470 hp and engines with a period in excess of two weeks between operations require pre-lubrication. If pre-lubrication is required, utilize this paragraph.

****

Provide pre-lubricating oil pump with a capacity and head rating as recommended by the engine manufacturer. Incorporate a built-in relief valve and directly connect to an electric motor with the motor-pump assembly mounted on a common case iron or steel base. Furnish the pump complete and ready for operation with all controls inclusive. Allow the pre-lubrication pump to completely fill the engine oil lines and establish lubricating oil pressure prior to starting. Provide pump motor in accordance with the requirements of paragraph MOTORS.

]2.7 COOLING SYSTEM

****

NOTE: There are three basic types of engine cooling systems available. These are systems using liquid-to-air heat exchangers (radiators) or cooling towers, systems using liquid-to-liquid heat exchangers (systems using shell and tube, plate and frame heat exchangers) and systems using submerged pipe systems. No matter which system is specified, engine outlet water temperature should be kept constant, and the differential between inlet water to outlet water of the cooling system should be kept at about 8 degrees C 15 degrees F. The radiator requires forced air through the heat exchanger causing higher noise levels. For an indoor application, the radiator can be located outside with a higher pressure pumping system to deliver the required flow to the radiator. The radiator should be mounted less than 15 m 50 ft above the engine to

avoid leakage at the engine water pump seal.

When the approach between coolant and air temperatures is under 15 degrees C 27 degrees F, towers become more economical. A surrounding clean environment is required with towers due to the openness of the design. The shell and tube heat exchanger requires an expansion tank to remove air from the system. The raw water supply system should be closely coordinated when applying a shell and tube heat exchanger.

Cooling towers have limiting working ranges and can be applied successfully only in certain climates.

The submerged pipe cooling system requires a large quantity of raw water and an expansion tank. Factors for consideration when evaluating cooling systems include engine size, space limitations, acceptable noise levels, raw water supply, maintenance, operational requirements, and system operating costs. Engine suppliers should be contacted for assistance in selecting the appropriate cooling system for the application.

****

a. Each engine must have its own cooling system. Provide closed type system that operates automatically while the engine is running.

b. Provide cooling system with an engine-driven water pump, [fin-tube radiator,] [cooling tower,] [remotely mounted fin-tube radiator,] [shell-tube heat exchanger, expansion tank,] [plate and frame heat exchanger, expansion tank,] [submerged pipe, expansion tank,] and an automatic temperature regulating valve. The maximum temperature rise of the coolant across each engine is not allowed to exceed the engine manufacturer's recommendation as submitted in paragraph SUBMITTALS.

c. Provide closed type engine cooling system arranged to prevent rust and minimize formation of scale deposits within the engine. Circulate jacket-coolant through the engine at the temperature and flow rate recommended by the engine manufacturer. The coolant must be an ethylene-glycol water mixture with a concentration sufficient for freeze protection at the minimum outdoor temperature specified. The maximum temperature rise of the coolant is no more than that recommended and submitted in paragraph SUBMITTALS.

2.7.1 Coolant Pumps

****

NOTE: Delete raw-water pump option for closed-loop systems.

****

Provide centrifugal type engine-driven jacket water pumps.[Raw-water centrifugal circulating pumps must be [electric motor driven equipped with manual-off-automatic controllers] [engine driven].] Provide each engine with an engine-driven primary pump. Provide electric motor driven secondary pumps with automatic controllers. Provide a bronze fitted, single stage type pump with removable seal rings and stuffing box and properly sized for the intended purpose.

2.7.2 Radiator

****

NOTE: Radiator location and mounting details should be shown on the plans. An electric motor-driven fan is provided on remotely located radiators to circulate air across the radiator. The fan should operate when the engine operates.

****

Size each radiator to limit the maximum allowable temperature rise on the coolant across the engine to that recommended and submitted in paragraph SUBMITTALS, for the maximum outdoor design temperature and site elevation. Use radiator fabrication materials that are corrosion resistant and suitable for service in the ambient application conditions. The radiator may be factory coated with corrosive resistant film provided that corrective measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over-sizing or other compensating methods. Internal surfaces must be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Ensure radiators are the pressure type incorporating a pressure valve, vacuum valve, and a radiator cap. Provide radiator cpas for pressure relief prior to removal. Ensure each radiator and the entire cooling system is capable of withstanding a minimum pressure of 48.4 kPa 7 psig. Protect each radiator with a strong grille or screen guard. Radiators must have at least two tapped holes. Equip one tapped hole in the radiator with a drain cock; plug the rest. [Provide the remote located radiator with an electric motor-driven fan. Wire the fan to operate when the engine operates.]

[2.7.2.1 Shell and Tube Heat Exchanger

Provide a multiple pass shell type heat exchanger with removable U-tube bundles to facilitate cleaning and retubing. The heat exchanger must be of sufficient capacity to cool the engine with [_____] degrees C F input cooling water. Operate the heat exchanger with low temperature water in the shell and high temperature coolant in the tubes. Construct exchangers in accordance with requirements of ASME BPVC SEC VIII D1 and certify with an ASME stamp secured to the heat exchanger. Construct shells with seamless steel, welded steel, or cast iron. Provide tubes that are either cupronickel or inhibited admiralty, meeting requirements of ASTM B395/B395M, suitable for the temperature and pressure specified. Design the shell side and tube side of the heat exchanger for 1.03 MPa 150 psig working pressure and factory test at 2.06 MPa 300 psig. Locate high temperature, low temperature, and pressure relief connections in accordance with the manufacturer's standard practice. Coolant pressure loss through clean tubes must be as recommended by the engine manufacturer. Minimum coolant velocity through the tubes must be at least 300 mm/sec 12 inch/sec and sufficient to assure turbulent flow. Provide one or more pressure relief valves for each heat exchanger in accordance with ASME BPVC SEC VIII D1. Install a drain connection with a 19 mm 3/4 inch hose bib connection at the lowest point in the system near the heat exchanger.

][2.7.2.2 Plate and Frame Heat Exchanger

The heat exchanger must be a multiple pass type with removable plates to facilitate cleaning. The heat exchanger must be of sufficient capacity to cool the engine with [_____] degrees C F input cooling water. Construct heat exchanges in accordance with ASME BPVC SEC VIII D1 and certify with an ASME stamp secured to the heat exchanger. Select materials for the plate and frames that are appropriate for the service required. Locate high and low temperature and pressure relief connections in accordance with the manufacturer's standard practice. Water pressure loss through clean plates must be as recommended by the engine manufacturer. Provide one or more pressure relief valves for each heat exchanger in accordance with ASME BPVC SEC VIII D1. Install a drain connection with a 19 mm 3/4 inch hose bib connection at the lowest point in the system near the heat exchanger.

][2.7.2.3 Cooling Tower

****

NOTE: The maximum outdoor design temperature, coolant temperature, and availability of water are critical to the proper selection of the appropriate cooling tower. Applicable ASHRAE guides should be consulted for application guidance.

****

Size the cooling tower to limit the maximum allowable temperature rise in the coolant across the engine to that recommended by the engine manufacturer. The Contractor is responsible for the proper selection of system components based on the site conditions and the dieselnatural gas fueled engine pump drive[s] used. Internal and external materials must be appropriate for the heat used. Use cooling towers in conjunction with a liquid-to-liquid heat exchanger to keep the engine cooling in a closed loop with conditioned coolant. Furnish the cooling tower as a complete operating system with a liquid-to-liquid heat exchanger, a surge tank, an auxiliary water pump, necessary filters in the water return lines, and interconnecting piping and isolation valves as required for maintenance and operation.

][2.7.2.4 Submerged Pipe

****

NOTE: Protection for the submerged pipe or coil should be considered. The pipe or coil should be kept out of mud or silt and away from the bottom of the cooling pond to ensure maximum efficiency.

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Provide pipe or coil of sufficient length to cool the engine at the specified raw water temperature. Use piping materials as specified in paragraph PIPE (150 PSI SYSTEM AND UNDER). Install pipe as specified in paragraph PIPING INSTALLATION. Always slope the pipe from the return bend up to prevent air locks in the system. Furnish a drain plug at the lowest point of the system. Connect the system so that the jacket water flows from the engine to the cooling coils and then to the expansion tank before returning to the jacket water pump inlet.

]2.7.3 Thermostatic Control Valve

Provide a modulating type, thermostatic control valve in the coolant system to maintain the engine coolant temperature in the range submitted in paragraph SUBMITTALS.

2.7.4 Ductwork

Provide ductwork as specified in [Section 23 30 00 HVAC AIR DISTRIBUTION] [_____] except use a flexible connection to connect the engine radiator. Material for the connection must be wire-reinforced fiber glass. The connection must be airtight.

2.7.5 Temperature Sensors

Equip each engine with coolant temperature sensors. Use temperature sensors to provide signals for pre-high and high coolant temperature indication and alarms.

Equip each engine with coolant temperature systems for both the jacket water system and the intercooler system when the engine is turbocharged.

2.7.6 Expansion Tank

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NOTE: Size of the expansion tank at least 15 percent of the coolant volume in the total system to take care of expansion.

****

Furnish an expansion tank of no less than [_____] L gal for each engine. Properly fit the tank for vent, overflow, expansion, and make-up lines. The tank must be suitable for an operating temperature of 121 degrees C 250 degrees F and a working pressure of 860 kPa 125 psig. Construct tank of welded steel, hot-dipped galvanized inside and outside after fabrication, test, and stamp in accordance with ASME BPVC SEC VIII D1 and register with the National Board of Boiler and Pressure Vessel Inspectors. Mount tank so that the bottom of the tank is above the top of the engine. Support tank by steel legs or bases for vertical installations or steel saddles for horizontal installation.

2.8 SPECIAL LIMITATIONS

2.8.1 Sound Limitations

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NOTE: The noise limits must conform to applicable local and OSHA codes. The designer is responsible for determining code noise limit requirements for specific site applications. Specific information regarding applicable noise limits should be inserted in this section. Site specific requirements and limitations are key components in the criteria selection. Generally, the most cost effective approach is to use hearing protection in conjunction with building and room insulation to control noise.

****

[_____]

2.8.2 Vibration Isolation and Seismic Restraints

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NOTE: Provide seismic requirements and show details on the drawings if the Government designer (either

Corps office or A/E) is the Engineer of Record. Delete the bracketed phrase in the last sentence of this paragraph if seismic details are not provided. Pertinent portions of UFC 3-301-01 and properly edited Sections 13 48 73 and 23 05 48.19 must be included in the contract documents.

****

Limit the maximum engine vibration in the horizontal, vertical, and axial directions to 0.15 mm 6 mils peak-peak RMS, with an overall velocity limit of 24 mm/sec 0.95 inch/sec RMS.[Install a vibration-isolation system between the floor and the base. The vibration-isolation system must limit the maximum vibration transmitted to the floor at all frequencies to a maximum of [_____] [_____] peak force.][Provide engine with a vibration-isolation system in accordance with the manufacturer's standard practice.] Design and qualify vibration-isolation systems (as an integral part of the base and mounting system) to the seismic forces specified. Where the vibration-isolation system does not secure the base to the structure floor or unit foundation, provide seismic restraints in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS[and as indicated].

2.9 AIR INTAKE EQUIPMENT

Provide filters and silencers in locations that are convenient for servicing as shown on the project plans. The silencer must be of the high-frequency filter type, located in the air intake system as recommended by the engine manufacturer. A combined filter silencer unit meeting requirements for the separate filter and silencer items may be provided. Expansion elements in air-intake lines must be [copper][rubber].

2.10 EXHAUST SYSTEM

Provide a separate and complete system for each engine. Support exhaust piping to minimize vibration. Make provisions for pipe thermal expansion. Where a V-type engine having more than one exhaust outlet is provided, use a V-type connector, with necessary flexible sections and hardware, to connect the engine exhaust outlets. Incorporate engine-mating and silencer-mating flanges, eliminating the need for adapters. Ensure the muffler and exhaust piping together is capable of reducing the noise level at the exhaust discharge location to a point below the maximum sound levels specified in paragraph SOUND LIMITATIONS, at a distance of [_____] m ft from the end of the exhaust piping directly along the path of discharge for horizontal discharged exhaust; or at a radius of [_____] m ft from the muffler/discharge piping, at 45 deg apart in all directions, for vertically discharged exhausts, with the engine operating at 100 percent of service load.

2.10.1 Flexible Sections and Expansion Joints

Provide a flexible section at each engine and an expansion joint at each muffler. Provide flexible sections and expansion joints with flanged connections. Ensure flexible sections are multiple-ply stainless steel expansion bellows type with standard 38 and 76 mm 1.5 and 3 inch allowable axial expansion. Use elements in the flexible sections that are capable of absorbing vibration from the engine and compensating for thermal expansion and contraction.

2.10.2 Exhaust Muffler

****

NOTE: Muffler locations and mountings should be shown on the plans. The designer should consider the use of first cost versus life-cycle cost analysis to determine the appropriate metal to use. Stainless steel Series 321 and aluminized steel should be considered in lieu of painted steel materials.

****

Provide a chamber type exhaust muffler. Fabricate the muffler of welded steel and design for [outside] [inside] [vertical] [horizontal] mounting. Provide eyebolts, lugs, flanges, or other items as necessary for support of the muffler in the location and position indicated on the plans. Do not allow the pressure drop through the muffler to exceed the recommendations of the engine manufacturer. Fabricate outside mufflers from [aluminized steel] [stainless steel]. Provide muffler with a drain valve, nipple, and cap at the low-point of the muffler. Supply a complete muffler with any necessary soot boxes or inspection ports required for adequate operation and maintenance. Size the entire exhaust system appropriately so that the operation of the engine is not affected by the exhaust system.

2.10.3 Exhaust Piping

****

NOTE: Exhaust piping should be sized at a gas velocity of less than 25.4 m/sec 5,000 fpm. The exhaust piping location and routing should be shown on the plans.

****

Slope horizontal sections of the exhaust piping downward away from the engine to a condensate trap and drain valve. Make changes in direction utilizing long radius fittings. Run exhaust piping not covered in this paragraph in accordance with paragraph PIPING INSTALLATION. Insulate exhaust piping, mufflers, and silencers with ASTM C533 calcium silicate insulation, minimum of 75 mm 3 inch thickness or an appropriate thickness to limit the surface temperature to values below 80 degrees C 175 degrees F. Secure insulation with no less than 9.525 mm 0.375 inch wide Type 304 stainless steel bands spaced no farther apart than 200 mm 8 inches on center. Provide an aluminum jacket encasing the insulation. Provide aluminum jacket with a minimum thickness of 0.406 mm 0.016 inch with a factory-applied polyethylene and kraft paper moisture barrier. Secure the jacket with no less than 13 mm1/2 inch wide stainless steel bands, spaced no farther apart than 200 mm 8 inch on centers. Lap longitudinal and circumferential seams of the jacket no less than 75 mm 3 inch. Install jackets on horizontal lines so that the longitudinal seams are on the bottom side of the pipe. Place the seams of the jacket for the vertical lines on the off-weather side of the pipe. On vertical lines, overlap the circumferential seams of the jacket so that the lower edge of each jacket overlaps the upper edge of the jacket below. Provide vertical exhaust piping with a hinged, gravity-operated, self-closing rain cover. When the exhaust pipe exits the building, isolate the pipe from the [wall][roof] by means of thimbles in accordance with NFPA 37.

2.11 PYROMETER

****

NOTE: For engines smaller than 1,000 kW 1,340 hp delete this paragraph. Pyrometers with individual thermocouples are not normally available and should not be specified for engines smaller than 1,000 kW 1,340 hp.

****

Provide a pyrometer [multi-point selector with individual thermocouples][and thermocouple] with calibrated leads to indicate the temperature [in each engine cylinder and the combined exhaust] [in the combined exhaust]. For a supercharged engine, provide additional points, thermocouples and leads to show the temperature in the turbocharger exhaust gas outlet and combustion air discharge passages. Provide a double pole selector switch, with an off position, one set of points for each thermocouple, and a suitable indicating dial. Calibrate the pyrometer, thermocouple, leads, and compensating devices to show true exhaust temperature within ñ1 percent above the highest temperature encountered at 110 percent load conditions.

2.12 EMISSIONS

The finished installation must comply with Federal and local regulations and restrictions regarding the limits of emissions such as carbon monoxide (CO), hydrocarbon (HC), and nitros (NOx).

2.13 STARTING SYSTEM

****

NOTE: The engine can be started by either pneumatic (compressed air) or an electric starting system. The selection of the starting system should be based on costs and availability of compressed air or electric power. The starting system should be of adequate capacity to start the engine under the coldest conditions encountered. Generally, in pumping plants with an existing station air system or where a station air system will be installed, a pneumatic system will have the lowest initial cost. The designer should ensure that the requirements for the station air system include an air receiver of adequate size to accommodate the cranking cycle of each engine in the station without recharge by the station air compressor. Paragraph ELECTRICAL STARTING SYSTEM should be deleted if a pneumatic starting system is specified. Paragraph COMPRESSED AIR STARTING SYSTEM should be deleted if an electric starting system is specified.

Torque available from air motors of pneumatic systems is capable of accelerating the engine to twice the engine cranking speed in about half the time required by electric starters. The starting system should be the manufacturer's standard equipment.

The starting system, regardless of type, should have a start-stop switch providing functions including

testing, reset, manual run/start manual stop, an adjustable cranking cycle and cool down mode of operation.

If an electric system is provided, an adjustable cranking limit device should be specified to limit the engine cranking to a specified time limit.

****

Provide each diesel engine with a starting system. Provide a [pneumatic] [electric] system of sufficient capacity to start the engine at the minimum temperature specified. Provide system with a start-stop switch which provides functions including testing, reset, manual run/start, manual stop, and adjustable cranking and cooling down operation. Ensure the starting system is the manufacturer's standard equipment.

2.13.1 Electrical Starting System

****

NOTE: Delete this paragraph and subparagraphs in their entirety if a pneumatic starting system is specified.

****

Provide an electrical starting system to operate on a [24] [_____]-V DC utilizing a negative circuit ground. Include an adjustable cranking device to limit the engine cranking to a specified time limit. Provide starting motors in accordance with SAE ARP892.

2.13.1.1 Battery

****

NOTE: Select a nickel-cadmium type battery only when the battery temperature cannot be maintained above -6 degrees C 22 degrees F.

****

Provide a starting battery system and include the battery, battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering, and relaying. Provide battery in accordance with SAE J537. Design critical system components (rack, protection, etc.) to withstand the seismic acceleration forces specified in subparagraph VIBRATION ISOLATION AND SEISMIC RESTRAINTS under paragraph SPECIAL LIMITATIONS. The battery must be a [lead-acid] [nickel-cadmium] type, with sufficient capacity, at the minimum [outdoor] [indoor] temperature specified, to provide a minimum cranking cycle consisting of three cranking periods of up to 8 sec per period with 8-sec intervals between crank periods.

2.13.1.2 Battery Charger

Provide a current-limiting battery charger, conforming to UL 1236, to automatically recharge the batteries. Ensure charger is capable of providing both automatic float charging and equalizing charging of the battery installation. The charger must be capable of recharging fully depleted batteries within [8] [_____] hr and providing a floating charge rate for maintaining the batteries in a fully charged condition. Provide an ammeter and voltmeter on the charger to indicate charging rate and voltage. Ensure charger has alarm functions providing indications of low battery voltage, high battery voltage, and battery charger malfunction.

2.13.2 Compressed Air Starting System

****

NOTES: Delete this paragraph and subparagraphs in their entirety if an electric starting system is specified.

The complete compressed air system should be shown on the plans. Two receivers, redundant piping, and two compressors may be required so that starting capability is not lost when tank maintenance is required. Valve arrangement should permit any receiver to be removed from service, drained, repaired, or replaced without loss of starting air from the system. The check valves between the plant air system and the air starting receivers should be considered to ensure that failure of the plant air system does not deplete the backup supply. The designer should analyze various starting scenarios and determine the necessity of providing a gasoline or diesel engine-driven compressor for a black-plant (no electrical sources available) start-up.

Each compressor should have sufficient capacity to refill the air starting system air receiver in a maximum of 3 min. Size the receiver to crank the largest engine for 15 sec at an ambient temperature of 21 degrees C 60 degrees F without recharging.

Either the air-motor starting option or the cylinder injection starting option should be used and the other paragraph deleted.

****

Provide a compressed air starting system. Use station service air. Furnish a complete system with oilers, regulators, and solenoid control valves. Provide air motor type system with a working pressure of 1.03 MPa 150 psig or cylinder injection type with a working pressure of 2.07 MPa 300 psig. Provide compressed air system piping as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.13.2.1 Air Filter

Install an air filter upstream of the air connection to each engine. The filter must be capable of removing particles 10 mm 3/8 inch and larger.

2.13.2.2 Air Driven Motors or Cylinder Injection

Either type of air starting system, air motors or direct injection, is acceptable. If an air motor starting system is used, the cranking motors must be complete with a solenoid valve, strainer, and lubricator. If cylinder injection starting is used it must be accomplished by admitting compressed air into two or more engine cylinders through a timing valve, or through a distributor into a sufficient number of cylinders to ensure successful starting regardless of piston positions.

2.13.3 Starting Aids

****

NOTE: Jacket coolant and/or lube-oil heaters are normally provided for most applications to aid starting. Either injection or glow plugs may also be required for combustion air temperatures significantly below 0 degrees C 32 degrees F. Consult manufacturers for availability and need in the application size range.

****

2.13.3.1 Jacket-Coolant Heaters

Mount a thermostatically controlled electric heater in the engine coolant jacketing to automatically maintain the coolant within ñ10 deg of the control temperature. Operate the heater independently of engine operation so that starting times are minimized, condensation is controlled, and the system ensures dependable, cold weather starts. Power supply for the heaters will be [_____] volts AC.

2.13.3.2 Glow Plugs

Design glow plugs to provide sufficient heat for fuel combustion within the cylinders to guarantee starting at an ambient temperature of -23 degrees C -20 degrees F.

[2.13.3.3 Lube Oil Heaters

Mount a thermostatically controlled electric heater in the engine lube oil storage tank to automatically maintain the lube oil within ñ10 deg of the control temperature. Operate the heater independently of engine operation so that starting times are minimized and the system ensures dependable cold weather starts. Select heaters so that heater skin temperatures do not exceed 150 degrees C 300 degrees F and have maximum heat densities of 0.02 W/mm square 13 W/inch square. Power supply for the heaters will be [_____] volts AC.

]2.14 SAFETY SYSTEM

Provide and install all system items, such as devices, wiring, remote annunciator panels, and alarm panels, as a complete system to automatically activate the appropriate signals and initiate appropriate safety actions. Provide safety system with a self-test method to verify its operability. Provide alarm signals with manual acknowledgment and reset devices. The alarm signal systems must reactivate for new signals after acknowledgment is given to any signal. The systems must be dealt with as an alarm on that system element. Provide remote annunciator panels and alarm panel as specified in paragraph PANELS.

2.14.1 Audible Signal

****

NOTE: High dB levels are required for audible alarms located near an engine. Audible signaling devices with sound levels in excess of 100 dB should be specified for engine room application, and the alarm location should be shown on the plans.

****

The audible alarm signal must sound at a frequency of [70] [_____] Hz at a volume of [75] [_____] dB at 3.1 m 10 ft. The sound must be continuously activated upon alarm and silenced upon acknowledgment. Provide signal locations as shown on the plans.

2.14.2 Visual Signal

The visual signal must be a panel light. Ensure the light is normally be off but activates to blinking upon alarm. The light must change to continuously lit upon acknowledgment. If automatic shutdown occurs, the display must remain in an activated status to indicate the cause of failure and must not reset until the cause of alarm has been cleared and/or restored to the normal condition. Shutdown alarms must be amber.

2.14.3 Alarms and Action Logic

2.14.3.1 Shutdown

Use shutdown signals to simultaneously activate the audible signal, activate the visual signal, and stop the engine.

2.14.3.2 Problem

Use problem signals to activate the visual signal.

2.14.4 Alarm Panel

Fabricate and locate the panel as specified in paragraph PANELS, and contain the following functions:

FUNCTION OR INDICATION/CONTROL ACTION (AUXILIARY ACTION)

a. Red emergency stop (push button or switch)/shutdown engine.

b. Day tank overfill indication (95 percent volume)/problem (shutdown pump supplying fuel to day tank).

b. Panel-mounted detonation sensing system with alarm and shutdown lights. The detonation system will sense individual cylinder detonation and individually adjust cylinder timing to avoid detonation. The system must be programmable by standard PC with software and operating manual supplied at no additional charge. The system installed must have the capability of up to 30 crankshaft degrees of total timing variation for each cylinder. Beyond a programmed limit, the system will act to shut down the engine.

c. Engine overspeed indication (overspeed indication point as recommended by the engine supplier)/shutdown engine.

d. High lube-oil temperature indication (temperature as submitted)/shutdown engine.

e. Low lube-oil pressure indication (pressure as submitted)/shutdown engine.

f. High coolant fluid outlet temperature indication (temperature as submitted)/shutdown engine.

g. Pre-low lube-oil pressure indication (110 percent of low lube-oil pressure)/problem (none).

h. Pre-high coolant fluid temperature indication (5 degrees C 10 degrees F lower than high coolant-fluid outlet temp. alarm)/problem (none).

i. Pre-high lube oil temperature indication (5 degrees C 10 degrees F) lower before problem (none).

j. Day tank empty indication (20 percent volume remaining)/shutdown engine.

j. Crankcase pressure switch (adjustable) to detect crankcase pressure increase associated with scoring of liner and possible short term catastrophic failure. Shutdown with setpoint as submitted. Setpoint of the crankcase pressure switch is to be adjusted during start-up to provide close tolerance protection without nuisance tripping.

k. Failure to start within the specified time indication/problem (none).

[l. Compressed air low-pressure indication (80 percent of working pressure)/problem (none).

][m Engine battery voltage-low/problem (none).

][n. Engine battery voltage-high/problem (none).

][o. Engine battery charger malfunction/problem (none).]

2.14.5 Time-Delay on Alarms

For startup of the engine, install time-delay devices bypassing the low lubricating oil pressure alarm during cranking[and the low coolant-fluid outlet temperature alarm]. The lube-oil time-delay device must return its alarm to normal status after the engine starts.[The coolant time-delay device must return its alarm to normal status 5 minutes after the engine starts.]

[2.14.6 Remote Alarm Panel

****

NOTE: The remote alarm panel location should be shown on the plans. Delete requirements for the remote alarm panel where it is not used. The remote panel may be furnished loosely and unmounted, to be installed on the pump station control console by others.

****

Provide a remote alarm panel with 100 percent functional redundancy to the alarm panel.[Locate amd mount the remote panel as shown on the plans.] [Pack and ship the remote panel as directed by the Contracting Officer for installation by others on the station control console.]

]2.15 GOVERNOR

Provide each engine with a governor to control the rotational speed of the engine in response to changing load requirements. Configure the governor for safe manual adjustment of the speed during operation of the engine, without special tools.

2.15.1 Speed Regulating Governor

Maintain close speed regulation under all load conditions. Do not allow the speed variation to exceed 6 percent of normal speed when full load is suddenly applied or removed. Design the governor such that the engine speed may be changed by governor adjustment during engine operation to any speed between 80 and 100 percent of the normal speed (corresponding to normal operating pump speeds) within 2 percent. The speed fluctuation at any load is not allowed to exceed 2 percent. Mount a raise/lower speed control on the engine instrument board.[Provide speed adjust control with provisions for allowing control of the speed control circuits from a remote location.] Provide engine fuel rack servomotor suitable for operation from a 120-V AC source.

2.15.2 Emergency Overspeed Governor and Load Limit

****

NOTE: If the pump drive is out of service for extended periods with little or no maintenance, then the shutdown mechanisms for overspeed should prevent both fuel and air supplies from entering the cylinders. If the units are well maintained and used frequently, either type termination should work satisfactorily.

****

Provide an emergency governor with overspeed trip on each engine to shutdown the unit should the speed exceed a predetermined RPM. Also provide an alarm signal for remote indication. The emergency governor must be independent of the regulating governor. When the overspeed stop has been tripped, the shutdown mechanisms must be such that the engine fuel[and][or] air supply is prevented in the shortest time practicable from entering the engine cylinders. The trip mechanism may be part of the governor. Set the overload fuel limit at 110 percent of the full load as specified in paragraph FUEL PUMP.

2.15.3 Governor Controls Location

Locate governor control at a point convenient to the location of the engine instrument board as shown on the plans.

2.16 ENGINE INSTRUMENT BOARD

****

NOTES: All panels (including the engine instrument board), except the remote panel, can be combined. Delete the pyrometer devices for engines smaller than 1,000 kW 1,340 hp. See paragraph PYROMETER.

Use the first subparagraph "f" and first subparagraph "g" if diesel engines are specified; use the second subparagraph "f" and second subparagraph "g" if natural gas fueled engines are specified.

****

Provide engine instrument board as specified in paragraph PANELS, and contain the following items:

a. Coolant-fluid inlet temperature display

b. Lubricating-oil pressure indicator

c. Lubricating-oil inlet temperature display

d. Red emergency stop (push-button or switch)

e. Run-time meter

f. Fuel meter display

g. Fuel-header-pressure display

h. Manifold vacuum display

i. Intake air temperature display

j. Tachometer display

k. Engine start-stop switch

l. Start-attempt indicator light

m. Lubricating-oil prelubricating pump start-stop switch

n. Alarm panel

[o. Pyrometer display with selector switch]

****

NOTE: The following instrumentation may be included on the engine instrument board.

****

[p. Ammeter for starting battery charger

][q. Voltmeter for starting battery

][r. Timer for setting the starting battery charger's equalize charging rate duration

][s. Air starting system pressure]

2.17 PANELS

****

NOTE: All panels (including the engine instrument board), except the remote panel, can be combined into a single panel paragraph. Provide a panel-mounting location and detail for panels not mounted on the engine base. The designer may elect other locations such as adjacent to the engine, etc. Provide panel nameplate and instrument nameplate, unique identifiers, or user-preferred

identifiers. Provide sizes, materials, and attachment preferences.

Delete either the analog or electronic instruments paragraph option.

****

Each panel must be of the type and kind necessary to provide specified functions. Mount panels [on the engine base by vibration/shock absorbing type mountings][as shown on the plans]. Mount instruments flush or semiflush. Provide convenient access to the back of panels to facilitate maintenance. Calibrate instruments using recognized industry calibration standards. Provide a panel identification plate which clearly identifies the panel function as indicated on each panel. For each instrument and device on the panel, provide a plate which clearly identifies the device and its function as indicated. Ensure all instruments and devices are vibration resistant.

2.17.1 Enclosures

Design enclosures for the application and environment, conforming to NEMA ICS 6. Locking mechanisms [are optional] [must be keyed alike].

2.17.2 [Analog] [Electronic]

****

NOTE: Select appropriate alternative paragraph.

****

[Provide analog electrical indicating instruments in accordance with ANSI C39.1 with semiflush mounting. Panel-mounted instruments must [be the manufacturer's standard][have 100-deg scales] with an accuracy of no less than 2 percent. The instrument's operating temperature range must be -20 to +65 degrees C -4 to +150 degrees F.]

[Provide electronic indicating instruments that are 100 percent solid state, state-of-the-art, microprocessor controlled to provide all specified functions. Ensure control, logic, and function devices are compatible as a system, sealed, dust and water tight, and utilize modular components with metal housings and digital instrumentation. Provide an interface module to decode serial link data from the electronic panel and translate alarm, fault, and status conditions to a set of relay contacts. Ensure instrument accuracy is no less than 2 percent for unit mounted devices, and 1 percent for control room, panel mounted devices, throughout a temperature range of -20 to +65 degrees C -4 to +150 degrees F. Data display must utilize LED or back-lit LCD. Additionally, the display must provide indication of cycle programming and diagnostic codes for troubleshooting. Use a numeral height of [13 mm1/2 inch] [[_____] mminch].]

2.17.3 Parameter Display

Provide continuous indication of the tachometer, lubricating-oil pressure, and safety system parameters. Specify a momentary switch for other panels.

2.18 BASE

****

NOTES: The diesel-engine pump drive can be equipped so that it has its own base, or it can be on an

integral base with the pump and speed reducer. With an integral base, coordination with the other equipment specifications and the use of the statement, "suitable holes for anchor bolts", should be included in the plans and specifications.

Coordinate with the subparagraph VIBRATION ISOLATION AND SEISMIC RESTRAINTS under paragraph SPECIAL LIMITATIONS.
****

Construct the base of structural steel. Design the base to rigidly support the engine, ensure permanent alignment of all rotating parts, arrange to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. Do not permit skidding in any direction during installation. Mitigate and withstand the effects of synchronous vibration of the engine and pump. Provide base with [suitable holes for anchor bolts] [[_____] mm inch diameter holes for anchor bolts]. Ensure the entire engine assembly is capable of withstanding the load imposed by earthquake forces.

2.19 MOTORS

Provide electric motors conforming to the requirements of NEMA MG 1. Provide motors with sealed ball bearings and a maximum speed of 1,800 rpm. Provide motors with drip-proof frames; ensure alternating current motors larger than 373 W 1/2 hp are of the squirrel-cage induction type for operation on [_____] V, [50] [60] Hz, three-phase AC power. Provide alternating current motors 373 W (1/2 hp) or smaller, that are suitable for operation on 120 V, [50] [60] Hz, single-phase, AC power. Use direct current motors that are suitable for operation on [125] [_____] V DC. Provide motor controllers and starters conforming to the requirements of NFPA 70 and NEMA ICS 2.

2.20 PAINTING

Clean, prime, and paint the engine and the accessory equipment including, but not limited to, panels, valves, piping, intake, and exhaust system components [in accordance with the manufacturer's standard color and practice] [as specified in Section [09 90 00 PAINTS AND COATINGS] [09 97 02 PAINTING: HYDRAULIC STRUCTURES].]

2.21 FACTORY INSPECTION AND TESTS

Prior to shipment, inspect and test each engine at the factory in the presence of the Contracting Officer or the authorized government representatives. Inspect and test all components including, but not limited to, governors, instrumentation panels, engine starting system, intake and exhaust, lubrication system, cooling system, and fuel system. Complete inspection and make all necessary repairs prior to testing. Unless otherwise directed by the Contracting Officer or the authorized government representative, perform the following factory tests:

a. Simulated emergency or overspeed trip test.

b. Sustained operation test of 4 hr at rated full load.

c. Sustained operation test of 2 hr at 70 percent of rated full load.

d. Fuel consumption tests of not less than 1 hr each at 70 and 100 percent rated full load, respectively, using [the type of diesel fuel specified][natural gas].

e. Operate engine at no load to demonstrate that the governor and its associated engine manifold shutoff valve function properly.

f. Take test data at 30-min intervals and record on the manufacturer's dieselnatural gas fueled engine test data sheets. The test data sheets must provide entries for all data required for the evaluation of diesel natural gas fueled engine performance including noise and vibration. Subbmit test data for approval as required in paragraph SUBMITTALS. Do not ship engine until the test data has been approved by the Contracting Officer.

PART 3 EXECUTION

3.1 EXAMINATION

Before performing any work, visit the installation site and verify all details of the work. For new construction, review plans and elevations for adequacy and notify the Contracting Officer in writing of any discrepancies.

3.2 INSTALLATION

****

NOTE: Provide an equipment layout on the plans which allow clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Include requirements for staging and a laydown area for disassembly or removal and replacement of major parts of the engine. Additionally, it is advisable to provide access to remove the unit and/or major parts of equipment from the engine room and the building through either doors/passageways or equipment hatches. For large units, specify a bridge crane of an adequate capacity as recommended by the engine manufacturer.

****

Coordinate the installation of the equipment furnished under this section and related pumps and gear reducers under other sections and install in accordance with the approved installation procedures. Submit a copy of the manufacturer's installation and alignment procedures, including a detailed description of the manufacturer's recommended break-in procedure.

3.3 PIPING INSTALLATION

Do not allow any section of pipe within a building to exceed 6 m 20 ft in length between flanged fittings. Except where otherwise specified, utilize flanged fittings to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Make connections to all equipment with flexible connectors and isolation valves. Bend pipe with pipe benders, and ensure no malformation is visible on bent pipe. Properly flash pipes extending through the roof. Support piping and permit to expand and contract without damage to joints or hangers. Install drain valves of 15 mm 0.6 inch at each low point in the piping.

3.3.1 Supports

Provide hangers, inserts, and supports of sufficient size to accommodate any insulation and conform to MSS SP-58. Space supports in accordance with ASME B31.1. Do not attach piping supports to metal decking. Do not attach supports to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

3.3.1.1 Ceiling and Roof

Support exhaust piping with appropriate sized Type-41 single pipe roll and threaded rods; support all other piping with appropriately sized Type 1 clevis and threaded rods.

3.3.1.2 Wall

Make wall supports for pipe by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

3.3.2 Flanged Joints

Provide Class 125 type flanges, drilled, and of the proper size and configuration to match the exhaust outlet of the engine. Ensure flanged joints are gasketed and made to be square and tight.

3.3.3 Cleaning

After fabrication and before assembly, manually wipe clean all piping interiors of all debris.

3.3.4 Pipe Sleeves

Fit pipes passing through construction such as ceilings, floors, or walls with sleeves. Extend each sleeve through and securely fasten in its respective structure and cut flush with each surface. Build the structure tightly to the sleeve. The inside diameter of each sleeve must be a minimum of 15 mm 0.6 inch larger than the outside diameter of the passing pipe or pipe covering, and where pipes pass through combustible materials, 25 mm 1 inch larger than the outside diameter of the passing pipe or pipe covering.

3.4 ELECTRICAL INSTALLATION

Electrical installation must comply with NFPA 70, IEEE C2, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide vibration isolation for all conduit, cable trays, and raceways attached to the engine.

3.5 ONSITE INSPECTION AND TESTS

Perform the tests outlined in the subsequent subparagraphs after complete installation of each engine and its associated equipment and in accordance with the approved Dynamic Analysis of Engine, Pump, and Governor. Include supporting calculations with the Dynamic Analysis submittal.

Record data taken during runs at 30-min intervals and include all available pressure and temperature data which is monitored by the instrumentation furnished with the engine.

3.5.1 Instruments

Verify readings of items such aspanel gauges, meters, displays, and instruments provided under the specification during all test runs by test instruments of greater precision and accuracy than the operational equipment. Calibrate instruments used in the tests by a recognized standards laboratory within 30 days prior to testing.

3.5.2 Sequence

Follow the sequence outlined in subsequent paragraphs. Make measurements and record all parameters necessary to verify that each engine meets specified parameters. If the results of any of the test sequences are not satisfactory, make adjustments or replacements and repeat the test sequence until satisfactory results are obtained.

3.5.2.1 Piping Test

a. Flush lube-oil and fuel-oil piping with the same type of fluid intended to flow through the piping, until the out-flowing fluid is free of obvious sediment and emulsions.

b. Hydrostatically pressure test the lube oil, fuel-oil and coolant piping [and piping and pressure vessels of the air starting system] at 150 percent of the maximum anticipated working pressure, but in no case less than 1.03 MPa 150 psig for a period of 2 hr to demonstrate the piping has no leaks. If piping is to be insulated, perform the test before the insulation is applied.

Submit certificates of compliance for pressure vessels including official, signed statements from the fabricators of heat exchangers and expansion tanks associated with the engine cooling system certifying compliance with ASME BPVC SEC VIII D1.

3.5.2.2 Initial Inspection

a. Visually inspect and check engine mounting bolts for proper application and torque.

b. Demonstrate correct functioning of the high and pre-high lubricating oil temperature circuit by removing the temperature-sensing elements from the engine and immersing the elements in a vessel containing controlled-temperature hot oil and recording the temperature at which the elements activate.

c. Demonstrate correct functioning of the high and pre-high coolant-fluid outlet temperature circuit by removing the temperature-sensing elements of the circuit from the engine and immersing the elements in a vessel containing controlled-temperature hot coolant-fluid and recording the temperature at which the elements activate.

3.5.2.3 Electric Protective Device Tests

Visually and mechanically inspect, adjust, test, and calibrate protective devices in accordance with the manufacturer's published instructions. Document device ratings, settings, and other operational data.

3.5.2.4 Safety Run Test

Should there be insufficient water available to operate the plant and to perform the engine tests, the Contracting Officer may delay the test for up to 9 months. The safety run test consists of the following sequence of tests:

a. Start the engine, record the starting time, and perform all of the engine manufacturer's recommended after-starting checks and inspections following a reasonable warm-up period.

b. Operate engine for at least 2 hr at 75 percent rated speed.

c. Verify proper operation of all controls.

d. Verify proper operation and set points of all gauges and instruments. Record setpoints.

e. Verify proper operation of all ancillary equipment.

f. Activate manual emergency stop switch and record the time to stop the engine.

g. Start the engine, record the starting time, perform and record the engine manufacturer's after-starting checks and inspections, and operate the engine for at least 15 min at 75 percent of rated speed.

h. Manually adjust the governor to increase engine speed past the overspeed limit. Record the engine RPM at shutdown.

[i. Mnaually fill the day tank to a level above the overfill limit. Record the level at which the overfill alarm activates. Verify shutdown of the fuel transfer pump. Drain the day tank below the overfill limit following the test.]

j. Remove the time-delay low-lube oil pressure alarm bypass temporarily from the engine safety circuits and make an attempt to start the engine. Record the results.

k. Attach a manifold to the engine oil system containing a shutoff valve in series with a connection for the engine's oil pressure sensor, followed by an oil pressure gauge, ending in a bleed valve. Move oil pressure sensor from the engine to the manifold and temporarily seal its normal location on the engine. Place the manifold shutoff valve in the open position and close the bleed valve.

l. Start the engine, record the starting time, perform and record the engine manufacturer's after-starting checks and inspections, and operate the engine for at least 15 min at 75 percent of rated speed.

m. Close the manifold shutoff valve. Slowly bleed off the pressure in the manifold through the bleed valve while observing the pressure gauge. Record the pressure at which the engine shuts down. Capture oil spillage from the bleed valve in a container. Refill oil system, remove the manifold, and reinstall the engine's oil pressure sensor on the engine following the test.

n. Start the engine, record the starting time, perform and record the engine manufacturer's after-starting checks and inspections, and operate the engine for at least 15 min at 100 percent of rated speed. Record the maximum sound level in each frequency band at a distance of 22.9 m 75 ft from the end of the exhaust piping directly along the path of discharge for horizontally discharged exhausts. Record the maximum sound level in each frequency band at a distance of [22.9 m 75 ft] [10.7 m 35 ft] from the silencer at 45 deg apart in all directions around the unit.

[o. Slowly drain the fuel from the day tank to lower the fuel level below the no fuel level limit and record the level at which the audible alarm sounds. Add the fuel back to the day tank, filling it above the low level alarm limit following the test.]

3.5.2.5 Final Inspection

a. Remove the lube-oil filter and examine the oil and filter by the engine manufacturer for excessive metal, abrasive foreign particles, and other indications of engine distress. Verify any corrective actions for effectiveness by running the engine for 8 hr at full rated speed, then re-examine the oil and filter.

b. Inspect the engine and check all engine mounting bolts for tightness and visible damage.

3.6 MANUFACTURER'S FIELD SERVICE

3.6.1 Onsite Training

****

NOTE: Delete video taping if not required.

****

Conduct training courses for the plant operating staff as designated by the Contracting Officer. The training period consists of a total of [_____] hr of normal working time and commence after the system is functionally completed, but prior to final acceptance. Cover pertinent points involved in operating, starting, stopping, and servicing the equipment, as well as all major elements addressed in the operations and maintenance manuals. Additionally, include demonstrations and instruction in all routine maintenance operations including oil change, oil filter change, air filter change, etc. [Submit two [CD] [DVD] copies of the entire training session.]

Submit a letter giving the proposed date for conducting the onsite training course[and][,] the agenda of instruction [, a description of the video taping service to be provided, and the kind and quality of the tape].

3.6.2 Field Engineer

Furnish a qualified engineer to supervise the complete installation of the engine, assist in performance of the onsite tests, and instruct personnel regarding operational and maintenance features of the equipment. Submit certification that the field engineer is qualified to perform the functions.

3.7 FIELD PAINTING

Perform field painting as specified in Section [09 90 00 PAINTS AND COATINGS] [09 97 02 PAINTING: HYDRAULIC STRUCTURES].

3.8 MANUFACTURER'S PUBLISHED INSTRUCTIONS

Post instructions, including wiring and control diagrams showing the key mechanical and electrical control elements and a complete layout of the entire system. The instruction set must be weatherproof, laminated in plastic, framed, and posted at a location as directed.

3.9 ACCEPTANCE

Final acceptance of the engine will not be made until the Contractor has successfully completed all tests, corrected all defects in installation material, and/or installation procedures, and all deficiencies identified in on-site testing or routine operation have been corrected.

3.10 CLOSEOUT ACTIVITIES

3.10.1 As-Built Drawings

Submit As-Built Drawings accurately depicting the as-built configuration of the supplied, installed, and accepted dieselnatural gas fueled engine pump drive.

3.10.2 Operation and Maintenance Manual

Also submit an Operation and Maintenance Manual for the dieselnatural gas fueled engine detailing start-up and operating procedures, lubrication instructions, installation and alignment procedures, routine maintenance requirements and procedures, complete detailed procedures for disassembly and reassembly of the engine, parts list for all parts detailed, assembly plans of the engine showing all parts, suppliers for all parts, settings and adjustment for protective devices, and a list of all tools, handling devices, and spare parts furnished.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-43 11 00.10 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-43 11 00 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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SECTION 43 11 00.10

OFF-GAS FANS, BLOWERS AND PUMPS

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PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-43 11 00.10 (May 2020)**

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****

SECTION 43 11 00.10

OFF-GAS FANS, BLOWERS AND PUMPS

05/20

****

NOTE: This guide specification covers the requirements for fans, blowers or vacuum pumps and drive units.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: On many hazardous, toxic, radioactive waste (HTRW) projects, the Contractor is required to treat air or off-gas, as well as furnish the equipment. Measurement and payment and unit pricing may be necessary to cover treatment costs.

When it is determined that lump sum contract is advisable this paragraph will be deleted.

****

Measurement and payment will be based on completed work performed in accordance with the drawings, specifications, and the contract payment schedules. No additional payment will be made for installation, calibration or commissioning of the equipment.

1.1.1 Measurement

Volume of [air supplied] [off-gas treated] will be determined by initial and final meter readings.

1.1.2 Payment

Payment will be made for volume of [air supplied] [off-gas treated] at the contract unit price per actual cubic meter foot. Payment will include the furnishing of testing, plant, labor, and material and incidentals necessary to complete the work, as specified and as shown.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings

ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 2098	(2016) Industrial Ventilation: A Manual of Recommended Practice for Design

AMERICAN GAS ASSOCIATION (AGA)

AGA ANSI B109.2	(2000) Diaphragm Type Gas Displacement Meters (500 cubic ft./hour Capacity and Over)

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6011	(2014J) Specifications for High Speed Helical Gear Units

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.40	(2024) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes
ASME PTC 25	(2023) Pressure Relief Devices

ASTM INTERNATIONAL (ASTM)

ASTM D4167	(2015) Fiber-Reinforced Plastic Fans and Blowers

ASTM F1139	(1988; R 2024) Steam Traps and Drains
ASTM F1508	(1996; R 2021) Standard Specification for Angle Style, Pressure Relief Valves for Steam, Gas, and Liquid Services

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA MC96.1	(1982) Temperature Measurement Thermocouples

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250	(1991) Calibration Services Users Guide

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

WATER ENVIRONMENT FEDERATION (WEF)

WEF MOP 11	(2017) Operation of Water Resource Recovery Facilities

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detailed Drawings; G, [_____]

Detailed Process Flow Diagrams; G, [_____]

Piping and Instrumentation Diagram; G, [_____]

Control System; G, [_____]

SD-03 Product Data

Flame Arrestor; G, [_____]

Instrumentation; G, [_____]

Air Moving Equipment; G, [_____]

Variable Speed Controls; G, [_____]

Field Training

SD-06 Test Reports

Field Testing

SD-07 Certificates

Air Moving Equipment

Manufacturer's Representative

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

1.4 QUALITY ASSURANCE

1.4.1 Contractor

Contractor must have a minimum of [2] [3] [5] [_____] years of experience in the construction of systems for handling sour gas, condensable gas, off-gas or vapor.

1.4.2 Single Source Supplier

Assign to a single supplier full responsibility for the furnishing of the off-gas moving system. The designated single supplier, however, need not manufacture the system but must coordinate the selection, assembly, installation, and testing of the entire system as specified herein.

1.4.3 Manufacturer's Representative

Provide the services of a manufacturer's field service representative who is experienced in the installation of the equipment furnished and who has complete knowledge of the proper operation and maintenance of the system. Submit the names and qualifications of the manufacturer's representative and training engineers, and certification from the manufacturer that the representative and trainers are qualified in the appropriate technical areas.

1.4.4 Detailed Drawings

Submit detailed drawings including location of components, layout and anchorage of equipment and appurtenances, equipment relationship to other parts of the work, clearances for maintenance and operation of the off-gas system and subsystems. Drawings must be to the approved scale.

1.4.5 Detailed Process Flow Diagrams

Submit detailed process flow diagrams and data including, but not limited to: air and off-gas stream flows, direction of flow, range of flow rate and range of composition, identified by lines and arrows denoting the direction and destination of the flow; material, mass and energy balances for the entire air and off-gas system; subsystem equipment, operating capacity and operating conditions; blowers and pumps, valves and other in-line devices; sizes of conveying devices (pipe, ducts, etc.); number of parallel components or lines.

1.4.6 Piping and Instrumentation Diagram

Submit a piping and instrumentation diagram indicating: process equipment; instrumentation; piping and valves; stacks, vents and dampers; control equipment (including sensors, process controllers, control operators, valves, interlocks, and alarms); labels and other necessary information to correlate to the process flow diagram. Include blowers and pumps, valves and other in-line devices.

1.5 PARTNERING/PRE-INSTALLATION MEETING

****

NOTE: Remove this paragraph when meeting is not required.

****

[Partnering] [Pre-installation] meeting will be required. Ensure that involved subcontractors, suppliers, and manufacturers are [notified] [represented]. Furnish the date and time of the meeting to the Contracting Officer for approval.

1.6 DELIVERY, STORAGE, AND HANDLING

Store in a clean, dry location equipment delivered to the site and designated for storage; cover the equipment for protection against dust and moisture. For equipment stored longer than 60 days, suspend silica bags in the outlet and inlet of unit, fill bearings full of grease, fill unit with oil, coat machine surfaces with grease, and enclose entire unit with plastic or tarps. Turn shaft of rotating equipment, including motors, every two weeks to prevent flat spots on bearings.

1.7 SEQUENCING AND SCHEDULING

****

NOTE: Coordinate with the appropriate air pollution control equipment. The temperature increase induced by the air moving equipment may affect the materials selected in other Sections of the contract. Review the table of contents to assure that appropriate specifications have been included.

****

Details of and requirements for [stack] [vapor injection] [vapor extraction well construction] [_____] and treatment equipment are included in other sections of this specification. Notify the Contracting Officer of any deviations from head conditions specified for the source and discharge to ensure coordination with this Section. Provide pipe and valves not specified in this Section in accordance with Section 31 21 00 OFF-GASSING

MITIGATION.

1.8 EXTRA MATERIALS

****

NOTE: This paragraph covers items to be furnished to the Government by the Contractor for future maintenance and repair. Items that might be difficult to obtain because of color or pattern match, or spare parts needed to ensure continued operation of critical equipment should be included. Specifications should identify the items, state the quantities required, and indicate to whom, when, and where items are to be delivered. Insert text as required or remove this paragraph.

****

Deliver auxiliary equipment, tools and spare parts at the same time as the equipment to which they pertain. Protect and safeguard the equipment, tools and parts until completion of the work, at which time deliver them to the Contracting Officer. Furnish auxiliary equipment and spare as follows:

a. Spare parts for each different item of material and equipment specified including the parts recommended by the manufacturer to be replaced after [1] [and] [3] [year] [years] service.

b. For each air mover: one extra of each part used that is made from glass, hard rubber, or clear plastic; one complete set of gaskets; [4] [_____] air intake filter replacement cartridges.

c. Provide one complete set of special tools, calibration devices, and instruments [as recommended by the manufacturer for field maintenance of the system] [as required for operation, calibration, and maintenance of the equipment]. Special tools are considered to be those tools which, because of their limited use, are not normally available but which are necessary for the particular equipment. Special tools must be high-grade, smooth, forged, alloy, tool steel.

d. One or more [tool boxes] [tool boards] [steel tool cases] complete with flat key locks, two keys, and clips or hooks to hold each special tool mounted [in the equipment room] [on the wall in a convenient location] [as directed by the Contracting Officer].

e. One [pressure] [lever type] grease gun or other lubricating device for each type of grease required.

f. [_____] sheaves of differing diameter covering the range of operation of belt driven equipment.

g. [_____].

1.9 MAINTENANCE SERVICE

****

NOTE: This paragraph covers provisions for maintenance service as applicable to critical systems, equipment, and landscaping. Insert text as required or remove this paragraph.

****

Maintenance service includes [_____].

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

****

NOTE: Determine design wind speed from ASCE 7-16 or UFC 3-301-01. Use 161 km/h 100 mph minimum. Use 1.2 kPa 25 psf snow load for most heavy snow climates; delete snow load where maximum snow is not a factor. In some cases, local climates and topography will dictate that a value greater than 197 Pa 25 psf be used for snow loading; this may be determined from ANSI A58.1, local codes, or by research and analysis of the effect of local climate and topography. Coordinate with paragraph Seismic Requirements in PART 3.

****

Ensure capacity and design of the air moving equipment and accessories is suitable for 24-hour full load service in an [outdoor] [indoor] [_____] location, and meets the following criteria.

Design Life	
Minimum	[_____] years
Altitude (above MSL)	
Minimum	[_____] m ft
Barometric pressure	
Maximum	[_____] kPa in Hg
Minimum	[_____] kPa in Hg
Ambient air temperature	
Maximum	[_____] degrees C F
Minimum	[_____] degrees C F
Seismic parameters	[_____]
Soil bearing capacity	
Maximum	[_____] MPa psf
Wind speed	
Maximum	[_____] km/h mph

Ground snow load	
Minimum	[_____] kPa psf
i. Air relative humidity	
Maximum	[100+] [_____] percent
Minimum	[_____] percent

2.1.2 Selection Criteria

****

NOTE: Requirements included here may limit the selection of specified equipment.

****

Design air moving equipment using criteria based upon actual model developmental test data, and select it at a point within the maximum efficiency for a given impeller/casing combination. Deviations within [10] [5] [3] percent of maximum efficiency are permissible. Air moving equipment having impeller diameters larger than [90] [95] percent of the published maximum impeller diameter for the casing, or less than [15] [10] [5] percent larger than the published minimum impeller diameter for the casing, will be rejected. Do not base acceptable maximum impeller diameter calculations on percentage of impeller diameter range for a given casing.

2.1.3 Performance Requirements

****

NOTE: Provide required information for each air mover identified on the drawings. Co-ordinate with PART 2 and delete inapplicable requirements. Verify that more than one manufacturer's product can meet the efficiency requirement, ideally more than three.

****

Equipment identification number [_____] must be [appropriate for the capacity requirements of this paragraph] [a fan] [a blower] [a vacuum pump] [_____]. [Standard] [Actual] output volume must be a minimum of [_____] cubic meters/second cfs at a [minimum inlet] [minimum positive discharge] pressure of [_____] kPa feet of water [gage] [actual] [positive] [vacuum]. The minimum efficiency must be [_____] percent under the stated conditions.

2.1.4 Service Conditions

****

NOTE: Delete chemical data if the equipment is designed to deliver a fresh air supply. Standard materials will be adequate.

****

Service [air supply to] [vapor collected from] [municipal landfill] [hazardous waste landfill] [petroleum spill] [subsurface remediation unit] [air stripper]. Anticipated contaminant concentration in the [air] [vapor] [off-gas] is:

[_____]	[_____] ug/L Maximum
	[_____] ug/L Average
pH	[_____] Minimum
	[_____] Average
	[_____] Maximum
Sulfide	[_____] mg/L Maximum
	[_____] mg/L Average
Ammonia	[_____] mg/L Maximum
	[_____] mg/L Average

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate equipment that has been in satisfactory operation at least [2] [_____] years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Ensure pieces of equipment of the same types are products of the same manufacturer. Provide new and unused equipment, except for test equipment. Materials may be reprocessed/recycled with equivalent durability and product warranty/guarantee.

2.2.2 Nameplates

Provide each piece of equipment with a standard nameplate securely affixed in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, the nameplate for each air moving unit must show the capacity in standard cubic meters/second feet per minute (SCFM) at rated speed in rpm and head in kPa inches of water. Nameplate for each electrical motor must show, at least, the minimum information required by paragraph 10.38 of NEMA MG 1. Show any other information that the manufacturer may consider necessary to complete identification on the nameplate.

2.3 AIR MOVING EQUIPMENT

****

NOTE: Coordinate these paragraphs with a schedule on the drawings showing the air moving equipment identification number and type and with paragraph Performance Requirements. Delete inappropriate types of equipment or service.

****

Furnish and install air moving equipment complete with drive units, filters, controls and appurtenances indicated or specified. Provide equipment capable of operating at partial-load conditions without increased vibration over the normal vibration at full load operation and capable of continuous operation down to the lowest step of unloading. Provide each unit with unloading, vibration isolators, thermal overloads, high-and-low pressure safety cutoffs, low oil pressure cutout, internal motor-winding temperature sensing protection device, internal pressure relief valve, a complete oil charge, and protection against short cycling. Submit the following:

2.3.1 Capacities and pressure differentials

Make and model with associated performance charts and curves (including the complete selection of impeller sizes for a given casing for centrifugal blowers).

2.3.2 System Layout

Diagrams showing the complete layout of the entire system, including equipment, piping, valves, wiring and control sequence. Condensed operating instructions in typed form explaining preventative maintenance procedures, safe methods of checking the equipment for normal operation, and safe procedures for starting and stopping the equipment. Post diagrams and instructions, framed under glass or in approved laminated plastic, where directed before acceptance testing of the systems.

2.3.3 Component Items List

Complete list of equipment and materials. A listing covering component items forming a system or items that are interrelated and scheduled to be coordinated and submitted concurrently. Schedule certifications to be submitted with the pertinent drawings. Include in the data tabular lists showing location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work.

2.3.4 Manufacturer Testing Certification

Date statements after contract award. State the Contractor's name and address, project and location, and the specific requirements which are being certified. Indicate in the certificate the methods of testing used. In lieu of a certificate, a seal or label from a nationally recognized testing agency will be acceptable as evidence that the equipment conforms to agency requirements.

2.4 FANS

****

NOTE: See Section 1 (Fans and Systems) of AMCA 201 (Fan Application Manual) for additional guidance on selection of fans.

****

Provide centrifugal or propeller type fans as best suited for the application.

2.4.1 Single-Stage

****

NOTE: Fan pressure will vary with fan revolutions per minute (RPM) ratio squared. Single stage

equipment allows flow variation at low end pressure.

Fans are generally divided into two classifications based on the airflow through the impeller. The classes are centrifugal and axial. In axial fans, airflow is parallel to the shaft. Axial fans are most commonly used in low static pressure applications, while centrifugal fans are used at higher static pressures.

****

A single-stage fan is allowable for the capacity range 0.025 to 50 cubic meters/second 53 to 106,000 cfm at pressure ranges from 0.25 to 15 kPa 0.08 to 5 feet of water column.

2.4.2 Industrial Centrifugal

An industrial centrifugal fan is allowable for the capacity range over 45 cubic meters/second 95,000 cfm at pressure ranges from 7.5 to 12 kPa 2.5 to 4 feet of water column.

2.4.3 Pressure Blower

A pressure blower fan is allowable for the capacity range of less than 2.4 cubic meters/second 5,100 cfm at pressure ranges from 10 to 30 kPa 3.3 to 10 feet of water column.

2.4.4 Multiple Stage

****

NOTE: Multiple stages limit volume and develop pressures toward the upper end.

****

A multi-stage pressure blower fan is allowable for the capacity of less than 3.3 cubic meters/second 7,000 cfm at pressure ranges up to 70 kPa 23 feet of water column or vacuum to -40 kPa -13 feet of water column.

2.4.5 Backwards Inclined Impeller

****

NOTE: If the flow is relatively clean, backwards inclined impeller fans should be specified for higher efficiency and quieter operation.

****

A backwards inclined impeller fan is allowable for the capacity range over 190 cubic meters/second 403,000 cfm and pressure ranges from 2.5 to 4.5 kPa 0.84 to 1.5 feet of water column.

2.5 DYNAMIC BLOWERS

****

NOTE: Dynamic blowers should be designed for highest inlet pressure loss and highest inlet air temperature conditions within the design operating range.

****

Provide oil-free dynamic blowers of modular design with the required number of compression stages to comply with the specified operating requirements.

2.5.1 Single Stage Centrifugal

A single stage centrifugal blower is allowable for pressure ranges from 0.25 to 7.5 kPa 0.084 to 2.5 feet of water column.

2.5.2 Regenerative

****

NOTE: Regenerative blowers are compact single or multi-stage centrifugal blowers.

****

A regenerative blower is allowable for capacity up to 5 cubic meters/second 10,000 cfm and pressure ranges of 20 to 60 kPa 6.7 to 20 feet of water column or vacuum up to -35 kPa -12 feet of water column.

2.5.3 Axial Flow

An axial flow blower is allowable for pressure ranges higher than 70 kPa 23 feet of water column or vacuum requirements greater than -40 kPa -13 feet of water column.

2.6 POSITIVE DISPLACEMENT BLOWERS

2.6.1 Rotary Lobe

A rotary lobe blower is allowable for capacity up to 14 cubic meters/second 30,000 cfm at pressures higher than 125 kPa 42 feet of water column or up to 10 cubic meters/second 21,200 cfm at vacuum up to -125 kPa -41.8 feet of water column.

2.6.2 Helical Screw

A helical screw blower is allowable for capacity up to 1 cubic meter/second 2,100 cfm and pressure ranges of 30 to 60 kPa 10 to 20 feet of water column or vacuum up to -35 kPa -11.7 feet of water column.

2.7 VACUUM PUMPS

2.7.1 Dry Rotary Blower

A dry rotary blower vacuum pump is allowed for vacuum flows of 1 cubic meter/second 2,100 cfm at -90 kPa -30.1 feet of water column to 6 cubic meters/second 12,700 cfm at -60 kPa -20.1 feet of water column.

2.7.2 Water-Sealed Rotary Blower

A water-sealed rotary blower vacuum pump is allowed for vacuum flows of 1 cubic meter/second 2,100 cfm at -80 kPa -26.8 feet of water column to 6 cubic meters/second 12,700 cfm at -70 kPa -23.4 feet of water column.

2.7.3 Rotary Vane

A rotary vane vacuum pump is allowed for vacuum flows of 2.5 cubic m/second 5,300 cfm at -100 kPa -33.5 feet of water column to 4.25 cubic m/second 9,000 cfm at -60 kPa -20.1 feet of water column. Include oil injection and outlet demisting systems for each rotary vane vacuum pump.

2.7.4 Liquid Ring

A liquid ring vacuum pump is allowed for vacuum flows of 2.5 cubic m/second 5,300 cfm at -80 kPa -26.8 feet of water column to 8 cubic m/second 16,950 cfm at -60 kPa -20.1 feet of water column. Include water injection systems and outlet water separation systems for each liquid ring vacuum pump.

2.8 CASING OR HOUSING

Provide casing or housing of modular design to permit inspection or removal and replacement of wearing parts. Provide ample clearance between the impeller or blades and casing. Incorporate ribbed construction to resist heat accumulation, deflection and distortion under the specified operating conditions.

2.8.1 Construction Materials

****

NOTE: Three types of spark resistant construction are available for fans as detailed by AMCA 99 (Classification for Spark Resistant Construction). Temperature is limited to 177 degrees C 350 degrees F when using aluminum parts.

Type A - all aluminum fan housing, inlet cone and wheel with a ground and polished steel shaft cover with an aluminum sleeve.

Type B - aluminum wheel and wear plate where shaft passes through the housing.

Type C - aluminum inlet cone and wear plate where shaft passes through the housing.

****

Fabrication must be from [alloy steel] [monel] [316 stainless steel] [304 stainless steel] [heavy gauge hot rolled low carbon steel with continuous welds] [fiberglass in accordance with ASTM D4167]. Construction must be close grain cast [iron] [aluminum Type [A] [B] [C] in accordance with AMCA 99] of uniform quality and free from blowholes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects.

2.8.2 Single Piece Casing

Provide single piece casings with separate head plates.

2.8.3 Horizontally Split Casing

Machine horizontally split casings at the split to maintain the pressure without a gasket.

2.8.4 Vertically Split Casing

Provide vertically split casings consisting of rigid sections secured between inlet and outlet heads by steel tie rods.

2.8.5 Connections

2.8.5.1 Inlet and Discharge Connections

****

NOTE: Threaded and sweat connections should be considered if flange-connected types are not available in small capacity units.

****

Inlet and discharge connections must be ASME B16.1 or ASME B16.5 [Class 125] [125 pound] [_____] drilled and tapped flanges and are an integral part of the head. Connections 75 mm 3 inches in diameter and smaller must be [threaded] [sweat] [_____].

2.8.5.2 Casing Drains

Provide tapped and plugged drains at the low points in the casing.

2.8.5.3 Lifting Eyes

Provide casing with lifting eyes capable of supporting the equipment for installation and maintenance purposes.

2.9 BLADES OR IMPELLERS

****

NOTE: Require non-sparkling impeller material if it is likely that the mixture of air and other gases will be within the explosive limits during the project life.

****

Cast or fabricate blades, vanes or impellers [iron] [aluminum] [aluminum alloy] [fiberglass] [monel] [steel] [carbon steel] [phenolic coated steel] [PTFE coated steel] [304 stainless steel] [316 stainless steel] [non-sparkling material].

2.9.1 Dynamic Impellers

Provide guide or diffuser vanes configured to receive and direct flow to the downstream impeller at the inlet to each centrifugal blower stage. Ensure centrifugal impellers are [open radial bladed] [closed backward bladed]. Butt multiple stage impeller hubs against each other either directly or through one piece metal spacers.

2.9.2 Rotary Lobe Impellers

Provide straight, two-lobe involute type rotary lobe impellers which operate without rubbing, liquid seals, or lubrication.

2.10 SHAFT

Make shaft of accurately machined, ground and polished high grade [ductile iron casting] [alloy steel] [stainless steel] [carbon steel]. Impellers or blade [and shaft must be a common casting.] [assembly must be mounted and keyed to the shaft and secured by a lock nut.] Design must permit inspection or replacement of the [seals] [and] [bearings] without [disconnecting suction or discharge piping] [disassembling the casing].

Design the shaft to operate at below [80] [90] percent of the first critical speed. Provide shaft of sufficient diameter, mass and strength to perform the work required with minimum vibration.

2.11 SEALS, GASKETS AND PACKING

Select gasket and packing material in accordance with WEF MOP 11. Ensure gaskets and seal ratings encompass the maximum pressure or vacuum capacity of the equipment and the ranges of temperature and quality of the off-gas or air.

2.11.1 Shaft Seals

Provide solid carbon mechanical ring shaft seals where the shaft passes through the inlet and discharge heads. Ensure seals are [purged] [or] [non purged], [balanced] [or] [unbalanced] to conform to specified service requirements. Ventilate to the atmosphere on the impeller side of shaft seals to eliminate carry-over of lubricant into the air stream.

2.11.2 Internal Seals

Provide labyrinth seals between blower stages.

2.11.3 Bearing Seals

Provide a [lip type oil] [grease] seal at each bearing to prevent lubricant from leaking into the output. Ventilate to the atmosphere on the impeller side of oil seals to to eliminate any carry-over of lubricant into the air stream.

2.12 BEARINGS

****

NOTE: Verify bearing L-10 life requirements.

****

2.12.1 Shaft Bearings

Support shaft by anti-friction [spherical ball] [roller] bearings designed for both radial and thrust loads and sized for a minimum L-10 life of [30,000 hours] [50,000 hours] [5 years] continuous operation as defined by ABMA 9 or ABMA 11.

2.12.2 Blower Bearings

****

NOTE: Delete inapplicable lubrication methods.

****

Provide each blower with two [pressure, oil lubricated, sleeve type journal] [splash, oil lubricated, anti-friction type] [oil bath lubricated] [grease lubricated] bearings. Bearings must be self-aligning, designed for both radial and thrust loads and sized for an L-10 life of [30,000 hours] [50,000 hours] [5 years] continuous operation as defined by ABMA 9 or ABMA 11. Replace the bearings without disassembling the casing or disconnecting piping.

2.13 DRIVE CONNECTION

****

NOTE: Direct-driven equipment is limited to common synchronous motor speeds (3600, 1800, and 1200 rpm). This equipment is usually noisier than belt-driven equipment because it tends to run at higher speeds. Motors that run slower than 1800 rpm are expensive and not as readily available.

On belt-driven equipment, the speed is increased or decreased by changing pulleys or changing the diameter of adjustable pitch pulleys. On a fixed air moving system, flow rate is directly proportional to speed. The power requirement varies with the cube of the speed. A 25 percent increase in speed raises the flow rate 25 percent, but it almost doubles the power requirement. V-belts are generally used on positive displacement blowers.

****

Each unit must be [close coupled] [directly connected through a flexible coupling] [driven by a V-belt].

2.13.1 Coupling

Provide heavy-duty, flexible forged steel spacer coupling, keyed or locked to the shaft. Disconnect without removing the driver half of the driven unit half of the coupling from the shaft. Machine outside surface of coupling parallel to the axis of the shaft. Machine coupling faces perpendicular to the axis of the shaft.

2.13.2 V-Belt Drive

Design v-belt drive for no less than 150 percent of the driving motor capacity. When belt drive is provided, provide an adjustable sheave to furnish no less than 20 percent speed adjustment. Select sheaves to provide the required capacity at the approximate midpoint of the adjustment. The drive belt must be [covered with an acoustically treated sheet metal guard] [or] [completely enclosed within the unit casing].

2.14 GEARS

Make gears of hardened, helical, alloy steel, manufactured in accordance with AGMA 6011 with a minimum 1.5 service factor applied to full power rating of the motor. [Furnish single speed centrifugal blower with high speed increasing gears.] [Time positive displacement impellers by a pair of machined, heat-treated, spur tooth timing gears.] Mount timing gears on the impeller shafts on a tapered fit and secure by a lock nut.

2.15 LUBRICATION SYSTEM

****

NOTE: Delete inapplicable lubrication systems.

****

Provide [pressure oil lubricated] [splash oil lubricated] [grease lubricated] drive. Provide [pressure oil lubricated] [splash oil lubricated] timing gears and gear end bearings. Lubricate bearings and seals as previously indicated. Design system to prevent leakage and contamination. Design oil-lubrication systems and vents so that oil vapors do not enter the air stream or motor and the shaft bearings will be isolated. Provide each oil reservoir with an opening for filling, an overflow opening with overflow container at the proper location to prevent overfilling, and a drain at the lowest point.

2.15.1 Pressure Oil

Provide console mounted pressure oil lubrication system and include a main oil pump driven by the shaft, an auxiliary electric motor driven oil pump, an oil cooler, an oil [strainer] [or] [filter], oil reservoir with 3-minute minimum retention time, and the switches, temperature and pressure gauges and controls necessary to protect unit. The electric motor driving the auxiliary oil pump must be totally enclosed fan cooled (TEFC), Design Type B in accordance with NEMA MG 1, with Class F insulation and equipped with 120 volts space heaters. Provide control in accordance with NEMA ICS 1. Provide factory piped and wired lubrication system with minimal interconnecting piping between the console and the oil pump required in the field.

2.15.2 Splash Oil

Provide splash lubrication by a slinger on the shaft splashing oil into the bearing whenever the compressor is running. A constant level oiler located on the bearing housing or a metering orifice will be provided to maintain the oil level in the oil reservoir integral with the bearing housing. Provide a sight level gauge in the bearing housing. Provide a labyrinth seal combined with an atmospheric vent to prevent oil contamination of the air stream.

2.15.3 Grease

Equip grease type bearings with grease fittings. Extend grease tubing to a convenient location if fittings are inaccessible. Provide grease fittings which prevent over-lubrication and over-pressurization.

2.16 INTAKE FILTER

Install intake [screen and filter] [filter] on inlet to each unit.

2.16.1 Efficiency

Intake filter must be at least [90] [96] percent efficient when tested in compliance with ASHRAE 52.2 dust spot method. [Provide high volume bag intake filter for filtration down to 5 microns 2 mils on vacuum pump intake.]

2.16.2 Surface Area

Provide a minimum filter surface area of 1 square meter per 0.127 cubic m/second 1 square foot per 25 cubic feet/minute to produce a filter flow through velocity of less than 0.127 m/second 25 feet per minute.

2.16.3 Media

Filter media must be [washable] [or] [disposable] dry type felt material made from [glass fiber,] [polyester,] fiber resistant to moisture and chemicals to which it will be exposed with 25 mm 1 inch pleat separation.

2.16.4 Weather Hood

Coat steel intake hood and filter housings with a chemically resistant coating and ensure entire unit element is resistant to moisture and chemicals to which it will be exposed.

2.17 NOISE MINIMIZATION

****

NOTE: Equipment selection should consider the pressure drop through silencer or muffler.

****

Install flexible connections and silencers, muffler or sound barriers on the equipment [discharge] [inlet and discharge] to attenuate sound level.

2.17.1 Silencer

****

NOTE: Canister type silencers should be considered for attenuation of low frequency sound levels, pressures higher than 5 kPa 20 inches of water and velocities greater than 20 meters per second 4,000 feet per minute. Use high temperature acoustical packing for temperature greater than 122 degrees C 250 degrees F.

****

Provide each blower with [inlet] [and] [discharge] silencers. Use silencers for [standard] [critical] grade silencing. Provide [absorption] [canister] [chamber] type intake silencers. Provide [absorption] [canister] [chamber] [combination chamber-absorption] type discharge silencers. Construct canister type silencer of two concentric perforated cylinders lined with high temperature acoustical packing forming an annular flow path, with an internal plug creating a blocked line of sight. Use silencer size as recommended by the silencer manufacturer and compatible with the blower requirements. Ensure silencer connections match the adjacent piping. Provide mounting brackets as required for silencer support. Construct silencer of heavy-duty rolled and welded steel plate with the inner liner welded to the outer shell to acoustically deaden the outer shell.

2.17.2 Muffler

****

NOTE: Hot-gas mufflers should be considered to effectively minimize the transmission of hot-gas pulsations whenever the noise level is an important consideration.

****

Install hot-gas muffler [on the intake] [on the exhaust] [in-line] to minimize the transmission of hot-gas pulsations.

2.17.3 Acoustical Insulation

Wrap silencers, [interior air piping,] [expansion joints,] [valves,] [and] [drive guards] with 25 mm 1 inch thick high density woven glass fiber mat having a minimum density of 4.6 kg/square meter 15 ounces/square foot and lag with a 0.41 mm 0.016 inch thick aluminum jacket. Provide insulation conforming to EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.17.4 Sound Barriers

****

NOTE: Barriers generally have limited high frequency attenuation.

****

Make sound barriers of insulated ductwork fastened to sheet steel walls. Limit flow velocity parallel to barriers to 1200 m 4000 feet per minute at pressures less than 5 kPa 20 inches of water.

2.18 MONITORING

****

NOTE: On projects with extensive process monitoring and control, replace text with a reference to Section 40 60 00 PROCESS CONTROL.

****

Equip each unit for monitoring the flow downstream of any bypass connections. Calibrate sensors with standards traceable to NIST and in conformance with NIST SP 250.

2.18.1 Flow

[Provide a turbine type flow meter equipped with transmitter and recorder for continuous metering of the process flow. Ensure accuracy is within 0.5 percent of full scale.] [Provide gas meters conforming to AGA ANSI B109.2.]

2.18.2 Temperature

2.18.2.1 Thermometers

Provide thermometers conforming to ASME PTC 19.3 TW with wells and temperature range suitable for the use encountered. Provide thermometers to indicate [inlet air temperature,] [discharge air temperature,] [and] [lubrication oil temperature.] Ensure thermometers are either red-reading mercury-in-glass type or dial type. Scale range must include full range of expected operation and up to 125 percent, but no more than 150 percent of maximum. Ensure accuracy is within 0.5 percent of full scale.

2.18.2.2 Thermocouples

Provide sensors conforming to ISA MC96.1, Type K, and provide downstream of each blower or as otherwise directed. Ensure thermocouple is suitable for continuous operation and control at temperatures up to [_____] degrees C F, accurate to [0.75] [_____] percent of full scale, and long enough to be inserted 150 mm 6 inches into the air flow. Provide thermocouple with an adjustable flange and with a protecting tube suitable for insertion into the air flow without support of the projecting end. Supply compensating lead wire 1.52 mm 16 gauge in diameter and 30 m 100 feet long with a weatherproof braid for connecting the thermocouple to the instrument. The installed unit must indicate gas passage temperatures and activate the high temperature alarm when the set point temperature is exceeded.

2.18.3 Pressure

****
NOTE: Verify the pressure ranges for the system.
****

Provide 6 mm 1/4 inch NPT female high and low pressure connections with a [stainless steel bar stock valve] [suitable shutoff cock] at each connection. [Provide high pressure connection to the gauge with a 10 micrometer 10 micron pleated paper filter and the low pressure connection with a fine mesh stainless steel strainer.] [Provide each pressure connection to the gauge with a snubber.]

2.18.3.1 Draft Gauge

Provide gauge conforming to ASME B40.100 with a diaphragm or bellows actuating system, a circular scale and a zero adjustment screw. Provide inlet gauges with a range of 0 to 7.5 kPa 0 to 30 inches water gauge vacuum. Include the accessories for [control panel] [wall] [pipe] mounting.

2.18.3.2 Pressure Gauge

Provide gauges conforming to ASME B40.100 with a single Bourdon tube style actuating system, a circular scale and a zero adjustment screw. Provide discharge gauges with a range of 0 to 75 kPa 0 to 11 psi. Include the accessories for [control panel] [wall] [pipe] mounting.

2.18.3.3 Differential Pressure Gauge

Equip housing of each unit with a direct-reading gauge that measures the differential pressure range [of 0 to 100 kPa 0 to 14.5 psi with an accuracy of plus or minus 2 percent of full scale, calibrated linearly with 2 kPa 0.34 psi scale graduations] [necessary to operate in conjunction with the corresponding venturi tube]. During operating conditions the pointer must be within the mid-range of the gauge. Ensure accuracy is within 0.5 percent of full scale.

2.18.3.4 Piston Element

Provide piston type element consisting of a spring-supported, corrosion resistant piston moving inside a glass cylinder with an operating pressure of 1.03 MPa 150 psi. Provide cylinder with stainless steel end flanges with Viton O-ring seals and a cylinder burst pressure of no less than 4.15 MPa 600 psi. Construct the gauge such that a 3-valve manifold is not necessary. If only one bar stock valve is closed, do not damage the gauge by up to 2.1 MPa 300 psi differential pressure in either direction.

2.18.3.5 Bellows Element

Install bellows pressure sensing element to measure pressure differential across the air moving equipment and dual opposed, liquid filled, rupture-proof type with bellows movement converted to rotation and transmitted by a torque tube. Provide stainless steel bellows housing with a rated working pressure of no less than 3.5 MPa 500 psi. Use liquid to fill the bellows that is suitable for the expected maximum temperature of the off-gas and the minimum ambient temperature.

2.18.4 Contaminant Monitoring and Sampling

2.18.4.1 Explosimeter

Perform continuous monitoring and recording of percentages of upper and lower explosive limits.

2.18.4.2 Hygrometer

Locate humidity sensor downstream of the heat exchanger or blower.

2.18.4.3 Sampler

Provide sampling port and equipment for collecting discrete and composite samples with adequate access for personnel and equipment.

2.18.4.4 Transmitter

Use transmitter to provide an analog two-wire electrical 4-20 milliamp signal directly proportional to the differential pressure and accurate to within 0.25 percent of sensor indication. Provide transmitter with built-in pulsation damper and suitable over-range protection. Do not require recalibration due to power outages. Transmitter must be UL listed for [Class 1, Division 1, Group D hazardous locations] [the electrical classification for the area as indicated on the drawings]. Supply each transmitter with a factory assembled five-valve stainless steel manifold. Furnish vent valves on upper ports of each transmitter. Mount and install transmitter according to manufacturer's recommendations.

2.18.4.5 Remote Indicator and Recorder

Display monitored parameters and excursion alarms locally on the control panel. Record digital data at intervals not exceeding one minute. Maintain process data in the control room and record on magnetic media in the approved micro computer compatible digital format. Flow information must include rate monitoring, integration and totalizing. Maintain hard copies of recorded data and summaries of recorded data in the control room. Ensure copies are available upon request.

2.19 CONTROL SYSTEM

****

NOTE: The designer will decide which automatic controls are needed and delete any inapplicable items.

****

Provide [a manual][an automatic] control system. Automatic controls are responsible for the balancing of the capacity with system requirements. Use these controls to automatically balance the equipment capacity with the load. Provide the system with the necessary control devices required for normal operation. TAlso include each of the following: a safe system operating mode when controls fail, indications for system failure, protective mechanisms and controls that are required for the safe operation of system equipment in an enclosure conforming to NEMA ICS 6. Submit wiring and ladder diagrams, and control sequences showing the control of the entire system.

2.19.1 Sequence of Control

****

NOTE: Develop and insert the sequence of control for each system.

****

The sequence of control are as follows: [_____].

2.19.2 Sequence of Equipment Operation

****

NOTE: Develop the sequence of equipment operation and insert requirements in this paragraph.

Include instrumentation to modulate the output to meet pressure and/or volume demands as well as start or stop units if the system requires pressure and/or volume control.

****

Include logic to allow for automatic or manual alternation of lead/lag/standby assignments of units installed in parallel. Include Instrumentation to modulate the pressure and volume output as well as start or stop units to meet pressure and/or volume demands. Off-gas systems with safety, emission, or process controls are subject to automatic control logic permissives. Include start and stop push button switches, [hand-off-automatic (H-O-A) switches where the system controls operation] [safety features such as blade and belt guards, vibration or temperature switches] [surge warning and shutdown,] [low oil pressure,] [high oil temperature switches] [process oriented switches such as upstream or downstream process equipment failure shutdown or emission detection shutdown]. Provide additional controls or protective devices as indicated.

Submit detailed manufacturer's data on the overall controls, sensors, process controllers, control operators, valves, interlocks and alarms.

2.19.3 Intake Volume Control

****

NOTE: Under colder air operating conditions, in centrifugal blowers with a relatively flat characteristic flow curve, volume may be controlled over a narrow working range by adjusting variable inlet guide vanes to vary the pressure-volume characteristics. Variable inlet vanes are acceptable, but inefficient. A butterfly valve may be used to create inlet head losses to throttle the blower inlet and reduce volumetric flow rate.

****

Install [automatically] [manually] controlled [adjustable guide vanes] [line sized butterfly valve] on blower inlet to create inlet head losses and reduce the volumetric flow rate.

2.19.4 Outlet Volume Control

****

NOTE: The most efficient method to vary both volume

and pressure is to vary the speed of the driver.

Other methods of controlling output are outlet damper and eddy current coupling (generally an outdated way to achieve speed control). Outlet dampers may serve if high pressure at low volume is desired and high energy costs are not of concern.

****

[Install variable speed control to control output volume] [Provide automatically controlled bypass to recirculate directly around the blower] [Install manual line sized [unloading] [check] [butterfly] valve on blower outlet to create system head losses and reduce the volumetric flow rate].

2.19.5 Panel

****

NOTE: Delete inapplicable items. Consider site location and operational factors for alarm requirements. Indicate equipment on drawings and/or reference other specifications as appropriate.

****

A NEMA [4] [7] [12] [explosion proof] [weather proof] [instrument panel] [control panel] enclosing relays, Contractor, timers, and selector switches must be [floor mounted] [wall mounted] [mounted with vibration isolators on the unit] and provided with hinged cover and latch. Provide direct reading type instruments that are factory mounted and connected. Connect shutdown feature to the annunciator on the instrument panel and identify each shutdown feature. Include the following features and instruments:

a. Running time meter.

b. Alarm annunciator [with single audible alarm] [and] [with contacts to operate a remote alarm] and individual lights for each alarm condition.

2.19.6 Protective Devices

Provide blower protective devices, upon alarm condition, to cause immediate de-energization of the motor, initiate the automatic shutdown sequence, and provide audible and visual alarm indication.

2.19.6.1 Bearing Temperature

Install temperature sensors with switches on each bearing. The control relay, selector switch, test push buttons, and running indicator, or light, on the panel must indicate bearing status. High temperature of any bearing must initiate protective shutdown and the indicator, or light, must indicate the affected bearing.

2.19.6.2 Surge and Overload Protection

****

NOTE: Centrifugal blowers are subject to a characteristic called "surge" or minimum flow point below which the blower performance is unstable. The instability manifests itself in pressure pulsations and flow reversals which can become severe enough to damage the blower or system. Surge occurs when the

system resistance is greater than the pressure that the blower is capable of producing at a given inlet volume; this results in a backward rush through the blower and out the inlet, lowering the pressure in the discharge line at which time normal compression resumes and cycle is repeated, until discharge pressure is decreased or blower pressure increased. Surge may be prevented by using manual or automatic controls.

****

Provide a set-point controller to monitor current input to the motor. Allow the controller to open and close the inlet [guide vanes] [butterfly valve] in response to current. Initiate automatic shutdown sequence and give visual indication of reason for shutdown if surge conditions are indicated by the motor current. Provide manual control and override to enable equipment startup and shutdown.

2.19.6.3 Oil Temperature and Pressure

Install temperature and pressure sensors with switches on each oil pump. The control relay, selector switch, test push buttons, and running indicator, or light, on the panel must indicate status. High oil temperature, high oil pressure or low oil pressure must initiate protective shutdown and the indicator, or light, must indicate the affected setting.

2.20 ELECTRICAL EQUIPMENT

****

NOTE: Show hazardous area classification on the drawings.

****

Provide electrical equipment conforming to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical motor driven equipment herein specified complete with motors, motor starters, and controls. Provide electrical equipment and wiring in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

2.20.1 Electric Motors

Drive each electric motor-driven unit by a weather-protected, Type [I][II][totally-enclosed fan cooled] continuous-duty electric motor. Provide motor with a [_____] service factor. Provide [squirrel-cage induction][synchronous] motors with normal-starting-torque and low-starting-current characteristics, and sized to avoid exceeding the nameplate power rating throughout the entire published characteristic curve. Provide premium efficiency type integral size motors in accordance with NEMA MG 1. Use motor bearings to provide smooth operations under the conditions encountered for the life of the motor. Provide adquate thrust bearing in the motor to carry the weight of the rotating parts plus the hydraulic thrust that are capable of withstanding upthrust imposed during starting [and under variable head] conditions specified. Ensure motors are rated [_____] volts, [_____] phase, 60 Hz and such rating is stamped on the nameplate. Motors must conform to NEMA MG 1.

2.20.2 Control Equipment

[Manually controlled units must have START-STOP pushbutton in cover.][Automatically controlled units must have three-position MANUAL-OFF-AUTOMATIC selector switch in cover.] Provide additional controls or protective devices as indicated.

2.20.3 Variable Speed Controls

****

NOTE: Include this paragraph if any of the motors has a variable speed control.

****

The variable speed motor controller must convert 460 volt plus 15 percent, minus 5 percent, three phase, 60 Hz (plus or minus 2 Hz) utility power to adjustable voltage/frequency, three phase, ac power for stepless motor control from 5 percent to 105 percent of base speed. With the product data submittal for the controls, provide capacities and capacity ranges; performance charts and curves.

2.20.3.1 Description

Use variable speed drive to produce an adjustable ac voltage/frequency output for complete motor speed control. The variable speed drive must be automatically controlled by [a pneumatic 20.7 to 103.4 kPa 3 to 15 psig control signal] [a grounded electronic control signal]. The variable speed drive must be self contained, totally enclosed in a NEMA MG 1 ventilated cabinet and capable of operation between 0 and 40 degrees C 32 and 104 degrees F. The variable speed drive maximum output current rating must be equal to or exceed the motor nameplate full load. The manufacturer must advise the maximum recommended motor sine wave current for each controller rating. Variable speed drive multiple motor operation at same frequency/speed must be possible as long as the sum of connected motor full load sine wave currents are less than or equal to the variable speed drive maximum continuous current rating. Variable speed drive must be [85] [90] [95] percent efficient at 100 percent of rated output power.

2.20.3.2 Governing Requirements

Provide variable speed drive in compliance with 47 CFR 15 regulation of RF1/EM1 emission limits for Class A computing devices. Display the FCC label of compliance on the variable speed drive. Variable speed drive and option design and construction thereof must comply with the applicable provisions of NFPA 70, Article 43D, Sections A-L.

2.20.3.3 Basic Features

Provide variable speed drive with the following basic features:

a. Hand/off/auto operation.

b. Manual/auto speed reference switch.

c. Minimum/maximum adjustable speeds.

d. Speed potentiometer.

e. Auto restart.

f. Linear timed acceleration and deceleration for soft starting and stopping.

g. Controlled speed range 3-63 Hz. (Factory set at 15 Hz minimum).

h. Terminal connections for time clock control, fire, smoke, freeze detectors, and EP relay pre-set speed override.

i. Output frequency terminals for remote metering.

2.20.3.4 Protective Circuits and Features

Provide variable speed drive controller including the following protective circuits/features:

a. Current limits to 100 percent design by slowing the down motor.

b. Instantaneous electronic trip to automatically shut down the motor if current exceeds 120 percent of design or phase-to-phase output short circuit occurs.

c. The variable speed drive will restart automatically when input line returns to normal in the event of intermittent power outage or phase loss or overvoltage shutdown.

d. Input power protection shuts down the unit on low input line voltage or loss of an input phase.

e. Insensitive to incoming power phase.

f. Fast acting current limiting input fuses, (Class J) rated with 200,000 interrupting amperes capability.

g. Isolated 115 volt control circuit and dedicated control transformer.

h. Line-to-line fault protection.

i. Line-to-ground short circuiting and accidental motor grounding protection.

j. Output thermal overload relay trip.

2.20.3.5 Adjustments

The variable speed drive must have 0 to 75 percent of minimum speed, and 100 percent of maximum speed, adjustments available via potentiometers located on the faceplate of a single, regulator printed circuit board.

2.21 APPURTENANCES

2.21.1 Dielectric Fittings

Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves. Use dielectric fittings, suitable for the required working pressure, to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.21.2 Isolation Joints

Install isolation joints between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints must consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets must be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves must be full length. Units must be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.21.2.1 Sleeve-type Couplings

Use sleeve-type couplings for joining plain end pipe sections. The two couplings must consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

2.21.2.2 Split-sleeve Type Couplings

Use split-sleeve type couplings, in aboveground installations when approved in special situations, that consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

2.21.3 Valves

****

NOTE: Evaluate the need for silencers and/or carbon adsorption units if handling toxic gases downstream of relief and/or unloading valves.

Threaded connections are common on valves 25 mm 1 inch and smaller, and are sometimes used on valves up to 50 mm 2 inch. If a welded end connection is desired for valves 50 mm 2 inch and smaller, a socketweld is usually chosen. Socketweld end dimensions are standardized by ASME B16.11. Buttweld ends are preferred when zero leakage is required. The valve body material must be compatible with the adjoining pipe material for welding.

****

Valve diameter must be equal to the diameter of the pipe in which the valve is located unless otherwise indicated. Ensure valves are [screw] [socket weld] [buttweld] [sweat] [flange] connected. Rated operating conditions are [_____] degrees C F and [_____] kPa psig, minimum. Materials of construction are [aluminum] [bronze] [stainless steel] [_____] body, [bronze] [316 stainless steel] trim, and [Buna-N] [EPR] [Viton] [PTFE] elastomers. Mark valves in accordance with MSS SP-25 to identify the manufacturer, valve sizes, pressure rating, body and seat material.

2.21.3.1 Relief Valve

****

NOTE: Relief valves are provided in the following configurations: weighted type (install in horizontal position only), spring type and pilot operated diaphragm type which (with an optional solenoid valve) can be used for an unloading valve as well. Relief valves are also used to relieve possible

thermal expansion in a pipe line if no other provisions exist. Indicate on the drawings a site flow indicator downstream of each relief valve. Indicate the operating pressure required for each valve.

ASTM F1508 covers only spring-loaded, angle style valves.
****

Provide relief valve capable of maintaining a constant upstream pressure regardless of the downstream demand for each air mover. Valve must be [ASTM F1508 angle spring loaded] [weighted] [pilot-operated diaphragm] differential pressure relief valve with a [_____] percent accumulation. Rate valve to relieve [the full capacity of the air moving equipment] [[_____] cubic meters/second feet/minute]. Ensure vlve is factory-set to open at the [actual] [gauge] [pressure] [vacuum] of [_____] kPa psi and field adjustable within a minimum range of plus or minus 20 percent. Locate valve within [_____] m feet upstream of vacuum equipment or downstream of pressure equipment.

2.21.3.2 Unloading Valve

****
NOTE: Unloading valves allow the blower to start under reduced pressure.
****

Unloading valve must be [pilot-operated diaphragm valve with auxiliary solenoid operator] [butterfly valve] actuated by the system controls and field adjustable within a minimum range of plus or minus 20 percent. Set unloading valve to relieve [_____] cubic m/second feet/minute at a set gage pressure of [_____]kPa psi or a vacuum of [_____] kPa inches Hg.

2.21.3.3 Combination Relief and Unloading Valve

****
NOTE: Combination valves should be carefully located with respect to heavily contaminated off-gas streams or deleted in favor of separate valves.
****

Set combination relief and unloading valve to relieve at a set [actual] [gauge] [pressure] [vacuum] of [_____] kPa psi.

2.21.3.4 Purge Valve

****
NOTE: For vacuum pump applications, an automatic purge valve is useful in clearing the system of vapors which may condense in shutdown or startup.
****

Equip each vacuum unit with a manually adjustable, normally closed automatic purge valve. Ensure valve is factory-set to open at at the gauge pressure of 0.5 kPa 0.15 inches Hg and field adjustable within a minimum range of plus or minus 20 percent. Locate valve within 1 m 3.3 feet downstream of vacuum equipment.

2.21.3.5 Vacuum Breaker

****

NOTE: Edit the settings appropriately for the equipment required.

****

Provide [pilot-operated diaphragm type with auxiliary solenoid operator] [butterfly valve actuated by blower system controls] vacuum breaker to protect blower or vacuum pump from surges. Rate valve to relieve 0.05 cubic m/second 1.76 cfm at a set gage pressure of 100 kPa 14.7 psi or a vacuum of -50 kPa -15 inches Hg. Materials must be [aluminum] [bronze] [stainless steel] body, [bronze] [316 stainless steel] trim, and [Buna-N] [EPR] [Viton] [Teflon] elastomers. Provide rating of 100 degrees C 212 degrees F and 1000 kPa 147 psi, minimum.

2.21.3.6 Check Valve

Provide a [pilot-operated diaphragm valve with auxiliary solenoid operator] [butterfly valve actuated by system controls] with a closing time of 1 to 5 seconds, located on the discharge side of each air mover. Prevent reverse flow and open at a controlled rate to keep air mover starting surges from shocking downstream equipment. Opening rate must be adjustable from 5 to 60 seconds.

2.21.3.7 Control Valve

****

NOTE: Starting and stopping the air moving equipment is preferable to operation against a closed system.

****

Valve must be a [pilot-operated diaphragm valve with auxiliary solenoid operator] [butterfly valve actuated by system controls].

2.21.3.8 Back Pressure Valve

Valve must be capable of maintaining a constant upstream pressure regardless of the downstream demand.

2.21.3.9 Manual Valve

[Provide ball valves in accordance with MSS SP-72. Provide gate, plug and ball valves in accordance with API Spec 6D. Provide thermoplastic gas shutoffs and valves in accordance with ASME B16.40. Manual valve must be wrench operated, rising stem, with cap.] [Provide non-automatic valve as required by Section 31 21 00 OFF-GASSING MITIGATION.]

2.21.4 Inlet and Discharge Elbows

Inlet and discharge elbows must be of the long sweep type with ASME B16.1, Class 125 flanges.

2.21.5 Expansion Coupling

Provide inlet and the outlet of each unit with flexible expansion couplings of extra heavy gauge rubber, wire reinforced type suitable for temperature range of minus 29 to plus 121 degrees C minus 20 to plus 250 degrees F and pressure range from 51 to 103 kPa 15 inches of mercury vacuum to 15 psig.

2.21.6 Heat Exchanger

Provide [an air-to-air] [a water cooled] heat exchanger on the blower [inlet] [outlet] with sufficient capacity to reduce the air temperature [_____] degrees C F.

2.21.7 Flame Arrestor

Locate flame arrestor immediately upstream of any source of flame. Submit rating, capacity and pressure differentials. Also include installation instructions with the submittal.

2.21.8 Drip Trap

Provide drip trap in accordance with ASTM F1139.

2.21.9 Liquid Receiver

Design, fit, and rate liquid receivers for 0.345 MPa 50 psi working pressure. Provide each receiver with a storage capacity no less than [_____] L gal. Equip each receiver with inlet and outlet drop pipe, drain with valve, relief valve and two bull's-eye liquid-level sight glasses. Ensure sight glasses are in the same vertical plane, 90 degrees apart, perpendicular to the axis of the receiver, and not over 75 mm 3 inches horizontally from the drop pipe measured along the axis of the receiver. In lieu of bull's-eye sight glass, provide external gauge glass with metal glass guard and automatic closing stop valves. The outside of liquid receivers must be galvanized or supplied with commercial enamel finish.

2.21.10 Air Receiver

Design receiver for 0.345 MPa 50 psi working pressure. Equip receivers with safety relief valves and accessories, including pressure gauges and automatic and manual drains. Design and construct receivers in accordance with ASME BPVC SEC VIII D1 and with the design working pressures specified herein. Provide a display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. The outside of air receivers must be galvanized or supplied with commercial enamel finish.

2.22 BASE PLATE

Mount each unit on all-welded structural steel or cast iron base complete with vibration isolators with published load rating. Provide base plate with vertical jacking screws to facilitate leveling. Isolate the entire unit from the building structure.

2.23 WEATHERPROOF ENCLOSURE

****

NOTE: Include this paragraph for equipment mounted partially or completely outdoors.

****

Provide a weatherproof enclosure for the air moving equipment and motor assembly. Provide enclosure with lockable access doors and louvered for ventilation. [Insulate and equip the enclosure with a thermostatically controlled electric heating and ventilation.]

2.24 ATTACHMENTS

Provide shafts, chains or gear driven equipment with all-metal guards enclosing the drive mechanism. Construct guard of galvanized sheet steel, or galvanized woven wire, or expanded metal set in galvanized steel frame. Secure guards in position by steel braces or straps which will permit easy removal for servicing the equipment.

2.25 COATINGS OR FINISHES

****

NOTE: Consult with coatings supplier on specific coating once liquid and gas composition are known. Be aware of the VOC content of the coating and the regulations that restrict application of high VOC coatings; use low VOC coatings unless quality of coating will not meet requirements.

****

Clean and prime motors, casings and similar parts of equipment finished in the shop and give two finish coats with [alkyd primer followed by two alkyd modified silicone final coats] [severe chemical service phenolic type coatings] [paint suitable for the environment in which the unit is to be placed] at the factory. Give ferrous surfaces not painted at the factory a shop coat of grease or other suitable rust resistant coating.

2.26 FACTORY TESTS

****

NOTE: Delete inapplicable tests.

****

Equipment is subject to in-plant shop and quality control inspections before approval for shipment from manufacturer's facilities. Operate rotating parts of the equipment throughout the required range without excessive end thrust, vibration or noise.

2.26.1 Integrity

Test each [impeller] [rotor] assembly by operating at a speed to [20] [_____] percent above operating speed and check for cracks using the dye penetrant method or similar method of equal accuracy.

2.26.2 Balance

Statically and dynamically balance rotating parts in accordance with ISO 1940-1. First critical speed is at least 150 percent of maximum operating speed. Statically and dynamically balance the shaft and impeller or blade assembly as a unit. Removing of metal from the impeller or blades by boring is not an acceptable means of balancing the shaft and impeller unit. Impeller or blade assemblies must be statically and dynamically balanced to within 0.5 percent of W times R squared, where W equals weight and R equals impeller radius.

2.26.3 Deflection

Total shaft peak-to-peak dynamic deflection measured by vibrometer at seal face is not allowed to exceed 5.1 microns 2 mils under the complete range of operating conditions.

2.26.4 Vibration

****

NOTE: Deflection is normally specified for centrifugal blowers. Velocity is normally specified for positive displacement blowers.

****

[Vibration is not allowed to exceed 2.5 microns 1.0 mil at the bearing housing with the equipment operating.] [Ensure peak vibration velocity is less than 7.62 mm/second 0.30 inch per second.]

2.26.5 Capacity

Determine volume and pressure characteristics of air moving equipment by the [manufacturer] [a nationally recognized testing agency] in accordance with AMCA 210. Submit certified test results and sample calculation from test readings to the Contracting Officer. Where two or more identical units are specified, the capacity of only one representative unit needs to be tested.

2.26.6 Noise

Test air moving equipment with sound attenuation devices installed by the [manufacturer] [a nationally recognized testing agency]. Submit certified test results and sample calculation from test readings to the Contracting Officer. Where two or more identical units are specified, only one representative unit needs to be tested. Test fans in accordance with AMCA 300 with results interpreted in accordance with AMCA 301.

2.26.7 Variable Speed Drive

Subject each variable speed drive to an in-plant quality control inspection. Integrated circuits must undergo a 160-hour "burn-in" to test reliability. Cycle the temperature between 0 and 70 degrees C 32 and 158 degrees F during the "burn-in". Each completed unit must undergo a fully loaded 24-hour "burn-in".

2.26.8 Continuity

Check wiring and instrumentation assembled at the factory for continuity prior to shipping.

2.26.9 Receivers

Ensure receivers are factory air tested to 1.5 times the specified working pressure.

2.26.10 Valve Testing

Test relief valves in accordance with ASME PTC 25.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

****

NOTE: Rotary lobe blowers must be absolutely horizontal to operate properly.

****

Install vibration dampener in sufficient quantity to isolate each unit from the structural base on which the unit is installed. Install, align and level each air moving unit and motor in accordance with the written instruction of the manufacturer [and under the direct supervision of the manufacturer's representative]. [Deviation from horizontal must be below limits of measurement.] [Set impellers by the manufacturer's representative]. Do not use flexible couplings to compensate for misalignment between driver and driven unit. Blower venting is not allowed toviolate the provisions of either ACGIH 2098 or AMCA 99.

3.2.1 Concrete Foundations

Provide concrete for equipment foundations [as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE] [with a minimum compressive strength of at least 17 MPa 2,500 psi]. Provide concrete foundations that are [integral with and of the same class as that of the building floor] [entirely separated from the surrounding floor with a premolded filler strip installed between the foundation and floor slab as shown]. Furnish foundation bolts, as required, for proper positioning during the placement of the concrete.

3.2.2 Seismic Requirements

****

NOTE: Provide seismic requirements, if a Government designer (either Corps office of A/E) is the Engineer of Record and show on the drawings. Delete the bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-310 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS, properly edited, must be included in the contract documents.

****

Support and bracequipment and attached valves to resist seismic loads as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS[as shown on the drawings].

3.3 FIELD PAINTING

Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

3.3.1 Touch-Up Painting

Clean factory painted items, requiring touching up in the field, of foreign material and prime top-coat with the manufacturer's standard factory finish, provided it does not discolor in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) conditions.

3.3.2 Exposed Ferrous Surfaces

Paint equipment which did not receive a factory finish and other exposed ferrous surfaces as specified in Section 09 90 00 PAINTS AND COATINGS. Ensure coating is not less than 0.05 mm 1.75 mils thick.

3.4 MANUFACTURER'S FIELD SERVICES

Provide the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. Supervise the installing, adjusting, and testing of the equipment.

3.5 POSTING FRAMED INSTRUCTIONS

Post framed instructions containing wiring and control diagrams where directed. Post condensed operating instructions as specified. Post the framed instructions before acceptance testing of the systems.

3.6 FIELD TESTING

3.6.1 Deficiencies

If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

3.6.2 Correct Installation

Assure that the units and appurtenances have been installed correctly, there is no objectionable heating or vibration, noise from any part is not excessive, and manual and automatic controls function properly.

3.6.3 Field Equipment Test

After installation of the air moving units and appurtenances is complete, carry out operating tests to ensure that the installation operates properly. [Make arrangements to have the manufacturer's representative present when field equipment tests are made.] Give each unit a running field test in the presence of the Contracting Officer for a minimum of [4] [_____] hours [at its rated capacity] [at the point of maximum power requirement indicated on the head-capacity curve or point on the curve selected by the Contracting Officer]. Provide an accurate and acceptable method of measuring the discharge flow and pressure.

3.6.4 Noise Suppression

Sound level must be less than [60] [70] [80] dB measured at 1.5 m 5 feet from the source.

3.6.5 Reporting

Submit test reports in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed equipment. Identify test methods used and record test results. Indicate the final position of controls in each test report.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Field Training

****

NOTE: The number of hours required to instruct a Government representative in operation and maintenance of the system will depend on the complexity of the system specified. Designer is to establish the number of hours of training based on equipment manufacturer recommendations, system complexity and consultation with the installation.

****

Conduct a field training course for designated operating, maintenance and supervisory staff members. Submit training course curriculum and training instructions 14 days prior to the start of training. Provide training after the system is functionally complete but prior to final acceptance tests, for a total period of [16] [24] [_____] hours of normal working time. Cover the items contained in the operating and maintenance instructions.

3.7.2 Operating and Maintenance Instructions

3.7.2.1 Operating Instructions

Submit [six] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the operating instructions the following for system components: manufacturer's name, model number, service manual, parts list, and brief description of each piece of equipment and its basic operating features; flow diagrams; system layout showing piping, valves, and controls; [as-built] [approved] wiring and control diagrams; control sequence describing startup, operation, and shutdown; manufacturer's bulletins, cuts, and descriptive data.

3.7.2.2 Maintenance Instructions

Submit [six] [_____] complete copies of maintenance instructions for each piece of equipment including the following: manufacturer's complete list of parts, recommended spare parts and supplies, with current unit prices and source of supply; routine maintenance procedures, including the requirements of WEF MOP 11, as a minimum; possible breakdowns and repairs; a troubleshooting guide to help the operator determine what steps must be taken to correct any equipment problems.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-43 15 00.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15211N (August 2003)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

SECTION 43 15 00.00 20

LOW PRESSURE COMPRESSED AIR PIPING (NON-BREATHING AIR TYPE)

04/06

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-43 15 00.00 20 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change**
UFGS-15211N (August 2003)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 43 15 00.00 20

LOW PRESSURE COMPRESSED AIR PIPING (NON-BREATHING AIR TYPE)
04/06

****
NOTE: This guide specification covers the requirements for non-breathing air compressed air systems inside of buildings with pressures up to 862 kPa (gage) 125 psig.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: Project requirements may require supplemental information added to the paragraphs contained herein.
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

ANSI/AHRI 520	(2004) Performance Rating of Positive Displacement Condensing Units

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping

ASME B31.9	(2020) Building Services Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D1330	(2004; R 2010) Rubber Sheet Gaskets

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FLUID POWER ASSOCIATION (NFLPA)

ANSI/NFLPA T3.12.3	(1992; Rev 2) Pneumatic Fluid Power - Pressure Regulator - Industrial Type

PLUMBING AND MECHANICAL CONTRACTORS ASSOCIATION (PMCA)

PPIC Seismic Restraint	(1982) Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J513	(1999; R 2019) Refrigeration Tube Fittings - General Specifications

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689	(Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film)
CID A-A-58092	(Basic; Notice 1; Notice 2) Tape, Antiseize, Polytetrafluoroethylene
CID A-A-59617	(Basic, Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections
CID A-A-60001	(Rev A) Traps, Steam
FS F-F-351	(2019; Rev G; Notice 1) Filters and Filter Elements, Fluid Pressure: Lubricating Oil, Bypass and Full Flow
FS QQ-B-654	(Rev A; Notice 1; Notice 2) Brazing Alloys, Silver
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil,

	or Steam
FS XX-C-2816	(Rev A) Compressor, Air, Reciprocating or Rotary, Electric Motor Driven, Stationary, 10 HP and Larger

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Air compressor

Air Dryer

Air receiver

Desiccant air dryers

Desiccant

Pipe

Fittings

Valves

Pressure gages

Hangers and supports

Quick disconnect couplings

Filters

Strainers

Traps

Lubricators

Flexible connections

Dielectric unions

Hose reel assembly

Valve box

Identification labels for piping

Tubing

For receivers, include Manufacturer's Data Report Form U-1 or U-1A

SD-06 Test Reports

Non-Destructive Examination (NDE) report for welding of piping

Leak tightness tests

SD-07 Certificates

Employer's record documents

Welding procedures and qualifications

Cleaning and flushing procedures

SD-08 Manufacturer's Instructions

Air receiver

Include manufacturer's recommended certification test procedure and recommended procedure for cleaning, external painting, and delivery preparation.

SD-10 Operation and Maintenance Data

Air compressor, Data Package 4

Air dryer, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted operating instructions for air compressor

Posted operating instructions air dryer

1.4 QUALITY ASSURANCE

****

NOTE: The SMACNA Seismic Restraint Manual referenced in the paragraph below must be applied to locations subject to significant risk of seismic induced loads. The degree to which this manual is to be used for contract drawings and specifications must be determined by the designer of record in coordination with the NAVFAC Engineering Field Division's Mechanical Design Branch.

****

Provide work specified in this section, including design, materials, fabrication, assembly, erection, installation, and examination, inspection and testing of compressed air systems in conformance with ASME B31.9[and SMACNA 1981], as modified and supplemented by this specification section and accompanying drawings. In ASME B31.1, ASME BPVC SEC VIII D1, and ASME BPVC SEC IX, the advisory provisions must be considered mandatory, as though the word "must" had been substituted for "should" wherever it appears; reference to the "authority having jurisdiction" and "owner" must be interpreted to mean the Contracting Officer.

1.4.1 Welding procedures and qualifications

Provide welding work specified in this section for compressed air piping systems in conformance with ASME B31.9, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

1.4.1.1 Butt Welded Joints

Butt welded joints must be full penetration joints.

1.4.2 Employer's Record Documents

Submit to the ROICC for his review and approval the following documentation. This documentation and the subject qualifications must be in compliance with ASME B31.9.

a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.

b. List of qualified welders, and welding operators that are proposed to be used to provide the work specified in this specification section.

c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

1.4.3 Welding Procedures and Qualifications

Specifications and Test Results: Submit copies of the welding procedure specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

1.4.3.1 Certification

Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification must state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.4.3.2 Renewal of Qualification

Requalification of a brazer or brazing operator must be required under any of the following conditions:

a. When a brazer or brazing operator has not used the specific brazing process for a period of 6 months.

b. There is specific reason to question his ability to make brazes that will meet the requirements of the specifications.

1.4.4 Equipment Data

Submit the following data for equipment listed for "Operation and Maintenance Instructions, Parts and Testing."

a. Name and address of authorized branch or service department.

b. Characteristic curves.

c. Following applicable data completely filled in:

    (1) Manufacturer and model number [_____]

(2) Operating speed [_____]

(3) Capacity [_____ (CMS) (CFM)]

(4) Type of bearings in unit [_____]

(5) Type of lubrication [_____]

(6) Type and adjustment of drive [_____]

(7) Capacity of tank [_____]

(8) Electric motor: Manufacturer, frame and type [_____]

(9) Motor speed [_____] rad/sec RPM

(10) Current characteristics and kW hp of motor [_____]

(11) [_____] Thermal cut-out switch: Manufacturer, type and model [_____]

(12) Starter: Manufacturer: Type and model [_____]

1.5 SAFETY PRECAUTIONS

1.5.1 Temperature Restriction

****

NOTE: The designer must assure that the piping design temperature is not exceeded, especially for high pressure systems. Provide aftercoolers and high temperature shutdown devices as required for safe operation of the systems.

****

Compressors or other equipment must not discharge compressed air to the piping systems above [38] [_____] degrees C [100] [_____] degrees F unless approved by the Contracting Officer. Aftercoolers or other devices must be provided to comply with the temperature restriction.

1.5.2 Rotating Equipment

Fully guard couplings, motor shafts, gears and other exposed rotating or rapidly moving parts in accordance with OSHA 29 CFR 1910.219. Provide rigid and suitably secured guard parts readily removable without disassembling guarded unit.

1.5.3 Welding and Brazing

Safety in welding, cutting, and brazing of pipe must conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 LOW PRESSURE AIR COMPRESSOR, 7 1/2 TO 224 KW 10 TO 300 HP

****

NOTE: Prepare section for cooling water and include in project specification. See Section 23 64 26

CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS for piping and equipment which may be useful.
****

7 1/2 kW to 224 kW, up to 862 kPa (gage) 10 to 300 hp, up to 125 psig. Configuration and dimensions of the air compressor must be compatible with the indicated space allocated. Sound level must not exceed 84 dBA one meter from compressor unit. Conform to FS XX-C-2816and following ordering data (paragraph 6.2) thereof:

a. Specification title, number and date: As listed hereinbefore under "REFERENCES."

b. Type: [I - Single acting (reciprocating)] [II - Double acting (reciprocating)] [III -Rotary (vane, screw)].

c. Issue date of applicable specifications and standards: As specified.

d. Packaged assembly requirement: [Packaged Unit required] [Field assembled].

e. First article inspection: [Not required; furnish certified test report.] [Required.]

f. Capacity (cms) (cfm): [At least as indicated.] [cms cfm:[_____].]

    (1) Discharge working pressure: [At least as indicated.] [kPa (gage) psig: [_____].]

g. Number of stages for Type I compressor: [Single stage.] Type I [Two stages.].

    (1) Water-jacketed cooling: [Not applicable.] [Required] [Not required].

h. Number of stages for Type II compressor: [Single Stage] [Two stages] [Not applicable].

i. Oil-free air delivery Type II compressors: [Required.] Type II [Not required.]

j. Type bearings: Manufacturer's standard.

k. Air filter to function as muffler: Required.

l. Air Filter conformance with MS: Not required; provide manufacturer's standard.

m. Safety valve in discharge line when no receiver provided: [Not applicable.] [Required, ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped safety relief valve.]

n. Shut-off valve on compressor discharge: [Not required] [Required].

o. Oil Filter compliance with FS F-F-351: Not required; provide manufacturer's standard.

p. Drain plug conformance with MS: Not required; provide manufacturer's standard.

q. Electric, thermostatically controlled immersion oil heater: [Not] required.

r. Compressor regulation method: [Constant-speed control]. [Dual control: Alternative constant speed or automatic start-stop.]

s. Timed stop control (for constant speed control: [Not applicable] [Required].

****

NOTE: Edit Table A to select only the optional safety controls required for the project.

****

(1) t. Optional safety controls required: As specified on Table A.

TABLE A. OPTIONAL SAFETY CONTROLS

	Type I		Type II		Type III	
	Alarm	Shut Down	Alarm	Shut Down	Alarm	Shut Down
High-lubrication oil temp.	-	-	x	x	x	x
Cylinder lubrication failure	-	-	-	x	-	-
High main bearing temperature	-	x	-	x	-	x
High discharge-air temperature	x	x	x	x	x	x
High discharge-air pressure	x	x	x	x	x	x
High intercooler air temp.	x	x	x	x	-	-
Low cooling water flow	-	x	-	x	-	-
Low water pressure	-	x	-	x	-	-
High water temperature	x	x	x	x	-	-
High intercooler moisture separator level (two-stage compressors only)	x	x	x	x	-	-
Excessively high motor temp.	x	-	x	-	x	-
Excessive vibration	-	x	-	x	-	-

t. Gages and visual I.D. lights mounting (optional controls): [Panel-mounted.] [Mounted on separate console.]

(1) [Not applicable.]

u. Aftercooler: Required; [Water-cooled, shell-and-tube type] [or] [air-cooled, tube-and-fin type]. A centrifugal moisture separator is also required.

v. Air receiver: [Required] [Not required].

w. Receiver volume: [As specified in FS XX-C-2816.] [As indicated.] [[_____] liter gal.] [[_____] cu. meter ft.] [Not applicable.]

x. Receiver mounting stand: [Required] [Not required] [Not applicable].

(1) Position of receiver: [Horizontal] [Vertical].

y. Compressor and motor: [Required] [Not required]. To be mounted on receiver: [Not applicable].

z. Compressor housing (III units): [Not applicable] [Required].

aa. Motor: As specified in FS XX-C-2816.

ab. Electrical power supply characteristics: As indicated.

ac. Motors 93 kW 125 hp and larger to be synchronous: [Required] [Not required] [Not applicable].

ad. Motor starter: As specified in FS XX-C-2816.

ae. Provision for limitation of starting current inrush: [Required] [Not required] [Not applicable].

af. Type Drive: [Direct drive] [Multi-V-Belt drive].

(1) Direct drive coupling: [Close-coupled] [Integral-coupled] [Flexible-coupled] [Not applicable].

ag. Electromagnetic interference control: [Not required] [Required].

ah. Fungus resistance: Not required.

ai. Cleaning, treatment, and painting: [As specified in FS XX-C-2816] [Other: (specify)].

aj. Cleaning, treatment and painting in accordance with Section 09 90 00 PAINTS AND COATINGS.

ak. Color of finish coat: [Manufacturer's standard] [Other: [_____]-(specify)-Samples required.]

al. Initial lubrication: Factory lubrication service required.

am. Skid base (Type II or III): Required.

an. Lifting attachments and tiedown device: Lifting attachments as required. Tiedown devices [required.] [Not required.]

ao. Spare parts and maintenance tools: Not required.

ap. Tool boxes: Not required.

aq. Production pack inspection: Not required.

ar. Level of preservation packaging, and packing: Level C or better (Delivery of unit to project site in undamaged condition is Contractor's responsibility.)

as. Preservation-packaging: Not applicable.

2.2 LOW PRESSURE AIR COMPRESSOR UNIT, LESS THAN 7 1/2 kW 10 HP

Low pressure air compressor unit, less than 7 1/2 kW 10 hp, up to 862 kPa (gage) 125 psig, must conform to the following.

2.2.1 Compressor and Receiver Capacity

Sized as indicated. [Oil-free air] [Air] delivered at indicated pressure.

2.2.2 Mounting

Common sub-base for receiver and compressor.

2.2.3 Compressor Type

Reciprocating [or rotary].

2.2.4 Nameplate

Metal, securely fastened to equipment or base, listing:

Manufacturer's name and address
Model and serial numbers
Compressor operating data and rating.

2.2.5 Receiver

ASME BPVC SEC VIII D1 and ASME BPVC SEC IX stamp. Provide service valve, pressure gage, and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX code safety valve.

2.2.6 Receiver Condensate Drain

Automatic float-type trap per CID A-A-60001.

2.2.7 Compressor Accessories

Air inlet filter and silencer. Air-cooled intercooler and aftercooler which reduce air discharge temperature to 38 degrees C 100 degrees F.

2.2.8 Control

Unloaded start with enclosed diaphragm-type pressure switch automatically controlling start-and-stop.

2.2.9 Motor

Squirrel-cage induction motor with drip-proof enclosure and conforming with NEMA MG 1, suitable for operation on the indicated power supply. Rated horsepower of motor must equal or exceed power required for continuous operation of compressor at full load.

2.2.10 Starter

Capacity and electrical characteristics must be compatible with motor. Starter must conform with NEMA ICS 2 with NEMA ICS 6 enclosure. Include thermal overload protection of all phases.

2.2.11 Noise

84 dBA maximum sound level one meter from compressor unit.

2.3 LOW PRESSURE AIR RECEIVER

ASME BPVC SEC VIII D1, labeled and rated for [862] [1379] kPa (gage) [125] [200] psig, equipped with required valves and trimmings, including gage and automatic drain valve and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX pressure safety relief valve. Pressure as indicated. [Sandblast exterior and interior to SSPC SP 10/NACE No. 2, near-white. Lining must be a factory applied 0.20 mm 8 mil minimum white epoxy coating.] Exterior finish must be [standard factory finish] [two coats of rust inhibitor primer and one coat epoxy enamel].

2.4 LOW PRESSURE COMPRESSED AIR DRYERS

****

NOTE: Normally used for under 944 scms 2000 SCFM capacity systems.

****

Provide low pressure compressed air dryers of the mechanical refrigeration type, equipped with an automatic temperature shutdown switch to prevent freezing, a regenerative air to air exchanger (in capacity sizes above 4.72 or 28.31 scms 10 or 60 scfm as standard with the manufacturer), and a main compressed air cooling exchanger. Refrigeration system must cool compressed air to dry the air. Dryer must have no internal traps or filters and must have pressure drop not greater than [20.68] [_____] kPa [3] [_____] psi [indicated]. Air must leave the dryer at a temperature of [_____] degrees C F and dew point of [_____] degrees C F, based on an inlet temperature of [38] [_____] [100] [_____] degrees C F. Provide internal tubing, wiring, and piping complete, such that only connections to air inlet and outlet, to refrigerant compressor contactor, and to condensate drain are necessary.

2.4.1 Air Circuit

a. Regenerative Heat Exchanger: Inlet compressed air to outlet compressed air heat exchanger (in capacity sizes above 4.70 or 28.30 scms 10 or 60 scfm as standard with the manufacturer) designed to reduce cooling load at design conditions minus 7 degrees C 20 degrees F by inlet air precooling.

b. Main Heat Exchanger: Single-pass, with air in the tubes, heat sink, direct expansion, or flooded cooler type.

c. Separator: Fabricated in accordance with ASME B31.1; code stamp not required; moisture separator low velocity type incorporating change of air flow direction to prevent moisture carryover.

d. Dryer Operating Pressure: 862 kPa (gage) 125 psig working pressure.

e. Drain Line: Provide with exterior mounted condensate trap to facilitate servicing.

2.4.2 Refrigeration System

a. Refrigeration Compressor: ANSI/AHRI 520. Hermetic, semi-hermetic, or open reciprocating type equipped with automatic start-stop or unloading capacity control; standard components include inherent motor protection, crankcase oil strainer, and suction screen. Refrigerant must be R-22.

b. Dryer Controls: Capable of automatic 0 to 100 percent capacity control. Refrigeration controls must maintain pressure dew point within the specified range without freezing of condensate. Controls must include such devices as capillary tube, expansion valve, suction pressure regulator, thermostat, or other approved devices as standard with the manufacturer. Dryer must have automatic shutdown switch sensor located at point of lowest temperature to prevent freezing.

c. Refrigerant dryer and suction line strainer.

d. Air-cooled condenser, with condenser fan and motor.

2.4.3 Instrumentation and Control

Include control panel in dryer cabinet containing:

a. Indicators for the Following Services: Inlet air pressure gage, discharge air pressure gage, inlet air temperature gage, main exchanger temperature gage, refrigeration compressor suction pressure gage, refrigeration compressor discharge pressure gage, green "Power On" light, power interruption light, and high temperature light.

b. Electrical Relays: Locate in an enclosed portion of the panel, accessible for ease of servicing.

c. Controls and Interlocks: To maintain required compressed air dew point and to cycle air-cooled condenser with refrigeration compressor [while maintaining head pressure control with low ambient temperature].

2.5 LOW PRESSURE COMPRESSED AIR DRYER (CHILLED WATER TYPE)

****

NOTE: Chilled water air dryers are usually provided for 944 scms 2000 scfm and larger capacities. CAUTION: Specify correct system pressure. If the specification is edited to use a dryer with direct heat exchange between air and refrigerant, assure that the air is not used for breathing since refrigerant leakage into the compressed air may be hazardous to personnel; warning signs may be required.

****

Provide low pressure compressed air dryer of the mechanical refrigerator type, with closed chilled water system, regenerative air to air exchanger, and main compressed air to water heat exchanger. Refrigeration system must produce chilled water which, in turn, circulates through air-water exchanger to dry the air. Provide internal tubing, wiring and piping complete, such that only connections to air inlet and outlet, to pump contactor, to refrigerant compressor contactor, to condensate drain, and to air cooled condenser need be provided. Dryer must be suitable for a compressed air operating pressure of 862 kPa (gage) 125 psig, with air leaving temperature of [_____] degrees C F and dew point of [_____] degrees C F at rated pressure.

2.5.1 Air Circuit

a. Regenerative Heat Exchanger: Air to air exchanger, with inlet air passing through tubes and outlet air in shell, designed to reduce cooling load at design conditions by precooling inlet air minus 7 degrees C 20 degrees F.

b. Main Heat Exchanger: Shell and tube construction, single-pass, with air in tubes and water in shell, designed for minimum air pressure drop, flanged connections, tubes rolled into tube sheets, and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped.

c. Separator: Fabricated of carbon steel to ASME BPVC SEC VIII D1and ASME BPVC SEC IX Code and stamped.

d. Drain: With condensate trap.

2.5.2 Chilled Water Circuit

a. Circulating Pump: Single stage, mechanical seals, electric motor driven with line shut-off valves.

b. Liquid Cooler: Direct expansion, refrigerant in tubes, water in shell, designed for 2068 kPa (gage) 300 psig working pressure, removable tube bundle, ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped and insulated with foam type insulation.

c. Expansion Tank: With sight glass, vent, and fill cock.

d. Flow Switch: To shut down refrigeration compressor on loss of chilled water flow.

2.5.3 Refrigeration System

a. Refrigeration Compressor: ANSI/AHRI 520. Hermetic or semihermetic reciprocating type, with 183 rad/sec 1750 rpm motor, integral capacity control, oil pressure pump, oil scavenger pump, full-flow oil filter, oil sight glass, inherent motor protection, crankcase heater, suction and discharge service valve, crankcase oil strainer, Monel suction screen, and hot gas bypass capacity control below last step of unloading. Refrigerant must be R-22.

b. Accessories: Include a discharge line muffler, sight glass, refrigerant dryer, solenoid valve, thermostatic expansion valve, and suction line strainer.

c. Air-cooled Condenser: As indicated. Complete air-cooled condenser factory-fabricated and assembled unit consisting of coils, fans, and electric-motor drive. Base capacity at design conditions on minus 7 degrees C 20 degrees F temperature differential between entering air and condensing refrigerant. Saturated refrigerant condensing temperature not over 40.5 degrees C 105 degrees F. Base entering dry bulb outside air temperature on [32] [_____] degrees C [90] [_____] degrees F. Do not take subcooling into account in determining compressor and condenser capacities. Air-cooled condenser may be used for refrigerant storage in lieu of a separate receiver, provided that condenser storage capacity is 20 percent in excess of fully charged system. [Provide head pressure control during low ambient temperature.]

2.5.4 Instrumentation and Control

Provide a control panel on the dryer containing:

a. Pressure gages 114 mm 4 1/2 inches diameter) for the following services:

    (1) Inlet air

    (2) Condenser water inlet

    (3) Refrigeration compressor suction

    (4) Refrigeration compressor oil pressure

    (5) Outlet air

    (6) Condenser water outlet

    (7) Refrigeration compressor discharge

b. Electrical Relays: Locate in an enclosed portion of the panel, accessible from front of panel.

c. Start-Stop buttons and green running indicating light.

d. Controls and Interlocks

    (1) 115-volt control transformer

    (2) Circulating pump across the line contactor

    (3) Compressor across the line contactor

    (4) Condenser water pressure safety switch

    (5) Freeze protection safety switch

    (6) Pump-out relay with normally open and normally closed contacts

    (7) Oil safety switch

    (8) Four stage thermostatic control

    (9) Refrigerant dual pressure switch

2.5.5 Temperature Indicators

a. Air inlet

b. Air outlet

c. Chilled water in

d. Chilled water out

e. Dew point

2.6 DESICCANT AIR DRYERS

Chamber of welded steel, 862 kPa (gage) 125 psig working pressure, ASME labeled conforming to ASME BPVC SEC VIII D1, with flanged or threaded fittings, and [manual] [automatic] drain valve. Manufacturer's recommended desiccant in tablet form which will not nest or cake. Contractor must provide a supply of desiccant for initial operations in unbroken shipping containers equal to not less than four charges of desiccant for the dryer.

2.7 LOW PRESSURE COMPRESSED AIR PIPING AND ACCESSORIES

Low pressure compressed air piping and accessories 862 kPa (gage) at 65 1/2 degrees C 125 psig at 150 degrees F, must conform to the following:

2.7.1 Steel Piping

a. Pipe: ASTM A53/A53M, seamless [or electric resistance welded] carbon steel, Schedule 40, black.

b. Fittings, size 50 mm 2 inches and larger: ASME B16.9, carbon steel, butt welding, schedule 40, or ASME B46.1, carbon steel welding neck flanges, Class 150, ASME B46.1, flanged fittings, carbon steel, Class 150, gaskets 1.50 mm 1/16 inch oil resistant synthetic rubber ASTM D1330, bolts ASTM A193/A193M, Grade B7, and nuts, ASTM A194/A194M, Grade 7. Butt welded joints must be full penetration consumable insert or backing ring type.

c. Fittings, size 40 mm 1 1/2 inches and smaller: ASME B16.3, threaded malleable iron, Class 150, or ASME B16.11, forged carbon steel Class 3000 socket welding or Class 2000 threaded. Joints may also be butt welded or flanged, as specified for sizes 50 mm 2 inches and larger.

d. Flat-faced steel flanges: Where connections are made to Class 125 cast iron flanges with steel flanges, use only flat-faced Class 150 steel flanges.

e. Unions: ASME B16.39, Class 1 (2068 kPa (gage) 300 psig WOG).

2.7.2 Copper Tubing

a. Tubing: ASTM B88M ASTM B88, Type K or L, hard drawn, Class 1.

b. Fittings: ASME B16.22 wrought copper or bronze, with silver brazed joints.

c. Brazing filler metal: FS QQ-B-654, Class III.

d. Unions: bronze, CID A-A-59617, brazed joint type.

e. Flanges and flanged fittings: ASME B16.24, bronze, Class 150, gaskets, oil resistant synthetic rubber, ASTM D1330, bolts ASTM A193/A193M, Grade B7, and nuts ASTM A194/A194M, Grade 7.

f. Flared fittings: ASTM B88M ASTM B88, Type K or L, annealed, with ASME B16.26 or SAE J513 flared fittings.

2.7.3 Valves

2.7.3.1 Gate Valves

a. Bronze Gate Valves: MSS SP-80, Class 150, 50 mm 2 inches and smaller, wedge disc, rising stem, inside screw type, with brazed joints ends when used with copper tubing.

b. Steel Gate Valves: ASME B16.34, 50 mm 2 inches and smaller, ASME B16.34, over 50 mm 2 inches, flanged ends, outside screw and yoke type with solid wedge or flexible wedge disc, [Class 150] [as recommended by the manufacturer for the conditions indicated.] [Provide motor operator where indicated.]

2.7.3.2 Globe and Angle Valves

a. Bronze globe and angle valves: MSS SP-80, Class 150, 50 mm 2 inches and smaller, Class 200, except that Class 150 valves with brazed ends may be used for copper tubing. Valves must have renewable seats and discs except brazed-end valves which must have integral seats.

b. Steel globe and angle valves: ASME B16.34, 50 mm 2 inches and smaller, ASME B16.34, over 50 mm 2 inches, flanged ends, [Class 150.] [As recommended by the manufacturer for the conditions indicated.] [Provide motor operator where indicated.]

2.7.3.3 Pressure Reducing Valves

ANSI/NFLPA T3.12.3, with nominal pressure rating of not less than inlet system pressure indicated. Provide pressure reducing valves capable of being adjusted to specified flow and pressure, and suitable for intended service. Provide pilot valve for dome loaded type if required for proper operation.

2.7.3.4 Safety Valves

ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped safety valve), 862 kPa (gage) 125 psig, for unfired pressure vessels, bronze, with threaded or flanged connections; factory set and sealed.

2.7.3.5 Check Valves

MSS SP-80, Bronze body with brazed joint or threaded ends or steel body with flanged end, ASME B16.34, or threaded ends, ASME B16.34. The check valve must have a perforated piston with closed downstream end, in line with the pipe and held closed by a steel poppet return spring.

2.7.3.6 Pressure Regulators

Diaphragm type, air loaded, tight closing single seat, brass body [with integral filter and bowl]. [Pressure regulators used to deliver compressed air for cleaning must be factory set at not more than 207 kPa (gage) 30 psig and must be nonadjustable.]

2.7.3.7 Needle Valves

One-piece bodies with integral or screwed bonnet, stems of hardened stainless steel with fine thread for metering and ease of adjusting, teflon packing; and must be of the pressure balanced type. Needle valves must be of the slow opening type.

2.7.3.8 Ball Valves

Full port design, copper alloy body, except sizes 65 mm 2.5 inches and larger must be ANSI Class 150 steel-bodied. Valves must have two-position lever handles.

2.7.4 Pressure Gages

ASME B40.100, Accuracy Grade A, for air, with steel or brass case, and nonshatterable safety glass, and a pressure blowout back to prevent glass from flying out in case of an explosion. Gages must have a 90 mm 3 1/2 inch minimum diameter dial and a dial range of approximately twice working pressure.

2.7.5 Hangers and Supports

Provide pipe hangers and supports conforming to MSS SP-58 and ASME B31.1, except as specified or indicated otherwise. Furnish zinc plated pipe hangers and supports except for copper plated inserts for copper piping. Provide tubing supports of U-shaped steel bolts and nuts firmly secured to adequately support structures such as walls, columns, floors, or brackets. Clips must fit closely around piping but must have sufficient clearance to permit longitudinal movement of piping during normal expansion and contraction. Provide supports at valves, fittings, branch lines, outlets, changes in direction, equipment, and accessories.

2.7.6 Quick Disconnect Couplings

All brass and suitable for a working pressure of not less than 862 kPa (gage) 125 psig. Female side of coupling (fixed end) must have male thread connection with automatic shutoff. Provide male side of coupling with hose stem and ball check to bleed pressure from hose and prevent hose whipping.

2.7.7 Single Cartridge Type Filters

862 kPa (gage) 125 psig operating pressure and filter housing of brass or bronze. Provide cellulose cartridge filters of graded density construction capable of removing liquids and solids of 5 microns and larger. Filter capacity must be compatible with rated flow of equipment or pressure reducing valves provided.

2.7.8 Strainers

FS WW-S-2739. Bronze or malleable iron body, Class 125, Style Y, Type II, simplex type, with 20-mesh Monel or stainless steel screen.

2.7.9 Traps

CID A-A-60001 to drain water and other liquids from system. Type of traps, as indicated, and rated working pressure not less than system operating pressure.

2.7.10 Lubricators

Brass body, 862 kPa (gage) 125 psig minimum rating, with [clear plastic bowl and metal guard.] [metal bowl.]

2.7.11 Flexible Connections

Vibration isolation, wire braid reinforced corrugated metal hose type, line-sized, with bronze end connections, suitable for pressure indicated. Length as recommended by manufacturer but not less than [457] [_____] mm [18] [_____] inches.

2.7.12 Dielectric Unions

Steel female pipe thread end and copper solder-joint ends, conforming to dimensional, strength and pressure requirements of ASME B16.39, Class 1. Steel parts must be galvanized or plated. Union must have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, it must also be able to withstand a 600-volt breakdown test.

2.7.13 Tetrafluoroethylene Tape

CID A-A-58092 for screw-jointed pipe.

2.7.14 Hose Reel Assembly

Complete with 15 meters 50 foot hose rated for a minimum of 862 kPa (gage) 125 psig, ball stop, hose extension with air coupler, hose rollers, [reel enclosure,] [nonsparking ratchet pawl,] and required accessories.

2.8 SLEEVES

2.8.1 Floor Slabs, Roof Slabs, and Outside Walls Above and Below Grade

Galvanized-steel pipe having an inside diameter at least 12.70 mm 1/2 inch larger than the outside diameter of the pipe passing through it. Provide sufficient sleeve length to extend completely through floors, roofs, and walls, so that sleeve ends are flush with finished surfaces except that ends of sleeves for floor slabs must extend 15 mm 1/2 inch above finished floor surface. Sleeves located in waterproofed construction must include flange and clamping ring.

2.8.2 Partitions

Galvanized sheet steel, 26 gage or heavier, of sufficient length to completely extend through partition thickness with sleeve ends flush with partition finished surface.

2.9 VALVE BOX

Provide rectangular concrete design with words "Compressed Air" cast or otherwise marked on the cover. Size must be large enough for removal of valve without removing box. Provide valve box for areas as follows:

a. Roads and traffic areas: Heavy Duty, cast iron cover

b. Other areas: Standard duty, heavy steel plate or concrete cover

2.10 IDENTIFICATION LABELS FOR PIPING

Labels for pipes 20 mm 3/4 inch o.d. and larger must bear printed legends to identify contents of pipes and arrows to show direction of flow. Except that of pipes smaller than 20 mm 3/4 inch o.d., labels must have color coded backgrounds to signify levels of hazard in accordance with ASME A13.1. Legends and type and size or characters must also conform to ASME A13.1. Labels must be made of plastic sheet in conformance with CID A-A-1689 with pressure-sensitive adhesive suitable for the intended applications or they may be premolded of plastic to fit over specific pipe outside diameters 20 mm 3/4 inch and larger. For pipes smaller than 20 mm 3/4 inch o.d., furnish brass identification tags 38 mm 1 1/2 inches in diameter with legends in depressed black-filled characters.

2.11 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

Polyethylene plastic tape manufactured specifically for warning and identification of buried utility lines. Tape must be of the type provided in rolls, 150 mm 6 inches minimum width, color codes for compressed air (gray) with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification must be "CAUTION BURIED COMPRESSED AIR LINE BELOW" or similar wording. Code and letter coloring must be permanent, unaffected by moisture and other substances contained in trench backfill material.

2.12 FRESH WATER

Fresh water for cleaning, flushing, and testing must be clean and potable.

2.13 SOURCE QUALITY CONTROL

Test air compressors and compressed air dryers at the factory to assure proper operation. Certify satisfactory accomplishment of tests.

PART 3 EXECUTION

3.1 INSTALLATION

Install materials and equipment as indicated and in accordance with the manufacturer's recommendations.

3.1.1 Excavation and Backfilling

Section 31 00 00 EARTHWORK.

3.1.2 Corrosion Protection

Provide corrosion protection for buried steel piping in accordance with Section 09 97 13.28 PROTECTION OF BURIES STEEL PIPING AND STEEL BULKHEAD TIE RODS.

3.1.3 Piping

Provide Non-Destructive Examination (NDE) report for welding of piping. Unless specifically stated to the contrary, fabrication, assembly, welding, and brazing must conform to ASME B31.1 for all piping of the air system. Piping must follow the general arrangement shown. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing, except where cold-springing is specified. Piping and equipment within buildings must be entirely out of the way of lighting fixtures and doors, windows, and other openings. Locate overhead piping in buildings in the most inconspicuous positions. Do not bury or conceal piping until it has been inspected, tested, and approved. Where pipe passes through building structure, pipe joints must not be concealed, but must be located where they may be readily inspected and building structure must not be weakened. Avoid interference with other piping, conduit, or equipment. Except where specifically shown otherwise, vertical piping must run plumb and straight and parallel to walls. Piping connected to equipment must be installed to provide flexibility for vibration. Adequately support and anchor piping so that strain from weight of piping is not imposed on the equipment.

3.1.3.1 Fittings

****

NOTE: Delete bending of medium and high pressure pipe when not included in project.

****

Use long radius ells where appropriate to reduce pressure drops. Pipe bends in lieu of fittings may be used for low pressure piping where space permits. Pipe bends must have a uniform radius of at least five times the pipe diameter and must be free from any appreciable flattening, wrinkling, or thinning of the pipe. Mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction must not be used. Make branch connections with welding tees, except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1 may be used.

3.1.3.2 Clearances for Welding

Provide clearances from walls, ceilings, and floors to permit the installation of joints. The clearances must be at least 150 mm 6 inches for pipe sizes 100 mm 4 inches and less, 250 mm 10 inches for pipe sizes over 100 mm 4 inches, and sufficient in corners. However, the specified clearances must not waive requirements for welders to be qualified for the positions to be welded.

3.1.3.3 Cleaning and Flushing Procedures

Before jointing and erection of piping or tubing, thoroughly clean interiors of pipe sections, tube, and components. In steel pipe, loosen scale and other foreign matter by rapping sharply and expel by wire brush and swab. Blow out both steel pipe and copper tube and components with compressed air at 689 kPa (gage) 100 psig or more. Maintain cleanliness by closure of pipe/tube openings with caps or plugs. Before making final terminal connections, blow out complete system with compressed air at 689 kPa (gage) 100 psig or more.

3.1.3.4 Changes in Pipe Size

Use reducing fittings for changes in pipe size. The use of bushings will not be permitted. In horizontal lines, 65 mm 2 1/2 inches and larger, reducing fittings must be of the eccentric type to maintain the bottom of the lines in the same plane.

3.1.3.5 Drainage and Flexibility

Compressed air piping must be free of unnecessary pockets and pitched approximately 25 mm per 10 meters 3 inches per 100 feet in the direction of flow to low points. Where pipes must be sloped so that condensate flows in opposite direction to air flow, slope 50 mm per 10 meters 6 inches per 100 feet or greater. Provide flexibility by use of fittings, loops, and offsets in piping. Install branches at top of a main to prevent carryover of condensate and foreign matter.

3.1.4 Threaded Joints

Where possible use pipe with factory cut threads, otherwise cut pipe ends square, remove fins and burrs, and cut taper pipe threads in accordance with ASME B1.20.1. Threads must be smooth, clean, and full cut. Apply thread tape to male threads only. Work piping into place without springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed.

3.1.5 Welding and Brazing Procedures

Perform welding and brazing in accordance with qualified procedures using qualified welders and welding operators and brazers. Do not perform welding and brazing when the quality of the completed weld or braze could be impaired by the prevailing working or weather conditions. The Contracting Officer will determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural members must be in accordance with AWS D1.1/D1.1M.

3.1.5.1 Cleaning for Welding and Brazing

Surfaces to be welded or brazed must be free from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces must be smooth and free from defects which might affect proper welding. Clean each layer of weld metal thoroughly by wire brushing, grinding, or chipping prior to inspection or deposition of additional weld metal.

3.1.5.2 Stress Cracking During Brazing

For material susceptible to stress corrosion cracking from molten brazing filler metal, avoid applying stress during brazing.

3.1.5.3 Welding or Brazing of Valves

Welding or Brazing of Valves: Disassemble valves subject to damage from heat during welding or brazing and reassemble after installation. Open valves two or three turns off the seat when not subject to heat damage during welding or brazing; do not backseat valve.

3.1.6 Flare Fittings

Provide flare fittings only where necessary to connect copper tubing to equipment. Use short sections of annealed tubing soldered or brazed to hard drawn tubing using couplings on expanded ends on the annealed tubing made with special tools designed for that purpose. Make flares with the appropriate flaring tools. Cut annealed tubing only with cutting wheel tool. Do not ream out inside burr or lip left by the cutting wheel but fold back lip with flare tool to form seal/gasket inside flare. When new, the flare should cover not more than 75 percent of the flare seating surface of either the male or female flare fittings. Put the flare nut on the tube before making the flare.

3.1.7 Valves

ASME B31.1. Install valves at the locations indicated and elsewhere as required for the proper functioning of the system.

3.1.7.1 Gate Valves

Provide gate valves unless otherwise directed. Install valves in positions accessible for operation and repair. Install valve with stem horizontal or above.

3.1.7.2 Globe Valves

Install globe valves so that the pressure will be below the disk. Install globe valves with the stems vertical.

3.1.7.3 Pressure-Reducing Valves

Provide compressed air entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two block valves and with a globe or angle bypass valve and bypass pipe. Provide a bypass around a reducing valve of reduced size to restrict its capacity to approximately that of the reducing valve. Provide each pressure reducing valve unit with an indicating gage to show the reduced pressure, and a safety valve on the low pressure side. These requirements do not apply to small pressure regulating valves used to adjust pressure for pneumatic equipment.

3.1.8 Hangers and Supports

****

NOTE: See NAVFAC P-355, "Seismic Design for Buildings," Chapter 10, "Mechanical and Electrical Elements," for calculating pipe support spacing for schedules not shown. Delete Table I and reference to seismic requirements if not required.

****

Selection, fabrication and installation of piping hangers and supports must conform to MSS SP-58,[except that spacing of the hangers and supports must be as per Table I.][Provide seismic restraints for piping in accordance with PPIC Seismic Restraint.]

TABLE I. MAXIMUM SPAN FOR PIPE (METERS)

DIAMETER MM	STD. WT. STEEL PIPE SCHEDULE 40	EX. STRONG STEEL PIPE SCHEDULE 80	COPPER TUBE TYPE K	COPPER TUBE TYPE L
15	1.50	1.50	1.10	1.00
20	1.75	1.75	1.30	1.30
25	2.00	2.00	1.50	1.45

TABLE I. MAXIMUM SPAN FOR PIPE (METERS)

DIAMETER MM	STD. WT. STEEL PIPE SCHEDULE 40	EX. STRONG STEEL PIPE SCHEDULE 80	COPPER TUBE TYPE K	COPPER TUBE TYPE L
40	2.30	2.35	1.75	1.70
50	2.60	2.60	2.00	2.00
65	2.80	2.90	2.20	2.10
80	3.10	3.20	3.35	2.30
90	3.35	3.35	2.50	2.50
100	3.50	3.60	2.75	2.70
125	3.90	3.90	3.05	2.90
150	4.20	4.25	3.25	3.20
200	4.70	4.90		
250	5.20	5.30		
300	5.55	5.80		

TABLE I. MAXIMUM SPAN FOR PIPE (FEET-INCHES)

DIAMETER INCHES	STD. WT. STEEL PIPE SCHEDULE 40	EX. STRONG STEEL PIPE SCHEDULE 80	COPPER TUBE TYPE K	COPPER TUBE TYPE L
1/2	5'-0"	5'-0"	3'-9"	3'-9"
3/4	5'-9"	5'-9"	4'-3"	4'-3"
1	6'-6"	6'-6"	5'-0"	4'-9"
1-1/2	7'-6"	7'-9"	5'-9"	5'-6"
2	8'-6"	8'-6"	6'-6"	6'-6"
2-1/2	9'-3"	9'-6"	7'-3"	7'-0"
3	10'-3"	10'-6"	7'-9"	7'-6"
3-1/2	11'-0"	11'-0"	8'-3"	8'-3"
4	11'-6"	11'-9"	9'-0"	8'-9"

TABLE I. MAXIMUM SPAN FOR PIPE (FEET-INCHES)

DIAMETER INCHES	STD. WT. STEEL PIPE SCHEDULE 40	EX. STRONG STEEL PIPE SCHEDULE 80	COPPER TUBE TYPE K	COPPER TUBE TYPE L
5	12'-9"	13'-0"	10'-0"	9'-6"
6	13'-9"	14'-0"	10'-9"	10'-6"
8	15'-6"	16'-0"		
10	17'-0"	17'-6"		
12	18'-3"	19'-0"		

3.1.9 Pressure Gages

Provide pressure gages with a shut-off valve or petcock installed between the gage and the line.

3.1.10 Strainers

Provide strainers with meshes suitable for the services where indicated, or where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.1.11 Equipment Foundations

Provide equipment foundations of sufficient size and weight and of proper design to preclude shifting of equipment under operating conditions or under any abnormal conditions which could be imposed upon the equipment. Provide foundations which meet the requirements of the equipment manufacturer, and when required by the Contracting Officer, obtain from the equipment manufacturer approval of the foundation design and construction for the equipment involved. Equipment vibration must be maintained within acceptable limits, and must be suitably dampened and isolated.

3.1.12 Equipment Installation

Install equipment strictly in accordance with these specifications, and the manufacturers' installation instructions. Grout equipment mounted on concrete foundations before piping is installed. Install piping in a manner that does not place a strain on any of the equipment. Do not bolt flanged joints tight unless they match properly. Extend expansion bends adequately before installation. Grade, anchor, guide and support piping without low pockets.

3.1.13 Cleaning of System

Clean the various system components before final closing as the installations are completed. Remove foreign matter from equipment and surrounding areas. Preliminary or final tests will not be permitted until the cleaning is approved by the Contracting Officer.

3.1.14 Pipe Sleeves

Provide pipe sleeves where pipes and tubing pass through masonry or concrete walls, floors, roofs, and partitions. Hold sleeves securely in proper position and location before and during construction. Sleeves must be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Extend sleeves in floor slabs 50 mm 2 inches above the finished floor. Pack space between the pipe or tubing and the sleeve firmly with oakum and caulk both ends of the sleeve with elastic cement.

3.1.15 Floor, Wall, and Ceiling Plates

Provide chromium-plated steel or nickel-plated cast iron plates on pipes passing through floors and partitions of finished rooms. Provide painted cast-iron, malleable iron, or steel for other areas.

3.1.16 Flashing for Buildings

Provide flashing [as required] [in accordance with Section 07 60 00 FLASHING AND SHEET METAL] where pipes pass through building roofs and outside walls.

3.1.17 Unions and Flanges

Provide unions and flanges where necessary to permit easy disconnection of piping and apparatus, and as indicated. Provide a union for each connection having a screwed-end valve. [Provide unions or flanges not farther apart than 30 meters 100 feet.] [Provide unions or flanges as indicated.] Provide unions on piping under 50 mm 2 inches in diameter, and provide flanges on piping 50 mm 2 inches and over in diameter. Install dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous to non-ferrous connections.

3.1.18 Painting of Piping and Equipment

Paint piping and equipment in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.1.19 Identification of Piping

Identify piping in accordance with ASME A13.1. Use commercially manufactured piping identification labels. Space identification marking on runs not farther apart than 15 meters 50 feet. Provide two copies of the piping identification code framed under glass and install where directed.

3.1.20 Warning and Identification Tape

Coordinate installation of utility warning and identification tape with backfill operation. Provide tape above buried lines at a depth of 200 to 300 mm 8 to 12 inches below finish grade.

3.2 CLEANING SILVERBRAZED PIPING

****

NOTE: All silverbrazed piping, including low pressure systems, should be cleaned to preclude corrosion from residual brazing flux.

****

Clean silverbrazed piping to remove residual flux remaining in the system after fabrication. Use one of the procedures below. The hot flush and hot recirculating flush are preferred. Minimum flow rate through any part of the system in liters per second gallons per minute must be 0.0037 1.5 times the inside diameter of the pipe in mm inches. For any flushing method used, the system must be full of water so that joints are completely submerged at all times.

3.2.1 Hot Flushing Method

Hot flush the system for one hour using heated fresh water. No part of the system must go below 43 degrees C 110 degrees F.

3.2.2 Hot Recirculating Flush Method

Perform hot recirculating flush for one hour. Heat water during flushing so that no part of the system falls below 43 degrees C 110 degrees F. After completing the hot recirculating flush, flush the system with cold fresh water for 15 minutes.

3.2.3 Cold Soak Method

Cold soak the system using fresh water at not less than 15.50 degrees C 60 degrees F for 12 hours. Following the 12 hour soak, flush the system with fresh water at not less than 15.50 degrees C 60 degrees F for 4 hours.

3.3 FIELD QUALITY CONTROL

3.3.1 Examinations

3.3.1.1 Welding Examinations

[The Contractor must] [The Government will] perform visual examinations to detect surface and internal discontinuities in completed welds. NDE on piping welds covered by ASME B31.9 is visual inspection only. Verify piping welds meet the acceptance criteria. Submit a NDE report meeting the requirements specified in ASME B31.9. Visually examine all welds. When examination indicates defects in a weld joint, the weld must be repaired by a qualified welder. Remove and replace defects as specified in ASME B31.1, unless otherwise specified. Repair defects discovered between weld passes before additional weld material is deposited. Whenever a defect is removed, and repair by welding is not required, blend the affected area into the surrounding surface, eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, examine the area by the same methods which first revealed the defect to ensure that the defect has been eliminated. After rewelding, reexamine the repaired area by the same test methods originally used for that area. Any indication of a defect must be regarded as a defect unless reevaluation by surface conditioning and reexamination shows that no unacceptable defects are present. The use of any foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

3.3.1.2 Brazing Examinations

The Contractor must perform brazing examinations. Visually examine all compressed air systems as follows:

a. Check brazed joint fit-up. Diametrical clearances must conform to brazing procedure requirements.

b. Check base material of pipe and fitting for conformance to the applicable drawing or specification.

c. Check grade of brazing alloy for conformance to the brazing procedure before fit-up or brazing.

d. Check completed brazed joint for a complete ring of brazing alloy between the outside surface of the pipe and the face of the fitting, and for a visible fillet.

e. Check stainless steel and other susceptible material for evidence of stress cracks. Check inside of joint if possible with borescope or other aids.

Defective joints may be repaired. However, no more than two attempts to repair by reheating and additional face feeding of brazing filler metal will be permitted, after which the defective joint must be unsweated, reprepared as a new joint, examined for defects on pipe and fittings, and rebrazed.

3.3.2 Testing

****

NOTE: If air (pressure) drop tests are used for system acceptance, assure leakages at acceptable rates through valves (or other components) are not causing pressure drop. Most hard-seated valves have some allowable leakage rate (about 10 cubic centimeters 0.0026 gal per hour of water per 25 mm one inch of valve size or 3 liters per hour 0.1 cubic feet per hour of gas per mm inch of valve size). Delete check for cross-connection if only one type of system is involved in project.

****

3.3.2.1 General Requirements, Testing

Perform testing after cleaning. Contractor must provide everything required for tests. Tests must be subject to the approval of the Contracting Officer. Calibrate the test pressure gages with a dead weight tester within [15] [_____] days before use and certify by initial and date on a sticker applied to dial face. [Pressurize each piping system individually and check to assure that there are no cross-connections between different systems prior to hydrostatic and operational tests.]

3.3.2.2 Hydrostatic Tests and Leak Tightness Tests

a. Preliminary Preparation

Remove or isolate from the system the compressor, air dryer, filters, instruments, and equipment which would be damaged by water during hydrostatic tests and reinstall after successful completion of tests.

b. Performance of Hydrostatic Tests

****

NOTE: Specify or show on the drawings the design working pressure of each system in the project.
****

Hydrostatically test piping systems in accordance with ASME B31.1. Vent or flush air from the piping system. Pressurize system for 10 minutes with water at one and one-half times design working pressure, then reduce to design working pressure and check for leaks and weeps.

c. Compressed Air Leak Test

After satisfactory completion of hydrostatic pressure test, blow systems dry with clean, oil-free compressed air, and test with clean, dry air at design working pressure. Brush joints with soapy water solution to check for leaks. Install a calibrated test pressure gage in piping system to observe any loss in pressure. Maintain required test pressure for a sufficient length of time to enable an inspection of joints and connections.

3.3.2.3 Operational Tests

Test equipment as in service to determine compliance with contract requirements and warranty. During the tests, test equipment under every condition of operation. Test safety controls to demonstrate performance of their required function. Completely test system for compliance with specifications.

3.4 INSTRUCTION TO GOVERNMENT PERSONNEL

Provide [2] [_____] man-days of instruction to [2] [_____] Government personnel in accordance with Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS for each type of compressor and compressed air dryer in the project.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-43 21 29 (April 2006)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Replacing without change**
UFGS-13401 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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FLOW MEASURING EQUIPMENT [POTABLE WATER] [SEWAGE TREATMENT PLANT]

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PART 1 GENERAL

PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-43 21 29 (April 2006)**
Change 1 - 11/24

Preparing Activity: NAVFAC **Replacing without change**
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SECTION 43 21 29

FLOW MEASURING EQUIPMENT [POTABLE WATER] [SEWAGE TREATMENT PLANT]

04/06, CHG 1: 11/24

****

NOTE: This guide specification covers the requirements for flow measuring equipment for use in potable water or sewage treatment plant.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Special consideration not included in this guide must be given to sewage with high salt water concentration or carrying industrial wastes containing components detrimental to materials used in typical treatment plant and biodegrading micro-organisms.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME PTC 19.5	(2022) Flow Measurement

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C704	(2019) Propeller-Type Meters for Waterworks Applications

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for

1.2 SYSTEM REQUIREMENTS

The flow measuring equipment must be the [variable head meter type for closed channel] [variable head meter type for open channel] [variable area meter type] [propeller meter type] [electromagnetic meter type] [volumetric meter for [open] [closed] channel] [ultrasonic meter type]. The design must permit ease of installation and must not have any features hazardous to personnel or detrimental to the equipment. Provision must be made to align and adequately lubricate moving parts. Interior parts must be easily accessible for adjustment, repair, and replacement.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Flow Measuring Equipment Components

Read-out Device

SD-06 Test Reports

Flow Measuring Equipment Calibration

Open Channel Test

Dimensional Inspection Report

Closed Channel Test

SD-08 Manufacturer's Instructions

Flow measuring Equipment Components

Submit manufacturer's written recommendation for installation and handling.

1.4 QUALITY ASSURANCE

1.4.1 Requirements

Perform calibration and submit test report for flume in variable head meter for open channel. Submit dimensional inspection report and flow versus differential head curve for variable head meters for closed channel; accuracy must be plus or minus 1.0 percent over a 10 to 1 flow range. Submit as required in paragraph entitled "Field Tests and Inspections."

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

****

NOTE: Choose the paragraphs which follow based on type of meter needed for the system selected in the paragraph entitled "System Requirements."

****

Unless otherwise specified, all materials and equipment must be standard commercial products in regular production by the manufacturer and suitable for the required service.

2.1.1 Variable Head Meter for Closed Channel

****

NOTE: Delete this paragraph and the subparagraphs which follow when variable head meter for closed channel is not required.

****

must include [an orifice plate] [a flow nozzle] [a Venturi tube] as differential head producer, a diaphragm meter as differential measurement, and [an indicator] [and an integrator] as read-out device[s]. [Remote transmission also must be included.] Meter must be provided for [potable water] [plant water] [water for chlorination] [air for aeration] [recirculated plant effluent] [plant effluent] [plant influent] [bypass line] [primary sludge] [return sludge] [sludge to waste] [digested sludge] flow where indicated.

[2.1.1.1 Orifice Plate

****

NOTE: Select this paragraph ORIFICE PLATE or the paragraphs below FLOW NOZZLE, VENTURI TUBE, or MODIFIED VENTURI.

****

must be of the differential producing type with circular hole, and designed for insertion in a [_____] mm inch pipe where indicated. The orifice plate must measure the flow of [_____] to [_____] [cubic meter per second] [gpm]. Provide the orifice plate with a flange union to hold the plate perpendicular to the axis of the pipe. The flange must have a pressure rating of 862 kPa 125 psi and must have threaded ends. The orifice plate must be of stainless steel and must be furnished with a tab designating line size, orifice size, and flow direction. The orifice plate must be in accordance with recommendations of the ASME PTC 19.5, except as modified herein. The pressure taps must be of the [flange] [one diameter upstream and one-half diameter downstream] [corner] type and sized in accordance with recommendations of the ASME PTC 19.5.

][2.1.1.2 Flow Nozzle

must be of the differential producing type having a modified Venturi flow nozzle contour, and designed for at least 90 percent head recovery for insertion in [_____] mm inch pipe where indicated. The nozzle must measure the flow of [_____] to [_____] [cubic meter per second] [gpm]. The flow nozzle must have 862 kPa 125 psi flanged ends conforming to ASME B16.1. Construct the nozzle of cast iron conforming to ASTM A126, Grade B. The throat liner must be of bronze conforming to ASTM B61. The length of the throat liner must be equal to 75 percent of the throat diameter. The inlet pressure tap must be one diameter upstream and the outer pressure tap must be [one-half diameter downstream] [the throat type]. [The taps for use with sewer and sludge must have built-in capabilities for manual rodding of the holes.]

][2.1.1.3 Venturi Tube

must be of the differential producing type, and designed for [potable water] [sewage] [sludge] service with at least 90 percent head recovery [in accordance with recommendations of the ASME PTC 19.5] for use in a [_____] mm inch pipe where indicated. The Venturi must measure the flow of [_____] to [_____] [cubic meter per second] [gpm]. The Venturi must have 862 kPa 125 psi flanged ends conforming to ASME B16.1. The laying length must be approximately that indicated. Construct the body of cast iron conforming to ASTM A126, Grade B. The throat section and vent bushing must be bronze conforming to ASTM B61. [For sludge service, equip the tube with manual vent cleaners requiring not more than 1.57 rad 90 degrees rotation for full operation.] [For sludge service, provide a water purge system and two matched assemblies of piping, valves, rotometers, and fittings. The purge system must operate on a clean water supply of 0.000063 cubic meter per second one gpm at a regulated pressure of 69 kPag 10 psiggreater than line pressure. The Venturi interior waterways must be finished with an anti-stick coating.]

][2.1.1.4 Modified Venturi

must be of the differential producing type, and designed for [potable water] [sewage] [sludge] service with at least a 90 percent head recovery for use in a [_____] mm inch pipe where indicated. The Venturi must measure the flow of [_____] to [_____] [cubic meter per second] [gpm]. The laying length must be approximately that indicated. The modified Venturi must be of the insert type constructed of fiberglass reinforced polyester. The holding flange must be carbon steel, bronze, or fiberglass reinforced plastic with integral pressure taps for mounting between 862 kPa 125 psi ASME B16.1 flanges.

]2.1.1.5 Diaphragm Meter

must have a range of [_____] to [_____] [cubic meter per second] [gpm], and a minimum differential of not less than 25 mm one inch. The maximum differential must be equal to the range squared but must not exceed 2500 mm 100 inches of water column. It must have stainless steel bellows with built-in overrange protection to prohibit deformation of the bellows. Contain the bellows in a forged brass or cadmium-plated forged carbon steel housing to withstand a working pressure of at least 3.45 MPa 500 psi. Transmit the output motion of the bellows to the local read-out device. There must be zero adjustment in the diaphragm meter. Accuracy must be plus or minus 0.5 percent of full scale over a 3 to 1 flow range.

[2.1.2 Variable Head Meter for Open Channel

****

NOTE: Delete these paragraphs when variable head meter for open channel is not required.

****

must include [a weir] [a flume] as head producer, a stilling well with float and cable as head measurement, and [an indicator] [a recorder] [and an integrator] as read-out device(s). [Remote transmission also must be included.] Provide meter for [potable water] [plant influent] [bypass line] [plant effluent recirculation] [return sludge] [plant effluent] flow where indicated.

[2.1.2.1 Weir

****

NOTE: Select this paragraph WEIR, or the paragraphs below PARSHALL FLUME or FLUME."

****

must be of the [rectangular] [1.05 rad] [60 degree] [triangular (V-notch)] [1.57 rad] [90 degree] [triangular (V-notch)] [Cipolletti] type as indicated. The weir must measure the flow of [_____] to [_____] [cubic meter per second] [mgd]. The upstream face of the weir plate must be flat and smooth. Any bolts or rivets used to fasten the plate must be countersunk flush with the plate. Bolt holes must include provision for adjustment of height and level. The edges of the weir plate exposed to flow must not exceed 3 mm 1/8 inch in thickness; where thicker plates must be used, the edge must be beveled 0.78 rad 45 degrees or more to the required 3 mm 1/8 inch. Make the weir plate of stainless steel or fiberglass reinforced polyester laminate containing at least 30 percent fiberglass by weight.

][2.1.2.2 Parshall Flume

must be of the Parshall type, and must measure the flow of [_____] to [_____] [cubic meter per second] [mgd]. The flume must have a converging upstream section, a throat, and a diverging downstream section. The complete unit must have vertical walls. Stilling wells and throat floor must be inclined downward. Construct the flume of polyester resin reinforced with not less than 30 percent fiberglass by weight and provided with locking devices for engagement with the grout around the liner. Reinforcing ribs must be an integral part of the flume while removable bracing must be provided to ensure proper maintenance of liner dimensions during shipment and installation.

][2.1.2.3 Flume

must be of the characterized type, and must measure the flow of [_____] to [_____] [cubic meter per second] [mgd]. The flume must have a cast iron measuring section having a circular inlet and a characterized outlet. The inlet line size must be [_____] mm inches. The inlet must be ASME B16.1, 862 kPa 125 psi, flanged. The flume must have a flat invert free from pockets and obstructions. [Equip the flume with a manual vent cleaner and sediment trap.]

]2.1.2.4 Float and Cable

must have a range of [_____] to [_____] [cubic meter per second] [mgd] with a head measurement of [_____] mm inches. Measure the crest level in a stilling well as indicated. The measuring system must include a float, cable, drum, transfer gear assembly, and cam mechanism to provide uniformly graduated units of flow. The float must be of polyester, stainless steel, or copper, and of a weight and shape that conform to the application requirements. The cable must be plastic-coated multi-strand stainless steel, stainless steel beads, or multi-strand monel. Groove the drum to prevent overlapping of the cable. Provide the float and cable with stops to prevent overranging and to provide a zero adjustment. All materials of construction must be corrosion-resistant. Provide protection tubes for the cables. Accuracy must be plus or minus 2 percent of the actual rate over a 5 to 1 range.

]2.1.3 Variable Area Meter for [Open] [Closed] Channel

****

NOTE: Delete this paragraph when a variable area meter for an open or closed channel is not required.

****

Provide a variable area meter as indicated. Make the variable area meter of a tapered tube with a float that will indicate a flow range of [_____] to [_____] [cubic meter per second] [gpm]. The tube must be glass with flow units etched on it and must be placed vertically for reading. It must consist of fiberglass, stainless steel, or aluminum with stainless steel fitted ends and fluorinated hydrocarbon rubber or chloroprene O-rings. The float must be stainless steel and easily read. The metering tube must be easily removed for range change or cleaning without tools or removing the meter from the line. Provide a needle valve for adjusting flow where indicated. Accuracy must be plus or minus 5 percent over a 3 to 1 range.

[2.1.4 Propeller Meter

****

NOTE: Delete this paragraph when a propeller meter is not required.

****

Provide a propeller meter where indicated. The meter must measure the velocity and convert it to flow units. The meter must have a range of [_____] to [_____] [cubic meter per second] [gpm] for use in a [_____] mm inch pipe. Materials must conform to the applicable requirements of AWWA C704. [The propeller meter must be of the saddle type for a working pressure of 862 kPa 125 psi and be supplied with a steel welding saddle and separate straightening vanes.] [The propeller meter must be of the tube type for a working pressure of 862 kPa 125 psi and be furnished complete with a tube, built-in straightening vanes, and 862 kPa 125 psi ASME B16.1 flanged ends, or threaded connections, as appropriate for the pipe.] Provide the meter head with a conical shaped three-blade propeller mounted transversely in the line. The meter must be completely sealed from water pressure and able to withstand thrust on the front of the propeller. Accuracy must be plus or minus 2 percent of actual rate over a 10 to 1 range.

][2.1.5 Electromagnetic Meter

****

NOTE: Delete this paragraph when an electromagnetic meter is not required.

****

****

NOTE: For plant influent service, allow the optional use of chloroprene-lined stainless steel or steel, polyurethane-lined stainless steel or steel, or fiberglass tubes. For primary sludge service, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, vitreous enamel-lined stainless steel or steel, glass-lined stainless steel or steel, or tetrafluoroethylene-lined aluminum tubes. For recirculated plant effluent, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, chloroprene-lined stainless steel or steel, or fiberglass tubes. For return sludge service, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, chloroprene-lined stainless steel or steel, or fiberglass tubes. For sludge to waste service, allow the optional use of tetrafluoroethylene-lined stainless steel, vitreous enamel-lined stainless steel or steel, or glass-lined stainless steel or steel tubes. For digested sludge service, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, chloroprene-lined stainless steel or steel, or fiberglass tubes. For plant effluent service, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, chloroprene-lined stainless steel or steel, or fiberglass tubes.

****

****

NOTE: Delete the bracketed sentence beginning "Provide a transformer..." when power supply is 120 volts.

****

****

NOTE: Delete requirements for cleaning except when meter is for any sludge service.

****

Provide a magnetic flow meter where indicated. The magnetic flow meter must measure the flow of [_____] to [_____] [cubic meter per second] [mgd] and be suitable for a [_____] mm inch pipe. The magnetic flow meter system must include a flow tube, local read-out receiver, [remote transmission,] and interconnecting cable where indicated. The flow meter must be a [tetrafluoroethylene-lined stainless steel or steel] [chloroprene-lined stainless steel or steel] [polyurethane-lined stainless steel or steel] [vitreous enamel-lined stainless steel or steel] [glass-lined stainless steel or steel] [tetrafluoroethylene-lined aluminum] [fiberglass] tube with the necessary cores and coils to provide a magnetic field without any interference and with [1034 kPa] [150 psi] [modified ASME B16.1 carbon steel flanges] [Dresser type coupling] [Victaulic type couplings] [integral fiberglass flanges]. Electrodes must be of stainless steel. The tube must operate from [120] [240] volts, [_____] hertz, single-phase ac power. A weatherproof housing must cover the magnets, coils, and connections. [Provide a transformer within the transmitter housing to provide 120 volts power to the receiver.] [Provide a system for cleaning the electrodes or tube automatically without taking the tube out of service. Automatic mechanical cleaning of electrodes or tube will not be acceptable.] The metering tube must have an approximate laying length as indicated. Provide all necessary cable between the transmitter and receiver. Accuracy must be plus or minus one percent over a 10 to 1 range. The receiver must convert the ac voltage signal generated in the flow tube to a uniform flow signal. There must be an adjustment for zero and span.

][2.1.6 Volumetric Meter

****

NOTE: Delete this paragraph when a volumetric meter is not required

****

Provide a volumetric meter where indicated. The meter must conform to AWWA C700. The meter must be of the rotating-disc type for use in a [_____] mm inch pipe and must be of the frostproof type, if applicable.

][2.1.7 Ultrasonic Meter

****

NOTE: Delete this paragraph when an ultrasonic meter is not required.

****

Provide an ultrasonic meter where indicated. The meter must have a velocity range of 0 to 1.52 meters per second through 0 to 6.10 meter per second 0 to 5 feet per second through 0 to 20 feet per second for use with a [_____] mm inch pipe. The flow meter must consist of [separate transmitting and receiving transducers clamped to the outside of the pipe to measure the liquid flow without, in anyway, intruding into or altering the pipe.] [the primary element employing a single pair of electro-acoustic transducers mounted diagonally in a flow tube, and in direct contact with the liquid flow to be measured] [a single transducer with twin crystals encapsulated in an epoxy housing mounted on the outside of the pipe. The transmitting crystal must emit a continuous ultrasonic pulse or frequency into the liquid stream to be reflected back to the receiving crystal. It must measure the difference in frequencies which is proportional to the liquid flow.] The transmitter must contain all necessary circuitry enclosed in NEMA 4 [indoor] [outdoor] housing suitable for [wall] [panel] mounting and connected to the transducers by [_____] m feet of cable. It must produce an accurate 4 to 20 mA dc signal linear with flow rate. It must provide linearity of plus of minus 0.5 percent and repeatability of 0.1 percent under simulated flow. Long term drift of the pulse rate output must be less than 0.1 percent. It must operate with 115 or 230 volt plus or minus 10 percent, 50 or 60 Hz electrical power. The unit must function over an ambient temperature range of [_____] degrees C F to [_____] degrees C F indoor or [_____] degrees C F to [_____] C F outdoor. The flow rate indicator must be integrally mounted in the transmitter housing. Graduate 150 mm 6 inch scale length in [meter per second] [cubic meter per second] [fps] [gpm].

]2.2 READ-OUT DEVICE

****

NOTE: Retain appropriate paragraphs and delete others.

****

Provide the meter with the following read-out device which must read from [_____] to [_____] [cubic meter per second] [gpm].

[2.2.1 Local Read-Out

****

NOTE: Choose this paragraph entitled "Local Read-Out," or the paragraph below entitled "Local Read-Out and Remote Transmission," including its subparagraphs "Indicator," "Recorder," and "Integrator."

****

Provide [an indicator] [a recorder] [and an integrator] for local read-out of flow. The scale graduation must be [uniform] [square root]. The read-out must be visible through a shatterproof clear window. The read-out mechanism must not be affected by the intended end use environment. The unit must be non-corrosive and weatherproof or provided with a separate weatherproof housing with a sealed door for access to the mechanism, and designed to prevent the accumulation of moisture or fog inside the case. Provide a suitable mounting.

][2.2.2 Local Read-Out and Remote Transmission

Provide [an indicating transmitter] [a recording transmitter] [and an integrator] for local read-out and transmission of flow data to remote read-out. The scale graduation must be [uniform] [square root]. The read-out must be visible through a shatterproof clear window. The read-out and transmission mechanism must not be affected by the intended end use of environment. The transmission must be impulse duration type or milliampere dc analog signal type to the remote read-out. Actuate all transmission by the output motion or the ac voltage signal of the meter. Power required [must come from the meter] [must be [_____] volts, [_____] hertz, ac]. When impulse duration type transmission is used, the system must have a 15 second maximum cycle actuating a cam-operated contact. The contact must be of the totally-enclosed type. The unit must be non-corrosive and weatherproof or provided with a separate weatherproof housing with a sealed door for access to the mechanism, and designed to prevent the accumulation of moisture or fog inside the case. Provide a suitable mounting.

2.2.2.1 Indicator

must be a minimum of 150 mm 6 inches long.

2.2.2.2 Recorder

must be a minimum of 250 mm 10 inches in diameter and must rotate once [daily] [weekly] [monthly]. The chart drive must be driven by a synchronous motor from [_____] volts, [_____] hertz, ac.

2.2.2.3 Integrator

must read the total flow in the units specified using only a whole power of 10 multiplier.

]2.2.3 Remote Read-Out

Provide [an indicator] [a recorder] [and an integrator] for remote read-out of flow. The scale graduation must be [uniform] [square root]. The read-out must accept the signal output and be of the same range and flow units as the local read-out and remote transmission device. The signal must actuate an electro-mechanical receiver in which the input duplicates the output of the remote transmission device. Ac or dc power supply must be provided, if required. The read-out must be visible through a shatterproof clear window. The read-out must not be affected by the intended end use environment. The unit must be weatherproof or provided with a separate weatherproof housing with a sealed door for access to the mechanism, and designed to prevent the accumulation of moisture or fog inside the case. Provide a suitable mounting.

2.2.3.1 Remote Read-Out Indicator

must be a minimum of 150 mm 6 inches long.

2.2.3.2 Remote Read-Out Recorder

must be a minimum of 250 mm 10 inches in diameter and must rotate once [daily] [weekly] [monthly]. The chart drive must be driven by a synchronous motor from [_____] volts, [_____] hertz, ac.

2.2.3.3 Remote Integrator

must read the total flow in the units specified using only a whole power of 10 multiplier.

2.3 ELECTRICAL REQUIREMENTS

****

NOTE: Delete paragraph except when electromagnetic meter, electric drive chart for recorders, or remote read-out is required.

****

****

NOTE: Delete requirements for signal circuit when remote read-out is not required.

****

Unless indicated or specified otherwise, the electrical components of the meters, such as chart drives and electrical disconnecting (isolating) means, are included under this section. [Provide wiring for signal circuit as specified by the equipment manufacturer.] The interconnecting conduit and wire (except when otherwise specified herein, or when included in factory-assembled equipment) and the electrical connection of the meters to the electrical power circuit are specified in Division 26.

2.4 SPARE PARTS

****

NOTE: Delete the bracketed sentence when recorder is not required.

****

Provide all standard recommended spare parts as specified in the manufacturer's instruction manuals for each component in the system. [Furnish one year's supply of charts and ink for each recording device.]

PART 3 EXECUTION

3.1 MATERIALS PROTECTION

The entire tube, except the throat section of the [flow nozzle] [Venturi] [characterized flume], must receive a series of coats of paint conforming to MIL-DTL-24441. Apply the paint in the following order: one coat of Formula 150, one coat of Formula 151, one coat of Formula 156, and one coat of Formula 152. The final total dry-film thickness must be not less than 0.25 mm 10 mils. Furnish all other items in accordance with the manufacturer's standard practice suitable for end use environment.

3.2 INSTALLATION

Furnish the services of an engineer representative of the manufacturer of the flow measuring equipment for checking the installation, making the necessary adjustments and calibrations, placing the equipment in operation, and performing the acceptance tests. The representative also must be available for not less than 2 days to instruct operating personnel in the use, operation, and maintenance of the equipment during the initial operating period. Install all flow measuring equipment in accordance with the recommendations of the manufacturer. Install variable head meter[s] for closed channel[s] in accordance with the ASME PTC 19.5. Install weir[s] with the top exactly level at the elevation indicated.

3.3 FIELD TESTS AND INSPECTIONS

Test and calibrate in place the flow measuring equipment to demonstrate that it meets the accuracy requirements for the full range of flows specified herein. Provide all labor, equipment, and incidentals required for the tests, including electric power and water required for tests. The Contracting Officer will witness all field tests and conduct all field inspections. The Contractor must give the Contracting Officer ample notice of the dates and times scheduled for tests. Rectify any deficiencies found and retest work affected by such deficiencies at the Contractor's expense. Record data from each field test must be recorded and documented in a formal field test report.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-43 31 13.13 10 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-43 31 13.14 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

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ACTIVATED CARBON-GAS AND LIQUID PURIFICATION FILTERS

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PART 3   EXECUTION

-- End of Section Table of Contents --

****
USACE / NAVFAC / AFCEC **UFGS-43 31 13.13 10 (August 2018)**

Preparing Activity: USACE **Superseding**
UFGS-43 31 13.14 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION 43 31 13.13 10

ACTIVATED CARBON-GAS AND LIQUID PURIFICATION FILTERS
08/18

****
NOTE: This guide specification covers the requirements for systems to transfer organic contaminants from water to activated carbon adsorption media.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 UNIT PRICES

****
NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
****

The Payment Schedule included with the Bid Form describes how treated water is paid. Unit payment for each modular activated carbon unit includes delivery, installation and placement in service. Unit payment for [reactivation][disposal] and replacement of the activated carbon includes placement of the spare unit in service, disconnection of the exhausted unit, drainage and treatment of the free water, transport of the activated carbon [to and from reactivation][to the disposal] facility, [reactivation][disposal and replacement] of the activated carbon and placement of the fresh carbon filled unit in the spare position.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA B600	(2024) Powdered Activated Carbon
AWWA B604	(2018) Granular Activated Carbon
AWWA B605	(2018) Reactivation of Granular Activated Carbon
AWWA C504	(2023) Standard for Rubber-Seated Butterfly Valves

AWWA C509	(2023) Resilient-Seated Gate Valves for Water Supply Service
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C701	(2019) Cold-Water Meters - Turbine Type for Customer Service
AWWA D100	(2021) Welded Steel Tanks for Water Storage
AWWA D102	(2024) Coating Steel Water-Storage Tanks
AWWA D120	(2019) Thermosetting Fiberglass-Reinforced Plastic Tanks

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A530/A530M	(2012) Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D1998	(2013) Polyethylene Upright Storage Tanks
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2652	(2011; R 2020) Activated Carbon
ASTM D2854	(2009; R 2019) Standard Test Method for Apparent Density of Activated Carbon
ASTM D2862	(2016) Standard Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D3299	(2010) Filament-Wound

	Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM D3860	(1998; R 2020) Determination of Adsorptive Capacity of Activated Carbon by Aqueous Phase Isotherm Technique
ASTM D4607	(2014) Determination of Iodine Number of Activated Carbon
ASTM D5158	(1998; R 2013) Determination of the Particle Size of Powdered Activated Carbon by Air Jet Sieving
ASTM D5421	(2015) Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM E1067/E1067M	(2018) Standard Practice for Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meeting

****

NOTE: Remove this paragraph when meeting is not required.

****

[Partnering][Pre-installation] meeting isrequired. Ensure that involved subcontractors, suppliers, and manufacturers are [notified][represented]. Furnish the date and time of the meeting to the Contracting Officer for approval.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Adsorption Battery Components

Backwash System

Carbon Storage and Transfer System

SD-03 Product Data

Activated Carbon Adsorption Units

Activated Carbon; G, [_____]

Safety Data Sheet

Adsorption Battery Components; G, [_____]

Posting Framed Instructions

Delivery, Storage, and Handling

Discharge

Iodine Number

Backwash System

SD-05 Design Data

Activated Carbon Adsorption Units; G, [_____]

Activated Carbon; G, [_____]

Total Head Loss

SD-06 Test Reports

Activated Carbon

Adsorption Battery components

Backwash System

Carbon Storage and Transfer System

Granular Activated Carbon

Factory Pressure Test Reports

Discharge Permit Compliance

SD-07 Certificates

Activated Carbon

Shells and Tanks

Shell and Tank Foundations

Motors

Manufacturer's Certificates

SD-10 Operation and Maintenance Data

Activated Carbon Adsorption System; G, [_____]

Operation and Maintenance Data in accordance with Section 01 78 23 OPERATION MAINTENANCE DATA, Data Package [2][3].

Preventive Maintenance Plan And Schedule

1.5 MAINTENANCE MATERIAL SUBMITTALS

Provide special tools necessary for adjustment, operation, maintenance, and disassembly for each type of equipment furnished; a lever type grease gun or other lubricating device for each type of grease required; and one or more steel cases mounted on the wall complete with flat key locks, two keys, and clips or hooks to hold each tool in a convenient location. Provide tools that are high-grade, smooth, forged, alloy, tool steel. Deliver tools at the same time as the equipment and hand over on completion of the work.

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

Provide pressure rated adsorption shells bearing the ASME BPVC SEC VIII D1 code stamp.

1.6.2 Qualifications

1.6.2.1 Constructor

Requires a cumulative minimum of [2][3][5][_____] years of experience in the construction of water treatment plants, wastewater treatment plants, industrial wastewater treatment plants, or industrial wastewater pretreatment plants.

1.6.2.2 Single Source Supplier

Assign full responsibility for the furnishing of the adsorption system to a single supplier. The designated single supplier coordinates the selection, assembly, installation, and testing of the entire system as specified herein. The designated single supplier need not manufacture the entire system.

1.6.2.3 Manufacturer's Representative

Provide the services of a manufacturer's field service representative experienced in the installation, adjustment, and operation of the equipment furnished and who possesses complete knowledge of the proper operation and maintenance of the system.

1.6.2.4 Welding

Provide documentation including welding procedures, lists of welders, and qualifications of welding operators in accordance with Sections 8.2 and 8.8 of AWWA D100.

1.6.2.5 Reactivation Facility

Provide qualifications of reactivation facility procedures and operation in accordance with AWWA B605.

1.7 DELIVERY, STORAGE, AND HANDLING

Submit instructions for any required sampling, preparation and shipping of activated carbon to reactivation or disposal facility. Submit a copy of the safety data sheet along with [materials] [materials and each chemical] delivered to the site. Submit the safety data sheet in conformance with 29 CFR 1910 Section 1200(g) for [activated carbon][activated carbon and each chemical].

1.7.1 Granular Activated Carbon

Package, mark, and ship granular activated carbon for potable water treatment in accordance with [AWWA B604,][AWWA B604 and AWWA B605].

1.7.2 Powdered Activated Carbon

Package, mark, and ship powdered activated carbon for potable water treatment in accordance with AWWA B600.

1.7.3 Equipment and Accessories

Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide an activated carbon adsorption units system as a complete process for removal of organic and inorganic contaminants from water as specified herein. Provided equipment to include, but not be limited to, vessels containing activated carbon, supporting equipment and accessories. Terminology is in conformance with ASTM D2652.

2.1.1 System Submittals

Submit the following data:

a. Process flow diagrams and instrumentation diagrams(s) showing all major pieces of process equipment with controls. Show on the drawings complete piping, wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and properly functions as a unit. Also show proposed layout and anchorage of equipment and appurtenances; equipment relationship to other parts of the work; clearances for maintenance and operation; and shop and erection details, including cuts, copes, connections, holes, bolts, and welds.

b. List of Federal, State, and local laws, regulations, and permits concerning activated carbon adsorption units that are applicable to operations and the requirements imposed by those laws, regulations, and permits.

c. Instrumentation and controls; capacities and pressure drop; make and model; complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions.

d. A complete list of parts, supplies and recommended spare parts for each different item of material and equipment specified, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1] and [3] year(s) of service.

e. Structural calculations for the adsorber shells, tanks and mounting and support details. Verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering, as appropriate, in the State in which the system was fabricated, stating that the fabrication drawings and pressure calculations for the shells and tanks were designed for the listed conditions in accordance with the appropriate codes and standards.

f. Designs for foundations, footings and supports. Verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering, as appropriate, in the State in which the system was fabricated, stating that the erection drawings for the shell and tank foundations and supports were designed for the listed conditions in accordance with the appropriate codes and standards.

g. Submit removal and replacement instructions including handling and reactivation of spent activated carbon in accordance with AWWA B605.

2.1.2 Design Requirements

****

NOTE: Determine wind speed from ASCE 7-16, Chapter 1. Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase in the first paragraph if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT, properly edited, must be included in the contract documents.

****

Provide seismic details in accordance with UFC 3-301-01 and [Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT][as indicated].

Minimum design life, modular unit		[_____] years
Minimum design life, other equipment		[_____] years
Adsorption system dimensions		
	Maximum vertical projection	[_____] m ft
	Maximum ground surface coverage	[_____] by [_____] m ft

Soil bearing capacity		[_____] MPa psf
Seismic parameters		[_____]
Wind speed (maximum)		[_____] km/h mph
Ground snow load		[_____] kPa psf
Ambient air temperature		
	Maximum	[_____]degrees C F
	Minimum	[_____]degrees C F

2.1.3 Influent Chemical Conditions

****

NOTE: Obtain an analysis of the water to be treated giving appropriate information to be inserted in the blank spaces. Provide all the available information. Average values for inorganic constituents may be adequate if additional information is not available.

Use of activated carbon for filtration is rarely cost effective. Plain or enhanced sedimentation is the preferred method for removal of suspended solids. Length of runs between backwash cycles and the media capacity may be reduced by biological activity or physical plugging which may result from continuous application of iron bearing or bioactive turbid waters to the adsorption unit. Activated carbon is fouled by growth on the media and formation of deposits on the carbon surface. Iron in the ferrous state may pass through the system. Ferric compounds are insoluble over a pH range of about 3 to 8, the pH range of most water supplies. Manganese is insoluble at a pH of 9 or greater. Pretreatment should be evaluated if iron exceeds 0.2 mg/L, manganese exceeds 0.1 mg/L, calcium exceeds 80 mg/L or magnesium exceeds 40 mg/L.

Lowering the pH by addition of mineral acids has been used to decrease the hydrogen bonding of dissolved organics and to increase metal solubility.

Raw water should be coagulated and filtered if the suspended solids exceed 5 mg/L (ppm) or if the turbidity exceeds 2.5 NTU. Prefiltration may aid in reducing deposition of iron or manganese.

Oxidizing agents, commonly chlorine or oxygen, may result in a loss of volume capacity and more frequent replacement of the media. Sources of oxidizing agents should be removed where feasible.

****

Influent inorganic chemical concentrations of [waste water][water from surface impoundment][ground water] are as determined by the AWWA 10084 method for each.

Influent Characteristic	Minimum	Average	Maximum
pH	[_____]	[_____]	[_____]
Conductivity (mho)	[_____]	[_____]	[_____]
Total hardness (mg/L as CaCO3)	[_____]	[_____]	[_____]
Total Iron (mg/L)	[_____]	[_____]	[_____]
Ferric Iron (mg/L)	[_____]	[_____]	[_____]
Ferrous Iron (mg/L)	[_____]	[_____]	[_____]
Total Manganese (mg/L)	[_____]	[_____]	[_____]
Soluble Manganese (mg/L)	[-----]	[_____]	[_____]
Calcium (mg/L)	[_____]	[_____]	[_____]
Magnesium (mg/L)	[_____]	[_____]	[_____]
Sodium (mg/L)	[_____]	[_____]	[_____]
Potassium (mg/L)	[_____]	[_____]	[_____]
Copper (mg/L)	[_____]	[_____]	[_____]
Total alkalinity (mg/L as CaCO3)	[_____]	[_____]	[_____]
Hydroxide alkalinity (mg/L as CaCO3)	[_____]	[_____]	[_____]
Carbonate (mg/L as CaCO3)	[_____]	[_____]	[_____]
Bicarbonate (mg/L as CaCO3)	[_____]	[_____]	[_____]
Sulfate (mg/L)	[_____]	[_____]	[_____]
Nitrate (mg/L)	[_____]	[_____]	[_____]
Chloride (mg/L)	[_____]	[_____]	[_____]
Fluoride (mg/L)	[_____]	[_____]	[_____]
Free Carbon Dioxide as CaC03 (mg/L)	[_____]	[_____]	[_____]
Dissolved Oxygen (mg/L)	[_____]	[_____]	[_____]

Influent Characteristic	Minimum	Average	Maximum
Free Chlorine Residual (mg/L)	[_____]	[_____]	[_____]
Silica (mg/L)	[_____]	[_____]	[_____]
Total Solids (mg/L)	[_____]	[_____]	[_____]
Total Dissolved Solids (mg/L)	[_____]	[_____]	[_____]
Total Suspended Solids (mg/L)	[_____]	[_____]	[_____]
Turbidity/Nephelometric Turbidity units (NTU)	[_____]	[_____]	[_____]
Color by Platinum Standard Comparison	[_____]	[_____]	[_____]

2.1.4 Performance Requirements

2.1.4.1 Flow Rate

Minimum [_____] L/second gpm
Average [_____] L/second gpm
Maximum [_____] L/second gpm

2.1.4.2 Water Temperature

Minimum [_____] degrees C degrees F
Average [_____] degrees C degrees F
Maximum [_____] degrees C degrees F

2.1.5 Bench Scale Data

****

NOTE: Include results, require performance of tests or both.

****

2.1.5.1 Isotherm Data

[Results of isotherm tests, as determined by ASTM D3860, are as follows: [_____].] [Carry out the isotherm test data with activated carbon similar to that to be supplied for use. If applicable, use reprocessed/reactivated carbon typical of the type to be supplied in the isotherm tests, including the same type of manufacture if from processed coal, coconut shell, wood, etc.]

2.1.5.2 Operating Performance Data

Results of operating performance tests are as follows: [_____].

2.1.5.3 Carbon Equivalency Test Data

Results of carbon equivalency tests are as follows: [_____].

2.1.6 Organic Contaminant Concentrations

****

NOTE: Water treated for potable use should meet the maximum contaminant level goals (MCLGs) of 40 CFR 141 for each identified organic contaminant. Additional requirements for potable water may be imposed by regulators or the Army Center for Health Promotion and Preventive Medicine. Because concentrated organic solutions are more readily treated than dilute solutions, overstatement of the influent concentrations of organic chemicals usually leads to problems. It is more prudent to increase the contact requirement in Paragraph: ADSORPTION BATTERY COMPONENTS and not apply safety factors here.

****

Organic Contaminant		
Influent Concentration (µg/Lppb	Maximum Effluent Concentration (µg/Lppb)	Percent Removal Requirement
Total Organic Carbon (TOC)		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]

Determine removal percentage as follows:

$$\frac{100\% \text{ x (Influent concentration - Effluent concentration)}}{\text{Influent concentration}}$$

2.1.7 Inorganic Contaminant Concentrations

****

NOTE: Activated carbon treatment of inorganics is specialized. Try to find more than one manufacturer of activated carbon that can treat the contaminants.

****

Inorganic Contaminant		
Influent Concentration (μg/Lppb)	Maximum Effluent Concentration (μg/Lppb)	Percent Removal Requirement
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]
[_____]		
Maximum [_____]	[_____]	NA
Average [_____]	NA	NA
Minimum [_____]	NA	[_____]

Determine removal percentage as follows:

$$\frac{100\% \text{ x (Influent concentration - Effluent concentration)}}{\text{Influent concentration}}$$

2.2 EQUIPMENT

****

NOTE: Completeness of steam regeneration is pressure/temperature dependent.

****

Provide new and unused materials and equipment with the exceptions noted for reprocessed activated carbon, reprocessed materials and modular treatment units. Provide an estimate or analysis of the pre-existing "heel" and the nature of any residual with the supply documentation if reprocessed carbon is to be supplied. The Contracting Officer reserves the option to refuse delivery of reprocessed carbon if, in the opinion of the Contracting Officer, the quality might interfere with accomplishment or verification of the treatment.

2.2.1 Activated Carbon

****

NOTE: To determine the working capacity of a specific brand of activated carbon: Determine the contact time (inverse of reaction rate) for the particular brand of carbon at the known total volatile organic content in the influent water and determine the amount of carbon required (isotherms) to obtain the reduction of the known volatile organic carbon content in the influent water.

Utilize rapid small-scale column test procedures to verify properties of activated carbon being used.

Designer should also evaluate with government whether full-scale column testing is warranted based on project size, flow rate, economics, etc. in an effort to ensure the Government is getting the optimum GAC and not wasting.

Activated carbon used in treatment of water for potable use should conform to AWWA requirements. Wastewater carbon is not manufactured to AWWA standards. Remove or reword this paragraph when carbon is not required to conform to AWWA.

Activated carbon should be in accordance with AWWA if the treated water goes into a potable water system. Verify with the appropriate authorities that wastewater carbon is acceptable for water that is to be discharged or re-injected.

****

Provide material free from impurities that affect the serviceability and appearance of the finished product. Provided activated carbon that does not require dosing or addition of a chemical mixture or solution to the water to be treated or to the water used for backwashing. Furnish the following quantity: [[_____] cubic meters cubic feet][[_____] kg pounds] of processed and graded activated carbon for [potable] [waste] water treatment. Submit design calculations indicating removals of each of the listed compounds in the carbon bed. Material must conform to the following:

a. Adsorptive capacity, iodine number as determined by ASTM D4607, not less than [500][650][900][950][1,000][_____] milligrams per gram. Submit the iodine number; isotherm and column test data.

b. Apparent density, as determined by [ASTM D2854][ASTM D5158], [0.4 to 0.6][_____] grams per cc[25 to 37][_____] lb. per cu. ft, corrected for moisture.

c. Effective size [0.35 to 1.30][_____] mm [0.14 to 0.5][_____] inches and uniformity coefficient not greater than [2.1][_____], as determined by ASTM D2862, with the following gradation:

(1)

SIEVE	PERCENT PASSING
2.36 mm No. 8	[90] [_____]
2.00 mm No. 10	[_____]
1.70 mm No. 12	[85] [_____]
1.40 mm No. 14	[_____]
1.18 mm No. 16	[_____]
0.85 mm No. 20	[_____]
0.60 mm No. 30	[4] [_____]
0.42 mm No. 40	[4] [_____]
0.30 mm No. 50	[4] [_____]

d. Submit manufacturer's certificates, including the name and address of the production facility, attesting that the activated carbon furnished meets the specified requirements. Submit certification of the activated carbon [supplier][transporter][reactivation facility in accordance with AWWA B605]. Submit copies of the Department of Transportation licenses of carbon reactivation service

2.2.1.1 Powdered Activated Carbon

Provide powdered activated carbon for potable water service in conformance with AWWA B600.

2.2.1.2 Granular Activated Carbon

Provide clean and hard granules.

2.2.1.2.1 Potable Water Service

Provide granular activated carbon for potable water service conforming to [AWWA B604][AWWA B604 and AWWA B605],as appropriate. Submit reports of testing granular activated carbon in accordance with AWWA B604.

2.2.1.2.2 Waste Water Service

Provide granular activated carbon for waste water service [reprocessed from previous as long as it meets the specified requirements][of a type suitable for reactivation] and supported by services for transportation of [shell][and spent carbon] and reactivation[of spent carbon]. Submit documentation and copies of licenses to the Contracting Officer.

2.2.2 Adsorption Battery Components

****

NOTE: See EM 1110-1-4008 Liquid Process Piping for compatibility of materials with the solution being treated. General rules for configuration of a liquid phase activated carbon system are as follows:

a. Two stage serial operation to provide longer contact and more complete exhaustion of the carbon is preferred, particularly when anticipated carbon consumption is high, required bed depths exceed 4.5 meters 15 feet and/or contact times in excess of 30 minutes are required for contaminant reduction. In serial operation, the unit with the freshest carbon at any given time should be in the lag position. For critical operations, lead, lag and standby units should be provided.

b. Multiple units in parallel operation are frequently used for high flows with low contamination levels when short contact times are adequate. Single units should be used only in installations in which the system can be shut down for change out of the activated carbon adsorption media. Multiple smaller units are always preferable to single large units containing the same amount of carbon and providing equal contact.

c. Upflow pulsed bed operation should be considered in lieu of multiple units in series.

d. An appropriate piping configuration arrangement can adapt the units for serial or parallel operation. Arrangements that allow conversion from parallel to series and the reverse, provide the flexibility to respond to differing conditions.

e. Design surface loadings range between 0.7 and 4 liters per second per square meter 1 and 6 gpm/sq ft. Lower surface loadings result in longer runs between backwashes and higher backwash flow rate requirements.

f. Minimum bed depth is based on the contact time required to achieve the required removal. Additional bed volume allows time between carbon changes. The minimum bed depth specified should not be less than 0.75 m 30 inches to avoid short circuiting. Minimum freeboard above the bed must be not less than 25 percent of bed depth. At loading

rates between 3.4 and 4 liters per second per square meter 5 and 6 gpm/sq ft the minimum bed depth should be increased from 0.75 m 30 inches to 1 m 36 inches in proportion to the surface loading to maintain the volumetric loading below 4.5 liters per second per cubic meter 2 gpm per cubic foot.

g. Coordinate number and location of units with the appropriate drawings.

****

Provide adsorption batteries consisting of [_____] units. Performance specified refers to each unit and not to the battery as a whole. Provide a downflow liquid adsorption unit, having a capacity to treat [_____] liters gallons of water at a flow rate not exceeding [_____] L/second gpm with a maximum influent total organic carbon concentration of [_____] [milligrams][micrograms] per liter during the interval between carbon replacements to a maximum effluent total organic carbon concentration of [_____] [milligrams][micrograms] per liter. Ensure carbon replacement intervals are not less than [_____] days.

2.2.2.1 Head Loss

****

NOTE: Compare several manufacturers data and select a reasonable number.

****

Head loss in each unit at rated flow must not exceed [2][3][7][30][60][_____] kPa [0.3][0.44][1][4][8][_____] psig when filled with fresh media. Submit demonstration of, or design calculations for, the total head loss through the carbon, adsorbers and appurtenant piping.

2.2.2.2 Adsorption Shell

****

NOTE: Avoid pressurizing shells that do not conform to ASME BPVC SEC VIII.

****

Ensure adsorber shells have a minimum effective cross sectional area of [_____] square meters square feet with a minimum straight shell (tangent line to tangent line) height of [_____] meters feet.

2.2.2.2.1 Modular units

****

NOTE: Transportable units should be considered for units containing less than 900 kg 2000 pounds of activated carbon and the required hydraulic capacity is less than 600 liters per second 10,000 gpm or the appropriate configuration is a standard product of a nearby supplier. Spare units are used for replacement of exhausted units, which are returned to the carbon manufacturer for reactivation of the activated carbon. Drum style containers may be used for very small amounts of carbon.

****

Modular units need not be new if pressure rating and all other requirements of this section are met. Provide factory assembled units secured to a structural frame suitable for shipment or transport with a forklift and set on a level area for operation. Prepare unit for connection to on-site pipelines. Mount shell on skid supports of cast-iron or steel to support the weight of the units, carbon and water while in service without point bearing on the floor slab. Fabricate skid mountings and shells for the live and dead loads of the shell full of water. Provide assembly structure that is adequate to provide support to the units during transport. Provide connectors for connection of modular tank inlets and outlets to the permanent piping system. Provide modular units in compliance with [AWWA B605][Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS] for transport of spent carbon.

2.2.2.2.2 Permanent Units

Design, fabricate, and erect adsorption shells not equipped with an open vent of steel in accordance with ASME BPVC SEC VIII D1 for a gage working pressure of [8.8][_____] MPa [125][_____] psi. Stamp working pressure on shell. Fiberglass or polyethylene adsorption shells are acceptable if equipped with an open vent or overflow. Ensure fiberglass shells comply with AWWA D120 or with ASTM D3299 with nozzle flanges in accordance with ASTM D5421. Ensure polyethylene shells conform to ASTM D1998. Line steel shell and both sides of false bottom with nontoxic epoxy, vinyl ester or rubber. Supply shells with cast-iron or steel supports. Fabricate supporting structures and shells for the seismic and wind loads listed in the design requirements, plus live and dead loads of the shell full of water.

2.2.2.2.3 Connections

Provide a vent and a rupture disc on the influent of each adsorber. Provide each adsorber with a means for carbon fill and removal and with permanent connections for water inlet, outlet, and backwash.

2.2.2.2.4 Openings

****

NOTE: Access openings 100 by 150 mm 4 x 6 inches or larger will be provided in upper head of shells less than 0.9 meter 36 inches in diameter; access openings 275 by 400 mm 11 x 15 inches or larger will be provided for shells 0.9 meters 36 inches in diameter and larger.

****

Provide each shell with an access opening [100 x 150][275 x 375][_____] mm [4 x 6][11 x 15][_____] inches or larger. Provide openings with closure and positive seal adequate for the tank pressure rating.

2.2.2.2.5 Hardware

Provide stainless steel bolts and attaching hardware conforming with ASTM F593.

2.2.2.3 Collection/Underdrain System

****

NOTE: Select appropriate system and remove

subparagraphs describing systems not needed in the project.
****

Provide an underdrain system within the shell for collecting treated water as specified below and to distribute the backwash water uniformly over the entire bed cross-section at velocities that prevent channeling of the carbon bed. Under actual operating conditions do not wash the activated carbon out of the apparatus regardless of the change of demand rate up to the maximum on the apparatus.

2.2.2.3.1 Nozzle Type

Provide a collector/backwash nozzle for each [93,000][_____] square mm [1][_____] square foot of carbon surface area.

2.2.2.3.2 Deflector-Plate Type

****
NOTE: Shells smaller than 1500 mm 60 inches in diameter will be equipped with nozzles or deflector-plate collector system.
****

Provide a deflector-plate made of [cast-iron][or][steel], and [rubber][or][nontoxic epoxy] lined, fastened to the bottom of the shell, and arranged for discharge through radial slots. Provide pipe connections for treated water outlet or backwash inlet on the underside between the deflector and the shell bottom.

2.2.2.3.3 False Bottom Type

****
NOTE: Shells larger than 1500 mm 60 inches in diameter may be equipped with false-bottom or header-lateral-distributor type collector system.
****

Provide a false bottom with attached strainers constructed of stainless steel strainers and fasteners.

2.2.2.3.4 Header-Lateral-Distributor Head Type

****
NOTE: The false bottom or header-lateral-distributor head type will be allowed for all shells 900 mm 36 inches in diameter or larger.
****

Provide a header-lateral-distributor head consisting of a circular, square or branched manifold or header, connected to laterals provided with strainer heads or strainers with openings placed radically so as to discharge horizontally or downward. Provide [stainless steel, conforming to ASTM A312/A312M and ASTM A530/A530M][polyvinyl chloride, conforming to ASTM D1785 or ASTM D2241] headers and laterals. Manufacture strainer heads and strainers of materials compatible with the header-lateral system, (polyethylene, polypropylene, polyvinyl chloride or stainless steel). Ensure laterals and strainer heads, after being placed, do not protrude into the header or laterals. Support system by [a steel plate or steel angles conforming to ASTM A666 with [vinyl ester][nontoxic epoxy][or rubber] linings][or by][concrete fill][or][directly on the bottom of the shell].

2.2.3 Mode of Operation

2.2.3.1 Serial Operation

Provide valves on the influent, effluent and backwash connections of each unit to allow any unit to operate and function as the lead or lag unit or stand-by as required.

2.2.3.2 Parallel Operation

Provide valves on the influent, effluent and backwash connections on each of the parallel units adequate to allow the unit to be taken out of service to backwash or change out the activated carbon in the unit without affecting the operation of the other units.

2.2.3.3 Parallel or Serial Operation

Provide units designated for use in either series or parallel operation with valves on the connections that allow switching between modes of operation without disconnecting any of the piping.

2.2.4 Total Organic Carbon Analyzer

****

NOTE: Optimum operation for serial operation would be for the lead column to be operated until the influent and effluent are of equal concentration and the carbon bed is completely spent. The combination of a predictable influent and a well developed sampling program would eliminate the need for the on-line analyzer.

****

Provide a wall mounted analyzer for automatically testing the total organic carbon content of the water in the effluent line leading from each adsorption unit. Provide analyzer capable of carrying out intermittent tests on the effluent and giving visual warning that the residual organic carbon present exceeds a predetermined limit. Equip the analyzer with necessary wiring and [controls for automatic alternation of units][an alarm device to give notice] when the total organic carbon in the water delivered by the lead adsorption unit exceeds [_____] [milligrams][micrograms] per liter [ppm][ppb].

2.2.5 Water Meter

Provide each adsorption unit with a displacement or turbine-type water meter reading in [_____] liters gallons, conforming to AWWA C700 or AWWA C701 as appropriate. Provide meter in the adsorption unit [influent line][effluent line] and locate to be readily accessible for reading and setting. Provide infinitely adjustable meter contacts over the range of the meter to permit setting to suit actual total organic carbon content of the water being treated. Equip meter with necessary wiring and electric controls for automatic backwashing or an alarm device to give notice when the adsorber has delivered [_____] liters gallons of water.

2.2.6 Differential Pressure Sensor

Provide differential pressure sensor capable of measuring plus or minus 5 percent variation in the pressure drop across the media. Equip sensor with necessary wiring and controls for automatic backwashing or an alarm device to give notice when the pressure differential exceeds the set point.

2.2.7 Interlocks and Alarms

Provide interlock system to prevent backwashing of more than one unit at a time and to prevent backwashing when the waste backwash tank capacity is inadequate to contain any additional backwash. Provide a manual-reset alarm timer on the backwash control panel for timing backwash cycles. Locate alarm lights on the local control panel and duplicate on a panel in the main control room. Locate audible annunciator above the appropriate vessel with an automatically resetting waterproof manual shut-off located with no obstructions to access [_____][1.2] m [_____][4] feet above grade.

2.2.8 Pressure Gauges and Sampling Cocks

2.2.8.1 Pressure Gauges

Provide pressure gauges connected to the influent and effluent to indicate the pressure loss through the adsorber and its pipe, valve, and fitting assembly for each adsorption unit. Provide precision type gauges with bronze Bourdon tube and phenolic case and an accuracy of plus or minus 1/2 percent conforming to ASME B40.100.

2.2.8.2 Sampling Cocks and Valves

Provide [steel,][PVC][or][brass], ground key, lever handle, faucet type sampling cocks or ball valves upstream of the adsorbers and on the downstream side of each unit for sampling the influent and the effluent of each of the individual adsorbers.

2.2.9 Valves

****

NOTE: Delete the inapplicable types of operation.

****

Ensure the design of the valve operators and mechanisms avoids initial surges and sudden inrushes of influent or backwash by gradually allowing flows to increase as ports are opened. Provide a dial pointer to indicate each step of the operation.

2.2.9.1 Butterfly Valves

Provide butterfly valves 75 through 1,800 mm 3 through 72 inches conforming to AWWA C504.

2.2.9.2 Gate Valves

Provide gate valves less than 75 mm 3 inches in diameter made of bronze with screwed ends, conforming to MSS SP-70 and valves 75 mm 3 inches or larger must conform to AWWA C509. Provide valves that open in counter clockwise direction, with an operating wheel having an arrow, cast in the metal, indicating the direction of opening.

2.2.9.3 Package-Type Valve Nest

Provide package-type valve nest consisting of a pilot valve connected with fittings as may be required to each one of a nest of valves hydraulically or pneumatically operated. Connect the nest of valves to raw water inlet, treated water outlet, backwash inlet and outlet, and activated carbon refill inlet and outlet.

2.2.9.4 Ball Valves

Provide full port stainless steel ball valves on carbon fill and discharge lines.

2.2.10 Isolation Joints

2.2.10.1 Dielectric Fittings

Provide dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, to prevent metal-to-metal contact of dissimilar metallic piping elements. Ensure fittings are suitable for the required working pressure.

2.2.10.2 Isolation Joints

Provide isolation joints between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Provide isolation joints consisting of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Provide full faced isolation gaskets with outside diameter equal to the flange outside diameter. Bolt isolation sleeves must be full length. Provide units shaped to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.2.10.2.1 Sleeve-type Couplings

Use sleeve-type couplings for joining plain end pipe sections. Provide couplings consisting of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

2.2.10.2.2 Split-sleeve Type Couplings

Use split-sleeve type couplings in aboveground installations when approved in special situations; consisting of gaskets and a housing in two or more sections with the necessary bolts and nuts.

2.2.11 Pipe and Fittings

Provide pipe hangers and supports with Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING. Provide pipe, valves and fittings for liquids in accordance with Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING. Provide pipe, valves and fittings for compressed air in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.2.12 Bolts, Nuts, and Fasteners

Unless otherwise indicated, furnish galvanized bolts, anchor bolts, nuts, washers, plates, bolt sleeves, and all other types of supports necessary for the installation of the equipment with the equipment.

a. Where indicated, specified, or required, provide anchor bolts with square plates at least 100 by 100 by 9 mm 4 by 4 by 3/8 inch thick or with square heads and washers set in the concrete forms with suitable sleeves.

b. Provide expansion bolts with malleable-iron and lead composition elements.

c. Unless otherwise specified, provide stud, tap, and machine bolts of refined bar iron, with threads conforming to ASME B1.1.

d. Zinc coat bolts, anchor bolts, nuts, and washers specified to be galvanized after being threaded, by the hot-dip process in conformity with ASTM A123/A123M or ASTM A153/A153M. Provide Type 316 stainless steel bolts, anchor bolts, nuts, and washers indicated to be stainless steel.

2.2.13 Electrical Work

****

NOTE: Carbon dust is conductive and ignitable and can form explosive mixtures with air. Coordinate hazard areas with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and the drawings. AWWA calls for water tight enclosures.

****

Implement indicated hazard classifications in accordance with NFPA 70. Perform electrical work in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2.13.1 Motors

Provide electrical motor-driven equipment complete with starters and alternating current motors conforming to NEMA MG 1. Provide single-phase 115-volt 60 cycle fractional horsepower electric motors. Provide three-phase 60 cycle integral horsepower electric motors. Provide motor starters complete with properly sized thermal overload protection and other appurtenances necessary for the motor specified. Design each motor for operation in a 40 degree C 104 degree F ambient temperature.

2.2.13.2 Controls and Panels

Provide manual or automatic controls and protective or signal devices required for the operation specified, and any control wiring required for controls and devices. Ensure motor controls conform to NEMA ICS 1 and enclosures for power and control panels conform to NEMA ICS 6.

2.2.14 Storage Tanks

Fabricate each tank from steel conforming to ASTM A666 not less than 5 mm 3/16 inch thick, lined with enamel, or of fiber glass filament-wound reinforced plastic construction, conforming to ASTM D3299.

2.2.15 Backwash System

****

NOTE: The backwash system is a major system that

should be shown on the drawings. Four or more adsorbers in parallel may have sufficient effluent flow for backwashing because the backwash flow requirement for a single adsorber is approximately equal to three times the effluent flow. Backwash supply tankage and backwash pumps might not be required if the discharge pressure is adequate. Elimination of waste backwash tankage is rarely feasible.

****

Initiate backwash operation via [fully automatic differential pressure sensors or timers][semiautomatic push button switch in response to an alarm connected to a water meter][manual in response to an alarm connected to a water meter].

2.2.15.1 Backwash Flow Controller

Install an adjustable flow control valve on the backwash supply header to regulate the flow at any set point between [_____] and [_____] L/second gpm to the backwashing adsorber regardless of variations in upstream head conditions.

2.2.15.2 Backwash Initiation and Return to Service

[Ensure automatic and semiautomatic controls permit backwashing to proceed automatically with no manual assistance.][Control manual backwash and return to service manually by the operator by turning the multiport valve or pilot valve.] Controls are subject to convenient and accurate manual adjustment designed for manual operation in the event of failure of the electrical equipment.

2.2.15.3 Backwash Supply Tankage

****

NOTE: Each filter is backwashed at approximately 10.2 liters per second per square meter 15 gallons per minute per square foot to provide 25 to 50 percent bed expansion. Backwash supply 10.2 liters per second x 900 seconds x 2 backwashes for each square meter 15 gpm x 15 minutes x 2 backwashes for each square foot of activated carbon bed surface area.

****

Provide backwash supply system with a minimum effective capacity to provide storage of [_____] liters gallons.

2.2.15.4 Backwash Waste Holding Tankage

****

NOTE: To provide time for backwash wasting or recycling, the minimum waste backwash holding capacity is 1.5 to 2 times the backwash supply holding capacity.

****

Provide waste backwash system holding tank having a minimum capacity to provide storage of [_____] liters gallons.

2.2.15.5 Valves, Switches, and Sensors

Equip each tank with a [float][or][solenoid] operated inlet valve. Activate solenoid-operated valve by a [probe,][a float-operated switch][or][a timer together with a float switch] to automatically shut off the incoming flow in the event of failure of the timing mechanism. Mount water inlet valves and switches externally. Mount floats and probes internally or externally, as long as the rapid evacuation of the tank does not interfere with their operation.

2.2.15.6 Pumps

Provide backwash pump in accordance with Section 23 21 23 HYDRONIC PUMPS. Provide waste backwash return pump in accordance with Section 23 21 23 HYDRONIC PUMPS.

2.2.16 Carbon Storage and Transfer System

****

NOTE: Most vessels are pneumatically charged directly from the carbon delivery truck. On-site storage and transfer is provided for remote and large systems. The transfer system is a major system that should be shown on the drawings. Activated carbon storage guidelines for medium to large systems: fresh carbon storage should allow for 1 truck + 1 tank of 44,000 kg 20,000 lbs and spent carbon storage should allow for 1 truck + 2 tanks.

****

2.2.16.1 Fresh Carbon Storage Tanks

Provide a fresh carbon storage system with a minimum capacity of the system provides storage of [_____] kg pounds of dry carbon at a bulk density of [_____] kg per cubic meter pounds per cubic foot.

2.2.16.2 Spent Carbon Storage Tanks

Provide a spent carbon storage supply system with a minimum capacity to store [_____] kg pounds of wet carbon saturated with organics.

2.2.16.3 Carbon Slurry Transfer Pump

Provide carbon slurry transfer pump in accordance with Section 23 21 23 HYDRONIC PUMPS.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Assemble the adsorption system equipment in the shop to the maximum practical extent. Conduct a factory pressure test at [125][250][_____] percent of the rated pressure of the equipment. Examine fiberglass tanks in accordance with ASTM E1067/E1067M. [Furnish test reports with the equipment][Submit factory pressure test reports to the Contracting Officer prior to shipment of the equipment].

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

3.2.1 Equipment Installation

****

NOTE: Pump bases and footings for adsorbers should be located and detailed on the drawings.

****

Mount each adsorber shell or tank [by anchoring to a footing isolated from the floor slab][on a skid base]. Provide anchor brackets, anchor rods or straps to hold the shell to anchors in the footing. Fabricate skids from [cast iron][or][steel] channels and design to support the equipment and to distribute the weight in transit and in service filled with water without point loading on the tank or concrete slab.

3.2.2 Pipe, Valves, Fittings and Appurtenances

Install piping, including cleaning, cutting, threading and jointing, in accordance with Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING or Section 22 00 00 PLUMBING, GENERAL PURPOSE, as appropriate to the application. Provide differing metals with isolation devices.

3.2.2.1 Strainers

****

NOTE: This paragraph is needed only for header-lateral-distributor collectors.

****

Protect strainer heads and strainers during placement of concrete fill provided for support of the header-lateral-distributor head.

3.2.2.2 Heat Trace and Insulation

Provide exterior pipe and appurtenances with an electrical heat trace and insulate in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.3 Electrical Work

Perform electrical work as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Transfer

3.2.4 Onsite

****

NOTE: The flow rate is usually based on a 50 mm 2 inch pipe diameter. Average velocity in the pipe

during transfer should be between 0.9 and 2.1 meters 3 and 7 feet per second to maintain the carbon in suspension. Design velocities above 3 meters 10 feet per second result in excessive head losses and unstable operation. The slurry carries between 0.1 and 0.4 kg carbon per liter 0.7 and 3 lbs. carbon per gallon of water.
****

Unload spent media from and load new media in permanently mounted adsorbers. Transfer carbon slurry between vessels at a rate between [_____] and [_____] L/second gpm.

3.2.5 Offsite Reactivation of Modular Units

Remove modular units from service, disconnect from the permanent piping, drain of free water and return to the supplier for reactivation.

3.3 FIELD QC

3.3.1 Sequencing and Scheduling

****
NOTE: Head conditions for the influent pumps, backwash pumps and carbon slurry transfer pumps specified in Section 23 21 23 HYDRONIC PUMPS depend on the head losses encountered in the equipment specified in this Section.
****

Perform sampling and analyses to demonstrate system performance and effluent compliance.

3.3.2 Tests

Carefully inspect all products for defects in workmanship and material; clean debris and foreign matter out of valve openings and seats; operate all operating mechanisms to check their proper functioning; and check all nuts and bolts for tightness. Repair or replace valves and other equipment which do not operate easily or are otherwise defective.

3.3.2.1 Hydrostatic Tests

****
NOTE: Disinfection of vessels that are supplied prefilled with carbon is not feasible. The test pressure for vessels supplied with carbon should not exceed the rated pressure. Testing of pipe and fittings should be specified in the same section that the pipe is specified in.
****

After installation, test all tanks for water tightness. Include testing plugs or caps, all necessary pressure pumps, pipe connections, gauges, other equipment, and all labor. Test at a pressure of [[_____] kPa psi][as indicated in the schedule]. Isolate the piping systems from the tanks for pressure testing at the specified test pressures.

3.3.2.2 Performance Tests

****

NOTE: The approximate constant flow rate for the operating capacity test will be inserted in the blank spaces provided. For some adsorption units, the tests may be modified as necessary where high capacity activated carbons are used and the total organic carbon is such that complete tests would require abnormally extended periods of time. In such cases this paragraph will be suitably rewritten.

****

After installation of the activated carbon adsorption system, carry out operating tests to assure that the system operates properly. If any deficiencies are revealed during any tests, correct such deficiencies and repeat the tests. Put [each][a typical] adsorption unit through a complete cycle of operation [at a constant flow rate][to exhaustion at a constant flow rate] of approximately [_____] L/second gpm for the capacity test. Document a complete log of each test run, with the following data: date, time of readings and sampling, total backwash, and total water treated. Determine total organic carbon removed by analyses of the influent at such intervals as gives a representative organic carbon content. When the required quantity of water, [_____] liters gallons, has been run through the adsorber, take samples of the effluent for analysis. Use results of the tests in determining the capacity and performance of the adsorption unit.

3.3.2.3 Liquid Sampling and Analyses

Collect, mark, preserve and analyze influent and effluent samples .

3.3.2.4 Activated Carbon Sampling and Analyses

Perform sampling and analyses of the activated carbon media in accordance with [requirements for spent carbon transport and requirements of AWWA B605 and of the reactivation facility][requirements of the RCRA permitted treatment, storage and disposal facility].

3.3.2.5 Discharge

During the capacity test, store treated water as necessary to maintain the required flow rate. Submit reports for discharge permit compliance.

3.3.2.6 Utilities

The contractor is responsible for obtaining water, electric power and other utility items as well as the disposal of water drainage during testing.

3.3.3 Manufacturer Field Service

Provide the services of a representative of the manufacturer experienced in the installation, adjustment, and operation of the equipment specified to supervise the installation, adjustment, and testing of equipment.

3.3.4 Posting Framed Instructions

Post framed instructions containing wiring and control diagrams showing the complete layout of the system where directed. Prepare, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, frame and post beside the diagrams. Submit wiring and control diagrams, systems layouts and isometrics, instructions, and other sheets, prior to posting. Post the framed instructions before acceptance testing of the systems.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Painting/Corrosion Prevention

Coat or paint all ferrous surfaces.

3.4.1.1 Exterior Surfaces

Solvent-clean factory primed surfaces before painting. Prepare and prime surfaces that have not been factory primed in accordance with the paint manufacturer's recommendations. Apply the paint system to the outside of the tank in accordance with Section 09 90 00 PAINTS AND COATINGS. Provide color as indicated on the paint schedule or as otherwise approved.

3.4.1.2 Interior Surfaces

****

NOTE: Some state and local health agencies have listings of acceptable paint materials for the interior of potable water tanks. Contact the appropriate state and local authorities to determine if the paint systems are acceptable. If these systems are not acceptable, determine the best acceptable system and revise this specification accordingly. Some states require NSF approval for coatings in contact with potable water. The zinc coating system specified in Section 3.8 of AWWA D102 is not acceptable.

****

Coat tank interior surfaces with the coating conforming to Section 3.2, 3.3, 3.4, 3.5, 3.6, or 3.7 of AWWA D102. System of three coats, 0.10 - 0.15 mm 3.9 - 5.9 mils dry film thickness (DFT) per coat, for total of 0.30 - 0.45 mm 11.7 - 17.7 mils minimum DFT.

3.4.1.3 Touch-Up Painting

Touch up factory painted items as needed. Factory painted items requiring touching up in the field must be thoroughly cleaned of all foreign material, primed and top-coated with the manufacturer's standard factory finish.

3.4.1.4 Field Painting

Paint equipment which did not receive a factory finish as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4.1.5 Corrosion Resistant Metals

Painting of corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel is not required unless otherwise specified.

3.4.2 Field Training

Conduct a training course for designated operating, maintenance and support staff members. The training period, for a total of [8][12][16][_____] hours of normal working time, must start after the system is functionally completed but prior to final acceptance tests. Field training must cover each item contained in the operating and maintenance data.

3.5 MAINTENANCE

Submit a preventive maintenance plan and schedule including routine recommended chemical preventive measures for handling contaminant/biofouling of the carbon adsorption unit under conditions of the application including strong acid/alkali/alternative chemical soaks and instructions for storage and handling of treatment chemicals and waste products.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-44 10 00 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-44 10 00 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 44 - POLLUTION AND WASTE CONTROL EQUIPMENT

SECTION 44 10 00

AIR POLLUTION CONTROL

11/22

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-44 10 00 (November 2022)**

Preparing Activity: USACE **Superseding**
UFGS-44 10 00 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 44 10 00

AIR POLLUTION CONTROL
11/22

****

NOTE: This guide specification covers the requirements for air pollution control equipment and accessories for use with various pollutant emitters.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also

use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 204	(2005; R 2012) Balance Quality and Vibration Levels for Fans
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)

AIHA Z9.3	(2007) Spray Finishing Operations - Safety Code for Design, Construction and Ventilation

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 169	(2021) Climate Data for Building Design Standards

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)

ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(2024) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME B31.3	(2022; Errata 2023) Process Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME PTC 6	(2004; R 2014) Steam Turbines
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes
ASME PTC 38	(1980; R 1985) Determining the Concentration of Particulate Matter in a Gas Stream

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A302/A302M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Alloy Steel, Manganese-Molybdenum and Manganese-Molybdenum-Nickel
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B68/B68M	(2011) Standard Specification for Seamless Copper Tube, Bright Annealed (Metric)
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless

	Copper Water Tube (Metric)
ASTM B280	(2023) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM D2854	(2009; R 2019) Standard Test Method for Apparent Density of Activated Carbon
ASTM D2862	(2016) Standard Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D6216	(2020) Standard Practice for Opacity Monitor Manufactures to Certify Conformance with Design and Performance Specifications
ASTM D7036	(2016) Standard Practice for Competence of Air Emission Testing Bodies
ASTM F1139	(1988; R 2024) Steam Traps and Drains

HYDRAULIC INSTITUTE (HI)

HI ANSI/HI 3.1-3.5	(2021) Rotary Pumps

INSTITUTE OF CLEAN AIR COMPANIES (ICAC)

ICAC EP-1	(2000) Terminology for Electrostatic Precipitators
ICAC EP-7	(2004) Electrostatic Precipitator Gas Flow Model Studies
ICAC EP-8	(1993) Structural Design Criteria for Electrostatic Precipitator Casings
ICAC F-3	(2002) Operation and Maintenance of Fabric Filters
ICAC F-5	(1991) Types of Fabric Filters
ICAC G-1	(1968; R 1972) Gaseous Emissions Equipment: Product Definitions and Illustrations

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 91	(2020) Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids
NFPA 496	(2024) Standard for Purged and Pressurized Enclosures for Electrical Equipment

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SSPM	(2010) SSPC Painting Manual, Volume 2, Systems and Specifications

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-28	(Rev H) Paint, Aluminum, Heat Resisting (1200 Degrees F.)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910-SUBPART D	Walking - Working Surfaces
29 CFR 1910.28	(Nov 2016)Duty to Have Fall Protection and Falling Object Protection
40 CFR 50	National Primary and Secondary Ambient Air Quality Standards
40 CFR 60	Standards of Performance for New

Stationary Sources

UL SOLUTIONS (UL)

UL 5	(2016; Reprint Jul 2022) UL Standard for Safety Surface Metal Raceways and Fittings
UL 674	(2022) UL Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations
UL 823	(2006; Reprint Jan 2021) UL Standard for Safety Electric Heaters for Use in Hazardous (Classified) Locations
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units
UL 1203	(2023; Reprint May 2024) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G, [_____]

SD-03 Product Data

Emission Monitoring System

Air Pollution Control Equipment

Instrumentation and Controls

Training

System Performance Test; G, [_____]

SD-06 Test Reports

Factory Tests

System Performance Test;

SD-07 Certificates

Manufacturer's Field Representative

SD-10 Operation and Maintenance Data

Air Pollution Control Equipment; G, [_____]

Accessories; G, [_____]

1.3 QUALIFICATIONS

1.3.1 Welding

****

NOTE: If the need exists for more stringent requirements for weldments, delete the first bracketed statement and the last bracketed statement applies. Dust collection equipment covered by the guide specification is not normally manufactured to the requirements of the ASME Boiler and Pressure Vessel code. Welding of these vessels will be governed by Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

****

[Weld piping welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders are to be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and the tests furnished at the work site if practicable. The Contracting Officer will furnish a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator must apply his assigned symbol near his welds using a rubber stamp or felt-tipped marker with permanent weatherproof ink or other methods approved by the Contracting Officer that do not deform the metal. Structural members are to be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.] Non-Pressurized dust collection vessels must be welded in accordance with provisions of Section 05 50 14 STRUCTURAL METAL FABRICATIONS.

1.3.2 Contractor

Contractor must have a minimum of [2][3][5][_____] years of experience in the construction and maintenance of industrial air pollution control systems.

1.3.3 Manufacturer's Field Representative

Provide a manufacturer's field representative and training engineer, who is experienced in the installation, adjustment, and operation of the equipment furnished, and who has complete knowledge of the proper operation and maintenance of the system. Field representative will be onsite to supervise the installation, adjustment and compliance testing of the equipment. Field representative must provide supervision of the system for [_____] days after startup of the system.

1.4 CONSTRUCTION REQUIREMENTS

Ensure system is suitable for [indoor] [outdoor] installation and provided [with] [without] a weather enclosure. [Provide unit with [_____] mm inch of insulation with a k value of [_____] W/m K Btu/h ft] [Unit will not be insulated]. System must be designed for [a wind load of [_____] kph mph] [and] [an internal [negative] [positive] static pressure of [_____] Pa inch of water gauge]. [Design system for a snow load of [_____] kPa psf]. Seismic protection of equipment must be in accordance with UFC 3-301-01, Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT, Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS, and Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

1.5 DELIVERY, STORAGE, AND HANDLING

Store all equipment delivered and placed in storage as recommended by the manufacturer, with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.6 EXTRA MATERIALS

****

NOTE: Include items needed for future maintenance and repair, items that might be difficult to obtain and spare parts needed to ensure continued operation of critical equipment.

****

Provide auxiliaries for maintenance with the equipment and include all special tools, rigs, jigs, fixtures, equipment, or other devices required for normal operation and service. Provide any equipment required for routine maintenance such as filter wash facilities, oil or refrigerant removal, and replacement devices. Include tests or measurement instruments or gauges. Also furnish the following:

[a. Spare parts for each different item of material and equipment specified including all the of parts recommended by the manufacturer to be replaced after [1 year] [1 year and 3 years] service.]

b. [One set of special tools for each type of equipment, including calibration devices, and instruments required for adjustment, calibration, disassembly, operation, and maintenance of the equipment.] [One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment].

[c. One or more steel tool cases mounted on the wall, installed in a location agreed to by the government, complete with flat key locks, two keys, and clips or hooks to hold each special tool.]

[d. [_____].]

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Standard Products

Provide material and equipment that are the standard products of a manufacturer regularly engaged in the manufacture of the products. Use items of equipment that essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening. Provide equipment supported by maintenance organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Maintenance organization must respond to a service call within [_____] hours [_____] days.

2.1.2 General Requirements

Provide equipment and appurtenances as specified and as shown on the approved detail drawings, and suitable for the service intended. Provide new and unused materials and equipment including testing equipment furnished under the contract. Ensure components that serve the same function and are the same size are identical products of the same manufacturer.

Detail drawings contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

2.1.3 Nameplates

Provide each major component of equipment with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment. Ensure each piece of equipment bears the approval designation and the markings required for that designation. Mark valves in accordance with MSS SP-25 and securely attach tag with the manufacturer's name, catalog number and valve identification permanently displayed.

2.1.4 Equipment Guards[and Access]

****

NOTE: Catwalk, ladder, stair, and guardrail may be required. If so, select the applicable item, delete the others, and indicate on drawings the selected item.

****

Enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto, to prevent accidental personal injury, in accordance with 29 CFR 1910, Subpart O, Machinery and Machine Guarding. Provide removable guards and arrange to allow access to the equipment for maintenance. Guard or cover high-temperature equipment and piping so located as to endanger personnel or to create a fire hazard with insulation of type specified for service. Provide [items such as[catwalk,][stair,][ladder,][and][guardrail] where shown and in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS][05 51 00 METAL STAIRS][05 52 00 METAL RAILINGS]]

Platforms, Walkways, Stairways, Handrails, Kick plates and Fixed Ladders that are required for operation, examination, testing and maintenance of pollution and waste control equipment must be provided as required for access. Platforms, walkways, stairways, handrails, kick plates and fixed ladders must be factory or shop fabricated, must provide suitable access, and must meet 29 CFR 1910-SUBPART D for safety of maintenance and operating personnel. Walkways must be provided for maintenance and inspection of maintenance points. Walkways and platforms must be connected by stairways or fixed ladders. Platforms, walkways, stairways, fixed ladders, handrails, and kick plates must be hot dipped galvanized after fabrication in accordance with ASTM A123/A123M. Minimum galvanized coating weight per surface must be not less than 0.70 kilogram per square meter 2.3 ounces per square foot.

2.2 GAUGE

****

NOTE: Pipe, fitting, and valve materials listed in this section are suitable for water service, but not for corrosive, erosive, and some petrol services. The designer should select the proper alloy (e.g., stainless steel 304, 316, etc.), rubber or other elastomer lining or plastic for these and other applications where the chemistry of the process must dictate material selection.

****

Conform gauge to the following:

2.2.1 Draft Gauge

ASME B40.100. Provide tubing for gauges for service above 66 degrees C 150 degrees F conforming to ASTM B68/B68M; for service below 66 degrees C 150 degrees F, plastic tubing conforming to ASTM D3350 may be used.

2.2.2 Gauges, Pressure and Vacuum

ASME B40.100, select a pressure range that is approximately twice the normal operating pressure of the media. The maximum operating pressure should not exceed 75% of the full-scale range..

2.3 LOW-WATER CUTOFF

****

NOTE: Low-water cutoff applies to all wet scrubber tanks, reservoirs, and sumps if low level or loss of water can affect scrubber or boiler operation and safety. Coordinate requirement for deenergizing boiler panel to stop firing the boiler if scrubber components are subject to damage from excess heat in a loss of water supply.

****

Provide low-water cutoff for all scrubber liquid sumps, holding tanks, reservoirs, and mixing tanks. Cut-off must cause a safety shutdown of the scrubber and must be provided with auxiliary contacts to be used to sound an alarm. [Low-water shutdown must require a manual reset before any equipment can recycle or operate.]

2.4 PIPE, FITTINGS, AND TUBING

Provide pipe, fittings, and tubing conforming to the following:

2.4.1 Pipe

ASTM A53/A53M, Type S, Grade A, standard weight; or copper pipe, ASTM B42.

2.4.2 Nipples

ASTM A733, standard weight to match adjacent piping.

2.4.3 Pipe Fittings

2.4.3.1 Steel Pipe Fittings

ASME B16.9 for butt-welding fittings; ASME B16.11 for socket-welding fittings; and ASME B16.5 for flanged fittings.

2.4.3.2 Brass or Bronze Pipe Fittings

ASME B16.15, Class A, 862 kPa 125 pound.

2.4.3.3 Malleable-Iron Pipe Fittings

ASME B16.3, type to match adjacent piping.

2.4.3.4 Unions

ASME B16.39, type to match adjacent piping.

2.4.3.5 Flanges, Cast-Iron and Bronze

ASME B16.1 and ASME B16.24.

2.4.3.6 Pipe Threads

ASME B1.20.2MASME B1.20.1.

2.4.4 Tube, Copper

2.4.4.1 Tube for Air, Water, Gas, and Drains

ASTM B68/B68M or ASTM B88M ASTM B88.

2.4.4.2 Tube for Refrigeration Systems

ASTM B280.

2.5 STEEL SHEET

Provide steel sheets conforming to the following:

2.5.1 Zinc Coated (Galvanized)

ASTM A653/A653M;ASTM A924/A924M for dust collector casings, housing, and components. Gauges specified are manufacturers' standard gauge.

2.5.2 Low-Carbon

ASTM A568/A568M. Gauges specified, for dust collector casings, housings, and components, refer to manufacturers' standard gauge.

2.5.3 Corrosion Resistant

ASTM A240/A240M, Class 304 or 316. Gauges specified refer to U.S. Standard Gauge.

2.6 AIR TRAPS

Provide air traps for removal of moisture from plant compressed air supplied to air pollution control equipment conforming to ASTM F1139.

2.7 THERMOMETERS

Provide thermometers conforming to ASME PTC 19.3 TW with wells and temperature range suitable for the use encountered.

2.8 VALVES

Provide valves conforming to ASME B16.34, and the following:

2.8.1 Angle Valves

MSS SP-80, Types 1, 2, or 3, Class 125, except that valves over 80 mm 3 inch must have iron bodies and brass or bronze standard trim with glands or followers in the stuffing boxes. Provide valves with nonmetallic renewable composition discs and raised flat seats designed for 862 kPa 125 psi steam. Secure wheels with hexagonal nuts.

2.8.2 Check Valves

MSS SP-80, Types 1, 2, 3, or 4, Class 125, as required. Ensure valves over

80 mm 3 inch have iron bodies and are the swing type designed for 862 kPa 125 psi steam. Provide check valves with renewable composition discs or with metallic discs of the regrinding type to permit regrinding without removing valve from the line.

2.8.3 Ball Valves

Provide ball valves having flanged or buttwelded end connections conforming to MSS SP-72; provide ball valves having threaded end connections conforming to MSS SP-110. Ball valves must be one piece construction, full port, and adjustable packing glands. Seats and seals must be made of tetrafluoroethylene, and be designed for 862 kPa125 psi.

2.8.4 Globe Valves

MSS SP-80, Type 1. Ensure valves over 80 mm 3 inch iron bodies and brass or bronze standard trim and glands or followers in the stuffing boxes. Provide valves with nonmetallic renewable composition discs and raised flat seats designed for 1035 kPa 150 psi steam. Secure wheels to the stems with hexagonal nuts.

2.9 WATER METERS

Provide disc type water meters with reinforced disc for hot water above 66 degrees C 150 degrees F, and rubber or carbon disc for cold water, that are constructed of bronze composition or cast iron protected by noncorrosive coating. Ensure moving parts subject to wear are easily replaceable. Provide meters conforming to the requirements of AWWA C700.

2.10 ELECTRICAL WORK

****

NOTE: Indicate on drawing the type and class of motor enclosure depending on environment in which the motor is to be used.

****

Provide electrical motor-driven equipment specified complete with motors, motor starters, and controls. Provide electrical equipment and wiring in accordance with [Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM]. [Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION]. [Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION]. Ensure electrical characteristics are as indicated or specified. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Ensure each motor is of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified but not shown. Motors must conform to NEMA MG 1, with enclosures as indicated [except as specified for Petrol Vapor Recovery Unit]. Assemble controls, interlocks, instruments, status indication lights, and other devices required for operation and observation of equipment status on an [open face panel] [enclosed panel with [latched door] [key locked door]]. Provide [factory-assembled panel, connected to equipment, and mounted on unit] [or] [factory assembled panel and boxed for field installation]. [Instrumentation and control system must include local control panels and a central control panel located in the facility control room. The control system must integrate local controls provided with equipment, as specified, so that complete system operation can be monitored and controlled from the control room]. Integrate the air pollution control system with the emission generating equipment. The control system must provide integrated control of all system processes and equipment, and contain all necessary instrumentation required for monitoring and operation of the air pollution control system. Ensure control system panels graphically display the system. Provide local control panels with selector switches so that equipment can be operated manually for test and maintenance purposes. Incorporate suitable safety interlocks to assure that proper permissive conditions have been met prior to changing the operating status of major system components. Automatically initiate shutdown of the air pollution control equipment system, or portion thereof, with alarms should unsafe conditions arise during operation of the system. Provide visible and audible alarms on critical functions locally and at central control room. Provide controls conforming to NEMA ICS 1. Provide enclosures for power and control panels conforming to NEMA ICS 6.

2.11 DRAFT FANS

****

NOTE: In new installations, coordinate design with boiler or incinerator specification. For retrofit, fans will be sized for air pollution control equipment. For fans operating in corrosive or erosive environment, provide liners for scroll sheets and rotor blades. References to draft fans will be deleted if inapplicable for the equipment specified.

****

Furnish centrifugal fans conforming to AMCA 801 [Type I] [Type II] [forced draft] [and] [induced draft] as an integral part of air pollution control equipment design. Provide [centrifugal] [_____] fans with [backward curved blades] [radial tip blades] [or] [axial flow type]. Size each fan for an output volume and static pressure rating sufficient for pressure losses, leakages, temperature, and elevation corrections for ASHRAE 169, 1 percent Cooling Dry Bulb, Mean-Coincident Wet Bulb ambient conditions. In addition, ensure fan sizing includes margins of 10 percent volume and 21 percent static pressure, plus margins of [5] [_____] degrees C [10] [_____] degrees F for forced draft fans and [22] [_____] degrees C [40] [_____] degrees F for induced draft fans. [Provide induced draft fans with outlet dampers]. Ensure noise levels for fans do not exceed 85 decibels in any octave band at a 914 mm 3 foot station. Provide fan bearings which are [air cooled] [or] [water cooled], and backward curved fan blade type with bearings not requiring water cooling may be of the self-aligning antifriction type. [Provide scroll sheets and rotor blades with liners.]

2.11.1 Draft Fan Control

****

NOTE: Variable speed control, inlet vane control, and inlet damper control are, in descending order of efficiency, capable of control draft fan conditions. The choice is based on economics. However, in erosive services, inlet vane control is not desirable.

****

Provide forced draft centrifugal fans with [inlet vane control] [variable speed control] where indicated. Provide induced draft centrifugal fans with [inlet vane control] [inlet damper control] [variable speed control]. [Provide axial propeller fans with variable propeller pitch control and variable speed drive.] Provide inlet vanes or dampers suitable for use with air pollution control equipment.

2.11.2 Draft Fan Drives

****

NOTE: Where motor starters for mechanical equipment are provided in motor control centers, delete the reference to motor starters.

Steam driven boiler auxiliaries will not be used unless the exhaust steam can be utilized completely. Reference to steam drives will be deleted if inapplicable for the equipment specified.

****

Drive fan by [an electric motor] [or] [a steam turbine]. [Provide [drip-proof] [totally enclosed nonventilated] [totally enclosed fan-cooled] [totally enclosed fan-cooled], electric motor suitable for installation in a Class II, Division 1, Group F, hazardous location conforming to NFPA 70]. [Provide magnetic [across-the-line] [reduced voltage start] type motor starter with [general-purpose] [weather-resistant] [water tight] [dust-tight] [explosion-proof] enclosure and furnish with four auxiliary interlock contacts]. [Operate steam turbines properly with a steam inlet pressure of [_____] Pa psig and with steam back pressure of [_____] Pa psig. Provide turbines with horizontally-split, centerline support casings, water-cooled bearing housings with ring-oiled, babbitt-lined, bronze packed sleeve bearings. Also equip turbines with a mechanical shaft speed governor and valve, and independent emergency overspeed governor and trip valve, reed tachometer, constant pressure type governor, insulation with removable metal jacket, oil-sight glasses with guards, removable stainless steel steam strainer [without disconnecting piping], any special wrenches and tools required for servicing turbine, and a sentinel warning on the exhaust casings. Turbines must conform to ASME PTC 6].

2.12 DUCTWORK

****

NOTE: References to ductwork will be deleted if inapplicable for the equipment specified. Ductwork thickness or gauge will depend on both size and pressure.

****

Ductwork must be [galvanized sheet metal conforming to ASTM A653/A653M] [_____] with a minimum thickness of [_____] mm [_____] gauge [_____] inch [_____] gauge.Ductwork must be sized to limit friction losses in accordance with ASHRAE 90.1 - IP Fan Power Limitation Guidelines. Ductwork must be constructed in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION. Seismic protection of equipment must be in accordance with UFC 3-301-01, Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT, and Section 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS. Brace ducts externally and install and anchor so as to be free of vibration. Provide access and inspection doors as indicated, with a minimum of one in each section between dampers or items of equipment. Construct duct with long radius elbows having a centerline radius of 1.5 times the duct width, or where the space does not permit the use of long radius elbows, short radius or square elbows with factory-fabricated turning vanes may be used. Ensure duct joints are substantially air-tight and have adequate strength for the service.

2.13 AIR POLLUTION CONTROL EQUIPMENT

****

NOTE: Delete all equipment requirements not required on the project. Title 40, Part 60 of the Code of Federal Regulations for Protection of Environment (40 CFR 60), state and local codes contain regulations pertaining to air pollution control. 40 CFR 60 contains Standards of Performance for New Stationary Sources. In addition, EPA Test Report No. AP-42 with latest supplements contains emission factors for the specific pollutant emitter (uncontrolled). Determine the degree of required pollutant removal from the gas stream to meet the more stringent of local, state and EPA regulations and indicate whether EPA, state or local regulations apply. With the information thus obtained, determine the most effective and economical air pollution control equipment required. This process will be repeated for each pollutant emitter identifying the pertinent regulation. Indicate on drawings for each pollution control equipment electric power requirements including motor sizes, etc., where applicable. Coordinate performance, operation, and control of pollution control equipment with all other related system components to assure total system operation and that safety requirements are met. Indicate on drawings any such items as walkways, guardrails, stairs, and ladders furnished as part of the pollution control equipment, if required.

****

Performance of equipment must be as indicated in Paragraph SCHEDULES. [Provide paint spray and wet process gas ductwork in compliance with AIHA Z9.3 and NFPA 91.][Provide air and water piping in conpliance with ASME B31.1.][Use particulate emission control equipment conforming to ASME PTC 38].[Provide equipment with steel walkways, safety rails and stairs, or ladders as indicated. Ensure access is by means of [29 CFR 1910.28compliant ladder][step stairs with handrails]].

a. Submit a complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply.

b. Submit proposed diagrams, instructions, and other sheets, prior to posting. Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, including equipment, piping, valves, and control sequence, where directed. Prepare condensed operating instructions explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system in typed form, frame as specified above for the wiring and control diagrams, and post beside the diagrams. Post the framed instructions before acceptance testing of the system.

c. Submit detailed manufacturer's data on the instrumentation and controls. Include overall controls, sensors, process controllers, control operators, ladder diagrams, timers, sequence of controls, valves, alarms, signals, interlocks and cut off systems. Data describing in detail the equipment used to monitor emissions, including the sampling probe, filters, sampling pump, moisture separator/drier, tubing, analyzer, analyzer calibration system, data recorder, and alarms. Process and instrumentation diagrams (P&IDs).

2.13.1 Dry Dynamic Precipitator

****

NOTE: Select construction features required including drive component and delete all others. Dry dynamic precipitators may be used for collecting coarse dry particulates from coal crusher, conveyor, and bunker ventilation where the objective is to control material losses and to remove coarse fly-ash particulates from boiler flue gases of chain-grate or stoker-fired boilers. It is not effective in removing gaseous pollutants or particles of 7 micrometers and under.

****

Unit must be a mechanical collector consisting of a motor-driven fan, a fan casing, a hopper or dust bin, fan motor, fan motor starter with overload protection, [fan drive coupling] [belt drive with fan and motor pulleys and adjustable motor base], fan and motor mounting base on hopper, and a [ceiling mounting] [floor mounting] stand for the entire assembly. The fan must comply with AMCA 99, Section 99-0401, Classification for Spark Resistant Construction, AMCA 210, and AMCA 300.

2.13.1.1 Fan Impeller

Fan Impellers must be steel and designed to provide the static head required for pumping the dirty and cleaned gas streams through the duct systems and related components. Ensure impeller is keyed and locked on a cold drawn, turned and polished steel shaft mounted on heavy duty grease or oil lubrication ball or roller bearings. Provide shaft with a diameter and stiffness that will limit deflection at the maximum shaft loading, within the operating range of the fan, to no more than 0.167 mm/meter 0.002 inch/foot of shaft. Provide shaft with a locked key slot for mounting a pulley, a direct drive, or coupling. Balance the entire rotating assembly dynamically at operating speeds. Balance fans dynamically and factory-test in accordance with AMCA 204 at the design operating RPM to Fan Application Category BV-3, Balance Quality Grade G6.3 or approved equivalent. Installed vibration levels must not exceed the levels specified in AMCA 801.

2.13.1.2 Fan Casing

Fan casing must be abrasion resistant cast iron conforming to ASTM A48/A48M or abrasion resistant steel consisting of a fan support base with back-housing, involute fan discharge scroll with inlet and discharge duct connections, and a dirt discharge port. Provide scroll with readily replaceable wear plates and constructed to permit field positioning the direction of discharge in at least eight different directions. Scroll must provide means for accumulating and diverting the bulk of the particulate enriched gas stream into the hopper before the gas stream is returned to the inlet to the scroll.

2.13.1.3 Hopper Storage

****

NOTE: Determine the rate and quantity of pollutant material collected, the final disposition of the material, and the manner and frequency of transport to disposal location. From this, determine the hopper size to be indicated and select the bracketed hopper outlet. Delete those not selected.

****

Hopper storage capacity must be as indicated. Construct unit of no less than 3.4 mm 10 gauge [welded low carbon] [corrosion resistant] steel plate for the vertical sides and bottom which must be sloped steeper than the slump angle of the material being collected to minimize bridging over at the outlet. Construct top to support the fan, motor, and drive without buckling or being resonated by the fan and no less than 6.4 mm 1/4 inch thick. Provide hopper with an access door and [a manually-operated rotary lock] [a motor-driven rotary lock] [a guillotine-type slide gate].

2.13.1.4 Test Connections

Provide pressure test connections at the suction and discharge ducts connecting to the precipitator.

2.13.2 Wet Dynamic Precipitator

****

NOTE: Select construction features required including drive component and delete all others. Wet dynamic precipitators are frequently used for ventilation air cleaning of coal crushing, conveying, and storage facilities where the dust loading is 1 to 4.6 grams per cubic meter 1/2 to 2 grains (weight) per cubic foot of air and the particles are 50 percent or more of 2 to 7 micrometers size. It will remove some gaseous pollutants.

****

Provide a mechanical collector unit consisting of a motor-driven fan, a fan casing with water sprayhead, [a hopper or slurry bin,] fan motor, fan motor starter with overload protection, [fan drive coupling,] [belt drive with fan and motor pulleys and adjustable motor base,] [fan and motor support on [the hopper] [a rigid structural steel base] arranged for [floor mounting]]. Provide in compliance with AMCA 99,Section 99-0401, Classification for Spark Resistant Construction, AMCA 210, and AMCA 300.

2.13.2.1 Collector

****

NOTE: Delete inapplicable materials and equipment. Pipe, fitting, and valve materials listed in this

section are suitable for water service, but not for corrosive, erosive, and some petrol services. The designer should select the proper alloy (e.g., stainless steel 304, 316, etc.), rubber or other elastomer lining or plastic for these and other applications where the chemistry of the process must dictate material selection.

****

Provide collector consisting of a heavy steel plate fan housing constructed of low carbon steel. Provide fan with ASTM A240/A240M stainless steel blades and rivets. Fasten blades to a heavy forged steel hub mounted on a forged, ground, and polished ASTM A302/A302M stainless steel shaft supported on ball or roller bearings. Provide shaft with a diameter and stiffness that will limit deflection at the maximum shaft loading to no more than 0.167 mm/meter 0.002 inch/foot of shaft. Ensure impeller and driven units are lock-keyed to the shaft with the entire assembly dynamically balanced at all operating speeds. Dynamically balance fans and factory-test in accordance with AMCA 204 at the design operating RPM to Fan Application Category BV-3, Balance Quality Grade G6.3 or approved equivalent. Provide housing and impeller with components that will provide for uniformly covering rotating and stationary parts with a film of moving water to provide for wetting and capturing of centrifugally impinged particulates. Provide means for separation from the air stream and drainage of the water and particulate slurry from the collector. Installed vibration levels must not exceed the levels specified in AMCA 801.

2.13.2.2 Hopper Storage

****

NOTE: Determine hopper storage capacity and indicate an open drain or valved outlet. Omit entire paragraph if hopper is not required for an installation piped to drain filtrate to a coal recovery or ash pit.

****

Hopper storage capacity must be as indicated. Construct unit of no less than 3.4 mm 10 gauge [welded black] [welded corrosion resistant] steel plate for the vertical sides and sloped bottom. Construct top to support the fan, motor, and drive without buckling or being resonated by the fan and no less than 6.4 mm 1/4 inch thick. Slope hopper bottom for complete drainage of slurry of collected material; free of ledges and pockets; and provide for full free flushing of particulate when operating wet. Provide hopper with an inspection window, cleanout, and access door. Provide hopper with electric heating coils, modules, or blankets to keep collected material dry and free flowing with the unit installed outdoors and out of service in a local winter outdoor design temperature of [_____] degrees C degrees F.

2.13.2.3 Nonstainless Components

Coat water wetted, nonstainless components with a permanently bonded, abrasion and corrosion resistant rubber facing suitable for the operating temperature of the gas stream.

2.13.2.4 Water Supply Components

Provide precipitator with water supply components sized to meet equipment capacity requirements and include:

a. A stainless steel water supply strainer with removable screen, flow control valve [with rate adjustment] [pressure gauge] [low pressure alarm switch] [water meter].

b. Analog solenoid water flow control valve.

c. Adjustable water pressure control switch with contacts to open on low pressure to stop or prevent operation of the fan motor if water pressure is below the minimum required for efficient operation of the collector. [An additional set of contacts to close on low pressure to permit operation of an annunciator alarm.] The adjustable range of the switch trip must be from [_____] to [_____] kPa [_____] to [_____] psig.

d. Water pressure gauges with 0 to 690 kPa 0-100 psig range.

e. Adjustable automatic water pressure or water flow rate regulator to provide a steady controlled rate of water flow as required for optimum collector performance.

f. Water flow meter sized for rate required by the collector.

2.13.2.5 Test Connections

Provide pressure test connections at the suction and discharge ducts connecting to the precipitator.

2.13.2.6 Drain Connections

Provide slurry drain connections which are screwed or flanged pipe connections sized as recommended by the manufacturer.

2.13.3 Conical Dry Dust Collector

****

NOTE: The conical dry dust collector removes up to 80 percent by weight of particles, 10 micrometers and over, from a gas stream and is used primarily on general industrial dusts and occasionally to clean boiler flue gases since it has a temperature tolerance up to 371 degrees C 700 degrees F. It is not effective in removing gaseous pollutants or particles of 7 micrometers size and under. Its high air friction drop may require a booster fan. It normally is selected for pressure drops in the 890 Pa to 1652 Pa 3-1/2 to 6-1/2 inch water gauge range at operating conditions.

****

Provide a mechanical collector unit consisting of a top horizontal involute scroll gas inlet and outlet mounted over a vertical cylindrical shell or cone which has a narrow angle cone below. Design unit specifically to impart a high velocity vortex spin to the incoming downflowing gas stream to throw particulates to the wall of the cylinder and cone before turning upward in an internal vortex to the outlet. Replaceable wear plates [are] [are not] required.

2.13.3.1 Scrolls, Cylinder, and Cone

****

NOTE: Delete inapplicable materials and equipment. Pipe, fitting, and valve materials listed in this section are suitable for water service, but not for corrosive, erosive, and some petrol services. The designer should select the proper alloy (e.g., stainless steel 304, 316, etc.), rubber or other elastomer lining or plastic for these and other applications where the chemistry of the process must dictate material selection.

****

Provide scrolls, cylinder, and cone consisting of no less than [3.4 mm 10 gauge] [4.8 mm 3/16 inch] [9.5 mm 3/8 inch] [welded black] [corrosion resistant] steel. Connect inlet and outlet scrolls for [clockwise] [counterclockwise] connection and rotation of the vortex when looking down on the collector. Provide four equally spaced, welded steel support brackets on the bottom of the inlet scroll or on the vertical walls of the cylindrical section of the collector. Do not use collector cone for storage. Remove and collect particulate, and provide cone bottom with an air-tight seal. Provide [a guillotine-type slide gauge] [a manually-operated rotary lock] [a motor-driven rotary lock] on the [bottom of cone] [bottom of surge tank] [bottom of storage receptacle].

2.13.3.2 Test Connections

Provide pressure test connections at the inlet and outlet ducts connecting to the collector.

2.13.3.3 Self-Cleaning Ductwork to Collector

The design velocities of self-cleaning duct must be determined for specific dust handled and duct sized accordingly to maintain required velocity range.

Design all ductwork between dust source and collector to be self-cleaning. Ductwork meeting the following requirements will be considered to be self-cleaning.

a. A duct at an angle greater than 45 degrees to the horizontal plane with gas flowing downward.

b. A duct at an angle greater than 60 degrees to the horizontal plane with gas flowing upward.

2.13.4 Multitube, Centrifugal Dry Dust Collector

****

NOTE: The multitube centrifugal dust collector has similar performance to the conical dry dust collector except it removes more of both coarse and fine particulates. This collector is often used on stoker-fired boiler applications. The pressure drop range is normally 635 Pa to 1144 Pa 2.5 to 4.5 inches water gauge at operating conditions. Sixty

degree hopper valley angle is considered adequate for worse case coal/ash scenario. If designer can confirm that application is less demanding, he should consider a lower valley angle 55 degrees or 45 degrees. In certain applications the size of the unit may require some subassembly in the field, negating the restrictions on field assembly.

****

Provide a mechanical collector unit utilizing a number of parallel vertical or horizontal tubes of small diameter in an enclosure having a single gas inlet and single gas outlet.

2.13.4.1 Inlet Tube Assemblies, Casing and Hopper

Provide inlet tube assemblies that are replaceable [cast iron] [wear resistant steel with replaceable cast iron spinner vanes and cones] [wear resistant steel with replaceable spinner vanes and cones]. Provide [3.4 mm 10 gauge] [4.8 mm 3/16 inch] [6.4 mm 1/4 inch] [low carbon] [corrosion resistant] steel casing with the dust released into a [3.4 mm 10 gauge] [4.8 mm 3/16 inch] [6.4 mm 1/4 inch] [black] [corrosion resistant] steel sloped bottom dust hopper. Ensure hopper valley angle is 60 degrees from the horizontal. Provide hopper with a poke hole and access door. Provide hopper bottom outlet with [a guillotine-type slide gate] [a gravity-type trip gate opened by the weight of the collected material] [a manually-operated rotary lock] [a motor-driven rotary lock]. Provide unit with a welded steel support assembly for field erection with no additional work other than setting and bolting the unit in place.

2.13.4.2 Test Connections

Provide pressure test connections at the inlet and outlet ducts connecting to the collector.

2.13.5 Dry Electrostatic Precipitator (Dry ESP)

****

NOTE: Electrostatic precipitators are highly effective with efficiencies up to 99.9 percent by weight in removing fine particulates down to 0.3 micrometers in size from gas streams having light loading of material by weight. They are frequently applied in gas streams of 371 degrees C 700 degrees F or higher but may require a precleaner such as a dynamic precipitator, conical, or multitube centrifugal to bring the gas stream down to an optimum loading. They require a relatively large space. They have a very low gas flow friction but are quite sensitive to having a uniform distribution of gas flow through the unit. The efficiency may sharply fall under a gas flow above design rate. Efficiency is also affected by dust particle electrical resistivity which can be too high or too low for maximum performance. Frequently in these situations the addition of relatively small quantities of flue gas conditioning agents have been very effective in improving precipitator performance. Depending on the particle electrical resistivity level, flue gas conditioning will be

considered a viable option. Commercial systems are available for ammonia, sodium compounds (carbonate and sulfate), and sulfur trioxide flue gas addition. Pulse energization, the modification to a conventional precipitator power supply to include the capability to superimpose a high voltage pulse on the base voltage, is a second enhancement technique for high resistivity particle applications. Intermittent pulsation, the programmed interruption of normal high voltage waveform, is another enhancement technique. Optimization of precipitator energization and rapping systems through the use of microprocessor-based controls results in lower power levels, reduced electrode failure, and overall improved collection efficiency. Examples of control schemes that can be accomplished with properly programmed microprocessors include:

a. Spark Prediction and Advance

b. Back Corona Detection

c. Opacity Feed Back

d. Rapping Optimization

e. Electrical Power Conservation

Reentrainment of collected material can be limited by a proper balance of factors that affect performance, such as gas velocity through the plates; uniformity of gas velocity profile; ratio of plate height to depth; size of lumps of agglomerated material rapped from the collecting plates and discharge electrodes; and others. Control may also be achieved by a system of automatic programmed gas flow dampers coordinated to operate with related rappers for sequential cleaning of each of the chambers.

Power consumption is generally equivalent to the additional power required by other collecting methods. The pressure drop across units is typically less than 127 Pa 0.5 inch water gauge. Caution should be exercised in their use where combustible or explosive coal dusts or oil fumes may be present and could be ignited by a "spark-over" of the high voltage across the electrodes.

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Provide unit in compliance with requirements of ICAC EP-1, ICAC EP-7, and ICAC EP-8, to remove [aerosols] [and] [particulates] from processed gas stream by impressing a polarized electrostatic charge to the contaminants causing them to be drawn to and deposited upon opposite polarity charged plates. Unit must contain multiple chambers and be of gas-tight construction. Unit must be suitable for [indoor] [outdoor] installation. Provide unit with [insulator compartments] [penthouse]. Provide unit with anti-sneak baffles to force all gas flow through ionizing gas passages and to prevent gas bypassing the precipitator sections. Provide assembly consisting of discharging electrodes and opposite charged plates, high voltage power pack and controls, a rapping system for knocking dust from the discharge electrodes and collector plates, perforated gas distribution plates, sheet steel enclosure with dust collecting hopper bottom, dirty gas inlet, clean gas outlet, and structural steel frame. Ensure precipitator systems include microprocessor based controls [flue gas conditioning systems] [pulse energization] [intermittent energization].

2.13.5.1 Electrostatic Precipitator Layout and Component Drawings

Drawings must indicate the kind, size, arrangement, weight of each component, and breakdown for shipment; the external connections, location of local controls, remote control panels, anchorages, and supports required; the dimensions needed for installation and correlation with other materials and equipment; [seismic structural calculations;] and foundation and loading information. Supply drawings for each component showing design and assembly. Provide schematics of all electrical and pneumatic circuits used. Submission must include, but not limited to the following details:

a. Transformer-rectifier equipment.

b. High voltage switches and disconnects.

c. High voltage fuses and circuit breakers.

d. Control systems.

e. Ground lugs.

f. Protection against electrolysis.

g. Graphic display panel indicating power components.

h. Lubrication locations.

i. Electrodes and collecting surfaces.

j. Platforms, walkways, stairways, and ladders which will be required for operation, inspection, testing, and maintenance, and furnished with the precipitator.

k. Location of field welds, in conformance to AWS D1.1/D1.1M

2.13.5.2 Discharge Electrodes

Discharge electrodes must be [wires and weights] [rigid electrodes] [rigid frame]. Provide top supported discharge electrodes with the bottom free to expand and contract with gas stream temperature changes. Provide laterally restrained electrodes to maintain optimum spacing from the plates. Provide electrodes with a stiffness, length, or restraints required to prevent vibration or flutter when the unit is in service.

2.13.5.3 Collecting Plates

Provide collecting plates consisting of vertical panels of multiple steel strips hanging edgewise in the horizontal air stream so as to form the equivalent of many vertical splits of the gas stream into many gas passages. Use strips that are convoluted, stiffened or constructed with raised ribs, to provide sufficient stiffness to prevent distortion of the plates and also present vertical ridges to support boundary layer edges to increase plate dust retention. Provide top supported plates with the bottom free to expand and contract with changes of gas stream temperature. Coordinate plate configuration and support system design with the plate rapping system design and operation to shed collected material from the plates and to retain a consistent and optimum spacing from the discharge electrodes. Assemble the collecting surfaces at the factory. Factory assembled modules which can be shipped to the field for erection may be provided. Provide high voltage frames with sway braces or other devices as required to prevent swaying. Incorporate gas baffles into the collecting plates to provide a gas flow quiescent zone and to provide stiffening.

2.13.5.4 Power Supply and Control System

Provide solid state microprocessor type power supply and control system. Control system must provide for continuous monitoring and regulating of applied voltage for effective maximum performance of precipitation over the range of plate loadings with minimum sparking and arcing to the plates. Provide entire system with a system of safety interlocks and grounding devices to prevent personnel physical contact with high voltage components. Provide voltage insulators with heaters.

2.13.5.5 Rapping Systems

Provide rapping systems consisting of multiple hammers or other impact devices to cause particulate shedding from the collecting plate. Ensure rapping is automatically programmed so that a minimum number of collecting plates and discharge electrodes are rapped simultaneously. Ensure rapper controls have adjustments for independent field repeat intervals and for independent field rest time. Design unit to limit reentrainment of collected material falling from the collecting plates and discharge electrodes during the rapping operation without exceeding the design cleaning efficiency. Provide the rapper system with surge suppressors and other devices as required to eliminate high voltage spikes.

2.13.5.6 Inlet and Discharge Ducts

Provide inlet and discharge ducts with turning vanes, deflectors, and baffle plates to provide for uniform distribution of gas flow through all gas passages and in each gas passage in accordance with ICAC EP-7. Provide pressure test connections at the inlet and discharge ducts connecting to the precipitator.

2.13.5.7 Dust Storage Hopper

Provide unit with a [4.8 mm 3/16 inch] [6.4 mm 1/4 inch] [low carbon] [corrosion resistant] sloped steel bottom dust storage hopper having the dust holding capacity indicated. Arrange hopper to prevent reentrainment of collected material into the gas stream. Provide hopper bottom with rappers or fluidizing pads and a hopper valley angle of 60 degrees which is free of pockets, ribs, fins, or any other obstruction to hold or interfere with free release of collected material to the outlet. Provide outlet with [a guillotine-type slide gate] [a manually-operated rotary lock] [a motor-driven rotary lock]. Provide hopper with a poke hole and gasketed access door and with a collected material level indicator for [local indication] [local indication with terminals for wiring to a remote indicator]. Provide a special plate reinforced "pounding area" on each hopper face for external manual vibrating. Each pounding plate will be 300 by 300 by 25 mm12 by 12 by 1 inch thick ASTM A36/A36M plate steel. Provide a work platform with stairs to each pounding area for units with pounding areas more than 1.50 meters5 feet above ground. [The level indicator must include a high material level audible alarm.] [Provide hopper with electric heating coils, modules, or blankets to keep collected material dry and free flowing with the unit installed outdoors and out of service in a local winter outdoor design temperature of [_____] degrees C degrees F]. [The capacity of the heating coil module or blanket must be as shown.] [Base the heating coil module or blanket's size on the ambient temperature of [_____] degrees C degrees F]. [Provide an individually, thermostatically controlled hopper heater system with adjustable setpoint and include power, control, and alarm components.] [Size the system to provide a hopper skin temperature of not less than [_____] degrees C degree F when the insulation is in place during minimum ambient temperatures specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Insulation must be installed in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Design the system with a minimum heating safety factor of 1.1 and a minimum wind heat loss factor of 1.12.]

2.13.6 Wet Electrostatic Precipitator (WESP)

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NOTE: Wet Electrostatic precipitators are highly effective with efficiencies up to 99 percent by weight in removing fine particulates down to 0.3 micrometers in size from gas streams having light loading of material by weight. They are frequently applied in gas streams of 371 degrees C700 degrees F or higher but may require a pre-cleaner such as a dynamic precipitator, conical, or multitube centrifugal to bring the gas stream down to an optimum loading. They require a relatively large space. They have a very low gas flow friction but are quite sensitive to having a uniform distribution of gas flow through the unit. The efficiency may sharply fall under a gas flow above design rate. Unlike dry ESPs, WESP control systems sometimes include a prequench (water spray) to cool and saturate the gases prior to entering the electrical fields. As Particulate Matter accumulates on the collector plates of a WESP, the plates are cleaned by a continuous or intermittent film of water spray. Pulse energization, the modification to a conventional precipitator power supply to include the capability to superimpose a high voltage pulse on the base voltage, is a second enhancement technique for high resistivity particle applications. Intermittent pulsation, the programmed interruption of normal high voltage waveform, is another enhancement technique. Optimization of precipitator energization and rapping systems through the use of microprocessor-based controls results in lower power levels, reduced electrode failure, and overall improved collection efficiency. Examples of control schemes that can be accomplished with properly programmed microprocessors include:

a. Spark Prediction and Advance

b. Back Corona Detection

c. Opacity Feed Back

d. Rapping Optimization

e. Electrical Power Conservation

When recycled water is used, the solids content of the water increases with each recycling. If the solids content becomes excessive, the effectiveness of the cleaning mechanism is reduced. Increased solids content can also lead to plugging of spray nozzles.

Power consumption is generally equivalent to the additional power required by other collecting methods. The pressure drop across units is typically less than 127 Pa0.5 inch water gauge. Caution should be exercised in their use where combustible or explosive coal dusts or oil fumes may be present and could be ignited by a "spark-over" of the high voltage across the electrodes.

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2.13.6.1 Wet Electrostatic Precipitator Layout and Component Drawings

Drawings must indicate the kind, size, arrangement, weight of each component, and breakdown for shipment; the external connections, location of local controls, remote control panels, anchorages, and supports required; the dimensions needed for installation and correlation with other materials and equipment; [seismic structural calculations;] and foundation and loading information. Supply drawings for each component showing design and assembly. Provide schematics of all electrical and pneumatic circuits used. Submission must include, but must not be limited to the following details:

a. Transformer-rectifier equipment.

b. High voltage switches and disconnects.

c. High voltage fuses and circuit breakers.

d. Control systems.

e. Ground lugs.

f. Protection against electrolysis.

g. Graphic display panel indicating power components.

h. Lubrication locations.

i. Electrodes and collecting surfaces.

j. Platforms, walkways, stairways, and ladders which will be required for operation, inspection, testing, and maintenance, and furnished with the precipitator.

k. Location of field welds, in conformance to AWS D1.1/D1.1M

2.13.6.2 Discharge Electrodes

Discharge electrodes must be [wires and weights] [rigid electrodes] [rigid frame]. Discharge electrodes must be top supported with the bottom free to expand and contract with gas stream temperature changes. Electrodes must be laterally restrained to maintain optimum spacing from the plates. Electrodes must have a stiffness, length, or restraints required to prevent vibration or flutter when the unit is in service.

2.13.6.3 Collecting Plates

Collecting plates must be configured in a [circular], [concentric], [tubular], or [flat] plate manner. The plates must be of sufficient stiffness to prevent distortion of the plates. Plates must be top supported with the bottom free to expand and contract with changes of gas stream temperature. Plate configuration and support system design must be coordinated with the plate spray system design and operation to shed collected material from the plates and to retain a consistent and optimum spacing from the discharge electrodes. Assemble the collecting surfaces at the factory. Factory assembled modules which can be shipped to the field for erection may be provided. Provide high voltage frames with sway braces or other devices as required to prevent swaying. Incorporate gas baffles into the collecting plates to provide a gas flow quiescent zone and to provide stiffening.

2.13.6.4 Power Supply and Control Systems

Power supply and control system must be solid state microprocessor type. Control system must provide for continuous monitoring and regulating of applied voltage for effective maximum performance of precipitation over the range of plate loadings with minimum sparking and arcing to the plates. Entire system must be provided with a system of safety interlocks and grounding devices to prevent personnel physical contact with high voltage components. Voltage insulators must be provided with heaters.

2.13.6.5 Spray System

The WESP must be provided with a [prequench cycle], [continuous wash cycle], [intermittent wash cycle, operating every __ hours]. Recycled water must be provided with a conditioning system to keep a consistent [_____], [5-7] pH. Blowdown systems must keep suspended solids under [_____] ppm, and chloride concentration below [_____] ppm. All water used in the WESP spray system must be routed to a water treatment facility before discharge.

2.13.6.6 Inlet and Discharge Ducts

Inlet and discharge ducts must be provided with turning vanes, deflectors, and baffle plates to provide for uniform distribution of gas flow through all gas passages and in each gas passage in accordance with EP-7. Pressure test connections must be provided at the inlet and discharge ducts connecting to the precipitator.

2.13.6.7 Corrosion Resistance

Due to the saturated conditions of the process gas WESPs are susceptible to corrosion. Proper analysis of the Material selection must be based on the process gas, expected pH and chloride levels of the water. Material of construction must be [carbon], [corrosion resistant]steel, or [_____].

2.13.7 Wet Scrubber

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NOTE: Select scrubber type based on efficiency required. Wet scrubbers are used for the removal of gaseous pollutants such as sulfur oxides, nitrogen oxides, and other gaseous materials from boiler flue gases. Removal of sulfur oxides (flue gas desulfurization) is covered by Paragraphs "Wet Flue Gas Desulfurization System" and "Spray Dryer Flue Gas Desulfurization System". Wet scrubbers will also remove fumes, mists, dusts, and smoke particles from laboratory fume hood and welding booth exhausts. With appropriate adsorbents they can collect vapors of paint thinners and solvents. They can handle boiler flue gases as high as 371 degrees C 700 degrees F, but impose a heavy water demand for evaporative cooling causing a heavy water vapor plume from the chimney. This water use also increases flue and chimney condensation and possible corrosion damage. Those problems can be minimized with a heat exchanger with a pump and water coils to precool the hot flue gas to the scrubber and deliver the recovered heat to the relatively cool cleaned gas out of the scrubber, as required. Any surplus heat can be used for other heating applications. The scrubber requires a water and chemicals supply system with problems of slurry or sludge removal; chemicals storage, mixing, feeding, and monitoring; and corrosion prevention of wetted parts. Since the scrubber system is relatively costly to install and operate, care should be exercised to limit its use to the function that only it can perform. In addition to its primary function of removing gaseous pollutants, it will also remove particulates. In addition to water sources shown within brackets, there may be other sources such as recycled water from waste treatment plant among others. Insert source within brackets and delete the others.

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Provide unit in compliance with ICAC EP-1 and all federal and state regulations as a wet scrubber for removing gases, fumes, and particulates from the air exhausted from [welding] [and] [paint spray] booths [and from [_____]]. Ensure scrubber is one of the types identified as a [venturi,] [spray,] [tray,] [fixed packed bed,] [mobile bed,] [impingement,] [or] [entrainment] type [or a combination of these types].[Unit must have moisture eliminator with chevron, mist pad, or loose fill type design.] Unit must employ a small quantity of water or chemical neutralizing water solution to provide for maximum scouring and pollutant removal of the gas stream. Water demand rates of less than 0.13 L/second per cubic meter per second one gpm per 1000 cfm of processed gases must use [potable] [cooling tower blowdown] [_____] water with waste to drain. Water demand in excess of the above flow rate must provide for recirculation of the washing liquor. Provide unit with [an automatic water supply control valve,] [a float-operated water level control valve,] [a totalizing water meter,] strainer, and water pressure gauge.

2.13.7.1 Chemical System

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NOTE: Investigate user agency, facility operation, and maintenance standards and procedures; analyze the pollution control equipment's consumption of materials; confer with equipment suppliers; and determine the optimum time period for reserve capacity. Select the "reserve" time period, and delete all other periods. The above investigation will also determine if the last sentence within the brackets should be retained or deleted.

****

Provide each unit requiring neutralizing chemical additives with a complete automatic chemical monitoring, control, mixing, feeding, and reserve storage system. Provide chemical system with a reserve capacity for [[24] [36] [48] hours] [[3] [7] [10] days] of continuous scrubber operation at design conditions without requiring servicing. [Provide components that must be taken out of service for routine maintenance or chemical loading in duplicate arranged for transfer by manual operation of switches and valves.]

2.13.7.2 Scrubber

Scrubber must be fluid-tight construction of [glass fibre reinforced polyester] [rolled low-carbon steel coated with a protective coating that is suitable for the process gas and temperature] [ASTM A302/A302M stainless steel] [ASTM A240/A240M stainless steel] [PVC] [CPVC] [polypropylene] [FRP lined mild steel]. Provide unit with leak-tight viewing windows and access doors to permit appraisal of entire operation as well as full access for all service operations or parts replacement. Use vanes, baffles, deflectors, or diffuser plates to provide for uniform gas flow through the processing area. Scrubber must be factory assembled, piped, and wired on floor mounted welded steel bases as indicated.

2.13.7.3 Recirculation Pumps

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NOTE: Determine if facility will require continuous operation or if it can be shut down or if the pollution control equipment can be out of service for extended periods. If continuous operation is required, select wording for duplicate pumps and remove brackets.

****

Unit requiring recirculation of the scrubbing liquor must be provided with [direct] electric motor centrifugal pumps [in duplicate] to conform to HI ANSI/HI 3.1-3.5. Pumps must develop the system pressure head required by the scrubber. Ensure materials, construction, ratings, application, and testing conform to the standards and recommendations of HI ANSI/HI 3.1-3.5 for corrosion resistant operation of pumping the scrubber liquor. [Provide a manual selector switch for selection of "Lead" and "Lag" operation of the duplicate pumps.] Provide each pump with a discharge pressure gauge appropriate for the pump head and a low pressure limit switch to [start the backup pump] [and] [close a circuit for an alarm]. Provide pumps with corrosion-resistant strainers, valves, and piping suitable for the system and the gas to be processed. [Provide pumps for metering the feed rate of scrubber chemical additives with [manual] [automatic] means for varying the feed rate.]

2.13.7.4   Piping Materials

****

NOTE: Delete inapplicable materials and equipment. Pipe, fitting, and valve materials listed in this section are suitable for water service, but not for corrosive, erosive, and some petrol services. The designer should select the proper alloy (e.g., stainless steel 304, 316, etc.), rubber or other elastomer lining or plastic for these and other applications where the chemistry of the process must dictate material selection.

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Provide piping materials that are compatible with the scrubber fluids. Nozzles must be non-plugging type for wetting packing.

2.13.7.5   Scrubber Collector System

Provide each scrubber requiring the use of chemical additives with a system for removing and dewatering the collected material and chemical residues of the scrubber process. Provide related equipment and controls. Provide pressure test connections at the inlet and outlet ducts connecting to the collector.

2.13.8   Dry Fabric Collector for Boiler Flue Gases

****

NOTE: Dry fabric collectors are highly effective in removing up to 99.9 percent by weight of particulates of submicron size and larger from gas streams of more than 229 mg per cubic meter 0.1 grain (weight) per cubic foot. Emissions will consistently be less than 11 mg per cubic meter 0.005 grain/actual cubic foot. Fabrics are available for gas streams up to 288 degrees C 550 degrees F and are often used for particulate removal from coal handling operations and boiler flue gases. Fibre selection and fabric construction and finish are extremely critical to the performance and service life of a dry fabric collector. Chemical, temperature and abrasion resistance, strength, and dimensional stability are important fibre selection considerations. Fabric weave, weight, finish, and dimensional stability are major fabric requirements. Fabric filters can be harmed by corrosive chemicals. It may be necessary to scrub the gas prior to the dry fabric collector. The space requirement is rather large and pressure drop is typically in the 1.02 kPa to 1.53 kPa 4 to 6 inch water gauge range. An important consideration is

whether the processed stream can be interrupted, such as a nonproduction type welding facility exhaust, or if it must remain in continuous operation, such as for a base boiler plant. If the process is relatively small and the dust loading is relatively light, or if the process is intermittent, it may be desirable and economic to use replaceable deep pocket type or automatic moving media type filters. If the loading is high and process must not be interrupted, a cleanable baghouse type unit may be desired.

****

Unit must be type identified as [an unsupported tubular [unibag] [multibag] [side entry] [top entry] type] [a supported filter element [tubular] [or] [envelope] type]. Provide fabric collectors in compliance with ICAC F-3. Coordinate the collector provided with the boiler combustion control and safety system so as to assure that the boilers operate within design conditions throughout entire operating range at design capacity of the collector. Ensure collector is an ICAC [standard collector, medium-to-heavy duty, usually continuous service cleaning gases at [_____] degrees C degrees F] [special or custom-designed collector, heavy duty continuous service cleaning gases at [_____] degrees C degrees F].

2.13.8.1 Filter Cleaning

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NOTE: In the last sentence, three filter cleaning methods are available, any or all of which may be allowed depending upon site conditions and available utilities. Under the present state of the art, the use of compressed air pulse jet cleaning should be limited to systems below 142 cubic meter per second 300,000 acfm (actual cfm). Efforts to reduce flue gas pressure drop in fabric collectors have led to the development of more vigorous cleaning methods, in particular, the use of sonic horns in combination with conventional air exchange cleaning methods, such as reverse air, pulsed jet, or shake/deflate. Up to 60 percent reduction in pressure drop has been realized using sonic horns with no deterioration in particulate emission levels. Pressure level, frequency, power levels, and spatial distribution of horns within the collector compartment are all important specification criteria.

****

Filter element cleaning must be automatically initiated and executed [on an adjustable programmer time cycle] [by operation of an adjustable high filter pressure drop switch]. Accomplish cleaning by powered vibrator or shaker devices, reverse cleaned air flow with [positive] [negative] air pressure in the unit, a combination of shaker and reverse air flow [or compressed air pulse jet cleaning]. [Filter element cleaning must include sonic horns.]

2.13.8.2 Filter Enclosure

Fabricate filter enclosure of [4.8 mm 3/16 inch] [6.4 mm 1/4 inch] [low carbon] [corrosion resistant] steel of welded or bolted construction or combinations thereof. Give enclosure sheets supporting strength and rigidity by folding or bending or support on supplemental structural steel shapes. Provide unit with gas inlet and outlet connections and baffles, vanes, deflectors, or low friction diffuser plates that will ensure uniform gas flow to all elements of the fabric system without causing flutter, vibration, or erosion of the fabric. Provide hinged, latched, and gasketed access doors for all parts and areas that require inspection or service. Secure and support fabric elements by internal rings or equivalent method so that the entire fabric surface is so deployed that gas flow and particulate collection will be uniform over entire working surface. Ensure dust shedding properties are uniform so that entire fabric surface will be equally cleared by a cleaning operation without damage to media other than normal service wear. Arrange media in elements, sections, pockets, or tubes that can be handled, removed, replaced, and secured without special facilities.

2.13.8.3 Collector Cleaning

Provide units with means for isolating a compartment or section for cleaning while other compartments are performing their normal dust removal function. Compartment isolation must effectively prevent reentrainment of the particulate during the cleaning operation. Base unit rating upon operation with one section out for cleaning. Cleaning operation must be [operator initiated and executed by manually operating the cleaning cycle on each compartment in sequence until all filters have been cleaned] [operator initiated to have the filters cleaned automatically one compartment at a time until all filters have been cleaned] [automatically initiated by an adjustable filter air pressure drop switch operating at a high pressure set point to initiate the filter cleaning operation] [automatically initiated by a timer to initiate the filter cleaning operation]. Once started, the cleaning operation must progressively clean one compartment at a time until all filters are cleaned. Remove collected particulate by discharging from a hopper below. Collector manufacturer must provide all of the components required for the entire cleaning operation including [manual rappers] [motorized rappers] [rotary air valve] [manual dampers] [motorized dampers] [compressed air surge receiver] [air compressor with receiver, motor drive, and controls] [blast or pulse jet controls, nozzles, and valves] [shaker or flutter blower, motor, drive, and controls]. [Provide automatic operations with a manual override for starting, stopping, interrupting, and restarting operation.]

2.13.8.4 Test Connections

Provide pressure test connections at the inlet and outlet ducts connecting to the collector.

2.13.8.5 Flue Gas Dust Collectors Designed for In-Place Cleaning

Provide dust collectors designed and constructed for in-place cleaning of the fabric with a [3.4] [4.8] [6.4] mm [10 gauge] [3/16 inch] [1/4 inch] [low carbon] [corrosion resistant] steel sloped bottom dust storage hopper having the dust holding capacity as indicated. Construct collector and hopper system to minimize reentrainment of collected material into the gas stream. Provide hopper bottom with rappers or fluidizing pads and with a hopper valley angle of 60 degrees from the horizontal and free of pockets, ribs, fins, or any other obstruction to hold or interfere with free and complete release of all collected material to the outlet. Provide outlet with [a guillotine-type slide gate] [a motor-driven rotary lock] [automatic lock hoppers]. Provide hopper with a poke hole and gasketed access door and with a collected material level indicator for [local indication] [local indication with terminals for wiring to a remote indicator]. Level indicator must include a high material level audible alarm. [Provide hopper with electric heating coils, modules, or blankets to keep collected material dry and free flowing with the unit installed outdoors and out of service in a local winter outdoor design temperature of [_____] degrees C degrees F].

2.13.9 Dry Fabric Collector for Dust Control

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NOTE: Dry fabric collectors are highly effective in removing up to 99.9 percent by weight of particulates of submicron size and larger from gas streams of more than 229 mg per cubic meter 0.1 grain (weight) per cubic foot. Emissions will consistently be less than 11 mg per cubic meter 0.005 grain/actual cubic foot. Fabrics are available for gas streams up to 288 degrees C 550 degrees F and are often used for particulate removal from coal handling operations and boiler flue gases. Fibre selection and fabric construction and finish are extremely critical to the performance and service life of a dry fabric collector. Chemical, temperature and abrasion resistance, strength, and dimensional stability are important fibre selection considerations. Fabric weave, weight, finish, and dimensional stability are major fabric requirements. Fabric filters can be harmed by corrosive chemicals. It may be necessary to scrub the gas prior to the dry fabric collector. The space requirement is rather large and pressure drop is typically in the 1.02 kPa to 1.53 kPa 4 to 6 inch water gauge range. An important consideration is whether the processed stream can be interrupted, such as a nonproduction type welding facility exhaust, or if it must remain in continuous operation, such as for a base boiler plant. If the process is relatively small and the dust loading is relatively light, or if the process is intermittent, it may be desirable and economic to use replaceable deep pocket type or automatic moving media type filters. If the loading is high and process must not be interrupted, a cleanable baghouse type unit may be desired.

****

Provide unit of the type identified as [an unsupported tubular [unibag] [multibag] [side entry] [top entry] type.] [a supported filter element [tubular] [or] [envelope] type.] Provide fabric collector in compliance with ICAC F-5 and ICAC F-3. The collector must be an ICAC F-5 [unit, Type I, for light duty, intermittent service cleaning gases at or near room temperature.] [standard collector, for light-to-medium duty [intermittent] [continuous] service cleaning gases at continuous temperatures from room temperature to 135 degrees C 275 degrees F] [standard collector, for medium to heavy duty 260 degrees C 500 degrees F] [special or custom designed collector, heavy duty continuous service cleaning gases at [_____] degrees C degrees F].

2.13.9.1 Filter Cleaning

****

NOTE: The choice of filter cleaning methods should be based on site conditions, available utilities, and operational requirements. For example, dust control of coal bunkering is usually intermittent as related to arrival of coal transporters and does not warrant a fully automatic continuous operation facility. Under the present state-of-the-art, the use of pulse jet cleaning should be limited to systems up to 142 cubic meters per second 300,000 acfm (actual cfm).

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Filter cleaning of collector units processing air or gas streams at or near ambient temperatures, must be [manually initiated and executed by [operating the required dampers and cleaning devices]] [automatically initiated and executed [on an adjustable or timed cycle] [by operation of an adjustable high filter pressure drop switch]]. [Powered cleaning must be for [intermittent] [continuous] service employing [powered vibrator or shaker devices] [reverse air flow with atmospheric air and] [reverse cleaned air pressurized air flow with] [positive] [negative] air pressure in the unit [compressed air pulse jet cleaning] [of individual or a few elements] [of an entire compartment].] [Filter element cleaning must include sonic horns.]

2.13.9.2 Filter Enclosure Construction

Fabricate filter enclosure of [3.4] [4.8] [6.4] mm [10 gauge] [3/16 inch] [1/4 inch] [low carbon] [corrosion resistant] steel of welded or bolted construction or combinations thereof. Give enclosure sheets supporting strength and rigidity by folding or bending or support on supplemental structural steel shapes. Provide unit with gas inlet and outlet connections and baffles, vanes, deflectors, or low friction diffuser plates that will insure uniform gas flow to all elements of the fabric system without causing flutter, vibration, or erosion of the fabric. Provide hinged, latched, and gasketed access doors for all parts and areas that require inspection or service. Secure and support fabric elements in a manner to have the entire fabric surface so deployed that gas flow and particulate collection will be uniform over the entire working surface. Ensure dust shedding properties are uniform so that the entire fabric surface will be equally cleared by a cleaning operation without damage to the media other than normal service wear. Arrange media in elements, sections, pockets, or tubes that can be handled, removed, replaced, and secured without special facilities.

2.13.9.3 Intermittent and Continuous Service Units

[Equip intermittent service units with [washable] [cleaning-in-place] fabric filters.] [Provide continuous service units with means for isolation of a compartment or section for cleaning while other compartments are performing their normal dust removal function. Ensure compartment isolation effectively prevents reentrainment of particulate during the cleaning operation.] Base unit rating upon operation with one section out for cleaning. Cleaning operation must be [operator initiated and executed by manually operating the cleaning cycle on each compartment in sequence until all filters have been cleaned] [operator initiated to have the filters cleaned automatically one compartment at a time until all filters have been cleaned] [automatically initiated by an adjustable filter air pressure drop switch operating at a high pressure set point to initiate the filter cleaning operation] [automatically initiated by a timer to initiate filter cleaning operation]. Once started, the cleaning operation must progressively clean one compartment at a time until all filters are cleaned. Removal of collected particulate must be by [raking out] [removal and dumping of a particulate pan or tray] [draining from a hopper below]. Collector manufacturer must provide all of the components required for the entire cleaning operation including [manual rappers] [motorized rappers] [manual dampers] [motorized dampers] [compressed air surge receiver] [air compressor with receiver, motor, drive, and controls] [blast or pulse jet controls, nozzles, and valves] [shaker or flutter blower, motor, drive, and controls] [traveling ring components]. [Provide automatic operations with a manual override for starting, stopping, interrupting, and restarting operation.]

2.13.9.4 Test Connections

Provide pressure test connections at the inlet and outlet ducts connecting to the collector.

2.13.9.5 Dust Collectors Designed for In-Place Cleaning

Provide dust collectors designed and constructed for in-place cleaning of the fabric with a [3.4] [4.8] [6.4] mm [10 gauge] [3/16 inch] [1/4 inch] [low carbon] [corrosion resistant] steel sloped bottom dust storage hopper having the dust holding capacity as indicated. Construct collector and hopper system to minimize reentrainment of collected material into the gas stream. Provide hopper bottom with rappers or fluidizing pads and ensure the hopper valley angle is 60 degrees from the horizontal and free of pockets, ribs, fins, or any other obstruction to hold or interfere with free and complete release of all collected material to the outlet. Provide outlet with [a guillotine-type slide gate] [a manually-operated rotary lock] [a motor-driven rotary lock] [automatic lock hoppers]. Provide hopper with a poke hole and gasketed access door, and a collected material level indicator for [local indication] [local indication with terminals for wiring to a remote indicator]. Include a high material level audible alarm. [Provide hopper with electric heating coils, modules, and blankets to keep collected material dry and flowing with the unit installed outdoors and out of service in a local winter outdoor design temperature of [_____] degrees C degrees F].

2.13.10 Gaseous Emissions Control Unit

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NOTE: The gaseous emissions control units are to be used for cleaning particulate and gaseous solvent materials from the exhaust air at laboratory fume hoods, welding booths, water curtain paint spray booths, and other similar type problems. The fabric prefilter will collect a reasonable amount of particulates and the carbon will adsorb the gaseous vapors. The unit may be used without the prefilter to collect gasoline vapor from small storage tank vents, but the tank should be installed underground or be shaded to minimize boil-off. Project conditions may make regeneration of the carbon desirable. A typical gaseous emission control with carbon regeneration unit consists of two or more

adsorber vessels with deep bed (typically 450 to 600 mm 18 to 24 inches) of high grade gas phase activated carbon. The manufacturer should provide the bed depth as part of his design, and should consider the life cycle cost when sizing the adsorbent unit. The dampers and control valves will be based on timer operation or solvent sensor operation. Once the adsorption bed is saturated with solvent vapors, the flow into the adsorber is automatically diverted to the second adsorber. Low pressure steam is used to desorb the saturated adsorber, regenerating the carbon and producing a steam and solvent mixture which is condensed in a shell and tube condenser. Water insoluble solvents should be separated in a decanter for reuse. The system must be complete with adsorber vessels, blower, filter, condenser, and controls. Deposition of the waste effluents is dependent on the specific project and cannot be determined in the guide specification.

****

Ensure unit complies with ICAC G-1 and consists of a dry type particulate removal precleaner followed by an adsorption unit of activated carbon or other approval adsorbent material.

2.13.10.1 Prefilter

Provide [cleanable] [replaceable] prefilter. Provide prefilter with a cleaning performance equal to or exceeding ASHRAE 52.2 of 95 percent arrestance by weight, 80 to 90 percent atmospheric dust spot efficiency, and a dust-holding capacity of not less than 530 grams per 1 cubic meter per second 250 grams per 1,000 cfm cell. Provide media complying with UL 900 and with a support frame or construct to be self-supporting without sagging either with or without gas flow. Hold each cell securely in place with applied pressure leak-tight joint between the media, media flange, and media collar, and secure the filter to the media bulkhead with latches or clips to permit removal, replacement, and securing without special tools.

2.13.10.2 Adsorbent Unit

Provide adsorbent section consisting of [a system of trays, hollow panels, canisters, or other means of holding a deep bed of activated carbon conforming to ASTM D2854 and ASTM D2862, or other adsorbent material, to cause the processed gas to pass through a uniform depth of material in the gas flow direction][a system of filter frames constructed of activated carbon loaded in a pleated, non-woven synthetic media, with a V-bank configuration].[Design trays, panels, and canisters to assure that the adsorbent bed will be uniform, full and free of voids or thin spots and supported and contained to prevent movement, pulverizing, abrasion, or dusting of the adsorbent and easy and full recharging without special facilities or tools.] Secure adsorbent units leak-tight in a [bulkhead] [filter frame] forcing all gas to pass through the adsorbent bed.

2.13.10.3 Prefilter and Adsorbent Assemblies

Enclose prefilter and adsorbent assemblies in a welded, bolted, or riveted sheet metal enclosure that limits both in-leakage or out-leakage of gas. Ensure enclosure access doors or panels are bolted, or gasket-sealed and latched to provide independent access to the prefilter and the adsorbent plenums. Design the enclosure for the maximum differential pressure (positive or negative) under any mode of operation.

2.13.10.4 Inlet and Outlet Ducts

Provide unit with inlet and discharge vanes, baffles, diffusers, or other devices to assure uniform gas flow through the processors. Provide pressure test connections at the inlet and outlet ducts connecting to the collector.

2.13.11 Petrol Vapor Recovery Unit

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NOTE: The petrol vapor recovery unit is intended for use at fuel depots or fuel distribution terminal facilities. It is used to recover fuel vapors by refrigerated condensation of the material from tank and transporter vents. Underground storage tanks at petrol dispensing stations do not commonly require refrigerated petrol recovery units but are equipped to have the unloading fuel displace a like volume of vapor from the underground tank into the transporter through a vent hose and manifold which are integral with the transporter vehicle. The transporter then hauls this vent gas to the local depot for recovery as the transporter is reloaded. Some jurisdictions may require vehicle tank venting back to the storage tank as the vehicle is loaded. Gaseous emission activated carbon emission control units, with and without carbon regeneration, can be used in this application.

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Provide a complete air-cooled mechanical refrigerated electric-operated unit designed for condensing the fuel vapors vented from gasoline system storage tanks. Ensure recovery process is in two steps. Precool the vent gas to slightly above water freeze point to remove most of the water vapor without a defrost cycle in the first step. During second step, cool the gas to the required vapor pressure with minimum frost collection. Include storage capacity and circulation system for defrosting fluid. Provide refrigerants which are classified as nontoxic, nonflammable, conforming to ASHRAE 15 & 34, Group 1.

2.13.11.1 Defrosting

[Fuel handling operation will allow defrosting for about [4] [5] [6] hours after midnight.] [Fuel handling operation will not allow time for defrosting and provide a duplicate cooler with automatic controls to alternate the units between cool and defrost modes with status indication of each.]

2.13.11.2 Unit Operation and Control

Provide unit for [complete monitoring and control at the unit] [operation and control at the unit with remote indication of ON-OFF position of unit power supply switch] [operation and control at the unit with remote indication of operating and control of the unit with complete process indication with maintenance and service operation at the unit]. [Provide [visible] [and] [audible] alarms on critical functions [locally] [and at remote station].]

2.13.11.3 Design and Fabrication Requirements

Provide unit from single supplier and of coordinated design, fully assembled and subjected to factory tests before shipment. Skid mount unit on a permanent steel base with pick-up lugs and anchor bolt holes for installation on a concrete foundation. Provide electric power connection, vent gas inlet, return line for condensed hydrocarbons, and drain for aqueous liquids. Install components in a ventilated weather proof enclosure with full accessibility for operation and service through hinged access doors with latches or removable panels. Use doors for access to all operating functions. Insulate cold components and piping of the entire system subject to sweating or frosting. Provide electrical equipment and installation work conforming to requirements of hazardous locations for Class I, [Division I,] [Division II,] Group D, of NFPA 70 and NFPA 496, and Type X conforming to UL 5, UL 674, UL 1203, and UL 823 requirements. Inlet vent gas flow to the unit must be through a 0.075 mm 200 mesh removable ASTM A240/A240M stainless steel or equal strainer. Perform refrigeration work complying with ASHRAE 15 & 34 and ASME B31.5. Ensure petrol vapor, condensed hydrocarbon returns, and aqueous waste piping is in compliance with ASME B31.3.

2.13.12 Gravel Bed Filter

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NOTE: Electrostatically enhanced gravel beds, combining granular filtration and electrostatic collection, are highly effective with collection efficiencies in excess of 99 percent on submicron particles. Gravel beds without electrostatic enhancement have collection efficiency greater than 95 percent on coarser particulate. They are frequently applied to gas streams in excess of 371 degrees C 700 degrees F and are particularly suitable for the collection of high resistivity particulates with potential fire and explosion hazards. Gravel beds are more compact then electrostatic precipitators or fabric filters for comparable applications. The unit is relatively insensitive to variations in gas flow and temperature excursions, and, in most cases, chemical makeup of the exhaust gas and particulate. Pressure drop across the gravel bed ranges from 763 Pa to 1271 Pa 3 to 5 inches water gauge. Carbon steel is the normal material of construction although high temperature and/or corrosive environments require the use of alloys or stainless steel.

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The system must remove particulates from process gas streams through granular filtration in a moving bed of filter media supplemented by electrostatic collection resulting from the application of high voltage power to [an electrical grid located in the bed] [an ionization grid located upstream of the bed in addition to an electrical grid located in the bed].

2.13.13 Wet Flue Gas Desulfurization System

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NOTE: A flue gas desulfurization (FGD) system is used to reduce emission of sulfur dioxide from solid waste incinerator and boiler flue gases. It can also reduce other acid gas emissions such as hydrochloric acid and hydrofluoric acid. FGD systems are classified as either wet or dry processes. In the wet process, the flue gas reacts with a sorbent solution, producing a liquid product. The reagent selected will result in either a waste product, which must be disposed of, or a by-product, in which the sulfur recovered is in useable form. In general, the capital cost of regenerative systems may be up to twice the cost of non-regenerable systems.

****

System must remove sulfur dioxide, [hydrochloric acid] [hydrofluoric acid] [particulates] [and] [______] from processed gas stream. Provide [non-regenerative] [regenerative] system and use wet scrubbing process. Include all equipment required for a complete, operable FGD system, including wet scrubbing system, complete reagent feed system, [waste] [by-product] handling system, and instrumentation and controls for safe, reliable operation of the system.

2.13.13.1 Wet Scrubber System

Provide wet scrubber complying with ICAC EP-1. Scrubber must be a [venturi,] [spray,] [tray,] [fixed packed bed,] [mobile bed,] [impingement,] [or] [entrainment,] type [or a combination of these types]. Provide scrubber consisting of fluid-tight construction of [glass fiber reinforced plastic] [rolled low-carbon steel coated with a protective coating that is suitable for process gas and temperatures] [ASTM A302/A302M stainless steel] [ASTM A240/A240M stainless steel] [_____]. Construct unit with leak-tight viewing windows and access doors to permit appraisal of scrubbing process as well as full access for all service operations or parts replacement. Use vanes, baffles, deflectors, or diffuser plates that provide for uniform gas flow through the scrubbing chamber. Design scrubber internal components to minimize scaling and plugging inside the tower. Provide mist eliminator consisting of fluid-tight construction. Ensure vanes, baffles, or deflectors provide for uniform gas flow to the mist eliminator elements. Design mist eliminator to minimize re-entrainment of liquid into the gas stream. Provide mist eliminator with a water washing system to prevent solids buildup on the blades. Size and orient washing nozzles to spray entire mist eliminator area. Provide system with clean gas reheater upstream of stack to prevent acidic condensation and corrosion in the stack.

2.13.13.2 Reagent Feed System

Provide reagent feed system including all components required for storage of dry reagent, preparation of reagent slurry, delivery and re-circulation of the selected reagent. Use one reagent feed system to serve all scrubbers. Reagent feed system must have a reserve capacity for [[24] [36] [48] hours] [[3] [7] [10] days] of continuous FGD operation at design capacity without servicing. [Provide components that must be taken out of service for routine maintenance or reagent loading in duplicate, arrange for transfer by manual operation of switches and valves.] Include all tanks, agitators, pumps, piping, valves and other equipment required by a specific system design. Provide system equipment of design, material and construction appropriate for scrubbing solution delivery and for re-circulation of scrubbing effluent. Design piping to prevent settling of scrubbing solution inside the pipes. Include provisions for drainage and clean-out of feed system components, including pumps and piping in the design.

2.13.13.3 Waste Handling System

Provide waste handling system including all equipment required for pre-disposal treatment of the scrubbing effluent, including tanks, agitators, liquid-solid separator, vacuum filter, solid waste holding bin, pumps, piping, and valves as required.

2.13.13.4 Test connections

Provide pressure test connections at the inlet and outlet ducts connecting to the scrubber.

2.13.14 Spray Dryer Flue Gas Desulfurization System

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NOTE: A flue gas desulfurization (FGD) system is used to reduce emission of sulfur dioxide from solid waste incinerator and boiler flue gases. It can also reduce other acid gas emissions such as hydrochloric acid and hydrofluoric acid. FGD systems are classified as either wet, wet/dry, or dry processes. The spray dryer FGD process is a wet/dry process, in which the flue gas reacts with an alkaline reagent, usually a lime slurry, and the reaction product is in dry form. The reagent selected will result in either a waste product, which must be disposed of, or a by-product, in which the sulfur recovered is in useable form. In general, the capital cost of regenerative systems may be up to twice the cost of non-regenerable systems.

****

System must remove sulfur dioxide, [hydrochloric acid] [hydrofluoric acid] [particulates] [and] [_____] from processed gas stream. Provide non-regenerative system and use a spray dryer scrubbing process. Include all equipment required for a complete, operating FGD system, including spray dryer scrubbing system, complete slurry feed system, waste handling system, particulate collecting unit consisting of [fabric filter collector,] [electrostatic precipitator,] and instrumentation and controls for safe, reliable operation of the system.

2.13.14.1 Spray Dryer System

Provide spray dryer in compliance with ICAC EP-1. Spray dryer must be of gas-tight construction. Construct unit with leak-tight viewing windows and access doors to permit appraisal of scrubbing process as well as full access for all service operations or parts replacement. Spray dryer system must include flue gas preheater prior to spray dryer inlet. Design vanes, baffles, deflectors, or diffuser plates to provide complete mixing of flue gas and chemical reagent, and to provide adequate time for chemical reaction and evaporation of liquid in spray dryer chamber. Provide [rotary] [or] [dual fluid] atomizing system to provide uniform dispersion of the chemical reagent in the spray dryer chamber and prevent gas droplet deposition on spray dryer walls. [Dual fluid nozzle atomizers must use compressed air as the atomizing fluid. Provide a dedicated air compressor system for dual fluid atomizing system.] Design scrubber internal components to minimize scaling inside the tower.

2.13.14.2 Reagent Feed System

Provide chemical reagent feed system including all components required for storage, preparation, delivery and re-circulation of the chemical reagent. Use one reagent feed system to serve all scrubbers. Reagent feed system must have a reserve capacity for [[24] [36] [48] hours] [[3] [7] [10] days] of continuous FGD operation at design capacity without servicing. [Provide components that must be taken out of service for routine maintenance or reagent loading in duplicate, arrange for transfer by manual operation of switches and valves.] Include all tanks, agitators, filters, pumps, piping, valves and other equipment required by a specific system design. Provide system equipment of design, material and construction appropriate for reagent delivery and for re-circulation of spray dryer effluent. Design piping to prevent settling of solids inside the pipes. Include provisions for drainage and clean-out of feed system components, including pumps and piping in the design.

2.13.14.3 Particulate Collecting Unit

Design particulate collecting unit to collect spray dryer products and fly ash remaining in the gas stream exiting the spray dryer. Provide particulate collection unit consisting of [fabric filter collector] [electrostatic precipitator]. [Provide fabric filter collector in accordance with paragraph DRY FABRIC COLLECTOR FOR BOILER FLUE GASES]. [Provide electrostatic precipitator in accordance with paragraph DRY ELECTROSTATIC PRECIPITATOR (DRY ESP)].

2.13.14.4 Test connections

Provide pressure test connections at the inlet and outlet ducts of each spray dryer and fabric filter collector.

2.13.15 Selective Catalytic Reduction (SCR) System

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NOTE: All fossil fuel burning processes produce nitrogen oxides (NOx). Selective catalytic reduction (SCR) reduces NOx to N2 in the presence of a catalyst. The reducing gas is usually ammonia (NH3), and the catalyst may be composed of various materials, such as oxides of vanadium or tungsten. The catalytic reduction reaction requires temperatures in the range of about 300 to 425 degrees C 600 to 800 degrees F. Selection of the catalyst material and configuration, as well as the operating temperature, depends on the type of fuel being burned. The catalytic reactor will receive a high dust, low dust, or tail end gas stream, depending on its location in the system. In the

high dust location, the catalyst is located upstream of an electrostatic precipitator. Location of the SCR system downstream of an electrostatic precipitator results in a low dust environment for the catalyst. In the tail end location, the SCR system is located downstream of an electrostatic precipitator and/or a flue gas desulfurization system, which provides the cleanest gas to the catalyst. Location of the SCR in the system will have an impact on catalyst life.

Efficiency of conventional SCR equipment in removal of NOx is about 80-90 percent. SCR may be used in conjunction with combustion modifications, such as low NOx burners. A potential complication of SCR using ammonia when high sulfur coal is burned is the formation of ammonium bisulfate. When unreacted ammonia passes through the catalytic reactor, called ammonia slip, it will combine with SO3 present in the flue gas, forming ammonium bisulfate. Ammonium bisulfate, a sticky, corrosive material, will condense on downstream equipment. Ammonia slip is a major design concern when burning high sulfur coal.

****

Design system to reduce nitrogen oxides from processed gas stream. Use ammonia as the reducing agent. Include all equipment required for a complete, operable SCR system, including, but not limited to, ammonia delivery system, catalytic reactor [with sootblowers], ash removal system, instrumentation and controls for safe, reliable operation of the system, and other pollution control devices as required.

2.13.15.1 Ammonia Delivery System

Provide ammonia delivery system including all components required for storage, preparation, and delivery of ammonia to the flue gas stream downstream of the economizer, prior to the catalytic reactor. Design ammonia delivery system to automatically deliver ammonia based on the quantity of NOx detected in the gas stream. Design ammonia vaporizers to ensure uniform ammonia distribution in the gas stream. Locate ammonia vaporizers in ductwork at a sufficient distance upstream of the catalytic reactor to provide complete mixing of ammonia and flue gas prior to the catalytic reactor inlet.

2.13.15.2 Catalytic Reactor

Catalytic reactor must provide environment for chemical reaction between ammonia and nitrogen oxides, to produce elemental nitrogen and water as the products. Ensure catalytic reactor configuration provides for uniform gas flow through all elements of the reactor. Catalytic reactor must be of gas tight construction Locate catalytic reactor between boiler economizer and boiler air preheater. [Locate catalytic reactor [upstream of an electrostatic precipitator] [downstream of an electrostatic precipitator] [downstream of a flue gas desulfurization system] [downstream of an electrostatic precipitator and a flue gas desulfurization system].] [Provide catalytic reactor with sootblowers.] Limit ammonia slip to [_____] ppm.

2.14 EMISSION MONITORING SYSTEM

****

NOTE: Provide in-situ opacity monitoring equipment where applicable to insure emission compliance of the particulate control equipment.

State and local regulatory authorities should be contacted at an early stage of the project design to determine if they consider the test methods cited to be adequate, and if they have any additional requirements.

****

Provide emission monitoring system complete with all components, accessories, analyzers [analyzer calibration system] [and recorders,] [alarms], and free-standing factory assembled panel to [monitor opacity, sulfur dioxide, nitric oxide, nitrogen dioxide, and carbon monoxide emissions in boiler flue gases.] [In-situ opacity monitoring.] [_____]. System must [continuously monitor] [time program monitor as indicated] [be manually operated to monitor] the emissions. Submit reports for emissions permit compliance. Indicate [and record] emissions in ppm and percent of sample.

Emission monitoring system must be designed for monitoring the specific flue gas characteristics (moisture) discharged.

2.14.1 Gas Sampling System

Sampling locations for air pollution control equipment performance must be in accordance with 40 CFR 60, Appendix A. Use a vacuum pump to draw a gas sample through a filter probe mounted inside the stack, a prefilter, and a moisture separator/drier. It must discharge the sample through a flow meter on each analyzer to atmosphere as indicated. Provide equipment and necessary tubing for automatically purging pollutants from sampling tubing, stack probe, and drier tubing, and for automatic regeneration of the drier. Cleaning and drying operation must be time programmed.

2.14.2 Analyzing System

System must provide simultaneous measuring and analyzing of sample gas by each analyzer with independent flow meters, valves, piping, and accessories. Each analyzer must indicate ppm of the measured pollutant. Provide each analyzer with a visual color coded, panel mounted, high limit alarm with a single audible alarm with silencing button for all alarms. Provide a relay on each analyzer for connection to a remote alarm.

Analyzers must incorporate only approved methods of detection as per 40 CFR 60, Appendix B, Performance Specification 1 (PS-1), ASTM D6216, and Clearance Permit System 001 (CPS-001) when applicable. Analyzers must be capable of satisfying applicable EPA and/or local regulations as listed in the operating permit for relative accuracy. Analyzer Sensitivity must meet all performance criteria of PS-1 and all other applicable state and federal regulations. Analyzer output signals must have the capability of communicating a signal directly to the [plant control system] [existing Data Acquisition System]. The output signal must be linearly proportional to the opacity value sensed for entire scale in use. Discrete Output Signals of System Controller must be available for Analyzer malfunction, Analyzer is in calibration, and Measured concentration exceeds predefined limits. Analyzers must be equipped with a direct readout display or an independent output for a local panel display device. Analyzer displays must provide readings in accepted engineering units.

2.14.3 System Mounting

Gas sampling, analyzing [, and recording] systems must be piped, wired, and mounted within a factory fabricated 2.657 mm 12 gauge cold rolled black steel enclosure with angle frame support and key-locked doors for [wall] [floor] mounting. Entire system must be suitable for 120 Vac, 60 Hz, single-phase electric service.

2.14.4 Calibration

Provide calibration gas tanks of capacities indicated complete with regulators, valving, and tubing for the specified emissions.

2.15 FACTORY APPLIED INSULATION

****

NOTE: Insert equipment and related piping, casings, and enclosures requiring insulation as applicable.

****

Insulate the following equipment and appurtenances with materials, jacketing, and finishes, as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS:

a. [_____]

b. [_____]

2.16 PAINTING AND FINISHING

Provide equipment and component items that are factory primed and finish coated with the manufacturer's standard finish. Painting must be in accordance with SSPC SSPM. Clean exterior surfaces to base metal in accordance with SSPC SP 6/NACE No.3 and paint at the factory with two coats of paint conforming to FS TT-P-28FS TT-P-28. Items located outside the building must have weather resistant finish. Refinish damaged finish surfaces with an identical type of finish used at the factory. Power clean to bare material and touch up exterior surfaces damaged during field installation or during shipment.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install work as indicated and in accordance with manufacturer's diagrams and written instructions. [A factory installation specialist must be at the site for erection of [dry electrostatic precipitator,] [wet electrostatic precipitator,] [baghouse,] [scrubber,] [wet flue gas desulfurization system] [spray dryer flue gas desulfurization system] [selective catalytic reduction system] [and] [petrol vapor recovery unit]

[and] [emission monitoring system].] Field applied insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide an aluminum, brass, or type 304 or 316 stainless steel nameplate and fasten to equipment in a visible location by means of rivets or sheet metal screws of the same material as the nameplate material. Nameplate must contain data that consists of the manufacturer's name, model or series number, and serial number. Indent or emboss the information in the metal. Offset the nameplate a sufficient amount to avoid being covered by insulation.

3.3 OPERATION AND PERFORMANCE REQUIREMENTS

****

NOTE: Select the appropriate performance data forms required for the equipment selected. Fill in the data on the forms. Delete or retain the topic items as appropriate. EPA Technical Report AP-42 including Supplements 1 through 9 (and later supplements if issued) will be used to determine the properties or qualities and quantities of uncontrolled emissions from the various polluting equipments, systems, and operations to be corrected under this guide specification. Show in tables on drawings operating performance requirements for fans, pumps, motors, and other auxiliaries, indicating cfm, gpm, hp, etc. Fill out separate table for each air pollution control equipment selected for a given project in accordance with the following guide:

Table	**Type Effluent**	**Applicable Equipment**
I	**General Dust**	**Dry Dynamic Centrifugal Fabric, Fabric, or Wet Dynamic**
II	**Boiler Fly Ash**	**Dry Dynamic, Centrifugal Fabric, or ESP**
III	**Boiler Flue Gases & Other Fume Sources**	**Scrubber, Flue Gas Desulfurization System, Selective Catalytic Reduction System**
IV	**Petrol & Other Vapor**	**Refrigeration Unit or Sources Fabric Prefilter with Activated Carbon with Regeneration**

****

Air pollution control equipment must process and remove pollutants from exhaust gas streams to produce an effluent that will conform to 40 CFR 50 and other federal, state, and local regulations, without degrading the performance of related system components. The air pollution control equipment installed must perform the cleaning operation as indicated on the Air Pollution Equipment Performance Data forms attached to this section.

3.4 FRAMED INSTRUCTIONS

Post framed instructions containing wiring and control diagrams under glass or in laminated plastic where directed. The instructions must show wiring and control diagrams and complete layout of the entire system. The instructions must include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system. Post the framed instructions before acceptance testing of the system.

3.5 FIELD QUALITY CONTROL

3.5.1 System Performance Test

The right is reserved by the Government to inspect the equipment at the manufacturer's plant, during or after manufacture. Acceptance at the factory will not constitute final acceptance.

Upon completion, and prior to acceptance of the project, test the air pollution control equipment and monitoring system in accordance with 40 CFR 60, Appendix A and state and local codes by an independent testing organization accredited by The American Association for Laboratory Accreditation (A2LA) to meet three environmental standards; the Stack Testing Accreditation Council (STAC) for ASTM D7036. [A factory startup specialist must be at the site to direct and monitor startup for testing of [electrostatic precipitator,] [baghouse,] [scrubber,] [wet flue gas desulfurization system] [spray dryer flue gas desulfurization system] [selective catalytic reduction system] [and] [petrol vapor recovery unit] [emission monitoring system].] Notify the Contracting Officer [_____] days in advance of the test date. [An independent testing organization must furnish all instruments and personnel required for the tests.]Submit a proposed performance test procedure, 30 days prior to the proposed test date, containing a complete description of the proposed tests and sample locations, with calibration curves or test results by an independent testing laboratory of each instrument, meter, and gauge to be used in the tests. The test must not commence until the procedure has been approved. Electricity and water will be furnished by the Government. Conduct and fully document emission monitoring certification testing as required by local, state, and federal regulatory requirements to demonstrate compliant system operation.

3.5.1.1 Retesting

If any deficiencies are revealed during test, correct such deficiencies and reconduct the tests.

3.5.1.2 Reporting

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed, including results, to provide compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report must indicate the final position of controls and performance criteria.

3.5.2 Manufacturer's Field Service

Provide services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the specified equipment.

The representative must supervise the installing, adjusting, and [testing] [testing start-up] of the equipment.

3.6 CLOSEOUT ACTIVITIES

3.6.1 Training

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NOTE: Insert number of hours required to train personnel for the equipment operations.

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Conduct training course for operating and maintenance staff as designated by the Contracting Officer.[Contractor to provide maintenance for first year after acceptance, and provide proposal for annual maintenance thereafter.] The training period, of a total of [_____] hours of normal working time, must start after the system is functionally completed, but prior to final acceptance tests. The field instructions must cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Submit training course curriculum and training instructions [14] [_____] days prior to the start of training.

3.6.2 Operations and Maintenance

Submit complete copies of operation manual outlining the step-by-step procedures required for system startup, operation, and shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and its basic operating features. Also, submit complete copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repair, and troubleshooting guides. Include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. Ensure operation and maintenance manuals are approved prior to training course.

3.7 SCHEDULES

a. TABLES I and II: List any or all properties of particulate materials such as corrosive, toxic, abrasive, sticky, flammable, explosive, abrasive, friable, spherical fibrous, and hygroscopic.

b. TABLES I and III: Delete reference to particulates if the scrubber is to be installed with a particulate precleaner.

c. TABLE III: Delete reference to water supply data if not applicable for equipment selected.

d. TABLES III and IV: The volume to be listed here is the total volume of exhaust or ventilation air flow with which the pollutant is mixed. Add or delete items under Analysis of Gaseous Pollutants.

TABLE I. AIR POLLUTION CONTROL EQUIPMENT PERFORMANCE DATA	
Type Collector:	[_____]
Contaminate Stream:	[_____]
Collector Inlet Conditions:	

TABLE I. AIR POLLUTION CONTROL EQUIPMENT PERFORMANCE DATA

Elevation:	[_____] meters feet
Gas Density:	[_____] kg per cubic meter pcf
Volume:	[_____] actual cubic meters per second cfm [stoichiometric] [pitot]
Pressure:	[_____] Pa inches of water gauge
Temperature:	[_____] degrees C F
Grain Loading:	[_____] mg per actual cubic meters grain/acf
	[_____] mg per standard cubic meter grains/scf
	[_____] nanograms per J pounds/10^6 Btu
Moisture:	[_____] percent
Analysis of Particulates:	
Specific Gravity:	[_____]
Bulk Density:	[_____] kg per cubic meter pcf
Physical Properties:	[_____]
Paricle Size Distribution, µm microns	Percent by Weight of Dust in Range
0-5	[_____]
5-10	[_____]
10-20	[_____]
20-30	[_____]
30-40	[_____]
<40	[_____]
Chemical Analysis	
Collection Efficiency:	[_____] percent
Allowable Outlet Emission:	[_____] mg per actual cubic meters grains/acf
	[_____] mg per standard cubic meter grains/scf
	[_____] nanograms per J pounds/10^6 Btu
Allowable Collector Pressure Drop:	[_____] Pa inches water gauge Inlet Flange to Outlet Flange
Hopper Capacity:	[_____] cubic meter feet
Collector Internal Pressure Relative to Atmosphere	

TABLE I. AIR POLLUTION CONTROL EQUIPMENT PERFORMANCE DATA	
Positive	[_____] Pa inches of water gauge
Negative	[_____] Pa inches of water gauge
Water Supply:	
Pressure:	[_____] kPa psig
Flow Rate:	[_____] L/sec gpm
Water Analysis:	[_____]

TABLE II. AIR POLLUTION CONTROL EQUIPMENT PERFORMANCE DATA	
Type Collector:	[_____]
Contaminate Stream:	[_____]
Type of Fuel-Percent by weight as fired:	
Volatile Matter:	[_____]
Fixed Carbon:	[_____]
Moisture:	[_____]
Sulfur:	[_____]
Ash:	[_____]
J/kgBtu/pound	[_____]
Fuel Firing Rate	[_____] kg per hour pounds per hour
Collector Inlet Conditions:	
Elevation:	[_____] meters feet
Volume:	[_____] actual cubic meters per second acfm [stoichiometric] [pitot]
Pressure:	[_____] Pa inches of water gauge
Temperature:	[_____] degrees C F

TABLE II. AIR POLLUTION CONTROL EQUIPMENT PERFORMANCE DATA	
Grain Loading:	[_____] [mg per actual cubic meter] [mg per standard cubic meter] [nanograms per J] [grains/acf] [grains/scf] [pounds/10^6 Btu]
Analysis of Paticulates:	
Specific Gravity:	[_____]
Bulk Density	[_____] kg per cubic meter pcf
Physical Properties:	[_____]
Paricle Size Distribution, µm microns	Percent by Weight of Dust in Range
0-5	[_____]
5-10	[_____]
10-20	[_____]
20-30	[_____]
30-40	[_____]
<40	[_____]
Chemical Analysis	
Collection Efficiency:	[_____] percent
Allowable Outlet Emission:	[_____] mg per actual cubic meters grains/acf
	[_____] mg per standard cubic meter grains/scf
	[_____] nanograms per J pounds/10^6 Btu
Allowable Collector Pressure Drop:	[_____] Pa inches water gauge Inlet Flange to Outlet Flange
Hopper Capacity:	[_____] cubic meter feet
Collector Internal Pressure Relative to Atmosphere	
Positive	[_____] Pa inches of water gauge
Negative	[_____] Pa inches of water gauge

TABLE III. AIR POLLUTION CONTROL EQUIPMENT PERFORMANCE DATA	
Maximum Outlet Emission:	[_____] mg per actual cubic meters grains/acf
	[_____] mg per standard cubic meter grains/scf
	[_____] nanograms per J pounds/10^6 Btu
Type Collector:	[_____]
Contaminate Stream:	[_____]
Type of Fuel-Percent by weight as fired:	
Volatile matter:	[_____]
Fixed Carbon:	[_____]
Moisture:	[_____]
Sulfur:	[_____]
Ash:	[_____]
Fuel Firing Rate:	[_____] kg per hour pounds per hour
Collector Inlet Conditions:	
Elevation:	[_____] meters feet
Volume:	[_____] actual cubic meters per second cfm [stoichiometric] [pitot]
Pressure:	[_____] Pa inches of water gauge
Temperature:	[_____] degrees C F
Grain Loading:	[_____] mg per actual cubic meters grain/acf
	[_____] mg per standard cubic meter grains/scf
	[_____] nanograms per J pounds/10^6 Btu
Moisture:	[_____] percent
Analysis of Particulates:	
Specific Gravity:	[_____]
Bulk Density:	[_____] kg per cubic meter pcf
Physical Properties:	[_____]
Paricle Size Distribution, µm microns	Percent by Weight of Dust in Range
0-5	[_____]

TABLE III. AIR POLLUTION CONTROL EQUIPMENT PERFORMANCE DATA	
5-10	[_____]
10-20	[_____]
20-30	[_____]
30-40	[_____]
<40	[_____]
Chemical Analysis	
Analysis of Gaseous Pollutants:	
Sulfur Dioxide	[_____] ppmv dry
Nitrous Oxide	[_____] ppmv dry
Hydrocarbons	[_____] ppmv dry
Moisture Content	[_____] percent
Collection Efficiency:	[_____] percent
Allowable Outlet Emission:	[_____] mg per actual cubic meters grains/acf
	[_____] mg per standard cubic meter grains/scf
	[_____] nanograms per J pounds/10^6 Btu
Allowable Collector Pressure Drop:	[_____] Pa inches water gauge Inlet Flange to Outlet Flange
Collector Internal Pressure Relative to Atmosphere	
Positive	[_____] Pa inches of water gauge
Negative	[_____] Pa inches of water gauge
Water Supply:	
Pressure:	[_____] kPa psig
Flow Rate:	[_____] L/sec gpm
Water Analysis:	[_____]

TABLE IV. AIR POLLUTION CONTROL EQUIPMENT PERFORMANCE DATA	
Type Collector:	[_____]
Contaminate Stream:	[_____]
Collector Inlet Conditions:	
Volume:	[_____] actual cubic meters per second cfm [stoichiometric] [pitot]
Pressure:	[_____] Pa inches of water gauge
Temperature:	[_____] degrees C F
Relative Humidity:	[_____] percent
Analysis of Gaseous Pollutants:	
Sulfur Dioxide	[_____] ppmv dry
Nitrous Oxide	[_____] ppmv dry
Paint Solvents	[_____] ppmv dry
Hydrocarbons	[_____] ppmv (by species) dry
Moisture Content	[_____] percent
Analysis of contaminants which must be filtered out upstream of carbon bed.	
Allowable Emissions (by species).	

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-44 13 10.13 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-43 13 13.13 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 44 - POLLUTION AND WASTE CONTROL EQUIPMENT

SECTION 44 13 10.13

VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS

05/20

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PART 2 PRODUCTS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-44 13 10.13 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-43 13 13.13 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 44 13 10.13

VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS

05/20

****

NOTE: This guide specification covers the requirements for systems to transfer organic contaminants from a contaminated air/gas stream (e.g. landfill off gas, soil vapor extraction, air stripping, process tank vapors, thermal desorption) to activated carbon adsorption media.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: This specification only covers offsite disposal or regeneration of activated carbon; it does not cover onsite regeneration

****

1.1 UNIT PRICES

****

NOTE: On many hazardous, toxic and radioactive waste (HTRW) projects, the Contractor is required to treat contaminated air/gas, as well as furnish the

equipment. Measurement and payment and unit pricing may be necessary to cover treatment costs. Write the contract to provide an incentive for the Contractor to do the job efficiently. It may be preferable to base payment on the kg lbs of contaminants removed from the air/gas stream entering the carbon vessel. However, if carbon is being used to treat the air from an air stripper, the basis would be the volume of water treated in the air stripper or kg lbs of volatile organic chemicals in the water stream entering the air stripper. Or, if the mass of contaminant decreases during the long term operation of the unit, while at the same time the O&M expenses stay approximately constant, it may be preferable to base the payment on the volume of air/gas treated.

****

Payment for contaminated air/gas treated will be as described in the Payment Schedule of the Bid Form.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition
ASHRAE FUN SI	(2021) Fundamentals Handbook, SI Edition

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM D2652	(2011; R 2020) Activated Carbon
ASTM D2854	(2009; R 2019) Standard Test Method for Apparent Density of Activated Carbon
ASTM D2862	(2016) Standard Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D2866	(2011) Total Ash Content of Activated Carbon
ASTM D2867	(2009; R 2014) Moisture in Activated Carbon
ASTM D3802	(2016) Standard Test Method for Ball-Pan Hardness of Activated Carbon
ASTM D4607	(2014) Determination of Iodine Number of Activated Carbon
ASTM D5228	(2016) Standard Test Method for Determination of the Butane Working Capacity of Activated Carbon

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	(2023) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for

Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Activated Carbon Adsorption Units; G, [_____]

SD-03 Product Data

Emissions

Activated Carbon Adsorption Units; G, [_____]

Vapor Phase Activated Carbon; G, [_____]

Posted Framed Instructions; G, [_____]

SD-05 Design Data

Activated Carbon Adsorption Units; G, [_____]

SD-06 Test Reports

Field Quality Control

SD-07 Certificates

Vapor Phase Activated Carbon

Certification of the activated carbon [supplier] [transporter] [regeneration facility]. [Copies of the Department of Transportation licenses of carbon transporter service.]

Activated Carbon Adsorption Units Carbon Vessel Fabrication

SD-08 Manufacturer's Instructions

Activated Carbon Adsorption Units

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G, [_____]

1.4 QUALIFICATIONS

1.4.1 Contractor

Provide documentation of having [a minimum of [2] [_____] years experience in the construction, startup and operation of industrial air pollution control devices] [installed a minimum of [2] [_____] vapor phase carbon adsorption units in the past [5] [_____] years].

1.4.2 Single Source Supplier

Assign to a single supplier full responsibility for furnishing of the activated carbon system. The designated single supplier, however, need not manufacture the system but coordinates the selection, assembly, installation, and testing of the entire adsorption system, including preheater, the blower and ductwork specified in other Sections. The supplier has [been in the business of manufacturing, fabricating or installing these systems for a minimum of [2] [_____] years] [manufactured and supplied a minimum of [5] [_____] vapor phase carbon adsorption units].

1.4.3 Carbon Vessel Fabricator

****

NOTE: Verification from a registered professional engineer should only be required for large systems which have to be bolted to the foundation. Delete this paragraph for small units which are on forktubes or a flat base and not fastened to the foundation.

****

Provide verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering, as appropriate, in the State in which the system is to be installed to verify that: 1) The fabrication drawings and pressure calculations for the vessels and appurtenances were done for the site conditions in accordance with the appropriate codes and standards. 2) The erection drawings for the shells and tank foundations and supports were done for the site conditions in accordance with the appropriate codes and standards. Submit certification from this Engineer documenting the verification.

1.5 PARTNERING AND/OR PRE-SUBMITTAL MEETING

****

NOTE: Remove this paragraph when a meeting is not required.

****

A [partnering] [and] [Pre-submittal] meeting will be required. Ensure that involved subcontractors, suppliers, and manufacturers are notified. Furnish the date and time of the meeting to the Contracting Officer for approval.

1.6 DELIVERY, STORAGE, AND HANDLING

Preassemble parts to the largest extent possible, compatible with transportation limitations and equipment protection considerations. Field assembly, if any, requires merely bolting together of match-marked components. Crate and deliver equipment to protect against damage during shipping. Protect flange faces from damage. Cover all openings to prevent entrance of dirt, water and debris. Properly protect all parts so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and until the units and equipment are ready for operation. Properly protect finished iron or steel surfaces to prevent rust and corrosion. Protect all equipment, delivered and designated for storage, from the weather (humidity and temperature), dirt and dust, and other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Provide additional information about equipment preceding and following the carbon vessel. This is to provide the vendor with a complete picture of the unit's purpose and operation. Some paragraphs may be eliminated or modified if this Section is to be issued as a performance specification. Others will be eliminated or modified if it is to be issued as a design specification.

Laboratory adsorption studies are seldom done for air/gas adsorption. Estimates are obtained from isothermal data or from vendor computer programs. The ASTM Standards do not provide information on the minimum and maximum values that are acceptable for specifying carbon. Manufacturers may need to be contacted to determine the acceptable values. The characteristics for virgin and regenerated carbon will be different. Verify that the requirements are correct for the type of carbon specified.

****

Provide a vapor phase activated carbon adsorption system as a complete once-through forced flow system. Furnish system capable of reducing the levels of the listed organic contaminants to the values shown in paragraph Performance Requirements. Fill the unit with granular activated carbon for removal of organic contaminants from [landfill gas] [soil vapor extraction air/gas] [air stripping air/gas] [process tank vapor emissions] [low temperature thermal desorption air/gas] [_____]. Equipment includes, but is limited to, vessels containing activated carbon, supporting equipment and accessories. Terminology is in conformance with ASTM D2652. Provide complete system with [[2] [_____] parallel trains of [2] [_____] carbon vessels in [series] [parallel]] [[2] [_____] carbon vessels [in series] [parallel]], activated carbon, [blowers], instruments, controls, valves, piping, pre-heater/cooler and other specified appurtenances. Arrange the piping [as shown on the drawings] [_____] to allow any of the [2] [_____] units to serve as the primary unit and to also allow any unit to operate alone while the other units are being emptied and refilled with fresh carbon. Design the system to operate continuously, 24 hours per day, 7 days per week.

2.1.1 Design Requirements

****

NOTE: The most difficult part of designing an activated carbon adsorption system may be determining the contaminant concentration in the air/gas stream to be treated. Many times design estimates are based on limited data. The actual rate, particularly after the unit has operated for a while, may be much different. An approach may be to design the process for easy addition or removal of carbon units as determined after startup.

Determine seismic parameters from paragraph Seismic Requirements, and wind speed from ASCE 7-16, Chapter 1, or UFC-3-301-01. Specify whether the unit will be installed inside or outside and any other conditions that will affect the operation of the unit. Coordinate this Section with other pertinent Sections to ensure that information is presented only once. Verify that the floor and footings are designed to support the equipment.

****

Meet the following requirements:

a. Minimum equipment design life: [_____] years.

b. Vessel type: [permanent with carbon] [replacement] [interchangeable canisters].

c. Adsorption system design requirements:

  (1) Maximum vertical projection: [_____] m ft.

  (2) Maximum ground surface coverage: [_____] by [_____] m ft.

d. Seismic parameters: [_____].

e. Wind speed (maximum): [_____] km/h mph.

f. Ground snow load: [_____] kPa psf.

g. Ambient air temperature:

  (1) Maximum: [_____] degrees C degrees F.

  (2) Minimum: [_____] degrees C degrees F.

2.1.2 Influent Air/Gas Conditions

****

NOTE: Remove this paragraph if the specification is to be issued as a design specification. Obtain an analysis of the air/gas to be treated giving appropriate information to be inserted in the blank spaces. The inlet air/gas composition may be difficult to obtain. If the specification is to be issued as a performance specification the inlet

composition will need to be estimated.

Oxygen and methane data are useful if the methane concentration is high enough to have a potential to be in the explosive range. If the concentration is well below this range, remove the methane and oxygen concentration lines. Provide all available information. All available pertinent site characterization data should be placed in an appendix of the technical specifications or on the drawings, and referenced here. Indicate the detail to which site characterization has been performed and indicate where data gaps exist. The information should also include soil gas data, chemical data, geotechnical data, sampling locations, and boring logs. Table must be edited to add contaminants not listed and delete those that are not applicable. Verify that carbon will adsorb the organic chemicals since many organic chemicals do not adsorb well on carbon.

****

	Minimum	Average	Maximum	Unit of Measure
Oxygen			[_____]	percent
Methane			[_____]	percent
Relative Humidity	[_____]	[_____]	50	percent
Carbon Tetrachloride	[_____]	[_____]	[_____]	ppmv
Trichloroethen	[_____]	[_____]	[_____]	ppmv
Benzene	[_____]	[_____]	[_____]	ppmv
Toluene	[_____]	[_____]	[_____]	ppmv
Xylene	[_____]	[_____]	[_____]	ppmv
Carbon Monoxide	[_____]	[_____]	[_____]	ppmv
Ozone	[_____]	[_____]	[_____]	ppmv
[_____]	[_____]	[_____]	[_____]	ppmv

2.1.3 Performance Requirements

****

NOTE: Remove these paragraphs if the specification is to be issued as a design specification. Removal expressed as a percent is dependent on inlet concentrations which can vary. Ensure that the desired emission rates can be met before using percent removal.

****

2.1.3.1 Physical Requirements

	Minimum	Maximum
Air/gas flow rate	0.0005 cu m/s1 scfm	
Air/gas temperature		60 degrees C140 degrees F
Inlet Pressure		70 kPa10 psig

2.1.3.2 Chemical Requirements

	Maximum Emission	Percent Removal
Carbon Tetrachloride	[_____] ppmv	[_____]
Trichloroethene	[_____] ppmv	[_____]
Benzene	[_____] ppmv	[_____]
Toluene	[_____] ppmv	[_____]
Xylene	[_____] ppmv	[_____]
[_____]	[_____] ppmv	[_____]

2.1.3.3 Carbon Replacement

Replace carbon at intervals no less than [_____] days.

2.1.4 Design Calculations

****

NOTE: Delete this paragraph when design is done by the Government.

****

Supply a copy of all the design calculations to the Contracting Officer before initiation of construction.

2.1.5 Conformance to Design

Provide calculations, layouts and drawings of the carbon adsorption system to clearly show the basis for the design; including isotherms, estimated breakthrough volumes, and calculations to show that the entire system will conform to paragraph Performance Requirements.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least [2] [_____] years prior to bid opening. Provide materials and equipment supported by a service organization that is located within [_____] km miles of the site.

2.2.2 Nameplates

Provide major equipment items such as adsorption vessels, blowers and motors with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.3 VAPOR PHASE ACTIVATED CARBON

****

NOTE: Performance specifications are recommended to allow the Contractor to install proven "off-the-shelf" units supplied by two or three reputable manufacturers. Determine if the first charge of carbon needs to be virgin carbon for liability requirements. Remove items not required below.

****

Provide material conforming to the following list; submit certificates attesting that the activated carbon furnished meets the specified requirements. Also, submit the type of activated carbon, with isotherms for the selected carbon, with each of the volatile organic compounds listed in the effluent requirements for the anticipated temperature range at 50 percent relative humidity. Use design calculations or vendor computer models to estimate the mass of carbon required and the breakthrough curves for the listed organic compounds in the carbon bed.

a. Provide an initial charge of carbon that is [virgin] [regenerated] [virgin or regenerated] carbon. Provide subsequent charges that are [virgin] [regenerated] [virgin or regenerated] carbon.

b. Furnish carbon adsorption system capable of reducing emissions for individual compounds to below the limits specified in SYSTEM DESCRIPTION.

c. Base approximate average volatile organic composition of the vapor stream on estimated influent component levels as specified in SYSTEM DESCRIPTION.

d. Provide minimum butane working capacity of new activated carbon of [23.8] [_____] percent by weight as determined by ASTM D5228.

e. Provide minimum iodine number of virgin or reactivated carbon of [1000] [_____] as determined by ASTM D4607.

f. Provide maximum moisture content of [2] [_____] percent by weight as determined by ASTM D2867.

g. Provide maximum total ash content of [10] [_____] percent by weight as determined by ASTM D2866.

h. Provide minimum hardness number of [90] [_____] necessary for the required life in vapor phase applications as determined by ASTM D3802.

i. Provide uniform activated carbon particle size for consistent pressure drop characteristics. Provide maximum particle size of 4.6 mm 0.2 inch diameter as determined by ASTM D2862.

j. The granular activated carbon must be of the type that can be accepted for offsite regeneration of the spent activated carbon by an approved carbon regeneration facility.

k. Provide minimum apparent density of [0.45] [_____] g/cc as determined by ASTM D2854.

l. Maximum pressure drop is [_____] kPa/m inches of water per foot of bed depth, measured in air at 21 degrees C 70 degrees F.

m. US Sieve size is [4 x 8] [_____].

n. Furnish material that is free from impurities that affect the serviceability and appearance of the finished product.

2.4 ACTIVATED CARBON ADSORPTION UNITS

****

NOTE: General rules to the system designer for configuration of a vapor phase activated carbon system are as follows:

a. Two stage series operation to provide longer contact and more complete exhaustion of the carbon is preferred. In series operation, the unit with the freshest carbon at any given time should be in the lag position. For critical operations, lead, lag and standby units should be provided as specified in paragraph SYSTEM DESCRIPTION.

b. Multiple units in parallel operation are frequently used for high flows with low contamination levels when short contact times are adequate. Single units should be used only in installations in which the system can be shut down for change out of the activated carbon adsorption media. Multiple smaller units containing the same amount of carbon and providing equal contact are usually preferable to single large unit.

c. An appropriate piping configuration which can adapt the units for series or parallel operation should be considered. Arrangements that allow conversion from parallel to series and the reverse allow the flexibility to respond to differing conditions.

d. Surface loading ranges between 12 and 24 cu m/min/sq m 40 and 80 cfm/min/sq ft are often used.

e. Minimum bed depth at a given velocity is based on the minimum contact time required to achieve the required removal. Additional bed volume allows more time between carbon changes.

f. The relative humidity of the air/gas entering

the carbon unit should be 50 percent or less. If the air/gas entering the unit has entrained water an air/gas-water separator should be used. Without this, the temperature of the air/gas will have to be elevated enough to vaporize the mist and lower the relative humidity to about 50 per cent. At this higher temperature the organic chemical may not adsorb well.

****

2.4.1 Velocity

****

NOTE: In an up-flow system the velocity should generally be in the range of 12 to 24 m/sec 40 to 80 feet per minute; this depends on the particle size. In a down-flow system, the flow velocity is only limited by the allowable pressure drop.

****

The minimum and maximum acceptable flow velocities are as follows: 0.25 m/sec at [_____] cu m/sec minimum; and 0.375 m/sec at [_____] cu m/sec maximum 40 ft/min at [_____] scfm minimum; and 80 ft/min at [_____] scfm maximum.

2.4.2 Vapor Distribution/Collection Systems

Provide effective distribution across the bed throughout the stated capacity range. Provide a system to minimize short circuiting or channeling of contaminated air/gas through the carbon vessel. Design the system to evenly distribute the controlled contaminated air/gas flow across the cross section, with the nominal velocity under design conditions not exceeding 0.41 m/sec 80 fpm for up-flow systems. Adequately design the inlet and outlet to prevent local pressurization in excess of the vessel rating or design.

2.4.3 Shell Design

****

NOTE: Most carbon vessels are not designed for vacuum. Verify that a vacuum cannot be drawn on the vessel exceeding the manufacturer's recommendation. If the vessel will have internal pressure greater than 103 kPa 15 psig, it may need to be ASME rated. Vessels with less than this pressure may or may not need to be pressure rated depending on special ASME or State/local codes.

****

2.4.3.1 Corrosion Prevention

Use corrosion resistant steel, fiberglass, or other plastic for shell construction or a steel shell with a corrosion resistant [enamel] [_____] coating. Provide lining system with a corrosion resistant [epoxy or phenolic resin] [_____] coating. Furnish paint kits for use after assembly and finishing.

2.4.3.2 Manways

Minimum manway requirements, for access, addition and removal of carbon are [1] [_____] per adsorber and 610 mm 24 in minimum nominal diameter.

2.4.3.3 Insulation

****

NOTE: Insulation is optional. It may be needed if the carbon units are installed outside in cold climates. A high differential pressure across a fan or blower that precedes the carbon unit may result in a high air/gas discharge temperature. Pipes and fittings down stream may not need insulation. Plastic or fiberglass pipes and fittings should not be used if the discharge temperature can exceed that recommended for the material.

****

Install insulation [and heat tape] to prevent cooling of the air/gas in the system as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Insulate all outside surfaces of the following equipment: [adsorbers] [pipes] [fittings] [stacks] [_____].

2.4.3.4 Vessel

****

NOTE: If the specification is to be issued as a performance specification, remove adsorber diameter and carbon quality in this paragraph. Delete the minimum bed depth for a performance specification. Small units do not need inlet air/gas distributors. Add a paragraph requiring an outside access ladder if the top of the vessel must be accessed frequently. The number of carbon vessels should conform to those specified in SYSTEM DESCRIPTION.

****

Comply with the following requirements:

a. Minimum Number of Vessels: [2] [_____].

b. Minimum Adsorber Diameter: [_____] m ft.

c. Material of Construction: [carbon steel] [_____].

d. Maximum Allowable Working Pressure: [_____] kPa psig.

e. Minimum Carbon Quantity per Vessel: [_____] kg lbs.

f. Minimum Carbon Bed Depth: 922 mm 36 inches.

g. Flow Direction: [upflow] [downflow].

h. Outlet Collector: [_____].

i. Inlet Distributor: Integral

j. Min. Allowable Temperature: [_____] degrees C degrees F.

Each unit must be [skid-mounted. Fabricate skids of [cast iron] [steel] channels and design to support the equipment and to distribute the weight in transit and in service without loading on the tank or concrete slab;] [equip with lifting lugs] and pre-pipe internally. Secure each vessel to a structural steel frame suitable for shipment or transport with a forklift or crane and set on a level area for operation. Coat exterior structural steel surfaces with a suitable primer and top coat to resist corrosion due to water spray. Provide a minimum of one ground connection for each unit. If required, provide each unit with an inlet air/gas distributor. Provide sampling ports on the inlet and outlet pipes of each vessel to allow independent sampling and measurement of breakthrough for each unit.

2.4.3.5 Fire Sprinklers

****

NOTE: A fire suppression system is needed if the carbon manufacturer believes the adsorbed contaminant can react and cause a fire.

****

Equip carbon vessels with an internal water sprinkler to suppress carbon fires.

2.4.3.6 Seismic Requirements

****

NOTE: Provide seismic requirements, if a government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Remove the bracketed phrase if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS properly edited, must be included in the contract documents.

****

Support and brace adsorption units to resist seismic loads as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS [as shown on the drawings].

2.4.4 Unit Submittals

2.4.4.1 Layout and Detail Drawings

Drawings showing complete equipment layout, piping, wiring and schematic diagrams, and installation instructions and any other details required to show equipment relationships, clearances for maintenance and operation and to demonstrate that the system has been coordinated and will properly function as a unit. Process flow diagrams and instrumentation diagrams showing all major pieces of process equipment with controls. Details on the carbon adsorber shell including information on vapor diffusion, carbon contact shell dimensions, construction materials and structural and supporting design calculations.

2.4.4.2 Calculations and Modeling

Design calculations or computer modeling results for vapor phase carbon adsorption system indicating removals of each of the organic compounds listed. Demonstration of, or design calculations for, the total head loss through the carbon unit. Provide isotherm and design calculations or manufacturer's computer models to estimate the mass of carbon required and the breakthrough curves. Calculations showing how the vapor phase carbon adsorption system functions with the entire air/gas system including carbon vessel, [regeneration equipment], preheater, instrumentation and controls, dimensions, capacities, make and model, materials of construction, coating systems, pressure drop through each component of the system, including line sizing, valving, pressure and temperature gauges. Structural calculations for fabrication and erection drawings if requested (not needed for drum/canister applications).

2.4.4.3 System Supplier Testing

Submit certificate from system supplier showing that the equipment has been tested and has passed all quality control criteria.

2.5 ACCESSORIES

2.5.1 Blowers

Conform to Section 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS.

2.5.2 Preconditioning Equipment for Inlet Air/Gas Stream

****

NOTE: An air/gas preheater may not be needed if the carbon unit is preceded with a blower. Blowers heat the air/gas which reduces the relative humidity. A blower may raise the temperature of the air/gas more than needed. If this occurs, cooling will be required before entering the carbon unit. If a specific type of preheater is needed, specific information on the type of heater, materials of construction and type of energy source (electricity, steam, natural gas) should be indicated on the drawings or added to the specifications. Either the paragraph on the air/gas preheater or the air/gas cooler or both should be deleted.

****

[A preheater is required if the relative humidity is greater than [50] [_____] per cent. Provide preheater [of the type and size as shown on the schedule on the drawings] [_____]. The preheater must lower the relative humidity of the influent to [50] [_____] percent. Provide materials of construction and controls and cutoffs. Provide heating element that is [directly] [indirectly] heated.] [The vapor stream leaving a forced draft blower that precedes the carbon vessel must pass through a heat exchanger that cools the air/gas stream. Provide heat exchanger of the type and size as shown on the schedule on the drawings. The heat exchanger must lower the temperature enough to raise the relative humidity to no more than 50 percent.]

2.5.3 Carbon Storage and Transfer System

****

NOTE: Fresh carbon storage vessels and exhausted carbon storage vessels are not usually used in vapor phase systems. In large systems, the carbon is vacuumed or removed by eductor (water) and put into a truck. In smaller systems the carbon is usually removed by vacuum.

If there is no onsite storage, two trucks are needed, one empty to receive the used carbon and one with fresh carbon. Economics should dictate whether to install extra vessels at the site or to have an empty truck accompany the truck with the fresh carbon. It is often desirable to size the vessels to hold a full truck load of activated carbon to reduce shipping costs. On many small systems, the entire vessel containing the used carbon is replaced with a vessel containing fresh carbon. Vessels are sometimes filled from 400 to 450 kg 900 to 1000 pound sacks or 90 kg 200 pound drums. In this situation, no storage tanks are needed. Remove the paragraph on fresh Carbon Storage Tank and Exhausted Carbon Storage Tanks if these will not be required.

****

2.5.3.1 Fresh Carbon Storage Tanks

Provide a fresh carbon storage system. Minimum capacity of the system must provide storage of [_____] kg pounds of dry carbon at a bulk density of [_____] kg/cubic meter pcf.

2.5.3.2 Exhausted Carbon Storage Tanks

Provide an exhausted carbon storage supply system. Minimum capacity of the system must provide storage of [_____] kg pounds of wet carbon saturated with organic chemicals.

2.5.3.3 Sampling Valves

Provide sampling valves at the inlet and outlet of each carbon unit.

2.5.3.4 Piping

Furnish piping in accordance with Section 31 21 00 OFF-GASSING MITIGATION.

2.6 ACTIVATED CARBON INSTRUMENTATION AND CONTROLS

****

NOTE: These paragraphs can be used in conjunction with Sections 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION and 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC modified as required for this application. An instrumentation and control Guide Specification for hazardous waste systems is being written.

****

2.6.1 Sensors and Transmitters

****

NOTE: The humidity interlock will prevent condensation of water vapor in the carbon during startup if conditions exist that could allow high humidity air to the carbon unit.

****

Provide sensors and transmitters that have a range selected for the application, using the smallest range available from the controls manufacturer that will meet all expected sensed conditions in the sequence of control. Provide sensors and transmitters consisting of the following:

2.6.1.1 Relative Humidity Sensors

Provide relative humidity sensing element with a relative humidity sending range from 0 to 100 percent (condensing). Provide sensor capable of sensing a condensing air stream (100 percent RH) without affecting the sensors calibration or harming the sensor. Provide sensing elements with an accuracy of plus or minus 5 percent of full scale within the range of 20 to 80 percent relative humidity. Mount all sensors in locations that are accessible for calibration and fit for ease of calibration and re-calibration.

2.6.1.2 Airflow Measuring

****

NOTE: Pitot-tube type flow measuring devices can malfunction if the air/gas contains water droplets.

****

Provide velocity sensing elements that are the [RTD or thermistor type, with linearizing means. Distribute the sensing elements across the pipe in the quantity and pattern set forth for measurements and instructions in ASHRAE FUN SIASHRAE FUN IP and SMACNA 1780 for traversing of ducted airflows. The resistance to airflow through the airflow measurement station must not exceed 2 mm 0.08 inch water gauge at an airflow of 600 m/min 2,000 fpm. Station construction must be suitable for operation at airflows of up to 1500 m/min 5,000 fpm over a temperature range of 4 to 60 degrees C 40 to 140 degrees F, and an accuracy of plus or minus 3 percent over a range of 40 to 760 m/min 125 to 2,500 fpm scaled to air volume.] [multiple pitot tube type with averaging manifolds. Distribute the sensing elements across the pipe in the quantity and pattern set forth for measurements and instruments in ASHRAE FUN SIASHRAE FUN IP or SMACNA 1780 for the traversing of ducted airflows. The resistance to airflow through the airflow measurement station must not exceed 2 mm 0.08 inch water gauge at an airflow of 600 m/min 2,000 fpm. Station construction must be suitable for operation at airflows of up to 1500 m/min 5,000 fpm over a temperature range of 4 to 60 degrees C 40 to 140 degrees F, and an accuracy of plus or minus 3 percent over a range of 150 to 760 m/min 500 to 2,500 fpm scaled to air volume. Do not use this device if the required velocity measurement is below 210 m/min 700 fpm.]

2.6.1.3 Pressure Gauges

Provide pressure gauges conforming to ASME B40.100.

2.6.1.4 Thermometers

Provide dial type thermometers, 88 mm 3-1/2 inch diameter, chromium plated case; remote or direct-type bulb as required; plus or minus 0.5 degree C 1 degree F accuracy; white face with black digits graduated in 1 degree C 2 degree F increments. Provide thermometer wells of the separable socket type for each thermometer with direct-type bulb. Range of thermometers is [_____] to [_____] degrees C degrees F.

2.6.2 Controllers

Provide controllers that have set point, action, proportional band, authority throttling range, ratio, and remote set point adjustment as required to meet requirements of the sequence of control. Mount controllers on a unit control panel located [in the same room as the system being controlled] [near the carbon vessels].

2.6.2.1 Relative Humidity Controllers

Provide space-type humidity controllers that take full control action for a relative humidity change of plus or minus 5 percent of the setting of the controller. Set point adjustment range is approximately [20] [_____] percent to [80] [_____] percent relative humidity. Provide controllers with adjustable throttling ranges. Mount insertion type controllers in the interior of piping and fit with air shields where so recommended by the manufacturer.

2.6.2.2 Alarms

Alarm annunciation must be by [visual] [and] [audible] indication. Alarm signals must be locked in and require manual reset. [Furnish an auto dialer] [Telemeter alarms to the master control panel in the control room].

2.6.2.3 Relative Humidity Alarms

Install relative humidity alarms immediately upstream from the carbon vessels to alert the operator of relative humidity exceeding [50] [_____] percent.

2.6.2.4 Pressure Alarms

Install pressure [alarms] [indicators] on each side of the carbon vessels to alert the operator of excessive pressure drop.

2.6.2.5 Temperature Alarms

****

NOTE: Temperature or carbon monoxide alarms can be used to monitor for fire in the carbon bed.

****

Provide temperature on excursions (drop or rise) of [10] [_____] degrees C [18] [_____] degrees F outside the control range in the duct leaving the carbon vessel.

2.6.2.6 Carbon Monoxide Alarms

Provide carbon monoxide alarms to alert the operator of concentrations in excess of [100] [_____] ppm in the exit gas.

2.6.2.7 Timing Interlock

Provide a timing interlock to delay starting the blower until the preheater has been turned on for [15] [_____] seconds. Provide interlock to prevent saturation of the carbon during startup procedures and to delay blower stops after every shut performed.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with the details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work.

3.2 EQUIPMENT INSTALLATION

Install equipment as shown and in accordance with written instructions of the manufacturer. Each vessel must be [anchored to a footing isolated from the floor slab] [mounted on a skid base]. Provide anchor brackets, anchor rods or straps to hold the shell to anchors in the footing. Design reinforced concrete foundations for each carbon unit to support the unit and in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3 PAINTING FOR CORROSION PREVENTION

Paint equipment which did not receive a factory finish, unless specified otherwise. Apply paint system to the outside of the tank in accordance with Section 09 90 00 PAINTS AND COATINGS. Prime surfaces that have not been factory primed and top coat with the manufacturer's standard factory finish. Provide factory painting conforming to manufacturer's standard factory finish. Repair all defects in the finish prior to or during installation of the equipment as specified in Section 09 90 00 PAINTS AND COATINGS. Paint all exposed ferrous surfaces not painted in the factory in accordance with Section 09 90 00 PAINTS AND COATINGS. Painting of corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel is not required, unless otherwise specified. Coat or paint all ferrous surfaces. Provide color as indicated on the paint schedule or as otherwise approved.

3.4 POSTED FRAMED INSTRUCTIONS

Post installation instructions, sequences, and precautions, including tolerances for level, horizontal, and vertical alignment as specified. Submit for approval prior to posting: Grouting requirements, including grout spaces and materials; wiring and control diagrams; system layouts and isometrics; instructions and other sheets; operating instructions explaining preventive maintenance procedures and checks to assure the system is operating normally and safely. Methods of checking the system for normal safe operation; procedures for operating the system; and prepare procedures for safely starting and stopping the system in typed form, framed and posted beside the diagrams. Write instructions for any required sampling, carbon transfer and shipping of activated carbon to regeneration or disposal facility. Catalog cuts are not acceptable.

3.5 FIELD QUALITY CONTROL

Submit reports on tests performed to show compliance with instructions.

Include in the test reports all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Indicate in each test report the final position of all controls. Reflect performance test data in the operating instructions.

3.5.1 Equipment Tests

After installation of the carbon adsorption system is complete, carry out operating tests to ensure that the unit installed operates properly. Inspect all products carefully for defects in workmanship and material; clean debris and foreign matter out of all equipment; test all operating mechanisms to check their proper functioning; and check all nuts and bolts for tightness. Repair or replace valves and other equipment which do not operate easily or are otherwise defective. Assure that there is no vibration, or noise from any parts. If deficiencies are revealed during tests, correct such deficiencies and reconduct the tests at the Contractor's expense.

3.5.2 Performance Tests

****

NOTE: Running the unit to exhaustion should only be required if this is expected to occur within the test period. Some vessels may not get to exhaustion for a long period of time. Verify that the sample ports are addressed in Section 31 21 00 OFF-GASSING MITIGATION. Coordinate sampling requirements of this paragraph with the sampling requirements of other units/processes in the entire treatment train.

****

After installation of the activated carbon adsorption system, carry out operating tests to ensure that the system operates properly. Include the adsorption units, all accessories and instruments and controls. If any deficiencies are revealed during any tests, correct such deficiencies and repeat the tests. Run[each] [a typical] adsorber at a constant flow rate of approximately [_____] cubic meters/second scfm [until the maximum emissions as listed in paragraph Chemical Requirements occur] [for [24] [_____] hours]. Make a complete log of each test run, giving the following data: date, time of readings and sampling. Determine total chemicals removed by analyses of the inlet and outlet for the chemical requirements listed in paragraph Performance Requirements. Take samples of the emissions for analysis after [each [_____] cubic meters feet have been run through the adsorber] [[_____] hours of operation]. Use results of the tests in determining the capacity and performance of the adsorption unit. Submit the reports to document emissions permit compliance. Perform sampling and analyses in accordance with [_____].

3.5.3 Spent Activated Carbon Sampling and Analyses

Perform sampling and analyses of the spent activated carbon media in accordance with requirements [for spent carbon transport and requirements of the regeneration facility] [of the RCRA permitted treatment, storage and disposal facility].

3.5.4 Carbon Testing

Test the carbon to be used during the performance testing to ensure it meets the requirements of [_____].

3.5.5 Breakthrough Monitoring

****

NOTE: Continuous emission monitors are not addressed in this Section. If continuous emission monitors are required, verify that the detector used is specific for the chemicals to be monitored.

****

Monitoring the emissions for the chemicals listed in paragraph CHEMICAL REQUIREMENTS once every [7] [_____] days to determine when to replace the granular activated carbon. Record the volume of air/gas that was treated, from the time that the vessel was placed in the upstream position until breakthrough was consistently determined, as the breakthrough volume. Breakthrough volume is the volume of air/gas that was treated before the concentration of any one of the chemicals in paragraph Chemical Requirements was exceeded. The criteria for determining when to replace granular activated carbon may be modified as more data are generated.

3.5.6 Noncompliance with Performance Requirements

Removals must meet or exceed those specified in the performance requirements of this specification. If at any time during the first [12] [_____] months of operation the results of the organic analyses of the air/gas emissions are not in compliance with maximum emissions levels listed in paragraph CHEMICAL REQUIREMENTS, except for periods when the carbon is saturated, flow through the unit and the system is inoperable. If at any time the operation of the system does not meet the flow rate requirements, instrumentation or control requirements set forth in this contract, stop flow through the system. Proceed immediately to repair or modify the system for compliance with the contract documents. Make repairs or modifications entirely at the Contractor's expense. Notify the Contracting Officer one day before the system is to be restarted and retested.

3.6 OPERATION AND MAINTENANCE SUPPLIES

3.6.1 PARTS, TOOLS AND HANDLING EQUIPMENT

Submit a complete list of parts, supplies, special tools, instruments and accessories and special lifting and handling devices required for periodic maintenance, repair, adjustment and calibration and recommended spare parts for each different item of material and equipment specified, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [one] [_____] and [three] [_____] years of service.

3.6.2 EXTRA MATERIALS

Within 30 days of system approval, furnish a spare parts list for each different item of material and equipment specified with the shop drawings submitted. Include in the list parts, supplies, prices and sources schedule. Furnish those spare parts and special tools which are recommended by the manufacturer. Also provide 12 months supply of any expendable items and frequently replaced parts, except for carbon, as identified by the manufacturer. Following completion of the startup and operating period [replenish the spare parts inventory and provide a twelve month supply] [supply the [carbon regeneration] [carbon disposal] facility name, address and price schedule].

3.7 MANUFACTURER'S FIELD SERVICE

Provide the services of the manufacturer's representative, who is experienced in the installation, adjustment and operation of the equipment specified, for a minimum of [16] [_____] hours at the site. Supervise the installation, adjustment, and testing of the equipment. Prior to startup, inspect the equipment for alignment and connections by a factory representative. Inspect the final installation and supervise the adjustment and testing of the equipment. Schedule and coordinate the testing to coincide with the later phases of the carbon column testing, to prove out the complete installation in the presence of a Government representative. After completion of all testing, assist the plant operators in plant startup.

3.8 CLOSEOUT ACTIVITIES

3.8.1 Operating and Maintenance Manuals

Submit [six] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions layout, wiring, and control diagrams of the system as installed. Also the manufacturer's name, model number, service manual, parts list, brief description of all equipment and their basic operation features, and operating instructions for each piece of equipment and bulletins, cut sheets and descriptive data. [Six] [_____] complete copies of maintenance instructions listing routine preventative maintenance procedures, possible breakdowns and repairs, and trouble shooting guides list showing lubricants for each item of mechanical equipment, approximate quantities needed per year and recommended lubrication intervals.

3.9 FIELD TRAINING

Conduct a training course of operating staff as designated by the Contracting Officer. Start the training period, for a total of [24] [36] hours of normal working time, after the system is functionally complete but prior to final acceptance tests. Cover the topics included in the Operating and Maintenance Manuals. Also provide [16] [_____] hours of training, as directed by the Contracting Officer, following completion of the [one year] [_____] operating period for the follow-in Contractor.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-44 13 51 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
UFGS-44 13 52 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC **UFGS-44 13 51 (May 2020)**

Preparing Activity: USACE **Superseding without Revision**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 44 13 51

THERMAL OXIDATION EQUIPMENT

05/20

****

NOTE: This guide specification covers the requirements for systems to destroy, by thermal oxidation, organic contaminants contained in an off-gas stream; with options to use concentration system, heat recovery and/or a catalyst to conserve fuel.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: Measurement and payment requirements will be specified for work subject to extreme variation in estimated quantity when unit price bidding is required. This paragraph is not used when quantities can be reasonably calculated from information included in the contract.

****

Measurement and payment and unit prices for quantities of off-gas treated will be determined in accordance with the Bid Schedule.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA ANSI B109.1	(2000) Diaphragm Type Gas Displacement Meters (Under 500 cubic ft./hour Capacity)
AGA ANSI B109.2	(2000) Diaphragm Type Gas Displacement Meters (500 cubic ft./hour Capacity and Over)
AGA ANSI B109.3	(2019) Rotary-Type Gas Displacement Meters
AGA Report No 3	(2016; 5th Ed) Orifice Metering of Natural Gas And Other Related Hydrocarbon Fluids; PART 2: Specification and Installation Requirements

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.15/CSA 9.1	(2021) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 25-16	(2016) Earthquake-Activated Automatic Gas Shutoff Devices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B16.33	(2024) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 175 psi, (Sizes NPS 1/2 Through NPS 2)
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM E230/E230M	(2012) Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves,

	Fittings, Flanges and Unions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 31	(2024; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2024) National Fuel Gas Code
NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 82	(2024) Standard on Incinerators and Waste and Linen Handling Systems and Equipment
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250	(1991) Calibration Services Users Guide

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
40 CFR 60	Standards of Performance for New Stationary Sources

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or

complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Emissions

Temperature Sensors, Transmitters and Controllers; G, [_____]

Thermal Oxidation System; G, [_____]

Field Training

SD-06 Test Reports

Factory Tests

Field Quality Control/Tests

SD-07 Certificates

Motors

Manufacturer's Field Representative

SD-10 Operation and Maintenance Data

Thermal Oxidation System; G, [_____]

Maintenance; G, [_____]

1.4 QUALIFICATIONS

1.4.1 Contractor

Have had a minimum of [2] [3] [5] [_____] years of experience in the construction of industrial air pollution control systems, sanitary wastewater sludge digestion gas systems, landfill off-gas or vapor extraction off-gas handling systems.

1.4.2 Single Source Supplier

Assign to a single supplier full responsibility for the furnishing of the adsorption system. The designated single supplier, however, need not manufacture the system but coordinate the selection, assembly, installation, and testing of the entire specified system.

1.4.3 Manufacturer's Field Representative

Provide the services of a manufacturer's field representative and training engineer, who is experienced in the installation, adjustment, and operation of the equipment furnished, and who has complete knowledge of the proper operation and maintenance of the system. Submit names and qualifications of each manufacturer's field representative and training engineer with written certification from the manufacturer that each representative and trainer is technically qualified.

1.4.4 Welders

[Welders must have passed qualification tests using procedures covered in AWS B2.1/B2.1M or ASME BPVC SEC IX and have the appropriate certification.] [Qualifications of welders, and welding and nondestructive testing procedures for piping will be as specified in Section 40 05 13.96 WELDING PROCESS PIPING.] [Structural members must be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] Require any welder to retake the test when, in the opinion of the Contracting Officer, the work of the welder creates reasonable doubt as to proficiency.

1.5 REGULATORY REQUIREMENTS

****

NOTE: Add applicable regional, state, or local requirements. Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS includes basic requirements.

****

Abide by the following requirements: [_____].

1.6 PARTNERING OR PRE-INSTALLATION CONFERENCE

[Partnering] [Pre-installation] conference [may] [will] be [requested] [required]. Ensure that involved subcontractors, suppliers, and manufacturers are [notified] [represented]. Submit the date and time of the conference to the Contracting Officer for approval.

1.7 DELIVERY, STORAGE, AND HANDLING

Protect from the weather, excessive humidity, excessive temperature variation, and dirt, dust, or other contaminants all equipment delivered and placed in storage. Catalyst material are to be protected in accordance with the manufacturer's recommendations.

1.8 SEQUENCING AND SCHEDULING

****

NOTE: Testing of the thermal oxidation system should be concurrent with the start of gas flow from the landfill, vapor extraction system, or other source.

****

Installation of the thermal oxidizer must be complete and the system operational prior to completion of the [gas collection system] [vapor extraction system] [landfill cap]. Avoid point source release of untreated off-gas to the maximum extent consistent with completion of the contract. Perform sampling and analyses to demonstrate system performance and emission compliance.

1.9 EXTRA MATERIALS

****

NOTE: Include items needed for future maintenance and repair, items that might be difficult to obtain and spare parts needed to ensure continued operation of critical equipment. Consider whether an initial operating period is included in the contract.

****

[Provide an inventory of all equipment, tools, and items to the Contracting Officer at the start of the operating period. Update the inventory monthly. A current inventory must be delivered to the Contracting Officer when the operating period is complete.] [Concurrent with delivery and installation of the specified equipment, furnish auxiliary equipment and spare parts.] Furnish the following:

a. [Spare parts for each different item of material and equipment specified including all of the parts recommended by the manufacturer to be replaced after [1 year] [1 year and 3 years] service.] [Spare parts, replacement parts and other items duplicated or replaced during the operating period.]

b. For each type of grease, one lever type grease gun or other lubricating device.

c. [One set of special tools for each type of equipment including calibration devices, and instruments required for adjustment, calibration, disassembly, operation, and maintenance of the equipment.] [One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.]

d. One or more steel tool cases mounted on the wall in a convenient location complete with flat key locks, two keys, and clips or hooks to hold each special tool.

e. A [three] [six] month supply of lubricants, [fuel,] [and] [consumable items] at the end of the contract.

f. [_____].

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a thermal (catalytic) oxidation system as a complete unit process for destruction of organic contaminants carried in the [off-gas] [vapor phase]. Equipment must include, but not limited to, a complete and operational thermal oxidation system, including supporting equipment and accessories.

2.1.1 Design Requirements

****

NOTE: Find the wind speed and seismic zone for the stack design in ASCE 7-16.

****

Provide the thermal oxidation system in conformance with section 60.18 of 40 CFR 60. Provide vertical and lateral supports for the stack in accordance with NFPA 82 and NFPA 211, as applicable, for the wind forces indicated. Design the system for the following parameters:

Altitude	[_____] m ft above mean sea level (MSL)
Stack discharge	[3] [_____] m [10] [_____] ft above [existing grade at the site] [MSL]
Minimum equipment [service] [design] life	[_____] years
Oxidizer system dimensions	
1) Maximum vertical projection, (excluding stack)	[_____] m ft
2) Maximum ground surface coverage	[_____] x [_____] m [_____] x [_____] ft
Soil bearing capacity	[_____] MPa psf
Seismic zone	[_____]
Wind speed (maximum)	[_____] km/h mph
Ground snow load	[_____] kPa psf
Ambient air temperature	
1) Maximum	[_____] degrees C F
2) Minimum	[_____] degrees C F
Groundwater temperature	

1) Maximum	[_____] degrees C F
2) Minimum	[_____] degrees C F

2.1.2 Inorganic Chemical Concentrations

****

NOTE: Indicate method in the first blank. The table is an example. Include all identified site contaminants.

Volatile metals, chlorine, fluorine, phosphorus, sulfur or freon at low concentrations will poison, foul or mask catalysts. More innovative technologies should be strongly considered when freon is present.

****

2.1.2.1 Estimated Influent Inorganic Chemical Concentrations

Determine estimated influent inorganic chemical concentrations in the [off-gas] [vapor phase] by [_____].

Influent Concentration	Minimum	Average	Maximum
Fluorides	[_____]	[_____]	[_____]
Total Metals (as CaCO3)	[_____]	[_____]	[_____]
Copper	[_____]	[_____]	[_____]
Lead	[_____]	[_____]	[_____]
Zinc	[_____]	[_____]	[_____]

2.1.2.2 Chemical Concentrations of Entrained [Water] [Groundwater] [_____]

Determine chemical concentrations of entrained [water] [groundwater] [_____] by AWWA 10084.

Concentration	Minimum	Average	Maximum
pH			
Total hardness (mg/L as CaCO3)			
Calcium (mg/L)			
Magnesium (mg/L)			
Total iron (mg/L)			

Concentration	Minimum	Average	Maximum
Ferric iron (mg/L)			
Ferrous iron (mg/L)			
Manganese (mg/L)			
Sodium (mg/L)			
Potassium (mg/L)			
Copper (mg/L)			
Total alkalinity (mg/L as CaCO3)			
Hydroxide alkalinity (mg/L as CaCO3)			
Carbonate (mg/L as CaCO3)			
Bicarbonate (mg/L as CaCO3)			
Nitrate (mg/L)			
Nitrite (mg/L)			
Sulfate (mg/L)			
Sulfide (mg/L)			
Phosphate (mg/L)			
Chloride (mg/L)			
Chloride (mg/L)			
Fluoride (mg/L)			
Free carbon dioxide (mg/L as CaCO3)			
Dissolved oxygen (mg/L)			
Free chlorine residual (mg/L)			
Silica (mg/L)			
Total solids (mg/L)			
Total dissolved solids (mg/L)			
Suspended solids (mg/L)			
Turbidity in nephelometric turbidity units (NTU)			

Concentration	Minimum	Average	Maximum
Color by platinum standard comparison			

2.1.3 Performance Requirements

****

NOTE: Coordinate controls with the blower specified in Section 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS.

Select the retention time appropriate for the oxidation device considering any regulated compounds.

****

Minimum retention time in the combustion chamber will be [0.5] [1.0] [1.5] [2.0] [2.5] [_____] seconds at [1095] [982] [820] [760] [400] [260] degrees C [2,000] [1,800] [1,500] [1,400] [750] [500] degrees F minimum at maximum flow. The flow rate must be [constant at [_____] cu m/second scfm] [off and on at [_____] cu m/second scfm maximum, with a turndown range of four to one (4:1)] [variable between [_____] cu m/second scfm minimum and [_____] cu m/second scfm maximum]. Flow rates are to be based on measurement at standard temperature and pressure (STP), 101.3 kPa at 15.5 degrees C 14.7 psia at 60 degrees F. Influent gauge pressure must vary between [_____] Pa inch H2O minimum, [_____] Pa inch H2O average, and [_____] Pa inch H2O maximum. Inlet temperature must vary between [_____] degrees C degrees F minimum, [_____] degrees C degrees F average and [_____] degrees C degrees F maximum. Materials of construction are to be compatible with the ambient and operating temperatures and long term exposure to untreated and treated gas constituents.

2.1.4 Off-Gas Composition

****

NOTE: Reduce the dew point to below 50 degrees C 120 degrees F ahead of the thermal oxidizer.

If the unit will be classified as a hazardous waste incinerator, required emission limits for specific compounds are given in the National Emission Standard for Hazardous Air Pollutants (NESHAP) Maximum Achievable Control Technology (MACT) Standard. The MACT standard is scheduled to be finalized the end of 1998 and will not appear in hard copies of the 40 CFR 63 until the July 1999 edition is issued by EPA. Until the 1999 CFR is available, it will be necessary for designers to obtain the Federal Register in which the new standard is given.

Establishing and enforcing air regulations is primarily done at the State level; therefore, it is critical that designers research State specific requirements applicable to the unit.

The BDT control device is a combustion device capable of reducing NMOC emissions by 98

weight-percent or an outlet NMOC concentration of 20 ppmv or less. The EPA 98 percent DRE requirement applies to total emissions as determined by stack gas analysis (to include aerosols, particulates, VOCs, etc.), not individual contaminants, and may not be attainable on individual contaminants in long term performance.

Include appropriate off-gas discharge requirements (or DRE) and products of incomplete combustion (if appropriate). Use energy conservation/recovery on long term or high volume devices.
****

The system must be capable of oxidation of the organic components of gaseous, solid and aerosol type emissions, as follows. Submit reports for permit compliance.

Off-Gas Constituent		Influent Estimate	Effluent Requirement	Destruction Requirement
Total Hydrocarbon (ppmv)	Maximum			NA
	Average			NA
	Minimum		NA	[98*] [_____] percent
Methane (ppmv)	Maximum			NA
	Average		NA	NA
	Minimum		NA	[98*] [_____] percent
Non Methane Organic Compounds (NMOC) (ppmv)	Maximum		[20**] [_____]	NA
	Average		NA	NA
	Minimum		NA	[98*] [_____] percent
[_____]	Maximum			NA
	Average		NA	NA
	Minimum		NA	[95] [_____] percent
Carbon Monoxide (ppmv)	Maximum			NA
	Average		NA	NA
	Minimum		NA	[98*] [_____] percent

Off-Gas Constituent		Influent Estimate	Effluent Requirement	Destruction Requirement
Nitrogen, NOX (ppmv)	Maximum			NA
	Average		NA	NA
	Minimum		NA	
Total Sulfur, as SO2 (ppmv)	Maximum		NA	NA
	Average		NA	NA
	Minimum		NA	NA
Sulfer, SOX (ppmv)	Maximum			NA
	Average		NA	NA
	Minimum		NA	
Total Chlorine, as HCl (ppmv)	Maximum			NA
	Average		NA	NA
	Minimum		NA	
HCl (ppmv)	Maximum			NA
	Average		NA	NA
	Minimum		NA	
Water Vapor (percent saturation)	Maximum	100 percent	NA	NA
	Average		NA	NA
	Minimum		NA	NA
Particulates (mg/m3 gr/dscf)	Maximum			NA
	Average		NA	NA
	Minimum		NA	
Opacity (percent)	Maximum			NA
	Average		NA	NA
	Minimum		NA	NA

Off-Gas Constituent		Influent Estimate	Effluent Requirement	Destruction Requirement
Oxygen (percent)	Maximum		NA	NA
	Average		NA	NA
	Minimum			NA
* Destruction percentage will be determined as follows: 100% x ((Influent mass - Effluent mass)/(Influent mass)).				
** Dry basis, as hexane at 3 percent oxygen.				

2.2 MATERIALS AND EQUIPMENT

****

NOTE: A life cycle cost analysis should be performed before selection of the equipment option: flare, enclosed combustor, thermal oxidizer, catalytic thermal oxidizer, regenerative thermal oxidizer, recuperative thermal oxidizer or catalytic recuperative thermal oxidizer.

****

2.2.1 Standard Products

Materials and equipment are to be the standard products of a manufacturer regularly engaged in the manufacture of such products and essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.2 General Requirements

Equipment and appurtenances are to be as specified and as shown on the detail drawings, and be suitable for the service intended. Materials and equipment will be new and unused, except for testing equipment. Components that serve the same function and are the same size are to be identical products of the same manufacturer. The system will be rejected upon failure to achieve both the minimum temperature and the minimum retention time specified in paragraph PERFORMANCE REQUIREMENTS.

Provide detail drawings containing complete flow diagrams, piping, wiring, schematic, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings must show capacities and pressure drop; heat and material balances; make and model; complete list of equipment and materials. Show on drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation

2.2.3 Nameplates

Each major item of equipment must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Each piece of equipment must bear the approval designation and the markings required for that designation.

Valves are to be marked in accordance with MSS SP-25 and bear a securely attached tag with the manufacturer's name, catalog number and valve identification permanently displayed.

2.2.4 Equipment Guards [and Access]

Belts, chains, couplings, and other moving parts are to be completely enclosed by guards, to prevent accidental personal injury, in accordance with 29 CFR 1910, Subpart O, Machinery and Machine Guarding. Guards are to be removable and arranged to allow access to the equipment for maintenance. Enclose high temperature components with thermal insulation to prevent ignition of combustible materials and to preclude personnel contact.

2.3 FLARE

****

NOTE: See 40 CFR 60.18 for shroud requirements; edit this paragraph if shroud is not needed.

****

The [candlestick] [open] [ground] flare are to be composed of an open combustion chamber without enclosure or shroud.

2.4 ENCLOSED COMBUSTOR

****

NOTE: Enclosed combustors must demonstrate either 98 percent NMOC reduction or outlet NMOC concentration of 20 ppmv or less.

****

The enclosed combustor must be composed of a vertical enclosed combustion chamber that maintains a constant temperature by controlling fuel and combustion air.

2.5 THERMAL OXIDIZER

****

NOTE: Catalytic oxidation operates at a reduced temperature and should be considered when the organic carbon is between 150 ppmv and 2,000 ppmv. Review the anticipated off-gas analysis for substances that mask or poison catalysts. Edit this paragraph as required.

****

The thermal oxidizer must be composed of a horizontal enclosed combustion chamber, with catalyst, that maintains a constant temperature by controlling fuel and combustion air. Ensure catalyst is suitable for use under the conditions listed in paragraph SYSTEM DESCRIPTION and fabricated in modules for ease of installation in the combustion chamber. Thermal oxidizer must be compatible reduced temperature operation with the catalyst in place and high temperature operation without using the modular catalyst unit.

2.6 REGENERATIVE THERMAL OXIDIZER

****

NOTE: This system is a high temperature operation that recovers energy by cycling exhaust and inlet gases through regenerative heat exchange media.
****

Compose the thermal oxidizer of a horizontal enclosed combustion chamber that maintains a constant temperature by controlling fuel and combustion air.

2.7 RECUPERATIVE THERMAL OXIDIZER

****
NOTE: This system consists of a high temperature operation, without catalyst, or low temperature operation, with catalyst, that recovers energy by counter current passing of the exhaust and inlet gases through the heat exchanger. Edit this paragraph as required for job conditions.
****

Compose the thermal oxidizer of a horizontal enclosed combustion chamber, with catalyst modules, that maintains a constant temperature by controlling fuel and combustion air. The thermal oxidizer must be compatible with the temperatures of operation with or without using the modular catalyst unit.

2.8 CONTAMINANT CONCENTRATION SYSTEM

****
NOTE: Fuel costs for dilute or wet off-gas streams are substantially reduced by using a concentration system. Consider a concentration system if the organic carbon is less than 2,000 ppmv.
****

Increase inlet gas concentration of [total hydrocarbon] [methane] [non methane organic compounds (NMOC)] [_____] by a minimum of [ten] [five] [two] times the initial concentration.

2.9 HEAT RECOVERY SYSTEM

****
NOTE: Use media for regenerative systems or heat exchanger for recuperative systems.
****

2.9.1 Media Chambers

Ensure exhaust flow through media chambers recycle a minimum of [50] [_____] percent of the heat input at maximum operating conditions (maximum flow and temperature).

2.9.2 Heat Exchanger

Ensure the multiple pass, or single pass plate heat exchanger, or tube and shell heat exchanger recycle a minimum of [80] [_____] percent of the heat input at maximum operating conditions (maximum flow and temperature).

2.10 FLAME TRAP/ARRESTER

****
NOTE: This is a safety requirement that must be implemented.
****

Provide flame arrester, in accordance with FM APP GUIDE, at the inlet to the oxidation system. The pressure drop across the flame arrester must be a maximum of [_____] [1.5] kPa [_____] [6] in W.C. at maximum flow. Ensure the flame arrester has a clean-out cover to facilitate maintenance.

2.11 INLET PROTECTION

****
NOTE: The system should be protected by moisture reduction.
****

2.11.1 Knock-Out Pot

Provide knock out pot, with a minimum collection efficiency of [98] [98.5] [99] percent.

2.11.2 Mist Eliminator

Provide a mist eliminator, with a minimum collection efficiency of [85] [98] [98.5] [99] [_____] percent of the impinging mist.

2.12 IGNITION SYSTEM/BURNER ASSEMBLY

2.12.1 Pilot

****
NOTE: ASCE 25-16 applies to earthquake actuated systems.
****

Provide automatic gas shutoff system conforming to ASCE 25-16 on the pilot supply. The pilot assembly must be removable and provided with pressure indicator, pressure regulator, solenoid valve, manual shutoff valve and pilot gas pressure manometer port. Pilot inlet nozzle will be 150# ANSI, stainless steel, flanged.

2.12.2 Igniter

Provide electronic spark ignition. The igniter assembly must be removable from outside the combustion chamber without disconnecting conduit or wiring.

2.12.3 Burner Assembly

Ensure the primary air mixed burner is compatible with the specified fuel, has multiple small gas ports or jets, and constructed of 304L/316L stainless steel, heat and corrosion resistant alloy steel, ceramic and/or castable refractory. The burner must be of adequate capacity to maintain the required combustion temperature at the maximum flow with no fuel value in the off-gas.

2.12.4 Refractory Insulation

Provide removable, cast venturi burner lining assemblies with a [1500] [_____] degrees C [2,700] [_____] degrees F rating. Refractory insulation will be continuous, a minimum of 50 mm 2 inches of ceramic fiber insulation blanket surrounding the combustion cylinder, attached to the wall and floor with Inconel studs and washers, with plate retainers installed around all open edges of the blanket. Coat the refractory insulation with a high temperature, surface sealer protectant.

2.13 EXHAUST TREATMENT

2.13.1 Adsorber

****

NOTE: Adsorbers are not commonly required.

****

Treat exhaust gas with an activated carbon adsorption system in accordance with Section 44 13 10.13 VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS.

2.13.2 Scrubber

****

NOTE: Scrubber is used only for high acid concentrations resulting from chlorine or sulfur in the feed or combustion of nitrogen.

****

Ensure scrubber removes [85] [90] [95] [_____] percent of the acid gas formed.

2.14 STACK

2.14.1 Minimum Exit Velocity

The stack exit velocity will be no less than [_____] m/sec ft/sec.

2.14.2 Minimum Elevation

The stack elevation will be no less than stated in paragraph Design Requirements.

2.14.3 Lining

Stack will be lined with ceramic and/or castable refractory.

2.14.4 Lightning Protection

Provide an engineered lightning protection system with grounding.

2.14.5 Lugs

Provide lifting lugs at the top of the stack for ease of installation; each lug must be capable of supporting the entire weight of the stack.

2.14.6 Access

Provide access to the interior of the stack by an insulated, [hinged or supported 0.6 x 0.6 m 24 x 24 inch square or 0.6 m 24 inch diameter, manway] [150 x 150 mm 6 x 6 inch square or 150 mm 6 inch diameter, hand hole] located above the burners.

2.14.7 Ladder

Mount an aluminum or galvanized steel fixed ladder to allow access for removal or replacement of each of the thermocouples. The ladder furnished with the system will have side rails. Individual rung ladders are not acceptable. Conform ladder 29 CFR 1910, Part 27 Fixed Ladders, except as specified herein. Provide the safety cage with locking device to prevent unauthorized access.

2.15 PROVISIONS FOR OBSERVATION AND SAMPLING

2.15.1 Observation Ports

Provide observation ports or sight glasses with removable tempered glass covers and cooling holes. View port diameter will be a minimum of [75] [50] mm [3] [2] inch. Ports must be located to allow viewing the pilot flame, the base of the main flame, and a view of each of the thermocouples.

2.15.2 Inlet Sample Port

Inlet sample port [50] [_____] mm [2] [_____] inch minimum diameter, with cap and cooling holes, located upstream of all contributing flows, with the exception of the off-gas.

2.15.3 Outlet Sample Port

Outlet sample port [50] [_____] mm [2] [_____] inch minimum diameter, with cap and cooling holes, located [upstream of the cooling or dilution air inlet] [and] [two stack diameters from the top of stack].

2.15.4 Sampling Equipment

****

NOTE: Add sampler requirements.

****

Provide the following equipment: [_____].

2.16 CONTROLS

****

NOTE: Blower controls are in Section 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS. Omit last sentence if not applicable to the project.

****

Link set points, signals and control functions and dampers by a central programmable logic controller (PLC) located in the control panel. Control signals are to be 4-20 ma or 0-10 Vdc, compatible with the controller and sensor or control device. Include burner control diagnostics. For parameters specified to be continuously recorded, record digital data at intervals not exceeding one minute. Sensors are to be calibrated with standards traceable to NIST and in conformance with NIST SP 250. Connect each alarm to an [auto-dialer] [or] [telemetry] system.

2.16.1 Ultraviolet (UV) Flame Scanner

Provide ultraviolet scanner, installed and calibrated to provide for safety shutdown on the absence of flame. The signal from each scanner must incorporate a time delay appropriate to the control sequence. The burner flame scanner will monitor the burner flame. The pilot flame scanner will monitor the pilot flame.

2.16.2 Timers

Automatic timers must provide independent adjustment of the start and duration of each step in the control sequence.

2.16.2.1 Purge Timer

Set the minimum purge cycle at four changes of [air] [or] [inert gas]. Purge cycle must have both automatic and manual start.

2.16.2.2 Igniter Timer

****

NOTE: The spark duration adjustment extends the life of the plug, transformer and other pilot components.

****

Provide an igniter timer, with [manual] [automatic] adjustment of the spark duration, to set the time and duration of the igniter spark during the ignition cycle, and to compensate for the distance of the pilot gas supply from the oxidizer.

2.16.2.3 Pilot Timer

At the end of the purge, the pilot timer must begin automatic ignition. If the UV sensor fails to sense the pilot flame, close the pilot solenoid valve, extinguish the pilot flame, the system must shut down and the pilot fail alarm activated.

2.16.2.4 Main Flame Timer

Extend the main flame timer beyond the pilot timer cycle. When the burner flame lights and the temperature exceeds the low temperature set point on the temperature controller, shut off the pilot flame. Shut down the system , and activate the main flame fail alarm , if the UV sensor fails to sense the pilot flame or the flame temperature does not reach the low temperature set point by the end of the main flame step.

2.16.3 Temperature Sensors, Transmitters and Controllers

Submit detailed manufacturer's data on the overall controls, sensors, process controllers, control operators, ladder diagrams, timers, sequence of controls, valves, alarms, signals, interlocks and cut off systems. Data describing in detail the equipment used to monitor emissions, including the sampling probe, filters, off-gas transport tubing, sampling pump, moisture removal system, analyzer calibration systems, and data recorder. Process and instrumentation diagrams (P&IDs).

2.16.3.1 Thermocouples

****

NOTE: Narrow temperature ranges are more responsive than broad ranges because the sensitivity is a percentage of the range.

****

Conform thermocouples to ASTM E230/E230M, Type K, suitable for continuous operation and control at temperatures up to [50] [100] [150] [_____] degrees C [80] [180] [260] [_____] degrees F above the temperature specified in the performance requirements and accurate to 0.75 percent of the maximum temperature. Provide each thermocouple used for control with high and low set points and an adjustable time delay before initiation of each control action. A thermocouple located in or immediately downstream of the combustion chamber must control burner operation and [indicate] [and] [record] combustion chamber temperatures. Space [three] [_____] additional thermocouple ports at vertical intervals equal to the stack diameter, starting two stack diameters from the top of the stack. Compensating lead wire connecting the thermocouple to the read out must be 16 gauge with a weatherproof braid.

2.16.3.2 Thermometers

Conform thermometers to ASME PTC 19.3 TW, with wells and temperature range suitable for the use encountered.

2.16.3.3 Combustion Chamber Temperature Controller

The combustion temperature control must [record the combustion chamber temperature] [and] [maintain the temperature between the adjustable high temperature and low temperature set points]. The controller will control the [damper actuator motors] [blowers]. Control logic will include auto position signal and automatic switch over capabilities.

a. Shut down the system and do not attempt to restart if the temperature exceeds the allowable combustion chamber temperature range. A high temperature shutdown must activate the high temperature alarm.

b. During operation, shut down the system and not attempt to restart if the temperature falls below the allowable combustion chamber temperature range. During the ignition cycle, if the temperature does not reach or exceed the low temperature shutdown setting, the system must shut down and not attempt to restart. A low temperature shutdown during operation or during the ignition cycle must activate the low temperature alarm.

2.16.3.4 Primary Combustion Air Control

****

NOTE: For this and the following paragraph, refer to Section 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS for combustion air control.

****

Furnish fully adjustable air dampers on each burner with remote operation by external lever control, sized to provide a minimum of [100] [115] percent of theoretical stoichiometric air as primary air. Ensure dampers allow the operator to adjust the primary air/fuel ratio while burner is in operation.

2.16.3.5 Total Combustion Air Control

[Provide motor operated louver dampers. Actuators must cause louvers to fail open on loss of signal or power.] [Provide two multistage centrifugal blower trains, each with a suction valve, discharge valve, and discharge check valve.]

2.16.3.6 Quenching/Dilution Air Control

Provide motor operated louver dampers. Ensure actuators cause louvers to fail open on loss of signal or power.

2.17 FLOW METERS, TRANSMITTERS AND FLOW CONTROLLER

The flow control system must include an automatically actuated main fuel valve with fail-closed feature and limit switches for position indication. Ensure the flow rate metering system includes recording, totaling and alarm capabilities.

2.17.1 Off-Gas Flow Meter

Conform flow metering for the off-gas AGA Report No 3.

2.17.2 Supplemental Fuel Flow Meter

****

NOTE: Supplemental fuel meters should be sized on peak requirement. Off-gas meters should be based on blower size.

****

Conform gas meters to [AGA ANSI B109.1] [AGA ANSI B109.2] [AGA ANSI B109.3].

2.18 PRESSURE MEASUREMENT AND CONTROL

Furnish one differential pressure sensor with large diameter sensing holes. Provide a differential pressure transmitter and mount within 1 m 3 feet of the sensor. Install a compound vacuum/pressure gauge on each blower. Furnish the compound gauges with a differential pressure range of [0.1 to 100] [_____] kPa [0.015 to 15] [_____] psig. The piping from the sensor to the transmitter must be 3 mm 1/8 inch stainless steel tubing with stainless steel drain valves on each pipe, at low points. Piping must be plumbed so that condensate will drain back into the pipe. The transmitter must be equipped with zero and span adjustment, and provide a standard volumetric output rate reading to the chart recorder (included with the control system) without the need for separate compensating pressure or temperature transducers. A pressure gauge must be installed on the discharge side of each blower. The pressure gauges must be furnished with a range of 0 to 34 kPa 0 to 5 psi. The gauges are to be weatherproof, with 113 mm 4-1/2 inch dials and Type 316 stainless steel Bourdon tubes. Furnish the gauges with pressure snubbers and diaphragm seals and valves. Isolation valves are to be installed between the process pipe and the seal. Diaphragm seals are to be furnished with top and bottom housings and diaphragms of Type 316 SS. The diaphragm cavities are to be liquid filled with silicone.

2.18.1 Draft Gauges

Draft gauges are to be Type I, Class 1 or 2, as applicable, conforming to ASME B40.100 with a diaphragm or bellows actuating system and a circular scale. The gauges will have a zero adjustment screw. Provide suitable shutoff cocks.

2.18.2 Pressure Gauges

Conform pressure gauges to ASME B40.100 and be of pressure detecting Class, single Bourdon tube style, and suitable for detecting air pressure.

2.18.3 Pressure Switches

Pressure switches are to be provided to activate the blowers.

2.18.4 Pressure Release

A pressure release valve are to be located on the off-gas line upstream of the oxidizer.

2.19 EXPLOSIMETER

****

NOTE: The fuel concentration should be greater than 30 percent of LEL. Combustion air should be less than 30 percent of LEL.

****

A combustible gas analyzer, with a minimum of four in-line sensors, calibrated to methane are to be located in the control panel.

2.19.1 Lower Explosive Limit (LEL)

The lower explosive limit of the fuel and of the off-gas must be continuously indicated. The lower explosive limit of the off-gas must be continuously recorded.

2.19.2 Upper Explosive Limit (UEL)

The upper explosive limit of the combustion air and of the off-gas are to be continuously indicated.

2.20 OXYGEN METERING AND MAKE-UP AIR CONTROL

2.20.1 Oxygen Meter

The upper oxygen level of the combustion air and of the off-gas are to be continuously indicated.

2.20.2 Methane Monitor

The methane level of the combustion air and of the off-gas are to be continuously indicated.

2.21 OPERATING INDICATORS AND ALARMS

Simulated running lights to indicate normal operating conditions and alarms are to be displayed at the control panel.

2.21.1 Visible Alarms

Each visible alarm are to be indicated at the control panel and by a red light at the device.

2.21.2 Audible Alarms

Locate each audible alarm at the device.

2.21.3 Remote Alarms

****

NOTE: The Contractor should respond to alarms for the duration of the contract.

****

Remote alarms must activate the programmable auto dialer. A prerecorded message must provide specific information to the operator about the alarm condition. At contract close out, the dialer must be reprogrammed to the number indicated by the Contracting Officer.

2.22 ELECTRICAL WORK

****

NOTE: Hazard classifications in accordance with NFPA 70 should be indicated on the drawings.

****

Ensure all electrical equipment, wiring and controls comply with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and with NFPA 70, with proper consideration given to environmental considerations such as moisture, dirt, corrosive agents and proper NFPA 70 hazardous area classification. Provide lightning and surge protection.

2.22.1 Motors

Provide electric motor driven equipment complete with starters and alternating current motors conforming to NEMA MG 1. Fractional horsepower motors are to be 115-volt, single-phase, 60 cycle. Integral horsepower motors are to be three-phase, 60 cycle. Provide motor starters complete with properly sized thermal overload protection and other appurtenances necessary for the motor specified. Each motor will be designed for operation in ambient temperatures up to 40 degrees C 104 degrees F. Submit manufacturer's certificates attesting that the motors meet the NFPA 70 requirements for the hazardous area classification.

2.22.2 Control Panels

A complete control panel with options for various control schemes and control wiring must be included. Manual or automatic controls, protective or signal devices and control wiring for the controls and devices required for the operation specified must be provided. Conform motor controls to NEMA ICS 1. Conform enclosures for power and control panels to NEMA ICS 6. Panels located outdoors will be [NEMA 4X] [NEMA 4] and be weatherproof.

2.22.3 Resistance Heaters

****

NOTE: The designer should select the most cost effective heat source for the application.
****

Electric resistance pre-heaters and dryers are to be used where indicated on the drawings.

2.23 AUXILIARY FUEL SYSTEM

****
NOTE: The designer should select the most cost effective heat source for the location.
****

2.23.1 Feed Capability

The auxiliary fuel system will have direct feed capability to the thermal destruction system with meters, pressure gages and controls to maintain the specified operating conditions. Design must be in conformance with the applicable requirements of NFPA 30 and NFPA 31, NFPA 54 or NFPA 58, as appropriate to the fuel type.

2.23.2 Auxiliary Fuel Regulator

Auxiliary fuel rate must be controlled by the temperature of the combustion chamber.

2.23.3 Secondary Containment

Fuel storage tanks are to be provided with secondary containment as required by NFPA 30, paragraph 2-3.4 Control of Spillage from Aboveground Tanks.

2.24 VALVES

Design of valve operators and mechanisms must avoid initial surges and sudden inrushes by gradually allowing flows to increase.

2.24.1 Butterfly Valves

Butterfly valve will be cast iron body with resilient seat, 316 stainless steel disc and shaft and actuator. Valve will have fail-safe closing in ease of a power failure. Valve will have location limit switch for use in the control system.

2.24.2 Other Valves

Conform other valves to API Spec 6D, ANSI Z21.15/CSA 9.1 or ASME B16.33 as appropriate for the type.

2.25 JOINTS

2.25.1 Dielectric Fittings

Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings must prevent metal-to-metal contact of dissimilar metallic piping elements and be suitable for the required working pressure.

2.25.2 Isolation Joints

Isolation joints must be installed between non-threaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints will consist of a dielectric sandwich type flange isolation gasket with isolation washers and isolation sleeves for flange bolts. Isolation gaskets are to be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves are to be full length. Units are to be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.25.2.1 Sleeve Type Couplings

Sleeve type couplings must be used for joining plain end pipe sections. Each coupling will consist of a steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

2.25.2.2 Split Sleeve Couplings

Split sleeve type couplings may be used in aboveground installations, when approved in special situations, and consist of gaskets and housing in two or more sections with the necessary bolts and nuts.

2.25.3 Bolts, Nuts, and Fasteners

Bolts, anchor bolts, nuts, washers, plates, bolt sleeves, and all other types of supports necessary for the installation of the equipment are to be furnished with the equipment and are to be galvanized unless otherwise indicated. Anchor bolts must be provided with square plates at least 100 by 100 by 9 mm 4 by 4 by 3/8 inch or have square heads and washers and be set in the concrete forms with suitable sleeves. Expansion bolts must have malleable-iron and lead composition elements. Unless otherwise specified, stud, tap, and machine bolts are to be of refined bar iron. Conform all threads to ASME B1.1. Bolts, anchor bolts, nuts, and washers specified to be galvanized, be zinc coated, after being threaded, by the hot-dip process in conformance with ASTM A123/A123M or ASTM A153/A153M. Bolts, anchor bolts, nuts, and washers indicated to be stainless steel will be Type 316 stainless steel.

2.26 FACTORY TESTS

Skid mount and assemble the thermal oxidation system equipment in the shop, to the maximum practical extent, in the configuration outlined in the detail drawings and specifications. Perform a factory pressure test at [125] [250] [_____] percent of the rated pressure of the equipment. Perform continuity check and process simulation at the factory before shipping the control panel. Test fire the system with the specified fuel and air and maintained at the temperature specified in paragraph PERFORMANCE REQUIREMENTS for [two] [_____] hours. Submit test reports [with the equipment] [to the Contracting Officer prior to shipment of the equipment].

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 PREPARATION

Inspect all equipment and products for defects in workmanship and material. Clean debris and foreign matter out of valve openings and seats. Check each operating mechanism during operation to check proper functioning. Each nut must be checked for tightness. Valves and other equipment that do not operate easily or are otherwise defective are to be repaired or replaced.

3.3 FOUNDATIONS AND SKID BASES

Foundations for the thermal oxidizer and appurtenances, and pads for skid bases, are to be constructed of concrete, reinforced where necessary, in conformance with the applicable requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE, except as otherwise shown or specified. Concrete surface are to be [75] [_____] mm [3] [_____] inch above grade in outdoor locations. Mounting feet must be provided so that appropriate anchorage can be provided. Anchor embedment depth and spacing must be sufficient for seismic attachment to the foundation and for prevention of overturning. Concrete pad must extend [150] [_____] mm [6] [_____] inch beyond the equipment.

3.4 ERECTION

3.4.1 Welding

****

NOTE: Use second set of brackets when critical pipe welding is required.

****

[Welding procedures will be as specified in AWS D1.1/D1.1M] [Welding and nondestructive testing procedures for piping will be as specified in Section 40 05 13.96 WELDING PROCESS PIPING] [Structural members will be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING].

3.4.2 Painting/Corrosion Prevention

All ferrous surfaces must be coated or painted. Exposed ferrous surfaces are to be painted in accordance with Section 09 90 00 PAINTS AND COATINGS. Color will be as indicated on the paint schedule or as otherwise approved.

3.4.2.1 Factory Primed Surfaces

Factory primed surfaces are to be solvent-cleaned before painting.

3.4.2.2 Touch-Up Painting

Factory painted items must be touched up as needed. Factory painted items requiring touching up in the field must be thoroughly cleaned of foreign material, primed and top coated with the factory finish.

3.4.2.3 Field Painting

Equipment which did not receive a factory finish are to be prepared, primed and painted, as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4.2.4 Corrosion Resistant Metals

Painting of corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel is not required unless otherwise specified.

3.5 INSTALLATION

3.5.1 Insulation

Equipment and piping will be insulated in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.5.2 Utilities

****

NOTE: Points of connection are normally shown on the drawings. Occasionally, the name, address and telephone number of each utility company is shown on the drawings. Delete the following paragraphs if the information is shown elsewhere.

****

Fuel and utilities are to be provided at locations shown on the drawings. Verify availability and locations of utilities and compensate the utility company for connection and usage. Fuel, water, sewer, power and any other utility bills must be paid on receipt.

3.5.2.1 Electricity

The power [utility] [company] is [_____], telephone number [_____].

3.5.2.2 Water

The water [utility] [company] is [_____], telephone number [_____].

3.5.2.3 Natural Gas

The natural gas [utility] [company] is [_____], telephone number [_____].

3.5.3 Fuel System

****

NOTE: Coordinate requirements for the fuel source specified in paragraph Feed Capability.

****

Fuel system installation and testing will comply with the applicable requirements of NFPA 30 and NFPA 31, NFPA 54 or NFPA 58, as appropriate to the type of fuel.

3.6 POSTING FRAMED INSTRUCTIONS

****

NOTE: If the user preference is known, show the location on the drawings and edit this paragraph.

****

Wiring and control diagrams and typed condensed operating instructions framed under glass or in laminated plastic must be posted where directed. Diagrams will show the complete layout, wiring and control of the entire system. Condensed operating instructions will explain preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system. The diagrams and instructions must be posted before acceptance testing of the system.

3.7 FIELD QUALITY CONTROL/TESTS

3.7.1 Pressure and Leakage Test

****

NOTE: Testing of pipe and fittings should be specified in the pipe specification. The test pressure for vessels should not exceed the rated pressure.

****

After installation, test all piping, equipment, joints and connections for gas tightness. Test connections and piping by subjecting the complete system to pneumatic pressure of not less than [[105] [_____] kPa [15] [_____] psi] [the pressure indicated in the schedule] for 6 hours. During the test, the system must be disconnected from the source of pressure and, with corrections made for barometric and temperature changes, the pressure must remain constant for the test period, as indicated by a test gauge. Test joints using a soapy water solution to detect leaks.

3.7.2 Operational/Performance Tests

****

NOTE: Coordinate with the blower specification and the design sequence of operation. Testing requirements should be edited to fit the intended mode of operation for the system. Flow rates for operating capacity tests will be inserted in the blank spaces provided.

****

After installation and pressure testing, the entire off-gas system must be subjected to [an operational test] [a performance test] to demonstrate satisfactory functional efficiency. Use results of the tests in determining the capacity and performance of the oxidation unit. Correct any deficiencies revealed during the tests and repeat the tests.

3.7.2.1 Constant Flow Tests

****

NOTE: This procedure is appropriate for a system without blowers or with a single constant speed blower.

****

Operate each unit at a constant flow rate of approximately [_____] cubic m/second cubic feet/second (actual) for the capacity test. Take samples of the influent and effluent at [[1] [8] hour] [1 day] [1 week] intervals for analysis.

3.7.2.2 Variable Flow Tests

****

NOTE: This procedure is appropriate for a system with variable speed blowers regulated by a pressure controller.

****

Operate each unit at flow rates varying between [_____] and [_____] cubic m/second [_____] and [_____] cubic feet/second (actual). Take samples of the influent and effluent at the high flow rate and [1 intermediate rate] [[2] [3] [_____] intermediate rates] for analysis.

3.7.2.3 Cyclic Flow Tests

****

NOTE: This procedure is appropriate for a system with constant speed blowers operated by on/off control.

****

Put each unit through a complete cycle of operation [at a constant flow rate of approximately [_____] cubic m/second cubic feet/second (actual)] [through the complete range of flows]. Take samples of the influent and effluent at the beginning and end of each cycle and at [1 intermediate time] [[2] [3] [_____] intermediate times] for analysis.

3.7.3 Sampling and Analyses

Collect samples of influent and effluent off-gas and analyze for the parameters listed in Paragraph OFF-GAS COMPOSITION in accordance with the Sampling and Analysis Plan.

3.7.4 Test Logs and Reports

Provide a complete log of each test, giving the following data: date, time of each reading and each sampling event, fuel use, and total off-gas treated. Upon completion and testing of the installed system, submit test reports, with corresponding logs and in booklet form, showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Indicate the final position of controls on each test report.

3.7.5 Manufacturer's Field Service

Emplay services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, calibration, commissioning, start-up and operational/performance testing of the equipment.

3.8 CLOSEOUT ACTIVITIES

3.8.1 Operating Instructions

Provide complete copies of detailed operating instructions with step-by-step procedures and sequences for system startup, operation and shutdown. The instructions include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and the operating features of each element. The instructions will include as-built drawings of the piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. Describe automatic controls, functional logic, control loops, set points and alarm signals. Include flow diagrams in the instructions.

3.8.2 Maintenance Instructions

Provide complete copies of maintenance instructions listing maintenance procedures, possible breakdowns and repairs, and trouble shooting guides.

3.8.3 Field Training

****

NOTE: Complexity of the system and experience of the user operators should be taken into consideration.

****

Provide a field-training course for designated operating and maintenance personnel. Submit the training course curriculum and training instructions, [14] [_____] days prior to the start of training. Provide training for a total period of [_____] hours of normal working time and start after the system is functionally complete but prior to the [performance] [operational] test. Field training must cover each item contained in the operating and maintenance manuals, as well as demonstrations of routine maintenance operations.

3.9 MAINTENANCE

****

NOTE: Select the option that is compatible with the Bid Schedule.

****

Manage, operate, maintain, and monitor the off-gas control system [until contract close out] [for at least [one year] [_____] after construction, startup and performance testing are complete]. Provide at a minimum, an operator on site [eight] [_____] hours per week to operate, maintain, and calibrate the equipment and instruments, and to collect samples for analyses. A qualified person must be on call to respond to emergencies and alarm conditions at the off-gas system within two hours of alarm conditions. Prepare compliance and monitoring records and reports and maintain for the Contracting Officer and regulatory agencies. The operator must maintain a log of the actions taken.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-44 41 00 (August 2020)**
Change 1 - 02/24

Preparing Activity: NAVFAC **Superseding**
UFGS-44 41 00.00 20 (May 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 44 41 00

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USACE / NAVFAC / AFCEC **UFGS-44 41 00 (August 2020)**
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References are in agreement with UMRL dated January 2025
****

SECTION 44 41 00

WATER POLLUTION CONTAINMENT AND CLEANUP EQUIPMENT

08/20, CHG 1: 02/24

****
NOTE: This guide specification covers the requirements for factory fabricated storage tanks used to contain fire suppressant discharge. Except when used to contain fire suppressant discharge during an emergency, the containment tank must remain empty. The containment tank must be expeditiously emptied after each emergency that discharges fire suppressant, water or fuel. The tank operator will need to use the strapping chart and stick gauge to determine quantity for disposal. The tank is not meant for storing hazardous substances other than emergency discharges that are expeditiously emptied and would not include connections that would allow any discharges to storm or sanitary sewer.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: This specification is intended for systems using factory-fabricated storage tanks with

capacities less than or equal to 227,000 L 60,000 gal. Additional system components/devices necessary to meet state and local regulations must be added by the designer.

Coordinate the design and installation of underground factory-fabricated storage tanks with Base Environmental.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges
AASHTO M 294	(2021) Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO MP 20	(2013; R 2017) Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 1500-mm (12- to 60-in) Diameter

AMERICAN PETROLEUM INSTITUTE (API)

API MPMS 2.2E	(2004; Errata 2009; R 2009) Petroleum and Liquid Petroleum Products - Calibration of Horizontal Cylindrical Tanks - Part 1: Manual Methods

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 1615	(2011) Installation of Underground Petroleum Storage Systems
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM F679	(2016) Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F714	(2024) Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

ASTM F794	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F844	(2019; R 2024) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F894	(2024) Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2562/F2562M	(2015; R 2019) Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	(2013; E 2014) Standard Specification for 6 to 30 in. (152 To 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe And Double Wall Pipe
ASTM F2764/F2764M	(2024) Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881/F2881M	(2021; E 2021) Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 77	(2024; ERTA 1 2023) Recommended Practice on Static Electricity
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

PETROLEUM EQUIPMENT INSTITUTE (PEI)

RP900-17	(2017) UST Inspection and Maintenance

STEEL TANK INSTITUTE (STI)

STI SP131	(2014) SP131 Standard for Inspection & Repair Underground Steel Tanks

UL SOLUTIONS (UL)

UL 58	(2018) UL Standard for Safety Steel Underground Tanks for Flammable and Combustible Liquids
UL 1316	(2018; Reprint Mar 2019) UL Standard for Safety Fiber Reinforced Underground Tanks for Flammable and Combustible Liquids
UL 1746	(2007; Reprint Dec 2014) External Corrosion Protection Systems for Steel Underground Storage Tanks

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy

and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding

SD-03 Product Data

Underground Storage Tank; G, [_____]

Tank Protective Coatings; G, [_____]

Atmospheric Vent; G, [_____]

Independent Level Alarm System; G, [_____]

Manhole Containment Sump; G, [_____]

SD-06 Test Reports

Underground Storage Tank Tightness Tests; G, [_____]

Tank Manufacturer's Tests

Tank Fill Tests

Tank Inspection Reports; G, [_____]

SD-07 Certificates

Letter; G, [_____]

Manufacturer's Certification; G, [_____]

[State Certification; G, [_____]

][Pollution Liability Insurance

] Permitting

Registration

Licensed Personnel

Demonstrations

STI SP001 Inspector's Certification; G, [_____]

SD-08 Manufacturer's Instructions

Underground Storage Tank

Independent Level Alarm System

SD-10 Operation and Maintenance Data

Underground Storage Tank; G, [_____]

Independent Level Alarm System; G, [_____]

SD-11 Closeout Submittals

Warranty

1.3 QUALITY CONTROL

1.3.1 Regulatory Requirements

1.3.1.1 Permitting

Obtain necessary permits in conjunction with the installation of storage tanks as required by federal, state, or local authority.

1.3.1.2 Registration

****

NOTE: Confirm with the DoD Installation the number of days required to obtain the permit documentation.

****

Obtain and complete all tank registration forms required by federal, state, and local authorities. Submit all completed tank registration forms within [30][_____] days after contract award to the Contracting Officer. The Contracting Officer will ensure the Base Environmental staff for the DoD Installation submits the forms to the proper regulatory agencies.

1.3.1.3 Licensed Personnel

Tank installers must be licensed by the state when required by state law or regulations.

1.3.2 Contractor Qualifications

****

NOTE: Include specific local regulatory requirements into the specification as applicable.

****

Each installation Contractor must have successfully completed at least 3 projects of the same or similar scope, and the same size or larger within the last 3 years and demonstrated specific installation experience in regard to underground tank installation. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. The letter must also include evidence of prior manufacturer's training, and other related information.

[State certified installers must be provided by the Contractor.]Each installation Contractor must have taken, if applicable, manufacturer's training courses on the installation of storage tanks and meet all applicable licensing requirements in the state. Installers must also be trained and certified by the manufacturer to install the equipment and materials[and be STI certified].[Contractor must have Pollution Liability Insurance.]

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer, upon recommendation by Base Environmental for the DoD Installation. Replace damaged or defective items.

1.5 PROJECT/SITE CONDITIONS

Exposed moving parts, parts that produce high operating temperatures and pressures, parts that may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired.

1.6 WARRANTY

All factory fabricated storage tanks must come with a manufacturer's warranty of a minimum period of 30 years. All warranty paperwork will be completed and submitted by Contractor to both the tank and system component manufacturers, the Contracting Officer, and the Base Environmental for the DoD Installation. This includes all applicable completed manufacturers' equipment installation checklists.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

This section defines the requirements for factory fabricated storage tanks used to contain fire suppressant discharge.

2.1.1 Design Requirements

2.1.1.1 Electrical Work

****

NOTE: Coordinate the ignition temperature of the fuel(s) to be handled with the electrical design. Ignition temperatures will be as defined in NFPA 497. Fuel ignition temperatures will dictate the maximum allowable location classification of the electrical system components.

****

2.1.1.1.1 Grounding and Bonding

Grounding and bonding must be in accordance with NFPA 70, NFPA 77, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.1.1.2 Earthwork

****

NOTE: The designer developing the earthwork specifications will evaluate the need for a filter fabric to be installed between the native soil and the new backfill material. The intent of a filter fabric would be to prevent the displacement of new backfill material with native soil due to a high water table. If the new backfill material is displaced, it could affect the structural integrity of the tank. If a filter fabric is determined to be necessary, include the requirements for the new fabric in the excavation and backfilling specifications.

****

Excavation and backfilling for tanks must be as specified in Section 31 00 00 EARTHWORK.

2.2 MANUFACTURED UNITS

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products and that are of a similar material, design and workmanship. Provide materials and system components that have been in satisfactory commercial or industrial use for a minimum 3 years prior to bid opening. The 3 year period must include applications of the system components and materials under similar circumstances and of similar size. Provide materials and system components that have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 3 year period.

Internal parts and components of system components, piping, piping components, and valves that could be exposed to fuel during system operation must not be constructed of zinc coated (galvanized) metal, brass, bronze, or other copper alloys. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

2.2.1 Underground Storage Tank

Provide a factory fabricated double wall storage tank. Tank may be either steel with a non-metallic outer jacket or a double wall fiberglass tank. Tank must be designed and manufactured for an underground, horizontal installation. The exterior tank walls must be separated from the interior tank walls by standoffs; creating an open or interstitial space. The entire interstitial space must be monitorable for leaks.

****

NOTE: Provide a concrete anchor pad(s) or deadmen for any tank that will be installed in areas subject to high water tables or flooding. Size the pad(s)

or deadmen in accordance with API RP 1615. Require the tank to be connected to the pad(s) or deadmen in accordance with the tank manufacturer's recommendations.

Delete the bracketed sentences if concrete anchor pads or deadmen are not required.
****

[For tanks requiring concrete anchor pads or concrete deadmen, provide holddown straps and accessories as recommended by the tank manufacturer. Use filler strips between the tank shell and any metal holddown straps that conform to the tank manufacturer's requirements.

]2.2.1.1 Double Wall Tank (Steel with Non-Metallic Jacket)

The primary tank must be constructed of steel and jacketed with a non-metallic secondary containment tank. The entire tank assembly must conform to UL 58 Type II and UL 1746 Part III. The UL 58 label must be affixed to the exterior surface of the tank.

2.2.1.2 Double Wall Fiberglass Tank

Provide a UL 1316 compliant fiberglass tank. The tank manufacturer must be recognized by Underwriters Laboratories as a manufacturer of tanks listed to the UL 1316 standard. The UL 1316 label must be affixed to the exterior surface of the tank.

2.2.1.3 Tank Protective Coatings

2.2.1.3.1 Interior Surfaces

Use an SSPC QP-3 certified coating company to apply interior coating. Coat 100 percent of a metal tank's interior surfaces including all metal piping and metal appurtenances with the manufacturer's standard coating system.

2.2.1.4 Tank Piping Penetrations

****
NOTE: Use tank manholes as the primary point of entry for piping penetrations unless unfeasible. Pipe penetrations into an underground storage tank are the most likely place for a leak to occur. Designing pipe penetrations to enter through a tank manhole allows each of the penetrations to be contained in a manhole containment sump. The piping that penetrates the manhole must be flanged on both sides of the manhole hatch. This will allow the piping to be removed from the manhole and allow removal of the manhole without having to cut the piping.

Where stand alone tank piping penetrations are required, indicate on the drawings the required number, size, and location of each penetration.

Flanged nozzles must be installed in locations with ISO Corrosivity Categories C3, C4, and C5.
****

Provide a flanged pipe nozzle for each tank piping connection. Seal all unused or spare tank piping penetrations with a steel blind flange.

2.2.1.5 Tank Striker/Impact Plates

****

NOTE: Striker plates under all openings used for manual gauging in steel tanks and all openings in fiberglass tanks.

****

Provide an interior striker/impact plate under the manual gauging/sampling hatch and each tank manhole and pipe connection. Each plate must be a minimum of 6 mm 1/4 inch in thickness, be larger in diameter than the tank penetration, fit the curvature of the tank bottom, and be completely coated in the same fashion as the interior tank bottom coating. Each plate must be welded or bonded to the tank bottom at the factory (full circumference connection). The welds must be non-destructive tested using the appropriate means.

2.2.1.6 Manual Gauging/Sampling Hatch

Provide a combination gauging and sampling hatch assembly that includes a bronze top-seal type adapter with a corresponding locking type cap (adapter and cap both externally-mounted to the top of the tank)[and a [steel][or][aluminum] stilling well pipe.][The stilling well pipe must be a minimum 100 mm 4 inches in size and extend downward through the top of the tank to within 75 mm 3 inches of the tank bottom. Provide the entire length of pipe inside the tank with 13 mm 1/2 inch wide by 300 mm 12 inches long slots at alternate locations. Coat the pipe in the same fashion as the interior tank bottom coating.]

2.2.1.7 Tank Manhole

****

NOTE: Indicate the number, size, and location of each tank manhole required.

Provide tanks 18,900 L 5,000 gallons and smaller with a minimum of one 760 mm 30 inch tank manhole to allow for internal tank access. Provide tanks larger than 18,900 L 5,000 gallons with a minimum of two 915 mm 36 inch tank manholes (one manhole for access).

****

Provide a minimum of [2][1][_____] tank manholes with an internal diameter of [760 mm][813 mm][915 mm][30 inches][32 inches][36 inches]. Provide each manhole with a matching flanged watertight manhole cover. Manhole covers must be UL listed, be constructed of pressed or mild steel, and include a UL listed gasket.[Frame and cover assembly must be rated to withstand H-20 highway loading as defined by AASHTO HB-17.]

2.2.1.8 Atmospheric Vent

Provide atmospheric, updraft type cap no closer than 5 feet from any building openings. Cap must be constructed of aluminum or carbon steel and have an internal brass or bronze insect screen, minimum 40-mesh. Cap must prevent rain, snow, or ice from entering the vent piping.

2.2.1.9 Nameplates

****

NOTE: In a salt water environment, substitute acceptable non-corroding metal such as, but not limited to, nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

Require melamine plastic nameplates for all NAVFAC projects. Also, for NAVFAC projects, require nameplates to be associated or keyed to system charts and schedules.

****

Attach nameplates to all specified system components defined herein. List on each nameplate the manufacturer's name, address,[contract number,][acceptance date,] component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of[anodized aluminum][stainless steel][melamine plastic, 3 mm 0.125 inch thick, UV resistance, black with white center core, matte finish surface and square corners][_____]. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size for nameplates is 25 by 65 mm 1 inch by 2.5 inches. Provide manufacturer's storage tank nameplates as required. Provide normal block style lettering with a minimum height of 6 mm 0.25 inches. Accurately align all lettering on nameplates.[For plastic nameplates, engrave lettering into the white core.][Key the nameplates to a chart and schedule for each system. Frame charts and schedule under glass, and locate where directed near each system. Furnish two copies of each chart and schedule. Each nameplate description must identify its function.]

2.2.2 Manhole Containment Sump

****

NOTE: Require on the drawings a containment sump to be installed directly above each tank manhole. Do not require the sump to be connected in any way to the surfaces above (e.g., street manhole cover, concrete and similar accessories).

Typical installations include a street manhole cover to be installed directly above each sump in order to allow access to the sump and the tank manhole below. Size the manhole cover large enough to allow the removal of the sump access cover below.

****

Provide a factory fabricated, direct-buried sump that provides a watertight connection either directly to the exterior of the tank or to a flanged manhole opening. Sump must be constructed of [fiberglass reinforced plastic][_____]. Sump construction must be chemically compatible with the type of products being handled within the connecting tank. Sump must allow access to a tank manhole cover without disturbing surrounding backfill. Sump must be larger in diameter than the connecting tank manhole, designed to withstand the underground burial loads, and prevent the influx of rainfall drainage or ground water.

2.2.2.1 Piping Penetrations

Sump sides allow the penetration of carrier pipes, exterior containment pipes, conduits, and vapor pipes as required. Boot or seal sump penetrations to ensure that liquid will not escape from the sump in the event that the liquid level within the sump rises above the pipe penetration. Boots and seals used must be chemically compatible with the type of products being handled, be water resistant to prevent the influx of water from outside the sump, and be designed and installed to accommodate the anticipated amount of thermal expansion and contraction in the piping system.

2.2.2.2 Access Cover

****

NOTE: Require watertight covers if high ground water is a problem and frequent access to the manhole below is not necessary. Watertight covers are generally bolted or strapped down. Strapped down covers provide easy access to the sumps without the use of tools. Friction fit covers will prevent the influx of rainwater and are easily removable by hand.

****

Where indicated, cap the entire top of a containment sump with a[friction fit][bolted down, watertight][strapped down, watertight] access cover that allows water to flow away from the manhole. Construct cover of the same material as the sump. Cover must have a larger diameter than the tank manhole cover below.[Provide lightweight cover not exceeding 16 kilograms 35 pounds].

2.2.3 Interstitial Space Access Sump

Provide an access sump around the interstitial monitoring pipe to allow for manual monitoring of the interstitial space of the tank in accordance with RP900-17 Section 7.5.7. Cap the monitoring pipe with a watertight[threaded cap,][quick release cap,][or other cap as may be recommended by the manufacturer]. Both the monitoring pipe and the sump will be labeled respectively as the "interstitial monitoring pipe" and "interstitial monitoring pipe access". Label must be affixed to the exterior surface of the tank

2.3 COMPONENTS

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Provide materials and system components that have been in satisfactory commercial or industrial use for a minimum 3 years prior to bid opening. The 3 year period must include applications of the system components and materials under similar circumstances and of similar size. Provide materials and system components that have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 3 year period.

Internal parts, system components, piping, piping components, and valves that could be exposed to fuel during system operation must not be constructed of zinc coated (galvanized) metal, brass, bronze, or other copper alloys. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

2.3.1   Independent Level Alarm System

****

NOTE: Level alarms are used to ensure that the tank does not fill by infiltration in the drain line or other means. The containment tanks needs to remain empty so that it can contain fire suppressant discharge during the anticipated fire event.

Use this paragraph for tanks equal to or greater than 112,500 L 30,000 gallons. These tanks are required to have an independent level alarm system in addition to an independent manual tank gauging system.

This paragraph should be used for tanks less than 112,500 L 30,000 gallons to provide a level alarm system.

Include the bracketed options if multiple tanks are to be monitored as part of the design.

****

[Provide an independent level alarm system that will monitor [2][_____] programmable liquid level setpoints. The system must delineate between each individual setpoint[as well as each individual tank]. The system must produce an audible and visible alarm in the event of monitoring an alarm condition. Mechanically-actuated float assemblies must be field adjustable. The system must be totally independent of the tank gauging system.

]2.3.1.1   Setpoints

****

NOTE: The suggested low-low level alarm setpoint for underground tanks is 5 percent tank capacity.

****

Configure the alarm system's setpoints in accordance with the following.

a. Low Level Setpoint. Produce an audible and visual alarm condition when a tank's liquid level rises above [10][_____] percent capacity.

b. Low-Low Level Setpoint. Produce a visual alarm condition when a tank's liquid level rises above [5][_____] percent capacity.

2.3.1.2   Independent Level Alarm Control Panel

****

NOTE: Indicate on the drawings the location of the system control panel. Panels located outdoors will require NEMA 4 enclosures. Panels located indoors will only require a standard industrial enclosure. Explosion-proof enclosures are typically unavailable.

****

Install the control panel for the alarm system in a[NEMA 4 rated enclosure in accordance with NEMA 250][standard industrial enclosure]. Provide panel with left and right swinging doors.

2.3.1.2.1 Audible Alarm

****

NOTE: If speakers external to the panel are necessary, indicate their location on the drawings.

****

Provide panel with [internal][external] speakers that produce a buzzer sound of [70][_____] decibels or greater in the event of a detected alarm condition.

2.3.1.2.2 Visual Alarm

Provide panel with a visual alarm that illuminates in the event of a detected alarm condition. The visual alarm may include either individual lights for each alarm condition or a single light and a liquid crystal display (LCD) panel that displaces information regarding each alarm condition.

2.3.1.2.3 Acknowledge Switch

Provide panel with a [pushbutton][keyed] acknowledge switch that will deactivate the audible alarm. The acknowledge switch must not deactivate subsequent audible alarms unless depressed manually again for each occurrence. Under no circumstance will this acknowledgement switch extinguish the visual alarms until the alarm condition has been corrected. The acknowledge switch must be an integral component located on the front of the control panel.

2.3.1.2.4 Test Pushbutton

Provide panel with a manual test pushbutton that will enable operators to verify that the panel is powered, and the visual and audible alarms are working properly.

2.4 MATERIALS

2.4.1 Piping

Pipe shall be of the sizes indicated and conform to the specified requirements.

2.4.1.1 Poly Vinyl Chloride (PVC) Pipe

Submit the pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, prior to installation of the pipe.

2.4.1.1.1 Type PSM PVC Pipe

ASTM D3034, Type PSM, maximum SDR 35, produced from PVC certified by the Manufacturer as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.4.1.1.2 Profile PVC Pipe

ASTM F794, Series 46, produced from PVC certified by the Manufacturer as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.4.1.1.3 Smooth Wall PVC Pipe

ASTM F679 produced from PVC certified by the Manufacturer as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.4.1.1.4 Corrugated PVC Pipe

ASTM F949 produced from PVC certified by the Manufacturer as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.4.1.2 Polyethylene (PE) Pipe

Submit the pipe manufacturer's resin certification, indicating the cell classification of PE used to manufacture the pipe, prior to installation of the pipe. The minimum cell classification for polyethylene plastic will apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D3350.

2.4.1.2.1 Smooth Wall PE Pipe

ASTM F714, maximum DR of 21 for pipes 80 to 600 mm 3 to 24 inches in diameter and maximum DR of 26 for pipes 650 to 1200 mm 26 to 48 inches in diameter. Produce pipe from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 335434C.

2.4.1.2.2 Corrugated PE Pipe

****

NOTE: Do not install corrugated PE pipe culverts and storm drains beneath airfield pavements unless approved in writing by the major command. Type S pipe has a full circular cross-section, with an outer corrugated pipe wall and a smooth inner liner. Type C pipe has a full circular cross-section, with a corrugated surface both inside and outside. Corrugations may be either annular or helical.

****

AASHTO M 294Type [S][C]. For slow crack growth resistance, determine acceptance of resins by using the notched constant ligament-stress (NCLS) test meeting the requirements of AASHTO M 294. Provide pipe with pipe walls having the following properties:

Nominal Size (mm) (inch)	Minimum Wall Area (square mm/m) (square in/ft)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm) (in. to the 4th/in.)
300 12	3200 1.5	390 0.024
375 15	4000 1.91	870 0.053

Nominal Size (mm) (inch)	Minimum Wall Area (square mm/m) (square in/ft)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm) (in. to the 4th/in.)
450 18	4900 2.34	1020 0.062
600 24	6600 3.14	1900 0.116
750 30	8300 3.92	2670 0.163
900 36	9500 4.50	3640 0.222
1050 42	9900 4.69	8900 0.543
1200 48	10,900 5.15	8900 0.543
1350 54	12,000 5.67	13,110 0.800
1500 60	13,650 6.45	13,110 0.800

2.4.1.2.3 Profile Wall PE Pipe

ASTM F894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 334433C. Provide pipe with pipe walls having the following properties:

Nominal Size (mm) (inch)	Minimum Wall Area (square mm/m) (square in/ft)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm) (in to the 4th/in)	
		Cell Class 334433C	Cell Class 335434C
450 18	6300 2.96	850 0.052	620 0.038
525 21	8800 4.15	1150 0.070	840 0.051
600 24	9900 4.66	1330 0.081	970 0.059
675 27	12,500 5.91	2050 0.125	1490 0.091
750 30	12,500 5.91	2050 0.125	1490 0.091
825 33	14,800 6.99	2640 0.161	2160 0.132
900 36	17,100 7.81	3310 0.202	2700 0.165
1050 42	16,500 8.08	4540 0.277	3720 0.227
1200 48	18,700 8.82	5540 0.338	4540 0.277

2.4.1.3 Steel Reinforced Polyethylene (SRPE) Pipe

SRPE pipe will meet the requirements of ASTM F2562/F2562M 200 - 3000 mm 8 - 120 inch diameter pipe and AASHTO MP 20 (300 - 152512 - 60 inch diameter pipe).

2.4.1.4 Polypropylene (PP) Pipe

Double wall and triple wall pipe with a diameter of 300 to 1525 mm 12 to 60 inches must meet the requirements of ASTM F2736, ASTM F2764/F2764M, or ASTM F2881/F2881M.

2.5 ACCESSORIES

2.5.1 Stick Gauge

****

NOTE: Provide each tank with a stick gauge and tank calibration chart. Provide a minimum of one additional gauge for each tank.

****

For each tank, provide [2][_____] wooden stick gauges with length sufficient to allow the measurement of the entire level in the corresponding tank. Provide gauges compatible with the fuel to be measured (no swelling or damage from fuel contact). Provide gauge with non-sparking caps on each end. Mark gauges in m/mm in 1 mm increments feet/inches in 1/16 inch increments. Marking must be embossed into the stick and painted in a contrasting color impervious to water and hydrocarbon products.

2.5.2 Manual Interstitial Space Monitoring Equipment

Provide all equipment and materials required to monitor the interstitial space.

2.5.2.1 Dip Stick

Provide [2][_____] dipsticks for manual interstitial space monitoring.

2.5.3 Tank Strapping Table

****

NOTE: Provide each tank with a tank calibration chart.

Reference API MPMS 2.2E is for horizontal tank applications. For tanks smaller than 19,000 L 5,000 gallons, choose tank manufacturer certified strapping tables.

****

Furnish [2][_____] API MPMS 2.2E [tank manufacturer]certified strapping tables (calibration charts) for each tank. One of the tables must indicate the liquid volume in liters for each 1 mm of tank depth and the other in gallons for each 1/16 inch of tank depth. Strapping table volumes for all tanks 19,000 liters 5,000 gallons and larger must be determined using physical measurements and not calculated values. For each tank, provide an electronic media file of each strapping table.[For tanks larger than 19,000 L 5,000 gallons, perform tank strapping after installation at the site.]

2.5.4 Concrete Anchor Bolts

Provide concrete anchor bolts that conform to ASTM A307, Grade C, hot-dipped galvanized.

2.5.5 Bolts and Studs

Provide carbon steel bolts and studs that conform to ASTM A307, Grade B, hot-dipped galvanized. Provide stainless steel bolts and studs conforming to ASTM A193/A193M, Grade 8.

2.5.6 Nuts

Provide carbon steel nuts conforming to ASTM A563, Grade A, hex style, hot-dipped galvanized. Provide stainless nuts conforming to ASTM A194/A194M, Grade 8.

2.5.7 Washers

Provide flat circular washers under each bolt head and each nut. Washer materials must be the same as the connecting bolt and nut. Provide carbon steel washers conforming to ASTM F844, hot-dipped galvanized. Provide stainless washers conforming to ASTM A194/A194M, Grade 8.

2.5.8 Street Manhole Assembly

****

NOTE: Delete this paragraph if street manhole assemblies are addressed in the Civil specifications.

Style A frames are for manholes up to 760 mm 30 inches in diameter. Style B frames are for manholes between 915 and 1070 mm 36 and 42 inches in diameter.

****

Round street manhole frames and covers must be the straight traffic type. Frames and covers must be constructed of[cast steel in accordance with ASTM A27/A27M, grade 60-30 as a minimum][cast iron in accordance with ASTM A48/A48M][aluminum in accordance with ASTM B26/B26M][or][an engineered lightweight laminate material].[Covers must be the solid plate type with a checker pattern.] Covers must form a watertight seal with the manhole frame to prevent surface water inflow. Frame and cover assembly must be rated to withstand H-20 highway loading as defined by AASHTO HB-17.

PART 3 EXECUTION

3.1 INSTALLATION

****

NOTE: During design, layout system components to allow adequate access for routine maintenance. Do not rely solely on the Contractor to make these judgments. Show access doors where applicable for maintenance.

****

Install work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Handle storage tanks with extreme care to prevent damage during placement and install in accordance with the manufacturer's installation instructions and NFPA 30. Inspect the exterior surface of each tank for obvious visual damage prior to and during the placement of each storage tank. Repair surface damage to a storage tank according to manufacturer's requirements before proceeding with the system installation. Provide the termination of fill lines within a tank with an anti-splash deflector. Provide nylon dielectric bushings on pipe connections to a steel tank.

3.1.1 Underground Storage Tank

Install underground storage tanks in accordance with API RP 1615 except as modified herein. Place tank on a 3 mm per 30 mm 1/8 inch per foot slope with the fill point at the low end and the vent connection at the high end. Locate tank so that discharge pipes slope up uniformly toward the outlet. Install containment sumps prior to any backfill being added above the storage tanks.

3.1.1.1 Steel Underground Storage Tank Handling

Store, handle, and place externally coated steel tanks with care and in a manner that will minimize damage to the coating and will not reduce its protective value. Place coated tanks in position carefully and with a minimum of handling. Prior to backfilling a tank, visually inspect the tank exterior protective coating for damage. Repair any damaged tank coating in accordance with the appropriate UL standard, UL 1746 or UL 58.

3.1.1.2 Steel Underground Storage Tank Installation Procedures

****

NOTE: Provide straps and anchors designed to prevent flotation of underground tanks located in areas with high groundwater level or subject to flooding. Provide electrical isolation strips between hold-down straps and metal tanks. Anchors may be concrete anchor slab under the tank or concrete deadmen. Tailor paragraph to suit design. Underground storage tanks occasionally rely on backfill and top slab to hold the tank in place in addition to the hold down straps and concrete deadmen. When new or existing USTs are exposed, the contractor must take steps to ensure the tank remains safely in place without damage. Manufacturer's suggestions for installation of new tanks must be followed and used on existing tanks until the tank is safe from damage due to a sudden or slow influx of water. Existing hold down straps must be inspected to assure they are adequate for holding the tank in place and compromised hold downs reported to the Resident Engineer with a suggested solution. The recommendations of API 1615 must also be followed.

****

[Set tank on a minimum of 150 mm 6 inches of backfill material.][Anchor tank to a reinforced concrete anchor pad as indicated using manufacturer's supplied holddown straps. Separate tank from an anchor pad by a minimum of 300 mm 12 inches of backfill material. Coat metal straps, turnbuckles, anchors, and accessories to resist corrosion.]Uniformly place backfill material around the entire tank and extend to grade level. Inspect tank cathodic protection anodes, if applicable, to ensure integrity during backfill operations.

3.1.1.3 Fiberglass Underground Storage Tank Handling

Handle tank with extreme care to prevent damage during installation and transportation to the site. Any damaged tank must be replaced or repaired and tested under direct supervision and advice of the tank manufacturer, using the manufacturer's written procedures.

3.1.1.4 Fiberglass Underground Storage Tank Installation Procedures

****

NOTE: Provide straps and anchors designed to prevent flotation of underground tanks located in areas with high groundwater levels or subject to flooding. Anchors may be a concrete anchor slab under the tank or concrete deadmen. Tailor paragraph to suit design. Underground storage tanks occasionally rely on backfill and top slab to hold the tank in place in addition to the hold down straps and concrete deadmen. When new or existing USTs are exposed, the contractor must take steps to ensure the tank remains safely in place without damage. Manufacturer's suggestions for installation of new tanks must be followed and used on existing tanks until the tank is safe from damage due to a sudden or slow influx of water. Existing hold down straps must be inspected to assure they are adequate for holding the tank in place and compromised hold downs reported to the Resident Engineer with a suggested solution. The recommendations of API 1615 must also be followed.

Use 300 mm 12 inches of backfill in Maryland. Maryland requires 300 mm 12 inches of backfill under a UST.

****

[Set tank on a minimum of [300 mm][150 mm] [12 inches][6 inches] of backfill material.][Anchor tank to a reinforced concrete anchor pad as indicated through the use of manufacturer's supplied holddown straps. Separate tank from an anchor pad by a minimum of 300 mm 12 inches of backfill material.]

3.1.2 System Components

Properly level, align, and secure system components in place in accordance with manufacturer's instructions. Provide supports for system components, appurtenances, and pipe as required. Install anchors, bolts, nuts, washers, and screws where required for securing the work in place. Sizes, types, and spacing of anchors and bolts not indicated or specified must be in accordance with manufacturer's instructions for proper installation.

3.2 FIELD QUALITY CONTROL

3.2.1 Underground Storage Tank Tightness Tests

****

NOTE: Pneumatic tests are the preferred type of tightness tests. Brine level tests will only be specified for Fiberglass tanks. Delete the

inapplicable tests.
****

Perform a tightness test on each underground storage tank on-site just prior to their placement into the ground. Pneumatically pressurize each storage tank's primary chamber to 35 kPa 5 psig and monitor for a drop in pressure over a 2-hour period during which there must be no drop in pressure in the tank greater than that allowed for thermal expansion and contraction. Following the successful completion of the primary chamber test, bleed the pressure from the primary chamber into the interstitial space. Maintain this pressure while applying soapsuds or equivalent material over the exterior of the tank. While applying the soapsuds, visually inspect the entire tank, including the bottom surfaces, for leaks (bubble formations). Inspection of the bottom surfaces of a tank may be performed by rotating the tank; however, a tank may only be rotated in strict accordance with the manufacturer's recommendations. Do not rotate a tank more than 90 degrees from the upright position. During testing, install a pressure relief device that relieves at the tank manufacturer's suggested pneumatic pressure limit. Gauges used in pneumatic tests must have a scale with a maximum limit of 103 kPa 15 psig.

3.2.1.1 Brine Level Test

In lieu of the pneumatic testing procedures described above, a brine level test may be performed on the interstitial space of double-walled Fiberglass tanks (not applicable to steel tanks). For a brine level test, completely fill a Fiberglass tank's interstitial space with a brine solution. Connect a riser pipe to the interstitial space that will allow the solution to rise within the riser at least 300 mm 12 inches. After filling the interstitial space, the tank must set approximately 3 hours. Following the 3-hour period, measure and record the level of solution within the riser. After a subsequent 4-hour period, again measure and record the level of solution within the riser. If the level of solution within the interstitial decreases anytime during the test, the tank is considered leaking and therefore fails the test.

3.2.1.2 Repairs

Repair leaks discovered in either the primary chamber or the interstitial space in accordance with the tank manufacturer's instructions. Following any tank repairs, re-test the tank until the tank successfully passes the testing requirements defined herein.

3.2.2 Tank Manufacturer's Tests

In addition to the tests required herein, perform any additional tests (i.e., leak tests) on each storage tank that are required by the tank manufacturer's written test procedures. Manufacturer's tests that are redundant to tests already required by this specification will only be performed once per tank. Repair all leaks discovered during the tests in accordance with manufacturer's instructions. Following tank repairs, re-test the tank until the tank successfully passes the manufacturer's testing requirements.

3.2.3 Tank Inspection Reports

Prior to system commissioning, a certified inspector must inspect the completed underground tank in accordance with STI SP131 and deliver a full report to the Contracting Officer. The report must include the tank data plate information and photograph of the tank data plate. Provide the paper and electronic copies of the report and UTMs to the Contracting Officer for filing with the tank's "as-built drawings." Refer to Section 01 45 00 QUALITY CONTROL for STI SP001 Inspector's Certification requirements.

3.3 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components and systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components and systems, both operational and practical theories, and associated routine maintenance procedures. The training session consists of a total of [_____] hours of normal working time and starts after the system is functionally completed, but prior to final system acceptance. Coordinate with the Contracting Officer prior to scheduling onsite training and agree on a proposed date for conducting the training session. Notify the Contracting Officer at least 14 working days prior to the proposed training date.

3.4 TANK FILL TESTS

Fill each storage tank to verify the tank level alarm system operates properly. Stop filling each tank when the operation of all alarms is verified. Correct and retest any problems with the level alarm system until alarms operate as specified herein.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-46 07 13.13 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-02 51 13 (May 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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05/21

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USACE / NAVFAC / AFCEC **UFGS-46 07 13.13 (May 2021)**

Preparing Activity: USACE **Superseding**
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SECTION 46 07 13.13

PRECIPITATION/COAGULATION/FLOCCULATION (P/C/F) WATER TREATMENT

05/21

****

NOTE: This guide specification covers the requirements for precipitation/coagulation /flocculation (P/C/F) systems with flow rates ranging from 4 to 940 liters 1 to 250 gallons per minute.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

****

NOTE: This Section is intended for specification of PCF unit processes and is specifically applicable for remediation of ground water and landfill leachate containing dissolved heavy metals. This guide specification should not be used until thorough, site specific treatability studies (jar testing) have been performed, clearly demonstrating that P/C/F is an appropriate treatment technique that can meet the performance criteria set forth in this Section.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Std 650	(2013; Errata 1 2013; Addendum 1 2014; Errata 2 2014; Addendum 2 2016; Addendum 3 2018) Welded Tanks for Oil Storage

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2017) Minimum Design Loads for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA D100	(2021) Welded Steel Tanks for Water Storage
AWWA D103	(2019) Factory-Coated Bolted Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM C582	(2023) Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment
ASTM D2035	(2019) Standard Practice for Coagulation-Flocculation Jar Test of Water
ASTM D3299	(2010) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ANSI/ISA 5.1	(2024) Instrumentation Symbols and Identification

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250	(1991) Calibration Services Users Guide

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Tanks; G, [_____]

Mixers; G, [_____]

Clarifiers; G, [_____]

Instrumentation and Control; G, [_____]

Structural Skids; G, [_____]

Design Submittal

SD-03 Product Data

Tanks; G, [_____]

Mixers; G, [_____]

Clarifiers; G, [_____]

Instrumentation and Control; G, [_____]

Spare Parts

Regulatory Requirements

Pre-startup Testing; G, [_____]

Proof of Performance; G, [_____]

P/C/F System; G, [_____]

Qualifications

SD-06 Test Reports

Tests.

Field Quality Control

SD-07 Certificates

Equipment Certificate of Conformance

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual Updates

1.3 QUALITY CONTROL

****

NOTE: The designer should review all federal, state, and local regulations to determine the applicable regulations which may impact the design of the P/C/F system. Specifically, water regulations should be reviewed to determine the required effluent quality for a specific site. Air regulations should be reviewed to determine if tank covers, vents, and emission control devices are required. Hazardous waste regulations, which cover tank standards and secondary containment, may apply where the groundwater or leachate being treated is classified as a hazardous waste.

****

1.3.1 Regulatory Requirements

Obtain all permits, certifications, and/or meet the regulatory requirements necessary for the configuration, installation, startup, and operation of the treatment plant. Ensure all work meets or exceeds applicable minimum requirements established by federal, state, and local laws and regulations. Notify the Contracting Officer within 30 days of a change in regulatory requirements which may affect the contract. Submit permits, certifications, and/or substantive regulatory requirements before work starts plus copies of applications for permits and certifications not required until later, along with a schedule for obtaining them. Transport, store and handle equipment, raw materials (including reagents/additives), contaminated materials, and treated materials in accordance with Sections 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS and 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES.

1.3.2 Qualifications

Contractor and Subcontractors demonstrate that their capabilities and experience with similar P/C/F systems and applications are adequate to supply, install, and operate a P/C/F system to remediate [ground water] [and] [landfill leachate] [_____] by providing descriptions of at least [2] [_____] P/C/F full-scale remediation projects. Provide a field team (consisting of [ground water] [and] [landfill leachate] [_____] unit operators, quality control personnel, health and safety personnel, supervisory engineering, and technical staff) qualified to install and operate the treatment system. Field team personnel are required to have a minimum of [_____] years' experience in the installation and operation of similar treatment systems and show evidence of satisfactory operation for each installation. Welding procedures and welders are required to be qualified in accordance with the code under which the welding is specified to be accomplished. Submit [one] [_____] [copy] [copies] of qualified procedures and list of identification symbols and names of certified welders and welding operators prior to the commencement of welding operations.

1.4 DELIVERY, STORAGE, AND HANDLING

Store and protect from inclement weather, excessive humidity and temperature variation, and dirt, dust or other contaminants, per the recommendations of the equipment manufacturer. The government is not responsible for damage caused by improperly storing materials.

1.5 SITE CONDITIONS

1.5.1 Ambient Conditions

****

NOTE: When temperatures are below freezing, the treatment plant equipment may not function properly and efficiently. The general practice is to avoid the operation of an outdoor treatment plant during extreme winter weather. In places where there is a long winter season or in projects where plant operation is required throughout the year to meet the project schedule, the remediation activities should be performed inside a building with proper heating and ventilation. For outdoor operations, piping and equipment should be designed with freeze protection by insulation and heat-tracing.

****

Ensure the P/C/F system is [operated continuously] [not operated] [_____] during the winter when temperatures reach freezing or below. Install the system [outdoors] [indoors] [_____]. Provide outdoor equipment with [insulation] [_____] and [heat tracing] [_____]. Ensure the system is equipped with sufficient lighting as shown on the drawings for security purposes and for treatment plant operation during inadequate daylight or at night. Refer to Sections 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and 26 56 00 EXTERIOR LIGHTING for proper heating, ventilation, air conditioning, and illumination.

1.5.2 Existing Conditions

****

NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record, and show on the drawings. Delete the second bracketed phrase at the end of this paragraph if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL

SYSTEMS, properly edited, must be included in the contract documents.
****

Operate the P/C/F system in a [remote] [urban] [industrial] [commercial] [residential] setting. The Contractor is required to become familiar with the existing site conditions, including site location, site configuration, topography, climate, site accessibility, and adjacent land use. Ensure the P/C/F system is designed for a soil bearing capacity of [_____] MPa psf. Provide seismic protection [in accordance with UFC 3-301-01] [as shown on the drawings].

1.6 MAINTENANCE MATERIAL SUBMITTALS

1.6.1 Spare Parts

Submit a list of spare parts with the manufacturer's part number, a current unit price, [date of manufacturer] and source of supply for each different material or equipment specified, after approval of the related submittals and not later than [_____] months prior to the system startup. Include the following information on: 1) parts recommended by the manufacturer to be replaced during the first [_____] years of service, 2) a list of special tools recommended by the manufacturer for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly and 3) spare parts data for each different item of equipment and materials specified. At least two (2) sources of supply are suggested to be submitted.

PART 2 PRODUCTS

****

NOTE: The designer should review the methodologies and results of the previously conducted treatability testing and other predesign information, along with the required effluent quality, to determine the types and sizes of equipment, the chemicals, and chemical dosages to be specified.

As a minimum, the designer should provide a process flow diagram (PFD), a piping and instrumentation diagram (P&ID), an instrument index, a site layout drawing, and an equipment layout drawing. The PFD should depict the P/C/F and ancillary equipment required for the specific water to be treated and display the process design conditions for each unit. Such process design conditions should include consideration of minimum, average, and maximum values of each significant parameter (e.g. pressure, temperature, flow rate, etc.). The P&ID should define all piping and instrumentation of the system and should include descriptive tag names for all piping and fittings including materials of construction, tag number, and line size. The P&ID drawings should also include tag numbers for all instruments in accordance with ANSI/ISA 5.1. The instrument index should include drawings detailing the types of instruments to be used, their range and scale, related appurtenances, and their associated tag numbers; all such information must be

coordinated with the P&ID.

The designer should verify that the appropriate (on/off, proportional, set point, etc.) controller to be used in the P/C/F system for chemical feed control is specified in Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS. The designer should provide a site layout drawing to indicate to an equipment supplier what the general location of the equipment will be and how much space is available for the proposed equipment. The designer should also provide a detailed equipment layout drawing that identifies all the major equipment and their related orientations inside the site plan. This equipment layout drawing should indicate where off-site piping and utility lines enter and/or leave the site. If the equipment layout drawing is only a suggestion or recommendation to the Contractor, the designer should so state on the drawing.

****

2.1 SYSTEM DESCRIPTION

2.1.1 P/C/F System Description

****

NOTE: The system described in this paragraph includes the P/C/F equipment required for a water treatment plant to remove dissolved metals. The system can be a stand-alone system, or it can be a pretreatment system for other systems such as air stripping, advanced oxidation, activated carbon, etc. Ancillary P/C/F equipment which may be required for pre-treatment or post-treatment of the water is also described and includes an equalization unit, an oxidation/reduction unit, a clarification unit, a post-pH adjustment unit, and an effluent holding unit. The precipitation, coagulation, and flocculation units may be supplied by the Contractor as individual pieces of equipment or as a single, integral unit. Typically, if a single unit is supplied, it will incorporate the coagulation, flocculation, and precipitation equipment within a clarification unit. Alternately, a unit may be supplied which performs two of the processes, e.g., precipitation and coagulation within one unit.

This paragraph should be edited to identify only the necessary equipment to suit conditions at the project site. The design team should review treatment objectives, water characterization data, and results of previously conducted treatability testing and other predesign information to determine the equipment required.

****

The Precipitation/Coagulation/Flocculation (P/C/F) system is required to be a fully integrated water treatment plant which is designed to remove dissolved heavy metals and solids from [groundwater] [and] [landfill leachate] [_____]. The system is required to include equipment for [flow equalization,] wastewater conveyance, precipitation, coagulation, flocculation, clarification, [post-pH adjustment,] and treated effluent storage required to meet the specified performance requirements. Provide the P/C/F system complete with required instruments, controls, and local control panels. Provide a main control center to facilitate the overall control of the treatment plant. Factory or shop preassembled all parts to the maximum extent possible, compatible with transportation limitations and equipment protection considerations. Minimize field assembly to the assembly of match-marked components. Submit installation instructions and framed, typed operating instructions for posting and explaining methods of checking the system for startup and normal safe operations, normal and emergency shutdown operations, and procedures for safely starting and stopping each piece of equipment within the system.

2.1.1.1 Equalization Unit

Provide the equalization unit with [one tank] [[_____] tanks] complete with accessories, mixers, piping, valves, [pumps,] motors, and instrumentation and controls to provide a constant flow and contaminant concentration to the subsequent treatment equipment. Furnish components of the unit as shown on the drawings.

2.1.1.2 Oxidation/Reduction Unit

****

NOTE: Delete this paragraph if the contaminants in the water to be treated do not include metals which require reduction prior to precipitation (e.g., chromium 6+), or metals which require oxidation prior to precipitation (e.g., iron or manganese).

****

[Provide the reduction unit with a mix tank, a mixer, a chemical feed system for acid addition, a chemical feed system for the reducing agent addition, piping, valves, pumps, motors, pH controls, oxidation-reduction potential (ORP) controls, and other instrumentation and controls as indicated on the drawings.] [Provide the oxidation unit with a mix tank, a mixer, a chemical feed system for oxidant addition, piping, valves, pumps, motors, oxidation-reduction potential (ORP) controls, and other instrumentation and controls as indicated on the drawings.]

2.1.1.3 Precipitation Unit

Provide the precipitation unit with a mix tank, a mixer, a chemical feed system for the precipitant addition, piping, valves, pumps, motors, pH controls, and other instrumentation and controls as indicated on the drawings.

2.1.1.4 Coagulation Unit

Provide the coagulation unit with a mix tank, a mixer, a chemical feed system for the coagulant addition, piping, valves, pumps, motors, and instrumentation and controls as indicated on the drawings.

2.1.1.5 Flocculation Unit

Provide the flocculation unit with a tank with accessories (e.g., nozzles, supports, lifting lugs, etc.), a mixer, a flocculation chemical stream feed system for the coagulant aid addition, piping, valves, pumps, motors, and instrumentation and controls as indicated on the drawings.

2.1.1.6 Clarification Unit

Provide the clarification unit with an inclined plate or tube type settler with all necessary accessories (e.g., inlet distribution system, separator module, skimmer, etc.), [a thickener,] a sludge removal system, piping, valve, pumps, motors, and instrumentation and controls as indicated on the drawings.

2.1.1.7 Post-pH Adjustment Unit

Provide the post-pH adjustment unit complete with piping, chemical feed systems for both acid and base addition, and in-line pH instrumentation and controls as indicated on the drawings.

2.1.1.8 Effluent Holding Unit

Provide [one effluent holding tank] [[_____] effluent holding tanks] to store treated water for testing prior to discharging. Ensure all tanks include piping, valves, sample taps, pumps, and instrumentation and controls as indicated on the drawings.

2.1.2 Performance Requirements

****

NOTE: The designer, in consultation with the appropriate technical team personnel, should use the treatability testing results and other predesign information to set influent parameters, such as maximum and minimum ground water and landfill leachate flow rates, maximum and minimum temperatures, pH, viscosity, density, and maximum and minimum influent metals and solids concentrations. The required effluent quality is typically established by federal, state, or local agency permit or regulation.

The designer should consider that fugitive emissions from landfill leachates or contaminated groundwater may have volatile components. Federal, state, or local air regulations should be consulted to establish allowable air emissions for the P/C/F system.

Performance requirements for the Contractor will indicate that the supplied equipment must be operated to meet the required effluent quality. Performance requirements for the Contractor stated in this paragraph should only apply to the performance of the complete system and not individual pieces of equipment. Performance criteria and minimum equipment standards for specific equipment should be listed under PART 2 PRODUCTS, where applicable.

Flow rates specified for the P/C/F system should be consistent with the pumping rates required by

Section 23 21 23 HYDRONIC PUMPS or 22 13 29 SANITARY SEWERAGE PUMPS.
****

Provide a P/C/F system capable of processing [ground water] [landfill leachate] [_____] at the conditions provided below:

Flow Rate	
Maximum	[_____] L gal per minute
Minimum	[_____] L gal per minute
Temperatures	
Maximum	[_____] degrees C F
Minimum	[_____] degrees C F
Influent/Effluent pH	
Maximum Influent	[_____]
Minimum Influent	[_____]
Maximum Effluent	[_____]
Minimum Effluent	[_____]
Liquid Properties	
Liquid Viscosity	[_____] centipoise lb-sec/(sq. ft.)
Liquid Density	[_____] gm/ml at [_____] degrees C F
Maximum Air Emissions	
Particulates	[_____] ppmv
Volatile Organic Compounds	[_____] ppmv
[_____]	[_____] ppmv
Space Availability	
Maximum Area	[[_____] m feet by [_____] m feet] [[_____] square meters feet]
Maximum Height	[_____] m feet

Provide a P/C/F system capable of meeting the maximum effluent metals and solids concentrations achieved in the previously conducted treatability testing (report appended to this specification), as listed below at the indicated maximum concentrations. Influent and effluent solids are as determined in accordance with Part 2000 Physical and Aggregate Properties, and metals as determined in accordance with Part 3000 METALS of AWWA 10084:

	Maximum Influent Concentration mg/L	Maximum Effluent Concentration mg/L
Total Cadmium	[_____]	[_____]
Hexavalent Chromium	[_____]	[_____]
Total Chromium	[_____]	[_____]
Total Copper	[_____]	[_____]
Total Iron	[_____]	[_____]
Total Lead	[_____]	[_____]
Total Mercury	[_____]	[_____]
Total Nickel	[_____]	[_____]
Total Silver	[_____]	[_____]
Total Zinc	[_____]	[_____]
TSS	[_____]	[_____]
TDS	[_____]	[_____]

Ensure the P/C/F system instrumentation and controls have the necessary accuracy and sensitivity to measure and control the operating ranges of the specified equipment. Perform sampling and analysis in accordance with [_____].

2.1.3 Results of Previously Conducted Treatability Studies

****

NOTE: Treatability testing reports should be appended to this specification to enable the Contractor to make a full evaluation of the testing methodologies used, the results of the testing, and to evaluate the completeness of necessary data gathering. The Contractor will use these treatability testing reports along with the required effluent quality to select the specific P/C/F equipment (including ancillary equipment) required to meet the specified performance requirements.

****

Even though methodologies and results of the previously conducted treatability studies in Appendix [_____] have demonstrated that P/C/F is capable of meeting the post treatment criteria identified in this section, perform an independent evaluation of these studies and results in accordance with ASTM D2035. Based on the Contractor's own interpretation of all treatability study results, provide a full scale treatment plant which meets the performance requirements identified in this section.

2.1.4 Utilities

****

NOTE: The locations and details (such as utility point of contact, sizes, capacities, and flows) of the utility hookups should be provided on the drawings for the Contractor to use.

****

Provide the utilities associated with the installation and operation of the treatment plant including, but not limited to: telephone, electricity, water, [gas], sanitary and solid waste facilities. The [telephone] [electricity] [_____], [steam] [water] [gas] [sanitary] [_____], and [solid waste facilities] [_____] are available at the site. Refer to the drawings for hookup locations.

2.1.5 Design Submittal

Submit the following items:

a. Detailed drawings of clarifiers showing the dimensions, nozzle orientation and elevations, interconnecting piping, equipment layout, hydraulic profile, and other details required to demonstrate that the unit has been coordinated and properly functions as part of the overall P/C/F system. Show proposed layout, foundation requirements (to include seismic considerations in seismically active areas and soils assumptions based on site specific geotechnical information), anchorage of equipment and accessories, installation/connection details, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation. Submit manufacturer's descriptive data, specifications, technical literature, utility requirements, performance charts and curves, and catalog cuts for the clarifier.

b. Electrical one-line diagrams for instrumentation and controls, illustrating all electrical components (motor controls, disconnects, starters, selector switches, pushbuttons, pilot lights, conduit, wire, etc.), electrical load analyses, cable and conduit schedules (including conduit designation, materials of construction, descriptions for each conduit of the end points of each conduit segment in a run, wire count by number, type and size, wire length, etc.), and complete control ladder logic diagrams. Coordinate all control ladder logic diagrams between components and ladder rungs to illustrate component tag names for all relays, timers, selector switches, pushbuttons, pilot lights, etc. Number tag wires and terminals. Distinguish terminal designations between terminals contained within differing enclosures such as control panels, equipment enclosures, motor control centers, etc. Ensure all auxiliary relay contacts are illustrated and designated. Number all ladder rungs with cross referencing between all associated rungs. Provide a narrative description that has been fully coordinated with the ladder logic diagrams so as to fully describe all control operations, sequences, interlocks, alarms, and shutdowns for the P/C/F system including, but not limited to, flow control systems, level control systems, pH/ORP control systems, chemical addition control systems, pump/valve controls, alarm and shutdown schemes, PLC input/output points, and all component interlocking. Designate the locations of all control panels, equipment enclosures, motor control centers, etc. on an equipment layout drawing. Submit manufacturer's descriptive data, specifications, technical literature, utility requirements, performance charts and curves, and catalog cuts for each instrument and control component supplied.

c. A pre-startup test plan identifying the procedures and methods used to verify the integrity, calibration, and operability of the equipment, piping, electrical wiring, and instruments and control systems. Specify acceptance criteria and tolerances to be achieved during the pre-startup testing within the plan.

d. A list of the P/C/F system components and specify its required performance criteria when operated using contaminated water. Ensure the test plan describes the operating procedures to be followed during the test period including detailed descriptions of the measurements, record keeping, sampling and analyses to be performed to document that performance criteria has been achieved. Address full-scale operation of all equipment, piping, electrical wiring, and instruments and control systems included in the P/C/F system within the plan.

e. Manufacturer's certificates attesting that the equipment meets the specified requirements. Date the statement after the award of the contract, state the Contractor's name and address, name the project and location, and list the specific requirements which are being certified. Ensure the certificate indicates the methods of testing used.

f. [Six] [_____] copies of operation and maintenance manuals for the P/C/F system containing the manufacturer's operating and maintenance instructions for each piece of equipment. Provide one complete set prior to the performance of the field test (see Paragraph Tests); submit the remaining sets prior to startup. Furnish each set in loose leaf three-hole ring binders. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name of equipment, name and location of the building, name of the Contractor, and contract number. Place cover sheets before instructions identifying each subject. Use standard letter size paper for instruction sheets, with larger sheets of drawings folding in to approximately the same size. Include, but do not limit the instructions to the following:

(1) System layout detailing piping, piping supports, valves, and controls.

(2) Approved wiring and control ladder logic diagrams prepared in accordance with ANSI/ISA 5.1 including a drawing index, legend and symbols list, and abbreviation and identifiers.

(3) A narrative control sequence describing startup, operation, and normal and emergency shutdown to include the detailed operational narrative described in Paragraph Control System.

(4) Operating instructions for each equipment, instruments and control system including process monitoring requirements and recommendations for operations reporting to document the results of all process monitoring.

(5) Maintenance instructions for each piece of equipment, including lubrication instructions and a troubleshooting guide to help the operator determine what steps to take to correct anticipated problems that may occur in the system.

(6) Manufacturer's bulletins, cut sheets and descriptive data of equipment; submitted after approval of detail drawings, and not

later than [2] [_____] months prior to delivery of the system.

2.2 MANUFACTURED UNITS

2.2.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide new and unused equipment, except for test equipment. Where two or more pieces of equipment performing the same function are required, they are required to be products of the same manufacturer. Equipment is required to be supported by a service organization that is, in the opinion of the Contracting Officer, capable of providing service, materials, and equipment in an expedient manner.

2.2.2 Tanks

Submit detailed drawings of each tank showing the dimensions, nozzle orientations and elevations, interconnecting piping, equipment layout, hydraulic profile, and any other detail required to demonstrate that the tank has been coordinated and properly function as a part of the overall P/C/F system. On the drawings, show the proposed layout, foundation requirements, anchorage of equipment and accessories, installation/ connection details, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation. Submit manufacturer's descriptive data, specifications, technical literature, and catalog cuts for each tank supplied.

2.2.2.1 General Requirements

****

NOTE: When required by the corrosive nature of stored water, lack of proper maintenance facilities, or by climatic conditions, this paragraph will be modified to provide for corrosion allowance.

Determine basic wind speed from ASCE-7. The designer will choose between the AWWA and API procedures. Use 1200 Pa 25 psf snow load for most heavy snow climates; delete snow load where maximum snow is insignificant. In some cases, local climate and topography will dictate that a value greater than 1200 Pa 25 psf be used for snow loading.

In some application, wastewaters may require closed tanks to contain and/or control air emissions. VOCs from landfill leachate or groundwater from contaminated plumes can require closed tanks for the entire system. Show all process nozzles, spare nozzles, vents, drains, and manholes on the P&ID. If tanks are located inside a room or building, the designer can delete the wind loading requirements.

****

Use manufacturer's standard size tanks whenever possible. Tank construction material and paints, coatings, or liners are required to be compatible with the wastewater to be stored. Select tank dimensions to fit the available space as shown on the drawings. Unless noted otherwise on the drawings, include flanged fittings for inlet, outlet, overflow, and drain on each tank. Provide manholes when shown on the drawings. Provide hold down lugs to anchor the tank to the base. Provide influent and effluent baffles and weirs to avoid short circuiting. Ensure the tank geometry combined with mixer design to avoid dead spots and excessive turbulence relative to internal tank baffles and mixer orientation. Ensure the system provides for complete mixing. Tanks supplied as part of the P/C/F system are required to meet the following nominal size requirements:

Type of tank	Design Hydraulic Retention Time (HRT)	
	Minimum	Maximum
Equalization Tank	[2] [_____] hrs	
Oxidation/Reduction Tank	[5] [_____] min	
Precipitation Tank	[5] [_____] min	
Coagulation Tank	[1] [_____] min	[2] [_____] min
Flocculation Tank	[20] [_____] min	
Effluent Holding Tank	[5] [_____] min	
[_____]	[_____] min	

Design, fabrication, and erection of the tank in accordance with [AWWA D100] [API Std 650] [AWWA D103] except as modified herein. Minimum equipment design life: [_____] years. Design tanks for a [basic wind speed of [_____] km/hour mph in accordance with ASCE 7 or designed in accordance with [AWWA D100] [AWWA D103] [API Std 650] wind load design, whichever provides the greater pressure.] [snow load of [1200 Pa25 psf] [[_____] kPa psf]][freeboard of [03m1 ft][___].] Utilize a safety on overturning of elevated tanks under design wind load of 1.33 minimum. When a footing is required, use an inverted truncated pyramid of earth with 2 on 1 side slopes above top of footing in determining overturning stability.

2.2.2.2 Tank Construction Materials

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NOTE: Tank shell thickness should be calculated using AWWA D100, AWWA D103, or API 650 procedures. The strength of the materials of construction for each tank should include allowances specified herein.

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2.2.2.2.1 Carbon Steel

Carbon steel sheet is required to be hot rolled in accordance with ASTM A283/A283M Grade C with a minimum yield of 476 MPa 40,000 psi; use a minimum thickness of 3.4 mm 10 gauge. Ensure structural steel conforms to ASTM A36/A36M and [AWWA D100] [AWWA D103] [API Std 650] for steel tanks.

2.2.2.2.2 Polyethylene

Provide polyethylene tanks manufactured in accordance with ASTM C582.

2.2.2.2.3 Stainless Steel

Ensure stainless steel conforms to the material specification for 304SS, 316SS, 316LSS, 317SS.

2.2.2.2.4 Structural Steel

Ensure structural steel conform to ASTM A36/A36M.

2.2.2.2.5 Fiberglass

Provide fiberglass tanks in conformance with ASTM D3299.

2.2.2.3 Corrosion Allowance

****

NOTE: The designer should specify a minimum corrosion allowance for wetted surfaces giving consideration to the types of liquids to be stored, the vapors above the liquids, and the atmospheric environment. It is expected that some tanks in the P/C/F system may have a low pH and some may have a high pH, and others will have contaminants and chemicals at varying concentrations. A corrosion allowance can be calculated using available corrosion rate information from material suppliers or National Association of Corrosion Engineers (NACE) standards. The designer should take into account the changes in temperature over the range of operating conditions and the effects of liquids and vapors on the materials of construction.

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Corrosion allowance is dependent upon the materials of construction and finish coatings. Corrosion allowances are to be calculated as follows: For a lined interior finish, corrosion allowances are allowed to be [0.0 mm 0.0 inches] [_____]. For a coated or painted interior finish, the corrosion allowance is allowed to be [0.0 mm 0.0 inches] [_____]. For tanks with no protective finish, the corrosion finish is required to be [0.0 mm 0.0 inches] [_____].

2.2.2.4 Shop Fabrication

Perform all welding in conformance with [AWWA D100] [AWWA D103] [API Std 650] using ASME certified welders. Ensure all shell seams are full penetration using Sub Arc Welding (SAW). Ensure other seams are made with [Gas Metal Arc Welding (GMAC)] [Shielded Metal Arc Welding (SMAC)] [Flux Cored Arc Welding (FCAW)] [Submerged Arc Welding] processes.

2.2.2.5 Bolts

Bolts used in the shell joints are required to meet the requirements of Section 2.2 of AWWA D103. Bolts used in tanks designed under [AWWA D100] [API Std 650] are required to meet the requirements as specified in [AWWA D100] [API Std 650].

2.2.2.6 Gaskets

Ensure all bolted connections use gaskets of suitable chemical resistance for the service. Gaskets used to seal bolted joints in tanks are required to meet the requirements of AWWA D103 Section 2.10.

2.2.2.7 Accessories

2.2.2.7.1 Manholes and Pipe Connections

Manholes and pipe connections are required to meet the minimum requirements of [AWWA D100] [AWWA D103] [API Std 650]. Provide the number, type, elevation, orientation, and size of manholes and pipe connections [as shown on the drawings] [provided by Contractor].

2.2.2.7.2 Baffles, Weirs, and Overflow Pipes

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NOTE: Design each tank with an overflow that will pipe, channel, or otherwise direct an overflowing tank to a containment area or to the next tank in the system. If a weir or exit pipe is plugged and cannot pass the maximum process flow rate, wastewater must be contained to prevent spills.

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Design inlet baffles to dissipate influent flow energy at maximum flow rates and to avoid short circuiting to effluent weirs. Weirs for the tanks are required to consist of an overflow weir and outside drop pipe, adequately supported and capable of discharging the design flow rate with [_____] mm inches of head. [Install the top of the weir [_____] mm inches below [the top edge of the tank] [overflow height].] [as indicated.] Provide all tanks with emergency overflow outlets to direct overflow of wastewater to a containment area. Terminate the overflow pipe 300 to 600 mm 1 to 2 feet above grade and fit it with a flapper valve or screen to prevent ingress of birds, insects, or small animals of any kind. Design internals to meet the requirements of [AWWA D100] [AWWA D103] [API Std 650].

2.2.2.7.3 Vents

****

NOTE: Vents on covered tanks should be designed to allow vapor control systems to be attached. Design tank vents in accordance with guidelines published in the American Institute of Chemical Engineers (AICHE) G3 "Guidelines for Safe Storage and Handling of High Toxic Hazard Materials" (1988), and API Publication 2557 "Vapor Collection and Control Options for Storage and Transfer Operations in the Petroleum Industry" (1993).

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On covered tanks, weld the vent to a cover plate on the roof. Provide tank manufacturer's standard type mushroom vent with bird and insect screen. Design vent as specified by [AWWA D100] [AWWA D103] [API Std 650]. Size the open area of a vent screen at 50 percent in excess of the [_____] L/second gpm pump-in rate and [_____] L/second gpm pump-out rate. Screening for vent is required to conform to [AWWA D100] [AWWA D103] [API Std 650] ensuring fail-safe operation in the event that screen frosts over. Ensure the bottom of the screen is sufficiently elevated for snow consideration in the area.

2.2.2.7.4 Ladders and Safety Devices

Provide an outside access ladder on tanks greater than 1.5 m 5 feet in height. Provide ladders and safety devices in accordance with [AWWA D100] [AWWA D103] [API Std 650]. Locate ladders as shown on the drawings. In addition, provide safety cage, rest platforms, roof ladder handrails, and other safety devices as required by federal or local laws or regulations.

2.2.2.7.5 Scaffold and Cable Support

Include attachment rings or hooks on the inside and outside of closed top tanks, at four points at the top of walls, to secure scaffolding and cable support during maintenance activities.

2.2.2.7.6 Miscellaneous Tank Accessories

Ensure miscellaneous tank accessories, such as support legs, saddles, skirts, lifting lugs, etc., conform to [AWWA D100] [AWWA D103] [API Std 650].

2.2.3 Chemical Feed Systems

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NOTE: The designer must verify that appropriate (on/off, proportional, set point) controller is specified in Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS.

****

Provide chemical feed systems in accordance with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS. Furnish control signals and wiring to the chemical feed controllers in accordance with the requirements of this section.

2.2.4 Mixers

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NOTE: Different types of mixers can be used for a P/C/F treatment system including: impeller, jet and in-line static mixers. Delete items that are not required. Impeller mixers are divided into three groups: propellers, turbines, and paddles. Turbine and propeller mixers are used for rapid mixing applications while paddle mixers are typically used in flocculation.

Propeller mixers are high speed mixers, operated on low horsepower, which are used primarily for flash mixing applications. Propeller speeds range from 400 rpm to 1750 rpm. When top entry is required, the propeller mixer is mounted angled and off center. Where side entry is recommended, the propeller mixer is mounted horizontally, offset from the centerline of the tank.

Turbine mixers are primarily used in low speed applications where heavy solids may be generated and a large mixing energy input is required to keep the solids in suspension. These type mixers can be used

for equalization of the wastewater, flash mixing or flocculation. Turbine speed ranges from 55 to 125 rpm. The turbine mixer is typically mounted vertical, one half to one diameter off the floor of the mixing chamber. In an unbaffled tank the unit is mounted off center. In a baffled tank the unit is mounted on center.

Paddle mixers are low speed mixers whose peripheral paddle speed typically varies from 0.15 to 0.61 m/sec 0.5 to 2.0 feet/second. Paddle mixers are used primarily in flocculation applications.

Jet mixers use hydraulic action for mixing resulting in lower capital and operating costs as compared to impeller mixers. Jet mixers are used only for rapid mixing, and are not suitable for flocculation due to the high pressure liquid ejected at the discharge nozzle, which can break up the floc previously formed.

Static mixers are typically installed downstream of chemical addition points for blending or dispersion applications. They are used in combination with metering pumps and must be sized based on the flow rate. In-line static mixers use hydraulics for mixing instead of impellers, requiring no external power and no maintenance. In-line static mixers have high head losses up to 1 m 3 ft; and the mean temporal velocity gradient G cannot be changed to meet varying requirements.

Mixers are usually sized based on liquid viscosity, liquid temperature and liquid density among other parameters. However for each of the mixing locations, at most sites, it is expected that the viscosity and density will not be significantly different from water; if that is not the case, the designer should specify the requirements that the mixing device must meet.

****

Furnish mixers on each tank or unit as designated on the drawings. On tanks, supply tank baffles, where required by the mixer design, to achieve complete mixing and mixer support as required. Submit detailed drawings of each mixer including dimensions, mounting details, wiring, schematics, and any other details required to demonstrate that the system has been coordinated and properly functions as a unit. Submit manufacturer's descriptive data, specifications, technical literature, utility requirements, performance charts and curves, and catalog cuts for each mixer supplied.

2.2.4.1 Equalization Unit Mixer

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NOTE: Because the water level in the equalization tank varies, the designer must specify the minimum water level at which the mixer will be turned off to avoid burning out the mixer motor.

****

Mixers are required to be a [propeller] [turbine] [paddle] [jet] type mixer. Number of mixers: [_____].

a. Ensure propeller, turbine, or paddle mixers meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratios are required to be [4:1] [_____]. Design mixer to develop a velocity gradient (G value) not less than [300] [_____] sec-1. Mount mixers [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Jet mixers are to consist of, but not be limited to, a jet motive pump to circulate liquid in the mixing basin; jet mixing nozzle assembly, retrieval system and in-basin secondary fluid lines. Design jet mixer to obtain a maximum mean velocity of [100] [_____] sec-1 or G(t) values of [104] [_____]. The jet motive pump is to driven by submersible non-clog units. Provide motors that operate on 230/460 volt, three phase, 60 hertz power supply. Provide nozzle assembly and piping made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

2.2.4.2 Precipitation Unit Mixer

Achieve mixing by use of a [propeller] [turbine] [jet] [in-line static] type mixer. Number of mixers: [_____].

a. Provide propeller or turbine type mixers that meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio is required to be [4:1] [_____]. Design mixer to develop a maximum velocity gradient (G value) not less than [300] [_____] sec-1. Mount mixers [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Provide jet mixer consisting of, but not limited to, a jet motive pump to circulate liquid in the mixing basin; jet mixing nozzle assembly, retrieval system and in-basin secondary fluid lines. Design the jet mixer to obtain a mean velocity of [25-100] [_____] sec-1 or G(t) values of [103-104] [_____]. The jet motive pump is required be driven by submersible non-clog units. Provide motors that operate on 230/460 volt, three phase, 60 hertz power supply. Provide nozzle assembly and piping made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

c. Provide in-line static mixers that meet the following requirements. Maximum precipitant feed rate: [_____] L/s gpm. Provide in-line static mixers with a helical shaped element which is made of the same material as the housing wall. The sealing edge between the element and housing wall is required to create an integral unit without pieces to fatigue or vibrate. Ensure the in-line static mixers incorporate the required number of elements to provide complete mixing at all design conditions. Size the mixer to fit [_____] mm inches diameter conveying pipe. Materials of construction: [carbon steel] [stainless steel] [polyethylene] [polypropylene] [FRP] [Teflon] [_____].

2.2.4.3 Coagulation Unit Mixer

Achieve mixing by use of a [propeller] [turbine] [jet] [in-line static] type mixer. Number of mixers: [_____].

a. Propeller or turbine mixers are required to meet the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio is required to be [4:1] [_____]. Design mixer to develop a velocity gradient (G value) not less than [300] [_____] sec-1. Mount mixers [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. [Provide][Do not provide] the mixer support with the mixer. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Jet mixers consist of, but are not be limited to, a jet motive pump to circulate liquid in the mixing basin; jet mixing nozzle assembly, retrieval system and in-basin secondary fluid lines. Design jet mixer to obtain a mean velocity of [25-100] [_____] sec-1 or G(t) values of [103-104] [_____]. The jet motive pump is to be driven by submersible non-clog units. Provide motors that operate on 230/460 volt, three phase, 60 hertz power supply. Provide nozzle assembly and piping made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

c. Provide in-line static mixers that meet the following requirements. Maximum coagulant feed rate: [_____] L/s gpm. Provide in-line static mixers that have a helical shaped element which is made of the same material as the housing wall. The sealing edge between the element and housing wall is required to create an integral unit without pieces to fatigue or vibrate. Provide in-line static mixers that incorporate the required number of elements to provide complete mixing at all design conditions. Size the mixer to fit [_____] mm inches diameter conveying pipe. Materials of construction: [carbon steel] [stainless steel] [polyethylene] [polypropylene] [FRP] [Teflon] [_____].

2.2.4.4 Flocculation Unit Mixer

Provide mixers that are [turbine] [paddle] type mixers. Number of mixers: [_____]. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio is required to be [4:1] [_____]. Design mixer to develop a maximum velocity gradient (G value) no more than [100] [_____] sec-1. Mount mixers [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. [Provide][Do not provide] mixer support. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

2.2.4.5 Effluent Holding Unit Mixer

Achieve mixing by use of a [propeller] [turbine] [jet] [in-line static] type mixer. Number of mixers: [_____].

a. Provide propeller or turbine mixers meeting the following requirements. Mounting: [[top] [side] [bottom] entering] [_____]. Mixer speed: [constant] [variable] at a maximum rpm of [_____]. Variable speed turndown ratio is required to be [4:1] [_____]. Design mixer to develop a velocity gradient (G value) not less than [300] [_____] sec-1. Mount mixers [angled and off center] [horizontally offset from the centerline of the tank] [vertical off center] [_____] of the mixing chamber. Shaft construction: [carbon steel] [316 stainless steel] [_____]. Impeller construction: [carbon steel] [316 stainless steel] [_____]. [Include][Do not include] mixer support. Design mixer bearings to operate continuously at full load for [100,000 hours] [_____] before replacement.

b. Provide jet mixers consisting of, but not limited to, a jet motive pump to circulate liquid in the mixing basin; jet mixing nozzle assembly, retrieval system and in-basin secondary fluid lines. Design jet mixer to obtain a mean velocity of [25-100] [_____] sec-1 or G(t) values of [103-104] [_____]. The jet motive pump is to be driven by submersible non-clog units. Provide motors that operate on 230/460 volt, three phase, 60 hertz power supply. Provide nozzle assembly and piping made of [plastic] [or] [stainless steel] [_____] material to prevent corrosion by process liquid.

2.2.5 Clarifiers

****

NOTE: This paragraph specifies only inclined plate or tube settlers. The inclined plate or tube settler requires minimum space, no moving parts (therefore minimizing maintenance), less potential for short circuiting, and generally lower capital and operating costs than conventional clarifiers. For metallic sludges, the overflow rate typically ranges from 2.1 to 4.2 L/s/sq. m 360 to 720 gpm/sq. ft. and generally will not exceed 5.9 L/s/sq. m 1000 gpm/sq. ft.

****

Clarifier is required to be an inclined [plate] [or] [tube] settler designed to meet the following conditions:

a. Influent pH: Maximum [_____], Minimum [_____].

b. Solids Loading: [_____] kg/day lbs/day.

c. Effluent TSS: [_____] mg/L.

Provide for an effective surface overflow rate of [_____] L/m3/m2.s gpd/ft2 and a detention time of [2] [_____] hours at the design flow rate. Clarifiers are required to include, at a minimum, the following accessories: influent distribution system, a separator module consisting of [corrugated plate packs,] [inclined tube packs,] skimmer mechanism with scum collection trough, sludge removal system, effluent collection flumes, access ladder, operating platform, associated piping, fittings, sampling valves, and a sludge hopper.

2.2.5.1 Clarifier Vessel

Construct the bottom and sides of the clarifier vessel 6 mm 1/4 inch minimum thickness carbon steel plate meeting or exceeding ASTM A36/A36M. Provide the vessel complete with inlet, outlet, overflow, and drain connections. The structural steel framework is an integral part of the vessel to ensure it is self-supporting. Design the clarifier for seismic forces in accordance with paragraph Existing Conditions.

2.2.5.2 Influent Distribution and Effluent Collection Systems

The influent distribution system dissipates the entrance energy and equalizes flow to the separator module. Include weirs and baffles to control the local velocities and eliminate short circuiting. Use adjustable weirs along each effluent collection flume to maintain uniform flow distribution.

2.2.5.3 Separator Module

Construct the separator module using [parallel corrugated plates placed [38 mm 1-1/2 inches] [[_____] mm inches] apart] [inclined tubes at [45] [60] [_____] degrees from the horizontal]. The separator module is required to be constructed to be removable for maintenance and inspection. Construct the separator module with corrosion resistant materials. Provide [corrugated plate packs] [tube packs] constructed of [fiberglass reinforced plastic] [polypropylene] [coated steel] [stainless steel] [_____].

2.2.5.4 Skimmer and Sludge Collection/Thickening Devices

The mechanical skimmer and drive is required to continuously collect floating scum and remove it to a collection trough. Equip the sludge holding compartment with a hopper bottom having sides tapering downward at an angle not less than [55] [_____] degrees above horizontal for sludge collection. The sludge hopper is to be mounted in a [fixed] [removable] [_____] position and be equipped with a vibrator pack for sludge thickening. Size the sludge hopper to provide a minimum of [_____] L gallons of sludge storage. Provide a flanged outlet for each hopper which connects to a pump for sludge removal.

2.2.5.5 Miscellaneous

Supply the clarifier with a steel platform around the perimeter complete with ladder, handrail, and toe plates. Paint in conformance with Sections 09 90 00 PAINTS AND COATINGS and 09 97 02 PAINTING: HYDRAULIC STRUCTURES, unless otherwise indicated.

2.2.6 Piping/Valves

Provide piping and valves for chemical feed in accordance with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS. Install low point drains in interconnecting piping.

2.2.7 Pumps

Provide pumps that meet the following requirements. Provide pumps for specific services and accessories per the following specifications.

2.2.7.1 Water Pumps

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NOTE: Water pumps include, but are not limited to, the following: equalization transfer pumps, water pumps for chemical dilution, and effluent water recycle and discharge pumps. Water pumps may be horizontal or vertical centrifugal pumps. Delete and/or add paragraphs to meet job requirements.

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Design water pumps in accordance with Section 23 21 23 HYDRONIC PUMPS.

2.2.7.2 Chemical Metering Pumps

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NOTE: Chemical metering pumps may be piston, positive displacement diaphragm, or balanced diaphragm pumps. The unit application depends on the pressure involved, corrosiveness of the chemical, feed rate, accuracy required, viscosity and specific gravity of the fluid, other liquid properties, and the type of control.

****

Manufacture and install chemical metering pumps in accordance with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS.

2.2.7.3 Sludge Pumps

****

NOTE: Sludge pumps may be centrifugal, diaphragm (air operated) or progressive cavity. The unit application depends on the pressure involved, the pumping rate (constant or variable), the specific gravity of the sludge and the type of control.

****

Manufacture and install sludge pumps in accordance with Section 22 13 29 SANITARY SEWERAGE PUMPS.

2.2.8 Electrical Equipment

2.2.8.1 General

Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and in conformance with NFPA 70. Install circuits in accordance with Sections 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION and 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.2.8.2 Electric Motors

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NOTE: Electrical motor driven equipment should be provided complete with motors, motor starters, and controls.

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Provide for each motor a circuit breaker type combination motor circuit protector, complete with properly sized thermal overload protection on each phase, along with a hand-off-automatic (HOA) selector switch; red and green pilot lights; manual reset pushbutton; and all other appurtenances necessary for the motor control specified. Ensure each motor has sufficient capacity to drive the equipment at the specified capacity at or below a 1.0 service factor and without exceeding the nameplate rating of the motor when operating at the specified electrical system voltage and frequency. Each electric motor-driven piece of equipment is required to be driven by a chemical/mill duty, [explosion-proof] [totally-enclosed fan cooled (TEFC)] [totally-enclosed non-ventilating (TENV)] [_____] motor rated for continuous duty at a 40 degrees C ambient temperature. Provide motor with a [1.15] [1.0] [_____] service factor. Ensure all motors conform to the respective sections of NEMA MG 1. Three phase motors are required to be squirrel-cage induction type having normal-starting-torque and low-starting-current characteristics. Size motors with sufficient power and torque so that the nameplate power rating, without consideration of the service factor, is not exceeded under any operating condition. Provide adequate thrust bearings in the motor to handle any thrust forces that are transmitted to motor under any operating condition. Three phase motors are required to be rated at 230/460 volts, 60 hertz. Fractional horsepower motors are required to be 115 volts, 60 hertz. Stamp all motor nameplate information on the attached nameplate in accordance with the requirements of NEMA MG 1. Supply motors that have a premium efficiency design, class F insulation, automatic thermal protection of the stator windings, and standard NEMA frame ratings.

2.2.9 Instrumentation And Control

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NOTE: Instrumentation and control systems are used in water treatment to ensure consistent quality, to optimize process reliability, to assist operating personnel in monitoring process operations, and to minimize operating costs. The measurement and control instruments may range from a simple control panel indicator to a complex, multi-component, programmable logic controller based system.

In developing the scope of the instrumentation and control system design, the designer should consider the following parameters: size of the plant, type and complexity of the treatment process, type of vendor-supplied controls, amount of funds available, current design standards, discharge compliance criteria, special interfaces with other control systems, and the ability of the owner to properly maintain a control system. Generally, the designs of P/C/F systems incorporating manual operation would be limited to batch processes in which the control of pumps and chemical addition is accomplished by operator action. The continuous operation of P/C/F systems usually involves more complex control schemes. Chemical addition can be manually or automatically proportioned to flow and/or to other process feedback signals generated by process instrumentation. The degree of automation incorporated into the system design

generally depends upon the complexity of the treatment system, the remoteness of the site, the planned level of operator attention, and the duration of the project. Systems designed for unattended operation would require the greatest degree of automated system controls. Control schemes may include the use of remotely located programmable logic controllers, remote data telemetry, and telecommunication systems.

The designer should consider how the P/C/F system will be operated for each site-specific application. The equipment used in a P/C/F system can be supplied to operate either in a batch or a continuous mode of operation. A batch operation may be more economical than continuous operation when wastewater flows are small (less than 0.6 L/s 10 gpm), or are intermittent from sources such as a small landfill leachate recovery system or small ground water pumping wells. When the wastewater flows are larger than 0.6 L/s 10 gpm, continuous operation should be used. In the continuous mode of operation, all equipment would run uninterrupted and the wastewater would be fed to the system at a controlled rate.

If a batch operation is used, the designer must decide whether treatment can be performed in one single tank or if multiple tanks are required. In a single tank, the required chemicals for precipitation, coagulation, and flocculation are added sequentially to the same tank at a mixing intensity appropriate for the chemical being added. Following chemical addition, all mixers would shut down to allow a quiescent time for settling to occur. The settled sludge on the bottom of the tank could be drawn off and the supernatant adjusted for final pH. The water can be stored in this one tank until it is analyzed and discharged, or a separate tank can be used to store the water. This type of system is appropriate for sites that generate small amounts of water where the time to treat one batch does not exceed the time to generate a volume of water to be treated. A flow equalization tank must be provided to receive the water while treatment is occurring in the batch tanks.

Alternatively, if more frequent treatment is required, batch treatment can employ multiple tanks where one volume of water is pumped sequentially through the precipitation, coagulation, flocculation, and clarification tanks. The equipment used in this system would be the same as for a continuous operation, except that the instrumentation and controls would be designed to allow intermittent pumping, mixing, and chemical addition rather than continuous. In either mode of operation, the controls can be designed to operate the system with 1) manual control, 2) semiautomatic

control, or 3) automatic control. The designer must select the control scheme appropriate for the site considering the complexity of the system and personnel availability.

In manual control, the operator will start only one process at a time (e.g., precipitation, coagulation, flocculation, clarification, etc.) and check the results of each before starting next operation. In semiautomatic control, the operator must be present to start the P/C/F system and transition from one process to another will be controlled automatically using either an electronic or pneumatic distributed control system. In automatic control, the entire system will operated without an operator. The normal running of the system is linked to one or more governing factors (tank level, flow rate, etc.) which will start up each system when set points are reached. Maximum reliability of a fully automated system can be obtained by using a logic control system which checks that the orders given have been received and carried out and, if not, stops the operations and alarms the operator. All controls should have manual override.

****

Provide the instrumentation and control system to be [batch] [on-off in response to influent flow] [manual] [semi-automatic] [automatic] [_____] with complete electrical power, control and instrumentation as specified or recommended by the equipment manufacturer for the safe operation and supervision of the P/C/F system. Supply the instrumentation and control package for the P/C/F system as indicated on the drawings. Ensure the probes for pH and oxidation reduction potential (ORP), measuring devices, and level sensors specified in the following four subparagraphs are made of materials resistant to chemical attack over a pH range of 2 to 12, and suitable for a temperature range from [0 to 100] [_____] degrees C [32 to 212] [_____] degrees F and for the liquid to be monitored. All enclosures for pH, flow, and level sensors and transmitters are to be rated NEMA 4X.

2.2.9.1 pH Monitoring/Control

Provide pH probes [where indicated on drawings] [on the effluent line of each reactor] for the purposes of pH monitoring and/or pH control through an associated control device (PLC, single loop controller, etc.). Ensure installed probes are easily removable without interrupting service. Provide probe materials that are resistant to operating pressures of up to [_____] kPa psi. Interconnect the probes to associated transmitters/indicators that are located preferably in the main control panel. Connect probes to a micro-processor based pH analyzer having a 4 digit readout with 38 mm 1-1/2 inch high letters and an isolated 4 - 20 mA DC output signal proportional to the pH. Ensure the accuracy of the pH unit is plus or minus 0.5 percent of full scale.

2.2.9.2 ORP Monitoring/Control

Provide an oxidation reduction potential (ORP) probe [where indicated on drawings] [_____] for the purpose of ORP monitoring and/or control. Install probe so it is easily removable without interrupting service. Supply probe materials that are resistant to operating pressures of up to

[_____] kPa psi. Interconnect the probes to associated transmitters/indicators that are located [preferably] in the main control panel. Connect the probe to a microprocessor based pH analyzer having a 4 digit readout with 38 mm 1-1/2 inch high letters and an isolated 4 - 20 mA DC output signal proportional to the ORP. Ensure the accuracy of the ORP unit is plus or minus 0.5 percent of full scale.

2.2.9.3 Flow Monitoring/Control

Provide flow measuring devices [where indicated on drawings] [on the influent line] [on the effluent line] for the purpose of flow monitoring and/or control. Install measuring devices in a manner that ensures they are easy to maintain without interrupting service. Supply measuring devices that are resistant to operating pressures of up to [_____] kPa psi. Connect measuring devices to a microprocessor based flow analyzer having a digital readout with 38 mm 1-1/2 inch high letters and an isolated 4 - 20 mA DC output signal proportional to the flow. Ensure the accuracy of the flow monitoring unit provided is plus or minus 0.5 percent of full scale. Coordinate the type of flow meter selected with the application involved as shown on the drawings to assure that the flow meter meets all installation and operational criteria (upstream and downstream distances from appurtenances, minimum and maximum flow velocities, degree of required accuracy, full pipe flow, etc.).

2.2.9.4 Level Monitoring/Control

Provide level indicator gauges of the direct-reading type, equipped with a shutoff valve, on the discharge side of the tank. Provide gauges with 150 mm 6 inch dials that are stem mounted and conform to ASME B40.100. Provide gauges with accuracy of Grade A in accordance with ASME B40.100. Calibrate gauges in kPa psi in not more than 10 kPa 2 psi increments from 0 to 350 kPa 0 to 50 psi in excess of the normal operating pressure at the tank. Provide level (float) switches that are mechanically actuated with Form C contacts. Include a sending unit in all electronic level sensing devices that transmit an analog or discrete signal, as required for the application, to an associated control panel or control device. Provide level monitoring/control sensors [where indicated on drawings] [_____]. Locate sensors in a location to be easily removable without interrupting service. Connect analog level sensors to a microprocessor based level indicator and/or controller as required by the application having a 4 digit readout with 38 mm 1-1/2 inch high letters and an isolated 4 - 20 mA DC output signal proportional to the level to be measured.

2.2.9.5 Control System

****

NOTE: The designer should include a detailed operating and control procedure in this paragraph to explain the control philosophy for each component of the P/C/F system. This operating and control procedure should include all information required for system start-up, continuous operations, and normal and emergency shut-down operations. This procedure should include all operating set points for pump starting/stopping/alarming/shutdown, all normal/alarm/shutdown pH values, all normal/alarm/shutdown ORP values, all normal/alarm/shutdown liquid levels, as well as all other normal/alarm/shutdown values for any other

control or processing equipment. This procedure should delineate all normal operational values for each component of the P/C/F system.
****

Design the control system to operate as shown on the drawings and described in the operating and control procedures provided [below] [as an attachment]. Ensure all alarms and/or shutdowns consist of both visible alarm lights and audible alarm signals on either the main control panel, or on a remote microprocessor controller screen. Ensure the alarms and shutdowns function through a first-out-sequence annunciation. Provide alarms for high and low water and chemical levels, high and low pH values, and high and low ORP values. Provide automatic shutdowns for each system when a control value or an operational system ranges out of normal operational limits where personnel safety is a concern, where mechanical damage can occur to process equipment, or where the process excursion has the potential to violate discharge water quality criteria; such shutdowns can occur for both high and low conditions. Ensure power failures and equipment failures initiate an alarm as well as an orderly and automatic shutdown of the treatment system. [Provide for auto-dialing to an indicated remote location to report each alarm or shutdown that stops the movement of process water through the treatment system or stops chemical feed systems. The Contractor is responsible for providing the associated telephone line for the auto-dialer system.] Provide all control power transformers, relays, adjustable timers, auxiliary contacts, switches, or additional equipment required to interconnect the treatment equipment to a monitoring/control system. Furnish conduit and wiring between control panels, treatment components, and all control devices.

2.2.9.6 Control Panel Enclosures

Ensure all required control panels for the control system are rated NEMA 4X [fiberglass] [stainless steel] and are sized to assure that adequate internal space is available for all components specified and/or required with an allowance of no less than 30 percent spare space. To the greatest extent possible, install all instrument transmitters in or adjacent to the control panel enclosure.

2.2.10 Structural Skids

Where a P/C/F system has structural skids, supply skids fabricated in accordance with Section 05 12 00 STRUCTURAL STEEL. Submit shop details for each structural skid including members (with their connections) not shown on the drawings. Show standard welding symbols on the drawings in accordance with AWS A2.4.

2.2.11 Paint/Coatings

****
NOTE: UFGS 09 97 02 is a guide specification developed for Civil Works projects.
****

Perform paint and coatings work in accordance with Sections 09 90 00 PAINTS AND COATINGS[and 09 97 02 PAINTING: HYDRAULIC STRUCTURES].

2.2.12 Insulation/Heating/Ventilation

****

NOTE: In cold climates, exposed pipe, valves, pumps and equipment should be insulated and/or heat traced to prevent freezing. Tanks should be insulated and heated to keep the tank contents above freezing temperatures.

****

Provide insulation for pipes, valves, pumps, tanks, instrumentation and controls, and other equipment in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2.13 Nameplates

Provide a nameplate on each major item of equipment that includes the manufacturer's name, address, type or style, model or serial number, and catalog number. Secure nameplate to the item of equipment.

2.2.14 Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration and maintenance of the equipment, as recommended by the manufacturer. Provide a list of special tools including description, manufacturer, model number, and a source for purchasing replacements if lost.

PART 3 EXECUTION

3.1 EXAMINATION

****

NOTE: The designer will determine if the examination by the Contracting Officer is to apply to all equipment or only to special items to be inspected.

****

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before work begins. After equipment is delivered to the site and prior to installation, examine the treatment plant equipment for any damage, defect, or deterioration and verify that all construction equipment used at the site is of sufficient capacity and in good mechanical condition. Document the results of this pre-installation examination and submit to the Contracting Officer for review.[Contracting Officer reserves the right to also conduct this examination independently.] Based on the examination, the Contracting Officer has the right to reject damaged, defective, or deteriorated equipment. The contractor is required to correct surface damage to equipment following the manufacturer's requirements. Any costs associated with the delay caused by the rejection of equipment is understood to be borne by the Contractor. Provide all specified preconstruction submittals to the Contracting Officer.

3.2 INSTALLATION

Handle equipment with extreme care to prevent damage during placement. Install equipment, except as otherwise specified, as indicated on the drawings, and in accordance with the manufacturer's written instructions [and under direct supervision of the manufacturer's representative] [_____]. Installation includes furnishing all materials required for initial operation. Properly level, align, and anchor all equipment in place in accordance with the manufacturer's instructions. Provide supports for equipment, appurtenances, and pipes as required. Install piping runs to be straight and evenly supported. Install valves with stems horizontal or above the pipe centerline. Install flanges and unions where valve and equipment maintenance may require disassembly. Provide the P/C/F system complete and ready for operation. Ensure all plumbing work conforms to the requirements of [Section 22 00 00 PLUMBING, GENERAL PURPOSE][_____].

3.2.1 Foundations

Construct foundations for tanks, clarifier, and other equipment of reinforced concrete, except as shown or specified herein.

3.2.2 Excavating, Filling, and Grading

Perform excavation, filling, and grading work to conform to the applicable requirements of Section 31 00 00 EARTHWORK.

[3.2.3 Cathodic Protection

Provide cathodic protection on steel tanks and clarifiers, conforming to Section 26 42 15 CATHODIC PROTECTION SYSTEM FOR THE INTERIOR OF STEEL WATER TANKS.

]3.2.4 Welding

Perform tank welding in accordance with [Section 8 of AWWA D100] [AWWA D103] [API Std 650].

3.2.5 Erection

Perform tank erection in accordance with [Section 10 of AWWA D100] [AWWA D103] [API Std 650].

3.2.6 Field Painting

****

NOTE: UFGS Section 09 97 02 is a guide specification developed for Civil Works projects.

****

Perform field painting in accordance with Sections 09 90 00 PAINTS AND COATINGS[and 09 97 02 PAINTING: HYDRAULIC STRUCTURES]. Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

3.2.7 Inspections and Testing

Inspect and test tank in accordance with Section 11 of AWWA D100. Mill and shop inspections [are not required] [are required to be performed by an approved commercial inspection agency]. Contractor is required to perform the hydrostatic test. Perform final hydrostatic test before painting.

3.2.8 Radiographic Inspection and Testing

Perform tank radiographic inspection and testing of tanks in accordance with Section 11 of AWWA D100. Radiographic inspections [are not required] [are required to be performed by an approved commercial inspection agency]. Perform all testing before painting.

3.3 FIELD QUALITY CONTROL

3.3.1 Inspection

****

NOTE: The system's P&ID and the as-built drawings are used to verify that all equipment, piping, and valves are installed according to plans and specifications. The electrical one-line diagrams and wiring diagrams are useful to verify the electrical and instrumentation systems. Grounding of equipment should also be inspected. Vendor's certified shop drawings and equipment operating manuals should be used to check the equipment installation and operation.

****

After the installation is complete, each component the Contracting Officer inspects to verify that the components of the system are properly installed according to drawings and specifications. Correction of all discrepancies found and work affected by such deficiencies is wholly at the Contractor's expense.

3.3.2 Tests

Ensure each piece of equipment is subject to an operational test, under the supervision of a factory representative. The Contracting Officer maintains the right to observe test. Tests are required to demonstrate that the equipment is not defective and is in safe and satisfactory operating condition. Notify the Contracting Officer [7] [_____] days prior to the dates and times for acceptance tests. Perform a running field test on all equipment in the presence of the Contracting Officer for a minimum of [2] [_____] hours. If any deficiencies are revealed during the tests, correct such deficiencies and repeat the tests. Submit Test Reports in booklet form showing field tests performed to adjust each component and to prove compliance with the specified performance criteria upon completion and testing of the installed system. Identify all test methods used and record all test results. Indicate within each test report the final set point of each control device. Provide test reports for pre-startup testing and startup performance testing; also include test reports showing the results of factory tests performed.

3.3.3 Manufacturer's Service

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative is required to supervise the installation, adjustment, and testing of the equipment. Include up to [5] [7] [10] [_____] days of service.

3.4 SYSTEM STARTUP

****

NOTE: Pre-start-up procedures should be provided for each component of the P/C/F system and procedures should be provided for start-up of the whole system. The startup plan must include pre-startup checkouts, pre-startup testing, and the

actual startup. The following sections describe startup operations of a P/C/F treatment system. The startup procedure follows a planned sequence of events for each component of the system.

****

3.4.1 Hydrostatic Tests

****

NOTE: The test pressure should not exceed 130 percent of the rated pressure. Testing of pipe and fittings should be specified in the same section where the pipe is specified in.

****

After installation, test all tanks for leaks or damage in shipment. Test the tanks hydrostatically [to [_____] kPa psig] [as indicated in the schedule] or 1.5 times the system operating pressure, whichever is greater. Test the tanks for a period of [24] [_____] hours. Furnish testing plugs or caps, all necessary pressure pumps, pipe connections, gauges, other equipment, and all labor required. Repair all damage or leaks in tanks or replace tanks at the Contractors expense. Test the joints of air lines using a soapy water solution to detect leaks.

3.4.2 Pre-startup Checkout

****

NOTE: The pre-startup checkouts are designed to verify the integrity of the system components prior to pre-startup testing.

****

Ensure the following items subjected to the pre-startup checkout:

a. Check foundations to verify that they are placed and sealed properly;

b. Check system to verify that all equipment has been properly installed and connected;

c. Check rotating equipment which requires lubrication to ensure that manufacturer's procedures have been followed;

d. Level and check all equipment for proper alignment, anchored, and static ground wires installed;

e. Check piping, flange bolts, gaskets, and hoses to ensure that connections are tight, and flushed clean;

f. Check valves for position and operability and flushed clean;

g. Check electrical wiring and lighting to verify that wiring has been completed correctly;

h. Perform continuity checks on wiring loops;

i. Check High/Low liquid level alarms on tanks, as well as pump on/off level controls, for proper installation and response;

j. Check chemical feed systems for proper installation;

k. Check chemicals for proper type, required quantity and mixing; fill tanks;

l. Check lockout devices and site security devices checked for proper installation.

3.4.3 Pre-startup Testing

****

NOTE: The pre-startup testing of the system should be performed to verify the integrity of each component and of the whole system prior to actual startup.

****

Subject each component of the system to the pre-startup testing as described below:

a. Pressure test piping and hoses transporting liquid on clean water for at least one hour, with no loss of pressure at 1.5 times the working pressure; pressure test tanks at the maximum hydraulic head using clean water;

b. Test electrical wiring to verify that there is no wiring damage or deterioration that could cause injury to personnel or damage to equipment;

c. Turn power on to test equipment and control systems only after the electrical systems are tested and certified ready for operation;

d. Test lighting and put in service to support work in all areas of the plant;

e. Test rotating equipment such as pumps, mixers, and blowers, if used, for correct direction of rotation by bumping the starter manually;

f. Operate each pump for a minimum of [4] [_____] continual hours at operating or test conditions. Ensure that the units, controls and instrumentation have been installed correctly, and that there is no over-heating, vibration or excessive noise;

g. Depending on the complexity of the control system, testing can proceed from this point to verify that manual and automatic controls function properly and control valves open/close. Fill all tanks and empty to determine if high and low level alarms sound at the prescribed liquid level;

h. Test safety shutdown sequences, controls/alarms and interlocks in the control system to ensure that they are installed properly and functioning as intended;

i. Label and test each emergency shutoff switch to determine that it works properly;

j. Test electrical "lockout" devices with padlocks to ensure that power has been disconnected;

k. Calibrate instrumentation before systems are put into service. Test all pressure and temperature gauges against standardized gauges. Utilize NIST SP 250 calibration standards where they exist.

3.4.4 Startup Performance Testing

****

NOTE: The startup check and functional performance tests should be performed in accordance with the manufacturer's recommended procedures. The startup should proceed following a startup plan prepared well in advance. Performance testing begins with equipment or components, proceeds through systems, and ends with the complete treatment system passing its performance specifications and contractual requirements testing.

****

Do not initiate startup until after each component of the system has been demonstrated to meet the requirements of the pre-startup testing and until written approval has been received from the Contracting Officer. Once steady state operation is achieved, perform a functional performance test as described in the following startup checklist:

a. Check flow rates, pH, and contaminant levels of the wastewater feeding the reactor tank;

b. Check pump operating points to verify that the actual operating point matches the pump curve specification for flow and pressure;

c. Start/stop pumps from all control mechanisms;

d. Check that current draw and voltage balance match specifications for all phases;

e. Check the reagent feeding systems to verify that the actual chemical feed rate is within the specified accuracy range;

f. Check the pH in the reactor to verify that operating values are within the design range;

g. Adjust the reagent feed rates, and the pH control system as required to achieve maximum metal removals;

h. Monitor the composition of the effluent to verify that it meets the specified performance requirements.

i. Check the clarifier overflow rate to verify that it is within the design range;

j. Check the sludge collecting device to verify that it is operating properly, and no sludge is overflowing the weir;

k. Check the control system to verify that the system operates within set parameters; and

l. Check the monitoring systems and instruments to verify that they hold calibration.

m. Include [48] [_____] hours of operation processing water from the design influent source at design capacity and meeting effluent requirements with less than 20 percent down time. Before system acceptance, the Contractor is required to correct any deficiencies and complete all performance checks. Replace or upgrade equipment not capable of performing as specified at no additional cost. Submit Proof of Performance and Equipment Certificate of Conformance as specified. Submit a list of the proposed operating conditions for process parameters to be continuously monitored and recorded. Include detailed descriptions of the proof of performance schedule, operating conditions and parameters, influent sources, and required sampling and analyses.

3.4.5 Field Training

****

NOTE: The field training provided by the Contractor must be modified if the process will be operated by the Contractor for the first year.

****

Upon completion of the installation and at a time designated by the Contracting Officer, conduct a field training course for a representative of the Government in the operation and maintenance of equipment furnished under the contract. Ensure these field instructions cover all the items contained in the operation and maintenance instructions. Provide training for a total period of [8] [16] [_____] hours per day for a period of [5] [_____] days of normal working time and start after the system is functionally complete but prior to final acceptance tests. Ensure field instructions cover the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations. Prepare a video tape of the field training course as a permanent record for future training use.

3.4.6 Operation and Maintenance Manual Updates

****

NOTE: The O&M Manual is intended for use by operating personnel and should be adapted to the particular features of the equipment installed; therefore, the document must be written for the operator.

****

Include the following items in the O&M manual::

a. General description of the treatment process;

b. A detailed description of equipment;

c. Process flow diagram;

d. Piping and instrumentation diagrams;

e. Certified drawings for equipment components and equipment layout;

f. Practical operating procedures including performance testing, influent, and effluent concentrations, and trend analysis of influent;

g. A complete set of fully updated and annotated piping and instrument diagrams, process flow diagrams, instrument indexes, control ladder logic diagrams, description of controls, alarms, interlocks, instrument interface, and maintenance procedures;

h. Specialty items such as type of oil and grease, desiccants, tools, analytical instruments, etc.;

i. Initial startup procedures;

j. Emergency and scheduled shutdown procedures;

k. Monitoring and quality control, spill controls;

l. Equipment specifications;

m. A list of modes of failure for each piece of equipment;

n. Fault/failure analysis, and trouble shooting guide;

o. List of spare parts;

p. Process safety and protective equipment requirements; and

q. Record keeping (electronic or other) requirements.

In order to plan all the inspection and maintenance operations required for plant operation, the contract is required to provide a maintenance schedule. Include the following items in the maintenance schedule:

a. Scheduled maintenance procedure for each piece of equipment;

b. Sensor and measurement device calibration frequency;

c. Periodic reports regarding consumption of chemicals such as acid, caustic, polymer, and coagulants;

d. Electronic or other recording data;

e. Personnel training requirements;

f. The time required for each maintenance task;

g. Equipment shutdown and lock and tag requirements during maintenance/repair; and

h. Mothballing and preservation procedures for equipment layaway.

Record the entire schedule and the results of each task for future analysis. Include other items as follows:

a. Spare parts list with suppliers and costs;

b. Plant utility requirements such as electrical, air, drinking water, service water, telephone, and sewer;

c. Detailed safety procedures for chemical handling; and

d. Name, address, and telephone number of technical personnel to contact in case of an emergency related to the treatment system.

Final acceptance of the P/C/F system is contingent upon these documents being supplied, reviewed, and approved by the Contracting Officer.

3.4.7 System Operation by Contractor

Do not initiate the first period of operation until after the Contractor has successful completed all work and received written approval from the Contracting Officer. Continue to operate the system for a period of [30 days] [6 months] [1 year] [_____] being responsible for operations, process monitoring, maintenance, chemical testing, and record keeping during operation in conformance with this specification.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-46 07 53 (February 2020)**

Change 2 - 11/23

Preparing Activity: NAVFAC **Superseding**

UFGS-46 07 53.13 (February 2011)

UFGS-46 07 53.16 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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USACE / NAVFAC / AFCEC | **UFGS-46 07 53 (February 2020)**
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SECTION 46 07 53

PACKAGED WASTEWATER TREATMENT EQUIPMENT

02/20, CHG 2: 11/23

****

NOTE: This guide specification covers the requirements for prefabricated package wastewater treatment biochemical and aeration systems, including extended aeration, contact stabilization, step aeration, and complete mixing. These facilities are intended for treatment of domestic wastewater only. Special consideration must be given to wastewater containing industrial wastes.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: On the project drawings, show:

1. Type of plant: (Extended Aeration, Contact Stabilization, Step Aeration, or Complete Mixing).

2. Design flow.

3. 5-day BOD loading.

4. Suspended solids loading.

5. Whether a comminutor is needed for facilities 1.09 L/s 25,000 GPD or less in size.

6. Whether mechanical aerator is allowed.

7. Whether plant should be concrete , steel, composite, or a combination.

8. Whether piling is required for foundations.

9. Whether hypochlorinator or whether chlorinator will used for facilities in 4.38 to 6.57 L/s 100,000 to 150,000 GPD range.

10. Whether raw wastewater recirculation box (recirculation to pumping station) is needed.

11. Whether plant is to be of aboveground or belowground construction.

12. Seismic loading (if necessary).

13. Electric power characteristics for motors.

14. Whether automatic operation of air lift pumps are required.

15. Wind load and ice load for rotating sludge collector.

16. Organic loading (5-day BOD).

17. Total suspended solids.

18. Size of hypochlorite mixing chamber if larger capacity than 113.4 L 30 gallons is needed.

19. Size of hypochlorite solution chamber if larger capacity than 208 L 55 gallons is needed.

20. Whether, for extended aeration type plant, eventual conversion to step aeration type is anticipated.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature

when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
AGMA 2011	(2014B) Cylindrical Wormgearing Tolerance and Inspection Methods
AGMA ISO 10064-6	(2010A) Code of Inspection Practice - Part 6: Bevel Gear Measurement Methods
AGMA ISO 17485	(2008A; Supplement 2008) Bevel Gears - ISO System of Accuracy (Including Supplement - Tolerance Tables 2008)
ANSI/AGMA 2001	(2004D; R 2010) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
ANSI/AGMA 2004	(2008C; R 2014) Gear Materials, Heat Treatment and Processing Manual
ANSI/AGMA 6013	(2006A; R 2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6034	(1992B; R 2010) Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for

Pipeline and Piping Valves

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C206	(2023) Field Welding of Steel Water Pipe
AWWA C207	(2023) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C504	(2023) Standard for Rubber-Seated Butterfly Valves
AWWA C900	(2022) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon

	Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding

Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Package Wastewater Treatment Plant Layout

Package Wastewater Treatment Plant Component

Diffuser Layout

Mechanical Aerator Drawings

Special Concrete Work

Walkways

Access

Handrails

SD-03 Product Data

Air Blower Assembly; G, [_____]

Air Diffusers; G, [_____]

Mechanical Aerator; G, [_____]

Piping System; G, [_____]

Spray Nozzles; G, [_____]

Comminutor; G, [_____]

Mechanical Sludge Collection Equipment; G, [_____]

Scum Collection and Transfer Equipment; G, [_____]

Electrical Control System Components; G, [_____]

Program timer; G, [_____]

Air Blower Accessories; G, [_____]

Flow Measuring Equipment; G, [_____]

[Hypochlorinator Assembly; G, [_____]

][Chlorinator Assembly; G, [_____]

] SD-06 Test Reports

Package Wastewater Treatment Plant Performance Test Reports; G, [_____]

Chamber Tests; G, [_____]

Comminutor Tests; G, [_____]

Mechanical Aerator Tests; G, [_____]

Blower-driven Assembly Operation Tests; G, [_____]

Chlorinator Tests; G, [_____]

Discharge Capacity Test for Air Lift Pump; G, [_____]

Flow Measuring Equipment; G, [_____]

Electrical Control System Tests; G, [_____]

Hypochlorinator Tests; G, [_____]

System Startup; G, [_____]

SD-07 Certificates

Warranty

Electrical Control System

Mechanical Aerators

Materials Not Labeled or Certified

SD-08 Manufacturer's Instructions

Aeration Equipment

Air Blower Assembly

Sludge Transfer Pumps

Mechanical Sludge Collection Equipment

Comminutor

Froth Control System Pump

Flow Measuring Equipment

Corrosion Protection

Utilities Service Connections

Electrical Wiring

Excavation and Backfilling

[Hypochlorinator Assembly

] SD-10 Operation and Maintenance Data

Package Wastewater Treatment Plant Acceptance Test Results, Data Package 3; G, [_____]

Package Wastewater Treatment Plant Operation and Maintenance Data, Data Package 3; G, [_____]

Aeration System, Data Package 3; G, [_____]

Air Blower Assembly, Data Package 3; G, [_____]

Froth control System, Data Package 3; G, [_____]

Comminutor, Data Package 3; G, [_____]

[Hypochlorinator Assembly, Data Package 3; G, [_____]

]1.3 MAINTENANCE MATERIAL SUBMITTALS

1.3.1 Spare Parts

Provide manufacturer recommended spare parts that are identical and interchangeable with original parts. Protect spare parts from corrosion and furnish in clearly marked containers. Spare parts must meet standards recommended by the manufacturer in the manufacturer's operation, maintenance, or instruction manual.

1.4 QUALITY CONTROL

Unless otherwise specified, all materials and equipment must be new and be standard commercial products in regular production by the manufacturer, and suitable for the required service.

1.4.1 Manufacturer's Representative

Procure the services of an engineer representative of the manufacturer of the major portion of the treatment plant who is also familiar with the other equipment furnished. The representative inspects the equipment after erection, make adjustments in placing the equipment in operation, and is present during final inspection, start-up, and acceptance test.

1.4.2 Regulatory Requirements

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NOTE: Ensure compliance with NPDES permits.

****

Conduct a regulatory review to determine impact of new and existing permit conditions and regulations. Notify the Contracting Officer of any discrepancies.

1.4.3 Standard Products

Provide materials and equipment which are the standard products of a

manufacturer regularly engaged in the manufacture of such products and which essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment manufacturer must be able to provide on-site support and should be convenient to the site.

1.4.4   List of Prior Installations

Submit a list of installations where plants of similar type as specified have been constructed, including the date of construction and capacity of the plant. Certify that the plant furnished and installed is the latest model and that spare parts are available.

1.4.5   Welding

Weld in accordance with AWS D1.1/D1.1M.

1.5   DELIVERY, STORAGE, AND HANDLING

1.5.1   Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with a minimum of handling. Store materials in enclosures or under protective covering. Rubber gaskets which are not to be installed immediately must be stored under cover, out of direct sunlight. Do not store materials directly on the ground. Keep interior of pipes, valves and fittings free of dirt and debris.

1.5.2   Handling

Handle pipe, fittings, valves, and other accessories in such manner as to ensure delivery in sound, undamaged condition. Avoid damage to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged.

1.6   PROJECT AND SITE CONDITIONS

1.6.1   Environmental Requirements

Comply with applicable local, state, and Federal environmental requirements as directed by the Contracting Officer.

1.7   WARRANTY

Provide a system with a minimum [5] [_____] year warranty. Submit the manufacturer's warranty for each piece of equipment.

PART 2   PRODUCTS

2.1   SYSTEM DESCRIPTION

2.1.1   Design Requirements

****

NOTE: Insert values for 5 day BOD loading, total suspended solids (TSS), and design and peak flow rates; values should be based on tests of the wastewater to be treated. A typical influent value for BOD is 200 mg/L.

If effluent standards require a 5-day B.O.D. of less than 10 mg/L, effluent filters are recommended. Tertiary treatment may be required.

****

Provide a Package Wastewater Treatment Plant capable of treating wastewater with the following flow and removal requirements:

a. Average daily design flow of [_____] L/s gallons per day of domestic wastewater

b. Total Suspended Solids removal; [80] [90] [_____] percent

c. 5-day BOD removal; [80] [90] [_____] percent

The influent domestic wastewater has a 5-Day BOD and Total Suspended Solids (TSS) concentration between [200] [400] [_____] mg/L

2.1.2 Package Wastewater Treatment Plant

****

Plant material selection includes steel, concrete, composite. Among the factors to be considered are initial cost, maintenance costs, life expectancy, and possible need for relocation during period of useful life.

****

The Package Wastewater Treatment Plant includes a [comminutor,] aeration chamber, [flow equalization chamber,] clarifier chamber, sludge holding chamber, disinfection chamber, aeration equipment, and other related equipment. Duplicate facilities of equal size having a combined capacity equal to the average design flow specified when one unit is out of service are acceptable.

2.1.3 Components and Systems

****

NOTE: Delete reference to mechanical sludge collection equipment for extended aeration type below 0.66 L/s 15,000 GPD capacity. For facilities below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for settling chambers. For facilities above 4.38 L/s 100,000 GPD capacity, mechanical sludge collectors only should be used in clarifier chambers. For plants between 0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed as a Contractor's option.

Delete reference disinfection equipment not used. Hypochlorinator may be specified for facilities 4.38 L/s 100,000 GPD capacity and below. Chlorinator may be specified for facilities 6.57 L/s 150,000 GPD capacity and above. Between 4.38 L/s and 6.57 L/s 100,000 GPD and 150,000 GPD capacity either is suitable. Selection should be made on basis of existing station or base practices, local availability, and comparative costs.

Delete reference to mechanical sludge collector for extended aeration of 4.38 L/s 100,000 GPD capacity and less and for step aeration of 3.0 L/s 67,500 GPD capacity and less.

****

The Package Wastewater Treatment Plant includes the following equipment: A diffused air aeration system [or mechanical aerator(s)] for the aeration chamber and the sludge holding chamber; [mechanical sludge collection equipment for the clarifier chamber;][froth control system for the aeration chamber;] sludge pumps in the clarifier chamber and the sludge holding chamber for sludge transfer; scum removal system for the clarifier chamber; [a comminutor at the plant inlet;] a disinfection system, and all necessary piping.

[2.1.4 Concrete Work

****

NOTE: The applicable requirements for cast-in-place concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 03 45 33 PRECAST [PRESTRESSED] STRUCTURAL CONCRETE should be incorporated into the appropriate section of the project specification.

****

Concrete work includes [concrete plant walls, partitions, and bottom;] [support slab for all-steel plant or concrete bottom for steel wall plant;] and concrete pad for equipment support.

]2.2 MANUFACTURED UNITS

2.2.1 Process Chambers

****

NOTE: Use appropriate wording depending on whether plant is to be installed above ground (hydrostatic pressures...liquid level) or below ground (soil pressures...operating level).

Delete reference to comminutor and screening basket when not required for the plant. For facilities of 1.09 L/s 25,000 GPD capacity and below, the comminutor and bar screen unit may be omitted, and in lieu thereof, a screening basket provided in the aeration chamber. For installations in which all wastewater has passed through a comminutor and bar screen upstream of the plant, a comminutor and bar screen unit need not be provided as a part of the plant equipment.

Delete reference to influent distribution channel for extended aeration type.

For a detention time in the aeration chamber, insert values of 18 to 24 hours for extended aeration, 5.0 to 7.5 hours for step aeration, and 30 minutes to 2 hours for contact stabilization systems.

For organic loading in aeration chamber, insert 5.67 kg 12.5 pounds, 5 day BOD for extended aeration, 13.6 to 22.1 kg 30 to 50 pounds, 5-day BOD for step aeration, and 52.16 kg 115 pounds, 5-day BOD for complete mixing systems. Organic loadings used in this specification are those for wastewater strength of 200 mg/L. Organic loadings for higher strength wastewater would be proportional.

Delete the requirement for clarifier chamber detention time when the complete mixing process is specified.

For detention time in the clarifier chamber for extended aeration, insert 4.0 hours for plants of less then 2.19 L/s 50,000 GPD, 3.6 hours for plants from 2.19 L/s 50,000 GPD to 6.57 L/s 150,000 GPD capacity, and 3.0 hours for facilities of 6.57 L/s 150,000 GPD capacity and above. For step aeration, insert 3.0 hours.

Delete reference to mechanical aeration when step aeration or complete mixing is specified, or when not allowed for extended aeration. Mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consideration should be given to temperature and detention time of the liquid and freeboard in the chamber in determining temperatures that may be tolerated. Mechanical aerator is not suitable for extended aeration where eventual conversion to step aeration is contemplated.

For extended aeration, insert 0.013 L/s 300 GPD for 6.57 L/s 150,000 GPD capacity and less; and 0.026 L/s 600 GPD for facilities of more than 6.60 L/s 150,000 GPD capacity. For step aeration, insert 0.026 L/s 600 GPD. For complete mixing, insert 0.02 L/s 50 GPD.

Delete reference to mixing with aeration chamber contents for extended aeration and step aeration.

Delete references to and requirements for seismic loading when unnecessary to consider seismic loading. For specific environmental loads (wind, seismic) see UFC 3-301-01.
****

Pass the raw wastewater through a [comminutor] [screening basket] [and an influent distribution channel], aeration chamber of adequate capacity to provide [not less than [_____] hours detention time and] a maximum organic loading not to exceed [_____] kg per 1000 cubic meter [_____] pounds 5-day BOD per 1,000 cubic feet of aeration chamber volume at average design flow rate. A clarifier chamber of adequate capacity to provide [not less than [_____] hours detention time and] a surface settling rate not to exceed [_____] L/s per square meter GPD per square foot at average design flow rate. The settled sludge is [collected by a mechanical sludge collector and] recirculated back to the aeration chamber [where it is rapidly and thoroughly mixed in with the aeration chamber contents,] or wasted to the sludge holding chamber. Size a disinfection chamber to provide a detention time of at least 15 minutes at peak flow and then to an outfall. The sludge holding chamber has a capacity of not less than 0.057 cubic meter 2 cubic feet per capita. Aeration is by [diffused air] [mechanical aeration].

Plant includes an aeration chamber, [equalization chamber,] clarifier chamber, sludge holding chamber, and disinfection chamber. Chambers may be separate or contiguous with a common partition between. Ensure the plant structure and separate chamber structures withstand [hydrostatic pressures [and seismic loading] when installed above grade and filled to normal operating liquid level] [soil pressures (as indicated by Government-furnished soil borings) when installed below grade, backfilled, and dewatered] [; and seismic loading when installed below grade, backfilled, and filled to normal liquid operating level]. The plant and foundation must have sufficient mass to overcome flotation forces when the entire plant is dewatered. Provide for dewatering of individual chambers or compartments and the entire plant.

The Package Wastewater treatment Plant is constructed of [steel] [composite] [concrete] [_____]. It must be complete and self-sufficient except for electric power, water supply, and disinfection agent. All structural steel must conform to ASTM A36/A36M. All submerged steel members must have minimum thickness of 6 mm 1/4 inch. Perform cast-in-place concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Precast concrete must be in accordance with [_____]. Results of Government-made soil bearing tests will be furnished to the Contractor.

2.2.1.1 Aeration Chamber

****

NOTE: A mechanical aerator may not be suitable for use in areas having prolonged periods of sub-freezing temperatures when spray may form accumulation of ice. Consider temperature and detention time of the liquid and freeboard in the tank in determining temperatures that may be tolerated. A mechanical aerator is not suitable for extended aeration type where eventual conversion to step aeration is contemplated.

****

The aeration chamber will have capacity to provide [a minimum of [24][_____] hours retention of the average daily flow] [a volume of [_____] L gallons]. Ensure that the interior configuration of the aeration chamber provides thorough mixing and efficient air dispersion, precludes short-circuiting of the liquid flow, and inhibits solids deposition. Provide a [_____] mm inch diameter influent opening, reinforced with a pipe flange or steel plate and with a suitable connection for the [inlet sewer] [raw wastewater pump discharge pipe]. Provide air diffusers in accordance with paragraph DIFFUSED AIR AERATION EQUIPMENT.

2.2.1.2 Clarifier Chamber

****

NOTE: Delete the first and fourth sentences for

extended aeration type facilities above 4.38 L/s 100,000 GPD capacity, step aeration type facilities above 3.0 L/s 67,500 GPD capacity, and for all complete mixing type facilities.

Delete reference to mechanical sludge collection equipment for extended aeration type below 0.66 L/s 15,000 GPD capacity. For facilities below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for clarifiers. For facilities above 4.38 L/s 100,000 GPD capacity, consider mechanical sludge collectors clarifier chambers. For facilities between 0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector may be allowed as a Contractor's option.

In all facilities (except circular facilities with concentric inner clarifier) where the design flow exceeds 4.38 L/s 100,000 GPD, the clarifier chamber should be in multiple units each capable of independent operation and whose combined capacity equals the design flow rate when one unit is out of operation. In fourth sentence, delete first and third optional wordings when design flow is 4.38 L/s 100,000 GPD and below; delete second optional wording when design flow exceeds 4.38 L/s 100,000 GPD.

****

[Provide clarifier chamber with a minimum of 4 hours retention time and a hopper bottom[when mechanical sludge collection equipment is not provided].]The clarifier chamber[, except in circular facilities with a concentric inner tank,] is [in a single unit][or][in multiple units] [each of which is capable of independent operation and] whose combined capacity equals the design flow when one unit is out of operation.[The hopper bottom of the clarifier cannot have slide slopes of less than 1.05 rad 60 degrees from the horizontal; horizontal area of hopper bottom is commensurate with the capability of the sludge pump for efficient sludge withdrawal. In lieu of the above, a flat bottom may be provided with a mechanical sludge scraper in accordance with paragraph SLUDGE AND SCUM COLLECTION AND TRANSFER EQUIPMENT.] Provide means of velocity control at the clarifier chamber inlet. Provide a scum baffle, weir, or other means to prevent scum from passing out with effluent. Provide air lift sludge and scum pumps in accordance with paragraph SLUDGE AND SCUM COLLECTION AND TRANSFER EQUIPMENT.

2.2.1.3 Sludge Holding Chamber

****

NOTE: Insert capacity, generally all waste sludge produced in one week of operation.

****

Provide a sludge holding chamber with a minimum capacity of [_____] cubic meters cubic feet. Provide a supernatant draw-off connection between the sludge-holding chamber and the aeration chamber. Provide an inlet pipe connection or sludge weir for transfer of sludge from the clarifier chamber to the sludge holding chamber. Provide pipe connection(s) in this chamber for waste sludge draw-off. Provide air diffusers in accordance with paragraph DIFFUSED AIR AERATION EQUIPMENT.

2.2.1.4 Disinfection Chamber

Provide a disinfection chamber as an integral part of the plant or an adjacent detached tank. Ensure at least 15 minutes contact time at peak flow rate. Provide baffles to eliminate short-circuiting and ensure complete mixing. Provide disinfection equipment in accordance with paragraph DISINFECTION EQUIPMENT. Provide a flange on the outlet of the tank.

2.2.1.5 Structural Requirements for Steel Tanks

Provide tanks suitable for support by and anchorage to a concrete base. Steel tank walls and bottom are structural steel plate. Use minimum 6 mm 1/4 inchstructural steel shapes for reinforcing and bracing are in the thinnest section. Placement of reinforcing and bracing cannot adversely affect the performance characteristics with the aeration tank. All sides, compartment partitions, tank bottoms, braces, and corners are continuously welded inside and out and ground smooth before priming. Ensure that water tightness is provided by means of welding. Ensure that the common partitions are reinforced to withstand pressures resulting from liquid level differentials that would occur when any individual compartment(s) is dewatered while contiguous compartments remain at normal operating liquid level.

2.3 EQUIPMENT

2.3.1 Aeration Equipment

****

NOTE: Delete reference to mechanical aerator when step aeration type or complete mixing type is specified, or when not allowed.

****

Aeration will take place by [diffused air] [fixed mechanical aeration]. Ensure that the aeration system supplies a minimum of [3] [_____] cubic meters of air per minute per 100 cubic meters of tank volume [30] [_____] cubic feet of air per minute per 1000 cubic feet of tank volume (cfm/1000 cu. ft.). The aeration equipment will completely mix the contents of the aeration tank and maintain a minimum velocity of 0.18 m/s 0.6 fps.

2.3.1.1 Diffused Air Aeration Equipment

****

NOTE: Delete reference to coarse bubble type when not allowed. For facilities of 2.19 L/s 50,000 GPD capacity and below, fine bubble diffusers or coarse bubble diffusers are allowed as Contractor's option. For facilities of more than 2.19 L/s 50,000 GPD, use fine bubble diffusers.

****

Aeration equipment includes diffusers, diffuser holder assembly, air blower assembly, and piping. Provide [fine bubble] [coarse bubble] diffusers. Ensure that the oxygen transfer capacity of the diffuser system is capable of furnishing an adequate supply of oxygen in the aeration tank to meet treatment requirements at the design wastewater load.

2.3.1.1.1 Air Diffusers

Ensure that the diffuser layout provides sufficient mixing capacity to thoroughly mix the waste water throughout the tank depth. Use fixed-nozzle diffusers, individually attached to the headers by screwed connections, U-bolts, or stainless steel straps and springs. Welded or other nonremovable connections are not acceptable. Ensure an oxygen transfer efficiency of at least 6 percent and a pressure drop not greater than 3.5 kPa 0.5 psi at the design flow rate. Provide diffusers of plastic, stainless steel, rubber, or other corrosion resistant material and seal under no-flow conditions to prevent wastewater from entering the piping system.

2.3.1.1.2 Diffuser Holder Assembly

****

NOTE: Delete reference to swing-out type when steel plant only is required.

****

The assembly includes an air control and shut-off valve and all the air piping downstream from this valve. Select a butterfly valve, plug valve, or globe valve suitable for air control with indicator markings for throttling and complete shut-off. The diffuser holder assembly is the [fixed type] [or swing-out type]. Ensure that the spacing of diffuser assemblies in the tank and diffusers on the header is as recommended by the diffuser manufacturer. Provide independently valved and supported headers capable of being independently removed from service without the use of a crane or hoist and without dewatering of the tank.

2.3.1.1.3 Air Diffusers

Provide a drop-pipe with air diffusers in the chamber with placement of diffusers near the bottom. Ensure that the amount of air supplied to the tank is sufficient to allow aerobic stabilization of solids and in no case less than 0.25 cubic meter per second of air per 1,000 cubic meters 15 CFM of air per 1,000 cubic feet of tank volume.

2.3.1.2 Mechanical Aeration Equipment

****

NOTE: Delete paragraph and subparagraph when step aeration type or complete mixing type is specified, or when mechanical aerator is not allowed.

****

Provide a fixed type mechanical aerator. Include a drive assembly, impeller shaft, impeller, and shroud. Provide all accessories necessary for proper operation and to generate the necessary required oxygenation capacity, including flow straightening surge rings or tank baffles.

2.3.1.2.1 Drive Assembly

Provide a fully enclosed for outdoor installation drive assembly including an electric motor, gear reduction unit, and bearings.

a. Motor: Motor is constant speed, totally enclosed, fan-cooled, horizontal type, with solid shaft, suitable for outdoor service, and conforming to NEMA MG 1. Ensure that the motor is of adequate wattage horsepower to drive the equipment continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor must be suitable for operation with the voltage characteristics indicated. Motor must be protected against overload, low voltage, and unbalanced voltage. Connect vertical motor directly to the gear reduction unit or else connect by a flexible coupling. Connect horizontal to the gear reduction unit by a flexible coupling only. In lieu of a constant speed motor with a gear reduction unit, a two-speed motor may be provided as a means of speed reduction.

b. Gear Reduction Unit: Ensure a minimum AGMA service factor when the unit is operating at full load motor wattage horsepower, 24 hours a day continuous running under moderate shock loads, of 1.5 for speed reducers and 2.0 for gear motors. Ensure a life expectancy of 100,000 hours with the probability of no more than 10 percent failures prior to its expected life. Gearing may be spur, helical, spiral bevel, or a combination. If helical, the helical angle must not exceed 0.314 rad 18 degrees. Worm gearing will not be acceptable. All gears must be AGMA Quality 10 or higher as outlined in AGMA ISO 10064-6, AGMA ISO 17485 or AGMA 2011. Provide a lubrication system for the gears.

c. Bearings must have a minimum rated life expectancy (L-10) of 100,000 hours based on ABMA 11 Standards when operating continuously at the rated full-load motor wattage horsepower and speed under the specified loading conditions. Internal bearings may be either oil or grease lubricated. All grease lubrication pressure lines must be fed from fittings accessibly located above the platform supporting the mechanism.Underwater bearings are not acceptable.

2.3.1.2.2 Impeller Shaft

Ensure that the shaft is of sufficient diameter to withstand the loading imposed by the impeller, using a safety factor of 1.5. The shaft must be removable from the speed reducer.

2.3.1.2.3 Impeller

The aeration blades must be designed to achieve the maximum aeration and pumping effect. The impeller must be readily removable from the shaft.

2.3.1.2.4 Shroud

Equip the aerator with a shroud to prevent the mixed liquor from splashing and spraying the underside of the supporting platform, walkway, railings, and walls of the aeration tank.

2.3.1.2.5 Mechanical Aerator Supports, Walkways and Rails

Place supports for mechanical aerator mounting plate on the bottom of the chamber or extended from structural steel beams on tank walls. Provide a service walkway to the mechanical aerator and handrails on each side.

2.3.1.3 Screening

****

NOTE: Delete comminutor and subparagraphs when comminutor is not required. For facilities of 1.09

L/s 25,000 GPD capacity and below, the comminutor may be omitted, and a screening basket provided. For installations in which all wastewater has passed through a comminutor and bar screen upstream, a comminutor is not required.

****

Provide a [comminutor] [screening basket] [bar screen] in the influent line immediately upstream of the aeration chamber.

[2.3.1.3.1 Comminutor

Provide a rotating type comminutor capable of cutting all wastewater solids including sticks, rags, and stringy material without clogging the screen or binding, jamming or stalling the moving parts under normal load conditions. Ensure that the comminutor is capable of continuous operation and have a hydraulic capacity at least equal to the treatment facility peak flow rate and at zero flow conditions. Ensure that the screen configuration is such that all wastewater must pass through it before entering the treatment facility. Space screen bars not greater than 6 mm 1/4 inch apart. Provide cutters constructed of tool steel with a surface hardness of at least 35 on Rockwell C scale. Ensure cutters are removable for replacement. Ensure free discharge where the discharge is located above the liquid level in the aeration chamber or controlled discharge when partially submerged.

2.3.1.3.1.1 Comminutor Drive

Provide a comminutor driven by an electric motor, constant speed, totally enclosed, horizontal or vertical type, suitable for outdoor service, and conforming to NEMA MG 1. The motor must be of adequate wattage horsepower to drive the comminutor continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor must be suitable for operation with the voltage characteristics as indicated. Motor must be protected against overload, low voltage, and unbalanced voltage.

][2.3.1.3.2 Screening Basket

Provide at the plant influent, a readily removable, fabricated steel screening basket, sized for maximum flow, located so that the total volume of incoming raw wastewater is screened before it enters the plant. Fabricate the basket from 5 mm 3/16 inch diameter 302 stainless steel wire or 10 mm 3/8 inch hot-rolled steel bars with 25 mm one inch space between bars.

][2.3.1.3.3 Bar Screen

Provide an inlet bar screen to remove large solids from the incoming raw wastewater. Fabricate the bars from 13 mm 1/2 inch diameter bars spaced 25 mm one inch apart and arranged as shown in the drawings. The bars will be sloped to permit easy cleaning of debris. Furnish a drying deck for the debris.

]2.3.2 Sludge and Scum Collection and Transfer Equipment

****

NOTE: For facilities below 0.66 L/s 15,000 GPD capacity, hopper bottom only should be specified for clarifier chambers. For facilities above 4.38 L/s

100,000 GPD capacity, mechanical sludge collectors should be used in clarifier chambers. For facilities between 0.66 L/s and 4.38 L/s 15,000 and 100,000 GPD capacity, either hopper bottom or mechanical sludge collector should be allowed.

Delete reference to mechanical sludge collection equipment for extended aeration facilities below 0.66 L/s 15,000 GPD capacity.

****

Provide equipment to collect sludge from the bottom of the clarifier chamber. Collect sludge through the use of a hopper bottom clarifier chamber or a flat bottom clarifier chamber with a mechanical collector. The equipment will also collect scum from the top of the clarifier. Sludge and scum collection and transfer equipment includes sludge transfer pump(s), [mechanical sludge collection equipment [(if used)],] scum collection and transfer system, and supernatant transfer.

2.3.2.1 Sludge Transfer Pumps

Provide a positive sludge recirculation system. If the sludge clarifier is the hopper bottom type, provide at least one air lift pump in each hopper. If the clarifier contains a mechanical sludge collector, provide an air lift pump at the collector discharge. Each air lift includes a foot piece, eductor, air and vent piping, and control valves. Sludge recirculation air lifts will have recirculation capacity of 0 percent to 150 percent of the design flow. Support pump and equip with a clean-out plug for cleaning and maintenance.

2.3.2.2 Mechanical Sludge Collection Equipment

If the clarifier does not have a hopper bottom, provide a mechanical sludge collector to scrape the entire tank bottom. Mechanical sludge collectors may be either the rotating arm or conveyor type. Drive the collector by an electric motor through an appropriate gear or chain drive. Position motors and drives above the plant high water level or use equipment suitable for submerged service. Ensure motors are totally enclosed and conform to NEMA MG 1. Furnish each motor with a magnetic starter with thermal overload protection and control devices conforming to NEMA ICS 1. Avoid sludge-residence time exceeding 3 hours. Scraper blades will be replaceable. Provide collector drive with overload protection.

2.3.2.3 Scum Collection and Transfer Equipment

2.3.2.3.1 Scum Collection in Hopper Bottom Settling Tanks

Scum collection is accomplished by means of a suction skimmer. Suction skimmer is a 50 mm 2 inch diameter drop pipe supported by a structural steel member and so mounted that it can be raised or lowered with respect to the liquid surface by means of stainless steel adjusting screws with hand knobs or by corrosion-resisting turnbuckles located above the liquid surface. Attach the lower end of drop pipe to a 50 mm 2 inch air lift by means of a flexible hose of chloroprene or other material suitable for use in sewage.

2.3.2.3.2 Scum Collection in Circular Settling Tanks

Scum Collection in Circular Setting Tanks With Mechanical Sludge

Collectors: Scum collector assembly includes a blade skimmer and a scum trough. Assembly is continuously move surface scum to the scum trough. The assembly discharges scum with a minimum discharge of water. Blade skimmer includes an arm fabricated of structural steel shapes and attached to a steel blade skimmer or floating redwood skimmer, with an adjustable chloroprene wiper. Scum skimmer is supported by the center shaft and one scraper arm. Scum trough is welded structural steel, minimum thickness 6 mm 1/4 inch, has a connection to the scum airlift pump, and supported from the tank wall or scum baffles. Shape the inclined approach ramp leading to the scum trough to contain the scum as it is moved up the incline to the trough by the scum skimmer.

2.3.2.3.3 Scum Collection in Rectangular Settling Tanks

Scum Collection in Rectangular Setting Tanks With Mechanical Sludge Collectors: Accomplish the scum collection by means of traveling blade or paddle skimmer or by suction skimmer. Attach the traveling blade or paddle skimmer to the traveling sludge collector at surface level and designed to sweep the surface of the settling tank in one direction only with each pass of the sludge collector. Collected scum is discharged into a trough, collector pipe or suction skimmer. Scum trough is steel, 6 mm 1/4 inch minimum thickness, with approach ramp and have a connection to the scum air lift pipe and supported from the tank wall. The collector pipe is steel pipe with a 1.05 rad 60 degree wide slot cut symmetrically above the vertical axis. At maximum intervals of 750 mm 30 inches, a 50 mm 2 inch wide band of full circumference is left for stiffness. End supports includes a rolled steel collar welded to an adjustable steel end plate. Provide a readily renewable grease-resistant, watertight seal and so constructed that it will allow smooth action of the revolving pipe. Ensure that the seal is readily renewable without removing pipe. Secure the end supports to the concrete walls by stainless steel anchor bolts having a minimum diameter of 16 mm 5/8 inch. Collector pipe operator is a manual, lever type, mounted on the collector pipe. Operator is steel pipe having a minimum diameter of 31 mm 1 1/4 inches and secured to the collector pipe with a bolted connection. The operator extends at least 900 mm 3 feet above the top of tank and permits rotation of the collector pipe to at least 0.52 rad 30 degrees of each side of the vertical axis. Ensure that the collector pipe has a suitable means of discharge to the scum airlift pump.

2.3.2.3.4 Scum Recirculation System

Scum transfer is accomplished by means of an airlift pump. Airlift pump consists of a 50 mm 2 inch airlift skimming device. The skimming device will skim and return floating material to the aeration chamber. Equip the supply airline with a valve to regulate the rate of return. Ensure the scum intake is adjustable providing exact positioning of the skimmer at water level.

2.3.2.4 Supernatant Transfer

When a pump is used for supernatant transfer, provide a positive means of flow regulation. Provide all necessary piping.

[2.3.3 Froth Control System

****

NOTE: Froth removal may be required where nicardia foaming is a potential problem.

****

Provide a froth control system including: pump, piping, manifold, spray nozzles, and valves.

2.3.3.1 Froth Control System Pump

Provide an electric motor operated, self-contained, submersible pump suitable for the required service. Mount the pump with the suction no less than 50 mm 2 inches below the water surface but not so deep that the pump will pick up settled solids. Provide an intake screen around the pump suction. Ensure that the screen openings are no larger than the pump nozzle opening. Provide a watertight motor in accordance with NEMA MG 1. Provide controls, including a magnetic starter with start and stop buttons and a circuit breaker with reset button in conformance with NEMA ICS 1.

2.3.3.2 Spray Nozzles

Provide self-cleaning spray nozzles, that will produce a sharp flat or conical spray at normal pumping rates. Use spray nozzles of corrosion-resisting materials to provide sufficient force at a flow rate of 0.1 L/second 1-1/2 gpm per nozzle to effectively break down accumulated froth. Mount spray nozzles to provide uniform coverage of the chamber.

2.3.3.3 Piping and Valves

Provide a froth spray header of at least 25 mm one inch diameter galvanized steel or PVC pipe and mount above the water surface opposite the air diffusers. Provide for a garden hose connection for wash-down purposes.

]2.3.4 Air Blower Assembly

Provide an air blower assembly including: air blowers, blower driver, V-belt drive (for positive displacement blower), housing and accessories. Provide each blower with [a filter-silencer on the suction side,] a check valve, pressure relief valve, and pressure gauge.

2.3.4.1 Air Blower

Provide at least two air blowers with the capacity to produce the plant air requirement at the necessary operating pressure including allowance for pressure drop in air piping, fittings, and accessories. The unit will deliver [_____] cubic meters/second cfm when operating at [_____] kPag psig. Ensure blowers are suitable for continuous operation. Each blower must have the capacity to provide the total plant air requirement.

2.3.4.2 Blower Driver

The blower drive consists of an electric motor, V-belts, and sheaves. Motor must be suitable for operation with the voltage characteristics as indicated. Blower motor will be weatherproof conforming to NEMA MG 1. Provide a constant speed, totally enclosed, fan-cooled motor, suitable for outdoor service, and conforming to NEMA MG 1. Ensure that the motor is of adequate wattage horsepower to drive the equipment continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Ensure that the motor is suitable for operation with the voltage characteristics as indicated. Protect the motor against overload, low voltage, and unbalanced voltage. Provide any silencing or dampening required.

2.3.4.3   Air Blower and Blower Driver Housing

Mount the blower-driver on a base plate with vibration dampening in a weatherproof, corrosion resistant enclosure. Ensure that the base plate has provisions for adjustment of V-belt tension, and provides the necessary anchoring. Provide louvers or ventilation adequate to provide air for cooling and, if the intake is in the enclosure, for blower supply. Allow access to the blowers and motors for maintenance.

2.3.4.4   Air Blower Accessories

[2.3.4.4.1   Air Filter Silencer

****

NOTE: Optional, consider use of filter-silencers on blowers of 0.094 cubic meters/second 200 cfm or less or separate silencer and air filter as well as a discharge silencer on blowers over 0.094 cubic meters/second 200 cfm.

****

Provide filter-silencer type, cleanable, air filters. If filters are mounted outside, provide weatherproof enclosures. Provide filters having a maximum pressure loss of 25 mm 1.0 inch water gage mm In.W.G. at the maximum capacity of blower when clean. Ensure that the silencing chamber has a peak attenuation in the frequency range 300-1, 1,200 cycles per second.

]2.3.4.4.2   Pressure Relief Valve

Provide a pressure relief valve for each blower on the discharge side. Furnish a valve for a pressure setting of not more than 90 percent of the maximum operating pressure.

2.3.4.4.3   Check Valve

Provide a check valve on the discharge side of each blower.

2.3.4.4.4   Pressure Gage

Provide an air pressure gage on the discharge line from each blower. Gauge scale range to include the full range of expected operation and up to 125 percent, but not more than 150 percent of maximum. Mount the gages in an easy to read location within the enclosure.

2.3.5   Disinfection Equipment

****

NOTE: Delete the reference to a heater for plants in areas where freezing temperatures are not encountered.

For small facilities of that do not require flow proportional chlorination, a tablet chlorinator offers a safe and effective means of disinfection.

Delete unused disinfection system paragraphs below. Hypochlorinator may be specified for plants 4.38 L/s 100,000 GPD capacity and below. Chlorinator may be

specified for all plants 6.57 L/s 150,000 GPD capacity and above. Make a selection on basis of existing station or base practices, local availability, and comparative costs.
****

Provide the manufacturer's standard disinfection system [Chlorine Tablet Feed] [Chlorinator Assembly] [Hypochlorinator Assembly] [UV Disinfection].

[2.3.5.1 UV Disinfection

Ultra-violet system includes lamps, ballasts, and controls.[Provide heater.]

][2.3.5.2 Chlorine Tablet Feed

Provide a tablet chlorinator feeder[, provide heater if required].

][2.3.5.3 Hypochlorinator Assembly

Provide hypochlorite assembly in accordance with Section 46 31 11 CHLORINE GAS FEED EQUIPMENT. Provide an adjustable capacity system of between 2 to 8 mg/L of chlorine equivalent, with fully automatic and manually adjustable operation[, provide heater if required].

][2.3.5.4 Chlorinator Assembly

Chlorinator assembly includes chlorinator, scale, chlorine gas manifold, flexible connector, water piping, chlorine solution piping, vent tubing, vacuum signal tubing, diffuser, and housing. Provide chlorinator assembly in accordance with Section 46 31 11 CHLORINE GAS FEED EQUIPMENT. Ensure that the chlorinator has proportional-automatic control. Ensure that the chlorinator receives chlorine gas from chlorine cylinders and water from the water supply system[, provide heater if required]. Discharge the chlorine solution through piping to the diffuser located in the chlorine contact chamber.

]2.3.6 Flow Measuring Equipment

2.3.6.1 V-notch weir

Use a V-notch weir that can measure flow to plus or minus 2 percent of the actual rate over a five-to-one range.

2.3.6.2 Float Operation

Provide flow measurement of wastewater by an effluent weir and a recorder. The recorder will be of the electrically operated circular or strip chart type and continuously record the flow through the plant in L/second gpm. The recorder will also produce an electrical signal in proportion to the flow for control of the chlorinator. Provide a weatherproof enclosure for the recorder.

2.3.6.3 Ultrasonic Measuring

Measure wastewater flow by an effluent weir and an ultrasonic flow meter with digital recorder. Measurement is noncontact, echo-time measuring-type for use with V-notch weir. Provide reference receivers for instant compensation in gas medium for temperature, atmospheric pressure and humidity changes. Provide a NEMA 4X enclosure for the transmitter and include an indicator and recorder. Ensure the transmitter provides a flow proportional signal if required.

2.3.6.4 Flow Control

Provide adjustable weirs at the inlet and outlet of the disinfection chamber for control of wastewater depth in the plant.

2.4 COMPONENTS

2.4.1 Piping System

2.4.1.1 Air Piping

Air piping includes all piping from the blowers to the diffusers and air lift pumps. Provide gate valves in air piping branches from air main when serving two or more air diffuser drop pipes; provide gate valves as blow-off valves for air mains.

2.4.1.2 Sludge Return, Waste Sludge and Scum Return Piping

Provide valves on air lift discharge piping between the air lift discharge riser and the air separator. Provide gate valves, globe valves, or plug valves in branch piping for return sludge and waste sludge lines when separate return sludge and waste sludge pumps are not used.

[2.4.1.3 Froth Control System Piping

Provide valves in suction and discharge piping to froth control pump and in the froth control main line piping.

]2.4.1.4 Miscellaneous Piping

Provide a flanged connection to incoming wastewater line. [Provide inlet piping for concrete aeration tanks in sleeve in wall and connected to incoming sewer by means of a grout ring.]Provide gate valves or shear gates for a tank drain or dewatering piping.

2.4.2 Electrical Control System Components

****

NOTE: Specify outdoor type enclosure except when enclosure will be located in a building.

****

The system includes enclosure; main and branch circuit breakers; starters, contactors, and reset buttons; selector switches, push buttons, and pilot lights; circuit control items for electrical control of the various plant components; and all necessary wiring and tubing. Provide an electrical control system in accordance with NEMA ICS 1. Ensure that all electrical components are in accordance with the requirements of NFPA 70.

Mount electrical controls in [outdoor weatherproof enclosure, NEMA [3R][4X]] [indoor enclosure, NEMA 1 OR NEMA 12]. Wire electrical controls so that the various items of plant equipment can be operated either manually or automatically. Completely wire all electrical control system components and mount in the enclosure at the manufacturer's facility and test prior to shipment from the factory. The electric service available is

[_____] volt, [_____] phase, [_____] Hertz, [_____] wire. [Install all push buttons, selector switches, and indicating lights on the outside of the door(s), properly identified with name plates.]Identify all components on the [outside of enclosure and on the] internal panel.

2.4.2.1 Sequence of Operation

Ensure the electrical control system and its components perform the following automatic functions:

****

NOTE: Delete reference to comminutor when not required.

****

a. The 7-day program timer automatically starts and stops the blowers [comminutor,] [and froth control system pump]. A percentage timer automatically starts and stops blower motors.

b. If operating lead blower should stop, standby blower, acting in response to setting of failure transfer timer, automatically starts and stays in operation until such time as lead blower returns to service. Range of failure transfer timer is such as to prevent the transfer to the standby system from such causes as momentary interruptions of power, loss of power and similar malfunctions. Provide a selector switch to allow manual change in the lead-standby system. Arrange pressure switches in the motor control circuit to cause the system failure transfer circuit to operate when there is a lack of or loss of pressure due to belt slippage or breakage, or air loss, until such time as the fault is corrected. Horn and warning light alarm circuits are energized to indicate that the standby system has replaced the selected lead blower in operation.

c. [Chlorinator is controlled by the flow meter and starts, stops, and proportionally regulates the dosage in response to the received signals.][[Hypochlorinator][Tablet feeder] starts and stops in response to signals from liquid level sensing probes.]

d. Thermostat automatically places into operation equipment automatically taken out of service by the 7-day timer when the outside air temperature drops below 0 degrees C 32 degrees F or any other predetermined temperature setting.

e. A percentage timer automatically controls the sludge transfer pump, scum transfer pump, and supernatant return pump.

[f. Ensure that the froth control system pump is suitably interlocked with blowers so as to automatically start and stop in parallel with the blowers.

]2.4.2.2 Circuit Breakers

All circuit breakers must be thermal magnetic type and meet the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.4.2.2.1 Main Circuit Breaker

Ensure that the main circuit breaker has a maximum capacity of 150 percent of the electrical load. The main circuit breaker has an external handle mechanism mounted outside the enclosure to permit operation of this breaker from outside the enclosure. Provide the main circuit breaker with positive locking device to permit locking the operating handle.

2.4.2.2.2 Branch Circuit Breakers

****

NOTE: Delete references to unused components.

****

Provide an E-frame bolt-on type branch circuit breakers mounted on an interior bus bar. Provide branch circuit breakers for each blower, [comminutor,] [mechanical aerator(s),] froth control system pump, [sludge collector drive motor,] [hypochlorinator,] control circuit, [control circuit transformer,] flow meter, [chlorinator housing heater,] [hypochlorinator housing heating device,] drive motor, lighting circuit(s), and receptacle. Ensure that the panel includes spaces for four additional circuit breakers.

2.4.2.3 Starters, Contactors, and Reset Buttons

Provide magnetic starters for each blower motor, [(each) mechanical aerator motor,] [comminutor motor,] and froth control system pump motor, [sludge collector drive motor]. Mount reset buttons for magnetic starters on enclosure doors.

[2.4.2.4 Selector Switches, Pushbuttons, and Pilot Lights

Mount selector switches, pushbuttons, and pilot lights on the outside of the enclosure. Provide One Hand-Off-Automatic (H-O-A) selector switch for each motor starter. Provide one selector switch for changing lead blower in the lead-standby system. Provide push buttons for manual (Hand) operation of motors. Provide pilot lights for each H-O-A selector switch: red to indicated motor is running and amber to indicate automatic operation. Connections to the selector switch are such that only the normal automatic regulating control devices will be by-passed when the switch is in the "Hand" position. Connect all safety control devices such as motor overload protection devices in the motor control circuit in both the "Hand" and "Automatic" positions.

]2.4.2.5 Circuit Controls

****

NOTE: Delete last sentence when not necessary.

****

Circuit controls include the following: Program timer, 30-minute percentage timer, thermostat, control circuit transformer, and all necessary relays and pressure switches to carry out the sequence of operation as specified above. Program timer is the 7-day type, electric motor driven, with each hour of the day shown. Ensure that the time intervals are adjustable with a minimum switching interval of 4 hours. Percentage timer is 30-minute type.[Provide a transformer to step down incoming service voltage to 120 volts.]

[2.4.2.6 Alarm

****

NOTE: Delete requirements for alarm circuit

auxiliary contacts where transmission of alarm to remote 24-hour manned station is impractical or not desired. Transmission is preferred where necessary to expedite investigation of alarm condition. Insert identity of remote location. Provision should be made in the appropriate section of the project specification to extend alarm circuit wiring from auxiliary contacts to the remote location.
****

Provide a horn or 150 mm 6 inch bell alarm, battery and necessary circuits to sound alarm:

a. when standby blower(s) has replaced lead blower

b. when power to plant has been interrupted

[Include an alarm circuit with auxiliary contacts for transmission of signal indicative of either alarm condition to [_____].

]]2.4.2.7 Electrical Wiring

Wire all control circuits in accordance with the Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.5 MATERIALS

2.5.1 Treatment and Painting

Except as otherwise specified, treat and paint equipment in accordance with the manufacturer's standard practice.

2.5.2 Lubrication

For equipment requiring lubrication, provide means for lubrication of all moving parts and lubricate prior to delivery.

2.5.3 Steel Plates, Shapes, and Bars

For steel plates, shapes, and bars, conform to ASTM A36/A36M or ASTM A276/A276M.

2.5.4 Ductile Iron Pipe and Fittings

For ductile iron pipe, conform to AWWA C151/A21.51, ASME B16.4 and ASME B16.5.

2.5.4.1 Flanged Ductile Iron Pipe

For flanged pipe, conform to AWWA C115/A21.15 with ASME B16.1, Class 125 flanges.

2.5.4.2 Joints

For joints for ductile iron pipe, conform to AWWA C111/A21.11.

2.5.4.3 Fittings for Ductile Iron Pipe

For fittings for ductile iron pipe, conform to AWWA C110/A21.10.

2.5.5 Steel Pipe

For steel pipe, conform to AWWA C200.

2.5.5.1 Flanged Joints

For flanged joints, conform to AWWA C207, Class B Ring Type.

2.5.5.2 Slip Joints

For slip joints, conform to AWWA C200.

2.5.5.3 Mechanical Joints

For mechanical joints, conform to AWWA C200.

2.5.5.4 Welded Joints

For welded joints, conform to AWWA C206.

2.5.5.5 Fittings for Steel Pipe

For steel pipe fittings, conform to AWWA C200.

2.5.6 Galvanized Steel Pipe and Fittings

Galvanized steel pipe will conform to ASTM A53/A53M, standard weight, galvanized. Pipe smaller than 100 mm 4-inch diameter will have screwed joints in accordance with ASME B1.20.2M ASME B1.20.1. Fittings will be galvanized malleable iron in accordance with ASME B16.3. Pipe 100 mm 4-inch diameter and larger has flanged joints and fittings in accordance with AWWA C207.

2.5.7 Polyvinyl Chloride (PVC) Pipe and Fittings

PVC pipe and fittings less than 100 mm 4-inch diameter will be in accordance with ASTM D1785 or ASTM D2241. PVC pipe and fittings 100 mm 4 inch in diameter and larger is in accordance with ASTM D2241 or AWWA C900 and have push-on joints.

2.5.7.1 Push-On Joints

Push-on joints will conform to ASTM D3139 or ASTM F477.

2.5.7.2 Solvent Cement

Solvent cement will conform to ASTM D2564.

2.5.8 Pipe Hangers and Supports

Pipe hangers and supports will conform to MSS SP-58.

2.5.9 Valves

2.5.9.1 Angle, Check, and Globe Valves

Angle, check and globe valves will conform to MSS SP-80, Type 3 Globe and Angle, Types 3 and 4 Check.

2.5.9.2 Gate Valves

Gate valves will conform to MSS SP-80 or MSS SP-70.

2.5.9.3 Plug Valves

Bronze plug valves will conform to MSS SP-78. Iron plug valves will conform to API Spec 6D.

2.5.10 Butterfly Valves

Provide butterfly valves conforming to AWWA C504.

2.5.11 Joint Compound

Joint compound for screwed joints will be a stiff mixture of graphite and oil, inert filler and oil, or a graphite compound.

2.5.12 Joint Tape

Joint tape for screw joints will conform to ASTM D3308.

2.5.13 Bolts and Nuts

Bolts and nuts will conform to ASTM A307, Grade B.

2.5.14 Gears

Conform to the following for AGMA standards for surface durability, strength and materials: Spur gearing and helical gearing: AGMA 908, ANSI/AGMA 2001, ANSI/AGMA 2004, ANSI/AGMA 6113 ANSI/AGMA 6013, and ANSI/AGMA 6034

2.6 ACCESSORIES

[2.6.1 Chlorine Gas Manifold

Ensure that the chlorine gas manifold is a material resistant to chlorine and suitable for the working pressure involved.

2.6.2 Flexible Connector

Ensure that the flexible connector between the chlorine gas manifold and the chlorinator is extra-heavy Type K seamless copper tube conforming to ASTM B88M ASTM B88.

2.6.3 Water Piping

Water piping is schedule 80 PVC piping with solvent welded joints. Provide a gate valve and check valve conforming to MSS SP-80 and a Y-pattern brass or stainless steel strainer.

2.6.4 Solution Piping

Ensure that the solution piping from chlorinator to diffuser is flexible polyethylene pipe, chlorine solution hose, rigid polyvinylchloride (PVC) pipe, or rigid acrylonitrile-butadiene-styrene (ABS) pipe.

2.6.5 Vent Tubing

Vent tubing is any elastomer or plastic tubing resistant to chlorine or chlorine solutions. Any other material having qualities acceptable for such use may be substituted in place of the elastomer or plastic tubing. Slope the vent line continuously downward to outside of housing without dips or sags. Provide an insect screen at end of line.

2.6.6 Signal Tubing

Signal tubing is Type K soft copper tubing.

2.6.7 Diffuser

Provide a diffuser of rigid PVC or ABS pipe, resistant to chlorine solution. Provide an open channel type diffuser that is perforated and fastened at each end to the tank wall near the bottom in the flow stream of the influent to the chlorine contact tank.

2.6.8 Housing

Enclose the chlorinator scale, piping, and controls in a weatherproof housing constructed of 0.9 mm 20 gage metal with minimum 25 mm one inch insulation. Provide a full access door for easy access to equipment. Mount the housing on top of treatment plant or on a concrete pad adjacent to the chlorine contact tank that projects not less than 150 mm 6 inches beyond outside face of housing. Provide a thermostatically controlled space heater within the housing to maintain a temperature of 21 degrees C 70 degrees F.

]2.6.9 Appurtenances and Accessories

2.6.9.1 Walkways, Platforms, and Bridges

****

NOTE: Include handrails around plant perimeter if plant is installed with tank walls at or near grade.

****

Provide access walkways and platforms for access to all equipment for operation and maintenance. Make walkways and platforms nonslip open grating fabricated from galvanized steel, factory painted mild steel, aluminum, or fiberglass. Provide rigid handrails along the sides of walkways and platforms [and around the perimeter of the entire plant]. Fabricate handrails from aluminum, galvanized steel or painted steel, be 1075 mm 42 inch high, and have two horizontal rails. Provide gates as required for access to equipment. Provide access walkways, platforms, and handrails conforming to Section 05 12 00 STRUCTURAL STEEL.

[2.6.9.2 [Access Stairway] [Access Ladder]

****

NOTE: Delete references and requirements for access ladder as Contractor's option unless it can be justified on an economic and technical basis. Although more expensive, a stairway is preferable in that it provides safer and easier access to platforms and walkways.

Delete "raised platform floor plate" or "grating" as necessary. Delete references and requirements for raised platform floor plate or for grating as necessary. Grating is recommended where snow or ice accumulation may be anticipated; otherwise, use floor plate.

****

When top of plant is more than 600 mm 24 inches above surrounding ground level, provide an access [stairway] [ladder]. Fabricate stairway of structural steel members. Steps are [raised-pattern floor plate] [grating].[Provide access ladder(s) of steel or aluminum and be 450 mm 18 inches wide minimum, with step bars spaced 300 mm 12 inches on center. Provide ladders anchored at the bottom, top, and intermediate points with brackets 1.8 m 6 feet apart. Ensure that the brackets are the same size as side bars and of such length as to hold ladder 150 mm 6 inch away from walls. Provide curved returns at top of ladder. Aluminum side bars and step bars conform to ASTM B221M ASTM B221.]

]2.6.9.3 Handrails

Provide handrails on stairways, platforms, bridges, and other points of personnel access for operation and inspection. Provide a handrail around the perimeter of the tank if the top of the exposed side wall is less than 1.07 m 3 feet 6 inches above grade. Construct handrails of structural steel section or of standard 38 mm 1 1/2 inch pipe conforming to ASTM A53/A53M.

[2.6.9.4 Raw Wastewater Recirculation Box

****

NOTE: Delete this paragraph when raw wastewater recirculation box is considered unnecessary. When wastewater is pumped to the treatment plant, the use of a raw wastewater recirculation box (which recirculates a portion of incoming wastewater back to the pumping station) should be considered to provide uniform flow and avoid surges through the plant. Base decision on undesirability of surge effects on the plant vs. economics of the recirculation system.

****

Fabricate a raw wastewater recirculation box from 6 mm 1/4 inch steel plate and have suitable sized connections for incoming raw wastewater line, plant influent line, and recirculation line. Provide box with a fixed weir and an adjustable weir or other suitable means of flow regulation so that a portion of the incoming raw wastewater may be recirculated. Provide a removable or hinged cover. Continuously weld the joints inside walls, bottom, and partitions inside and out. After welding, remove weld spatter and extreme roughness. Inlet cannot be less than 200 mm 8 inch size.

]2.6.9.5 Influent Flow Division Box

****

NOTE: Delete this paragraph when not used. Delete for extended aeration type 0.66 L/s 15,000 GPD and below and for all step aeration type and complete mixing type facilities and extended aeration type

when complete mixing type facilities and extended aeration type when eventual conversion to step aeration type is contemplated.
****

With two or more aeration tanks, provide a plant influent flow division box. Fabricate the box of 6 mm 1/4 inch steel plate and have suitably sized connections for incoming raw wastewater line and influent lines to each aeration tank. Ensure that the box for dividing flow between two tanks has a hinged divider plate that will permit adjustment of from zero to 100 percent to either outlet. Divider plate has locking nut and handle. Ensure that the box has a hinged cover with provisions for padlocking. Provide a continuous weld for all inside walls, bottom, and partitions, inside and out. After welding, remove all weld spatter and extreme roughness. Flow division boxes for more than two tanks are as specified herein, except that method of flow division is as recommended by the manufacturer of the plant.

2.6.9.6 Influent Distribution Channel

****
NOTE: Delete this paragraph for extended aeration type except when eventual conversion to step aeration type is contemplated.

Use first optional wording in fifth sentence for step aeration type and second optional wording for complete missing type.
****

Continuously weld the aeration tank influent distribution channel to the side of the tank wall. Ensure that the bottom of the channel is at the same elevation as the liquid surface of the aeration tank. The inlet to the channel is at one point and not less than 200 mm 8 inches in diameter. Fabricate the channel from steel plate of not less than 6 mm 1/4 inch thickness. Provide the channel with [adjustable weirs or stop gates, not less than three in number, spaced the full length of the channel] [multiple discharge openings] for uniform distribution to the aeration tank. Provide weir or stop gates of stainless steel or aluminum. Ensure that the gates have gaskets on the bottom, with wedges or other means to insure a close fit. Guides for the gates are of the same material as the gates. Ensure that the channel is of such size as to accommodate the peak flow to the plant.

2.6.9.7 Sludge Division Box

****
NOTE: Delete this paragraph when sludge return is not used.
****

Provide a sludge division box to divide return sludge and waste sludge. Fabricate the box of 6 mm 1/4 inch steel plate and have a suitably sized connection for incoming sludge and outlets for return sludge and waste sludge. Provide the box with a hinged plate or adjustable gate that will permit adjustment of flow from zero to 100 percent to either outlet. Plate or gate to have a locking nut and handle. Provide a weir on each outlet. Ensure that the box is adequately [covered] [and baffled] to prevent splashing of the sludge. Continuously weld all joints between walls, bottom, and partitions inside and out. After welding, remove all weld spatter and extreme roughness.

2.6.9.8 Clarifier Effluent Weir and Scum Baffle

Provide weir and scum baffles of stainless steel, ASTM A240/A240M, ASTM A36/A36M, or aluminum ASTM B209M ASTM B209 or ASTM B221M ASTM B221, alloy 6061, temper T6. Provide weirs, of a size and section for structural stability to handle peak flows through the plant. The upstream face of the weir plate is flat and smooth. Ensure that the weir plates and baffle supports permit horizontal and vertical adjustment of the weir and baffle. Mount weir plates to fill any voids between the tank and the weir plate.

2.6.9.9 Mixer for Return Sludge Mixing

****

NOTE: Delete this paragraph and subparagraphs thereto except for complete mixing type.

****

2.6.9.9.1 General

Provide a vertical mixer and include a drive assembly, impeller shaft and impeller, and support. The mixer will continuously mix raw wastewater with return sludge so that the mixture is homogeneous.

2.6.9.9.2 Drive Assembly

Mixer driver assembly includes an electric motor connected to a gear reduction unit whose output shaft is directly connected to the mixer impeller shaft. Motor is constant speed, totally enclosed, fan-cooled horizontal type, suitable for outdoor service, and conforming to NEMA MG 1.

Ensure that the motor is of adequate wattage horsepower to drive the equipment continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Ensure that the motor is suitable for operation with the voltage characteristics indicated. Protect the motor against overload, low voltage, and unbalanced voltage. Power transmission from motor to impeller shaft is by means of a vertical or a right angle gear reduction unit. Ensure that the reduction ratio is such as to produce the proper operating speed for the mixer.

Ensure that the gear reduction unit will withstand any loadings produced by thrust, out-of-balance, and vibration resulting from operating conditions and operate from zero rpm to a speed compatible with the impeller speed. All components must continuously withstand the full load wattage horsepower. Use bronze for worm gears. Use wrought or alloy steel for all other gears. The gear teeth may be through-hardened, contour-induction-hardened, nitrided, or carburized. Flame-hardened gears will not be acceptable. Provide a lubrication system for the gears.

Ensure that the housing is of high quality, close-grained cast iron or fabricated steel. Bearings may be lubricated with oil or grease. Base plate or mounting lugs are of steel or integrally cast with the gear reduction unit and furnished with leveling anchor bolts with lock nuts.

2.6.9.10 Anchorage

Materials necessary for anchorage of the plant to the concrete support slab are as recommended by the manufacturer of the facility.

2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

2.7.1 Factory Inspection

****

NOTE: Delete the paragraph when concrete plant only is required.

****

Factory inspection includes soundness of welds and water tightness for tanks fabricated at the factory. Inspect the primary and finish shop painting for pin holes or voids.

2.7.2 Quality Assurance

2.7.2.1 Package Wastewater Treatment Plant Layout Drawings

Show the complete assembly of the plant with all components, equipment, and parts, each with an assigned number corresponding to the plant manufacturer's parts list.

2.7.2.2 Package Wastewater Treatment Plant Component Drawings

Show construction details for each component and piece of equipment, including aeration chamber, clarifier chamber, sludge holding chamber, disinfection chamber, blower assembly, diffuser layout, pump assemblies, [comminutor assembly,] [,mechanical aerator assembly,] support slab, [disinfection assembly,] appurtenances, and all piping and wiring.

2.7.2.3 Diffuser Layout Drawings

Show construction details for the diffuser layout including diffusers, diffuser holders and diffuser holder assemblies, blower assembly, and air piping layouts.

[2.7.2.4 Mechanical Aerator Drawings

****

NOTE: Delete the bracketed phrase when step aeration type of complete mixing type is specified or when mechanical aerator is not allowed for extended aeration type.

****

Show manufacturer's suggested geometry in sufficient detail for construction.[Show construction details for the mechanical aerator assembly, including shroud and draft tube (if used).]

]2.7.2.5 Excavation and Backfilling

Include specific instructions for excavation and backfilling as interrelated to plant installation and any special concrete work necessary.

2.7.2.6 Package Wastewater Treatment Plant Performance Test Reports

Submit reports of plant performance evaluation tests by the National Sanitation Foundation (NSF). These tests are performed in conformance with the criteria based on the use of the Standard Performance Evaluation Method of the NSF report. [Base the test on the subdivision flow pattern.]For all units not tested by NSF, reports of independent performance tests are required on the type of plant submitted for the project. These tests are in accordance with the Standard Performance Evaluation Method based on the subdivision flow pattern as established by the NSF.

2.7.2.7 Chamber Tests

****

NOTE: Delete paragraph sentence when concrete plant only is required.

****

Submit a test report stating that all chambers of the prefabricated steel plant have been tested (1) as watertight, (2) welds are sound, (3) the finish is smooth, and (4) are shop painted before shipment to the site.

2.7.2.8 Electrical Control System

Ensure that the electrical control system and its components are wired and tested, including motors and controls in accordance with specification requirements for manual and automatic operation of wastewater treatment plant equipment.

[2.7.2.9 Mechanical Aerators

****

NOTE: Delete paragraph when step aeration type or complete mixing type is specified or when mechanical aerator is not allowed.

****

Submit certification that the aerator has an oxygenation capacity of 1.36 kg 3.0 lb of oxygen per electrical input watt per hour horsepower per hour, when tested under standard conditions in clear tap water at 20 degrees C 68 degrees F and zero D.O. Certification includes description of test procedure, test data, and calculations of oxygenated capacity. Also furnish data to substantiate that the manufacturer's aerator can achieve mixing and adequate velocities for the geometry of the basin as indicated.

]2.7.2.10 Materials Not Labeled or Certified

For materials whose compliance with organizational standards or specifications is not regulated by an organization using their own listings or labels as proof of compliance, submit a certificate stating that the material complies with the applicable referenced standard or specification. This statement is in addition to any proof required.

2.7.3 Source Quality Control

****

NOTE: When two or more 22.0 L/s 0.5 MGD or four or more 11 L/s 0.25 MGD Package Wastewater Treatment Plants are contracted for at one time, select the

alternative to witness the factory tests.
****

Conduct all factory tests by the manufacturer of the package Package Wastewater Treatment Plant in the presence of the Contracting Officer.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Protection from Moving Parts

Ensure that all belts, chains, couplings, and other moving parts are completely enclosed by guards to prevent accidental personal injury. Guards are removable or so arranged as to allow access to the equipment for maintenance. If equipment is housed in a lockable enclosure, this is sufficient protection and no additional guards are necessary.

3.2 PREPARATION

All work not absolutely required to be performed in the field is performed in a factory under controlled conditions. Fabricate the treatment facility from not less than 6 mm 1/4-inch steel plate with welded joints and reinforced as necessary with steel angles, tees, or other structural members. Construct the units for transportation, installation, and operation without detrimental buckling, distortion, or other defects. Tanks cannot leak when filled with water or wastewater. Excavation, filling, and backfilling is in accordance with Section 31 00 00 EARTHWORK. Install a reinforced concrete foundation pad, of the size and design recommended by the treatment facility manufacturer, in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.1 Corrosion Protection

****
NOTE: Specify corrosion protection for metal plants in contact with soil. If other than steel is specified, specify an appropriate protective coating system for the plant material.

Cathodic protection is only recommended in severely corrosive soils or environments.

Identify site specific atmospheric conditions that would produce a corrosive environment for plant materials so that the proper protective coatings or corrosion resistant materials can be provided.
****

For [below ground] [partially above and partially below ground] [above ground] metal plants, provide corrosion protection. Provide an exterior [75 mil polyurethane coating] [_____] [[_____] mil coating and cathodic protection] that protects the plant from the in situ soil conditions.

3.2.2 Electrical Work

Electrical work is in accordance with the applicable requirements of Section [33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION][33 71 02

UNDERGROUND ELECTRICAL DISTRIBUTION].

3.3 INSTALLATION

Install the treatment facility and equipment in compliance with the manufacturer's written instructions. Submit drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show on the Drawings the proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

3.3.1 Sequence of Operations

Sequence of operations follows the recommendations of the facility manufacturer. Installation of facility cannot begin until the concrete support slab has achieved not less than fifty percent of its maximum strength. Modify backfilling operations as recommended by the instructions of the plant manufacturer. Complete, inspect and receive approval for all welding, corrosion protection, alignment, water tightness testing, painting, and anchoring before any backfilling is done.

3.3.2 Matchmarking

Ensure that all parts and components of the plant are clearly match marked, corresponding to assembly drawings furnished by the manufacturer of the facility.

3.3.3 Piping and Valve Installation

Install piping in a neat manner with all joints tight and with no undue marring of finishes. Ensure that installed piping, valves, and fittings are free from strain and excessive stresses caused by weight or misalignment.

[3.3.4 Clarifier Floor

****

NOTE: Delete requirements for signal transmission to the chlorinator when not used.

****

When a rotating sludge collector is used, work is as hereinbefore specified through placing of tank floor except for sludge cone. Provide a sludge cone in accordance with the manufacturer's recommendations. The tank floor is then given a screed finish, after which the floor is roughened by scoring with a rake or similar tool. Following installation of the rotating sludge collector mechanism, bring the tank floor to finish grade by means of a cement-mortar grout surfacing swept into place by use of the sludge collector arms, as hereinafter specified. When the collector mechanism has been erected and inspected by the engineer representative of the manufacturer and the arms and blades have been adjusted to give the required clearance above final floor grade, fasten a 50 by 150 mm 2 by 6 inch wooden straight-edge with metal-clad edge to each sweeping arm approximately 6 mm 1/4 inch below the sweeping blades to provide a suitable squeegee.

Cement-mortar grout is composed of one part cement, three parts sand, with sufficient water as required for conditions of placement, and with one teaspoon of powdered aluminum added per bag of cement. Before the cement-mortar grout is placed, thoroughly clean the floor of dirt, soil, or other substances that would prevent the proper bonding of the surfacing to the concrete subfloor. Bring the grout surfacing to finish grade as nearly as possible by hand. Rotate the collector arms with straightedges attached manually to complete the operation. Use of the drive unit for sweeping in the grout surfacing will not be permitted. Make provision to prevent grout from entering the sludge cone; remove immediately any grout which falls in the sludge cone or on the tank walls.

]3.3.5 Utilities Service Connections

[3.3.5.1 Water Service

****

NOTE: Specify in the appropriate section of project specification the nearest point of connection to the facility, and also type of connection available.

Delete reference to "frost-proof" for facilities in areas where freezing temperatures are not encountered.

Delete reference either to chlorinator or to hypochlorinator.

Delete reference either to chlorinator or to hypochlorinator.

****

The water line is a[25 mm one inch] [_____] copper water line extending from a point not less than[1.52 m 5 feet] [_____] from the treatment facility to the [hypochlorinator housing] [chlorinator]. Provide a 25 mm one inch valve in a[frost-proof] valve box below grade.[Provide a 19 mm 3/4 inch hose bibb in the [hypochlorinator] [chlorinator] housing.]

]3.3.5.2 Electrical Service

Provide electric service from a point not less than 1.52 m 5 feet from the treatment plant to the electrical control system enclosure.

3.4 FIELD QUALITY CONTROL

Conduct field inspections and witness field tests specified in this specification. Perform field tests and provide all labor, equipment and materials required for testing, except that the Government will provide water, fuel, and electric power required for field test, when available. Correct all defective equipment, materials, or workmanship disclosed as a result of the tests given herein at no cost to the Government.

3.4.1 Tests

Before allowing any liquid to discharge into the tanks, ensure that all tanks, chambers, channels, launders, piping and pieces of equipment are clean and free of any debris such as pieces of wood, concrete or leaves. Test all mechanical and electrical units as specified herein. Remedy any defects that occur before or during the tests, make changes or replacement equipment as necessary and retest.

3.4.1.1 Coating Testing

Examine coatings for flaws and test for thickness and holidays. Measure thickness of coatings by a commercial film thickness gauge. Test coatings for pinholes, holidays, and other defects with an electric flaw detector equipped with an audible signal that operates when a pinhole is detected. The detector is a 90-volt wet sponge pinhole detector.

3.4.1.2 Comminutor Tests

****

NOTE: Delete the paragraph when comminutor is not required for facility.

****

Operate the comminutor with liquid flowing through the comminutor. After two hours of operation, check for overheating, noise, vibration, and speed of the motor and comminutor. Check the automatic reversing of the comminutor when an object is lodged in the cutting stream.

3.4.1.3 Mechanical Aerator Tests

****

NOTE: Delete paragraph when step aeration type or complete mixing type is specified or when mechanical aerator is not allowed for extended aeration type.

****

Test the mechanical aerator(s) as soon as practicable after installation, and the aeration tank is ready for use. Operate the aerator under the varying submergence conditions specified in the factory test. During these tests, operate the unit(s) without overheating or excessive vibration and ensure satisfactory operation. Conduct the field tests under the supervision of the facility manufacturer. Supply labor and materials necessary to properly perform the tests. During the tests, take operating data at regular intervals and incorporate in a report. Base data readings on facility meters, gages, and instruments, and include the following: motor amperes, motor kilowatts, bearing temperatures, and lubricating oil pressures and temperatures.

3.4.1.4 Blower-Driven Assembly Operation Tests

Test the blower-driven assembly as soon as practicable after installation. Operate the blower under varying capacities and discharge pressures covering the range of conditions specified. During these tests, ensure that the units operate without overheating or excessive vibration. Conduct the initial operation of the blower driver and the the field tests under the supervision of the facility manufacturer. Supply such labor and materials as may be necessary to properly perform the tests. During the tests, take operating data at regular intervals and incorporate in a report. Base the data readings on facility meters, gages and instruments, and include the following:

a. Air volume

b. Air inlet and discharge pressure and temperature

c. Motor amperes

d. Motor kilowatts

e. Bearing temperatures

f. Stator temperatures

g. Lubricating oil pressures and temperatures

h. Lubricating oil cooling water temperatures

3.4.1.5 Diffusers

Conduct performance capacity and mixing tests on the diffusers in the field according to the manufacturer's instructions.

3.4.1.6 Hypochlorinator Tests

****

NOTE: Delete this paragraph when hypochlorinator is not required.

****

Inspect and adjust the pulley and belt drive for the average flow of feed solution desired. Test the capacity of the feeder for a period of not less than 2 hours nor more than 6 hours. Make the following tests:

a. Check the unit for leaks.

b. Determine the amount of chemical solution used during the test run to ascertain if the unit is functioning within the prescribed limits of the feed rate indication plus 15 percent.

c. Ensure the unit shuts off automatically when the liquid elevation in the chlorine contact tank drops below the contact sensing probes and start when the water rises. The unit starts and stops 10 times out of 10 consecutive starts.

3.4.1.7 Chlorinator Tests

****

NOTE: Delete this paragraph when chlorinator is not required.

****

Operate the unit for a period of not less than 2 hours nor more than 6 hours. Perform the following tests:

a. Check the unit for leaks by using an aqueous ammonia solution on a cotton or cloth swab on a wooden stick held close to all connections of the chlorinator.

b. Determine the amount of chlorine used during the test run to ascertain if the unit is functioning within the prescribed limits of 4 percent of the set feed rate.

c. Stop the chlorinator when the water supply is interrupted or shut off.

d. When the gas supply is exhausted or shut off, there is no back-flow of water into the unit.

3.4.1.8 Air Lift Pump

Test the air lift pump for discharge capacity in liters per second gallons per minute of clean water. Base this on percentage of submergence of the eductor pipe to the total height of the eductor pipe. Test and adjust the air throttling valve to provide the desired discharge rate. Test all joints in the airline for leaks at 689.4 kPa 100 psi pressure.

3.4.1.9 Electrical Control System Tests

The plant manufacturer's representative inspects the installation of the electrical control system with the Contracting Officer and checks circuits and connections to all motors and electrical controls. The manufacturer's representative, upon satisfactory operation of all circuits and controls to the Contracting Officer, submits [three] [_____] copies of a letter certifying that the wiring is complete and in accordance with the intent of the specifications for both manual and automatic operation and proper functioning of the Package Wastewater Treatment Plant.

3.4.2 Inspection

3.4.2.1 Alignment and Leveling

Make inspections to assure that the facility is level within tolerances recommended by the facility manufacturer. Check all facility components and equipment to ensure that they are properly aligned and level.

3.5 SYSTEM STARTUP

A manufacturer's representative will be present at facility start-up. Follow the manufacturer's manual on operation and maintenance step by step, so that as each piece of equipment is put into operation, the manufacturer's representative will explain in detail its function. Once the facility is filled with water or wastewater the follow the furnished flow diagram and check out the on-site inspection.

Adjust equipment as required. Examine the plant to determine if it is structurally sound. Report and correct all defects, submit findings.

3.6 ADJUSTING AND CLEANING

3.6.1 Coating Repair

If welding is required after application of the coating or if the coating is damaged in any way, repair consists of preparing the affected area in compliance with manufacturer's recommendations and reapplying the coating to that area. If holidays are detected or film thickness is insufficient, prepare the surface and apply additional coats in the affected area in compliance with the manufacturer's instructions.

3.6.2 Adjustments

For items of equipment involving V-belt drives, adjustment of sheave alignment and belt tension is carried out in accordance with product manufacturer's instructions.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Operation and Maintenance Manuals

Post framed instructions containing wiring and control diagrams under glass or in laminated plastic where directed. The instructions show wiring and control diagrams and complete layout of the entire system. The instructions include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system. Post the framed instructions before acceptance testing of the system.

Submit [_____] copies of operation and maintenance manuals for the treatment facility equipment furnished. [One][_____] complete set prior to performance testing and the remainder upon acceptance. Operation manuals detail the step-by-step procedures required for system startup, operation, and shutdown. Operation manuals include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

Submit Package Wastewater Treatment Plant Operation and Maintenance Data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.7.2 Demonstration

As soon as practicable after completion, perform an operating test of the treatment facility and all equipment to demonstrate that the facility functions properly. After completion of all tests, adjust the facility for proper operation while on-line with the wastewater source in accordance with the manufacturer's written instructions. For the final acceptance, the facility must perform as specified, submit Package Wastewater Treatment Plant acceptance test results.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-46 20 20 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 20 20 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 46 20 20

SEWAGE BAR SCREEN AND MECHANICAL SHREDDER

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-46 20 20 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 20 20 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 46 20 20

SEWAGE BAR SCREEN AND MECHANICAL SHREDDER

05/21

****

NOTE: This guide specification covers the requirements for sewage bar screen and mechanical shredder for use in sewage treatment plants normally handling domestic sewage.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Refer to UFC 3-240-02 for design requirements. This guide specification is written for one bar screen and mechanical shredder.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,

and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and

	Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1677	(2022) Tests and Procedures for Carbon Steel and High Strength Low Alloy Steel Tubing

UL SOLUTIONS (UL)

UL 98	(2016; Reprint Jan 2022) UL Standard for Safety Enclosed and Dead-Front Switches

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the

"G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Materials And Equipment; G, [_____]

SD-03 Product Data

Spare Parts

Framed Instructions

SD-06 Test Reports

Tests

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

1.3 MAINTENANCE MATERIAL SUBMITTALS

1.3.1 Extra Materials

Furnish a complete set of manufacturer's recommended spare parts, including cutting teeth and combs or other cutting elements, fasteners, screens, seals or bearings, etc. Furnish special tools for the proper operation and maintenance of equipment, installed in a wall-mounted hardwood or metal container.

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings, and not later than [_____] months prior to the date of beneficial occupancy. Include in the data package a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1][and][3] year(s) of service.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

a. Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products, that conform to the respective publications and other requirements specified and that essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening. Ensure all equipment is supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

b. To each major item of equipment, securely attach a plate to the item that includes the manufacturer's name, address, and catalog or model number. In lieu of adding a nameplate on the shredder and bar screen, integrally cast the adding a manufacturer's name or trademark onto the shredder, or stamp, or otherwise permanently mark the shredder.

c. Fully enclose moving parts of the equipment, such as drive chains and sprockets, in removable guards. Fully enclose equipment above the level of the sewage-carrying channel in a cast iron or 1.897 mm (14 gauge) 14 gauge sheet steel or wrought-iron housing. Ensure housing is provided with a sufficient number of doors or removable panels to ensure ready access to any part of equipment for repairs, replacements, or cleaning. The joint between the housing and the concrete foundation is required to be leakproof.

d. Submit detail drawings consisting of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Ensure detail drawings contain complete wiring and schematic diagrams, equipment layout and anchorage, and any other details required to demonstrate that the system has been coordinated and is fully functional as a unit.

2.1.1 Bearings

ABMA 9 and ABMA 11.

2.1.2 Iron, Steel, and Miscellaneous Metal

2.1.2.1 Miscellaneous Metal

Provide bolts, nuts, anchors, washers, and other types of supports necessary for the installation of equipment made of steel or wrought iron, galvanized according to the requirements of ASTM A153/A153M.

2.1.2.2 Malleable Iron

ASTM A47/A47M, grade No. 32510, minimum.

2.1.2.3 Structural Steel

ASTM A36/A36M.

2.1.3 Motors, Electric

NEMA 250, NEMA ICS 1, NEMA ICS 3, NEMA ICS 4, NEMA ICS 6 and NEMA MG 1.

2.1.4 Motor Controls

NEMA ICS 2.

2.1.5 Switches, Enclosed

UL 98.

2.2 COMPONENTS

2.2.1 Electrical Work

Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical work must comply with NFPA 70, latest edition. Supply with electrical characteristics as indicated. Provide automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices but not shown on electrical plans, under this section of the specification.

2.2.1.1 Electric Motors

Provide equipment complete with motors of the [open] [totally enclosed] ball-bearing squirrel-cage induction type, with a maximum speed not to exceed 1800 rpm. Provide motors of sufficient capacity to drive equipment at the specified capacity without exceeding rating shown on nameplate attached to the motor.

2.2.1.2 Motor Controls

****

NOTE: For complex automatic controls, the Designer is to review UFGC Section 40 60 00 PROCESS CONTROL and reference it in this paragraph if required.

****

Provide motor controls required to control the motor in the manner indicated or specified with the associated motor and ensure they contain properly sized thermal-overload protective elements. Except where otherwise indicated, provide starters in [general-purpose] [weatherproof] enclosures. Where manual control is specified, provide starter with a start-stop pushbutton in the cover. Where automatic control is specified, provide starter with a hand-off-automatic selector switch in the cover. Provide each starter with an appropriate nameplate or stencil identifying the equipment controlled. [Provide controls in accordance with Section 40 60 00 PROCESS CONTROL.]

2.2.2 Hydraulic Work

Provide hydraulic equipment and application in accordance with Section 35 05 40.14 10 HYDRAULIC POWER SYSTEMS FOR CIVIL WORKS STRUCTURES. Provide manual or automatic control and protective or signal devices required for the operation specified, and any control wiring or hydraulic connections required for controls and devices but not shown on electrical or hydraulic plans, under this section of the specification.

2.2.2.1 Fluid Motors

Provide equipment complete with fluid motors of the [vane] [piston] type. Ensure motors are of sufficient capacity to drive equipment at the specified rating without exceeding rating shown on the nameplate attached to the motor.

2.2.2.2 Hydraulic Controls

Provide controls in the manner indicated or specified, coordinated with the associated equipment, and having properly sized overload protective elements.

2.2.2.3 Fluid Power Valves

SAE J1677.

2.2.2.4 Fluid Tubing

SAE J1677.

2.2.2.5 Hydraulic Fluid

Provide hydraulic fluid in accordance with Section 35 05 40.14 10 HYDRAULIC POWER SYSTEMS FOR CIVIL WORKS STRUCTURES.

2.3 MANUFACTURED UNITS

2.3.1 Mechanically-Cleaned Bar Screen

A bar screen consists of a stationary bar screen, a screen rake, a rake mechanism operated by [an electric] [a hydraulic] drive unit, and a dead plate and rake-cleaning device, where required. Install equipment so as not to obstruct the flow of sewage to bar screen. Unless otherwise specified, ensure all metal that is submerged in the sewage-carrying channel or that comes in contact with sewage consists of wrought iron, steel, cast iron, or other equally corrosion-resistant metal.

2.3.1.1 Bar Screen

Ensure each bar screen is suitable for installation in a rectangular channel [_____] m [_____]-feet [_____]-inches wide by [_____] m [_____]-feet [_____]-inches deep, and is designed for handling sewage flows as follows:

a. Minimum, [_____] cubic meters/day MGD.

b. Average, [_____] cubic meters/day MGD.

c. Maximum, [_____] cubic meters/day MGD.

2.3.1.2 Screen Rake

Ensure rake is designed to rake up screenings collected on the bar screen and in the openings between bars, and to convey screenings to a [drain platform] [collection trough] [grinder]. Provide rake made of cast iron, steel, or other suitable material not less than [_____] mm inch thick. Space rake teeth to pass between bars of the screen. Ensure rake teeth plate is easily removable and replaceable.

2.3.1.2.1 Rake Mechanism

Provide a revolving-frame, automatic-hoist, endless-chain type mechanism, or screw-drive type mechanism that includes parts and accessories necessary for a complete operating unit. Ensure parts for the mechanism are amply proportioned for stresses that may occur during fabrication, erection, and operation. Provide interchangeable individual parts that are alike in each. Provide shearing pins or an overload-release mechanism for overload protection. Ensure rake speed ranges from [____] to [____] m/second feet per minute. Provide rake mechanism with a complete and adequate system of lubrication to moving parts subject to wear. Provide grease- or oil-lubricated bearings except submerged bearings which are required to be fabricated from alloy-bearing metal designed to operate without any lubrication and to prevent accumulation of deposits.

2.3.1.2.2 Revolving-Frame-Type

A revolving-frame-type rake mechanism consists of two pairs of structural-steel-angle rake arms mounted on a horizontal shaft. Screen rakes are attached to steel crossbars mounted on the outer end of each pair of rake arms. The entire rake mechanism is required to revolve about the horizontal shaft.

2.3.1.2.3 Automatic-Hoist-Type

An automatic-hoist-type rake mechanism consists of a reciprocating rake mounted on a horizontal shaft or frame and guided by steel channels or angles at each end of the frame. The rake and frame are pulled up the slope of the guide rails by two or more cables operating over motor-propelled grooved drums. After screenings are discharged, the rake frame is required to automatically tilt and lower to the bottom of screen.

2.3.1.2.4 Endless-Chain-Type

An automatic-chain-type rake mechanism consists of a drive chain, drive sprockets, and sprocket wheels mounted on a drive shaft, and an idler shaft where required, operating two endless chains with rakes securely attached.

a. Fabricate the drive chain connecting motor sprocket with the drive shaft and the endless chain of malleable iron with heat-treated-steel pins or rivets. Provide a chain tightener or takeup bracket for drive chain. Ensure chains are of suitable size and design to withstand strains imposed.

b. Fabricate the sprockets for the drive and endless chains of semi-steel or cast iron with chilled teeth and rims. Grind the rims and teeth of the sprockets to fit chains. Provide sprockets of the size recommended by the equipment manufacturer. Fabricate shafts of cold-rolled steel, straight and true, and of ample diameter to transmit the power required without undue deflection. Accurately cut the keyways where required. Provide malleable iron or bronze safety collars where required to keep shafting and sprockets in alignment.

2.3.1.2.5 Screw-Drive Type

A screw-drive type rake mechanism consists of a reversing threaded screw-drive and bearing nut attached to rake. Provide all rakes with reciprocating action.

2.3.1.2.6 Rake Mechanism Control Equipment

Start motors by means of [automatic time switch for intermittent operation, adjustable to give 3 to 60 minutes between cycles] [float switch for automatic operation at predetermined levels] [float switch for automatic operation at predetermined rise in head of sewage on the upstream side of the screen bar]. [Provide floats constructed of corrosion-resistant metal.]

a. Endless-Chain-Type-Rake Mechanism: Provide a motor-reversing switch so that direction of travel of the rake mechanism is reversible in the event of jamming. Provide a motor-reversing switch consisting of a double-throw externally operable switch enclosed in a [raintight] [watertight] enclosure. Mark the switch as follows: "Forward," "Off," "Reverse."

b. Automatic Hoist-Type Rake Mechanism: Provide starters for this type of rake mechanism that are the reversing type. Arrange control devices so that on completion of upward travel of the rake mechanism, motor stops and then reverses, and rake travels to the lower position, at which point motor again stops and automatically adjusts for the next automatic operation.

c. Revolving Frame-Type Rake Mechanism: Provide an emergency stop push-button and a rake limit switch in a weatherproof enclosure, to always stop the rake out of water after discharge of screenings.

d. Bearing Type Rake Mechanism: Control the travel of the rake in a downward or upward direction by proximity switches. Provide for adjustable frequency. Provide rake delay on the [top] [bottom]. Provide [electric][hydraulic] rake drive. Provide overload protection for down and up stroke. Provide drive with a control panel (minimum NEMA ICS 2) mounted.

e. Rake Wiper: Where required to remove screenings from rake, provide a rake wiping or scraping device at the discharge point of rake. Fabricate device to include either a plate attached to swinging hinged arms or a continuous hinged plate actuated by motion of the rake. Design wiper so that after cleaning of the rake is completed, wiper falls into the proper place ready for the next scraping operation. Control the fall of wiper either mechanically or hydraulically to absorb any shock.

f. Dead Plate or Apron: Provide a wrought iron or steel dead plate where required to prevent any deposited screenings from falling into the downstream side of rake. Ensure provided dead plate is not less than 2.657 mm 12 gauge metal if required by the design and type of rake mechanism installed, and is rigidly braced if required.

2.3.2 Mechanical Shredder, Cutter, or Grinder

2.3.2.1 Operation Requirements

Provide shedder, cutter, or grinder unit suitable to receive screenings from screening unit specified and to discharge resulting pulp into the sewage flow. Operate machine by means of an electric drive unit designed to cut sewage solids, including sticks, rags, and stringy material without clogging, jamming, or stalling moving parts. Direct connect grinder and drive unit by a flexible or friction-type coupling integrally mounted on a structural steel or cast iron base. Provide grinder with a water-flushing system where required to flush ground solids through the machine. Ensure machine provided has a capacity of grinding [_____] kg pounds of sewage screening per hour.

2.3.2.2 Control Equipment

Arrange control so that shredder motor automatically start when the rake-mechanism motor starts. Provide a relay to allow the shredder to continue to run for a predetermined time after rake mechanism has stopped, and to automatically stop the shredder motor.

2.3.2.3 Cutter Mechanism

The cutter consists of cutting blades or impellers mounted on a revolving shaft or drum in contact with a stationary cutter screen or blade. Provide cutting devices made of tool steel or other material equally suitable for cutting tools. Ensure devices are accurately cut and ground to size to provide sharp cutting edges having extreme resistance to wear.

2.3.2.4 Bearings

Provide bearings of the self-aligning ball or roller type. Design bearings and bearing supports to safely carry and withstand the stresses imposed by the disintegrating action of the grinder.

2.3.2.5 Stuffing Boxes

Wherever the drum shaft passes through the machine housing, provide stuffing boxes of proper depth and construction.

2.3.2.6 Lubrication

Ensure bearings and moving parts, subject to wear, are provided with adequate devices for grease or oil lubrication.

2.4 PAINTING

Thoroughly clean, prime, and give all equipment two finish coats of paint at the factory in accordance with the recommendations of the manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

3.2.1 Installation of Concrete Foundations

Use concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Concrete foundations are required to be integral with, and of same strength as the building floor, unless otherwise specified. For concrete used in foundations that are entirely separated from the surrounding floor, use 17 MPa 2500 psi. When new foundations are constructed on existing concrete, bond new concrete to old as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Furnish foundation bolts, as required, for proper positioning during placement of concrete.

3.2.2 Installation of Equipment

Install all materials and equipment as shown and in accordance with the approved written recommendations of the equipment manufacturer.

3.2.3 Field Painting

Field painting is specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 FIELD QUALITY CONTROL

3.3.1 Tests

After installation of the sewage bar screen and mechanical shredder is complete, conduct operational tests required to demonstrate that the sewage bar screen and mechanical shredder and controls operate in accordance with the requirements of this section of the specifications. At a minimum, operate the rake through [5][10][__] cycles to ensure the system is operating correctly. Conduct a minimum of [2][5][__] tests with the rake loaded with debris to simulate actual field conditions. Indicate the final position of controls in each test report.

3.3.2 Manufacturer's Field Services

Obtain the services of the manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Ensure the representative supervises the installation, adjustment, and testing of the equipment.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Framed Instructions

Provide framed instructions, including wiring and control diagrams, showing the complete layout of the entire system, posted where directed. Pot the framed instructions before acceptance testing of the systems. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. Submit proposed diagrams, instructions, and other sheets, prior to posting.

3.4.2 Operating and Maintenance Instructions

Submit operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include within the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Submit maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include simplified diagrams for the system as installed.

3.4.3 Training

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [_____] hours of normal working time and starting after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the Operating and Maintenance Instructions in the field training.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-46 23 00 (February 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-46 23 00 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 46 23 00

GRIT REMOVAL AND HANDLING EQUIPMENT

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USACE / NAVFAC / AFCEC **UFGS-46 23 00 (February 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-46 23 00 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 46 23 00

GRIT REMOVAL AND HANDLING EQUIPMENT
02/20

****

This guide covers the requirements for grit removal and handling equipment to remove, collect, pump, and wash grit from wastewater. This guide is for treatment of domestic wastewater only.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: This guide specification is for treatment of domestic wastewater only. Special consideration must be given to wastewater containing industrial wastes.

Show the following information on the project drawings.

1. Size, depth and general configuration of grit separation, chamber, final discharge point, collection, removal, and washing facilities. Give space limitations which may affect optional choices;

2. Percentage of removal of grit required;

3. Electrical characteristics of motor(s) for grit separation, collection, removal, pumping and washing equipment;

4. Flow range in cubic meter per second mgd facility is designed to serve;

5. Type of diffuser holder assembly;

6. Supply of external air quantity in cubic meter per second cfm and pressure in kPa psi;

7. Type of diffuser, whether non-porous nozzle or valve orifice type is used;

8. Source of power for hoist.;

9. Type of velocity control, whether regulator or weir;

10. Applicable wind and ice loadings;

11. Type of grit pump configuration, whether vertical or horizontal;

12. Removal capacity of screw conveyor in cubic meter per second cubic feet per hour;

13. Pitch diameter of flights and liner plate diameter for screw conveyors;

14. Type of wastewater from which grit is to be removed, whether raw wastewater or settled primary sludge;

15. Capacity in cubic meter per second gpm and pressure in kPa psi for the cyclone;

16. Cyclone pressure switch range in kPag psig;

17. Type of walkway, whether raised pattern floor plate or grating, on shallow tank separator; and

18. Whether corrosive conditions exist in wastewater or in atmosphere at installation.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 11	(2005; R 2013) Standard Method of Test for Materials Finer Than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T 27	(2014) Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GAS ASSOCIATION (AGA)

AGA GMC	Gas Measurement Committee Report No. 3

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
ANSI/AGMA 6034	(1992B; R 2010) Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B17.1	(1967; R 2017) Keys and Keyseats
ASME B17.2	(1967; R 2017) Woodruff Keys and Keyseats
ASME B29.400	(2001; (R 2008) (R 2013) (R 2018) (R 2023)) Combination, "H" Type Mill Chains, and Sprockets

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C504	(2023) Standard for Rubber-Seated Butterfly Valves
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASSOCIATION FOR IRON AND STEEL TECHNOLOGY (AIST)

AIST PB-229	(2008) Stainless Steels: A Steel Products Manual

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM B30	(2023) Standard Specification for Copper Alloys in Ingot Form
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods,

	Wire, Profiles, and Tubes (Metric)
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

1.2 DEFINITIONS

1.2.1 Grit

The settleable solids load present in wastewater such as sand, gravel, cinders, metal fragments not ameliorated by secondary treatment or sludge removal techniques and capable of producing excessive wear on mechanical equipment.

1.2.2 Grit Separation

The process of separating grit from wastewater by controlling the velocity of the wastewater with aeration to suspend organics or by tank configuration to separate the grit from the organic solids by differential sedimentation and scour.

1.2.3 Grit Collection

****

NOTE: Delete the first option when an aerated grit chamber with an inclined bottom is required, delete the second option when an aerated grit chamber with an inclined bottom is not required.

****

The process of gathering the separated grit in a hopper or other point of collection [by mechanical equipment designed for the purpose] [by means of hydraulic flow over an inclined chamber floor].

1.2.4 Grit Removal

****

NOTE: Delete the first option when washing equipment is not required, delete the second option when washing equipment is required.

****

The process of conveying grit out of the chamber from the point of collection in the chamber to [washing equipment for further processing] [the indicated point of discharge]. Grit removal equipment may accomplish some dewatering.

1.2.5 Grit Washing

The process of further separation of grit by washing putrescible matter from the removed grit by means of sprays or washing the tanks and dewatering with screw conveyors or cyclones. These screw conveyors or cyclones also convey the grit to the indicated point of discharge.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grit Handling Equipment

SD-06 Test Reports

Performance Tests

Grit Pump tests

[Grit Washing Equipment tests

] SD-07 Certificates

Warranty

SD-10 Operation and Maintenance Data

Grit Handling System, Data Package 3; G, [_____]

1.4 SPARE PARTS

Furnish spare parts for the equipment specified above in the quantities listed below. The spare parts must be identical and interchangeable with the original parts. Furnish the parts in wooden containers clearly marked with contents on two sides and top. Where the number of spare part units required by the schedule results in a fractional number of units, round off the number furnished to the next highest.

Description of Spare Part Unit	Number of Spare Units Required as Percentage of Part Units Installed
a. Screw [Collector] [and] [Conveyor]:	
Drive chains	25 percent
Drive sprocket with shear pin hub	25 percent
b. Chain and Bucket Collectors:	
Drive chains	25 percent
Collector chain lengths	5 percent
Buckets, complete with attachments	55 percent
Drive sprocket with shear pin hub	25 percent
c. Aerated Grit System:	
Diffusers	5 percent
d. Grit Pump:	

One set of pump gland packing	
One complete set of gaskets	
One complete set of bearings, bushings, sleeves and seals	
e. Cyclone:	
One complete rubber lining	
f. In addition, also furnish one dozen shear pins of each size used.	

1.5 QUALITY CONTROL

1.5.1 Regulatory Requirements

****

NOTE: Design Grit Removal System in accordance with UFC 3-240-01, "Wastewater Treatment and Collection." Ensure compliance with permits.

****

Conduct regulatory review to determine impact of new and existing permit conditions and regulations, communicate with federal, state, local and DOD agencies.

1.5.2 Qualifications

Ensure welds are in accordance with AWS D1.1/D1.1M using procedures, materials, and equipment of the type required for the work.

1.5.3 Shop Drawings

Submit grit handling equipment drawings showing layout of all equipment. Include construction and erection details for all components of the complete grit separation, collection removal [and washing] system and also show associated connections with plant piping.

1.6 DELIVERY, STORAGE, AND HANDLING

Package equipment and parts for shipment to prevent breakage, damage or problems with calibration, readings or controls. Inspect materials delivered to the site for damage and unload and store with a minimum of handling. Store equipment and materials indoors, off the floor. Area must be dry with adequate ventilation, free from dust or water, and permit easy access for inspection and handling.

1.7 WARRANTY

Provide grit separation equipment with minimum [_____] [5] year warranty. Submit the manufacturer's warranty.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a grit removal system to separate, collect, remove, wash and deposit grit at the indicated point of its discharge, within the area and at the elevations indicated.

2.1.1 Design Requirements

****

NOTE: Delete all references to washing when washing is not included in the grit removal system. The use of any combination of grit removal system for any wastewater treatment facility will be the responsibility of the project engineer. The combinations of equipment for the following systems are several:

1. **Aerated grit system.**

2. **Aerated grit system (inclined bottom chamber).**

3. **Longitudinal grit system.**

4. **Vortex type grit system.**

5. **Detritor grit removal.**

Select the grit removal system based on the following factors:

1. **Site area availability;**

2. **Amount of grit anticipated;**

3. **Type of sewer system, separate or combined;**

4. **Other selected process i.e., air available if diffused air activated sludge processes; incineration disposal for grit; primary sedimentation process; and**

****

2.1.2 Grit Removal System Type

****

NOTE: Choose one of the paragraphs below, AERATED GRIT REMOVAL SYSTEM, INCLINED BOTTOM GRIT REMOVAL SYSTEM, LONGITUDINAL GRIT REMOVAL SYSTEM, VORTEX TYPE GRIT REMOVAL SYSTEM, and DETRITOR GRIT REMOVAL SYSTEM.

Determine which grit removal system is suitable for the project. Delete paragraphs which describe systems and options which are not included in the project. When it is anticipated that the bottom of a chamber will be utilized for grit storage, a screw conveyor should be used for collecting grit when the

depth of the stored grit is expected to exceed the height of a rake or bucket collector. Use a grit pump for removal when a cyclone is included with the washing equipment. Space limitations may preclude the use of inclined removal equipment. Delete reference to screw-type washers when a cyclone is the only washer required. Delete screw conveyor when space limitations prohibit an inclined screw, delete screw conveyor and bucket elevator when cyclone is included in washing equipment.

****

[2.1.2.1 Aerated Grit Removal System

Separate grit in an aerated grit chamber. Collect and remove grit by [horizontal screw conveyor and bucket elevator,] [horizontal screw conveyor and inclined screw conveyor,] [horizontal screw conveyor and grit pump,] [chain and bucket equipment,] [and] [airlift pump]. Use a [cyclone] [and] [screw-type washer].

][2.1.2.2 Inclined Bottom Grit Removal System

Separate grit in an inclined bottom aerated grit chamber. Chamber bottom must be inclined to move grit to the point of removal. Remove grit by [screw conveyor] [airlift pump] [bucket elevator] [grit pump]. Use a [cyclone] [and] [screw-type washer].

][2.1.2.3 Longitudinal Grit Removal System

Separate grit in a longitudinal grit chamber. Collect and remove grit by [horizontal screw conveyor and bucket elevator,] [horizontal screw conveyor and inclined screw,] [horizontal screw conveyor and grit pump,] [and] [chain and bucket equipment]. Use a [cyclone] [and] [screw-type washer].

][2.1.2.4 Vortex Type Grit Removal System

Separate grit in a vortex type grit removal system. Remove grit by a [grit pump] [airlift pump]. Use [cyclone] [and] [screw-type washers].

][2.1.2.5 Detritor Grit Removal System

Separate grit in a detritor grit removal system, including a rotating grit-collecting mechanism and a reciprocating grit-washing mechanism. Collect and remove grit by [grit auger and grit pump,] [horizontal screw conveyor and bucket elevator,] [horizontal screw conveyor and inclined screw,] [horizontal screw conveyor and grit pump,] or [chain and bucket equipment]. Use a [cyclone] [and] [screw-type washer].

]2.1.3 Performance Requirements

Provide a system capable of separating and removing [_____] percent of [_____] mesh grit having a specific gravity of [2.65] [_____] from a flow ranging from [_____] to [_____] cubic meter per second million gallons per day.

2.1.4 Electrical Requirements

Unless indicated or specified otherwise, electrical components of mechanical equipment, such as motors, motor starters, control (pushbutton) stations, electrical disconnecting (isolating) means, and other devices functioning to control associated mechanical equipment, are included under this section. The work must be complete and operable, and in accordance with NFPA 70 and the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 ASSEMBLY [OR] FABRICATION

2.3 EQUIPMENT

Unless otherwise specified, provide standard commercial products in regular production by the manufacturers and suitable for the required service. Unless otherwise specified, structural steel must conform to ASTM A36/A36M, hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M. Submerged steel must have a minimum thickness of 6 mm 1/4 inch. Unless otherwise specified, cast iron must conform to ASTM A48/A48M. Bronze castings not otherwise specified must conform to ASTM B30. Drives, lubrication, and bearings must be accessible from walkways at or above ground level.

2.3.1 Materials and Equipment

****

NOTE: Choose this paragraph and its subparagraphs or one of the paragraphs below, LONGITUDINAL GRIT SEPARATION EQUIPMENT, VORTEX TYPE GRIT SEPARATION, and DETRITOR GRIT REMOVAL EQUIPMENT, and its subparagraphs.

****

[2.3.1.1 Aerated Grit Separation Equipment

Include air piping and valves, swing diffuser holder assembly, header pipes, hoist, and diffusers. Provide baffles of structural steel plate 50 mm 2 in, or manufacturer's standard. Provide system with air from an external supply at a maximum rate of [_____] cubic meter per second cfm at [_____] kPa psi.

2.3.1.1.1 Air Piping

Provide manufacturer's recommended piping from air main to diffusers.

2.3.1.1.2 Diffuser Holder Assembly

Provide an upper pivot joint with air control and shut-off valve, a drop pipe with intermediate pivot joint, and a diffuser header. Provide unit with mounting to wall anchorage and a rotating joint, either permanently lubricated or with grease fittings for lubrication. Include gaskets at each pivot bearing to ensure air and water tightness. Provide valve for air control with indicator markings for throttling and complete shut-off, conforming to AWWA C504. Provide connections for the upper and lower hanger pipes. Provide locking device to allow positive locking in any position. Ensure spacing of diffuser assemblies in the basin and diffusers on the header is as recommended by the diffuser manufacturer. Ensure the diffuser is level. Provide a portable hoist to raise and lower the diffuser assembly. Use hoist by the same manufacturer, and compatible with, the diffuser holder assembly. Hoist must be hydraulically operated and adequately powered to raise the assembly from the tank. Provide means of locking the diffuser header in a raised position over the tank or the walkway.

2.3.1.1.3 Diffusers

Provide saddle mounted or thread mounted diffusers as recommended by the manufacturer. Ensure diffusers are sized for the particular application for the range of exit velocity and back pressure.

][2.3.1.2 Longitudinal Grit Separation Equipment

****

NOTE: Choose one of the following paragraphs VELOCITY CONTROL REGULATOR or PROPORTIONAL WEIR.

Where corrosive environment is not present, specify structural steel. Where corrosion can occur and cost is not a factor, specify stainless steel, otherwise specify aluminum, or manufacturer standard.

****

Control velocity with a [velocity control regulator] [proportional weir].

[2.3.1.2.1 Velocity Control Regulator

Maintain the velocity of flow through a channel of cross sections indicated. Provide regulator conforming to [AIST PB-229, Type 304 stainless steel] [structural steel] [aluminum conforming to ASTM B209M ASTM B209 or ASTM B221M ASTM B221, Alloy 6061, Temper T6]. Regulator opening must be adjustable and provide a range of flows from zero to [_____] cubic meter per second mgd.

][2.3.1.2.2 Proportional Weir

Control velocity with a [AIST PB-229, Type 304 stainless steel] [aluminum conforming to ASTM B209M ASTM B209 or ASTM B221M ASTM B221, Alloy 6061, Temper T6] [structural steel] proportional weir. Weir will provide a constant velocity through the grit chamber for a range of flows from [_____] to [_____] cubic meter per second mgd.

]2.3.1.2.3 Framework and Control Sections

****

NOTE: Specify material compatible with material specified in paragraph VELOCITY CONTROL REGULATOR or PROPORTIONAL WEIR.

****

Provide compatible fasteners for anchoring or bolting the control device.

][2.3.1.3 Vortex Type Grit Separation

[2.3.1.3.1 Forced Vortex

Include motor drive assembly, paddle drive tube; [air [lift pump,] piping and valves,] [vacuum pump] [suction pump]; and control box.[Provide system air from an external supply at a maximum rate of [_____] cubic meter per second CFM at [_____] kPa psi.]

2.3.1.3.1.1   Mechanical Drive

Ensure sustained operation at the continuous output torque rating without excessive wear and to develop twice the continuous output torque rating without damage to or failure of the drive assembly components.

][2.3.1.3.2   Induced Vortex

Include [air [lift pump,] piping and valves,] [vacuum pump] [suction pump].[Provide system air from an external supply at a maximum rate of [_____] cubic meter per second CFM at [_____] kPa psi.].

][2.3.1.3.3   Multi-Tray Vortex

Provide manufacturer standard trays and distribution system.

]][2.3.1.4   Detritor Grit Removal Equipment

Provide manufacturer's standard system.

]2.3.1.5   Collector Systems

****

NOTE: Choose one paragraph, and its subparagraphs, of the following: SCREW COLLECTOR AND BUCKET ELEVATOR, SCREW [COLLECTOR] [AND] [CONVEYOR] or CHAIN AND BUCKET ELEVATOR COLLECTOR.

Some manufacturers combine a screw collector and a bucket elevator utilizing the bucket chain to drive the screw and using only one drive assembly. This unit may be used in either an aerated grit removal system or a longitudinal grit removal system when the screw conveyor is not more than 15 m 50 feet long or when the amount of grit to be removed does not exceed 0.06 cubic meter per second 120 cubic feet per hour. Delete this paragraph and all subparagraphs when this unit is not allowed as an alternate to the separate units or when the above physical limits will be exceeded.

****

2.3.1.5.1   Screw Collector and Bucket Elevator

Provide a unit utilizing the bucket chain of the elevator as a drive chain for the screw collector. Include screw shafts and bearings, liner plate, chain, sprockets, grit buckets, drive assembly, housing and overload protection. Ensure unit is capable of continuous and intermittent operation with a removal capacity of not less than [_____] cubic meter per second cubic feet per hour of dry grit weighing [1922] [_____] kg per cubic meter [120] [_____] pounds per cubic feet.

2.3.1.5.1.1   Screw Collector Assembly for Combination Unit

****

NOTE: The following table lists the requirements for selecting a screw.

Grit Cap. Cu. m/sec	Dia. MM	Screw Conveyor Pipe Size MM	Watts	Shaft Dia. MM
0.03	300	100	746	50 or 61
0.05	400	100	1,119	75
0.08	500	125	1,492	75 or 86

Grit Cap. Cu. Ft/Hr.	Dia. Inch	Screw Conveyor Pipe Size Inches	H.P.	Shaft Dia. Inches
55	12	4" Std.	1.0	2 or 2 7/16"
100	16	4" X-Hvy	1.5	3"
163	20	5" Std.	2.0	3 or 3 7/16"

Alternate screw type can be helicoid with short shafts.

****

a. Provide [_____] mm inch diameter screw, half pitch with 10 mm 3/8 inch flights and mounted on [_____] mm inch steel pipe conforming to ASTM A53/A53M and bushed for [_____] mm inch shaft. As an alternate, provide a helicoid type screw conveyor section with 10 mm 3/8 inch steel flights. Screw must be made in the manufacturer's standard lengths.

b. Ensure shafts are cold rolled steel conforming to ASTM A108 and coupling bolts are AIST PB-229, Type 316 stainless steel. Couple driven end to the foot shaft of the bucket elevator. Grease lubricate tail shaft bearings; provide with cast iron, high carbon or heat treated alloy steel bushings. Ensure bearings are rated for a minimum of five years on a continuous service basis.

c. Provide a curved 10 mm by [_____] mm 3/8 by [_____] inch I.D. steel liner plate with edges drilled for plug welding to 13 by 150 mm 1/2 by 6 inch steel straps embedded in the concrete, with a Brinell hardness of 300 to 350.

2.3.1.5.1.2 Bucket Elevator Assembly for Combination Unit

a. Provide bucket chain of ASME B29.400 combination "H" Type Mill C102 having an average ultimate strength of 160 kN 36,000 pounds and weighing no less than 15 kg per meter 9.7 pounds per foot, with chain links of corrosion resisting malleable iron having an average tensile strength of at least 483 MPa 70,000 psi and an average Brinell hardness between 170 and 190.

b. Ensure sprockets are high-test cast iron, having a minimum tensile strength of 138 MPa 20,000 psi cast in a chill, with a Brinell hardness of not less than 360 with a chill depth of at least 5 mm 3/16 inch, stress relieved before machining. Sprocket teeth must be accurately ground to fit chain. Sprockets must be split construction assembled with cadmium plated nuts and bolts. Driven sprocket and the sprockets on the head shaft and screw shaft must be keyseated with keys and keyseats conforming to ASME B17.1 or ASME B17.2.

c. Ensure shafting is solid, cold-finished steel conforming to ASTM A108, straight and continuous for full width of tank, of sufficient size to transmit the maximum force developed by the drive assembly. Provide keyways where necessary to attach or locate sprockets on shafting. Keys and keyseats must conform to ASME B17.1 and ASME B17.2. Use polished shafting in areas of contact with bearings.

d. Ensure bearings are babbitt-lined, ductile-iron type, self-aligning ball-and-socket type or heat treated ductile-iron self-aligning type, designed to allow minimum field variations without shimming. Provide bearings above water with flush ball-check grease-lubrication fittings. Water lubricate underwater bearings with tops designed to prevent solids accumulation. Equip underwater bearings with flush ball-check grease-lubrication fittings. Ensure all bearings are rated for a minimum of 5 years on a continuous service basis.

e. Fabricate grit buckets of structural steel or malleable iron with hardened lip designed to drain off free water; attached to chains at not more than 1.5 m 5 foot intervals with heat treated carbon steel pins and rivets having a minimum diameter of 17 mm 11/16 inch.

2.3.1.5.1.3 Drive Assembly for Combination Unit

Include motor; speed reducer; drive sprocket on output shaft of speed reducer; drive chain from drive sprocket to driven sprocket; shear pin; and chain guard. Fully enclose unit and ensure suitability for mounting outside and exposed to the weather.

a. Motor must be suitable for operation with the voltage characteristics as indicated.

b. Ensure chain and belt drives incorporated in the drive assembly have a minimum factor of safety of 4 as applied to ultimate breaking or transmission strength of the chain or belt with respect to the loads transmitted at normal continuous operating load.

2.3.1.5.1.4 Housing

****

NOTE: Specify galvanized steel unless corrosion is considered a problem.

****

Mount 1.8 mm 14 gage [galvanized steel] [AIST PB-229, Type 302 or AIST PB-229, Type 304 stainless steel] on the structural supports and securely fasten to the structural frame with bolts or sheet metal screws of the same material as the housing. Provide suitable openings for chain installation and inspection at convenient locations in the housing.

2.3.1.5.2 Screw [Collector] [and] [Conveyor]

****

NOTE: Choose this paragraph and its subparagraphs,

the paragraph above, SCREW COLLECTOR AND BUCKET ELEVATOR, and its subparagraphs, or the paragraph below, CHAIN AND BUCKET ELEVATOR COLLECTOR and its subparagraphs.

NOTE: Screw mechanisms may be used as collectors, conveyors, or both together. Delete "collector and" when screw type collector is not allowed; delete "and conveyor" when screw type conveyor is not allowed; use all optional wording and appropriate pluralizations when both screw collector and conveyor are not allowed.

****

Include screw assembly, motor drive assembly, [liner plates,] [and] [trough,] and appurtenances. Liner plates and troughs may be fiber reinforced plastic instead of steel.

Provide screw [collector] [and] [conveyor] suitable for continuous or intermittent operation and with a removal capacity of not less than [_____] cubic meter per second cubic feet per hour of dry grit weighing [1922] [_____] kg per cubic meter [120] [_____] pounds per cubic foot.

2.3.1.5.2.1 Screw Assembly

****

NOTE: The following table lists the requirements for selecting a screw.

Grit Cap. Cu. m/sec	**Dia. MM**	**Screw Conveyor Pipe Size MM**	**Watts**	**Shaft Dia. MM**
0.03	**300**	**100**	**746**	**50 or 61**
0.05	**400**	**100**	**1,119**	**75**
0.08	**500**	**125**	**1,492**	**75 or 86**

Grit Cap. Cu. Ft/Hr.	**Dia. Inch**	**Screw Conveyor Pipe Size Inches**	**H.P.**	**Shaft Dia. Inches**
55	**12**	**4" Std.**	**1.0**	**2 or 2 7/16"**
100	**16**	**4" X-Hvy**	**1.5**	**3"**
163	**20**	**5" Std.**	**2.0**	**3 or 3 7/16"**

Alternate screw type can be helicoid with short shafts.

****

a. Provide [horizontal] [inclined] screw of [_____] mm inch diameter, half pitch with 10 mm 3/8 inch flights butt welded or fillet welded both sides and mounted on [_____] mm inch Schedule 80 steel pipe conforming to ASTM A53/A53M and bushed for [_____] mm inch shaft. As an alternate, a helicoid type screw conveyor section with 10 mm 3/8 inch steel flights may be provided with short shafts of solid cold rolled steel conforming to ASTM A108. Screw must be made in manufacturer's standard lengths with a coupling flight connection for ease of installation and removal. Protect outer leading edges of the flighting with a coating of weldment, a minimum of 25 mm one inch wide and 3 mm 1/8 inch thick. If carbon steel flighting is provided with a minimum 10 mm 3/8 inch thickness, it will be acceptable without coating provided that it has a minimum Brinell hardness of 500.

b. Ensure shafting is cold rolled steel conforming to ASTM A108 and coupling bolts are AIST PB-229, Type 316 stainless steel. Provide keyway to attach driven sprockets. Keys and keyseats must conform to ASME B17.1 or ASME B17.2.

c. Ensure driven sprocket is high-test cast iron having a minimum tensile strength of 138 MPa 20,000 psi cast in a chill, and with a Brinell hardness of not less than 360 with a chill depth at least 5 mm 3/16 inch, and stress relieved before machining. Sprocket teeth must be accurately ground to fit chain. Sprocket must be split construction assembled with cadmium-plated nuts and bolts. Key seat sprocket on the screw drive shaft.

d. Grease lubricate tail shaft bearings; provide with cast iron, high carbon or heat treated alloy steel bushings. Ensure bearings are rated for a minimum of 5 years of continuous service.

****

NOTE: Delete first optional paragraph below when horizontal screw collector is not allowed: Delete second optional paragraph when inclined screw conveyor is not allowed.

****

e. Grease lubricate drive end bearings for horizontal screw; provide bearings with high carbon or heat-treated alloy steel bushings. Ensure bearings are suitable for taking thrust. Provide bearings with lubrication fittings brought to an accessible location. Ensure bearings are rated for a minimum of 5 years of continuous service.

f. Ensure drive end bearings for inclined screw are extra heavy roller bearing pillow blocks, suitable for taking thrust. Grease lubricated ball bearings will be allowed. Ensure bearings have a minimum rated life expectancy (L-10) of 40,000 hours based on American Bearing Manufacturers Association Standards on a continuous service basis.

2.3.1.5.2.2 Motor Drive Assembly

Include an electric-motor-driven speed reducer; drive sprocket on output shaft of speed reducer; drive chain from drive sprocket to driven sprocket; shear pin; and chain guard.

a. Motor must be suitable for operation with the voltage characteristics as indicated.

b. Ensure chain and belt drives incorporated in the drive assembly have a minimum factor of safety of 4 as applied to ultimate breaking or transmission strength of the chain or belt with respect to the loads transmitted at normal continuous operating load.

2.3.1.5.2.3 Liner Plate

****
NOTE: Specify liner plate for horizontal grit collector and trough for inclined grit conveyor.
****

Provide curved 10 by [_____] mm 3/8 by [_____] inch I.D. abrasion-resistant steel liner plate with edges drilled for plug welding to 50 by 150 mm 1/2 by 6 inch steel straps embedded in the concrete for the horizontal screw, and a Brinell hardness of 300 to 350.

2.3.1.5.2.4 Steel Trough

****
NOTE: Specify liner plate for horizontal grit collector and trough for inclined grit conveyor.
****

Fit abrasion-resistant stainless steel 10 mm 3/8 inch thick trough with a gasket at the inspection opening, a clean-out plate on the lower end and a discharge spout on the upper end. Ensure the upper (drive end) bearings are suitable to take thrust for inclined screw. Ensure trough has a Brinell hardness of 300 to 350.

2.3.1.5.2.5 Structural Supports

****
NOTE: Delete this paragraph when inclined screw conveyor is not allowed. Specify galvanized steel unless corrosion is considered a problem.
****

Construct structural supports using minimum 6 mm 1/4 inch thick material[and based on a safety factor of 4.0 against vertical load and torque]. Use [AIST PB-229, Type 302 or AIST PB-229, Type 304 stainless steel] [galvanized steel] assembly and anchor bolts.

2.3.1.5.3 Chain and Bucket Elevator Collector

****
NOTE: Choose this paragraph and its subparagraphs or one of the paragraphs above, SCREW COLLECTOR AND BUCKET ELEVATOR and SCREW [COLLECTOR] [AND] [CONVEYOR], and its subparagraphs.

NOTE: Chain and bucket mechanisms may be used as an elevator or as a combination collector and elevator.
****

Provide chain and bucket collection and removal assembly suitable for continuous or intermittent operation with a removal capacity of not less than [_____] cubic meter per second cubic feet per hour of dry grit weighing [1922] [_____] kg per cubic meter [120] [_____] pounds per cubic foot which operates at a speed of from 0.04 to 0.05 meter per second 8 to 10 feet per minute. Include housing, motor drive assembly, chain, shafting, sprockets, grit buckets, and overload protection.

2.3.1.5.3.1 Chain and Bucket Assembly

a. Ensure bucket chains are ASME B29.400 combination "H" Type Mill C110 having an average ultimate strength of 134 kN 30,000 pounds and must weigh no less than 7.8 kg per m 5.2 pounds per foot with links of corrosion resisting malleable iron having an average tensile strength of 483 MPa 70,000 psi and an average Brinell hardness between 170 and 190.

****

NOTE: At the text below, delete all references to idler sprockets when chain and bucket elevator is not allowed for the project.

****

b. Ensure sprockets are high-test cast iron, having a minimum tensile strength of 138 MPa 20,000 psi cast in a chill, and a Brinell hardness of not less than 360 with a chill depth of at least 5 mm 3/16 inch and stress relieved before machining. Sprocket teeth must be accurately ground to fit chain. Sprockets must be split construction assembled with cadmium-plated nuts and bolts. Driven sprocket on the head shaft must be of the offset type. Keyseat sprockets on the head shaft. Keys and keyseats must conform to ASME B17.1 or ASME B17.2.[Do not keyseat idler wheel and chain take-up shaft sprocket but, except for number of teeth, must be identical in other respects to the head shaft sprockets. Set-screw idler wheel and take-up shaft sprocket to the shaft.]

c. Ensure bearings babbitt-lined, self-aligning ball-and-socket type or heat treated ductile-iron, self-aligning type. Bolt bearings, except those for bracket-supported driven sprockets, to the tank walls. Ensure bearings are designed to allow minimum field variations without shimming. Bracket supports, except on head shaft driven sprocket, are not be allowed. Provide bearings above water with flush ball-check grease-lubrication fittings. Provide water lubrication to underwater bearings, with tops designed to prevent solids accumulation, and flush ball-check grease-lubrication fittings. Provide self-aligning take-up bearings on take-up shaft arranged to slide between or to be steadied by two cast iron, mild steel or silicon bronze guides, with a minimum range of travel of 250 mm 10 inches and positioned by a stainless steel or silicon bronze threaded power bolt, which must be arranged for locking at any position of the bearing. Ensure bearings are rated for a minimum of 5 years of continuous service.

****

NOTE: At the text below, delete references to stirring flights when only bucket elevator is to be specified.

****

d. Fabricate grit buckets of structural steel or malleable iron with hardened lip[and stirring flights fabricated from structural steel angles and plates]. Ensure buckets are designed to drain off free water. Buckets[and stirring flights] must have replaceable alloy cast iron or malleable iron wearing shoes that can be rotated to distribute the wear. Attach buckets[and stirring flights] to the chains at not more than 1.5 m 5 foot intervals with heat treated carbon steel pins and rivets having a minimum diameter of 17 mm 11/16 inch.

****
NOTE: Delete the paragraph below when only bucket elevator is allowed.
****

e. For each collector mechanism, provide [one] [two] industrial type steel rail(s), minimum weight 8 kg per m 16 pounds per yard. Include necessary splice bars, rail clips, and appurtenances. Ensure structural steel return tracks have a minimum thickness of 10 mm 3/8 inch. Support return tracks by steel cross members supported from chamber walls.

2.3.1.5.3.2 Motor Drive Assembly

Include a motor; speed reducer; drive sprocket on output shaft of speed reducer; drive chain from drive sprocket to driven sprocket; shear pin; and chain guard. Ensure unit is fully enclosed and suitable for mounting outside and exposed to the weather.

a. Motor must be suitable for operation with the voltage characteristics as indicated.

b. Ensure chain and belt drives incorporated in the drive assembly have a minimum factor of safety of 4 as applied to the ultimate breaking or transmission strength of the chain or belt with respect to the loads transmitted at normal continuous operating load.

2.3.1.5.3.3 Housing

****
NOTE: Specify galvanized steel unless corrosion is considered a problem.
****

Mount 1.8 mm 14 gage [galvanized steel] [AIST PB-229, Type 302 or AIST PB-229, Type 304 stainless steel] above the operating floor and 5 mm 3/16 inch below the floor, on structural supports and securely fastened to the structural steel frame with bolts or sheet metal screws of the same material as the housing. Ensure the drive unit and head shaft assembly are as indicated on the shop drawings. Provide suitable openings for chain installation and inspection at convenient locations in the housing.

2.3.1.6 Grit Pump

Provide heavy-duty [[vertical] [horizontal], torque flow vortex pump with mechanical variable speed drive] [vertical close-coupled, vacuum primed pump]. Position pump suction and discharge as indicated. Ensure pump is suitable for pumping grit under the following conditions of services:

Capacity: [_____] cubic meter per second gpm

Maximum Solid Size: [_____] mm inches

Range of Head Conditions: [_____] m feet

Amount of Grit in Water: [_____] percent

Final selection of pump operating conditions will depend upon actual cyclone selected. Include casing, impeller shaft, bearings, motor, drive unit, 6.28 rad 360 degree pressure sensors, and anchor bolts.

2.3.1.6.1 Pump Casing

Provide manufacturer standard pump casing. Equip suction and discharge with flanges.

2.3.1.6.2 Radial and Thrust Bearings

Provide a minimum rated life expectancy (L-10) of 40,000 hours based on ABMA 11 when operating continuously at the rated full-load motor wattage horsepower and speed under the specified loading conditions. Internal bearings may be either oil or grease lubricated.

2.3.1.6.3 Pump and Motor Base

Provide manufacturer's standard base.

2.3.1.6.4 Motor

Motor must be suitable for operation with the voltage characteristics as indicated.

2.3.1.6.5 Drive Unit

Provide drive unit with a mechanical variable speed drive with a [_____] to 1 ratio, manually adjustable in infinite steps over the entire range.

[2.3.1.6.6 Pressure Switch

Provide a pressure switch in the piping to the cyclone to monitor the pressure buildup.[Wire switch to an alarm which will actuate when pressure exceeds a preset value. Provide industrial type alarm including rotating beacon, 90-decibel horn, and spare contact for remote signal.] Furnish switch for a pressure range of from [_____] to [_____] kPag psig with an adjustable alarm contact.

]2.3.1.7 Airlift Pump

Include an air pipe, educator, foot piece, tail pipe, air separator and a vent pipe. Provide zinc-coated Schedule 40 steel pipe to the educator of adequate size to discharge the required amount of liquid without excessive pressure drop. Provide a MSS SP-80 globe valve, MSS SP-72 ball valve, or MSS SP-78 plug air control valve on the air pipe for accurate adjustment of the airlift discharge rate. Ensure tail pipe below the foot piece, the educator pipe, air separator and vent from it are of zinc-coated steel. Fittings must be of zinc-coated malleable iron or cast iron. Provide educator with a clean-out above the water level. Install airlift pump so as to permit easy removal for maintenance.

2.3.1.8 Cyclone

Provide cylindrical-conical cyclone unit with a replaceable, high-density, lining, with a capacity of [_____] cubic meter per second gpm at a maximum feed pressure of [_____] kPa psi and capable of making a separation at approximately [_____] mesh predicated on a feed solids concentration of not more than one percent solids for grit pumped from the point of removal of the grit chamber. Provide flanged components for feed connections, and transition fittings to adapt to both the feed and overflow connections.

2.3.1.9 Screw Type Washing Equipment

Include washing tank, steel screw conveyor mounted in a housing, drive unit, and supporting substructures.

Provide heavy-duty stainless steel vessel grit washer suitable to capture grit slurry and separate the grit from the organics. The Grit Washer must be suitable for the following conditions of services:

Design Flow of Grit Slurry per unit: [_____] cubic meter per second gpm

Grit Processing Capacity per unit: [_____] kg per hr ton per hr

Maximum water content in washed grit: [_____] percent at design flow

Maximum volatile solids in washed grit: [_____] percent at design flow

Minimum capture rate of [_____] size grit: [_____] percent at design flow

Surface overflow rate: [_____] cubic meter per second per squared meter gpm per square foot

Horsepower of Driver: [_____] watts HP

2.3.1.9.1 Mechanism

****

NOTE: The following table lists the requirements for selecting a screw.

Grit Cap. Cu. m/sec	**Dia. MM**	**Screw Conveyor Pipe Size MM**	**Watts**	**Shaft Dia. MM**
0.03	**300**	**100**	**746**	**50 or 61**
0.05	**400**	**100**	**1,119**	**75**
0.08	**500**	**125**	**1,492**	**75 or 86**

Grit Cap. Cu. Ft/Hr.	**Dia. Inch**	**Screw Conveyor Pipe Size Inches**	**H.P.**	**Shaft Dia. Inches**
55	**12**	**4" Std.**	**1.0**	**2 or 2 7/16"**
100	**16**	**4" X-Hvy**	**1.5**	**3"**
163	**20**	**5" Std.**	**2.0**	**3 or 3 7/16"**

Alternate screw type can be helicoid with short shafts.

****

Convey grit from washer settling compartment and discharge by means of a screw conveyor. Mount [_____] mm inch diameter, [half pitch] with 10 mm 3/8 inch flights, incline screw on [_____] mm inch pipe. Provide manufacture's standard screw, ensuring ease of installation and removal.

a. Grease lubricate tail shaft bearings; provide with high carbon or heat treated alloy steel bushings. Ensure bearings are rated for a minimum of 5 years of continuous service.

b. Ensure drive end bearings are extra heavy roller bearing pillow blocks suitable for taking thrust. Grease lubricated ball bearings are acceptable. Ensure bearings have a minimum rated-life expectancy (L-10) of 40,000 hours based on ABMA 11 on a continuous service basis.

2.3.1.9.2 Housing

Construct the washing tank of 6 mm 1/4 inch steel plate, suitably reinforced and mounted on steel supports. Ensure tank provides a settling compartment for grit separation. Provide suitable anchor bolts. Arrange the substructure to support the washing tank and cyclone, include necessary mounting brackets as a component part of the washer.

2.3.1.9.3 Drive Unit

Provide mechanical variable speed drive unit with a [_____] to 1 ratio, manually adjustable in infinite steps over the entire range.

2.3.1.9.4 Motor

Motor must be suitable for operation with the voltage characteristics indicated.

2.3.1.9.5 Overflow Weir

Regulate depth of liquid in the settling compartment by an adjustable weir fitted at the end of the settling tank. Regulate pool depth to a minimum of 150 percent of the spiral diameter.

2.4 COMPONENTS

2.4.1 Motor

Provide motor that is constant speed, totally enclosed, thermally protected horizontal type, suitable for outdoor service, and conforming to NEMA MG 1. Motor must be of adequate wattage horsepower to drive the equipment continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Motor must be suitable for operation with the voltage characteristics as indicated. Protect motor against overload, low voltage, and unbalanced voltage. Connect motor directly to speed reducer or drive unit through a flexible coupling.

2.4.2 Speed Reduction Unit

Provide speed reducer with a fully enclosed gear reduction unit. Ensure gears used in speed reducer conform to applicable requirements of the following standards. Ensure speed reducer is designed with a minimum AGMA service factor of 2.0 and has an AGMA Service Classification II.

a. Helical Gearing: AGMA 908, ANSI/AGMA 6034,ASTM A48/A48M, and ASTM A536.

b. Worm Gearing: ANSI/AGMA 6034 and ASTM A536.

2.4.3 Bearings

Provide anti-friction drive bearings conforming to the following minimum schedule of rated-life expectancy (L-10) based on the ABMA Standards when operating at the normal continuous torque rating of the mechanism.

a. Worm and wheel gear box bearings: L10-100,000 hours

b. Geared motor (direct drive): L10-100,000 hours

c. Intermediate helical and spur gear box bearings: L10- 17,000 hours

d. Geared motor (indirect drive): L10- 17,000 hours

2.4.4 Chain and Belt Drives

Enclose chain and sprockets or V-belt and pulleys connecting motor and speed reducer in a weatherproofed guard. Chain connecting motor and speed reducer must be steel roller type. Sprockets must be hardened ground alloy steel or high-test cast iron, having a minimum tensile strength of 276 MPa 40,000 psi cast in a chill, and must have Brinell hardness of not less than 360 with a chill depth of not less than 5 mm 3/16 inch. Sprocket teeth must be accurately ground to fit the chain. V-belt drives must be adjustable to increase or decrease belt tension. Drive sprocket must be keyed on the output shaft of the speed reducer and provided with shear pin overload protection. Provide a drive chain tightener to adjust and tighten the chain.

2.4.5 Drive Unit

Provide drive unit that is mechanical variable speed drive with ratio indicated, and is manually adjustable over the entire range. The drive unit must be suitable for mounting with motor provided. Include a motor sheave, speed reduction sheave and V-belt. Transmit the required power with multiple belts. Ensure a minimum service factor of 1.5.

[2.4.6 Overload Protection and Alarm

Provide waterproof torque actuated overload alarm system, or indicating ammeter overload unit designed to indicate the load on the mechanism at all times, to sound an alarm in case of impending excessive load, and to stop the mechanism when such load is reached. Include an industrial Type 90-decibel horn, rotating beacon, relay and reset button in a weatherproof metal housing with a removable gasketed cover. Construct horn of corrosion-resisting material and ensure that it is suitable for remote mounting. Provide shut-off switch, for horn and beacon.

]2.5 MATERIALS

2.5.1 Finishes

Except as otherwise specified, treat and paint equipment in accordance with the manufacturer's standard practice.

PART 3 EXECUTION

3.1 INSTALLATION

Install grit handling equipment and accessories specified herein in accordance with approved shop drawings and manufacturer's recommendations. Provide all lubricants for initial operation.

3.1.1 Air Piping

Install piping in alignment and support with pipe hangers and supports. Make mechanical joints in accordance with the requirements of AWWA C600. Make flanged joints tight, avoid undue strain on flanges, valves, fittings, and other equipment and accessories. Make screwed joints tight with pipe thread tape, pipe cement and oil, or PTFE powder and oil, applied to the male threads only. Leave no more than 3 threads exposed, ensure threads are full cut. Make up joints for PVC pipe with solvent cement conforming to ASTM D2564 and join in accordance with the Appendix thereto.

3.1.2 Grit Pump

Mount the pump complete with driver and motor on a heavy duty base. Ensure the base is complete with machined undersurface mounting pads and lifting brackets. Install the complete unit in accordance with the recommendations of the manufacturer. Provide oil and grease for initial operation in accordance with the manufacturer's recommendations.

3.1.3 Cyclone

Install in accordance with the manufacturer's instructions to ensure self-regulation and produce a low moisture grit.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

3.2.1.1 Grit Separation, Collection, Removal and Washing Equipment

Test equipment in operation to demonstrate correct alignment, smooth operation, freedom from vibration and freedom from noise and overheating of moving machinery. Correct all defects.

3.2.1.2 Aerated Grit Equipment

3.2.1.2.1 Air Diffusers

Test for uniformity. Each diffuser must have uniform distribution along the entire header as determined by the method of testing specified.

a. Test using a large easily read scale for measuring the flow of air to the header system and pressure gauges for measuring pressure at the third point of the header. Test the header and diffusers in the aerated grit tank. Use orifice type meter, of proper size, and installed in accordance with the recommendation of AGA GMC. Before tests are started, check the calibration of the orifice meter with a standard displacement type gas meter of not less than [_____] cubic meter per second cubic feet per hour capacity which has been accurately calibrated volumetrically in a manner satisfactory to the Contracting Officer.

b. For uniformity testing, submerge diffusers in tap water to a depth of 0.30 m one foot. Diffuse air at a rate of [_____] cubic meter per second cubic feet per minute per diffuser for one minute. Then reduce the airflow to [_____] cubic meter per second cubic feet per minute per diffuser, observe uniformity. Replace nozzle having unsatisfactory distribution.

3.2.1.3 Grit Pump

After pump has been installed, conduct such tests as are necessary to indicate that the pump conforms to the specifications. A 24-hour operating period of the pump is required before acceptance. Submit sufficient data, including manufacturer's rating curves showing pump characteristics of head, wattage brake horsepower, and speed to show that the pump meets all requirements of the specifications.

3.2.1.4 Performance Tests

****

NOTE: Performance tests consist of determining the amount of grit entering the chamber and the amount of grit in the effluent from the chamber and comparing the two values as a percentage.

****

Provide field test data demonstrating the performance of grit removal efficiencies as specified. Specified performance must be met before equipment will be accepted. The contractor is responsible for testing costs. Submit an acceptable grit removal efficiency test procedure prior to actual testing.

3.2.1.5 Cyclone

Upon installation, operate equipment for 24 continuous hours at the design flow specified. During this period, sample cyclone overflow periodically as directed by the Contracting Officer, but not less than once every four hours. Dry and test samples as specified by AASHTO T 27 and AASHTO T 11. If particles average more than 5 percent larger in size than [_____] mesh, adjust the equipment to meet these specifications.

3.2.2 Manufacturer Field Service

3.2.2.1 Manufacturer's Representative

Provide the services of an engineer representative to supervise the field installation and start-up of the equipment and accessories, in accordance with the manufacturer's specifications.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Grit Handling System

Submit grit handling equipment information, including operation and maintenance manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, for each item of the grit separation, collection, removal and washing system.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-46 24 16 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 24 16 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-46 24 16 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 24 16 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 46 24 16

COMMINUTORS

05/21

****

NOTE: This guide specification covers the requirements for comminutor for use in sewage treatment plants normally handling domestic sewage.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA MG 1	(2021) Motors and Generators

1.2 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Comminutor; G, [_____]

SD-03 Product Data

Spare Parts

Submit after approval of the drawings and not later than [_____] months prior to the date of beneficial occupancy.

Materials and Equipment

Framed Instructions

SD-06 Test Reports

Field Tests

Booklet form.

SD-10 Operation and Maintenance Data

Operating Instructions; G, [_____]

[Six] [_____] copies each of the operation and maintenance manuals.

1.3 QUALITY CONTROL

1.3.1 Manufacturer's Services

Obtain the services of the manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified to supervise the installing, adjusting, and testing of the equipment.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect from weather, humidity and temperature variations, dirt and dust, or other contaminants all equipment delivered and placed in storage.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide materials and equipment conforming to the respective publications and other requirements specified and which are the standard products of a manufacturer regularly engaged in the manufacture of the products. Provide items of equipment that essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening. Ensure equipment is supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.1 Nameplates

Provide nameplates for major equipment items to include manufacturer's name, address, type or style, catalog number and model or serial number on a plate securely attached to item of equipment. In lieu of nameplate on the comminutor, integrally casting the manufacturer's name or trademark with comminutor, stamping, or otherwise permanently marking is acceptable.

2.1.2 Protection From Moving Parts

Fully enclose moving parts of the equipment, such as drive chains and sprockets, in removable guards. Fully enclose all equipment above the level of the sewage-carrying channel in a cast-iron or 1.720 mm (14 gauge) 14 gauge sheet steel or wrought-iron housing. Provide housing with a sufficient number of doors or removable panels to insure ready access to any part of equipment for repairing, replacing, or cleaning. Ensure all joints between the housing and the concrete foundation are made leakproof.

2.1.3 Design

****

NOTE: Refer to UFC 3-240-02 for design requirements. The following information should be shown on the project drawings covered by the specification as appropriate:

a. Size and type of channel pipe or joint in which comminutor is to be mounted. Specify whether comminutor access openings are located within pits or manholes.

b. Minimum, average, and maximum sewage flows. The maximum rating of a comminutor should be made with the combs fully submerged.

c. Normal and maximum liquid levels, including flooding level for submersible drive.

d. Allowable head loss at maximum flow. Head loss should not be set too low for it could exclude rotating type comminutors.

e. Whether comminutor has free discharge or controlled discharge.

f. Whether location requires explosion-proof equipment.

g. Electrical power characteristics.

h. Type of drive mounting and elevations pertinent thereto.

i. Channel design, size and type, should be conducted in manner that optimizes channel width and allows for maximum competition among comminutor suppliers. If the channel width is designed too narrow it could exclude rotating type comminutors.

j. Each comminutor device should have a by-pass for maintenance and repair purposes.

****

Provide a comminutor capable of passing a minimum flow of [_____] cubic meters/second million gallons per day (mgd), an average flow of [_____] cubic meters/second mgd, and a maximum flow of [_____] cubic meters/second mgd. Ensure the head loss at maximum flow does not exceed [____] mm inches of water. Design comminutor for [free] [controlled] discharge. [Design so the downstream submergence is [_____] mm inches at maximum flow for controlled discharge units.] Ensure comminutor is capable of operating satisfactorily at zero flow.

2.2 COMPONENTS

2.2.1 Electric Motor and Controller

Provide electric motors that conform to NEMA MG 1. Provide motor controller that conforms to NEMA ICS 2.

2.2.2 Comminutor

Provide a comminutor of the [rotating] [or] [oscillating] type for use in a sewage treatment plant. Comminutor consists of an electric motor-driven mechanical shredder or cutter with [gear motor] [hydraulic drive] capable of continuous and automatic operation and must reduce sewage solids to particle sizes between 6.4 and 9.5 mm 1/4 and 3/8 inch. The cutting and screening mechanism are required cut or shred all sewage solids including sticks, rags, and stringy material, without removing them from the sewage flow, without clogging the screen, and without binding, jamming, or stalling the moving parts.

Submit drawings indicating clearances required for maintenance and operation, containing complete wiring and schematic diagrams, equipment layout and anchorage, and any other details required to demonstrate that the system has been coordinated and properly function as a unit.

2.2.2.1 Rotating Drum Type

Rotating drum type comminutors are required to include a slotted drum that functions as a screen and support for the rotating cutters, a casing supporting the stationary cutters, and a drive assembly. Evenly spaced cutting teeth pass through a stationary comb section cutting against it as the cutters rotate. Ensure the unit has a smooth, continuously available torque, 360-degree rotation with equal performance in either direction of rotation. Provide casing made of close-grain cast iron or aluminum alloy of adequate strength and rigidity to withstand all loads imposed on it from the operation of the comminutor and drive assembly. Provide casing with manufacturer's recommended concave semi-circular screen of stainless steel attached to it.

2.2.2.2 Rotating Disc or Conical Type

Rotating disc or conical type comminutors include a stationary grid frame cutter-comb support with cutter-combs, rotating cutter plate/screen with adjustable teeth, and a drive assembly. Cutter plates are fixed and keyed to the center drive shaft permitting only one cutter tooth and a cutter comb to be engaged at one time for load power saving. Provide frame, grid, and discs made of close-grained cast iron or aluminum alloy. Construct the conical screen of the manufacturer's recommended stainless steel.

2.2.2.3 Oscillating Type

Oscillating type comminutors include a stationary semi-circular screen, a stationary cutter bar mounted on a support casing, an oscillating cutter bar, and a drive assembly. Ensure cutter bars are adjustable and readily removable for inspection, sharpening, or replacement. Actuate oscillation by mechanical conversion of the driver rotation. Provide a casing made of close-grain cast iron or aluminum alloy of adequate strength and rigidity to withstand all loads imposed on it from the operation of the comminutor and drive assembly. Construct the casing of the manufacturer's recommended semi-circular screen of stainless steel attached to it.

2.2.3 Motor Controller

Mount the control panel where indicated. Ensure the motor controller is rated as indicated and conform to NEMA ICS 2. Ensure the control system includes an automatic motor starter reset for power failure protection [and an automatic drive motor reversal with time delay for jamming protection in the event of hard particle entrapment in the comminutor cutters]. Design the reversing controller to sense jams and reverse motor rotation as often as necessary, while continuing to operate providing partial sweeps on the comminutor arm, with no danger of motor damage. Provide an audible and visual alarm system to signal both field operator and area office in case of malfunction.

2.2.4 Gear Motor

****

NOTE: Totally enclosed motors should be used except in locations where explosive-proof equipment is required.

****

Provide an electric motor of constant speed, [totally enclosed] [totally enclosed fan cooled] [explosion-proof], capable of operating in air, partially or completely submerged. Ensure motors are UL listed for Class I, Div I, Group D service, horizontal or vertical type, suitable for outdoor use and conforming to NEMA MG 1. The unit is required to be capable of withstanding any loadings produced by the thrust, out-of-balance, and vibrating forces resulting from operating conditions. Supply gears made of be wrought or alloy steel except that worm gears be bronze. Flame hardened gears are not acceptable. Construct housing of close-grained cast iron, fabricated steel, or aluminum alloy.

2.2.5   Gear Motor Mounting

Mount the comminutor gear motor [close-coupled with the comminutor] [on [an open] [a gas tight] stand with universal shaft to the comminutor. Enclose universal shaft in protective piping to elevation indicated. Provide protective piping with a tapped and plugged hole for drainage] [on an extension pipe at the elevation indicated with universal shafting to the comminutor. Equip extension pipe with handholds to allow inspection and repair of shafting].

2.2.6   Hydraulic Drive

Mount hydraulic actuator on the unit and connected to the shaft. Supply pressurized hydraulic fluid using a power unit that includes an oil reservoir, motor-driven positive displacement pump, and all necessary control valves. Ensure the pump motor is constant speed [totally enclosed] [totally enclosed fan cooled] [explosion-proof], vertical type suitable for outdoor service and conform to NEMA MG 1. Protect motor against overload, low voltage, and unbalanced voltage. Provide rubber-covered abrasion-resistant pressure hose with suitable connectors for connecting the power unit to the hydraulic actuator.

2.2.7   Cutting Elements

Fabricate all secured elements, combs, teeth, and bars of a corrosion- and wear-resistant chrome-tungsten type alloy or equal possessing Brinell Hardness of 450 or better. Ensure all elements are readjustable to compensate for wear, and removable for sharpening or replacement.

2.2.8   Bearings

Provide bearings of the antifriction type having a rating-life expectancy (L-10) of 100,000 hours when equipment is operating continuously. [Provide intermediate guide bearings, where required for extended shafting, for adequate support and alignment made of the ball bearing type enclosed in a self-aligning pillow block housing.]

2.2.9   Lubrication

Lubricate and protect all moving parts of the comminutor from flooding according to the manufacturer's recommendations. Ensure bearings are either oil or grease lubricated. Ensure gear reduction unit is oil lubricated. Provide oil lubricated bearings and reduction units with a sight glass or other positive means of determining oil level. Ensure grease-lubrication pressure-line fittings and oil fill and drain lines are easily accessible when comminutor is in place.

2.3 MATERIALS

Provide materials that conform to the following:

2.3.1 Cast Iron

ASTM A48/A48M Class 30, minimum.

2.3.2 Bearings

ABMA 9 and ABMA 11.

2.3.3 Aluminum Alloy

ASTM B108/B108M.

2.3.4 Miscellaneous Metal

Provide bolts, nuts, anchors, washers, and other types of supports necessary for the installation of equipment made of steel or wrought iron, galvanized according to the requirements of ASTM A153/A153M. Ensure all anchor bolts and nuts for the comminutor, motor, or power unit are Type 316 stainless steel, ASTM F593.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install materials and equipment as shown and in accordance with the approved written recommendations of the equipment manufacturer.

3.2.1 Installation within a Channel

****

NOTE: Delete this paragraph when comminutor is to be installed in a pipeline.

****

Ensure the comminutor, motor, power unit, guide bearings, and all equipment requiring attachment to structural supporting members are furnished complete with bolts, nuts, anchors, washers, sole plates, or any other type of supports necessary for the installation of the equipment.

3.2.2 Installation within a Pipeline

****

NOTE: Delete this paragraph when comminutor is to be installed in a channel.

****

Provide comminutor with standard flanged or bell and spigot connections for installation in pipeline.

3.2.3 Electrical Work

Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical characteristics as indicated. Provide manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices but not shown on electrical plans.

3.2.4 Painting

Thoroughly clean, prime, and give two finish coats of paint to all equipment at the factory in accordance with the recommendations of the manufacturer. Ensure all field painting complies with Section 09 90 00 PAINTING, GENERAL.

3.2.5 Special Tools

Furnish special tools for the proper operation and maintenance of equipment. Install in a wall-mounted hardwood or metal container. Furnish a complete set of manufacturer's recommended spare parts including cutting teeth and combs or other cutting elements, fasteners, screens, seals or bearings, etc. Include a complete list of parts and supplies with current unit prices and source of supply in the spare parts data submission.

3.2.6 Framed Instructions

Post, where directed, framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Submit proposed diagrams, instructions, and other sheets, prior to posting. Post the framed instructions before acceptance testing of the systems.

3.3 FIELD TESTS

After installation of comminutor is complete, conduct operational tests required to demonstrate that the comminutor operates in accordance with the specified requirements. Submit test reports showing all field tests performed on the installed system to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Ensure each test report indicates the final position of controls.

3.3.1 Scheduling

Provide the Contracting Officer [14] [_____] calendar days notice of the dates and times scheduled for the tests.

3.3.2 Tests

Test the comminutor mechanism in the operation mode to demonstrate correct alignment, smooth operation, proper adjustment, freedom from vibration, and freedom from noise and overheating of moving machinery. Ensure the test period includes one hour of operation in each specified range and not less than one cycle of automatic stop, reversal, and restart. Measure head losses at the specified flow ranges during the tests to assure that the requirements are met. Test operate installed controls to assure that operational requirements of paragraph MOTOR CONTROLLER are satisfied. Make two complete cycles to verify that the system continues to function satisfactorily under all requirements.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Training

****

NOTE: Consult equipment manufacturers for recommended time required to train personnel for the proper operation of the unit and insert number of hours.

****

Provide a field training course for operating and supervising staff members. Provide training for a total period of [_____] hours of normal working time and must start after the system is functionally complete but prior to final acceptance tests. Ensure the field instructions cover all of the items contained in the operating and maintenance instructions.

3.4.2 Operating Instructions

Provide manual of operation explaining in detail step-by-step procedures required for system startup, operation, and shutdown. Include parts list, and a brief description of all equipment and operating features in the instructions.

Provide maintenance manuals explaining in detail routine maintenance procedure including inspection, adjustments, lubrication, and cleaning. List possible breakdown, methods of repair, and a troubleshooting guide in the instructions. Include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed in the instructions for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Identify the manuals by title, equipment and manufacturer. Submit and obtain approval of all manuals prior to the field training course.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-46 25 14 (February 2011)**
Change 1 - 11/13

Preparing Activity: NAVFAC **Superseding**
UFGS-44 42 53 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION 46 25 14

COALESCING [OR VERTICAL TUBE] OIL-WATER SEPARATORS

02/11, CHG 1: 11/13

PART 3   EXECUTION

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-46 25 14 (February 2011)**
Change 1 - 11/13

Preparing Activity: NAVFAC **Superseding**
UFGS-44 42 53 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 46 25 14

COALESCING [OR VERTICAL TUBE] OIL-WATER SEPARATORS

02/11, CHG 1: 11/13

****

NOTE: This guide specification covers the requirements for parallel plate, and vertical tube gravity oil-water separators to remove free oil and particulate matter from oily waste water.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Vertical tube coalescers shall not be used on Army projects.

****

****

NOTE: When influent conditions require treatment beyond the capability of a parallel plate, vertical tube, or API type gravity separator (e.g. presence of a mechanical or chemical oil-water emulsion), the designer shall prepare specifications to add one or more of the following unit operations to the separation system to comply with discharge criteria:

Hydrocyclone
Chemical pretreatment unit

Flocculator
Dissolved air floatation unit
Electrocoagulation unit
Filter membranes
Cartridge filters
Activated carbon absorber
Multimedia filtration
Sludge dewatering equipment

In addition, these separators are not intended as containment devices. Where applicable regulations dictate containment of accidental spills, suitable containment systems shall be designed.

****

****

NOTE: The following information shall be shown on the project drawings:

1. Inlet and outlet pipe invert elevations.

2. Sampling ports integral with the influent pipe and effluent pipe, when required.

3. Accessory equipment.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings

NPS 1/2 Through NPS 24 Metric/Inch Standard

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes

1.2 SYSTEM DESCRIPTION

1.2.1 Applications

****

NOTE: Delete parts of paragraph which are not applicable for project with respect to liquid carrier. Identify oily wastewater source(s) such as machine and paint shops, aircraft maintenance operations, aircraft washrack and rinse (corrosion control) areas, tank farm and fuel transfer areas, runway and fire training areas, bilge and ballast water, accidental spills, and contaminated stormwater runoff.

****

****

NOTE: Pumping of influent will mechanically emulsify oil in water unless a positive displacement pump or other low emulsifying, de-rated pump is used.

****

****

NOTE: Identify site specific atmospheric conditions that would produce a corrosive environment for oil-water separator materials so that the proper protective coatings or corrosion resistant materials can be provided.

****

The separator shall remove free oil [and] [emulsified oil] [and suspended solids] from oil-in-water mixtures of [freshwater] [freshwater and seawater] [seawater] originating from [_____] operations. The influent oil-in-water mixture will [flow by gravity] [be pumped] to the unit which [will] [will not] be located in an area with a corrosive atmosphere. [The corrosive atmosphere is composed of [_____].]

1.2.2 Influent Characteristics

****

NOTE: Insert maximum design flow and wastewater characteristics which have been established by direct measurement and chemical analysis.

****

Provide oil-water separator designed for a maximum flow of [_____] liters per second gallons per minute. Operating temperatures of the influent oil-in-water mixture will range from [_____] to [_____] degrees C degrees F and ambient air temperatures will range from [_____] to [_____] degrees C degrees F. The specific [gravity] [gravities] of the [oil] [oils] at operating oil-water temperatures will range from [_____] to [_____]. The specific gravity of the [freshwater] [freshwater and seawater] [seawater] at operating temperatures will range from [_____] to [_____]. The average specific gravity of the suspended solids is [_____]. The influent is further characterized as follows:

****

NOTE: List additional types and concentrations of detergents, anti-oxidants, solvents, acids or bases, and heavy metals that may be present in the oil-in-water mixture. If these additional items are present: chemical addition, flocculation and dissolved air flotation, or other appropriate unit operations may be needed for effective treatment of these constituents.

****

Oil-in-Water Mixture	Minimum	TO	Maximum
Total solids	[_____]	to	[_____] mg/L
Total suspended solids	[_____]	to	[_____] mg/L
[Total grease and oil]	[[_____]]	[to]	[[_____] mg/L]

Oil-in-Water Mixture	Minimum	TO	Maximum
[Petroleum hydrocarbons]	[[_____]]	[to]	[[_____] mg/L]
Detergent content	[_____]	to	[_____] ppm
pH	[_____]	to	[_____]
Oil droplet size	Greater than [20] microns		

1.2.3 Performance Requirements

****

NOTE: Make choice based on standards or guidelines established by environmental regulatory agency(ies); or other design considerations, such as unit wastewater treatment process(es) that follow downstream from this separator. Quantity of free oil removed is dependent on characteristics of oil-in-water mixture. The practical minimum concentration achievable is 10 mg/L for a parallel plate separator under ideal conditions.

****

****

NOTE: In general, free oil is defined as dispersed oil globules that rise to the surface of the water in which it is contained. The rate of rise of the oil particle is a function of its size and specific gravity as defined by Stoke's Law. Oil droplets with diameters of greater than 20 microns and specific gravities of 0.95 or less are considered to constitute the free oil form. Smaller oil droplet diameters are attributed to mechanically or chemically emulsified oil.

****

The [grease and oil] [petroleum hydrocarbon] concentration in the effluent from the oil-water separator shall not exceed the following limitations:

Contaminants	Maximum
[Total grease and oil, 30-day average]	[[_____] mg/L]
[Total grease and oil, daily maximum]	[[_____] mg/L]
[Petroleum hydrocarbon, 30-day average]	[[_____] mg/L]
[Petroleum hydrocarbon, daily maximum]	[[_____] mg/L]
[_____]	[_____]

To achieve [this goal] [these goals], it will be necessary to remove all free oil droplets equal to or greater than [20][_____] microns.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Separator; G, [_____]

[Accessory equipment; G, [_____]]

Submit shop drawings for separator [and accessory equipment] including principal dimensions, location of fittings and unit foundation. Include data to verify center of gravity with the unit empty and filled with water.

SD-05 Design Data

Separator; G, [_____]

[Accessory equipment; G, [_____]]

Submit analysis, signed by a registered professional engineer, which indicates that at the calculated overflow rate, the separator will be provided with the required square meter square feet of projected plate separation area to achieve the specified performance under laminar flow (i.e. Reynolds number of less than 500) conditions. Calculations shall take into account the rate of flow, potential surge flow, influent concentrations, particle characteristics, fluid temperature, fluid specific gravities, and pH.

SD-06 Test Reports

Shop hydrostatic test; G, [_____]

Submit results of hydrostatic and dynamic testing.

Inspection

Field hydrostatic test

Preoperational test

In-service test

SD-07 Certificates

Separator corrosion protection; G, [_____]

Submit written verification on the fabricator's letterhead that surface preparation and coating application were performed in accordance with the manufacturer's printed recommendations for the coating system.

SD-08 Manufacturer's Instructions

Separator system; G, [_____]

SD-10 Operation and Maintenance Data

Separator system, Data Package 3; G, [_____]

[Accessory equipment, Data Package 3; G, [_____]]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, such as subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. If special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.

1.4.2 Handling

Handle separator in such a manner as to ensure delivery to final location in sound, undamaged condition. Take special care not to damage interior and exterior surfaces of separator, coalescing plates, [or tubes] and associated supports and pipe coatings or linings. Make satisfactory repairs to damaged materials at no cost to Government. Carry and do not drag materials.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Insert reinforced concrete or other suitable material if carbon steel is not acceptable. On larger separators (e.g. flow rate greater than 3.16 L/s 50 gpm, 6 mm 1/4 inch minimum thickness for carbon steel is recommended. Consult manufacturers' data.

****

Use [3/16] [_____] mm inch minimum thick carbon steel conforming to ASTM A36/A36M [_____] or material having equivalent structural properties and corrosion resistance for separator, hoppers, stationary and adjustable weirs, nozzles, flow distributor and energy dissipator device, bolts, seals, stiffeners, washers, [separator cover] and nuts. Weld in accordance with AWS D1.1/D1.1M to provide watertight separator that will not warp or deform under load. Use welders qualified in accordance with AWS Standard Qualification Procedure. Grind welds smooth and remove weld spatter. Fabricate free of kinks and sharp bends in a manner not to reduce the strength of steel to a value less than that intended by the design. Size and shape of bends shall be uniform. Clean and finish [carbon steel] [_____] surfaces as described in paragraph entitled "Separator Corrosion Protection."

2.1.1 Separator Corrosion Protection

2.1.1.1 Steel Separator

After shop conducted hydrostatic tests have been successfully completed, provide a MIL-DTL-24441 coating system to the interior and exterior surfaces of the separator. Prior to shop painting, abrasive blast clean the surfaces in accordance with SSPC SP 10/NACE No. 2 to a surface profile of 0.025 to 0.0625 mm 1 to 2 1/2 mils. Apply primer conforming to MIL-DTL-24441/1, Formula 150 applied to a minimum dry film thickness of 0.075 to 0.10 mm 3 to 4 mils. Apply intermediate coat conforming to MIL-DTL-24441/2, Formula 151 applied to a minimum dry film thickness of 0.075 to 0.10 mm 3 to 4 mils. Apply topcoat conforming to MIL-DTL-24441/3, Formula 152 applied to a minimum dry film thickness of 0.075 to 0.10 mm 3 to 4 mils. Total dry film thickness shall not be less than 0.23 mm 9 mils. Repair and replace areas of the coating system which are found to be damaged or defective upon delivery of equipment to the site or found to be defective due to work of the applicator. An interior polytetrafluoroethylene liner with a minimum thickness of 3 mm 1/8 inch may be provided in lieu of paint coating the interior separator surfaces.

2.1.1.2 Other Than Steel Separator

****
NOTE: If other than steel is specified for the separator material, the designer shall specify an appropriate protective coating system for the separator material specified.
****

After shop conducted hydrostatic tests and have been successfully completed, provide a coating system which will protect the separator from the oil-in-water mixture, [atmosphere,] and in situ soil conditions specified herein.

2.1.1.3 Cathodic Protection

****
NOTE: Specify cathodic protection for metal separators in contact with soil. Design cathodic protection in accordance with the current edition of UFC 3-570-02N, "Electrical Engineering Cathodic Protection" and edit the appropriate guide specification for inclusion in the project specification.
****

For [below ground] [partially above and partially below ground] [above ground] metal separators, provide cathodic protection with test stations as specified in Section [26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM] [26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM] in addition to the protective coating.

2.1.2 Substitutions

****
NOTE: Designer shall check manufacturer's literature to assure construction material option selected is capable of withstanding anticipated forces and moments for the size of separator designed. Navy has experienced some problems with the fiberglass covered plywood and timber units when the fiberglass cracks; due to water seepage, wood has deteriorated causing structural failure.
****

****
NOTE: Insert suitable material if carbon steel is not acceptable. Consult manufacturers' data.
****

Separators constructed of [reinforced fiberglass][or] [reinforced glass fiber resin laminates over a rigid urethane foam core] may be provided in lieu of carbon steel [_____]. Provide fiber glass separator with lifting straps. Glass fiber reinforced plastic weirs may be accepted as a suitable weir and baffle material provided that necessary requirements for anchorage of these items include provisions for contraction and expansion. Surfaces shall be seamless, chemically resistant to oil-in-water mixture, and resistant to ultraviolet deterioration.

2.1.3 External Surfaces

****

NOTE: Include bracketed text as appropriate for below ground or partially below ground installations.

****

External surfaces and appurtenances shall be resistant to corrosion from the in situ soil, [backfill material,] [groundwater,] [and surface runoff] [surface runoff and the surrounding atmosphere] [soil pH] [soil resistivity].

2.1.4 Internal Surfaces

****

NOTE: The solvents in oil allow some plastic composite surfaces to absorb the oil. Once the plastic surfaces become saturated with oil they can become sticky. This is especially critical with plates since solids will tend not to slide down and eventually will clog the area between the parallel plates, resulting in increased maintenance.

****

Parallel plate [or vertical tube] material and orientation shall enhance oil coalescence and solids removal, and be corrosion and chemically resistant to the oil-in-water mixture [and atmosphere] as specified in paragraph entitled "SYSTEM DESCRIPTION."

2.1.5 Hardware

Bolts, stiffeners, washers, nuts, screws, pins, and fittings as required shall be corrosion resistant [and resistant to seawater]. Provide materials that are inherently corrosion resistant and not merely treated with a corrosion-resistant coating, such as provided by the galvanizing process.

2.1.6 Accessibility

****

NOTE: Separators below grade with access manholes and extension tubes to the surface are not recommended because of the obvious problems associated with visual inspection, cleaning, maintenance and safety. The designer is encouraged to provide an open type unit with removable grates, covers, or guard rail in order to minimize safety problems and improve accessibility. The preferred design is a separator with top at or above grade and open to the atmosphere, or if absolutely necessary, a cover which is completely removable. Access for routine sampling of wastewater should be provided. The cover should be designed so that it is easily removable by one person without the use of special hoists or other equipment. A separator that is completely open will require a guardrail around the top. However, if the designer is faced with an air emission standard (i.e. State of California) the

separator may need to be vapor tight and would preclude the use of open separators.
****

Do not bury tops of separators. Make the entire top area of the separator visible from ground surface. Separators below grade with access manholes and extension tubes to the surface will not be permitted. Use separators with an open top or a completely removable cover. Use open top separators with removable grating unless otherwise shown. Use top cover and grating that is easily removable by two persons. As a minimum provide access hatches over the following areas: parallel plates, oil storage compartments, Influent sampling area, effluent sampling area, oil skimmer, and weirs. Parts subject to wear or requiring adjustment, inspection, cleaning or repair shall be accessible and capable of convenient removal when required.

2.2 SEPARATION CHAMBER

Provide [above ground] [below ground] [partially above and partially below ground] separator to withstand hydraulic and soil loadings under static and dynamic conditions while empty and during operating conditions. Provide adequate support for additional loadings from separator appurtenances including weirs, hoppers, internal supports, parallel plate [or vertical tube] oil coalescers, equipment transportation, and rapid lowering and braking of load during handling operations. Bolt separator [and accessories] to weld-fabricated, structural steel skid base, or mount on manufacturer's standard base.

2.2.1 Lifting Mechanism

****
NOTE: For units fabricated from fiberglass, specify straps. In a salt water environment substitute acceptable non-corroding metal such as but not limited to copper-nickel, 316 stainless steel, or monel. Aluminum is unacceptable. Consult manufacturers' data.
****

Fit separator with lifting [lugs] [straps] [padeyes] [supports] for handling and installation. Each [lug] [strap] [padeye] [support] shall carry the total dry weight of the separator and attendant appurtenances. Prominently display lifting instructions on [anodized aluminum] [_____] plate located on outside of separator.

2.2.2 Flanges

Use only flat face flanges and drill 1,034 kPa 150 pound ANSI Standard bolt circle and remove burrs. Use flanged piping connections that conform to ASME B16.5, welding neck type.

2.2.3 Weirs

****
NOTE: Insert suitable material if carbon steel is not acceptable. Consult manufacturers' data.
****

****

NOTE: Angle of slope of hopper bottom shall be greater than the angle of repose of the stored material. Volume and angle of repose for solids collected to be determined by designer based on oil-in-water mixture characteristics and frequency of cleaning.

****

Attach stationary weirs and adjustable weir supports to separator side walls to provide a watertight seal between adjoining compartments and trough to prevent hydraulic short-circuiting. Use carbon steel [_____] for weir plates and baffles. Provide sharp crested weirs of size and section specified by manufacture. Provide slotted holes in weir plates and baffles or supports to permit horizontal and vertical adjustment of weir or baffle. Use nondeteriorating sealant or gaskets for mounting weir plates. Fill voids between separator wall and weir plate with sealant to make watertight.

2.2.4 Low Point Drains

Provide means at low points for dewatering separator.

2.2.5 Identification Plates

****

NOTE: In a salt water environment substitute acceptable non-corroding metal such as but not limited to copper-nickel, 316 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) to be established by designer.

****

Provide [anodized aluminum] [_____] identification and instruction plates and stamp necessary data. Securely affix plates, in prominent location, to separator with nonferrous screws or bolts of not less than 3 mm 1/8 inch in diameter. Nomenclature shall be [_____].

2.2.6 Instruction Plates

Instruction plates shall describe special or required procedures to operate and service equipment, and shall include warnings of hazardous procedures and notice of safety and health requirements. Plates shall be durable and legible throughout equipment life.

2.2.7 Warning Sign

On entrances to the separator (and entrances to the vault) place a permanent sign which states the following: "DO NOT ENTER separator (OR VAULT) OR PERFORM HOT WORK ON OR IN separator UNTIL THE ATMOSPHERE HAS BEEN TESTED AND CERTIFIED GAS FREE AND SAFE."

2.3 INLET COMPARTMENT

****

NOTE: Where a separate sedimentation basin has been provided the volume of the inlet compartment may be reduced. If total solids are less than 100 mg/L, these elements may be eliminated after adequate benchscale testing has been completed to support this conclusion. Designer shall indicate run of

solids removal line from outlet nozzle to a point above grade.
****

Provide inlet compartment of sufficient volume to effectively reduce influent [suspended] [settleable] solids and dissipate energy. Use inlet compartment that provides a minimum of 45 minutes detention ahead of the oil coalescing compartment. Provide nonclogging flow distributor and energy dissipator device [and the primary solids collection hopper as specified in paragraph entitled "Reduction of Solids"]. Locate [adjustable, primary surface oil overflow weir and] sample ports as recommended by the manufacturer.

2.4 OIL SEPARATION COMPARTMENT

2.4.1 General

The maximum surface loading rate for the oil separation compartment shall be [_____] liters per square meter per day) [_____] gallons per day per square foot. The separator will also provide a minimum detention time within the oil separation compartment of [_____][45] minutes at design flow. Detention time will recomputed by calculating the volume of the separation zone within the separator and dividing this volume by the design flow rate. For computing detention time, total volume shall be reduced by 20 percent for the space occupied by settled solids (sediment) and accumulated oil at the surface.

2.4.2 Parallel Plates

Provide parallel plates at an angle from 0.70 to 1.05 rad 40 to 60 degrees with respect to longitudinal axis of the plate corrugations and space not less than 19 mm 3/4 inch apart for removal of free oil and settleable solids. Configuration used shall not promote solids buildup on plates which would increase velocities to point of discharging an effluent of unacceptable quality. Maintain laminar flow at maximum design flow rate throughout plate packs including entrance and exit so as to prevent re-entrainment of oil(s) with water. Flow through plate packs shall be in a downflow mode parallel to plate corrugations or cross-flow perpendicular to plate corrugations, so that the oil collects and coalesces at high point of corrugations and rises to top of pack without clogging from oil or settleable solids. Make minimum effective projected surface area ([_____]square meters [_____]square feet).

****
NOTE: Vertical tube coalescers shall not be used on Army projects
****

[2.4.3 Vertical Tubes

If vertical tubes are provided, install tubes perpendicular to bottom of tank and align in a pattern to maintain laminar flow at maximum design flow rate through tube packs including entrance and exit to prevent emulsifying the oil(s) with water. Inlet to tube packs shall prevent hydraulic short-circuiting of oil-in-water mixture across the top of the tubes.

]2.4.4 Supports

Brace and support individual plates [and tubes] or plate packs [and tube packs] to withstand loads associated with transportation and operation of units, including inplace cleaning. Equip each plate [or tube] pack with lifting lugs or other attachments for handling and installation. Each lug shall carry total weight of plate pack [or tube pack]. Provide adequate structural supports to facilitate inplace cleaning of plate pack [or tube] bundles.

2.4.5 Baffles

Provide oil retention baffle, adjustable surface oil overflow weir with trough, and stationary underflow baffle. Position underflow baffle to prevent resuspension of solids that have accumulated in secondary solids hopper.

2.5 OUTLET COMPARTMENT

Provide outlet compartment of [_____] cubic meter cubic feet, an adjustable overflow effluent weir, a sampling port, and nozzles.

2.6 ACCESSORIES [AND ACCESSORY EQUIPMENT]

****

NOTE: Specific project requirements may include one or more of the following accessories:

Access platforms
Access ladders (with minimum 1050 mm 42 inch extensions above hatch opening with locking device)
Handrailing
Waste oil transfer pump
Oily waste transfer pump
Sludge transfer pump
Sludge or waste oil storage tanks
Immersion heaters
Tank windows
System monitoring and control instrumentation (e.g. oil content monitor, oil-water interface sensors, control panel, pressure gages, high level alarms, oil flooded alarms, tank level indicators)
Sight glasses
Inlet strainer (duplex)
Air vent valve
Pitot tube sampling valve assemblies
Check valves
Manually actuated valves
Motor actuated valves
Explosion proof doors
Separator backwash system

Select and specify as required. For those accessories required in the project, specify detailed requirements (including sizes, ratings, capacities, performance characteristics) in subparagraphs under paragraph entitled "ACCESSORIES [AND ACCESSORY EQUIPMENT]."

****

****

NOTE: Review applicable Federal, State, and local

air pollution and ventilation requirements to determine need for vapor containment.

****

Provide bolts, stiffeners, washers, nuts, screws, pins, gaskets, and fittings as required for adjustable weirs, [separator covers] and parallel plate packs [or vertical tube packs]. [Provide separator covers with a vapor proof seal for vapor control with [_____] mm inch inside diameter gas vents and suitable access manways to each separator compartment.]

2.7 FABRICATION

****

NOTE: Specific project requirements may include one or more of the following accessories:

Access platforms
Access ladders (with minimum 1050 mm 42 inch extensions above hatch opening with locking device)
Handrailing
Waste oil transfer pump
Oily waste transfer pump
Sludge transfer pump
Sludge or waste oil storage tanks
Immersion heaters
Tank windows
System monitoring and control instrumentation (e.g. oil content monitor, oil-water interface sensors, control panel, pressure gages, high level alarms, oil flooded alarms, tank level indicators)
Sight glasses
Inlet strainer (duplex)
Air vent valve
Pitot tube sampling valve assemblies
Check valves
Manually actuated valves
Motor actuated valves
Explosion proof doors
Separator backwash system

Select and specify as required. For those accessories required in the project, specify detailed requirements (including sizes, ratings, capacities, performance characteristics) in subparagraphs under paragraph entitled "ACCESSORIES [AND ACCESSORY EQUIPMENT]."

Where the separator is to be mounted in a concrete vault with a hatch cover, the designer shall address, as a minimum, the following:

1. Hatch covers shall provide access to the entire separator.

2. Hatch covers shall lock in the open position.

3. Light weight covers for non-traffic areas.

4. Interior ladder rungs shall not be set away from

cover opening so as to require a person to swing in and grab.

****

****

NOTE: Review applicable Federal, State, and local air pollution and ventilation requirements to determine need for vapor containment.

****

Provide shop fabricated, skid mounted oil-water separator, or other shop fabricated unit approved by the Contracting Officer, which is comprised of a separator containing an inlet compartment, parallel plate [or vertical tube] oil coalescing compartment, outlet compartment [and the following accessories]:

[Separator Cover [with vapor proof seal]
] [_____]

2.7.1 Shop Hydrostatic Test

Prior to applying coatings, perform hydrostatic test at atmospheric pressure by filling separator with water in the shop for a minimum of 4 hours. Testing shall be conducted after all seams have been cleaned and all welds have been inspected in accordance with ASTM E165/E165M. Acceptance criteria, for the hydrostatic test, is no leakage after 4 hours using a thorough visual inspection for the leaks.

2.7.2 Reduction of Solids

****

NOTE: Designer shall address special influent characteristics as part of the design when using this specification. Special characteristics include, but are not limited to, inflow rate, grit content, viscosity of petroleum product, AFFF foam, heavy metals, and reverse emulsion. Determine need for a solid waste basin preceding the separator and specify solid waste basin requirements when required by site conditions.

****

****

NOTE: If total solids are less than 100 mg/L, these elements may be eliminated after adequate benchscale testing has been completed to support this conclusion. Designer shall indicate run of solids removal line from outlet nozzle to a point above grade.

****

Inlet compartment shall reduce [suspended] [settleable] solids to nonclogging level for parallel plates [or vertical tubes,] and provide a uniform oily wastewater hydraulic loading across inlet face of oil coalescing compartment, under laminar flow conditions. Equip compartment with an inlet nozzle with wastewater sampling port, nonclogging flow distributor and energy dissipator device, [primary solids collection hopper,] [primary solids outlet nozzle,] [oil retention weir,] [adjustable surface oil overflow weir with trough,] [primary oil outlet nozzles]. [The oil-water separator shall be preceded by a solid water basin which includes a removable solids or trash basket. Equip the solid water basin with a hoist for servicing the trash basket. Size the basket to retain all solids larger than 75 mm 3 inches in any dimensions. The solid waste basin shall have a minimum storage volume of [945] [_____] liters [250] [_____] gallons.]

2.7.3 Oil Coalescing Compartment

****

NOTE: The interpretation of "easily removable" has two meanings in the industry. One is the complete removal of the entire bundle from the separator; the second is removal of individual 300 mm square one foot square bundles. The designer shall adapt the specification to the specific demands of the project.

****

Equip oil coalescing compartment with easily removable and reinstallable, parallel, corrugated plates [, or vertical tubes] arranged to optimize separation of free oil from liquid carrier. Use parallel plates [or vertical tubes] that are easily removable without dismantling packs and without confined space entry. Provide adjustable surface oil overflow weir with trough, oil outlet nozzle and stationary underflow baffle, oil retention baffle positioned to prevent discharge of free oil that has been separated from the carrier liquid in inlet and oil coalescing compartments. Provide access to each plate pack [or tube bundle] from top. Each bundle shall be equipped with handles or lifting rings. Plate designs that permit cleaning of plate packs in place are not acceptable.

2.7.4 Wastewater Sampling Port

Equip inlet and outlet compartments, adjustable overflow effluent weir, effluent trough, and wastewater outlet nozzle with wastewater sampling ports permitting easy access for obtaining isokinetic influent and effluent samples.

2.7.5 Connections

Connect the separator at the inlet and outlet pipe invert elevations indicated. Follow equipment manufacturer's recommendation for setting and adjusting top of weir elevations throughout unit.

2.7.6 Storage

****

NOTE: Normally oil storage compartments will be contained inside the separator and the requirement for an adjacent waste oil storage tank will be deleted. However, when conditions warrant, an adjacent waste oil storage tank may be provided.In order to size the waste oil tank, the designer shall contact the activity to determine frequency of waste oil collection performed at the activity. Designer shall check current Federal and State requirements governing the need and installation criteria for secondary containment (e.g. double wall waste oil tank).

****

Provide oil and suspended solids collection, storage, and transfer systems as an integral part of proposed oil-water separator system. As a minimum, the separator oil storage compartment shall have a capacity of not less than 10 percent of the total separator volume.[The adjacent waste oil tank shall have a capacity of [_____] liters gallons.]

PART 3 EXECUTION

3.1 INSPECTION

Inspect each component of separator for compliance with requirements specified in PART 2 PRODUCTS. Redesign or modification of equipment to comply with specified requirements, or necessary redesign or modification following failure to meet specified requirements, shall receive particular attention for adequacy and suitability. This element of inspection shall encompass visual examinations and dimensional measurements. Noncompliance with specified requirements, or presence of one or more defects preventing or lessening maximum efficiency of separator operation, shall constitute cause for rejection.

3.2 INSTALLATION

Lift separator as required without parallel plate packs [or vertical tube packs] in place onto level foundation using lifting mechanism provided. Level separator and bolt to supports to prevent hydrostatic uplift and ensure unit stability. Use a lifting bar through lugs to insert plate packs into separator and place on supports. Caulk around packs and pack supports with sealing compound conforming to ASTM C990 to prevent hydraulic short-circuiting. Avoid abrupt contact between the packs and the separator walls and pack supports to avoid damage. Separator system installation shall be conducted in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Hydrostatic Test

After separator has been leveled and secured to foundation and parallel plate packs [or vertical tube packs] are in place, level effluent overflow weir at elevation specified by manufacturer and hydrostatically test unit at atmospheric or operational pressure (for no leakage) for an additional 8 hours by filling with water. Perform the hydrostatic test prior to backfilling below ground or partially below ground installations.

3.3.2 Preoperational Test

The manufacturer's service representative shall inspect, operate, and test unit before in-service testing by the Contractor.

3.3.2.1 Tests

Tests shall include but not be limited to the following:

a. Soundness (without cracked or otherwise damaged parts).

b. Completeness in all details, as specified.

c. Correctness of setting, alignment, and relative arrangement of each component.

d. Verification of proper operation for all system components.

3.3.2.2 Preoperational Investigation and Test Report

Submit manufacturer's service representative's preoperational test report. Document inspections, operations, adjustments, and tests performed and indicate whether they were acceptable or not. For unacceptable items, describe corrective action taken or recommended. Include detailed descriptions of points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. Include the manufacturer's certificate that equipment conforms to specified requirements and is ready for permanent operation and that nothing in installation will render manufacturer's warranty null and void.

3.3.3 In-Service Test

After hydrostatic test and preoperational test have been successfully completed and unit has been properly connected to influent and effluent piping, allow influent oil-in-water mixture previously described in paragraph entitled "SYSTEM DESCRIPTION" to flow into separator filled with water. Adjust and level [primary] [and secondary] surface oil overflow weirs to optimize oil skimming and minimize water overflow to oil recovery. Optimize operation of unit within 5 working days. Operate unit for a minimum of ten separator volume changes prior to testing for removal of contaminants and document testing results.

3.3.3.1 Analytical Methods

Test and sample preservation methods for test contaminants shall be in accordance with the latest revisions of AWWA 10084, APHA Standard Methods for the Examination of Water and Wastewater, EPA 600/4-79/020, EPA Methods for Chemical Analysis of Water and Wastes, or those substitute methods approved by the governing regulatory agencies having jurisdiction.

3.3.3.2 Test for Contaminants

Verify the separator efficiency by testing influent and effluent for contaminants described in paragraph entitled "Performance Requirements." If effluent quality is found to be unacceptable, then verify influent to effluent performance in particle size removal at the site. Tests shall be performed by an independent certified testing laboratory.

3.3.3.3 Sampling Procedures

****

NOTE: The separator top hatch covers are used by many manufacturers to satisfy the sampling port requirement. The designer has the option to provide dedicated sampling points integral to the influent pipe and effluent pipe.

****

Within an 8 hour period and at regular intervals collect a minimum of 10 influent and effluent samples from sampling ports provided as part of the separator. Purge each sampling port to remove built-up solids or other material prior to collecting sample. Collect wastewater samples isokinetically in clean glass containers with polytetrafluoroethylene lined caps. Collect duplicate wastewater samples in separate glass containers.

Do not attempt to split sample. Use containers for other contaminants as recommended in references listed in paragraph entitled "Analytical Methods."

3.3.3.4 Acceptance Criteria

****

NOTE: Based on standards or guidelines established by environmental regulatory agency(ies) in which the project is located or based upon wastewater treatment process(es) that follow downstream from this separator, specify the maximum unacceptable limit permitted in order for the separator to be accepted as meeting the performance requirements of this specification.

****

90 percent of the effluent samples taken shall not exceed the specified daily maximum limit for [grease and oil] [petroleum hydrocarbon] contaminants. The remaining samples shall not exceed [[_____] mg/L for grease and oil] [[_____] mg/L for petroleum hydrocarbon] contaminants. If the separator does not meet requirements of this specification, due to poor workmanship and wrong fabrication dimensions, the unit may be rejected. If the unit is not operating at design efficiency 5 days after installation, Government may reject system. In the event Government rejects unit, Contractor shall remove separator or defective components and replace with acceptable unit or components and test as specified above.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-46 30 00 (August 2017)**

Preparing Activity: USACE **Superseding**
UFGS-43 32 69 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION 46 30 00

WATER AND WASTEWATER CHEMICAL FEED SYSTEMS

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SECTION 46 30 00

WATER AND WASTEWATER CHEMICAL FEED SYSTEMS
08/17

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NOTE: This guide specification covers the requirements for chemicals and controlled volume pumps and appurtenances consider Specification 41 31 11 for CHLORINE GAS FEED. THIS SPECIFICATION IS PRIMARILY USED FOR WATER, WASTEWATER AND MECHANICAL PROCESS WATER TREATMENT SYSTEM..

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z400.1/Z129.1	(2010) Hazardous Workplace Chemicals – Hazard Evaluation and Safety Data Sheet and Precautionary Labeling Preparation

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B201	(2018) Soda Ash
AWWA B300	(2024) Hypochlorites
AWWA B302	(2023) Ammonium Sulfate
AWWA B303	(2024) Sodium Chlorite
AWWA B402	(2024) Ferrous Sulfate
AWWA B403	(2024) Aluminum Sulfate - Liquid, Ground, or Lump
AWWA B404	(2022) Liquid Sodium Silicate
AWWA B405	(2024) Sodium Aluminate
AWWA B406	(2020; Errata 2020) Ferric Sulfate
AWWA B407	(2024) Liquid Ferric Chloride
AWWA B408	(2018) Liquid Polyaluminum Chloride

AWWA B451	(2023) Poly(Diallyldimethylammonium Chloride)
AWWA B452	(2020) EPI-DMA Polyamines
AWWA B453	(2013) Polyacrylomide
AWWA B501	(2019) Sodium Hydroxide (Caustic Soda)
AWWA B502	(2023) Sodium Polyphosphate, Glassy (Sodium Hexametaphosphate)
AWWA B503	(2023) Sodium Tripolyphosphate
AWWA B504	(2024) Monosodium Phosphate, Anhydrous
AWWA B505	(2024) Disodium Phosphate, Anhydrous
AWWA B511	(2023) Potassium Hydroxide
AWWA B550	(2023) Calcium Chloride
AWWA B600	(2024) Powdered Activated Carbon
AWWA B601	(2017) Sodium Metabisulfite
AWWA B602	(2017) Copper Sulfate
AWWA B603	(2016) Permanganates
AWWA B701	(2024) Sodium Fluoride
AWWA B702	(2024) Sodium Fluorosilicate
AWWA B703	(2011) Fluorosilicic Acid

ASTM INTERNATIONAL (ASTM)

ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D1998	(2013) Polyethylene Upright Storage Tanks
ASTM D3299	(2010) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM D5421	(2015) Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM E1067/E1067M	(2018) Standard Practice for Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels
ASTM F441/F441M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC)

Plastic Pipe, Schedules 40 and 80

HYDRAULIC INSTITUTE (HI)

HI 9.1-9.5	(2021) Pumps General Guidelines for Materials, Sound Testing, and Decontamination - B117
HI ANSI/HI 7.1-7.5	(2023) Controlled-Volume Metering Pumps American National Standard for Nomenclature, Definitions, Application, and Operation - B115

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 37	(2024) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF/ANSI 60	(2022; Addenda 2022) Drinking Water Treatment Chemicals - Health Effects

PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION (PHCC)

NAPHCC NSPC	(2015) National Standard Plumbing Code Illustrated

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that

require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, [_____]

SD-03 Product Data

Chemical Feed System; G, [_____]

Safety Data Sheets

Framed Instructions

Auxiliary Equipment and Spare Parts

Factory Test Report

SD-06 Test Reports

Operating Tests

Tank Testing

Controlled Volume Pumps - Operational Tests

Controlled Volume Pumps - Time, Volume And Pumping Pressure Tests

System Pressure Tests

Flow Tests

Synchronization Tests

SD-07 Certificates

Supplied Chemical

Service Organization

Certificates; G, [_____]

SD-10 Operation and Maintenance Data

Operating Instructions; G, [_____]

Maintenance Instructions; G, [_____]

SD-11 Closeout Submittals

Extended Warranty; G, [_____]

1.3 MAINTENANCE MATERIAL SUBMITTALS

****

NOTE: Designer must specify any additional devices that are required to be provided by the contractor to ensure the system operator is able to accurately measure the desired analytes being distributed by this system. Delete items below which may not be required for specific project.

****

Concurrent with delivery and installation of the specified equipment, furnish auxiliary equipment and spare parts as follows:

a. Spare parts for each different item of material and equipment specified including all of the parts recommended by the manufacturer to be replaced after [1][and][3] [year][years] service.

b. For each machine: one extra of each part used that is made from glass, hard rubber, or clear plastic; one extra set of solution-hose connections; one extra set of diaphragms, two filler plug seal washers; two ball checks; two seats; two complete sets of all gaskets; one spare diaphragm for each back pressure regulator; one hydraulic plunger assembly for each different size metering pump; one of each type of material back pressure regulator, with three spare springs and fluorocarbon resin diaphragms for each; one spare diaphragm and air valve for pulsation dampener.

c. For each different size of direct current motor one SCR circuit board with 12 drive motor fuses and 12 SCR controller fuses; overload replacement elements for each size and type of motor.

d. One set of special tools for each type of equipment including calibration devices, and instruments required for adjustment, calibration, disassembly, operation, and maintenance of the equipment.

e. Two pairs of safety goggles and/or face shields, two chemical resistant aprons, and two pairs of chemical resistant gloves in one or more wall mounted steel cases.

f. One assembly tool for tubular diaphragm.

g. One lever type grease gun or other lubricating device for each type of grease required.

h. One or more steel tool cases mounted on the wall in a convenient location complete with flat key locks, two keys, and clips or hooks to hold each special tool.[

i. [_____].]

1.4 DELIVERY, STORAGE, AND HANDLING

Protect material and equipment delivered and placed in storage from the weather, excessive humidity and excessive temperature variation, dirt, dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a chemical feed system consisting of a chemical supply storage tank from which the chemical solution is pumped through piping or tubing, as appropriate, to the point of application. Include with each chemical feed system controlled volume pumps, tanks, mixers, gauges, back pressure regulators, strainers, pressure relief valves, sight glasses and flow metering devices, check valves, and hand valves.

2.1.1 System Requirements

Select and fabricatee the pumps in accordance with HI ANSI/HI 7.1-7.5 and HI 9.1-9.5 except as modified herein. Provide pump stands and platforms adequate to support the pumping system.

2.1.2 Performance Requirements

Capacity and features of the chemical feed systems and accessories must be suitable for 24-hour full load service in ambient, non-freezing conditions.

2.1.3 Submittal Data for Chemical Feed System

Submit manufacturer's performance charts, and pump curves. List of materials, list of equipment, including a complete list of parts and supplies with current unit prices and source of supply. List of special tools for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly.

2.1.4 Extended Warranty

provide Manufacturer's Extended Warranty to cover system components for [3][5][_____] years.

2.2 EQUIPMENT

2.2.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least [2][5][ ] years prior to [bid opening][request for proposal]. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Submit Service Organization Certificates outlining their location and qualifications to the Contracting Office.

2.2.2 Nameplates

Secure a plate to each major item of equipment containing the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.2.3 Controlled Volume Pumps

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NOTE: See HI 7.1-7.5 to determine the optimum type of metering pumps with capacities between 0.04 liters per hour0.011 gph and 10,000 liters per hour 2500 gph. Materials for each pump must be as recommended in Table 9.3 of HI 9.1-9.5 for the material to be pumped. If the system backpressure is not at least 5 psi0.35 bar greater than the suction pressure, a backpressure valve must be installed in the discharge piping to prevent flow through (downhill pumping) which contributes to pump failure and undesired flow at pump shutdown. System backpressure must not exceed the rated discharge pressure of the pump.

****

Provide controlled volume pumps as defined by HI ANSI/HI 7.1-7.5. Each pump must be capable of delivering chemical solution at any rate from the minimum flow rate to the maximum flow rate and be capable of continuous operation at rated capacity. Accuracy must be plus or minus 2 percent over a 100 to 1 range from the required maximum capacity to the minimum pumping rate. Net positive suction head required cannot exceed 90 percent of the net positive suction head available, as installed. Provide in a configuration as simple as practicable to provide equipment isolation, bypass and reliable service and to be readily accessible for inspection, cleaning, adjustment, repairs, and replacements.

2.2.3.1 Acid Feed System

Provide the following for [hydrochloric][sulfuric][_____] acid solution delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].

Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.
Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPa psig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,] [hypalon][nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber,][and _____].

2.2.3.2 Adsorption Agent Feed Systems

Provide the following for [powdered activated carbon][_____] slurry delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.

Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPapsig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,] [hypalon][nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber,][_____].

2.2.3.3 Base Feed System

Provide the following for [sodium carbonate (soda ash)][sodium hydroxide (caustic soda)][_____] solution delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum L/hour gph.
Back pressure at point of injection:	kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at kPa psig. Regulators must be of construction with diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.

Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon] [nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber] [, _____].

2.2.3.4 Biocide Feed System

Provide the following for [copper sulfate][_____] solution delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.
Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPa psig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon] [nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber][, _____].

2.2.3.5 Coagulant Aid Feed System

Provide the following for [photoelectron][_____][solution][slurry] delivery.

Concentration of material on suction side of pumps:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].

Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.
Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPapsig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon] [nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber][, _____].

2.2.3.6 Disinfecting Agent Feed Systems

Provide the following for [ammonium sulfate][hypochlorite][_____] solution delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.

Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPapsig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon][nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber][, _____].

2.2.3.7 Miscellaneous Feed System

Provide the following for [poly(diallyldimethylammonium chloride)][calcium chloride][sodium aluminate][sodium metabisulfite (sodium pyrosulfite)][sodium chlorite][sodium silicate][monosodium phosphate][disodium phosphate][_____][solution][slurry] delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.
Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPapsig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.

Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon][nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber][, _____].

2.2.3.8 Oxidant Feed System

Provide the following for [potassium permanganate][hydrogen peroxide][_____] solution delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.
Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPapsig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon][nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber][, _____].

2.2.3.9 Precipitant Feed System

Provide the following for [_____] solution delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.

Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.
Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPapsig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon][nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber][, _____].

2.2.3.10 Primary Coagulant Feed System

Provide the following for [aluminum sulfate][ferric chloride][ferric sulfate][ferrous sulfate][_____] solution delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.

Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPapsig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon][nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,] [hard rubber][, _____].

2.2.3.11 Prophylaxis Feed System

Provide the following for [hydrofluosilicic acid][sodium fluoride][sodium silicofluoride][_____] solution delivery.

Concentration of material on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.
Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPa psig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.

Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon][nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber][,_____].

2.2.3.12 Sequestrant Feed Systems

Provide the following for [sodium polyphosphate, glassy (sodium hexametaphosphate)][sodium tripolyphosphate][_____] solution delivery.

Concentration on suction side of pump:	Minimum [_____] percent; maximum [_____] percent.
Number of pumps:	[_____].
Type of pump:	[Packed plunger][Packed piston][Mechanically or hydraulically coupled diaphragm].
Configuration:	[Simplex][Duplex][Multiplex].
Controls:	[Automatic][Semiautomatic][Manual] rate adjustment.
Feed or flow rate:	Minimum [_____] L/hourgph; maximum [_____] L/hourgph.
Back pressure at point of injection:	[_____] kPapsig. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at [_____] kPa psig. Regulators must be of [polyvinyl chloride][or][_____] construction with [fluorocarbon resin][or][chlorosulphonated polyethylene] diaphragms.
Suction valve cartridge:	[Single][Double][Slurry type] ball check.
Discharge valve cartridge:	[Single][Double][Slurry type] ball check.
Materials of construction allowed for wetted parts:	[Type [304L][316][316L] stainless steel,][PVC,][hypalon][nylon,][fluorocarbon resin,][chlorosulfonated polyethylene,][hard rubber] [, _____].

2.2.4 Controls

****

NOTE: Proportional control is appropriate for variable flow systems. Batch systems should have manual, pH, ORP, or timer control. Constant pumping rate systems should respond to pump operation or a flow switch, if the pumps are remote from the feed system. Designer should delete any paragraphs below that are not necessary for this specific project.

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Provide the chemical metering equipment with the appurtenances and accessories, as required, for flow capacity adjustment. Provide manual range adjustment on all systems.

2.2.4.1 Automatic Control

Provide automatic control with the capability to vary feed rate based on signals from a [flow], [oxidation-reduction potential (ORP)], [or] [pH] meter or controller.

2.2.4.1.1 Flow meter and Controller

Provide flow meter and controller capable of varying the chemical dosage in proportion to the measured flow with the dosage per flow unit manually adjustable.

2.2.4.1.2 Oxidation-Reduction Potential Probe

Provide oxidation-reduction potential probe located where indicated. Supply probe capable of varying the chemical feed rate in response to the deviation from set point.

2.2.4.1.3 pH Probe

Provide pH probe and locate the pH probe where indicated. Supply probe capable of varying the chemical feed rate in response to the deviation from set point.

2.2.4.2 Semiautomatic Control

Provide semiautomatic control with the capability to automatically start and stop the chemical metering equipments. The pump start and stop must respond to [flow switch][or][pump operation][or][timer] status. Install flow switch for semiautomatic operation in the pipe line upstream of chemical injectors.

2.2.4.3 Manual Control

Provide nonautomatic control with the capability for starting or stopping the chemical metering equipment and adjustment of the solution feed rate by the operator.

2.2.5 Drives for Controlled Volume Pumps

****

NOTE: Alternating current motors are preferred where a reliable power supply is accessible. Water power drives are feasible only when the take off can be located at a point with significantly higher pressure than the injection pressure. Designer should delete any paragraphs below that are not necessary for this specific project.

****

Provide with and drive the metering pumps by [water pressure][alternating current electric motor][direct current electric motor][plant air][gasoline engine] drives.

2.2.5.1 Water Pressure Drive

Provide appropriate pressure regulation devices for water pressure drives operated off system water pressures.

2.2.5.2 Electric Motor Drive

Electric motor must be of sufficient capacity to operate the chemical metering equipment under all operating conditions without exceeding their rated nameplate current or power, or their specified temperature limits. Provide motors having starting characteristics and ruggedness necessary under the actual conditions of operations or clean-up procedures used in the areas where they are located. Alternating current motors with power rating of 248.6 W1/3 hp or less must be 115 volts, single-phase, 60-Hz service; motors with power rating in excess of 248.6 W1/3 hp must be 460 volts, three-phase, 60-Hz service. Electrical features of direct current motors, including the ratings of the motors, must be compatible with the capabilities and ratings of the rectifier controllers with which they are used.

2.2.5.3 Gasoline Engine Drive

Provide gasoline engines that develop sufficient horsepower to operate the chemical metering equipment continuously under the maximum operation conditions without overheating or overloading when operating at a speed not to exceed [_____] rpm. Provide 4-cycle, vertical, single cylinder, high tension magneto, air cooled type engines. Connect the engine to the pump or mechanical device by V-belts that are fully guarded.

2.2.6 Calibration Standpipes

Provide chemical metering equipment with a calibration standpipe for measuring pump output. The standpipe must allow convenient observation of the change of fluid level for at least 1/2 minute at full stroke and maximum speed settings, and of Schedule 80, clear PVC pipe conforming to ASTM D1785 with Schedule 80 fittings equipped with a flanged connection to the pump manifold and an end cap fitted with a PVC vacuum breaker and ball valve for air venting. The standpipe must have a clear, observable length of at least [300 mm12 inches][_____] and be permanently calibrated inliters gallons and fractions thereof, to allow reading of the fluid contents with an accuracy of [1][_____] percent.

2.2.7 Valves

2.2.7.1 Metering Pump Valves

Equip the metering pump with adjustable internal vacuum and pressure relief valve, hydraulic oil refill valve, and automatic air bleed valve. The relief valve must be adjustable over the full pressure range of the pump and preset at the factory.

2.2.7.2 Suction and Discharge Valves

Fit suction and discharge valve cartridges with ball checks that open to full pipe diameter.

2.2.7.3 Back Pressure Valve

Install back pressure regulating valve on the pump discharge and factory adjust to crack open at the indicated pressure. Provide spring opposed diaphragms with loading pressures adjustable by means of a screw in the top works.

2.2.7.4 Pulsation Dampeners

****

NOTE: The pulsation dampener should always be installed as close to the pumps as possible in order to reduce the length of pipe in which pulsating flow occurs. A pulsation dampener is a pneumatically charged diaphragm within a chamber that stores energy carried in the acceleration of the pumped fluid. On the discharge side it will protect sensitive equipment from pulsating flow spikes, and will translate pulsating flow to near linear flow by reducing the peak flow and pressure generated by the metering pump. When a pulsating dampener is used on the suction side of a metering pump, it will improve suction pressure conditions by reducing pressure losses associated with the acceleration of the fluid.

****

Size pulsation dampeners for the displacement of each pump. Pulsation dampeners must have a diaphragm separating the upper chamber from the lower chamber. Charge the upper chamber with compressed air to 50 percent of the expected line pressure. Provide the diaphragm of molded construction and prevent the air charge from being dissolved in the process fluid. The lower chamber must be [plastic][or][lined with inert plastic material] to prevent corrosion by the process fluid. Equip the upper chamber with a tire valve type charging valve and air pressure gauge. Provide an air line and air hose with pressure regulator and hand-operated, lever-type valve suitable for charging the pulsation dampers.

2.2.8 Solution Tanks

****

NOTE: This paragraph lists tank specifications. If single wall tanks are preferred, designer must ensure secondary containment is provided within the plans and that containment is separated from other tank containment areas to prevent mixing of chemicals during a spill event. Size dissolving baskets and tank mixers to provide initial mixing and maintain suspensions.

****

Provide tanks that are fully resistant to the effects of the full-strength and fully diluted solution concentrations, and be pressure rated for 1.5 times the weight of solution at full capacity. Each tank must have the capacity listed in the following table and be equipped with a fill nozzle, vent, discharge, level instrument, drain, and two spare connections. Reinforce tanks to withstand all forces when full of solution. Tanks must be completely shop fabricated with no field assembly permitted. Provide drain connections permitting complete drainage of the tank. All gaskets must be fluorocarbon elastomer; nuts and bolts Type 316 stainless steel;

and steel supports either stainless or epoxy coated. Furnish each tank with a calibrated side wall strip to indicate volume. Attach a permanent plastic sign indicating the tank contents to the front of each tank. Fit tanks smaller than 900 mm36 inches in diameter with removable lids. Fit tanks larger than 900 mm36 inches in diameter with 600 mm24 inch manways. Manufacture polyethylene tanks in accordance with ASTM D1998. Manufacture fiberglass tanks in accordance with ASTM D3299 with flanged openings in accordance with ASTM D5421. Line steel tanks with [ceramic], [rubber] or [plastic], as indicated herein. Provide tanks designated to be double walled or provided with secondary containment, as indicated in the tables. Provide dissolving baskets and tank mixers as indicated. Provide floating seals as indicated.

2.2.8.1 Acid Tank

Provide [hydrochloric][sulfuric] acid solution resistant tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	"DANGER - [HYDROCHLORIC][SULFURIC] ACID SOLUTION."
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.2 Adsorption Agent Tank

Provide [powdered activated carbon][_____] slurry resistant tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	[_______]
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.3 Base Tank

Provide [sodium hydroxide (caustic soda)][_____] solution resistant tank tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	"DANGER - ALKALI (SODIUM HYDROXIDE) SOLUTION."
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.4 Biocide Tank

Provide [copper sulfate][Tolcide(R)][Glutaraldehyde][_____] solution resistant tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign to read:	[_____].
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.5 Coagulant Aid Tank

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NOTE: Polyelectrolytes degrade with storage.

****

Provide [polyelectrolyte][_____] solution resistant tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	"CAUTION - [POLYELECTROLYTE SOLUTION - SLIP HAZARD] [_____]."
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].

Containment:	Double wall and secondary containment.

2.2.8.6 Disinfecting Agent Tank

Provide [ammonium sulfate][hypochlorite] solution resistant tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	[_____].
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.7 Miscellaneous Tanks

Provide [poly(diallyldimethylammonium chloride)][calcium chloride][sodium aluminate][sodium metabisulfite (sodium pyrosulfite)][sodium chlorite][sodium silicate][monosodium phosphate][disodium phosphate] solution resistant tanks and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	[_____].
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.8 Oxidant Tank

Provide [hydrogen peroxide][potassium permanganate] solution resistant tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	["DANGER - STRONG OXIDIZER"] [_____].

Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.9 Precipitant Tank

Provide [_____] solution resistant tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	[_____].
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.10 Primary Coagulant Tank

Provide [aluminum sulfate][ferric chloride][ferric sulfate][ferrous sulfate] solution resistant tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	[_____].
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.11 Prophylaxis Tank

Provide [hydrofluosilicic acid][sodium fluoride][sodium silicofluoride] solution resistant tank and comply with the following:

Number of tanks:	[_____].

Minimum tank capacity:	[_____] litersgal.
Sign reading:	[_____].
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.8.12 Sequestrant Tank

****

NOTE: Polyelectrolytes degrade with storage.

****

Provide [sodium polyphosphate, glassy (sodium hexametaphosphate)][sodium tripolyphosphate] solution resistant tank and comply with the following:

Number of tanks:	[_____].
Minimum tank capacity:	[_____] litersgal.
Sign reading:	"CAUTION - [SODIUM HEXAMETAPHOSPHATE] [SODIUM TRIPOLYPHOSPHATE] SOLUTION - SLIP HAZARD."
Mixer:	[Constant][Variable] speed [_____] rpm, maximum.
Dissolving basket:	[_____].
Floating seal:	[_____].
Containment:	Double wall and secondary containment.

2.2.9 Pressure Gauges

Provide diaphragm type gauges with Bourdon tube and diaphragm compartments filled completely with oil, and made of materials suitable for the application. Install diaphragm seals at each gauge connection to isolate gauges from corrosion, sludge or other hazards of the process fluid. Provide seal material that is compatible with the oil in the gauge and the process fluid.

2.2.10 Injectors

Introduce injectors for chemical solution into the pipeline mains by means of a [hard rubber] [or] [plastic] injection nozzle, or by means of a suitable diffuser tube inserted through a corporation cock. Construct the device for introducing the solution into a pressure main in such a way that accidental breakage of discharge hose or tubing does not cause water to escape from the pipeline, and allows disassembling of the unit without leakage.

2.2.11 Piping

2.2.11.1 Backflow Preventor

Provide backflow prevention devices or air gaps on tank fill lines in accordance with NAPHCC NSPC.

2.2.11.2 Chemical Solution Piping

****

NOTE: Select materials in accordance with EM 1110-1-4008 Liquid Process Piping.

****

Incorporate provisions to allow solution piping to be conveniently and safely bled of trapped air and minimize infiltration of air bubbles. Provide chemical solution piping in accordance with Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING.

2.2.11.2.1 Smaller than 40 mm1-1/2 inch Diameter

Chemical solution piping smaller than 40 mm1-1/2 inch diameter must be [PVC pipe conforming to ASTM D1785 or CPVC pipe conforming to ASTM F441/F441M][[_____] tubing][or][rubber hose]. Provide plastic fittings for plastic pipe with [flanged][or][threaded] joints. Make joints for rubber hose using a clamp-type mechanical coupling.

2.2.11.2.2 Piping 40 mm1-1/2 inch Diameter or Greater

Chemical solution piping of 40 mm1-1/2 inch diameter or larger must be [rubber-lined] [or] [plastic-lined] steel pipe. Steel pipe must have [threads] [or] [flanges integral with the pipe] [or] [forged-steel flanges screwed to the pipe barrel].

2.2.11.3 Pipe Lining

Linings for steel pipe smaller than 150 mm6 inches must be not less than 4.8 mm3/16 inch thick. Provide continuous linings free of holidays.

2.2.11.4 Pipe Fittings

For steel pipe provide [flanged conforming to ASME B16.1 or ASME B16.5][or][forged-steel threaded conforming to ASME B16.11] pipe fittings.

2.2.11.5 Plumbing

Provide water piping, drain, waste and vent piping in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.2.12 Electrical Work

****

NOTE: Coordinate hazard areas with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and the drawings.

****

Provide electric motor-driven equipment complete with motor, motor starter, and controls. Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Implement hazard classifications in accordance with NFPA 70.

2.2.12.1 Motor Starters

Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified.

2.2.12.2 Control and Protective Devices

Provide manual or automatic control and protective or signal devices required for the operation and any control wiring required for controls and devices. Provide motor controls conforming to NEMA ICS 1 or NEMA ICS 2. Prewire equipment to the maximum practicable extent. Control cabinets must conform to the requirements of UL 50, NEMA 250, [Type 4,][Type 7,][or][Type 12].

2.2.13 Equipment Appurtenances

Provide galvanized steel, cadmium plated or Type 316 stainless steel bolts, nuts, anchors, washers and all other types of supports necessary for the installation of the equipment.

2.2.14 Factory Painting

Factory painting must conform to manufacturer's standard factory finish, provided it does not discolor in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) conditions. Coating must be at least 0.05 mm1.75 mils thick.

2.2.15 Factory Test Report

Factory examine fiberglass tanks in accordance with ASTM E1067/E1067M prior to shipping. Furnish a copy of the corresponding test report with each tank.

2.3 MATERIALS

Submit Safety Data Sheets in conformance with ANSI Z400.1/Z129.1 for each chemical. Provide a [30][90][_____] day supply at the maximum pumping rate for each feeder or pair of duplexed feeders. Submit [two][_____] copies of certification stating that each supplied chemical meets the following requirements.

2.3.1 Acids

AWWA B300 Hydrochloric (muratic acid), AWWA B703 sulphuric (sulfuric acid).

2.3.2 Adsorption Agents

AWWA B600 powdered activated carbon.

2.3.3 Bases

AWWA B501 caustic soda, AWWA B511 potassium hydroxide, AWWA B201 soda ash (sodium carbonate).

2.3.4 Biocides

Glutaraldehyde (10 to 50 percent solution); Tolcide(R) (50 percent solution); AWWA B602 copper sulfate.

2.3.5 Coagulant Aids

NSF/ANSI 60 Anionic polyelectrolytes, NSF/ANSI 60 cationic polyelectrolytes.

2.3.6 Disinfecting Agents

AWWA B302 ammonium sulfate, AWWA B300 hypochlorites.

2.3.7 Miscellaneous

AWWA B451 poly(diallyldimethylammonium chloride), AWWA B452 EPI-DMA polyamines, AWWA B453 polyacrylamide, AWWA B550 calcium chloride, AWWA B405 sodium aluminate, AWWA B601 sodium metabisulfite (Sodium Pyrosulfite), AWWA B303 sodium chlorite, AWWA B404 liquid sodium silicate, AWWA B504 monosodium phosphate, anhydrous, AWWA B408 polyaluminum chloride, AWWA B505 disodium phosphate, anhydrous.

2.3.8 Oxidants

[50][35][_____] percent NSF/ANSI 60 hydrogen peroxide solution, AWWA B603 potassium permanganate [potassium permanganate may be supplied in powder form for onsite preparation] at the discretion of the Contracting Officer.

2.3.9 Precipitants

AWWA B501.

2.3.10 Primary Coagulants

AWWA B403 aluminum sulfate, AWWA B407 liquid ferric chloride, AWWA B406 ferric sulfate, AWWA B402 ferrous sulfate.

2.3.11 Prophylaxis

AWWA B703 hydrofluosilicic acid, AWWA B701 sodium fluoride, AWWA B702 sodium silicofluoride.

2.3.12 Sequestrants

AWWA B502 sodium polyphosphate, glassy (sodium hexametaphosphate), AWWA B503 sodium tripolyphosphate.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Submit detail drawings containing complete piping, wiring, schematic, flow diagrams, and any other details required to demonstrate that the system has been coordinated and properly functions as a unit. On the drawings show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation.

3.2.1 Chemical Feeding Equipment

Install controlled volume pumps, equipment, and appurtenances to provide a complete and integrated system in accordance with the instruction of the manufacturer and under the direct supervision of the manufacturer's representative.

3.2.2 Gasoline Engines

Install gasoline engines in accordance with NFPA 37.

3.2.3 Pipe, Tubing, Hangers and Supports

Install pipes and tubes in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2.4 Field Painting

Thoroughly clean, prime and top-coat factory painted items requiring touching up in the field with the manufacturer's standard factory finish provided it does not discolor in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) conditions. Paint the equipment which did not receive a factory finish as specified in Section 09 90 00 PAINTS AND COATINGS. Coating must be at least 0.05 mm1.75 mils thick. Provide piping identification as specified in [ASME A13.1][Section 09 90 00 PAINTS AND COATINGS. Mark pipe carrying materials not listed in Section 09 90 00 PAINTS AND COATINGS in accordance with ASME A13.1.]

3.2.5 Framed Instructions

Submit framed instructions for approval prior to postings. Final size must be easy to read by operators 5 feet from instructions. Limit frame size to 11" x 17" size provide multiple frames if needed. Post framed instructions, containing wiring and control diagrams, where directed. Post condensed operating instructions as outlined in paragraph 3.4.2 Operating Instructions. Post the framed instructions before acceptance testing of the systems.

3.3 FIELD QUALITY CONTROL

3.3.1 Testing

After installation of each controlled volume pump, carry out operating tests as specified below to assure that the chemical metering installation operates properly. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests. Submit reports of all tests in booklet form prior to final acceptance of the installation. Show all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

3.3.1.1 Tank Testing

Clean tanks of loose debris and dry prior to testing. Field test tanks for leaks or damage in shipment. Hydrostatically test tanks to [_____] kPapsig or 1.5 times the system operating pressure, whichever is greater, to detect large leaks and then with the specified chemical to detect small leaks. Test each tank with its solution for a period of 24 hours at which time no visible leakage is evident. Supply all pipes, hoses, pumps, water, power and other equipment required to convey the test liquids and to carry out the tests. Repair damage or leaks in tanks or replace tanks. Replace damaged ceramic tanks.

3.3.1.2 Controlled Volume Pumps - Operational Tests

Test pumps to demonstrate that the pumps are capable of operating without vibration or leakage. Perform testing at the pump's maximum flow rate and at half the flow rate. Demonstrate testing while controlled and operated in all feasible modes with the pumps operated singly and in unison. Plot the response of each pump on curves for the various operating pressures encountered and the results compare to the curves shown on the manufacturer's published pump data. If control characteristic curves are not available at the time of testing, the pump manufacturer's service engineer must generate such curves for each pump; graphically depicting the pump displacement at 25, 50, 75, and 100 percent of motor speed for SCR equipped pumps, and at 25, 50, 75, and 100 percent of maximum stroke position for all pumps. Generate curves only for the specified back pressure.

3.3.1.3 Controlled Volume Pumps - Time, Volume and Pumping Pressure Tests

Test pumps by filling [the standpipe][a portable calibrated standpipe furnished by the Contractor] with chemical and measuring the outage, with all other equipment valved off. Record the time, volume and pumping pressures.

3.3.1.4 System Pressure Tests

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NOTE: To establish that full service can be provided, fill in the blank with the numerical value of the pressures that can be expected during normal operation of the system.

****

Carry out tests at [_____] and [_____] kPapsig. Manually control back pressure valves for this testing, and reset as necessary after testing. The time to deliver a given quantity of chemical at a given stroke and speed setting must be the same at all pressures.

3.3.1.5 Flow Tests

Test pumps to demonstrate zero L/secondgpm flow at a zero stroke or speed setting. Failure to meet this test is cause for rejection. Test pumps through full range of performance: min. flow [_____]. Submit test results to prove pump functions within specified system parameters.

3.3.1.6 Synchronization Tests

Operate the pumps for a period of 4 hours to demonstrate that the double diaphragm systems do not lose their synchronization. Loss of synchronization is also cause for rejection; repair or replace the pump as necessary to achieve synchronization. Fully retest repaired or replaced equipment.

3.3.2 Chemical Waste

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NOTE: In selection of chemicals, consider the environmental consequences, including disposal of precipitated solids and other wastes. Select the most appropriate options and edit to fit the situation for drinking water or waste water treatment systems.

****

Neutralize chemicals wasted during testing procedures to achieve a pH value between 6.5 and 9.5 and a chlorine concentration of not more than 1 percent (10,000 mg/L). Route all chemicals wasted during testing procedures [as directed by the Contracting Officer][to the sanitary sewer] [through the treatment process] at a rate that the process can assimilate without upset.

3.3.3 Manufacturer Field Service

Provide the services of a manufacturer's representative who is certified by manufacturer in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, and testing of the equipment. Submit certificates to Contracting Officer for approval.

3.4 CLOSEOUT ACTIVITIES

3.4.1 FIELD TRAINING

Conduct a field training course for designated operating, maintenance and supervisory staff members. Provide training for a total period of [_____] hours of normal working time and start after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the Operating and Maintenance Instructions during field training.

3.4.2 Operating Instructions

Submit complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Also include in the instructions as-built drawings of the piping layout, equipment layout, simplified wiring and control diagrams of the system as installed, and flow diagrams.

3.4.3 Maintenance Instructions

Submit complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-46 30 13 (February 2011)**

Preparing Activity: USACE **Superseding**
UFGS-44 44 53 (October 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 46 30 13

ADVANCED OXIDATION PROCESSES (AOP)

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****

SECTION 46 30 13

ADVANCED OXIDATION PROCESSES (AOP)
02/11

****
NOTE: This guide specification covers the requirements for liquid phase advanced oxidation processes using titanium dioxide or hydrogen peroxide and/or ozone with or without ultraviolet light.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2024) Factory-Made Wrought Buttwelding Fittings
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A182/A182M	(2024) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe

	Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A269/A269M	(2024) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A774/A774M	(2024) Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778/A778M	(2024) Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM D1710	(2008) Extruded and Compression Molded Polytetrafluoroethylene (PTFE) Rod and Heavy-Walled Tubing
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3222	(2018a) Standard Specification for Unmodified Poly(Vinylidene Fluoride)

	(PVDF) Molding Extrusion and Coating Materials
ASTM F593	(2024) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

CAGI B19.1	(2010) Safety Standard for Compressor Systems

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-4.1	(2009) Cleaning Equipment for Oxygen Service; 6th Edition
CGA G-4.4	(2020) Oxygen Pipeline Systems; 4th Edition
CGA HB	(1999) Handbook of Compressed Gases; 4th Edition

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ANSI/ISA 5.1	(2024) Instrumentation Symbols and Identification

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-43	(2019) Wrought Stainless Steel Butt-Welding Fittings
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 55	(2023; TIA 22-1; TIA 22-2; TIA 23-3; TIA 23-4) Compressed Gases and Cryogenic Fluids Codes
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

AOP System; G, [_____]

Air Preparation System; G, [_____]

Oxygen Generation System; G, [_____]

LOX Storage System; G, [_____]

Ozone Generation System; G, [_____]

Reactor Vessel; G, [_____]

Metering Pump; G, [_____]

Local Controls and Panels; G, [_____]

Liquid Process Tank; G, [_____]

Maintenance; G, [_____]

Drawings showing shop and erection details and chemical application locations; including cuts, codes, connections, holes, bolts, welds, anchorage, installation details, wiring diagrams, schematic diagrams, component identification tables and directory, and clearances for maintenance and operations.

SD-03 Product Data

AOP System; G, [_____]

Calculations; G, [_____]

Commissioning/Demonstration Plan; G, [_____]

Manufactured Units

Performance Requirements; G, [_____]

Qualifications; G, [_____]

SD-06 Test Reports

Performance Requirements; G, [_____]

SD-07 Certificates

AOP System

Field Training

SD-10 Operation and Maintenance Data

AOP System; G, [_____]

Maintenance; G, [_____]

1.3 QUALIFICATIONS

****

NOTE: Designer should edit the subsequent paragraphs and remove requirements not applicable to the project.

****

1.3.1 Contractor

Provide documentation of a minimum of [3] [_____] years of experience in the construction of water, wastewater, industrial wastewater, or hazardous and toxic waste water treatment facilities. The Contractor is responsible for installation and start-up of the AOP equipment supplied, as well as operator training.

1.3.2 Equipment Manufacturer

Submit a statement by the equipment manufacturer listing any exception to or deviations from the contract drawings and specifications. Written evidence that equipment and accessories are a product of a qualified and experienced manufacturer. Statement indicating the system is capable of treating the wastes to the levels identified.

1.3.3 Ultraviolet (UV) Oxidation System Supplier

Equipment provided must duplicate equipment that has been in satisfactory service for a minimum of [2] [_____] years prior to bid opening. The UV oxidation system supplier isresponsible for furnishing a complete prepackaged system. The supplier need not manufacture the entire system, but coordinate the selection, assembly, installation, and testing of the entire system as specified.

1.3.4 Manufacturer's Representative

Provide services, as specified, of a qualified manufacturer's field representative experienced in the installation, adjustment, and operation of the equipment furnished and who has complete knowledge of the proper operation and maintenance of the system. Include a statement indicating the operators designated to train the on site operators have been trained to operate the installed equipment.

1.3.5 Welding

Perform welding following qualified procedures, using performance qualified welders and welding operators. Furnish a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators to the Contracting Officer prior to beginning any work on the AOP equipment.

1.4 REGULATORY REQUIREMENTS

Conform the AOP system to all federal, state, regional, and local regulations concerning chemical storage, air, noise and water pollution control requirements.

1.5 PRE-SUBMITTAL CONFERENCE

Assemble the primary process designer, AOP equipment and major component suppliers, electrical and mechanical subcontractors, and major component manufacturer's representatives at [the construction site] [_____] prior to preparation of the Contractor's AOP submittal for government approval. This meeting is intended to ensure that facility construction is properly scheduled; power, control, plumbing, space interfaces are verified; and responsibilities coordinated among subcontractor's and suppliers and reflected on the Contractor's AOP submittals.

1.6 DELIVERY, STORAGE, AND HANDLING

****

NOTE: Designer should coordinate with the Contracting Officer and user to determine appropriate locations for equipment storage. Identify unusual requirements either here or on the drawings.

****

Deliver equipment free of structural or other damage and place in storage, in accordance with the manufacturer's requirements, protected from structural damage, the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants that could otherwise damage its components.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: This paragraph should be edited to identify the appropriate contaminants of concern as well as those parameters which potentially inhibit the process as indicated in ETL 1110-1-161 ULTRAVIOLET/CHEMICAL OXIDATION dated 29 March 96.

Effluent limitations are generally dictated by regulatory requirements. List the performance requirements in this specification.

If this specification is used as part of a Request for Proposals, the designer should identify maximum values for power and oxidant usage based on bench or pilot studies and include this information in Paragraph Performance Requirements.

****

Provide the AOP including all items necessary as a complete system for removal of those chemicals identified below to the levels indicated. Equipment includes, but is not limited to, AOP contact vessels, lamps when required, piping to units upstream and downstream of the contact vessels, oxidant feed system, gas emission treatment, controls, accessories and equipment to provide complete and functional system within the limits identified. Analytical and sampling protocols areas specified in [_____].

2.1.1 Design Requirements

Minimum equipment life	[20] [_____] years
Max. equipment dimensions	[As indicated] [_____]
Maximum AOP reactor operating pressure	[_____] kPa psi
Reactor inlet pipe diam.	[_____] mm inch
Reactor outlet pipe diam.	[_____] mm inch
Max. cooling water temp.	[_____] degrees C F
Max. cooling water flow rate	[_____] L/s gpm
Max. AOP influent flow rate	[_____] L/s gpm

Minimum reactor vessel detention time	[_____] minutes
Max. liquid temperature rise across AOP reactor	[_____] degrees C F

2.1.2 Performance Requirements

Submit performance tests results indicating temperature rise through the reactor, oxidant dosage, detention time, catalyst dosage, ultraviolet light dosage, ambient gas monitoring results, and treatment system off gas monitoring and destruction results, equipment and analytical testing methods used, and removal of constituents identified below stated in mass/unit volume treated relative to the influent concentration.

Report in booklet form, upon completion of the installed system. Test report will include field tests performed to adjust each component and field tests conducted to prove compliance with the specified performance criteria. Test report must indicate the recommended position of the controls.

a. Influent characteristics:

Inorganic Constituent Concentration	
Iron (Fe2+)	[_____] mg/L
HCO3- (as CaCO3)	[_____] mg/L
[_____]	[_____] mg/L

Organic Constituent Concentration	
[_____]	[_____] µg/L
pH	[_____] units
Total Organic Carbon (TOC)	[_____] mg/L

b. Effluent requirements:

Organic Constituent Concentration	
[_____]	[_____] g/L
Total Organic Carbon (TOC)	[_____] mg/L
pH	[_____] units
Maximum effluent temperature	[_____] degrees C F

c. Efficiency factors:

Ozone usage	[_____] mg/L

Hydrogen peroxone usage	[_____] mg/L
Power consumption	[_____] kW/L
[Catalyst usage]	[_____] mg/L

2.1.3 Treatability Testing

****

NOTE: This paragraph should be deleted if previous treatability studies have not been conducted. The system parameters used during the treatability study may not duplicate the system proposed by the Contractor. The previous treatability studies should be properly documented to include the information contained in ETL 1110-1-161.

****

The previously conducted treatability study information contained in Appendix [_____] is provided for the Contractor's information. The study results indicate [ultraviolet oxidation] [peroxone] [_____] is capable of meeting the criteria in paragraph PERFORMANCE REQUIREMENTS. Evaluate the applicability and adequacy of the treatability studies and results provided. If deemed necessary by the Contractor, additional studies may be performed at the Contractor's expense to confirm the previously conducted treatability study and results. Based on the Contractor's own interpretation of the previous studies and results, and additional studies and results the Contractor elects to perform, provide a full scale treatment plant which meets the requirements identified.

2.2 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and which essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment is to be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.3 NAMEPLATES

Provide each major item of equipment with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Nameplates are to be provided for, but not limited to, each contact vessel, pumps, motors, oxidant equipment and accessories, and electrical components such as transformers.

2.4 MATERIALS

2.4.1 Plates, Shapes and Bars

Conform steel to ASTM A36/A36M; stainless steel must conform with ASTM A276/A276M, type 316.

2.4.2 Pipe and Fittings

****

NOTE: Designer should coordinate with the oxidizer

equipment suppliers to coordinate piping and gasket material requirements.
****

Gasket materials for pipe and fittings are to be silicon, or teflon unless otherwise shown or specified.

2.4.2.1 Stainless Steel Pipe

a. Conform pipe 100 mm 4 inch and larger to ASTM A312/A312M, Schedule 40, Type 316L with maximum carbon content of 0.04 percent. Conform flanged fittings sto ASME B16.5, F316L Class 150 with 2 mm 1/16 inch minimum thickness silicon, teflon, expanded PTFE, PVDF, or viton gaskets. Butt weld fittings must conform to ASTM A403/A403M and MSS SP-43, Grade 316L, Schedule 10S with full penetration welds.

b. Pipe less than 100 mm 4 inch will be type TP316, and conform to ASTM A312/A312M Schedule 80S for threaded joints, and Schedule 40S for welded joints. Conform flanged joints to ASTM A182/A182M, F316 or F316L, Class 150; dimensions and drilling are to be in accordance with ASME B16.5 with 2 mm 1/16 inch minimum thickness silicone, teflon, expanded PTFE, PVDF, or viton gaskets. Butt weld fittings must conform to ASTM A774/A774M, ASTM A778/A778M, and ASME B16.9.

c. Liquid tubing 10 mm 3/8 inch and smaller will be seamless austenitic stainless steel and conform to ASTM A269/A269M, Type TP316. Wall thickness are to be adequate for the pressure required. Fittings must be compression type made from bar stock material conforming to ASTM A276/A276M, Type 316, with forgings conforming with ASTM A182/A182M, Type 316. Assemblies will consist of tube, fittings and components of one manufacturer.

2.4.2.2 Polyvinyl Chloride (PVC) Pipe

PVC pipe and fittings less than 100 mm 4 inch diameter will be in accordance with ASTM D1785 or ASTM D2241. PVC pipe and fittings 100 mm 4 inch in diameter and larger will be in accordance with ASTM D2241. Pipe and joints are to be rated for a working pressure of [_____] kPa psi. Solvent cement joints must conform to the requirements of ASTM D2564. Flanged joint diameter and drilling must conform to ASME B16.5, Class 150.

2.4.2.3 Polytetrafluoroethylene (PTFE) Pipe and Tubing

Conform pipe and fittings to ASTM D1710, Type I, Grade 1, Class A, with PTFE compression type fittings. Pipe, tubing and associated fittings are to be rated for a minimum working pressure of [_____] kPa psi.

2.4.2.4 Polyvinylidene Fluoride (PVDF) Pipe and Tubing

PVDF pipe, tubing and fittings are to be manufactured from materials conforming to ASTM D3222 for type II homopolymers. Pipe tolerances for outside diameter and wall thickness will be in accordance with ASTM D1785 for schedule 80 pipe. Tubing and associated fittings are to be rated for a minimum working pressure of [_____] kPa psi.

2.4.2.5 Copper Pipe

Pipe 100 mm 4 inch and smaller will be standard weight, seamless, cold drawn type conforming to ASTM B88M ASTM B88 Type K, temper H. Fittings are to be cast or wrought copper alloy, solder joint type, conforming with ASME B16.18 or ASME B16.22, as appropriate. Solder used will be lead free and comply with ASTM B32, grade Sb5, 95-5 tin-antimony or Sn96, 96-4 tin-silver solder.

2.4.3 Pipe Hangers and Supports

Pipe hangers and supports will conform to MSS SP-58.

2.4.4 Stainless Steel Gas Tubing and Fittings

Stainless steel tubing will conform to ASTM A778/A778M. Wall thicknesses will be a minimum of 1.5 mm 0.062 inch for tubing 250 mm 10 inches and smaller, tubing 300 mm 12 inch in diameter will have a minimum wall thickness of 1.9 mm 0.078 inch, tubing 350 through 450 mm 14 through 18 inch in diameter will have a minimum wall thickness of 2.7 mm 0.109 inch. Fittings will conform to ASTM A774/A774M, and be of the same material, grade, schedule or wall thickness as specified for tubing. Joints are to be full penetration butt welded joints or Van Stone type joints using angle face rings with bracing flanges drilled in accordance with ASME B16.5.

2.4.5 Valves

2.4.5.1 Liquid Oxygen (LOX)

LOX valves are to be bronze or Type 316 stainless steel intended for cryogenic extended service. Materials must be compatible with the piping installed.

2.4.5.2 Gate

Gate valves are to comply with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.4.5.3 Ball

Ball valves are to comply with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE. Valves used for hydrogen peroxide service are to be passivated and vented in accordance with the hydrogen peroxide supplier recommendations.

2.4.5.4 Check

Check valves are to comply with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.4.6 Injectors

****

NOTE: Designer should coordinate pressure requirements with equipment manufacturers to determine if supplemental pumping is required to ensure adequate gas transfer. In certain situations, multiple injectors may be required if large flow variations are expected. Injectors are most commonly used on smaller applications such as multiple columns in series where ozone can be injected to the individual columns.

****

High efficiency venturi type injectors will be constructed of 316L stainless steel or PVDF at a rated pressure of [_____] kPa psi. Each unit will have a liquid flow capacity of [_____] L/s gpm, and be capable of applying 150 percent of the design gas flow of standard [_____] L/minute cubic feet/hour of a [_____] percent ozone in [air] [oxygen] mixture. Injectors are to be designed to operate with an available pressure head to the injector of [_____] kPa psi, and a back pressure of [_____] kPa psi.

2.4.7 Diffusers

****

NOTE: Designer should coordinate with diffuser manufacturers to determine the proper flow rate and coverage per diffuser. Rod type diffusers are generally used on larger rectangular tanks versus the dome or disc type which can be used in either circular reactors, or on rectangular units.

Coordinate access requirements with paragraph AOP Reactor Vessel.

****

Fine bubble diffusers are to be ceramic construction, of the tube, disc or dome type. Ceramic are to be of bonded silica or alumina, and be resistant to degradation by ozone in oxygen concentrations of [16] [_____] percent. Pore size will be a maximum of [50] [_____] um [0.002] [_____] inch or the manufacturer's standard pore size which will produce bubbles [2] [_____] mm [0.005] [_____] inch in diameter or smaller. Gas flow per diffuser will be a maximum of standard [_____] L/s cubic feet/minute at a submergence of [_____] m feet. Maximum allowable headloss per diffuser islimited to [_____] mm inch. Brackets, holders, bolts, rods, washers and other accessories are to be 316 stainless steel unless otherwise indicated. Gaskets are to be of silicone construction.

2.4.8 Couplings

Fittings, flanges, bolts, nuts and washers are to be the same material as the piping unless otherwise indicated. Sleeve type couplings for ozone service are to be of stainless steel conforming with ASTM A312/A312M, Grade TP316L with ozone resistant gaskets. Couplings for non-ozone ferrous metal piping will be ASTM A53/A53M, Grade B.

2.4.9 Insulating Joints

Insulating joints are to be provided when ferrous metal piping is joined with non-ferrous metal piping, fitting or valve materials. Insulating flanges are to be installed and have insulating flange gaskets, insulating sleeves for studs, and insulating washers for both sides of flanges. Steel washers are to be installed between the insulating washers and nuts. Couplings are to be of the same pressure rating as the pipe installed.

2.4.10 In Pipeline Static Mixers

****

NOTE: Static mixers are generally recommended to ensure complete mixing when peroxide is used. Static mixers may also be needed in other processes in the treatment train; if so, coordinate and list

those requirements separately or coordinate them with other specification sections to ensure there is no duplication.

****

In pipeline static mixers are to be installed [at the locations indicated] [upstream of the reaction chamber]. Mixers are to be [installed in a flanged section of piping] [with removable mixing sections] [inserted into the pipeline], have a pressure rating equal to that of the piping installed, have a maximum headloss of [_____] mm inch of water, [at [_____] L/s gpm] while inducing completely turbulent mixing conditions in the pipeline installed. Mixers [and housing] are to be constructed of [Grade 316 stainless steel] [_____] and be compatible with [hydrogen peroxide] [_____]. [The static mixer must be ported for direct application of the applied chemical.]

2.4.11 Bolts, Nuts, Anchors and Fasteners

Bolts, nuts, anchors and fasteners will be stainless steel in conformance with ASTM F593.

2.5 MANUFACTURED UNITS

****

NOTE: Edit the following paragraphs to reflect the type of ozone generator feed gas (air or oxygen) that is included in the design package. A cost comparison should be performed prior to selecting the feed gas. Typically, oxygen in a liquid form or generated onsite from ambient air will be used. Air feed ozone generators typically produce ozone concentrations of approximately 2 percent in air, while oxygen feed systems typically produce ozone concentrations of 6 percent or greater in oxygen. VSA systems are generally used for systems that generate greater than 900 kg 2000 pounds per day.

For liquid oxygen (LOX) tanks, smaller than the minimum capacity stated in NFPA 55, state that the requirements indicated in the standard are to be applied to the tank size specified. LOX tanks should not be located inside a treatment facility. This paragraph contains statements describing a complete manufactured unit, usually a standard catalog item; statements may include descriptive requirements for the materials, specific fabrication, finishes, and function. Separate paragraphs for each different item should be used when appropriate. The name used for the manufactured unit must be consistent throughout the specification.

Generally, skid mounted equipment is preferred; however, this may not be possible with larger oxygen generation units (greater than 225 kg 500 pounds per day). Verify dimensions with manufacturers to ensure the skid mounted units are transportable and do not have an excessively large space requirement over equipment that is field assembled. The

following paragraphs may need to be modified to allow assembly, wiring, and plumbing in the field.

Additional information is contained in ETL 1110-1-161.

****

Submit wiring and control diagrams, systems layouts and isometrics, component identification tables, instructions, and other sheets, prior to posting. Condensed operating instructions explaining preventative maintenance procedures, methods of checking the system for safe operation, making adjustments, and procedures for safely starting and stopping the system are to be prepared in typed form, framed and posted beside the diagrams.

2.5.1 Swing Adsorption Oxygen Generation System

The Oxygen Generation System are to be Swing Adsorption type. [Pressure swing adsorption (PSA)] [Vacuum swing adsorption (VSA)] system equipment must be a complete unit process, including the compressor, [particulate filters,] [aftercooler separator,] heat exchangers, switching valves, instrument air dryer, adsorbent beds, adsorbent material, [oxygen receiver,] controller and other equipment as required by the manufacturer to provide a complete and operational oxygen generation system. [The unit] [Each component] will be completely wired requiring only [interconnecting wiring between components] [an external connection for a single external power supply and remote monitoring] [and control] be done in the field. [PSA] [VSA] system equipment must include all work from the outside air inlet to the ozone generator inlet connection. The [PSA] [VSA] system must be a continuous output system with the following characteristics:

Min. oxygen generation capacity	[_____] kg/day lbs/day
Oxygen purity (minimum)	[90] [_____] percent
Temperature to generator (max.)	[30] [_____] degrees C[86] [_____] degrees F
Dewpoint maximum (below 0 degrees)	[60] [_____] degrees C[76] [_____] degrees F
Oxygen utilization efficiency (min.)(Ratio of oxygen delivered to the ozone generator/oxygen present in the air feed to the oxygen	[40] [_____] percent
Cycle time (adjustable range)	[_____] minutes
Hydrocarbon concentration to ozone generator (maximum)	[0] [3] [_____] ppm
Discharge pressure to ozone generator	[_____] kPa psi
Power supply	[480] [_____] volt, 3 phase, 60 hertz.
Cooling water supply (max. temperature)	[_____] degrees C F
Cooling water flow rate (maximum)	[_____] L/s gpm

Adsorption vessels will be designed and constructed in accordance with ASME BPVC SEC VIII D1.

2.5.2 Liquid Oxygen (LOX) Storage and Supply System

****

NOTE: Provide seismic requirements for piping, tanks and related equipment supports, if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS, properly edited, must be enclosed in the contract documents.

****

LOX storage system and associated equipment must comply with NFPA 55 and CGA G-4.4. Tanks, vaporizers and regulators are to be suitable for exterior installations. Cleaning for components, equipment, valves, piping and tanks for oxygen service are to be accomplished in accordance with CGA G-4.1, CGA HB. The system must be rated to withstand a minimum wind speed of [_____] km miles per hour, maximum ambient temperature [_____] degrees C F, minimum ambient temperature [_____] degrees C F, [_____] relative humidity, and [_____] meters feet mean sea level altitude. System must be supported and braced to resist seismic loads [as specified in UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS] [as indicated].

2.5.2.1 LOX Storage Tanks

****

NOTE: Typically, 304 stainless steel is used for LOX inner tanks less than 6000 L 1500 gallons or 6750 kg 15,000 pounds, while 9 percent nickel units are generally specified for larger tanks principally due to economic considerations. Typical maximum operating pressure for the LOX system will generally be less than 515 kPa 75 psi; significant cost savings can be achieved by reducing the tank pressure requirements, but lower pressure tanks may require a longer lead time to procure since the 1.2/1.7 MPa 175/250 psi tanks are most commonly provided.

****

Bulk LOX storage tanks are to be [_____] kg pound double walled vertical tanks constructed in conformance with [ASME BPVC SEC VIII D1] [_____], rated for a maximum operating pressure of [1.2] [_____] MPa [175] [_____] psi and design temperature between minus 212 and plus 65 degrees C minus 350 and plus 150 degrees F, and seismic parameters defined in previous paragraph. Construct the inner wall of [Grade 304 stainless steel] [9 percent nickel steel] [_____], the outer shell constructed of carbon steel with a minimum outer shell thickness of [10] [_____] mm [0.375] [_____] inch. Annular area between the inner and outer walls are to be insulated to limit oxygen boil off rate to less than [0.25] [_____] percent of the tank capacity per day at the maximum ambient conditions. Piping must be copper or 316 stainless steel. Fittings must be bronze or 316 stainless steel.

2.5.2.2 Vaporizers

****

NOTE: Vaporizers should be designed for the anticipated flow rate to the ozone generator. If vaporizers are oversized, gas temperatures will reach outside ambient temperatures, resulting in higher oxygen gas temperatures during the summer months being fed to the ozone generator, reducing its efficiency. Normal operating pressure for an ozone generator is approximately 103 kPa 15 psi. Resulting pressure at the diffusers is approximately 103 kPa 15 psi less system losses.

In cold climates, heaters may be required to warm the oxygen gas feed to the ozone generator. The actual heating requirements should be coordinated with the ozone generator manufacturer. In cases where ambient temperatures fall below freezing for extended periods, supplementary heating may be necessary.

LOX systems may require a small quantity of nitrogen gas be added to the feed stream to facilitate ozone gas flow through the generator. This may be accomplished by adding a small volume of dried ambient air (about 2 percent).

****

Vaporization equipment will consist of a minimum of [2] [3] ambient air vaporizers and [single] [double] regulator system complete with automatic switching and a manual bypass. Each vaporizer must be rated for 100 percent capacity, under continuous operation at a [_____] cubic meters/second SCFM withdrawal rate and also capable of supplying a peak withdrawal rate of [_____] cubic meters/second scfm. Design the vaporization equipment for an inlet pressure of [_____] kPa psi, and a maximum headloss between the tank and ozone generator of [_____] kPa psi. The vaporizer extrusions must have extra wide spacings between the individual extrusions with a minimum area per extrusion of [1.65] [_____] square meters/meter [5] [_____] sf/ft. [Heaters are to be provided to automatically warm the oxygen feed gas to the ozone generator when the oxygen feed temperature falls to less than [_____] degrees C F. Ensure heaters are capable of warming the oxygen feed gas to a temperature range between [10 and 22] [_____] degrees C [50 and 72] [_____] degrees F]. Each vaporizer must operate for a minimum of [8] [_____] hours at the minimum ambient conditions and continuous withdrawal rate specified. The defrost cycle for each vaporizer be a maximum of [8] [_____] hours at the minimum ambient conditions and continuous withdrawal rate specified. Piping between the LOX tank and ozone generator are to be insulated as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.5.2.3 Regulators

Regulators are to be factory tested with outlet pressure field adjustable over a downstream pressure range from [69 to 172] [_____] kPa [10 to 25] [_____] psi, from 0 to 100 percent of the specified oxygen flow rate. Regulators are to be rated at 1030 kPa 150 psi, and constructed of 316 stainless steel.

2.5.3 Ozone Generator Air Feed System

System equipment which processes ambient air directly as the ozone generator feed gas must be provided by a single supplier, [be of the pressure swing type and] include an air compressor and receiver, aftercooler, [refrigerative dryer], vapor/liquid separator, [coalescing and] [particulate] filters, desiccant air dryer, particulate after filter, switching valves, pressure, temperature and moisture monitors, local controller and other equipment as required by the manufacturer to provide a complete and operational air preparation system. [The equipment must be skid mounted.] Adsorption vessels are to be designed and constructed in accordance with ASME BPVC SEC VIII D1. Adsorption material must be [activated alumina] [_____]. The unit is to be completely wired requiring only an external connection for a single external power supply and remote monitoring [and control]. The air preparation system supplier isresponsible for all work from the outside air inlet to the ozone generator inlet connection. The air preparation system is to be a continuous output system with the following characteristics based on 100 percent relative humidity and maximum ambient temperature of [_____] degrees C F:

Minimum dry air feed to ozonator	[_____] cms scfm/m
Operating pressure at stated capacity	[345] [_____] kPa[50] [_____] psi
Pressure drop through desiccant dryers (maximum)	[20] [_____] kPa[3] [_____] psi
Maximum air temperature to ozone generator	[30] [_____] degrees C[86] [_____] degrees F
Maximum dewpoint (below 0 degrees)	[60] [_____] degrees C[76] [_____] degrees F
Maximum hydrocarbon concentration	[0] [1] [_____] ppm
Discharge pressure to ozone generator (min)	[_____] kPa psi
Cycle time adjustable range	[1 to 5] [_____] minutes
Power supply	[480] [_____] volt, 3 phase, 60 hertz

2.5.4 Ozone Generator System

****

NOTE: Delete this paragraph if an ozone generator is not used. Horizontal tube, medium frequency generators are the most common; however, since the state of the art is constantly changing, verify that other types of generators are not available or appropriate for the particular application.

Coordinate pressure requirements with paragraph Ozone Generator Air Feed System. Typical pressure ranges required for ozone systems are dependant upon the final ozone outlet pressure, generally between 69 and 103 kPa 10 and 15 psi plus losses through the equipment.

****

Ozone generation equipment are to be continuous duty water cooled, multi-tube glass or non-glass multitube dielectric [horizontal tube] [vertical tube] assemblies contained in a pressure vessel [with hinged gas-tight doors] with a rated design pressure of [_____] kPa psi. Each unit is to be provided with [medium] [high] frequency electrical power supply units including input and output transformers, power controller, frequency inverter, harmonic mitigation equipment (if required). The generator must be provided with complete controls, [compatible with the central control unit,] instrumentation, panels, appurtenances and miscellaneous equipment required for a complete ozone generating system using [oxygen] [air]. All equipment, valves, piping, associated appurtenances must be suitable for ozone in [oxygen] [air] service. Generator design requirements are as follows:

Capacity	[_____] kg lbs/day
Gas flow rate to generator	[_____] cms scfm
Outlet pressure ± 5 percent)	[_____] kPa psi
Ozone concentration	[_____] percent
Generator vessel design pressure	[_____] kPa psi
Ozone output concentration turn down	[10:1] [_____]
Cooling water temperature rise at rated production capacity	[3] [_____] degrees C[5] [_____] degrees F
Carrier gas rise across generator (max.)	[30] [_____] degrees C[17] [_____] degrees F
Inlet hydrocarbon concentration (max)	[0] [_____] ppm
Power supply	[480] [_____] volt, 3 phase, 60 hertz

2.5.4.1 Ozone Generator Vessels

All ozone generator metal parts which come into contact with ozone or cooling water are to be constructed of Type 316L stainless steel. The vessel must be designed to resist an internal pressure of 1.5 times the design pressure, including the tubes and shell. Provide over pressure protection based on worst case operating conditions. The vessels are to be constructed in accordance with ASME BPVC SEC VIII D1 code. Provide viewing ports to allow visual inspection of all internal dielectrics during operation.

2.5.4.2 Dielectric Tubes

Dielectric tubes are to be constructed to resist thermal shock and to evenly distribute the applied electrical charge over the entire dielectric surface without arcing. Dielectric tubes are to be formed from either glass or a non-glass material with a certified voltage breakage strength of 1.5 times the maximum possible operating voltage under maximum temperature and applied power conditions. Dielectric tubes are to be protected by fuses or functionally equivalent devices to prevent shorting dielectric tubes from damaging the shell and tube structure in the ozone generator.

2.5.5 Ozone Destruct System

****

NOTE: High concentrations of chlorinated organics may be liberated by systems which use ozone in air or oxygen. These chlorinated organics may "poison" a catalyst bed designed only for ozone destruction. If considerable concentrations of chlorinated organics are anticipated (greater than 1000 ppm) in the reactor off gas, a chlorine resistant catalyst should be specified or a separate specification section should be used.

****

Ozone off gas destruction equipment must be thermal assisted catalyst destruct type units suitable for moist ozone in [oxygen] [air] service. The catalyst containment unit, piping, ductwork, and other metallic components are to be constructed of 316 stainless steel. The units are to be capable of destroying contactor off gas generated by the ozone generators which feed the AOP reactors. The ozone destruction unit must have the capability to function at a minimum turn down ratio of 20 to 1. Each off gas destruction unit are to be a skid mounted unit consisting of [a demister,] an electric resistance heater, catalyst trays and containment vessel [, and a centrifugal blower]. The destruction unit discharge duct must be sloped away from the destruct unit to reduce the probability of catalyst fouling from condensation. Ducts carrying ozone laden off gas from the AOP reactors are to be sloped to a low point valved drain located upstream of the ozone destruct system. The ozone destruct system must reduce the ozone concentration from the off gas flow to less than [0.10] [_____] ppm by volume of ozone from zero flow to the maximum off gas flow rate. Normal operation is defined as [50] [_____] percent of the maximum off gas flow rate with an ozone concentration of [1.0] [_____] percent by weight. Ozone destruction equipment are to meet the following requirements:

Maximum pressure drop through catalyst at maximum flow rate	[_____] mm of mercury[_____] inches of water
Maximum pressure drop through heater at maximum flow rate	[_____] mm of mercury[_____] inches of water
Maximum off gas relative humidity	[_____] percent
Max. temperature rise across heater	[20] [_____] degrees C[35] [_____] degrees F
Catalyst chamber empty bed contact time	[1.0] [_____] seconds
Max. ozone concentration into destruct unit	[1.0] [_____] percent by weight
Off gas flow rate (maximum)	[_____] cubic m/sscfm
Maximum catalyst bed temperature	[120] [_____] degrees C[250] [_____] degrees F
Off gas temperature to catalyst bed	[15] [_____] degrees C[60] [_____] degrees F
Power supply	[480] [_____] volts, [3] [_____] phase, 60 hertz

The catalyst are to be non-hazardous [manganese dioxide/copper oxide] [nickel] [_____] based material suitable for catalytic ozone destruction at the specified conditions. Provide the catalyst containment unit swith a flanged and bolted top or hatch a minimum of 300 mm 12 inch in diameter to facilitate change out of the catalyst material when the catalyst is exhausted.

2.5.6   Hydrogen Peroxide System

****

NOTE: Edit Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS to provide on-off, set point, or proportional control as appropriate.

Hydrogen peroxide storage system requirements should be coordinated with suppliers to ensure material compatibility. Floating roof manway area should equal 1 in 2 per 400 L 100 gallons for solutions less than 52 percent, and 2 in 2 per 400 L 100 gallons for solutions greater than 52 percent. Process safety management requirements must be followed any time more than 3375 kg 7500 pounds of H2O2 is stored, or the solution strength is greater than 52 percent; refer to 29 CFR 1910.119 for information.

Hydrogen peroxide storage tanks should be located outside when possible. Polyethylene should not be used for peroxide concentrations greater than 52 percent.

****

The hydrogen peroxide storage tank must be constructed of cross linked polyethylene, 316 stainless steel, or 99.5 percent pure aluminum alloys designated in [ASTM B209M] [ASTM B209] as 1060, 5254, 5652. Hydrogen peroxide storage tanks are to be provided with secondary containment [as detailed on the drawings] [_____] with a minimum capacity equal to [110] [_____] percent of the maximum storage tank volume. Hydrogen peroxide storage tanks are to be equipped with [50] [_____] mm [2] [_____] inch female quick fill connection; [600] [_____] mm [24] [_____] inch hinged, weighted and gasketed manway cover; [50] [_____] mm [2] [_____] inch filtered breather vent; liquid level site tube; and [600] [_____] mm [24] [_____] inch free floating roof manway cover. All piping connections must be flanged. Conform feed pumps to the requirements of Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS.

2.5.7   Redox Potential Meter

Provide the oxidation reduction meter [where indicated on the drawings] [on the effluent line of each reactor]. Probe is to be easily removable without interrupting service. Probe materials are to be resistant to ozone as well hydrogen peroxide attack over a pH range of 2 to 12 and operating pressures of up to [_____] kPa psi and suitable for a temperature range from [0 to 100] [_____] degrees C [32 to 212] [_____] degrees F and suitable for the medium monitored. Probe must transmit output to an ORP analyzer with digital output. The ORP analyzer must transmit a [[4 to 20] [_____] mA signal proportional to the ORP] [direct digital reading] to the central control unit.

2.5.8 pH Probe

The pH probe is to be provided [where indicated on the drawings] [on the effluent line of each reactor]. Ensure probe is easily removable without interrupting service. Probe materials are to be resistant to ozone as well hydrogen peroxide attack over a pH range of 0 to 14 and operating pressures of up to [_____] kPa psi and suitable for a temperature range from [0 to 100] [_____] degrees C [32 to 212] [_____] degrees F and suitable for the medium monitored. Probe must transmit output to a pH analyzer with digital output. The pH analyzer must transmit a [[4 to 20] [_____] mA signal proportional to the pH] [direct digital reading] to the central control unit.

2.5.9 Ozone Monitors

2.5.9.1 Vapor Phase

Separate ozone monitors are to be provided to monitor ozone in ambient air, [at the locations shown on the drawings,] determining the ozone levels downstream of the off gas ozone destruct system, [and the ozone concentration in the ozone generator discharge]. The ambient air monitoring unit intake is tobe located [within 455 mm 18 inches above the treatment plant floor] [at the location shown on the drawings] [adjacent to the AOP process equipment]. The ambient air monitors are to be interlocked with the ozone generation system to initiate an alarm condition, and ozone generator shut down when readings exceed preset levels. Analyzers are to be [4 to 20 mA] [direct digital] output ultraviolet adsorption photometer type with built in pressure and temperature compensation. Ozone off gas monitor must have a minimum of five separate ranges to monitor concentrations between [[0 to 15] [_____] percent,] [[0 to 99,000] [_____] ppm by volume]. Ambient air and off gas destruct monitors must have a minimum of five separate ranges to monitor concentrations between [0 to 10] [_____] ppm. Each monitor is to be provided with a builtin digital ozone concentration readout at the unit.

2.5.9.2 Liquid Phase

Liquid phase monitors are to be provided [where indicated on the drawings] [on the effluent line of the last reactor]. Sensor must transmit output to an ozone analyzer with digital display and remote signal transmission to the central control unit. Probe must transmit output to a liquid phase ozone analyzer with digital output. The liquid phase ozone analyzer must transmit a [[4 to 20] [_____] mA signal proportional to the ozone concentration] [direct digital reading] to the central control unit.

2.5.10 Temperature Sensors

Temperature sensors are to be dual switch trip point independently adjustable type with a minimum accuracy of 0.5 percent of full scale. Thermal system is to be constructed of 316L stainless steel. Temperature range will be from [0 to 100] [_____] degrees C [32 to 212] [_____] degrees F and suitable for the medium monitored. Sensor must transmit output to an analyzer with digital output. The analyzer must transmit a [[4 to 20] [_____] mA signal proportional to the temperature] [direct digital reading] to the central control unit.

2.5.11 Compressors

Air compressors are to conform to CAGI B19.1. Air compressors are to be factory packaged [rotary screw] [centrifugal] [rotary] [reciprocating] type units. The air compressors are to be packaged in an enclosure with sound attenuating properties which allow a maximum noise level measurement of 75 dBA at the equipment enclosure. Air compressors are to be [water] [air] cooled and rated for continuous operation. Guards must shield exposed moving parts. Compressor motors and starters are to conform with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Air compressors are to have the manufacturer's name and address, together with trade name, and catalog number on a nameplate securely attached to the equipment. Any special maintenance instructions (required before startup or shutdown) are to be included in the Operations and Maintenance Manuals. Compressor equipment used for processing ambient air for the ozone generator feed gas are to include the air compressor, receiver with automatic condensate drain, intake air filter and silencer, after cooler, a high efficiency moisture separator, [refrigerative dryer], pressure, temperature and moisture monitors, local controller and other equipment as required by the manufacturer to provide a complete and operational oil free, dry compressed air system. Compressor receivers, air piping, valves and appurtenances unless otherwise specified, are to be in conformance with Section 22 00 00 PLUMBING, GENERAL PURPOSE. Dry contacts and 4 to 20 mA signals are to be provided in the control panel for remote monitoring.

Minimum capacity	[_____] cms scfm
Operating pressure at stated capacity	[345] [_____] kPa[50] [_____] psi
Maximum air temperature to PSA/VSA system	[30] [_____] degrees C[86] [_____] degrees F
Maximum dewpoint to PSA/VSA system (below 0 degrees)	[60] [_____] degrees C[76] [_____] degrees F
Maximum hydrocarbon concentration	[0] [_____] ppm
Cycle time adjustable range	[1 to 5] [_____] minutes

2.5.12 Blowers

Blowers are to conform to [Section 43 11 00.10 OFF-GAS FANS, BLOWERS AND PUMPS] [_____]. Dry contacts and 4 to 20 mA signals are to be provided in the control panel for remote monitoring.

2.5.13 Dew Point Monitor

The dew point transmitter are to be of a solid state design housed in a NEMA 4 enclosure as defined in NEMA 250, with an accuracy of plus or minus 3 degrees C over an operating ambient temperature range of minus 10 to plus 60 degrees C, over a dew point range of minus 110 to plus 10 degrees C. The transmitter must receive the signal from the thin film aluminum metal oxide sensor, convert and send it as a [single 4 to 20 mA DC signal proportional to the dewpoint level] [direct digital reading] to the central control unit. Sensor must transmit output to an analyzer with digital display.

2.5.14 Pressure Gauges

Water pressure gauges are to be glycerine filled units conforming to the requirements of ASME B40.100.

2.5.15 Sampling Ports

Aqueous and gas phase sampling ports are to be provided [where indicated on the drawings] [upstream and downstream of each reactor vessel]. Sampling ports are to be provided at locations accessible to plant operators. Ports and associated piping are to be constructed of [6] [12] [_____] mm [1/4] [1/2] [_____] inch minimum diameter [PVDF] [316 stainless steel] [teflon] [_____] with [PVDF] [316 stainless steel] [_____] [NPT x hose] ball valves.

2.5.16 Gas Flow Meters

****

NOTE: Numerous meters may be required which may necessitate a table be included identifying the flow capacity for each unit.

****

Flow meters for ozone or oxygen applications must have stainless steel body, tube, valves, floats, and knobs with glass windows. Flow meter must be rated for a flow rate of [_____] cms scfm at a minimum pressure of [345] [_____] kPa [50] [_____] psi. Provide each flow meter with a separate stainless steel valved connection for ease of maintenance. Equip each pipe penetration through the reactor wall serving a single ozone diffuser or bank of diffusers with a flow meter. The [air] [oxygen] feed stream to the ozone generator must also be equipped with a flow meter. Each flow meter must have an easily readable scale in cms scfm with a minimum of ten divisions from zero to 150 percent of the expected flow through the meter. Provide each meter with an analyzer which receives the signal from the flow meter transmitter, converts and sends it as a [single 4 to 20 mA DC signal proportional to the flow rate] [direct digital reading] to the central control unit. Sensor must transmit output to an analyzer with digital display.

2.5.17 Level Monitoring

Pressure type level sensors, associated analyzers and transmitters are to be provided for each liquid process tank associated with the AOP system. Ensure sensor element is removable for servicing or replacement without taking the tank out of service. As a minimum, the following tanks are to be equipped with level monitoring equipment: [reactor vessels,] [hydrogen peroxide storage and feed tanks,] [equalization tank,] [effluent storage and equalization tanks,] [_____]. Each level control element are to be of solid state design constructed of materials compatible with the liquid stored. Provide each controller with an analyzer which receives the signal from the level sensor, converts and sends it as a [single 4 to 20 mA DC signal proportional to the liquid level] [direct digital reading] to the central control unit.

2.5.18 Reactor Vessel

****

NOTE: Coordinate paragraph Gas Flow Meters requirements for the application; indicate penetration requirements, if a packing support is required; view ports; site glasses; or material options to stainless steel reactors. Also include access requirements for removal and maintenance of diffusers. Coordinate unique concrete material ozone resistance requirements with Section 03 30 00

CAST-IN-PLACE CONCRETE if concrete reactor vessels are used.

Reactors for peroxone systems, where either the ozone or hydrogen peroxide dose is not expected to exceed 25 ppm, may be constructed of fiberglass if appropriate resins are used. Coordinate with tank suppliers regarding specification requirements.
****

The reactor vessel will be [circular] [rectangular], fabricated of [316L stainless steel] [concrete conforming to Section [03 30 00 CAST-IN-PLACE CONCRETE] [_____] provided with [_____] mm inch, [_____] kPa psi flanged connections.] Reactor vessels will have a minimum water depth above the diffusers of [6] [_____] m [18] [_____] feet, with a minimum free board water depth above the liquid level of 600 mm 2 feet. [Reactor will be designed to accommodate a vacuum of [25] [_____] mm [1] [_____] inch applied to the reactor headspace.] Welding will be performed in accordance with AWS D1.1/D1.1M by welders certified to have passed qualification tests using procedures covered in AWS B2.1/B2.1M or ASME BPVC SEC IX. Reactors are to be equipped with openings required to ensure maintenance and installation/removal of the following equipment: liquid inlets and outlets, gas inlet supply and off gas collection points, sampling connections, [quartz sheath wipers], [UV lamps], [pH probe], [redox meter], [level switch], site glass liquid level indicator, and other connections as indicated or required. Reactor vessels are to be equipped with a minimum of [one] [_____] viewing port no smaller than [0.5] [_____] m [1.5] [_____] feet located [0.7] [_____] m [2] [_____] feet minimum above the bottom of the reactor. The viewing port must be covered with clear plastic material not susceptible to ozone degradation, with a minimum thickness of [10] [_____] mm [3/8] [_____] inch.

2.6 ELECTRICAL

Electrical products are to be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reactor vessels containing ultraviolet lamps are to be independently grounded.

2.6.1 Motors

Motors, all motor starters, and any control or signal wiring required for the operation of the specified equipment are to be provided and installed under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM unless otherwise specified herein, in other sections, or indicated on the drawings.

2.6.2 Local Controls and Panels

Manual or automatic controls, protective or signal devices required for the operation specified, and any control wiring required for controls and devices, provided. Enclosures for local power and control panels are to conform to NEMA ICS 6.

2.6.3 Ultraviolet Equipment Electrical Requirements

a. Provide a separate prewired power panel for each module.

b. Ground fault detection or independent ground will be standard with the UV lamp equipment.

c. Control and monitoring components are to be housed in NEMA enclosures. Internal components are to be sealed from the environment. System electronics to be used in an interior environment are to be housed in enclosures conforming to NEMA 250 TYPE 12. System electronics to be used in an exterior and corrosive environment, as defined in NEMA 250, are to be housed in enclosures conforming to NEMA 250 TYPE 4X.

d. Provide sufficient cooling to the medium and high temperature UV bulbs as well as associated ballasts to prevent overheating.

e. Wiring and electrical connections are to be protected against moisture and corrosive gases to prevent electrical shorts or failure. Electrical installation and materials are to conform to NFPA 70. The unit must be completely wired requiring only an external connection for a single external power supply and remote monitoring and control.

f. Interconnecting, multiconductor, unshielded cables must be suitable for outdoor installation. Insulation will be thermoplastic rubber with an operating range of minus 60 to 125 degrees C minus 75 to 260 degrees F with low temperature flexibility and flame retardants. UV stabilized jacketing must be resistant to oils, chemicals, fuels, solvents, and to mechanical abuse and abrasion. Cable must be supplied by the equipment manufacturer and be of sufficient length and number for a complete system.

g. Cableways provided are to be stainless steel, 1.98 or 1.59 mm 14 or 16 gauge thick.

2.7 AOP CONTROL SYSTEM

****

NOTE: Delete items within this paragraph that do not apply. Not all UV systems (especially those with low intensity lamps) have light intensity monitors; verify design requirements for type or need of lamps. Hydrogen peroxide monitoring on all but very large plants (larger than5.7 ML/day 1.5 MGD) will consist of tank level readings and an indication that the chemical feed pump is working. Coordinate with paragraph Alarms and Interlocks if separate audible or visual alarms beyond the control system specified are required, and their location.

If an autodialer is required, reference the controls and instrumentation section of the specification; or if none is included and an autodialer is required, include those requirements in this paragraph.

****

Equipment will be locally controlled and capable of receiving standard digital or analog control signals from the plant central control system. Provide status and adjustments to the equipment [locally] [and] [from the plant central control system]. Instruments are to be provided with mounting hardware as appropriate. Transmitters with digital outputs must be accurate to within [_____] percent. All equipment will be designed for operation on a 120 volts 60 hertz electrical input. Provide controls to remotely monitor [and adjust] [hydrogen peroxide delivery rate,] [oxygen] [air] [and ozone output,] [_____] [individual lamp failure,] [power on and off status for each lamp [ballast]] [ultraviolet lamp intensity]. [Provide each lamp with a nonresettable elapsed time meter with ability to record operable hours from 0 to 99,999].

2.7.1 Ozonation Control System

The ozonation control system must be interfaced with the plant central control system. Changes to the ozone generator equipment operating conditions are to be accomplished locally or from the master control panel. The power, control and instrumentation system provided as specified or as recommended by the ozone generator manufacturer for safe operation and supervision of the ozone generator and related gas feed equipment. Provide schematics and interconnecting wiring diagrams for power, control, and instrumentation circuits. Provide control power transformers, relays, adjustable timers, auxiliary contacts, switches, or additional equipment to interconnect the generator to other auxiliary equipment and master control panel, and control circuits as shown on schematic or instrument control drawings. An emergency stop button must be provided at the local generator control panel. The ozone generator must be protected from power surges, and variations in power supplied to the equipment.

2.7.2 Hydrogen Peroxide Feed

****

NOTE: Hydrogen peroxide metering rate is generally done manually with an interlock to shut the system down when a flow switch or other interlock at the AOP master control indicates a flow interruption. If a variable flow rate is anticipated, although rarely used, the hydrogen peroxide feed rate can be tied to the influent meter or AOP master control. Coordinate operation with Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS.

****

Conform hydrogen peroxide feed pump and control to the requirements of Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS.

2.7.3 Alarms and Interlocks

****

NOTE: Delete items in this paragraph that are not required.

Coordinate this paragraph with process and instrumentation diagrams (PIDs) and other specification sections. Metering accuracy for hydrogen peroxide is generally done manually. Indicate if separate audible or visual alarms beyond the AOP master control system are required, and their location.

****

Provide alarms and interlocks to ensure proper operation of the advanced oxidation equipment, and its sequenced shutdown based on potentially unsafe or improper conditions that may exist. The following paragraphs list alarms that (as a minimum) are to be monitored at the central control point, or that will initiate shutdown of the appropriate advanced oxidation equipment components.

2.7.3.1 AOP System

Failure of major equipment components such as lamps, ballasts, or safety interlocks must initiate system, followed by plant shutdown, if not acknowledged.

a. AOP system alarms and control interlocks are to be provided for the following items:

    (1) Lamp failure
    (2) Ballast failure
    (3) Safety interlocks for open door on reactor vessel or panel
    (4) High water temperature in AOP reactor vessel
    (5) Low water flow to the reactor vessel
    (6) Sleeve wiper failure
    (7) High pressure in reactor vessel headspace
    (8) [_____].

b. Submit the following data for the AOP System

    (1) Manufacturer's descriptive and technical literature; performance charts and curves, catalog cuts for specified equipment including: instrumentation and controls; capacities and pressure drop; model number; and installation instructions.

    (2) Materials of construction; inlet and outlet pipe sizes; power demand requirements; and ozone generator cooling water flow rate.

    (3) Spare parts data for each piece of equipment, current unit prices and source of supply.

    (4) Manufacturer's descriptive and technical literature; performance charts and curves, catalog cuts for specified equipment including: instrumentation and controls; capacities and pressure drop; model number; and installation instructions.

    (5) Materials of construction; inlet and outlet pipe sizes; power demand requirements; and ozone generator cooling water flow rate.

    (6) Spare parts data for each piece of equipment, current unit prices and source of supply.

    (7) Manufacturer's certificates stating that the equipment meets the specified requirements, and has been installed in accordance with the equipment manufacturer's requirements.

2.7.3.2 Metering Pump

Pump failure must initiate system, followed by plant shutdown, if not acknowledged. Metering Pump alarms and control interlocks are to be provided for the following items:

a. Hydrogen peroxide feed
b. Catalyst feed
c. Pump failure
d. [_____].

2.7.3.3 Hydrogen Peroxide Tank

Hydrogen peroxide tank [alarms] [and control interlocks] are to be provided for the following items:

a. High liquid level
b. Low liquid level
c. Low low liquid level
d. High temperature
e. High pressure
f. [_____].

2.7.3.4 Ozone System

Ozone system alarms and control interlocks are to be provided for the following items:

a. High dew point in gas feed to ozone generator
b. Over current to the power supply unit (PSU)
c. Over voltage to the PSU, rectifier, and inverter
d. Over frequency protection
e. High temperature shut down
f. High inlet gas temperature
g. High inlet cooling water temperature
h. High gas pressure to the generator
i. Insufficient gas flow to the generator
j. High outlet ozone gas temperature
k. High moisture level in control cabinet
l. [_____].

Major equipment component failure such as over current, over voltage, over frequency, high cooling water temperature or other condition that could damage the equipment or result in effluent non-compliance must initiate system, followed by plant shutdown, if not acknowledged.

2.7.3.5 Gas Feed System

Gas feed system alarms and control interlocks are to be provided for the following items:

a. High pressure across gas filters
b. High temperature in gas desiccant dryer
c. High pressure downstream of reducing valves
d. Air preparation system failure
e. Ozone monitor failure
f. [_____].

Major equipment component failure, such as high cooling water temperature, air preparation failure, or other condition that could damage the air feed or ozone equipment, or result in effluent non-compliance must initiate system, followed by plant shutdown, if not acknowledged.

2.7.3.6 Ozone Destruct System

Ozone destruct system alarms and control interlocks are to be provided for the following items:

a. High ozone in ambient air space
b. High gas flow rate to destruct unit

c. Low temperature in ozone destruct unit
d. High ozone in destruct unit exhaust gas
e. Ozone destruct system failure
f. High ozone concentration in off gas
g. Destruct system failure
h. [_____].

Health and safety ambient ozone level non-compliance must initiate ozone system alarm and shutdown, followed by overall plant shutdown, if alarm is not acknowledged (high ambient ozone levels will not shutdown the ozone destruct system concurrently with other processes).

2.7.3.7 Cooling Water System

Cooling water system alarms and control interlocks are to be provided for the following items:

a. Cooling systems failure
b. High water temperature
c. No/low cooling water flow
d. Pump failure
e. [_____].

Major equipment component failure such as no/low cooling water flow, pump failure or other condition that could damage the gas feed, ozone equipment or result in effluent non-compliance must initiate ozone generator, followed by plant system shutdown, if not acknowledged.

2.7.3.8 Metering Accuracy

Metering accuracy alarms and control interlocks are to be provided for the following items: Ozone and Hydrogen Peroxide

2.7.3.9 Ground Fault

Provide a ground fault protection alarm.

2.8 SPECIAL EQUIPMENT AND TOOLS

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment. Provide a tube cleaning rack or racks with adequate capacity to hold [50] [100] percent of the dielectric tubes from the ozone generator being serviced. Equip each rack with locking casters to allow the rack to be easily moved between the ozone generator and the location where the dielectric tube cleaning will occur. Each dielectric is to be provided with an individual padded holder.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work. Compare the limits of work for the equipment supplied to field conditions to ensure the limits previously identified for piping, electrical and control interfaces meet the actual physical requirements at the facility. Bring any discrepancies to the attention of the Contracting Officer for correction.

3.2 PREPARATION

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NOTE: This paragraph covers actions required to physically prepare the surface, area, or site to incorporate the specified primary products.

****

Provide the reactor vessel, [ozone and feed gas equipment,] [hydrogen peroxide storage and feed system,] [electrical support equipment,] and [_____] with an equipment pad isolated from the floor slab [as detailed on the drawings] [adequate to properly support the equipment]. Reinforced concrete are to be designed and installed in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Prior to placing ozone piping, or other equipment, into service it is to be cleaned by one of the methods specified in CGA G-4.1. Piping and equipment used to store or feed hydrogen peroxide must be passivated in accordance with the hydrogen peroxide supplier's requirements.

3.3 EQUIPMENT INSTALLATION

Perform the equipment installation as indicated on the drawings, shop drawings, manufacturer's instructions and recommendations. Piping, valves, fittings, and appurtenances are to be installed in accordance with the manufacturers recommendations, as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE, or as otherwise indicated. All valves, fittings, meters and other appurtenances are to be given unique identification numbers corresponding to those used in operation and maintenance manuals, and in AOP submittals prepared. Identification numbers are to be placed on brass identification tags and securely fastened to all valves, fittings, meters and other appurtenances. Tags are to be no less than 38 mm 1-1/2 inches in diameter with depressed black figures 13 mm 1/2 inch high. Piping for wet ozone service must be PVDF, stainless steel, or PTFE. Piping for dry ozone service must be PVDF, stainless steel, or PTFE. Oxygen Piping will be copper or stainless steel. Hydrogen peroxide piping is to be stainless steel, PTFE or PVDF. Oxygen piping will [be insulated in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS] [not be insulated].

3.4 ELECTRICAL WORK

Perform electrical work in accordance with the drawings and applicable requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Equipment is to be appropriate for continuous duty, and installation in a dusty, humid and corrosive environment. Electrical equipment and wiring must comply with NFPA 70.

3.5 TOOLS

Provide tools to the Contracting Officer prior to the onsite training identified in paragraph FIELD TRAINING.

3.6 PAINTING/CORROSION PROTECTION

All ferrous surfaces are to be coated or painted. Color will be as indicated on the paint schedule or as otherwise approved. Factory painted items are to be touched up as needed. Factory painted items requiring touch up in the field are to be thoroughly cleaned of all foreign material, primed and top coated with the manufacturer's standard factory finish in accordance with the manufacturer's recommendations, including dry finish thickness. Equipment which did not receive a factory finish must be painted in accordance with the requirements indicated in Section 09 90 00 PAINTS AND COATINGS. Painting corrosion resistant metals such as brass, bronze, aluminum, copper, galvanized steel and stainless steel is not required unless otherwise specified.

3.7 CHEMICALS

****

NOTE: Coordinate these requirements with other specifications which may address extended operation and maintenance occurring in some HTRW Projects. If other supplies such as catalysts are required, include that information as well.

****

Provide the chemicals needed to do all the operational and start up testing, and completely refill the [oxygen], [hydrogen peroxide], [catalyst], [_____] tanks at the time of contract completion.

3.8 WELDING

****

NOTE: Use second set of brackets when critical pipe welding is required.

****

[Piping will be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders are to be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests. Structural members are to be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures for piping will be as specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

3.9 SAMPLING AND ANALYSIS

Perform sampling, analysis, and sample turn around time to demonstrate system performance and effluent compliance. Submit a commissioning/demonstration plan for approval to ensure the equipment meets the standards indicated. Coordinate this plan with other plans and unit operations to ensure they do not conflict and the AOP system is ready for testing. Coordinate and obtain regulatory approvals prior to notifying the contracting officer that the equipment is ready for testing.

3.9.1 Plan Details

The plan will include a detailed description of proposed sampling and analysis required to document system performance. A plan detailing the sampling locations, frequency, analytical protocols, and duration which will ensure the equipment complies with the standards indicated. Submit the plan to the Contracting Officer [_____] [30] days prior to equipment start up. Coordinate work within this section with other sections to ensure upstream and downstream unit processes are complete and operational prior to startup/commissioning the AOP unit.

3.9.2 Plan Calculations

Include the following calculations in the commissioning/demonstration plan.

a. Headloss calculations through the process units at the design flow rate, including headloss calculations for associated compressed air and pumping systems.

b. Oxidant demand and subsequent AOP unit sizing.

c. Electrical usage rate.

d. Removal performance and material mass balance.

e. Chemical feed requirements and equipment sizing.

f. Diffuser system layout, mass transfer calculations.

3.9.3 Chemical Sampling

The chemical parameters identified in paragraph PERFORMANCE REQUIREMENTS [and ambient and ozone off-gas destruction concentrations] are to be sampled [daily] [_____], monitored [at the locations identified on the drawings] [at the locations indicated in the startup/commissioning plan] for [7] [_____] days of continuous 24 hour operation, using analyses with detection limits one order of magnitude lower then the levels indicated in paragraph PERFORMANCE REQUIREMENTS.

3.10 POSTING FRAMED INSTRUCTIONS

Post framed instructions containing wiring and control diagrams, under glass or in laminated plastic, adjacent to the equipment or where otherwise directed before acceptance testing of the system. Condensed operating instructions, prepared in typed form, are to be framed as specified above and posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

3.11 FIELD TESTS AND INSPECTIONS

****

NOTE: These tests are required for installed or completed work; they are different and separate from those required for materials and products prior to installation or application. Delete tests not applicable or required.

Provide in this section a reference to the plant commissioning or start-up specification which includes the processes in the treatment facility.

****

Accessories such as the [UV equipment,] [ozone generator,] [compressor,] [ozone generator gas feed equipment,] and [_____] are to be factory tested prior to shipment to the job site.

3.11.1 AOP Reactor Vessel

The AOP reactor vessel and attached appurtenances are to be assembled at the factory and an operational test of all components accomplished prior to shipment. Certification that the equipment and components assembled at the factory are operational and meet the specification requirements are to be provided to the Contracting Officer a minimum of [10] [_____] calendar days prior to shipment. Components not assembled at the factory aresubject to the same tests and inspections prior to onsite leak testing using potable water. Following installation at the project site, and prior to leak testing, retest the AOP system to ensure the equipment and auxiliary components act as a complete and operational system. This will include operation of all valves, pumps, blowers, analyzers, alarms, meters, interlocks, monitors, level and pump controls, sensors, switches, off gas destruct equipment and all other equipment associated with the AOP system. Complete testing prior to leak testing and written notification provided to the Contracting Officer stating the equipment is working in accordance with the contract documents and manufacturer's recommendations prior to the commencement of leak testing.

3.11.2 Diffuser or Injector System

Pressure test the entire gas piping system with dry air or oxygen at a minimum of [two] [_____] times the normal design pressure for a minimum of 60 minutes and such additional time as required for the Contractor to inspect the piping system for leaks. All leaks are to be repaired and the system retested until no leakage is detected. Do not introduce ozone into the system until all leaks have been identified, repaired, and the system retested. [Diffusers] [Injectors] are to be installed in accordance with the suppliers recommendations. After installation, the [diffusers] [injectors] are to be covered with clear water to a depth of approximately [1] [_____] m [3] [_____] feet. Dry air or oxygen must be released through the [diffusers] [injectors] and the system are to be inspected for uniform air or oxygen distribution throughout the reactors. Following the initial testing at [1] [_____] m [3] [_____] feet, the distribution testing must be repeated at a water depth of [3] [_____] m [9] [_____] feet to ensure bubble distribution is adequate throughout the reactor. [Diffuser] [Injector] replacement or repositioning must be accomplished as required to maintain uniform air distribution throughout the reactor. If after repositioning, air distribution throughout the reactor lacks uniformity, additional redistributors or deflectors are to be installed in the reactor as recommended by the [diffuser] [injector] supplier to accomplish uniform flow distribution throughout the reactor.

3.11.3 Leak Testing

Leak testing must be accomplished at the factory to verify the integrity of the reactor vessels and associated gas and liquid piping. The factory leak test are to be accomplished on the reactor vessel and appurtenances following assembly at the factory. Onsite hydrostatic leak testing will include all piping between the upstream and downstream processes, and be accomplished using potable water at a pressure 1.5 times the working pressure, or 350 kPa 50 psi unless otherwise approved by the Contracting Officer. The reactor vessel and appurtenances are to be isolated from the connecting piping and retested for leaks using potable water following assembly at the site. The ozone generator gas connections are to be tested with dry air or oxygen at the maximum pressure allowed by the manufacturer, or as identified in the previous paragraph. Any gas or liquid leaks identified during the aforementioned testing must be repaired and the system retested until the systems are free of leaks.

3.11.4 Control Panel

A local control panel functionality test are to be performed and approved by the Contracting Officer prior to commencement of leak testing or testing using oxidizers. The central control testing must be accomplished prior to overall plant startup.

3.11.5 Ozone Generation System

****

NOTE: The installer or manufacturer should demonstrate the operation and efficiency of the equipment. Power consumption for ozone generation should be less than 10 kWhr per 0.5 kg pound of ozone generated assuming a PSA oxygen feed system is used to generate a 10 percent ozone feed; verify this with multiple equipment suppliers based on the specific ozone application pressures to be used, gas feed, and applied ozone concentration.

****

The ozone generation system must be tested to ensure that the actual ozone production, power usage, or water consumption rates meet recommended requirements. Power usage must be measured after achieving steady state conditions as determined by the ozone generator supplier. Power usage must be measured at the central motor control center or at each individual component including the [air dryer,] [refrigerant driers,] [desiccant driers,] [oxygen generator,] ozone generator, cooling water pumps, and master control panel. Power usage must be within [5] [_____] percent of [_____] kWh per kg pound of ozone generated at 100 percent of rated capacity. Also measure cooling water supply. Cooling water consumption rate are not to exceed [_____] L/s gpm at the parameters listed in paragraph Ozone Generator System by more than [5] [_____] percent. If the equipment does not meet the specified consumption rates, make the necessary system revisions to meet the rates specified at no additional cost to the Government. Power usage must also be evaluated at 25, 50, and 75 percent of the design production rate.

3.12 MANUFACTURER'S SERVICES

****

NOTE: Use this paragraph when manufacturers are to provide field quality control with onsite personnel for instruction/supervision of the installation or application of their products, or for startup or demonstration.

This paragraph covers requirements of the installer or manufacturer to demonstrate the operation and maintenance of equipment to the owner's personnel.

****

Provide a manufacturer qualified service representative, experienced in the installation, adjustment, operation and maintenance of the equipment specified, for a minimum of [3] [_____] days to supervise the installation, adjustment, testing, and to provide instruction in the operation, and maintenance of the equipment. If major components from multiple suppliers are provided, such as an [ozone generator] [air preparation system] [oxygen preparation system] [ozone destruct system] [_____], each supplier isrequired to visit the site a minimum of [1] [_____] times during equipment installation or startup. During the startup and [one] [_____] years operating period, the major equipment suppliers are required to be onsite [2] [_____] times to verify that the equipment is installed and operates properly, and to provide trouble shooting and technical assistance.

3.13 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. The training will include operation of individual components as well as the integrated system, maintenance needs and procedures, instrument calibration, safety issues and emergency procedures, control and alarm features, troubleshooting equipment and control problems, and laboratory analytical procedures. Training will be provided during normal working time and will start after the system is functionally complete but prior to performance testing. Field training must cover all of the items contained in the operating and maintenance manuals. Each major equipment vendor including, but not limited to, the ozone generator, ozone destruct system, ozone monitoring system, and gas feed system is required to provide two [8] [_____] hour periods of classroom and hands-on operating instruction to the individuals selected by the Contracting Officer. The first period will be at system startup and the second [as defined by the Contracting Officer] [at the end of the Contractor's operating contract, prior to turning over to the long term facility operator]. Upon completion, submit certificates indicating the designated personnel have received training specified and have successfully operated the installed AOP equipment.

3.14 MAINTENANCE

3.14.1 Extra Materials

****

NOTE: Delete inapplicable portions of these paragraphs. Coordinate this section with other sections of the specifications to ensure there are not conflicts regarding supplying consumables. Verify the duration of the initial operating period, which is generally 1 year.

****

Furnish the initial supplies to fill the vessels, as well as all consumables during the startup, prove out, and initial operation period. At the time the Contractor turns the plant over to the long term Operation and Maintenance Contractor, the vessels storing consumables such as LOX, hydrogen peroxide [and] [_____] are to be refilled within [two] [five] days prior to the plant turn over.

3.14.1.1 Lamps

Provide a complete set of lamps reserved for change out by the equipment supplier following the one year warranty period. This extra set of lamps are to be delivered to the treatment facility 60 days prior to the end of the one year warranty period and installed by the Contractor. Lamp replacement during the one year warranty period is to be provided by the supplier, as needed by the Contractor.

3.14.1.2 Spare Parts

The supplier must provide, in addition to the lamps specified above, a minimum of ten percent of each of the following items, or a minimum of two, whichever is greater:

a. Lamp ballasts

b. Quartz sleeves

c. End seals

d. Socket connectors

e. O-rings

f. Quartz sleeve cleaners

g. Diffusers

h. Rotometers

i. Generator dielectrics

j. Generator dielectric fuses

k. pH probe element

l. ORP probe element

3.14.2 Maintenance Service

****

NOTE: Delete this paragraph if UV lamps are not used. The designer may want to provide additional information regarding lamp change out if the system is limited to a certain lamp type. Medium pressure lamps have an approximate life of 3 to 4000 hours, while low pressure lamps have an approximate life of 7 to 10000 hours; certain proprietary, high intensity lamps may have a life less than 2000 hours.

****

Changing out lamps, ballasts, and quartz tube wipers, at the frequency recommended by the manufacturer during the one year warranty period or as otherwise required, is Contractor's responsibility. Lamps and ballasts supplied as specified below, are to be provided in addition to the complete set supplied for installation (following the warranty period) and those installed as needed during the warranty period. The ozone generator dielectrics are to be cleaned in accordance with the manufacturer's recommendations immediately prior to the conclusion of the Contractor's operating period; or after one year, if greater than one year after startup, and at the conclusion of the Contractor's operating period.

3.14.3 Operating Instructions

Submit [six] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system start-up, operation and shutdown, routine maintenance, potential breakdowns and repairs, and troubleshooting. The instructions are to include drawings and schematics of the system as installed. The instructions are to include the manufacturer's name, model number, service manual parts list and brief description of all equipment and their basic operating features. The instructions are to include, but not be limited to, the following:

a. System layout showing piping, valves and controls, process flow diagrams, piping and instrumentation diagrams with all valves, meters, and similar units identified.

b. Approved wiring and control diagrams prepared in accordance with ANSI/ISA 5.1 including a drawing index, legend and symbols list, and abbreviations and identifiers.

c. A control sequence describing startup, how to make adjustments to the equipment during operation, standard and emergency shutdown procedures.

d. Operating and maintenance instructions for each piece of equipment, including lubrication instructions and other periodic maintenance and inspection information as well as trouble shooting guides.

e. Manufacturer's bulletins, cut sheets and descriptive data, parts lists, and recommended spare parts, and sources of supply for all major pieces of equipment.

-- End of Section --

****
USACE / NAVFAC / AFCEC **UFGS-46 31 11 (August 2017)**

Preparing Activity: USACE **Superseding**
UFGS-43 32 76 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-46 31 11 (August 2017)**

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SECTION 46 31 11

CHLORINE GAS FEED EQUIPMENT

08/17

****

NOTE: This guide specification covers the requirements for chlorine feeding equipment for the treatment of water or sewage.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A587	(2022) Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM F441/F441M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC)

	Plastic Pipe, Schedules 40 and 80

CHLORINE INSTITUTE (CI)

CI Pamphlet 1	(2023) Chlorine Basics, Edition 7
CI Pamphlet 6	(2020) Piping Systems for Dry Chlorine, 17th Edition

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

30 CFR 72	Health Standards for Coal Mines

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, [_____]

SD-03 Product Data

Framed Instructions

Manufacturer's Descriptive Data

Technical Literature

Performance Charts And Curves

Catalog Cuts

Installation Instructions

Equipment And Material; G, [_____]

SD-06 Test Reports

Operating Test; G, [_____]

SD-07 Certificates

Service Organization

Spare Parts; G, [_____]

SD-10 Operation and Maintenance Data

Operating Manuals

Maintenance Manuals

1.3 MAINTENANCE MATERIAL SUBMITTALS

1.3.1 Auxiliary Equipment and Spare Parts

****

Note: Delete any items listed below that are not required. Designer must specify, in addition to the list provided below, what additional device or devices are required to be provided by the contractor in the performance of this contract to ensure that the user of the equipment is able to measure the desired analytes that are being distributed by this system.

****

Furnish auxiliary equipment and spare parts as follows:

a. One spare flow rate indicator for each machine.

b. One flexible tank connection for each machine, except where the machine is direct cylinder-mounted.

c. Three each of all special gaskets to fit all joints and unions.

d. One set of all necessary hose clamps to suit all hose connections.

e. Fifty cylinder valve gaskets.

f. One 118 mL4 ounce bottle of ammonia.

g. Stationary metal platform scale without wheels, with a capacity of [2][4][_____] chloride containers of [1][2][_____] kgpounds size and of the [dial][beam] type.

h. [[1][2][_____] air-purifying respirators, with cartridges conforming to 30 CFR 72; Subpart 710.] [[_____] self-contained air breathing units.]

i. [1][2][_____] residual-chlorine comparator of a type employing permanent color standards and 13- or 26-millimeter viewing-depth sample tubes, with corrosion-resistant case, a color disk reading from 0.0 mg/L to [_____] mg/L, and sufficient DPD tablets for 100 tests. Provideresidual chlorine comparators that meet EPA requirements.

j. [1][2][_____] emergency repair kit for chlorine cylinders.

k. [1][2][_____] emergency repair kit for chlorine [1][_____] metric ton ton containers.

1.3.2 Special Tools

For each type of equipment furnished provide:

a. Special tools necessary for adjustment, operation, maintenance, and disassembly.

b. A grease gun or other lubricating device for each type of grease required.

c. One or more steel cases mounted on the wall complete with flat key locks, two keys, and clips or hooks to hold each tool in a convenient location. Provide high-grade, smooth, forged, tools fabricated from alloy tool steel. Provide lever type grease guns. Deliver tools at the same time as the equipment and hand over on completion of the work.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a chlorine feed system for the treatment of sewage effluent or potable water systems. Provide system consisting of chlorine feed pump, controls, cylinder connections, gauges, meters, etc. as described in the following paragraphs.

2.1.1 Standard Products

Provide equipment and material which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least [2 years prior to bid opening][2 years prior to issuance of Request for Proposal]. A service organization that is, in the opinion of the

Contracting Officer, reasonably convenient to the site must be proposed to support all equipment.

2.1.2 Nameplates

Secure a plate to major equipment items containing the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.1.3 Miscellaneous Supports

Provide bolts, nuts, anchors, washers, and all other types of supports necessary for the installation of the equipment which are fabricated of galvanized steel, cadmium plated steel, or Type 316 stainless steel.

2.1.4 Submittal Data

Submit a complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Submit a list of Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [1][3][_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1][and][3] year(s) of service.

2.1.5 Material Compatibility

Supply materials that are compatible with the concentration of solutions to which they are exposed. It is the contractor's responsibility to ensure all supplied materials are compatible within all submitted products.

2.1.6 Factory Painting

Use factory paint which conforms to manufacturer's standard factory finish.

2.2 CHLORINE-FEEDING MACHINE

Select components for the machine for the treatment of [water][sewage] by the application of chlorine [solution][gas] against a [positive][negative] head of [_____] mmfeet using the facility's system for operation of the machines under a variation in pressure from [_____] minimum to [_____] maximum kPapsi. The chlorine-feeding system consists of controls and devices necessary for a complete operating system including a chlorine pressure gauge or other device that indicates loss of chlorine pressure, a chlorine pressure-reducing valve, a meter with rate-of-flow, injector, pressure-relief valves, water-pressure gauges, water strainers, backflow preventer and water-pressure regulator if required.

2.2.1 Mounting

Provide each chlorine-feeding machine with means for [direct cylinder mounting][wall mounting][floor mounting on a panel or in a cabinet] so that the chlorine gas feed rate control is under [a vacuum][pressure] when the machine is in operation. [Mix chlorine gas with liquid after being measured through the meter.]It is essential that the chlorine feeding machine function accurately regardless of normal variations in pressure in the chlorine cylinders[and in the liquid pressure operating the machines].

2.2.2 Protection of Components

Automatically protect the machine against flooding or damage in the event of a failure of the chlorine supply so that under operating conditions it is not possible for water to get back into the chlorine inlet line or dry-gas control parts. Provide parts subject to contact with chlorine made of materials resistant to the action of chlorine at the pressures and concentrations that could be encountered. Construct a system as simple as practicable that provides reliable service and is readily accessible for inspection, cleaning, adjustment, repairs, and replacements.

2.2.3 Capacity

****

NOTE: Choose chlorine feed capacity based on minimum and maximum chlorine requirements required by chemical analysis to treat water fed through the system.

****

Provide Chlorine-feeding machines capable of delivering chlorine from a minimum of [_____] kgpounds to a maximum of [_____]kgpounds in 24 hours while operating continuously at rated capacity.

2.2.4 Chlorinator Controls

Provide [fully automatic][semiautomatic][program control][manually-adjusted] type chlorine-feeding machine. [All fully automatic machines are to be equipped to receive standard 4-20 mA control signals.] [Fully automatic controls consist of devices with accessories to adjust continuously the rate of chlorine feed automatically in direct proportion to [flow][and][chlorine residual][to compensate for changes in the chlorine demand] of the [water][or] [sewage]being chlorinated. Acceptable controls are not to require manual attention other than adjustment of the required chlorine residual.] [Semiautomatic controls consist of devices with accessories to start and stop the chlorine-feeding machine automatically with the starting and stopping of the [water][or][sewage] being chlorinated or with a timer mechanism.] [Program control consists of a device with accessories to change the chlorine feed rate of the machine automatically according to a predetermined cycle.] [Manual controls consist of adjustment and indicating devices for regulating the chlorine dosage manually. Provide manually adjusted types that are capable of receiving standard 4-20 mA control signals by the addition of an automatic control device.]

2.2.5 Cylinder Connections

Provide cylinder connections for attaching standard chlorine cylinders to the chlorine-feeding machines. Connections include flexible metal tubing, an auxiliary valve for each chlorine cylinder, a manifold for connecting [2][4][_____] cylinders to each chlorine-feeding machine, and other necessary fittings, unless the machine is direct cylinder-mounted.

2.2.6 Switchover Valves

Supply two or more mechanically operated or loss of chlorine supply-operated automatic gas switchover valves to automatically regulate chlorine gas [pressure] [vacuum] and install [in the gas header] [directly on the chlorine cylinders]. Size the switchover valves appropriately and equipped with filters [and traps]. Factory set the switchover [pressure] [vacuum].

2.2.7 Chlorine Pressure Gauges

Supply chlorine pressure gauges, when applicable, of the diaphragm type with the Bourdon tube and diaphragm compartments filled completely with suitable oil. Construct the gauge on the line from the chlorine tank to indicate accurately the pressure of chlorine gas as supplied from the gas tank to the chlorine feeder.

2.2.8 Chlorine Pressure-Reducing Valves

Provide chlorine pressure-reducing valves that reduce the pressure of the gas and maintain the pressure constant for any given setting of rate of feed regardless of changes in the cylinder pressure.

2.2.9 Vacuum and Chlorine Relief

Provide vacuum and chlorine relief to limit the vacuum within the chlorine-feeding machines and provide for the release to a suitable vent to the outside atmosphere of any chlorine gas pressure build-up in the parts of the machine, normally under vacuum, through improper functioning of the equipment. A vacuum sealing valve which seals off the system when excessive vacuum is present may be substituted for the vacuum relief valve.

2.2.10 Chlorine-Metering Devices

Furnish chlorine-metering devices in sufficient numbers to cover properly the range specified. The chlorine feed rate control system must maintain the feed rate within 4 percent of the indicated rate.

2.2.11 Injectors

Provide injectors with the chlorine-feeding machines to receive all chlorine and solution water and to discharge the resulting solution to the points of application. Introduce the chlorine solution into the [water][or][sewage] main by means [of a [ceramic][hard rubber][or][plastic]injection nozzle] [of a suitable diffuser tube inserted into the main through a corporation cock].

2.2.12 Alarm Actuators

Equip each chlorine-feeding machine with alarm actuators to indicate loss of vacuum and excess vacuum. Provide alarm actuators for low chlorine gas pressure and high chlorine gas pressure, unless the chlorine-feeding machine is direct-cylinder mounted. [Also, provide a solution water low pressure alarm actuator.]

2.2.13 Pumps

Provide a pump for each chlorine-feeding machine when the minimum water pressure specified is below that required for satisfactory operation of the machine. Provide hydraulically operated or electric motor-drive pumps. The electric motor will be rated for [_____]-volt, [_____]-phase, [_____]-Hz ac, and a maximum speed of [_____] rpm. Equip the pump with a suitable starter in accordance with the type of control specified.

2.3 EVAPORATORS

****
NOTE: Delete this paragraph in its entirety for installations where chlorine withdrawal rates will not exceed chlorine gasification rate.
****

Evaporators are required whenever gas withdrawal rates exceed the rate at which liquid chlorine gasifies at the operating temperature. Provide water immersed tank heat-exchanger evaporators suitable for evaporating liquid chlorine complete with controls and devices for a complete operating system including: Vaporizing chamber, electric water heaters, water temperature thermostat and indicator, high and low water temperature alarm actuators, water-level gauge, automatic make-up water control system, low water alarm actuator, chlorine gas temperature, and pressure gauges, [make-up water visual flow-indicator], ammonia-type flanged connections for chlorine inlet and outlet, drain and vent line connections, and cathodic protection system with ammeter. Provide parts which are subject to contact with chlorine made of materials resistant to the action of chlorine at pressure and concentrations that could be encountered. Construction is to be as simply as practicable to provide reliable service and to be readily accessible for inspection, cleaning, adjustment, repair and replacement.

2.3.1 Capacity

Provide evaporators with a capacity to convert [_____] kgpounds per day of liquid chlorine into gaseous state.

2.3.2 Vaporizing Chamber

Provide a vaporizing chamber constructed of steel and designed to conform to ASME BPVC SEC VIII D1. Test the chamber hydrostatically at 5.5 MPa800 psig minimum. Protect the gas chamber and water bath tank from cathodic corrosion. Provide insulated, galvanized tank to conform to ASTM A153/A153M.

2.3.3 Water Heaters

Design the water heaters for operation on a 3-phase, 60-Hz current of the voltage indicated. Include a vapor-sealed magnetic contactor for handling the current to the heaters. The holding coil is to be rated for single-phase, 60-Hz current.

2.3.4 Switchover System

Supply a liquid chlorine automatic switchover system to automatically change to reserve supply when the on-line liquid chlorine supply runs out.

2.3.5 Pressure-Relief System

Equip each evaporator with a chlorine pressure relief system located downstream of the gas outletwith the following features:

a. Rupture disk with 1.7 MPa250 psig minimum rating.

b. Pressure switch protected by a diaphragm seal and actuated at 137.9 kPa 20 psig.

c. Self-reseating pressure relief valve with manufacturer's standard pressure rating, set for a pressure compatible with the respective rupture disk rating figure.

2.4 PIPING

2.4.1 Water Piping

Provide galvanized steel water piping conforming to ASTM A53/A53M or provide copper tubing conforming to ASTM B88M ASTM B88. Malleable-iron unions and fittings for installation of steel pipe are to conform to ASME B16.3.

2.4.2 Chlorine Piping

Provide chlorine solution piping smaller than 40 mm1-1/2 inches in diameter made of [PVC pipe conforming to ASTM D1785 or CPVC pipe conforming to ASTM F441/F441M] [rubber hose]. Provide piping of 40 mm1-1/2 inches in diameter or larger made of [plastic pipe] [rubber hose] [rubber-lined] [plastic-lined steel pipe]. Line steel pipe smaller than 150 mm6 inches with plastic lining not less than 3.2 mm1/8 inch thick; and for steel pipe larger than 150 mm6 inches, it cannot be less than 4.8 mm3/16 inch thick. Provide plastic fittings for plastic pipe with [flanged] [threaded] joints. Provide joints for rubber hose that use a clamp-type mechanical coupling. Provide lined steel pipe that is [threaded] [flanged integral with the pipe] [forged-steel flanges screwed to the pipe barrel]. Provide fittings for steel pipe which are [flanged conforming to ASME B16.1 or ASME B16.5] [forged-steel threaded conforming to ASME B16.11] and are compatible with lined steel pipe.

2.4.2.1 Piping for Dry Chlorine

****

NOTE: Selection of chlorine-gas piping is dependent on the service for which the system is designed. The designer will consult the Chlorine Manual and CI Pamphlet 6, Piping Systems for Dry Chlorine for applicable piping system.

****

Ensure piping for dry chlorine conforms to CI Pamphlet 1 and CI Pamphlet 6. [Ensure steel pipe 19 through 40 mm3/4 through 1-1/2 inches in diameter conforms to [ASTM A106/A106M, Schedule 80, Grade A or B][or][ASTM A587]. Ensure steel pipe over 40 mm1-1/2 inches in diameter conforms to ASTM A53/A53M, Schedule [40][80], Grade [E][or][S]. Fittings for steel pipe are to conform to CI Pamphlet 6]. [Provide seamless copper tubing conforming to ASTM B88MASTM B88 in the annealed state with Type K wall thickness or heavier. Provide fittings for copper tubing in accordance with CI Pamphlet 6.] If moisture may be present, provide piping smaller than 40 mm1-1/2 inches in diameter made of [polyvinylidene fluoride][polyvinylidene fluoride lined steel pipe]; if piping is larger than 40 mm1-1/2 inches in diameter, provide polyvinylidene fluoride lined steel pipe. For piping for dry or moist chlorine gas under vacuum provide chlorinated polyvinyl chloride piping.

2.4.2.2 Piping for Liquid Chlorine

Specify piping for liquid chlorine free of moisture the same as for dry chlorine gas under pressure. Whenever a portion of the liquid chlorine piping can be isolated between two closed valves, protect that portion with a liquid chlorine expansion chamber.

2.4.3 Cylinder Connections

Use cylinder connections made of flexible metal tubing of required size cadmium-plated copper. Install flexible cylinder connector assembly with lead-gasketed, naval-bronze fittings.

2.5 ELECTRICAL WORK

Provide electric motor-driven equipment, and wiring per Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ratings will be as indicated. Provide motor starters complete with thermal-overload protection and other appurtenances necessary for motor controls specified. Provide mannual or automatic control and protective or signal devices required for controls and devices. Prewire all electrical connections at junction terminal boxes and at contactor-starter unit enclosures.

PART 3 EXECUTION

3.1 INSTALLATION

Submit detail drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show on the drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

3.1.1 Chlorine-Feeding Equipment

Install the chlorine feeding machines, [the evaporators] and all equipment appurtenances in accordance with CI Pamphlet 1 and CI Pamphlet 6 so as to provide a complete and integrated system in accordance with the instructions of the manufacturer [and under the direct supervision of the manufacturer's representative].

3.1.2 Pipe, Tubing, Hangers, and Supports

Install pipes and tubes in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

After installation of the chlorine-feeding machine [and evaporators] is complete, perform an operating test at design system flow rates and pressures to assure that the chlorine-feeding installation operates properly. Test all piping hydrostatically and for leaks. No leaks are allowed in piping. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

Submit test report in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

3.2.2 Manufacturer Field Service

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified, to supervise the installation, adjustment, and testing of the equipment.

3.3 Field Painting

Paint equipment which did not receive a factory finish as specified in Section 09 90 00 PAINTS AND COATINGS. Follow manufacturers' recommendations for number of coats, primer and paint type and thickness. Thoroughly clean factory painted items requiring touching up in the field of all foreign material and prime and topcoat with the manufacturer's standard factory finish (provided it does not discolor in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) condition)s. Provide coating that is not less than 0.05 mm1.78 mils thick.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Training

Conduct a field training course for designated operating staff members conducted by the manufacturer's representative and provided for a total period of [8][16][_____] hours of normal working time. Start after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the operating and maintenance instructions during field training.

3.4.2 Operating Manuals

Submit complete copies of operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.

3.4.3 Maintenance Manuals

Submit complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the instructions gas pipe layout, liquid chlorine pipe layout, dilution liquid pipe layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

3.4.4 Framed Instructions

Post framed instructions, containing wiring and control diagrams, where directed. Post operating instructions as discussed in the Operating and Maintenance Manual. Post the framed instructions before acceptance testing of the systems.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-46 43 21 (February 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-46 43 21 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-46 43 21 (February 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-46 43 21 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 46 43 21

CIRCULAR CLARIFIER EQUIPMENT

02/20

****

This guide specification covers the requirements for circular clarifiers for use in Water Resource Recovery Facilities (WRRFs). This guide specification may be used to prepare specifications for either primary or secondary clarifiers for the treatment of domestic wastewater only. Special consideration must be given to wastewater containing industrial wastes.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Show the following on the project drawings or provide:

1. Type of clarifier: primary or secondary

2. Dimensions of clarifier tank

3. Whether clarifier is a center feed with peripheral overflow type or a peripheral feed with center overflow type

4. Whether influent enters through side of tank or through center column when clarifier is center feed with peripheral overflow type

5. Whether rapid sludge removal system is to be used and the number and size of the sludge uptake pipes

6. Size of influent well when clarifier is a center feed with peripheral overflow type

7. Size and section of effluent trough when clarifier is a peripheral feed with center overflow type

8. Size and section of weirs and baffles; and anchorage details

9. Sizes of piping, points of connection to plant piping, and types of joints for wall castings and sleeves

This guide specification may be used to prepare specifications for either primary or secondary clarifiers.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
AGMA 2011	(2014B) Cylindrical Wormgearing Tolerance and Inspection Methods
AGMA 2015/915-1	(2002A) Accuracy Classification System - Tangential Measurement Tolerance Tables for Cylindrical Gears
AGMA 9002	(2014C) Bores and Keyways for Flexible Couplings (Inch Series)
AGMA ISO 10064-6	(2010A) Code of Inspection Practice - Part 6: Bevel Gear Measurement Methods
AGMA ISO 17485	(2008A; Supplement 2008) Bevel Gears - ISO System of Accuracy (Including Supplement - Tolerance Tables 2008)
ANSI/AGMA 6013	(2006A; R 2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6034	(1992B; R 2010) Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)
ANSI/AGMA 9000	(2011D) Flexible Couplings - Potential Unbalance Classification

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B17.1	(1967; R 2017) Keys and Keyseats
ASME B17.2	(1967; R 2017) Woodruff Keys and Keyseats

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C111/A21.11	(2023) Rubber-Gasket Joints for

	Ductile-Iron Pressure Pipe and Fittings
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Circular Clarifier System; G, [_____]

SD-03 Product Data

Clarifier Mechanism; G, [_____]

Grout Materials; G, [_____]

Electrical Control System; G, [_____]

SD-07 Certificates

Warranty

Gears

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

SD-09 Manufacturer's Field Reports

Circular Clarifier Mechanism; G, [_____]

SD-10 Operation and Maintenance Data

Circular Clarifier, Data Package 3; G, [_____]

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meetings

****

NOTE: Conduct a regulatory review to determine impact of new and existing permit conditions and regulations; coordinate with Environmental Services Group to determine permitting responsibility.
Design separator in accordance with UFC 3-240-01.
Ensure compliance with NPDES permits.

****

Coordinate with the Government for environmental concerns and permits. Ensure compliance with permits and requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

Ensure that the equipment and parts are packaged for shipment to prevent breakage and damage to components. Deliver materials to the site, inspect for damage, unload and store with minimum handling. Store materials off the ground and under a weathertight covering.

1.5 WARRANTY

Provide a clarifier with a minimum [_____] [5] year warranty. Submit the manufacturer's warranty.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Circular Clarifier

****

NOTE: Construct the concrete section of the project

specification in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

When a center feed with peripheral overflow clarifier is not specified for the project, delete references to this type and the requirements for associated components, including scum removal assembly (for this type), center column used as influent pipe, influent well, and (peripheral) weirs and scum baffles.

When a peripheral feed with center overflow clarifier is not specified for the project, delete references to this type and the requirements for associated components, including scum removal assembly (for this type), influent skirt, and effluent trough and weir assembly.

****

Clarifier equipment includes a clarifier mechanism [with effluent trough and weir assembly], [weirs and baffles,] [influent skirt,] and piping. Use structural steel conforming to ASTM A36/A36M. For completely or intermittently submerged steel members use a minimum thickness of 6 mm 1/4 inch. Use cast iron conforming to ASTM A48/A48M, Class 30 minimum.

2.1.1.1 Shop Drawings

Show the complete assembly of the circular clarifier system with all components, mechanisms, and parts; each with an assigned number corresponding to the equipment manufacturer's parts list. Show details for each component of the clarifier mechanism including installation of piping, anchorage, wiring, tank, and tank floor surfacing.

2.1.2 Clarifier Mechanism Design Requirements

****

NOTE: Design clarifier in accordance with UFC 3-240-01.

Delete requirements for and references to rapid sludge removal system when this system is not included in the project.

When a center feed with peripheral overflow clarifier is larger than 11 m 35 feet in diameter or peripheral feed with center overflow clarifier is larger than 18 m 60 feet in diameter, delete requirements for and references to bridge-supported clarifier mechanisms and associated components, including support bridge, center shaft, and scraper arms of structural shapes.

Other items associated with the circular clarifier, but not covered in this section, include (when used) valves, sluice gates, and perimeter handrail. These items should be covered in the appropriate sections of the project specification.

****

The clarifier mechanism includes a sludge collector assembly [with rapid sludge removal system]; drive assembly; [supporting bridge or] center column and access bridge; operating platform and access walkway; influent [well] [skirt and effluent trough and weir assembly]; scum removal assembly; overload protection and alarm; and electrical control equipment.

The drive assembly rotates the sludge collector assembly, that [moves settled sludge to a centrally located sludge hopper] [concentrates settled sludge ahead of pipes for rapid sludge removal system]. At maximum hydraulic capacity, or no chains, sprockets, bearings (except sleeve bearing when used) or operating mechanism is below the liquid surface or in contact with the liquid. Assemble the mechanism in the shop to ensure to ensure proper fitting of parts, match-mark for erection, and disassemble for shipment.

2.1.2.1 Design

****

NOTE: Insert torque value(s) as follows:

Support Mechanism	**Diameter (metersfeet)**	**Torque (Joulesfoot-pounds)**
Bridge-supported	**6-8.5 m20-28 feet**	**2,710 joules2,000 foot-pounds**
Bridge-supported	**9-12 m30-40 feet**	**5,420 joules4,000 foot-pounds**
Bridge-supported (for peripheral feed with center overflow type only)	**13-18 m42-60 feet**	**8,130 joules6,000 foot-pounds**
Center-column-supported	**Less than 16.8 mm 55 feet**	**27,100 joules20,000 foot-pounds**
Center-column-supported	**16.8 to 23 m55 to 75 feet**	**40,650 joules30,000 foot-pounds**

This guide specification is written for one clarifier. If the project includes more than one circular clarifier, all necessary pluralizations should be made or use the word "each."

Insert peripheral speed value(s) as follows:

Peripheral Speed	
Primary Clarifier	**0.04 to 0.06 meter per second8 to 12 fpm**
Secondary Clarifier	**0.035 to 0.05 meter per second7 to 10 fpm**

Use recommended values from UFC 3-301-01, Structural Engineering, for wind load and ice load.

****

Provide a clarifier mechanism manufactured for continuous 24-hour service under design load without excessive wear, damage, or failure. Ensure that the operating stresses do not exceed those allowed in AISC 360. Ensure a minimum continuous output torque rating of [_____] joules foot-pounds [for center-column-supported units and [_____] joules foot-pounds for bridge-supported units] with the scraper arms rotating at a constant speed producing a peripheral speed of [_____] meter per second fpm.

Ensure a safety factor of 2.5, to withstand all structural and mechanical stresses brought about by the following loadings: continuous output rated torque load; dead load; wind load of [_____]; ice load of [_____] (except on scum skimmer); and a live load of 2.5 kPa 50 psf on the access bridge [or on access section of supporting bridge]. Under maximum load, deflection of access bridge must not exceed 1/240 of span[; deflection of supporting bridge must not exceed 1/360 span].

2.2 EQUIPMENT

2.2.1 Sludge Collector Assembly

****

NOTE: Delete requirements for center shaft and rapid sludge removal system when not included in this project.

****

Provide a sludge collector assembly including scraper arms, scraper blades, [and] center drive cage or drum [or center shaft] [, and rapid sludge removal system].

2.2.1.1 Scraper Arms, Blades & Squeegees

****

NOTE: Use first bracketed wording in the second sentence when rapid sludge removal system is not included in the project; use second bracketed wording in this sentence when rapid sludge removal system is included.

****

Use structural steel, using welded truss construction of triangular or box section [; or structural steel shapes or closed end pile supported either by steel guy-rods or steel tie-rods or both]. Weld or bolt steel scraper blades, with attached squeegees, to scraper arms and [move settled sludge to a centrally located sludge hopper] [concentrate settled sludge ahead of pipes for rapid sludge removal system]. Connect scraper arms to [center shaft or] center drive cage or drum by bolted or welded connections. Use scraper blades of steel plate with a minimum thickness of 6 mm 1/4 inch.

Make squeegees bronze [, fiberglass,] or stainless steel with a minimum thickness of 3 mm 1/8 inch [for metal, 6 mm 1/4 inch for fiberglass], and connect to scraper blades with bronze or stainless steel bolts and nuts with a minimum of 50 mm 2 inches. of vertical adjustment.

2.2.1.2 Center Drive Cage or Drum

Fabricate of structural steel, using a box truss or cylindrical drum construction. Connect center drive cage or drum to drive assembly with machine screws or a bolted connection.

[2.2.1.3 Center Shaft

Construct from a solid steel shaft or steel pipe conforming to ASTM A53/A53M, Schedule 40.

][2.2.1.4 Rapid Sludge Removal System & Piping

Rapid sludge removal system includes [_____] mm inch diameter sludge uptake pipes of PVC 1120 or PVC 1220 conforming to ASTM D1784, ASTM D3034, SDR 35 or ASTM D2241, SDR 26, attached to the scraper arms and arranged so that the flow from each can be observed, adjusted, and sampled in the sludge well. Uptake pipe system includes all necessary intermediate clamps and supports and terminates in a suitable fitting or flexible coupling in sludge well. Provide the discharge end of each uptake pipe with an adjustable slip tube or orifice control gate to permit flow adjustment. Sludge well must be of structural steel plate having a minimum thickness of 6 mm 1/4 inch.

]2.2.2 Drive Assembly

****

NOTE: Delete reference to chain drives when clarifier tank is more than 12 m 40 feet in diameter. Check with manufacturer.

****

Include motor, speed reduction and turntable gearing, turntable bearing assembly, drive assembly bearings, and belt drives[or chain drives, or both]. Drive assembly must permit sustained operation at the continuous output torque rating without excessive wear and develop twice the continuous output torque rating without damage to or failure of drive assembly components.

2.2.2.1 Motor

Provide a motor adequate to drive the sludge collector assembly continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Provide the starting torque needed to move sludge collector assembly from a dead stop in a dewatered clarifier tank as well as torque needed to move it from a dead stop under the maximum loading specified without overloading.

Motor must be suitable for operation with the voltage characteristics as indicated. Protect motor against overload, low voltage, and unbalanced voltage. Use a constant speed motor, totally-enclosed, fan-cooled, suitable for outdoor service, and conforming to NEMA MG 1. Flexible coupling for connecting shafts of close-coupled motor and speed reducer must conform to the applicable requirements of AGMA 9002, and ANSI/AGMA 9000.

Motor position must be adjustable to increase or decrease belt [or chain] tension.

2.2.2.2 Speed Reduction and Turntable Gearing

****

NOTE: Delete references relating to pinion-and-spur-gear reduction unit and intermediate speed reducer when clarifier tank is less than 11 m 35 feet in diameter.

Delete reference to worm-gear reduction unit when clarifier tank is more than 11 m 35 feet in diameter.

****

Speed reduction and turntable gearing for the primary [and intermediate]speed reducer[s] must be a worm or helical or a combination thereof. Gearing for the turntable must be [a worm gear reduction unit] [a pinion-and-spur-gear reduction unit]. Ensure an AGMA service factor as recommended in the applicable AGMA Standards ANSI/AGMA 6113 ANSI/AGMA 6013, ANSI/AGMA 6034 or when drive is operating at full load motor wattage horsepower, 24 hours a day continuous running. Gearing will withstand any loadings produced by thrust, out-of-balance, and vibration resulting from operating conditions and operate from zero rpm to a speed consistent with the maximum peripheral speed. Component parts of the speed reduction and turntable gearing will operate at sustained operation at the continuous output torque rating for the life expectancy specified without excessive wear and develop twice the continuous output torque without damage to or failure of any component part.

Ensure that the gears conform to applicable requirements of the following AGMA Standards: AGMA 908, AGMA ISO 10064-6, AGMA ISO 17485, AGMA 2011, ANSI/AGMA 6034, AGMA 2015/915-1. Gears for primary [and intermediate] reducer[s] must be not less than AGMA Quality 10, AGMA 2015/915-1, AGMA ISO 10064-6, AGMA ISO 17485, AGMA 2011, or ANSI/AGMA 6113 ANSI/AGMA 6013. Gears for turntable must be not less than AGMA Quality 6, AGMA ISO 10064-6, AGMA ISO 17485, AGMA 2011. Certify gears as meeting the specified quality.

2.2.2.2.1 Gear Lubrication

Provide an oil or grease lubrication system for speed reduction gearing, including means to stop drive motor in event of insufficient lubrication.

2.2.2.3 Gearmotor

Gearmotor, where practicable, may be used in lieu of separate motor and primary speed reducer. Motor component of gearmotor must be as specified in paragraph MOTOR. Speed reducing component of gearmotor must conform to the applicable requirements specified in paragraph SPEED REDUCTION AND TURNTABLE GEARING, and in ANSI/AGMA 6113 ANSI/AGMA 6013 and ANSI/AGMA 6034.

2.2.2.4 Turntable Bearing Assembly

Turntable bearing assembly includes the turntable bearings upon which the turntable and attached sludge collector assembly are supported; the turntable; and the drive assembly/turntable support base. Assembly must withstand all radial and axial loads imposed by drive assembly and sludge collector assembly. Arrange component parts for replacement of balls or rollers, or the bearing raceways, or the complete bearing unit. Bearing raceway material must have adequate strength to withstand all radial and axial loads and must have a Rockwell "C" hardness of not less than 58.

Turntable bearing assembly [for a center-column-supported clarifier mechanism] must support, where applicable, a drive assembly, turntable, spur gear, and one end of the access bridge. [A bridge-supported clarifier mechanism may incorporate a submerged split-case, water-lubricated bottom guide bearing or an intermediate steady bearing where manufacturer's design requires use of such bearing in addition to turntable bearings.] A bottom support bearing is not acceptable. Bearing must run in an oil bath or be grease-lubricated. Turntable and drive assembly/turntable base must be of cast iron, nodular cast iron, or steel; if of steel, these parts must have sufficient thickness to provide the rigidity necessary to maintain alignment of sludge collector assembly. Turntable must be cast integrally with spur gear or be fastened to the spur gear with machine screws or bolts.

2.2.2.5 Drive Assembly Bearings

Load rating and fatigue life for bearings must be based on ABMA 9 and ABMA 11, as applicable. Bearings must be either oil lubricated or grease lubricated.

[2.2.2.6 Chain Drives and Belt Drives

Belt drives[and chain drives] incorporated in drive assembly include V-belt-and-pulley[and chain-and-sprocket] arrangements, except that belt drives must not be used directly on the[center shaft or on the] center drive cage or drum. Belt drives[and chain drives] must have a minimum safety factor of 4 as applied to ultimate breaking or transmission strength of the belt[or chain] with respect to loads transmitted at twice the continuous output torque rating of the clarifier mechanism.

Key mount the pulleys[, sprockets,] and other motive power transmitting connections. Connect the [drive pulley] [drive sprocket] on the output shaft of the primary speed reducer by a shear-pin hub arrangement to protect the motor against overload[; sprocket must have a bronze bushing with grease lubrication]. Shear-pin hub arrangement must be such that it will not bind or freeze into position. Fabricate guards of steel and make weatherproof.

]2.2.3 Scum Removal

****

NOTE: Select the applicable paragraphs(s) from the following:

****

[Provide a skimmer assembly and [heated] scum trough. Skimmer assembly will continuously move surface scum to tank periphery and automatically flush the scum into the scum trough with a minimum discharge of water.

2.2.3.1 Skimmer Assembly

****

NOTE: Delete references to and requirements for aluminum wherever a corrosion problem with aluminum may be anticipated.

****

****

When center feed with peripheral overflow type clarifier is larger than 11 m 35 feet in diameter or peripheral feed/center overflow type clarifier is larger than 18 m 60 feet in diameter, delete requirements for and references to bridge-supported clarifier mechanisms and those components peculiar thereto, including support bridge, center shaft, and scraper arms of structural shapes.

****

Skimmer assembly includes a [fixed] [hinged or pivoting] skimming blade, a hinged or pivoting plow blade with wiper blades, and support legs. Skimming blade must be of structural steel and extend from influent well to scum trough. Plow blade is [structural steel] [aluminum], and is the width of the scum trough. Securely clamp in position grease- and oil-resistant wiper blades. Ensure the plow blade and its hinged or pivoted connections have proper alignment and is in continuous contact between wiper blades, scum trough approach ramp, and scum baffle. Plow blade must have provision for field adjustment in the vertical plane. Provide means to carry plow blade smoothly over the scum trough. Use corrosion-resistant materials for moving parts within the skimming assembly. Support blades, provide bracing where necessary to maintain the rigidity of the assembly. Use structural steel for support legs.

2.2.3.2 Scum Trough

Provide a welded structural steel scum trough, minimum thickness 6 mm 1/4 inch with a flanged connection for the scum discharge pipe, supported from the tank wall. The inclined approach ramp leading to discharge section of scum trough must be shaped to contain the scum as it is moved up the incline to the trough by the plow blade.

][2.2.3.3 Scum Removal Assembly

****

NOTE: Select the applicable paragraphs(s) from the following:

When a peripheral feed with center overflow type clarifier is not specified for the project, delete references to the scum removal assembly (for this type).

In cold climates where ice build-up is a problem, require heated scum trough and hinged or pivoting skimming blades in lieu of fixed blades.

****

Scum Trough: Use an adjustable dipping weir type scum trough and include collector pipe and operator.

(1) Provide a steel collector pipe conforming to ASTM A53/A53M Schedule 20 minimum. Pipe must have a 1.05 rad 60 degree wide slot cut symmetrically about the vertical axis, with the horizontal edges of the slot parallel to the longitudinal axis of the pipe. At maximum intervals of 750 mm 30 inches,

a 50 mm 2 inch wide band of full circumference must be left for stiffness. The pipe must be plugged on the inboard end and open on the effluent end. End supports include a rolled steel collar welded to an adjustable steel end plate. Provide a grease and oil-resistant, watertight seal, so constructed that it allows smooth motion of the rotating pipe; seal must be readily renewable without removing pipe. Secure end supports to concrete tanks walls by stainless steel anchor bolts of 16 mm 5/8 inch minimum diameter.

(2) Operator: Mount a manual operating lever on the collector pipe. Lever must be steel pipe having a minimum diameter of 31 mm 1 1/4 inches and secured to collector pipe with a chain or bolted connection. Lever must extend at least 0.91 m 3 feet above the top of the tank wall and permit rotation of collector pipe at least 0.52 rad 30 degrees each side of the vertical axis.

]2.2.4 Center Column

****

NOTE: When a center feed with peripheral overflow type clarifier is not specified for the project, delete references to this type and the requirements for those components peculiar thereto, including center column used as influent pipe.

****

Use a cylindrical, structural steel, column to support the entire clarifier mechanism, including the inboard end of access bridge.[The center column also serves as the influent pipe with large openings at its upper end to direct influent flow into the influent well at a low velocity.] Provide an accurate fit between the top of the center column and the drive assembly. Attach the center column to the drive assembly with bolts or machine screws. Provide anchorage for the center column to the tank according to the manufacturer's instructions.

[2.2.5 Effluent Trough and Weir Assembly

Assembly must include effluent trough, effluent weirs, and supporting members. For effluent trough use welded structural steel. Attach weir plates to each side of the effluent trough. Weir plates must be structural steel[or fiberglass]. Bolt weir plates to effluent trough and permit horizontal and vertical adjustment of weir. Ensure proper alignment. Supporting members must be of sufficient cross section to prevent vertical movement due to the flotation forces developed with trough empty and liquid level in tank at base of weir. Supporting assembly must be capable of vertical adjustment to permit leveling of trough.

]2.3 MANUFACTURED UNITS

2.3.1 Access Bridge, Walkway, and Operating Platform

Provide an access bridge extends from tank sidewall to the center and beyond that is sufficient to support walkway and operating platform.[Where the bridge supported unit is used, the supporting bridge must be used as the access bridge.] Ensure walkway and operating platform are skidproof. Walkway and operating platform must comply with 29 CFR 1910. Ensure maximum deflection of L/360 when both dead and live loads are applied.

[2.3.2 Supporting Bridge

Include two structural steel beams and braces of sufficient depth and thickness to support entire clarifier mechanism within the specified maximum allowable deflection.

][2.3.3 Influent Well

Provide an influent well to diffuse the liquid into the tank. The well must project below and 100 mm 4 inches above the water level at maximum hydraulic capacity and radially diffuse and dampen the influent without inhibiting the clarifier process. Provide a flanged connection for the influent pipe.

][2.3.4 Influent Skirt

****

NOTE: Delete references to and requirements for aluminum wherever a corrosion problem with aluminum may be anticipated.

****

The tangential inlet must be shaped to direct influent liquid through the influent raceway. Influent skirt is [steel sheet] [aluminum sheet, minimum thickness] 1.8 mm 14 gage, with bars or structural shapes at top and bottom for rigidity. [Aluminum must conform to ASTM B209M ASTM B209 or ASTM B221M ASTM B221, Alloy 6061, Temper T6.]Supporting assembly must be capable of horizontal and vertical adjustment for final location and leveling of influent skirt.

]2.4 COMPONENTS

2.4.1 Electrical Control System

Provide an enclosure; main and branch circuit breakers; starter, contactors, and reset buttons; pushbuttons; lockout/tagout disconnects and appurtenances and all necessary wiring. Electrical control system must be in accordance with NEMA ICS 1 and NEMA ICS 2. Design, fabrication, and installation of electrical components must be in accordance with requirements of NFPA 70. Mount electrical controls in a weatherproof enclosure.

2.4.1.1 Circuit Breakers

Circuit breakers must be thermal magnetic type and meet the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Main circuit breaker must have a maximum capacity of 150 percent of the electrical load. The main circuit breakers must be an external handle mechanism, with positive locking device, mounted outside the enclosure to permit operation of breaker from outside the enclosure. Provide branch circuit for each drive motor, control circuit, [trough heating device,] and receptacle. Ensure that the panels include spaces for two additional circuit breakers.

2.4.1.2 Motor Starter [, Contactors,] and Pushbutton Station

Provide a pushbutton actuated magnetic motor starter with overload and undervoltage protection for the motor. Starter must have thermal overload protection in each phase and short circuit protection. Ensure overload protective devices give adequate protection to motor windings, are of thermal inverse-time-limit type, and include a manual-reset type pushbutton. Use 2-button Start-Stop pushbutton station.[Provide contactors for trough heating devices.]

2.4.1.3 Overload Protection and Alarm Device

Provide clarifier mechanism with an overload protection and alarm device to indicate load on the mechanism at all times, to sound an alarm in case of impending excessive load, and to stop the mechanism when such load is reached. Device must be of the torque-actuated or indicating-ammeter type, mounted except for alarm, in an enclosure. Include an industrial-type horn or 150 mm 6 inch bell, relay, reset button, test circuit, and an independent On-Off switch. The horn or bell must be constructed of noncorrodible material and be suitable for remote mounting.[Provide auxiliary contacts in alarm circuit for transmission of signal to existing alarm system.]

2.4.1.4 Wiring

Wire control circuits with 1.8 mm No. 14 gage stranded, 1 mm 2/64 inch insulation machine-tool wire with ring tongue compression type lugs and number tags on both ends of wires. All power circuit wiring must be minimum 2.5 mm No. 12 gage, include all terminations as necessary and be labeled with number tags. Secure wires with either plastic ties or wiring duct, or both. Wires going to components mounted on the enclosure door must be secured in a cable-like bundle and strapped to the door and the enclosure with sufficient slack to allow easy operation of the door. Terminate circuits requiring field connection on panel terminals.

2.4.2 Lubrication

Provide bearings and other moving parts subject to wear with lubrication.

2.4.3 Key Mounted Connections

Where connections between shafts and sprockets, gears, pulleys, and other component parts are specified to be key mounted, keys and keyways must conform to ASME B17.1 or ASME B17.2.

2.4.4 Weir Plates and Scum Baffles

Use [steel] [aluminum conforming to ASTM B209M ASTM B209 or ASTM B221M ASTM B221, Alloy 6061, Temper T6] [fiberglass]. Ensure weir plates and baffles or their supports permit horizontal and vertical adjustment of the weir and baffle. Seal according to manufacturer's recommendations.

2.5 MATERIALS

2.5.1 Clarifier Piping Connections

The influent connection to the clarifier will be as shown on the drawings and consist of one [_____] mm inch diameter flanged pipe connection. The effluent connection will be as shown on the drawings and consist of one [_____] mm inch diameter flanged pipe connection.

2.5.1.1 Pipe and Fittings

Use manufacturer's standard pipe and fittings.

2.5.2 Anchor and Connecting Bolts, Nuts, and Washers

Use manufacturer's standard anchor and connecting bolts, nuts, and washers. Show bolt sizes and locations on the approved shop drawings for the equipment[, except as otherwise indicated].

2.5.3 Grout Materials

Use grout conforming to ASTM C1107/C1107M.

2.5.4 Materials Protection

Except as otherwise specified, treat and paint equipment in accordance with the manufacturer's standard practice.

2.6 ACCESSORIES

2.6.1 Spare Parts

Provide manufacturer recommended spare parts that are identical and interchangeable with original parts. Protect spare parts from corrosion and furnish in clearly marked containers. Spare parts must meet standards recommended by the manufacturer in the manufacturer operation, maintenance, or instruction manual.

2.6.2 Tools

Provide special tools necessary for the proper maintenance and operation of the equipment together with a properly identified hardwood or metal box for their storage.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 General

Install clarifier equipment in accordance with the manufacturer's instructions. Correctly align equipment components.[After final positioning of center column, provide full bearing under base plate using non-shrink grout.]

3.2 PREPARATION

3.2.1 Surfacing of Clarifier Tank Floor

Perform surfacing operation in accordance with the approved recommendations of the manufacturer of the clarifier equipment, except as otherwise specified.

Immediately before the surfacing operation is begun, clean the floor of all dirt, soil, and other substances which would prevent the proper bonding of the surfacing to the concrete subfloor. Bring the grout surfacing to finish grade, as near as possible, by hand. If the manufacturer's recommended procedure calls for use of straightedges attached to scraper arms, fasten a 50 by 150 mm 2 by 6 inches metal clad wooden straightedge to each scraper arm approximately 6 mm 1/4 inch below the scraper blade to form a suitable screed; rotate scraper arms manually to complete the surfacing operation; do not use drive unit to move the arms. Prevent grout from entering sludge cone; immediately remove any grout that falls in the sludge cone or on clarifier tank walls. Immediately after surfacing operation is complete, clean clarifier tank floor and circular clarifier equipment of deposits of excess grout.

3.3 INSTALLATION

Install clarifier in accordance with the manufacturer's installation instructions.

3.3.1 Piping

****

NOTE: Delete piping applications not covered in this section. In general, piping external to the clarifier tank that is part of the water resource recovery facility interconnecting piping system should be covered in a separate piping section in the project specification.

****

Install piping in accordance with manufacturer's instructions. Make flanged joints up tight, avoid undue strain on flanges. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose is not be permitted. Install flanged pipe so that adjoining flange faces are not out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. Provide hangers and supports where necessary to support piping.[For buried piping, use push-on joints or mechanical joints, and make in accordance with AWWA C600; for mechanical joints, also follow recommendations of Appendix A to AWWA C111/A21.11].

3.3.2 Weirs

Mount weir plates in accordance with manufacturer's instructions. Use sufficient sealant to fill all voids between tank and weir plates.

3.4 FIELD QUALITY CONTROL

3.4.1 General

Perform all field tests and provide all labor, equipment, and incidentals required for tests. The Contracting Officer will witness field tests and conduct all field inspections. Provide the Contracting Officer ample notice of dates and times scheduled for tests.

3.4.2 Tests

Test circular clarifier mechanism as in operation to demonstrate correct alignment, smooth operation, proper adjustment of flow distribution, freedom from vibration, and freedom from noise and overheating of moving machinery. Include in test at least two full cycles of successful operational sequences to demonstrate that the system continues to function satisfactorily after meeting all operational requirements.

3.4.3 Repair Painting

Inspect painted surfaces for holidays, scratches, chipping, and other damage. Refinish imperfections by cleaning burrs and rough surfaces and sanding to a smooth finish, prime and repaint.

3.4.4 Manufacturer Field Service

Provide the services of the clarifier equipment manufacturer's representative or technician, experienced in installation and operation of the type of systems being provided, to supervise the erection, start-up, acceptance tests, and final inspection.

3.5 CLOSEOUT ACTIVITIES

3.5.1 System Operation

Provide Circular Clarifier, Data Package 3, including operation and maintenance manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, providing basic data relating to the design, operation and maintenance of the circular clarifier.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-46 51 00.00 10 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 51 00.00 10 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION 46 51 00.00 10

AIR AND GAS DIFFUSION SYSTEM

05/21

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PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-46 51 00.00 10 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 51 00.00 10 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 46 51 00.00 10

AIR AND GAS DIFFUSION SYSTEM

05/21

****

NOTE: This guide specification covers the requirements for air supply and diffusion equipment for sewage treatment plants.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6011	(2014J) Specifications for High Speed Helical Gear Units

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C207	(2023) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C208	(2022) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2023) Standard for Rubber-Seated Butterfly Valves

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A480/A480M	(2024a) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A524/A524M	(2021) Standard Specification for Seamless Carbon Steel Pipe for Atmospheric and Lower Temperatures
ASTM A530/A530M	(2012) Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
ASTM A554	(2021) Standard Specification for Welded Stainless Steel Mechanical Tubing
ASTM A774/A774M	(2024) Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

ASTM A778/A778M	(2024) Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products
ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2310	(2006; R 2012) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2992	(2012) Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.13	(2024) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA ST 20	(2014) Dry-Type Transformers for General Applications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 845	(2021) UL Standard for Safety Motor Control Centers

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment Installation

Drawings as specified.

SD-03 Product Data

Materials and Equipment

SD-06 Test Reports

Field Testing

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G, [_____]

1.3 QUALITY CONTROL

1.3.1 Qualifications

Welding procedures and welders are required to be qualified in accordance with the code under which the welding is specified to be accomplished.

1.4 MATERIALS SUBMITTALS

Submit a complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, proposed diagrams, installation instructions and other sheets. Spare parts data for each different item of material and equipment specified, after approval of the related submittals, and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply.

1.4.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and which essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment in required to be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.4.2   Nameplates

Include on each major item of equipment the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

1.4.3   Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

1.4.4   Factory Painting

Unless otherwise specified, clean, prime, and give two coats of machinery enamel to all equipment at the factory. Fiberglass, stainless steel, and galvanized components need not be painted.

1.5   DELIVERY, STORAGE, AND HANDLING

Ensure all equipment delivered and placed in storage is stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

PART 2   PRODUCTS

2.1   SYSTEM DESCRIPTION

An air and gas diffusion system consists of Air Supply Equipment, the Air Distribution System, the Air Diffusers, and other Miscellaneous Equipment, as specified herein.

2.2   EQUIPMENT

2.2.1   Air-Supply Equipment

The air-supply consists of [multi-stage] [_____] [centrifugal] [and] [or] [positive displacement] air blowers and drive units with filters, controls, and appurtenances as indicated or specified.

2.2.1.1   Centrifugal Blowers

****

NOTE: Blowers should be identified on the drawings by type and operating characteristics.

****

2.2.1.1.1   Performance and Design Requirements

Provide blowers that are [multistage] [single stage] centrifugal, oil-free types designed for continuous duty with [closed backward-bladed] [open radial-bladed] impellers. Provide with performance and design requirements as shown.

2.2.1.1.2 Casing

Provide centrifugal blowers of modular design with the casing either vertically or horizontally split and with the required number of compression stages to comply with the specified operating requirements. Machine all horizontally split casings at the split to be tight without a gasket. Vertically split casings are to include rigid cast iron sections held securely between cast iron inlet and outlet heads by steel tie rods. Provide tapped and plugged drains at the lowest points of the casing. Ensure inlet and discharge connections comply with ASME B16.1 [Class 125] [125 pound] [_____] drilled and tapped flanges and are an integral part of the head. Provide casing with lifting eyes capable of supporting blower.

2.2.1.1.3 Impellers

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NOTE: Other impeller materials, such as steel, are available. Consult with various manufacturers for recommendations.

****

Provide impellers cast of high grade [aluminum alloy] [steel], mounted and keyed to the shaft and secured by a locknut. Install impeller hubs to be butted against each other either directly or through one piece metal spacers. Provide ample clearance between the impeller and casing. Test each impeller by operating at a speed to [20] [_____] percent above operating speed and check for cracks using the dye penetrant method or similar method of equal accuracy. Ensure the impeller and shaft assembly are statically and dynamically balanced as a unit. Removing of metal from the impeller by boring is not an acceptable means of balancing the impeller and shaft unit. Vibration is not allowed to exceed 0.025 mm 1.0 mil at the bearing housing with the blower operating. First critical speed is required to be at least 150 percent of maximum operating speed.

2.2.1.1.4 Diffusers

Provide diffuser vanes, cast into each section of the blower casing, to receive air from the impeller and direct the air to the next impeller for multi-stage type blowers.

2.2.1.1.5 Shaft

Provide a shaft of ground and polished high grade [high alloy steel] [carbon steel][stainless steel] of sufficient diameter to operate below first critical speed.

2.2.1.1.6 Shaft Seals

Provide solid carbon ring shaft seals where the shaft passes through the inlet and discharge heads. Design seals to permit seal inspection or replacement without disconnecting suction or discharge piping.

2.2.1.1.7 Internal Seals

Provide labyrinth type seals between stages.

2.2.1.1.8 Bearings

****

NOTE: Delete inapplicable lubrication method. Verify bearing L-10 life requirements.

****

Provide each blower with two [pressure oil lubricated sleeve type journal] [splash oil lubricated anti-friction type] bearings. Design bearings for both radial and thrust loads and size for an L-10 life of 5 years continuous operation as defined by ABMA 9 or ABMA 11. Design bearings to allow replacement without disassembling the blower casing or disconnecting piping.

2.2.1.1.9 Pressure Oil Lubrication System

Provide a console mounted pressure lubrication system to oil the sleeve bearings. The lubrication system consists of a main oil pump mounted on and driven by the blower shaft, an auxiliary electric motor driven oil pump, an oil cooler, an oil filter, a 3-minute retention time oil reservoir, and all required switches, temperature sensors, and gauges. Ensure the electric motor driving the auxiliary oil pump has Class F insulation, Type NEMA Design B, in accordance with NEMA MG 1, and is totally enclosed fan cooled; equipped with 120 volts space heaters; and controlled in accordance with NEMA ICS 1. Completely pipe the lubrication system and wire with only interconnecting piping between the console and the pump required in the field.

2.2.1.1.10 Splash Oil Lubrication System

Provide a simple splash lubrication system with each bearing having its own oil reservoir integral with the bearing housing. Maintain proper oil level by a constant level oiler located on each bearing housing. Provide a slinger on the shaft to splash oil into the bearing when the compressor is running. Provide a sight level gauge in the bearing housing. Provide a labyrinth seal combined with an atmospheric vent to prevent oil contamination of the air stream.

2.2.1.1.11 Inlet Guide Vanes

Provide inlet guide vanes for each single stage centrifugal blower.

2.2.1.1.12 Centrifugal Blower Speed Increasing Gears

Provide high speed, single stage centrifugal gears made of hardened, helical, alloy steel, manufactured in accordance with AGMA 6011 with a minimum 1.5 service factor applied to full horsepower rating of blower.

2.2.1.2 Positive Displacement Blowers

****

NOTE: Blowers should be identified on the drawings by type and operating characteristics.

****

2.2.1.2.1 Performance and Design Requirements

Provide positive displacement rotary blowers, oil-free types, designed for continuous duty. Performance and design requirements are to be as shown.

2.2.1.2.2 Casing

Provide a one piece blower casing with separate head plates constructed of close-grained cast iron, suitably ribbed to prevent distortion under the specified operating conditions. Fabricate casing with lifting eyes for installation and maintenance purposes.

2.2.1.2.3 Impeller and Shaft

Provide impeller and shaft constructed of a common ductile iron casting. Provide impellers of the straight, two-lobe involute type that operate without rubbing, liquid seals, or lubrication. Ensure the peak vibration velocity of blower is less than 7.62 mm/second 0.30 inch/second.

2.2.1.2.4 Timing Gears

Positively time impellers by a pair of machined, heat-treated, spur tooth timing gears. Mount timing gears on the impeller shafts on a tapered fit and secured by a locknut.

2.2.1.2.5 Bearings

****

NOTE: Verify bearing L-10 life requirements.

****

Support impeller shaft by antifriction [spherical ball] [roller] bearings sized for a minimum L-10 life of [30,000] [50,000] hours as defined by ABMA 9 or ABMA 11.

2.2.1.2.6 Seals

Provide a lip type oil seal at each bearing to prevent lubricant from leaking into the air stream. Provide labyrinth seals at the point where the shaft passes through the head. Provide ventilation of the impeller side of the oil seals to atmosphere to eliminate any carry-over of lubricant into the air stream.

2.2.1.2.7 Lubrication

****

NOTE: Delete inapplicable lubrication system. Use bracketed sentences if "pressure oil lubricated" is to be used in the lubrication system.

****

Provide drive and bearings of the [grease lubricated type and also provide with a grease fitting] [splash oil lubricated type]. Provide timing gears and gear end bearings of the [pressure oil lubricated type] [splash oil lubricated type]. Regulate oil level by a metering orifice.

[If using a full pressure lubrication system built into positive displacement blower, direct connect to oil pump and include oil strainer, oil reservoir, piping to bearings, and oil spray for gears with piping to air-to-oil cooler. Design oil vents so that oil vapors do not enter motor. Design system to prevent leakage and dirt contaminants.]

2.2.1.3 Drive Connection

****
NOTE: Verify cubic meter/second cfm increments for additional sheaves.
****

[Connect the blower to the motor by a heavy-duty flexible forged steel spacer coupling, keyed or locked to the shaft.] [Connect the blower to the motor by a V-belt drive capable of transmitting the motor power to the blower. Provide additional sheaves so that the blowers output can be varied in [0.189] [_____] cubic meter/second [40] [_____] cfm increments between minimum and maximum flow conditions.] Cover the drive with an acoustically treated sheet metal guard.

2.2.1.4 Motors

Size motors to be within their rated load under the specified operating conditions. Ensure all motors conform to NEMA MG 1 and are the squirrel cage induction Type NEMA Design B, Class B or F insulated, with a service factor of not less than 1.15. Motors are required to be horizontal foot-mounted, totally enclosed fan-cooled, cast iron or aluminum construction and a quiet series type with a noise level not exceeding 80 dB (A Scale). The motor frame is required to be the standard NEMA assigned frame size supplied for constant speed use on full voltage, fixed frequency line power. Provide resistance temperature detectors (RTD's) embedded in two phases of the stator windings. Provide motor bearings with a minimum L-10 life of 50,000 hours.

2.2.1.5 Power Factor Capacitors

Equip all motors over 3.7 kW 5 hp with power factor correcting capacitors. Furnish capacitors complete with internal fusing and bleed-off resistors. Provide for a corrected power factor of not less than 95 percent at full load. Install capacitors in enclosures coordinated with the individual motor construction with leads terminated in the motor terminal box and identified as capacitor leads. Provide overcurrent device settings within the motor controls that are properly reduced for the motor and capacitor combination.

2.2.1.6 Blower - Motor Base

Provide a full length common base of steel box construction for the blower and drive. Ensure the base is suitable for direct attachment to the foundation. Provide anchor bolts, [anti-vibration strips,] and grout as required for proper installation.

2.2.1.7 Concrete Foundation

Provide a concrete foundation as indicated. Ensure the foundation is entirely separated from the surrounding floor. Provide concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.2.1.8 Filters

****
NOTE: Consult diffuser manufacturers to verify the percent efficiency required for the diffusers specified. Use of prefilter blanket increases

filter life.

Delete the last sentence for warm climate projects.
****

Provide filters of the [washable dry type,] [disposable dry type,] rated to be at least 90 percent efficient when tested in compliance with ASHRAE 52.2 dust spot method. Ensure filter has at least 0.093 square meter 1 sq. ft. of filter area per 0.0118 cubic meter/second 25 cfm of air flow. Use polyester felt filter material with 25 mm 1 inch pleat separation. For filters located outside of the building, provide a weather hood designed to keep rain, snow, and other foreign articles away from the filter element. Design the weather hood for inlet velocities between the hood and the filter element of 2.54 m/second 500 ft/min or less. Provide a manometer or differential pressure gauge on the filter unit to indicate when the filter element requires cleaning or replacing. [Provide a filter element by-pass with counter-weighted doors to prevent destruction of the element in the event freezing moisture clogs the filter].

2.2.1.9 Accessories

****
NOTE: Consult the blower manufacturer to determine silencer requirements.
****

2.2.1.9.1 Silencers

Provide each blower with [inlet] [and] [discharge] silencers. Provide silencers for [standard] [critical] grade silencing. Provide intake silencers of the [chamber] [absorption] type. Provide discharge silencers of the [chamber] [absorption] [combination chamber-absorption] type. Size silencer as recommended by the silencer manufacturer and ensure compatibility with the blower requirements. Ensure silencer connections match the adjacent piping. Provide mounting brackets as required for silencer support. Construct silencer of heavy-duty rolled and welded steel plate with inner liner properly welded to outer shell for purpose of deadening outer shell.

2.2.1.9.2 Acoustical Insulation

Wrap silencers, [interior air piping,] [expansion joints,] [valves,] [and] [drive guards] with 25 mm 1 inch thick high density woven glass fiber mat having a minimum density of 4.6 kg/square meter 15 ounces/square foot and lag with a 0.41 mm 0.016 inch thick aluminum jacket. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.2.1.9.3 Gauges

Provide gauges that comply with ASME B40.100. Ensure inlet gauges have a range of [0 to 762 mm] [_____] [0 to 30 inch] [_____] water gauge vacuum. Ensure outlet gauges have a range of [0 to 103 kPa] [_____] [0 to 15 psi] [_____]. Provide all accessories for [control panel] [wall] [pipe] mounting of the gauges.

2.2.1.9.4 Thermometers

Provide thermometers to indicate [inlet air temperature,] [discharge air temperature,] [lubrication oil temperature,] [and] [diffuser point of discharge temperature for three locations within the system]. Thermometers of either red-reading mercury-in-glass type or dial type are acceptable. Provide a scale range covering the full range of expected operation and up to 125 percent, but not more than 150 percent of maximum.

2.2.1.9.5 Temporary Screens

Provide a temporary screen, consisting of 16-mesh wire backed up by 6.4 mm 1/4 inch hardware cloth, at the blower inlet connection. Remove the screens after initial blower start-up and testing.

2.2.1.9.6 Inlet and Discharge Elbows

Provide inlet and discharge elbows of the long sweep type constructed of cast iron with ASME B16.1, Class 125 flanges.

2.2.1.9.7 Expansion Couplings

Provide couplings of the extra heavy gauge rubber, wire reinforced type suitable for temperature range of -29 to plus 121 degrees C -20 to plus 250 degrees F and pressure range from 381 mm 15 inch of mercury vacuum to 103 kPa 15 psig.

2.2.1.10 Manual Control System

****

NOTE: Delete inapplicable control system. NEMA 3R and NEMA 4 Types are exterior panel types.

****

Provide each blower with a control panel containing all starters, circuit breakers, disconnects, and other equipment required for manual starting and stopping of the blower. Ensure controls and motor control centers conform to NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4, NEMA ICS 6, UL 508, and UL 845. Ensure circuit breakers conform to IEEE C37.13. Provide the control panel in a NEMA 250, [Type 12] [Type 3R] [Type 4] enclosure. Ensure all materials and construction complies with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2.1.11 Automatic Control and Monitoring System

****

NOTE: Delete inapplicable control system.

****

Provide each blower with an automatic control and monitoring system to control start-up and shut-down sequences, to indicate various operation parameters, and to actuate blower protective devices. All accessory devices are required to be operated through this system.

2.2.1.11.1 Panel Construction

****

NOTE: NEMA 3R and NEMA 4 Types are exterior panel types.

****

Enclose the automatic control and monitoring system in a NEMA 250, [Type

12] [Type 3R] [Type 4] panel and that is completely wired and tested with internal connections being made on terminal blocks. Provide a power supply to the control panel rated at [_____] volts ac, [_____] phase, 60 Hz to a [_____] amp flange mounted disconnect. Derive internal voltages, including [120] [_____] volts ac, from the [_____] volts ac, supply. Provide control power transformer rated at [_____] volts primary and [_____] volts secondary with kVA rating as recommended by the manufacturer. Ensure instrument and control transformers comply with IEEE C57.13 and NEMA ST 20.

2.2.1.11.2 Automatic Control

a. Provide automatic controls for all machine parts to ensure proper startup and shutdown sequences. Provide a manual-off-automatic switch for each blower. In addition, provide manual control switches for the [auxiliary oil pump,] [unloading valve,] [and] [inlet butterfly valve]. Ensure the manual control switches are active only when the selector switch is in the manual position. When the selector switch is in the automatic position, initiate the control system sequence startup of the blower as follows:

    (1) Start auxiliary oil pump and allow to run for 3 minutes.

    (2) Open unloading valve and close inlet butterfly valve.

    (3) Start main drive motor.

b. When the motor reaches full speed, open the inlet butterfly valve and close the unloading valve. Open the inlet butterfly valve to a minimum set point slightly above the surge point. Control the inlet butterfly valve from then on by a 4 to 20 mA dc signal from the control system to maintain the desired flow. When the shaft-driven main oil pump reaches specified pressure setting, stop the auxiliary oil pump.

c. Upon turning the selector switch to the off position, initiate the control panel sequence shutdown of the blowers as follows:

    (1) Open the unloading valve and close the inlet butterfly valve.

    (2) De-energize the drive motor.

d. When the shaft-driven oil pump pressure drops, start the auxiliary oil pump and allow to run for [30] [_____] minutes to provide for post lubrication and cooling.

2.2.1.11.3 Indicators

Provide the following indicators, mounted on the control panel:

a. Inlet and outlet pressure gauges.

b. Valve position indicators for the unloading valve (open or closed) and the inlet butterfly valve (in percentage open).

c. Inlet air volume in cfm indicator. Provide an ammeter measuring the current draw of the blower motor and calibrated so that a given amount of current draw correspond to the volume of air being handled by the blower.

d. Lights to indicate the auxiliary oil pump is running and is as required for the protective devices.

2.2.1.11.4 Blower Protective Devices

a. All blower protective devices, upon alarm condition, are required to cause immediate de-energization of the motor, initiation of the automatic shutdown sequence, and provide audible and visual alarm indication. Equip positive displacement blowers with automatic pressure relief valve.

b. Provide bearing temperature protection consisting of encapsulated temperature switches in milled slots directly over each blower bearing, a control relay, a selector switch and test pushbuttons, and a running light. Upon excessively high temperature of any bearing, initiate protective shutdown and indicate which bearing is affected.

c. Provide a protective device to prevent the blower from operating in a surge condition. Initiate automatic blower shutdown sequence when the blower is reduced to surge volume as indicated by motor current draw and give visual indication of reason for shutdown. Provide an override as necessary for blower startup and shutdown.

d. Provide a system to control blower overload by opening and closing the inlet [butterfly valve] [inlet guide vanes on single stage centrifugal blower] based upon the current draw of the motor. The system is required to monitor motor current input to a suitably conditioned and set-point controller.

2.2.1.11.5 Vibration Monitoring

Provide vibration pick-ups for motor and blower bearings. Provide vibration monitoring system on control panel. Equip centrifugal blowers with radial and axial vibration monitoring. Monitor consists of front panel and circuit board and includes switches for display of signal and alarm levels, LED indicators for annunciation of OK and alarm status, calibration and alarm adjustments, and connectors for output signals.

2.2.1.11.6 Control Logic

Provide control logic to monitor dissolved oxygen level signals and select the number and [inlet guide vane setting for single stage centrifugal blowers] [rotation speed of positive displacement blowers] to provide for sufficient air to maintain desired dissolved oxygen level in aeration tank(s).

2.2.2 Air Distribution System

Provide a system, including piping, valves, and supports to distribute air from the blowers to the air diffusers. Ensure the system is of adequate capacity for the intended purpose and is adjustable for balancing of air distribution.

2.2.2.1 Air Main

Supply the air main from the blowers to the air supply assemblies as indicated. Provide eccentric reducers at each change in air main diameter. Ensure the crown of the air main is maintained at the same elevation for the full length of the tank. Provide fittings as indicated. For air main piping 150 mm 6 inches in diameter and larger, provide be ductile iron or Schedule 40 steel pipe. For air main piping less than 150 mm 6 inch in diameter, provide ductile iron or Schedule 40 galvanized steel pipe. Provide hangers and supports as required for a complete installation.

2.2.2.2 Removable Header Air Distribution System

****

NOTE: Delete inapplicable header types and materials of construction.

****

Provide removable header air distribution systems as indicated that consist of an air supply assembly, removable header assembly, and supports. Ensure the system is compatible with the air main and the specified diffusers.

2.2.2.2.1 Air Supply Riser Assembly

****

NOTE: Include this paragraph if distribution system is mounted on a T-wall.

****

Provide an air supply riser assembly for each removable header to connect the drop leg to the air main. The riser assembly consists of a vertical pipe projecting from the air main through a floor sleeve cast in the concrete T-wall, an elbow, a butterfly valve between the elbow and the drop leg, and required supports and anchors.

2.2.2.2.2 Air Supply Lateral Assembly

****

NOTE: Include this paragraph if distribution system is mounted on a Y-wall.

****

Provide an air supply lateral assembly for each removable header to connect the drop leg to the air main. The lateral assembly consists of piping, a butterfly valve, and required supports and anchors.

2.2.2.2.3 Removable Header Assembly

The removable header assembly consists of a drop leg and a header. The upper end of the header assembly contains a 90 degree elbow with face ring and neoprene gasket for connection to the air supply assembly. The connection to the air supply assembly is required to be a [quick coupling flange][grooved coupling system]. Provide a flanged connection for the lower end of the drop leg for connection to the header. Provide welded end caps and a beveled flange on the headers for connection to the drop leg. Provide diffuser connectors for field installation of diffusers. Design the removable header assembly to withstand a vertical load that results in a moment of 56.5 Nm 500 inch-pounds at the diffuser connection without permanent deformation. Provide lifting lugs on the assembly as required for removal of the header. Fabricate the removable header assembly of stainless steel or galvanized steel as follows:

a. Stainless Steel Systems: Fabricate the removable header assembly from 304L stainless steel complying with ASTM A240/A240M. Ensure drop legs and headers have a nominal wall thickness of 2.78 mm 0.1094 inch (12 gauge). Use the header dimensions as indicated with dimensional tolerances complying with ASTM A530/A530M and ASTM A554. Fabricate welded wrought stainless steel fittings and welded stainless steel tubular products in accordance with ASTM A774/A774M and ASTM A778/A778M. Perform all welding in the shop. Add filler wire to all welds to provide a cross section equal to the parent material. Ensure butt welds have full penetration to the interior surface. Ensure all interior weld beads are smooth, evenly distributed, with an interior projection not exceeding 2 mm 1/16 inch. Wire brush outside weld areas with stainless steel brushes. After fabrication, passivate the assembly by pickling and ensure it is completely neutralized. Use nickel plated ductile iron for the quick-coupling flange and equip with a stainless steel hinge pin. Provide anchor bolts made of 303 stainless steel.

b. Galvanized Steel Systems: Fabricate the removable header assembly from Schedule 40 steel pipe conforming to ASTM A53/A53M. Perform all welding in the shop. Ensure all butt welds are full penetration welds with an interior projection not exceeding 2 mm 1/16 inch. Ensure welding conforms to AWS D1.1/D1.1M. Hot-dip galvanized the assembly after fabrication. Provide anchor bolts made of 303 stainless steel. Use nickel plated ductile iron for quick-coupling flange and equip with a stainless steel hinge pin.

2.2.2.2.4 Supports and Guides

Support removable header by two adjustable supports with vee-shaped guides. Fabricate supports from 6 mm 1/4 inch steel plate and provide at least 25 mm 1 inch vertical adjustment. The supports are required to support the weight of the assembly so that the quick-coupling can be easily disconnected.

2.2.2.3 Rotary or Swing Header Air Distribution System

****

NOTE: Delete inapplicable header types and materials of construction.

****

Provide rotary or swing header air distribution systems as indicated consisting of an air supply assembly, rotary or swing-type air header assembly, and supports. Ensure system compatibility with the air main and the specified diffusers.

2.2.2.3.1 Air Supply Assembly

Provide an air supply assembly for each rotary or swing header to connect the upper swing joint to the air main. The assembly consists of the required pipe and fittings, a butterfly valve, and a combination connector and support for the upper swing joint.

2.2.2.3.2 Rotary or Swing Header Assembly

The rotary or swing header assembly consists of an upper swing joint, a knee joint, hanger pipes, and a header. The upper swing joint connects to the air supply assembly and includes connectors for field installation of diffusers. Design the rotary or swing header assembly to withstand a vertical load that results in a moment of 56.5 Nm 500 in-lb at the diffuser connection without permanent deformation. Provide lifting lugs on the assembly as required to lift the header assembly out of the tank.

Fabricate the rotary or swing header assembly of stainless steel systems, carbon steel systems, galvanized steel systems, or fiberglass systems as follows:

a. Stainless Steel Systems: Provide upper swing joint and knee joint of cast stainless steel. Connect between the two sections by means of a stainless steel pin working in a graphite bronze bushing. Provide graphite impregnated cast bronze bearings complying with ASTM B584. Provide seal rings with labyrinth grooves between the two joint sections. Provide a grease fitting to lubricate the seal rings. Provide an adjustable stop to prevent the knee joint from opening beyond 180 degrees. Fabricate the hanger pipes and air headers from 304L stainless steel in accordance with ASTM A240/A240M. Fabricate the upper hanger pipes from Schedule 10S. Fabricate the hanger pipes from Schedule 5S. Fabricate air header pipes from 12 gauge. Provide header dimensions as indicated with dimensional tolerances in accordance with ASTM A530/A530M and ASTM A554. Fabricate welded wrought stainless steel fittings and welded stainless steel tubular products in accordance with ASTM A774/A774M and ASTM A778/A778M. Perform all welding in the shop. Add filler wire to all welds to provide a cross section equal to the parent material. Ensure butt welds have full penetration to the interior surface. Ensure interior weld beads are smooth, evenly distributed, and with an interior projection not exceeding 2 mm 1/16 inch. Wire brush outside weld areas with stainless steel brushes. After fabrication, passivate the assembly by pickling and ensure it is completely neutralized. Weld the hanger pipes to the upper swing joint and knee joint. Flange connect the header pipe to the hanger pipe. Weld diffuser connectors to the header. Provide the header with welded end caps.

b. Carbon Steel Systems: Provide the upper swing joint and knee joint of cast steel. Connect between the two sections by means of a stainless steel pin working in a graphite bronze bushing. Use graphite impregnated cast bronze bearings in accordance with ASTM B584. Provide brass seal rings with labyrinth grooves between the two joint sections. Provide a grease fitting to lubricate the seal rings. Provide an adjustable stop to prevent the knee joint from opening beyond 180 degrees. Fabricate the hanger and header pipes from schedule [40] [80] carbon steel pipe in accordance with ASTM A524/A524M. Provide header dimensions as indicated. Perform welding in the shop. After fabrication, paint the assembly with the manufacturer's standard finish. Weld the hanger pipes to the upper swing joint and knee joint. Connect the header pipe to the hanger pipe. Weld diffuser connectors to the header. Provide the header with welded end caps.

c. Galvanized Steel Systems: Provide the upper swing joint and knee joint made from cast iron. Connect between the two sections by means of a stud equipped with a spring to maintain seal between the faces. Use graphite impregnated bronze seal rings and bearings in accordance with ASTM B584. Provide grease fittings for lubrication. Fabricate the hanger and header pipes from schedule [40] [80] galvanized steel pipe in accordance with ASTM A53/A53M. Provide header dimensions as indicated. The header consists of two lengths of pipe, flange connected to a cast iron tee. Screw connect the hanger pipes to the upper swing joint and knee joint, and flange connected to the header tee. Weld the diffuser connectors to the header. Provide the header with gasketed, screwed end caps.

d. Fiberglass Systems: Provide the upper swing joint and knee joint of the trunnion sleeve type manufactured of glass reinforced synthetic resin capable of continuously operating in pH levels of 5.0 to 9.0 and at gas temperatures up to 108 degrees C 225 degrees F. Rib all areas of high stress to provide increased strength. Provide each rotating bearing surface with ring type air seals. Hold the assemblies together by a 13 mm 1/2 inch diameter stainless steel rod with locking nuts. Fabricate the hanger and header pipes from reinforced thermosetting resin pipe in accordance with ASTM D2310, Type I, Grade l, Class F, ASTM D2992, and ASTM D2996. Provide pipe in accordance with the following: 275.8 MPa 40,000 psi minimum hoop stress; 65.5 MPa 9,500 psi minimum tensile strength; 131.0 MPa 19,000 psi minimum axial compression strength; minimum 55 Barcol hardness; 54.75 degree wind angle; 2.8 mm 0.110 inch minimum wall thickness. Provide ultraviolet protection for the pipe material. Provide liner resin that is 85 to 89 percent resin with glass filler and at least 0.51 mm 0.020 inch thick. Use filled epoxy adhesive joints. Provide header dimensions as indicated. Flange connect the hanger to the header.

2.2.2.3.3 Supports and Guides

Provide supports and guides as required for support and leveling of the header.

2.2.2.4 Fixed Header Air Distribution System

****

NOTE: Delete inapplicable header types and materials of construction.

****

Provide a fixed header air distribution as indicated consisting of a drop leg assembly, fixed headers, and supports. Ensure the system is compatible with the air main and the specified diffusers.

2.2.2.4.1 Drop Leg Assembly

Provide a drop leg assembly to connect the fixed headers to the air main. Provide the assembly of the dimensions indicated.

2.2.2.4.2 Fixed Headers

Provide fixed headers of the dimensions and configuration indicated. Provide header connections of a type allowing rotational adjustment of individual header sections of sufficient strength to transmit the longitudinal forces caused by expansion and contraction of the header. Design the headers to allow expansion and contraction up to a maximum temperature of 52 degrees C 125 degrees F without damage to the system. Prevent rotation of the header due to thermal expansion and contraction. Provide fixed headers of stainless steel systems or fiberglass systems as follows:

a. Stainless Steel Systems: Fabricate all welded parts of the system from 304L stainless steel in accordance with ASTM A240/A240M. [Provide stainless steel pipe with a 2D finish in accordance with ASTM A480/A480M.] Provide pipe wall thickness as follows: for 250 mm 10 inch diameter and less, supply 1.59 mm 0.0625 inch (16 gauge) thick pipe; for 300 mm 12 inch diameter, supply 1.98 mm 0.0781 inch (14 gauge) thick pipe; for 350 mm 14 inch through 450 mm 18 inch diameter, supply 2.78 mm 0.l094 inch (12 gauge) thick pipe; for 500 mm 20 inch diameter, supply 3.18 mm

0.1250 inch (11 gauge) thick pipe; for 600 mm 24 inch diameter, supply 3.57 mm 0.1406 inch (10 gauge) thick pipe. Provide header dimensions as indicated with dimensional tolerances in accordance with ASTM A530/A530M and ASTM A554. Fabricate welded stainless steel fittings and welded stainless steel tubular products in accordance with ASTM A774/A774M and ASTM A778/A778M. Perform all welding in the shop. Add filler wire to all welds to provide a cross section equal to the parent material. Ensure butt welds have full penetration to the interior surface. Ensure interior weld beads are smooth, evenly distributed, and with an interior projection not exceeding 2 mm 1/16 inch. Wire brush outside weld area with stainless steel brushes. Prior to fabrication, passivate each part of the assembly by pickling and ensure it is completely neutralized. Provide bolts, washers, follower flanges, and other non-welded parts made of 304 stainless steel. Provide low silicon bronze nuts in accordance with ASTM B98/B98M.

b. Fiberglass Systems: Provide reinforced thermosetting resin pipe in accordance with ASTM D2310, Type I, Grade l, Class F, ASTM D2992, and ASTM D2996. All pipe is required to be in accordance with the following: 65.5 MPa 9,500 psi minimum tensile strength; 110.3 MPa 16,000 psi minimum axial compression strength; minimum 55 Barcol hardness; 54.75 degree wind angle; 2.8 mm 0.110 inch minimum wall thickness. Provide ultraviolet protection for the pipe material. Use liner resin with 85 to 89 percent resin with glass filler and is at least 0.51 mm 0.020 inch thick. Use filled epoxy adhesive joints. Provide header dimensions as indicated. Provide a 25 mm 1 inch drain leg at each end of each section of pipe.

2.2.2.4.3 Support System

Provide a system for support and anchoring of the header. Ensure the system is compatible with the expansion and contraction control design. Ensure the support system provides for a minimum of 100 mm 4 inch vertical adjustment and 25 mm 1 inch lateral adjustment of the header. Contour the system to fit the bottom 90 degrees of the pipe while maintaining a bearing surface at least 50 mm 2 inch wide.

2.2.2.5 Lagoon Air Distribution System

****

NOTE: Delete inapplicable header types and materials of construction.

****

2.2.2.5.1 Fixed Air Distribution Headers

Provide fixed air distribution headers to connect the air main to the lagoon aeration diffuser tubing. Construct header and feeder piping using PVC with flanged or threaded connections. Provide one of the following types of air distribution systems:

a. Dual Header System: The system consists of a dual header supported above the side slopes, one on each side of the lagoon with feeder tubes connecting to each end of the diffuser tubing.

b. Single Header System: The system consists of a single header, supported above the lagoon bottom in the center of the lagoon with feeder tubes connecting to one end of the diffuser tubing.

2.2.2.5.2 Supports

Provide adjustable supports that allow free longitudinal movement with little or no lateral or vertical movement for the air header piping. Ensure all ferrous metal in the support system is galvanized.

2.2.2.5.3 Airlift Purge System

Provide a plastic airlift, complete with integral plastic air jet. Include air supply tubing and piping connected to the main air header. Provide a control valve on the air supply pipe.

2.2.2.5.4 Gas Cleaning System

Provide a complete system as required for gas cleaning of the air diffusion system. Provide a single valve to control flow to all points.

2.2.3 Diffusers

****

NOTE: Aeration tanks should be identified on the drawings. Diffuser performance requirements should be inserted. Maximum allowable headloss should not exceed 14 inches of water.

****

2.2.3.1 Diffuser Performance

a. Provide an air flow rate of [_____] standard L/second/28.3 cubic meters scfm/1000 cubic feet of tank volume.

b. Provide an oxygen transfer rate of [_____] kg pounds of oxygen per day per 28.3 cubic meters 1000 cubic feet of tank volume at the specified air flow rate in clear water at 20 degrees C 68 degrees F and zero dissolved oxygen.

c. Set maximum allowable headloss in the system to [_____] mm inch of water, excluding submergence.

2.2.3.2 Porous Diffusers

****

NOTE: Delete inapplicable types of diffusers and materials of construction.

The mean permeability rating of the porous diffusers will be inserted. The permeability rating is defined as the number of cubic meters per second cfm of air, at 21 degrees C 70 degrees F and 10 to 25 percent relative humidity, that will pass through 0.093 square meter 1 square foot of diffuser area to the atmosphere, under a differential pressure equivalent to 508 pascals 2 inches of water below the plate or within the tube when it is tested dry in a room maintained at a temperature of 21 degrees C 70 degrees F and a relative humidity between 30 and 50 percent. To date, this is the accepted method of measuring the ability of porous diffuser media to diffuse air and provide a desirable rate of oxygen

absorption. Lower permeability should produce smaller bubbles, which should result in higher rates of oxygen absorption. Lower permeability rating, however, requires higher air pressure and results in more rapid clogging and higher pressure losses. Consequently, any benefits obtained initially by specifying a permeability rating may be offset by the higher maintenance and operating costs. The best balance between desired oxygen absorption and operating and maintenance cost is afforded by a permeability rating of from 0.203 to 0.406 40 to 80. Non-porous diffusers do not have a permeability rating.

****

Provide one of the following types of diffusers with a mean permeability rating of [_____]:

2.2.3.2.1 Porous Ceramic Discs

Provide porous ceramic plate diffusers composed of silica sand bonded together with a synthetic silicate, fused alumina, or an organic bond; grains of crystalline aluminum oxide bonded with high alumina glass; aluminum silicate grains ceramically bonded at high temperature; crushed porcelain grains bonded together with alumina glass or electrically fused aluminum grains bonded together with alumina glass. Ensure all diffuser plates provide [_____] square mm square inch of horizontal diffuser area.

2.2.3.2.2 Porous Membrane Tubes with Supports

Provide porous membrane media composed of a tubular flexible synthetic membrane sheath that is open at one end and closed at the other. Ensure the tubular sheath fits over a tubular air duct/air plenum frame or is supported by a one-piece semicircular corrosion resistant support rod. Clamp the sheath to a nozzle with a corrosion resistant removable clamp. Ensure the sheath is capable of flexing from its unexpanded shape to its expanded inflated convex hollow cylindrical shape when air is diffused through it to slough foulants. Ensure apertures of the sheath close whenever the air flow is shut off and purge themselves when air is restarted. Supply each diffuser with a check valve for wastewater backflow prevention. Ensure the nozzle is compatible with the diffuser connector on the air header.

2.2.3.2.3 Porous Cloth Media with Plastic Tube Liner

Provide porous cloth media composed of a tubular flexible synthetic fiber cloth sheath that is open at one end and closed at the other. The media fits over a plastic tube liner and is clamped to a cast iron nozzle with a stainless steel clamp. Vinyl coat the cast iron nozzle, except for the threads attaching it to the header. Provide diffuser media [_____] mm inch in length and a diameter of [_____] mm inch.

2.2.3.3 Non-Porous Diffusers

****

NOTE: Delete inapplicable types of diffusers and materials of construction.

****

2.2.3.3.1 Nozzle-Type Diffusers

Provide one of the following nozzle type diffusers:

a. Diffuser consisting of a molded plastic body with four high velocity, short tube orifices, each discharging at right angles to the adjacent orifice. [Equip the diffuser with a deflector ring above the discharge orifices and include a control orifice to ensure proper headloss.]

b. Diffuser consisting of molded plastic and including a top piece containing inverted V-shaped air shear slots and an upward sloping air deflector and a bottom piece containing a control orifice and an air header connector.

2.2.3.3.2 Orifice-Type Diffusers

Provide one of the following non-valved orifice type diffusers:

a. Diffuser constructed of stainless steel and consisting of a balancing nozzle, an inverted air reservoir, air exit ports located on horizontal planes on two levels, and a deflector. Ensure the deflector directs the liquid along the diffuser's outer walls.

b. Diffuser consisting of an open bottom, molded plastic, rectangular box containing tapered air release holes. Ensure air entering the diffuser is controlled by a control orifice.

c. Diffuser consisting of an elongated, peaked dome air chamber with steep inverted V-shaped serrations on both sides. Ensure air exiting the header is controlled by an orifice.

2.2.3.3.3 Valved Orifice Diffusers

Provide one of the following valved orifice diffusers:

a. Diffuser consisting of a molded plastic body with an air flow control orifice and a PVC disc cap retained by a stainless steel ring.

b. Diffuser consisting of a stainless steel body containing a control orifice, a polytetrafluroethylene ball, and a stainless steel deflector disc.

c. Diffuser consisting of a molded plastic body with air release orifices, a ball check valve, and a screw-in cap that allows varying the quantity of orifices through which air can exit.

d. Diffuser consisting of a cone-shaped plastic base with a flexible elastomer cover held in place by a center bolt.

e. Diffuser consisting of a rubber body with a molded control orifice (pinch valve) that is normally closed and is actuated by specific pressures applied to the backside of the diffuser.

2.2.3.4 Lagoon Aeration Diffuser Tubing

****

NOTE: Delete inapplicable types of diffusers and materials of construction.

****

Use [13] [_____] mm [1/2] [_____] inch inside diameter flexible polyethylene diffuser tubing containing small, precise, orifices or slots in the lower side of the tubing at [38] [_____] mm [1-1/2] [_____] inch maximum spacing. Ensure the orifice is small enough to prevent particulate matter from flowing through the orifice during negative diffuser pressure. Pre-weight the diffuser by a continuous lead strip in the bottom of the tube encapsulated in polyethylene.

2.2.3.5 Spare Diffusers

****

NOTE: The percentage of replacements required will be inserted. A sound policy would require sufficient media to enable the operator to replace all media in any one aeration tank.

****

Furnish not less than [_____] percent of the installed quantity of diffusers as replacements. Furnish diffusers complete with all parts required for installation.

2.2.4 Materials and Equipment

Ensure materials and equipment conform to the following respective publications and other specified requirements.

2.2.4.1 Ductile Iron Pipe and Fittings

Provide ductile iron pipe conforming to AWWA C115/A21.15 or AWWA C151/A21.51. Provide thickness class as follows: Class 51 for pipe up to 100 mm 4 inch diameter and over 750 mm 30 inch diameter; Class 51 for pipe 150 mm 6 inch through 600 mm 24 inch diameter. Provide mechanical joints that conform to AWWA C111/A21.11 as modified by AWWA C151/A21.51. Provide flanged joints that conform to AWWA C115/A21.15. Provide fittings that conform to AWWA C110/A21.10. Ensure all buried piping has standard bituminous coating and lining.

2.2.4.2 Steel Pipe and Fittings

Provide steel pipe 150 mm 6 inch in diameter and larger in accordance with AWWA C200. Provide steel pipe less than 150 mm 6 inch in diameter with threaded end, galvanized, in accordance with ASTM A53/A53M, standard weight. Ensure mechanical joints conform to AWWA C200. Ensure flanged joints conform to AWWA C207. Provide fittings for steel pipe 150 mm 6 inch in diameter and larger in accordance with AWWA C200 and fabricated in accordance with AWWA C208. For steel pipe less than 150 mm 6 inch in diameter, provide galvanized fittings in accordance with ASME B16.3.

2.2.4.3 Polyvinyl Chloride (PVC) Pipe and Fittings

****

NOTE: The Designer must use caution when specifying PVC air piping. PVC pipe and fitting use is normally reserved for low pressure, low temperature environments where ultraviolet exposure is limited. PVC tends to become brittle with age and even air pressures much lower than the rated pressure class

of the pipe can cause catostrophic failure.
****

Ensure PVC pipe and fittings conforming to ASTM D1785, Schedule [40] [80] [120], or ASTM D2241, SDR [2l] [26] [32.5]. Use solvent weld joints conforming to ASTM D2564.

2.2.4.4 Stainless Steel Tubing and Fittings

Unless shown or specified otherwise, provide stainless steel tubing in accordance with the following.

2.2.4.4.1 Stainless Steel Tubing

Ensure stainless steel tubing conforms to ASTM A778/A778M. Provide wall thicknesses as follows: tubing 250 mm 10 inch diameter and less, provide 1.59 mm 0.0625 inch (16 gauge) thick tubing; tubing 300 mm 12 inch diameter, provide 1.98 mm 0.078 inch (14 gauge) thick tubing; tubing 350 mm 14 inch through 450 mm 18 inch diameter, provide 2.78 mm 0.109 inch (12 gauge) thick tubing; tubing 500 mm 20 inch diameter, provide 3.17 mm 0.125 inch (11 gauge) thick tubing; tubing 600 mm 24 inch diameter, provide 3.57 mm 0.140 inch (10 gauge) thick tubing.

2.2.4.4.2 Stainless Steel Tubing Fittings

Provide stainless steel tubing fittings conforming to ASTM A774/A774M, grade and schedule or wall thickness as specified for tubing.

2.2.4.4.3 Stainless Steel Tubing Joints

Fabricate stainless steel tubing joints by shop welding full penetration butt joints or Van Stone joints using angle face rings with backing flanges drilled in accordance with ASME B16.5, Class 125.

2.2.4.5 Pipe Hangers and Supports

Provide pipe hangers and supports conforming to MSS SP-58.

2.2.4.6 Valves

2.2.4.6.1 Butterfly Valves

Ensure butterfly valves and operators conform to AWWA C504, air service class [25A] [_____], flanged or mechanical joint ends as required.

2.2.4.6.2 Gate Valves

Ensure gate valves conform to AWWA C500, flanged or mechanical joint ends as required.

2.2.4.6.3 Globe Valves

Ensure globe valves conform to MSS SP-80, Type 3, Class 150.

2.2.4.6.4 Relief and Unloading Valves

Provide combination relief and unloading valves with [carbon steel] [_____] body, that allow blower unloading for startup, and are set for pressure relief at [_____] kPa psig.

2.2.4.6.5 Check Valves

Provide check valves of double door type, flange or wafer style, capable of handling 862 kPa 125 psig cold working pressure (CWP) with cast iron body and aluminum bronze internal parts, low torque spring for low pressure air service. Ensure seal material is capable of handling temperatures from -29 to plus 121 degrees C -20 to plus 250 degrees F with tight shutoff capability.

2.2.4.7 Expansion Couplings

Construct expansion couplings for nonsubmerged locations in the aeration system of materials suitable for temperatures up to 121 degrees C 250 degrees F and pressures up to 103 kPa 15 psig. Use couplings of the filled arch type. Provide back-up or retaining rings as required. Yoke couplings to transmit tension loadings. Ensure the compressive and lateral movement of the joint is not impaired by the yoke system.

2.2.5 Hoist

****

NOTE: Coordinate with type of air distribution system specified. Delete steering attachment where not required.

****

Provide portable hoist designed to raise and lower the [removable] [rotary or swing] air distribution system. Hoist is to be furnished by the aeration system manufacturer. Mount the hoist on wheels or casters [and provide a suitable steering attachment]. Power the unit by [hand] [hand pump] [battery operated motor] [air operated motor] [electric motor] [gasoline engine]. Provide a means to hook the hoist in place during the hoisting operation. Equip the lifting arm with a quick latching arrangement to securely grip the air diffusion unit without the use of tools. Provide a hoist of sufficient capacity for the required service.

2.2.6 Metering and Instrumentation

****

NOTE: Insert section number and title or delete sentence and insert metering and instrumentation requirements.

****

Metering and instrumentation is specified in Section [_____].

2.2.7 Purge System

****

NOTE: Coordinate specific purge system requirements with equipment manufacturer.

****

Provide a purge system incorporated into the aeration system. Locate purge valves at the low points in the system to allow bleeding off of condensed water that builds up in the air piping. Purge valves may be incorporated into an automatic pump system when low points occur below water level.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 EQUIPMENT INSTALLATION

Submit drawings containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show in the drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

3.2.1 Blower Installation

Install blowers as indicated and in accordance with the manufacturer's written instructions.

3.2.2 Air Distribution System Installation

****

NOTE: The range of adjustment of the system on the header is dependent on various design parameters such as header size and basin shape and size. Consult various manufacturers for proper dimension.

****

Install the air distribution system as indicated and in accordance with the manufacturer's written instructions. Perform all excavation, trenching, and backfilling in accordance with the applicable requirements of Section 31 00 00 EARTHWORK. Maintain the crown of the air main at the same elevation. Adjust the system such that all diffusers on a header are within [_____] mm inch of a common horizontal plane.

3.2.3 Diffuser Installation

Install diffusers as indicated and in accordance with the manufacturer's written recommendations.

3.2.4 Framed Instructions

Post framed instructions containing wiring and control diagrams under glass or in laminated plastic where directed. Show wiring and control diagrams and complete layout of the entire system in the instructions. Also include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system. Post the framed instructions acceptance testing of the system.

3.2.5 Welding

****

NOTE: Retain the applicable welding requirements.

****

[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Ensure the procedures and welders are qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer are acceptable to the extent permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests perform all tests at the work site if practical. Instruct the welder or welding operator to apply his assigned symbol near each weld he makes as a permanent record. Weld structural members in accordance with AWS D1.1/D1.1M.] [Welding and non-destructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

3.2.6 Electrical Work

Ensure all electrical work is performed in accordance with the National Electric Code (NFPA 70, Latest Edition).

3.3 FIELD QUALITY CONTROL

3.3.1 Field Testing

Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate the final position of controls in each test report.

3.3.1.1 Blower Test

After the air distribution and diffusion systems have been installed, test each blower at the specified operating conditions to determine compliance with the specifications and proper operation.

3.3.1.2 Piping System Test

Test all piping with air at a minimum of two times the normal design pressure for at least 60 minutes and such additional time as is required for the Contracting Officer to inspect the piping for leaks. Repair all leaks and retest and the system until no leakage is discovered.

3.3.1.3 Diffuser Test

After diffuser installation, cover the diffusers with clear water to a depth of approximately 600 mm 2 feet. Release air through the diffusers and inspect the system for uniform air distribution. Replace diffusers as required to obtain uniformity.

3.3.2 Manufacturer's Services

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Ensure that the representative supervises the installation, adjustment, and testing of the equipment.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Field Training

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [_____] hours of normal working time and start training after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the operating and maintenance manuals in the field training.

3.4.2 Operating and Maintenance Manuals

Provide [six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. Submit one complete set prior to performance testing and the remainder upon acceptance. Ensure the operating manuals detail the step-by-step procedures required for system startup, operation, and shutdown. Ensure operating manuals include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Ensure the maintenance manuals list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Have all manuals approved prior to the field training course.

3.5 PAINTING

Conduct all field painting as specified in Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-46 53 22 (May 2018)**

Preparing Activity: USACE **Superseding**
UFGS-43 31 14 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION TABLE OF CONTENTS

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SECTION 46 53 22

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PART 2 PRODUCTS

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USACE / NAVFAC / AFCEC **UFGS-46 53 22 (May 2018)**

Preparing Activity: USACE **Superseding**
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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****

SECTION 46 53 22

TRICKLING FILTER

05/18

****

NOTE: This guide specification covers the requirements for a trickling filter for use in sewage treatment plants normally handling domestic sewage.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insertappropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: Special consideration must be given to sewage carrying industrial wastes containing components detrimental to biodegrading microorganisms. Show the following information on the project drawings or provided by the project designer:

a. Dimensions of filter tank and elevation of base slab.

b. Design flows and loading rate.

c. Available head.

d. Depth of filter bed.

e. Size of inlet piping.

f. Location of vent stack pipes.

g. Design loads for wind and ice where applicable.

h. Clearance of arms above filter surface.

i. Number of distribution arms.

j. Type(s) of filter media to be allowed.

k. Type of filter blocks.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B241/B241M	(2022) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B429/B429M	(2010; E 2012) Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C144	(2024) Standard Specification for Aggregate for Masonry Mortar
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C159	(2006; R 2021) Standard Specification for Vitrified Clay Filter Blocks
ASTM C700	(2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 8	(1982; E 2004) Pickling

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Rotary Distributor; G, [_____]

SD-03 Product Data

Rotary Distributor; G, [_____]

Spare Parts

Submit spare parts data after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy.

Plastic Media; G, [_____]Filter Media

SD-07 Certificates

Size And Grading

Layout Of Filter Block Units

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals

1.3 EXTRA MATERIALS

Provide spare nozzles, seals, and all other standard spare parts as recommended in the manufacturer's instruction manuals for each component of the equipment. Include a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A trickling filter includes a rotary distributor, reinforced concrete walls and base, filter media, filter block underdrainage system, and all other components indicated or necessary for proper operation.

2.2 MATERIALS

****

NOTE: Delete materials that are not used.

****

2.2.1 Standard Products

Unless otherwise specified, provide standard commercial products in regular production by the manufacturer and suitable for the required service. [Provide ASTM A36/A36M structural steel.] [Provide ASTM A53/A53M steel pipe for structural members and distributor arms.] [Provide steel members with a minimum thickness of 6 mm 1/4 inch when members will be in contact with sewage, completely or intermittently, during normal operation of the equipment.] [Provide ASTM A48/A48M, Class 30 cast iron.] [Provide ASTM B209 (3003-H14)aluminum alloy for structural members, and provide ASTM B429/B429M (6063-T6) aluminum alloy for pipe.]

2.2.2 Materials Protection

Provide ferrous metal surfaces that can be pickled in accordance with SSPC SP 8. Provide ferrous metal surfaces, including rotating assembly, distributor arms, supports, and attachments that are zinc coated in accordance with ASTM A123/A123M or ASTM A153/A153M, as applicable. Pickle and galvanize the interior and exterior of all fabricated ferrous metal components after fabrication. Insulate components such as gaskets, couplings, or bushings, of a dielectric-type To prevent corrosive action of bimetallic-type contacts, at connections between dissimilar metals.

2.2.3 FILTER MEDIA

2.2.3.1 Quality

****

NOTE: When plastic media is to be used exclusively, delete all requirements for and reference to other materials. Consider economic and geographic influences when deciding the filter media type. When trickling filters will be used in cold weather conditions, covers, hydraulic controls, and ventilation should be considered to ensure the optimum trickling filter biological performance.

****

[Provide [crushed stone or crushed slag][or][random-dumped or stacked modular plastic] media. Ensure the top 460 mm 18 inches of media has a loss by the 20-cycle sodium sulfate soundness test of ASTM C88 of not more than 10 percent by weight; the balance of the media must pass a 10-cycle test using the same criteria.] [Provide plastic media that is random-dumped ring type or stacked modular type. Provide random-dumped ring type media of long term heat aging, rigid polypropylene plastic specially manufactured as trickling filter media, with a minimum void volume of 90 percent, and a minimum surface area of 82 square meters per cubic meter 25 square feet per cubic foot.] [Provide plastic stacked modular type [vertical or crossflow] media of saran, polyvinyl chloride (PVC), fiberglass reinforced resins, or plastic equally resistant to oxidation, ozone aging or effects of ultraviolet exposure, and a minimum void volume and surface area per cubic meters feet volume as required for random-dumped ring type media.] Provide media with a minimum projected life of 25 years in the intended service. Base projected life on case history or simulated aging tests as performed by an independent testing laboratory acceptable to the Contracting Officer. Substantiate such tests by certified test reports. Provide installed media that can provide support for the weight of two workmen working together on any part of the surface of the filter without damage or displacement of the media.

2.2.3.2 Size and Grading

[Conform stone or slag media to the following size distribution and grading and mechanical graded over a vibrating screen with square opening: 100 percent passing 5.0 inch sieve; 95-100 percent by weight retained on 3.0 inch sieve; 2 percent by weight passing the 2.0 inch sieve; and 1 percent by weight passing the 1.0 inch sieve.] [Provide plastic media in accordance with the manufacturer's standard as approved by the Contracting Officer. Provide random-dumped media with a specific gravity between 0.90-0.97 grams per cubic centimeter, a minimum tensile strength of 4500 pounds per square inch, and a minimum modulus of elasticity of 200000 pounds per square inch. Provide stacked modular media with a specific gravity between 1.39-1.50 grams per cubic cemtimeter, a minimum tensile strength of 6000 pounds per square inch, and a minimum modulus of elasticity of 325000 pounds per square inch. Evaluate the module's bearing capacity in the top layer, intermediate layers, and bottom layers.]

2.3 EQUIPMENT

2.3.1 Standard Products

Unless otherwise specified, provide standard commercial products in regular production by the manufacturer and suitable for the required service.

2.3.2 Rotary Distributor

Provide a rotary distributor suitable for the uniform distribution of sewage over the filter bed at the rates of flow and operating conditions specified herein. Provide a rotary distributor including distributor arms, center column, and other appurtenances necessary for proper operation. Provide a rotary distributor that rotates solely from the reaction of sewage flowing through jets or nozzles in the distributor arms and operates freely and effectively over the entire range of operation. Submit detail rotary distributor drawings and installation instructions. Include detail drawings containing equipment layout and anchorage, and sufficient details to demonstrate that the rotary distributor will properly function as a unit.

2.3.2.1 Operating Requirements

****

NOTE: Delete ice coating requirements in warm climates.

****

Provide a rotary distributor designed for a filter bed of [_____] mm feet inside diameter. Provide design flows that range from a minimum of [_____] L/second gpm to a maximum of [_____] L/second gpm and with average design loading of [_____] L/second gpm. Provide an available total head at the inlet (above the media surface) of [_____] at the maximum rate of flow. Ensure the maximum velocity in the arms does not exceed 1.22 m/second 4.0 fps. Provide a rotary distributor and each of its component parts that are designed to withstand all structural and mechanical stresses brought about by the following loadings: weight of equipment plus liquid; wind loading; and a live load of [_____] N pounds at any point on the arm; and an ice coating of [_____] mm inch thick. Provide a minimum safety factor of 1.6 based on the yield point of the steel. Provide anchorage of the concrete center pier that is designed to resist, with a 2.0 minimum safety factor, a maximum overturning moment brought about when arms on one side of the distributor are filled with water and those on the other side are empty. Ensure vertical deflections at the end of the distributor arms do not exceed 100 mm 4 inches. Provide arms that have a clearance above the surface of filter bed as indicated. Provide a rotary distributor designed for continuous 24-hour service under the design load without excessive wear, damage, or failure. Ensure stresses developed under the aforementioned operating conditions and loads do not exceed the stresses allowed under AISC 360.

2.3.2.2 Center Column

****

NOTE: Delete bracketed wording pertaining to weirs or dependent on the provisions of weirs when distributors have less than four arms, except when two-compartment arms are used.

The trickling filter tank should be constructed in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Walls should have standard finish. Horizontal surfaces should have screed finish. Insert the following requirements in the appropriate place: "Construct the hollow concrete center pier,

including installation of anchor bolts, in accordance with the recommendations of the manufacturer of the rotary distributor, as approved by the Contracting Officer."

Type IIA cement normally will be specified, but Type V cement will be specified when the soils contain in excess of 0.2 percent water soluble sulfate as SO(4), or waste water contains in excess of 1,000 parts per million sulfates. Alkali reactive aggregates require use of a cement containing less than 0.60 percent alkalis. Type I cement may be permitted when it can be assured that the water soluble sulfates in the soil will be less than 0.1 percent and the waste water will contain less than 150 parts per million sulfates over the design life of the project. Air entrainment admixtures will be used in all types of concrete.

****

Provide a mast-type or turntable-type center column including a stationary assembly, rotating assembly, seal, bearing assembly, lubricating fittings, and anchor bolts. Provide port areas or openings to permit unrestricted flow of sewage from inlet in stationary assembly through rotating assembly into distributor arms.

a. Stationary Assembly: Fabricate elements of the stationary assembly from cast iron, structural steel, steel pipe, or aluminum alloy. Provide a stationary assembly with a [_____] mm inch diameter inlet, and designed for anchorage to the hollow concrete center pier by anchor bolts.

b. Rotating Assembly: Fabricate elements of the rotating assembly from cast iron, structural steel, or aluminum alloy, except as otherwise specified herein. Select cast iron turntables only, when provided. Provide steel for nonstructural applications with a minimum yield point of 207 MPa 30,000 psi. [Provide an adjustable weir to divide the flow between the primary and secondary arms so that only primary arms will operate at minimum flow and that all arms will discharge uniformly at maximum flow. Provide a weir that is accessible for adjustment without dismantling the equipment. Provide a weir in the rotating assembly, unless provided in each secondary arm as specified hereinafter.] Provide a rotating assembly with machined surfaces suitable for installation of distributor arms and a height that provides suitable anchorage for the distributor arm supports.

c. Seal: Provide a mechanical seal or an air gap to prevent the leakage of water between the stationary and rotating assemblies at the maximum hydraulic head. Any type of seal employing mercury as the sealing element is not allowed.

    (1) Mechanical Seal: Design the mechanical seal, to withstand the full hydraulic head in the rotating assembly. Provide seals having an annular ring of replaceable grease-resistant neoprene or tetrafluoroethylene with a low coefficient of friction. Provide seals between horizontal surfaces that are maintained against the seal plate by annular steel weight strips and steel seal clamps. Provide seals between vertical surfaces that are spring loaded in steel retainer rings attached to the rotating assembly.

(2) Air Gap: Provide an air gap, to prevent the liquid from entering the rotor bearing and that requires no auxiliary equipment to maintain the air gap between the fixed feeder pipe or column and the rotating sleeve and/or drum. Provide means to prevent the liquid level in the rotating equipment from rising positively to the elevation of the air gap. Provide a relief device to prevent this that is constructed to force any overflow to discharge on the surface of the filter, visible to the operator and at a point above or apart from normal distribution outlets.

d. Bearings: Ensure radial and axial loads of the rotating assembly and distributor arms are transmitted to the stationary assembly by an anti-friction thrust bearing of the ball or roller type. Provide guide or steady bearings where necessary to maintain alignment. Design bearing so that the rotating assembly maintains its alignment, starts freely, and operates satisfactorily at the minimum head at all conditions of wind and temperature. Ensure bearings are designed for the vertical thrust of the machine full of water and the horizontal thrust due to eccentric loads on the arms. Provide bearings that have a minimum rated life expectancy of 100,000 hours (L-10). When the equipment is operating continuously under specified loading conditions, the load rating and the fatigue life is based on ABMA 9 and ABMA 11, as applicable.

e. Lubrication Fittings: Provide all moving parts subject to wear and all bearings with adequate means for lubrication. Lubrication is by grease or oil, as suitable. Provide greased bearings with fittings for grease gun service. If not easily accessible, provide a bearing lubrication with grease tubing extended to convenient locations. Provide grease fittings that prevent over-lubrication and pressure build-up injurious to bearings. Provide oil reservoirs that are liberal in size and have an opening for filling, an overflow opening at the proper location to prevent overfilling, an oil-level sight glass, and a drain at the lowest point. Provide the manufacturer's recommended lubricant sufficient for 6 months of normal operation.

f. Anchor Bolts: Provide anchor bolts, with necessary hex nuts and washers, fabricated of Type 304 stainless steel. Provide anchor bolts and accessories to secure the stationary assembly to the hollow concrete center pier.

2.3.2.3 Distributor Arms

Provide distributor arms that are attached to the rotating assembly by flanged or screwed connections. Provide arms fabricated of steel pipe, structural steel with a minimum wall thickness of 6 mm 1/4 inch, or aluminum alloy that conforms to ASTM B241/B241M. [When the adjustable flow division weir specified in paragraph Rotating Assembly is not provided in the rotating assembly, provide one adjustable, accessible overflow weir in each secondary arm to cut off flow to that arm at minimum flow and to allow uniform flow of all arms at maximum flow.] Provide the end of each arm with a quick-opening shear gate for flushing. Support the arms from the rotating assembly by cables, steel tie rods with turnbuckles, or a steel truss. Conform wire strand for cables to ASTM A475. Provide arm supportsto support the design loads. Brace arms laterally by means of horizontal steel tie rods with turnbuckles. Provide each arm with openings spaced to distribute the flow uniformly over the filter bed. Provide nozzles and spreaders at each opening and constructed of corrosion-resistant nonferrous material. Design nozzles to provide maximum reactive force with minimum head loss. Ensure spreaders disperse the flow evenly from each opening. Provide spreaders that are easily removable for cleaning and equipped with replaceable orifices permitting variation of flow capacity with different orifices. Provide rectangular-arm distributors that have orifices in the spreaders. Provide orifices of nonclogging design.

2.3.2.4 Center Pier Supply Fittings

Provide the [_____] mm inch supply inlet line junction fitting with a [base tee and riser pipe] [base-plate with short riser pipe and flange] suitable for the rotary distributor center column attachment. Construct center pier supply fittings of ductile iron, or steel conforming to AWWA C151/A21.51 or ASTM A53/A53M, respectively.

2.4 FILTER BLOCKS

Provide an underdrain system that includes rectangular and cut tile blocks, cover blocks for drainage channels, and vent blocks. Conform all blocks to ASTM C159, Type I-H, except provide cover blocks without apertures and provide vent blocks with openings to accommodate vent stacks. Provide cut or angle blocks that are cut on an angle to conform approximately to the wall curvature. Provide filter underdrain blocks that have semicircular inverts or equivalent sections and cover the entire floor of the filter. Provide vent stack pipes of extra strength vitrified clay pipe conforming to ASTM C700 and that are provided as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Placing Rotary Distributor

****

NOTE: Delete bracketed wording pertaining to weirs or dependent on the provisions of weirs when distributors have less than four arms, except when two-compartment arms are used. Coordinate with paragraph CENTER COLUMN.

****

Provide rotary distributor that is installed in accordance with the recommendations of the manufacturer and by workmen experienced in the installation of this type of equipment. Carefully check all components with galvanized or other corrosion-protective coating and restore any damaged or abraded areas to the original or an equivalent coating. Provide proper alignment of all equipment. Set the anchor bolts in place and the nuts tightened against the shims. Securely bolt the stationary assembly in place. Further check the alignment of equipment after securing to the foundations and, after confirming all alignments, grout the stationary assembly in place using grout that conforms to ASTM C1107/C1107M. Align equipment with associated piping and under no circumstances will "pipe springing" be allowed.[Set the weirs in accordance with the directions of the manufacturer, based on anticipated flows.]

3.1.2 Placing Filter Block

Lay filter underdrain blocks in a dry mortar bed. Provide mortar thatcontain one part cement conforming to ASTM C150/C150M, Type II, and 4 parts sand conforming to ASTM C144, except a 1:3 cement-sand mortar bed for the first course of blocks where cover blocks are used. After the blocks are laid and before the stone is placed, dampen the dry mortar bed by sprinkling. Install filter blocks providing an uninterrupted flow through the drainage channels in the blocks to the effluent channel. Lay blocks in true alignment, with cross joints staggered in longitudinal rows at right angles to the center drains. Start the rows of blocks at the edge of the drainage channel and end at a sufficient distance from the filter wall to provide an air passage around the inside periphery of the filter. Provide air ducts comprised of either blocks or stacks for venting air to the atmosphere as shown on the drawings. Provide the manufacturer's plan layout of filter block units.

3.1.3 Placing Filter Media

[Store stone or slag media delivered to the filter site on wood planks or other clean hard surface areas. Do not dump stone and slag directly into the filter. Rescreen and fork the media at the filter site to remove all fines before placement in the filter. Place material by hand to a depth of 300 mm 12 inches above the filter blocks and place all material without damaging or displacing the underdrains. Place the remainder of the material by means of belt conveyors, wheelbarrows, or other equipment recommended by the manufacturer. Place the media in layers not exceeding 450 mm 18 inches in depth. Place filter media as near as practicable in final position to avoid excessive rehandling; take special care to avoid breakage or segregation of different size particles. Dumping the filter media directly from trucks into the filter, dropping the filter media from heights exceeding 1 m 3 feet or throwing the media into the filter is not permitted. If it is determined that an excessive amount of fractured stone or dust is passing into the underdrains, remove and rescreen the filter media at a location outside the filter walls. Walkways or runways over the filter, except for the purpose of installing materials or equipment for the filter, are not be permitted. Storing materials, such as cement or sand, or placing heavy construction equipment within the filter walls will not be permitted. Do not pass concrete, sand, dirt, or other materials deleterious to the filter over the filter by any means. Driving trucks, tractors, or other heavy equipment over the filter during or after construction is not permitted.][Install plastic filter media in accordance with the recommendations of the media manufacturer.]

3.2 FIELD TESTS AND INSPECTIONS

Provide all labor, equipment, and incidentals required for the tests, except that water required for the field tests will be supplied as set forth in the CONTRACT. Notify the Contracting Officer [_____] days prior to dates and times of field tests. Perform all field tests in the presence of the Contracting Oficer. Rectify any deficiencies found and completely retest work affected by such deficiencies. Test the distributor mechanism to demonstrate correct alignment, smooth operation, and uniformity of flow distribution over the filter media.

3.3 CLOSEOUT ACTIVITIES

Submit operating and maintenance manuals. Provide manuals that include the manufacturer's name, model number, service manual, parts list, brief description of all equipment and their basic operating features, and simplified wiring diagrams for the system as installed.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-46 53 62 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 53 62 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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SECTION 46 53 62

CONTINUOUS LOOP REACTOR (CLR) WASTEWATER TREATMENT SYSTEM

05/21

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USACE / NAVFAC / AFCEC **UFGS-46 53 62 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 53 62 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 46 53 62

CONTINUOUS LOOP REACTOR (CLR) WASTEWATER TREATMENT SYSTEM
05/21

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NOTE: This guide specification covers the requirements for continuous loop reactor wastewater treatment system.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6013	(2006A; R2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 2-06	(2007) Measurement of Oxygen Transfer in Clean Water

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B31.1	(2024) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm) and Larger

AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2023) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C509	(2023) Resilient-Seated Gate Valves for Water Supply Service

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A420/A420M	(2024a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service
ASTM A707/A707M	(2019) Standard Specification for Forged Carbon and Alloy Steel Flanges for Low-Temperature Service
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for

Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Treatment System Installation; G, [_____]

SD-03 Product Data

Manufactured Units; G, [_____]

Spare Parts; G, [_____]

Framed Instructions; G, [_____]

Manufacturer's Written Instructions; G, [_____]

Welding

SD-06 Test Reports

Field Tests and Inspections; G, [_____]

Furnish test results in booklet form not less than 30 days prior to the date of work completion.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, [_____]

[Six] [_____] [hard] [optical disc] copies.

1.3 MAINTENANCE MATERIAL SUBMITTALS

1.3.1 Extra Materials

Submit spare parts data for all materials and for each different item of equipment specified, after approval of the detail drawings, and not later than [3] [_____] months prior to the date of work completion. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect from damage, deterioration, weather, humidity and temperature variations, dirt and dust, or other contaminants, equipment in storage as required by the manufacturer.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: A continuous loop reactor or oxidation ditch utilizes biological action to degrade organics in the wastewater. Consideration should be given to wastewaters from industrial facilities to ensure there are no components detrimental to microorganisms. In addition, Army facilities utilizing continuous loop reactors should include pretreatment equipment such as bar screens, comminuters and a grit chamber as required by the process conditions. Final clarification, sludge handling and disinfection equipment is also generally required. These and other possible components of the complete treatment system guide are not covered under this section.

Continuous loop reactors can take on many shapes (racetrack, folded U, concentric multi-channel, etc.) and configurations (serus, parallel, etc.). The designer is required to consider these options for space limitations, construction cost considerations, maintenane cost considerations, etc.

As required for military construction, only sprayed concrete (shotcrete) or placed reinforced concrete will be acceptable for the basin construction. Clay lined or synthetic membrane lined basins (even those protected from erosion) are not acceptable.

****

The work required by this section consists of furnishing and installing a continuous loop reactor (CLR). The system specified is a modified form of the activated sludge process and classified as an extended aeration system. The basin is to be constructed of an [earthen channel with an impervious sprayed concrete surface] [reinforced concrete structure], constructed at the depth and configuration indicated. The basin includes all aeration/mixing equipment, [piping,] [pumps,] [baffles,] [weirs] and [turning walls] necessary for proper performance and operation.

2.1.1 Design Requirements

****

NOTE: Some states and regulatory agencies require a minimum detention time of 24 hours. Check the governing regulations for activated sludge/extended aeration processes for the project location.

Insert average daily and peak daily flow rates and the required BOD5 removal efficiency. Typically,

90-95 percent removal can be achieved in a continuous loop reactor. Comply with UFC 3-240-02 to determine design criteria.

****

Treatment of the wastewater is accomplished by contact with the waste activated sludge in the CLR for a minimum of [18] [_____] hours. Size the CLR for an average daily flow of [_____] L/second mgd and a peak daily flow of [_____] L/second mgd. The CLR is required to remove a minimum of [_____] percent of the influent five day BOD at the average daily flow rate and influent five day BOD.

2.1.2 Mixing Parameters

The aeration/mixing system selected provides the propelling force for circulation and mixing of the basin contents. Size the aeration/mixing unit(s) to maintain an average horizontal velocity of not less than [0.305] [_____] m/second [1.0] [_____] fps throughout the basin and maintain a uniform mixed liquor suspended solids (MLSS) concentration throughout the basin at MLSS concentrations up to [5000] [_____] mg/L, with one aeration/mixing device not operating.

2.1.3 Aeration Parameters

****

NOTE: The Actual Oxygen Requirement (AOR) is calculated by the designer. The oxygen required for oxidation of BOD and the oxygen required for nitrification must be included in the AOR. Typical values are 0.82 kg 1.8 pounds of oxygen per 0.45 kg 1.0 pound of BOD applied and 2.1 kg 4.6 pounds of oxygen per 0.45 kg 1.0 pound of TKN applied. The alpha coefficient is defined as the ratio of the oxygen transfer in the wastewater to the oxygen transfer in clean water and may vary from 0.2 to 1.5. The alpha coefficient is a direct multiplier in determining oxygen transfer capabilities and is affected by mixed liquor temperature, liquid depth and basin geometry, the level of turbulence, mixing patterns and the nature of dissolved organics and mineral constituents in the wastewater and even the type of aeration equipment. Fine bubble aeration systems typically have lower alpha values than mechanical aeration systems. Because of this variation in alpha value a default value is not shown below. The Beta coefficient is defined as the ratio of oxygen saturation level for the wastewater (mixed liquor) to the oxygen saturation level for tap water. Theta is a temperature correction coefficient for oxygen transfer efficiency (OTE). Values of 1.020 to 1.028 are normally used for diffused air systems, while a value of 1.024 is normally used for mechanical aeration systems.

An OTE of 0.507 mg oxygen per joule 3.0 lb. oxygen/hp-hr under standard conditions is an average value for aeration equipment commonly used in closed loop reactor applications. Designer should contact the aerator manufacturer for the OTE of a particular

aerator. An aeration system in this range will provide oxygen transfer for an average power cost. Insert the efficiency value desired for the particular design.

The requirement to maintain a minimum dissolved oxygen concentration of 0.5 mg/L should be omitted if the designer has provided for an anoxic zone within the reactor.
****

Base the aeration/mixing system selected upon the following process requirements:

a. Actual Oxygen Requirement (AOR) [_____] kg oxygen/day lbs. oxygen/day.

b. Alpha Coefficient [_____].

c. Beta Coefficient [0.95] [_____].

d. Theta Coefficient [1.024] [_____].

e. Wastewater temperature [20] [_____] degrees C [68] [_____] degrees F.

Select the aeration/mixing system to provide no less than [_____] mg oxygen/joule lb. oxygen/hp-hr under standard (clean water) conditions [and to maintaining a dissolved oxygen concentration of not less than [0.5] [_____] mg/L anywhere in the CLR]. Provide factory test results for a similar treatment application and configuration to substantiate the OTE.

2.2 MANUFACTURED UNITS

Provide a complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; installation instructions; and a recommendation on quantities of spare parts to have on hand at all times for each piece of equipment.

2.2.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and which essentially duplicate items that have been in satisfactory use in similar facilities for at least 2 years prior to bid opening. Ensure all aeration/mixing equipment, associated accessories, and appurtenances is supplied by the same manufacturer. Ensure equipment is supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.2 Nameplates

Provide pumps, blowers and motors with the manufacturer's name, address, type or style, model or serial number, and catalog number on a stainless steel plate permanently secured to the item of equipment.

2.2.3 Protection of Moving Parts

Completely enclose, chains, couplings, and other moving parts by use of guards to prevent accidental personal injury. Configure guards to be removable or so arranged as to allow access to the equipment for maintenance. If equipment is housed in a lockable housing, ensure housing provides sufficient protection and no additional guards are necessary.

2.3 EQUIPMENT

2.3.1 Disc and Rotor Aerators

****

NOTE: The paragraphs that follow contain optional types of aeration systems which may be used by the designer. Only the paragraphs applying to the selected system should be left and the others removed. However, if the disc and rotor option is selected note that these aerators can normally be substituted, one for the other, in the same basin configuration so that both disc and rotors may be specified.

****

2.3.1.1 Aeration Mechanism

Provide the [disc] [or] [rotor] aeration system as indicated. Provide complete units and include [disc] [or] [rotor] assemblies, shaft, or torque tube, drive unit, bearings, supports and all appurtenances necessary for the proper operation of the equipment. Design the [disc] [or] [rotor] aeration system for continuous operation.

2.3.1.1.1 Disc Assembly

****

NOTE: Twelve individual discs or rotors in an assembly are typical. The diameter of the unit is variable and should be designed based upon basin configuration, oxygen transfer rates, velocity and efficiency requirements.

****

Provide each assembly with individually molded [plastic] [fiberglass] discs, [_____] mm inch in diameter and mounted not less than 150 mm 6 inch on center. Provide the number and spacing of disc assemblies indicated. Secure the disc assemblies to the shaft with a clamp ring, by using a keyed shaft or by another method to hold the assembly tightly, ensure no slippage, and provide continuous proper alignment. Split the discs into two sections for attachment or removal without disassembling the shafting. Supply stainless steel positioning bolts to hold the two halves together on the shaft.

2.3.1.1.2 Rotor Assembly

****

NOTE: Twelve individual discs or rotors in an assembly are typical. The diameter of the unit is variable and should be designed based upon basin configuration, oxygen transfer rates, velocity and efficiency requirements.

****

Each blade assembly consists of [12] [_____] individual or six dual [stainless steel] [plastic] [epoxy coated steel] [hot-dipped galvanized steel] blades, [_____] mm inch in diameter mounted not less than 150 mm 6 inch on center. Provide the number and spacing of rotor assemblies indicated. Secure the blade assemblies to the shaft with a clamp ring, by using a keyed shaft, by compression between the assembly blades and the shaft or by another method to hold the assembly tightly, ensure no slippage, and provide continuous proper alignment. Provide the blades so they are removable by unbolting. Welding blades to the shaft is not allowed.

2.3.1.1.3 Velocity Baffles

Provide velocity baffles at the indicated locations and alignment and in accordance with all structural and installation requirements as recommended by the manufacturer of the aeration mechanism.

2.3.1.1.4 Splash Plates

****

NOTE: If outboard bearings are not required or if they are designed to be wetted, or if protective covering hoods include splash protection delete this paragraph.

****

Mount fabricated [steel] [aluminum] [stainless steel] plates in the vertical concrete walls at the drive assembly and outboard bearings and bolt to the frames as indicated. Ensure the opening in the wall formed by the splash plate is of sufficient width for removal of shafts. Where the shaft passes through the splash plates, provide a rubber gasket seal on both sides to seal water from the service area.

2.3.1.1.5 Disc and Rotor Immersion Requirements

****

NOTE: To maintain the water level within the recommended range it is very important that the effluent weir be sized properly and be manually adjustable.

The immersion depth will vary with the diameter of rotor selected. The depths indicated assume a standard 1220 mm 48 inch diameter unit.

****

To ensure the most efficient operation of the aeration system and to avoid damage to the drive system the [operate disc with a minimum immersion of [300] [_____] mm [12] [_____] inch and a maximum immersion of [535] [_____] mm [21] [_____] inch] [operate rotor blades with a minimum immersion of [100] [_____] mm [4] [_____] inch and a maximum immersion of [355] [_____] mm [14] [_____] inch].

2.3.1.1.6 Shafts and Bearings

****

NOTE: There are no apparent mechanical or operational advantages in stub shafts and continuous through shafts. Different manufacturers market different shafts. Check with potential

manufacturers before specifying shaft type. Contractor should usually be allowed to use either shaft.

****

Support the [disc] [or] [rotor] assembly at both ends by a shaft fabricated of steel conforming to ASTM A36/A36M. Provide a [solid steel shaft] [steel torque tube shaft with a minimum 9.5 mm 0.375 inch wall thickness]. Furnish each [disc] [or] [rotor] assembly support bearing assemblies. Ensure bearings are waterproof, self-aligning and consist of a cast-iron pillow block set on adjustable anchor plates. Provide grease lubricated bearings with a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11.

2.3.1.1.7 Protective Covering

Provide an [ultraviolet light protected fiberglass] [_____] cover, extending over the length of each aeration unit. Design the cover to protect all adjacent structures from splashing caused by the units. Mount the cover independent of the aeration equipment and install in accordance with the manufacturer's requirements.

2.3.1.2 Drive System

2.3.1.2.1 Reducer

Construct the drive system reducer to maintain alignment of bearings and gearing while absorbing the external loads of the [disc] [or] [rotor] assembly. Design the unit to continuously withstand all internal loadings developed at the full load motor wattage horsepower, including motor starting torques up to 250 percent of motor running torques. Design the unit to also withstand all external loadings produced by torque, out-of-balance and vibration resulting from operating conditions. Provide a speed reducer with lifting lugs. Vent the interior of the gear case by use of an approved breather, constructed to retard the entrance of water vapor.

2.3.1.2.2 Housing

Construct drive to be weatherproof and made of steel in accordance with ASTM A36/A36M or high grade cast-iron in accordance with ASTM A48/A48M. Apply a protective coating that will not peel, crack or discolor at continuous operating temperatures up to 121 degrees C 250 degrees F.

2.3.1.2.3 Rating

Provide drive gearing with a minimum service factor of at least [1.4] [_____] times the rated brake horsepower of the drive motor. Ensure gear reduction system is suitable for continuous operation and moderate shock loading in accordance with ANSI/AGMA 6113AGMA 6013 for gear motor reducers or gear motors using helical and spiral bevel gears.

2.3.1.2.4 Bearings

Provide power transmission bearings that are of the antifriction type and have a minimum L-10 life of 100,000 hours at maximum operating speed in accordance with ABMA 9 or ABMA 11. Ensure bearings are fully sealed and protected from water spray.

2.3.1.2.5 Lubrication

****

NOTE: If lubricating pumps are not used delete subparagraph b. and edit accordingly.

****

a. Provide lubrication by [gears running in an oil bath] [an oil slinger] [pumps]. Provide the drive with an oil "dam", spring loaded lip seals or other means of positive protection against lubricant leakage around the output shaft. Also provide an oil level gauge or sight glass and drain fittings. Ensure the thermal rating of the gear reducer exceeds the design load or provide proper cooling.

b. Ensure lubricating pumps are removable for maintenance without disassembly of the drive and/or removal of the motor. Provide either a low pressure or low oil level switch to shut off the unit in the event of insufficient lubrication.

2.3.1.2.6 Couplings

Transmit power from the motor to the gear reduction system by means of [a flexible coupling, direct drive of the non-lubricated type, manufacturer's standard, selected to provide a minimum service factor of 2.0] [sheaves and [V-belts] [chains]. To reduce the output speed, provide removable sheaves.] Cover the assembly with a suitable guard and protect from splashing.

2.3.1.3 Mounting

Provide a base mounted drive system which is separately mounted on a concrete pier or a shaft mounted drive system which is supported by the drive side rotor bearing.

2.3.2 Low Speed Surface Aerators

Furnish and install low speed mechanical surface aerators as indicated. Ensure each supplied unit is complete and include an electric motor, a gear reducer, shaft and impeller driven at a constant speed, and all necessary fasteners, stabilizers, anchoring devices, and other mechanical and structural appurtenances necessary for the mounting and operation of the units. Design the aerators for continuous operation.

2.3.2.1 Impeller Shaft

Construct the shaft of [carbon steel] [_____] and size to withstand all torque loads and bending moments produced by operation of the system. Design the shaft and bearing assembly to allow operation below 80 percent of its natural frequency without the use of stabilizing devices. Ensure the shaft is constructed so its deflection will not affect the alignment of the antifriction bearings or cause misalignment of the gearing during the mixing/aeration operation. Ensure the shaft supporting the impeller is removable from the drive assembly, without disassembly of the gear box. Use rolling, antifriction type bearings on the impeller shaft which have a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11. Support the entire weight of the shaft and impeller by a thrust bearing integral with the gear reducer. Use a rigid coupling to connect the shaft and turbine assembly to the output shaft of the reducer. Provide bearings on the shaft that are either grease or oil lubricated, and are positively sealed against penetration of moisture, or leakage of lubricant down the shaft. Include provisions for checking the adequacy of lubrication.

2.3.2.2 Impeller

Construct the impeller of [carbon steel] [_____] and positively fasten it to the shaft with all [carbon steel] [_____] hardware. Provide means for adjustment of the impeller. If the adjustment is on the shaft, provide means to prevent the impeller from dropping off the shaft during adjustment. Impeller submergence to ensure the most efficient operation of the aeration system.

2.3.2.3 Drive System

2.3.2.3.1 Reducer

Construct the drive system reducer to maintain alignment of bearings and gearing while absorbing the external loads of the impeller. Design the unit to withstand continuously all internal loadings developed at the full load motor wattage horsepower, including motor starting torques up to 250 percent of motor running torques. Design the unit to also withstand all external loadings produced by torque, thrust, out-of-balance and vibration resulting from operating conditions. Provide the speed reducer with lifting lugs. Vent the interior of the gear case by means of an approved breather, constructed to retard the entrance of water vapor.

2.3.2.3.2 Housing

Construct the drive housing to be waterproof and made of steel in accordance with ASTM A36/A36M or high grade cast-iron conforming to ASTM A48/A48M. Apply a protective coating that will not peel, crack or discolor at continuous operating temperatures up to 121 degrees C 250 degrees F.

2.3.2.3.3 Rating

Provide gearing with a minimum service factor of at least [2.5] [_____] times the rated brake horsepower of the drive motor. Ensure the gear reduction system is suitable for continuous operation and moderate shock loading in accordance with ANSI/AGMA 6113AGMA 6013 for motor reducers or gear motors using helical and spiral bevel gears.

2.3.2.3.4 Bearings

Use power transmission bearings of the antifriction type which have a minimum L-10 life of 100,000 hours at maximum operating speed in accordance with ABMA 9 or ABMA 11. Ensure bearings are fully sealed and protected from water spray.

2.3.2.3.5 Lubrication

****

NOTE: If lubricating pumps are not used delete subparagraph b. and edit accordingly.

****

a. Provide for lubrication by [gears running in an oil bath] [an oil slinger] [pumps]. Provide drive with an oil "dam" or other means of positive protection against lubricant leakage around the output shaft.

Also provide an oil level gauge or sight glass and drain fittings. Ensure the thermal rating of the gear reducer exceeds the design load. If this is not the case, then provide a proper means of cooling.

b. Ensure lubricating pumps are removable for maintenance without disassembly of the drive and/or removal of the motor. Provide either a low pressure or low oil level switch to shut off the unit in the event of insufficient lubrication.

2.3.2.3.6 Couplings

Transmit power from the motor to the gear reduction system by a non-lubricated coupling which is direct driven. Use manufacturer's standard couplings selected to provide a minimum service factor of 2.0.

2.3.2.4 Mounting

****

NOTE: To maintain the water level within the recommended range it is very important that the effluent weir be sized properly and be manually adjustable. Verify immersion depth with potential manufacturers.

****

Construct a [structural bridge of steel conforming to ASTM A36/A36M] [concrete bridge] and support assembly designed to mount each aeration unit as indicated. Structurally anchor the bridge assembly to the basin walls. To ensure the most efficient operation of the aeration system, mount the aerator with the top of the impeller blades [50] [_____] mm [2] [_____] inch above the minimum water surface elevation. Ensure the blades are not submerged more than [200] [_____] mm [8] [_____] inch at the maximum water surface elevation.

2.3.2.5 Protective Covering

The manufacturer is required to supply an [ultraviolet light protected fiberglass] [_____] cover for each aeration unit. Design the cover to protect all adjacent structures from splashing caused by the unit. Mount the cover independent of the aeration equipment and be install it in accordance with the manufacturer's requirements.

2.3.3 Submerged Turbine Draft Tube Aerators

Furnish and install the submerged turbine draft tube aeration system as indicated. Provide the unit complete to include blowers, drive unit, turbine aerator unit and supports, draft tube assembly, and all appurtenances necessary for the proper operation of the equipment. Design the aerators for continuous operation.

2.3.3.1 Impeller Shaft

Construct the shaft of [carbon steel] [_____] and size it to withstand all torque loads and bending moments produced by operation of the system. Design the shaft and bearing assembly to allow operation below 80 percent of its natural frequency without the use of stabilizing devices. Construct the shaft so that its deflection will not affect the alignment of the antifriction bearings or cause misalignment of the gearing during the mixing/aeration operation. Ensure the shaft supporting the impeller is removable from the drive assembly, without disassembly of the gear box. Use rolling, antifriction type bearings on the impeller shaft with a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11. Support the entire weight of the shaft and turbine by means of a thrust bearing installed integrally with the gear reducer. Use a rigid coupling to connect the shaft and turbine assembly to the output shaft of the reducer. Provide bearings on the shaft that are either grease or oil lubricated and are positively sealed against penetration of moisture or leakage of lubricant down the shaft. Provide means for checking the adequacy of lubrication.

2.3.3.2 Impeller

Construct the impeller of [carbon steel] [_____] and positively fasten it to the shaft with all [carbon steel] [_____] hardware. The impeller is required to be removable from the shaft. Means for adjustment of the impeller. If the adjustment is on the shaft, provide a means to prevent the impeller from dropping off the shaft during adjustment.

2.3.3.3 Drive System

2.3.3.3.1 Reducer

Construct the drive system reducer to maintain alignment of bearings and gearing while absorbing the external loads of the impeller. Design the unit to continuously withstand all internal loadings developed at the full load motor wattage horsepower, including motor starting torques up to 250 percent of motor running torques. Design the unit to withstand all external loadings produced by torque, thrust, out-of-balance and vibration resulting from operating conditions. Provide lifting lugs with the speed reducer. Vent the interior of the gear case using an approved breather, constructed to retard the entrance of water vapor.

2.3.3.3.2 Housing

Provide a weatherproof drive housing constructed of steel in accordance with ASTM A36/A36M or high grade cast-iron conforming to ASTM A48/A48M. Apply a protective coating that will not peel, crack or discolor at continuous operating temperatures up to 121 degrees C 250 degrees F.

2.3.3.3.3 Rating

Ensure the gearing has a minimum service factor of at least [2.0] [_____] times the rated brake horsepower of the drive motor. Ensure the gear reduction system is suitable for continuous operation and moderate shock loading in accordance with ANSI/AGMA 6113AGMA 6013 for motor reducers or gear motors using helical and spiral bevel gears.

2.3.3.3.4 Bearings

Provide power transmission bearings that are antifriction type and have a minimum L-10 life of 100,000 hours at maximum operating speed in accordance with ABMA 9 or ABMA 11. Ensure bearings used are fully sealed and protected from water spray.

2.3.3.3.5 Lubrication

****

NOTE: If lubricating pumps are not used delete

subparagraph b. and edit accordingly.
****

a. Provide lubrication by [gears running in an oil bath] [an oil slinger] [pumps]. Provide drive with an oil "dam" or other means of positive protection against lubricant leakage around the output shaft. Also provide an oil level gauge or sight glass and drain fittings. Ensure the thermal rating of the gear reducer exceed the design load or provide proper cooling.

b. Ensure all lubricating pumps are removable for maintenance without disassembly of the drive and/or removal of the motor. Provide either a low pressure or low oil level switch to shut off the unit in the event of insufficient lubrication.

2.3.3.3.6 Couplings

Transmit power from the motor to the gear reduction system by using a non-lubricated coupling, direct driven. Ensure all couplings are the manufacturer's standard and select to provide a minimum service factor of 2.0.

2.3.3.4 Draft Tube

Each draft tube consists of upper and lower sections of epoxy coated steel. The upper section consists of the suction cone, supports for connection to the turbine support assembly, air distribution assembly, deflection-limiting system, flow direction baffles, and supports for connection to the bottom section. The bottom section is required to be [_____] mm feet long, sufficient to carry the design flow with minimal pressure drop. Shape bottom section to carry the wastewater to a sufficient depth to dissolve the required oxygen and direct the flow forward in the channel. The draft tube is required to be [_____] mm inch in diameter with a 6 mm 1/4 inch minimum wall thickness, and equipped with grout rings as shown.

2.3.3.5 Mounting

Construct a [structural bridge of steel conforming to ASTM A36/A36M] [concrete bridge] and support assembly designed to mount each aerator as indicated. The bridge assembly is required to be sufficient to support the turbine aerator, suction cone, air sparge assembly and the flow directional baffle assembly.

2.3.3.6 Air Supply Equipment

Provide blower(s) that conform to Section 46 51 00.00 10 AIR AND GAS DIFFUSION SYSTEM.

2.3.4 Jet Aeration

****
NOTE: Jet aeration systems require that preliminary treatment system be included upstream of the CLR to remove grit and other larger particles to reduce the likelihood of plugging the nozzles.

The aeration equipment covered in this specification is listed below along with some general requirements

for their use. For further assistance in determining the applicability of the CLR, refer to UFC 3-230-14A and for design criteria refer to UFC 3-240-02.

a. Disc or Rotor (Brush) Aerators: This type of aeration system creates surface agitation to provide oxygen transfer and imparts a horizontal velocity by the rotation of the unit. The channel may be constructed with either sloped or vertical side walls. Typically the channels are constructed 2.4 m 8 feet to 3.7 m 12 feet deep. Channels greater than 2 m 7 feet deep may require a velocity baffle downstream of the aeration unit to help impart a downward velocity to the wastewater and improve mixing along the channel bottom. The CLR should not be constructed with a sidewater depth greater than 4.3 m 14 feet if disc or brush aerators are specified. In addition, turning walls are recommended at each bend to maintain channel velocities around the corners.

b. Low Speed Surface Aerators: This type of aeration system creates surface agitation to provide oxygen transfer and imparts a velocity to the wastewater by the swirling action created by the impeller. The aerators must be placed at the turns in the channel to achieve effective horizontal velocity. At bends where aerators are not located, turning walls are recommended to maintain channel velocities around the corners. Floating aerators should not be considered for use in a CLR application due to the area required for the pontoons. The channel may be constructed with either sloped or vertical side walls. With this equipment, vertical side walls are recommended at the turns. Channel depths will vary from 2 to 5 m 6 to 16 feet). Draft tubes should be provided when recommended by the manufacturer.

c. Submerged Turbine Aerators: Submerged turbine aerators used in CLR's utilize a downward pumping impeller to force an air and water mixture through a draft tube that extends below the bottom of the basin and through a barrier wall extending across the basin. The barrier wall may be constructed of concrete, compacted clay or reinforced earth. The turbine's impeller should be located at a depth of approximately 20 percent of the basin sidewater depth. The air is discharged through a sparge ring below the impeller and becomes entrained in the downward flow of water through the draft tube. The system requires an air blower, as well as the turbine unit. However, the system offers turn down flexibility because the turbine and blower are operated independent of each other. Sloped or vertical walls are acceptable with this system and the basin should have a single side water depth within the range of 2.4 to 5 m 8 to 16 foot

sidewater depth. In addition, turning walls are recommended at each bend to maintain channel velocities around the corners.

d. Jet Aeration: Jet aeration combines air flow and pumped liquid in a vortex jet nozzle which is discharged just above the channel floor. The jet system consists of a recirculation pumping system and an air blower, each feeding headers that discharge through the jet nozzles. The typical configuration utilizes a concrete basin with a 3.7 to 6 m 12 to 20 foot sidewater depth, preferably with vertical side walls. In addition, turning walls are recommended at each bend to maintain channel velocities around the corners. The jet nozzles can be fixed or they can be mounted on removable or swing headers to facilitate maintenance. Removable and swing header systems will require the construction of thrust blocks located behind the nozzles to prevent any deflection caused by the jet action.

e. Diffused Aeration/Low Speed Mixer System: In this system, a coarse, medium or fine bubble diffused aeration system is used in conjunction with a submerged low speed mixing unit that supplies the horizontal velocity. The propeller type mixer, mounted on guide rails, is positioned immediately upstream of the diffusers. Vertical or sloping side walls are acceptable with basin sidewater depth ranging between 3.7 to 6 m 12 to 20 foot. In addition, turning walls are recommended at each bend to maintain channel velocities around the corners. Vertical side walls are recommended in the area of the diffusers to maximize oxygen transfer. Consideration should also be given to providing a removable or swing header system to facilitate maintenance of the diffusers.

f. System Choice: Since the configuration of the channel will vary with the type of equipment selected, the choice of aeration system must be decided upon first. Each aeration system listed above is specified herein. Only the paragraphs applying to the aeration system selected should be included in the specification. All paragraphs and subparagraphs for the other aeration systems should be deleted.

****

Provide the jet aeration system as indicated. The system includes air-liquid jet manifolds, [vertical propeller] [submerged centrifugal] pumps, pneumatic backflush system, air blowers, and all in-basin air and liquid piping and supports. Design the jet aeration system for continuous operation.

2.3.4.1 Submerged Jets

****

NOTE: The nozzle size will affect the performance of the system by changing the water and air mixture. The standard nozzle size is 40 mm 1-1/2 inches, however, the process requirements should be checked to determine proper nozzle size. The number and size of nozzles is site specific and is effected by the tank size, solids concentration, oxygen demand requirements and other factors. Designer should contact the equipment manufacturer for information on nozzle sizing.

****

The jet aeration system consists of [fiberglass reinforced plastic] [_____] jet nozzles, oriented in a common direction and attached to a common manifold. The manifold consists of separate liquid and air piping so that the air and liquid do not mix prior to reaching the mixing chamber of the jet. The liquid portion of the manifold is required to provide uniform distribution of mixed liquor from the inlet of the manifold to each of the jets. The jets consist of 2 nozzles and a mixing chamber constructed integrally with the manifold. The primary jet directs the mixed liquor into the mixing chamber where air is introduced and combined with the liquid. The air-liquid mixture then discharges into the secondary nozzle and, hence horizontally into the basin. Carefully mold the two nozzles to maintain proper alignment and tolerances. To reduce the likelihood of plugging, each jet nozzle has a minimum intake and discharge diameter of 40 mm 1-1/2 inches. Construct the manifold assembly of [fiberglass reinforced plastic] [epoxy coated carbon steel] [_____]. Design the manifold to withstand all normal stresses encountered in shipping, handling and operation.

2.3.4.2 Recirculation Pumps

****

NOTE: Select the applicable pump from the following paragraphs:

****

2.3.4.2.1 Vertical Propeller Pump

****

NOTE: Vertical propeller pump manufacturer design manuals should be consulted to determine spacing of pumps to avoid influence of the pump suctions.

Pumps should be identified on the drawings by a number. Insert the identification number in part b. of this paragraph; part b. should be repeated as necessary for pumps of the same type with different operating characteristics.

****

a. General: Install the pumping system as indicated and ensure it is suitable for outdoor installation. Design the unit, consisting of vertical shaft, [single] [multistage] propeller type pump and motor to operate safely in the reverse direction of rotation, due to water returning through the pump. Carry the weight of the revolving parts of the pump, including the unbalanced hydraulic thrust of the propeller, by means of a thrust bearing in the motor. Support the pump from a base plate by means of a vertical column having horizontal discharge located below the base plate.

b. Pump Characteristics: Provide pump number(s) [_____] having the following operating characteristics:

(1) Pump Service.

(2) Design Operating Point: [_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency.

(3) Maximum Operating Point: [_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency.

(4) Minimum Operating Point: [_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency.

(5) Propeller Type: [_____].

(6) Discharge Diameter: [_____] mm inch.

(7) Bell Diameter: [_____] mm inch.

(8) Column Length: [_____] mm feet.

(9) Operating Speed: [_____] rpm.

(10) Minimum Bell Submergence: [_____] mm inch.

(11) Pump Control: [_____].

c. Pump Column and Discharge Elbow: Construct the pump supporting column of steel pipe with a minimum [6] [_____] mm [1/4] [_____] inch thickness. Use a flanged discharge opening for connection to the discharge pipe. Use long radius discharge elbows made of [welded steel] [cast-iron].

d. Base Plate: Suspend the pumping unit from a base plate of adequate structural design to support the weight of the complete unit filled with water. Fabricate the base plate of cast iron or steel and size to allow the entire pump to be removed, with the discharge flange attached. Use stainless steel base plate mounting hardware. Locate the packing box on or above the base plate to provide for easy maintenance. Mount the motor above the pump.

e. Suction Bell and Impeller Housing: Construct the suction bell and impeller housing of [ductile] [cast] iron [_____] and design for easy removal of the propeller and lower bearing. Provide the suction bell with a flared inlet designed to reduce entrance loss and provide with flanges to adequately support the lower bearing and support the weight of the propeller and propeller shaft.

f. Propeller: Construct the pump propeller using [bronze] [_____] and balance propeller statically and dynamically to reduce vibration and wear.

g. Propeller Shaft: Size the propeller shaft to operate without objectionable distortion or vibration in both forward and reverse rotation. Fabricate the propeller shaft using [stainless steel] [_____] and direct couple propeller shaft to the line shaft. Ensure the propeller shaft is adjustable with reference to the bowl. Construct the line shaft of [carbon steel] [_____] and extend as one unit to the motor shaft. Enclose the line shaft in a water-tight steel column.

h. Bearings: Ensure the pump is equipped with a [bronze] [_____] sleeve bearing immediately above the propeller, and a [bronze] [_____] lower support bearing below the propeller. For line shafts greater than 3 m 10 feet in length, also provide [bronze] [_____] intermediate shaft bearings. Install the intermediate shaft bearings inside the water-tight steel column. At the top of the line shaft, include a [bronze] [_____] tension bearing with a tension nut and tension ring. Ensure all bearings are easily replaceable and spaced to provide adequate support for the shaft and to prevent vibration. Use bearings with an L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11.

i. Lubrication: Equip the pump with an automatic lubricating system which supplies grease lubricant to all but the lower support bearings. Grease pack the lower support bearings.

2.3.4.2.2 Submersible Centrifugal Pumps

Provide submersible centrifugal pumps used for the jet aeration system in accordance with Section 22 13 29 SANITARY SEWERAGE PUMPS.

2.3.4.2.3 Self-Priming Centrifugal Pumps

Provide self-priming centrifugal pumps used for the jet aeration system in accordance with Section 22 13 29 SANITARY SEWERAGE PUMPS.

2.3.4.2.4 Vertical Turbine Pumps

****

NOTE: Vertical turbine pump manufacturer design manuals should be consulted to determine spacing of pumps to avoid influence of the pump suctions.

****

Provide vertical turbine pumps used for the jet aeration system in accordance with Section 23 21 23 HYDRONIC PUMPS.

2.3.4.2.5 Pump Suction Screens

Mount a [stainless steel] [_____] screen to the suction of the pump. Provide a screen sized to ensure nothing larger than 25 mm 1 inch in diameter to pass.

2.3.4.3 Blowers

Provide blowers in accordance with Section 46 51 00.00 10 AIR AND GAS DIFFUSION SYSTEM.

2.3.5 Diffused Aeration/Slow Speed Mixer System

Furnish and install the diffused aeration/slow speed mixer system as indicated. Provide a complete system including air supply, distribution and diffuser equipment designed to satisfy the oxygen requirement, and the adequate number of submersible mixing units to create and maintain a horizontal velocity in the basin and maintain solids suspension. The air supply and distribution system includes blowers, piping, valves, diffusers, supports and all necessary appurtenances to ensure proper operation of the equipment. The mixing units consist of a propeller driven by a [submersible electric motor] [hydraulic system], a support structure that allows the unit to be easily removed from the basin, and all cables and appurtenances necessary to ensure proper operation of the equipment. Design the combined system for continuous operation.

2.3.5.1 Diffused Aeration System

Provide the diffused aeration and blower system as specified in Section 46 51 00.00 10 AIR AND GAS DIFFUSION SYSTEM.

2.3.5.2 Slow Speed Mixer (With Submersible Electric Motor)

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NOTE: Designer will allow bids on either hydraulic motors or electric motors unless job requirements warrant eliminating one of the options.

****

Ensure all components of the mixer, including the motor, are capable of continuous underwater operation while the mixer blade is either completely submerged or partly submerged. In addition, ensure all components of the mixer, including motor, are capable of continuous operation in air, completely unsubmerged, for a minimum of [2] [_____] hours.

2.3.5.2.1 Mixer Propeller

Construct the propeller of [ASTM A167, Type 304 stainless steel] [cast-iron] [molded fiberglass] [_____] and shape so that no solids, fibrous material and other material found in normal wastewater applications collects on the blades. Dynamically balance the propeller to [5.3] [_____] N/meter [0.03] [_____] pounds/inch and [internally key it for engagement with the shaft] [ensure it slides onto the shaft and is securely fastened with a screw washer and sleeve] [_____].

2.3.5.2.2 Drive System

Provide each mixer be direct-driven, close-coupled, completely submersible units. Use mixer motors that are squirrel-cage induction, shell type design, housed in an air-filled, watertight chamber. Insulate the stator winding with moisture-resistant Class F insulation in accordance with NEMA MG 1 and design for continuous duty. Ensure the cable entry is an integral part of the stator casing and is leakproof. In addition, machine all mating surfaces where water tight sealing is required and fit with [nitrile] [_____] rubber O-rings.

2.3.5.2.3 Shafts and Seals

Ensure the mixer motor shaft is integral with the propeller shaft and rotates on two permanently lubricated bearings. Provide ball bearings with a minimum L-10 life of 100,000 hours as defined by ABMA 9 or ABMA 11. Provide each mixer with a tandem mechanical rotating shaft seal system on the propeller shaft. Provide lapped end face type seals and run them in an oil reservoir. The inner seal is required to contain one stationary and one positively driven rotating ceramic ring. The outer seal is required to contain one stationary and one positively driven rotating tungsten carbide ring.

2.3.5.2.4 Mounting

Configure mixer capable of being raised and lowered from the basin for ease of repair and maintenance. Mount the mixer on and guide by a sliding bracket constructed to withstand all thrust created by the mixer. Provide a lifting cable and winch mechanism to permit raising and lowering of the mixer on the sliding bracket.

2.3.5.3 Slow Speed Mixer (With Hydraulic Motors)

Each hydraulic horizontal mixer consists of a hydraulic power unit and motor, a direct drive shaft and propeller, hydraulic lines, and all mounting and support brackets to provide for proper operation. In addition, all components of the mixer are required to capable of continuous operation in air, completely unsubmerged, for a minimum of [2] [_____] hours.

2.3.5.3.1 Mixer Propeller

Construct the propeller of [cast-iron] [molded fiberglass] [_____] and shaped so that no solids, fibrous material and other material found in normal wastewater applications collects on the blades. Dynamically balance the propeller to [5.3] [_____] N/meter [0.03] [_____] pounds/inch and [internally key it for engagement with the shaft] [ensure it slides onto the shaft and is securely fastened with a screw washer and sleeve] [_____].

2.3.5.3.2 Drive System

a. Hydraulic Motor: Provide hydraulic motor of the low speed, high torque, fixed displacement type to drive the propeller. Ensure the hydraulic motor is capable of withstanding end thrust loads of not less than 4.45 kN 1000 pounds either into or out from the motor. Ensure hydraulic motor is rated for a B-10 life of not less than 100,000 hours in accordance with ABMA 9 or ABMA 11. Connect the hydraulic motor to the hydraulic pump with a hose having a continuous pressure rating of not less than 20.7 MPa 3000 psi.

b. Hydraulic Pump: Enclose the hydraulic pump in the hydraulic reservoir and mount directly to the electric motor adapter. Ensure the hydraulic pump has a continuous pressure rating of not less than 13.8 MPa 2000 psi. Ensure the hydraulic fluid flow control mechanism lock and is fully adjustable to allow for infinitely variable speed control.

c. Reservoir and Accessories: Construct the hydraulic reservoir of steel. Include a filler/breather assembly, and a fluid level/temperature gauge and clean-out cover. Connect the hydraulic reservoir to the hydraulic motor with a hose having a continuous pressure rating greater than the rating of the hydraulic pump but not less than 20.7 MPa 3000 psi.

2.3.5.3.3 Mounting

Provide mixer capable of being raised and lowered from the basin for ease of repair and maintenance. Mount the mixer on and guide by a sliding bracket constructed to withstand all thrust created by the mixer. Provide a lifting cable and winch mechanism to permit raising and lowering of the mixer on the sliding bracket.

2.3.6 Lubrication Requirements

Provide an adequate means of lubrication for all moving parts subject to wear. Except as otherwise specified, lubricate using grease or oil. Provide grease fittings for all grease-type bearings. If bearings are not easily accessible, provide grease tubing in a convenient location. Provide bearings with relief ports to prevent build-up of pressures which might damage the bearings or seals. Size oil reservoirs liberally and provide with an opening for filling, an overflow opening at the proper location to prevent overfilling, and a drain opening at the lowest point. Vent reservoirs to prevent pressure build-up.

2.3.7 Electric Motors

Utilize a squirrel-cage induction motor suitable for continuous duty. Provide motor with a non-overloading power rating for any conditions under which the driven equipment function.

2.3.7.1 Frame

Select the motor frame size in accordance with NEMA MG 1. Ensure that motors of the same rating, mounting, and characteristics are interchangeable.

2.3.7.2 Design

Induction motors are required to be Design B as defined in NEMA MG 1, with normal torque and low starting current.

2.3.7.3 Enclosure

Provide a totally enclosed fan cooled enclosure.

2.3.7.4 Terminal Boxes

Size cast-iron terminal boxes for the space required, for the allowable bending radius and stiffness of the motor supply cables, and for terminating a grounding conductor. Provide gaskets for the terminal boxes and threaded conduit entrances or hubs. Ensure terminal boxes are rotatable for connection from any one of four directions at 90 degree intervals with a motor lead seal and separator gasket provided between the motor frame and terminal box.

2.3.7.5 Bearings

Provide grease lubricated, shielded, antifriction steel ball bearings and grease with a moisture resistant grease. Ensure all grease fittings and excess grease purge plugs are readily accessible and locate externally so that bearing lubricant can be changed without removing fan housing or dismantling the motor.

2.3.7.6 Windings

Provide nonhygroscopic, epoxy coated motor windings.

2.3.7.7 Motor Characteristics

Ensure motor rotors receive a standard dynamic balance. Ensure the maximum amplitude (peak to peak) of motor vibration, as measured at the bearing housing, and the method of measurement are in accordance with NEMA MG 1. Ensure motor characteristics such as wattage horsepower, speed, rpm, voltage and phase requirements and insulation class are provided as indicated.

2.3.7.8 Motor Controls

NEMA ICS 1.

2.3.8 Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration and maintenance of the equipment.

2.4 MATERIALS

Ensure materials and equipment conform to the following requirements.

2.4.1 Steel Plates, Shapes and Bars

ASTM A36/A36M.

2.4.2 Pipe

Furnish and install piping as indicated and ensure it is in accordance with the applicable standard specification.

2.4.2.1 Steel Pipe

ASTM A53/A53M, all pipe sizes.

a. Flanged Joints: ASTM A707/A707M.

b. Slip Joints: AWWA C200.

c. Mechanical Joints: AWWA C200.

d. Welded Joints: AWS D1.1/D1.1M.

e. Bolts: ASTM A307, Grade B.

f. Fittings: ASTM A420/A420M.

2.4.2.2 Ductile-Iron Pipe

AWWA C115/A21.15, all pipe sizes.

a. Flanged Pipe: AWWA C115/A21.15 with ASME B16.1, Class 125 flanges.

b. Rubber-Gasket Joints: AWWA C111/A21.11.

c. Fittings: AWWA C110/A21.10.

d. Push-On Joints: AWWA C151/A21.51.

e. Bolts and Nuts: ASTM A307, Grade B.

f. Coatings and Linings: Provide bituminous coating on all buried piping.

2.4.2.3 Polyvinyl Chloride (PVC) Pipe and Fittings

Provide PVC pipe and fittings less than 102 mm 4-inch diameter in accordance with ASTM D1785 or ASTM D2241. Provide PVC pipe and fittings 102 mm 4 inch in diameter and larger in accordance with ASTM D2241 and ensure they have push-on joints.

a. Push-On Joints: ASTM D3139 or ASTM F477.

b. Solvent Cement: ASTM D2564.

2.4.3 Pipe Hangers and Supports

MSS SP-58.

2.4.4 Valves

2.4.4.1 Gate Valves

Gate valves are required to withstand a working pressure of not less than 1.03 MPa 150 psi. Ensure valves have a clear waterway equal to the full diameter of the valve, and are opened by turning counterclockwise. On operating nut or wheel handle, provide an arrow, cast in metal, indicating the direction of opening. For valves used for buried service, provide with non-rising stem (NRS), 50 mm 2 inch square nut operated with joints applicable to the pipe or installation. Furnish buried valves with extension stems comprised of socket, extension stem and operating nut, that are long enough to bring operating nut to within 150 mm 6 inch of grade. Furnish one 1.2 m 4 foot "T" handle valve wrench for each quantity of six buried valves. For gate valves which are exposed or installed inside, provide outside screw and yoke (OS&Y), handwheel operated with flanged ends unless otherwise indicated. Flanges are not to be buried. Provide a approved pit for all flanged connections.

a. Valves smaller than 75 mm 3 inch are required to be all bronze conforming to MSS SP-80, Type 1, Class 150.

b. Valves 75 to 305 mm 3 to 12 inch in size are required to be resilient-seated gate valves conforming to AWWA C509.

c. Valves 355 mm 14 inch and larger are required to be iron body, bronze mounted conforming to AWWA C500. Provide solid wedge type valves. Equip valves with gearing to reduce operating effort. Equip all valves installed in horizontal lines in the horizontal position with stems horizontal with bronze track, roller and scrapers to support the weight of the gate for its full length of travel. Fit valves installed in vertical pipe lines with stems horizontal with slides to assist the travel of the gate assembly.

2.4.4.2 Plug Valves

Plug valves are required to be eccentric type capable of withstanding a minimum working pressure of 1.03 MPa 150 psi. Provide flange valve conforming to ASME B16.1, Class 125. Provide mechanical or push-on type rubber gasket joint ends conforming to AWWA C110/A21.10 and AWWA C111/A21.11. Ensure port area for valves is at least 80 percent of full pipe area. Valve bodies, plugs or discs, seats, shafts, shaft seals and actuators are required to conform to AWWA C504. Valves are required to open counterclockwise and the operating nut or wheel have an arrow, cast in metal, indicating the direction of opening. Ensure valves meet all performance, leakage, and hydrostatic tests required by AWWA C504. On request, furnish a certified statement from the manufacturer that proof-of-design tests were carried out as described in AWWA C504 and all requirements were successfully met.

2.4.4.3 Check Valves

Check valves are required to permit free flow of sewage forward and provide a positive check against backflow. Check valves are required to withstand a minimum working pressure of 1.03 MPa 150 psi or as indicated. Provide iron body check valves. Directly cast on the body the manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow. Flanges are required to be the 56 kg 125 pound type complying with ASME B16.1.

a. Provide ball check valves with flanged or threaded ends and the non-slam type. Construct ball of stainless steel unless otherwise specified.

b. Ensure swing check valves comply with AWWA C508, are bronze mounted, and have flanged ends. Equip check valves with [outside lever and spring] [_____].

2.4.5 Joint Compound

For joint compound for threaded joints, use a stiff mixture of graphite and oil, inert filler and oil, or a graphite compound.

2.4.6 Joint Tape

Ensure joint tape for threaded joints complies with ASTM D3308.

PART 3 EXECUTION

3.1 EXAMINATION

Verify all dimensions in the field, and advise the Contracting Officer of any discrepancy in the contract documents before performing the work.

3.2 TREATMENT SYSTEM INSTALLATION

Submit drawings containing complete wiring and schematic diagrams; equipment layout and anchorage; and any other details required to demonstrate that the system has been coordinated and functions as a unit. Drawings are to show the proposed layout and anchorage of equipment in appurtenances and equipment relationship to other parts of the work including clearances required for maintenance and operation. Submit all submittals for this system at the same time. It is not acceptable to piecemeal submittals.

Perform all excavation, filling, and backfilling in accordance with Section 31 00 00 EARTHWORK. Install reinforced concrete, of the size and design indicated, in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.1 Welding

Weld piping in accordance with AWS D1.1/D1.1M using welders certified to have passed tests using procedures in accordance with AWS B2.1/B2.1M or

ASME BPVC SEC IX. Ensure the welder or welding operator applies the assigned personal symbol near each weld made, as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING. Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.

Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform the tests at the work site if practicable.

3.2.2 Pipe and Valve Installation

Install piping with all joints tight and with no undue marring of finishes. Ensure installed piping, valves, and fittings is free from strain and excessive stresses caused by weight or misalignment.

3.2.2.1 Flanged Joints

Tighten bolts uniformly to prevent overstressing flanges and misalignment.

3.2.2.2 Screwed Joints

Make screwed joints tight with joint compound, applied to the male threads only, or with joint tape.

3.2.2.3 Push-On Joints for PVC Pipe

Bevel pipe ends to facilitate assembly. Mark pipe to indicate when the pipe is fully seated. Lubricate gaskets to prevent displacement. Exercise care to ensure that the gasket remains in proper position in the bell or coupling while joints are made.

3.2.2.4 Solvent-Weld Joints for PVC Pipe

Weld joints in accordance with the manufacturer's written instructions.

3.2.2.5 Valves

Installed and locate valves for easy access for operation.

3.2.3 Equipment Installation

Install equipment in accordance with the manufacturer's written instructions.

3.2.4 Electrical Work

Perform electrical work in accordance with the applicable requirements of Section [_____].

3.2.5 Painting

Paint all metal surfaces, except aluminum, bronze, brass, galvanized steel, and stainless steel. Perform surface preparation and painting in the field. Finish manufactured items, such as motors and switchboards, per with the manufacturer's standard finish.

3.2.5.1 Preparation and Application

Prepare ferrous metal surfaces in accordance with SSPC SP 6/NACE No.3 and painted with a three coat MIL-DTL-24441 epoxy painted to achieve a total dry film thickness of 150 microns (6 mils). The contractor may substitute Master Painter's Institute (MPI) #120 Epoxy, High build, Self-Priming, Low Gloss, for MIL-DTL-24441.

3.2.5.2 Coating Examination

Examine all coatings for flaws and test for thickness and holidays. Measure the thickness of coatings wet and dry using a commercial film thickness gauge. Notify the Contracting Officer in advance of any painting. Do not apply additional coats until the previous coat has been approved. Perform all repair or additional coatings at no additional cost to the government.

3.2.5.3 Coating Repair

If welding is required after application of the coating or if the coating is damaged in any way, repair by preparing the affected area in compliance with SSPC SP 6/NACE No.3 and reapply the coating to that area. If holidays are detected or film thickness is insufficient, prepare the surface and apply additional coats in the affected area in compliance with the manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Tests And Inspections

Supply water required for the field tests. Give the Contracting Officer [14] [_____] days prior notice of the dates and times for acceptance tests to allow the Contracting Officer the ability to witness all field tests. Rectify any deficiencies found. All work affected by such deficiencies required to be completely retested at the Contractor's expense.

3.3.1.1 Basin Leakage Test

After completion of the installation and as soon as practical, conduct a leakage test on the CLR basin. Fill the basin with clean water and leave standing for 24 hours. Basin leakage is not allowed to exceed 25 mm 1 inch drop in water surface elevation in 24 hours. Repair leaks encountered and retest the basin. Ensure the basin is watertight prior to proceeding with the tests specified below.

3.3.1.2 Operating Tests

After completion of the installation and as soon as practical, perform an operating test of the CLR and all equipment to demonstrate that the system functions properly. Include all manufacturer's recommended tests for equipment vibration, horizontal and vertical alignment and structural integrity. Check and verify wattage horsepower [and air flow rates] against the manufacturer's design data for the specified equipment. Ensure the aerator wattage horsepower meets nameplate plus or minus five percent. After completion of all tests, adjust the system for proper operation in accordance with the manufacturer's written instructions and the operating and maintenance instructions.

3.3.1.3 Velocity Test

After completion of the basin leakage and operating tests, conduct a velocity test on the basin. Record velocity cross-sections at a distance of 3 m 10 feet upstream of the shaft centerline of each aerator. Cross-sections consist of a minimum of 16 velocity measurements equidistantly spaced so that the distance between measurement points does not exceed 1.2 m 4 feet vertically or horizontally. Begin measurement points at approximately 0.6 m 2 feet from walls. The average velocity at each cross-section is not to be less than 0.3 m/s 1.0 fps. Where average velocities are found to be less than that specified, make modifications to the system as needed to produce the required velocities at no extra cost to the Government.

3.3.1.4 Standard Oxygen Transfer Efficiency Test (S.O.T.E.)

After completion of the velocity test, perform an S.O.T.E. test in accordance with ASCE 2-06. The aeration system oxygenation capacity is not allowed to be less than [1.4] [_____] kg [3] [_____] pounds of oxygen per watt horsepower per hour with [_____] aeration units operating at a combined power draw of [_____] watts horsepower. Repeat tests in the same water until ten tests have been run or until the total dissolved solids (TDS) exceed 2000 mg/L. Plot a minimum to maximum power curve from the results. Base power input on wire power. Use a nationally recognized independent testing laboratory for all tests.

3.3.1.5 Reporting Test Results

Upon completion and testing of the installed system, submit test reports that show all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Indicate the final position of controls in each test report. Report results in accordance with paragraph 9.0 "REPORTING" of ASCE 2-06.

3.3.2 Manufacturer's Services

3.3.2.1 Supervise Installation, Adjustment, and Testing

Obtain the services of the manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified to supervise the installation, adjustment and testing of the equipment in accordance with manufacturer's written instructions.

3.3.2.2 Field Training

Conduct a training course for the operating staff as designated by the Contracting Officer. Provide a training period consisting of a total of [_____] hours of normal working time and start after the system is functionally complete but prior to final acceptance tests. Ensure all field instruction covers all of the items contained in the Operating and Maintenance Instructions, as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Framed Instructions

Submit approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping valves, and control sequence, framed under glass or in approved laminated plastic, for posting where directed. In addition, prepare in typed form condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system. Frame as specified above for the wiring and control diagrams and post beside the diagrams. Post the framed instructions before acceptance testing of the systems

3.4.2 Operating And Maintenance Instructions

Furnish instructions including the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Permanently bind each set and include a hard cover. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the facility, name of the Contractor, and contract number. Ensure information includes, but is not necessarily limited to, the following:

a. System layout showing piping, valves, and controls.

b. Approved wiring and control diagrams.

c. A control sequence describing startup, operation, and shutdown.

d. Operating and maintenance instructions for each piece of equipment, including lubrication instructions and troubleshooting guide.

e. Manufacturer's bulletins, cut sheets and descriptive data, parts lists, and recommended spare parts.

f. Simplified diagrams for the system as installed.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-46 61 00 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 61 00 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION 46 61 00

FILTRATION EQUIPMENT

05/21

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-46 61 00 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 61 00 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 46 61 00

FILTRATION EQUIPMENT
05/21

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NOTE: This guide specification covers the requirements for filtration systems with capacity less than 750 liters 200 gallons per minute.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN LADDER INSTITUTE (ALI)

ALI A14.3	(2008; R 2018) Ladders - Fixed - Safety Requirements

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A1264.1	(2017) Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrail/Handrail Systems

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B100	(2016; Errata 2017; Addenda 2018) Granular Filter Material
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA D100	(2021) Welded Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2021) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A420/A420M	(2024a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service

ASTM A707/A707M	(2019) Standard Specification for Forged Carbon and Alloy Steel Flanges for Low-Temperature Service
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C582	(2023) Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment
ASTM C1147	(2014; R 2022) Standard Practice for Determining the Short Term Tensile Weld Strength of Chemical-Resistant Thermoplastics
ASTM D1330	(2004; R 2010) Rubber Sheet Gaskets
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3299	(2010) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D4097	(2001; R 2010) Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM F477	(2014; R 2021) Standard Specification for

	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ANSI/ISA 5.1	(2024) Instrumentation Symbols and Identification

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2022) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other

submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Filtration System; G, [_____]

Include complete wiring and schematic diagrams; equipment layout and anchorage; and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

SD-03 Product Data

Posting Framed Instructions

Qualifications

Media

Materials and Equipment

Control System

Spare Parts

Submit after approval of the shop drawings, and not later than [_____] days prior to the start of operation.

SD-06 Test Reports

Acceptance Testing

Factory Tests

SD-07 Certificates

Materials and Equipment

SD-10 Operation and Maintenance Data

Field Training

Operating and Maintenance Instructions; G, [_____]

1.3 MAINTENANCE MATERIAL SUBMITTALS

1.3.1 Extra Materials

Provide standard spare parts as recommended in the manufacturer's instruction manuals for each component of the equipment. Submit spare parts data for each different item of material and equipment specified. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

1.4 QUALIFICATIONS

Submit qualifications of the installer, and the manufacturer's and media supplier's representatives.

1.4.1 Installer

Installers are required to have a minimum of [_____] years' experience in the installation of a minimum of [_____] similar filtration systems and are required to show evidence of satisfactory operation for each installation.

1.4.2 Manufacturer's Representative

Ensure a representative of the filtration system manufacturer, who is familiar with the design and experienced in the installation, adjustment, and operation of the equipment specified is present at the jobsite during installation of the filtration system.

1.4.3 Media Supplier Representative

Ensure a representative of the media supplier who is experienced in the installation of the specified filtration media is present at the jobsite during media installation.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from weather, excessive humidity, excessive temperature variation, and dirt, dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a [pressure] [continuous backwash] [traveling bridge] [cartridge] [bag] filtration system. Design, construct and install the filtration system to comply with the following design conditions. Supply auxiliary systems and equipment required to maintain complete and workable filter systems including, but not limited to, required piping between units, auxiliary equipment for plumbing and power, and controls and interfaces between auxiliary equipment and the filter. Chemical additives [are] [are not] allowed to enhance the filtration system. Construct the installation [indoors] [outdoors]. [_____] volts of electricity, [_____] Pa psi air pressure, and [_____] Pa psi water pressure is available for installation.

2.1.1 Influent Flow Characteristics

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NOTE: This paragraph describes influent flow characteristics for continuous backwash, traveling bridge, and pressure filtration systems.

****

Design Flow	[_____]L gallons per minute
Maximum Flow Rate	[_____]L gallons per minute
Minimum Available Head	[_____]m feet
Design Influent Temperature	[_____]degrees C degrees F
Maximum Influent Temperature	[_____]degrees C degrees F
Minimum Influent Temperature	[_____]degrees C degrees F
Flow Conditions	[intermittent] [continuous] [batch]
Design Influent, Suspended Solids	[_____] mg/L
Design Influent, Particle Size	[_____] micron
Maximum pH	[_____]
Minimum pH	[_____]
Maximum BOD	[_____] mg/L
Minimum BOD	[_____] mg/L
Source of Process Water	[metals precipitation] [biological treatment] [surface water] [landfill leachate]
Chemical Pretreatment	[alum] [polymer] [_____]

Alkalinity	[_____] mg CaCO3/L
Calcium Concentration	[_____] mg/L
Hardness	[_____] mg/L
[_____]	[_____]

2.1.2 Design Criteria

****
NOTE: This paragraph specifies minimum design requirements for continuous backwash, traveling bridge, and pressure filtration systems.
****

Number of Filters	[_____]
Maximum Effluent, Suspended Solids	[_____] mg/L
Maximum Effluent, Particle Size	[_____] micron
Maximum BOD	[_____] mg/L
Backwash Type	[_____]
Maximum Filtration Rate	[_____] L/second/square meter [_____] gal/second/square foot
Maximum Influent, Pipe Velocity	[_____] m/s[_____] ft/s
Maximum Effluent, Pipe Velocity	[_____] m/s[_____] ft/s
Clean Bed Maximum Headloss (at design flow and temperature)	[_____] meters[_____] feet

2.1.3 Cartridge and Bag Influent

****
NOTE: This paragraph describes influent flow characteristics for cartridge and bag filtration systems. In addition to the information listed below, concentrations of Target Compound List (TCL) and Target Analyte List (TAL) compounds in the waste stream should be included in the influent stream characteristics paragraph. This information will

help ensure that the bag or cartridge filtration materials are compatible with the waste stream.

****

Design Flow	[_____] L/minute[_____] gal/minute
Maximum Flow Rate	[_____] L/25 cm filter[_____] gal/25 cm filter equivalent
Design Inlet Pressure	[_____] Pa[_____] psi
Design Influent Temperature	[_____] degrees C[_____] degrees F
Maximum Influent Temperature	[_____] degrees C[_____] degrees F
Minimum Influent Temperature	[_____] degrees C[_____] degrees F
Fluid Viscosity	[_____] cP[_____] lb/ft-s
Flow Conditions	[intermittent] [continuous] [batch]
Design Influent, Suspended Solids	[_____] mg/L
Design Influent, Particle Size	[_____] micron
Maximum pH	[_____]
Minimum pH	[_____]
Source of Process Water	[metals precipitation] [biological treatment] [surface
Chemical Pretreatment	[alum] [polymer] [_____]
Alkalinity	[_____] mg CaCO3/L
Calcium Concentration	[_____] mg/L
Hardness	[_____] mg/L
[_____]	[_____]

2.1.4 Cartridge and Bag Design Criteria

****

NOTE: This paragraph specifies minimum design requirements for cartridge and bag filtration systems.

****

Total Number Operating Units	[_____]

Number of On-line Units	[_____]
Number of Stand-by Units	[_____]
Number of Elements per Unit	[_____]
Design Effluent, Suspended Solids	[_____] mg/L
Design Effluent, Particle Size	[_____] micron
Maximum Differential Pressure	[_____] Pa[_____] psi at design temperature
	[_____] Pa[_____] psi at maximum temperature

2.2 EQUIPMENT

2.2.1 Materials and Equipment

****

NOTE: Pipes, valves, pumps, and appurtenances are generally supplied as part of the package filtration system, but the designer must specify those sites requiring special materials of construction, sizing, etc., based on the influent stream characteristics.

****

Ensure all recyclable materials conform to EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment that is supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.1.2 Nameplates

Provide each major item of equipment with the manufacturer's name, address, type of style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.2.1.3 Protection of Moving Parts

Completely enclose by guards belts, chains, couplings, and other moving parts to prevent accidental personal injury. Fabricate guards to be removable or arranged in a way to allow access to the equipment for maintenance. If equipment is housed in a lockable housing, ensure the housing provides sufficient protection and no additional guards are necessary.

2.2.1.4 Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

2.2.1.5 Steel Plates, Shapes and Bars

ASTM A36/A36M.

2.2.1.6 Pipe and Fittings

Provide pipe and fittings that conform to the standards specified below.

2.2.1.6.1 Steel Pipe

ASTM A53/A53M.

a. Flanged Joints: ASTM A707/A707M.

b. Welded Joints: AWS D1.1/D1.1M.

c. Bolts: ASTM A307, Grade B.

d. Fittings: ASTM A420/A420M.

2.2.1.6.2 Ductile Iron Pipe

AWWA C115/A21.15.

a. Flanged Pipe: AWWA C115/A21.15 with ASME B16.1, Class 125 flanges.

b. Rubber-Gasket Joints: AWWA C111/A21.11.

c. Fittings: AWWA C110/A21.10.

d. Push-on Joints: AWWA C151/A21.51.

e. Bolts and Nuts: ASTM A307, Grade B.

2.2.1.6.3 Stainless Steel Pipe

ASTM A312/A312M, Schedule 40, Type 316 or Type 304.

a. Flanged Pipe: ASME B16.5, Class 150.

b. Rubber-Gasket Joints: ASTM D1330.

c. Fittings: ASME B16.3.

d. Bolts: ASTM A193/A193M, Class 1, Grade B8.

e. Nuts: ASTM A194/A194M, Grade 8.

2.2.1.6.4 Polyvinyl Chloride (PVC) Pipe

Provide PVC pipe and fittings less the 100 mm 4 inch diameter in accordance with ASTM D1785 or ASTM D2241. Provide PVC pipe and fittings 100 mm 4 inch in diameter or larger in accordance with ASTM D2241 with push-on joints.

a. Push-on Joints: ASTM D3139 or ASTM F477.

b. Solvent Cement: ASTM D2564.

2.2.1.7 Pipe Hangers and Supports

MSS SP-58.

2.2.1.8 Valves

2.2.1.8.1 Steel Valves

ASTM A216/A216M, Grade WCB.

2.2.1.8.2 Cast Iron Valves

ASTM A126, Class B.

a. Globe and Angle Valves: MSS SP-85.

b. Gate Valves: MSS SP-70.

c. Plug Valves: MSS SP-78.

d. Butterfly Valves: MSS SP-67.

e. Ball Valves: MSS SP-72.

f. Check Valves: MSS SP-71.

2.2.1.8.3 PVC Valves

ASTM D1784, Class 12454-B (formerly designated Type I, Grade 1).

2.2.1.9 Other Materials

2.2.1.9.1 Polypropylene Support Material

****

NOTE: The polypropylene requirements are applicable to use for support materials for bag and cartridge filters.

****

ASTM C1147.

2.2.1.9.2 Joint Compound

Use joint compound for threaded joints made from a stiff mixture of graphite and oil, inert filler and oil, or a graphite compound.

2.2.1.9.3 Joint Tape

Provide joint tape for threaded joints that complies with ASTM D3308.

2.2.2 Electrical Equipment

2.2.2.1 Electrical Work

[Provide electrical motor-driven equipment specified complete with [motors] [motors and motor starters] and controls.] [Motor starters complete with properly sized thermal overload protection and other appurtenances necessary for the motor specified.] Perform electrical work as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices.

2.2.2.2 Electric Motors

Provide motors that conform to NEMA MG 1. Provide motors with nameplate horsepower equal or greater than 380 watts 1/2 hp that are suitable for 480 volt, 3 phase operating service, unless otherwise specified. Provide motors of greater than 760 watts 1 hp that are high efficiency type as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2.2.3 Motor Controls

Provide controls that conform to NEMA ICS 1.

2.2.2.4 Electrical Power Control

****

NOTE: Generally, the filter manufacturer will supply a standard control system with the package unit. To allow maximum flexibility, the control system should be specified only to the extent necessary to achieve project needs. The following sub paragraphs provide specification for several control system components the designer may require the manufacturer to incorporate into the package system. Delete paragraphs not required.

****

2.2.2.4.1 General Requirements

Provide a [manual] [semi-automatic] [automatic] [_____] complete electrical power, control, and instrumentation system as specified or recommended by the equipment manufacturer for the safe operation and supervision of the filter units and related equipment, except those items specified to be furnished under other sections. Provide schematics and interconnection wiring diagrams for power, control, and instrumentation circuits to equipment specified. Provide terminal blocks (plus 25 percent spare terminals) in panels to terminate field and interconnection wiring.

2.2.2.4.2 Control System

Provide control power transformers, relays, adjustable timers, auxiliary contacts, switches, or additional equipment as required to interconnect the filter equipment to a remote plant monitoring system, and control circuits as shown on schematic or instrument control system drawings. Furnish conduit wiring between control panels and control devices as part of this specification. Submit a description of the control system including, but not be limited to, the following items:

a. Product information for sensors/transducers and field instruments.

b. Programmable Controller System Information

    (1) System Description

    (2) Hardware Description

    (3) Software Description

c. Panels, Consoles, and Cabinets Information

    (1) Layout Drawings

    (2) Panel schematic and internal point-to-point wiring interconnect and/or piping diagrams

    (3) Electrical control schematics in accordance with NFPA standards for all circuits indicated in the specifications or on the Contract Drawings. "Typical" wiring diagrams are acceptable but the use of tables or charts to describe wire numbers is not acceptable. Label wires and shown on the submittal drawings.

    (4) Plan showing equipment layout.

    (5) Stock lists or Bill of Materials for each panel including tag number, functional name, manufacturer's name, manufacturer's model number, and quantity for components mounted in and on the panel, console, or cabinet.

d. Field wiring and piping diagrams and point-to-point wiring diagrams including interconnections between field devices, panels, control stations, lighting panels, and motor starters.

e. Instrument loop diagrams for analog display, control and I/O loops prepared using ISA standard symbols.

f. System Software Documentation to include the following as a minimum:

    (1) Complete hard copies of ladder diagram programming.

    (2) Complete listing of external and internal I/O address assignments, register assignments, and preset constant values along with functional point descriptions. Also list unused/undefined I/O and data table registers available.

    (3) Complete hard copies of program documentation for all types of programs.

    (4) Detailed system memory map defining memory segments used and spare memory segments available for system memory, I/O tables, Data Tables, and control program.

    (5) Complete database listing.

    (6) User's manual describing procedures and providing examples for use of programming terminal, accessories, and system utility routines to perform control, program modification, program verification,

diagnostics, program documentation, loading and backup, and other required system support functions.

2.2.2.5 Remote Alarm and Process Variable Monitoring

****

NOTE: Coordination with remote systems, such as Supervisory Control and Data Acquisition (SCADA) System and annunciators, must be specified in this paragraph and must include the method of transmission to remote locations for the process variables to be monitored for each unique application. If remote alarm and process variable monitoring is not used, this paragraph must be deleted.

****

2.2.2.6 Bolts, Nuts, Anchors, and Washers

Provide steel bolts, nuts, anchors, and washers, galvanized in accordance with ASTM A153/A153M.

2.2.2.7 Valves

Transfer water to and from the filtration unit by a means of [ball valve] [butterfly valve] [globe valve] [air solenoid] [_____] for [automatic] [semiautomatic] [manual] operation. Design the valve mechanisms such that gradually increasing flows are attained as ports are opened and initial surges and sudden inrushes of water are avoided. Include a dial pointer to indicate each step of the operation.

2.2.2.8 Pumps

Supply air compressors where insufficient head is available to move the [influent] [effluent] [backwash] [wash] water. Ensure the pump complies with the requirements of Section 23 21 23 HYDRONIC PUMPS.

2.2.2.9 Air Compressors

Supply pump in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.2.2.10 Pressure Gauges

Show or schedule gauge sizes and scale ranges on the Contract Drawings. Provide gauges that comply with ASME B40.100 Type 2A, as a minimum. Provide compound gauges on the suction side of pumps and standard pressure gauge on the discharge side of pumps. Use gauges with clear acrylic or shatterproof glass windows and shock-resistant cases. Set the design operations to fall at the midpoint of the graduated scale. Equally space major divisions and show in whole integers. Engrave scale units on the scale face. Limit pointer travel to not less than 200 degrees nor more than 270 degrees arc. Provide gauge accuracy of plus or minus 0.5 percent of span. Provide each gauge, except those for hydraulic systems, with a process shutoff valve.

2.2.2.11 Gauge Panel

Provide a gauge panel on which [1] [2] [_____] nominal pressure gauges to sense unit inlet and outlet pressures and [1] [2] [_____] pressure switch are mounted. Wire the pressure sensor switch to a control panel which sounds an alarm when the differential pressure exceeds the [maximum differential pressure specified in Paragraphs Design Criteria or Cartridge and Bag Design Criteria (as applicable)] [maximum differential pressure specified by the manufacturer].

2.2.2.12 Tank Requirements

****

NOTE: Further requirements for tanks specific to each filtration process are presented in the applicable paragraph.

****

2.2.2.12.1 Parameters

Provide specified tanks in accordance with the following general requirements, unless otherwise indicated. Provide each tank with flanged fittings for inlet, outlet, overflow and drain. Provide the size, elevation and orientation in accordance with construction drawings. Provide hold down lugs to anchor the tank to the base.

2.2.2.12.2 Tank Construction Materials

****

NOTE: Tank construction materials must be compatible with the materials to be handled. This requirement is applicable for all tanks (e.g., filter tanks, backwash tanks, chemical feed, polymer supply, etc.).

****

Provide tank construction material compatible with the material to be handled. Provide tanks constructed of polyethylene, polypropylene, and fiberglass reinforced plastic (FRP) that conform to applicable material and construction provisions of ASTM C582, ASTM D3299, and ASTM D4097. Provide tanks constructed of steel that conform with applicable material and construction provisions of AWWA D100. Fabricate carbon steel tanks with ASTM A283/A283M carbon steel Grade C or D and protected with [an appropriate interior coating system for the intended service] [vinyl ester epoxy] [_____] in accordance with applicable requirements in Section 09 90 00 PAINTS AND COATINGS. Fabricate stainless steel tanks of Type 304 stainless steel conforming to ASTM A167 with structural support conforming to ASTM A276/A276M. Provide exterior painting or coating in accordance with Paragraph PAINTING.

2.2.2.12.3 Site Glasses

Provide a [_____] mm inch diameter observation port in the tank wall. Locate the observation port [at the surface of the filter media] [at the media interface] [_____].

2.2.3 Media

Provide filter materials that conform to the requirements of AWWA B100. Perform a sieve analysis in accordance with ASTM C136/C136M and AWWA B100. Determine specific gravity in accordance with ASTM C127 for support media and ASTM C128 for [silica sand] [anthracite coal] [high-density media]. Submit characteristics of each filter media material.

2.2.3.1 High-Density Sand

Provide high-density sand composed from [garnet] [ilmenite] [_____] with a specific gravity of [3.6] [4.0] [4.2] [_____], uniformity coefficient less than or equal to [_____], and an effective size between [_____] and [_____]. Ensure ninety-five percent of the material is larger than or equal to [_____].

2.2.3.2 Silica Sand

Provide silica sand with an effective size between [_____] and [_____], uniformity coefficient less than or equal to [_____], and a specific gravity of [2.55] [2.60] [2.65] [_____]. Ensure ninety-five percent of the material is larger than or equal to [_____].

2.2.3.3 Anthracite Coal

Provide anthracite coal with a specific gravity of [1.45] [1.50] [1.55] [1.73] [_____], uniformity coefficient of [_____], and an effective size between [_____] and [_____]. Ensure ninety-five percent of the material is larger than or equal to [_____]. The anthracite media is required to be clean and free from thin or scaly pieces, with a calcium carbonate and magnesium carbonate hardness of [_____].

2.2.3.4 Support Media

Provide support gravel consisting of hard, rounded stones with an average specific gravity of not less than [_____]. Ensure not more than [_____] percent by weight has a specific gravity of [_____] or less. Ensure gravel contains not more than [_____] percent by weight of thin, flat, or elongated pieces (pieces in which the largest dimension exceeds three times the smallest dimension), and is free from shale, mica, clay, sand, loam, and organic impurities of any kind.

2.2.4 Continuous Backwash Filtration System

2.2.4.1 Equipment Capacity

Provide each unit with a moving bed, continuous backwash [upflow] [downflow] granular media filter, having a capacity to filter [_____] L/minute gpm of water at the operating conditions identified in Paragraph Design Criteria.

2.2.4.2 Filter Tank

****

NOTE: Provide seismic details if a Government designer (either Government Agency Office or A/E) is the engineer of record, and show on the drawings. Delete the bracketed phrase, in the last sentence, if seismic details are not provided. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

****

Provide a cylindrical, sloped-bottom filter tank with the dimensions shown and constructed of [epoxy coated carbon steel] [type 304 stainless steel] [fiberglass reinforced plastic] [_____] construction, free from physical imperfections. Construct the tank with a minimum number of pieces and a minimum thickness of metal parts exposed to the water of [_____]. Fit the tank with lifting lugs to facilitate handling and placement. Provide the filter tank with sufficient support to withstand wind speed in excess of [_____] km/hour mph and design for seismic forces in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR MECHANICAL SYSTEMS [as shown on the drawings].

2.2.4.3 Filter Media

Provide silica sand filter media at a total depth of [_____] m feet. Ensure all media conforms to the requirements of AWWA B100.

2.2.4.4 Influent Dosing System

****

NOTE: Each continuous backwash filter manufacturer has a particular influent dosing system. The influent dosing system should be specified only to the extent necessary to achieve the project objectives.

****

Provide an influent dosing system capable of delivering the influent stream uniformly over the entire media bed. Introduce the influent water to the [bottom] [top] of the filter tank. Construct all components of the dosing system of [stainless steel] [fiberglass reinforced plastic] [_____].

2.2.4.5 Effluent Collection System

Collect effluent by [discharge of filtrate overflow over an effluent weir constructed of [stainless steel] [fiberglass reinforced plastic] [_____] and placed and sized dimensionally as shown on the Construction Drawings.] [a filtrate line connected to a filtrate chamber consisting of a cylinder with a wedgewire screen periphery and hood. Construct the screen of stainless steel trapezoidal bars having an opening smaller than the finest media grain. Configure and size dimensionally the effluent collection system as shown on the Construction Drawings.] [_____] discharge effluent through a [_____] mm inch diameter [stainless steel] [fiberglass reinforced] [_____] pipe.

2.2.4.6 Media Cleaning System

The media cleaning system consists of a sand lift, sand washer, sand distribution equipment and reject collection system.

2.2.4.6.1 Sand Lift

The sand lift consists of [Type 304] [Type 304L] stainless steel eductor pipe. The pipe mounts [externally] [internally] and fixed [by welding] [by means of a [_____] ANSI gasketed flange] [_____] to the filter vessel. Supply compressed air at [_____] to [_____] cubic meters cubic feet per minute at [_____] Pa psig to the eductor pipe. Provide a suction rate that is sufficient to result in internal recycling of the media once every [_____] hours.

2.2.4.6.2 Sand Washer

****
NOTE: Delete cross-sectional area sizing requirements if the sand washer unit is external to the filter tank.
****

The sand washer consists of a chamber constructed of [Type 304 stainless steel] [acrylic] [fiberglass reinforced plastic] [_____]. Provide a sloped floor to clear the sand from the bottom of the chamber. Equip the chamber with [_____] baffles attached to its walls with a slope sufficient to cause the descending sand to strike the opposing chamber wall before dropping to the next level. Size the cross-sectional area to assure sufficient velocity of upflowing water to transport separated solids into the wash chamber and out the reject pipe.

2.2.4.6.3 Sand Distribution Equipment

Return the cleaned sand to the bed via a [sand distribution cylinder] [sand distribution cone] [return pipe] [washbox skirt] [_____], constructed of [fiberglass reinforced plastic] [Type 304 stainless steel] [_____] placed and sized as shown. Return the sand so that the media distributes evenly in a cone on top of the media bed.

2.2.4.6.4 Reject Collection System

The reject collection system consists of a stainless steel reject weir and a [_____] diameter reject nozzle. Position the reject weir to achieve the desired differential head between the effluent water and the reject water. Design the reject collection system to allow no more than [2] [10] [20] [_____] percent reject water.

2.2.4.7 Effluent Rate Control

Control filter operation by the liquid level in the filter tank using a proportional, displacer-type liquid level sensor. Provide an automatic effluent control [globe] [ball] [_____] valve with a pneumatic positioner to regulate the degree of opening in response to a [_____] to [_____] pneumatic signal. Ensure that an increase in signal air pressure increases the degree of valve opening. Ensure the flow control system is self-contained and does not require manual adjustments.

2.2.4.7.1 Pneumatic Controls

The pneumatic controls consist of a pressure gauge and a flowmeter. Mount the pressure gauge on the panel with a [_____] to [_____] Pa psi range and a [_____] mm inch face. Provide a flowmeter of the variable area type with a stainless steel indicator. Provide the meter with a metering valve, [_____] mm inch scale, and a range of [_____] to [_____] cubic meters cubic feet per minute. Mount both devices on a hinged panel visible through a window in the control enclosure.

2.2.4.7.2 Headloss Switch

Supply a headloss switch to signal when the media bed is beginning to foul. Rate the switch contacts at [_____] amps and connect to [an alarm] [process controls] [purge valve] [_____].

2.2.4.8 Equipment Control Panel

The equipment manufacturer is required to furnish a control panel containing all necessary timers, contact switches, internal wiring, completely assembled and mounted in a NEMA [4] [4X] [12] [_____] enclosure. The control panel provides for [automatically starting and stopping pumps] [manual operation of the control valves] [_____]. Mount the control panel on the filter unit and provide electrical wiring and connections external to the unit.

2.2.4.9 Flowmeters

Equip influent and effluent lines with [kennison nozzle] [parshall flume] [shuntflo stream] [sonic] [_____] flowmeters.

2.2.5 Traveling Bridge Filter

2.2.5.1 Tank

Provide a tank [_____] wide by [_____] long by [_____] deep constructed of [_____] thick [mild steel] [carbon steel] [_____]. Construct the assembled tank to allow loading and unloading as a unit and equip with lifting lugs. Furnish integral supports so that the body of the tank, when installed, are [_____] mm inches above the concrete slab. Place the supports to allow for full inspection of the underside of the tank. Construct tank in accordance with Paragraph Tank Requirements and prepared in accordance with the requirements of Paragraph PAINTING and Paragraph MATERIALS PROTECTION.

2.2.5.2 Filter Bed

2.2.5.2.1 Cell Dividers

Provide a filter bed [_____] wide by [_____] long and consisting of a series of self-supporting lateral partitions (cell dividers) which divide the filter into a multitude of [_____] wide compartments. Arrange each compartment for connection to a separate backwash port. Fabricate the divider sheets of [glass fiber reinforced plastic binder] [Type 304 stainless steel] [_____] with a finished thickness of [_____]. Ensure all divider sheets are without voids and/or air pockets. Cell sheets are not allowed to twist, curve or bend.

2.2.5.2.2 Porous Plate

Provide a porous plate supporting underdrain constructed of [fused aluminum oxide] [polyethylene] [_____] to a thickness of [_____] that is factory installed. Provide for a maximum pore diameter of [_____] microns. Provide sheets with a porosity between [_____] and [_____] and a minimum flexural strength of [_____] Pa psi. The plate allows a flow of [_____] L gallons per minute per [_____] mm inch water column pressure. Seal the porous plate completely with a [polyurethane] [silicone] [_____] sealant during installation. Provide a sealant with, at a minimum, [_____] hardness and [_____] tensile strength that does not contain asbestos fibers.

2.2.5.3 Voids Distribution

Provide media with uniform voids distribution from coarse to fine in the direction of flow. Ensure all filter materials conform to the requirements of AWWA B100.

2.2.5.4 Rails

Provide [_____] kg lb ASCE rails with stainless steel splice plates and hardware mounted on the two main filter walls. Provide Type 304 stainless steel caps factory installed on each rail. Install and have a factory service engineer field adjust carriage rail stops fabricated from 300 Series stainless steel.

2.2.5.5 Carriage Mechanism

2.2.5.5.1 Carriage Frame

Traveling carriage or bridge systems contain and support the [positive drive mechanism] [pumps] [automatic backwash system] [washwater removal system] [motors] [limit switches] [_____]. Fabricate the carriage frame of welded steel construction. Provide a separate maintenance platform.

2.2.5.5.2 Carriage Drive

The carriage drive unit consists of a gear reducer, sprockets, stainless steel drive shaft, a NEMA B design single speed [_____] watt TCFC motor for three phase, [_____] hertz, [_____] volt power supply, provided with a sealed conduit box. Design the drive unit so that a torque limiting device is not required and has a strength of [_____]. Ensure all gear reducers are AGRA approved. Provide the drive shaft of sufficient size to adequately and safely withstand bending and torsional loads of starting and operating. Fully enclose all gearing in an oil-tight cast iron housing with the gears running in oil and anti-friction type bearings.

2.2.5.5.3 Carriage Wheels

Provide double flanged wheels of hardened Type 304 stainless steel. Provide self-aligning bearings with lubrication fittings. Provide wheels capable of compensating for minor misalignment of rails by sliding on the shaft. Do not use horizontally mounted wheels within the tank to align the carriage. Do not use caster-type wheels.

2.2.5.6 Automatic Backwash System

****

NOTE: If adjustable compression springs are not required, delete the second sentence.

****

Attach a fabricated backwash support frame to the traveling carriage on the effluent chamber side. Furnish adjustable stainless steel compression springs mounted between the carriage weldment and the backwash frame to allow adjustment of the backwash valve from outside the tank while the filter is in use. Mount a backwash shoe on the frame that can independently follow any irregularities of the matching backwash surface along the effluent ports. Construct the shoe of a material softer than the mating backwash surface (strip). Control the shoe flexible movement by using 300 series stainless steel springs. Attach the shoe to the piping by means of a flexible hose. Connect the piping to the backwash pump and include a throttle valve to achieve the correct pumping rate. Factory bolt the backwash surface (strip) to the effluent header by means of countersunk Type 304 stainless steel fasteners.

2.2.5.7 Washwater Removal System

Fabricate the washwater hood from [[304] [316L] stainless steel] [fiberglass reinforced plastic] [_____]. Ensure the hood permits the uniform expansion of the filter media. Fabricate the hood width to be [_____] times the cell width. Install a [stainless steel] [PVC] [_____] manifold in the upper portion of the washwater hood and connect to the washwater pump. Provide the washwater hood with a [high density polyethylene] [304 stainless steel] [_____] raking device and a minimum of two vent pipes extending to [_____] above the overflow weir.

2.2.5.8 Washwater Launders

Construct the washwater launders from [_____] mm inch [A36 steel] [fiberglass reinforced plastic] [_____] with a [_____] mm inch depth and [_____] mm inch width as an integral part of the filter tank wall. Ensure both backwash and washwater pumping systems are capable of discharging into the launder. Provide a "V" notch weir plate to calibrate and balance the flow of the washwater pumping system.

2.2.5.9 Equipment Control

2.2.5.9.1 Automatic Controls

Furnish automatic controls for the filter operation as an integral part of the carriage mechanism. Mount the automatic controls on the end of the filter tank. Factory assemble the carriage mechanism and attaching components and test for mechanical and electrical operation prior to shipment.

2.2.5.9.2 Control Panel

Provide the control panel with a hinged door for access to the control equipment. Mount "Hand-off-auto" selector switches with indicating lights for each pump motor and the carriage motor on the front of the panel door. Provide a main disconnect switch to de-energize the control panel with a pendulum handle operator extending through the control panel door. Provide a ground fault protected convenience outlet. Fabricate the enclosure from NEMA [3R] [4X] [_____], [painted steel] [Type 300 series stainless steel] construction, factory wired and tested. The pump and carriage motor controls consisting of magnetic contactors with thermal overcurrent protective devices.

2.2.5.9.3 Motors

Include controls, a timing device, relays and magnetic motor starters for each pump motor and carriage motor in the panel. Actuate these motors automatically by a predetermined increase in hydraulic head, or by the timing device to control the interval between each cleaning cycle. [Terminate the cleaning cycle by a signal from the low water sensing electrode. Control the "off time" of the cleaning cycle by a reset timer with a range of 1 minute to 60 hours. When the timer times out, actuate the motors. During the "on time", de-energize the timer and reset for starting "off time" at the end of the cycle. Should high water occur "off time", start the motors by a relay actuated from the high water electrode signal, with a corresponding resetting of the timer.] [Continue the washing cycle, when activated, for one complete pass of the filter bed. Under normal operation, ensure the carriage does not come to rest other than at either end of the filter.]

2.2.5.9.4 Backwash Mechanism

Wire the control sequence for the backwash mechanism so the backwash mechanism stops at either end of the filter upon termination of the backwash cycle, which is also at the low operating probe signal. Install a low water shutoff probe to prevent pumping the filter tank below the minimum water level point. Furnish additional electrodes to protect the submersible pumps by giving a signal prior to reaching the overflow point.

2.2.5.9.5 Electrification System

Provide a stretch cable electrification system. Construct the cable of [_____] diameter stainless steel. Provide a stainless steel turnbuckle at one end for cable tension adjustment. Equip the electrification system with a number of non-friction nylon trolley carriers which support the electrical flat cable used to power the carriage. Connect the electrification system to a NEMA [4X] [3R] [_____] [Type 300 series stainless steel] [fiberglass reinforced plastic] equivalent junction box.

2.2.5.9.6 Factory Tests

Submit test reports of all factory tests specified in the above paragraphs and throughout this specification.

2.2.5.10 Auxiliary Equipment

2.2.5.10.1 Pumps

Power the backwash and washwater systems by a submersible pump suspended from the filter carriage. Any pumps other than dual submersible pumps are not acceptable. Furnish each pump capable of providing a minimum pumping rate of [_____] at a head of [_____]. Equip the pumps with stainless steel shafts, and abrasive-resistant impellers. Supply pumps in accordance with the requirements of Section 23 21 23 HYDRONIC PUMPS.

2.2.5.10.2 Weirs

Construct the influent and effluent weirs of sufficient length so that the flow does not exceed [_____] L cubic feet per minute per weir length at the average daily flow. Install the influent weir [_____] mm inch above the effluent weir. Install the effluent weir [_____] mm inch above the top of the cell dividers. Fabricate the weirs of Type 304 stainless steel to be [_____] deep with [_____] mm inch adjustment. Mount the weirs on [_____] mm inch mild steel plate with Type 304 stainless steel hardware on [_____] mm inch centers sealed with a neoprene rubber gasket. Install the overflow weir a minimum of [_____] mm inch above the effluent weir. Fabricate the weir to be the full width of the filter. Do not allow the overflow to discharge into the backwash channel.

2.2.5.10.3 Backwash Channel and Washwater Trough

Fabricate the bottom surface of the washwater trough to be at least [_____] m feet above the overflow weir. Construct the backwash channel of [stainless steel] [fiberglass reinforced plastic] [_____]. Provide a tank drain in the backwash channel.

2.2.6 Pressure Filters

2.2.6.1 Pressure Filter Tank

****

NOTE: Delete the partition wall requirement if the vessel will not be divided into multiple filter cells.

****

Construct the pressure filter tank to have a diameter of [_____] m feet, a height of [_____] m feet, straight shell length of [_____] m feet and oriented [horizontally] [vertically]. Provide each vessel with [_____] partition wall to divide the vessel into [_____] filter cells. Construct the filter vessels of welded steel and test to withstand a hydrostatic pressure of [_____] Pa psi in excess of the working pressure of [_____] Pa psi. Design and fabricate the vessel in accordance with the ASME BPVC SEC VIII D1 and stamp and certify as such. Provide lifting lugs, supports, connections and appurtenances as detailed on the drawings. Construct the filter tank in accordance with Paragraph Tank Requirements and prepared in accordance with the requirements of Paragraph PAINTING and Paragraph MATERIALS PROTECTION.

2.2.6.2 Underdrain System

Furnish each filter with [pipe laterals with nozzles] [pipe laterals with orifices] [a porous plate] [_____] underdrain system. Provide underdrain of standard manufacturer's design particular to the supplied filter unit and furnished with the constructed package unit. Design the underdrain system to withstand all loads due to design pressures, design loading rates, and loads from the media to be installed in the filter tank.

2.2.6.3 Pressure Filters Media

Ensure the media provides uniform voids distribution from coarse to fine in the direction of flow. Ensure filter materials conform to the requirements of AWWA B100.

2.2.6.4 Distributor/Collector

Provide each filter with an influent distributor/backwash collector of the [central manifold] [lateral arm] [_____] type. Fabricate the influent distributor and waste water collector as an integral part of the filter tank. Construct the system from [steel] [aluminum] [fiberglass] [_____] of the manufacturer's standard design.

2.2.6.5 Surface Wash Agitators

****

NOTE: Since surface wash systems vary greatly, additional information regarding the strength, construction, method of connection and nozzle size and type may be required to adequately specify surface wash agitators. The designer is required to add this information and any other additional information necessary for adequate specification.

****

Provide each filter with a [straight line] [S-shaped] [_____], [single] [double] arm [rotary] [fixed] agitator constructed of [stainless steel] [brass-bronze] [_____] components. Design the agitator to create the most efficient degree of agitation to all portions of the filter. Ensure each agitator is capable of discharging [_____] L cubic feet per minute of water at an operating pressure of [_____] Pa psi. Maximum increase in bed expansion from surface wash is [_____] percent.

2.2.6.6 Air Scour System

2.2.6.6.1 Air Wash Distribution

Provide each tank with a separate air wash distributor. The distributor consists of a [brass] [red brass] [_____], [_____] mm inch air header with [_____] mm inch slotted [brass] [red brass] laterals on approximately [_____] mm inch center. [Introduce air to the media bed through the underdrain system.] [Introduce air at the top of the [gravel support layer] [underdrain].] A headloss up the wall of the filter of [_____] L per minute per square meter cubic feet per minute per square foot at [_____] mm inch of water column is acceptable.

2.2.6.6.2 Air Blower

Supply a positive displacement air blower for supplemental air wash. Provide the blower with a minimum capacity of [_____] L cubic feet per minute at [_____] Pa psi discharge pressure and supply in accordance with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.2.6.7 Equipment Control

2.2.6.7.1 Control Valves

Ensure the filter influent, backwash, waste, rinse, and surface wash valves allow for automatic operation of each filter unit.

2.2.6.7.2 Effluent Rate Controllers

Provide each filter with an effluent rate of flow controller consisting of a [flanged venturi tube] [butterfly valve] [electronic differential pressure transmitter] [_____].

2.2.6.7.3 Backwash Controller

Provide one backwash rate of flow controller consisting of a [flanged venturi tube] [butterfly valve] [electronic differential pressure transmitter] [_____].

2.2.6.8 Equipment Control Panel

Supply a control panel with a NEMA [4X] [12] [_____] enclosure to contain all necessary timers, lights, contact switches, internal wiring, etc. and associated equipment to allow for the completely automatic operation of the system. Provide the control panel for [automatically starting and stopping pumps] [manual operation of the control valves] [[manual] [automatic] [_____] backwash initiation] [_____]. Initiate backwash by [elapsed time] [high head loss] [high turbidity] [manual initiation] [_____]. Furnish the panel completely assembled, wired, and tested at the factory prior to shipment. Provide the panel with required switches for manual operation as required.

2.2.6.9 Backwash Tank

****

NOTE: The designer should consider the size of the facility in determining whether a separate specification section for the backwash tank is warranted or if the following paragraph is adequate.

****

Furnish the backwash tank with a capacity of [_____] to backwash the system at the manufacturer's recommended rate, pressure and frequency. Construct the tank in accordance with the requirements of Paragraph Tank Requirements.

2.2.7 Cartridge Filter

2.2.7.1 Equipment Capacity

Supply [_____] filtration units. [_____] units are required to be on-line, [_____] units are required to be on standby. On-line and standby units are required to have the capacity to treat the entire waste stream as specified in Paragraph Cartridge and Bag Design Criteria.

2.2.7.2 Filter Material

Filter material consists of [acetate] [acrylic] [glass] [nylon] [polyester] [polypropylene] [rayon] [saran] [cotton] [fluorocarbon] [teflon] [polyethylene] [_____] construction.

2.2.7.3 Cartridge Style

Cartridge style are to be [double open end industrial] [single open ended (SOE) flat closed end to fit housings with 020 O-ring posts] [SOE flat closed end with external 222 O-rings] [double open end with internal O-rings] [SOE flat closed end with external 226 O-rings] [SOE fin end with external 226 O-rings] [SOE fin end with external 222 O-rings] [double open end with internal O-rings] [SOE flat closed end with internal 120 O-rings].

2.2.7.4 Gasket or O-Ring Material

Provide the gaskets or O-rings fabricated from [silicone] [buna-n] [white silicone] [white buna-n] [viton-a] [EPDM] [teflon].

2.2.7.5 Pore Size/Rating

Provide filter pore sizes of [0.1] [0.2] [0.45] [1] [3] [10] [30] [50] [75] [100] [200] [_____] microns.

2.2.7.6 Filter Cartridge Dimensions

The filter cartridge is required to be the standard length of 250 mm 10 inch. Provide the cartridge inside diameter of [_____]. Provide the cartridge outside diameter of [_____].

2.2.7.7 Core Material

Provide cartridge core material made of [tinned steel] [polypropylene] [304 stainless steel] [316 stainless steel] [_____].

2.2.7.8 Filter Housing

2.2.7.8.1 Material of Construction

****

NOTE: Where flange options are specified, the designer must account for clearance of flanged fittings during installation.

****

Construct the filter housing head, shell, and associated internal and external connections and internal and external hardware of [304 stainless steel] [316 stainless steel] [carbon steel] [teflon] [polypropylene] [fiberglass reinforced plastic] [acrylic]. Prefabricate the housing and deliver to the site in such a condition that the unit can be fastened in the location designated on the design drawings. Provide the filter housing with the following dimensions and inlet, outlet, and system control connections:

Diameter	[_____]
Overall Height	[_____]
Inlet/Outlet	[_____] [NPT] [Flange] [ANSI 150 lb] raised face, [threaded flanges] [_____]
Body/Sump Drain	[_____] [NPT] [Flange] [_____]
Vent	[_____] [NPT] [Flange] [_____]
Gauge	[_____] [NPT] [Flange] [_____]

2.2.7.8.2 Shell O-Ring Material

Provide filter housing shell O-ring material composed of [buna-n] [silicon] [neoprene] [viton-a] [ethylene] [propylene] [_____] material.

2.2.8 Bag Filter

2.2.8.1 Equipment Capacity

Supply [_____] filtration units. [_____] units are set to be on-line, [_____] are set to be standby. Each on-line and standby unit is required to have the capacity to treat the entire waste stream as specified in Paragraph Cartridge and Bag Design Criteria.

2.2.8.2 Filter Material

Provide filter material consisting of [acetate] [acrylic] [glass] [nylon] [polyester] [polypropylene] [rayon] [saran] [cotton] [fluorocarbon] [teflon] [polyethylene] [_____] construction.

2.2.8.3 Gasket Material

Provide a single gasket cover seal for each bag element. Provide [silicone] [buna-n] [white silicone] [white buna-n] [viton-a] [EPDM] [teflon]as material of construction.

2.2.8.4 Pore Size/Rating

Provide bag pore size of [0.1] [0.2] [0.45] [1] [3] [10] [30] [50] [75] [100] [200] [_____] microns.

2.2.8.5 Bag Surface Area

Provide bag surface area of [_____].

2.2.8.6 Bag Support

Support material fabricated from [tinned steel] [polypropylene] [304 stainless steel] [316 stainless steel] [_____].

2.2.8.7 Filter Housing

2.2.8.7.1 Material of Construction

****

NOTE: Where flange options are specified, the designer must account for clearance of flanged fittings during installation.

****

Construct the filter housing head, shell, and associated internal and external connections and internal and external hardware of [304 stainless steel] [316 stainless steel] [carbon steel] [teflon] [polypropylene] [fiberglass reinforced plastic] [acrylic]. Prefabricate the housing and deliver to the site in such a condition that the unit can be fastened in the location designated on the design drawings. Provide filter housing having the following dimensions and inlet, outlet, and system control connections:

Diameter	[_____]
Overall Height	[_____]
Inlet/Outlet	[_____] [NPT] [Flange] [ANSI 150 lb] raised face, [threaded flanges] [_____]
Body/Sump Drain	[_____] [NPT] [Flange] [_____]
Vent	[_____] [NPT] [Flange] [_____]
Gauge	[_____] [NPT] [Flange] [_____]

2.2.8.7.2 Shell O-Ring Material

Provide filter housing shell O-ring material made of [buna-n] [silicon] [neoprene] [viton-a] [ethylene] [propylene] [_____] material.

2.2.9 Sample Ports

Locate two sample ports, at a minimum, on each unit; one to sample the influent and one to sample the effluent. Fabricate so the sample ports are readily accessible and of the manufacturer's standard design and placement.

2.2.10 Turbidimeter

****

NOTE: Delete the interface screening requirement if turbidity monitoring will not be performed at the media interface and for bag and cartridge filters.

****

Install a turbidimeter for automatically testing the turbidity of the water in the [influent line] [effluent line] [media interface] for each filter unit. Obtain [influent] [effluent] samples directly from the piping. Collect interface samples from a screen located within the media bed [_____] mm inch above the media interface. House the turbidimeter in a NEMA [4x] [12] [_____] enclosure located within [_____] from the sensor. Turbidimeter is required to be programmable to read in NTU, FTU, and engineering units and provide a measurement range from [_____] NTU to [_____] NTU.

2.2.11 Drain Line

Locate a drain line to facilitate the removal of water from the filter tank. Ensure the drain line is readily accessible and of the manufacturer's standard design and placement.

2.2.12 Chemical Feed

Provide chemical feed systems in accordance with the requirements of Section 46 30 00 WATER AND WASTEWATER CHEMICAL FEED SYSTEMS.

2.2.13 Materials Protection

Treat the interior and exterior of fabricated ferrous metal components after fabrication to prevent corrosion. Sandblast the surfaces of the filter tanks and completely factory finish paint prior to shipment. Use insulating components such as gaskets, couplings, or bushing or dielectric-type which prevent corrosion of bimetallic-type contacts, at connections between dissimilar metals.

2.2.14 Access Walkways, Platforms, Ladders And Handrails

****

NOTE: Drawings should provide for the location of access walkways, platforms, ladders and handrails.

****

Provide walkways, platforms and ladders for access to equipment for operation and maintenance in accordance with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS. Walkways and platforms are required to be nonslip open grating fabricated from [galvanized steel] [aluminum] [fiberglass] [_____]. Provide rigid handrails and kick-plates along the sides of walkways and platforms. Fabricate handrails from [galvanized steel] [aluminum] [_____], to be [_____] high, and to have two horizontal rails. Provide gates as required for access to equipment. Set the last rung of the ladder on top at the same level as the top of the tank. Ensure construction conforms to ASSP A1264.1 and ALI A14.3.

PART 3 EXECUTION

3.1 EXAMINATION

Verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

3.2.1 Fabrication

Any work not required to be performed in the field is to be performed in a factory under controlled conditions.

3.2.2 System Installation

Install the system such that proper wastewater flow through the unit and required effluent conditions as specified in Paragraphs Design Criteria or Cartridge and Bag Design Criteria (as applicable) is achieved and maintained. Perform all electrical work in accordance with the applicable requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2.3 Painting

Perform painting in accordance with applicable requirements provided in Section 09 90 00 PAINTS AND COATINGS, and additional requirements provided herein.

3.2.3.1 Metal surfaces

Paint all metal surfaces except aluminum, bronze, brass, galvanized steel, and stainless steel. Surface prepare and paint in the shop or in the field as indicated. Finish manufactured items, such as motors and switchboards, with the manufacturer's standard finish.

3.2.3.2 Preparation and Application

Prepare ferrous metal surfaces in accordance with SSPC SP 6/NACE No.3 and paint with two or three coats of MIL-DTL-24441 epoxy paint to achieve a total dry film thickness of 150 microns (6 mils). Master Painter's Institute (MPI) #120 Epoxy, High Build, Self-Priming, Low Gloss, is an acceptable replacement to MIL-DTL-24441.

3.2.3.3 Coating Testing

Examine coating for flaws and tested for thickness. Measure the thickness of coatings wet and dry using a commercial film thickness gauge. Notify the Contracting Officer in advance of any painting. Do not apply additional coats until the previous coat has been approved. Repair or add additional coats at no additional cost to the government.

3.2.3.4 Coating Repair

If welding is required after application of the coating or if the coating is damaged in any way, prepare the affected area in compliance with SSPC SP 6/NACE No.3 and reapply the coating to that area. If holidays are detected or film thickness is insufficient, prepare the surface and apply additional coats in the affected area in compliance with the manufacturer's instructions.

3.2.4 Valve And Pipe Installation

3.2.4.1 Valves

Install valves as nearly as possible in the position shown in the Contractor provided Shop Drawing. Install and support valves in their respective position free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in workmanship and material. Debris and foreign material Clean out debris and foreign material from valve openings and seats; operate operating mechanisms to check their proper functioning, and check nuts and bolts for tightness. Valves and other equipment which do not operate easily or are otherwise defective are to be repaired or replaced at no additional cost.

3.2.4.2 Piping

Install piping to accurate lines and grades. Use temporary supports that are sufficiently rigid to prevent shifting or distortion of the pipe. Make provision for expansion where necessary. Pitch piping toward low points, and provide for draining at these low points. Use a sufficient number of unions or flanges allow for the dismantling of all water pipe, valves, and equipment. Install piping including cleaning, cutting, threading and jointing, in accordance with [Section 22 00 00 PLUMBING, GENERAL PURPOSE] [_____].

3.2.5 Filter Tank

3.2.5.1 Installation

Install the filter tank in accordance with the recommendations of the manufacturer and by workers experienced in the installation of this type of equipment. Check Components with corrosion protective coating and restore any damaged or abraded areas to the original or an equivalent coating.

3.2.5.2 Erection of Equipment

Properly align equipment. Turn unit to a vertical position and set in place. Set the anchor bolts in place and tighten the nuts against the shims. After the foundation alignments have been approved, bolt the stationary assembly securely in place. Check the alignment of equipment after securing to the foundations. Remove bracing and shipping from the bottom and/or interior of the tank. Connect piping as indicated. Close valves.

3.2.6 Underdrain

****

NOTE: Prefabricated package systems may have the underdrain installed. This paragraph should only be included where the underdrain is to be installed in the field.

****

Install the underdrain in accordance with approved shop drawings and requirements of the manufacturer, including instructions of the manufacturer's representative. Clean and wash the filter tank prior to installation of the underdrain. Replace broken or defective components. Do not modify the manufacturer-supplied underdrain. Following installation, completely clean the underdrain system and wash free of loose materials and debris. Restore any damaged surfaces to the original or equivalent coating. Do not subject to internal water pressure or testing of the system for a minimum of [_____] days after completion of installation. Maintain the underdrain system in clean condition until installation of filter media.

3.2.7 Support Media

****

NOTE: The need for a supporting layer of gravel will depend on the selected underdrain. If the underdrain does not require a gravel layer, delete this paragraph. Also, delete this paragraph for traveling bridge, continuous backwash, cartridge and bag filters.

****

Provide gravel size and layer thickness as follows:

Gravel Layer	Layer Thickness	Size Limits
Bottom	[_____]	[_____]
Second	[_____]	[_____]
Third	[_____]	[_____]
[_____]	[_____]	[_____]
Top layer	[_____]	[_____]

Place the gravel by hand to avoid movement to the underdrain system and to ensure free passage of water from the underdrain. Complete each gravel layer before the next layer above is started. Remove gravel that becomes mixed and replace in layers as specified. Obtain the correct thickness of each layer as follows: Before the gravel is placed, mark the top of each layer on the side of the filter. Then level the top of each layer against a water surface held at the appropriate mark. No particles are allowed to be less than half submerged, and nowhere are places to be left where additional gravel can be placed without the particles extending more than 1/2 their volume above the water surface. Blackwash the support gravel after it has been placed, in accordance with AWWA B100.

3.2.8 Filter Media Installation

****

NOTE: Media installation may be performed by the manufacturer supplying the filter system for package treatment systems. This paragraph should be used only when the media will be installed in the field. Delete the freeboard requirement for filtration systems which do not require bed expansion during backwashing.

****

Install media under the supervision of the filter equipment supplier. Before installing the filter media, check all piping connections and ensure filter components are in good condition and proper position. Place media to the depths [required by the manufacturer] [as follows:

Media Type	Layer Thickness
Sand	[_____]
Anthracite	[_____]
[_____]	[_____]

]
Leave a minimum freeboard of [_____] between the top of the media and the top of the tank.

3.2.8.1 Media Layers

Complete each layer of media before the next layer above is started. Deposit each layer of media so as not to disturb the level surface of the layer below. Remove and replace media which is made dirty before or after placement.

3.2.8.2 Cleaning of Media

Backwash, scrape, and skim the filter media in accordance with AWWA B100 to remove excess fine material upon completion of placement of each layer. Perform the number of washes, the wash rate and duration of wash to achieve the specified gradation for each layer in accordance with the recommendations of the filter media supplier.

3.2.9 Identification Systems

3.2.9.1 Identification Tags

****

NOTE: Delete when identification tags are not considered necessary on small projects.

****

Install identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number on valves, except those valves installed on supplies at plumbing fixtures. Size tags to be 35 mm 1-3/8 inch minimum diameter, and stamp and engrave all markings. Provide black indentations, for reading clarity. Attach tags to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.2.9.2 Color Coding

****

NOTE: Color coding for piping identification as required by using agency will be developed and inserted in the Color Code Schedule in Section 09 90 00 PAINTS AND COATINGS.

****

Color code piping identification as specified in Section 09 90 00 PAINTS AND COATINGS.

3.2.10 Vent Line Installation

****

NOTE: This paragraph only applies to cartridge and bag filters.

****

Install the vent line according to the manufacturer's standard design and placement. Locate the vent line in position to reduce system operating pressure prior to replacement of filter elements.

3.3 FIELD QUALITY CONTROL

****

NOTE: If the Contractor will be responsible for obtaining water for filter acceptance testing, such requirement should be indicated in the following paragraph.

****

Perform field tests in the presence of the Contracting Officer and provide labor, equipment, and incidentals required for the tests. Provide for disposal of all waste residuals resulting from the tests. Notify the Contracting Officer [_____] days prior to the date and time for the acceptance tests. Rectify any deficiencies found and retest any work affected by such deficiencies.

3.3.1 Initial Operation

Following completion of installation of the treatment systems and after the Contractor and manufacturer's representative agree the system is ready for operation, operate the system over an initial operating period not to exceed [_____] days. Demonstrate proper operation of the equipment, including, but not limited to, the ability of the system to produce the minimum specified effluent requirements detailed in Paragraphs Design Criteria or Cartridge and Bag Design Criteria (as applicable), proper operation of the media cleaning equipment, and the control system ability to provide the correct operational logic to optimize the filtration process.

3.3.2 Acceptance Testing

Commence acceptance testing not sooner than [_____] days and not later than [_____] days following approval of the initial operation. Demonstrate within the acceptance the ability of the filtration system to meet the specified effluent requirements when operating at the design flow rate and demonstrate the ability of the control system to provide the correct operational logic to optimize the filtration process. Conduct the tests over [_____] days of continuous operation. Collect [_____] effluent samples during each [_____] hour period. Do not take samples less than [_____] hours nor more than [_____] hours apart. Analyze the samples for [turbidity] [total suspended solids] [effluent particle size] [_____] by standard methods as described in [_____]. For the filtration system to qualify for process acceptance, the average value of each of the filtered water effluent parameters monitored during the continuous testing is required to not exceed the values of the specified parameters. In the event that the specified filtered water quality requirements are not met during the period that acceptance testing is conducted, the defective equipment or operation must be modified or replaced and the testing repeated. The schedule for retesting is subject to approval by the

Contracting Officer.

Submit test reports in booklet form showing field tests performed to adjust each component and to prove compliance with the specified performance criteria. Indicate the final position of controls in each test report.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Posting Framed Instructions

Post frame instructions containing wiring and control diagrams under glass or in laminated plastic where directed. Frame condensed operating instructions, prepared in typed form, as specified above and post beside the diagrams. Submit proposed diagrams and instruction prior to posting. Post the framed instructions before acceptance testing of the system.

3.4.2 Field Training

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [_____] hours of normal working time and start after the system is functionally complete but prior to final acceptance test. Cover all of the items contained in the Operating and Maintenance Instructions in the field training. Ensure the instructions include, but are not necessarily limited to the following:

a. System layout showing piping, valves and controls and installation requirements.

b. Approved wiring, logic, and control diagrams prepared in accordance with ANSI/ISA 5.1 including a drawing index, legend and symbols list, and abbreviations and identifiers.

c. A control sequence describing startup, operation, and shutdown; including the functional and operational description of the control system covering the procedures for programming, operation, startup, shut-down, and calibration.

d. Operating and maintenance instructions for each piece of equipment, including checkout, troubleshooting, and servicing.

e. Manufacturer's bulletins, cut sheets and descriptive data, parts list, and recommended spare parts.

3.4.3 Operating And Maintenance Instructions

Provide operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of equipment and their basic operating features in the instructions. Also, provide maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides. Include simplified diagrams for the system as installed. Show valves numbered and tagged in the manual and provide a schematic indicating the number of each valve. Permanently bind each set and provide with a hard cover. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the facility, name of the Contractor, and contract number.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-46 66 56 (May 2021)**

Preparing Activity: USACE **Superseding**
UFGS-46 66 56 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-46 66 56 (May 2021)**

Preparing Activity: USACE **Superseding**
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SECTION 46 66 56

OPEN-CHANNEL DISINFECTION EQUIPMENT

05/21

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NOTE: This guide specification covers the requirements for ultraviolet (UV) disinfection equipment for treatment of wastewater.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

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NOTE: This specification should be used to allow the Contractor to install proven "off-the-shelf" units supplied by reputable vendors. This guide specification includes technical requirements for ultraviolet disinfection equipment and controls. This specification will not be used for disinfection of water or industrial wastes.

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1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide

specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C82.4	(2017; R 2022) Lamp Ballasts - Ballasts for High- Intensity-Discharge and Low-Pressure Sodium Lamps
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-240-01	(2020; with Change 3, 2024) Wastewater Collection and Treatment

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout; G, [_____]

SD-03 Product Data

Framed Instructions

Field Training; G, [_____]

Spare Parts

UV System Equipment

SD-06 Test Reports

Design Conditions

Operating Test

Site Visits

SD-07 Certificates

Manufacturer's Qualifications

Standard Products

Performance Testing

SD-10 Operation and Maintenance Data

Instruction Plan; G, [_____]

Operating and Maintenance Manuals; G, [_____]

[Six] [_____] complete [hard] [optical disc] copies of operating instructions and maintenance instructions. Each manual must have an index listing the contents and tab separators between sections. [Manuals must be bound in sturdy three-ring, loose-leaf binders.]

1.3 ADMINISTRATIVE REQUIREMENT

1.3.1 Preconstruction Conference

A preconstruction conference is required and all subcontractors, suppliers, and UV equipment manufacturer are required to attend.

1.4 MAINTENANCE MATERIAL SUBMITTAL

1.4.1 Extra Materials

Supply all new spare parts that are exact replacements and separately packaged. Submit the parts list including recommended spare parts and maintenance supplies with current unit prices and source of supply for each item of operable equipment. Include parts recommended by the manufacturer to be replaced after 1 and 3 years of service. List special tools, instruments, accessories, and special lifting and handling devices required for periodic maintenance, repair, adjustment, and calibration.

Include with the package bill of materials with quantity, item description, and part number. Furnish the following spare parts and safety equipment:

a. One completely assembled lamp module.
b. Ten percent of the total number of the system lamps.
c. Five percent of the total number of the system ballasts.
d. Ten percent of the total number of the system lamp sleeves.
e. Ten sets of lamp end seals.
f. Ten sets of lamp socket connectors.
g. [Four] [_____] personnel safety shields which block out UV wavelengths between 200 and 400 nm.

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

1.5.1.1 Contractor Qualifications

Possess a minimum of [2] [_____] years of experience in the construction of water, wastewater, and/or industrial wastewater facilities.

1.5.1.2 Manufacturer's Qualifications

Manufacturer is required to demonstrate experience in the production of substantially similar equipment, and is required to show evidence of satisfactory operation of identical equipment to that proposed in at least 3 installations for a period not less than one year disinfecting secondary effluent with similar effluent flow and characteristics to the treatment plant in this contract.

1.5.1.3 Equipment Parts

Manufactured parts to standard sizes and gauges so that repair parts furnished at any time can be installed in the field. Ensure that like parts of duplicate units are fully interchangeable.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect from damage, deterioration, weather, excessive humidity, excessive temperature variation, dirt, dust, and contaminants equipment and materials delivered, handled, and placed in storage, from the time of shipment until installation is completed and the equipment and materials are ready for operation. Mark and store equipment to permit easy identification and inspection. Tag each item of the equipment or mark it as identified in the delivery schedule or on the shop drawings. Include with each shipment complete packing lists and bills of materials.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide an ultraviolet (UV) disinfection system complete and operational with controls and accessories as shown and as specified. Provide equipment suitable for outdoor open channel, gravity flow installation including, but not limited to, the following components, and appurtenances necessary for the interconnection of components, in the quantities required:

a. UV lamp module with support rack and bracket.
b. UV system instrumentation, controls, and power distribution.
c. Wireway and interconnecting cables.
d. Water level control device.
e. UV intensity monitoring system.
f. Elapsed time meter.
g. Cleaning system.
h. Spare parts.

2.1.1 Operation of Existing Facility

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NOTE: Include the following paragraph only where UV disinfection system is replacing another disinfection system at the existing wastewater treatment plant.

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Maintain the continuous flow of wastewater and disinfection until the new system is tested, approved and fully operational. No discharge of untreated wastewater, reduction in existing hydraulic capacity or organic treatment capacity is allowed.

2.1.2 Design Conditions

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NOTE: Determine or estimate plant flows, total suspended solids (TSS), UV transmittance, and influent microorganism count. A value for UV transmittance must be determined from an independent laboratory. Occasionally, a wastewater quality may

be encountered which exceeds the experience of design engineers (e.g. due to an unfamiliar process design, a familiar but poorly operated process, an under-designed plant, an unusual influent to the treatment plant, etc.). In these cases, a pilot study should be conducted to provide information required for design. Channels must be designed for peak design flow.

The reports listed below in subparagraphs a. thru f. need to be tailored by the designer to meet state standards where the process is being permitted.

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Ultraviolet equipment are required to disinfect wastewater effluent with the following characteristics:

Peak flow, cubic meter per sec Mgd	Initial [______]
	Design [______]
Average flow, cu. meter/sec Mgd	Initial [______]
	Design [______]
Minimum flow, cu. meter/sec Mgd	[______]
Total suspended solids (TSS), mg/L	[______]
Average turbidity, NTU	[______]
UV transmittance at 253.7 nanometers (nm), through a 1 cm cell	[______]
Influent [fecal coliform][______], MPN/100 mL	[______]

Submit the following reports confirming compliance with the design conditions characteristics:

a. Results of tests done by an independent testing laboratory showing effective hydraulic design of the reactor, including headloss calculations.

b. Documentation showing that the type of ballast required for the particular lamp supplied for the system have performed successfully for a period of not less than one year.

c. Hydraulic calculations demonstrating compliance with the specified hydraulic characteristics.

d. Residence time distribution (RTD) data plotted as concentration versus time, and as cumulative tracer passed versus time in accordance with UFC 3-240-01. The Contracting Officer reserves the right to require separate tests to be conducted on a system identical in design to the proposed system if the hydraulic test data submitted by the manufacturer is determined to be unacceptable.

e. In the test unit used in the development of the RTD curves, use a number of lamps based on achieving the stated treatment adjectives for a worst case realistic influent scenario for the system. Utilize the same lamps, electronic lamp controller, ballast and automatic level controller as that proposed in the full scale system.

2.1.3 Performance Requirements

****

NOTE: Typical values for nominal average intensity, UV density and theoretical retention time are 5100 microwatts per square cm, 3.35 watts per liter, and 7 seconds, respectively. Nominal average intensity will vary between manufacturers. Density depends upon the design of the particular UV system and the number of lamp banks. Retention time depends upon the channel geometry and number of lamp banks. Insert values per specified equipment manufacturer's calculations.

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2.1.3.1 Inactivation

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NOTE: Predominate effluent criteria used in performance requirements for UV systems is for whole body contact: 200 most probable number (MPN)/100 ml of fecal coliforms, with a maximum 7-day average of 400 MPN/100 ml. Some states have different microbe and disinfection standards; therefore, determine the site specific disinfection requirements from the state permitting authority.

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Provide a system capable of reducing the influent [fecal coliform] [_____] count to [200 MPN/100 mL] [_____] on a 30 day geometric mean of daily samples.

2.1.3.2 UV Dose

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NOTE: Conventional units for UV dosage are microwatt-seconds per square cm. The standard dosage of UV radiation is determined by the effluent; unfiltered effluent may require a 30,000 dosage while a dosage of 16,000 to 20,000 is more typical of filtered effluent to achieve a disinfection safety factor of 2.0. Insert value per equipment manufacturer's recommendation.

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Use a UV dosage not less than [_____] microwatt-seconds per square cm based on peak design flow conditions, lamp output at 65 percent of its initial level after 1 year (8750 hours) of lamp operation without fouling on the lamp sleeves, and minimum UV transmittance as stated in paragraph Design Conditions.

2.1.3.3 Nominal Average Intensity

Ensure the nominal average intensity within the channel is not less than

[_____] microwatts per square cm at a transmittance of 70 percent after 100 hour burn-in of lamps and with no fouling on the lamp sleeves.

2.1.3.4 UV Density

Ensure the UV density of the channel is not less than that required in the test runs, lab analysis, channel configuration, and residence times.

2.1.3.5 Retention Time

Ensure that the actual retention time (t) of the effluent within the system determined by hydraulic analysis is not less than 0.9 times the theoretical retention time (T). Ensure the theoretical retention time (T) is not less than [_____] seconds at the peak design flowrate.

2.1.3.6 Plug Flow

The flow characteristics through the system are expected to closely simulate ideal plug flow conditions under the full operating flow range. The Morrill Dispersion Index, defined as the time required for 90 percent of the salt and dye traces to pass, divided by the time required for 10 percent to pass, is to be less than 2.0. The ratio of the time required for 50 percent of tracer to pass to the mean residence time is required to have a value between 0.9 and 1.1. The ratio of the time of initial tracer appearance to the theoretical residence time is required to have a value greater than 0.5.

2.1.3.7 Dispersion

Ensure the dispersion coefficient, which accounts for the deviation of the channel's hydraulic behavior from that of perfect plug flow, is less than 100 square cm per second. Ensure the dispersion number (ratio of the dispersion coefficient to the product of flow velocity and channel length) is less than 0.l.

2.1.3.8 Turbulence

Flow through the system is required to be turbulent with a Reynolds Number greater than 4,000 at average flow.

2.1.3.9 Channel Volume

Make full use of the channel volume throughout the flow range. Ensure the ratio of the mean residence time (theta) to theoretical residence time (T) is greater than 0.9.

2.1.3.10 Headloss

Ensure the headloss caused by each bank of horizontal lamp modules is such that at the peak flow rate no lamp is exposed to the atmosphere and the maximum depth over the uppermost lamp sleeves is 40 mm 1.5 inch. The headloss through vertical lamp banks is not allowed to exceed 150 mm 6 inch.

2.1.3.11 Cross Sectional Area

Ensure the cross-sectional area occupied by the lamp module frame at the entrance and exit of each bank is no greater than 35 percent of the cross-sectional area occupied by the effluent in the channel.

2.1.3.12 Aspect Ratio

Provide a minimum aspect ratio (ratio of channel length to hydraulic radius) of 15 per lamp bank.

2.2 EQUIPMENT

2.2.1 UV System Equipment

Submit product data to include: design calculations relevant to the type of system proposed indicating removal performance including dose; nominal average intensity within each reactor; UV density; theoretical retention time of effluent within the system; dispersion coefficient; maximum headloss caused by each bank of lamp modules; lamp module cross-sectional area; aspect ratio of lamp bank; installation list; manufacturer's illustrations; and a statement by the equipment manufacturer listing any exception to or deviations from the contract drawings and specifications.

2.2.1.1 Layout

The physical layout of the system shown is based on equipment manufactured by [_____]. Submit drawings showing fabrication methods, assembly, accessories, installation details and point-to-point wiring diagrams; instrumentation and controls; equipment; dimensions; make and model; materials of construction and installation instructions. In the drawing, indicate clearances required for maintenance and operation and include complete wiring and schematic diagrams, equipment layout, dimensions, templates and directions for the installation of anchor bolts and other anchorages and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

If UV equipment proposed is sufficiently different than that shown, submit detailed, modified layout drawings and descriptions for approval by the Contracting Officer within 5 working days following Notice to Proceed. Also obtain approval, if applicable, from the State permitting authority for the sufficiently different equipment and layout proposed within [15] [_____] working days following Notice to Proceed.

2.2.1.2 Equipment Construction

2.2.1.2.1 UV Lamp Module

a. Module consists of lamps with each lamp placed in an individual sleeve. Module is required to be capable of being withdrawn as a unit and replaced without interrupting operation of any other module, to be self-supporting in the channel, and to be capable of supporting a weight of 90 kg 200 pounds.

b. Horizontal lamp module a have lamps in sleeves sealed and supported in a NEMA 6P stainless steel frame. Electrical wires which carry power to the lamps and ballasts are required to be completely enclosed in the frame and isolated from the wastewater. The frame is required to be capable of protecting lamps and sleeves from foreign material or debris within the channel.

c. Vertically oriented modules have lamps installed in a weatherproof, watertight enclosure. Fit sleeve to the enclosure using compression fitting and neoprene gasket. Wiring is required to include numbered terminal strips which correspond to the numbering in the main power panel. Fit lamp enclosure with a waterproof wiring connector to allow the enclosure to be disconnected and removed from the channel. Install lamp connection above the waterline or ensure it is waterproof. Provide a safety interlock switch to turn off power to the lamps when module enclosure covers are opened. Provide a Class B, ground fault circuit interrupter for each enclosure to turn off power if water enters the enclosure. Arrange lamps so that they can be replaced without disassembling or removing lamp module.

d. Ensure system allows for complete system shutdown or by-pass.

e. Ensure system allows for continuous disinfection while replacing lamps, sleeves, and ballasts; and while cleaning the lamp sleeves.

f. Individual lamp modules weighing 25 kg 55 pounds or less are required to be removable without requiring mechanical lifting devices. Systems with individual lamp modules weighing over 25 kg 55 pounds are to be provided with a mechanical lifting device as [specified] [indicated].

2.2.1.2.2 UV Lamps

a. Supply low-pressure mercury vapor type lamps of the hot-cathode, instant-start design in which the coiled filamentary cathodes are heated by the arc current. Provide a clamped design filament that withstands shock and vibration.

b. Ensure lamps have the following characteristics:

   (1) 90 percent of UV radiation within the wavelengths of 233.7 to 273.7 nm.

   (2) Produce a minimum UV intensity of 190 microwatts per square cm at a distance of 1 meter.

   (3) Maximum power input of 65 watts (not including ballast losses).

   (4) Have a minimum arc length of 1475 mm 58 inches.

   (5) Rated to produce zero levels of ozone.

   (6) Have a minimum UV output of 26.7 watts at 100 hours.

c. Provide a lamp base made of metal and ceramic, resistant to UV light and ozone. Ensure lamp tube is capable of transmitting 90 percent of the radiation produced therein.

d. Ensure that changing lamps does not require removal of the sleeve from the lamp module frame. Ensure lamp ballasts are capable of being replaced by plant operating personnel.

e. Ensure system uses lamps available from at least 2 currently active lamp manufacturers without modifications to the system.

2.2.1.2.3 UV Lamp Sleeve

a. Provide a sleeve consisting of clear fused quartz circular tubing rated for transmittance of 89 percent or more and not be subject to solarization over its life. Provide a nominal wall thickness between 0.8 and 2.09 mm 20 and 53 inch.

b. Configure sleeve such that one end of each sleeve is closed and the other end is sealed by a lamp end seal and compressed O-ring. The closed end of the sleeve is required to be held in place by means of a retaining O-ring. No part of the sleeve is allowed to come in contact with any steel in the frame.

2.2.1.2.4 Lamp End Seal and Lamp Holder

a. Configure sleeve so the open end of the lamp sleeve is sealed by means of a stainless steel nut which compresses an external sleeve O-ring seal. Ensure the sleeve unit has a surface which allows a positive hand grip for tightening without the use of any tools for removal.

b. Hold the lamp holder in place in such a way as to isolate and seal the lamp from the module frame and other lamps in the module. Configure the lamp sleeve such that in the event of a fracture, the seal prevents moisture from entering the module frame and the electrical connections to other lamps in the module. Incorporate UV resistant materials into the lamp holder to prevent lamp sleeve from touching steel.

2.2.1.2.5 UV Lamp Module Support Rack

Fabricate rack from stainless steel construction that does not allow UV light to radiate above the channel when the lamp modules are energized and fully immersed in the effluent.

2.2.1.3 Lamp Array Configuration

2.2.1.3.1 Horizontal

Arrange horizontal lamp configurations in a uniform array with lamps parallel to each other and to the flow. Space lamps evenly in horizontal and vertical rows with centerline spacings equal in both directions. Pattern the single array to be continuous and symmetrical throughout each reactor.

2.2.1.3.2 Vertical

Configure vertical lamps in a staggered uniform array with lamps parallel to each other, but perpendicular to the flow. Space lamps evenly with alternating rows offset by one-half the uniform centerline spacing.

2.2.1.4 Water Level Control

****

NOTE: If more than 1 channel is required, there needs to be a positive method of flow distribution to each channel. The downstream level control device is designed to build-up negligible head at peak flow rates and may not distribute flow equally to all channels. The equipment manufacturer should be consulted for recommended methods of flow distribution in multiple channels.

Automatic Slide/Sluice Gates: These gates are required, two per channel, if the UV system is to operate in an automatic mode for multiple channel configurations. These gates are not necessarily

supplied by the UV equipment manufacturer. Additionally, it is the gate manufacturer's responsibility to properly install and set up each gate, such that a gate closed limit switch, one per gate, is transmitted to the UV Control Center. Each gate must be able to receive one opening and one closing signal from dry 10 amp contacts located in the Control Center. To insure disinfection under all conditions, gate interlocking, both mechanical and electrical, is required to prevent all gates from being closed at any given time. These interlocks are the responsibility of the gate manufacturer.

During automatic operation, if channels are to be placed in and out of service, accommodations should be made to drain the channel when the channel is not in service. Channels, when out of service, must be completely isolated and not allow any leakage through slide gates or valves to enter final effluent.

****

a. Place a level control device [at the discharge end] [both ends] of each channel. Level control device is required to maintain constant channel water level within tolerances required to keep lamps submerged and prevent excessive water layer over the top lamps.

b. [Pivot the automatic level controller above the effluent water surface so that each unit opens across the width of the channel. Adjust counterweights using counterbalance weight at startup for the full flow range. Counterweights are not to require adjustment after initial setting. Use stainless steel, Lexan, Delrin bearings, counterweights of carbon steel with galvanized finish and corrosion resistant seal of neoprene or other suitable elastomer.] [Use stainless steel for fixed weirs.] [_____].

c. Install a water level sensor within the channel to provide an alarm indication and/or automatic system shutdown in the event the water level drop below the uppermost part of the top row of horizontal lamps. Provide alarm contacts for remote annunciation.

2.2.2 Electrical

2.2.2.1 Parameters

a. Divide the system into the proper number of parallel electrical subsystems for the peak design flow.

b. Power each electrical subsystem from a distribution center and include ground fault circuit detection, circuit protection, modules, and interconnecting cables.

c. Supply one power panel for each module and prewire by the manufacturer, except for the final connection of the individual modules to the power panel.

d. Provide standard ground fault detection with the UV equipment manufacturer.

e. House control and monitoring components and power supply in NEMA enclosures. Seal internal components from the environment. House system electronics to be used in an interior environment in enclosures conforming to NEMA 250 Type 12. House system electronics to be used in an exterior and corrosive environment, as defined in NEMA 250, in enclosures conforming to NEMA 250, Type 4X.

f. Provide sufficient cooling to ballasts. Ensure magnetic ballasts have a minimum allowable air flow per ballast of 0.014 cu. m/s 30 cfm.

g. Protect wiring and electrical connections against moisture to prevent electrical shorts or failure. Ensure electrical installation and materials conform to NFPA 70. Completely wired the unit requiring only an external connection for a single external power supply and remote control.

h. Ensure controls and designations conform to NEMA ICS 1.

2.2.2.2 Interconnect Cables

a. Multiconductor unshielded cable suitable for outdoor installation.

b. Thermoplastic rubber insulation with operating range of minus 60 to 125 degrees C minus 76 to 52 degrees F with low temperature flexibility and flame retardants.

c. UV stabilized jacketing resistant to oils, chemicals, fuels, solvents, and to mechanical abuse and abrasion.

d. Cable supplied by the equipment manufacturer in sufficient length and number for a complete system.

e. Cable of a modular repairable type to allow for field replacement and repair of its components by plant operators.

2.2.2.3 Connectors and Receptors

Waterproof Type S.O. cable connectors for in-line connection. Design to allow fast and easy positive coupling and uncoupling. Mount connector out of possible flood-prone environments. Use "snap-on" style connectors having no threads that allow for visual confirmation that the connection is locked in place.

2.2.2.4 Ballasts

Supply ballasts that conform to ANSI C82.4; are coordinated to the ballast supplies; are rated for [120] [208] [240] [277] [480] [volts] [the voltage indicated]; and have a power factor of not less than 90 percent at a crest factor of 2.0 or less, and a voltage range of not less than plus or minus 10 percent. Ensure ballasts are suitable for operating at [minus 15] [minus 30] [minus 40] degrees C [5] [minus 22] [minus 40] degrees F and above. Locate and/or enclose magnetic ballasts in an environment not susceptible to the effects of heat, cold and moisture. Use modular design ballasts allowing for quick disconnect and replacement by operators.

2.2.2.5 Cableway

If required by the equipment manufacturer, install cable in weatherproof and submersible cableway. Fabricate the cableway of stainless steel, 1.98 or 1.59 mm thick 14 or 16 gauge. Ensure cableway is gasketed and completely watertight under a submerged condition.

2.2.2.6 Instrumentation and System Controls

2.2.2.6.1 Controls

Provide equipment of the fully automatic program control type capable of receiving standard 4-20 mA control signals from the plant effluent flowmeter. Control of 2 or more banks of modules by turning lamp banks on and off in proportion to flow variations. Provide controls capable of continuously adjusting the UV intensity automatically in proportion to wastewater flow. Provide controls that require no manual attention other than adjustment of the required UV intensity.

2.2.2.6.2 Lamp Status Indicators

a. Provide indicators that indicate the status whether ON/OFF of each lamp in the module being powered.

b. Provide indicators to indicate the status "POWER ON", only, in each module.

c. Ensure the lamp monitoring system indicates the geometric location of each individual lamp and operating status of each lamp by means of a neon lamp or alpha-numeric data display (LED or LCD). Upon lamp failure, illuminate the corresponding lamp and activate contact closure for remote alarm annunciation. Provide contact closure for remote annunciation to indicate lamp module failure due to ground fault interruption.

2.2.2.6.3 UV Intensity Detection System

a. Provide a submersible UV sensor to continuously sense the UV intensity produced in each bank of lamp modules. Ensure the sensor measure only the germicidal portion of the light emitted by the lamps within the channel between 254.5 and 255.0 nm. Display the UV intensity on the intensity meter. Locate each UV intensity probe at a point of minimum expected intensity within the lamp array. Mount the probe to any lamp in the array using a clip-on and self-aligning mount to assure the proper spacing from the tube without necessity of hand tools. Factory calibrate the probe with verification in the field prior to startup. The UV equipment manufacturer is required to provide justification for the sensor location.

b. Provide one UV intensity meter per bank of lamp modules. The meter is required to indicate safe intensity, low intensity, and unsafe intensity by means of color codes on the meter face, or have a 0 to 100 percent scale. Clearly label the UV intensity meter and locate on the remote control panel.

c. Provide a nonresettable elapsed time meter per bank of lamp modules. Ensure the meter records hours of UV bank operation from 0 to 99,999 hours.

d. Provide one hand/off/auto switch for each UV bank and for each automatic slide gate shown and specified.

e. Time delay alarms to prevent nuisance alarms.

2.2.2.6.4 Minor Alarms

Provide minor alarms and dry contacts to indicate that maintenance attention is required. Include the following minor alarms:

a. Low warning UV intensity.
b. Individual lamp failure.

2.2.2.6.5 Major Alarms

Provide major alarms and dry contacts to indicate an extreme condition in which the disinfection performance may be jeopardized. Include the following major alarms:

a. Low UV intensity.
b. Lamp failure of 2 or more adjacent lamps.
c. Multiple lamp failure.
d. Module failure.

2.2.2.6.6 Flow Pacing

****

NOTE: If the system consists of 2 or more banks of lamps, the system can be flow-paced using a signal from an effluent flow monitoring device in the plant.

****

a. Provide a flow pacing system to turn the UV banks on and off in relationship to the signal received from the plant effluent flowmeter. Ensure the flow pacing sequence is as recommended by the UV equipment manufacturer. Where lamp dimming is used, provide a controller to allow plant operator to ratio the flow to UV dosage and UV intensity. Where on/off control is used, ensure the system allows the operator to vary the flowrate setting and allow the operator the option to operate individual banks in either the manual or automatic mode. Provide logic and time delays to regulate the UV bank ON/OFF cycle to prevent excessive cycling on both startup and shutdown of the UV bank. Multicycle lamps may be specified in applications which demand up to 100,000 annual cycles.

b. The normal mode of operation places each effluent channel continuously in service.

2.2.3 Cleaning System

2.2.3.1 General Requirements

Provide cleaning equipment and cleaning solutions. Provide a cleaning system that is [a permanent in-channel installation] [an out-of-channel installation] [a portable cleaning installation with basin] for cleaning individual lamp sleeves or entire lamp modules.

2.2.3.2 Cleaning Tank

Fabricate portable cleaning tank of stainless steel and equip with air blower (compressor), lamp module rack, hose connections and drains. Ensure tank holds at least [3 horizontal modules] [1 vertical module] and is equipped with hard rubber casters. Provide sealed cover for tank to prevent spilling. Equip unit with disconnect switch, a grounded plug and 3 m 10 feet of outdoor cable.

2.2.3.3 Cleaning Rack

Provide a cleaning rack mounted above the portable cleaning tank to hold one horizontal module above the cleaning liquid for hand wiping of the sleeves.

2.2.3.4 Cleaning Fluid

Provide sleeve conditioner and cleaning solution 12 months of normal operation. Supply conditioner and cleaning solution in containers not greater than 20 L 5 gallon capacity.

2.3 MATERIALS

All metal in contact with plant effluent is required to be either Type 316 or Type 304 stainless steel, passivated. Wiring which may be exposed to UV light is required to be a material that resists degradation by UV light. Material exposed to UV light is required to be stainless steel, passivated; quartz; polytetrafluoroethylene or other UV resistant material.

2.3.1 Standard Products

Provide material and equipment which are the standard product of a manufacturer regularly engaged in the manufacture of the product and which essentially duplicate equipment that has been in satisfactory operation for at least 2 years prior to bid opening. Submit written evidence that equipment and accessories are products of a qualified and experienced manufacturer. Ensure equipment is supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.3.2 Nameplates

Provide major equipment items with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.4 ANCHOR BOLTS

Provide stainless steel anchor bolts of the size required and with ample strength for the purpose intended by the Contractor. Embed anchor bolts directly during placement of concrete at depths sufficient to account for potential concrete spalling or deterioration.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Perform installation in accordance with the drawings, shop drawings, and manufacturer's instructions and recommendations.

3.3 FIELD QUALITY CONTROL

3.3.1 Operating Test

After Contractor and Contracting Officer have mutually agreed that the equipment installation is complete and ready for continuous operation, conduct an operating test of the equipment and controls in the presence of the Contracting Officer to demonstrate satisfactory operation.

Include in the book form test report all field tests performed to adjust each component and field tests conducted to prove compliance with the specified performance criteria. Ensure the test report indicates the final position of controls.

3.3.2 Performance Testing

a. Begin performance testing after the UV equipment has been installed and field tested. Collect samples at times when the flow through the plant is at or near the peak flow rating from one section of the channel. Where multiple systems are supplied, the plant flow is required to be at or near the peak flow rating of at least one system or one section of the UV system.

b. Analyze the samples collected for the following, using standard testing methods or procedures:

    (1) [Fecal coliform] [_____] in MPN/100 mL just prior to UV disinfection.

    (2) [Fecal coliform] [_____] in MPN/100 mL just after UV disinfection.

    (3) Total suspended solids prior to disinfection.

    (4) Percent UV transmittance at 254 nm with 1 cm cell length prior to disinfection.

c. Continue performance testing for 14 days and collect samples 3 times per 24 hour period. Record the data obtained in booklet form. Ensure test reports indicate the final position of controls.

d. The effluent quality exiting the UV unit is required to be equal to or better than the specification requirement. Continue retesting for at least 2 consecutive days or until satisfactory bacteriological results have been obtained.

e. Submit statements signed by responsible official or representatives of the manufacturer attesting to conformance to the specified requirements. Date the statements after performance testing has been completed, include the name the project, and list the specific requirements which are being certified.

3.3.3 Manufacturer's Representative

Provide the services of a qualified manufacturer's field service representative to supervise the installation, adjustment, testing of equipment and instruct plant operators in the care, operation, and maintenance of the equipment.

3.3.4 Site Visits

Manufacturer's representative is required to assist in the proper installation and checking of the equipment for a period of time necessary to insure a completed installation. Submit a written report of the results of each visit by the manufacturer's representative, including purpose and time of visit, tasks performed and results obtained.

The representative is required to, for a period not less than three full days, start up the equipment, supervise initial operations, perform the required field tests and instruct plant operators in the proper care, operation and maintenance of the equipment. Upon request of the Government, at any time during the 1-year warranty period, the representative will recheck the system, recalibrate and adjust equipment, answer plant operator's questions and review operation and maintenance procedures.

3.4 ADJUSTING AND CLEANING

Test, calibrate, adjust and operate to verify its satisfactory operation. Clean equipment of dirt, dust and foreign matter.

3.5 CLOSEOUT ACTIVITIES

3.5.1 Operating and Maintenance Manuals

a. Submit operating instructions outlining the step-by-step procedures required for system startup, normal operation, short- and long-term deactivation, and shutdown. Include an introduction and overall equipment description, purpose, functions, and simplified theory of operation in the beginning of the instructions. Include the manufacturer's name, model number, service manual, parts list, and brief description of each piece of equipment and its basic operating features in the instructions. Include component layouts, simplified wiring, and control diagrams for the system as installed. Ensure performance test data is reflected in the operating instructions.

b. Submit maintenance instructions listing routine maintenance procedures, calibration procedures, possible breakdowns and repairs and troubleshooting guides, prior to the start of the training course.

3.5.2 Field Training

Include a combination of classroom and hands-on training at the site. Instruct designated maintenance and operations personnel in the recommended corrective and preventive maintenance procedures for the equipment. Submit the proposed lesson plan of field instruction, 30 days prior to commencement of scheduled training. Cover each item contained in the operating and maintenance manuals in the field training.

3.5.2.1 Instruction Plan

Prepare a lesson plan which includes the elements presented in the outline specified below. Identify specific components and procedures in the proposed lesson plan. Detail specific instruction topics. Reference and attach to the proposed lesson plan training aids to be utilized in the instruction where applicable. Describe any hands-on demonstrations planned for the instruction and estimated duration of each segment of the training in the lesson plan.

3.5.2.2 Training Outline

Include in the instruction, as a minimum, the following elements presented in the following outline:

a. Equipment operation.
b. Detailed component description.
c. Equipment preventative maintenance.
d. Equipment troubleshooting.
e. Equipment corrective maintenance.
f. Hands-on demonstrations.

3.5.2.3 Framed Instructions

Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, where directed. Prepare condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system in typed form and post beside the diagrams. Post the framed instructions before acceptance testing of the systems.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-46 71 16 (February 2011)**

Preparing Activity: USACE **Superseding**
UFGS-44 46 13 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

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USACE / NAVFAC / AFCEC **UFGS-46 71 16 (February 2011)**

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SECTION 46 71 16

GRAVITY BELT THICKENERS
02/11

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NOTE: This guide specification covers the requirements for sludge collecting equipment.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ANSI H35.2M	(2024) Dimensional Tolerances for Aluminum Mill Products
AA H35.1/35.1M	(2024) American National Standard Alloy and Temper Designation Systems for Aluminum

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

ANSI/AGMA 2001	(2004D; R 2010) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
ANSI/AGMA 6034	(1992B; R 2010) Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(2024) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,

	Welded and Seamless
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A354	(2017; E 2017; E 2018) Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
ASTM B429/B429M	(2010; E 2012) Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B632/B632M	(2024) Standard Specification for Aluminum-Alloy Rolled Tread Plate
ASTM D256	(2010; R 2018) Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D790	(2017) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2047	(2017) Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2017) Metal Bar Grating Manual
NAAMM MBG 532	(2019) Heavy Duty Metal Bar Grating Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA Rules	(2023) Rules for the Measurement & Inspection of Hardwood & Cypress

REDWOOD INSPECTION SERVICE (RIS) OF THE WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

RIS Grade Use	(2019) California Redwood Lumber Grades and Uses

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

SD-03 Product Data

Sludge Collectors for Rectangular Tanks

Collectors for Circular and Square Tanks

Spare Parts

Framed Instructions

Qualifications

SD-06 Test Reports

Testing

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G, [_____]

[Six] [_____] [hard] [optical disc] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance.

1.3 QUALIFICATIONS

Qualify procedures and welders in accordance with the code under which the welding is specified to be accomplished. Submit qualified procedures and list of names and identification symbols of qualified welders and welding operators, prior to welding operations.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment, delivered and placed in storage, from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Provide each major item of equipment with the manufacturer's name, address, type or style, model or serial number, and catalog number if applicable on a plate secured to the item of equipment.

2.1.3 Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

2.1.4 Spare Parts

Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

2.2 MATERIALS

****

NOTE: Steel components are often specified galvanized where not submerged or intermittently wetted to minimize painting and paint maintenance.

****

2.2.1 Steel Plates, Shapes, and Bars

Provide steel plates, shapes, and bars that are ASTM A36/A36M, minimum 6 mm 1/4 inch thickness unless otherwise specified.

2.2.2 Malleable Iron

Provide malleable iron conforming to ASTM A47/A47M.

2.2.3 Iron Castings

Provide iron castings conforming to ASTM A48/A48M.

2.2.4 Aluminum for Structural and Rolled Shapes

Provide aluminum for structural and rolled shapes conforming to AA H35.1/35.1M, alloy 6061-T6, and AA ANSI H35.2M.

2.2.5 Aluminum for Extruded Shapes

Provide aluminum for extruded shapes conforming to AA H35.1/35.1M, alloy 6063-T6.

2.2.6 High Strength Bolts

Provide high strength bolts conforming to ASTM A325M ASTM A325 with suitable nuts and washers conforming to ASTM A354; galvanized, ASTM A153/A153M.

2.2.7 Anchor Bolts

Provide anchor bolts conforming to ASTM A307; galvanized, ASTM A153/A153M.

2.2.8 Fiberglass Reinforced Polyester Plastic (FRP)

2.2.8.1 Molded FRP

Fiberglass reinforced polyester plastic must be 6 mm 1/4 inch thick and molded by the matched die method to produce uniform, smooth surfaces. Through the use of "low profile" resin systems, ensure all surfaces are smooth, resin rich, free of voids and porosity, without dry spots, crazes, or unreinforced areas, and provide for increased corrosion resistance and weathering.

2.2.8.2 FRP Laminate

Provide laminate with a glass content of 30 plus or minus 2 percent using Type "E" glass with chrome or silane finish. Provide powdered reinforcements consisting of 47.5 plus or minus 1 percent of resin mixture. Use resin mixture of the "low profile" type. Ensure final laminate thickness is within plus or minus 10 percent of the specified thickness.

2.2.8.3 Physical Properties

Physical properties of fiberglass reinforced polyester plastic are as follows:

a. Minimum Tensile Strength: 96.5 MPa 14,000 psiconforming to ASTM D638.

b. Minimum Flexural Strength: 172.4 MPa 25,000 psiconforming to ASTM D790.

c. Minimum Flexural Modulus: 0.9 by 10 to the sixth power conforming to ASTM D790.

d. Minimum Impact, Notches, Izod: 720 Joules/meter 13.5 ft-lb per inch conforming to ASTM D256, Method A.

e. Maximum Average Coefficient of Thermal Expansion: 29 by 10 to the negative sixth power mm per mm, per degree K 16 by 10 to the negative sixth power inch per inch, per degree F.

f. Maximum Water Absorption: 0.02 percent in 24 hours conforming to ASTM D570.

2.2.8.4 Resin Sealing

Where plates of nonstandard length or mounting hole configuration are required, resin seal machined or cut edges.

2.3 HANDRAILS

****

NOTE: Handrails specified are the utilitarian type. Drawings will show design requirements, locations, and general configuration of railing. Where railing is to be fabricated of material other than pipe, this paragraph must be rewritten for type

chosen and the drawings must show configuration and design requirement for type of railing selected.
****

Provide handrails that are 1065 mm 42 inches high with two horizontal rails. Fabricate handrails of Schedule 40 [galvanized] steel pipe conforming to ASTM A53/A53M or Schedule 40 [mill finished] [anodized] aluminum pipe conforming to ASTM B429/B429M. Provide pipe size of [40] [50] mm [1-1/2] [2] inch NPS. To maximize extent practicable, shop fabricate railing. Provide rigid joints consisting of flush-finished welded assembly. Reinforce joints with tight fitting interior sleeves and assemble by welding rails and posts to flush-type fittings, or by mitering and welding joining rails to posts. Locate expansion joints at lengths of rails as recommended by the manufacturer. Provide inner-sleeved slip joint type expansion joints with one end of the sleeve secured to the railing. Locate expansion joints and splices near the intersection of rails and posts. Make bends in railing smooth and in a manner that will not crush or deform the railing. Grind all welds smooth and ensure railings are free of burrs and sharp corners and edges. Removable sections must be as indicated.

2.4 FLOOR GRATING AND FRAMES

Design [carbon steel] [aluminum] [stainless steel] grating in accordance with [NAAMM MBG 531] [NAAMM MBG 532] to meet the indicated load requirements. Band edges with bars 6 mm 1/4 inch less in height than bearing bars for grating sizes above 19 mm 3/4 inch. Make banding bars flush with the top of bearing grating. Provide frames of welded steel construction finished to match the grating. [Galvanize floor gratings and frames after fabrication.]

2.5 FLOOR PLATES

****
NOTE: Specific pattern should not be indicated unless required for matching purposes or to meet design requirements.
****

Provide aluminum floor plates in conformance with ASTM B632/B632M. Provide other aluminum floor plates consisting of 6 mm 1/4 inch thick, [raised thread steel] [pattern indicated] [galvanized] [slip-resistant, carbon steel conforming with ASTM A283/A283M having a minimum static coefficient of friction of 0.50 when tested in accordance with ASTM D2047. Ensure wearing surface is aluminum oxide or silicon carbide].

2.6 LUMBER

Provide Red Cypress conforming to NHLA Rules, clear, S4S finish. Provide Redwood conforming to RIS Grade Use, clear all heart, S4S finish.

2.7 MOTORS

Provide motors conforming to NEMA MG 1.

2.8 COLLECTORS FOR CIRCULAR AND SQUARE TANKS

2.8.1 Drive Unit

Provide drive unit consisting of a gear reducer and motor, direct or flexible coupled. Provide drive unit with a [cast iron housing] [or] [fabricated steel housing with integral hardened steel raceway] and designed in compliance with ABMA 9 and ABMA 11, ANSI/AGMA 2001 and ANSI/AGMA 6034. Base the continuous torque rating of the spur gear assembly upon the smaller of the values developed by ANSI/AGMA 2001 and consider as the rated torque capacity the entire gear will develop continuously over a 20-year period. Rate drive unit as follows:

Approximate Rotational Speed	[_____] rpm
Continuous Operating Torque	[_____] N-m ft-lb
Alarm Torque	[_____] N-m ft-lb
Shut-off Torque	[_____] N-m ft-lb
Momentary Peak Torque	[_____] N-m ft-lb

2.8.2 Bridge Supported Drive

The reduction unit must be one of the following types:

2.8.2.1 Primary Worm Gear Type

A unit consisting of a primary worm gear speed reducer coupled with a final reduction gear. Mount the final gear on a ball bearing assembly with the balls running in replaceable hardened alloy steel races. Ensure all bearings for this type of unit are antifriction type and run in an oil bath. Ensure reduction unit has housings effectively sealed against contaminants. Provide an oil filling and level check pipe.

2.8.2.2 Chain and Sprocket Drive Type

A unit consisting of a chain and sprocket drive, connected to a worm and worm gear final reduction unit. All bearings for this type unit must be tapered roller type.

2.8.3 Bridge Supported Drive Torque Tube

Bolt a steel torque tube to the final reduction gear to support and rotate the sludge collection arms.

2.8.4 Center Pier-Supported Drive Reduction Unit

Provide the helical or worm gear type primary speed reducer, coupled to the intermediate speed reducer directly or by a standard steel roller chain and steel sprockets. Protect chain and sprockets by chain guards. The intermediate speed reducer consists of a worm and worm gear or planetary gear, keyed to a shaft which drives the internal spur gear. Ensure the final speed reducer is a spur gear designed to withstand the maximum torque loads imposed on the clarifier mechanism. Provide antifriction type bearings. Run bearings in cast iron units in replaceable hardened alloy steel races. Run all gears in an oil bath. Provide oil seals and oil fill, drain, and level check systems. Lubricate chains as recommended by the manufacturer. Provide a drive cage, with provision to connect to the final reduction unit. Fabricate drive cage from structural steel members and design to withstand the momentary peak torque of the collector without permanent deformation of the members. The drive cage must have provision for attachment of sludge removal arms.

2.8.5 Electric Motor

Provide motor that operates on [_____] volts ac, [_____] phase, 60 Hz and is totally enclosed fan cooled with a minimum [1.15] [_____] service factor. Equipment vendor must size motor to be of sufficient size for duty to be performed and do not exceed full load rating under the most severe conditions expected. Make necessary adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually installed. Furnish each motor with a magnetic full-voltage starter conforming to NEMA ICS 1. The starter must be in weatherproof cast metal enclosure. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor. Mount controls in starter cover or in separate weatherproof cast metal enclosure.

2.8.6 Overload Protection

Provide drive unit with an overload protection system, enclosed in a weatherproof housing. The system must consist of two micro-switches actuated by the movement of the worm shaft in the worm gear housing. Adjust switches to sound an alarm when the torque reaches [120] [_____] percent of the continuous operating torque and to stop the drive motor when the torque load reaches [140] [_____] percent of the continuous operating torque. Visually indicate overload points. Provide a shear pin assembly to serve as back-up overload protection and set to fail at [160 to 180] [_____] percent of continuous operating torque.

2.8.7 Influent

2.8.7.1 Siphon Feed Influent/Support Column

****

NOTE: Siphon feed influent is most commonly associated with center pier supported mechanisms.

****

Provide a combination influent and support column to support the drive, collector mechanism, and access bridge and to serve as the center influent pipe. Fabricate column from steel plate and anchor to the concrete. The column must be a minimum of [_____] mm feet-inches in diameter and have a series of openings near the upper end to direct flow into the influent feedwell at low velocity.

2.8.7.2 Siphon Feed Influent Feedwell

****

NOTE: Use 76 mm per second 0.25 fps for primary collectors and 46 mm per second 0.15 fps for secondary collectors.

****

Fabricate the influent feedwell from steel plate sections with bolted connections and support from the center cage. Ensure the feedwell is of adequate size and design to diffuse the flow into the tank. Design feedwell such that the flow-through velocity does not exceed [46] [76] mm/second [0.15] [0.25] fps at maximum flow. Provide baffled ports at the water surface in the feedwell to permit the escape of scum.

2.8.7.3 Side Feed Influent Feedwell

****

NOTE: Side feed influent is most commonly associated with bridge supported mechanisms.

****

Fabricate the influent feedwell from steel plate with necessary stiffening members. Support the feedwell by structural steel members which span the tank and are attached to brackets mounted on the tank wall above design water level. Design feedwell to diffuse the flow into the tank and with baffled ports at the water surface to permit the escape of scum. Provide a flanged pipe connection and an influent pipe from the tank side.

2.8.7.4 Influent Feedwell for Thickeners

****

NOTE: Energy dissipating feedwells may not be required for all thickeners.

****

Faricate the influent feedwell from steel plate with necessary stiffening members. Ensure feedwell is of energy dissipating design having 3 internal peripheral horizontal shelves with tangential inlet ducts to provide counterflows of influent which shear on each other as they are displaced inward beyond the shelves. Support the feedwell by structural steel members which span the tank and are attached to brackets mounted on the tank wall. Provide a flanged pipe nozzle and influent pipe from the tank side. Provide a cleanout at the point where the flow splits prior to entering the influent feedwell.

2.8.7.5 Peripheral Feed Influent

Provide peripheral feed system consisting of an influent channel and either an orifice and baffle system or a downcomer pipe system. Construct influent channel of [concrete] [steel plate] at the periphery of the tank and in conjunction with the effluent channel. Design influent and effluent channels for proper flow distribution and collection. The orifice and baffle system must consist of orifice openings in the floor of the influent channel, a steel plate orifice baffle for each orifice, and a steel plate influent skirt to prevent short circuiting. Use orifice dimensions and spacing as determined by the manufacturer for even flow distribution. The orifice baffles must contain no restriction less than the diameter of the orifice or greater than the orifice diameter plus 25 mm 1 inch. Extend the influent skirt 1.5 m 5 feet below the water surface or 300 mm 1 foot below the influent channel bottom, whichever is greater. Provide sufficient clearance between the bottom of the influent skirt and the tank floor to permit operation of the collector mechanism. Provide downcomer pipe system consisting of steel drop pipes spaced evenly around the influent channel. The bottom of the drop pipe must have a fiberglass 90 degree bend and flared discharge nozzle oriented toward the center of the tank.

2.8.8 Scraper Sludge Removal

Provide unit consisting of [one] [two] [_____] structural steel scraper arms, equipped with blades or scrapers designed to move settled sludge to a hopper at the center of the tank. Provide adjustable [spring brass] [PVC] [galvanized steel] squeegees for each scraper blade. Ensure squeegees project 40 mm 1-1/2 inches below the scraper blade and are adjustably secured by [brass] [or] [stainless steel] bolts and nuts.

2.8.9 Hydraulic Sludge Removal

****

NOTE: Hydraulic sludge removal is most commonly associated with activated sludge systems.

****

Accomplish hydraulic sludge removal by the use of the header and manifold system or the uptake pipe system.

2.8.9.1 Header

Design header to continuously remove the required proportional settled solids volume to effect uniform withdrawal over the entire tank diameter, collecting larger volumes of sludge at greater distances from the tank center. Collect the sludge from the tank bottom and transmit it through the header to the manifold, removal being accomplished by hydrostatic pressure. Maximum peripheral speed of the header is not allowed to exceed [0.061] [_____] meters/second [12] [_____] fpm and maximum allowable head loss from the clarifier water level to the sludge pipe connection at the pier bottom is [_____] mm feet. Provide header that is fabricated from steel plate, rectangular, and varies in size from a minimum at the outer end to a maximum at the center of the tank. Stepped and constant cross sectional area type headers are not acceptable. The header must be parallel to the tank bottom, and mount the longitudinal cross sectional axis at an angle of 45 degrees to provide a peaked top. Extend the leading edge of the header downward 50 mm 2 inches to provide an equalizing vane as an integral part of the header and to direct the sludge into the area of influence of the orifice. Provide a 3.175 mm 10 gauge steel scraper with a neoprene blade to clean the tank bottom around the manifold and direct the sludge to the first orifice. Space inlet orifices along the length of the header such that in a single revolution the header will clean the entire tank bottom. Maximum orifice spacing is [775] [_____] mm [30] [_____] inches. Drill orifices accurately in the header. Support the header from the center cage by steel tie-bars with turnbuckles, clevises, and locknuts. The support system must hold the header in alignment both horizontally and vertically. Provide a suitable counterweight to counterbalance the header.

2.8.9.2 Manifold

Fabricate the sludge collection manifold from steel plate. Provide two seals to ensure that the sludge enters the manifold only through the headers. Anchor the bottom plate to the tank bottom, align, and grout in place.

2.8.10 Uptake Pipe System

****

NOTE: Provide sufficient quantity of nozzles for a maximum of 1 to 1.5 meter 3 to 5 foot spacing.

****

Provide system consisting of a sludge discharge column within the influent column; [two] [_____] truss-type sludge collection arms, supported from and driven by the drive cage; V-plow blades and squeegees attached to the sludge collection arms; a minimum of [_____] suction nozzles per arm, supported by the sludge collection arms, and piping to a sitewell; and either sludge control boxes or variable orifice slip tubes inside the sitewell.

a. Fabricate sludge discharge column from steel plate and extend from the sludge sitewell to the bottom of the stationary influent column where it connects to the sludge discharge pipe under the tank bottom.

b. Provide sludge collection arms of welded truss construction requiring no tie rods for support. Provide V-plow blades with [spring brass] [_____] squeegees with [brass] [_____] fasteners. Ensure the blades completely rake the bottom [twice] [_____] per revolution.

c. Provide suction nozzles that are a minimum of [_____] mm inches in diameter. Provide Schedule 80 PVC suction piping sized for a flow velocity no less than 0.16 meters/second 0.5 fps at minimum flow to prohibit solids settling in the piping. Provide Type 304 stainless steel or Schedule 80 PVC fittings with bell-type ends with O-ring seals.

d. Provide sitewell approximately [_____] mm feet square by [_____] mm feet deep, fabricated from steel plate, and containing either sludge control boxes or variable orifice slip tubes. Provide a neoprene seal between the sitewell and influent column. Ensure sludge control boxes are integral with the sitewell. Control sludge being withdrawn from each section of the arm by a submerged orifice sludge control box to allow pacing of the recycled rate. Each box must have a manually controlled PVC gate valve with positioning stem and position indicator. Provide variable orifice slip tubes of steel or PVC pipe construction that permit throttling of individual sludge lines by rotating the slip tubes.

e. Induce sludge flow by means of hydraulic head differential between the tank water level and the sludge control boxes or variable orifice slip tubes at a head of [_____] mm feet. The total sludge drawoff must be dependent on and controlled solely by the pumping rate from outside the mechanism.

2.8.11 Corner Scrapers for Square Tanks

Provide a corner blade on [one] [each] sludge scraper arm. Corner scraper blades consist of a straight blade attached to two horizontal members mounted on the main scraper arm. Pivot the scraper mechanism on special underwater bearings and actuate by a counterweight or spring to keep the end of the arm in contact with the side of the tank. Provide steel guide plates for the tank corners to direct the path of the corner blades. Provide a carrier wheel on the outer end of each corner blade. Provide springs, cable, and chain composed of stainless steel, galvanized steel, or other corrosion-resistant material.

2.8.12 Scum Removal for Tank Water Surface

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NOTE: Use of dual skimmer arms and wide scum beach/box improves scum removal performance.

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Scum removal consists of a [single] [dual] skimming device, a scum baffle, and [one] [two] skimmer blade ramp(s) and scum box(es).

a. Sweep the water surface of the tank and automatically move the scum up the skimmer blade ramp and into the scum box. Support skimming devices by structural steel members attached to the [sludge collection arms and counterweight] [torque tube]. Do not rely on the scum baffle for support. Provide neoprene scum scraper blade.

b. Fabricate scum baffle from [steel plate] [or] [fiberglass reinforced polyester plastic]. [Provide fiberglass scum baffle plates in standard lengths not to exceed 3600 mm 12 feet]. Construct connections between baffle sections in a manner that will not interfere with smooth contact of the skimmer. Provide all supports and connectors required for a complete installation.

c. Provide scum boxes of the dimensions indicated and fabricated from steel plate. Provide assembly with a scum sump, vertical steel sides, and a sloping skimmer blade ramp. Provide a flexible connector between the scum outlet piping and the tank wall. [Provide an automatic flushing device, which will open as the scraper passes.]

2.8.13 Influent Channel Scum Removal

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NOTE: Influent channel scum removal is required only on peripheral feed collectors. Delete the inapplicable system.

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In addition to the tank water surface scum removal, provide a system for removal of scum from the influent channel. The system consists of [an additional scraper blade attached to the main tank skimmer,] [or] [an influent channel spray nozzle system designed to move the scum to the scum box,] a scum box, and a motorized telescopic scum control valve. Provide all controls required for the system.

2.8.14 Bridge

2.8.14.1 Bridge Design and Construction

Provide bridge fabricated from structural steel and all-welded construction. Use either truss or beam type bridge design. Maximum allowable deflection of the bridge is 1/360 of the span length under a live load of 2.9 kPa 60 psf. Provide bridge walkway composed of [floor plate] [grating]. Provide handrail with a 100 mm 4 inch high toe plate on both sides of the walkway. If truss-type bridge construction is used, the truss members may be used as handrail.

2.8.14.2 Bridge for Bridge-Supported Drives

The bridge must span the entire tank diameter and be supported by and anchored to the tank wall. The bridge must support the drive and collector mechanism and provide access for maintenance. Ensure access walkway is at least 900 mm 3 feet wide. Provide at least 775 mm 2 feet 6 inches clearance between the drive unit and the handrails on all sides where maintenance is required.

2.8.14.3 Bridge for Center Pier-Supported Drives

Support bridge on one end by the tank wall and on the other end by the drive unit. Ensure access walkway is at least 900 mm 3 feet wide and extends to a point 775 mm 2 feet 6 inches beyond the drive assembly. Provide at least 775 mm 2 feet 6 inches clearance between the drive unit and the handrails on all sides where maintenance is required.

2.8.15 Effluent

2.8.15.1 Weir Plates

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NOTE: Sludge collectors which require additional linear footage of weir, beyond weir trough circumference length can utilize finger weir or weir pans to increase length up to two and one-half times length of single circumferential weir. Manufacturer of this type should be required to have at least five years experience in furnishing weir pan systems.

****

Weir plates must be [fabricated from steel plate][or][fiberglass reinforced polyester plastic]. Provide weir plates of the dimensions indicated. Mold vee notches in fiberglass weir plates in the plate; cut edges are not acceptable. Mount weir plates in a manner to be watertight and to provide a minimum of 50 mm 2 inches vertical adjustment.

2.8.15.2 Effluent Trough and Drop Box

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NOTE: The effluent trough and drop box may be cast of concrete with the tank wall and deleted from this specification.

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Fabricate the effluent trough and drop box from [steel plate] [or] [fiberglass reinforced polyester plastic]. Trough and drop box dimensions are as indicated. Ensure joints between sections are watertight. Provide support assemblies of adequate strength to prevent trough or box distortion through filling and draining of the tank.

2.9 SLUDGE COLLECTORS FOR RECTANGULAR TANKS

2.9.1 Chain and Flight Scraper Type Collectors

Provide sludge collector including chain, flight and wear shoes, sprockets, shafts, wall bearings, return tracks with support brackets, tee rails, drive unit complete with reducer, motor and overload device, and all associated attachment and anchor bolts. Allow chain for primary tank collectors to run over four sets of sprocket wheels at a design speed of [_____] fpm, so that the flights will clean the sludge from the tank bottom and skim the surface on the return run, concentrating scum in front of the scum pipe. Allow chains for intermediate tank collectors to run over three sets of sprocket wheels at a design speed of [_____] fpm, so that the flights will clean the sludge from the tank bottom and route it to the sludge collection trough. Ensure cross collectors run at twice the speed of the longitudinal collectors. Select collector components based upon the following criteria: operation under dry tank conditions; friction factor for dry steel on dry steel of 0.33; friction factor for polyurethane on dry steel of 0.25; bearing friction of 5 percent of shaft assembly.

2.9.1.1 Metallic Chains

Manfacture metallic chains of corrosion-resistant processed metal having an average tensile strength of [551.6] [_____] MPa [80,000] [_____] psi and a hardness range of 179-229 Brinell. Provide 7205 heavy pintle type chains with 150 mm 6 inch [_____] pitch, weighing [7.6] [_____] kg/m [5.1] [_____] lb/ft, and with plain and attachment links assembled with 19 mm 3/4 inch diameter hardened steel pins and rivets. The chain must have an allowable working load of [15.7] [_____] kN [3,540] [_____] pounds and proof test each assembled strand at a minimum of [83.6] [_____] kN [18,800] [_____] pounds to detect and remove defective castings. Provide rigid attachments for full depth of the flight and attach with four 10 mm 3/8 inch diameter bolts. Match chain sections within 5 mm in 3 meters 3/16 inch in 10 feet, tag, and wire together in pairs.

2.9.1.2 Nonmetallic Chains

Provide nonmetallic chains with 152 mm 6 inch [_____] pitch links manufactured of acetal resin and connected with pins manufactured of reinforced nylon resin. Provide pins of T-head or T-end construction to prevent rotation and hold in place without the use of pinlocks or cotters. Provide chain with a working load of [8.0] [_____] kN [1,800] [_____] pounds. Provide rigid attachments full depth of the flights and attach with four 10 mm 3/8 inch diameter bolts.

2.9.1.3 Drive Chains

Provide H-78 mill type drive chains manufactured of a corrosion resistant processed metal, consisting of[66.27 mm 2.609 inch] [_____] pitch links, and with an allowable working load of [10.4] [_____] kN [2,350] [_____] pounds. Proof test each assembled strand at a minimum of [44.5] [_____] kN [10,000] [_____] pounds to detect and remove defective castings. Provide a hot-dip galvanized chain tightener to take up unnecessary slack in the drive chain.

2.9.1.4 Wood Flights

Provide wood flights os[50 by 150 mm 2 by 6 inch][75 by 200 mm 3 by 8 inch] nominal size and space approximately [3000] [_____] mm [10] [_____] feet on centers. Use redwood or red cypress flights. Drill all flights accurately and notch at the factory to ensure proper alignment.

2.9.1.5 Fiberglass Flights

Provide fiberglass flights of[50 by 150 mm 2 by 6 inch][75 by 200 mm 3 by 8 inch] nominal size, especially designed for sludge collector service. Provide scraper with continuous fiberglass filaments running the full length of the member and include a scraper lip on the leading edge to ensure cleaning of the tank floor. Include filler blocks for bolting the member to the chain attachment links. Ensure flight spacing is approximately [3] [_____] m [10] [_____] feet. Buoyant flight design will not be acceptable.

2.9.1.6 Wearing Shoes

Provide each flight with 13 mm 1/2 inch thick polyurethane wearing shoes to run on the floor rails and return tracks. Ensure wearing shoes are reversible, providing two usable wearing surfaces.

2.9.1.7 Rails

Furnish two 11 kg 25 pound ASCE tee rails and install in the tank floor in accordance with manufacturer's written recommendations.

2.9.1.8 Return Tracks

Provide return tracks composed of[76.2 by 50.8 by 9.5 mm 3 by 2 by 3/8 inch] [_____] thick steel angles with 6 mm 1/4 inch thick steel support brackets. Design each bracket to cantilever the return track off the tank wall. Space support brackets approximately 3000 mm 10 feet apart and fasten to the tank wall by a minimum of two anchors.

2.9.1.9 Sprockets

Provide sprockets consisting of chilled tooth bearing surfaces with a hardness of no less than 360 Brinell and chill depth of at least 4.8 mm 3/16 inch. Key driving sprockets firmly to the headshaft. Provide corner shafts with one sprocket setscrewed and one running loose on the shaft. Provide double-life type collector chain sprockets composed of split construction. Ensure headshaft sprockets are no less than [_____] mm inch pitch diameter and have no less than [_____] teeth. Ensure all other collector chain sprockets are no less than [_____] mm inch pitch diameter and have no less than [_____] teeth. Traction wheels, idler wheels, or other substitutions for sprockets will not be acceptable. Fit the drive sprocket with a bronze bushing and provide with a shear pin device to provide for full protection of equipment in case of excessive loading. Ensure the driving sprocket on the reducer shaft is not less than [_____] mm inch pitch diameter and has no less than [_____] teeth. Provide driven sprocket on the collector headshaft composed of split construction, no less than [_____] mm inch pitch diameter, and no less than [_____] teeth.

2.9.1.10 Shafts

Ensure shaft sizing is compatible with the tank dimensions and sprocket location. Maximum shaft deflection is 4 mm/meter 3/64 in/ft of shaft length. Shafting must be straight and true, solid, cold-finished steel and held in alignment with set collars. Shafting must contain keyways with fitted keys where necessary and must be of sufficient size to transmit the power required. Extend shafting the full width of the tank and turn in bearings mounted on the tank walls. Ship shafting to the project site as complete subassemblies with sprockets, bearings, and set collars in place.

2.9.1.11 Bearings

Provide underwater bearings consisting of cast iron construction, babbitted, and of the water-lubricated, ball and socket, self-aligning type designed to prevent the accumulation of settled solids on their surfaces. Bolt bearings directly to the tank wall in a manner to permit easy adjustment. Ensure take-up bearings provide no less than 250 mm 10 inches of horizontal travel. Take-up bearings must be of cantilevered design, with a fabricated steel support base, and have cadmium plated take-up screws. Design take-up bearings so that no recesses in the concrete are required to maintain clearances.

2.9.1.12 Drive Unit

Provide drive unit consisting of a motor, speed reducer, and electrical control equipment to power the sludge collector. Where a drive unit operates two separate collectors, provide suitable clutches to permit independent operation of each collector. Ensure drive unit for primary collectors is rated for [_____] N-m ft-lb torque, based on dry tank conditions. Ensure drive unit for intermediate collectors is rated for [_____] N-m ft-lb torque, based on dry tank conditions. Base torque rating of the gear assembly on the smaller of the values developed by ANSI/AGMA 2001 and consider as the rated torque capacity the entire gear will develop continuously over a 20-year period. Design drive unit in accordance with ABMA 9 and ABMA 11 and ANSI/AGMA 2001 and ANSI/AGMA 6034.

a. The motor must be totally-enclosed, fan-cooled; ball bearing, constant speed; and of ample power for starting and continuously operating the mechanism under most severe expected operating conditions without overloading. Provide motor conforming to NEMA standards and suitable for operation on [_____] volts ac [_____] phase, 60 Hz with [1.15] [_____] service factor. Connect the motor directly to the speed reducer by a flexible coupling. V-belt drives are not acceptable. Make necessary adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually installed.

b. The drive unit speed reducer must be of the [helical] [worm] gear type, fully housed, running in oil, with antifriction bearings throughout.

c. Furnish each motor with a magnetic full-voltage starter conforming to NEMA ICS 1. Provide starter in weatherproof cast metal enclosure. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor. Mount controls in starter cover or in separate weatherproof cast metal enclosure. [If motors have reversing starters, provide a jog type switch such that mechanism is activated in the reverse direction only as long as button is pushed down. Ensure multiple collectors operated by same drive unit have jaw type disengaging clutches.] [Provide sludge-collector motors with nonreversing starters and 2-button start-stop pushbutton stations.]

2.9.1.13 Overload Protection System

Provide a shear pin assembly to serve as overload protection and set to fully protect the equipment.

2.9.1.14 Cross Collector

Provide cross collector of either the helical coil or the conveyor type and designed to scrape and convey the collected sludge from the sludge channel to a sludge sump. Use materials in the construction of the cross collector of the same type and quality as those used in the main sludge collector. Helical coil consists of a helical steel blade mounted on a steel shaft, driven by a sprocket-connected drive. Conveyor must be similar in operation to the conveyor used in the main sludge collector.

2.9.2 Traveling Bridge Type Collectors

Provide traveling bridge collector composed of a complete bridge assembly supported on ASCE type rails. Provide bridge assembly consisting of a traveling bridge with walkway, bridge drive, sludge removal system, support rail and anchorage parts, and electrical control panel with necessary controls for the operation of the mechanism. Design drive train to withstand maximum horizontal loads placed on the bridge and sludge removal system. Ensure all parts of each mechanism are proportioned for stresses that may occur during fabrication, erection, and operation. Provide bridge with a travel speed of [_____] meters/second fpm and a reverse speed of [_____] meters/second fpm.

2.9.2.1 Bridge Construction

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NOTE: Beam bridges are normally provided for tank widths between 4.5 and 13.75 m 15 and 45 feet. Truss bridges are normally provided for widths greater than 13.75 m 45 feet.

****

Design bridge to span the entire width of the tank and to withstand all dead loads required for the proper operation of the mechanism, a [_____] N pound sludge load per foot of blade length, and a 2394 Pa 50 psf live load on the walkway. Maximum deflection under all loads not allowed to exceed 1/360 of the span length. Provide walkway that is a minimum of 750 mm 30 inches wide and cover itwith [floor plate] [grating]. [Construct bridge of parallel beams with lateral bracing as required.] [Construct bridge of two parallel trusses fabricated from structural steel and diagonal supports welded to the upper and lower chords.]

2.9.2.2 Bridge Drive

****

NOTE: Gear and rack drivers are desirable in climates that have freezing rain and snow.

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Provide bridge drive consisting of a drive assembly, wheels, rails, drive shaft, [rack and pinion,] and controls.

a. Provide drive assembly consisting of a [single speed] [dual speed] [variable speed] drive, gear reducer, drive chain, and drive and driven sprockets. Fully enclose all gearing in an oil-tight housing with the gears running in oil. Use anti-friction type bearings. Provide roller chain type drive chain. Ensure motor is totally-enclosed, fan-cooled; ball bearing; and of ample power for starting and continuously operating the mechanism under most severe expected operating conditions without overloading. Provide motor conforming to NEMA standards and suitable for operation on [_____] volts ac [_____] phase, 60 Hz with [1.15] [_____] service factor. V-belt drives are not acceptable. Make necessary adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually installed.

b. Furnish each motor with a magnetic full-voltage starter conforming to NEMA ICS 1. Provide starter in weatherproof cast metal enclosure. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor. Mount controls in starter cover or in separate weatherproof cast metal enclosure.

c. Provide drive shaft of sufficient size to adequately and safely withstand all bending and torsional loads of starting and operating. Support drive shaft by multiple, grease lubricated bearings. Provide two load-bearing wheels, one flanged and one flangeless, running on roller bearings mounted on idler shafts at each end of the bridge. Provide running rails that are 18 kg 40 pound [_____] ASCE with standard rail splices and anchor to the tank wall. Provide four rail stops; locate at travel extremes. Drive bridge by gears with a 75 mm 3 inch pitch, keyed to the ends of the drive shaft. Mesh gears with a steel rack anchored to the top of the tank wall.

2.9.2.3 Scraper Sludge Removal, Blades, and Supports

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NOTE: Scraper type traveling bridge collectors are normally used for primary basins where the volume of sludge is low and the main requirement is to increase the sludge concentration.

****

Provide scraper blades consisting of a minimum 300 12 inch deep structural steel channel, polyurethane wear shoes, and neoprene strips acting as squeegees on the tank bottom. Position and guide scraper blade assembly by two or more rigid structural steel support assemblies attached to the bridge. Attach scraper blade assemblies through pivot joints and bearings to the support assemblies. Ensure scraper assembly retracts above the water surface for maintenance and inspection.

2.9.2.4 Scraper Sludge Removal Cross Collector

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NOTE: Cross collectors are normally desirable on long basins. Spacing of cross collectors is dependent upon the type of sludge encountered.

****

Provide a screw cross collector consisting of a drive unit with an overload alarm, vertical drive torque shaft, underwater gear box, helical screw, bearings, and anchors. Provide drive unit consisting of a motor and gear reducer connected to a vertical drive shaft through a flexible coupling. Provide totally-enclosed, fan-cooled, ball bearing, constant speed motor of ample power for starting and continuously operating the mechanism under most severe expected operating conditions without overloading. Provide motor conforming to NEMA standards and suitable for operation on [_____] volts ac [_____] phase, 60 Hz with [1.15] [_____] service factor. Vendor must size motor of sufficient size for duty to be performed without exceeding full load under most severe conditions expected. Make necessary adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually installed.

a. The gear reducer must be of the worm gear type with anti-friction bearings and completely immersed in oil in a sealed housing.

b. Provide a replaceable switch, with normally open and normally closed contacts to be actuated upon shear pin failure. Design drive unit to rotate the screw at a speed of [_____] rpm. Provide pressure lubricated underwater gear box with bearings and seals designed for submerged operation. Provide grease lubrication lines from each submerged bearing to an accessible location. Provide helical screw with [_____] mm inch diameter blades of 4.8 mm 3/16 inch thick steel plate welded to a hollow steel core. Support screw by end bearings [and intermediate bearings].

c. Furnish each motor with a magnetic full-voltage starter conforming to NEMA ICS 1. Provide starter in weatherproof cast metal enclosure. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor. Mount controls in starter cover or in separate weatherproof cast metal enclosure.

d. Provide an automatic control system for operation of the collector, enclosed in a NEMA 250, Type 3R control panel and mounted on the bridge. Prewire and factory test all electrical components. Provide an electric overload system, consisting of suitable relays and an indicating meter plainly showing the overload points. The overload system must sound an alarm when the load reaches full load torque capacity of the drive motor and de-energize the motor. Provide a torque sensing and indicating device to indicate percentage of maximum torque being developed.

2.9.2.5 Vacuum Sludge Removal

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NOTE: Vacuum and siphon sludge removal systems are normally used for secondary basins in activated sludge systems where large volumes of sludge are to be removed.

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Provide traveling bridge with [_____] sludge pick-up heads, each [_____] mm feet, inches long, suspended from the bridge. Provide pick-up heads with continuous slot orifices or include neoprene sludge guides covering all settling areas to divert the sludge to large diameter inlet ports. Power vacuum system by [_____] self-priming centrifugal solids handling pumps mounted on the bridge. Provide pumps capable of pumping [_____] L/second gpm per pump at a static head of [_____] mmfeet.

a. Provide totally-enclosed, fan-cooled, ball bearing, constant speed pump motor of ample power for starting and continuously operating the mechanism under most severe expected operating conditions without overloading. Provide motor conforming to NEMA standards and suitable for operation on [_____] volts ac [_____] phase, 60 Hz with [1.15] [_____] service factor. Connect motor directly to the speed reducer by a flexible coupling. V-belt drives are not acceptable. Make necessary adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually installed.

b. Furnish each motor with a magnetic full-voltage starter conforming to NEMA ICS 1. Provide starter in weatherproof cast metal enclosure. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor. Mount controls in starter cover or in separate weatherproof cast metal enclosure.

c. Provide a manual control system for operation of the collector, enclosed in a NEMA 250, Type 3R control panel and mounted on the bridge. Prewire and factory test all electrical components. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor.

2.9.2.6 Siphon Sludge Removal

2.9.2.6.1 Sludge Removal Siphons

Provide traveling bridges with [_____] sludge removal siphons, [each consisting of a horizontal pipe header with uniformly spaced inlet ports] [each having one large diameter pick-up port and neoprene sludge guides covering all settling areas to divert sludge to the inlet ports]. Submerge siphon discharge in the sludge trough.

2.9.2.6.2 Vacuum Priming System

[Provide a portable vacuum pump for siphon priming. Connect pump manually to a male hose cock on the siphon pipe. Manually turn connection between the pump and siphon pipe to "OFF" as the pipe is primed.] [Provide a bridge mounted vacuum pump for siphon priming. Pipe pump to a vacuum header through a vacuum canister. Terminate vacuum header by hand-operated valve to allow vacuum header purging after the priming operation. Manually turn each connection between the vacuum header and siphon pipes to "OFF" as the pipe is primed.]

2.9.2.6.3 Siphon Flow Control

[Control sludge removal rate of each siphon pipe by an eccentric plug valve, manually operated from the bridge by a handwheel.] [Control sludge removal rate of each siphon pipe by a pneumatically controlled variable orifice pinch valve. Size valve to provide no restriction or change of shape in the siphon pipe when in the full open position. Adjust throttling status of each valve manually and independently maintain by a pneumatic control circuit. Automatically allow the siphon pipes to purge daily at maximum velocity and then return flows to the preset quantities.] [Control sludge removal rate of the siphons by a control box at the discharge end of the traveling bridge. Provide control box of sufficient depth to allow filling the box to the water level in the tank. Regulate discharge from the control box by a [manually] [pneumatically] [hydraulically] [electromechanically] operated sluice gate.]

2.9.2.7 Airlift Pump Sludge Removal

Provide traveling bridge with [_____] sludge pick-up heads, each [_____] mm feet, inches long, suspended from the bridge. Provide pick-up heads including neoprene sludge guides covering all settling areas to divert the sludge to large diameter inlet ports. Size drop pipes for a maximum sludge removal rate of 100 percent of the average daily flow. Use airlift to provide a pumping rate of [_____] L/second gpm per pump at a static head of [_____] mm feet. Power airlift system by a positive displacement blower or centrifugal compressor, depending on air volume required. Mount compressor on the bridge.

a. Provide totally-enclosed, fan-cooled, ball bearing, constant speed compressor motor of ample power for starting and continuously operating the mechanism under most severe expected operating conditions without overloading. Provide motor conforming to NEMA standards and suitable for operation on [_____] volts ac [_____] phase, 60 Hz with [1.15] [_____] service factor. Connect motor directly to the speed reducer by a flexible coupling or V-belt drive. Make necessary adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually installed.

b. Furnish each motor with a magnetic full-voltage starter conforming to NEMA ICS 1. Provide starter in weatherproof cast metal enclosure. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor. Mount controls in starter cover or in separate weatherproof cast metal enclosure.

c. Provide a manual control system for operation of the collector, enclosed in a NEMA 250 l Type 3R control panel and mounted on the bridge. Prewire and factory test all electrical components. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor.

2.9.2.8 Power Supply Stretch Cable System

Provide a stretch cable system, consisting of a stainless steel cable stretched between two anchor posts. Provide cable with a number of pulleys which support the electrical cable used to power the collector. Loop electrical cable in coils with each coil being attached to a separate pulley. Upon traveling to the end of the basin, extend the coils to form a draped electrical cable supported by the pulleys, and as the cable returns, retract the loops by the action of the bridge.

2.9.2.9 Power Supply Trolley Track System

Provide a trolley track system, which allows the electrical cable to uncoil and retract as the bridge moves.

2.9.2.10 Power Supply Cable Reel System

Provide a cable reel system capable of unwinding and rewinding the power cable while maintaining a constant tension on the cable. Provide a strain relief device to protect the fixed end of the cable.

2.9.2.11 Control System for Bridge Drive

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NOTE: NEMA Class 250, Type 4X is recommended where corrosive gases, dust, or water hosedown are environmental factors. NEMA 4X type is not ventilated.

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Provide an automatic control system for operation of the collector, enclosed in a NEMA 250, Type 3R control panel and mounted on the bridge. Prewire and factory test all electrical components. Provide an electric overload system, consisting of suitable relays and an indicating meter plainly showing the overload points. The overload system must sound an alarm when the load reaches full load torque capacity of the drive motor and de-energize the motor. Provide a torque sensing and indicating device, mounted on the bridge, to indicate percentage of maximum torque being developed.

2.9.3 Center Track Airlift Pump Type Collectors

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NOTE: Center track airlift pump type collectors are normally limited to basins no larger than 12 m 40 feet long and 6 m 20 feet wide.

****

Provide collector consisting of a support beam and track assembly, carriage assembly, motor and gear reducer, drive chain and sprockets, sludge pick-up assembly, and compressor. Ensure all moving parts are above the water level. Ensure lubrication and adjustment points are readily accessible. Design system to handle a horizontal load (drag) of [438] [_____] N [30] [_____] pounds per lineal meter foot on the scraper blade and all stresses which may occur in fabrication, shipping, erection, and operation. Provide unit with a traverse speed of [_____] mm/second fpm in both directions.

2.9.3.1 Support Beam and Track Assembly

The support beam and integral track must constitute a single box structure spanning the length of the basin. Locate track inside the support beam for weather protection. Provide assembly of sufficient rigidity to withstand both horizontal and vertical loads without supplemental stiffening members. Provide a mounting assembly for attaching the beam and track to the basin wall at the correct height.

2.9.3.2 Carriage Assembly

Provide a carriage assembly to traverse the track assembly. Provide assembly with four flanged support wheels to travel along the track. Ensure assembly has four additional wheels to oppose moment resulting from drag on the scraper blade.

2.9.3.3 Drive Assembly

Provide drive assembly consisting of a motor and gear reducer driving a continuous chain through a shear pin protected drive sprocket. Provide single speed, [_____] volts ac, [_____] phase, 60 Hz motor. Mount motor and gear reducer directly on the support beam. Totally enclose drive sprocket, chain, and driven sprocket in the support beam assembly. Provide a means for adjusting chain tension at the driven sprocket. Direct linkage between the drive chain and the carriage is prohibited. Allow chain to run continuously in one direction with reciprocating motion of the carriage imparted by a fitting on the chain which will engage the carriage at two different points. Allow a brief dwell time at each end of the travel. Engagement of the carriage must not produce eccentric loads on the chain.

a. Provide totally-enclosed, fan-cooled, ball bearing, constant speed motor of ample power for starting and continuously operating the mechanism under most severe expected operating conditions without overloading. Provide motor conforming to NEMA standards and suitable for operation on [_____] volts ac [_____] phase, 60 Hz with [1.15] [_____] service factor. Make necessary adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually installed.

b. Furnish each motor with a magnetic full-voltage starter conforming to NEMA ICS 1. Provide starter in weatherproof cast metal enclosure. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor. Mount controls in starter cover or in separate weatherproof cast metal enclosure.

2.9.3.4 Airlift Pump

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NOTE: Airlift pumps are made of noncorrosive materials. Air lines are removable with multiorifice diffuser discharge end. Airlift pump must be properly reinforced to handle structural and dynamic loads. Capacity, submergence, and air requirements should be calculated for each airlift pump. Priming pump vacuum is heavy-duty industrial vacuum with minimum liquid volume of 23 liters 6 gallons, double filtration system, and automatic

water level shutoff float.
****

Provide each collector with a sludge pick-up head [_____] mm feet, inches long, suspended from the carriage. Provide pick-up head including neoprene sludge guides covering all settling areas to divert the sludge to large diameter inlet ports. Size drop pipe for a maximum sludge removal rate of 100 percent of the average daily flow. Use airlift to provide a pumping rate of [_____] L/second gpm per pump at a static head of [_____] mm feet. Power airlift system by positive displacement blowers or centrifugal compressors, depending on air volume required. Provide a pair of compressors to feed a common air manifold to provide air supply for [_____] collectors as shown. Provide required check valves, shut-off valves, and regulating valves for isolation, regulation, and balancing.

a. Provide totally-enclosed, fan-cooled, ball bearing, constant speed compressor motor of ample power for starting and continuously operating the mechanism under most severe expected operating conditions without overloading. Provide motor conforming to NEMA standards and suitable for operation on [_____] volts ac [_____] phase, 60 Hz with [1.15] [_____] service factor. Connect motor directly to the blower by a flexible coupling or V-belt drive. Make necessary adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually installed.

b. Furnish each motor with a magnetic full-voltage starter conforming to NEMA ICS 1. Provide starter in weatherproof cast metal enclosure. Provide a separate pole with manually reset thermal-overload protection in each ungrounded conductor. Mount controls in starter cover or in separate weatherproof cast metal enclosure.

2.9.3.5 Controls

****
NOTE: NEMA Class 250, Type 4X is recommended where corrosive gases, dust, or water hosedown are environmental factors. NEMA 4X type is not ventilated.
****

Provide an automatic control system for operation of the collector. Enclose controls in a NEMA 250, Type 3R control panel and mount on the support beam. Ensure all electrical components are prewired and factory tested.

2.9.4 Floating Bridge Siphon-Type Collectors

Provide collector consisting of a floating bridge, bridge drive and idler stand, siphons and sludge removal system, float system, control system, and necessary support structures and anchorage. Ensure collector is capable of removing settled solids from the tank floor and discharging them into a sludge trough. Control flow rate of the mechanism over a range of [_____] L/second gpm to [_____] L/second gpm per collector bridge assembly by individually adjustable siphon pipes.

2.9.4.1 Floating Bridge

Design and contruct floating assembly to comply with the hydraulic conditions of the system. Provide bridge consisting of rigidly interlaced aluminum beams, stainless siphon pipes, and fiberglass floats, all designed to support the entire mechanism and maintain a minimum floating clearance of 50 mm 2 inches from the floor of the collector basin. Furnish beams of sufficient size to support the floats and the siphon pipes. Furnish stainless steel brackets and pipe clamps to securely mount all of the siphon pipes in the proper position to the support beams. Mount floats securely to the siphon pipes to provide uniform travel of the bridge in both directions, the full length of the collector basin. Design floats for the general hydraulic conditions and consisting of closed cell polyurethane foam encased in a fiberglass enclosure and support by structural aluminum angle. Ensure recyclable materials conform to EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Secure aluminum tow brackets to the siphon pipes and furnish with stainless steel mounting hardware of adequate quantity and size to withstand the loading and tension applied to the towing cable when the collector reverses direction. Secure inboard and outboard end trucks and guide wheel assemblies to the floats or support beams and design to allow for thermal expansion and contraction of the floating bridge. Provide wheels composed of noncorrosive material.

2.9.4.2 Bridge Drive Assembly and Idler Stand

Tow each floating bridge along the longitudinal length of the basin by a stainless steel, stranded wire cable. Use cable of adequate size to tow the entire structure and span the length of the tank with a minimum of catenary. Affix drive cable to floating bridge assembly through tow bridle assembly. Provide bridge drive consisting of a reducer driven by a constant torque, variable speed dc electric motor, [single] [_____] phase, 60 Hz, [120] [_____] volts, totally enclosed, suitable for continuous duty. House reducer in an oil- and dust-tight casing, equip with anti-friction bearings, and design for splash-type lubrication. Provide switches permitting directional change of the unit on the drive base assembly. Provide an idler stand complete with adjustable base and sheave at the opposite end of the tank. Provide a complete corrosion-resistant enclosure for each drive and idler assembly.

2.9.4.3 Sludge Removal System

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NOTE: Assemblies, parts, and connectors in submerged service should be made of 304/316 stainless steel or fiberglass, rather than aluminum.

****

Provide total sludge removal capacity range of the vacuum sludge removal system which is adjustable from [_____] L/second gpm to [_____] L/second gpm. Construct all siphon piping and headers of stainless steel with vacuum tight welded joints. Design piping assembly structure to adequately support itself on the tank floor with the basin dewatered. Provide orifices of adequate size and spacing in each header pipe. Design entrance velocity at each orifice to create an angular zone in influence, to permit all sludge on the basin floor to be cleaned at the end of each cycle. Each siphon pipe must be independent from the others and independently controlled. Terminate and discharge each siphon pipe into a sludge control device. The submerged siphon piping must be stainless steel on the exterior surface in accordance with collector manufacturer's recommendations to protect the pipe from oxygen cell corrosion. Furnish individual sludge control for each siphon as an integral part of the siphon collector. Ensure control is corrosion resistant and adequately supported. Suspend control device from the floating structure and secured to the siphon piping. Manually adjust flow rate by setting the adjustable discharge opening using a rising stem operator. Construct sludge control device to prevent air from breaking the siphon during priming. Design siphon collector to permit priming of each suction header. Furnish a priming device consisting of a portable, wet-dry vacuum pump with handle and wheels. Provide valves for each siphon pipe that are capable of holding 635 mm 25 inches of mercury with zero leakage. Provide flexible single ply rubber priming hose and quick disconnect couplings with each unit. The vacuum pump must be industrial wet/dry type, [single] [_____] phase, 60 Hz, [120] [_____] volts ac. Provide one priming pump per pair of siphon collector mechanisms.

2.9.4.4 Control Panel

Furnish a control panel by the collector manufacturer containing all controls necessary for the operation of the collector. Ensure all of the components are factory installed in a NEMA 250, Type 4 [4X] [3R] enclosure, factory prewired to numbered terminal strips within the enclosure and factory tested. Include manual override controls for collector travel in addition to the automatic operations. Furnish areversing mechanism with time delay relays to change the collector direction of travel automatically. Provide a SCR controller to vary the speed of the collector at between [1.2] [_____] m/minute [4] [_____] fpm and [3.7] [_____] m/minute [12] [_____] fpm for both directions of the bridge travel. Furnish limit switches with internal heaters and stainless steel limit switch actuators to reverse the movement of the collector. Mount one limit switch securely to the bridge drive, and mount the other limit switch securely to the idler stand. Affix microswitch to overclutch clutch to activate alarm and shut down.

2.9.4.5 Automatic Programmer

Provide a programmer in the control panel to automatically adjust rate of collector travel. Upon reversing direction of the collector, allow collector rate of travel to increase automatically for manually preset distance and then return to preset normal rate of travel. Ensure programmer has a manual override. Provide a single phase, 60 Hz, [120] [_____] volts ac solid state, encapsulated, proximity switch as an integral part of the programming control.

2.9.5 Scum Removal

Provide a retracting surface skimmer to remove scum from the tank. Attach mechanism with a blade extending the width of the tank, or as required, to the bridge. Allow skimmer to operate while the bridge is traveling in one direction only and retract for the return trip of the bridge. Provide a beaching type scum trough across one end of the basin. Construct trough of [steel plate] [or] [fiberglass] to the dimensions indicated. Provide all hardware required for trough installation.

2.9.6 Effluent Removal

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NOTE: Coordinate with paragraph WEIR PLATES.

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Provide weir plates composed of [fabricated steel plate] [or] [fiberglass reinforced polyester plastic] of the dimensions indicated. Mold vee notches in fiberglass weir plates in the plate; cut edges are not acceptable. Mount weir plates in a manner to be watertight and to provide a minimum of 50 mm 2 inches vertical adjustment. Fabricate effluent trough from [steel plate] [or] [fiberglass reinforced polyester plastic] to the dimensions indicated. Ensure joints between sections are watertight. Provide support assemblies of adequate strength to prevent trough distortion through filling and draining of the tank.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 FACTORY PAINTING

Ensure all ferrous metal equipment, except stainless steel and galvanized steel, is cleaned, primed, and given two coats of machinery enamel at the factory. Field paint in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.3 FRAMED INSTRUCTIONS

Post framed instructions, containing wiring and control diagrams under glass or in laminated plastic, where directed. Show wiring and control diagrams and complete layout of the entire system. Include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system. Submit a copy of the posted instructions proposed to be used. Post framed instructions before acceptance testing of the system.

3.4 EQUIPMENT INSTALLATION

3.4.1 Installation

Install equipment as indicated and in accordance with the manufacturer's written instructions. Submit drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

Furnish grease and oil, of grades recommended by the manufacturer, as part of the installation and as required for initial operation.

3.4.2 Adjusting

Make field adjustments as required for proper operation of the equipment.

3.4.3 Testing

3.4.3.1 Operational Test

Subject each mechanism to an operational test, under the observation of the Contracting Officer. Demonstrate that the equipment is not defective and is in safe and satisfactory operating condition. Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

3.4.3.2 Torque Test

Conduct a torque test on one mechanism selected by the Contracting Officer. Conduct test under the supervision of a factory serviceman and observation of the Contracting Officer. The purpose of the test is to verify the structural integrity and adequacy of the mechanism and drive. Perform torque test consisting of securing all rake arms at multiple points by cables to anchor bolts installed in the tank floor at locations recommended by the manufacturer. Apply a torque load to the drive by hand if possible. Measure the magnitude of the applied load by a calibrated pressure reading, the plunger and rod area, and the distance of the line of action of each cylinder from the centerline of the mechanism. Take readings at 100, 120, and 140 percent of continuous operating torque. Apply test loads such that the torque overload device can be used to indicate the alarm and motor shut-off torque values of the drive.

3.4.3.3 Retesting

If any deficiencies are revealed during any test, correct such deficiencies and reconduct the tests.

3.4.4 Tank Bottom

Finish the tank bottom in such a manner that full contact will be obtained between the [sludge scrapers] [flights] [manifold] and the surface.

3.5 WELDING

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NOTE: If the need exists for more stringent pipe welding requirements, delete the sentences in the first set of brackets.

****

[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Use qualified procedures and welders in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform the tests at the work site if practical. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Use welding and nondestructive testing procedures for piping as specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

3.6 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Supervise the installation, adjustment, and testing of the equipment.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Field Training

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [_____] hours of normal working time and start after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the Operating and Maintenance Manuals.

3.7.2 Operating and Maintenance Manuals

Detail in the Operation manuals the step-by-step procedures required for system startup, operation, and shutdown. Include in the Operation manuals the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the Maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the Maintenance manuals piping and equipment layout and simplified wiring and control diagrams of the system as installed. Obtain approval of manuals prior to the field training course.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-48 06 15 (November 2023)**

Preparing Activity: USACE **Superseding**
UFGS-48 06 15 (August 2020)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

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USACE / NAVFAC / AFCEC **UFGS-48 06 15 (November 2023)**

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SECTION 48 06 15

TURBINE OIL

11/23

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NOTE: This guide specification covers the requirements for turbine oil for hydroelectric power plants. Requirements in this section assume a complete or significant change out of power plant oil. For contracts procuring smaller amounts of supplemental oil, testing requirements may be lessened depending on risk-tolerance, and it might be cost-effective for all testing to be performed by the Government rather than the Contractor.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: It is advised to consult with the technical proponent of the specification prior to its use. Corps Districts/Project offices can contact the Hydroelectric Design Center for assistance and/or request additional information/clarification related to the information contained in the entire document (POC: Catherine Campbell 503-808-4255 or Catherine.L.Campbell@usace.army.mil).

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PART 1 GENERAL

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NOTE: Initial compatibility testing is more involved than per-delivery compatibility testing. Initial compatibility testing is to demonstrate that the chemistry of the new name-brand oil is itself compatible specifically with the in-service oil at the plant in question. Per-delivery compatibility testing is to confirm the delivered oil is in fact the correct oil, and to confirm that no contamination occurred during delivery which affected compatibility. Often the initial compatibility testing is performed by the Government, for instance using oil samples which are sent in together with bids for a job. For a very large job such as a major powerhouse rehabilitation, where the turbine oil replacement is only a fraction of the cost, it might be advantageous to require the Contractor to perform the initial compatability testing. Initial compatibility testing should include all Tier 1 and Tier 2 tests in ASTM D7155 "Standard Practice for Evaluating Compatibility of Mixtures of Turbine Oil" plus Viscosity and Acid Number from Tier 3, and RPVOT, Rust Prevention, and Copper Corrosion from Tier 4. This testing should be performed even if the oil being purchased for the complete plant oil replacement is the same name-brand of oil which was purchased for the previous complete plant oil replacement, to ensure that even the same name-brand oil is still compatible with in-service oil. (A name brand can have a change in the proprietary recipe without notification to the Government.) Depending on the situation, an additional Tier 4 test may be recommended also to reduce risk, the Sludging and Corrosion test. This test is onerous, especially if performed on 5 or 6 samples with varying ratios of new and old oil, because it takes 1,000 hours just to run the test. An example scenario when the Sludging and Corrosion test may be warranted is when turbine oils from different manufacturers are being mixed (because neither manufacturer can fully vouch for expected compatibility between their oils), and in particular when the new oil will NOT be completely replacing the old oil, meaning the oils must work together long-term, in any ratio, because the Plant's turbine oil all gets mixed together over the years. Initial test results can take up to 4-6 weeks even expedited (and will take even longer if 1,000-hr tests are ordered). If multiple bids/brands might be accepted, testing on bidder-submitted samples by the Government may exceed GPC (Government purchase card) limits depending on number of samples/bids. If testing is to be done at this stage, it is recommended to solicit quotes ahead of time to allow for timely testing and adequate competition. The testing

duration should also be taken into account when soliciting the contract.

Note that for significant quantities of oil, such as a railcar at at time (20,000-24,000 gallons), and especially if the Contractor is filtering the oil pre-delivery, the lead time between placing a task order and getting a delivery can be 12-16 weeks or longer.

This specification assumes use of traditional Group 1 and 2 mineral oils, not any Environmentally Acceptable Lubricants (EALs), because a drop-in EAL turbine oil replacement is not considered technically feasible at this time. If experimenting with a synthetic EAL is desired, for instance during a major rehabilitation in an environmentally sensitive area, replacing turbines, and with opportunity to replace any incompatible oil-wetted materials (seals, paint), please contact the PROPONENT. There are efforts both pending and underway to develop, research, test, and vet potentially feasible EALs, for example by the Centre for Energy Advancement through Technological Innovation (CEATI) Hydropower Plant Equipment Interest Group (HPEIG). At this time, however, the most viable candidates for performance in hydropower units are also entirely incompatible with in-service oils, as well as incompatible with several materials. Additionally, there is concern that EALs might not have as much hydrodynamic thrust bearing load capacity as traditional mineral oils.

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NOTE: The 17/15/12 cleanliness level and 100 ppm water content PPM level in this spec assume that all the oil is being changed in a Powerhouse at once, in which case it is typically more convenient for the Government to have the Contractor perform filtration and dehydration such that new oil does not require any purification by the Project prior to use. (For digital governors, the offline "kidney-loop" filter dedicated to the governor sump can further polish the governor oil up to 15/13/10, if the governor sump has breathers to exclude contamination from the air.) If only supplemental oil is needed or the Project wishes to handle purifying, the cleanliness and water requirements should be changed to FIO or removed.

Two recommended ways of oil procurement are through a SATOC (Single Award Task Order Contract) or a DLA (Defense Logistics Agency) purchase. A SATOC allows for issuing task orders each time the powerhouse is ready to accept another "batch" of oil. DLA purchases allow for specification of a name brand product for consistency and risk reduction. Extra storage may be key to having enough flexibility to

deliver only the new oil from the clean lubrication oil tank in the oil storage room to the powerhouse for makeup oil and to fill empty units, while holding all oil that is drained back to the dirty lubrication oil tank in the oil storage room to be trucked away. During this transition, the Project's own lube oil purifier would be entirely idle, with no oil being moved from the dirty tank to the clean tank. This offers tremendous savings and simplicity over constructing a parallel oil delivery system to keep the new and old oils separate. To get extra storage room for incoming and outgoing oil, it may be beneficial to empty out the transformer oil tanks, wasting any residual oil, testing for PCBs (hopefully none) and wiping those tanks down to accept lube oil, at least temporarily. At the end of the contract, it may be desirable to empty and wipe down at least the dirty transformer oil storage tank again, to be ready in case a sudden urgent need to drain a transformer comes up. To change all the oil in the powerhouse this way, it is strongly recommended for the new oil being delivered to be clean enough to go straight to the units.

Ordering "batches" of oil in railcar quantities (20-24k gallons) to the extent possible will get the Government a better price.

Oil can be delivered to temporary Contractor-provided storage containers onsite at the Project, or the delivery truck's tanks can remain on-site within a containment berm. This allows the Government to use a sample taken from the actual delivered oil, send it to the lab for testing, and only move it into Government tanks or equipment after it passes all tests. If the oil is immediately moved into Government tanks or equipment, and failed oil test results arrive later, this can be very difficult to resolve satisfactorily with the Contractor. (The risk may be acceptable in a case where a Contractor is making multiple oil deliveries, and has successfully delivered acceptable oil a few times, and is using the exact same procedures through the contract.)

For change out of all the oil in a Powerhouse, it is highly recommended to flush the system first; see EM 1110-2-1424 LUBRICANTS AND HYDRAULIC FLUIDS. Contact the Hydroelectric Design Center for questions, concerns, and support for flushing specifications.

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1.1 SUMMARY

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NOTE: When changing the oil in a Powerhouse, there will typically be some waste. It is highly desirable to have flexibility in the contract to allow the

last delivery order to be an unknown amount smaller than a full truckload, though typically that will mean a higher per-gallon price for the final delivery.

It is desirable to have zinc-free turbine oil. Zinc-free oil is more environmentally friendly. Also zinc additives like "ZDDP", while effective, can break down under certain conditions into undesirable compounds. Over time, ZDDP + Water + Heat => Sulfuric Acid + Hydrogen Sulfide. This can pose a risk, for example in a poorly ventilated area such as the bottom of a damp regulating outlet tower in a reservoir with hydraulic-operated gates and a submerged oil heater in the sump. Typically for hydropower applications, zinc or ZDDP as an anti-wear additive is not needed due to relatively mild conditions, though there are some exceptions such as when speed-increasing gears are part of the equipment being lubricated by the same turbine oil. (Even in these cases, "extreme pressure" additives should be avoided due to being more chemically aggressive and unnecessary.) Note that some oils may have "EP" in the name brand without actually having the aggressive additives.

For turbine bearings and governors in powerhouses, however, compatibility requirements have sometimes led to the choice of non-zinc-free oils.

Typically if an oil is zinc-free, its Product Data Sheet (PDS) will explicitly claim "zinc-free".

There are times when a particular name brand of oil is justified and this is known prior to advertisement because comprehensive compatibility checks were done beforehand for a complete oil replacement, or the quantity of top-off oil does not justify experimenting with anything other than the existing name brand. This specification has bracketed choices which allow for a name brand to be indicated if approved.

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NOTE: Depending on initial oil compatibility testing strategy and/or whether a name brand is justified, consult with contracting regarding whether the language about "...bidders must submit one gallon of proposed turbine oil with proposals" in the second paragraph belongs here and/or in Instructions to Offerors.

The seven ratios below include 2 special ratios (highlighted orange) using 5% and 95%. These are not normally part of the ASTM D7155 testing, but can be included for an extra fee if communicated with the oil testing lab ahead of time. The number of ratios can be reduced depending on the situation and

risk tolerance. The test with just 5% in-service oil is meant to represent a situation where all of the in-service oil is intended to be removed, but some residue remains. The test with just 5% new oil is meant to represent a situation where a small portion of new oil is used as "make-up" oil in governor sump full of in-service oil.

****

This specification includes [zinc and]chlorine-free rust and oxidation inhibited (R&O) mineral oils for use in hydraulic turbine and generator bearings, Kaplan turbine hubs, hydraulic-turbine governors, and other applications, where high grade turbine oil having anti-corrosion and anti oxidation properties is required. In addition, this specification covers delivery and installation of up to [_____] gallons of approved [(ISO viscosity grade 68)][(ISO viscosity grade 100)] turbine oil for [_____] Powerhouse. Laboratory test results for [each railcar of oil ordered and for]each truck of oil delivered are required.[Oil is to be delivered at the unusual cleanliness level of 17/15/12(c) and with less than 100 ppm of water.]

[Because compatibility is a critical feature of replacement turbine oil, bidders must submit one gallon of proposed turbine oil with proposals. The Government will have compatibility tests performed at its own cost. Any oils which fail to demonstrate compatibility with the in-service oil at [_____] Powerhouse per ASTM D7155 will be ineligible. The following tests from ASTM D7155 will be performed:.

From Tier 1 Visual Appearance, all tests.
From Tier 2 Interfacial Properties, all tests.
From Tier 3 Physical/Chemical Properties, ASTM D445 or ASTM D7042, and ASTM D664 or ASTM D974.
From Tier 4 Performance Properties, ASTM D2272, ASTM D665 [, and ASTM D130][ASTM D130, and ASTM D4310].

The above tests will be performed with the following seven ratios:

100 percent new oil to 0 percent in-service oil
95 percent new oil to 5 percent in-service oil
90 percent new oil to 10 percent in-service oil
50 percent new oil to 50 percent in-service oil
10 percent new oil to 90 percent in-service oil
5 percent new oil to 95 percent in-service oil
0 percent new oil to 100 percent in-service oil

Potential bidders may wish to have their own tests conducted prior to bidding, and may request a one-gallon sample of in-service oil for that purpose.]

1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. The year refers to the basic date of issuance of the standard or code. All Codes and Standards are to include published Interpretations and Interim Amendments or Revisions by the Standard or Code Authorities referenced must be current as of date of contract.

ASTM INTERNATIONAL (ASTM)

ASTM D92	(2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97	(2017b) Standard Test Method for Pour Point of Petroleum Products
ASTM D130	(2018) Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
ASTM D445	(2019a) Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D664	(2018; E 2018; E 2019) Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration
ASTM D665	(2019) Standard Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water
ASTM D892	(2013; E 2016) Standard Test Method for Foaming Characteristics of Lubricating Oils
ASTM D974	(2014; E 2016) Standard Test Method for Acid and Base Number by Color-Indicator Titration
ASTM D1401	(2019) Standard Test Method for Water Separability of Petroleum Oils and Synthetic Fluids
ASTM D2270	(2010; R 2016) Standard Practice for Calculating Viscosity Index from Kinematic

	Viscosity at 40 and 100°C
ASTM D2272	(2014a) Standard Test Method for Oxidation Stability of Steam Turbine Oils by Rotating Pressure Vessel
ASTM D3427	(2019) Standard Test Method for Air Release Properties of Petroleum Oils
ASTM D4057	(2012; R 2018) Standard Practice for Manual Sampling of Petroleum and Petroleum Products
ASTM D4177	(2016; E 2017) Standard Practice for Automatic Sampling of Petroleum and Petroleum Products
ASTM D4310	(2022) Standard Test Method for Determination of Sludging and Corrosion Tendencies of Inhibited Mineral Oils
ASTM D6304	(2016; E 2016) Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
ASTM D7042	(2020) Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)
ASTM D7155	(2011) Standard Practice for Evaluating Compatibility of Mixtures of Turbine Lubricating Oils
ASTM D7647	(2010; R 2018) Standard Test Method for Automatic Particle Counting of Lubricating and Hydraulic Fluids Using Dilution Techniques to Eliminate the Contribution of Water and Interfering Soft Particles by Light Extinction

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 4406	(2021) Hydraulic Fluid Power - Fluids - Method for Coding the Level of Contamination by Solid Particles
ISO 11171	(2022) Hydraulic Fluid Power - Calibration of Automatic Particle Counters for Liquids
ISO ISO/IEC 17025	(2017) General Requirements for the Competence of Testing and Calibration Laboratories

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.3 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project.

The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "HDC" for the Hydroelectric Design Center MCX in Portland District, "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

In this SUBMITTALS paragraph below, choose the first bracketed item for Navy and Air Force projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Oil Test Independent Laboratory Qualifications; G,HDC

Oil Delivery Truck [And Temporary Contractor-Provided Clean Oil Storage Tank]Cleaning Methods; G,HDC[

Filtration Procedure(s); G,OPS,HDC]

OIL SAMPLING PLAN; G,OPS,HDC

Oil Spill Prevention Procedure; G,OPS,ECC,HDC

Oil Vendor Qualifications; G,HDC

Oil Delivery and Removal Procedure; G,OPS,ECC,HDC

SD-04 Samples

One Gallon Of Oil From Each Onsite Tank Or Truck; G,OPS

SD-06 Test Reports

[INITIAL COMPATIBILITY TESTING; G,HDC

] Data Of Chemical And Physical Characteristics, Per Delivery; G,HDC

Compatibility Testing Results, Per Delivery; G,HDC

SD-07 Certificates

[Certification Of Brand Name Product; G,HDC

] Certification Of Clean Oil Delivery Truck, Per Delivery; G,HDC,OPS

Chain Of Custody, Per Delivery; G,OPS

1.4 OIL TEST INDEPENDENT LABORATORY QUALIFICATIONS

Submit for approval the qualifications of the proposed oil testing laboratory, within 60 days of Award. The laboratory must be independent of [oil manufacturer][ExxonMobil][Shell][Chevron] and independent of the Contractor. The laboratory must be ISO ISO/IEC 17025 certified, and must have a minimum of 3 years of experience performing the ASTM D7155 Tier 1 Visual Appearance compatibility testing (note that this Tier 1 testing is not certified by ISO). Examples of qualifying laboratories are:

TestOil, 20338 Progress Drive, Cleveland, OH 44149, (216) 251-2510

SGS Herguth Laboratories, 101 Corporate Place, Vallejo, CA 94590, (800) 645-5227

Lubrication Engineers, 1919 E. Tulsa Street, Wichita, KS 67216, (800) 537-7683

MRT Laboratories, 305 Nebraska Street, South Houston, TX 77587, (713) 944-8381

1.5 OIL DELIVERY

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NOTE: Quarantining the oil in Contractor storage

reduces the risk taken on by the Government. In a case where the oil fails compatibility, any tanks that held the incompatible oil will need to be thoroughly cleaned prior to accepting more oil. By utilizing Contractor-provided storage tanks, it can be ensured that the Government tanks will not be contaminated by incompatible oil. This also puts the entire chain of custody of any rejected oil in the hands of the Contractor.

However, using Contractor-provided temporary oil storage also adds cost and increases the need for oil spill prevention measures. It may be an added burden for the Project to inspect daily for leaks, for instance. There are various ways to reduce everyone's risk, depending on the partnering relationship, costs, and quantity of oil. For example, if several railcars (20-24k gallons of oil) are being ordered, and the distributor has a tank farm with rail spurs, they may be able to hold a railcar from the manufacturer pending a set of test results to be approved by the Government. Then the distributor takes custody of the oil from the manufacturer, pumps it into clean tanks for filtration, submits cleanliness measurements to the Government, then pumps it into clean trucks for delivery, takes a sample from the truck at delivery, pumps it into the Government's clean tank, where it is quarantined pending acceptable test results from that sample. This way, Government acceptance of the oil depends only on factors which were in the Contractor's control. However, the Contractor must have confidence in their process, because rejection will mean the oil must be removed from the Government's tank and replaced at no additional cost to the Government. Also in this case the Government's tank should be cleaned, pumping or vacuuming out all oil and using squeegees and/or lint-free rags to wipe surfaces clean. Cleaning Government tanks prior to accepting the first delivery of new oil into them is good practice in any case. If other on-site work is already required in the contract, it might be worth requiring the Contractor to perform this work, which likely includes tanks which are confined spaces.

In any case, the samples used for final Government acceptance of the oil should be taken after the oil is onsite at the Powerhouse, to avoid accepting oil which is then contaminated during delivery. (One exception might be a tote which was filled and shipped directly from the oil manufacturer, which is sealed with no opportunity for contamination between the manufacturer and the Project.)

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[All oil deliveries will be held in Contractor-provided temporary onsite storage for up to one week after submittal of lab test results in order to allow for review and approval.][Oil will be held in Government storage tank pending acceptable test results. If test results are unacceptable, remove the oil from the Government tank and replace it within 12 weeks at no additional cost to the Government.] Particular lab test results required include both property testing and compatibility testing as specified below.

1.5.1 OIL DELIVERY TRUCK [AND TEMPORARY CONTRACTOR-PROVIDED CLEAN OIL STORAGE TANK]CLEANING METHODS

Submit for approval the specific cleaning fluid and methods which will be used to clean oil delivery trucks and the qualifications of the truck cleaning company, within 60 days of Notice of Award. Include a description of how the cleaning procedure results in zero residue and therefore minimizes risk of contamination of new oil. Include a description of what documentation will be offered to serve as certification that a delivery truck was cleaned. Cleaning methods must include but not be limited to the steps outlined in paragraph Oil Delivery Truck [and Temporary Contractor-Provided Clean Oil Storage Tank] Cleaning or approved equivalent procedure.

Once the delivery truck, hoses, and pump(s) have been cleaned the first time per these specifications, if no products other than [the approved oil][name brand (if justified) e.g. Mobil DTE, Shell Turbo T68] have been transported by this equipment as evidenced by the manifests, then additional cleaning is not needed between loads.

1.5.1.1 Oil Delivery Truck [and Temporary Contractor-Provided Clean Oil Storage Tank] Cleaning

(a) Drain each compartment and discharge line.

(b) Use one of the following as a cleaning fluid:
   (i) clean unused diesel fuel with less than 0.1% biodiesel and less than 0.2% total additives
   (ii) kerosene
   (iii) gasoline
   (iv) jet fuel

(c) For tanks or single-compartment trucks, utilize a minimum of 50 gallons of cleaning fluid in the compartment. For triple-compartment trucks, utilize a minimum of 10 gallons of cleaning fluid in each compartment.

(d) Introduce cleaning fluid from the top of each compartment, such as by attaching a spinner ball or spray head to man-way on top of compartment. Attach the discharge hose to the discharge port of the compartment. Circulate the cleaning fluid through the discharge hose to the spinner ball or spray head. Repeat this for a minimum of 30 minutes. If there are multiple discharge ports, clean each discharge port (i.e., circulate the cleaning fluid through each discharge port during the cleaning process).

(e) After cleaning process is complete, discharge the cleaning fluid through the discharge hose to a proper container.

(f) After cleaning, check the compartment for residual product, emulsion, dirt, strong odor, or foreign debris. If compartment does not look clean, repeat flushing procedure.

(g) After cleaning, drain all discharge ports on the transport, including all manifold points of discharge and all internal valves opened, and check for residual product or diesel fuel. Slight elevation of the transport front will facilitate drainage. Total residual cleaning fluid remaining in the entire transport or tank must not be more than 5 gallons.

(h) Use a nitrogen or dry compressed-air blowdown.

1.5.1.2 Onboard Hose Cleaning

(a) Drain and flush all hoses used to deliver product with cleaning fluid. Inspect, and repeat as needed until clean.

(b) Drain cleaning fluid from hoses and blow dry with nitrogen or air.

1.5.1.3 Onboard Pump Cleaning

(a) Clean pump to be visibly free of dirt, water, or other contamination.

(b) Pump a minimum of 4 gallons of [approved oil][name brand (if justified) e.g. Mobil DTE, Shell Turbo T68]. Oil used for pump flushing may be of any viscosity.

1.5.2 DELIVERY HOSE REQUIREMENTS

Hoses must have a rated pressure of no less than 125 psi or 150 percent of the relief valve setting on the delivery pump system, whichever is greater. Delivery hose must be not less than 2 inches in nominal diameter. Hoses must be cleaned by a rag or pig to remove any loose visible contamination including dirt, sludge, varnish, lint, metal or any other visually observable debris. Before connecting the hoses allow the Government to visually check to confirm that the cleaning has occurred.

[1.5.3 FILTRATION PROCEDURE(S)

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NOTE: There is good evidence that filtration does eventually remove anti-foam additives from the oil regardless of the method used. Certainly it is preferable to filter oil that is above 50 degrees F and relatively dry. All other things being equal, higher flow rates seem to be beneficial in slowing removal of anti-foam additives. See also notes at paragraph PROPERTIES and paragraph DEGRADATION.

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Submit filtration procedure(s) no later than 30 days prior to filtering any oil. Procedures must follow oil manufacturer's recommendations and must include, but not be limited to, flow rates, temperatures, and filter information such as manufacturer, media, micron & Beta ratings. As applicable, differentiate between procedures for pre-delivery filtration at Contractor facility, pre-delivery filtration in delivery truck, onsite filtration in Contractor-provided temporary storage tank, and filtration during delivery through a filter cart.

]1.5.4 OIL SAMPLING PLAN

Obtain all samples per ASTM D4057 or ASTM D4177. See also paragraph OIL TESTING AND SAMPLES. Submit for approval an oil sampling plan including but not limited to the following:

(a) Description of method of delivery (e.g. truck capacity, number of compartments) and onsite storage (e.g. Contractor-provided temporary double-walled storage tank) for each delivery of [_____] gallons of new [approved oil][name brand (if justified) e.g. Mobil DTE, Shell Turbo T68].

(b) Procedure to take oil samples for acceptance testing and for the Government (e.g. truck driver will pull sample with equal parts of oil coming from each oil compartment, with Government witness, and will label the container with the date and product name).

Procedure to provide clean sample bottles to the Government for in-service oil from [_____] Power Plant for compatibility testing (e.g. shipped directly from testing lab).

1.5.5 OIL SPILL PREVENTION PROCEDURE

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NOTE: A spill prevention RESPONSE plan (who to call, cleanup) should also be submitted per the environmental specification complying with site specific environmental concerns and requirements. Any other requirements or plans per the environmental specification or PDT's ECC should also be submitted. Compliance with the Clean Water Act is a HIGH priority.

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Submit an Oil Spill Prevention Procedure no later than 30 days prior to delivery, including but not limited to containment around the delivery truck, product data for oil spill prevention materials to be brought onsite, planned placement of oil socks/diapers, taping plastic around any hose connections, and plugging any drains being crossed by the hoses. The work must also include spill prevention for the truck, hoses, and any temporary storage tanks through which the oil is delivered, stored, and removed. Spill prevention must be in compliance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. Spill prevention must be set up and observed by the Government prior to delivering or removing any oil.

1.6 OIL VENDOR QUALIFICATIONS

Submit qualifications certifying that the oil vendor:

(a) Is an Authorized Distributor of [approved oil][name brand (if justified) e.g. Mobil DTE, Shell Turbo T68], as indicated either on the distributor locator website or by a letter from [oil manufacturer][ExxonMobil][Shell][Chevron]

(b) Can prove through other documentation such as manifests, chain-of-custody documentation, and/or a letter from [oil manufacturer][ExxonMobil][Shell][Chevron], that the oil being provided is the exact name brand specified, AND;

(c) In addition to a or b, also has the ability to provide consistent timely turnaround on oil sample test results, as evidenced by a contracted relationship with, or a letter of commitment from, a qualified testing lab or labs.

PART 2 PRODUCTS

[2.1 INITIAL COMPATIBILITY TESTING

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NOTE: As was noted above, compatibility between new oil and in-service oil must be evaluated and determined by lab testing. Only oils found to be compatible may be mixed with in-service oil or used as replacement oil. The compatibility testing is necessary, even when both base oils are mineral oils such as Group 1 and Group 2 oils, because the new oils currently readily available on the market may have been formulated with different additives, which may not be fully compatible with additives of the in-service oils. Compatibility testing for oil purchases of any significant volume is necessary even when replacing in-kind, as formulas change over the years. This paragraph is included in brackets in case the decision has been made to have initial compatibility testing performed by the Contractor. "Equivalency" of another product cannot be established without repeating all of this testing, because oil manufacturer's additive package "recipes" are proprietary. If there is a need to switch from one new oil to another new oil mid-way through the contract (for instance due to manufacturer stopping production of original product), this testing must be conducted between new oil #1 and new oil #2 as well as between new oil #2 and the in-service oil.

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Do not purchase any oil, other than in quantities required to perform testing, prior to Government approval of initial compatibility testing results from an approved independent oil testing laboratory. Coordinate with the Contracting Officer to provide sample container(s) to the proper address and to have sample(s) of in-service oil shipped to the laboratory for evaluation of compatibility between the two oils. Perform compatibility evaluation in accordance with ASTM D7155, including the following tests for each of the seven mixtures listed below:

From Tier 1 Visual Appearance, all tests.
From Tier 2 Interfacial Properties, all tests.
From Tier 3 Physical/Chemical Properties, ASTM D445 or ASTM D7042, and ASTM D664 or ASTM D974.
From Tier 4 Performance Properties, ASTM D2272, ASTM D665, [and ASTM D130][ASTM D130, and ASTM D4310].

Oils which fail to demonstrate compatibility with the in-service oil at [_____] Powerhouse per ASTM D7155 will not be approved for purchase. Perform all the tests listed above with each of the following seven ratios:

100 percent new oil to 0 percent in-service oil
95 percent new oil to 5 percent in-service oil
90 percent new oil to 10 percent in-service oil
50 percent new oil to 50 percent in-service oil

10 percent new oil to 90 percent in-service oil
5 percent new oil to 95 percent in-service oil
0 percent new oil to 100 percent in-service oil

Do not purchase any oil other than the exact name brand of oil which has been approved by the Government as being compatible with in-service oil. No "equivalent" products are acceptable for this requirement.

][2.2 CERTIFICATION OF BRAND NAME PRODUCT

Submit certification such as a letter with the manufacturer's certificate of analysis, Product Data Sheet (PDS), and Material Safety Data Sheet (MSDS) attachments that the product to be delivered per these specifications is the exact brand name specified. No "equivalent" products are acceptable for this requirement.

]2.3 GENERAL REQUIREMENTS

2.3.1 Properties

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NOTE: In recent years, it has become apparent from test results that filtering oil to the desired cleanliness levels DOES remove anti-foam additive. Cleanliness levels are more important than foam for equipment life. It may be necessary to check whether oil level sensors are susceptible to false readings in case of foam (e.g. ultrasonic, laser). Removal of anti-foam additive affects the foam "tendency", meaning how much foam is formed, but should not significantly affect foam "stability", or how long the foam lasts. Therefore, if the Contractor is to filter new oil, the foam tendency test results must be FIO (though the foam stability test results are still "G"). If the Contractor is not required to filter new oil prior to delivery, then the foam tendency results are "G" (as well as the stability results) but the cleanliness and water content results are FIO.

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Provide turbine oil which is a blend of virgin petroleum-based stocks plus additives, free of [zinc and]chlorine, resulting in high-grade turbine oil having anti-rust and anti-oxidation properties suitable for use in hydraulic turbines, generator bearings, Kaplan turbine hubs and related applications. Chemical and physical characteristics of oil must meet or exceed the requirements listed in TABLE 1, [with the exception that foam tendency results are FIO][with the exception that cleanliness and water content results are FIO]. Determine oil characteristics by tests conducted in accordance with the tests methods as noted in the table.

2.3.2 Chemical And Physical Characteristics

The turbine oil must conform to the requirements established in TABLE 1 when tested according to the standards indicated. Submit certified test data showing that the oil meets or exceeds characteristics values specified in TABLE 1.

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NOTE: This table must be tailored depending on the actual oil chosen, in particular with respect to the RPVOT value and Acid Number. If there is a wide range of allowable turbine oils, add a requirement that the values for these characteristics must be within either 10 percent of the manufacturer's published value or within the manufacturer's quality control limits (in case values are not published) for new, unused oil.

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TABLE 1: CHEMICAL AND PHYSICAL CHARACTERISTICS REQUIREMENTS AND TEST METHODS FOR RUST AND OXIDATION (R&O) INHIBITED ISO 68 & 100 TURBINE OILS

Chemical and Physical Characteristics	**Requirements ISO 68 Oil**	**Requirements ISO 100 Oil**	**Test Method**
Viscosity at 40 C, centistokes (cSt)	65 - 70	95 - 102	ASTM D445 or ASTM D7042
Viscosity Index, minimum	98	95	ASTM D2270
Flash Point, minimum, C (F)	204 (400)	210 (410)	ASTM D92
Pour Point, maximum, C (F)	-9 (16)	-9 (16)	ASTM D97
Acid Number (AN) mg KOH/g, maximum	0.15	0.15	ASTM D664 or ASTM D974
Oxidation Stability by Rotating Pressure Vessel Oxidation Test (RPVOT), minutes, minimum	500	500	ASTM D2272
Rust Preventive Characteristics, Procedures "A" and "B"	Pass	Pass	ASTM D665
Water Content, parts per million (ppm), max	100	100	ASTM D6304
Water Separability of Petroleum Oil	40-40-0 (30)	40-40-0 (60)	ASTM D1401
Corrosion from Oil by Copper Strip Tarnish Test	Class 1	Class 1	ASTM D130
Foaming characteristics after 5 minutes blowing period:			
Sequence 1, foam volume in ml, maximum	100	100	ASTM D892 (Option "A" excluded) NOTE: These numbers are the foam "tendency" results.
Sequence 2, foam volume in ml, maximum	50	50	
Sequence 3, foam volume in ml, maximum	100	100	
Foaming characteristics after 10 minutes settling period:			

TABLE 1: CHEMICAL AND PHYSICAL CHARACTERISTICS REQUIREMENTS AND TEST METHODS FOR RUST AND OXIDATION (R&O) INHIBITED ISO 68 & 100 TURBINE OILS

Chemical and Physical Characteristics	**Requirements ISO 68 Oil**	**Requirements ISO 100 Oil**	**Test Method**
Sequence 1, foam volume in ml, maximum	10	10	ASTM D892 (Option "A" excluded) NOTE: These numbers are the foam "stability" results.
Sequence 2, foam volume in ml, maximum	0	0	
Sequence 3, foam volume in ml, maximum	10	10	
Air Release Properties, minutes, max.	30	60	ASTM D3427
Cleanliness, Reported per ISO 4406 as Iso Code Particle Count, for particles greater than 4, 6, and 14 m (c)	17/15/12(c)	17/15/12(c)	ASTM D7647 (ISO 11171 Cal)
Appearance	Clear and Bright	Clear and Bright	Visual Observation

2.4 DEGRADATION

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NOTE: In recent years, contracts for turbine oil replacement have required that the Contractor deliver oil to 17/15/12 cleanliness, and also test delivered oil for properties & characteristics. Results from this have shown that filtration will affect "foam tendency" significantly due to removal of anti-foam additives (especially if oil is filtered with high water content). But even though the removal of anti-foam additives will tend to allow more foam to be generated (tendency), that foam should still subside when the oil is at rest - in other words, "foam stability" should NOT be significantly affected by the removal of the anti-foam additive.

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The physical and chemical properties of the oil, with the exception of foam tendency, must not be degraded (changed from the specified values) by filtration through two-micron mechanical type filters, by centrifugal purification, two-micron coalescing filters, balanced charge agglomeration or by vacuum type purifier, all of which have been designed for turbine oil.

2.5 HOMOGENEITY

Additive agents must remain uniformly distributed throughout the oil at all temperatures above the pour point and up to 120 degrees C 250 degrees F. When the oil is cooled below the pour point, it must regain homogeneity while standing at temperatures of 5 degrees C 10 degrees F above the pour point, and retain clear and bright appearance.

PART 3 EXECUTION

3.1 OIL TESTING AND SAMPLES

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NOTE: Actual testing plans, pre-advertisement, pre-award, and/or during contract, can vary depending on the details of the situation. Please consult with the proponent.

Due to the cost to perform testing on oil, it is recommended to provide an estimate to the number of tests required throughout the life of the contract.

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3.1.1 Data of Chemical and Physical Characteristics, Per Delivery

As a rough estimate for information only, [_____] of these submittals are expected to be required overall.

Furnish certified test data, for the [approved oil][name brand (if justified) e.g. Mobil DTE, Shell Turbo T68], showing results for all the values specified in TABLE 1. The certified test data must be submitted for approval within five business days after the delivery unless otherwise approved. This testing is required for each delivery of oil; differentiate the submittals using an identifier such as a delivery date and powerhouse name. A new submittal is required for each delivery.

3.1.2 Compatibility Testing Results, Per Delivery

As a rough estimate for information only, [_____] of these submittals are expected to be required overall.

Furnish certified test data, showing compatibility results for each delivery of oil per ASTM D7155 Tier 1, visual rating, using blends of in-service oil and new oil the ratios 100/0, 90/10, 50/50, 10/90, 5/95 and 0/100; include results for all six samples (the two "neat" oil samples and the four mixtures). Each compatibility test requires a sample of the powerhouse's in-service oil, which will be furnished by the Government, in a Contractor-furnished one-gallon sample container. Use one gallon of new oil from each delivery, which is a blend of oil from each container used in the delivery, e.g. if oil is delivered by a tanker truck with one extra tank, the gallon used for this testing should be half from the truck and half from the extra tank. The certified test data must be submitted for approval within ten business days after each delivery of oil unless otherwise approved. This testing is required for each delivery of oil; differentiate the submittals using an identifier such as a delivery date and powerhouse name.

3.1.3 One Gallon of Oil From Each Onsite Tank or Truck

As a rough estimate for information only, [_____] of these one-gallon samples are expected to be required overall.

Submit a one-gallon sample of the oil from each container in the truck at each delivery. Sample is to be obtained in a manner specified in ASTM D4057 or ASTM D4177. Contractor may submit a single gallon of evenly mixed oil from all containers if desired - e.g. if oil is delivered by a tanker truck with one extra tank, a single gallon, comprised of a half-gallon from the truck, and a half-gallon from the extra tank, may be submitted rather than two separate gallons. This sampling is required for each delivery of oil; differentiate the samples using an identifier such as a delivery date on the sample container.

[3.2 FILTRATION

In all cases, including at Contractor's facility if applicable, warm oil to a minimum of 50 degrees Fahrenheit prior to filtration.

]3.3 DELIVERY OF NEW OIL

Deliver new oil in accordance with specifications and in coordination with the Contracting Officer for the delivery schedule. Spill prevention must be set up and observed by the Government prior to delivering any oil.

3.3.1 Oil Delivery and Removal Procedure

[Coordinate with the Contracting Officer regarding best location for oil delivery and removal trucks onsite.][Park oil delivery and removal trucks as close as possible to the oil fill/discharge cabinet in the erection bay.][Use a filtration cart with calibrated particle counter during each oil delivery. Deliver new oil at a minimum of 50 degrees Fahrenheit through the filtration cart.]Submit a detailed Oil Delivery and Removal Procedure for new oil deliveries and for the used oil removal[, including but not limited to product data on the filtration cart, product data on the filters themselves, product data on the particle counter, and calibration certificate for the particle counter per ISO 11171]. Include details regarding how used oil will be removed and disposed of. Set up oil delivery truck inside erected truck spill containment. Set up spill containment for the hoses prior to connecting and routing the hoses. All spill prevention equipment and provisions must be approved by the Contracting Officer prior to delivering oil. Take samples at each delivery of new oil as specified herein.

3.3.2 Chain of Custody, Per Delivery

Upon delivery of oil, provide a chain of custody report that includes documentation such as the bill of lading. Reports must track the oil, referenced by its batch number, from its origin to final delivery signed and dated by a designated representative. In the event of a failed compatibility test, this will be used to investigate when the oil was contaminated. Submit chain of custody at each delivery; use dates to differentiate among submittals.

3.3.3 Certification of Clean Oil Delivery Truck, Per Delivery

As a rough estimate for information only, [_____] of these submittals are expected to be required overall.

Prior to pumping oil into a powerhouse, submit certification that the truck used for that particular delivery was cleaned per the approved procedure, and that only [approved oil][name brand (if justified) e.g. Mobil DTE, Shell Turbo T68] has since been introduced into the truck. [This may be submitted electronically at the time the truck is being filled with oil for this contract, or may be submitted physically at the time of delivery.] Note that rejection of truck cleanliness constitutes rejection of oil delivery, unless otherwise approved in writing by the Contracting Officer.

[3.3.4 Temporary Onsite Oil Storage

Provide means of temporary new oil storage to hold approximately [_____] gallons of new oil or leave oil truck tankers on site as new oil storage while compatibility testing is performed. Provide means of temporary used oil storage to hold approximately [_____] gallons of used oil, and remove used oil once the Project is ready to dispose of it. Oil containment measures must be provided with any form of temporary storage except in the instance of a double-walled tank. Coordinate with Project personnel for staging locations.

Upon Government approval of oil delivered to temporary onsite storage, pump approved oil into the Government's storage tank.

]3.4 INSPECTION AND ACCEPTANCE

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NOTE: The Corps' Districts/Projects may perform Quality Assurance (QA) tests on samples taken at the delivery point. The QA tests should include, as a minimum, the viscosity, acid number, elemental spectroscopy, and oxidation stability. Any of the other tests in TABLE 1 are beneficial and should be considered in addition to the minimum QA tests. Samples should be taken from each bulk shipment and from not less than 10 percent of the drums taken at random from drum shipments. Such samples should be not less than 4 L 1 gal, which may be stored in more than one sample container, and a portion of each sample should be saved for later confirmation tests in the event that the results from the first tests indicate that the oil does not meet the specification requirements.

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At the point of oil delivery, the Government will obtain samples in a manner specified in ASTM D4057, and may perform such tests as are deemed necessary to determine whether the oil meets compatibility requirements as well as the specifications values listed in TABLE 1. The delivered oil must remain in a storage tank (if applicable) and cannot be used until the test results are received from the laboratory. Should the oil fail to meet requirements, or show results incompatible with being the specified name brand required, or be so contaminated at the delivery point that it fails compatibility testing with in-service oil, the Contractor is responsible for removing oil[, cleaning Government tanks used to store that oil,] and disposing of the rejected oil and replacing the oil at no additional cost to the Government, within 3 months of initial delivery.

[3.5 TANK CLEANING

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NOTE: Do NOT permit the use of any detergents in cleaning tanks, or any turbine oil-containing equipment. Do NOT permit the use of engine oil either, because engine oil is HIGHLY additized, including detergents and dispersants that will contaminate the turbine oil. Even pipe dope, cosmoline, and other common substances or residues on piping equipment should be prevented from

contaminating turbine oil-containing equipment. Any of the cleaning fluids allowable per paragraph OIL DELIVERY TRUCK [AND TEMPORARY CONTRACTOR-PROVIDED CLEAN OIL STORAGE TANK]CLEANING METHODS is acceptable as an interim measure, but the final cleaning should be with lint-free absorbent rags.
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[In the event that new oil was allowed to be stored in the Government's storage tank at the power plant, and that oil subsequently fails to meet criteria and is rejected by the Government, clean the Government tanks after removal of rejected oil.

][Clean the two xx,xxx-gallon transformer oil storage tanks.][Clean the xx,xxx-gallon Clean Lube Oil Storage Tank prior to any oil deliveries.][Clean the xx,xxx-gallon Dirty Lube Oil Storage Tank after all used oil has been removed from the powerhouse.]Tanks must be thoroughly manually cleaned by the Contractor. The Contractor is to physically clean and wipe out all residues from the tanks using oil-absorbent and lint-free cloths to remove all visible dirt, varnish, and debris, to the point that no residual contamination can be detected on clean lint-free white cloths. If desired, the Contractor may propose for the Contracting Officer's approval, use of their own equipment other than cloths as a first cleaning, such as a vacuum, squeegee system or pump. This may be necessary to remove oil from the very bottom of tanks. Detergents may NOT be used. Engine oil (which is highly additized including detergents) may NOT be used at all, not even on rags used to clean the tank. In any case, the final cleaning must be performed manually with oil absorbent and lint-free cloths. In this process, coordinate work with the Contracting Officer, perform all work in accordance with [SECTION 01 11 01.00 XX SUPPLEMENTARY REQUIREMENTS], and comply with all confined space requirements and procedures. The plan must be a complete plan in accordance with 29 CFR 1910 and EM 385-1-1. Cleaning of tanks is to be considered completed when inspected and approved by the Contracting Officer.

]3.6 REMOVAL OF USED OIL

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NOTE: Removal of used oil typically requires about a week's notice. The truck used to remove oil is typically completely separate from the delivery truck, and is subcontracted out. It is desirable for the contract to have flexibility regarding the total number of truckloads to be removed, and to allow for a final oil removal with less than a truckload, which will affect pricing for that load.
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Remove and properly dispose of up to [_____] 8,000-gallon truckloads of used oil from the Powerhouse. With the truck parked inside the powerhouse as close as possible to the oil [supply/discharge cabinet connections][storage tanks] as directed by the Government. Approximately [_____] gallons at a time of existing used oil will be pumped to the truck. Dispose of oil offsite in accordance with applicable laws and regulations. Coordinate with the Government prior to arriving on-site for final staging locations.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-48 14 00 (May 2017)**

Preparing Activity: AFCEC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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DIVISION 48 - ELECTRICAL POWER GENERATION

SECTION 48 14 00

SOLAR PHOTOVOLTAIC SYSTEMS

05/17

PART 1 GENERAL

PART 2 PRODUCTS

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-48 14 00 (May 2017)**

Preparing Activity: AFCEC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 48 14 00

SOLAR PHOTOVOLTAIC SYSTEMS
05/17

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NOTE: This guide specification covers the requirements for large scale solar photovoltaics (PV) systems, and related equipment and materials. Large scale is considered greater than one megawatt capacity and grid connected.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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NOTE: Show the following information on the project drawings:

1. Mounting surface features.

2. Locations of solar PV modules, inverters, combiner and junction boxes, conduits and raceways, and other related equipment and materials.

3. Circuit wiring diagram of solar PV system.

4. Troubleshooting instructions.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-10	(2010; Errata 2011; Supp 1 2013) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2024b) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM E772	(2015; R 2021) Standard Terminology of Solar Energy Conversion
ASTM G173	(2003; R 2012) Standard Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37 Degree Tilted Surface

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 80	(2013) Guide for Safety in AC Substation Grounding
IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 242	(2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE 1547	(2018) Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
IEEE 1547.1A	(2015) Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems -- Amendment 1
IEEE 1547A	(2020) Standard for Interconnecting Distributed Resources with Electric Power Systems - Amendment 1
IEEE C2	(2023) National Electrical Safety Code
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

ANSI IEC 60529	(2020) Degrees of Protection Provided by Enclosures
IEC 61215	(2005; ED 2.0) Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval
IEC 61646	(2008; ED 2.0) Thin-Film Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval
IEC 62446	(2018) Photovoltaic (PV) Systems - Requirements for Testing, Documentation, and Maintenance - Part 1: Grid Connected

	Systems - Documentation, Commissioning Tests and Inspection

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-501-01	(2015; with Change 2, 2023) Electrical Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

UL SOLUTIONS (UL)

UL 96	(2016; May 2023) UL Standard for Safety Lightning Protection Components
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 1741	(2010; Reprint Jan 2015) UL Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
UL 2703	(2015; Reprint Jul 2023) UL Standard for Safety Mounting Systems, Mounting Devices, Clamping/Retention Devices, And Ground Lugs For Use With Flat-Plate Photovoltaic Modules And Panels
UL Subject 3703	(2011; Edition 2014) Outline of Investigation for Solar Trackers

1.2 RELATED REQUIREMENTS

****

NOTE: Include Section 26 08 00, APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.

****

[Section 26 08 00, APPARATUS INSPECTION AND TESTING apply to this section with additions and modifications specified herein.

]

****

NOTE: To expedite interconnection and activity, solicit local utility point of contact, if known.

****

Coordinate with local utility interconnection and activity. [Point of contact [_____].]

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in the IEEE Stds Dictionary.

b. Unless otherwise specified or indicated, solar energy conversion terms used in these specifications, and on the drawings, are as defined in ASTM E772.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S"

classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Permits are assumed to be obtained by firm holding design responsibility. Ensure this is clarified in contract bid package.

****

SD-01 Preconstruction Submittals

Commissioning Plan; G, [_____]

Commissioning Schedule; G, [_____]

SD-02 Shop Drawings

Site plan drawings; G, [_____]

Riser diagram and general notes; G, [_____]

Complete solar PV system components and interconnection wiring diagrams; G, [_____]

Shop Drawings; G, [_____]

Installation and Assembly Details; G, [_____]

SD-03 Product Data

Photovoltaic Modules; G, [_____]

Inverters; G, [_____]

Disconnect; G, [_____]

Combiner Boxes; G, [_____]

Monitoring equipment; G, [_____]

System wiring; G, [_____]

Ground mounting structure; G, [_____]

Sample warranty certificate; G, [_____]
Submit for all materials to be provided. Submit data sufficient to indicate conformance to specified requirements.

SD-05 Design Data

Design Calculations; G, [_____]

SD-06 Test Reports

Inverter startup tests; G, [_____]

Functional Performance Testing; G, [_____]

SD-07 Certificates

Materials; G, [_____]

Commissioning Agent Qualification; G, [_____]

Seismic Certification; G, [_____]

Wind Certification; G, [_____]

SD-08 Manufacturer's Instructions

Installation Instructions; G, [_____]

SD-10 Operation and Maintenance Data

Data Package 5

SD-11 Closeout Submittals

Solar Posted operating instructions; G, [_____]

Solar Training documentation; G, [_____]

Final Commissioning Report; G, [_____]

Warranty; G, [_____]

As-Built Drawings; G, [_____]

1.5 MAINTENANCE MATERIAL SUBMITTALS

Comply with requirements specified in Section 01 78 00 CLOSEOUT SUBMITTALS.

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 Drawings

Submit minimum of three (3) hard copies of drawings for government approval prior to manufacturing and equipment construction or integration. Submit shop drawings at a minimum of 11 by 17 inches in size using a minimum scale of 1/4 inch per foot, for the exception of drawings not requiring scale. Submit site plan drawings and riser diagram and general notes at a minimum of 24 by 36 inches. Submit Installation and Assembly Details at a minimum of 24 by 36 inches. Submit at minimum scale of 1/2 inch per foot for overview and 2 inches per foot for detail.

1.6.2.1 Product Drawings

Submit complete detailed product drawings for the solar PV system consisting of shop drawings and product data sheets. Include in the shop drawings [one][three] [four] wire diagrams, utility interconnection diagrams, switchboard and switchgear drawings layout and arrangement of PV modules, support and mounting mechanism, inverters, combiner boxes, AC and DC disconnects, equipment enclosures, conduits, monitors, meters, and all other accessories associated with the installation of the PV system. Provide equipment dimensions, weights and structural mounting details.

Provide design Calculations.Include nameplate data, size, and capacity of each PV module. Include all assumptions such as applicable wind speed, snow and seismic loads. Include applicable federal, military, industry, and technical society publication references.

1.6.2.2 Installation and Assembly Drawings and Details

Submit site plan drawings, components and interconnection wiring and general notes, and installation and assembly Details drawings prior to start of construction. Include sufficient detail on drawings for all parts of the work to enable the Government to check conformity with the requirements of the contract documents. Include in the site plan drawings: topographic and utility survey; bore logs; soils report; site plan(s); site construction details; structural drawings; structural construction details; site electrical plan; and site electrical construction details. Include in the installation and assembly drawings and details: parts lists; assembly drawings; interconnection wiring diagrams; wire and cable schedules; wire and cable termination schedules; instrument plan; instrument and control wire, conduit and cable schedules; instrument wire and cable termination schedule; control diagrams; control sequence of operation; seismic restraint details; and wind restraint details.

1.6.2.3 "As-Built" and Record Drawings

After completion of construction, submit As-Built Drawings prepared and certified by the construction contractor, showing in red ink, on-site changes to the original construction details and all underground utilities measured from field benchmarks, accurate to within 1" of centerline of the utility. Immediately record for inclusion into the as-built drawings all modifications to original drawings made during installation. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Prepare "as-built" on a minimum of 24 by 36 inches vellum using red ink.

After submittal and approval of "As-built" Drawings, submit Record Drawings, prepared and by the project engineer(s) and architect(s), of the original design drawings reflecting all design changes and contractor noted changes in the "As-Built" drawings.

1.6.3 Standard Materials and Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products with satisfactory commercial or industrial use for [2][_____] years prior to bid opening, and past performance documentation with consistent design and bill of materials. Include applications of equipment and materials under similar circumstances and of similar size. Where [two][_____] or more items of the same class of equipment are required, products will be from a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

Proof of compliance with requirements of UL, where material or equipment is specified to comply. The label of or listing in UL Electrical Construction Directory will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved nationally recognized testing laboratory (NRTL) equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters Laboratories may be submitted.

1.6.3.1 Alternative Qualifications

Products having less than a [2][_____]-year field service record will be acceptable if a certified record of satisfactory field operation of not less than [6,000][_____] hours, exclusive of the manufacturers' factory or laboratory tests, is furnished. These alternative qualifications do not apply to materials in Section 2.2 of Section 26 31 00 FACILITY-SCALE SOLAR PHOTOVOLTAIC (PV) SYSTEMS.

1.6.3.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than [3][_____] years prior to date of delivery to site, unless specified otherwise.

1.6.4 Operations and Maintenance Data

Submit operation and maintenance Data Package 5 in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein.

1.6.5 Commissioning Agents

Commissioning Agents Qualifications: Engage commissioning service personnel, that specialize in the types of inspections and tests to be performed.

1.6.6 Installers

Demonstrate that installers have successfully installed at least [four][_____] projects that, in aggregate, equal or exceed the size of the proposed project. Provide references for each of these referenced projects.

1.6.7 Qualified Testing Organization

Engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the solar PV system and equipment listed herein. The organization must be independent of the supplier, manufacturer, and installer of the equipment. The organization must be a First Tier Contractor.

The organization must have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of [5][_____] years. The organization must have a calibration program, and test instruments used to be calibrated in accordance with NETA ATS.

1.6.8 Permitting

The [Owner][Contractor] is responsible for obtaining all necessary development permits and regulatory and utility service provider approvals prior to construction.

The [Owner][Contractor] is responsible for obtaining all necessary electrical and building permits and inspections.

1.6.9 Training

Provide training by a factory trained instructor to provide full instructions to designated Government personnel in the operation, maintenance and programming of the specified systems and equipment. Include safety training for first responders including fire department[,][_____][and][_____] representatives.

Submit Training documentation along with the proposed training date[s], at least [14][_____] days prior to date[s] of proposed training course. Provide training session for [six][_____] personnel specifically oriented to installed equipment, system layout, and user operations.

1.7 DELIVERY, STORAGE, AND HANDLING

Store solar PV panel modules in the original packaging according to the manufacturer's guidance, and remain in packaging until day of installation. If a solar PV module is removed from its packaging, store according to the manufacturer's guidance. Do not store solar PV panel modules on-site for more than [12][_____] months.

1.8 WARRANTY

Warrant the overall system for both parts and labor for a minimum period of [5][_____] years. Provide the following component specific warranties:

a. Photovoltaic Modules: Minimum warranty period of 25-year for linear minimum output and 10-years for workmanship, material, visual, and manufacturing defects from the date of manufacture followed by an additional fifteen (15) years at not more than 20 percent power loss.

b. Ground Mounting Structure: Mounting structure system hardware to be free from defects in the material and workmanship for a minimum period of [10][_____] years.

c. Combiner Boxes: Combiner boxes to be free from defects in material and workmanship for a period of [5][_____] years.

d. Inverters: Inverters to be from defects in material and workmanship for a minimum period of [20][_____] years.

Provide a list of all applicable warranties for all equipment and components. Include warranty information, names, addresses, telephone numbers, and procedures for filing a claim and obtaining warranty services.

1.8.1 Inverter Software Upgrades

Provide and install, at no cost or charge, any inverter software upgrades that become available during the warranty period.

1.8.2 Warranty Exclusions

The warranty must cover all system malfunctions and failures except those resulting from misuse, abuse, neglect, fire, vandalism, acts of nature, or other causes beyond the control of the Contractor or manufacturer.

1.9 CERTIFICATIONS

Provide Seismic Certificationand Wind Certification, prepared by a licensed professional engineer or National Recognized Testing Laboratory, (NRTL) for all components and assembled systems in accordance with ICC IBC,ASCE 7-10 state and local building codes. Seismic and wind certifications must demonstrate system will withstand wind and seismic requirements as installed and remain remain online and functional after a seismic or wind event.

1.10 HEALTH AND SAFETY REQUIREMENTS

Section 01 35 26, GOVERNMENTAL SAFETY REQUIREMENTS applies to this section with additions and modifications specified herein.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide utility scale solar PV system feeding AC power to utility grid in accordance with IEEE 1547 and local utility regulations. The PV system must comply with these specifications, all applicable codes and standards, all construction documents, and all local authorities having jurisdiction.

Installation must consist of either a fixed-axis, single- or dual-axis utility scale-ground mount system. Tracking requirements must comply with local siting requirements regarding reflectivity restrictions and airspace safety requirements. Support structures must either be individual modules or where applicable, groups of panels configured for shade structures. Provide all necessary accessories for a complete, secure, and operational solar PV system. Commercial-grade and residential-grade rooftop systems are excluded from this UFGS.

2.1.1 System Requirements

2.1.1.1 System Characteristics

The system characteristics include [_____] minimum rated [kW][MW] DC output, [_____] minimum [kWh][MWh] AC per year, [_____] system voltage, and [fixed axis][tracking [one-][two-]axis] ground-mounted at full load rated power [1][_____] percent mean ambient summer operating temperature. Rate all electrical equipment for the current and voltage ratings appropriate for the application.

The system must be rated for outdoor installation. Provide system equipment capable of operating under the location's maximum and minimum documented temperatures during summer and winter times. The entire system must be rated and warranted to withstand and operate under these conditions.

2.1.1.2 Capacity Ratings

Specify rated PV system capacity in direct current (DC) [kilo][mega]watts peak under both Standard Test Conditions (STC) and Photovoltaics for

Utility Scale Applications (PVUSA) Test Conditions (PTC) ratings.

a. The STC rating assumes direct current referred as "[k][M]Wdc-STC". It is also referred as [kilo][mega]watts peak, or "[k][M]Wp". Specific PV module manufacturer maximum and minimum power data must be specified for this rating. The STC rating is based on 1,000 watts/m^2 solar irradiance, 25 degrees C cell temperature, air mass equal to 1.5, and ASTM G173 standard spectrum.

b. The PTC rating is based on 1,000 watts/m^2 solar irradiance, 20 degrees C ambient temperature and 1 meter/second wind speed at 10 meters above ground level.

2.1.1.3 System Wiring

****

NOTE: The possible exposure to a corrosive environment should be carefully examined. Even when the correct conductor size and the selected joining (connecting) method have satisfied all the IEEE 837 test requirements, it may be prudent to choose a larger conductor size to compensate for some gradual reduction in the conductor cross section during the design life of the installation where the soil environment tends to promote corrosion. Coordinate soil environment with Geotechnical Engineer.

****

System wiring [must conform to Section [_____] and]must be in accordance with Section 690 of NFPA 70. The conductors used must have a temperature rating of [90][_____] degrees C or higher and be sized according to the appropriate DC or AC voltage application. Cabling exposed to sunlight must be UV resistant. [All wiring must be copper conductor if Navy eventually takes ownership of system.]

[Provide conduits in accordance with Section [_____].]Use galvanized rigid steel conduit above grade and mount on UV resistant high-density polyethylene (HDPE) supports. Conduit below grade must be Schedule 40 PVC, minimum.

2.1.1.4 Site Design

Provide adequate space for personnel, vehicles and equipment throughout the PV array to facilitate installation, inspection and maintenance access to all modules.

2.2 PHOTOVOLTAIC MODULES

****

NOTE: Include in this section specifying CEC information and requirements for projects abiding by California Energy Commission.

****

Utilize PV modules with [crystalline silicon][ribbon sheet][thin film] technology and conform to Section 26 31 00 FACILITY-SCALE SOLAR PHOTOVOLTAIC (PV) SYSTEMS. Include bypass diodes with each PV module installed in the module junction box.

2.2.1 Compliance

The PV modules must comply with the Buy American Act[and must be listed on the California Energy Commission's PTC list][and must qualify for eligibility under the California Solar Initiative (CSI) Program]. The system must comply with IEC 61215 or IEC 61646.

2.2.2 Electrical Characteristics

Provide high-power type PV module(s), with typical peak power of not less than [315][] watts, +/- [3][_____] percent power tolerance, under Standard Test Conditions (STC). The AC output must not be less than [80][] percent of the DC kWp rating. The individual current harmonics and TRD are not to exceed the limits specified in IEEE 1547.

The operating voltage corresponding to the power output mentioned above should be at least [54][_____] volts. The open circuit voltage of the PV modules under STC should be at least [64][_____] volts. Operate PV module at an ambient temperature range of [minus 40][_____] degrees C[minus 40][_____] degrees F to [plus 85][_____] degrees C[plus 185][_____] degrees F with [100][_____] percent relative humidity.

2.2.3 Terminal Box

Include a terminal box on the module having a provision for opening for replacing the cable, if required.

2.2.4 Nameplate

Include the following on the module namplate so as to be clearly visible:

a. Name of the Manufacturer or distinctive logo;

b. Model or Type Number;

c. Serial Number;

d. Year of make;

e. Peak wattage rating;

f. Peak voltage; and

g. Peak current.

2.3 INVERTERS

Provide solid state type inverter unit capable of accepting the output of the photovoltaic panels and providing rated output as indicated. Provide the inverter with monopole, negative grounded, and positive grounded array configuration capabilities.

2.3.1 Listings

Provide inverter listed on the California Energy Commission's PTC list[and must qualify for eligibility under the CSI Program]. The inverter must be UL 1741 listed and conform to IEEE 1547A and NFPA 70 standards.

2.3.2 Ratings

Rate the inverter's output as [250][500][_____] kW, [600][1,000][_____] Vdc, 3 phase, [320-600][420-850][_____] maximum power point tracking (MPPT) voltage range. The peak inverter power conversion efficiency must be [95][97][_____] percent or greater.

Operate inverter at an ambient temperature range of [minus 20][_____] degrees C[minus 4][_____] degrees F to [plus 50][_____] degrees C[plus 122][_____] degrees F with [95][_____] percent humidity (non-condensing).

2.3.3 Safeties and Protection

Equip each inverter with the following safeties and Protection:

a. DC input disconnect;

b. Surge protection;

c. Ground fault interrupter;

d. Isolation transformer;

e. AC output disconnect; and

f. Data Monitoring Equipment/System.

The inverter must be able to sustain an overload across its output terminals up the [150][_____] percent load, while supplying any load within its rating and without reducing its output voltage. Fuse power semiconductors in the inverter with fast acting fuses to prevent cascading failures. Provide each fuse with a blown fuse and alarm indicating diodes on the control panel.

2.3.4 Features

Include each inverter with the following:

a. Automatic operation including start-up, shutdown, self-diagnosis, and fault detection;

b. Digital Signal Processor (DSP) based controls with self-diagnostics and [remote][local] display of operating status;

c. Over- and under-voltage and frequency protection, shutting down the inverter in compliance with UL 1741; and

d. Anti-islanding protection to prevent back-feeding inverter generated power to the grid in the event of a utility outage.

Provide inverter in [floor-mount][wall-mount][support structure mount], NEMA [1][3R][4][4X][6][6P], [steel][aluminum][stainless steel][polymeric] enclosure in accordance with NEMA 250.

2.4 COMBINER BOXES

Provide combiner box[es] in [wall-mount][pole-mount], NEMA [3R][4X][_____], [steel][aluminum][stainless steel] enclosure in accordance with NEMA 250. Include in the combiner box[es] fuses and a bus to combine the outputs of the strings. Each combiner box must be UL 1741 listed and operate at an ambient temperature range of [minus 25][_____] degrees C[minus 13][_____] degrees F to [plus 57][_____] degrees C[plus 135][_____] degrees F. Provide combiner box capable of at least [12][_____] inputs and an input fuse rating of [15][_____] amps. Include output circuit disconnecting means listed for intended use and purpose.

Provide combiner box output terminals for paralleling two conductors for the PV positive and negative, as well as the equipment ground conductors. Run set of wires from the combiner box to the inverter. Combiner output must be compatible with inverter input.

2.5 GROUND MOUNTING STRUCTURES

Provide array ground mounting structure for PV modules that provides the designed panel tilt. The mounting system must be [ground][tracking] mounting type [, [two][four] rails][, [one][two] axis], and be [UL 2703] and [UL Subject 3703] listed.

Design all structural components in a manner commensurate with attaining a minimum [30][_____] year design life. Array mounting hardware must be compatible with the site considerations and environment. Aluminum and stainless steel components and hardware are preferred.

2.5.1 Wind and Seismic Ratings

The mounting system and overall installation must be capable to withstand winds of Category [1][2][3][4] or [5] as defined by the Saffir-Simpson Hurrican Wind Scalefor all attachment points and consistent with the manufacturer's installation instructions. Provide wind certifications for all components and assemblies.

All structures and structural elements must be suitable for Seismic Design Category [_____] in accordance with UFC 3-301-01, ICC IBC, ASCE 7-10, and all other applicable building codes and standards pertaining to the erection of such structures.

2.6 CAST-IN-PLACE CONCRETE

Provide concrete foundations for ground mounting structural members as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and in accordance with manufacturer's recommendations.

Provide mounting assembly and connections where system is to be installed on a concrete structure.

2.7 METERING AND POWER MONITORING

Provide and install a revenue grade alternating current (AC) Interval Data Recording (IDR) meter, located on the output side of the inverter, complete with industry standard telemetry for communications with Ethernet, cellular or other common output capabilities. Meter must conform to the Owner's[, Navy's,] and Electrical Company metering requirements.[If the power is tied into the Navy's internal electrical grid, then advanced metering infrastructure (AMI) meters are to be installed. Provide new AMI meters that are compatible with installation's current AMI system.]

2.7.1 Meter Characteristics

The meter must be UL listed and have an operating temperature range of [minus 20][_____] degrees C[minus 4][_____] degrees F to [plus 70][_____] degrees C[plus 158][_____] degrees F with a humidity range of [95][_____] percent relative humidity (RH) non-condensing. Provide the meter conforming to ANSI C12.1.

Provide meter capable of measuring kWh, Demand, Instantaneous power, volts, amps, watts, VAR and VA per phase.

2.7.2 Power Monitorning System

[Provide and connect][Connect] meter to a power monitoring/data collection system recording solar production through Time of Use (TOU) increments applicable to the installation and utility standards, with a minimum [15][_____] minute intervals and [30][_____] day memory.

2.8 POSTED OPERATING INSTRUCTIONS

Provide posted operating instructions for solar PV system equipment laminated between thermoplastic sheets. After operating instructions are approved, install where directed.

2.9 MANUFACTURER'S NAMEPLATE

Provide on each equipment item, including PV panels, a nameplate bearing all manufacturer's information securely affixed in a conspicuous place. Nameplates exposed to weather are to be ASTM A240/A240MType 316 stainless steel with stamped engraving.

2.10 FIELD FABRICATED NAMEPLATES

****

NOTE: Use of the following paragraph where nameplates are fabricated to identify specific equipment designated on drawings.

****

Provide field fabricated nameplates in accordance with ASTM D709 as specified or as indicated on the drawings. Minimum size of nameplates is 25 by 65 mm 1 by 2.5 inches. Lettering is a minimum of 6.35 mm 0.25 inch high normal block style.

2.11 WARNING SIGNS

Provide clearly visible warning signs for arc flash protection in accordance with UFC 3-501-01 and NFPA 70E for all electrical equipment and components that are required to examine, adjust, service, or maintain while energized.

2.12 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS

Provide machine printed polyethylene cable tags for each cable entering or leaving manholes, handholes, and vaults. Do not provide handwritten tags.

2.13 GROUNDING AND BONDING

NFPA 70, IEEE 80, IEEE 142, IEEE 242, and IEEE C2, except that grounds and grounding systems must have a resistance to solid earth ground not exceeding 5 ohms.

2.13.1 Ground Rods

Provide ground rods made of [copper-clad steel] [solid copper] conforming to conform to UL 467 with minimum diameter of [19][_____] mm/[3/4][_____] in and length of [3][_____] m/[10][_____] ft.

2.13.2 Ground Plates

Provide grounding plates made of [copper-clad steel][iron][stainless steel][solid copper] conforming to UL 96.

2.13.3 Ground and Bonding Conductors

Equipment grounding conductors must be insulated stranded copper, except that sizes No. 10 AWG and smaller must be solid copper. Insulation color must be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger must be identified per NFPA 70NEC.

Bonding conductors must be bare stranded copper, except that sizes No. 10 AWG and smaller must be bare solid copper. Bonding conductors must be stranded for final connection to motors, transformers, and vibrating equipment.

2.13.4 Ground Connections

Below Grade and Inaccessible Locations: Exothermic-welded type connectors.

Above Grade:

a. Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs must use [zinc-plated][cadmium-plated] steel bolts, nuts, and washers. Bolts must be torqued to the values recommended by the manufacturer.

b. Connection to Building Steel: Exothermic-welded type connectors.

c. Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with [zinc-plated][cadmium-plated]/ steel bolts, nuts, and washers. Bolts must be torqued to the values recommended by the manufacturer.

d. Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with [zinc-plated][cadmium-plated] steel bolts, nuts, and washers. Bolts must be torqued to the values recommended by the manufacturer.

2.14 Lightning Protection System

Provide Lightning Protection System and components in accordance with Section 26 41 00 LIGHTNING PROTECTION SYSTEM.

PART 3 EXECUTION

****

NOTE: Use and coordinate paint and coating requirements with Section 09 90 00, PAINTS AND COATINGS when provided in the job. Use the second bracketed option when Section 09 90 00 is not provided or when requirements are beyond what is specified in Section 09 90 00.
****

3.1 INSTALLATION

3.1.1 Site Preparation

Prepare the site for system installation by removing vegetation, grading for adequate drainage and avoid standing water on site, and excavating and compacting foundations for individual module installation. Provide access roads, pathways, fencing and other improvements as necessary for site access and security. Provide vegetation barrier to keep surrounding area free from array-shading vegetation as required.

Provide walking and vehicle space throughout the PV array to facilitate installation, inspection, and maintenance access to all modules in accordance with NFPA 70 and IEEE C2. Maintain a minimum ground clearance of [3][_____] m[10][_____] ft 3 maround arrays. Maintain a minimum ground clearance of [1][_____] m/[3][_____] ft below arrays for all site-specific conditions including possible array-shading vegetation, ground/vegetation maintenance, and/or array-shading snowfall.

3.1.2 Equipment Installation

Install all equipment and all required wiring for a complete and operational system. Follow manufacturer's guidelines for the installation of the array components, including mounting hardware and PV modules. Provide required conductor terminations to devices for a complete system to function as specified and indicated. Complete installation must comply with all local building codes, manufacturer's instructions, and applicable industry standards.

3.1.3 Conductor Installation

Furnish and install conductors required to connect incoming and outgoing circuits. Install conductors with conduits, boxes, and terminal cabinets in a totally enclosed installation. Install buried cable per Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Comply with IEEE 1547 for interconnection with utility providers.Color-code all conductors per Section 26 05 19.00 10, INSULATED WIRE AND CABLE and as recommended by the equipment manufacturer.

Rate all enclosures for electrical connections and interconnections for [NEMA 6 in accordance with NEMA 250] or [IP67 in accordance with ANSI IEC 60529].

3.2 GROUNDING

Ensure PV system grounding installation is in accordance with NFPA 70 and IEEE C2.

3.2.1 Grounding Electrodes

Provide ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL

DISTRIBUTION. Connect grounding conductors to ground rods by exothermic weld[or compression connector].

3.3 FOUNDATIONS OF EQUIPMENT AND ASSEMBLIES

[Conduct soil borings and provide recommended foundation design by a licesened geotechnical engineer.] [Design foundation in accordance with foundation design recommenations.] Construct equipment foundations.

3.3.1 Ground Mounted Structures

Provide reinforced concrete foundations for ground mounted structures. Provide 4" reinforced concrete housekeeping pads for electrical equipment other than PV structures.

Provide excavating and backfilling in accordance with Section 31 00 00 EARTHWORK. Perform concrete work in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Coordinate provision of utility warning and identification tape with backfill operation. Provide tapes above buried lines at a depth of 8 to 12 inches below finish grade.

3.4 FIELD APPLIED PAINTING

Apply field painting as specified in Section 09 90 00 PAINTS AND COATINGS.

3.5 FIELD FABRICATED NAMEPLATE MOUNTING

Provide equipment nameplates as indicated.

3.6 WARNING SIGN MOUNTING

Provide the number of warning signs required to be readable from each accessible side. Locate and space signs in accordance with NFPA 70E.

3.7 CABLE TAG INSTALLATION

Install cable tags in manholes, handholes, and vaults as specified, including each splice. Locate tags over any fireproofing, if any, and clearly visible on cabling without disturbance in manholes, handholes, and vaults.

Identify and label all cables per NFPA 70.

3.8 [FACTORY SYSTEM TESTING]

[Provide testing of the complete system in accordance with IEEE 1547.1A. IEEE 1547 allows for type testing to be performed on complete systems, multifunction relays, discrete devices, or any combination. If type testing is performed on anything other than a fully integrated system, some of the component times may not be available. In these cases, production and/or commissioning tests must be conducted to fully demonstrate the ability of the complete system to comply with the timing required by IEEE 1547.]

3.9 FIELD QUALITY CONTROL

3.9.1 Manufacturer's Field Service

Provide the services of factory trained and approved field service engineer during system installation, testing and commissioning.

3.10 COMMISSIONING

****

NOTE: Sections 01 91 00.15 BUILDING COMMISSIONING, are intended for building systems, however, the basic requirements are applicable to PV comissioning processes. Section 01 91 00.15 will need to be tailored for PV systems when compiling project specifications.

****

Conduct Commissioning, after the system is installed and is ready for operation, in accordance with Section 01 91 00.15 BUILDING COMMISSIONING, item (6)renewable energy generation, to verify that the completed and installed system meets the requirements of IEEE 1547. Tailor for non-building systems.

3.10.1 Commissioning Agent Qualification

Individual qualified in testing protective equipment (e.g., professional engineer, factory-certified technician, licensed electrician with experience in testing protective equipment) must perform or directly supervise commissioning tests.

3.10.2 Commissioning Plan and Schedule

Develop and implement a commissioning plan and commissioning schedule in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

3.10.3 Start-up Pre-functional Checklists

Carry out a checklist of startup requirements and conduct a series of safety tests to ensure proper installation, safe operation, and performance conforming to specification.

3.10.4 Functional Performance Testing

Prepare test procedures and conduct functional performance testing of the installed system. Include the following test requirements:

a. All inverter startup tests as specified by the inverter manufacturer in the inverter operation manual;

b. Actual power;

c. Loss of grid;

d. Grid resume;

e. Data monitoring check out;

f. V_{oc} measurement of every source circuit and log it;

g. Verify tightness of all wiring terminations;

h. Verify proper markings and labeling of all wire terminations and enclosures;

i. Verify startup/shut down procedures;

j. Verify system [5][_____] minutes delay upon restart;

k. Verify PV array quick connectors are fully mated and wires are neatly secured;

l. Verify no debris on the modules, no damaged or broken modules;

m. Verification and inspections (see IEEE 1547.1 7.2)

n. Field-conducted type and production tests (see IEEE 1547 7.3))

o. Unintentional islanding functionality test (see IEEE 1547.1)

p. Cease-to-energize functionality test (see IEEE 1547.1)

q. Unintentional islanding functionality test (see IEEE 1547.1)

r. Cease-to-energize functionality test (see IEEE 1547.1 7.5)

s. Revised settings (see IEEE 1547.1 7.6)

3.10.5 Functional Performance Testing Results

Coordinate, observe and record the results of the functional performance testing. Coordinate retesting as necessary until satisfactory performance is verified. Verify the intended operation of individual components and system interactions under various conditions and modes of operation.

Document items of non-compliance in materials, installation or operation. Immediately address observed non-conformance and deficiencies in terms of notification to responsible parties, and provide recommended actions to correct deficiencies.

3.10.6 Final Commissioning Report

Prepare and submit final commissioning report. Summarize all of the tasks, findings, conclusions, and recommendations of the commissioning process in accordance with IEC 62446.. Include the results of all tests and a listing of the final settings.

3.11 FINAL ACCEPTANCE

The acceptance of the solar PV system occurs only after all deficiencies identified by the functionalacceptance tests and commissioing report are corrected[, and the system operates successfully during a [30][_____] day initial testing period].

The Contracting Officer must sign appropriate certificates, if equipment and systems are operating satisfactorily in accordance with the specifications, stating the system's operation has been tested and accepted at the end of the final start-up and testing.

3.12 CLOSEOUT ACTIVITIES

3.12.1 Demonstration

Demonstrate, upon completion of functional acceptance tests, that all circuits and devices are in proper operating condition and performing as intended.

3.12.2 Training

Furnish training service by a factory-trained representative for a period of [5][_____] calendar days. Document that each qualified employee has received the required training in accordance with 29 CFR 1910. Maintain all training documentation in a central location for the entire employee's employment duration. Minimum documentation data includes employee's name, training name, and date(s) of training.

-- End of Section --

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USACE / NAVFAC / AFCEC **UFGS-48 14 13.00 20 (May 2015)**

Preparing Activity: NAVFAC **Superseding**
UFGS-48 14 13.00 20 (November 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 48 - ELECTRICAL POWER GENERATION

SECTION 48 14 13.00 20

SOLAR LIQUID FLAT PLATE AND EVACUATED TUBE COLLECTORS

05/15

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC **UFGS-48 14 13.00 20 (May 2015)**

Preparing Activity: NAVFAC
Superseding
UFGS-48 14 13.00 20 (November 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 48 14 13.00 20

SOLAR LIQUID FLAT PLATE AND EVACUATED TUBE COLLECTORS

05/15

****

NOTE: This guide specification covers the requirements for medium-temperature (38-82 degrees C 100-180 degrees F), liquid-flat-plate or evacuated tube collector loop systems, heat storage tanks, pumps, controls and related equipment and materials.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

****

NOTE: Applications of the solar systems may be domestic hot water, space heating, swimming pool heating, process fluid heating, spa water heating, air conditioning for solar cooling and heating, agricultural process heating, or other commercial and industrial uses.

****

****

NOTE: The following information shall be shown on the project drawings:

1. Control equipment operation matrix.

2. Control operations sequence.

3. Details of soft-drawn copper-tubing connectors to top and bottom headers of solar-collector panel.

4. System diagram.

5. Panel array layout and locations.

6. System equipment locations.

7. Equipment piping details.

8. Mounting details.

9. Schedules in accordance with UFC 3-400-01, "Renewable Energy Systems - Facility".

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 93	(2010; Errata 2013; Errata 2014) Methods of Testing to Determine the Thermal

	Performance of Solar Collectors
ASHRAE 96	(1980; R 1989) Methods of Testing to Determine the Thermal Performance of Unglazed Flat-Plate Liquid-Type Solar Collectors

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023) Scheme for the Identification of Piping Systems
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2024) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2023) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding

ASTM INTERNATIONAL (ASTM)

ASTM A193/A193M	(2024a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications

ASTM A194/A194M	(2024) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B168	(2019; E 2022) Standard Specification for Nickel-Chromium-Iron Alloys, Nickel-Chromium-Cobalt-Molybdenum Alloy, and Nickel-Iron-Chromium-Tungsten Alloy Plate, Sheet, and Strip
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM D3667	(2016) Standard Specification for Rubber Seals Used in Flat-Plate Solar Collectors
ASTM D3832	(1979; R 2011) Standard Specification for Rubber Seals Contacting Liquids in Solar Energy Systems
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E822	(1992; R 2009) Standard Practice for Determining Resistance of Solar Collector Covers to Hail by Impact With Propelled Ice Balls
ASTM E1160	(2013; R 2021) Standard Guide for On-Site Inspection and Verification of Operation of Solar Domestic Hot Water Systems

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

SOLAR RATING AND CERTIFICATION CORPORATION (SRCC)

SRCC CRIS	(ongoing online) Certification Ratings Information Service (CRIS)
SRCC OG-100	(2015) Solar Thermal Collector Certification Program
SRCC OG-300	(2015) Solar Thermal System Certification Program
SRCC STD 300	(2015) Solar Thermal System Standard

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50561	(Basic) Pumps, Rotary, Power-Driven, Viscous Liquids
CID A-A-50568	(Basic; Notice 1) Gages, Liquid Level Measuring, Tank
CID A-A-59617	(Basic, Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections
CID A-A-60001	(Rev A) Traps, Steam
FS F-T-2907	(Rev A; Notice 1) Tanks, Portable Hot Water Storage

UL SOLUTIONS (UL)

UL 873	(2007; Reprint Feb 2015) Standard for Temperature-Indicating and -Regulating

Equipment

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Solar Energy Systems; G, [_____]

Include collector structural supports, solar collector control sequences, and instrument mounting and interconnections.

SD-03 Product Data

Piping; G, [_____]

Instrumentation; G, [_____]

Valves; G, [_____]

Piping Specialties; G, [_____]

Pumps; G, [_____]

Solar Storage Tanks; G, [_____]

Solar Collectors; G, [_____]

For the selected collectors, include test results per ASHRAE 93.

Heat Exchangers; G, [_____]

Compression Tanks; G, [_____]

Solar-Boosted Domestic Water Heaters; G, [_____]

Collector Heat Transfer Fluid; G, [_____]

Insulation Around Piping and Storage Tanks; G, [_____]

For each pump, include manufacturer's data including pump speed and characteristic impeller performance curves. Indicate capacity versus head, efficiency, and brake power for the full range from shut-off to free delivery.

SD-06 Test Reports

****

NOTE: Underground tanks are not a recommended method for thermal storage. A design with thermal storage within a building is more ideal for efficiency.

****

[Underground Solar Storage Tanks Holiday Test; G, [_____]

Submit a factory holiday test certificate for each tank.]

SD-07 Certificates

Solar Energy System Installation; G, [_____]

Submit technical representative's certification that the solar energy system installation has been done as recommended by the manufacturer.

SD-08 Manufacturer's Instructions

Solar Energy Systems; G, [_____]

SD-10 Operation and Maintenance Data

Solar Energy Systems, Data Package 3; G, [_____]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions for Solar Energy System; G, [_____]

1.4 QUALITY ASSURANCE

For brazing and soldering procedure qualification, conform to ASME B31.1; for preparation and procedures for joints, conform to ASME B31.1 and CDA A4015.

1.4.1 Operation and Maintenance Data

Submit Solar Energy Systems data package for the following items in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

a. Troubleshooting guide for solar energy systems

b. Solar collector warranty

c. Operation instructions

d. Preventive maintenance and inspection data, including a schedule for system operators.

e. Project drawings.

1.5 SOLAR COLLECTOR WARRANTY

****

NOTE: Warranties on Navy construction: Warranties for equipment, materials, or design furnished, or workmanship performed by the Contractor or any subcontractor or supplier, has a duration of one year from the date of final acceptance of the work. An exception is in normal commercial practice longer warranty period for particular construction are given.

A warranty duration of longer than a year, and not covered normally by the industry, requires a Level III Contracting Officer's written determination documenting that the extra warranty protection is needed.

The warranty clause for solar collectors in this guide specification has been approved by NAVFACENGCOM HQ in accordance with the requirements of the Naval Facilities Acquisition Supplement (NFAS). NFAS can be found at the following link: https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_forbusinesses_ **This clause may be used without any HQ approval or request for waiver.**

****

Furnish ten year manufacturer's warranty against defects in materials and workmanship.

1.6 POSTED OPERATING INSTRUCTIONS

Provide for piping identification codes and diagrams of solar energy systems, operating instructions, control matrix, and troubleshooting instructions.

1.7 HEALTH AND SAFETY RECOMMENDATIONS

Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS, applies to this section with additions and modifications specified herein.

PART 2 PRODUCTS

2.1 SOLAR ENERGY SYSTEMS

****

NOTE: SRCC OG-300 applies to residential and light commercial systems of 119 gallons or less. SRCC OG-100 applies to the collectors only.

****

[SRCC OG-300 listed] [SRCC OG-100 Collector certification], and provide necessary materials to fabricate solar energy systems in accordance with this section. At the Contractor's option, provide factory-prefabricated solar equipment packages which include heat exchanger, compression and storage tanks, pumps and controls and which meet the requirements of this section or are certified by an ANSI-accredited certification body to SRCC STD 300 or other applicable ANSI standard.

2.2 PIPING

2.2.1 Copper Pipe

ASTM B88MASTM B88, minimum Type L, hard drawn copper tubing, except that the connection tubes of collectors may be soft-drawn.

2.2.2 Bronze Flanges and Flanged Fittings

ASME B16.24.

2.2.3 Solder-Joint Fittings

ASME B16.22, wrought copper.

2.2.4 Unions

CID A-A-59617, solder joint.

2.2.5 Dielectric Union

Provide insulated union with a galvanized steel female pipe-threaded end and a copper solder joint end conforming to ASME B16.39, Class 1. Provide a dry insulation barrier, impervious to water and capable of withstanding a 600 volt breakdown test and limiting galvanic current to one percent of the short circuit current in a corresponding bimetallic joint.

2.2.6 Expansion Joints

2.2.6.1 Bellow Expansion Joints

****

NOTE: In corrosive atmospheric conditions such as oceanic air, use only nickel-chromium-iron alloy bellows.

****

Corrugated, [unreinforced] [or] [with [reinforcing] [or] [equalizing] rings], and [single-bellow] [double-bellow] expansion joints. Construct bellows of [copper alloy] [nickel-chromium-iron alloy, conforming to ASTM B168] [or] [stainless steel].

2.2.6.2 Guided Slip-Tube Expansion Joints

[Ring packing with seal to allow repacking under pressure][Permanent packless seal], [internally][internally and externally] guided, and [single][double] slip-tube. Provide drain port in the housing. [For packless seal, provide a Type 304 or 321 stainless steel bellows with laminated or multi-ply construction.]

2.3 VALVES

[Provide end connections as indicated.] Valves shall open when turned counterclockwise.

2.3.1 Gate Valves

MSS SP-80, bronze, Class 150; [Type 1, solid wedge non-rising stem] [or] [Type 2, solid wedge, inside screw rising stem]; with solder, threaded, or flanged ends.

2.3.2 Globe and Angle Valves

MSS SP-80, bronze, Class 150; [Type 1, metal disc integral seat] [or] [Type 2, non-metallic disc, integral seat]; with solder, threaded, or flanged ends.

2.3.3 Ball Valves

MSS SP-72 for flanged or butt-welding ends or MSS SP-110 for threaded, socket-welding, solder joint, grooved and flanged ends.

2.3.4 Balancing Cocks, Flow Rate Control and Meter

Bronze, solder, threaded, or flanged ends. Provide square head, flow indicator arc or check pressure ports for differential flow metering device. Provide valve construction with rating of 116 degrees C at 862 kPa 240 degrees F at 125 psi.

2.3.5 Check Valves

****

NOTE: When thermal siphon is a problem, such as an active flow indicator during nighttime or poor system performance, use only spring-loaded check valves with elastomer seals.

****

MSS SP-80, bronze, Class 150; [Type 3, swing check, metal disc to metal seat] [or] [Type 4, swing check, non-metallic disc to metal seat]. [Provide spring-loaded construction with elastomer seals.]

2.3.6 Water Pressure-Reducing Valves

ASSE 1003 with ASSE seal, self contained, direct acting, and single seat diaphragm.

2.3.7 Control Valves

UL listed. Provide valves actuated by electric motors. Construct valves to permit replacing valve seals without draining the system. Provide bronze body construction and stainless steel valve stems, with rating of 4 to 166 degrees C at 862 kPa 40 to 240 degrees F at 125 psi. Include external position indicators and steel enclosures to protect operating components.

2.3.7.1 Shutoff and Diverting Control Valves

Bronze valves with 100 percent shutoff, stainless steel butterfly or ball, and elastomer seats and seals.

2.3.7.2 Non-Shutoff Mixing Valves

ASSE 1017,MSS SP-25 marking modulating, [bronze] [or] [brass] body construction, stainless steel valve stems, and thermostatically controlled.

2.3.7.3 Valve Operators

Provide electric [two-position] [or] [proportioning] operators, with oil-immersed gear trains. Two-position operators may be single-direction with [spring-return] [or] [reversing] construction. [For [reversing] [and] [proportioning] operators, provide limit switches to limit the lever in either direction unless the operator is the stalling type.] Operators shall function properly with a 10 percent plus or minus change in the line voltage feeding the equipment. Totally enclose operators and gear trains in dustproof housings of pressed steel or metal castings with rigid conduit connections. Equip valve operators with a spring yield device so that when in the closed position it will maintain on the valve disc a pressure equivalent to the pressure rating of the valve.

2.3.8 Air Vents and Relief Valves

2.3.8.1 Air Vents

CID A-A-60001, float construction for pressures up to 862 kPa 125 psi.

2.3.8.2 Relief Valves

ASME labeled valves with a relief setting 200 percent higher than the normal operating pressure. Provide nonferrous or stainless steel valve seats and moving parts exposed to fluid, compatible with the operating conditions.

2.4 PIPING SPECIALTIES

2.4.1 Bolts and Nuts

Stainless steel; ASTM A193/A193M for bolts and ASTM A194/A194M for nuts.

2.4.2 Gaskets

****

NOTE: For cold weather region of below minus 10 degrees C 14 degrees F, consider gaskets made of rubber in accordance with ASTM D3667 (for flat plate solar collectors) or ASTM D3832 (for evacuated tube solar collectors), Type C.

****

[Fluorinated elastomers, ethylene-propylene-diene-terpolymer (EPDM) or silicone][ASTM D3667, Type C rubber][ASTM D3832, Type C rubber], compatible with flange faces.

2.4.3 Brazing Metal

AWS A5.8/A5.8M, 15 percent silver-base alloy, minimum melting point 816 degrees C 1,500 degrees F, for copper pipes rated at maximum 862 kPa and 177 degrees C 125 psi and 350 degrees F. Provide cadmium free filler metals.

2.4.4 Solder Metal

ASTM B32, Alloy Grade Sb5, Sn95, or Sn96, with minimum melting 221 degrees C 430 degrees F.

2.4.5 Strainers

Class 125; Style Y pattern; threaded or soldered ends, for 50 mm 2 inches and smaller; and flanged ends in accordance with ASME B16.1, for 65 mm 2 1/2 inches and larger.

2.4.6 Piping Identification Labels

Plastic slip-on or adhesive backed labels conforming to ASME A13.1.

2.4.7 Hangers and Supports

MSS SP-58.

2.5 [BOOSTER] [AND] [CIRCULATING] PUMPS

****

NOTE: If silicone based fluids are used, rotary pumps should be used to avoid seepage problems.

****

[Section 23 21 23 HYDRONIC PUMPS, centrifugal] [CID A-A-50561, rotary][; pump styles as indicated]. Provide flanged inlets and outlets, mechanical seals, flexible couplings, and electronically commutated motors (ECM). Select pumps to operate not more than 5 percent below and on the shut-off side of the maximum efficiency point of the impeller curve. Provide bronze or cast iron body construction, bronze or stainless steel fitted.

2.6 COMPRESSION TANKS

ASME BPVC SEC VIII, steel construction with ASME label for 862 kPa (gage) 125 psig working pressure. Hot-dip galvanize interior and exterior surfaces of tanks after fabrication. Provide cast iron or steel saddles or supports. Provide tanks with drain, fill, air charging and system connections, and liquid level gage.

2.7 SOLAR STORAGE TANKS

****

NOTE: Small mixing pumps and shrouds to enhance tube bundle heat exchanger performance in the tanks are an exception and should be used only where required. The corrosive nature of some water supplies may require copper lining. For better stratification (hot water on the top, cold water on the bottom), vertical solar tanks should be used. Up to 18,950 liters 5,000 gallon capacity, solar storage tanks may be unpressurized, internally stainless-steel-lined, factory insulated, and covered with enamel steel outer jackets for indoor applications or fiberglass jackets for outer and underground applications. Solar storage tanks, if intended for an usable life in excess of 5 years, should not be pressurized. Unpressurized stainless steel tanks should last in excess of 20 years; other unpressurized tanks should last up to 15 years; pressurized steel tanks with copper heat exchangers may last only 3 to 8 years, due to galvanic corrosion. Recommend 122 liters 3 gallons of storage capacity for each square meter foot of collector surface facing the sun.

****

Except as modified herein, FS F-T-2907; [stone lined (cement lined)] [glass lined] [stainless steel] [Type 18-8 stainless steel lined] [or] [baked-on phenolic] steel tank with ASME label for [862 kPa (gage)] [125 psig] [_____]. Do not use baffles or perforated pipes in tank construction. For the steel tank, include [collector loop heat-exchanger bundle] [and] [domestic hot water] [and] [space heating] heat-exchanger bundle.

2.7.1 Underground Tanks

UL listed,[double-walled,] fiberglass coated steel tanks. Provide exterior surfaces of steel tanks with a glass reinforced isophthalic polyester resin of sufficient thickness to resist 35,000-volt Holiday test. Provide automatic monitoring system with audible alarms to continuously monitor leaks.

2.7.2 Tank Insulations and Jackets

Comply with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Separate aboveground tanks from supports with insulation.

2.8 HEAT EXCHANGERS

****

NOTE: Where potable fluids are not used, double wall and vented construction provides fail-safe leak detection without attendance by any operator. If the operator is not present, sound alarms may not be heard, and visual indicators may not be observed in some cases. For many years, industrial applications commonly use shell-and-tube or tube-in-tube heat exchangers. In recent years, some industrial applications use plate-and-frame heat exchangers as options. Plate-and-frame construction requires much less space, i.e., from one tenth to one half of the space required by shell-and-tube construction. Plate-and-frame heat exchangers generally have high heat transfer rates. Electropolished stainless steel plates may be specified to minimize fouling. Titanium or nickel-brazed stainless steel heat exchangers should be used in spas due to high temperature water and high chlorination.

****

ASME BPVC SEC VIII, construction with ASME label for 1034 kPa (gage) 150 psig working pressure and 2068 kPa (gage) 300 psig factory-rating pressure. [Provide automatic monitoring system with audible alarms to continuously monitor leaks.] [Provide relief vent with a visual indicator to detect leaks by the change of coloring in the heat transfer fluid.]

2.8.1 Plate-and-Frame Construction

[Stainless steel] [or] [monel] plates and carbon steel frames, with baked epoxy-enamel, and shroud. Provide stainless steel side bolts and nozzles. Provide one piece molded [nitrile rubber] [ethylene-propylene rubber viton] [neoprene] [or] [butyl] gaskets. Fabricate heat exchangers with design results of heat transfer coefficients greater than 5680 watt per square meter degree C 1,000 Btu per square foot per hour per degree F.

2.8.2 [Shell and Tube] [or] [Tube in Tube] Construction

[Double wall vented], [straight tube] [or] ["U" tube] [as indicated]. Low temperature water [mixture] shall pass through tubes. High temperature water [mixture] shall pass through shells. Fabricate tubes from [16 mm 5/8 inch] [or] [20 mm 3/4 inch] od [stainless steel] [or] [seamless No. 20 BWG cupro-nickel (90-10)]. Provide tube bundles removable through flanged openings.

2.9 SOLAR COLLECTORS

****

NOTE: In accordance with ASHRAE 93 and ASHRAE 96, a solar collector is "a device designed to absorb incident solar radiation and to transfer the energy to a liquid passing through it." Use the liquid flat-plate collector for system design, including cooling applications up to 141 kW 40 tons. Use ASHRAE 93 for glazed collectors and ASHRAE 96 for unglazed collectors. The State of Florida requires all solar collectors to be certified by FSEC (Florida Solar Energy Center). If the project site is not in Florida and the state and local regulations do not prohibit FSEC certified

collector, the use of FSEC collector may be considered as an option. Provide lightning protection as required by the local environment. A collector in which the internal risers and headers are in a reverse return arrangement will have uniform flow and uniform heating, but it will be too restrictive to limit only this arrangement. When inlet and outlet tubes are not located conveniently on the collector, the collector will take up additional space, resulting in more exposed roof area between the collector.

****

[ASHRAE 93] [ASHRAE 96] [SRCC OG-100 and SRCC CRIS listed] [or] [Florida Solar Energy Center (FSEC) certified]; liquid flat-plate collectors and evacuated tube collectors. Provide factory fabricated and assembled, [single glazed] [double glazed] [triple glazed] [or] [unglazed] panels. [Internal manifold collectors may be used if manufacturer standard.] Include the following design features:

2.9.1 Collector Sizes

Maximum filled weight not to exceed 24.40 kg per square meter five pounds per square foot of gross collector area.

2.9.2 Minimum Performance Parameters

****

NOTE: In accordance with ASHRAE 93 and ASHRAE 96, instantaneous collector efficiency is "the amount of energy removed by the transfer liquid per unit of gross collector area during the specified time period divided by the total solar radiation incident on the collector per unit area (solar flux) during the same time period, under steady-state or quasi-steady-state (the state of the solar collector test when the flow rate and temperature of the liquid entering the collector are constant but the exit liquid temperature changes gradually due to the normal change in irradiation that occurs with time for clear sky conditions) conditions." Read ASHRAE 93 and ASHRAE 96 for further details and unit measurements.

****

Provide total collector flow rate in accordance with manufacturer's recommendations. Provide instantaneous collector efficiency as follows:

Minimum Instantaneous Collector Efficiency, Percent	Inlet Fluid Parameter
74	0
54	0.03
40	0.05

Determine inlet fluid parameter (IFP) in accordance with the following formula:

IFP = (A - B)/C

Where:

A = Liquid inlet temperature in collector
B = Ambient air temperature
C = Solar flux

2.9.3 Absorber

Fabricate of [aluminum] [stainless-steel] [copper tubes on copper sheet or aluminium] [or] [copper tubes with copper or aluminum fins]. Provide the absorber rated for [1034 kPa (gage)] [150 psig] [_____] with working pressure of [862 kPa (gage)] [125 psig][_____].

2.9.4 Absorber Plate Coating

Provide selective or semi-selective absorber coating with minimum absorptivity 0.90, maximum emissivity 0.12, and minimum breakdown temperature at [204 degrees C] [400 degrees F][_____].

2.9.5 Collector Case

Fabricate from at least 20 gage [galvanized steel] [or] [ASTM B209MASTM B209 alloy or equivalent aluminum]. Paint collector box with durable baked enamel or powder coat. In the back of case, provide insulation with a heat transfer factor of maximum 0.57 watts per degree C per square meter 0.1 Btu per hour per degree F per square foot. Use only insulation without out-gassing or other breakdown at or under stagnation temperature, such as rigid mineral fiber panels. Fabricate cover frame and glazing channel of [galvanized sheet steel] [stainless steel] [or] [extruded aluminum]. Provide preformed gaskets of EPDM or silicone as specified.

2.9.6 Collector Cover (Glazing Material)

ASTM C1048, Kind FT, fully tempered glass; Condition A, uncoated surfaces; Type I, transparent glass; Class 1, clear; Quality q3, glazing select; [3] [5] [or] [4] mm [1/8] [3/16] [or] [5/32] inch float glass.

2.9.7 Collector Identification

On each collector, provide the following information:

a. Manufacturer's name or trademark

b. Model name or number

c. Certifying agency label and rating.

2.9.8 Other Components

Provide collectors for the complete removal of internal moisture which may develop in the collectors. [Collector weep holes or desiccants with air vents may be used. If desiccants are used, provide 8 mesh silica gel with approximately 10,000 cycles of regeneration.]

2.9.9 Hail Protection

Manufacturer's hail protection performance measured according to ASTM E822, or equivalent.

2.10 COLLECTOR SUPPORTS

[As indicated.] [Provide a commercial integrated structural system, supplied by a single manufacturer, consisting of formed aluminum or galvanized or plated steel channels, perforated with round or square holes, and corrosion resistant brackets, clamps, bolts and nuts.]

2.11 COLLECTOR HEAT TRANSFER FLUID

****

NOTE: In lieu of the collector heat transfer fluid, the use of water in a drainback concept may be acceptable. Recommend to use only non-toxic heat transfer fluid.

****

Conform to the following:

a. Liquid useful temperature range of [-40] to [204][_____] degrees C [400][_____] degrees F.

b. Non-ionic, high dielectric, non-aqueous, non-reactive, stable fluid which does not corrode copper, aluminum, iron, or steel, or attack plastics.

c. Flash point exceeding 193 degrees C 380 degrees F.

d. Fluid stability of five years.

e. Maximum acute oral toxicity of 5 grams per kilogram 5000 ppm.

2.12 SOLAR-BOOSTED DOMESTIC WATER HEATERS

ASHRAE 90.1 - SIASHRAE 90.1 - IP and UL listed. Provide built-in [, double wall] heat exchanger and factory insulation jacket. Non-pressurized, vented, drainback systems may use single-wall heat exchanger.

2.13 INSULATION

Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.14 INSTRUMENTATION

Use corrosion resistant materials for wetted parts of instruments.

2.14.1 Solar Controller

UL listed. Solid-state or electrical only, with overvoltage protection.

2.14.1.1 Differential Temperature Control

Factory assembled and packaged device.

2.14.1.2 High Limit Control

Provide high temperature cut-off to limit upper half of the storage tank temperature to be [71] [82] [_____] degrees C [160] [180] [_____] degrees F.

[2.14.1.3 Swimming Pool Control

****

NOTE: Delete this paragraph if the project is not for a swimming pool.

****

Provide adjustable thermostatic setting to prevent pool overheating, with range from [13] [_____] to [29] [_____] degrees C [56] [_____] to [85] [_____] degrees F. Turn solar heater on when solar collectors are 2.77 degrees C 5 degrees F hotter than pool temperature. When pool temperature is above the thermostatic setting, drain water from the panels.

]2.14.1.4 Controller Enclosure

NEMA 250; Weathertight rated to NEMA 4X.

[2.14.2 Differential Thermostat

****

NOTE: Use this only in large systems, generally not residential. It is recommended that the differential thermostat be 4.40 degrees C 8 degrees F turn on and 1.70 to 2.80 degrees C 3 to 5 degrees F turn off.

****

Provide UL-listed differential thermostat for controlling the magnetic starter, not in the same circuit as pump motor. [For integral collector freeze protection, provide two independent contact relays [, rated ten amperes at 120 Vac].] [Provide a switch with ON, OFF, and AUTO positions.] Provide weathertight enclosures.

][2.14.3 Sensors

****

NOTE: Delete this paragraph if solar collectors are unglazed.

****

Construct sensors to withstand stagnation temperatures of glazed solar collectors. Provide primary and alternate collector sensors attached to an absorber plate. Provide [copper] [brass] wells which can be inserted into the collector tube, storage tank, or [_____]. Sensors may be strapped onto pipes and covered with insulation.

]2.14.4 Pressure Gages

ASME B40.100, brass body, and minimum 90 mm 3 1/2 inch diameter dial face.

2.14.5 Tank Gages

CID A-A-50568; Type [I, buoyant force;] [II, diaphragm;] [or] [III, purge, bubble-pipe].

2.14.6 Thermometers

ASTM E1, [liquid-in-glass type] [dial type, liquid-filled tube and bulb]. For pipe and tank applications, provide separate sockets fabricated of brass, copper, or stainless steel and rated for 862 kPa 125 psi working pressure.

2.14.7 Test Ports

Solid brass, 6 mm 1/4 inch fitting to receive either a temperature or pressure probe 3 mm 1/8 inch outside diameter, two valve cores of neoprene, fitted with color coded and marked cap with gasket, and rated for 6894 kPa (gage) 1,000 psig.

[2.14.8 Monitoring System

****

NOTE: For small systems such as family housing, do not use monitoring system, due to high initial cost and the labor to maintain it.

****

a. [Solar Differential Controller with] Kilojoule Btu Meter: [Controller conforming to UL 873 with] Sensing and Monitoring device to measure and display the heat energy produced by the solar system, with minimum sensitivity of 0.5 percent over the entire scale. Provide electromechanical kJ Btu counter plus digital-panel meter indicating sensor temperatures, differential temperature, flow rate, and watt Btu per minute or hour.

b. [Water] [and] [Heat Transfer Fluid] Leak Detection: UL-listed system consisting of a sensor probe, control panel, and LED indicators for [water; yellow,] [and] [heat transfer fluid; red,] with audible alarm at minimum 75 dB sound level; reference 10 exponential minus 12 watts.

][2.15 SOLAR COLLECTOR CONTROL SEQUENCES

As indicated.

]PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Solar Collector System

****

NOTE: Disinfect domestic water systems, if connected with solar collector panels. Provide disinfection provisions in either Section 22 00 00 PLUMBING, GENERAL PURPOSE or another appropriate project section.

****

Install the solar collector system in accordance with this section and the printed instructions of the manufacturer. [Disinfect domestic water systems, if connected with collector panels, in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.] Prior to system start-up, protect collector from direct sunlight.

3.1.2 Piping Installation

Accurately cut pipe to measurements established on site and work into place without springing or forcing. Locate piping out of the way of windows, doors, openings, light fixtures, electrical conduit, equipment, and other piping. Provide for expansion and contraction. Do not bury, conceal, or insulate until piping has been inspected, and tested. Locate joints where they may be readily inspected. Provide flexibility in piping connected to equipment for thermal stresses and vibration. Support and anchor piping connected to equipment to prevent strain from thermal movement and weight from being imposed on equipment. [Provide seismic restraints in accordance with SMACNA 1981.] Install hangers and supports in accordance with MSS SP-58, unless otherwise indicated.

3.1.2.1 Fittings

Provide long-radius ells wherever possible to reduce pressure drops. Do not bend pipes, miter pipe to form elbows, use bushings, or notch straight runs to form full-sized tees. Provide union for disconnection of valves and equipment for which a means of disconnection is not otherwise provided. Provide reducing fittings for changes of pipe size.

3.1.2.2 Measurements

Determine and establish measurements for piping at the job site and accurately cut pipe and tubing lengths accordingly. Where possible, install full pipe lengths. Do not use couplings to join random lengths.

3.1.2.3 Cleaning

Thoroughly clean interior of water piping before joining by blowing clear with either steam or compressed air. Maintain cleanliness of piping throughout installation. Provide caps or plugs on ends of cleaned piping as necessary to maintain cleanliness.

3.1.2.4 Panel Connections to Headers

Connect panels to top and bottom headers with soft-drawn long bend "S" or "U" copper tubes brazed with 15-percent silver solder. Provide tube bender only. Hand-formed tubing will not be acceptable. Install bottom headers behind the panels to protect the header insulation from abuse. For panels with internal headers, provide copper couplings and soldering.

3.1.2.5 Header Thermal Expansion and Contraction

Install slip tube or bellows type expansion joints. Limit thermal expansion of collector headers to [6] [_____] mm for 93 degrees C [1/4] [_____] inch for 200 degrees F maximum rise.

3.1.2.6 Flanged Joints

Provide flanged joints for making flanged connections to flanged pumps and other flanged piping components. Install joints so that flanged faces bear uniformly. Engage bolts so that there is complete threading through the nuts and tighten until bolts are equally torqued.

3.1.2.7 Sleeves

Provide schedule 10 galvanized steel sleeves for pipe and tubing passing through floors, roofs, walls and partitions of either concrete or masonry construction, except that sleeves are not required for floor slabs on grade. After piping has been installed, pack oakum into the space between the pipe or tubing and the sleeve and seal both ends with insulating cement.

3.1.2.8 Flashing

[Section 07 60 00 FLASHING AND SHEET METAL.] Provide watertight flashing for pipe and tubing extending through the roof.

3.1.2.9 Escutcheons

Provide chrome plated steel escutcheons for uninsulated pipe and tubing passing through floors, walls and ceilings.

3.1.2.10 Drain Lines

Provide drain lines from air vents and relief valves to the nearest [roof drains] [floor drains] [disposal points as directed].

3.1.2.11 Insulation and Identification

Insulate piping in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. [Frostproof air vents by insulating or shielding from night sky reverse radiation.] After piping has been insulated, apply identification labels and arrows in accordance with ASME A13.1. Apply identification over the insulation jacket of piping. Provide two copies of the piping identification code framed under glass and install where directed. Where insulation shall be exposed to the exterior of a building, sunlight, or the elements, insulation shall be shielded from the elements with appropriate aluminum, stainless steel, or UV-inhibited PVC jacketing.

3.1.2.12 Excavating and Backfilling

Provide in accordance with Section 31 00 00 EARTHWORK. Coordinate provision of utility warning and identification tape with backfill operation. Provide tapes above buried lines at a depth of 200 to 300 mm 8 to 12 inches below finish grade.

3.1.3 Instrumentation

Install instruments as recommended by the control manufacturers. [For the monitoring system to detect [water] [and] [heat transfer fluid], locate the sensor probe in the lowest corner of double-wall [tank] [and] [heat exchanger].] Locate control panels [inside mechanical room] [_____].

3.2 FIELD QUALITY CONTROL

3.2.1 Field Inspection

Prior to initial operation, inspect the piping system for conformance to drawings, specifications and ASME B31.1. Inspect the following information on each collector:

a. Manufacturer's name or trademark

b. Model name or number

c. Certifying agency label and rating.

3.2.2 Tests

Provide equipment and apparatus required for performing tests. Correct defects disclosed by the tests and repeat tests. Conduct testing in the presence of the [Contracting Officer] [QC Representative].

3.2.2.1 Piping Test

****

NOTE: Use pneumatic test if non-aqueous heat transfer fluid are used, to avoid contamination of fluids with water and to eliminate seepage problems.

****

[Pneumatically test new piping for leakage using air at a pressure of 138 kPa (gage) 20 psig or] [Test new water piping for leakage using water at a pressure of at least690 kPa (gage) 100 psig or] 1.5 times the system pressure. Install a calibrated test pressure gage in the system to indicate loss in pressure occurring during the test. Apply and maintain the test pressure for one hour, during which time there shall be no evidence of leakage, as detected by a reduction in test pressure. Should a reduction occur, locate leaks, repair, and repeat the test.

3.2.2.2 Operation Tests

****

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

****

Perform tests on mechanical systems, including pumps, controls, controlled valves, and other components in accordance with manufacturer's written recommendations. Test entire system in accordance with [Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC][_____] and ASTM E1160.

3.2.3 Manufacturer's Field Services

Furnish the services of a technical representative of the collector manufacturer, at the job site during each phase of inspection, installation, and testing. For solar collectors, furnish the services of a manufacturer's representative to instruct Government personnel for one manday, in the operating and maintenance of equipment. Notify the Contracting Officer in writing, prior to scheduling instructions.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-48 15 00 (May 2017)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 48 - ELECTRICAL POWER GENERATION

SECTION 48 15 00

WIND GENERATOR SYSTEM

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-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-48 15 00 (May 2017)**

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION 48 15 00

WIND GENERATOR SYSTEM

05/17

****

NOTE: This guide specification covers the requirements for wind generator systems.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CLEAN POWER ASSOCIATION (ACP)

AWEA O&M RP	(2017) AWEA Operations and Maintenance Recommended Practices, Second Edition

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ASCE/AWEA RP2011	(2011) Recommended Practice for Compliance of Large Land-based Wind Turbine Support Structures

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z359	(2013) Fall Protection Code

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 80	(2013) Guide for Safety in AC Substation Grounding
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 242	(2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE 519	(2022) Standard for Harmonic Control in Electrical Power Systems
IEEE 1547	(2018) Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

IEEE C2	(2023) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61400-SER	(2014) Wind Turbine Generator Systems - ALL PARTS

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

Unless otherwise specified or indicated, wind turbine terms used in these specifications, and on the drawings, are as defined in IEC 61400-SER.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meetings

Comply with Section 01 30 00 ADMINISTRATIVE REQUIREMENTS and hold a pre-installation meeting [no earlier than][1][2][_____] weeks prior to start of installation work.

1.3.2 Scheduling

Provide a delivery and installation schedule to the CO [no later than] [30][60][_____] days prior to start of installation work to allow internal coordination.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Permits are assumed to be obtained by firm holding design responsibility. Ensure this is clarified in contract bid package.

****

SD-01 Preconstruction Submittals

Commissioning Plan; G, [_____]

Commissioning Schedule; G, [_____]

SD-02 Shop Drawings

****

NOTE: Submittal is for diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project and prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

****

Shop Drawings, Drawings, Schedules; G, [_____]

****

NOTE: Control diagram and software documentation to include software/Contractor's manual, program listing, and applicable hierarchy diagrams. The software manual must describe the functions for all wind turbine system control and monitoring software

and must include all instructions necessary for proper loading, testing, debugging, and operations. Software description must include the following as a minimum: general system descriptions, including control system operating philosophies, sequence of operations, and interface definitions; explanation of program error messages; Data format, entry retrieval, archiving, and trending capabilities.

****

Site Plan Drawings; G, [_____]

Riser Diagram; G, [_____]

Installation ands Assembly Drawings and Details; G, [_____]

SD-03 Product Data

Wind Turbine System; G, [_____]

Sample Warranty Certificate; G, [_____]

Manufacturer Data Sheet; G, [_____]

Submit for all materials to be provided. Submit data sufficient to indicate conformance to specified requirements.

SD-05 Design Data

Wind Turbine System; G, [_____]

Towers/Support Structures; G, [_____]

Foundations; G, [_____]

Visual Impact Analysis & Mitigation; G, [_____]

Static Loading and Dynamic Response Analysis; G, [_____]

Noise Analysis & Mitigation; G, [_____]

Wildlife Impact Analysis & Mitigation ; G, [_____]

Groundings System Analysis; G, [_____]

SD-06 Test Reports

Work Plan; G, [_____]

Factory Test Plan; G, [_____]

Factory Tests Report; G, [_____]

Functional Performance Testing Results; G, [_____]

SD-07 Certificates

Certificate of Completion; G, [_____]

Commissioning Agents Qualifications; G, [_____]

Seismic Certification; G, [_____]

Wind Certification; G, [_____]

SD-08 Manufacturer's Instructions

Operations Manuals; G, [_____]

System Startup, Shutdown, and Emergency Procedures; G, [_____]

Definition and Use of All System, Command, and Application Software; G, [_____]

Alarms and Alarm Presentation; G, [_____]

Recovery and Restart Procedures; G, [_____]

Contractor Commands (Control Consoles, Indicating/Control Panels, and Peripheral Devices); G, [_____]

SD-10 Operation and Maintenance Data

Data Package 5

Corrective Maintenance Manuals; G, [_____]

Preventative Maintenance Manuals; G, [_____]

Recommended Multi-Year Operations and Maintenance (O&M) Requirements Schedule; G, [_____]

Special Tools and Equipment; G, [_____]

Special tools if required must be identified by part number and function/description.

SD-11 Closeout Submittals

Training Materials; G, [_____]

Training Course; G, [_____]

Commissioning Report; G, [_____]

Decommissioning Plan; G, [_____]

Warranty; G, [_____]

As-built Drawings; G, [_____]

1.5 OPERATION AND MAINTENANCE MANUALS

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NOTE: Review AWEA website for updated O&M requirements for wind turbines.

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Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system, stressing and enhancing the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, Data Package 5. Comply with AWEA O&M RP.

Include manufacturer's standard wind turbine system operations manuals that integrate operational instructions for the installed equipment. The wind turbine system manual must fully describe all wind turbine system operational aspects including, but not limited to:

a. Control and monitoring configuration and instruction.

b. System performance capabilities and equipment specifications.

c. System startup, shutdown, and emergency procedures.

d. Definition and use of all system, command, and applicable software.

e. Alarms and alarm presentation.

f. Recovery and restart procedures.

g. Contractor commands.

h. Detailed step-by-step instructions must be provided for user interfaces, such as control consoles, indicating/control panels, and peripheral devices.

1.5.1 Preventative Maintenance Manuals

Preventative Maintenance Manuals must include as a minimum, the applicable visual examinations, software and hardware tests, and diagnostic routines and resultant adjustment procedures necessary for periodic maintenance of control equipment. Instructions on how to load and use the test and diagnostic program and special or standard test equipment must be an integral part of the manuals.

1.5.1.1 Corrective Maintenance Manuals

Corrective Maintenance Manuals must include as a minimum, detailed logic diagrams and flow charts must also be provided, as necessary, for trouble-shooting analysis and field repair actions. For mechanical items required field repairs, information on tolerances, clearances, and wear limits, and maximum bolt down torques must be supplied. Information on the loading and use of special off-line diagnostic program tools, tests equipment, and any cautions or warnings that must be observed to protect personnel and equipment, must also be included.

1.5.2 Spare Parts

Provide a spare parts list (Data Package 5) and Special Tools and Equipment list required for maintaining total system availability at [95] percent. Parts list must include, as a minimum, part description, recommended quantity, shelf life, storage conditions, manufacturer, model number, and estimated delivery times. Parts must be identified on a list or drawing in sufficient detail for procurement of any repairable or replaceable part.

These parts must be identified by their individual by the industrial, generic part numbers, and must have second source referencing whenever possible.

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.6.3 Drawings

Submit minimum of three hard copies of drawings for government approval prior to manufacturing and equipment construction or integration. Submit Shop Drawings, Drawings, Schedules at a minimum of 11 by 17 inches in size using a minimum scale of 1/4 inch per foot, for the exception of drawings not requiring scale. Submit site plan drawings and Riser Diagram and general design notes at a minimum of 24 by 36 inches. Submit Installation ands Assembly Drawings and Details at a minimum of 24 by 36 inches. Submit installation details at minimum scale of 1/2 inch per foot for overview and 2 inches per foot for detail.

1.6.3.1 Product Drawings

Submit complete detailed product drawings for the wind turbine system consisting of Shop Drawings, Drawings, Schedulesand Manufacturer Data Sheet. Include in the shop drawings [one][three][four] wire diagrams, utility interconnection diagrams, switchboard and switchgear drawings, equipment enclosures, conduits, monitors, meters, and all other accessories associated with the installation of the PV system. Provide equipment dimensions, weights and structural mounting details.

Include nameplate data, size, and capacity of each wind turbine. Include all assumptions such as applicable wind speed, snow and seismic loads. Include applicable federal, military, industry, and technical society publication references.

1.6.3.2 Installation and Assembly Drawings and Details

Submit site plan drawings, Riser Diagram and general notes and Installation ands Assembly Drawings and Details prior to start of construction. Include sufficient drawing detail for all parts of the work to enable the Government to check conformity with the requirements of the contract documents. Include in the site plan drawings: topographic and utility survey; bore logs; soils report; site plan(s); site construction details; structural drawings; structural construction details; site electrical plan; and site electrical construction details. Include in the installation and assembly drawings and details: parts lists; assembly drawings; interconnection wiring diagrams; wire and cable schedules; wire and cable termination schedules; instrument plan; instrument and control wire, conduit and cable schedules; instrument wire and cable termination schedule; control diagrams; control sequence of operation; seismic restraint details; and wind restraint details.

1.6.3.3 "As-Built" and Record Drawings

After completion of construction, submit "As-built" Drawings prepared and certified by the construction contractor, showing in red ink, on-site changes to the original construction details and all underground utilities measured from field benchmarks, accurate to within 1" of centerline of the utility. Immediately record for inclusion into the as-built drawings all modifications to original drawings made during installation. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Prepare "As-built" Drawings on a minimum of 24 by 36 inches vellum using red ink.

After submittal and approval of "As-built" Drawings, submit Record Drawings, prepared and by the project engineer(s) and architect(s), of the original design drawings reflecting all design changes and contractor noted changes in the "As-Built" drawings.

1.6.4 Factory Acceptance Testing

Prepare Work Plan and Factory Test Plan. Conduct Factory Acceptance Testing during manufacturing of the wind generators as follows:

a. Tower: mil certificate for steel plates, dimensional inspection report, non-destructive test report, coating inspection report, non-conformance reports, inspection certificate from certifying agency;

b. Electrical Parts: generator, wind turbine generator transformer, converter system, and controller;

c. Nacelle: gear box, lubrication system, main shaft installation, yaw drives and system; blade pitch system, cooling system; and major castings.

Prepare Factory Test Reports after completion of testing.

1.6.4.1 Work Plan

Submit [6][_____] copies of schedules of dates for factory tests, installation, field tests, and operator training for the UPS system. Furnish a list of instrumentation equipment for factory and field test reports.

1.6.4.2 Factory Test Plan

Submit [6][_____] copies of factory test plans and procedures at least [21][_____] calendar days prior to the tests being conducted. Provide detailed description of test procedures, including test equipment and setups, to be used to ensure the UPS meets the performance specification and explain the test methods to be used. As a minimum, the test procedures to include the test required under the paragraph entitled "Factory Testing."

1.6.4.3 Factory Tests Report

Submit [6][_____] copies of factory test report within [45][_____] calendar days after completion of tests. Receive approval of test prior to shipping unit. Factory test reports must be signed by an official authorized to certify on behalf of the UPS manufacturer of that the system meets specified requirements in accordance with the requirements set forth in paragraph entitled "Factory Testing". Provide test reports in booklet form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports to state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.7 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

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NOTE: An initial visual, noise, and wildlife analysis may occur in initial planning stage for site down-select; however, site specific analysis is required for the final site design and selected turbines.

****

The wind turbine system must conform to applicable federal, state, regional, and local regulations regarding visual impact, noise pollution control, and wildlife impact. Perform and submit Noise Analysis & Mitigation, Visual Impact Analysis & Mitigation, and Wildlife Impact Analysis & Mitigation to [Contracting Officer][_____] for review and approval prior to mobilization in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

1.8.2 Existing Conditions

Location	[_____]
Elevation	[_____] meters [_____] feet above sea level.
Seismic Zone	Site is in ICC IBC Seismic Use Group [_____] Importance Factor [_____]
Temperature Range	[_____] to [_____] degrees C [_____] to [_____] degrees F

Average Humidity	[_____] percent
Lightning	[_____] annual average strikes
Rainfall	[_____] in. mean total annual rainfall

1.8.2.1 Available Utilities

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NOTE: Early utility interconnect coordination is critical, as is an approved power agreement.

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Utility power is presently supplied by [utility] from a [_____]kV line transformed down to [_____]kV for local distribution. Coordinate with the utility company for the available fault current value at the new wind farm transformer located at [TBD], and to design the wind turbine system to meet or exceed the available fault current values at the individual wind turbine points of connection (step-up transformer at the base of each turbine).

1.8.2.2 Wind Resource Data

The prevailing wind is from the [compass direction] with average annual wind speeds estimated to be [_____] m/s [_____] mph at [60][_____] meters [197][_____] ft above ground level at the preferred locations for these new wind turbines. Peak 15 minute average wind has been recorded from the [compass direction]at [25][_____] m/s [56][_____] mph. Summary average annual wind data results from past wind resource assessments are included in Attachment 1 of this specification. Validate the site(s) wind resource characteristics and design wind turbine system specifically for site conditions.

Validate the Wind Farm system's components and design parameters with respect to wind loading and survival wind speed. [Additional wind resource assessment data is available upon request.] The wind turbine system will be designed to maintain structural integrity and safe operation under specified environmental conditions, without damage to life or property for the [20][_____] year life of the wind turbine system.

1.8.2.3 Site Equipment Limitations

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NOTE: Reference any known site limitations, such as bridge weight limitations, height restrictions, etc.

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Identify and provide any special crane requirements for shipping, off-loading and erection of the wind turbine and its components.

1.9 WARRANTY

Wind turbine system must provide reliable operation, free from breakdowns(not excluding normal maintenance), for the design life of the wind turbine system[[20][_____] years].

1.10 CERTIFICATIONS

Provide Seismic Certification and Wind Certification, prepared by a licensed professional engineer or National Recognized Testing Laboratory, (NRTL) for all components and assembled systems in accordance with ICC IBC, ASCE 7-16 state and local building codes. Seismic and wind certifications shall demonstrate system shall withstand wind and seismic requirements as installed and remain remain online and functional after a seismic or wind event.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The wind turbine system must be furnished as totally coordinated assemblies which, after site installation and testing, shall comply with the design and performance requirements of this specification.

2.2 DESIGN REQUIREMENTS

All materials used in construction must be noncombustible wherever practical, and must be new materials.

Analysis of all required erection equipment loadings (i.e., on gin poles, winches, cranes, cables, earth anchors) must be performed as required for erection and/or maintenance purposes. Reference IEC 61400-SER and wind turbine manufacturer's standards. Provide UV resistant exposed cables and stainless steel cable ties.

2.2.1 General Requirements

General requirements for the wind turbine system includes:

a. The wind turbine system should consist of a [horizontal] [vertical]. axis, upwind active yaw control configurations, with a minimum of three rotor blades.

b. Rotor controls must be supplied to provide an active variable pitch (power/torque) air-foil design.

c. Operational RPM's must be variable, no less than [minus 10][_____] percent to [plus 5][_____] percent of synchronous RPM's.

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NOTE: 80 meter hub height has been the standard. Newer technology is allowing higher hub heights. Ensure correct hub height is used for specification and permitting.

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d. Wind turbine hub height of [80][_____] meters [263][_____] feet maximum, due to FAA height and other design issues, and energy production requirements.

e. Rotor diameter of [_____] meters [_____] feet minimum to [_____] meters [_____] feet maximum.

f. Low-voltage ride-through capability (see IEEE draft standard and/or European REE and EON grid code requirements.)

g. Reactive power support capability of [0.96][_____] inductive to [0.98][_____] capacitive power factor range, or approved equal.

2.2.2 Controls

The wind turbine controls will utilize standard "soft start" technologies to minimize the impact to electrical power systems. The design must include active power factor and load leveling controls to help reduce the need for supplemental active VAR control and to stabilize and/or minimize the system frequency/power changes due to wind variability respectively. The design requirements for the wind turbine subsystem components must be as described below.

2.2.3 Enclosures

All wind turbine equipment, controls, terminations, etc., supplied with the wind turbine system, which are intended to be located outside the nacelle, must be located in NEMA 12 (or equal) gasketed minimum rated enclosures for improved corrosion and environmental protection. If temperature control is required within the wind turbine control enclosures, provide all equipment, devices, and controls necessary to maintain the required temperature.

2.2.4 Rotors

Wind turbine rotors must consist of nonmetallic composite airfoils of a design resistant to abrasion related efficiency losses and must be non-EMI conductive/reflective. The rotor design must be optimized to provide maximum wind turbine output performance based on the specific wind regime characteristics[given in the supplied wind data]. Further, the rotor controls must be designed to provide a minimum of one level of safety beyond the primary systems.

2.2.5 Reduction Gear Assemblies

High-efficiency, reduction gear assemblies (if required) must be supplied that are designed for low temperature rise, low levels of vibration, long life, and low noise emissions. Further, the gear assembly designs must provide reliable operation, free from breakdowns (not excluding normal maintenance), for the design life of the wind turbine system[([20][_____] years)].

2.2.6 Bearings and Seals

The drive train must utilize tapered roller bearing technology, wherever possible, to maintain parallelism and axial tolerance of the drive train during all operating conditions.

Maintenance-free sealing must be installed on all shafts to prevent leaking of gear lubrication and intrusion of dirt and dust.

2.2.7 Foundations

Determine soil and foundation load requirements and comply with applicable requirements of ASCE/AWEA RP2011.

2.2.8 Towers/Support Structures

The tower must be a free-standing construction consisting of tubular steel (or approved equal), with provisions for safely climbing and servicing the turbine. The tower must be provided with a catwalk or maintenance platform just below or within the turbine to provide for turbine servicing as per manufacturer's standard design. Determine proper height of tower assembly for optimum operation of the wind turbines. Tower construction using self erecting crane systems are encouraged, and should be considered in cases where the height limitations of the installation may severely limit the performance of the offered system. Establish and maintain all precautions with regards to wind turbine installation and safeguarding the cranes for all possible wind conditions. Comply with IEC 61400-SER, ASCE/AWEA RP2011, and wind turbine manufacturer's standards.

All tower components including, but not limited to, or tube elements, anchors, supports, rails, ladders, etc., will be of a corrosion resistant steel construction, or coated with certified [10]-year surface coatings as per Section 09 90 00 PAINTS AND COATINGS.

2.2.8.1 Wind Ratings

The wind turbine system must be capable to withstand winds of Category [1][2][3][4] or [5] as defined by the Saffir-Simpson Hurricane Wind Scale. Provide wind certifications for all components and assemblies.

The tower assembly (and all associated components subject to fluctuating/cyclic loading) must be designed to withstand all operating conditions for the specific wind region characteristics based on, but not limited to, the supplied wind data. Static loading and dynamic response analysis must be submitted for review, for all loads imposed on the wind turbine system. The analysis must also include all required erection equipment loadings (i.e., on gin poles, winches, cranes, cables, earth anchors), as required for erection and/or maintenance purposes.

2.2.8.2 Seismic Ratings

All structures and structural elements must be suitable for Seismic Design Category [_____] in accordance with ICC IBC, ASCE 7-16, and all other applicable building codes and standards pertaining to the erection of such structures.

All bolted connections must meet AISC 325 standards for loading and torque specifications.

2.2.9 Brakes

A brake system, active yaw control, and/or airfoil system, in combination with brakes, must be supplied as required to support:

a. Manual shutdown during design wind conditions;

b. Over-speed shutdown;

c. Parking for maintenance; and

d. Loss of electrical grid power during rated wind operations.

Main shaft type braking is the preferred technology, although other types of technologies are not excluded provided they can be shown to meet the functional and performance requirements defined herein. The braking system must provide maintenance-free braking operations for a minimum of five years (i.e., no new brake pads), with significant use of pitch and yaw controls to minimize braking requirements. The braking system must be configured to prevent any type of runaway conditions that could exist whether grid power is available or not. The braking system must be capable of providing sufficient braking force for parking, normal stopping, and emergency stopping of the wind turbine system, as described below. A braking system other than those described below may be submitted for "or equal" substitute based upon performance.

2.2.9.1 Parking Brakes

A parking brake must be supplied capable of preventing rotor rotation at wind speeds up to the survival wind speed and/or as required for maintenance support, and capable of being used when there is no power.

2.2.9.2 Normal Stopping Brake System

A normal stopping brake system (or equal) must be supplied to dissipate the kinetic energy of the rotating machinery at the design over speed condition, while suffering no irreparable damage. The braking system must include fail-safe automatic operational mode in the event of a power out condition (i.e., loss of utility power while operating at rated wind speed).

2.2.9.3 Emergency Brake

An emergency brake must be supplied that is designated to meet the same requirements of the normal stopping brake above. In addition, upon activation, the emergency brake must alarm and require manual resetting prior to resuming automatic operation of the wind turbine.

2.2.10 Electrical Systems

Perform an independent stability and reliability study with a focus on determining the impacts to the installation's site facilities. Operate the wind-farm in strict adherence to IEEE 519 guidelines for controlling voltage, current, and harmonic distortions. Operate the wind-farm with all the power conditioning equipment necessary to maintain a stable power factor. Operate the wind-farm in a manner that does not diminish the capacity of existing installation facilities. Operate the wind-farm with appropriate controls and equipment that will automatically separate the wind-farm from the installation, or the installation and the Utility so that installation's site operations are not compromised in the event of equipment, and/or system failures. Operate the wind-farm with standing agreements cooperating jointly in maintenance processes and procedures.

2.2.10.1 Equipment

All generators, motors, and related electrical systems must meet the requirements of NFPA 70, IEEE C2, and/or IEC requirements for all construction. Wind turbine generators must be high-efficiency, continuous rated machines, with a minimum of Class F insulation and temperature rise. The generator efficiency will be a minimum of 90 percent for all loads greater than 10 percent of rated load. The generator must include embedded temperature protection with solid state sensors.

2.2.10.2 Power Distribution

Isolation breakers must be provided for key system assemblies to facilitate maintenance without interruption operation of other wind turbine systems. All fuses, circuit breakers, power supplies/regulators, and line conditioners necessary for wind turbine operations within the specified service conditions must be provided for all wind turbine equipment and assemblies. Power to the wind turbine control and monitoring subsystems must be distributed from a central point within one of the wind turbine system cabinets located within each nacelle. Voltage and current requirements must be identified and documented in the submittals to facilitate the design and transformer sizing.

2.2.10.3 Overcurrent Protection and Disconnect

A [circuit breaker][switch] must be installed as the primary means disconnecting the wind turbine incoming power cables/lines from the wind turbine system. The [circuit breaker][switch] must be capable of being locked in the open position and located conveniently for maintenance and operating personnel. The rating of the [circuit breaker][switch] must be sized per NFPA 70 for the maximum rated load current expected at the wind turbine. All electrical equipment supplied must be rated or protected to withstand and/or interrupt (without damage) the maximum available fault current expected at the point of connection to the wind turbine system. The fault current available at the wind farm site is initially estimated at approximately [_____] kAIC symmetrical at [_____] kVAC at each tower base, to be more closely determined during wind farm electrical modeling and design.

2.2.10.4 Step-up Transformer

A step-up transformer may be required and must be provided by others if the wind turbine output does not match the planned collector/distribution system voltage of [34.5][_____] kV (where the turbine is to be interconnected), or if the planned system is not suitable for the wind turbine standard design requirements.

2.2.10.5 Surge Suppression

External power input connections must be surge protected against IEEE C62.41 Category B transients.

2.2.10.6 Harmonics

The wind turbine generated harmonics measured at the wind generator system ac output must not exceed the levels required to conform with IEEE 519.

2.2.10.7 Grounding

****

NOTE: The possible exposure to a corrosive environment should be carefully examined. Even when the correct conductor size and the selected joining (connecting) method have satisfied all the IEEE 837 test requirements, it may be prudent to choose a larger conductor size to compensate for some gradual reduction in the conductor cross section during the design life of the installation where the soil environment tends to promote corrosion. Coordinate soil environment with Geotechnical Engineer.

****

Grounding must conform to NFPA 70, IEEE 80, IEEE 142, IEEE 242 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms. Provide ground grid for maximum permissible touch and step voltages as per IEEE 80.

Provide inner ring electrode around the foundation and bond it through the foundation to the turbine tower. Provide additional ring electrodes of gradually increasing depth and diameter in order to reduce touch and step voltages at the edges of the system. Provide a Groundings System Analysis.

****

NOTE: The possible exposure to a corrosive environment should be carefully examined. Even when the correct conductor size and the selected joining (connecting) method have satisfied all the IEEE 837 test requirements, it may be prudent to choose a larger conductor size to compensate for some gradual reduction in the conductor cross section during the design life of the installation where the soil environment tends to promote corrosion. Coordinate soil environment with Geotechnical Engineer.

****

2.2.10.8 Equipment Labeling

Install permanent labels on all major switches, controls, electrical panels, cabinets, disconnects, motor starters, major equipment, or components. Weatherproof labels must be either laminated black phenolic plastic with white engraved letters, or engraved (or embossed) stainless steel nameplates. Lettering for panels and equipment must be minimum [12][_____] mm [1/2][_____] inch high. Labels must be permanently installed by gluing or screwing to equipment covers. Labels must show panel or load name and circuit fed from.

2.2.10.9 Power Factor (PF) Correction

Active pf control must be installed as a integral portion of each wind turbine electrical system, and must include control provisions to maintain a minimum power factor of [0.95][_____] at rated load (adjustable range of 0.9 to 1.0). Additional (supplemental) pf correction equipment utilizing capacitor technologies is not excluded (i.e. must be integrated and cannot be included in lieu of active pf control); however, the capacitors must incorporate provisions for disconnection and safe controlled bleed off of electrical energy to support safe maintenance, as required.

2.2.11 Control and Monitoring Systems

Wind turbine control and monitoring system electronics (both local and remote) must be microprocessor-based, provide control of all critical functions, and include (but not be limited to) fail-safe automatic shutdown in the event of any component malfunction, rotor over speed condition, or excess vibrations. The system must be designed with on-line diagnostic capabilities to allow technicians to trouble-shoot subsystem problems down to the module or board level. Provide controls for manual and automatic indicated wind turbine starts. Contractor control panels will be supplied both at ground level and within the nacelle control compartment; and each will be equipped with all the vendor standard control switches, indicators, and metering necessary to support normal wind turbine operations. In addition, the Contractor panel(s) will include a serial communications interface or Ethernet port to communicate directly to the wind turbine microprocessor control system via[IBM][_____] compatible, portable laptop computer.

The wind turbine control system must provide normal operations monitoring to start and stop the wind turbine based on available wind, and to support automatic shutdown in the event an abnormal operating condition occurs. Automatic shutdown must be provided for the system failures identified above as a minimum.

2.2.11.1 Control System Modularity

All system controls and indicators must be solid state, modular, plug-in construction, so that any module may easily be removed from the system and replaced without breaking or making solder type connections. Subassemblies and modules performing identical functions must be interchangeable without making wiring changes. The number of types and sizes of modules must be kept to a minimum, in order to reduce the extent and cost of required spare parts.

2.2.11.2 Variable Speed/Load Leveling

To maximize reliability, impact on energy security, and reduce life cycle costs, the wind turbine generator control systems are preferred that include active variable speed technologies (variable rotor, pitch, and/or rotor-generator speeds) and active machine damping to reduce/limit peak torque effects due to wind gusts and/or grid supply fluctuations.

2.2.11.3 Assembly Wiring

Internal assembly wiring, including jumpers, must be color coded or permanently labeled using heat shrinkable, sleeve type markers[[Brady B321][_____] or approved equal,] as indicated on system schematics. Label identifications must be typed or printed. Wiring terminal strips must be provided and clearly identified for all equipment. Power and signal terminal strips must be separated. Provide [20][_____] percent spare terminals for all electrical connections where possible.

Label all furnished cables, cable terminations and connections. Cables and connections must be located in easily accessible areas. Signal and power wiring must be routed in separate bundles and kept separate by providing separate terminal blocks and connectors. Wires must be terminated using calibrated crimp ring lugs. Internal wiring and cabling must conform to NFPA 70 and IEC 61400-SER.

2.2.11.4 Ground Level Controls

Provide a standard ground level control panel(s) with the following functional characteristics as a minimum:

a. Allow local manual isolation of, or set it in a safe maintenance mode for, the wind turbine unit both from the normal power supply and from remote Contractor initiated controls to support safe maintenance activities.

b. Allow local ground level manual controls to initiate shutdown of the wind turbine system.

c. Supplied to allow the Contractor to access the standard diagnostic functions, provide software and interface to allow direct connection of a portable, laptop computer to directly access the master microprocessor system (or control interface/PLC, etc.).[The new system must be capable of being integrated with (i.e., interface directly to), and/or be an extension of, the existing wind farm monitoring and control system.]

d. Allow ground level monitoring (without the need of the serial communications interface) of the following status and metered functions as a minimum (or equivalent functions):

  (1) Discrete indicators (lights or approved equal),

    (a) Wind turbine system READY,

    (b) Wind turbine system FAULT,

    (c) Wind turbine system ON LINE;

  (2) Meters/selectable Liquid Crystal Displays (LCDs) (for approval);

  (3) Grid Voltage,

    (a) Line to Line volts - Phases AB, BC, and CA;

  (4) Wind turbine output power,

    (a) Kilowatts and kilowatt hours;

  (5) Power Factor,

    (a) Percent PF showing 0.5 - 1 - 0.5 (both leading/lagging);

  (6) Rotor RPM;

  (7) Pitch monitoring for active pitch turbines;

  (8) Manual start/stop;

  (9) Emergency stop (latching mushroom head switch with shield);

  (10) Automatic and emergency shutdown indicators (lights or approved equal) with shutdown/manual reset; and

  (11) Local/remote selector.

2.2.11.5 Remote Monitoring and Control Work Stations

****

NOTE: Review Agency network security requirements if an Agency remote terminal is desired.

****

Wind farm remote monitoring and control (SCADA) workstations are to be installed at the remote facilities/rooms as shown in the contract drawings as part of the wind farm/turbines project. The remote monitoring system must include two desktop computers, with modems, running Windows operating systems, and interfacing with the wind turbines using standard turbine manufacturer's supplied software. The new wind turbines must have remote control and monitoring software installed on the wind turbine workstations, and must be able to be accessed via fiber optic connection to support internet access through the SCADA computer for monitoring and reporting of Wind Farm power production. The workstations must be able to access the wind turbines for remote monitoring and control via fiber optic cable system. No DOS based software allowed in the installation of the new systems.

The new wind turbines must also have communications accessibility via dedicated external fiber optic cable, DSL connection, satellite connection, or other for manufacturer's warranty purposes, depending on the requirements of the wind turbine manufacturer. Determine, supply and define the SCADA system, for the Installation Contractor to install, to support the above wind turbine communications and monitoring hardware and software (Procure the fiber optic cable and related components). Provide Definition and Use of All System, Command, and Application Software.

2.2.11.6 Local Nacelle Monitoring and Controls

Provide manufacturer's standard wind turbine system monitoring, controls, and alarms within the nacelle/base at the Contractor control panel with ability to remote monitor as required. All controls, meters, LCD displays, etc., must be located within NEMA 12 (or equal) gasketed enclosures. The nacelle Contractor panel will include service switches to prevent the operation of the turbine from the base control panel when service personnel are in the nacelle, as well as the basic Contractor functions identified in subparagraph, GROUND LEVEL CONTROLS of this section. In addition, system failures, malfunctions, and/or warning indications must be provided as identified below (as a minimum):

a. Loss of enclosure cooling (if cooling is required);

b. Under/over voltage;

c. Under/over frequency;

d. Out of phase sequence;

e. Phase current unbalance;

f. Excess vibration;

g. Generator problem,

    (1) Generator excess power,

    (2) Generator over current,

    (3) Generator over temperature,

    (4) Generator over speed,

    (5) Generator cooling failure;

h. Yaw system failure;

i. Cable over twist (if cables are used);

j. Hydraulic system failure;

k. Loss of gear box oil pressure;

l. Gear box over temperature;

m. Pitch control system failure (as required); and

n. Communications systems failure.

2.2.12 Cable Over Twist Protection

If the proposed system utilizes cables between the yaw deck and the tower, the wind turbine system must incorporate the necessary cable twist sensors to detect and determine the net number of nacelle rotations to prevent cable damage due to over twist. In the event a cable over twist is sensed, the wind turbine system controls must operate to safely bring the rotor to a complete stop, untwist the cable by counter yawing, and restart the wind turbine system. This system must be tolerant of total power outages and not lose track of previous twist information.

2.3 PERFORMANCE REQUIREMENTS

The wind turbine system output performance must meet the minimum criteria given in paragraph, DESIGN REQUIREMENTS of this section (less 2.5 percent tolerance). The minimum annual gross energy production required to meet this specification was calculated using historical data and corresponding distribution with long-term annual average wind speed of [_____] m/s [_____] mph at [_____] meters [_____] feet AGL, tower/hub height of [_____] meters [_____] feet, wind sheer of [_____] between [_____] and [_____] meters [_____] and [_____] feet, altitude curve of [1.06][_____] kg/m^3 [6.617][_____] lb/ft^3 x 10^{-2} air density.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

Perform pre-performance and performance tests, inspections, and verifications in accordance with IEC 61400-SER.

Submit all manufacturer's standard airfoil performance and mechanical stress/strength tests data under the maximum expected operating conditions.

All wind turbines controls must be tested to standard manufacturing and systems tests and must include but not be limited to:

a. Rotor controls (if required);

b. Yaw control (if required;)

c. Cooling system controls (if required);

d. Safety and shutdown systems; and

e. Braking systems.

Prepare and submit for review and approval a test plan and procedures for factory and site testing. Tests must include an integrated control systems test where a minimum of the wind turbine generator and associated controls must be tested as a complete or mock assembly. These tests must be subject to witness by the Contracting Officer (or designated representative). Notify the Contracting Officer at least [30][_____] working days in advance of the tests. Should the Contracting Officer elect not to have a representative present during factory tests conducted by Contractor, the Contractor must still conduct such factory tests and inspections and submit test data and reports.

Data must be reported as taken during testing. Data format must be such that it can be included in performance test data submitted to the Contracting Officer.

Furnish the Contracting Officer [two][_____] copies of all shop and field test reports (and/or certificate of compliance) and [two][_____] additional information copies of these reports, clearly identified as such.

PART 3 EXECUTION

3.1 SITE PREPARATION

Evaluate and ensure site is accessible for the size and weight of planned equipment and facilities. Coordinate transportation routes to site.

Prepare site and lay down areas in accordance with approved contract documents.

3.2 WIND TURBINE SYSTEM PREPARATION

Ensure the wind turbine systems, remote work stations, control, power monitoring equipment, and all ancillary installed equipment are operational in accordance with this specifications section. All testing, both on site and at the factory, must be organized and supported by approved Commissioning plans. Submit a Commissioning Plan and procedures to the Contracting Officer for approval no later than [20][_____] business days after approval of the final design. The plan must state what equipment configuration will be tested, when it will be tested, which tests will be run, any special test equipment required, any required simulation software, and who will conduct and witness the tests as a minimum. The test procedures must define the operating steps and expected results to demonstrate compliance with the requirements of this specifications section. The Commissioning Report must record all test results and describe nonconformance events and corrective actions.

Ensure that the wind turbine components and associated subsystem must be tested by the manufacturer before shipment to verify proper assembly and function of all components/subsystems, and to ensure that the final assembled unit meets or exceeds the requirements of this specifications section. Component tests will be performed and/or Manufacturer's Factory certificates of compliance will be submitted indicating the equipment has been fully tested and meets the manufacture's standard design requirements. These tests must include (as a minimum):

a. Full Load Generator Tests - Full load test must be performed using the full load nameplate rating of the wind turbine generator unit. Full load testing must validate the vibration, temperature rise, and voltage and current outputs are within standard manufacturing limits (and/or meet) the manufacture's specifications.

b. Generator Insulation Tests - Generator insulation resistance and high potential tests must be performed with an insulation tester. Stator readings must be taken at the generator circuit breaker/switch. All results of insulation tests must be recorded. Readings must be within the standard manufacturing limits specified by the generator manufacturer.

c. Gearbox/Transmission Full Load Tests - Full load testing must validate the vibration, temperature rise, sealing, audible noise, gear tooth patterns, and lubrication systems are within the limits specified by the manufacturer. Full load test must be performed using the full load nameplate rating of the transmission or wind turbine generator unit (whichever is greater).

All factory component tests described above may be performed at the manufacturing facility.

3.3 ERECTION

Determine all hoisting and rigging and other installation requirements, and must make arrangements, if appropriate, for rent or purchase of any of these special installation tools.

Comply with ASSP Z359 Fall Protection Code during all construction, operations, and maintenance actions.

3.4 INSTALLATION

Install, test and commission wind turbine system. Provide detailed instructions and necessary oversight for installing all wind turbine system equipment. Notify the [CO][COR] of any errors in installation ensure that any and all installation errors are corrected in accordance with the manufacturer's instructions and specifications. Certify that the wind turbine system and wind turbine equipment are ready to operate. The Contracting Officer must receive [30][_____] working days' notice of the scheduled start up of the wind turbine system, with validation of the final schedule [21][_____] days prior to startup.

The scope of the Contractor's installation of the wind energy system must include, but not be limited to, the following activities:

a. Wind towers installation and setup support, including for hoisting, rigging, leveling, etc.;

b. Nacelle and rotor installations;

c. Control, monitoring, and terminal cabinet installations; and

d. Wiring connections/hookup.

3.5 SYSTEM INTERFACES

Wind turbine control and monitoring system is not authorized to interface with installation information network without approved software and hardware, and either an Authorization to Operate (ATO), Interim ATO (IATO), or Interim Authorization to Test (IATT). Permanent connection is not allowed without an Approval to Connect (ATC) or Interim ATC (IATC) authorization. Comply with IEEE 1547.

3.5.1 Power System Interface

The wind farm generator connections to the site power grid will be field located as shown in the contract drawings. Validate proper voltage drop of system after completion of the wind turbine Contractor submittals. Locate the wind turbine system ground level controls to enable safe manual ground level shutdown.

3.5.2 Dispatch Interface

The remote monitoring and control system must be integrated to allow the [UTILITY][Contractor's][User's] power dispatch, via the master workstations at the remote facilities, to monitor and control Wind Farm status and record aggregate power output and wind turbine status from the Wind Farm system.

3.5.3 Control System Interface

The wind turbine system must be supplied with a standard fiber optic, DSL, satellite or 56 kbit/s to 115 kbit/s minimum serial interface communications interface [by others] to link standard wind turbine control and monitoring functions with the existing remote monitoring/control system. The wind turbine communications interface will be capable of driving control signals, from the final locations recommended for the wind turbines to the remote facility workstations. The communications interface must include all the standard software drivers, installation and operation documentation, and programming support necessary to allow easy integration directly with the [Contractor's][user's] workstations located at the remote.

3.6 FINISHING, CLEANING, AND PAINTING

All surface finishes, cleaning, and painting must conform with Section 09 90 00 PAINTS AND COATINGS. All exposed surfaces that protect material must be UV resistant to maintain appearances through the design life of the system.

3.7 EQUIPMENT IDENTIFICATION

Each piece of equipment must be identified so that it can be easily correlated with the documentation. The means of identification must be uniform throughout the system. The identification mark must be permanently affixed to the part it identifies. This requirement includes internal wiring, terminal strips, input/output cables and connectors, input/output modules, power supplies, and other subsystem components and subassemblies.

3.8 NAMEPLATES

Each major piece of wind turbine system equipment must be furnished with a permanently attached 316 stainless steel nameplate, which contains a minimum of the following information:

a. Tag number;

b. Manufacturer name;

c. Model number;

d. Serial number; and

e. Purchase order number.

Each nameplate must be fully visible when the equipment is in operating condition and consist of a self-adhesive label having [_____] [6][_____] mm [1/4][_____] in embossed letters. Shipping container must be labeled with the same data.

3.9 FIELD QUALITY CONTROL

3.9.1 Manufacturer's Field Service

Provide the services of factory trained and approved field service engineer during system installation, testing, and commissioning.

3.9.2 Start Up Services

Carry out a checklist of startup requirements and conduct a series of safety tests to ensure proper installation, safe operation, and performance up to specification. Develop a Commissioning Report detailing all procedures, testing, and results.

After installation, prepare the new wind turbine systems for final testing and commissioning. The wind turbine systems must be fully debugged and operating in accordance with all requirements of this specifications section. Final start-up services must include, but will not be limited to, the following:

a. Final functional checks of all installed wind turbine systems, automated control modes, and associated controls and instrumentation.

b. Final verification and calibration of all wind turbine system control and instrumentation signals and digital readouts.

c. Final verification of the proper operation of all controlled shutdown functions and capabilities; and both automatic and ground level supported operating, monitoring, and related control functions.

d. Alarm systems.

3.9.3 Functional Acceptance Testing

After installation, conduct functional acceptance testing of the equipment and all accessories furnished to verify their proper performance under conditions of actual operation. Notify the CO at least [30][_____] working days in advance of the tests. Compliance with all requirements of this specifications section and all applicable standards (as amended) must be verified by an on-site startup/operational test.

3.9.4 Operational Testing

Support complete on-line operational testing on site to formally commission wind turbine operations, validate warranties, perform training, and initiate maintenance schedules. The wind turbine manufacturer will support the Installation Contractor who will be responsible for developing and implementing approved operational test procedures for testing all of the wind turbine operational and failure/failsafe systems. A certificate of completion must be provided at the conclusion of system's construction, installation, and commissioning. Coordinate all formal correspondence and reporting required for approval of the test plan. Project implementation must require the installation, testing, and operation of the wind turbine generating units in parallel with the installation's [_____] kV distribution system. Installation and start-up support service submittals, test plan documents, and test schedule information must be submitted for review and approval.

Perform and submit field data reports for the following:

a. Verification of proper electrical power connection to all wind turbine system components.

b. Verification of proper termination of all system interconnect wiring and signal transmitter calibrations.

c. Verification of proper wind turbine system monitoring, controls, and environmental support system functionality.

d. Functional checks of all analog and digital signals, modems, and data communications systems associated with the wind turbine system.

e. Verification of wind turbine equipment alignments, torques and adjustments, and vibration block installations.

f. Functional checks (and correction if necessary) of all lubrication and cooling system levels and operations, shaft seals, and or other system fluid leaks.

g. All variations to documentation must be documented and submitted immediately to the CO and/or the COR.

3.10 COMMISSIONING

****

NOTE: Section 01 91 00.15 BUILDING COMMISSIONING is intended for building systems, however, the basic requirements are applicable to PV commissioning processes. Section 01 91 00.15 will need to be tailored for PV systems when compiling project specifications.

****

Conduct Commissioning, after the system is installed and is ready for operation, in accordance with Section 01 91 00.15 BUILDING COMMISSIONING, item (6)renewable energy generation, to verify that the completed and installed system meets the requirements of IEEE 1547. Tailor for non-building systems.

3.10.1 Commissioning Agent

Individual qualified in testing protective equipment (e.g., professional engineer, factory-certified technician, licensed electrician with experience in testing protective equipment) must perform or directly supervise commissioning tests. Provide Commissioning Agents Qualifications.

3.10.2 Commissioning Plan and Schedule

Develop and implement a commissioning plan and commissioning schedule in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

3.10.3 Start-up Pre-functional Checklists

Carry out a checklist of startup requirements and conduct a series of safety tests to ensure proper installation, safe operation, and performance conforming to specification.

3.10.4 Functional Performance Testing

Prepare test procedures and conduct functional performance testing of the installed system. Test on completion each individual wind turbine generator and then test on completion the complete wind power system plant. Test the complete wind power system for a minimum duration of 200 hours, of which 150 hours should be generator time with 85 percent availability.

Provide testing of the following:

a. Collector System

b. Collector and Substation Equipment

c. Ground Grid

d. Main Power Transformers

e. Circuit Breakers

f. Arrestors

g. Switches and Switchgear

h. Instrument Transformers

i. Wind Plant Relays

j. Wind Plant Energization

k. Turbine Transformer

l. Overhead Collection Circuits

m. Fiber Optics and Secondary Cables

n. Medium Voltage Cable Systems

o. Power Performance

p. Nacelle Anemometer Verification

q. Acoustic Noise

r. SCADA and Controls

s. Back Up/Black Start Generator(s)

t. Grid Synchronization and Interface

3.10.5 Functional Performance Testing Results

Coordinate, observe and record the results of the functional performance testing. Coordinate retesting as necessary until satisfactory performance is verified. Verify the intended operation of individual components and system interactions under various conditions and modes of operation.

Document items of non-compliance in materials, installation or operation.

Immediately address observed non-conformance and deficiencies in terms of notification to responsible parties, and provide recommended actions to correct deficiencies.

3.10.6 Final Commissioning Report

Prepare and submit final commissioning report. Summarize all of the tasks, findings, conclusions, and recommendations of the commissioning process in accordance with IEC 61400-SER. Include the results of all tests and a listing of the final settings.

3.11 CLOSEOUT ACTIVITIES

3.11.1 Demonstration

Provide hands on demonstration of wind turbine systems and controls as part of the training session. Minimum demonstration areas must include pre-startup inspections, system startup, grid connection; operations, operator initiated shutdown, emergency shutdown, and extreme conditions procedures.

Demonstrate, upon completion of functional acceptance tests, that all circuits and devices are in proper operating condition and performing as intended.

3.11.2 Training

Provide a [1][3][5] day comprehensive training course covering operations and maintenance, critical spares, and unique tools requirements, with complete training materials, at construction completion.

Provide recommendations and sources for advanced maintenance personnel training and certification programs.

3.11.3 Spare Parts

Provide a spare parts list in accordance with the manufacturer's recommendations that will ensure [95][_____] percent system availability for from one year to 2 years of operation for each wind turbine unit, (according to options awarded). The list must include/identify all required gaskets, seals, sealing materials required for maintaining the weather tight integrity of the wind turbine tower and nacelle.

3.11.4 Special Tools and Equipment

Identify special tools and equipment designed specifically for the wind turbine equipment operation and maintenance. Special tools and devices, including any metric wrenches or other hand tools that are not standard in the United States, required for operation and maintenance of the equipment furnished under this specifications section, must be listed and clearly identified with the name of the equipment.

3.11.5 Site Restoration

Clean and restore temporary work areas to pre-existing conditions.

3.11.6 Decommissioning Plan

Provide a decommissioning plan to Contracting Officer for approval.

Decommissioning plan must include actions necessary to restoring site and access roads to natural conditions and option to evaluate structure and components for life extension upgrades.

3.11.7 Warranty

Provide system and major component Warranty in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS

3.12 OPERATION

3.12.1 Normal Operations

The wind turbine system must be operating in an automatic, unmanned mode, unless a failure alarm is detected in the wind farm control system, or maintenance is being performed on the system. Wind turbine system controls must be provided to optimize wind turbine system outputs under normal wind conditions, as described in paragraph, EXISTING CONDITIONS of this section. Standard wind turbine controls must be designed to keep the wind generating system operational within its normal operating limits over the design life of the wind farm system, producing efficient, optimized, electrical power. Should the wind turbine or its control system malfunction, the protection system/safety schemes must maintain it in a non-hazardous condition. Acceptable safety schemes must include braking, blade pitching, spoilers, and active yawing, as required by the turbine generator manufacturer. Provide wind turbine Operations Manuals, Alarms and Alarm Presentation, System Startup, Shutdown, and Emergency Procedures, and Contractor Commands (Control Consoles, Indicating/Control Panels, and Peripheral Devices).

3.12.2 Pre-Startup Inspections

Pre-startup inspections must be performed prior to initiating wind turbine system operations. To support automatic operations, the inspections will only be required following maintenance and/or abnormal shutdowns brought on by the automatic shutdown features of the controls. Pre-starting inspection will be performed using manufacturer's instructions and procedures to ensure that the wind turbine system is ready for on-line operations. The necessary instructions, procedures, checklists, etc. must be supplied as part of the documentation submittals as required herein.

3.12.3 Connection to Grid

To connect grid power to the associated wind turbine unit, coordinate with utility company grid operations to close the wind turbine switchgear breakers either manually at the site or remotely via the Contractor stations. Compliance with interconnection agreement requirements is mandatory.

3.12.4 Initiate Wind Turbine Operations

Once grid power is supplied to the wind turbine, the wind turbine control system will begin its internal system diagnostics, as necessary, to prepare the control system for active operations. All faults normally detected by the control system, or occurring as a result of automatic shutdown, will have to be manually reset prior to allowing active operations. When the fault indications have been reset, the controls will output a wind turbine "READY" indicator to notify that the wind turbine is ready to activate soft start operations.

3.12.5 Normal Operations

Final wind turbine connection to the grid for normal on-line operation will occur when the he ON-LINE command is initiated, either from the Contractor's panel or remotely via the serial communications/control link. Normal operation must include normal pitch, speed, and voltage controls to automatically optimize output while operating within normal wind speed parameters. ON-LINE operations will invoke normal operation where the wind turbines will begin soft start (solid state soft start, reduced voltage starting, or equal) operations (to reduce the impact of connecting the wind turbine to the grid) if adequate wind is available.

3.12.6 Normal Shutdown

All Normal shutdowns must result in immediate orderly shutdown, including a functional disconnect of the wind turbine generator from the grid at the wind turbine output control (or equal). The wind turbine control system must remain operational to maintain full control of the wind turbine shutdown (application of normal braking, required rotor and blade pitch operations, active yawing, etc.) as necessary to effect safe (non-damaging) shutdown of the wind turbine unit. Prior to beginning maintenance operations, shut down the system, applying the parking brake, open the switchgear breaker supplying the wind turbine system, open the wind turbine local disconnect breaker, and set the wind turbine operations switch into the LOCAL mode.

3.12.7 Emergency Shutdown

Emergency shutdown procedures/functions must be included as an integral part of the wind turbine basic operating capabilities. The emergency shutdown system must operate to disconnect the wind turbine from the grid and apply appropriate braking actions, require rotor and blade pitch operations, active yawing, etc., as necessary to effect safe (non-damaging) shutdown of the wind turbine unit in emergency, extreme operating conditions, survival wind speeds or a loss of grid power while operating. These include, but are not limited to, loss of grid power, breaker trip, over speed, contractor control, and other anomalies. Provide Recovery and Restart Procedures.

3.12.8 Extreme Operating Conditions

Peak wind speed, high temperature, and earthquakes all constitute extreme operating conditions, which may exist whether the wind turbine is in operation or not. The wind turbine system design analysis must consider the effects of extreme operating conditions; and the resulting design configuration must include the necessary safety elements to mitigate damage from the extremes (and still effect safe shutdown). Contractor inspection and manual reset is expected before any operation following an extreme event.

3.13 MAINTENANCE

Contractor to create maintenance schedule and perform system and component maintenance in accordance with equipment manufacturers' recommendations and AWEA O&M RP. Provide a Recommended Multi-Year Operations and Maintenance (O&M) Requirements Schedule.

-- End of Section --

****

USACE / NAVFAC / AFCEC **UFGS-48 16 00 (May 2017)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

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SECTION TABLE OF CONTENTS

DIVISION 48 - ELECTRICAL POWER GENERATION

SECTION 48 16 00

LANDFILL GAS SYSTEMS

05/17

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC **UFGS-48 16 00 (May 2017)**

Preparing Activity: USACE **New**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 48 16 00

LANDFILL GAS SYSTEMS

05/17

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NOTE: This guide specification covers the requirements for landfill gas systems as utility grade renewable power generation source.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

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NOTE: Use this UFGS in conjunction with UFC 3-460-01 "Design: Petroleum Fuel Facilities". Include in this specification any additional equipment/devices necessary to meet state and local regulations.

The specification is written around ASME's standard Class 150 rating. For applications requiring higher pressure ratings (e.g., Class 300, etc.), the designer will have to modify this specification appropriately.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API STD 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators
IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended

	Practice for Powering and Grounding Electronic Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024; TIA 24-1) Flammable and Combustible Liquids Code
NFPA 58	(2024; TIA 24-2) Liquefied Petroleum Gas Code
NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 77	(2024; ERTA 1 2023) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 24-2) Standard for Aircraft Fuel Servicing
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60.18	General Control Device and Work Practice Requirements
40 CFR 60.752	Standards for Air Emissions from Municipal Solid Waste Landfills

UL SOLUTIONS (UL)

UL 913	(2013; Reprint May 2022) UL Standard for Safety Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations

1.2 RELATED REQUIREMENTS

****

NOTE: To apply this guide specification to other

divisions of the project specification, insert the appropriate division number and title. Ensure that the appropriate sections having electrical equipment include the following paragraph:

Delete sections in the paragraph that are not in the job. The requirements of this specification section are being incorporated into the other specification sections that reference it with the intent of phasing out this section. As the requirements of this section are incorporated into each specification section, that section should be added to the list in the paragraph below. Do not use this section, and delete reference to it, if the only sections used in the job are listed below.

****

This section applies to certain sections of Division 13, SPECIAL CONSTRUCTION, and Divisions 22, PLUMBING. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections.

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Permits are assumed to be obtained by firm holding design responsibility. Ensure this is clarified in contract bid package.

****

SD-02 Shop Drawings

Grounding and Bonding; G, [_____]

SD-03 Product Data

Condensate pump stations; G, [_____]

Condensate knockouts; G, [_____]

Blowers; G, [_____]

Propane stations and components; G, [_____]

Skid mounted flare systems and components; G, [_____]

Gas condensers; G, [_____]

Gas dryer systems and components; G, [_____]

Aftercoolers; G, [_____]

Gas turbines; G, [_____]

Microturbines; G, [_____]

Internal combustion engines; G, [_____]

Filtration systems and components; G, [_____]

Landfill gas analyzers and components; G, [_____]

Control Systems; G, [_____]

Gas Collection and Control System; G, [_____]

Generator; G, [_____]

SD-07 Certificates

Emissions Compliance; G, [_____]

Warranty; G, [_____]

SD-10 Operation and Maintenance Data

Condensate pump stations; G, [_____]

Condensate knockouts ; G, [_____]

Blowers; G, [_____]

Propane stations and components; G, [_____]

Skid mounted flare systems and components; G, [_____]

Gas condensers ; G, [_____]

Gas dryer systems and components; G, [_____]

Aftercoolers ; G, [_____]

Gas turbines ; G, [_____]

Microturbines ; G, [_____]

Internal combustion engines ; G, [_____]

Filtration systems and components; G, [_____]

Landfill gas analyzers and components; G, [_____]

Control Systems ; G, [_____]

Gas Collection and Control System; G, [_____]

Generator; G, [_____]

SD-11 Closeout Submittals

Demonstrations; G, [_____]

1.4 QUALITY ASSURANCE

1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Materials and equipment must have been in satisfactory commercial or industrial use for a minimum two years prior to bid opening. The two year period must include applications of the equipment and materials under similar circumstances and of similar size. Materials and equipment must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two year period.

1.4.2 Nameplates

****

NOTE: In a salt water environment, substitute acceptable non-corroding metal such as, but not limited to, nickel-copper, 304 stainless steel, or monel. Aluminum is unacceptable. Nomenclature (or system identification) should be established by the designer.

Require melamine plastic nameplates for all NAVFAC projects. Also for NAVFAC projects, require nameplates to be associated or keyed to system charts and schedules.
****

Attach nameplates to all specified equipment, thermometers, gauges, and valves defined herein. List on each nameplate the manufacturer's name, address, contract number, acceptance date, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 25 by 65 mm/1 by 2-1/2 inches. Lettering must be the normal block style with a minimum 6 mm/1/4 inch height. Accurately align all lettering on nameplates.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 WARRANTY

Warranty overall landfill gas collection, processing, control, and generation system to be free from material, workmanship, and manufacturing defects (excluding normal maintenance), for a period of [5] years.

a. Gas Collection and Control System. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

b. Skid Mounted Flare Systems. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

c. Blowers. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

d. Gas Treatment System. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

e. Generator. Free from materials, workmanship, and manufacturing defects for minimum period of [5] years.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The landfill gas system includes the following:

a. Landfill gas and condensate piping and accessories;

b. Condensate pump stations;

c. Condensate knockouts;

d. Blowers;

e. Propane stations;

f. Skid mounted flare systems;

g. Gas condensers;

h. Gas dryer systems;

i. Aftercoolers;

j. Gas turbines;

k. Microturbines;

l. Internal combustion engines;

m. Filtration systems;

n. Landfill gas analyzers; and

o. Control systems.

2.2 Design Conditions

Equipment specified herein must be designed to for:

a. Elevation [_____] meters/[_____] feet.

b. Minimum/maximum ambient temperature [_____] / [_____] degrees C/[_____] / [_____] degrees F.

c. Landfill gas and condensate to be handled.

d. Maintaining a [75] percent collection efficiency.

e. Raw gas inlet conditions of:

    (1) LFG flow: [_____] liters/minute/[_____] SCFM.

    (2) LFG temperature: [_____] / [_____] degrees C/[_____] / [_____] degrees F.

    (3) Relative humidity: [100] percent.

    (4) Raw gas composition:

        [_____] percent methane

        [_____] percent carbon dioxide

        [_____] percent nitrogen

        [_____] percent oxygen

f. Treated gas conditions of:

****

NOTE: Specify for end use. I.e. on site power generation equipment requirements, direct use, or distribution.

****

(1) Sulfur (hydrogen sulfide, sulfur dioxide) less than [57] mg/MJ/[60] microgram/BTU.

(2) Halides (chlorine/fluorine) less than [19] mg/MJ/[20] microgram/BTU.

(3) Ammonia less than [2.81] mg/MJ/[2.96] microgram/BTU.

(4) Particulates less than [10] microns.

(5) Siloxanes less than [0.56] mg/MJ/[60] microgram/BTU.

(6) Moisture less than [80] percent relative humidity at lowest temperature.

2.3 MATERIALS

Internal parts and components of equipment, piping, piping components, and valves that could be exposed to landfill gas and/or condensate during system operation must not be constructed of zinc coated (galvanized) metal. Do not install cast iron bodied valves in piping systems that could be exposed to landfill gas and/or condensate during system operation.

2.3.1 Nitrile Butadiene (Buna-N)

Provide Buna-N material that conforms to SAE AMS3275.

2.3.2 Acrylonitrile Butadiene Rubber (NBR)

Provide NBR material that conforms to SAE AMS3275.

2.4 ELECTRICAL WORK

****

NOTE: Show electrical characteristics, motor starter type(s), enclosure type, and maximum rpm in the equipment schedules on the drawings.

Where reduced-voltage motor starters are recommended by the manufacturer or required otherwise, specify and coordinate the type(s) required in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Reduced-voltage starting is required when full voltage starting will interfere with other electrical equipment and circuits and when recommended by the manufacturer. Where adjustable speed drives (ASD) are specified, reference Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS. The methods for calculating the economy of using an adjustable speed drive is described in UFC 3-520-01 DESIGN: INTERIOR ELECTRICAL SYSTEMS.

Coordinate the ignition temperature of the fuel(s) to be handled with the electrical design. Ignition temperatures will be as defined in NFPA 497M. Fuel ignition temperatures will dictate the maximum allowable temperature rating of the electrical equipment. Coordinate the area classification and

the electrical design with UFC 03-460-01.
****

2.4.1 General

Provide motors, motor starters, controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of equipment, except controllers indicated as part of motor control centers.[Provide electrical equipment, including motors and wiring.] Provide switches and devices necessary for controlling and protecting electrical equipment. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Comply with API RP 540 and API RP 2003.

2.4.2 Motors

Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Motors must be rated for continuous duty with the enclosure specified. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of the enclosure. Comply with IEEE 112.

2.4.3 Motor Controllers

Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Use solid-state variable-speed controllers for motors rated 7.45 kW/10 hp or less and adjustable frequency drives for larger motors. Controllers and contactor must have a maximum of 120-volt control circuits and must have auxiliary contacts for use with the controls provided. For packaged equipment, the manufacturer must provide controllers including the required monitors and timed restart.

2.4.4 Underground Wiring

Provide underground electrical wiring in PVC conduit, as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.4.5 Grounding and Bonding

Grounding and bonding must be in accordance with NFPA 70, NFPA 77, NFPA 780, IEEE 1100, IEEE 142. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.5 GAS COLLECTION AND CONTROL SYSTEM

Landfill gas collection and control system (GCCS) to comply with 40 CFR 60.752.

Provide piping, accessories, and valving in accordance with in Section 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES.

2.6 CONDENSATE PUMP STATIONS

****

NOTE: Refer to NAVFAC Standard Design 140-40-05 TRUCK UNLOADING SYSTEM and UFC 3-460-01 for detailed information of an off-loading assembly.

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Assembly must be a complete, packaged, factory fabricated for use in the landfill, transferring condensate or leachate from landfill gas header and subheader piping. Assembly must include automatic level control of condensate or leachate and must pump to a point of disposal.

2.6.1 Condensate Pump Station and Enclosure

Provide pump station that is fully enclosed, weatherproof, polyethylene or PVC construction with an intermediate storage reservoir. Provide with quick connect/disconnect fittings and corrosion resistant components. Assembly must have a vault for access and maintenance. Comply with NEMA 250.

2.6.2 Condensate Pumps

Provide electric centrifugal or submersible type condensate pump sized and designed for condensate service.

2.6.3 Service Nameplate

In addition to the equipment identification nameplate, provide pump station service nameplate, of type 18-8 stainless steel or monel, securely attached by stainless steel pins at an accessible and conspicuous point on the pump station. Tagging in letters 6 mm/1/4-inch high must bear the equipment number as shown on the drawings. The pump station service nameplate must be stamped with the following information:

a. Manufacturer's name;

b. Pump serial number;

c. Capacity, [_____] L/s/[_____]gpm;

d. Pumping head, [_____] m/[_____] ft;

e. Pumped fluid maximum specific gravity;

f. Revolutions per minute; and

g. Driver horsepower.

2.7 CONDENSATE KNOCKOUTS

Provide complete packaged assembly, factory fabricated, for use in-line with the landfill gas pipelines to remove condensate from the landfill gas stream. Assembly must include automatic condensate level control and must pump to a point of disposal. Provide cleanout and monitoring ports.

2.7.1 Condensate Knockout Enclosure

The knockout must have a fully enclosed, weatherproof, polyethylene or PVC construction with an intermediate storage reservoir. Provide with quick connect/disconnect fittings and corrosion resistant components.

2.7.2 Condensate Pumps

Pumps must be an electric centrifugal or submersible type. Comply with API STD 610.

2.7.3 Service Nameplate

Provide a knockout service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the knockout, must be furnished in addition to the identification nameplate. The knockout service nameplate must be stamped with the following information:

a. Manufacturer's name;

b. Pump serial number;

c. Capacity, [_____] L/s/[_____]gpm;

d. Pumping head, [_____] m/[_____] ft;

e. Maximum specific gravity of fluid to be pumped;

f. Revolutions per minute; and

g. Driver horsepower.

2.7.4 Identification Nameplate

Provide a knockout identification nameplate of Type 18-8 stainless steel or monel and securely attached by stainless steel pins to a conspicuous place on the knockout. Tagging in letters 6 mm/1/4-inch high must bear the equipment number as shown on the drawings.

2.8 BLOWERS

Provide positive displacement blowers, completely assembled with strainer, silencers, check valves, pressure relief valves, shaft seals, and intake and discharge pressure gauges. Provide with variable frequency drive for LFG flow control. Provide actuated fail-safe valve on intake and discharge side for blower isolation during normal and emergency shutdown operations.

2.9 PROPANE STATIONS

Provide propane station compatible with flare pilot system requirements and integrated into the main station control panel. Size propane storage for 6 [_____] months of operation. Comply with ASME BPVC SEC VIII D1, ASME Boiler and Pressure Vessel Code, NFPA 58, and piping as specified in 33 51 15 NATURAL-GAS / LIQUEFIED PETROLEUM GAS DISTRIBUTION PIPELINES.

2.10 SKID MOUNTED FLARE SYSTEMS

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NOTE: Check local air quality board for more stringent emissions requirements.

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Provide a skid mounted flare system for use in landfill gas destruction. Assembly must include burners, louvers, weather protection, insulation, access ladder and platform, heat shields, purge blower, flame arrester/thermal valve, wind shields, pilot light system, flame sensor, modulation control valves, and controls. Completely assemble flare control system and test prior to shipment by the flare supplier at the supplier's own fabrication facility.

Flare system must be capable of continuous stable combustion operation with [30] to [50] percent methane at the maximum required flow rate. Flare must have a minimum exhaust gas retention time of [0.5] [1.0] [_____] seconds at a minimum temperature of [760] to [980] degrees C/[1400] to [1800] degrees F.

The flare must be capable of achieving a minimum destruction efficiency of >98 percent of total non-methane organic compounds (NMOCs)by weight and 99 percent destruction of hydrogen sulfide. Design flare to comply with and operate in compliance of 40 CFR 60.18.

2.10.1 Skid Mounted Flare Construction

Flare construction must be carbon steel with a stainless steel weather and heat protection at the top of the flare.

2.10.2 Flare Insulation

Insulate flare with 100 mm/4 inch ceramic fiber blanket insulation to achieve a not to exceed skin temperature of 121 degrees C/250 degrees F.

2.10.3 Burner and Propane Pilot

Burner must be stainless steel construction. Propane pilot must be stainless steel construction. Provide thermocouple flame recognition system and purge system.

2.10.4 Manifold

Provide low pressure type manifold with flame arrestor and safety shutdown valve.

2.11 GAS DRYER SYSTEMS

Provide a complete packaged gas dryer system for use in landfill gas piping to remove water vapor and condition the landfill gas to a quality acceptable for use specified microturbines and combustion engines.

2.11.1 Gas Dryer Construction

Provide modular construction gas dryer with stainless steel wetted parts, heat exchanger tubes, and moisture separator. Gas dryer system must be mounted on a structural solid steel base.

2.11.2 Refrigeration System

The refrigerant used must not contain CFC. The refrigeration system must include:

a. Liquid line dryer;

b. Suction line dryer;

c. Site glass;

d. Crank case heater;

e. Isolation valves for compressor and evaporator;

f. Condenser and liquid receiver;

g. Condenser pressure relief valve;

h. Compressor discharge check valve;

i. Separator/filter; and

j. Dew point sensor and readout.

2.12 AFTERCOOLERS

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NOTE: Piston type differential pressure gauges do not require calibration. Suggest showing on the drawings a pressure gauge installed on the high pressure side of the differential pressure gauge. The pressure gauge should have a scale range from 0 to 2068 kPa (300 psi).

****

Provide an aftercooler after the blower. Aftercooler cores must be made of stainless steel to resist attacks from acids of sulfur, chlorine and fluorine. Provide condensate collection and piping.

2.13 GAS TURBINES

****

NOTE: Indicate the location and approximate configuration of each station. Mount all the control equipment on a single equipment rack next to the corresponding receiving/dispensing equipment. Include the sequence of operation for each station on the drawings.

****

Provide a gas turbine based [grid parallel] [dual mode] [grid isolated] generator system designed for landfill gas fuel meeting the following criteria:

a. Electrical efficiency [30] percent LHV;

b. Nominal heat (HHV) [_____] BTU/kWh;

c. Nominal heat (LHV) [_____] BTU/kWh;

d. Nominal electrical power [_____] kWh;

e. Voltage [_____] VAC;

f. Frequency [_____] Hz;

g. Service 3 phase, wye, 4 wire;

h. Grid isolation +- [0.50] percent nominal voltages and +- [0.50] percent nominal frequency;

i. Transient handling +- [10] percent nominal voltages maximum and +- [5] percent frequency max; and

j. Meets or exceeds [CARB] emissions standards.

k. Sound level not to exceed [_____] dB at [1] meter/[3] feet.

l. Minimum design life of [80,000] hours with overhauls.

2.14 MICROTURBINES

Provide microturbine based generator [grid parallel] [dual mode] [grid isolated] system designed for landfill gas fuel. Microturbine must have recuperator and integrated heat recovery.

a. Electrical efficiency [30] percent LHV;

b. Nominal heat (HHV) [_____] BTU/kWh;

c. Nominal heat (LHV) [_____] BTU/kWh;

d. Nominal electrical power [_____] kWh;

e. Voltage [_____] VAC;

f. Frequency [_____] Hz;

g. Service 3 phase, wye, 4 wire;

h. Grid isolation +- [0.50] percent nominal voltages and +- [0.50] percent nominal frequency;

i. Transient handling +- [10] percent nominal voltages maximum and +- [5]percent frequency max; and

j. Meets or exceeds [CARB] emissions standards.

k. Sound level not to exceed [1] meter/[3] feet.

l. Minimum design life of [80,000] hours with overhauls.

2.15 INTERNAL COMBUSTION ENGINE

Provide a internal combustion engine based [grid parallel] [dual mode] [grid isolated] generator system designed for landfill gas fuel.

a. Electrical efficiency [30] percent LHV;

b. Nominal heat (HHV) [_____] BTU/kWh;

c. Nominal heat (LHV) [_____] BTU/kWh;

d. Nominal electrical power [_____] kWh;

e. Voltage [_____] VAC;

f. Frequency [_____] Hz;

g. Service 3 phase, wye, 4 wire;

h. Grid isolation +- [0.50] percent nominal voltages and +- [0.50] percent nominal frequency;

i. Transient handling +- [10] percent nominal voltages maximum and +- [5] percent frequency max; and

j. Meets or exceeds [CARB] emissions standards.

k. Sound level not to exceed [_____] dB at [1] meter/[3] feet.

l. Minimum design life of [80,000] hours with overhauls.

2.16 FILTRATION SYSTEMS

Provide filtration system to remove particulates and other contaminants as required to comply with specified generation system specifications.

2.17 LANDFILL GAS ANALYZERS

Provide continuous gas analyzer for methane, carbon dioxide, [_____] and oxygen. Provide warning alarm at [2] percent oxygen and shutdown alarm at [4] percent oxygen. Provide output to main control panel and generator control system to allow automatic system shutdown.

****

NOTE: Methane may seep into buiding structures/enclosed spaces.

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Provide methane sensor/alarm within enclosed structures.

2.18 CONTROL SYSTEMS

Control systems must have all necessary sensors, interlocks, relays, alarms, and user interfaces to allow for continuous monitoring and [grid parallel][dual mode][grid isolated]operations. Use gas analyzer output to adjust generator speed and air/fuel ratio set point for emissions compliance and power output optimization.

Provide critical shutdown alarms for:

a. Shutdown oxygen level - [4] percent or greater, by volume;

b. Low methane level - less than [30] percent by volume;

c. Flare failure;

d. Blower fault;

e. Blower inlet and exit bearing temperatures greater than [100] degrees C/ [212] degrees F;

f. Emergency stop;

g. Power loss;

h. Condensate tank high level;

i. Gas dryer failure; and

j. Enclosed structure methane level greater than [4] percent by volume.

Provide non-critical alarms for:

a. High oxygen levels - greater than [2] percent by volume;

b. Low propane supply pressure;

c. Low flare temperature;

d. Landfill gas temperature at wellhead - greater than [60] degrees C/ [140] degrees F; and

e. Methane detection within enclosed structures.

[Provide automated trouble notification system for critical shutdown [and non-critical] alarms.]

PART 3 EXECUTION

3.1 SITE PREPARATION

Evaluate and ensure site is accessible for the size and weight of planning equipment and facilities. Prepare site and lay down areas in accordance with approved contract documents.

3.2 INSTALLATION

Installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.3 and NFPA 30, NFPA 70 except as modified herein. Safety rules as specified in NFPA 30 and NFPA 407 must be strictly observed. When work is not in progress, securely close open ends of pipe and fittings with expansion plugs so that water, earth, or other substances cannot enter the pipe or fittings. Comply with UL 913.

3.2.1 Equipment

Properly level, align, and secure equipment in place in accordance with manufacturer's instructions. Provide supports for equipment, appurtenances, and pipe as required. Provide floor-mounted pumps and other floor mounted equipment with mechanical vibration isolators or a vibration isolation foundation. Install anchors, bolts, nuts, washers, and screws where required for securing the work in place. Sizes, types, and spacings of anchors and bolts not indicated or specified must be as required for proper installation.

3.3 SYSTEM COMMISSIONING

System commissioning must conform to Section 01 91 00.15 BUILDING COMMISSIONING.

3.4 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the equipment/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/equipment/systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of 8 hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the on-site training.

-- End of Section --